EMRP Call 2011 - Health, SI Broader Scope & New Technologies

Selected Research Topic number: **SRT-n15**
Version: 1.0

Title: Microwave and terahertz metrology for homeland security

Abstract

Terahertz (THz) and millimetre-wave (MMW) spectroscopy are increasingly used for security applications, like personnel scanners, helping to detect illicit or hazardous substances. Important properties of these systems like field strength, frequency and performance parameters like the uncertainty of spectroscopic measurements are difficult to assess. The aim of this topic is to develop robust and comprehensive metrology for these properties. This will allow the determination of the human exposure to (sub-)mm waves to monitor compliance with safety limits and provide data for further regulatory action. Furthermore, it will enable the optimisation of new technology with regard to reliability and optimum performance at lowest possible radiation levels.

Conformity with the Work Programme

This Call for JRPs conforms to the EMRP Outline 2008, section on “Grand Challenges” related to Health, New Technologies & Fundamental Metrology on pages 9, 25,26 and 31.

Keywords

Millimetre and Terahertz Waves, Traceable Characterisation of Sources and Detectors, Measurement Uncertainty of Terahertz Spectroscopy, Security Personnel Scanners, Active and Passive THz Imaging, Remote Scanning, Beam Forming, Field Strength Assessment, Dosimetry of Non-Ionising Radiation, Living Cell and Skin Phantoms

Background to the Metrological Challenges

Understanding how mm and THz radiation interacts with human bodies is key to the safe deployment and public acceptance of these technologies. European Directive EC 2004/40/EC sets exposure limits up to 300 GHz, based on the International Commission on Non-Ionizing Radiation Protection (ICNIRP) guidelines. However, no reliable measurement capabilities exist to assess the human exposure for scanned persons and operating personnel of millimetre and THz systems not to mention traceability to the SI units. Such procedures will also facilitate the development of equipment, which minimises human exposure, and extension of the exposure guidelines to higher frequencies. In order to be able to estimate the benefit and reliability of the available technologies, the reliable determination of operation parameters is necessary, including the assessment of measurement uncertainties.

The properties of millimetre and THz radiation being non-ionizing and penetrating through most cloth materials have led to the development of personnel scanners. While the personnel scanners tested at airports right now operate at frequencies between 20 GHz and 100 GHz, active remote scanning has also been demonstrated at higher frequencies and might be used in the next generation of scanners. Currently, measurements in the THz and MMW bands are carried out using different modalities, and no methodology exists for comparing and combining the data. Thus the two areas – time-domain spectroscopy and frequency-domain network analysis - remain artificially separate and fail to benefit from synergies. Although THz time-domain spectrometers (TDS) have been used in R&D for over 10 years, very little work has been done on developing metrology and standards in this area. Instruments are seldom tested or calibrated, and quoted performance specifications are inconsistent.

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The necessary metrology to determine the properties of scanners and spectrometers as needed for the evaluation of benefit, the improvement of technology and the assessment of possible adverse health effects does not exist so far.

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 providing the necessary metrology for the new emerging security technologies like scanning systems, active imaging, ultra-wideband radar and spectrometers operating in the sub-Terahertz and Terahertz frequency range between 20 GHz and 6 THz. Measurement methodologies to reliably determine the properties of such systems including radiated power, field strength, operation frequency and performance parameters shall be developed.

The specific objectives are:

1. Characterisation of sources, scanners, sensors, interconnects and transmission lines
2. Develop novel techniques where needed for calibration of CW and pulsed sources
3. Robust measurement procedures to characterise THz spectrometers
4. Investigation of the comparability of free space systems (e.g. THz pulsed spectrometers) and wave-guide based instruments (e.g. vector network analysers).

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, and standardisation and regulatory bodies, is strongly recommended.

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.

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

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 Security sector.

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. 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.