DESIGN OF THE PEP-II LOW ENERGY RING VACUUM SYSTEM

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I. INTRODUCTION

A vacuum system based on the antechamber approach is being designed for the PEP-II, B-factory, Low Energy Ring (LER) arc sections to be installed at the Stanford Linear Accelerator Center. Pressures in the six arc regions are to be less than 10 nanotorr at a nominal positron beam energy of 3.1 GeV and current of 3 amperes. The high energy and large beam current result in high gas loading due to photon induced gas desorption. The antechamber design allows 90% of the photons and over 99% of the synchrotron radiation power to be dumped on special photon stops away from the main beam chamber and close to vacuum pumps. The high photon flux at the stops gives the added benefit of quickly scrubbing these surfaces, further reducing the outgassing. *

Each of the six arc sections of the PEP-II ring contains 16 standard cells. Half of a standard cell is shown in Fig. 1. There are 192 of these half-cells in the LER arcs. Except for some variation in the arrangements of the magnets, the cells are identical. The arc regions represent 1460 meters of the total 2200 meter LER circumference.

The outside dimensions of the magnet chamber extrusion are limited by the magnet apertures. The height is kept to a minimum mainly to reduce the power requirements of the dipole magnets. A groove is provided in each side of the magnet chamber for the addition of tubular heaters if an in situ bakeout is needed. Water channels are also provided for cooling and temperature control.

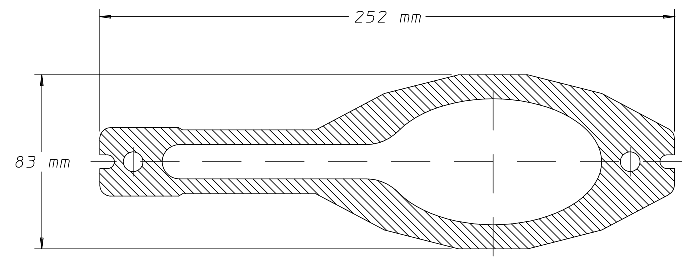

Fig. 2 Magnet chamber

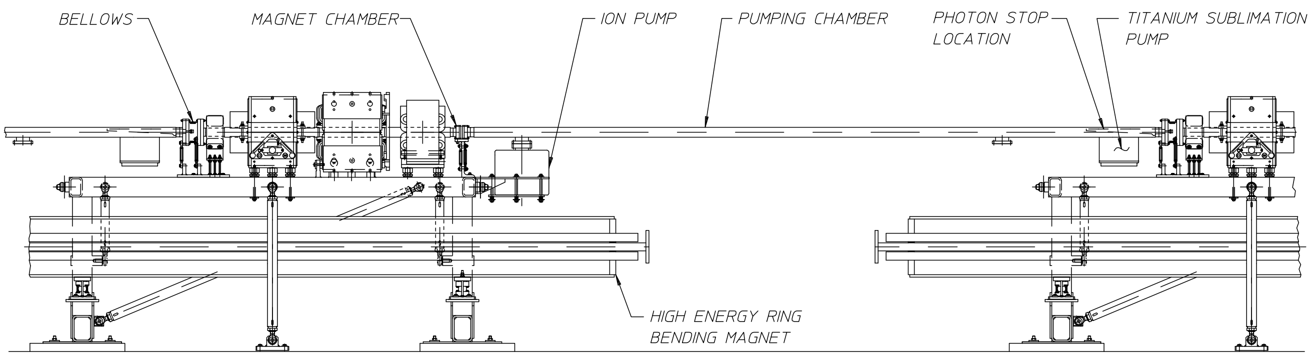

Fig. 1 Low Energy Ring Arc Half Cell

II. PUMPING AND MAGNET CHAMBERS

Each arc vacuum chamber will consist of a magnet chamber, a pumping chamber, and a bellows section. The magnet chamber (Fig. 2), which fits inside the magnets, will be two meters long. Due to limited access, there will be no pumping provided for the magnet chamber except through its ends. The slot height between the beam chamber and antechamber is a compromise between that which is allowed by beam dynamics and achieving maximum photon passage.

The pumping chamber (Fig. 3), which contains the photon stop and pumps, will be about 5.5 meters long. The chambers will be extruded from 6063 aluminum alloy. The size of the chamber is limited by the extrusion industry limit. Finite-element temperature and stress analyses have determined that a photon beam hitting the beam channel wall due to the worst case beam misalignment will not damage the chamber.

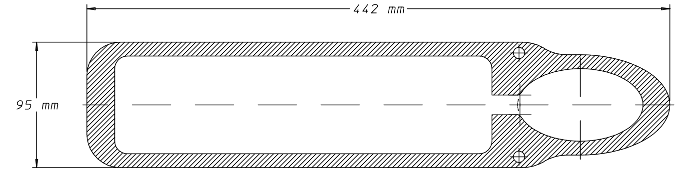

Fig. 3 Pumping chamber

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To minimize costs, both chamber types have been designed using standard industry extrusion tolerances. Finite-element stress and deflection analyses for vacuum loading have verified the designs. Studies are under way currently to determine if an inner surface coating in the beam envelope is necessary to reduce secondary electron emission.

III. PHOTON STOP

At the design value of 3.5 GeV and 3 amperes, each dipole produces 15,000 watts of synchrotron radiation power, a power density of 5,700 watts per square centimeter (full width at half maximum) at a distance of six meters from the dipole. These photons are stopped by a water cooled, dispersion strengthened copper surface (Fig. 4) located at the downstream end of the pumping chamber. Water flows through multiple parallel channels 2 mm wide by 6 mm high, machined into the back side of this hot wall. To reduce the power density to the surface, the face of the photon stop is inclined at a small grazing incidence angle of 50 mrad. Besides the grazing angle, the length of the photon stop is determined by the slot height between the beam chamber and antechamber, and tolerances for the beam location, manufacturing, and alignment. The photon stops are a brazed assembly consisting of the dispersion strengthened copper hot wall, an intermediate copper wall to aid in the brazing, and a stainless steel back wall. Air guard channels open to the atmosphere will isolate the water channel braze joints from the vacuum wall to avoid the possibility of water leaking into the vacuum system.

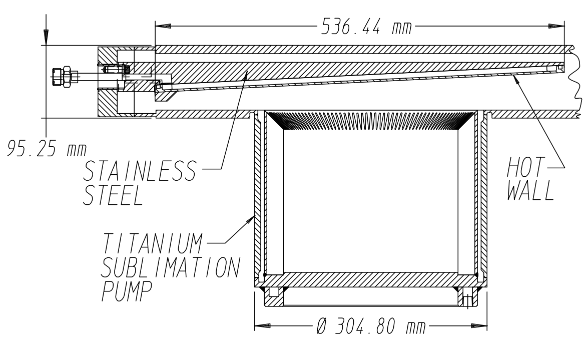

Fig. 4 Photon stop and TSP

IV. TITANIUM SUBLIMATION PUMP

Titanium sublimation pumps (TSPs) (Fig. 4) have been chosen to pump the photon stop region because of their high reliability, high pumping speed, and low cost. The TSP is located right under the photon stop and has a pumping speed of 8,000 liters per second. The active surface of the pump will be extruded from 6063 aluminum alloy. The face of these walls have deep grooves that increase the capture capability and capacity. The grooves increase the pumping surface by a factor of ten. The initial pumpdown of the chamber will be done with ion pumps. Once the major gas load is removed, the TSPs will be activated. After initial pumpdown, it is anticipated that the time between activations will be in excess of three months.

V. SCHEDULE

The contract for the magnet chamber extrusion has been awarded, ion pumps have been ordered, and the pumping chamber extrusion requests for quotations will be out within a month. Fabrication of the Low Energy Ring vacuum system is to be completed by the end of 1997. The PEP-II project is to be completed by the end of 1998.