E01-012

Spin Duality Status Report

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Hall A Collaboration Meeting
December 11, 2003

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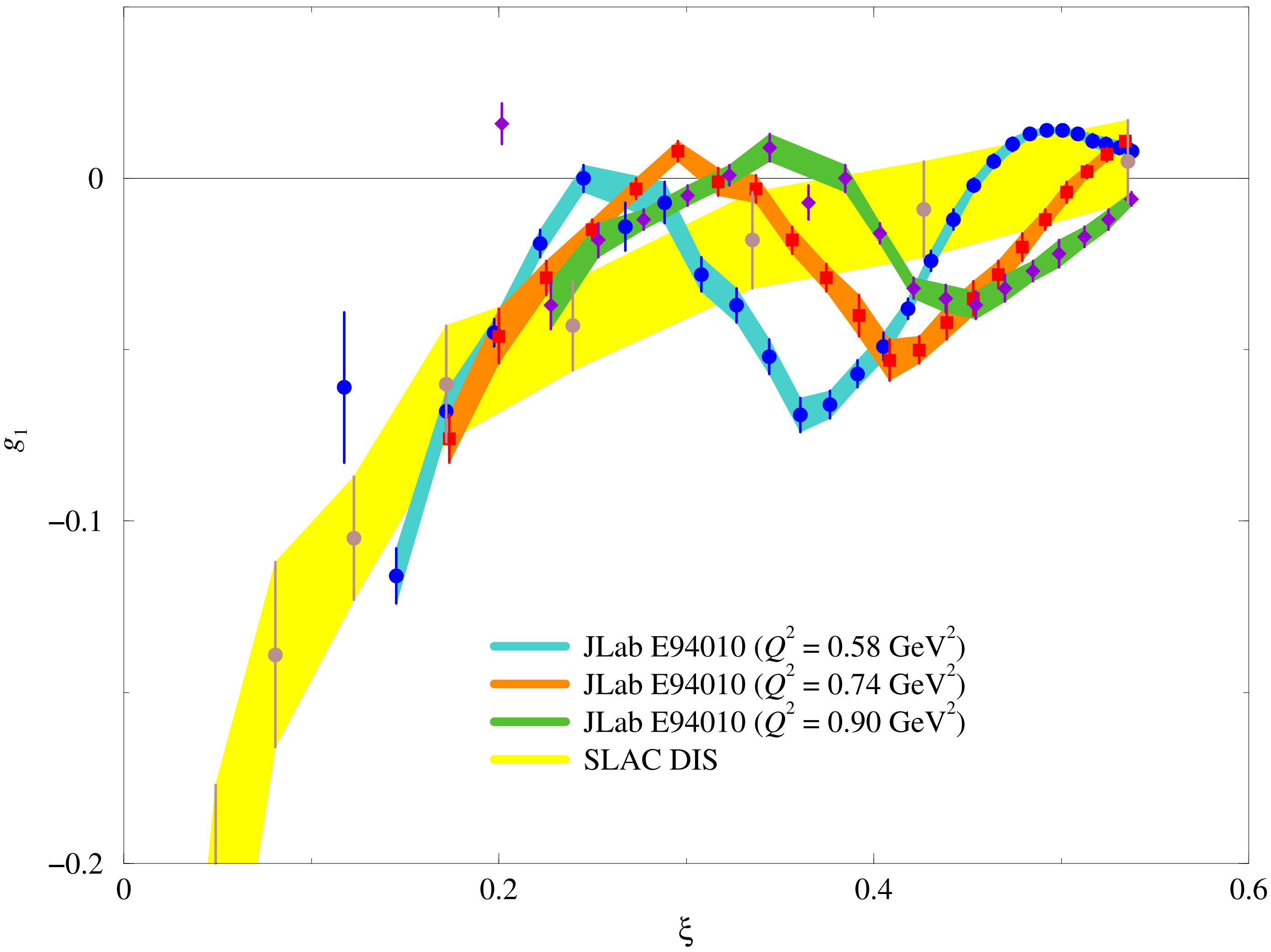
Quark-Hadron Duality

- *Bloom-Gilman duality* was first observed at SLAC in the 70's on spin independent structure functions.

  E.D. Bloom and F.J. Gilman, Phys. Rev. D **4**, 2901 (1971)

  $\Longrightarrow$ In a certain kinematic region, the resonances average on the scaling curve.

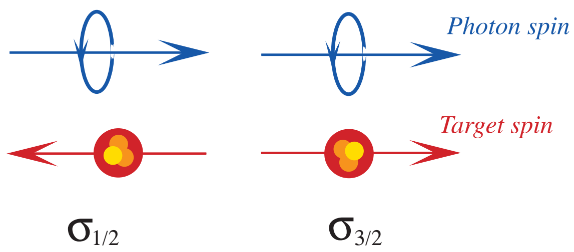
- Duality holds when higher twists are suppressed.
- Experimental confirmation of duality:
  - Hall C for F_2^p I. Niculescu et al., Phys. Rev. Lett. **85**, 1186 (2000)
- Experimental approaches to duality on spin structure functions:
  - HERMES for A_1^p A.Airapetian et al., Phys. Rev. Lett. **90**, 092002 (2003)
  - Hall B for g_1^p
  - Hall A for g_1^n



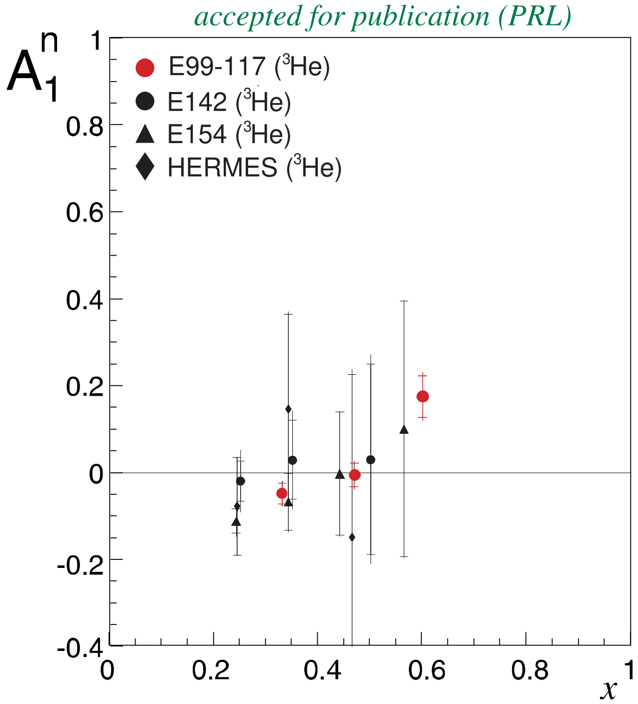
$$\xi = \frac{2x}{1 + \sqrt{1 + \frac{4M^2x^2}{Q^2}}}$$

Neutron Spin Asymmetry A_1^n

$$A_1 = \frac{\sigma_{1/2} - \sigma_{3/2}}{\sigma_{1/2} + \sigma_{3/2}}$$



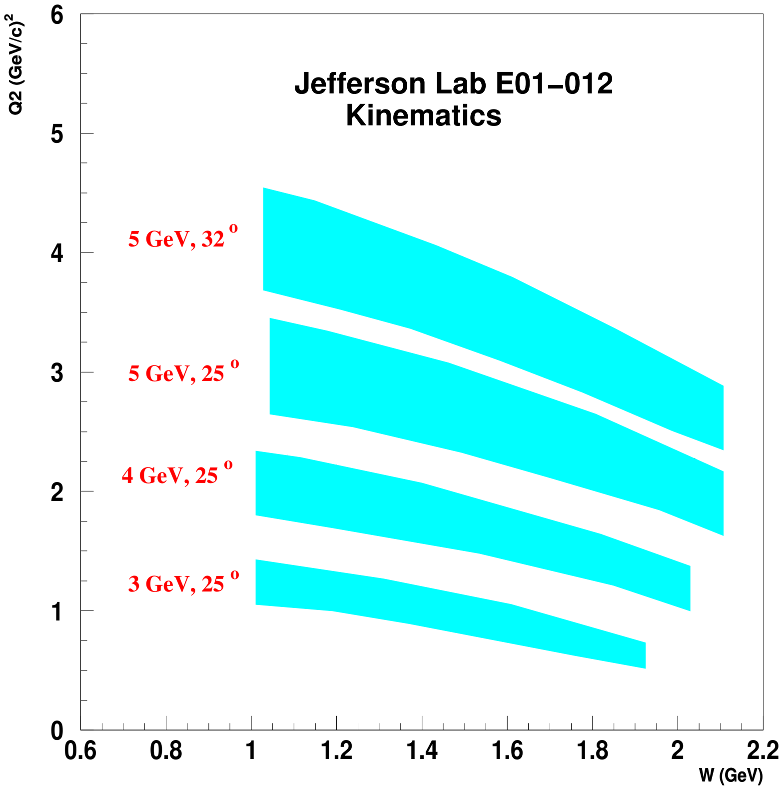
X. Zheng et al., Nucl-ex/030811 v2 (2003) accepted for publication (PRL)



- A_1^n tells us about the valence quark spin distributions in the neutron.
- Lack of data in the high x region.
- Theoretical predictions differ dramatically.
- Duality will make the high x region more easily accessible.

The experiment E01-012

- E01-012 measured $g_1^{^3He}$ in the resonance region up to W=2 GeV for $1 < Q^2 < 4$ GeV^2.
- will extract $A_1^{^3He}$.
- Inclusive experiment: $^3\overrightarrow{He}(\vec{e}$,e')X.
- Used *polarized ^3He* as an *effective polarized neutron*.



Getting A_1 and g_1 ...

- Extraction of A_1 from asymmetries:

$$A_{\parallel} = \frac{\sigma^{\downarrow\Uparrow} - \sigma^{\uparrow\Uparrow}}{\sigma^{\downarrow\Uparrow} + \sigma^{\uparrow\Uparrow}} \quad \text{and} \quad A_{\perp} = \frac{\sigma^{\downarrow\Rightarrow} - \sigma^{\uparrow\Rightarrow}}{\sigma^{\downarrow\Rightarrow} + \sigma^{\uparrow\Rightarrow}}$$

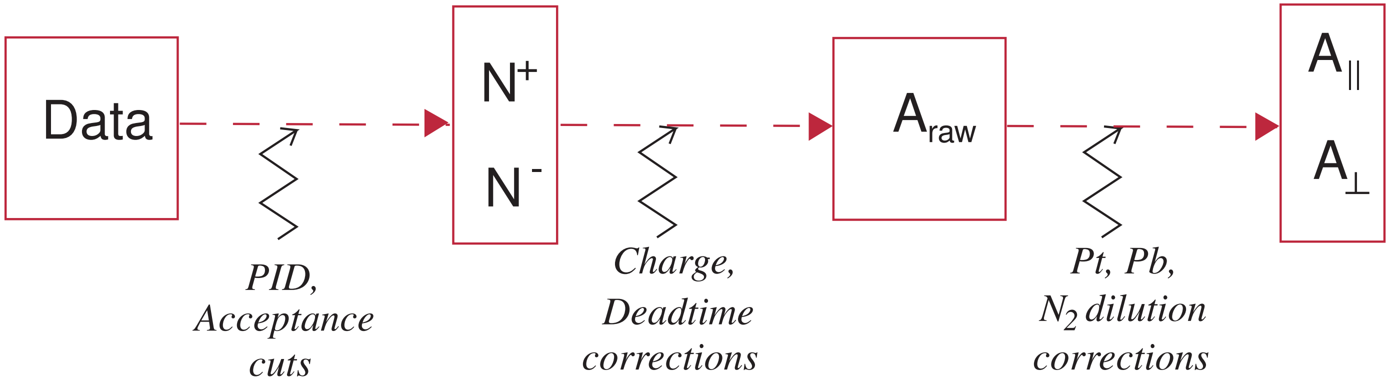
$$A_1 = \frac{A_{\parallel}}{D(1+\eta\xi)} - \frac{\eta A_{\perp}}{d(1+\eta\xi)}$$

- Extraction of g_1 from cross sections:

$$g_1 = \frac{MQ^2\nu}{4\alpha_e^2}\frac{E}{E'}\frac{1}{E+E'}\left[\Delta\sigma_{\parallel} + tan(\frac{\theta}{2})\Delta\sigma_{\perp}\right]$$

Physics asymmetries

- At present: 1^{st} pass analysis with extraction of the asymmetries.
- In the future: 2^{nd} pass analysis $\rightarrow$ cross sections and asymmetries.

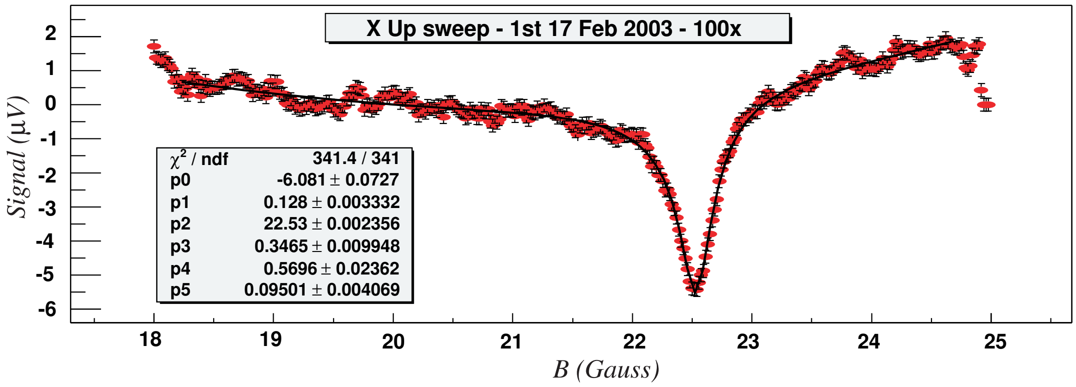


$$A^{raw}_{\parallel,\perp} = \frac{N^{-}_{corr.} - N^{+}_{corr.}}{N^{-}_{corr.} + N^{+}_{corr.}} \quad \text{then} \quad A^{phys}_{\parallel,\perp} = \frac{A^{raw}_{\parallel,\perp}}{f_{N_2}.P_{beam}.P_{targ}}$$

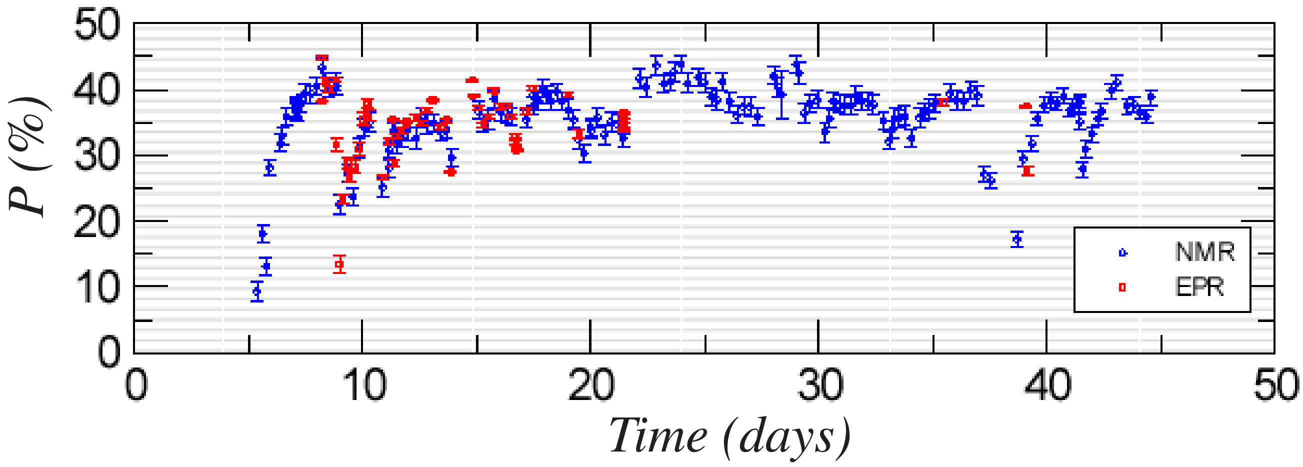
Data analysis

- Target:

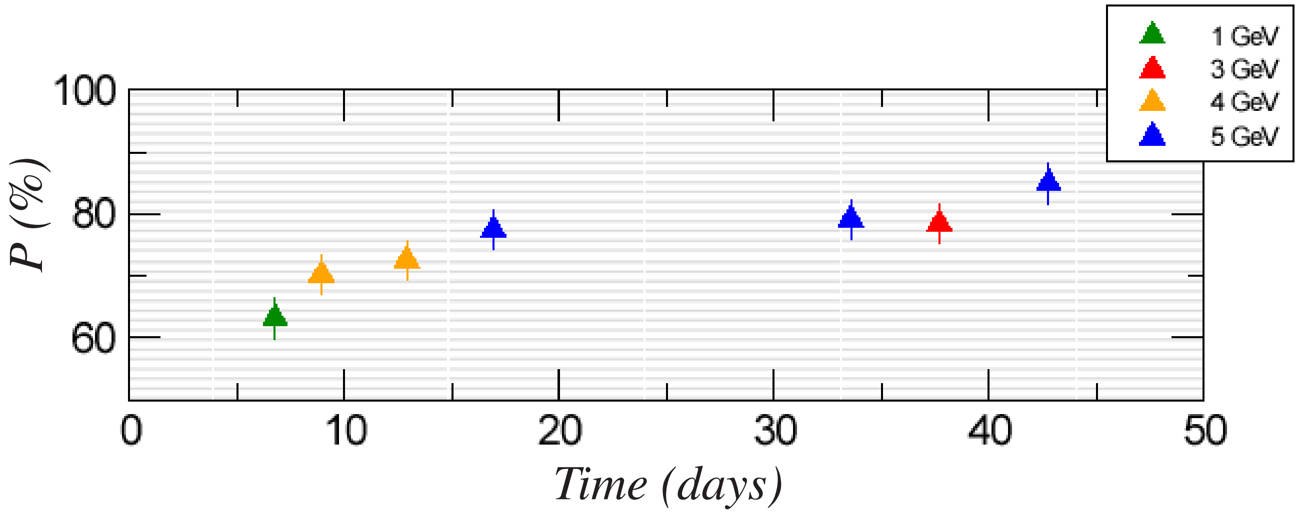
Water calibration used to extract target polarization from NMR (Vincent Sulkosky)



Target polarization used in the 1^{st} pass analysis:



- Beam polarization: from Moller measurements (Eugene Chudakov *et al.*).

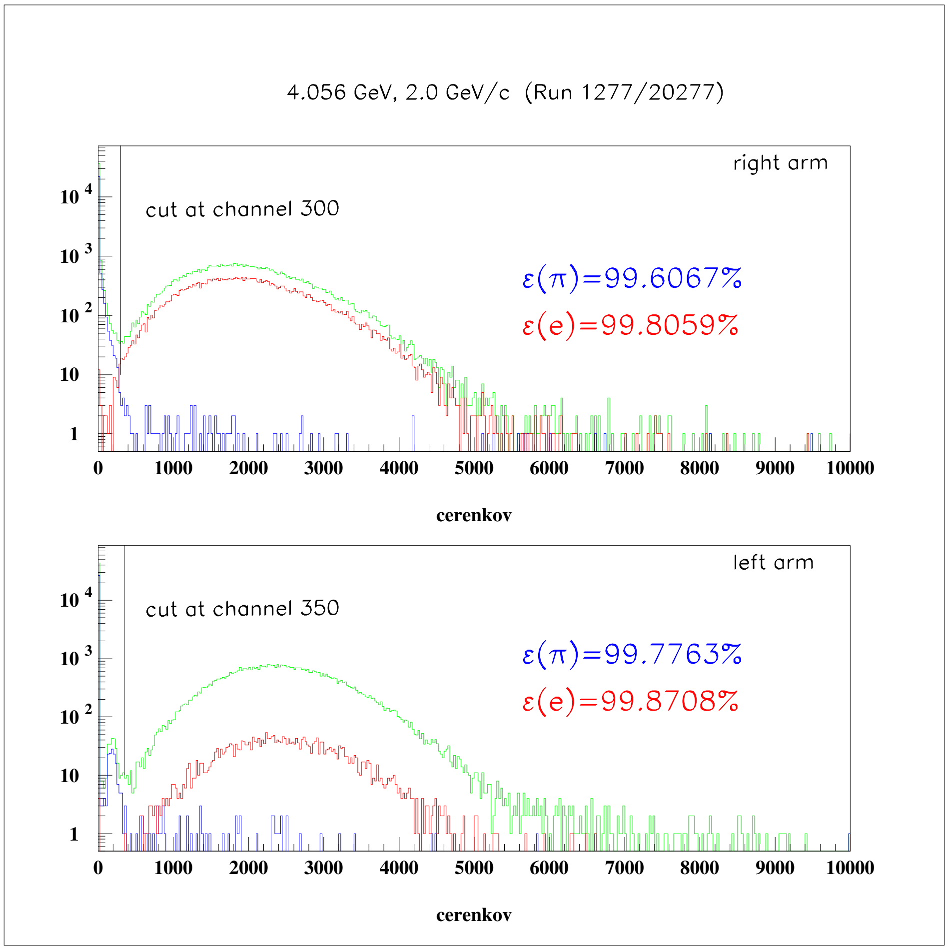


- BPM/raster correction done for all runs (following Bodo Reitz's method).
- PID detector calibration and cut optimization are done.

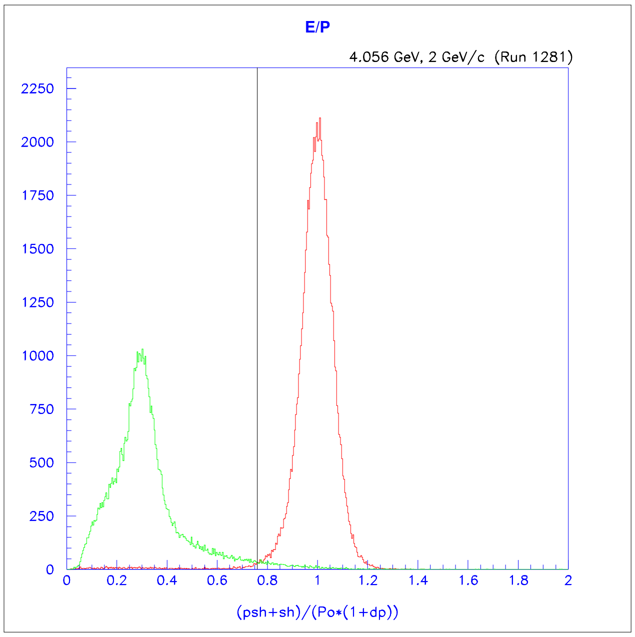
PID cut optimization

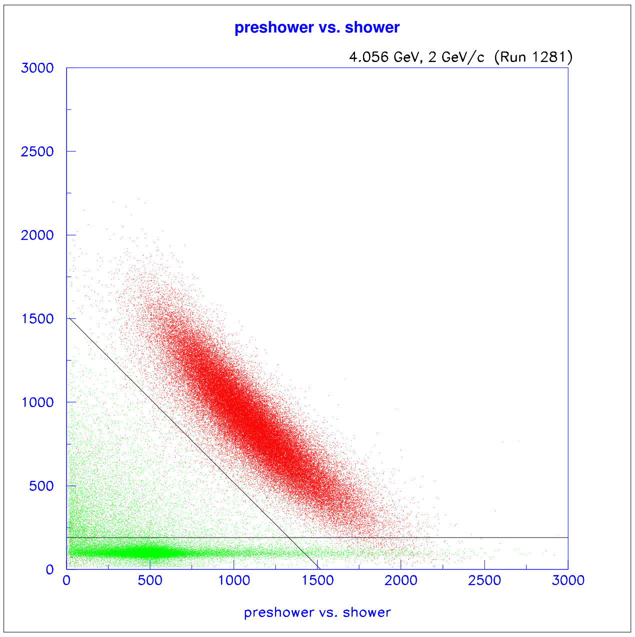
<u>Goal</u>: remove pions while keeping electron efficiency high.

→ *Cut positions change with kinematics.*

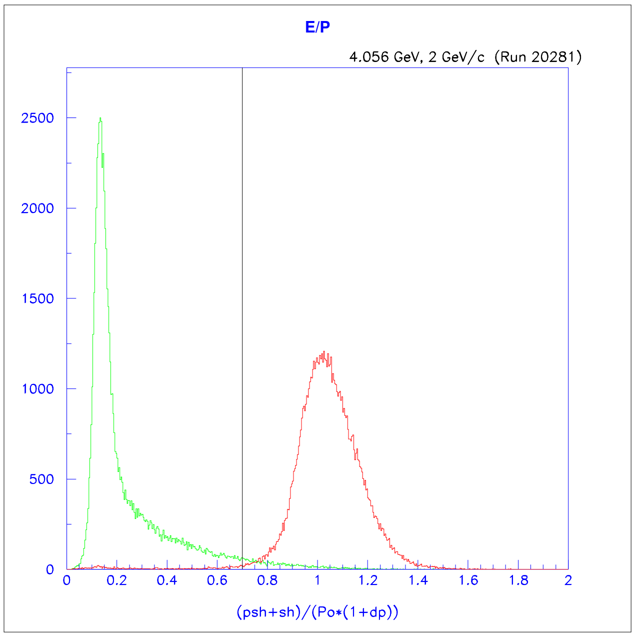


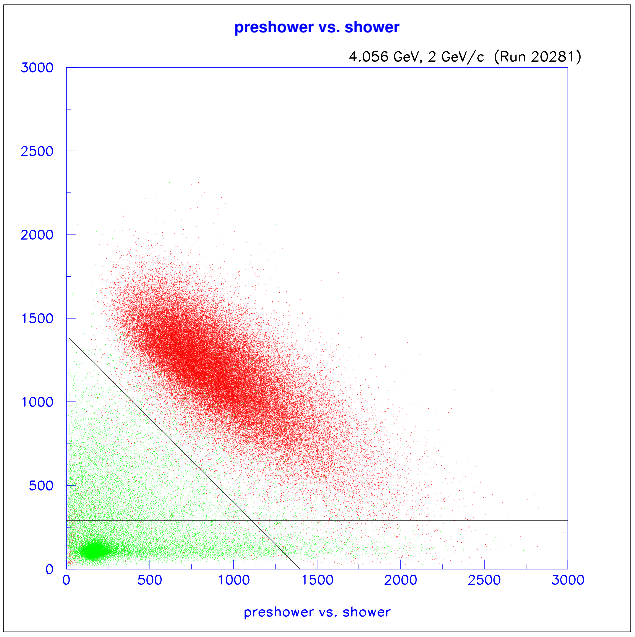
Right arm



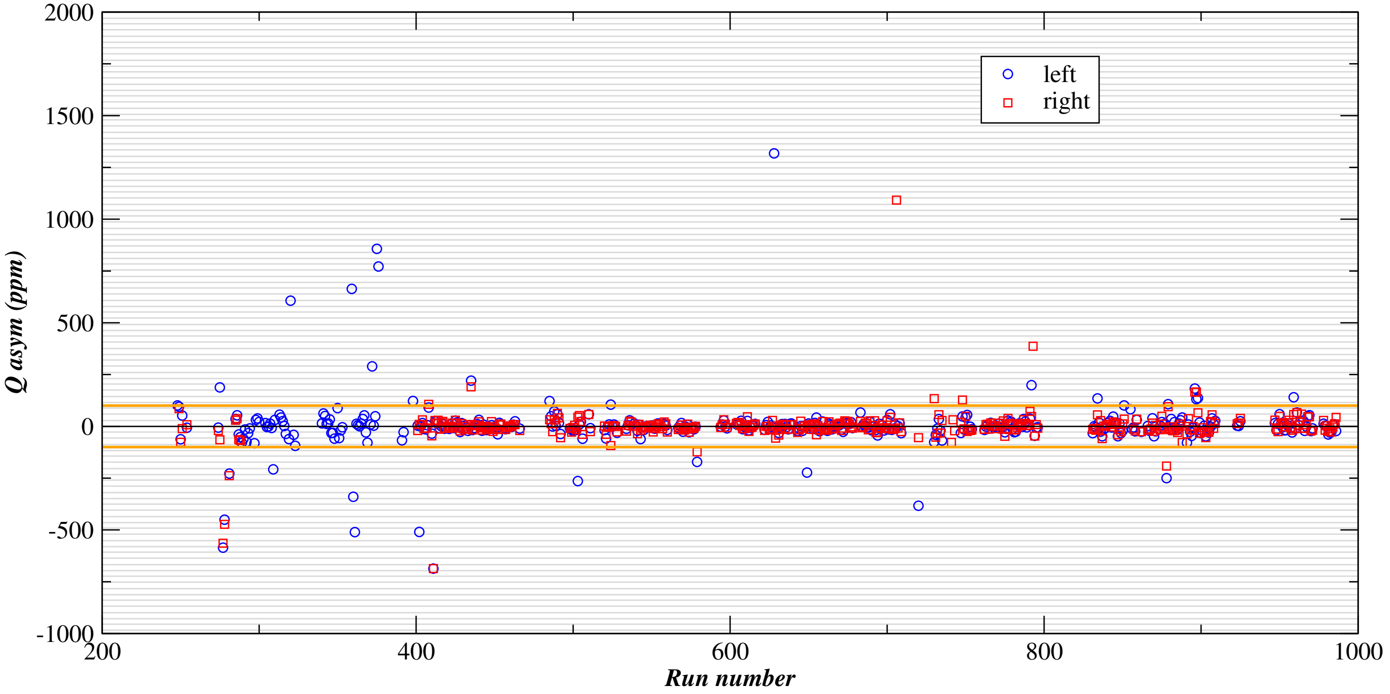


Left arm



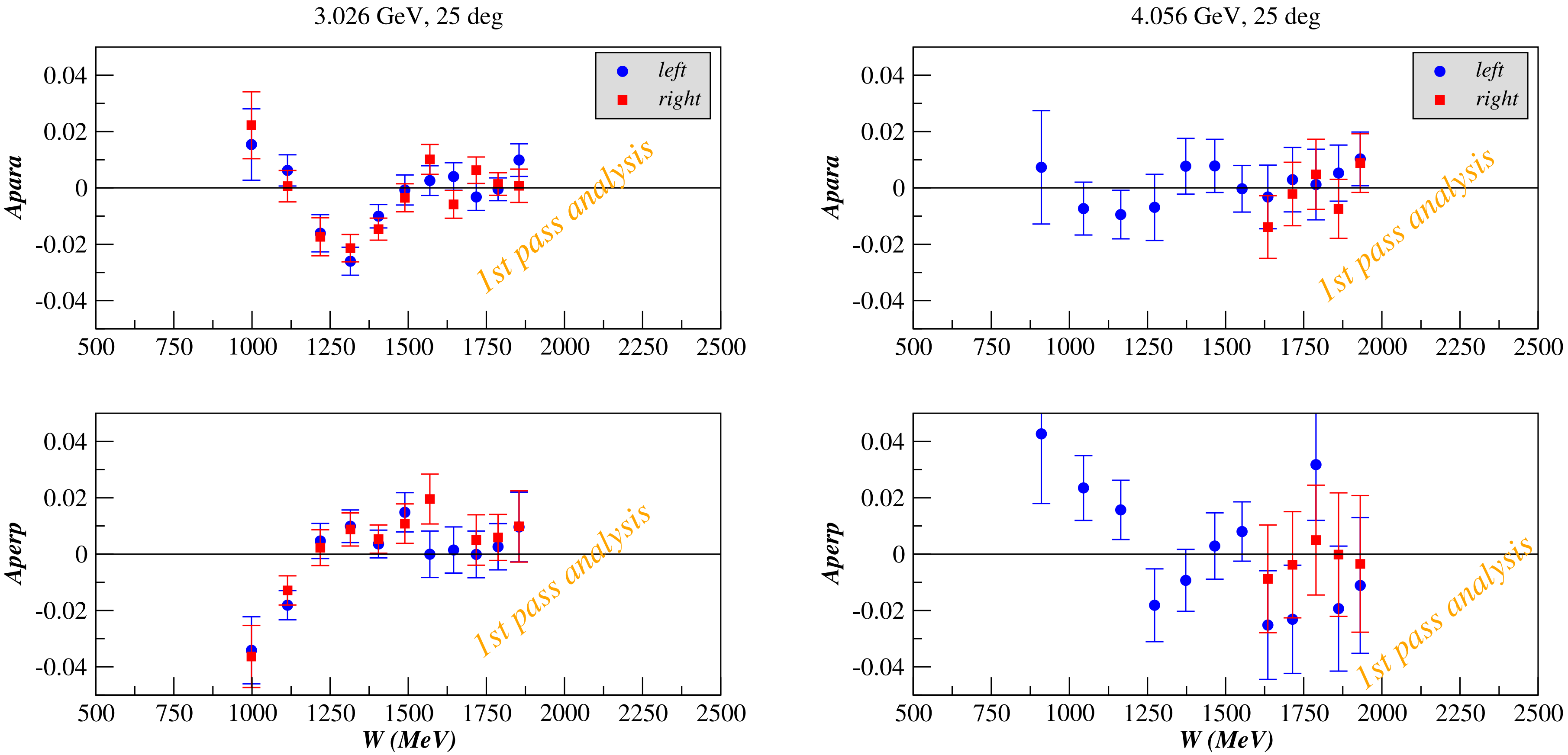


Charge Asymmetry

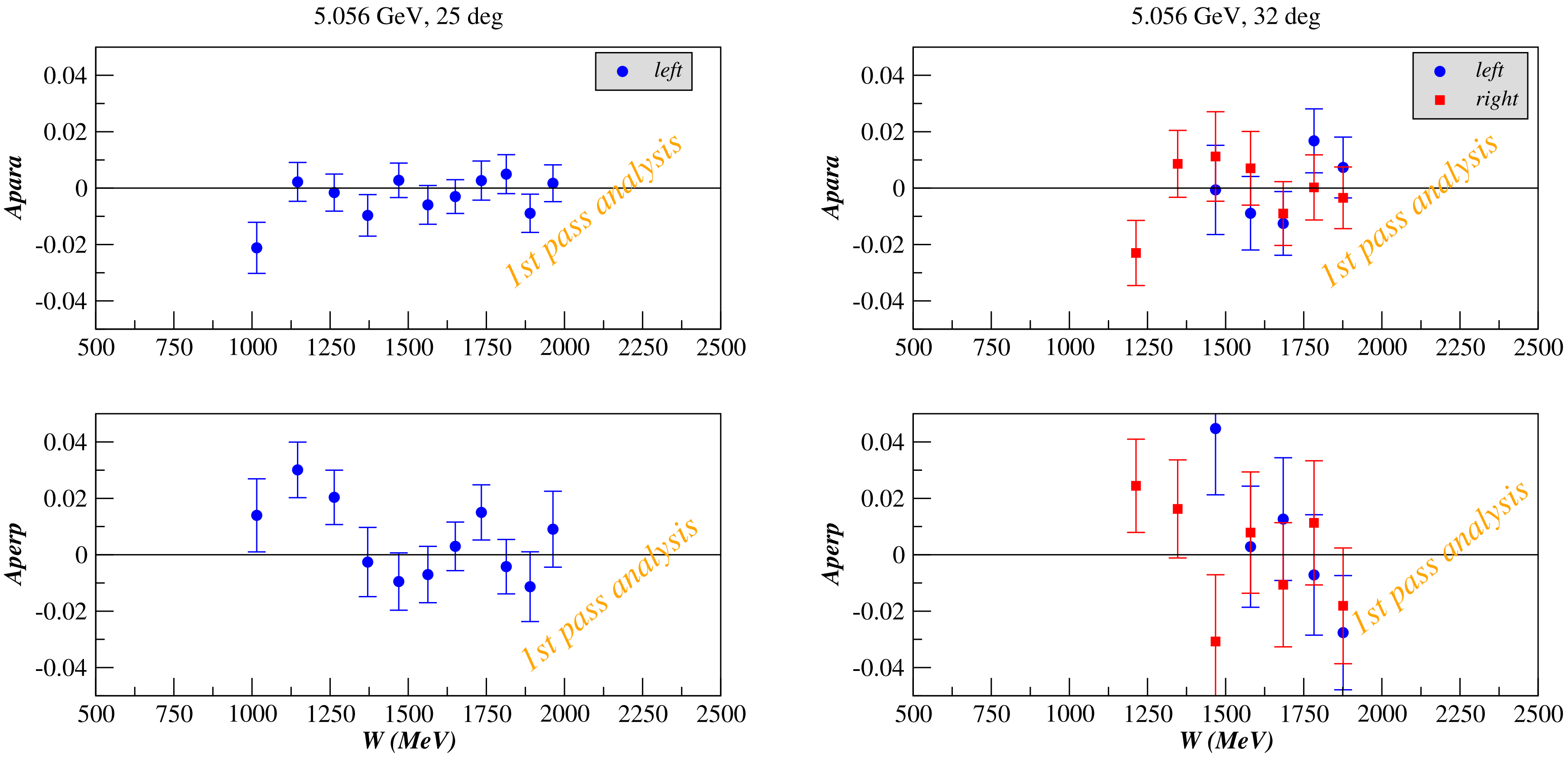


Mostly $Q_{asym} < 100$ ppm (ran Charge Asymmetry feedback).

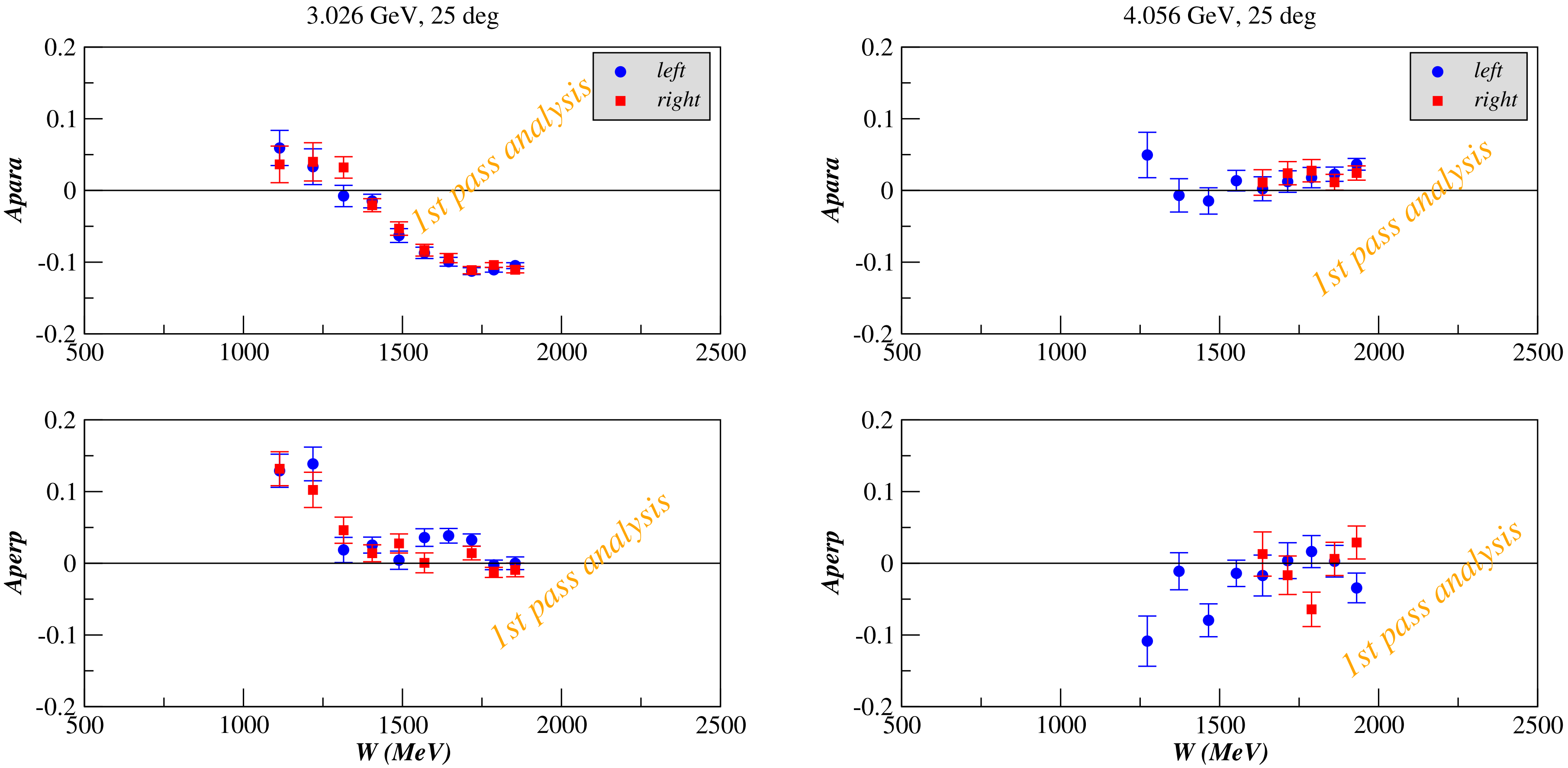
Physics Asymmetries



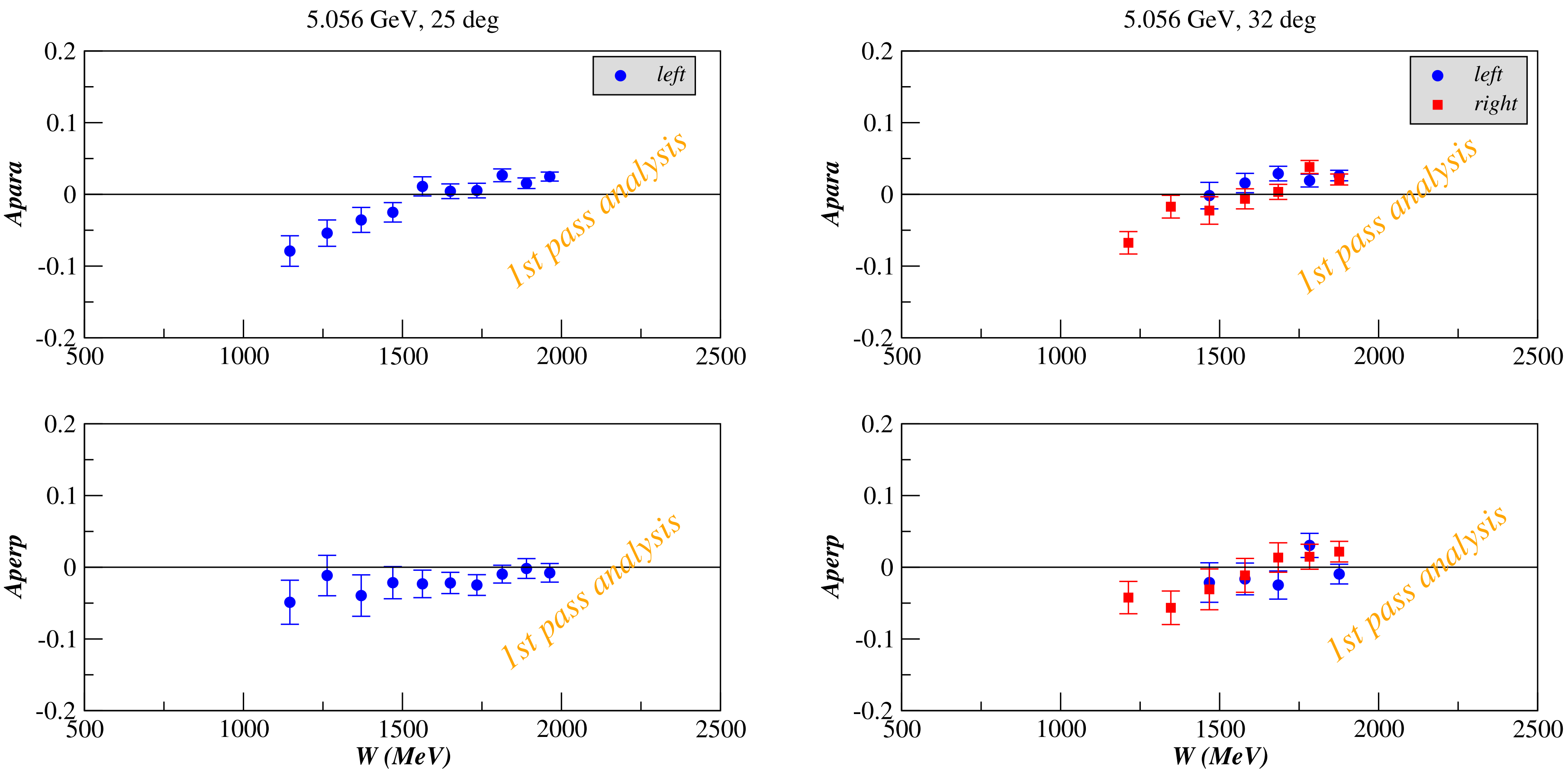
Physics Asymmetries



Pion Asymmetries

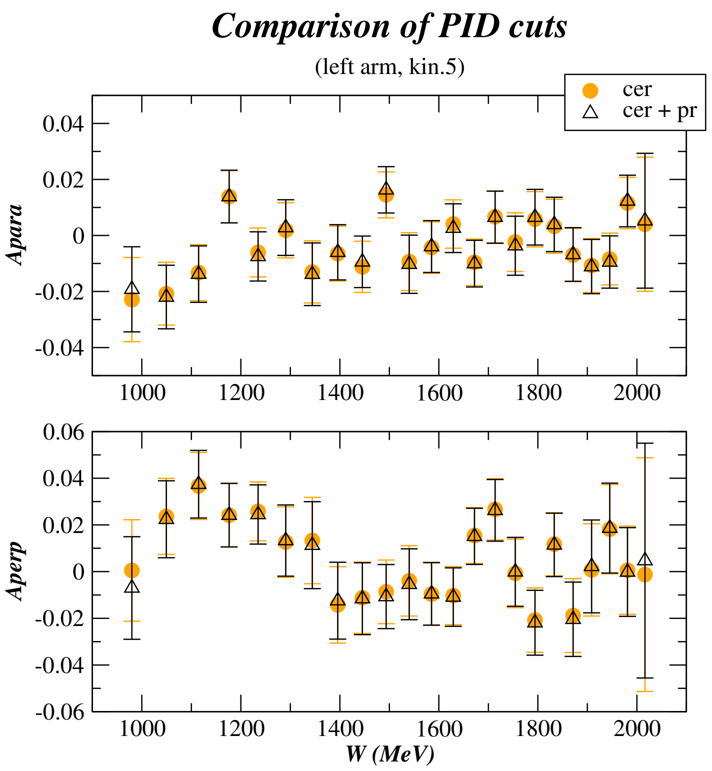


Pion Asymmetries

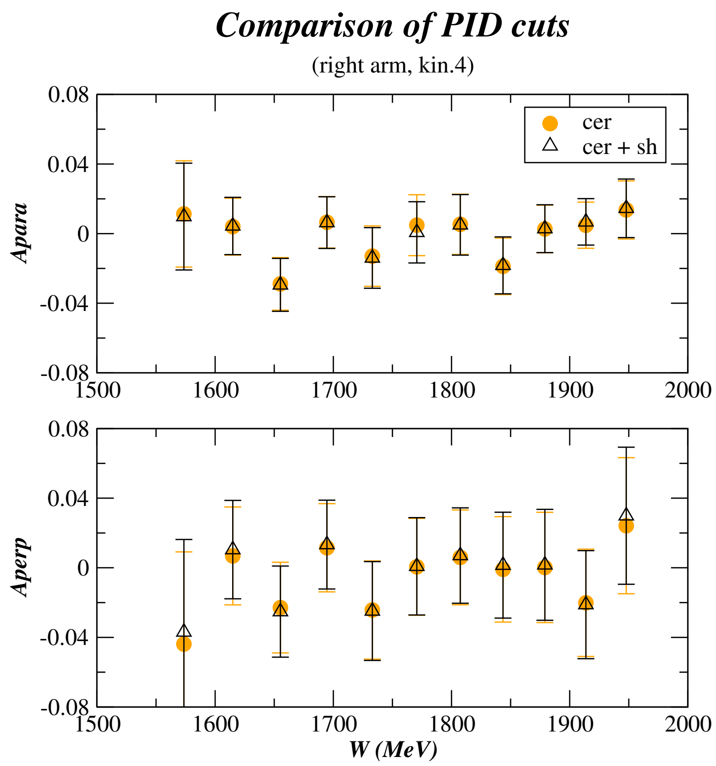


PID cut effect on asymmetries

5 GeV - 25°, $0.1 < \pi/e < 1.0$



4 GeV - 25°, $0.4 < \pi/e < 1.0$



$\longrightarrow$ Cerenkov detector does a pretty good job by itself.

Summary of the data analysis

Work done

- → PID calibration and efficiency.
- → BPM/raster correction for all runs.
- → Removed bad runs (short, DAQ or HRS problem, etc)
- → First asymmetries.

To do

- → Elastic and target analyses.
  (Both already pretty good from On-Line)
- → Regenerate asymmetries.
- → Extract cross-sections.
- → Radiative Corrections.
- → Extract g_1^n and A_1^n.