VA 1: Vacuum Technology: New Developments and Applications

Time: Monday 9:30–12:00 Location: HSZ 301

VA 1.1 Mon 9:30 HSZ 301

Ultra-high-quality-factor membrane oscillators for gas pressure sensing — •Hossein Masalehdan[1], Christoph Reinhardt[2], Axel Lindner[2], and Roman Schnabel[1] — [1]Institut für Laserphysik und Zentrum für Optische Quantentechnologien der Universität Hamburg, 22761 Hamburg, Germany — [2]Deutsches Elektronen Synchrotron (DESY), 22607 Hamburg, Germany

Recent years have seen a rapid development of nanomechanical resonators with ultra-high mechanical quality factors Q. As a result, these devices become increasingly sensitive to smallest changes in certain environmental parameters, such as the pressure of the surrounding gas. In this work, we demonstrate the practical use of a mm-scale nanomechanical trampoline resonator with intrinsically-limited $Q \sim 10^7$ for gas pressure sensing. To this end, we place the trampoline inside an ultra-high-vacuum chamber and investigate the pressure-dependency of its resonance frequency and Q from high-vacuum to ambient pressure. We present a combined model, including molecular and viscous loss, which matches measured values within ±15%, for air and helium gas. Finally, we discuss potential applications and possible next steps towards improved sensing capabilities.

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VA 1.2 Mon 10:00 HSZ 301

Transient modeling of neutral gas flow in particle exhaust system of fusion reactors — •Christos Tantos, Stylianos Varoutis, and Christian Day — Karlsruhe Institute of Technology, Karlsruhe, Germany

In the present work the transient response of the neutral gas flows inside the geometrical complex particle exhaust systems of fusion reactors is studied. In this study the particle exhaust system of DEMO fusion reactor is investigated in a wide range of the operating conditions. The transient flow behavior is analyzed by solving the Boltzmann equation by applying kinetic models supplemented with the Discrete Velocity Method (DVM). The time of the neutral gas flow establishment is studied as a function of the initial divertor conditions as well as the pumping capability of the vacuum pumps. In addition, the effect of the intermolecular interaction law on the transient distributions of the neutrals gas flow quantities is also investigated. The analysis shows that the applied deterministic methodology allows a computationally efficient transient study of the neutral gas dynamics in the particle exhaust of the future fusion reactors.

VA 1.3 Mon 10:30 HSZ 301

Advanced simulation methodologies for optimizing aerosol injectors used for single-particle diffractive imaging — •Surya Kiran Peravali[1,4], Lena Worbs[1,2], Amit K Samanta[1,3], Muhamed Amin[1], Jochen Küpper[1,2,3], Philipp Neumann[4], and Michael Breuer[4] — [1]Center for Free-Electron Laser Science, Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany — [2]Department of Physics, Universität Hamburg, Germany — [3]Center for Ultrafast Imaging, Universität Hamburg, Germany — [4]Fakultät für Maschinenbau, Helmut-Schmidt-Universität,Germany

Single particle diffractive imaging (SPI) is a technique used for imaging atomic-scale structures and dynamics of nano-particles or biomolecules. These experiments require the collection of thousands of diffraction patterns from identical particles. The particles are transferred into the gas phase and the collimated particle stream is then extracted in vacuum. The sample injection methods used for SPI must be optimized to produce high-quality particle beams, i.e., a high particle density and sample purity. We present a novel simulation framework which provides a quick and efficient way to search the experimental parameter space for optimizing the process. The framework requires simulating the gas flow inside the particle injectors and the expansion into the experimental vacuum chamber. Since the flow is at least partially in the rarefied regime i.e., high Knudsen number, a multi-scale approach combining simulation tools for continuum and free-molecular flow is applied. Subsequently, particle trajectories are computed using the forces obtained from interpolated force fields.

VA 1.4 Mon 11:00 HSZ 301

Novel Ionization Vacuum Gauge Suitable as Reference Standard — •Matthias Bernien[1], Frédéric Boineau[2], Nenad Bundaleski[3], Claus Illgen[1], Berthold Jenninger[4], Janez Šetina[5], Ricardo A.S. Silva[3], Anke Stöltzel[4], Orlando M.N.D. Teodoro[3], Martin Wüest[6], and Karl Jousten[1] — [1]PTB, Abbestr. 2-12, 10587 Berlin, Germany — [2]LNE, 1 rue Gaston Boissier, 75724 Paris Cedex 15, France — [3]CEFITEC, Nova University of Lisbon 2829-515 Caparica, Portugal — [4]CERN, 1211 Geneva 23 Switzerland — [5]IMT, Lepi pot 11, 1000 Ljubljana, Slovenia — [6]INFICON AG, Alte Landstrasse 6, LI-9496 Balzers, Liechtenstein

Within the EURAMET project 16NRM05 (www.ptb.de/empir/16nrm05-home.html) a new type of ionization vacuum gauge was developed for the pressure range from 10^{-6} Pa to 10^{-2} Pa. Unlike conventional Bayard-Alpert and extractor gauges, the new gauge features well-defined electron trajectories and mechanically robust electrodes. It exhibits excellent stability and linearity resulting in a measurement uncertainty of 1%, a reduction by one order of magnitude compared to the conventional gauges. The gauge revealed excellent metrological properties and is suitable as accurate reference and transfer standard.

At the moment the ISO standard 6737 is written standardizing the essential parameters of the gauge geometry and electrode voltages. By adhering to the standard manufactures can produce gauges with predictable gauge sensitivity and relative gas sensitivity factors without the need of characterizing them metrologically.

VA 1.5 Mon 11:30 HSZ 301

Inelastic electron scattering at a single-beam structured light wave — •Sven Ebel[1] and Nahid Talebi[1,2] — [1]Institute of Experimental and Applied Physics, Kiel University, 24098 Kiel, Germany — [2]Kiel Nano, Surface and Interface Science KiNSIS, Kiel University, 24118 Kiel, Germany

In this work we demonstrate the inelastic scattering of slow-electron wave packets at a propagating Hermite-Gaussian light beam. The pulsed Hermite-Gaussian beam thereby forms a pondermotive potential for the electron with large enough momentum components, leading to the inelastic scattering of electrons and their bunching along the longitudinal direction. We show that the resulting energy-gain spectra after the interaction is strongly influenced by the self-interference of the electron in this pondermotive potential. It is shown that this effect is observable for various optical wavelengths and intensities and further discuss how the variation of the electron velocity and the light intensity allow to control the energy modulation of the electron wave packet. This effect opens up a new platform for manipulating the electron wave packet by utilizing the vast landscape of structured electromagnetic fields.