The half-cylinders are covered along their inner and outer diameters with aluminized mylar foils stretched between the two end plates of each half-cylinder, as shown in the figure. The enclosure provides environmental isolation of the MVD, which is crucial, since both detector wafers and front-end electronics are bare silicon. The air inside the enclosure will be temperature and humidity controlled. The enclosure will allow the MVD to run at a lower temperature than the ambient temperature of the experimental hall, if necessary. The foils will also help electrically shield the silicon from the other elements of PHENIX to address problems of noise pickup.

We have investigated mounting the silicon detector cylinder to the central magnet pole faces. Though the pole faces move due to thermal expansion by an amount comparable to the silicon detector placement tolerance, the silicon must remain in a fixed position with respect to the tracking detectors. Consequently, we support the cylinder rigidly with respect to one magnet pole face and reference the tracking detectors to the same pole face. The support bars are graphite composite struts similar to the internal struts in the half cylinders. On one side the support bars are fixed to the reference pole face, and the strut on the other side has a spring-loaded foot to push against the pole face. The spring-loading also provides vibrational isolation. A vertical support is required for the air channels to and from the cylinder. The air cooling system fan and heat exchanger is located near the top of the lower youke of the central magnet.

5.3.2 Support of Strip Detectors

Figure 5.2 schematically shows three azimuthal sectors of the silicon strip barrel located inside a half-cylinder. Each sector corresponds to one azimuthal sector of the barrel. Each azimuthal sector contains two sets of 12 silicon strip detector wafers, one set for the inner and one for the outer barrel layer.

The barrel detector wafers are supported on Rohacell "cages" which are in turn fixed to the endplates of the support cylinder. Rohacell is a lightweight, rigid foam from Rohm Tech Inc. It has a coefficient of thermal expansion which is small and well-matched to that of silicon. It is sufficiently rigid that the material in the support structure can be minimized by machining the Rohacell into cages with ribs approximately 3 mm in thickness. This aids in our ability to remove heat from the detectors via air cooling, and adds very little mass to the inner detector system. The Rohacell is coated with epoxy to minimize water absorption from the atmosphere. The support cages add a maximum of less than 0.005% of a radiation length in a radial direction.

Figure 5.3 shows the Rohacell cage structure for a single azimuthal sector. The Rohacell cages will be machined in sections as it is difficult to fabricate a cage 64-cm long. These sections are tied together and stiffened by graphite epoxy bars on each side. These bars are very thin layers of material, and one is visible in the figure. The detector wafers are glued to the Rohacell structure. The hybrid circuits, which are connected to the detector wafers by flexible kapton cables, are supported independently by the main support struts in the cylinders, rather than by the Rohacell cages.

The azimuthal sectors are mounted to endplates of the support cylinder via a tab connected to a small half cylinder which extends 5 cm into the cylinder volume from the inner

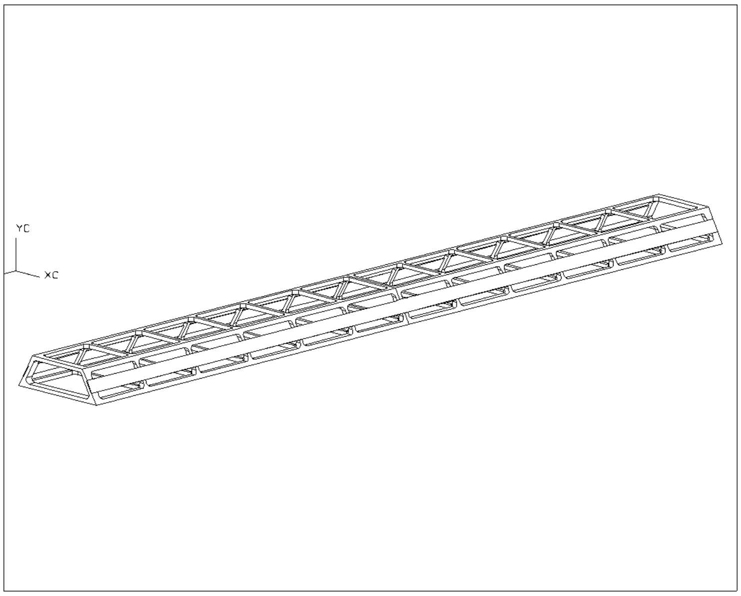

Figure 5.3: Rohacell cage structure for one azimuthal sector of silicon strip detector barrel.

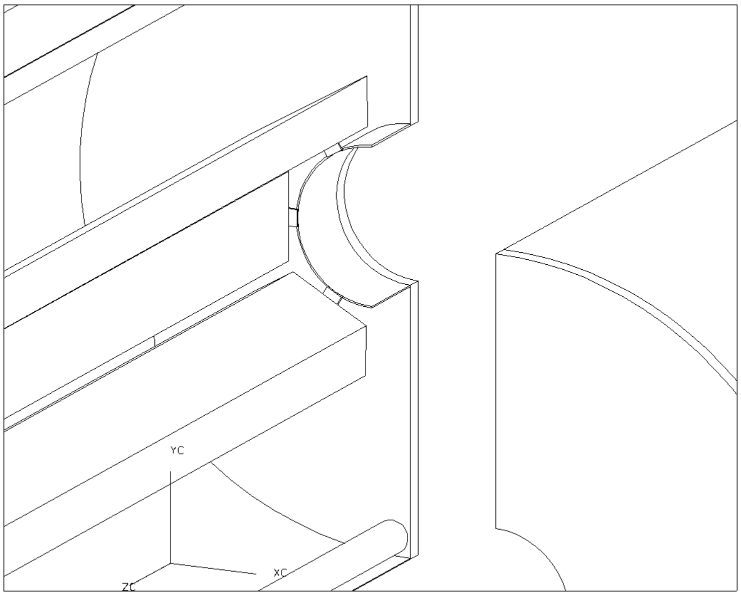

Figure 5.4: Detail of the silicon support half-cylinder. Mounting of azimuthal sectors of barrel is illustrated.

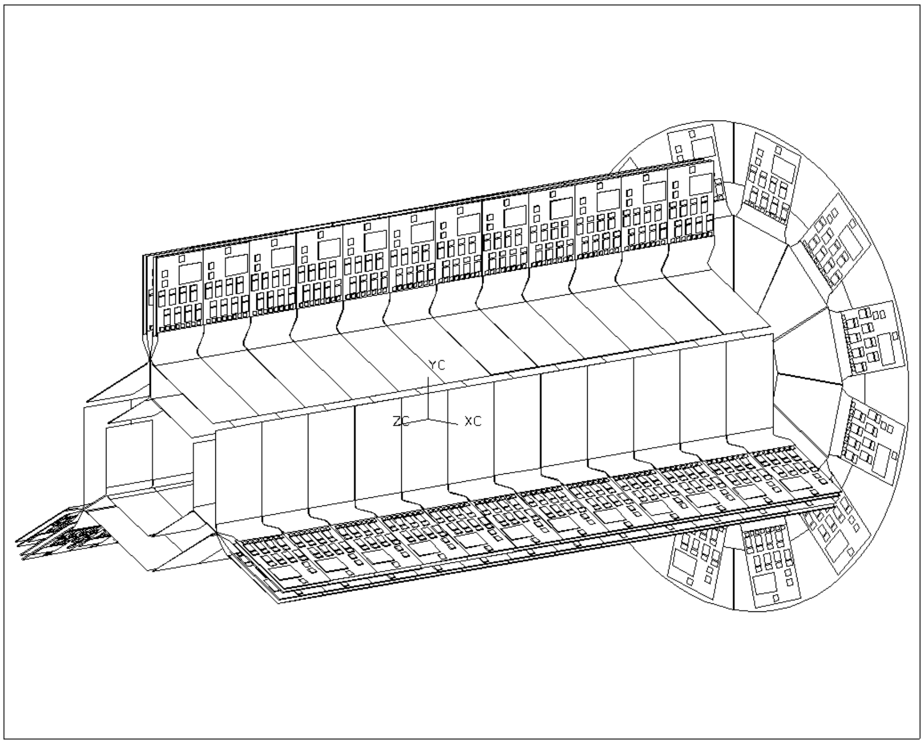

Figure 5.5: Detectors, cables and hybrid circuits in silicon barrel layers and one of the two endcaps.

radius of the end plate. This small half cylinder, shown in Fig. 5.4, is also used to mount the inner aluminized foil which forms part of the MVD enclosure. The connection to this tab is still being designed; it must allow for assembly and disassembly of individual azimuthal sectors to the cylinder.

The assembly scheme for an azimuthal sector is as follows: First the kapton cables are glued and then bonded to the strip detectors. We may use tab bonding techniques rather than wire bonding for this step to enhance reliability. The detector-cable assembly is then tested before being mounted on the Rohacell support. The hybrid circuits (described below) are independently mounted, and finally the cables are connected. We use a connector consisting of a clamp and an elastomer strip which conducts in one direction only. Such elastomers have been successfully used at both LANL and BNL recently. This type of connector facilitates the assembly and servicing of the system. Figure 5.5 shows the entire silicon barrel and one endcap, including the detector wafers, cables and hybrid circuits. The approximately 90° angle between silicon strip detector wafers and hybrid circuits is clearly visible. The cabling is further discussed below.

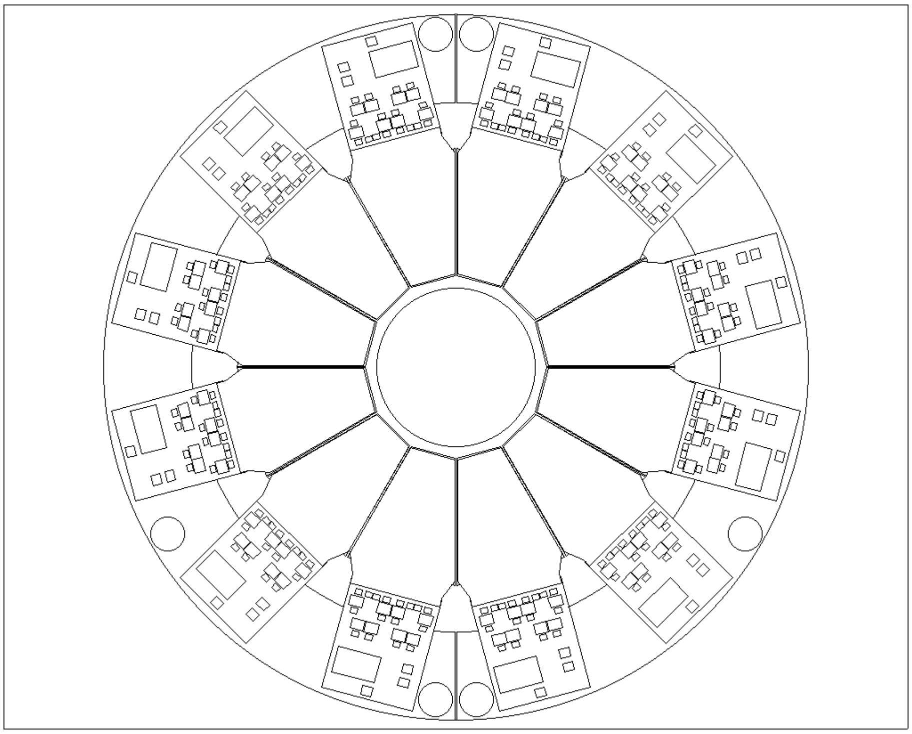

Figure 5.6: Silicon pad detector endcap, including hybrid circuits and motherboard.

5.3.3 Support of Pad Detectors

The silicon pad detector wafers are mounted to a motherboard which supports both the detectors and the hybrid circuits as well as providing DC power and buses to connect the hybrids together. These annular motherboards separate in half along a vertical cut for installation around the beam pipe. The motherboard is fabricated from a rigid material, most likely G-10. It serves to locate the silicon pads with respect to each other and the rest of the silicon detectors. We are studying the option of using a Rohacell structure underneath the actual detector wafers to ensure a good match of coefficients of thermal expansion. The motherboard halves are bolted to the cylinder endplates. One endcap, including silicon detector wafers, hybrid circuits, and motherboard with cut, is shown in Fig. 5.6.

The detector wafers are glued to the motherboard (or Rohacell structures) to maintain positioning accuracy. The location of the hybrid circuits is less critical, since the connection of detector wafer to hybrid circuit is via a flexible kapton cable. The kapton cable is connected to the hybrid using an elastomer-plus-clamp connector, as described for the silicon strips above. The connection between the detector and the cable can be done by soldering to tabs on the kapton cable, and represents a logical extension of current techniques of soldering wires to silicon pad detectors for readout.

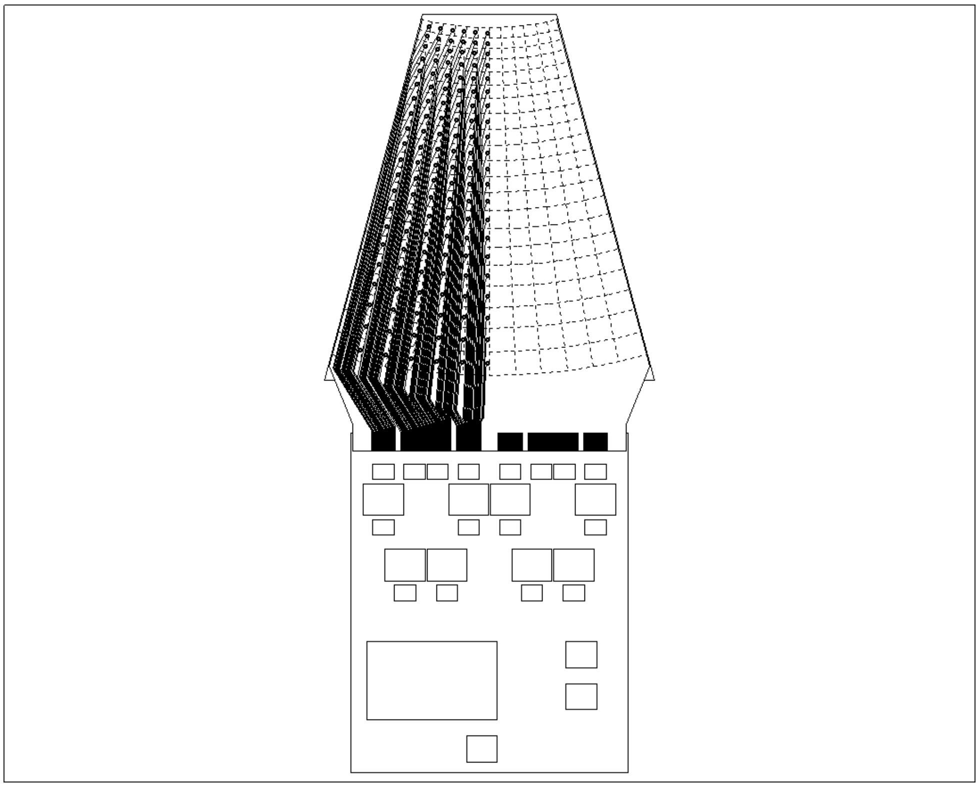

Figure 5.7: Bonding of kapton cable to pad detector and hybrid circuit.

5.3.4 Cabling

Connection of detector wafers to hybrids by kapton cables has been described above. The kapton cables provide physical distance between the silicon wafers and hybrids, which may be crucial for thermal and electrical isolation. The kapton cable is 50-μm thick and is glued to the silicon wafer to form a mechanical connection. Wirebonds or tab bonds extend from the cable to the bonding pads on the silicon strip detector wafers at a 200-μm pitch. This pitch is considerably larger and hence easier to construct on the kapton and bond to than the 50-μm pitch used in the L3 microvertex detector currently being built. [2]

For the silicon pad wafers the cabling is more complicated, because of the geometry of the detector, especially the pad granularity in azimuthal angle. For the chosen pad arrangement, the cable will most likely cover the entire detector surface and have holes to allow a solder connection to each pad. This is currently in the design and prototyping stage. Figure 5.7 illustrates how such an arrangement might look. Note that, unlike for the strip detectors, the cable does make a 90° bend. The hybrid circuit, also shown, is described below.

The length of the kapton cables is approximately 8–9 cm for the silicon pad detector, 5 cm for the inner central barrel layer, and 3 cm for the outer layer. For the strip detectors, the detector end of the kapton cable has a pitch of 200 μm, which tapers to a pitch of 150 μm at the hybrid end. The pad detector cables also have 150-μm pitch at the hybrid end.