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

Selected Research Topic number: **SRT-v16**
Version: 1.0

Title: Metrology for mass spectrometry traceability for nuclear decommissioning and environmental monitoring

Abstract

Plasma mass spectrometry (ICP-MS) is increasingly used to meet the Europe-wide challenge of achieving cost-effective nuclear decommissioning and environmental monitoring around nuclear sites. Given its increasing application, radionuclide quantification by ICP-MS must be underpinned by traceable, fit-for-purpose methods, which are critically lacking. This will lead to the development of relevant reference sources initiating ICP-MS-specific radionuclide inter-comparison exercises. ICP-MS as an established routine technique will improve end-user confidence in the fields of nuclear decommissioning and environmental monitoring.

Keywords

Nuclear decommissioning, environmental monitoring, ICP-MS, traceability, nuclear decay data, reference materials

Background to the Metrological Challenges

The cost of decommissioning nuclear facilities in the EU is estimated at €150 billion, with 91 power plants currently undergoing decommissioning. Of the available techniques, plasma mass spectrometry (ICP-MS) is being increasingly adopted as the solution for rapid, cost-effective, high throughput and routine measurement of multiple medium and long-lived radionuclides as an alternative to alpha and beta-counting techniques and has expanded the number of radionuclides measurable compared to decay counting techniques alone. A range of ICP-MS designs have been applied to radionuclide measurement, including ICP-MS/MS, MC-ICP-MS, HR-ICP-MS, and ICP-TOF-MS. Each design has relative strengths and disadvantages with regards to sensitivity, detection limits, selectivity and the precision of isotope ratio measurements (e.g. $^{236}U/^{238}U$ and $^{239}Pu/^{240}Pu$) for determining the source of contamination for nuclear security purposes. The capabilities of different instruments are generally known, as is the increasing ability of ICP-MS to expand the number of radionuclides measurable compared to decay counting techniques alone. The combination of atom counting by ICP-MS and decay counting using primary and secondary techniques to improve nuclear decay data has been recognised by several laboratories around Europe. The existing data for number of radionuclides suffer from outdated measurements, high uncertainties and/or poor understanding or dissemination of the uncertainty budget, which in turn impacts the quality and confidence of the measurements made in decommissioning and environmental monitoring applications. There is an opportunity to initiate the first ICP-MS-specific proficiency testing in this field, which will also improve understanding of the capabilities of different instrument designs. The establishment of fit-for-purpose, harmonised methods across the measurement community will increase end-user's confidence in this technique, and methods will be transferable to a range of fields including air, land and water monitoring, nuclear forensics, geological dating and climate change studies through isotopic ratio measurements.

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 Plasma Mass Spectrometry (ICP-MS) method for the quantification of radionuclides.

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The specific objectives are

1. To optimise different ICP-MS designs by using standard solutions of actinide radionuclides (^{235,236,238}U, ^{239,240}Pu, ^{237}Np, ^{241}Am) by comparing the relative strengths and limitations of the different designs. The focus will be on relative instrument performance with respect to current measurement challenges, and establishing detection limits in relation to regulatory waste criteria levels or environmental regulations and in comparison to decay counting techniques.
2. To improve nuclear decay data by combining ICP-MS with established primary counting techniques.
3. To prepare a sample matrix (filter, water and/or concrete) containing actinide radionuclides as a reference material for inter-comparison exercise and quality control of decommissioning analysis.
4. To facilitate take up of the technology developed in the project by end users, such as nuclear decommissioning and environmental monitoring industries, by producing good practice guides, standard operating procedures and in general by developing and providing a collective traceable approach to ICP-MS measurement.

These objectives will require large-scale approaches that are beyond the capabilities of single National Metrology Institutes and Designated Institutes. To enhance the impact of the research, the involvement of the appropriate user community such as industry, standardisation and regulatory bodies is strongly recommended, both prior to and during methodology development.

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

EURAMET expects the average EU Contribution for the selected JRPs in this TP to be 2.0 M€, and has defined an upper limit of 2.3 M€ for this project.

EURAMET also expects the EU Contribution to the external funded partners to not exceed 35 % of the total EU Contribution across all selected projects in this TP.

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 nuclear 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.