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

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Overview of Invited Talks and Sessions

Invited Talks

VA 1.1	Mon	10:00–10:40	H 0106	**The vacuum systems for the European X-ray free electron laser project XFEL** — •Kirsten Zapfe
VA 3.1	Mon	14:00–14:40	H 0106	**The Ultra High Vacuum system of FAIR (Facility for Antiproton and Ion Research)** — •Hartmut Reich-Sprenger, Maria Cristina Bellachioma, Andreas Kraemer, Holger Kollmus, Markus Bender, Stefan Wilfert
VA 4.1	Mon	15:00–15:40	H 0106	**Surface and Bulk Investigations at the High Intensity Positron Beam Facility NEPOMUC** — •Christoph Hugenschmidt, Günther Dollinger, Werner Egger, Gottfried Kögel, Benjamin Löwe, Jakob Mayer, Philip Pikart, Christian Piochacz, Klaus Schreckenbach, Peter Sperr, Martin Stadlbauer

Sessions

VA 1.1–1.5	Mon	10:00–12:00	H 0106	**Vacuum systems and monochromators at XFEL and PETRA**
VA 2.1–2.2	Mon	12:00–12:40	H 0106	**Vacuum pumps and gauges**
VA 3.1–3.2	Mon	14:00–15:00	H 0106	**UHV systems at FAIR and KATRIN**
VA 4.1–4.4	Mon	15:00–16:40	H 0106	**NEPOMUC positron source and experiments**
VA 5.1–5.1	Tue	9:30–11:00	PTB-Pforte	**Laboratory visit**
VA 6.1–6.1	Wed	13:30–14:15	HE 101	**Gaede prize talk**

Annual General Meeting of the Vacuum Science and Technology Division

Montag 16:50–17:30 Raum H 0106

- Bericht des Fachverband-Vorsitzenden
- Perspektiven des Fachverbandes
- Verschiedenes

VA 1: Vacuum systems and monochromators at XFEL and PETRA

Time: Monday 10:00–12:00 Location: H 0106

Invited Talk VA 1.1 Mon 10:00 H 0106

The vacuum systems for the European X-ray free electron laser project XFEL — •Kirsten Zapfe — Deutsches Elektronen-Synchrotron DESY, Notkestrasse 85, D-22607 Hamburg

The European X-Ray Free Electron Laser XFEL, a new international research facility, will be build in close connection with DESY/Hamburg. The XFEL will generate extremely brilliant and ultra short pulses of X-rays with tunable wavelengths down to 0.1 nm, and exploit them for revolutionary scientific experiments at various disciplines. Therefore electron bunches are brought to high energy of about 20 GeV through a superconducting linear accelerator, and conveyed to up to 250 m long undulators where the X-ray pulses are generated by SASE (Self-Amplified Spontaneous Emission).

The beam vacuum system of the XFEL will operate at temperatures of a few K in the areas of the superconducting accelerating structures, thus requiring an insulating vacuum system. In addition to standard UHV requirements the vacuum system for this facility needs to preserve the cleanliness of the superconducting cavity surfaces, which are prepared with procedures similar to semiconductor industry. Thus the preparation of all vacuum components for the 1.6 km long main linac includes cleaning of the components in a clean room to remove particles, installation into the machine under local clean rooms and special procedures for pump down and venting. In the room temperature vacuum system the requirements to the aluminium vacuum chambers of the 700 m long undulators are challenging with respect to very low surface roughness and thickness of oxide layers.

VA 1.2 Mon 10:40 H 0106

Simulations of the pressure profile in the Petra III frontends — •Christian Amann, Ulrich Hahn, Mathias Hesse, and Horst Schulte-Schrepping — Deutsches Elektronen Synchrotron DESY, Hamburg, Germany

Petra III will be a high brilliance, small emittance, third generation synchrotron radiation source. The undulators will deliver photon beams with small cross sections and therefore the components in the frontend will be as compact as feasible. The resulting narrow cross sections of the vacuum system will yield a small conductivity in the whole beamline. The design of the frontends is now at an advanced state so that the initial design of the vacuum system has to be revised. The vacuum specification demands for a hydrocarbon and dust free vacuum system. To provide this, the beamline will be initially pumped down with a dry pumping station to a pressure of 10-6mbar. After reaching this pressure, the pumping station will be switched off and a set of ion getter pumps will pump the beamline continuously. To protect the ion getter pumps, it is necessary that during operation the pressure in the pumps will be below 10-6mbar. The simulation shows that especially at the high power slit systems and during the start of operation, a high amount of gas will be photodesorbed. To cope with this, additional pumps will be installed in the frontends as compared to the first design step. To control the pressure inside some beamline components an optional pressure control system is also introduced. The simulations of the pressure profileswere done with a Monte Carlo simulation program (Molflow developed by R. Kersevan / ESRF).

VA 1.3 Mon 11:00 H 0106

The vacuum interlock system for the PETRA III beamlines — •Markus Degenhardt, Ulrich Hahn, Mathias Hesse, and Horst Schulte-Schrepping — Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany

The storage ring PETRA at DESY in Hamburg is being reconstructed into the third generation source for synchrotron radiation, PETRA III. The up to 100 m long beamlines are large UHV-systems that guide the synchrotron radiation from the storage ring to the experiments. Each beamline will be equipped with a vacuum interlock system to ensure the safe operation of the vacuum components. In particular the task of the vacuum interlock is to prevent faulty operations that can cause a ventilation of the vacuum system or a damage of vacuum components by the high power synchrotron radiation beam.

The interlock system will be implemented as a PLC that is connected to a distributed input/output layer via a field bus system. As a specialty, the PLC will be realised as a soft-PLC running on a PC with a real time windows operating system. Another specialty is the visualisation and remote control of the vacuum interlock system by means of a website. At the beamline the interlock will be operated via a touch panel that displays the visualisation website. Additionally, the interlock can be remotely operated from any location by opening the visualisation website with a browser. The interlock is protected against unauthorised operation by a login page. All relevant interlock data will be fed into the existing network-based archive system.

VA 1.4 Mon 11:20 H 0106

Tests on a prototype high heat load monochromator for PETRA III — •Hans-Christian Wille[1,2], Jan Horbach[1], Ralf Roehlsberger[1], Ulrich Hahn[1], Horst Schulte-Schrepping[1], Carsten Detlefs[2], and Thomas Roth[2] — [1]Hamburger Synchrotronstrahlungslabor, D-22607 Hamburg, Germany — [2]European Synchrotron Radiation Facility, F-38043 Grenoble Cedex, France

We report on tests of a prototype high heat load monochromator for the PETRA III synchrotron radiation source under construction at the Hamburger Synchrotronstrahlungslabor (HASYLAB) which will be operational in 2009. The tests have been carried out at the European Synchrotron Radiation Facility (ESRF) on the beamline ID06 which is partly dedicated to tests of x-ray optical elements for 3rd generation synchroton radiation sources within the framework of a cooperation of HASYLAB and the ESRF. First tests started in October 2007 and focussed on the (mechanical) stability and the behaviour under high heat load of the monochromator.

VA 1.5 Mon 11:40 H 0106

Design eines Large Offset Monochromators für PETRA III — Markus Degenhardt, Ulrich Hahn, •Jan Horbach und Horst Schulte-Schrepping — Deutsches Elektronensynchrotron, Hamburg

Für die neue Synchrotronstrahlungsquelle PETRA III ist die Entwicklung verschiedener Monochromatoren mit spezifischen Eigenschaften notwendig. Um eine kompakte Anordnung der Strahlführungen in der Experimentehalle zu realisieren, wurde ein Large Offset Monochromator (LOM) konzipiert, der es erlaubt, den Synchrotronstrahl um 1,25 m in der Höhe zu versetzen. Hierdurch können zwei Experimente übereinander angeordnet werden. Auf Grund des großen vertikalen Versatzes des Strahls und einem angestrebten Energiebereich von 5 bis 29 keV sind für die Kristalle zwei getrennte Linearbewegungen über jeweils 1,5 m notwendig. Eine weitere Anforderung ist es, die Energie des Strahls in Schritten von etwa 10 meV variieren zu können und eine schmale Energiebreite des Bragg-Reflexes zu erreichen. Dies ist für hochauflösende Röntgenbeugungsexperimente notwendig. Die zur Realisierung notwendigen Komponenten und Konzepte werden in diesem Beitrag vorgestellt. Ein Stabilisierungssystem unter Verwendung von Piezoaktoren erlaubt es, die Ablage des Strahls am Experiment auf 10 μm genau festzulegen. Der LOM ist als Hochvakuumsystem ausgelegt. Eine möglichst geringe Konzentration von Kohlenwasserstoffen wird angestrebt, um eine Kontamination der optischen Flächen zu verhindern. Um den Synchrotronstrahl durch Positionsmonitore nicht unnötig abzuschwächen, kommt ein Lasersystem zum Einsatz, welches Lage- und Winkelabweichungen der Kristalle detektiert.

VA 2: Vacuum pumps and gauges

Time: Monday 12:00–12:40 Location: H 0106

VA 2.1 Mon 12:00 H 0106

Investigations of turbo-molecular pumps in magnetic fields for the KATRIN experiment — •Aleksandra Gotsova and Norbert Kernert — Tritiumlabor, Forschungszentrum Karlsruhe, Postfach 3640, 76021 Karlsruhe (KATRIN Collaboration)

The **KA**rlsruhe **TRI**tium **N**eutrino experiment (KATRIN) aims to measure the electron neutrino mass from the β-decay of tritium with an unprecedented sensitivity of 0.2 eV/c^2. The decay electrons will be guided magnetically from the gaseous tritium source through a differential pumping section (DPS) to the high resolution spectrometer. The DPS consists of a beamline with super-conducting magnets and 16 turbo-molecular pumps (Leybold WMAG 2800), which have to prevent tritium gas from entering the UHV spectrometer section.

Systematic studies have been conducted, investigating the rotor temperature and stability of operation of the turbo-molecular pumps (TMP) at full speed as a function of magnetic field strength and direction of the field. The temperature of the moving rotor was measured in vacuum with an infra-red camera. In addition the stability of the pump controller in magnetic fields has been tested. This talk reports on the results of these measurements, giving limits for the save operation of TMPs in magnetic fields.

In part supported by BMBF project 05CK5VKA/5.

VA 2.2 Mon 12:20 H 0106

Partial Pressure Measurement — •Andreas Schopphoff — Pfeiffer Vacuum GmbH, Berliner Str. 43, 35614 Asslar

Partial pressure gauges are essential tools to generate a better knowledge of the state of vacuum. Typical applications are leak detection and residual gas analysis. One of the most often used partial pressure gauge is the quadrupole mass spectrometer. Because of its small size and the high performance it is used in multiple applications. The general operation of a quadrupole mass spectrometer will be discussed in this presentation.

VA 3: UHV systems at FAIR and KATRIN

Time: Monday 14:00–15:00 Location: H 0106

Invited Talk VA 3.1 Mon 14:00 H 0106

The Ultra High Vacuum system of FAIR (Facility for Antiproton and Ion Research) — •Hartmut Reich-Sprenger[1], Maria Cristina Bellachioma[1], Andreas Kraemer[1], Holger Kollmus[1], Markus Bender[1], and Stefan Wilfert[1,2] — [1]Gesellschaft für Schwerionenfiorschung mbH GSI, Darmstadt, Germany — [2]Otto-von-Guericke-Universität, Magdeburg, Germany

The accelerator complex of FAIR is planned to deliver heavy ion beams of increased energy and highest intensity. Whereas the energy is planned to be increased roughly by a factor of 10, the ion beam intensities are planned to be enlarged by three orders of magnitude. An UHV-accelerator system with a base pressure in the low 10E-12mbar regime is required, even under the influence of ion beam loss induced desorption processes.

An intensive program was started to upgrade the Ultra High Vacuum (UHV) system of the existing synchrotron SIS18 (bakeable) and to design and lay out the UHV systems of the future synchrotron SIS100 and SIS300 (mainly cryogenic). The strategy of this program includes basic research on the physics of the ion induced desorption effects as well as technical developments, design and prototyping on bakeable UHV components (vacuum chambers, diagnostics, bakeout-control, pumping speed), collimator for controlled ion beam loss, NEG coating and cryogenic vacuum components.

The key issues of FAIR relevant UHV R&D and system design will be presented

VA 3.2 Mon 14:40 H 0106

Outgassing measurements after $350°C$ bake-out of the KATRIN sectrometer — •Joachim Wolf — Universität Karlsruhe, IEKP, Postfach 3640, 76021 Karlsruhe (KATRIN Collaboration)

The **KA**rlsruhe **TRI**tium **N**eutrino experiment (KATRIN) aims to measure the electron neutrino mass from the β-decay of tritium with an unprecedented sensitivity of 0.2 eV/c^2. The kinetic energy of the decay electrons will be measured in an electrostatic spectrometer. Background considerations require a very good vacuum of 10^{-11} mbar or better in the large spectrometer vessel (volume 1240 m^3, surface: 690 m^2). A combination of NEG pumps and turbo-molecular pumps will provide the necessary pumping speed. In addition a very clean surface and low outgassing rates are mandatory. This talk reports on the commissioning and final outgassing measurements before and after bake-out at $350°C$.

In part supported by BMBF projects 05CK5VKA/5, 05CK5REA/0, 05CK5PMA/0 and 05CK5UMA/3.

VA 4: NEPOMUC positron source and experiments

Time: Monday 15:00–16:40 Location: H 0106

Invited Talk VA 4.1 Mon 15:00 H 0106

Surface and Bulk Investigations at the High Intensity Positron Beam Facility NEPOMUC — •Christoph Hugenschmidt[1,2], Günther Dollinger[3], Werner Egger[3], Gottfried Kögel[3], Benjamin Löwe[1], Jakob Mayer[1], Philip Pikart[1,2], Christian Piochacz[1,2], Klaus Schreckenbach[1,2], Peter Sperr[3], and Martin Stadlbauer[1,2] — [1]TU Munich, Department of Physics E21, James-Franck-Strasse, 85478 Garching — [2]TU Munich, ZWE FRM II, Lichtenbergstrasse 1, 85748 Garching — [3]UniBW Munich, LRT2, Werner-Heisenberg-Weg 39, 85577 Neubiberg

NEPOMUC – the NEutron induced POsitron source MUniCh – delivers a low-energy positron beam (E = 15 - 1000 eV) of high intensity in the range between $4 \cdot 10^7$ and $5 \cdot 10^8$ moderated positrons per second. At present four experimental facilities are in operation at NEPOMUC: A coincident Doppler-broadening spectrometer (CDBS), a positron annihilation induced Auger-electron spectrometer (PAES) and an apparatus for the production of the negatively charged positronium ion Ps$^-$. Recently, the pulsed low-energy positron system (PLEPS) has been connected to the NEPOMUC beam line and first positron lifetime spectra were recorded within short measurement times. A positron remoderation unit, which is operated with a tungsten single crystal in back reflection geometry has been implemented in order to improve the beam brilliance. An overview of the status of the neutron induced positron source NEPOMUC at the research reactor FRM II and recent developments at the running spectrometers is given.

VA 4.2 Mon 15:40 H 0106

Gas moderation of positrons — •Benjamin Löwe[1,2], Klaus Schreckenbach[1,2], and Christoph Hugenschmidt[1,2] — [1]TU München, FRM II, Lichtenbergstr. 1, 85747 Garching — [2]TU München, Physik Department E21, James Franck Str., 85748 Garching

A variety of low energy positron experiments need an improved brilliance of the beam by means of a remoderator. Conventionally, a tungsten foil or single crystal is used as a remoderator in transmission or reflection geometry. In this project a novel remoderation unit was developed and tested at the positron beam facility NEPOMUC at the

FRM II. This remoderation is based on inelastic positron scattering and the drift of positrons in a suitable gas. The stopping of positrons in nitrogen has already been shown by Surko et al. and is currently used to store positrons in a trap.

Positrons from the NEPOMUC source are decelerated at the entrance of the remoderation chamber to about 50 eV by an electric field and enter into the gas region (about 0.01 mbar). Due to inelastic scattering with gas molecules the positrons lose energy through different processes such as vibrational excitations, electronic excitations and ionisation. Above energies of 8 eV losses due to positronium formation occur. After thermalisation in the gas the positrons drift along the focusing electric field lines. At the exit the moderated positrons have been measured by a retarding potential analyser. The principle of the new gas remoderator and first measurements will be presented.

VA 4.3 Mon 16:00 H 0106

A new device for a pulsed positron beam at the NEPOMUC positron facility — •Christian Piochacz[1,2], Gottfried Kögel[2], Werner Egger[2], Christoph Hugenschmidt[1], Peter Sperr[2], and Günther Dollinger[2] — [1]ZWE FRM II, TU München, Lichtenbergstraße 1, 85747 Garching — [2]LRT 2, Universität der Bundeswehr München, Werner-Heisenberg-Weg 39, 85577 Neubiberg

Positron annihilation is a highly sensitive method to study defects of atomic size. Both, the types and the concentrations of defects can be determined by positron lifetime measurements. To perform such measurements with micrometer spatial resolution, a pulsed positron beam is focused down to micrometer spot size in the Munich Scanning Positron Microscope (SPM). For a much higher event rate it is intended to operate this SPM at the high intense positron source NEPOMUC at the FRM II. Since April 2007 a remoderated positron beam of sufficient brilliance is available at NEPOMUC.

The new pulsing device must transform this dc-beam into a train of sharp pulses without losing much intensity. Therefore, a two stage pulsing concept is applied, where a pre-buncher concentrates the intensity into the nanosecond time windows of the resonant sine wave main buncher. The new device has been completed and installed at the open beam port of NEPOMUC. We present the design concepts and results from both, particle tracing simulations and first measurements.

VA 4.4 Mon 16:20 H 0106

Improvement of the CDBS at NEPOMUC - Simulations and first measurements — •Martin Stadlbauer[1,2], Christoph Hugenschmidt[1,2], and Klaus Schreckenbach[1,2] — [1]TU München, ZWE FRM-II, Lichtenbergstr. 1, D-85748 Garching — [2]TU München, Physikdepartment E21, James-Franck-Str., D-85748 Garching

Coincident Doppler broadening spectroscopy with positrons (CDBS) is a well established technique to investigate lattice defects and their chemical surrounding in solids and has been successfully implemented at the high intense positron source NEPOMUC at the research reactor FRM-II in Munich. In order to improve the existing spectrometer for measurements on materials with low positron trapping rates, it has been redesigned and improved with a cryostat for sample cooling to liquid nitrogen temperature. A recently installed brilliance enhancing remoderator facility at NEPOMUC enforced further changes at the CDBS-facility like an insulated magnetic field termination and a new lens system.

The new design of the CDBS-facility and simulations of the positron trajectories are shown and first measurements of the beam parameters at the sample position are presented. Furthermore, ion-irradiated magnesium samples have been investigated with the new CDBS-facility, since the positron trapping rate in magnesium is low and the trapping sites are shallow.

VA 5: Laboratory visit

Time: Tuesday 9:30–11:00 Location: PTB-Pforte

Tutorial VA 5.1 Tue 9:30 PTB-Pforte

Besichtigung des Laboratoriums für Vakuummetrologie der PTB — •Karl Jousten — Physikalisch-Technische Bundesanstalt, Abbestr. 2-12, 10587 Berlin

Kalibrierungen von Vakuummessgeräten werden in der PTB auf international höchstem Niveau durch Vergleich mit Primärnormalen vorgenommen. Die Besichtigung wird Gelegenheit bieten, einige der Primärnormale für Vakuumdrücke zu sehen und deren Funktionsweise zu verstehen. Vorherige Anmeldung unter karl.jousten@ptb.de erforderlich.

VA 6: Gaede prize talk

Time: Wednesday 13:30–14:15 Location: HE 101

Prize Talk VA 6.1 Wed 13:30 HE 101

Structure formation, kinetics and mechanics in thin films and solids: from nanoscale to macroscopic properties in experiments and simulations. — •S. G. Mayr — I. Physikalisches Institut, Georg-August-Universität Göttingen — Träger des Gaede-Preises

Macroscopic properties of functional thin films and solids, including structure and mechanics, are frequently dominated by processes at the atomic level, while the growing demand for miniaturization in science and technology has strongly triggered interest in nanoscale phenomena. Fine tuning and creation of new materials can thus greatly benefit from a detailed understanding across time and length scales. To achieve this, we employ a complimentary approach of experiments, atomistic computer simulations and analytical modelling, which we exemplify in two instances: We report about our studies on i) the mechanisms of self-organized structure formation at surfaces in driven systems and on ii) the nanomechanics in disordered solids. While i) combines an external forcing (materials deposition, energetic ions, templates) with intrinsic thermodynamics / kinetics to induce pattern formation or ultrasmooth surfaces, ii) is characterized by the occurrence of a highly heterogeneous dynamics in response to stress. In both cases, i) and ii), we choose metallic glasses as model systems due to their spatial isotropy, but also investigate generalizations to non-metallic as well as crystalline systems. Recent implications for the miniaturization of functional thin films and applications are also discussed.

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