TUT 1: Next generation of SI-Units (joint session VA/TT/TUT)

Time: Sunday 16:00–18:20 Location: H2

Tutorial TUT 1.1 Sun 16:00 H2

A Quantum-Based Pressure Standard for a New SI Realization of the Pascal — •Jay Hendricks — NIST Thermodynamic Metrology Group, Gaithersburg, MD, US

Moving forward, the next generation of pressure standards will provide a new route of SI traceability for the pascal. By taking advantage of both the properties of light interacting with a gas and that the pressure dependent refractive index of helium can be precisely predicted from fundamental, first-principles quantum-chemistry calculations, a new route of realizing the pascal has been demonstrated. This lecture will briefly cover the classical methods of realizing pressure that have served the metrology community well for the past 375 years. And then will take a deeper dive into the next generation of light-based pressure standards that will enable the elimination of mercury manometers, replacing them with a smaller, lighter, faster, and higher precision standards. From a metrology stand point, the new quantum-based SI pascal will move us from the classical force/area definition, to an energy density (joules per unit volume) definition. Should the technique be further miniaturized, it will lead to a revolution in pressure metrology, enabling a photonics based device that serves both a gas pressure sensor and a portable gas pressure standard all in one.

Tutorial TUT 1.2 Sun 16:35 H2

Redefinition of the Kelvin - With what accuracy can temperatures be measured? — •Steffen Rudtsch — Physikalisch-Technische Bundesanstalt (PTB), Abbstraße 2-12, 10587 Berlin

On 20 May 2019, World Metrology Day, the revised International System of Units (SI) will enter into force. From this day on, all units will be traced back to natural constants. The redefinition of the Kelvin via the Boltzmann constant opens up new possibilities in the field of high-precision temperature measurements and metrological traceability. The lecture gives an overview of the currently used precision measurement methods in contact thermometry, in the range from 1 mK to 2000 °C, and shows which changes result from the new definitions.

Tutorial TUT 1.3 Sun 17:10 H2

The new kilogram - Now approachable for extraterrestrials and nonhumans — •Frank Härting — Physikalisch-Technische Bundesanstalt (PTB), Abbstraße 2-12, 10587 Berlin

The presentation gives an overview of the work that have been done and which is still in progress in order to realize the new kilogram after the redefinition of the SI on Mach 20, 2019. Beside some historical information, the presentations will focus on the actual and future scientific challenges that have to be solved in mass metrology.

Tutorial TUT 1.4 Sun 17:45 H2

Counting electrons for the new ampere — •Frank Hohls — Physikalisch-Technische Bundesanstalt (PTB), Bundesallee 100, 38116 Braunschweig, Germany

On November 16th 2018 the General Conference for Weights and Measures, CGPM, adopted the resolution on the biggest revision of the International System of Units (SI) in its history: From May 20th on the SI system is completely determined by fixing the values of 7 constants of nature. One of these constants is the elementary charge which will have the exact value e = 1.602 176 634 * 10-19 As. For the unit of electrical current, the Ampere, this has the nice consequence, that the physics of electrical current and the definition of the ampere are rejoined: Counting or controlling the number of electrons passing a conductor in each second will be the natural realization of the ampere. This could be achieved by a single-electron transport (SET) pump that transfers exactly n electrons in each of its operation cycles, generating a quantized current I = nef when operated at a frequency f. The present state of the art of the SET based current standard with emphasis on the most advanced candidate will be reviewed, a SET pump based on dynamic semiconductor quantum dots with electrically tunable energy barriers.