EMPIR Call 2019 – Energy, Environment, Normative and Research Potential

Selected Research Topic number: **SRT-n13**
Version: 1.0

Title: Traceable dosimetry for small fields in MR-guided radiotherapy

Abstract

The next step in advanced radiotherapy is to combine beams of ionizing radiation and MRI to image the patient during treatment. Two methods lead the field, MR-guided X-ray therapy (MRgXT) and MR-guided proton therapy (MRgPT). In MRgXT, small MV photon beams are extensively used to deliver optimised dose distributions to the patient. MRgPT is foreseen as the future method by using small proton beam based MRgRT facilities. Both modalities require more research in small field dosimetry, in the presence of magnetic fields, before developing written standards.

Keywords

MR-guided radiotherapy, small field dosimetry, photon beams, proton beams

Background to the Metrological Challenges

1.4 million cancer treatments are performed with radiotherapy annually in Europe. MR-guided X-ray therapy (MRgXT) is the next step in the ongoing development of radiotherapy to improve treatment efficacy. Several university groups in collaboration with industry are exploring the feasibility of MR-guided proton therapy (MRgPT) by integrating proton beams with MRI scanners. The main difference between MRgPT and MRgXT is the superior physical properties of proton beams compared to photon beams, which makes the dose deposition sharply peaked in depth with no dose deposited behind this peak.

While developments in MRgPT are lagging behind MRgXT, universities and industry will need traceable methods for dosimetry to show the feasibility of dose delivery with MRgPT prototypes on the short term and to prepare for pre-clinical and clinical investigations on the longer term. However, methods for traceable dosimetry in scanned proton beams in the presence of magnetic fields are lacking and this needs to be addressed. Nevertheless, MRgXT and MRgPT are facing similar challenges in small-field dosimetry. There is a strong need for pre-normative research supporting the development of guidelines for dosimetry in MRgRT and to harmonize the to-be-developed small field dosimetry methodology for MRgRT with the IAEA TRS-483 formalism.

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 traceable measurement and characterisation of absorbed dose-to-water in small photon and proton beams (< 3 cm) in the presence of magnetic fields.

The specific objectives are

1. To investigate detector properties and their suitability for small-field dosimetry in MR-guided X-ray therapy (MRgXT) and MR-guided proton therapy (MRgPT).
2. To determine correction factors and develop a measurement methodology for small fields in MRgXT extending the concept of IAEA/AAPM TRS-483 with a target uncertainty of 2.0 % (k = 1). This should be done by performing measurements (primary standards and indirect methods) and Monte Carlo simulations, including investigations on field characteristics and off-axis conditions.

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3. To investigate whether established traceable dose measurement methods for MRgXT are applicable for scanned pencil-beam based MRgPT modalities (experimentally and by Monte Carlo simulations) and can be extended to the concept of IAEA/AAPM TRS-483.
4. To facilitate the take up of methods, technology, guidelines, Codes of Practice and measurement infrastructure developed in the project by the standards developing organisations (such as IAEA) and end-users, such as clinical stakeholders, and manufacturers of facilities and measurement equipment.

The proposed research shall be justified by clear reference to the measurement needs within strategic documents published by the relevant Regulatory body or 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. The proposal must name a “Chief Stakeholder”, not a member of the consortium, but a representative of the user community that will benefit from the proposed work. The “Chief Stakeholder” should write a letter of support explaining how their organisation will make use of the outcomes from the research, be consulted regularly by the consortium during the project to ensure that the planned outcomes are still relevant, and be prepared to report to EURAMET on the benefits they have gained from the project.

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

EURAMET expects the average EU Contribution for the selected JRPs in this TP to be 0.8 M€, and has defined an upper limit of 1.0 M€ for this project.

EURAMET also expects the EU Contribution to the external funded partners to not exceed 30 % of the total EU Contribution across all selected projects in this TP.

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,
- Transfer knowledge to the medical sector.

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.