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R&D PROPOSAL

LIQUID ARGON CALORIMETRY WITH LHC–PERFORMANCE SPECIFICATIONS

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Summary

Good electomagnetic and hadronic calorimetry will play a central role in an LHC detector. Among the techniques used so far, or under development, the liquid argon sampling calorimetry offers high radiation resistance, good energy resolution (electromagnetic and hadronic), excellent calibration stability and response uniformity. Its rate capabilities, however, do not yet match the requirements for LHC.

The aim of this proposal is to improve the technique in such a way that high granularity, good hermiticity and adequate rate capabilities are obtained, without compromising the above mentioned properties. To reach this goal, we propose to use a novel structure, the 'accordion', coupled to fast preamplifiers working at liquid argon temperature. Converter and readout electrodes are no longer planar and perpendicular to particles, as usual, but instead they are wiggled around a plane containing particles (see Fig 1). Cutting the readout electrodes in longitudinal strips "automatically" brings signals equivalent to a tower readout to the front or back face of the calorimeter. With a charge preamplifier directly connected there, the most favourable situation is reached for low inductance and low capacitance, resulting in low noise, high speed and reduced cross–talk.

1) Spokesperson, 2) Contactperson

A first prototype was built to test these ideas. It uses lead converter plates cladded with stainless steel, multilayer kapton boards for the readout electrodes, and two different sets of cold preamplifiers, one based on Si–technology, and the other one on GaAs. The "tower" size is 2.5 by 2.8 cm. A simulation with GEANT of electron showers in this device predicts a resolution of $8.3\%/\sqrt{E}$ with a constant term smaller than 1%. Data taken with this prototype at the SPS, during a short first test, are presently being analysed.

The electonic noise has been measured to be about 4 MeV per channel with a shaped response peaking at 120 ns. The purpose of the next beam test (1991) is to operate this same prototype with fast electronics giving a peak response at 30 ns. This requires the development of new shapers. Work will also continue to improve the preamplifiers, in both the Si and the GaAs approaches.

Meanwhile, a mechanical study of a complete electromagnetic calorimeter using the accordion structure will be undertaken. Working dimensions are a cylinder of 1.3 m internal radius and 10 m length with segmentation of typically 0.02 to 0.03 in both azimuth and rapidity. This study will be followed by the construction of a module which could be considered a 'preprototype' of a sector (typically 80cm by 80cm) of this calorimeter.

For the hadronic calorimeter, proposed studies are centered on two aspects: the first one concerns compensation with the aim of avoiding the use of uranium while maintaining acceptable e/h ratio and a small constant term in jet energy resolution (for example using different cladding materials to reduce the response of electrons relative to pions). The second one is devoted to mechanics. The first scheme to be studied incorporates the accordion structure coupled to an 'electrostatic transformer' readout (Fig. 2).

After completion of these studies, the aim is to build a module of full thickness (9 interaction lengths) covering the same solid angle as the electromagnetic sector. We plan to have both prototypes ready for the fixed target period of 1992.

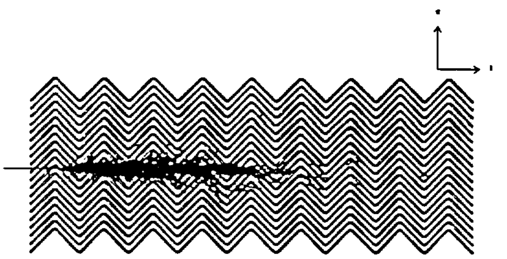

Fig. 1: Display of a 40 GeV electron shower in the accordion structure. Only charged tracks above 10 MeV are shown.

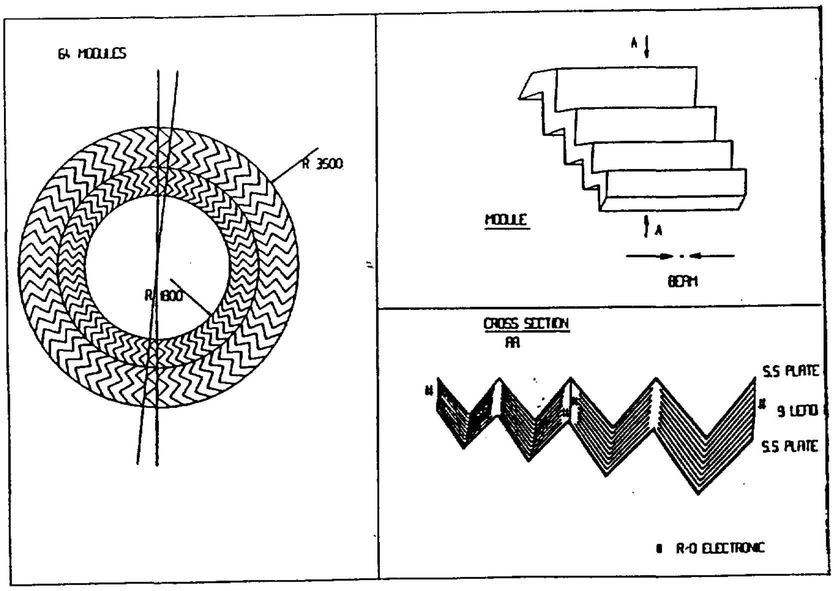

Fig. 2: A possible layout for the barrel hadronic calorimeter, using the accordion and electrostatic transformer concepts.