MEDICAL PHYSICS International

FINAL EDITORIAL FROM THE MPI FOUNDING CO-EDITORS IN CHIEF - S Tabakov and P Sprawls
NEW PRESIDENT OF THE IOMP 2022-2025 - J Damilakis
THE GLOBAL FOCUS OF THE MPI JOURNAL ISSUES
INCLUDING ELEMENTS OF BIOMEDICAL & CLINICAL ENGINEERING IN THE MEDICAL PHYSICS MSc CURRICULUM
VISUALIZATION, IMAGINATION, AND THINKING FROM EINSTEIN TO TEACHING MODERN PHYSICS
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IAEA RLA 9061: ENHANCING CAPACITY BUILDING OF MEDICAL PHYSICISTS IN LATIN AMERICA AND CARIBBEAN
IUPESM STATUTES AND BYLAWS UPDATE, FORMATION OF LEGAL STATUS AND FELLOWSHIP INTRODUCTION
AN AFRICAN FIRST
MEDICAL EQUIPMENT MANAGEMENT: A PERSPECTIVE FROM PHILIPPINES, RWANDA, AND SYRIA
THE ROLE OF THE CLINICAL ENGINEER IN HOSPITAL
CURRENT AND FUTURE DEVELOPMENT OF THERAGNOSTIC NUCLEAR MEDICINE
"MODERN DIAGNOSTIC X-RAY SOURCES – Technology, Manufacturing, Reliability"
PROTON THERAPY PHYSICS (2ND EDITION)
"MEDICAL EQUIPMENT MANAGEMENT "
MEDICAL PHYSICS INTERNATIONAL HISTORY EDITION
NBC 2023 POSTER
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ICTP COLLEGE ON MEDICAL PHYSICS CELEBRATING 30 YEARS
IUPESM FELLOWS

IOMP

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International Organization for Medical Physics

MEDICAL PHYSICS INTERNATIONAL
The Journal of the International Organization for Medical Physics

Aims and Coverage:
Medical Physics International (MPI) is the official IOMP journal. The journal provides a new platform for medical physicists to share their experience, ideas and new information generated from their work of scientific, educational and professional nature. The e- journal is available free of charge to IOMP members.

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EDITORIALS

FINAL EDITORIAL FROM THE MPI FOUNDING CO-EDITORS IN CHIEF

Slavik Tabakov[1,2] and Perry Sprawls[3]

[1] King's College London, UK, [2] Past President IOMP, [3]Sprawls Educational Foundation, USA, www.sprawls/org

Dear Colleagues,

It was 10 years ago when we made this photo at the beginning of our activities of developing and editing the new IOMP Journal *Medical Physics International* (MPI). For this period of time this open access e-Journal has grown dramatically as the only Journal in medical physics focused on educational materials and methods, development of the medical physics profession and organizations and related topics. We started from zero, by registering the MPI unique identifier ISSN 2306-4609, planning the e-Journal web site, which was developed by the Technical Editor Magdalena Stoeva, securing the domain name (mpijournal.org), soliciting suitable publications; building content and engaging the medical physics community from all IOMP member societies … creating the image of the MPI Journal.

During these 10 years MPI grew to be one of the most read publications in our profession, attracting the attention of thousands of readers – both medical physicists/engineers and also educators from other professions. Our topics on e-learning were especially popular due to the newness and rapid growth of these e-materials and software. Over 340 papers on educational/professional subjects were published. MPI also published abstracts of PhD theses, MSc Projects, IOMP, IAEA and other specific materials, etc. During this period of time this volume of the MPI was over 2000 pages.

Additionally, MPI published Annexes with the abstracts of several International Conferences on Medical Physics. The volume of these materials alone was about 2100 pages.

In 2018 MPI began separate Editions on the history of medical physics and medical applications., initially as Special Issues, and now as the *Medical Physics International History Edition*. So far eight History issues were published with volume over 900 pages.

The MPI History Editions will continue, separate from the regular issues of the established MPI journal, with Geoffrey Ibbott joining us as an Editor (focusing on the field of Radiation Oncology).

In summary, for 10 years MPI published 28 e-issues with over 5,000 pages, read by over 6,000 colleagues each month.

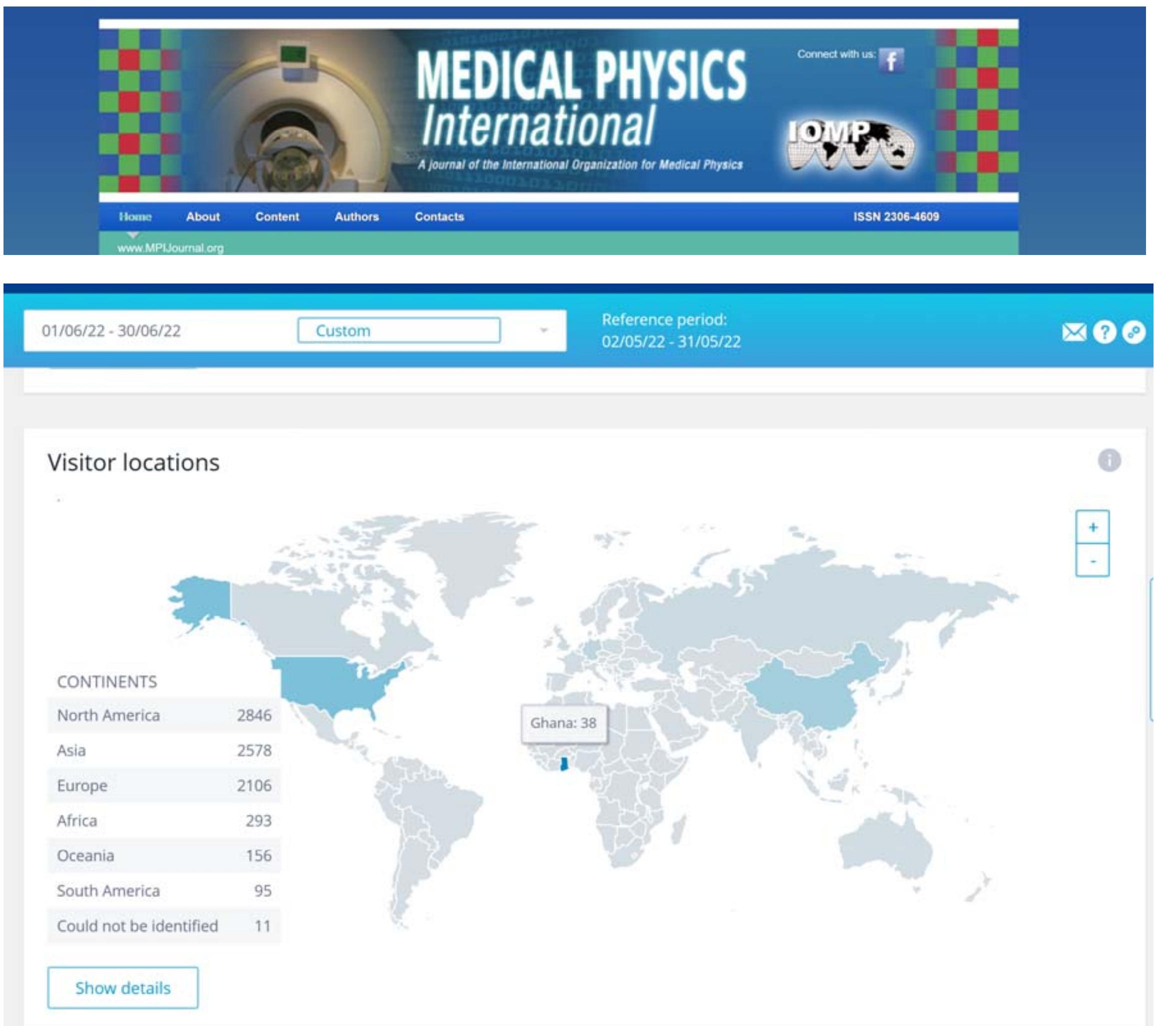
This final Editorial from us as Founding Co-Editors-in-Chief is not simply an overview and statistics of the Journal (we published these in the previous issue), rater it is a brief description of the vector of development, which we consider most important for the global growth of the profession, especially in Low-and-Middle Income (LMI) countries.

We live in a time when many Journals have become business orientated. The original aim of a Journal – the spread of experience and knowledge between scientists all over the world – has gradually merged with the necessity to collect citations for academic and other promotions. This decreased the number of educational materials and textbooks as these produced fewer citations. This naturally led to significantly reduced volume of educational and professional publications. Our goal is to create a forum where authors can describe such activities. In the past 4 years alone, we published information from 65 countries describing the development of the profession in all continents. This information will be valuable resource for planning activities aiming at the global growth of medical physics. The educational and practical papers additionally support the development of new educational courses, modules and programmes, especially in LMI countries.

All of these activities would have been impossible without your active involvement in the MPI publications, for what we are very grateful. We have seen that together we can increase the interest in educational and professional topics.

We would like to especially thank all authors of papers in the MPI during these 10 years. And also, thank all colleagues on the MPI Editorial Board, special appreciation to the Technical Editor Magdalena Stoeva, the MPI History Edition Co-Editor Geoffry Ibbott, the MPI Editorial assistant Vassilka Tabakova, and the Contributing Co-Editors to the MPI topical issues from all IOMP Regional Organisations (AFOMP, SEAFOMP, MEFOMP, FAMPO, ALFIM, EFOMP).

Now, as we conclude our second successful term as Founding Co-Editors-in-Chief, we would like to wish all the best to the new MPI Co-Editors-in-Chief and to assure them of our support in the further work toward the aims of MPI.



Global distribution of the readers of MPI issue June 2022 (official web server statistics)

NEW PRESIDENT OF THE IOMP 2022-2025

John Damilakis, PhD, FIOMP, FIUPESM[1]

[1]University of Crete, School of Medicine, Crete, Greece

We live in a world that is constantly changing. The world looks strikingly different from the one W.V. Mayneord lived in when he became the IOMP's first President almost 60 years ago. We need to address current issues and try to predict the future.

During the Council Meeting at the World Congress in Singapore I sketched a few plans that will be discussed with the IOMP ExCom during my presidential term. The pandemic did not allow many of you to participate in this important meeting and, for this reason, I'll provide a summary here.

We need to expand the visibility of IOMP and the work of our members. There are many ways to do this. For example, IOMP's website is not only its internet identity but also an excellent tool for communication with colleagues and the public. Any effort should be made to improve and enrich the content and expand our website.

We need to achieve financial sustainability through efficient and effective financial planning. There are several ways to increase income for the benefit of the Medical Physics society, for example, we can increase the number of corporate members by strengthening our relationship with the industry.

IOMP has a duty to ensure that all medical physicists have access to the educational opportunities needed to acquire, maintain, and refine the knowledge and skills to fulfil their role in the clinical and academic environment. We provide advanced education through the 'IOMP School'. The main activity so far was the organization of webinars. We will continue organizing webinars. There is high demand for developing continuing education courses in medical physics due to the rapid development of medical techniques based on ionizing and non-ionizing radiation. I hope that the covid pandemic will be soon over in all countries of the world and we will be able to organize onsite events, for example, a Workshop Series for cutting-edge topics. Moreover, the School needs an operation manual to describe in detail the processes that the School uses to provide its services.

We should also consider developing an e-learning platform to provide on-line medical physics material that meets different levels of knowledge and interests. This platform will provide opportunities of sharing resources such as webinar recordings with other colleagues all over the world.

The IOMP Journal Medical Physics International (MPI) has now completed its tenth year since the first issue of the Journal in April 2013. Dr. Slavik Tabakov and Dr. Perry Sprawls have completed their 2nd term as Editors-in-Chief and I would like to wholeheartedly thank them for their valuable services. At the time of writing this article, we are in the process of selecting the new MPI Editors-in-Chief.

We need to increase the impact of IOMP's publications and further develop our publishing portfolio. Specific actions may include exploring new publishing models and potentially developing a new journal. We also need to produce a number of policy statements, guidelines, and recommendations. All IOMP committees can play an important role in policymaking, and especially the Professional Relations Committee, the Science Committee and the Education and Training committee.

We have excellent relationships with international organizations such as the IAEA, WHO, and ICRP. It is true that the healthcare sector is 'an interdependent world'. To meet challenges and address major issues, it is important to develop a strong and positive relationship with international organizations and interested parties in the area of health care.

We also need to streamline processes and improve internal organizational structure. To be a valued organization, and able to achieve our strategic goals, we should improve internal organization. The Rules Committee will review and update the Bylaws as necessary.

IOMP is a reliable source for public information on matters related to medical physics. We will work to increase the effectiveness of existing IOMP programs such as the IDMP and the IMPW to communicate the benefits of medical physics research, clinical and other services to the public We can also increase the amount of information IOMP provides to the public and create resources that target policymakers to provide them with better understanding of the benefits and importance of medical physics.

I'm convinced that the success of our work depends on the commitment and expertise of volunteers. The current membership of IOMP covers national and regional organizations which together represent about 30000 medical physicists. Working together, we can ensure that medical physics realizes its true potential as a force for a better world.

I am really honored to have become IOMP’s President for the term 2022-2025 and determined to keep the organization growing strongly. I would like to assure National Member Organizations, Regional Organizations and all our members that the new Executive Committee will continue to support the development of our profession globally.

THE GLOBAL FOCUS OF THE MPI JOURNAL ISSUES

Slavik Tabakov[1,2,3,4]

[1] King's College London, UK, [2] Past President IOMP, [3]Emeritus President IUPESM, [4]MPI Founding Co-Editor in Chief

The *Medical Physics International* (MPI) Journal was created in 2012. Since 2018 its issues were edited with a specific focus of each issue, alongside the other papers.

The regular MPI issues after 2018 had a focus on the educational/professional development in all IOMP Regional Organisations (RO) – the Federations of the medical physics organisations in each continent. These issues were based mainly on invited papers and were with additional Contributing Co-Editors from all RO. These issues were focused on:
-MPI 2019 (vol7) No.1 - Latin America (ALFIM), related also to the ICMP 2019 in Chile. This issue also presented a paper about the North America professional development;
-MPI 2019 (vol7), No.2 – Africa (FAMPO), Contributing Co-Editors: T Ige and F Hasford;
-MPI 2020 (vol.8), No.1 – South-East Asia (SEAFOMP), Contributing Co-Editors: Kwan Ng and A Krisanachinda;
-MPI 2020 (vol.8) No.2 – Asia-Oceania (AFOMP), Contributing Co-Editors: A Chougule, E Bezak, A Azhari;
-MPI 2021 (vol.9) No.1 – Middle East (MEFOMP), Contributing Co-Editors: H al-Naemi and M H Kharita;
-MPI 2021 (vol.9) No.2 – Europe (EFOMP), Contributing Co-Editors: D Lurie, E Koutsouveli and P Gilligan.

These issues included papers from 65 countries:
Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panama, Chile, Brazil; USA and Canada; South Africa, Zimbabwe, Nigeria, Ghana, Morocco, Algeria, Tunisia, Egypt, Zambia, Rwanda, Kenya; Vietnam, Indonesia, Thailand, Philippines, Myanmar, Lao PDR; Australia and New Zealand, Bangladesh, Japan, India, Korea, Malaysia, Mongolia, Nepal, Philippines, Singapore, Thailand, Pakistan; Iraq, Jordan, Kuwait, Lebanon, Oman, Palestine, Qatar, Saudi Arabia, Syria, Yemen; Denmark, France, Bulgaria, Hungary, Lithuania, Malta, Norway, Poland, Spain, Serbia, Sweden, Ukraine.

These 6 MPI issues provide an image of the worldwide professional development around the 2020-ies. The previous progress of medical physics development can be seen in the book "Medical Physics and Engineering Education and Training" (2011, edited by S Tabakov, P Sprawls, C Lewis, A Krisanachinda), which presents professional development in 27 countries. Further back in time, the book "Medical Radiation Physics - A European Perspective" (1995, edited by C Roberts, S Tabakov and C Lewis) – presents the status around 1995 in 30 European countries - both books are available from: http://www.emerald2.eu/mep_index.html

These focussed MPI issues (and the books mentioned above) were related to the major goal to which I dedicated the past 30 years of my professional career – to support the development of medical physics education (part of which was the pioneering of e-learning in the profession). I believe the information gathered in the focussed issues and the books will present a vector of development of our profession over the years and will help to set up objectives for the future steps in reaching the projected c.60,000 medical physicists globally by 2035.

The MPI issue 2022 (vol.10) No.1 had as a focus two other main projects, which I worked on over the years – the development of the Encyclopaedia of Medical Physics (and related Medical Physics Scientific Dictionary of Terms in 32 languages) – both used globally as educational references by thousands of colleagues each month. Additionally, in this MPI issue we celebrated the 10^{th} anniversary of the MPI Journal, which we edited since 2012 with P Sprawls (a friend and colleague with whom we share the same passion for educational development).

The current issue MPI (vol.10) No.2 has a focus on another activity I supported throughout all my professional life – the collaboration between medical physicists and biomedical & clinical engineers. This collaboration is very important especially in the Low and Middle Income (LMI) countries, where our colleagues often do not have dedicated medical engineering support. This MPI issue presents this collaboration in a developed European country and in several LMI countries from Africa, Middle East and Asia. Additionally, the issue presents the need for including elements of such collaboration in the curricula of MSc education in medical physics. This focus is also supported by the description of the activities of IUPESM (the Union of IOMP and IFMBE) in the past term of office (2018-2022) and the recent ICTP College on Medical Physics for LMI countries. The current MPI issue includes also book reviews indirectly related to this collaboration.

Alongside the various foci of the MPI issues we have always presented novel topics – such as the papers in the current MPI issue on Artificial Intelligence, Theragnostics and Proton Therapy (book review).

I believe the future MPI issues will continue to focus on various aspects of the global development of medical physics, what should form part of the activities of each one of us.

EDUCATIONAL TOPICS

INCLUDING ELEMENTS OF BIOMEDICAL & CLINICAL ENGINEERING IN THE MEDICAL PHYSICS MSc CURRICULUM

S Tabakov[1] R Padovani[2], M Stoeva[3], KP Lin[4]
[1]IUPESM, [2]ICTP, [3]IOMP, [4]IFMBE

Abstract

The paper describes various educational activities where Biomedical & Clinical Engineering topics have been successfully included in the medical physics MSc curriculum. Examples are shown from various international projects, the curricula of the MSc in the University of Plovdiv, King's College London and ICTP and the University of Trieste. The feedback from the medical physics students shows very high appreciation of these activities (usually between 80 and 100 %). Further, examples are given about including such engineering elements in the Encyclopaedia of Medical Physics and the new sequel of IUPESM Workshops dedicated to collaboration between medical physicists and biomedical & clinical engineers. These collaborative examples are very useful for broadening the horizon of medical physicists about the numerous medical devices in a hospital. These are especially useful in Low-and Middle Income (LMI) countries, where the workforce of both professional occupations is often not sufficient to cover both clinical activities and equipment management.

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Keywords- **medical physics education, biomedical engineering education, collaboration between medical physicists and biomedical & clinical engineers.,**

I. INTRODUCTION

From the beginning of the establishment of professional societies in medical physics (MP) and biomedical engineering (BME), it was obvious that the specialists with these occupations collaborate closely in most healthcare institutions. Thus, in a number of countries medical physicists and biomedical engineers formed joint societies. It was natural to aim also at collaboration in the field of education. This paper presents very successful examples in this field. Additionally, inclusion of some BME elements in the curriculum of MP programs, contributes to better understanding the complex medical imaging and radiotherapy equipment. This also supports the collaboration between medical physicists and biomedical engineers.

This process is especially important in Low-and Middle Income (LMI) countries, where very few hospitals have dedicated team of clinical engineers (CE) handling all processes from the life cycle of a medical device.

Having basic understanding of the main principles of various types of medical equipment is very important for broadening the horizon of medical physicists about the various medical devices in a hospital. On the one side this is a very important moment of understanding the role of medical imaging equipment, radiotherapy equipment and other important medical devices in the technical park of a hospital. On the other side this is an important moment of understanding the specific steps in acquisition and maintenance of medical equipment – an area where medical physicists normally collaborate with clinical engineers.

II. INTRODUCING BME ELEMENTS IN THE TRADITIONAL MEDICAL PHYSICS MSc MODULES

Traditionally medical physicists work with equipment in medical imaging and radiotherapy. This equipment is the most complex in a hospital and should not be regarded as a "black box". Understanding the main elements inside the "black box" is very important also for the activities related to Quality Control of these very complex pieces of equipment.

When the Curriculum of the MSc in Medical Radiation Physics was developed in the project ERM (introduced in Plovdiv, Bulgaria during 1997), all specialized modules addressed both the physics and the engineering principles of the equipment [1,2] – the module names reflect this:

- Physics and Equipment of X-ray Diagnostic Radiology;
- Physics and Equipment of Nuclear Medicine;
- Physics and Equipment of Radiotherapy.
- Physics and Equipment of Ultrasound, MRI and Lasers in medicine;

These elements were found very useful by the students. The feedback results from 1998 and 1999 showed 100% student satisfaction. Based on this, modules with similar content and structure were introduced also in the curriculum of other medical physics MSc programs, developed with the support of the experience from the MSc in Plovdiv [2,3].

In a similar way engineering elements were introduced also in the Emerald e-learning materials [4,5] supporting medical physics training (**www.emerald2.eu**) – Fig.1. These materials were fully introduced at the teaching program of the ICTP College on Medical Physics in 1999. Following this the Emerald e-learning materials were given free to all College students. During the following years these e-materials formed the backbone of the Quality Control checks in most LMI countries. The use of elements of these materials continues even today in some countries (over 20 years since their introduction).

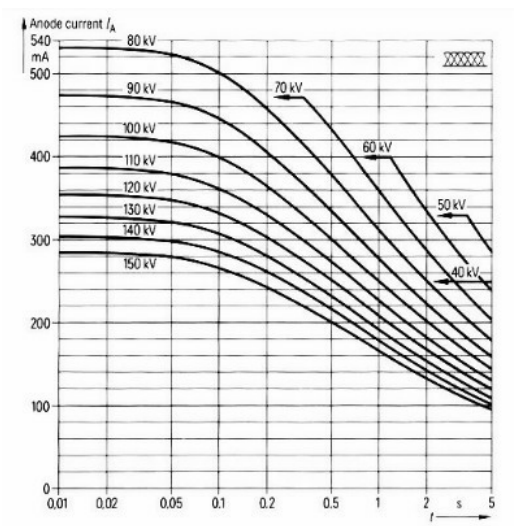

Fig.1 Typical engineering diagram of the function of an X-ray tube – example from the EMERALD medical physics e-learning training materials.

In 2001 this approach was also introduced at the MSc Medical Engineering and Physics at King's College London and is now used for over 20 years. Specific practicals were introduced in the medical imaging MSc modules, discussing not only the variation of some image quality parameters, but also the potential engineering reasons for this. Further medical physics students had discussions with industry engineers and visits to some manufacturers of imaging and radiotherapy equipment. The feedback collected was very positive.

Medical imaging practicals based on discussing problems with medical imaging equipment were introduced also at the ICTP College and were highly appreciated by the students. A Feedback Questionnaire with these students conducted in 2002 showed 100% approval of including engineering elements in their teaching program. These combined with use of e-learning showed significant increase of students' knowledge before/after the College (Fig.2 stats based on 60 students) [6].

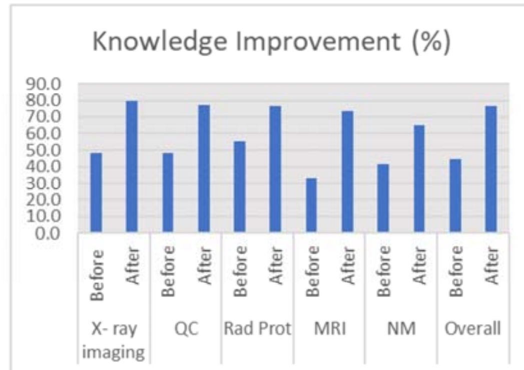

Fig.2 Improvement the % of student knowledge before and after the ICTP College in 2012 (self-assessment)

Additionally, in these questionnaires many students expressed desire to have some understanding of preparation of specifications and basic knowledge of maintenance and servicing of equipment, as in the LMI countries they are often without support from local service engineers and have to be able to better communicate both with the clinical engineers from nearby large hospitals and with the representatives of the equipment manufacturers.

While developing of basic Clinical engineering lectures for medical physicists required more time (and we shall describe it below), this feedback revealed the need of medical physicists to have a broader view of the medical equipment in a hospital.

III. INCLUDING SEPARATE MODULES ABOUT THE VARIOUS TYPES OF MEDICAL EQUIPMENT IN THE MEDICAL PHYSICS MSc CURRICULUM

In 2002 a new module was included in the set of foundation/core modules of the MSc on Medical Engineering and Physics (MEP) at King's College London - "Introduction to Medical Technology" [7]. The main parts of the module included elements grouped in the following fields:

A. The technology of medical imaging;
B. Application of radiation to therapy;
C. Artificial support systems;
D. The technology of physiological investigation;
E. Basis of hospital safety;
F. Quality and IT in healthcare.

The module (led by S Tabakov) was built as the forerunner for all MSc studies and was presented as a block module at the beginning of the academic year. Its aim was to introduce students to the concepts and application of a wide range of technology in healthcare (used for diagnosis, therapy and management). The module provided the students with an understanding of the physical and physiological principles, together with engineering design, which underlies the specific medical equipment. It was also introducing them to the concepts of safe working practice through identification of hazards and methods for their reduction.

The MSc MEP was designed to have common foundation/core modules for medical physicists and biomedical engineers, each of the two groups of students later studying separate specialist modules for MP or BME.

The Introduction to Medical Technology foundation/core module was designed with about 30 hours lectures and related practicals. The results of the 2012 Questionnaire from 32 medical physics students and 14 clinical engineering students showed that MP students mark the usefulness of the module with an average of 86%, while CE students mark it with 78%. These marks remain similar in later years – e.g.: in 2014 the mark for MP students was 80% and for CE students was 83%; in 2016 the mark for MP students was 88% and for CE students was 80%.

IV. INCLUDING ELEMENTS OF MEDICAL EQUIPMENT MANAGEMENT IN THE MEDICAL PHYSICS MSc CURRICULUM

In 2003 the MSc MEP at King's College London introduced a new specialist module for clinical engineers – "Management of Medical Equipment" [7]. The module (led by C Roberts and K Ison). The aim of the module was to provide students with an insight into the problems and challenges of managing medical equipment within a healthcare system; to develop an awareness of the business process; to increase awareness of how maintenance of equipment is influenced by its design. The main parts of the module included elements grouped in the following fields:

A.Healthcare organisation and the role of clinical engineering;

B. Equipment specification and procurement;

C. Equipment management;

D. Quality systems in equipment management;

E. Safety in the clinical environment;

F. Business development (this part included coursework requiring the students to develop a business case for the operation of an equipment management service).

This specialised module included 30 hours lectures and practicals and was optional for those students who had decided to follow the path of clinical engineering. The module was left open for all students and from the beginning it attracted students from other BME sub-specialities (such as Rehabilitation Engineering). Surprisingly students from the medical physics specialisation attended a number of lectures in this module and during the next year there were foreign students in medical physics who had opted to pay for attending the full module. Their feedback showed both interest on the subject and lack of background knowledge.

In 2011 the UK NHS Modernising Scientific Careers framework included in the MSc curriculum in both themes "Medical Physics" and "Clinical Engineering" significant part of the elements of the module "Introduction to Medical Technology". This formed part of a new core module "Introduction to Medical Physics and Clinical Engineering". This module aimed to give a broad view to all students about medical equipment in healthcare. The new module also included simplified elements of the specialist module "Management of Medical Equipment". The syllabus of this module was designed to be used by all students in England, aiming at training and certification either as medical physicists or clinical engineers.

In 2009 the materials for the module "Management of Medical Equipment" were included in a textbook project (led by K Wislon, K Ison and S Tabakov) [8]. The textbook "Medical Equipment Management" was published in 2013 (see a review of the book further in this MPI issue).

V. INCLUDING MEDICAL EQUIPMENT MANAGEMENT IN THE CURRICULUM OF THE MSc IN MEDICAL PHYSICS AT ICTP AND THE UNIVERCITY OF TRIESTE

The unique College on Medical Physics at ICTP, Trieste, has been described in several issues of the MPI Journal as a vital educational activity for most medical physicists from the LMI countries. After 2002 the College teaching programme always included engineering elements in the typical medical physics lectures. These attracted constant high appreciation in all students' Questionnaires.

From 2006 the College introduced specific lectures and discussions about the development of medical physics MSc curriculum. These were very important for the establishment of new Medical Physics MSc programmes in various LMI countries. In the course of several years the answers from the Questionnaires (and the following discussion with students) underlined the need of additional foundation knowledge in medical equipment management, what would allow medical physicists in small countries to communicate better with their clinical engineering colleagues [9].

In 2014 a specific MSc in Medical Physics was established in Trieste, Italy – a collaboration between the ICTP and the University of Trieste, supported by the IAEA, IOMP and the Association of Medical Physicists in Italy. This MSc (led by R Padovani and R Longo) is specifically orientated to support students from LMI countries. It is in English and takes 2 years (the second year being dedicated mainly to Hospital training and MSc project). Each year there are hundreds of applications from LMI countries for about 20-40 places.

The results of the Questionnaire (completed by 41 students mostly from Low-income countries) showed their collaboration with the local clinical engineers and the need of basic knowledge on this subject. Fig.3 shows their answers to the question about the local hospital management organisation. These answers revealed that in about half of the local hospitals in their countries there are no Departments of Clinical Engineering. Additionally, all students expressed need to know better the equipment management process in order to communicate better either with the clinical engineers or with the manufacturer's engineers dealing with equipment maintenance [10].

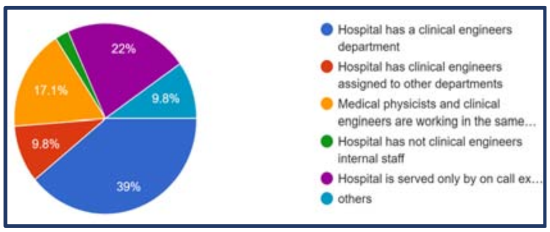

Fig.3 Results from the Questionnaire (from 41 students from 18 LMI countries) about the equipment management in their local hospitals

After the first couple of years, the MSc program was enriched with a module on Equipment Management. The module was based on the structure of the book "Medical Equipment Management" and introduced the students to basic concepts of equipment management in a hospital, specifically orientated to radiological equipment (imaging and radiotherapy).

The students' answers to a Questionnaire in 2019 showed that about 36% of the students think that they have sufficiently understood the subject and similarly 36% think that they cannot understand it. The remaining 38% think that they shall not be involved in the process of management of medical equipment (this corresponds well with Fig.2, where 39% of the LMI students work in hospitals with existing Departments of Clinical Engineering).

In parallel with the MSc curriculum, the ICTP College (which takes 3 weeks) included specific lectures on preparation of Specifications for Radiological equipment and on Basis of Organisation of Radiological Equipment Maintenance. The College in 2022 included these topics within the overall focus of the College –Medical Physics Capacity Building in LMI countries (see in this MPI issue a separate paper about the ICTP College 2022).

VI. THE ENCYCLOPAEDIA OF MEDICAL PHYSICS AS AN EDUCATIONAL REFERENCE, ENRICHED WITH ENGINEERING ELEMENTS

The success of introducing engineering elements in the medical physics curriculum led to the invitation of IFMBE colleagues to join the team of the EMITEL project (2006-2009, coordinated by S Tabakov), developing the first Encyclopaedia of Medical Physics – an open online reference to all colleagues, used today by thousand of colleagues each month through its web site: **www.emitel2.eu**

The engineering elements in the Encyclopaedia were supported with hundreds of specially made diagrams and block diagrams of radiological equipment. The first issue of the Encyclopaedia was released online in 2010 and on paper in 2012.

The second edition of the Encyclopaedia included about 650 new terms [11]. All previous emphasis of avoiding the "black box" presentation of the radiological equipment was kept and additional elements were added in the General part of the Encyclopaedia (led by S Tabakov and M Stoeva). For the first time basic terms of Clinical engineering were introduced (adapted for medical physicists). This sub-part of the Encyclopaedia was led by E Iadanza. This edition was also supported with numerous diagrams – see examples on Fig.4 and Fig.5.

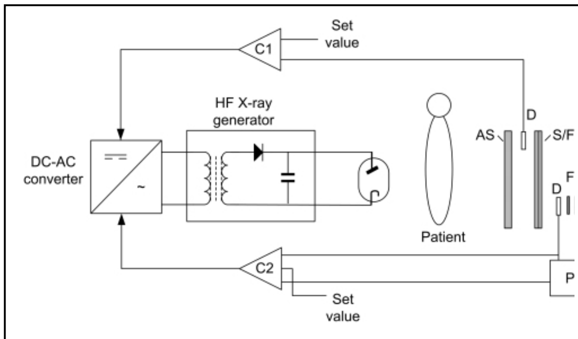

Fig.4 Block diagram of Automatic exposure control system - *from Encyclopaedia of Medical Physics II Edition - article: Automatic exposure control system*

The main aim of this Encyclopaedia is educational – supporting the MSc-level courses as an open online resource. The diagrams and block diagrams have already found place in a number of MSc lectures on the subject. The second edition of the Encyclopaedia was released on paper in 2021.

In parallel with the Encyclopaedia Update a textbook was developed "Introduction to Medical Physics", aiming to give a broad view to a medical physicist about the various sub-fields in the profession. This was necessary as the volume of the knowledge in the profession (respectively - the MSc curriculum) was constantly being enlarging with many new methods and equipment, while the hours in the typical MSc curriculum remain the same). This created the necessity for many medical physics MSc programmes to cut significantly the general parts of their curriculum and to introduce early narrow specialisation. The textbook aimed to add information about the subjects outside the narrow specialisation, again enriched with some engineering elements (see the review of this book in the MPI issue from 2022 – vol.10, No.1). The book was also aimed at the emerging new BSc programmes on medical physics and biomedical engineering. The textbook was published by CRC Press (both on paper and as e-book) in 2022 [12].

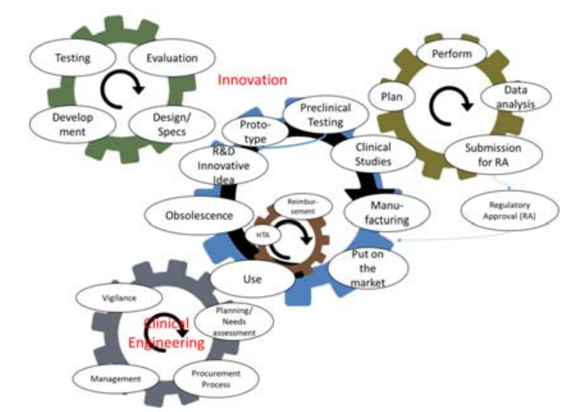

Fig.5 A diagram illustrating the Life cycle of an equipment - *from Encyclopaedia of Medical Physics II Edition - article: Life cycle of equipment*

VII. IUPESM WORKSHOPS FOR COLLABORATION BETWEEN MEDICAL PHYSICISTS AND BIOMEDICAL/CLINICAL ENGINEERS

In order to strengthen the links between medical physicists and biomedical & clinical engineers IUPESM introduced in 2018 a new activity – Collaborative Workshops (led by M Stoeva and KP Lin).

The first such activity was organised in Taipei, as a satellite to the International Conference on Biomedical and Health Informatics (ICBHI 2019). It naturally focussed on collaborative educational activities. The same topic was highlighted at the second such Workshop in Rome, satellite to the International Clinical Engineering and Health Technology Management Congress (ICEHTMC 2019) – Fig.6. Other such events followed either at events under the aegis of IFMBE, or IOMP, or IUPESM [13, 14]. Such Workshops were organised also during the World Congress

Fig.6 Organisers and lecturers (including the co-authors of this paper) at the IUPESM Workshop on collaboration between medical physicists and biomedical & clinical engineers, Rome, 2019.

on Medical Physics and Biomedical Engineering (Singapore, 2022), the Asia-Oceania Congress on Medical Physics (Taipei, 2022) and during 2022 IOMP hosted a Webinar during the Day of Clinical Engineering (Co-organised by M Stoeva and E Iadanza).

All the collaborative activities between medical physicists and biomedical & clinical engineers support not only exchange of ideas and potential collaborative research, but also the enrichment of the educational programmes. The latter are especially important for LMI countries, where the currently existing workforce needs additional knowledge to support both the clinical activities and the management of medical equipment

VIII. CONCLUSION

The introduction of engineering elements in the MSc curricula for medical physicists proved to be beneficial for the understanding of the enormous variety of medical devices in a hospital. This broadening of their horizon received the high approval of most students. Further, the understanding of the main engineering principles of equipment used in medical imaging and radiotherapy was found to be very useful for the understanding and analysis of various Quality control tests.

The basic understanding of equipment management principles by medical physicists supports their collaboration and communication with the clinical engineers. This is especially important during the process of procurement of new such equipment and arranging its maintenance. In LMI countries, where only small number of hospitals have clinical engineering staff this knowledge is vital for the exploitation of the imaging and radiotherapy equipment.

The enormous speed of development and implementation of various medical devices in healthcare, and the limited number of academic hours in an MSc programme leads often to an early narrow specialization of medical physicists. The natural expansion of medical physics education is in the direction of including basic and core topics (of both medical physics and biomedical engineering) at the rapidly emerging new BSc programs on the subject. This process is already gaining speed and the successful collaboration between medical physicists and biomedical engineers will be very important for the preparation of further foundation topics for the future BSc programs in these fields.

The international success of the collaboration between medical physicists and biomedical engineers through IUPESM led to the international recognition of both scientific fields as unique parts of physics and engineering applied to medicine. Further IUPESM led the international recognition of both professional occupations (medical physicists and biomedical engineer) in the ISCO-08 (the International Standard Classification of Occupations). It is only natural that the increased collaboration in the field of education will continue to expand this success of the development, clinical implementation and management of medical devices, which are now an indispensable part of contemporary healthcare.

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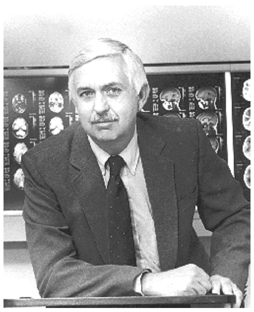
VISUALIZATION, IMAGINATION, AND THINKING
FROM EINSTEIN TO TEACHING MODERN PHYSICS

P. Sprawls

Dept. Radiology and Imaging Sciences, Emory University and Sprawls Educational Foundation, www.sprawls.org



I. INTRODUCTION BY THE AUTHOR

As of the date of this publication, 2023, I have been a *physics teacher*--I prefer the term *educator*--over 60 years, first teaching general and nuclear physics before transitioning to medical physics, a specialization within the field of modern physics, for most of my career.

A major interest and effort throughout this period has been the development of concepts, methods, and resources to enhance the teaching and learning process in order to help learners/students develop a knowledge of physics that is of value in all aspects of their lives, especially professional activities such as the practice of medicine.

Visualization is a critical factor in learning physics to support many activities and is what we will explore here.

I began my physics teaching career, as I had been taught, in a classroom being lectured to along with a blackboard usually filled with equations. I soon began to realize that I was not providing my students with an opportunity to develop a knowledge of physics that would be useful to them both in everyday living and in their careers. This especially applied to those who were entering the medical profession. In essence, the traditional classroom was like a “box” in which we were enclosing our students, completely hiding them from the physical world they should be learning about. It occurred to me that physics classrooms needed “windows” or visuals through which the students could see the components of the physical universe they were studying, and the “teachers” could use their knowledge and experience to guide effective learning activities. A major effort of my career is producing “windows” or visuals and making them available to all physics educators, so that together, we can provide valuable learning opportunities for our students, as illustrated in Fig. 1.

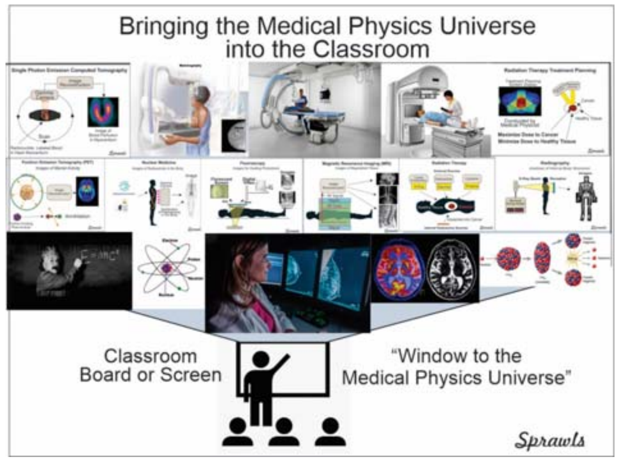


Fig.1. Classroom learning enhanced with visuals “windows” that bring the physical universe into the classroom for viewing and discussions.

Now, as we continue, I invite you to *think* along with me! Perhaps first, let us remember our experiences as students and how we were “taught” and what we learned. For those of us who are physics educators, we can use our knowledge and experience to help many others benefit from a knowledge of physics. There are also challenges.

The components or elements of the physical universe are of two forms with respect to human vision: they are either *visible* or *invisible*. Throughout much of history physics knowledge was limited to elements that could be sensed and interacted with using vision, hearing, or touch and feel. These were the physics areas of mechanics, optics, thermal, and acoustics. The fields of electricity and magnetism developed because of the observable effects they produced, including physical forces, visible light, and biological stimulation.

There were major components of the physical universe that were yet to be discovered and used in applications to benefit society. These were the several forms of *invisible* radiation and interactions with matter at the atomic level.

This invisibility not only delayed the discovery of these radiations but is also a continuing challenge in the effective teaching and learning of modern physics, especially the field of medical physics.

III. LEARNING PHYSICS

Learning physics--that is, the physical characteristic of the physical universe--is a natural human process that is continuing throughout our lives every day as we observe and interact with the physical environment around us. Learning the physics of water is an example illustrated in Fig. 2.

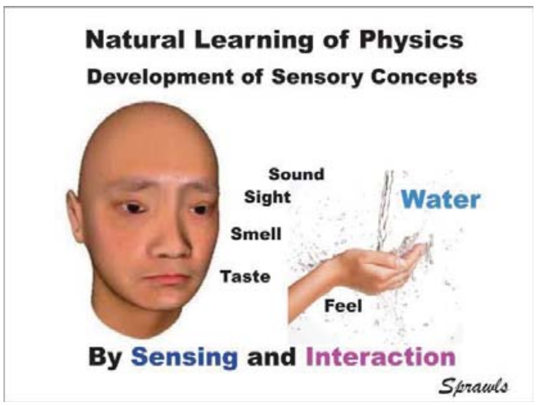


Fig. 2. Learning the physics of water.

IV. SENSORY CONCEPTS

Let's think about how our knowledge of water is recorded in our brains. It is as images and sensations of water in many forms developed from our past experiences and observations, and interactions. We have visual images showing various characteristics, color, transparency, flow patterns, waves, etc. along with feeling characteristics, temperature, buoyancy, etc. This knowledge is a network of *sensory concepts* developed over time as we have experienced water and is illustrated in Fig. 3.

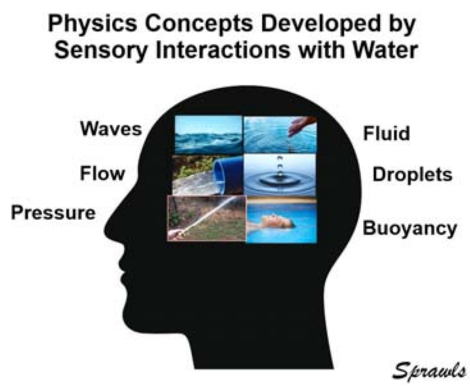


Fig. 3. The network of physics sensory concepts developed through seeing and interacting with water.

This is the physics knowledge that is necessary to guide our future interactions with water, from swimming in a river to preparing a cup of tea.

V. SYMBOLIC REPRESENTATION OF THE PHYSICAL UNIVERSE

The physical universe can be described in two symbolic forms, *words,* and *mathematical symbols*. Words are used to provide definitions and verbal descriptions of objects, interactions, relationships, etc. Physics is a *quantitative* science with relationships described with mathematical symbols and equations.

This is the representation of the physical universe generally provided by textbooks and classroom lectures as shown in Fig. 4.

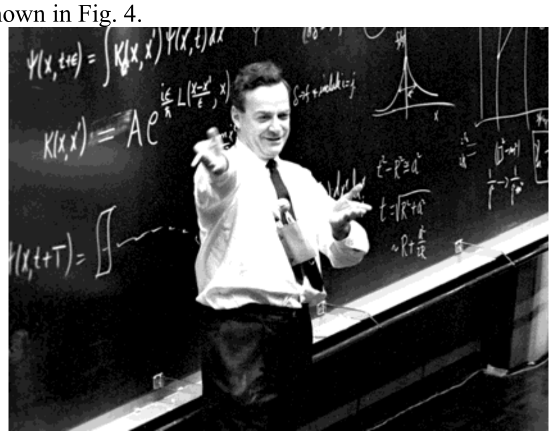


Fig. 4. Physicist Richard Feynman, famous for his creative lectures, combined spoken words and mathematical symbols on the blackboard to help students understand the quantitative relations in physics.

This is the method of teaching used in most academic physics courses for several reasons. It is the traditional form of physics education used over the years, and how we were taught. It is relatively efficient, not requiring extensive preparation of materials, especially classroom visuals or visible demonstrations. It is also easy to test with written examinations, both verbal and with mathematical problems to solve.

This type of teaching does not significantly contribute to the formation of *sensory concepts,* which is the knowledge that gives meaning to the symbolic knowledge using words and mathematical equations. Knowledge in the form of *sensory concepts* is of great value for physicists, engineers, etc. who also need the symbolic representations, especially mathematical equations. It is the physics knowledge *needed by everyone* to better understand the physical universe in which we live and do not need to know equations and make calculations.

Physics is one of the fundamental sciences of medicine. The human body is a physical universe itself filled with many forms of physical interactions and activity including force provided by muscles, the beating heart and associated blood flow, and electrical activity of the heart (EKG) and the brain (EEG). The medical field, physiology, is essentially the physics of the human body. An understanding of physiology as studied and applied by medical professionals is enhanced by an established knowledge of sensory physics concepts, for example, those related to fluids as illustrated in Figure 3. Those are concepts developed by observation and interaction with visible and touchable physical substances, i.e., water.

Many modern medical procedures, both diagnostic and therapeutic, use components of the physical universe that are *invisible*, including several forms of radiation, magnetic fields, and ultrasound. These are the medical specialties of Radiology/Roentgenology and Radiation Oncology/Therapy. For these specialties, physics is a required course in the Residency/Registrar programs for medical doctors and a significant part of the Board certifying examinations.

Medical Physicists are the educators who provide the courses, classes, and learning opportunities for these medical doctors, the Radiologists. A long-time and continuing challenge is helping radiology residents develop physics knowledge that will be of value in their future clinical activities and not just memorized materials to pass Certifying Board examinations.

The two types of physics knowledge for Radiologists and Radiology Residents, including how the knowledge is developed (learned) and used are illustrated in Fig. 5.

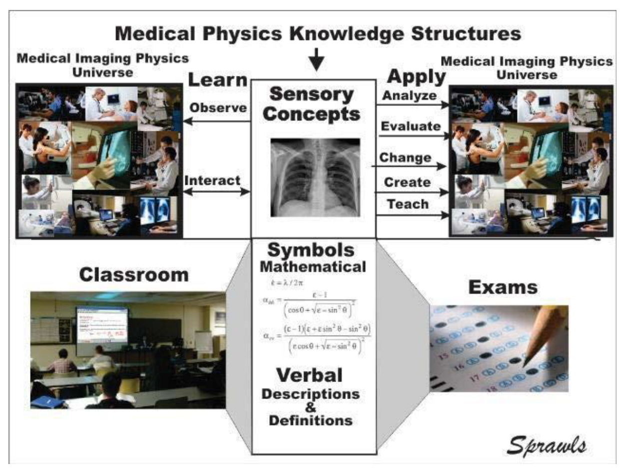


Fig. 5. Physics knowledge for Radiologists, both sensory concepts and symbolic representations.

The physics knowledge that is of the most value to the practice of Radiology and Medical Imaging is the network of *sensory concepts* that is developed through observation and experience, that is observing, interacting with, and applying it in clinical procedures. Also, in classes and conferences where the learning process is guided by an experienced "teacher" using appropriate images and visuals. These include concepts of both the visible and invisible components of the physical universe.

An example in which knowledge in the form of *visible physics concepts* is critical to the practice of Radiology and Medical Imagining is illustrated in Fig. 6.

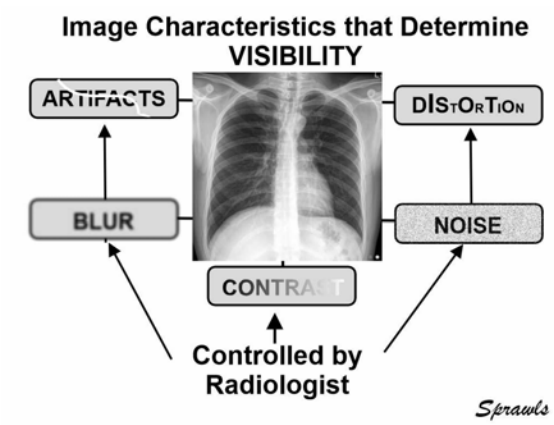


Fig. 6. The physical characteristics of medical images that collectively determine visibility of specific objects and conditions within the human body.

A medical image is a physical object with specific characteristics associated with it. These characteristics can be represented symbolically with both *words* (definitions and descriptions) and *mathematical symbols* and *equations* (quantities and relationships). These are the representations that are often the easiest to "teach" and test on examinations, but not the knowledge to support clinical applications.

Effective application of physics principles to control and optimize medical imaging procedures requires the ability to *visualize* these characteristics and their effects on visibility of objects within the human body in relationship to the object's physical characteristics. It requires sensory/visual concepts of each characteristic and the factors that control them.

VI. THE VALUE OF KNOWLEDGE TYPES

The two types of knowledge, or representations of the physical universe, each has value relating to how it is to be used. An example is illustrated in Fig. 7.

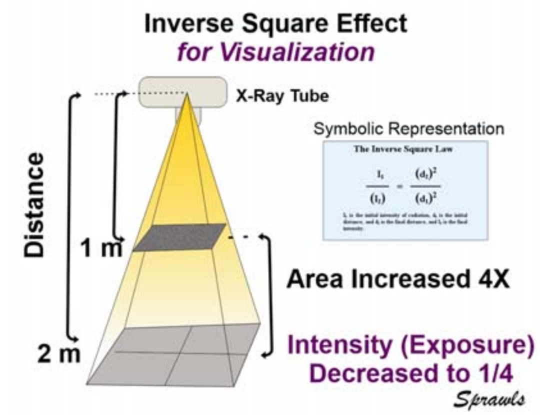


Fig. 7. The representation of the inverse-square law both visually and symbolically.

X-ray beams as used in medical imaging follow the inverse-square law with the intensity (radiation exposure or dose) decreasing with distance from the source.as seen here.

The medical doctors--the Radiologists-- and the technologists conducting the imaging procedures--the Radiographers--need an understanding of this effect for setting up and adjusting the imaging procedures and for radiation safety considerations. This is conceptual knowledge and the ability to *visualize* the characteristics of the x-ray beam as illustrated above.

Physicists also need the conceptual knowledge but also the symbolic representation (mathematical equations) for the purpose of calculating intensity (exposure, dose) values at various distances from the source of the radiation.

VII. VISUALIZATION AND IMAGINATION

Both the formation and use of sensory concepts requires the *process of visualization.* Visualization is the process of forming visible images in the brain and is a major form of human learning. Many--perhaps most--of our memories from throughout our lives are in the form of images that we can recall and "see" again. These mental images were formed as we viewed and interacted with actual physical items and activities and are a continuing process. For example, today, we can visualize much of what we saw yesterday, and other days in the past.

Imagination is the act or power of forming mental images of or visualizing something that we have never viewed. It is a very important form of thinking in the process of developing solutions to problems and creating new things. It is visualizing what can be, at least in our minds.

A network of *visual concepts* in the brain provides a foundation for *imagining* new and valuable possibilities that does not come from a knowledge consisting of memorized facts and symbolic representations.

VIII. Einstein on visualization, imagination, and thinking

Albert Einstein, the highly intelligent physicist who made major discoveries including several forms of relativity, the photo-electric effect, etc., was a visual thinker. His interest was in visualizing and thinking about factors that were not visible to the human eye--the invisible components of the physical universe. It appears he first developed theories with visualization and imagination (mental experiments) and later developed the mathematical expressions. This is emphasized in two of his quotes:

"*Visualization* is More Important Than Knowledge
Imagination is Everything. It Is the Preview of Life's Coming Attractions"

One of the most popular stories is about his riding on a beam of light and wondering about the effect on visibility, like looking at himself in a mirror. One of the many illustrations of this is in Fig. 8.

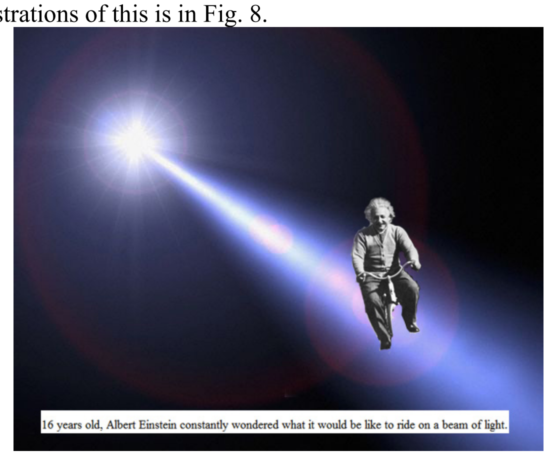


Fig.8.Einstein riding on a beam of light…in his imagination.

In addition to his many discoveries and developments in physics, his perspective on physics education provides guidance for effective educational methods that we can use now. Two of his thoughts are illustrated in Fig. 9.

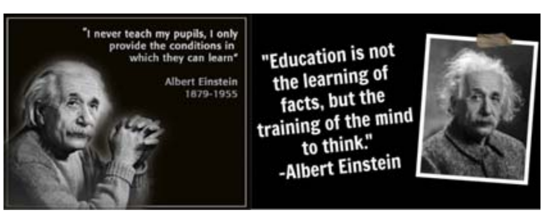


Figure 9. Einstein's thoughts on physics education.

IX. Thinking

The use of physics knowledge in virtually all applications ranging from preparing a cup of hot tea to developing and using advanced medical imaging procedures requires *thinking.* That is the mental process used to define and organize experiences, plan, learn, reflect, and create.

Let's do a brief experiment by *thinking* about the food, pizza. What comes to your mind? Generally, images of round pizzas with your favorite toppings along with memories of taste and smell, the sensory concept of pizza that has developed over the years. As we *think* we can plan on what flavor of pizza we would like to have the next time.

Productive thinking and planning require the ability to visualize objects, conditions, relationships, etc. as we have just done for pizza. A mental network of sensory concepts, especially visual, provides the foundation of productive thinking as illustrated in Fig. 10.

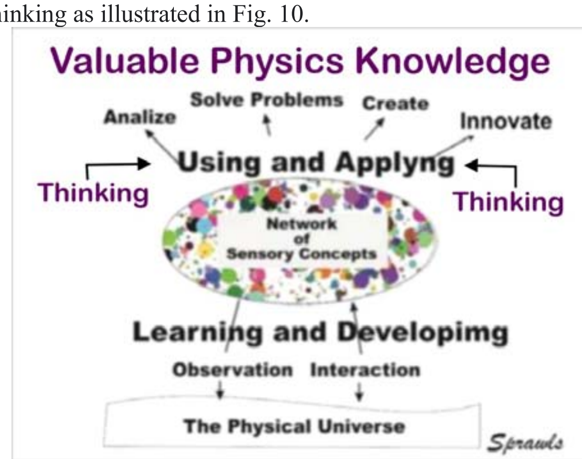


Fig. 10. Physics knowledge that enables thinking and useful applications.

Training a mind to think, as expressed by Dr. Einstein, first requires a collective knowledge of things (objects, relationships, characteristics, etc.) to think about. A major function of physics education is providing conditions in which "pupils", students, or learners, can learn by observing and interacting with the physical universe as we have learned the physics of water. The challenge is visualizing and interacting with the invisible components of the physical universe, especially the radiations and associated interactions.

In learning laboratory and practical experiences, we can measure the quantitative characteristics of radiation (air KERMA, penetration, etc.) which is a valuable learning experience that can be applied later in professional physics activities including radiation therapy treatment planning and optimizing medical imaging procedures. This does not? provide a comprehensive conceptual knowledge of radiation that can be the foundation for productive thinking as described above.

Perhaps this is what we can learn from Prof. Einstein: learning physics is a natural human process, and the role of educators, "teachers", is to provide conditions in which pupils can learn, using visualization, imagination, and thinking.

X. The value of visualization and imagination in modern physics

As we are exploring here, the physical universe consists of both visible components (water is the example we are using) and invisible, including several forms of radiation, magnetic fields, and the interactions of radiation with matter at the atomic and nuclear levels.

If we can "see" or visualize radiation as we can substances like water, it then becomes possible to develop sensory concepts that enables thinking that can be used to support many productive activities and possible innovations.

The physics of x-ray imaging in medicine is one of the Author's special interests. The physical elements of this component of the physical universe are all invisible as illustrated in Fig. 11.

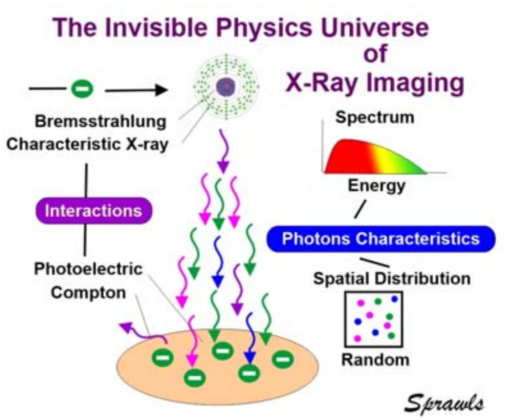


Fig. 11. The invisible physical elements of the x-ray imaging process.

Let's compare this to Fig. 2. That was illustrating how we learn the physics of water through visualization and other sensory interactions. We do not have the same opportunity for learning the physics of x-radiation which is completely invisible.

XI. Teaching modern physics

We cannot effectively teach modern physics--x-ray imaging is our focus here--by lecturing and telling learners what we know. We can teach the quantitative and mathematical relationships but that does not contribute to the formation of visual images and concepts that can be a foundation knowledge for productive applications and innovations.

XII. Effective learning and teaching

In the context of our thinking here, *effective learning* is the process of developing knowledge that can be used and applied for productive purposes as illustrated in Figure 10.

My perspective of *effective teaching* is the combination of providing pupils with the opportunity to learn (especially visualization and mental interaction) as expressed by Dr. Einstein and then a learning facilitator (teacher) helping the pupils to learn. This can be by using their knowledge and experience to guide and enhance the learning process as illustrated in Fig. 12.

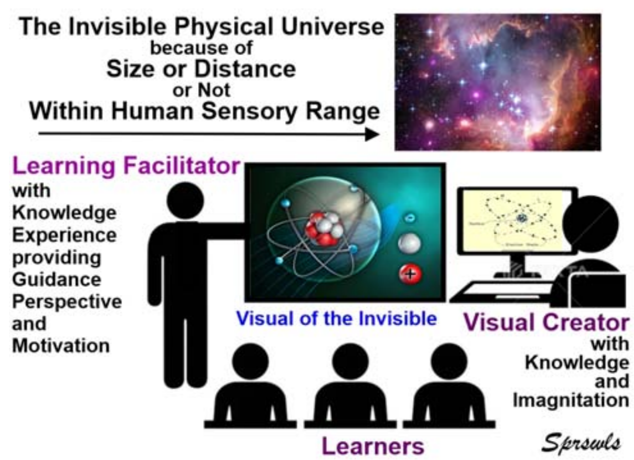


Fig. 12. An effective learning environment for developing conceptual knowledge of the invisible components of the physical universe.

XIII. Visualizing the invisible

It has been suggested that perhaps 99% of the physical universe is invisible to humans because of factors identified in Fig. 12. Visibility of some has been achieved with the development of instruments including microscopes (size) and telescopes (distance) but physical objects that are not within the human sensory (especially vision) remain a challenge. It is the ability to visualize these that enables the development of sensory concepts that is the foundation for valuable applications (analyze, problem solving, create, innovate, etc.) as illustrated in Fig. 10.

What is needed is the ability to visualize these objects, their characteristics, and their physical interactions.

XIV. THE VISUAL CREATOR

Creating visual representations of the invisible elements of the physical universe requires *imagination*. That is the ability to use accumulated knowledge, especially that developed from personal experience and observation, and think how the objects, characteristics, interaction, etc. can be represented in a visual form.

An effective visual creator is a physicist who "has this talent" just as effective writers and authors provide good written descriptions, as in most textbooks.

The general function of a visual creator is illustrated in Fig. 13.

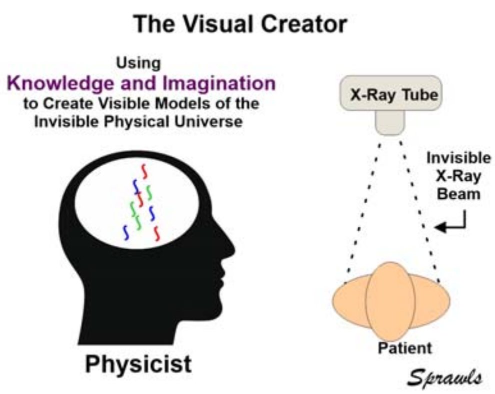


Fig. 13. Creating visuals of the invisible.

Creating conditions in which "pupils" can learn physics, as described by Dr. Einstein, is a collaborative effort by textbook authors, classroom learning facilitators (teachers), student laboratory instructors, and *visual creators*. Visuals (illustrations, diagrams, pictures, etc.) have been a valuable element in physics education in textbooks and class presentations and discussions.

Here we distinguish between a *visual creator* and others who produce illustrations, diagrams, pictures, etc. of visible objects or systems that are also valuable in the learning process by helping learners visualize components of the physical universe.

A *visual creator* must use their *imagination* to produce visible representations of invisible objects along with their characteristics, relationships, and interactions. It generally requires an understanding of the physical principles, laws, and quantitative (equations) relationships as the foundation knowledge to work with.

Creating and publishing visuals (from one to many) that can be used to help learners visualize components of the physical universe, an x-ray beam is an example, is an opportunity for physicists to receive recognition and contribute to and educational process around the world. Fig. 14 is a composite of several visuals created by the Author and are available, along with many others at: www.sprawls.org/resources .

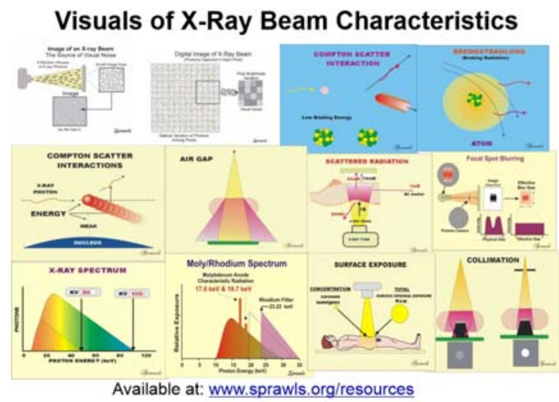


Fig. 14. Selected visuals provided by the Author illustrating the many, generally invisible, characteristics of an x-ray beam.

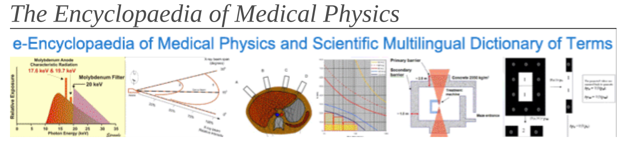
Visuals as shown here, enable learners to visualize and develop conceptual knowledge of the many characteristics and relationships of x-radiation. This is the type of physics knowledge that supports clinical applications.

XV. SOURCES OF VISUALS FOR LEARNING AND TEACHING

The internet and World Wide Web (WWW) is a vast source of visuals that are valuable for physics learning activities. The interest here is specifically for the field of medical physics.

The visuals can be found and downloaded through the following websites.

The Encyclopaedia of Medical Physics



This is an extensive on-line open resource (free of charge) with articles on virtually every medical physics topic including images and visuals.
These are available at:
http://www.emitel2.eu/emitwwwsql/encyclopedia.aspx

The Sprawls Resources

The Resources is a collection of textbooks and modules created by the Author with an emphasis on images and visuals that can be used in class or conference presentations and discussions.
These are available at: www.sprawls.org/resources .

Google Images

This is a search program for finding images/visuals on the internet by a specific topic. It is available at: https://images.google.com/

Here is an example. Searching on the term, “x-ray sprawls” finds the images shown here: x-ray sprawls - Google Search

XVI. SUMMARY AND OVERVIEW

As emphasized by Professor Einstein, *visualization* and *imagination* are critical functions in learning physics and applying it in creative activities. Learning physics is an ongoing natural human function as we observe and interact with the physical universe around us developing a network of sensory concepts that provide a foundation for *thinking*. Physics courses in academic institutions provide a symbolic and more quantitative representation of the physical universe in the form of words (definitions and descriptions) and mathematical symbols (quantities and relationships). Both *conceptual* and *symbolic knowledge* are valuable, depending on the needs of the learner with respect to applications, both in daily living and professionally, especially in the practice of medicine.

A specific challenge in some fields of physics education, especially medical physics, is providing opportunities for learners to visualize the invisible components of the physical universe, especially radiation.

Physicists, especially those with experience and imagination, can contribute to medical physics education around the world by creating and sharing visuals over the internet that enable others to *visualize*, *imagine*, and *think* productively about physics.

XVII. THE AUTHOR

Perry Sprawls, Ph.D., FAAPM, FACR, FIOMP, FIUPESM, is a clinical medical physicist specializing in medical imaging and diagnostic radiology and in education. He is Distinguished Emeritus Professor at Emory University School of Medicine in Atlanta and has served as Co-Director of the College on Medical Physics at the ICTP in Trieste. He contributes to medical physics education around the world through the Sprawls Educational Foundation, www.sprawls.org. It is the combination of his experience as a clinical physicist and educator that is the foundation for developing and sharing resources to support the teaching of medical physics. His continuing research and development activities are resulting in models for increasing the effectiveness of both the learning and teaching process, especially for clinically applied medical physics. This can be reviewed in the Bibliography.

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MEDICAL PHYSICS EDUCATION AND TRAINING IN KENYA: CURRENT STATUS OVERVIEW

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Abstract—**Medical Physics as defined by several international bodies and organizations, amongst them International Organization of Medical Physics (IOMP), is the application of Physics principles and techniques both in diagnosis and treatment of diseases. Medical Physics encompasses allied areas in Medical engineering, electronic and instrumentation and biophysics techniques. The medical physics professionals practices in Radiation therapy, Diagnostic radiology, Nuclear Medicine and in Health physics. In Kenya Medical Physics education and training is young and only two years old, this makes the ratio of medical physicist to population all times high. In Kenya, the Medical Physics education started in 2021 at the Technical university of Kenya, with clinical training at the Kenyatta National Hospital..**

Keywords— **Medical Physicist, Radiotherapy, Diagnostic radiology Nuclear medicine, Technical university of Kenya**

I. Introduction

Cancer is the second leading cause of fatalities and deaths among the non-communicable diseases in Kenya. This trend is expected to increase unless proper mechanisms of detection and treatment are put in place. Kenya is an East African countries with the demography as shown in the Table 1.

Table 1: Kenya Demography

Area	GDP Growth	Per capita	Population	No: of MPs
582.646 km^2	5.1 % (As of January 2022)	1.76 USD (As of December 2021)	53.77 million (As of September 2020)	32 (As of July 2022)

The history of diagnostic radiology services in Kenya dates back to 1936 when the first X-ray facility was installed and subsequent examination performed on 827 people. This was followed with major expansion at the national hospital and four more hospitals outside the capital city. But in 1968 the first cobalt 60 machine was installed in Kenya with a visiting Medical Physicist training the local physicist on the job. It was not until 2020 that, with the assistance of International Atomic Energy Agency (IAEA), a formal training syllabus was drawn and effectively implemented in 2021. This was the genesis of Medical Physics education and training in Kenya.

The training of medical physicist takes place at the Technical University of Kenya for theoretical courses and clinical training takes place at the Kenyatta National Hospital (KNH). The training is divided in segments undertaken per semester. The duration is 2 calendar years. The first year is spent at the University for taught modules that includes: physics of radiotherapy, radiology and nuclear medicine, and radiobiology, anatomy and physiology, ionizing and non-ionizing radiations, electronic and instrumentation and safety and quality management. The second year is dedicated to research project and clinical placements. The Medical Physics program faced several challenges, among them is lack of enough staff and limited funding. These challenges have been addressed gradually.

The history of Kenya's radiation equipment and distribution of medical physicists are presented in Table 2 and Table 3 respectively.

Table 2: History of radiation equipment in Kenya.

Year	Equipment	Centre
1936	First X-ray	KNH
1948 - 1951	Second X-ray (4 Provincial Hospitals)	Kisumu, Mombasa, Nakuru, Nyeri
1958	First Mobile Fluoroscopy	KNH
1968	First Cobalt 60 EBRT, Rectilinear scanner	KNH
1970	First Radionuclide imaging	KNH
1980	Brachytherapy Equipment	KNH
2010	First LINAC in Kenya	Cancer Care Centre

Table 3: Distribution of MPs

Discipline	Total
Radiation Therapy	26
Diagnostic Radiology	2
Nuclear Medicine	2
Private/ Academic	2

II. Infrastructure

Kenyatta National Hospital, the centre for clinical training, there are computerized treatment planning systems for both radiation therapy external beam and brachytherapy, and hospital health information management system. The country has three functional nuclear medicine departments, two private and one Government equipped with a SPECT gamma camera and PET/CT. The country has several diagnostic radiology equipment conventional X-rays machines both public and private institutions as well as CT scanners, mammography units, fluoroscopy units and interventional radiology units. Table 4 presents radiation and imaging equipment in Kenya as of July 2022.

The development has seen Kenya with approximate population of 54 million persons having 8 radiotherapy centers, 3 being government-owned and five privately-owned. All the centers are both in the capital city Nairobi and outside Nairobi with various facilities as below table.

Table 4: Radiation and Imaging Equipment in Kenya

Equipment	Total	Population (million) per Equipment
Cobalt 60	2	26.885
Linear Accelerator	12	4.481
HDR Brachytherapy	8	6.721
X-ray	2000+	≤ 0.027
CT Scanner/CT Simulator	3000+	≤ 0.018
MRI	50+	≤ 1.075
Mammography	40+	≤ 1.344
Gamma camera	3	17.923
PECT/CTs	1	53.77
Cyclotron	2	26.885

III. Regulatory framework for medical physics

Medical physics as a profession has never had any regulatory framework in Kenya, this was occasioned by the huge deficit in number of trained Medical Physicist. There is no proper regulatory framework and the registration of Association of Medical Physicist of Kenya (AMPKen) is underway (Table 5). Currently, all medical physicist are cooperated in Eastern Africa Association of Radiation Protection as members, although in voluntary basis. There is also a requirement from Kenya Nuclear Regulatory Authority to license all radiation workers of which Medical Physicist subscribe to.

Table 5: Professional Society (AMPKen)

Year	First President	First Sec Gen	Members
2022 (Registration year)	Mr. Wakhule Aggrey (Interim Chairman)	Mr. Bernard Ochieng (Interim Sec Gen)	Male: - 18 Female: - 12

IV. Way forward

2021 has been the turning point for Medical Physics training in Kenya, both academic and clinical. The country has developed structured clinical training programme. Once the first batch of trainees are out, the country will have a pool of trained medical physicists. With more and more people showing interest in Medical Physics, the roles and responsibilities of Medical Physics are now becoming clearer with the government and private centers urged to draft schemes of service for the profession. The IAEA technical cooperation (TC) projects have also assisted with awareness and variety of responsibilities of medical physicists practicing in various specialty. Medical physicists are expected to play key roles in projects that touch on the development of this profession.

IV. Conclusion

With the current development, both in the expansion of radiotherapy and diagnostic centers, there has been a need to have medical physicist in every institution with radiation equipment. Interest in establishment of medical physics education and training programme in Kenya has seen tremendous rise over the last decade. The country has as of 2021 successfully established one academic and clinical programme, with a promising future for more training centres to be established in the near future. The IAEA syllabus has formed the basis of training within the second cohort of trainees in the first year of study.

ACKNOWLEDGEMENT

We would like to acknowledge the contributions in kind of the IAEA in sending an expert to look at our program before roll out and in sponsoring several medical physicists for both long term and short term trainings on skill developments. Special thanks support in curriculum development and the experts who have supported the program so far. Also acknowledged are the interim officials of association of Medical Physics of Kenya led by Aggrey Wakhule and Benard Ochieng for the devoted time in seeking registration of the association.

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PROVIDING MEDICAL PHYSICISTS WITH KNOWLEDGE AND SKILLS IN ARTIFICIAL INTELLIGENCE CODING

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Abstract –

Artificial Intelligence (AI) is gaining wide attention for its outstanding performance in image-recognition tasks, such as medical imaging. In the past few years, medical physicists have made many imaging interpretations of medical images. The need to train medical physicists with AI knowledge is thus urgent to prepare them for this transformation technology. This article details our experience conducting the 20th ACOMP workshop 'Introduction to Artificial Intelligence' on Sept 19-20, 2022. The workshop practiced a flipped classroom concept. Materials were given to participants prior workshop. During the workshop, interactive sessions and hands-on coding were conducted. We received positive feedback from the participants that they enjoyed and learned the most during the interactive session.

Keywords- **Artificial Intelligence, Machine Learning, Digital Medicine, Coding, Medical Physicists**

I. INTRODUCTION

With the increasing amount of imaging examinations in the radiology department, the workload of medical physicists increased tremendously, and the burnout concern is intensifying. The development of computer technology and the introduction of machine learning applications have shown encouraging results in improving the accuracy and efficiency of the healthcare process.

A recent international survey of opinion on the AI role in medical physics from 219 respondents representing 31 countries revealed that 81% of participants agreed that AI would improve daily work. However, the average AI knowledge is below average, with 2.3 on a scale of 5. 95% of participants showed interest in enhancing their AI skills [1]. It is vital for medical physicists to upskill their AI knowledge and efforts have been made to encourage for AI to be incorporated into the medical physic programme [2].

Last year, the first ACOMP workshop, which consisted of didactic lectures and coding classes, was conducted [3]. This year, we introduced flipped classroom concept in the workshop – "Introduction to Artificial Intelligence" (Figure 1). The workshop aims to introduce AI's basic concepts and techniques and provide hands-on coding experience to participants using contemporary AI methods to solve practical problems.

Figure 1 Workshop Poster

II. THE EXPERIENCE OF 'INTRODUCTION TO ARTIFICIAL INTELLIGENCE'

This workshop on 'Introduction to Artificial Intelligence' consists of a two-day workshop of one-and-a-half-hour session each of interactive sessions with participants, and hands-on coding delivered by Universiti Malaya lecturer, Dr. Shier Nee Saw and Bahçeşehir Üniversitesi lecturer, Dr. Mustafa Ümit Öner. The topics covered in the workshop are shown in Table 1.

Table 1 Topics covered in the two-day workshop

Topics
1. Lecture:
a. Machine learning concepts
b. Classification
c. Regression
2. Hands-on Workshop:
a. Classification problem hands-on Workshop.
b. Regression problem hands-on workshop
c. Develop machine learning model for medical problems

Materials were provided in advance so that participants could learn and have knowledge before entering the workshop. During the workshop, a 2-ways discussion between the lecturer and participants was conducted. Participants were encouraged to ask questions and participate actively in the discussion. Hands-on coding was conducted after interactive sessions.

During the two-day course, lecturers gave lectures on three topics: (i) machine learning concepts, (ii) classification and (iii) regression.

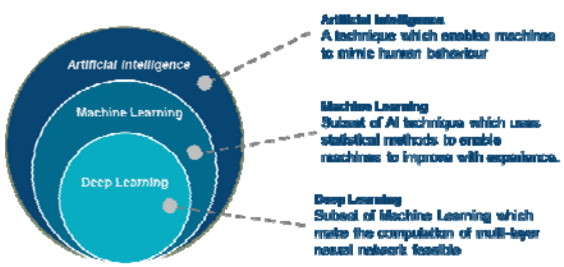

Figure 2 An example of a diagram to describe the relationship between AI, machine learning and deep learning.

Classification and regression lectures were given to enable students to grasp the concepts, followed by a practical session where students were asked to code in developing an AI model using the Google Colab platform. After learning the concepts and examples, students were tasked to develop an AI model to classify benign and malignant breast cancer. In this exercise, students were required to re-use the concepts and code learned in the workshop to create the AI model. The materials of the hands-on Colab coding workshop are available at https://github.com/shiernee/2022-ACOMP-AI-Workshop.

II. DEMOGRAPHICS OF PARTICIPANTS, FEEDBACKS AND OUTCOME OF THE WORKSHOP

31 participants from Thailand, Malaysia, Singapore, Sri Lanka, India, Bangladesh, Indonesia, and the Philippines attended this workshop. The participants include medical physic students, medical physics practitioners, and academic lecturers. Overall, participants rated 4.5/5.0 for the workshop. Most of the participants enjoyed the interactive sessions and will recommend the workshop to others in the future. A certificate is given to all participants who had completed the course.

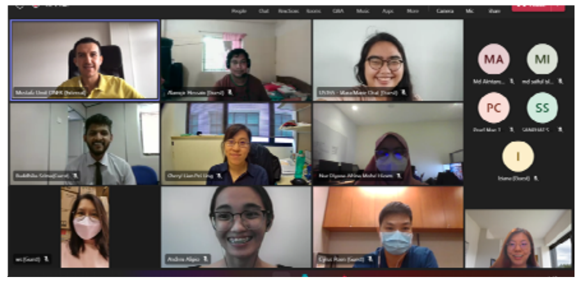

Figure 3 A screenshot of lecturers and participants.

This initiative aims to give participants knowledge of the foundations of AI and, more crucially, hands-on coding experience. Participants can use the knowledge gained and the code after the session, extending it to tackle other medical AI problems.

III. CONCLUSION

The ACOMP workshop - 'Introduction to Artificial Intelligence' has been successfully conducted. With the interactive and coding sessions, participants gain basic AI knowledge and will be able to understand how AI can aid in medical imaging diagnosis. This workshop serves as a model for higher education institutions to contemplate introducing AI in medical physics programs.

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THE ICTP COLLEGE ON MEDICAL PHYSICS 2022 WITH A FOCUS ON BUILDING CAPACITY IN DEVELOPING COUNTRIES

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Abstract: **The paper gives a brief description of the organization and delivery of the ICTP International College on Medical Physics 2022 – focused towards supporting the professional growth in the Low-and-Middle Income (LMI) countries. Some statistics of the feedback is presented plus the success of the College focus on building capacity in developing countries and introducing elements of management and leadership in the curriculum.**

Keywords – *ICTP, College on Medical Physics, Education in Medical Physics, e-Learning.*

The College on Medical Physics in ICTP, Trieste, Italy (ICTP – the Abdus Salam International Centre for Theoretical Physics) continued its activity in 2022, after the cancellation of this regular biannual College in 2020 due to the pandemic. As it was not sure that all travel and attendance restrictions would be lifted in 2022, the College was organized very close to its time (5-23 Sep 2022). The College participants attended all lectures together with the students of the MSc on Advanced Medical Physics, organized at ICTP with the University of Trieste. This way the overall 52 students were from 40 LMI countries: Angola, Bahamas, Belarus, Burkina Faso, Cameroon, Colombia, Croatia, Dominican Rep., Ecuador, Egypt, El Salvador, Ethiopia, Ghana, Honduras, Indonesia, Jamaica, Kazakhstan, Latvia, Lesoto, Lybia, Madagascar, Malawi, Mexico, Morocco, Namibia, Nepal, Niger, Nigeria, Oman, Palestine, Peru, Philippines, Rwanda, Sudan, Syria, Tanzania, Togo, Tunisia, Ukraine, Zimbabwe.

The lecturers to the unique College included: S Tabakov, F Milano, P Bregant, M Stoeva, S Tipnis, J Oshinsky, V Tabakova, R Padovani, R Longo, L Bertocchi and online lecturers P Sprawls and A Seibert. Traditionally the course is without fees and the lecturers bring various teaching materials for the students. The students receive a full set of teaching materials, e-books and educational images, later to be used in the educational and professional activities in their countries.

This ICTP College focused on medical physics activities in the field of medical imaging and related radiation safety. Additionally, a number of activities were focused on building capacity in developing countries – management of medical equipment, leadership, organizing of departments, etc. These activities were found of increased importance by the colleagues in LMI countries, where often the medical physicist does not have the immediate support from a local clinical engineer and has to take decision on various stages of the life of a medical device.

The topics on leadership were distributed in all lectures, based on specific examples from the practice of the lecturers. The topics on management had specific lectures and exercises, but elements of these were also distributed in the various parts of the curriculum. As usual a half day Workshop was organized with all students, aimed at increased international interaction and exchange of experience and ideas. Each participant presented a poster from his/her country, describing the main types of medical imaging and radiotherapy equipment in the country, the available workforce and its organization, the education and training, specific problems and solutions. The best posters and presentations received the College "EMERALD AWARD" – these were from: Rwanda (J A Kamanzi) and the Philippines (J Inamarga and M D Marquez). The Runner-up posters were from Syria (M W Al-Masri), Ecuador (M Subia), Lybia (A M Genaw amd R F Almijbari) and Tanzania (M J Kumwenda and J Dachi). The presenters of the posters from Rwanda, the Philippines and Syria were encouraged and guided to prepare a joint paper for the MPI Journal, describing the existing equipment management systems and activities in their countries (see the paper further in the Journal).

Traditionally the College includes visits and practicals at the Trieste Hospital ASUGI. Being the first medical physics educational course, which used e-learning (in 1996), the College includes additional practicals based on simulation sessions in the PC rooms of the ICTP.

As usual, after the College end, Questionnaires were used for collecting feedback from the attendees. About half of the students responded. The overall satisfaction from the College type "Train the Trainer" was 100% and all attendees stated that they shall share the received information with the colleagues in their countries. Also 100% of all stated that after the College they see better their place in the healthcare system in their country (87% of them reported existing good interactions with the medical and hospital staff). This was also supported by a mark of 93% given by the students to the College curriculum.

The usefulness of the e-learning materials and educational websites during the College was marked with 92%. Interestingly 26% of the students stated that they have not used e-learning and online learning during the pandemic. This corresponds with the preference of the type of teaching, expressed by the students: 26% prefer classical teaching; 20% prefer e-learning; 54% prefer blended classical plus e-learning.

The long story of the ICTP College has produced a number of local leaders in medical physics – colleagues who have organized societies, built educational courses, support the healthcare in their country and some of them later participated at international fora and organisations dealing with healthcare in LMI countries. In the Annex 1 to this MPI issue, we have presented the History of this unique College on Medical Physics with photographs from all College and other ICTP activities in the field of medical physics in the past 24 years.

During 2022 IOMP re-accredited the other large medical physics activity, associated with the ICTP – the MSc in Advanced Medical Physics, offered by the ICTP and the Trieste University. Additionally, to its founders, this unique MSc is supported by the IAEA, IOMP and the Italian Association of Medical Physics. The MSc is orientated towards students from LMI countries. Following their academic studies, they have practical training (and MSc project) in one of the Italian Hospitals in the consortium.

The MSc students interact with the College participants and attend most of the College lectures. This further increases the international collaboration between these colleagues. The huge network of College participants and MSc students will soon be officially formed.

The 8th cohort of students from this unique MSc graduated in December 2022. This was followed by Certification exams guided by the IMPCB.

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Fig.1 International College of Medical Physics with the staff and students' Awards, September 2022, ICTP Trieste

Fig.2 Graduation of the MSc in Advance Medical Physics with lecturers and supervisors, December 2022, ICTP Trieste

COLLABORATING ORGANIZATIONS

IAEA RLA 6091: ENHANCING CAPACITY BUILDING OF MEDICAL PHYSICISTS IN LATIN AMERICA AND CARIBBEAN

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Abstract: **In Latin America and the Caribbean, important investments have been made in high-tech and complex equipment. However, the number of qualified medical physicists (MP) remains insufficient to meet the current demand, especially in diagnostic radiology (DR) and nuclear medicine (NM). In addition, the lack of education and clinical programs in agreement with IAEA recommendations aggravates the problem. Considering this scenario, the project RLA6091, intends to improve the quality and safety of diagnostic and interventional radiology and nuclear medicine services through several activities, which include regional training courses, expert missions, workshops, and meetings. The project's expected outcome is to improve the knowledge and skills of MPs in the region. Project outputs will contribute to increasing competencies in medical physics that will impact the quality and safety of patient diagnosis and treatment.**

Keywords – medical physicist, education, clinical program, quality, safety

I. INTRODUCTION

In the last decade, the demand for medical physicists (MPs) increased significantly in Latin America and the Caribbean. Besides the growth of radiotherapy (RT), nuclear medicine (NM), and diagnostic radiology (DR) new departments, a significant technological advance was observed in the region. However, the number of MPs well qualified and updated needs to be increased to attend to this demand. Although many efforts have been made by International Atomic Energy Agency (IAEA) so far, many actions are still necessary to provide the quality and safety of patients submitted for diagnosis and treatment (1,2).

Concerning this current situation in the region, IAEA approved at the end of 2021 the project RLA 6091, "Enhancing Capacity Building of Medical Physicists to Improve Quality and Safety in Medical Practices." (https://www.iaea.org/projects/tc/rla6091). The overall objective is "To improve the quality and safety in medical practices with an emphasis on diagnostic and interventional radiology and nuclear medicine fields through building capacities and strengthening skills and competencies of MPs in the region." The project is expected to increase the medical physics workforce competencies in patient diagnosis and treatment over the years. In addition, focusing on the education and training in medical physics, the outcome expected is strengthening the knowledge and competencies, contributing to patient care improvement, and reducing potential risks of adverse effects of radiation. In the project, we are glad to have the following participants countries: Argentina, Barbados, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, Guatemala, Honduras, Mexico, Nicaragua, Paraguay, Peru, Uruguay, and Venezuela. Each country will select different numbers of hospitals.

In the context of medical physics for sustainable health care, the International Day of Medical Physics (IDMP) 2022 message of the International Organization for Medical Physics (IOMP) (https://www.iomp.org/idmp-2022/), it is foreseen that this project will contribute to building sustainable health care since all efforts will be made to improve health and well-being without exhausting natural resources or causing adverse ecological damage.

II. CURRENT BASELINE IN THE REGION

During the project design, several common problems were identified, which included an insufficient number of well-qualified MPs, especially in diagnostic radiology (DR) and nuclear medicine (NM), and a low number of academic and clinical training programs for MPs, among which few accomplished the new international recommendations and are updated to new technologies. In addition, in many countries, MPs are not recognized as health professionals and their presence, in general, is mandatory only in RT services. Consequently, few MPs have dedicated themselves to NM and DR. In addition, only a few countries have national radiation protection laws and standards updated to the new international recommendations and new technologies, especially in DR and NM fields (3). Although this survey was done in 2013, in the survey carried out in 2022, it was identified that many problems still remain and actions should be taken.

A special concern is identified specifically in education and training. The difference between clinical training and academic courses between countries include the syllabus, the theoretical and practical clinical training hours, the structure, and the MP evaluation process. Therefore, some points need to be verified, such as: Can we ensure that the MPs are clinically qualified? Are they well-prepared to assume their responsibilities independently after the clinical training? Did they acquire all the necessary skills to act as MPs in one of the chosen areas? All these questions can be answered as long as the entire education and training system is properly improved and meets the highest standards. Therefore, some activities will be carried out to achieve these goals.

Two surveys were carried out at the beginning of this project to update the information on the region, one for the official representative of the country in this project (counterpart) and one for participant hospitals. The countries which answered the survey before the first coordination meeting were: Argentina, Barbados, Bolivia, Brazil, Chile, Colombia, Cuba, Ecuador, Honduras, Paraguay, Peru, Uruguay, and Venezuela. A summary of the results is presented below.

III. BASELINE COLLECTED FROM EACH COUNTERPART

a) Clinical training program

Of the 13 countries surveyed, Barbados, Bolivia, Ecuador, Honduras, Paraguay, and Uruguay did not have a structured and supervised clinical training program, representing approximately 46% of the participant countries. The period of the training course also varies in the countries. In most clinical training, the duration of the training is one year (58 %), whereas only 25% of the duration is two years.

b) MP recognition

Another important result is the lack of recognition by law of the MP profession as a health professional in the region (61,5%). One strategy should be adopted to demonstrate the importance of this recognition which the International Labour Organization has already established.

c) Certification process

The certification process, essential to prove that the MP has the knowledge and skills and meets all the regulatory requirements to be a MP qualified, is not implemented in 77% of the countries. This result indicates that specific actions should be taken to change this current situation.

d) Staff

During routine procedures, the presence of a MP and radiation protection officer in the hospital is mandatory in 58% and 50 %, respectively. However, for radiologists and nuclear physicians, the presence is mandatory in 83%. In all RT centres, the radiation oncologist should be present during the procedures.

e) Regulatory framework

Regulatory bodies are in place in all participant countries, and laws and directives are established.

The MP presence in the hospital is mandatory in 53% of NM departments and 100% in radiotherapy. Only 58% of the countries require clinical training to consider the clinically qualified MP (6,7).

A quality control program is mandatory in 69% of DR services, 77% of NM, and 92,3 % of radiotherapy (RT). The patient dose assessment program is mandatory mainly in RT (61%), whereas in 38% of the countries is not mandatory in any area. Optimization of medical exposure is mandatory in 69% of NM and RT services and 54% of DR services. In more than 90% of the DR and NM services, establishing Diagnostic Reference Levels (DRL) is not mandatory.

A special concern is regarding education and training. The difference between clinical training and academic courses between countries is significant. The differences include the syllabus, the theoretical and practical clinical training hours, the structure, and the medical physicist evaluation process. Other points that should be answered are: Can we ensure that the medical physicists are clinically qualified? Are they well-prepared to assume their responsibilities independently after the clinical training? Did they acquire all the necessary skills to act as a medical physicist in one of the chosen areas? All these questions can be answered as long as the entire education and training system is properly improved and meets the highest standards. Therefore, some activities will be carried out to achieve these goals.

IV. BASELINE COLLECTED FROM HOSPITALS

All countries assigned one hospital to participate in the project, except Brazil, Cuba, and Paraguay, which assigned three. Most participating hospitals are public (79%) and provide DR, NM, and RT services. The specific data obtained for each department individually will be presented below.

Specific information from the DR department

a) Staff

Considering the different hospital dimensions in the DR departments, the number of radiologists presents a significant variation from 1 to 40. However, the number of physicists 'MPs varies from 1 (47%) to 12 (6,7%). A huge variation was also observed regarding the number of medical radiation technologists (from 1 to 80).

b) X-Ray Equipment

Most hospitals have conventional radiography and computed tomography (CT), but seven many hospitals do not have mammography equipment. Tomosynthesis and cone-beam CT are not in place in the majority of hospitals. Most hospitals have fluoroscopy equipment and C-arm systems.

c) Quality Assurance (QA)

In 66 % of the countries, there is a MP qualified in the DR department. However, many international requirements are not accomplished. In 73% of the hospitals, a QA program is implemented, protocols and guidelines are in place, and instrumentation and phantoms are available. However, 87% of the hospital did not implement programs for monitoring and managing patient radiation doses, and most did not have software for dose monitoring. In 80% of the DR services, Diagnostic Reference Levels (DRL) were not implemented, and 50% had no optimization program. Approximately 50% did not regularly participate in quality audit programs. Dedicated work is needed to solve these problems.

Specific information from the NM department

a) Staff

The number of nuclear physicians and MPs varies from 1 to 5 specialists, whereas the number of medical radiation technologists varies from 1 to 13. Only seven departments reported the presence of radiopharmacists (range 1-8). Most departments include 1 or 2 nurses in their staff to support NM activities.

b) Equipment

Most departments did not have Radioimmunoassay (RIA) or dedicated Positron Emission Tomography (PET). However, approximately 50 % have gamma cameras and single-photon emission computerized tomography (SPECT) systems in place. In around 60% of the departments, PET-CT and SPECT-CT equipment are available. Approximately 50% of the departments have at least one gamma probe. Radionuclides therapy is carried out in approximately 67% of the departments. However, the majority do not carry out internal dosimetry.

c) Quality Assurance (QA)

QA programs are implemented in 67% of the departments. Instrumentation and phantoms are available. Quality Control (QC) protocols and guidelines are established and implemented. However, 86.7% do not implement patient dose monitoring and management programs. Only 20% of the departments have tools for internal radiation dosimetry in patients. More than 93% of the services do not have DRL. Although 73% of the services have MP, in 60%, the optimization program is not in place. Radiopharmaceutical therapy is performed in 60% of the NM departments, but only in 36% is internal dosimetry performed. NM departments use mostly 99mTc, 18F, and I-131. More than 50% of the services do not regularly participate in any quality audit program. Dedicated efforts are needed to improve the NM services.

Specific information from the RT department

a) Staff

The number of radiation oncologists (RO) varies from 1 to 14, whereas the number of MPs varies from 1 (25%) to 12 (8,3%). A huge variation is also observed in the number of medical radiation technologists (from 4 to 30). In 40% of the services, there is only one dosimetrist.

b) Equipment

Only three departments have fluoroscopy equipment, but most of them have CT simulators available. The majority of the departments have two treatment planning systems. Only five departments have X-ray Superficial Therapy equipment, and four have equipment for Teletherapy with Cobalt-60.

Equipment such as gamma knife, tomotherapy, equipment for proton therapy, Low dose rate (LDR) Brachytherapy (Caesium-137), or Cyberknife is not present in the RT departments. Only one service has Pulsed Dose Rate (PDR) systems for brachytherapy (Iridium-192. Almost all departments have a Linear Accelerator (LINAC) capable of performing Intensity-modulated radiation therapy (IMRT), but just 4 departments have LINACs capable of performing ArcTherapy (VMAT). The majority of the departments have two LINACs in total. Intracranial SRS is provided in 46,2% of the departments, and only 30% provide stereotactic radiation therapy (SRT) and stereotactic body radiation therapy (SBRT) techniques. Most services have HDR Brachytherapy (Co-60) equipment.

c) Quality Assurance

The QA program is implemented in 92% of the services, and instrumentation and phantoms are available. Only 7,7% of the RT departments did not have a medical physicist trained and updated in the routine. Most of the departments regularly participate in quality audit programs.

V. PROBLEMS TO BE ADDRESSED

1) Lack of education and clinical training courses for MP in new technologies and imaging processing techniques
2) Necessity to develop educational and clinical training programs in RD and NM according to international recommendations
3) Need to improve the quality and safety of diagnosis and therapy in RD and NM, by implementing standardized quality assurance (QA) and quality control (QC) protocols, standardized dose assessment, monitoring and dose management, optimization programs, and individual clinical dosimetry methods for patient radionuclide treatment to maximize benefits for patients
4) Lack of doses registry systems in DR and NM to estimate absorbed doses to the target organs and healthy tissues.
5) Lack of regulations in the specifications that imaging equipment must meet.

VI. OUTPUT AND ACTIVITIES

Main Outputs:

- **Clinical training program in MP**. Efforts will be dedicated to updating the existing programs and supporting the creation of new ones through workshops, expert missions, and audits. In addition, support will be provided to review documents and proposed clinical training according to new IAEA recommendations (4) and also specific education regulations of the country

- **Network of reference hospitals with qualified MP**: to promote the quality and safety of medical applications, some hospitals will be carefully chosen to provide technical support for hospitals that requires special attention. These hospitals will demonstrate that all requirements were achieved, including establishing a quality assurance program, DRL, dose assessment, monitoring, and management, including patient's internal dose assessment methods in radionuclide treatment.

- **QC/QA procedures:** although some countries have already established QC/QA programs, the advent of new technologies has challenged many medical physicists in the region. Special protocols should be elaborated, and adequate instrumentation and phantoms must be available. In addition, special training courses could be necessary for many countries to prepare the medical physicist to carry out performance tests with accuracy and precision.

- **DRLs established**: DRLs are not implemented in any Latin American country. Standard protocols should be elaborated and presented in regional training courses. It is fundamental that all health professionals of the participant hospitals be aware of the importance of DRL in the optimization process and that all should be committed to the establishment of DRL.

- **Number of MPs trained and updated in complex technologies increased**: To achieve this output, more than 50 activities are scheduled, such as a workshop, regional training course, and expert missions. Expert missions will support the regional training courses, especially in practical lectures, including measurements to establish DRLS. In addition, the expert mission will help to review the e-learning materials prepared by the working in Spanish and Portuguese. The main objective is to achieve medical physicists in remote places and consider different knowledge levels.

VII. EXPECTED RESULTS

This is the first-ever TC project specially designed for imaging medical physicists for the last 10 years. The training courses and all activities are tailored to meet the medical physicist's needs. It is expected to increase the number of well-trained medical physicists and reduce the inequality between countries and even in different regions of the same country. The main goal is to provide an accessible high-level of quality diagnostic and therapy for the patients independently of their geographic location. Therefore, the education and training of medical physicists should break these barriers. The number of clinical training centres in different regions should be stimulated and supported. Adequate work conditions for medical physics it also necessary to avoid leaving in search of better places to work. Safety culture, when well disseminated, can open more opportunities even in remote places.

It is a challenge we have to face, but it is feasible when the knowledge is disseminated equally, and so are the opportunities. At the end of the project, we expect to provide medical physics for sustainable health care, to benefit the care of patients, reduce inequalities and improve the health service offered to the population.

VIII. ACTIVITIES IN 2022

1. Regional Training Course (RTC) on Structured and Supervised Clinical Training Programmes in Medical Physics, 24 to 28 October, Brazil.

Fifteen countries and 50 medical physicists participated in the course. The IAEA's new recommendations were presented. The event aims to train the participants on establishing and carrying out structured and supervised clinical training in alignment with the Guidelines for Academic and Clinical Training Programmes for Medical Physics in Latin America. As a result, it is expected to bring more quality and safety to the medical practices that undertake ionizing radiation by strengthening clinical training centres, developing capacities, and strengthening the skills and competencies of medical physicists in the region. Only a few countries have a structured clinical training program.

The training provided theoretical lectures, which included useful educational tools and practical exercises to assist in implementing clinical training programs, and a technical visit to the National Cancer Institute (Inca). The course concentrated all effort on giving the necessary support to update the current clinical training programs and the programs in the implementation phase.

2. RTC on Quality Assurance and Dosimetry in general radiography (conventional and digital), fluoroscopy, and interventional radiology, 14-18 November 2022, Costa Rica

The purpose of the training course was to train participants on all aspects related to physics, technology, quality assurance, quality control, and dosimetry in general radiography (conventional and digital), fluoroscopy, and interventional radiology, and the learning objectives were the following:

1. To update the knowledge on dosimetry in radiography, fluoroscopy, and interventional procedures
2. To become familiar with the latest image quality metrics in radiography, fluoroscopy, and interventional procedures
3. To understand the role of quality assurance in upgrading the radiology service and in avoiding incidents and accidents

4. To learn about the role of dose monitoring and how to perform efficient patient dose surveys
5. To become familiar with the concept of automated quality control and artificial intelligence in radiography, fluoroscopy, and interventional procedures

The course had a theoretical part with lectures and a practical part with quality control and dosimetry exercises in small groups.

3. RTC on Internal Dosimetry: Activity Quantification and Dosimetry Formalisms 5-9 December 2022, Cuba

The event aims to train the participants on image quantification and internal dosimetry. Molecular radiotherapy has demonstrated unique therapeutic advantages in treating many cancer types. Such treatments can deliver high-absorbed doses to specific targets (tumour lesions) and healthy organs (organs at risk) and, thus, require a patient-specific dose assessment. This would help to optimize the amount of radioactivity to be administered and to reduce the risk of under or over-dosing patients, otherwise observed when using empirical approaches to activity determination.

IX. WORK IN PROGRESS

After the first coordinating meeting, work groups were established to elaborate protocols and e-learning materials at the beginning of this year.
In diagnostic radiology, the thirteen groups established were divided between developing the following documents: harmonized QA/QC and dose assessment, monitoring and dose management protocols for complex technologies, good practices protocol based on new recommendations, DRL protocols for mammography, tomosynthesis, CT, fluoroscopy, interventional, Dental, cone-beam CT and digital systems, e-learning material with emphasis on complex technologies. In addition, one group should define the requirements to be a reference centre, select the essential instrumentation for reference centres and software, and adapt the audit QUADDRIL focus on MP.
In nuclear medicine, eleven groups are divided between working on the following subjects: harmonized QA/QC, dose assessment, monitoring, and dose management protocols for complex technologies, protocols harmonized and updated, harmonized dose assessment protocol for patient radionuclide therapy, Paediatric DRL, Hybrid techniques (PET/CT, SPECT/CT), e-learning material with emphasis on complex technologies (NM), to select the essential instrumentation for reference centres and software. (NM)requirements to be a reference centre, to define good practices in NM based on new recommendations, and to adapt the audit QUANUM (5), an IAEA tool for NM audits focused on MP

X. CONCLUSIONS

For the first time, one project dedicated to the education and training of medical physicists, with a special focus on diagnostic radiology and nuclear medicine, will certainly be a great milestone for strengthening these areas in the region. Increasing the number of medical physicists updated and well-prepared for new technologies will bring expressive benefit to the patients and to the healthcare systems.

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IUPESM STATUTES AND BYLAWS UPDATE, FORMATION OF LEGAL STATUS AND FELLOWSHIP INTRODUCTION (2018-2022)

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Abstract: **The paper describes briefly the activities in IUPESM leading to formation of its legal status and the update of its Statutes and Bylaws during the period 2018-2022, as well as the introduction of the IUPESM Fellowship scheme to celebrate the 40th anniversary of the Union in 2020.**

Keywords – *International Union for Physical and Engineering Sciences in Medicine, IUPESM history.*

I. Introduction

The International Union for Physical and Engineering Sciences in Medicine (IUPESM) was created in 1980 as a Union between the International Organization for Medical Physics (IOMP) and the International Federation for Medical and Biological Engineering (IFMBE) [1,2]. Initially a main goal of the Union was to achieve the membership of IUPESM in ICSU (International Council of Scientific Unions, now ISC - International Science Council). This was achieved in 1999 and was of great importance for the international recognition of both scientific fields – medical physics and biomedical engineering.

The next step of IUPESM was towards the recognition of both professional occupations – *medical physicist* and *biomedical engineer* by the International Labour Organisation (ILO). This was achieved in 2011 when ILO included both occupations in the International Standard Classification of Occupations (ISCO) - under categories: medical physicist (2111) and biomedical engineer (2149) [3].

Together with this, IUPESM organised successfully 15 World Congresses (WC) of Medical Physics and Biomedical Engineering [6] and represented both professions at various high-level international fora. All this underlined both - the very important role of IUPESM and the need for IUPESM to be a legal body. This required revision of the Statutes and Bylaws of the Union, as drafted in 1980.

The IUPESM Administrative Council (AC) 2018-2022, made steps in this direction. At its meeting (at WC2018 in Prague) it created an ad-hoc Rules Committee (RC) - S Tabakov (Chair), C Orton, KY Cheung, R Magjarevic, J Goh. Additionally, a Work Group (WG) on the IUPESM Incorporation was created with members: S Tabakov (Chair), L Pecchia, S Keevil.

II. World congress contract revision

The Rules Committee's (RC) first activity was the review of the existing Contract for the World Congresses (WC). The changes in this Contract emphasized the fact that the Congress Organising Committee (COC) will have to synchronise its activities with the Congress Coordinating Committee (CCC). This was necessary as in the past the COCs had often taken decisions based on local requirements without discussing these with the IPESM-led CCC.

The timing of various stages during the 3 years of WC preparation was also specified, together with the specific Committees of the WC. At all these stages the equal representation of medical physicists and biomedical engineers was taken into consideration. The Calls for Papers and the Calls for Special Sessions were specifically linked with the IUPESM CCC.

The Publications agreements of WC abstracts/proceedings and the legacy of the WCs were also specified. It was suggested that each WC website shall be a property of the IUPESM in order for the Union to keep for long time the information related to the World Congress.

The financial part of the Contract was also specified, as well as categories for fees reductions or waivers.

RC took the opinion of all IUPESM AC members and further the WC Contract was discussed and agreed with the COC of WC2021. The revised Contract was finalised by the end of 2018 and accepted as template for future WC Contracts. Early in 2020 the revised Contract was signed with the WC2021 hosts from Singapore.

This step appeared to be very important on the background of the coming Covid-19 pandemic in 2020, what led to the postponement of the WC2021 to WC2022. The latter was the first IUPESM WC held as a hybrid (on-line and in-person) activity – a Congress organised very well by the WC hosts and all colleagues from Singapore, including the IUPESM President J Goh.

III. IUPESM STATUTES AND BYLAWS UPDATE

IUPESM was created in 1980 as an Union based on good will between both Constituent Organisations (IOMP and IFMBE). As the first IUPESM President (J Mallard) states it had been taken care at the beginning for equal state of both professions *"...the physicists did NOT dominate the engineers, nor vice-versa..."*.[4] The update of the Statutes and Bylaws of the IUPESM was made by the RC in this spirit of existing democracy and harmonious relations between the two Constituent Organisations, aiming to support the decisions taking by consensus in an amicable atmosphere.

After the creation of IUPESM, the Statutes and Bylaws had only a minor update in 1992-93. During the past 30 years there were many changes in the life of both Constituent Organisations, which needed to be addressed, but more importantly the update had to include the establishment of the legal status of the IUPESM.

The draft of the changes was prepared by the Rules Committee in 2020-21. Further these were discussed, finalised and supported for proposal to the General Assembly (GA) by all IUPESM Administrative Council (AC): Prof James Goh (President, Singapore), Prof Slavik Tabakov (Vice-President, UK), Prof Kin Yin Cheung (Past-President, Hong Kong), Prof Leandro Pecchia (Secretary General, UK), Prof Magdalena Stoeva (Treasurer, Bulgaria), Prof Madan Rehani (President IOMP, USA), Prof Shankar Krishnan (President IFMBE, USA), Prof John Damilakis (Vice-President IOMP, Greece), Prof Ratko Magjarevic (Vice-President IFMBE, Croatia), Prof Eva Bezak (Secretary General IOMP, Australia), Prof Kang Ping Lin (Secretary General IFMBE Taiwan, China), Prof Geoff Ibbott (IOMP, USA), Prof Stephen Keevil (IOMP, UK), Prof Timo Jamsa (IFMBE, Finland) and Prof Marc Nyssen (IFMBE, Belgium).

The main updates/changes included:

-Replacing the term Chairman with Chairperson (emphasizing the increased role of women in the AC and the profession as a whole);

- Linking the IUPESM Official Address with the address of the IUPESM Company;

-Removing the "National members" category, as they are not direct members of IUPESM and do not pay membership fees to the IUPESM. The Union between the Constituent Organisations (IOMP and IFMBE) has never included National Societies as direct members. The National Member Societies of IOMP and IFMBE are members to IUPESM through IOMP and IFMBE;

- Specifying that Affiliate members to IUPESM have no voting rights;

- Introducing the possibility to take IUPESM decisions with electronic ballot;

- Specifying the succession in IUPESM Officers in case someone is not able to perform the assigned duties;

- Increasing the Officers to 6 (President, Vice-President, Secretary-General, Treasurer, Past-President, Past Vice-President) to allow equal representation of both Constituent Organisations (also this was related with the IUPESM Company, which was agreed to be established by all Officers as Directors – 3 medical physicists +3 biomedical engineers);

- The Standing Committees were listed as: Congress Coordinating Committee; Nominating Committee; Awards and Honours Committee (Honours was added to reflect the new IUPESM Fellowships scheme – see below); Rules Committee (a new Committee). There are other Active IUPESM Committees and Work Groups – these are regularly listed at the IUPESM Web site;

- The dues structure was specified to be reviewed by AC triennially (related to the Constituent Oragnisations);

- A special new paragraph was added to link the Statutes and Bylaws with the new IUPESM Company.

These updates and amendments of the Statutes and Bylaws were approved by all AC and sent to GA for discussion and approval. These were approved by the IUPESM General Aseembly during December 2021 and were activated from 1 January 2022 – see IUPESM web site>Stautes/Bylaws [1].

IV. IUPESM LEGAL STATUS (IUPESM COMPANY)

A number of IUPESM activities required the arrangement of its legal status. Hence the formation of an IUPESM Company was proposed to provide legal representation of IUPESM. This activity followed the steps of the successful arrangement of the IOMP Legal status in 2017 - at that time an IOMP Work Group was formed on the subject: S Tabakov (Chair), S Keevil and S Hawking [5].

The new IUPESM Work Group on the IUPESM Incorporation included S Tabakov (Chair), L Pecchia, S Keevil, supported by F McKeown and S Hawking from the IPEM, York, UK. Active part in these steps took also the President J Goh and Past-President KY Cheung. The WG consulted its activities with a specialist lawyer and later the AC discussed at length the Company draft documents. These were agreed to be sent to the IUPESM General Assembly for discussion and approval.

Due to the specific nature of the IUPESM, a different structure of the Company was developed (as compared to the IOMP Company) - IUPESM Company formed by the 6

IUPESM Officers (as Directors). The Directors change as per the normal change of IUPESM Officers at each World Congress. This way each IUPESM Officer has two functions – as officer of the Organisation and as Company Director. The IUPESM Company is fully accountable to the Administrative Council and the General Assembly. The Objectives of the IUPESM Company are identical with the Objectives of the IUPESM. This keeps the existing ultimate authority of the General Assembly and the Council whilst providing the legal representation of IUPESM.

The format of the Company follows the IOMP Company incorporated in the UK - 'Company Limited by Guarantee', a not-for-profit company with no shareholders and no distribution of dividends or other financial benefits to the Company Directors/Members. The primary purpose of the new company is to act on behalf of IUPESM wherever legal representation is necessary. The IUPESM Company is part of the final paragraph of the updated IUPESM Statues and Bylaws.

The IUPESM President (who is also a Chair of the Board of Directors of the Company) will present, on behalf of the Company, regular annual reports to the GA and the AC to keep all informed. The Company Articles of Association were drafted with the help of a solicitor to ensure they meet the requirements for registration as a Company Limited by Guarantee within the UK, where the IUPESM head office is situated for over 10 years. This does not restrict IUPESM from relocating in the future, should it be necessary.

Following a ballot in the General Assembly, the new IUPESM Company was approved in December 2021 (with 97% support of all National member societies of IOMP and IFMBE). The new IUPESM Company Limited by Guarantee passed the registration procedure in the UK and was officially formed on 5 May 2022. The Company was announced at the IUPESM Web site - the Founding members of the IUPESM Company are the 6 current IUPESM officers, who are also members of the Board of Directors of the IUPESM Company: James Goh, Slavik Tabakov, Leandro Pecchia, Magdalena Stoeva, Kin Yin Cheung and Ratko Magjarevic.

After the World Congress in Singapore (June 2022) the Company Directors are: Madan Rehani, Shankar Krishnan, Magdalena Stoeva, Elliot Vernet, James Goh and Slavik Tabakov.

A new plaque of the IUPESM Company was placed at the IPEM office in York, UK, where the Official Address of the IUPESM is at present (Fig.1).

V. IUPESM FELLOWSHIP

In parallel with the above activities the IUPESM Awards Committee: S Tabakov (Chair), KY Cheung, R Magjarevic, S Renha, J Goh took steps for the recognition of those colleagues who have contributed to the IUPESM during the past 40 years and 15 World Congresses. The draft of a IUPESM Fellowship scheme (FIUPESM) was prepared by S Tabakov and discussed by all Committee and AC. The FIUPESM scheme is designed to acknowledge the hard work of many high-profile colleagues, who voluntarily contribute to the global development of medical physics and biomedical engineers [6]. The scheme also encourages more colleagues to contribute this way to the IUPESM.

The Fellowship scheme includes 90 points in three main tiers/groups (A, B, C). Group A (max 56 points) is associated with various positions taken at IUPESM AC and the leadership of IFMBE, IOMP and their parts. The remaining 34 points are for Group B (max 23 points) associated with the leadership and roles related to the organisation and delivery of World Congresses and additionally Group C includes discretionary points (max 11 points). The number of points required for Fellowship status is minimum 40, of which a minimum 15 points required from group A.

The AC approved the FIUPESM scheme. Badges and poster were made (with the support of KP Lin and M Stoeva). J Goh and S Tabakov prepared special Diplomas plus Folders for FIUPESM recipients and plaques for the other colleagues.

The first group of IUPESM Fellows included all past AC members. The list of inaugural Fellows – the outstanding international leaders of medical physics and biomedical engineering – includes 58 high-level specialists from 26 countries (this List with FIUPESM included also 15 of the initial builders of the Scientific Union, awarded posthumously). J Goh and S Tabakov collected the addresses of all these colleagues. The colleagues (or their families) were invited to the Special Online celebration of IUPESM 40th Anniversary on 20 November 2020. The virtual celebration (due to the pandemic situation) was attended by over 200 colleagues and relatives. It included also presentations highlighting the achievements of the IUPESM during the past 4 decades [2, 6] and short Bio for each of the inaugural Fellows (**see Annex to this MPI issue**).

The first group FIUPESM (2020) includes: Prof. John Mallard, Prof Robert L. Clarke, Prof. John "Jack" Hopps, Prof. Masao Saito, Prof. Oivind Lorentsen, Prof. Alexander Kaul, Prof Lawrence H. Lanzl, Prof. Nandor Richter, Prof. Robert Nerem, Prof John R Cunningham, Prof. Orest Roy, Prof. Niilo Saranummi, Prof Udipi Madhvanath, Prof. Jos Spaan, Prof Keith Boddy, Prof. Kajiya Fumihiko, Prof. Gary Fullerton, Prof. Jean-Pierre Morucci, Prof. Colin Orton, Prof. Kwan Hoong Ng, Prof. Inger-Lena Lamm, Prof. Azam Niroomand-Rad, Prof Oskar Chomicki, Prof. Dov Jaron, Prof. Heikki Teriö, Prof. Joe Barbenel, Prof. Joachim Nagel, Prof. Peter H. S. Smith, Prof Barry J Allen, Prof. Makoto Kikuchi, Prof. Ratko Magjarevic, Prof. Alun Beddoe, Prof. George Mawko, Prof. Antonio Fernando Catelli Infantozzi, Prof. Herbert Voigt, Prof. Fridtjof Nuesslin, Prof. Shankar M. Krishnan, Prof. Caridad Borrás, Prof. Kin Yin Cheung, Prof. Yimin Hu, Prof. James Goh, Prof. Slavik D. Tabakov, Prof. Madan Rehani, Prof. Tomas Kron, Prof. De Pei Liu, Prof. Monique Frize, Prof. Marc Nyssen, Prof. Eva Bezak, Prof. Ákos Jobbágy, Prof. Kang Ping Lin, Prof. Virginia Tsapaki, Prof. Howell Round, Prof. Magdalena Stoeva, Prof. John Damilakis, Prof. Timo Jämsä, Prof. Geoffrey S. Ibbott, Prof. Stephen Keevil, Prof. Leandro Pecchia.

In 2022 a second Group of FIUPESM was awarded, included colleagues who have contributed to the organisation of IUPESM World Congresses and further international promotion of medical physics and biomedical engineering. This group was announced at the hybrid (on-line and in-person) ceremony at the WC2022 in Singapore. Their Bios were prepared by J Goh and S Tabakov and presented at the ceremony (**see Annex 2 to this MPI issue**).

The FIUPESM 2022 group includes the following 38 outstanding contributors (medical physicists and biomedical engineers) to IUPESM: Prof. Dietrich Harder, Prof.Walter Bleifeld, Prof. Tapani Jauhiainen, Prof. Perry Sprawls, Prof. David Kopp, Prof. Hiroshi Abe, Prof. Carlos de Almeida, Prof. Ronney Panerai, Prof. Pierre Aletti, Prof. Bernard Rigaud, Prof. William Hendee, Prof. Alfred R. Potvin, Prof. Nigel Lovell, Prof. Tae Suh Suk, Prof. Sun Il Kim, Prof. Lodewijk Bos, Prof. Luis Kun, Prof. Wolfgang Schlegel, Prof. Olaf Dossel, Prof. Per Ask, Prof. Yubo Fan, Prof. Raymond Wu, Prof. Yadin David, Prof. Gilda Barabino, Prof. David Jaffray, Prof. Tony Easty, Prof. Jaroslav Cmíral, Prof. Libor Judas, Prof. Lenka Lhotska, Prof. Anchali Krisanachinda, Prof. Stelios Christofides, Prof. Simone Renha, Prof. Lip Teck Chew, Prof. Chwee Teck Lim, Prof. James Cheow Lei Lee, Prof. Hwa Liang Leo.

Fig.1 Placing the IUPESM Company plaque at its official address in IPEM, York, UK (S Tabakov with IPEM President R Farley, Chief Executive P Morgan and IUPESM/IOMP administrators S Hawking and F McKeown)

VI. Conclusion

The very successful IUPESM term of office 2018-2022 achieved the formation of the legal status o the Union. This was also related to the most significant update of the Statutes and Bylaws of the Oragnisation, thus tracing its future development in support of the global recognition and growth of medical physicists and biomedical engineers. The inaugurated IUPESM Fellowship provided a most necessary recognition to colleagues who voluntarily contribute to the objectives of the Scientific Union of both professions.

Acknowledgements

The information in the paper is based on S. Tabakov's Vice-President and other Reports for the IUPESM General Assembly (period 2018-2022), submitted for presentation at WC2022. I would like to specially thank the colleagues from the Awards and Honours Committee, Rules Committee and the Work Group (WG) on IUPESM Incorporation (all mentioned in the text of the paper).

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PROFESSIONAL ISSUES

AN AFRICAN FIRST

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Abstract— **The first conference of the Federation of African Medical Physics Organizations (FAMPO) was held in Marrakech, Morocco, from 10 – 12 November 2022.**

Keywords— **FAMPO conference, medical physics, Africa**

The first conference of the Federation of African Medical Physics Organizations (FAMPO) was held in Marrakech, Morocco, from 10 – 12 November 2022. The conference was hosted by the Moroccan Association for Medical Physics, with substantial local support.

The objective of the conference was to provide a platform for the exchange and sharing of scientific ideas and experiences in all aspects of the profession – hence the broad theme of the conference "From Imaging to Treatment" was chosen to be as inclusive as possible. The conference was meant to happen in 2019 already, but had to be postponed. Virtual conference options were rejected in favour of a first meeting that would be in-person.

The opening ceremony was attended by the presidents of Mohammed V and Cadi Ayyad Universities in Morocco, who signed a memorandum of understanding at that time. In addition, the Director of the National Graduate School of Arts and Crafts, the Director of the National Centre for Energy Sciences and Nuclear Techniques, and selected members of FAMPO ExCom, led by the president, were also present. The local team, under the chairmanship of Lakbir El Hamidi, as well as the co-chair, Asma Chaik, worked hard to make the conference a success.

The conference consisted of a combination of plenary sessions, teaching lectures, oral and poster presentations, as well as vendor workshops. The venue – Complexe Administratif et Culturel, Mohammed VI – was spectacular, showcasing exquisite architecture and fine mosaic patterns.

Conference attendance was excellent, the official number provided by the conference organizers was 268. The International Atomic Energy Agency has invested quite heavily in medical physics in Africa and supported this conference as well. The American Association of Physicists in Medicine had representatives from the Global Representatives Subcommittee and the Global Medical Physics Education and Training Committee who attended the conference, and Medical Physics for World Benefit also had a speaker at the conference.

The conference venue

The International Organization for Medical Physics, who supported the conference from even before the pandemic, were very glad that the conference was finally re-instated.

One of the challenges of hosting a regional conference in Africa is that many participants must leave Africa, to get back into Africa to attend. Flight routes are not back to pre-Covid levels yet. With this in mind, it was extremely encouraging to see the number of Moroccan participants who came from all over the country to participate in the meeting; especially students and young professionals took advantage of this opportunity. It was the aim of the Moroccan association to use this conference as a springboard for the profession, and by all accounts this could very well be the case. The conference even made national news on television.

Invited speakers gave fantastic talks on topics ranging from machine learning in nuclear medicine to the importance of audits for innovative radiotherapy techniques, from hypofractionated treatments and stereotactic radiotherapy to 50 years of the IAEA postal dose audit results, from quantification challenges in PET/CT to diagnostic reference levels, or from new horizons in multimodality imaging technology to a novel model for medical physics education. Collaboration avenues were explored and discussed, professional networks were built and expanded. This was very motivating!

Participants engaged with vendors, who made many new contacts.

While many lessons were learnt from an organizational perspective, it is fair to say that the conference was well-received and enjoyed. Perhaps in future an additional day or more parallel sessions are required for more African research to be presented.

The Moroccan gastronomy was relished, and the sights and sounds of Morocco were savoured.

Poster describing the IOMP

Conference banner

The vision and purpose of FAMPO include the promotion of the medical physics profession and related activities, the advancement of the status of the profession, the promotion of research and development in the field, to organize regional or international conferences and meetings, as the collaboration with other scientific organizations. This conference provided an avenue to promote all these aspects.

No decision has been taken yet on where or when the next FAMPO conference will be held. It remains a challenge to make activities like this sustainable in Africa. A FAMPO conference is more likely to succeed if there is substantial local buy-in, which already poses a problem in most countries in Africa, who lack a critical mass of medical physicists to start off with. No virtual attendance was offered in the first edition of the FAMPO conference, but hybrid conference options seem to be the new normal and certainly offer a convenient way to listen to talks, even if the networking aspects and vendor engagement suffer. One solution may be to explore closer collaborations with other regional organizations to host an inter-regional conference.

Whatever will be decided, we look forward to meeting you at the next FAMPO conference!

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The first FAMPO conference

MEDICAL EQUIPMENT MANAGEMENT: A PERSPECTIVE FROM PHILIPPINES, RWANDA, AND SYRIA

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Abstract— **Medical equipment management has long been an integral component of healthcare. For countries considered to be part of the low-middle income (LMI) bracket, challenges relating to medical equipment management influence the overall healthcare performance of an institution. The aim of this paper is to identify the similarities and differences in medical equipment management of different countries. Moreover, the challenges and efforts to address these challenges in managing medical equipment will be presented as well.**

Keywords—**medical equipment, management, medical physicists, low-middle income**

I. Introduction

Medical equipment management has long been an integral component of healthcare. This ensures that proper diagnosis, treatment, management are afforded to the patients within a safe environment of care [1,2]. Moreover, these medical devices should be properly stored and maintained to maintain a safe working environment for the benefit of the patients and staff [3]. Figure 1 shows the equipment life cycle of an equipment.

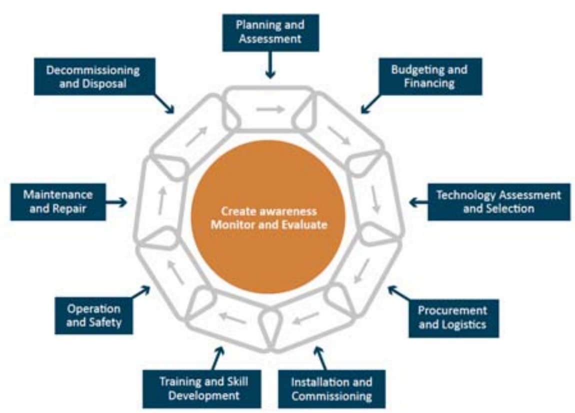

Fig. 1 Equipment Life Cycle [4]

The aim of this paper is to identify the similarities and differences when it comes to equipment management from different parts of the world. Another secondary objective is to identify the challenges being encountered by medical physicists in their respective institutions and how they are being addressed. This paper is limited to discussing challenges and experiences regarding medical equipment management from the three (3) countries: Philippines, Rwanda, and Syria.

II. Country Information

This section of the paper gives a brief background about each country that will be mentioned in this paper.

A. PHILIPPINES

The Republic of the Philippines is an archipelago of about 7,641 islands. The country has a land area of approximately 300, 000 sq. km. and a total coastline of 36, 289 km. As of December 2022, the country has a population of more than 100 million Filipinos. The recorded gross domestic product (GDP) last 2021 of the Philippines was $394.1 billion [10].

B. RWANDA

Rwanda is one of the sub-Saharan countries and part of the East African Community (EAC) of Burundi, Kenya, Uganda and Tanzania, South Sudan, and Democratic Republic of Congo (DRC). It is a small country, of just over 10,000 square miles and the country population of nearly 13 million. Rwanda is geographically bordered by the Democratic Republic of Congo, Uganda, Tanzania, and Burundi. The country elevation makes the climate much cooler and more comfortable than a typical equatorial climate. It is a well-organized and safe country with a committed Government and very low corruption rates, making Rwanda a potential regional hub for health care activities in a long-term perspective. The country has tried to stabilize its economy and it was ranked 2nd in Africa in the ease of doing business by the World Bank [5]. Finally, Rwanda is one of the few South Saharan African countries on track to achieving most of the Millennium Development Goals (MDGs), despite the large number of challenges and needs in the health care sector. Therefore, the market for doing business in the health sector is thus largely untapped, and for investors or exporters there is enormous potential.

C. SYRIA

Syrian Arab Republic, or more commonly known as Syria, is a country located in the Middle East. It has direct access to the Mediterranean. Syria has a total area of 185, 180 sq. km and a total coastline of 193 km. As of writing, Syria has a population of more than 18 million people [6].

III. EXISTING PRACTICE ABOUT MEDICAL EQUIPMENT MANAGEMENT

The access and effective management of healthcare technologies leads to improved quality of healthcare provision to most of the population worldwide. However, there is still a remarkable imbalance in medical technology management across different region of the world, specifically between high resources and low resources countries.

During the 90s, the situation of medical equipment management in Rwanda generally was not effectively done in the proper way. During this time, the large fraction of medical equipment in the country was donated or funded by international donors or foreign governments. Most of these devices were poorly maintained, under-utilized, and or out of service due to various reasons such as inaccessibility to spare parts, accessories, and consumables, and lack of trained professionals able to execute the needed repairs or maintenance, mainly biomedical engineers or technicians [7,8].

In the step afterwards to overcome all these, the government of Rwanda established different plans and policies for sustainable medical equipment management and support. One of those was the establishment of medical technology and infrastructure division which provides efficient management and coordination of healthcare equipment and infrastructure in all public healthcare facilities in the country.

In the Philippines, health facilities can be classified as government hospitals, private hospitals, or primary health care facilities. Hospitals are usually classified based on the ownership of that facility. It could either be a public or private hospital. About 40% of the hospitals are classified as public while the remaining 60% are considered as private institutions. Clearly, the private institutions outnumber the government hospitals in the country [9].

The acquisition of new equipment begins by planning and assessing the needs of the hospitals and their patients. It also considers the appropriateness of the equipment to be acquired to its environment, the equipment users and the allocated budget and financing. The budget and financing portion takes into consideration the estimated purchase cost and the estimated “cost of ownership”.

In Syria, the procurement process for private hospitals begins and is directly monitored and processed by the hospital management. The medical physicist is responsible for making the trend book, and the final decision is made by the hospital manager. The maintenance contract (if applicable) is yearly reviewed and revisited and directly made with the company leadership. Public hospitals, on the other hand, the procurement process is applied through the ministry belongs to (ministry of health or ministry of higher education and scientific research), and the scientific committee, consists of a medical doctor, medical physicist, and medical engineer, is established to review the trend book which is written by the medical physicist. This is carefully reviewed together with the offers to ensure that the scientific requirements are fulfilled [10].

In addition, the administrative committee is established to study the offer from a financial point of view. Both committees may contain medical physicists and radiation oncologists. It is a tender based, meaning that it needs to announce a tender and make a tender book and apply through the Purchasing Department in the hospital and make an announcement for the tender for the first and second time and receive the proposals to be opened from a tender opening committee.

A. PLANNING, TECHNICAL SPECIFICATION, INSTALLATION, AND COMMISSIONING OF MEDICAL EQUIPMENT

In Rwanda, the planning of new medical equipment, and associated activities such as budgeting and financing, procurement and tendering are done by the selected team that include the available involved professionals at the healthcare institution level: oncologists, radiologists, and management team (for radiological equipment). Sometimes, the foreigner experts in the fields like consultant medical physicists are invited to help the hospital. However, medical physicists were not available in the country until just a year ago (2021), so the healthcare institution historically used to seek experts abroad to assist in the planning and specification of the new equipment, and in the procedures of acceptance and commissioning.

After the equipment installation, the equipment vendor organizes the onsite training of the respective professionals who will regularly work with the equipment during the patient diagnosis and/or treatment. These onsite training help the involved professionals to understand the functionality of the equipment, its safe and effective usage.

In the Philippines, the participation of medical physicists in identifying the technical specifications of an equipment is not always guaranteed. For one, there are a lot of healthcare facilities who do not have an in-house medical physicist. As a result, they would often rely on the expertise of consultants and the vendor. This is due to the fact that until now, the number of medical physicists is still far from sufficient as compared to the number of healthcare facilities [11].

B. EQUIPMENT MAINTENANCE AND REPAIRS

For the three (3) countries in this study, a contract with the appropriate vendor is, more often than not, secured by the hospital management as a form of assurance that should their equipment breakdown, support will be readily available. However, these contracts are usually costly and should also be considered during the planning stage under the "cost of ownership". Generally, the healthcare institutions take the responsibility of their equipment maintenance and repair. For oncology equipment, regular QC and QA are done by the physicists or therapy technologists with the supervision of physicist. However, there are QC/QA procedures in diagnostic radiology departments that are not properly implemented. This requires urgent attention for the proper functionality of the available diagnostic department equipment (x-ray machine, CT, and MRI) country. Historically, the absence of medical physicists, and specifically physicists working in diagnostic radiology triggered this issue. Currently, physicists who specialised in diagnostic radiology are available, and the establishment of a medical physics society can help address all these challenges.

Medical equipment repair maintenance is in accordance with the vendor and hospital agreement. Both parties agree on a service contract which is renewed yearly. Currently, some vendors have the local service company with a local biomedical trained engineer which deals with the equipment regular service, and the vendor intervenes when the machine requires a serious repair like tube replacement, etc. however, there is still a challenge in availability of spare parts which causes the equipment long breakdown period.

IV. Challenges Encountered About Medical Equipment Management

The following are the similar challenges being experienced, in general, by the three (3) countries mentioned in this study:

I. Large critical and non-critical equipment not functioning.
II. Management do not consult medical physicists in terms of technical specifications that may help them save money.
III. Poor cost-cost benefit analysis of management in terms of purchasing equipment (i.e focus on the cost of equipment but not the "cost of ownership").
IV. Costly contracts after the warranty period ends which small hospitals may not be able to afford.
V. High attrition rate of technologists and medical physicists to look for greener pasture
VI. Lack of local experts and in-house medical physicists
VII. Lack of qualified manpower and dependence of foreign expertise to install and maintain medical device
VIII. No infrastructure to organize the workshop
IX. Proper tools (i.e phantoms) are not available for technical staff
X. No specific policy, strategy, and planning for medical equipment management at hospital/clinic level

V. EFFORTS BEING DONE TO ADDRESS THESE CHALLENGES

Listed in this section are the similar efforts being done by each country in order to address these challenges surrounding the medical equipment management umbrella of a hospital:

I. Stronger support from the regulatory bodies in terms of human resource staffing for medical physicists.
II. Support and promote biomedical engineering training in higher learning institutions
III. Inspire biomedical innovations among students and researchers through the establishment of competitions and awards
IV. Use public procurement contracts as a tool for technological learning and commercialization.
V. Creation of a network of centers of excellence in biomedical sciences and engineering
VI. Different policies and guidelines for medical technologies management and maintenance have been developed
VII. Establishment of web-based system "Medical Equipment Maintenance Management System" for inventory, preventive and curative maintenance management and spare parts procurement

VI. Conclusions

Medical equipment, without a doubt, is a crucial part of our healthcare system. Moreover, managing medical equipment should be a priority for all hospitals. The process in which we acquire them, maintain them, and use them should be carefully planned by the management and their technical staff. This is where the role and expertise of a medical physicist come in. For the three (3) countries represented by the three (3) authors, the practice in managing equipment has similarities and differences as well.

The patients and health care providers and environment must be protected for any unnecessary or potential harm associated with the improper functionality of the hospital equipment. To achieve this, there should be a proper hospital equipment management system in every hospital irrespective of size and location of the hospital.

The healthcare technology management policies and QA/QC procedures should always be implemented at hospital/clinic level to ensure that hospital equipment and other systems used in healthcare are safe, operational and a proper maintenance of the equipment to meet the mission and vision of the healthcare institution. The role of medical physicists in the management of medical equipment should be recognized at the hospital/clinic level and during tendering for the new equipment, the responsible team should include the QC tools/materials in the entire budget.

Without a doubt, the role of medical physicists is crucial in ensuring that the medical equipment management is given urgent attention. Another issue that the authors realized is the lack of formal educational institutions and training opportunities for medical physicists in the graduate level as well as a clinical residency training program. Both of which are integral in honing clinically qualified medical physicists in different fields.

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The authors would like to thank, first and foremost, the College Director, Prof. Slavik Tabakov, for the encouragement to prepare this paper and the guidance on the subject matter. The authors do further would also like to thank the International Centre for Theoretical Physics for organizing the College on Medical Physics last September 05 – 23, 2022. This gave the authors an opportunity to collaborate with one another.

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INVITED PAPERS

THE ROLE OF THE CLINICAL ENGINEER IN HOSPITAL-BASED HEALTH TECHNOLOGY ASSESSMENT OF MEDICAL DEVICES

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Abstract: **This article provides a brief introduction to the formal process of health technology assessment (HTA), how the HTA process for pharmaceuticals is not so easily implemented for medical devices and how clinical engineering departments can play a role in implementing HTA for medical devices at the local hospital level. Examples are given where this has been done successfully at a London NHS hospital.**

Keywords – *Health Technology Assessment, Clinical Engineering and Medical Physics*

I. INTRODUCTION

The World Health Organisation (WHO) defines HTA as "the systematic evaluation of properties, effects, and/or impacts of health technology: the application of organized knowledge and skills in the form of medicines, medical devices, vaccines, procedures and systems developed to solve a health problem and improve quality of life. It is a multidisciplinary process to evaluate the social, economic, organizational, and ethical issues of a health intervention or health technology."

However, formalised health technology assessment (HTA) is a surprisingly nascent creation. The National Institute for Health and Care Excellence (NICE) in the UK wasn't founded until 1999 and its medical devices evaluation stream - not until a few years later. In Europe it wasn't until 2005 that a group of 35 Organisations throughout Europe, led by the Danish Centre for HTA (DACEHTA), answered a call from the European Commission and Council of Ministers to make HTA a top priority, and consequently led to the creation of the EUnetHTA Project (URL).

Why is this of concern to the clinical engineering and medical physics community? By far the largest portion of HTAs are conducted on pharmaceuticals, however, there are an increasing number of new medical devices (over 100K medical devices registered in the UK versus approximately 1K pharmaceuticals)[1,2] for both treatment and diagnostics that are now being brought through the same assessment and it is becoming clear that the processes used for approving drug treatments do not map simply to medical devices (Table 1). The International Federation of Medical and Biological Engineering (IFMBE) created the Healthcare Technology Assessment Division (HTAD) and now runs HTA courses for post-graduate biomedical engineers and medical physicists, (from which this table was adapted), as well as an open access journal IFMBE International Journal of Clinical Engineering and HTA, since 2016.

The adoption of new medical devices is usually championed by a medical specialist consultant; high capital cost items such as the latest PET or MRI scanners, MRI-Linacs or robotic surgery. At the other end of the cost scale, patients will quickly adopt new medical devices in the form of smart phone apps that provide quick feedback and assurance or otherwise about chronic medical conditions such as blood pressure, insulin levels or memory. The medical specialist consultant has a deep knowledge of the health condition being managed, and the patient is increasingly becoming the end user of app based technology; the clinical engineer or medical physicist then sits squarely between these two groups. This staff group are the necessary link that can provide the technical knowledge required to fully understand both the optimal use of the medical device as well as the range of devices available to ensure context-specific efficacy and efficiency.

Published literature on approaches to medical device purchasing decisions encourage a systems-approach that incorporates local realities and interactions of "technical, financial, safety and clinical requirements" [3]. Medical physics and clinical engineering services, that can be said to be 'system-facing,' are well-placed and well-equipped to support this.

Drugs	Medical Devices
Principal action	
Pharmaco/Immunologic/Metabolic Chemical based	Physiological Mechanical/EMR/Materials
Product Life Cycle	
Long life cycle Unchanging compound	Short life cycle Constantly updated, or repaired
Clinical Evaluation	
Easy to blind One end user Short learning curve Less dependent on use setting Easy to standardise for RCTs	Difficult to blind (can't do placebo) Multiple users Long learning curve Very dependent on use setting Difficult to standardise for RCTs
Use Issues	
Efficacy is not user-dependent Usually does not require specialist training to administer Complications (adverse reactions) increase with use	User-dependent efficacy Requires specialist training Complications decrease with use.
Diversity and hetereogeneity	
Mainly large multinationals Only therapeutic	Mainly small companies but also multinationals Therapeutic and diagnostic
Costs	
High overheads with quick return on investment Lower distribution costs No maintenance or installation	Varying overheads and slow ROI Higher distribution costs Higher maintenance/installation costs

Table 1. A list of specific differences between the healthcare technology assessment process of drugs and medical devices both defined as healthcare technologies by WHO.

Driver	Hospital-based HTA questions
Efficacy	Does it work under ideal conditions?
Effectiveness	Does it work under everyday conditions?
Efficiency	Does it work at a reasonable cost?
Impact	Is it worth it for us?

Table 2. Summary of drivers that are considered during the formal HTA process.

HTA carried out by Medical Physics and Clinical Engineering hospital-based departments can be used to bridge the gap both between the medical profession and the patient but also between the medical profession and the local policy makers within the healthcare provider institutions (Table 2).

What is more, the use of *formalised* HTA can promote consistency that can make insights from HTA more robust and readily transferrable between collaborators. Formal HTA can go some way to address challenges posed by the diversity and heterogeneity (see Table 1) of medical device markets, by promoting common bases for assessment. Transferrable insights can reduce duplication in HTA efforts, as we collectively generate an understanding of which devices are best depending on the scenario.

Formal HTA at a local level to assist policy and decision making is not commonly performed, which is not surprising given the relatively recent development of HTA guidelines at international and national level. The use of Medical Physics and Clinical Engineering personnel to be involved in or even lead formal HTA of medical devices is even less common. The remainder of this article describes the successful collaboration of Medical Physics Department at Guy's and St Thomas' NHS Foundation trust (GSTT) in London, UK and the School of Biomedical Engineering and Imaging Sciences at King's College London (KCL), UK to provide formal HTA at both the local and national level of healthcare service provision.

II. KING'S TECHNOLOGY EVALUATION CENTRE (KITEC) AT KCL

The King's Technology Evaluation Centre (KiTEC) grew out of the King's Centre for Assessment of Radiological Equipment (KCARE), which was established at King's College Hospital in 1977 to evaluate the performance of new x-ray imaging equipment. These were 'hands on' evaluations by a multidisciplinary team of physicists, radiographers and radiologists and included clinical imaging of patients. Over time the methods used by KCARE moved more towards a modern HTA approach, including health economics and systematic reviews of relevant literature. In 2010, NICE issued a call for tenders for HTA centres to support its diagnostic and medical technology assessment programmes.

Under the leadership of Dr Cornelius Lewis and Prof Stephen Keevil KCARE became KiTEC, part of the part of the School of Biomedical Engineering and Imaging Sciences at KCL and incorporating medical statistics and health economics research groups also based at KCL. The KiTEC team now includes several GSTT hospital-based clinical engineers, medical experts, and academic medical statisticians and health economists. Since 2011 KiTEC has been an external assessment centre for NICE's diagnostic assessment programmes and medical technology evaluation programmes and most recently has been appointed as a Technology Specialist Evaluation Team (TSET) for the NHS-Transformation AI-Lab [4] to assist companies with building their evidence base for adoption of AI enabled medical devices by the NHS in England. Scotland, Wales and Northern Ireland have their own versions of this funding. Of the 13 "phase 4" projects funded since 2020 KiTEC is the TSET for four projects with a wide range of applications: mammography screening [5], ECG home monitoring [6], radiotherapy treatment planning [7] and incidental detection of vertebral fractures [8]. The set-up, facilitation and monitoring of these evaluations could not have been done without accessing the domain knowledge and institutional knowledge possessed by the medical physics and clinical engineering teams at all of the evaluation sites. In addition, the success of the evaluation trial designs and protocols were all heavily dependent on input from the Medical Department at Guy's and St Thomas' as to their feasibility and accuracy in obtaining the correct outcome measures. Going forward the multi-disciplinary team at KiTEC will be fundamental to the visionary MedTech Hub currently under construction at King's College London South Bank [8] providing that much needed link between medical research and health service delivery and policy making decisions. The MedTech Hub will provide a physical and creative space so that researchers, commercial entities and clinical specialist can work closely together using the framework of HTA to ensure that innovative medical technologies reach patients as quickly as possible.

III. CENTRE FOR INNOVATION, TRANSFORMATION AND IMPROVEMENT (CITI)

CITI was established at GSTT in 2021, with input from clinical engineers and medical physicists, alongside medical and nursing staff, improvement, analytics and implementation specialists, commercial innovation and legal teams.

The Centre is one example of a multidisciplinary unit, established with the purpose of delivering health service transformation. Initiatives like these have proliferated [9] due to a combination of health needs, economic challenges, emerging technologies, and learning from the Covid-19 pandemic. Medical devices and technology at large, are considered a significant vehicle for change in this space. Therefore, the role of HTA in decision-support is increasingly visible to the wider organisation—as are the clinical engineers and medical physicists involved in delivering it.

Within CITI a group clinical engineers and medical physicists, including some of the authors, led the development of a common framework for delivering innovation, transformation and improvement. Figure 1, using an analogy of London's 'circle' tube line, illustrates some of the common processes for innovation or improvement, moving from 'seeking opportunities' (on the left) through to refinement and deployment (on the bottom right).

It was identified that some form of HTA can be valuable at various points in the modelled 'innovation, transformation and improvement journey', and the framework could be used to signpost these. This includes possibilities for HTA to support decision making as practitioners "prioritise opportunities, …scan for current possibilities, …identify gaps and requirements,…evaluate solutions (in simulated environments), monitor and evaluate (post market)." By bringing medical device HTA and adoption alongside other processes for system improvement, initiatives like CITI not only showcases HTA and the work of medical physicists and clinical engineers but also exposes the role they might play in addressing challenges outside the remit of medical devices.

IV. AI CENTRE FOR VALUE-BASED HEALTHCARE AT KCL

The AI centre for value-based healthcare was established in February 2019 as part of the UK Government's Industrial Strategy Challenge Fund. The AI Centre is led by KCL and GSTT, alongside another 10 NHS Trusts, four Universities, several multi-national industry partners including Siemens Healthineers, NVIDIA, IBM, GSK, 10 UK-based SME's as well as the academic health science network (AHSN) Health Innovation Network. The centre aims to provide a "one-stop shop" for AI researchers and developers to link with front line clinicians with a goal to speed up and improve diagnosis and care across several patient pathways including stroke, dementia, heart failure and cancer using AI enabled tools. Part of this "one-stop shop" includes the facilitation of HTA at all stages of the project development process.

The team is necessarily a multi-disciplinary consortium of leading AI, data science, research, and clinical experts. Importantly the Clinical and Scientific Computing group within the department of Medical Physics at GSTT have played an essential role in building a robust and accessible platform for testing AI solutions in a way that will satisfy the HTA process of transparency and transferability.

The AI Deployment Engine (AIDE), is an open-source platform that allows the deployment of AI models in a safe, effective, and efficient way by enabling the integration of AI models into clinical workflows without the need to integrate into the local hospital IT network. AIDE provides a comprehensive system, encompassing administrative and clinical tasks as well as regulatory compliance, all important factors in the HTA process.

The platform allows any AI product to connect to the entire patient record database without requiring additional hardware or installation each time a new product is tested within a clinical workflow. Once the clinical data has been analysed by the AI product, the results can be sent back directly to the electronic patient record database to support further clinical decision making (see Figure 2).

AIDE has been built to be compliant with Digital Imaging and Communications in Medicine (DICOM), the international standard for using medical imaging information, and Health Level Seven (HL7), a framework for using electronic health information, making it easy to integrate into existing clinical settings. AIDE's dedicated IT infrastructure allows multiple algorithms to run simultaneously through bespoke Application Programming Interfaces (APIs).

In September 2021 the first instance of AIDE went live at King's College Hospital NHS Foundation Trust, with a stroke AI tool to support NHS clinicians to help improve direct patient care. By September 2023, the aim is to have this deployed across all 10 NHS Trust partners ready to provide access to candidate AI applications [10].

V. Conclusion

HTA can be defined as research that is intended to help decision makers deal with the development, acquisition, and utilisation of medical device technologies. Hospitals are tasked with ensuring that their healthcare technology investments show substantial improvement in patient outcomes in parallel with reduced operational costs. Hospital medical physics and clinical engineering departments have the experience and skills that make them obvious leaders in the HTA process and can bridge the gap between research findings and practical implementation in hospitals. Medical physics and clinical engineering departments are the hospital centres of medical device management. They are not only responsible for basic equipment control and safety but they also provide detailed cost and service analysis and support the annual capital acquisition processes for longer term strategic planning. The extremely successful collaboration between Medical Physics Department at GSTT and the Biomedical Engineering school at KCL demonstrate how powerful these partnerships can be. Together they have brought in more than £20 million over the last 5 years specifically for the translation of research into clinical practice.

Ideally all hospital decisions involving medical devices would be reviewed by a single multi-disciplinary committee, perhaps lead by the lead consultant healthcare scientist with a clear understanding of the components of a formal HTA process and that organization's mission, values, and strategies. Of course, in order to implement this an increase in the number of medical physics and clinical engineering staff with the relevant training in formal HTA processes will be needed.

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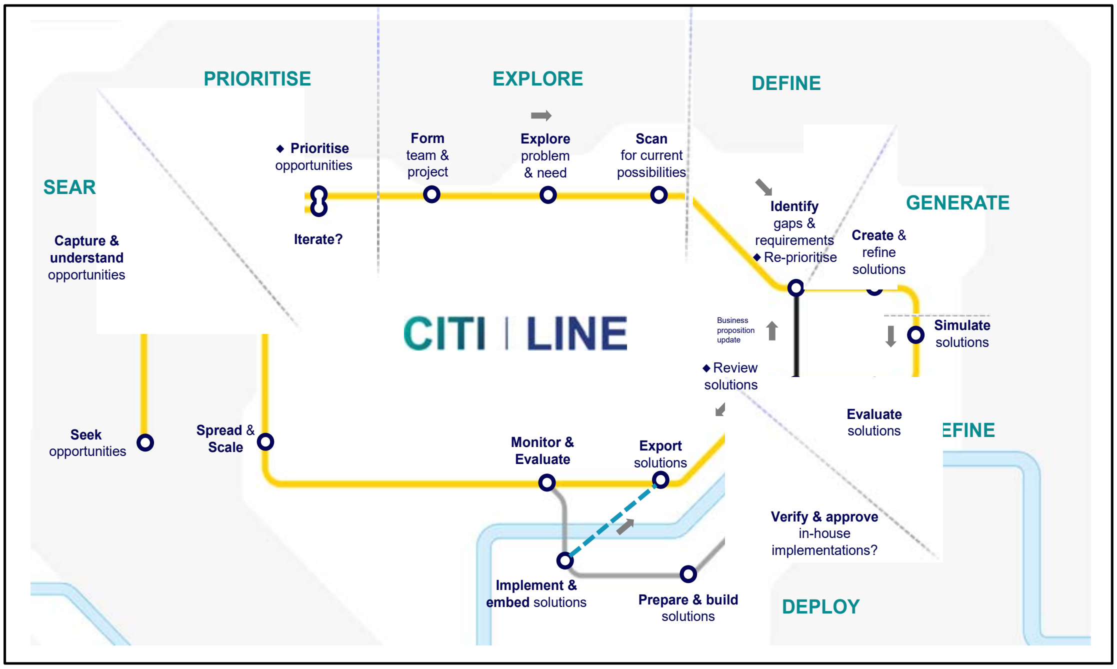

Figure 1. A cartoon version of the medical device design process from inception through to deployment viewed using the analogy of the circle tube line from the London Underground tube map.

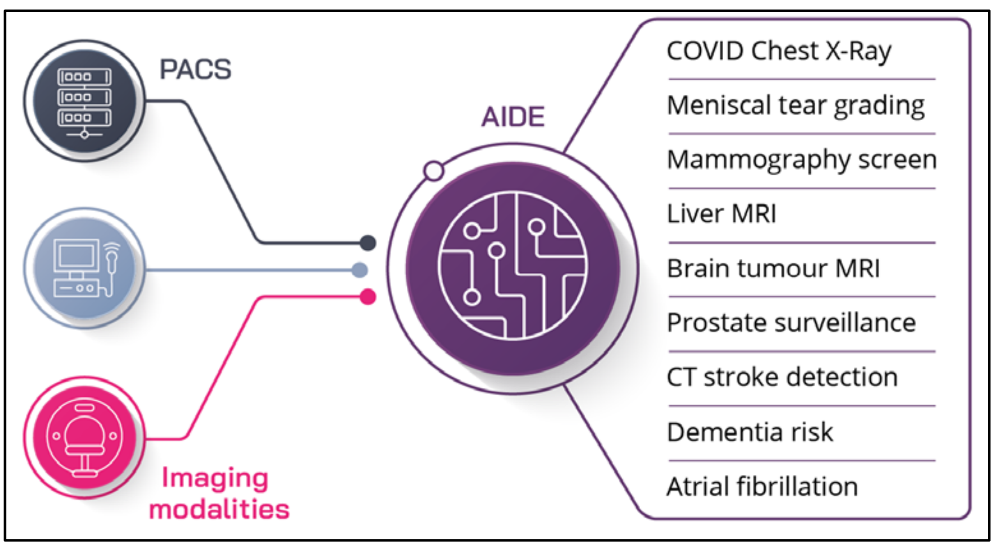

Figure 2. A schematic diagram of how the AIDE platform sits between the hospital data being analysed and the clinical services that are using the AI analysis.

CURRENT AND FUTURE DEVELOPMENT OF THERAGNOSTIC NUCLEAR MEDICINE

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Abstract— **Theragnostic nuclear medicine has gained increasing popularity in the recent years, primarily due to the advancement in molecular medicine and nanotechnology. Theragnostics can be achieved by either using a theragnostic radionuclide that emits both therapeutic (e.g. alpha, beta or Auger electrons) and diagnostic (eg. gamma or positron) radiations simultaneously; or incorporating two radionuclides (one for imaging, another for therapy), also known as the theragnostics pair, into the same radiopharmaceutical formulation. Multiple factors need to be considered when choosing a suitable theragnostic radionuclide or theragnostics pair, including their physical half-life, radioactive decay properties, linear energy transfer (LET), therapeutic and diagnostic radiations energy, ratio of non-penetrating to penetrating radiations, radiation safety, etc. This article aims to review the currently available theragnostic radiopharmaceuticals for clinical applications or clinical trials, as well as to discuss some emerging theragnostic radionuclides for future applications.**

Keywords— **Medical Physics Teaching**

Introduction

Theragnostics (or theranostics) has become a popular term in medicine. It refers to the combination of therapeutics and diagnostics agent(s) in one delivery system for targeted therapy or personalized medicine. The concept is described as "see what you treat and treat what you see" (1). In theragnostic nuclear medicine, a molecular targeting vector is labelled with diagnostic as well as therapeutic radionuclide(s) to acquire diagnostic images while delivering a therapeutic radiation dose to the targeted tissues (Fig. 1). This can be achieved by either using a theragnostic radionuclide that emits both therapeutic (e.g. alpha, beta or Auger electrons) and diagnostic (eg. gamma or positron) radiations simultanesouly; or incorporating two radionuclides (one for imaging and another one for therapy) into the same radiopharmaceutical formulation (2). The diagnostic agents are used to localize the site or disease state as a surrogate for a potential therapeutic agent, to examine its biodistribution and predict treatment outcome, to determine the optimal therapeutic dosage or activity to be administered, as well as to monitor treatment response throughout the treatment course.

Although the term "theragnostics" was introduced in medical encyclopedia in the early 2000's, the principle is not new at all in nuclear medicine. The first example of theragnostic nuclear medicine can be back dated to 1941 when Dr Saul Hertz first applied radioiodine (I-131) for hyperthyroidism treatment (3). I-131 emits both high energetic beta (maximum energy 606 keV) and gamma (364 keV) radiations hence it can be used for diagnostic and therapeutic purposes simultaneously, which fulfil the basic principle of theragnostics. I-131 has since then been used in multiple theranostics applications, such as I-131-NaI for thyroid malignancies, I-131-MIBG for neuroblastoma, I-131-Rituximab for non-Hodgkin lymphoma, etc. Recently, due to the advancement in nanotechnology and molecular medicine, theragnostic nuclear medicine has been expanded to treat multiple diseases/conditions. This article aims to review the current and future developments of theragnostics in nuclear medicine.

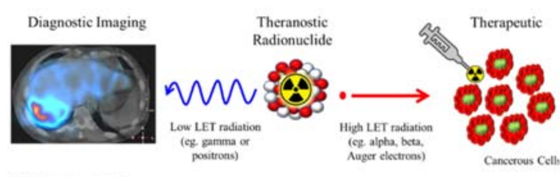

Fig. 1: Basic principle of theragnostic nuclear medicine (adapted from (2).

Selection of a Suitable Theragnostic Radionuclide

Selection of an ideal theragnostic radionuclide depends on several factors. First of all, the radionuclide should have appropriate biochemical reactivity and decay properties (4). For example, the radionuclide should have an appropriate physical half-life, usually between several hours to several days to achieve optimum treatment efficacy and radiation safety. The therapeutic radiations should have medium to high linear energy transfer (LET) and penetrate in sufficient range in tissue for the treatment purpose.

On the other hand, the diagnostic radiation energy should be suitable and sufficiently detected by a gamma camera or positron emission tomography (PET) scanner. Besides, the ratio of non-penetrating to penetrating radiations should be high, and the radionuclide should decay into a short-lived or stable daughter for safety purpose (5).

In addition, the radiopharmaceutical should have high selective concentration along with prolonged retention in the targeted tissues with minimal or no uptake in normal tissues (4).

Theragnostic Radiopharmaceuticals with Dual Functionality

Table 1 shows some examples of currently available theragnostic radionuclides with dual functionality (for therapeutic and diagnostic imaging).

Table 1: Currently available theragnostic radionuclides with dual functionality (therapy and diagnostics).

Radionuclide	**Physical half-life**	**Therapeutic radiation, energy, keV (%)**	**Diagnostic radiation, energy, keV (%)**	**Radiopharmaceuticals (commercially available/under clinical trials)**	**Clinical Applications**	**Ref.**
Gold-198 (Au-198)	2.7 d	β⁻ 960 (99%)	ϒ 412 (96%)	Au-198-nanoparticles	Therapy of bladder, cervix and prostate cancer, reduce fluid accumulation secondary to a cancer, relief pain in the synovial joints	(6–8)
Holmium-166 (Ho-166)	26.8 h	β⁻ 1854 (50%) 1774 (49%)	ϒ 81 (6%)	Ho-166-chitosan complex	HCC, skin cancer, cystic brain tumour, renal cysts, RA and hemophilic arthropathy	(9–12)
				Ho-166-DOTMP Ho-166-EDTMP	Bone metastases	
				Ho-166-PLLA microspheres	Liver malignancies, head, and neck squamous cell carcinoma	
Iodine-131 (I-131)	8.0 d	β⁻ 606 (89%)	ϒ 364 (82%)	I-131-NaI	Thyroid cancer and hyperthyroidism	(13–16)
				I-131-MIBG	Neuroblastoma, pheochromocytomas, paragangliomas, medullary thyroid carcinomas and other NETs	
				I-131-anti-CD45	Bone marrow ablation	
				I-131-CD276	Neuroblastoma for CNS	
				I-131-BA52	Metastatic melanoma	
				I-131-MIP-1095	Metastatic prostate cancer	
Lutetium-177 (Lu-177)	6.7 d	β⁻ 498 (79%) 385 (9%) 176 (12%)	ϒ 208 (11%) 113 (6%)	Lu-177-DOTATATE	Somatostatin receptor–positive gastroenteropancreatic NETs	(17–21)
				Lu-177-DOTMP Lu-177-EDTMP	Bone metastases	
				Lu-177-PSMA	mCRPC	
				Lu-177-NTSR1	Pancreatic ductal adenocarcinoma, colorectal cancer, gastric cancer	
				Lu-177-CD37	Indolent NHL, follicular lymphoma, diffuse large B-cell lymphoma	
Rhenium-186 (Re-186)	3.7 d	β⁻ 1069 (80%) 932 (22%) 581 (6%)	ϒ 137 (9%)	Re-186-HEDP	Bone metastases	(22–24)
				Re-186-sulfide-colloid	RA	
Rhenium-188 (Re-188)	17.0 h	β⁻ 2120 (71%)	ϒ 155 (15%)	Re-188-DMSA Re-188-HEDP	Bone metastases	(25–28)

		1965 (26%)		Re-188-HDD-iodized oil Re-188-HDD-lipiodol Re-188-HSA microspheres	HCC	
				Re-188-SCT	Skin cancer	
				Re-188-tin-colloid	RA	
Samarium-153 (Sm-153)	46.3 h	β^- 808 (18%) 705 (50%) 635 (32%)	γ 103 (28%) 70 (5%)	Sm-153-EDTMP	Bone metastases	(29–31)
				Sm-153-HA	RA and haemophilic arthropathy	
Tin-117m (Sn-117m)	13.6 d	Conversion electrons 152 (26%) 129 (12%) 127 (65%)	γ 159 (86%)	Sn-117m-DOTA-Annexin	Vulnerable plaque	(32–34)

Abbreviations:
CNS: central nervous system; HCC: hepatocellular carcinoma; mCRPC: metastatic castration-resistant prostate cancer; NETs: neuroendocrine tumours; NHL: non-Hodgkin lymphoma; RA: rheumatoid arthritis

Theragnostic Pairs

While there are limited choices of radionuclides that emit both therapeutic and diagnostic radiations in the suitable energy range, combining the emitting characteristics of different radionuclides with the same molecular targeting vector is an alternative approach. These radiopharmaceuticals are known as “theragnostic pairs”. For example, Ga-68-DOTATATE is used for PET imaging of neuroendocrine tumours before Y-90-DOTATATE is administered to treat the tumours. Table 2 presents some examples of the theragnostic pairs used in current clinical applications/trials.

Table 2: Examples of theragnostic pairs for current and future applications (3).

Disease	**Target**	**Companion Diagnostic agents**	**Therapeutic agents**
Currently available:			
Malignant pheochromocytoma, paraganglioma	Norepinephrine transporter	I-123-MIBG	I-131-MIBG
Neuroendocrine tumours	Somatostatin receptor	In-111-Pentetreotide Ga-68-DOTATATE Ga-68-DOTATOC	Lu-177-DOTATATE Lu-177-DOTATOC Y-90-DOTATATE Y-90-DOTATOC
Non-Hodgkin lymphoma	Anti-CD20 receptor	In-111-Ibritumomba Tiuxetan I-131-Rituximab	Y-90-Ibritumomba Tiuxetan Lu-177-Rituximab
Bone metastasis	Bone turnover	Tc-99m-MDP F-18-NaF	Sr-89 Sm-153-EDTMP Ra-223
mCRPC	PSMA	Ga-68-PSMA F-18-PSMA	Lu-177-PSMA Ac-225-PSMA
Hepatocellular carcinoma, cholangiocarcinoma, liver metastasis	Hepatic microcirculation	Tc-99m-MAA	Y-90-microspheres
Currently being evaluated:			
Multiple myeloma	CXCR4	Ga-68-CXCR4	Lu-177-CXCR4
Breast cancer	PD-1, PD-L1	Zr-89 F-18-anti-PD-1	Anti-PD-1 Anti-PD-L1

		F-18-anti-PD-L1	
Various tumours	HER2	Zr-89-anti-HER2	Anti-HER2

Emerging Theragnostics Radionuclides

A. Copper-64 (Cu-64)

Cu-64 is an interesting radionuclide as it decays via three different modes, i.e. positron decay, beta decay and electron capture (Fig. 2). Additionally, it has an unusually long physical half-life for a positron emitter. Therefore, it poses a great potential to be an excellent theragnostic agent. The positrons can be used for PET imaging while the high-energetic beta particles and Auger electrons can be used for therapeutic purposes. Recent studies showed that Cu-64 labelled to a variety of biomolecular markers demonstrated promising results for cancer treatment, such as prostate, glioblastoma, melanoma, colorectal and breast cancers (35). In a comparison study for prostate cancer (36), Cu-64-PSMA showed better image resolution than Ga-68-PSMA, and with the absence of urinary excretion it permits clear visualization of the prostate and bladder by PET. Cu-64-PSMA has a similar resolution as F-18-PSMA but Cu-64 has a longer half-life which is useful for therapeutic purposes. More clinical applications of Cu-64 are foreseen in the future with these promising theranostics characteristics.

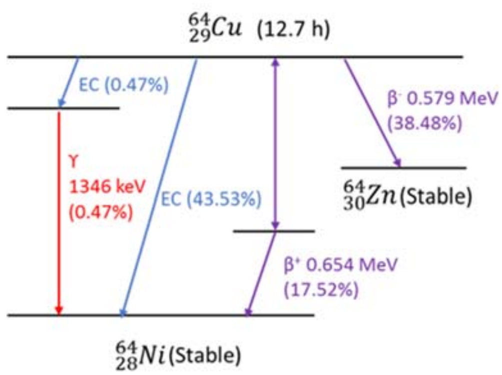

Fig. 2: Decay scheme of Cu-64 (Jalilian et al., 2017).

B. Copper-67 (Cu-67)

Cu-67 is another promising theranostic radionuclide in the copper family. It has a physical half-life of 2.58 days and it decays by beta ($E_{\beta-max}$ = 562 keV) and gamma emissions (E_{Υ} = 93 keV and 185 keV), rendering it with potential for simultaneous therapeutic and diagnostic applications. Cu-67-HER2 has shown promising results in radioimmunotheranostics of HER2-positive breast cancer (37). Furthermore, the recent breakthrough in Cu-67 production (via ^{68}Zn (ϒ, p) ^{67}Cu reaction) offers great opportunities to revitalize Cu-67 radiopharmaceuticals with high specific activity, high radionuclide purity, and with sufficient quantity (38). Interestingly, Cu-67 can also be paired with Cu-64 to perform pre-therapy biodistribution determinations and dosimetry by PET.

C. Terbium-161 (Tb-161)

Tb-161 has interesting decay characteristics that make it a promising theranostic radionuclide for oncology. It decays with a physical half-life of 6.9 days to stable Dy-161 by emitting beta particles ($E_{\beta-average}$ = 154 keV) associated with several conversion and Auger electrons, as well as gamma radiations (E_{Υ} = 49 keV and 75 keV). The co-emission of a large number of conversion and Auger electrons adds to the value of therapeutic effect as compared to Lu-177. On an average, 2.24 conversion and Auger electrons are emitted along with one beta particle decay (39). Based on some pre-clinical studies, the use of Tb-161 for cancer therapy showed minimal or no side effects to kidneys, as compared to Lu-177 (40). Furthermore, Tb-161 can be produced in high specific activity and radionuclide purity, rending it a potential theragnostic radionuclide for future applications.

D. Lead-212 (Pb-212)

Generator-produced Pb-212 is a particularly promising radionuclide for α-particle therapy of metastatic melanoma, neuroendocrine tumors, and other cancers. It has a physical half-life of 11 h and it decays 100% via beta decay to alpha emitters, Bi-212 and Po-212 (Fig. 3). The multiple alpha and beta particles emissions make it a useful therapeutic radionuclide. However, due to the lack of diagnostic imaging characteristic, a surrogate imaging agent is necessary to fulfil the theragnostics application.

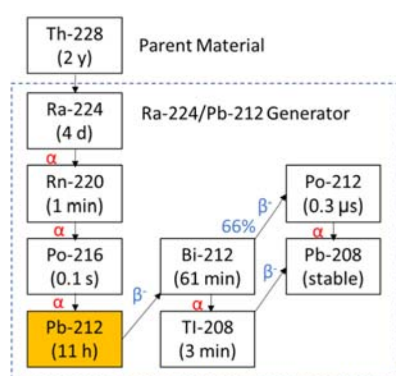

Fig. 3: Ra-224/Pb-212 generator (adapted from (41))

E. Actinium-225 (Ac-225)

Ac-225 is a pure alpha emitter. It decays via a cascade of six relatively short-lived radionuclides to long lived Bi-209 with a number of α-particles (high cumulative energy of 28 MeV) and β^- particles ($E_{\beta-max}$ = 1.6 and 0.6 MeV). It has a relatively long half-life (10 days) and rapid decay chain, render it a particularly cytotoxic radionuclide. However, similarly to Pb-212, it needs a surrogate imaging agent to perform biodistribution and treatment assessment imaging. Some clinical trials have demonstrated remarkable therapeutic efficacy of Ac-225 radiopharmaceuticals in treating various types of cancer including brain tumours, NETs, bladder cancer and prostate cancer (42).

F. F-18-FDG as a Theragnostic Agent

F-18-FDG is extensively used in PET imaging in oncology. F-18 emits energetic positrons with high abundance (96%) and a path length in tissue of 1 to 2 mm. Theoretically, these positrons can kill cancer cells in the same manner as electrons. Besides, F-18-FDG has a potential role as an immunomodulator to upregulate PD-L1 expression in tumours to enhance the efficacy of immunotherapy using ani-PD-L1. In a much recent study (43), a group of researchers from China and Singapore explored the potential of using F-18-FDG to induce PD-L1 expression in tumour and to create an immune-favourable microenvironment for anti-PD-L1 immunotherapy. The group has tested the method in different tumour cell lines (melanoma, breast, and colorectal cancer) and found that F-18-FDG significantly increased the expression of PD-L1 mRNA on tumour cells in a dose-dependent manner. The study was continued with in-vivo animal (mice) study using MC38 and CT26 colorectal tumour models. Their results showed that F-18-FDG induced significant PD-L1 upregulation and remodelled the tumour microenvironment, and subsequently enhanced the efficacy of immunotherapy using αPD-L1. As F-18-FDG is routinely used in cancer diagnosis, the combination of F-18-FDG and αPD-L1 mAb treatment would provide a new paradigm for cancer therapy.

Conclusion

In conclusion, theragnostic nuclear medicine has broadened the opportunities for innovative, safer and effective strategies towards personalized medicine. The field is currently undergoing rapid and exciting development that would mark the future of nuclear medicine. However, a sustainable development that provides continuous supply, reliable quality and affordable costs of theragnostic radiopharmaceuticals should be considered and maintained.

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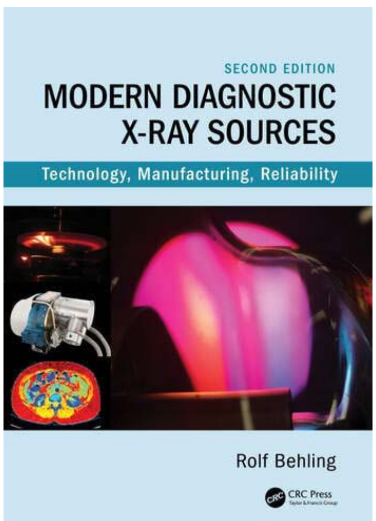
BOOKS

"MODERN DIAGNOSTIC X-RAY SOURCES – Technology, Manufacturing, Reliability" by ROLF BEHLING

S. Tabakov[1,2], L. Bertocchi[3]

[1] King's College London, UK, [2] Past President IOMP, [3] ICTP, Trieste, Italy

Abstract— **This article is a brief review of the textbook "Modern Diagnostic X-Ray Sources – Technology, Manufacturing, Reliability" by Rolf Behling (1st Edition in 2016 and 2nd Edition in 2021), CRC Press, Boca Raton, USA, ISBN-13 9781482241327 and 9780367546922**



The book "Modern Diagnostic X-Ray Sources – Technology, Manufacturing, Reliability" is an unique publication covering specifically X-ray tubes used in contemporary medical diagnostic X-ray equipment. Its 2nd Edition was published in 2021 - ISBN 9780367546922. The 2nd Edition has more colour illustrations and extended focus on education (which is also very good in the 1st Edition).

The author Dr Rolf Behling is one of the top world experts in the field with some 40 years experience on the subject, including Head of the Philips Group for Advanced Development of X-ray Tubes and X-ray Generators. He is also part-time lecturer at the University of Hamburg, and after his retirement, is consultant in XtraininX, Germany.

Dr Behling is known to the readers of the Journal Medical Physics International (MPI) through his paper "Performance and Pitfalls of Diagnostic X-Ray Sources: An Overview" (MPI 2016, vol.4, No.2), and his history article "X-Ray Tubes Development" (MPI 2018, Special Issue 1).

The book has c.400 pages (additional to the 24 pages preliminary info, including 6 pages detailed content of the 10 chapters – see Amazon *lookinside*). The book includes c. 400 diagrams, figures and tables, supporting its educational value. The comprehensive book Index is on 15 pages.

The 1st Chapter "Historical Introduction and Survey" gives a comprehensive introduction of X-ray tubes development from Roentgen's time, through various major steps of X-ray tubes design and development, including the first Rotating anode X-ray tubes, the Metal-Ceramic X-ray tubes, the Rotating frame X-ray tubes, various High-power CT X-ray tubes, etc. The chapter includes photos of the main types of X-ray tubes and discusses their principles.

The 2nd Chapter "Physics of Generation of Bremsstrahlung" present all necessary theory on the subject and links very well the theory with the generation of X-rays in diagnostic X-ray sources, formation of spectra, angular distribution of the Continuum radiation and Scattered radiation; Electron scatter in the anode and backscatter; Isotropic X-ray intensity distribution and the Heel effect.

The 3rd Chapter "Interaction of X-rays with Matter" looks as a standard chapter of this type, but again it includes various information and diagrams, related to absorption and scattering, rarely seen in the well-known textbooks on the subject. As in all chapters, here are listed main textbooks, which could be consulted.

The 4th Chapter "More Background on Medical Imaging" discusses the formation of the X-ray image. Comprehensively are covered the Linear Systems Theory and Modulation Transfer Function. The are also presented the foundations of Spectral imaging, Phase-Contrast imaging, Fluorescence imaging and Polarized X-rays.

The 5th Chapter "Imaging Modalities and Challenges" presents the foundations of Computed Tomography (with its sub-methods), Cardio and Vascular Imaging, as well as specific Radiographic equipment for Mammography, Dental and other applications. The types of X-ray tubes for these imaging modalities are specially discussed.

All these chapters are superbly presented as an unique mix of physical principles, engineering methods (see Fig.1) and application procedures. This way of presentation is not seen in most of the existing books on the subject. The next 6th Chapter "Diagnostic X-ray Sources from the Inside" is almost a small book by itself. No similar chapter exists in all medical physics books. Here the industrial experience of the author shows the components of the X-ray tubes in a way which really opens the "black box" of the X-ray tube and presents the details of such a complex part of the equipment from the perspective of its engineering. The chapter is supported with many photos, diagrams and tables, which can be very useful both in the process of learning/ teaching about X-ray tubes and in the process of selecting/purchase of such. The X-ray tube components: Anode, Cathode and others (rotor systems, drives, vacuum bearing) are given in an unprecedented detail. The chapter also discussed the ways of maintaining the X-ray tube vacuum. The chapter explains very well the subject and could satisfy even the most demanding lecturer or most curious student. This chapter can be seen as an example of presenting topics of applied physics – from the principles to their engineering application.

The 7th Chapter "Housings, System Interfacing and Auxiliary Equipment" covers the X-ray tube assembly, the shielding, filtration, beam limitation, cooling, protection of implosion and explosion, etc.

The 8th Chapter "The Source of Power" gives a comprehensive coverage of the main types of X-ray Generators and its components (transformers, rectifiers, stabilizers, wave forms, etc). The chapter includes block diagrams and electrical circuits.

The 9th Chapter "Manufacturing, Service and Tube Replacement" gives sufficient information for the medical physicist about these important engineering procedures. Average lifetime of X-ray tubes and main sources of failure are presented, together with associated warranty, Costs of ownership and recycling.

The 10th Chapter "X-ray Source Development for Medical Imaging" discusses the newest developments and trends in the field, such as Liquid metal anodes, Carbon nanotube filed emission cathodes, Non-bremsstrahlung sources of X-rays, etc.

The book is written very well – with logical and condense structure, which supports well its understanding. Reading the book requires knowledge of medical physics principles and is one of the best sources of information for preparation of lectures in the field of Physics and Equipment of X-ray Diagnostic Radiology.

The book of Dr Rolf Behling about X-ray tubes can be seen as a must for each Medical Physics Department with activities in X-ray Diagnostic Radiology – from Quality Control to selection/purchase of new X-ray equipment (and replacement X-ray tubes). For some countries the book can be seen also as a bridge between medical physics and clinical engineering activities.

We would like to conclude this brief review with a congratulation to the author for this unique excellent book with much needed detail about X-ray tubes – the devices which triggered the beginning of medical physics profession and still support over 2/3 of all medical imaging procedures.

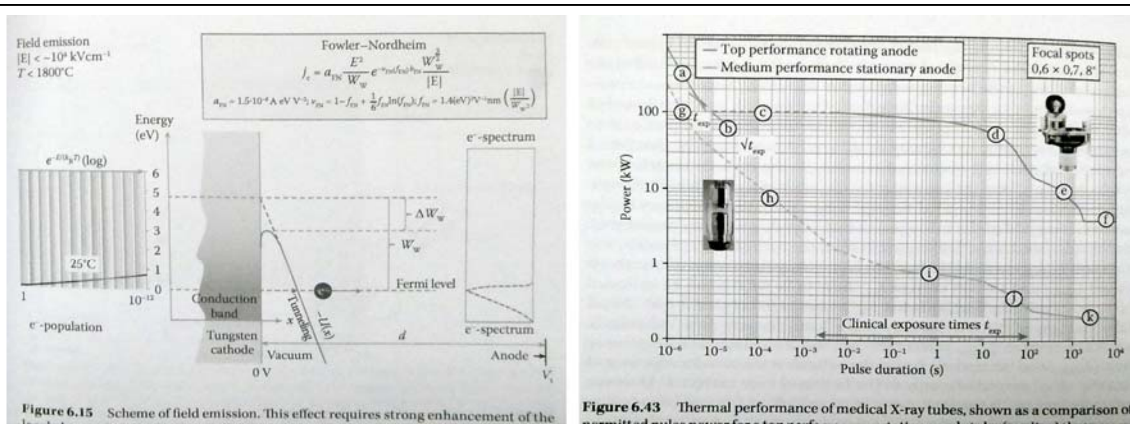


Fig.1 Indicative diagrams from the book (Ch.6), including physics principle and engineering performance details

PROTON THERAPY PHYSICS
(2ND EDITION)
(HARALD PAGANETTI, EDITOR)

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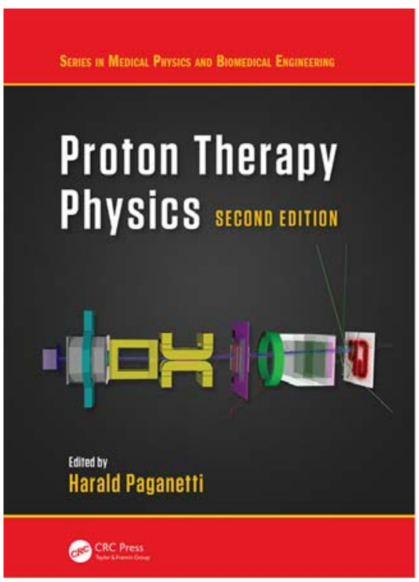
I. Book details

Proton Therapy Physics (Second Edition), 772 pp, CRC Press Taylor & Francis Group
Edited by: Harald Paganetti
ISBN: 9780367570781 (paperback)
ISBN: 9781138626508 (hard cover)
ISBN: 9781315228310 (e-book)



II. Review

This is the second edition of a book published 11 years ago that had a remarkable and successful impact on the proton therapy community. The first edition deserved to be updated due to the considerable evolution and the widespread diffusion of proton therapy since then. The book was updated including new chapters organized in thematic sections named: “Background”, “Beam Delivery”, “Dosimetry”, “Operation”, “Treatment Planning/Delivery”, “Imaging” and “Biological Effects”. In some cases, the names given to each session were misleading and not clear of what that session was referring to. For example, the “Operation” section puts together Acceptance and Commissioning with Monitor Unit Calibration chapter that maybe would have been more relevant if grouped in the “Dosimetry” section; or the “Monte Carlo Simulations” chapter in the “Dosimetry” section would have been better placed in the “Treatment Planning/Delivery” section. Nonetheless the efforts put to improve the significance of each chapter with respect to the previous edition were massive. This resulted in a total of 23 chapters compared to the 20 of the previous edition.

The first two chapters give a complete and valid background to medical physics students that approaches proton therapy in terms of history and theory behind the rationale of using protons in clinical radiotherapy applications. Here, all the main formulae for the physics description of proton interaction with matter can be found.

One of the main improvements of the book regarded the dosimetry section. This part was enriched with an entire chapter dedicated to Monte Carlo (MC) and a whole variety of its application in proton therapy. From a general introduction to MC methods for the estimation of uncertainties due to the method itself, from the simulation of passive beam lines to the simulation of scanned beam delivery with an interesting concluding paragraph on practical MC clinical applications such as organ motion studies, simulation of LET distributions, detectors modeling etc. The section was further improved in the chapter dedicated to absolute and reference dosimetry with a new paragraph dedicated to the importance of dosimetric intercomparisons and reference dosimetry audit, confirming the clinical orientation the editor decided to give to this edition of the book.

In the section “Operation” there is an interesting chapter dedicated to the calibration of monitor units. This is one of the most interesting improvements with respect to the previous edition since it was presented as a theoretical and practical guide to the reader of one of the most delicate step during the commissioning phase of a proton therapy facility.

The section “Treatment Planning/Delivery” is very similar to the previous edition confirming the importance the authors decided to give to the effect the uncertainties (setup, range, motion, anatomy, RBE etc.) can have on the quality of dose delivered. The robustness evaluation seems to be sacrificed in this section. The impact of this topic on clinical practice is relevant and it deserved to be treated more carefully than a single paragraph. The improvements in the section were mainly focused on how to consider the uncertainties in planning and delivery phases and on robust optimization. In particular, more space was dedicated to 4D robust optimization and the management of breath hold in the planning phase. At the end of the chapter the topic of the optimization of rotational proton therapy is also introduced. The authors decided to give a general overview on the spot scanning proton-arc with no further details that could have been misleading for the reader since this topic is constantly evolving and changing.

The “Imaging” section was enriched with new clinical applications such as the use of SGRT in clinical practice which is becoming widely used in the radiation therapy community. The paragraph on in-vivo PET and prompt gamma gave a detailed background to whoever is approaching these topics. In accordance with the rest of the book this section was improved, with respect to the previous edition, by giving feedback to the reader on how these techniques can be applied in a real clinical workflow and first clinical experience.

The section on proton biology remains, from a didactical point of view, a valid guide to medical physicists approaching this topic. It still gives a valid background of the importance of RBE and an idea of how difficult a clinical application of this concept, different from the classical formulation of the 1.1 scaling factor, can be in clinical practice. The chapter had two more paragraphs treating the problem of the biological optimization and the estimation of out-of-field effects. This was possible thanks to the LET based planning concept that is going to be clinically applicable in the new commercial treatment planning systems.

In general, the book confirmed its validity and its importance for the proton therapy community. Having a book that treats all of the above-mentioned aspects of proton therapy in a didactical form and gives all the updated references helps both the students that are approaching the field and the experts in being updated on each of these topics. The previous version of the book needed an update and the way it was done, focusing on clinical application for each section, was the best because gave an idea of the real problems a team of medical physicists has to solve every day in clinical workflows. Some topics needed more emphasis and insight like the robustness evaluation that has such a relevant impact on proton therapy clinical practice. In summary, this book is a welcome confirmation to proton therapy bibliography and should be on the bookshelf of every medical physicist in the community.

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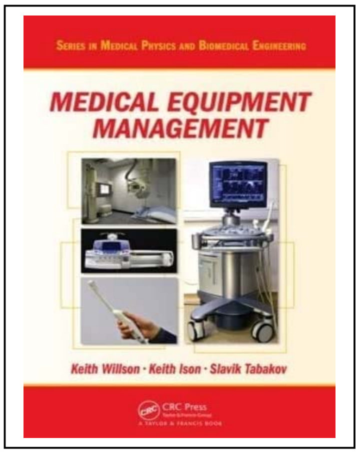
"MEDICAL EQUIPMENT MANAGEMENT "
by Keith Wilson, Keith Ison and Slavik Tabakov

Stoeva, M.[1,2]

[1] Medical University of Plovdiv, Bulgaria, [2] Secretary General IOMP,

Abstract— **This article is a brief summary of the content and the 10-year experience of using the textbook "MEDICAL EQUIPMENT MANAGEMENT" by Keith Wilson, Keith Ison and Slavik Tabakov, CRC Press, Boca Raton, USA, ISBN-13 9781420099584**



Over the years the textbook "Medical Equipment Management" has become an important resource for both clinical engineers and medical physicists. Equipment management however is a key topic not only when it comes to medical equipment's physical and technical aspects, but also healthcare management. Therefore the book turns out to be an important resource of information and practical guidance for hospital managers, healthcare administrators, academic departments chairs, etc.

The book is based on the lecturing of the module "Management of Medical Equipment" at the MSc Medical Engineering and Physics at King's College London, UK – a unique module introduced in 2003 and delivered to this day. The authors, who have introduced the content of this module, have worked on the book from 2009 to 2013 and have structured the book in an unusual and very effective way. The book includes sections, allowing the user to access various moment of the Medical Equipment Life Cycle. Most of the sections include examples of three different equipment: small, medium, large (syringe driver, Ultrasound scanner; X-ray equipment). This practical approach makes the book very usable for various specialists dealing with medical equipment. Since 2014 the knowledge from the book has been applied by S Tabakov in the curriculum of the ICTP College on Medical Physics. Later the book structure and approach have been used in the MSc in Advanced Medical Physics of the ICTP and the University of Trieste and in various medical physics-related lectures at the Medical University of Plovdiv. To our knowledge elements of the book are used also in medical physics/engineering educational courses in various countries

Many examples in the book are based on the experience and legislation of the UK and the European Union, but the authors have aimed the content to be of use in various countries. Special focus is given on applicability in LMICs where access to such or similar guidance material may be quite limited and quite often Departments for Medical Physics and Clinical Engineering do not exist.

The book has c.340 pages and includes a detailed Content of 10 pages. The book has 14 chapter and two Appendices and concludes with an Index of 12 pages. The Chapters of the book are:

1.Introduction;
2.Medical Equipment and its Life Style;
3.Medical Device Risk, Regulation and Governance;
4.Approaches to Equipment Management: Structure and Systems;
5.Purchase and Replacement: Allocating Priorities and Managing Resources;
6.Procurement, Specification and Evaluation;
7.Equipment Training for Clinical and Technical Users;
8.Assessing Maintenance and Support Needs;
9.Maintenance Contract Management;
10.Adverse Incidents, Investigations, Control and Monitoring;
11.Supporting Research and Development;
12.Disposal;
13.Sources of Information for Equipment Management Professionals;
14.Improving Performance: Quality Indicators, Benchmarking and Audit;
Appendix A: Practical Issues in Running and In-House Clinical Engineering Service;
Appendix B: Electrical Safety for Medical Equipment.

As seen from the Content the book covers the specific parts of Medical Equipment Management and gives excellent practical advice. Thus, activities as: Preparing specifications; Understanding tenders and purchase of equipment; Dealing with Service Contracts; Training staff; Investigating incidents; Improving performance; Disposing equipment, etc. are part of the activities of medical physicists in many countries.

The book can find its place and value in medical physics or engineering departments as well as healthcare management & decision makers globally.

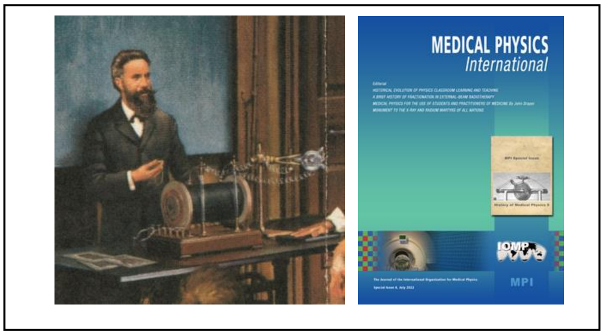
HISTORY TOPICS

MEDICAL PHYSICS INTERNATIONAL HISTORY EDITION

Sprawls, P[1], Tabakov, S.[2,3]

[1]Sprwals Educational Foundation, USA, [2] King's College London, UK, [3] Past President IOMP

Abstract— **This article describes briefly the History Editions of the Medical Physics International Journal.**



The medical physics profession has an extensive and dynamic history and heritage that is the foundation of who we are today. The objective of the journal, Medical Physics International History Edition series is to provide all medical physicists and related professionals with the opportunity to know and appreciate our background consisting of scientific discoveries and the development of technology and procedures that is a major component of modern medicine as it is practiced today. This has been along with and supported by the development of the medical physics profession with educational programs and dedicated scientific and professional organizations in all regions of the world.

Although physics and physical principles had been applied in a variety of medical procedures over the years it was the event shown here that can be considered as the origin of medical physics and the medical physics profession as we know it today.

In 1895 a physicist, Prof. Wilhelm Roentgen, not only discovered a "new kind of radiation", but he also quickly conducted extensive research to determine its characteristics and, in the lecture and demonstration shown here, introduced x-ray and medical imaging to the world. It was the physicists in the various countries who had the knowledge, and often the equipment to conduct x-ray imaging procedures and begin collaboration with the medical doctors. From that time on, physicists have been leaders in the development of the many modern imaging modalities (CT, MRI, Mammography, Ultrasound, and several Radionuclide Imaging methods.) With the discovery of the biological effects of ionizing radiation on human tissues the several methods of radiation therapy were developed and planning and optimizing clinical procedures for individual patients is performed by physicists around the world.

This is our history and heritage.

The journal, Medical Physics International History Edition, was first published in 2018 as a project described in the MPI Journal 2017, vol.5, No1, p. 68-6 . The Founding Co-Editors, Slavik Tabakov and Perry Sprawls plan and organize each Edition with articles authored by medical physicists from throughout the international medical physics community.

From Special Issue 3 (in 2020) the Editors are: Slavik Tabakov, Perry Sprawls and Geoff Ibbott. From its 1st issue to the current 8th Issue the MPI History Edition series have published 960 pages with historical materials, including many photographs, diagrams and references.

Many of the authors published in the MPI History Edition are medical physicists with many years of experience that coincides with some of the major developments in medical imaging and radiation oncology. These authors often provide a unique and valuable perspective based on their personal experiences and observations.

The articles published so far can be read here:

*ROENTGEN'S INVESTIGATION DETERMINING THE CHARACTERISTICS OF X-RADIATION

Diagnostic Imaging

*X-RAY TUBES DEVELOPMENT - IOMP HISTORY OF MEDICAL PHYSICS

*FILM-SCREEN RADIOGRAPHY RECEPTOR DEVELOPMENT A HISTORICAL PERSPECTIVE

*FLUOROSCOPIC TECHNOLOGY FROM 1895 TO 2019

DRIVERS: PHYSICS AND PHYSIOLOGY
*THE SCIENTIFIC AND TECHNOLOGICAL DEVELOPMENTS IN MAMMOGRAPHY A CONTINUING QUEST FOR VISIBILITY
*REVIEW OF THE PHYSICS OF MAMMOGRAPHY
*HISTORY OF DENTAL RADIOGRAPHY: EVOLUTION OF 2D AND 3D IMAGING MODALITIES
*THE HISTORY OF CONTRAST MEDIA DEVELOPMENT IN X-RAY DIAGNOSTIC RADIOLOGY
*THE MANY STEPS AND EVOLUTION IN THE DEVELOPMENT OF COMPUTED TOMOGRAPHY
*TECHNOLOGY AND IMAGING METHODS, THE QUEST FOR ENHANCED VISIBILITY THE FIRST FIFTY YEARS

Radiation Therapy

* A RETROSPECTIVE OF COBALT-60 RADIATION THERAPY: “THE ATOM BOMB THAT SAVES LIVES”
*A BRIEF HISTORY OF FRACTIONATION IN EXTERNAL-BEAM RADIOTHERAPY -BEAM RADIOTHERAPY

Ultrasound Physics

*A HISTORY OF MEDICAL ULTRASOUND PHYSICS – INTRODUCTION
*ULTRASOUND – THE FIRST FIFTY YEARS
*ULTRASONICS METROLOGY I.
THE HISTORY OF THE MEASUREMENT OF ACOUSTIC PRESSURE AND INTENSITY USING HYDROPHONES
*ULTRASONIC METROLOGY II.
THE HISTORY OF THE MEASUREMENT OF ACOUSTIC POWER AND INTENSITY USING RADIATION FORCE
*ULTRASONICS METROLOGY III.
THE DEVELOPMENT OF THERMAL METHODS FOR ULTRASOUND MEASUREMENT
*A HISTORY OF MEDICAL ULTRASOUND PHYSICS: PART II – INTRODUCTION
*HISTORY OF MEDICAL ULTRASOUND
*THE DIASONOGRAPH STORY
*HEWLETT PACKARD - INNOVATIONS THAT TRANSFORMED DIAGNOSTIC ULTRASOUND IMAGING
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Medical Physics Education

*HISTORY OF MEDICAL PHYSICS E-LEARNING INTRODUCTION AND FIRST ACTIVITIES
*HISTORY OF MEDICAL PHYSICS EDUCATION AND TRAINING IN CENTRAL AND EASTERN EUROPE – FIRST CONFERENCES, PROJECTS AND MSC COURSES
*HISTORICAL EVOLUTION OF PHYSICS CLASSROOM LEARNING AND TEACHING
*MEDICAL PHYSICS FOR THE USE OF STUDENTS AND PRACTITIONERS OF MEDICINE
By John Draper, 1885

The X-Ray and Radium Martyrs

* MONUMENT TO THE X-RAY AND RADIUM MARTYRS OF ALL NATIONS

Development of Medical Physics Around the World

*MEDICAL PHYSICS DEVELOPMENT IN AFRICA – STATUS, EDUCATION, CHALLENGES, FUTURE
*MEDICAL PHYSICS DEVELOPMENT IN SOUTH-EAST ASIAN FEDERATION OF ORGANIZATIONS FOR MEDICAL PHYSICS (SEAFOMP): 2000 - 2020

History of the IOMP

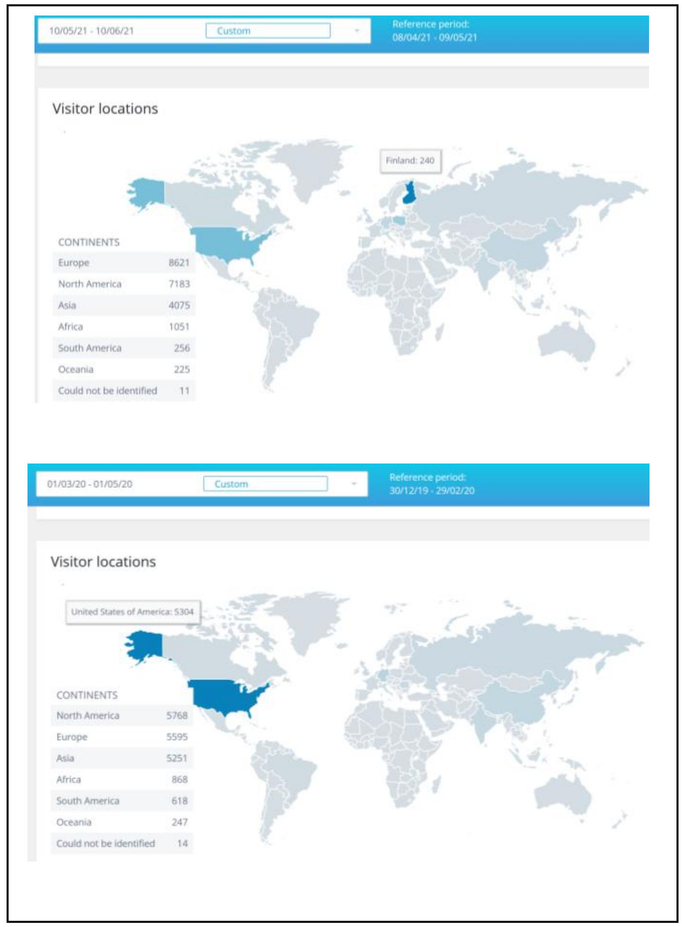
*IOMP HISTORY – ACTIVITY DEVELOPMENT AND MAIN DOCUMENTS

*A HISTORY OF THE INTERNATIONAL ORGANIZATION FOR MEDICAL PHYSICS – 50 YEARS ANNIVERSARY – PART I (Reprint from MPI 2013)

*A HISTORY OF THE INTERNATIONAL ORGANIZATION FOR MEDICAL PHYSICS – 50 YEARS ANNIVERSARY – PART II (Reprint from MPI 2014)

*HISTORY AND ACHIEVEMENTS OF THE IOMP IN THE PERIOD 2012-2022

*ANNEX: IOMP HISTORY TABLES



Medical Physics International History Edition continues with up to two publications each year adding to the extensive collection of articles listed above.

Over the years the History articles were welcomed by a number of medical specialists globally. The statistics diagrams from the MPI server give an indication of the global distribution of the History Edition series readers for two separate issues (in 2020 and 2021 – in the field of X-ray Diagnostic Radiology and Ultrasound Imaging).

Currently the MPI History Edition series are preparing a topical issue, celebrating IOMP 60th Anniversary in 2023.

Physicists who are interested in sharing of their interest, experience, and observations to publish additional historical articles can contact the Editors of the MPI History Editions series to select appropriate topics for consideration.

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ANNEX

ICTP College on Medical Physics

Celebrating 30 Years

A brief College History and
Compilation of Appreciation Messages from around the World

This Folder for the ICTP Board was presented

to the ICTP Deputy Director Prof. Sandro Scandolo

and to the ICTP Director Prof. Fernando Quevedo

during ICTP College on Medical Physics, 2018

The Folder was compiled by Prof. Slavik Tabakov

on behalf of the Directors and Faculty of ICTP College 2018,

it includes appreciation messages from College students from 40+ countries,

as well as brief history of the College on Medical Physics and its global impact.

ICTP College on Medical Physics Celebrating 30 years (free e-book)

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Celebrating 30 years of ICTP College on Medical Physics – Global Impact

The ICTP College on Medical Physics - need and impact on healthcare in LMI countries

Medical physicists have a very important role in contemporary medicine, associated with the clinical application of various physical principles – most often applied to medical imaging and radiotherapy equipment plus associated radiation safety. This way it is only natural to see growth of the number of medical physicists with the increased use of this equipment in healthcare. Medical physicists work mainly in hospitals, but also in Universities, Research Institutions, Regulatory bodies, Industry, etc.

According to the data of the International Organization for Medical Physics (IOMP) in 2017 there are close to 26,500 medical physicists in the world. However these are very unequally distributed (Fig.1). About 70% of all medical physicists are in North America and Europe, serving population of the order of 1 billion. The remaining 30% of medical physicists serve the healthcare of the rest of the world – about 6.5 billion population [1].

The number of medical physicists in Low-and-Middle-Income (LMI) countries is below all current recommendations and this affects the healthcare provision in these countries, especially in the fields of diagnosis and treatment of noncommunicable diseases (e.g. cancer, heart disease, stroke). Many LMI countries have diagnostic imaging equipment and radiotherapy equipment, but do not have staff, especially medical physicists, who can assure the effective and safe use of this complex equipment [2].

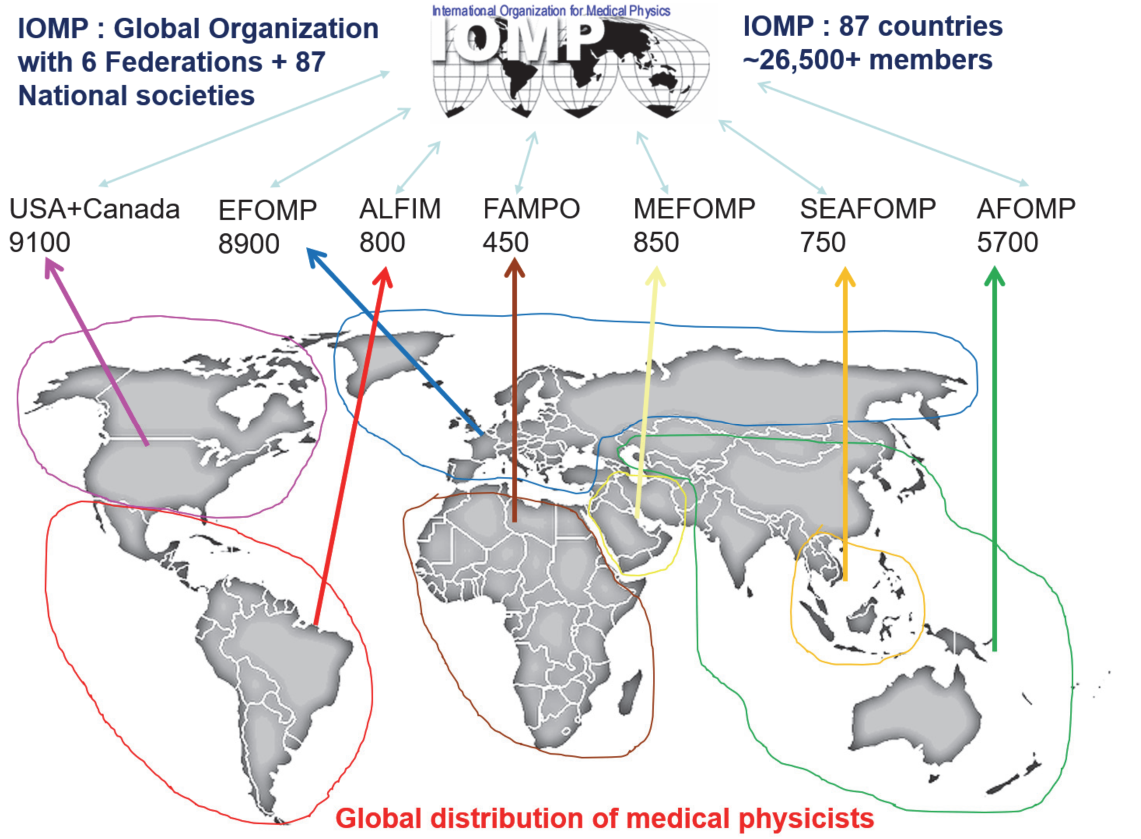

Fig.1 Global distribution of medical physicists (data from 2017) as per the Regional Federation of IOMP: EFOMP (Europe), ALFIM (Latin America), FAMPO (Africa); MEFOMP (Middle East), SEAFOMP (South-East Asia), AFOMP (rest of Asia).

Most of medical physicists (about 2/3) work primarily in the field of radiotherapy. Understandably there are courses in this field organised by IAEA and other international and national organizations. Some of these and the remaining 1/3 of medical physicists work in the field of medical imaging using various imaging modalities and related radiation safety. This is also a very important field, as more than 95 per cent of the radiation dose to the global population, coming from man-made sources, stems from medical exposures [3]. As per the UNSCEAR 2008 Report [4], the annual number of medical diagnostic radiation uses in the world are:

- 3,143 million diagnostic medical examinations (X-ray) – c. 220% increase compared with 1988;
- 32,7 million nuclear medicine procedures – c. 40% increase compared with 1988.

This very high increase of the radiation use in diagnostic medicine continues with similar trends. This requires well trained medical physicists, capable to optimise medical exposures, aiming to achieve high image quality with low radiation dose.

Over the recent decades medical imaging has developed from basic x-ray procedures to include many more complex imaging methods including computed tomography (CT), magnetic resonance imaging (MRI), and methods administering radioactive materials to patients including SPECT and PET. A medical physicist is the medical imaging professional with the knowledge and experience to analyse and optimize procedures with these modern imaging methods to obtain accurate diagnostic information at the lowest risk to patients.

Beginning in the 1990s general X-ray imaging transitioned from producing images on film to producing images in electronic digital format. While this provided many values and advantages it also introduced a complexity that requires medical physicists in the hospitals and clinics to support the modern imaging procedures. This required modified education and training of LMI medical physicists to be introduced at the beginning of the new century, associated specifically with digital imaging. Thus the College provision was changed during 2001 to make it suitable for educating young physicists from LMI countries who can deliver such service to the healthcare of their own countries. All ICTP College lectures were adapted to provide the most important information to these colleagues, alongside with skills related to imaging optimisation, quality control and radiation safety. The modification of the educational program took in consideration also the background physics education in most LMI countries. The unique new education program of the College included also the pioneering medical physics e-learning materials - Sprawls Resources, EMERALD, EMIT and EMITEL. Thus the College succeeded in the limited period of only 3 weeks to prepare specialists who were then able to apply their knowledge in their own healthcare systems and university courses. More than 700 students from 89 countries passed through this unique ICTP College in the period 2002-2018 (Fig.2).

A major objective of the College is to develop the participants as educators who can create effective medical imaging programs in their countries. This is being achieved through the combination of three specific activities. 1. Providing them with instruction on the modern imaging methods; 2. Providing instruction on the process of learning and teaching and the development of appropriate educational programs for their institutions; and 3. Providing them with extensive high-quality teaching materials and resources to be used in their courses. Through this process much of the learning that occurs in the College on Medical Physics program in Trieste is duplicated in many countries around the world as these students further disseminate the knowledge in their countries using the materials provided to them at the ICTP College. A number of the participants organised medical physics courses – both local and university (MSc-Level) in their own countries. Some of them created medical physics societies or became officers of the existing societies. This provided a real backbone of the medical physics professional development in LMI countries. Even most importantly these students assisted in the diagnosis and treatment of millions of patients in this part of the world.

The ICTP College on Medical Physics is unique worldwide in its role of providing such education. Due to this reason it was logical for it to become member of the first Medical Physics e-Learning project EMERALD, which global impact was the reason for receiving in 2004 the inaugural Award for Vocational Education of the European Union – the Leonardo da Vinci Award. Further the ICTP College and its students took an active part in the creation of the first Multilingual Dictionary of Medical Physics Terms, which is currently translated to 30 languages: English, French, German, Italian, Swedish, Spanish, Portuguese, Bulgarian, Czech, Greek, Hungarian, Lithuanian, Polish; Estonian, Romanian, Turkish, Latvian, Russian, Thai, Arabic, Iranian, Bengal, Slovenian, Malay, Chinese, Croatian, Japanese, Finnish, Korean, Georgian. About 1/3 of the languages were translated by past students of the ICTP College. Based on this Dictionary a large further project - EMITEL Encyclopaedia of Medical Physics - was developed. This was the largest international project in the profession and its team included the Presidents of 21 National and International Societies (some of them past College participants). The Encyclopaedia Conference and the first International Conference on e-Learning in Medical Physics were organised at ICTP, Trieste. Until now these unique educational materials are used by over 4000 specialists per month through the web site: www.emitel2.eu [5].

Over the years the ICTP College on Medical Physics triggered the initiation of other medical physics activities in ICTP [6] as various IAEA courses, the Radiotherapy School, the unique international MSc programme and others. Today most of the medical physicists from LMI countries consider ICTP as the place of medical physics knowledge.

ICTP Colleges on Medical Physics (2002-2018) – student's countries of origin:

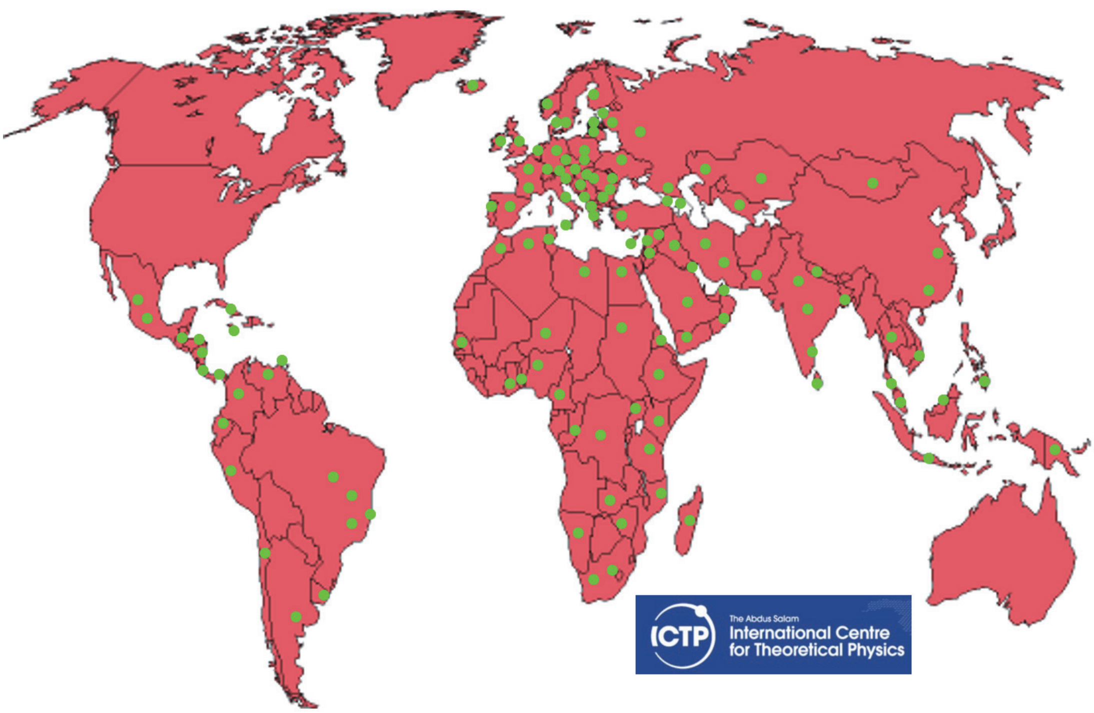

Fig.2 ICTP Colleges on Medical Physics (2002-2018) –students from: Albania, Algeria, Armenia, Argentina, Bangladesh, Belarus, Bosna, Brazil, Brunei, Bulgaria, Cameroon, P.R. China, Chili, Croatia, Congo, Costa Rica, Columbia, Cuba, Czech Rep., Ecuador, Estonia, Ethiopia, Egypt, Eritrea, Ghana, Guatemala, Honduras, Hungary, India, Indonesia, Iran, Iraq, Jordan, Kenia, Kuwait, Latvia, Lebanon, Lesotho, Lithuania, Libya, FYRO Macedonia, Malaysia, Malawi, Moldova, Mongolia, Mexico, Morocco, Montenegro, Namibia, Nepal, Nigeria, Oman, Peru, Philippines, Papua New Guinee, Panama, Pakistan, Poland, Romania, Russia, Serbia, Senegal, Slovenia, Slovakia, Sudan, Syria, Sri Lanka, South Africa, Tanzania, Trinidad and Tobago, Thailand, Turkey, Uganda, Ukraine, Uruguay, Uzbekistan, Venezuela, Vietnam, Yemen, Zambia, Zimbabwe

History, Development, Dissemination and Projects

The links between physics and medicine go back for centuries. Medical Physics, as we know it today, emerges after the discovery of X-rays. Since then physical principles have entered firmly in medicine and continue to transform it creating the advanced contemporary medicine. It is not without reason that the first Nobel Prize was given to Wilhelm Roentgen primarily because of the medical application of the X-rays.

By a coincidence Prof. Abdus Salam received his Nobel Prize in Physics in 1979, the same year when an engineer and a physicist - Godfrey Hounsfield and Allan McLeod Cormack - received the Nobel Prize for Physiology or Medicine (Fig.3). Their discovery and development of the X-ray Computed Tomography totally transformed medical diagnostic imaging and opened the way for the discovery and medical implementation of many new medical imaging methods – to name a few: Single Photon Emission Tomography, Positron Emission Tomography, Magnetic Resonance Imaging (a method whose physics creators received the Nobel Prize for Physiology or Medicine in 2003).

The association of the ICTP with medical physics began in 1982 with an International Conference on the Applications of Physics to Medicine and Biology, organised by Giorgio Alberi (see the history paper of L Bertocchi in an Annex to this Folder). However the idea for creating a College on Medical Physics at ICTP for colleagues from developing countries originated from Dr Anna Benini (at that time IAEA expert) and was supported over the years by Prof. Luciano Bertocchi (at that time ICTP Deputy Director). Both continue to be at the heart of the College and of other medical physics activities in the ICTP (Fig.4). The first ICTP College on Medical Physics was held in 1988 and since then continues to be one of the most oversubscribed regular activities of the ICTP (currently the College is held for 3 weeks, bi-annually).

	
Fig.3 Nobel Prize winners 1979, including Abdus Salam (3rd from right), Godfrey Hounsfield and Alan Cormac (1st and 3rd from left) – image courtesy to ICTP Archives.	Fig. 4 Anna Benini and Luciano Bertocchi (2nd and 3rd from right) with fellow College Directors (R>L): F Milano, A Benini, L Bertocchi, P Sprawls, M De Denaro and S Tabakov, at the 20th anniversary of the College, ICTP, 2008

Since the start in 1988 the Medical Physics Colleges at ICTP were held during 1992, 1994, 1996, 1999, 2002, 2004, 2006, 2008, 2010, 2012, 2014, 2016, 2018 (see List of Directors in an Annex). During 2001 the Coordinating Directors (P Sprawls and S Tabakov) modified the Teaching programme to allow forming a cohesive teaching entity, adapted for colleagues from LMI countries, and gradually building the knowledge necessary for the clinical application of digital medical imaging.

The materials presented to the students after 2002 were enriched with the purpose built e-learning materials, which were given to each student at the end of each College. This facilitated the global dissemination of the knowledge from the College, as many of the College students used these materials for their teaching activities and organising courses in their countries (see College students' achievements and appreciation in the Annexes).

The new programme structure also allowed the College to be condensed in 3 weeks (from 2008) and to introduce to each College a different emphasis. This structure allowed introduction of laboratories with simulations, and further (from 2012) practical labs at the Trieste Hospital, facilitated by M De Denaro, P Bregant and A Benini. This structure continues to be the backbone of the College and is appreciated by all students (see Students' appreciation in an Annex).

The structure of the ICTP College on Medical Physics was used as background for similar activities in India, in South-East Asia and in Latin America and Caribbean Region. The structure also included a Workshop, where students present the main activities in their countries. This exchange of experience facilitated the creation of professional networks and friendship, which they continue to support.

In 1995 the Coordinator of the first e-learning project in Medical Physics EMERALD (S Tabakov) invited ICTP to join this pioneering international activity. The project developed the 2nd in the world image database on CD-ROM with ISBN (Fig.5, 6). The e-learning materials of the project were tested at the ICTP College and further became a regular part of it. These materials, together with the further e-learning project EMIT, brought to the team in 2004 the inaugural EU Leonardo da Vinci Award. Alongside P Sprawls published all his renowned educational books on free e-books. Copies of these materials were made available to each College student. This association of ICTP with education and training in medical physics led to various other international activities: ICTP hosted the first International Conference on Medical Physics Training (EMERALD) in 1998; ICTP hosted the first International Conference on Medical Physics e-learning (EMIT) in 2003; ICTP hosted the Medical Physics Encyclopaedia Conference (EMITEL) in 2008 (Fig.7, 8). In 2011 ICTP published the book "Medical Physics and Engineering Education and Training" and distributed it free to College students.

The ICTP College on Medical Physics was also the first international user of the pioneering medical physics educational web sites (www.emerald2.eu and www.sprawls.org opened in 1999 and 2000), significant parts of these web sites being made specifically for the College. Since 2004 the College participants became part of the large international project Dictionary of Medical Physics (led by S Tabakov), providing cross translation of medical physics terms between any of its 30 languages.

In 2005 ICTP was Co-Organiser of the large UNESCO World Conference on Physics and Sustainable Development (November 2005, Durban, South Africa). At this high-level international event the case of *Physics and Health* was presented by P Sprawls, D Van Der Merwe, S Tabakov and A Niroomand-Rad. This resulted in selecting of this area of applied physics to be one of the 4 main areas with special importance for the years ahead.

The success of the College on Medical Physics led to opening and supporting of other medical physics activities in ICTP – notably various IAEA Courses. In 2015 ICTP started a regular activity - School of Medical Physics for Radiation Therapy (in alternating years with the College). This School is headed by R Padovani, with the support of L Bertocchi (Fig. 9). From 2006 Administrator of most medical physics activities in ICTP is S Radosic.

In 2002 and 2004 the College Directors (S Tabakov, P Sprawls and L Bertocchi) discussed with the ICTP Director the idea of forming a regular post-graduate educational course in ICTP. This continued to be discussed and updated until in 2014 ICTP formed an alliance with the University of Trieste, resulting in the first international MSc programme in Medical Physics, headed by R Padovani and R Longo. This MSc on Advanced Studies in Medical Physics, with IAEA support, has already produced several alumni and has the strong support of the Italian Association of Medical Physics (Fig.10, 11).

Fig.5 Project EMERALD team, developing the first e-learning in medical physics 1995-98 – Project Consortium

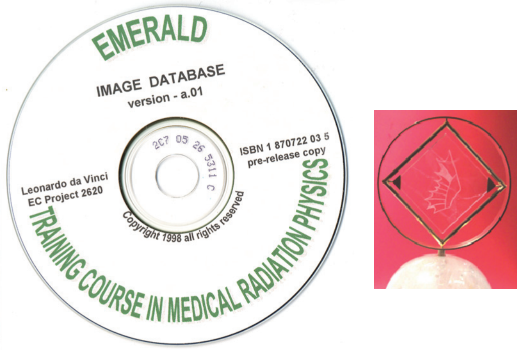

Fig.6 The second in the world CD-ROM Image DB with ISBN with Leonardo da Vinci Award

Fig.7 EMIT Conference – the first International Conference on e-Learning in Medical Physics, ICTP, Trieste, 2003: L>R: C Lewis, C Deane, A Cvetkov, C Oates, T Jansson, D Goss, G Helms, S Keevil, M Buchgeister, M Stoeva, C vaan Pul, G Clarke, K Nagyova, A Krisanachinda, P Sprawls, N Poutanen, J Young, Y Ider, A Milan, A Rosenfeld, A Simons, R Wirestam, I Hernando, V Gersanovska, P Zarand, P Caplanis, F Stahlberg, C Etard, N Fernando, R Stollberger, P Smith, F Milano, A Lukoshevicius, V Aitken, E Perrin, A Evans, A Briquet, C Bigini, A Paats, M Almqvist, G Boyle, F Fidecaro; in Front: C Roberts, J-Y Giraud, Mr L Torres, S Riches, S Tabakov, I-L Lamm, M Radwanska, S Naudy, R Magjarevic, L Musilek, T Wehrle

Fig.8 EMITEL Encyclopaedia on Medical Physics Conference, ICTP, Trieste, Italy, 2008 (part of participants): from L>R sitting: E Morris, E Chaloner, J Calvert, G Clarke, J Chick, A Krisanachinda, I-L Lamm, M Radwanska, B Allen, M Lewis, R McLauchlan, I Horakova, M Almqvist, V Tabakova, S Tabakov, A Benini; standing: C Oates, K Olsen, G Mawko, M Petersson, B-A Jonsson, R Magjarevic, M Secca, E Moser, J Boyle, P Bregant, N Pallikarakis, S Christofides, D Bradley, F Schlindwein, S Keevil, R Wirestam, F Milano, D Frey, E Podgorsak, A Cvetkov, K Keppler, D Goss; 2nd row: M DeDenaro, C Deehan, M Buchgeister, G Taylor, A Simmons, T Schaeffter, J Thurston, D Platten, H Terrio, M Leach, T Jansson, C Deane, P Zarand, A Evans, M Grattan, P Smith, C Lewis (photo includes 21 past & present Presidents of National/International Societies).

Conclusion

For the 30 years of its existence the ICTP College on Medical Physics became a real beacon of medical physics for colleagues from LMI countries. It supported the professional growth of medical physicists in almost 100 countries and created more than 1,000 medical physics professionals, who contribute to the healthcare in their countries. The applications to the College (each time more than 200 applications for 40-50 places) shows the College popularity among young medical physicists. Similarly high are the applications for the MSc course and other ICTP medical physics activities.

In 2016 the ICTP College and its participants addressed all medical physicists in the world on the occasion of the IDMP – the International Day of Medical Physics (celebrating in 2016 the 150th birthday of the Patron of Medical Physics - Maria Sklodowska Curie).

The education and training activities of the ICTP College on Medical Physics will be pivotal in the dealing with the current challenge confronting the profession – the shortage of medical physics specialists in many countries and, related to this, the need of almost tripling the medical physicists globally by 2035 [1].

This Folder, celebrating the 30th Anniversary of the ICTP College on Medical Physics, is a real example of the immense appreciation and gratitude of hundreds of medical physicists from LMI countries, who have benefitted from this unique ICTP College, and who have made the physics applied to medicine an inseparable part of the lives of millions of patients globally.

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ANNEXES:

1. List of ICTP College on Medical Physics Faculties (Directors and Organisers)
2. Photos of ICTP College students
3. Achievements of College students (2002-2010) from 25 countries
4. Appreciation from College students (2010-2016) from 40 countries
5. Letters from various medical physics-related International Organisations
6. Papers related to the ICTP College on Medical Physics and its global impact

Fig. 9 The newly established ICTP School on Medical Physics for Radiation Therapy, 2015

Fig. 10 Master of Advanced Studies in Medical Physics – ICTP and University of Trieste, 2015

Fig. 11 Graduation of students from Master of Advanced Studies in Medical Physics with supporting colleagues from the Italian Association for Medical Physics, 2017

ST, 2018

ANNEX 1

Directors/Organisers of all ICTP Colleges on Medical Physics

1988 – College on Medical Physics

A Benini, L Bertocchi, J Cameron, F De Guerrini , S Mascarenhas

1990 – College on Medical Physics

A Benini, L Bertocchi, J Cameron, F De Guerrini , S Mascarenhas

1992 – College on Medical Physics: Imaging and Radiation Protection

A Benini, L Bertocchi, S Mascarenhas, J Cameron, F De Guerrini

1994– College on Medical Physics: Radiation Protection and Imaging Techniques

A Benini, L Bertocchi, S Mascarenhas, J Cameron, F De Guerrini

1996 – College on Medical Physics: Methods, Instrumentation and Techniques in Medical Imaging

A Benini, R Cesareo, S Mascarenhas, P Sprawls, L Bertocchi, J Chela-Flores

1999 – College on Medical Physics

A Benini, P Sprawls, L Bertocchi

2002 – College on Medical Physics

A Benini, P Sprawls, S Tabakov, L Bertocchi (faculty including C Lewis, F Milano, G D Frey)

2004 – College on Medical Physics

P Sprawls, A Benini, S Tabakov, L Bertocchi (faculty including C Lewis, F Milano, G D Frey)

2006 – College on Medical Physics

P Sprawls, A Benini, S Tabakov, F Milano; L Bertocchi (faculty including M DeDenaro,C Lewis, G D Frey)

2008 – College on Medical Physics

ABenini, GD Frey, F Milano, S Tabakov, P Sprawls. L Bertocchi (faculty including M DeDenaro, P Bregant, C Lewis)

2010 - College on Medical Physics: Digital Imaging Science and Technology to Enhance Healthcare in the Developing Countries

STabakov, A Benini, F Milano, GD Frey, L Bertocchi, P Sprawls (faculty including M DeDenaro, P Bregant, C Lewis)

2012– College on Medical Physics: Applied Physics of Medical Imaging

S Tabakov, A Benini, F Milano, G D Frey, L Bertocchi,P Sprawls (faculty including M DeDenaro, P Bregant, C Lewis)

2014 - College in Medical Physics: Advances in Medical Imaging Physics to Enhance Healthcare in the Developing Countries

S Tabakov, A Benini, F Milano, GD Frey, P Sprawls, L Bertocchi(faculty including S Tipnis, M DeDenaro, P Bregant, C Lewis)

2016 - College on Medical Physics: Enhancing the Role of Physicists in Clinical Medical Imaging: Procedure Optimization, quality Assurance, Risk Management, Training

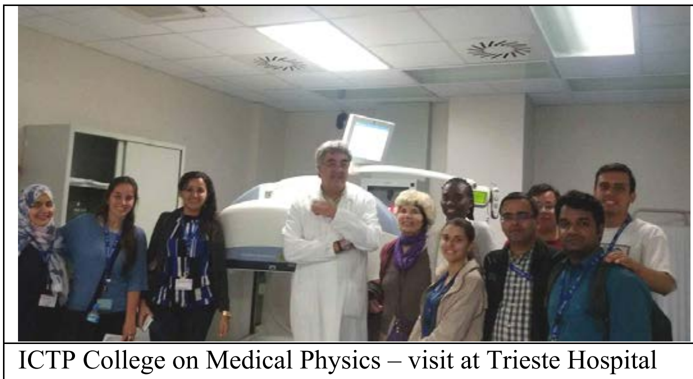
S Tabakov, A Benini, F Milano, S Tipnis, M DeDenaro, P Sprawls, L Bertocchi (faculty including J Oshinski, M Stoeva, P Bregant, C Lewis)

2018 - College on Medical Physics: Applied Physics of Contemporary Medical Imaging – expanding utilization in developing countries

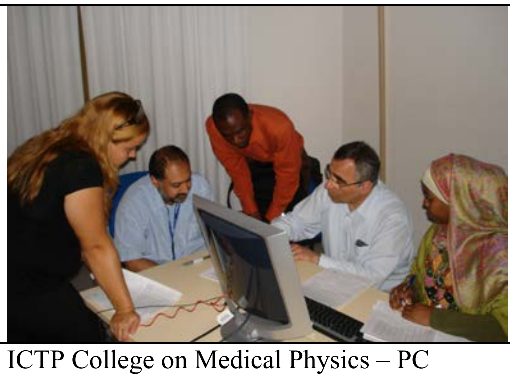
S Tabakov, A Benini, F Milano, M DeDenaro, L Bertocchi, P Spawls, M Stoeva, S Tipnis, J Oshinski

(faculty including: P Bregant, V Tabakova, A Seibert)

PHOTOS from some College activities



ICTP College on Medical Physics – visit at Trieste Hospital with practical



ICTP College on Medical Physics – PC laboratory with simulations practical

ICTP College on Medical Physics – discussion of Participants' posters

ICTP College on Medical Physics – Feedback discussion at the last day of the regular College

ICTP College on Medical Physics – topical meeting with students from Latin America

ICTP College on Medical Physics – topical meeting with students from Africa

ICTP College on Medical Physics – topical meeting with students from Asia

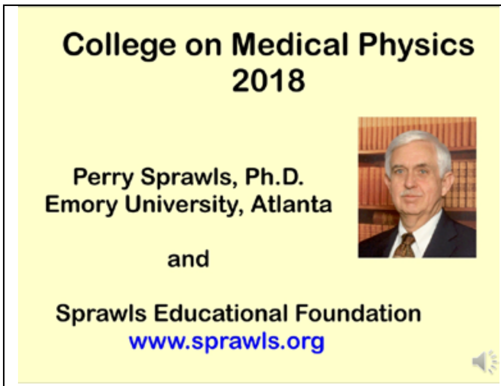
ICTP College on Medical Physics – topical meeting about the Medical Physics Encyclopaedia

Presenting ICTP Director Prof. Quevedo with IOMP Plaque by IOMP Vice-President Prof. S Tabakov

Presenting College Co-Director Prof. S Sprawls with ICTP Plaque for long service to College

Presenting the College Founders Prof. L Bertocchi and Dr A Benini with IOMP Appreciation plaques

The joint contribution of College faculty to the common aim:supporting medical physicists from LMI countries – made all lecturers and students part of a network: Faculties 2016 – private gatherings with friends



Prof. P Sprawls and Prof. A Seibert deliver online lectures from USA to the ICTP College students

Presenting Diplomas to participants at completion of ICTP College studies

ICTP College 2016 and 2018 – Students receive the newly established EMERALD Award Certificates

ANNEX 2, 3 and 4

2. Photos of ICTP College participants

3. National/International Achievements of College students (2002-2010) from 25 countries

4. Appreciation from College students (2010-2016) from 40 countries

ANNEX 2

Photos of ICTP Colleges on Medical Physics (1988-2016) faculty, students (some with their countries)

ICTP College 1988

ICTP College 1990

ICTP College 1992

ICTP College 1994

ICTP College 1996

ICTP College 1999

ICTP College 2002 (students from 39 countries): ALBANIA, ALGERIA, ARGENTINA, BANGLADESH, BOSNIA, BRAZIL, CAMEROON, CHINA, CONGO, CUBA, ESTONIA, ETHIOPIA, GHANA, GREECE, INDIA, IRAN, ITALY, KENYA, LATVIA, LIBYA, MALAYSIA, NEPAL, NIGERIA, PAKISTAN, PHILIPPINES, ROMANIA, RUSSIA, SENEGAL, SOUTH AFRICA, SRI LANKA, SUDAN, SYRIA, TANZANIA, THAILAND, TURKEY, UKRAINE, VIETNAM, YUGOSLAVIA, ZIMBABWE

ICTP College 2004 (students from 34 countries): ARGENTINA, BANGLADESH, BELARUS, BULGARIA, BRAZIL, CAMEROON, CHINA, COSTA RICA, CROATIA, CUBA, ETHIOPIA, EGYPT, INDIA, IRAN, ITALY, KENYA, LATVIA, MALAWI, MEXICO, MOROCCO, MALAYSIA, NEPAL, NIGERIA, PAKISTAN, PHILIPPINES, SRI LANKA, SUDAN, TANZANIA, THAILAND, TURKEY, UKRAINE, VIETNAM, YUGOSLAVIA

ICTP College 2006 (students from 40 countries): BANGLADESH, BULGARIA, BRUNEI, BRAZIL, CAMEROON, CZECH REPUBLIC, CUBA, EGYPT, EQUADOR, ETHIOPIA, HUNGARY, INDONESIA, GHANA, GUATEMALA, INDIA, IRAN, ITALY, KENYA, LEBANON, MACEDONIA, MOLDOVA, MONGOLIA, MONTENEGRO, MOROCCO, MALAYSIA, NEPAL, NIGERIA, PAKISTAN, PHILIPPINES, PERU, ROMANIA, SOUTH AFRICA, SRI LANKA, SUDAN, SYRIA, THAILAND, TURKEY, UKRAINE, VENEZUELA, WEST BANK

ICTP College 2008 (students from 48 countries): ALGERIA, ARGENTINA, ARMENIA, BANGLADESH, BRAZIL, CHINA, CAMEROON, CHILE, COLOMBIA, CUBA, ETHIOPIA, GHANA, INDONESIA, IRAQ, INDIA, IRAN, KENYA, LATVIA, LESOTO, LIBYA, MEXICO, MOROCCO, MOLDOVA, MONGOLIA, NEPAL, NIGERIA, PAKISTAN, PANAMA, PAPUA NEW GUINEA, PHILIPPINES, PERU, POLAND, RUSSIA, SERBIA, SLOVENIA, SOUTH AFRICA, SRI LANKA, SUDAN, SYRIA, TANZANIA, THAILAND, TRINIDAD AND TOBAGO, URUGUAY, UKRAINE, VIETNAM, VENEZUELA, ZIMBABWE

ICTP College 2010 (students from 35 countries): ARGENTINA, BANGLADESH, BULGARIA, BRAZIL, CAMEROON, CHINA, CROATIA, CUBA, ESTONIA, GHANA, HONDURAS, INDONESIA, INDIA, IRAN, IRAQ, JORDAN, KENYA, LITHUANIA, MEXICO, MOROCCO, NEPAL, NIGERIA, PAKISTAN, PHILIPPINES, PERU, RUSSIA, SRI LANKA, SUDAN, SYRIA, SPAIN, THAILAND, VENEZUELA, VIETNAM, ZIMBABWE, ZAMBIA

ICTP College 2012 (students from 37 countries): ALGERIA, ARGENTINA, BANGLADESH, BRAZIL, BULGARIA, CROATIA, COLOMBIA, CUBA, EQUADOR, ETHIOPIA, GHANA, GUATEMALA, INDIA, IRAN, IRAQ, ITALY, INDONESIA, MACEDONIA, MALAYSIA, MOROCCO, MONGOLIA, NEPAL, NIGERIA, OMAN, PAKISTAN, PHILIPPINES, RUSSIA, SERBIA, SLOVENIA, SRI LANKA, SUDAN, THAILAND, TURKEY, UKRAINE, UGANDA, VENEZUELA, ZIMBABWE

ICTP College 2014 (students from 38 countries): ALGERIA, ARGENTINA, BANGLADESH, BULGARIA, BRAZIL, CAMEROON, COLOMBIA, CUBA, ERITHREA, GHANA, INDONESIA, INDIA, IRAN, IRAQ, JORDAN, KENYA, KUWAIT, MALAYSIA, MEXICO, NEPAL, NIGERIA, PAKISTAN, PHILIPPINES, PERU, SERBIA, SRI LANKA, SUDAN, TANZANIA, THAILAND, TURKEY, UKRAINE, VIETNAM, VENEZUELA, UGANDA, UZBEKISTAN, YEMEN, ZAMBIA, ZIMBABWE

ICTP College 2016 (students from 47 countries): ALGERIA, ARMENIA, ARGENTINA, BANGLADESH, BRAZIL, BULGARIA, BURKINA FASO, COLOMBIA, COTE D'IVOIR, CROATIA, CUBA, EGYPT, EL SALVADOR, EQUADOR, ESTONIA, ETHIOPIA, GHANA, GUATEMALA, HONDURAS, INDIA, IRAN, IRAQ, JORDAN, KENYA, MADAGASCAR, MALAYSIA, MEXICO, MONGOLIA, MOROCCO, NAMIBIA, NEPAL, NICARAGUA, NIGERIA, OMAN, PAKISTAN, PHILIPPINES, PERU, SENEGAL, SERBIA, SUDAN, THAILAND, TURKEY, UGANDA, UKRAINE, VIETNAM, ZAMBIA, ZIMBABWE

- The College congratulates medical physicists worldwide with the International Day of Medical Physics

ICTP College 2018 (students from 32 countries): ALGERIA, ARGENTINA, BANGLADESH, BELARUS, BRAZIL, BULGARIA, COSTA RICA, COLOMBIA, CUBA, EGYPT, GEORGIA, GHANA, GUATEMALA, HONDURAS, IRAN, LATVIA, MALAYSIA, MEXICO, MOROCCO, NAMIBIA, NIGER, NIGERIA, PHILIPPINES, SAUDI ARABIA, SINGAPORE, SUDAN, TANZANIA, THAILAND, TURKEY, UGANDA, VIETNAM, ZIMBABWE (see also the photo on the cover – celebrations of 30th anniversary)

ANNEX 3

National and International Achievements of students from the ICTP College on Medical Physics

Many of the students from the ICTP College on Medical Physics became respected specialists in their countries who established Department and Societies; became Professors, Heads of Department and Officers of their Societies; took active role in the further professional development and healthcare provision in their countries; took part in various international projects, including the Multilingual Medical Physics Dictionary.

As per our current knowledge we are listing here below some of the early College students (2002-2010) from 25 countries, who have become leading scientists in their countries, have taken part in international projects, have further established medical physics courses and other activities:

Algeria
GURAIONIS Hussein - Dictionary Arabic translation

Argentina
RUGGIERI Ricardo Miguel - Secretary General of the MP National Association in Argentina

Bangladesh
AZHARI Hasin - Founding President of MP National Society in Bangladesh, Dictionary Bengal translation
AKHTARUZZAMAN Md – Secretary General of National Society, Dictionary Bengal translation

Brazil
PEDROSA de AZEVEDO, A.C. – Officer of MP National Society in Brazil, IOMP Committee member

Bulgaria
AVRAMOVA Simona – President of MP National Society in Bulgaria
STOEVA Magdalena – Editor IOMP Medical Physics World, Co-Editor of Springer J. Health and Technology, Dictionary Software developer, IUPAP Young Scientist Medal

Colombia
MARIN Vanessa Peña – Vice President of Colombian Asociación for Radiation Protection

Cuba
PEREZ Marlen – Officer of National Society in Cuba

Estonia
KEPLER, Kalle – Officer of MP National Society in Estonia, IOMP Committee member

Ghana
SCHANDORF, Cyril - Officer of MP National Society in Ghana, supports MSc and other courses in the country
INKOOM Stephen - Officer of National Society in Ghana,
HASFORD Francis – Secretary General of African medical Physics Federation (FAMPO)

India
JHEETA, Kuldeep Singh- Officer of MP National Society in India,
SHARMA Sunil Dutt - Officer of MP National Society in India, Officer of National Regulatory Body
CHOUGULE Arun, President of National Society, President of Asia Med.Phys Federation (AFOMP), Chair ETC of IOMP

Iran
BINESH, Alireza - Officer of National Society in Iran, supports MSc and other courses in the country, Dictionary Iranian translation
MOWLAVI, Ali A. - Officer of National Society in Iran, Dictionary Iranian translation, IUPAP Young Scientist Medal

Jamaica
VOUTCHKOV Mitko – established MSc medical physics programme in Jamaica

Malaysia
TAJUDDIN, Abdul A.- Officer of National Society in Malaysia, supports MSc and other courses in the country

Mexico
MEDEL BAEZ Eva - supports MSc and other courses in the country

Morocco
BENATYEB Farida - Officer of National Society in Morocco, Dictionary Arabic translation

Nepal
CHAURASIA, Pradumna P. – Founding President of National Society in Nepal
ADHIKARI Kanchan P. – Secretary General of National Society in Nepal

Romania
POPESCU, Aurel - Officer of National Society in Romania, Dictionary Romanian translation

Russia
KAZANTSEV Pavel – Secretary General of National Association in Russia

Serbia
CIRAJ, Olivera – Officer of National Society in Serbia, IAEA/IOMP Web site person

Slovenia
TOMSE Petra – Dictionary Slovenian translation

Sudan
ABBAS, Nada Ahmed - Officer of National Society in Sudan, Officer of National Regulatory Body
OMER Hiba Baha Eldin Sayed - organises MSc and other courses in the country

Tanzania
MUHOGORA Wilbroad - IOMP Committee member

Thailand
KRISANACHINDA, Anchali – Founding President of National Society in Thailand, President of South-East Asia MedPhys Federation, Officer IOMP
SUWANPRADIT YANGDERM P – Organises courses and materials

Turkey
UNAK Perihan - Dictionary Turkish translation

Vietnam
HOANG Trang – Organises courses and materials

ANNEX 4

Appreciation and Gratitude from ICTP College on Medical Physics students (2010 to 2016) from 42 countries (collected by Prof. Slavik Tabakov in the period May-August 2018)

ARGENTINA
Ricardo Miguel Ruggeri, Agustina Corti

Dear Slavik,

Currently I work as head of the Medical Physics service of the Fundacion Medica de Rio Negro (FUNMED) and Neuquen and the Integral Oncology Center (belong to the same institution) in the areas of Radiotherapy, Nuclear Medicine and Diagnostic Imaging.

I also work as Director of the first Medical Physics Residence in the country that includes the areas of Nuclear Medicine, Diagnostic Imaging and Radiotherapy with University endorsement (Universidad Nacional del Comahue) with the first entrants this year.

The theoretical content acquired during my course in the summer school of ICTP, is used in the theoretical classes of the residence and distributed among them.

From SAFIM, and with the collaboration of FUNMED and COI, we have developed the First Pace of Physics of Patagonia, which has had more than 50 Physician assistants from all over the country presenting and sharing their work in all areas of the same.

I greet you with great affection and cordiality.

Secretary of Argentine Society of Medical Physics (SAFIM)

>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>

Dear Mr. Tabakov,

I am very honored to receive your email. This contact is especialy important for mi because I am working in the preparation of the contents of a course "Medical images laboratory" in Medical Physics (degree career). I´ll be to start to teach this course this year in my University.
I am very glad, and working a lot, specially with material from the College!

I would like to thank you again for the enormous work you do to teach us to teach this beautiful and important discipline.

ALGERIA
Amel Cherfi

Dear Professor Tobakov,

I would like to thank you and thank ICTP for that great experience I shared with you, the other professors and all the participants in the college. It was very beneficial for me and I learned a lot especially in the practical sessions at ICTP and at the hospital.

I am in touch with most of the participants in the college and we share many informations. Nowadays, I teach atomic and nuclear physics, and in my course I give many informations about the applications of nuclear especially in Medical physics.

Unfortunately I don't teach medical physics, and I don't use the materials I received in the college because we don't have a master in Medical physics in our faculty. We plan to reopen it in the 2019 – 2020 academic's year. I'll provide students with all the informations I have acquired during the college, I know how they will be useful for them. We will need your valuable advices for that Master.

I'm in the 5th year in my Phd. I have difficulties especially in the experimental part of my thesis which concerns the correction of the respiratory motion in PET/CT imaging. Unfortunately we don't have a PET/CT in our country (there is just one in a private centre), I try to obtain an internship abroad in order to do the experimental part.

Again, it was a great pleasure to meet you and I hope I will have the opportunity to meet you again on other occasion.
Thanks a lot

BANGLADESH
Hasin Anupama Azhari, Nahid Hossain

At ICTP the training activities in medical physics began in 1983 with efforts of Anna Benini, Sergio Mascaren. Later in 1988, for strengthening the medical physics in developing countries the series of college on medical physics [CMP] began to make the scientists familiarize the role and responsibilities of medical physicists in radiology and imaging. The main promoters and organizers of CMP, ICTP are Anna Benini, John Cameron, Perry Sprawls, Luciano Bertocchi , Slavik Tabakov, Franco Milano and others. In this report, I would like to describe a brief report of my gain in CMP, ICTP.

After having M.Sc degree in medical physics (2006) from the Dept of Medical Physics and Biomedical Engineering (MPBME), Gono University (Thesis semester in Heidelberg University, Germany), I have applied to ICTP college of medical physics in 2006 for attending the course CMP, ICTP. As this course is enriched in imaging which is really helpful for a beginner as an academic person. I must remember during that period organizers asked the participants to present medical physics situation in their countries. Recall myself some of countries representative has present their situation and I was one of them. I have prepared my slides working hard, day and night collecting from different sources specially from Prof Zakaria, Germany. I must admit, I am the beginner of that time knowing very little about the MP in Bangladesh. On behalf of Bangladesh I am the only one participant, my thought was I must do something for the sake of my country. Really that was the guidance of rest of my pathway in MP. Since 2008 I have awarded as the associate member in ICTP in Medical Physics area till 2021. During my visit as regular associate, ICTP, I have joined several times the course on College on medical Physics. We have got the best poster presentation award in 2014.

In the following years I have attended CMP, ICTP course shows in the following figures:

- 4 September to 29 September, 2006, ICTP, Trieste, Italy
- 12 - 23 November 2007, ICTP Regional College on Medical Physics - 2007 in Radiological Physics & Advisory Division, Bhabha Atomic Research Centre, India
- 10 September - 28 September 2012, College on Medical Physics, Trieste, Italy
- 1 September 2014 - 19 September 2014, College on Medical Physics, Trieste, Italy

- Other than CMP ICTP I also attended in 4 November- 1 December, 2013:Training course on medical physics for radiation therapy; 25 March-25 April, 2017: School of Medical Physics on radiation Therapy: Dosimetry and treatment planning for basic and advanced applications. Organizer(s): R. Padovani (Udine), M. De Denaro (Trieste) with EFOMP and IOMP. ICTP Local Organizers: L. Bertocchi, J. Niemela.

Contribution of Knowledge of Emerald to the Department of Medical Physics and Biomedical engineering:
For my 15 years of teaching experience I have transferred my knowledge to the students, colleagues of the CMP, ICTP course. Sprawls Educational Foundation and e-learning materials of the projects EMERALD is using in the department as one of the teaching material. The chapters of radiology and imaging with figures is helping the students quiet a lot. This website will guide the us the direction of the pathway of study parallel to the book. Book on Magnetic Resonance Imaging: Principles, Methods and Techniques has been written in a very simple way for easy understanding of the students. The students are practicing the workbook with tasks and visualizing the database of digital images is of a great help for them to update their knowledge. The radiation protection class delivered by Anna Benini was very informative at that time for our country. Also lesson plan can be organized in radiology and imaging course using the structured timetable provided in the website.

Contribution of Knowledge of College on Medical Physics to the BMPS (Bangladesh Medical Physics Society):
In Bangladesh there is no medical physicist working in the radiology and imaging sector. Knowledge from college on medical physics has been disseminated to the BMPS through its members. BMPS, MPBME together we have started to make public awareness as well as approach to the hospitals to make them understand the role, importance of MP in radiology and imaging. Emerald website, knowledge of ICTP is also helping us for this type of activities.

Contribution of Encyclopaedia EMITEL and its Multilingual Dictionary:
I am one of the fortunate person selected by Prof Dr Slavik Tabakov to conduct the project international Encyclopedia EMITEL and its Multilingual Dictionary representing Bangladesh as a coordinator.

The other members are Mr Safayet Zaman, Mr Akhtaruzzaman and Prof. Dr. G A Zakaria. We are informing to our students to use this Encyclopaedia, which is beneficial for the students. In Bangladesh education language is Bengali upto the higher secondary stage (12th grade) so after university admission it is very handy for the undergraduate students having the MP Encyclopaedia from Bengali to English.

Acknowledgement: Thanks to Luciano Bertocchi for always supporting during my visit in ICTP, Dr. Slavik Tabakov who always encouraged medical physicists in the developing countries and his vision for women empowerment, thanks to Dr. G A Zakaria who continuously encourages us for attending this type of activities and driving his force towards improvement of MP in Bangladesh.

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“College on Medical Physics- Advances in Medical Imaging Physics to Enhance Healthcare in Developing Countries” which was held on 01 September - 19 September 2014 in ICTP, Trieste, Italy – The program was very much efficient for the medical physicists as per their professional development. It was a great chance for acquiring updated knowledge regarding the Physical Science and Technology of Diagnostic Radiology, Nuclear Medicine and Radiation Oncology. As a medical physicist from developing country, I was exposed to a higher technical environment and resource persons in the ICTP and this was definitely influenced my intellectual development.

In my institute I actively Involve in supervision of the operation, data analysis, quality control, imaging and instrumentation of the nuclear medicine equipments such as PET/CT, SPECT/CT, SPECT etc. I supervise the PET/CT, SPECT laboratory and Hot lab. I am also member of the Radiation Safety Committee in my Institute. I engage in supervision of the therapy procedure and dose management for therapy patients. I am responsible for ensure radiation protection of patients, workers, patient's attendents and members of the public in my institute. I am also delivering lectures to post graduates medical in “MD in Nuclear Medicine” course which is held in my institute, under the Bangabandhu Sheikh Mujib Medical University, Dhaka. After paticipating the program in ICTP, my knowledge and skills was updated regarding all of my works and can contribute effectively to meet the demand of my institute. Thus I was benefited both professionally and personally.

Considering all facts I believe that after participating the program, I can contribute in better management of imaging, instrumentation, radionuclide therapy and dosimetry in my institute as a medical physicist. Now a day the world wide need (especially in my country) for skilled Medical Physicist is in much demand with the rapidly developing integrated therapy and imaging technologies. As a number of world renowned professionals were involved with the program, I believe that after attending this program, my knowledge and skills were updated.

ICTP always give the assistance to support professional development to the medical physicists in developing countries. I would like to deliver a great thanks to ICTP for providing me the travel award and really this was great help me for successfully participating the event.

BRAZIL
Thamiris Rosado Reina

Dear Professor Tabakov,

Hi! It's been a week since we have finished the College and I'm already missing the classes!

I am writing to thank you again for the oppotunity to attend to the College and for the fantastic material we received to bring back home. I also would like to tell you that I engaged to an e-Learning 360 hours Course of Specialization for Preceptor in Healthcare in the public company I work for. This 3 weeks at ICTP were not only knowledge enriching, but it was very inspiring for me. Now I want to contribute to the medical physics to develop in Brazil. I am thinking for the next years to create with my colleagues in the Federal University Hospitals all over the country a clinical training following the model of ICPT's mater's program. It is a dream, but maybe someday we can make it comes true. And last, but not least, thank you very much for the first pages book! I'll follow these steps to make my hospital better! It's been very helpful!!

BULGARIA
Todorka Dimitrova

I have participated at the ICTP College on Medical Physics 2016 Teaching Program “Enhancing the Role of Physicists in Clinical Medical Imaging: Procedure Optimization, Quality Assurance, Risk Management, Training”.

The achieved knowledge and practical skills, as well the new contact with people from different countries were very useful in my work. Actually, I am the Director of the Master Program in Medical Radiation Physics and Technics and I am responsible for the Bachelor’s courses in Medical Physics.

Impact on the Education
Due to the good previous contacts with the Nuclear Medicine Department in St George’s University Hospital in Plovdiv, the practical part of the course in Nuclear Medicine is performing there. The students were visiting the gamma-camera division. Recently, they got access also to the newest PET/CT division. This year we have negotiated also to conduct the practical part of the course in Physics and Technics of the Clinical Radiotherapy at the Radiotherapy Clinic of the same hospital. Students get familiar with the LINACs SIEMENS PRIMUS MID and SIEMENS

PRIMUS HE, with the cyberknife M6 of ACCURA and with the modern radiotherapy planning systems and dosimetry equipment.

Since now the Education in Medical Physics for Bachelors was one of the modules of the Engineering Physics where students were following some specialized courses in Medical Physics in the 3th and in the 4th year of their study. Actually, the program is separated as independent specialization in Medical Physics and the new program is starting in 2018/2019 academic year. In the frame of this program two courses in Medical Imaging (theory and practice) will be conducted at the Cathedra of Medical Imaging at the Medical University Plovdiv.

After my training at ICTP College on Medical Physics I have developed a new course in Introduction to Medical Physics for Bachelors. A course in Medical Radiation Physics for Bachelors is in preparation.

In 2018 I have delivered a series of lectures in Medical Physics in the National Technical University of Athens, Greece in the frame of the Erasmus+ EC Program.
Performing all this activities, I found very useful the materials I've got after the College – lectures, presentations, books, as well the EMERALD materials/images (www.emerald2.eu) and the Encyclopaedia/Dictionary EMITEL (www.emitel2.eu).

International collaboration and Medical Physics knowledge popularization
During the ICTP College on Medical Physics Course I met Assoc. Prof. PhD Trang Hoang from Vietnam and the Medical Physicist Jelena Samac from Serbia. I have invited them to be members of the Organizing Committee of the VII International Conference of Young Scientists (YSIC Plovdiv-2017), 15-16 June 2017, House of Scientists, Plovdiv, were several oral and poser presentations in Medical Physics were reported. This was good opportunity to extend our international collaboration. I was initiator and Chair-women of this conference for many years and, since in the 2015 I left the Club of Young Scientists, I continue to support the conference as a Vice Chair-women. After participating at the ICTP College in Medical Physics course and meeting many Medical Physicists from other countries, I got the idea to open Section in Medical Physics at this conference. Additional work is needed to get more people in this field for the VIII YSIC Plovdiv 2019 which is in preparation.

Medical Physicists in Plovdiv are between the first in the world how started in 2013 to celebrate the International day of Medical Physics. This tradition continues as common event between the University of Plovdiv "Paisii Hilendarski", the Medical University of Plovdiv, The Technical University Sofia - Branch Plovdiv and with the strong support of the Union of Scientists in Bulgaria – Plovdiv.

In 2016 and 2017 I started to organize a new kind of conference in Civil Education through Natural Sciences. There also were reported several presentations treating topics in Medical Physics. I permanently invite speakers for public lectures in Medical Physics, as well for our students.

I would like to thank for the knowledge, educational materials, personal contacts and inspiration I got from the ICTP College on Medical Physics.

BURKINA FASO
Konfe Amadou

Dear Prof

This is a short reply about the ICTP College on Medical Physic in Burkina Faso.
In Burkina no medical physicist had any clinical training and the ICTP college on medical Physics allowed us to reinforce the knowledge in many area of Medical Physics.
For exemple the practical exercise during this college was useful for us.

These courses allowed us to propose quality control protocols in nuclear medicine at the yalgado Ouedraogo University Hospital.

Also, in order to strengthen the medical Physics profession Burkina Faso, we have proposed to the ministry of health to train physicists at the ICTP. and today we have one student in training at ICTP.
The material given at this college is very useful because we refer to this material whenever we need to understand an aspect of medical physics.
Also this material makes it possible to fill the lack of practical training in Burkina Faso

Many thanks to you and the ICTP College.

COLOMBIA
Vanessa Peña Marín

Dear Professor Tabakov,

As for the College of Medical Physics in ICTP, this was a great help for me and my colleagues in the university and in the hospital. After my participation in the course I held a conference for the students and professors of the university in which I showed them what I learned, and I gave them to know the resources of emerald. During these two years I know that several have made use of the platform and have used the encyclopedia and resources during the classes. The resources that are in the platform are very illustrative and optimal to give enough clarity to the students in the teaching of medical physics.

In the radiology physics group, we teach these resources to all students who enter the group and are interested in medical physics.

On the other hand, the University and the Secretaría Seccional de Salud de Antioquia perform quality controls on radiodiagnostic equipment every year, the tests performed in these controls and the protocols used were improved according to what was learned during the college.

What has been learned in the ICTP comes not only to the university, but also to the hospital centers where the medical physicists who trained in it work. The courses taught by the ICTP allow all countries to have knowledge of new technologies, protocols and tools that allow medical physicists to improve the conditions of hospital centers through quality assurance programs.

For me and my colleagues at the University, participation in the ICTP College is very helpful, and I thank the organizers for allowing people from our country, like me, to participate in them and make use of the tools that there they learn.

CNINA P.R.
Li Zhou,

Dear Prof. Slavik Tabakov,

The ICTP College on Medical Physics is very useful for me. Through the education in the ICTP College on Medical Physics and our efforts, medical Physics education has been developed promptly in my University and also in my country and have been matured now. We have set up medical technical undergraduate education for years and planning to carry out the project for master and doctor graduate student education in medical technology professional construction, subject development and talents cultivation.

I found the materials you gave me after the College is also very useful. I have used the EMERALD materials/images (www.emerald2.eu) and the Encyclopaedia/Dictionary EMITEL (www.emitel2.eu) , and shared those websites with my colleagues, students in my University. They are so wonderful. Thank you once again.

CROATIA
Katarina Ružić, Doris Segota

Dear prof. Tabakov,

From 2010 the number of medical physicists in University Hospital Centre Zagreb and in other hospitals in Croatia is starting growing and their role is being recognized. Since there was and still is not existing a formal program for education of medical physicists in Croatia, ICTP gave us a great opportunity to bring this knowledge to physicist in Croatia and to their hospitals.

Through all these years we attended courses on physics in radiotherapy, imaging in medical physics. small photon fields, modern radiotherapy techniques... This helped us in our professional growth, broadened our knowledge and improved process in hospitals in which medical physicist are involved - in other words, better service for patients.

In the last two years, we also attended courses on medical physics in radiology (imaging, CT optimization). This gave us a courage and knowledge to start and take part in radiology at UHC Zagreb. Thanks to that, today we have almost full quality control program in radiology.
Taking part in these courses, we had an opportunity to discuss our problems, to talk to professors, to make connections with other physicist.

We were also users of EMITEL and EMERALD project. This college is a great platform for exchanging knowledge, materials and experience. We are thankful for that and hope we will be part of it further in the future.

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Dear prof. Tabakov,

I have attended only few days of College on Medical Physics in September 2016 since my instituiton couldn't manage a longer stay but I found it very useful in many ways. My targeted lessons were about CR and DR technology since in my hospital we were replacing film-screen system with digital units. I had a little knowledge about DR detectors and the QC tests that should be performed but no experience with CR systems. Lessons that I attended on ICTP helped me to understand CR and DR systems and to develop QC protocols.

Also, I found EMERALD very useful when preparing lessons for my students. I think College on Medical Physics on ICTP is very useful, helpful and it gives basic knowledge to the medical physicists involved in diagnostic radiology. I am very thankful that I was enabled to attend these lessons and I recommended it to other young medical physicists in my country that started working in diagnostic department.

CUBA
Dayana Ramos Machado

Dear Professor Tabakov,

The ICTP College on Medical Physics gave me the possibility to have a general background of the medical physics field. Before the college I was working closely linked to the internal dosimetry field and after that experience a huge spectrum that I did not know was opened for me.

Nowadays I work as a member of an advisory group in my country, this group provides national quality control services for diagnostic x ray equipment, as well as other services related to the practice of nuclear medicine, such as the verification of the radiation protection requirements for the safety of patients, occupationally exposed workers and the public members. Part of the mission of this group is also the training of new specialists, so now I use the lectures given in the college and all the materials that were provided to us, in order to improve the national radiation protection course that my group prepare twice every year, this course is the only one in Cuba recognized by the nuclear regulatory authority for the licensing of radiation protection officers. Therefore, the College was very useful to me and to my country in some ways. I really appreciate the opportunity I had, I´m grateful for have been a student of The ICTP College on Medical Physics.

ECUADOR
William V. Ona Rodriguez, Alexcei Pérez Baranovski

Dear Prof. Tabakov

Its really a honor for me to receive this mail from you.
I am Alexcei Pérez, Medical Physicist from Ecuador. I attended to 2012 MP college as a Physicist, and finished last year my master degree in Heidelberg Advanced Methods in Radiotherapy. This visit in Trieste motivated some mates to apply and finished their master degree in Medical Physics in ICTP.

I am working now in some educational projects in Ecuador with other Medical Physicists, and of course I will use the ICTP material, so, in some weeks I will mail you to let you know the progress.

I want to take this opportunitty to consult if IOMP have the possibility to start a collaboration program to develop the medical physics in my country?

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Dear Professor Tabakov

It's a really pleaseure to receive an email from you. I have met you in Trieste in 2014. I am the first promotion of the Master of Medical Physics in ICTP and it was a beautiful experience in my personal life and profession.

Through the Master's Degree in Medical Physics I made in 2014 at the ICTP I have been able to carry out several activities related to education and teaching in my Home Institution. I have been able to share several talks related to modulated treatments in head and neck and prostate. I have taken care of several students who are doing internships and their bachellor thesis topics. It has been possible to carry out two papers on topics related to research in my Hospital and a project was carried out directly with the IAEA to train all the Radiotherapy staff and purchase a new equipment for quality control for VMAT. Now a last project to perform pediatric radiotherapy in the year 2020 was presented.

ETHIOPIA
Seife Teeferi,

Dear professor ,

Since I am working as diagnostic medical physics , ICTP college on medical physics helps me in various ways. For the last fifteen years , I was the only medical phycisist working in diagnostic areas. During these times getting materials and practices as refeshment were difficult . After joining the 2016 courses , the materials helps helps me to supply that of mine .I used to teach them radiology residents and medical radilogy technology students found in ethiopia .

The practical helps me to do my further research on these areas for which I became associate professor . The practical also helps me to enhance my previous radiation protection activities in the country . I am one of the three persons who have private radiation service in my country . But, because of lack of materials I am involved only through conventional X Rays and dental X Rays. Surprisingly, the hospital for which I am working for (TIKUR ANBESSA SPECIALIZED REFERAL HOSPITAL) has no dosimeters. The hospital has two CT, 128 and 64 sliceexcept those phantom coming with them we do not have dosimeters, 16 and 32 cm diameter phantom for dose analysis .we have also 1.5 tesla MRI. I think you are required to give more practical on MRI areas For hospitals X Rays I am using my own dosimeters for safety assessment and teaching students .

GHANA
Vivian Della Atuwo-Ampoh, Theresa B. Dery

Dear Sir,

Many thanks for the email. I am Vivian Della Atuwo-Ampoh from Ghana and was part of the 2016 College of Medical Physics.

I must confess that the opportunity granted me was a dream come through. I learnt a lot through the basic teachings of Imaging that covered all modalities. I best appreciated the MRI concepts and Sprawls model teaching. The interaction with seasoned and selfless lecturers was really great. I exchanged knowledge and experience with colleagues who were from different countries. The African forum granted by Dr. Slavik Tabakov was special and gave us the opportunity to share pertinent issues.

Back home I disseminated the lecture notes and materials to some colleagues at work and also I have been instrumental in assisting Physics, Radiography and Medical Students during their internship and Rotation. This has been very helpful. At the moment, I have also been instrumental in the establishment of the Medical Imaging Department of the University of Health and Allied Sciences in Ho, Ghana. I have been engaged as a part-time Lecturer.

The college of Medical Physics program is very dynamic and unique I must say and I remain eternally grateful to the organizers and lecturers for such a wonderful opportunity granted us. Many thanks.

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Dear Prof Tabakov,

It gives me great joy as I look back at the last four years and what I have achieved through the ICTP College of Medical Physics in 2014. It came at a time where my country wanted to strengthen the clinical, research and educational programs in the radiological sciences to provide effective and efficient health care delivery systems.

The College was hugely required in order to gain competency which was applied in research and training. Through the lecture series with practical exercises and learning experiences in medical imaging, I can say am a trained Medical Physicist. The College assisted me to be well-armed to uphold the highest level of safety assessment in the diagnostic facilities in my country. College

2014 pioneered my confidence, especially for being among the few women Medical Physicist in my country and Ghana being among of the four other countries (Bangladesh, Thailand, Sudan and Cuba) for winning the TAQI BINESH PRIZE for best poster.

Currently, the knowledge acquired through ICTP 2014 has provided educational training through seminars for the medical physics profession in my country. Today, as a PhD candidate, I am grateful to ICTP for giving me the opportunity to take part in the College. I hope others would also benefit from this skilled and innovative programme. The College was very successful and well organized. Thank you to ICTP College of Medical Physics and the facilitators.

GUATEMALA
Roberto Montezuma

Dear Professor Slavik

In the time that I assisted to the college (Enhancing the role of Physicist in Clinical Medical Imaging 2016) I was working as a dosimetrist in the national center for cancer in Guatemala, in the radiotherapy department. For that reason I didn't have knowledge about imaging in medical physics. During the lectures and with the practical sessions I had a brief but very useful knowledge about this branch of the medical physics, that in my country is not developed but is very needed, when I came back to Guatemala I started to teach to the technicians of the radiotherapy department and in the school for technicians in x-ray, some subjects related with the radiation protection, imaging theory and general physics, where were very useful the content of the lectures that I received in the college.

This year I moved to Trieste but this time to the master programme of medical physics (MMP 2018/2019) and I am increasing my knowledge during the classes that I still having, with the idea of to make the training year in nuclear medicine. In summary this college helped me to meet people from many countries and share information with them, to have an very good knowledge about the imaging in medical physics and to decide to apply to the master programme in where now I am.

INDIA
Arun Chougule, Arun Kumar

Dear Slavik,

I have been benefited immensely from ICTP in particular and India in general. My association started with ICTP after I got the Regular Associteship of ICTP in 2014 and subsequently i visited several times and attended many programmes.

I have written an article on "Contribution of ICTP to Medical Physics....'and is published in AFOMP newsletter. I am attaching the article and the newsletter for the ready reference
[see Annex 6]
Arun Chougule

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Dear Prof.Tabakov,

Thank you very much for your mail. It is indeed very nice to receive a mail from you to submit the accomplishments achieved on being an ICTP Medical Physics College participant. Before that I would like to highlight the opportunities ICTP offered to me during my career as a Medical

Physicst. ICTP offered me a fully paid fellowship to participate in their biennial programme: "College on Medical Physics: Imaging and Radiation Protection" held at Trieste, Italy during 1992. Subsequent to that I am fortunate enough to be part of two more ICTP Colleges in 2002 and 2010 respectively. In fact, I still remember the first ICTP College which gave me an opportunity to look outside world of Medical Physics, other than my home country, India.

I am hailing from the southern most state of India, Kerala, where the literacy and health indicators are on par with developed countries. However, the health infrastructure is no way near around the developed countries. Participation in ICTP Medical Physics college helped me to set up radiation acceptance & quality assurance programmes for diagnostic radiology equipment and diagnostic radiology facilities in my state Kerala which were not available earlier, though we had full fledged radiation oncology medical physics activities in the state. Subsequently, Kerala became the first State in India which established a Directorate of Radiation Safety (DRS) under the State Government of Kerala for the monitoring of radiation safety & quality assurance of all diagnostic radiation facilities of Kerala in co-ordination with the national regulator, Atomic Energy Regulatory Board (AERB) of India. During this period, we have formed the medical physics society of the state, Kerala Association of Medical Physicists (KAMP) and I served as the Secretary and Treasurer of KAMP twice. Eventually, KAMP has been converted into the Kerala Chapter of Association of Medical Physicists of India (AMPI) recently.

After a stint of about 12 years service in India, I have been invited by the Ministry of Health, Government of Oman to join as the first Medical Physicist in Ministry of Health (MOH), Sultanate of Oman and to establish the Dept. of Medical Physics & Radiation Protection Service (MP & RPS) for the Ministry which caters all the Medical Physics and Radiation Protection needs of the Ministry in Radiation Oncology, Diagnostic Radiology, Nuclear Medicine, Research and all other areas of radiation use in MOH. Thus I joined the Ministry of Health (MOH), Oman as the first Medical Physicist in 1999. Since 1999, I am working in Muscat, Oman as the Head of Medical Physics in Ministry of Health for almost 20 years now.

I was nominated as Technical Expert by International Atomic Energy Agency (IAEA), Vienna for various scientific activities since 2002 and continuing.

Was Chair of Scientific Sessions in various national and international scientific conferences including World Congresses on Medical Physics.

In conclusion, I am proud to say that the participation in ICTP Medical Physics programmes moulded me as a medical physicist especially at the early days of my career.

INDONESIA

Lukmanda Evan Lubis, Dwi Seno K. Sihono, Eka Djatnika Nugraha

Dear Prof. Tabakov,

I participated in ICTP College on Medical Physics in September 2012, that is before I finished my MSc. I chose academic career in Universitas Indonesia (UI) after I finished, and all the materials given during the three-weeks course came into use in a very handy way. Aside of using the knowledge delivered during the course for teaching and research, I also spread the materials to students with appropriate credentials (so they know it's from the course). It's been five years since I started teaching, so these materials have come across students from five year-classes. Evidently, I found students submitting their assignments using materials (figures, references, statements) from either these ICTP slides or EMERALD/EMITEL entry to support their answers.

Since some of my students have started working, I can tell you that their knowledge eased them in getting through the beginning of their careers. In that context, I have heard comments from senior clinical physicists that 'physicists graduating from UI nowadays are relatively more knowledgeable' and I believe my participation in ICTP 2012 has a part in it somewhere in the course.

Aside of the above academic impact, the three-weeks experience in Trieste has enabled me to speak out with confidence about the science and beauty of medical physics to the national community. Since 2015 I took active role on the national medical physicist society as one of a few members concentrating in diagnostic and interventional radiology. My primary appointment as lecturer allows me to get numerous talk invitations in the society's activities – again, this is where my knowledge from the 2012 ICTP course has played a significant role in my confidence. Outside the campus and society, I also have some involvements in the activities of our Ministry of Health as well as our National Nuclear Energy Regulatory Agency, mostly in composing regulations and policies regarding radiation sources in healthcare services. The memories and knowledge from 2012 ICTP course are among those experiences enabling me to give thorough inputs and suggestions to our government.

To conclude my remarks, I must let you rest assured that I (I believe I also speak for the others) received nothing but abundant benefits from these ICTP courses. If it is possible, please make sure that these words reaches all those who are involved in making the ICTP College on Medical Physics happen. I can not thank you and everyone enough for this opportunity in 2012. It changed my life, as well as those I influence in my career as academia.

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Dear Prof. Tabakov,

I participated in ICTP College on Medical Physics in 2010. As a lecturer and researcher in Universitas Indonesia, the course is very important and useful. I used the knowledge delivered during the course for my lecture and research. Since 2012 I pursued my PhD in the field of Medical Physics in Department of Radiation Oncology, University Medical Center Mannheim, University of Heidelberg. My research topic is about Image Guided Radiation Therapy using ultrasound.

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Dear Prof Slavik,

about the training of medical physics in trieste, I find it very useful especially for developing countries. for Indonesia itself, this is very useful as it coincides with the regulatory body policy for QA inspection of X ray equipment in hospitals across Indonesia, so we teach almost to all agencies (in this case BATAN conducts training and workshop) and ofcourse we are using www.emerald2.eu for one of reference . thank you for all that is taught and your support to us prof slavik.

IRAQ
Hussien Zahed

Dear Slavik,

I would like to show how we benefited from the participation I had in my country:

1. Once I have returned back home, and according to our education system, I required to show what did I got from this participation and therfore how can I dissaminate the knowlegde I had to other colleagues.

2. I have confirmed to you while I was there in Trieste 2016, I and we were/are realy interested in the QA/QC programs to be conducted in our hospitals, and specifically in our radiology deprtments. This thing was welcome by the heads of our deprtments but the conduction was a bit slow due that this needs some prepartions and almost the tools we lack to persue the work of the QC/QA. For example, tools such dose measurements device.....etc.

3. Personally, I took MSc student htrough him I am dissminating a lot of the QC/QA education in the hospital and X-ray deprtments. This was a good opprtunity to educate the worker there on how to reduce the patients dose and on how to take care of the equipment they are using with limited capabilities. And realy we did reduce the dose somewhere else especially for the high frequent PA chest X-ray projection.

4. We just established a new local DRL for our city for the first time ever for a number of the X-ray projections.

5. We, in the physics department, interested in opening a branch for the medical physics, and the project is on table, this need some preparartions to be issued by our ministry and we did try this year but the time gone of and the deadline passed so we postponde it to the next year.

6. Generally, the interst in the importance of medical physics is becoming realy high and the evidence for this is that are two academic institutes have opened BSc of medical physics branches and they are going on.

JAMAICA
Mitko Voutchkov

The Medical Physics programme in Jamaica was introduced in Jamaica after participation in the ICTP College on Medical Physics in September 2008. With support of programme organisers and lecturers, the University of the West Indies has launched in 2009 a Bachelor of Science Degree programme in Medical Physics, and in 2011 a Master's of Science Degree in Medical Physics. Further support was provided through IAEA TC grants and participation to the "School on Medical Physics for Radiation Therapy: Dosimetry and Treatment Planning for Basic and Advanced Applications" in 2015 at Trieste, Italy. Presently, over 140 students graduated with BSc degree in Medical Physics and some 35 with Master's and PhD degrees in Medical Physics. Among graduates are students from Jamaica, Trinidad and Tobago, St. Lucia, Dominica, Bahamas and Nigeria.

One of the MSc graduates from Jamaica is currently enrolled in the ICTP's Master of Advanced Studies in Medical Physics (MMP) program, which includes a year's clinical residency in hospitals. Jamaica is a leading country in the IAEA regional project RLA6081 "Strengthening Human Capacities of Caribbean Countries in Radiation Medicine" which aims "to expand professional development opportunities, building on an IAEA-supported medical physics programme started in 2011 at the University of the West Indies in Jamaica" (https://www.iaea.org/newscenter/pressreleases/iaea-helps-strengthen-radiation-medicine-in-the-caribbean).

KENIA
Bernard Ochieng

Dear Prof,

Below is my short gratitude note:

I wish to sincerely thank ICTP School of Medical Physics for having empowered me with knowledge and skills that I acquired there. Subsequent to the course that I attended in Trieste, I've been engaged in both diagnostic radiology and radiotherapy physics as follows:

- Help establish three radiotherapy centres namely Texas Cancer Centre, Equra Health Kenya (where I currently work) and Kenyatta University Hospital (where my consultancy for the institution is ongoing in Radiotherapy and PET/Cyclotron Project). I've played the role of both Medical Physicist and Head of Radiotherapy Division.
- Contributed to the curriculum development for the BSc (Radiography) at Jomo Kenyatta University, MSc (Medical Physics) at the Technical University of Kenya and MMed (Radiation Oncology) at the University of Nairobi.
- I'm anticipating to initiate similar programmes in the next one year at Kenyatta University Hospital when the institution facilitates the same.
- I've found the Emerald notes and images very useful in teaching at some of the Universities above. I can't forget to mention Prof Sprawls' MRI book which I've since a course book. I thank him once more for the complementary copy.

The seeds you planted are growing. May you endevour to plant and nurture more.

MALAYSIA
Anis Suhana Ahmad Sabri, Nurmazaina Md Ariffin

Dear Prof

As a participant in ICTP College of Medical Physics 2014, i found the course is very useful and informative as a learning center for all young medical physicist from developing countries to share our knowledge and experiences with the guide from IAEA expert and speakers.

The material provided during the course also is very useful for me and my colleagues as it can be applied in our daily work. We also use www.emerald2.eu as our reference.

2014 College of Medical Physics student is my changing point in becoming knowledgeable medical physicist that is valuable for my institution. Thank a lot for having me in the program. I'm very grateful and appreciate the opportunities.

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Dear Prof,

Thank you to you and ICTP College on Medical Physics for giving me an opportunity to attend the course and gain knowledge and experience from all the beneficial good lecture giving during the session. Until now, I still remember your lecture on the introduction of electronic learning materials on Emerald2 and EMITEL. It was a very useful source of information that I always used as reference to get better understanding of the concept apply in medical physics. From this Emerald2 and EMITEL also we try to apply the concept, since currently we are in the stage of finalizing our quality control methodology in radiology equipment especially in CR and DR system. This method will be used by medical physicist in Malaysia in verifying the quality control of radiology equipment in their hospital.

Beside that, I always used this reference as our continuous medical education program in my department. This is the platform for us to discuss and fill in the gap of knowledge between the medical physicist in the department. The presentation material is so attractive so we can get better understanding on the topic discussed. In addition, material from Prof Sprawl also helpful.

In 2016, MOH Malaysia are in the beginning of developing new quality assurance program (QAP) to supersedes the current QAP which are outdated. After the ICTP courses in September 2016 and with the long discussion on diagnostic reference level (DRL) during the session, I suggest that Malaysian DRL which develop in 2013 to be as part of QAP indicator, since both are in medical exposure. We manage to relate DRL for CT scanner and fluoroscopy cases into the QAP Manual. This Manual now still in trial stage at hospital level before this manual are fully implemented.

All the learning material given by ICTP during the courses also I share with my colleagues. Once again, thank you for giving me an opportunity to attend courses organized by the ICTP. Hopefully this kind of courses still continue to give changes to interested participant from all over the world.

North MACEDONIA
Dushko Lukarski

Dear Sir/Madam,

I was participant at the ICTP College of Medical Physics in 2010. The College provided very useful education in the field of Imaging QC and RP. I was introduced to the basics of different modalities of imaging in medicine by lectures and lecturers of very high quality. Not only that they improved my personal knowledge of the subject, but provided me with valuable resources for dissemination of these information (EMERALD, EMIT, EMITEL and Sprawls Educational Foundation).

I used the experience to improve the radiotherapy practice at my home institution, the University Clinic of Radiotherapy and Oncology in Skopje, Macedonia, and to conduct series of lectures on the subject for my younger colleagues.

Even today I use the resources provided by the College in preparing the lectures and practical exercises of the young students in Radiation Technology Therapy at the Medical Faculty in Skopje. Also, the contacts with my fellow colleagues made at the College are still kept today and on several occasions I was able to discuss professional issues with my friends from different centers around the world.

I thank you for the opportunity to participate at this College and wish you a successful future in introducing young medical physicist to the world of medical imaging.

MONGOLIA
Bilguuntur Otgonpurev, Lkhagvasuren Bold

Dear Slavik

We have only 5 medical physicists in whole country. 4 of us are radiotherapy specialties and only I am diagnostic and nuclear medicine specialty.

There is not academic preparation of medical physics at the moment. All we have graduated as a nuclear physics and specialized on radiotherapy and nuclear medicine medical physics through IAEA's fellowship programme in duration 2 months to 1 year in abroad.

For me, I have participated College on Medical Physics which was Enhancing the Role of Physicists in Clinical Medical Imaging: Procedure Optimization, quality Assurance, Risk Management, and Training, from 5 September 2016 to 23 September 2016 by full grant.

It was valuable opportunity for me. Because of new SPECT/CT, X-ray machine and Diagnostic CT and MRI had being installed at my institute that time. I was responsible for procurement, room preparation and installation of that equipment. There was nobody to teach me how to do calibration, commissioning and QA of diagnostic equipment. Medical imaging physic is very wide subject. Therefore it was deal to learn myself from handbooks.

I done calibration, commissioning and QA of newly installed diagnostic equipment successfully using my knowledge that gained from 3 weeks course at ICTP.
I was sharing my gained knowledge to the other radiotherapy medical physicists and radiology resident students.

Therefore, one of my colleagues contributed ICTP Collage on medical physics materials through presented at Annual Radiology Congress in 2016 which was “Radiation Protection Principles and Quality assurance in Diagnostic Radiology”.

Also, full grand was very good chance to participate that wonderful course. Because of people of developing country like as Mongolia is not possible to pay for training in abroad. I am very much appreciating with support of ICTP. Moreover 2 radiotherapy medical physicists had participated to ICTP medical physics course.

In my opinion, ICTP Collage on medical physics was help to strengthening radiotherapy and diagnostic radiology field in Mongolia. Due to introduction of new technology, we need to improve our knowledge continuously.

I hope that ICTP always will be help to successful development of Mongolian medical physics in the future.

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Hello Dear Tabakov

This is Mr. Bold from Mongolia. I am the first trainee in this program

This program still giving its benefit to Mongolians. I am still delivering information and teaching your lectures to diagnostic resident doctors who are being trained in the National Cancer Center

I have met several times with Ministry of health to organize nationwide diagnostic equipment's QA program but they still could not due to financial problem

But thanks to you we still have that knowledge to pay realy big attention on QA of diagnostic equipments and I am still delivering to new doctors so hope the system will change in Mongolia

MOROCCO
Mohammed Bougtib, Farida Bentayeb

Dear Tabakov;

I bring to your knowledge that the ICTP helped me a lot in the field of medical physics, because I was a student in master of the medical physics of trieste, and it was a good experience for me where I took a lot of things in medical physics, and during the period of my master degree I attended colleges in medical physics which made me much help in the field of medical physics.

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Dear Prof. Slavik Tabakov,
Dear Organizers of the ICTP College on Medical Physics,

Taking this opportunity, I have the pleasure and honor to congratulate the ICTP College on Medical Physics organizing committee. This college has been very useful for me, my university and my country.

I would like to congratulate and thank the entire organizing team, all the professors and specialists, and the local ICTP organization team, who look after to hold it each two years, for thirty years now! I greet you all without exception and wish you to continue and provide this interesting training that people in the field, from developing countries, can benefit and push to develop this discipline in their countries.

The ICTP College on Medical Physics has been very useful for me and for my country. Indeed, in 2006: it was my starting point in the domain! 12 years ago! This college was so interesting that I also attended, during other sessions, when I was an ICTP associate member.

Attending this interesting scientific event helped me to establish, in 2007 and for the first time in Morocco, training on medical dosimetry (university degree in medical dosimetry, Bachelor's degree of Science). Several promotions have been formed (20 students per promotion). The laureates work as dosimetrists in hospitals. Some of them continued a master's degree and are now medical physicists and others have obtained the defended their Ph.D thesis's.

I note that the EMERALD's online learning materials, as well as Sprawls Educational Foundation courses and the multilingual dictionary have been very beneficial to our students. I also had the opportunity and the honor to participate in the multilingual dictionary of the EMITEL international encyclopedia.

Following the establishment of medical dosimetry training in my country, a research team in medical physics was formed in our laboratory. Thesis work was done in collaboration with Italian specialists and a Brazilian professor whom I had the chance to meet, during the ICTP College on Medical Physics in 2006, Some Ph.D students of my team have benefited, through internships through ICTP's scientific programs, to develop their Ph.D thesis. Certain treatment techniques in radiotherapy were developed during these courses and are applied and appreciated in Moroccan oncology centers. Some works have been published in international journals and proceedings of international congresses. Our team's activities are axed on radiology and mammography, radiotherapy and nuclear medicine (imaging and dosimetry).

MEXICO
Eva Medel-Baez

Dear Prof. Tabakov,

It is a pleasure to stay in touch with you and with all the Medical Physics College. I attended the MP College in 2014 and I could summarize my achievements as follows:

1. Right after the College, I applied for an IAEA grant in order to receive founds for dosimetry equipment, phantoms and experts visits. That grant was accepted within the MEX6010 Technical Cooperation Project for the 2018-2019 period. During this year I expect to receive the equipment and some fellowships for Mexican radiologists are planned to take place by the end of this year.

2. By the end of 2016 and with the help of a Belgian dosimetry company, I borrowed a diagnostic dosimetry kit and I started a dosimetry review of CT, mammo, radiography and c-arms withing the center I work at and with the help of one master student and the vendor manuals. By mid 2017, all

the diagnostic equipment at my hospital was verified according to the vendor's recommendations and/or AAPM guidelines, and we prepared a based line report of the operation conditions for each machine.

3. In Juanuary 2017 we received an IAEA expert from MD Anderson Cancer Center with whom we followed the QA/QC of a CT and mammography equipment. We had group sessions and we involved radiologists and medical physicists from the academia to the seminars with the expert. This year we expect to receive another IAEA expert to work with us in the set up of a QA/QC program for our hemodynamics department.

4. Recently this year and after knowing the IAEA project was accepted for implementation, IMSS hospitals in the state of Puebla has accepted I perform an evaluation of their 52 diagnostic machines installed. I started with a personal interview with the radiation safety officer, I prepared a questionnaire involving installation time of the equipment, radiation safety aspects, operation licence, level of training of the operators, QA/QC programs existence, radiation levels, dose registry in their personal dosimeters, and estimated dose in each practice. The current scenario is not encouraging, but I am still performing my site visits since it is evident that there is a lot to do in this regard. The second stage of this visits will take place by the end of this month and we will start performing dosimetry tests. For this part I am involving my master students to prepare reports and perform research on the vendor's recommendations in case are not available at each facility. We look forward to fiish this evaluation and to extent our radiation protection program to other states in Mexico.

5. I have started a collaboration with different centers in south Mexico to carry out a remote CT dosimetry verification based on the design of a low cost CT phantom for dose and image quality assessment.We are in the CT phantom design phase, and in the characterization process of OSLD dosimeters for CT beam quality. I expect our first CT phantom prototype would be ready in a couple of months so we can send it to different centers to be irradiated at certain conditions, we would receive back the image they obtained and we would read the CT dose stored in the OSL detector; those centers that are out of certain tolerance levers we expect to visit them and perform CTDI verification on site.

6. BUAP University in Puebla, Mexico; is interested in exploring the possibility of setting up an SSDL dedicated to the calibration of diagnostic dosimetry detectors since there is not such standard in Mexico. I do collaborate with BUAP University in setting up a diagnostic radiology consulting program for low income medical centers in Puebla.

I thank you very much for following up our progress.

MONTENEGRO
Melisa Nurkovic

Dear Prof.Tabakov,

At that time, 2014, I was one of the Master in medical physics student at ICTP. Even that it was a little bit difficult to follow our school obligations regarding the exams and the College, it helped me before all, in the field of Magnetic resonance exam (which was immediately after the College), to pass well, and with more understanding! Generally, the Course was very useful for me during all my 2 years study in Italy. Also, practical session in Informatics laboratory were very useful, especially about DR image parameters.

Related to the given course material, I found it very useful, and often I use it, especially the Encyclopedia.

In connection with the achievement on this field in my Institution, I hope, with above mention new facilities, and new equipment, we will improve medical Imaging physics in our Radiotherapy department. Just to remind that I am involved only in work on Radiotherapy.

NAMIBIA
Vera Uushona-Mikka

Good day Sir,

Thank you for the email. The 2016 ICTP college on Medical Physics was very beneficially to Namibia. The notably achievement is the development of quality control procedures for diagnostic radiology. computed tomography and mammography. Unfortunately there is still no academic programme in medical physics in Namibia, however several undergraduate physics students at the university has done projects in medical physics as part of their research.

NEPAL
Ram Yadav, Matrika Prasad Adhikari, Kanchan P. Adhikari

Dear Respected Sir,

It is my pleasure to write about benefits from college on medical physics course conducted by ICTP for Nepalese medical physicists. when I flipped my profession from teaching physics at Tribhuvan University to medical physicists at department of radiation oncology of Bhaktpur Cancer Hospital in 2006, I was facing problems to understand medical imaging. how it is formed? How it is used for QA, Dosimetry and planning? But when I participated in college on medical physics course at ICTP in 2013, most confusion of CT , MR and X-ray images were cleared.

Now I am working as a senior medical physicists in radiation oncology department of BP Koirala Memorial Cancer Hospital since 2011. Now I am effectively use medical images in radiation treatment planning without any confusion.

Finally I would like to thank you, ICTP for continuation of college on medical physics till now. I also recommend to include QA and QC of nuclear medicine equipment in college on medical physics because this is still new for us to learn and implement in our institute.

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Dear Prof. Slavik

I Started My Carrier as an assistant Professor of Physics after completion of M.Sc.I taught general Physics for six years. Then I shifted to work as an Instructor of Radiation Physics in 2002 in a deemed university. There i started to teach Radiation Physics,Radio-biology, Radiation Protection and many radiation related equipment which were almost unknown to me.

It is very sad to share that there was not a single book of radiation Physics in the library, however i was able to find a book of Christensen and Bushong which was a big achievement at that time.I started lobbing with administration to buy books and fortunately we get few textbooks in next year. However i did not have any special knowledge and training about Medical Physics and radiation Physics, hence it was a big challenge at that time .

However i accepted the challenge and collect enough confidence that if I have books I can do it.

The feeling at that time was like being lost in ocean. Luckily in Sep. 2006 i got chance to Participate the college on Medical Physics .We stayed there in ICTP from 4-25 September. The classes were very useful and have made a permanent impact in my Carrier.

I got huge collection of ready made power points ,that i could use for teaching with full confidence and without any guilt. I was so happy and confident. I have not felt any difficulty for teaching any topics after that. The beauty of the course is that we were provided with World standard material and Power point Presentation by International experts and almost all topics were covered such as Cancer, Radio diagnosis, Nuclear medicine and Some topics in Radiotherapy and Radiobiology. Many a times i felt regret of leaving the main stream of Physics and college and coming to join the aliens the doctors and technologist. Of course The Radiologist and Technologist also used to behave like aliens to me and never supportive. However the continuity is very important and skill of communication and constant effort make a person to create a space . I did that.

The other benefit of the course is that getting chance to visit a foreign country for training is considered a big achievement among the colleagues and they start to see me as a special person and lucky one to go abroad for training. Their perspective towards me was changed and started to respect me. This happens in Developing world.

This opportunity of training in ICTP really helped me to continue my carrier in the field of Medical Physics, otherwise i would have left this field long back.

In 2007 i got a fellowship to do Diploma in Radiological Physics in India and now i have been working as a Senior Medical Physicist in B.P.Koirala Memorial Cancer Hospital , Chitwan Nepal and Asst Professor of Medical Physics in "Chitwan Medical College" and still continuing my teaching profession too.

I got chance to Participate the College on Medical Physics in 2016 also and updated my knowledge.I am Still using the material of ICTP and have been known as a good teacher of Medical Physics and continuing my carrier as a happy professional Medical Physicist.

I would like to express my heartfelt thanks to ICTP for conducting such course and my Respected teachers Prof Perry, Prof Anna, Prof Slavik Prof Franko, Paula, Vidimiri , Donald Frey, Giannini, Meghzifene, cionini for their contribution and big thanks to Professor Bertochhi for his support to the course.

I feel the need of the continuation of the course which support the Medical Physicists from Developing world for Continue Medical education and upgrading and updating the Recent development in this field and providing them a platform to share and care each other.

>>>>>>>>>>>>>>>>>>>>>>>>>>>>>

It is a privilege to write about International Center for Theoretical Physics (ICTP) College as Secretary General of Nepalese Association of Medical Physicist (NAMP). I was one of the participants of the ICTP College on Medical Physics from 30 August to 22 September, 2004. It was my first trip abroad and hence remains very special to me. I do still retain distinct memories of participants attending that college. Until now, almost all (eight medical physicists) of Nepal have visited ICTP College on Medical Physics.

At that time, ICTP College on Medical Physics was a hope and an opportunity for physicists from Low and Middle Income Countries like Nepal, for upgrading their knowledge. At that time, most of the medical physicists working in Nepal did not have formal degree of medical physics. Most of them with master in physics degree. Hence, ICTP College on Medical Physics as well as e-learning materials of the projects EMERALD, EMIT and Sprawls Educational Foundation happen to be important tool for upgrading the knowledge and competency in the field of medical physics.

In Nepal, almost all medical physicists are working in radiation therapy, hence college on medical physics is the only place where they can learn diagnostic & imaging part. I am myself a going example of that. Before attending the college on medical physics, I was working only in Radiotherapy. In Nepal, there is still lack of QA program, commissioning and acceptance test in diagnostic radiology. After attending the college, I have started my work in the field of diagnostic radiology and have published my articles in different journals besides completing my PhD in radiation protection.

During my research, I have used lot of e-learning materials of the projects EMERALD, EMIT and using it. It has helped me a lot to do quality control tests in diagnostic radiology.

ICTP College on Medical Physics has provided lot of resources to Nepalese medical physicists. We are still using these learning materials in our PG program in MD radiology and MD Radiation Therapy, B.Sc & M.Sc (Medical Imaging Technology). Nepal has also participated ICTP visiting Scholar Program VS-439, Dr. Anna Benini form ICTP College on Medical Physicist had visited Nepal several times. We had done some research in radiation protection in interventional radiology at Gangalal Heart Center, Kathmandu.

ICTP College on Medical Physics has opened a door to the medical physicists working in Nepal to understand recent development in medical physics and helped to promote contacts for future work in the field of medical physics. Now, we are still in contact and commutating with ICTP College of Medical Physics academician for development of medical physics in Nepal.

Nepal has benefited a lot through ICTP college on Medical Physics e-learning materials of the projects EMERALD, EMIT and Sprawls Educational Foundation. Finally, I would like to thank ICTP College on Medical Physics for providing an opportunity to develop medical physics field in Nepal through education and training.

NIGERIA

Omuvwie Bernard Evwierhurhoma, Abdulkadir Muhammad

Dear Sir,

I am very pleased to be a graduate of the ICTP College on Medical Physics in Trieste and it has enabled me to create more awareness of the various medical physics e-learning resources among undergraduates and graduates from my university and others in Nigeria.

I have facilitated industrial training, internship, research assistance for upcoming physicist and this has led them to pursue their career in the medical physics profession and even with a medical physics library being set up in my hospital.

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Personally, the ICTP college and sprawls materials have greatly influenced my medical imaging teaching techniques and confidence.

I have now adopted the rich class room approach with a lot of visual display and consequently, it has positively improved the understanding and appreciation of imaging principles by my students as it has reflected in their general attitude as well as performance.

I say a big thank you to the organizers and I will continue to build upon what I have learned from the college.

PAKISTAN

Muhammad Asif, Sajid Bashir, Kashif Islam

Dear Slavik Tabakov,

The ICTP College on Medical Physics was a very good platform that delivered comprehensive knowledge covering all aspects of radiological imaging physics.

This College helped me in many ways, this give me basic medical physics knowledge. College gave me chance to discuss medical physics problems with world’s renowned medical physicist. It helped me to establish quality control program in radiology department. It make me a better teacher to teach physics to radiology residents at my institution.

After attending this college the knowledge management of medical physics was very easy for me. The EMITEL & EMERALD CD answered my questions like a teacher and I gain a lot of Medical Physics Knowledge and confidence through these learning resources.

Thank You

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Dear Professor

In 2016, I have attended the College in Medical Physics at ICTP and found it extremely useful despite some deficiencies. The faculty delivered the lectures in a clear and concise way that made the material easy to understand. This was particularly important for those people who were working in nuclear medicine departments only and have no previous experience in diagnostic radiological physics.

The lectures materials I brought from ICTP have been found very useful. The quality of presentation content reflect the endeavors made by the faculty. I have been using these presentations frequently to prepare my lectures to medical physicists, radiology and nuclear medicine residents. Particularly I am thankful to Prof. Perry Sprawls, Prof. Slavik Tabakov, Prof. Oshinski and Prof. Anna Benini for sharing their professional experience with us in class.

From the college in medical physics, I got the idea of holding the summer college in medical physics in Pakistan. This week long activity will be held under the umbrella of Nathiagali Summer College in Islamabad on (23-29) July, 2018. This activity has been endorsed by AAPM. Just for the sake of information, Nathiagali summer college was first organized by Prof. Abdus-Salam in Pakistan back in 1976.

Lastly, I will say this activity provides opportunities to medical physicists from developing counties to learn directly from renowned faculty about latest developments in their field of interest and, therefore, this activity should continue. I appreciate the efforts made by the college organizers and the faculty in making this event a success. In future, I offer my services for this college if the organizers deem necessary.

>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>

Dear Prof. Slavik Tabakov,

As a medical physicist, I have been using ICTP materials from time to time for the preparation of slides while talking to colleagues (technologists, radiologist) working in nuclear medicine and radiology. In radiation training of workers, we especially used the experiences of Trieste Hospital training conducted while our course. I also wrote about my experiences at college on medical physics in a national publication of Pakistan Organization of Medical Physicists.

The knowledge ascertained from ICTP college has been utilized for technical procurement of cancer hospital. Being part of technical procurement for computerized radiography, the assistance was taken from your presentations on computerized tomography and sprawls educational materials directly because the images were directly relevant and related to radiology. I must appreciate endeavors made by ICTP in regards to EMERALD, EMIT and Sprawls educational foundation.

Being part of a new hospital, it was very easy for us to implement radiation protection strategies from the very beginning. The hotlab environment is monitored online through area monitor, a fume hood is installed for radiation safety and patients have been advised to inform about any medical conditions in their first visit to medical doctors, and for this, graphical signboards are installed in radiology and nuclear medicine departments.

In short, the knowledge obtained from the ICTP college on medical physics improved the quality of our work. Therefore, I am highly thankful and would request to keep it improving according to the requirements of the time. I am thankful for remembering us even after six years and appreciate your patience with this feedback.

PERU
Yazmyn Paraguay

Dear Prof. Tabakov
Sorry for the delay in responding to your email, but I was on vacation throughout the month of July until yesterday.
I hope it is not too late to respond to your request.
so I will be very brief and I will comment on the following:

The first time I attended a College on Medical Physics was in 2006 , was just beginning to make my internship in Medical Physics at the Dos de Mayo Hospital for what I learned during that time was very important since the knowledge learned in that course as well as in others served as the basis for this hospital to be a reference hospital for ionizing radiation.

The second time I attended a College on Medical Physics, I was already a professor at a university in my country, so the information given in EMERALD and the Encyclopaedia / Dictionary EMITEL are indispensable as reference material for students, even for professionals who request information in the regulatory office of my country.

RUSSIA
Pavel Kazantsev, Alexandra Kamp (Zvereva)

Dear Prof. Tabakov,

thank you for the invitation to present developments in Russian medical physics achieved after our participation in the College on Medical Physics in Trieste - and apologies for the late answer!

My colleagues and me participated in 2010 CMP session; since then, many things have changed for all of us individually - as well as for the whole russian medical physics community. Although there are very few medical physicists working in radiology departments in Russia, radiotherapy medical physicists need to know the fundamentals of medical imaging as well.

I can honestly say that CMP became for us a kind of a "train the trainers" event, and the knowledge obtained there we used later as lecturers in medical physics training courses organized by the Association of Medical Physicists in Russia. Materials distributed during the CMP, especially EMERALD data and presentations of P. Sprawls, were particularly useful for preparation of lectures for trainees. During the last several years, training courses for russian-speaking medical physicists are organized several times annually, and although I personally am not involved there anymore, the presentations prepared based on the materials and information from CMP are still in use. I believe, that our participation in CMP ultimately helped to improve the average level of medical physics in clinics of the former USSR.

Personally for me, CMP was not only a great training opportunity but a place where I met friends and even some future colleagues and I hope that next generations of young medical physicist will also benefit from participation in College on Medical Physics!
Thank you and best regards

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Dear Professor Tabakov,

I am pleased to inform you about the achievements made in Russia in the last years through the education of several medical physicists, including me, in the ICTP College on Medical Physics in Trieste. During the last eight years, since my colleagues and I had an opportunity to attend the College, a lot has changed in medical physics in Russia in general, as well as in our individual careers in particular. The greatest achievement, in my opinion, has been made in the educational sphere. Thanks also to the Association of Medical Physicists in Russia (AMPR), educational and training courses for medical physicists are organized on a regular basis, so the general level of education of medical physicists in Russia is gradually increasing.

The ICTP College on Medical Physics and its excellent lecturers, besides improving our own level of knowledge in the field, helped us to disseminate this knowledge further to other medical physicists in the country through our teaching activities. The materials provided at the College were of a great use while preparing our own lectures and other educational materials that are still in use at the courses organized by the AMPR. From time to time, I still come back to the e-learning materials provided – the last time recently while preparing for my PhD defense.

Thank you for your efforts in educating medical physicists around the world and for the great networking opportunities for young medical physicists at the ICTP College on Medical Physics.

SENEGAL
Adji Yaram Diop

Dear Dr. Tabakov

I had been in the ICTP College on Medical Physics. I had an internship like medical physicist but in radiotherapy. Now i am student in the Master of Advanced Studies in Medical Physics at ICTP.

My participation in the college was very useful for me and my hospital, because there are no medical physicist in medical imaging in my country. The college helped us to understand a lot of thing in medical imaging, radiation protection...

I shared all the materials that i get in the college to the others medical physcist in my country. They are 3 and all works in radiotherapy, so the materials are very helpful for them mostly doing the quality control for the CT simulator, because they don't have strong knowledge in that area.
They plane to start some control in medical imaging (in CT)and they have now not all but some

materials.
SERBIA Jelena Samac
Dear professor Tabakov, As a participant of Colledge on medical physics in 2016, I had a chance to obtain new knowladge in areas of diagnostic radiology, magnetic resonance, radiation protection and, most important for me, in nuclear medicine physics. Lectures by professor Tippnis were wery good, consise, and full with usefull information, otherwise hard to find in books. What I found most usefull was the practical session in Catinara Hospital with prof. deDenaro, in nuclear medicine department. Using the knowladge and learning materials form these sessions, I was able to implement a QA/QC programme for planar gamma camera and SPECT in my nuclear medicine department in Clinical Centre if Vojvodina, Novi Sad as part of my residency project, that I compleeted last month. There is an iniciative to make my residency paper a national quideline for conventional imaging in nuclear medicine in Serbia. The materials in EMERALD base provided good practical examples and images. The last, but not least important thing I would like to mention about Colladge on Medical Physics are the colegues, some of which I call my friend today, I have meet, particularly from neighbouring Croatia, who have helped me finish my residency project, either by letting me borrow some QC equipment (not owned by any hopital in Serbia) or by organizing fellowship visit in their hospital. I hope many more medical physicist will have the same opportunity to attend Colledge on Medical physics in future, as I consider it to be one of the most important post-graduation educational activity working as a medical physicist in diagnostic imaging.
SLOVENIA Petra Tomše, Luka Jensterle
Dear prof. Tabakov, Both, my colleague Luka Jensterle and I were fortunate to have an opportunity to attend the ICTP College on Medical Physics at the begining of our work at University Medical Centre Ljubljana. Our background education in Physics/Electrical Engineering did not at the time of our studies cover any subjects of Medical Physics, therefore the ICTP College was the most welcome source of knowledge an excellent starting point for us. Through the education at the College our institution as well as the country gained professionals with basic knowledge of the topics which have later been introduced to the Medical Physics master program at the University of Ljubljana, but was at the time not possible to achieve elsewhere. We also appreciate the EMERALD materials and EMITEL dictionary which we use when looking for specific information in our work about quality control, dosimetry, radiation protection, or when educating younger collegaues.
SRI LANKA Indika Pathirana
Hi Professor Tabakov,

In 2014 I have completed my MPhil at Kings College London, department of Physics (X-ray Physics) and current working as a researcher (Cardiac MRI) at Stephenson Cardiac Imaging Center in Foothills hospital, Calgary Alberta. Meanwhile I am supporting to develop Medical Physics course unit at University of Sri Jayewardenepura, Sri Lanka.

ICTP course helped me a lot to complete my research at King's and to develop course for the undergraduate in Sri Lanka. To me it was very successful course and still I am using those materials as a guideline for my current studies.

Thank you very much and have a wonderful day!

SUDAN
Almubarak Mubarak Yousif

Dear director of ICTP College on medical physics

I am writing this email to express my gratitude for the opportunity to participate in one of the valuable activities organized by Ictp College on medical physics on December 2014(Advances in Medical Imaging Physics to enhance healthcare in developing country). This activity had good impact in our project to optimize the radiation dose for patients, workers and public in radiology departments. To achieve the goal of this project Our quality control department in ministry of health conducted Qc On an annual basis for all the radiology facilities in Khartoum state and measure the radiation dose rate in control area, supervisor area and public area around the departments to ensure that the design fulfill the regulator requirement

One of our future goals to provide regular training for radiologist and technicians because always we thinking they are the first responder and responsible for operation work in radiology department.

Finally your cooperation and your ability to motivate others have resulted in significant improvement in my career as medical physicist specialist. Your usual support and cooperation for the development of the professional is greatly appreciated.

TANZANIA
Wilbroad Muhogora

I have participated in ICTP's Colleges of Medical Physics as ICTP Regular Associate (1999, 2000, 2002) and as ICTP's Simons Associate (2014). Through this involvement and also with IAEA connection, a number of studies related to optimization of patient dose and image quality diagnostic radiology in Tanzania have been performed.

I have also co-supervised three (3) MSc students in medical physics related research topics in radiotherapy and diagnostic radiology at University of Dar es Salaam in Tanzania. I have also co-supervised two (2) M.Sc students at the Faculty of Health Sciences, University of Johannesburg and 1 student at Stellenbosch University, Cape Town both Universities being in South Africa in radiation protection related topics in diagnostic radiology.

Such collaborative work with students have resulted to over 20 papers published in peer review journals mainly on imaging physics, medical physics and radiation protection. I am regularly recruited by IAEA to train participants in IAEA's training programme on radiation protection of patients in diagnostic radiology in the African region as an external expert. I have also served as an external reviewer in a number of journals such *Tanzania Journal of Science, Journal of Medical*

Physics of India, Peadrics Journal, International Journal of Medicine and Medical Sciences , Medical Science Monitor Journal, Journal of Digital Imaging, Journal of Public Health and Epidemiology.

I am currently serving as a Science Committee Member of the International Organization for Medical Physics. I believe such achievements have been largely been contributed by the knowledge obtained through the ICTP's College of Medical Physics.

THAILAND
Thunyarat Chusin,

Dear president of IOMP,

Thank you again for giving an opportunity to me and Thai medical physicists to attend the ICTP College on Medical Physics for many years. For me, I got valuable knowledge as well as education materials through the college. I use it for teaching and training numerous students in Naresuan University and staff who work for radiology such as radiographer and medical physicist in Thailand. I do research and publish articles based on this knowledge as well. Subsequently, I achieved my goal to be an assistant professor. My students got a good job in hospitals that serves for lacking of radiographer in Thailand. The staff improved their profession on healthcare services. In addition, I and my classmates in the college stay in touch and hope that we will have collaboration in the near future.

TURKEY
Bilal Kovan, Recep Kandimir

Dear Mr Tabakov

First of all, the ICTP College on Medical Physics was very useful in improving my professional knowledge. I was following this course for a long time. It was possible to participate in this course with the support of both ICTP and EFOMP in 2016.

Theoretical and practical applications of the course given by lecturers in terms of medical physics have opened my horizon. In particular, my theoretical and practical knowledge about radiology physics and radiation protection information was higly developed by means of the lectures given by Anna Benini.

Thanks to "Medical Physics e-Learning" lectur given by Mr. Slavik Tabakov', I have been able to follow the developments of medical physics in electronic environment. The EMITEL web page is an important reference to professional terms. I am taking advantage of EMERALD / EMIT web page intensively while teaching. I have benefited greatly from both web pages when preparing my graduate thesis.

I have started scientific studies in our clinic with the support of the information and web pages. After returning from the COMP course, I began to my PhD education by taking advantage of the knowledge and experience I gained via on the course. After that time, I follow developments from EFOMP and ICTP's web pages. I follow EFOMP and ICTP scientific events with interest.

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Dear Sir,

I would like to inform you about myself shortly. I am currently continuing my doctorate in the field of medical physics and working in the department of radiation oncology.

The ICTP College on Medical Physics was very useful for me. The times I spent on the course was an unforgettable moment for me. Besides acquiring friends from many different countries, I got valuable information on medical imaging. It was also very important to meet very valuable scientists from different countries like you. During the course, resources such as books and presentations were presented to us.

Especially the EMERALD materials/images and the Encyclopaedia / Dictionary EMITEL were very good for me. If there is a question that I am still curious about, it is among the sources that I refer to.

UGANDA
Alen Musisi

Dear prof

I reference to your first mail, the ICTP College on Medical Physics training have helped me in a number of ways;
1. I gained more substantial knowledge about the field especially in QA/QC that I have used at my place of work (mengo hospital)
2. I have trained two new young physicists based in the same hospital.
3. I have presented my ICTP experiences and knowledge gained in a number of conferences in my country
4. I work as an assistant lecturer also (teaching radiographers), the information I received from ICTP helped me improved my lecturer notes and kept them up to date.
5. The training boasted my CV that impacted on my admission decision to a MSC. Medical Physics at University Sains Malaysia which I am currently finalising.
6. Me and other colleagues in Uganda are planning to design a curriculum for BSc. Medical Physics which we hope to be accredited by the end of 2019. This was all because of motivation i got from ICTP training.

VIETNAM
Soai Dang Quoc, Anh Mai

Dear Professors,

I would like to thank Professors very much for your continuous supports !

Thanks to the knowledge from Advance Medical Physics Course, I have done following in my hospital:

I. About research

1. Research, analyze the dose results calculated with AAA algorithm in Eclipse software of new treatment planning system.
2. Compare the difference between dose results calculated with Analytical Anisotropic Algorithm (AAA), dose results calculated with PCB algorithm in Eclipse Software, and measurement dose

II. About my job
1. I have contributed to the implementation IMRT treatment, consulted to buy QA IMRT equipment in my hospital. Now we are using IMRT technique for head - neck treatment and we

have Scandidos 4D for QA IMRT plan.
2. Edited QA LINAC protocol in my hospital follow IAEA_TRS398
3. Calcualted radiation safety to repair Nuclear Medicine Department.

III. About tranning
2016: I was supervisor of one student of Master of Physics course in Hanoi University of Science. His thesis is "the quality control for LINAC use in Medicine"
2017: I was supervisor of one student from School of Nuclear Engineering and Enviromental Physics of Hanoi University of Science. His thesis is "Compare Fields in Field Technique with Dynamic Wedge Technique Using in Whole Brain Treatment in Hanoi Oncology Hospital"
2018: I am teaching for a college, Who is working in Oncology Hospital of Thanh Hoa province. The course is "Medical Physicist in Nuclear Medicine".
I hope that I will be the better medical physicsit in future
Many thanks Professors

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Dear ICTP,

I'm a medical physicist. Now I'm working in Radiation and Radiosurgery department, 108 hospital, Hanoi, Vietnam. I joined a course about Medical Imaging Protect from ICTP. And then, I backed my country and used something which I learned for my work. I have seen my work have improved many time about quantity and quality. I think that it's useful. And if you can, you will continue courses like that.

I usually update new informations from EMERALD. Especial about the physic of Radiotherapy. it's useful so much. i am going on continue update these information from yours.

Thank you so much about knowledge you provide us.

ZAMBIA
Nkonde Kangwa, Mwansa Kawesha

Dear Prof. Slavik,

The course had helped improve our quality assurance check on radiology equipment, especially CT and Mammography. We had used the EMERALD course to teach physicists from the regulatory authorities basic QA test in CT.

The skills obtained during the month long training in Medical Physics held at ICTP in 2014, has contributed to my performance and generally improved overall healthcare in the Ministry of Health- Zambia, in terms of stringent QA program for CT and Mammography. It also propelled me to start collecting data to set up DRLs for Nuclear medicine.

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Dear Prof Tabakov,

Following my participation in the 2016 ICTP College on Medical Physics, I have had the opportunity to use the knowledge I gained at the Cancer Diseases Hospital in Lusaka, Zambia. With a better understanding of Medical Imaging Quality Control and Safety, I was better able to support the Medical Physics Team in Zambia with the monitoring of the hospital's Medical Imaging devices. Recently, a staff training programme has been introduced in my country and some

Medical Physicists have been tasked with educating the trainees in the Physics of Medical Imaging, Radiobiology and Safety in Medical Imaging. I hope to share the e-learning materials with these new trainees, as they embark on becoming the first Radiologists trained in Zambia.

I sincerely thank you for the valuable knowledge that you have shared with me.

ZIMBABWE

E. Mhukayesango

Zimbabwe has had a chance to participate in the ICTP College on Medical Physics and as such I had the opportunity to attend one of the courses in 2014. The meeting was really interactive and had the chance to meet various experts from around the world. After the course, the following was realised:

a. provision of the relevant material necessary in the dispatch of duties in diagnostic radiology
b. Appreciated the role of the Medical Physicist in diagnostic radiology.
c. Safety concerns for staff, the patient, the public and the environment.
d. The trade off between image quality and exposure to the patient.
e. Appreciated the role of quality assurance in medical imaging.
f. The role of dosimetry in x rays imaging.

Through the items listed above, the impact to the hospital has been in the following areas:

a. Quality assurance on imaging equipment.

There has been a marked increase in the frequency of quality assurance activities on imaging equipment especially x-ray units. In the past, some of the QA equipment was not yet available or underutilized. In addition, record keeping of all quality activities has been improved markedly.

b. Safety concerns for staff, the public and the patient.

From the material obtained from the course, the hospital Medical Physicist in conjunction with the Radiation safety team have developed comprehensive safety procedures, especially for the x ray machines and CT scanners.

c. Image quality

From the activities of the course, imaging protocols have been updated in order to give the optimal image quality for minimum exposure to the patient, staff and the public.

g. Dosimetry in x- ray and CT scanners.

The course material also highlighted the necessary equipment, procedures in making dose measurements in x ray imaging. Thus our department managed to source out the necessary equipment necessary to perform the required dosimetry.

Course material such as the one from website of Sprawls had been beneficial in providing theoretical and practical knowlegde on the use other imaging modalities such as ultrasound and MRI. The material from EMERALD materials/image and Encyclopaedia/Dictionary EMITEL is also used in the routine Medical Physics work.

ANNEX 5 and 6

5. Letters of Gratitude from:

-International Organization for Medical Physics

-Asia-Oceania Federation of Organizations for Medical Physics

-Federacion de Radioproteccion de America Latina y El Caribe

-Federation of African Medical Physics Organizations

-European Federation of Organizations for Medical Physics

6. Papers about the History and Impact of the ICTP College on Medical Physics

International Organization for Medical Physics

IOMP

INTERNATIONAL ORGANIZATION FOR MEDICAL PHYSICS

Member of the International Union of Physical and Engineering Sciences in Medicine

(Union Member of the International Council for Science)

http://www.iomp.org

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Professor Fernando Quevedo
Director ICTP, Trieste, Italy

Address to ICTP, celebrating 30 years College on Medical Physics

31 May 2018

Dear Professor Quevedo, Distinguished ICTP Board members,

The International Organisation for Medical Physics (IOMP) is the umbrella of all medical physics societies in the world, with about 27,000 members in 86 countries. Medical Physics is often invisible in healthcare, but contemporary medicine is impossible without medical physicists – the professionals who deal with the development and effective and safe use of many types of medical equipment, including various imaging modalities, linear accelerators and others, which form the backbone of diagnostic imaging and radiotherapy in healthcare.

The Abdus Salam International Centre for Theoretical Physics (ICTP) supports our profession for many years. In 2018 the regular ICTP International College on Medical Physics celebrates its 30th anniversary. Over the years this College has educated more than 1000 students from around 100 Low-and-Middle-Income (LMI) countries.

These ICTP activities are vital for the training of medical physicists in developing countries, who not only undergo education and training in the ICTP, but also receive full sets of teaching materials, which help them to later organise similar courses in their countries. Now about 80% of all medical physicists in LMI countries are linked to the training in ICTP and benefit directly or indirectly from it. This is of high importance for the healthcare delivery in the developing countries.

IOMP is immensely grateful to ICTP for this support for the medical physics profession and its activities in developing countries. We strongly believe that ICTP will continue its support for our profession!

With sincere gratitude and best wishes

Prof. Slavik Tabakov, President IOMP

宙時魂

Asia-Oceania Federation of Organization
for Medical Physics
www.afomp.org

16 July 2018

Dear ICTP Board,

Congratulations to ICTP Board for great contribution by ICTP of the International Medical Physics College.

For more than 30 years the ICTP College on Medical Physics in Trieste is educating young medical physicists from low-and-middle-income (LMI) countries. The students are now more than 1,000 and most of them work directly in the healthcare application of medical physics, or in teaching other students on this very important subject. I know that many of these colleagues are from the Region of AFOMP

On behalf of the Asia-Oceania Federation of Organization for Medical Physics (AFOMP), it is my great pleasure and honor to express the gratitude of the colleagues of this part of the world for the education in the ICTP College on Medical Physics

For these great achievements I want to specially thank all colleagues from the ICTP Board and Prof. Slavik Tavakov, Past Immediate President of IOMP.

I believe that this outstanding international achievement will continue and will grow in the future.

With gratitude and best wishes,

Tae Suk Suh, PhD
President
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Federación de Radioprotección de América Latina y El Caribe

Creada el 26 de noviembre de 1993

Abdus Salam International Centre for Theoretical Physics (ICTP)
ICTP, Trieste, Italy

16 July 2018

Dear Board of the ICTP

On behalf of the Radiation Protection Federation of Latin America and Caribbean, I wish to express our appreciation and gratitude to the very efficient work of ICTP College on Medical Physics related to the Education and Training of medical physicists from the Latin America region. The excellence of the ICTP College medical physics program has been the differential for the capacitation of the health professionals from our region. Besides, the ICTP College on Medical Physics has been the most expected opportunity to students in countries that do not have medical physics courses in place.

As result of the outstanding contribution of the ICTP College in the past decades, the region had gained more qualified professionals working with competence in different areas of healthcare and thereby improving the quality of the health services in Latin America.

We hope that this important collaboration can be further strengthened in the future

With gratitude and my highest consideration

Simone Kodlulovich Renha
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FEDERATION OF AFRICAN MEDICAL PHYSICS ORGANIZATIONS

Member of the International Organization for Medical Physics (IOMP)

https://fampo-africa.org

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APPRECIATION NOTE TO THE BOARD OF ICTP COLLEGE ON MEDICAL PHYSICS

The Executive Committee and the entire membership of the above named Federation (FAMPO) in the nooks and crannies of our region wishes to Congratulate the Board of the ICTP College on Medical Physics on the occasion of her 30th Year Anniversary.

Our members from the different countries have benefited immensely from the multitudes of innovative courses that have been mounted by the College year-in year-out and this has greatly impacted and deepened the medical physics practice in our various health establishments in the region.

It's indeed a landmark achievement that has been accomplished over these years and we want to plead from the African continent that innovative funding mechanisms should be deployed to make the programmes being constantly developed by this unique body, sustainable and even grow in leaps and bounds.

Once again, we felicitate with our indefatigable patron – Prof. Slavik Tabakov – and all the other board members on this epoch making milestone and fervently and sincerely pray that the activities of the College shall be further strengthened and sustainably maintained in the coming years.

Kindest regards.

Taofeeq A. IGE (PhD)

President

Federation of African Medical Physics Organizations (FAMPO)

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25 July 2018

APPRECIATION NOTE TO THE BOARD OF ICTP COLLEGE ON MEDICAL PHYSICS

Since more than 30 years, the ICTP College on Medical Physics is promoting education and training of young medical physicists from low-and-middle-income countries. Among them, also many young colleagues from eastern Europe have benefited from these events.

Making bridges between different part of the world is among the most important achievements which have been accomplished over these years by the ICTP College on Medical Physics.

On behalf of the European Federation of Organisations for Medical Physics (EFOMP), it is my great pleasure and honour to Congratulate the Board of the ICTP College on Medical Physics on the occasion of its 30th Year Anniversary.

We believe that the activities of the College shall be maintained and further strengthened in the coming years, with the collaboration of all the National and Regional Organisations related to medical physics.

Kindest regards

Marco Brambilla (PhD)
President
European Federation of Organisations for Medical Physics

THE IMPACT OF THE ICTP COLLEGE ON MEDICAL PHYSICS FOR THE ESTABLISHMENT OF MEDICAL PHYSICS IN DEVELOPING COUNTRIES

S Tabakov[1], P Sprawls[2], A Benini[3], F Milano[4], G D Frey[5], L Bertocchi[6]

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Abstract- The regular College on Medical Physics at ICTP (the Abdus Salam International Centre for Theoretical Physics), Trieste, Italy, has been a strong support for the development of medical physics in developing countries. Additionally ICTP has participated in several medical physics education/training projects and has hosted several International Conferences in this field. Recent feedback assessment shows significant (66%) increase of participants knowledge. During its more than 20 years history the college has educated more than 1000 young medical physics colleagues from developing countries.

Keywords- Education, training, developing countries.

INTRODUCTION

The International College on Medical Physics (CMP) at ICTP (the Abdus Salam International Centre for Theoretical Physics) in Trieste, Italy has operated for more than 20 years. Although ICTP does not have a permanent Research Activity in the field of Medical Physics, a very vigorous training and Conference activity takes place. It started with an International Conference on the Applications of Physics to Medicine and Biology in 1982 (organised by Giorgio Alberi). Another successful Conference and several Workshops were organised in the following years, demonstrating the need for Medical Physics education for the developing countries. This convinced ICTP to expand their training activities with Medical Physics. The first College on Medical Physics took place in 1988 (a 4 week activity with the participation of 68 scientists from developing countries). The regular series of Colleges begun in 1992 and continues to run on a regular basis (usually bi-annually). During the period the ICTP has educated more than a 1000 young medical physicists mainly from developing countries. From the beginning corner stones for the ICTP involvement in Medical Physics were Luciano Bertocchi (then Deputy Director of ICTP) and Anna Benini (then IAEA Officer). Additionally, a number of prominent professionals were engaged with the College on Medical Physics, including John Cameron (USA), Sergio Mascarenhas (Brazil), Perry Sprawls (USA) and Slavik Tabakov (UK). The current Co-Directors include also Franco Milano (Italy) and George D Frey (USA), while the Hospital training is organised by Mario De Denaro.

MEDICAL PHYSICS COLLEGES AT ICTP

The transfer of knowledge and experience to the developing countries is a major objective of the College. Each participant receives a full set of lecturing materials, including Power Point slides, e-Learning materials, access to web sites, etc. These have triggered tens of Medical Physics activities and courses in the developing countries and helped hundreds of colleagues from these countries to practice the profession. Due to this reason CMP is always one of the most over-subscribed training activities of the ICTP – see Figure 1.

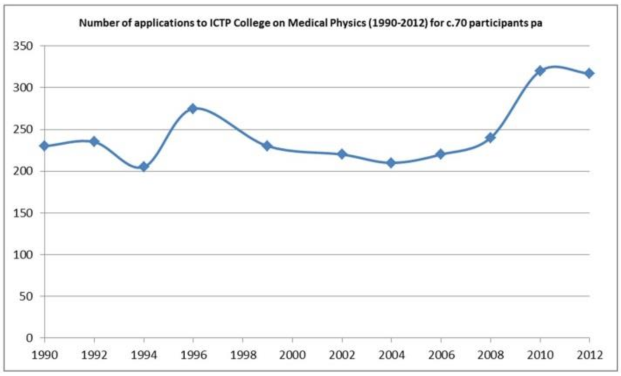

Figure 1. Applications to ICTP College on Medical Physic

CMP usually accepts colleagues from 30 to 40 developing countries. It is known that in general, physicists from these countries have good educational foundations in general physics. The College builds on this foundation by providing education on the recent advances in medical physics. Participants of previous Colleges on Medical Physics have demonstrated its great value as they have formed a significant medical physics infrastructure in their countries.

ACTIVITIES AND EFFECTIVENESS OF THE ICTP COLLEGE ON MEDICAL PHYSICS

Some areas of Applied Physics in medicine (especially Radiotherapy physics) are covered by specific courses provided by various institutions, organizations, and agencies, however there are not sufficient courses, available elsewhere, which cover Physics of Medical Imaging. Additionally very few of those include training on the practical application and optimization. Because of this the CMP emphasis during the last decade is on Medical Imaging Physics.

The effectiveness of the 2010 and 2012 Colleges (both with focus on Digital Imaging) was assessed with 3 Questionnaires – collecting feedback on the College Organisation, syllabus, knowledge transfer and suggestions. The results of these questionnaires showed significant effectiveness in increasing the knowledge of participants. In brief while the student's estimate of their knowledge prior to the College was with a mean of 45%, after the College it was with a mean of 75%. This regular feedback is also used for modifying the programme for each following College. This approach to improve the Curriculum with the active participation of the students has been one of the successes of CMP.

The increased interest of ICTP in Medical Physics led to its inclusion in several international projects. Most notable are EMERALD, EMIT and EMITEL. The first two developed e-Learning training materials in physics of: X-ray Diagnostic Radiology, Nuclear Medicine, Radiotherapy, MRI and Ultrasound Imaging. EMERALD was not only the first e-learning in medical physics, but introduced one of the first ever e-books. Currently each participant receives a free set of these materials. In connection with these training materials ICTP hosted three International Conferences (in 1998, 2003 and 2008) – these were the first international Conferences on medical physics training. The importance of the above projects can be judged by the fact that in December 2004 the EMIT project received the inaugural European Union "Leonardo da Vinci" award.

The Conference in 2008, related to project EMITEL, introduced the first e-Encyclopaedia of Medical Physics (currently used by some 9000 colleagues each month). This Conference established a good relationship of ICTP with IOMP (also a partner in EMITEL). Recently IOMP supported other medical physics activities of the ICTP.

Apart from the regular CMP in Trieste, ICTP initiated similar courses in other countries. The first Regional College on Medical Physics was conducted in Mumbai, India during November 2007. The first week was devoted to The Physics and Technology of Medical Imaging and the second week to The Physics and Technology of Radiation Therapy. Perry Sprawls and S.D.Sharma were the Academic Directors and the College was also supported by the ICTP, and the Bhabha Atomic Research Centre (BARC), Mumbai, India. Additional co-sponsors were the American Association of Physicists in Medicine (AAPM) and the Association of Medical Physicists in India (AMPI).

ICTP operates under the aegis of UNESCO and IAEA and naturally alongside the CMP, hosts many IAEA Workshops and Symposia. In 2005 ICTP was the Co-Organiser of the World Conference "Physics and Sustainable Development" in Durban, South Africa, where one of the main directions for applied physics in the XXI century was voted to be Physics in Medicine.

ICTP also supports Medical Physics research in a similar way to other scientific areas. This is through two programs for individuals: The Associate Members and the Programme of Research and Training in Italian Laboratories. Associate Members are scientists from developing countries who are given the opportunity of spending periods of up to three months, three times during their appointment, to use the Centre's facilities and to conduct research. So far some 50 scientists have been appointed as Associate members in medical physics.

The programme of Research and Training in Italian Laboratories - TRIL - gives the opportunity to experimental scientists to spend periods of time up to one year joining a group in an Italian laboratory. In the area of Medical Physics 48 Italian laboratories offer this opportunity, and a total of 97 scientists were trained so far.

CONCLUSION

During its long history the College on Medical Physics at ICTP has introduced successful educational models and has helped many colleagues from less developed countries to begin/stabilise their medical physics activities. Many colleagues from these countries see ICTP as one of their first encounters with the profession and IOMP has always shown high appreciation and support for this international impact of the ICTP for the developing countries.

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50 YEARS ICTP AND ITS ACTIVITIES IN THE FIELD OF MEDICAL PHYSICS

L Bertocchi[1], A Benini[2], F Milano[3], R Padovani[1], P Sprawls[4] , S Tabakov[5]

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Abstract – ICTP (the Abdus Salam International Centre for Theoretical Physics) is an unique institution aiming to support the development of science knowledge in developing countries. It has supported the medical physics profession for more than 30 years. Many of the medical physicists from the developing countries have undergo training in the regular ICTP College on Medical Physics (starting from 1983). Last year ICTP initiated a regular School of Medical Physics (Radiotherapy) and an MSc Programme on Medical Physics. Acknowledging this support for the profession IOMP presented ICTP with its Plaque of Gratitude on the occasion of the ICTP Golden Jubilee this year.

This year ICTP (the Abdus Salam International Centre for Theoretical Physics) celebrates its Golden Anniversary. This international research institute for physical and mathematical sciences operates under a tripartite agreement between the Italian Government, United Nations Educational, Scientific and Cultural Organization (UNESCO), and International Atomic Energy Agency (IAEA). ICTP was founded in 1964 by Mohammad Abdus Salam, a Nobel Laureate in Physics of Pakistani nationality. The Centre buildings are in Trieste, Italy. The mission of ICTP is: To foster the growth of advanced studies and research in physical and mathematical sciences, especially in support of excellence in developing countries; To develop high-level scientific programmes keeping in mind the needs of developing countries, and provide an international forum of scientific contact for scientists from all countries; To conduct research at the highest international standards and maintain a conducive environment of scientific inquiry for the entire ICTP community. The Centre is an institution that is run by scientists for scientists. It regularly hosts meetings with Nobel Award winners and encourages research and teaching in physics.

By coincidence Abdus Salam was connected with medical physics through his Nobel Award in 1979, when he receives the Nobel in Physics (for the electroweak theory), together with Godfrey Hounsfield and Allan Cormack, receiving Nobel in Medicine (for the X-ray Computed Tomography).

Nobel Award winners 1979, including Abdus Salam (third from right), Godfrey Hounsfield and Alan Cormac (first and third from left) – image courtesy to ICTP Archives

The medical physics activities in ICTP had been initiated soon after - at the beginning of 1980-ties by Prof. Giorgio Alberi (ICTP) and a group of medical physicists including Anna Benini, John Cameron and Sergio Mascarenhas, and have been firmly supported by Prof. Luciano Bertocchi, Deputy Director of ICTP.

The first medical physics activity in ICTP took place in 1982 - an International Conference on the Applications of Physics to Medicine and Biology in 1982 (organised by Giorgio Alberi). Another successful conference and several workshops were organised in the following years, revealing the need of medical physics education for the Third World countries. On this background ICTP expanded their training activities in medical physics. This way the first College on Medical Physics took place in 1988. The regular series of Colleges begun in 1992 and since this time it runs on a regular basis (usually bi-annually).

From the beginning corner stones for the ICTP involvement in Medical Physics were Luciano Bertocchi (then Deputy Director of ICTP) and Anna Benini (then IAEA Officer). Additionally, a number of prominent professionals were engaged with the College on Medical Physics, including John Cameron (USA), Sergio Mascarenhas (Brazil), Perry Sprawls (USA) and Slavik Tabakov (UK). The current Co-Directors include also Franco Milano (Italy), George D Frey (USA) and Mario De Denaro (Italy).

ICTP International College on Medical Physics – students and Co-Directors, September 2010

The transfer of knowledge and experience to the developing countries is a major objective of the College. Each participant receives a full set of lecturing materials, including Power Point slides, e-Learning materials, access to web sites, etc. These have triggered tens of Medical Physics activities and courses in the developing countries and helped hundreds of colleagues from these countries to practice the profession. Due to this reason the College is always one of the most over-subscribed training activities of the ICTP. Some students from the College also take part in research activities organised by ICTP, namely as Associate Members and as participants in the Programme of Research and Training in Italian Laboratories (TRIL).

Alongside the College (focussing on Medical Imaging and Radiation Protection), ICTP hosts many other medical physics workshops, courses and conference, mainly related to IAEA activities. During 2005 ICTP was Co-organiser of the High-level UNESCO-led Conference in Durban "Physics and Sustainable Development". One of the decisions of this Conference was to identify areas of special interest for applied physics during the XXI century – one of these areas was agreed as "Physics and Medicine".

ICTP also took active part in the International projects EMERALD, EMIT and EMITEL, developing new e-learning and training materials in medical physics, as well as the first Medical Physics Encyclopaedia EMITEL. This way the first International Conferences for Medical Physics Training were held in ICTP, Trieste (1998, 2003, 2008).

EMITEL Medical Physics Encyclopaedia Conference, ICTP, November 2008
(the photo includes members of EMITEL project Consortium and Network, as well as Past and Present Presidents of IOMP and 21 National Medical Physics Societies and Regional Federations)

Inauguration of the new MSc course in Medical Physics, February 2014
(the photo includes the students, the Course Directors and Board, the EFOMP President,
the Head of the IAEA Human Health Division, the Rector of University of Trieste and the Director of ICTP)

ICTP also Co-organised medical physics activities outside Trieste – e.g. the Medical Physics College in Mumbai India (2007) and the Radiotherapy School in Guatemala (2013)

During 2013-2014 the ICTP medical physics activities expanded by organising a dedicated Master Programme in Medical Physics (led by Renata Longo and Renato Padovani). This MSc operates as a joint programme (in English) with the University of Trieste and is specially directed to students from developing countries. From the beginning IOMP supported this MSc programme, which attracted significant interest (for 2014 the programme received 440 application from developing countries).

Another new activity, initiated by Renato Padovani in 2013, is the new Radiotherapy School, headed by M DeDenaro, G Hartmann, M R Malisan and R Padovani. From 2015 the School will be a regular medical physics activity in between the years of the Medical Physics College. The School will include as Co-Directors also C Orton (IOMP), G Hartmann (EFOMP) and Y Pipman (AAPM).

From its foundation ICTP has been a pivot for the dissemination and development of various fields of physics in the world and in particular – in the developing countries. The medical physics activities organised by ICTP have helped thousands of young medical physicists from developing countries to firmly enter the profession and further spread the knowledge in their countries and regions. The International Organization for Medical Physics (IOMP) congratulates sincerely ICTP with its 50th anniversary and expresses its high appreciation and gratitude to the Centre as one of the strongest supporters of the medical physics profession.

Presenting an IOMP Plaque to ICTP Director Prof. Fernando Quevedo at the 50th Anniversary ICTP Conference, 7 Oct 2014

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ANNEX

The International College on Medical Physics (2014) included also a Poster session where students described the professional development and education/training activities in their countries. These Poster sessions, initiated 10 years ago are now an important part of the College, aiming exchange information and expertise between students, as well as helping the focus of the international activities supporting the global development of the profession.

The 2014 College had a focus on Africa and included a number of colleagues from the continent (some suggested by FAMPO – the Federation of African Medical Physics Organisations, a Regional Federation of IOMP). The best posters and presentations received the Binesh Award and an ICTP Diploma. Here below is a list of all Posters presented. The Award-winners authors have been asked to submit short paper for publication at the Medical Physics International. Here we include the presentations from Ghana and Bangladesh.

List of Poster presentations at ICTP College on Medical Physics (Advances in Medical Imaging Physics to Enhance Healthcare in the Developing Countries): 1/09/2014 – 19/09/2014

Medical physics in Vietnam, *Trinh Thi Mai*

Status of medical Physics In The United Republic of Tanzania, *W.E. Muhogora*

Overview of Medical Physics in Iran, *Afsaneh Lahooti; Hossein Aslian*

Medical Physics in Zimbabwe, *Edwin Mhukayesango*

Medical Physics in Indonesia: 'Nuclear for Welfare', *Eka Djatnika Nugraha*

Medical Physic Profession Uganda, *Musisi Alen*

Medical Physics Professional Status in Nepal, *Ram Narayan Yadav*

Academic Education, Clinical Training and Professional Recognition of Medical Physicist in Argentina, *Ruggeri Ricardo Miguel*

Present Status of Medical Physics in Bangladesh, *Hasin Anupama Azhari, M. N. Hossain*

Medical Physics Status in Cuba; Current Situation and Future Deveplopment, *Haydee Maria Linares*

Status of Medical Physics Education and Training in India, *Yalavarthy K. Phaneendra*

Development of Radiation Protection and Medical Imaging in Malaysia, *Anis Suhana Ahmad Sabri, Noor Zaimah Zainol Abidin*

Medical Physics Education in Turkey and the Statistical Distribution of CT, MRI and Mammography Devices, *Kandemir Recep*

Medical Physics in Ghana, *E. K. Sosu, F. Hasford, T. B Dery, E.W. Fiagbedzi, Y. Serfor-Armah, A W K Kyere*

Advances in Medical Imaging Physics to Enhance Health care in Developing Countries -Eritrea, *T. H. Teclehaimanot*

Medical Physics Education, Training and Professional Status in Brazil, *MARTINS Juliana Cristina, SANTOS Josilene Cerqueira, REINA Thamiris*

Medical Physics at Institute of Nuclear Physics in Tashkent, Uzbekistan, *JURAEVA Nozima*

Medical Physics Development in Serbia, *CEKLIC Sandra*

Education and Clinical Training of Medical Physics in Thailand, *Kitiwat KHAMWAN, Thunyarat CHUSIN*

Control of Unwarranted Radiation Exposures in Medical Applications – Sri Lanka, *Gunaratna Mudiyanselage, Nadeera Hemamali*

Medical Physics Applications and Actions in Mexico, *Medel Baez Eva*

Medical Physics in the Philippines, *Taguba Dona May Opiniano, Margallo Victor Angelo Caballero*

Advance in Medical Imaging in Zambia, *Nkonde Kangwa Alex*

Inclusion of Medical Physicists in Radiology – Venezuela, *Yanez Sanchez Miguel Angel*

Medical Physics in the Sudan: Continuous Development and Innovation, *Ahmed Murtada Ahmed*

Status and Progress of Ethiopia in Medical Physics, *Gebre Mesay Geletu, Yacob Alemiye Mamo*

Medical Physics Development in Nigeria: Personnel and Equipment, *AKPOCHAFOR Michael Onoriode, ARAGBAYE Adebola, EVWIERHURHOMA Omuvwie Bernard, ISIAKA Babatunde*

Awards were distributed to the Posters/Presentations from the following countries: Bangladesh, Cuba, Ghana, Sudan, Thailand

AFOMP Newsletter

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Asia-Oceania Federation of Organizations for Medical Physics

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Vol.8 No.02– December 2016

From the desk of editor

Let me *"wish you all very happy, healthy and prosperous New Year 2017"*. I am happy to bring out the December 2016 issue of AFOMP newsletter, the 7th newsletter after I took over as Editor AFOMP newsletter in December 2013. In last three years with support of all of you, I have tried to improve the contents and quality of articles/material in the newsletter. I take the opportunity to thank all the contributors for making the newsletter more useful.

In this issue of newsletter we have New Year message from AFOMP President Prof. Tae-Suk-Suh, an article by Prof. Franco Milano on "**Role of Medical Physicist Organization in Nuclear and Radiological Emergencies**" in addition a very informative article title "**Enhancing Medical Physics Education with Collaborative Teaching- *Mission, Model, and Materials***" from Prof. Perry Sprawls, article from Prof. Arun Chougule titled "**Contribution of ICTP to Medical Physics for Developing Countries** "and Dr. Eva Bezak's article "**Applications of Timepix Radiation Detector in Radiation Therapy**"

Hope you will find the newsletter readable and useful. I look forward for your valuable feedback for improving the newsletter as there is scope for it.

Once again I wish you very happy New Year 2017 and look forward to have you in Jaipur, Pink City of India for 17th AOCMP during 4th-7th November 2017 (www.aocmp-ampicon2017.org)

With good wishes to all

Prof. Arun Chougule
Editor, AFOMP Newsletter
Vice President, AFOMP

Prof. Dr.Arun Chougule

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Contribution of ICTP to Medical Physics for Developing Countries

Prof. Arun Chougule, Ph. D
Senior Professor & Head Radiological Physics, SMS Medical College & Hospitals, Jaipur, India
Dean, Faculty of Paramedical Sciences, RUHS, President AMPI & Vice President AFOMP

The Abdus Salam International Centre for Theoretical Physics (ICTP) is putting efforts to advance scientific expertise in the developing world for last more than 50 years through cutting edge research, education and training [www.ictp.it]. Although its name contains "theoretical physics", in fact its programmes covers many areas, both of fundamental and applied physical and mathematical sciences.

Today many of the ICTP alumni serve in very high positions as professors, chairpersons of academic departments, directors of research centers in nations throughout the developing world. Many of them have been recognized in their own countries and internationally for their contributions to science and science policy. My association with ICTP started in 2004 as Regular Associate [RA] and I visited ICTP since then as RA and participant in many activities of ICTP. I am immensely benefitted through ICTP activities and widened my horizon in the field of Medical Physics. I own a lot to ICTP for what I am today. I have no hesitation to put on record that the impact of ICTP extends well beyond the Centre's facilities to virtually every corner of the Earth.

To create imprints in future we must know history also and therefore I will talk little about the historical inception of ICTP. ICTP was created in 1964 by the late Nobel Laureate Prof. Abdus Salam with ambitious objectives, few dozen visitors and little money, and has grown consistently through the years and now permanently located in Trieste, Italy. The foundation stone of ICTP was placed on 18 June 1964 and the building was completed in 1968 and since then ICTP has served as a major force in stemming the scientific brain drain from the developing world. Today this institution is truly run by scientists for scientists towards fulfilling the dream and mission its founder Prof. Abdus Salam to Foster the growth of advanced studies and research in physical and mathematical sciences, especially in support of excellence in developing countries. Develop high-level scientific programmes keeping in mind the needs of developing countries, and provide an international forum of scientific contact for scientists from all countries. Conduct research at the highest international standards and maintain a conducive environment of scientific inquiry for the entire ICTP community.

Today ICTP is governed by tripartite agreement between UNESCO, IAEA and Italy. ICTP works with a network of about 400 Italian laboratories to help scientists from developing countries for advanced scientific training in a laboratory setting. ICTP has established several joint master's and doctoral programs with Italian universities to expand educational opportunities for developing world scientists.

-:Contd:-

ICTP celebrated its 50 years of success in international scientific cooperation and the promotion of scientific excellence in the developing world during 6 - 9 October 2014. In these 50 years, ICTP has provided scientists from developing countries with countless opportunities to conduct research and to study the latest advances in physics and mathematics. More than 250 distinguished scientists, ministers and others attended the anniversary celebration. Through the adoption of the universal language of science, ICTP has demonstrated the importance of a global approach to address the problems of our time. During its 50 years, ICTP has benefited more 130,000 scientists, although the real impact goes beyond any measurable quantity.

ICTP conducting research at the highest international standards in the area of

1. High Energy, Cosmology and Astroparticle Physics (HECAP),
2. Condensed Matter and Statistical Physics (CMSP),
3. Mathematics (MATH),
4. Earth System Physics (ESP),
5. Applied Physics (AP),
6. Quantitative Life Sciences (QLS) and
7. New Research Areas.

In addition the scientific sections are also responsible for organizing high-level training courses, workshops, conferences and topical meetings throughout the year. These broad seven research area groups are divided into various topics of research. ***Medical Physics is categorized as a part of topic of research in Applied Physics (AP) research group***

ICTP provides Postgraduate Diploma Programme in High Energy Physics, Condensed Matter Physics, Mathematics and Earth System Physics and degree in various subjects in collaboration with various institutes/universities as follows:

PhD in Physics and Mathematics (with SISSA, Politecnico di Torino)

PhD in Earth Science and Fluid Mechanics (with Univ. Trieste, OGS)

Laurea Magistralis in Physics (with Univ. Trieste)

Masters' in Economics (with Collegio Carlo Alberto)

Masters' in Physics of Complex Systems (with SISSA)

Masters' in Medical Physics (with Univ. Trieste)

-:Contd:-

Masters' in High Performance Computing (with SISSA)

To strengthen the scientific capability of young scientists and researchers from developing countries ICTP provides **Sandwich Training Educational Programme (STEP)** in Atomic and Nuclear Physics, Nuclear, Isotopes and Laser Techniques, **Synchrotron Radiation and Applications and Medical Radiation Physics.**

The following figures and statistics is sufficient to show contribution of ICTP to science in last 50 years More than 130,000 scientists from 184 countries visited ICTP between 1970 to 2014. Among them, 20 % of ICTP visiting scientists are women. ICTP have 30 staff scientists, 9 staff associates, 78 post docs and long term visitors and 36 consultants making them as a great research hub and place of attraction for scientists all over the world.

For research support, ICTP library holdings include 69,000 books, 267 journal subscriptions and 3246 e-journals.

ICTP organizes more than 60 conferences/ workshops each year.

ICTP welcomes 4,000 to 5,000 scientists from about 130 countries each year.

ICTP attracts an additional 1,000-2,000 scientist in a year through hosted activities.

ICTP has collaboration with more than 400 Italian Research Laboratories, which provide opportunities to scientists from developing countries to work in Italian Research Laboratories through ICTP-TRIL programme.

During the last one year [2015] ICTP beneficiaries are

191 ICTP Associate members from 49 countries, Highest from India (30)

62 TRIL fellows from 29 countries, Highest from India (12)

5670 visitors from 144 nations

51 training activities ON Campus, 21 in Developing countries

11 days average length of visit for conference participants

60 days average for research visitors

58 Postdocs ON Campus (47% from Developing countries)

238 students enrolled in Pre-PhD Educational Programmes

344 scientists engaged in career development programmes

Course participants by research area: CMSP-1259, AP-1039, HECAP-939, ESP-833, MATH-531,

-:Contd:-

QLS-141.

21 regional training activities in developing countries

458 participants from India, Highest number in Asia however, Iran is the second one with 283 participants.

1362 female visitors (24%), highest number is from Asia-411, Africa- 173, Latin America- 155, and Eastern Europe 112.

For any research institute the well-established library services is the key in addition to laboratories/ equipment's. To fulfill the needs of the scientists mostly from developing countries where access to international journals is practically nonexistence, ICTP has provide the facility in terms of Marie Curie library. **The library of ICTP collections comprise approx. 70,000 print books and over 3,000 current electronic periodicals, about 200 of which are also received in print. Catalogued e-books are a few hundreds and growing. Several thousand digital documents of different types are in the archives.** ICTP's popular book "One Hundred Reasons to be a Scientist "is translated and available in Urdu, English, Italian, Portuguese, Chinese & Marathi. Further the Marie Curie Library helps libraries in Developing Countries through the donation of scientific books and providing service of e Journals to scientists in least developed countries with current scientific literature.

Further ICTP provides many opportunities to develop scientific career through various schemes and programmes of ICTP such as Associate and Federation schemes and **Training and Research in Italian Laboratories (TRIL)** fellowships. **ICTP's Associate programmes** are especially designed for the promising young scientists who are at early stages of their career. These Associate programmes of ICTP enables individual young scientists from developing country to groom into a good researcher while maintaining a long term formal contact with active participation in scientific activities of ICTP. There is Junior, Regular and Senior Associate programmes which are six years appointment with three time's visit of ICTP, Trieste. The **TRIL Programme offers scientists from developing countries the opportunity to undertake training and research in an Italian laboratory in different branches of the physical sciences which includes Medical Physics.** As per agreement of ICTP with IAEA financial support is provided by the IAEA for research in Atomic and nuclear physics, nuclear isotope and laser techniques, **Synchrotron radiation and medical radiation physics**. The **ICTP- OPEC** Fund for International Development (OFID) provides fellowships for research and training opportunities to PhD students in developing countries

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ICTP provides training and skills to scientists from developing countries. Each year ICTP organizes about 60 (Schools/Colleges/Conferences/Workshops etc.) either on its Trieste premises, or at outside venues, usually in a developing or emerging country. These activities are known as ICTP's Scientific Calendar. Topics for activities are not restricted to theory. The activities are selected on the basis of scientific novelty and impact on the international community, with special emphasis on bringing together scientists from South and North, basic training for younger scientists, and hands-on training for computer-intensive subjects. Scientists and students from all countries that are members of the United Nations, UNESCO or IAEA may attend an ICTP activity.

ICTP activities have no registration fees. A limited number of grants are available to support the attendance of selected participants, with priority given to participants working in a developing country and who are at the early stages of their career.

<u>Medical Physics at ICTP:</u>

Presently the ICTP activities in the area of Medical Physics cover training courses/schools (often in cooperation with the IAEA); they often include practical at the Trieste Hospital and in the ICTP info labs. In addition TRIL and Step-sandwich programme (joint PhD with a home university) are available in medical physics and **ICTP master in medical physics** At ICTP the training activities in **medical physics began in 1983** with efforts of Anna Benini, Sergio Mascarenhas and others with following series of activities in subsequent years

Workshop in Medical Physics, 17 Oct – 4 Nov **1983**

1st workshop on quality control in medical physics x-ray diagnostic equipment 13-18 May **1985**

2nd workshop on quality control in medical physics x-ray diagnostic equipment 14-19 April **1986**

1st Training course in dosimetry and diagnostic radiology, 16-25 March **1994**

2nd training course in dosimetry and diagnostic radiology, 23-27 Oct **1995**

Looking to need of expanding the Medical Physics activity at ICTP so as to start and strengthen the medical physics in developing countries the **series of college on medical physics [CMP] began in 1988 with untiring and devoted efforts by Anna B**enini, John Cameron, Perry Sprawls, Luciano Bertocchi , Slavik Tabakov, Franco Milano and others. To cover selected topics of medical physics the duration was kept of the 3-4 weeks with 50 – 70 participants each [largest participation and longest duration activity as compared to other activities of ICTP] mainly devoted to imaging, radioprotection and dosimetry. Since the

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beginning of CMP in 1988 it is regularly conducted every alternate year. The details are as follows

1. Colleges in Medical Physics [CMP] 10 Oct – 4 Nov, **1988**
2. Colleges in Medical Physics [CMP] 10 Sept.-28 Sept, **1990**
3. **Colleges in Medical Physics [CMP]** 31 Aug –18 Sept **1992**
4. **Colleges in Medical Physics [CMP]** 5 Sept - 23 Sept **1994**
5. **Colleges in Medical Physics [CMP]** 9 Sept -27 Sept **1996**
6. **Colleges in Medical Physics [CMP]** 20 Sept- 15 Oct **1999**
7. **Colleges in Medical Physics [CMP]** 2 Sept -27 Sept **2002**
8. **Colleges in Medical Physics [CMP]** 30 Aug– 22 Sept **2004**
9. **Colleges in Medical Physics [CMP]** 4 Sept – 29 Sept **2006**
10. **Colleges in Medical Physics [CMP]** 1 Sept -19 Sept **2008**
11. **Colleges in Medical Physics [CMP]** 13 Sept– 1 Oct **2010**
12. **Colleges in Medical Physics [CMP]** 10 Sept– 28 Sept **2012**
13. **Colleges in Medical Physics [CMP]** 1 Sept– 19 Sept **2014**
14. **Colleges in Medical Physics [CMP]** 5 Sept -- 23 Sept **2016**

In addition to CMP, ICTP in collaboration and support of IAEA has started conducting advanced schools since 2007 regularly for benefit of medical physicists working in developing counties

Joint ICTP-IAEA advanced schools biomedical applications of high-energy beams: 12- 16 Feb. **2007**

2. Joint ICTP-IAEA advanced school nuclear data : medical applications: 12 – 23 Nov **2007**
3. Joint ICTP-IAEA advanced school imaging in advanced radiotherapy techniques: 20-24 Oct **2008**
4. Joint ICTP-IAEA advanced school quality assurance in radiotherapy with emphasis on 3-D treatment planning and conformal radiotherapy: 24 Nov-5 Dec **2008**
5. Joint ICTP-IAEA advanced school Dosimetry and diagnostic radiology and its clinical Implementation: 11 -15 May **2009**
6. Joint ICTP-IAEA advanced school Internal dosimetry for medical physicists specializing in nuclear medicine: 12-16 April **2010**
7. Joint ICTP-IAEA Advanced radiotherapy techniques with emphasis on imaging and treatment planning: 4-8 April **2011**
8. Joint ICTP-IAEA Advanced course on Mammography 3-7 Oct **2011**

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9. Joint ICTP-IAEA advanced school Monte Carlo radiation transport and associated data needs for medical applications: 17- 28 Oct **2011**
10. Joint ICTP-IAEA Training course on radiation protection for patients: 1- 5 Oct. **2012**
11. Joint ICTP-IAEA International training workshop on transitioning from 2d to 3d conformal radiotherapy and IMRT: 10-14 Dec, **2012**
12. Joint ICTP-IAEA advanced training in radiation protection of patients 16-27 Sept **2013**
13. Joint ICTP-IAEA workshop on nuclear data for science and technology: medical applications 30 Sept- 2 Oct **2013**
14. Joint ICTP-IAEA workshop on accuracy requirements and uncertainty in radiation therapy, 9-13 Dec. **2013**
15. Joint ICTP-IAEA workshop on determination of uncertainties of measurements in medical radiation dosimetry 9-13 June **2014**
16. Joint ICTP-IAEA Meeting on training in patient safety in radiotherapy 4- 28 Nov **2014**
17. Joint ICTP-IAEA Workshop on Monte Carlo radiation transport and associated data needs for medical applications 16-20 Nov **2015**
18. Joint ICTP-IAEA Workshop on Computed Tomography: Quality Control, Dosimetry and Optimization 2-13 May **2016**
19. Joint ICTP-IAEAWorkshop on Internal Dosimetry for Medical Physicists Specializing in Nuclear Medicine 21-25 Nov **2016**

ICTP also conducting Training Course on Medical Physics for Radiation Therapy: Dosimetry and Treatment Planning for Basic and Advanced Applications since 2013 and has conducted two programmes first during: 25 November – 6 December **2013** and **second** during 13 -24 April **2015.** The **third course** in this series will be organized during 27 March 2017 - 7 April 2017 with theme "**School of Medical Physics for Radiation Therapy: Dosimetry and Treatment Planning for Basic and Advanced Applications**".

In the Golden anniversary year of ICTP in 2014, ICTP took a big step forward and started two degree courses **Masters of Advanced Studies in Medical Physics with University of Trieste** and Masters in High Performance Computing with SISSA for promoting the students from developing countries and low developed countries. This noble step of ICTP of providing degree course of Masters of Advanced Studies in Medical Physics to participants from developing countries in collaboration with University of Trieste

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will definitely help the poor cancer patients from the poorer parts of the world. The first batch of these course awarded degrees in 2016.

ICTP/IAEA Sandwich Training Educational Programme (STEP) in Medical Radiation Physics provides a platform to PhD students to work at ICTP during their PhD in developing countries, having an opportunity to visit ICTP thrice in 6 year study period to carry out research work.

ICTP organizes about 60 School/Colleges/Conferences/Workshops/Meetings every year. In regard to Medical Physics, ICTP hosting 3 to 4 scientific events in the form of Schools, Colleges, Conferences and Workshops, details are available in the scientific calendar year [www.ictp.it]. Since 2014 ICTP and IAEA are organising joint activities largely funded by IAEA and a glimpse of few past and future joint ICTP-IAEA scientific events in Medical Physics are listed below

- Joint ICTP-IAEA Meeting on Training in Patient Safety in Radiotherapy: Nov 2014
- College in Medical Physics (Advances in Medical Imaging Physics to Enhance Healthcare in the Developing Countries): Sept 2014
- School on Medical Physics for Radiation Therapy: Dosimetry and Treatment Planning for Basic and Advanced Applications: Apr 2015
- Joint ICTP-IAEA Workshop on Advances in X-ray Instrumentation for Cultural Heritage Applications: July 2015
- IAEA International School on Radiation Emergency Management: Sept 2015
- Joint ICTP-IAEA Workshop on Transitioning from 2-D Brachytherapy to 3-D High-Dose-Rate Brachytherapy: Nov 2015
- Joint ICTP-IAEA Workshop on Computed Tomography: Quality Control, Dosimetry and Optimization: May 2016
- College on Medical Physics: Enhancing the Role of Physicists in Clinical Medical Imaging: Procedure Optimization, quality Assurance, Risk Management, Training: Sept 2016
- URSI-ICTP School on Radio Physics: Mar 2017
- School of Medical Physics for Radiation Therapy: Dosimetry and Treatment Planning for Basic and Advanced Applications: Mar 2017
- Joint ICTP-IAEA International Workshop on the Implementation of Image Guided Radiotherapy (IGRT): 2017

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In nutshell the contribution of ICTP for growth of Medical physics in developing countries is remarkable and appreciate from my core of my heart. Certainty, these few but firm efforts of ICTP for the upliftment of Medical Physics has helped in the advancement of Medical Physics for shaping the future of modern healthcare in developing countries. In today's era, Medical Physics profession is becoming more demanding with greater skills so as to bring hard core translational research from bench to bed which is made possible by ICTP through several short/long term programmes on hands on training and educational sessions. The scientific programmes of ICTP best suited for serving the purpose. ICTP should look forward to focus more on these kinds of training and educational programmes for the upliftment of Medical Physics, in turn which will result in better medical care of patients around the world.

As President AMPI and Vice President AFOMP I hope and wish that the efforts, initiates taken by ICTP for Medical physics growth are taken to the doors of needy, to improvement of quality of human life in this part of world.

Picture of College of Medical Physics [CMP2016] ICTP participants with Prof. Slavik Tabakov President IOMP and Prof. Arun Chougule Vice President AFOMP in UNESCO Room ,ICTP

AFOMP News letter, Vol 08 No.02 December 2016

2011

The book MEDICAL PHYSICS AND ENGINEERING EDUCATION AND TRAINING (PART I) includes papers from many colleagues and aims to support the exchange of expertise and to provide additional guidance for establishing and updating of educational/training courses in Medical Physics and Engineering. To support this aim the book will be distributed as a free e-book through www.emerald2.eu (through link in MEP various links and resources).

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Information about specific papers and permit to use data from these can be obtained from the respective authors.

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Medical Physics at ICTP – The Abdus Salam International Centre for Theoretical Physics, Trieste (from 1982 to 2010)

Luciano Bertocchi, Prof., Past Vice Director of ICTP (bertocch@ictp.it)

Although at Abdus Salam ICTP there is no permanent Research Activity in the field of Medical Physics, a very vigorous training activity takes place here in the period covering the 30 years from 1982 to 2011. It started with an International Conference in the year 1982 and the most recent one is the College on Medical Physics in September 2010. It is therefore proper to review this activity in some detail.

In the year 1982, due to the initiative and the enthusiasm of the late Giorgio Alberi, the ICTP hosted an International Conference on the Applications of Physics to Medicine and Biology, which saw the participation of 177 scientists. It was followed in 1983 by the Second International Conference on the Applications of Physics to Medicine and Biology, which had an even larger participation: 259 scientists. At this time Giorgio Alberi was already severely ill, but he insisted on being present at the Conference. He left us a few weeks later.

The success of these conferences, and the need of developing Medical Physics also in Third World countries, convinced ICTP that it was the right time to expand its training activities to include the field of Medical Physics. A first workshop on Medical Physics was organized in the same year, 1983, where the number of scientists from developing countries had already reached the figure of 33.

Two more short workshops on Quality Control in Medical Physics X-Ray Diagnostic Equipment followed in 1985 and 1986, organized by Dr. Anna Benini.

But it was only in the year 1988, with the expansion of the training activities of the ICTP to include a large number of scientific areas that a full-fledged College in Medical Physics, of a 4-week duration and

with the participation of 68 scientists from developing countries, was organized. Since the beginning, the topics were addressed to Medical Imaging, Quality Control and Radioprotection. This College started a regular series of Colleges, in 1992 and 1994. The key names in these first Colleges are the ones of John Cameron (USA), Sergio Mascarenhas (Brazil) and Anna Benini (Italy and IAEA), who organized and directed the Colleges.

In the years in between the Colleges, other International Conferences were held, as "Giorgio Alberi Memorials"; during these Conferences, special prizes for the best research papers were awarded to scientists from developing countries.

Special attention should be given to the two International Conferences on the Applications of Physics to Medicine and Biology, held in 1992 and 1996. The one of 1992, devoted to the Advanced Detectors for Medical Imaging, was held in the week immediately after the College, giving the opportunity to the scientists from the Third World who had attended the College, to participate in an International Conference; the one of 1996 was also held in conjunction with the College on Medical Physics, and at the same time it hosted the Conference of the EFOMP (European Federation of the Organizations of Medical Physics) and of the AIFB (Italian Association of BioMedical Physics). This modality of having an International Conference linked to a training College was continued later in 2004, and repeated also for the next College in 2008.

The year 1994 saw the involvement of the International Atomic Energy Agency (IAEA) in the activities of the ICTP in Medical Physics; Anna Benini (who had, in the meantime, joined the Agency) organized together with the IAEA a Training Course on Dosimetry and Dose Reduction Techniques in Diagnostic Radiology. (This involvement of the IAEA continued also in the subsequent years, and especially in the College of 1999, which was held in conjunction with a Workshop on Nuclear Data for Medical Applications).

The College of 1996 (held in conjunction with the V-th International Conference) saw for the first time the presence of Perry Sprawls (USA) among the College Co-Directors; Professor Sprawls was to be a central figure in the subsequent Colleges. He is a scientist with a deep knowledge of all the aspects of Medical Imaging and an excellent organizer; but he is also a person of an unusual dedication to the promotion of Medical Physics. In all the Colleges he Co-directed (in 1999, 2002, 2004, 2006, 2008, and 2010) he donated to every participant in the Colleges a copy of each of his two books, on Medical Imaging and on MRI.

The activities of the Centre entered in a new dimension around the end of the century, when ICTP joined the EMERALD/EMIT project (led by S Tabakov). **EMERALD - E**uropean **ME**dical **RA**diation **L**earning **D**evelopment -, followed later by **EMIT - E**uropean **M**edical **I**maging **T**echnology Training - are two web based education and training packages, covering diagnostic radiology, nuclear medicine, magnetic resonance tomography, ultrasound and radiotheraphy. The importance of this project can be judged by the fact that in December 2004 the EMIT project received the first ever European Union "Leonardo da Vinci" award. This project continued with the EMITEL(led by S Tabakov), which developed Medical Physics Reference Materials – the first Medical Physics e-Encyclopaedia and Multilingual Dictionary (this project also included ICTP as a collaborator).

The materials of EMERALD/EMIT project, developed by a consortium that included ICTP, were used as training material in all Colleges held in after 1999, and each participant received a free copy of the CD's containing these materials. For these Colleges the team of College Co-Directors consisted of Perry Sprawls (USA), Slavik Tabakov (UK) and Anna Benini (Italy and Denmark), joined later by Franco Milano (Italy) and George D Frey (USA).

To discuss the EMERALD and EMIT project, two preparatory International conferences in Medical Physics Training were organized at the ICTP in 1998 and in 2003. In 2008 ICTP also hosted of the EMITEL e-Encyclopaedia International Conference.

The Colleges in 1999, 2002, 2004 were mainly devoted to Medical Imaging and to Radiation Protection; the 2004 College was followed by the Fourth International Workshop on Medical Applications of Synchrotron Radiation (in collaboration with the Trieste Synchrotron Radiation facility ELETTRA), and again the participants of the College had the opportunity of attending an International Conference. This International Workshop was followed in 2005 and 2006 by three specialized workshops on Synchrotron Radiation Imaging. The 2006 College included also a fourth week on Radiation Therapy organized by Franco Milano (Italy) with help from IAEA.

During the last several years IAEA launched a vigorous programme of cooperation with the ICTP, organizing a number of Joint Workshops and Schools. Several of them were in the area of Medical Physics. This way, six joint training activities have taken place so far:
2007 – a 1 week Workshop on Biomedical Applications of High Energy Ion Beams, and a 1 week Workshop on Nuclear Data for Science and Technology: Medical Applications
2008 – a 1 week Joint ICTP-IAEA Activity on Imaging in Advanced Radiotherapy Techniques, and a 2 weeks Joint ICTP-IAEA School on Quality Assurance in Radiotherapy with Emphasis on 3D Treatment Planning and Conformal Radiotherapy;
2009 - a 1 week Joint ICTP/IAEA Advanced School on Dosimetry in Diagnostic Radiology and its Clinical Implementation, and a 1 week Joint ICTP-IAEA Advanced School on Internal Dosimetry for Medical Physicists Specializing in Nuclear Medicine, etc.
The ICTP/IAEA programme is to continue in future - 3 more activities are planned for 2011. These are more specialized Schools, often complemented with practicals at the Trieste Hospital, through a cooperation agreement signed between the ICTP and the Hospital.

Also in 2007 ICTP took steps for exporting some of its activities. As a result the first Regional College on Medical Physics was conducted in Mumbai, India from November 12-23, 2007. The first week was devoted to The Physics and Technology of Medical Imaging and the second week to The Physics and Technology of Radiation Therapy with Dr Perry Sprawls and Dr S. D. Sharma as Academic Directors.

The College was sponsored and funded by the Abdus Salam International Centre for Theoretical Physics (ICTP), Trieste, and the Bhabha Atomic Research Centre (BARC), Government of India, Mumbai, India. Additional co-sponsors were the American Association of Physicists in Medicine (AAPM) and the Association of Medical Physicists in India (AMPI).

The Medical Physics Colleges during 2008 and 2010 were three weeks long and attracted some 300 applicants each. These continued the focus on Medical Imaging and Radiation Protection but with the added emphasis on the rapid growth of digital technology and its applications in medicine. These Colleges and the plans for the future Medical Physics Colleges included special practical training sessions at the Ospedali Reuniti di Trieste – Dept. Medical Physics (led by Dr Mario Dedenaro).

Since 2004 the Colleges include sessions to help the participants become more effective educators when they return to their countries. This is achieved through a Workshop with presentations from most countries taking part in the current College, plus classes on the learning and teaching process and the use of available educational resources, many of which are provided to the participants.

What has been described above is the 30 years experience of ICTP in the field of Medical Physics, in the form of "collective" teaching activities (Colleges, Conferences, Workshops, etc). However in all scientific areas (including Medical Physics) ICTP operates two other "individual" modalities: The Associate Members, and The Programme of Research and Training in Italian Laboratories (TRIL).

Associate Members are scientists from developing countries who are given the opportunity of spending periods of up to three months, three times during their appointment, to use the Centre's facilities and to conduct research (in the case of Medical Physics also joining research groups in Trieste, at the local hospitals or at the Synchrotron Facility ELETTRA). Currently more than 40 scientists have been appointed as Associate members in the field of Medical Physics.

The programme of Research and Training in Italian Laboratories (TRIL) gives experimental scientists the possibility to spend periods of time (up to one year) joining a group in an associate Scientific laboratory in Italy. 48 Italian laboratories offer this opportunity in the field of Medical Physics, and a total of 97 scientists were trained with 155 grants (some of the scientists received more than one grant).

The extent of what the ICTP has achieved in these 30 years in the field of Medical Physics can also be understood through a few figures: over 2000 scientists have taken part in the activities of the Centre (most from developing countries); more than 700 scientists have been trained through various modalities; each Medical Physics College includes young specialists from around 40 developing countries; many of these attendees have later started specific Medical Physics activities and courses in their own countries.

AFTERWORD

A substantial part of this book was ready for print in 2006 when the EMITEL Encyclopaedia project started. To keep the tight deadlines for this huge Encyclopaedia+Dictionary project (which included all book Editors) we had to temporarily freeze the book. Immediately after completion of EMITEL the development of the book continued. Many of the papers were updated to reflect the changes during the period, but some remained as information from 2006. This will be updated in the future part II of this book. In it we shall publish new papers about the current development of education and training. Apart from continuing the papers from Asia, Europe and Africa, part II shall include more papers from America, as well as specific papers from the countries with most experience in the field. Part II will also include more papers related to Medical Engineering.

Very important news arrived after completion of the book – our professions were included in the International Standard Classification of Occupations (ISCO-08). This excellent achievement will result in the official recognition of medical physicists and medical engineers in many countries, where such recognition does not yet exist. This will lead to the development of new University programmes (both at postgraduate MSc level and at undergraduate BSc level) and of new training courses (at lower and higher level). This will be extremely important for the development of the profession as a future stand-alone entity and will be reflected in the book part II. In this connection I shall be grateful to colleagues who would send me information on the new developments of Medical Physics and Engineering Education and Training in their countries/projects at: slavik.tabakov@emerald2.co.uk

Slavik Tabakov

Chair Education and Training Committee of IUPESM

Directors and participants of ICTP College on Medical Physics (2018) present the Gratitude Folder with a printout of this e-book to ICTP Deputy Director Prof. S Scandolo

ELECTED INAUGURAL FELLOWS OF IUPESM (2020-2023) with brief Bios

IUPESM Fellow:
Prof. John Mallard


Prof. John Mallard
University of Aberdeen, UK

Service
- IUPESM Foundation Group Member , 1975
- First IUPESM President 1980-1985
- Serve in various IUPESM Committees
- Member IOMP Foundation Group
- First IOMP Secretary General, 1962-1965
- IOMP President 1979-1982
- Served IOMP ExCom and various committees
- IPEM President

Achievement
- Pioneering Role in MRI Imaging research
- Pioneering Role in PET Imaging research
- Founding role for IOMP and IUPESM
- One of the 50 outstanding medical physicists 2013

Honours and Awards
- IOMP John Mallard Award established 2016
- IUPESM Award of Merit, 1988
- Order of the British Empire
- IoP Fellow
- IPEM Fellow

IUPESM Fellow:
Prof Robert L. Clarke


Prof. Robert L. Clarke
Carleton University, Canada
Awarded Posthumously

Service
- IUPESM Founding Group member, 1975
- IUPESM Founding Sec-General, 1980-1985
- Serve in various IUPESM Committees
- Serve in various IOMP Committees
- Founding role in medical physics in Canada
- Secretary General of Canadian CAR

Achievement
- Founding of IUPESM and suggesting its name
- Leading role in medical physics educational standards in the world

Honours and Awards
- Robert L. Clarke Scholarship founded in Canada
- AAPM Fellow

IUPESM Fellow:
Prof. John "Jack" Hopps


Prof. John "Jack" Hopps,
National Research Council of Canada, Canada
Awarded Posthumously

Service
- IUPESM Founding Group member 1975
- IUPESM Secretary-General, 1985 – 1988
- IFMBE President, 1971 – 1974
- IFMBE Secretary General, 1976 - 1985
- Founding President, Canadian Medical and Biological Engineering Society, 1965

Achievement
- Co-invented the world's first cardiac pacemaker. This significant technical and scientific achievement continue to improve the lives of millions of people the world over. Left a legacy of medical devices and instruments that help people with a variety of disabilities.

Honours and Awards
- Officer in the Order of Canada
- IUPESM Merit Award
- Leadership Award , Alliance for Engineering in Medicine and Biology
- General A.G.L. McNaughton Award, IEEE
- Distinguished Scientist Award, North American Society for Pacing and Electrophysiology.

IUPESM Fellow:
Prof. Masao Saito


Prof. Masao Saito,
University of Tokyo, Japan
Awarded Posthumously

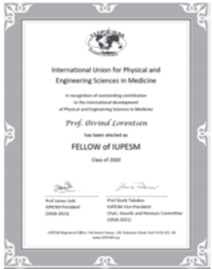
Service
- IUPESM Vice-President, 1982 -1985
- IFMBE President, 1979-1982
- Served as IFMBE AC and various Committees member for 12 years

Achievement
- Guided many policy-making national committees in Japan for engineering for infants and senior persons, in various aspects of care, positive life, assistive devices, manpower problems and industries. Strong interest in interaction of high technologies with human thought and published books, which is expected to guide many misdirected research efforts to the right way.

Honours and Awards
- IUPESM Merit Award (BME), 2000
- IFMBE Honorary Life Member, 1985
- IAMBE Fellow, 1997
- Fulbright Exchange Program at UPenn, U.S.A, 1959-1960

IUPESM Fellow: Prof. Oivind Lorentsen

Prof. Oivind Lorensten,
Rehab-Nor, Norway



Service
- IUPESM President, 1985 – 1988
- IFMBE President, 1982 – 1985
- IFMBE AC Member, 1973 - 1982

Achievement
- Development of Assistive Technology Devices and services to enhance the daily life of people with disabilities and the elderly
- Initiating and responsible for building up a National Center for Rehabilitation Technology, and establishing a network of county centers for service provision.

Honours and Awards
- Advocate of Rehabilitation Technology, Co-founder of EATS and TELEMATE programs
- Awarded His Majesty The King´s Medal of Merit in Gold for national achievements in the field of Rehabilitation Technology

IUPESM Fellow: Prof. Alexander Kaul

Prof. Alexander Kaul
Federal Institute for Radiation Protection, Germany

Service
- IUPESM Vice-President, 1985-1988
- Serve in various IUPESM Committees
- IOMP President 1982-1985
- IOMP Vice-President 1979-1982
- Serve in various IOMP Committees
- President German Society DGMP
- EFOMP Founding ETC Chair 1980

Achievement
- Leading role in medical physics in Europe
- Active role in radiation protection research

Honours and Awards
- Hanns-Langendorff-Medal
- Bundes verdienst kreuzes
- Honorary member EFOMP

IUPESM Fellow: Prof Lawrence H. Lanzl

Prof Lawrence H. Lanzl
University of Chicago, USA
Awarded Posthumously

Service
- IUPESM President, 1988-1991
- Serve in various IUPESM Committees
- IOMP President 1985-1988
- IOMP Vice-President 1982-1985
- Serve in various IOMP Committees
- AAPM President

Achievement
- Leading role in medical physics educational standards in USA and the world

Honours and Awards
- William D. Coolidge Gold Medal
- Farrington Daniels Award
- AAPM Fellow

IUPESM Fellow: Prof. Nandor Richter

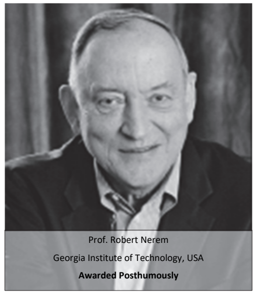
Prof. Nandor Richter
National Institute for Hospital and Medical Engineering (ORKI), Hungary
Awarded Posthumously

Service
- IUPESM Vice-President, 1988 - 1991
- IFMBE President, 1985 – 1988
- Board Member, Hungarian Academy of Engineering

Achievement
- Served as a UN expert in the field of health-related technical activities. An expert for project evaluations in the EU and for UN agencies (UNIDO, WHO). Head of Product Development and Design Laboratory of Medicor, the largest medical equipment company in Central Europe.

Honours and Awards
- Kolos Richard Award
- Csáki Frigyes Memorial Medal
- Dr. Katona Zoltán Medal
- Founding Fellow, International Academy for Medical and Biological Engineering
- Honorary Life Member, IFMBE
- Honorary Life Member, Hungarian National Society of Medical Engineering

IUPESM Fellow:
Prof. Robert Nerem



Prof. Robert Nerem
Georgia Institute of Technology, USA
Awarded Posthumously

Service

- IUPESM President, 1991 to 1994
- IFMBE President, 1988 - 1991
- AIMBE President, 1992-1994
- TERMIS President, 2002 to 2004
- Council Member, National Academy of Engineering, 1998 - 2004
- Founder of IAMBE

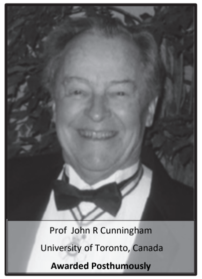
Achievement

- An outstanding mentor, educator and statesman, a highly regarded leader in the global Biomedical Engineering community. Strong advocate of integration, bringing BME communities around the world together and collectively with one voice to effectively raise public policy issues.

Honours and Award

- IUPESM' Hopps Award, 2015
- National Academy of Engineering, 1988
- Institute of Medicine, National Academy of Sciences, 1992
- Fellow of American Academy of Arts and Sciences; American Association for the Advancement of Science
- ASME's H.R. Lissner Award, 1989 ; AIMBE's Pierre Galletti Award, 2002; NAE's Founders Award, 2008

IUPESM Fellow:
Prof John R Cunningham



Prof John R Cunningham
University of Toronto, Canada
Awarded Posthumously

Service

- IUPESM Vice-President, 1991-1994
- Serve in various IUPESM Committees
- IOMP President 1988-1991
- IOMP Vice-President 1985-1988
- Serve in various IOMP Committees
- President Canadian Soc. COMP

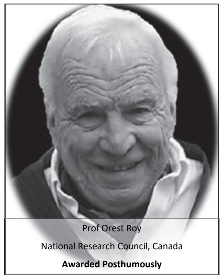
Achievement

- Leading role in medical physics education
- Leading role in radiotherapy development
- One of the 50 outstanding medical physicists 2013

Honours and Awards

- IOMP Marie Curie Award
- William D. Coolidge Gold Medal
- CAP/COMP Memorial Peter Kirkby Medal
- COMP Medal for "outstanding contributions to the field of medical physics in Canada"
- Officer of the Order of Canada
- AAPM Fellow
- CAP Fellow

IUPESM Fellow:
Prof. Orest Roy



Prof Orest Roy
National Research Council, Canada
Awarded Posthumously

Service

- IUPESM Secretary-General, 1991 – 1994
- IFMBE Secretary General , 1988-1991
- Canadian Medical and Biological Engineering Society President, 1976 to 1980

Achievement

- Instrumental in establishing Technical Aids and Systems for the Handicapped (TASH). Awarded the Walter Dinsdale Award for exceptional achievement in the development of technical aids for the benefit of disabled persons.

Honours and Awards

- Fellow, Rehabilitation Society of North America
- Honorary Life Member, IFMBE
- Senior Member, IEEE

IUPESM Fellow:
Prof. Niilo Saranummi

Prof. Niilo Saranummi
VTT Technical Research Centre, Finland
Awarded Posthumously

Service

- IUPESM President, 1994 – 1997
- IFMBE President, 1991 - 1994
- Co-Founder of EAMBES and HL7 Finland
- Editor-in-Chief, IEEE Transactions of Information Technology in Biomedicine

Achievement

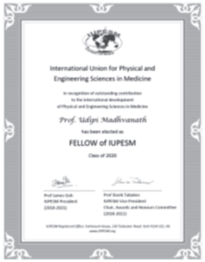
- A distinguished engineer and remarkable scientist who left a deep impact in the field of biomedical engineering and health informatics worldwide.

Honours and Awards

- Fellow of FACTE, IAMBE, AIMBE, IEEE, EAMBES and HL7
- IFMBE Otto Schmitt Award

IUPESM Fellow: Prof Udipi Madhvanath

Prof Udipi Madhvanath
Former BARC, India



Service
- IUPESM Vice-President, 1994-1997
- Serve in various IUPESM Committees
- IOMP President 1991-1994
- IOMP Vice-President 1988-1991
- Serve in various IOMP Committees
- Founding member and President of Indian Society AMPI
- Editor AMPI Medical Physics Bulletin
- Chair Asia Congress of Medical Physics, 1992

Achievement
- Leading role in medical physics in Asia

Honours and Awards
- Dr. Ramaih Naidu award
- AFOMP Outstanding Medical Physicist
- AMPI Fellow

IUPESM Fellow: Prof. Jos Spaan

Prof. Jos Spaan,
Amsterdam University Medical Centers,
The Netherlands

Service
- IUPESM Secretary General, 1994 - 1997
- IFMBE Secretary General, 1992-1998
- Chair, IFMBE Publications and Federation Journal Committee, 1988-1991
- EAMBES President, 2005
- MBEC Editor in Chief , 2006-2012

Achievement
- Applied biomedical engineering principles for the understanding of the mechanics, control and blood distribution in the coronary circulation and the role of the endothelial glycocalyx.

Honours and Awards
- Knight in the Order of the Dutch Lion
- Fellow of American Heart Association and Cardiovascular Section of the American Physiological Society
- Fellow of IAMBE; AIMBE; EAMBES
- Isaac Starr Lecture (2004) CSDS, Banff, Canada
- Wiggers Award, American Physiological Society, 2015
- IUPESM Awards of Merit, 2018

IUPESM Fellow: Prof Keith Boddy

Prof Keith Boddy
Regional Medical Physics Newcastle, UK
Awarded Posthumously

Service
- IUPESM President 1997-2000
- Serve in various IUPESM Committees
- IOMP President 1994-1997
- IOMP Vice-President 1991-1994
- Served IOMP ExCom and various committees
- EFOMP President
- IPEM President

Achievement
- Leading role in ICSU recognition of IUPESM membership
- One of the 50 outstanding medical physicists 2013

Honours and Awards
- IUPESM Award of Merit, 2000
- Glazebrook Medal of IoP
- Order of the British Empire
- Honorary Doctorate, De Montford University
- Fellow of IPEM, IoP, BNMS, RCR, BIR, SRP

IUPESM Fellow: Prof. Kajiya Fumihiko

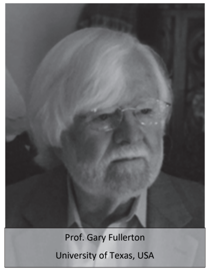
Prof. Kajiya Fumihiko
Kawasaki Medical School, Japan

Service
- IUPESM Vice-President, 1997-2000
- IFMBE President, 1994 – 1997
- Served in various capacity in IFMBE for 18 years (1982-2000)

Achievement
- Basic and clinical biomedical engineering mainly in the cardiovascular fields.

Honours and Awards
- IUPESM Award of Merit (BME), 2015
- IAMBE Fellow

IUPESM Fellow: Prof. Gary Fullerton



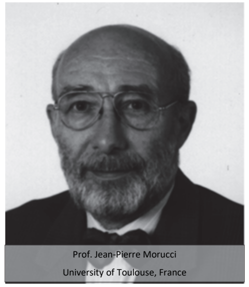
Prof. Gary Fullerton
University of Texas, USA

Service
- IUPESM Secretary General, 1997-2003
- Serve in various IUPESM Committees
- IOMP Secretary General, 1997-2003
- Served IOMP ExCom and various committees
- Co-President WC 1988
- AAPM President

Achievement
- Leading role in ICSU recognition of IUPESM membership
- Active role in Latin America medical physics development

Honours and Awards
- IUPESM Award of Merit, 2009
- Silver Medal International Society of Magnetic Resonance in Medicine 2002
- Fellow of AAPM; ACR; ISMRM; IOMP

IUPESM Fellow: Prof. Jean-Pierre Morucci



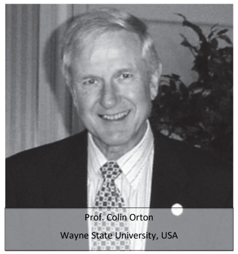
Prof. Jean-Pierre Morucci
University of Toulouse, France

Service
- IUPESM President, 2000 – 2003
- IFMBE President, 1997 – 2000
- French representative at the Commission of the European Communities (Brussels) in the Concerted Action Committee for Biological and Medical Engineering (1980-1990)

Achievement
- Advancement of Bioelectrical Impedance Techniques in Medicine

Honours and Awards
- Ampère Award, 1997
- Fellow Emeritus, International Academy of Medical and Biological Engineering

IUPESM Fellow: Prof. Colin Orton



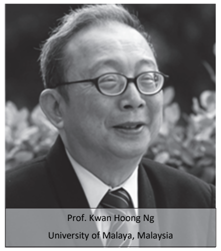
Prof. Colin Orton
Wayne State University, USA

Service
- IUPESM Vice- President, 2000-2003
- Serve in various IUPESM Committees
- IOMP President, 1997-2000
- IOMP Vice-President, 1994-1997
- IOMP Secretary-General, 1988-1994
- Served IOMP ExCom and various committees
- AAPM President
- IMPCB President

Achievement
- One of the 50 outstanding medical physicists, 2013
- Editor-in-Chief of J. "Medical Physics"

Honours and Awards
- IOMP Marie Curie Award
- IUPESM Award of Merit
- AAPM Coolidge Award
- ACMP Marvin M. D. Williams Award
- Ulrich Henschke Award, ABS
- IOMP Fellow

IUPESM Fellow: Prof. Kwan Hoong Ng



Prof. Kwan Hoong Ng
University of Malaya, Malaysia

Service
- IUPESM AC Member, 2000 – 2006
- Served IOMP ExCom and various committees
- SEFOMP Founding President, 2000-2006
- AFOMP President, 2010-2012

Achievement
- Active role in establishing medical physics activities in South-East Asia
- Active role in radiation protection research
- Active role in IOMP education/training activities
- One of the 50 outstanding medical physicists 2013

Honours and Awards
- IOMP Marie Sklodowska- Curie Award
- IOMP Award for IDMP
- Academy of Sciences Malaysia Fellow
- Fellow of IOMP; IoP
- Included in the 100 Asian Scientist, 2019

IUPESM Fellow: Prof. Inger-Lena Lamm

Prof. Inger-Lena Lamm
Lund University Hospital, Sweden

Service
- IUPESM AC Member, 2000 – 2006
- Serve in various IUPESM Committees
- Serve in various IOMP Committees
- EFOMP President
- Swedish Society SHPA President

Achievement
- Leading role in medical physics in Europe and establishing educational standards
- Active member of the pioneering e-learning projects

Honours and Awards
- Co-awarded EU Leonardo da Vinci Award
- IEC Award 2016
- Honorary member EFOMP
- Honorary member Swedish SHPA

IUPESM Fellow: Prof. Azam Niroomand-Rad

Prof. Azam Niroomand-Rad
Georgetown University, USA

Service
- IUPESM AC Member, 2000 – 2007
- IUPESM Vice-President, 2006- 2007
- Serve in various IUPESM Committees
- IOMP President, 2003 – 2006
- IOMP Vice-President, 2000-2003
- Editor Medical Physics World Newsletter
- Served IOMP ExCom and various committees

Achievement
- Active role in ILO recognition of medical physicists and biomedical engineering profession in ISCO
- Active role in founding of IUPAP Medical Physics Commission
- Active role in IOMP education/training activities

Honours and Awards
- IOMP Marie Sklodowska- Curie Award
- AAPM Achievement in Med Physics Award
- Fellow of AAPM; ACR; IOMP

IUPESM Fellow: Prof Oskar Chomicki

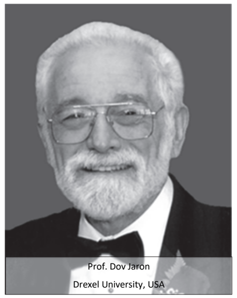
Prof Oskar Chomicki
Polish Medical Physics Society, Poland
Awarded Posthumously

Service
- IUPESM President, 2003-2006
- Serve in various IUPESM Committees
- IOMP President 2000-2003
- IOMP Vice-President 1997-2000
- Serve in various IOMP Committees
- Polish Society PTFM President

Achievement
- Active role in medical physics development in developing countries
- Founding member of Polish Society PTFM

Honours and Awards
- Honorary Member of EFOMP
- Honorary member Polish PTFM
- Knight of Gold Cross for Merit
- IOMP Fellow

IUPESM Fellow: Prof. Dov Jaron



Prof. Dov Jaron
Drexel University, USA

Service
- IUPESM Vice President, 2003 - 2006
- IFMBE President, 2000 - 2003
- ICSU Executive Board, 2008-2014

Achievement
- Dynamic, multiscale cardiovascular models that had led to the development, optimization, and clinical implementation of the cardiac assist device - the Intra-aortic balloon pump; and using the innovative models to elucidate complex mechanisms in the microcirculation.

Honours and Awards
- Fellow of IAMBE; AIMBE; IEEE; BMES
- Fellow of American Association for the Advancement of Science; Academy of Surgical Research; World Academy of Biomedical Technology
- IUPESM Merit Award (BME)
- Foreign member, Polish Academy of Sciences

IUPESM Fellow: Prof. Heikki Teriö


Prof. Heikki Teriö,
Karolinska University Hospital, Sweden

Service
- IUPESM AC Member, 2003 - 2010
- IUPESM Secretary General, 2003 – 2010
- IFMBE Secretary General, 1997 – 2003
- Chair, IFMBE Clinical Engineering Division, 2006-2009

Achievement
- Development of education/training in biomedical engineering internationally and supporting/strengthening management and maintenance systems of medical equipment in order to increase patient safety in emerging countries through development of international co-operation

Honours and Awards
- IFMBE Honorary Life Member, 2018
- Honorary Life Member, Swedish Society for Medical Engineering, 2018

IUPESM Fellow: Prof. Joe Barbenel


Prof. Joe Barbenel
University of Strathclyde, UK

Service
- IUPESM AC Member, 2003 – 2009
- IFMBE AC Member, 1988 - 1994
- Chair, IFMBE Constitution and Bylaws Committee, 2002-2012
- EAMBES Founding Member, 2003; Council Member, 2003-2006; Chair Academic Division 2003-2009.
- President, Biological Engineering Society, UK

Achievement
- Contributed extensively to secure global acceptance of Biomedical Engineering as an independent Academic discipline, appropriate for research, teaching and clinical application, and as a profession. Developed BME Postgraduate Courses in University of Patras, Greece and Chongqing University, China. Initiated discussion on formation of IPEM.
- Research expertise in structure and properties of the soft tissues to direct clinical applications.

Honours and Awards
- Founding Fellow EAMBES, 2012
- Presidents Medal, Society of Cosmetic Scientists
- Lifetime Achievement Award, European Pressure Ulcer Panel

IUPESM Fellow: Prof. Joachim Nagel


Prof. Joachim Nagel
University of Stuttgart, Germany
Awarded Posthumously

Service
- IUPESM AC Member, 2003 - 2012
- IUPESM President 2006 – 2009
- IFMBE President 2003 – 2006
- Founding Member, EAMBES

Achievement
- Led initiatives to increase visibility and importance of biomedical engineers and medical physicists in medicine and health.
- Research expertise in the cardiovascular monitoring, and physiology, medical imaging, Bio-MEMS, neurosciences, biological effects as well as therapeutic applications of ultrasound, and patient safety

Honours and Award
- IUPESM Award of Merit (BME), 2012
- Fellow of IAMBE; BMES; AIMBE; IoP
- Founding Fellow, EAMBES
- Honorary Life Member, IFMBE
- Academician Member, UNESCO/UATI World Academy of Biomedical Technologies

IUPESM Fellow: Prof. Peter H. S. Smith


Prof. Peter H. S. Smith
Former North. Ireland Med. Phys. Agency, UK

Service
- IUPESM AC Member, 2003 – 2009
- IUPESM Treasurer, 2006 – 2009; 2012 – 2015
- Serve in various IUPESM Committees
- IOMP Secretary General, 2003 – 2009
- Served IOMP ExCom and various committees
- EFOMP Treasurer
- IPEM President-Elect

Achievement
- Active role in ILO recognition of medical physicists and biomedical engineering profession in ISCO
- Active role in IOMP – WHO relations
- Chair, ICMP 2001

Honours and Awards
- IUPESM Award of Merit (MP), 2015
- IPEM Fellow
- IOMP Fellow

IUPESM Fellow: Prof Barry J Allen

Prof Barry J Allen

St George Hospital, Australia

Awarded Posthumously

Service
- IUPESM AC Member, 2003 - 2015
- IUPESM President 2009-2012
- IUPESM Vice-President, 2008-2009
- Served various IUPESM committees for 12 years
- IOMP President 2006-2009
- IOMP Vice-President 2003-2006
- Served IOMP ExCom and various committees
- AFOMP President
- Australasian ACPSEM President
- Co-President WC 2003

Achievement
- Leading role in medical physics in Asia and Oceania
- One of the 50 outstanding medical physicists 2013

Honours and Awards
- AFOMP Outstanding Medical Physicist Award
- Order of Australia Medal
- AIoP Fellow
- ACPSEM Fellow
- IOMP Fellow

IUPESM Fellow: Prof. Makoto Kikuchi

Prof. Makoto Kikuchi

Japan Association for the Advancement of Medical Equipment, Japan

Service
- IUPESM AC Member, 2003 - 2012
- IUPESM Vice-President, 2009-2012
- IFMBE President, 2006 – 2009
- Served in various capacity in IFMBE for 24 years (1985-2009)
- Japan Association for the Advancement of Medical Equipment (JAAME) President, 2020
- President of Mindful Home Care Product Design Research Institute

Achievement
- Development of BME profession worldwide through his activities and services with the government and industry sector.
- Started the Strategy Planning Committee of the METIS Consortium in Japan (2001).
- Active in Japanese Industrial Standard Committee more than 25 years, and chaired the JISC Medical Device and Equipment more than 15 years

Honours and Awards
- IFMBE Honorary Life Member 2015
- Kelvin Premium, IEE
- Medical Instrument Society of Japan Award
- Magna cum Laude Citation, American Society of Neuroradiology
- Japanese Society of Laser Surgery and Medicine Award
- Ministry Medal, Ministry of International Trade and Industry (MITI) of Japan
- Decoration of 3rd Order of the Sacred Treasure (Japan)

IUPESM Fellow: Prof. Ratko Magjarevic

Prof. Ratko Magjarevic

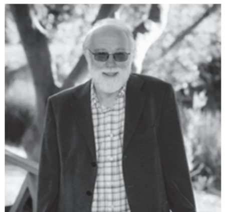
University of Zagreb, Croatia

Service
- IUPESM AC Member, 2003 – 2022
- IUPESM Vice-President, 2015-2018,
- Served in various IUPESM Committees, ie Union Journal, Nominating & Awards Committees etc
- IFMBE President, 2012 – 2015
- IFMBE Vice-President, 2009- 2012; 2018 – 2022
- IFMBE Secretary-General, 2003 - 2009
- Served IFMBE AC and various committees, ie Awards, Conference, Federation Journal, Nominating & Publicity Committees.

Achievement
- Doyen of Croatian biomedical engineering, has in addition to his research, scholarly and mentorship achievements, played a key role in building a worldwide network of biomedical engineering mainly through his engagement in IFMBE and IUPESM.

Honours and Awards
- Golden Medal "Josip Lončar", University of Zagreb, 2014
- Honorary Senator, University of Ljubljana, Slovenia, 2013
- Honorary Member, Society for Medical and Biological Engineering of Bosnia and Herzegovina, 2015
- Recognition of the Senate of the Republic of Colombia for excellence in his career and his constant work in progress and the development of bioengineering and science in Colombia and worldwide, 2009
- IFMBE medal for "extraordinary services, exceptional dedication and outstanding contributions", 2006

IUPESM Fellow: Prof. Alun Beddoe



Prof. Alun Beddoe

University Hospital Birmingham, UK

Service
- IUPESM AC Member, 2006 - 2009
- President of the Australasian ACPSEM
- Served various IUPESM committees
- Editor of J. New Zealand Medical Physics and Bio-medical Engineering
- Editor of J. Australasian Physical and Engineering Sciences in Medicine
- Editor-in-Chief Physics in Medicine and Biology

Achievement
- Active role in medical physics education and training standards and of publishing

Honours and Awards
- AFOMP Outstanding Medical Physicist Award
- ACPSEM Fellow
- IPEM Fellow
- IoP Fellow

IUPESM Fellow: Prof. George Mawko

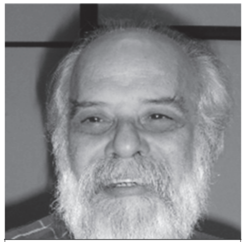
Prof. George Mawko
Queen Elizabeth II Health Science Centre, Canada

Service
- IUPESM AC Member, 2006 – 2009
- Serve in various IUPESM Committees
- IOMP Treasurer, 2006 – 2009
- Editor Medical Physics World Newsletter
- Served IOMP ExCom and various committees

Achievement
- World Congress and ICMP Finance Com, from 2003 - 2009

Honours and Awards
- CCPM Fellow
- COMP Fellow
- IOMP Fellow

IUPESM Fellow: Prof. Antonio Fernando Catelli Infantozzi



Prof. Antonio Fernando Catelli Infantosi
Federal University of Rio de Janeiro, Brazil
Awarded Posthumously

Service
- IUPESM AC Member, 2006-2012
- IFMBE AC Member,
- SBEB President, 1979-1981; 1994-1996; 2000-2002
- Latin American Regional Council on Biomedical Engineering (CORAL) President, 2001-2004

Achievement
- Prof Fernando played a fundamental role in the development of the Brazilian Journal of Biomedical Engineering, which subsequently re-named the international Research on Biomedical Engineering journal. He became an expert on biosignal processing, with particular emphasis on Neural Engineering, the main focus of his long career.

Honours and Awards
- Giulio Massarani Prize, COPPE Institute (UFRJ) 2009

IUPESM Fellow: Prof. Herbert Voigt

Prof. Herbert Voigt
Boston University, USA
Awarded Posthumously

Service
- IUPESM AC member, 2006 - 2018
- IUPESM President, 2012– 2015
- IFMBE President, 2009-2012
- AIMBE President, 2006-2007
- BMES President, 1999

Achievement
- Contributed extensively to global health, notably his travel to Nigeria, Sweden, Malaysia and Peru. Recipient of a Fulbright Scholarship to the Pontifical Catholic University of Peru (2014–15) to develop a new biomedical engineering PhD program and worked with Peru's National Institutes of Health to create a research program to detect heavy metals in biological samples.

Honours and Awards
- Fellow, American Institute of Medical and Biological Engineering
- CCNY Alumni Career Achievement Award, 1994
- Fulbright Scholarship (Peru), 2015
- Alpha Eta Mu Beta's Outstanding Dedication and Service Award, 2016
- BMES's President's Award, 2002 & Distinguished Service Award, 2004
- IEEE Distinguished Lecturer, 2012-2013

IUPESM Fellow: Prof. Fridtjof Nuesslin

Prof. Fridtjof Nuesslin
Technische Universität München, Germany

Service
- IUPESM AC Member, 2006 - 2015
- IUPESM Vice-President, 2012 – 2015
- Serve in various IUPESM Committees, 2006 – 2015
- IOMP President 2009-2012
- IOMP Vice-President 2006-2009
- President EFOMP

Achievement
- Active role in ILO recognition of medical physicists and biomedical engineering profession in ISCO
- Fostering the IUPESM role in the formation of ICSU Bio Cluster
- One of the 50 outstanding medical physicists 2013
- Active role in IOMP – WHO relations
- Active role in IOMP – IUPAP relations
- Editor-in-Chief European Journal Medical Physics

Honours and Awards
- Richard-Glocker-Award of the DGMP
- Honorary member EFOMP
- Honorary member Med.Phys Societies of Czech Rep., Saudi Arabia,
- Honorary member of German and Austrian Soc. Radio Oncology
- IOMP Fellow

IUPESM Fellow: Prof. Shankar M. Krishnan

Prof. Shankar M. Krishnan
Wentworth Institute of Technology, USA

Service

- IUPESM AC Member, 2006 – 2022
- IFMBE President, 2018 – 2022
- Served IFMBE Administrative Council for the past 17 years, as Treasurer, Secretary General, Vice President and President

Achievement

- Served over 30 years in academia, R&D in MedTech industry, consultancy, design, commissioning, operations management in hospitals; founded and led three Biomedical Engineering programs (in Illinois, Singapore, and Boston); Designed, developed, and managed modern teaching and research labs, earned two cycles of successful ABET accreditation

Honours and Awards

- CIMIT Kennedy Innovation Award,
- Fellow, American Institute of Medical and Biological Engineering
- Henry C. Lord Chair Professorship

IUPESM Fellow: Prof. Caridad Borrás

Prof. Caridad Borrás
George Washington University, USA

Service

- IUPESM AC Member, 2006 – 2009
- IUPESM HTTG Chair, 2006 – 2009
- Serve in various IUPESM Committees
- IOMP Science Com Chair 2000-2009
- Served IOMP ExCom and various committees
- AAPM Intern. Educ. Activities Com Chair

Achievement

- Active role in IOMP professional/scientific activities
- Leading IUPESM HTTG Book Rural Health Centres
- Active role in Latin America medical physics development
- One of the 50 outstanding medical physicists 2013

Honours and Awards

- IUPESM Award of Merit, 2009
- IOMP Award for IDMP
- AAPM Achievement in Med Physics Award
- Fellow of AAPM; ACR; HPS; IOMP
- Diplomas and Recognition awards of societies of Spain, Brazil, Peru, Cuba, Middle East

IUPESM Fellow: Prof. Kin Yin Cheung

Prof. Kin Yin Cheung
Hong Kong Sanatorium & Hospital, PR China

Service

- IUPESM AC Member, 2009 – 2022
- IUPESM President 2015-2018
- Served various IUPESM committees
- IOMP President 2012-2015
- IOMP Vice-President, 2009-2012
- IOMP ExCom member 2006 – 2018
- Served IOMP ExCom and various committees
- AFOMP Founding President

Achievement

- Leading role in medical physics in Asia and establishing of AFOMP
- Leading role in establishing the definition of roles & responsibilities of medical physicists
- Active role in IOMP education/training activities
- Active role in IOMP – WHO relations

Honours and Awards

- AFOMP Outstanding Medical Physicist Award
- IOMP Fellow

IUPESM Fellow: Prof. Yimin Hu

Prof. Yimin Hu
Cancer Institute, Beijing, PR China

Service

- IUPESM AC Member, 2009 - 2015
- Served various IUPESM committees
- AFOMP President
- Served IOMP ExCom and various committees
- President Chinese Society CSMP
- Chief Editor, Chinese Journal of Medical Physics
- WC2012 Co-President

Achievement

- Leading role in medical physics in Asia
- One of the 50 outstanding medical physicists 2013

Honours and Awards

- Prize Development of Medical Science and Technology, Chinese Academy
- AFOMP Outstanding Medical Physicist Award
- IOMP Fellow

IUPESM Fellow: Prof. James Goh

Prof. James Goh
National University of Singapore, Singapore

Service

- IUPESM AC Member, 2009 – 2022
- IUPESM Secretary General, 2010 – 2015
- IUPESM President, 2018 – 2022
- IFMBE President, 2015- 2018
- IFMBE Secretary General, 2006- - 2012

Achievement

- Pioneered BME education and activities in Singapore, actively engage regional development of BME programs. Foster global BME community through closer interactions. Expertise in Orthopaedic Biomechanics and Musculoskeletal Tissue Engineering.

Honours and Awards

- Fellow, American Institute of Medical and Biological Engineering
- Fellow, ASEAN Academy of Engineering and Technology
- Fellow, Institute of Engineers Singapore

IUPESM Fellow: Prof. Slavik D. Tabakov

Prof. Slavik Tabakov
King's College London, UK

Service

- IUPESM AC Member,2009 - 2022
- IUPESM Treasurer, 2009-2012
- IUPESM Vice-President, 2018-2022
- Serve in various IUPESM Committees
- IOMP President, 2015 – 2018
- IOMP Vice-President, 2012-2015
- IOMP Treasurer, 2009-2012
- Served IOMP ExCom and various committees

Achievement

- Develop/Lead the first Med.Phys. e-Learning
- Develop/Lead MP Encyclopaedia+Dictionary
- Active role in IOMP education/training activities in Low-Middle Income countries
- Active role in IOMP – WHO relations
- Co-Editor-in-Chief J. Med. Phys. International
- Co-Director ICTP College on Medical Physics
- Established IOMP Company

Honours and Awards

- IOMP Harold John Medal
- Lead co-award EU Leonardo da Vinci Award
- Medals/Diplomas of societies of Bulgaria, UK, Lithuania, Thailand, India, Middle East
- Dr Hon. Causa Medical Univ. Plovdiv, Bulgaria
- Fellow of IPEM, IOMP and HEA

IUPESM Fellow: Prof. Madan Rehani

Prof. Madan Rehani
Massachusetts General Hospital, USA

Service

- IUPESM AC Member, 2009 – 2022
- IOMP President, 2018 – 2022
- IOMP Vice-President, 2015-2018
- IOMP Secretary General 2009-2015
- Served IOMP ExCom and various committees

Achievement

- One of the 50 outstanding medical physicists 2013
- Active role in radiation protection research
- Active role in IOMP – WHO relations

Honours and Awards

- IOMP Harold John Medal
- Butterfly Award by Image Gently 2015
- Homi Bhabha Oration, 1999
- Dr. K.M. Rai Oration, 2001
- Honorary Membership of Society for Pediatric Radiology, 2011
- IOMP Fellow

IUPESM Fellow: Prof. Tomas Kron

Prof. Tomas Kron
Peter MacCallum Cancer Centre, Australia

Service

- IUPESM AC Member, 2009 - 2015
- Served various IUPESM committees
- IOMP Awards & Honours Com Chair
- Served IOMP ExCom and various committees
- President of the Australasian ACPSEM
- IMPCB Board member

Achievement

- Leading role in medical physics in Asia
- One of the 50 outstanding medical physicists 2013

Honours and Awards

- IOMP Award for IDMP
- AFOMP Outstanding Medical Physicist Award
- Order of Australia Medal
- ACPSEM Fellow
- IOMP Fellow

IUPESM Fellow: Prof. De Pei Liu

Prof. De Pei Liu
Chinese Academy of Medical Sciences, PR China

Service
- IUPESM AC Member, 2012 – 2015
- IUPESM WC 2012 Chair
- IFMBE AC Member, 2006 - 2009
- Co-Chair, IFMBE Strategic Planning Committee (2009-2012),

Achievement
- Contributions to scientific insights and higher education leadership in biomedical engineering

Honours and Award
- Fellow, International Academy of Medical and Biological Engineering (2013)

IUPESM Fellow: Prof. Monique Frize

Prof. Monique Frize,
University of Ottawa, Canada

Service
- IUPESM AC member, 2012-2018
- Chair, IUPESM WiMPBME Committee
- IFMBE AC and Chair, CoS, 2015-2022
- Chair, IFMBE Clinical Engineering Division, 1985-1990

Achievement
- Contributed extensively in BME education for 20 years, after 18 years as a clinical engineer in hospitals. Enjoyed sharing clinical engineering knowledge and experience with students, supervising their thesis (over 85 of them), and publishing over 200 papers in refereed journals and conference proceedings.

Honours and Awards
- Athlone Fellow (1967-1969)
- Officer, Order of Canada (OC) in 1993
- Fellow, Canadian Academy of Engineering (1982)
- Gold Medal, Professional Engineers Ontario (2000)
- Fellow (2012) and Life Member (2015) of IEEE
- Fellow of CMBES (2015); Engineers Canada (2010)

IUPESM Fellow: Prof. Marc Nyssen

Prof. Marc Nyssen
Vrije Universiteit Brussel, Belgium

- **Service**
- IUPESM AC Member, 2015 – 2022
- IUPESM Treasurer, 2015-2018
- Serve in various IUPESM Committees from 2003 – 2021, for instance Union Journal, Nominating & Awards Committees just to name a few.
- IFMBE Treasurer, 2012 - 2022
- Served IFMBE AC and various committees for the past 15 years from 2006 – 2022, for instance Secretaries Committee.
- **Achievement**
- Privileged to witness the birth and rising of electronic and ICT technologies and was able to design systems and contribute to their deployment, assisting thousands of patients and health care professionals and teaching talented students.
- **Honours and Awards**
- Member, Royal Belgian Academy of Oversees Sciences
- Founding Member, Belgian National Committee on Biomedical Engineering

IUPESM Fellow: Prof. Eva Bezak

Prof. Eva Bezak
University of South Australia, Australia

Service
- IUPESM AC Member, 2015- 2022
- Served various IUPESM committees
- Founding member and Chair of IUPESM Women in MP and BME Task Group
- IOMP Secretary General 2019-2022
- Served IOMP ExCom and various committees
- President of the Australasian ACPSEM
- AFOMP Vice-President
- WC2025 Co-President

Achievement
- Leading role in medical physics in Asia and women in medical physics

Honours and Awards
- IOMP Award for IDMP
- Women's Honour Roll, S.Australia
- ACPSEM Fellow

IUPESM Fellow: Prof. Ákos Jobbágy

Prof. Ákos Jobbágy,
Budapest University of Technology and Economics, Hungary

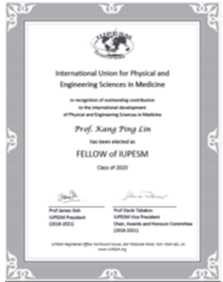
Service
- IUPESM AC member, 2015 – 2018
- IFMBE AC member, 2006 - 2012
- Served as Chair in numerous IFMBE committees from 2003 -2021, for instance National Secretaries' Committee, Membership Committee, IFMBE Constitution and Bylaws Committee

Achievement
- Development of devices and algorithms for early diagnosis and objective assessment of patients with neural and cardiovascular diseases

Honours and Awards
- Honorary Life Member of IFMBE, 2015
- Order of Merit of the Hungarian Republic, Knight Cross, 2008

IUPESM Fellow: Prof. Kang Ping Lin

Prof. Kang Ping Lin,
Chung Yuan Christian University, Chinese Taipei



Service
- IUPESM AC member, 2015-2022
- Chair, IUPESM Public & Intl Relations Comm, 2015-2022
- IFMBE Secretary General (2015 – 2022)
- Editor, IFMBE NEWS (2009-2015)

Achievement
- Linking and serving in biomedical engineering and medical physics communities particularly in the areas of biomedical imaging, bio-signals and medical devices.

Honours and Awards
- 2019 TSBME Wei Han Biomedical Engineering Service Award
- 2017 ACCE (USA) Antonio Hernandez International Clinical Engineering Award
- 2016 Chinese Institute of Engineers: Outstanding Engineering Professors Award
- 2013 Fellow, International Academy of Medical and Biological Engineering (IAMBE)

IUPESM Fellow: Prof. Virginia Tsapaki

Prof. Virginia Tsapaki
Konstantopoulio Gen. Hospital Athens, Greece

Service
- IUPESM AC Member, 2015 – 2019
- Served IUPESM various committees
- IOMP ExCom member 2012 – 2019
- IOMP Secretary General, 2015-2019
- Served IOMP ExCom and various committees
- Editor Medical Physics World Newsletter
- Founding Chair of IOMP Women Sub-Com.
- EFOMP Committees Chair
- President Greek Society HAMP

Achievement
- Active in role in medical physics in Europe and establishing professional standards
- Active role in radiation protection research

Honours and Awards
- IOMP Award for IDMP
- Appreciation Diploma Middle East
- IOMP Fellow

IUPESM Fellow: Prof. Howell Round

Prof. Howell Round
University of Waikato, New Zealand

Service
- IUPESM AC Member, 2015 - 2018
- IUPESM Secretary General 2015-2018
- Served various IUPESM committees
- Served IOMP various committees
- President of the Australasian ACPSEM
- AFOMP Secretary General 2012-2018

Achievement
- Leading role in medical physics in Asia and establishing educational standards

Honours and Awards
- IOMP Award for IDMP
- AFOMP Outstanding Medical Physicist Award
- ACPSEM Fellow
- IOMP Fellow

IUPESM Fellow: Prof. Magdalena Stoeva

Prof. Magdalena Stoeva
Medical University Plovdiv, Bulgaria

Service
- IUPESM AC Member, 2018 – 2022
- IUPESM Treasurer, 2018 – 2022
- Serve in various IUPESM Committees
- IOMP ExCom, 2015 – 2022
- Serve in various IOMP Committees
- Editor IUPESM Health & Technology Journal
- Editor Medical Physics World Newsletter
- Technical Editor J. Med. Phys. International

Achievement
- Leading role in IT of Med. Phys web sites development – Encyclopaedia, MPI Journal, MPW Newsletter, e-learning, IOMP.org, IOMP Women Sub-com
- Active member of the pioneering e-learning projects

Honours and Awards
- IUPAP Young Scientist Award Medical Physics
- Co-awarded EU Leonardo da Vinci Award
- IOMP Fellow

IUPESM Fellow: Prof. John Damilakis

Prof. John Damilakis
University of Crete, Greece

Service
- IUPESM AC Member, 2018 – 2022
- IOMP ExCom member 2012 – 2022
- IOMP Vice-President, 2018-2022
- Served IOMP ExCom and various committees
- EFOMP President
- President Greek Society HAMP

Achievement
- Active role in radiology dosimetry research
- Active role in radiation protection research
- Active role in IOMP education/training activities

Honours and Awards
- Walter E. Berdon Award of The Society for Pediatric Radiology
- IOMP Fellow

IUPESM Fellow: Prof. Timo Jämsä

Prof. Timo Jämsä
University of Oulu, Finland

Service
- IUPESM AC member, 2018-2022
- Co-Chair, IUPESM Edn & Trg Comm, 2018 - 2022
- IFMBE AC and EA-RGR, 2016-2021
- President, EAMBES, 2019-2021

Achievement
- Leadership and significant contribution in biomedical engineering education and research locally, at the European level, and internationally

Honours and Awards
- EAMBES Fellow (2016)
- Knight, First Class, Order of the White Rose of Finland (2011)
- Clinical Biomechanics Award 2004, European Society of Biomechanics

IUPESM Fellow: Prof. Geoffrey S. Ibbott

Prof. Geoffrey S. Ibbott
MD Anderson Cancer Center, University of Texas, USA

Service
- IUPESM AC Member, 2018 – 2022
- Serve in various IUPESM Committees
- IOMP Scientific Com Chair 2013 – 2022
- AAPM Award and Honors Com Chair
- AAPM President
- ABR Board of Governors member
- IEC 62C Chair

Achievement
- Leading specialist on radiotherapy - dosimetry standards and uncertainty of calibrations

Honours and Awards
- Farrington Daniels Award
- AAPM Fellow
- IOMP Fellow
- ACR Fellow
- ASTRO Fellow

IUPESM Fellow: Prof. Stephen Keevil

Prof. Stephen Keevil
King's College London, UK

Service
- IUPESM AC Member, 2018 – 2022
- IUPESM HTTG Chair, 2018 – 2022
- Serve in various IUPESM Committees
- IOMP Company Group, 2015 – 2018
- President IPEM, UK 2013-2015

Achievement
- Leading role in the Alliance for MRI, related to the EU Physical Agents (EMF) Directive
- Active member of the pioneering e-learning projects
- Active role in establishing IOMP Company

Honours and Awards
- Co-awarded EU Leonardo da Vinci Award
- IPEM Fellow
- IoP Fellow
- ESMR Fellow
- Honorary Member, Royal College of Radiologists

IUPESM Fellow: Prof. Leandro Pecchia

Prof. Leandro Pecchia
Warwick University, UK

Service
- IUPESM AC member, 2018 - 2022
- IUPESM Secretary General, 2018 - 2022
- IFMBE AC and Chair, HTA Division, 2015- 2018

Achievement
- Significant contribution in enhancing biomedical signal processing for patient monitoring in real setting, using wearable sensors and machine learning.

Honours and Awards
- Pilot Manager, Odin Project, 2020
- Large Scale Pilot Manager, Gatekeeper Project, 2019
- IFMBE Young Investigator Competition Award, ICBHI 2019 Taiwan
- Clinical Engineering Best Paper Award, 2018
- Fellow, British Higher Education Academy, 2017

IUPESM Fellow: Late Prof Hiroshi Abe

International Union for Physical and Engineering Sciences in Medicine

In recognition of outstanding contribution to the international development of Physical and Engineering Sciences in Medicine

Prof. Hiroshi Abe

has been elected as

FELLOW of IUPESM

awarded posthumously in 2022

Prof James Goh, IUPESM President (2018-2022)

Prof Slavik Tabakov, IUPESM Vice President, Chair, Awards and Honours Committee (2018-2022)

For his contribution as Co-Chair, Organizing Committee, 5th IUPESM World Congress on Medical Physics and Biomedical Engineering, 1991 held in Kyoto, Japan.

IUPESM Fellow: Late Prof Walter Bleifeld

International Union for Physical and Engineering Sciences in Medicine

In recognition of outstanding contribution to the international development of Physical and Engineering Sciences in Medicine

Prof. Walter Bleifeld

has been elected as

FELLOW of IUPESM

awarded posthumously in 2022

Prof James Goh, IUPESM President (2018-2022)

Prof Slavik Tabakov, IUPESM Vice President, Chair, Awards and Honours Committee (2018-2022)

For his contribution as Co-Chair, Organizing Committee, of the 2nd IUPESM World Congress on Medical Physics and Biomedical Engineering, 1982 held in Hamburg, Germany

IUPESM Fellow: Late Prof Lodewijk Bos

International Union for Physical and Engineering Sciences in Medicine

In recognition of outstanding contribution to the international development of Physical and Engineering Sciences in Medicine

Prof. Lodewijk Bos

has been elected as

FELLOW of IUPESM

awarded posthumously in 2022

Prof James Goh, IUPESM President (2018-2022)

Prof Slavik Tabakov, IUPESM Vice President, Chair, Awards and Honours Committee (2018-2022)

For his contribution as Co-Editor-in-Chief (2007-2018) of the IUPESM journal, Health & Technology published by Springer-Nature

IUPESM Fellow: Late Prof Dieter Harder

International Union for Physical and Engineering Sciences in Medicine

In recognition of outstanding contribution to the international development of Physical and Engineering Sciences in Medicine

Prof. Dietrich Harder

has been elected as

FELLOW of IUPESM

awarded posthumously in 2022

Prof James Goh, IUPESM President (2018-2022)

Prof Slavik Tabakov, IUPESM Vice President, Chair, Awards and Honours Committee (2018-2022)

For his contribution as Co-Chair, Organizing Committee, of the 2nd IUPESM World Congress on Medical Physics and Biomedical Engineering, 1982 held in Hamburg, Germany

IUPESM Fellow: Late Prof David Kopp

For his contribution as Co-Chair, Organizing Committee, 4th IUPESM World Congress on Medical Physics and Biomedical Engineering 1988, held in San Antonio, Texas, USA

IUPESM Fellow: Prof. Pierre Aletti

For his contribution as Co-Chair, Organizing Committee, 7th IUPESM World Congress on Medical Physics and Biomedical Engineering, 1997 held in Nice, France.

Brief Biography:

- Past president of the French Society of Hospital Physicist (1982-1985),
- Member of the ESTRO Board(1988-1991),
- Member of the Scientific Committee of ESTRO (1988 – 1992)
- French IOMP delegate (1994-1997)
- Correspondent member of the AAPM (American Association of Medical Physics)
- Co-Chairman of the NGO “PMSF”: Medical Physicist without border
- Collaboration with Morocco (Since 1978) for creating and then supporting the Cancer Institute in Rabat: INO Moulay Ben Abdallah
- PMSF (Medical Physicist without Border NGO) Mission in Cameroon 1993 (Douala and Yaoundé) and in Senegal(2000)
- Co-Chairman “ PMSF” : Medical Physicist without border (several missions in Cambodia and in Vietnam)
- Missions in Tunisia as expert Physicist (2008-2011)
- Expert physicist in Antananarivo (Madagascar)

IUPESM Fellow: Prof. Carlos de Almeida

For his contribution as Co-Chair, Organizing Committee, 6th IUPESM World Congress on Medical Physics and Biomedical Engineering 1994, held in Rio de Janeiro, Brazil.

Brief Biography:

- Full Professor in Medical Physics, Rio de Janeiro University
- Fellow M.D. Anderson Hospital
- Visiting Scientist Institut Gustave Roussy -1997
- Visiting Scientist Institut Pierre-Marie Curie-2010
- Certified by the American Board of Medical Physics
- Fellow AAPM and IOMP
- Creator of the Brazilian Board in Medical Physics – 1979
- Former Director of the Brazilian SSDL
- Former Member of the IAEA -SSDL Scientific Committee- 1983-1989
- Founding and Program Director of the National QA Program in Radiotherapy 2007-2010
- Founding and Program Director the Professional Master’s degree in Medical Physics- 2017to now
- IAEA expert in Several Technical and Teaching in Latin America Missions

IUPESM Fellow: Prof. Per Nils Åke Ask

For his contribution as Chair, IUPESM Union Journal Committee (2015-2018) overseeing the IUPESM’s journal Health & Technology

Brief Biography:

- IFMBE Nomination and Awards Committee
- 2018 IFMBE Honorary Life Member
- Head and Board member, AgoraLink 2007– 2012 Program for doctoral students
- Chairman, Swedish Association for Medical Engineering and Physics
- Chairman of the Prize committee of Erna Ebelings Prize in Biomedical Engineering, The Swedish Society of Medicine, 2005 - 2020
- Board member, NIMED Center of Excellence (Center for Non-Invasive Medical Measurement Techniques) 1996-2006.
- 1980 Fogarty Visiting Fellow, NIH, USA
- 1989 Fernströms prize for development of method for physiological pressure and flow measurements
- 1997 Awarded a JSPS guest professorship at Nara Institute of Science and Technology
- 1997 Erna Ebelings prize for research in the field of biomedical engineering

IUPESM Fellow: Prof. Gilda Barabino

For her contribution in IUPESM Women in Medical Physics and Biomedical Engineering for solutions to gender balance in STEM fields through support, training, education and mentoring.

Brief Biography:

Gilda A. Barabino has pioneered new engineering approaches to problems in medicine. Her seminal research in sickle cell disease has informed current technologies and formed the basis for novel therapies. She is a passionate advocate for health equity and leads national efforts to engage engineers in the development of solutions to health disparities.

Dr. Barabino is the second president of Olin College of Engineering, before this she served as Dean of The Grove School of Engineering at The City College of New York and held appointments in the Departments of Biomedical Engineering and Chemical Engineering, and the City University of New York School of Medicine. There she established the Master's in Translational Medicine, a program that addresses unmet clinical needs through the integration of engineering, medical innovation and entrepreneurship.

Dr. Barabino is an internationally recognized thought leader and highly sought-after speaker and consultant on race/ethnicity and gender in science and engineering, with particular focus on creating cultures and climates that support a sense of belonging. She has led a number of initiatives in these areas, including serving as the founder and Executive Director of the National Institute for Faculty Equity.

In recognition of her visionary leadership and outstanding professional achievement, Dr. Barabino has received many of the highest honors in academia. In 2021, she was elected to the American Academy of Arts and Sciences, She is also an elected member of the National Academy of Engineering and the National Academy of Medicine. She is a fellow of the American Association for the Advancement of Science, the American Institute of Chemical Engineers, the American Institute for Medical and Biological Engineering, and the Biomedical Engineering Society. She is president of the American Association for the Advancement of Science, the world's largest interdisciplinary scientific society.

IUPESM Fellow: Prof. Lip Teck Chew

For his contribution as Co-Chair, Organizing Committee, 15th IUPESM World Congress on Medical Physics and Biomedical Engineering 2022, held in Singapore.

Brief Biography:

Lip Teck is the Chief Physicist at the Radiation Oncology Suite at Farrer Park Hospital, Singapore. He holds a Bachelor of Science in Physics and a Master of Medical Physics from the University of Malaya, Kuala Lumpur. His clinical interest and responsibilities include automation both in radiation treatment planning and quality assurance processes. He has been an active member and President of the Society of Medical Physicists (Singapore) since he joined. He setup and commissioned full Varian Solutions at the Tan Tock Seng Hospital and full Elekta Solutions at the Farrer Park Hospital.

IUPESM Fellow: Prof. Stelios Christofides

For his contributions as President of IOMP Regional Organisation in Europe (EFOMP) and Co-organiser of MEDICON to host IUPESM AC meeting

Brief Biography:

Consultancy services for Radiation Protection and Medical Physics, with extensive experience in Diagnostic and Interventional Radiology, Nuclear Medicine, Radiation Protection and Non-Ionising radiation. Extensive knowledge of the relevant European Union Directives and guidelines as well as those of the IAEA. Education and Training in the above areas of expertise is part of the offered services.

Consultancy services for meeting the requirements of the Medical Devices regulations and their transposition to the Cypriot Legislation. Extensive knowledge of the relevant European Union Directives and guidelines. Education and Training in the above areas of expertise is part of the offered services.

Collaborate with the Cyprus Certification Company as a Technical Expert during ISO 9000 audit.

IUPESM Fellow: Prof. Jaromir Cmíral

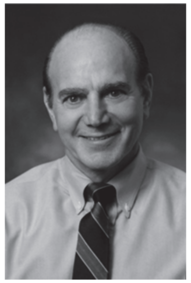
For his contribution as Co-Chair, Organizing Committee, 14th IUPESM World Congress on Medical Physics and Biomedical Engineering 2018, held in Prague, Czech Republic.

Brief Biography:

- 2018: Co-chair of organizing committee of IUPESM world congress.
- 2018: Gold Honorary Medal of the Czech Medical Association for merits.
- 2018: Honorary President of Czech Society for Biomedical Engineering and Medical Informatics.
- 2011-2018: President of Czech society for biomedical engineering and medical informatics.
- 2005: President of 3rd European Medical & Biological Engineering Conference IFMBE European Conference on Biomedical Engineering EMBEC 2005.
- 1991: President of Czechoslovak conference with international participation (Denmark, Hungary, Slovenia) on Biomedical Engineering.
- 2010: Cross of Merits of the Ministry of Defence.
- 2009: Commemorative Medal for the 10th anniversary of the Czech Republic's accession to NATO.
- 2004: Commemorative Medal of Military Medical Academy.
- 1999: Honorary Medal of Czech Medical Association for merits.
- 1990-1992: President of Czechoslovak society for biomedical engineering.
- 1998: Silver Medal Wladislava Pola (Poland Republic) for merits in the development in aviation medicine.
- 1985: Commemorative Medal of Czechoslovak Society for Science and Technology.

IUPESM Fellow:
Prof. Yadin David

For his contribution as Co-Chair, IUPESM Health Technology Task Group (2015-2018) to assist countries in defining their health technology needs.



Brief Biography:

Dr. David is a principal at Biomedical Engineering Consultants, LLC. He holds an adjunct academic appointment at the University of Texas - School of Public Health. In addition, he is also Honorary Director of Clinical Engineering at Capital Medical University in China. Dr. David has served as chairman and member of FDA advisory panels. He is a recipient of the FDA commissioner's special citation for protection of the public, the 2008 ACCE/AAMI Humanitarian Engineering award, the 2011 Lifetime achievement award, the Italian and Chinese clinical engineering associations' awards, and was elected in 2018 into the Hall of Fame of the American College of Clinical Engineering. He was also inducted into the WVU Academy of Distinguished Alumni of Engineering and Computer Science and into the WVU Academy of Chemical Engineering. Has served as technical adviser to the World Health Organization (WHO), as founder and 1st president of the Center for Telemedicine and e-Health Law (CTeL) in Washington, D.C., and as Editor-in-Chief of Global Clinical Engineering Journal (www.GlobalCE.org), and Interim President, Global Clinical Engineering Alliance (www.GlobalCEA.org). Dr. David helped found the International Clinical Engineering and Health Technology Management Congress, the Global CE Day, and serves as chairman of the Global CE Summits. He served as the founder & first president of the American College of Clinical Engineering (ACCE), and of the nonprofit Healthcare Technology Foundation (www.thehtf.org).

IUPESM Fellow:
Prof. Olaf Doessel

For his contribution as Co-Chair, Organizing Committee, 11th IUPESM World Congress on Medical Physics and Biomedical Engineering 2009, held in Munich, Germany.

Brief Biography:

Olaf Doessel is Professor at the Institute of Biomedical Engineering at Karlsruhe Institute of Technology (KIT) since 1996. Before he was head of a research department at Philips Research Laboratories in Hamburg. He has or had several honorary posts, among them: member of the management board of the German Association of Biomedical Engineering (DGBMT) and the German Association for Electrical, Electronic & Information Technologies (VDE), Dean of the department of Electrical Engineering and Information Technology at KIT. He is member of several academic societies, among them: the Academy of Science of Berlin-Brandenburg (BBAW), the German Academy of Technical Sciences (acatech), the North Rhine-Westphalian Academy of Sciences, Humanities and the Arts. He is member of the advisory board of the Physikalisch Technische Bundesanstalt (the German Metrology Institute). He is Fellow of the International Academy for Medical and Biological Engineering (IAMBE) and Fellow of the European Alliance of Medical and Biological Engineering and Science (EAMBES). In 2009 he was together with Wolfgang Schlegel President of the World Congress on Medical Physics and Biomedical Engineering in Munich and in 2019 he was Program Chair of the IEEE Engineering in Medicine and Biology Conference (EMBC) in Berlin, both with more than 3000 participants. He is Editor in Chief of the Journal Biomedical Engineering / Biomedizinische Technik. He is member of the board of Computing in Cardiology CinC. His main interests are bioelectric signals, computer modeling of the heart, the inverse problem of Electrocardiography, ECG biosignal processing, and new methods of medical imaging.

IUPESM Fellow:
Prof. Anthony Charles Easty

For his contribution as Co-Chair, Organizing Committee, 13th IUPESM World Congress on Medical Physics and Biomedical Engineering 2015, held in Toronto, Canada.

Brief Biography:

For the past ten years, my area of research focus has been the usability and safety of medical technologies throughout the health care system in a wide variety of environments of use, with a special focus on medication safety and safety in home care. I have participated in the establishment of a Healthcare Human Factors Group and the HumanEra Team comprising a total of fifteen expert staff, educated at the PhD and Masters levels in human factors engineering, cognitive psychology and biomedical engineering.

In July 2010, I was appointed the Inaugural Chair-holder of the Baxter Chair in Health Technology at the University Health Network/University of Toronto. This appointment allows me to focus full-time on research in health technology safety. I lead the Health Technology Safety Research Team, a team of eight PhD and Masters-trained individuals with academic preparation in biomedical engineering, human factors engineering and cognitive psychology.

IUPESM Fellow:
Prof. Yubo Fan

For his contribution as Co-Chair, Organizing Committee, 12th IUPESM World Congress on Medical Physics and Biomedical Engineering 2012, held in Beijing, China.

Brief Biography:

Professor Yubo Fan is founding dean of the School of Biological Science and Medical Engineering of Beihang University. He is also the Director of Beijing Advanced Innovation Centre for Biomedical Engineering, and Director of Key Laboratory for Biomechanics and Mechanobiology of Ministry of Education. He is a Changjiang Scholar and served in many research or training programs and committees, including the leader of Innovation group of National Science Fund of China (NSFC, 2015), He is the Fellow of AIMBE, IAMBE and the FBSE. Dr. Fan is past president of Chinese Biomedical Engineering Society (CSBME, 2008-2012, 2012-2015), past Chair of World Association for Chinese Biomedical Engineers (WACBE, 2017-2019), and the past council member of World Council of Biomechanics (2002-2014). He is vice president of China Strategic Alliance of Medical Devices Innovation. Dr. Fan has made significant contributions in the following areas: (1) Biomechanical analysis, design and manufacture of biodegradable Implants, (2) Mechanobiological study on cells under the physiological pulsatile flow, (3) Biomechanism of human impact injuries and protection. Dr. Fan has published more than 600 articles in scientific journals such as Advance Materials, Advanced Functional Materials, Biomaterials, ACS Nano, Material & Design etc with H-index 66. He has filed more than 100 patents and is active in translational research.

IUPESM Fellow: Prof. William R. Hendee

For his contribution as Co-Chair, Organizing Committee, 8th IUPESM World Congress on Medical Physics and Biomedical Engineering 2000, held in Chicago, USA.

Brief Biography:

Dr. Hendee holds the title of Distinguished Professor of Radiology, Radiation Oncology, Biophysics and Bioethics at the Medical College of Wisconsin. He is certified in Radiologic Physics by the American Board of Radiology and in Health Physics by the American Board of Health Physics. He has been a Director of the American Board of Health Physics and the Health Physics Society, chairman of the Diagnostic Physics and Quality and Safety Committees for the American Board of Radiology, and Past-President of the American Board of Radiology. He is past president of the American Association of Physicists in Medicine, the Society of Nuclear Medicine, the American Institute of Medical and Biological Engineering, the 2000 World Congress on Medical Physics and Biomedical Engineering, and past vice president of the National Patient Safety Foundation. He is currently President and Chief Executive Officer of the Commission on the Accreditation of Medical Physics Educational Programs. In 2010 he was awarded the American College of Radiology Gold Medal Award. He received an honorary doctorate from Millsaps College in 1988 and from the University of Patras, Greece in 2009. Other awards include the Radiological Society of North America's Gold Medal, the Gold Medal from the American Roentgen Ray Society, the Elda Anderson Award of the Health Physics Society, and the William D. Coolidge Medal from the American Association of Physicists in Medicine.

IUPESM Fellow: Prof. David Jaffray

For his contribution as Co-Chair, Organizing Committee, 13th IUPESM World Congress on Medical Physics and Biomedical Engineering 2015, held in Toronto, Canada.

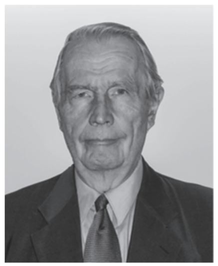
Brief Biography:

Dr. David Jaffray is a Board Certified in the discipline of Medical Physics by the American Board of Medical Physics. He is a senior vice president and chief technology and digital officer (CTDO) at The University of Texas MD Anderson Cancer Center and a Full Professor in Radiation Physics and Imaging Physics. Before joining MD Anderson, Dr. Jaffray served as executive vice president for Technology and Innovation at the University Health Network in Toronto. In the 17 years there, he also served as Head of Medical Physics, vice chair of Research for the University of Toronto's Department of Radiation Oncology, founding director of the STTARR Innovation Centre, and founding director of the Techna Institute. He was a Full Professor in the Departments of Radiation Oncology, Medical Biophysics, and IBBME at the University of Toronto and was active in strategic planning, teaching, and graduate student supervision.

He has received many honors, including the Sylvia Sorkin-Greenfield Award, the Farrington Daniels Award and the Sylvia Fedoruk Award. In 2018, he received the Gold Medal from the American Society for Radiation Oncology and was invited to join the US National Academy of Inventors in 2022. Dr. Jaffray has led the development of a variety of commercial products, including software and hardware for safe, high-quality cancer care and including the development of cone-beam CT guided radiation therapy

IUPESM Fellow: Prof. Tapani Jauhiainen

For his contribution as Co-Chair, Organizing Committee, 3rd IUPESM World Congress on Medical Physics and Biomedical Engineering 1985, held in Helsinki (Espoo), Finland



Brief Biography:

M.D. Ph.D. Helsinki University 1974,
Chief Physician of Department of Audiology Linköping University Hospital, Sweden 1972 - 1974,
Specialist in Phoniatrics, Helsinki University 1975,
Specialist in Audiology, Helsinki University 1979,
Associate Professor of Audiology, Linköping University 1975,
Associate Professor of Speech and Language Therapy, Helsinki University 1980-1983,
Chief Physician of Hearing Center, Department of Otorhinolaryngology, Helsinki University Hospital, 1974 - 2001,
Secretary of the Nordic Audiological Society, NAS 1983 – 1985,
President of the Nordic Audiological Society, NAS 1985 – 1991,
Secretary of the International Association of Physicians in Audiology, APA 1987 – 1997,
Promoter and Board member of the Finnish Society for Medical Physics and Medical Engineering
Scientific Publications on sensory physiology, audiology, phoniatrics, speech therapy and phenomenology.

IUPESM Fellow: Prof. Libor Judas

For his contribution as Co-Chair, Organizing Committee, 14th IUPESM World Congress on Medical Physics and Biomedical Engineering 2018, held in Prague, Czech Republic.

Dr Judas is a Senior Researcher at the National Radiation Protection Institute Prague where he is Head of Calibration Laboratory. He was Head of Medical Physics Department of the General Teaching Hospital in Prague (1999 – 2008). In the 1990s, he was a research worker of the Danish Cancer Society, Department Of Experimental Clinical Oncology, Aarhus, Denmark. He served at the Branch Board of the Doctoral Study Program (Medical Physics) at the Czech Technical University in Prague (CTU). He was also a member of the Examination Board for Master Examination in Medical Physics, CTU and the Examination Board and Certification Board for Medical Physics experts at the Ministry of Health. He was a member of the Accreditation Committee for CPD, Ministry of Health (1995 - 2005). He served as the President (2004 - 2010) of the Czech Association of Medical Physicists.

IUPESM Fellow:
Prof. Sun Il Kim

For his contribution as Co-Chair, Organizing Committee, 10th IUPESM World Congress on Medical Physics and Biomedical Engineering 2006, held in Seoul, South Korea.

Brief Biography:

- Past President, The Korean Society for Medical and Biological Engineering
- 2011 President, Medical Device Development Center
- Osong Medical Innovation Foundation
- 1988 Professor and Director, Dept. of Biomedical Engineering Hanyang University, Seoul, Korea.
- 2003-2005 Director General, Korea Science and Engineering Foundation (KOSEF)
- 1987-1988 Research Associate, Dept. of Biophysics & Physiology, Mayo Foundation, Rochester, MN, U.S.A.
- 1982-1987 Calhoun Endowed Research Fellow, Dept. of Biomedical Engineering, Drexel University, Philadelphia, PA, U.S.A.
- 1979-1982 Chief Engineer, Dept. of Biomedical Engineering, Seoul National University Hospital, Seoul, Korea.

IUPESM Fellow:
Prof. Anchali Krisanachinda

For her contribution as President of SEAFOMP (2005-2012), Co-organiser of ICMP2016 in Bangkok, Thailand and for hosting the IUPESM AC meeting.

Brief Biography:

Anchali Krisanachinda, the Founding President of the Thai Medical Physicist Society, was the President of SEAFOMP from 2005 through 2012, one of the Founders of AFOMP and has been the AFOMP Treasurer since 2001. She was a member of the IOMP ETC and IAB for Asia (2003-2006), became the Chair of ETC (2006-2009) and joined the Validation and Accreditation Committee of ETC (2009-2012).

In 2002, she pioneered the graduate program in diagnostic radiology medical physics education, with IAEA support, at Chulalongkorn University. She is also a National Project Coordinator (NPC) of the IAEA Regional Cooperative Agreement RAS 6038 project: Strengthening of Medical Physics through Education and Training in Asia and the Pacific. She supervised the integration, of the IAEA training modules, to the clinical residency training programs in radiation oncology medical physics (ROMP) in 2007, diagnostic radiology medical physics (DRMP) in 2010 and nuclear medicine medical physics (NMMP) in 2011.

Dr. Krisanachinda has been dedicated to the promotion of medical physics, both nationally and internationally, serving a lifetime to the advancement of the science from the university to the United Nations. She obtained "Outstanding Contributions Over the Last 50 Years" awards at ICMP 2013 at the 50th year of IOMP, Brighton, UK.

IUPESM Fellow:
Prof. Luis Kun

For his contribution as Co-Editor-in-Chief (2007-2018) of the IUPESM journal, Health & Technology published by Springer-Nature

Brief Biography:

- IFMBE – Ad-Com 2009-2015 & IFMBE – Chairman of the Global Citizen Safety and Security WG, (2006 – 2018).
- 2022 President Elect IEEE Society for Social Implications of Technology (SSIT).
- IEEE EMBS Adcom 2020-2022
- IEEE –SSIT Board of Governors 2008– Present
- IEEE – Computer Society (CS) – Distinguished Visitor Program (DVP)2003- 2017.
- IEEE EMBS - Distinguished Lecturer Program (DL) 2008-2013; 2016-2018.
- IEEE- SSIT Distinguished Lecturer (DL) 2010 – Present (Program Chair since 2016)
- 2019 - Medal of Honor from ARGENTINE Cyberdefense Command
- 2018 – IFMBE HONORARY LIFE MEMBER
- 2016 - Medal of Merit, the National Unit of Engineering Associations (UNAI) of Mexico.
- 2016 – Fellow, International Academy of Medical and Biological Engineering (IAMBE)
- 2016 - Life Fellow of the Institute of Electrical and Electronics Engineers (IEEE).

IUPESM Fellow:
Prof. James C L Lee

For his contribution as Scientific Committee Co-Chair, Organizing Committee, 15th IUPESM World Congress on Medical Physics and Biomedical Engineering 2022, held in Singapore.

Brief Biography:

Dr Lee is the Chief Radiation Physicist and Chairman of the Radiation Safety Committee at NCCS. He manages the Medical Physics team and Radiotherapy Physics at the Division of Radiation Oncology and heads the Secondary Standard Dosimetry Laboratory (IAEA SSDL network, Radiotherapy) for Singapore. He served as a special resource advisor to the Ministry of Health's PBT advisory committee. Since 2020, he has been serving as the President of the Society of Medical Physicists Singapore. He is actively involved in the South-East Asian region, organising the 2013 AOCMP-SEACOMP congress in Singapore and served as the President of SEAFOMP from 2015-2019. He was also in the initial group that formed the ASEAN College of Medical Physics with the key objective to enhance the training of Medical Physicists for the region. He introduced the first ROMP residency program in Singapore, was involved in various Medical Physics related projects, and was course director for a few IAEA regional training workshops. His research interests and publications are in radiation dosimetry, treatment planning and Monte Carlo simulation for radiotherapy and PBT. He was awarded the Institute of Physics Singapore's Physics Award 2015 for his contribution to medicine and the AFOMP Outstanding Medical Physicists Award 2020 for his contribution to Medical Physics in Singapore and the region.

IUPESM Fellow:
Prof. Hwa Liang Leo

For his contribution as Scientific Committee Co-Chair, Organizing Committee, 15th IUPESM World Congress on Medical Physics and Biomedical Engineering 2022, held in Singapore.

Brief Biography

Prof Leo Hwa Liang is an Associate Professor in the Department of Biomedical Engineering at the National University of Singapore (NUS). He received his B.Eng. degree from Leeds University (1996), M.Eng. from Nanyang Technological University (2000),and M.S. and Ph.D. degrees from Georgia Institute of Technology (2001, 2005). Assoc Prof Leo's research interests lies at the intersection of fluid dynamics and medicine, specifically on cardiovascular engineering and biofluids. He is actively involved in the development of various novel medical devices, such as drug screening perfusion platform, artificial liver assist devices, mitral percutaneous heart valves, carotid stents, and left ventricle assist devices. Since 2009, Dr Leo's lab has generated over 300 peer-reviewed journal papers including 142 journal articles, 162 conference proceedings and book chapters. He is the Treasurer of the Biomedical Engineering Society (Singapore). He is the Co-chair of the Scientific Committee of the 15^{th} World Congress on Medical Physics and Biomedical Engineering 2022, Singapore.

IUPESM Fellow:
Prof. Lenka Lhotská

For her contribution as Scientific Committee Co-Chair, Organizing Committee, 14th IUPESM World Congress on Medical Physics and Biomedical Engineering 2018, held in Prague, Czech Republic.

Brief Biography:

Lenka Lhotská, PhD, MIET, MIEEE, graduated as Master of Science in Electrical Engineering at the Czech Technical University in Prague (CVUT), Czech Republic and got PhD degree in Cybernetics from CVUT. Currently she is head of the Cognitive Systems and Neurosciences Department at the Czech Institute of Informatics, Robotics and Cybernetics and deputy head of Department of Natural Sciences of the Faculty of Biomedical Engineering, CVUT.

Her research focus: Knowledge-based systems, application of artificial intelligence (AI) methods to medicine, digital signal processing, machine learning, semantic interoperability, mobile technologies in healthcare, electronic health record. She is scientific secretary of the Czech Society for Biomedical Engineering and Medical Informatics, National representative in IFMBE, member of Council of Societies of IFMBE, co-chair of the WiMBE WG of IFMBE, chair of the Women in Medical Physics and Biomedical Engineering TG of IUPESM, chair of the Working Group Personal Portable Devices of European Federation for Medical Informatics (EFMI) and member of the EFMI Council, and National representative in International Society for Telemedicine and eHealth (IsfTeH). She was co-chair of the IUPESM World Congress 2018 and member of the PC EMBEC 2005, regularly she is PC member of conferences on AI and ICT in health care.

IUPESM Fellow:
Prof. Chwee Teck Lim

For his contribution as Co-Chair, Organizing Committee, 15th IUPESM World Congress on Medical Physics and Biomedical Engineering 2022, held in Singapore.

Brief Biography

Professor Chwee Teck LIM is the NUS Society Chair Professor of Biomedical Engineering and Director of the Institute for Health Innovation and Technology at the National University of Singapore. His research interest is in the development of innovative microfluidic and wearable technologies for biomedical applications. He is a prolific researcher having co-authored over 450 journal publications including in Nature and Science and given more than 420 plenary/keynote/invited lectures. He is also a serial entrepreneur having started six companies to commercialize technologies developed in his lab. Prof Lim is globally recognized for his distinguished academic achievements as is evidenced by his elected fellowship at the US National Academy of Inventors, the American Institute for Medical & Biological Engineering, the International Academy for Medical & Biological Engineering, the ASEAN Academy of Engineering and Technology, the Academy of Engineering, Singapore and the Singapore National Academy of Science. He and his team have garnered over 100 research awards and honours including Highly Cited Researcher, IES Prestigious Engineering Achievement Award, ASEAN Outstanding Engineering Achievement Award, Asian Scientists 100, Credit Suisse Technopreneur of the Year Award, Wall Street Journal Asian Innovation Award (Gold) and the President's Technology Award among others.

IUPESM Fellow:
Prof. Nigel Lovell

For his contribution as Co-Chair, Organizing Committee, 9th IUPESM World Congress on Medical Physics and Biomedical Engineering 2003, held in Sydney, Australia.

Brief Biography:

Nigel Lovell received the B.E. (Hons) and Ph.D. degrees from UNSW Sydney, Australia. He is currently at the Graduate School of Biomedical Engineering UNSW Sydney where he holds a position of Scientia Professor and Head of School, as well as Director of a newly established Tyree Institute of Health Engineering. He has authored 330+ journal papers and been awarded over $100 million in R&D funding. Over his career he has mentored 70 PhD students and delivered more than a hundred keynote presentations and founded several med-tech startup companies. He is a Fellow of eight learned academies throughout the world. He has been actively involved in conference organising activities, including being the Conference Co-Chair of the IUPESM World Congress in Medical Physics and Biomedical Engineering that was held in Sydney in 2003.

His research work has covered areas of expertise ranging from cardiac and retinal modelling and neurophysiology, medical informatics and data analytics especially related to telehealth technologies, biological signal processing, and visual prosthesis design. For 2017 and 2018 he was the President of the world's largest member-based biomedical engineering society – the IEEE Engineering in Medicine and Biology Society.

IUPESM Fellow: Prof. Ronney Panerai

For his contribution as Co-Chair, Organizing Committee, 6th IUPESM World Congress on Medical Physics and Biomedical Engineering 1994, held in Rio de Janeiro, Brazil.


International Union for Physical and Engineering Sciences in Medicine

In recognition of outstanding contribution to the international development of Physical and Engineering Sciences in Medicine

Prof. Ronney Panerai

has been elected as

FELLOW of IUPESM

Class of 2022

Prof James Goh, IUPESM President (2018-2022)

Prof Slavik Tabakov, IUPESM Vice President, Chair, Awards and Honours Committee (2018-2022)

Brief Biography:
Dr Panerai was a Professor at the Federal University of Rio de Janeiro. In 1986 he was awarded the Manuel N Morales Young Investigator Prize from the Organization of American States (Washington DC). From 1978 to 1991 he was an advisor to the Brazilian National Research Council, a frequent consultant to the Pan American Health Organization and the first Editor-in-Chief of the Brazilian Journal of Biomedical Engineering (RBE). In early 1992 he took a Senior Lecturership position at the Division of Medical Physics, University of Leicester, UK and was awarded the chair of Physiological Measurement in 2000. This appointment included responsibility for physiological measurement services provided by the Department of Medical Physics, University Hospitals of Leicester NHS Trust. From 1992 to 2012 he served in the editorial boards of several peer-reviewed journals and was actively involved with the World Health Organization as a consultant on health technology assessment and health informatics. He is now an Emeritus Professor in the Department of Cardiovascular Sciences, University of Leicester, UK.

IUPESM Fellow: Prof. Alfred R. Potvin

For his contribution as Co-Chair, Organizing Committee, 8th IUPESM World Congress on Medical Physics and Biomedical Engineering 2000, held in Chicago, USA.


International Union for Physical and Engineering Sciences in Medicine

Prof. Alfred R. Potvin

has been elected as

FELLOW of IUPESM

Class of 2022

Brief Biography:
Dr. Alfred Potvin began his academic career at UT Arlington in 1966 and served as the first Director of the Biomedical Engineering Program and founding chair from 1974 to 1984. Highly acclaimed throughout his career, Dr. Potvin is regarded as one of the outstanding leaders in biomedical engineering. In 1984, Dr Potvin founded and served as Director of the Medical Instrument Systems Division at Eli Lilly and Company in Indianapolis. He was the Chairman of the ASEE-Biomedical Engineering Division, and Chairman of the Education and Public Affairs Committee of BMES. He has served on the VA Rehabilitation Research and Development Merit Review Board, the FDA Physical Medicine Section of the Surgical and Rehabilitation Devices Panel, the Board of Directors for RMBS, and the Advisory Board of the Southern Biomedical Engineering Conference. Dr. Potvin has been President of the IEEE Engineering in Medicine and Biology Society. He became the Dean of Engineering and Technology at Indiana University and Purdue University. He established awards to recognize students with high academic and research performance.

IUPESM Fellow: Prof. Simone Kodlulovich Renha

For her contribution as an active member of IUPESM Awards Committee (2018-2022)


International Union for Physical and Engineering Sciences in Medicine

Prof. Simone Renha

has been elected as

FELLOW of IUPESM

Class of 2022

Brief Biography:

Dr Renha is a researcher of the National Commission of Nuclear Energy (CNEN). For more than 10 years was head of Diagnostic Radiology Division of the "Instituto de Radioproteção e Dosimetria" (IRD/CNEN) and currently is working at the Radiation Protection and Safety Division. She is also the President of the National Committee for the Certification of Radiation Protection Officer of CNEN.
Currently, she is a member of the Computed Tomography Accreditation Program of the Brazilian College of Radiology and Secretary of Brazilian Association of Technical Standards (ABNT) committee - CE 26:020.04 and IEC committee. And member-elect of the International Medical Physics Certification Board (IMPCB) and of the female medical physicist sub- group of IOMP. In the period of 2013-2015, she was a member of the Committee of Education and Training of IOMP. Currently is chair of the Honours and Awards committee of IOMP (2015-2018) and member of the Affiliated Commission 4 (AC4) of the International Union of Pure and Applied Physics. Also is member of Brazilian Association of Medical Physics (ABFM).
Participated in several scientific committees of medical physics congress (national and international), has publications in national/international journals as well as international conference proceedings. She was elected president of "Asociación Latinoamericana de Física Médica (ALFIM)" in 2010 for the period of 2010-2013 and re-elected for the period of 2013-2016.
In 2017, was awarded with the Fellow of IOMP (FIOMP).

IUPESM Fellow: Prof. Bernard Rigaud

For his contribution as Co-Chair, Organizing Committee, 7th IUPESM World Congress on Medical Physics and Biomedical Engineering, 1997 held in Nice, France.


International Union for Physical and Engineering Sciences in Medicine

Prof. Bernard Rigaud

has been elected as

FELLOW of IUPESM

Class of 2022

Brief Biography:
Bernard Rigaud graduated with a Doctoral degree in Medical and Biological Medical Engineering in 1994 and HDR at the University of Toulouse 2-Paul-Sabatier in 2003. He taught at Toulouse 2-Paul University -Sabatier from 2003 to 2004, then at the INU (National University Institute) Jean-François-Champollion frlm 2004. He was responsible for the biomedical technologies and methodologies sector. He was the senior university professor in biomedical engineering from 2006 to 2018. He also directed the School of Engineers in Computer Science and Information Systems for Health. In addition, he held the positions of Vice-Chairman of the Board of Directors (2006-2010), Deputy Director (2008-2010), then, since 2010, Director deputy general of the establishment.
Bernard Rigaud has been a Knight of the Order of Academic Palms since 2013.

IUPESM Fellow:
Prof. Wolfgang Schlegel

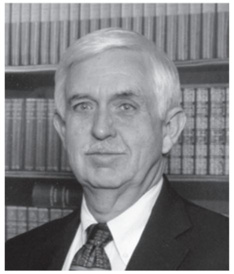
For his contribution as Co-Chair, Organizing Committee, 11th IUPESM World Congress on Medical Physics and Biomedical Engineering 2009, held in Munich, Germany.

Brief Biography:

Wolfgang Schlegel has made outstanding contributions to radiation therapy physics at the German Cancer Research Center in Heidelberg. Together with his colleagues, he developed novel radiation therapy technologies that significantly improved the precision and effectiveness of cancer therapy with ionizing radiation. His research covers important areas of radiotherapy physics and technology, such as 3D treatment planning, stereotactic radiosurgery, 3D conformal radiotherapy, intensity-modulated radiotherapy (IMRT), image-guided radiotherapy (IGRT), and ion therapy. His department has had a decisive influence on the precision and tailor-made dose distribution of the radiation. Prof Schlegel has already received numerous prizes for his work: in 1996 he received the "Karl-Heinz Beckurts Prize" from the Federal Ministry of Education and Research for successful technology transfer and in 2001 he was nominated for the German Future Prize. In 2003 he received the German Cancer Prize, and in 2010 the German Society for Medical Physics awarded him the Glocker Medal for his lifelong commitment to medical physics. He has been an honorary member of the German Society for Radiation Oncology (DEGRO) since 2013.

IUPESM Fellow:
Prof. Perry Sprawls

For his contribution as Co-Editors-in-Chief (from 2013) of the IUPESM-supported journal "Medical Physics International"



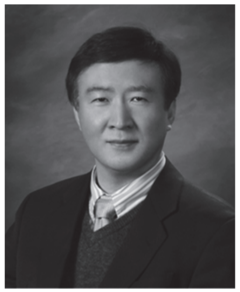
Brief Biography:

Perry Sprawls, Ph.D., is a clinical medical physicist and educator in medical imaging physics and clinical applications. He is currently Distinguished Emeritus Professor of Radiology at Emory University in Atlanta, concluding a 45-year career advancing the practice of radiology and medical imaging with an emphasis on the education of physicians, physicists, and other imaging professionals supporting the effective application of the new and evolving medical imaging methods, especially mammography, CT, MRI, and digital radiography. The extensive collection of his work is designated as the Sprawls Resources and is provided without cost for all to use by the Sprawls Educational Foundation online at www.sprawls.org.

In his ten-year service as Founding Co-Editor in Chief of the Medical Physics International journal his major objective has been to provide publications to advance medical physics education around the world. In addition to creating and sharing educational resources for study and teaching his research and development in the medical physics educational process has resulted in two of the AAPM Annual Innovation Awards, developing the concept and methodology of Collaborative Teaching (2010) and the process of Clinically Focused Physics Education (2011). The continuing efforts are to develop effective education activities for the evolving and advancing medical physics applications in clinical medicine with an emphasis on supporting medical physics educators around the world.

IUPESM Fellow:
Prof. Tae Suk Suh

For his contribution as Co-Chair, Organizing Committee, 10th IUPESM World Congress on Medical Physics and Biomedical Engineering 2006, held in Seoul, South Korea.



Brief Biography:

Professor Suh is a professor of Medical Physics at Dept. of Biomedical Engineering, director in "Research institute of Biomedical Engineering" and "Advanced Research Center for Medical Physics" at the Catholic University of Korea. He obtained BS in nuclear engineering from Seoul National University of Korea and received MS and PH.D in medical physics from the University of Florida, USA.

Professor Suh's career has spanned more than 40 years, a period which has witnessed huge advances in radiosurgery hardware and planning systems. He has contributed greatly towards the development of radiosurgery optimization techniques. he was the first to undertake flattening filter free(FFF) beam-based radiosurgery in a clinical setting. He also pioneered many other technologies, including the development of the radiation treatment planning system and 3T active shield magnetic resonance imaging.

As Secretary General of AFOMP during 9 years since 2003, he has been doing a lot of job in promoting the development of medical physics on a global basis. As President of AFOMP, he provided an effective solid platform for closer collaboration and mutual support amongst the medical physics organizations in the AFOMP. he has been working as a chair of publication committee of IOMP for 6 years. He also has worked as IMPCB Record and Registey Committee(RRC) chair.

Professor Suh received awards from IOMP and AFOMP; outstanding contribution over the last 50years(2013), IDMP(2020), Kiyonari Inamura memorial AFOMP Orator(2021) etc. Dr. Suh published over 300 peer-reviewed papers and more than 1300 proceedings.

IUPESM Fellow:
Prof. Raymond K. Wu

For his contribution as Co-Chair of the IUPESM Education and Training Committee (2015-2018)

Brief Biography:

Raymond K. Wu, Ph.D., DABR, DABMP, FACMP, FAAPM, FIOMP earned his PhD degree in Physics from Dartmouth College in USA in 1974. He completed his postdoctoral training in the Department of Radiation Therapy and Nuclear Medicine at Thomas Jefferson University Hospital in Philadelphia. He worked as a clinical medical physicist with teaching responsibilities in Temple University Medical School in Philadelphia holding a joint appointment as Associate Professor in the Radiotherapy Department and the Nuclear Medicine Department. Since 1985, he held the position of Professor of Radiation Oncology at the Eastern Virginia Medical School in Norfolk Virginia and served as the chief physicist in the Radiation Oncology department of its affiliated hospitals until 2002. From 2002 to 2008 he was Chief of Physics in the Radiation Oncology Department of the OhioHealth Medical System in Columbus Ohio. From 2008 to 2015 he was the Chief of Physics in the Department of Radiation Oncology & CyberKnife of the University of Arizona Cancer Center, and was also the Chief of Physics of the Gamma Knife section of the Barrow Neurological Institute, both in Phoenix, Arizona. Dr Wu is serving as the Chief Executive Officer of the International Medical Physics Certification Board (IMPCB) since 2014. Dr. Wu has been active in promoting the quality of medical physics in developing countries. He served as the Chair of the AAPM International Affairs Committee from 2006 to 2012, IOMP Professional Relations Committee from 2009 to 2014. In 2013 he was named a Fellow of the IOMP in Brighton, UK.

INFORMATION FOR AUTHORS

PUBLICATION OF DOCTORAL THESIS AND DISSERTATION ABSTRACTS

A special feature of Medical Physics International (on line at www.mpijournal.org) is the publication of thesis and dissertation abstracts for recent graduates, specifically those receiving doctoral degrees in medical physics or closely related fields in 2010 or later. This is an opportunity for recent graduates to inform the global medical physics community about their research and special interests.

Abstracts should be submitted by the author along with a letter/message requesting and giving permission for publication, stating the field of study, the degree that was received, and the date of graduation. The abstracts must be in English and no longer than 2 pages (using the MPI manuscript template) and can include color images and illustrations. The abstract document should contain the thesis title, author's name, and the institution granting the degree.

Complete information on manuscript preparation is available in the INSTRUCTIONS FOR AUTHORS section of the online journal: www.mpijournal.org.

INSTRUCTIONS FOR AUTHORS

The goal of the new IOMP Journal Medical Physics International (http://mpijournal.org) is to publish manuscripts that will enhance medical physics education and professional development on a global basis. There is a special emphasis on general review articles, reports on specific educational methods, programs, and resources. In general, this will be limited to resources that are available at no cost to medical physicists and related professionals in all countries of the world. Information on commercial educational products and services can be published as paid advertisements. Research reports are not published unless the subject is educational methodology or activities relating to professional development. High-quality review articles that are comprehensive and describe significant developments in medical physics and related technology are encouraged. These will become part of a series providing a record of the history and heritage of the medical physics profession.

A special feature of the IOMP MPI Journal will be the publication of thesis and dissertation abstracts for will be the publication of thesis and dissertation abstracts for recent doctoral graduates, specifically those receiving their doctoral degrees in medical physics (or closely related fields) in 2010 or later.

MANUSCRIPT STYLE

Manuscripts shall be in English and submitted in WORD. Either American or British spelling can be used but it must be the same throughout the manuscript. Authors for whom English is not their first language are encouraged to have their manuscripts edited and checked for appropriate grammar and spelling. Manuscripts can be up to 10 journal pages (approximately 8000 words reduced by the space occupied by tables and illustrations) and should include an unstructured abstract of no more than 100 words.

The style should follow the template that can be downloaded from the website at:
http://mpijournal.org/authors_submitapaper.aspx

ILLUSTRATIONS SPECIAL REQUIREMENTS

Illustrations can be inserted into the manuscript for the review process but must be submitted as individual files when a manuscript is accepted for publication.

The use of high-quality color visuals is encouraged. Any published visuals will be available to readers to use in their educational activities without additional approvals.

REFERENCE WEBSITES

Websites that relate to the manuscript topic and are sources for additional supporting information should be included and linked from within the article or as references.

EDITORIAL POLICIES, PERMISSIONS AND APPROVALS

AUTHORSHIP

Only persons who have made substantial contributions to the manuscript or the work described in the manuscript shall be listed as authors. All persons who have contributed to the preparation of the manuscript or the work through technical assistance, writing assistance, financial support shall be listed in an acknowledgements section.

CONFLICT OF INTEREST

When they submit a manuscript, whether an article or a letter, authors are responsible for recognizing and disclosing financial and other conflicts of interest that might bias their work. They should acknowledge in the manuscript all financial support for the work and other financial or personal connections to the work.

All submitted manuscripts must be supported by a document (form provided by MPI) that:

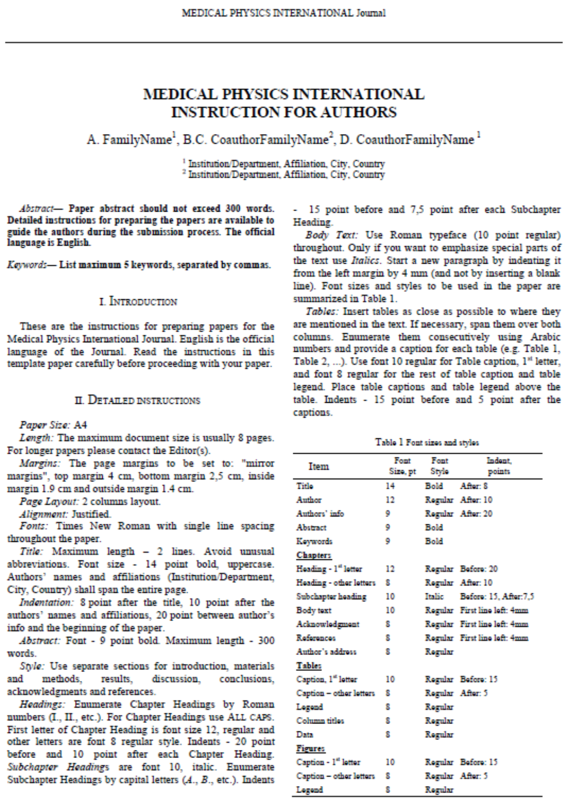
• Is signed by all co-authors verifying that they have participated in the project and approve the manuscript as submitted.

• Stating where the manuscript, or a substantially similar manuscript has been presented, published, or is being submitted for publication. Note: presentation of a paper at a conference or meeting does not prevent it from being published in MPI and where it was presented can be indicated in the published manuscript.

• Permission to publish any copyrighted material, or material created by other than the co-authors, has been obtained.

• Permission is granted to MPI to copyright, or use with permission copyrighted materials, the manuscripts to be published.

• Permission is granted for the free use of any published materials for non-commercial educational purposes.



MEDICAL PHYSICS INTERNATIONAL Journal

MEDICAL PHYSICS INTERNATIONAL
INSTRUCTION FOR AUTHORS

A. FamilyName[1], B.C. CoauthorFamilyName[2], D. CoauthorFamilyName[1]

[1] Institution/Department, Affiliation, City, Country
[2] Institution/Department, Affiliation, City, Country

Abstract— **Paper abstract should not exceed 300 words. Detailed instructions for preparing the papers are available to guide the authors during the submission process. The official language is English.**

Keywords— **List maximum 5 keywords, separated by commas.**

I. INTRODUCTION

These are the instructions for preparing papers for the Medical Physics International Journal. English is the official language of the Journal. Read the instructions in this template paper carefully before proceeding with your paper.

II. DETAILED INSTRUCTIONS

Paper Size: A4

Length: The maximum document size is usually 8 pages. For longer papers please contact the Editor(s).

Margins: The page margins to be set to: "mirror margins", top margin 4 cm, bottom margin 2,5 cm, inside margin 1.9 cm and outside margin 1.4 cm.

Page Layout: 2 columns layout.

Alignment: Justified.

Fonts: Times New Roman with single line spacing throughout the paper.

Title: Maximum length – 2 lines. Avoid unusual abbreviations. Font size - 14 point bold, uppercase. Authors' names and affiliations (Institution/Department, City, Country) shall span the entire page.

Indentation: 8 point after the title, 10 point after the authors' names and affiliations, 20 point between author's info and the beginning of the paper.

Abstract: Font - 9 point bold. Maximum length - 300 words.

Style: Use separate sections for introduction, materials and methods, results, discussion, conclusions, acknowledgments and references.

Headings: Enumerate Chapter Headings by Roman numbers (I., II., etc.). For Chapter Headings use ALL CAPS. First letter of Chapter Heading is font size 12, regular and other letters are font 8 regular style. Indents - 20 point before and 10 point after each Chapter Heading. *Subchapter Headings* are font 10, italic. Enumerate Subchapter Headings by capital letters (*A.*, *B.*, etc.). Indents - 15 point before and 7,5 point after each Subchapter Heading.

Body Text: Use Roman typeface (10 point regular) throughout. Only if you want to emphasize special parts of the text use *Italics*. Start a new paragraph by indenting it from the left margin by 4 mm (and not by inserting a blank line). Font sizes and styles to be used in the paper are summarized in Table 1.

Tables: Insert tables as close as possible to where they are mentioned in the text. If necessary, span them over both columns. Enumerate them consecutively using Arabic numbers and provide a caption for each table (e.g. Table 1, Table 2, ...). Use font 10 regular for Table caption, 1st letter, and font 8 regular for the rest of table caption and table legend. Place table captions and table legend above the table. Indents - 15 point before and 5 point after the captions.

Table 1 Font sizes and styles

Item	Font Size, pt	Font Style	Indent, points
Title	14	Bold	After: 8
Author	12	Regular	After: 10
Authors' info	9	Regular	After: 20
Abstract	9	Bold	
Keywords	9	Bold	
Chapters			
Heading - 1st letter	12	Regular	Before: 20
Heading - other letters	8	Regular	After: 10
Subchapter heading	10	Italic	Before: 15, After:7,5
Body text	10	Regular	First line left: 4mm
Acknowledgment	8	Regular	First line left: 4mm
References	8	Regular	First line left: 4mm
Author's address	8	Regular	
Tables			
Caption, 1st letter	10	Regular	Before: 15
Caption – other letters	8	Regular	After: 5
Legend	8	Regular	
Column titles	8	Regular	
Data	8	Regular	
Figures			
Caption - 1st letter	10	Regular	Before: 15
Caption – other letters	8	Regular	After: 5
Legend	8	Regular	

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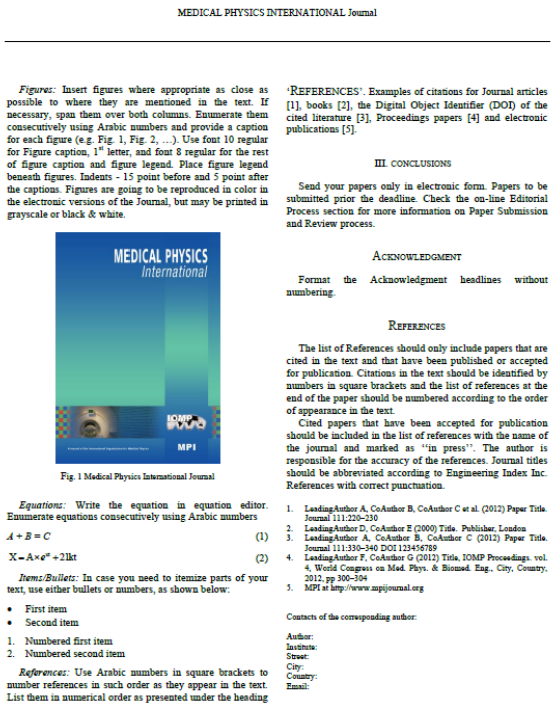

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Equations: Write the equation in equation editor. Enumerate equations consecutively using Arabic numbers

$$A + B = C \quad (1)$$

$$X = A \times e^{st} + 2lkt \quad (2)$$

Items/Bullets: In case you need to itemize parts of your text, use either bullets or numbers, as shown below:

- First item
- Second item

1. Numbered first item
2. Numbered second item

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III. CONCLUSIONS

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