Vacuum Technology
Room 2000 - Session VT-TuA

Extreme High Vacuum and Vacuum Metrology

Moderator: N.T. Peacock, MKS Instruments, Inc.

2:00pm **VT-TuA1 Extreme High Vacuum (XHV): The Need, Production and Measurement***, **M.L. Stutzman**, P.A. Adderley, M. Poelker,* Thomas Jefferson National Accelerator Facility **INVITED**

Extreme High Vacuum is defined to be pressures below 1x10@super -10@ Pa. The technology required to achieve XHV at room temperature involves careful consideration of vacuum chamber materials and preparation, pumping, and pressure measurement. Many vacuum applications find UHV pressure (1x10@super -7@ to 1x10@super -10@ Pa) adequate for their purposes and research focuses on rapid pumpdown times or control of specific process gasses. However, for applications such as particle storage rings and high current photoelectron guns, operational lifetime is inversely proportional to the total pressure, with XHV pressures beneficial or essential for operation. Literature regarding the materials, preparation and fabrication processes required to achieve XHV, and XHV pressure measurement will be discussed. The focus will be on work performed at JLab for photoelectron gun applications including high average current RF and DC high voltage electron guns.

2:40pm **VT-TuA3 1450 m@super 3@ at 10@super -9@ Pa: One of the KATRIN Challenges***, **Chr. Day**, R. Gumbsheimer, W. Herz,* Forschungszentrum Karlsruhe, Germany

The KATRIN project is a challenging experiment to measure the mass of the electron neutrino directly with a sensitivity of 0.2 eV. It is a next generation tritium beta-decay experiment scaling up the size and precision of previous experiments by an order of magnitude as well as the intensity of the tritium beta source. Ultrafine spectrometric analysis of the energy distribution of the decay electrons at their very endpoint of 18.57 keV is the key to derive the neutrino mass. This is provided by a high-resolution spectrometer of unique size (10 m in diameter, 22 m in length). To avoid any negative influence from residual gas, the spectrometer vessel is designed to UHV/XHV conditions (an ultimate total pressure of below 10@super -9@ Pa and a wall outgassing rate below 10@super -13@ Pam@super 3@/scm@super 2@). The paper shortly describes the experimental idea behind KATRIN. The emphasis will then be given to the pumping concept for how to achieve the target parameters and to the manufacturing of the spectrometer tank. Critical issues will also be discussed (surface treatment, welding, transportation). Finally, a description of the current status and an outlook on the overall KATRIN schedule completes the paper.

3:00pm **VT-TuA4 XHV Experience at Daresbury Laboratory***, K.J. Middleman, **J.D. Herbert**,* CCLRC Daresbury Laboratory, UK

The Energy Recovery Linac Prototype (ERLP) is a new accelerator being built at Daresbury Laboratory in the UK. The project is a research facility to develop the technology required to build a 4th Generation Light Source (4GLS). The vacuum science group of ASTeC* is responsible for the design of the vacuum systems for the ERLP machine and their subsequent commissioning. The ERLP project is the first at Daresbury to require XHV and as such has presented a number of challenges to the design team. This paper will outline the requirements for XHV for the ERLP and detail some of the challenges that have been faced. Some details of bakeout, particle control, measurement limitations and leak detection will be presented. @FootnoteText@ *Accelerator Science and Technology Centre of CCLRC

3:20pm **VT-TuA5 Development of a New NIST Calibration Service Using the Comparison Method for Vacuum Gauges Spanning the Range 0.65 Pa to 130 kPa***, **J.H. Hendricks**, P.J. Abbott, J.E. Ricker, J.H. Chow,* NIST

A new calibration service based on a secondary pressure transfer standard spanning the pressure range from 0.65 Pa to 130 kPa (5 millitorr to 975 torr) is being developed at NIST. Vacuum gauges in this range are presently calibrated using the NIST Ultrasonic Interferometer Manometers (UIMs). However, many customers desire direct traceability to NIST but cannot justify the cost of the NIST UIM calibrations. These customers are typically using less accurate gauges, such as Thermal Conductivity Gauges@footnote 1,2@ (TCGs), or the newer combination type gauges that have 2 sensors combined with electronics that average or select which sensor is being utilized depending on the pressure being sensed. This new system under development is being designed to add a lower cost Comparison Method Vacuum Gauge Service that is currently not available to NIST customers. This service will follow a similar model of other calibration services where a lower cost, and less accurate service is offered to customers who do not require the lowest uncertainty possible. The comparison method utilizes a high accuracy transfer standard package that consists of a 133 Pa (1 torr) Capacitance Diaphragm Gauge (CDG), a 13.3 kPa (10 torr) CDG and a 130 kPa (975 torr) Resonance Silicon Gauge (RSG) all encased in a temperature controlled enclosure that is periodically calibrated against the NIST 160 kPa UIM and 140 Pa Oil UIM Primary Pressure Standards. The transfer standard package, and ultimately the Comparison Method Vacuum Gauge Service, is designed to have expanded uncertainties as low as 0.05 % from 1.33 kPa to 130 kPa (10 torr to 975 torr) and 0.3 % from 1.33 Pa to 1.33 kPa (0.01 torr to 10 torr).

3:40pm **VT-TuA6 A Comparison of the High Vacuum Standards of the National Physical Laboratory of India and the National Institute of Standards and Technology, USA at 0.05 Pa using the Spinning Rotor Gauge***, P. Mohan,* National Physical Laboratory, India*; **P.J. Abbott**,* National Institute of Standards and Technology

High vacuum (10@super-1@ to 10@super-4@ Pa) standards are maintained by many of the world's National Metrology Institutes (NMI). For purposes of trade equity as well as scientific integrity, it is important that NMI's compare their standards and determine a degree of equivalence within a well documented uncertainty. Comparing high vacuum standards presents a special challenge, as the transfer standards available for use in this range measure pressure indirectly and tend to have much larger uncertainties than the transfer standards used for comparing medium and low vacuum standards.@footnote 1@ The spinning rotor gauge (SRG) has excellent stability and its calibration has been found to be independent of pressure in the high vacuum regime. For these reasons, two SRG's were used to compare the high vacuum standards of the National Physical Laboratory of India (NPLI) and the National Institute of Standards and Technology, USA (NIST) at a pressure of 0.05 Pa. NPLI served as the pilot lab for the comparison. To minimize the possible effects of rough handling during shipping, the rotors were carefully packed and hand-carried between India and the United States and back to India. At each laboratory, multiple measurements of the accommodation coefficients of two rotors were made using the respective high vacuum standards of NPLI and NIST. A discussion of these standards along with the results of the comparison will be presented. @FootnoteText@ @footnote 1@Final report on key comparison CCM.P-K5 of differential pressure standards from 1 Pa to 1000 Pa A P Miiller, G Cignolo, M P Fitzgerald and M P Perkin Metrologia 39 No 1A (Technical Supplement 2002) 07002 .

4:20pm **VT-TuA8 A Linear Pressure Drop Gas Flow Calibrator***, **P.D. Levine**,* Zero K Designs

Gas flow calibration is typically accomplished by measuring the rate at which volume is displaced by gas flowing at constant pressure. An alternative methodology is described below which uses the measurement of pressure drop at constant volume to define volumetric flow rates. The pressure of a gas leaking from a fixed volume through a small conductance decays exponentially. The time constant for the decay is directly proportional to the size of the fixed volume and inversely proportional to the conductance. Thus, for measurement intervals short compared to the exponential time constant, the pressure and consequentially the rate of gas flow from the volume falls linearly to first order. This greatly simplifies the calculation of flow rate. The calibrator design provides for various configurations of volume, conductance and gas pressure to generate a wide range of linear pressure drops in time intervals sufficient for collecting meaningful data. Measuring the pressure drop differentially, as well as absolutely, affords a high level of resolution and precision. A flow meter based on this concept has already been proven effective for an orifice flow vacuum calibration system.@footnote 1@ This paper describes a scaling up of that flow meter design to provide known gas flow rates approaching those generated by piston provers, with the possibility for even further extension. Details of the design and the overall calibration methodology are described. Sources of uncertainty are identified and the inherent advantages and practical limitations are discussed. @FootnoteText@ @footnote 1@P.D. Levine, J.R. Sweda "A Precision Gas Flowmeter For Vacuum Calibration", J. Vac. Sci. and Technol. A 15(3) May/June 1997; pp 747-752.

5:00pm **VT-TuA10 A Memory of Jim Lafferty***,*

James "Jim" M. Lafferty, a long time member of the society died on March 26 in Florida. During his time at General Electric, vacuum technology was central to the research he performed and directed. Having made a major contribution to AVS, including President 1968-1969, Jim Lafferty was elected as President of the International Union for Vacuum Science, Technique, and Applications (IUVSTA), serving with great distinction from 1980 to 1983.

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