

## Slides and plots for Group Meeting 7 July 2000 Part 1

- Candidate Events -  $\tau$   
Text Description and Event displays:

3263 25102

3024 30175

3356 17099

3333 17665

3039 01910

also refer to Neutrino 2000 slides

**3263 25102**

Period 4 ; E/B1

Tau candidate; LL

Vtx = 63412 -107419 8234 microns

trk	nseg	u	v	usl	vsl	ip	
401003831	7	0.0641	-0.1063	-0.0814	-0.1407	0.29	
401003956	2	0.0624	-0.1084	0.1203	0.1191	0.10	P
401003833	2	0.0624	-0.1063	0.1190	-0.1314	0.54	
391003610	7	0.064	-0.106	-0.001	-0.142	0.8	D

Flight length = 1947 microns

Kink angle = 0.130

Parent angle = 0.169

Delta phi = NA

Daughter mom = 2.0 +2.2 -0.7 MS

Pt = 260 MeV/c (MS)

Enu = &gt;10 GeV (e-m SFT + Ecal)

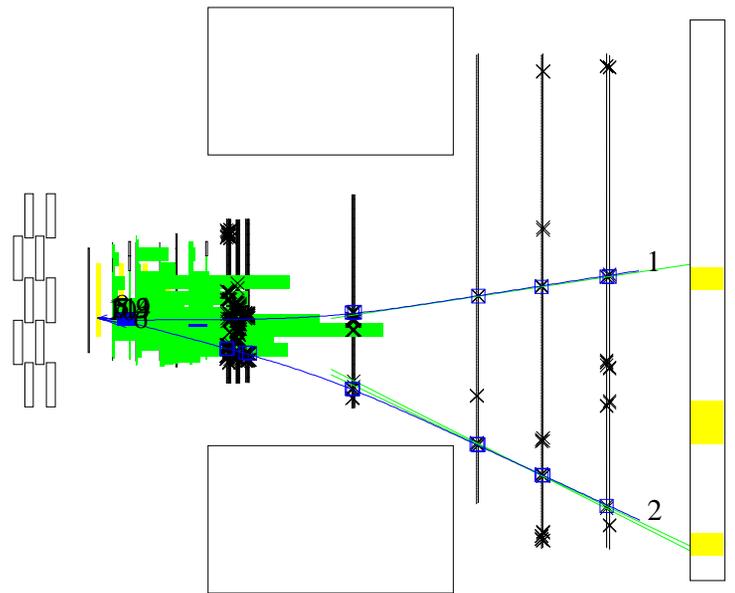
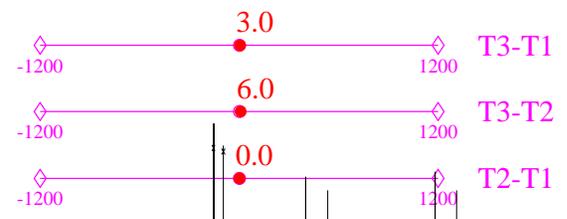
Comments:

The kink daughter (3610) is found in the SFT, although two primary tracks are close in the v-view. The pT is within the cuts, but close in both pT and momentum. An independent MS analysis yields 1.2+0.3 GeV/c using 7 segments.

The track scatters visibly twice in the u-view, with the maximum scatter angle of 4.2 mrad (between the 3rd and 4th segments). This track cannot be followed into the next station.

Track 3861 interacts in E/B2, and two daughters are matched in the DCs. One with a momentum of -3 GeV/c and another with momentum +2 GeV/c. They deposit 1.5 and 0.4 GeV in the Ecal, respectively, and so 3861 is assumed to be a hadron.

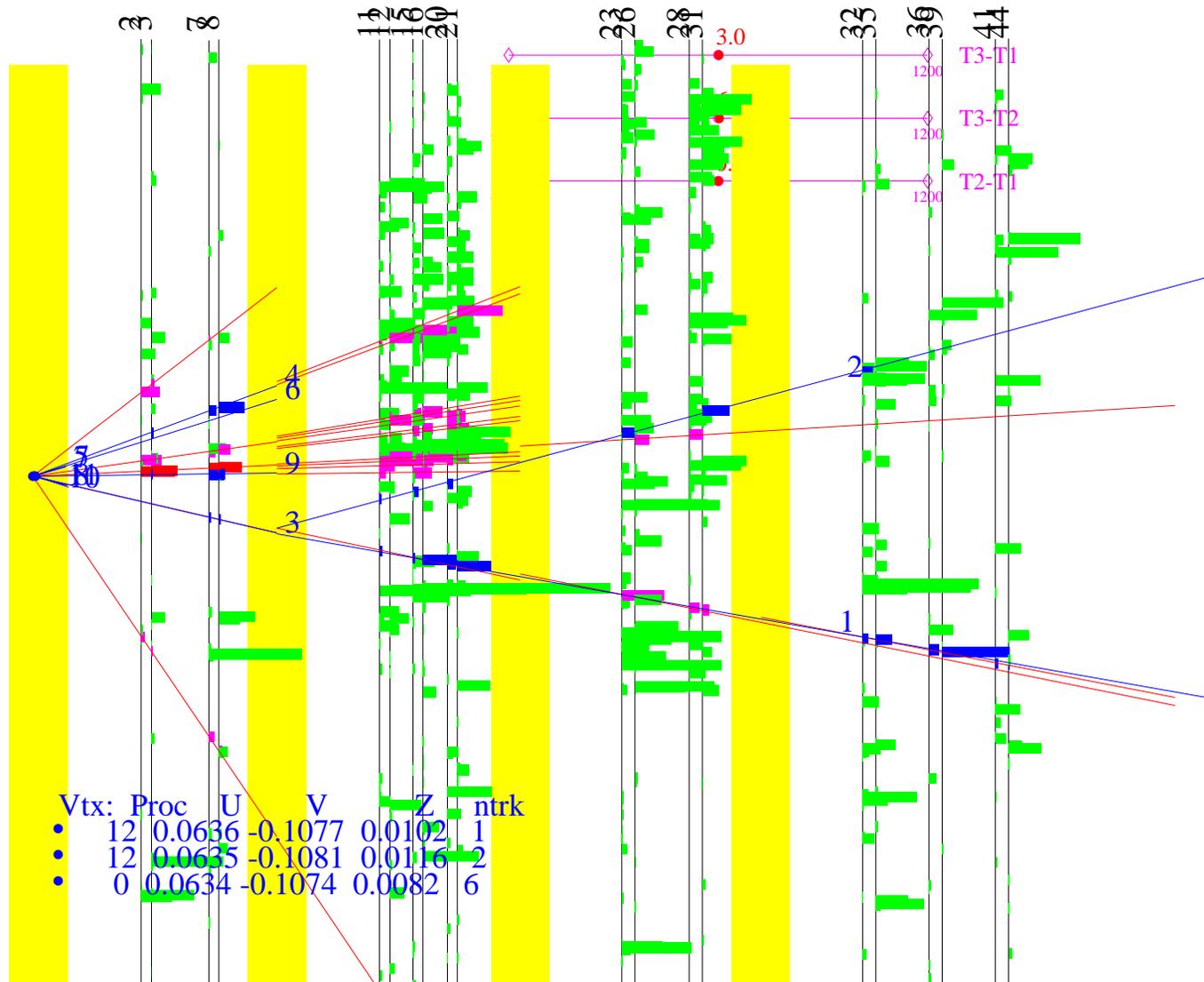
E872 Run= 3263 Event= 25102 Wght= 1.0  
 Triggers set  
 PHYSICS



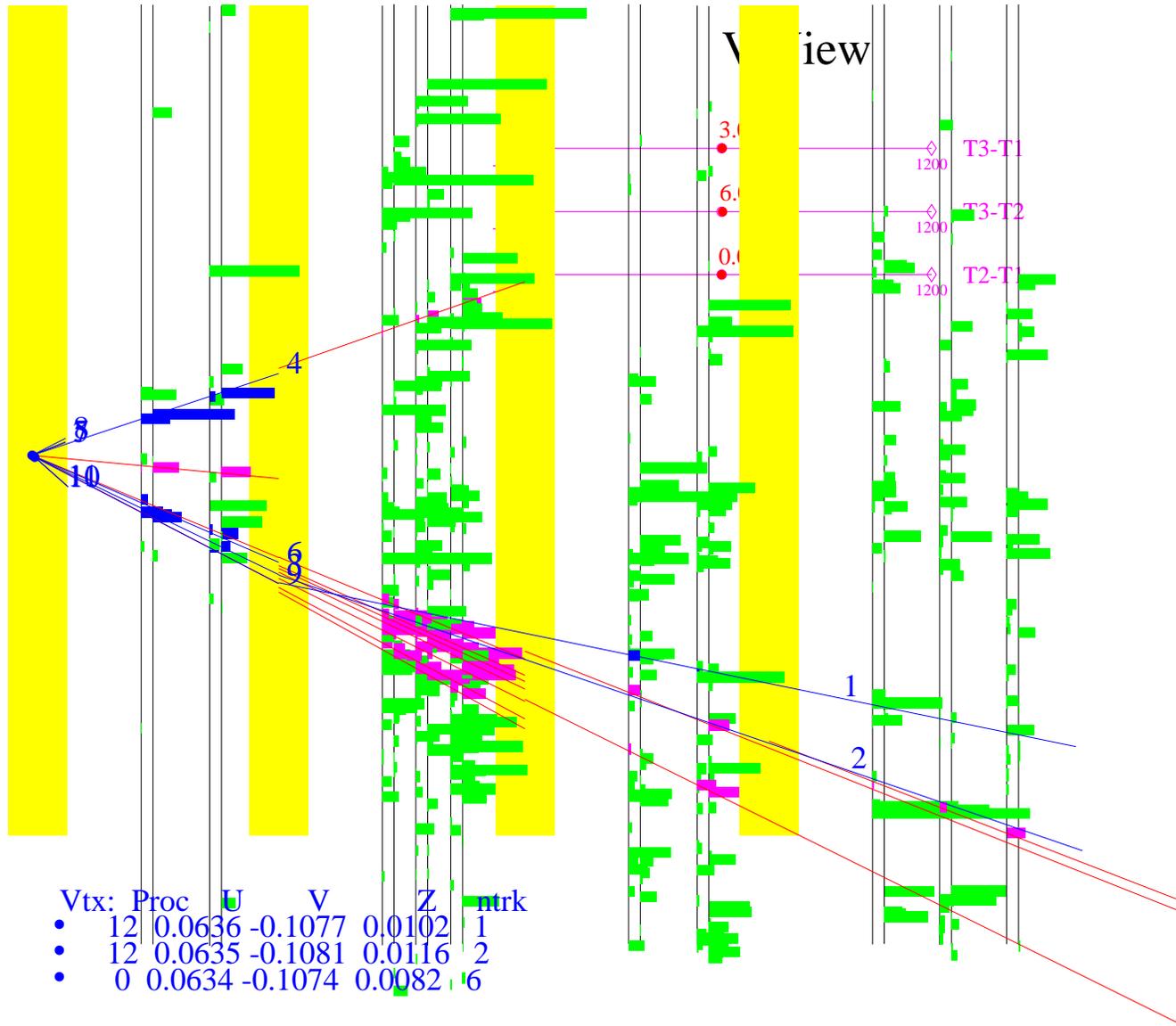
Trk	Mom	chi	nht	Emul	vtx
1	-2.8	1.4	32		0
2	2.0	1.3	25		0
3	0.0	1.4	6	401003831	1
4	0.0	0.9	8	381004628	1
5	0.0	0.0	0	401003956	1
6	0.0	0.0	0	401003833	1
7	0.0	0.0	0	401003953	1
8	0.0	0.0	0	402005705	1
9	0.0	1.9	8	391003610	2
10	0.0	0.0	0	392003111	2
11	0.0	0.0	0	392003110	3

E872 Run= 3263 Event= 25102 Wght= 1.0

### U View



E872 Run= 3263 Event= 25102 Wght= 1.0

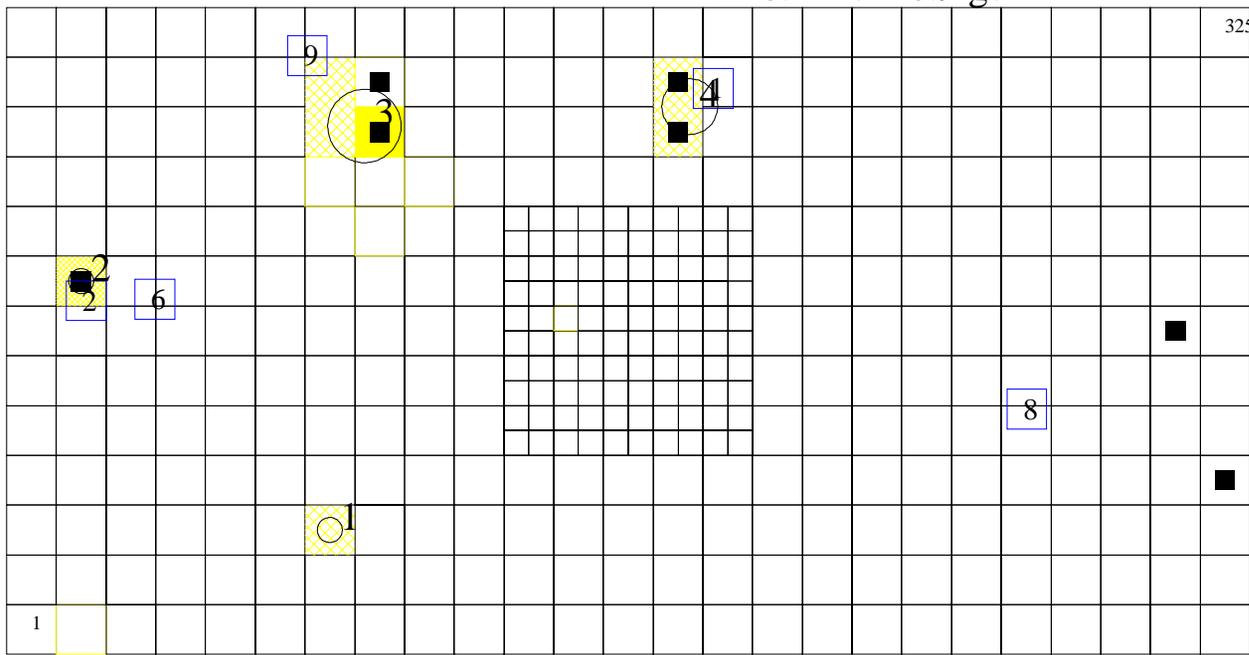


10  
11

E872 Run= 3263 Event= 25102

- E 18 GEV
- 8.5 e 18 gev
- 4.0 e 8.5 gev
- 1.8 e 4.0 gev
- 0.9 e 1.8 gev
- 0.4 e 0.9 gev

3



Cluster  $\Sigma E$  5

- 1 0.6
- 2 0.4
- 3 2.8
- 4 1.5

4 5 7

**3024\_30175**

Period 2

Tau candidate; LL

Vertex ECC1 @ 11796 43789 34959 microns

trk	seg	u	v	u'	v'	IP
121004373	12	0.0170	0.0500	-0.1500	-0.1781	1.20
121004485	7	0.0120	0.0447	-0.0070	-0.0261	0.79 P
121004657	7	0.0029	0.0363	0.2549	0.2148	4.48
122004200	1	-0.0006	0.0533	0.3541	-0.2710	11.49
122004457	1	0.0169	0.0469	-0.1467	-0.0876	1.93
092004391	13	0.012	0.048	-0.003	-0.116	1.3

Flight length = 4617  
 Kink angle = 0.090  
 Parent angle = 0.027  
 Delta phi = NA  
 Daughter mom = >3.3 +3.7 -1.2 MS  
                   7.8 +-1.6 SFT  
                   8.3 +-7.8 Ecal (@ 7.1 X0 ; 0.0 GeV)  
 Pt = 300 MeV/c (MS) ; 705 MeV/c (SFT)  
 Enu > 8 GeV

Comments:

This event was found in the first 40 located events, in the summer of 1998. There is a 90 mr kink at 4.6mm from the primary, which occurs in the base plastic of an emulsion sheet. It has only one primary track with an angle < 200 mr, the parent track of the kink. The tracks are very cleanly matched to the fiber data. The activity in the DCs and calorimeter is very low: only the daughter of the kink is within acceptance and this track showers in station 2. The two other large angle tracks are seen to deflect in going thru ECC3 (3 X0) and so a crude upper limit to their momentum can be given. Track 4657 deflection [du',dv'] is [0.019, 0.014] and track 4373 deflects [0.053, 0.022], implying upper limits of 3 and 1.3 GeV/c resp.

The daughter is positively identified as an electron. A conversion pair is found in the emulsion data along the daughter just before exiting the stack. The SFT data also clearly shows that this is an electron. The event occurs at a depth of 7.1 radiation lengths from the Ecal, and little, if any, energy is recorded for this track. This puts a weak upper bound on the initial electron energy [ >4 GeV 90%; >8 GeV 50% ]. A better estimate is made using the SFT information. The shower has all the properties of an electron with an initial energy of <10 GeV: shower max ~5 X0, number of e+- (SFT hits) <20. For low energies, the SFT/Emulsion system is a "good" calorimeter, and the SFT hits are usually separate and distinct. The multiple-scattering (MS) method is poor here for two reasons:(1) there track crosses only 9 Fe plates before exiting and (2) the track is an electron. The above MS estimate should be considered a lower limit.

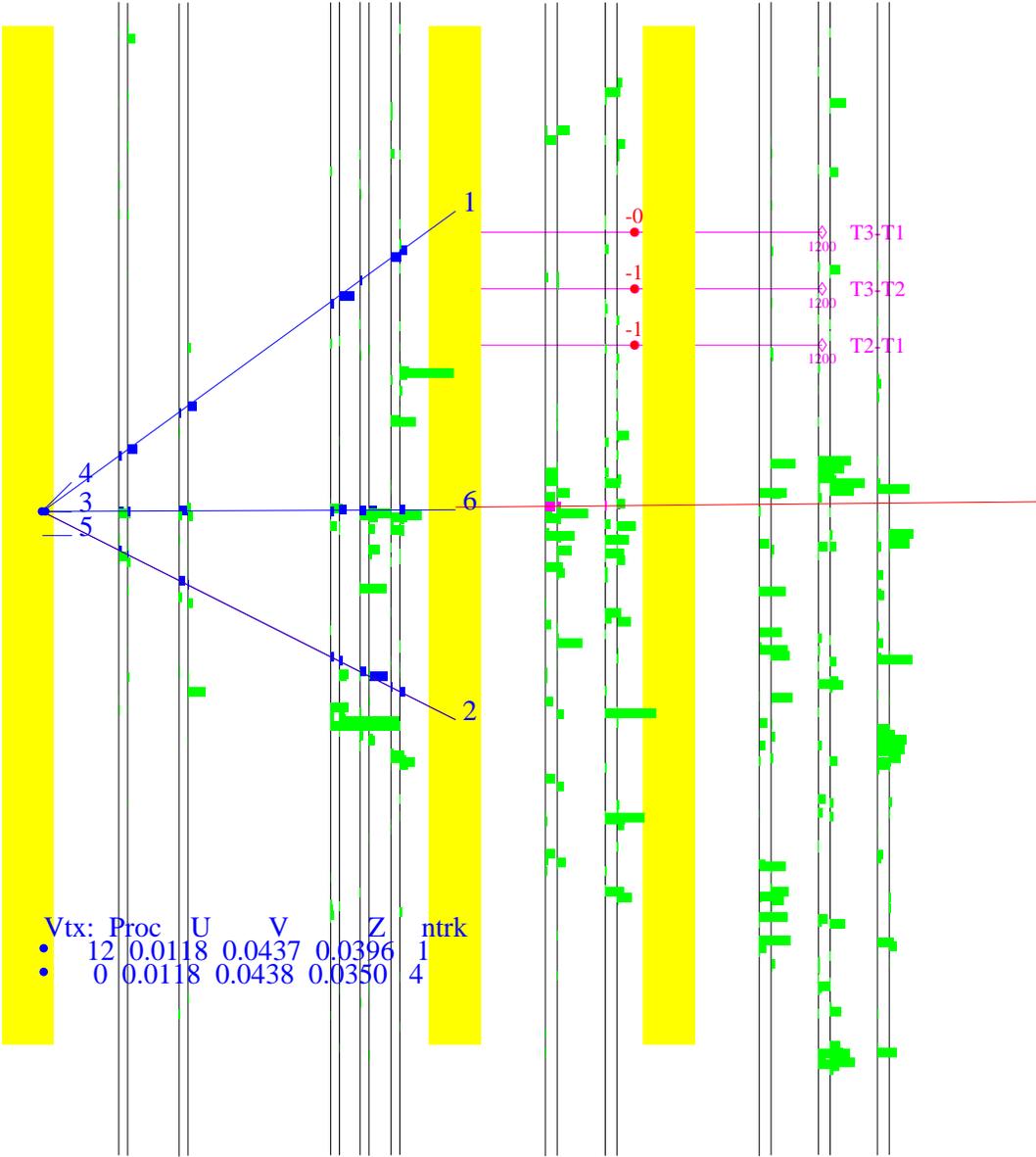
The tau hypothesis to this event implies that it is "almost" an elastic interaction. But the flight length is long, given the decay angle of 90 mr. The IP of the daughter wrt to the vertex is 410 microns, only 4% of the MC data has a larger IP. This suggests that the charged charm hypothesis is also likely. We can estimate the charm/tau relative "probability" by the following:

	production	chgd	BR	mis-ID	IP/ct	product
D+ -> l X	0.07	0.4	0.17	0.02	0.5	4.8e-5
tau-> (l or h)X	0.05	1.0	0.85	1	0.04	1.4e-3

For the charm hypothesis, the mis-identification probability is restricted to the probability that one of the two (large-angle) tracks is muon, which are out of the acceptance of the muon walls. One of these tracks (4373) appears to interact in E/B4 but neither interact in ECC3 => neither are electrons.

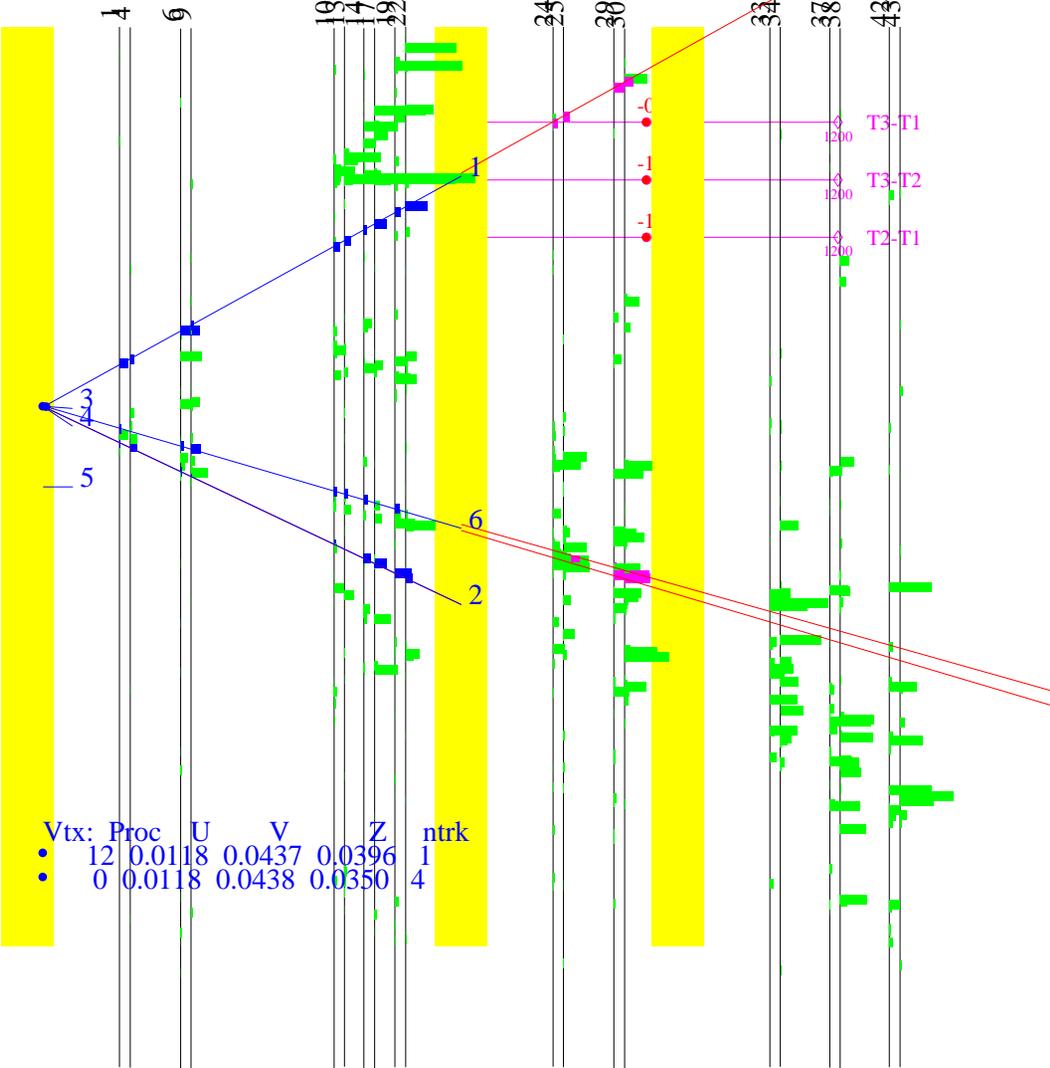
The scatter hypothesis is very unlikely for this event. The probability is estimated at 5e-5 based on pT, total track length, and material.

E872 Run= 3024 Event= 30175 Wght= 1.0  
U View

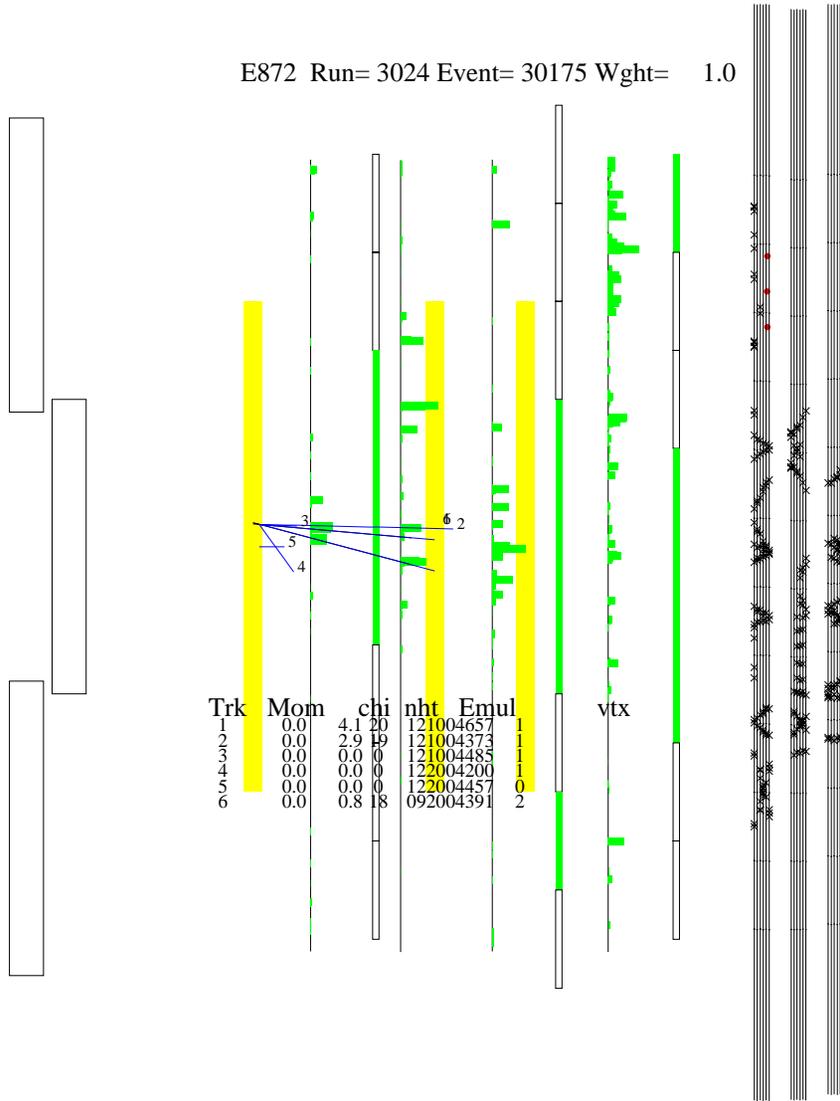


E872 Run= 3024 Event= 30175 Wght= 1.0

V View



E872 Run= 3024 Event= 30175 Wght= 1.0



### 3356 17099

Period 4 ; E/B3

Tau candidate; S

Vtx = -35789 -62367 589058 microns  
Vertex plate 411

trk	nseg	u	v	usl	vsl	ip
411004933	12	-0.0818	-0.0831	0.0781	0.0353	3.39
411004862	12	-0.0618	-0.0681	0.0442	0.0097	0.25
411004819	12	-0.0039	-0.0607	-0.0541	-0.0029	0.68
411004654	11	-0.0129	-0.0307	-0.0389	-0.0538	0.53
411004628	11	-0.0327	-0.0265	-0.0052	-0.0609	1.17
411004712	11	-0.0191	-0.0434	-0.0283	-0.0323	0.70
411005120	10	-0.0695	-0.1249	0.0573	0.1062	3.76
411004732	10	-0.1070	-0.0463	0.1209	-0.0273	2.10
412009057	6	0.0689	-0.0736	-0.1776	0.0190	0.69
422005484	1	0.0929	-0.1997	-0.2185	0.2332	6.94
411004844	12	-0.003	-0.069	-0.055	0.012	22.7 D

Flight length < 920.

Kink angle > 0.025

Parent angle = NA

Delta phi = NA

Daughter mom = 6.2 +3.5 -1.7

Pt > 160 MeV/c

Enu > 31 GeV

Comments:

This is an "S" candidate, so there are no parent segments visible. The daughter track (4844) can be well matched to the SFT, but must share hits with track 4819 in the u-view ( 1 mrad difference). The event is in the candidate list since the minimum pT is > 100 MeV/c and the daughter momentum is > 1 GeV/c.

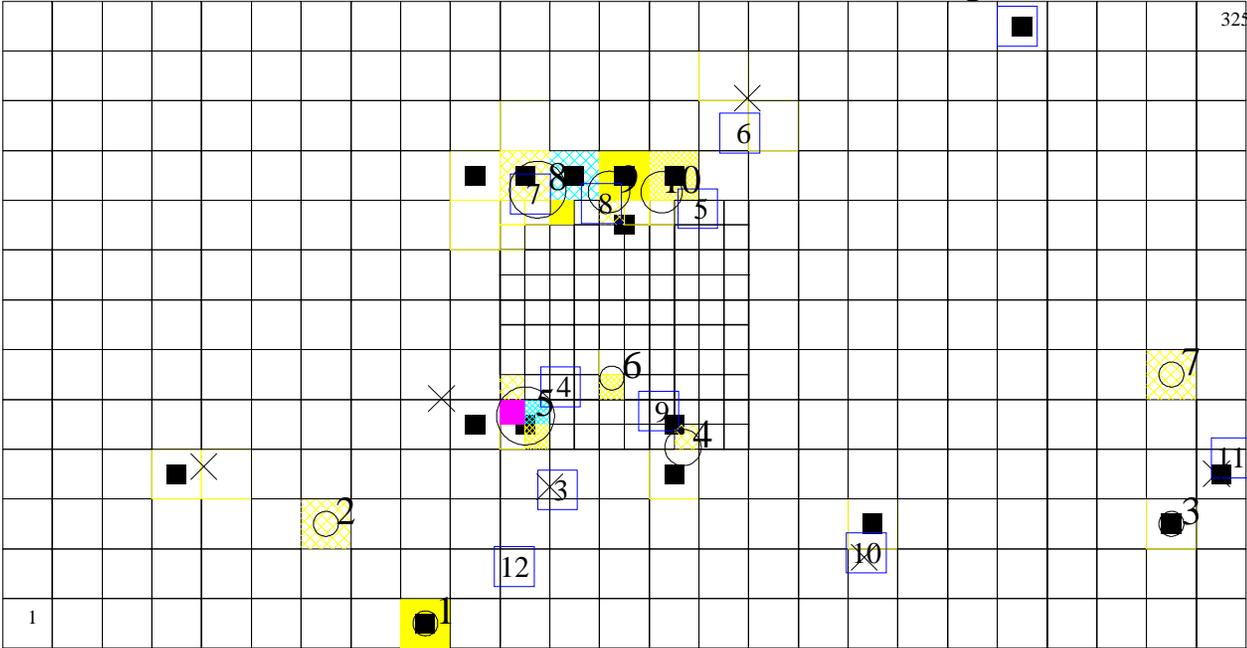
The calculated min pT is 160 MeV/c, which puts the most likely true pT at 260 MeV/c with a 90% range of 150 to 600 MeV/c. The track cannot be followed into the DCs. The multiplicity is high ( at least 9 primary tracks) so downstream tracking is limited mostly to the x-view.

There are probable showers in station 4 (SFT). The pattern in the DCs shows two probable e+e- associations with tracks (5120, 4732).

One track, 4628, is well reconstructed all the way through the spectrometer, and is found to have a momentum = -5.0 GeV/c. It has angles of (x',y') = (0.145,0.122) => 0.95 GeV/c pT. Most notably, its projection intersects 4 or 6 muon ID planes, and it records 3 of these four as hits on this track. The fact that this track has muon ID hits, and is isolated in angle implies that there is a significant probability that 4628 is indeed a muon, even though the momentum is very low (5 GeV/c).

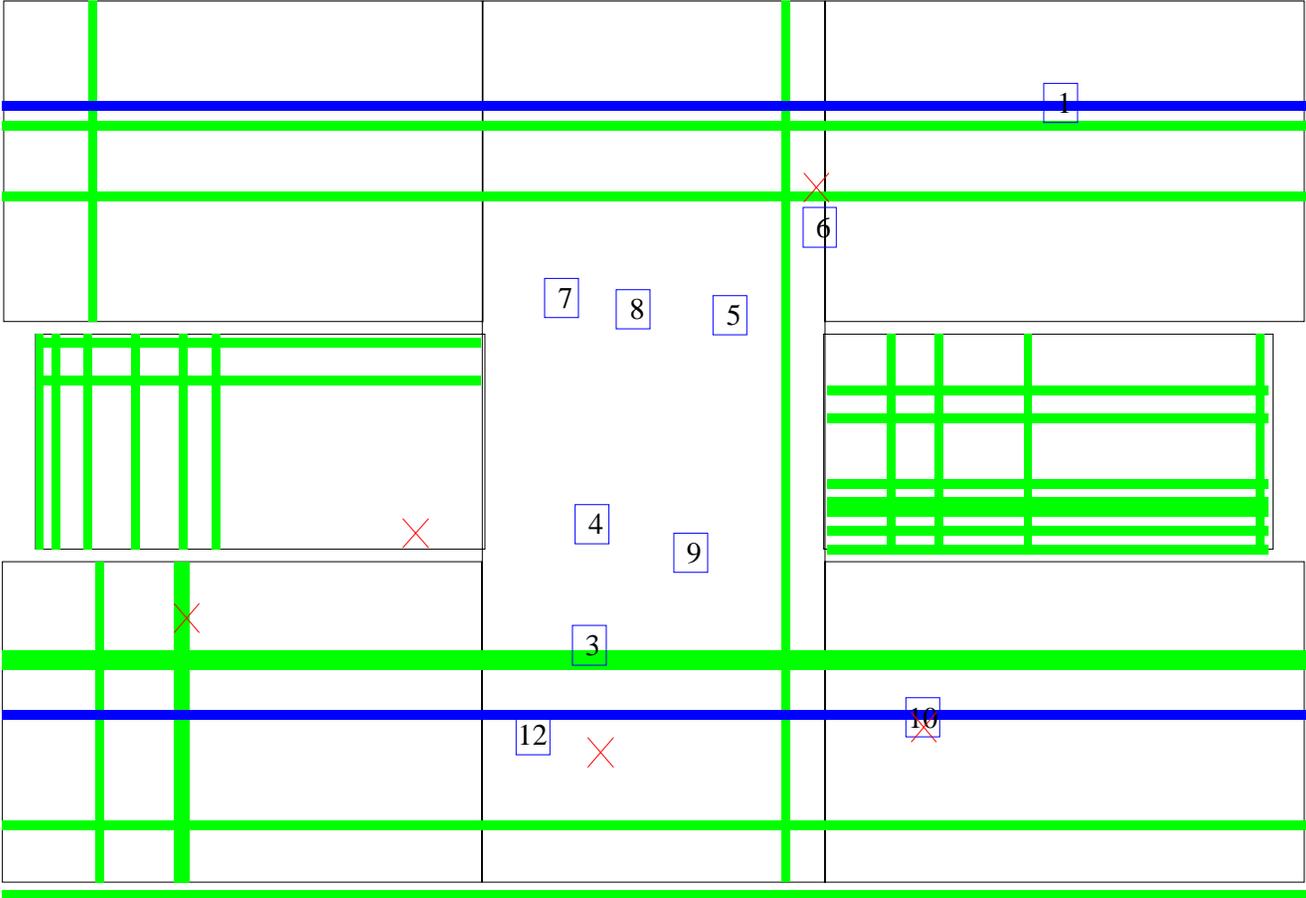
E872 Run= 3356 Event= 17099

- E 18 GEV
- 8.5 e 18 gev
- 4.0 e 8.5 gev
- 1.8 e 4.0 gev
- 0.9 e 1.8 gev
- 0.4 e 0.9 gev

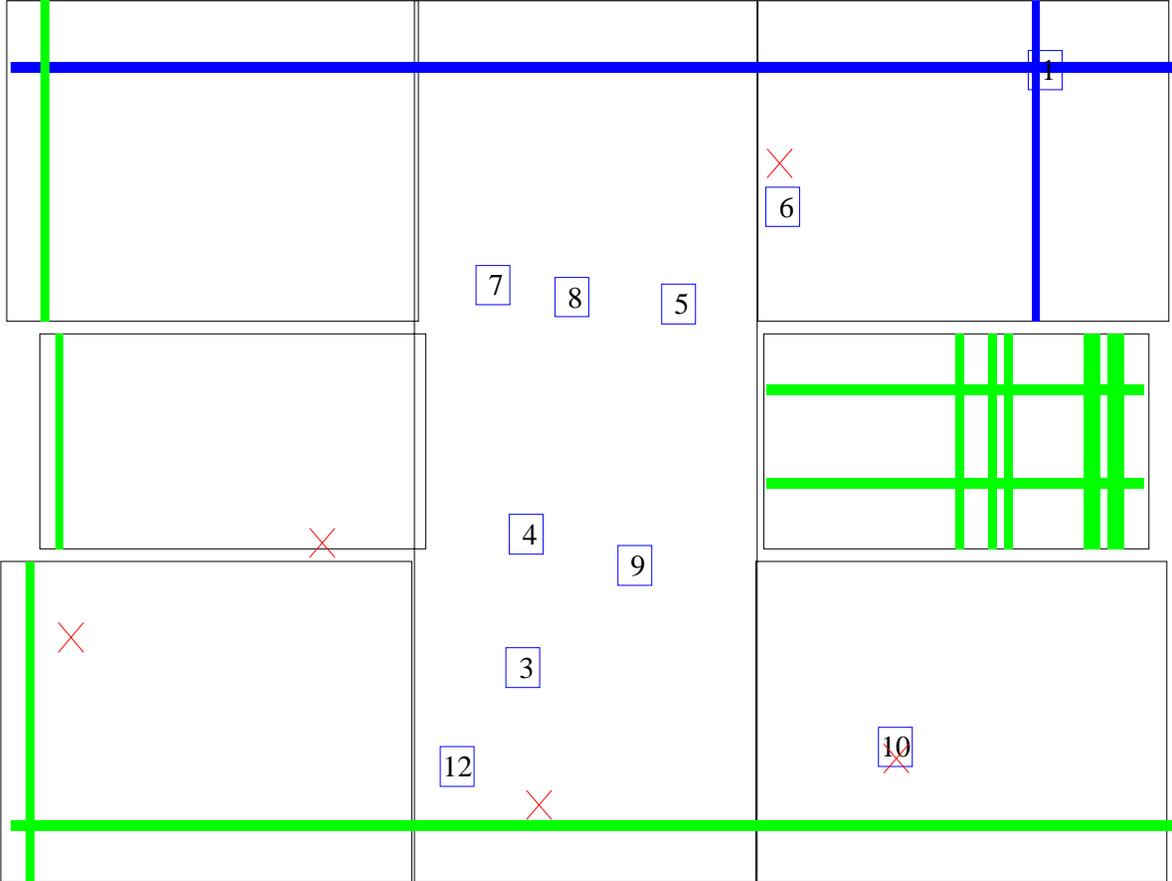


1	0.8	9	1.9
2	0.6	10	1.0
3	0.4		
4	0.9		
5	6.3		
6	0.6		
7	0.5		
8	5.6		

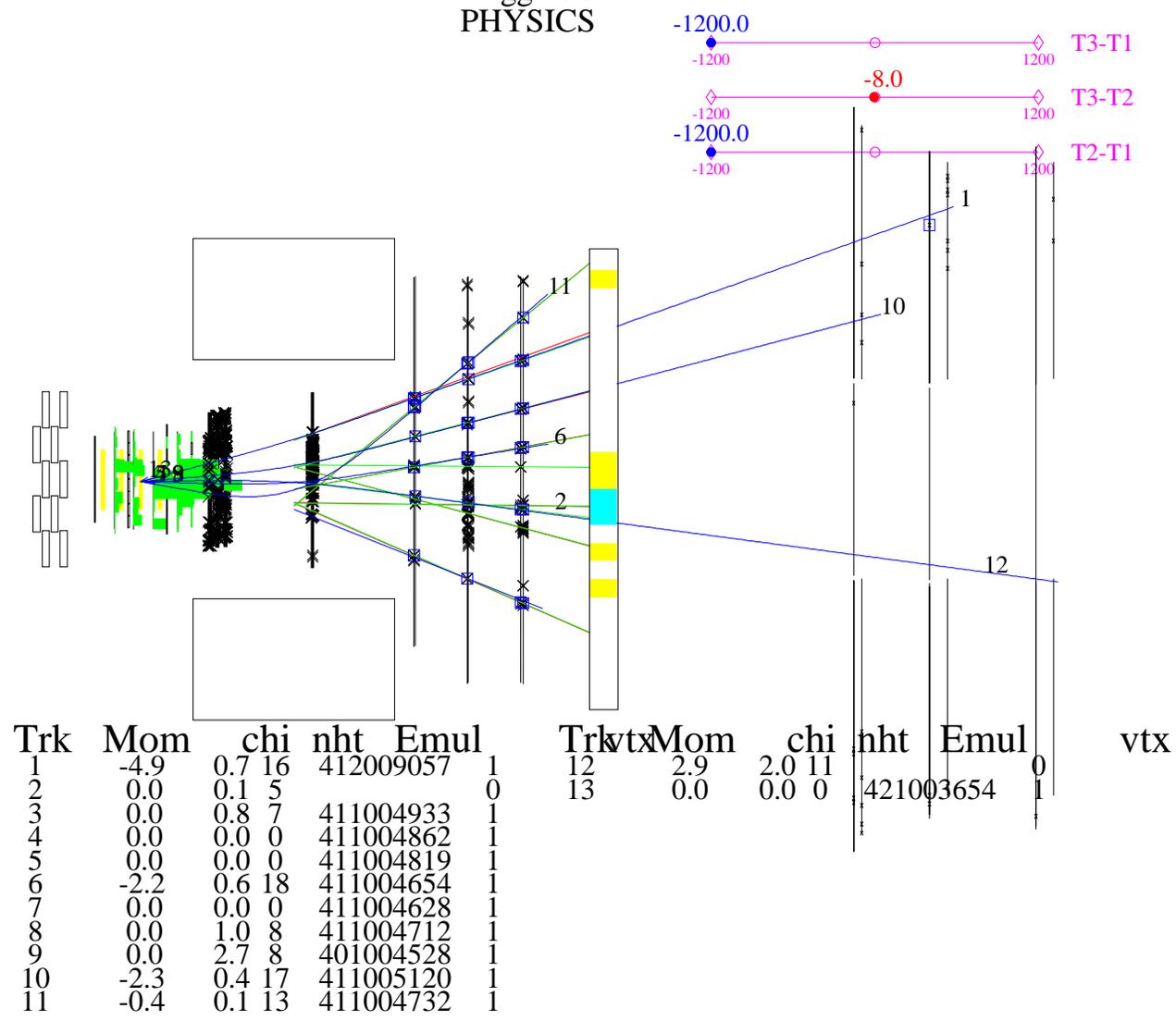
Y  
MID Station A  
X - West

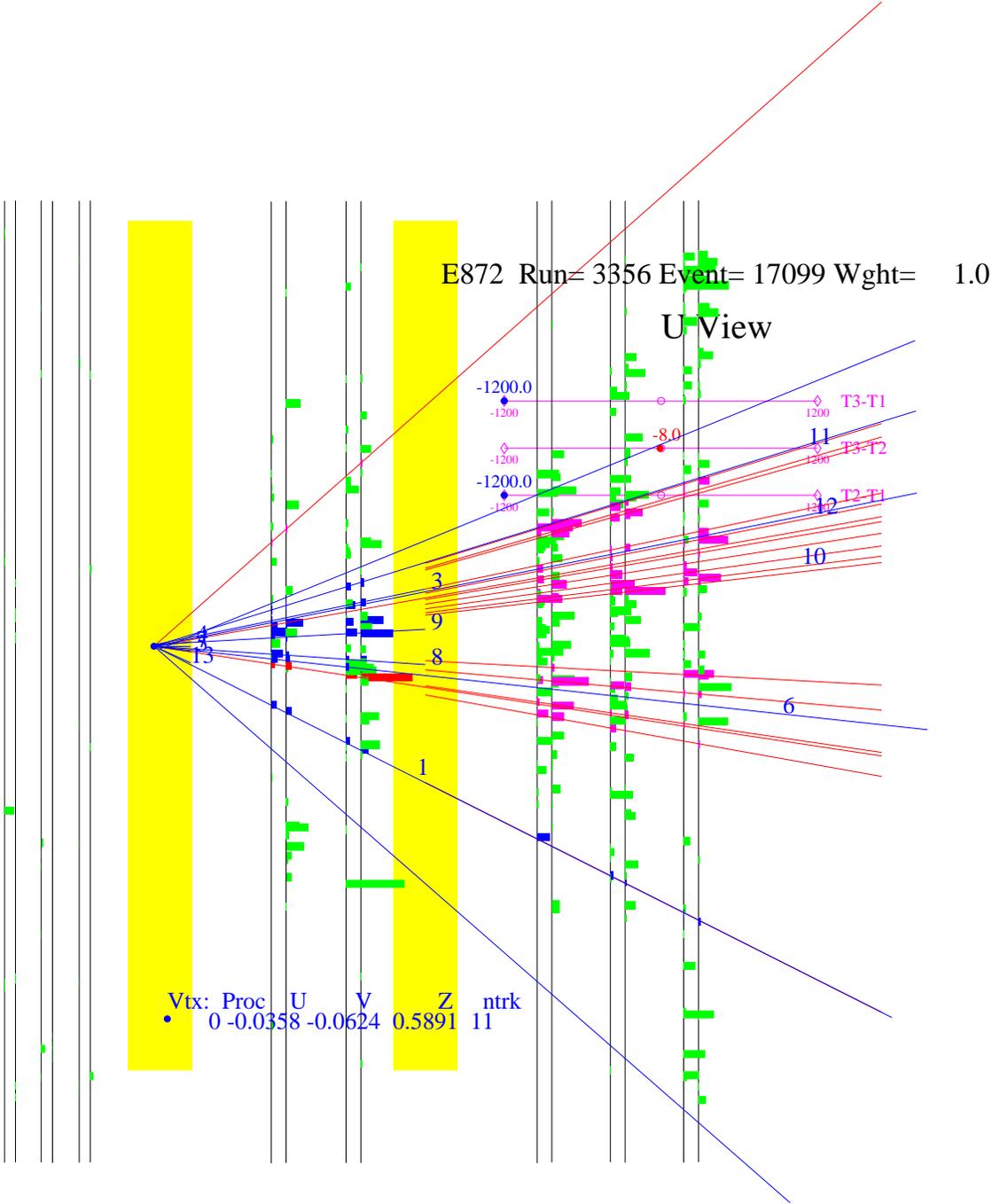


Y  
MID Station B  
X - West



E872 Run= 3356 Event= 17099 Wght= 1.0  
 Triggers set  
 PHYSICS





### 3333\_17665

Period 4

Tau candidate; LS

Vertex E/B2 @ 9577 66583 273592 microns

trk	nseg	u	v	usl	vsl	ip	
561004110	11	0.0144	0.0654	-0.0175	0.0042	7.56*	P/D
561004033	10	-0.0157	0.0993	0.0923	-0.1196	0.78	
561004107	9	-0.0313	0.0654	0.1494	0.0044	0.33	
561004134	5	0.0784	0.0490	-0.2516	0.0644	0.76	
561003910	4	-0.0329	0.1546	0.1553	-0.3218	0.54	
561003915	1	-0.0343	0.1608	0.1605	-0.3445	6.11**	
561004094	13	-0.0183	0.0731	0.1018	-0.0237	0.58	

(\* IP of segment 2-4 ; \*\* only 1 segment)

Flight length = 550 microns

Kink angle = 0.0131

Parent angle = 0.0091

Delta phi = NA

Daughter mom = >8.6 +4.0 -2.2 MS

31.0 +- 6.4 SFT

26 +-24 Ecal ( @ 7.1 X0 ; 4.5+0.7+0.3=5.5 GeV)

Pt > 120 MeV/c (MS)

= 405 MeV/c (SFT)

Enu = >35 GeV

Comments:

The primary vertex is less than 200 microns inside the steel plate. The kink lies in the base of the first emulsion sheet after the primary vertex. The daughter track (4110) is the last 10 segments, and the parent is recognized as the first segment only (nearest the steel). It was found due to the large IP, even when included in the primary vertex in an un-separated state. The IP of the daughter (using segs 2,3,4) is 7.6 microns, and the mean IP of the 5 other tracks that have >2 segments is 0.60 microns: hence this IP is far beyond errors in measurement. The daughter track is identified as an electron, clearly showering in

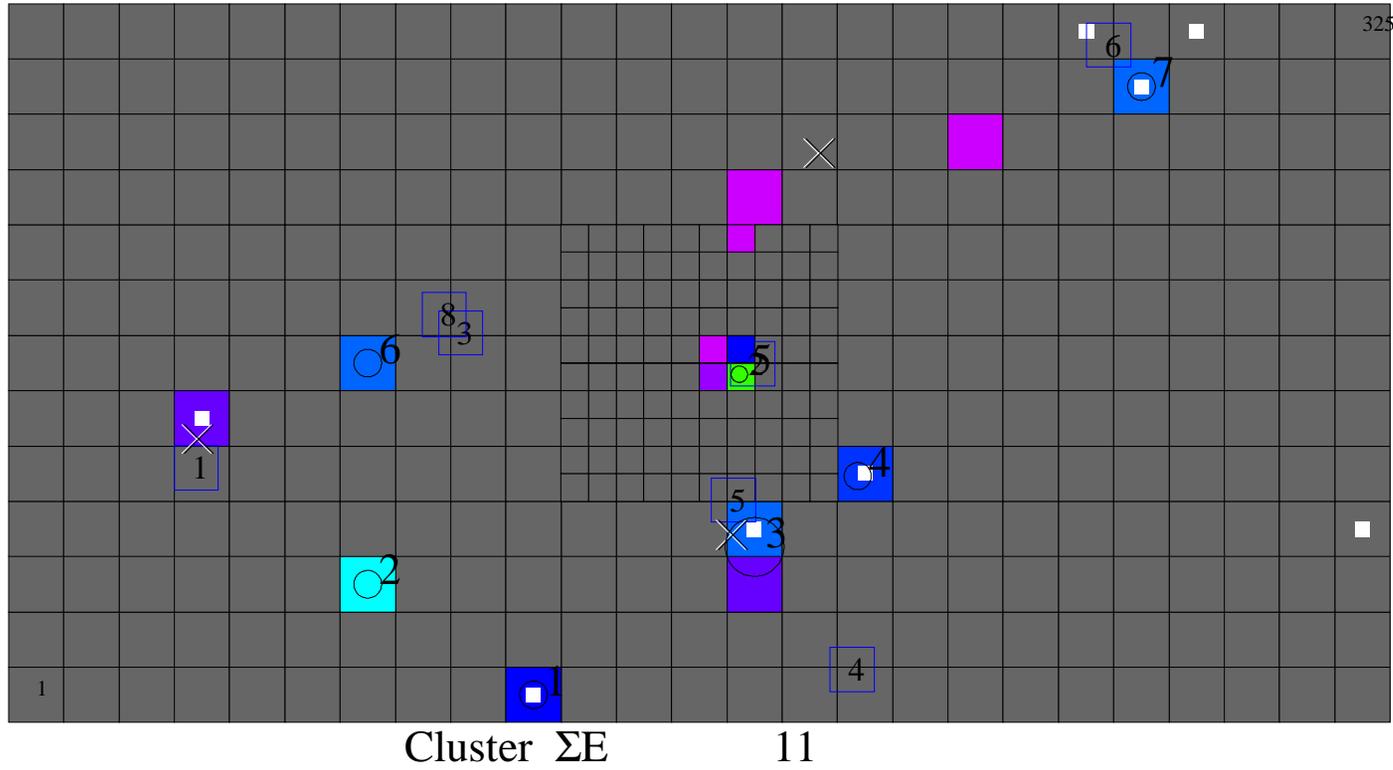
the SFT with a small cluster of energy (4.5 GeV) at the projected position in the calorimeter. Two other blocks (at least) in the Ecal are likely to be associated with this shower, giving a total Ecal energy of 5.5 GeV for this electron. Since there is 7.1 X0 between the Ecal and the vertex, the initial energy of the electron is much greater. The MS technique yields a lower estimate of 8.6 GeV/c, but the shower development in the SFT implies about 30 GeV. Thus, the scattering hypothesis in the emulsion data is very much suppressed, and the IP and kink are considered to be the result of kinematics (decay).

The dca of the daughter to the parent (using the vertex as a point on the parent) is found to be 1.9 microns at Z=274142.0 microns. The kink angle is 13.1 mrad. This is short decay, considering the estimated energy of the daughter.

There are two other tracks that have spectrometer information. Track (4134) has momentum +1.8 GeV/c and track (4094) has -1.6 GeV/c. Due to the showering of the electron, other tracks are more difficult to link to the DCs. One track (4033) projects into the MuID scintillator, but is not consistent with the DC data. Because of the fortuitous distribution in track angles, all other emulsion tracks are unlikely to be electrons, as there are no significant associated showers (except for 4110).

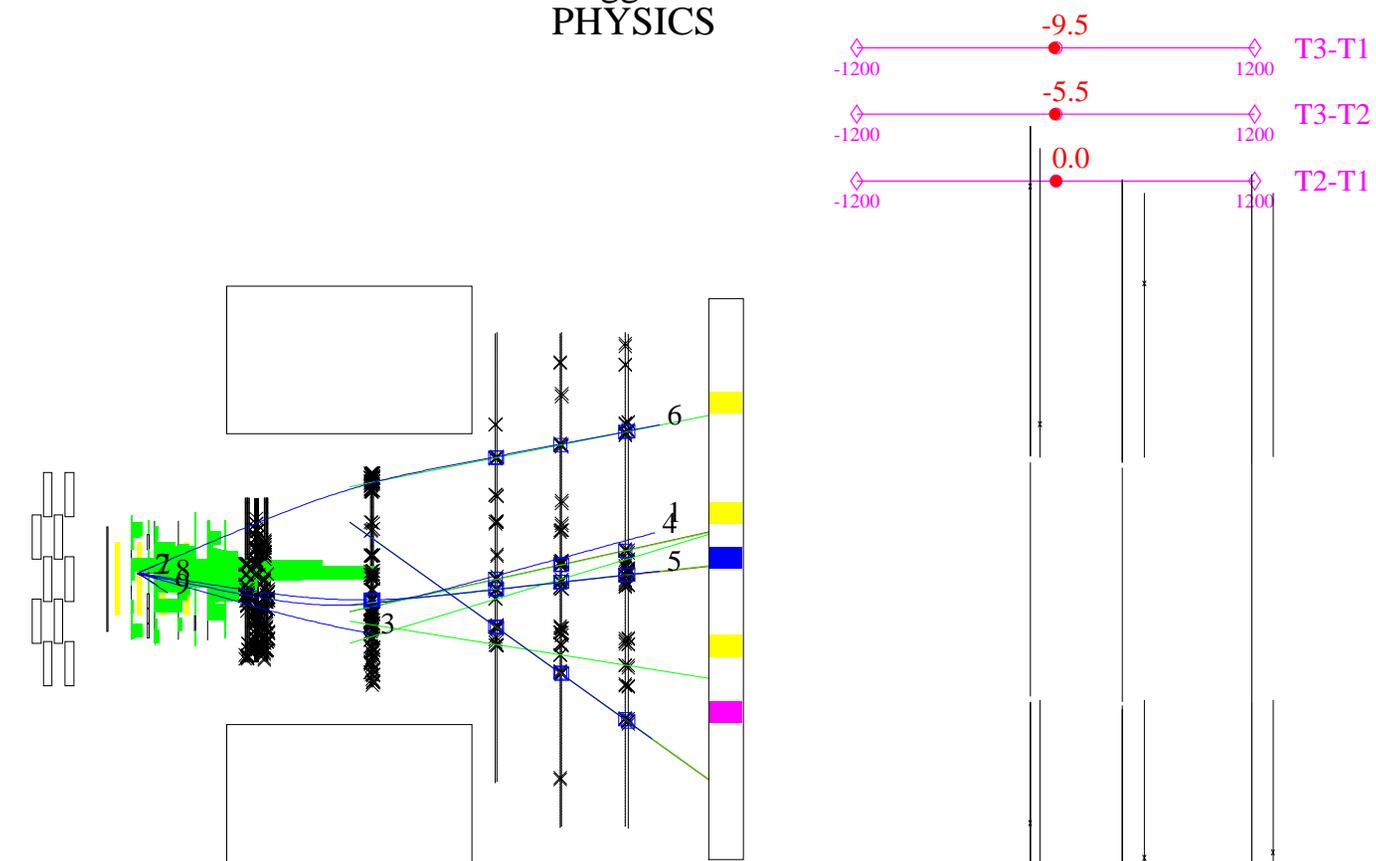
There is one track (4033) that projects to the muID scintillator. However it does not penetrate to the downstream end of the SFT. MS is barely visible, so it probably has p>2 GeV/c.

E872 Run= 3333 Event= 17665



1	0.4
2	1.1
3	1.0
4	0.7
5	4.8
6	0.7
7	0.6

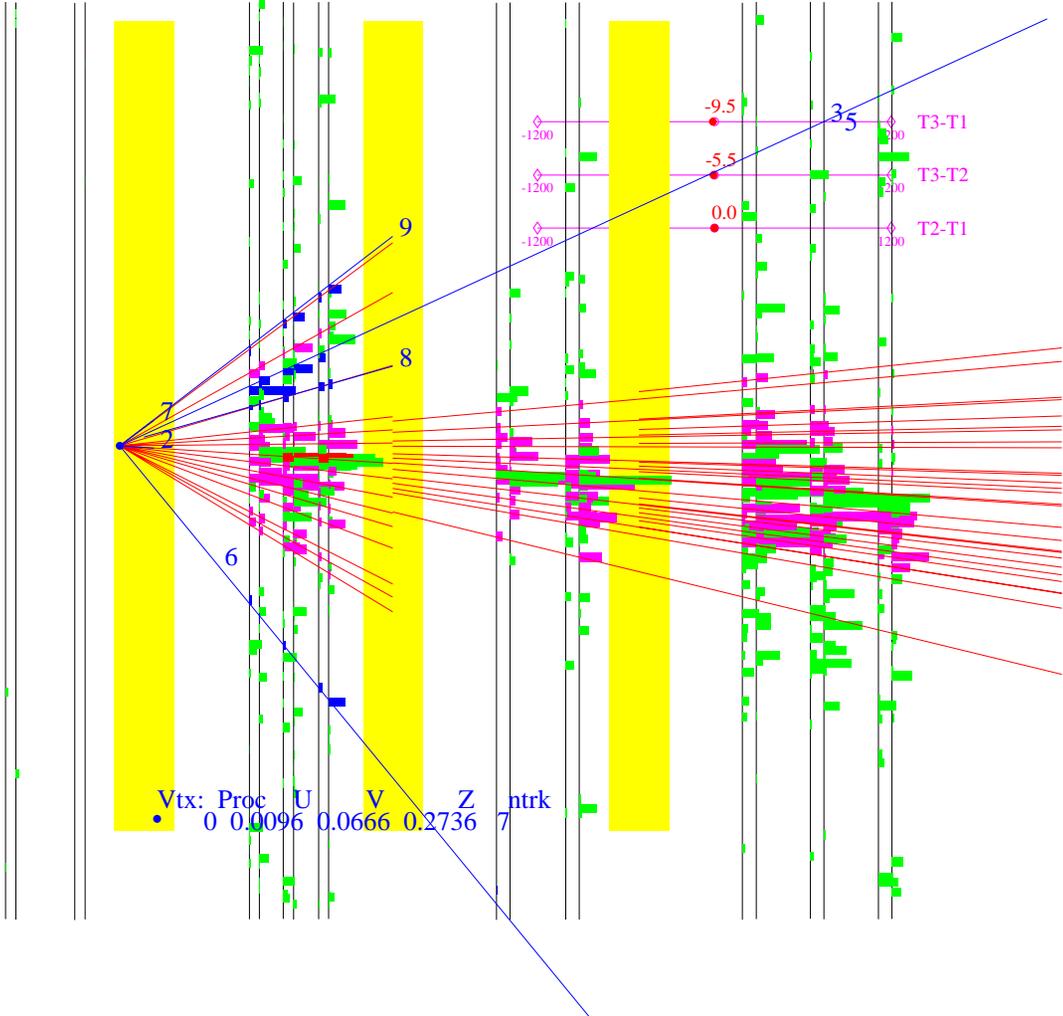
E872 Run= 3333 Event= 17665 Wght= 1.0  
 Triggers set  
 PHYSICS



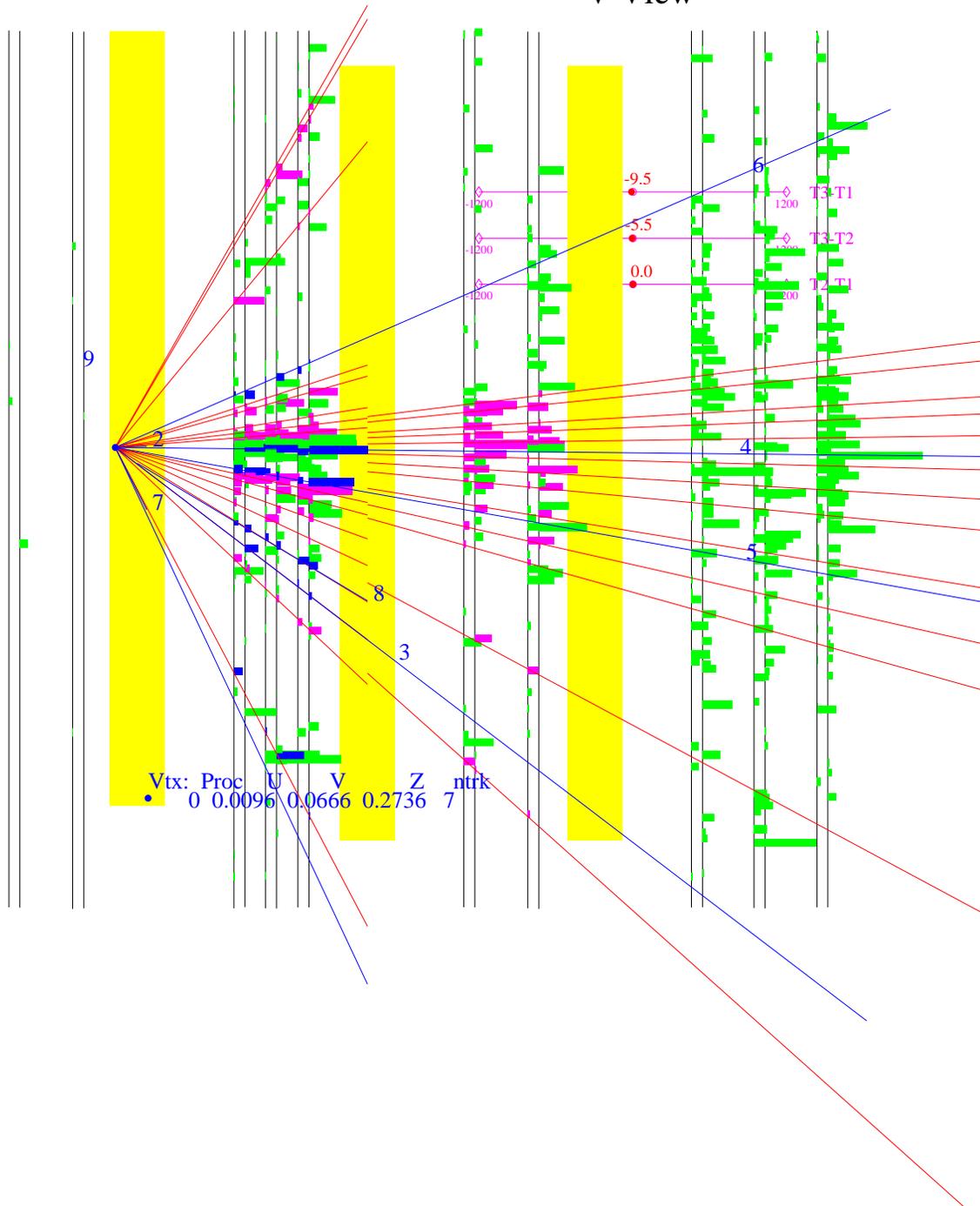
Trk	Mom	chi	nht	Emul	vtx
1	0.0	2.0	9		0
2	0.0	0.0	0	561004110	1
3	-2.4	2.7	11	561004033	1
4	-0.9	1.2	23	561004107	1
5	-1.6	0.7	23	561004094	1
6	1.9	4.9	28	561004134	1
7	0.0	0.0	0	561003910	1
8	-18.3	1.6	17		0
9	0.0	0.0	0	561003915	1

E872 Run= 3333 Event= 17665 Wght= 1.0

U View



E872 Run= 3333 Event= 17665 Wght= 1.0  
V View



3039 01910

Period 2 ; ECC1

Tau candidate; LL & S

Vtx = -74407 69527 27024 microns  
 Vertex plate 181

trk	nseg	u	v	usl	vsl	ip	
181003994	18	-0.0743	0.0693	-0.0036	0.0082	0.61	
182003551	16	-0.0744	0.0683	-0.0011	0.0447	0.07	
182003534	14	-0.0747	0.0688	0.0119	0.0281	0.12	
181004031	9	-0.0805	0.0636	0.2248	0.2181	0.63	
181003979	1	-0.0737	0.0711	-0.0246	-0.0590	0.41	P
182003461	17	-0.076	0.070	0.041	0.000		D

Flight length = 272 microns

Kink angle = 0.090

Parent angle = 0.064

Delta phi = NA

Daughter mom = 4.6 +1.6 -0.9 MS

Pt = 410 MeV/c (MS)

Enu = >85 GeV (e-m SFT + Ecal)

Comments:

There is a clear SFT match to the daughter track (3461) in stations 1 and 2 (in u,v and x) with angle match of [u,v]=[0.008, 0.000]. However the track “disappears” into some showers after ECC3, in station 3 and cannot be recovered, if it exits without interaction. The DCs are busy and DC2 appears to be oscillating and is useless. There is no Ecal energy at the projected position of the daughter. The kink occurs in the base of the emulsion sheet. As there are no emulsion track positions within 20cm of the muID scintillator or the edge of the muID, it is unlikely that any track is a muon. (4031 is a wide-angle track associated with SFT hits that show high, increasing p.h.).

There is, however, a great deal of e-m energy in this event, both in the SFT and Ecal. There several showers in SFT, which have the characteristics of low-energy, due to number of hits and that the hit number decreases in station 4, after 3.5 X0. Tracking in both u and v views is made difficult downstream of ECC3 by these showers/interactions. There is evidence that track 3551 escapes

the SFT uninteracted (v and x views), but tracks 3994 and 3534 cannot be separated from the general showers in the SFT, and may have interacted. There is Ecal energy (sum total 20.4 GeV) within 15cm of the projected emulsion tracks. All three primary tracks (3994, 3551, 3534) have show no sign of scattering in the emulsion, with the scatter rms of (0.36,0.41,0.30 microns) slightly better than the mean “high-momentum” rms of 0.50. Thus these tracks are all >3 GeV/c. The daughter, obviously, does show a small increase, with an rms of 0.73 microns (not super-fine aligned).

The Ecal energy distribution is interesting, both because of the total amount of energy ( 68 GeV) and its distribution. The total ET of the clusters in the calorimeter, wrt the neutrino direction, is 4.3 GeV. The direction of this sum is [x,y] = [3.31, -2.69]. This is approximately opposite in direction to the daughter track and 151 degrees relative to the parent. The most energetic cluster (20 GeV) has a ET = [0.74, -1.86] => 2.00 GeV total. It is not associated with any charged primary track. It appears to be from an interaction in E/B4, with several hi-ion. tracks radiating from this point, probably indicating an hadronic interaction. There is not a SFT charged particle upstream => a neutral hadron with momentum > 20 GeV/c (hypothesis).

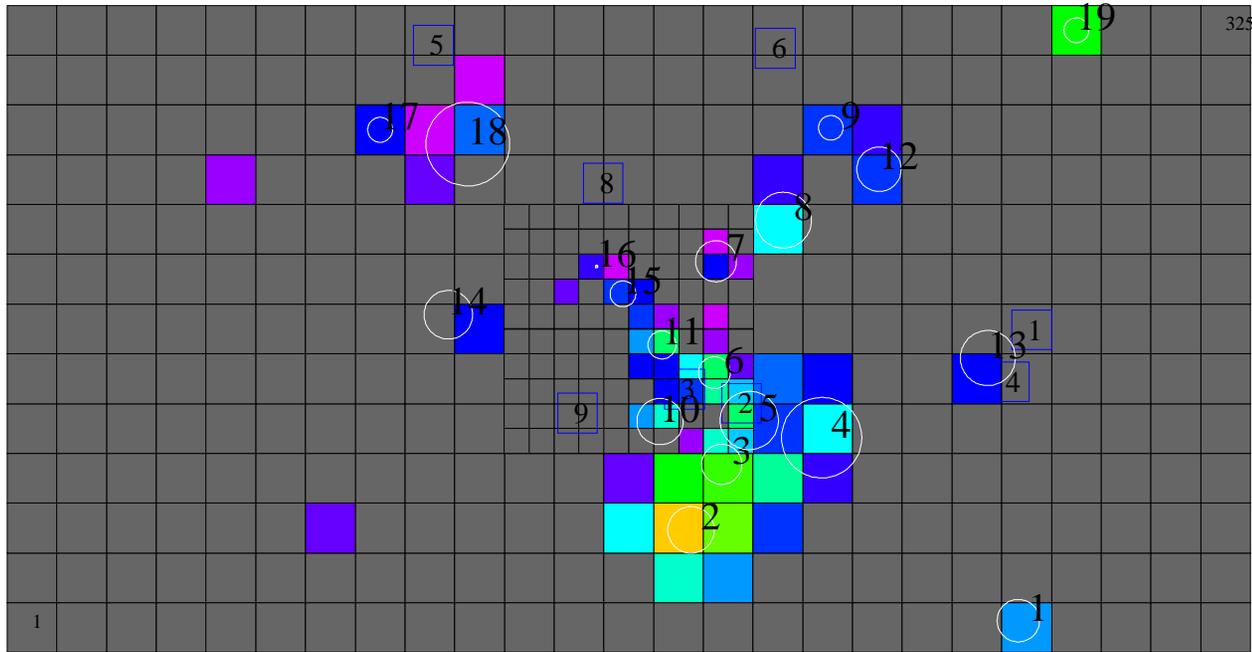
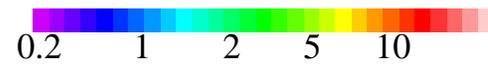
SF energy 7.22207165 24.532341

E, phsum sta	1.12538803	12.8106146	7.39506197	12 9 22 15	11.3400002
E, phsum sta	19.8253326	78.888443	7.39506197	12 11 19 15	10.5299997
E, phsum sta	6.74578524	32.6707611	7.39506197	15 13 34 23	16.7000008
E, phsum sta	2.75871634	18.5821171	7.39506197	17 13 36 23	17.2399998
E, phsum sta	5.9700346	29.9295807	7.39506197	15 13 37 22	17.2450008
E, phsum sta	5.74433327	29.1320457	7.39506197	15 13 38 24	18.0450001
E, phsum sta	1.60818243	14.5166092	7.39506197	18 15 45 28	20.9949989
E, phsum sta	1.8353802	15.3194313	7.39506197	18 15 42 27	19.9200001
E, phsum sta	0.842930913	11.8125286	7.39506197	18 14 40 25	18.8500004
E, phsum sta	3.91931152	22.6831779	7.39506197	15 13 38 26	18.5750008
E, phsum sta	4.78460598	25.7407684	7.39506197	16 12 42 25	19.3899994
E, phsum sta	0.791789174	11.631815	7.39506197	18 14 40 26	19.1149998
E, phsum sta	0.798285544	11.6547699	7.39506197	17 13 30 21	13.0933332
E, phsum sta	1.02146816	12.4434042	7.39506197	16 13 42 30	20.7150002
E, phsum sta	1.35109484	13.6081686	7.39506197	17 12 46 28	21.2649994
E, phsum sta	0.496771216	10.589344	7.39506197	18 13 47 30	22.0650005

E, phsum sta 0.451595902 10.4297132 7.39506197 15 9 35 24 17.2350006  
 E, phsum sta 1.71363211 14.8892241 7.39506197 14 8 35 23 16.9700012  
 E, phsum sta 3.0929749 19.7632484 7.39506197 13 9 19 17 11.0599995

1	1.125	0.193	-0.147	0.243
2	19.825	0.744	-1.856	2.000
3	6.746	0.338	-0.451	0.563
4	2.759	0.251	-0.154	0.295
5	5.970	0.366	-0.292	0.469
6	5.744	0.270	-0.169	0.319
7	1.608	0.077	0.026	0.081
8	1.835	0.138	0.060	0.151
9	0.843	0.080	0.060	0.100
10	3.919	0.097	-0.193	0.217
11	4.785	0.123	-0.086	0.150
12	0.792	0.091	0.043	0.100
13	0.798	0.127	-0.019	0.128
14	1.021	-0.063	-0.006	0.063
15	1.351	0.013	0.004	0.014
16	0.497	-0.001	0.007	0.007
17	0.452	-0.040	0.032	0.051
18	1.714	-0.092	0.110	0.143
19	3.093	0.604	0.342	0.694
pT sum X Y T	3.3143301	-2.69086742	4.26913929	

E872 Run= 3039 Event= 1910



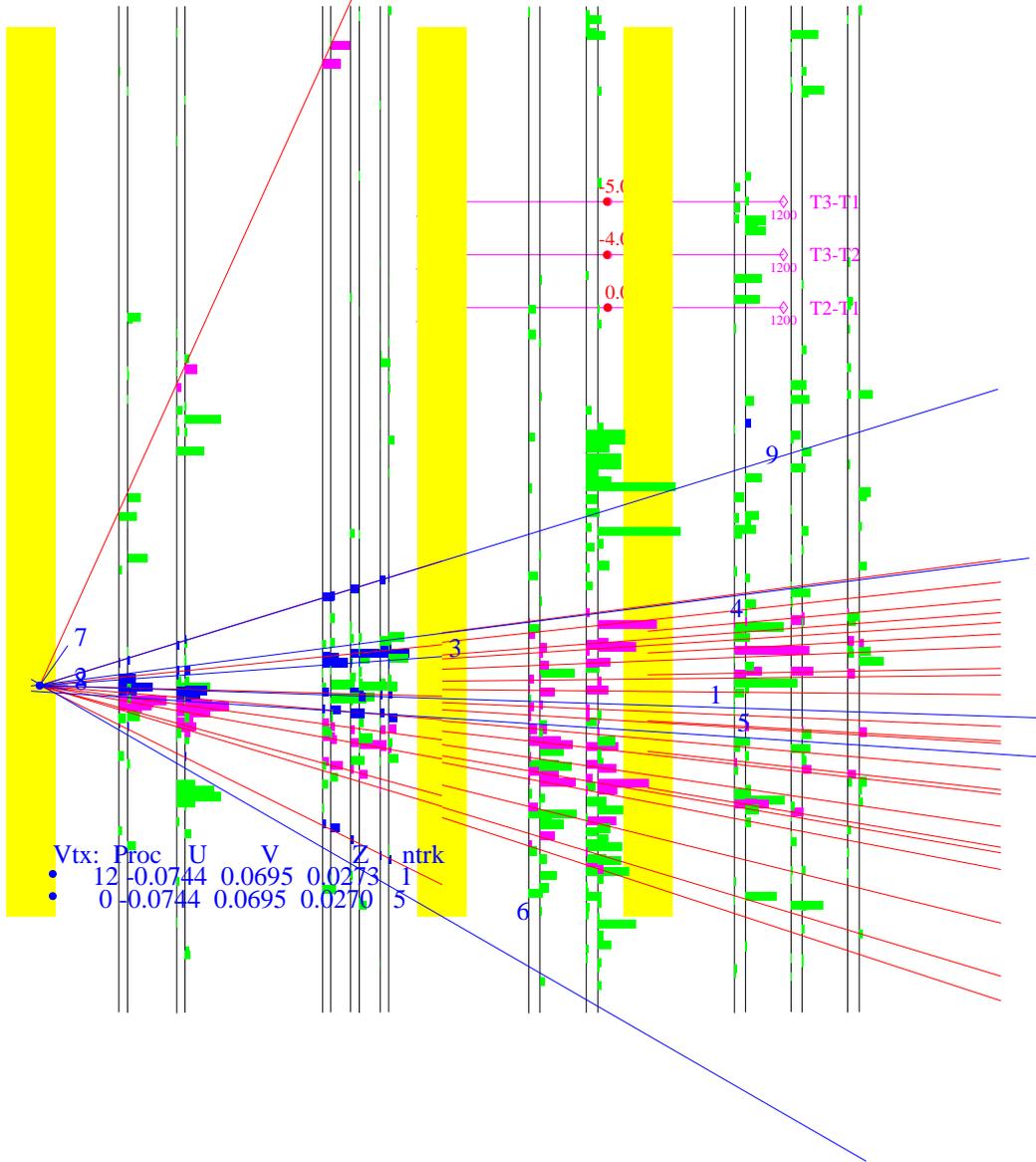
Cluster  $\Sigma E$  68

1	1.1	9	0.8	17	0.5
2	19.8	10	3.9	18	1.7
3	6.7	11	4.8	19	3.1
4	2.8	12	0.8		
5	6.0	13	0.8		
6	5.7	14	1.0		
7	1.6	15	1.4		
8	1.8	16	0.5		

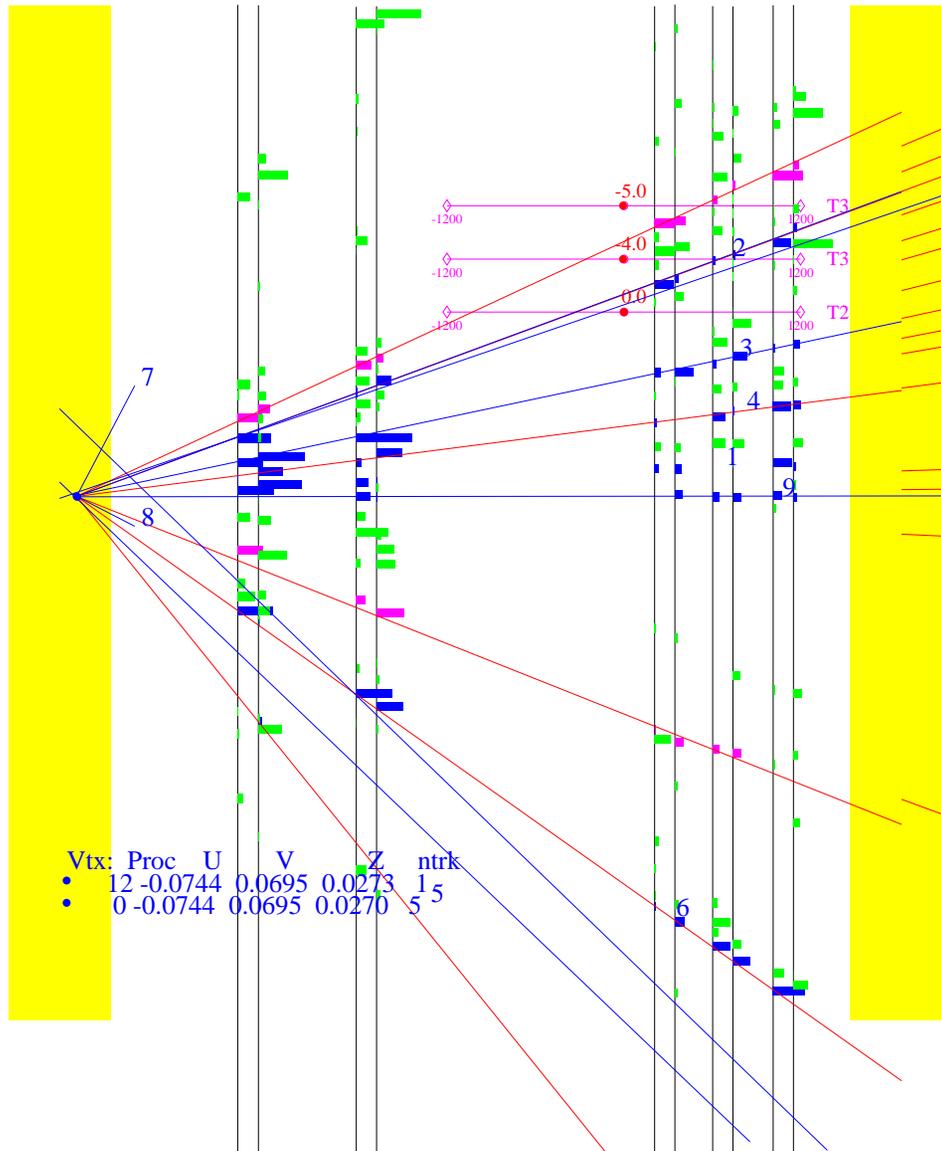


E872 Run= 3039 Event= 1910 Wght= 1.0

U View



E872 Run= 3039 Event= 1910 Wght= 1.0  
V View



E872 Run= 3039 Event= 1910 Wght= 1.0  
V View

