Performance of the BigBite Detector During the Neutron Transversity Experiment in Hall-A

Kalyan Allada

Department of Physics and Astronomy
University of Kentucky, Lexington, KY, 40506

May 3rd, 2009
APS April Meeting, Denver, CO

On behalf of the JLab Hall-A Transversity(E06-010) Collabration.

Spokespersons : Xiaodong Jiang(LANL), Jian-ping Chen(JLab), Evaristo Cisbani(INFN, Rome), Haiyan Gao(Duke), Jen-chieh Peng (UIUC)

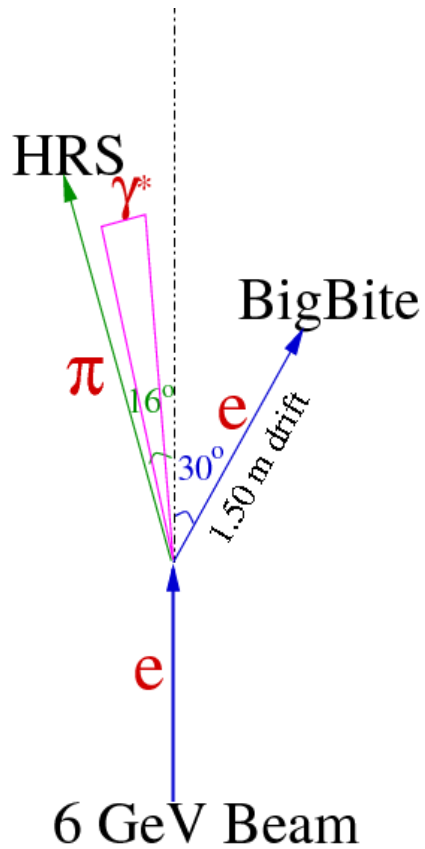
Thesis Students : K.Allada(Kentucky), C.Dutta(Kentucky), J.Huang(MIT), J.Katich(W&M), X.Qian(Duke), Y.Wang(UIUC), Y.Zhang(Lanzhou Univ)

Hall-A E06-010 Experiment at Jefferson Lab

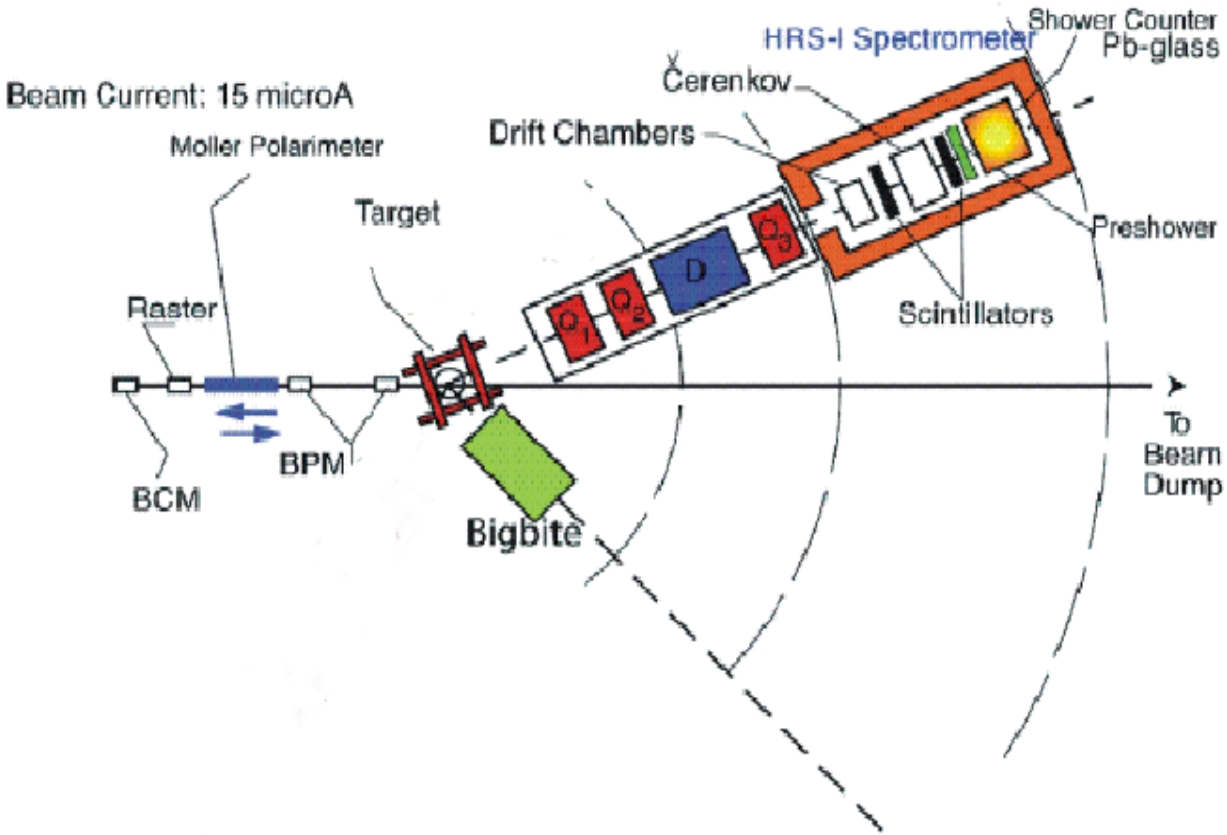
Run Period : Oct 2008 to Feb 2009

Goal: To measure the single target-spin asymmetries in semi-inclusive $n^{\uparrow}(e,e'\pi^{+/-})$ DIS reaction on a transversely polarized ^{3}He target.

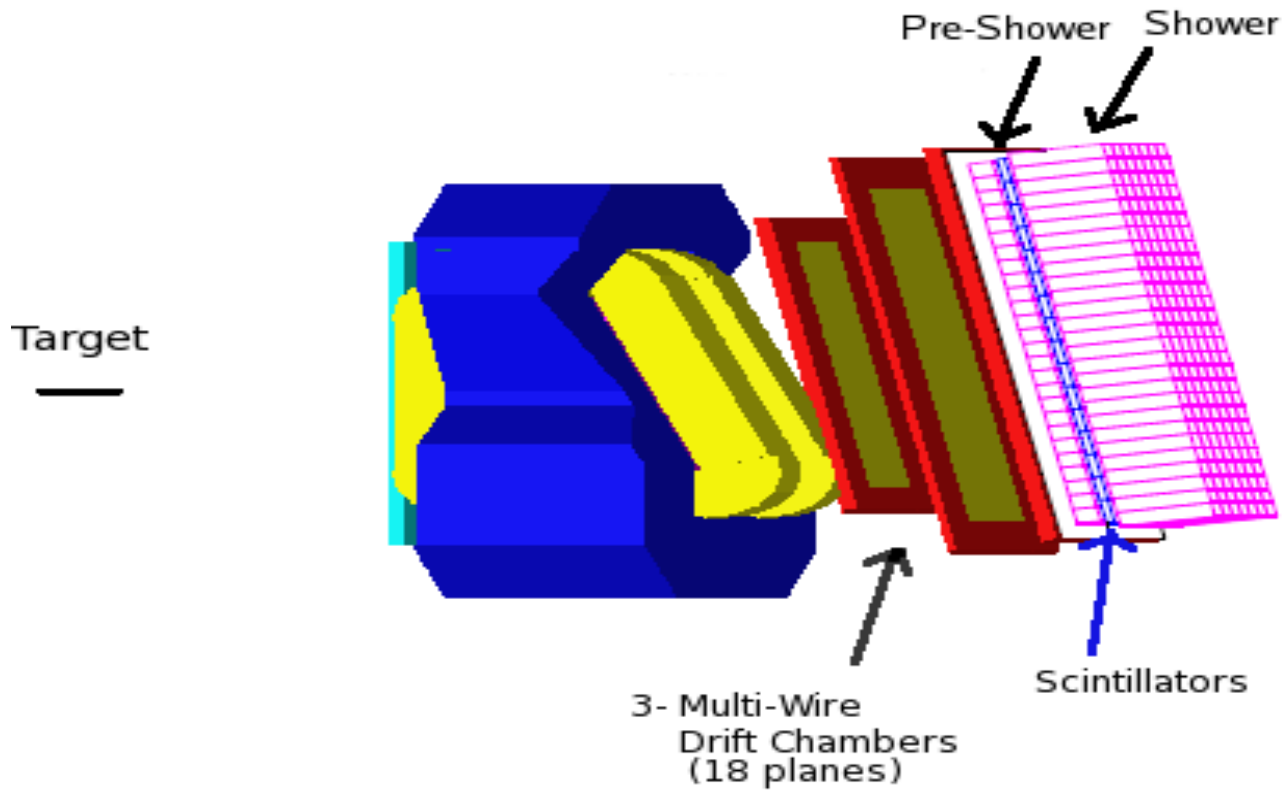
- Polarized ^{3}He gas target, 10atm pressure, polarization 65%.
- High Luminosity $\mathcal{L} = 10^{36}$ cm^{-2} s^{-1}
- High Resolution Spectrometer for detecting $\pi^{+/-}$ or $K^{+/-}$ at 16^0, solid angle $\simeq$ 6msr, $p_h = 2.4$GeV/c.
- BigBite spectrometer at 30^0, used as electron-arm, larger acceptance $\Delta\Omega$ $\simeq$ 64msr.



Experiment Setup in Hall-A

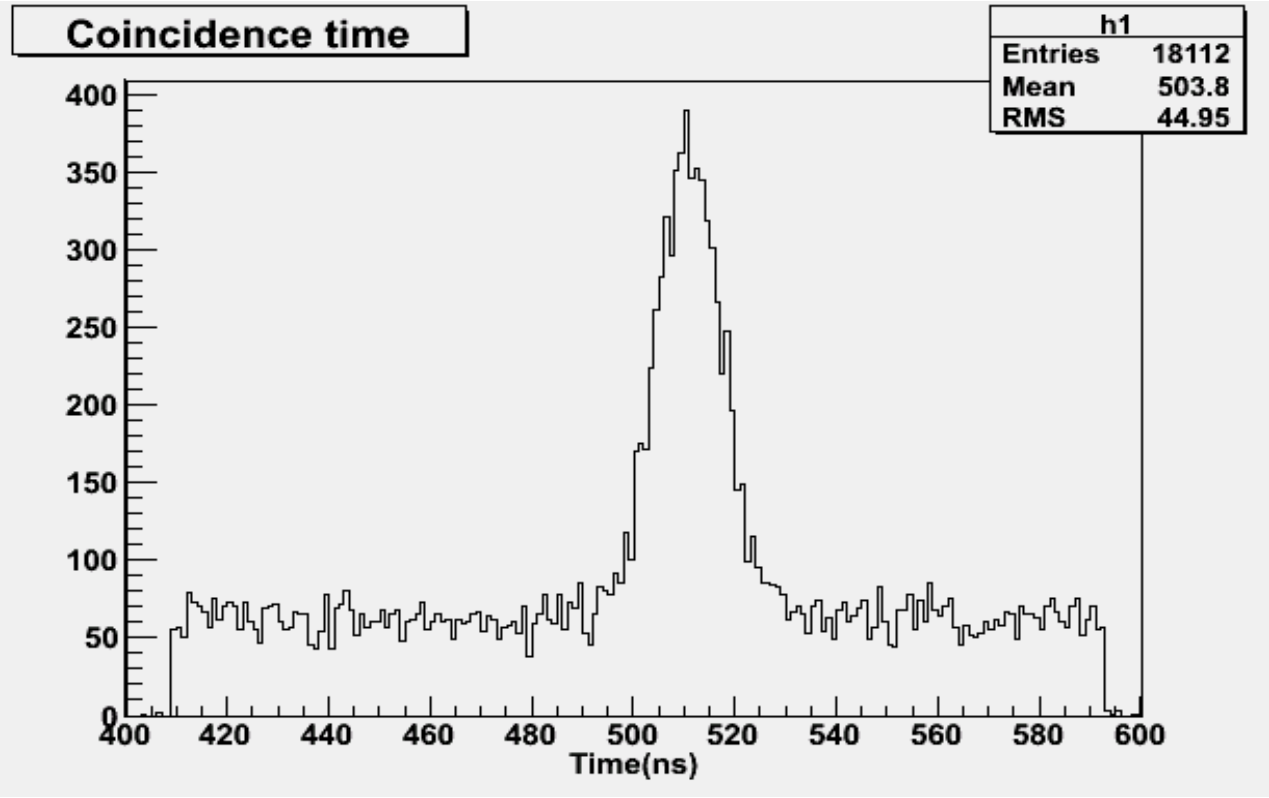


BigBite Spectrometer as e- Arm



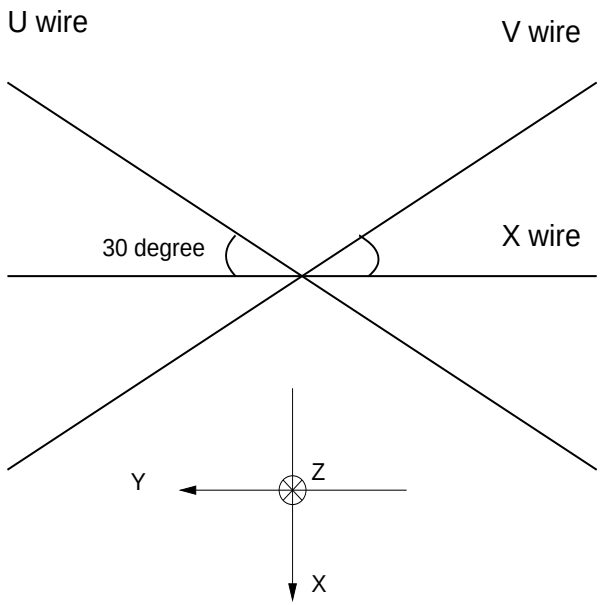
Coincidence Trigger Setup

- Coincidence between High Resolution Spectrometer($\pi^{+/-}$/$K^{+/-}$) and the BigBite detector (e^{-}).
- **Trigger in HRS** : Coincidence between two scintillator planes.
- **Trigger in BigBite** : Sum of two layers of pre-shower and shower blocks.
- Raw coincidence time (online).



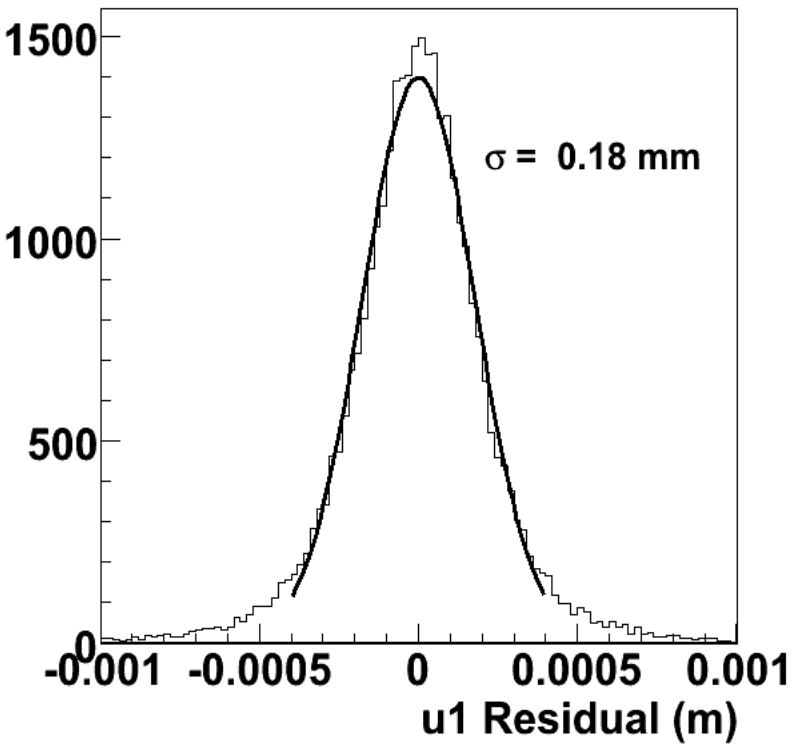
Multi-Wire Drift Chambers (MWDC)

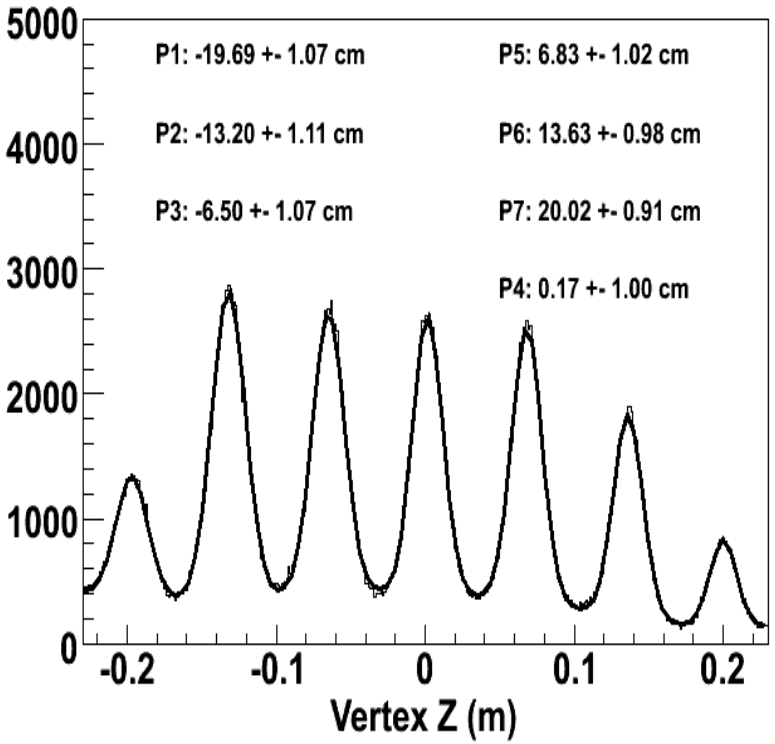
- Determine momentum of the scattered particle by reconstructing the track.
- Three types of wire planes, X, U, and V gives the ability to resolve track in 3D.
- Consists of 3 drift chambers, 18 wire planes in total, require at least 15 for finding a track.



Multi-Wire Drift Chamber Performance

- Measure of the "quality-of-fit" to track is given by the **residual** : (position of the fit track - the predicted position) $\simeq 180\mu$m.
- Vertex reconstruction using carbon-foil target.

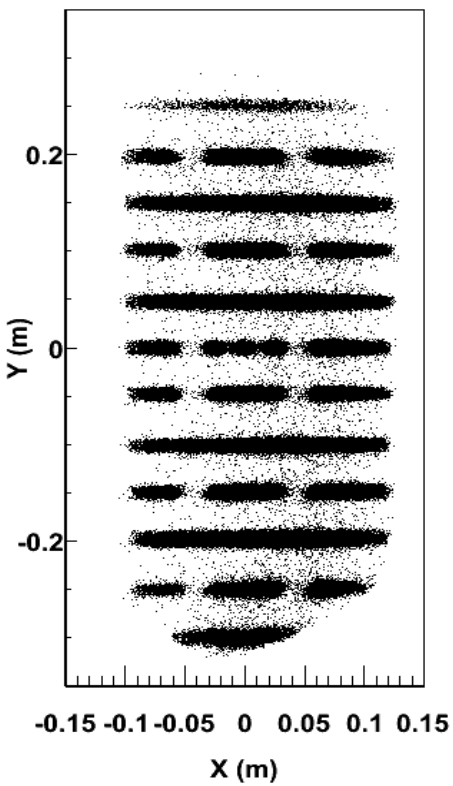




(plots by Xin Qian)

Multi-Wire Drift Chamber Performance - Sieve Plate Reconstruction

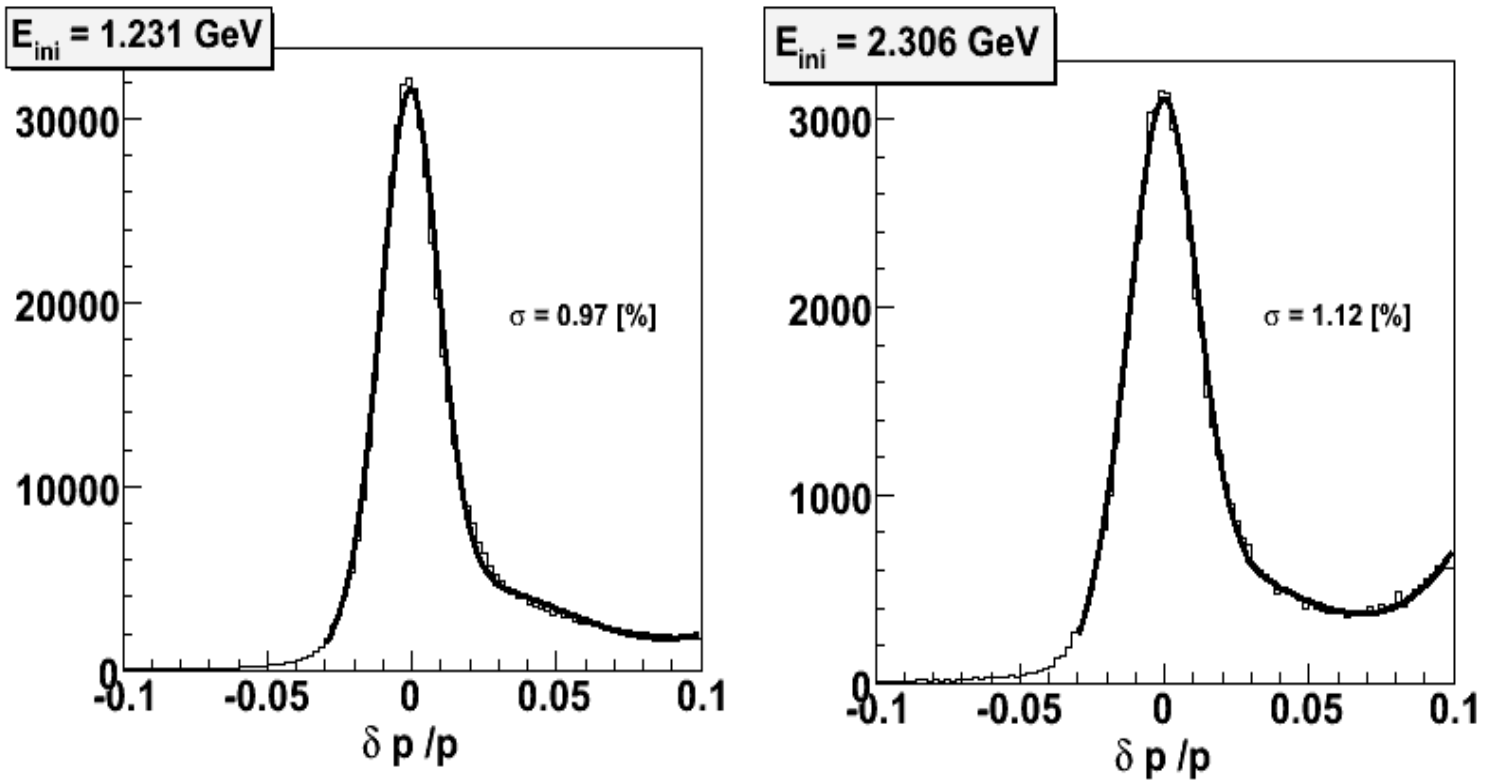
- 1.5 inch lead sieve-plate in front of the BigBite spectrometer.
- Good reconstruction of the sieve pattern.



(plot by Xin Qian)

Multi-Wire Drift Chambers Performance - Momentum

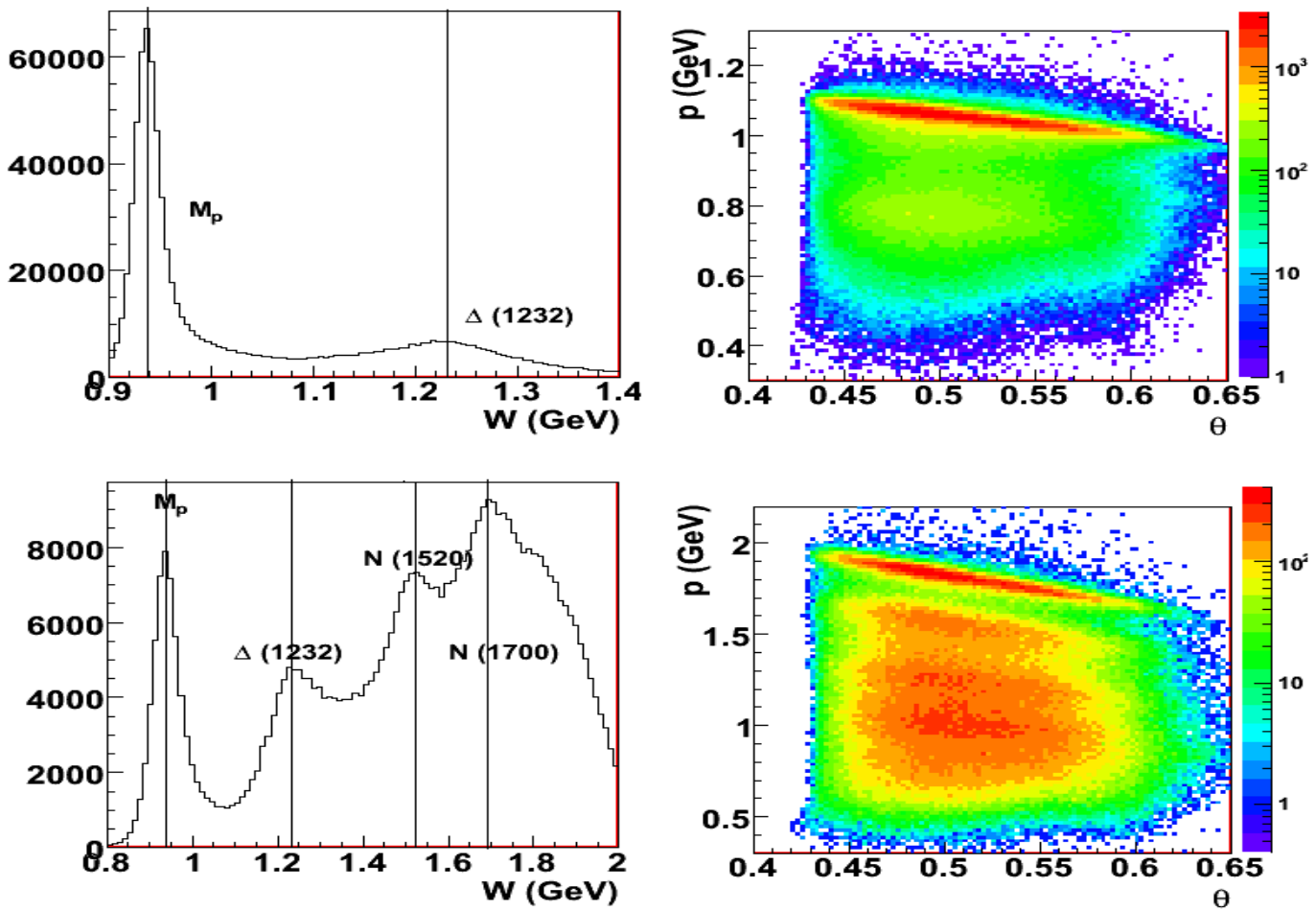
- Momentum of the scattered electron in H(e,e')p elastic reaction depends only on the scattered angle(ϕ_{scat}).
- Momentum resolution $\frac{\delta p}{p} \simeq 1\%$.



(plot by Xin Qian)

Multi-Wire Drift Chambers Performance cont..

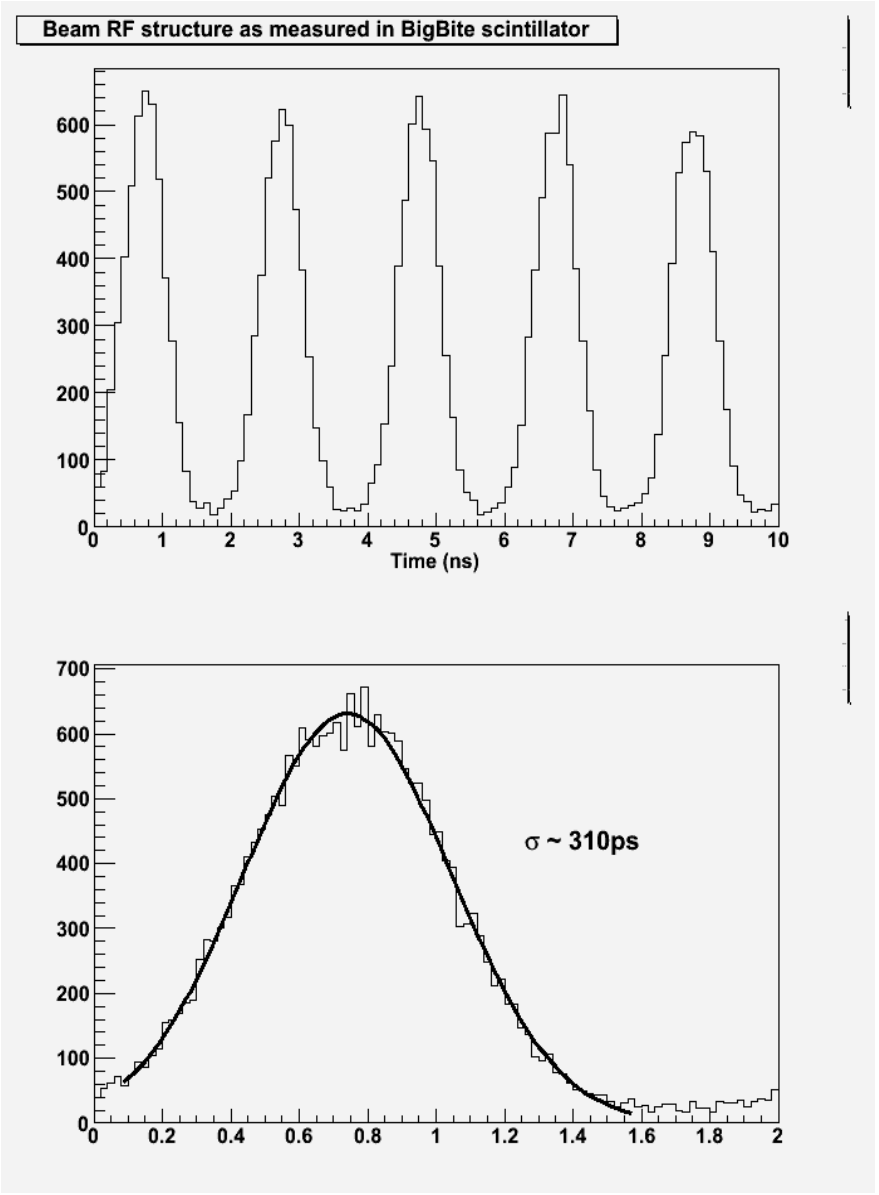
- Invariant mass spectrum and momentum vs scattering angle (ϕ_{scat}) is shown below for two different E', at E_{ini}=1.23GeV and E_{ini}=2.306GeV.



(plot by Xin Qian)

BigBite Scintillator Plane - Timing

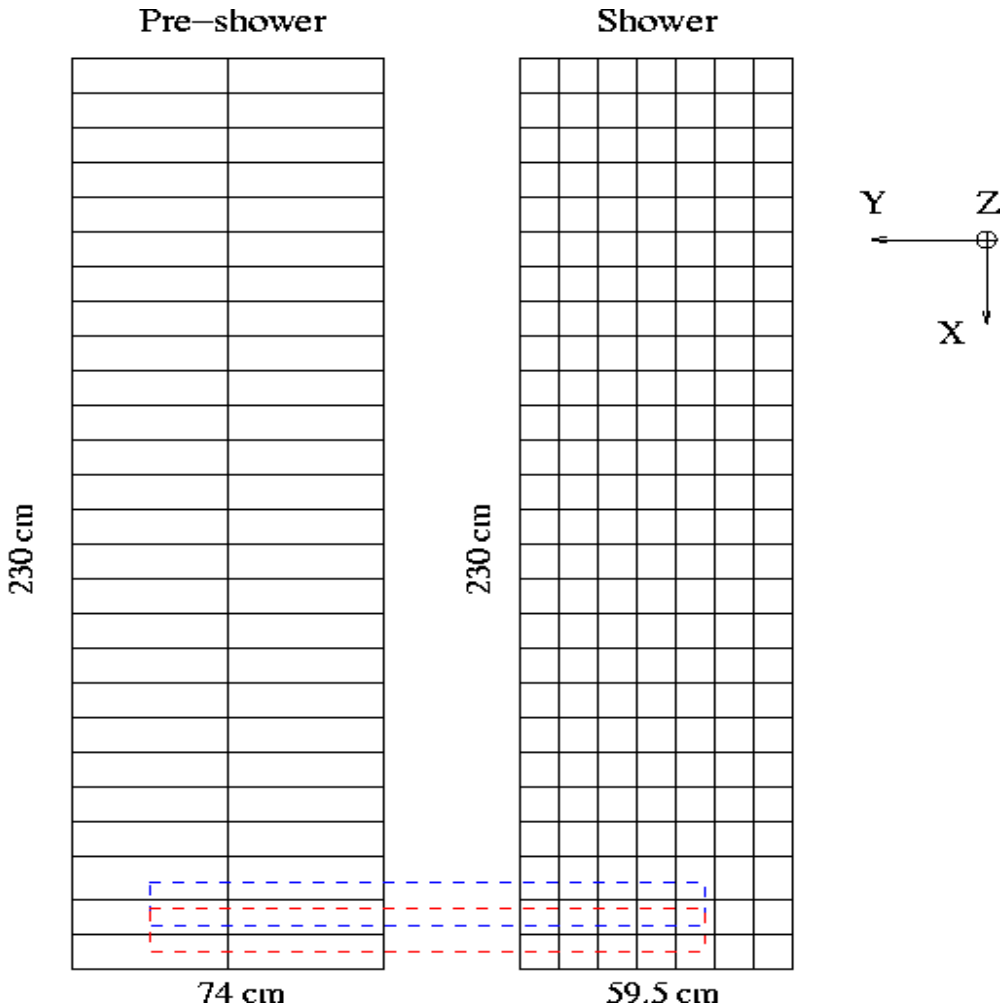
- Provides timing information, used in the coincidence time of flight measurement.
- Coincidence TOF provides another handle on PID in hadron arm.
- Consists of 13 bars with two PMTs on each side.
- Good timing resolution $\sigma = 310$ps.



(plot by Jin Huang)

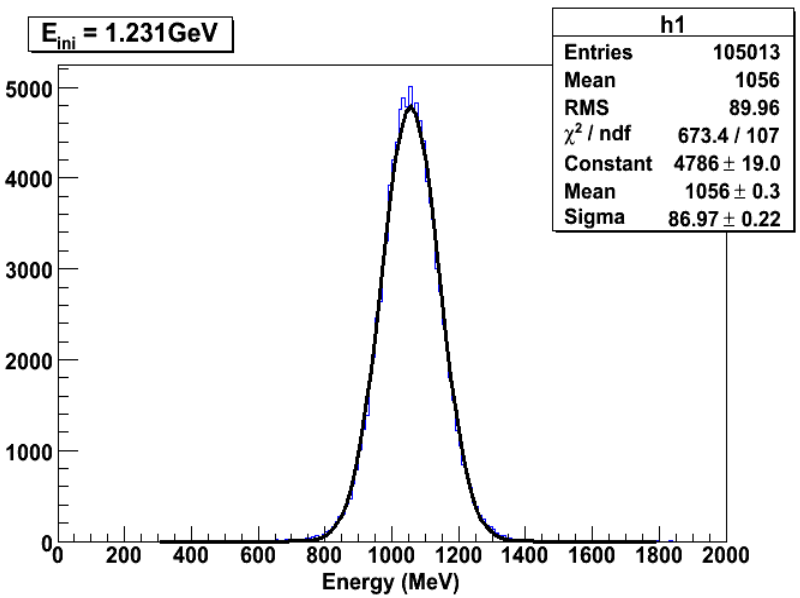
Pre-shower and Shower Detector

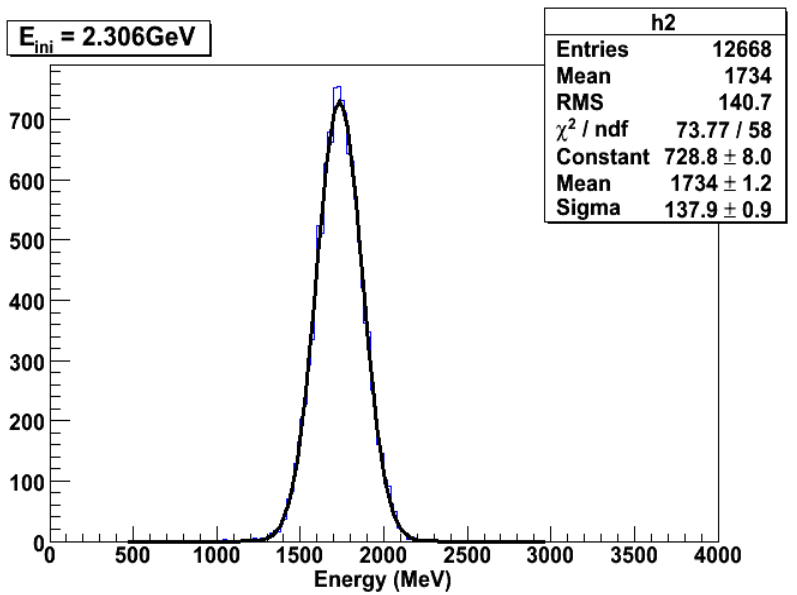
- PID for separating pions and electrons in the BigBite spectrometer.
- Two sets of lead-glass detectors, pre-shower and shower.
- 2x27 pre-shower blocks and 7x27 shower blocks.
- Size of each block: 8.5x8.5x37 cm.
- Provides good trigger for the electrons.
- Exploits the difference in energy deposition in each layer for pions and electrons to identify the particle.



Pre-shower and Shower Detector - Calibration

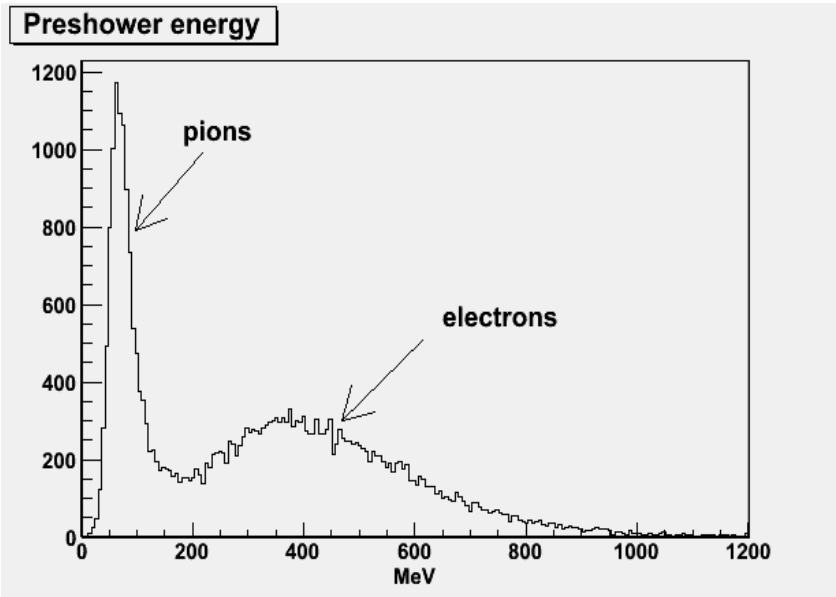
- Calibrate to known energy of the scattered electron using H(e,e')p elastic reaction.
- Energy reconstructed in the calorimeter, resolution about 8%.

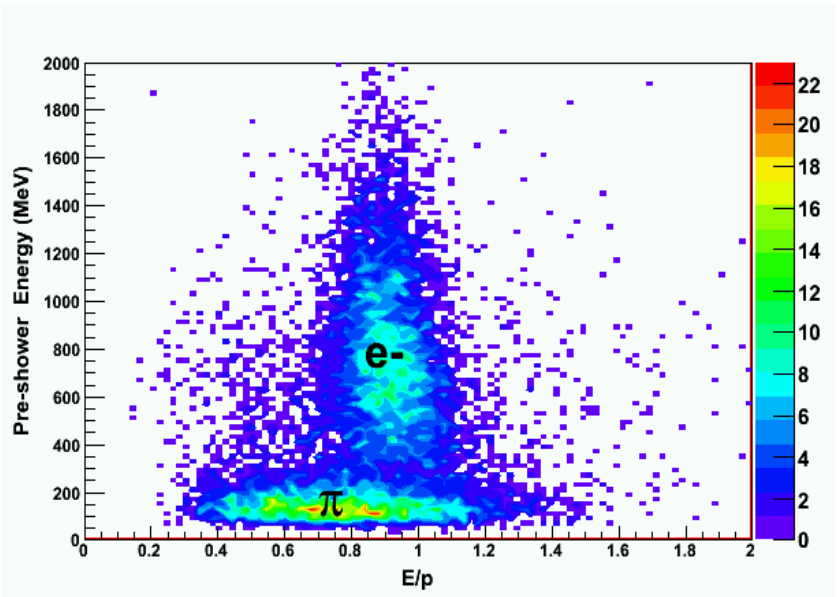




Pre-shower and Shower Detector - Particle Identification

- Well separated pions and electrons.





Summary

- Finished taking data in Feb. 2009.
- The BigBite spectrometer worked well as an electron arm.
- Achieved 1% momentum resolution through tracking.
- Timing resolution(310ps) in the scintillator is good enough to resolve 2ns beam RF structure.
- Lead-glass detector provided a good particle identification for $\pi^-/e^-$and provided trigger.
- Major part of the calibrations for the BigBite detectors has been completed.
- Working on the coincidence time of flight, which gives another handle on PID for the hadron arm.
- Hope to finish all the calibrations in few months.

Thanks to the Hall-A E06-010 collaboration