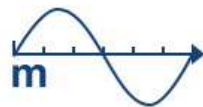


# TC for Metrology in Length: Highlights and Challenges

Antti Lassila, TC-L Chair  
MIKES-VTT, Finland

9th General Assembly

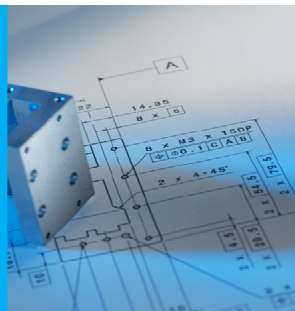
Krakow, Poland  
1-5 June 2015



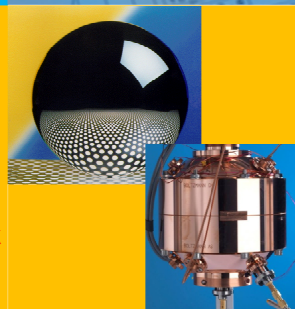
Length

## Length metrology - Areas of Impact

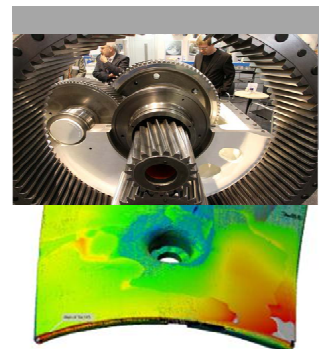
Traceability in dimensional measurements underpins all manufacturing, engineering and assembly industry worldwide, ensuring compatibility & interchangeability of parts.



Precision engineering and dimensional metrology are key to 3 SI re-definitions based on fundamental constants: form & dimension of Avogadro spheres and Boltzmann resonators, Planck balance interferometry



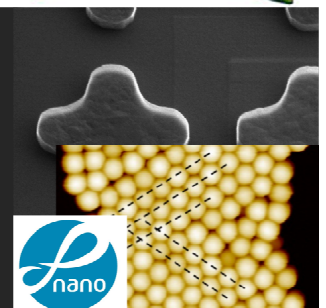
For new science (particle accelerators), energy generation (wind, civil nuclear), better accuracy & *in situ* calibration are speeding up manufacturing and enabling better efficiency, longer lifetimes. Solving gearbox problems is key to wind energy.



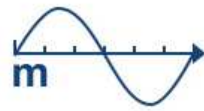
In aerospace, improving accuracy in aircraft assembly is reducing weight, reducing fuel burn (lower environmental impact, better energy efficiency). Key needs are accuracy and traceability for parts up to 40 m size.



Surface form and texture are critical to many nano-scale devices, particularly for *in-vivo* applications for health. Traceability infrastructure for 3D surface texture and simple dimensions on nano particles



- EMRP highlights
- EMPIR 2014
- Macroscale & TC-L



Length

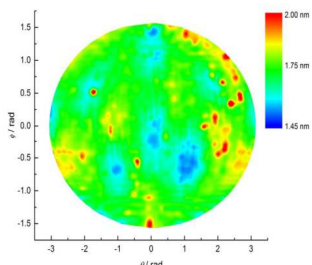
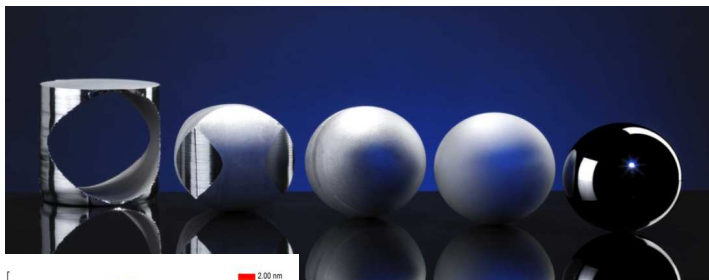
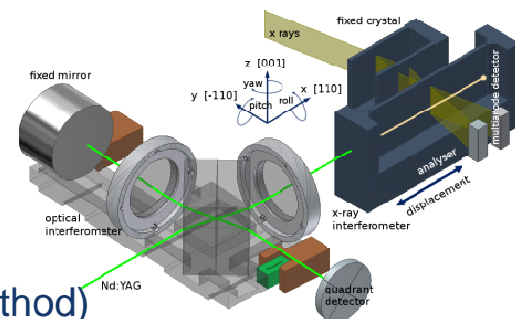
9th General Assembly, Krakow, Poland, 1-5 June 2015

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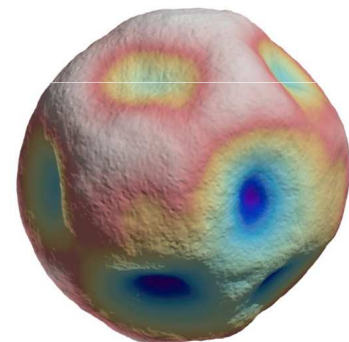
## SIB03-kNOW 2011

### Kilogram NOW – WP2 $^{28}\text{Si}$ Experiment

- Determination of  $N_A$  by counting atoms (XRCD method)
- INRIM remeasured Si lattice parameter => **halved uncertainty**
- Si sphere manufacturing chain and characterisation at PTB



Homogeneity  
of  $\text{SiO}_2$ -layer:  
 $\sigma = 0.16 \text{ nm}$



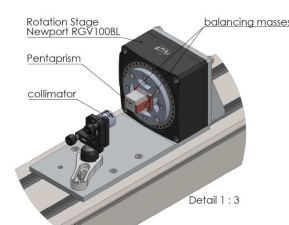
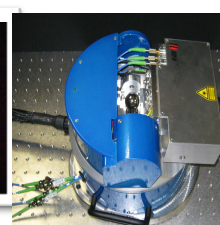
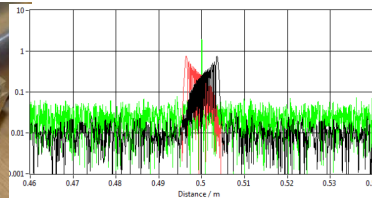
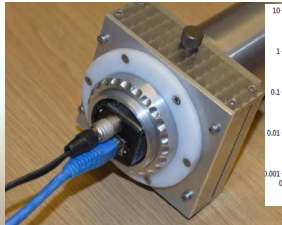
AVO28-S8c

Form deviation: (p-v) diameter = **38 nm**

Further improvements: **< 20 nm**

## “Addressing underpinning needs for metrology for *in situ* large measurements”

- ✓ **Ref. index-compensated** Absolute Distance Meter (20 m+ range) – ready for testing
- ✓ **Ref. index-compensated** laser tracer – being tested (at PTB)
- ✓ New 50 m ‘simulated industrial environment’ **test facility** (at GUM)
- ✓ Novel **multi target**, vibration-tolerant multilateration system based on FSI (at NPL)
- ✓ 4 **patents**, 2 commercial **licensing requests**, best practice training for laser tracker users
- ✓ NPL FSI targets installed at **CERN** – request for collaboration on LHC successor
- ✓ On-site evaluation of technologies at **Airbus** (planned for 2016)



## EMPIR 2014 industry call – TC-L related JRPs

12 JRPs with length related research agenda, 5 with multidisciplinary agenda, **5 to fund**

- ✓ JRP-i04 Metrology for innovative nanoparticles (Pilot NPL)
  - JRP-i05 Metrology for additive manufacturing production assurance (NPL)
  - JRP-i06 Dimensional metrology for high-aspect-ratio micro-nozzles (PTB)
  - JRP-i07 Vision based dimensional metrology (PTB)
- ✓ JRP-i08 Metrology for highly-parallel manufacturing (NPL)
  - JRP-i09 Reference nanodimensional metrology for nanomanufacturing (PTB)
  - JRP-i10 Traceable asphere and freeform metrology (PTB)
- ✓ JRP-i20 Metrology for length-scale engineering of materials (NPL)
- ✓ JRP-i21 Metrology for manufacturing 3D stacked integrated circuits (LNE)
- ✓ JRP-i22 Metrology for the photonics industry – optical fibres, waveguides & applications (MIKES)
  - JRP-i23 Reliable micro mechanical test data for modelling adv. materials (NPL)
  - JRP-i24 Optical metrology solutions for next generation lithography (PTB)

## Macroscale 2014 Conference

- Dimensional and related measurements at the macroscopic scale  
Macroscale 2014 Conference
- Organised by BEV and PTB in co-operation with CCL and EURAMET TC-L
- October 28<sup>th</sup> to 30<sup>th</sup>, 2014
- BEV, Vienna, Austria
- 81 participants from EURAMET, COOMET, SIM, GULFMET, AFRIMET and APMP, industry and academia



9th General Assembly, Krakow, Poland, 1-5 June 2015

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## Technical committee of Length

- 34 contact persons & 5 observer
- 28 active EURAMET projects
- Annual work shop or conference jointly with TC-L meeting
- TC-L meeting interest also NMIs outside EURAMET
- At 2014 meeting at BEV we had observers/guests from:
  - Saudi-Arabia
  - Ukraine
  - South-Africa
- Occasionally TC-L has also had observers/guests from:
  - Tunis
  - Egypt

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**Thank you for  
your  
attention!**



**TC-L 2014, BEV Austria**

