Tagger Timing Window Calibration

PrimEx Collaboration

PrimEx Note ???

Eric Clinton, July 2005

The TJNAF Hall B tagger has been described many times before. For interested readers, I refer any of the numerous documents describing it. However, in this document I will describe how the timing windows for the overlap E Channels, T Channels, and the ET coincidences were calculated. I will attempt to always refer to the geometrically and temporally created E and T Channel bins as "Channels" and to the raw E and T Counter hardware bins as "Counter" to avoid any ambiguity.

The task is quite simple. Determine, for a given timing window, how many counts from a coincidence peak, survive the cut. For this, the data file /mss/hallb/primex/data/october_2004/primex05003.dat.00 served as the source data. To create the E Channel timing overlap peaks between adjacent E Counters, E Counter events whose ID's were separated by 1 ID count, ie. adjacent Counters were selected. An indentical technique was used for the T Channel timing overlap peak. For ET coincidences, the geometry map located in the primex_online.TAG_ET_map MySQL database was read into memory from tagger_brun.cc. This map was then used to assure that E and T Channel events close in time were also geometrically matched. Events that were geometrically allowed were then histogrammed to form timing peaks.

The end result of the above effort created 3 histograms of all possible

'good' events that would fall into the E Channel (EE Window), T Channel (TT Window), and ET coincidence (ET Window) overlap peaks. See Figure 1 for a typical overlap peak and Figure 2 for a sample timing window cut. Some of these histograms had a fairly large background, so a statistical background subtraction method was used where appropriate. Events were counted over a large time interval ($\pm$20 ns) far away from the peaks. This event count was then used to determine an average number of background events/bin. Thus, as the timing cuts were made to the 3 histograms above, the flat background the timing peaks sat on could be subtracted away. This method tended to oversubtract the background, but it is far superior to leaving background counts in. Additionally, the only effect was to add a uniform negative shift in the calculated timing cut inefficiencies.

The specifics of the analysis really show the 'inefficiency' of the timing cuts. The analysis asks the question, "What percentage of the counts from the original overlap peaks survive the timing cut?" Thus, how inefficient is a given cut? In a number of discussions at the weekly PrimEx meetings, it was determined that an inefficiency of less the 1% is appropriate.

In all Figures, the data are presented in percentages. That is to say that '0.45' or '6.47' are percentages, and not raw decimal fractions. From these data, the timing window of 22 ns ($\pm$ 11ns) is a good, but not optimal cut (Figures 3, 4). A better EE timing window is 26 ns ($\pm$ 13ns) where 7 inefficiencies are over 1%. A EE timing window of 28 ns ($\pm$ 14ns) leaves only 2 inefficiencies over 1%.

Additionally, the timing cuts for the TT windows and ET window

are good but probably not optimal. For the TT Window data, please ingore the spuriously large percentages in any overlap with T Counter 9 as a member. There is a trigger cable timing length mis-match which is causing this anomaly. It also appears that the background subtraction was a little too aggressive, but manageable. Data in Figure 5 show that 13 ns is a very efficient timing cut. Significantly smaller inefficiencies are not gained by a larger time window.

Data in Figure 6 shows that 12 ns is a good time cut for our ET Window for most overlap regions, but a few overlaps only drop below the 1% efficiency after a 14 ns cut. Included are lower statistic ET coincidences binned by E channel ID. The data in these figures 7, 8, 9 also show that 14 ns is a more inclusive time window.

Any input regarding size of the timing windows from collaboration members would be appreciated. Thanks.

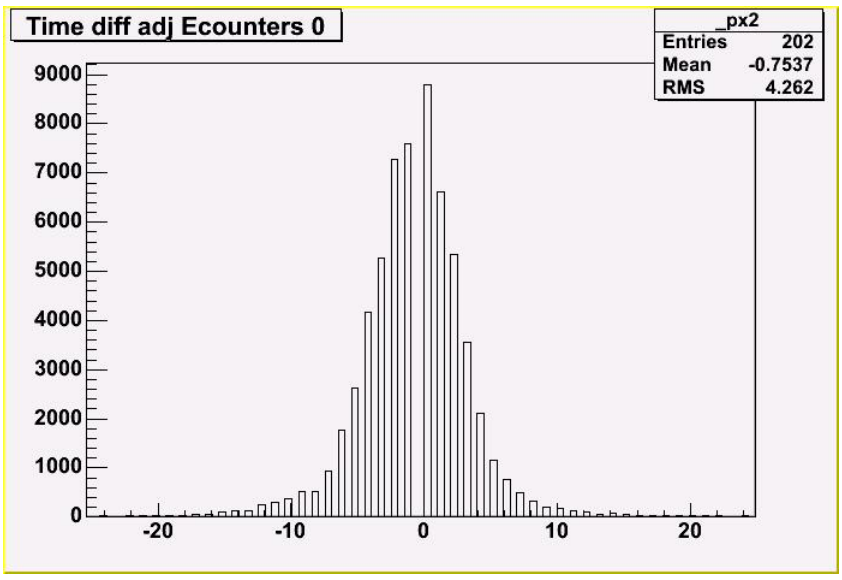

Figure 1: EE Overlap Timing Peak

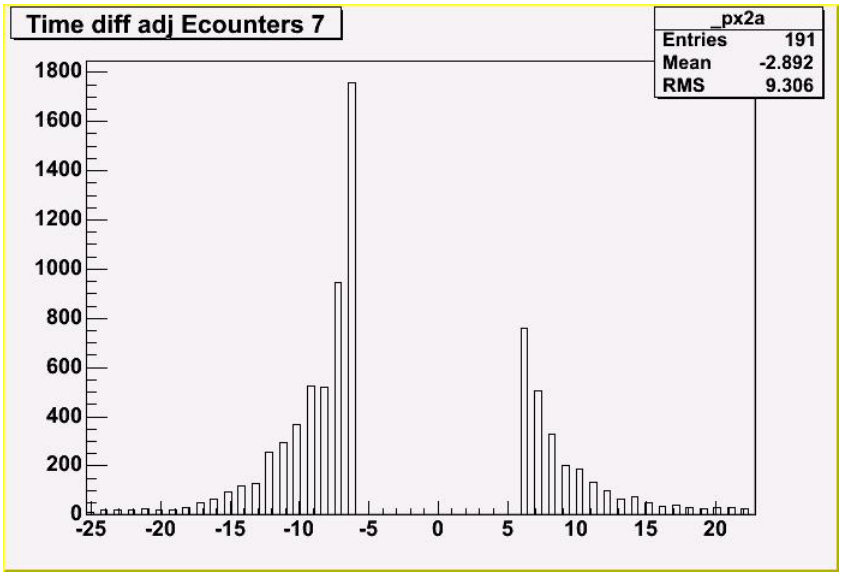

Figure 2: EE Timing Window cut of 12ns

EE Timing Window
currently set to 22 ns

data below are percentages of the events
that survived the timing Window/Cut listed

Window/Cut	14 ns	16 ns	18 ns	20 ns	22 ns	24 ns	26 ns	28 ns	total # of events	total backgr
Overlap of E Counters										
1,2	5.31	3.94	2.81	1.89	1.26	0.74	0.42	0.12	380910	3660
2,3	7.84	5.29	3.58	2.44	1.64	1.04	0.59	0.23	395406	4369
3,4	7.67	5.2	3.73	2.54	1.71	1.1	0.65	0.28	348242	3750
4,5	6.84	4.62	3.19	2.18	1.47	0.9	0.48	0.16	397057	5013
5,6	6.77	4.78	3.38	2.2	1.45	0.87	0.48	0.17	368484	4244
:	7.04	4.77	3.33	2.16	1.4	0.83	0.46	0.15	396648	4859
:	10.43	7.18	5.16	3.52	2.4	1.55	0.97	0.5	384355	5212
:	4.88	3.3	2.22	1.51	1	0.62	0.31	0.09	398686	4447
:	10.13	6.17	4.45	3.11	2.13	1.34	0.85	0.48	434889	3459
:	18.04	10.7	7.37	4.89	3.28	2.1	1.37	0.79	409669	4726
	7.93	5.08	3.73	2.63	1.83	1.16	0.77	0.43	413010	3887
	9.88	5.97	4.01	2.69	1.84	1.09	0.61	0.16	470034	10019
	5.27	3.18	2.11	1.27	0.65	0.1	-0.26	-0.6	470421	15400
	5.05	3.19	2.25	1.45	0.89	0.4	0.04	-0.29	426714	11083
	6.02	3.9	2.76	1.75	1.05	0.43	0.01	-0.4	489472	14643
	20.1	13.84	9.3	6.21	4.08	2.61	1.56	0.8	422910	9847
	11.03	7.95	5.52	3.74	2.39	1.4	0.71	0.06	449664	13671
	8.66	6.19	4.42	3.04	2.01	1.15	0.46	-0.1	438508	17290
	32.67	21.04	13.42	8.29	5	2.94	1.65	0.7	429327	10393
	7.55	5.16	3.66	2.57	1.76	1.1	0.62	0.23	460548	8157
	11.54	8.67	6.41	4.53	3.14	2.03	1.22	0.58	364021	8525
	10.95	7.73	5.71	3.95	2.7	1.79	1.11	0.58	342197	5354
	7.66	5.47	4.08	2.9	2	1.33	0.82	0.39	459875	7551
	9.52	6.23	4.03	2.65	1.71	1.03	0.5	0.11	421602	8752
	6.26	4.28	3.02	1.98	1.31	0.82	0.48	0.19	447174	3931
	6.82	4.61	3.34	2.27	1.55	1.01	0.64	0.34	450745	3710

Figure 3: EE Timing Window results, page 1

Window/Cut										
	14 ns	16 ns	18 ns	20 ns	22 ns	24 ns	26 ns	28 ns	total # of events	total backgr
	7.03	4.86	3.55	2.39	1.55	0.95	0.54	0.15	458242	7909
	6.88	4.36	2.83	1.74	0.91	0.21	-0.31	-0.81	464993	21009
	5.79	3.61	2.43	1.49	0.81	0.26	-0.15	-0.5	480846	14700
	4.01	2.57	1.8	1.15	0.71	0.39	0.17	-0.02	490736	4819
	6.86	4.54	3.27	2.29	1.48	0.93	0.59	0.29	457545	3689
	9.58	6.38	4.18	2.84	1.9	1.25	0.75	0.39	419562	4162
	5.87	4.25	3.01	2.02	1.36	0.82	0.47	0.14	447026	4504
	4.49	2.58	1.65	1.04	0.62	0.3	0.08	-0.1	574109	6143
	14.24	9.37	6.67	4.66	3.24	2.13	1.36	0.7	516608	8196
	5.97	3.93	2.74	1.89	1.26	0.71	0.32	-0.01	462253	8537
	4.61	2.97	2.14	1.4	0.86	0.47	0.2	-0.02	468159	5155
	6.97	4.18	2.97	1.94	1.23	0.73	0.39	0.12	490892	4789
	5.74	3.93	2.91	2.02	1.36	0.87	0.53	0.24	503753	4957
	6.46	4.23	2.85	1.94	1.32	0.84	0.5	0.22	449179	4702
	4.03	2.61	1.83	1.17	0.7	0.36	0.15	-0.02	447397	4189
	4.83	2.9	1.96	1.3	0.8	0.45	0.23	0.06	541563	4163
	22.83	14.5	10.35	7.04	4.53	2.87	1.89	1.12	374237	3113
	12.72	7.91	5.01	3.24	2.14	1.38	0.87	0.44	393456	3749
	4.43	2.99	2.05	1.36	0.87	0.5	0.26	0.05	503766	5222
	4.68	3.07	2.21	1.47	0.97	0.61	0.34	0.09	568100	6081
	4.55	3.11	2.27	1.5	0.95	0.58	0.31	0.06	535559	5830
	39.18	25.4	14.77	8.11	4.48	2.54	1.42	0.74	536498	5169
	5.3	3.37	2.13	1.35	0.8	0.41	0.16	-0.08	456692	5545
	5.03	3.36	2.26	1.54	0.99	0.59	0.32	0.11	520572	4503
	4.59	2.99	1.98	1.27	0.76	0.35	0.03	-0.2	474594	7738
	6.96	4.25	2.86	1.76	1.04	0.54	0.22	-0.06	555692	9236
	5.43	3.64	2.64	1.82	1.2	0.76	0.45	0.2	552539	5020
	3.45	2.24	1.56	1.01	0.6	0.33	0.13	-0.02	619009	5659
	6.45	4.6	3.16	2.09	1.38	0.85	0.42	0.06	387345	7440
	5.26	3.77	2.72	1.81	1.17	0.72	0.38	0.08	622261	9381
	2.05	1.26	0.78	0.42	0.13	-0.07	-0.2	-0.34	614579	9084
	5.48	3.18	1.92	1.02	0.46	0.03	-0.25	-0.48	451501	10959

Figure 4: EE Timing Window results, page2

TT Timing Windows
Currently set to 13 ns, All

data below are percentages of the events
that survived the timing Window/Cut listed

Window/Cut	8 ns	10 ns	12 ns	14 ns	16 ns	18 ns	20 ns	22 ns
T counter overlap								
1,2	25.88	4	0.49	0.21	-0.03	-0.07	0.11	0.17
2,3	75.64	31.34	4.7	1.35	0.03	-0.01	0.29	0.27
3,4	21.75	1.63	0.06	-0.03	-0.3	-0.28	-0.12	-0.05
4,5	96.43	75.91	25.75	3.25	0.64	0.36	-0.24	-0.28
5,6	-0.27	-0.69	-1.01	-0.98	-0.68	-0.58	-0.79	-0.67
6,7	-0.24	-0.75	-1.07	-0.94	-0.57	-0.45	-0.78	-0.66
7,8	-0.98	-1.02	-0.84	-0.8	-0.86	-0.82	-0.64	-0.57
8,9	100.15	100.39	100.17	99.82	100.54	100.64	99.98	77.23
9,10	100.18	100.32	100.05	100.04	100.33	100.5	100.23	92.68
10,11	97.4	90.31	69.02	26.44	4.2	0.17	-0.86	-0.82

total # events	Background
99343	9737
95408	13475
116703	11754
76924	8524
126117	9745
90269	9483
125238	8711
44038	10116
149799	11299
42622	12566

Figure 5: TT Timing Window results

TE Timing Windows
Currently set to 14 ns, All

data below are percentages of the events
that survived the timing Window/Cut listed

Non- overlap region
Physical T counters

Window/	4 ns	6 ns	8 ns	10 ns	12 ns	14 ns	16 ns	18 ns
T Channels								
2	6.7724	2.6097	1.0812	0.3485	-0.0296	-0.1654	-0.2115	-0.2187
4	7.1672	2.6849	1.0755	0.3620	0.0310	-0.1489	-0.2224	-0.2049
6	9.4416	4.4640	2.4222	1.3439	0.8209	0.5324	0.3706	0.3457
8	83.1472	70.1242	51.4971	24.1545	3.9900	0.2202	0.0104	-0.0600
10	9.7057	1.9151	0.6610	0.1679	-0.1116	-0.1941	-0.1951	-0.1912
12	7.1024	2.4515	0.9476	0.2218	-0.1680	-0.3171	-0.3315	-0.3232
14	7.2310	2.8978	1.2373	0.4045	0.0532	-0.0773	-0.1217	-0.1108
16	16.9399	12.5256	10.5474	8.4087	7.1416	6.5711	5.9969	5.0543
18	48.5298	46.3591	42.9694	31.3545	22.5795	19.9709	19.0886	16.6540
20	13.8178	8.3159	5.0936	2.8275	1.4763	0.7092	0.4073	0.1830

total events	total BG
67655	804
65854	1007
91520	2376
52163	451
105042	2020
67092	1030
106714	2069
27932	511
132362	1266
19698	352

Figure 6: ET Timing Window results.

TE Timing Windows
Currently set to 14 ns, All

data below are percentages of the events
that survived the timing Window/Cut listed

Window/Cut	4 ns	6 ns	8 ns	10 ns	12 ns	14 ns	16 ns	18 ns
T Channels								
2	*2.54*	*1.50*	*1.18*	*1.04*	*0.94*	*0.86*	*0.83*	*0.80*
4	*7.70*	*2.58*	*1.01*	*0.43*	*0.27*	*0.13*	*0.11*	*0.11*
6	27.36	12.41	6.61	3.74	2.10	1.45	1.06	0.75
8	23.38	12.80	7.74	4.20	2.14	1.24	0.78	0.70
10	*3.23*	*2.05*	*1.43*	*1.21*	*1.12*	*1.02*	*0.90*	*0.88*
12	*2.62*	*1.01*	*0.48*	*0.29*	*0.24*	*0.19*	*0.19*	*0.18*
14	*9.08*	*4.38*	*2.72*	*1.98*	*1.67*	*1.42*	*1.21*	*1.12*
16	22.44	7.56	2.98	1.08	0.70	0.43	0.29	0.22
18	40.10	19.39	11.58	7.88	5.54	4.22	3.41	3.12
20	21.05	13.06	8.60	5.32	2.83	1.31	0.90	0.61
	3.76	*2.68*	*2.23*	*1.98*	*1.81*	*1.72*	*1.57*	*1.50*
	6.48	*2.80*	*1.45*	*0.73*	*0.48*	*0.35*	*0.29*	*0.24*
	7.98	*4.62*	*3.40*	*2.74*	*2.31*	*2.04*	*1.79*	*1.63*
	43.78	19.01	8.43	3.64	1.77	0.76	0.45	0.31
	10.75	7.44	5.80	4.68	3.96	3.40	2.99	2.79
	6.08	*4.53*	*3.16*	*1.79*	*1.06*	*0.62*	*0.40*	*0.36*
	8.19	*3.86*	*3.07*	*2.50*	*2.13*	*1.66*	*1.31*	*1.01*
	114.11	51.61	6.74	0.81	0.47	0.40	0.25	0.18
	232.15	213.15	165.46	74.50	11.02	1.01	0.67	0.55
	58.42	55.28	48.14	30.94	8.38	1.01	0.47	0.37
	3.79	*2.19*	*1.79*	*1.65*	*1.53*	*1.48*	*1.44*	*1.37*
	6.10	*2.02*	*1.22*	*0.87*	*0.71*	*0.65*	*0.64*	*0.58*
	25.98	8.69	5.15	3.92	2.92	2.56	2.35	2.08

Figure 7: TE Timing Window results, page 1.

Window/Cut	4 ns	6 ns	8 ns	10 ns	12 ns	14 ns	16 ns	18 ns
	53.32	9.48	3.79	1.70	0.89	0.53	0.41	0.38
	16.19	5.74	4.10	3.20	2.62	2.26	2.03	1.84
	9.70	*5.51*	*3.60*	*2.41*	*1.41*	*1.00*	*0.83*	*0.68*
	3.53	*1.67*	*1.27*	*1.12*	*0.98*	*0.91*	*0.87*	*0.84*
	4.96	*1.74*	*0.81*	*0.48*	*0.35*	*0.33*	*0.28*	*0.28*
	33.67	12.72	7.06	4.19	2.58	1.92	1.47	1.20
	20.86	8.33	3.65	1.56	0.87	0.41	0.38	0.34
	9.78	*6.67*	*4.58*	*3.20*	*2.28*	*1.71*	*1.54*	*1.34*
	5.22	*3.77*	*2.61*	*1.93*	*1.12*	*0.77*	*0.73*	*0.70*
	5.47	*2.86*	*2.65*	*2.57*	*2.50*	*2.38*	*2.24*	*2.20*
	10.82	*4.49*	*2.55*	*1.51*	*1.12*	*1.00*	*0.87*	*0.82*
	45.58	25.45	17.29	12.69	10.28	8.84	7.67	6.94
	112.98	44.48	18.36	7.64	3.28	1.90	1.27	1.15
	48.78	28.04	17.60	11.17	8.01	6.35	5.72	5.01
	20.44	13.94	9.58	5.87	3.72	2.67	2.32	2.21
	53.04	17.68	12.28	9.72	8.23	7.15	6.21	5.67
	78.15	21.85	9.68	5.86	4.28	3.15	2.93	2.70
	167.55	78.59	48.67	30.72	19.55	13.16	8.78	6.65

total # of events	total background
21653	326
8906	96
12595	133
2429	26
10309	198
6268	97
9423	170
5843	95
5925	98

Figure 8: ET Timing Window results, page 2. Please ignore the spurious entries, as they suffer from a trigger cable timing mismatch much like T counter 9.

total # of events	total background
2442	52
12196	200
6292	89
44064	680
7389	116
23208	415
7281	137
10278	173
5551	88
13745	222
7391	112
9995	156
6885	113
11493	204
6838	117
23311	418
6297	101
8917	101
6047	66
8498	115
5308	70
7836	101
5177	45
10448	122
3917	58
6935	86
2527	30
4233	58
1722	29
741	16
444	5
752	13

Figure 9: ET Timing Window results, page 3.