SXLS Phase II Vacuum System*

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SUMMARY

Phase I of the SXLS (Superconducting X-Ray Lithography Source) is described in [1]. It is a room temperature, racetrack-shaped electron storage ring, 8.5 meters in circumference. The Phase II design consists of replacing the two room temperature 180° dipole magnets of Phase I with superconducting magnets. However, even though superconducting magnets are used, the vacuum chambers within them will operate at room temperature. The chambers are constructed as weldments and are made of INCONEL-625. They are bakeable to 150°C in-situ and incorporate nine photon beam ports. Each have built-in distributed sputter-ion pumps (DIP), non-evaporable getter (NEG) pumps, beam position monitors, and ion clearing electrodes. R & D is underway to optimize the DIP, which must operate at 3.86 Tesla, and to develop a low photo yield coating or treatment for the internal surfaces of the chambers. See Figure 1.

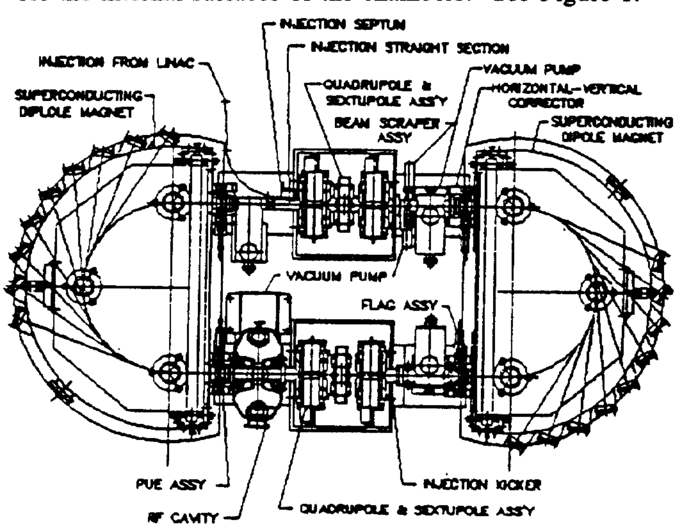

Figure 1 Phase II SXLS Plan View

DIPOLE CHAMBER

The dipole vacuum chamber must operate within a magnetic field of 3.86 Tesla. The decision to operate the chamber at room temperature, rather than at superconducting temperature, was dictated largely by the magnet design whichprecluded a beam absorber outside the cold magnet mass. The choice of INCONEL-625 was based on strength (60-90,000 psi) [2], weldability and magnetic permeability ($\mu = 1.002$) [2,3], resistivity (low eddy current losses) [2], and its proven excellence as a vacuum material (phase I chamber performance).

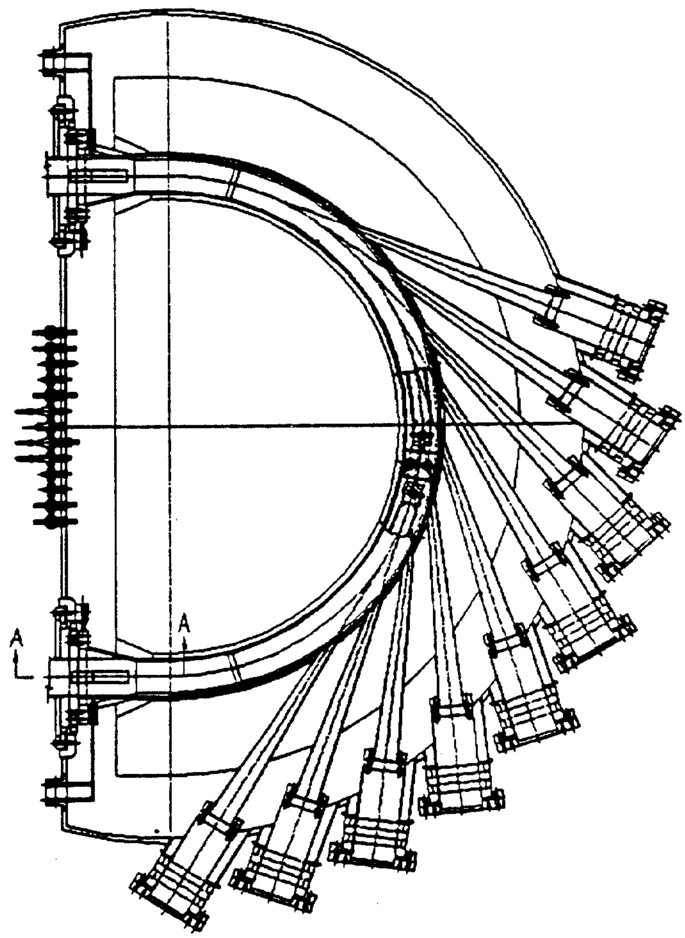

Figure 2 Plan View of Dipole Chamber

Figure 2 is a plan view of the dipole chamber and its surrounding and superconducting magnet. It shows nine photon beam ports, a four-button beam position monitor, and three clearing electrodes. Not obvious from this view is that as a room temperature chamber inside of a superconducting

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magnet there is vacuum on each side of the chamber, ultra-high vacuum inside and insulating vacuum outside. Some ramifications of this are that all pump, bakeout, and diagnostic leads must pass through an additional set of vacuum feedthrus, and that during maintenance and machine set-up there may be times with vacuum only on one side of the chamber causing an imbalance of forces tending to rotate the chamber within the magnet.

The chamber will be baked out in-situ to 150°C using flat etched heaters cemented to the chamber surfaces. All electrical feedthrus and mechanical bellows, which are susceptible to leaks, are replaceable without removing the chamber from the magnet.

Beam Absorber

Figure 3, a typical cross section of the dipole chamber, shows a photon beam port, absorber, and the two vacuum pumps that are built into the chamber. The beam absorber is made of OFHC copper with stainless steel cooling tubes furnace-brazed into one assembly. The copper surfaces are gold plated, 0.2 μm thick, to reduce its photodesorption yield. Measurements indicate that the yield of gold-plated copper is approximately one third that of plain copper. Both surfaces were argon glow discharged conditioned prior to the taking of measurements. Photodesorption measurements will be made on beryllium, titanium nitride and carbon coated surfaces in addition to copper.

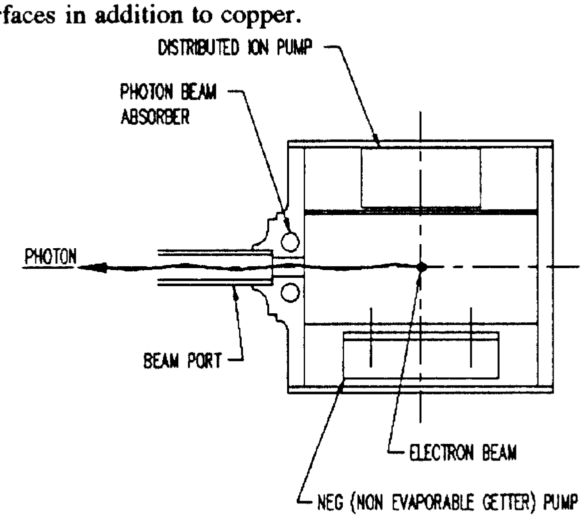

Figure 3 Typical Cross Section of Dipole Chamber

Pumps

Since the superconducting magnet has an air core instead of iron there is space to locate pumps directly above and below the electron beam. Figure 3 shows a DIP above the electron beam chamber and a NEG below. To avoid any possibility of ions or particulate matter from the pumps interacting with the electron beam, all pump-out holes in the pump mounting plates are located on either side of the pumps.

The distributed ion pump must operate at both injection energy and at stored beam conditions, corresponding to 1.1 Tesla and 3.86 Tesla respectively. Figure 4 is a typical pumping speed curve for versus magnetic field for this type of pump [4]. Tests are continuing to optimize a DIP design for this service.

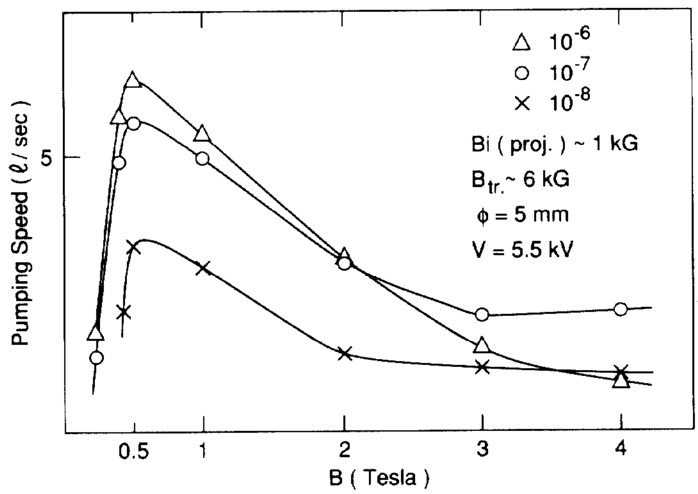

Figure 4 Pumping Speed vs. Magnetic Field for 5*mm* dia. Anode Cell

Extensive tests were made comparing the pumping speed of the standard NEG getter strip to a new size NEG module WP 950-15 [4], with length and width 300 cm and 1.2 cm respectively. After an activation temperature (420°C for thirty minutes), the initial pumping speed of the module for the H_2 and CO are 260 *l*/sec (0.37 *l*/sec cm^2) and 600 *l*/sec (0.85 *l*/sec cm^2) respectively. After pumping 0.38 Torr *l* of H_2, 0.24 Torr *l* of CO, and 0.1 Torr *l* of CO_2 the pumping speeds were 30 *l*/sec (0.04 *l*/sec cm^2) for H_2 and 160 *l*/sec (0.23 *l*/sec cm^2) for CO. See Figure 5.

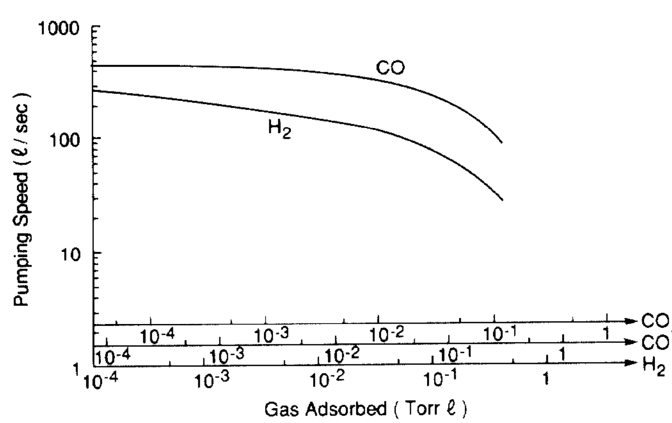

Figure 5 Pumping Speed vs. Gas Absorbed for NEG Module WP950-15

For roughing and bakeout, an oil-free turbomolecular drag pump will be used. This combination pump gave excellent performance for the Phase I machine. A similar pump station is planned for the superconducting magnet insulating vacuum.

DIAGNOSTICS

The Phase I beam position monitor-flag assembly is being replaced with a unit machined from a single piece of stock. Figure 6 is a photograph of a monitor housing that is completely machined with only two machine set-ups. Accuracy of $\pm$ 0.001 inches was achieved on sample units. Also shown is one of the four pick-up button assemblies.

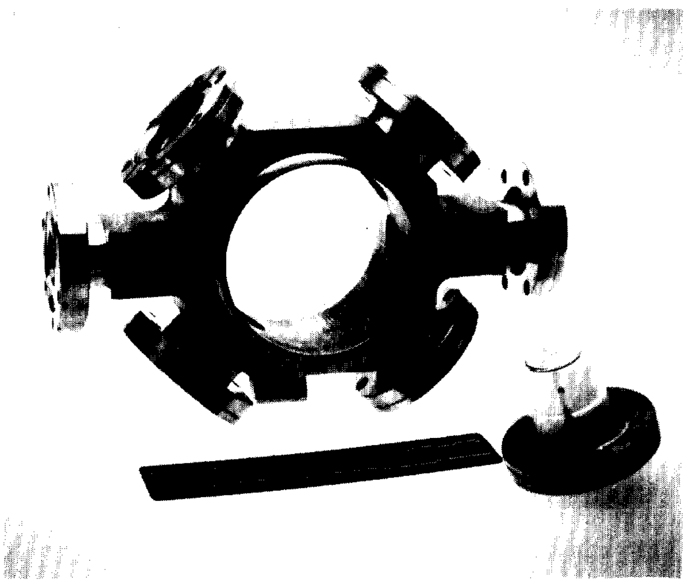

Figure 6 Beam Position Monitor-Flag Assembly

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[3] A. Ghosh BNL-ADD private communication, March, 1991.

[4] T.S. Chou, et.al., to be published in the 38rd AVS Symposium, Nov 1991, Seattle WA.

[5] SAES Getters/U.S.A, Inc., Colorado Springs, CO.