22NRM01 TraMeXI

Traceability in Medical X-ray Imaging Dosimetry

Summary of discussions on practical sessions

Workshop on X-ray imaging dosimetry

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INMRI-ENEA and Bambino Gesù Children's Hospital

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METROLOGY PARTNERSHIP
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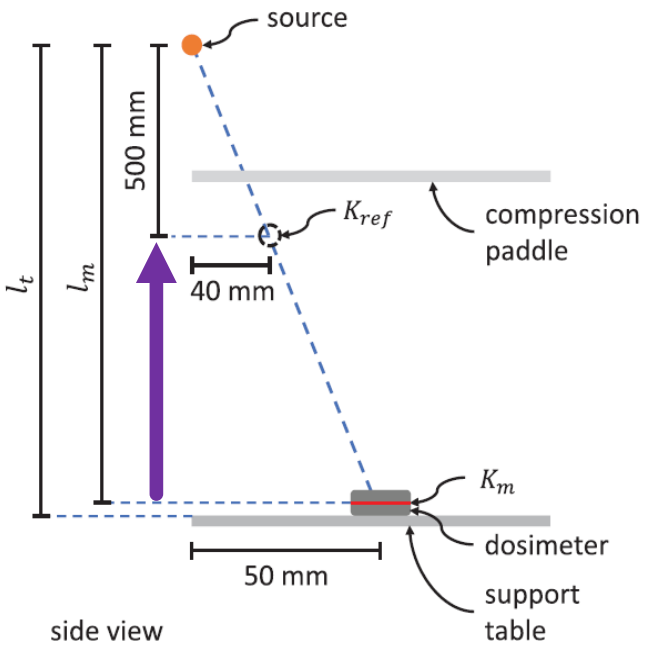
Mammography

- **Measurement geometry**: Sechopoulos I, Dance DR, Boone JM, et al. Joint AAPM Task Group 282/EFOMP Working Group Report: Breast dosimetry for standard and contrast-enhanced mammography and breast tomosynthesis. Med. Phys. 2024;51:712–739. https://doi.org/10.1002/mp.16842



Distance correction: square law

$$K_{ref} = K_m \left(\frac{l_m}{500\ mm} \right)^2 c_k$$

Forward scatter correction factor

Mammography

- **Measurement:**

- Ionization chamber:

Raw data (dosimeter readings) → calibration coefficient

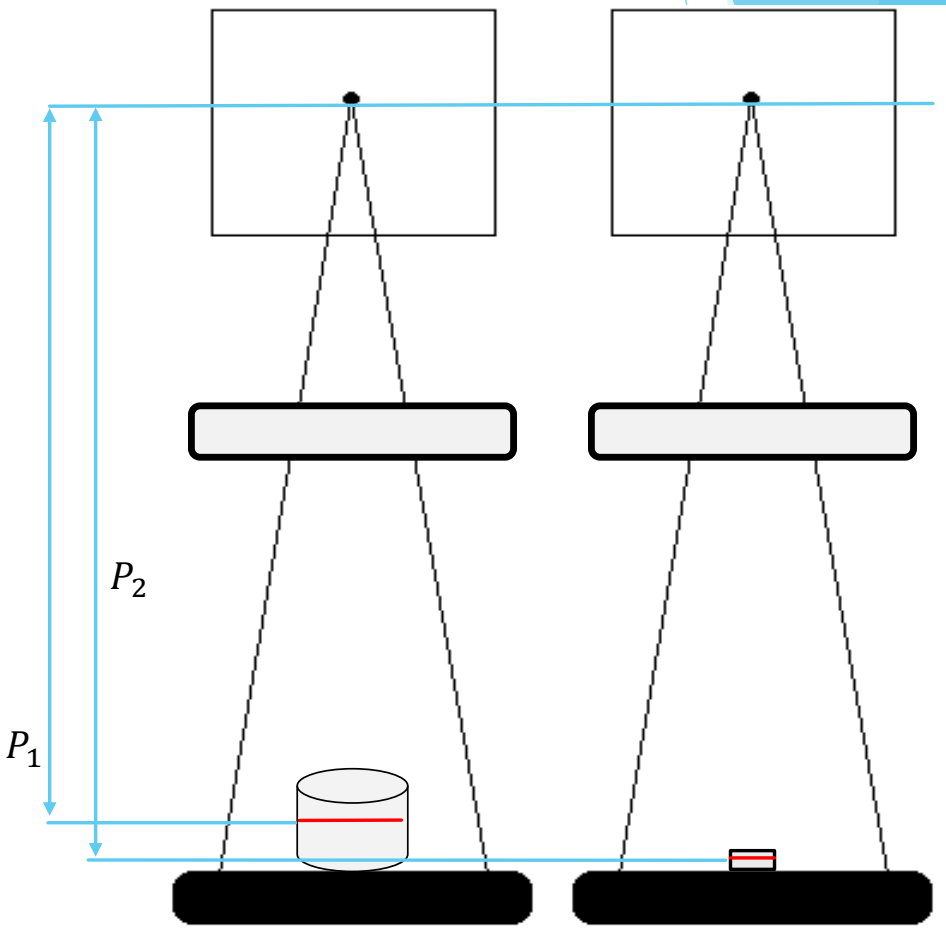
→ temperature and pressure correction coefficient

- XMM:

Raw data (dosimeter readings) → calibration coefficient

- Can we compare them? **NO!**

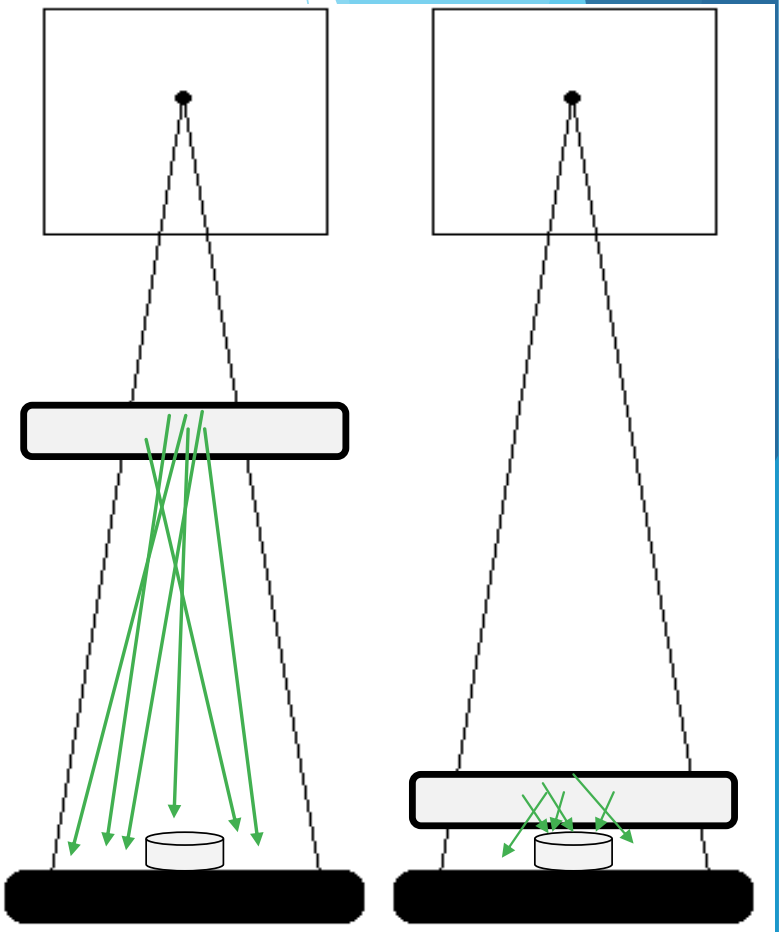
IC reference point P_1 and XMM refercence point P_2 are not at the same distance from the X-ray tube focus, use Inverse Square Law.



Mammography

- **Impact of compression paddle:**

Radiation Quality	In contact (0 cm)	Far (15 cm)	Forward scatter factor
	Air kerma (mGy)	Air kerma (mGy)	
W/Ag 28 kV	1.468	1.415	1.037



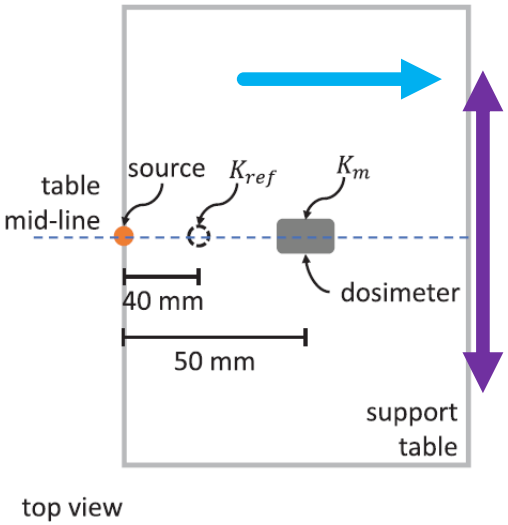
When the paddle was adjusted to its maximum clinical distance, the proportion of the detected forward scattering was only 1 %.

The most consistent way of performing air kerma measurements is to position the compression paddle at the maximum distance from the dosemeter [1].

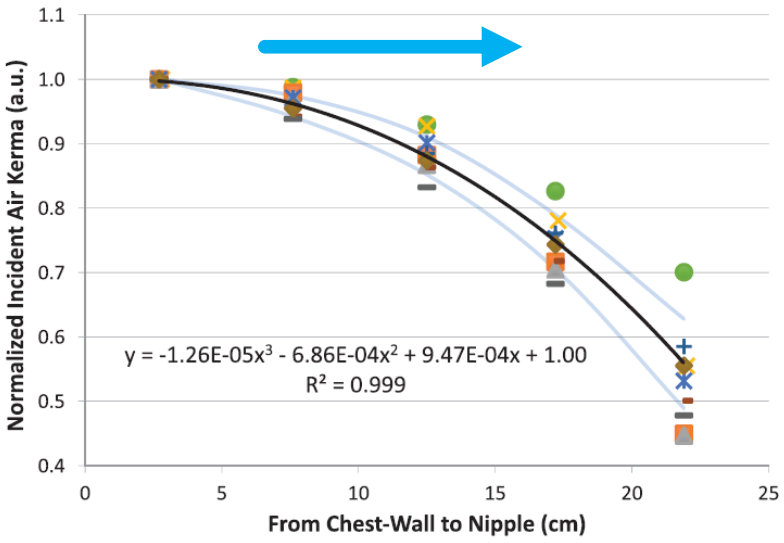
[1] Toroi P, Könönen N, Timonen M, Kortesniemi M. Aspects of forward scattering from compression paddle in the dosimetry of mammography. Radiat Prot Dosimetry 2013;154(4):439-45. https://doi.org/10.1093/rpd/ncs257.

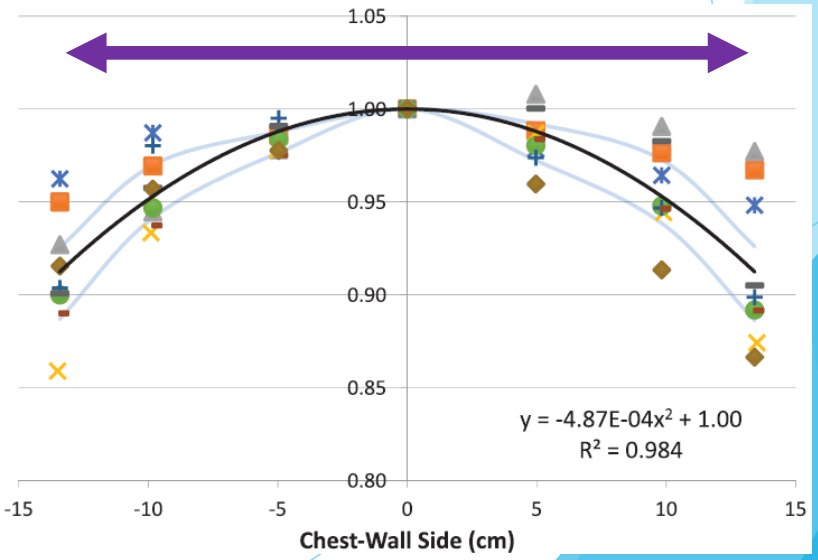
Mammography

- **Positioning:**



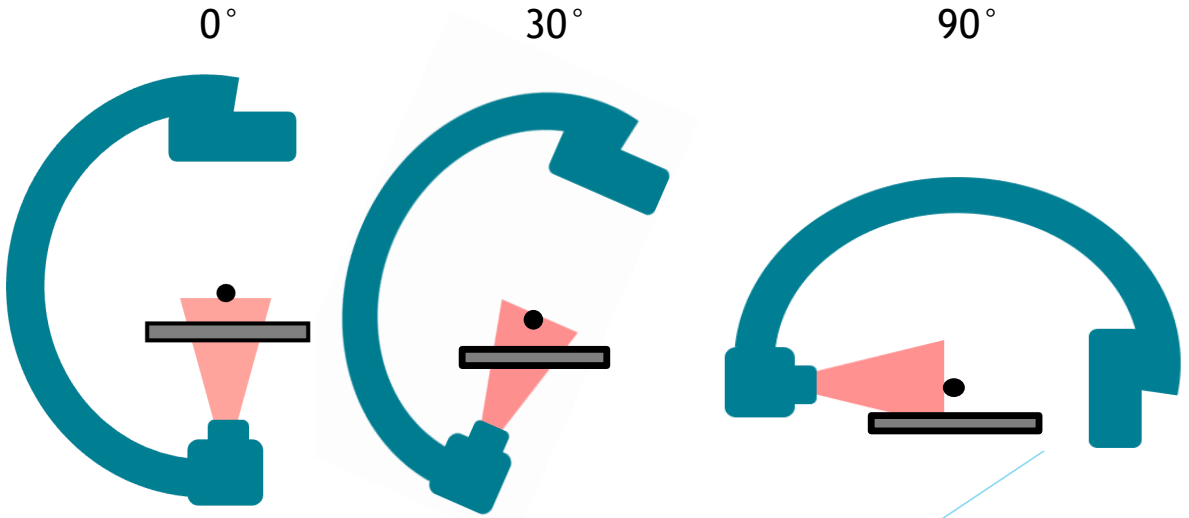
top view





Interventional X-ray system

- Inherent filtration: 2.5 mm Al
- Field size: 10 cm x 10 cm at isocenter
- Tabletop material: Carbon-fiber ≤ 1.4 mm Al
- Mattress: standard ≤ 0.6 mm Al, thick ≤ 1.0 mm Al
- Different irradiation geometry:

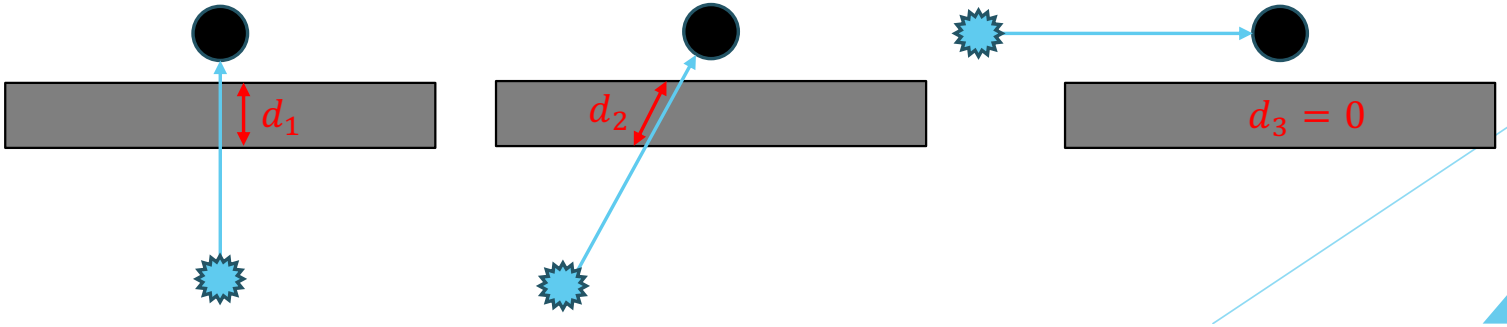


Interventional X-ray system

Table thickness crossed by the radiation is different for 0°, 30° and 90°.

$$d_2 > d_1 > d_3 = 0$$

Tube Voltage (kV)	Additional filtration (mm Cu)	Ka (mGy) 0°	Ka (mGy) 30°	Ka (mGy) 90°
70	0	0.447	0.408	0.674
70	0.9	0.021	0.020	0.029
125	0	1.410	1.351	2.044
125	0.9	0.299	0.286	0.390



Conventional projection radiography

- **Measurement geometry:**

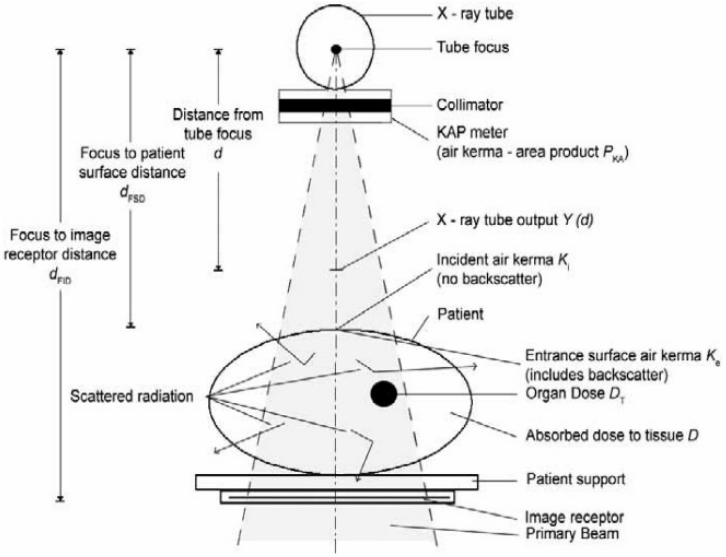
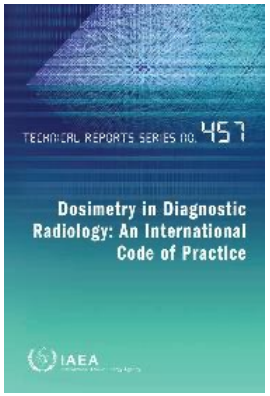


FIG. 3.2. Diagram of the measuring arrangement.



- **Measurement equipment:** XMM

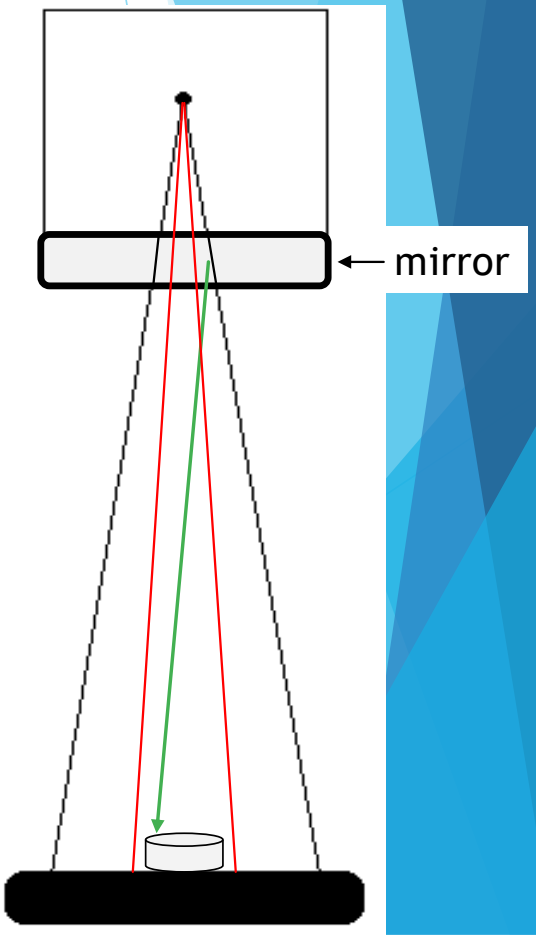
Conventional projection radiography

- **Impact of field size:**

Tube voltage (kV)	Additional filtration (mm Cu)	HVL (mm Al)	Ka (mGy) 10x10	Ka (mGy) 5x5	Ka (mGy) 50x50
120	0	4.91	1.1248	1.1036	1.2042
120	0.3	8.88	0.4546	0.4473	0.4810

What is the reason? **Scatter radiation**

For example, scatter in the mirror of the X-ray tube



Conventional projection radiography

- **Impact of the dosimeter position:**

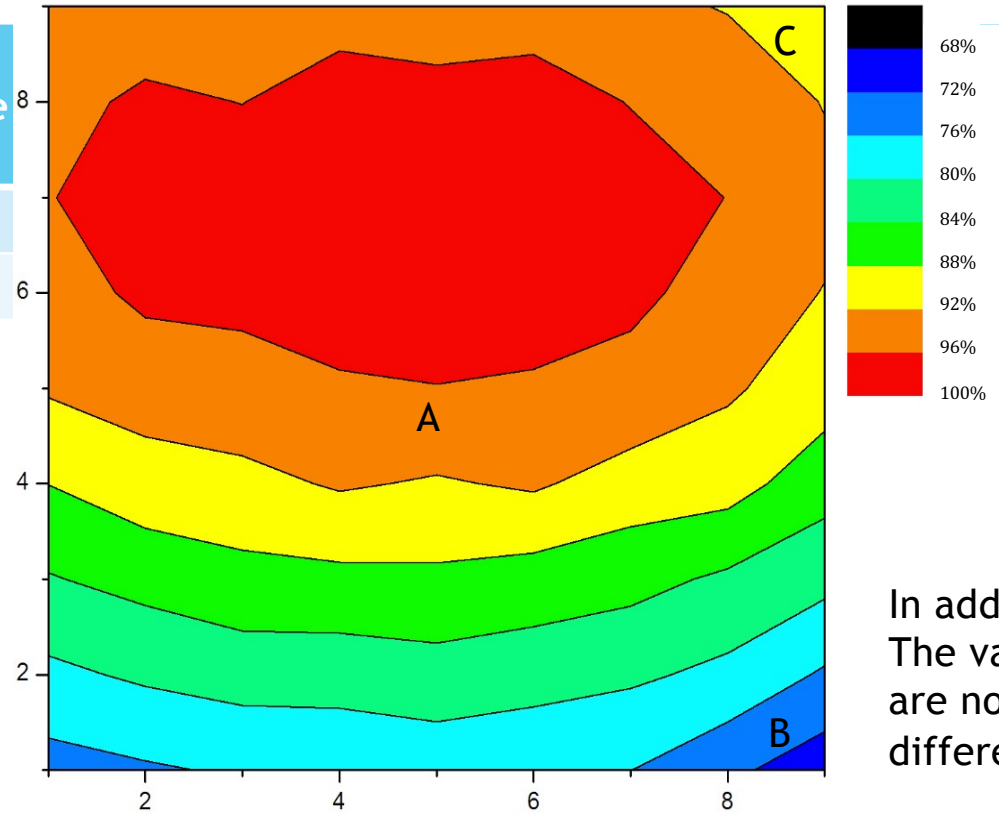
Tube voltage (kV)	Additional filtration (mm Cu)	HVL (mm Al)	Ka (mGy) 10x10	Ka (mGy) 5x5	Ka (mGy) 50x50	Ka (mGy) 50x50 corner
120	0	4.91	1.1248	1.1036	1.2042	1.0937
120	0.3	8.88	0.4546	0.4473	0.4810	0.3887

What is the reason? **Field inhomogeneity**

Conventional projection radiography

- **Impact of the dosimeter position:**

Tube voltage (kV)	Ka (mGy) 50x50	Ka (mGy) 50x50 corner
120	1.2042	1.0937
120	0.4810	0.3887



Position A

Position B

In addition, the corner are not all the same. The values of air kerma measured in the corners are not equal, measurement in corner B is different from measurement in corner C.

Thank you for your attention!

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