MEDICAL RADIATION PHYSICS TRAINING WITH EMERALD ELECTRONIC TRAINING MATERIALS

EMERALD Consortium, King's College London

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

Quality Control based on EMERALD X-ray Diagnostic Radiology training

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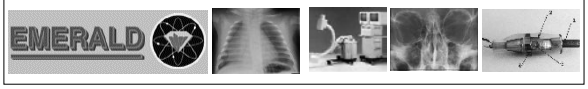
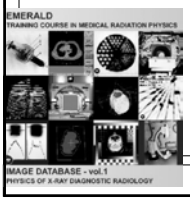
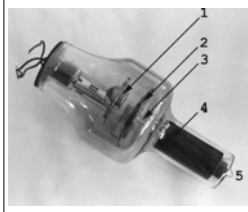




- EuroConference on Medical Physics & Engineering Education - *Budapest'94*
- Book with Education and Training Programmes (30 European countries)
- Inter-University MP Centre and MSc course - Plovdiv, BG (Tempus project)
- Joint Baltic MSc course (Tempus proj.)
- Project EMERALD (3 books and 3 CD)
- EuroConference on Medical Physics Training (26 countries) - *Triest'98*
- Emerald Training Seminars in Europe
- EMERALD e-learning (3 training CDs)

Objective of Project EMERALD



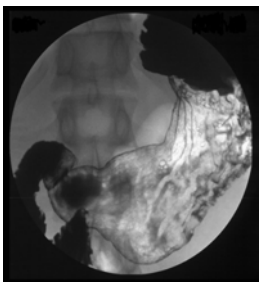
Development of 3 common training modules in:

- 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

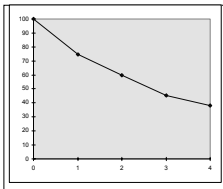


Each module incorporates:

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

Further developments:

- EMERALD Multimedia.



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

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*

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

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

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;

Basic structure of one task

Number of tasks:

DR - 44 tasks

NM - 46 tasks

RT - 48 tasks

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)

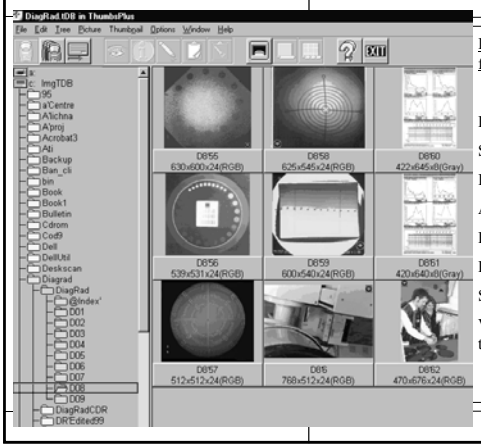


Image Database functions

Browsing

Slides (120x160)

Image Info

Annotations

Keywords

Boolean search

Sorting

Visualisation (up to 20 images)

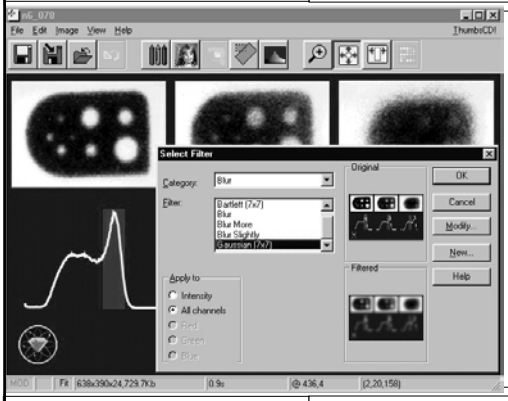


Image resolution

normally up to 800 horiz. px.

24 bits JPEG

Image Manipulation

Contrast

Brightness

Gamma

Filtering

Colour depth

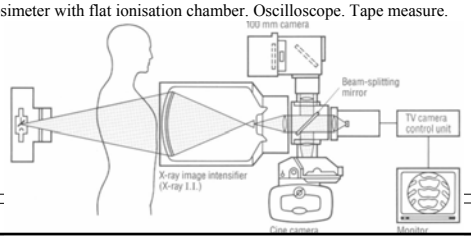
Zoom +/-

Captions

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.



8.1.4 Procedures and Measurements

Familiarisation with Block Diagrams of Fluoroscopic X-ray Equipment

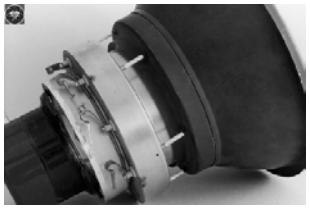
Study the block diagram of the Image Intensifier and identify it's parts.

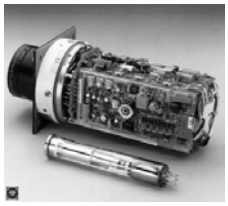
Comment on different types of luminifors used in II.

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 :

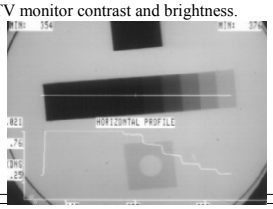
[min. visible contrast] as a function of the [corresponding detail size]

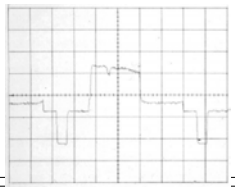
Row (for TO10)	**Detail size** diameter		Detail number and **limiting contrast** with II field size (using Leeds Test Object TO10 with ABC system on)					
	[mm]	II image field = 30cm		II image field = 23cm		II image field = 17cm	
		80kV	0.2mA	80kV	0.6mA	80kV	1.2mA
A	**11.1**	6	**0.032**	6	**0.032**	6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

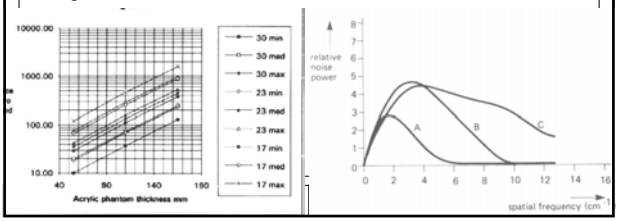
8.1.5.2 Compare the Contrast-detail Characteristic with the Normal values given in the Reference (IPSM Report 32).

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

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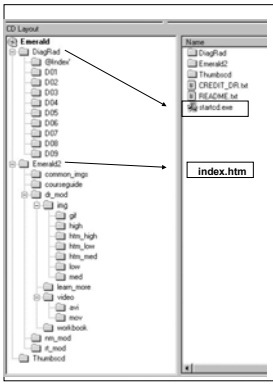
Verification (*Signature and date by the trainer*)

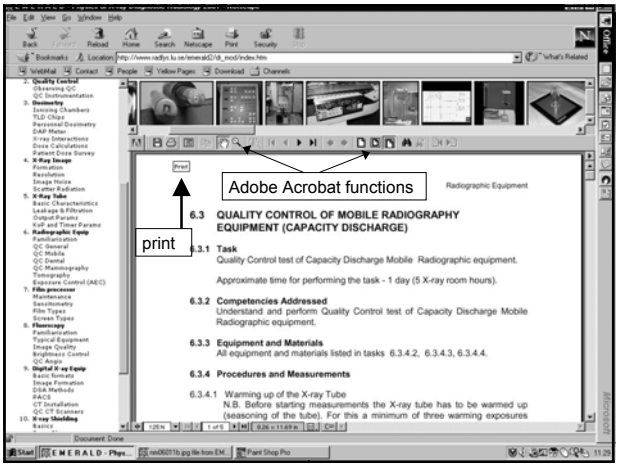
EMERALD CD-ROMS

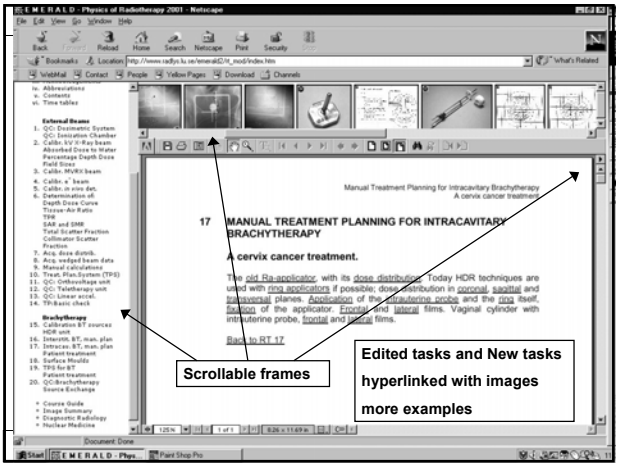


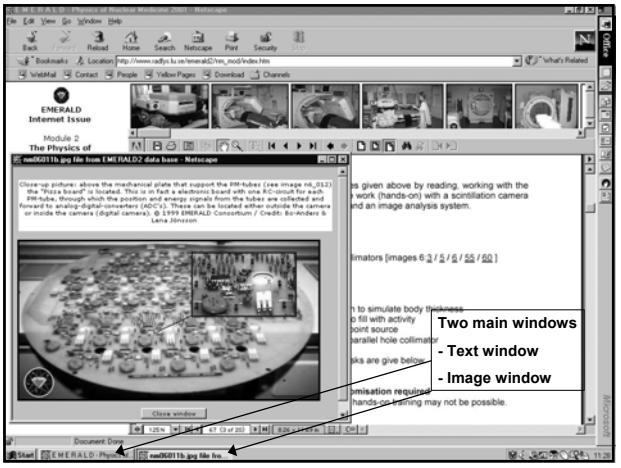
- Image Database (as before)
- E2 Internet site with:
  - * Navigational structure
  - * Text of tasks (from Workbooks)
  - * Images from database (smaller)
  - * Hyperlinks text>image
  - * Course Guide

Necessities (min):

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





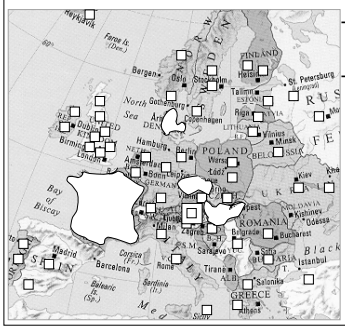


- EMERALD is a resource, which could support various training schemes, and not a replacement of these. Its greatest value is the flexibility offered - from one side the training tasks can be used *'as is'*, building to a full training package. Alternatively they can be used to substitute existing training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

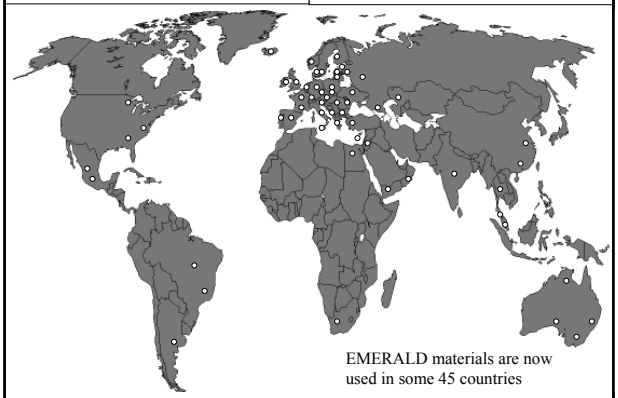
Project Emerald - Internet Issue (EMERALD II)



- 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

EMERALD around the world



EMERALD materials are now used in some 45 countries

EMERALD II Consortium

EU Leonardo da Vinci Project EMIT

European Medical Imaging Technology Training