

TraMeXI NEWSLETTER

2nd ISSUE · July 2025

EURAMET 22NRM01 TraMeXI project: An introduction

X-ray imaging is the most widely used medical diagnostic method and the largest source of artificial ionizing radiation exposure in Europe. While its use is typically justified, optimizing patient radiation dose without compromising image quality is essential. Modern semiconductor-based X-ray multimeters (XMMs) have largely replaced traditional ionization chambers, but their energy dependence and calibration challenges require careful attention. The EURAMET 22NRM01 TraMeXI project aims to update calibration and measurement procedures to better reflect current clinical practices and technological advancements.

This second newsletter presents the work carried out during the second year of the TraMeXI project. New reference radiation qualities has been proposed and tested, commonly used dosimeters has been assessed and harmonized calibration procedures have been defined. Validation of new calibration procedures through intercomparison is ongoing. Based on the data, updates to key international standards (IEC 61674, IEC 61676, IAEA TRS-457) will be proposed. These efforts will support reliable, traceable, and clinically relevant dosimetry to enhance patient safety.



Fig 1.: M18 joint meeting of TraMeXI project partners at STUK

TraMeXI consortium

The project is managed by the coordinator from STUK with a collaborative effort of the 22NRM01 TraMeXI consortium:

1. STUK – Radiation and Nuclear Safety Authority, Finland
2. CMI – Czech Metrology Institute
3. ENEA – National Institute of Ionizing Radiation Metrology, Italy
4. IMBiH – Institut of Metrology of Bosnia and Herzegovina
5. IST – Higher Technical Institute, Portugal
6. PTB – Physikalisch-Technische Bundesanstalt, Germany
7. TENMAK – Turkish Energy, Nuclear and Mineral Research Agency
8. VSL – National Metrology Institute, The Netherlands
9. EEAE – Greek Atomic Energy Commission
10. HUS – Helsinki University Hospital, Finland
11. INM – National Metrology Institute of the Republic of Moldova
12. OPBG – Italian Bambino Gesù Paediatric Hospital
13. SKBS – Municipal hospital Braunschweig, Germany
14. VINS – Vinca Institute of Nuclear Sciences, Serbia

In addition, the project has established collaborations with three institutions actively contributing to the project activities.

1. LUMC – Leiden University Medical Center, The Netherlands
2. LMRI-DEN/UFPE – Laboratory of Metrology of Ionizing Radiations, Department of Nuclear Energy, Federal University of Pernambuco, Brazil
3. ARPANSA – Australian Radiation Protection and Nuclear Safety Agency

This project is supported by broad metrological and scientific communities. For the time being, the 22NRM01 TraMeXI project has an extensive stakeholder committee (SC) with 22 members representing different stakeholders.

International organizations, standardization, regulators:

- IEC SC62C Working Group 3
- IAEA – International Atomic Energy Agency
- DIN NAR – German Institute of Standardization, Standards Committee Radiology
- HERCA – Heads of the European Radiological Protection Competent Authorities

Calibration laboratories:

- CEA – The French Alternative Energies and Atomic Energy Commission
- CIEMAT – Center for Energy, Environmental and Technological Research, Spain
- IRB – Ruđer Bošković Institute, Croatia
- UPC – Institute of Energy Technologies, Spain

Medical Physicist:

- EFOMP – European Federation of Organisations for Medical Physics
- DGMP – German Scientific Society for Medical Physics
- AIFM – Italian Association of Medical and Health Physics
- CHUV – The Vaud University Hospital Center, Switzerland
- SF – Finnish Society for Medical Physics and Medical Engineering
- NVKF – Society for Medical Physics in the Netherlands
- APT – Physics and Technology Working Group in Imaging Diagnostics, Germany

Companies (manufacturers):

- RTI Group, Sweden
- PTW – Freiburg, Germany
- RaySafe, Sweden
- IBA Dosimetry, Germany
- Radcal, USA
- Planmed, Finland
- QUART, Germany

Work packages and current results

This project was launched in July 2023 for the duration of three years. The overall objective of the project is to harmonize and standardize calibration and measurement procedures to ensure traceability and accurate dosimetry in medical X-ray imaging.

The last “Publishable Summary” is available here:

<https://www.euramet.org/research-innovation/search-research-projects/details/project/traceability-in-medical-x-ray-imaging-dosimetry>

WP 1: Revision of reference radiation qualities

The aim of this work package (WP) is to find a representative selection of radiation qualities relevant to medical X-ray imaging and, based on the outcome, to propose an update of the reference radiation qualities used for calibration purposes and testing of X-ray systems. The proposal will contribute to the future revisions of IEC 61267 and IAEA TRS-457.

During the second year of the project, the protocol for measuring the photon spectra under clinical conditions was developed and measurement for three type of devices was performed. The list of devices includes: 1. medical X-ray imaging devices used in mammography, 2. C-arm systems (with copper-filtered qualities), 3. conventional diagnostic projection units. Monte Carlo simulations for these clinical systems were performed and the results will be compared with the measured spectra.

The new clinically relevant and physical representative radiation quality (CPRQs) covering copper filtered beams were proposed and established in several calibration laboratories.

The spectrometry was performed for established CPRQs and existing standard IEC 61267 radiation qualities.

WP 2: Classification of dosimeters based on their performance

The aim of this work package is to investigate and evaluate the performance characteristics of different types of commercially available X-ray dosimeters (ionization chambers and XMMs) in terms of air kerma quantity. The obtained results will be used to define specific requirements for reference and field-class dosimeters. Based on relevant achievements, proposal on updated limits of variation will be provided

as input to the future revisions of IEC 61674 and IAEA TRS-457.

During the last period of the project, the protocol for testing the performance of the dosimeters was finalized and was used to assess the effect of the identified influence quantities.

The 13 Calibration laboratories performed measurements taken from over 40 dosimeters in accordance with the developed protocol. The analysis of the obtained results was carried out, and recommendations were written for the specific requirements which were presented at the IEC TC62 SC62C WG3 annual meeting in May 2025.

WP 3: Development of harmonized calibration and measurement procedures for X-ray multimeters

The aim of this work package is to define harmonized calibration and measurement procedures for XMMs and to investigate the current state-of-the-art clinical measurement devices covering different types of XMMs. The harmonized procedures will enable an unbroken traceability chain for measurements of relevant clinical parameters. This will provide input to the future revisions of IEC 61674, IEC 61676 and IAEA TRS-457.

Analysis of more than 75 papers and other documents was performed and summarized. Analysis also included the literature, questionnaires on clinical use of XMMs, calibration capabilities, legal requirements and KCDB review. This together with the data collected from survey sent to medical physicist (WP2) and dosimetry laboratories (WP3) was analysed and a scientific paper on calibration services for XMMs was submitted.

A long list of dosimeters, used in X-ray imaging dosimetry, was compiled (34 ionization chambers and 56 XMMs), and all available data on performance were collected.

The collection and review of existing calibration procedures has been completed. Also, the calibration procedures and uncertainty analysis at the laboratory for XMMs were created. The last final version for calibration of the X-ray multimeter needs to be updated.

Based on existing guidelines and standards and over 35 clinical procedures and protocols which were collected, a new clinical procedure was developed. In accordance with developed procedure the measurements for calibration and testing of XMMs was started.

In November 2024, HUS and STUK successfully organized workshop on X-ray imaging dosimetry for medical physicists (Figure 2).

WP 4: Validation of established calibration methods

The aim of this work package is to validate updated calibration and comparison procedures for radiation fields as identified in WP1, applied to different classes of dosimeters as selected in WP2 and following the protocols established in WP2 and WP3.

The comparison protocol was approved and implemented by EURAMET:

- EUR-1676 Pilot study of air kerma and tube voltage for new radiation qualities in x-ray imaging using XMMs
- EUR-1677 Supplementary comparison of air kerma standards for x-ray imaging (EURAMET.RI(I)-S21)
- EUR-1678 Supplementary comparison of tube voltage for x-ray imaging (EURAMET.RI(I)-S20)

Supplementary comparisons were registered at the KCDB BIPM.

The comparisons started on the 1st of November 2024. At June 2025 the first cycle (EU countries) of the comparisons is finished.

WP 5: Creating impact

This work package covers the activities related to dissemination, communication, exploitation and uptake.

The official website of the project is started on **tramexi.com** and it is running and updated regularly.

In addition to website was set-up an on-line Discussion Group on LinkedIn to exchange information among the project participants and the end-users

(<https://www.linkedin.com/groups/9515378/>)

Three papers were published on dosimeter testing using clinical mammography machines. The tests included the influence of the compression paddle,

different combinations of anode and filter material and different XMM settings on XMM indication of different quantities. One paper was published on determination of X-ray tube voltage by spectrometry.

- Kojić, A. et al (2024) 'Influence of anode/filtration setup on X-ray multimeter energy response in mammography applications', *Radiation Measurements* p. 107135. Available at <https://doi.org/10.1016/j.radmeas.2024.107135>
- Costa de Castro, M. et al (2024) 'Impact of the measurement conditions and compression paddle on mammography dosimeter response', *Physica Medica European Journal of Medical Physics*, 123(July 2024) p. 103405. Available at <https://doi.org/10.1016/j.ejmp.2024.103405>
- Jaroslav Šolc et al (2024) "The spectrometric practical voltage: determination of X-ray tube voltage up to 300 kV by in-beam X-ray spectrometry with a cadmium telluride detector", *Journal of Instrumentation*, Volume 20, February 2025. Available at <https://doi.org/10.1088/1748-0221/20/02/P02013>
- Elisabeth Salomon et al (2025) "Energy dependence of the response of X-ray multimeter for radiation qualities in mammography", *Scientific Reports* volume 15, Article number: 9857 (2025). Available at <https://doi.org/10.1038/s41598-025-93485-5>

Three presentations and a poster were presented at the ECMP - 5th European Congress of Medical Physics. One presentation was presented at the European Congress of Radiology 2025.

An article was published in the IAEA SSDL Newsletter no 79. Available at <https://www.iaea.org/publications/15737/ssdl-newsletter-issue-no-79-may-2024>

WP 6: Management and coordination

This WP covers the activities related to project management and coordination.

Past Events

Several project meetings, including monthly meetings and separate technical discussions, has been organized during the second year of the project. Here below are listed the most important meetings:

CCRI Webinar “X-ray imaging dosimetry challenges”

The webinar was held on Zoom on 28 May 2024 at 12:00 UTC.

The webinar covered topic of X-ray imaging dosimetry. Including following topics:

- *XMM Technology - Before and Today (Sören Sturesson, RTI, Sweden)*
- *International code of practice IAEA TRS457 and the need for updates (Zakithi Msimang, IAEA)*
- *Relevant IEC Standards (Wesley Culberson, IEC/UWADCL)*
- *Regulations on X-ray imaging dosimetry (Jenia Vassileva, Bulgaria)*
- *X-ray imaging dosimetry challenges Medical Physics perspective (Olivera Ciraj Bjelac, IAEA)*
- *Calibration Laboratory Perspectives (Helen Khoury, UFPE, Brazil)*



Fig 1.: CCRI webinar on X-Ray imaging dosimetry challenges

Recorded video is available on the CCRI YouTube channel

https://www.youtube.com/watch?v=TZe2vdv0EhU&list=PL-vj-3_a7wTAv-QmW_azu78r1UXvBiu&index=10

Also a EURAMET News was published on this event:

<https://www.euramet.org/publications-media-centre/news/news/webinar-on-x-ray-imaging-dosimetry-challenges-attracts-record-numbers>

M18 and 3rd Stakeholder Committee meetings

The meetings were organized from 18th to 19th November 2024 by STUK. A specific session was dedicated for the SC meeting which was held in an online format. The status of activities and corresponding achievements within were presented.

Workshop on X-ray imaging dosimetry

After M18 meeting in Helsinki from 20 to 22 November 2024 was organized workshop on X-ray imaging dosimetry for medical physicists.

The workshop covered the following topics: X-ray dosimetry equipment and procedures, uncertainties, patient-specific dosimetry, practical demonstrations, and experimental and computational dosimetry. The workshop was hosted by one of the participants - Helsinki University Hospital (HUS) and brought together 70 professionals in medical physics and metrology from 16 countries. The event was endorsed by EFOMP (European Federation of Organisations for Medical Physics) and organised in collaboration with NACP-RPC (Nordic Association for Clinical Physics Radiological Physics Committee).



Fig 2.: Workshop on X-ray imaging dosimetry at HUS

More information at the official workshop webpage:

<https://tramexi.com/workshop/>

Also EURAMET News was published on this event: <https://www.euramet.org/publications-media-centre/news/news/successful-metrology-partnership-project-workshop-on-x-ray-imaging-dosimetry>

EURAMET TC-IR Meeting

The Technical Committee for Ionizing Radiation (TC-IR) is concerned with the metrology of ionizing radiation related to medical, industrial, environmental, scientific and radiation protection applications. During the TC-IR meeting in the NPL (GB), from 1st to 3rd April 2025, the overview and advances of TraMeXI were presented by project coordinator Mrs. Paula Toroi (STUK).



Fig 3.: EURAMET TC IR meeting 2025 at NPL

CCRI Webinar on “Updates on X-ray imaging Dosimetry Practices”

As a follow-up to the CCRI webinar “X-ray imaging dosimetry challenges”, a CCRI Webinar on “Updates on X-ray imaging Dosimetry Practices” was organized almost a year later. The webinar was held on Zoom on 25 April 2025 .

This webinar responds to challenges that have been identified in the X-ray imaging dosimetry and ionizing radiation metrology. What updates are proposed to international standards, calibration capabilities and dosimetry codes or practice to address the current needs, and to maintain traceability in X-ray imaging dosimetry.

The webinar covered following topics:

- *Update of reference radiation qualities (Stefan Pojtinger, PTB, Germany)*
- *Definition of XMM measurement quantities (Miloš Živanović, VINS, Serbia)*
- *Clinical implementation of new procedures (Olivera Ciraj Bjelac, IAEA)*

Recorded video is available on the CCRI YouTube channel

https://www.youtube.com/watch?v=C94dm3xpml8&list=PL-vj-3_a7wTAv-QmW_azu78hR1UXvBiu&index=1&t=5s

Upcoming Events

The consortium is currently preparing to contribute to the following meetings, conferences and workshops:

Date	Event	Location
1 – 3 September 2025	Workshop for radiation metrologists on calibration of dosimeters for X-ray imaging dosimetry	Athens, Greece
4 – 5 September 2025	M27 meeting	Athens, Greece

22NRM01 TraMeXI

Traceability in medical X-ray imaging dosimetry

**September
1st - 3rd 2025**

**Greek Atomic Energy Commission
(EEAE), Athens, Greece**

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

This workshop is designed to update calibration laboratories on the new measurement calibration and type testing procedures developed in the project, for dosimeters used in X-ray imaging. The goal is to integrate these developments in XMM calibrations to enhance calibration accuracy and thereby optimizing patient safety.

Topics to be covered

- X-ray dosimetry equipment
- Calibration procedures in XMMs
- Uncertainties
- Hands-on training

Acknowledgements

The TraMeXI consortium is grateful to have this powerful support from colleagues worldwide. Further interest in collaboration with the partners of the 22NRM01 TraMeXI project is welcome.

Additional information about the consortium, work packages, project goals, publications, and events can be found on the project website at www.tramexi.com.

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