Realisation and Dissemination of the Length Unit

Definition of the metre

The metre (m) is the length of the path travelled by light in vacuum during a time interval of 1/299 792 458 seconds.

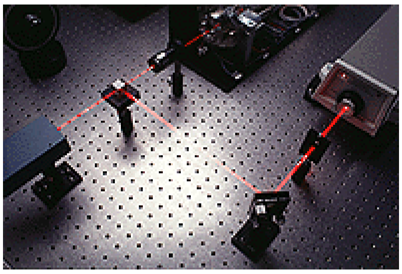
Realisation of the length unit

The realisation of the definition of the metre is done by means of lasers of a known and highly stable frequency. The primary standards at METAS consists of three helium-neon laser, whose optical frequency is stabilised to an atomic transition - namely, an absorption line of iodine gas. The optical frequency of these lasers is directly linked to the METAS atomic clock (realisation of the second) by means of a fibre optic frequency comb. The relative uncertainty of the metre realisation with iodine-stabilised HeNe lasers is $2.5 \cdot 10^{-11}$, which corresponds to 1 mm in the circumference of the Earth.

Dissemination of the length unit

The very exactly determined wavelength of the stabilised laser (0.633 µm for the red HeNe laser) creates the "immaterial scale", against which the dimensions to be measured can be directly compared. By using interferometry, the wavelengths of a laser along a path along-side a body are counted and interpolated, which makes an unusually large measuring range possible, from several dozen metres to fractions of nanometres.

Calibration of laser interferometers



The first link in any dimensional metrology calibration chain is the calibration of laser interferometers. This is achieved by superimposing the beam of the laser under test on that of the primary standard (iodine stabilised laser). The resulting beat signal corresponds to the optical frequency difference between the two superimposed beams, and can be measured directly by optoelectronic detection. The calibration of laser interferometers involves not only the determination of optical frequency, but also the calibration of refraction compensation units, which take into account the change of laser wavelength in air as compared to the stable vacuum wavelength.

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