EMPIR Call 2017 – Industry, Fundamental, Normative and Research Potential

Selected Research Topic number: **SRT-n02**
Version: 1.0

Title: Advancing measurement uncertainty - comprehensive examples for key international standards

Abstract

Accurate measurements and associated uncertainty propagation is at the heart of science and industry Consistent implementation of measurement uncertainty is vital to EU Directives and regulations. The Joint Committee for Guides in Metrology (JCGM) provides authoritative guidance documents to address measurement needs and is currently developing an expanded Guide to the Expression of Uncertainty in Measurement (GUM) that will provide measurement uncertainty propagation methods for a range of applications. Therefore, a comprehensive set of new worked examples to support modern industrial and research practices are needed for this document and to promote the consistent evaluation of measurement uncertainties.

Keywords

Data, uncertainty evaluation, measurement model, examples, GUM, JCGM, standards, accreditation, regulations, industrial.

Background to the Metrological Challenges

The global de facto standard for uncertainty evaluation in all areas of science and industry is the GUM which is published by the JCGM as JCGM-100. Web downloads of the GUM number more than 100,000 per year, and it is frequently cited in ISO/IEC 17025, the international standard that supplies the basis for calibration and testing competence. In addition to this, the GUM is essential for legal metrology and GUM uncertainty evaluations form the core of accreditation schemes run by European Accreditation and United Kingdom Accreditation Service (UKAS) services.

The JCGM Working Group 1 (JCGM-WG1) is composed of eight broadly-based international organisations (i.e. IEC, ISO, the International Laboratory Accreditation Cooperation (ILAC), BIPM, the International Organization of Legal Metrology (OIML), the International Federation of Clinical Chemistry (IFCC), the International Union of Pure and Applied Chemistry (IUPAC), and the International Union of Pure and Applied Physics (IUPAP)) and it has been tasked with re-issuing and expanding the GUM to include new examples of best practice in uncertainty derivation from the end-user community.

The examples in the current GUM are over 20 years old and are typically small in scale, that is, with few input quantities and few measurands. Therefore there is an urgent need for up-to-date examples that are more applicable to modern industrial and research requirements and that cover the challenging problems created by current measurement practices. Present day uncertainty calculations not only contain a larger numbers of inputs, but have other complications introduced by modern measuring instruments with in-built proprietary software or a “black-box” specification of the measurement model. Many uncertainty evaluations also involve non-normal distributions or require more advanced numerical solutions and uncertainty evaluation methods; none of which are currently covered by the published examples in the current GUM.

Adaptable template examples covering a broad range of applications from traditional areas such as temperature, optics, mass, photometry and analytical chemistry to emerging new ones in healthcare, earth science imaging, and climate monitoring using sensor networks, are needed to overcome the common perception that uncertainty evaluation is difficult. Examples set at an appropriate level will also facilitate accreditation of testing and calibration laboratories to ISO/IEC 17025.

Further to this, each example needs to illustrate common aspects such as specifying the measurand, building the measurement model, identifying significant influence quantities, using available knowledge to generate associated “input” uncertainties for use in the model, and the final model-based uncertainty propagation. It is

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also important that each example can be readily adapted for application in as many different circumstances as possible.

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 the evaluation of uncertainty by providing a comprehensive suite of examples to support the GUM and other related guides, and also that disseminated by ISO/IEC and shall derive best practice for uncertainty evaluation across scientific disciplines by providing illustrations of applying GUM principles to selected complex problems such as sensor networks for environmental and climate monitoring, and quantitative images in healthcare and earth science.

The specific objectives are

1. To develop examples of measurement uncertainty evaluations capable of acting as template solutions that end users can use for related problems. Examples should include (i) uncertainty model construction using JCGM 103, (ii) application of uncertainty evaluation principles for addressing industrial conformity assessments to support JCGM 106, and (iii) examples taking correlations into account as requested by the ISO Committee on Reference Materials (ISO/REMCO).
2. To derive worked examples of uncertainty analyses using the GUM and other methods to assist users to make informed choices on the best uncertainty evaluation method to use. This should include an examination of the extent to which the GUM is appropriate for certain applications - such as calibration, testing and key comparison data analysis - or whether Monte Carlo methods, outlined in GUM Supplements 1 and 2, have greater efficacy.
3. To collaborate with JCGM WG1, and the standardisation, regulatory and accreditation communities (ISO/REMCO, IEC, CEN, OIML, and the ILAC to ensure that the outputs of the project are aligned with their needs, communicated quickly, and in a form that can readily be incorporated into the JCGM Guides and other documents.

EURAMET expects the average EU Contribution for the selected JRPs in this TP to be 0.6 M€, and has defined an upper limit of 0.8 M€ for this project.

EURAMET also expects the EU Contribution to the external funded partners to not exceed 30 % of the total EU Contribution to the project.

Any industrial partners that will receive significant benefit from the results of the proposed project are expected to be unfunded partners.

The proposed research shall be justified by clear reference to the measurement needs within strategic documents published by the relevant Standards Developing Organisation or by a letter signed by the convenor of the respective TC or 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.

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 industrial, research and testing sectors.

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.

Additional information

[1] CEN/CENELEC identified this topic as one of their priorities. Details are available at: http://msu.euramet.org/current_calls/pre_norm_2017/documents/SRT_related_CEN_priorities/cen_priority_003_2017.pdf