TC Time and Frequency:

Highlights and Challenges

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EURAMET 5th General Assembly

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HIGHLIGHTS

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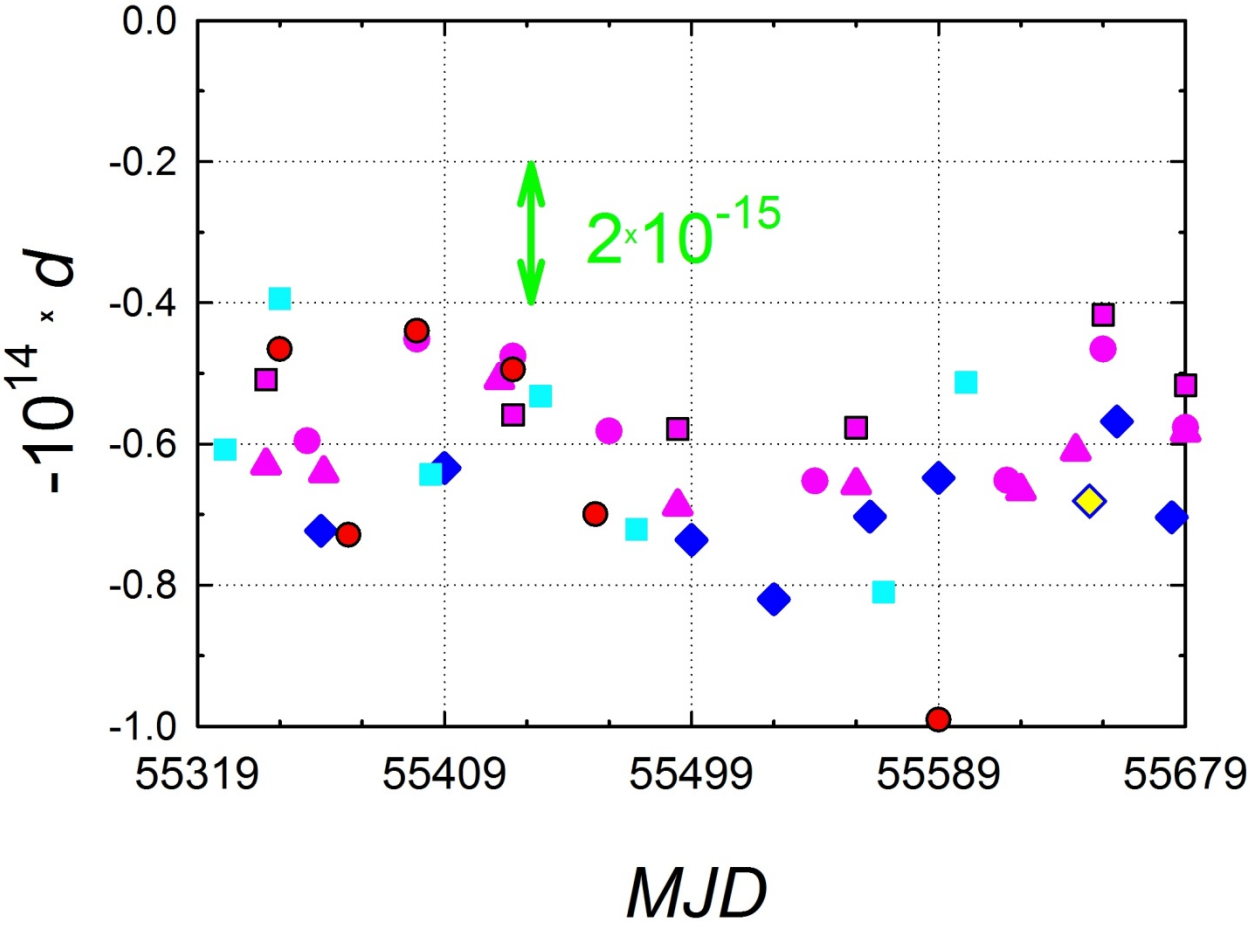
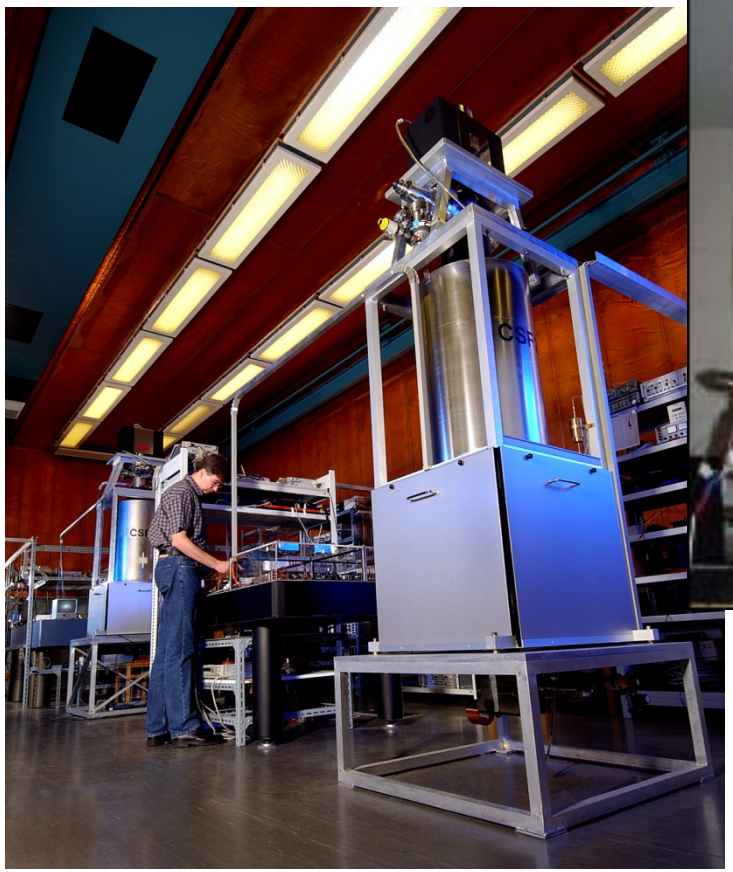
The European measurement infrastructure in the T+F domain is internationally competitive and recognized and is based on high-quality research.

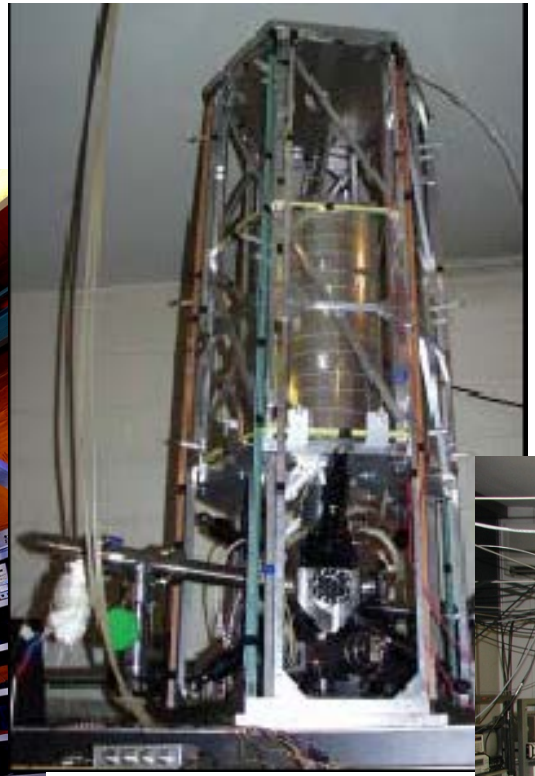
31 institutes residing in 25 EURAMET member states collaborate with BIPM to realize International Atomic Time, and they have contributed with data from more than 100 commercial atomic clocks and 10 primary clocks during the last 12 months.

Comparison of TAI to caesium fountains
CSF1, CSF2 of PTB, NPL CsF2,
LNE_SYRTE FO1, FO2 and FOM, INRIM CSF1
during 1 year including April 2011



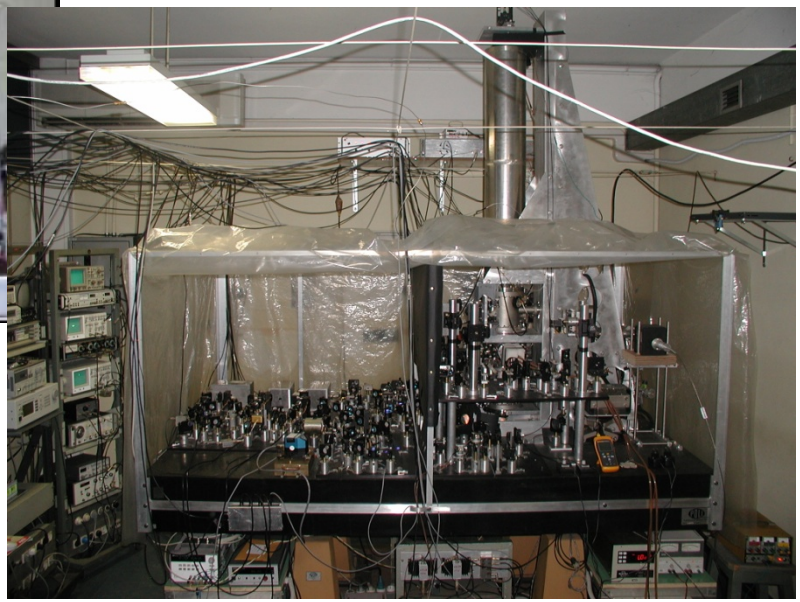
PTB





LNE-SYRTE
FO-2

INRIM



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The improvement in clock performance (stability and accuracy) has been overwhelming during recent years.

But it can only be exploited if the means for comparisons are improved at the same pace.

EURAMET members are actively pursuing projects
aimed at improving the quality of time and frequency transfer.

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- Work on the fiber transfer in an advanced state
  in France, Germany, Sweden, UK, Italy, CZ, Austria
- 2 PRTs / 1 SRT EMRP Calls 2011 “SI Broader Scope” from this field
- One EURAMET project regarding time transfer through optical fibers
- Two EURAMET projects regarding GNSS-based time transfer

Demonstration of long-distance optical frequency transfer

- 2 *dark* fibers (ITU-T G.652)

  n ~ 1.4681 at 1550 nm

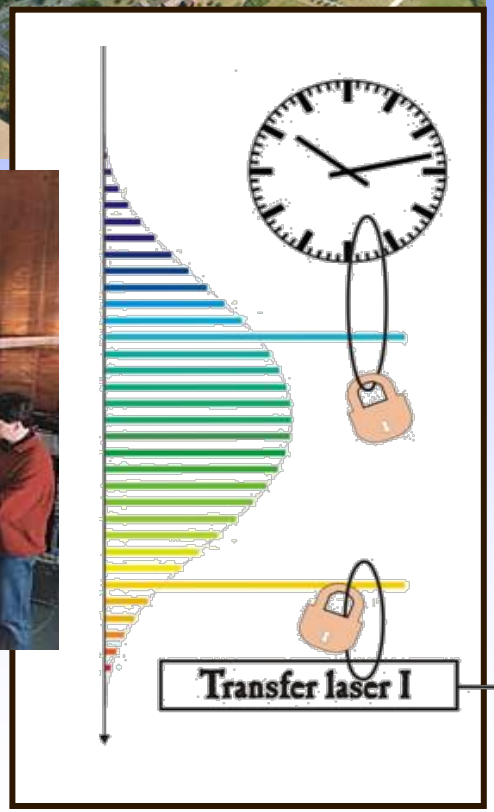
  A~ 0.23 dB/km

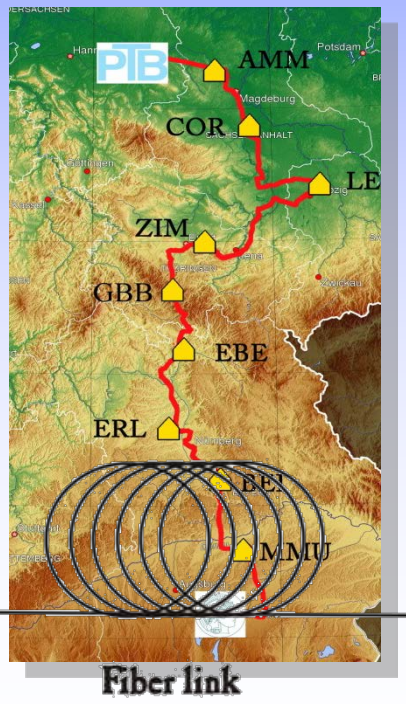
DFN Deutsches Forschungsnetz

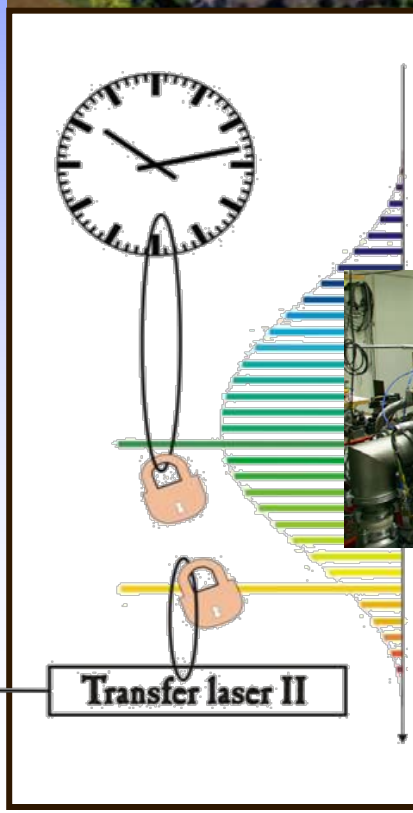
GasLINE

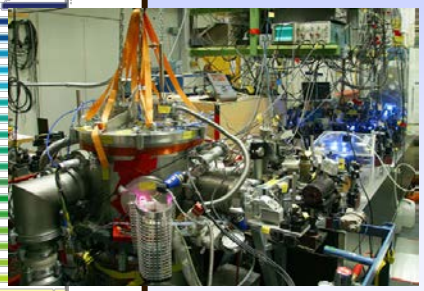
- Total fiber length 900 km
- Total one way loss >200 dB
- Access to the link at
  - 7 telecom containers
  - 2 computing centers

Precursor for a European network

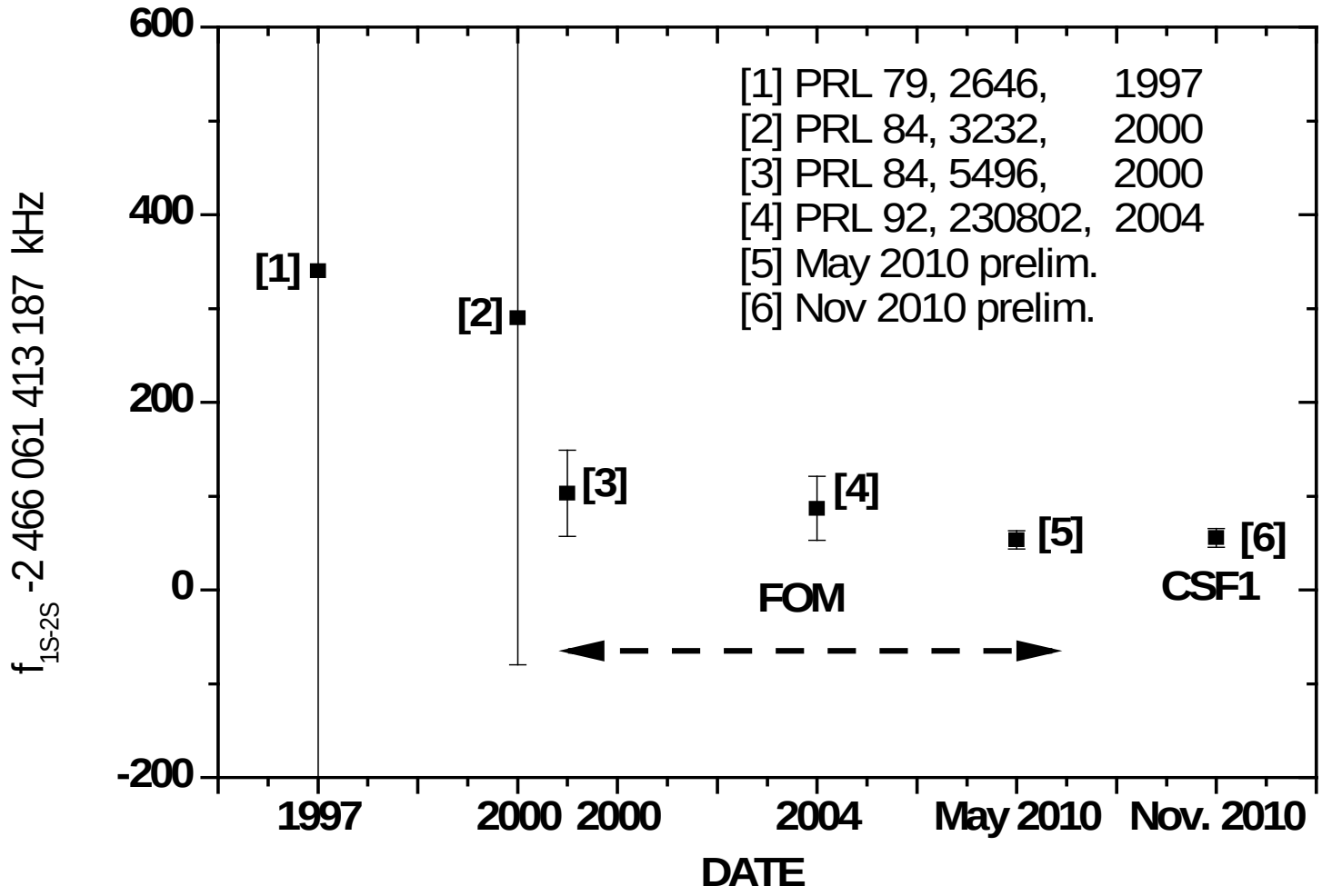




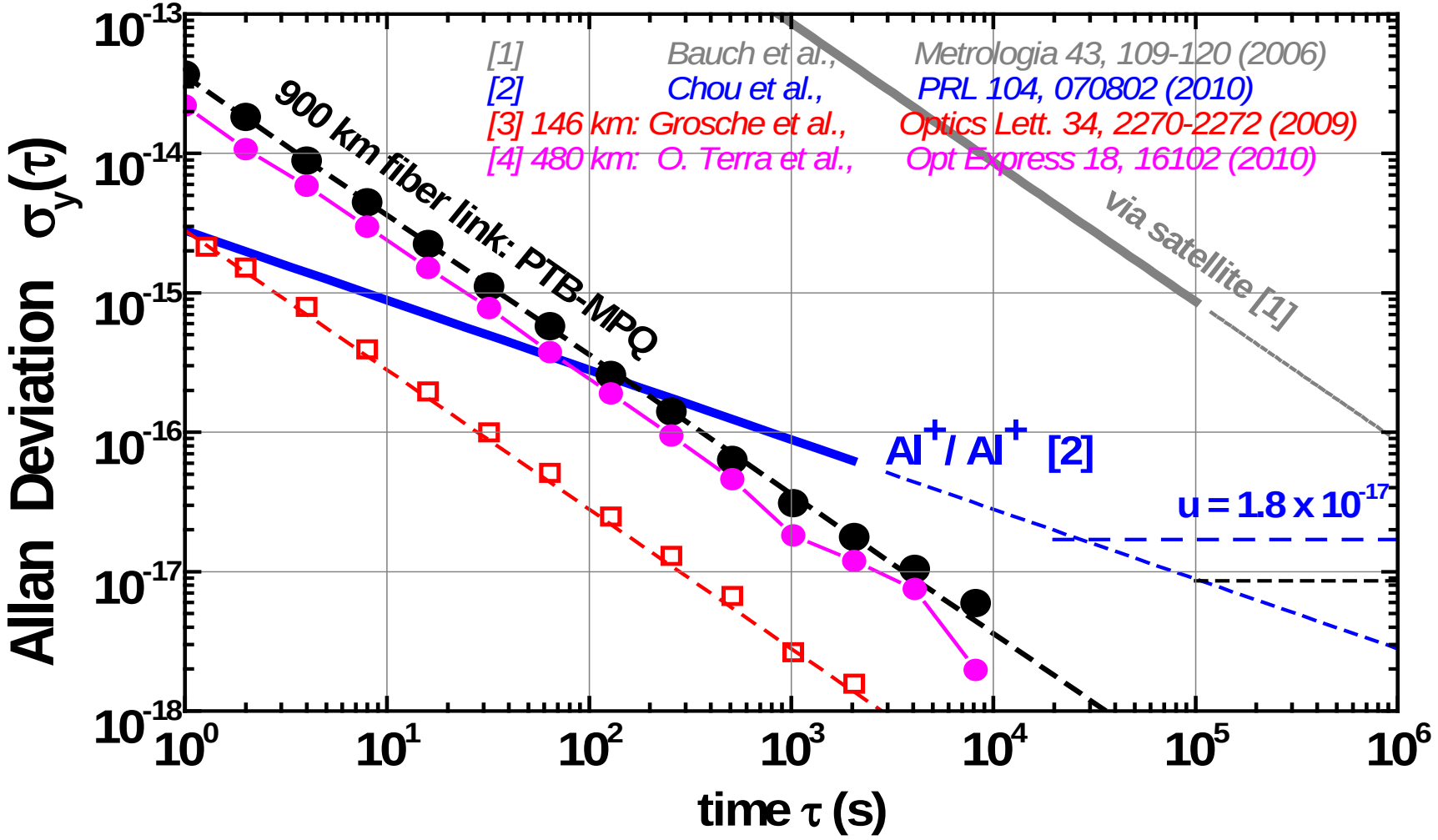




Example of applications:
Hydrogen 1S-2S frequency measurement



Clock comparisons using dark fiber



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HIGHLIGHTS

and challenges of routine TC work

Project 1117:

Survey of European countries' legal time regulations (MIRS/SIQ).
Booklet, authored by Rado Lapuh,
published by EURAMET,
sponsored by MIRS/SIQ.

Complies with the EURAMET strategic objective to promote the
work of its members effectively.
- That is our hope -

Preceding the 2011 annual TC-TF meeting,
a survey among the members was conducted:

CMCs published? **NO: 5**

CMC entries needing update? **Yes: 7**

Number of services offered? **19 in total**

Number of services actually requested by external customers?
Between "all declared" and < 20%

One Key Comparison serving the needs for all

CCTF-2009 Recommendation regarding GNSS receiver calibration

- encourages BIPM to continue GNSS receiver characterization for a subset of the laboratories
  - Imposes supplementary work to be done by RMOs
  - Issues:
    - Which are the most urgent needs?
    - Which receiver type is best suitable as travelling receiver?
    - How do we document the results and make use of them?

Link calibrations made during 2009 and 2010

ROA - PTB

PTB – METAS

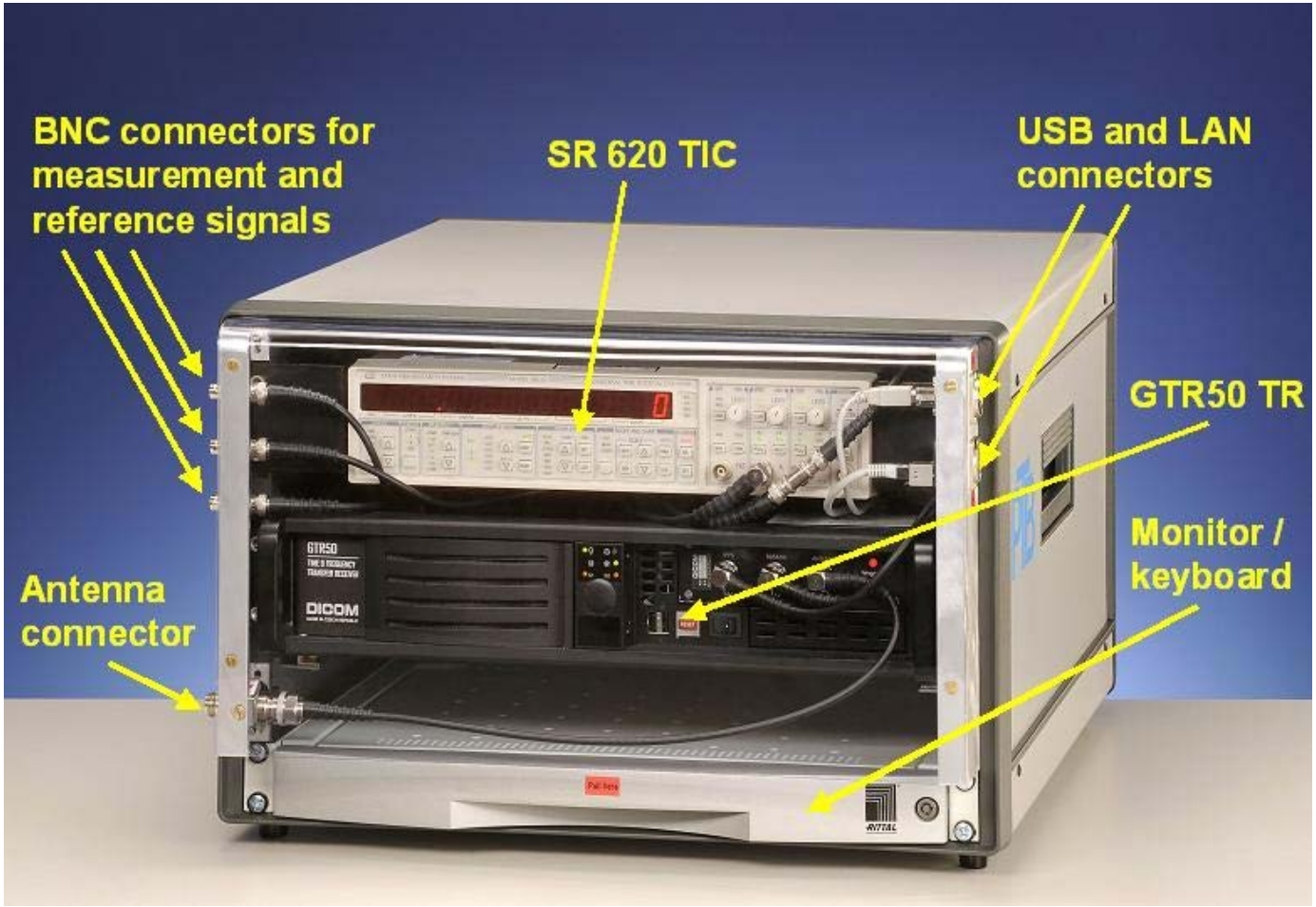
ROA – INRiM – PTB

PTB – NPL

NIM – PTB

PTB - USNO

ROA - PTB



Further challenges for the TC-TF?

- Many labs are service oriented and have no research capabilities or mandate – no real interest in many EURAMET activities
- 90% of all applications can be met with rather cheap GPS-disciplined oscillators plus some distribution equipment (if the equipment functions)
- Many delegates do not attend any scientific conference regularly for cost reasons – EURAMET TC-TF could meet at the same place as EFTF.

Need to support institutes from emerging members so that they meet their national requirements in the field.

Some countries / institutes are actively involved in the EURAMET Focus Group Facilitating National Metrology Infrastructure Development, either as experts and lecturers, or getting training and knowledge transfer.

The availability of suitable didactical material for training was questioned.

A Technical Guide is going to be produced in Project 1130 – would be helpful in this context - if ever finished.

The availability of further technical guides, calibration guides and work procedures will be surveyed.

Thank you for your attention