

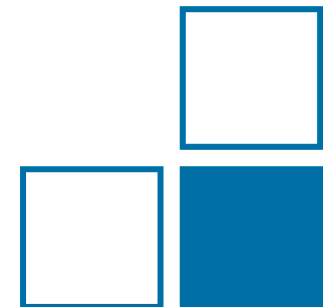


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Medical fields: user perspective about calibration in diagnostic radiology - X-ray multimeters Example: mammography

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PTB Dosimeters used in diagnostic radiology

Dosimeters used for
commissioning and quality control of medical imaging devices

Ionization chambers
working principal well known
low energy dependance of the response
require electrometer, temperature and pressure measurement
require time to equilibrate
determine dose/dose rate



X-ray Multimeters (XMMs)
directly ready to measure
some models can not be read directly and need to be connected to a computer
internal software requires selection of the modality radiology/mammography
for mammography: most XMM require selection of anode/filter combination used



The need of calibration in the clinic



Legal requirement in many countries – responsibility of the medical physicist



Links the reading of the dosimeter with international standards to ensure consistent and comparable data (traceability)



Direct impact on patient safety

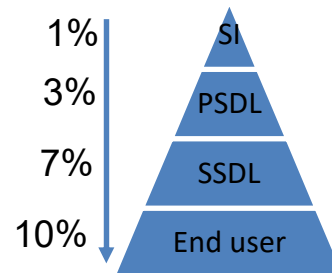
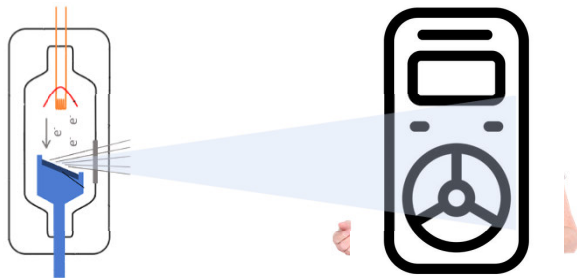


Questions asked:

- Use of XMMs for an anode/filter combination which are included in the software?
- Interpolation between anode/filter combinations?

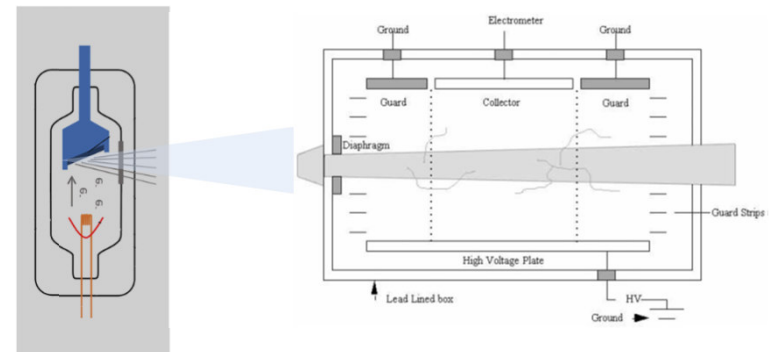
Quality control in the clinic

- Decision: pass / fail
- reference values specified during the acceptance test quality control guidelines



Calibration - Quality control of the dosimeter

- Challenge to cover all conditions in the clinic
- Use of reference radiation qualities: RQM, additional anode/filter combinations



Traceability in Medical X-ray Imaging

tramexi.com

Objectives:

- Update **reference radiation** qualities – input for future revisions of IEC 61267 and IAEA TRS 457
- **Evaluation of the performance** of different dosimeter types using calibration and clinical exposure conditions
- Definition of **harmonized calibration procedures for XMMs** to enable an unbroken traceability chain for relevant clinical parameters
- **Validation** of established and updated calibration procedures and related uncertainties
- Incorporation of the new findings in **future standards**

Example: Breast Imaging

Challenges

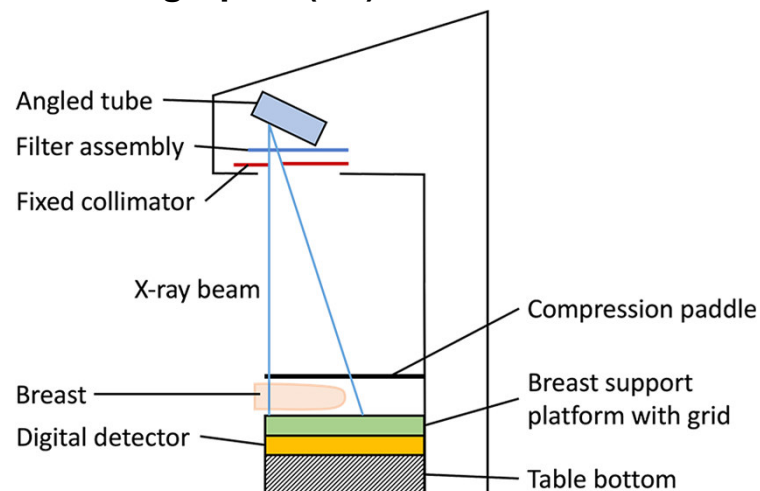
Used for screening and diagnosis

Highest quality standards for screening

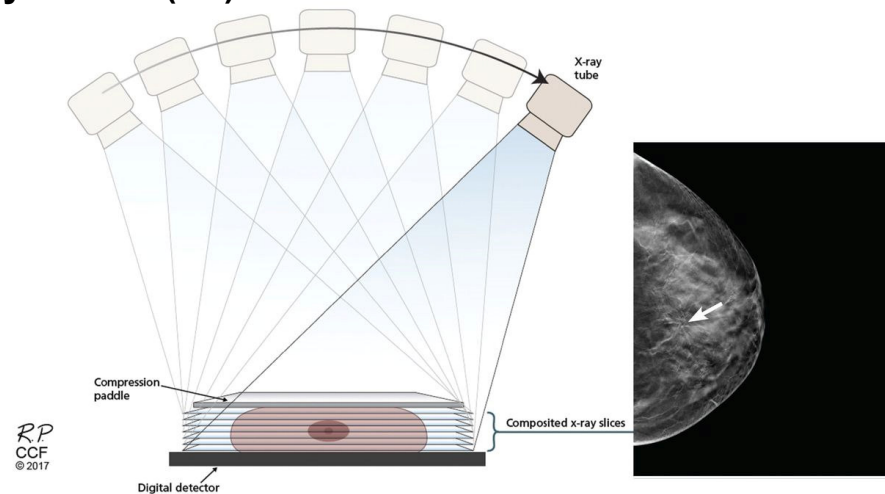
Large range of anode/filter/tube voltage combinations used

Most XMM require selection of anode/filter combination used before the measurement

Mammographie (2D)



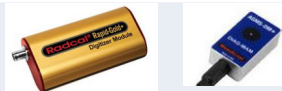
Tomosynthesis (3D)



PTB Measurement Scenarios

	Clinic	Calibration
Distance	60-65 cm	100 cm
Puls length	~ 0,2 s (T), up to ~ 2 s (M)	60 s (IC), 20 s (XMM)
Dose rate	specified by the system ~ 0,5 mGy/s (T) up to ~ 14 mGy/s (M)	controllable but limited < 1 mGy/s for calibration protocol
Compression paddle	in the beam material/thickness unknown	No
Anode angle	small focus: 10° large focus 16°-22,5°	18°-26°
Radiation Qualities	Mo 30µm Mo Mo 25µm Rh Rh 25µmRh Rh 30µmAg W 50µm Rh W 0,7mm Al W 50µm Ag W 1,0mm Al W 75µm Ag W 60µm Rh	IEC 61267 RQR-M Mo 30µm Mo W-tube most common in calibration laboratories

PTB X-ray multimeters tested

X-ray multimeters		Max deviation stated in the manual	
		Air kerma	HVL
	IBA MagicMax, XM Multi Detector [IBA]	$\pm 5\%$	$\pm 10\%$ or 0,05 mm Al
	Radcal Rapid Gold+ Digitizer, AGMS-DM+ [RRG]	$\pm 5\%$	$\pm 10\%$ or 0,05 mm Al
	RaySafe X2, MAM Detector [X2]	$\pm 5\%$	$\pm 5\%$
	RTI Piranha Multi [RTI]	$\pm 5\%$	$\pm 10\%$
	PTW NOMEX Dosemeter, Mulimeter [PTW]	$\pm 2,5\%$	$\pm 0,1$ mm Al

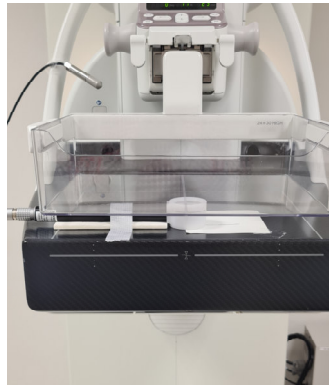
PTB Measurement protocol

Air kerma:

Radcal RC6M ionization chamber
Calibrated against the primary standard
Compression paddle in contact
Influence of the backscatter < 5 ‰

Half-value layer:

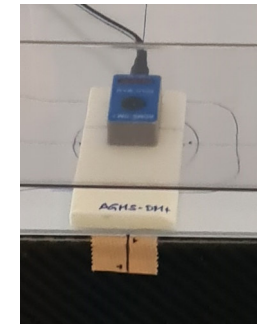
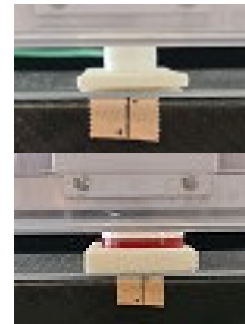
narrow beam geometry (TRS-457)
Compression paddle
High purity Al sheets



X-ray Multimeter:

In contact with the compression paddle
Same height of the individual reference points
RTI Piranha: scatter factor of 1,06

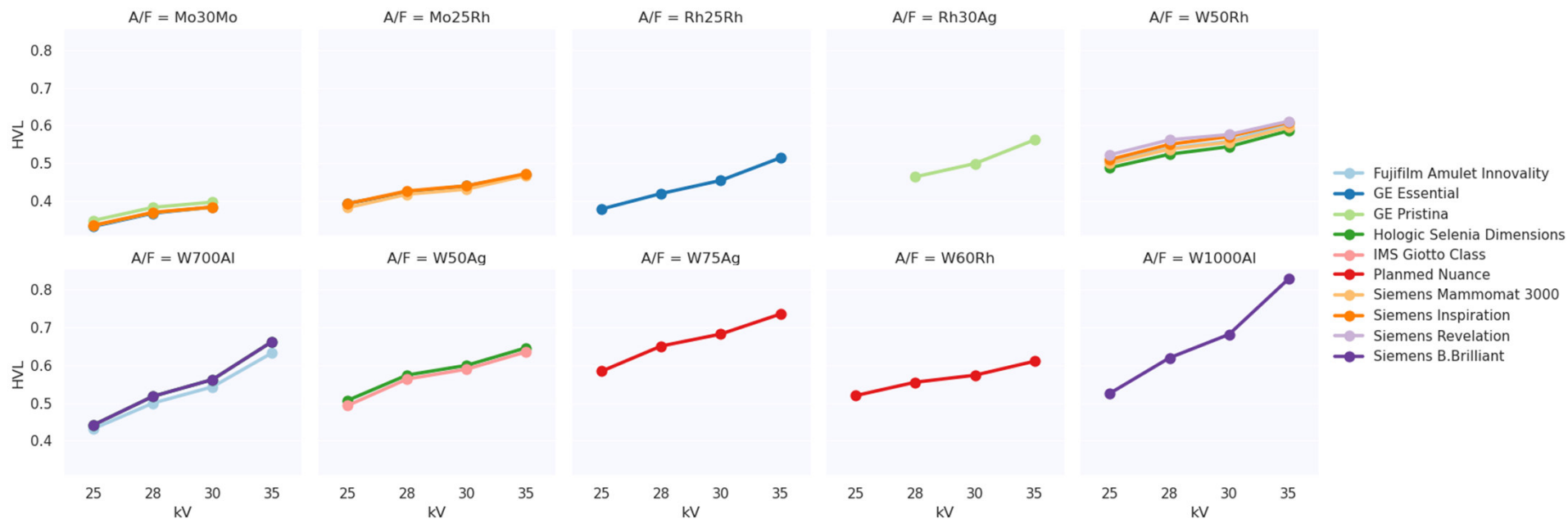
Selection in the XMM software:
anode/filter combination - X2 only for tube voltage
filter thickness – Nomex, Piranha
use of compression paddle – X2, Piranha, Nomex

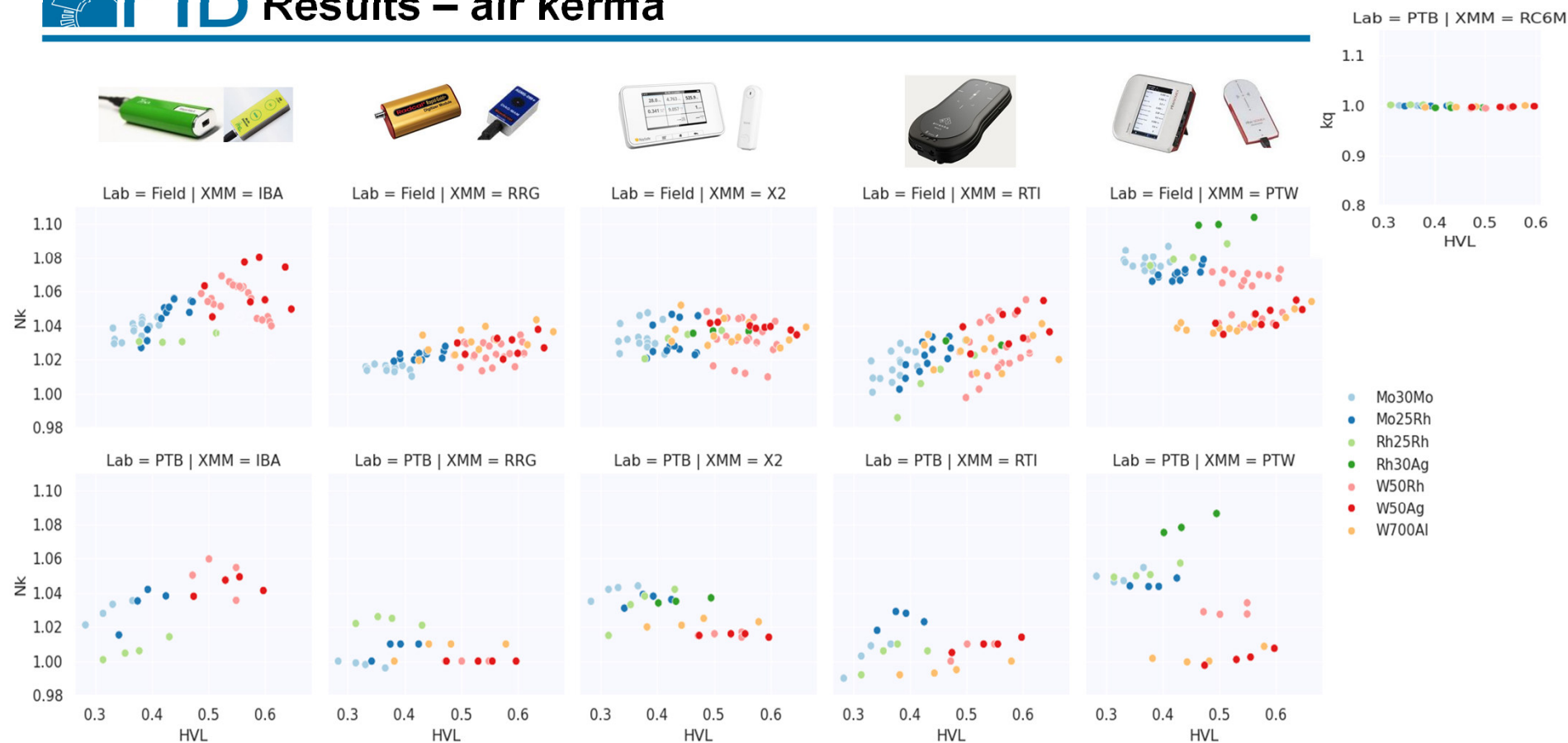


PTB Mammography systems

Manufacturer	Fujifilm	GE	Hologic	IMS Giotto	Planmed	Siemens	
Model	Amulet	Essential, Pristina	Selenia	Class	Nuance	Mammomat 3000, Inspiration, Revelation, B.Brilliant	
Max hight CP cm	148 185	125 280	238 268	283	160	200 250 252	
Mo 30µm Mo	Mo 25µm Rh	W 50µm Rh		W 0,7mm Al	W 50µm Ag	Rh 25µm Rh	Rh 30µm Ag
Siemens Mammomat 3000	Siemens Mammomat 3000	Hologic Selenia		Hologic Selenia	Hologic Selenia	GE Essential	GE Pristina
Siemens Inspiration	Siemens Inspiration	Fujifilm Amulet		Fujifilm Amulet	IMS Giotto Class		
GE Essential	GE Essential	Siemens Mammomat 3000		Siemens B.Brilliant			
GE Pristina		Siemens Inspiration					
	W 60µm Rh			W 1,0mm Al	W 75µm Ag		
	Planmed Nuance	Siemens Revelation		Siemens B.Brilliant	Planmed Nuance		

PTB Range of half-value-layers





PTB Results – HVL





- Use of XMMs for anode/filter combinations which are not included in the software?
- Interpolation between anode/filter combinations?



Not recommended due to the sensitivity on the X-ray spectra.



Compare measurement and calibration conditions



Consider the differences in the uncertainty – information in the calibration certificate

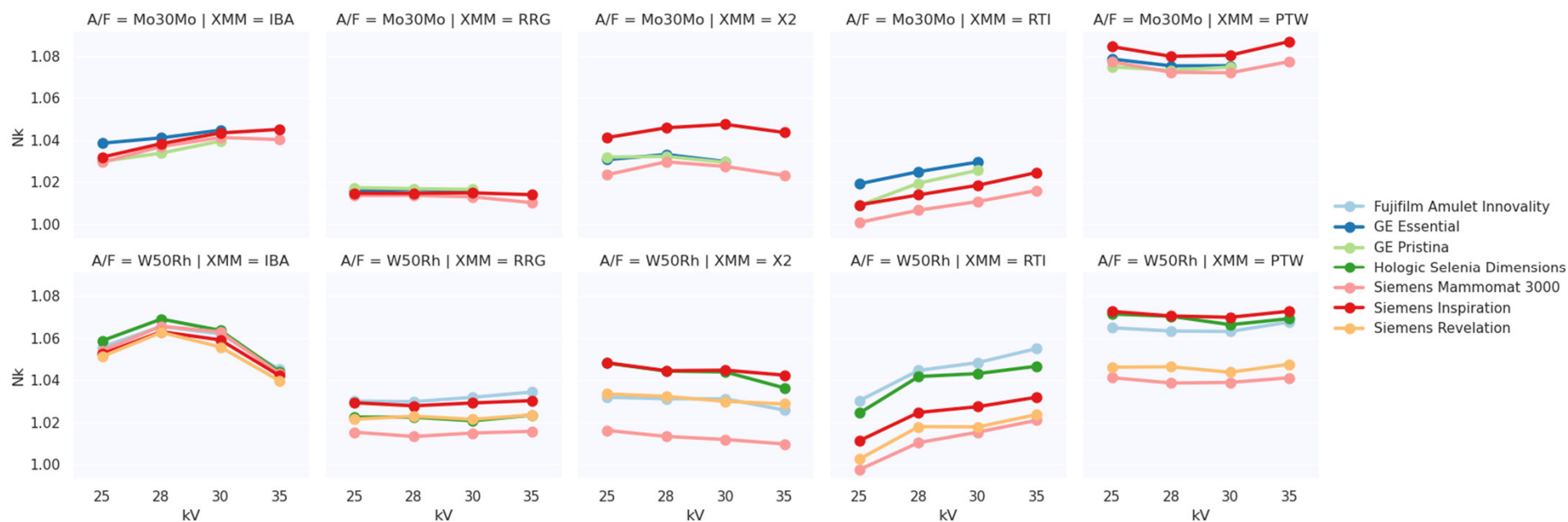


Request calibration representing the use



Know your equipment

PTB Results – air kerma



PTB Results – air kerma

