

INDTECH2018

Innovative industries for smart growth

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PILLAR 3

Session 3.6

Redefinition of the International System of Units (SI) with the support of current programmes at an international level

Jörn Stenger

PTB

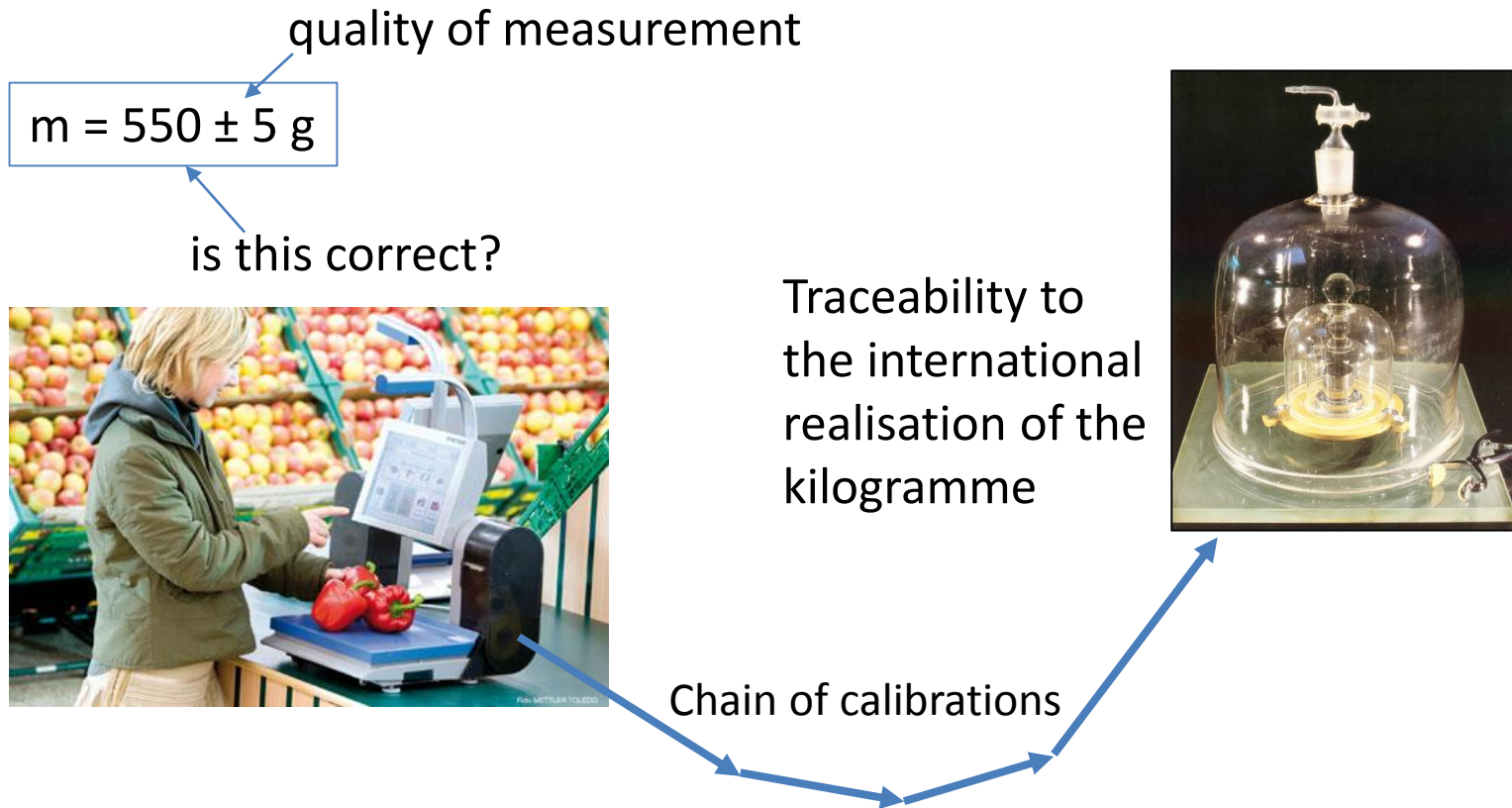
31 October 2018

What is the international system of units, the SI?

Joint Metrology Programmes enabling the revised SI

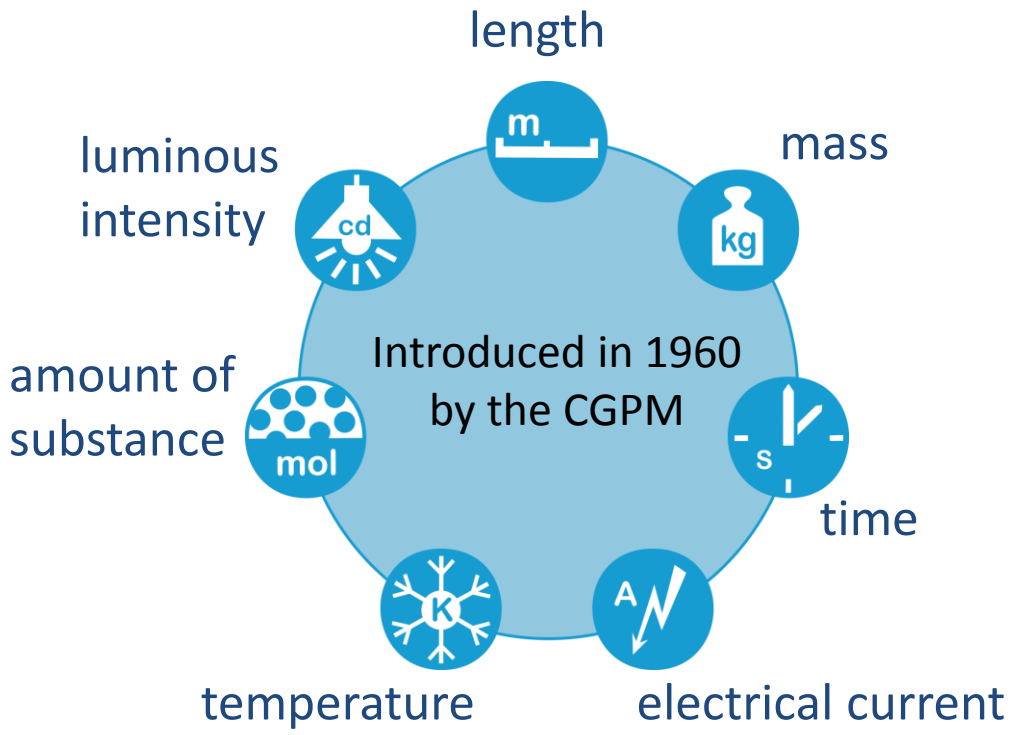
Joint Metrology Programmes enabling Innovation based on the revised SI

Need for future metrology research and its potential for innovation

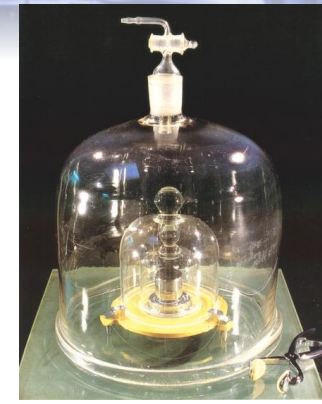
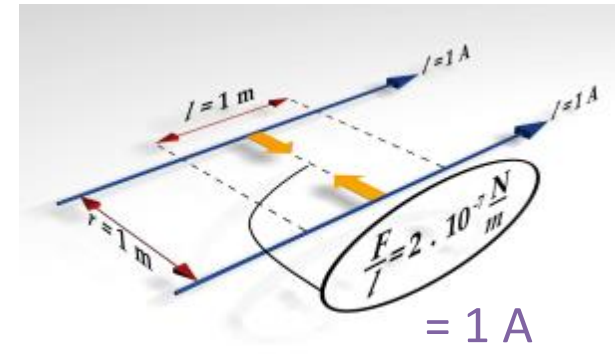




Seven SI base units



- Weaknesses of the traditional definitions of kilogramme, ampere, and kelvin



= 1 kg



= 273.16 K

Redefinition of the SI:

- **Fix numerical values of seven fundamental constants**
- **Be able to use any suitable equation of physics to build a unit realisation upon it**



Joint Metrology Programmes enabling the revised SI

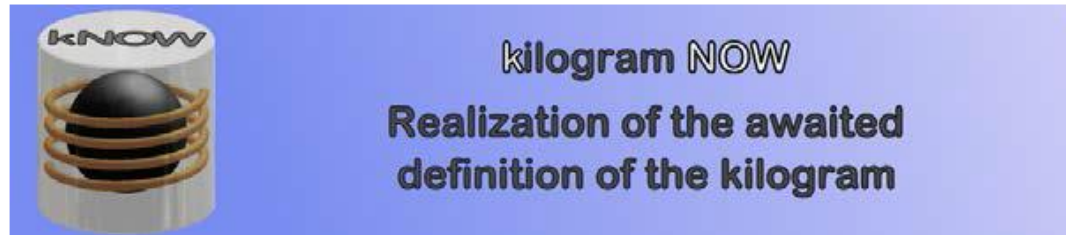
Among four others:
 $h = 6.62607015 \times 10^{-34} \text{ kg m}^2/\text{s}$ Planck's constant
 $e = 1.602176634 \times 10^{-19} \text{ A s}$ Elementary charge
 $k = 1.380649 \times 10^{-23} \text{ J/K}$ Boltzmann's constant

**Research was necessary to meet preconditions
for redefinition...**

A small selection of examples

SIB01
Implementing the new kelvin "InK"

JRP SIB03



JRP SIB07

“Quantum ampere: Realisation of the new SI ampere”

**... hard to imagine that a redefinition without
EMRP and EMPiR would have been possible**

Joint Metrology Programmes enabling Innovation based on the revised SI

Traditional SI:

One primary realisation of the kilogramm
One primary realisation of the kelvin

...

Redefined SI:

**Primary realisations are not
pre-described**

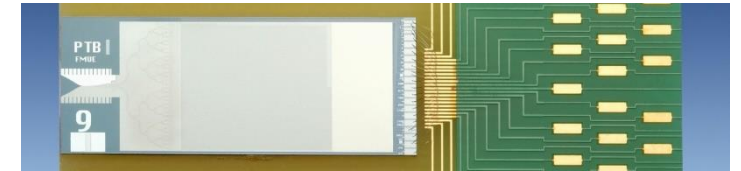
„free competition of methods“

„Side effect“ of the redefined SI:

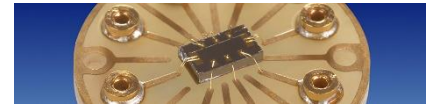
**The total set of constants of
nature has smaller uncertainties**

Commercial exploitation

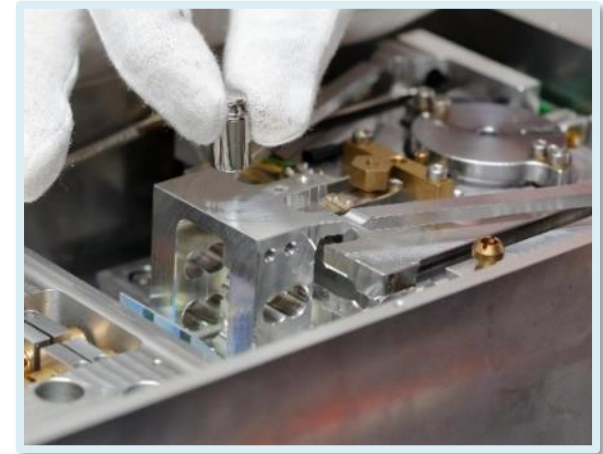
Josephson voltage standards



Quantum Hall resistors



Development of a commercial, primary Kibble balance



Temperature:

- Johnson-Noise thermometry
- Acoustic gas thermometry
- Planck spectra
- Line-broadening
- ...

**... there are many
more examples**

Need for future metrology research and its potential for innovation

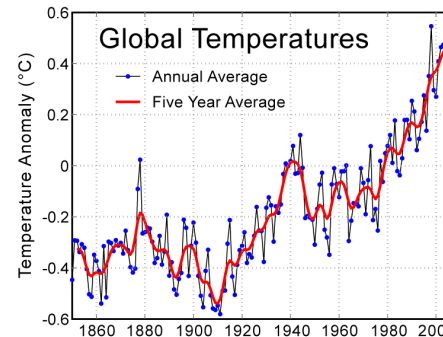
➤ Most of industrial production and trade rely on metrology...



➤ Society needs metrology...



... with ever increasing requirements



There will always be need for and benefit from metrological research