PRC R&D 00/02

Construction and test of an ElectroMagnetic Calorimeter prototype

S.Bertolucci, P. Ciambrone, M.Cordelli, S.Miscetti
I.N.F.N Laboratori Nazionali Di Frascati,
Frascati , Italy

P.Checchia, M.Margoni, F. Simonetto
I.N.F.N sezione di Padova and Dipartimento di Fisica G.Galilei,
Padova, Italy

A new Electromagnetic Calorimeter prototype to be used at a future Linear Collider is proposed. The prototype is an absorber-scintillator sandwich with lateral W.L.S. fiber read-out with the addition of three Si-pad planes. The Si planes are inserted in order to optimize the measurement of the shower development and the shower-to-shower separation.

1 Introduction

The recent studies [1] for the Physics at a future Linear Collider pointed-out that an excellent jet energy reconstruction is one of the most important requirements for a Linear Collider Detector. The best solution for the jet measurement is given by the capability to separate the contribution due to charged particle (which are well measured in the tracking system) from the one coming from neutral particles detected in the calorimeters. In particular showers produced by photons and electrons in the electromagnetic calorimeter must be distinguished w.r.t. the ones generated by charged hadron interactions. It is then necessary to design an ElectroMagnetic Calorimeter with the higest possible granularity (compatible with costs and a reasonable number of channels) both in the lateral and in the longitudinal direction.

Recently [2], it has been shown that such a detector can be built using the *Shashlik* technique with longitudinal segmentation. The present proposal concerns a different technique which improves the granularity with a geometry simplifying the mechanics and minimizing the dead regions between the electromagnetic and the hadronic calorimeter of a LC Detector. A brief discussion concerning the layout of a barrel calorimeter of a Linear Collider detector can be found in the last section.

2 Prototype

A sampling calorimeter (realized already in CDF [3]) can be made by absorber and scintillator layers with wavelength shiting fibers inserted in a way which maximizes the light collection.

Here it is proposed to realize a prototype consisting of 50 layers of lead (Tungsten) absorber $25 \times 25 \times 0.3$ cm^3 ($25 \times 25 \times 0.2$ cm^3) coupled to 50 layers of scintillator subdiveded in cells of $5 \times 5 \times 0.3$ cm^3 (fig. 1) with a green WLS fiber inserted following the "sigma tail" scheme (fig.

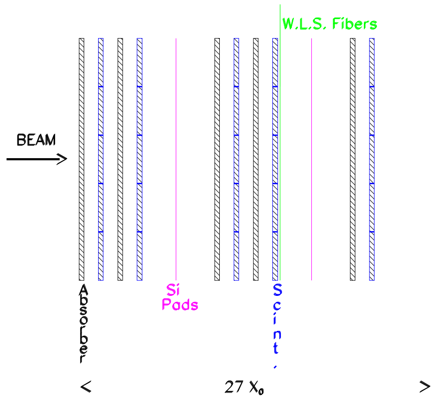

Figure 1: Layout of the calorimeter prototype.

2). The total depth is about 27 X_0. The WLS fibers can be connected to clean fibers with long attenuation length in order to transport the light signal at large distance.

It is also proposed to insert 3 planes of 625 silicon diode pads (1×1 cm^2) at the depth of 2, 6 and 12 X_0 from the calorimeter front face, respectively. These planes allow to obtain very precise information on the tranversal shower profile at different positions in the shower development increasing both the spatial resolution of the detector and its capability to disentangle nearby

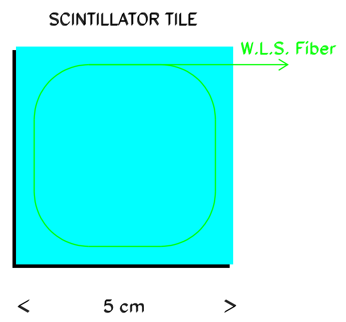

Figure 2: Layout of the scintillator tile with the WLS fiber.

showers produced by different particles. The low moliere radius Tungsten absorber is foreseen to further improve the two shower separation and the compactness of the detector. Longitudinal segmentation, mandatory for optimal rejection of hadronic showers, will be achieved by reading-out in a independent way the signal coming from different sets of subsequent fibers.

3 Production and test Plan

Studies for the optimization of fiber insertion will be done both in Padova and in LNF. The scintillator cell production with the fiber insertion will be done in LNF. The silicon plane production will be followed by the Padova group. The calorimeter mounting will be done in the LAB where for the first time a beam test will be performed (likely LNF). The support mechanics will be realized in Padova.

Concerning the beam tests, the 800 MeV e^+/e^- beam facility expected to be available from 2001 at LNF is indicated for a first step of measurements. In a second time it is expected to use the DESY and CERN beams in order to reach higher energies and to use pion beams.

The substitution of the Lead absorber with Tungsten and the corresponding test are foreseen in a later stage not before 2002.

4 Layout for a Barrel Electromagnetic Calorimeter

At a Linear Collider experiment, a barrel Electromagnetic Calorimeter realized with the proposed technique can be designed with a geometry similar to the one of the Si-W calorimeter described in the TESLA TDR. In particular all the absorber-scintillator plates and the Si-pads can be arranged in parallel planes and assembled in 8 modules of about 170 cm lenght in the XY plane. The space required to collect the fibers coming from the scintillator tiles is about 1.2 cm, corresponding to $1/6^{th}$ of the total detector depth with a lead absorber. A barrel calorimeter layout using sigma tiles can also be found in [4].

References

[1] ECFA 1997-182; DESY 1997-048,
http://www.desy.de/conferences/ecfa-desy-lc98.html,
TESLA TDR (in preparation).

[2] A.C. Benvenuti et al., Nucl. Instr. and Meth. **A432** (1999) 232-239,
"Test beam results for a longitudinal segmented electromagnetic calorimeter" Presented by M. Paganoni at the "VIII International Conference on Calorimetry in High Energy Physics June 13-19, 1999 Lisbon. ";
"Caleido: a shashlik e.m. calorimeter with longitudinal segmentation"
Poster presented by M. Margoni at the "1999 IEEE Nuclear Science Symposium & Medical Imaging Conference", Seattle, USA October 24-30, 1999" .

[3] "The CDF 2 Detector. Technical Design Report" Fermilab-pub-96/390-E

[4] " A Sandwich Sampling Calorimeter with Tileplate-and Waveleghshifter Read-out", presented by V.Korbel at the "International Workshop on Linear Colliders LCWS99" Sitges Spain April 28 - May 5, 1999, http://home.cern.ch/∼pachecoa/V.Korbel.pdf.