# The Encyclopaedia of Medical Physics II Edition: The update of Diagnostic Radiology field

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***Abstract:*** **The paper describes briefly the update of the Medical Physics Thesaurus of terms and the related update of Diagnostic Radiology field of the Encyclopaedia of Medical Physics II Edition (published 2021).**

***Keywords*** *– Medical Physics Encyclopaedia, Medical Physics Education, Medical Physics resources.*

## I. Introduction

The Encyclopaedia of Medical Physics development and its update are parts of a large project, which took over 20 years. The articles of the Encyclopaedia I Edition (published by CRC Press in 2013 [1]) were based on the Medical Physics Thesaurus of terms, developed in 2003 and updated in 2008. An additional minor update of the full Thesaurus was made in 2011. Thus, the Encyclopaedia Edition I included over 2800 articles explaining the foundation terms in medical physics. These were published by CRC Press (in paper) as a two-volume set and uploaded (together with the Scientific Dictionary of Medical Physics Terms in 32 languages) on the dedicated website www.emitel2.eu as a free reference and educational resource.

During the following 10 years materials for the Thesaurus update were collected and a major update was made in the period 2019-2020. This update included about 650 new terms. The Encyclopaedia II Edition is naturally listed alphabetically, but it has specific parts (fields), managed by different teams, as per the narrow specialty of the contributors. These fields are on Physics of: Diagnostic Radiology; Radiotherapy; Nuclear Medicine; Ultrasound Imaging; Magnetic Resonance Imaging; Radiation Protection; Non-ionising radiation protection; General terms (including Management). This new II Edition of the Encyclopaedia of Medical Physics was printed and published by CRC Press in 2021 [2]. The materials from the update were uploaded at the same website: www.emitel2.eu

## II. Diagnostic radiology update

This paper describes briefly the nature of the update and the new terms in the filed of Diagnostic Radiology. The initial Thesaurus of Diagnostic Radiology terms (from 2003) included topics related to X-ray tubes and generators; X-ray equipment and stands; X-ray films; Computed Radiography systems; Various Digital detectors in Radiology; Computed Tomography; Specific physics-based methods in Diagnostic Radiology, etc.

During the 10 years period this field has undergone significant development, which was necessary to be included in the medical physics knowledge bank.

The Encyclopaedia Editorial Board decided to keep the historical parts in all fields, as a number of these included some important methods and scientific approaches, which can be used for future references. In Diagnostic Radiology such were, for example, the fields of Linear Tomography (now forming the foundation of the Digital Tomosynthesis), or Classical X-ray Generators (forming the foundation of the Medium frequency X-ray generators today), etc.

A number of the existing Encyclopaedia articles were updated to include new developments in Diagnostic Radiology – such as articles related to Multi Detector Computed Tomography and related fields, or X-ray imaging printing systems. A major update was necessary for the quickly developing field of Digital Detectors. These subjects also included updated and new articles associated with the Image assessment and Quality Control (QC) related to Digital Detectors.

New articles were included associated with new Test objects (phantoms) and parameters used for assessment of the detectors, as well as real images related to QC – example in Fig.1

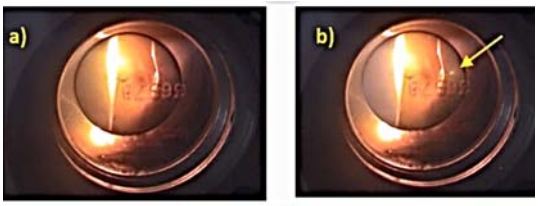


Fig.1 Arcing on X-ray tube photographed through the glass envelope: a) normal work of the X-ray tube (glowing-hot Anode on left and Cathode cup on right); b) small spark (arcing) appears close to Cathode - *from article: Arcing of X-ray tube*

Digital Tomosynthesis and various methods for Image Reconstruction were other fields, which have undergone significant update.

The Dual energy imaging description, as well as other Digital imaging methods, were explained in conjunction with the possible extraction of quantitative measurements used for diagnostic and QC purposes.

Special attention was given to fields, which are now forming important part of the educational process – such as visualisation of digital X-ray images (use of windowing and digital image filtration)- – example in Fig.2


Fig.2 Measurement of pixel value (PV) in a square ROI of 100 pixels, showing mean pixel value of 187.35, while individua pixel values in the ROI vary from 180 to 193. Note that the pixel value does not change (compared with Fig.1), despite the visualization of the image with better contrast (resulting from the different window parameters - see the histogram) – *from article: Pixel value*

Optimisation was another field, where a number of new articles were included, as well as previous articles were updated. Such articles were often shown in sync with articles from other fields (e.g. Nuclear Medicine physics). In a similar way, for example, articles related to Monitors were shared with General terms (this is valid for all fields of the Encyclopaedia). Due to this reason in many parts of the Encyclopaedia the Related Articles (normally at the end of the text of most articles) were updated and enlarged.

The naming of the articles was kept in a way to present a cluster of these in close proximity inside the Encyclopaedia. All these articles were illustrated in a way to allow their use in the education process (information about real imaging systems was excluded in the articles) – example in Fig.3

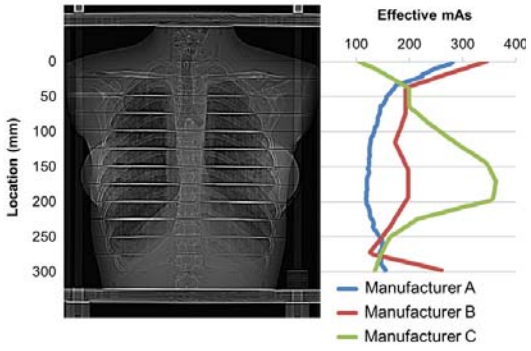


Fig 3 Comparison of the tube current when applying longitudinal modulation for different manufacturers – *from article: CT Optimization – longitudinal Modulation (z-axis)*

Short articles were included in connection with the use of DR methods outside their clinical application (such as Industry X-ray imaging).

Some very new emerging fields, such as Phase Contrast Imaging were included. In such case care was taken for the educational explanation of these and their good illustration. Many new diagrams and examples were presented to allow the reader to be introduced the field – example in Fig.4

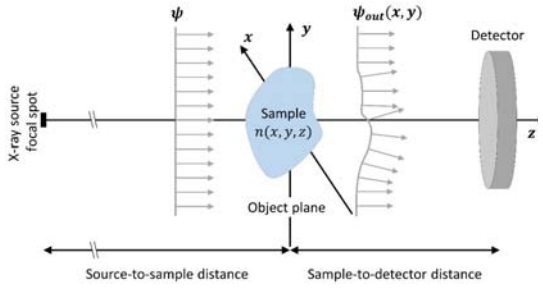


Fig 4 An X-ray beam, represented by the plane wave ψ, impinges on a sample described by the refractive index n(x,y,z). The wave ψout emerging from the object, is affected both in amplitude and in phase. Arrows represent the local direction of the X-ray wave – *from article: Phase Contrast Imaging*

As in the Edition I of the Encyclopaedia care was taken to include block diagrams and engineering information for the equipment, not taking it as a "black box". Fig. 5 gives an example.

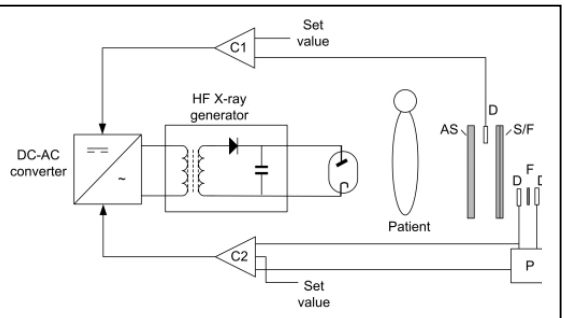


Fig 5. Block diagram showing two typical AEC types. C1 – used for chest radiography and C2 used for mammography – *from article: Automatic Exposure Control (AEC)*

## III. CONCLUSION

The update of the DR field included about 150 new articles. These were managed by the Coordinators of the Working Group on Diagnostic Radiology (X-ray): Slavik Tabakov, Perry Sprawls, Paola Bregant.

The update covered most new areas of the dynamic field of Diagnostic Radiology. The Editorial Board shall be grateful to information from our colleagues about new methods and equipment to be included in the III Edition of the Encyclopaedia (possibly around 2031).

## ACKNOWLEDGEMENTS

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