Define data processing and fusion methods

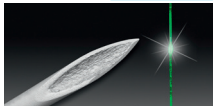
The developed approach was evaluated on simulated data extracted from the CAD model of a complex plastic part and successfully tested on measured data acquired on the same part using µCT.

Project

"Multi-sensor metrology for microparts in innovative industrial products" (Microparts), is a Joint Research Project (JRP) within the European Metrology Research Programme (EMRP) with a duration from 05/2013 to 05/2016. The consortium features 5 National Metrology Institutes (NMIs), 6 industrial partners and 5 research facilities across Europe. For further information on the project, please visit *https://www.ptb.de/emrp/microparts-home.html*.

Project partners

XPRESS Precision Engineering
DANISH TECHNOLOGICAL INSTITUTE
VSL Dutch Metrology Institute
NPL National Physical Laboratory
LNE Le progrès, une passion à partager
BAM
novo nordisk
The LEGO Group
IBS Precision Engineering
Loughborough University
METAS Bundesamt für Metrologie
The University of Nottingham UNITED KINGDOM · CHINA · MALAYSIA
FAU FRIEDRICH-ALEXANDER UNIVERSITÄT ERLANGEN-NÜRNBERG TECHNISCHE FAKULTÄT
Science & Technology Facilities Council Central Laser Facility
BOSCH



Physikalisch-Technische Bundesanstalt
Braunschweig und Berlin
Bundesallee 100
38116 Braunschweig, Germany

Dr.-Ing. Ulrich Neuschaefer-Rube
5.34 | Multisensor Coordinate Metrology

phone: +49 531 592-5311
e-mail: ulrich.neuschaefer-rube@ptb.de
www.ptb.de

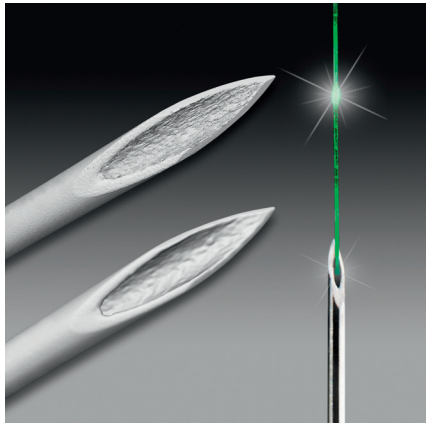
As of: 03/16

PTB

EMRP
European Metrology Research Programme
Programme of EURAMET

The EMRP is jointly funded by the EMRP participating countries within EURAMET and the European Union

Multi-sensor metrology for microparts in innovative industrial products



Physikalisch-Technische Bundesanstalt

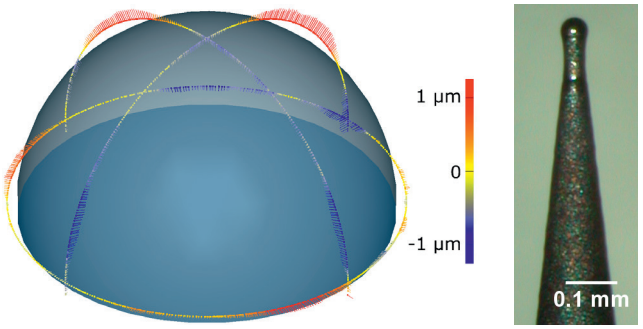
Overview

Parts having features from the sub-millimetre range to several tens of millimetres (microparts) play an important role in different industrial sectors, like automotive, healthcare or telecommunications. In many cases, their complete inner and outer geometry must be verified with sub-micrometre uncertainties.
The overall goal of the project is to achieve a significant improvement in state-of-the-art measurement capabilities of multi-sensor coordinate measuring systems (CMSs) for microparts. The project addresses the following major open challenges:

- Increase the accuracy of tactile probing by developing and characterizing smaller probes (below 100 µm)
- Increase the accuracy of optical and computed tomography (CT) measurements by systematic error correction and achieve traceability for these measurement techniques
- Establish procedures for intelligent processing and fusion of data acquired from measurements with different sensors

Increase accuracy of tactile probing

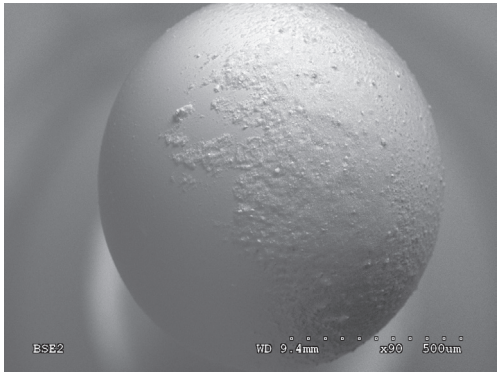
To enable more accurate measurements of the small structures on microparts, tungsten probes having a diameter of 50 µm or 65 µm were successfully manufactured by electrical discharge machining (EDM), polished and characterized. The resulting sphericity of the probes lies below 350 nm.



Manufactured probe with Ø 50 µm and a µCMM measurement of the probe sphericity. Source: Federal Institute of Metrology METAS

Increase accuracy of tactile probing

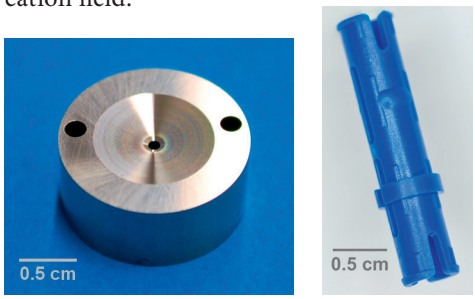
To enable efficient cleaning of small probes, on-site low-force cleaning procedures and inspection solutions were investigated during the project. Snow cleaning turned out to be a suitable solution in terms of cost, cleaning speed and reduction of damage to the probe.



Stylus before (right) and after (left) snow cleaning.
Source: University of Nottingham.

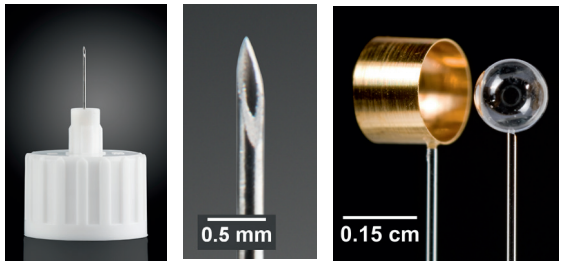
Reach traceability of optical and CT measurements

To establish a procedure for achieving traceability of optical and CT measurements in the industrial environment, four so-called workpiece-like reference standards were manufactured. They reflect a variety of measurement tasks, such as lengths, small diameters, cone angles and radii, which can be attributed to the corresponding application field.



Left: Fuel injection cone standard (automotive).
Right: Plastic connector (toy industry). Source: PTB.

Reach traceability of optical and CT measurements

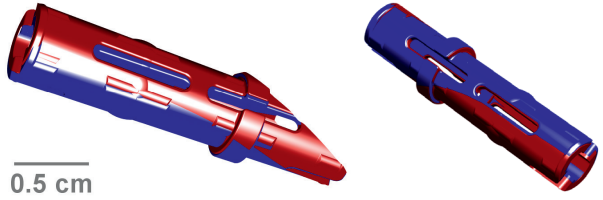


Left, middle: Insulin injection needle (healthcare).
Right: Laser micro-target to investigate fundamental plasma physics (research).
Source: PTB and STFC (RAL Space).

All four standards were calibrated using a tactile µCMM and further measurements have been made with an optical sensor, industrial CT, and synchrotron CT. The measurement parameters were adapted to the real conditions and the comparison with tactile measurement results allowed assessing uncertainty budgets for the measurements in the manufacturing chain. The outcome will be transferred to the facilities of industrial partners and will be accessible to third parties on request.

Define data processing and fusion methods

Linking data from different sensors to one coordinate system is a crucial step which influences the accuracy of multi-sensor measurements. The project aims to investigate the accuracy and efficiency of the existing registration methods along with the development of a new approach for linking data. For that purpose a reference artifact featuring four types of markers was manufactured.
To handle the limitations of existing registration methods, an approach combining automated coarse and fine registration was proposed.



Coarse (left) and fine (right) registration of the CT measurement of the connector part (red) to its CAD model (blue).
Source: Laboratoire national de métrologie et d'essais (LNE).