Tuesday Afternoon Poster Sessions

Vacuum Technology
Room: Exhibit Hall B2 - Session VT-TuP

Poster Session

VT-TuP1 The KATRIN Neutrino Mass Experiment - Vacuum Technological Aspects, ***C. Day***, *V. Hauer*, Forschungszentrum Karlsruhe, Germany, *J. Bonn*, University of Mainz, Germany

In modern particle physics, one of the most challenging task is to determine the rest mass of neutrinos. The energy spectrum of the electrons of the β decay can be used to derive upper limits of the electron neutrino mass. A new large tritium experiment is currently being planned, the KATRIN experiment, which is expected to increase the resolution of mass determination by one order of magnitude. It is an international effort and will be built up and operated in FZK, Germany. The KATRIN vacuum system can be subdivided into three main parts, the windowless gaseous tritium source (WGTS), the differential pumping section, and the pre- and main spectrometer. The WGTS introduces tritium gas into the central piping system, operated under fine vacuum conditions. Further in spectrometer direction follows a differentially pumped section to reduce the gas pressure by nine orders of magnitude. This is realised by a cascade of turbomolecular pumps combined with a cryogenic pump system (Ar frost). Between the tritium source and the main spectrometer a pre-spectrometer is inserted, acting as an energy pre-filter. The key component of the new experiment is the large MAC-E-filter with a diameter of 7 m and an overall length of about 20 m, designed for XHV conditions. The spectrometers are pumped by a two-stage system, comprising turbomolecular pumps with high compression ratio for hydrogen, and getter pump modules. This paper delineates the underlying concepts for the three different vacuum systems. Special requirements are full tritium compatibility, operation in strong magnetic fields and under high voltage conditions. The differential pumping section, especially the final cryogenic pump, must provide a capture probability of almost unity, to allow for XHV conditions in the pre-spectrometer tank. To limit the pumping speed requirements with respect to the getter pumps, the outgassing of the spectrometer vessel walls must be reduced to an absolute minimum.

VT-TuP2 Extended Measurements of Photon Stimulated Desorption from a Copper Beam Chamber after Removal of Surface Oxide[1], ***C.L. Foerster***, *C. Lanni*, Brookhaven National Laboratory

Photon Stimulated Desorption(PSD) was measured from a copper beam chamber after completely removing the vacuum surface oxide in order to reduce the PSD. Continuous measurements have been recorded for the chamber, over a year and a half exposure period, to determine long term exposure effects. The measurements of PSD and specular photon reflection were performed on NSLS beamline U9a at Brookhaven National Laboratory. It is well known that PSD causes a pressure rise in accelerator and storage ring vacuum, which limits their performance. For this experiment, a KEKB factory beam chamber from a previous experiment was chemically etched and chemically cleaned prior to installation on beamline U9a. Previous PSD measurements have shown that this chemical treatment removes any memory of prior exposure or conditioning. After installation, the copper chamber and end stop were vacuum baked to 250°C for more than a week to completely remove vacuum surface oxides. The chamber was exposed to more than $5x10^{24}$ photons direct from the source having a critical energy of 595 eV and striking at an incident angle of 100 mrad. The major PSD yields for hydrogen, carbon monoxide, carbon dioxide, and methane are reported as a function of accumulated photon flux and preparation. The PSD yields for the copper chamber, after oxide removal, were found to be greatly reduced when compared to previous measurements at this laboratory and by those reported from other laboratories. The PSD component gases remained the same during the long exposure and all were significantly reduced. Carbon dioxide and methane were reduced much more than hydrogen and carbon monoxide. Specular photon reflection did not change significantly during the extended exposure.

[1]Work performed under the auspices of the U.S. Department of Energy, under contract DE-AC02-98CH10886.

VT-TuP3 Synchrotron Radiation-Induced Desorption of NEG-Coated Vacuum Chambers at the ESRF, ***R Kersevan***, European Synchrotron Radiation Facility, France

The outgassing yield of several vacuum chambers under exposure to synchrotron radiation at the European Synchrotron Radiation Facility (ESRF) is given. Recently, Non-Evaporable Getter (NEG) coatings have been applied in order to reduce the pressure profile inside narrow-gap vacuum chambers, with the aim of reducing the interaction between the 6 GeV electron beam and the residual gas. Chambers made out of stainless steel, with copper coating, and extruded aluminum have been studied. Wherever possible, comparison between un-coated and NEG-coated chambers of the same geometry is made. It is shown that the NEG-coated chambers give a reduced amount of bremsstrahlung radiation, a clear indication of a reduced outgassing yield and distributed pumping. A brief description of a NEG-coating facility, capable of coating chambers up to 6 meters in length, being built and commissioned at the ESRF is given.

VT-TuP4 New Absorber in a Ceramic Kicker-chamber for the TLS Electron Storage Ring, ***G.-Y. Hsiung***, *S.-N. Hsu, C.-S. Ho, J.-R. Chen*, Synchrotron Radiation Research Center, Taiwan

An insertion device of 6T super-conducting wiggler has been installed in the injection section of the Taiwan Light Source (TLS) electron storage ring. A ceramic kicker-chamber downstream the device subjects an intensive synchrotron radiation on both side-wall. A water-cooled copper absorber, installed inside the ceramic chamber to shield the inner wall from irradiation, might cause serious problems. The problems contain the induced arcing between the absorber and the ceramic chamber, the induced interference magnetic field, etc. during the ignition of the kicker magnet. The efficiency of beam injection and the beam life time could be seriously degraded. The solution to cure those problems, the design of the absorber, and the commissioning results will be described in this paper.

VT-TuP5 Numerical Simulation of the Ion Beams Transmission Efficiency For the Design of the DC-72 Cyclotron Vacuum System, ***A.V. Tikhomirov***, *G.G. Gulbekian, R.Ts. Oganessian*, Joint Institute for Nuclear Research, Russia

The results of transmission efficiency numerical simulation for the ion beams due to a charge exchange with the residual gas in the cyclotron vacuum system including: the axial injection system; the cyclotron vacuum chamber as well as transport lines for accelerated ion beams are presented. Simulation method have been developed and tested on the base of experiments at four heavy ion cyclotrons of FLNR. Simulation results have provided determination of the main parameters for the DC-72 cyclotron vacuum system.

VT-TuP6 Study of the Performance of a Precision Constant Volume Flowmeter for Vacuum Calibration and Measurement, ***Y.W. Chang***, *J.S. Lin*, Precision Instrument Development Center, Taiwan, R. O. C.

The Vacuum Laboratory at Precision Instrument Development Center in Taiwan has developed a high vacuum calibration and measurement system by the orifice flow method. A constant volume flowmeter is used to provide a measurable, steady and uniform gas flow to the vacuum chamber in the range 10^{-2} to 10^{-5} Torr.l/s. With this type of flowmeter gas is supplied from a reservoir of fixed and known volume. The pressure drop in the volume is measured and the product of reservoir volume and the pressure drop per unit time determines the gas throughput of flowmeter. A regulating valve at the exit of reservoir controls the gas flow rate. The performance of such a flowmeter is verified by introducing the known gas flow rate to an orifice calibration chamber to generate a pressure, which can be determined by the flow rate and the orifice conductance under molecular flow conditions. The predicted pressure is compared with the pressures simultaneously measured by a spinning rotor gauge calibrated at PTB in German and an ion gauge calibrated at NML in Taiwan. When the correction factors for two gauges show the same tendency in repeated measures, the variations of correction factors then indicate the performance of the flowmeter. The pressure drops in the reservoir are measured both absolutely and differentially. In absolute way the reservoir pressure is measured with a capacitance diaphragm gauge (CDG); while in differential way the pressure difference between the reservoir and a reference volume is measured with a differential CDG. The measurement results of gas throughput of the flowmeter by two ways are also presented in this study.

VT-TuP7 Influence of Temperature on the Sensitivity Coefficient of a Hot Cathode Ionization Gauge, ***H. Akimichi***, *M. Hirata*, National Institute of Advanced Industrial Science and Technology, Japan

Hot cathode ionization gauges, such as a triode gauge and a Bayard-Alpert type gauge are used as reference, secondary and transfer standards in high and ultrahigh vacuum. For these applications, the stability of the sensitivity coefficient (S) of the gauge is very important. Under ideal conditions, the coefficient may be kept within 1%. It is well known, however, that the indication of the gauge is strongly affected by temperature. We studied the influence of temperature on the indication of the gauge. By cooling an ionization gauge with an electric fan, the indication at pressure lower than

about 10^{-4} Pa decreased with temperature, which dues to the decrease in the outgassing from the gauge itself. Typically, the indicated pressure at $6x10^{-6}$ Pa decreases about 30 % by the decrease in the temperature (Tg) of the gauge head from 40 to 27 °C. In contrast, at pressure higher than about 10^{-4} Pa, the decrease in the temperature caused an increment of the indicated pressure at about 2 %. The shift in the indicated pressure was explained by the thermal transpiration effect $S'/S = \sqrt{(Tg/Tg')}$. Change in room temperature (Tr) from 22 to 32 °C, on the other hand, the sensitivity coefficient of the gauge changed from 0.128 to 0.125 Pa^{-1}. This result was also explained by the relations $S'/S = Tr/Tr'$, since the temperature change in vacuum chamber and in gauge head are much the same. These results mean that compensation of the temperature for the sensitivity coefficient is important for a precious pressure measurement using an ionization gauge.

VT-TuP8 Influence of Gas-Surface Interaction on Thermal Transpiration of a Capacitance Diaphragm Gauge, *S. Nishizawa, H. Akimichi,* ***M. Hirata***, National Institute of Advanced Industrial Science and Technology, Japan

For a capacitance diaphragm gauge (CDG), the temperature difference between the sensor head and the vacuum chamber gives a non-linear sensitivity, which is called thermal transpiration. This sensitivity depends on gas species and pressure. It is supposed that under the same condition of gas-surface interaction, the sensitivity should be normalized by mean free path regardless of gas species. However, the sensitivity dependence of mean free path is also different from gas species. For example, at molecular flow regime, the sensitivity of He is slightly small in comparison with Ar and N_2. It means that the gas-surface interaction should be different from each gas. In this study, by using a direct simulation Monte Carlo (DSMC) method, the influence of gas-surface interaction on thermal transpiration was analyzed. In case of random and cosign reflection models, the sensitivity has non-linearity and depends on mean free path. On the other hand, in case of a perfectly elastic reflection model, the sensitivity is constant regardless mean free path. In case of complex reflection that is composed of random and elastic reflections, as increasing the elastic reflection component, the sensitivity decreases from that of random and cosign reflection to elastic reflection. From these results, it is suggested that the elastic reflection component of He-surface interaction is larger than Ar and N_2 -surface interaction. It means that as decreasing the molecule diameter, the elastic reflection becomes important.

VT-TuP9 Vacuum Chamber with Distributed Titanium Sublimation Pumping for the G-Line Wiggler at Cornell High Energy Synchrotron Source, ***Y. Li***, *Y. He, N.B. Mistry,* Cornell University

This paper describes a 3-meter long vacuum chamber for the newly installed wiggler magnet at the Cornell Electron Storage Ring (CESR) for the synchrotron light beam line of the Cornell High Energy Synchrotron Source (CHESS). Copper was chosen as the main chamber material for its good electric and thermal conductivities. Proper mechanical design and welding procedure were implemented to meet very tight tolerances to ensure adequate vertical aperture for the stored beams in CESR while allowing the required small wiggler gap. Distributed titanium sublimation pumping is incorporated along 3-meter length of the chamber to provide sufficient pumping speed and capacity for CESR and CHESS operations. The chamber pumping performance was evaluated prior to the installation. Linear distributed pumping speeds at the beam line of ~800 liter/sec/meter for N_2 and CO and ~4200 liter/sec/meter for H_2 were measured. The pumping speed is determined by the gas conductance of the slotted copper screen between the beam line and the TiSP compartments. The measured pumping capacities for N_2, CO and H_2 are ~1.0, ~2.0 and ~77 torr-liter, respectively, for each titanium sublimation cycle. Measurements also showed that CO molecules adsorb on the N_2 and H_2 saturated titanium films with virtually the same initial sticking coefficient as on a fresh titanium film. Detail analyses indicated very different CO adsorption mechanisms between the N_2 and H_2 saturated titanium films. While the replacement of surface H_2 by CO was observed, little desorption of N_2 was measured. Operational experience showed excellent vacuum pumping performance over seven months after the chamber installation.

VT-TuP10 XPS Studies of Al and Cu Samples Exposed to an Accelerator Environment, ***R.A. Rosenberg***, *M.W. McDowell, Q. Ma,* Argonne National Laboratory

Designers of present and future particle accelerators are becoming increasing concerned about the influence of the components surface chemistry on the accelerator performance. Bombardment of these surfaces by photons can cause desorption of gases and prod uction of primary and secondary electrons. In some cases interaction of these electrons with the particle beam and the chamber walls can lead to an amplification of the electron density which in turn can cause degradation of the beam. It is well known th a t exposure to an accelerator environment can cause "conditioning" of the chamber surfaces. In order to understand the manner in which the surface structure might influence the production of gases and electrons in the accelerator it is necessary to stud y s uch surfaces both before and after exposure to accelerator conditions. There have been numerous studies performed on representative materials prior to being inserted into an accelerator but very little done on materials that have "lived" in the accele r ato r for extended periods. In the present work we mounted Al and Cu coupons at different positions in a section of the Advanced Photon Source storage ring and removed them following exposures ranging from 6 to 18 months. XPS surface analysis was perfor me d be fore and after exposure. Changes were observed that depended on the location and whether the coupon was facing the chamber interior or chamber wall. These results will be presented and compared to data obtained from laboratory measurements meant to simulate the accelerator conditions. Work supported by U.S. Department of Energy, Office of Basic Energy Sciences under Contract No. W-31-109-ENG-38.

VT-TuP11 A Low Cost Method to Deposit Diamond Films on WC-Co and Si Substrates, ***S. Nasrazadani***, University of North Texas

Diamond Coatings are known to be highly desirable for their wear resistance as well as high thermal conductivities. High hardness, low coefficient friction makes diamond attractive for mechanical properties while, high thermal conductivity make it suitable for substrate material as a heat sink. Low cost deposition of this material was investigated using hot filament chemical vapor deposition. Effects of chamber gas composition was evaluated in morphology of diamond films formed on WC-Co and Si substrates.

VT-TuP12 Method to Control the Amount of Helium Delivered during Leak Testing, ***F.E. Juravic Jr.***, Fermilab

Purpose The purpose of this paper is to demonstrate a method for limiting the amount of helium administered during leak testing and provide a method for keeping the atmospheric helium in a location to a minimum to eliminate backstreaming into the system. This method utilizes the permeability of a balloon. The transporting of helium to the leak check area is also safer by not requiring a cylinder in the leak check location. Utilizing the many shapes of balloons and partially filling of the balloon, any configuration can deliver helium to the leak location. The balloon I filled for the test fell to the floor with the amount of helium I put into the balloon.

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Situation where a high background of helium cannot be tolerated will be avoided by limiting the amount of helium brought into the room during leak checking. Transporting helium in the balloon into remote areas will allow the technician from accidentally introducing huge amounts of helium that can backstream into the msld and can be kept in the remote areas where the space in limited. This method can be applied to all forms of leak checking. This method is not recommended for certification for cryogenic systems.

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