



Challenges in medical X-ray imaging dosimetry: the traceability chain is broken

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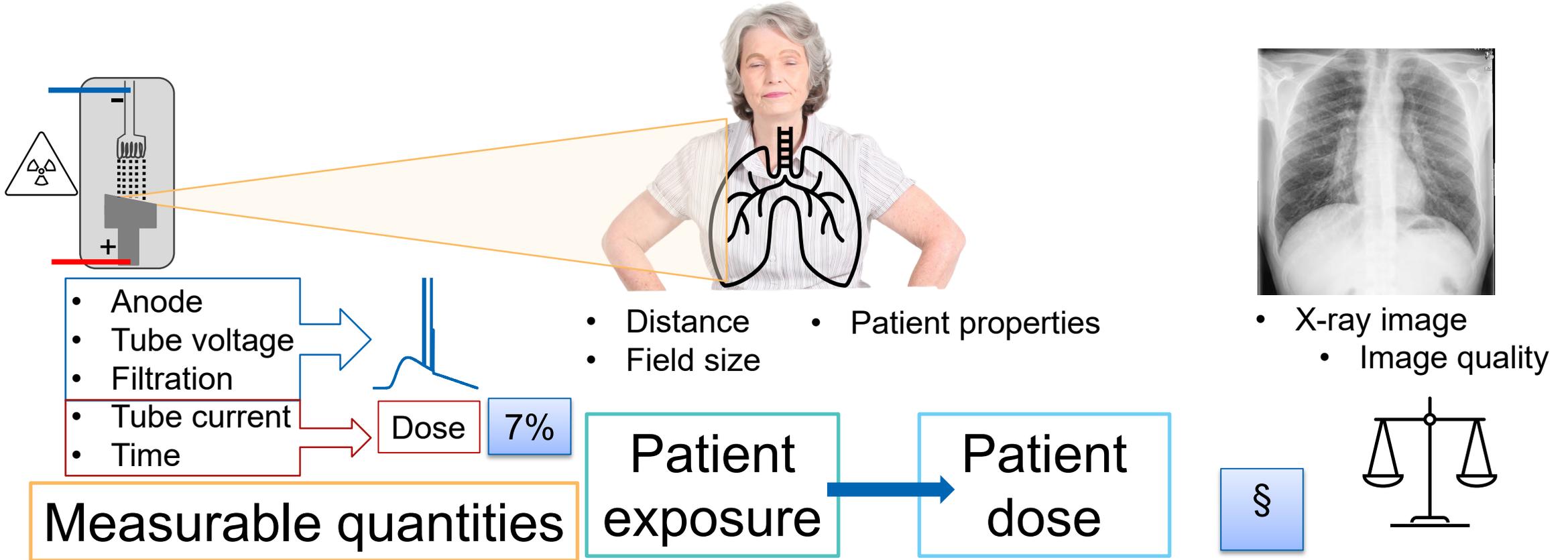
The project (22NRM01 TraMeXI) has received funding from the European Partnership on Metrology, co-financed from the European Union's Horizon Europe Research and Innovation Programme and by the Participating States. Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or EURAMET. Neither the European Union nor the granting authority can be held responsible for them.



ECMP_TraMeXI, P. Toroi

13.9.2024

X-ray imaging

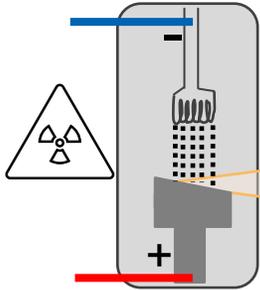


=> need for consistent and comparable measurement data

X-ray imaging dosimetry

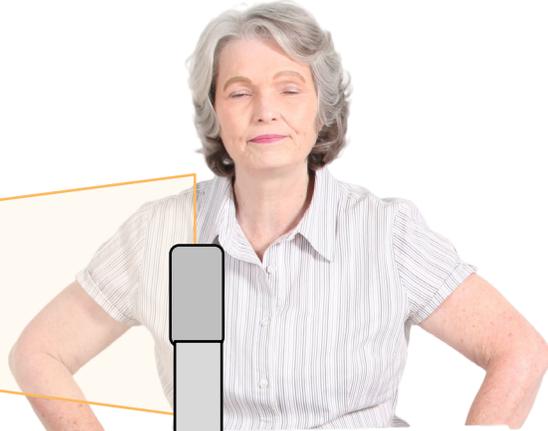
Consistent and comparable data => traceability

Measurements

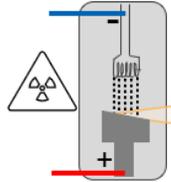
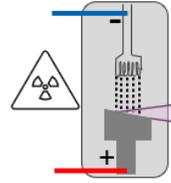


- Anode
 - Tube voltage
 - Filtration
 - Tube current
 - Time
- Dose

Measurable quantities

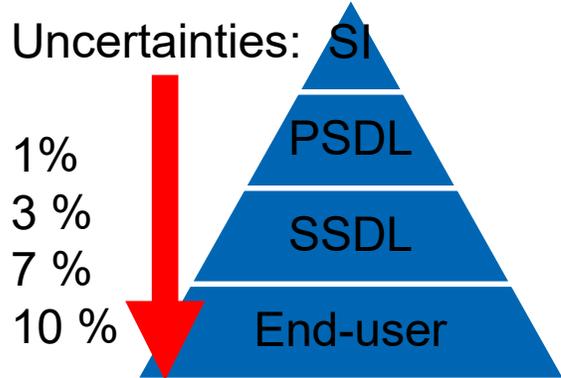


2 mGy	81 kV
3.2 mmAl	92 mAs



calibration

measurement



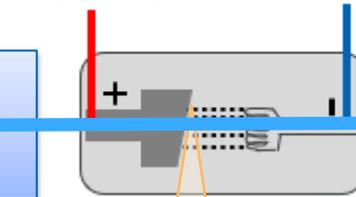
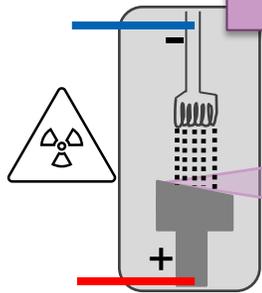
Calibration vs measurement conditions

Mammography example

Calibration

Unbroken chain of measurements

Measurement



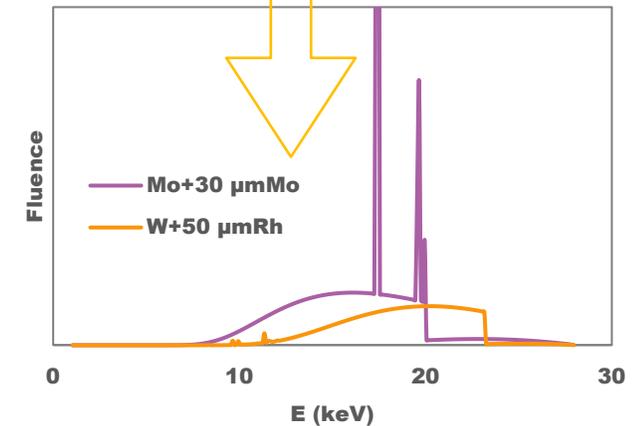
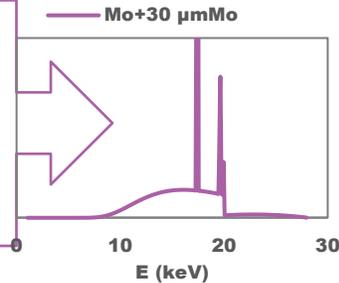
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Radiation quality:

- Anode: W, Mo, Rh
- Tube voltage: 25 – 50 kV
- Filtration: Mo, Rh, Ag, Al, Cu...
- Compression paddle

Radiation quality:

- Anode: Mo
- Tube voltage: 25 - 35 kV
- Filtration: 30 μm Mo



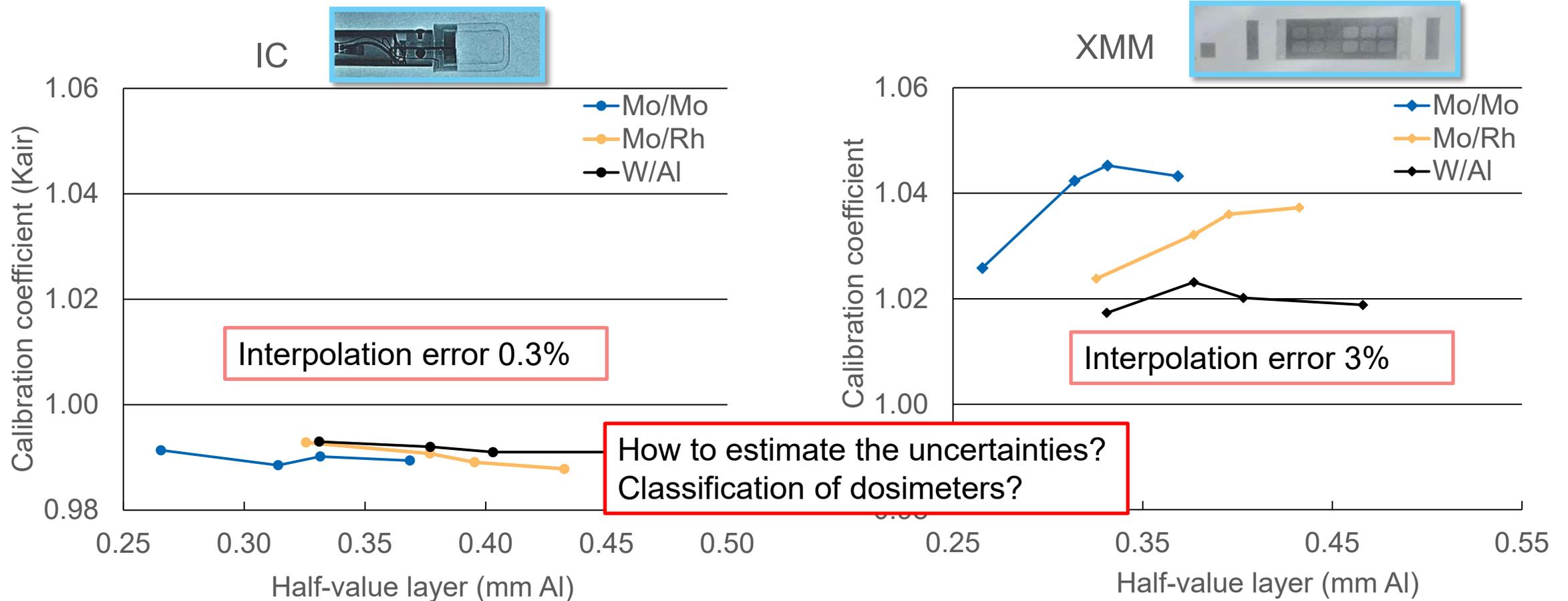
Dosimeter performance:

- IEC 61674: **requirements for dosimeters** in specific conditions.
 - What happens outside of this range, what is the uncertainty?
- No requirements for the other quantities.

Spectra provided by Spekpy (Joonas Tikkanen, STUK)

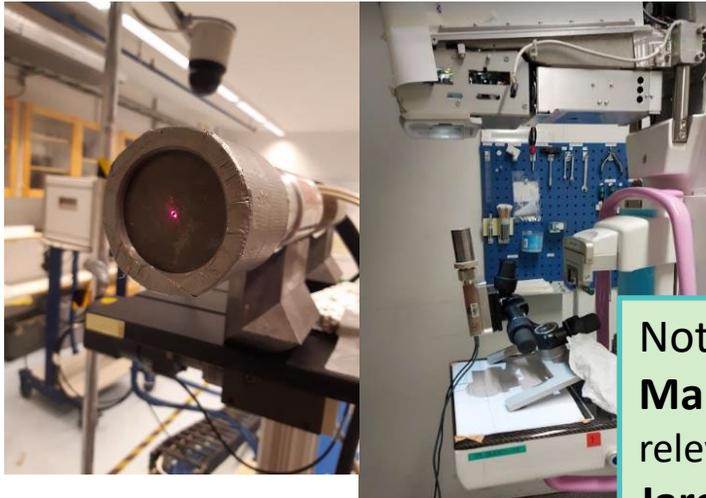
Impact of compression paddle: Costa de Castro et al. Physica Medica 2024 <https://doi.org/10.1016/j.ejmp.2024.103405>
Impact of measurement conditions: Kojić et al, Radiation Measurements 2024 <https://doi.org/10.1016/j.radmeas.2024.107135>

How to use the calibration coefficients?



Revision of reference radiation qualities (RQs)

1. Evaluation of the range of **clinically relevant RQs**
2. Validation with **spectrometry**
3. Consensus on **reference RQs**
 - **D1:** *Recommendations on which reference RQs should be included into IEC 61267...*
 - **D2:** *'Open access spectrum catalogue including spectra for reference RQs...'*



Proposed:

- General: new copper filtered ref. RQs
- Mammography: Mo/Mo => W-anode based ref. RQs



Note related ePosters

Markus Borowski et al., PP08.01: Mismatch between dosimeter calibration and clinically relevant x-ray spectra and resulting consequences

Jaroslav Šolc et al., PS03.31: X-ray fluence spectra of diagnostic and interventional radiology x-ray imaging equipment measured with a compact cadmium telluride spectrometer

Classification of dosimeters based on their performance

1. Usage of dosimeter
2. Criteria for performance evaluation and classification
3. Evaluation of performance
 - **D3: Paper on the performance of dosimeters**
=> data to enable uncertainty estimations
 - **D4: Recommendations on the specific requirements for reference- and field-class dosimeters**
=> potential input for update of IEC 61674.

Main results from the survey to medical physicists in 2023 (n = 91)

- Use of calibration certificate for X-ray multimeters (XMMs)
 - >75% not used for air kerma.
 - >90% not used for the other quantities.
- Challenges with uncertainty estimations



Development of harmonised calibration and measurement procedures for X-ray multimeters

1. **Clinical needs:** relevance of different quantities and target uncertainties.
- 2.-3. **Harmonized** calibration and measurement **procedures**
4. **Testing** of XMMs and new procedures

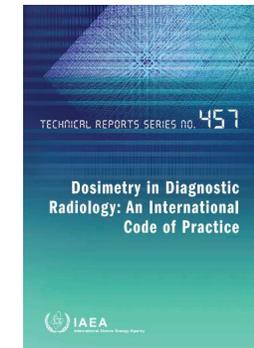
D5 Report on the **performance of XMMs** for relevant quantities

=> data to enable uncertainty estimations, recommendations for **update of IEC standards**

D6: **Calibration and measurement procedures for XMMs** for relevant quantities

=> providing inputs for the update of the IAEA TRS-457 (CRP E24024)

- Target uncertainties are not clear!
- Harmonized calibration procedures prepared
- Defined gaps in XMM measurements
 - Geometry: positioning, viewing angle etc.
 - Use of calibration certificate
 - Impact of software
 - Radiation quality selection
 - Related uncertainties



Note related contributions:

Luigi Rinaldi et al: PS03.12 Calibration of semiconductor-based x-ray multimeters in diagnostic radiology beams

Elisabeth Salomon and Stefan Pojtinger SC22.02

Field calibration for air kerma and half-value layer of x-ray multimeters on two different mammography systems



Thank you for your attention!



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