



Welcome to TraMeXI workshop!

Scope of TraMeXI

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**Workshop for radiation metrologists on
calibration of dosimeters used for X-ray imaging**

Greek Atomic Energy Commission (EEAE),
Athens, Greece, September 1st – 3rd, 2025

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Background & Expertise

- Coordinator of 22NRM01 TraMeXI project
- Technical leader of Radiation Metrology Laboratory of STUK
- >20 years of experience in metrology and clinical medical physics

Workshop Expectations & Goals

- Good cooperation with a group of radiation metrology experts

EURAMET 22NRM01 TraMeXI



www.tramexi.com

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

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 the IAEA CRP E24024**



14 Beneficiaries



3 Collaborators



Stakeholder committee (22 members):

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



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Revision of reference radiation qualities (RQs)

1. Evaluation of the range of clinically relevant RQs
2. Validation with **spectrometry** Clinical spectra!
3. Consensus on **reference RQs**

– **D1:** Recommendations on which reference RQs should be included into IEC 61267...

Proposed:

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

★

| Base RQ | TV (kV) | ~mmAl | +0.1 mmCu | +0.2 mmCu | +0.25 mmCu | +0.3 mmCu | +0.9 mmCu |
|---------|---------|-------|------------------------------------|-----------|------------|-----------|-----------|
| RQR 3 | 50 | 2.5 | | | | | |
| RQR 4 | 60 | 2.7 | | | | | |
| RQR 5 | 70 | 2.8 | 70 kV + 0, 0.1, 0.3 and 0.9 mmCu → | | | | |
| RQR 8 | 100 | 3.4 | | RQT 8 | | | |
| RQR 9 | 120 | 3.7 | | | RQT 9 | | |
| RQR 10 | 150 | 4.4 | | | | | |

0.3 mm Cu + 50, 70, 100, 120, 150 kV

| Name | Tube voltage | Total filtration | 1 st HVL in mm Al ^a |
|----------|--------------|------------------|-------------------------------------------|
| W25/50Rh | 25 | 0.05 mm Rh | 0.423 |
| W28/50Rh | 28 | 0.05 mm Rh | |
| W30/50Rh | 30 | 0.05 mm Rh | 0.468 |
| W35/50Rh | 35 | 0.05 mm Rh | 0.500 |

^acalculated for an anode angle 20°



– **D2:** ‘Open access spectrum catalogue including spectra for reference RQs...’

Classification of dosimeters based on their performance

1. Usage of dosimeter

Main results from the survey published

- Challenges with the use of calibration certificate for X-ray multimeters (XMMs)
- Challenges with uncertainty estimations

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.
 - E.g., energy dependence of response, limits of variation 5% =>



Calibration services for X-ray multimeters in Europe: current situation and future needs

Ivana Komatina^{a,b}, Vedrana Makarić^c, Miloš Živanović^a, Paula Toró^{d,e,*}, Aino Tietäväinen^d, Massimo Pinto^f, Luigi Rinaldi^{f,i}, Markus Borowski^e, Siarhei Saroka^b, Nikola Kržanović^g, Alessia Ciccotelli^h, Bartel Jansenⁱ, Stefan Pojtinger^j, Ana Fernandes^k, Vittorio Cannata^l, Mika Korttunen^c

| Influence quantity | IEC stated limits of variation [%] | Proposed limits of variation [%] | |
|--------------------|------------------------------------|----------------------------------|----------------------------|
| | | Field-class dosimeters | Reference-class dosimeters |
| Repeatability | 3 | 1* | 1* |
| Time Stabilization | 2 | 0.5 | 0.5 |
| Resolution | 1 | 0.5 | 0.5 |
| Linearity | 2 | 2 | 1 |
| Energy Dependence | 5 | 5 | 1.5 |
| Angular Dependence | 3 | 1 | 1 |
| Rotation | - | 0.5 | 0.5 |

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

1. **Clinical needs:** relevance of different quantities and target uncertainties.

- Target uncertainties for other quantities are not clear!

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*

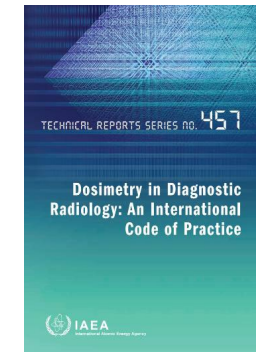
D6: Calibration and measurement procedures for XMMs for relevant quantities

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

- Defined gaps in XMM measurements
 - Geometry: positioning, viewing angle etc.
 - Impact of software
 - Radiation quality selection
 - Use of calibration certificate
 - Related uncertainties



Definition of "XMM quantities"



Validation of established calibration methods

1. Technical protocol for the comparison
2. Run the comparison
3. Draft comparison report



EURAMET Project 1676

Pilot study of air kerma and tube voltage for new radiation qualities in x-ray imaging using XMMs

Proposed identifier in Appendix B of the BIPM key comparison database (BIPM KCDB):

EURAMET Project 1677

Supplementary comparison of air kerma standards for x-ray imaging

Proposed identifier in Appendix B of the BIPM key comparison database (BIPM KCDB):

EURAMET.RI(I)-S21

EURAMET Project 1678

Supplementary comparison of tube voltage for x-ray imaging

Proposed identifier in Appendix B of the BIPM key comparison database (BIPM KCDB):

EURAMET.RI(I)-S20



Thank you for your attention!



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