Wednesday Morning, October 20, 2010

Vacuum Technology
Room: Laguna - Session VT-WeM

Accelerators, Large Vacuum Systems, and Vacuum Surfaces
Moderator: R.F. Berg, National Institute of Standards and Technology

8:00am **VT-WeM1 Architecture and Operation of the Z Pulsed Power Facility Vacuum System**, ***J.W. Weed***, Sandia National Laboratories, *D.W. Petmecky,* Ktech Corporation, *A.C. Riddle*, Sandia National Laboratories **INVITED**

The Z Pulsed Power Facility at Sandia National Laboratories in Albuquerque, New Mexico, USA is one of the world's premier high energy density physics facilities. The Z Facility derives its name from the z-pinch phenomena which is a type of plasma confinement system that uses the electrical current in the plasma to generate a magnetic field that compresses it. Z refers to the direction of current flow, the z axis in a three dimensional Cartesian coordinate system. The multiterawatt, multimegajoule electrical pulse the Facility produces is 100-400 nanoseconds in time. Research and development programs currently being conducted on the Z Facility include inertial confinement fusion, dynamic material properties, laboratory astrophysics and radiation effects. The Z Facility vacuum system consists of two subsystems, center section and load diagnostics. Dry roughing pumps and cryogenic high vacuum pumps are used to evacuate the 40,000 liter, 200 square meter center section of the facility where the experimental load is located. Pumping times on the order of two hours are required to reduce the pressure from atmospheric to 10^{-5} Torr. The center section is cycled from atmosphere to high vacuum for each experiment. The facility is capable of conducting one to two experiments per day. Numerous smaller vacuum pumping systems are used to evacuate load diagnostics. The megajoules of energy released during an experiment causes damage to the Facility that presents numerous challenges for reliable operation of the vacuum system.

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

8:40am **VT-WeM3 Vacuum System for the Large-Scale Cryogenic Gravitational Wave Telescope (LCGT)**, ***R. Takahashi***, National Astronomical Observatory of Japan, *Y. Saito, T. Suzuki*, KEK-High Energy Accelerator Research Organization, Japan

The large-scale cryogenic gravitational wave telescope (LCGT) project is proposed to open a new window for astronomy, which will be able to detect signals from the binary neutron star coalescence at 240Mpc away. LCGT requires an ultra-high vacuum tubes which the laser beams pass through. Two 3-km vacuum tubes are kept in ~10^{-7}Pa of vacuum pressure so as to reduce scattering-effects due to residual gas molecules.

Mirrors of the main interferometer are cooled to 20K to reduce thermal noises. The super-insulator (SI) which consists of multi-layered organic films is generally used for a thermal insulation of cryostat. However, the SI should not be applied to the cryostat of LCGT to avoid contamination on the extremely sensitive mirrors. We plan to use multi-layered metal shields with low emissivity and low outgassing for a thermal insulation.

9:00am **VT-WeM4 Working toward XHV: Characterization and Improvements of the Vacuum System for GaAs Photoemission Electron Sources**, ***M.L. Stutzman***, *P.A. Adderley, A. Comer, M. Poelker*, Jefferson Lab

The operational lifetime of a DC electron source using GaAs photocathode material is limited primarily by the system vacuum; the residual gasses ionized by the electron beam are accelerated into the photocathode where they cause damage and limit photocathode yield. Though we operate in the deep-UHV range, improvements to the vacuum should increase lifetime for today's electron sources, and is essential for proposed future accelerators needing considerably higher average current. This talk describes our efforts to improve vacuum in the Jefferson Lab polarized electron source, including efforts to characterize NEG and ion pumps in the deep-UHV range, carefully determine the x-ray limit of our Leybold extractor gauges, and quantify the reduction in outgassing from stainless steel chambers after a long 400°C heat treatment. The goal of these studies is to determine which factors primarily limit our ultimate pressure, to find ways to lower the ultimate pressure for future electron sources, and to quantify these improvements.

9:20am **VT-WeM5 The Role of Vacuum Technology in the Production of Neutron Generators**, ***J.L. Provo***, Sandia National Laboratories

Neutron generators are neutron source devices which are composed of small linear accelerators that produce neutrons by fusing isotopes of hydrogen. Such devices were first used in the ignition of nuclear weapons but many commercial applications have been developed over the past 50 years. The critical component of a neutron generator is a small particle accelerator called a neutron tube. Neutron tubes are composed of several components which include an ion source, ion optic elements, and a target on to which ions are accelerated. All components are enclosed in a vacuum tube enclosure with a high voltage insulator between the ion source and the target. The ion source and accelerator high voltages are provided by external power supplies either of electronic design or of a ferroelectric explosive design. Electronic generators can be used after function testing while explosive generators are destroyed.

Neutron tubes thus are similar to vacuum tubes previously used in televisions, radios, etc., and processes used for production of these devices can also be used for neutron tubes. Because of their application, the quality requirements for manufacturing such devices for weapons are very rigorous and are of the highest quality standards. These devices typically are designed and fabricated to operate over a temperature range of -65 °F to +168ºF with 99.99+% reliability at over 95% confidence. These are quality levels rarely found in any industry. To support these requirements, the latest in applied science and technology in analysis of materials and chemical and vacuum processes were utilized.

Described will be analyses and processes used in the characterization of materials and components used in vacuum neutron tube manufacture. These include surface analysis techniques used to prove materials have specified constituents with no impurities. Cleaning processes used to prepare tube components prior to sub- assembly, which include plasma cleaning, and vacuum firing, vacuum brazing assembly processes as well as thin film deposition processes for tube ion sources and targets, occluder film hydriding processes, and final tube exhaust processes , all of which use vacuum technology will be briefly described.

Some weapon and commercial versions of neutron tubes will also be described with external photos, their history, and their applications. It is very evident that the application of vacuum technology was absolutely necessary to produce the controlled environments that meet the quality standards for neutron tube weapon application as well as for the many commercial applications that require advanced-materials processing and manufacture in use now and in the future.

10:40am **VT-WeM9 Application of Electrochemical Buffing to Niobium Superconducting RF Cavity**, ***S. Kato***, *M. Nishiwaki, P.V. Tyagi, S. Azuma, F. Yamamoto*, KEK-High Energy Accelerator Research Organization, Japan

Niobium electropolishing for SRF cavities are generally considered to be the best technology today.

However, hydrofluoric and sulfuric acid mixture usually used in the EP process is harmful and requires us carefully controlled handling of it and the many additional facilities. In this article, we propose a new application of electrochemical buffing onto niobium SRF cavity. In the method of electrochemical buffing, a rotating disk with abrasive fine particles where electrolyte is supplied is pressed against the workpiece. The disk and the work function as a cathode and an anode, respectively and an aqueous solution of sodium nitrate is used for the electrolyte. This technique brings us a couple of advantages like high etching rate, ultra small surface roughness, cost-effective and environment-compatible polishing.

11:00am **VT-WeM10 Development of UHV Field Emission Scanner for Surface Study of Niobium SRF Cavity**, *S. Kato,* ***M. Nishiwaki***, *V. Chouhan, P.V. Tyagi, T. Noguchi*, KEK-High Energy Accelerator Research Organization, Japan

It is mandatory to investigate field emission on Nb SRF cavity systematically since strong field emission often limits the cavity performance. The field emission strength and the number of emission sites strongly depend on Nb surface properties which are determined by its surface treatment and handling. Field emission scanner developed allows us to measure a distribution of the field emitting sites over a sample surface at a given field strength along with its FE-SEM (field emission scanning electron microscope) observation and energy dispersive x-ray analysis. The field emission scanner consists of a sample stage driven by piezo actuators and an anode needle driven by precise 3D stepping motors. In addition, this system was newly equipped with a sample load-lock system for existing UHV suitcases. The compact scanner was installed into the space between the object lens and the SEM sample holder. The UHV pumps were additionally installed in order to improve the base pressure down to UHV to reduce adsorbates during the measurement. This article describes development of the field emission scanner and its preliminary results of the application to niobium samples.

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