Vacuum Science and Technology Division
Fachverband Vakuumphysik und Vakuumtechnik (VA)

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Overview of Invited Talks and Sessions

(Lecture room A 060)

Invited Talks

VA 1.1	Mon	9:00– 9:45	A 060	**Ion Pump design for improved pumping speed at low pressure** — •Mauro Audi
VA 2.1	Mon	10:15–11:00	A 060	**DIJ: New energy-efficient type of oil diffusion pump** — •Stefan Lausberg
VA 3.1	Mon	14:00–14:45	A 060	**Measurement and simulation of deuterium and tritium retention in the KATRIN beam line** — •Carsten Röttele, KATRIN Collaboration

Sessions

VA 1.1–1.2	Mon	9:00–10:15	A 060	**Vacuum Physics**
VA 2.1–2.3	Mon	10:15–12:00	A 060	**Vacuum Generation and Measurement**
VA 3.1–3.3	Mon	14:00–15:45	A 060	**Large Vacuum Systems**
VA 4	Mon	15:45–16:15	A 060	**Annual General Meeting**

Annual General Meeting of the Vacuum Science and Technology Division

Monday 15:45–16:15 A 060

VA 1: Vacuum Physics

Time: Monday 9:00–10:15 Location: A 060

Invited Talk VA 1.1 Mon 9:00 A 060

Ion Pump design for improved pumping speed at low pressure — •Mauro Audi — Agilent Technologies Via F.lli Varian 54 10040 Leini (Torino)

Even if Ion pumps are widely and mostly used in UHV conditions, virtually every existing Ion Pump has its maximum pumping speed around 10 E-6 mbar. The discharge intensity in the Ion Pump Penning cell (the number of ions that bombard the cathode per unit time) is pressure dependent, and it is the main parameter that influences the pumping speed. A study has been performed to evaluate the influence of magnetic fields and cell dimensions on the Ion Pump Discharge Intensity at different pressure. As a result, a combination of parameters that allows to design and build an Ion Pump with the maximum pumping speed shifted towards lower pressures has been obtained. Experimental results with several different experimental set ups are presented which lead to a new 200 L/S Ion Pump with its maximum pumping speed in the 10E-8 mbar range.

VA 1.2 Mon 9:45 A 060

Materialstudien zur Unterdrückung des Tritiummemoryeffekts in BIXS Analytiksystemen — •Max Aker — Karlsruher Institut für Technologie, Karlsruhe

In tritiumführenden Systemen wird Tritium ad- und absorbiert. Dies ist aus mehreren Gründen ein unerwünschter Effekt: Gebundenes Tritium geht dem Prozess verloren, muss in der Bilanzierung berücksichtigt werden und kontaminiert das System. Zudem führt adsorbiertes Tritium in Tritiumanalytiksystemen für die Bestimmung der Aktivität von Gasen zu einem ansteigenden Untergrundsignal. Dieser sogenannte Tritiummemoryeffekt ist abhängig von der Expositionsdauer und dem Expositionsdruck.

Um diese Effekte zu reduzieren wird die Tritiumadsorptionsfähigkeit unterschiedlicher Materialien untersucht. Ziel ist es Materialien zu finden, die möglichst wenig Tritium aufnehmen. Mit einem hierfür entwickelten Beladungstest werden Proben einer Tritiumumgebung ausgesetzt und anschließend die Oberflächenkontamination bestimmt.

Der Beladungstest ist darauf ausgelegt mehrere Proben gleichzeitig beladen zu können. Es werden Proben unterschiedlicher Oberflächenrauheit, Materialzusammensetzungen und unterschiedlichen Beschichtungen untersucht. Die Oberflächenkontamination wird in einem ersten Schritt mit Hilfe von Wischtests bestimmt. Geeignete Kandidaten mit geringer Oberflächenkontamination werden in anschließenden Tests mit Hilfe der BIXS-Methode (Beta Induced X-ray Spectrometry) untersucht, welche eine genauere Quantifizierung der Oberflächenkontamination ermöglicht.

VA 2: Vacuum Generation and Measurement

Time: Monday 10:15–12:00 Location: A 060

Invited Talk VA 2.1 Mon 10:15 A 060

DIJ: New energy-efficient type of oil diffusion pump — •Stefan Lausberg — Leybold GmbH, Bonner Str. 498, 50968 Köln, Germany

A century passed since the diffusion pump was invented by Wolfgang Gaede and it remained the high vacuum pump of choice for a very long time. Nowadays diffusion pumps are operated with oil which is not allowed for many applications, the most prominent example being semiconductor production. With the rise of turbomolecular pumps and cryopumps oil diffusion pumps were more and more replaced. Still their huge benefits have kept oil diffusion pumps relevant in modern vacuum systems. They are robust and relatively inexpensive for the performance they can deliver. However they require high energy consumption due to their principle of operation.

Leybold has now developed the DIJ: a new energy-efficient type of oil diffusion pump which saves energy in a number of ways. An energy saving unit controls the electrical heaters to keep the desired temperature with minimum power consumption. This also reduces the required cooling capacity of the chiller that supplies cooling water to the pump. On the other hand a thermal isolation reduces the heat flow to the environment. Finally, a new immersion heater design results in an optimized energy transfer to the oil. In this talk we will present the properties and benefits of this new type of diffusion pump in contrast to other high vacuum pumps.

VA 2.2 Mon 11:00 A 060

In-situ calibration of vacuum gauges in the KATRIN spectrometer system — Philipp Triebskorn, •Joachim Wolf, and KATRIN Collaboration — Karlsruhe Institute of Technology (KIT), ETP, Postfach 3640, 76021 Karlsruhe

The **Ka**rlsruhe **Tri**tium **N**eutrino (KATRIN) experiment uses the kinematics of electrons from the tritium β-decay to determine the effective neutrino mass with a sensitivity of $m_\nu = 200\,\mathrm{meV/c^2}$ (90% C.L.). The energy of the β-electrons, produced in the windowless gaseous tritium source (WGTS), is measured in the Spectrometer section at a pressure in the range of 10^{-11} mbar. The spectrometer section consists of the Pre-Spectrometer ($8.5\,\mathrm{m^3}$), the huge Main Spectrometer ($1240\,\mathrm{m^3}$), and the detector section, where electrons that pass the electrostatic filter of the Main Spectrometer, are counted. For to the low pressure regime in the KATRIN spectrometers the vacuum gauges (Inv. Magnetron, Extractor, RGA) are calibrated regularly in-situ at pressures between 10^{-10} and 10^{-7} mbar, using various constant gas flows of Ar, He, H_2, and N_2. Here we describe the calibration system and procedure. We acknowledge the support by KSETA, BMBF (05A17VK2), HAP and the Helmholtz association.

VA 2.3 Mon 11:30 A 060

Ultrahochvakuumsystem für das Atominterferometer der MAIUS-B Höhenforschungsraketennutzlast — •Michael Elsen — Universität Bremen, Zentrum für angewandte Raumfahrttechnik und Mikrogravitation (ZARM), 28359 Bremen

Das wissenschaftliche Experiment der MAIUS-B Höhenforschungsraketennutzlast dient zur Erzeugung des ersten Kalium 41 Bose-Einstein-Kondensat (BEC) im Weltraum und zur Durchführung von Atominterferometrie mit Rubidium 87 und Kalium 41. Zur Durchführung der Experimente muss ein Vakuum * 5*10-10 mbar erreicht werden. In der Beschleunigungsphase des Raketenstarts kommt es zu Beschleunigungen von 13 g und Vibrationen von 1,8 g RMS im Bereich von 20-2000 Hz. Statische Lasten von bis zu 50 g können während dem Wiedereintritt und der Landung auf dem Boden auftreten. Das Design des Ultrahochvakuumsystems zur Aufrechterhaltung der Pumpleistung/Vakuumqualität umfasst eine Ionengetterpumpe und zwei Titansublimationspumpen. Des Weiteren mussten aus Platz- und Gewichtsgründen nicht kommerzielle Dichttechnologien, zum Beispiel für die Fenster, verwendet werden. Das finale Design des Ultrahochvakuumsystem der MAIUS-B Höhenforschungsraketennutzlast wird in diesem Vortrag beschrieben, ebenso wie die durchgeführten Tests.

VA 3: Large Vacuum Systems

Time: Monday 14:00–15:45 Location: A 060

Invited Talk VA 3.1 Mon 14:00 A 060

Measurement and simulation of deuterium and tritium retention in the KATRIN beam line — •Carsten Röttele and KATRIN Collaboration — Karlsruhe Institute of Technology (KIT), ETP, Postfach 3640, 76021 Karlsruhe

The **Ka**rlsruhe **Tri**tium **N**eutrino (KATRIN) experiment aims to determine the effective neutrino mass with a sensitivity of $m_\nu = 0.2\,\mathrm{eV/c^2}$ (90% C.L.) using electrons from the tritium β-decay. The β-electrons produced in the windowless gaseous tritium source (WGTS) are magnetically guided through the beamlines of the transport and pumping section to the huge main spectrometer for energy measurement. In order to minimize the background rate from tritium (T_2) decaying in the spectrometer to less than 0.01 counts per second, the pumping sections have to reduce the tritium flow from the WGTS by at least 14 orders of magnitude. Therefore KATRIN combines a differential pumping section (DPS), using turbo-molecular pumps and a cryogenic pumping section (CPS) with a combined reduction factor of more than 10^{14}. This talk introduces the results of first deuterium (D_2) measurements probing the performance of the transport and pumping section, including first commissioning data for the 3-K-cold argon frost layer used to increase the cryo-sorption in the CPS. These results are compared with Test Particle Monte Carlo (TPMC) vacuum simulations with MOLFLOW+. The post-processing of the CPS TPMC results introduces a time dependent model of the reduction factor and of D_2 and T_2 migration along the beamline. This work was supported by GRK1694, BMBF (05A17VK2), KSETA and the HGF.

VA 3.2 Mon 14:45 A 060

Loops - The tritium processing system of the KATRIN experiment — •Alexander Marsteller — Karlsruher Institut für Technologie, Karlsruhe, Deutschland

The **Ka**rlsruhe **Tri**tium **N**eutrino (KATRIN) experiment aims to determine the effective neutrino mass with a sensitivity of $m_\nu = 0.2\,\mathrm{eV/c^2}$ (90% C.L.) using electrons from the tritium β-decay. The β-electrons produced in the windowless gaseous tritium source (WGTS) are guided by magnetic fields ranging from 3.0 T to 5.6 T through the beamlines of the transport and pumping section to the huge main spectrometer for energy measurement. To reduce systematic uncertainty on the neutrino mass, the tritium density inside the WGTS needs to be stable to the promille level. In order to minimize the background rate from tritium (T_2) decaying in the spectrometer to less than 0.01 counts per second, the pumping sections have to reduce the tritium flow from the WGTS by at least 14 orders of magnitude. Therefore KATRIN combines a differential pumping section (DPS), using turbo-molecular pumps and a cryogenic pumping section (CPS) with a combined reduction factor of more than 10^{14}.

This talk introduces the Loops system responsible for cycling tritium throughout the source section (WGTS and DPS) of the KATRIN experiment. Furthermore the magnetic shielding of the TMPs used in the Loops system of WGTS and DPS is introduced. This work was supported by BMBF (05A17VK2), KSETA and the HGF.

VA 3.3 Mon 15:15 A 060

The first gaseous $^{83\mathrm{m}}$Kr in the KATRIN experiment: hardware and simulation — •Fabian Friedel and KATRIN collaboration — Karlsruhe Institute of Technology (KIT), ETP, Postfach 3640, 76021 Karlsruhe

The aim of the **Ka**rlsruhe **Tri**tium **N**eutrino (KATRIN) experiment is to determine the effective mass of the electron antineutrino with a sensitivity of 200 $\mathrm{meV/c^2}$ (90% C.L.). This will be achieved by measuring the β-spectrum of tritium close to the kinematic endpoint at 18.6 keV. In the neutrino mass measurement the tritium will be injected into the **W**indowless **G**aseous **T**ritium **S**ource (WGTS). The β-electrons are guided magnetically through the 70 m long set-up and analyzed by an electrostatic filter and a silicium pixel detector. In July 2017 a commissioning milestone of the experiment has been achieved by measuring electrons from a gaseous $^{83\mathrm{m}}$Kr source transmitted through the whole KATRIN set-up. The radioactive $^{83\mathrm{m}}$Kr emitts monoenergetic conversion electrons at several energies between 17.8 keV and 32.1 keV. The Kr source was installed at the WGTS. It consisted of a zeolithe substrate where the parent radionuclide $^{83\mathrm{m}}$Rb had been implanted. The main results of the operation of this krypton source will be presented. Furthermore TPMC simulations of the gas distribution inside the vacuum tube have been performed. This work has been supported by BMBF (05A17VK2), KSETA and the Helmholtz Association.

VA 4: Annual General Meeting

Time: Monday 15:45–16:15 Location: A 060

Duration 30 min.