Conf-9010212--30

ANL-HEP-CP-90-92
For the Proceedings of the Symposium on Detector Research and Development for the Superconducting Super Collider, Ft. Worth, TX 15-18 October 1990

SCINTILLATING PLATE CALORIMETER MECHANICAL DESIGN*

Worthington Hotel
Forth Worth, Texas
October 15-18, 1990

ANL-HEP-CP--90-92

DE91 006530

A. Buehring, N. Hill, T. Kirk, J. Nasiatka, E. Petereit,
L. Price, J. Proudfoot, H. Spinka, and D. Underwood
High Energy Physics Division, Argonne National Laboratory
9700 South Cass Avenue, Argonne, Illinois 60439

M. Burke, D. Hackworth, T. Hordubay, D. Marshik,
D. Scherbarth, and R. Swensrud
Science And Technology Center, Westinghouse Electric Corporation
Pittsburgh, Pennsylvania 15235

Presented by H. Spinka

Abstract

Progress on designs for compensating scintillator plate calorimeters will be presented. One design includes a lead composite absorber, fiber readout, and radiation hardened scintillator plates, and the second design has depleted uranium absorbers, wave length shifter plate readout, and scintillator plates. The lead absorber is cast with slots to accept the scintillator in the first design, while the depleted uranium is in the form of plates in the second design.

Two mechanical designs for compensating scintillator plate calorimeters for the SSC have been developed based on different absorber materials and readout methods. The first uses lead cast into steel-reinforced modules with slots for the scintillator tiles. Wave length shifter fiber is embedded in the tiles, and clear fiber brings the collected light to photodetectors outside the calorimeter. The second design has depleted uranium (DU) plates alternating with scintillator tiles. Wavelength shifter (WLS) plate is used to transmit the light to the photodetectors.

For both designs, the calorimeter is separated into one electromagnetic (EMC, 25 X_0) and two hadronic (HACI, HACII) sections. The HAC sections are approximately projective, whereas the EMC section is rotated 8° from purely radial. The total absorber thickness is a minimum of 9λ in the barrel calorimeter and 11 λ in the endcap calorimeter. The scintillator plates are approximately 11 × 11 cm^2 at the inside diameter of the barrel (450 cm), and correspond to $\Delta\eta = 0.05$ and $\Delta\phi = 0.05$. A solenoidal magnet is assumed to be present inside the calorimeter. Magnetic flux return and phototube shielding in the barrel calorimeter are accomplished in part by a 30 cm thick iron cylinder located outside HACII. Additional iron will probably be necessary for the full flux return.

The scintillator plate thickness was assumed to be 2.5 mm in both designs. The lead thickness was 5.0 mm in the EMC and 10.0 mm in the HAC sections, corresponding to approximately compensating ($e/h = 1.00 \pm 0.05$) values. Similarly, the DU plate thickness was taken to be 3.3 mm for compensation.

Pure lead or lead alloys will not work as the absorber for the HAC section of the barrel calorimeter. Analytical and finite element analysis (FEA) calculations indicate that stresses would be beyond yield strengths for some locations with either lead plates or cast lead modules. Lead composites, reinforced with steel or some other material, will be required. It is not yet clear whether composites will be necessary in the EMC section.

Casting lead in a steel frame with steel reinforcing and slots for the scintillator tiles (see Fig. 1) appears most economical for the HAC section of the barrel calorimeter. The slots can be cast around teflon forms. Such a casting technique has already been demonstrated for 6 mm diameter teflon rods, which were easily removable after cooling. It has not yet been established that the slot thicknesses or the slot spacing can be made sufficiently uniform so they do not limit the calorimeter energy resolution.

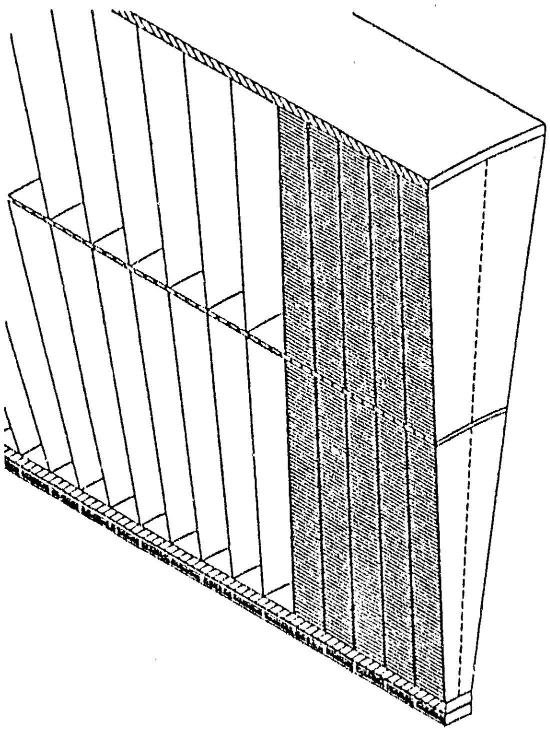

Figure 1 Conceptual design of a cast lead module. Steel plates at the inner, intermediate, and outer diameter of the HAC sections are shown as well as thin steel reinforcing between towers. The lead is cast with slots in the steel framework. A similar module design has been developed for DU absorber plates.

A calorimeter design with DU absorber and WLS plate readout, similar to ZEUS, seems to work acceptably based on analytical and FEA calculations. However, the DU processing costs and the poor fiducial volume resulting from the WLS plates are primary problems of this design compared to the design with fiber readout and lead absorber.

A variety of schemes to take advantage of the small diameter and good flexibility of the fibers exist. The lead absorber design shows reduced cracks between modules with the use of fiber readout. The photodetector location can be more accessible with fibers than with WLS plate readout. A scheme for reading multiple scintillator tiles in series has also been developed. A method of routing the fibers projectively to the outside of the calorimeter has been studied. However, it has not yet been established whether the routing method will permit a sufficiently uniform response in the scintillator tiles.

Having the EMC barrel calorimeter modules separate from the HAC modules will probably reduce the size of the cracks in the EMC section, and also minimize material inside the first EMC scintillator layer. The EMC modules would not necessarily be removable. Fiber readout to the module ends would be employed.

The HAC section of the barrel calorimeter modules are similar for the two conceptual designs studied. Both designs have evolved toward a module that is two towers wide in ϕ and many towers long in η. Both contain intermediate and inner steel reinforcing plates, and both utilize the outer 30 cm steel for structural strength as well as magnetic flux return and magnetic shielding for the photodetectors.

The barrel calorimeter will need to be in two or more sections longitudinally for the modules to be easily transportable. For three longitudinal sections, a scheme exists to reduce the effects of cracks and structural material at the ends of the modules. This involves HAC towers that are quasiprojective in η.

Two different methods for supporting the barrel calorimeter have been considered. Pure radial supports to external muon iron take up too much space and will be difficult to access and adjust. An alternate method, cradle or saddle supports from the bottom, will restrict the muon coverage in some regions asymmetrically, but appears to be the preferred solution.

Work has begun on a conceptual design for the endcap calorimeters. The endcap towers are assumed to be projective. Difficulties with the design at the barrel/endcap interface are being studied, as well as the optimum method to route cables from the central tracking detectors and the solenoid cryogenic system and current leads. Additional work is needed to develop a satisfactory endcap design.

Estimates of the materials for the cast lead design include a total lead weight of 5100 tons, a total iron weight of 1800 tons, a scintillator area of 4.7×10^8 cm^3, a WLS fiber length of ≈ 700 km and a clear fiber length of ≈ 8400 km. For the DU absorber design, the total DU weight is 5200 tons, the total iron weight is 1800 tons, the scintillator area is 7.6×10^8 cm^3, and the WLS plate area is $\approx 100 \times 10^6$cm^2. The sizes of the two calorimeters are very nearly the same. However, using an approximate cost of $6 per pound for processing the DU, and of $1.75 per pound for the lead material and processing, the cost difference for the absorber in the two designs is about $45M. The scintillator area is also much larger in the DU design. Work is continuing on the lead design, partly because of the much higher DU design costs.

These mechanical design studies are supported in part from the Compensating Scintillator Plate SSC Subsystem funds. Additional members of the collaboration include physicists and engineers from Ames Laboratory at Iowa State University, BICRON Corporation, Florida State University, Louisiana State University, University of Mississippi, Oak Ridge National Laboratory, University of Tennessee, Virginia Polytechnic University, and the University of Wisconsin. We are indebted to many of these collaborators and to other members of the SDC collaboration for helpful suggestions.

---

* Work supported in part by the U.S. Department of Energy, Division of High Energy Physics, Contract W-31-109-ENG-38.

END

DATE FILMED

02 / 01 / 91