SDC-92-335

SDC
SOLENOIDAL DETECTOR NOTES

Missing Et in Jets due to Calorimeter Cracks

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Abstract

This note presents a preliminary calculation of the mssing-Et generated by jets striking on or near cracks in the calorimeter. Two types of cracks---projective and dogleg---are studied using Isajet and parameterized showers. The dogleg geometry provides better coverage: the average leakage for jets striking the center of the crack is 2--8%, depending on pt, compared to 30--55% for a projective crack. Averaging over all incident values of phi, the fraction of 400 GeV jets losing more than 100 GeV is 0.15% for the dogleg and 1.2% for a projective crack of half the width, and 0.6% due to neutrinos.

Introduction

The SDC calorimeter group has recently specified the nature of the crack between hadronic modules. The design selected is a "dogleg", with a projective crack in HAD2 that is displaced in phi from the projective crack in the EM and HAD1 sections. This note compares the missing-Et response of the dogleg to that of a projective crack, and is a continuation of a similar study performed by Dan Green [SDC-92-319]. Because this study uses parameterized showers, the lateral leakage of showers into cracks is not included. A more reliable study will require the use of Geant. Geant will also be needed to study the more difficult geometric case of a non-projective, full-depth crack.

Jet Size

The fraction of jet Et lost in a crack depends on the lateral size of the jet. The average pt of a particle in a jet relative to the jet axis is independent of the jet boost, so the higher energy jets are narrower. Figure 1 shows the average jet profile in phi for 100--1500 GeV pt jets (at eta<1). The jet centroid is defined to the highest pt (visible) particle. This produces a very sharp peak at $\delta\varphi=0$ (Fig. 2). As shown in Fig. 3, the fraction of jet pt carried by the leading particle peaks at 0.16 (the average is 0.21).

Leakage Calculation

Isajet is used to generate jets in a specific pt region. The pt of all visible particles (ie., not neutrinos or muons) within a radius of 0.6 of the highest pt particle are summed to calculate the "true" jet Et. The particles are then showered using a parameterized model that produces a number of "energy spots" for each particle using longitudinal functions specified by Bock et al [NIM 186 (1981) 533]. The calorimeter depth required to contain 90%, 95% and 99% of an average shower is plotted as a function of energy in Fig. 4. The lateral shower development is ignored.

Crack Geometry

The geometry of the calorimeter is specified simply as a table of thicknesses (λ) vs phi. The crack is either centered on the crack or displaced in phi by a specified amount. Two types of geometry have been studied. Projective cracks extend through the full calorimeter (10λ), while doglegs extend only through the first 5λ. These are actually half-doglegs, since the crack in HAD2 is ignored. Since hadrons have deposited most of their energy by the time this crack is reached (90% on average for 100 GeV pions) and since shower development has increased the lateral size, this crack does not have as much impact. The projective cracks studied have width $\delta\varphi$=0.004, 0.008, and 0.016 (approximately 1, 2 and 4 cm at HAD1), while the dogleg has a width of 0.008.

Results

Figure 5 shows the fraction of jet Et that is lost by leakage for 400 GeV jets centered on the crack for the dogleg and for the projective crack of width 0.004. Figure 6 is similar, but averages over all incident values of phi for the jet. Although the total amount of material in the calorimeter is the same in the two cases, the missing Et is much worse with the projective crack. In fact, it is larger than that lost due to neutrinos (Fig. 7). The fraction of 400 Gev jets with missing-Et greater than 100 GeV is 0.15% for the dogleg, 1.3% for the projective crack, and 0.6% due to neutrinos.

Figure 8 shows the average leakage as a function of the distance between the jet and the crack for four geometric cases. The width of the crack increases the depth of the dip only slightly, since this is dominated by the leading particle, but it does increase the width of the dip. If the distance between the leading particle and the crack is greater than approximately $\delta\varphi$=0.015, the crack is almost not visible.

Conclusion

The dogleg design provides substantially better containment of jets than a projective crack. The non-projective, full depth crack has not been studied. With the jet centered on the crack, the missing-Et is, on average 2--8%, depending on Et. Averaging over all incident angles, the missing Et is significantly less than that due to neutrinos.

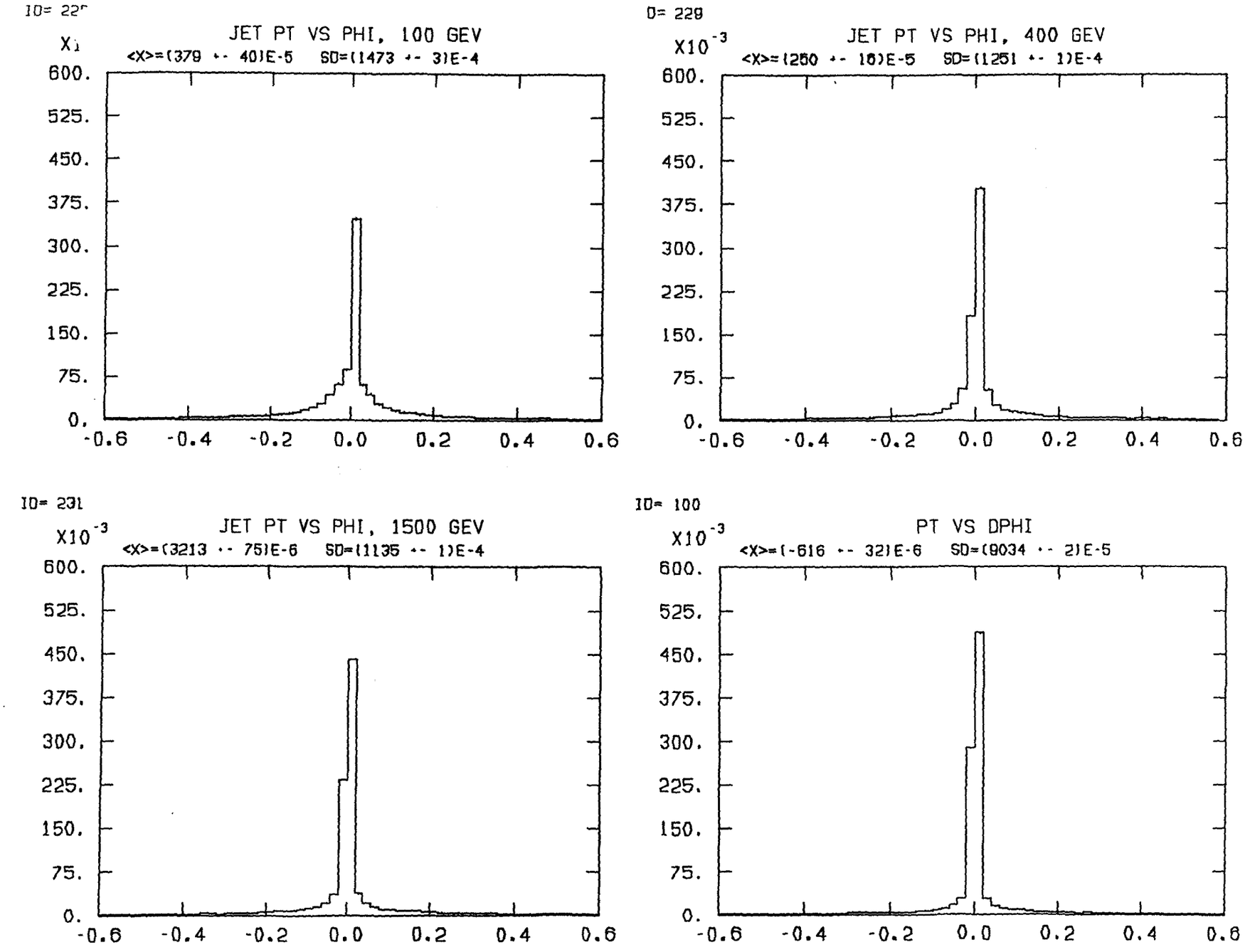

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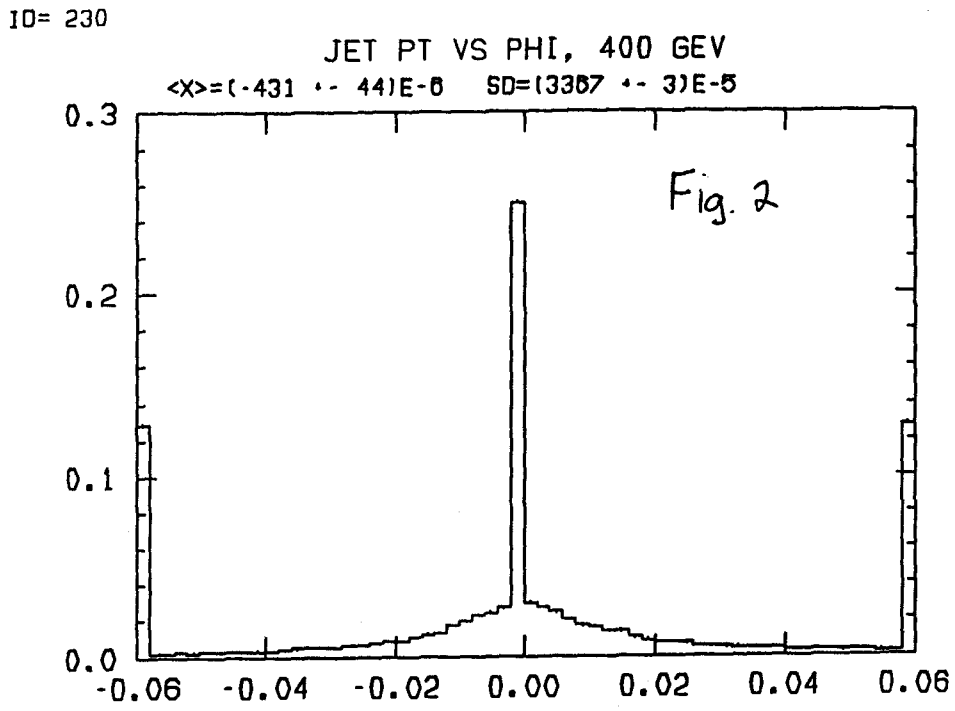
Fig. 1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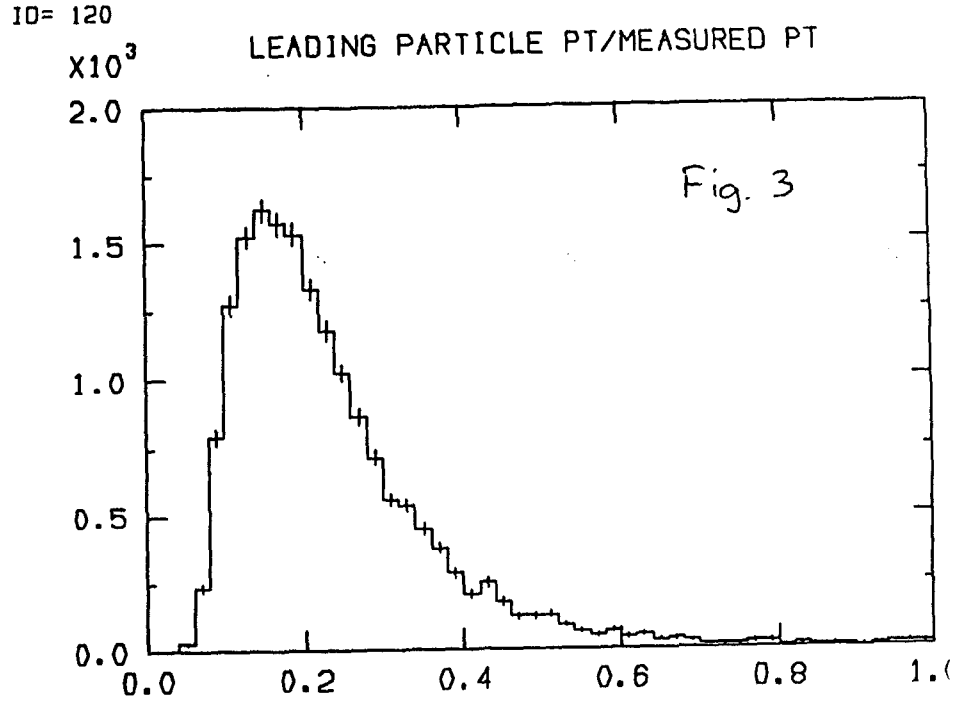
JET PT VS PHI, 400 GEV
<X>=(-431 +- 44)E-6 SD=(3367 +- 3)E-5
0.3
0.2
0.1
0.0
-0.06
-0.04
-0.02
0.00
0.02
0.04
0.06
Fig. 2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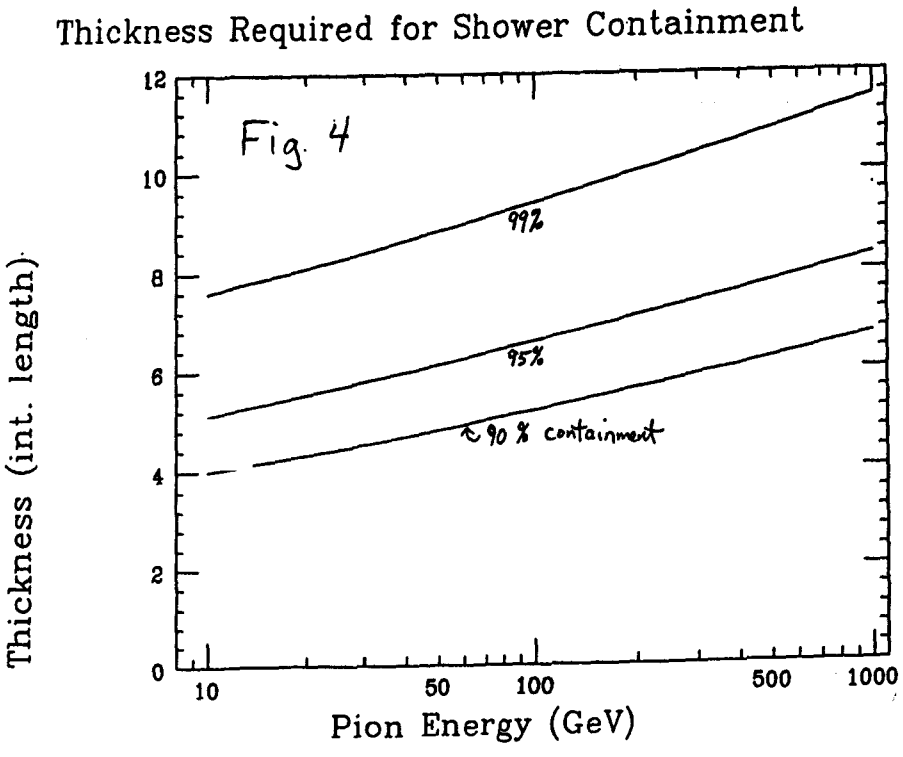
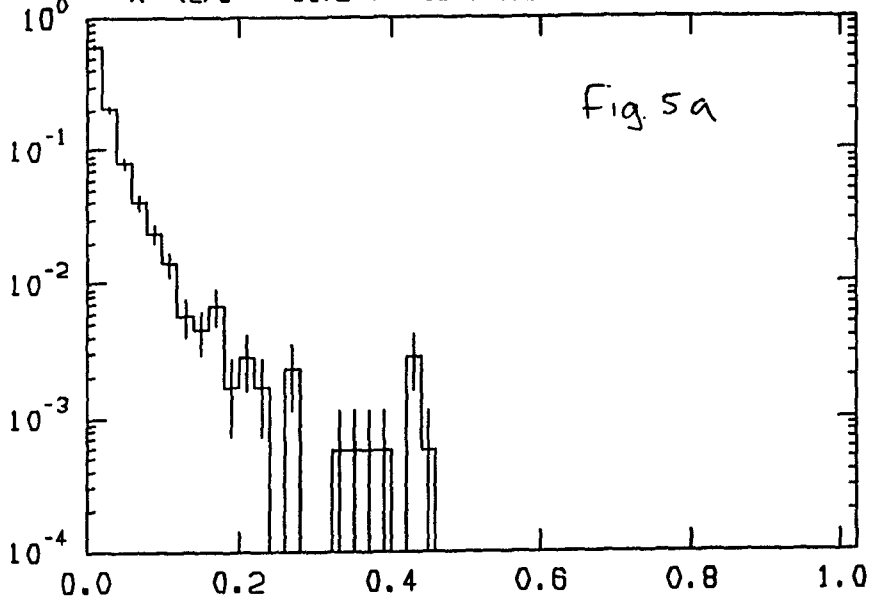
LEADING PARTICLE PT/MEASURED PT
X10^3
2.0
1.5
1.0
0.5
0.0
0.0
0.2
0.4
0.6
0.8
Fig. 3


Thickness Required for Shower Containment
Fig. 4
99%
95%
~90 % containment
Thickness (int. length)
Pion Energy (GeV)
0
2
4
6
8
10
12
10
50
100
500
1000

ID= 221

LEAKAGE DOGLEG 400 GEV AT CRACK

<X>=(273 +- 11)E-4 SD=(4462 +- 75)E-5



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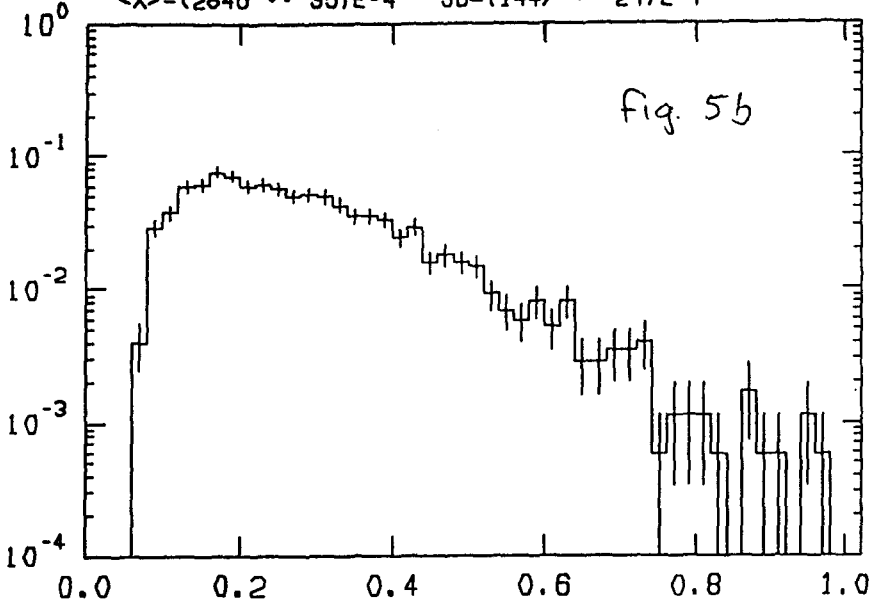
LEAKAGE PROJECTIVE 400 GEV AT CRACK

<X>=(2846 +- 35)E-4 SD=(1447 +- 24)E-4



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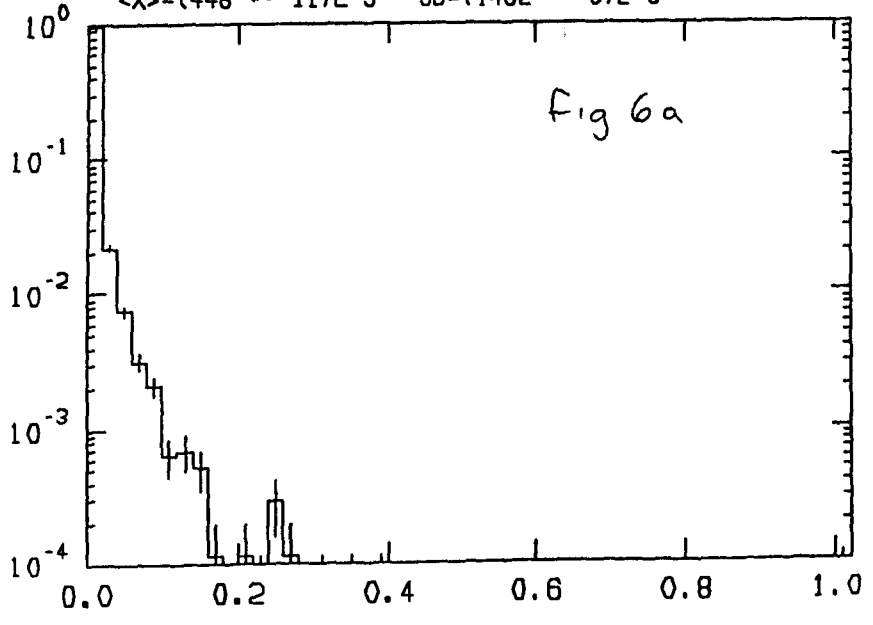
LEAKAGE DOGLEG 400 GEV ALL PHI

<X>=(448 +- 11)E-5 SD=(1452 +- 8)E-5



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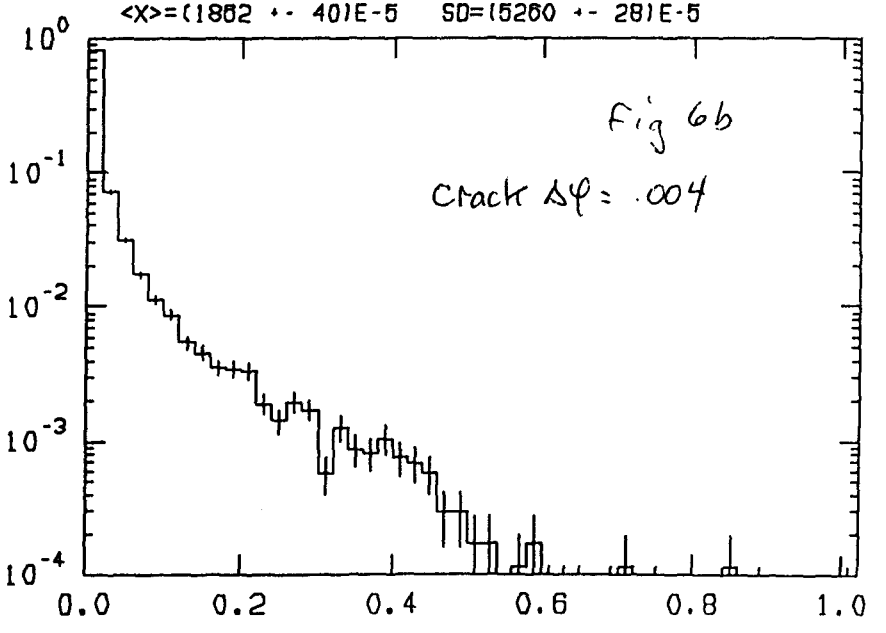
LEAKAGE PROJECTIVE 400 GEV ALL PHI

<X>=(1862 +- 40)E-5 SD=(5260 +- 28)E-5



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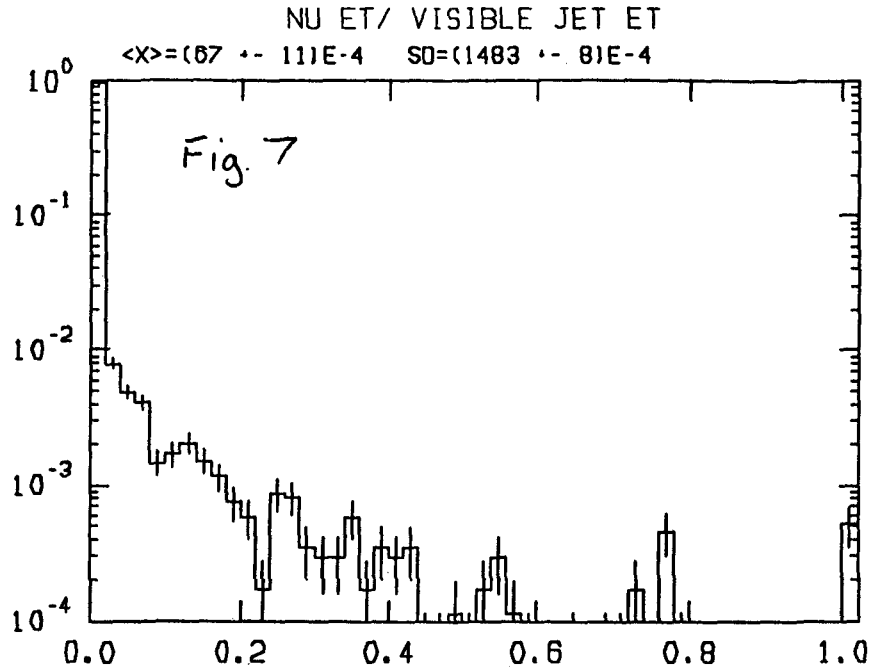

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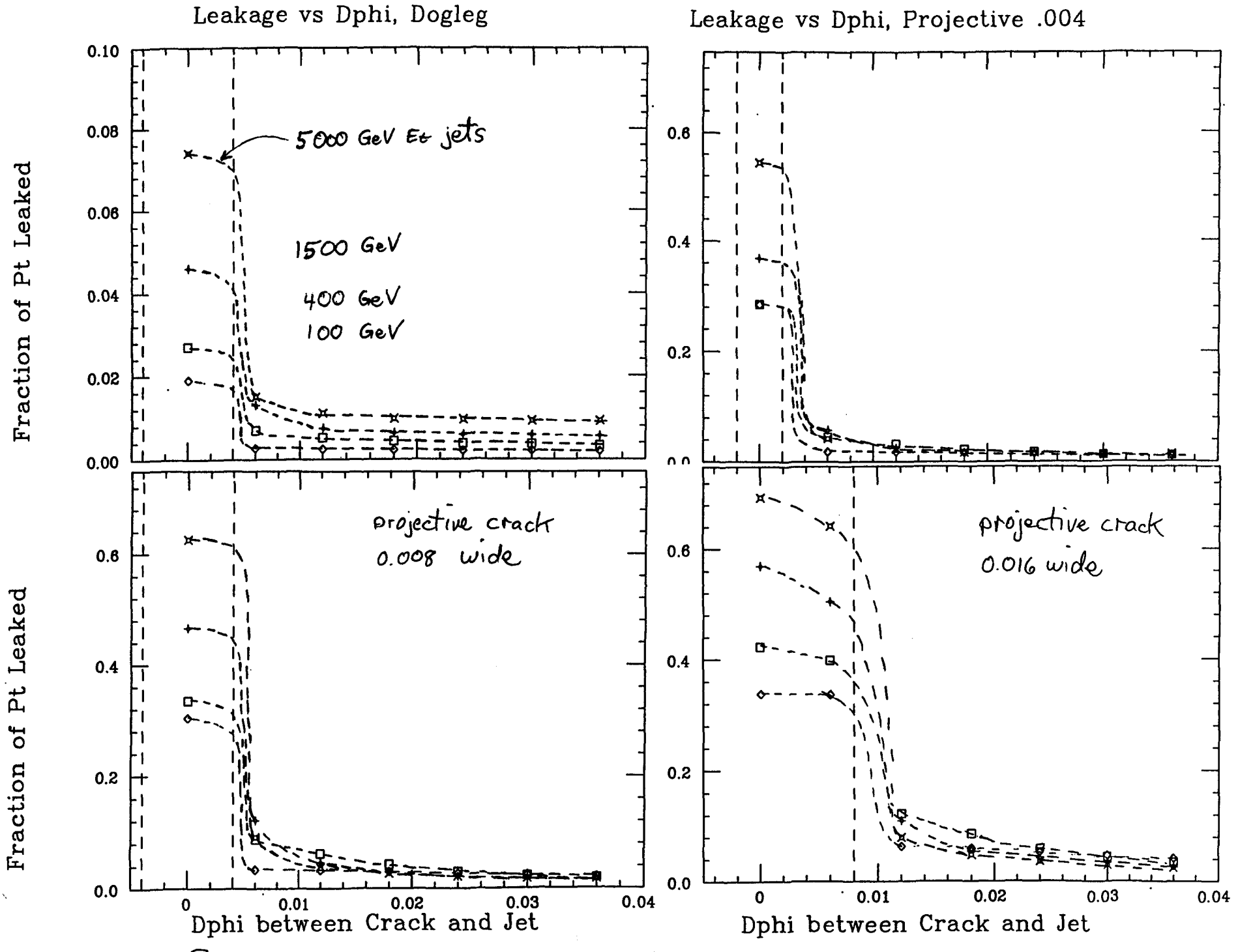
Leakage vs Dphi, Dogleg
Leakage vs Dphi, Projective .004
Fraction of Pt Leaked
5000 GeV Et jets
1500 GeV
400 GeV
100 GeV
projective crack
0.008 wide
projective crack
0.016 wide
Dphi between Crack and Jet
Dphi between Crack and Jet

Fig. 8