AI in metrological applications – an international perspective

Competence Centre for AI and Metrology

Maik Liebl

Physikalisch-Technische Bundesanstalt
The National Metrology Institute

PTB

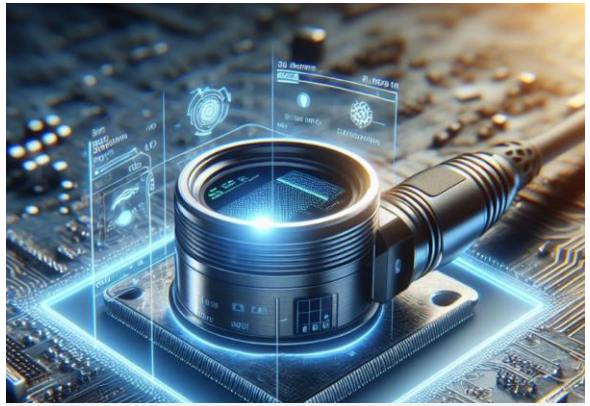
Federal Ministry
for Economic Affairs
and Climate Action

METROLOGIA 2025
150 anos de confiabilidade para um futuro sustentável
30 ANOS SBM

Digital future for the Quality Infrastructure (QI 2035)

Automated
quality management

Digital
Product Passport



Computational
Metrology

Intelligent
sensor networks

QI for AI-based products and
services

Images generated with Microsoft Designer

International QI collaborations

CIPM / BIPM

- CIE — INTERNATIONAL COMMISSION ON ILLUMINATION
- CODATA — COMMITTEE ON DATA OF THE ISC
- IEC — INTERNATIONAL ELECTROTECHNICAL COMMISSION
- ILAC — INTERNATIONAL LABORATORY ACCREDITATION COOPERATION
- IMEKO — INTERNATIONAL MEASUREMENT CONFEDERATION
- ISC — INTERNATIONAL SCIENCE COUNCIL
- ISO — INTERNATIONAL ORGANIZATION FOR STANDARDIZATION
- NCSLI — NATIONAL CONFERENCE OF STANDARDS LABORATORIES INTERNATIO
- OIML — INTERNATIONAL ORGANIZATION OF LEGAL METROLOGY

Joint statement of Intent

On the digital transformation in the international scientific and quality infrastructure

[…]

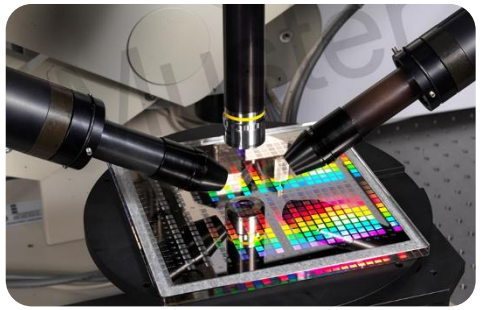
We the undersigned undertake to support in a way appropriate to each organisation the development, implementation, and promotion of the SI Digital Framework as part of a wider digital transformation of the international scientific and quality infrastructure.

2025

Examples for AI in metrological applications

Computational Metrology

Measurement of nanostructures for semiconductor production



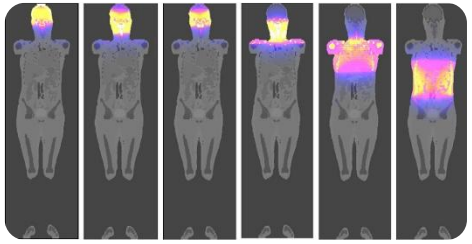
Detection of bioaerosols for environmental research

Detection of soot particles to determine air quality

[https://www.motointegrator.de/]

Autonomous driving

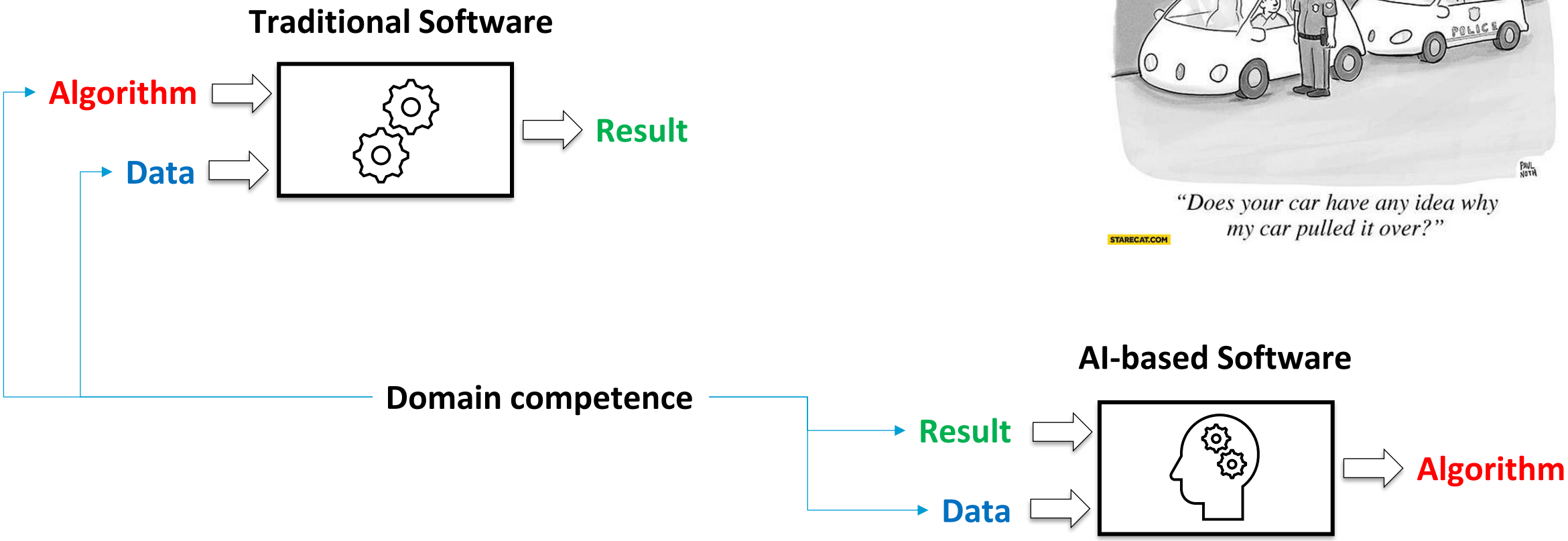
Personalised dosimetry



PTB, M. Kuhlmann et al., Phys Med. Biol.

Image reconstruction and processing in magnetic resonance imaging

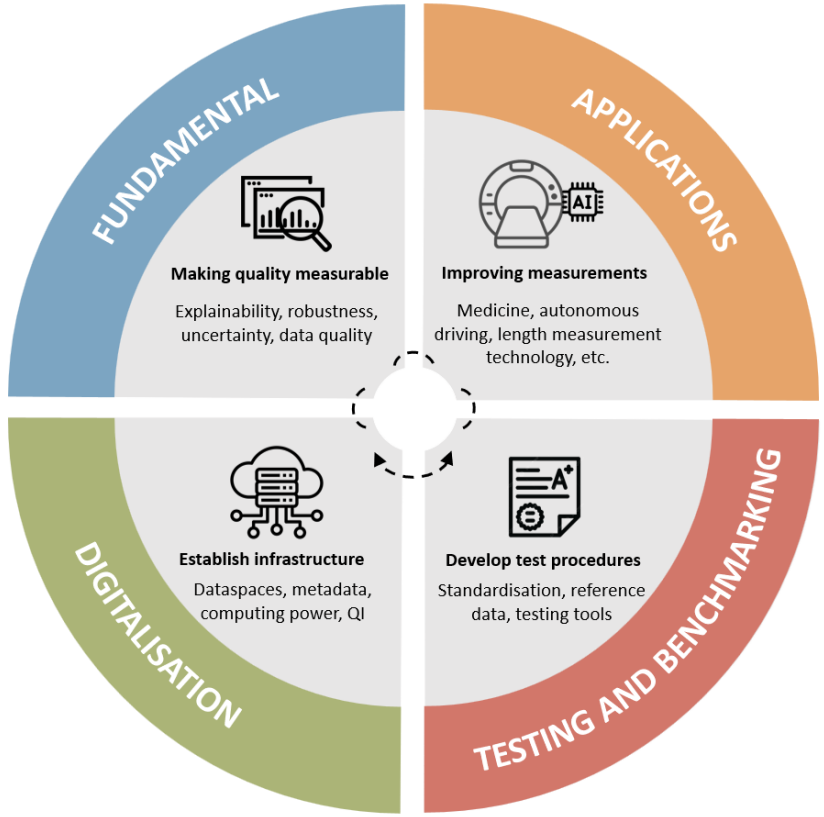
AI and the role of domain knowledge



Competence Centre AI and Metrology

Our activities at a glance:

- **Fundamental Research**
- Applications
- Testing and Benchmarking
- Digitalisation



Projects

QUALITÄTS INFRASTRUKTUR DIGITAL

AI matters

METROLOGY PARTNERSHIP | EURAMET

BioAirMet

TEF-Health Testing and Experimentation Facility for Health AI and Robotics

MAIN AI

Competence Centre AI and Metrology (KI-Met)

Assessment of data quality

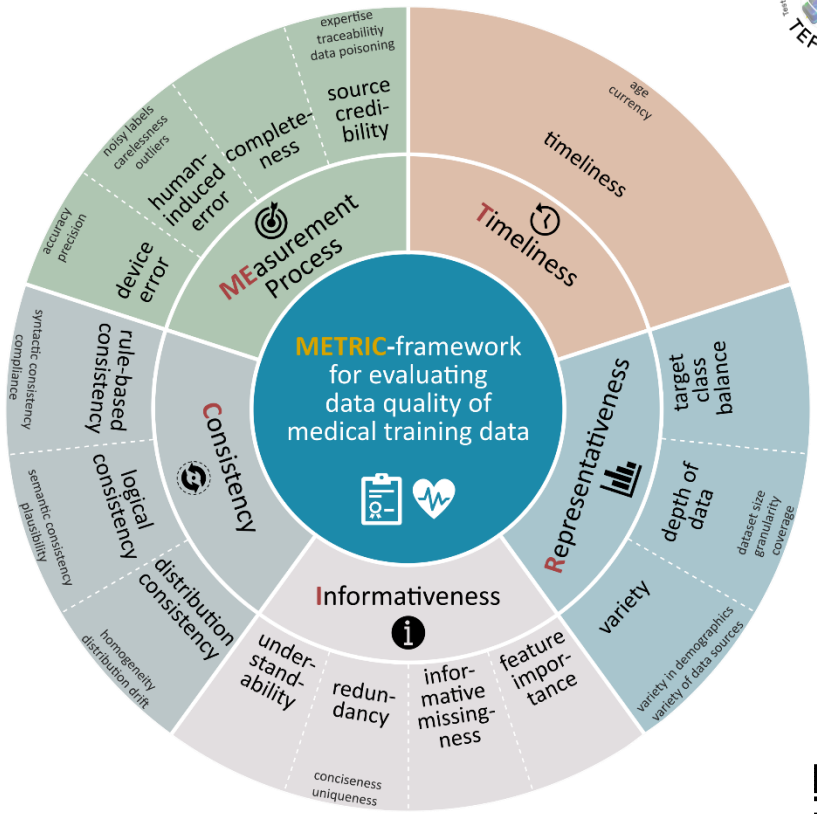
"METRIC Framework": Comprehensive system for evaluating the quality of medical data

Systematic evaluation of data quality
Foundation for trustworthy AI:

- Methodology for AI quality control
- Validation of training data (audit)
- Creation of reference data sets:
  - → Compilation of test data
  - → Metrologically curated data sets

Potential Services:

- Test stamps for data quality
- Provision of curated datasets



D. Schwabe et al., PTB, *npj Digital Medicine*, 2024

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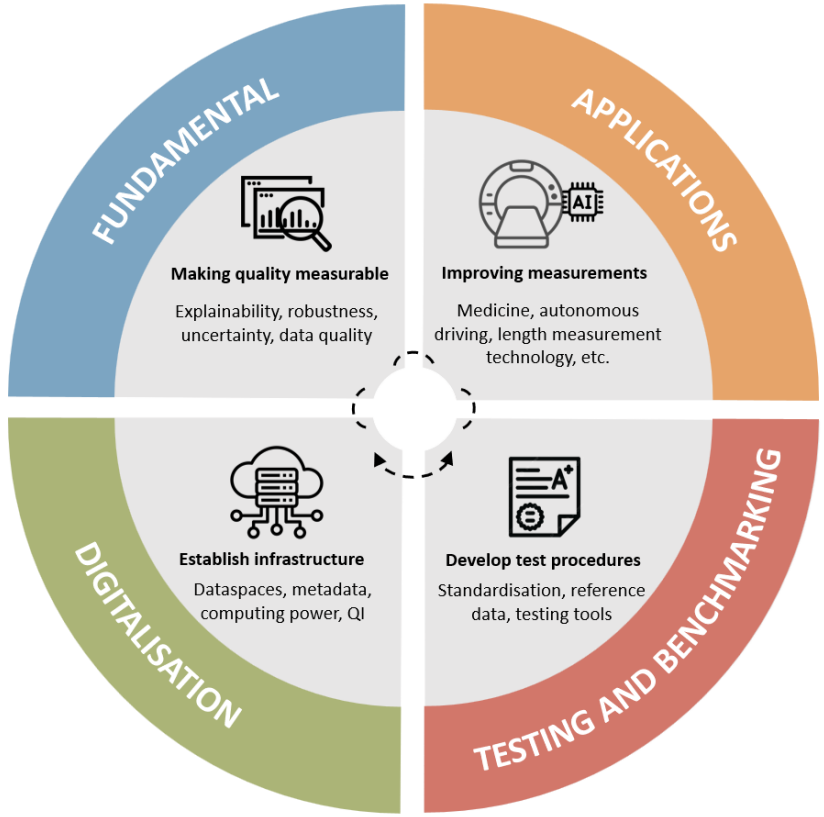

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MAIBE AI

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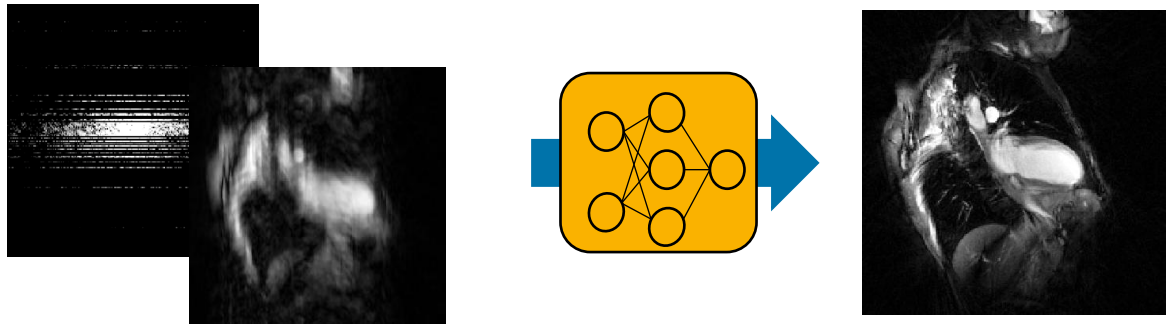
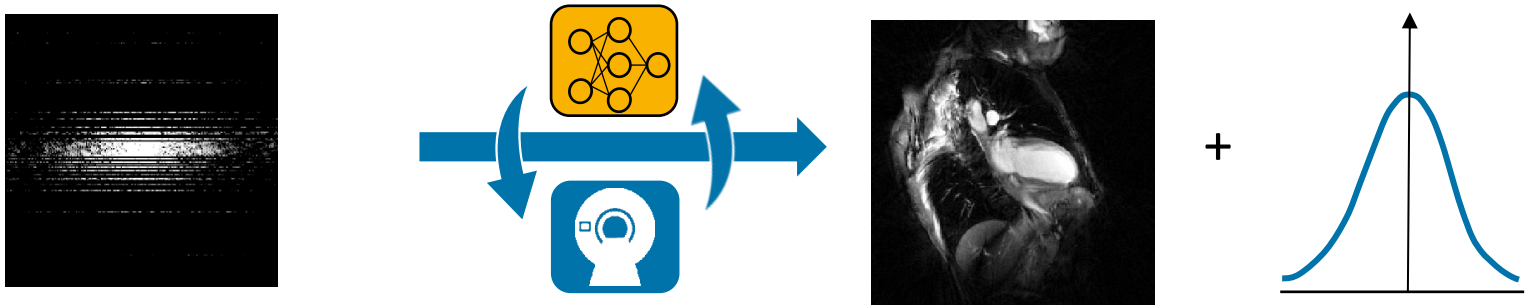
Robustness - AI for image reconstruction

Deep Learning Reconstruction



- complex CNN
- High number of parameters
- Large amount of training data

Physics-informed deep learning



- Effective Training
- **Robustness**
- Uncertainty

PTB, A. Kofler et al.

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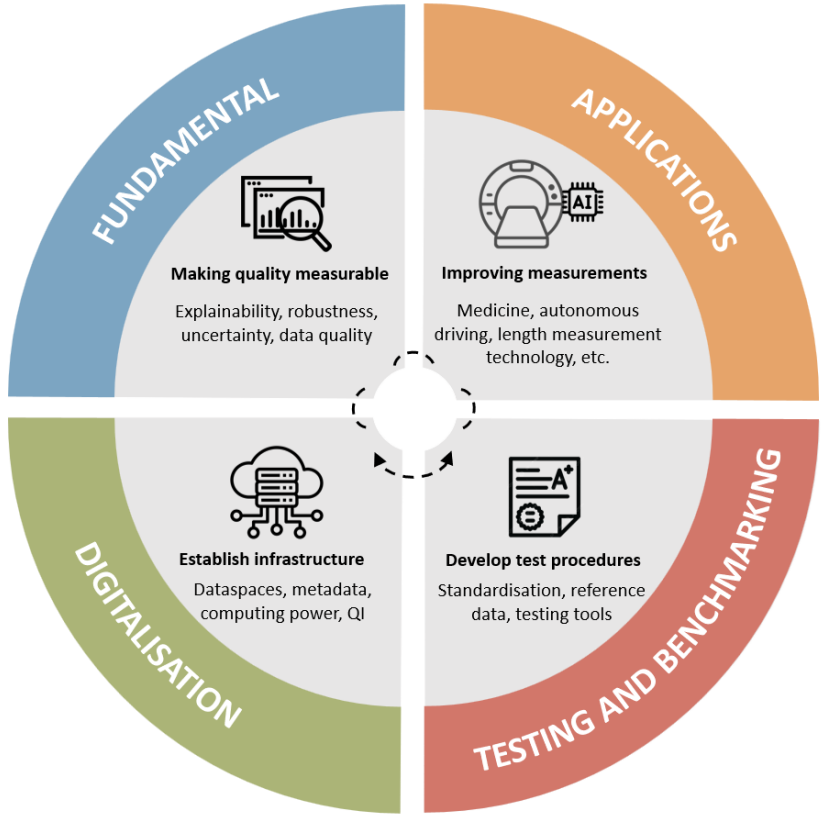
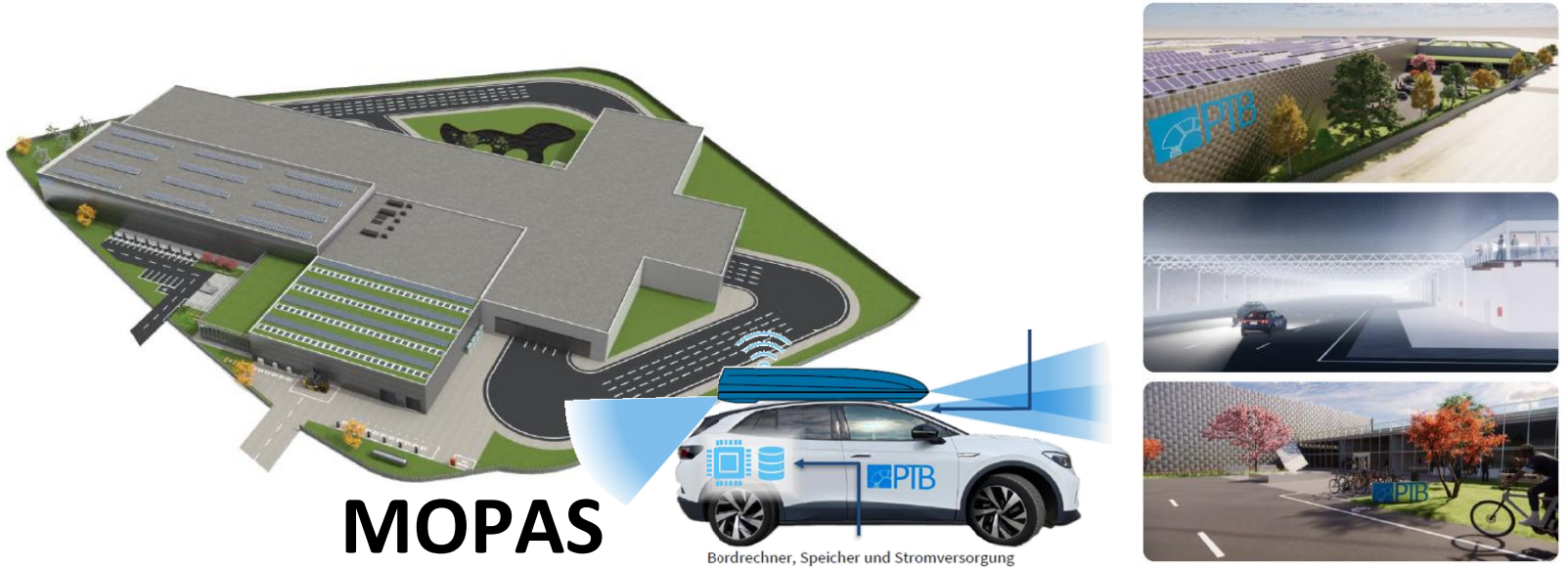


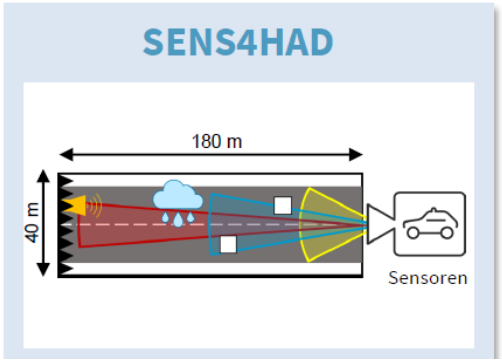
Projects

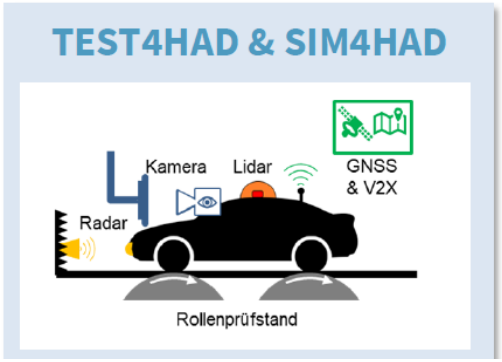
Competence Centre AI and Metrology (KI-Met)

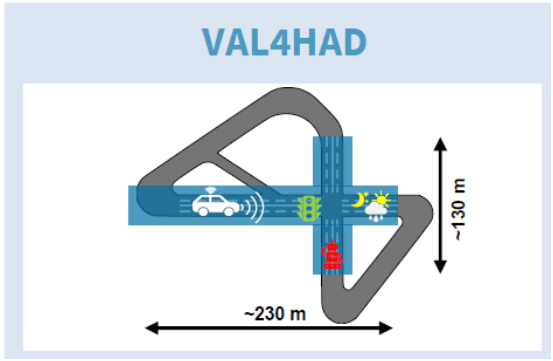
Physical test environments

TI-CAR Research Centre









T. Schrader, S. Meyne, S. Kothe, PTB

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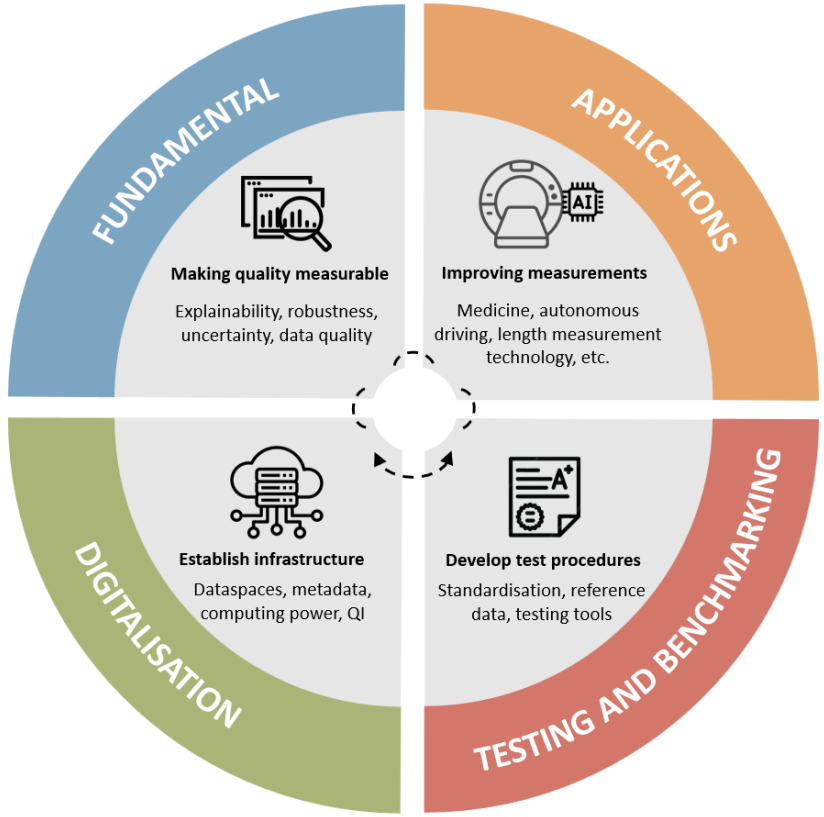

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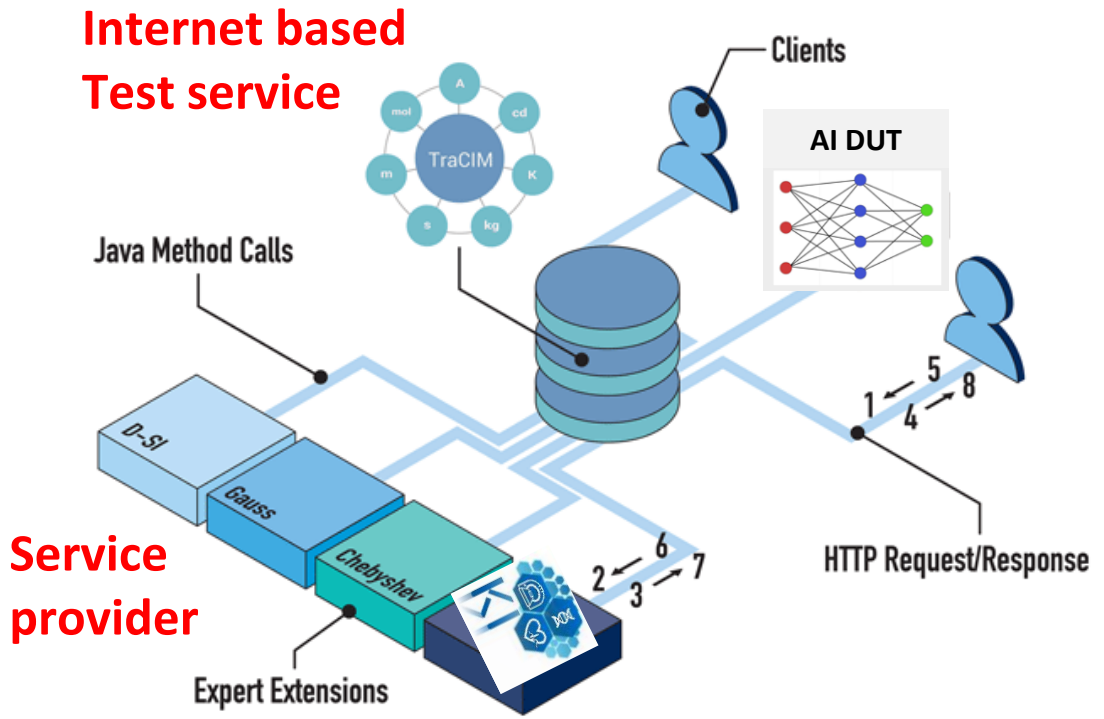
TraCIM-AI - Digital AI testing platform

Aim:

- Rapid innovations require **modern and digital testing**
- testing platform to build the necessary **infrastructure**
- quick **transfer** of data and metrics **into services**

Extension of TraCIM Ecosystem



AI evaluation

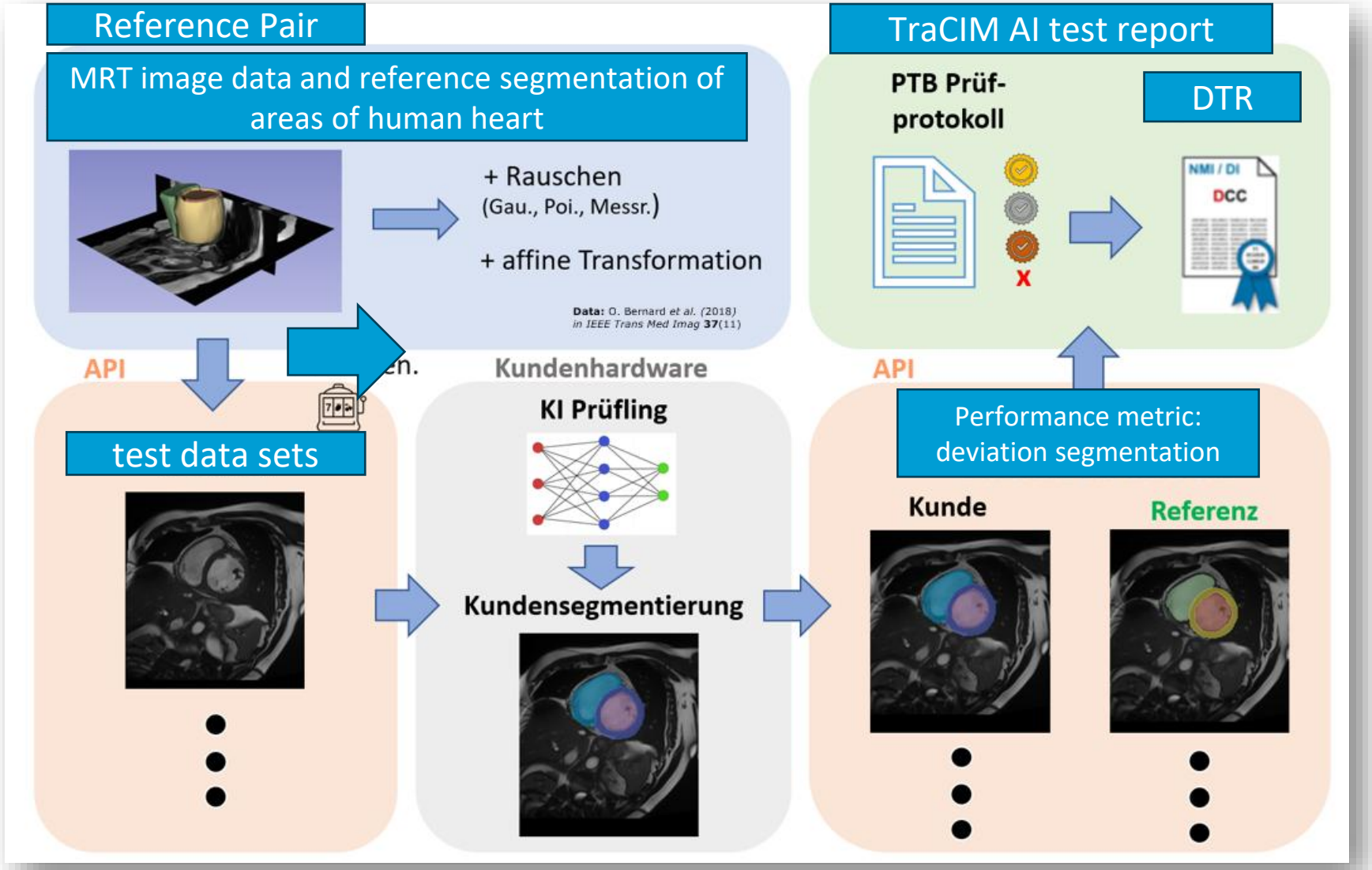
https://tracim.ptb.de

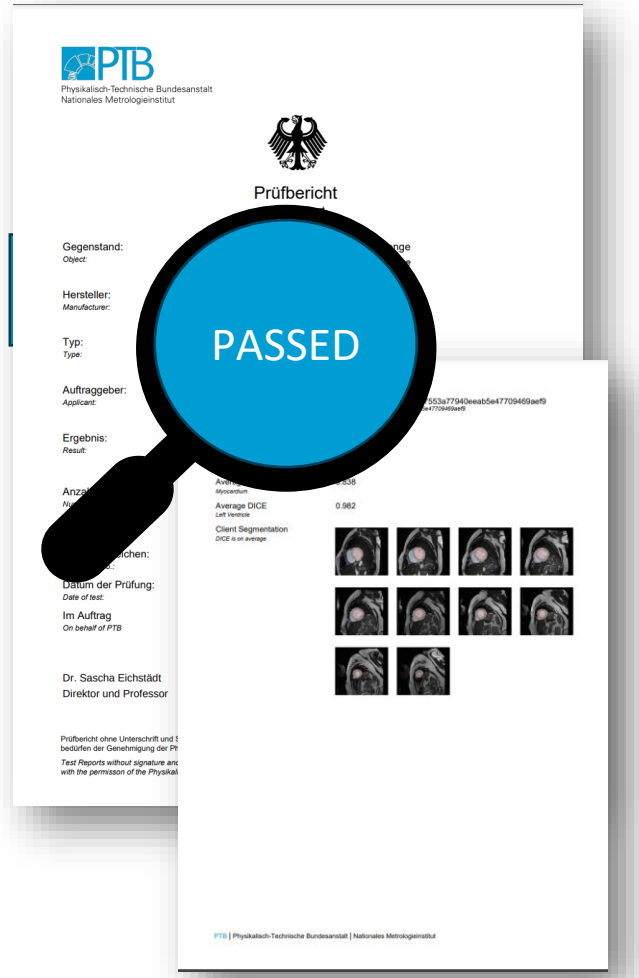
INTERNATIONAL METROLOGY CONGRESS CIM2025

Suggested: Key Comparison on AI reference data

F. Härtig, M. Liebl, PTB

TraCIM-AI - Evaluation Workflow





Accuracy

Objectivity

Passion

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The National Metrology Institute

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