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Study of TOF paddle positions

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Abstract

This short report looks at the paddle positions as determined from tracking data.

1 Motivation

Tracks from charged particles with momenta larger than 1 GeV/c are used to determined the intersection point with the TOF detector. These intersections points are then plotted for each TOF paddle separate that was found to be matching with the track. These 2-dim histograms can then be used to determine the central position of the paddle along its length. An example is shown in figure 1. It is obvious from the projected data that the central position of the paddle in the vertical dimension is not constant but does vary along its length. In the following a linear dependence is assumed and no attempt is made to look at curved (higher order) dependencies.

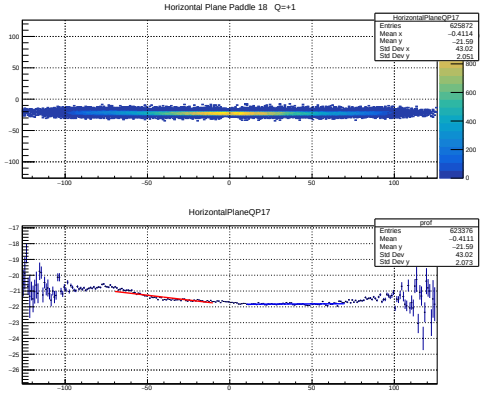

Figure 1: Hit positions on horizontal paddle 17 for negative charged tracks with larger than 1 GeV/c momenta.

2 Linear paddle positions.

The projections of each paddle distribution is fit with a linear function $f_i(x) = a_i x + _i$ with the index i indicating left or right side of the beam line. The slope and constant offset are used to calculate the central paddle position at ±10 cm and ±50 cm from the nominal beam line. The fit is done separately for the left and right section of the beam line from 10 cm to 50 cm for the paddle further away from the beam line and from 10 cm to 70 cm for paddle closer to the beam line where there is sufficient statistics to do such a fit. Any higher order dependencies are ignored at this point. Results of these fits on positive and negative tracks are listed in tables 1, 2, 3 and 4.

Note that the nominal geometrical positions for the paddles from the inside out are: 22(±3 cm), 21(±7.5 cm), 20(±10.5 cm), 19(±15 cm), 18(±21 cm), 17(±27 cm), 16(±33 cm), 15(±39 cm), 14(±45 cm), 13(±51 cm), 12(±57 cm), 11(±63 cm), 10(±69 cm), 9(±75 cm), 8(±81 cm), 7(±87 cm), 6(±93 cm) and 5(±99 cm). From these nominal values one can see that by the time we are 18 paddles away from the nominal beam line the difference between the actual location of the paddle (5 and 40) and the nominal location is about 1 cm. In addition, the last column indicates the

difference of the left and right fit at the center of the TOF plane. This difference is reasonably small except for the paddles 22 and 23 which are the short paddles that are obviously not connected at $x = 0$. If this discrepancy is not just due to the tracking resolution such difference can be verified directly by measuring the positions of these paddles in the TOF detector.

Pad#	a_l	b_l	$f_l(-10)$	$f_l(-50)$	a_r	b_r	$f_r(-10)$	$f_r(-50)$	$f_l(0) - f_r(0)$
05	-0.01755	-100.65	-100.47	-99.77	0.02129	-100.59	-100.38	-99.52	-0.10
06	-0.01791	-94.85	-94.67	-93.95	0.02133	-94.91	-94.69	-93.84	0.02
07	-0.01217	-88.79	-88.67	-88.18	0.01407	-88.96	-88.82	-88.26	0.15
08	-0.00571	-82.62	-82.56	-82.34	0.00910	-82.87	-82.78	-82.41	0.21
09	-0.00557	-76.54	-76.49	-76.27	0.00111	-76.61	-76.60	-76.56	0.11
10	-0.00459	-70.40	-70.35	-70.17	-0.00022	-70.48	-70.48	-70.49	0.12
11	-0.00559	-64.33	-64.27	-64.05	-0.00173	-64.36	-64.37	-64.44	0.10
12	-0.00657	-58.29	-58.22	-57.96	-0.00181	-58.25	-58.27	-58.34	0.04
13	-0.00727	-52.20	-52.13	-51.84	-0.00440	-52.04	-52.09	-52.26	-0.04
14	-0.00784	-46.14	-46.06	-45.75	-0.00576	-45.90	-45.96	-46.19	-0.11
15	-0.00754	-40.05	-39.98	-39.67	-0.00523	-39.82	-39.87	-40.08	-0.10
16	-0.00801	-33.94	-33.86	-33.54	-0.00465	-33.69	-33.74	-33.92	-0.12
17	-0.00801	-27.87	-27.79	-27.47	-0.00390	-27.64	-27.68	-27.84	-0.11
18	-0.00740	-21.78	-21.71	-21.41	-0.00197	-21.61	-21.63	-21.71	-0.08
19	-0.00740	-15.70	-15.63	-15.33	0.00019	-15.59	-15.58	-15.58	-0.04
20	-0.00581	-11.06	-11.00	-10.77	-0.00021	-10.93	-10.93	-10.94	-0.07
21	-0.00496	-7.92	-7.87	-7.67	-0.00092	-7.75	-7.76	-7.80	-0.10
22	-0.00827	-2.80	-2.71	-2.38	0.00168	-3.27	-3.25	-3.18	0.54
23	-0.00738	1.98	2.06	2.35	0.00659	2.63	2.69	2.96	-0.64
24	-0.00565	7.25	7.30	7.53	0.00366	7.32	7.36	7.51	-0.06
25	-0.00393	10.43	10.47	10.63	0.00360	10.46	10.50	10.64	-0.03
26	-0.00138	15.15	15.16	15.21	0.00143	15.16	15.18	15.24	-0.02
27	-0.00150	21.23	21.24	21.30	0.00455	21.18	21.22	21.40	0.02
28	-0.00032	27.40	27.40	27.41	0.00411	27.30	27.34	27.50	0.06
29	0.00133	33.55	33.54	33.48	0.00637	33.37	33.43	33.68	0.11
30	0.00295	39.69	39.66	39.54	0.00585	39.51	39.57	39.80	0.09
31	0.00447	45.81	45.77	45.59	0.00641	45.61	45.67	45.93	0.10
32	0.00299	51.81	51.78	51.66	0.00528	51.74	51.79	52.00	-0.01
33	0.00150	57.83	57.82	57.76	0.00555	57.83	57.89	58.11	-0.07
34	0.00124	63.92	63.91	63.86	0.00178	64.04	64.06	64.13	-0.16
35	0.00304	70.06	70.03	69.91	0.00154	70.10	70.12	70.18	-0.08
36	0.00125	76.08	76.06	76.01	0.00433	76.11	76.15	76.32	-0.08
37	0.00373	82.18	82.15	82.00	0.00113	82.23	82.24	82.28	-0.09
38	0.00760	88.31	88.24	87.93	-0.00051	88.28	88.28	88.26	-0.04
39	0.01776	94.50	94.32	93.61	-0.01030	94.43	94.32	93.91	-0.00
40	0.00253	99.97	99.95	99.85	-0.00799	100.12	100.04	99.72	-0.10

Table 1: Horizontal Plane Paddle positions from negatively charged tracks.

Pad#	a_l	b_l	$f_l(-10)$	$f_l(-50)$	a_r	b_r	$f_r(-10)$	$f_r(-50)$	$f_l(0) - f_r(0)$
05	-0.02677	-100.59	-100.32	-99.25	0.02572	-100.66	-100.40	-99.37	0.08
06	-0.01830	-94.60	-94.42	-93.68	0.01148	-94.66	-94.55	-94.09	0.13
07	-0.01668	-88.70	-88.54	-87.87	0.00860	-88.77	-88.68	-88.34	0.15
08	-0.00710	-82.41	-82.34	-82.06	0.00171	-82.61	-82.59	-82.52	0.25
09	-0.00987	-76.41	-76.32	-75.92	-0.00178	-76.47	-76.49	-76.56	0.18
10	-0.01116	-70.36	-70.25	-69.81	-0.00260	-70.39	-70.42	-70.52	0.17
11	-0.01109	-64.29	-64.18	-63.73	0.00016	-64.42	-64.42	-64.41	0.24
12	-0.01535	-58.38	-58.23	-57.61	-0.00020	-58.35	-58.36	-58.36	0.13
13	-0.01508	-52.32	-52.17	-51.57	-0.00176	-52.21	-52.23	-52.30	0.06
14	-0.01382	-46.21	-46.07	-45.52	-0.00259	-46.10	-46.13	-46.23	0.06
15	-0.01471	-40.19	-40.05	-39.46	-0.00174	-40.04	-40.06	-40.13	0.01
16	-0.01308	-34.05	-33.92	-33.40	-0.00181	-33.92	-33.94	-34.01	0.02
17	-0.01384	-28.02	-27.88	-27.32	-0.00000	-27.89	-27.89	-27.89	0.01
18	-0.01216	-21.88	-21.75	-21.27	0.00049	-21.84	-21.83	-21.81	0.08
19	-0.01345	-15.83	-15.70	-15.16	0.00110	-15.74	-15.73	-15.69	0.03
20	-0.01230	-11.20	-11.07	-10.58	0.00148	-11.14	-11.12	-11.06	0.05
21	-0.01105	-8.01	-7.90	-7.46	0.00149	-8.03	-8.01	-7.95	0.11
22	-0.01579	-2.94	-2.78	-2.15	0.00377	-3.53	-3.49	-3.34	0.71
23	-0.01208	1.97	2.09	2.57	0.00836	2.38	2.47	2.80	-0.38
24	-0.01212	7.15	7.28	7.76	0.00547	7.08	7.13	7.35	0.14
25	-0.01133	10.29	10.41	10.86	0.00508	10.23	10.28	10.48	0.13
26	-0.00980	14.98	15.08	15.47	0.00309	14.93	14.96	15.08	0.12
27	-0.00892	21.10	21.19	21.55	0.00544	20.98	21.03	21.25	0.16
28	-0.00915	27.20	27.29	27.66	0.00487	27.12	27.17	27.36	0.12
29	-0.00801	33.33	33.41	33.73	0.00622	33.20	33.26	33.51	0.15
30	-0.00855	39.40	39.48	39.83	0.00708	39.28	39.36	39.64	0.13
31	-0.00739	45.51	45.58	45.88	0.00764	45.38	45.45	45.76	0.13
32	-0.00797	51.58	51.66	51.98	0.00518	51.58	51.63	51.84	0.03
33	-0.00777	57.67	57.75	58.06	0.00450	57.70	57.75	57.93	0.00
34	-0.00767	63.79	63.87	64.17	0.00167	63.93	63.95	64.01	-0.08
35	-0.00693	69.91	69.98	70.26	-0.00126	70.11	70.10	70.05	-0.11
36	-0.00694	76.02	76.08	76.36	-0.00099	76.17	76.16	76.12	-0.07
37	-0.00249	82.18	82.21	82.31	-0.00400	82.25	82.21	82.05	-0.00
38	0.00391	88.33	88.30	88.14	-0.00839	88.38	88.29	87.96	0.00
39	0.01821	94.49	94.30	93.58	-0.01495	94.36	94.21	93.62	0.09
40	0.00417	100.00	99.95	99.79	-0.01202	100.05	99.93	99.44	0.03

Table 2: Horizontal Plane Paddle positions from positively charged tracks.

Pad#	a_l	b_l	$f_l(-10)$	$f_l(-50)$	a_r	b_r	$f_r(-10)$	$f_r(-50)$	$f_l(0) - f_r(0)$
05	-0.02265	-100.37	-100.14	-99.24	0.02900	-100.33	-100.04	-98.88	-0.10
06	-0.01464	-94.33	-94.19	-93.60	0.01291	-94.12	-93.99	-93.47	-0.20
07	-0.00549	-88.11	-88.06	-87.84	0.00709	-88.03	-87.96	-87.68	-0.09
08	0.00490	-81.78	-81.82	-82.02	0.00215	-81.82	-81.80	-81.71	-0.03
09	0.00879	-75.62	-75.71	-76.06	-0.00060	-75.59	-75.59	-75.62	-0.11
10	0.01006	-69.48	-69.58	-69.98	-0.00011	-69.53	-69.53	-69.54	-0.05
11	0.00806	-63.49	-63.57	-63.89	-0.00175	-63.45	-63.46	-63.53	-0.11
12	0.00868	-57.41	-57.50	-57.85	-0.00166	-57.39	-57.41	-57.47	-0.09
13	0.01039	-51.25	-51.36	-51.77	-0.00164	-51.28	-51.30	-51.36	-0.06
14	0.00971	-45.16	-45.25	-45.64	-0.00395	-45.13	-45.16	-45.32	-0.09
15	0.00954	-39.08	-39.17	-39.55	-0.00376	-39.06	-39.10	-39.25	-0.07
16	0.00970	-32.96	-33.05	-33.44	-0.00355	-32.96	-32.99	-33.14	-0.06
17	0.00911	-26.88	-26.97	-27.34	-0.00332	-26.86	-26.90	-27.03	-0.07
18	0.00897	-20.81	-20.90	-21.26	-0.00328	-20.82	-20.86	-20.99	-0.05
19	0.00573	-14.82	-14.87	-15.10	-0.00161	-14.80	-14.81	-14.88	-0.06
20	0.00682	-10.16	-10.23	-10.50	-0.00091	-10.24	-10.25	-10.28	0.02
21	0.00546	-7.03	-7.09	-7.30	-0.00197	-7.07	-7.08	-7.16	-0.00
22	0.00664	-2.41	-2.47	-2.74	0.00457	-2.11	-2.06	-1.88	-0.41
23	0.00597	3.60	3.54	3.30	-0.00446	3.00	2.95	2.77	0.59
24	0.00549	8.10	8.05	7.83	0.00100	7.93	7.94	7.98	0.11
25	0.00552	11.25	11.20	10.98	-0.00064	11.14	11.14	11.11	0.06
26	0.00582	15.89	15.84	15.60	-0.00245	15.81	15.78	15.68	0.05
27	0.00478	21.91	21.86	21.67	-0.00238	21.85	21.83	21.73	0.03
28	0.00533	28.00	27.95	27.74	-0.00337	27.98	27.94	27.81	0.01
29	0.00652	34.10	34.04	33.78	-0.00462	34.08	34.04	33.85	-0.00
30	0.00697	40.19	40.12	39.84	-0.00565	40.20	40.15	39.92	-0.03
31	0.00712	46.27	46.19	45.91	-0.00547	46.25	46.19	45.98	-0.00
32	0.00639	52.29	52.23	51.97	-0.00564	52.33	52.27	52.05	-0.05
33	0.00491	58.35	58.30	58.10	-0.00578	58.42	58.36	58.13	-0.06
34	0.00692	64.52	64.45	64.18	-0.00508	64.45	64.40	64.20	0.05
35	0.00719	70.58	70.50	70.22	-0.00641	70.54	70.48	70.22	0.03
36	0.00896	76.71	76.62	76.26	-0.00615	76.56	76.50	76.25	0.12
37	0.00967	82.73	82.63	82.24	-0.00775	82.64	82.57	82.26	0.06
38	0.01887	88.88	88.69	87.94	-0.00852	88.59	88.50	88.16	0.19
39	0.02273	94.81	94.58	93.67	-0.01380	94.49	94.36	93.80	0.23
40	0.03682	101.03	100.66	99.19	-0.02118	100.59	100.38	99.53	0.28

Table 3: Vertical Plane Paddle positions from negatively charged tracks.

Pad#	a_l	b_l	$f_l(-10)$	$f_l(-50)$	a_r	b_r	$f_r(-10)$	$f_r(-50)$	$f_l(0) - f_r(0)$
05	-0.00627	-100.08	-100.02	-99.77	0.01425	-100.07	-99.93	-99.36	-0.08
06	-0.00890	-94.23	-94.14	-93.78	0.01198	-94.12	-94.00	-93.52	-0.14
07	0.00040	-88.07	-88.07	-88.09	0.00738	-87.95	-87.87	-87.58	-0.20
08	0.00503	-81.88	-81.93	-82.13	0.00265	-81.74	-81.71	-81.61	-0.22
09	0.00620	-75.79	-75.85	-76.10	0.00219	-75.59	-75.57	-75.48	-0.28
10	0.00892	-69.63	-69.72	-70.07	0.00129	-69.44	-69.43	-69.37	-0.29
11	0.00796	-63.60	-63.68	-64.00	-0.00115	-63.38	-63.39	-63.44	-0.29
12	0.00905	-57.50	-57.59	-57.95	-0.00050	-57.36	-57.36	-57.38	-0.23
13	0.01043	-51.33	-51.43	-51.85	-0.00281	-51.22	-51.25	-51.36	-0.18
14	0.01209	-45.19	-45.31	-45.80	-0.00247	-45.17	-45.19	-45.29	-0.12
15	0.01135	-39.12	-39.24	-39.69	-0.00318	-39.09	-39.12	-39.24	-0.12
16	0.00946	-33.10	-33.20	-33.58	-0.00274	-32.99	-33.02	-33.13	-0.18
17	0.00916	-27.02	-27.11	-27.48	-0.00271	-26.88	-26.91	-27.02	-0.20
18	0.00837	-20.95	-21.04	-21.37	-0.00242	-20.85	-20.87	-20.97	-0.16
19	0.00669	-14.93	-15.00	-15.26	-0.00071	-14.81	-14.82	-14.84	-0.18
20	0.00699	-10.30	-10.37	-10.65	-0.00173	-10.17	-10.19	-10.25	-0.19
21	0.00665	-7.15	-7.21	-7.48	-0.00127	-7.03	-7.05	-7.10	-0.17
22	0.00901	-2.47	-2.56	-2.92	0.00303	-2.03	-2.00	-1.88	-0.56
23	0.00832	3.54	3.46	3.13	-0.00421	3.05	3.01	2.84	0.45
24	0.00583	7.97	7.91	7.68	-0.00012	7.99	7.99	7.99	-0.08
25	0.00627	11.13	11.07	10.82	-0.00066	11.17	11.17	11.14	-0.09
26	0.00821	15.83	15.74	15.42	-0.00171	15.80	15.78	15.71	-0.04
27	0.00758	21.85	21.78	21.47	-0.00125	21.83	21.82	21.77	-0.04
28	0.00881	27.96	27.87	27.52	-0.00166	27.93	27.92	27.85	-0.04
29	0.00942	34.04	33.95	33.57	-0.00263	34.04	34.01	33.91	-0.07
30	0.00990	40.13	40.03	39.64	-0.00299	40.11	40.08	39.96	-0.05
31	0.00991	46.20	46.10	45.70	-0.00276	46.15	46.12	46.01	-0.02
32	0.01058	52.30	52.20	51.77	-0.00341	52.24	52.21	52.07	-0.01
33	0.00886	58.34	58.25	57.90	-0.00495	58.36	58.31	58.12	-0.06
34	0.01069	64.49	64.38	63.96	-0.00451	64.40	64.35	64.17	0.03
35	0.01181	70.56	70.44	69.97	-0.00578	70.47	70.41	70.18	0.03
36	0.01229	76.63	76.51	76.02	-0.00493	76.52	76.47	76.27	0.04
37	0.01143	82.63	82.52	82.06	-0.00359	82.52	82.48	82.34	0.04
38	0.01955	88.79	88.60	87.82	-0.00857	88.65	88.56	88.22	0.03
39	0.02890	94.94	94.66	93.50	-0.01617	94.68	94.52	93.87	0.13
40	0.02723	100.70	100.43	99.34	-0.02540	100.74	100.49	99.47	-0.06

Table 4: Vertical Plane Paddle positions from positively charged tracks.