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A shashlik calorimeter with longitudinal segmentation for a linear collider☆

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CALEIDO Collaboration

Abstract

Two techniques for longitudinal segmentation of shashlik calorimeters are proposed. Results concerning energy resolution and e/π separation are reported. © 2001 Elsevier Science B.V. All rights reserved.

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1. Introduction

In recent years, the "shashlik" technology has been extensively studied to assess its performance at e^+e^-, ep and pp accelerator experiments [1–4]. Shashlik calorimeters are sampling calorimeters in which scintillation light is read-out via wavelength shifting (WLS) fibers running perpendicularly to the converter/absorber plates [5,6]. This technique offers the combination of an easy assembly, good hermeticity and a cheap solution compared to crystals or cryogenic liquid calorimeters. Shashlik calorimeters are, in particular, good candidates for barrel electromagnetic calorimetry at future Linear e^+e^- Colliders [7]. However, to fulfill the Linear Collider Physics requirements, a longitudinal segmentation should be implemented.

The CALEIDO collaboration proposes two solutions for the longitudinal segmentation: (1) thin vacuum photodiodes (5 mm) inserted between adjacent towers in the front part of the calorimeter (CALEIDO1); (2) two scintillator types with different decay times inserted, respectively, in first and in the second longitudinal part of the calorimeter (CALEIDO2).

☆Poster presented by P. Checchia.

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2. Prototypes and results

CALEIDO1. A prototype detector was exposed to a beam with the aim of measuring the sampling capability and demonstrating that the insertion of diodes neither deteriorates critically the energy response nor produces significant cracks in the tower structure. A very good e/π separation ($<5\times10^{-4}$ at 50 GeV) was achieved and an energy resolution

$$\frac{\sigma(E)}{E}=\sqrt{\left(\frac{9.6\%}{\sqrt{E}}+0.5\%\right)^2+\left(\frac{0.130}{E}\right)^2}$$

was obtained. The prototype description and a detailed discussion of the results can be found in Ref. [8].

CALEIDO2. The second prototype has 9 Pb/scintillator towers ($5\times5\times28\,\mathrm{cm}^3$) assembled in a 3×3 matrix. Each tower consists of 29 layers of 1 mm thick lead and 1 mm thick Bicron BC-444 scintillator (decay time of about 250 ns) and of 100 layers of lead and a standard plastic scintillator consisting of polystyrene doped with 1.5% para-terphenyl and 0.05% POPOP (faster than 10 ns). The light produced by both scintillators is carried to the photodetector (FEU-84-3 photomultipliers) by means of KY11 fibers. The BC-444 was installed in the first $5X_0$ and then its signal gives the information concerning the early shower development in a time interval where the signal from the standard scintillator is much smaller. The time distribution for both scintillators is shown in Fig. 1.

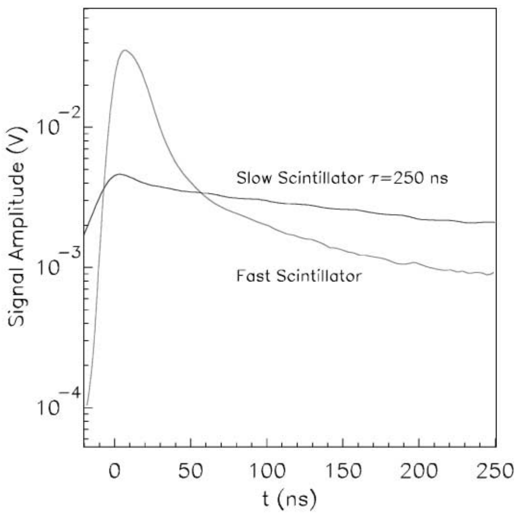

Fig. 1. Signal time distribution for fast and slow scintillators.

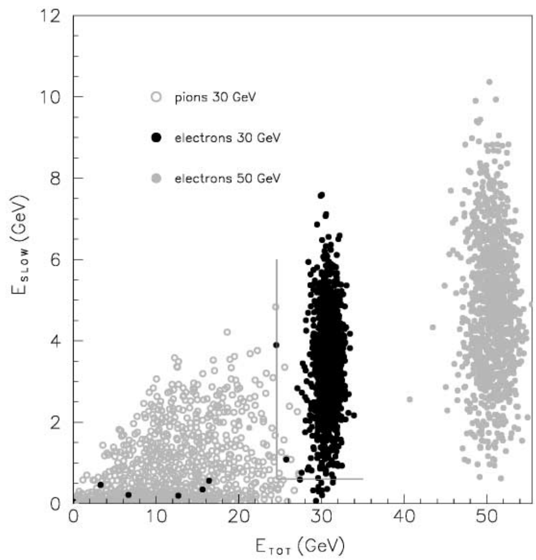

Fig. 2. CALEIDO2: slow scintillator energy versus total energy for e at 30 and 50 GeV and π at 30 GeV.

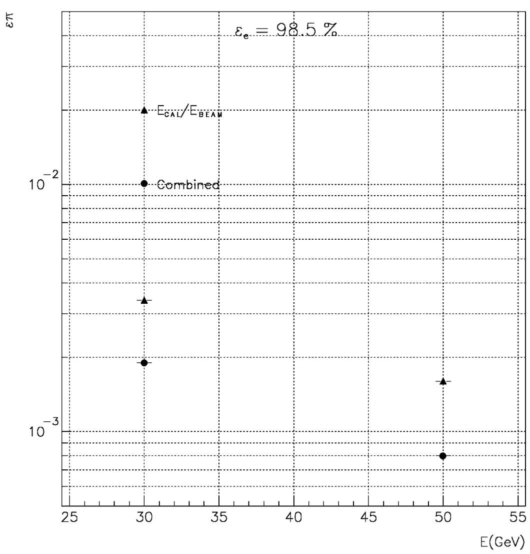

Fig. 3. Pion contamination versus energy for 98.5% electron efficiency.

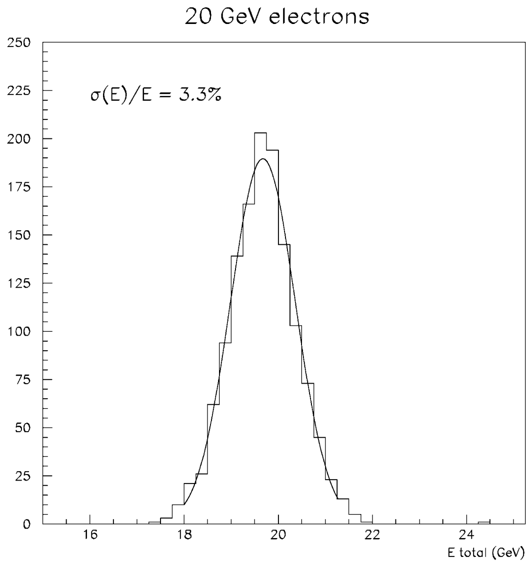

Fig. 4. Energy resolution for 20 GeV e beam.

Preliminary results show that the proposed technique works. The signal extracted from the slow component versus the total energy is shown in Fig. 2 for electrons and pions. The discriminating power of the E_{slow} information (Fig. 3) improves the separation capability by a factor ~ 2 w.r.t. E/p ratio. The energy response for 20 GeV electron beam is shown in Fig. 4.

3. Conclusions

Beam tests have demonstrated the technical feasibility of longitudinally segmented shashlik calorimeters in which longitudinal sampling is performed by lateral vacuum photodiodes or by using two scintillator types with different decay times.

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