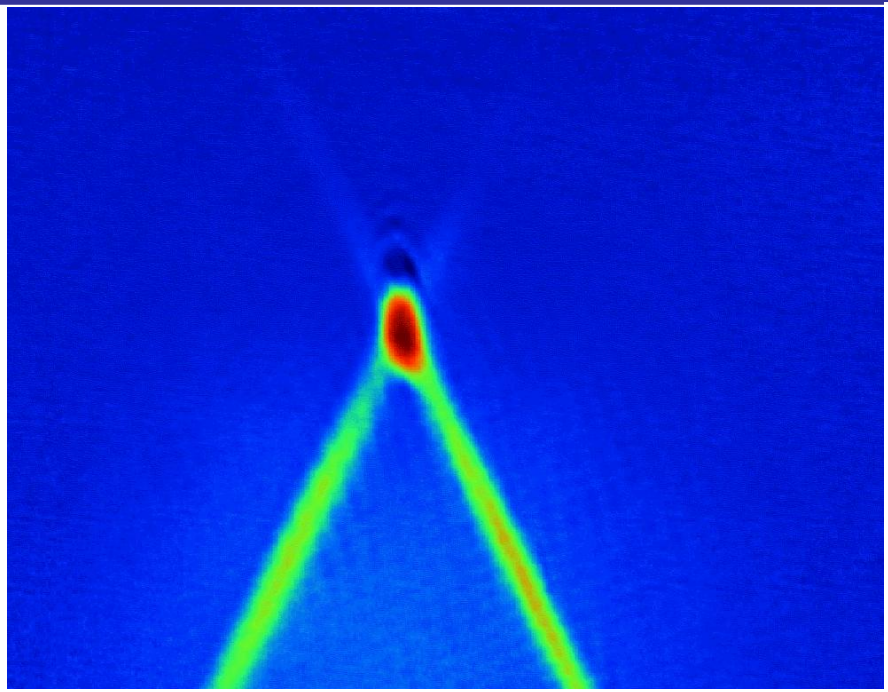
The European Metrology Research Program
Research Council Point of View



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Physique quantique et applications

Ecole Normale Supérieure, Paris, France

Brussels, November 29th, 2011

The EMRP Research Council Composition

- Institutional members:
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EMRP

- EMRP is a FP7 EU program under article 185.
- It was created in 2009 after IMERA +
- EMRP research Council has met 3 times, once per year since december 2008

The EMRP Research Council tasks

1) The Research Council (RC) advises the Euramet executive on the European Metrology Research Programs
2) The RC makes recommendations to Euramet on scientific and technical aspects
3) The RC endorses the selection made by Euramet of the Joint Research Programs (JRP's)
4) The RC suggests new strategic directions or new topics to consider in the European metrology landscape.

Metrology

Metrology is the science of precision measurement

It is at the core of every technical system existing in our societies
and, as such, extremely important in all aspects of technologies and life

Basic Science ⟺ applications ⟺ Society

National Research Labs
NMI's, Universities,
institutes

Fundamental Units
7 SI base units
meter, kilogram,
second, ampere, kelvin,
mole, candela

Industry

Industrial products

Measurement Instruments
Metrological Traceability

Examples:

GPS, GALILEO
Radiotherapy
Earth monitoring
Energy and resources
monitoring
……..

Structure of the program

EMRP Call 2007
SI and Fundamental constants, Health, Length, Electricity and Magnetism:
Funded JRPs and program closed: results available

EMRP Call 2009
Energy: Funded JRPs

EMRP Call 2010
Industry & Environment: Funded JRPs

EMRP Call 2011
Health, SI Broader Scope & New Technologies: in process

EMRP Call 2012
Industry, SI Broader Scope & Open Excellence: Call Details

EMRP Call 2013
Energy & Environment

Example 1

Determination of the Boltzmann constant for the redefinition of the kelvin

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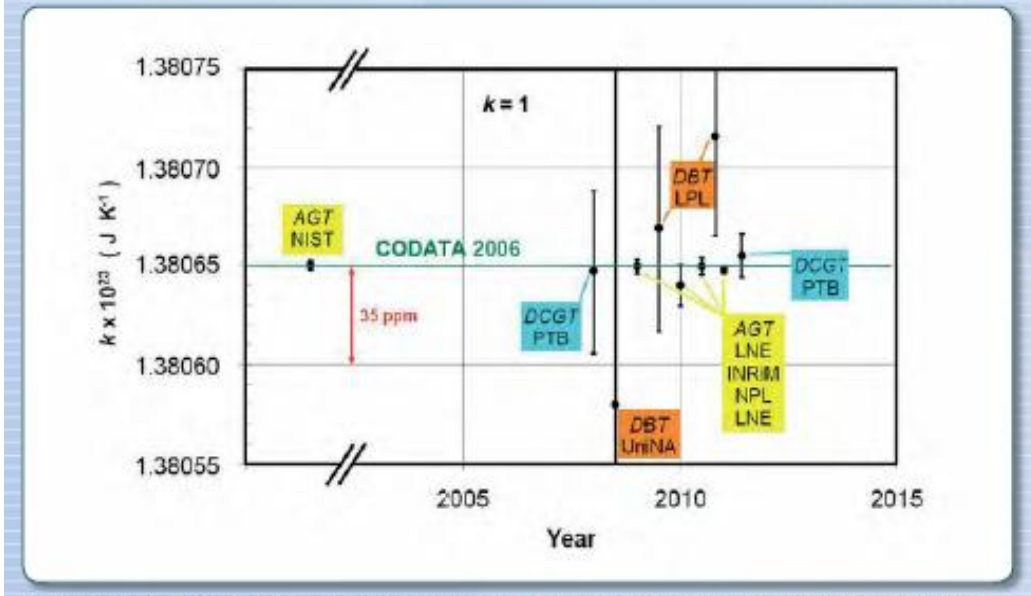
$$E = k_B T$$

AGT Cell - Spherical resonator for acoustic gas thermometry (AGT).



Results for the Boltzmann constant k obtained by dielectric constant gas thermometry (DCGT), Doppler broadening thermometry (DBT) and AGT.

Joint Research Project (JRP) Short Name: Boltzmann constant • JRP-Coordinator: Joachim Fischer (PTB) • JRP-Partners: CEM (Spain), CNAM (France), DFM (Denmark), INRIM (Italy), JRC (EC), LNE (France), NPL (UK), PTB (Germany)

Example 2

Enabling ultimate metrological Quantum Hall Effect (QHE) devices

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Quantum Hall effect discovered in 1980 by one current member of the EMRP Research Council, K. von Klitzing, 1985 Nobel laureate
2D electron gas in a magnetic field show quantized conductivity in unit of e^2/h

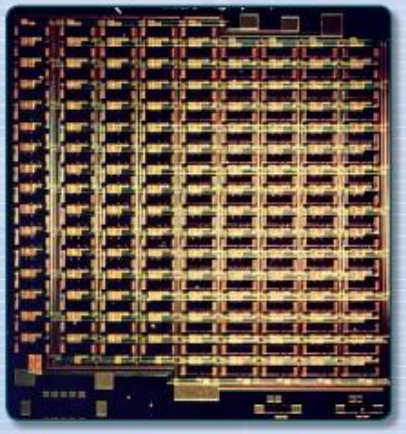
Since 1990, the standard of electrical resistance is given by:

$$R_{K\text{-}90} = h/e^2 = 25812.807557(18)\ \Omega$$

Reproducibility better than 10^{-9}

Develop arrays of QH bars for resistance standards between 100 Ohm and 1MΩ

Supports a redefinition of SI units



Picture of a 100 W QHARS (129 Hall bars in parallel with 16 Hall bars in series). The Hall bars are 400 µm wide. The total size of the device is 12 mm.

Joint Research Project (JRP) Short Name: ULQHE • JRP-Coordinator: Félicien Schopfer (LNE) • JRP-Partners: CEM (Spain), EJPD (Switzerland), INRIM (Italy), LNE (France), MIKES (Finland), PTB (Germany)

Example 3

Optical clocks for a new definition of the second

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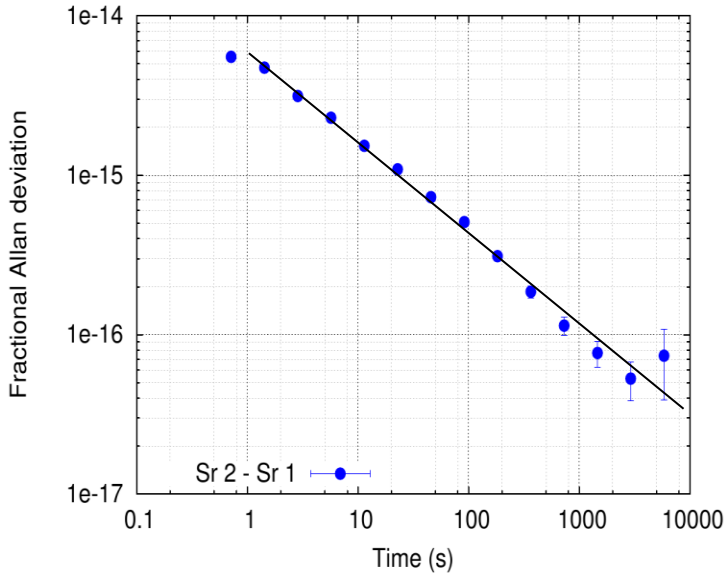

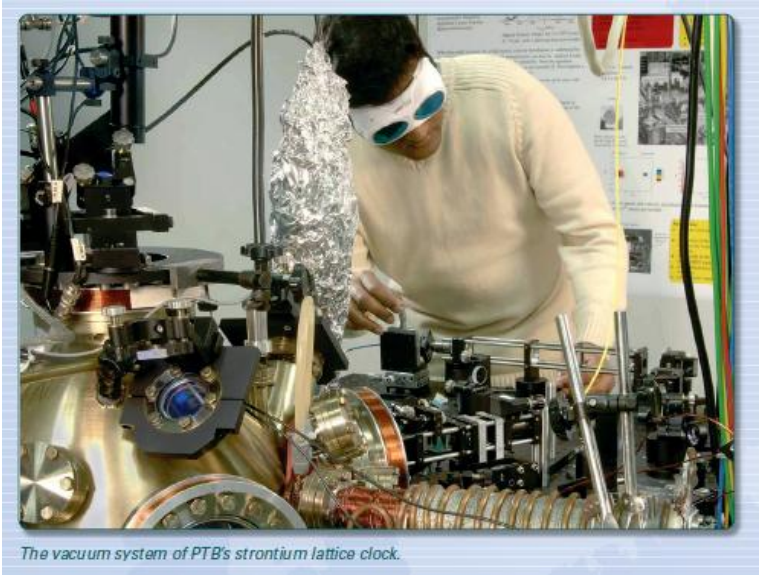
The vacuum system of PTB's strontium lattice clock.

Clocks with errors less than 1s over 3 billion years or 5s over the age of the universe !
Applications to satellite missions, geodesy, and positioning systems, GPS, GALILEO

Joint Research Project (JRP) Short Name: OCS • JRP-Coordinator: Pierre Lemonde (CNRS) • JRP-Partners: CNRS (France), INRIM (Italy), MIKES (Finland), NPL (UK), OBSPARIS (France), PTB (Germany)

The EMRP Research Council View (1)

Strong points:

• Has already profound impact on European Metrology Institutes and international competitiveness

• From European competition to European collaboration
Integrates european metrology by unifying efforts of 22 european NMI's

• Program well organized by Euramet with strong involvment of NMI's (50% co-funding)

• Competitive funding to achieve excellence

Weak points:

• Complex financial and reporting rules
• Needs more opening to academic world, i.e. universities, or other institutes

Overall, very successful program so far

The EMRP Research Council View (2)

Proposed program in FP8: **EMPIR** for **Innovation Union**
European Metrology Programme for Innovation and Research
A lot remains to be done in a globallly competitive economy

36 EURAMET members, 100 NMI's and designated Institutes (DI's)
4000 scientists

- Advanced Metrology meeting the Grand Challenges:
Energy, Environment and Health
- Industrial takeup and implementation of advanced metrology
for increased competitiveness
- Exploiting and serving basic science.

Steve Chu, Nobel laureate 1997: "Accurate measurement is at the heart of physics, and in my experience new physics begins at the next decimal place."

We could add:
new physics leads to new products, new applications, new jobs, and better lives