D0 Note 2504

A Study of the Effects of Fiber Placement Errors on the Level 1 CFT Trigger

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The effect of fiber placement errors on the level 1 trigger was studied with a single particle Monte Carlo. For each event a random Pt and initial direction ϕ_0 were chosen with the Pt spectrum weighted to approximate the minimum bias spectrum. The particle was then propagated in the magnetic field to each of the fiber layers. The fiber layer radius, fiber spacing (pitch) and fiber diameters were those for the base line detector. At each layer the position of the particle was calculated to determine which fiber was hit. The position was modified by adding a gaussian distributed random number before the hit fiber was found which simulated the possible random placement errors of the detector fibers. An independent error was generated for each of the 8 fiber layers of the detector. The variances of the displacement errors were varied from 10 microns to 250 microns, a range that varies between 1% and 25% of the fiber pitch. A value of 25 microns is the target value for the maximum fiber placement variation for the detector construction.

The trigger algorithm used in this study was the 'basic' algorithm as outlined in D0 NOTE 2359[1]. This algorithm uses half fiber wide bins in the doublet layers to form super layer vectors. The super layer vectors from the four super layers are combined in equations to find a track.

The first set of figures shows the trigger efficiency curves for various values of the variance of the fiber placement. Figure 1.1 shows the trigger efficiency for NO error. Since all positions and fiber efficiencies are perfectly known, the efficiency rises rapidly and stays at 100%. The solid, dotted and dashed lines are the low, medium and high Pt trigger levels. In the top plot the Pt ranges from 0 to 30 GeV, in the bottom the Pt ranges from 0 to 10 GeV.

Two trends are clear in figures 1.1 through 1.6. The first is, as expected, that the efficiency decreases as the placement error of the fibers increases. The second is that the efficiency for a given fiber placement error decreases as the Pt increases. This second trend is not so obvious and is occurring because of the way the trigger algorithm works. The algorithm in forming the super layer vector accepts as real only those tracks which for positive (negative) Pt bend to the right (left). If because of the placement error of a fiber the track appears to bend slightly the wrong way the track is rejected. Figures 2.1 and 2.2 show the trigger efficiency curves where now the super layer vector is modified to allow it to point to the wrong bend. This relaxation is most effective in gaining back the higher momentum tracks because they have the least bend. Figure 3 shows the trigger efficiency for the modified SL vector as the solid line and the original SL vector as the dashed line. From these figures we see that the momentum dependence of the efficiency goes away for the modified SL vector. We also see that the efficiency is better for all momenta.

Table 1 gives the equations found for the modified algorithm with 50um fiber placement errors. The fraction of tracks in each bin is relative to the sum of all the bins out to a D super layer bin of 12. The first column is the equation number. The next four columns are the relative offset of each super layer bin relative to the A super layer. The column for the A super layer is thus always 0. The sixth column is the fraction of tracks satisfying this equation out of all the tracks generated. The uncertainty is sqrt(N)/N where N is the number of tracks in the equation.

This table was generated by running the MC and counting the number of times a track went through a different combination of super layer bins out of all the bin combinations possible. The integer equation numbers are the 22 equations found when the MC is run with no fiber placement error. The equations numbered as x.y are the extra equations found when the placement error has a variance of 50 um. Equations 1.1 and 1.2 are found only with the modified SL vector definition. All of the rest of the extra equations were found with the basic SL vector definitions as well.

All of the ‘extra’ equations have acceptances well less than 1%. Also for D super layer offsets of 3, 6 and 9 there is only one equation each when there is no fiber placement error. These magic bins are a coincidence of the fiber geometry. As the fiber placement error increases extra equations appear at these values first and have the largest relative acceptance.

In conclusion we see that for a 25 um fiber placement error as expected in the built detector either the basic or the modified SL vector definition would remain efficient. As the error approaches 50 um the SL vector would have to be modified or relaxed to accept wrong bend SL vectors. With a modified SL vector definition a fiber placement

error of somewhat over 50 um could be acceptable. The equations do not need to be extended for fiber placement errors of less than 100 um.

Of course relaxing the SL vector definition would let in more false SL hits and lead to more false tracks. How modifying the algorithm to allow large fiber placement errors would effect the rate of false tracks needs study.

Equation Number	A Super Layer Offset	B Super Layer Offset	C Super Layer Offset	D Super Layer Offset	Fraction of Tracks in this bin.	Uncertainty in Fraction of Tracks in this bin.
1.1	0	-1	0	0	0.00007535	0.00007535
1	0	0	0	0	0.05966755	0.00216295
1.2	0	1	1	0	0.00007535	0.00007535
2	0	0	0	1	0.07213423	0.00237820
3	0	0	1	1	0.14285715	0.00334678
4	0	1	1	1	0.08350322	0.00255875
5	0	0	1	2	0.04712247	0.00192217
5.1	0	0	2	2	0.00007841	0.00007841
6	0	1	1	2	0.11949193	0.00306088
7	0	1	2	2	0.04861220	0.00195231
8.1	0	0	2	3	0.00031363	0.00015681
8	0	1	2	3	0.12803826	0.00316845
8.2	0	1	3	3	0.00023522	0.00013580
8.3	0	2	2	3	0.00023522	0.00013580
9	0	1	2	4	0.02203230	0.00131434
10	0	1	3	4	0.03583189	0.00167615
11.1	0	2	2	4	0.00007841	0.00007841
11	0	2	3	4	0.02054258	0.00126912
12	0	1	3	5	0.01521091	0.00109208
13	0	2	3	5	0.03300925	0.00160877
14	0	2	4	5	0.01356437	0.00103128
15.1	0	1	4	6	0.00007841	0.00007841
15	0	2	4	6	0.04304532	0.00183713
15.2	0	3	4	6	0.00015681	0.00011088
16	0	2	4	7	0.00831112	0.00080725
17	0	2	5	7	0.01427003	0.00105777
18.1	0	3	4	7	0.00007841	0.00007841
18	0	3	5	7	0.00776227	0.00078014
19	0	2	5	8	0.00525325	0.00064179
19.1	0	2	6	8	0.00015681	0.00011088
20	0	3	5	8	0.01176102	0.00096028
21	0	3	6	8	0.00635095	0.00070566
22.1	0	2	5	9	0.00007841	0.00007841
22.2	0	2	6	9	0.00015681	0.00011088
22	0	3	6	9	0.02015054	0.00125696
22.3	0	4	6	9	0.00007841	0.00007841

Table 1 The equation numbers, super layer offsets and fraction of tracks for 50 um fiber placement error and modified SL vector definition.

Fiber Placement Error	Number of Equations		Efficiency (%)	
	Basic SL Vector	Modified SL Vector	Basic SL Vector	Modified SL Vector
0	22	22	100	100
10	24	-	99	-
25	28	-	98	-
50	35	36	97	99
100	42	-	90	-
250	62	70	45	75

Table 2. Number of equations and average efficiency tabulated as a function of the variance of the fiber placement error.

References:

[1] Level 1 Trigger Design for the D0 Upgrade Central Fiber Tracker, Fred Borcherding, D0 NOTE 2359, November 21, 1994.