

# Application of NetScan to the other Experiments

DONUT, CHORUS and Fermilab E653

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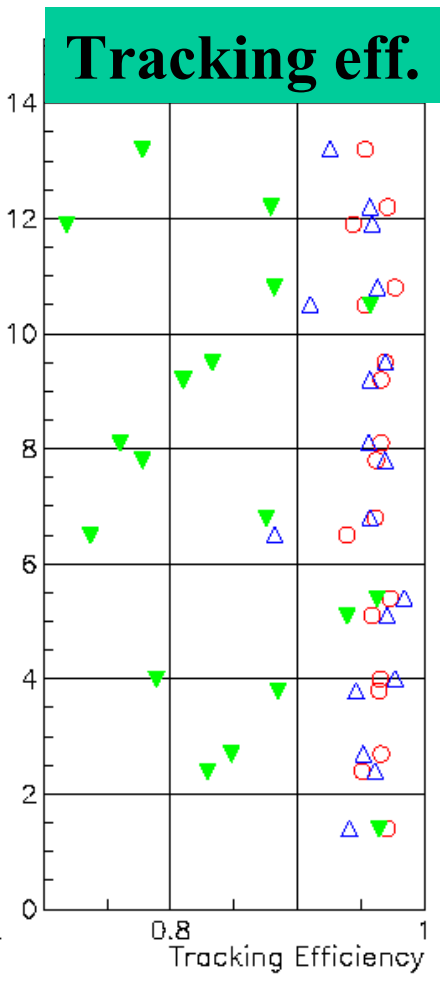
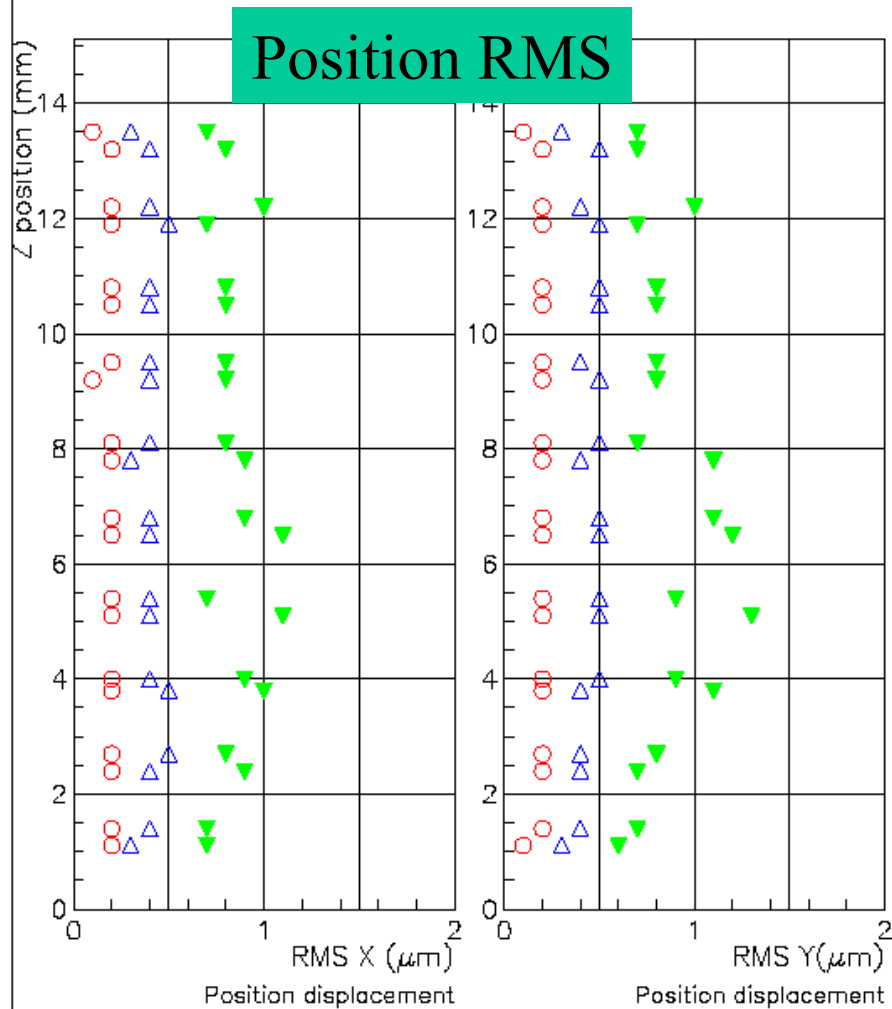
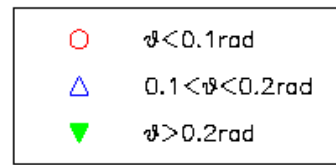
# Backgrounds of Application

- NetScan is developed on DONUT analysis based on very fast Automatic Scanning.
  - Since 1998, very fast Automatic Scanning system named “UTS” started to work.
  - NetScan is an analysis method to reconstruct tracks in emulsion module by offline process.
- Emulsion scanning has completely changed into data taking and offline reconstruction.

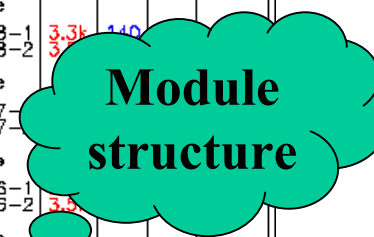
# Tracking Characteristics (Summary)

**e872**

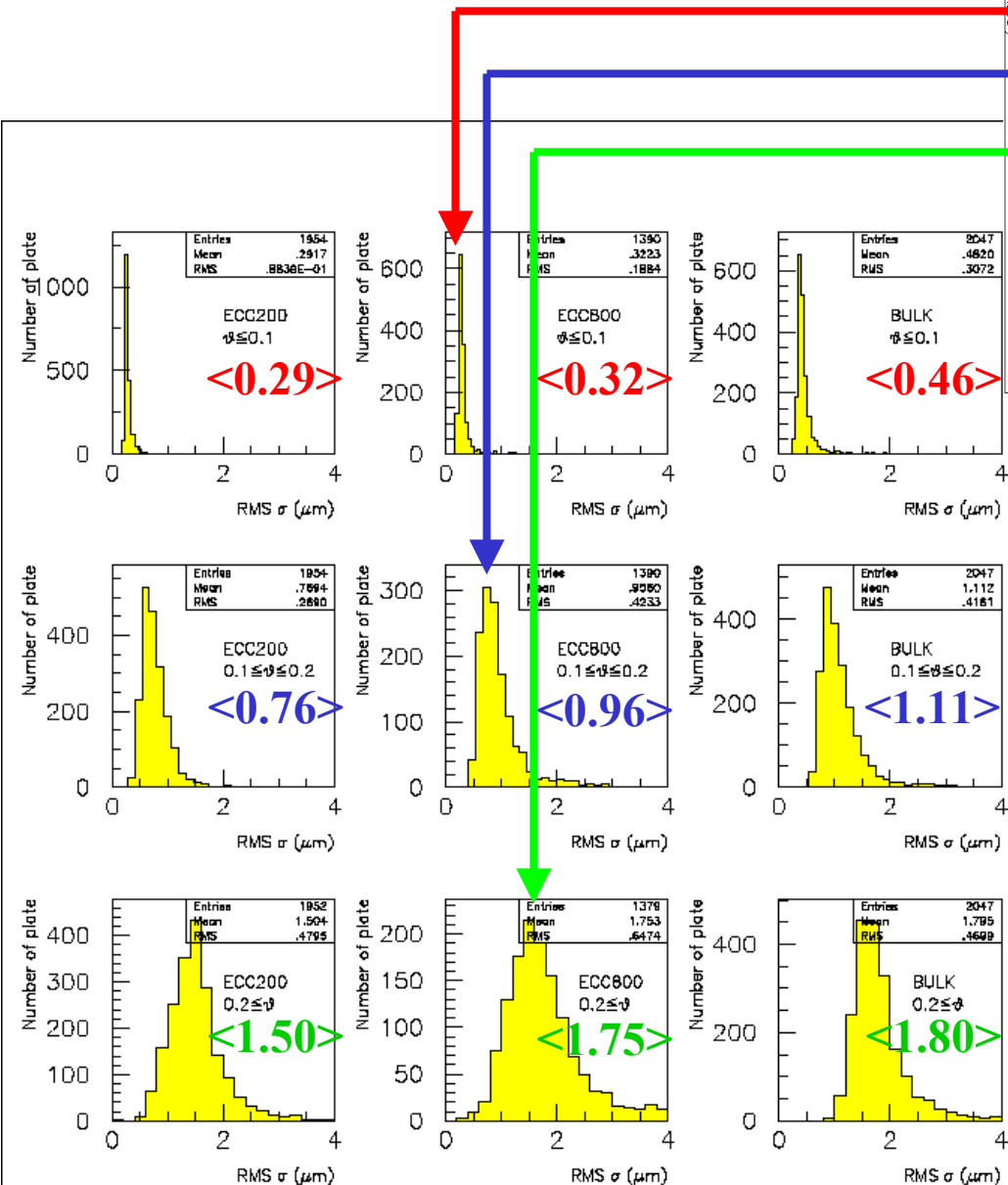
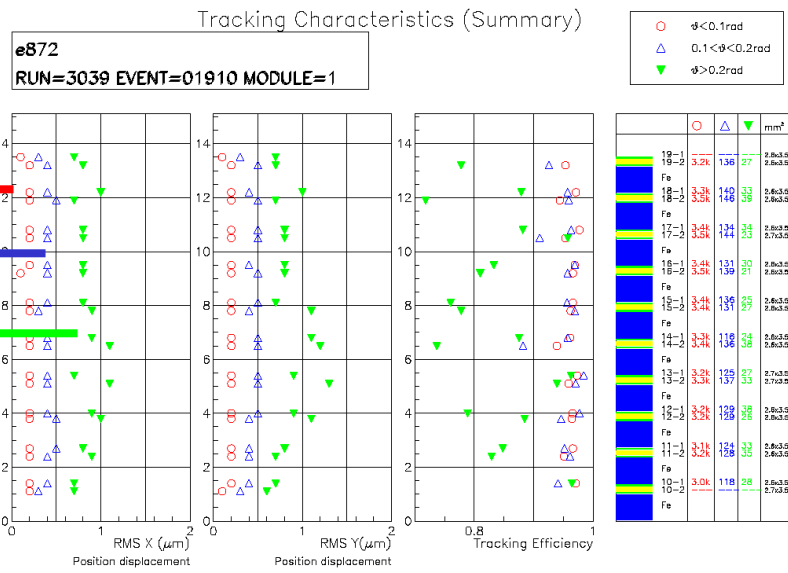
**RUN=3039 EVENT=01910 MODULE=1**



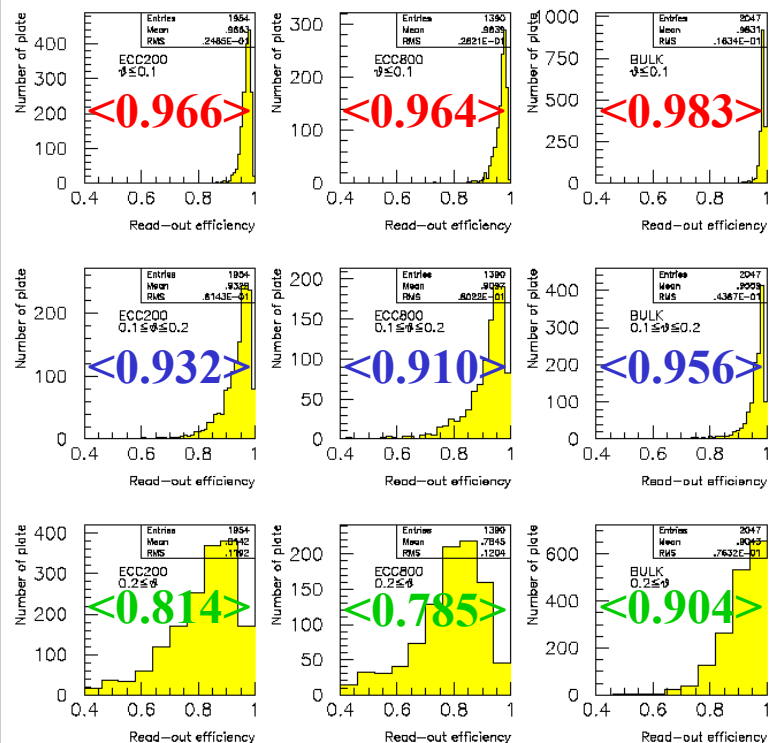
	○	△	▽	mm <sup>2</sup>
19-1	---	---	---	2.6x3.5
19-2	3.2k	136	27	2.6x3.5
Fe				
18-1	3.3k	140		
18-2	3.3k			
Fe				
17-1				
17-2				
Fe				
16-1				
16-2	3.5k			
Fe				
15-1	3.4k	136	25	2.6x3.5
15-2	3.4k	131	27	2.6x3.5
Fe				
14-1	3.3k	116	24	2.6x3.5
14-2	3.4k	136	38	2.6x3.5
Fe				
13-1	3.2k	125	27	2.7x3.5
13-2	3.3k	137	33	2.7x3.5
Fe				
12-1	3.2k	129	38	2.6x3.5
12-2	3.2k	129	26	2.6x3.5
Fe				
11-1	3.1k	124	33	2.6x3.5
11-2	3.2k	128	35	2.6x3.5
Fe				
10-1	3.0k	118	28	2.6x3.5
10-2	---	---	---	2.7x3.5
Fe				



# Alignment position RMS distributions



# Tracking efficiency distributions



# Requirements for NetScan

- Coordinate system
  - Fiducial mark (give global coordinate)
  - Module structure
  - Tracks path through plates for alignment
- Track segments (micro tracks)
  - 3D positions, vector information and pulse height on each emulsion sheets except time. In total six dimension.
- **NetScan should work in another experiments**

# NetScan module structure

**em** : emulsion    **ba** : plastic base    **fe** : iron    **pb** : lead

12	49920	80	em	80	ba	0	fe	0
11	49040	880	em	80	ba	800	fe	0
22	48960	80	em	80	ba	0	fe	0
21	48675	285	em	80	ba	205	fe	0
32	47610	1065	em	80	ba	0	fe	985
31	47325	285	em	80	ba	205	fe	0
42	46260	1065	em	80	ba	0	fe	985
41	45975	285	em	80	ba	205	fe	0
52	44910	1065	em	80	ba	0	fe	985
51	44040	880	em	80	ba	800	fe	0
62	43960	80	em	80	ba	0	fe	0
61	43675	285	em	80	ba	205	fe	0
72	42610	1065	em	80	ba	0	fe	985
71	41925	285	em	80	ba	205	fe	0
82	40860	1065	em	80	ba	0	fe	985
81	40575	285	em	80	ba	205	fe	0
92	39510	1065	em	80	ba	0	fe	985
91	39225	285	em	80	ba	205	fe	0
102	38160	1065	em	80	ba	0	fe	985
101	37875	285	em	80	ba	205	fe	0
112	36810	1065	em	80	ba	0	fe	985
111	36525	285	em	80	ba	205	fe	0
122	35460	1065	em	80	ba	0	fe	985
121	35175	285	em	80	ba	205	fe	0

***DONUT ST1***  
***Iron ECC***

12	-218740	350	em	350	ba	0	fe	0
11	-219180	440	em	350	ba	90	fe	0
22	-219530	350	em	350	ba	0	fe	0
21	-219970	440	em	350	ba	90	fe	0
32	-220320	350	em	350	ba	0	fe	0
31	-220760	440	em	350	ba	90	fe	0
42	-221110	350	em	350	ba	0	fe	0
41	-221550	440	em	350	ba	90	fe	0
52	-221900	350	em	350	ba	0	fe	0
51	-222340	440	em	350	ba	90	fe	0
62	-222690	350	em	350	ba	0	fe	0
61	-223130	440	em	350	ba	90	fe	0
72	-223480	350	em	350	ba	0	fe	0
71	-223920	440	em	350	ba	90	fe	0
82	-224270	350	em	350	ba	0	fe	0
81	-224710	440	em	350	ba	90	fe	0
92	-225060	350	em	350	ba	0	fe	0
91	-225500	440	em	350	ba	90	fe	0
102	-225850	350	em	350	ba	0	fe	0
101	-226290	440	em	350	ba	90	fe	0
112	-226640	350	em	350	ba	0	fe	0
111	-227080	440	em	350	ba	90	fe	0
122	-227430	350	em	350	ba	0	fe	0
121	-227870	440	em	350	ba	90	fe	0

***CHORUS***  
***Bulk***

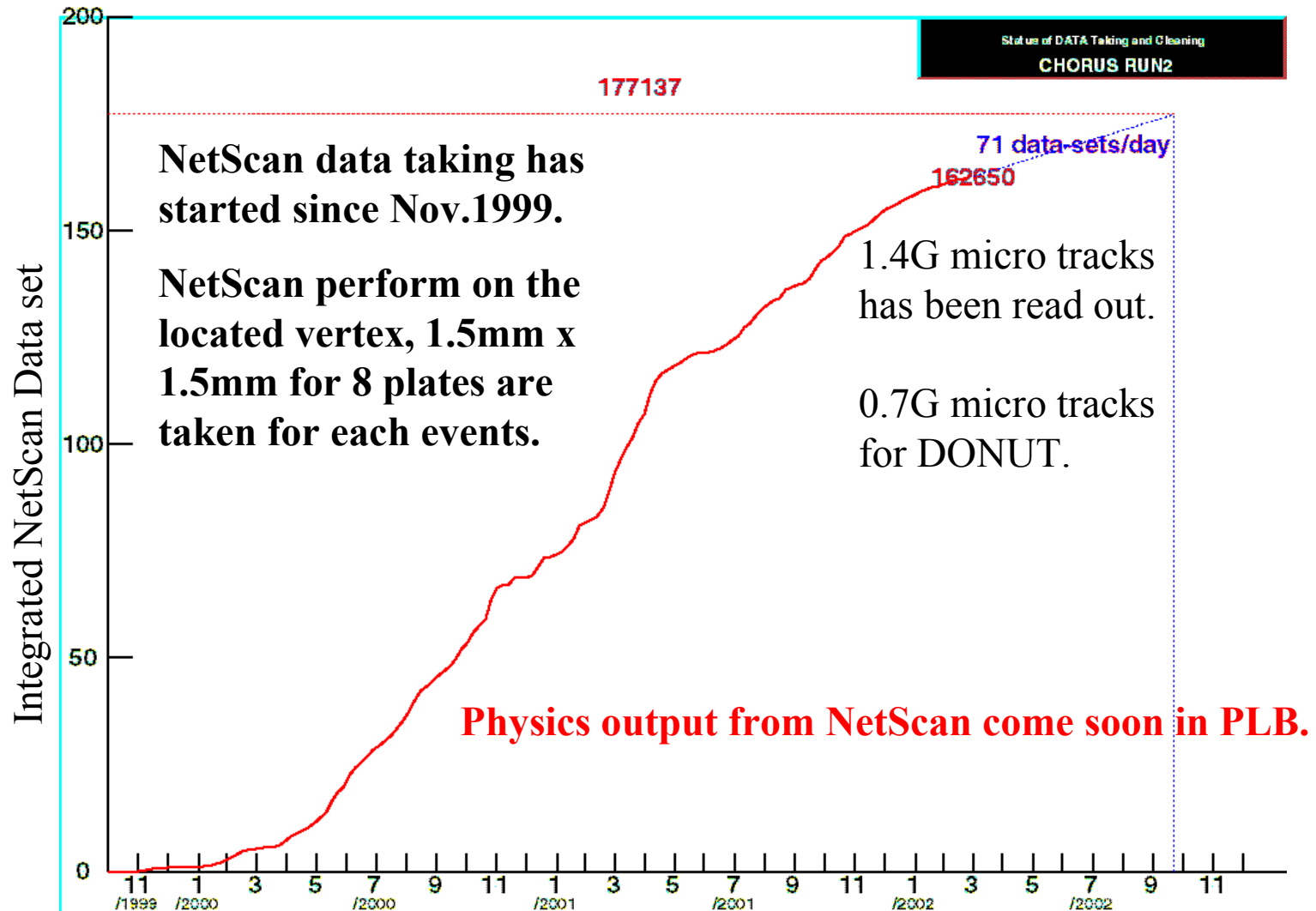
12	999950	50	em	50	ba	0	pb	0
11	999700	250	em	50	ba	200	pb	0
22	998650	1050	em	50	ba	0	pb	1000
21	998400	250	em	50	ba	200	pb	0
32	997350	1050	em	50	ba	0	pb	1000
31	997100	250	em	50	ba	200	pb	0
42	996050	1050	em	50	ba	0	pb	1000
41	995800	250	em	50	ba	200	pb	0
52	994750	1050	em	50	ba	0	pb	1000
51	994500	250	em	50	ba	200	pb	0
62	993450	1050	em	50	ba	0	pb	1000
61	993200	250	em	50	ba	200	pb	0
72	992150	1050	em	50	ba	0	pb	1000
71	991900	250	em	50	ba	200	pb	0
82	990850	1050	em	50	ba	0	pb	1000
81	990600	250	em	50	ba	200	pb	0
92	989550	1050	em	50	ba	0	pb	1000
91	989300	250	em	50	ba	200	pb	0
102	988250	1050	em	50	ba	0	pb	1000
101	988000	250	em	50	ba	200	pb	0
112	986950	1050	em	50	ba	0	pb	1000
111	986700	250	em	50	ba	200	pb	0
122	985650	1050	em	50	ba	0	pb	1000
121	985400	250	em	50	ba	200	pb	0

***TEST ECC***  
***Lead ECC***

# Emulsion experiments

- **Fermilab E872 DONUT** NetScan applied
  - NetScan is Developed in DONUT
- **CERN WA95 CHORUS**
  - Phase II analysis is based on NetScan
  - Physics output:  $D^0$  production, charm physics...
- **Fermilab E653**, CERN WA75
- Balloon and airplane experiments
- ETC...

# Systematic data taking in CHORUS



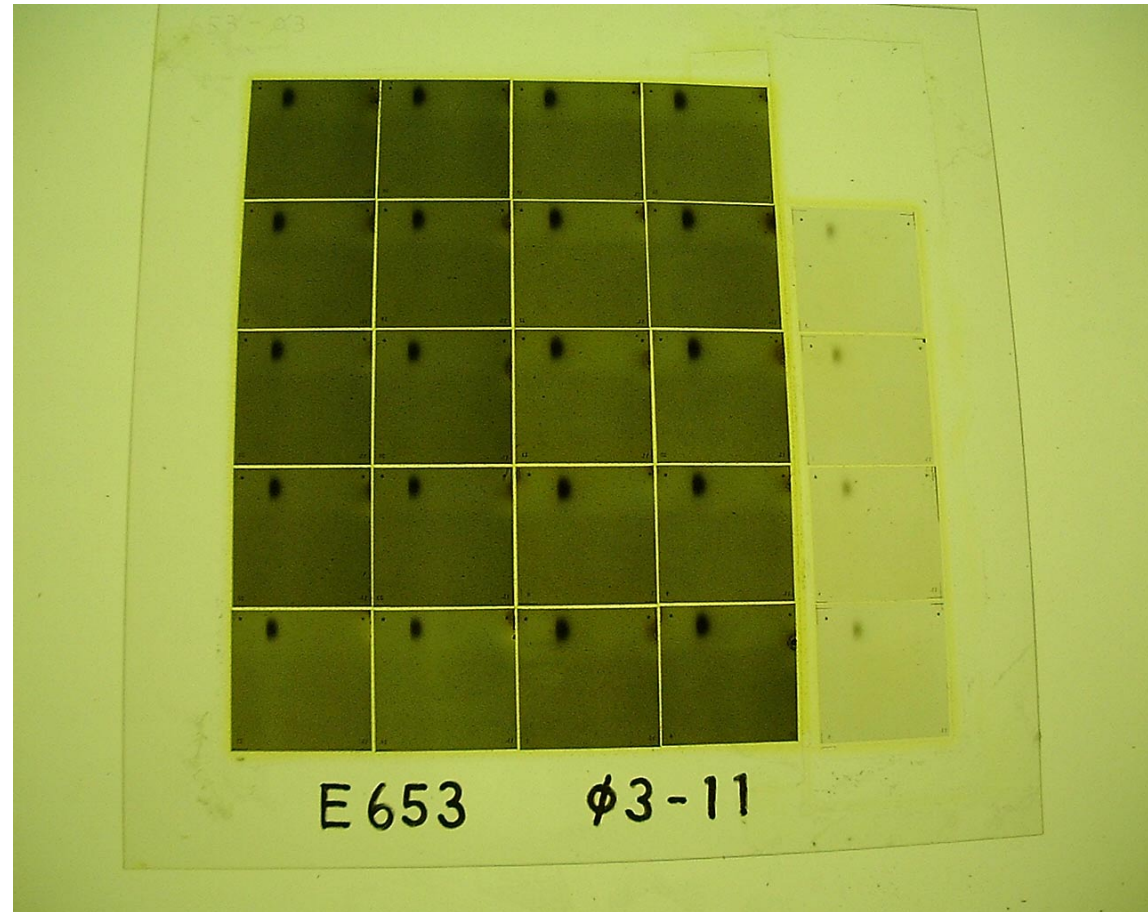


# NetScan in Fermilab E653

- Fermilab E653 first RUN
  - There is strong physics motivation to reanalyze **800GeV proton interaction to determine tau neutrino flux in DONUT.**
  - Nice example to check alignment accuracy of NetScan. 800GeV proton beam is free from multiple scattering effect in their emulsion module.
- NetScan in E653 has never been reported.

# Old Fermilab E653

- Analysis of E653 has terminated in 1996.
- We apply NetScan for this old emulsion to measure  $\sigma_{D_s} \times BR(D_s \rightarrow \tau \nu_\tau)$
- We have emulsion sheets.
- Just apply existing NetScan softwares to E653.



# Fermilab E653 2nd RUN

## Four of Ds goes to tau has been found.

These can be found by NetScan.

TABLES

Table 1. The event details. Where FL is flight length,  $\Delta\theta$  is decay angle,  $P_x$  is decay momentum and  $P_{T\beta}$  is decay transverse momentum of muon. M.C. is Monte Carlo simulation.

event#	FL $D_s$ ( $\mu m$ )	$\Delta\theta$ (mrad)	FL $\tau$ ( $\mu m$ )	$P_x$ (GeV/c)	$P_{T\beta}$ (GeV/c)	partner
1	$1250 \pm 200$	$1.5 \pm 0.3$	$1800 \pm 200$	$17.6 \pm 0.2$	$0.68 \pm 0.01$	N3
2	$1130 \pm 150$	$1.9 \pm 0.3$	$1250 \pm 160$	$45.6 \pm 0.6$	$0.55 \pm 0.01$	N2
3	$800 \pm 100$	$5.1 \pm 0.3$	$800 \pm 150$	$16.3 \pm 0.2$	$0.65 \pm 0.01$	None
4	$1900 \pm 250$	$1.0 \pm 0.3$	$2600 \pm 250$	$24.1 \pm 0.3$	$0.73 \pm 0.02$	N2
Av.	1263	2.4	1813	25.4	0.60	
M.C.	1833	3.3	1554	24.1	0.69	

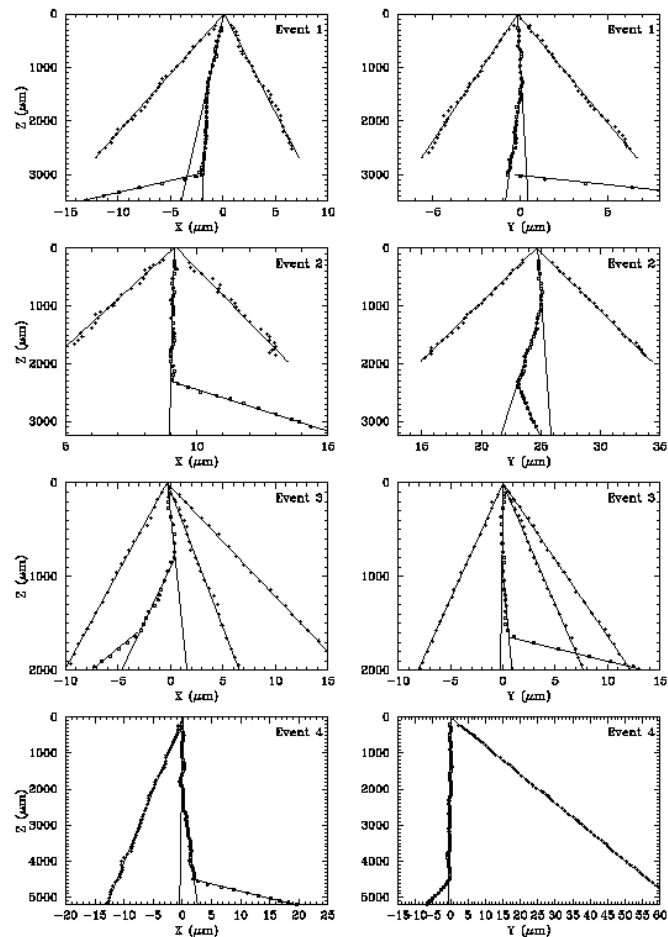
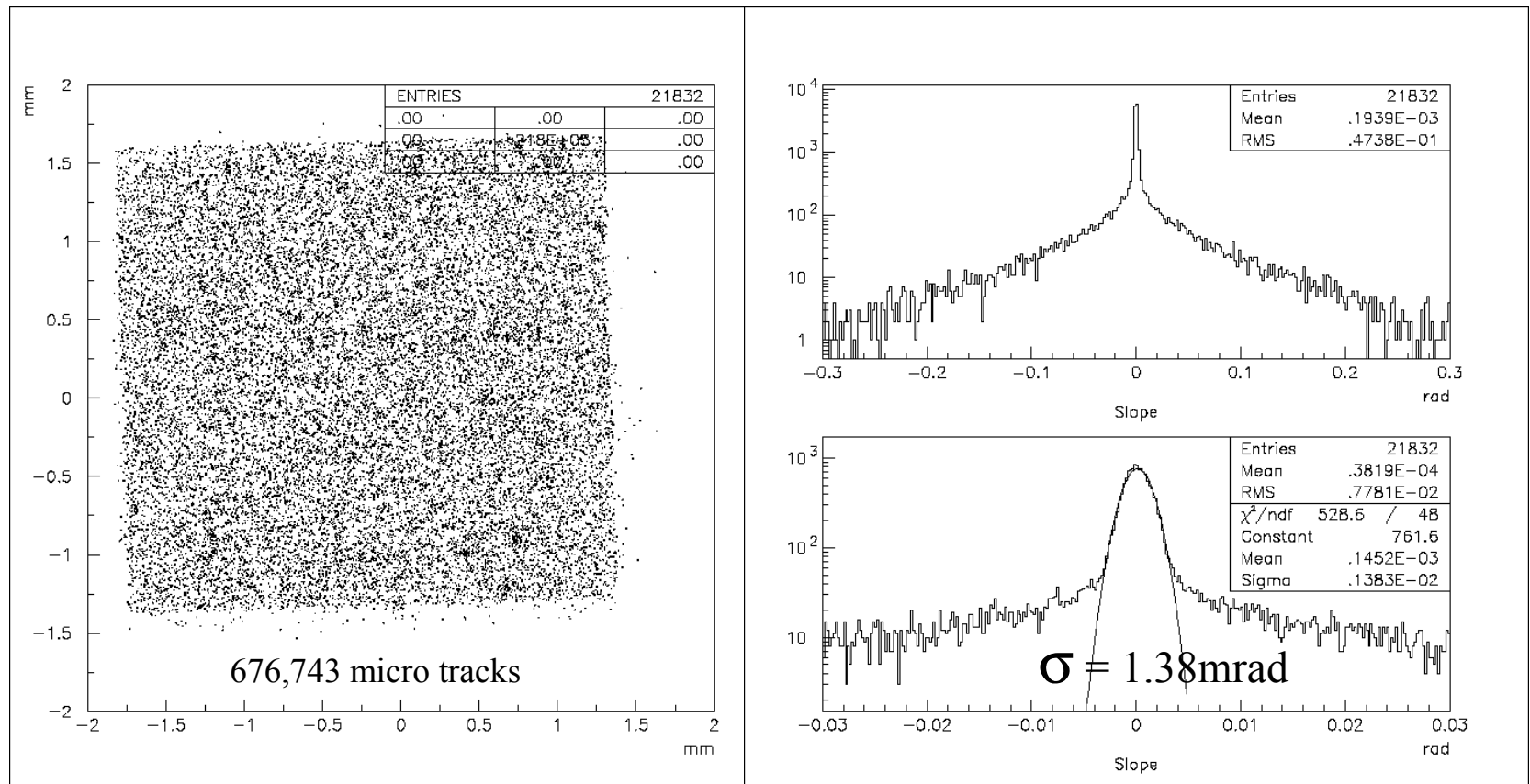


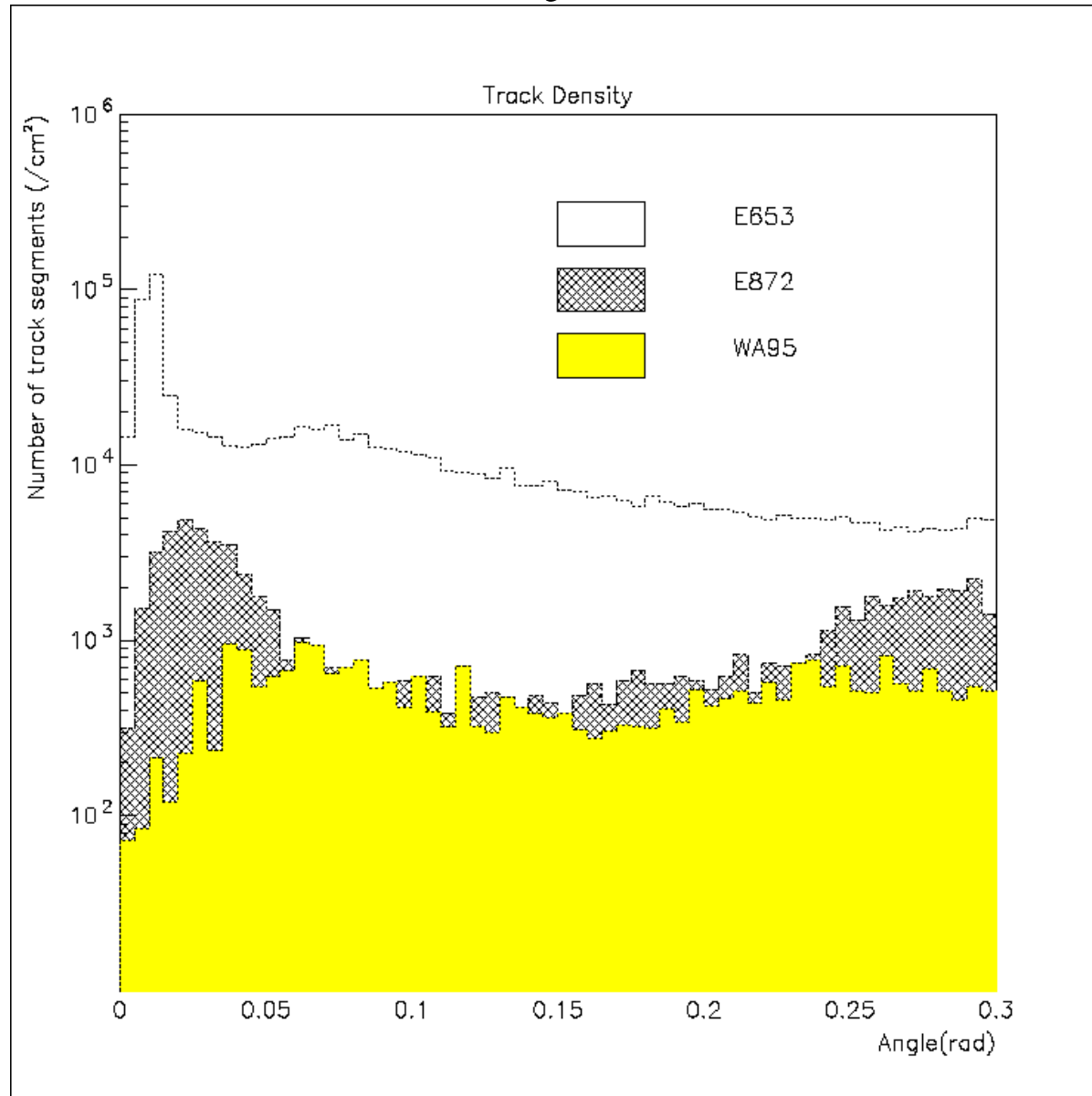
Fig. 2. Details of the structure of four candidate decays. The coordinates are represented in  $\mu m$ . X and Y coordinates are magnified by about 100 times. The points are the position measured. The circle, cross, and solid line represent the muon, KINK track, the backron track from primary vertex, and the fit result, respectively.

# NetScan data of Fermilab E653

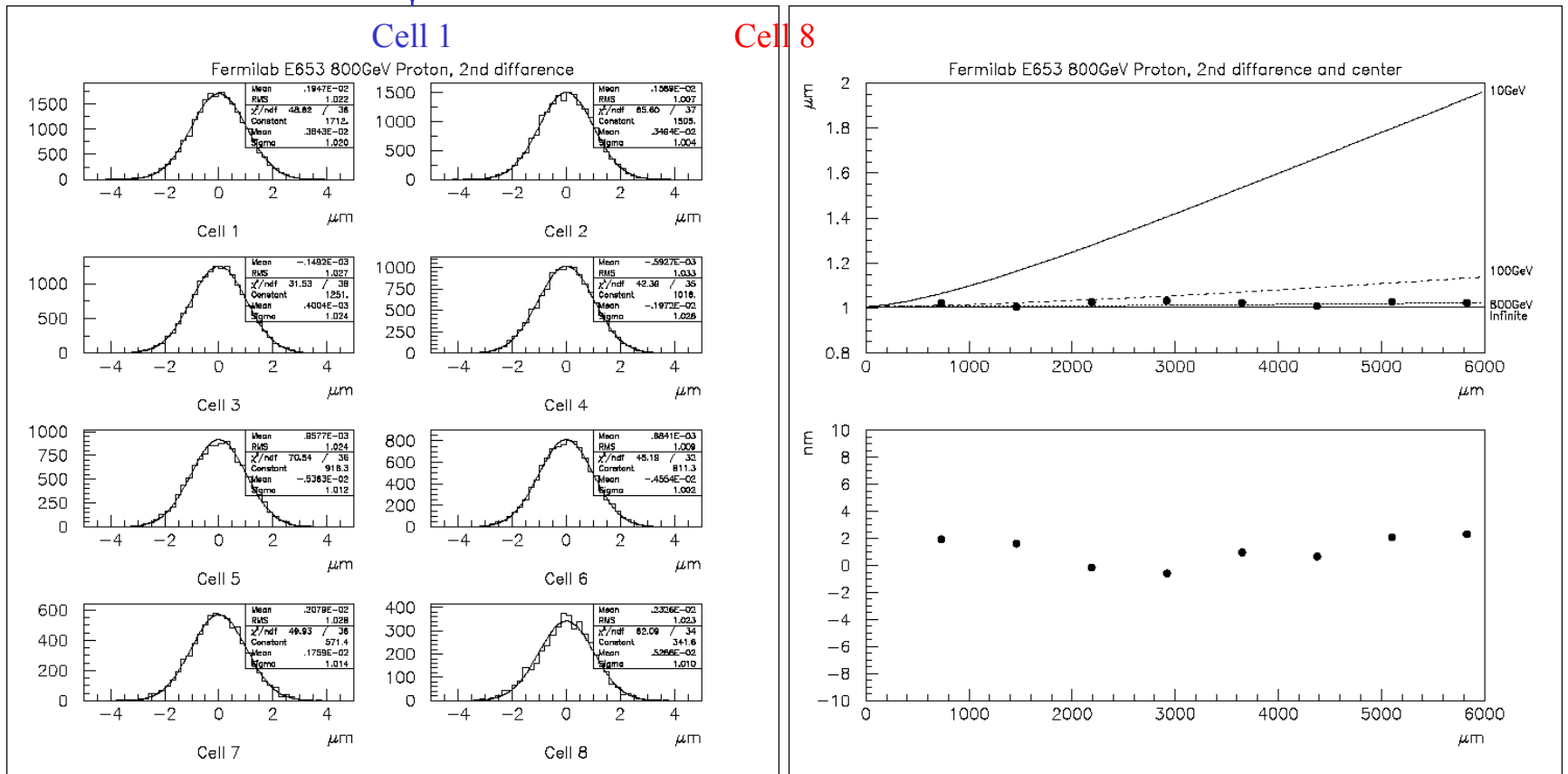
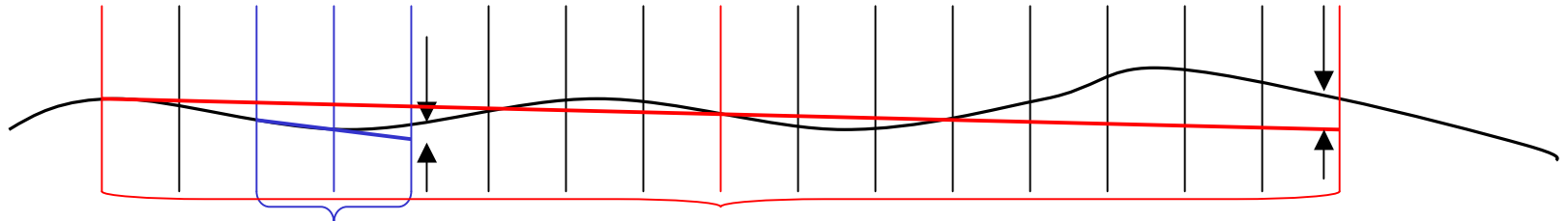
NetScan application in very high track density emulsion :  $10^5$  tracks /cm<sup>2</sup>  
800 GeV proton beam exposure. 3mm x 3mm within 300mrad tracks for 20 plates.



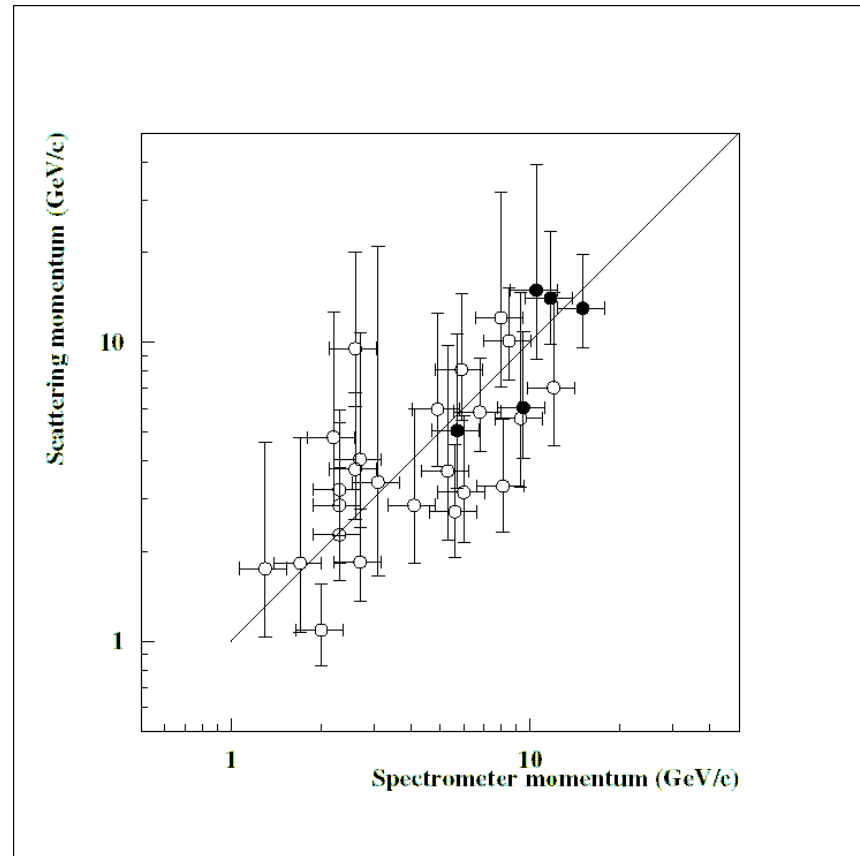
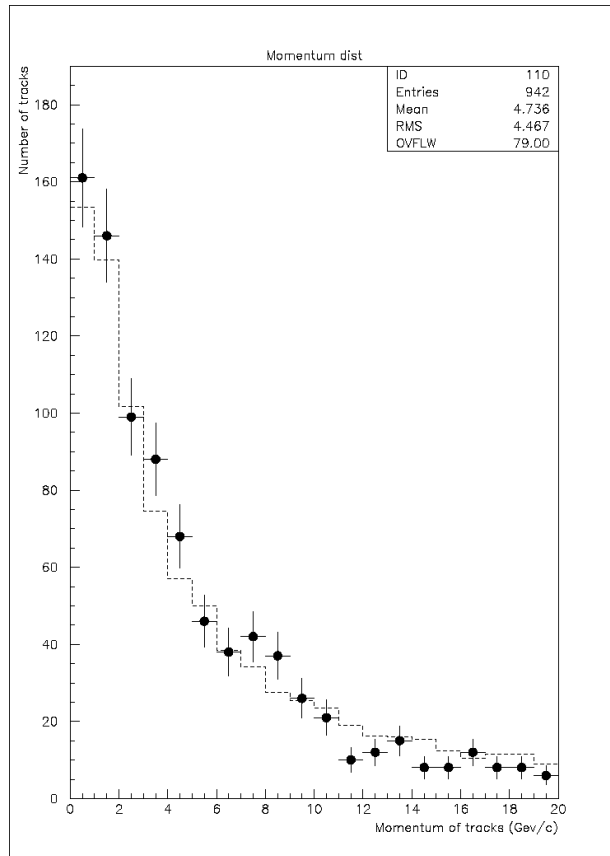
# Track density in NetScan



# Long range alignment in NetScan

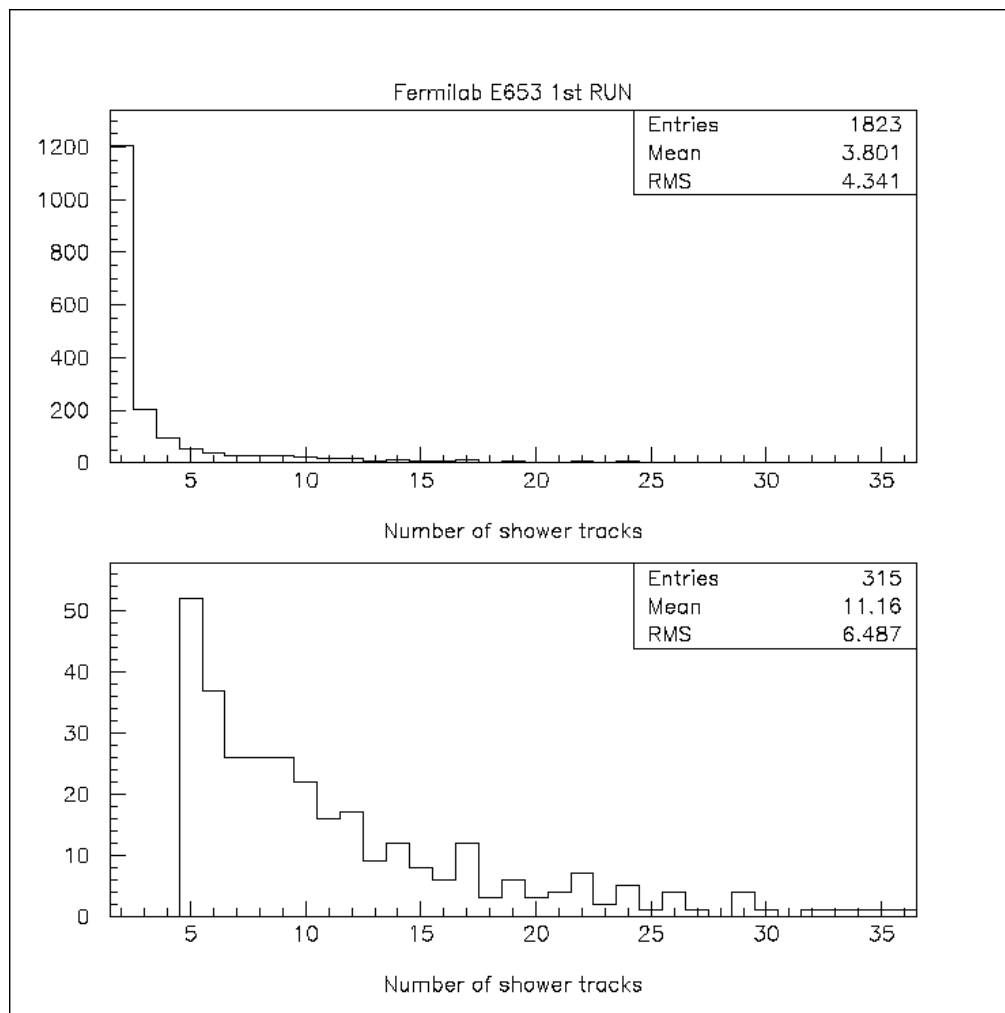


# Momentum measurement by MCS in DONUT

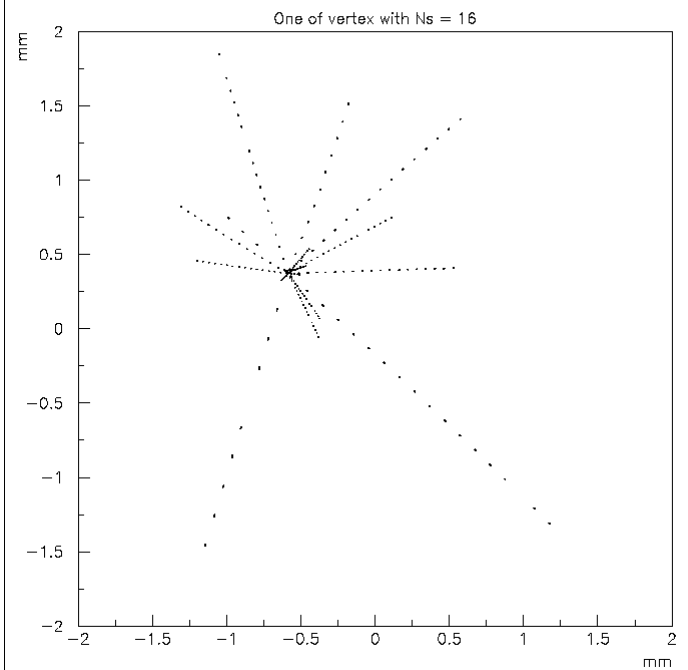
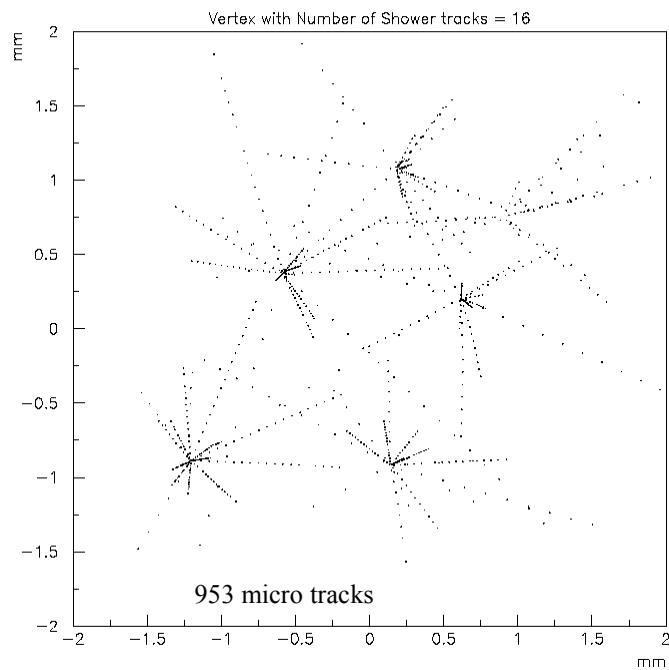
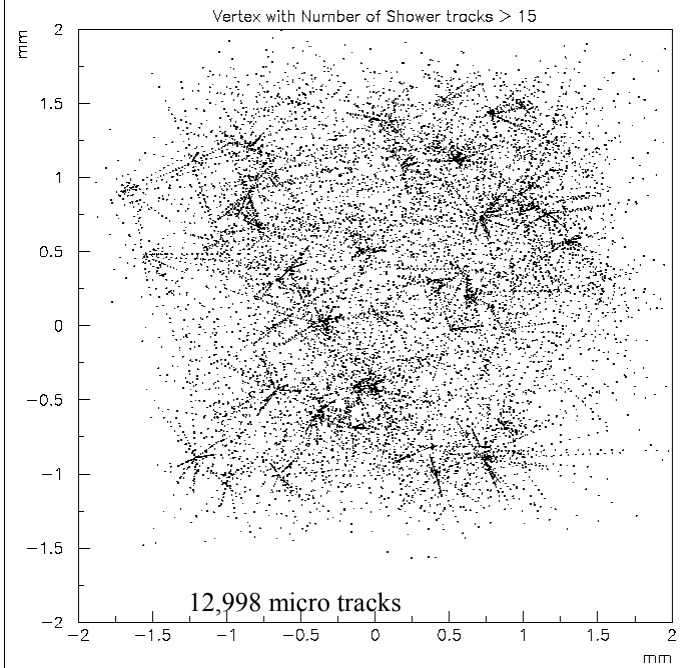
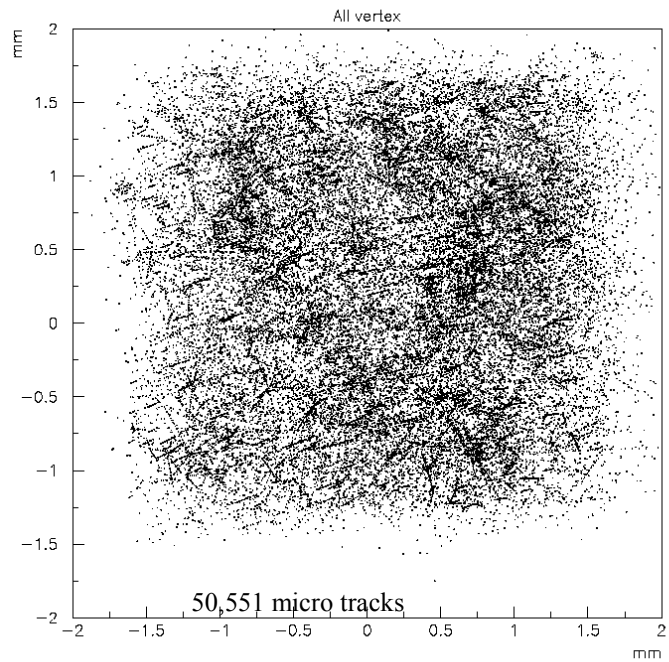


# Vertex Search in E653

- **We apply standard NetScan reconstruction and vertex search software ECFSAL and ECVTXA to E653 NetScan data.**
- 300 hadronic interactions are expected in the volume.
- This is a first trial, systematic analysis has not been done yet.

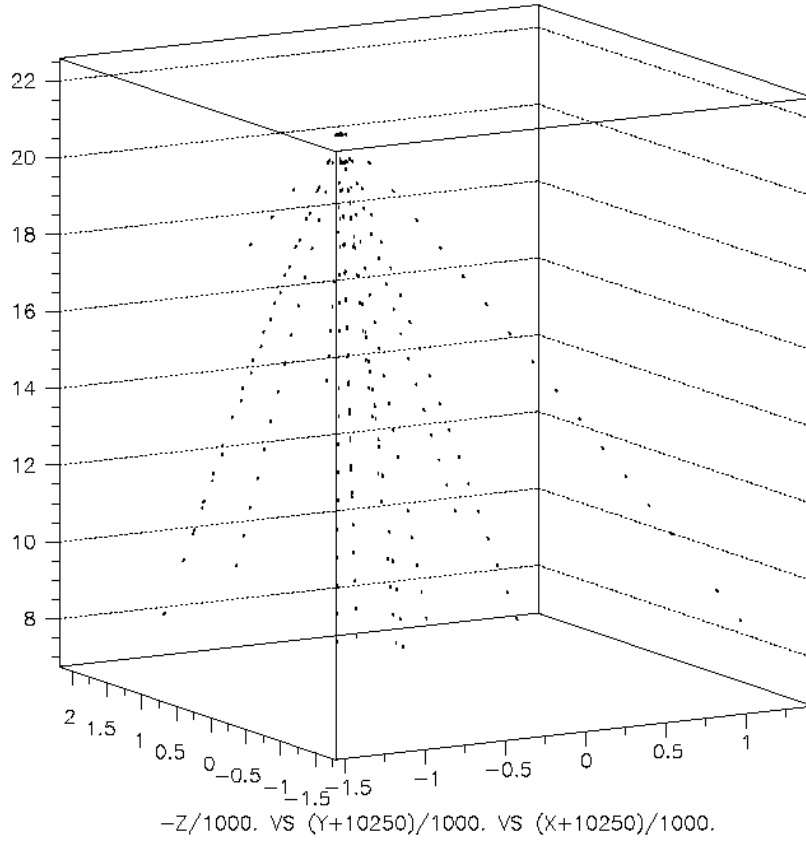




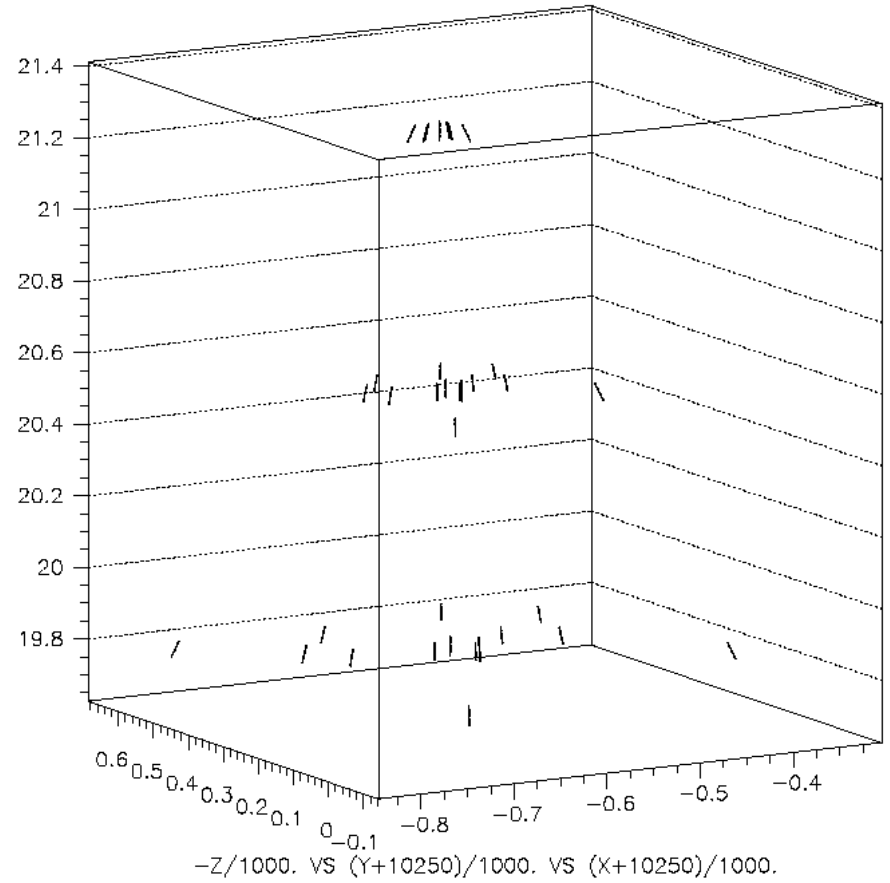




One of vertex with  $N_s = 16$



One of vertex with  $N_s = 16$



# Summary

- NetScan become **universal emulsion analysis method.**
- We apply NetScan to CHORUS, E653, old and new experiments.
- NetScan softwares work wide variety of **track density** (two or more order of magnitude dynamic range).
- **NetScan data structure and softwares are common for all emulsion module.**