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

Selected Research Topic number: **SRT-n10**
Version: 1.0

Title: Protection from accelerator based high-energy ionising radiation fields

Abstract

The use of pulsed high-energy radiation fields, produced by linear accelerators, is increasing in medicine, industry and research. Reliable measurements behind the protective shielding are urgently needed in order to ensure radiological protection of workers and the general public. Due to concerns over the applicability and performance of dosemeters used in this type of field, there is need to set-up a reference field for high-energy pulsed radiation. There is also a requirement to develop new concepts for standards specifying these fields and for type testing of the dosemeters in order to support the standardisation work of ISO/TC85/SC2 “Radiological Protection” and IEC/TC45/SC45B “Radiation Protection Instrumentation”.

Keywords

Radiological protection, dosemeters, high-energy radiation, linear accelerator, pulsed reference field, type testing

Background to the Metrological Challenges

The number of high-energy accelerators used in medicine and research is increasing. The structural radiation protection necessary for accelerators in hospitals and research facilities is calculated in advance of the construction. In order to ensure the radiological protection of occupationally exposed workers and the general public once the accelerator is in operation, dosemeters are used to measure the radiation behind the protective shielding. Pulsed radiation with a short pulse duration of a few microseconds, or even less, in combination with a very high pulse dose rate is a very demanding measurement condition for active electronic dosemeters, and electronic dosemeters can exhibit significant deficiencies under such conditions. The European Radiation Dosimetry Group (EURADOS) Working Group 11 “High Energy radiation fields” is planning an intercomparison using active and passive dosemeters at a special medical accelerator in order to investigate the problems likely arise to at new types of research accelerators e.g. Free-Electron Lasers (FEL) or the Extreme Light Infrastructure (ELI) in Hungary.

IEC/TS 62743:2012 “Radiation protection instrumentation – Electronic counting dosemeters for pulsed fields of ionising radiation” is a standard for type testing of counting dosemeters. A new work item proposal to extend this by a generalised test procedure is under development. This type testing standard is only applicable in the well-defined pulsed x-ray reference fields defined in ISO/TS 18090-1:2015 “Radiological Protection - Characteristics of reference pulsed radiation — Part 1: Photon radiation.” For the radiation fields used in research and medical linear accelerators, little experience exists and no standard reference fields are available. In addition, the dose contribution from the neutron component of such high-energy photon fields has historically often been neglected. Measurement of the neutron component is very demanding because adequate reference fields for validation are missing. The availability of suitable reference fields and type test requirements is therefore a precondition in order to develop a new generation of dosemeters able to cope with high-energy pulsed radiation fields and to ensure reliable radiation protection measurements.

There is an urgent need to bring together all these national approaches and to set up pulsed high-energy reference radiation fields based on a common international standard (ISO / CEN) and to establish type test requirements on an international basis (IEC / CENELEC).

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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 metrology research necessary to support standardisation in radiological protection for high-energy pulsed ionising radiation to underpin ISO/TC85/SC2 “Radiological Protection” and IEC/TC45/SC45B “Radiation Protection Instrumentation”.

The specific objectives are:

1. To set-up reference fields for high-energy pulsed photon radiation suitable for the calibration of dosemeters used for radiological protection at linear accelerators.
2. To develop measurement instruments to reliably characterise and measure the photon and the neutron components within high-energy pulsed photon radiation fields. To develop and to provide a reliable database for the ICRU and to provide suggestions for new radiation protection quantities at high energies.
3. To develop a method to traceably measure and characterise accelerator based, high-energy radiation reference fields and to develop a draft ISO/TS as an extension of ISO/TS 18090-1 based on this method.
4. To develop a method for type testing of dosemeters in pulsed radiation fields and to develop a more generalised draft IEC Technical Specification for type testing of dosemeters in pulsed radiation fields.
5. To contribute to the standards development work of ISO/TC85/SC2 and IEC/TC45/SC45B, particularly related to ISO/TS 18090-1 and IEC/TS 62743. To ensure that the outputs of the project are aligned with their needs, communicated quickly to those developing the standards and to those who will use them, and in a form that can be incorporated into the standards at the earliest opportunity

The proposed research shall be justified by clear reference to the measurement needs within strategic documents published by the relevant Standards Developing Organisation or by a letter signed by the convenor of the respective TC/WG. EURAMET encourages proposals that include representatives from industry, regulators and standardisation bodies actively participating in the projects.

Proposers should establish the current state of the art, and explain how their proposed research goes beyond this.

EURAMET has defined an upper limit of 1.2 M€ for the EU Contribution to this project.

EURAMET also expects the EU Contribution to the external funded partners to not exceed 30 % of the total EU Contribution to the project.

Any industrial partners that will receive significant benefit from the results of the proposed project are expected to be unfunded partners.

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,
- Feed into the development of urgent documentary standards through appropriate standards bodies, in particular ISO/TC85/SC2, IEC/TC45/SC45B and ICRU,
- Transfer knowledge to the radiological protection community, the medical sector dosemeter manufacturers and regulators.

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.