

Publishable Summary for 18NET05 MATHMET Support for a European Metrology Network for mathematics and statistics

Overview

The objective of this network project is to support the associated European Metrology Network (EMN) for Mathematics and Statistics (EMN MATHMET). This will be achieved by creating a Strategic Research Agenda (SRA), a stakeholder network and a Quality Management System (QMS). These additional activities will significantly maximise and accelerate the impact of the EMN MATHMET. This project will bring the associated EMN MATHMET to a position where it defines a point of reference for mathematics and statistics for metrology that includes input from stakeholders from industry, standardisation bodies and academia. Through this project, the associated EMN MATHMET will be enabled to promote best practice in mathematics and statistics for metrology through providing guidelines, software and dedicated projects.

European Metrology Network for Mathematics and Statistics (EMN MATHMET)

The precursor of the EMN MATHMET is the current European Centre for Mathematics and Statistics in Metrology (MATHMET) which was established in 2014 as an outcome from the EMRP project NEW04 *Novel mathematical and statistical approaches to uncertainty evaluation*. Members from seven different EU countries have joined this centre, whose main activity has been to hold a regular series of workshops and to prepare and facilitate EMPIR projects with a strong emphasis on mathematical and statistical methods. Approval for the present MATHMET centre becoming an EMN was agreed by the EURAMET General Assembly in May 2018. The MATHMET EMN was established in June 2019 with 11 NMIs and DIs signing the EMN Memorandum of Understanding (MoU).

Need

In the last decade metrology has expanded to address societal challenges related to energy, safety, climate, life science and health, using novel measurement modalities such as imaging, earth observation, spectroscopy and sensor networks [1-6]. Model based software and mathematical algorithms have increasingly become an integrated part of measurement devices, necessitating the development of novel mathematical and statistical tools in metrology. This includes uncertainty quantification of large sets of correlated data, handling complex systems, applications of machine learning, real-time simulations, forecasting for large-scale systems, virtual measurements and multi-physics modelling [7-9]. The development of adequate mathematical and statistical tools addressing these challenges requires substantial effort that goes far beyond the capabilities of a single national metrology institute (NMI) and requires an EMN addressing these challenges. Thus in 2018 the EMN MATHMET on mathematics and statistics was approved by the General Assembly of EURAMET. However, in order to optimise impact, the EMN needs a strong integration with stakeholders and the identification of their most urgent needs, as well as a focus on mathematical support for the grand challenges of metrology and procedures for the assessment of software and guidelines. Specifically, this network project will develop an SRA, implement a stakeholder consultation processes, and create a QMS for the associated EMN MATHMET.

Objectives

- 1. To develop an SRA for the EMN MATHMET that supports EU and EURAMET priorities by addressing the grand challenges in mathematics and statistics in metrology, e.g. large-scale and multivariate data analysis, new data analytics including machine learning, mathematical modelling, uncertainty quantification for large-scale metrology and virtual experiments and simulation.
- 2. To develop stakeholder consultation processes for the EMN MATHMET to enable it to identify the most urgent guidelines, software tools, virtual training and reference data in line with the SRA.

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The EMPIR initiative is co-funded by the European Union's Horizon 2020 research and innovation programme and the EMPIR Participating States



3. To create and implement a QMS that includes criteria and procedures for the assessment of advanced metrology software and guidance documents which ensures that the EMN MATHMET recommendations meet the highest quality levels and achieve wide use and substantial impact.

Results

Strategic research agenda

The SRA is the final output related to the first objective and will be a document of reference and provide guidance for future research in the field of mathematics and statistics in metrology. It will be made available on the EMNs website, and its acceptance will be promoted by a variety of dissemination activities such as workshops, conference presentations and publications in journals and websites. It is expected that the SRA will be updated regularly as part of the tasks of the associated EMN to account for new trends and future research topics.

Stakeholder consultation processes

The goal of the stakeholder consultation processes will be to specify the most urgent stakeholder needs in the field of mathematics and statistics in metrology. The envisaged stakeholders will come from the metrological community, industry, research institutes and academia. The outcome of the stakeholder consultation processes will be used as source of reference for developing the SRA and the QMS.

The stakeholder consultation processes developed in this project will be used to become part of the infrastructure of the EMN. It is envisaged that the stakeholder consultation processes will be sustained beyond the lifetime of this project, in order to ensure that the EMN will effectively address the important future stakeholder needs.

Quality management system

A QMS will be developed and implemented as additional support to the EMN MATHMET. The QMS will provide documented rules ensuring highest quality of software and guidelines developed by the associated EMN MATHMET.

Impact

The network infrastructure developed in this project will support the successful start of the associated EMN MATHMET, providing it with important basic tools for promoting best practice in mathematics and statistics for metrology. Via the support in this project the associated EMN MATHMET will provide a unique reference point for mathematical and statistical activities needed to tackle the grand challenges and emerging fields in such metrology in line with EURAMET priorities and stakeholder needs. The EMN MATHMET will have substantial long-term impact on the relevant stakeholder organisations and policymakers, therefore the input from this project at an early stage within the EMN will help to focus and identify the most important stakeholder needs and hence the resultant impact.

Direct impact

The SRA developed within this project will ensure that the associated EMN MATHMET has a sound basis to direct future research activities in the field of mathematics and statistics in metrology. This will be based on the most prominent needs of the stakeholders from industry, regulation bodies and academia. The focus provided by the SRA on urgent needs and grand challenges will also increase the efficiency of the EMN in its task to support research developments in modern metrology at the European level. The SRA will also enable the associated EMN MATHMET to influence the structure and topics of future European Research programmes to address such emerging needs. It will further bring the associated EMN MATHMET in the position to provide scientifically sound recommendations to science managers and policy makers for mathematics and statistics in metrology. At the same time, the input from the SRA to the EMN will help to close the gap between metrology applications and fundamental research on new methods in mathematics and statistics by involving top academic institutions in a stakeholder committee.

This project will involve such stakeholders in an extensive consultation to identify most urgent needs for software tools, guidelines, virtual trainings and reference data in line with the research agenda. This output from this consultation will enable the EMN MATHMET to disseminate best practice and provide support for industry and standardisation organisations and their technical committees for widespread applications of mathematical and statistical tools in metrology, in particular in the field of uncertainty evaluation. The impact



of this project's stakeholder consultation processes will be directly reflected in the project's SRA. Another direct impact of the stakeholder interaction will be to more rapidly increase the awareness level of the associated EMN.

The expected outcome of the QMS developed in this project is that the recommendations of the associated EMN MATHMET will be based on the highest quality levels and should achieve wide stakeholder use and hence substantial impact. Publication of the documentation of the QMS will also make the associated EMN MATHMET recommendations available to other institutions so that they can make use of them for improving the quality of their own work. The project's SRA and QMS will both help to define and address the research questions in the field of mathematics and statistics in metrology in terms of the highest societal needs and the highest impact on an improvement of the environment.

The impact activities for this project (e.g. presentations, workshops, publications, meetings, consultations) will ensure that the outcomes of the project will be disseminated to a wider audience, in order to increase the recognition and interest in the associated EMN. For this purpose, the outcomes of this project's stakeholder consultation processes, the SRA and the QMS will be presented to industry, standardisation bodies and academia, and the main projects results will be made available online as well.

Wider impact

The outcomes of this project will help the associated EMN MATHMET to achieve its impacts earlier and more efficiently in the longer term. This project will significantly support the successful start of the EMN MATHMET and help it to accomplish its goals. This project will also contribute to creating impact via the EMN's recommendations for mathematical and statistical procedures and by disseminating the state-of-the-art of application of computer methods related to metrological needs in fields like engineering, physics, chemistry, biology and medicine. The main source for this impact will be EMN MATHMET's best practice guides, software tools and training courses which will build upon the results of this project, in particular the developed QMS.

A wider impact of this project will also be created by the input from this project to subsequent research projects within the associated EMN MATHMET. The EMN has the ability to tackle the grand research challenges of modern metrology in areas such as healthcare and medical diagnostics, industrial production and quality assessment, energy and sustainability, safety and environmental monitoring. The associated EMN MATHMET, with input from this project, will also give support the development of capabilities for NMIs and stakeholders in the field of mathematics and statistics in metrology, thus leading to an improved European metrology research landscape.

List of publications

Project start date and duration:	1 June 2019, 48 months			
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Project website address: tbc				
Internal Funded Partners:	External Funded Partners:			Unfunded Partners:
1. PTB, Germany				
2. BAM, Germany				
3. IMBiH, Bosnia and Herzegovina				
4. INRIM, Italy				
5. IPQ, Portugal				
6. LGC, United Kingdom				
7. LNE, France				
8. NPL, United Kingdom				
9. VSL, Netherlands				