Abstract

A conceptual design is presented for a storage ring vacuum system at the Advanced Photon Source (APS) which is compatible with a multi-bend achromat (MBA) lattice under development for the APS Upgrade (APS-U) project [1]. Together, the interface with the magnets, required quantity and stability of beam position monitors, synchrotron radiation loading, and beam physics requirements place a demanding set of constraints on the vacuum system design. However, the requirements can be satisfied with a hybrid system which combines conventional extruded aluminum chambers incorporating "antechambers" with a variety of simpler tubular chambers made variously of copper-plated stainless steel, NEG-coated copper, and bare aluminum. This hybrid system has advantages over an all NEG-coated copper system with regard to overall project risk, required installation time, and maintainability.

Sector Layout

A sector assembly of the storage ring vacuum system is shown in Figure 1 with and without magnets. The sector consists of nine sections of four types named according to the functions of the magnets there.

Vacuum Chamber Design

The sector consists of nine sections of four types named according to the functions of the magnets there.

Beam Position Monitors

BPMs will be RF pickup-type and integrated with a pair of shielded bellows which decouple the BPMs from thermal motion on adjacent chambers (Figure 3). The inner design has not yet been optimized.

Absorbers

The insertion device x-ray beam extraction catch absorber is expected to be similar to that developed for ANKA [3] (Figure 4, left). The crotch absorber needed for extraction of the three pole wigglers x-ray beam and the absorbers needed to protect the downstream ends of L-band chambers will be based on existing APS designs (Figure 4, middle and right respectively).

Synchrotron Radiation Ray Trace

A radiation ray trace (Figure 5) illustrates how radiation-based heat loads and photon stimulated absorption informs the vacuum system design. Synchrotron radiation power densities are highest for source points near the ends and center of the arc. FODO vacuum chambers receive more than one third of the total bending magnet radiation power. Radiation incident on multiplet chamber walls is minimal.

Thermal-Mechanical Analysis

Thermal-mechanical finite element analyses (FEAs) guided material selection and optimization of the design. Some results for vacuum chambers in the FODO section where incident power densities are expected to be roughly 10 W/mm² are shown in Figure 6. The analyses confirm that high purity copper, due to its superior thermal conductivity and thus lowest thermal gradients, is an acceptable material.

Vacuum Analysis

VacuCalc, a computer code developed at SLAC [4], has been used to generate one-dimensional pressure profiles for various scenarios. A typical pressure profile expected during operation is shown in Figure 7. Average pressure for operations with beam is expected to be <2 mTorr.

REFERENCES