

## Important information about these documents

This call is being held ahead of any agreement from the Commission that the relevant funding will be available. At present the relevant legislation is still under discussion in both Council and Parliament, and there is no certainty on the detailed arrangements for funding selected projects. The funding of any selected project, and the terms and conditions of participation in the projects, are dependent on completion of the legislative process and the subsequent contractual processes between the European Commission and EURAMET. Proposers submit to this call at their own risk.

### Background

Last year, EURAMET submitted a draft proposal to the EC for a further research programme to be established under article 185 of the Treaty on the Functioning of the European Union (TFEU) to follow on from EMRP and EMPIR. This was published by the EC at [https://ec.europa.eu/info/research-and-innovation/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/european-partnerships-horizon-europe/candidates-digital-industry-and-space\\_en](https://ec.europa.eu/info/research-and-innovation/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/european-partnerships-horizon-europe/candidates-digital-industry-and-space_en)

The initiative would be called the European Partnership on Metrology and would aim to create, by 2030, a sustainable and effective system for metrology at European level that ensures Europe has a world-class metrology system that:

- Provides metrology solutions, fundamental metrological reference data and methods, offering fit-for-purpose solutions supporting and stimulating European innovation and responding to societal challenges.
- Supports and enables effective design and implementation of regulation and standards that underpin public policies that address societal challenges.

The Commission commissioned an impact assessment into this proposal and 11 others in similar priority areas, and, based on those findings, published their own proposal for the Partnership, their response to the impact assessment and a draft of the Decision on 23<sup>rd</sup> February 2021. See:

<https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2021:89:FIN>

[https://ec.europa.eu/commission/presscorner/detail/en/ip\\_21\\_702](https://ec.europa.eu/commission/presscorner/detail/en/ip_21_702)

<https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52021SC0035&qid=1614677899327>

That draft Decision is currently under discussion in the European Council and the European Parliament.

Under the assumption that the Council and Parliament pass the basic act which would form the legal basis for this research programme, and that the participating countries named in the Draft Decision submit the required commitment letters, EURAMET is publishing these potential Selected Research Topics and draft guidance notes. These documents are not approved by the Commission nor will they lead to a binding decision by EURAMET e.V. for any further negotiation or funding. All published guides and templates are subject to amendment by the EC and EURAMET e.V. as further information becomes known.

# Title: Metrology for emerging wireless standards

## Abstract

Key emerging wireless standardisation processes are required for Internet-of-Things (IoT), fifth-generation (5G) and sixth-generation (6G) mobile networks. New radio (NR) signals, systems, environments and exposures need to be investigated in order to support the competitiveness of European industry. Current challenges include the lack of accurate, fast, low-cost, and traceable methods for NR high-volume product verifications against wireless standards. Therefore, proposals should focus on the development of practical and efficient metrology for over-the-air (OTA) testing, for wireless channels up to sub-THz, and for radio frequency (RF) exposure assessment.

## Keywords

Internet-of-Things, 5G mobile networks, 6G mobile networks, new radio, mm-wave, measurement uncertainty, multiple-input-multiple-output, over-the-air testing, radio frequency exposure, reconfigurable intelligent surface, wireless coexistence communications

## Background to the Metrological Challenges

The European Digital Agenda has driven the need to better exploit Information and Communication Technologies in order to foster innovation and economic growth. The immediate challenge for communication networks is to scale up to meet increasing traffic requirements, as well as serving new elaborate machine-to-machine systems and applications, by using emerging wireless technologies such as IoT, 5G, automotive, and reconfigurable intelligent surface (RIS) assisted wireless communications. The operation of multiple-input-multiple-output (MIMO) capability in 5G has driven the development of OTA system-level test methodologies, which can accurately evaluate emerging wireless system performance in realistic scenarios. This is especially important for the mm-wave band, as antenna and RF circuitry become more highly integrated and OTA becomes the practical measurement method. The traceability, propagation channel, interference characterisation (especially for sparse multipath) and system-level testing present new challenges in a real-world environment as RF beamforming is essential to overcome the higher losses at these frequencies. Furthermore, with the industrial adoption of multi-user MIMO (MU-MIMO), massive MIMO beamforming, and the mm-wave band in emerging wireless systems, several multinational industries, research communities and standards bodies are now facing new measurement challenges in NR OTA testing (NR OTA testing is needed to verify products and ensure that they meet the performance parameters required for diverse technological requirements). In the EU, 5G beamforming massive MIMO base stations (BS) that operate at sub-6GHz, and in the mm-wave band, are currently undergoing real-world trials and several candidate methodologies are being considered in the 3rd Generation Partnership Project (3GPP).

NR MIMO OTA test metrology is needed for the evaluation of the realistic wireless performance of BS and user equipment. However, there is currently no clear test metrology for this, which can handle orthogonal frequency-division multiple access (OFDMA) scheduling in the time, frequency and space domain at the same time. OTA testing for small MIMO capable terminals is ongoing. For example, CENELEC and IEC/IEEE International Standards have set requirements for addressing the time-burden issue, when using current RF exposure assessment methods. These are applicable to a specific absorption rate (SAR) and power density (PD), especially, for high-volume beam reconfigurable product verifications. An internationally harmonised test standard needs to be developed to comply with the absorbed power density limits that have been defined by ICNIRP2020. Sub-THz propagation channel models, for in-city deployment, are an active research topic (e.g. in buildings research from EMRP JRP IND16 Ultrafast). In addition, commercial systems to measure mm-wave antennas are available and state-of-the-art techniques, including non-invasive electro-optic, efficient model-matching and compact range systems, have been developed in EMRP JRP IND51 MORSE. The state of the art for THz communication in Europe is a single-input and single-output system at 237.5 GHz, which is used for transmitting data over 20 m at a data rate of 100 Gbit/s. Therefore, this technique is promising, but the required technologies are not widely available at present. The achievements of the following EMPIR projects, 14IND10 MET5G, 16NRM07 Vector SAR and 18SIP02 5GRFEX, have also contributed to the current state of the art. However, further research is needed to develop realistic and practical enabling metrology.

## 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 metrology research necessary to support standardisation in wireless processes for the IoT and for 5G and 6G mobile networks.

The specific objectives are

1. To develop metrological methods for the measurement of NR OTA in MU-MIMO and massive-MIMO systems for sub-6 GHz and mm-wave bands, taking into account ETSI TR 38.827.
2. To characterise the complex real-world wide-bandwidth wireless radio propagation channel, for practical realisation in wide-bandwidth communications up to sub-THz for 5G, and to make recommendations on THz and mwT measurements to relevant standardisation bodies and industry groups (e.g. IEEE 802.15 SC THz and ETSI ISG on mwT).
3. To develop metrological methods for traceable and efficient RF exposure assessment, which should be applicable to SAR and PD, by, for example, using machine learning and statistical approaches, at sub-6 GHz and using mm-wave bands for application to versatile emerging wireless systems.
4. To contribute to the standards development work of the technical committees CENELEC CLC/TC 106X, IEEE 802.15 SC Terahertz, 3GPP and ETSI Industry Specification Group on Millimetre Wave Transmission, to ensure that the outputs of the project are aligned with their needs, communicated quickly to those developing the standards and to those who will use them (e.g. the telecommunications industry), and in a form that can be incorporated into the standards at the earliest opportunity.

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. In particular, proposers should outline the achievements of the EMRP JRPs IND16 Ultrafast and IND51 MORSE and the EMPIR projects 14IND10 MET5G, 16NRM07 Vector SAR and 18SIP02 5GRFEX and how their proposal will build on those.

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 Information and Communication technologies 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 the potential European Partnership on Metrology 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.