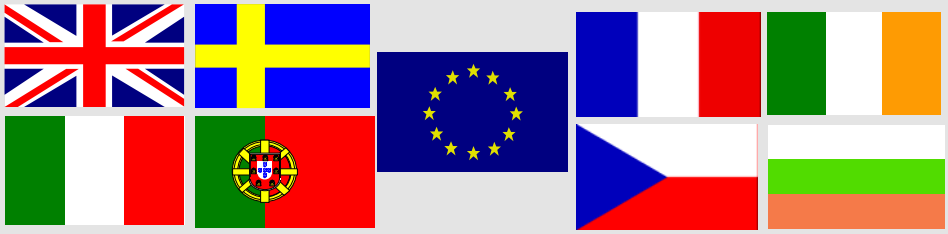
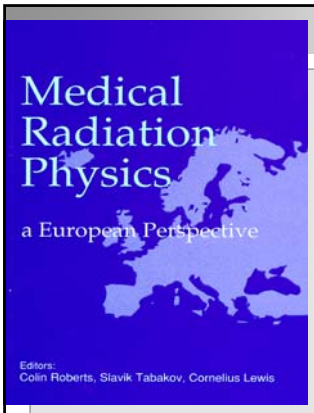
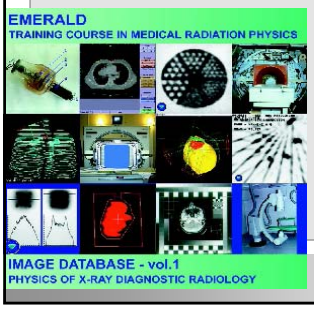
MEDICAL RADIATION PHYSICS TRAINING WITH EMERALD and EMIT e-LEARNING MATERIALS

EMERALD and EMIT Consortia



EU Leonardo Project: European Medical Radiation Learning Development - Internet Issue





- 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.

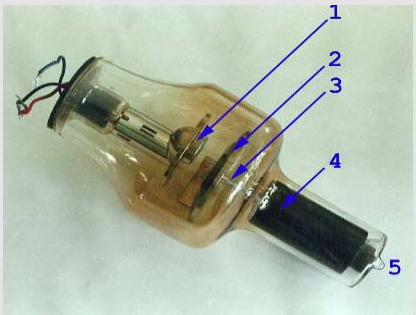

2.The easy upgrade of e-L materials is an advantage, imperative for dynamic profession as Medical Engineering and Medical Physics.


Quality Control based on EMERALD X-ray Diagnostic Radiology training

Dr Slavik Tabakov
EMERALD Consortium, King's College London




Objective of Project EMERALD



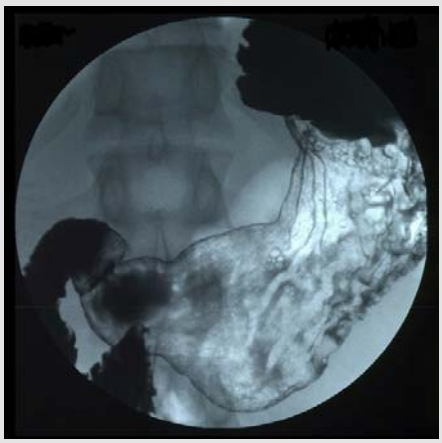
Development of 3 common training modules in:

- 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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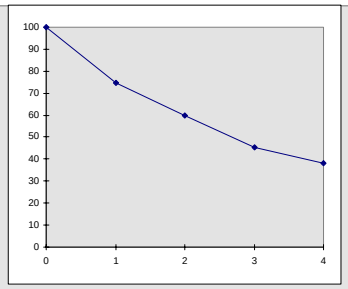

Student Workbook

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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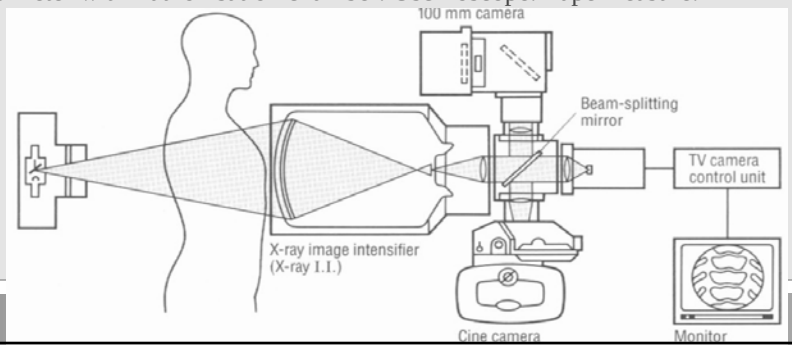
Task Performance - Example 1 (2 days) 1

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

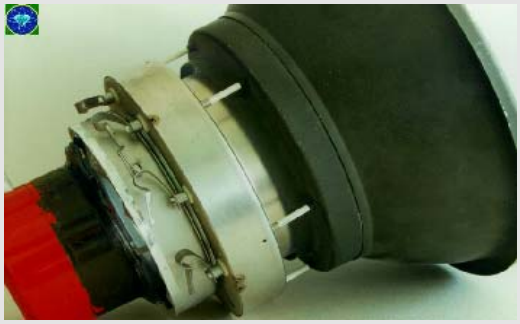
Familiarisation with Block Diagrams of Fluoroscopic X-ray Equipment Study the block diagram of the Image Intensifier and identify it's parts.

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]

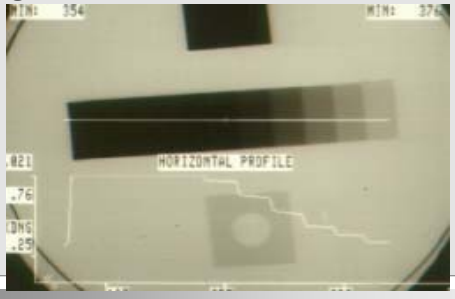
Row (for TO10)	**Detail size** diameter		Detail number and **limiting contrast** with II field size (using Leeds Test Object TO10 with ABC system on)				
	[mm]	II image field = 30cm		II image field = 23cm		II image field = 17cm	
		80kV	0.2mA	80kV	0.6mA	80kV	1.2mA
A	**11.1**	6	**0.032**	6	**0.032**	6	**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**

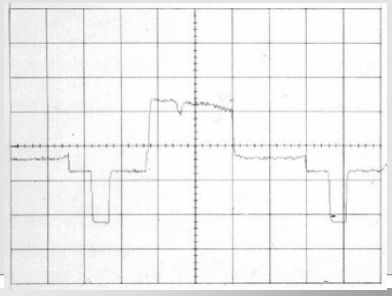
4

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.





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5

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		

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Results

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

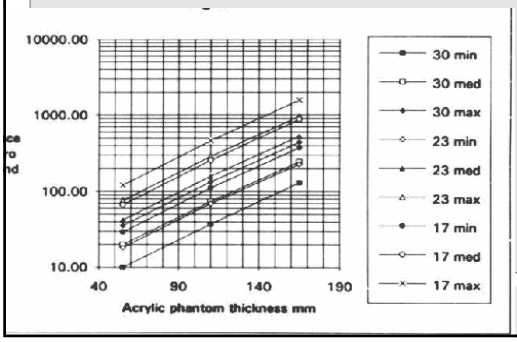
8.1.5.2 Compare the Contrast-detail Characteristic with the Normal values given in the Reference (IPSM Report 32).

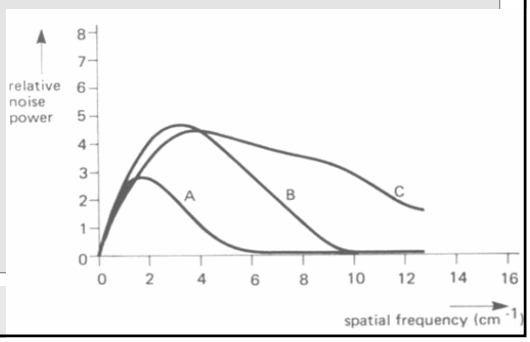
Compare and comment on the two different Contrast-detail functions.

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

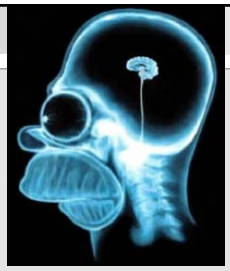
Observe the plotted contrast-detail functions and comment on their dependence on II image field size.

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).

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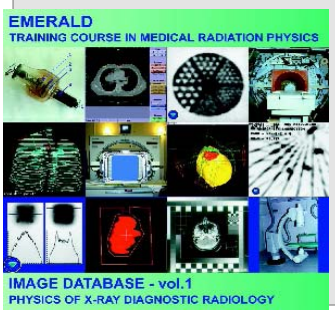
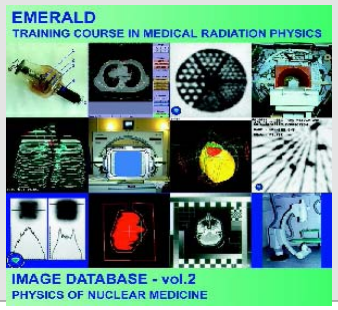
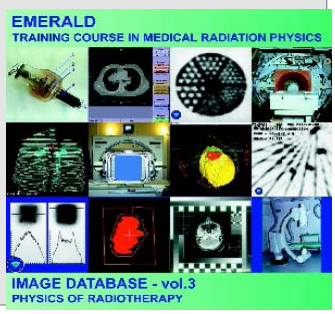
Image Database in 3 volumes (3 CD-ROMs) : DR, NM, RT

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)







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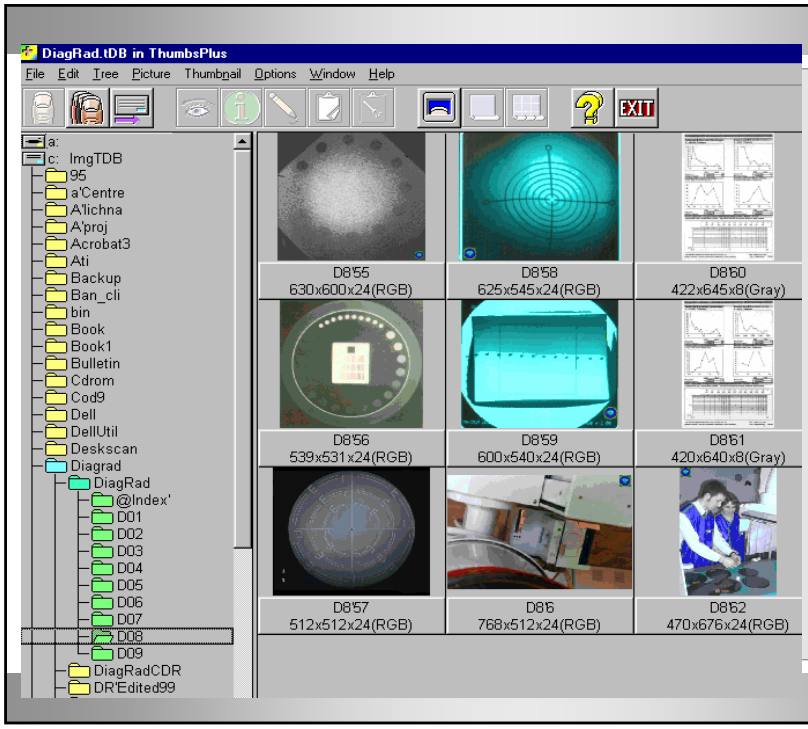


Image Database functions

Browsing

Slides (120x160)

Image Info

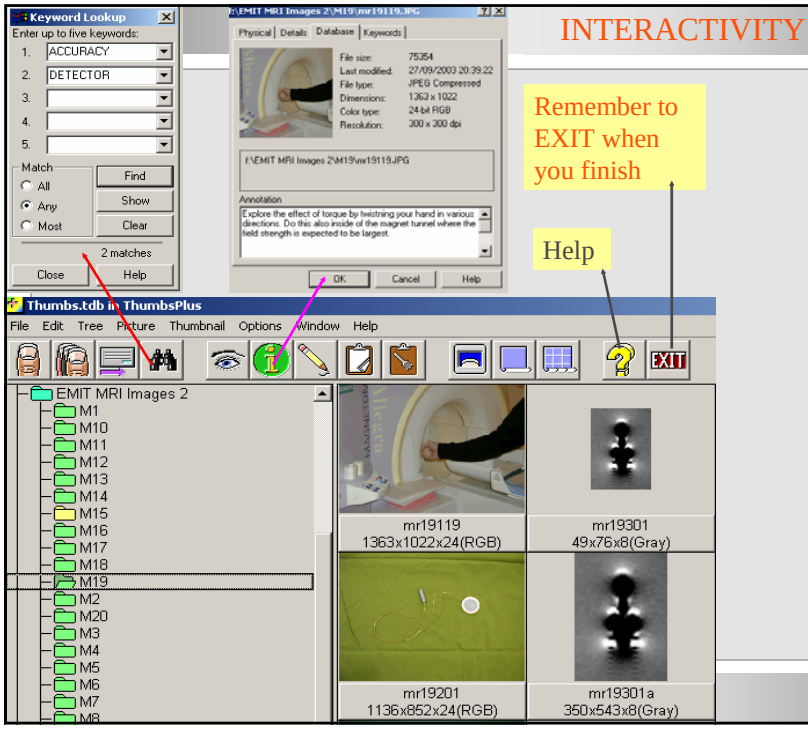
Annotations

Keywords

Boolean search

Sorting

Visualisation (up to 20 images)



INTERACTIVITY

Remember to EXIT when you finish

Help

Image Database functions

Browsing

Slides (120x160)

Image Info

Annotations

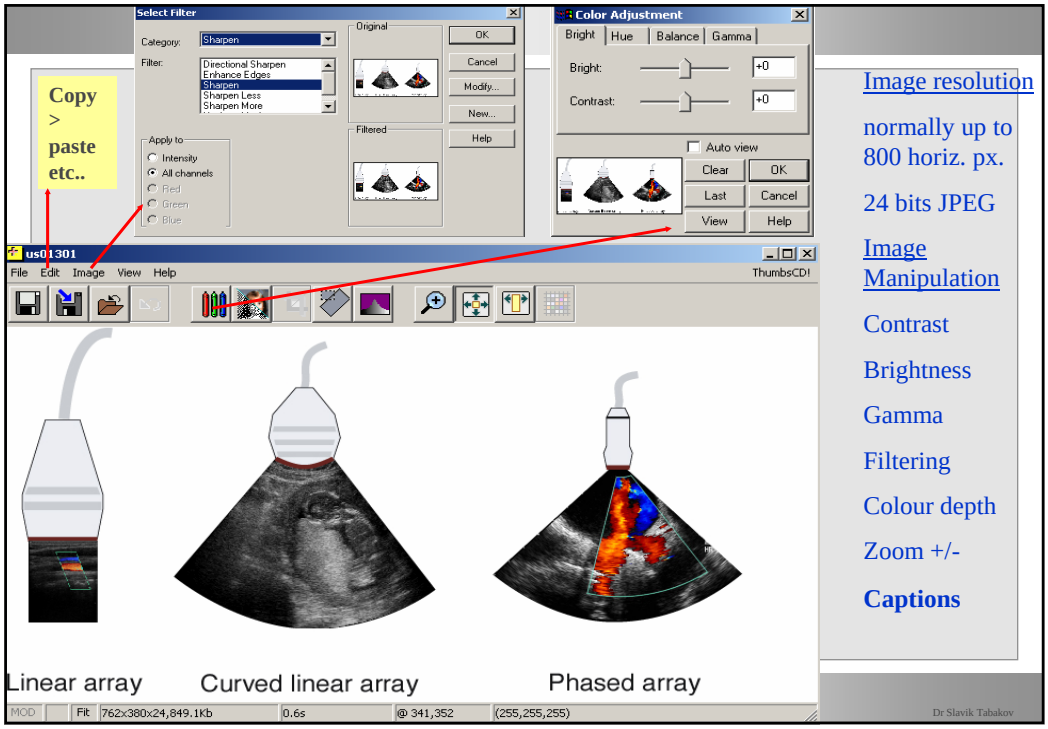
Keywords

Boolean search

Sorting

Visualisation (up to 20 images)

Each CD includes a freeware Thumbs browser



[Image resolution](#)

normally up to 800 horiz. px.

24 bits JPEG

[Image Manipulation](#)

Contrast

Brightness

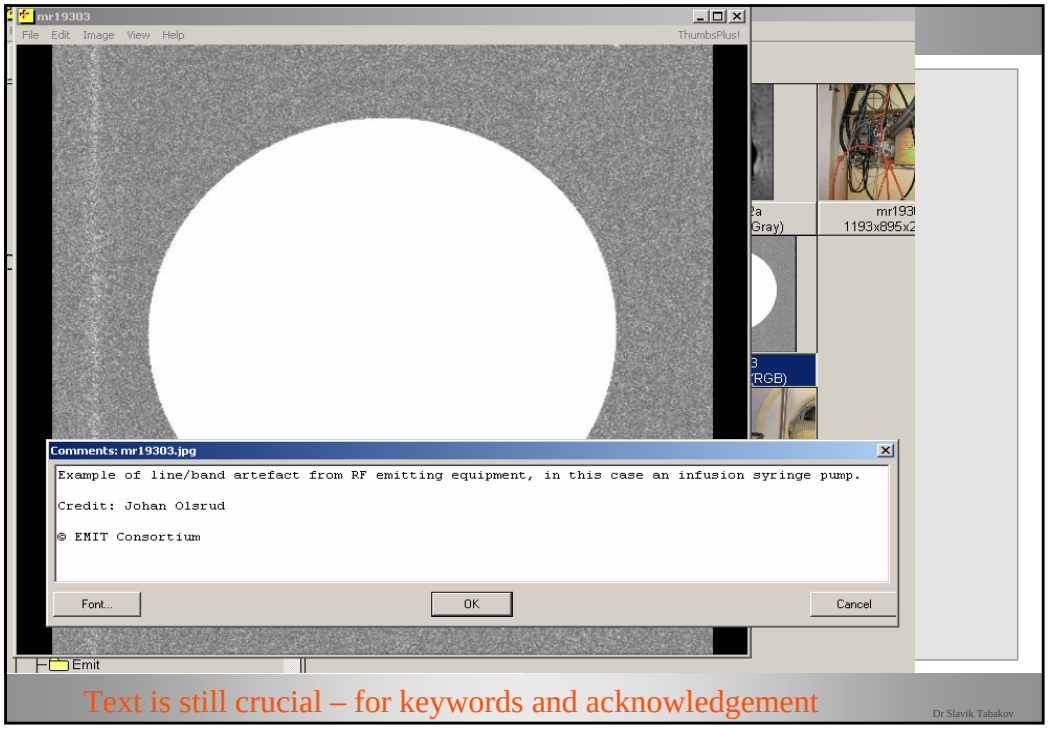
Gamma

Filtering

Colour depth

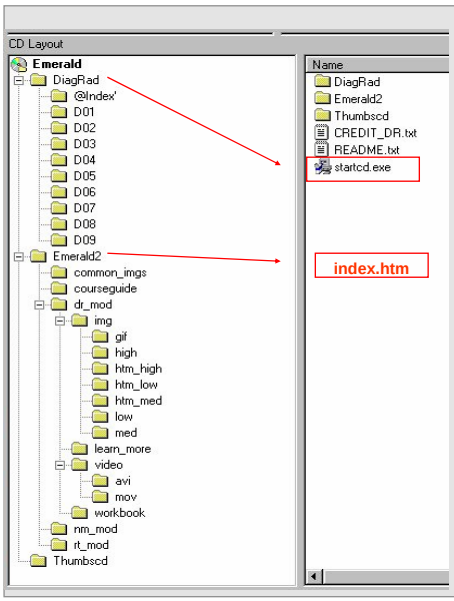
Zoom +/-

Captions



Text is still crucial – for keywords and acknowledgement

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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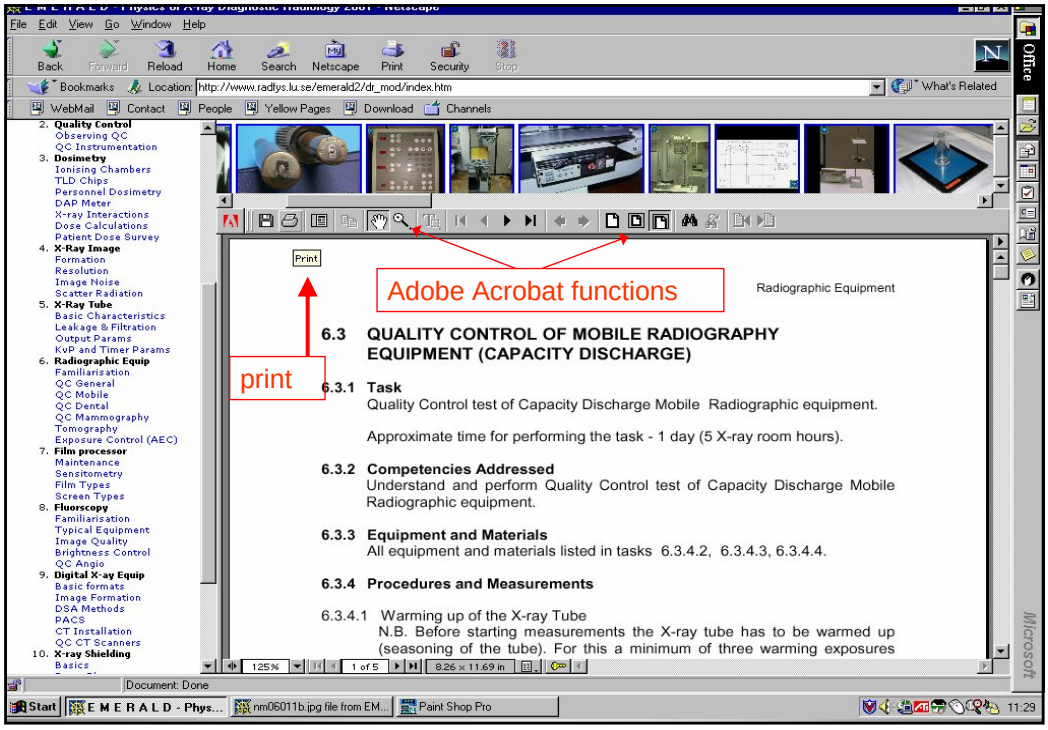
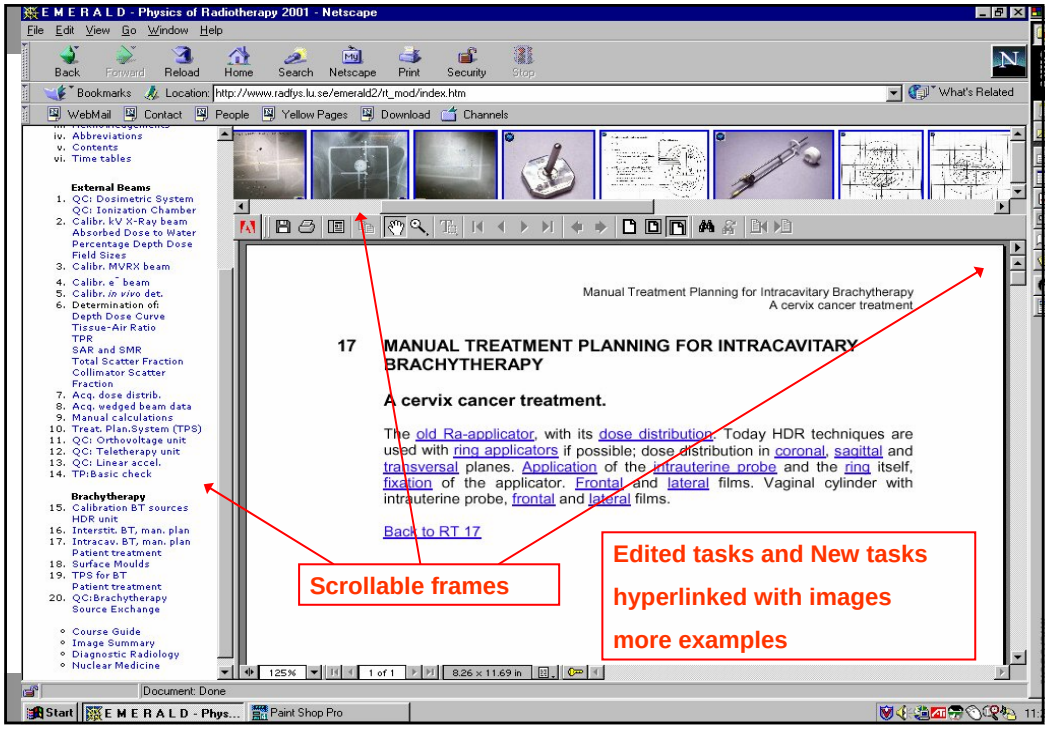
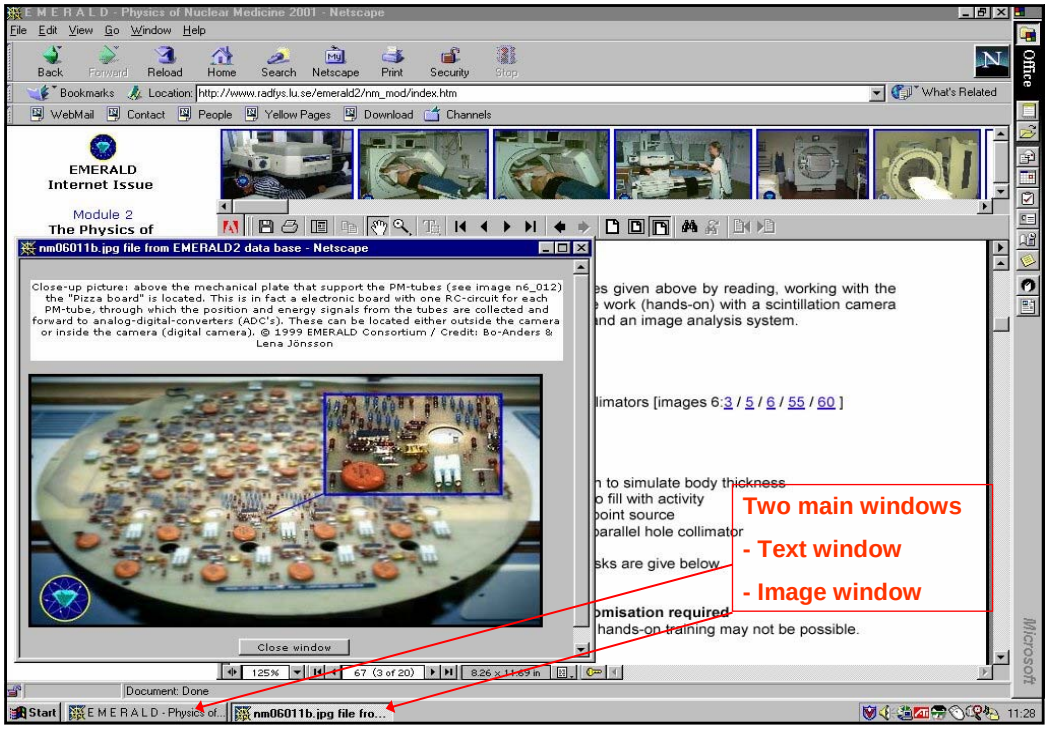
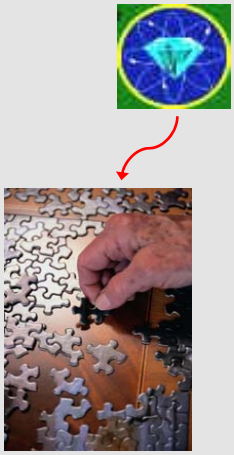



E M E R A L D - Physics of Radiotherapy 2001 - Netscape
Manual Treatment Planning for Intracavitary Brachytherapy
A cervix cancer treatment
17 MANUAL TREATMENT PLANNING FOR INTRACAVITARY BRACHYTHERAPY
A cervix cancer treatment.
Back to RT 17
Scrollable frames
Edited tasks and New tasks
hyperlinked with images
more examples


E M E R A L D - Physics of Nuclear Medicine 2001 - Netscape
EMERALD
Internet Issue
Module 2
The Physics of
nm06011b.jpg file from EMERALD2 data base - Netscape
Close-up picture: above the mechanical plate that support the PM-tubes (see image n6_012) the "Pizza board" is located. This is in fact a electronic board with one RC-circuit for each PM-tube, through which the position and energy signals from the tubes are collected and forward to analog-digital-converters (ADC's). These can be located either outside the camera or inside the camera (digital camera). © 1999 EMERALD Consortium / Credit: Bo-Anders & Lena Jönsson
Close window
Two main windows
- Text window
- Image window



- 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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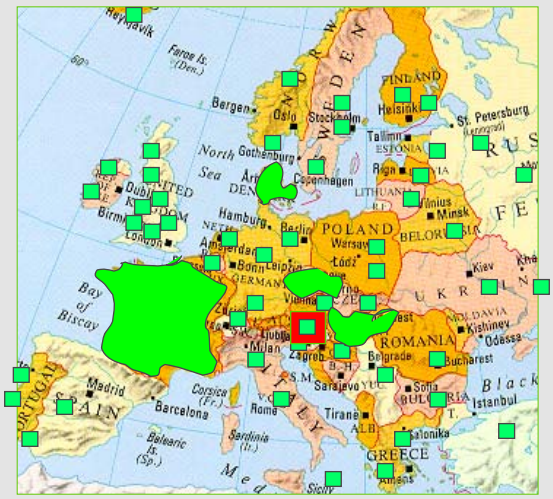
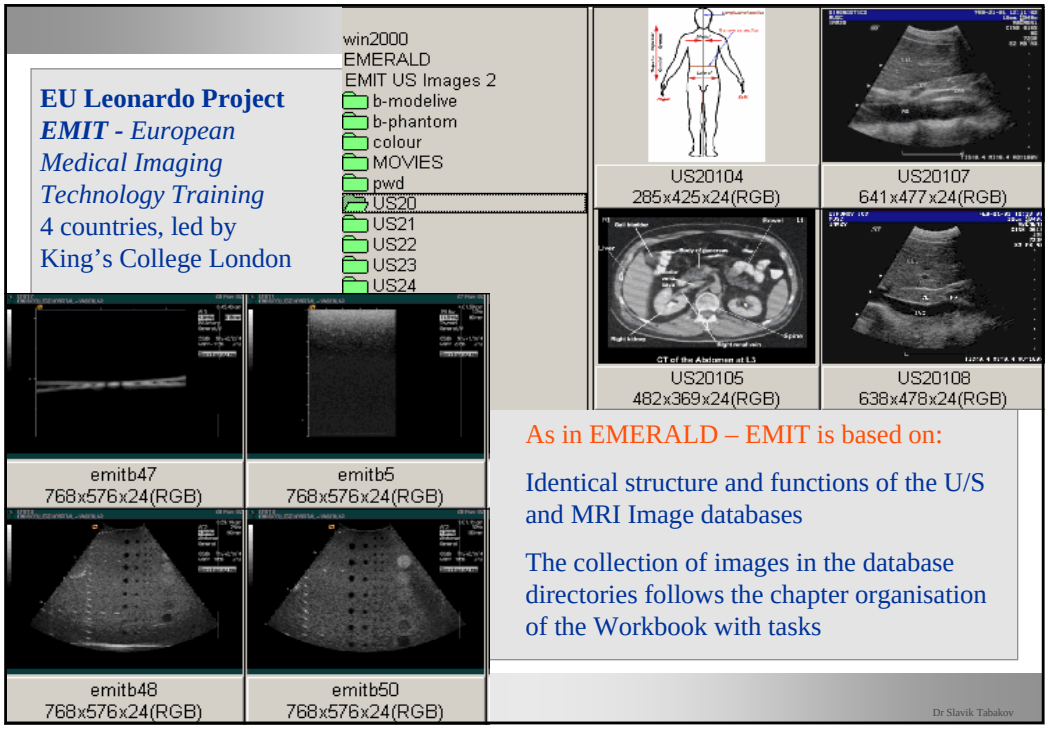
Project Emerald - Internet Issue (EMERALD II)



- EMERALD materials&CDs used in 46 countries
- Dedicated Internet Site for e-learning and training www.radfys.lu.se/emerald2
- A new EU Leonardo project EMIT – to develop training Ultrasound and Magnetic Resonance Imaging

http://www.emerald2.net


EU Leonardo Project
EMIT - European Medical Imaging Technology Training
4 countries, led by King's College London
win2000
EMERALD
EMIT US Images 2
b-modelive
b-phantom
colour
MOVIES
pwd
US20
US21
US22
US23
US24
US20104
285x425x24(RGB)
US20107
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US20105
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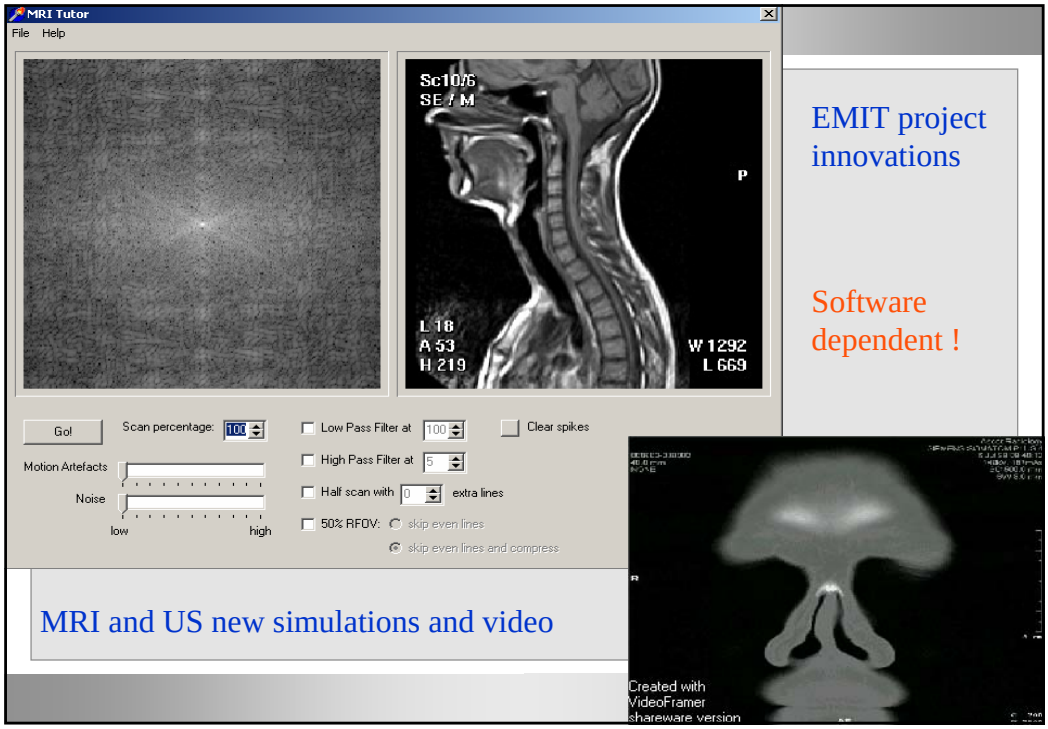
US20108
638x478x24(RGB)
emitb47
768x576x24(RGB)
emitb5
768x576x24(RGB)
emitb48
768x576x24(RGB)
emitb50
768x576x24(RGB)
As in EMERALD – EMIT is based on:
Identical structure and functions of the U/S and MRI Image databases
The collection of images in the database directories follows the chapter organisation of the Workbook with tasks
Dr Slavik Tabakov


MRI Tutor
File Help
Sc10/6
SE / M
P
L 18
A 53
H 219
W 1292
L 669
Go!
Scan percentage:
100
Low Pass Filter at
High Pass Filter at
Half scan with
extra lines
50% RFOV:
skip even lines
skip even lines and compress
Clear spikes
Motion Artefacts
Noise
low
high
EMIT project innovations
Software dependent !
MRI and US new simulations and video
Created with VideoFramer shareware version

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

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

Dr Slavik Tabakov

Leonardo da Vinci

EU2004.NL

Leonardo da Vinci Awards 2004

MAASTRICHT, 15 December 2004

Awarded to

"E-learning develops medical-imaging skills"

developed by **EMIT Consortium** - *King's College London and King's College Hospital NHS Trust - Dept. of Medical Engineering and Physics (UK)*

in partnership with University of Lund and Lund University Hospital (S), University of Florence (I), King's College London - GKTSM and King's College Hospital NHS Trust (UK), Hôpital Albert Michallon, Grenoble (F), European Federation of Organisations for Medical Physics - EFOMP (F).

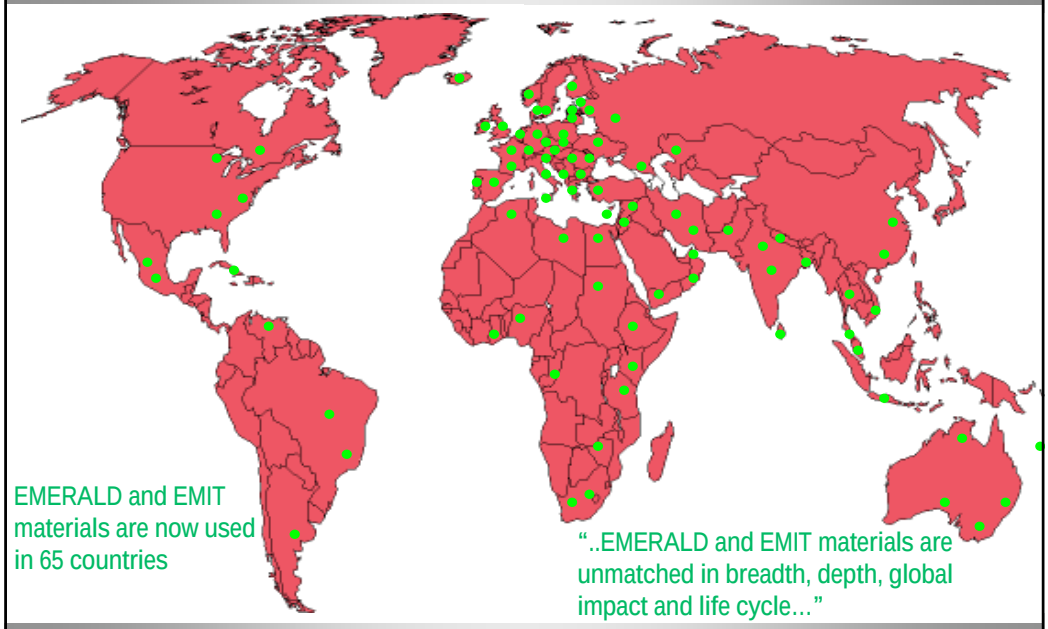
for quality and innovation in Vocational and Educational Training.

Ján Figeľ,

Member of the European Commission responsible for Education, Training, Culture and Multilingualism

Dr Slavik Tabakov

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…"

Dr Slavik Tabakov

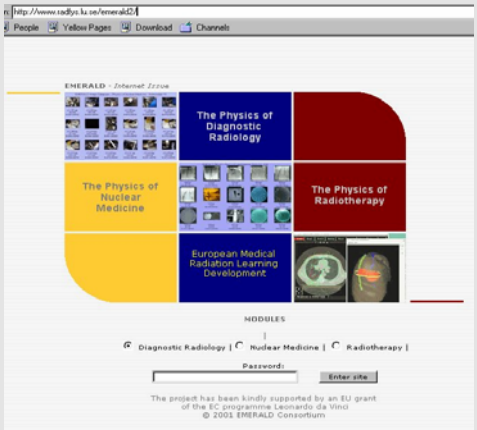
International Medical Physics College at ICTP, Trieste, Italy

- IAEA - IOMP - EFOMP - AAPM

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

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

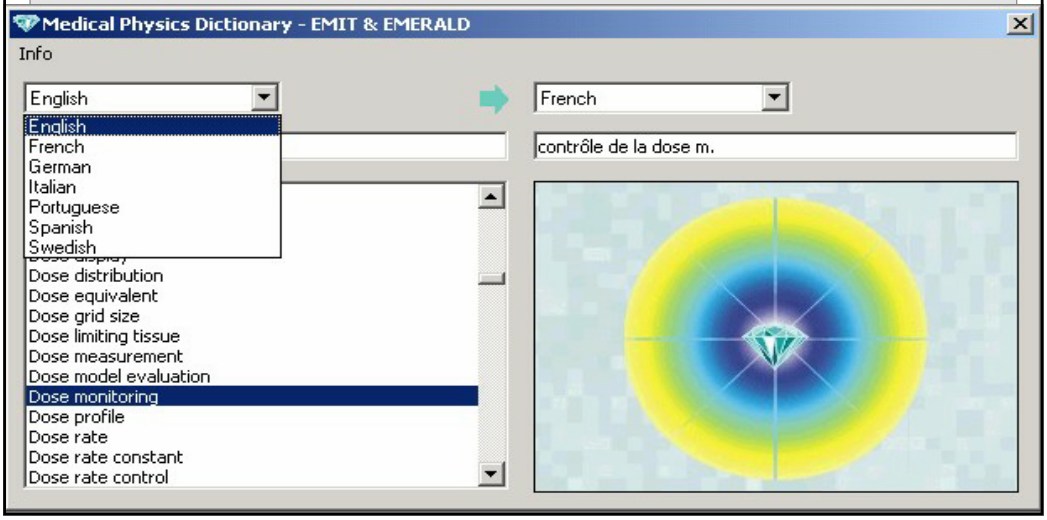
-99% are "browsing" the CD

…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)

Dr Slavik Tabakov

Address http://www.emitdictionary.co.uk

Choose Input Language: English | Output Language: French

Shield | Translate | CREDITS HELP

Languages: English->French
You Search for: Shield

English	French
Sorry, no matches found for Shield in English	
similar words to "Shield"	
Faraday shield	Protection de Faraday f.
Gonad shielding	Gonades, protection des f.
Intersource shielding	Protection de sources f.
Mobile shield	écran mobile
Passive shielding	protection passive
Shielded cable	cable blindé m.
Shielded gradient set	ensemble des gradients de contre champ
Shielded gradients	gradient de contre champ
Shielding	protection
Tenth-value layer (TVL), in shielding measurement	Couche d'atténuation dixième

www.emitdictionary.co.uk

Address http://www.emitdictionary.co.uk

Choose Input Language: French | Output Language: Thai

Protect | Translate | CREDITS HELP

Languages: French->Thai
You Search for: Protect

French	Thai
Sorry, no matches found for Protect in French	
similar words to "Protect"	
protection auditive f.	การป้องกันหู
Protection de Faraday f.	อุปกรณ์ป้องกันคลื่นวิทยุจากภายนอกมารบกวนเครื่องตรวจคลื่นแม่เหล็ก
Barrière de protection fixes f.	เครื่องป้องกันรั้งลีแบบอยู่กับที่
Gonades, protection des f.	ตัวป้องกันอวัยวะสืบพันธ์
conducteur de terre m. (de protection)	สายต่อลงดิน
conducteur de terre de protection m.	การป้องกันตัวท่าโดยการปล่อยกระแสร์ลงดิน
mis à la terre de protection	การปล่อยกระแสร์ลงดิน
protection contre la haute tension f.	เครื่องป้องกันความต่างศักย์แรงสูง
Comission internationale de protection radiologique	คณะกรรมการระหว่างประเทศที่ดูแลเกี่ยวกับการป้องกันอันตรายจากรังสี

WELCOME TO NEW LANGUAGES !

Dr Slavik Tabakov