Abstract: The lattice parameter of silicon can be regarded as a reproducible quantity of nature [1]. This sub-nm length is measured in the SI-unit of length by comparison with an optical wavelength in combined optical and x-ray interferometers [2]. The applied laboratory x-ray sources limit the photon flux at the detectors in practical set-ups to about 10000 cps and therefore the scanning speed of few nm/s with continuously smoothed intensity. A thermal x-ray source however produces single x-ray quanta incoherently, so that single photon interference becomes detectable, if all photons are detected separately in short time channels [3]. The correlation in this time series allows the off-line evaluation of the x-ray interference fringes and the scanning speed can be increased up to some µm/s. The single photon method is applied to the estimation of the lattice parameter of silicon.

The lattice parameter of Si can be applied as a naturally quantized standard of length in nanometrology [4] and especially in the case of isotopically enriched silicon-28 it is the link between the macroscopic 1 kg mass of silicon spheres and the microscopic atomic mass quantum $m_{Si}$ for the determination of the Avogadro constant $N_A$ in the framework of the new definition of the SI-unit of mass [5].

References: