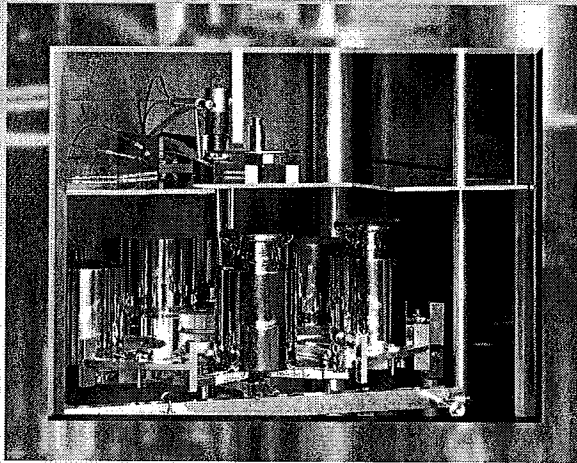


Welcome to the Working Group

1.81 Realisation of Mass



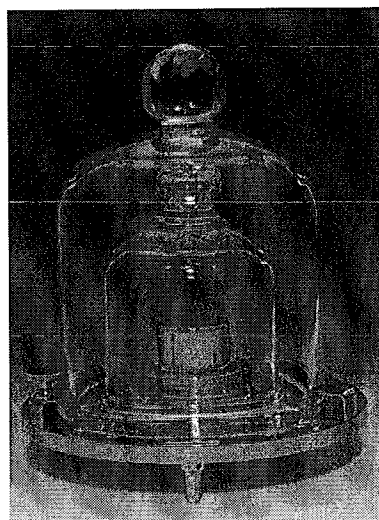
Tasks



- Maintenance of the national prototypes of the kilogram
- Realisation of the mass scale in the range between 1 mg and 5000 kg and dissemination of the mass unit by verification and calibration of weights and mass standards
- Research and development in the field of mass determination (mass determination in vacuum, sorption effects, long-term stability, determination of the air density, convection, magnetic properties)
- Participation in national and international organisations and committees (CCM, WGR-kg, WGD-kg, EURAMET, COOMET, OIML, DAkks, DKD-FA Mass, EVV, AA Scales & Weights, AA Grain analysis)
- Participation in national and international comparisons
- Accreditation of mass laboratories for Germany's National Accreditation Body (DKD/DAkks)
- Realisation and dissemination of the standard mass per storage volume of grain (kg/hl), maintenance of the national standard and the former community standard of EEC

National prototype of the kilogram No. 52 of the Federal Republic of Germany

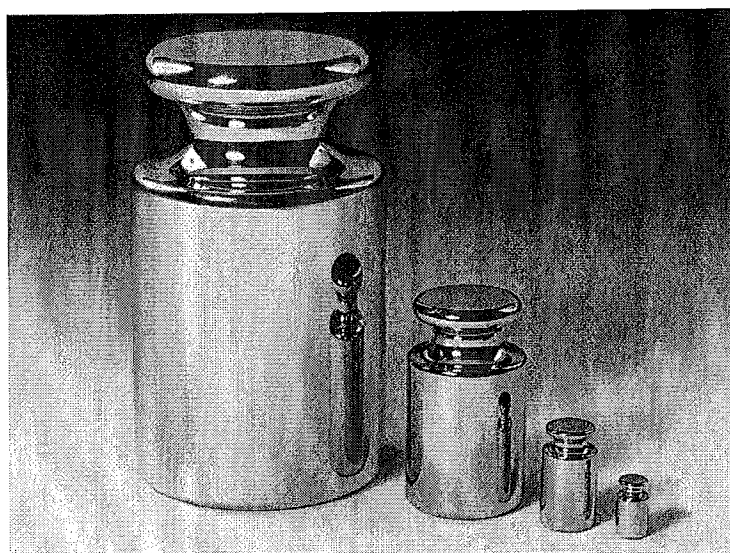
- Copy of the international prototype
- Cylinder (39 mm in height, 39 mm in diameter)
- 90% Pt - 10% Ir alloy
- Maintained at the PTB Braunschweig
- All primary standards of stainless steels are linked with the national prototype once a year
- $m = 1,000\,000\,271\text{ kg}$ (2015)

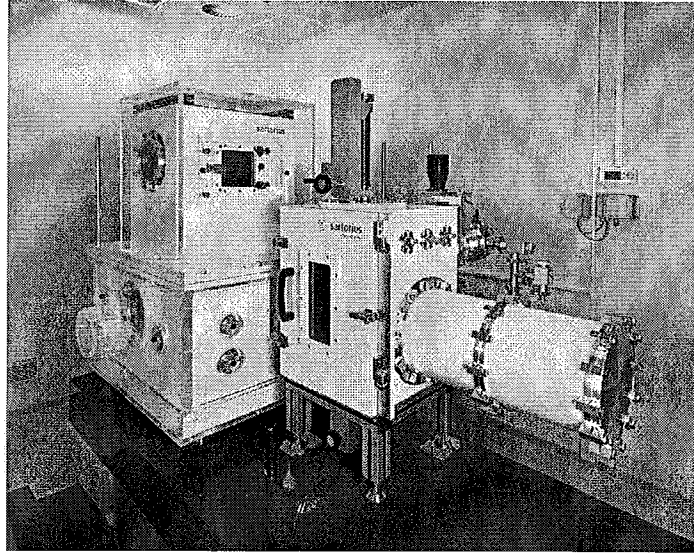
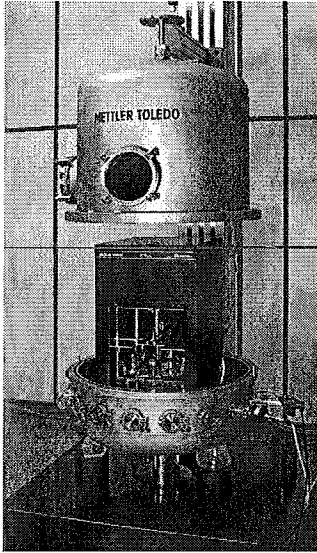


Reference standards (1 g – 20 kg)

Essential requirements:

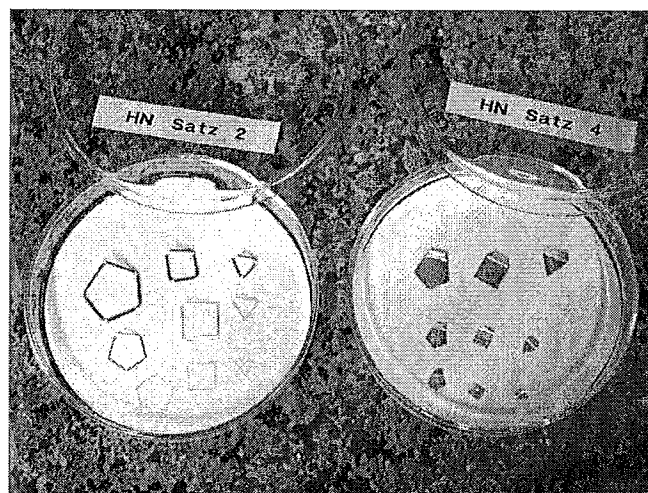
- Shape (good standing support, handling)
- Mechanical stability (erosion)
- Material properties (non-magnetic, corrosion resistant, surface roughness)
- Materials: stainless steel, brass with protective coating (Ni, Au, Cr), aluminium





- > Mass determination in air (const. pressure)/vacuum ($\leq 0,1$ Pa)
- > Automatic weight exchange mechanism with 6 and 8 positions, respectively
- > Electrical weighing range 1,5 g and 2 g, resolution 0,1 μg , standard dev. (typ.) $\leq 0,4 \mu\text{g}$ (4×10^{-10})
- > Mass determination of kilogram prototypes (P₁), reference standards (steel), Si spheres (Avogadro project, density standards) and realisation of the mass scale (100 g to 1 kg)

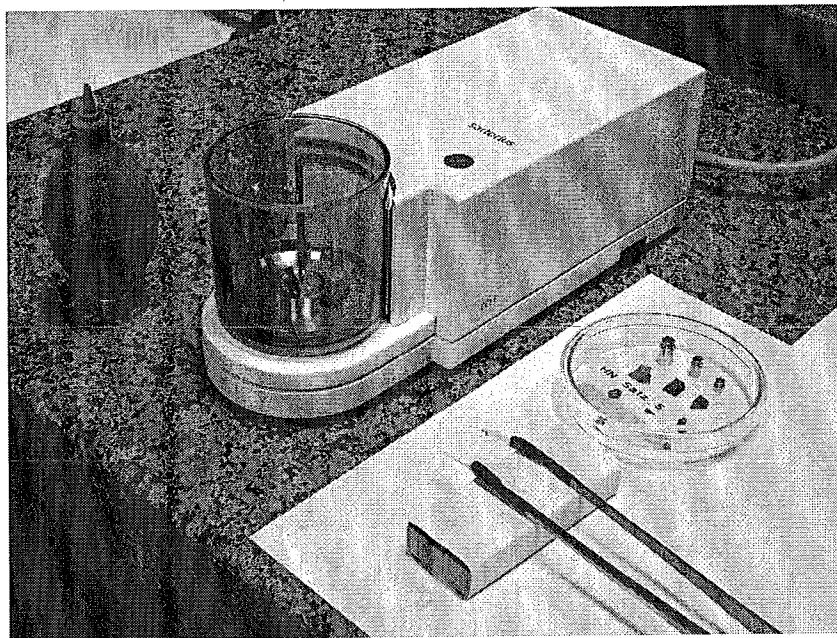
Reference standards (1 mg – 500 mg)



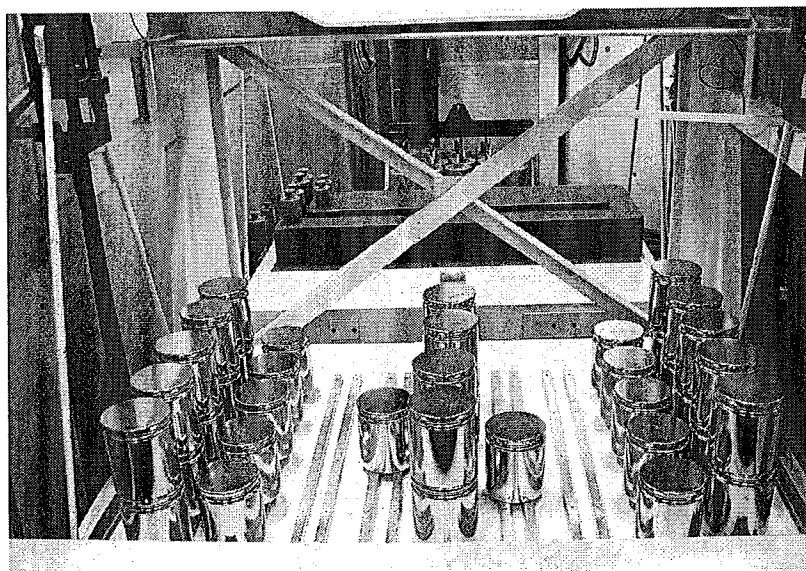
Wires
(stainless steel)

Polygonal sheets
(nickel silver, aluminium)

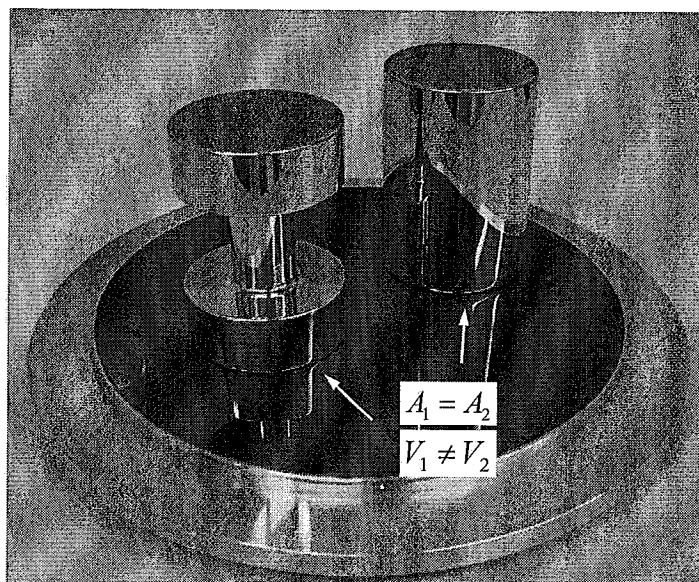
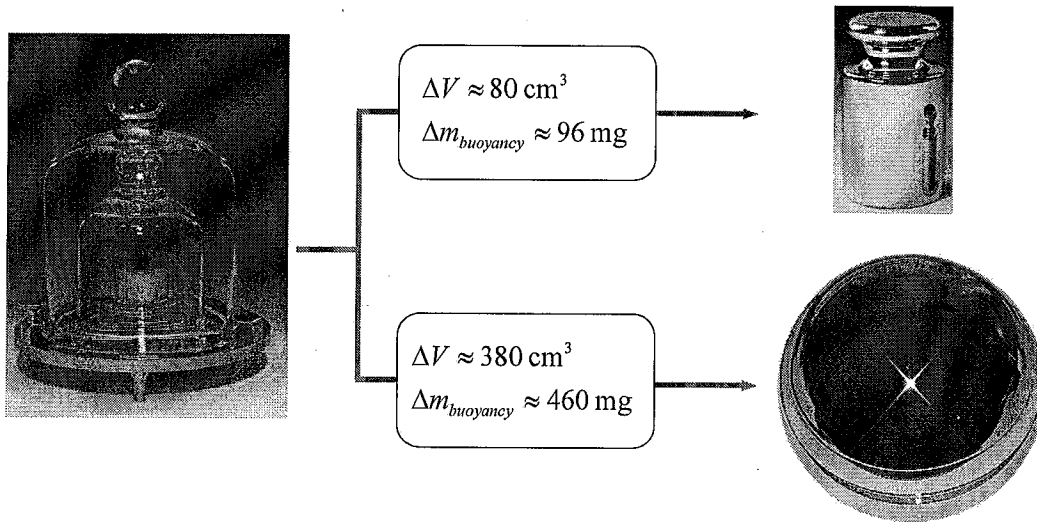
Mass determination between 1 mg and 5 g



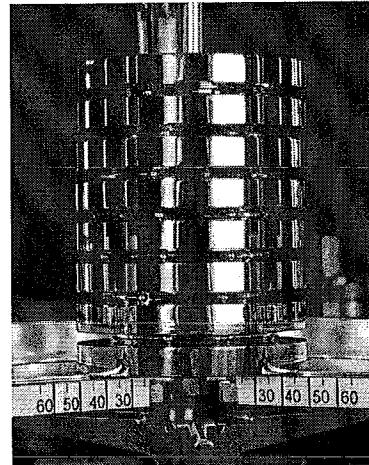
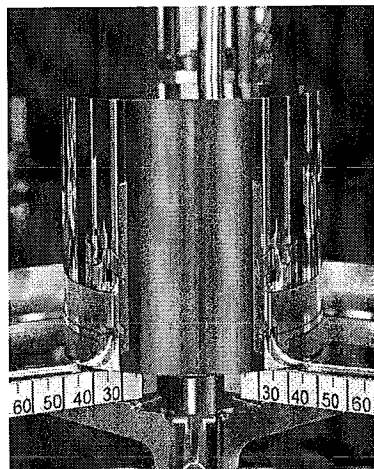
Mass determination up to 5000 kg



- Equal-arm beam balance, max. load 5000 kg
- Standard deviation 0,16 g (500 kg) to 0,6 g (5000 kg)
- Calibration of weights in the range between 500 kg and 5000 kg

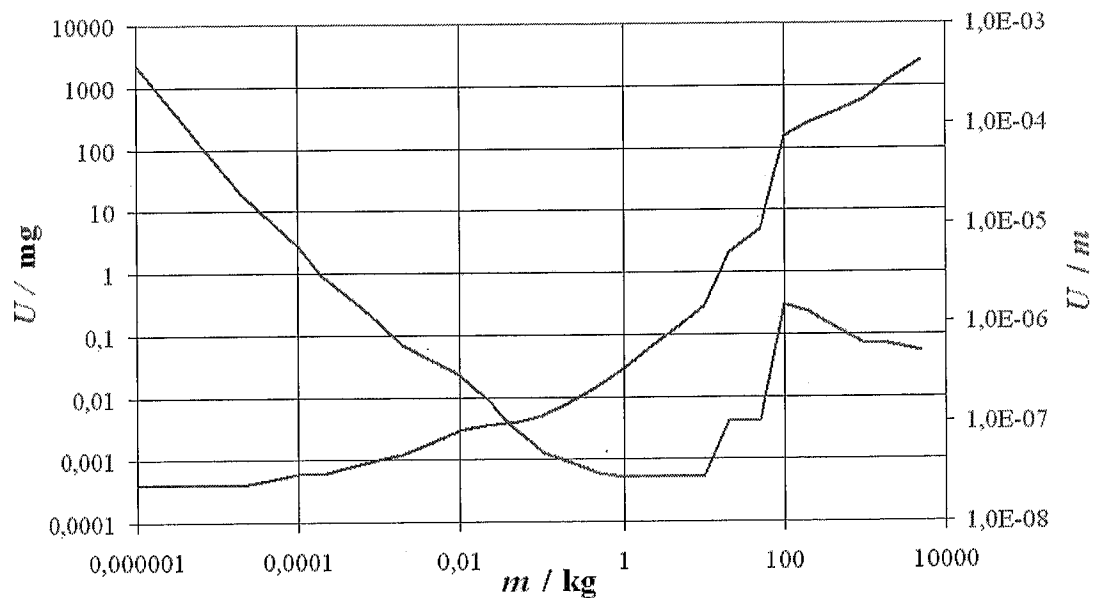


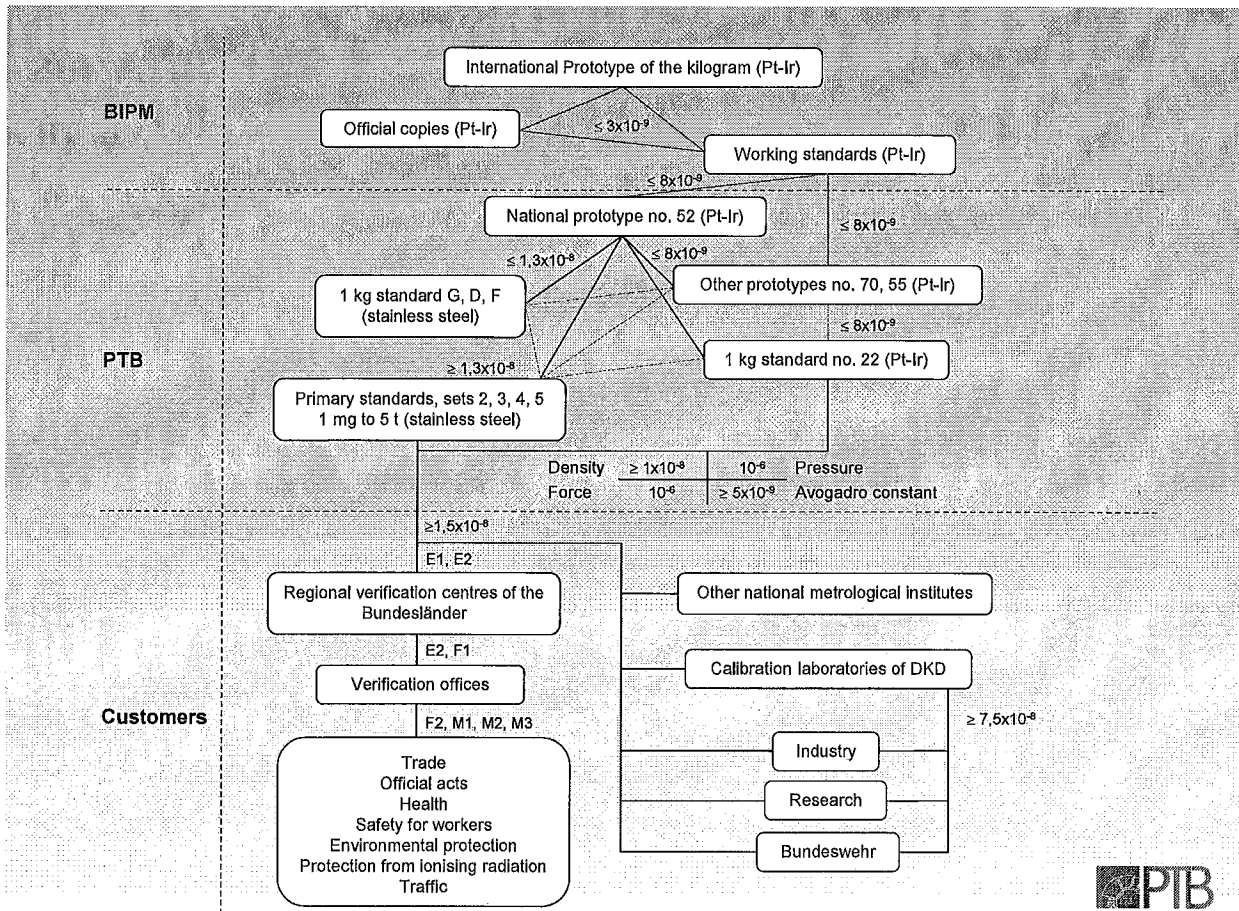
$$\rho_a = \frac{(m_1 - m_2) - (m_{w1} - m_{w2})}{V_1 - V_2}$$



- Pt-Ir sorption artefacts similar to artefacts proposed and designed by BIPM ($\Delta A \approx 180 \text{ cm}^2$)
- Raw material delivered by BIPM, manufactured at PTB
- Surface roughness: $2 \text{ nm} < R_a < 4 \text{ nm}$
- Typ. sorption correction on Pt-Ir cylinder: $2,8(1,0) \mu\text{g}$ (sorption coefficient $\approx 40 \text{ ng/cm}^2$)

Expanded measurement uncertainties $U_{\text{CMC}} (k = 2)$





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