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CARL-HENRIK HANQUIST

From European Metrology to Industrial Impact

How RISE and NMI Supports Swedish Manufacturing

National Metrology Institutes (NMI)

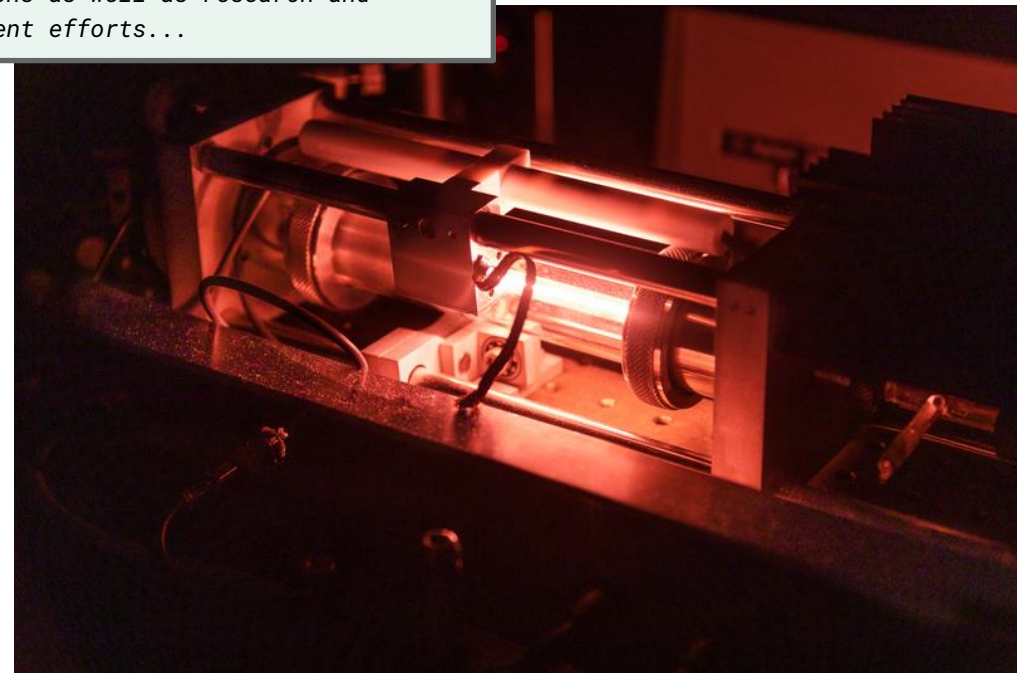
- RISE hosts the Swedish NMI
  - 32 physical quantities
  - 14 RISE laboratories are 'National Laboratories' ('Riksmätplatser')
  - Maintain national standards long-term and with international equivalence
  - Disseminate the international System of Units (SI) nationally

- Swedish Radiation Safety Authority, SSM Designated Institute
  - 4 physical quantities

Regulated by law

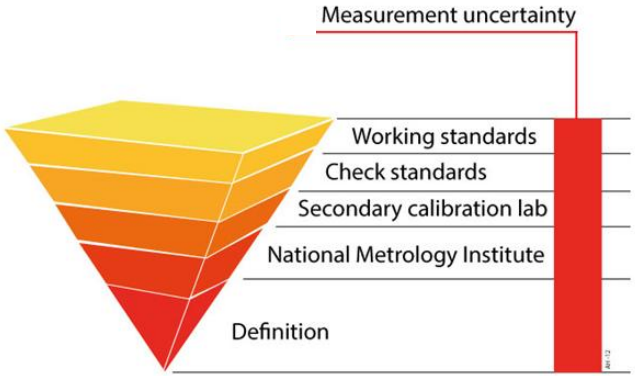
- National metrology activities in Sweden are regulated by legislation
  (SFS 2011:811 and SFS 2019:17)
- NMI activities (in brief)
  - Perform few high-accuracy calibrations to enable large-scale calibration services
  - Impartial hub for quality-assured metrology
  - Represent Sweden in international metrology cooperation
  - Conduct research and development in order to meet future metrology needs

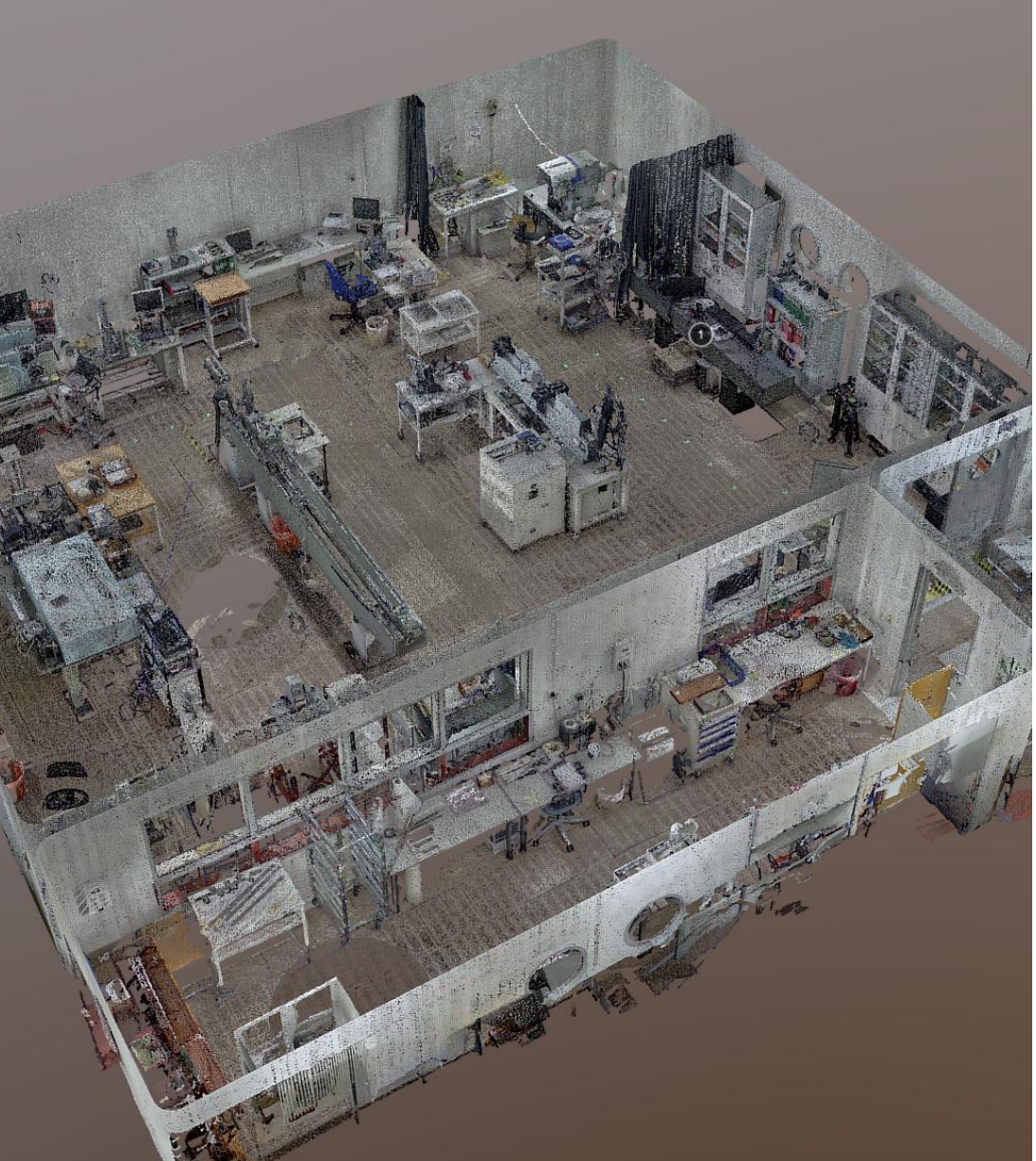
> *A "Riksmätplats" shall maintain a high standard with standards of sufficient scope and relevance. Traceability of measurement standards shall be ensured and developed through international comparisons as well as research and development efforts...*



Calibration

- Low measurement uncertainty services
  - Requires purpose-built instruments
- References used by other laboratories
- Custom-made objects
- Correct uncertainty level for your needs





National laboratory for dimension

- 4 laboratories
- A few nanometres to tens of metres
- Angles, surface roughness, form etc.
- ~40 main instruments
- >300 sets of reference objects

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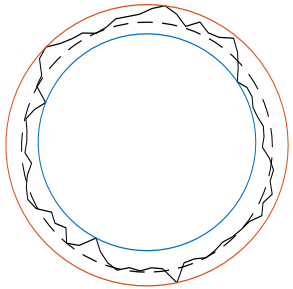
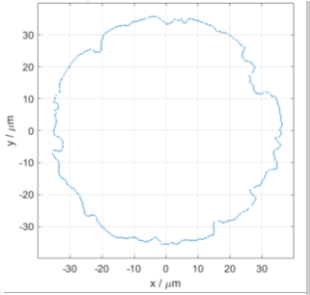
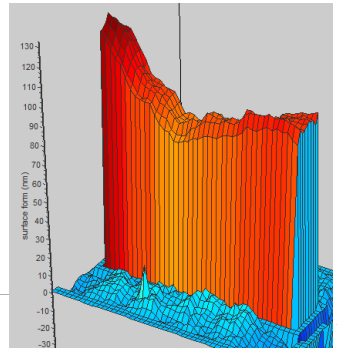
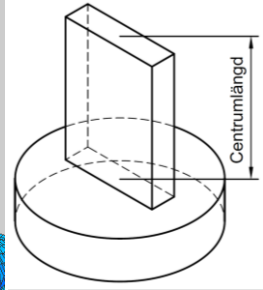
Impartial hub

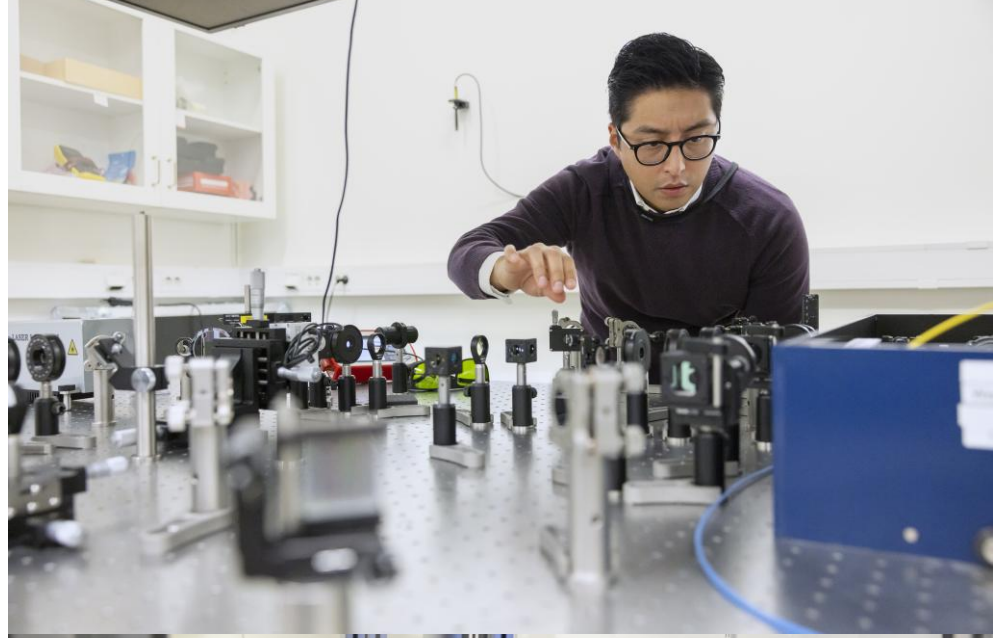
- Metrology education
- Experienced technicians
- A few steps away from new experts
- Leverage international connections
- Eye for small details that makes all the difference

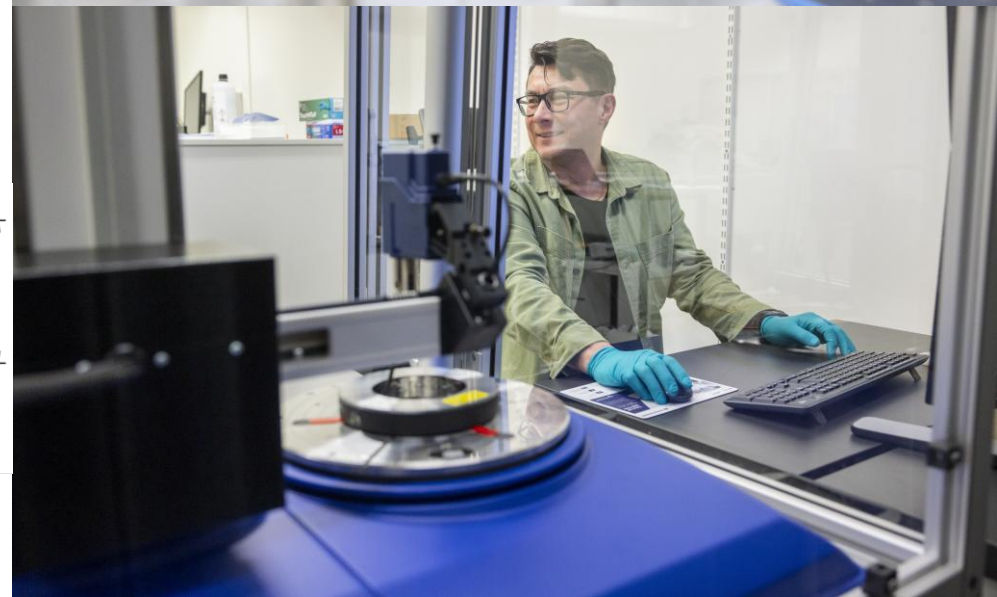












European Metrology Network
for Advanced Manufacturing

Strategic Research Agenda
Version 1.0 (05/2024)

EURAMET

ADVANCED MANUFACTURING

European Metrology Networks

- Advanced Manufacturing
- Clean Energy
- Climate and Ocean Observation
- Energy Gases
- Laboratory Medicine
- Mathmet
- Pollution Monitoring
- Quantum Technologies
- Radiation Protection
- Safe and Sustainable Food
- Smart Electricity Grids
- Smart Specialisation in Northern Europe

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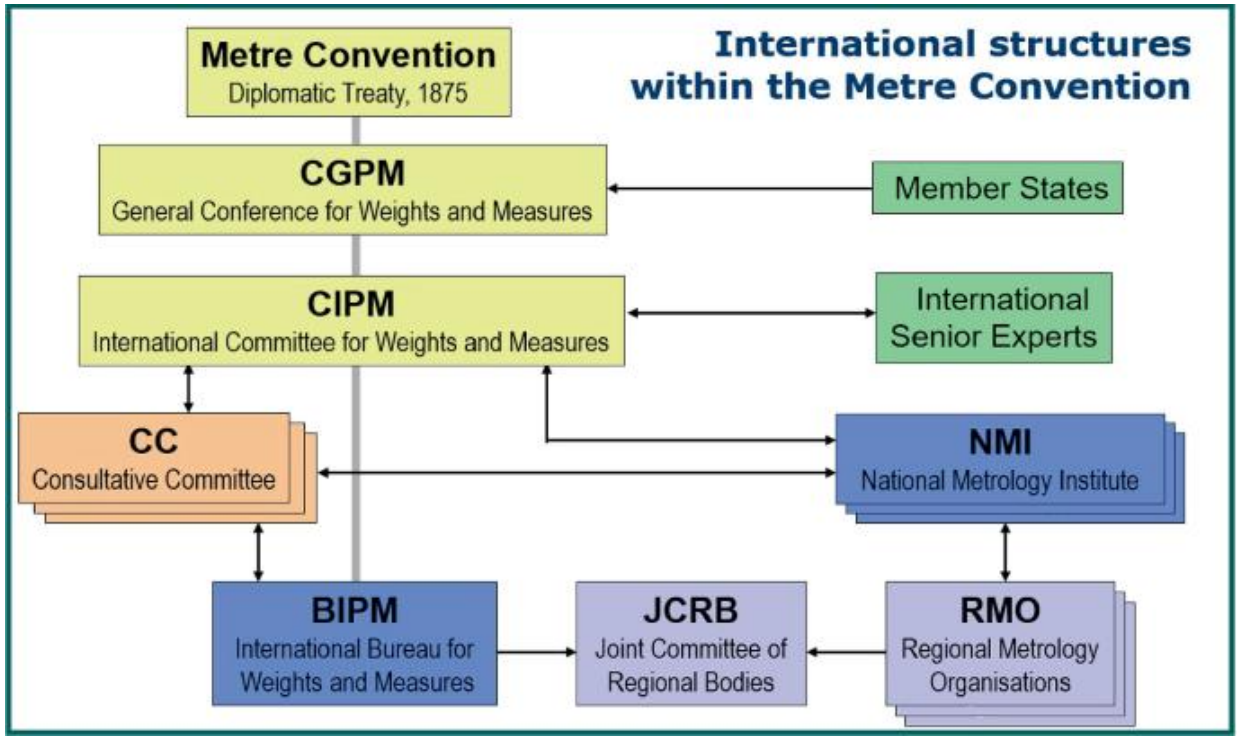
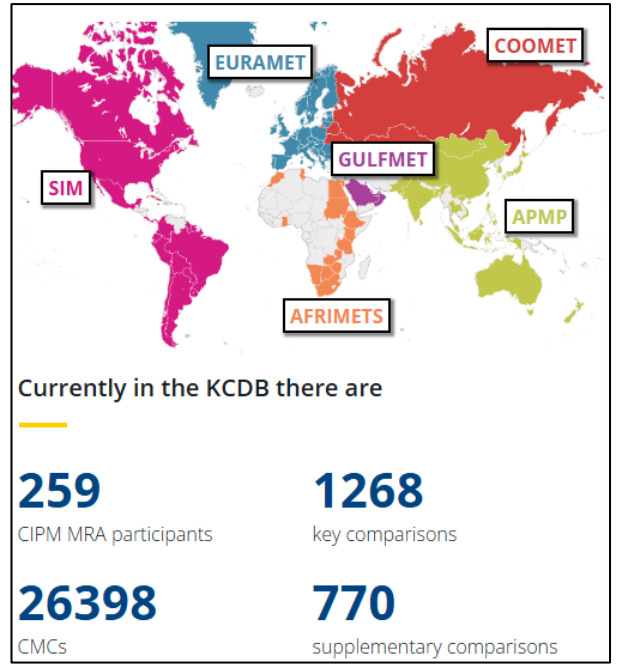
International cooperation





https://www.bipm.org/kcdb/

Omićević, Džanina, Dževad Krdžalić, and Esad Vrce. "Metre Convention Is a Root International System of Units." *International Symposium on Innovative and Interdisciplinary Applications of Advanced Technologies*. Cham: Springer International Publishing, 2021.

RISE accepted as a CCL member

Decision CIPM/113-30 (2024)

The CIPM accepted the following changes to the membership of the Consultative Committee for Length (CCL):

- INTI (Argentina) as a member
- RISE (Sweden) as a member
- SCL (Hong-Kong, China) as an observer

https://www.bipm.org/en/committees/ci/cipm/outcomes

Kvalitetssäkrad mätteknik på RISE
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RISE is a new member of the International Consultative Committee for Length Measurement, CCL.

"It is an acknowledgment and proof that our operations are of such high quality that we can be involved in influencing international metrology work at the highest level," says Sten Bergstrand, senior researcher at RISE.

The Committee coordinates the international measurement system in length and angles to ensure internationally comparable and traceable measurements. The Committee is the highest advisory body to the International Board of Weights and Measures (CIPM). To participate, you must, among other things, have the national responsibility for the quantities and qualified research in the field.

"In addition, you need to participate in and have good results in benchmarking at the highest level, and we have a good history there," says Sten Bergstrand.

What challenges is the committee working to solve right now?

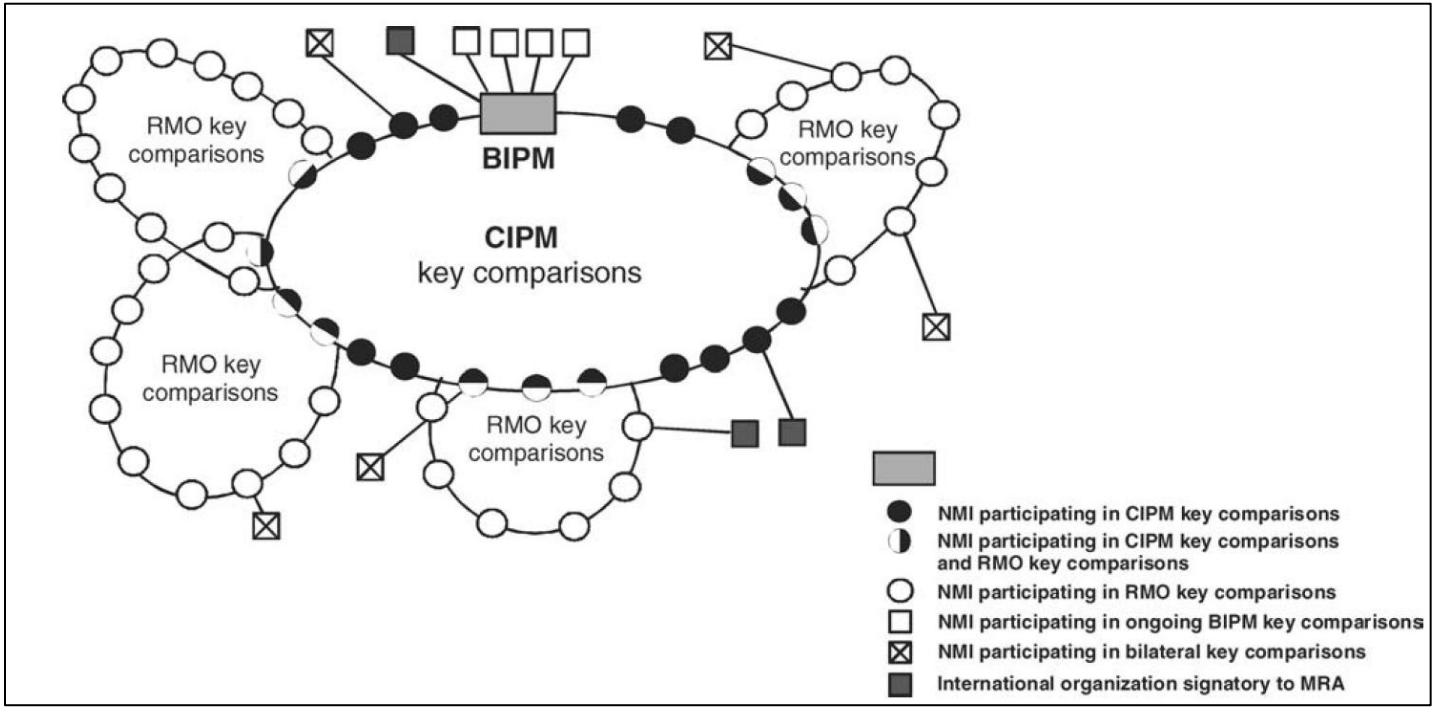
"There are always challenges in the work to ensure that measurements around the world are comparable with each other and to push the boundaries forward for quality-assured and reliable measurements and methods. An example of an area that needs to be developed is coordinate measurement. Although there are coordinate measuring machines that are widely used in industry, it is difficult to quality assure coordinates in three dimensions at the same level as pure length measurements, because uncertainties in measuring objects, measuring instruments and the relationships between them interact," says Sten Bergstrand.

This is the fifth consultative committee that RISE is a member of. In addition to CCL:
· CCEM (Electricity and Magnetism)
· CCM (mass)
· CCQM (Substance, Chemistry, Biology)
· CCTF (Time and Frequency)

Pictured: Karina Bastida from the Argentine National Metrology Institute INTI, also new members of CCL, the president of CCL Victoria Coleman from the Australian NMI and Sten Bergstrand on site at the International Bureau of Measures and Weights near Paris.

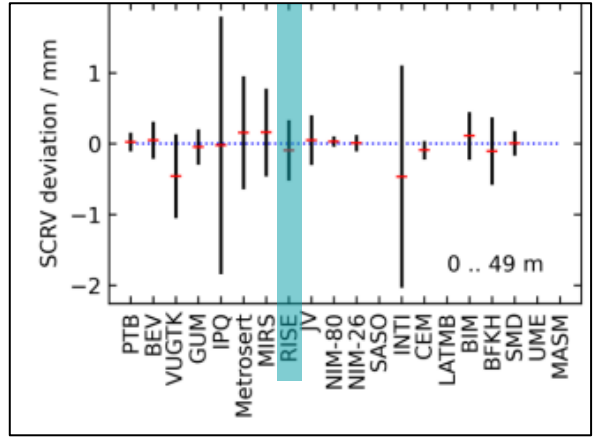
https://www.linkedin.com/showcase/kvalitetss-krad-m-tteknik-p-rise/

International equivalence

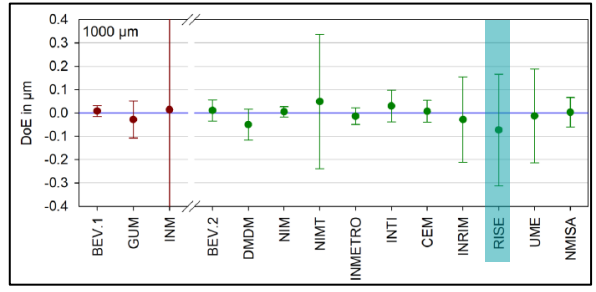


Meinrath, Günther, and Margarete Kalin. "The role of metrology in making chemistry sustainable." *Accreditation and quality assurance* 10.7 (2005): 327-337.

50 m steel tape: EURAMET.L-S2.3.n01
2018-2025
21 participants, 7 required further investigation

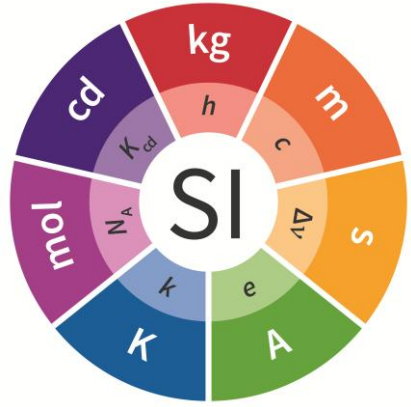


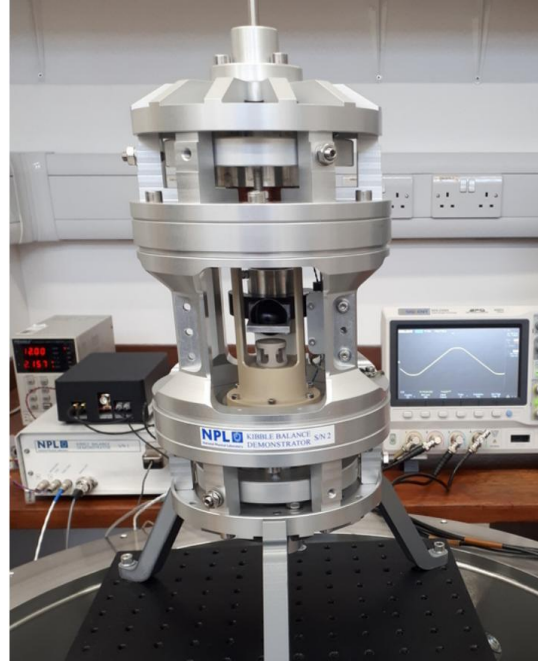
1 mm stage micrometer: EURAMET.L-S2.3.n02
2020-2024
13 participants from 4 RMOs, all measurements agreed



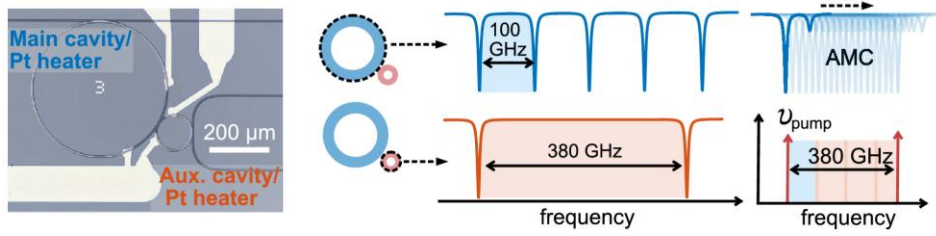
The unseen impact: thinking ahead

- 2019 revision of the SI
- SI-traceable "system-on-a-chip" technologies
- Removal of the leap second & lunar time
- New definition of the second ~2030+
- Digital calibration certificates
- New definition of gauge block length





Robinson, Ian A., et al. "Progress on the NPL, NMISA, RISE Kibble balance collaboration." 2024 Conference on Precision Electromagnetic Measurements (CPEM). IEEE, 2024.



Rebolledo-Salgado, Israel, et al. "Continuously tunable super-efficient microcombs." Optics Express 34.6 (2026): 9669-9679.

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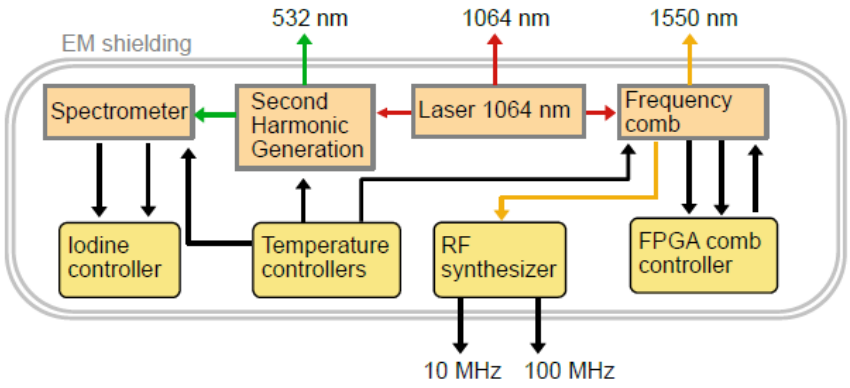

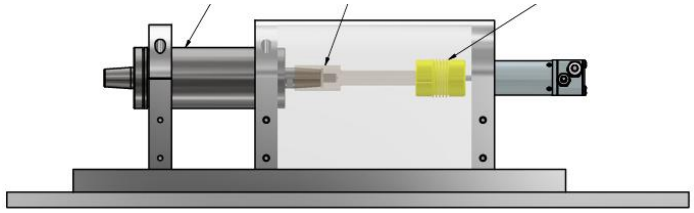

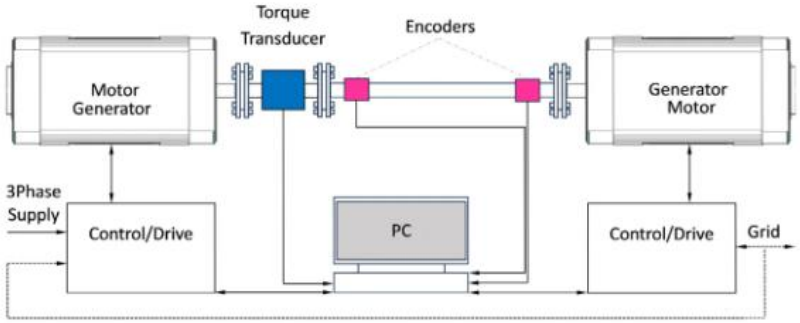

A sample of 2026

- Instrument - Optical Iodine clock & metre
- Instrument - Realisation of traceable speed
- Instrument - Traceable dynamic torque
- Revision of EURAMET calibration guide No. 10
  Pitch Diameter of Parallel Thread Gauges by Mechanical Probing
- SensMonCT II – Traceability and gauges for iCTs
- ADAM – Digital twins for freeform optical CMMs
- ScanClouDT – Traceability for advanced scanning systems

Dimensional metrology publications

- **Rebolledo-Salgado, I.**, Hammerschmidt, N., Fuhrmann, T., López-Ortega, C. H., **Zelan, M.**, & Torres-Company, V. (2026). Continuously tunable super-efficient microcombs. Optics Express, 34(6), 9669–9679. https://doi.org/10.1364/OE.587631
- **Rebolledo-Salgado, I.**, Helgason, Ó. B., Durán, V., Girardi, M., **Zelan, M.**, Torres-Company, V. (2024). Active feedback stabilization of super-efficient microcombs in photonic molecules. *Optics Letters*, 49(9), 2325–2328. https://doi.org/10.1364/OL.514761
- **Zakrisson, J.**, Silander, I., Kussike, A., Rubin, T., **Zelan, M.**, Axner, O. (2024). Effect of absorption of laser light in mirrors on Fabry-Pérot based refractometry. *Optics Express*, 32(14), 24656–24678. https://doi.org/10.1364/OE.528261
- Guillory, J., Truong, D., Wallerand, J.-P., **Svantesson, C.-G., Herbertsson, M., Bergstrand, S.** (2023). An SI-traceable multilateration coordinate measurement system with half the uncertainty of a laser tracker. *Measurement Science and Technology*, 34(6). https://doi.org/10.1088/1361-6501/acc26a
- **Rebolledo-Salgado, I.**, Quevedo-Galan, C., Helgason, Ã. B., Lööf, A., Ye, Z., Lei, F., Torres-Company, V. (2023). Platicon dynamics in photonic molecules. *Communications Physics*, 6(1). https://doi.org/10.1038/s42005-023-01424-5
- **Bergstrand, S., Jarlemark, P., Herbertsson, M.** (2020). Quantifying errors in GNSS antenna calibrations: Towards in situ phase center corrections. *Journal of Geodesy*, 94(10). https://doi.org/10.1007/s00190-020-01433-0
- **Flys, O., Berglund, J.**, Rosén, B. G. (2020). Using confocal fusion for measurement of metal AM surface texture. *Surface Topography: Metrology and Properties*, 8(2). https://doi.org/10.1088/2051-672X/ab84c3
- **Bergstrand, S., Herbertsson, M., Rieck, C., Spetz, J., Svantesson, C.-G.**, Haas, R. (2019). A gravitational telescope deformation model for geodetic VLBI. *Journal of Geodesy*, 93(5), 669–680. https://doi.org/10.1007/s00190-018-1188-1
- Lidberg, M., **Jarlemark, P. O. J.**, **Johansson, J.**, Ohlsson, K., Jivall, L., & Ning, T. (2019). Station calibration of the SWEPOS GNSS network. *Geophysica*, 54(1), 93–105. ISSN 0367-4231
- **Flys, O., Jarlemark, P**., Petronis, S., Patrik, S., Rosén, B. G. (2018). Applicability of characterization techniques on fine scale surfaces. *Surface Topography: Metrology and Properties*, 6(3). https://doi.org/10.1088/2051-672X/aacf5e
- **Flys, O., Källberg, S.**, Ged, G., Silvestri, Z., Rosén, B.-G. (2015). Characterization of surface topography of a newly developed metrological gloss scale. *Surface Topography: Metrology and Properties*, 3(4). https://doi.org/10.1088/2051-672X/3/4/04500

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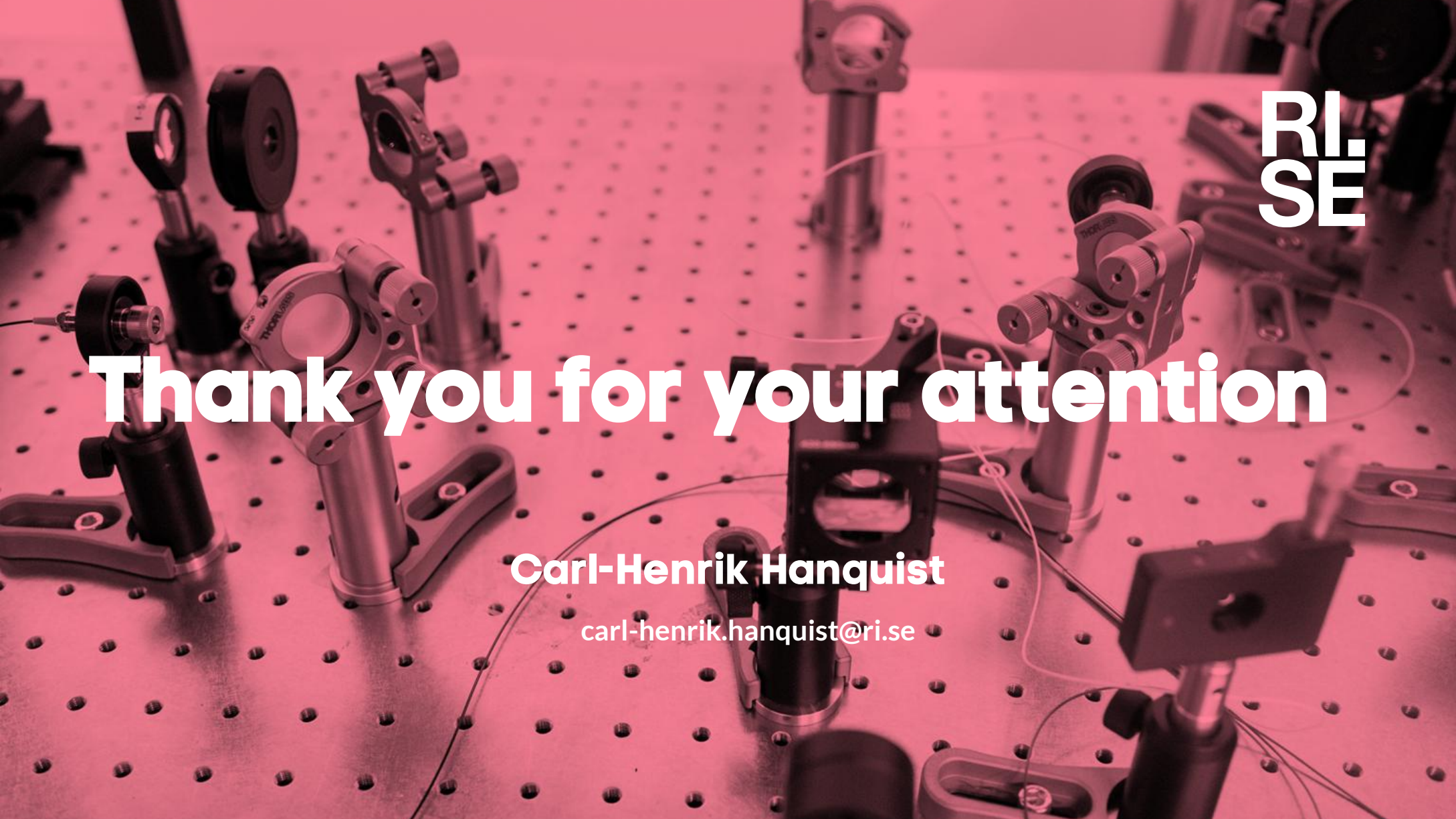
Challenge us



Thank you for your attention

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