LC-DET-2001-078

Performance studies for the TESLA forward tracking system with different layouts

Heiko Bauke*

September 13, 2001

1 Ghost hits

The intermediate tracking system of the proposed TESLA detector consists of different disk shaped silicon detectors. See [1] section 2.2 for the general intermediate tracking system. In this paper we will concentrate on the detectors FTD 4, FTD 5, FTD 6 and FTD 7.

This detectors are stripe detectors. In contrast to pixel detectors stripe detectors generate so called ghost hits, if more than one particle hit the detector at one time. Each hit in the detector generates a signal in a horizontal and a vertical stripe. If only one particle hits the detector the hit site can be reconstructed unique. The hit was on this site, where the strips with signal cross each other. If two particles hit the detector, the hit sites are not unique anymore. Two ghost hits appear in the detector as illustrated in figure 1 on the left side. With more hits at one time the situation gets more complicated as seen on the right side of figure 1.

In a detector with arbitrary high resolution n hits generate $\sum_{i=1}^{n} 2(n-i) = n^2 - n$ ghost hits. So the number of ghost hits grows quadratic with the number of hits.

*Heiko.Bauke@student.uni-magdeburg.de

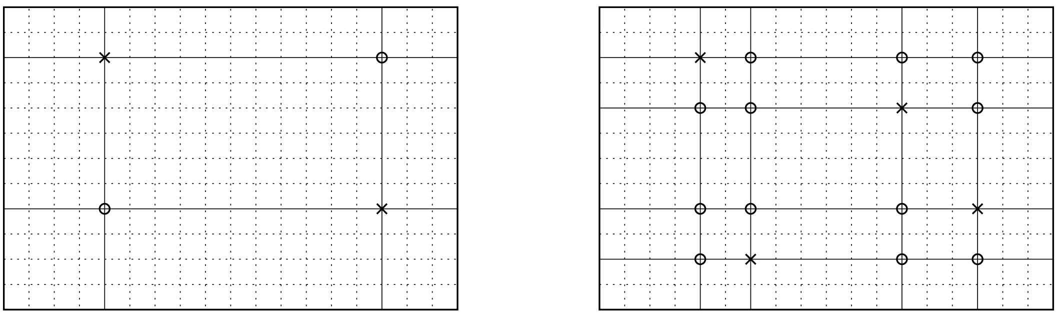

Figure 1: A particle generates signals on the stripes, where it hits the detector. The hit was on the site, where the stripes with signal cross each other. But there are more cross points than real hits, so one gets ghost hits. (crosses indicate real hits, circles indicate ghost hits)

The ghost hits are an additional difficulty for a track reconstruction algorithm. In this article the impact of ghost hits to the track reconstruction algorithm in BRAHMS [3] is investigated. BRAHMS is a reconstruction and analysis monte carlo software package. The track reconstruction algorithm does track reconstruction on two levels. On TS level the algorithms collects all possible good tracks. Later some ambiguities are solved on TK level. TK level is the higher and more important level. The pattern reconstruction algorithm is described in more detail in [4].

2 Layout of the forward detector

This article pays attention to the detector disks that lie perpendicular to the beam axis in each of the two end caps. Each disk is installed two times, one on the left, one on the right side of the intersection point. The disks contain 120 strip detectors with crossed strips. In figure 2 this layout is shown. In principle all disks FTD 4, FTD 5, FTD 6 and FTD 7 have the same layout, but with different dimensions. This dimensions are listed in table 1. The detectors in the innermost ring have a small overlap with the detectors in the middle ring. For the performance studies the disks are sometimes rotated 7.5° to the beam axis.

Table 1: The dimensions of the detectors FTD 4, FTD 5, FTD 6 and FTD 7. The notations in the table's headline correspond to the notations in figure 2.

module	z	R_1	R_2	R_3	R_4	R_5
FTD 4	±55 cm	5.49 cm	12.49 cm	12.0 cm	20.0 cm	28.0 cm
FTD 5	±80 cm	7.66 cm	14.66 cm	14.0 cm	22.0 cm	30.0 cm
FTD 6	±105 cm	9.73 cm	16.73 cm	16.0 cm	23.0 cm	30.0 cm
FTD 7	±130 cm	5.49 cm	12.49 cm	17.0 cm	23.0 cm	30.0 cm

The 120 sub detectors on each disk are not rectangular but trapezoidal. So two different strip alignment are obvious as shown in figure 3. In a real detector the strips lie more dense than in the picture.

3 Tracking performance

To accomplish the investigations as shown in the following the software package BRAHMS was used and adopted. In each case 100 bunch crossings were analysed with $\mathrm{e}^+\mathrm{e}^- \to \mathrm{q}\,\bar{\mathrm{q}}$ events without initial state radiation and $|\cos\theta_{\mathrm{thrust}}| > 0.95$.

In a first step it was assumed that the detectors generate no ghost hits at all. In table 4 we see that the global tracking performance at 500 GeV is almost 98 %. At 800 GeV the global tracking performance decreases slightly and the fake rate increases up to 7.7 % at TS level. The fake track rate is defined as the number of tracks per event which have 3 or less hits from a unique truth track. Such tracks arise from combinations of hits from different tracks, background or both[4]. In the following studies background consists only of ghost hits. In the following tables 5 and 6 the sub detector contributions track search performance on TS level and TK level are given. The most hits lie in the innermost detector FTD 4. Nevertheless tracking performance for FTD 4 is better than for the other detectors with more tracks.

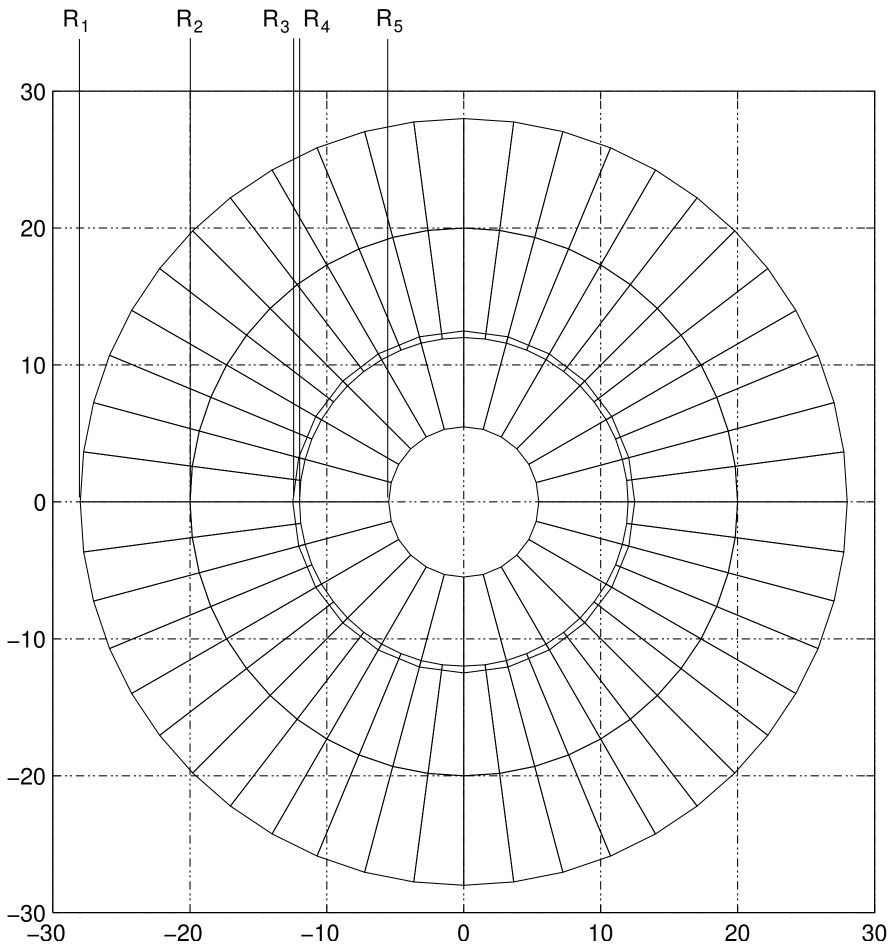

Figure 2: The layout of detector FTD 4.

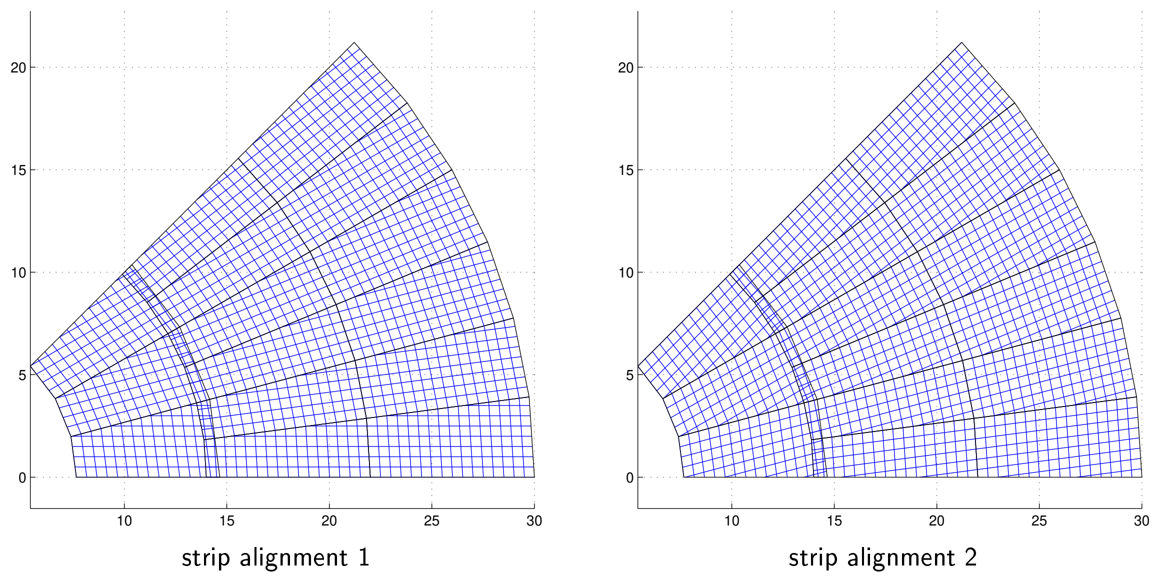

Figure 3: Detail view on the layout of detector FTD 5 and the two different possible strip alignment.

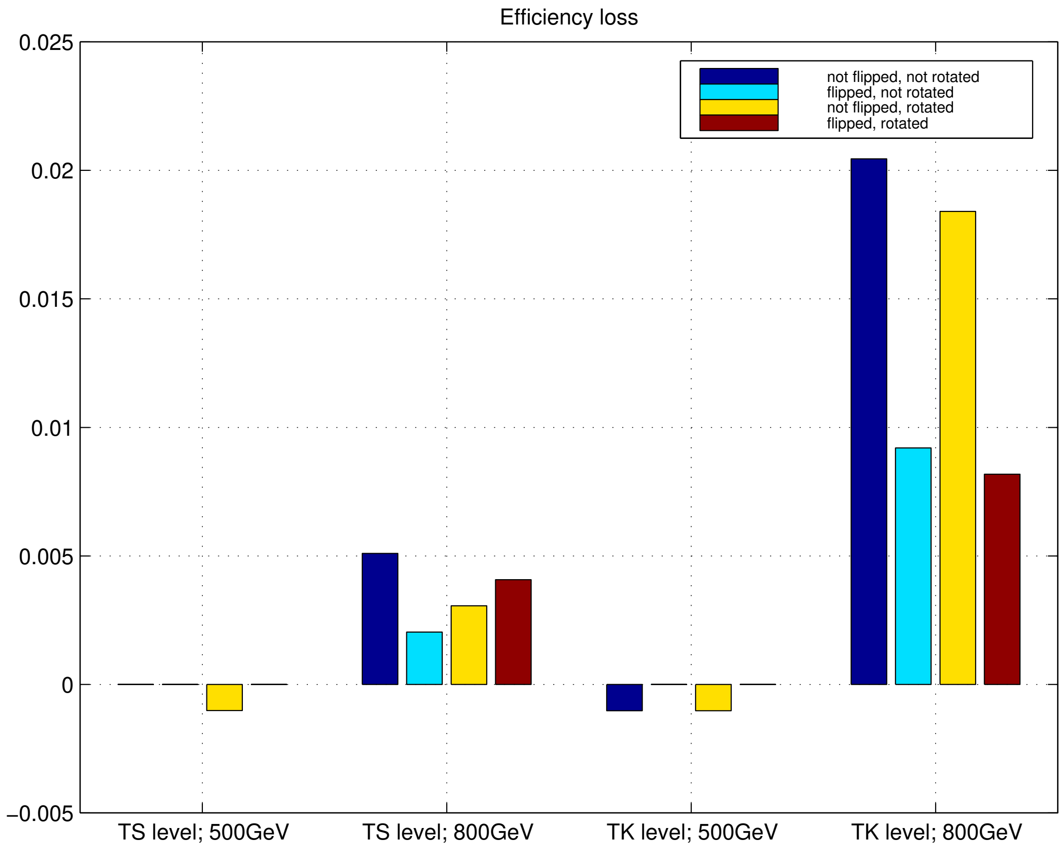

Figure 4: One minus ratio between tracking efficiency with ghost hits to tracking efficiency without ghost hits at 500 GeV and 800 GeV. For tracking efficiency see 'efficiency wrt. tree' in tables 4, 7 and 10.

These measurements are considered as a reference for analysing ghost hits' impact to the track reconstructing algorithm. These studies are done with different geometries.

1. All disks FTD 4, FTD 5, FTD 6 and FTD 7 had the same strip alignment, they were not rotated.
2. Disks FTD 4, FTD 6 had strip alignment 1 but disks FTD 5, FTD 7 had strip alignment 2. All disks were not rotated.
3. All disks FTD 4, FTD 5, FTD 6 and FTD 7 had the same strip alignment. Disks FTD 4 and FTD 6 were rotated 7.5°.
4. Disks FTD 4, FTD 6 had strip alignment 1 but disks FTD 5, FTD 7 had strip alignment 2. Disks FTD 4 and FTD 6 were rotated 7.5°.

In figure 4 the efficency loss as a result of ghost hits is shown. Efficency loss is defined by

$$\text{efficency loss} = 1 - \frac{\text{`efficiency wrt. tree' with ghost hits}}{\text{`efficiency wrt. tree' without ghost hits}}\,. \tag{1}$$

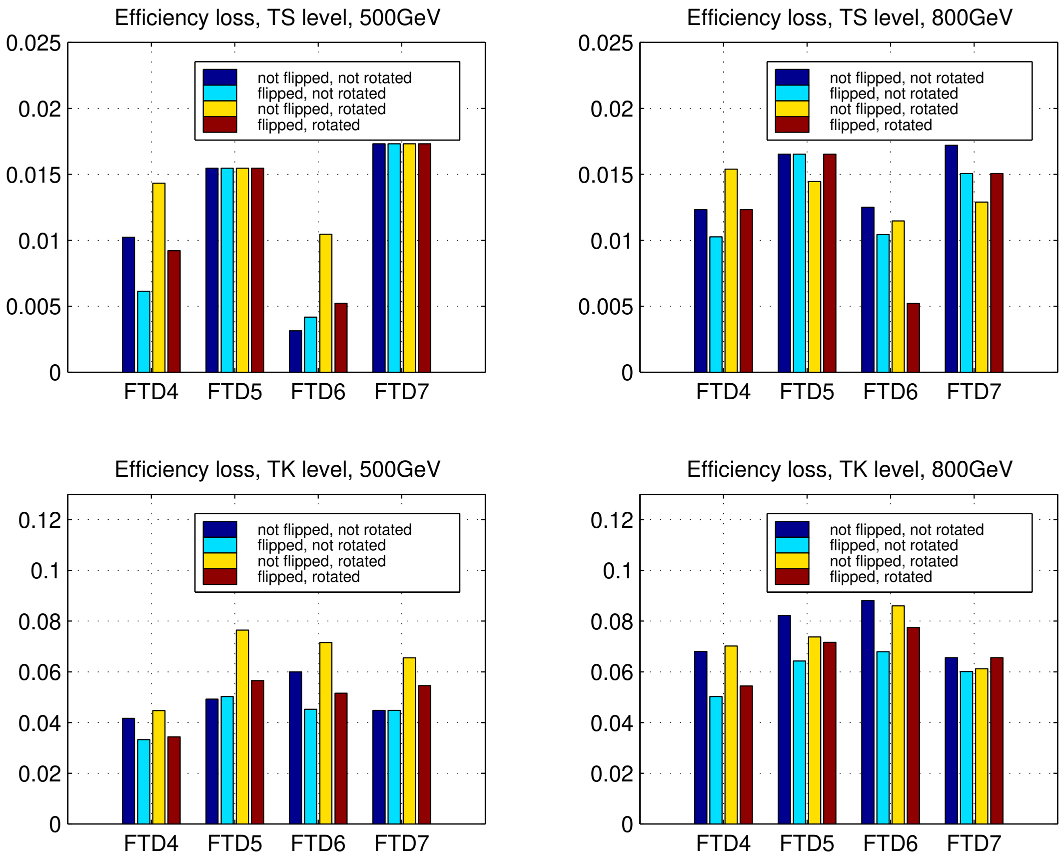

Figure 5: One minus ratio between tracking efficiency with ghost hits to tracking efficiency without ghost hits in respect of the different detectors at 500 GeV and 800 GeV. For tracking efficiency see 'efficiency wrt. tree' in tables 4, 7 and 10.

A zero length bar would indicate that tracking efficency with ghost hits is as good as without ghost hits. At 500 GeV there is no efficency loss, but at 800 GeV. Geometry 4 has the smallest efficency loss at 800 GeV at TK level. Flipping the strip alignment as in geometry 2 and 4 reduces the efficency loss at 800 GeV at TK level up to a factor of about two.

Figure 5 shows efficency loss in respect of the different detectors at 500 GeV and 800 GeV for the different geometries. The efficency loss at TK level is about three times larger than at TS level. Especially at high energies geometry 2 is advantageous. It has the smallest efficency loss at TK level for detector FTD 4, FTD 5, FTD 6 and FTD 7.

Another important point is the number of fake tracks. Figure 6 shows how the number of fake tracks grows, if ghost hits are considered in the simulation. For example at TS level at 500 level the number of fake tracks grows by a factor of 21. In general flipping the stripe alignment as in geometry 2 and 4 decreases the number of fake tracks. Rotating detector FTD 4 and FTD 6 decreases the number of fake tracks, too. With geometry 4 one gets the best result with a small number of fake tracks.

The time for tracking one event increases rapidly, if ghost hits are considered. With ghost hits the tracking algorithm has to do much more combinatorics, so the time needed to track one event grows. At 800 GeV the time increases more than at 500 GeV because there are

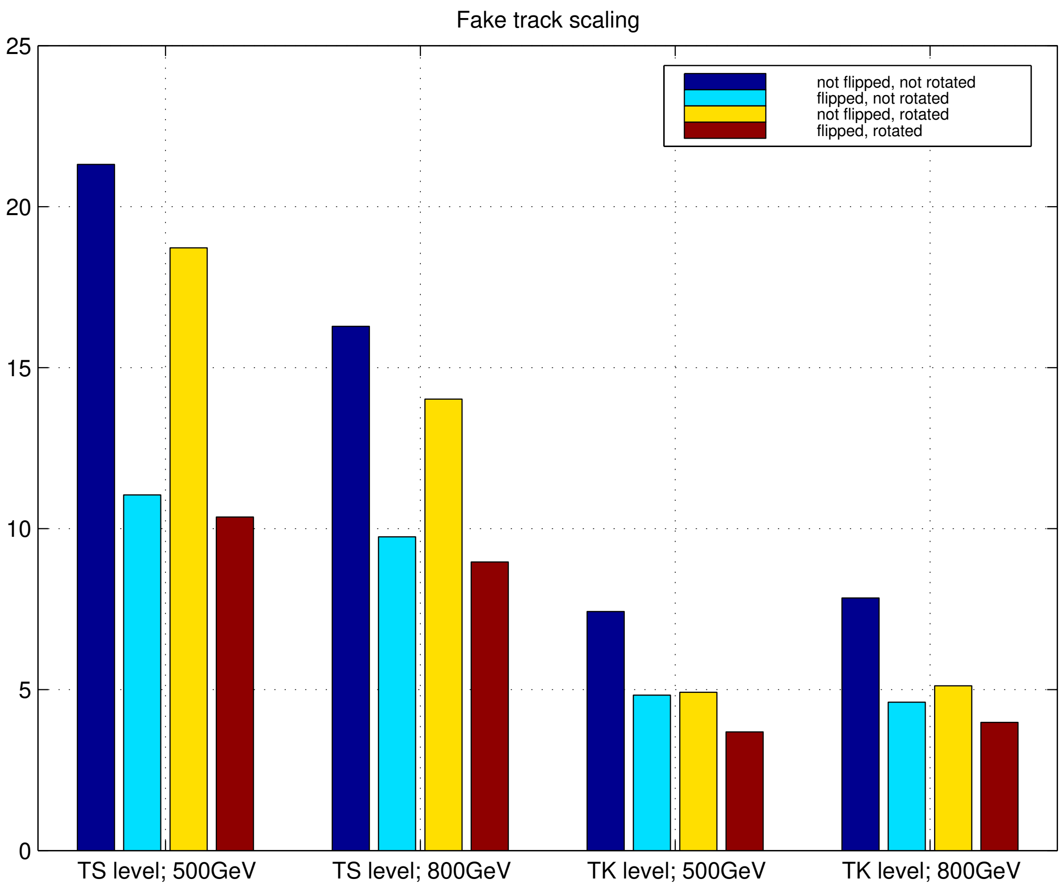

Figure 6: Ratio between number of fake tracks with ghost hits to number of fake tracks without ghost hits in respect of the different detectors at 500 GeV and 800 GeV.

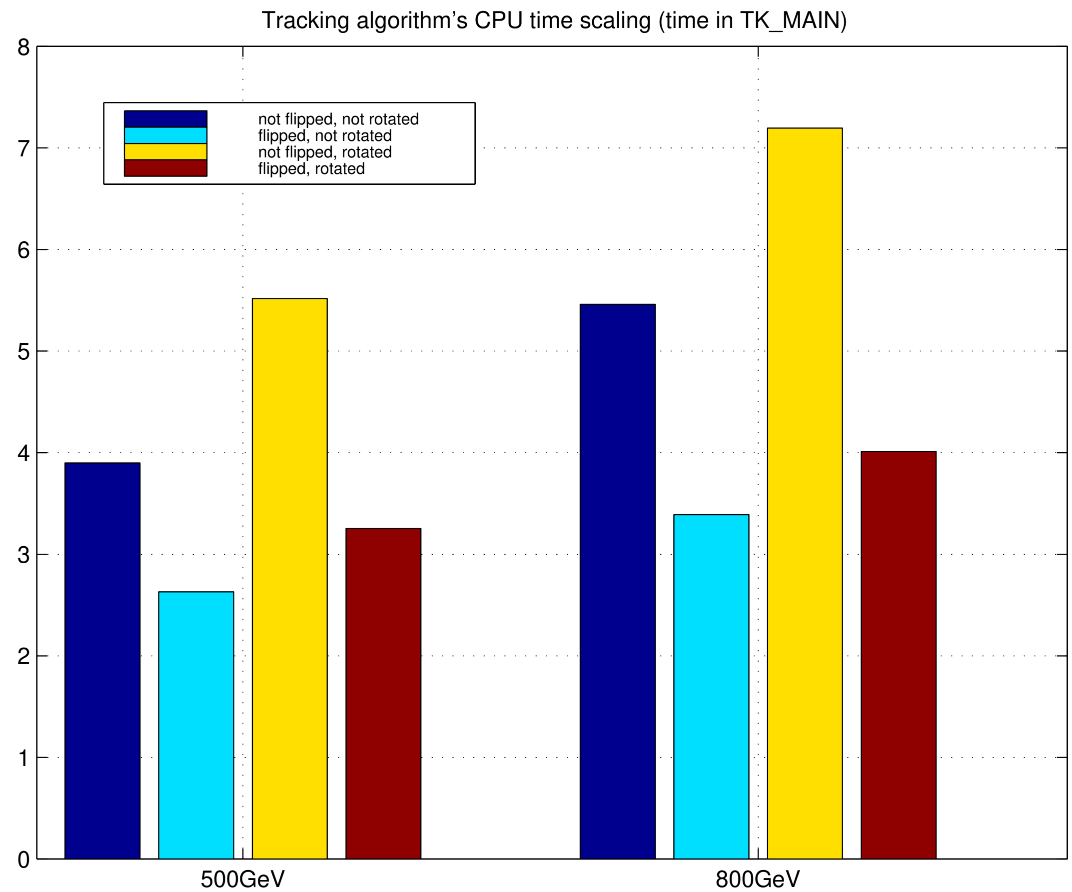

Figure 7: CPU time ratio for track finding algorithm with ghost hits to track finding algorithm without ghost hits.

Table 2: Tracking time per event at 500 GeV and 800 Ge on a PC with a Pentium III 800 CPU, (Compiler g77, GNU CPP version egcs-2.91.66, no optimisation)

	without ghost hits		with ghost hits							
			no rotation				7.5° rotated			
			same alignment		flipped alignment		same alignment		flipped alignment	
	500 GeV	800 GeV	500 GeV	800 GeV	500 GeV	800 GeV	500 GeV	800 GeV	500 GeV	800 GeV
total CPU time	4346 s	7633 s	16070 s	39989 s	10936 s	24954 s	22615 s	52590 s	13461 s	29485 s
CPU time per event	43 s	76 s	161 s	400 s	109 s	250 s	226 s	526 s	135 s	295 s
time spend in										
GTREVE	294 s	366 s	296 s	350 s	291 s	344 s	293 s	361 s	298 s	357 s
TKMAIN	4044 s	7258 s	15767 s	39631 s	10637 s	24601 s	22314 s	52220 s	13155 s	29119 s
UBTREV	1 s	1 s	1 s	1 s	1 s	1 s	1 s	1 s	1 s	1 s
rest of BRAHMS	6 s	8 s	6 s	8 s	6 s	8 s	6 s	8 s	6 s	8 s
routines in TKMAIN										
TKHDET	3 s	4 s	4 s	5 s	4 s	5 s	4 s	5 s	4 s	5 s
TKMKEX	5 s	8 s	8 s	16 s	6 s	12 s	8 s	15 s	7 s	12 s
TKPERF	2 s	2 s	2 s	3 s	2 s	3 s	2 s	3 s	2 s	3 s
for local pattern recognition										
LP_VTX	3741 s	6858 s	15337 s	39036 s	10259 s	24087 s	21891 s	51619 s	12775 s	28599 s
LP_TPC	109 s	136 s	109 s	137 s	109 s	136 s	109 s	137 s	109 s	136 s
LP_FCH	0 s	0 s	0 s	0 s	0 s	0 s	0 s	0 s	0 s	0 s
searches and ambiguity resolving										
FSFSTR	137 s	181 s	196 s	284 s	172 s	237 s	194 s	288 s	172 s	242 s
TKAMBI	40 s	59 s	101 s	140 s	78 s	112 s	98 s	144 s	78 s	113 s

much more ghost hits. The tracking time per event depends not only on the number of ghost hits. It depends also on the strip alignment. With flipped strip alignment as in geometry 2 and 4 the track reconstructing algorithm is much faster, than if strip alignment is not flipped. Rotating disk FTD 4 and FTD 6 slows the track reconstruction routine down. The reader finds a detailed view to tracking time in table 2 and figure 7. Figure 7 shows track reconstruction time relative to the track reconstruction time without ghost hits. The calorimeters were not taken into account. With calorimeters the CPU time per event would grow significantly.

In particular hits at close quarters are a reason for a high fake rate. But up to now it was not taken into account that the detectors have only a limited double track resolution. With a limited double track resolution these hits are indistinguishable and double track resolution can decrease fake rate. The following procedure was used to regard this. Points with a distance smaller than the double track resolution are merged together. A double track resolution of 540 µm was assumed.

$RES \leftarrow$ detector's double track resolution
for all sub detectors of a disk **do**
  repeat
    find the hits H_i and H_k in the sub detector with the smallest euclidian distance $|H_i - H_k|$
    $\Delta_{min} = |H_i - H_k|$
    if $\Delta_{min} < RES$ **then**
      $H_i \leftarrow$ center point betweenn H_i and H_k with the sum energy of H_i and H_k (H_i and H_k are weighted with their energy)
      delete H_k
    end if
  until $\Delta_{min} \nless RES$
end for

In figure 8 the result of such a merging process with a double track resolution of 1 cm is shown. A real detector has a higher double track resolution. The figure is only for illustration. If a double track resolution of 540 µm was assumed, less than one percent of hits are merged. Table 3 shows how often n hits were merged into one hit after 100 bunch crossings. The double track resolution affects the track reconstruction algorithm not much. The tables 19, 20 and 21 show tracking results in detail for geometry 4.

Table 3: This table shows how often n hits were merged into one hit after 100 bunch crossings. Less than one percent of hits are merged.

energy	1	2	3	4	5	6	7	8
	hits merged into one hit							
500 GeV	7621	31	0	1	1	0	0	0
800 GeV	8721	28	0	0	0	0	0	1

Table 4: Global track search performance at 500 GeV and 800 GeV beam energy and no ghost hits.

	500 GeV		800 GeV	
	TS level	TK level	TS level	TK level
number of tree tracks	2426	2426	3017	3017
tree tracks with hits	2426	2426	3017	3017
at least 3 hits	2426	2426	3017	3017
reconstructed 1 time	2106	2314	2496	2878
2 times	129	64	197	71
3 times	52	1	86	1
4 times	26	0	58	0
> 4 times	68	0	119	0
total tracks found	2381	2379	2956	2950
fake TS/TK	83	35	231	59
efficiency wrt. tree	0.981	0.981	0.980	0.978
eff. wrt. 3 hit tr.	0.981	0.981	0.980	0.978
fake rate wrt. tree	0.034	0.014	0.077	0.020

Table 5: Sub detector contributions to track search performance on TS level at 500 GeV and 800 GeV beam energy and no ghost hits.

	500 GeV					800 GeV				
detector	1	2	3	4	5	1	2	3	4	5
FTD 4	1704	1664	43	0	0.977	2008	1955	103	0	0.974
FTD 5	1437	1394	23	0	0.970	1632	1579	44	0	0.968
FTD 6	1027	982	9	0	0.956	1134	1087	39	0	0.959
FTD 7	694	641	10	0	0.924	729	678	17	0	0.930

1: tracks producing at least 1 hit in sub detector
2: tracks with correct TE in reconstructed TS
3: number of fake TS with good TE from this subdet
4: number of fake TS with noise TE from this subdet
5: efficiency wrt. tree tracks

Table 6: Sub detector contributions to track search performance on TK level at 500 GeV and 800 GeV beam energy and no ghost hits.

	500 GeV					800 GeV				
detector	1	2	3	4	5	1	2	3	4	5
FTD 4	1704	1637	11	0	0.961	2008	1918	15	0	0.955
FTD 5	1437	1373	9	0	0.955	1632	1548	14	0	0.949
FTD 6	1027	976	3	0	0.950	1134	1068	7	0	0.942
FTD 7	694	636	3	0	0.916	729	667	4	0	0.915

1: tracks producing at least 1 hit in sub detector
2: tracks with correct TE in reconstructed TK
3: number of fake TK with good TE from this subdet
4: number of fake TK with noise TE from this subdet
5: efficiency wrt. tree tracks

Table 7: Track search performance at 500 GeV and 800 GeV beam energy and ghost hits from strip detectors with same alignment.

	500 GeV		800 GeV	
	TS level	TK level	TS level	TK level
number of tree tracks	2426	2426	2945	2945
tree tracks with hits	2426	2426	2945	2945
at least 3 hits	2426	2426	2945	2945
reconstructed 1 time	1726	2281	2029	2732
2 times	211	86	237	87
3 times	104	1	146	1
4 times	84	0	102	0
>4 times	256	0	376	0
total tracks found	2381	2368	2890	2820
fake TS/TK	1769	260	3761	463
efficiency wrt. tree	0.981	0.976	0.981	0.958
eff. wrt. 3 hit tr.	0.981	0.976	0.981	0.958
fake rate wrt. tree	0.729	0.107	1.277	0.157

Table 8: Sub detector contributions to track search performance on TS level at 500 GeV and 800 GeV beam energy and ghost hits from strip detectors with same alignment.

	500 GeV					800 GeV				
detector	1	2	3	4	5	1	2	3	4	5
FTD 4	1704	1648	240	1147	0.967	1958	1884	572	2352	0.962
FTD 5	1437	1373	174	1122	0.955	1583	1507	341	2221	0.952
FTD 6	1027	979	135	846	0.953	1090	1032	285	1469	0.947
FTD 7	694	630	121	462	0.908	688	629	263	947	0.914

1: tracks producing at least 1 hit in sub detector
2: tracks with correct TE in reconstructed TS
3: number of fake TS with good TE from this subdet
4: number of fake TS with noise TE from this subdet
5: efficiency wrt. tree tracks

Table 9: Sub detector contributions to track search performance on TK level at 500 GeV and 800 GeV beam energy and ghost hits from strip detectors with same alignment.

	500 GeV					800 GeV				
detector	1	2	3	4	5	1	2	3	4	5
FTD 4	1704	1569	23	190	0.921	1958	1742	47	333	0.890
FTD 5	1437	1305	8	206	0.908	1583	1379	32	335	0.871
FTD 6	1027	917	15	169	0.893	1090	936	27	286	0.859
FTD 7	694	607	11	88	0.875	688	588	13	168	0.855

1: tracks producing at least 1 hit in sub detector
2: tracks with correct TE in reconstructed TK
3: number of fake TK with good TE from this subdet
4: number of fake TK with noise TE from this subdet
5: efficiency wrt. tree tracks

Table 10: Track search performance at 500 GeV and 800 GeV beam energy and ghost hits from strip detectors with flipped alignment.

	500 GeV		800 GeV	
	TS level	TK level	TS level	TK level
number of tree tracks	2426	2426	3017	3017
tree tracks with hits	2426	2426	3017	3017
at least 3 hits	2426	2426	3017	3017
reconstructed 1 time	1788	2288	2137	2818
2 times	214	86	257	103
3 times	96	1	123	1
4 times	81	0	106	0
> 4 times	202	0	334	0
total tracks found	2381	2375	2957	2922
fake TS/TK	917	169	2251	272
efficiency wrt. tree	0.981	0.979	0.980	0.969
eff. wrt. 3 hit tr.	0.981	0.979	0.980	0.969
fake rate wrt. tree	0.378	0.070	0.746	0.090

Table 11: Sub detector contributions to track search performance on TS level at 500 GeV and 800 GeV beam energy and ghost hits from strip detectors with flipped alignment.

	500 GeV					800 GeV				
detector	1	2	3	4	5	1	2	3	4	5
FTD 4	1704	1654	193	434	0.971	2008	1935	529	1012	0.964
FTD 5	1437	1372	98	560	0.955	1632	1554	213	1307	0.952
FTD 6	1027	978	106	248	0.952	1134	1076	236	568	0.949
FTD 7	694	630	62	240	0.908	729	668	169	582	0.916

1: tracks producing at least 1 hit in sub detector
2: tracks with correct TE in reconstructed TS
3: number of fake TS with good TE from this subdet
4: number of fake TS with noise TE from this subdet
5: efficiency wrt. tree tracks

Table 12: Sub detector contributions to track search performance on TK level at 500 GeV and 800 GeV beam energy and ghost hits from strip detectors with flipped alignment.

	500 GeV					800 GeV				
detector	1	2	3	4	5	1	2	3	4	5
FTD 4	1704	1583	23	72	0.929	2008	1822	51	128	0.907
FTD 5	1437	1304	11	111	0.907	1632	1449	17	175	0.888
FTD 6	1027	931	19	63	0.907	1134	996	26	97	0.878
FTD 7	694	607	10	40	0.875	729	627	15	76	0.860

1: tracks producing at least 1 hit in sub detector
2: tracks with correct TE in reconstructed TK
3: number of fake TK with good TE from this subdet
4: number of fake TK with noise TE from this subdet
5: efficiency wrt. tree tracks

Table 13: Track search performance at 500 GeV and 800 GeV beam energy and ghost hits from strip detectors with same alignment. FTD 4 and FTD 6 are rotated 7.5°.

	500 GeV		800 GeV	
	TS level	TK level	TS level	TK level
number of tree tracks	2426	2426	2932	2932
tree tracks with hits	2426	2426	2932	2932
at least 3 hits	2426	2426	2932	2932
reconstructed 1 time	1730	2281	1997	2723
2 times	214	90	262	92
3 times	114	1	126	1
4 times	67	0	107	0
>4 times	257	0	383	0
total tracks found	2382	2372	2875	2816
fake TS/TK	1554	172	3240	302
efficiency wrt. tree	0.982	0.978	0.981	0.960
eff. wrt. 3 hit tr.	0.982	0.978	0.981	0.960
fake rate wrt. tree	0.641	0.071	1.105	0.103

Table 14: Sub detector contributions to track search performance on TS level at 500 GeV and 800 GeV beam energy and ghost hits from strip detectors with same alignment. FTD 4 and FTD 6 are rotated 7.5°.

	500 GeV					800 GeV				
detector	1	2	3	4	5	1	2	3	4	5
FTD 4	1704	1641	234	1029	0.963	1949	1869	517	2044	0.959
FTD 5	1437	1373	192	726	0.955	1589	1516	343	1630	0.954
FTD 6	1027	972	143	517	0.946	1102	1045	285	968	0.948
FTD 7	694	630	81	333	0.908	707	649	255	741	0.918

1: tracks producing at least 1 hit in sub detector
2: tracks with correct TE in reconstructed TS
3: number of fake TS with good TE from this subdet
4: number of fake TS with noise TE from this subdet
5: efficiency wrt. tree tracks

Table 15: Sub detector contributions to track search performance on TK level at 500 GeV and 800 GeV beam energy and ghost hits from strip detectors with same alignment. FTD 4 and FTD 6 are rotated 7.5°.

	500 GeV					800 GeV				
detector	1	2	3	4	5	1	2	3	4	5
FTD 4	1704	1564	25	110	0.918	1949	1730	39	194	0.888
FTD 5	1437	1284	21	91	0.894	1589	1397	26	171	0.879
FTD 6	1027	906	20	60	0.882	1102	949	25	109	0.861
FTD 7	694	594	8	41	0.856	707	607	21	62	0.859

1: tracks producing at least 1 hit in sub detector
2: tracks with correct TE in reconstructed TK
3: number of fake TK with good TE from this subdet
4: number of fake TK with noise TE from this subdet
5: efficiency wrt. tree tracks

Table 16: Track search performance at 500 GeV and 800 GeV beam energy and ghost hits from strip detectors with flipped alignment. FTD 4 and FTD 6 are rotated 7.5°.

	500 GeV		800 GeV	
	TS level	TK level	TS level	TK level
number of tree tracks	2426	2426	3017	3017
tree tracks with hits	2426	2426	3017	3017
at least 3 hits	2426	2426	3017	3017
reconstructed 1 time	1789	2283	2126	2811
2 times	209	86	255	113
3 times	104	1	120	1
4 times	81	0	116	0
>4 times	198	0	340	0
total tracks found	2381	2370	2957	2925
fake TS/TK	860	129	2071	235
efficiency wrt. tree	0.981	0.977	0.980	0.970
eff. wrt. 3 hit tr.	0.981	0.977	0.980	0.970
fake rate wrt. tree	0.354	0.053	0.686	0.078

Table 17: Sub detector contributions to track search performance on TS level at 500 GeV and 800 GeV beam energy and ghost hits from strip detectors with flipped alignment. FTD 4 and FTD 6 are rotated 7.5°.

	500 GeV					800 GeV				
detector	1	2	3	4	5	1	2	3	4	5
FTD 4	1704	1650	190	419	0.968	2008	1932	488	960	0.962
FTD 5	1437	1372	110	473	0.955	1632	1554	214	1088	0.952
FTD 6	1027	977	105	159	0.951	1134	1082	248	425	0.954
FTD 7	694	630	62	226	0.908	729	668	171	506	0.916

1: tracks producing at least 1 hit in sub detector
2: tracks with correct TE in reconstructed TS
3: number of fake TS with good TE from this subdet
4: number of fake TS with noise TE from this subdet
5: efficiency wrt. tree tracks

Table 18: Sub detector contributions to track search performance on TK level at 500 GeV and 800 GeV beam energy and ghost hits from strip detectors with flipped alignment.FTD 4 and FTD 6 are rotated 7.5°.

	500 GeV					800 GeV				
detector	1	2	3	4	5	1	2	3	4	5
FTD 4	1704	1582	29	55	0.928	2008	1814	48	92	0.903
FTD 5	1437	1306	17	72	0.909	1632	1438	26	125	0.881
FTD 6	1027	925	18	22	0.901	1134	986	25	58	0.869
FTD 7	694	601	11	28	0.866	729	623	8	62	0.855

1: tracks producing at least 1 hit in sub detector
2: tracks with correct TE in reconstructed TK
3: number of fake TK with good TE from this subdet
4: number of fake TK with noise TE from this subdet
5: efficiency wrt. tree tracks

Table 19: Track search performance at 500 GeV and 800 GeV beam energy and ghost hits from strip detectors with flipped alignment. FTD 4 and FTD 6 are rotated 7.5°. Double track resolution of 540 µm was assumed.

	500 GeV		800 GeV	
	TS level	TK level	TS level	TK level
number of tree tracks	2426	2426	3017	3017
tree tracks with hits	2426	2426	3017	3017
at least 3 hits	2426	2426	3017	3017
reconstructed 1 time	1789	2285	2129	2813
2 times	211	85	257	112
3 times	104	1	118	1
4 times	81	0	120	0
>4 times	196	0	333	0
total tracks found	2381	2371	2957	2926
fake TS/TK	836	133	1921	243
efficiency wrt. tree	0.981	0.977	0.980	0.970
eff. wrt. 3 hit tr.	0.981	0.977	0.980	0.970
fake rate wrt. tree	0.345	0.055	0.637	0.081

Table 20: Sub detector contributions to track search performance on TS level at 500 GeV and 800 GeV beam energy and ghost hits from strip detectors with flipped alignment. FTD 4 and FTD 6 are rotated 7.5°. Double track resolution of 540 µm was assumed.

	500 GeV					800 GeV				
detector	1	2	3	4	5	1	2	3	4	5
FTD 4	1703	1650	184	409	0.969	2004	1935	453	868	0.966
FTD 5	1437	1376	106	456	0.958	1627	1552	242	937	0.954
FTD 6	1026	977	100	166	0.952	1133	1080	231	382	0.953
FTD 7	691	632	60	212	0.915	728	669	134	454	0.919

1: tracks producing at least 1 hit in sub detector
2: tracks with correct TE in reconstructed TS
3: number of fake TS with good TE from this subdet
4: number of fake TS with noise TE from this subdet
5: efficiency wrt. tree tracks

Table 21: Sub detector contributions to track search performance on TK level at 500 GeV and 800 GeV beam energy and ghost hits from strip detectors with flipped alignment.FTD 4 and FTD 6 are rotated 7.5°. Double track resolution of 540 µm was assumed.

	500 GeV					800 GeV				
detector	1	2	3	4	5	1	2	3	4	5
FTD 4	1703	1588	29	57	0.932	2004	1810	51	97	0.903
FTD 5	1437	1306	18	73	0.909	1627	1430	29	126	0.879
FTD 6	1026	925	19	22	0.902	1133	986	26	59	0.870
FTD 7	691	599	11	29	0.867	728	620	10	67	0.852

1: tracks producing at least 1 hit in sub detector
2: tracks with correct TE in reconstructed TK
3: number of fake TK with good TE from this subdet
4: number of fake TK with noise TE from this subdet
5: efficiency wrt. tree tracks

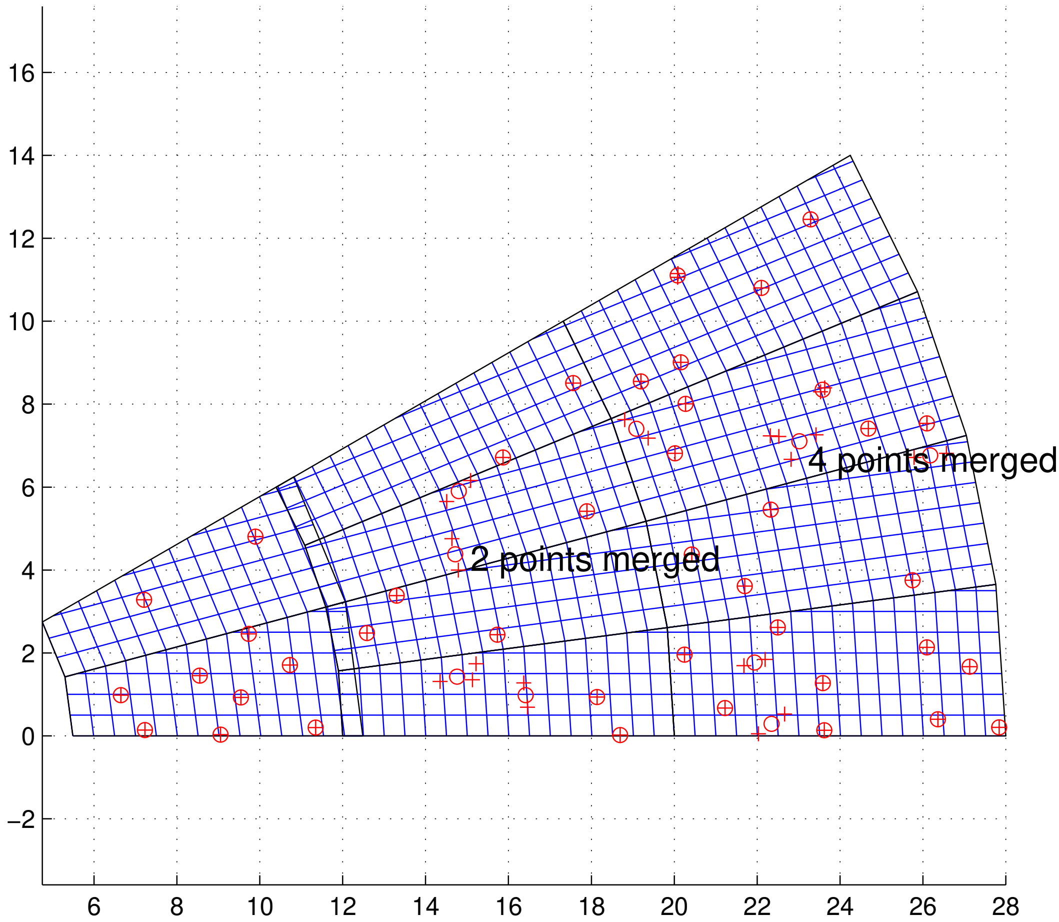

Figure 8: Points with a distance smaller than the resolution are merged together. Crosses indicate points before merging, circles after merging.

4 Conclusions

In this article the impact of ghost hits in detectors FTD 4, FTD 5, FTD 6 and FTD 7 to the tracking algorithm in BRAHMS was investigated. The performance of the track reconstruction algorithm can be influenced by the chosen geometry. Geometry 2 or 4 improve the tracking algorithm's performance significantly.

Also double track resolution examined. A double track resolution of 540 µm cannot decrease the tracking algorithm's performance crucial. Less than one percent of hits cannot be distinguished and are merged.

References

[1] T. Behnke, S. Bertolucci, R. D. Heuer, R. Settles (Editors), *TESLA Technical Design Report, Part IV: A Detector for TESLA*, DESY-2001-0111, ECFA-2001-209

[2] T. Behnke, G. A. Balir, I. Božović-Jelisavčic, M. Elsing, K. Harder, R. Hawking, K. M"onig, H. Vogt, D. Wicke, *Performance study of the proposed TESLA detector using a realistic track reconstruction package*, LC-DET-2001-029

[3] T. Behnke, G. A. Balir, et al., *BRAHMS: A Monte Carlo for a Detector at a 500/800 GeV Linear Collider*, LC-DET-2001-005

[4] Richard Hawkinings, *Vertex detector and flavour tagging studies for the TESLA linear collider*, LC-PHSM-2000-021-TESLA