Progress Report

Two-Pion background

Near Target Collimator Thickness Study

BigBite Solid Angle Study

Xin Qian

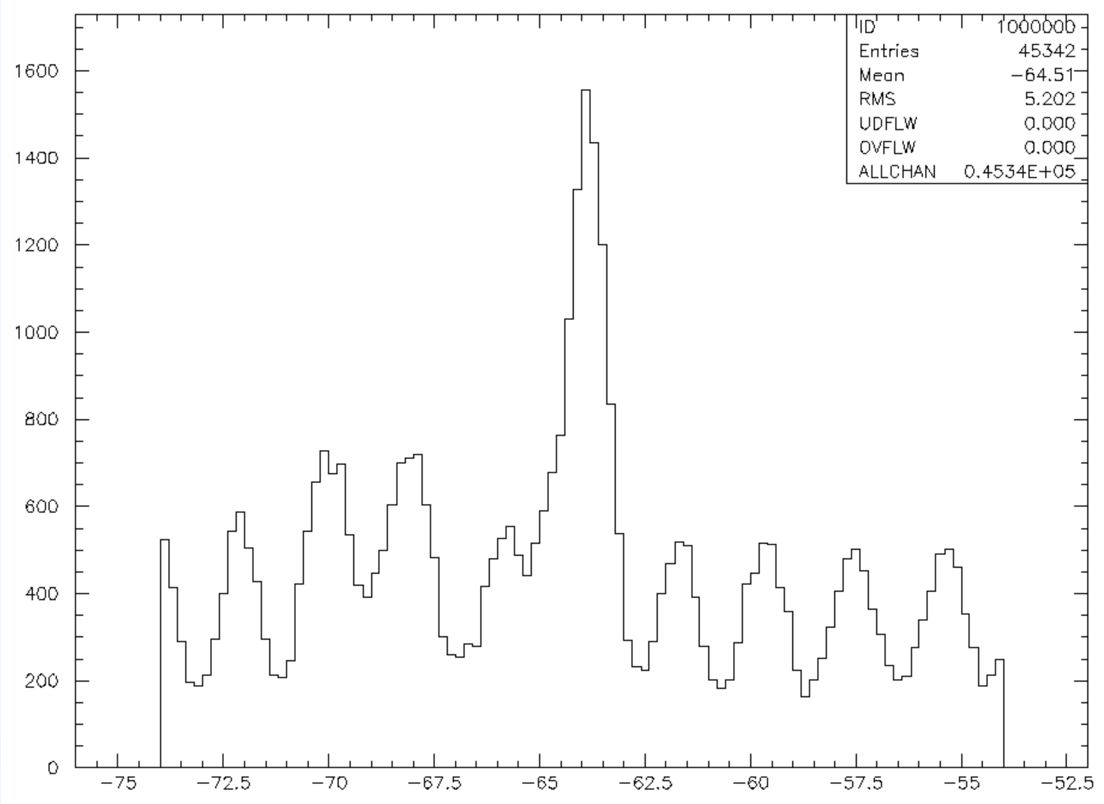
Duke University TUNL MEP group

Double pion background study

- Transversity conditions:
  - 5.7 GeV/c
  - BigiBite: 30 degree, momentum bite 0.6 GeV/c - 2.0 GeV/c
  - HRS: 16 degree 2.4 GeV/c +- 5%
- Semi-Sane test run
  - 5.76 GeV/c
  - SOS: 28 degree, momentum bite +- 20%, three momentum setting 0.9, 1.23 and 1.7 GeV/c
  - HMS: 10.8 degree, central momentum 2.7 GeV/c +- 10%

Double pion background study

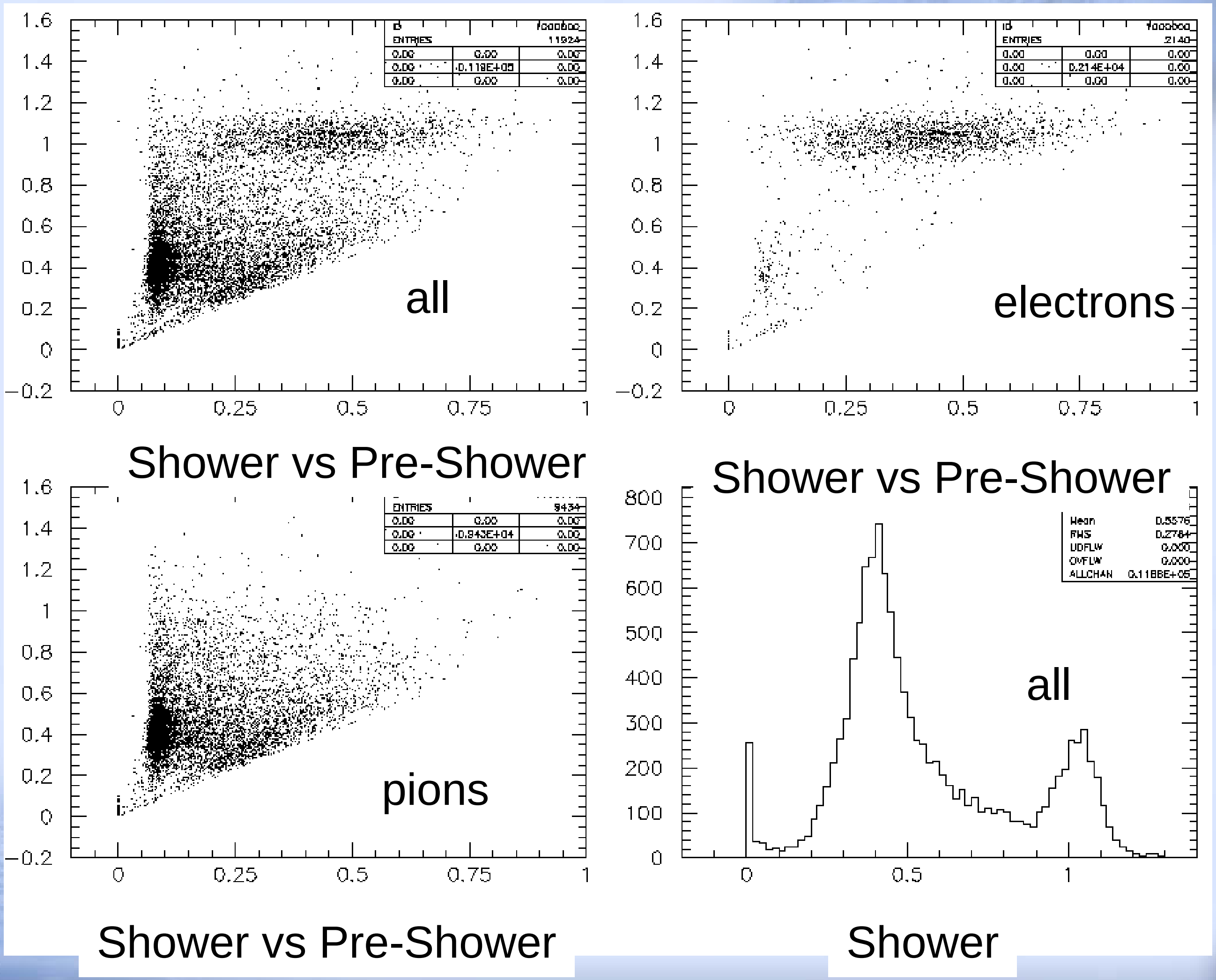
- Acceptance cut, random coincident subtraction.
- Using gas Cerenkov to select electron and pion.
- Test shower (shower + pre-shower) counter pion/rejection ability.



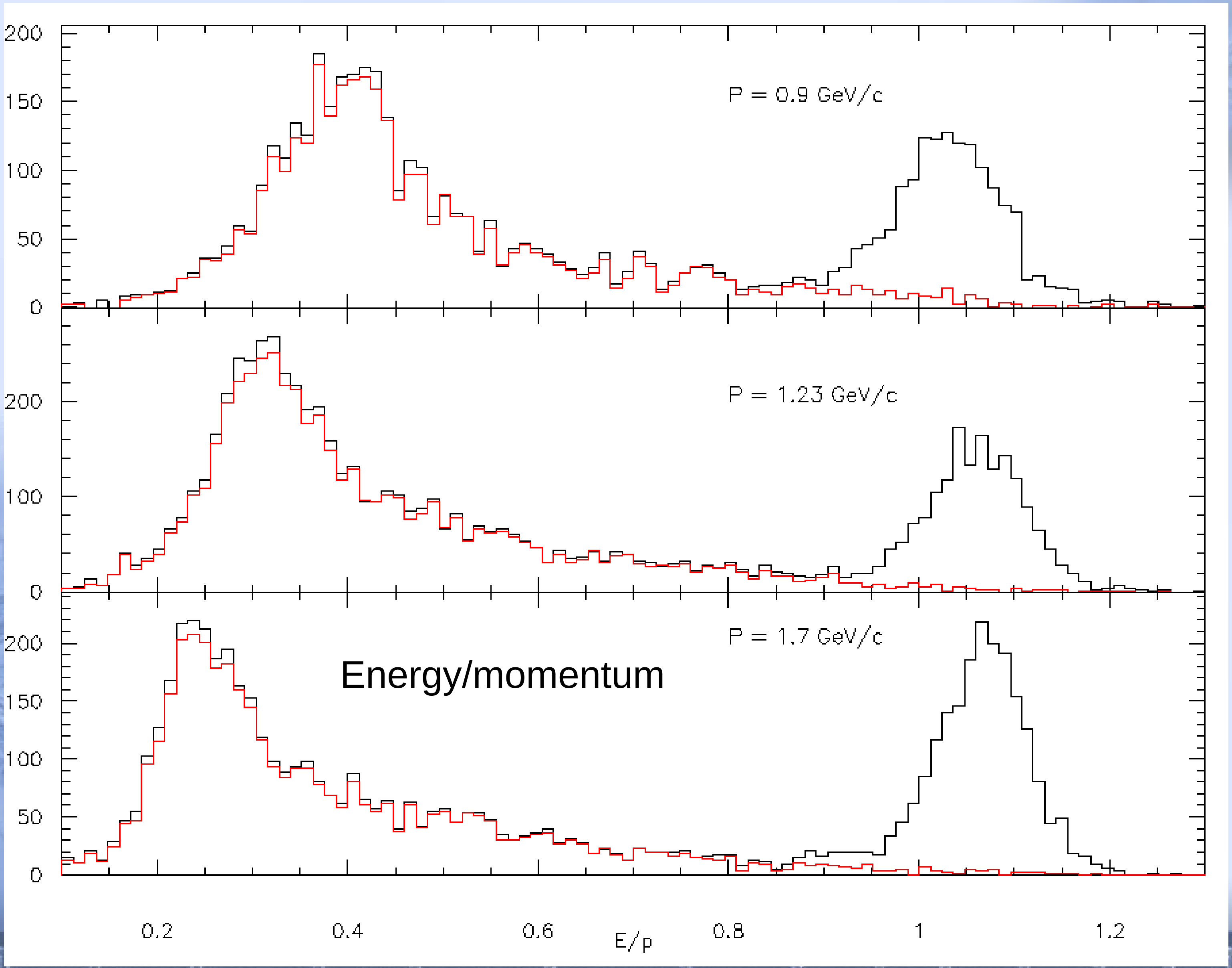
Timing information

Double pion background study

- Shower counter pion rejection with gas Cerenkov.
- Electron: number of photo-electron > 2.5
- Pion: number of photo-electron < 0.5



Double pion background study



Double pion background study

- Pion contamination become smaller with increasing electron arm momentum.
- Pion contamination become larger with decreasing hadron arm momentum
- Hadron arm angle dependence is not clear

P_{SOS}	all	P_{HMS}	P_{HMS}	θ_{HMS}	θ_{HMS}	θ_{HMS}
GeV/c		GeV/c	GeV/c	degree	degree	degree
cut		2.43-2.56	2.84-2.97	.lt.10.2	10.2-11.3	.gt.11.3
0.9	8.7%	18.0%	5.4%	11.9%	7.24%	7.5%
1.23	4.7%	6.0%	3.8%	7.8%	3.83%	3.0%
1.7	3.4%	4.8%	1.6%	3.1%	3.03%	4.0%

Pion contamination: pions passed the shower cut

Conclusion for two-pion background

- If neglecting hadron arm angle difference, pion contamination will be as large as 20% for the lowest x bin in transversity experiment.
- The angle dependence is not completely clear from this study.
- We need a gas Cerenkov for the electron identification.

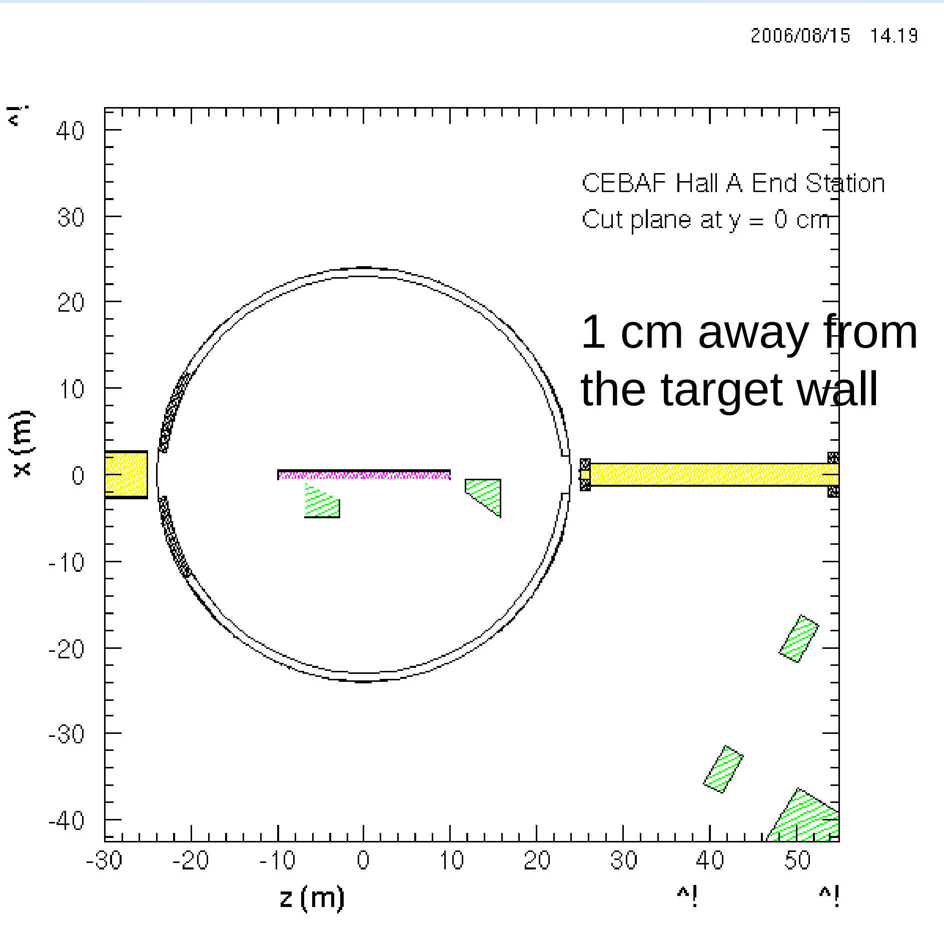
- Thanks Xiaodong and Peter's suggestions, comments and discussions.

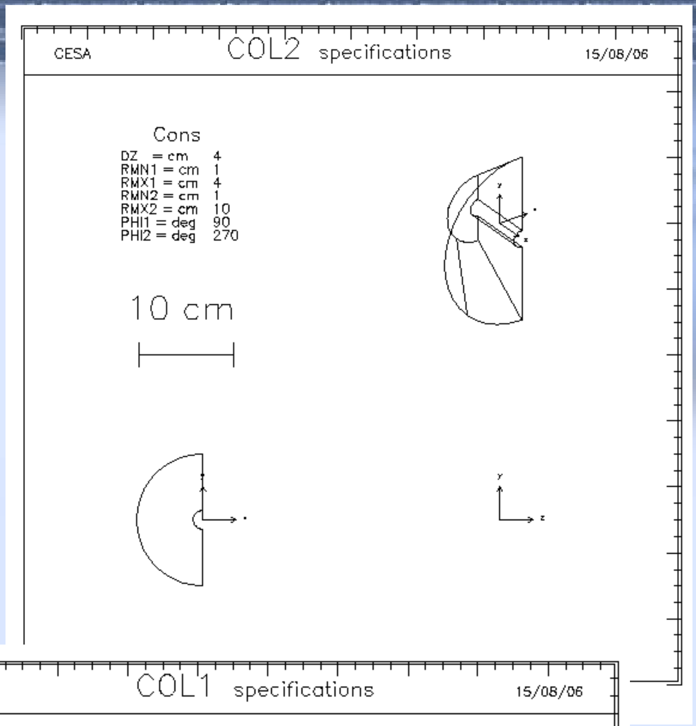
Collimator Thickness Study

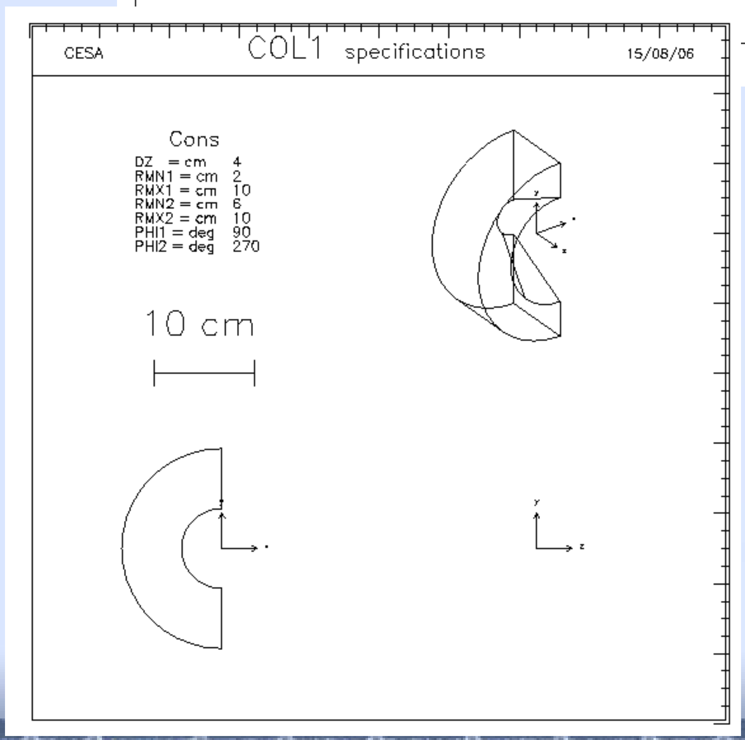
- Using Geant3 simulation
  - This code is from Pavel Degtiarenko.
  - This code has been used for several comparisons with experimental data (including wire chamber background during GEN).
- Motivation of collimator is to shield background rates from end-caps of glass.
  - This may help in reducing total background rates on wire chamber which is the current limitation on luminosity.

Model Description

- Shielding to avoid direct view from target end-caps.







Results

- No Collimator: 21.3 +- 2.16 MHz
- 3 cm thick: 17.6 +- 1.6 MHz
- 4 cm thick: 14.8 +- 1.5 MHz
- 5 cm thick: 13.6 +- 1.4 MHz
- 6 cm thick: 14.6 +- 1.5 MHz

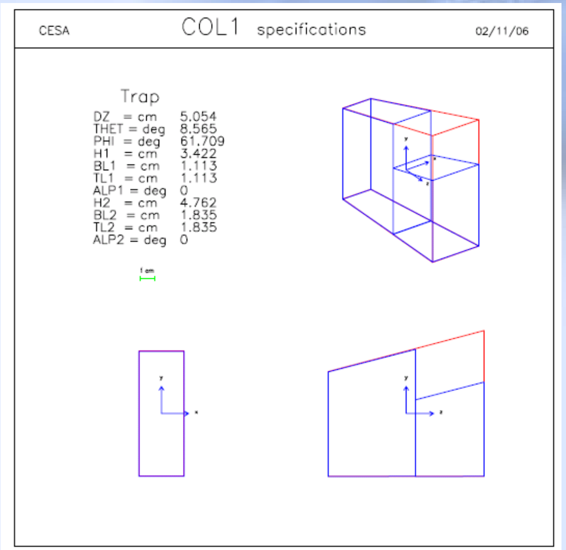
15 uA beam on 40 cm long ^{3}He target
rates on first chamber.
5-6 cm acceptance cut out of 40 cm.

We can handle 10 uA beam, so with 5 cm thick shielding, we will be able to handle 15 uA beam.

- Here 5 cm thick means 10 cm along the BigBite direction (30 degrees).

Conflict with the Oven

- The upstream collimator has conflict with the target oven.
  - The upper half of the collimator will only have 6 cm thickness.
  - Most background are due to electrons.
  - Electrons will lose energy when passing through the collimator, then bend over by the magnetic field.
  - The effect for the cut is expected to be small.



With cut: 15.5 +- 1.9 MHz
Without cut: 14.7 +- 1.9 MHz
Naively: 7-8% effect when neglecting the statistical error.

Conclusion

- With the collimator, we will be able to run at 15 uA.
- The acceptance lost will be 6-7 cm out of 40 cm.
- The cut due to the conflict with Oven will have a small effect.

- Thanks for Jian-Ping’s comments and suggestions.

BigBite Solid Angle Study

- There will be 3 full wire chambers during the TRANSVERSITY experiment.
  - Two big wire chambers and one small wire chamber.
- From two-pion background study, we conclude that we need a gas Cerenkov detector.
- One small Hall-C chamber can be used as a backup.
- The Pre-shower and Shower counter have to be moved further.
- The total solid angle will be limited by BigBite magnet, wire chambers, shower counters.

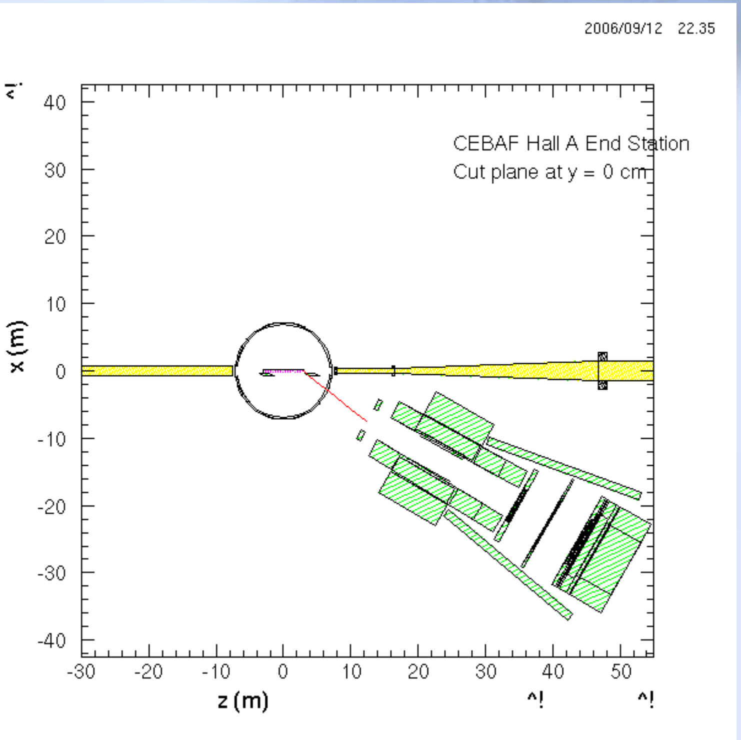
Configuration and Solid angle calculation

- Hall-C chamber 30*120 cm.
- Small chamber 36*150 cm.
- Large chamber 50*200 cm.
- Chamber thickness: 12 cm.
- Gas Cerenkov thickness 60 cm.
- Shower Counter: 60*230*34 cm.
- Pre-shower: 68*222*8.5 cm

- Solid angle for one point along the z-axis of target is calculated by simulation.
- The solid angle showed in the following slides are averaging by assuming 40 cm long target.
- Here we did not consider the lost of solid angle by adding collimator.
  - The average solid angle will be similar, however we will lose (6~7)/40 solid angle by collimator.

“GEN” configuration

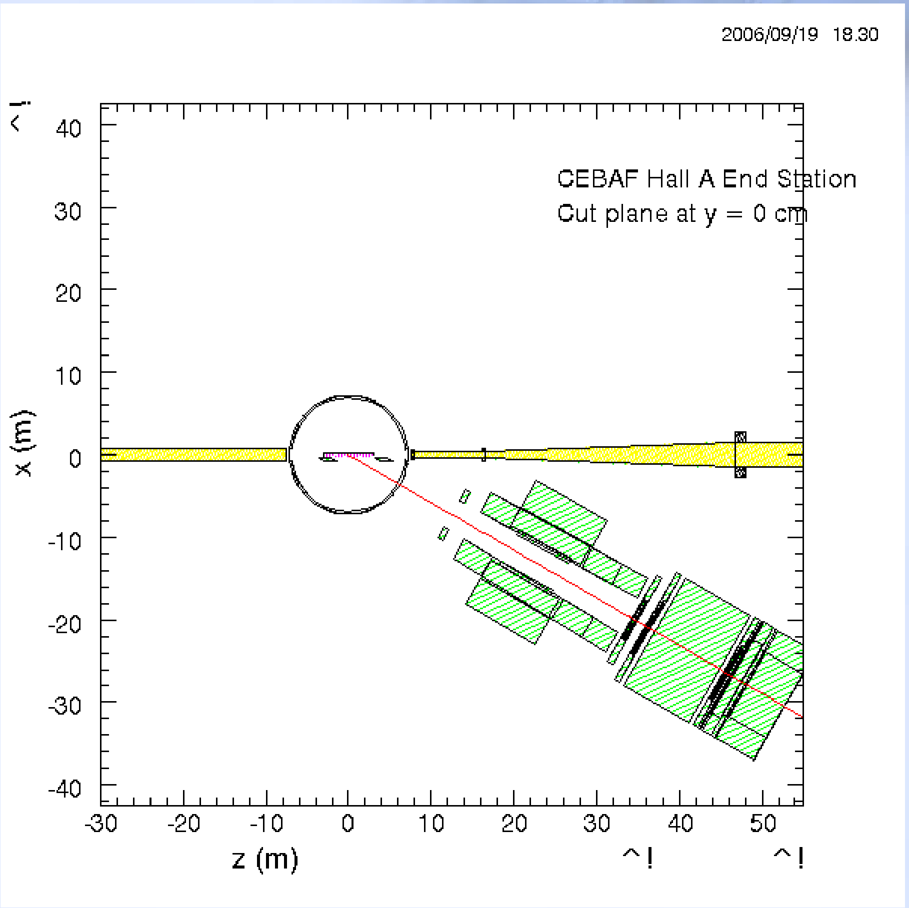
- Put one layer behind shower in order to figure out the influence of the shower counter in solid angle calculations.
- 0.6 GeV/c: 56.0 msr
- 1.2 GeV/c: 65.8 msr
- 1.8 GeV/c: 66.0 msr



1.5 m drift distance.

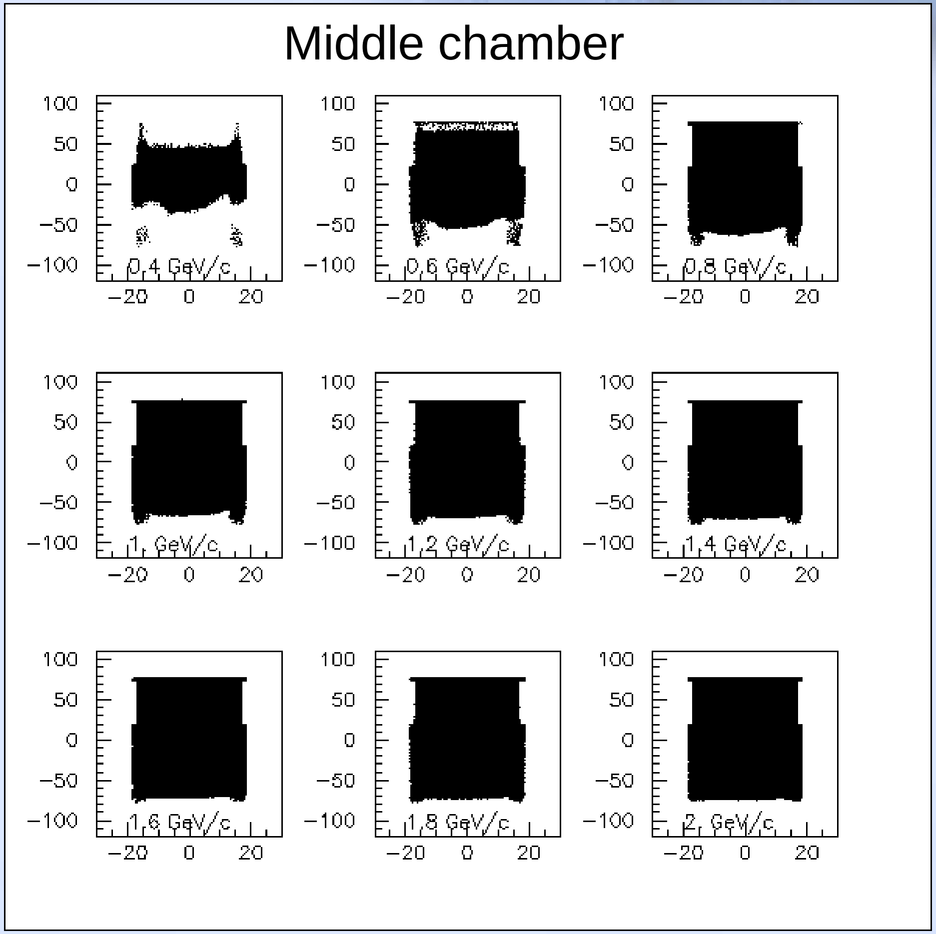
Standard Transversity configuration

- Two wire chambers (one big and one small) are in front of gas cerenkov, one large chamber are on the back of gas cerenkov.



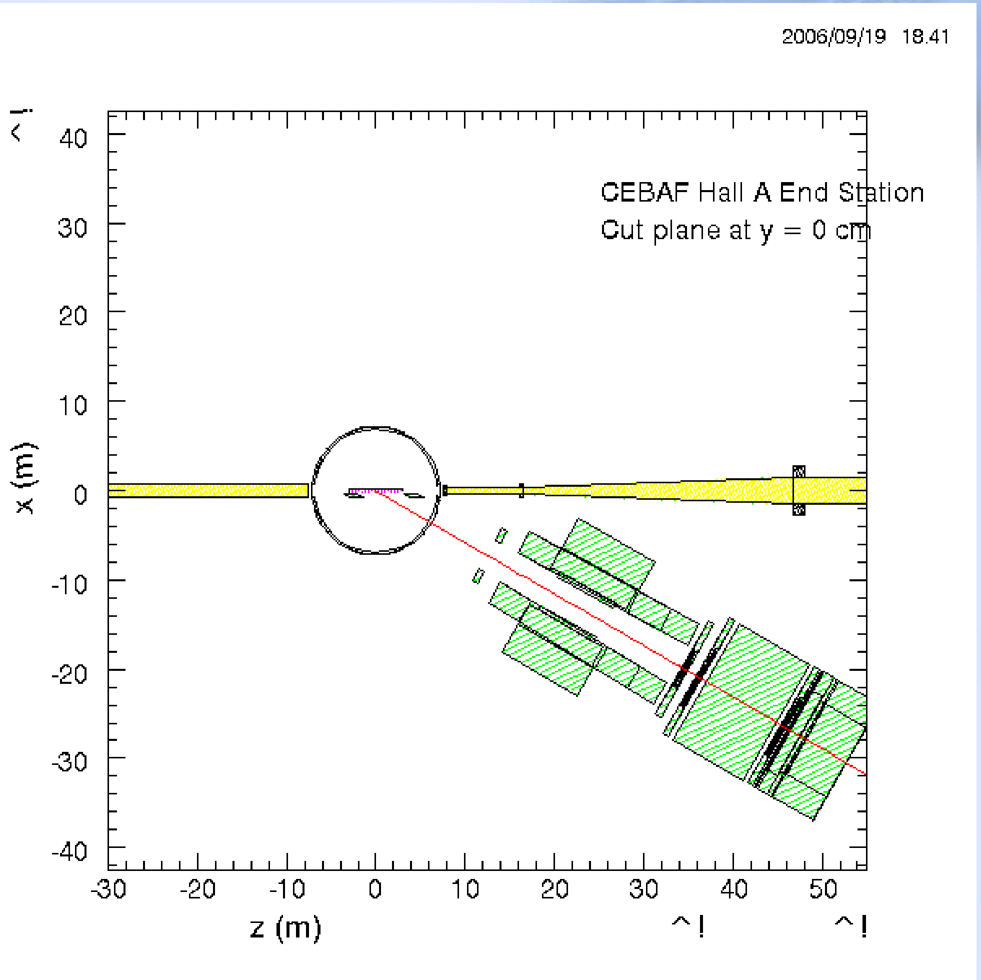
Standard Transversity configuration

- 0.6 GeV/c: 52.7 msr
- 1.2 GeV/c: 64.9 msr
- 1.8 GeV/c: 65.4 msr
- Lose 1-6% solid angle compared with "GEN" configuration.
- Acceptance in middle chamber.



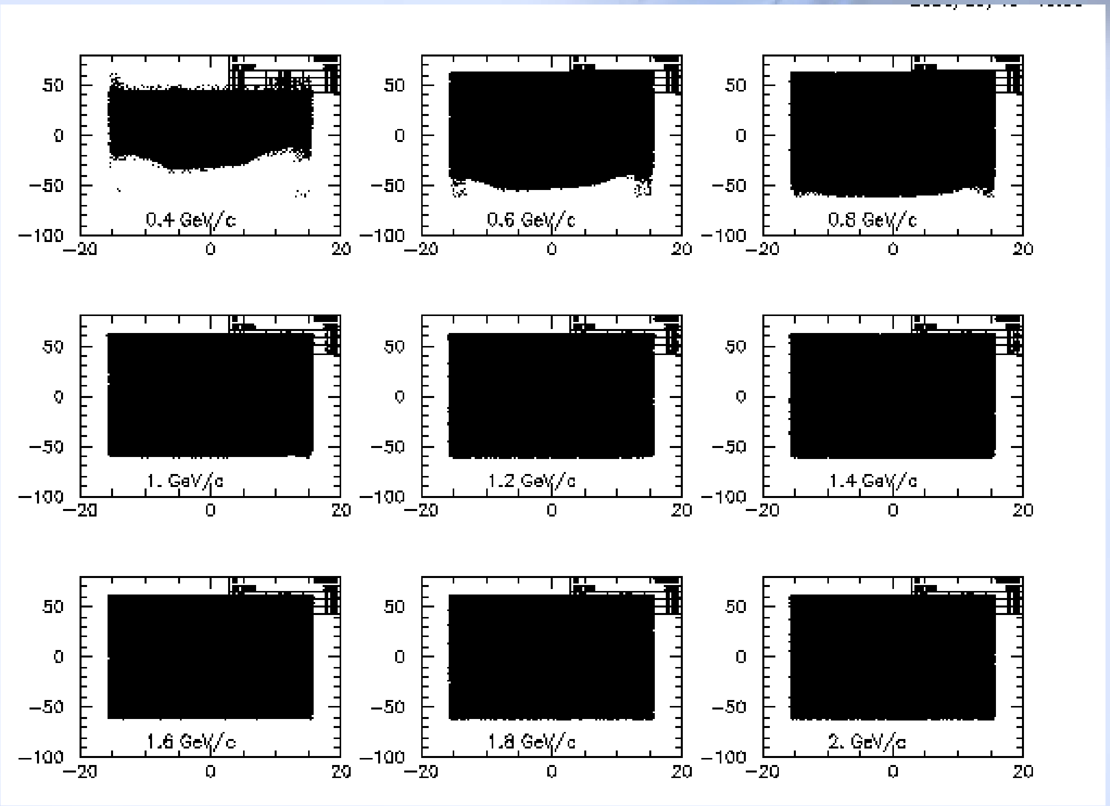
Disaster-1

- If small wire chamber is broken during the experiment, we have to use Hall-C chamber to replace it.



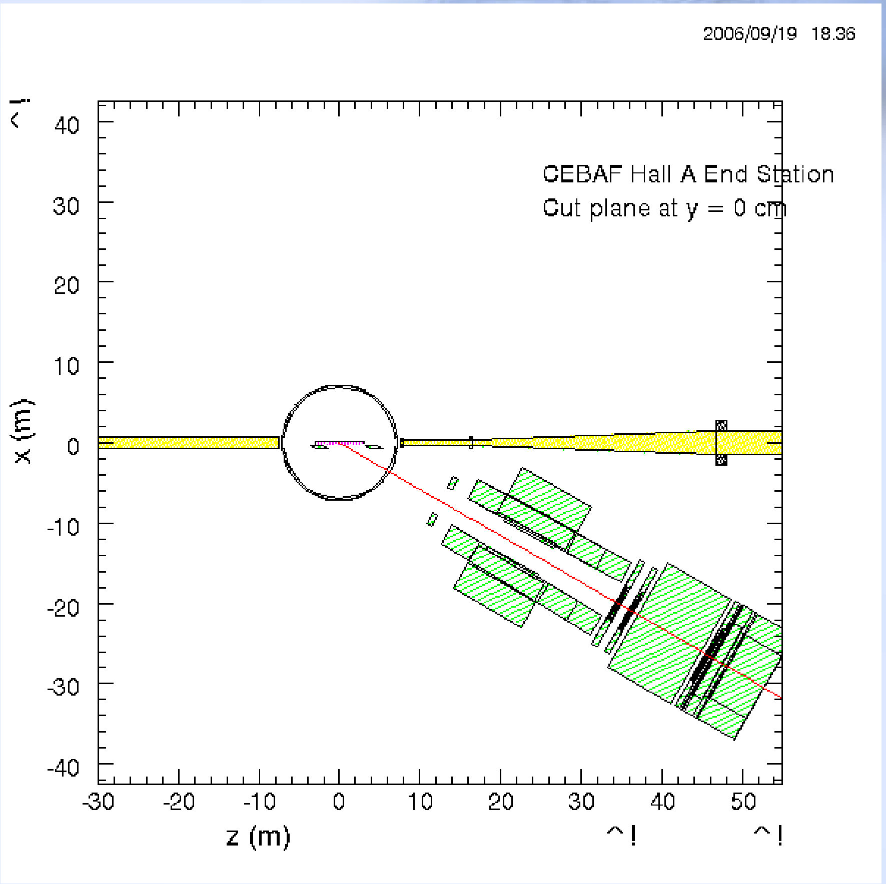
Disaster-1

- 0.6 GeV/c: 48.8 msr
- 1.2 GeV/c: 51.1 msr
- 1.8 GeV/c: 50.2 msr
- Lose 8 – 23 % acceptance compared with standard configuration



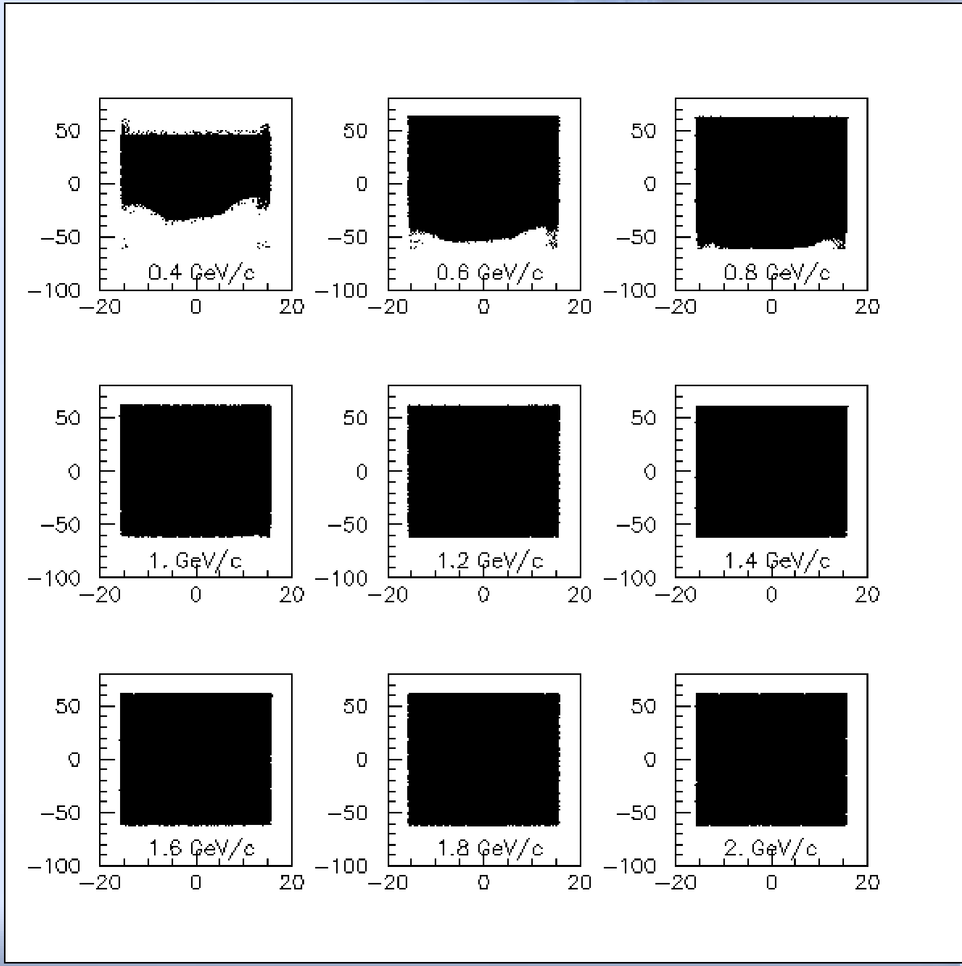
Disaster-2

- If one of the large chambers is broken, we will move the remaining large chamber behind the gas cerenkov, put the Hall-C chamber in the front, then small chamber.



Disaster-2

- 0.6 GeV/c: 48.7 msr
- 1.2 GeV/c: 51.1 msr
- 1.8 GeV/c: 50.3 msr
- Lose 8-23 % solid angle compared with standard situation.



Conclusion

- Adding Gas-cerenkov will lose 1-6 % solid angle compared with "GEN" configuration.
  - Small effect.
- Disaster situation will lose 8-23% solid angle
- Shielding can be put in front of the middle chamber according to acceptance plot to reduce background rates.
- In the disaster situation, the solid angle are defined by the shower counter and first wire chamber.
- In the normal situation, the BigBite magnet hole may contribute.
- Thanks Xiaodong and Jian-Ping for discussions.