EMPIR Call 2018 – Health, SI Broader Scope, Normative and Research Potential

Selected Research Topic number: **SRT-r02**
Version: 1.0

Title: Traceability for contact probes and stylus instruments measurements

Abstract

The surface finish and form of manufactured parts are important parameters for quality control as they relate to the functionality of the parts. Coordinate measuring machines (CMMs) with contact measurement probes and stylus instruments are used to characterise form and for surface roughness measurements. There is a need for traceable calibration of form and surface roughness measuring standards with uncertainties of 10 nm - 100 nm as well as a need for CMMs to have associated traceable methods which achieve submicron uncertainty levels for complex measurement objects. These needs require NMIs to improve their scientific knowledge, instruments, methods and research capability for coordinate metrology, contact measurement probes and stylus instruments.

Keywords

Surface roughness, tactile systems, form measurements, coordinate metrology, coordinate measuring machine (CMM), error mapping, stylus instruments, contact measurement probes

Background to the Metrological Challenges

The surface finish, including both form and surface roughness, of manufactured parts is an important parameter for quality control as it relates to the functionality of the parts. Surface finish can be measured using CMMs with contact measurement probes for form and stylus instruments for surface roughness. Due to the demand for higher throughput and efficiencies and lower uncertainties CMMs are often operated in a scanning/dynamic mode which requires more complex measurements. Both form and surface roughness types of measurement are performed in dynamic mode.

Flick standards are used to provide traceability for contact measurements probes, these are primarily calibrated using fully characterised form measuring instruments. For emerging NMIs, if no calibrated flick standard is available, they have to develop the capability to calibrate their own measuring device and the customer flick standards in order to provide traceability. The calibration of flick standards is also an important issue for experienced NMIs. The results of a recent EURAMET comparison (EURAMET Project 649) between experienced NMIs revealed a partly unsatisfactory agreement between the measured values and strongly varying measurement uncertainties reported by the participating institutes, which do not seem to be consistent with the observed deviations. Work is needed to address these issues for both experienced and emerging NMIs. Depth setting standards/spheres are used to provide traceability for stylus instruments and are primarily calibrated using special interference microscopes however these are not available in most NMIs. An alternative method is to use piezo capacitive sensors that are traceable to laser displacement interferometers as these are available in most NMIs. However this approach requires a good knowledge and understanding of stylus instruments and their performance in dynamic mode. An option is to design a portable displacement generator to enable the calibration and performance assessment of stylus instruments in both static and dynamic modes. The characterised stylus instrument could then be used to calibrate depth setting standards and flick standards.

The desire to improve the quality of products and requirements for improved accuracy for the measurement of more complex structures, particularly in countries with developing capability, requires better understanding and implementation of appropriate measuring techniques for contact measurement probes and stylus instruments to achieve lower uncertainties and reliable measurement results. This requires a close cooperation between metrology institutes to characterise, analyse and thus assess the reliability of the measurements.

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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 development of metrological capacity for the measurement of form and surface roughness.

The specific objectives are

1. To develop traceable and cost effective measurement capabilities for the calibration of form and surface roughness standards with uncertainties in the range 10 nm – 100 nm.
2. To develop novel methods for investigations of measurement probes and stylus instruments used in static and dynamic measurement conditions, particularly for amplitudes and wavelengths that cannot be achieved using commercial roughness and groove transfer standards defined in ISO 5436.
3. To investigate the use of "portable displacement generators" to calibrate stylus instruments under static (+/-1000 µm) and dynamic (+/-100 µm) measurement conditions with direct traceability to SI unit of length, the metre, and to prepare a best practice guide on their use.
4. To develop noise reduction methods, including the use of numerical methods on roughness and form profiles data, in order to reduce the overall uncertainties.
5. For each participant, to develop an individual strategy for the long-term operation of the capacity developed, including regulatory support, research collaborations, quality schemes and accreditation. They should also develop a strategy for offering calibration services from the established facilities to their own country and neighbouring countries. The individual strategies should be discussed within the consortium and with other EURAMET NMIs/DIs, to ensure that a coordinated and optimised approach to the development of traceability in this field is developed for Europe as a whole.

Joint Research Proposals submitted against this SRT should identify

- the particular metrology needs of stakeholders in the region,
- the research capabilities that should be developed (as clear technical objectives),
- the impact this will have on the industrial competiveness and societal needs of the region,
- how the research capability will be sustained and further developed after the project ends.

The development of the research potential should be to a level that would enable participation in other TPs.

Proposers should note that the programme funds the activity of researchers to develop the capability, not the required infrastructure and capital equipment, which must be provided from other sources.

EURAMET has defined an upper limit of 500 k€ for the EU Contribution to any project in this TP, and a minimum of 100 k€.

EURAMET also expects the EU Contribution to the external funded partners to not exceed 10 % 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,
- Provide a lasting improvement in the European metrological capability and infrastructure beyond the lifetime of the project,
- Facilitate improved industrial capability or improved quality of life for European citizens in terms of personal health or protection of the environment,
- Transfer knowledge to the engineering and manufacturing sectors and the metrology community.

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.