Fermilab

The Impact of a Displaced Vertex Trigger on the CFT L1 Axial Trigger

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Introduction

There is an interest in building a displaced vertex trigger, DVT, at level 2 for the D0 upgrade detector. The DVT would look for displaced vertexes from 100 to 1000 um from the beam origin. The main trigger seed for the level 1 and hence also the level 2 for the upgrade detector is the CFT Axial trigger. In this note we address the questions. How efficient is the base line CFT Ax trigger in finding displaced vertex tracks? What modifications would be needed to improve this efficiency and what are their implications?

Base Line Trigger

The base line trigger uses track roads which are computed assuming the track originates at the origin, r = 0. These roads are one fiber wide and therefore one would expect that they would only be efficient for tracks that originated less than one fiber radius from the origin. The fiber diameter/radius is 985/293 um so the efficiency would be expected to drop for larger displaced vertexes.

We ran a MC simulation which used the equations for roads from +-3 GeV and no displacement of the origin as in the base line. In this MC we allowed the track origin to vary from 0 to 1000 um from the beam origin in a flat distribution. Figure 1 shows in the upper plot the trigger efficiency as a function of track Pt and in the lower plot the trigger efficiency as a function of displaced vertex value.

The efficiency as a function of track Pt is flat which indicates that the overall inefficiency due to displacement is not a function of the track Pt. The efficiency as a function of displacement value starts at 100% and appears to fall linearly to a value of 65% at 2000 um. A simple linear fit gives;

$$\text{Eff (\%)} = 100\% - R_{disp}\ \text{(um)} \times 0.0175.$$

Trigger Modification

Faced with an inefficiency for tracks with a displaced vertex we can: leave the trigger alone and accept the resulting inefficiency, or add to the base line roads to regain track efficiency. The first option requires no resources or additional work on the L1 trigger but has implications on the physics results and DVT efficiencies. The second option adds to the resources required for the L1 trigger.

Table 1 shows the number of additional roads needed for the CFT L1 if it is to be 100% efficient for displaced vertexes out to 1000um. With no displaced vertex about 3300 roads are required per cell with a 1.5 GeV threshold. That's 12,000 roads per sector. With a displaced vertex the number is somewhat above 8000, an increase of almost 2.5 times. Table 2 lists a small subset of the calculated roads for the base line trigger. It lists the 14 equations which share the same outer layer bin number and inner layer bin number. This combination of bin numbers also happen to be for the highest Pt tracks. Table 3 lists the roads for the same inner and outer bins but with the track origin from 0 to 1000 um. Those roads which correspond to roads in table 1 are marked with the table 1 road number.

We see that requiring the trigger to be efficient for displaced tracks in expensive in trigger resources. In fact it requires an increase in resources that may not be attainable within the present budget restraints especially in light of other considerations which already indicate that any increased resources are necessary for realizing the base line trigger in a less than perfect world.

	0 um Vertex		1000 um Vertex		Ratio of
Cut	**Number**	**%**	**Number**	**%**	**1000 / 1**
0	3345	100	8078	100	2.4
1	2982	99.6	4889	96.3	1.6
5	2204	96.5	2608	88.6	1.2
10	1704	91.9	1859	81.8	1.1
20	1178	82.7	1145	69.5	1.0

Table 1 - The number of equations needed when the interaction is at r=0 or at r<1000 microns.

TRK_1-5GEV_04OCT96.EQU

1	25	31	37	43	49	55	61	67	321
2	25	31	37	43	49	56	61	67	1
3	25	31	37	43	50	55	61	67	3
4	25	31	37	43	50	56	61	67	1
5	25	31	37	44	50	55	61	67	1
6	25	31	37	44	50	56	61	67	1
7	25	31	38	43	49	55	61	67	4
8	25	31	38	44	49	55	61	67	5
9	25	31	38	44	50	55	61	67	1
10	25	31	38	44	50	56	61	67	6
11	25	32	38	43	49	55	61	67	5
12	25	32	38	44	49	55	61	67	18
13	25	32	38	44	50	55	61	67	24
14	25	32	38	44	50	56	61	67	24

Table 2 - Roads from the base line design which pass through inner layer bin 25 and outer layer bin 67. The final column is the relative acceptance for the road. Road 1 which has the largest relative acceptance represents tracks with the highest Pt.

TRK_1-5GEV_04OCT96_1000BEAM.EQU

	25	29	33	38	44	51	60	67	1
	25	30	36	42	48	54	61	67	1
	25	30	36	42	48	55	61	67	1
	25	30	36	43	49	55	61	67	1
	25	31	36	42	48	54	61	67	1
	25	31	37	42	48	54	60	67	1
	25	31	37	42	48	54	61	67	1
	25	31	37	42	48	55	61	67	1
	25	31	37	42	49	55	61	67	1
1	25	31	37	43	49	55	61	67	245
2	25	31	37	43	49	56	61	67	1
4	25	31	37	43	50	56	61	67	1
	25	31	37	44	49	55	61	67	1
5	25	31	37	44	50	55	61	67	3
6	25	31	37	44	50	56	61	67	7
7	25	31	38	43	49	55	61	67	2
8	25	31	38	44	49	55	61	67	6
9	25	31	38	44	50	55	61	67	4
10	25	31	38	44	50	56	61	67	9
	25	31	38	44	50	56	62	67	1
	25	31	38	44	51	56	62	67	1
11	25	32	37	43	49	55	61	67	4
	25	32	38	43	49	55	61	67	2
12	25	32	38	44	49	55	61	67	16
13	25	32	38	44	50	55	61	67	23
14	25	32	38	44	50	56	61	67	31
	25	32	38	44	50	56	62	67	2
	25	32	38	45	51	56	61	67	3
	25	32	39	45	51	57	61	67	1
	25	32	39	46	52	57	61	67	1
	25	32	39	46	52	57	62	67	1
	25	33	40	46	52	57	62	67	1
	25	33	41	47	53	58	62	67	1

Table 3 - Roads from the extend design where the track origin is from 0 to 1000 um from the beam origin. The fourteen original roads are labeled with the track number from the base line design. The extra roads are needed for tracks which originate away from the beam origin.

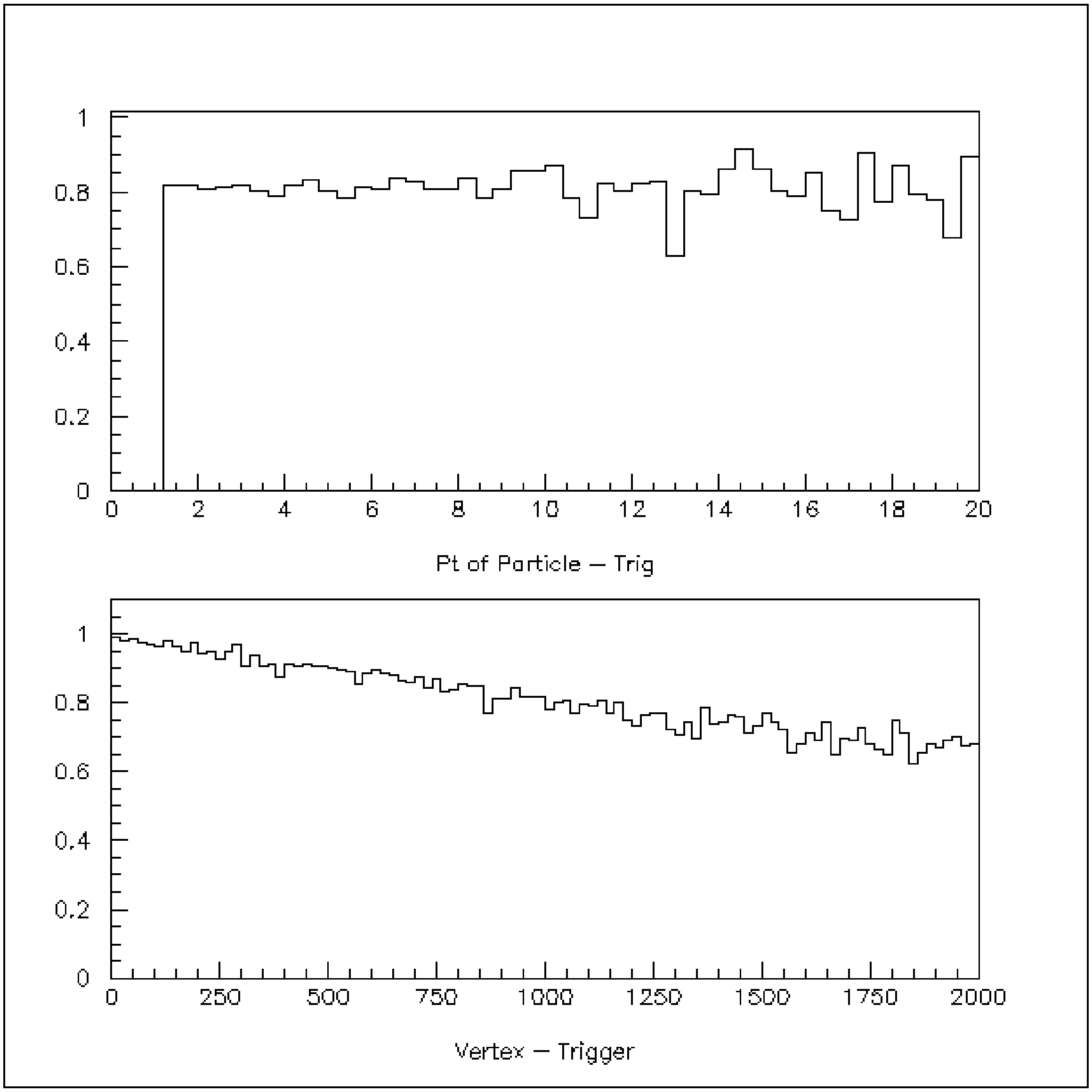

Figure 1 - The upper histogram is the efficiency of the trigger as a function of the track Pt. The units are in GeV. The lower histogram is the efficiency of the trigger as a function of the distance of the vertex from r=0. The units are in microns.