EMPIR Call 2016 – Energy, Environment, Normative and Research Potential

Selected Research Topic number: **SRT-r04**
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Title: Traceability for dosimetry in diagnostic radiology

Abstract

Ionising radiation, typically X-rays, is commonly used in medical diagnostics, and will usually account for the majority of the radiation exposure of the general public due to artificial sources. It is therefore important that the radiation received by a patient is minimised but effectively targeted to ensure reliable diagnostics.

A lack of harmonised practices in recently established NMI SSDLs and some clinical centres, together with limited understanding of the impact of factors such as the divergence between the clinical beam used and calibration beam qualities on the dosimetry of mammography and KAP meters, results in additional measurement effects and uncertainties being undetected and quantified.

There is therefore a need to improve traceability for radiation radiology qualities, quality assurance and calibration services of emerging NMIs/DIs and SSDLs to underpin measurements by clinical centres, and to transfer knowledge of the factors that influence radiation diagnostic dosimetry measurements to these end users.

Keywords

Traceability; TRS457 (IAEA Technical Report Series 457); KAP meter (Kerma Area Product meters); diagnostic radiology; quality assurance; intercomparison; SSDL (Secondary Standard Dosimetry Laboratory); mammography; radiography radiation qualities (RQR);

Background to the Metrological Challenges

Medical ionising radiation sources provide by far the largest contribution to the dose received by the public from artificial sources, with the majority of this contribution (above 90 %) arising from diagnostic X rays often due to the large number of X ray examinations performed every year.

Dosimetry for diagnostic radiology requires the use of specialised instrumentation, the design and performance of which must be matched to the needs of the clinical situation. The use of this instrumentation and the interpretation of the results obtained may require specialised techniques and knowledge. It is essential that the procedures for dose measurements used in clinics are standardised. In addition, it is important that the calibration of such instruments so that the measurements are traceable to national or international standards. Clinical needs together with the requirements for traceability of the measurements to the SI constitute the two pillars of the framework for dosimetry measurements in diagnostic radiology.

Diagnostic X-ray imaging covers a diverse range of examination types, many of which are increasing in frequency and technical complexity. This has resulted in the development of new dosimetric measuring instruments, techniques and terminologies which present challenges to those working in the clinical environment and those supporting them in calibration facilities. Some NMIs/DIs have recently established a Secondary Standard Dosimetry Laboratory (SSDL) unit for diagnostic radiology and need to build up their capability, whilst improvements are needed in the quality of dosimetry in diagnostic radiology performed by some clinical centres.

Well-defined energy of the radiation quality will have important influence on the quality of the calibration. NMIs and SSDLs need to ensure that the measurement capabilities they establish for radiography radiation qualities meet the acceptance criteria for each beam quality defined in the IAEA's 'Implementation of the International Code of Practice on Dosimetry in Diagnostic Radiology (TRS 457)'. Two weak points in the field of metrology for diagnostic radiology, namely dosimetry of mammography and KAP meters, have been identified where the divergence between the clinical beam used and calibration beam qualities introduces additional measurement effects and uncertainties. Calibrations of kerma air produce (KAP) meters is usually performed using small area fields, however the fields used in radiology diagnostics may differ from the area of calibration field and

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the impact of this needs to be determined. Clinical mammography measurements of the incident air kerma, K_i may well differ from the calibration of the mammography quality and this also should be taken into account.

It is therefore essential that there is a systematic and consistent approach to ensure effective and reliable traceability and quality assurance and quality control of X-rays used in diagnostic radiology, in order to prove more precise KAP meter and mammography measurements thus protecting patients and enabling reliable radiological diagnostics.

Objectives

Proposers should address the objectives stated below, which are based on the PRT submissions. Proposers may identify amendments to the objectives or choose to address a subset of them in order to maximise the overall impact, or address budgetary or scientific / technical constraints, but the reasons for this should be clearly stated in the protocol.

The JRP shall focus on the development of metrological capacity in dosimetry for diagnostic radiology.

The specific objectives are

1. To establish measurement capabilities for radiography radiation qualities, including the determination of half-value layer (HVL) values and to undertake a comparison between the participants of the new capabilities. The capabilities established should meet the acceptance criteria for the HVL value for each beam quality defined in the IAEA's Code of Practice TRS 457, namely that the K_{HVL}/K_0 ratio should be between 0.485 and 0.515, where K_{HVL} is the air kerma for the specified beam with an added attenuator equal to the HVL specified for the beam qualities in TRS 457.
2. To evaluate the effect of field size on the calibration of kerma area product (KAP) meters and to assess the accuracy of the determination of the air kerma at the point of measurement for the beam qualities and dosimeters used. To develop calibration uncertainty budgets which include the effect of field size on KAP calibrations.
3. To evaluate the influence of the different conditions during clinical mammography measurements of the incident air kerma, K_i, from those of calibration of the mammography quality and to determine the corrections that should be applied to account for this effect, where applicable. To support the end user community in developing realistic measurement uncertainty budgets.
4. To actively engage with clinical centres undertaking diagnostic radiology to ensure that they are aware to the potential divergence between the clinically beam used and the calibration beam qualities, which affects dosimetry of mammography and KAP meters and to facilitate uptake of the project's outputs by these end users.
5. For each participant, to develop an individual strategy for the long-term operation of the capacity developed, including regulatory support, research collaborations, quality schemes and accreditation. They should also develop a strategy for offering calibration services from the established facilities to their own country and neighbouring countries. The individual strategies should be discussed within the consortium and with other EURAMET NMIs/DIs, to ensure that a coordinated and optimised approach to the development of traceability in this field is developed for Europe as a whole.

Joint Research Proposals submitted against this SRT should identify

- the particular metrology needs of stakeholders in the region,
- the research capabilities that should be developed (as clear technical objectives),
- the impact this will have on the industrial competiveness and societal needs of the region,
- how the research capability will be sustained and further developed after the project ends.

The development of the research potential should be to a level that would enable participation in other TPs.

Proposers should note that the programme funds the activity of researchers to develop the capability, not the required infrastructure and capital equipment, which must be provided from other sources.

EURAMET has defined an upper limit of 500 k€ for the EU Contribution to any project in this TP, and a minimum of 100 k€.

Submitted proposals should, where possible, include representatives from the end user community (for example clinical centres) within the consortium.

EURAMET also expects the EU Contribution to the external funded partners to not exceed 10 % of the total EU Contribution to the project.

Potential Impact

Proposals must demonstrate adequate and appropriate participation/links to the “end user” community, describing how the project partners will engage with relevant communities during the project to facilitate knowledge transfer and accelerate the uptake of project outputs. Evidence of support from the “end user” community (e.g. letters of support) is also encouraged.

You should detail how your JRP results are going to:

- Address the SRT objectives and deliver solutions to the documented needs,
- Provide a lasting improvement in the European metrological capability and infrastructure beyond the lifetime of the project,
- Facilitate improved industrial capability or improved quality of life for European citizens in terms of personal health or protection of the environment,
- Transfer knowledge to the medical sector including clinical centres undertaking diagnostic radiology and the metrology community.

You should detail other impacts of your proposed JRP as specified in the document “Guide 4: Writing Joint Research Projects (JRPs)”

You should also detail how your approach to realising the objectives will further the aim of EMPIR to develop a coherent approach at the European level in the field of metrology and include the best available contributions from across the metrology community. Specifically the opportunities for:

- improvement of the efficiency of use of available resources to better meet metrological needs and to assure the traceability of national standards
- the metrology capacity of EURAMET Member States whose metrology programmes are at an early stage of development to be increased
- organisations other than NMIs and DIs to be involved in the work

Time-scale

The project should be of up to 3 years duration.