Current efforts for improvement

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EURAMET 22NRM01 TraMeXI

- Traceability in Medical X-ray Imaging dosimetry
  - Normative call: “Metrology support for Regulations and Standards”.

6/2023 – 5/2026

EUROPEAN PARTNERSHIP
Co-funded by the European Union
METROLOGY PARTNERSHIP
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1. Coverage of clinical **radiation qualities** in calibrations.
2. Understanding the **performance of dosimeters**
   => estimation of related uncertainties.
3. Harmonized **calibration and measurement procedures**
   - **Support to IAEA CRP E24024**

14 Beneficiaries

stuk – Radiation and Nuclear Safety Authority; CMI Czech Metrology Institute; INMRI – Istituto Nazionale di Metrologia delle Radiazioni Ionizzanti, ENEA; IJF; Técnico Lisboa; IMBIH; PTB – Physikalisch-Technische Bundesanstalt, National Metrology Institute; HUS Helsinki University Hospital; VSL National Metrology Institute; EEAE – Ελληνική Επιτροπή Ατομικής Ενέργειας, Greek Atomic Energy Commission; Institutul Național de Metrologie; skbs; Städtisches Klinikum Braunschweig; Bambino Gesù Ospedale Pediatrico; TENMAK NÜKEN

3 Collaborators

LMRI – DEN/UFPE; Australian Government, Australian Radiation Protection and Nuclear Safety Agency; LUMC Leiden University Medical Center

Stakeholder committee (22 members):

- Chief stakeholder:
  - Wesley Culberson (IEC SC62C WG3)
- IEC, IAEA, Herca, EFOMP
- Manufacturers: - IBA, PTW, Radcal, Raysafe, RTI, Quart, Planmed
- Calibration laboratories:
  - CEA, CIEMAT, IRB, INTE
- Medical physics associations:
  - DGMP, AIFM, CHUV, SF, NVKF, APT

stuk – Säteilyturvakeskus, Strålsäkerhetscentralen, Radiation and Nuclear Safety Authority

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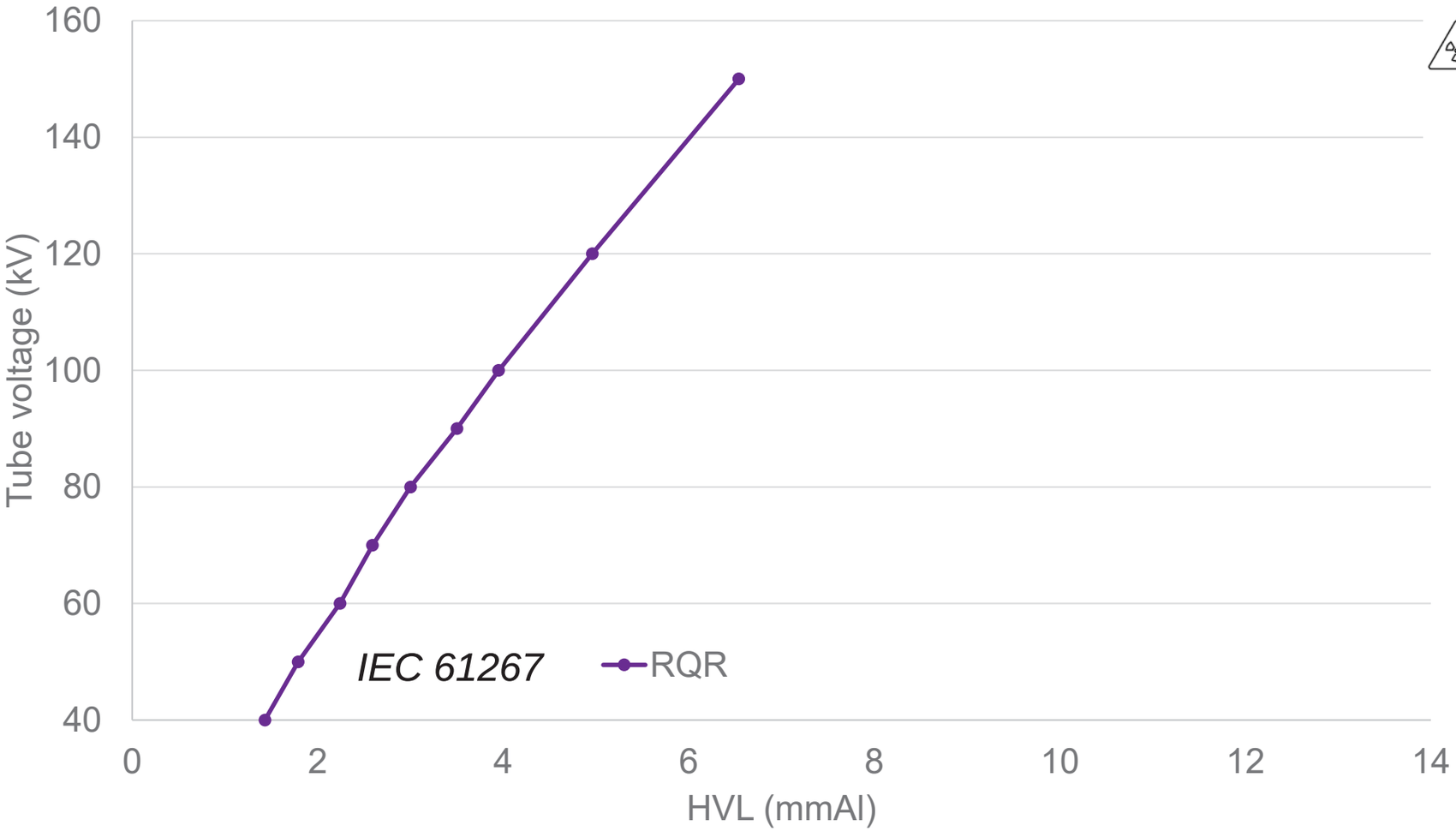
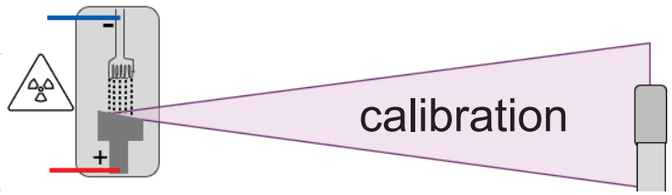
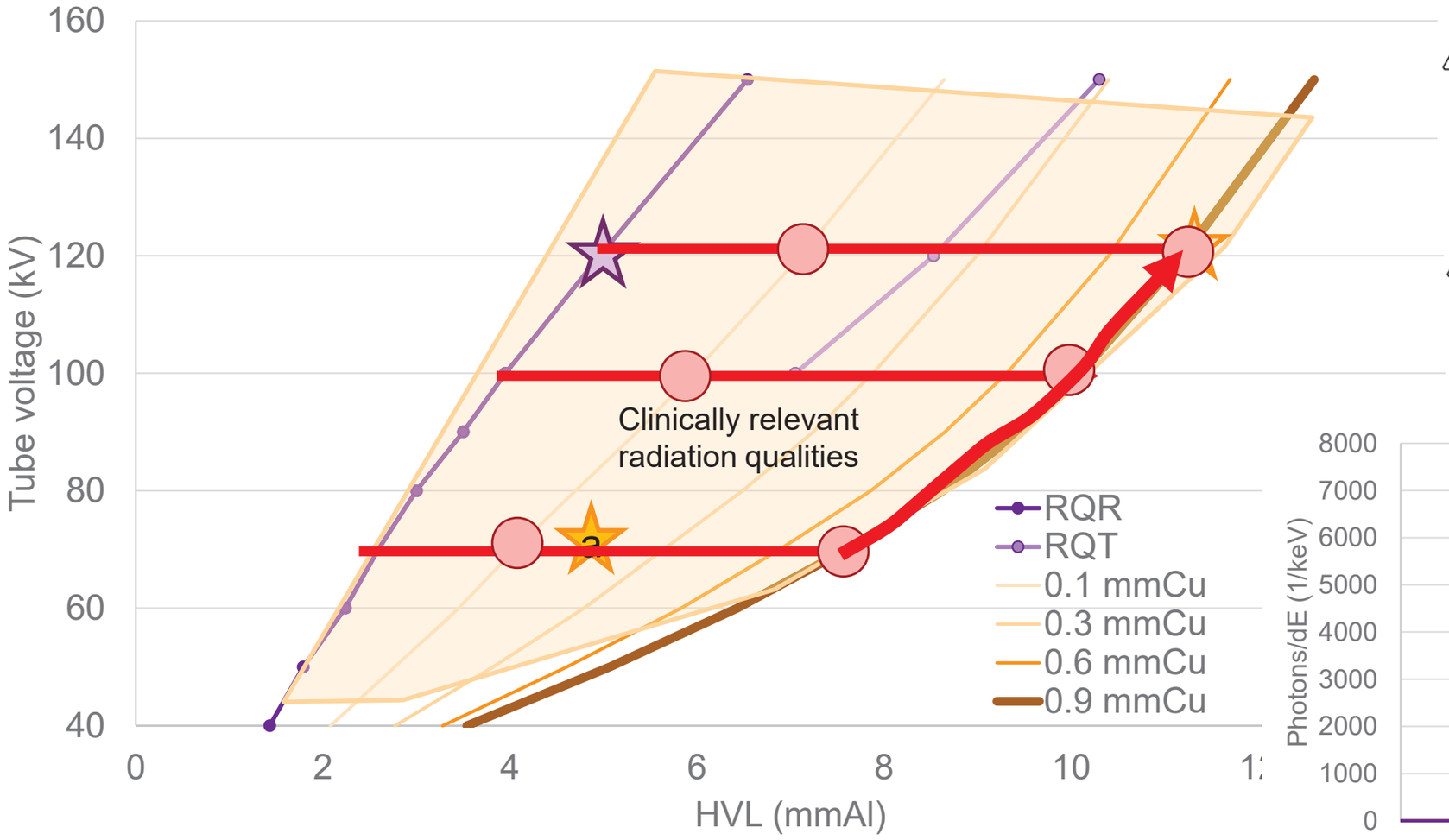
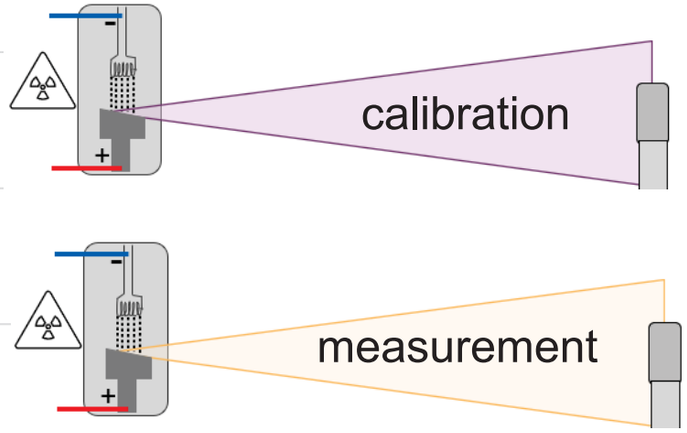
Reference radiation qualities

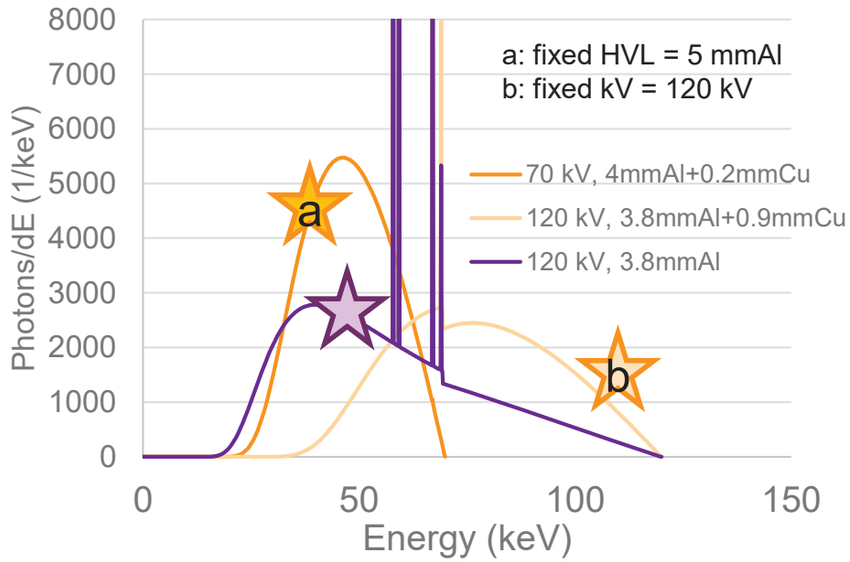




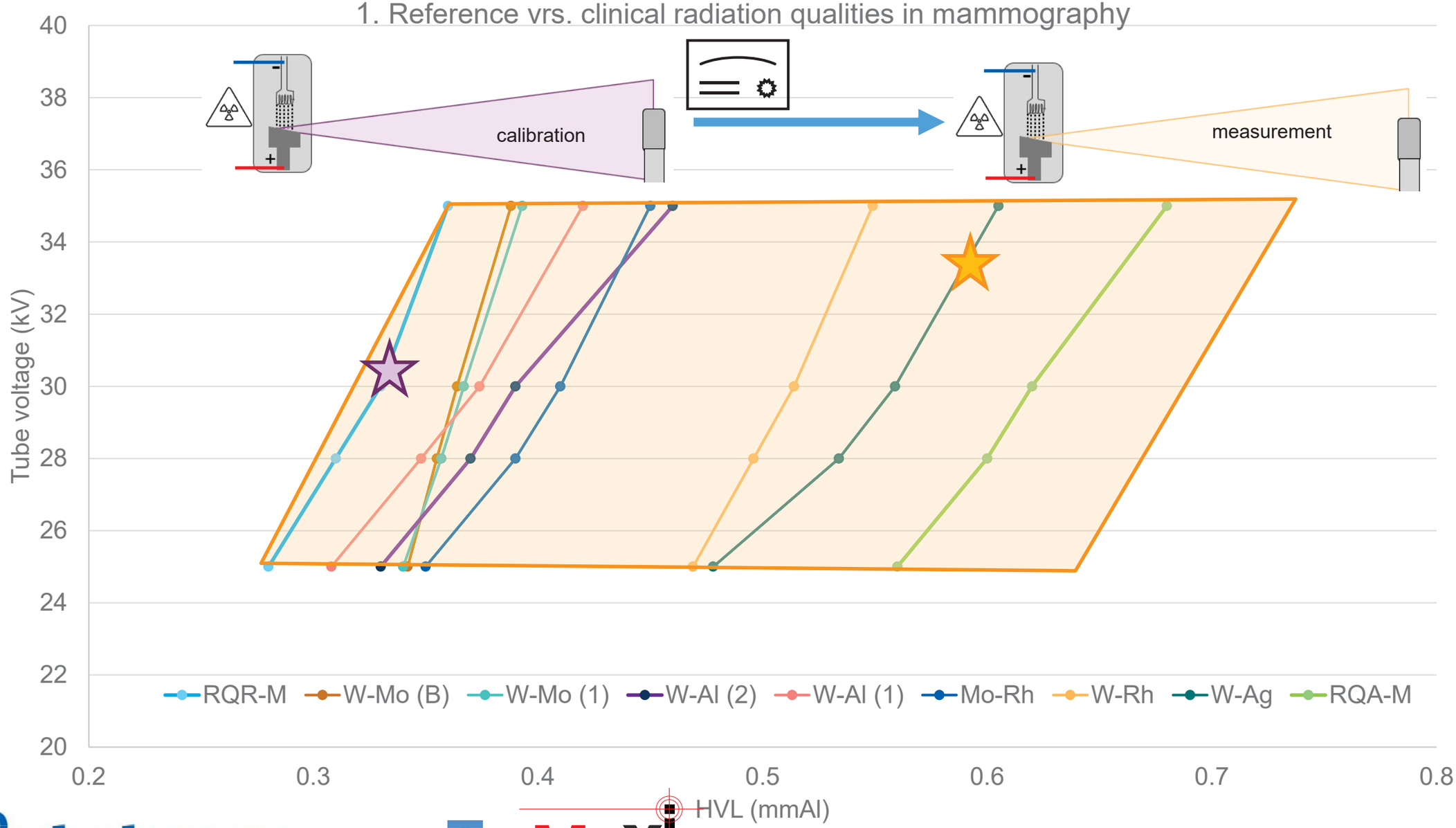
Reference vrs. clinical radiation qualities







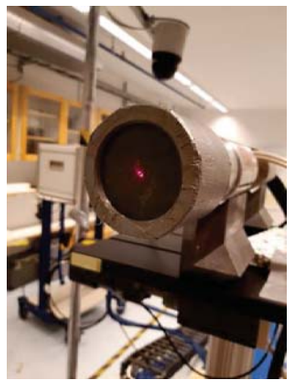
1. Reference vrs. clinical radiation qualities in mammography

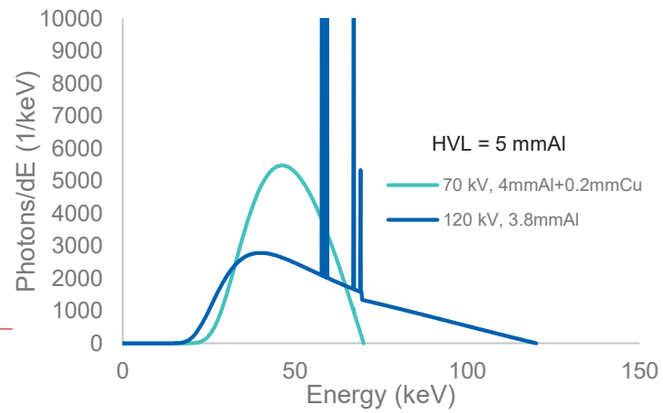


WP 1 Revision of reference radiation qualities

Physikalisch-Technische Bundesanstalt
National Metrology Institute

1. Evaluation of the **range of relevant radiation qualities**
   – Assess the range of clinically used exposure parameters.
2. Validation of radiation qualities and their specifiers with **spectrometry**
   – Spectra measurements
3. Consensus and comprehensive description on **reference radiation qualities**
   – **D1**: *Recommendations on which **reference radiation qualities** should be included into IEC 61267...*
   – **D2**: '*Open access **spectrum catalogue** including spectra for reference radiation qualities…*'





stuk SÄTEILYTURVAKESKUS STRÅLSÄKERHETSCENTRALEN RADIATION AND NUCLEAR SAFETY AUTHORITY

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2. Dosimeter performance in different conditions

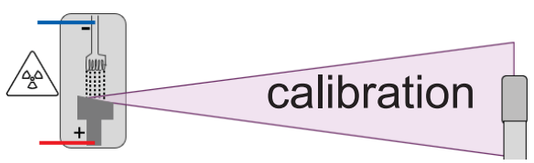
- IEC 61674: **requirements for dosimeters** in specific conditions.

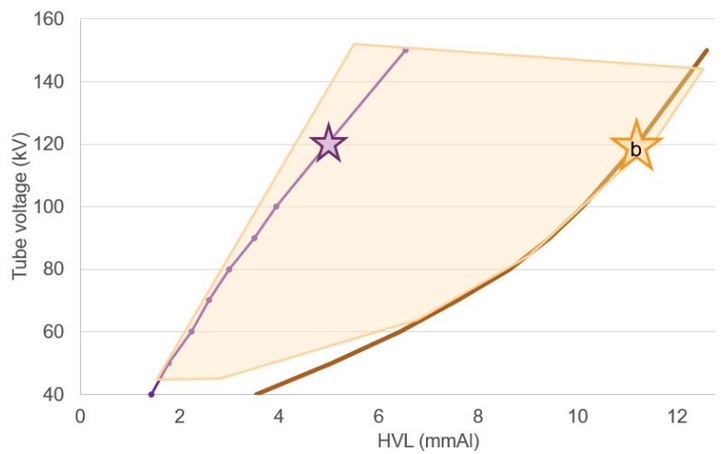
Table 5 – LIMITS OF VARIATION for the effects of INFLUENCE QUANTITIES

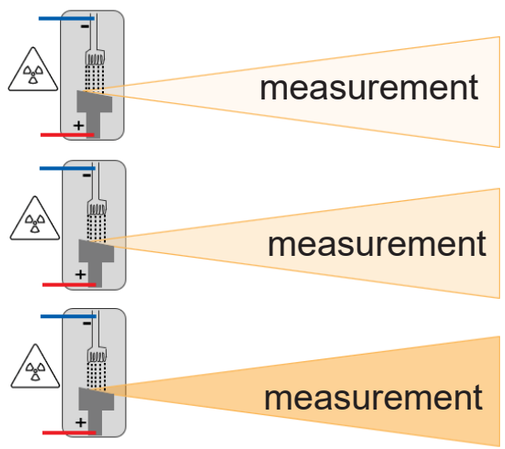
INFLUENCE QUANTITY	MINIMUM RATED RANGE	REFERENCE CONDITIONS	LIMITS OF VARIATION *L*
RADIATION QUALITY	*X-RAY TUBE VOLTAGE and Qualities*		
a) conventional diagnostic UNATTENUATED BEAM	50 kv – 150 kV RQR 3 – RQR 10 x IEC 61267	70 kV RQR 5 x IEC 61267	±5 %
b) conventional diagnostic ATTENUATED BEAM	50 – 150 kV RQA 3 – RQA 10 x IEC 61267	70 kV RQA 5 x IEC 61267	±5 %
c) mammography UNATTENUATED BEAM[a]	25 – 35 kV different anode + filter combinations[b]	28 kV	±5 %

IEC 61674 Medical electrical equipment – Dosimeters with ionization chambers and/or semiconductor detectors as used in X-ray diagnostic imaging.

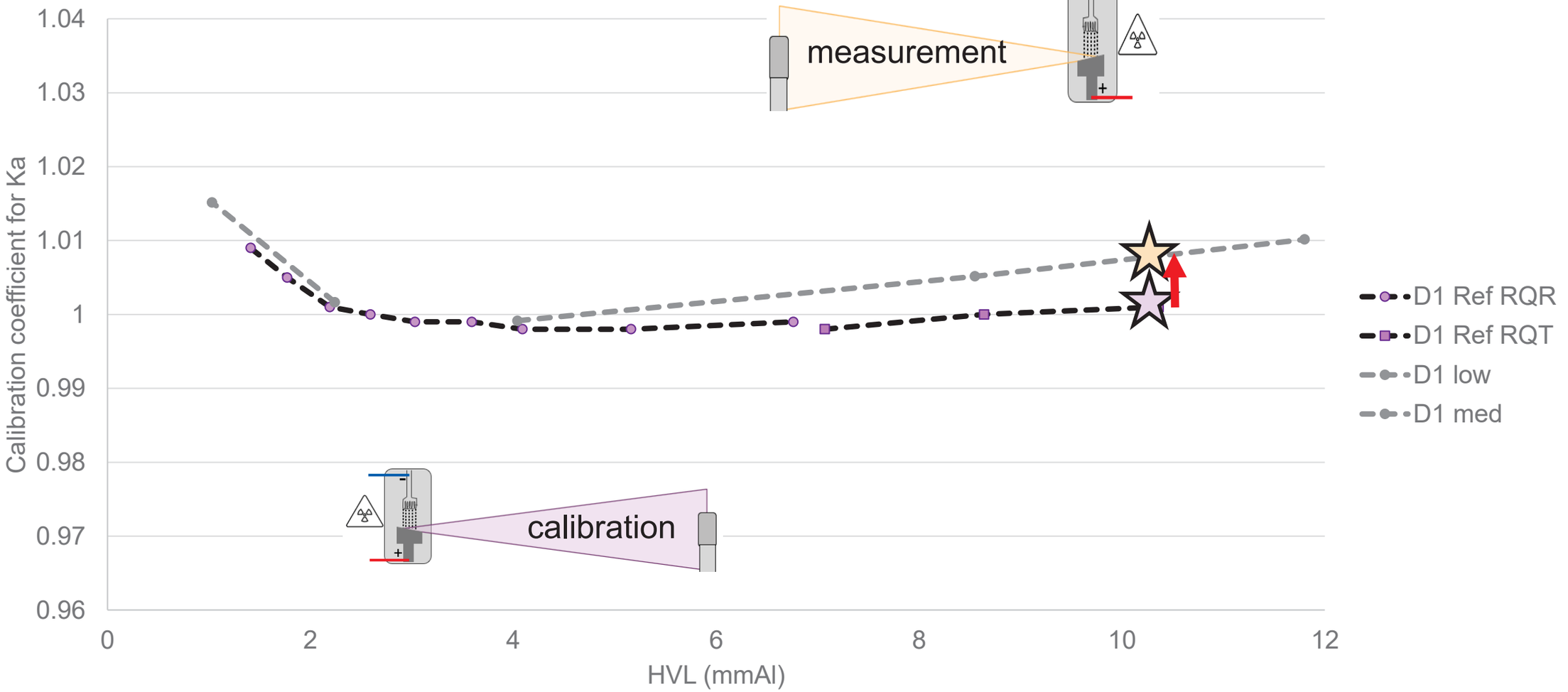
What happens when the measurement condition is outside the specified range?







2. Performance of dosimeters



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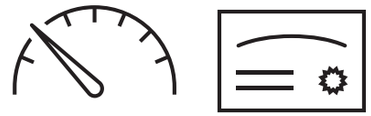


How to use the calibration coefficients?

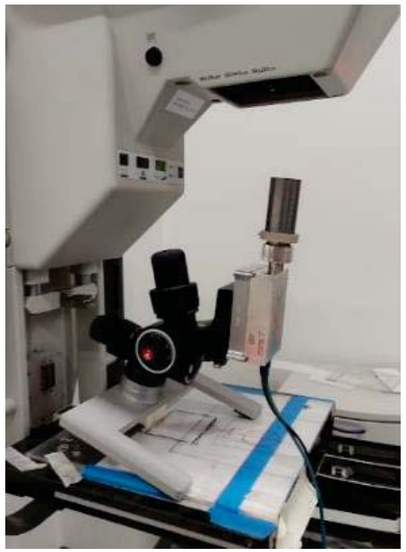
What is the uncertainty?

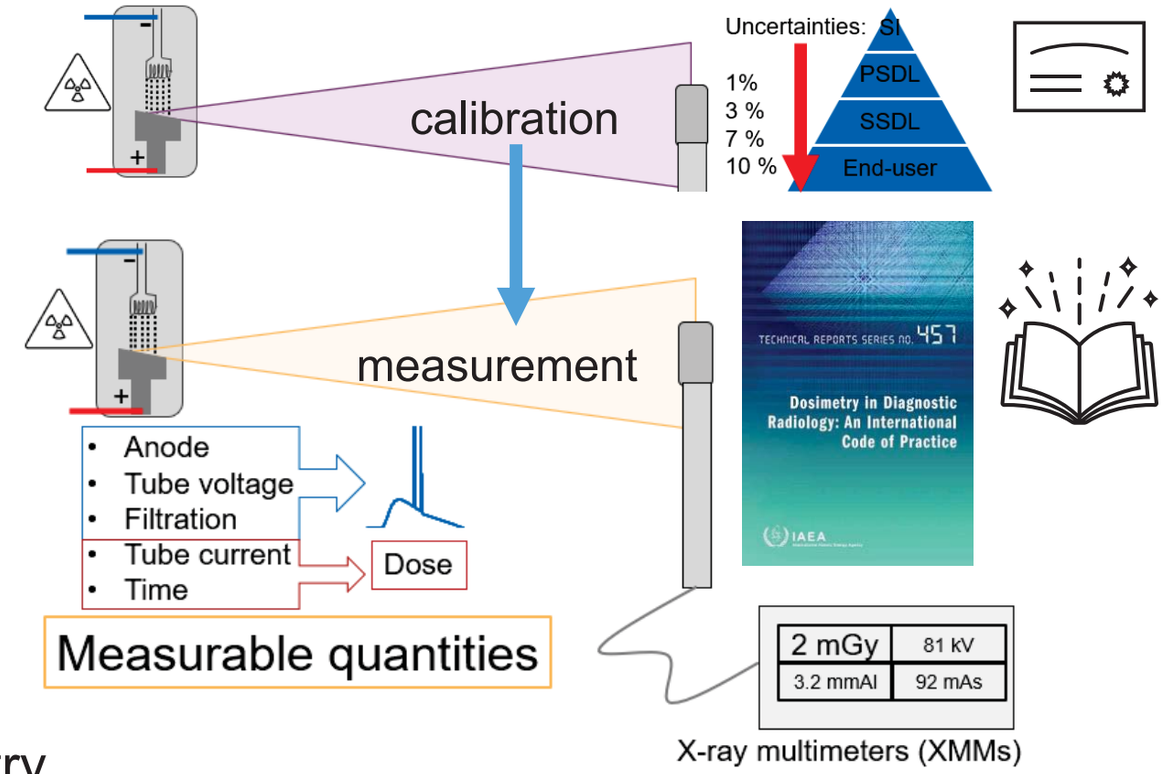
WP 2 Classification of dosimeters based on their performance

1. **Usage of dosimeter**
   - What dosimeters are used and how
2. **Criteria** for **performance evaluation** and classification
   - relevant influence quantities and dosimeter properties
3. **Evaluation of performance**
   - **D3**: *'Paper on the **performance of…commercially available X-ray dosimeter types…**estimation of uncertainties related to air kerma measurements with different dosimeters'*
   - **D4**: '*Recommendations on the specific requirements…for **reference- and field-class dosimeters** enabling traceable clinical measurements with the targeted uncertainty 7 % (k=2) and to be updated in future revisions of IEC 61674…'*

3. Calibration of XMMs

- How to gain traceability for all quantities?
- Need for harmonized methods.





3. Use of XMMs

- XMM measurement geometry
- Use of calibration certificate
- Impact of programs
  - Radiation quality selection

WP3: Development of harmonised calibration and measurement procedures for X-ray multimeters

1. Clinical needs: **what**?
   - Clinical and legal relevance of different quantities and parameters and target uncertainties.
2. Harmonized **calibration** procedures: **how**?
   - New or updated calibration procedures for all relevant quantities and parameters.
3. Procedures for **clinical** calibrations and measurements: **how**?
   - Provide new, updated and harmonized procedures and guidance for clinical measurements
4. **Testing** of XMMs and new procedures
   - **D5** "*Report on the performance of…XMMs…enabling estimation of uncertainties related to measurements of different quantities…recommendations for an* ***update of IEC 61676*** *and inclusion of other relevant QA parameters in* ***new or existing standards****…*".
   - **D6**: '***Calibration and measurement procedures of XMMs****…covering…air kerma, PPV and half-value layer and target uncertainties submitted to IAEA…providing inputs for the update of the TRS-457'*

WP4: Validation of established calibration methods

- **Running the comparison**
  - in terms of air kerma and X-ray tube voltage
  - **D7 (air kerma) and D8 (X-ray tube voltage)**:

‘*Draft B comparison report for supplementary comparison for air kerma calibrations in X-ray imaging reference radiation qualities with specified uncertainties is submitted to EURAMET TC IR.*

WP 5: Creating impact

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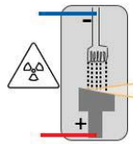
WP 6: Project management

* Patient dose and optimization

measurable quantity ≠ patient dose



- Distance
- Field size
- Patient properties

- X-ray image
- Image quality

Patient exposure → Patient dose

- Data **on irradiation and patient properties** is required:
  => Patient specific optimization
  => Personalized medicine.

Example:

i-Violin: optimization of oncological CT imaging

- Calculation of organ doses:
  - Comparison of tools
  - Estimation of uncertainties.
- Collaboration between different professionals
  - physicist, radiologist, radiographer
  - E&T: https://www.eibir.org/i-violin-education-and-training-webinars/

iVIOLIN

i-Violin = implementing verifiable oncological imaging by quality assurance and optimization.

https://www.eibir.org/projects/i-violin/

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Thank you for your attention!

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