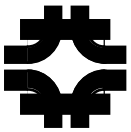

Fermilab

Fake Rate
in the CFT L1 Axial Trigger

by Fred Borcherding

The CFT L1 Axial trigger rate for Upgrade D0 as simulated in the Upgrade Geant MC is dominated by fakes, that is combinations of axial tracks below threshold that fake an axial track above threshold. We used a special MC to try and understand where these fakes come from.

We used a 3 GeV threshold trigger file for this study which was generated using the base line algorithm of one fiber wide bins on each of eight layers and requiring a hit on all eight layers.

For the first part of the study we generated multiple tracks below 1.5 GeV within a single 'cell'. There are four cells per sector and 80 sectors in the CFT. One cell has 11 fibers in the outermost layer and 4 in the innermost. The first three figures show that if the tracks are well below threshold there must be many tracks present to generate a fake trigger. Figure 1 with 100 tracks generated correspond to;

100 tracks x 4 cells x 80 sectors = 32,000 tracks.

For minimum bias events there are about 5 tracks per unit eta per event. The CFT is about 5 units in eta so one expects about 25 tracks per minimum bias event. The 32,000 corresponds to 1,280 interactions in one crossing! Figure 3 with 20 tracks corresponds to 256. So it seems that just a lot of tracks well below threshold do not cause a large fake rate.

For the next study a seed particle was generated above a given threshold and 9 other tracks were generated below the threshold. The seed threshold was independent of the trigger threshold which was held at 3 GeV as previously. Following the above discussion 10 tracks per cell correspond to 128 minimum bias events per crossing. First we generated a seed particle with Pt above 3 GeV and 9 particles with Pt less than 3 GeV.

Figure 4 shows the number of found tracks per event for this case. For a few events no tracks were found, we have a trigger inefficiency. For most of the events only one track was found. For a few events more than one track was found. Figure 5 shows the trigger efficiency for this case. The efficiency is between 90 and 95%.

For a comparison to no fake tracks figure 6 shows the efficiency for this trigger when only the seed track is generated. In fact the seed track was generated down to 1 GeV and figure 7 shows the rejection of these single track events below trigger threshold.

If we now lower the seed threshold to 2 GeV we get the number of found tracks shown in figure 8. The number of events which do not trigger is increased because there are now a substantial number of events with no tracks above 3 GeV. Figure 9 shows the trigger efficiency for this case. The efficiency is about the same as in the last case. The statistics are worse because fewer events have a trigger. Figure 10 shows the fraction of events without a trigger. All of the events with a seed Pt in the 2 GeV bin are not triggered on. The trigger rejection there is very good. For figure 11 the seed threshold was lowered to 1 GeV. Figure 12 shows the efficiency and figure 13 the rejection.

Table 1 summarizes the data in the histograms. As the seed threshold is lowered fraction of events with two or more events decreases. The fake rate is decreasing.

This study indicates that just a large number of below threshold tracks does not cause the fake problem. The fakes come from a large number of tracks below but near threshold. Since the Pt spectrum for minimum bias events falls exponentially raising the threshold should be very effective in decreasing the fake rate. Where raising the threshold is not the best option other methods must be found.

With a fast MC that seems to mimic the fakes properly we can now look at changes to the algorithm to lower the fake rate.

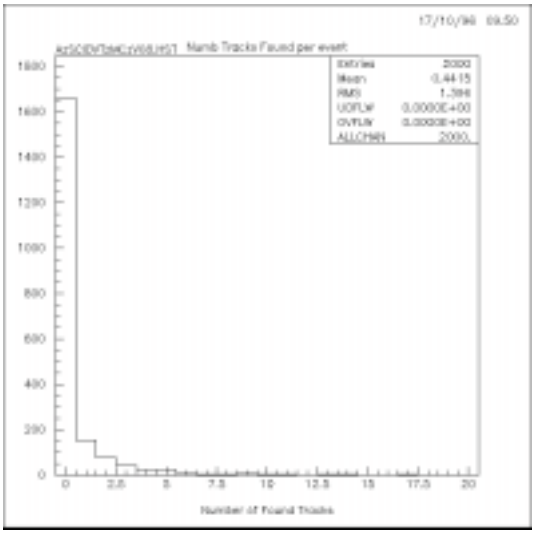

Figure 2 - Number of found tracks for 50 generated from 0.5 to 1.5 GeV.

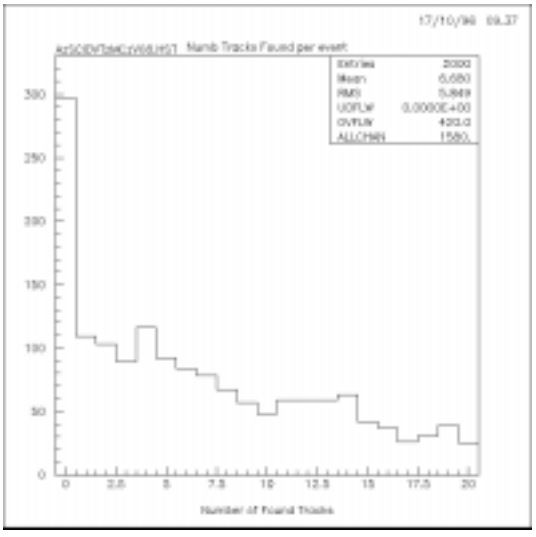

Figure 1 - Number of found tracks for 100 generated from 0.5 to 1.5 GeV.

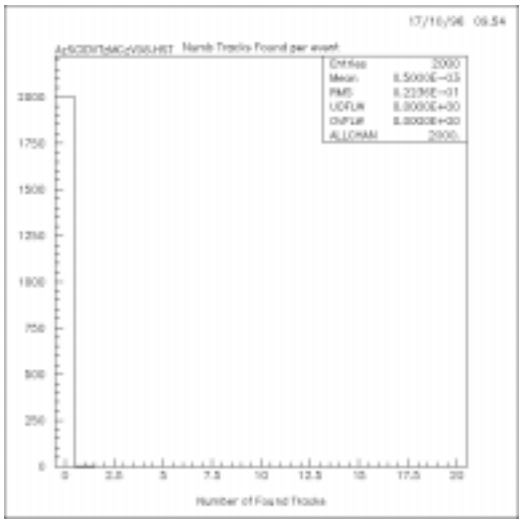

Figure 3 - Number of found tracks for 20 generated from 0.5 to 1.5 GeV.

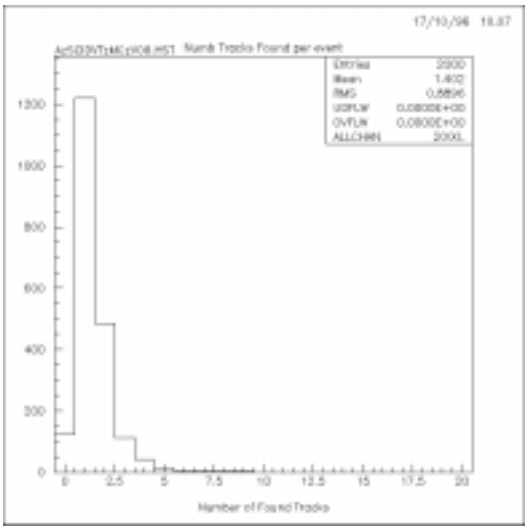

Figure 4 - Number of found tracks for 10 generated from 0.5 to 10.5 GeV. The seed threshold was set to 3 GeV.

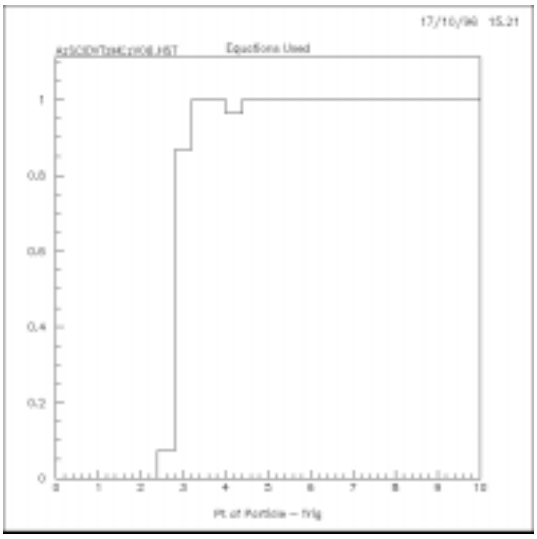

Figure 6 - Efficiency of trigger where seed track is above 1 GeV and NO extra tracks are generated.

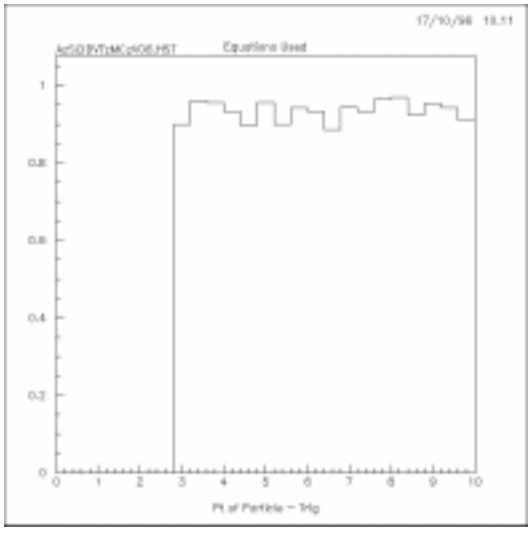

Figure 5 - Efficiency of 3 GeV Trigger with 9 extra tracks below 3 GeV.

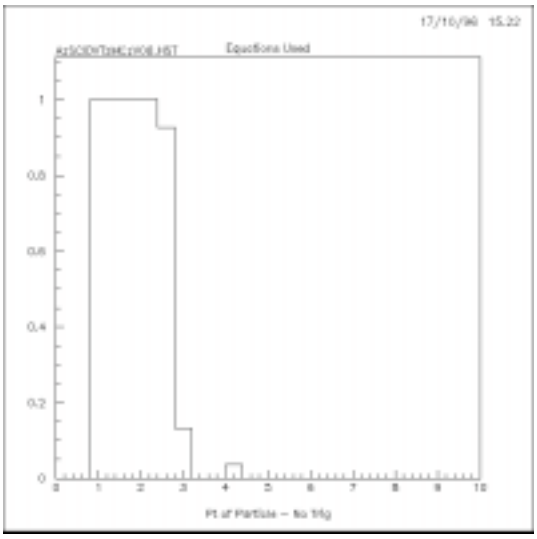

Figure 7 - Rejection of trigger where seed track is above 1 GeV and NO extra tracks are generated.

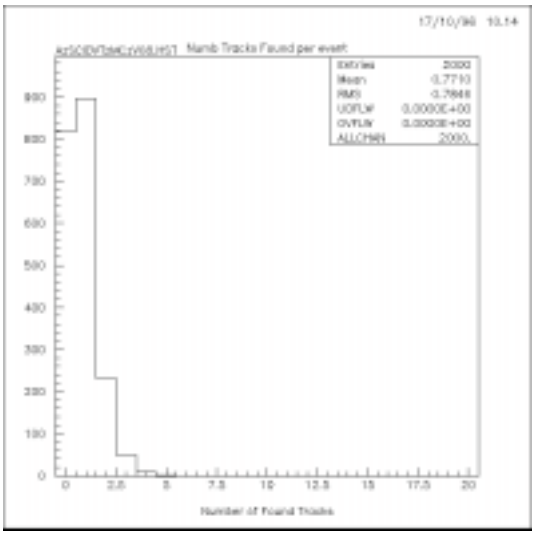

Figure 8 - Number of found tracks where the seed is now lowered to 2 GeV.

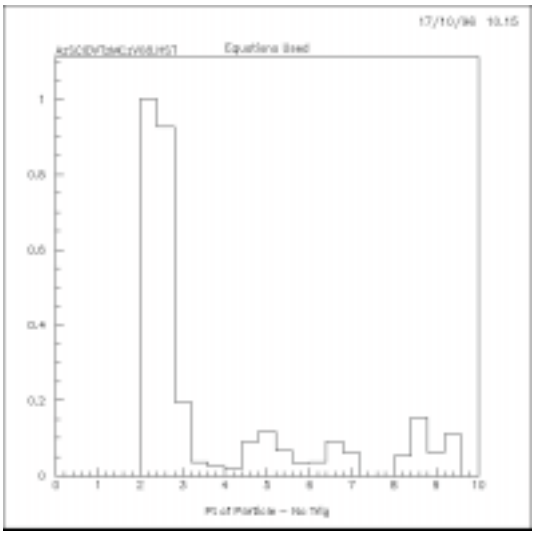

Figure 10 - Rejection versus Pt of non-triggered events. The trigger threshold is 3 GeV and the seed particles are generated from 2 GeV.

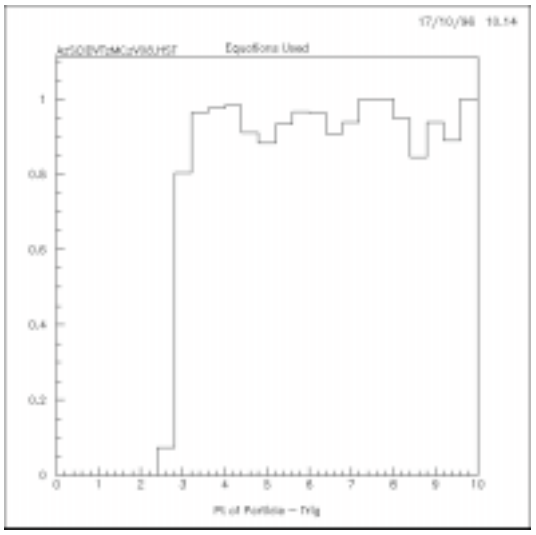

Figure 9 - Trigger Efficiency for this case.

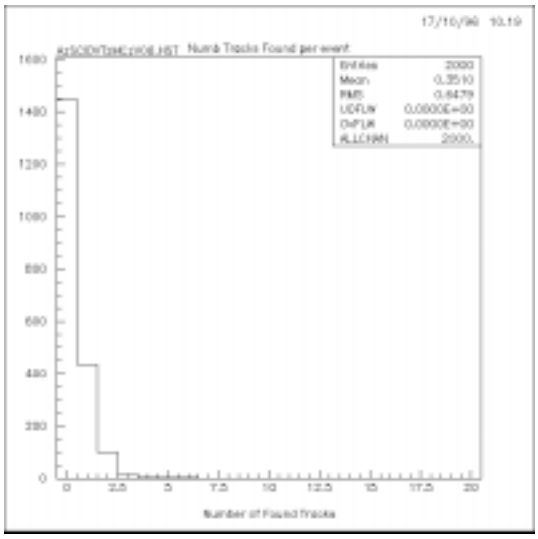

Figure 11 - Number of found tracks where the seed is above 1 GeV.

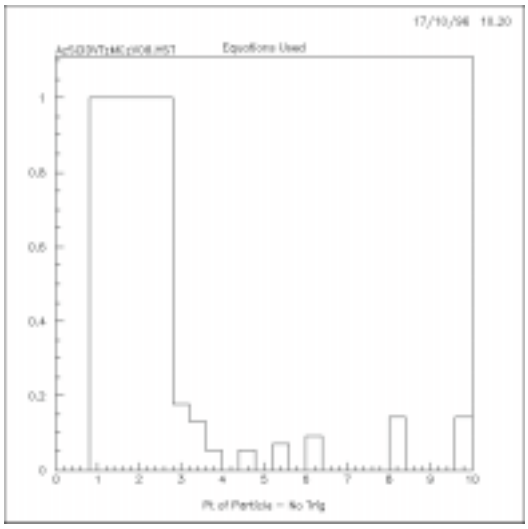

Figure 12 - The trigger rejection for this case.

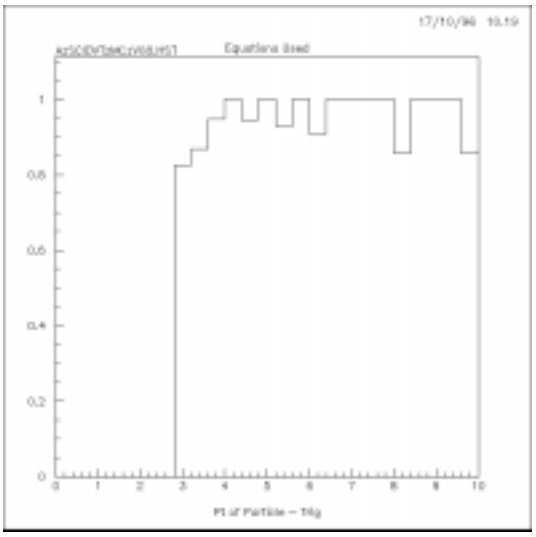

Figure 12 - The trigger efficiency for this case.

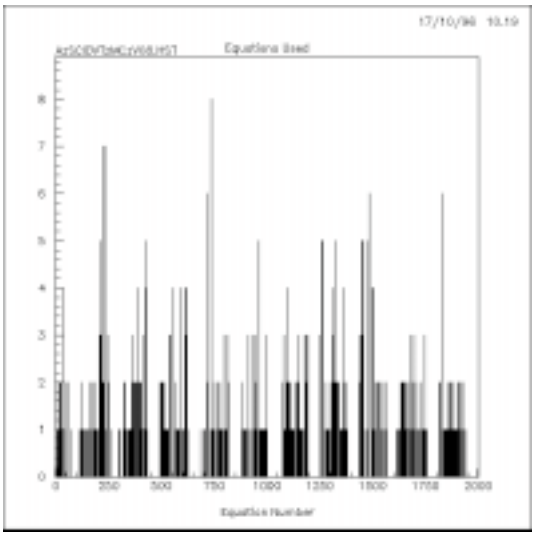

Figure 14 - Which equations were used for the found tracks. Note that there are 11 groups of equations corresponding to the 11 anchor bins in a cell.

	3 GeV Seed			2 GeV Seed			1 GeV Seed		
tracks	# of times	%	Integ %	# of times	%	Integ %	# of times	%	Integ %
0	120			815			1450		
1	1215	64.6	100.0	900	75.3	100.0	440	78.0	100.0
2	490	26.1	35.4	230	19.2	24.7	100	17.7	22.0
3	110	5.9	9.3	50	4.2	5.4	15	2.7	4.3
4	50	2.7	3.5	10	0.8	1.3	5	0.9	1.6
5	10	0.5	0.8	5	0.4	0.4	2	0.4	0.7
all rest	5	0.3	0.3	0	0.0	0.0	2	0.4	0.4

Table 1 - Multiplicity of found tracks for seed thresholds of 3, 2 and 1 GeV, The trigger threshold was 3 GeV. As the seed threshold drops the relative number of found tracks in multiplicity bins of 2 or more decreases.