MEDICAL RADIATION PHYSICS TRAINING WITH EMERALD and EMIT e-LEARNING MATERIALS

EMERALD, EMIT and EMITEL Consortia

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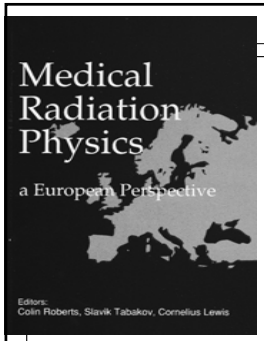
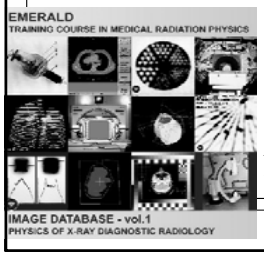




- EuroConference on Medical Physics & Engineering Education - *Budapest'94*
- Book with Education & Training Programmes
- Inter-University Med. Phys. Centre, Plovidv
- Joint Baltic MSc course (Tempus proj.)
- **Project EMERALD (3 books and 3 CD)**
- EuroConference on Medical Physics Training (26 countries) - *Triest'98*
- 6 Emerald Training Seminars in Europe
- **EMERALD e-learning**
- **EMIT e-Learning**

Assessment of the needs and feedback were pivotal for the development of these pilot projects

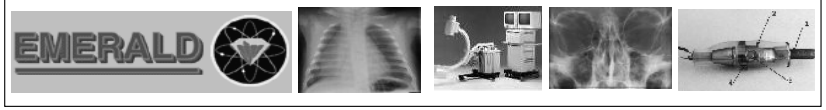
The delivery of contemporary healthcare is impossible without medical technology - one of the most advanced technologies of our time

1.The biggest e-L advantage is the easy explanation of contemporary science. Adding computer simulations, interactive diagrams or just pictures increases enormously the effectiveness of teaching.

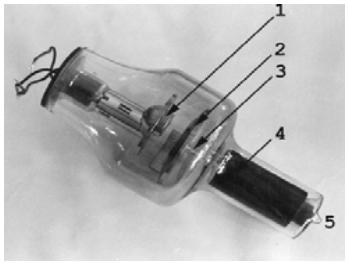
2.The easy upgrade of e-L materials is an advantage, imperative for dynamic profession as Medical Engineering and Medical Physics.

Quality Control based on EMERALD X-ray Diagnostic Radiology training

Dr Slavik Tabakov
EMERALD Consortium, King's College London



Objective of Project EMERALD



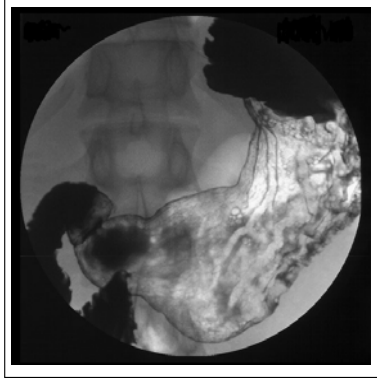
Development of 3 common training modules in:

- Diagnostic Radiology Physics,
- Nuclear Medicine Physics,
- Radiotherapy Physics,

each with duration of 4 months

4 months condensed EMERALD training (international) plus 1-2 months further in-house training (national)

EMERALD Structured Training Modules



Each module incorporates:

- List of Competencies (based on the IPEM scheme);
- Structured Timetables;
- Student Workbook with tasks;
- Teacher's (Course) Guide
- CD-ROM with images (searchable database);
- EMERALD e-book with tasks

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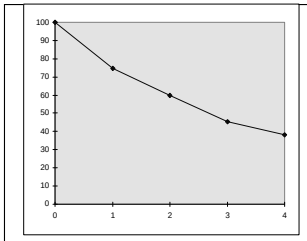
Student Workbook



Each Student Workbook contains:

- Structured Training Timetable,
- Tasks with detailed explanations tables, references and other data,
- Questions to be answered,
- Verification, etc.

- National Introduction - Sep'97
- Refereeing
- International Introduction - Sep'98

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TRAINING MODULE "PHYSICS OF DIAGNOSTIC RADIOLOGY"

TRAINING TIMETABLE

No.	Sub-module	Competencies (*)	Days
i	Introduction. Program. Using the training materials		1
1	General principles of Radiation Protection in DR	General	3
2	General principles of DR Quality Control organisation/ equipment	General	3
3	X-ray dosimetry and Patient dosimetry	3,5,9,10,12,13	11
4	Radiological image	3,7,10,11,14	4
5	X-ray tube and generator	2,3,4,5,14,15,22	7
6	Radiographic Equipment	1,2,3,4,5,6,8,10,14,16	12
7	X-ray screens/films and Laboratory	1,7,8,16	5
8	Fluoroscopic Equipment	1,2,3,7,8,10,11,14,15,16	10
9	Digital Imaging and CT Equipment	1,2,6,7,8,10,14,16	10
10	Basis of shielding in Diagnostic Radiology	16,17,18	5
ii	Organising of the portfolio, training assessment, etc.		9
	Total for 4 months: 16 weeks x 5 days = 80 days *Total:*		*80*

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Sub-module and Subject	Necessary materilas/arrangements	Competencies acquired	Days
X-ray tube and generator		**Understand/measur/ compare separate X-ray tube/gen. parameters *(2,3,4,5,14,15,22)**	**7**
Basic X-ray tube Components and Characteristics.	X-ray tube diagrams; Different company brochures; Several types tube inserts	Understand/compare X-ray tube paramet.	2
Assessment of X-ray tube Leakage radiation and X-ray tube output total filtration	Tube housing; X-ray radiogr. room; Dosemeter; Al plates HVL/Filt. diagrams; ~6 X-ray film/cassettes	Understand/measure X-ray tube filtration	1
Assessment of X-ray tube output parameters	X-ray radiogr. room; Dosemeter; calculator, Foc. spot meas. tool; LBD align. tool	Understand/measure/ calculate tube output param., focal spot size and LBD. Learn to season the tube	2
Assessment of X-ray Generator kVp and Timer parameters	X-ray gen. diagrams; X-ray radiogr. room; kVp divider; kVp non-inv. meter; oscilloscope; kVp cassette; mA and Timer meters.	Understand/measure kVp with different tools. Assess ripple. Measure mA. time of the exposure	2

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Sub-module and Subject	Necessary materilas/arrangements	Competencies acquired	Days
Radiographic Equipment		**Using and QC of radiographic equip. * (1,2,3,4,5,6,8,10, 14,16)**	**12**
Familiarisation with General Radiography Equipment.	General acquaintances with practice (patients) in the Radiographic room	Using DR equipment; Practical selecting X-ray parameters; Patient care.	2
Quality Control of a typical Radiography equipment.	X-ray radiogr. room; Dose, kVp, etc. meters; QC protocols, PC.	Perform QC tests and QC protocols; Accept DR radiogr.eq.	2
Quality Control of Mobile Radiography equipment (capacity discharge equipment).	Mobile X-ray radiogr. eq.; QC equipment; QC protocols, PC	Perform specific QC tests for mobile radiogr. eq. Interpret QC result	1
Quality Control of Dental Radiography Equipment.	Dental X-ray radiogr. eq.; QC equipment; QC protocols, PC	Perform specific QC tests and write QC protocols for Dental equipment;	2
Quality Control of Mammography Equipment.	Mammo X-ray radiogr. eq.; Special Mammo QC equip. and test objects; QC protocols, PC	Perform specific QC tests and write QC protocols for Mammo-graphic equipment;	2
Assessment of Conventional Tomography Equipment	Tomogr. X-ray radiogr. eq.; QC equipment and test objects; QC protocols, PC	Perform specific QC tests and write QC protocols for Tomo-graphic equipment;	1
Assessment of Automatic Exposure Control (AEC) systems in Radiography.	X-ray AEC radiogr. eq.; QC equipment, test objects; QC protocols, PC.	Use of different AEC. Perform specific QC tests and write QC protocols for AEC;	2

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5.2 ASSESSMENT OF X-RAY TUBE TOTAL FILTRATION

5.2.1 Task
Short explanation of the task; Approx. time for performing the task

5.2.2 Competencies Addressed
Understand and measure the X-ray tube beam filtration

5.2.3 Equipment and Materials
List with necessary Equipment, Materials, Arrangements

5.2.4 Procedures and Measurements

5.2.4.2 For Assessment of X-ray Tube Output Total Filtration
Detailed description of a method to perform the task

Added Al (mm)	Set kV (~80)	Set mA	Set msec	Set mAs (~20-40)	Meas. exp (mGy)	Exp.decr. (%)
+0mm Al	80					100
+1mm Al	80					
+2mm Al	80					
+3mm Al	80					
+4mm Al	80					<50

5.2.5 Calculations

5.2.5.2 For Assessment of X-ray Tube Output Total Filtration
Detailed description of a method to calculate certain parameters

5.2.6 Observations, Interpretations, Conclusions
Questions to answer; Problems to think about; Conclusions

5.2.7 References
List of some relevant books, documents, etc.

Verification
Signature and date by the trainer:

Learning through experience

<< Basic structure
<< of one task

Number of tasks:

DR - 49 tasks

NM - 46 tasks

RT - 48 tasks

MRI - 50 tasks

U/S - 54 tasks

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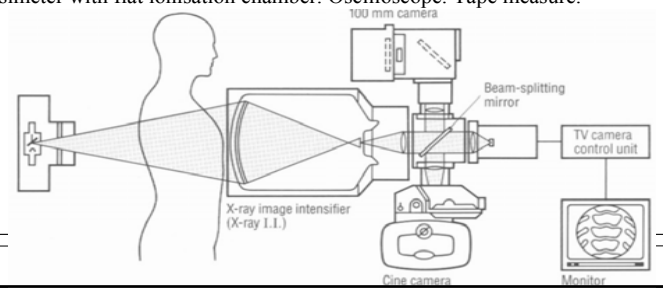
Task Performance - Example 1 (2 days) 1

8.1 - Basic Fluoroscopic X-ray Equipment QC

8.1.3 Equipment and Materials

- Block diagrams of fluoroscopic X-ray equipment.
- Information and images from several types of image test objects.
- A set of image test objects (minimum: edge phantom, spatial resolution phantom, contrast resolution phantom - overall image quality phantom).
- Copper plate 1 mm thick and with surface about 150 x 150 mm.
- Dosimeter with flat ionisation chamber. Oscilloscope. Tape measure.



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8.1.4 Procedures and Measurements

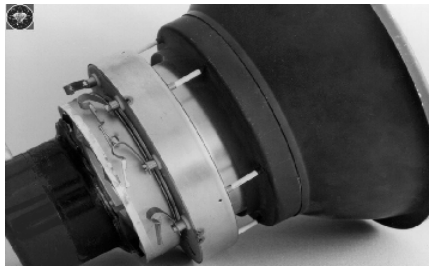
Familiarisation with Block Diagrams of Fluoroscopic X-ray Equipment Study the block diagram of the Image Intensifier and identify it's parts.

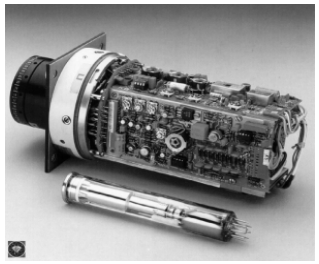
Comment on different types of luminifors used in II.

Study the block diagram of the TV video camera and identify it's parts.

Comment on different types of TV camera tubes.

Study the concepts of II Conversion factor and Contrast ratio.





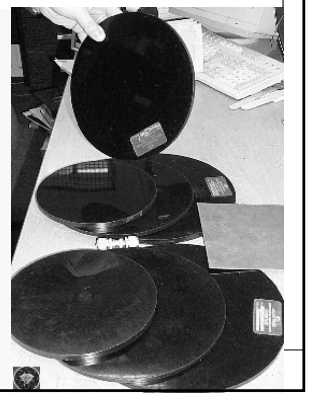
Familiarisation with Different Types of Image Test Objects

Study the images of several types of test objects.

Use the table given below (based on real measurements) to draw the contrast-detail characteristic :

[min. visible contrast] as a function of the [corresponding detail size]

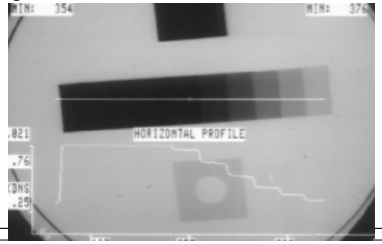
Row (for TO10)	**Detail size** diameter		Detail number and **limiting contrast** with II field size (using Leeds Test Object TO10 with ABC system on)				
	[mm]	II image field = 30cm		II image field = 23cm		II image field = 17cm	
		80kV	0.2mA	80kV	0.6mA	80kV	1.2mA
A	**11.1**	6	**0.032**	6	**0.032**	6	**0.032**
B	**7.9**	6	**0.032**	6	**0.032**	6	**0.032**
C	**5.6**	6	**0.032**	6	**0.032**	6	**0.032**
D	**4**	6	**0.045**	6	**0.045**	6	**0.045**
E	**2.8**	5	**0.066**	6	**0.045**	6	**0.045**
F	**2**	5	**0.066**	5	**0.066**	5	**0.066**
G	**1.4**	4	**0.16**	6	**0.086**	6	**0.086**
H	**1**	3	**0.23**	4	**0.16**	5	**0.123**
J	**0.7**	2	**0.35**	3	**0.23**	4	**0.16**
K	**0.5**	1	**0.93**	3	**0.5**	4	**0.35**
L	**0.35**	0	**0.99**	1	**0.93**	3	**0.5**
M	**0.25**	0	**0.99**	0	**0.99**	1	**0.93**

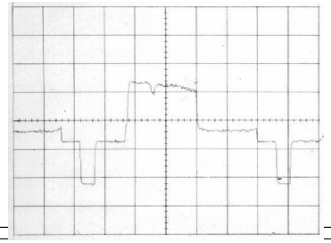


Familiarisation with the Concepts of II Image Brightness and Contrast and with Video Signal Assessment.

Connect the oscilloscope to the signal from the II TV camera - either at the special output of TV monitor or with a T-junction BNC connector (remember to terminate the TV signal chain (normally with 75 ohm special terminator). Set the oscilloscope parameters to 0.2 V and 10 ms/per division (TV signal measurements).

Use X-ray beam with 1 mm Cu attenuation and place the Step-wedge phantom (in case of Leeds test objects - Gray scale TOGS) as close as possible to the II, observe the set contrast and brightness and mark the proper position of the TV monitor contrast and brightness.





Record again the maximal amplitude of the video signal and measure the II entrance dose rate for this new image.

Select the appropriate II entrance dose rate (according to the manuf. specifications) - normally this is in the region of 0.2 - 10 µGy/s.

Measure (at least for two II field sizes) the specific parts of the video signal, given on the figure, and record them in the table:

Video signal parameter	[mV] @ II size….	[mV] @ II size….
Sync. pulse/ blanking		
Blanking/black level		
Loss of contrast (black)		
Camera noise (black) P-Pmax		
Blank/white ampl.		
Camera & quantum noise (white) P-P		
Vignetting slope		
Dose rate mR/min		
kVp/mA		

Results

8.1.5.1 Compare the characteristics of two TV camera tubes - Vidicon Plumbicon.

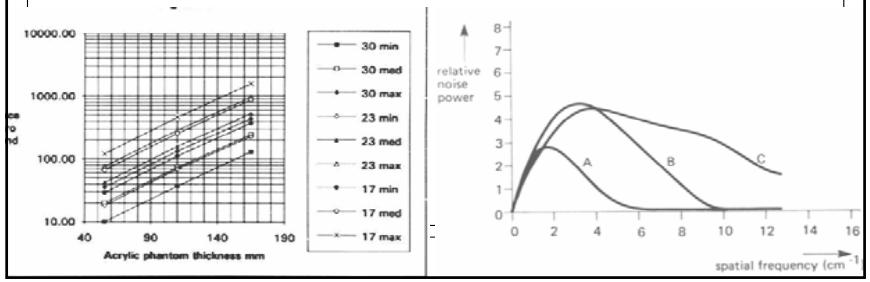
8.1.5.2 Compare the Contrast-detail Characteristic with the Normal values given in the Reference (IPSM Report 32).

Compare and comment on the two different Contrast-detail functions.

8.1.5.3 Compare the difference in video signal amplitude and II entrance dose rate for a screen with adjusted and mis-adjusted contrast and brightness.

Compare the noise on the video signal in both of the above cases.

Compare and comment on the difference in video signals for two different II image field sizes.



8.1.6 Observations, Interpretations, Conclusions

Comment on the effectiveness of the Fluoroscopic X-ray Equipment and explain why the patient dose during fluoroscopy is greater than that in radiography

Comment on the possible areas of application of the different TV cameras

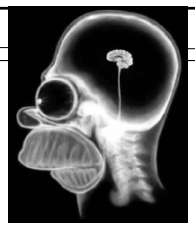
Observe the plotted contrast-detail functions and comment on their dependence on II image field size.

Describe a video signal whose parameters are NOT-Acceptable.

8.1.7 References

…….

Verification (*Signature and date by the trainer*)



Verbal Memory + Image Memory

For Assessment of X-ray Tube Leakage Radiation

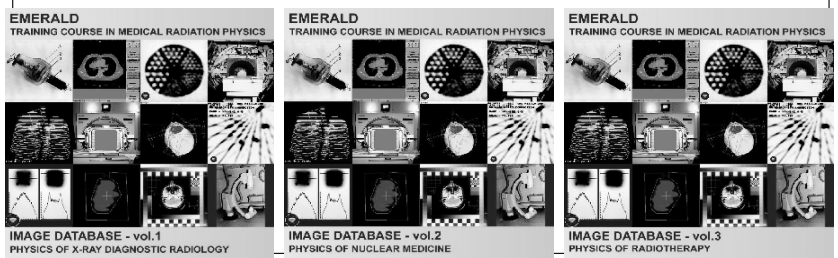
Close the X-ray tube diaphragm and place the tube down on the X-ray table.

Surround the X-ray tube with at least 6 big X-ray cassettes with films, forming a closed volume (cubicle) around the X-ray tube housing (number the films).

Image Database in 3 volumes (3 CD-ROMs) : DR, NM, RT

System requirements: PC with Windows 95/98; min. 486 (100 MHz) min. 16 MB; min. 1MB graphics (600x800/256); CD-ROM: min. x4

Image Browser: ThumbsPlus 4 (runs from the CD-ROM)



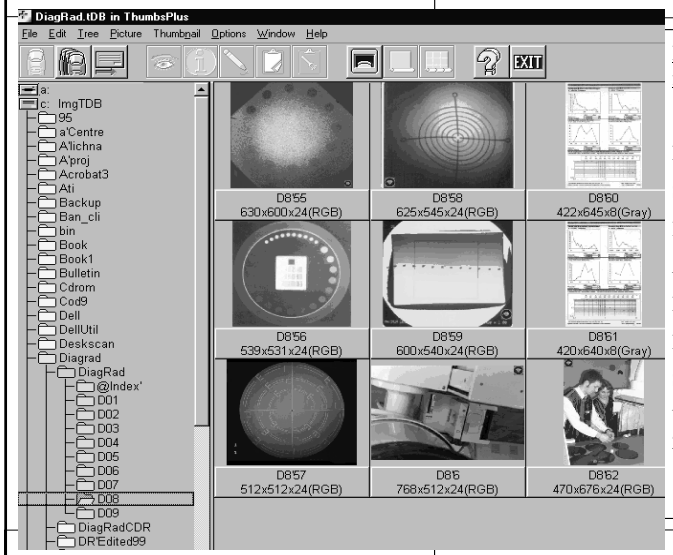


Image Database functions

Browsing

Slides (120x160)

Image Info

Annotations

Keywords

Boolean search

Sorting

Visualisation (up to 20 images)

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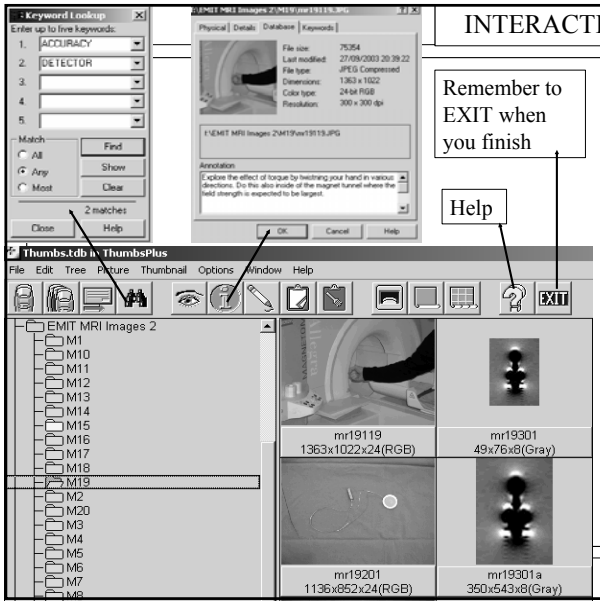

INTERACTIVITY

Remember to EXIT when you finish

Help

Image Database functions

Browsing

Slides (120x160)

Image Info

Annotations

Keywords

Boolean search

Sorting

Visualisation (up to 20 images)

Each CD includes a freeware Thumbs browser

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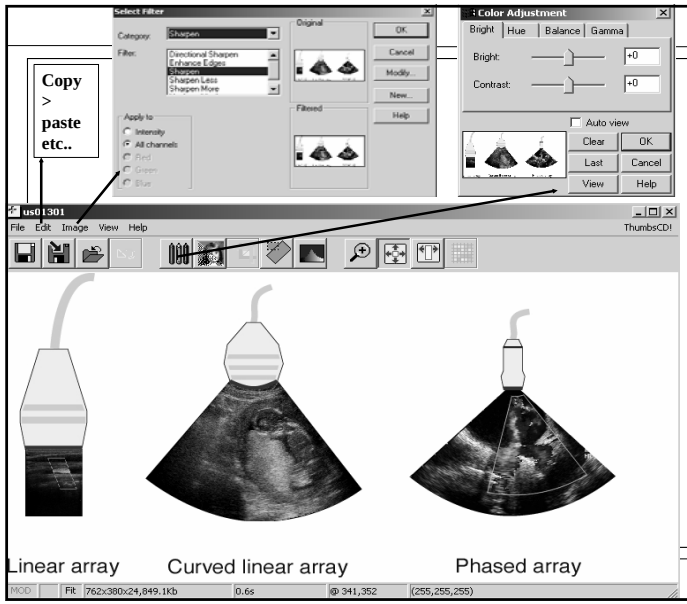

Image resolution

normally up to 800 horiz. px.

24 bits JPEG

Image Manipulation

Contrast

Brightness

Gamma

Filtering

Colour depth

Zoom +/-

Captions

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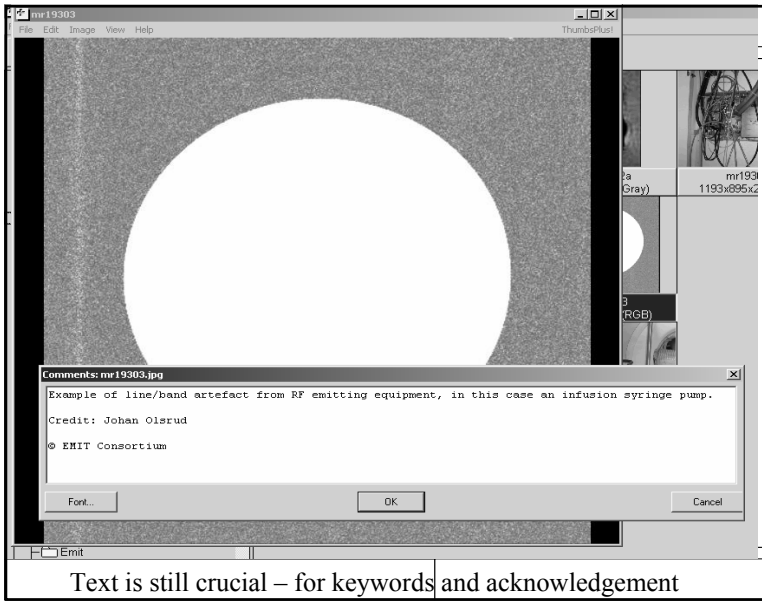

Text is still crucial – for keywords and acknowledgement

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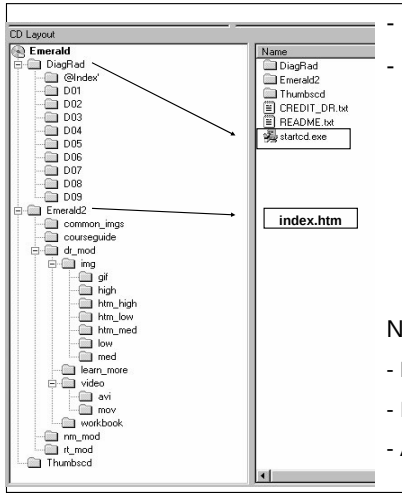
EMERALD CD-ROMS



- Image Database (as before)
- E2 Internet site with:
  - * Navigational structure
  - * Text of tasks (from Workbooks)
  - * Images from database (smaller)
  - * Hyperlinks text>image
  - * Course Guide

Necessities (min):

- PC100MHz, CDx4, 32 MB, 2MB graph.
- Internet browser (IE5 or N4)
- Acrobat Reader

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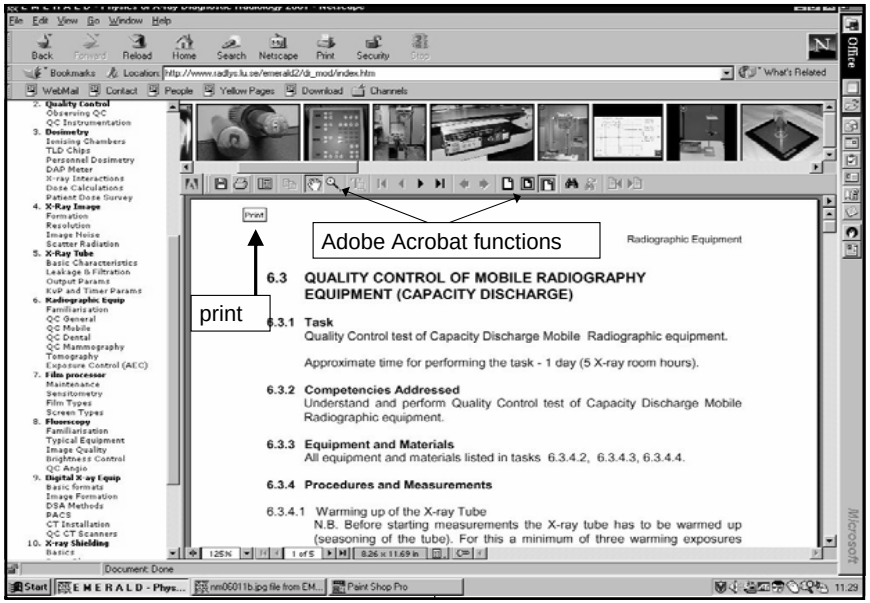

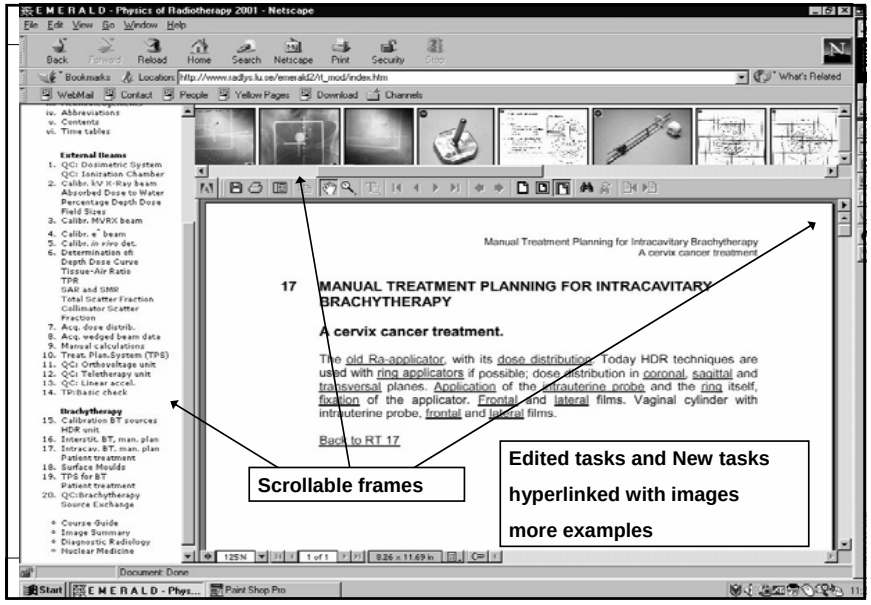

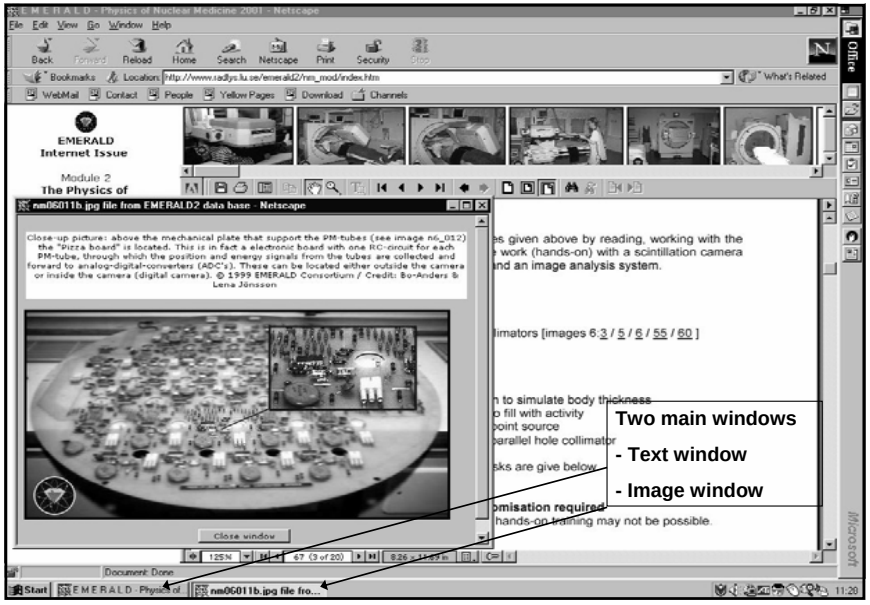

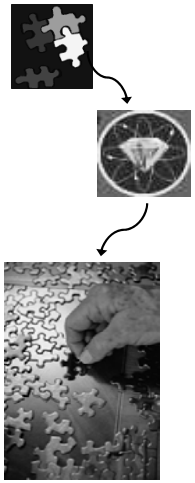

- EMERALD is a resource, which could support various training schemes, and not a replacement of these. Its greatest value is the flexibility offered - from one side the training tasks can be used *'as is'*, building to a full training package. Alternatively they can be used to substitute existing training schemes and suggest further training areas.

- EMERALD Image Database has been very useful for training. Additionally it has huge educational potential for Universities - from keyword search to image processing.

- EMERALD electronic training materials have been accepted very well by young colleagues.

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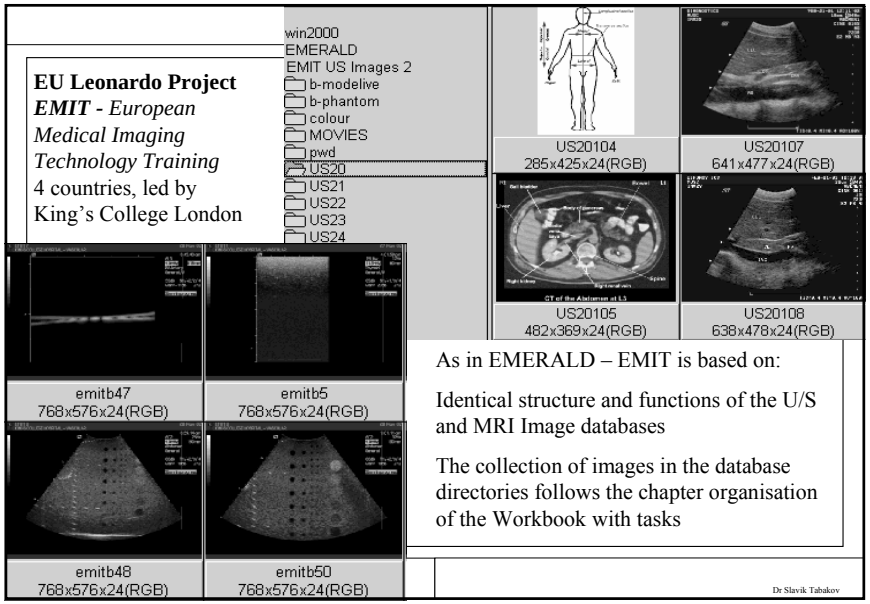
EU Leonardo Project
***EMIT** - European Medical Imaging Technology Training*
4 countries, led by King's College London



As in EMERALD – EMIT is based on:

Identical structure and functions of the U/S and MRI Image databases

The collection of images in the database directories follows the chapter organisation of the Workbook with tasks

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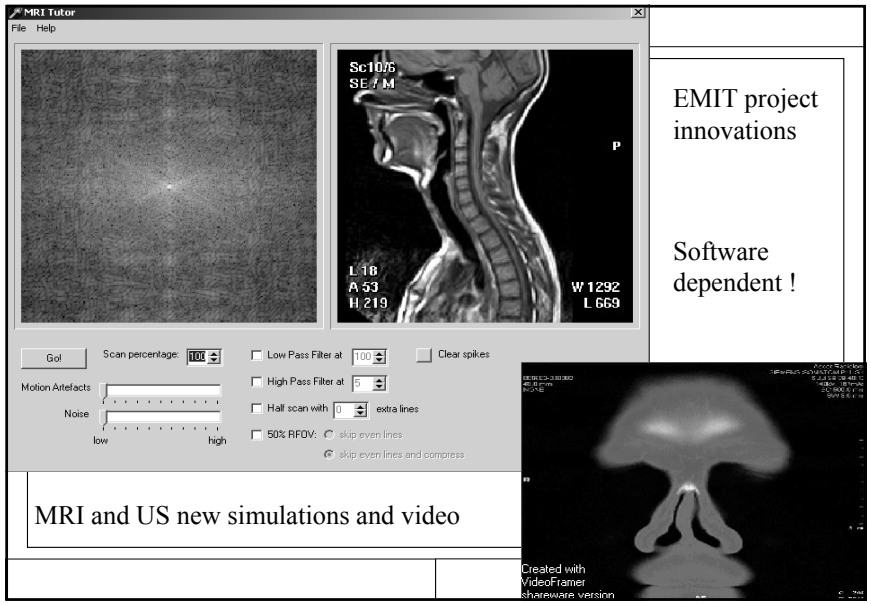

EMIT project innovations

Software dependent !

MRI and US new simulations and video

Second EuroConference on Medical Physics Training using e-Learning materials – EMIT

10-11 October 2003, ICTP, Trieste, Italy (experts from 26 countries)

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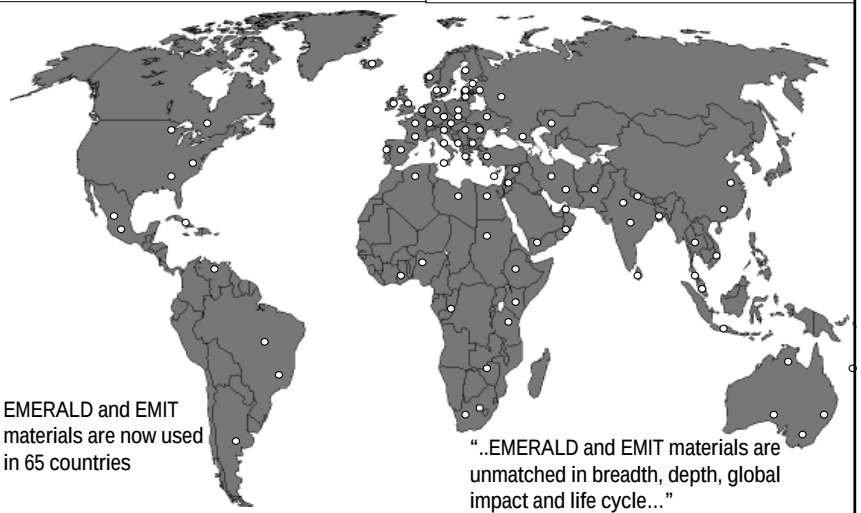
EMERALD and EMIT around the world



EMERALD and EMIT materials are now used in 65 countries

"..EMERALD and EMIT materials are unmatched in breadth, depth, global impact and life cycle..."

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International Medical Physics College at ICTP, Trieste, Italy

- IAEA - IOMP - EFOMP - AAPM

The Emerald and EMIT users: the biggest success is the ease of use

ICTP International College on Medical Physics, 2 – 13 September 2002, Trieste, Abdus Salam International Centre for Theoretical Physics

EMERALD Update

easy in nature, but difficult to make…

"training-on-demand" on Lund's server

Three ways to update:

- New fields and tasks
- New images for the IDB
- New e-materials on Internet

-Internet subscription - none

-Internet use of materials – limited

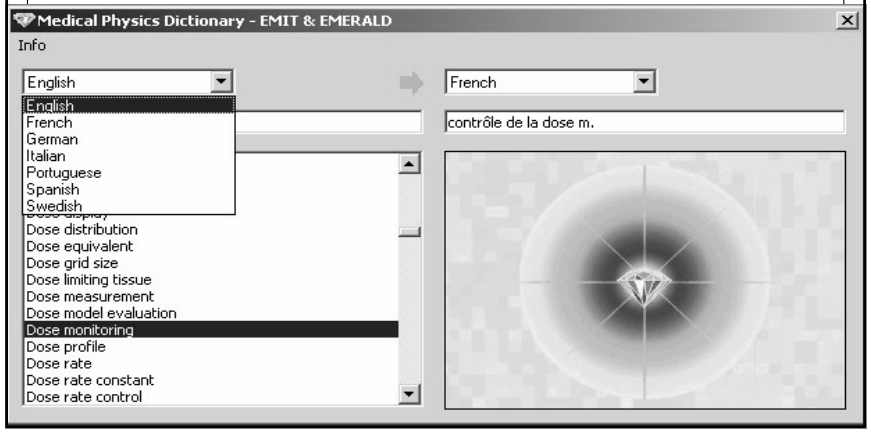
-99% are "browsing" the CD

…perhaps this will change in time

New Medical Physics Dictionary (covering both EMERALD and EMIT)

Translates terms (approx. 3500) to/from 9 languages

www.emitdictionary.co.uk



EMIT modules on MRI and U/S Imaging (2 CDs for MRI):

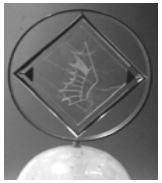
- Text pages (Workbooks+Guide, all translated) - 1300 pages

- Image Database volume - 1800 images (165 MB);

- e-books volume (text+images+captions) - 13500 files (210 MB)

-Overall volume of EMERALD + EMIT – approx. 950 MB

- Time for development ~ 10 years



EMERALD II and EMIT Project Consortia (1999-2004)

EMERALD - European Medical Radiation Learning Development – Internet Issue (Florence, 2000)

EMIT - European Medical Imaging Technology Training (Paris, 2003)

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EMITEL project for Multilingual Dictionary and e-Encyclopaedia for Medical Imaging Technology

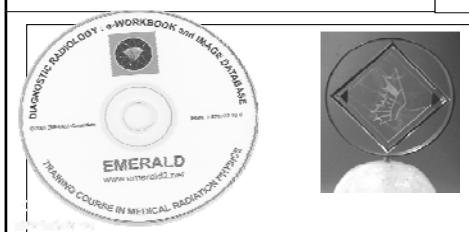
www.emerald2.eu

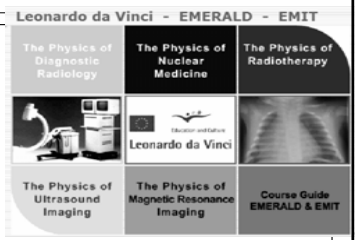
European Medical Imaging Technology
e-Encyclopaedia for Lifelong Learning (EMITEL)
Pilot Project of EU Leonardo da Vinci Programme

The objective of the pilot project European Medical Imaging Technology e-Encyclopaedia for Lifelong Learning (EMITEL) is to develop an original e-learning tool, which will be used for lifelong/continuing learning/training of a wide range of specialists in Medical Physics and Engineering.

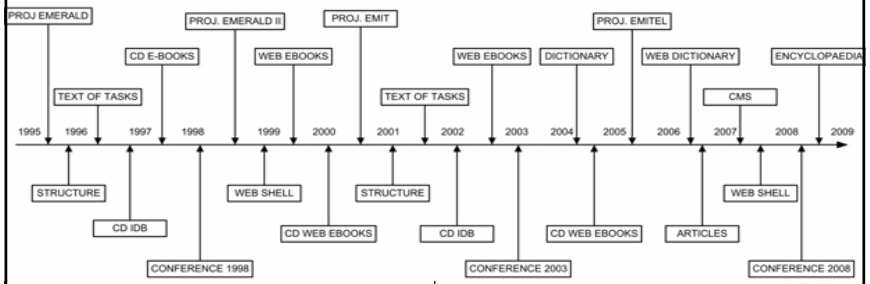
The tool will be linked to our existing EMERALD and EMIT materials and will additionally include Radiation Protection& Hospital Safety and Radiotherapy, thus forming a one-stop knowledge database for those who want to acquire a specific competence and for those who want to refresh their knowledge and to learn about the new developments in this technology and health &safety issues (namely–radiation protection).

The tool will be FREE and linked to our Digital Dictionary translating terms to/from any of its >20 languages (with various alphabets).





Sequence of 8 International projects



Project Partners: Universities+Hospitals+Professional Organisation

-King's College London and King's College Hospital (UK)

-University of Lund and Lund University Hospital (Sweden)

-University of Florence (Italy) and AM Studio, Plovdiv (Bulgaria)

-IOMP as an international partner

Why emphasising Medical Imaging Technology:

-Takes substantial part of the Healthcare budget

-Requires well trained workforce, collaborating with medical staff

-One of the most innovative technologies at present

-The speed of development can create "age-related" CPD problems

-Inter-professional field which needs multi-layered education

European Medical Imaging Technology
e-Encyclopaedia for Lifelong Learning (EMITEL)

The encyclopaedic articles will cover:

- •Diagnostic Radiology
- •Nuclear Medicine
- •MR imaging
- •Radiation Protection and General
- •Radiotherapy
- •Ultrasound imaging

Some medical and general physics terms included.
It is planned to extend to other areas of medical physics in the future.

Funding and support:

EMIT is partially funded by the European Union under the Leonardo da Vinci Program

Contribution from all IOMP Societies and key professionals

All previous EMERALD and EMIT project materials included

EMITEL CONCEPTS:

-Filling an educational gap

-Educational value – is first priority

-Allow easy update of the materials

-Minimal learning curve for update

-Maximal life cycle of the product

-Supported by a large professional orgsanisation

-Include various imaging material, diagrams and examples

-Use of simple software without compromising the content

-Useful for a broad audience of colleagues (use of dictionary)

-Supported both for on-line and off-line use

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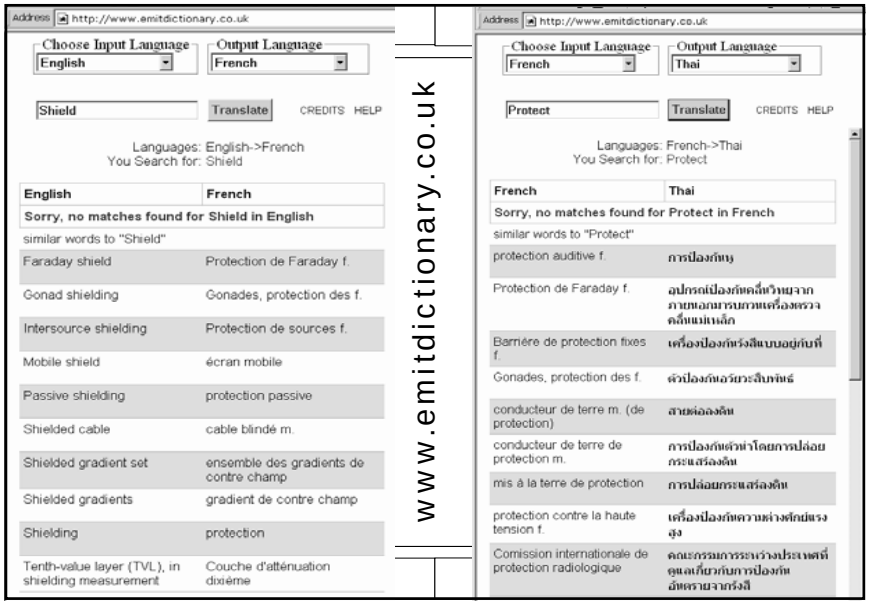

DICTIONARY TRANSLATIONS - CREDITS

Dictionary Coordinator: Slavik Tabakov

English Terms Collection: All EMIT Consortium members

Web Design: Magdalena Stoeva, Asen Cvetkov - AM Studio

German Translation: Markus Buchgeister, Gunther Helms, Stefan Delorme

French Translation: Alain Noel, Jean-Yves Giraud, Hélène Bouscayrol, Louis Blache

Swedish Translation: Inger-Lena Lamm, Monica Almquist, Ronnie Wirestam, Sven-Erik Strand, Bo-Anders Jonsson, Michael Ljungberg, Freddy Stahlberg, Thomas Jansson

Italian Translation: Franco Milano

Portuguese Translation: Ana Pascoal, Nuno Teixeira

Spanish Translation: Ignacio Hernand, Ana Paula Millán,

Alejandro García

Polish Translation: Marta Wasilewska-Radwanska, Katarzyna Grymek,

Hungarian translation: Paul Zarand, I Polgár, T. Porubszky, J. Martos, T. Daboczi, G. Sáfrány, F. Humml, J. Varga

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Aurel Popescu, Octavian Duliu, Raducu Popa, Constantin Milu

Thai Translation: Anchali Krisanachinda

Estonian translation: Kalju Meigas, Kalle Kepler, Jüri Vedru, Sigrid Rootsmaa

Lithuanian translation: Arunas Lukosevicius, Algidas Basevicius Dovile Serenaite

Turkish translation: Perihan Unak, Turgay Karalý, Fatma Yurt Lambrecht, F. Zumrut Biber Muftuler, Serap Teksoz

Arabic translation: Farida Bentayeb, Rachida El Meliani, Nagi Hussein, Ibrahim Elyasseery

Latvian Translation: Lada Bumbure, Marite Caikovska, Jurijs Dehtjars, Dzintars Emzins, Alexeis Katashevs, Sandiya Palude, Sergejs Popovs, Juris Rauzins

Czech Translation: Ivana Horakova, Anna Kindlova, Simona Trampotova, Daniela Kotalova, Václav Husak, Jaroslav Ptacek, Josef Pacholik

Greek Translation: Kaolis Demetrios, Kokona Georgiana, Menikou Georgios, Papaefstathiou Christos, Yianakkaras Charalambos, Charalambous Dora, Christodoulou Christodoulos, Christofides Stelios, Christodoulides George, Constantinou Demetra, Gerogiannis Yiannis, Heraklides Michalis, Kaplanis Prodromos, Mikelides Andreas, Papadopoulos Nicos, Sissou Anastasia, Spyrou Spyros

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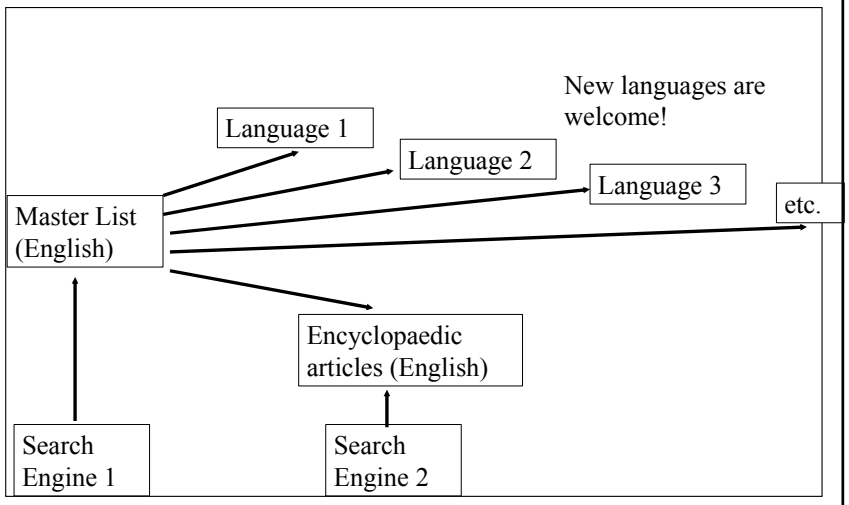

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EMITEL Articles:

-In English, but linked to the number of terms in the Dictionary and limited to c.500 words (large subject will be broken to small entries)

-Low knowledge level – MSc equivalent

-High knowledge level – unlimited (supported by “Related articles”) and including the newest developments

-Inclusion of supportive educational information (images, diagrams, examples, etc.), as well as links to existing web sites

-Inclusion of practical advice and figures (from Emerald, Emit and others) to create multi-layered educational approach

-Hyperlinked articles to entries with common meanings and separate articles for identical terms with different use

-Seven international working groups of contributors and referees

-System for future update and support of the web encyclopaedia

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Dedicated Content Management System (CMS) for upload to the Database

Additional short coverage of some medical terms alongside the medical physics and engineering.

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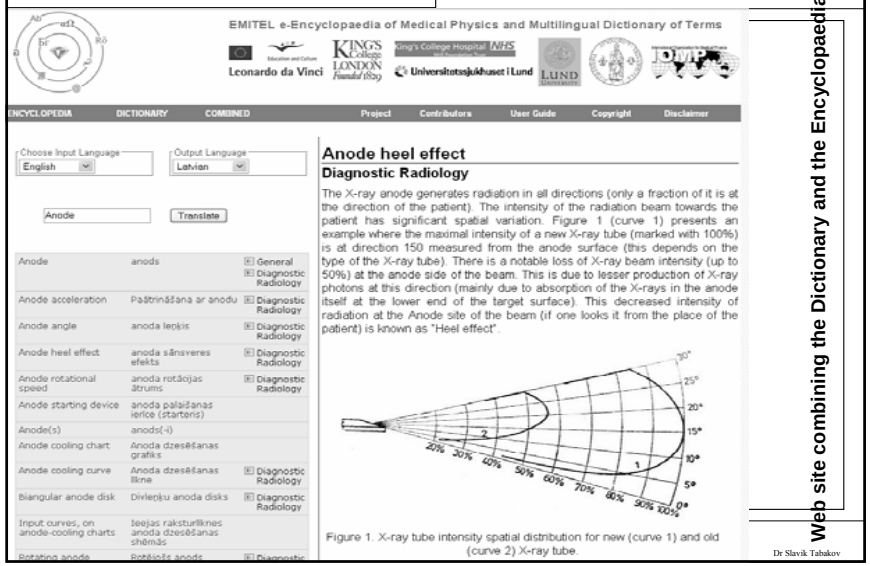

Web site combining the Dictionary and the Encyclopaedia

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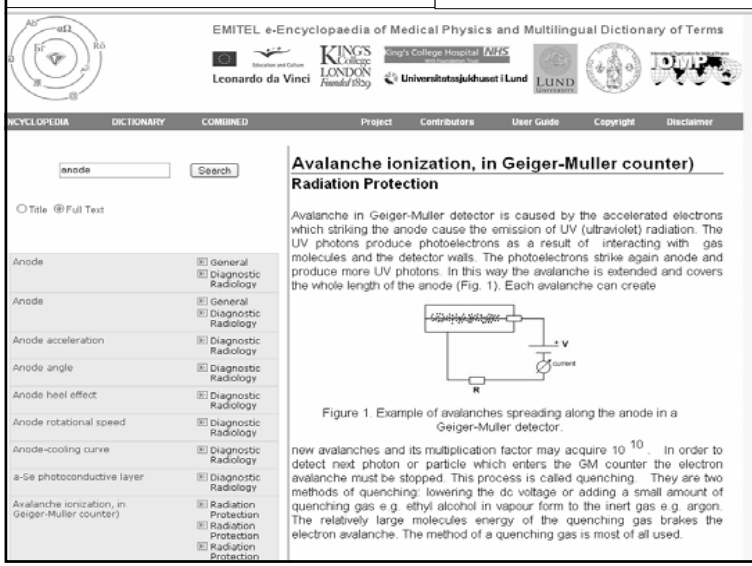

Two Search Engines – Multilingual and Full text search (inside article text)

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Next Steps in EMITEL Project

- Continue writing articles
- International Refereeing - Started
- International Conference EMITEL
- EMITEL Web launch – May 2009
- Major Launch at: World Congress on Medical Physics and Biomedical Engineering WC2009, Munich
- Continuing update with active volunteering involvement through International Work Group, supported by IOMP
- Printed version – 2010-2011

All members of the EMITEL Consortium gratefully acknowledge funding by the EU Leonardo Programme and the support of their own Institutions.
We would like to thank colleagues who volunteered to take part in EMITEL and those who would consider participating in this large international project.

A Model Curriculum for Medical Physics Education

A project of the International Organisation for Medical Physics

Reported by: Slavik Tabakov
Project Leader, IOMP ETC
slavik.tabakov@kcla.c.uk

International Organization for Medical Physics
IOMP

PROJECT OUTLINE

Entry requirements : undergraduate degree based on min. 3 years University education in Physics, Engineering or relevant.

Medical Physics course - Post-graduate programme (MSc) approx. 1 to 2 years

- Educational structure and teaching delivery
- MSc model curriculum and assessment
- Teaching materials (including IOMP supported Web resources)
- International pool of experts (faculty)
- MSc programme IOMP Validation
- ETC new sub-committee (Validation and Accreditation Panel)

Structure of the MSc programme

- Distributed delivery (classical)
  - Requires large faculty, problematic if lecturer is absent
  - Often preferred by students (easy to follow the material)
- Modular delivery
  - Suitable arrangement for the faculty (allows external lecturers)
  - Allows easier understanding of complex material
  - Problematic if student is absent
- Mixed delivery
  - local plus external lecturers
  - basis and optional courses (modules)

Draft MSc model curriculum structure

1. Taught element: overall contact and self-reading hours

Contact hours (min 250h)

Self-reading

~1100-1300 hours

2. Research element: MSc project and dissertation level/volume

Individual + tuition

~500-600 student hours

Overall ~ 1700-1900h

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Taught element - draft MSc curriculum

Pre-course preparatory modules (Physics, Engineering)

Basis of Human **Physiology** and Anatomy	~10%
Basis of Radiation Physics	~10%
Research Methods	~10%
Radiation Protection and Hospital Safety	~10%
Medical Imaging physics and equipment 1 non-ionizing radiation (MRI, US)	~10%
Medical Imaging physics and equipment 2 ionizing radiation (DR, NM)	~10%
Radiotherapy Physics	~15%

Other optional modules (Management, IT, etc.)

MSc project **~25%**

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M-level (MSc) project/thesis

- Suitable subject (a list of existing subjects and sample thesis from various Universities can help this issue);
- Form "Paper-like" (Introduction and Aim; Literature Survey; Material and Methods; Results and Discussion; Conclusion; References);
- Indicative volume ~10,000-15,000 words (50-70 pages), but the main guide should be the type and quality of research;
- Indicative time for development ~min 500-700 hours (max 6 months Full Time);
- Assessment – thesis marking model + oral examination

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Future project development

-ETC Working Group (future Validation and Accreditation Panel):

S.Tabakov, A Krisanachinda, P Sprawls, E Podgorsak, C Lewis.

- Detailed Curriculum for a number of subjects (as a sample);
- Teaching materials assessment/selection;
- Creating a pool of experts (external faculty);
- Criteria for Course Validation;
- Funding allocation;
- Introduction by WC2009
- Discussion at various stages (alongside the EMITEL project);

Dr Slavik Tabakov