d_2^n

A Probe of the Color Force

On Behalf of the E06014 Collaboration
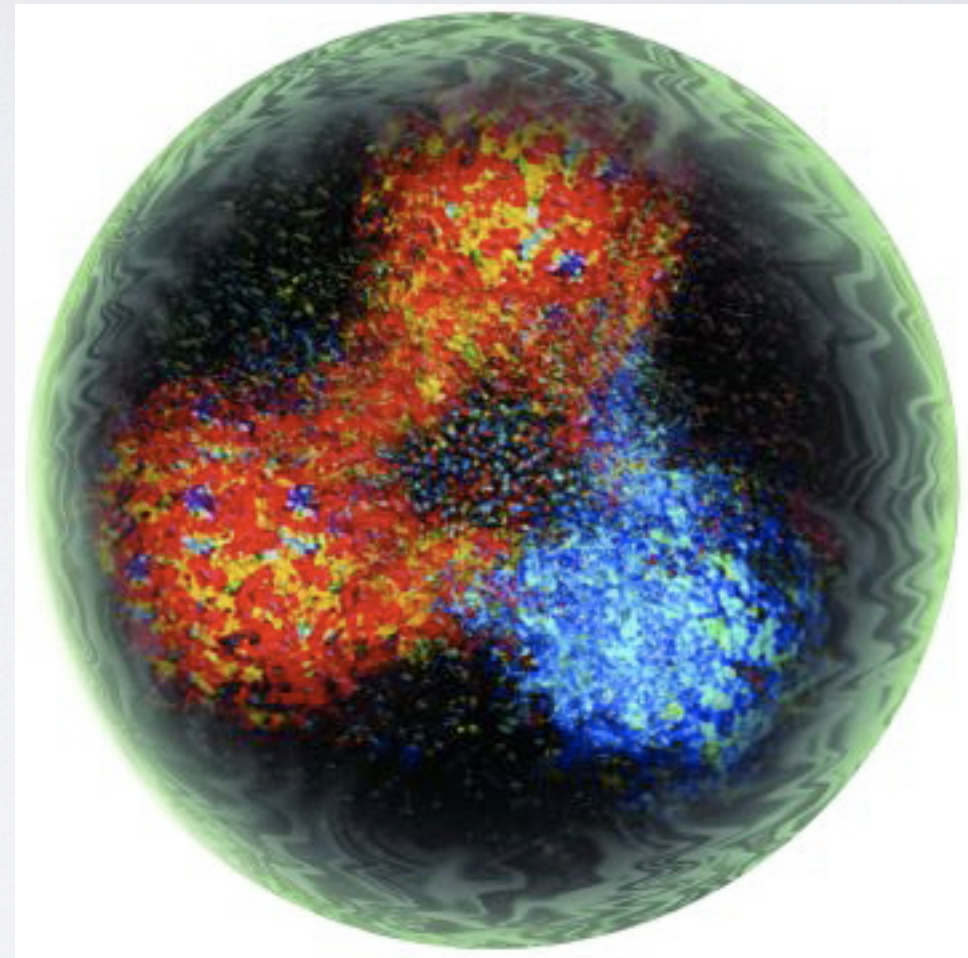
Hall A Collaboration Meeting
09 December 2010

Matthew Posik

Temple University

Graduate Students: David Flay (Temple), Diana Parno (CMU)

OUTLINE

- **What d_2^n is**

- **Experimental Set-Up**

- **LHRS**

- **BigBite**

  - Optics

  - MWDC

  - Cherenkov

Probing QCD Through Color

- d_2^n gives access to quark-gluon correlations

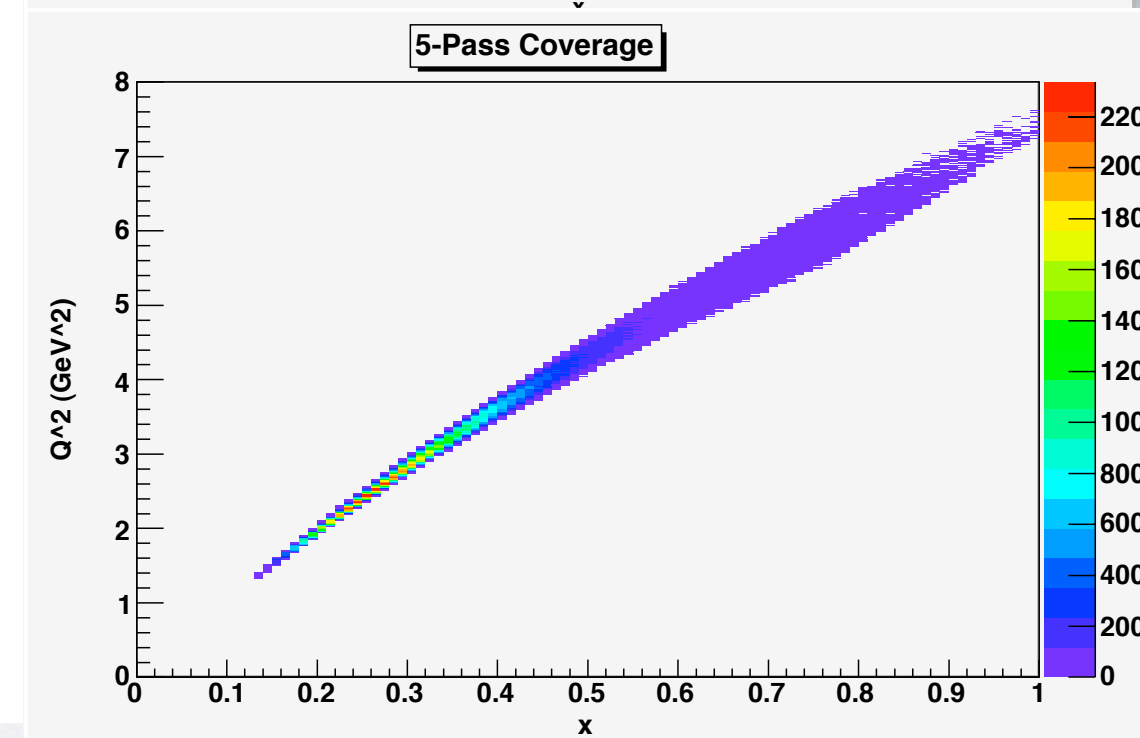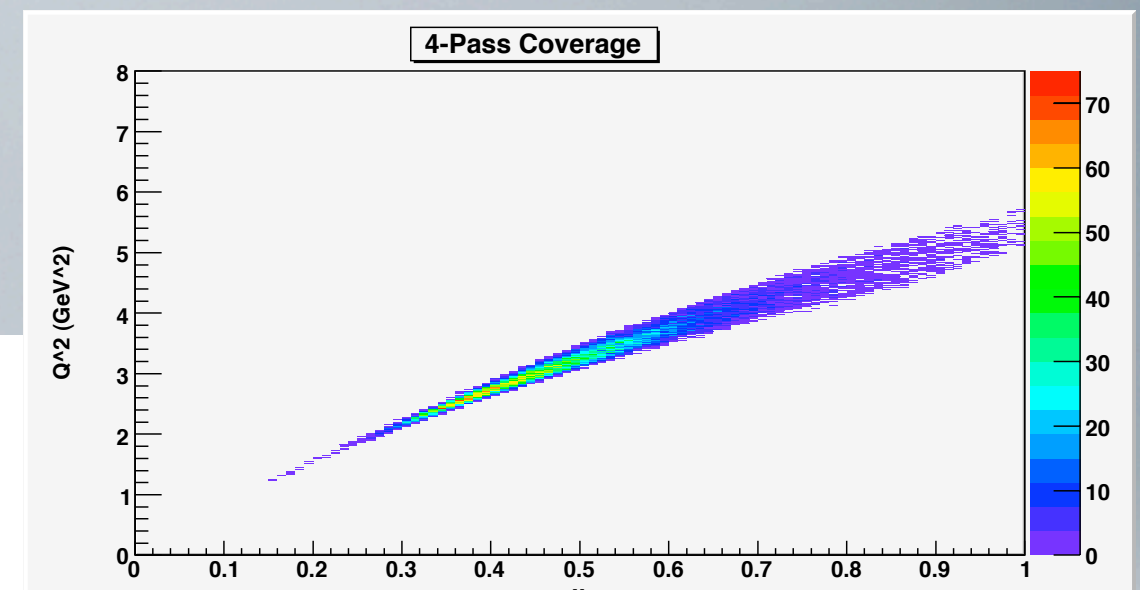$$d_2^n = \int_0^1 x^2 [2g_1^n(x, Q^2) + 3g_2^n(x, Q^2)]dx$$
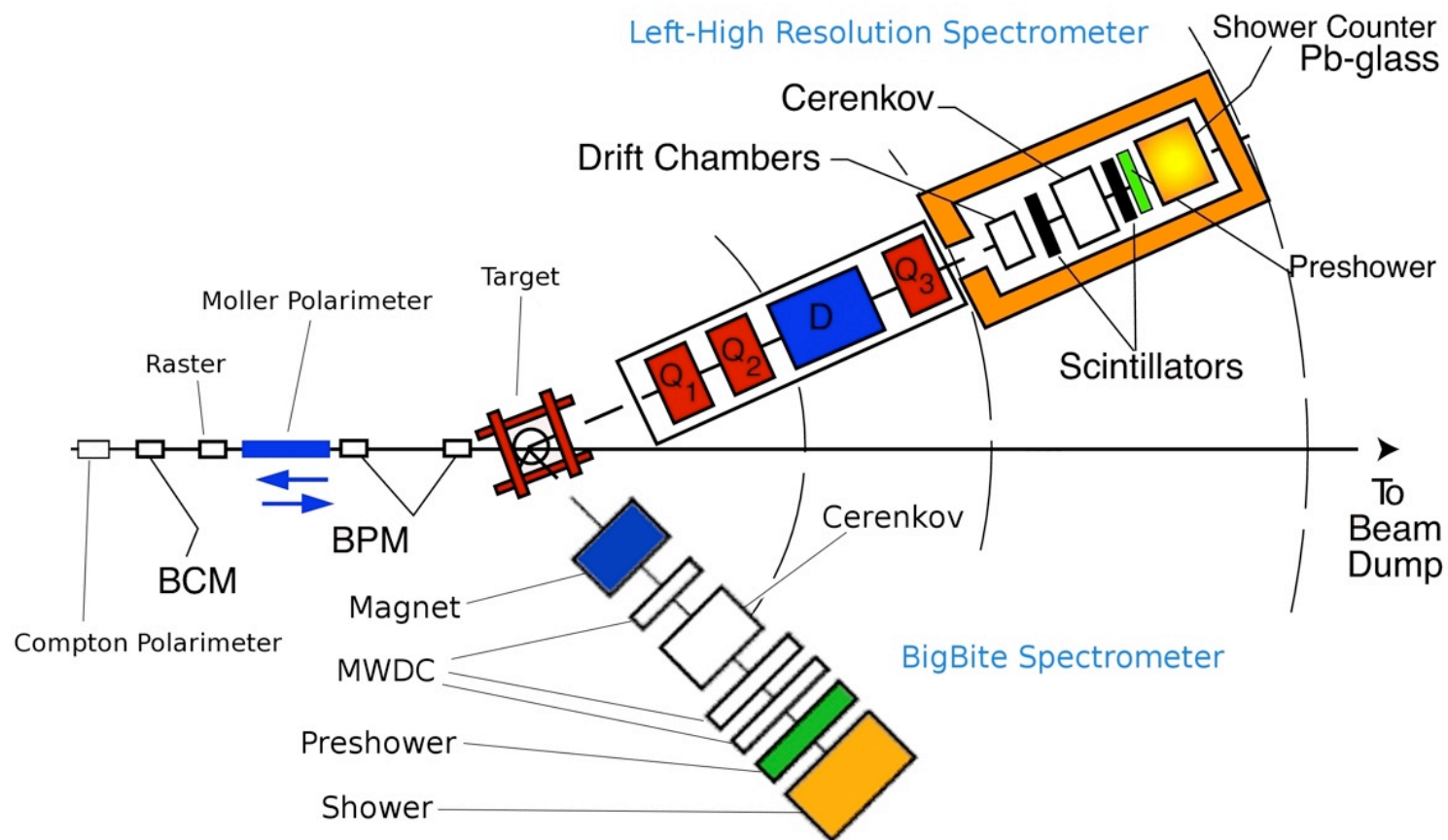
- How do we interpret d_2^n?

- Average transverse force on a quark just after interaction with a virtual photon (M. Burkardt)

Experimental Set-Up For E06014

- Scatter longitudinally polarized electron beam from a polarized He^3 target

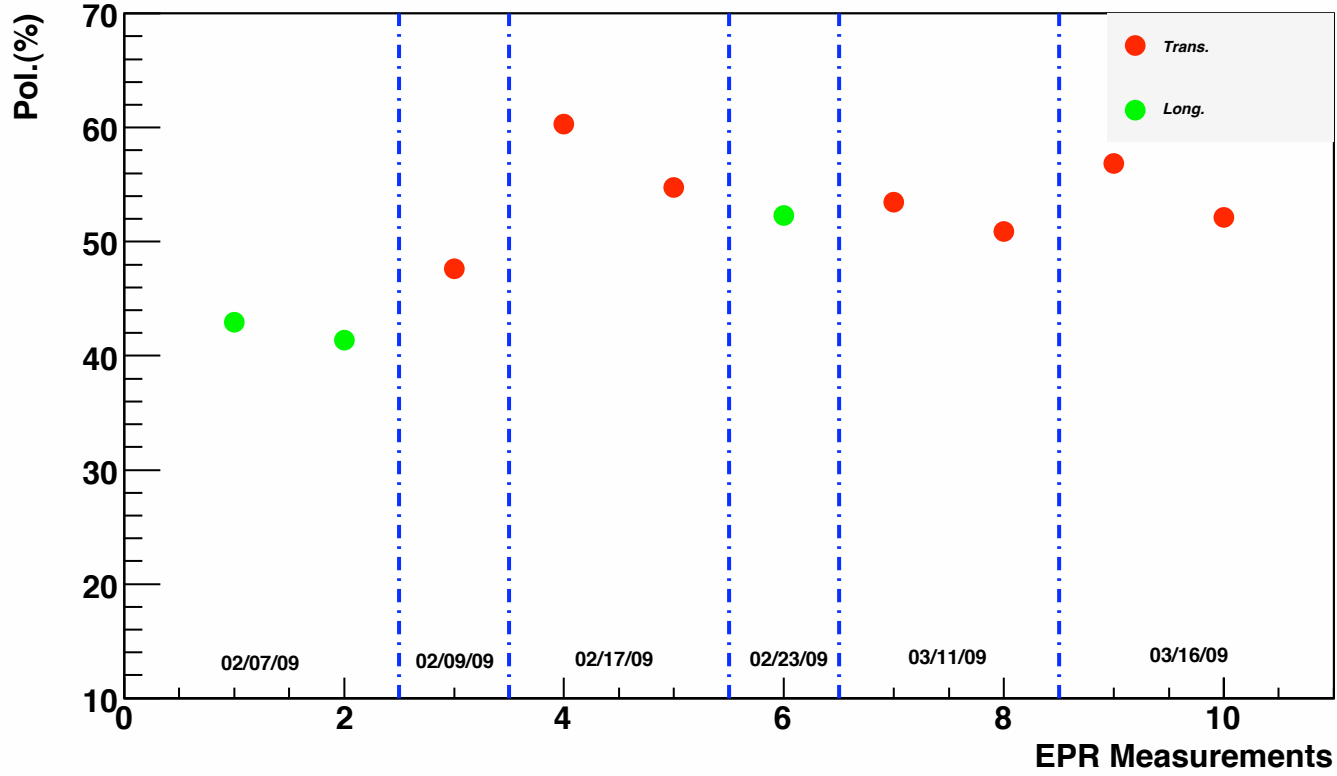- Change target directions to measure parallel and perpendicular asymmetries

$$0.2 < x < 0.7$$

$$2 < Q^2 < 6 \text{ GeV}^2$$
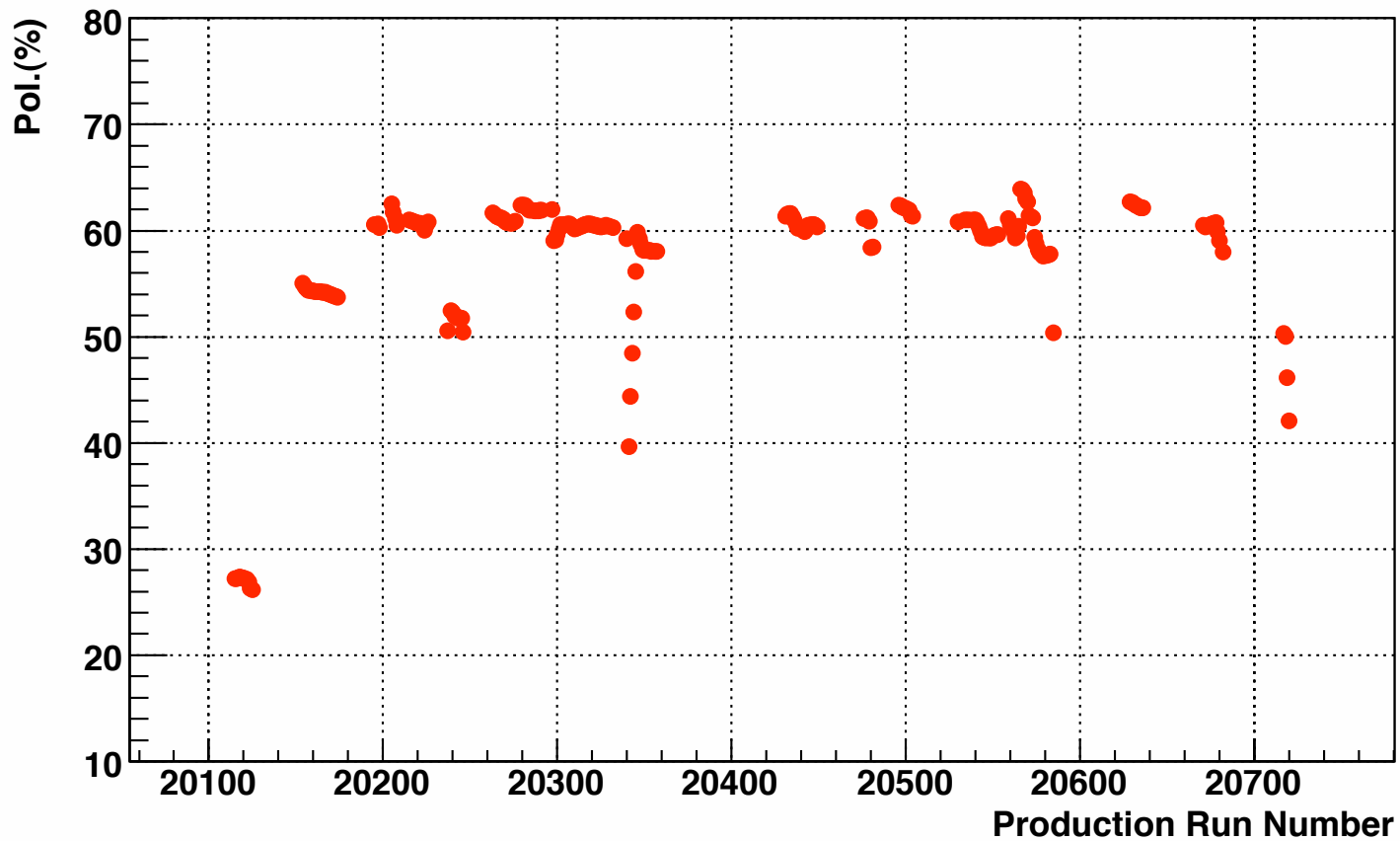
Target Polarization

EPR Polarization Summary for D2n

- Trans.
- Long.

02/07/09   02/09/09   02/17/09   02/23/09   03/11/09   03/16/09

Pol.(%)

EPR Measurements

Samantha(Spread to Run by Run)

Pol.(%)
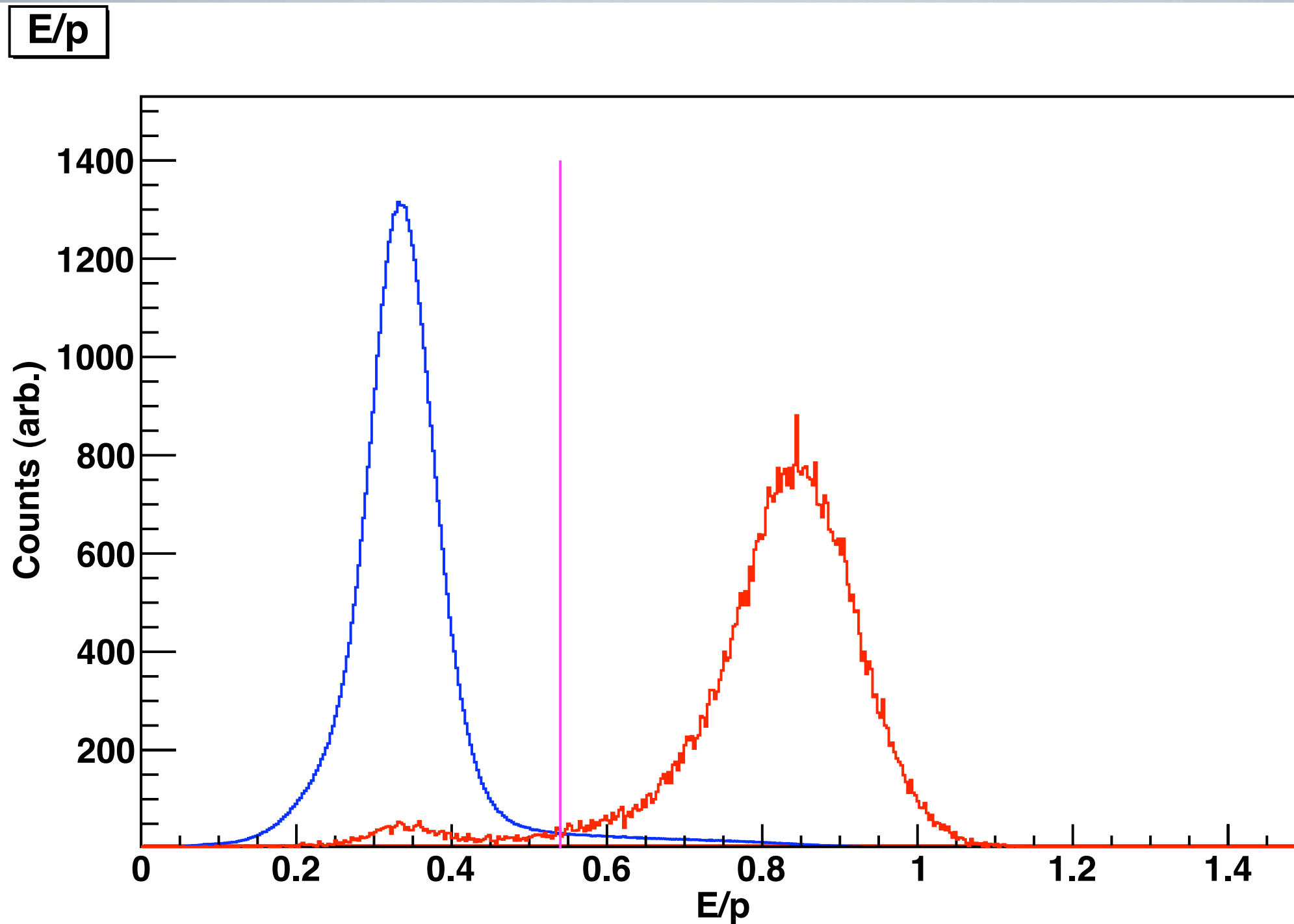
Production Run Number

LHRS: Pion Rejector

- Pion Rejection: 680
- Electron efficiency: 99%

LHRS: Cherenkov

● Pion Rejection: 600   ● Electron Efficiency: 96%

Gas Cherenkov ADC Sum

BigBite Negative Optics

Negative Sieve Reconstruction
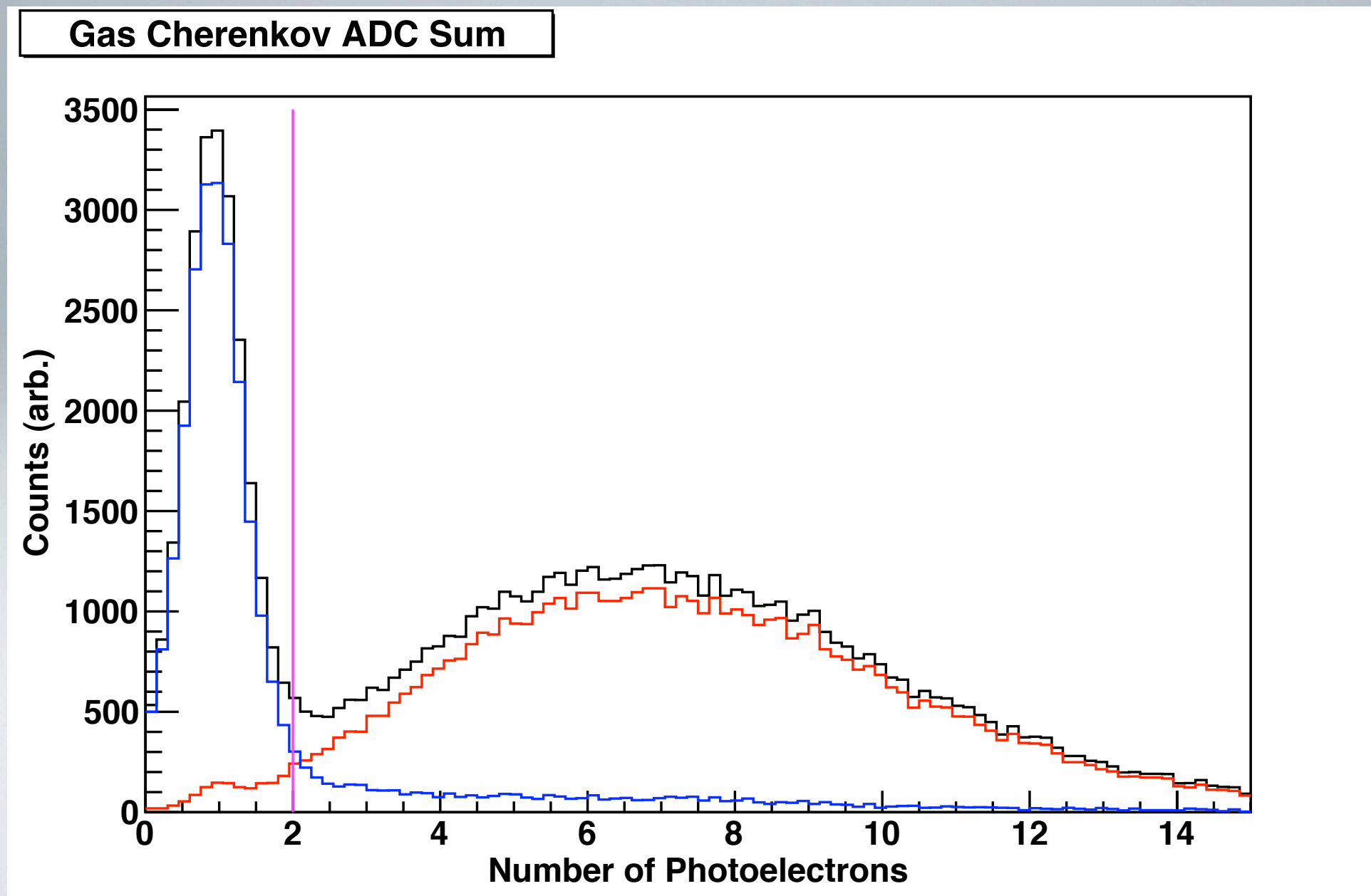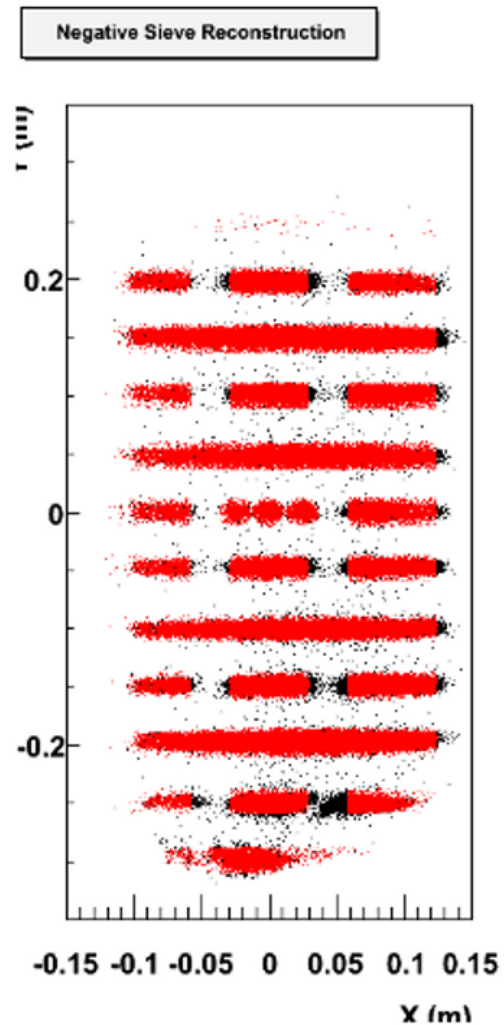
1-Pass Carbon

- Majority of optics done by Xin during Transversity

- Vertex resolution at centimeter level

P1: -0.1309 +- 0.0095 m   P3: 0.0010 +- 0.0090 m

P2: -0.0648 +- 0.0101 m   P4: 0.0669 +- 0.0084 m

P5: 0.1342 +- 0.0087 m

BB.tr.vz
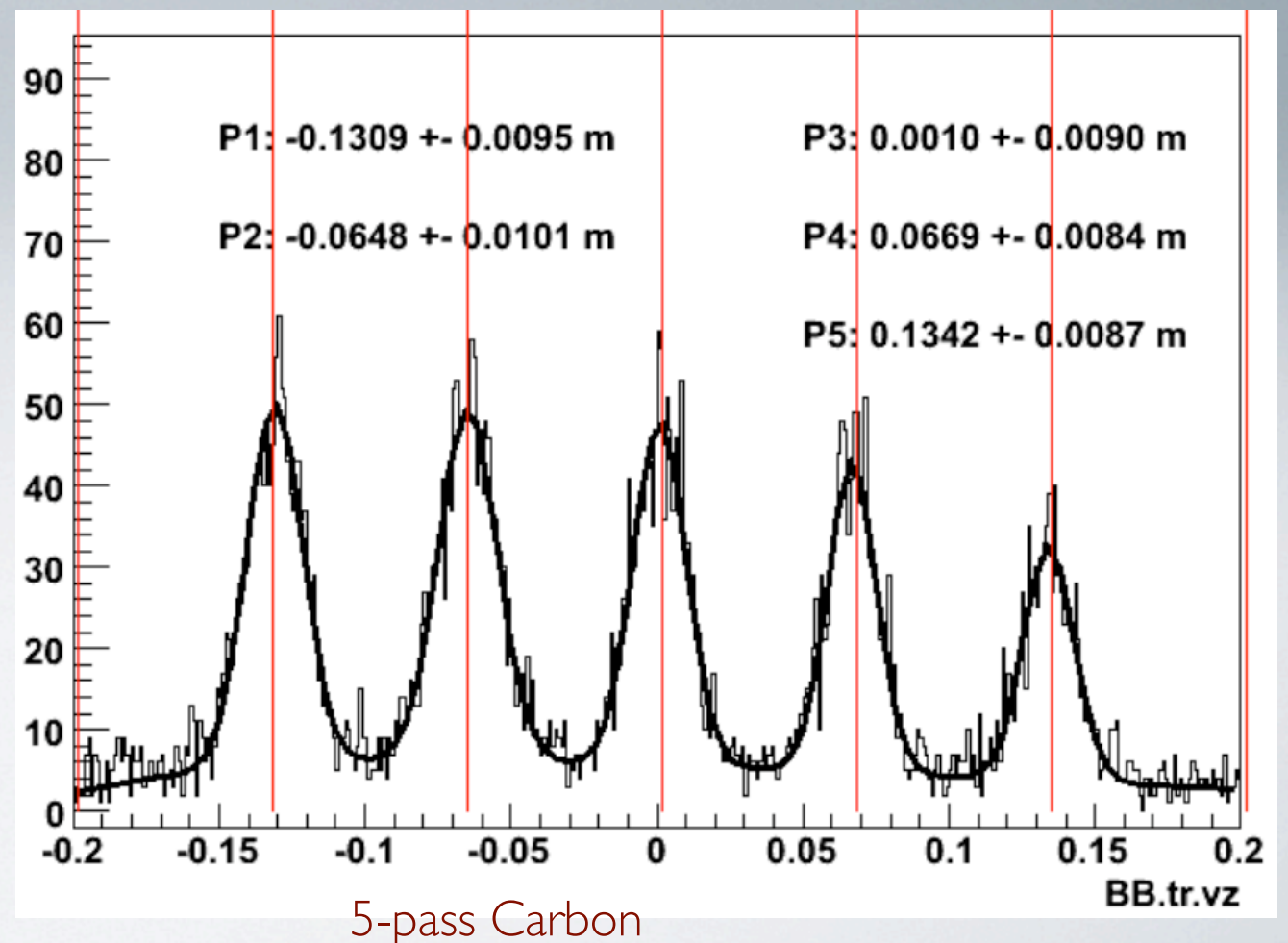
5-pass Carbon

BigBite Negative Optics

Momentum Distribution

- Original Momentum Function
- Updated Momentum Function

1-pass Hydrogen

Momentum (GeV/c)
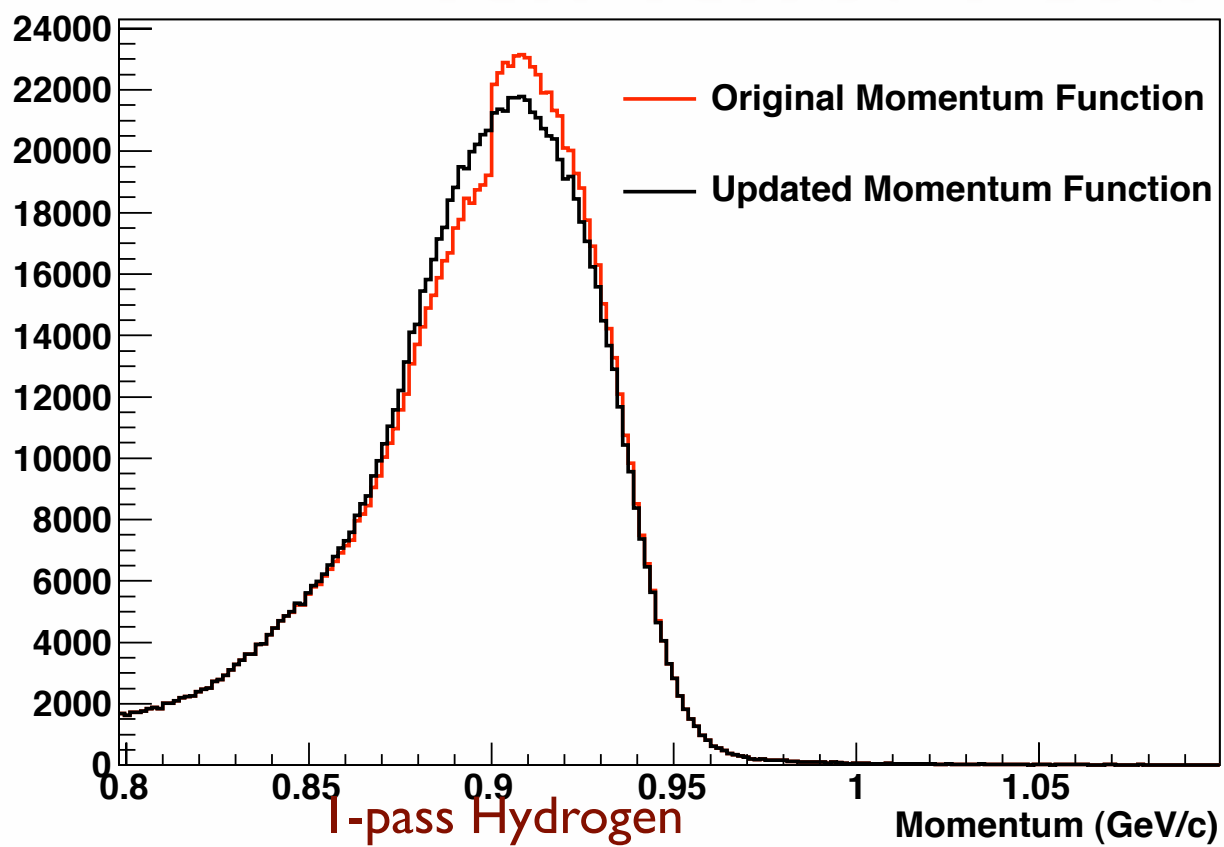
H_2 Elastic Scattering: Invariant Mass Spectrum

Invariant Mass (GeV/c^2)

$\delta p/p$

$\sigma=1.1\%$
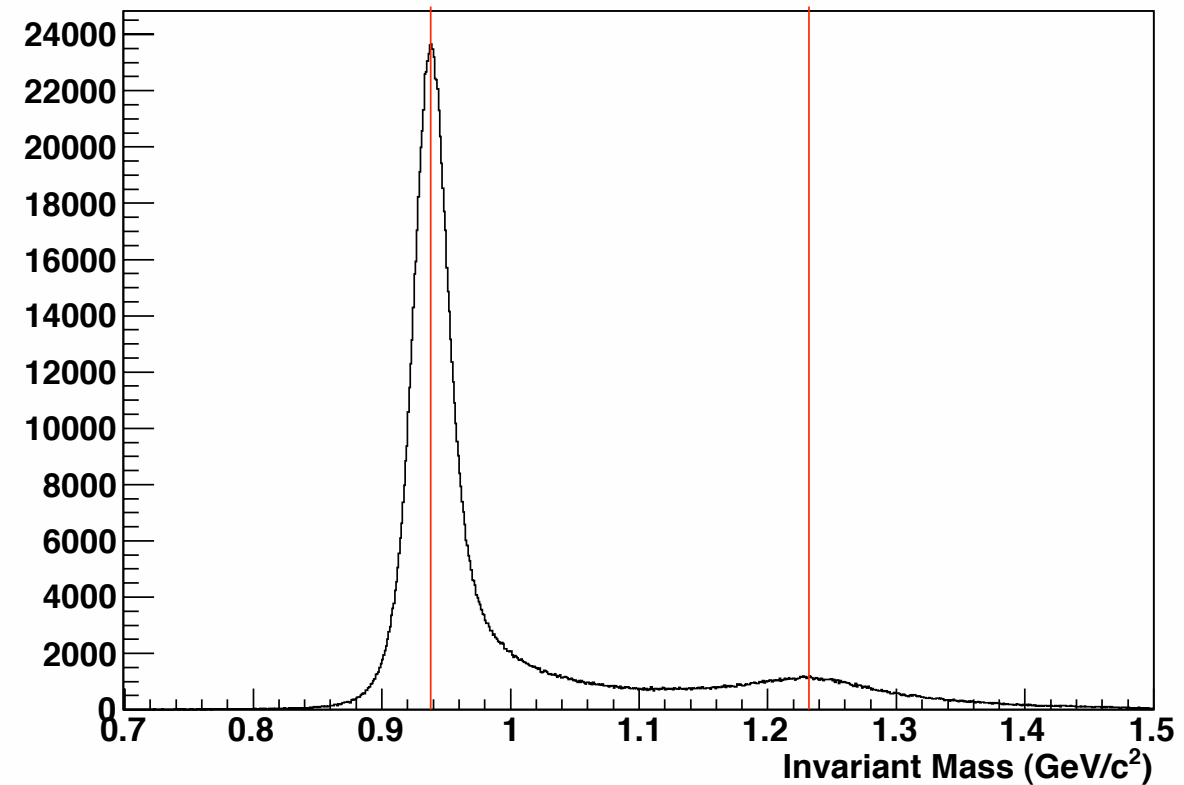
$\delta p/p$
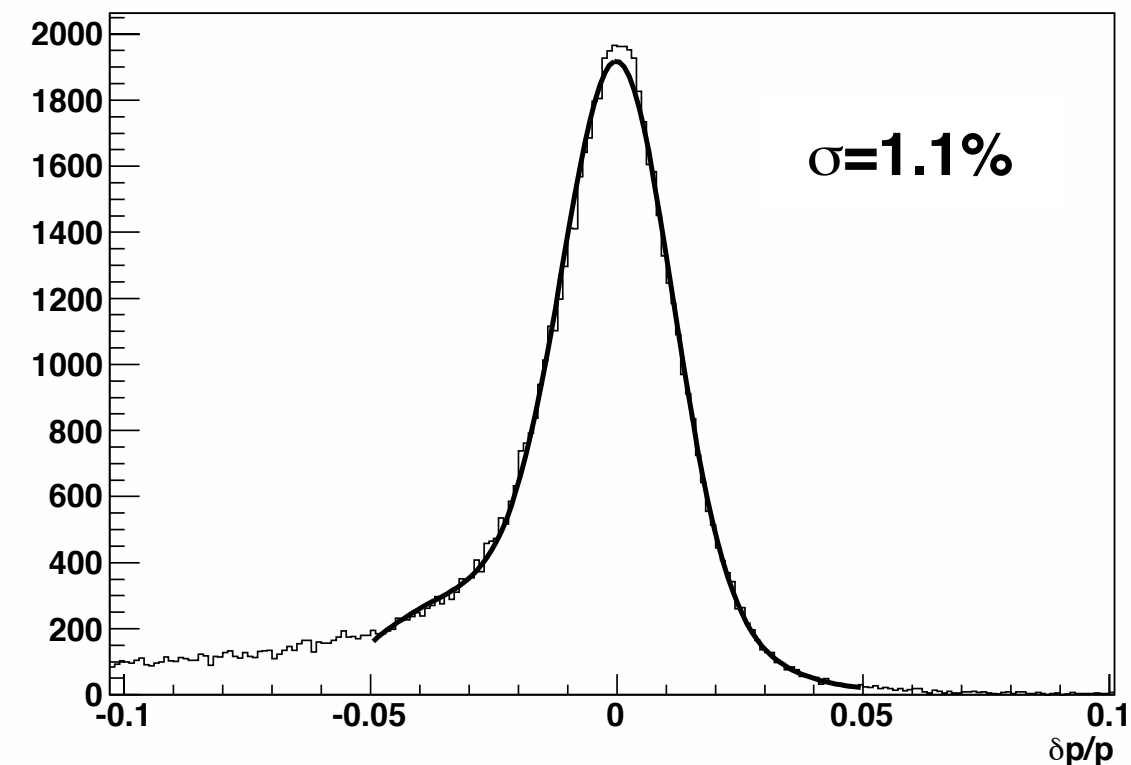
- Diana implemented a momentum correction to fix momentum discontinuity

- Momentum resolution of ~1%

BigBite MWDC

U plane track residuals

- After calibrating all MWDC planes the track residuals are checked

- Track residual resolutions varied from 190-265 um

u1 Plane
$\sigma = 0.25555$ mm

u1p Plane
$\sigma = 0.25566$ mm

u2 Plane
$\sigma = 0.25302$ mm

u2p Plane
$\sigma = 0.24984$ mm

u3 Plane
$\sigma = 0.23699$ mm

u3p Plane
$\sigma = 0.23437$ mm

Track Residual (m)
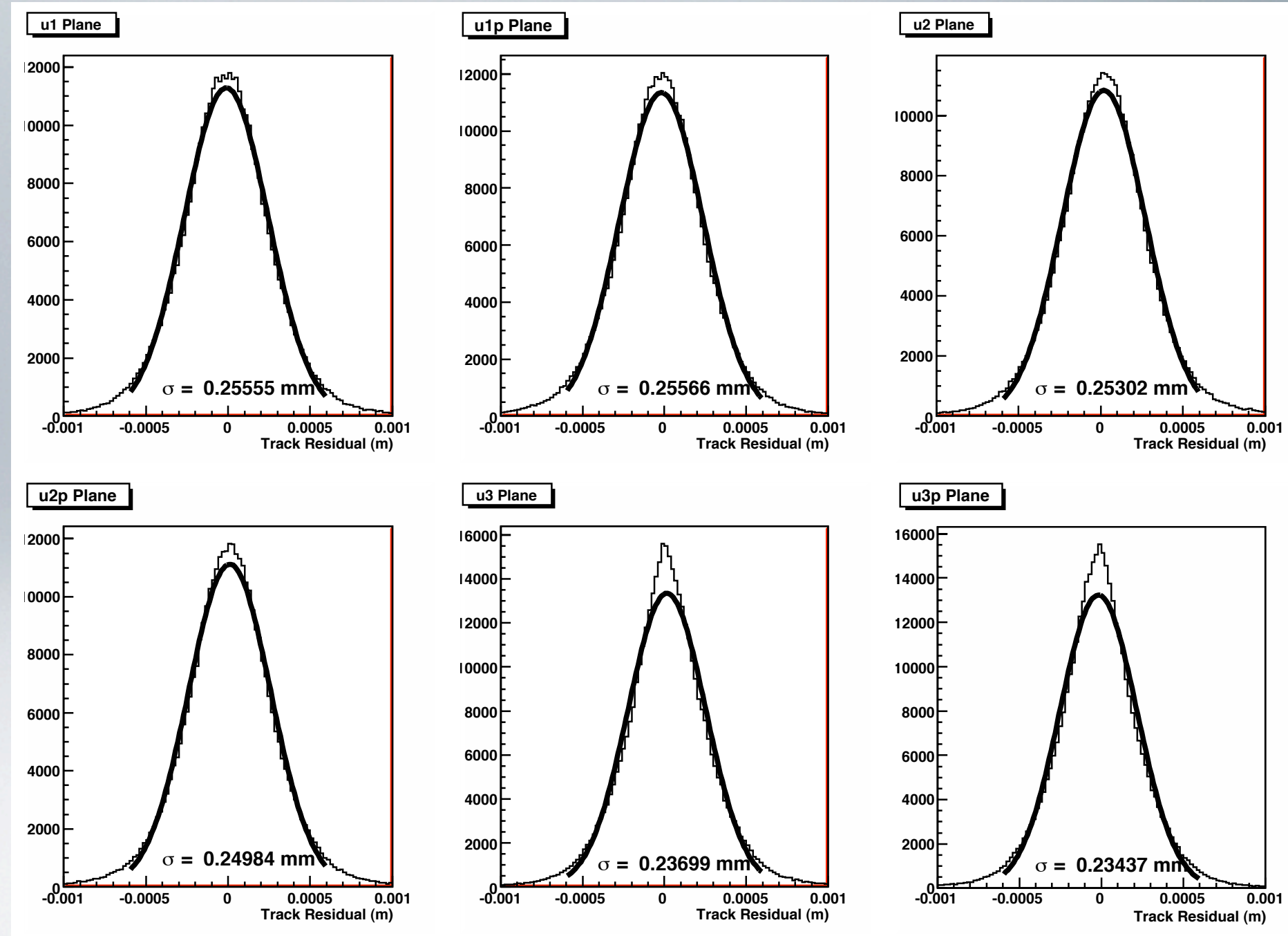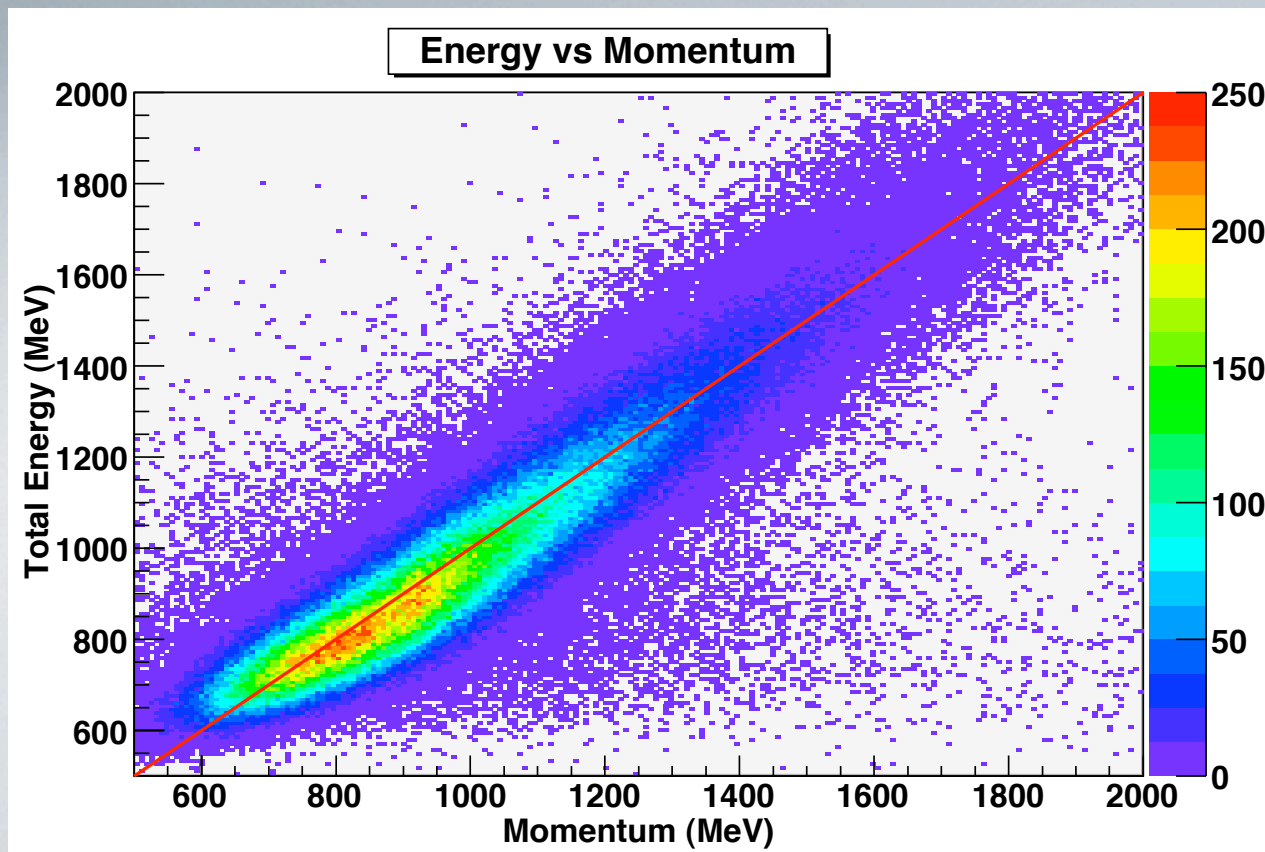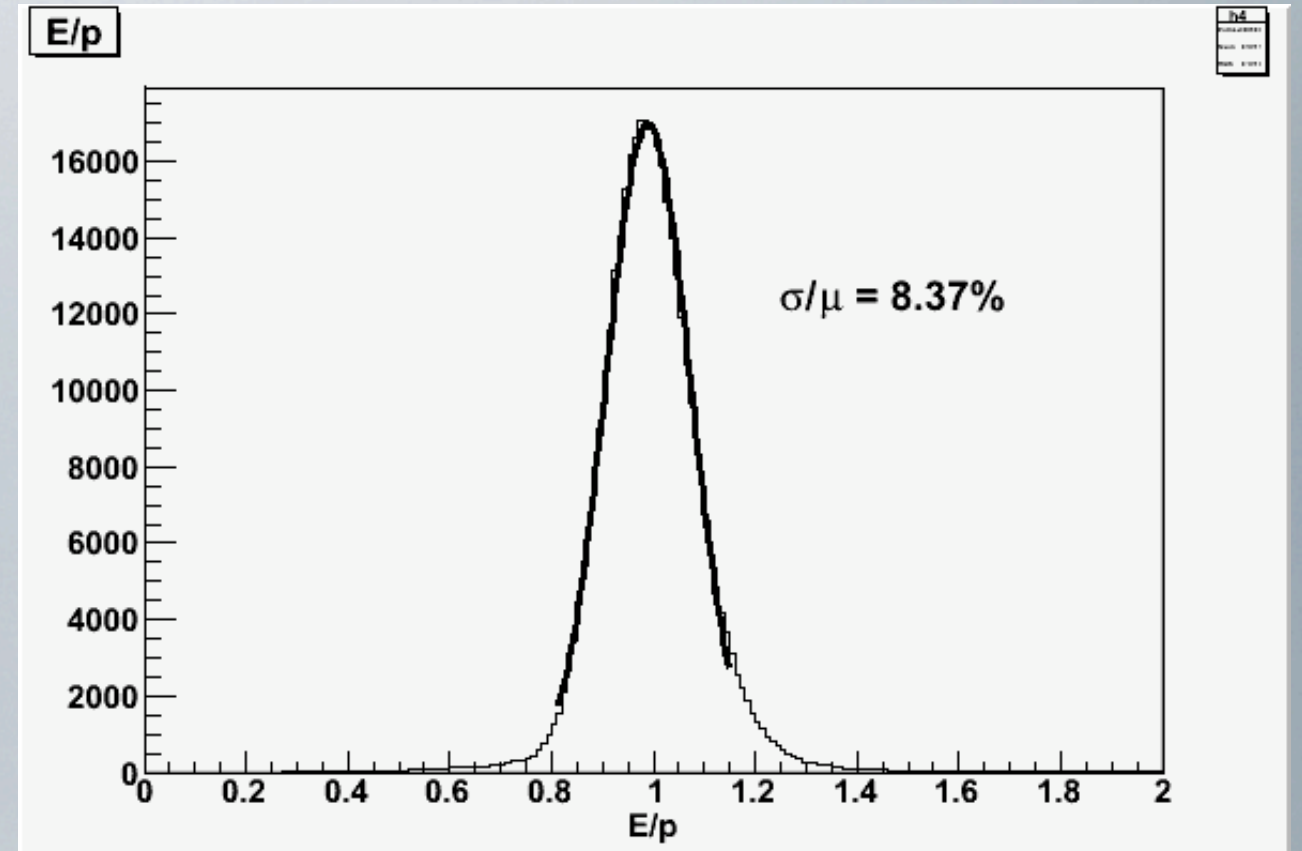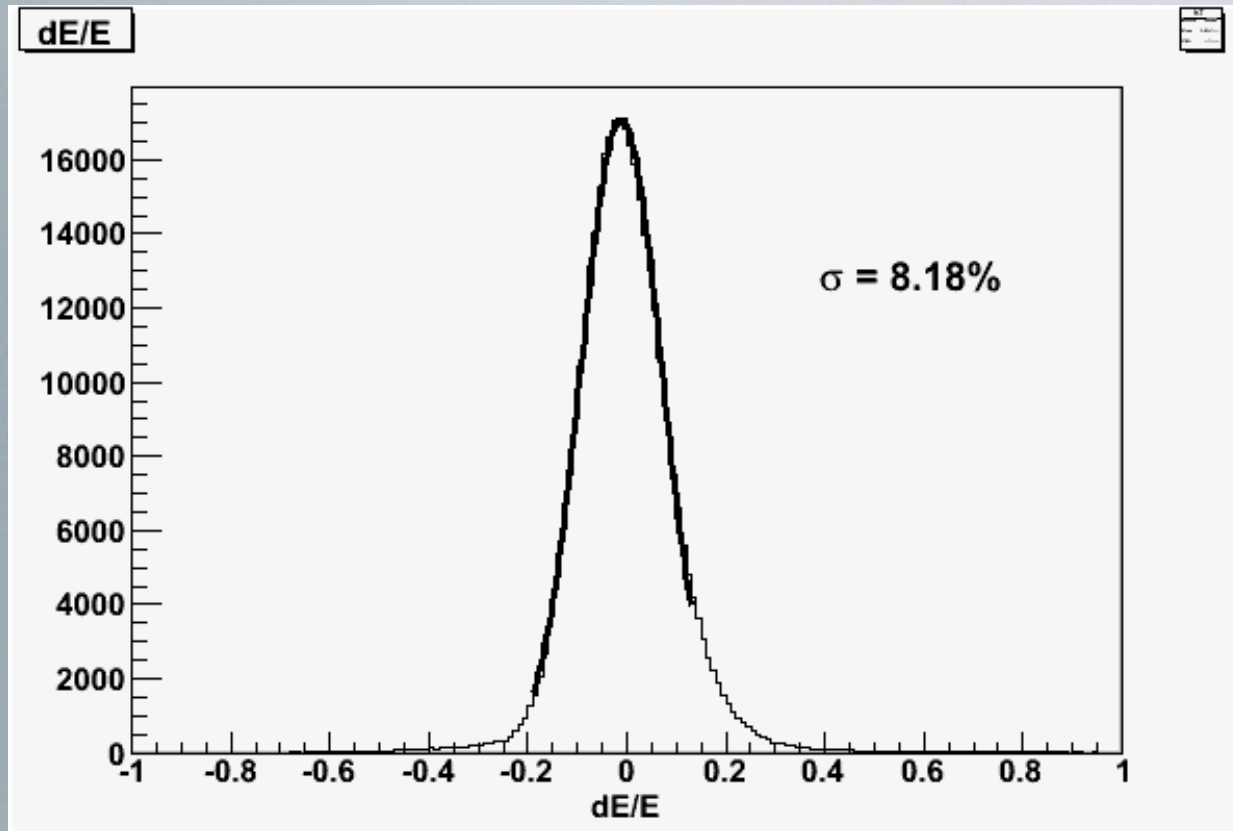
BigBite Shower

- Shower needs some fine tuning

- E/p resolution is **8.37%**

- Energy resolution is **8.18%**

BigBite Cherenkov

small angle side
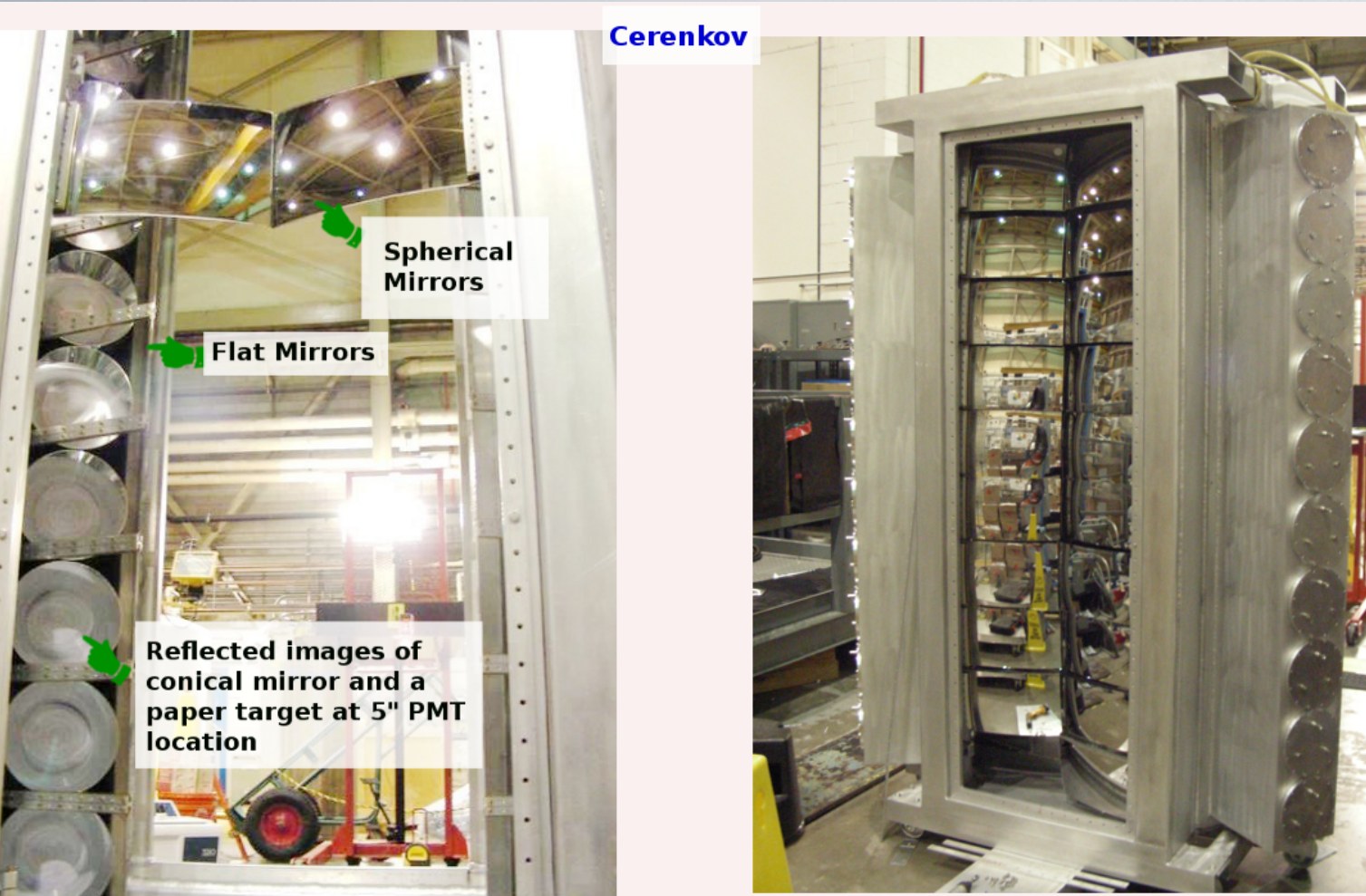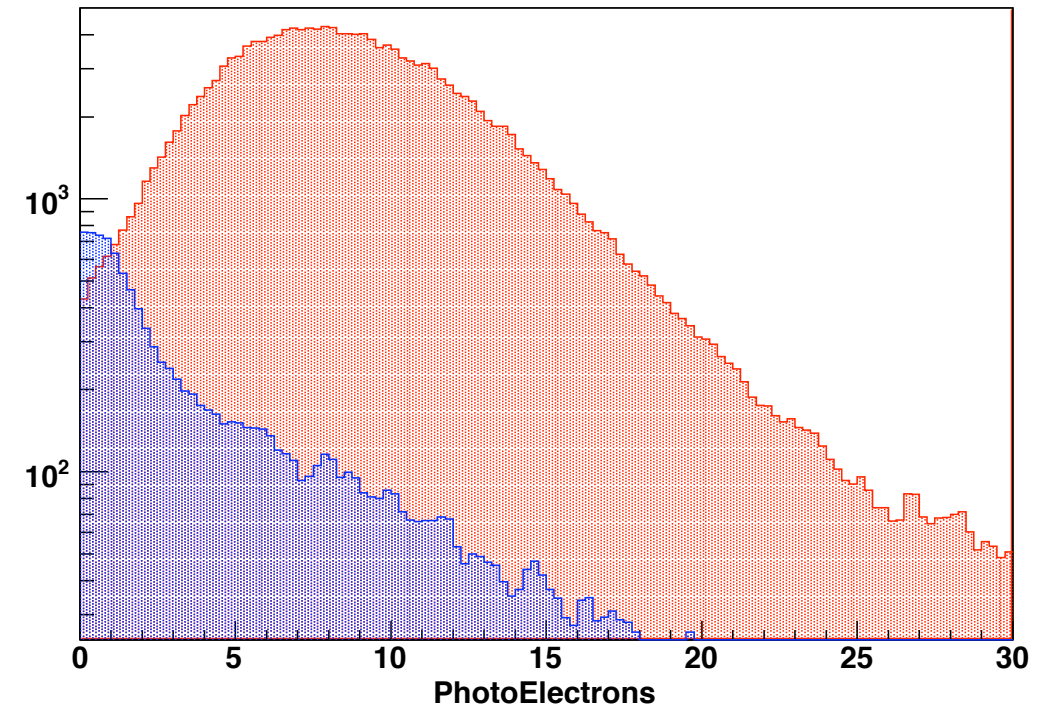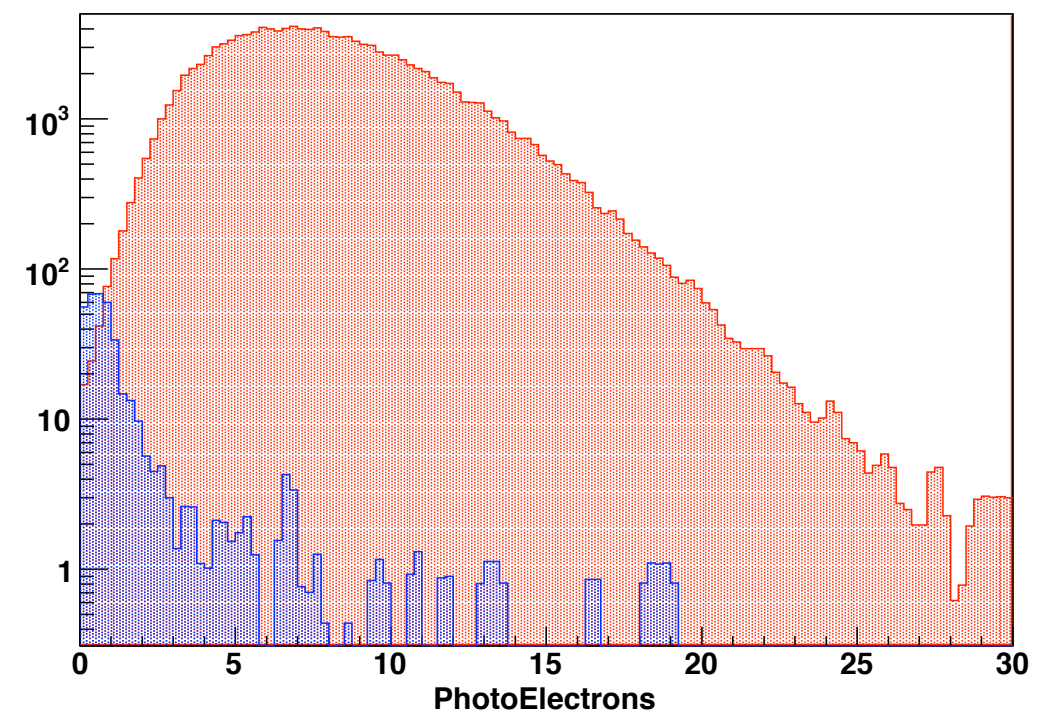
large angle side

Rate ~10 times larger on small angle side

Resulted in larger background on small angle side

BigBite Cherenkov: Pion Rejection

Pion Selection with T6 Trigger
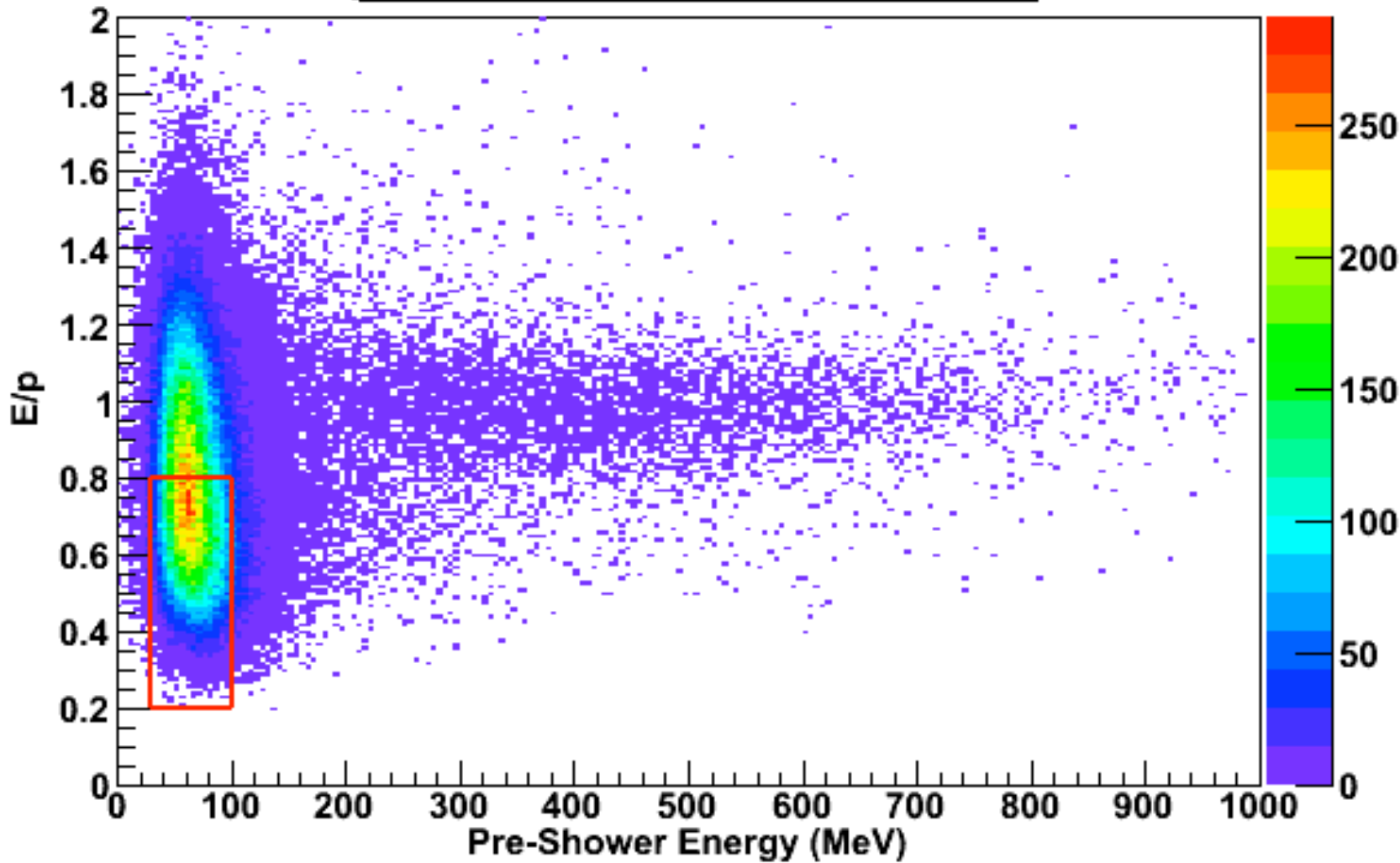
$$\epsilon_\pi = \frac{N_\pi}{N_{cer}}$$

- N_{cer} = Number of pions left after Cherenkov cut

- N_π = Number of events in pion sample

BigBite Cherenkov: Pion Rejection

BB Cerenkov Average π Rejection Factors As a Function of PhotoElectron Cut
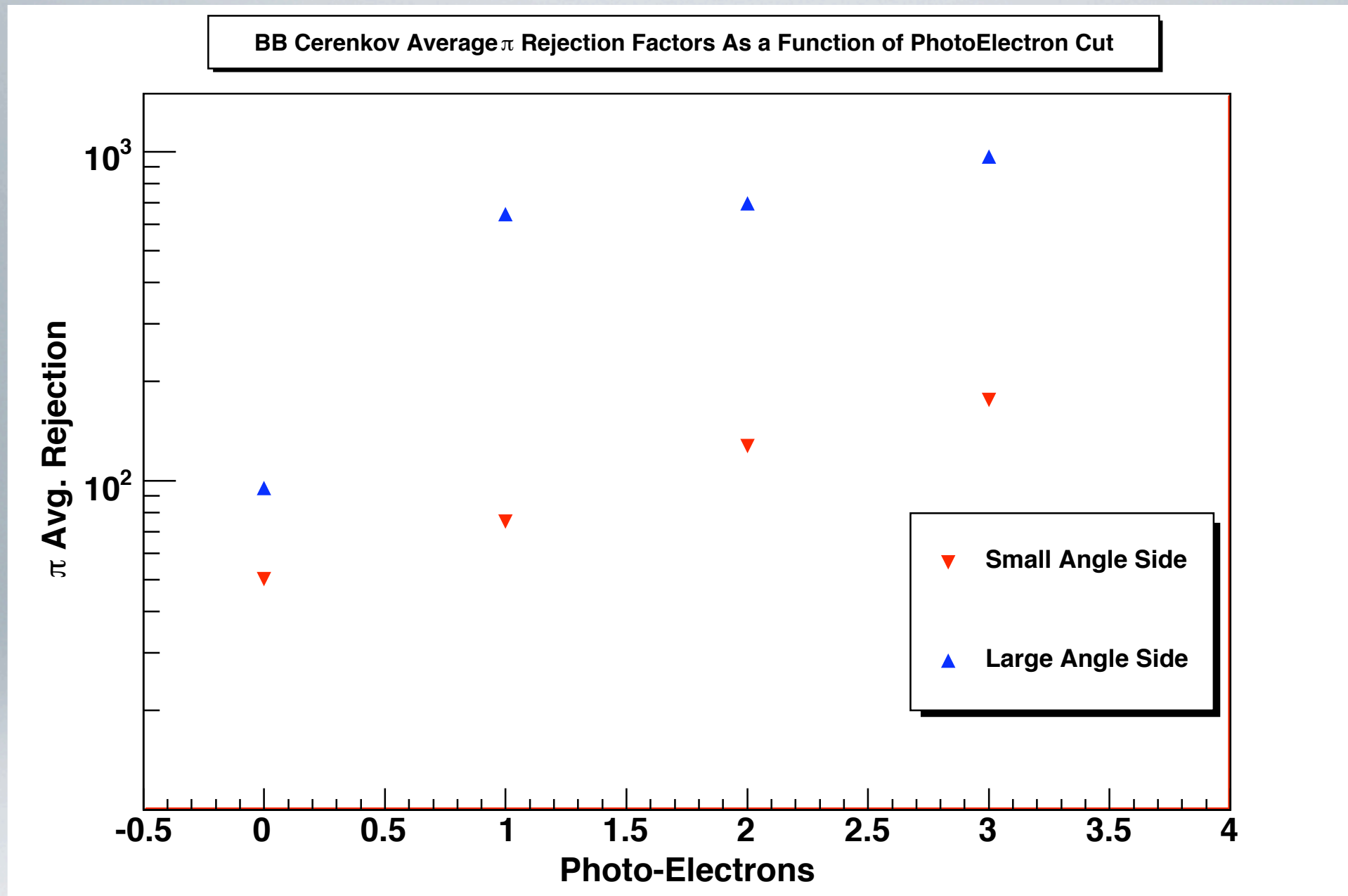
- Small angle side pion rejection factor at 3 photo-electron cut ~200

- Large angle side pion rejection factor at 3 photo-electron cut ~900

BigBite Cherenkov: Electron Efficiency
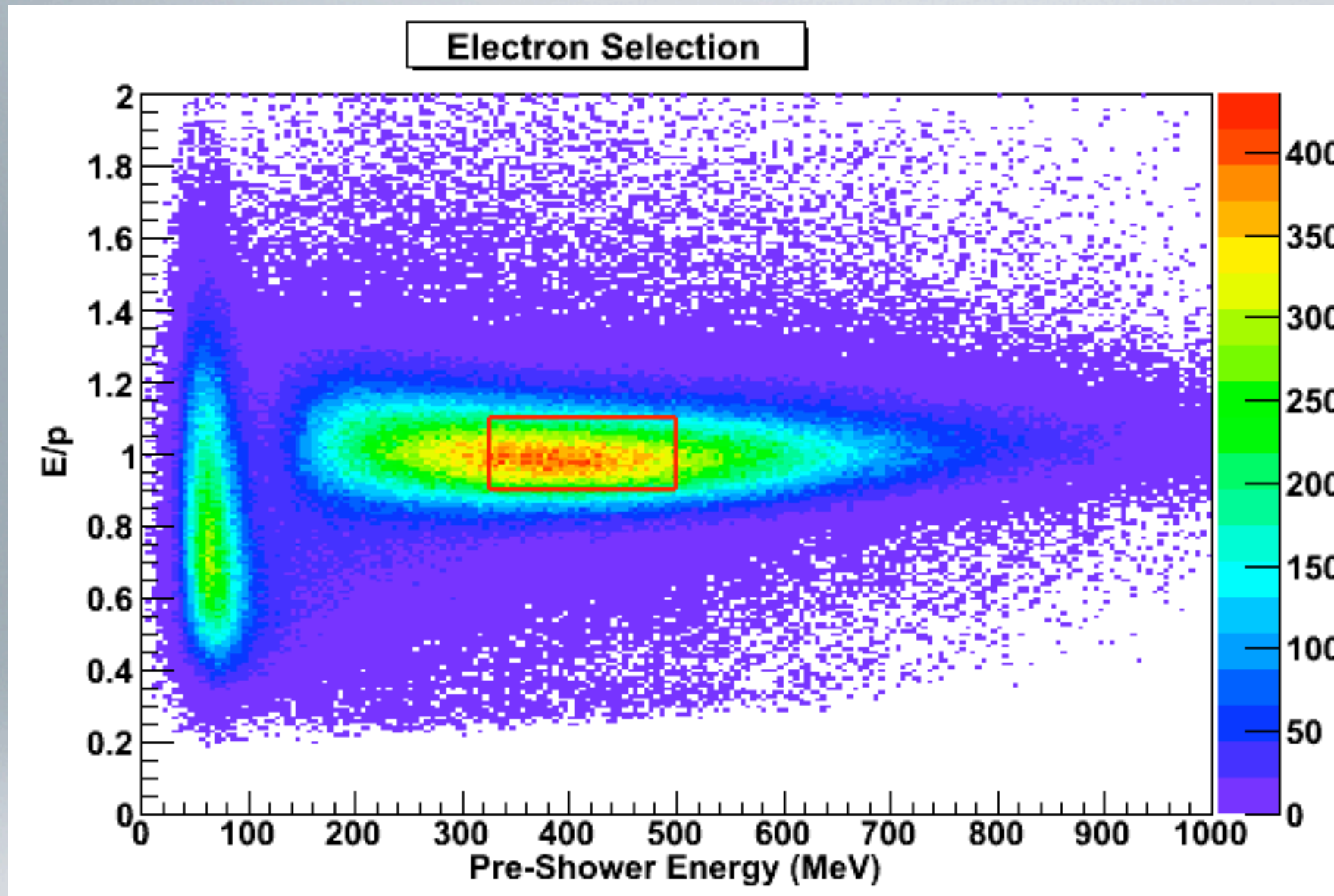
$$\epsilon_e = \frac{N_{cer}}{N_e}$$

- N_e = number of events in electron sample

- N_{cer} = number of events in electron sample after Cherenkov cut

BigBite Cherenkov: Electron Efficiency

PMTs on small-angle (beamline) side

BB Cerenkov Small Angle Electron Efficiency As a Function of Photo-Electron Cut

Legend:
- ● 0 PE Cut
- ▼ 3 PE Cut
- ▲ 3 PE Cut Compared to Poisson

y-axis: Electron Efficency

x-axis: PMT #
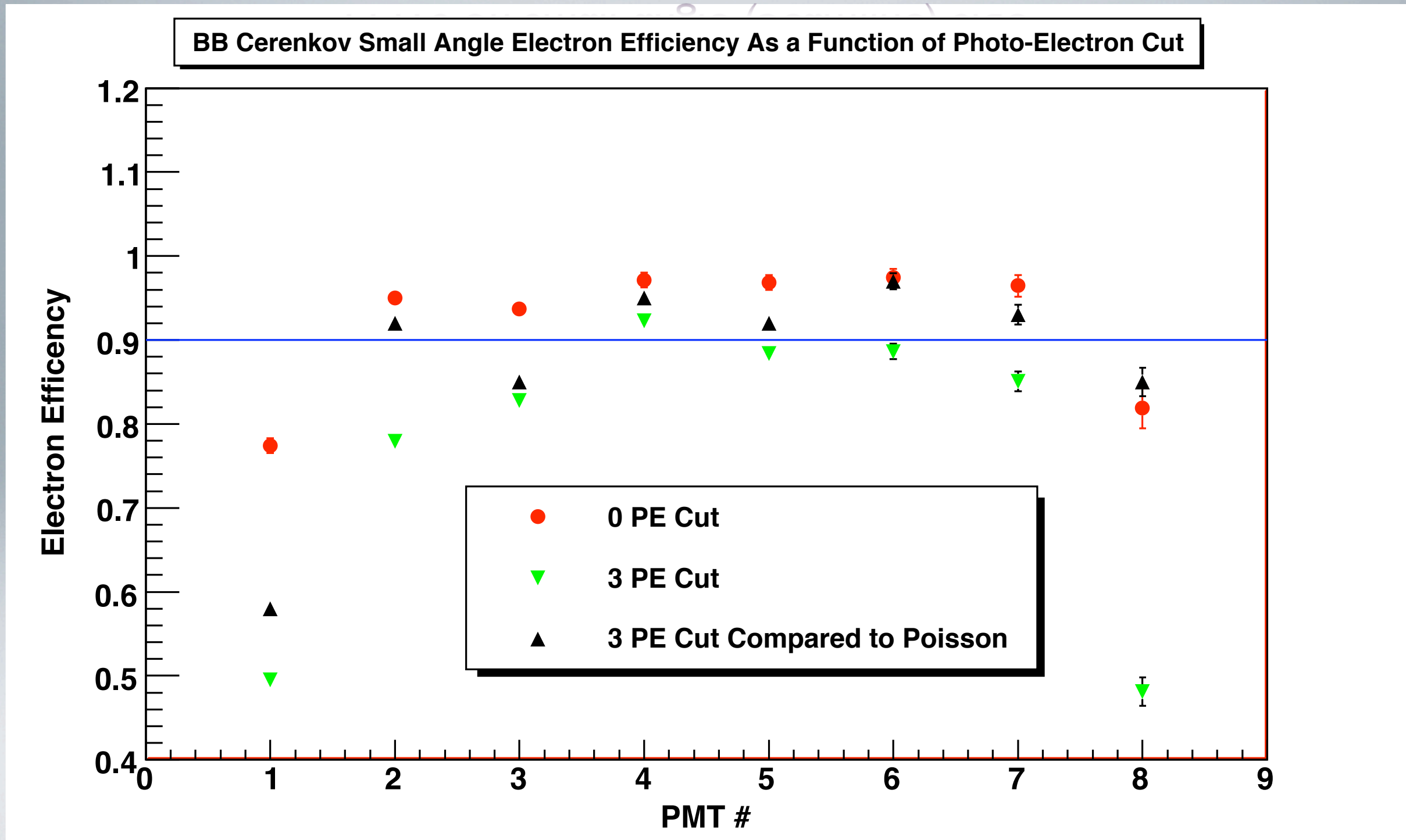
● Small angle average electron detection efficiency >85%

BigBite Cherenkov: Electron Efficiency

PMTs on the large-angle (RHRS) side

BB Cerenkov Large Angle Electron Efficiency As a Function of Photo-Electron Cut
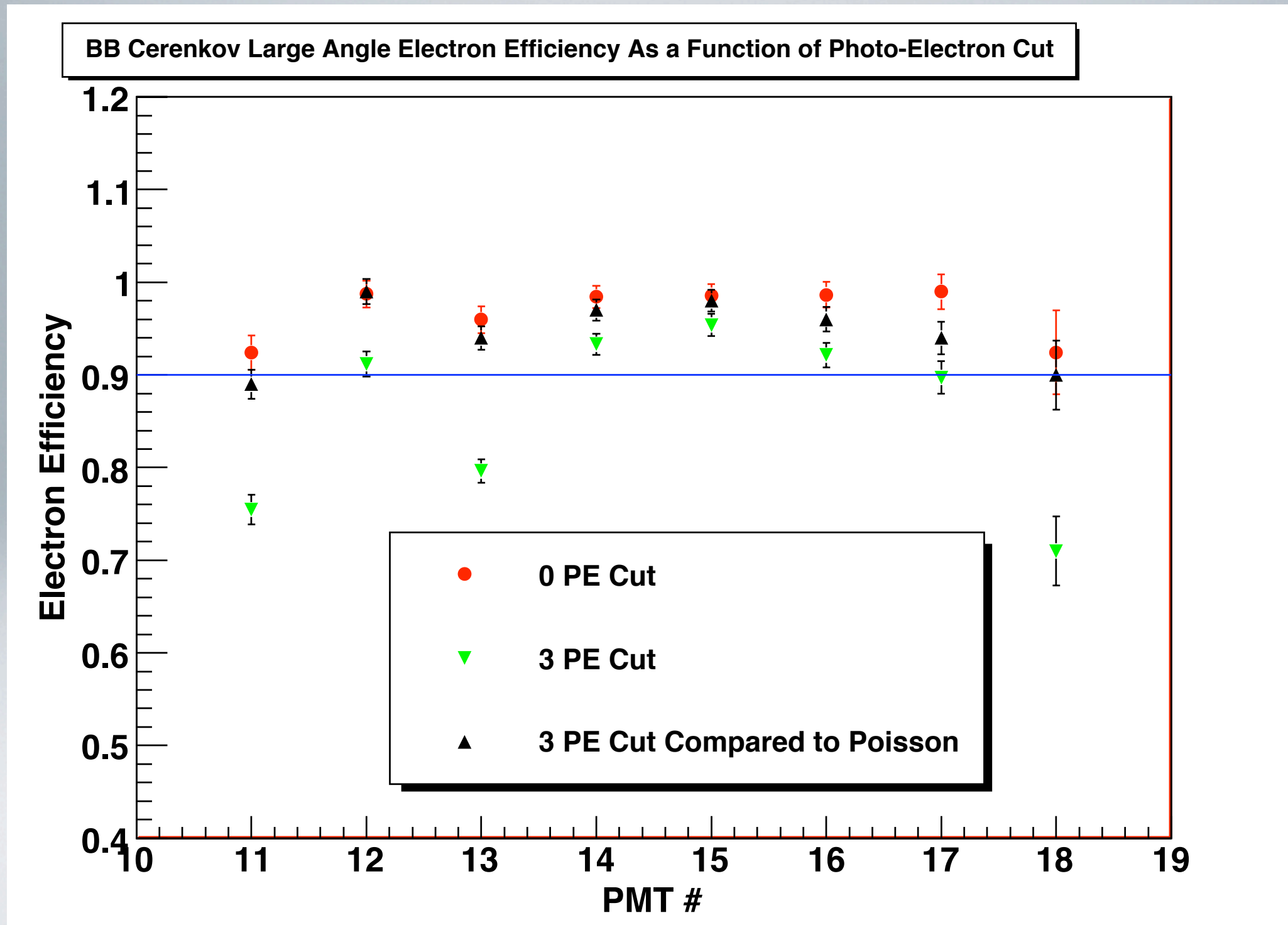
● **Large angle average electron detection efficiency >90%**

What's Next...

- Studying LHRS acceptance

- Finalize Cherenkov pion rejection factors and electron efficiencies

- Fine tune shower calibrations

- Data quality checks

- Begin extracting asymmetries

Thank You

- B. Sawatzky, Z.-E. Meziani, G. Franklin, L. El Fassi

- P. H. Solvignon, V. Sulkosky, S. Riordan, Yi Zhang

- X. Qian, J. Huang, K. Allada, C. Dutta, Yawei Zhang

- D. Flay, D. Parno

- The E06014 Collaboration

BigBite Cherenkov: Electron Efficiency

Poisson distribution

χ^2 / ndf	66.91 / 78
Const	2.499e+04 ± 79
μ	6.996 ± 0.008
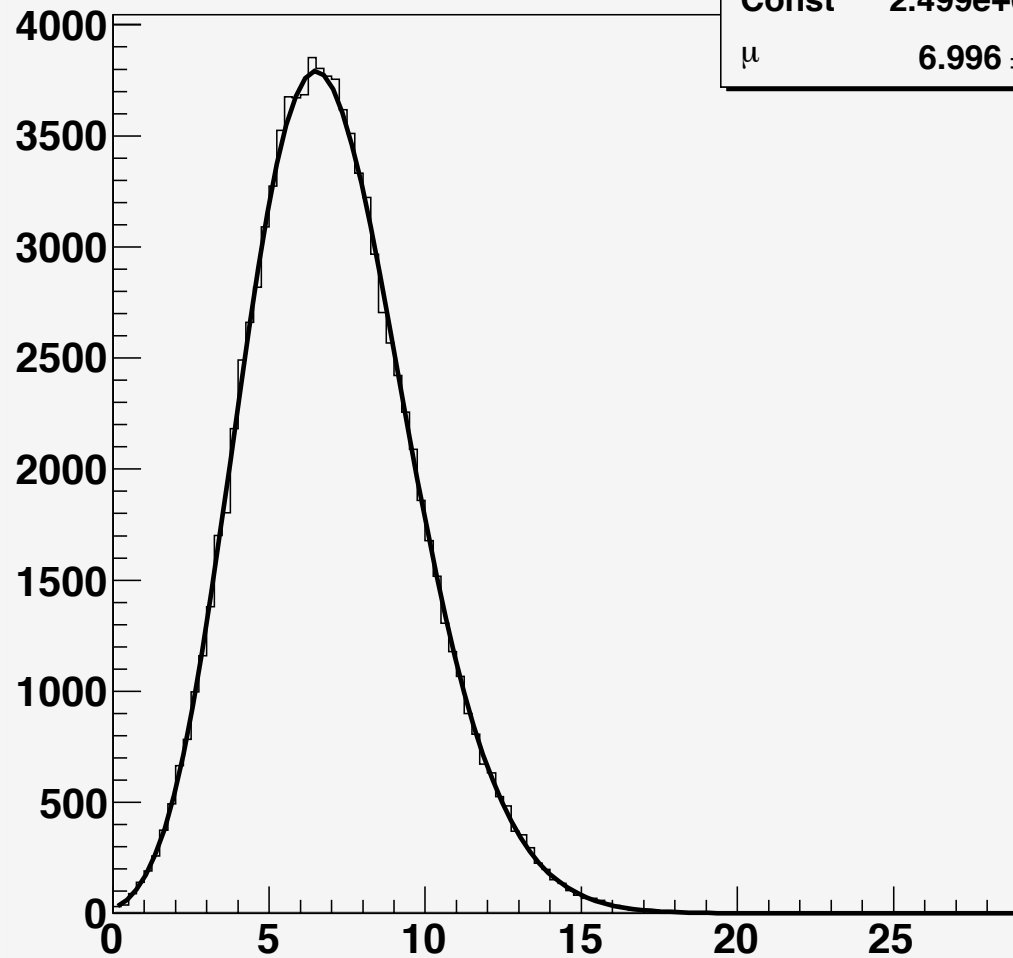
- Plot electrons in Cerenkov

- Find the mean photo-electrons

- Compare to Predicted distribution with same mean

BB Cerenkov ADC 07 with 0.0 Photo-Electron Cut

hcer	
Entries	11021
Mean	7.004
RMS	4.172
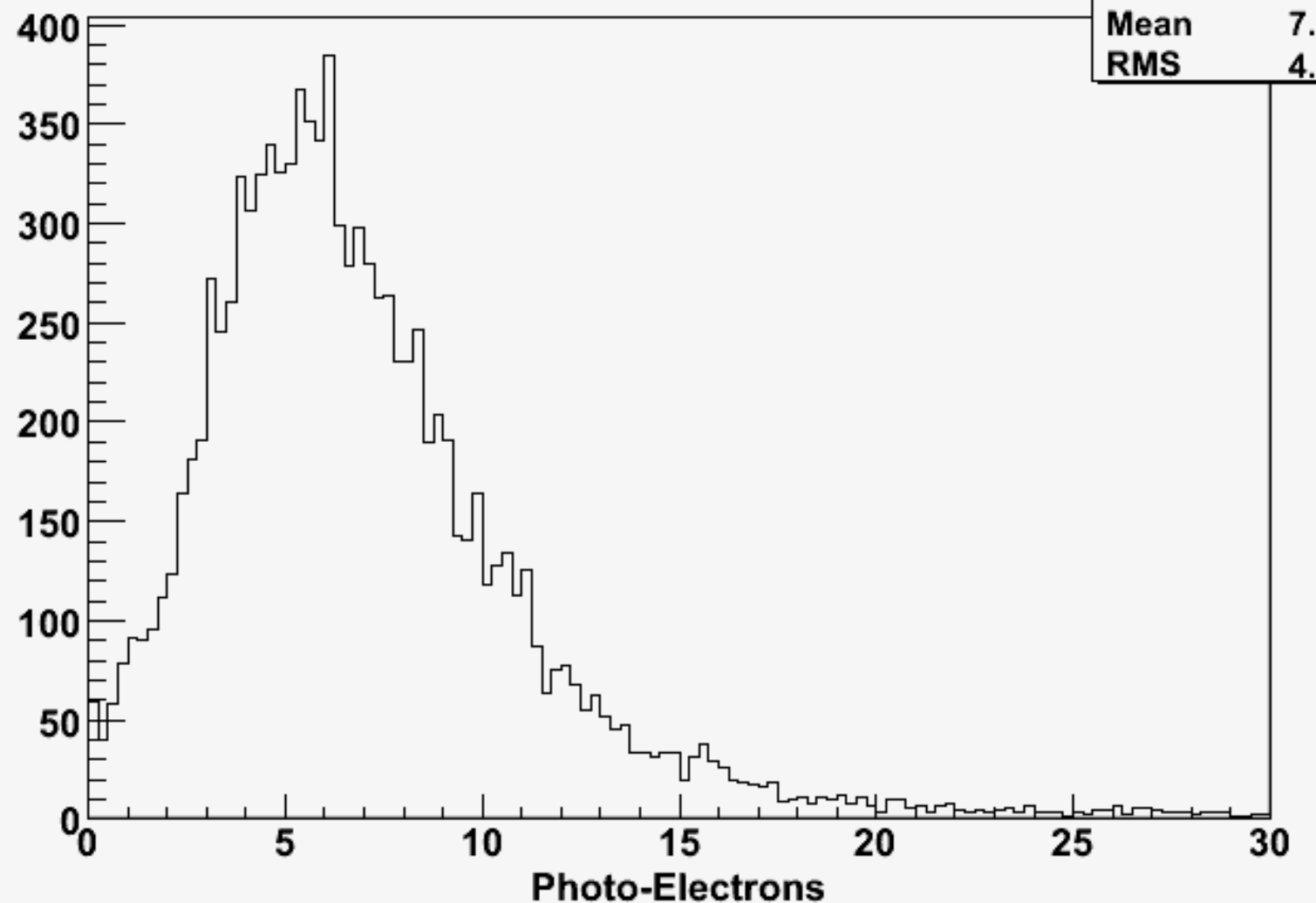
Photo-Electrons

- Predicted 3 photo-electron cut probability ~91%

- Empirical 3 photo-electron cut efficiency ~85%

BigBite MWDC

t0 calibration

All events

Events with tracks

- t0 calibration was done for each plane

- t0 calibrated to within 10 ns

drift distance to drift time

U1p

U1p - Profile
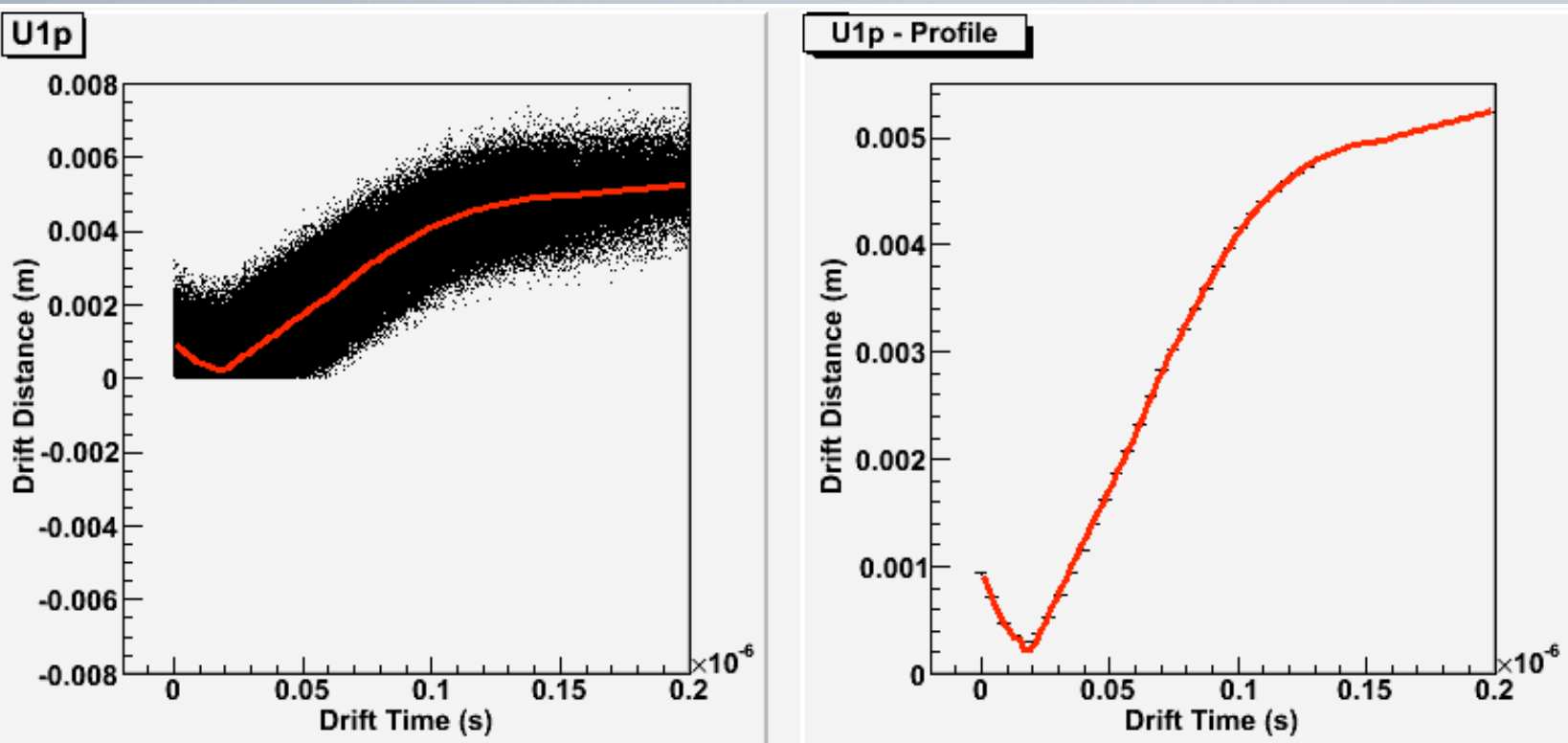
- Drift distance to drift time was parameterized for each plane

C1 overlaps with A+B+C+D

C2 overlaps with D+E+F+G

C3 overlaps with G+H+I+J

C4 overlaps with J+K+L+M

C5 overlaps with M+N+O+P

C6 overlaps with P+Q+R+S

C7 overlaps with S+T+U+V
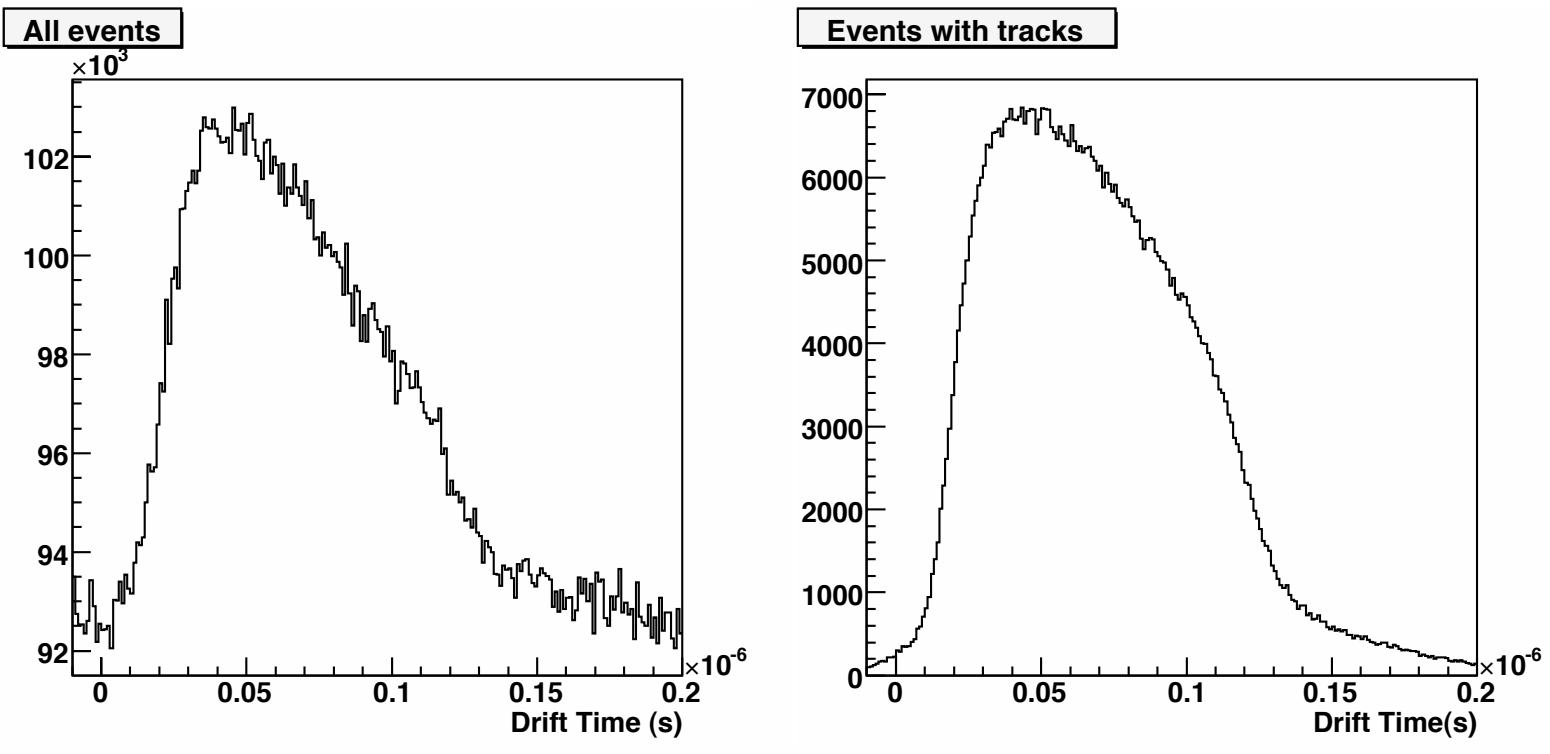
C8 overlaps with V+W+X+Y

C9 overlaps with Y+Z

	Sh/PSh Sum#	Short patch cable	Long patch cable
A	26	N4–24L	20
B	25	N2–24L	24
C	24	N3–21L	52
D	23	N6–36L	–
E	22	N3–22L	6
F	21	N4–21L	17
G	20	N4–23L	–
H	19	N1–21L	S6–1NAU
I	18	N1–22L	23
J	17	N3–24L	–
K	16	N2–21L	2
L	15	N2–22L	14
M	14	N1–24L	–
N	13	N4–22L	51
O	12	N2–23L	11
P	11	N3–23L	–
Q	10	N7–32L	1
R	9	N5–32L	9
S	8	N1–23L	–
T	7	N6–33L	53
U	6	N6–31L	5
V	5	N5–36L	–
W	4	N7–33L	3
X	3	N6–32L	21
Y	2	N6–35L	–
Z	1	N5–31L	50