EMRP Call 2012 – Open Excellence, Industry and SI Broader Scope

Selected Research Topic number: **SRT-s04**
Version: 1.0

Title: Traceable metrology for high frequency power in the millimetre-wave range

Abstract

Research in the millimetre-wave range of the electromagnetic spectrum is being focused on commercial, scientific, security, and military applications. This SRT calls for the development of novel, accurate, and traceable high frequency (HF) power measurement capabilities for electromagnetic waves in the frequency range 50 GHz to 300 GHz which will support these applications. Emphasis should be placed on frequencies beyond 110 GHz to address the existing traceability gap of the Terahertz range of the electromagnetic spectrum. The research should develop novel power standards, calorimeter calibration facilities, and measurement techniques for accurate power calibration in both waveguide and coaxial transmission line systems.

Conformity with the Work Programme

This Call for JRPs conforms to the EMRP Outline 2008, section on “Grand Challenges” related to Industry & Fundamental Metrology on pages 10 and 31.

Keywords

Millimetre-waves, microcalorimetry, CW power measurement, pulsed-power measurement, traceable HF power sensors, HF power sensor calibration, direct power comparison.

Background to the Metrological Challenges

Today, the utilisation of the millimetre-wave range for commercial (information and communication technologies), scientific, security, and military applications is the focus of high frequency research. On one hand, it is driven by the limited availability of bandwidth at lower frequencies, by fundamental advantages associated with shorter wavelengths such as generally higher transfer rates (due to the increased absolute available bandwidth), circuit, waveguide, and antenna miniaturisation, and higher spatial resolution in case of imaging applications. On the other hand, millimetre-wave systems become increasingly complex with increasing frequency and research and development in this field must be supported by high-performance measurements.

The calorimeter calibration of coaxial standards is established up to 40 GHz and results in significantly higher uncertainties compared with waveguide calorimeters. This is due to problems associated with transmission line losses, miniaturisation, connector repeatability, and thermal insulation. Beyond 110 GHz, traceable calorimeter calibration of waveguide power sensors as transfer standards cannot be performed in any European NMI (or elsewhere in the world).

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 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 traceability of HF power measurements in the frequency range between 50 GHz and 300 GHz.

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The specific objectives are

1. To develop fast, efficient, and accurate calibration methods for industrial power sensors up to 110 GHz
2. To develop novel and traceable transfer standards for power up to 300 GHz
3. To develop calorimeters for the calibration of waveguide power transfer standards up to 300 GHz, and for coaxial standards up to 110 GHz.

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 work, the involvement of the larger community of metrology R&D resources outside Europe is recommended. A strong industry involvement is expected in order to align the project with their needs and guarantee an efficient knowledge transfer into industry.

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

The total eligible cost of any proposal received for this SRT is expected to be around the 2.7 M€ guideline for proposals in this call. The available budget for integral Research Excellence Grants is 42 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 (eg letters of support) is encouraged.

You should detail how your JRP results are going to:

- feed into the development of urgent documentary standards through appropriate standards bodies
- transfer knowledge to the electromagnetics 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.