EMRP Call 2013 – Energy and Environment

Selected Research Topic number: **SRT-v20**
Version: 1.0

Title: Isotope metrology and trace analysis at single atom level for climate control

Abstract

Data on stable and radioactive environmental isotopes are increasingly used in climate monitoring, modelling, prediction and management. However, the metrological basis for these applications is not sufficiently developed yet. Mass spectrometry, low-level activity measurement techniques, atom trap trace analysis (ATTA) and traceable calibration methods for isotopes are required to facilitate the traceable and accurate measurement of very low-level monitoring of radionuclides and stable isotopes in the environment. The measurement of absolute levels and isotope ratios will provide important data for climate control monitoring.

Conformity with the Work Programme

This Call for JRPs conforms to the EMRP Outline 2008, section on “Grand Challenges” related to Energy and Environment on pages 8, 9 and 24.

Keywords

Climate control, radionuclides, stable isotopes, radionuclide metrology, atom-trap trace analysis (ATTA), single atom detection, low-level activity measurement, isotope ratio measurement

Background to the Metrological Challenges

Climate change is becoming an important issue in our lives. Better and more accurate understanding of the different parameters impacting climate change is required in order to improve the current prediction models and management methods. Measuring radionuclides and stable environmental isotopes is therefore important as they can play the role of tracers and indicators (mostly as isotopic ratios) of geochemical and /or biological phenomena.

Radionuclide dating techniques have been proved to be useful tools when investigating geological materials. For example, stable isotope ratios and the relative levels of uranium, thorium and lead isotopes can reveal information about climate conditions prevalent at the time of deposition. In addition, stable isotopes are important when measuring ice cores as they can reveal data about climate in the more recent past, especially when cores contain ancient dissolved air.

Consequently, organisations are using radioactive and stable atoms as a prediction tool for climate change. The measurement techniques involved are radiometric (low-level alpha-, beta- and gamma-spectrometry) and/or mass spectrometric (counting atoms is suitable for long-lived nuclides and stable isotopes). Due to the low-level of radioactivity and sometimes long-half lives and very low isotopic ratios ($<10^{-12}$), the two approaches complement each other. Another method that showed promising results due to its ability to detect and separate isotopes at low concentrations is Atom Trap Trace Analysis.

It is apparent that the measurement of radionuclides in environment (i.e. atmosphere, soils, oceans and sediments) can provide valuable information on climate change. The accurate measurement of these isotopes and metrological resources of isotopic applications need to be further developed in order to improve the current climate change prediction models.

Scientific and Technological 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

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overall impact, or address budgetary or scientific / technical constraints, but the reasons for this should be clearly stated in the JRP-Protocol.

The JRP shall focus on the traceable measurement and low-level monitoring of radionuclides and stable isotopes in the environment. The measurement of both absolute amounts and amount ratios of isotopes relevant for climate monitoring shall be addressed.

The specific objectives are:

1. To develop techniques centred on combined mass spectrometric/radiometric methods for dating and measurement at the sub-femtogram.
2. To build a demonstrator ATTA setup for e.g. ^{39}Ar or ^{85}Kr gas that extends measurement capabilities down to measurements at the attogram level.
3. To develop low-level standards of gas and other matrices for a range of different isotopes.
4. Measurement of nuclear data of radionuclides relevant for climate change as ^{7}Be, ^{10}Be, ^{26}Al, ^{231}Pa, ^{233}Pa and ^{234}Th or used as radiotracers as ^{41}Ca, ^{45}Ca and ^{233}Pa, etc.
5. Improvement of low-level and deep underground gamma-spectrometric measurements in particular for ^{222}Rn in water, and ^{7}Be, ^{210}Pb, ^{230}Th, ^{234}Th, ^{231}Pa, ^{233}Pa in environmental samples

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 R&D work, the involvement of the user community such as industry, and standardisation and regulatory bodies, as appropriate, is strongly recommended.

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

EURAMET expects the average size of JRPs in this call to be between 3.0 to 3.5 M€, and has defined an upper limit of 5 M€ for any project. The available budget for integral Research Excellence Grants is 30 months of effort.

Potential Impact

Proposals must demonstrate adequate and appropriate participation/links to the “end user” community. This may be through the inclusion of unfunded JRP-Partners or collaborators, or by including links to industrial/policy advisory committees, standards committees or other bodies. Evidence of support from the “end user” community (e.g. letters of support) is encouraged.

You should detail how your JRP results are going to:

- underpin and develop European and international regulation or feed into the development of urgent documentary standards through appropriate standards bodies
- underpin international climate control protocols and treaties
- transfer knowledge to the climate observation and modelling community
- transfer knowledge to the wider environmental sector.

You should detail other impacts of your proposed JRP as detailed in the document “Guide 4: Writing a Joint Research Project”

You should also detail how your approach to realising the objectives will further the aim of the EMRP to develop a coherent approach at the European level in the field of metrology and includes 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 Member States and countries associated with the Seventh Framework Programme whose metrology programmes are at an early stage of development to be increased
- outside researchers & research organisations other than NMIs and DIs to be involved in the work

Time-scale

The project should be of up to 3 years duration.