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LCCAL A R&D PROJECT FOR THE BARREL ELECTROMAGNETIC CALORIMETER [a].

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The status of an R&D project for the realization of a new Electromagnetic Calorimeter prototype is presented. The prototype is an absorber-scintillator sandwich with lateral W.L.S. fiber read-out with the addition of three Si-pad planes. Results from a preliminary test-beam run with a reduced part of the calorimeter are shown.

1 Introduction

An excellent jet energy reconstruction is one of the most important requirements for a Linear Collider Detector[1]. The capability to separate the contribution due to charged particles measured by the tracking system from the one coming from neutral particles detected in the calorimeters is the best solution for jet measurements. It is then necessary to distinguish showers produced by photons and electrons from the ones generated by hadron interactions and to design the calorimeters with the highest granularity compatible with costs and a reasonable number of channels. The proposed technique is meant to fulfill those requirements. It consists of a sampling calorimeter made by absorber and scintillator layers with wavelength shifting fibers and of 3 planes of Si pads to obtain very precise information on the transversal shower profile at different positions in the shower development.

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[a] Presented by: P. CHECCHIA at LCWS02 (Jeju Korea)

2 The prototype

The proposed prototype has 45 layers of lead (Tungsten) absorber $25 \times 25 \times 0.3$ cm^3 ($25 \times 25 \times 0.2$ cm^3) coupled to 45 layers of scintillator subdivided in cells of $5 \times 5 \times 0.3$ cm^3 with a green WLS fiber inserted following the "sigma tail" scheme (fig. 1). The WLS fibers are connected to clean fibers with long attenuation length in order to transport the light signal at large distance. The fibers corresponding to the scintillator cells placed at the same lateral position are grouped into 3-4 bundles each connected to a photo-multiplier, making a 3-4-fold longitudinal segmentation.

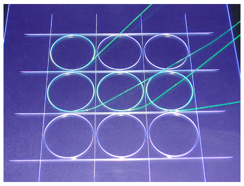

Figure 1: Scintillator plate with WLS fibers.

Three planes of 252 silicon diode pads (0.9×0.9 cm^2) are inserted at the depth of 2, 6 and 12 X_0 from the calorimeter front face, respectively. Each plane consists of 3×2 detectors of 6×7 pads which are connected through a conductive glue to a pcb where the front-end chip VA hdr9c from IDEas is mounted.

3 Production status

The production status for the different detector items is the following:

The scintillator tiles (scsn-61 from Kuraray and BC-408 from Bicron) were machined, with a vacuum plate as an holder, in order to produce circular grooves for the fiber insertion and linear grooves for cell light separation (fig. 1). The linear grooves are filled by Tyvec paper. More than 50 tiles have been completed.

All the WLS fibers (40 cm in length) were polished and aluminized on one face by sputtering. A light yield deterioration was observed after bending the fibers for the insertion into the 2.25 cm radius groove, but it was also noticed that the problem could be avoided by using a middle temperature oven (about 60°) to curl the fibers. More than 1100 fibers have been bended and glued to clear fibers with optical epoxidic glue and a small supporting tube.

The Silicon pad production was much slower than foreseen. One detector was mounted and fully tested. A set of 20 reasonably performing detectors was delivered and the first 6 detector plane is going to be mounted.

The first segment of the calorimeter (4 layers, 2 X_0) has been completed, the remaining layers are going to be equipped with fibers and assembled.

4 Test beam results

The first Calorimeter segment and the Si pad detector were exposed to the CERN SPS H4 beam. The experimental set up consisted of a telescope of two Si μ-strip (300 μm pitch) planes, followed by two scintillator fingers for the trigger, the 2 X_0 calorimeter sector and the Si pad detector. Electrons of 40 and 50 GeV and pions of 50 and 150 GeV were used.

The calorimeter sector was clearly too thin to contain showers and to give information about energy resolution. Nevertheless, the high energy pion beam gave useful information on the light yield and on the uniformity in light collection. This can be seen on fig. 2 where the width of peak for non-interacting particles (mip) proves that the number of photoelectrons per layer is at least 5.1. In fig. 2 (right) the peak value as a function of the beam impact position is shown.

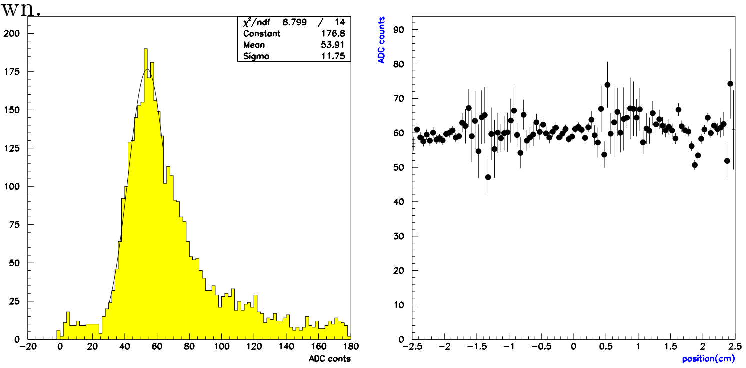

Figure 2: left: calorimeter signal from non interacting pions; right: signal as a function of the impact position.

Simulation studies show that a disuniformity smaller than 20 % is sufficient for an acceptable calorimeter performance. The first segment capability to distinguish hadrons from electrons is clearly visible in fig. 3.

Mip's are visible on the Si pads as it can be seen in fig. 4. The response to 50 GeV electrons is also shown in fig. 4. The shower position is determined though the center of gravity of the energy released on the pads. A position resolution of $\Delta x = 1.9$ mm is obtained comparing the reconstructed position with the particle impact point as given by the μ-strip telescope.

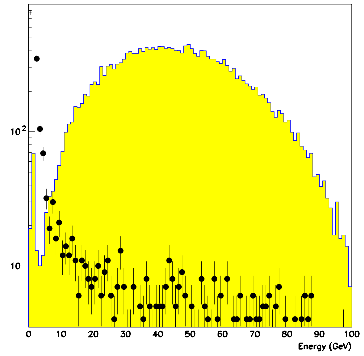

Figure 3: Energy release on the first calorimeter layers. Histogram: 50 GeV e^-; dots: 150 GeV π

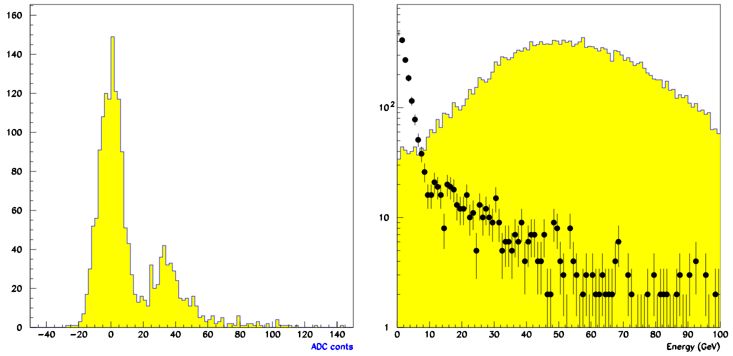

Figure 4: left: signal on the central Si pad; the non-interacting pion signal is well above pedestal; right: energy release on the Si pads: histogram: 50 GeV e^-; dots: 150 GeV π

5 Conclusions and future plans

The first results obtained with the proposed technique are encouraging. In the near future the detector construction should be completed and a first low energy test should be held in Frascati. Next year a high energy beam test at CERN and/or DESY should give the ultimate answer concerning the detector performance.

References

1. TESLA Technical Design Report DESY 2001-011 ECFA 2001-209, Part IV.