Understanding of GEN Optics

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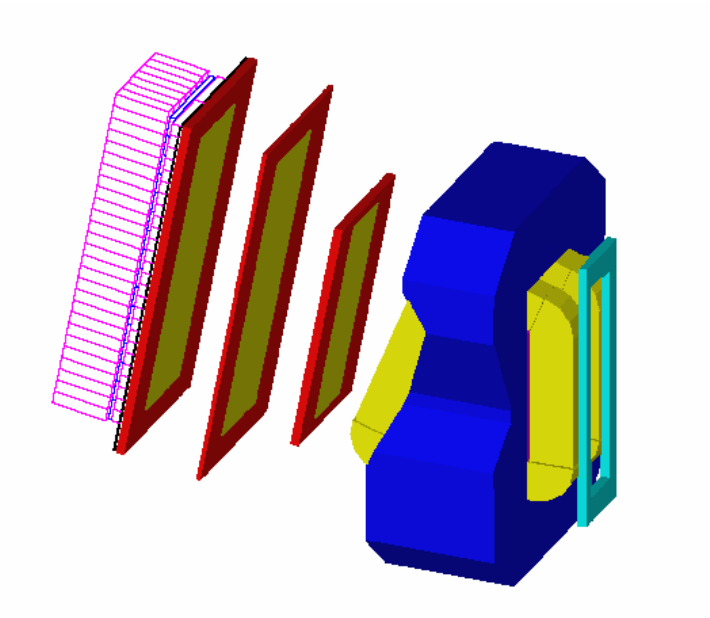
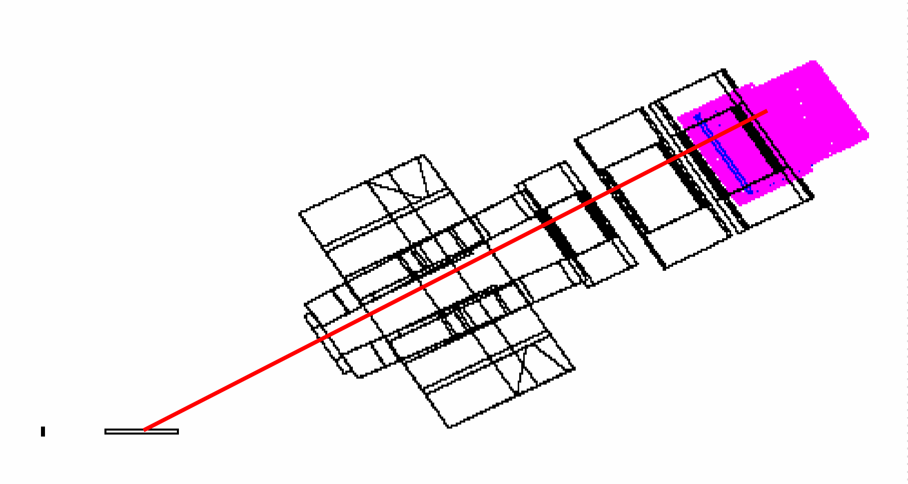


Outlook

- Understanding of GEN optics algorithm
- Beam_z reconstruction
- Momentum reconstruction & phi angle reconstruction
- Impact on TRANSVERSITY optics

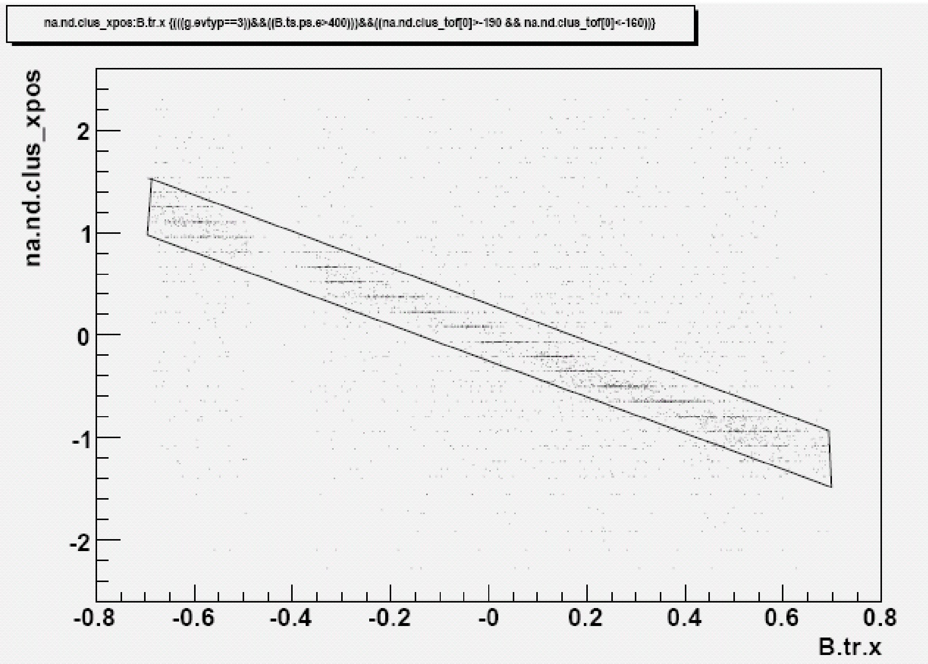
Understanding of GEN optics algorithm

- Carbon foils run to get the Beam_z (Y_targ) optics.
  - Do a straight line from wire chamber to get the Beam_z and phi angle.



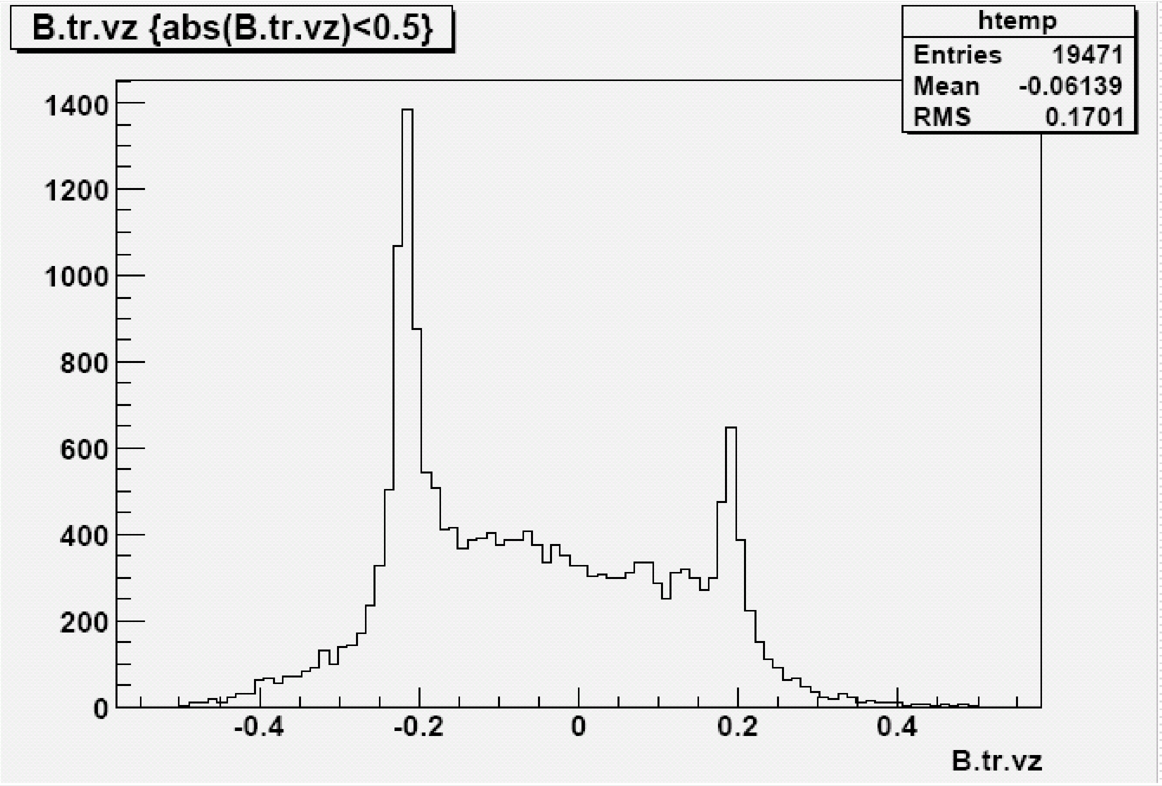
Understanding of GEN optics algorithm

- Hydrogen p(e,e'p) elastic run to get the p and ϕ optics (should also give the θ optics).
  - Use the coincidence and vertical position correlation of Neutron Arm and BigBite shower to select ep elastic data.



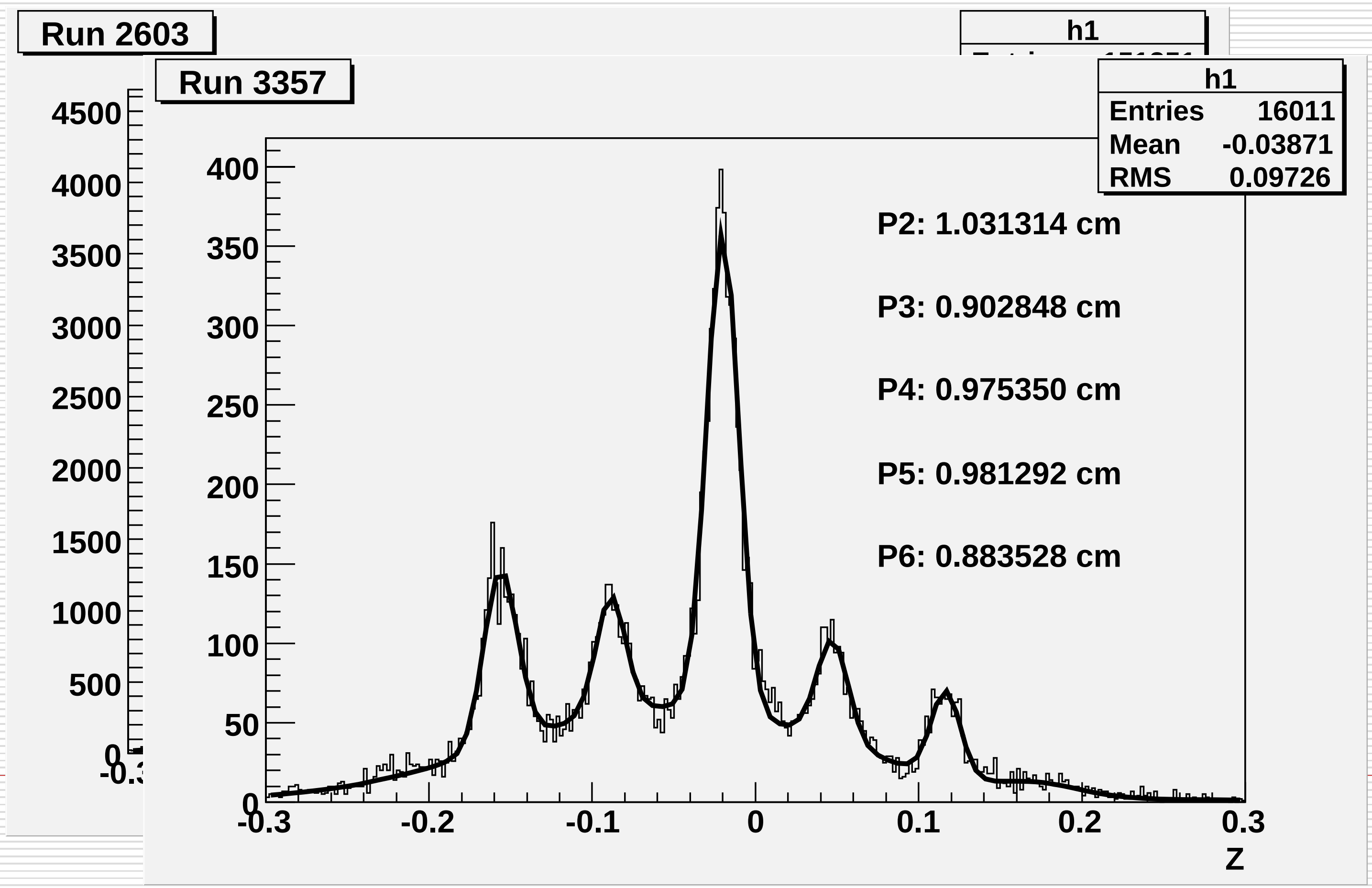
Beam_z reconstruction

- Hydrogen run, clearly see windows.

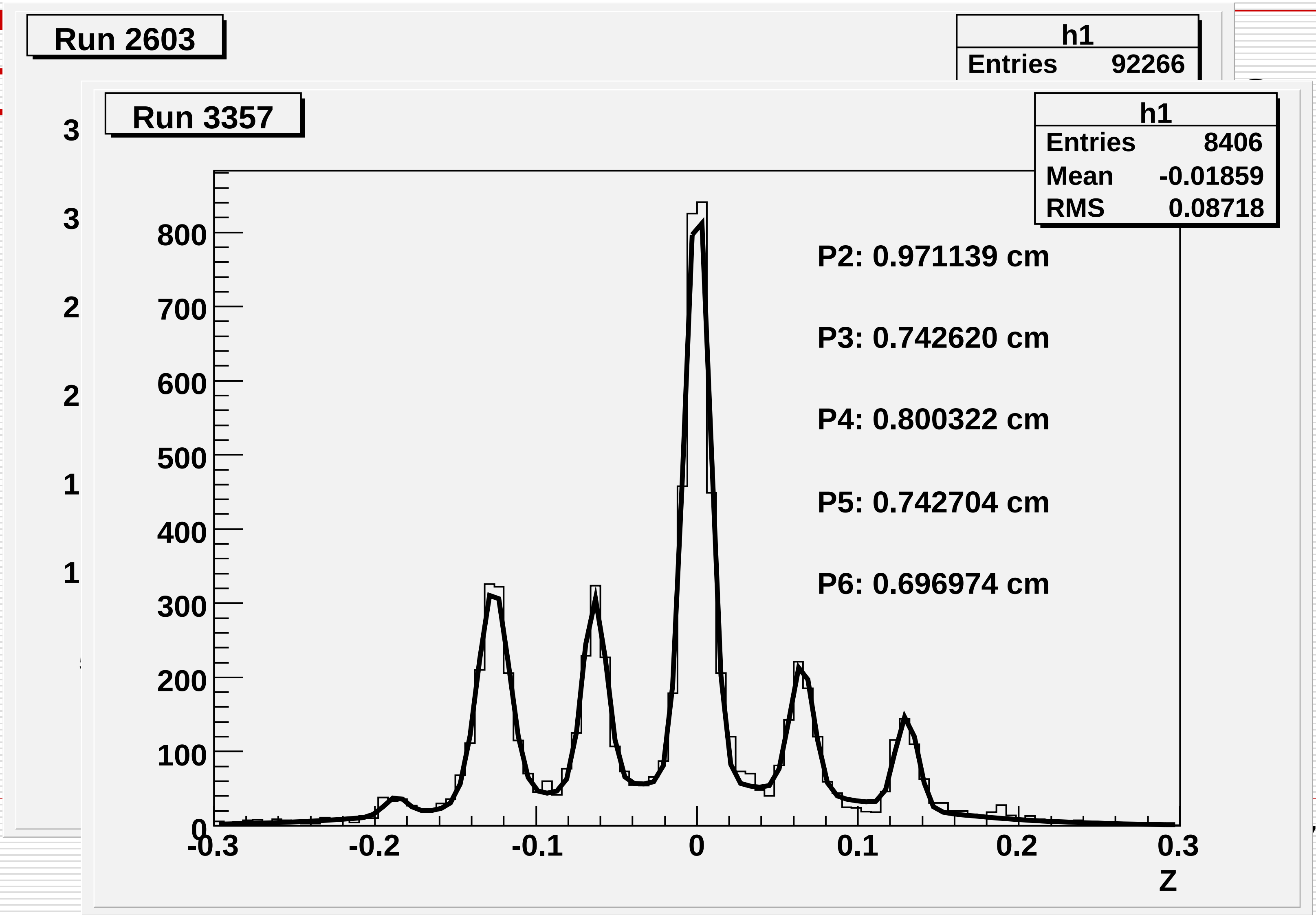


Beam_z reconstruction

- Carbon foil run:



Beam_z reconstruction



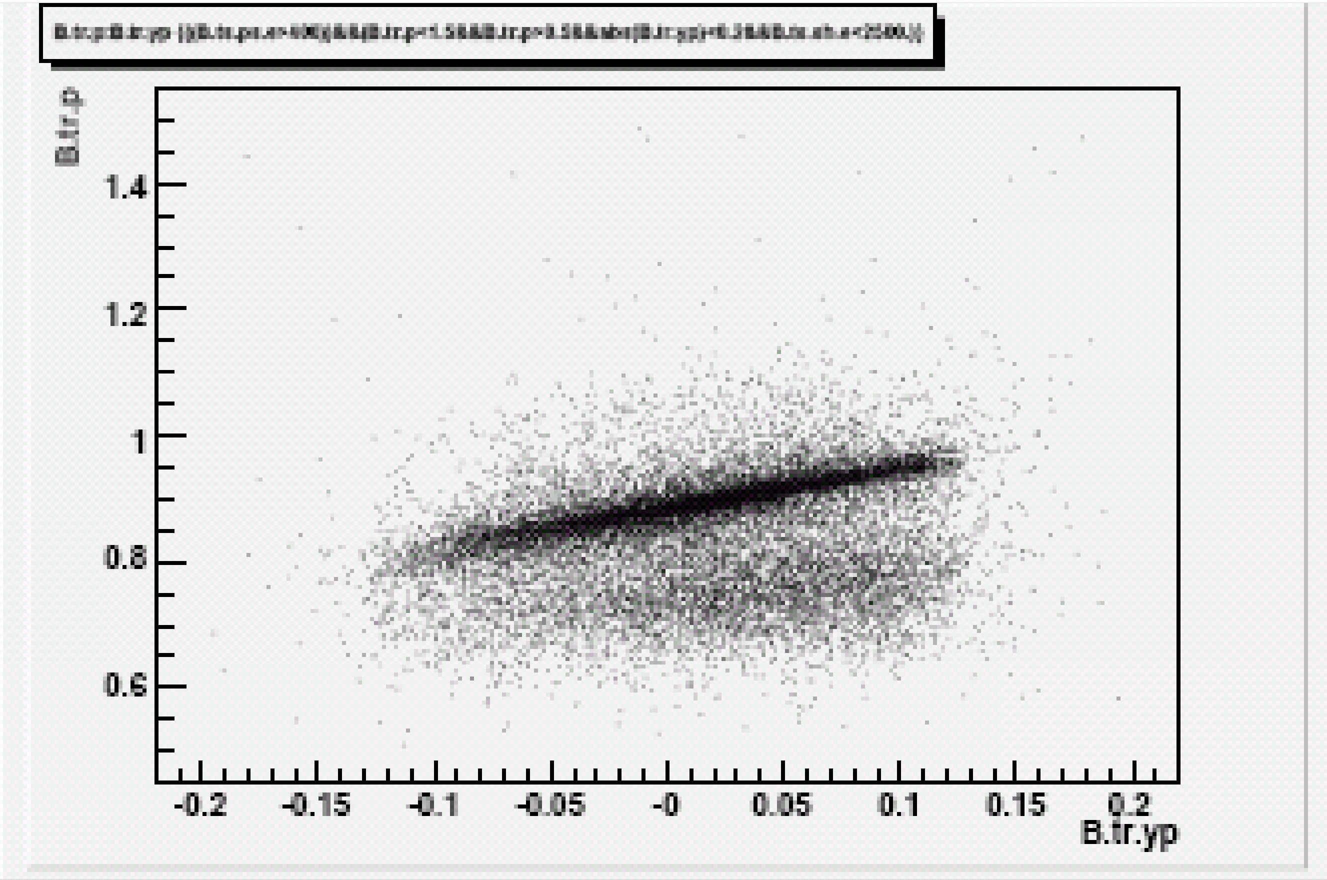
Beam_z reconstruction

- Estimation of resolution at 30 degrees
  - 0.72 *Sin(56.2) ~ 0.79 *Sin(50)
  - 0.72 * Sin (56.2) / Sin(30)
    - σ= 1.2 cm < 1.4 cm
  - Assuming HRS resolution is σ< 0.5 cm.
  - Total σ estimation < 1.5 cm.

Momentum resolution

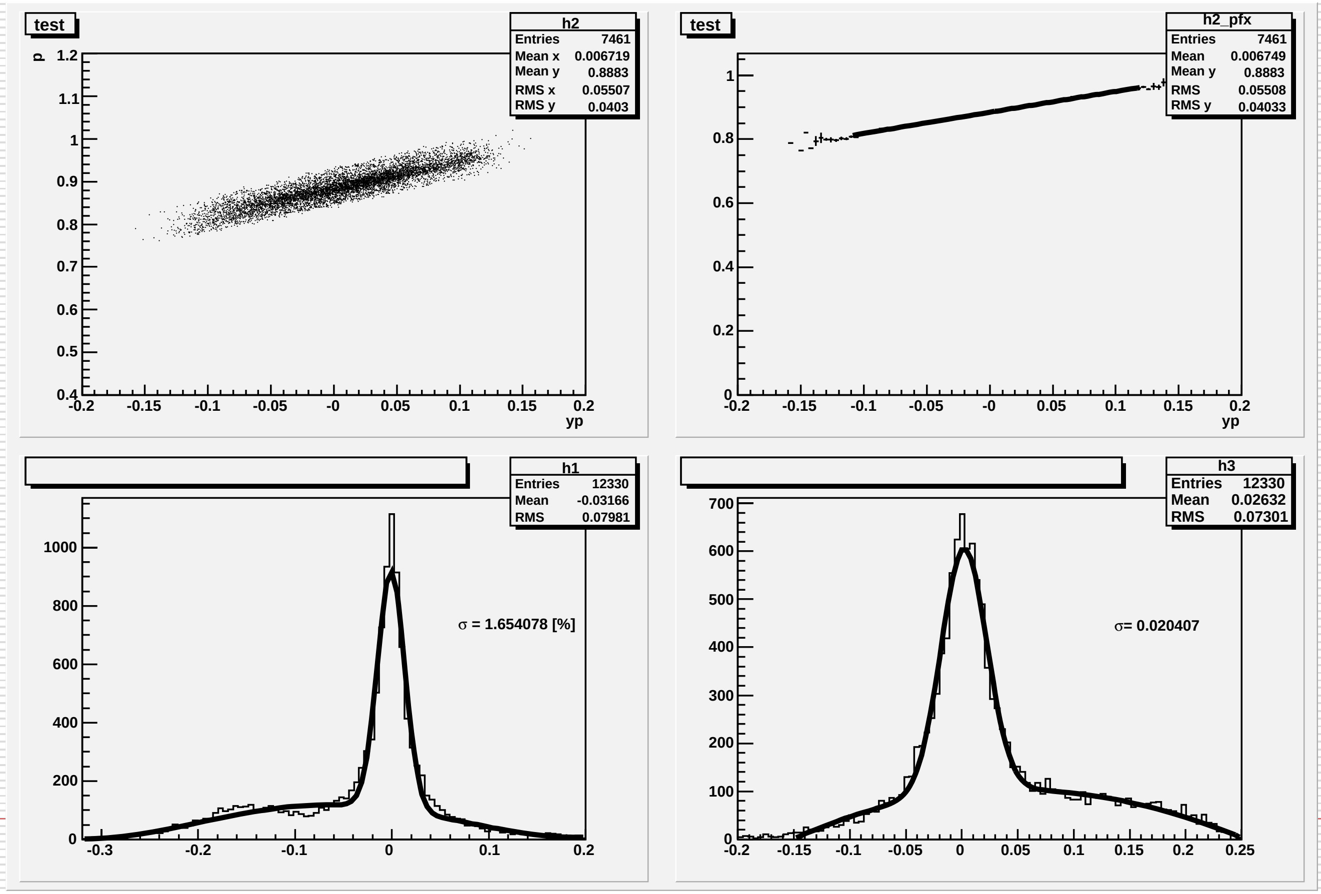
- Setting I, beam energy 1.519 GeV.
- S
- F : * θ

  -



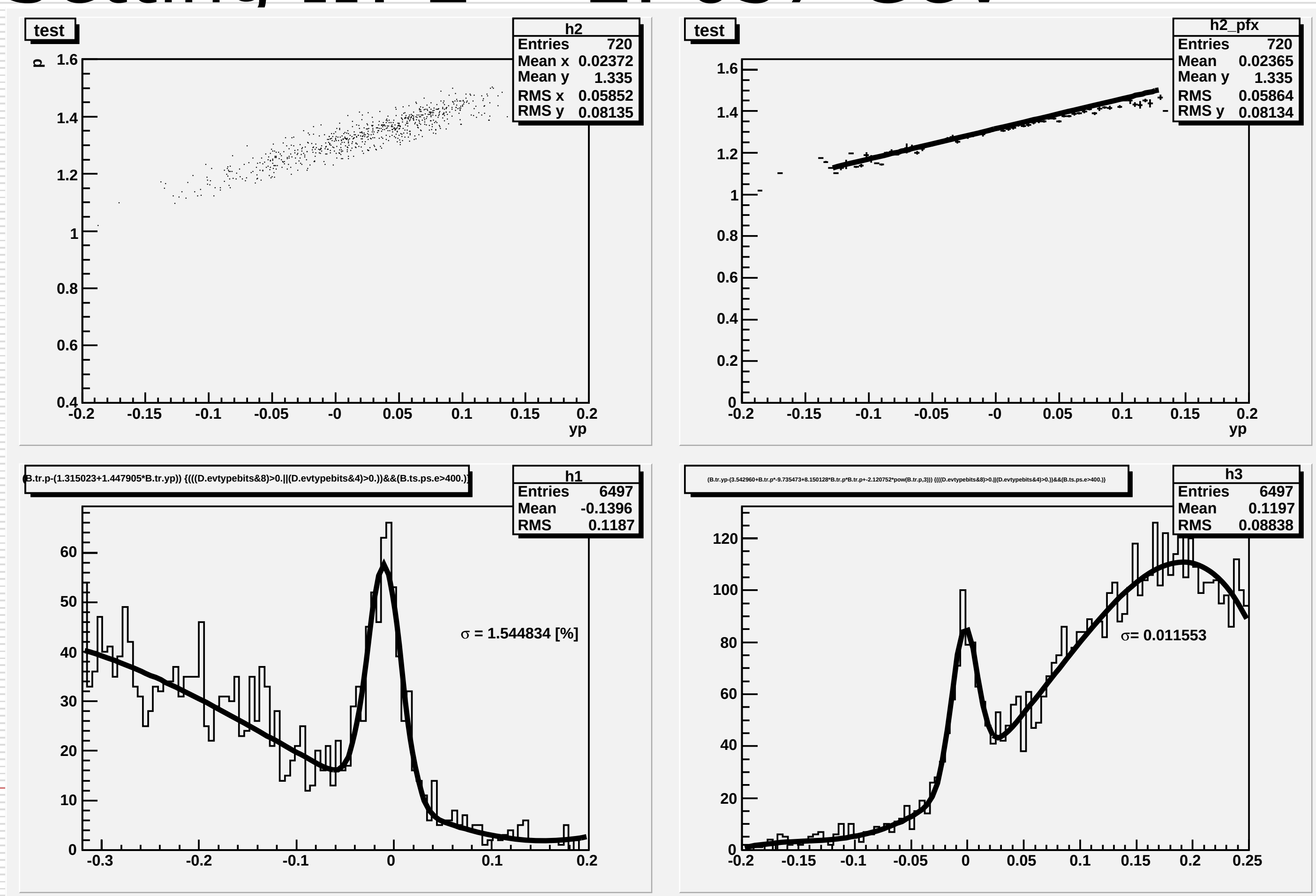
Momentum reslution

- Setting I:



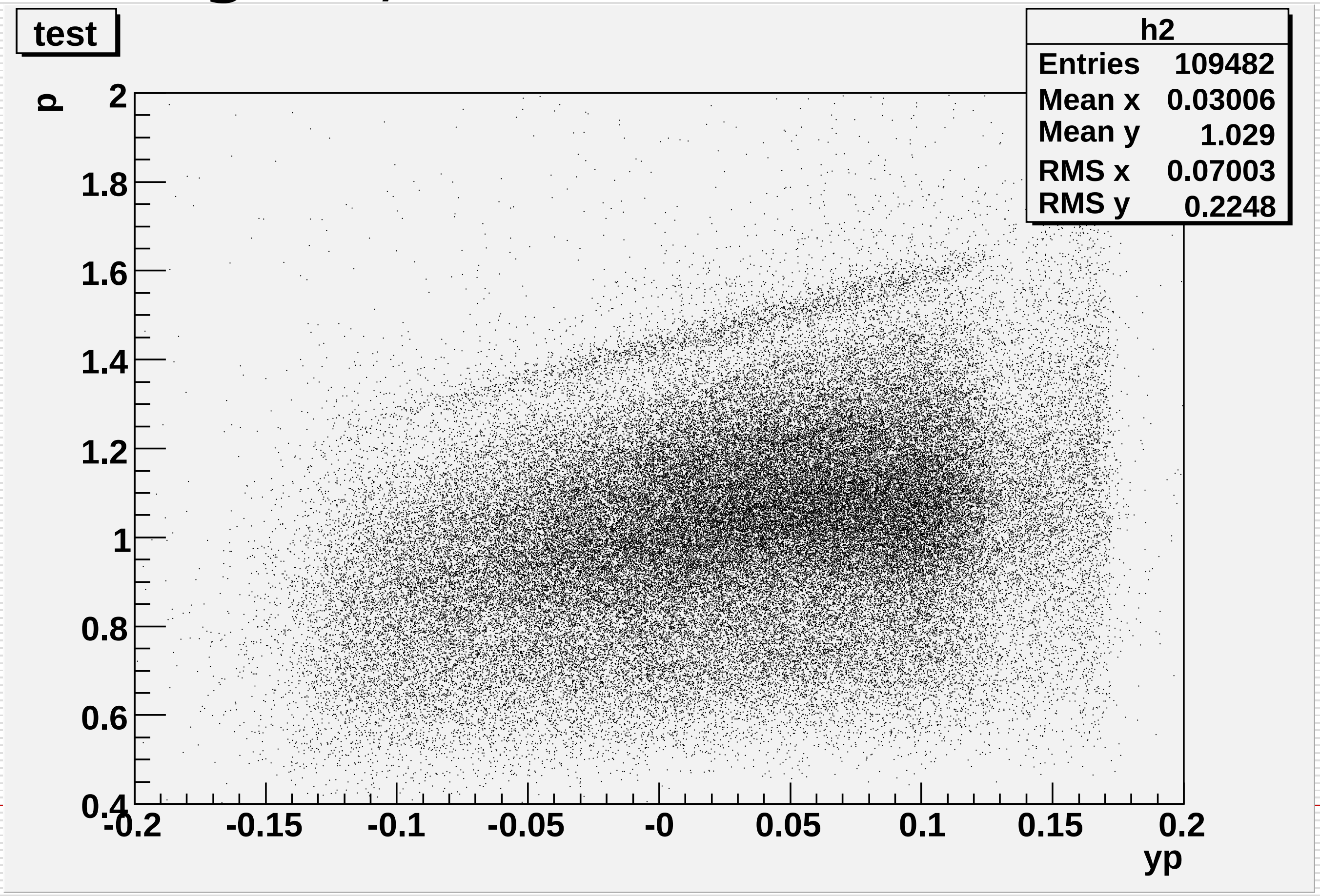
Momentum resolution

- Setting II: E = 2. 637 GeV



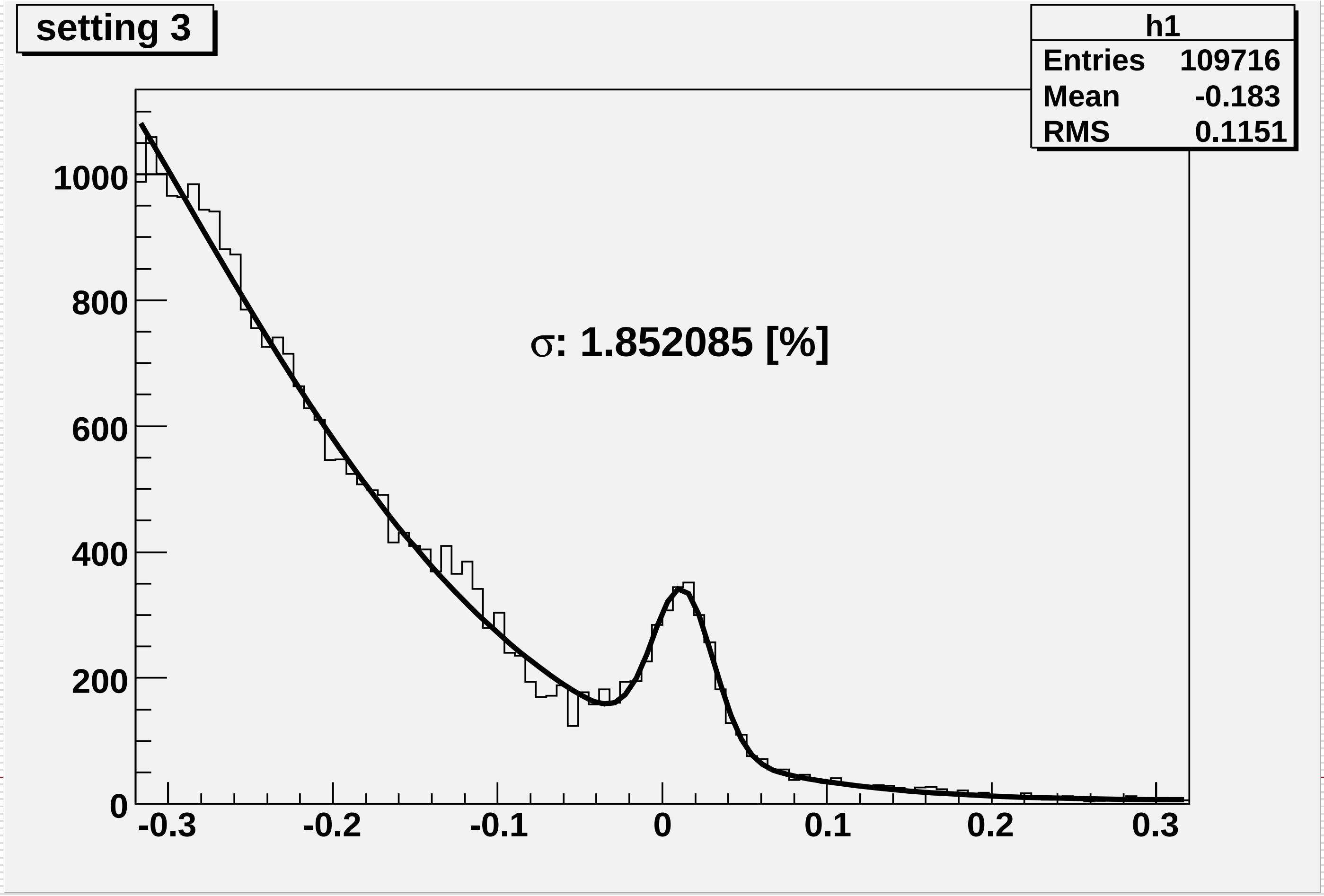
Momentum resolution

- Setting III, E=3.291 GeV



Momentum resolution

- Setting III:

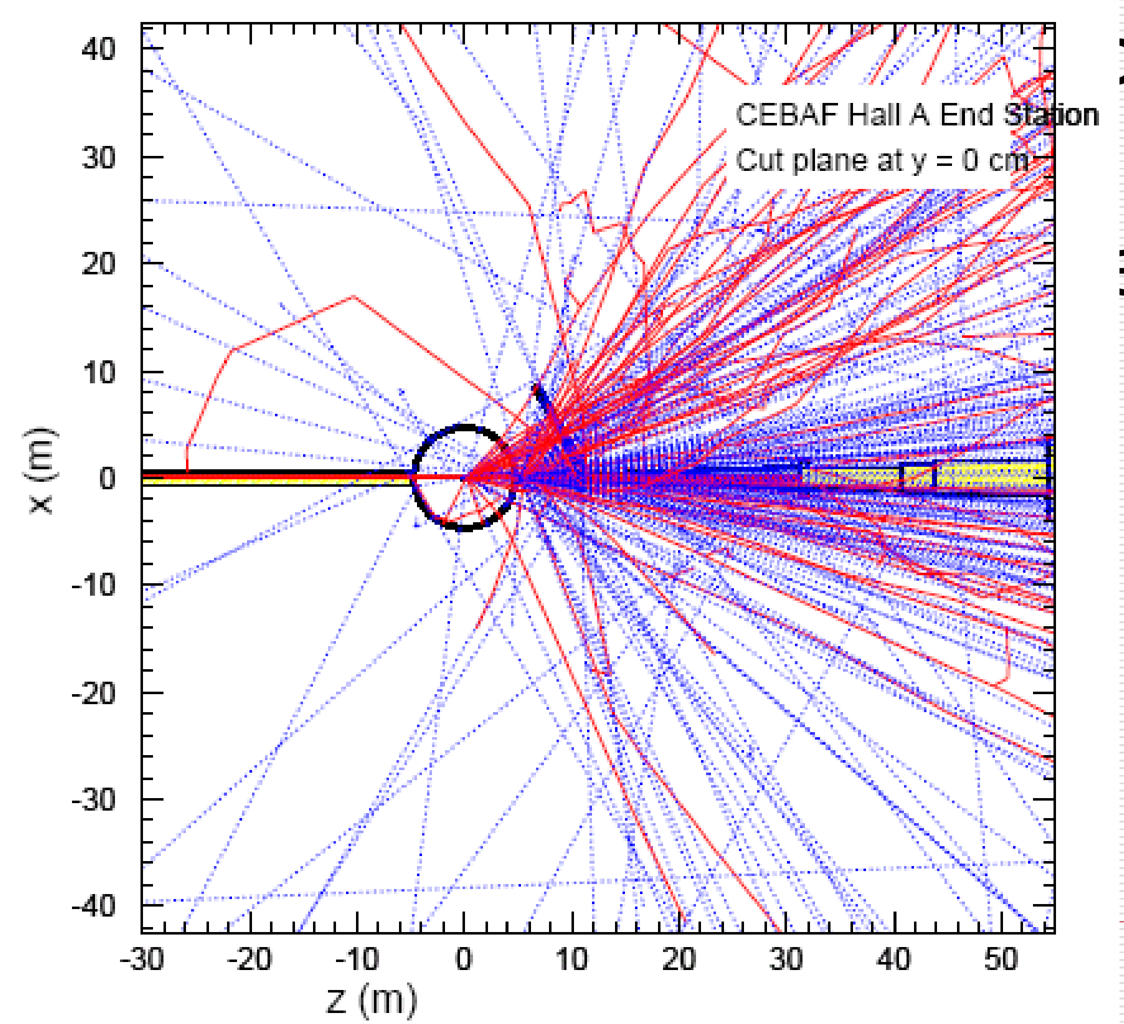


Impact on TRANSVERSITY optics

- Vertex resolution should be smaller than $\sigma < 1.5$ cm.
- Momentum resolution can be done at level of 1.5 %.
- Need wire chamber or thick sieve slit to do ϕ and θ optics.

Wire chamber background study

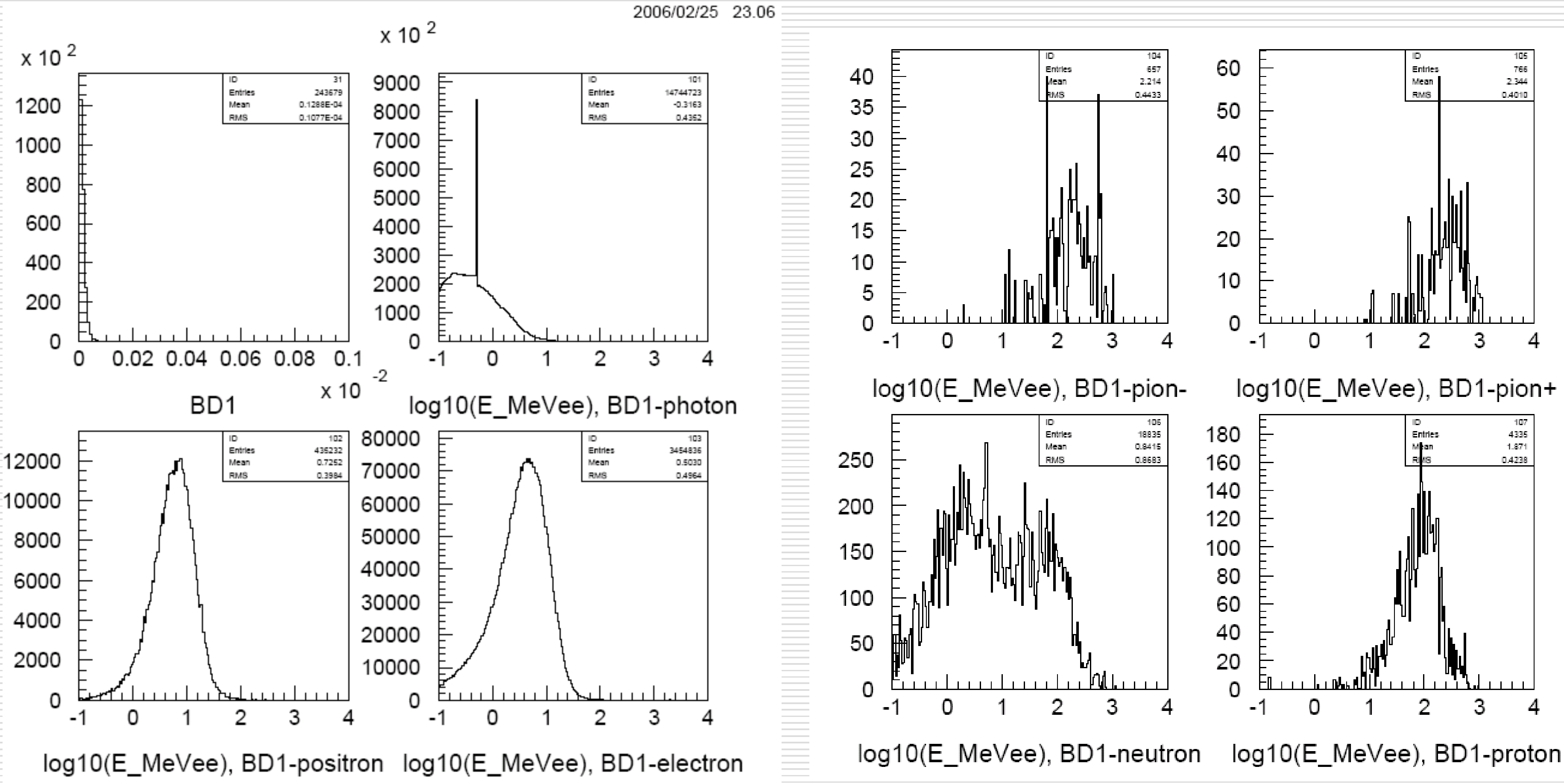
- Nai ... ber bac...
- 2 G... ent, 10 mg... X 120 cm)... net (1 m),...



Wire chamber background study

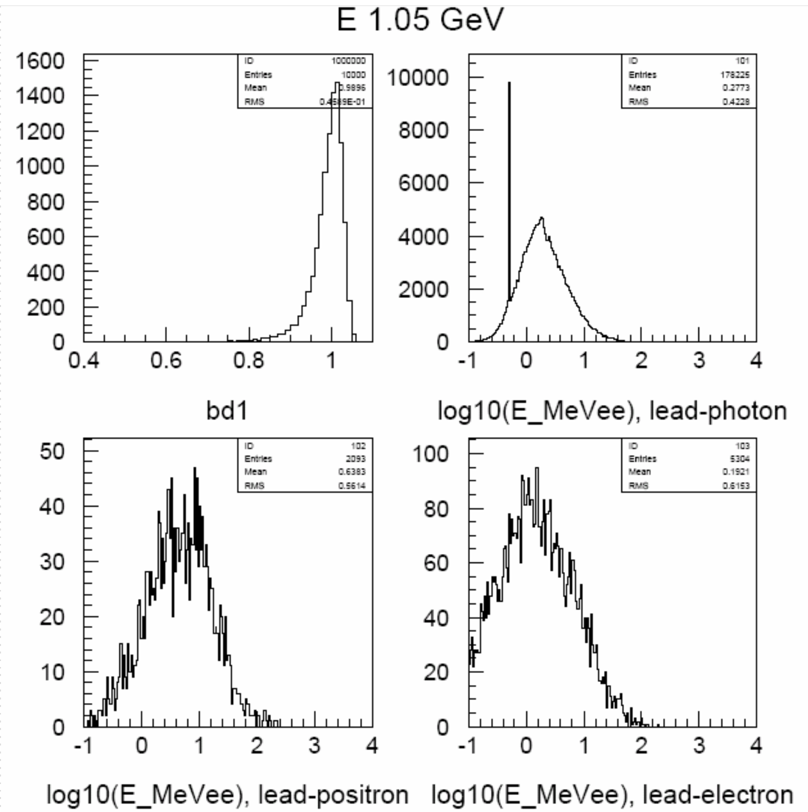
- Background rates at 5 nA:
- cut : 1keV 5keV
  - 2 GEV: 296 MHz 38 MHz
  - 3 GEV: 284 MHz 36 MHz
  - 6 GEV: 278 MHz 34 MHz
- Need to do a careful study of shielding possibility.

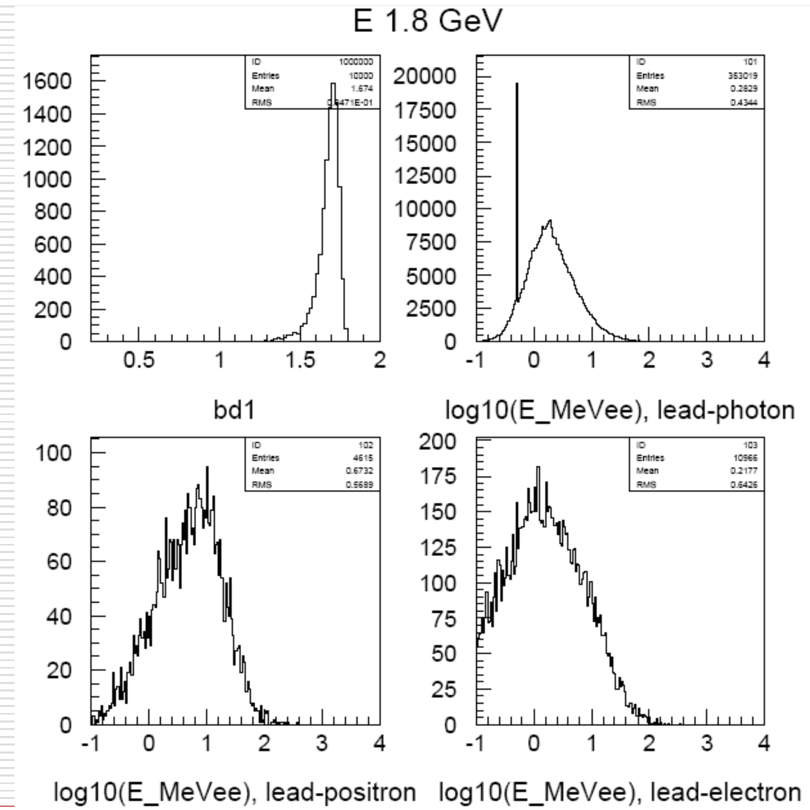
Spectrum on wire chamber



Thick sieve slit

- 3 inches Lead sieve slit.





Summary

- Vertex resolution $\sigma < 1.5$ cm.
- Momentum resolution ~1.5%
- We start to investigate the possibilities of putting wire chamber or sieve slit in front of BigBite magnet. (Need more study).

BigBite wire chamber background study for TRANSVERISYT experiment

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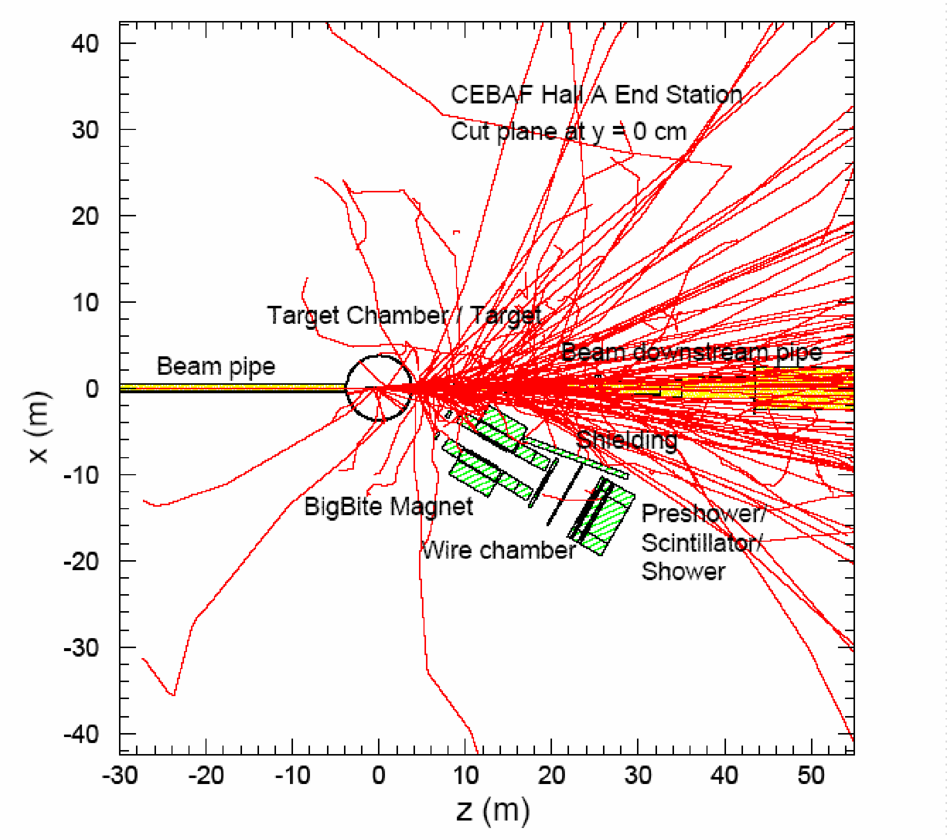
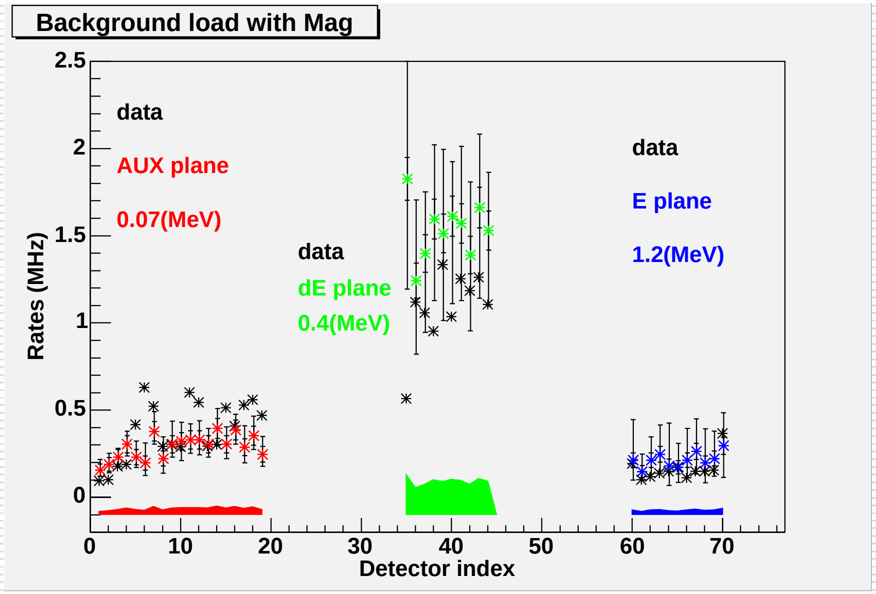


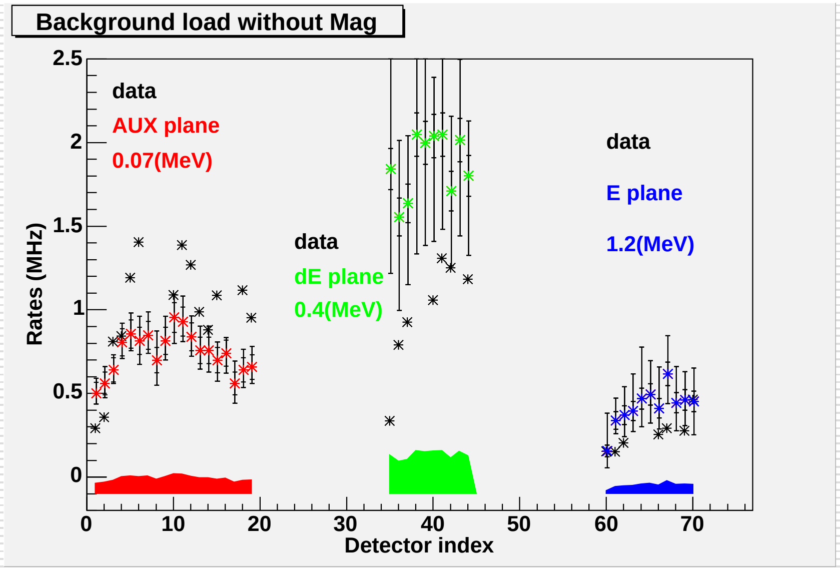
Outlook

- Summary of old work done on this issue.
- New comparison of GEN data and simulation
- Prediction on TRAN case
- BigBite tracking (middle chamber vs Cherekov)

Old work summary

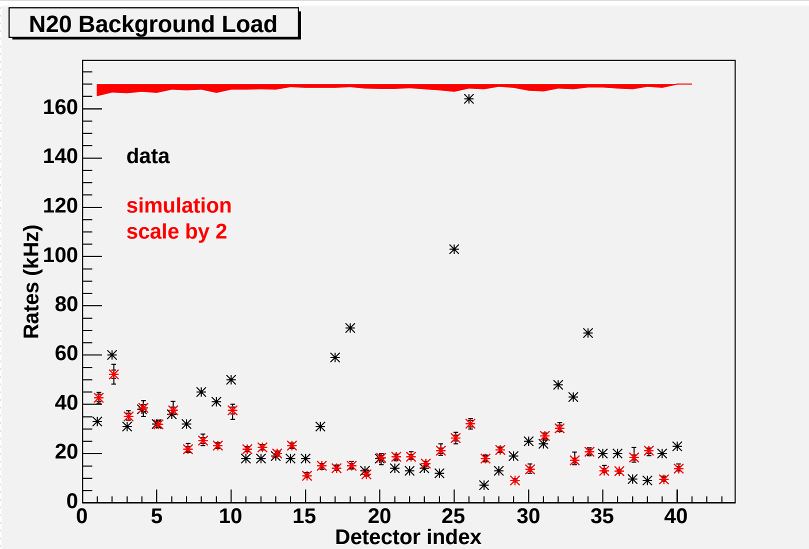
- TRANSVERSITY test run (data analysis by Lingyan)

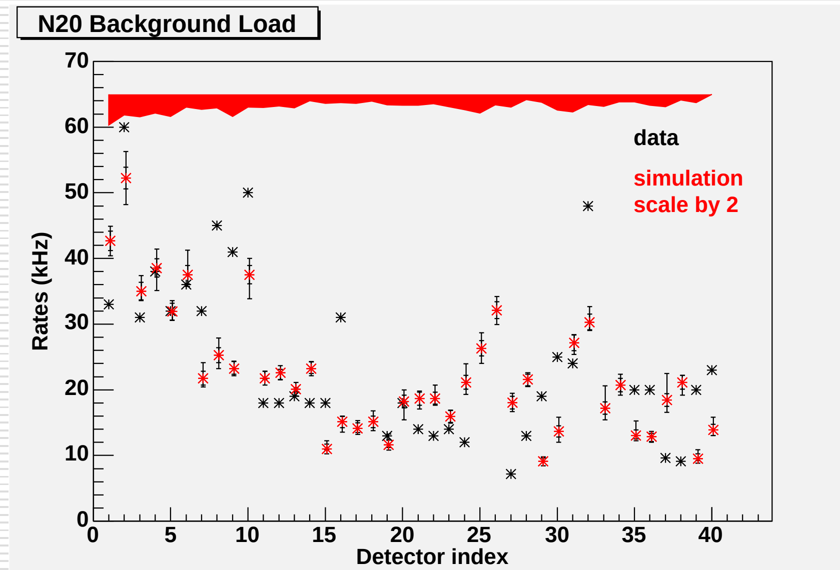




Old work summary

- N20 test run



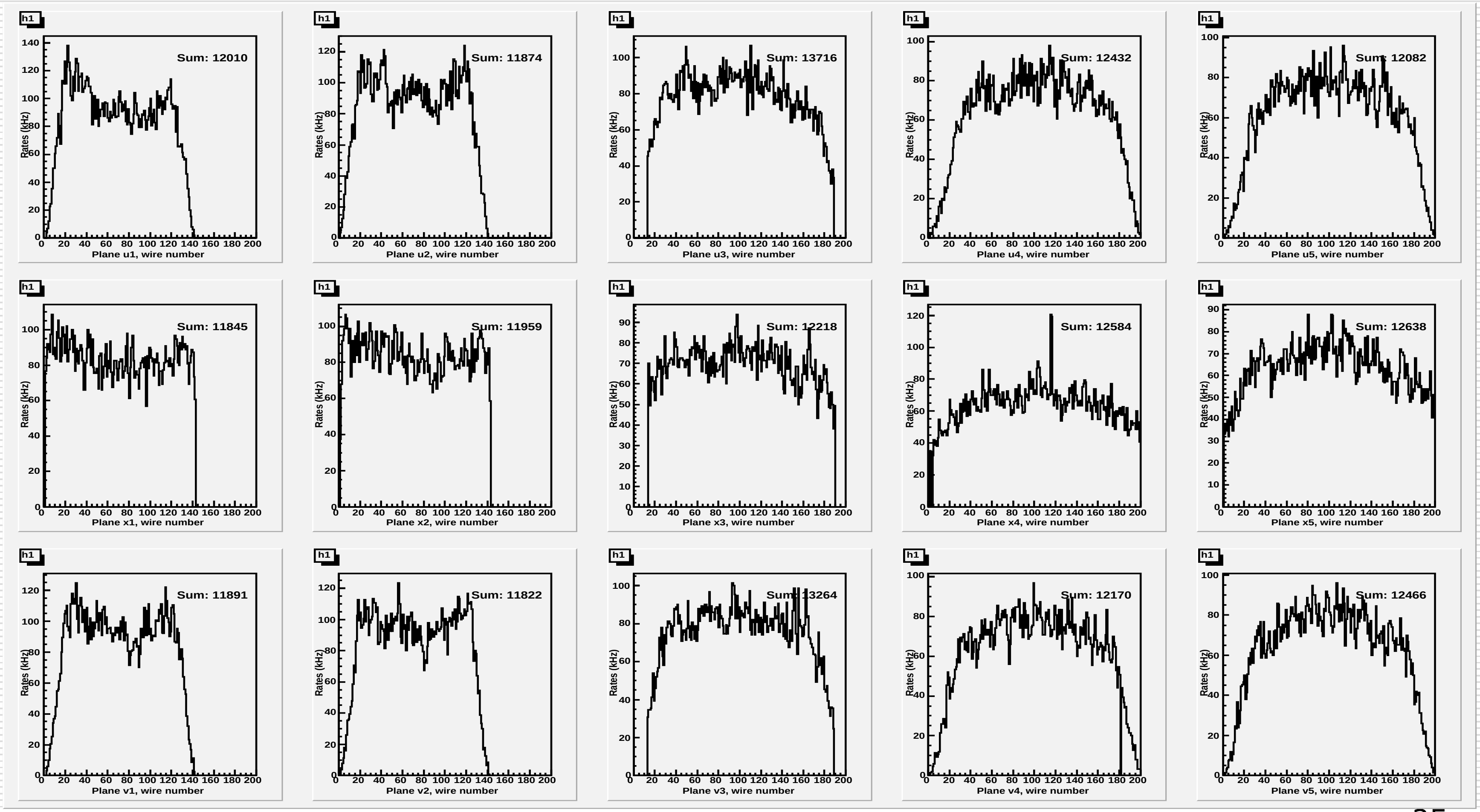


- SRC data: 70 kHz,
- Simulation: 142.8 +- 5.8 (stat) +- 24.8 (sys) kHz.

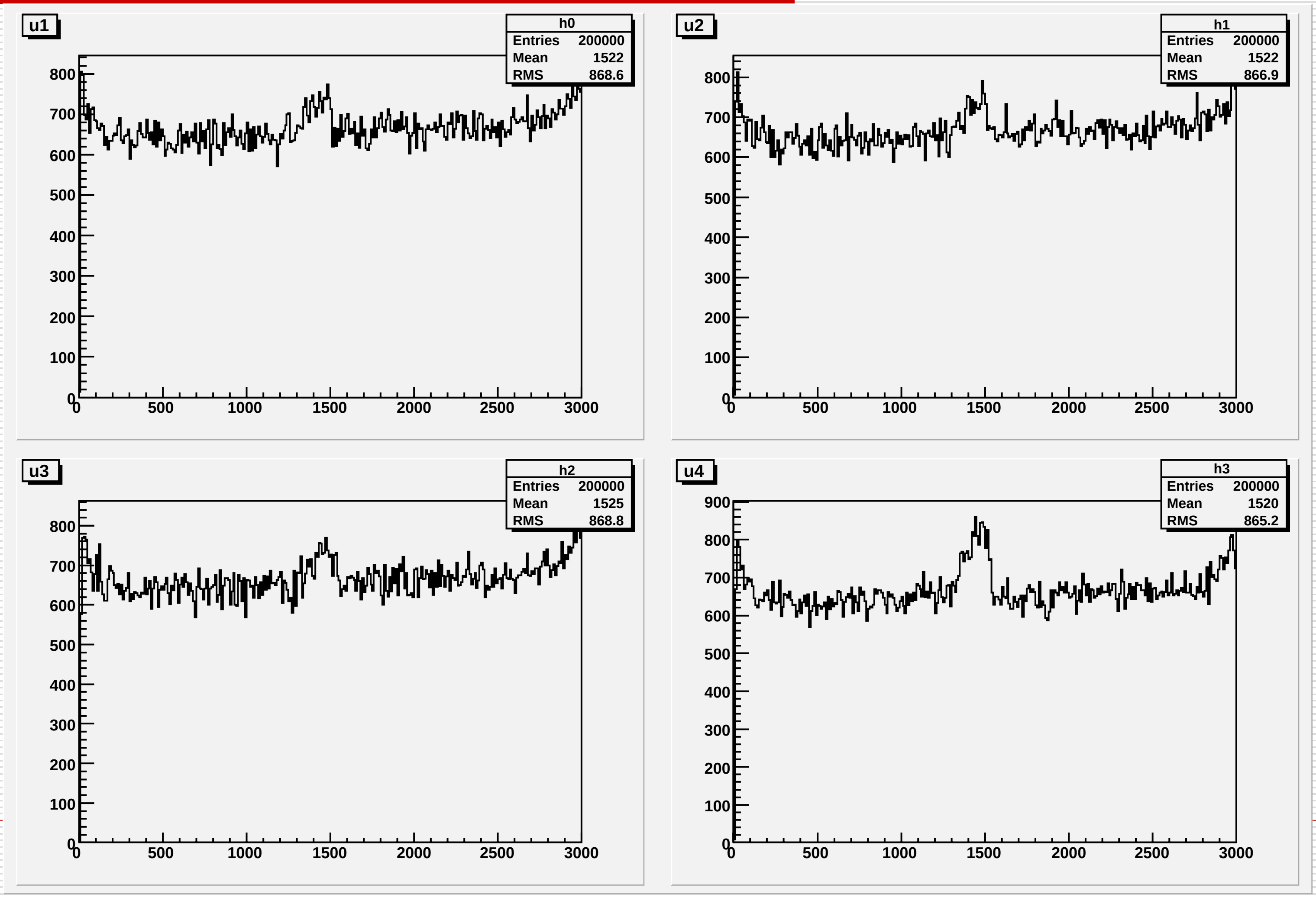
Old work summary

- Bare wire chamber test run
  - Data: rate per wire: 1.8 kHz.
  - Simulation with 1.0 keV cut: 9.88 +- 0.29 (stat.) +- 3.2 (sys.) kHz.
  - Simulation with 5.0 keV cut: 1.76 +- 0.12 (stat.) +- 0.57 (sys.) kHz.
- First chamber rate of GEN case with (3.244 GeV) shielding at 54 degree with 15 uA beam.
  - Cut 1.0 keV: 12.6 +- 2.2 MHz.
  - Cut 5.0 keV: 6.87 +- 1.62 MHz.
- TRANSVERSITY case with 15 uA on first chamber
  - Cut 1.0 keV: 20.2 +- 2.8 MHz
  - Cut 5.0 keV: 7.5 +- 1.7 MHz.

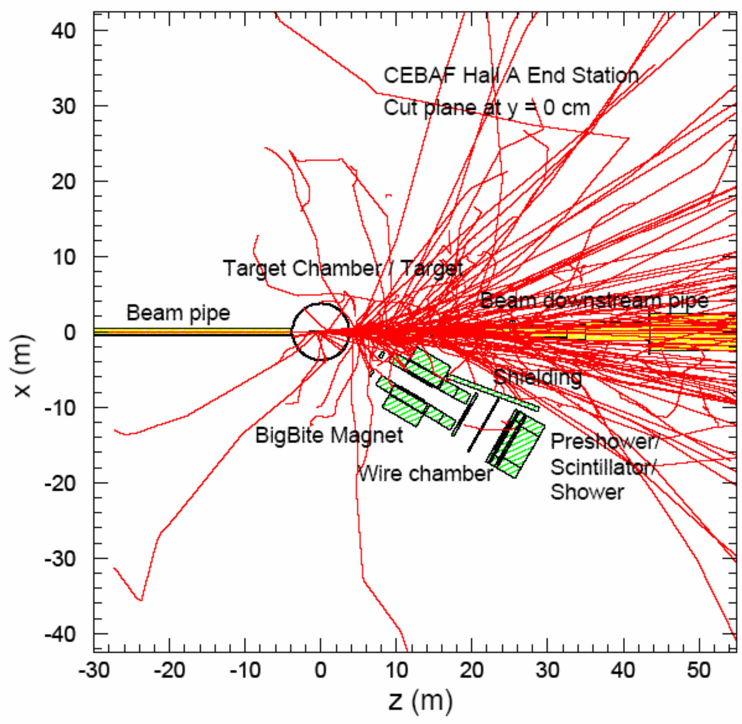
Comparison between GEN data and simulation

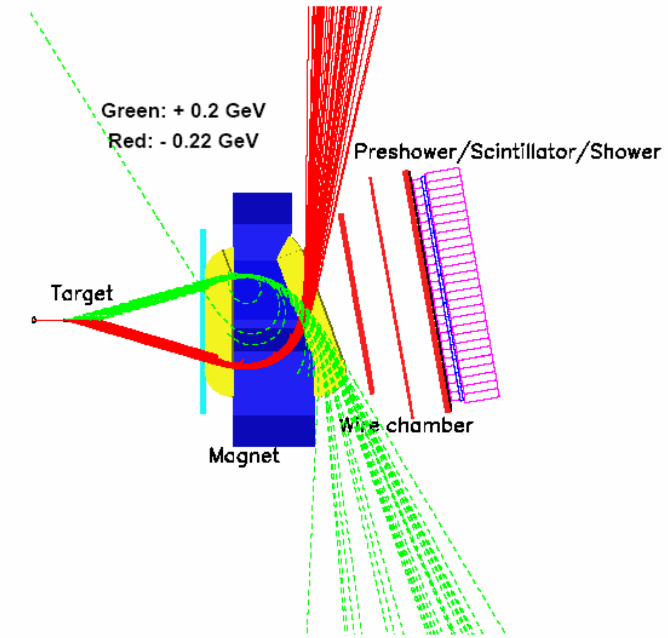


Drift Time for first hit on the first wire for Three Chambers



Model introduction





Comparison between GEN data and simulation

- Setting I, Run 2500 with 2 uA beam

	BD1(MHz)	BD2(MHz)	BD3(MHz)
Data :	14	7	5
NS :	12	37	39
WS :	2.34	4.07	3.41

- The shielding in the simulation is 3.15 inch lead. Much thicker than the shielding in the GEN (~1 inch Aluminum)
- Cut used 1 keV which should be a loose cut from bare wire chamber test run.

Comparison between GEN data and simulation

- Setting 2, Run 2812 5.0 uA beam

	BD1(MHz)	BD2(MHz)	BD3(MHz)
Data :	10.5	12.2	11.6
NS :	26.4	71.3	77.6
WS :	7.2	12.7	11.0

Comparison between GEN data and simulation

- Setting 3: Run 3464   7uA beam

	BD1(MHz)	BD2(MHz)	BD3(MHz)
Data:	15.0	16.7	15.0
NS :	34.8	91.8	94.9
WS :	8.48	16.6	12.72
SS :	10.16	21.09	13.2

- SS is 3.15 inch Aluminum.

Comparison between GEN data and simulation

	BD1(MHz)	BD2(MHz)	BD3(MHz)
GEN:	19.2	22.0	19.3
TRAN:	10.6	23.0	23.0

GEN at 9uA.

TRAN 10uA, 6GeV, 30 degree, with thick shielding wall.

First, Cut 1 keV is a loose cut.

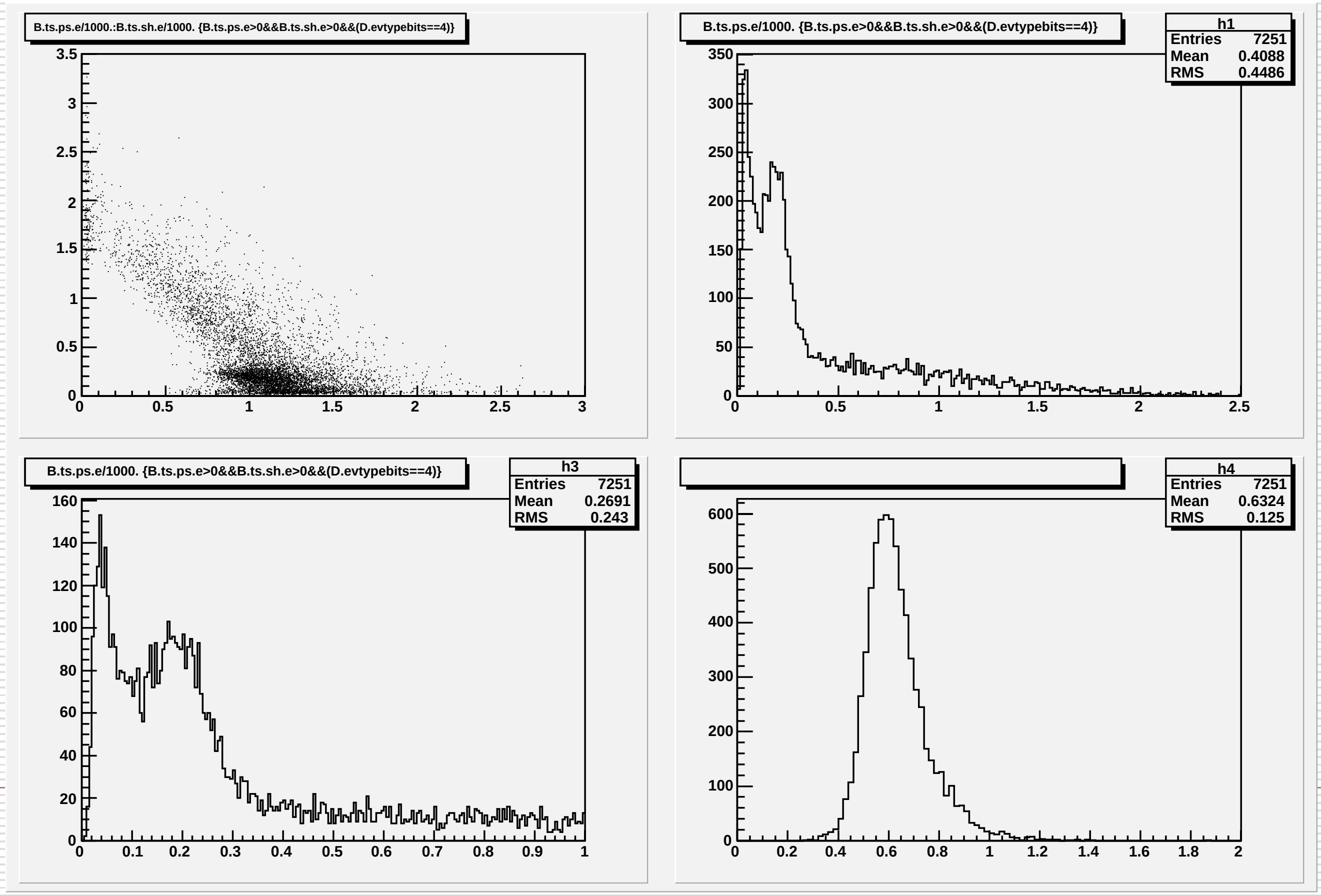
Second, thick shielding only on side of BigBite.

More shielding in front (collimator design, shield window etc.) can decrease the Background.

In TRAN case, the estimation is that wire chamber at least can survive at 10 uA beam current, an aggressive shielding can enhance the beam current limit.

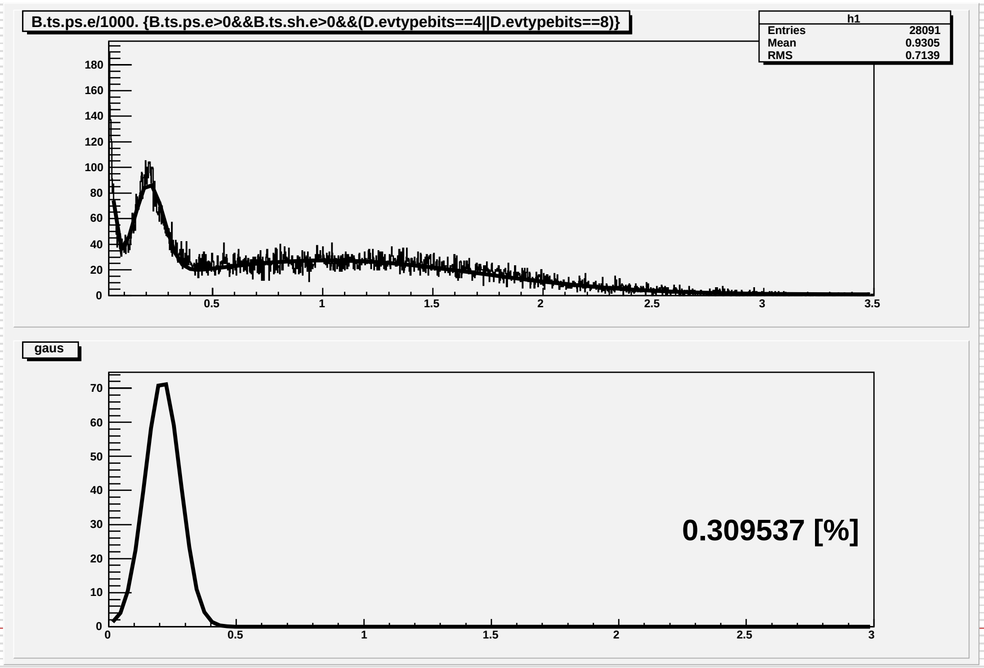
Tracking (Mid chamber vs Cherenkov)

- Naïve pion rejection factor study.



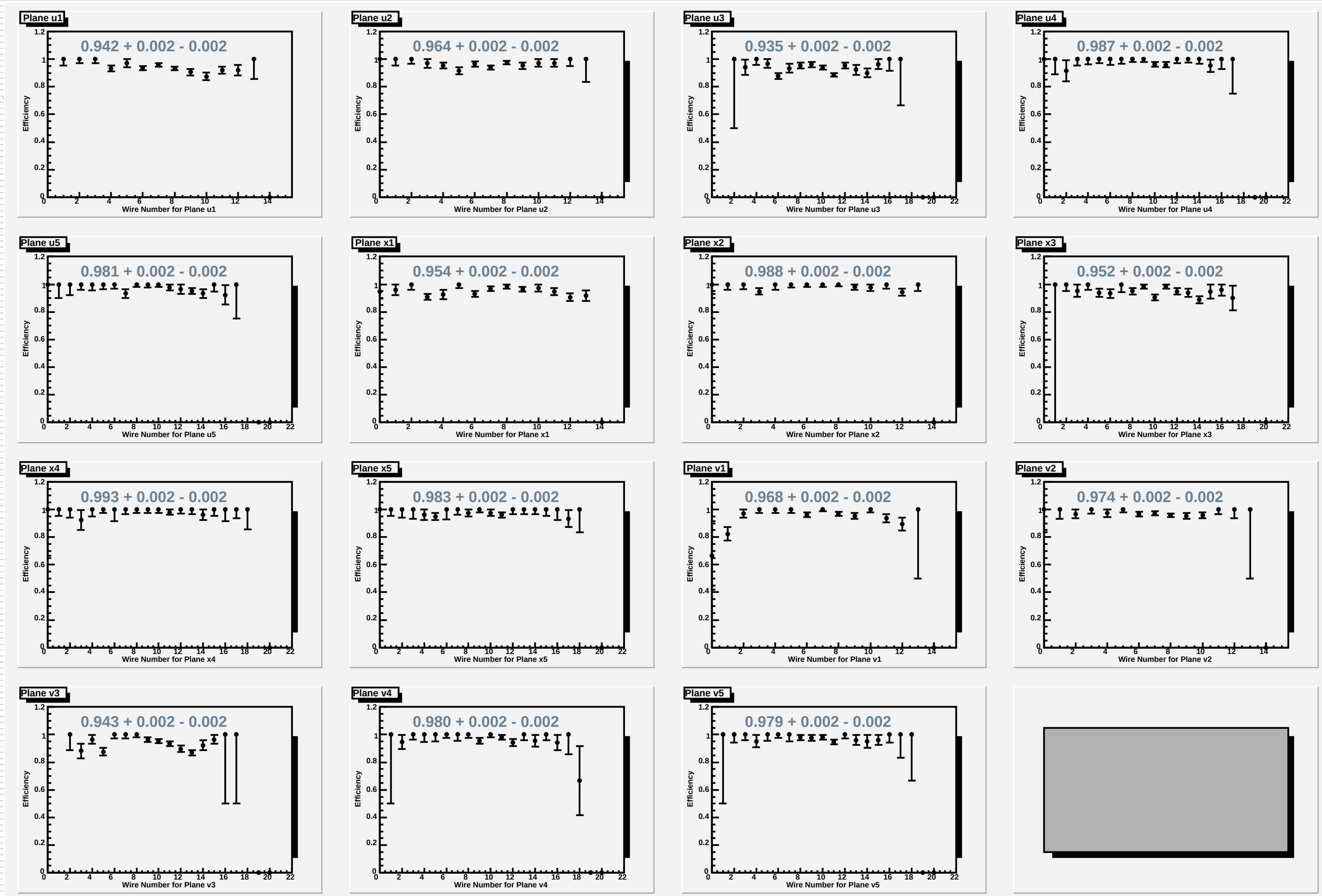
Naïve pion rejection study

- All data passing 700-800 MeV energy cut, pion leak into electron region can be several percent.



1uA 3He target

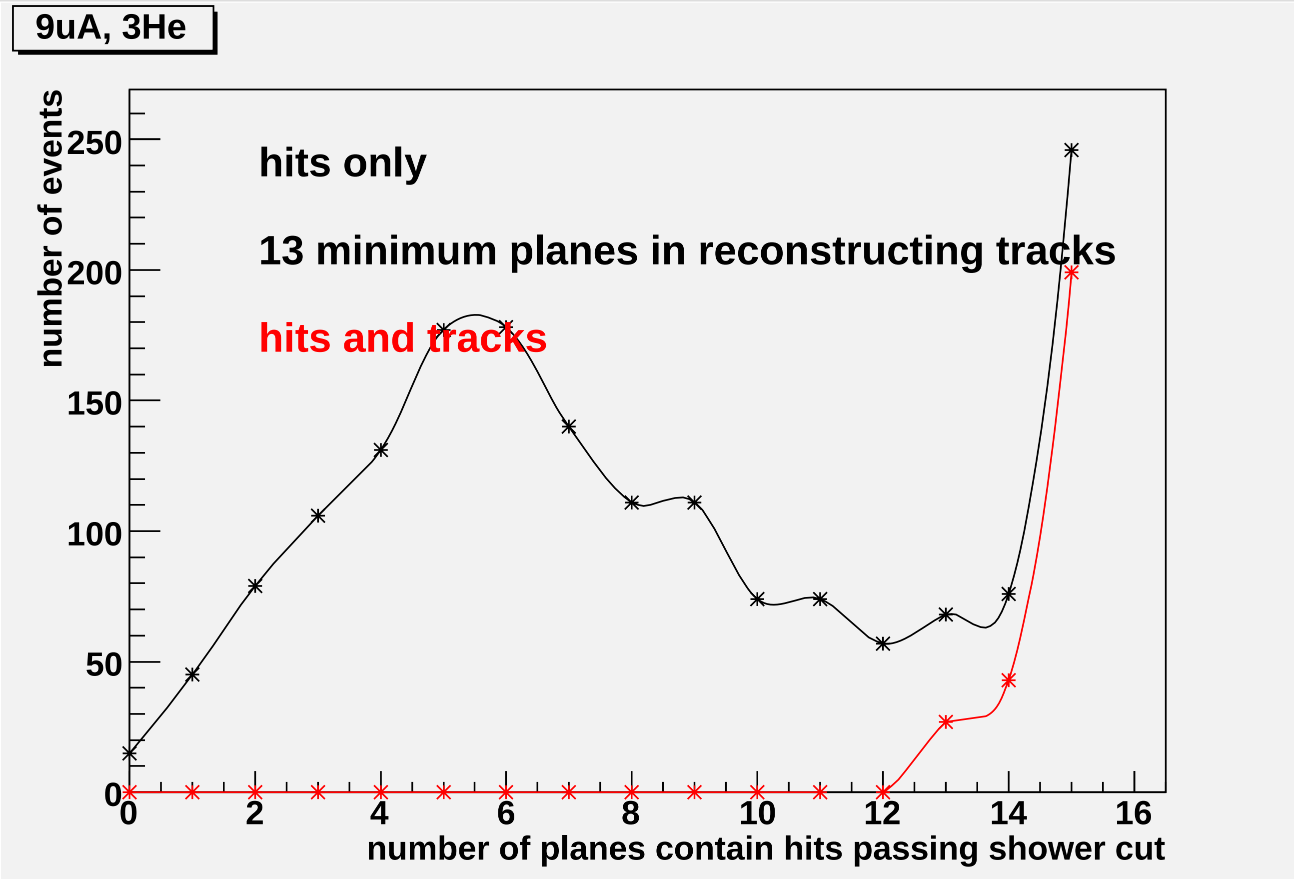
Wire chamber hitting efficiency



Calculated tracking efficiency

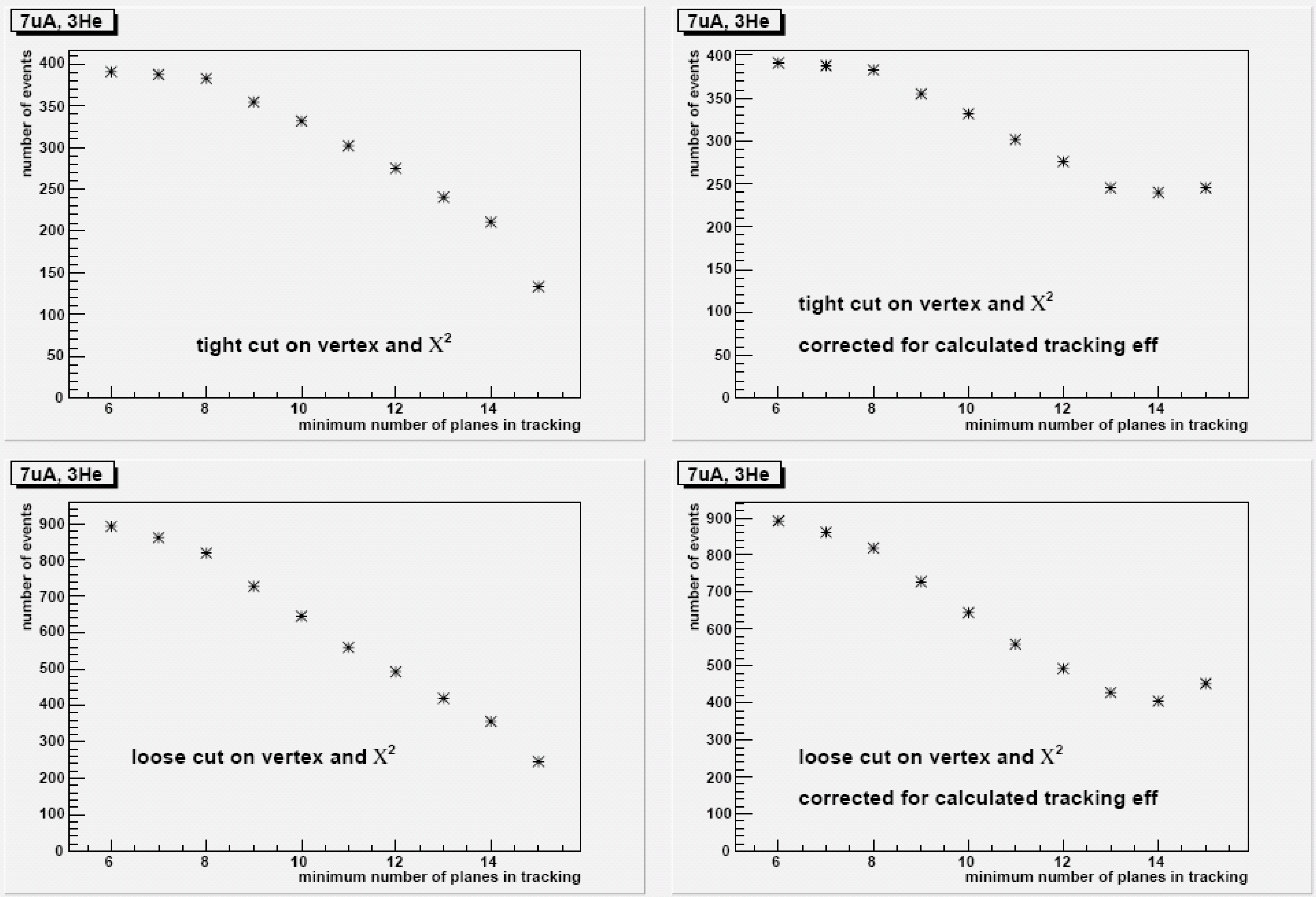
- Using average 96% plane eff, the tracking efficiency of minimum 13 planes is 98%.
- 98% of real tracks are recorded.
- From my understanding of tracking algorithm, the real tracks will be always found.
- The only problem is false track due to the background on wire chamber.

Origin of false track & tracking algorithm

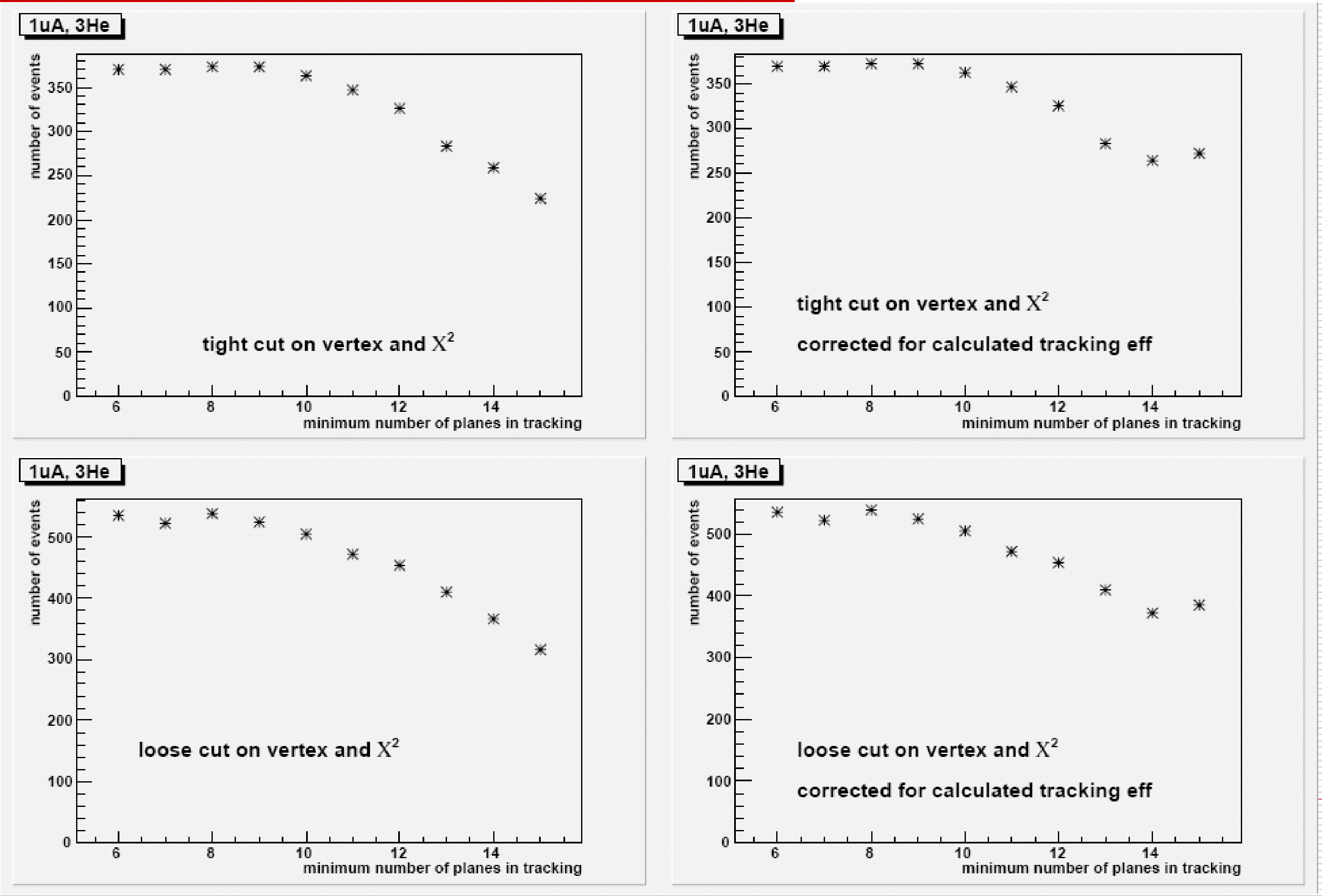


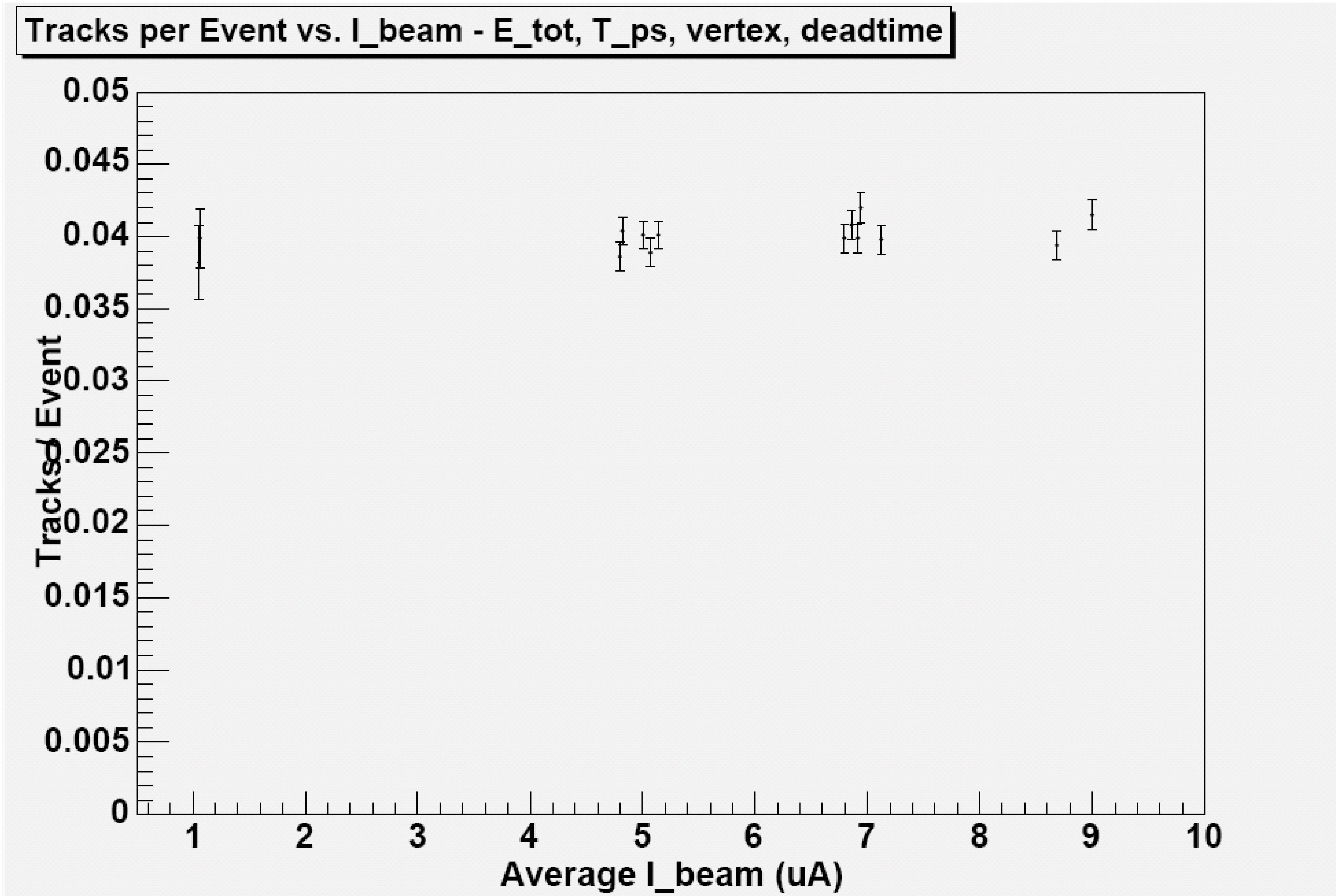
- Signals in Shower may come from the downstream beam, heavy shielding may help to improve this.
- Tracking starts with a large signal on shower system, construct a cone to the negative particle image area, then do Chi2 fit, etc.

False track study (7uA)



False track study (1uA)




Tracks per Event vs. I_beam - E_tot, T_ps, vertex, deadtime
Tracks / Event
0.05
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
1
2
3
4
5
6
7
8
9
10
Average I_beam (uA)

False track study

- There can be false tracks with loose cut or lower number of minimum planes.
- Although with tight cut, we may exclude false tracks, the question is that how many good tracks are lost?
- With higher background in TRANSVERSITY, can tight cut exclude most of false tracks?

Mid chamber vs Cherenkov

- The calculated tracking efficiency between (with middle chamber 13/15) and (without middle chamber 10/12) are similar.
- No middle chamber can increase the possibility of false tracks. (~30% effect Run 3414, 7 uA beam, No middle chamber: 1262, With middle chamber: 972)
- Pion rejection factor (1% , pion/e ratio 370-100-30-10:1 gives 10-370% effect).
- Need more study & Can we use both of them? Three full chamber + Gas Cherenkov?

Summary

- With medium heavy shielding, wire chamber can stand at 10 uA beam current in TRAN case.
- More heavy shielding can lead to higher beam current.
- More planes used in reconstruction, less false tracks.
- Tracking efficiency for real tracks should be high.
- Need to go into the tracking algorithm to understand more.

Acknowledgement

- Seamus
- Brandon
- J.P. Chen
- Xiaodong Jiang