

Project Start: 01 May 2025

Duration of the Project: 36 Months

Coordinator: Dr. Manuel Marschall, PTB

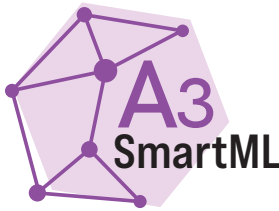
Phone: +49 30 3481 7948

Email: manuel.marschall@ptb.de

Project Website: <https://www.a3smartml.ptb.de/>

Internal Beneficiaries	External Beneficiaries	Unfunded Beneficiaries
PTB, <i>Germany</i>	Electro, Finden, UCAM, <i>UK</i>	INM, <i>Colombia</i>
CMI, <i>Czech Republic</i>	JCMwave, RWTH, <i>Germany</i>	
NPL, <i>UK</i>	Random Red, <i>Croatia</i>	
TUBITAK, <i>Turkey</i>	SOLEIL, <i>France</i>	
VTT, <i>Finland</i>	UNISA, <i>Italy</i>	

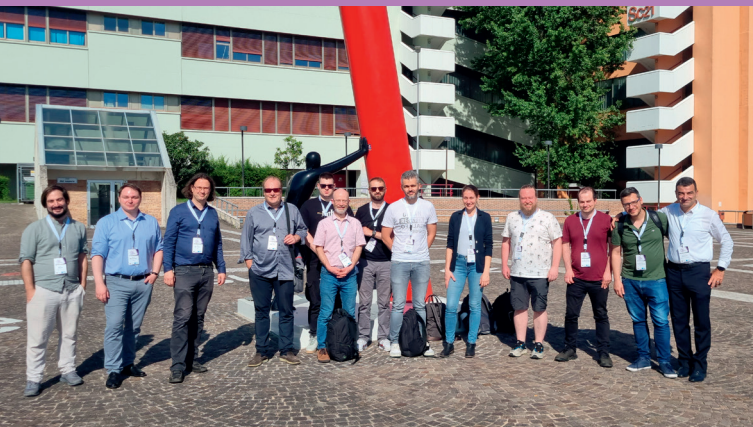
Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or EURAMET. Neither the European Union nor the granting authority can be held responsible for them. The project (24DIT03 A3SmartML) has received funding from the European Partnership on Metrology, co-financed from the European Union's Horizon Europe Research and Innovation Programme and by the Participating States.



A3SmartML (Automated, Adaptive and Uncertainty-aware Smart Measurements using Machine Learning) is a European research project within the European Partnership on Metrology programme co-financed from the European Union's Horizon Europe Research and Innovation Programme and by the Participating States. The project has 14 participants consisting of six National Metrology Institutes, three universities, one national synchrotron facility and four companies. The project is coordinated by Physikalisch-Technische Bundesanstalt (PTB).



About A3SmartML



Smart measurements are key enabling technologies to achieve and realise European strategic policies devoted to sustainability and digitalisation within the framework of Industry 4.0 and European Green Deal. These smart multidimensional measurements are often challenged by long acquisition times or limited resolution. This project will develop methods to significantly improve the efficiency of such measurements. The development will combine tools from machine learning, compressed sensing, regularisation, and Bayesian statistics. Several metrological case studies will be treated to demonstrate immediate impact. To further facilitate the uptake of the developed procedures, extensive guidance documents, documented software and reference datasets will be provided. Long-term impact will be generated through generic, automated, and adaptive measurement plans applicable to a wide range of multidimensional measurement tasks. This is expected to support the manufacturing industry (e.g. semiconductors) with better quality control leading to reduced costs, zero-waste and sustainable manufacturing targets.

Smart measurements using machine learning

Multidimensional measurements that perform measurements sequentially are often time-consuming and costly. Performing these measurements „smart“, using mathematical methods and tools from machine learning enables faster measurements, while maintaining high accuracy.

Validated Uncertainty Quantification

Employing machine learning tools and deep learning techniques to perform a „smart“ measurement requires validated uncertainty evaluation procedures to ensure thrustworthiness. Generative models that form prior knowledge and interpretable regularization techniques are explored.

Adaptive Measurement Protocols

Smart measurement procedures are automatically and adaptively adjusted during the measurement process. Incorporating physical properties and limitations in the development of methods is required to ensure practical implementation in experimental prototypes.

Generalising guidance and software

Application to several industrial case studies will result in guidance documents and software solutions to generalize the developed approaches to other use-cases and facilitate the applicability.

Our Objectives

The overall objective of the project is to develop novel and generalising approaches for smart multidimensional measurements with significantly reduced experimental effort and validated uncertainty evaluation.

The specific objectives of the project are:

1. To develop automated ML approaches to solve linear inverse problems based on digitised measurements, going beyond the state of the art by using techniques from compressed sensing, low-rank reconstruction, and deep learning. ML models are trained to represent prior knowledge and statistically regularise the inverse problem, using real and synthetic data.
2. To develop uncertainty evaluation methods and create generalised tools for metrological validation. The tools include statistical uncertainty assessments, calibration analysis and have the capacity to validate the robustness and reliability of the ML model.
3. To develop automated, adaptive measurement strategies and achieve a targeted uncertainty while satisfying the constraints of specific metrology applications. Define a framework to include data management strategies and appropriate automated feedback procedures.
4. To implement the approaches developed in objectives 1 to 3 for several metrological applications.
5. To facilitate the take up of the technology and measurement infrastructure developed in the project by standards and end users and to disseminate good practice guidelines and a public database for reference data to all relevant stakeholders.

