10.2 Layout and Mechanical

10.2.1 Interface to Magnet

The central and muon magnets that will be used by PHENIX are described in Chapter 4. The muon arm requires a few specialized additions to these two magnets to have an acceptable leakage rate of shower secondaries into the muon tracking chambers and muon identifier. The muon magnet, particularly the piston, has design features included to accomodate the tracking chamber support frames at their inner radius so as to minimize excluded solid angle. The support for the tracking chambers must be part of the lampshade or pass through it to reach the floor of the hall. The muon identifier takes advantage of the presence of the steel endplate flux return of the piston magnet to form the first of its three layers of inert absorber.

The additions to the central magnet are the copper nosecone upstream and the lead curtain downstream. A copper "piston plug" is added to the front of the steel piston of the muon magnet to provide improved shielding of small-angle shower secondaries than afforded by the central magnet yoke alone and to absorb secondaries caused by high energy particles from the vertex striking the face of the steel piston. An enlarged view of this area is shown in Fig. 10.9.

10.2.2 Specialized Absorber Sections

The copper nosecone to be placed on the upstream side of the central magnet pole from the muon magnet is shown in Fig. 10.10. This material must be nonmagnetic to avoid distorting the central magnetic field. Simulation studies have shown that a low Z material would be preferred on the grounds of mass resolution in the muon arm, by minimizing multiple Coulomb scattering, but that reduction of background arising from weak decays of charged pions and kaons is of paramount importance, favoring a material with a short interaction length. Copper was found to be a reasonable compromise. The nosecone starts 32 cm downstream of the nominal interaction vertex to accomodate the silicon strip and pad detectors. It also is a compromise between having an unobstructed view of the interaction diamond for e^+e^- detection and minimizing the vertex-to-nosecone distance for $\mu^+\mu^-$ physics. The nosecone can be mounted upon the central magnet pole after magnet installation but before vacuum pipe installation. A split design will be considered to remove this latter constraint.

The lead curtain mounts on the central magnet pole facing the muon arm. A design for it is shown in Fig. 10.11. This will be cast as a single piece and bolted onto the central magnet pole during magnet assembly. It will be encapsulated with an epoxy varnish for environmental reasons. The lead used will be a 6% antimony lead alloy for strength.

The copper piston plug is shown in Fig. 10.12. The design shown requires removal of some of the material from the outer radius of the copper piston plug on its downstream side in order to locate the inner radius support frames of the station #1 tracking chambers. The piston plug has a central cavity approximately 40-cm deep to accomodate the downstream beam-beam counters. The inner bore radius must accomodate the beam-beam counter, which has an outer radius of 15 cm. The 66 counters inside the plug require cable access

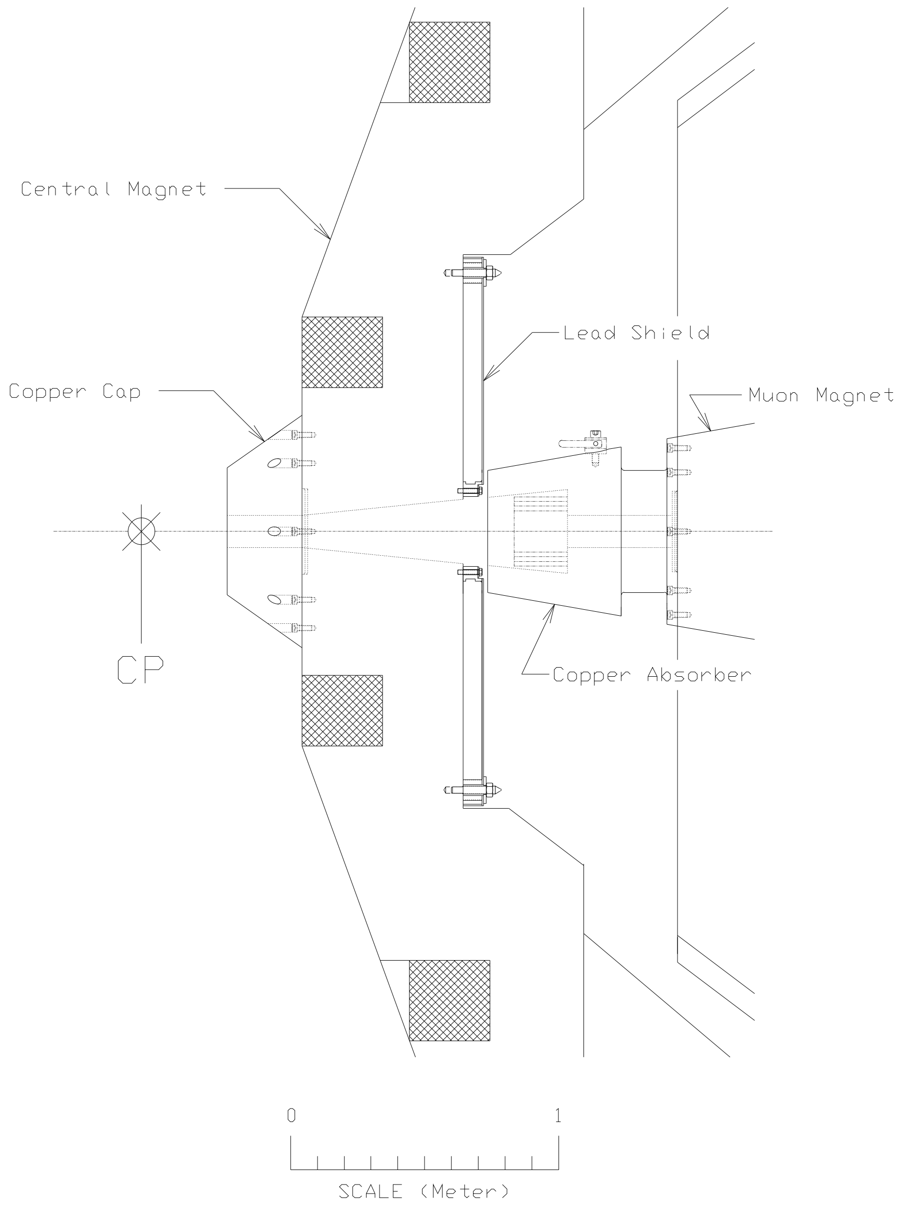

Figure 10.9: View of central magnet with additional absorber sections for the muon. Indicated are the Cu nosecone (or cap), the Cu piston plug (or absorber), and the Pb curtain (or shield).

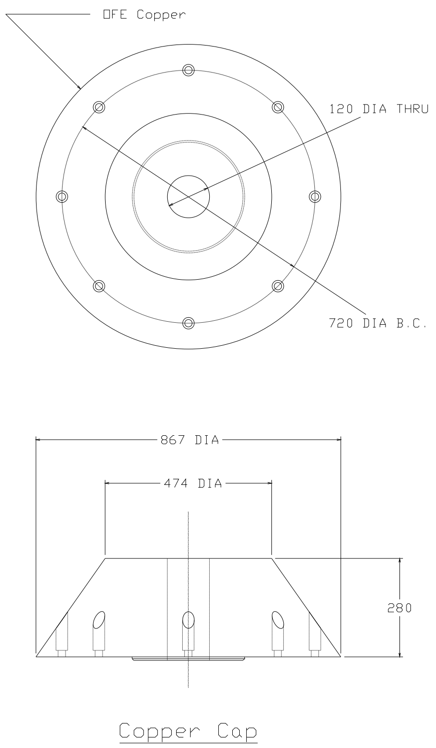

Figure 10.10: Design of the copper nosecone (or cap) to be placed on the central magnet pole face upstream of the muon arm.

which can be provided either by radial holes through the plug, or by building the plug as a two part design (along the beam axis) with slots included to allow cable egress. These slots would be angled back towards the rear of the central magnet pole to prevent secondaries streaming through them from striking the station #1 chambers. The plug must allow initial installation of the beam-beam counters as well as later service. This is accomplished by having a demountable design consisting of two parts.

10.2.3 Muon Arm Tracking Chambers

The PHENIX muon arm includes three stations of multiplane drift chambers to measure momenta and charge of the muons of interest as well as of the charged particles also entering the muon arm. An elevation view of the muon arm tracking spectrometer is shown in Fig. 10.13. Each of the three tracking stations is subdivided into octants in azimuth for reasons of construction and installation. Each octant is composed of stacked-plane drift chambers arranged in an $U - U' - Y - Y' - V - V'$ geometry with a stereo angle of 22.5°, chosen to match the octagonal geometry. A schematic view of the octant composition and wire orientations is shown in Fig. 10.14.

The three stations are labelled station #1, #2 and #3 in order of increasing distance

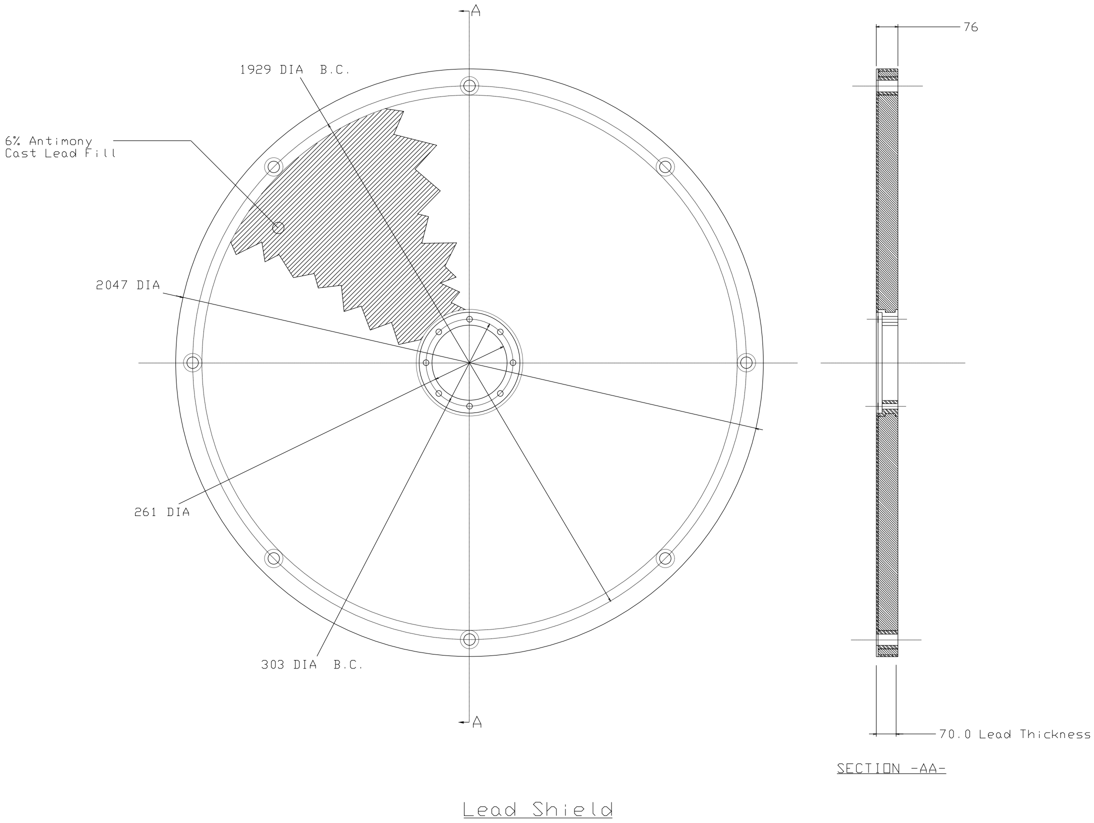

Figure 10.11: Design of the lead curtain (or shield) placed on the central magnet facing the muon arm to absorb soft electromagnetic shower products.

from the nominal vertex. The stations are located 1.85, 4, and 6 m along z, respectively. Station #1 is 15-cm thick, and stations #2 and #3 are each 30-cm thick. The muon magnet piston includes a recess just in front of the piston coil to accomodate the innermost side of the support frame of station #2. The support frame of station #3 sits just above the second part of the piston coil. This is done in order to preserve as much of the polar angle acceptance afforded by the piston as possible. Similar modifications are made to the copper piston plug to accomodate the inner support frame for station #1. An enlarged view of this region is shown in Fig. 10.15.

The chambers must achieve position resolutions for each station of the order of 150 μm, as discussed in Section 10.4.2. The trajectories of interest are known to be confined to a single azimuthal octant, meaning the critical alignment of the muon tracking chambers is that of the different stations relative to one another, by octant. The segmentation into octants may in fact help with achievement of final alignment tolerances in each octant of the muon arm by decreasing the mass and scale of the chamber sections being aligned. The support structure must be integrated with the muon magnet lampshade. A concept for this

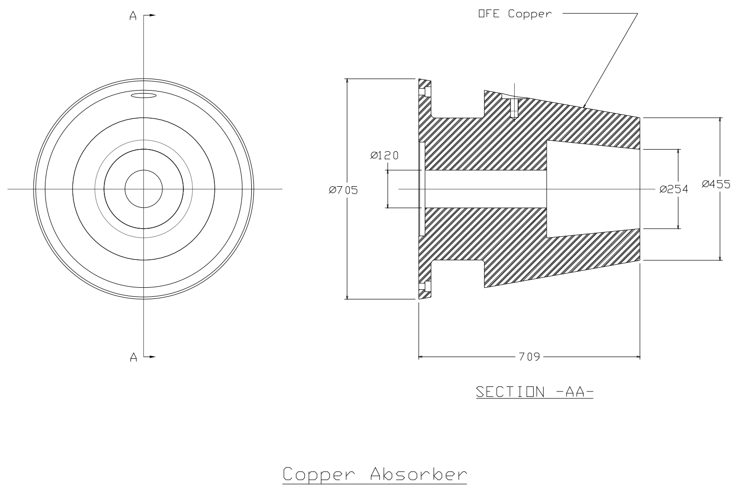

Figure 10.12: Design of the copper piston plug (or absorber)to be mounted on the upstream end of the muon magnet piston. One of the two sets of beam-beam counters mounts inside of this plug.

support system is shown in Fig. 10.16. This version supports the chambers from the floor of the major facility hall, avoiding possible problems with motion of the lampshade during energizing of the muon magnet were the chambers supported from the lampshade. Future engineering analysis will determine the magnitude of any such motion, and the results will be used to decide whether the chamber support should instead tie to the lampshade.

An active surveying system is planned to monitor chamber positions in real time. This is presently conceived to consist of a series of light emitting diodes mounted on station #1, together with corresponding lenses on station #2 focussing the light on a series of quadrant diodes on station #3. The locations of these devices will be chosen to measure motion of individual stations as well as motion of stations relative to one another. A UV-laser illuminating the active volume of the chambers is under discussion to provide reference trajectories.

The chambers are constructed of stacked frames of wires. The frames are made of "pull-truded" fiberglass as developed at BNL for use in large chambers for the Multi-Particle Spectrometer. We plan to prepare the wire frames by first winding wires onto a transfer frame, next positioning this transfer frame accurately relative to the chamber frames, then epoxying the wires to the chamber frames to anchor them mechanically, and finally applying a silver-loaded epoxy to make electrical connections to the wires. A cross-sectional view of a stack is shown in Fig. 10.17. Cathode wire planes alternate with anode + field planes, resulting in seven cathode planes and six anode + field planes per station octant. The cathode planes are planned to be held at constant electrical potential, meaning that no resistive grading of the cathodes is planned. One plane of "screen" wires is placed outside of each of the two outermost cathode planes and held at an electrical potential halfway between that