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D0 Note
456

Single Tower Trigger Studies

by

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I. Introduction

We have performed a study of triggers that rely on counting the number of trigger towers over threshold. This work was motivated by our efforts to find trigger algorithms that could be executed rapidly enough to be useful under some proposed high luminosity scenarios where the inter-bunch spacing would be as low as 200 nsec.

II. Elements of the Study

As inputs to the Monte Carlo, we have once again used the events generated by ISAJET and passed through the detector using Monte Carlo programs written by S. Linn.[1] This has the added attraction of allowing us a ready comparison of these triggers to those we have already studied which would utilize the full putative power of the Level 1 trigger. As before, we have studied the following classes of events:

1. Two-jet
2. W production
3. Z^0 production
4. "t" quark production

We consider the detector to consist of 1600 electromagnetic and 1600 hadronic trigger towers. The towers have noise added in the amounts of 0.3 GeV to the electromagnetic and 1.7 GeV to the hadronic towers. Towers that have less than 1.0 GeV of energy in them are not utilized and, where needed, the ratio of EM to H energy for a tower to qualify as EM is taken to be LEMHR = 3.0.

As usual the two-jet events are considered to be the background and their rate in Hz is calculated for each trigger.

III. Results

We consider first the W events setting our trigger to ask for at least one electromagnetic jet above a cut. The W efficiency and the corresponding 2-jet trigger rate vs. this cut are shown below:

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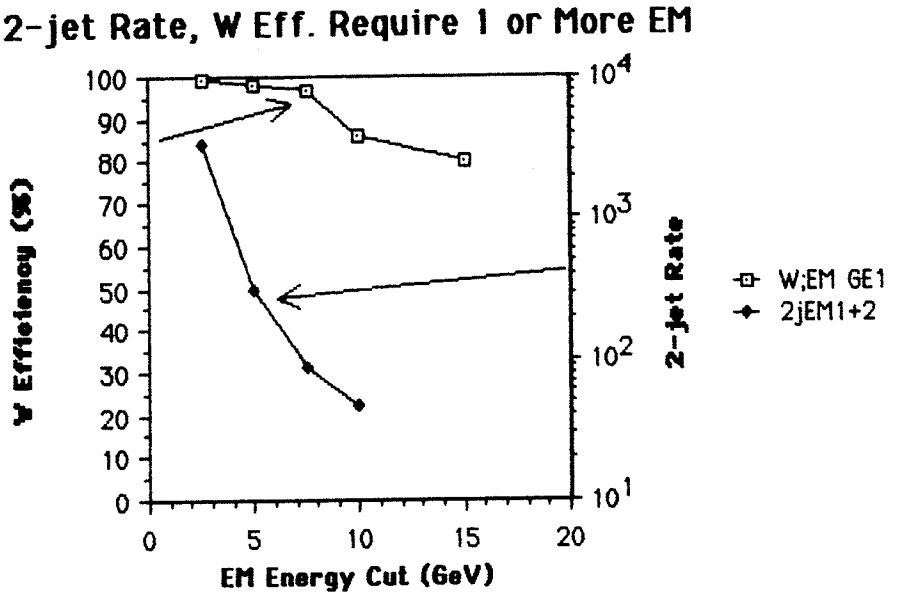
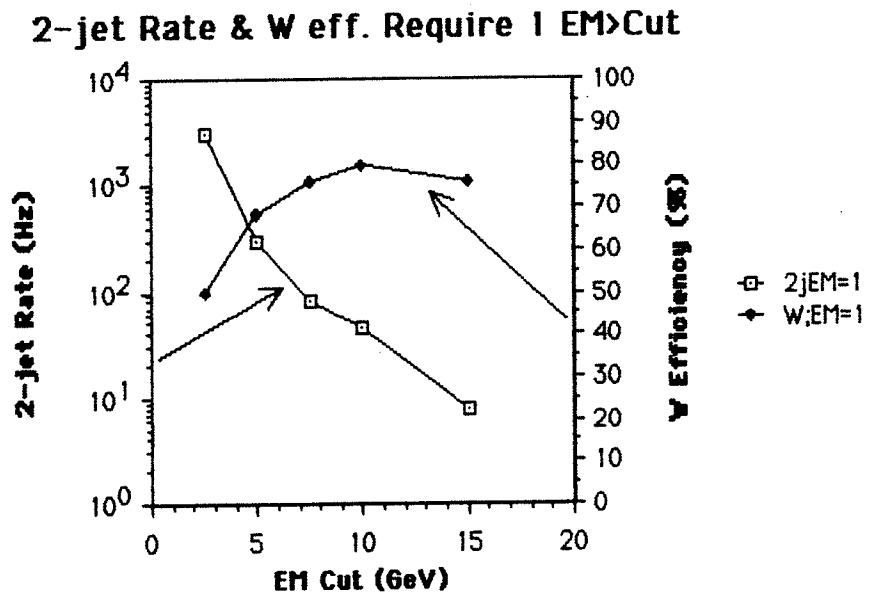
[1] For a detailed exposition see D0 Note 259, "Level One Trigger Studies for D0" by Maris Abolins and Dan Edmunds, September 12, 1985

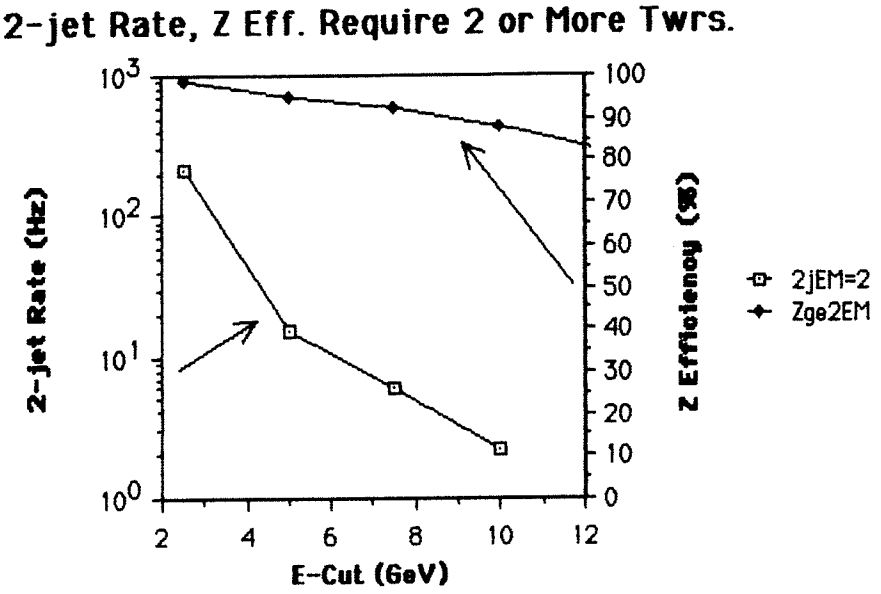


If we require 1 and only 1 EM tower in the trigger we get the following plot:

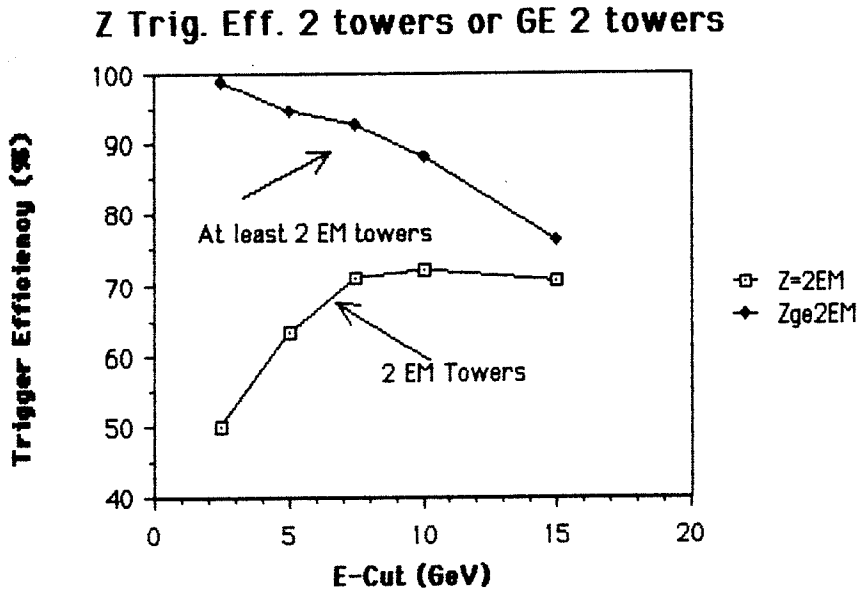


While the latter plot gives a somewhat lower 2-jet trigger rate for a given energy cut, it does so at the expense of the efficiency for the W. For example, at a cut of 10 GeV the efficiency is only 80% for the single tower trigger vs. nearly 90% for the trigger requiring one or more towers.

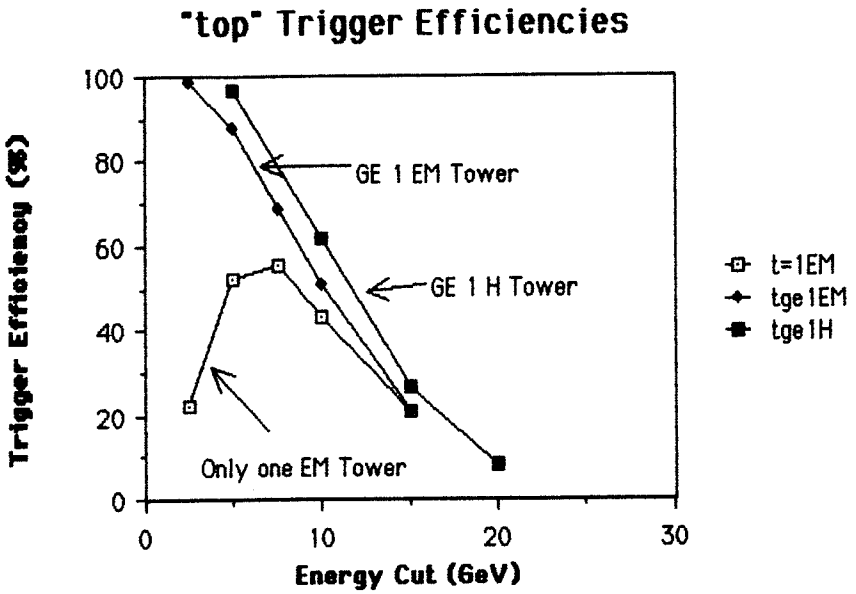
We turn next to the Z^0 triggers requiring two or more towers with EM energy. This yields the plot below:



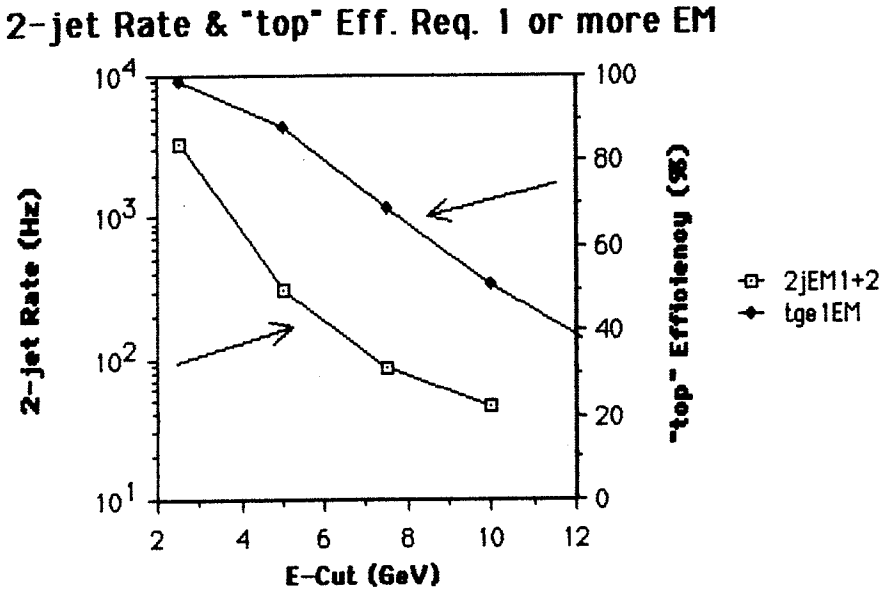
Requiring exactly two towers decreases the Z efficiency slightly but does not further decrease the 2-jet rate. This comparison is best seen in the following plot:



We consider next the "top" triggers. The Figure below shows the trigger efficiency for "top" events using three possible triggers: one and only one EM tower, at least one EM tower, and at least one H tower.



A plot of the "top" trigger efficiency along with the 2-jet rate requiring at least one EM tower to be above a cut, is included below.



Note that if a cut is imposed to reduce the 2-jet rate to a few hundred, then the corresponding "top" efficiency drops to 60% or less.

In all of the above, an EM jet was defined in terms of energy deposition in the EM part of the calorimeter relative to that in the fine hadronic. If this ratio exceeded some number "LEMHR", 3.0 in this study, then the energy was called electromagnetic. We have investigated the effects of not imposing this requirement. To our surprise, the only large

effect was to increase the trigger rate of two-jet events by about 25%. The other trigger rates were largely unaffected. The implication of this is that it probably is not necessary to build the LEMHR circuitry. If the interbunch spacing is decreased drastically, this may become an important consideration in saving time.

IV. Summary and Conclusions

The conclusions of this study are that a trigger based on counting the number of channels above a threshold can be very effective in selecting the desired signal and suppressing two-jet backgrounds. The surprising result is that this simple type of trigger yields results that are comparable to the full Level 1 trigger. For example, in Level 1 the "top" trigger has a requirement of two hadronic jets and missing p_t in addition to the EM jet, yet the much simpler "tower" trigger maintains the same efficiency for detecting the "top" and virtually the same rejection for two-jet background.

The observation that dropping the EM/H requirement in the definition of EM jets only increases the two-jet trigger rate by 25%, will facilitate the construction of a Level One trigger suitable for extreme luminosities.