

TraMeXI NEWSLETTER

1st ISSUE · April 2024

EURAMET 22NRM01 TraMeXI project: An introduction

X-ray imaging is the most frequently used form of medical diagnostics applications worldwide. The use of medical X-rays is undoubtedly beneficial to human health because it saves countless lives; however, it represents the largest component of exposure to artificial ionizing radiation in Europe. The use of ionizing radiation in medicine is typically well justified, but due to the potential detriment to patients, the radiation doses measured with dosimeters must be optimized with regards to acceptable image quality as required in the Council Directive (2013/59/Euratom). Therefore, accurate and consistent quantification of patient radiation exposure with calibrated dosimetry equipment is essential to ensure the safety of patients.

X-ray systems provide the option of adjusting their energy spectra so that image quality and patient dose can be optimised. Measuring instruments that have been most commonly used in the field of X-ray imaging are ionization chambers. The recent technological advances in dosimetry have brought into use the semiconductor-based X-ray multimeters (XMMs) that have become the most common dosimeters in use at hospitals. These dosimeters are capable of measuring radiation dose in terms of air kerma but also offer the possibility of measuring further quality control parameters which are used for X-ray system testing.

Compared to ionization chambers, the response of a semiconductor detector has more pronounced energy dependence. To overcome this challenge, manufacturers have created algorithmic corrections, which can also be challenging for confirmation of the uncertainties and traceability of the measurements. To achieve consistent, comparable, and traceable measurement results, these dosimeters must be calibrated, measurement methods must be harmonized and uncertainties must be estimated.

The calibration procedures used by calibration laboratories are mainly based on relevant standards IEC 61267, IEC 61674, IEC 61676 and international code of practice IAEA TRS-457. However, they do not fully consider the recent technical developments within medical X-ray imaging.

Calibration of relevant dosimeters in specific radiation beams requires appropriate selection of the radiation qualities that should be as close as possible to the ones used in clinical practice. According to the current situation in this field, these qualities do not cover the entire clinical range and thus the traceability chain cannot be fully achieved. This leads to the situation where calibration coefficients need to be interpolated or even extrapolated for different clinical conditions.

Requirements for performance of dosimeters used for X-ray imaging are defined based on limits of variation for the effects of influence quantities in both IEC 61674 and IAEA TRS-457. One important influence quantity is radiation quality, and the limits of variation are defined based on the given reference radiation qualities (IEC 61267). Currently, they do not allow a clear distinction between reference and field-class dosimeters, nor take sufficiently into account the characteristics of the dosimeters that exist on the market today. There are no agreed performance requirements, limits of variation or calibration guidance for dosimetry equipment used for these measurements. In addition, there are no agreed or validated calibration or measurement procedures for these dosimeters.

The EURAMET 22NRM01 TraMeXI project aims to update calibration and measurement procedures, so that they provide the best support for the end-users of dosimeter. This project will perform a critical assessment of conditions applied in calibrations compared to those used in clinical practice and will study the performance of different dosimeters used at clinics and for calibrations.

To achieve this goal the following activities will be performed: a review of relevant X-ray radiation fields, investigation of performance of several commercially available XMMs and update of relevant requirements, definition of harmonized calibration procedure for different parameters, validation of established calibration procedures through an intercomparison and, based on the outcomes, provision of inputs to IAEA CRP E24024 and proposal on revisions of IEC 61674, IEC 61676 and IAEA TRS-457.

TraMeXI consortium

The consortium of TraMeXI includes leading European institutions that contribute their competence, knowledge and experience in the field of X-ray imaging dosimetry and the practical use of relevant dosimeters. The project is managed by the coordinator from STUK with a collaborative effort of the 22NRM01 TraMeXI consortium. At the moment, 14 partners involving NMI, DI and hospitals are working on TraMeXI objectives.

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 first 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 “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 system. The proposal will contribute to the future revisions of IEC 61267 and IAEA TRS-457.

During the first year of the project, an investigation of the use of different radiation qualities in clinical practice was performed and measurement procedures for spectra measurements at clinical sites were developed.

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.

In the beginning of the project, an evaluation of the use of different dosimeters in clinical and calibration practice was performed. The data is collected and the relevant analysis is finalized based on literature studies and surveys which were sent to medical physicists and dosimetry laboratories.

Data on commercially available dosimeters and the performance requirements were gathered. This was done in order to identify the most relevant dosimeter

for further studies. The influence quantities and performance criteria of current IEC standards were evaluated. All the above will be used to make proposal for dosimeter classification.

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.

A selection of relevant XMMs has been done, but the specific activities related to the harmonization and update of the procedures and measurement uncertainties are in the initial phase.

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 validation of established calibration procedures will be performed through an intercomparison. The quantities are limited to air kerma and X-ray tube voltage according to qualities available in the Key Comparison Database (KCDB).

WP 5: Creating impact

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

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 first year of the project. Here below are listed the most important meetings:

Kick-off meeting of TraMeXI

The kick-off meeting was held on 11 – 12 July 2023 at STUK. Various administrative and technical formalities were discussed and workflow on further activities was planned. The WP leaders presented the planned activities and the stakeholder committee was formed.



Fig 1.: Kick-off meeting participants at STUK

1st Stakeholder Committee meeting

The 1st Stakeholders Committee meeting of TraMeXI project was held on 5th October 2023 in an online format. Project background and objectives of TraMeXI and WPs were presented to the SC.

M9 and 2nd Stakeholder Committee meetings

The meetings were organized from 6th to 7th February 2024 by ENEA and OPBG. 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.



Fig 2.: M9 joint meeting of TraMeXI project partners at OPBG

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, from 5th to 7th March 2024, the overview and advances of TraMeXI were presented by project coordinator Mrs. Paula Toroi (STUK).

Technical Visits

Several technical visits have been organized within the first year of the project:

- ❖ ENEA and STUK organized a technical visit related to the measurements of endpoint energy on the X-ray spectra generated using the low-energy and the medium-energy X-ray units, in July 2023 at STUK.
- ❖ STUK and CMI organized a technical visit related to the discussions on X-ray beam setups and spectrometry, in September 2023 at CMI.
- ❖ PTB and CMI organized a technical visit related to the discussions on X-ray spectrometry, in October 2023 at CMI.
- ❖ OPBG organized a technical visit related to the measurements of X-ray spectra and QA parameters with X-ray multimeters in clinical conditions, in February 2024 at OPBG.
- ❖ ENEA organized a technical visit related to the measurements of X-ray spectra in the calibration laboratory, in February 2024 at ENEA.
- ❖ PTB, STUK and Planmed organized a technical visit in February 2024 at Planmed.



Fig 3.: Technical visit at Planmed

Upcoming Events

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

Date	Event	Location
29 April – 1 May 2024	Council on Ionizing Radiation Measurements & Standards (CIRMS) conference	Rockville, MD, USA
2 – 3 May 2024	IEC SC 62C WG3 meeting	Alexandria, VA, USA
28 May 2024 12:00 UTC	CCRI Webinar (see the advertisement below)	virtual
11 – 14 September 2024	European Congress of Medical Physics (ECMP)	Munich, Germany
18 – 19 November 2024	TraMeXI M18 Meeting	Vantaa, Finland
20 – 22 November 2024	Workshop for medical physicists	Helsinki, Finland
September 2025	Workshop for radiation metrologists	Athens, Greece

28 May – 12:00 UTC: X-ray imaging dosimetry challenges

CCRI webinar

Programme

Introduction (*Paula Toroj*, STUK, Finland)

XMM technology before and today (*Sören Stuesson*, RTI, Sweden)

Current situations and need for updates :

- **Relevant IEC standards** (*Wesley Culbertson*, IEC/UWADCL, USA)
- **International code of practice IAEA TRS-457** (*Zakithi Msimang*, IAEA)
- **Regulations on X-ray imaging dosimetry** (*Jenia Vassileva*, Bulgaria)
- **Medical Physics perspective** (*Olivera Ciraj Bjelac*, IAEA)
- **Calibration laboratory perspective** (*Helen Houry*, UFPE, Brazil)
- **Current efforts for improvement** (*Paula Toroj*, STUK)



Registration to the CCRI webinar:

<https://bipm-org.zoom.us/meeting/register/tZYsceqtrDsvE9zwooSX8dq0bPc31f1hCKYp>

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.

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.

EUROPEAN PARTNERSHIP



Co-funded by the European Union

The project 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.

METROLOGY PARTNERSHIP

