# 60 years of vacuum metrology at PTB

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In the 1950s and 1960s, vacuum became an important tool for emerging scientific fields such as nuclear physics, surface science, thin film and semiconductor physics, and for related technologies such as nuclear, semiconductor and space technology. However, vacuum science and technology itself was still an immature science requiring significant development by physicists and engineers. This included vacuum metrology. It was therefore not surprising that the company Leybold Vacuum approached PTB in the 1960s to establish primary measurement standards for vacuum. In 1966, the Laboratory for Vacuum Physics was founded at PTB in West Berlin, a few years after the first such laboratories had been established at NPL in England and ASML in East Germany.

The period from 1966 to 1990 was characterised by the establishment and validation of the first vacuum primary standards, the static, continuous and molecular beam expansion. At the same time, the vacuum industry was making vacuum gauges easier to use, replacing mercury-based gauges such as the McLeod. PTB contributed to the establishment of a new type of gauge based on gas friction, the spinning rotor.

After 1990, the primary vacuum standards of the PTB were subjected to quality management standards and continuously improved. Comparisons between vacuum standards were made worldwide and, like vacuum technology as a whole, they were perfected. Triggered by the development of the first gravitational wave detector, the first vacuum standard based on tunable diode laser absorption technology was developed at PTB in 1996 and later. Both at PTB and worldwide, vacuum measurement standards based on laser technology are now on their way to replacing classical mechanical vacuum standards in the future.

Since 1990, standardisation as a tool for economic globalisation has also led to an increased demand for traceability of vacuum secondary standards. Whereas in 1993 PTB typically calibrated one vacuum gauge or leak standard per month, today it calibrates one per working day with the same number of staff. This could be achieved through greater automation and digitalisation. The future will show how digitalisation and machine learning will also shape vacuum technology and metrology.