Fermi National Accelerator Laboratory

FERMILAB-Conf-93/049-E

DØ

Low Energy Response of the DØ Calorimeter and Jet Energy Measurement

Pushpalatha C. Bhat
for the DØ Collaboration

Fermi National Accelerator Laboratory
P.O. Box 500, Batavia, Illinois 60510

November 1992

Presented at the *7th Meeting of the American Physical Society Division of Particles and Fields*, Fermi National Accelerator Laboratory, November 10-14, 1992

Operated by Universities Research Association Inc. under Contract No. DE-AC02-76CHO3000 with the United States Department of Energy

Disclaimer

LOW ENERGY RESPONSE OF THE DØ CALORIMETER AND JET ENERGY MEASUREMENT

Pushpalatha C. Bhat
Fermi National Accelerator Laboratory
P.O. Box 500, Batavia, Illinois 60510
for the DØ collaboration

ABSTRACT

Previous studies of the DØ calorimeter with electron and hadron beams above 10 GeV/c have shown excellent linearity of response and e/π ratio close to one. Here we report on our measurements of the response of the DØ central calorimeter modules down to 2 GeV/c. The measured low energy response for electrons and pions are convoluted with jet fragmentation from the PYTHIA Monte Carlo to obtain the corrections for jet energy.

1. Introduction

The DØ calorimeter[1], with its hermeticity, large angular coverage, fine longitudinal and transverse segmentation, sufficient depth for shower containment and $e/\pi \sim 1$, provides an excellent device for studying jet physics. Jets being manifestations of parton hadronization, contain a substantial fraction of low energy particles up to very high jet energies. Any uncorrected non-linearity in the response of the calorimeter for low energy particles, can result in a large error in the jet energy measurement. The fraction of low energy particles being dependent on the energy of the jet, the jet energy mis-measurement will also become energy dependent and distort the shape of the jet E_t spectrum. This can have important consequences for tests of QCD, search for compositeness etc. An effort was therefore made at the DØ testbeam to measure the response of the calorimeter to low energy particles. This paper reports preliminary results for the response of the calorimeter for electrons and pions down to 2 GeV.

2. D0 Test Beam Facility

The DØ test beam facility is located in the neutrino-west(NW) beamline at Fermilab. During the 1991 fixed target run some central calorimeter modules were calibrated and studied. The NW beamline was normally operated to transport 10 - 150 GeV/c electrons or pions. Electrons and muons in the beam were tagged by helium-filled threshold Cerenkov counters. Proportional wire chambers were used to reconstruct the beam trajectory and momentum. In order to obtain lower energy beams[2] the 150 GeV/c secondary π^- beam was re-targetted on a Beryllium target in a beam enclosure about 140 m upstream of the test beam cryostat and tertiary low energy beam was transported. Muons in the tertiary beam were tagged down to 2 GeV/c using a Cerenkov counter filled with Freon-114.

3. Test Beam Results

Above 10 GeV, the linearity of the response and the energy resolution of the central calorimeter modules are found to be consistent with our previous results[3] for the end calorimeter. The electromagnetic sampling resolution is found to be $14\%/\sqrt{E}$ with a constant term of 0.5% and the hadronic sampling resolution is $50\%/\sqrt{E}$ with a constant term of 4%. The measured energy distribution of the

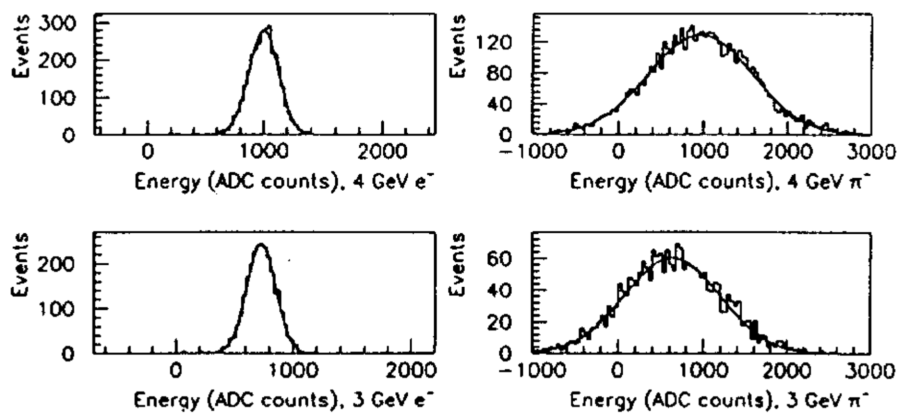

Figure 1: Calorimeter response to low energy electrons and pions

calorimeter for electrons and pions of energies 4 and 3 GeV are shown in Fig.1. The response curves are Gaussian down to these low energies. The response of the calorimeter is linear to within .25% for electrons and 3% for pions down to 15 GeV. The linear fit performed on data from 10 to 150 GeV requires negligible off-set in energy for electrons whereas for pions the off-set was about 600 MeV. However, at lower energies, a loss in the response is seen. Fig. 2(a) shows the deviation of electron response from the linear fit performed on data from 10 to 150 GeV. The same analyses is done on Monte Carlo data where the geometry of the calorimeter and the materials upstream of the calorimeter have been modelled in detail. The results are plotted in Fig. 2(a) along with data. A loss in the response is seen in the Monte Carlo at low energies similar to that seen in the data. The deviation of response for pions from the 10-150 GeV linear fit, plotted in Fig. 2(b), shows that within errors the data is consistent with the linear fit (with the large off-set mentioned above) down to 2 GeV. However, the progressive reduction of the response at lower energies can be examined by plotting the ratio of the response to the beam energy, as shown in Fig. 2(c) and (d). This normalised response for pions can be fit to a functional form of $(a - \frac{b}{E})$, where E is the beam energy. The fit to the data yields a=264.1 ADC counts/GeV and b=162.7 ADC counts. Work continues to understand the origin of the off-sets.

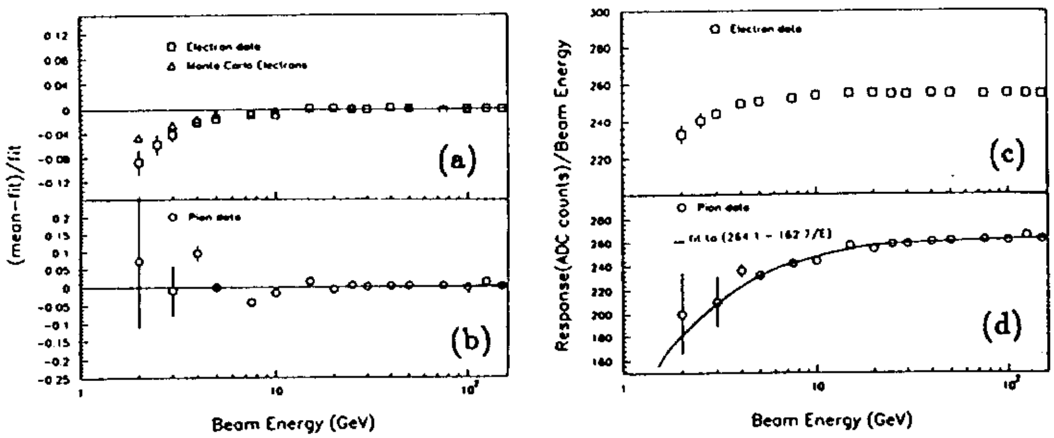

Figure 2: (a),(b) Deviation from a linear fit performed on 10-150 GeV/c data for e^- and π^-. (c),(d) Ratio of calorimeter response to beam energy for e^- and π^-

4. Jet Energy Corrections

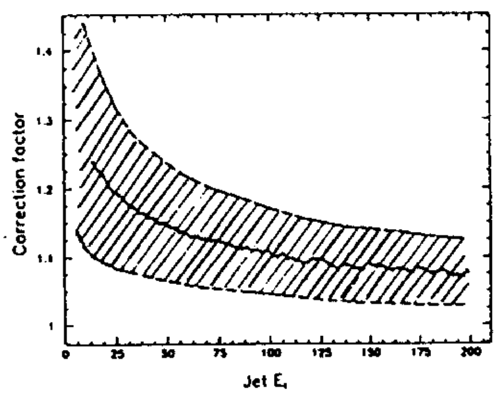

Figure 3: Jet energy corrections using test beam response for e^- and π^-. The band represents present statistical and systematic uncertainties in the corrections

The response for electrons and pions measured in the test beam were used in the PYTHIA Monte Carlo to reconstruct jets and the ratio of the actual jet E_t to the reconstructed jet E_t are plotted in Fig. 3. This gives the jet energy corrections required due to the reduced low energy response of the calorimeter. The corrections are of the order of 20% at jet E_t=25 GeV. With the present preliminary results the uncertainty in jet energy is about ± 12% at jet E_t=25 GeV.

6. References

1. The DØ Collaboration, "DØ Design Report", (1983, revised 1984) unpublished; J. Christenson, *Proceedings of the III Intenational Conference on Calorimetry in High Energy Physics*, Sept 29-Oct 2, 1992, Corpus Christi, Texas.
2. Pushpa Bhat, "Proposed NW Beamline Upgrade for D0 Test Beam Load-2", *DØ Internal Note* 1104 (1991).
3. The DØ collaboration,"Beam Tests of the D-zero Uranium Liquid Argon Calorimeter", *FNAL-PUB-92/162-E*, to be published in *Nucl. Inst. Meth.*