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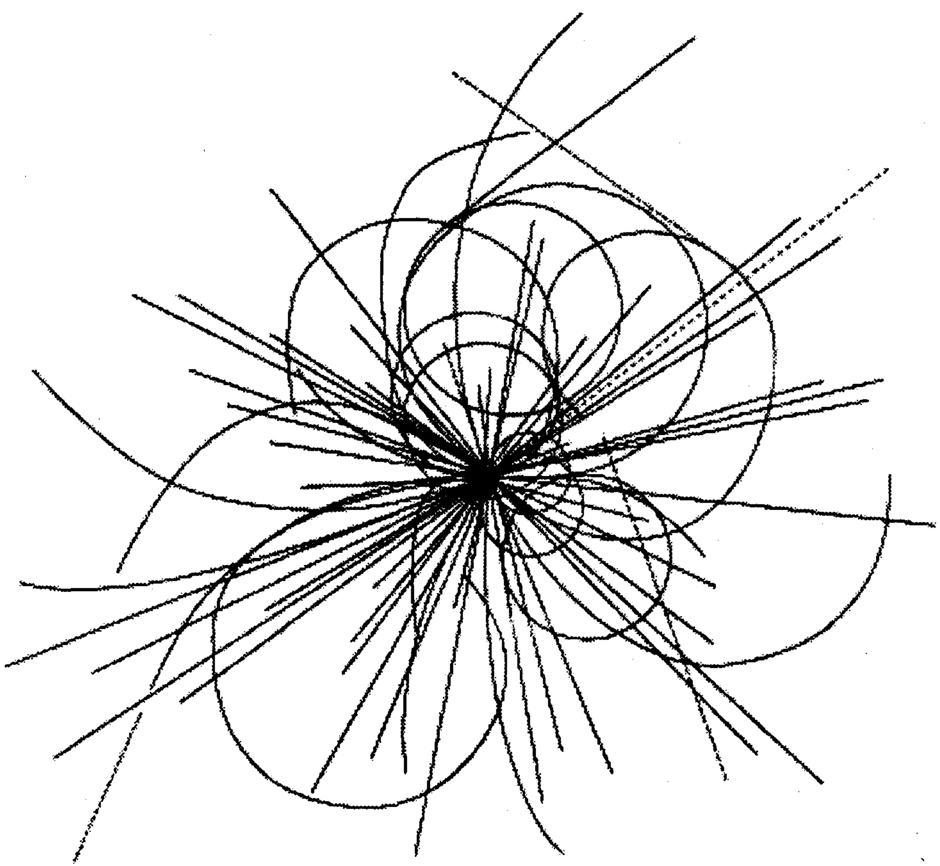

Superconducting Super Collider Laboratory

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CONCEPTUAL DESIGN OF THE CRYOSTAT SYSTEM FOR THE 2:1 VERTICAL BENDING DIPOLE MAGNET OF THE SSC COLLIDER RING

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INTRODUCTION

The beam separation is 90 cm throughout most of the SSC collider ring. As the beams approach the interaction points, the vertical beam separation is reduced from 90 cm down to 45 cm. The beams then travel through several quadrupole magnets and empty cryostats where the beam separation is 45 cm. Finally the separation is reduced from 45 cm down to zero, essentially, as they head for the interaction point. This final reduction takes place in a vertical bending dipole magnet, designated as BV1. The beam separation in this magnet starts out at 45 cm and goes down to 44 cm. A schematic of the beam lines in the interaction region is shown in Figure 1. This magnet is two coillider dipole cold masses that are rotated 90° to achieve vertical beam bending. If there is enough room, the cold masses could be contained in separate cryostat systems. However, if the available room is not large enough, then they will have to be contained in one cryostat system. Also, the normous weight of the two cold masses will impose severe transportation and handling structural loads on the cryostat system. The design must be robust enough to withstand these loads. Another prime design constraint of the cryostat is that it should fit in the unnel space without requiring local tunnel enlargements or encroaching on aisle space. Consequently, a vacuum vessel design that makes optimum use of tunnel space is required.

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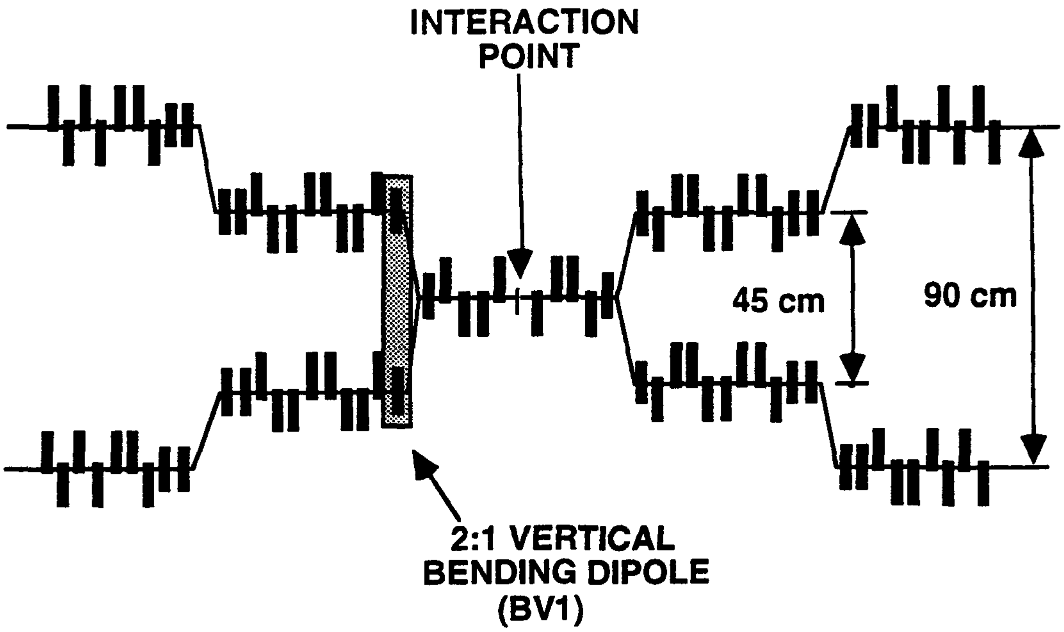

Figure 1. Layout of Magnets in Interaction Region.

This paper presents the various conceptual designs that were investigated to determine a feasible cryostat system for BV1. The three concepts investigated for this work were:

1. Two separate collider dipole magnets with a rotated upper magnet
2. Ellipto-cylindrical vacuum vessel
3. Cylindrical vacuum vessel

Each of these concepts is discussed in the following sections. It should be pointed out that detailed engineering analyses to study the thermal and structural performance characteristics of the various concepts have not been carried out. These analysis will be done when the design requirements are available. A cylindrical vacuum vessel design was the recommended design for the 2:1 cryostat system.

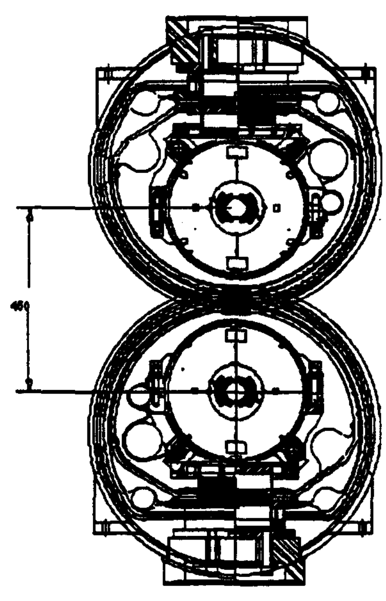

Figure 2. Separate Cryostat for Each Cold Mass and Rotated Upper Magnet.

ROTATED UPPER MAGNET

The first concept considered was installing one collider dipole magnet (CDM) directly above another while maintaining the 44–45-cm beam separation. This option is shown in Figure 2. The outside diameter of the CDM vacuum vessel is 686 mm. The clearance between the cold mass shells is 11 cm. This concept was not feasible because the vacuum vessels would interfere with each other. Also, it is desirable to couple the cold masses through the suspension system to facilitate alignment. This concept clearly does not provide this feature.

ELLIPTO-CYLINDRICAL VACUUM VESSEL

The ellipto-cylindrical vacuum vessel concept is a true 2 in 1 cryostat. A schematic of this concept is shown in Figure 3. The vacuum vessel is made up of cylindrical and elliptical sections that are welded together longitudinally. Here the two cold masses are coupled through a super cradle. The cradle consists three sections that bolt together to secure the cold masses. The lower section bolts onto the top of the support post and supports the lower cold mass. The middle section bolts onto the lower section, secures the lower cold mass and acts as a saddle to support the upper cold mass. Finally, the upper section bolts onto the middle saddle section and secures the upper cold mass. The vacuum vessel is very susceptible to buckling when it is evacuated. Also, the design poses fabrication and reliability issues that would drive up the cost of the magnet.

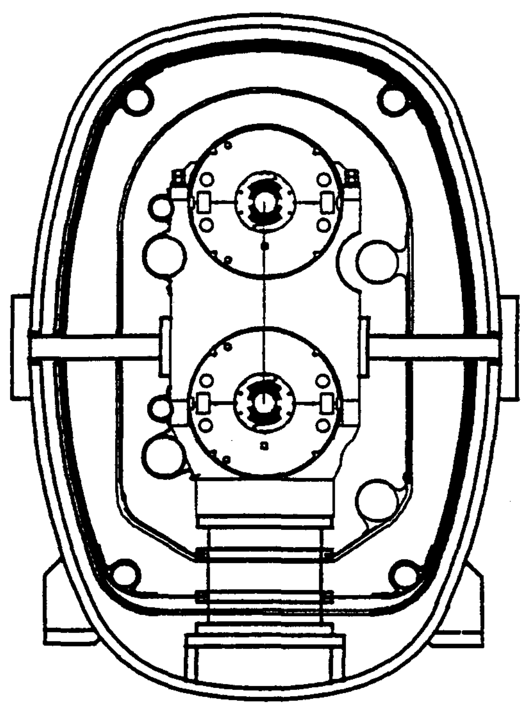

Figure 3. Ellipto-Cylindrical Cryostat - Two Cold Masses in One Cryostat.

CYLINDRICAL VACUUM VESSEL

The cylindrical vacuum vessel concept is similar to the cylindro-elliptical design. A drawing showing the concept is presented in Figure 4. The major difference between the wo is the shape of the vacuum vessel. It is a cylinder. with an outer diameter of 1364 mm. The wall thickness is 25 mm. The problems of buckling stability, fabrication and reliability associated with the cylindro-elliptical design are minimal. The cradle design is similar in the two concepts. Also, lateral struts are incorporated in the design to address the bending load effect of the cold mass assembly on the support posts. These struts would be attached to the cradles on one end and the vacuum vessel wall on the other end. The one big disadvantage this design has over the cylindro-elliptical design is that it takes up more aisle space in the tunnel.

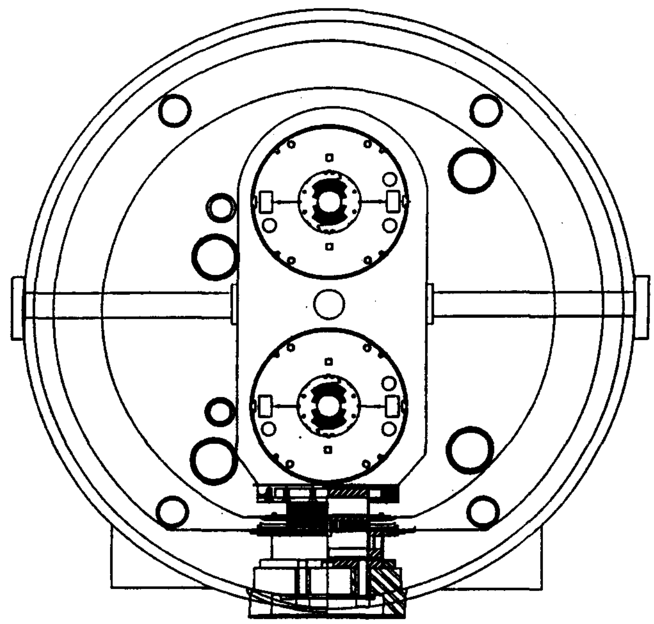

Figure 4. Cylindrical Cryostat - Two Cold Masses in One Cryostat.

SUMMARY

Three concepts were investigated for the 2-in-1 cryostat design of the vertical bending dipole magnets. One of the concepts involved the installation of one complete magnet vertically above another. This concept was not deemed feasible because there was not enough clearance to prevent the vacuum vessels from interfering with each other. The other two concepts both involved the use of a single vacuum vessel to contain both cold masses. These concepts were referred to as the 2-in-1 designs. One of these 2-in-1 designs used a vacuum vessel made up of cylindrical and elliptical sections that were welded together longitudinally. The complexity of the shape and the amount of welding required to fabricate this vacuum vessel would introduce fabrication and reliability issues that will drive up the cost of the system. Also, the shape of the vacuum vessel makes it very susceptible to buckling. The other 2-in-1 concept used a cylindrical vacuum vessel. This design minimizes the problems of buckling, fabrication and reliability. It is the preferred design concept; however, detailed engineering analyses will have to be carried out to validate the concept.

REFERENCES

1. Superconducting Super Collider Laboratory, "Site-Specific Conceptual Design," SSCL-SR-1056, July 1990.