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

Selected Research Topic number: **SRT-i05**
Version: 1.0

Title: Traceable in-process dimensional measurement

Abstract

In-process metrology enables cost-efficient and real-time quality control in modern production processes e.g. tools & adaptive measuring devices or equivalent measurement processes in or close to production lines. To ensure conformance, parts are inspected on the machine tool and are only removed when they have been verified.

Achieving high accuracy 3D-measurements on machine tools is challenging, especially in harsh factory environments. To overcome this, robust measurement standards for determining the performance of machines and for the correction of task specific errors are needed, as well as verified procedures and pre-normative guidelines for estimating measurement uncertainties.

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 13 and 38.

Keywords

in-process measurements, performance testing, quality inspection, measurement uncertainty, measurement standard

Background to the Metrological Challenges

Traceable high-precision three-dimensional metrology is an indispensable prerequisite for ensuring the high quality manufacture of complex components. Complex geometries with decreasing tolerances demand robust and reliable in-line measuring technologies, but against this is the need to inspect fabricated parts more quickly and to specified tolerances in-process i.e. on machine tools whilst in the production environments. Common components requiring such measurements range in size from several millimetres up to 1 m and in order to satisfy future production requirements, the measurement uncertainties need to be reduced by at least an order of magnitude.

Measurements on machine tools (i.e. in-process) are affected by the environment, in particular the temperature in or close to the production process, as well as by other parameters such as high probing forces, vibration, noise, sound and light. Current machine tool calibration techniques, which are carried out non-dynamically (i.e. with zero force applied to the tool) cannot overcome many of these factors. Machining forces and heat loads cause changes in the machine geometry during operation and hinder the traceability and reliability of the measurements. In addition, laser-based calibration techniques do not take in account the measurement errors of the system.

In the absence of suitable procedures for the calibration of machine tools and for verification of measurements in different environments, it is not possible to rely on measurements during the manufacturing process to ensure quality control. The precision inspection of fabricated parts has to be carried out in remote metrology rooms, leading to long production downtimes and high costs.

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 traceable and high accuracy dimensional measurements in the production process e.g. tools & adaptive measuring devices or equivalent measurement processes in or close to production lines. The methods developed should target a few µm uncertainty within a metre cube.

The specific objectives are

1. The development of methods for implementing high accuracy dimensional measurements on machine tools through the specification, design, fabrication and test of multi-purpose calibrated artefacts which are robust against environmental influences and mechanical stress.
2. The determination of errors and uncertainties associated with the developed methods.
3. Provision of pre-normative guidelines for dimensional in-process measurements.
4. Demonstration to end users of the improvements to production processes possible through the implementation of such methods. This should include stakeholder events and good practice guides.

Proposers shall give priority to work that meets documented industrial needs and include measures to support transfer into industry by cooperation and by standardisation. An active involvement of industrial stakeholders is expected in order to align the project with their needs.

Proposers should establish the current state of the art, and explain how their proposed project goes beyond this and the current FP7 integrated project 'Manufacturing Error-free Goods at First Time' (MEGaFiT).

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 industrial sector, such as machine engineering and the automotive and renewable energy industries.

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.