Disclaimer

DØ Note 526

Triggering on Jets
with
One x One Clusters

by

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I. Introduction

In this note we describe some results of studies relevant to triggering in D0 using the basic trigger tower size ($\Delta\eta \times \Delta\phi$ of 0.2x0.2) to define the size of the cluster. We analyze ISAJET events generated over the following range of parton center of mass energies:

ISAJET EVENTS

E-transverse (GeV)	Number of Events
2 - 5	1,980
5 - 10	2,396
10 - 20	508
20 - 40	467
40 - 80	486
80 - 120	187
120 - 160	356
W->e υ	486
Z-> e^+e^-	964

The events were run through the current GEANT Monte Carlo and the results were written onto tape. Our analysis started by organizinig the outputs from the calorimeter portion of the program into trigger towers and writing a summary file of this data onto disk for easier analysis. Noise was added to both the electromagnetic (EM) and fine hadronic (FH) calorimeter sections. The amounts were 300 and 600 MeV respectively. Energy cuts of 1.0 GeV per tower were imposed. That is, no tower was considered in the trigger if its energy did not exceed the cut.

2. Trigger Efficiencies

The essence of the analysis is to compare the 1x1 clusters with our previous analysis which used 2x2 clusters in an overlap mode. We start by considering the efficiencies for W and Z detection where the W decays into an e and a neutrino and the Z into an electron-positron pair. These comparisons are made in Figures 1 and 2 below. In both plots the efficiency for detection is plotted versus the minimum energy requirement in the EM cluster. In the case of the W only one EM cluster is required whereas for the Z we require both clusters to exceed the cut.

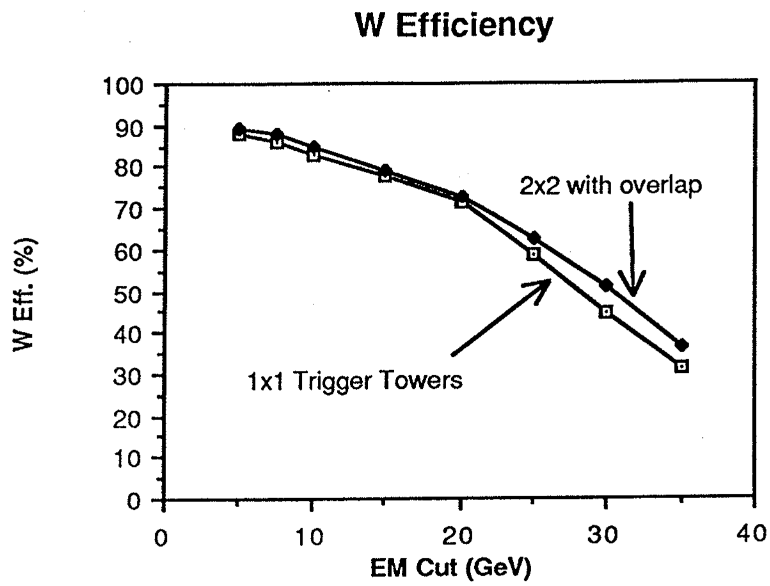

Figure 1

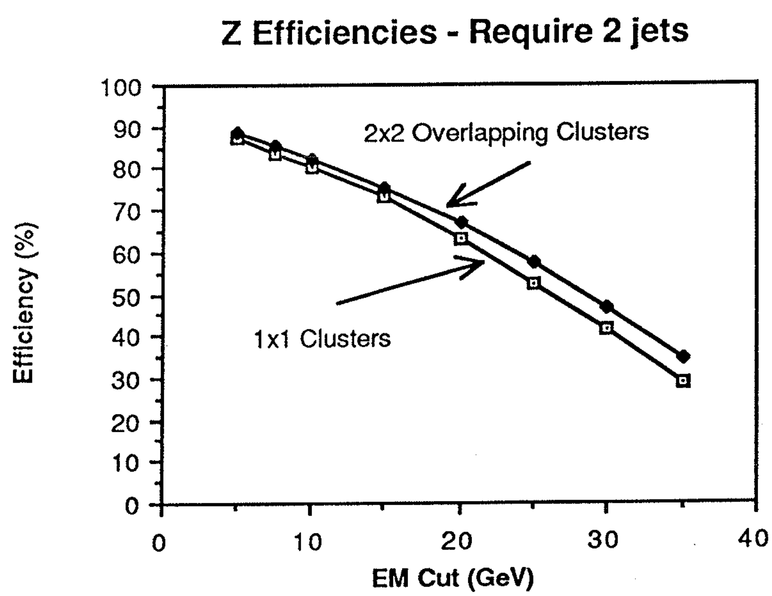

Figure 2.

As can be seen there is very little difference between the two sets of curves indicating that there is little loss in efficiency in switching from the 2x2 to the 1x1 clustering mode. This might be anticipated as the transverse size of an electromagnetic shower is considerably smaller than a trigger tower.

We next turn to the more difficult problem of triggering on jets. Here, once again, we concentrate on a comparison with the 2x2 tower overlap trigger. The Monte Carlo data is analyzed with our jet finder trigger using two different cluster sizes: a) 1x1 trigger towers and b) 2x2 trigger towers in the overlap mode. Our jet finder searches the η,ϕ plot for the largest cluster and reports the address of this cluster as the address of the jet. We compare the two sets of addresses found and define a correlation co-efficient as the fraction of events whose found addresses fall within one tower address of one another. We plot the results as a function of the parton energy in Figure 3 below.

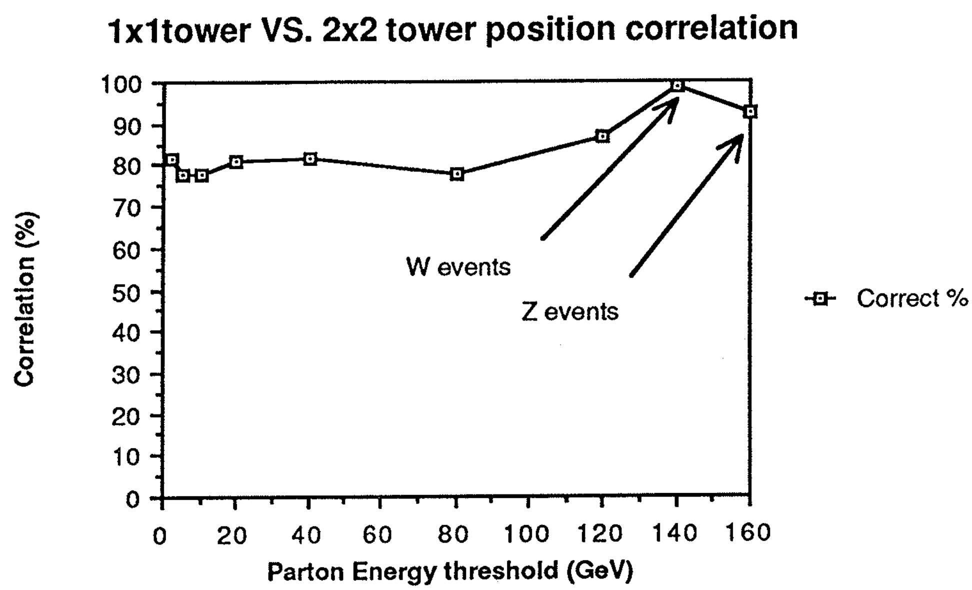

Figure 3

Note that the W and Z data have been added as the last two points. The W correlation is near 100% and that for the Z is 90%, whereas the 2-jet correlations are nearer 80%. We interpret this to mean that sometimes the jet finder finds the "other" of the two jets in the event. In the case of the Z this happens 10% of the time and for the 2-jet events it is near 20%. Thus the correlations that we have found have to be viewed as lower limits.

While Figure 3 answers the question of relative efficiency, it does not tell us what the actual efficiency for jet detection is. This is given in Figure 4, below, where we plot the 1x1 trigger tower efficiency for triggering on one of the two jets in "2-jet" events as a function of the energy cut on the hadronic tower. The different lines connect data generated with the same parton energies.

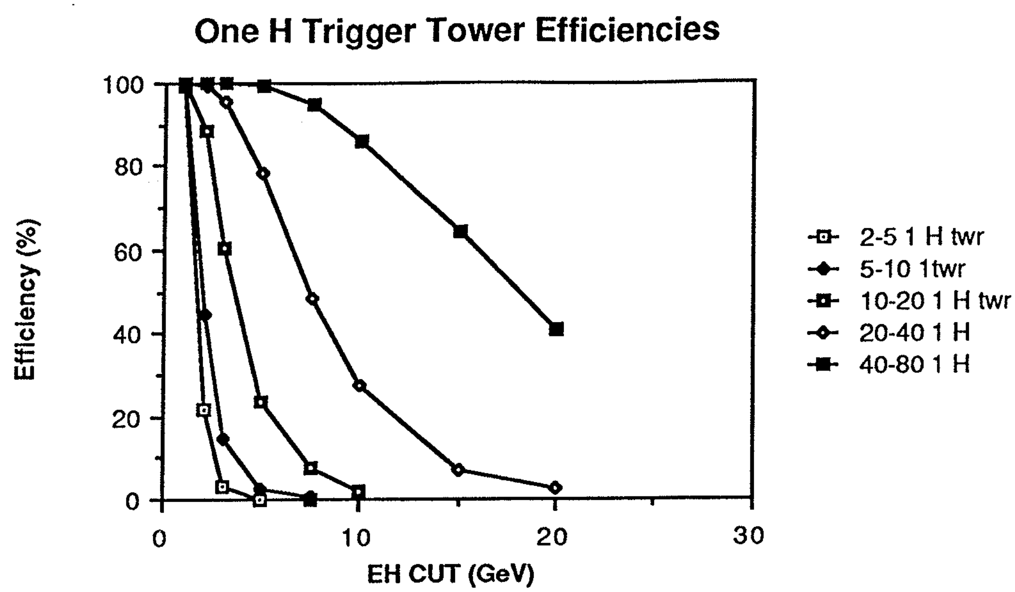

Figure 4

3. <u>Jet Isolation</u>

Our analyses indicate that the two jet events are characterized by a single tower carrying a large fraction of the jet energy. Thus the two jets in an event will have two energetic towers separated from each other by a large distance in η,ϕ space. One way to test this is to impose isolation criteria on the jets. We do this by studying the efficiency of finding 1, 2, 3 or 4 jets as a function of the "dead" space surrounding each jet. These results are summarized in Figure 5 below. We compare the 1x1 tower results with no isolation criteria with those requiring that there be no jet closer than 5 or 8 trigger towers from any other.

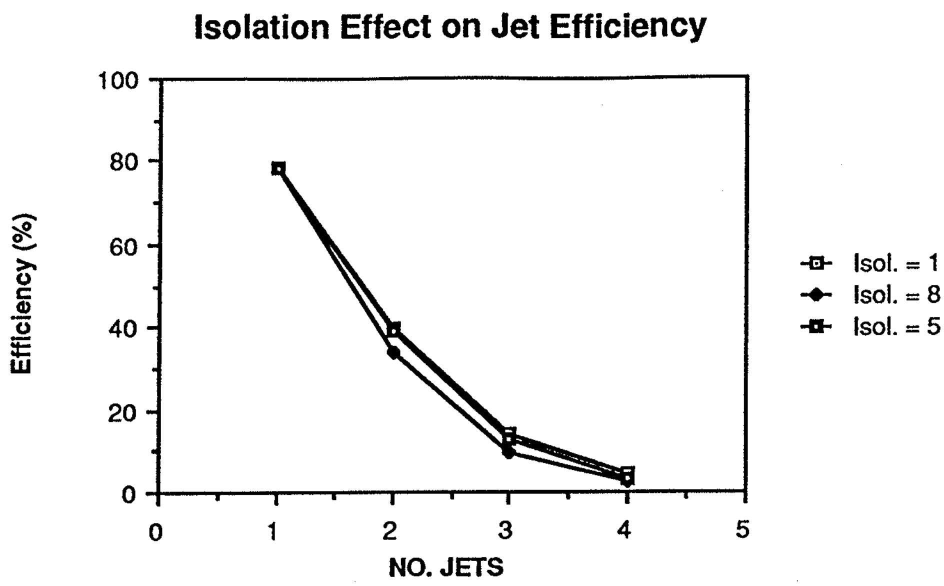

Figure 5

Note that there is no discernible difference among the efficiency curves as we increase the "dead" area around the towers. Figure 5 is based on events generated with parton energies from 20 to 40 GeV and the "jets" are defined as towers with at least 5 GeV of energy.

4. <u>EM to FH ratios</u>

Another result of our studies is that there is very little to be gained in the rejection of hadronic background to electron candidates by looking at the ratio of energies in the EM section to that in the fine hadronic (FH). Varying this ratio from 1 to 10 changed the rejection factor less than 20%. This result is not unwelcome from the viewpoint of electronics construction as implementing this feature would have been difficult and costly.

5. <u>Effect of Vertex Distribution on Transverse Energy</u>

Using these same events we attempt to investigate the effects of the finite size of the interaction diamond. Not knowing the z-position of the interaction vertex translates into an uncertainty in the production angle and the transverse energy of the jet. To get an idea of the size of this effect we have taken our 2-jet events and have required that a jet have at least 5 GeV of energy. We have computed the transverse energy (E_t) of the jet in two ways:

1. by assuming that the vertex was at z=0.0

and
2. by using the actual interaction vertex.

In order to do this we need to know the location of the shower in the calorimeter. Since the "location" is an ill defined concept, we have assumed, for simplicity, that in the central calorimeter all showers occur at a radius of 95 cm and that in the end caps all showers occur at z = 180 cm. These numbers represent the middle of the EM sections of the respective calorimeters.

Next we have made histograms of the differences in the two E_t measurements and have computed the RMS widths of the distributions. A convenient way of presenting the results is to plot these RMS widths divided by the energy of the original partons. These results, plotted versus the partons' energies are shown in Figure 6 below.

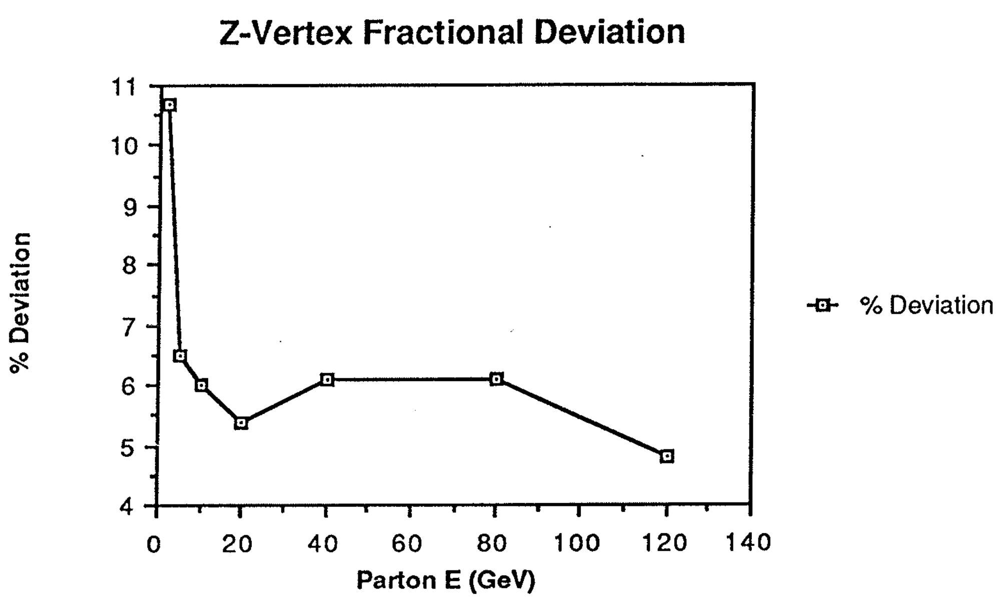

Figure 6

We have computed these fractions for W and Z events as well and the results are fractional deviations of 4.0% and 4.6% respectively.

Note that all of the fractional deviations are less than 6% except for the first point which has events with energies from 2-5 GeV. It is this bin which is most affected by noise and it is conceivable that this discrepancy is due to a few misidentified events. Our expectation was that there would be no energy dependence of this quantity as the effect is purely geometrical in nature.

6. Conclusions

Our tentative conclusions are that the 1x1 clustering is very nearly as effective as the 2x2 in overlap mode. There is little justification for building the circuitry to measure ratios of energy depositions in the EM and FH sections as this constraint does little to reduce 2-jet background. Thus an EM shower will simply be energy deposition in the EM section of the calorimeter. A further conclusion is that precise information of the vertex position of the event is not necessary at the trigger level as the fractional error is small.