E01-006: Resonance Spin Structure (RSS)

- Inclusive scattering of polarized electrons off solid polarized NH_3 and ND_3 targets.
- Measured beam-target asymmetries with target polarization parallel ,$A_{||}$, and perpendicular ,$A_{\perp}$, to the beam.
- Q^2 centered at 1.3 GeV^2 and 0.8 $<$ W $<$ 1.9 GeV.
- Ran from Jan 21 to March 3, 2002
- Collaborators: Universitat Basel, Florida International University, Hampton University, Jefferson Laboratory, Mississippi State University, North Carolina A&T State University, Norfolk State University , Old Dominion University, Southern University at New Orleans, Tel Aviv University,University of Massachusetts, University of Maryland , University of North Carolina at Wilmington, University of Virginia, Virginia Polytechnic Institute, Yerevan Physics Institute

E01-006: Goals of Experiment

- Determine W dependence of A_1 and A_2 in the region of the resonances for both proton and deuteron.

$$A_1 = \frac{\sigma^T_{1/2} - \sigma^T_{3/2}}{\sigma^T_{1/2} + \sigma^T_{3/2}} \quad A_2 = \frac{2\sigma^{TL}_{1/2}}{\sigma^T_{1/2} + \sigma^T_{3/2}}$$

- Model free extraction of A_1 and A_2

$$A_{\parallel} = D(A_1 + \eta A_2) \quad A_{\perp} = d(A_2 - \psi A_1)$$

- Extraction of g_1 and g_2 spin structure functions from A_1 and A_2

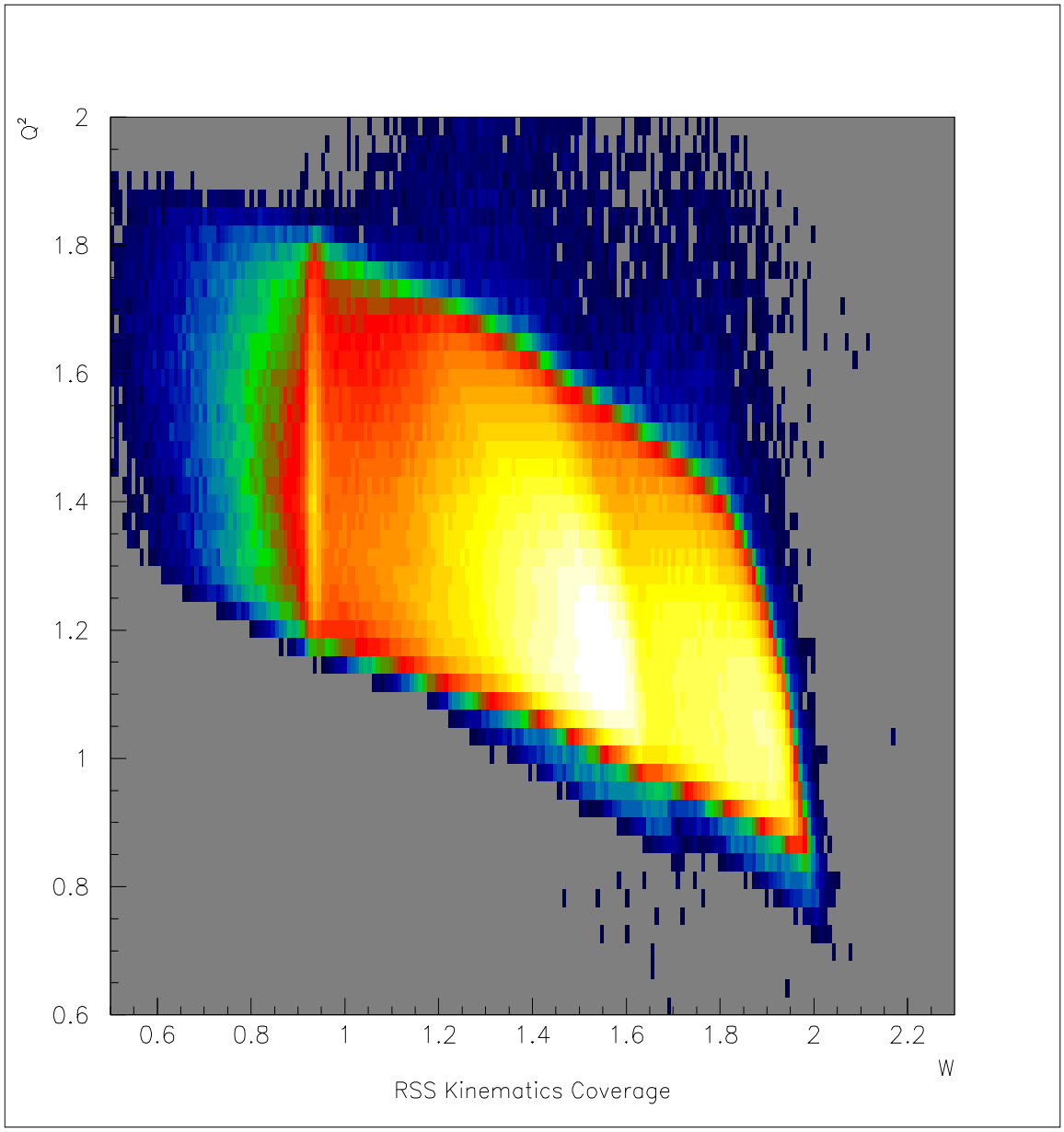
$$g_1 = \frac{F_1}{1+Q^2/\nu^2}(A_1 + A_2 \frac{Q}{\nu})$$
$$g_2 = \frac{F_1}{1+Q^2/\nu^2}(\frac{\nu}{Q} A_2 - A_1)$$

- Test local (Bloom-Gilman) duality for the spin structure functions

Kinematic coverage

E_{beam} = 5.755 GeV θ_e = 13.08° NH_3 target

Two settings of HMS central momentum of 4.707 and 4.081 GeV

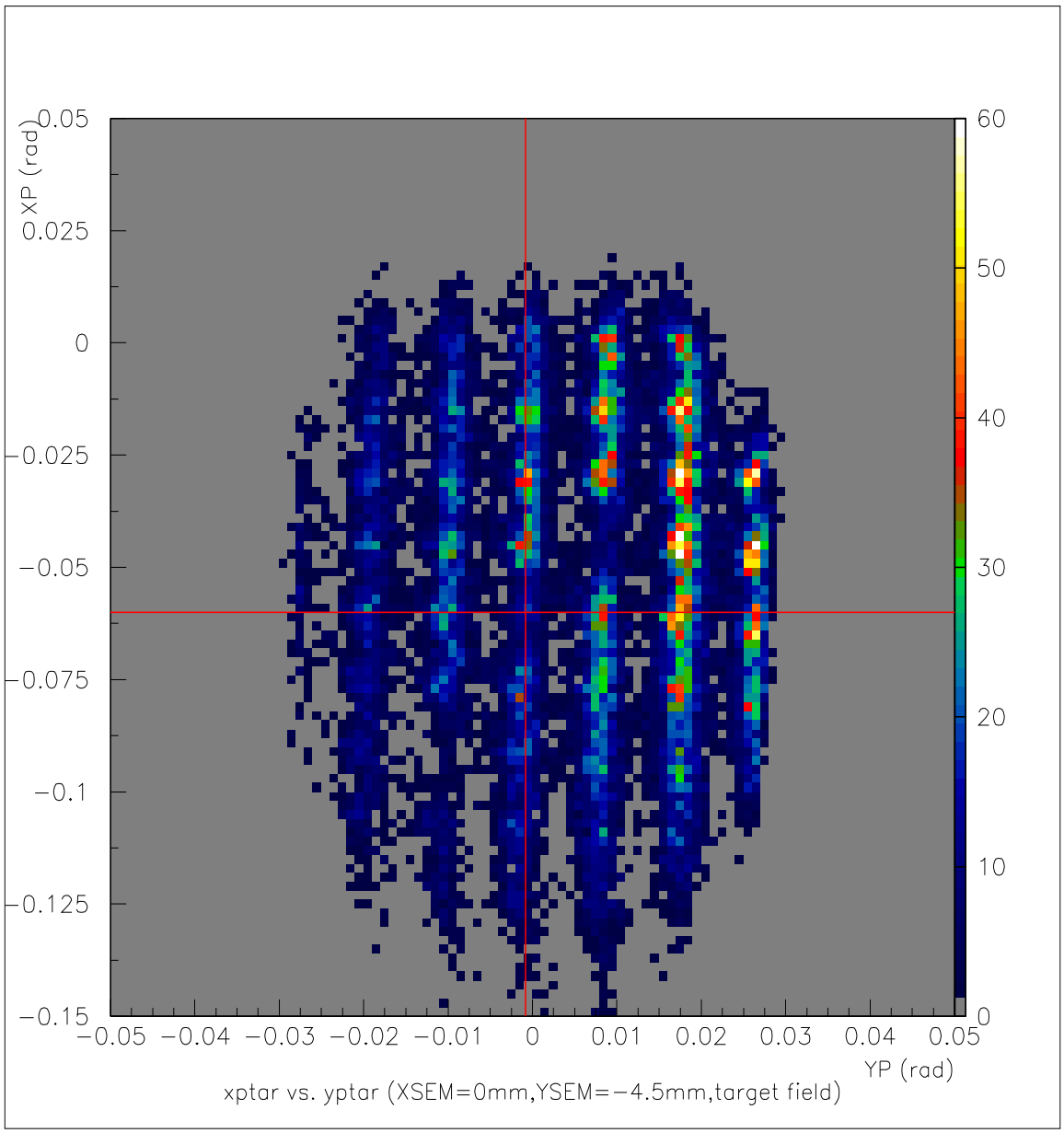


Optics studies

Runs	Target field	Beam pos X	Beam pos Y	Out-of-plane angle Expected	Out-of-plane angle Measured
43201	off	-2.3mm	0.0	0.0006	0.001
43355-6	perp	-9.0	4.5	-0.053	-0.050
43357-8	perp	0.0	-4.5	-0.059	-0.059

Runs	Target field	Beam pos X	Beam pos Y	In-plane angle Expected	In-plane angle Measured
43201	off	-2.3mm	0.0	-0.0014	-0.0024
43355-6	perp	-9.0	4.5	-0.005	-0.0064
43357-8	perp	0.0	-4.5	0.000	-0.0008

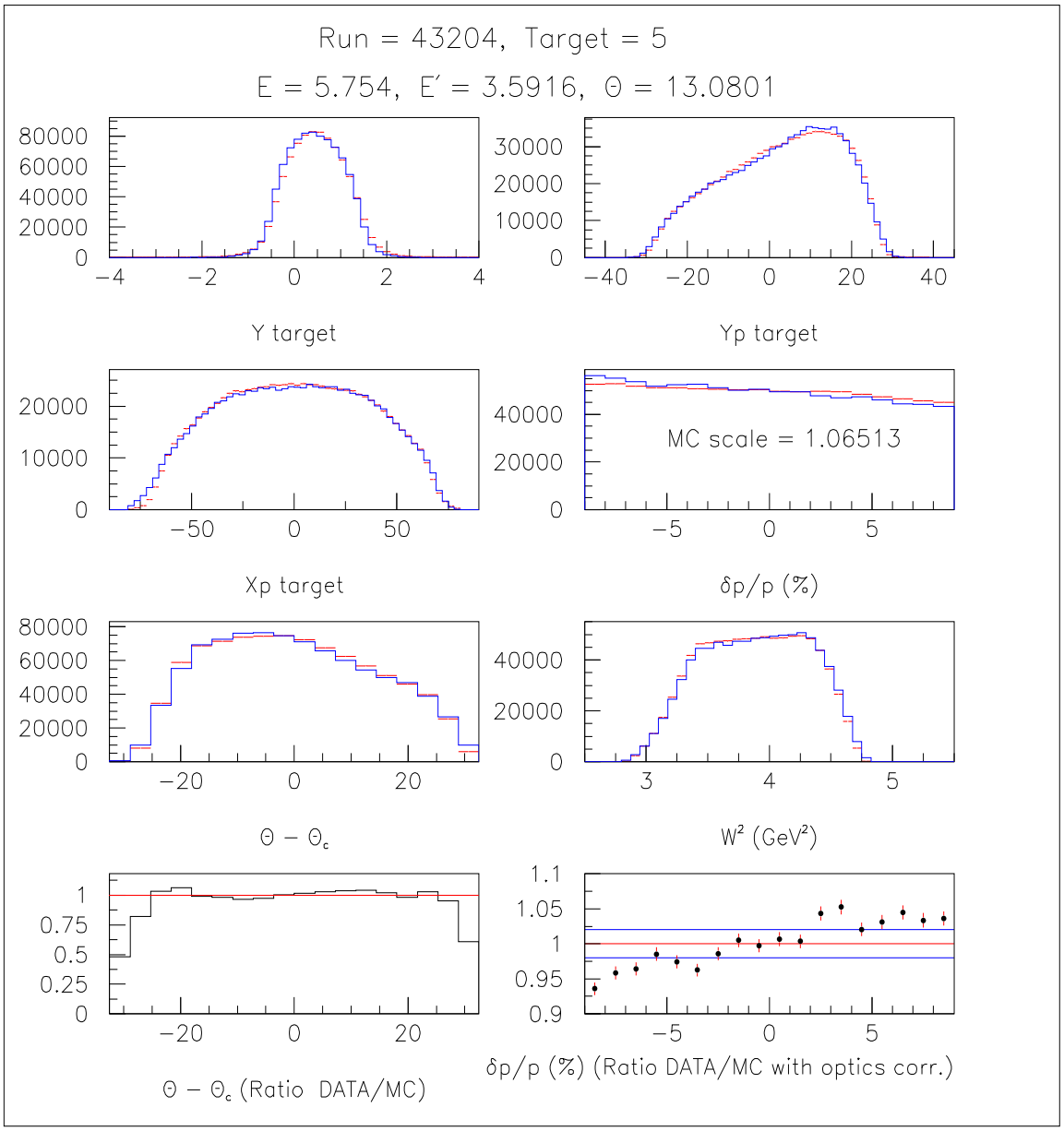
Optics studies with perpendicular target field



Thick carbon target with no target field

Eric Christy made comparison using MC for e99-118

modified for 1 cm radius raster and x_{tg} correction for δ and x'



Raw to Physical Asymmetry (A simple view)

$$A_{\text{raw}} = \frac{\frac{N^{\uparrow\Updownarrow}}{C^{\uparrow}} - \frac{N^{\downarrow\Updownarrow}}{C^{\downarrow}}}{\frac{N^{\uparrow\Updownarrow}}{C^{\uparrow}} + \frac{N^{\downarrow\Updownarrow}}{C^{\downarrow}}}$$

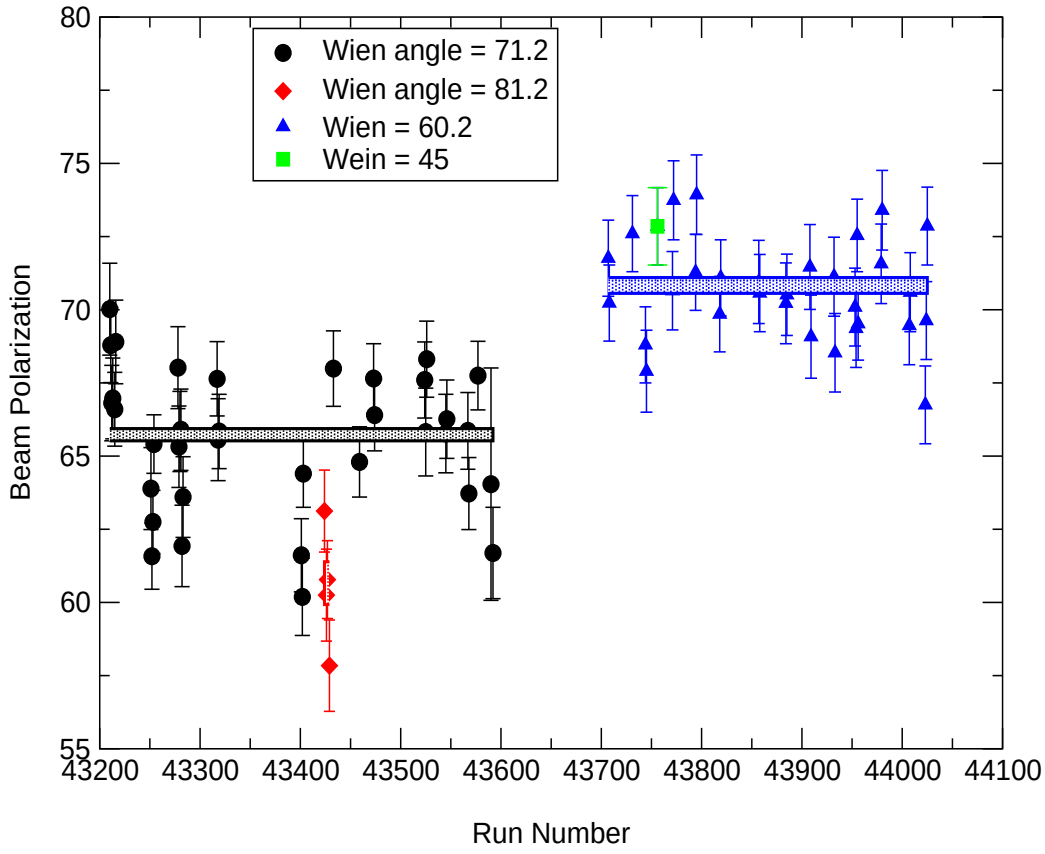
N are counts for beam helicity parallel ($\uparrow$) and anti-parallel ($\downarrow$) for a given target polarization ($\Updownarrow$)

Counts are normalize amount of charge ,C , for each beam helicity.

$$A_{\parallel} \text{ or } A_{\perp} = \frac{A_{\text{raw}}}{f P_{beam} P_{target}} + A_{RC}$$

$$\begin{aligned} f &= \text{Dilution factor} \\ P_{beam} &= \text{Beam Polarization} \\ P_{target} &= \text{Target Polarization} \\ A_{RC} &= \text{Radiative Corrections} \end{aligned}$$

Beam Polarizations



Wien angle	Weighted average	Gaussian
71.2°	65.55 ± 0.22	65.55 ± 2.6
81.2°	60.66 ± 0.73	
60.2°	70.74 ± 0.24	70.74 ± 1.7

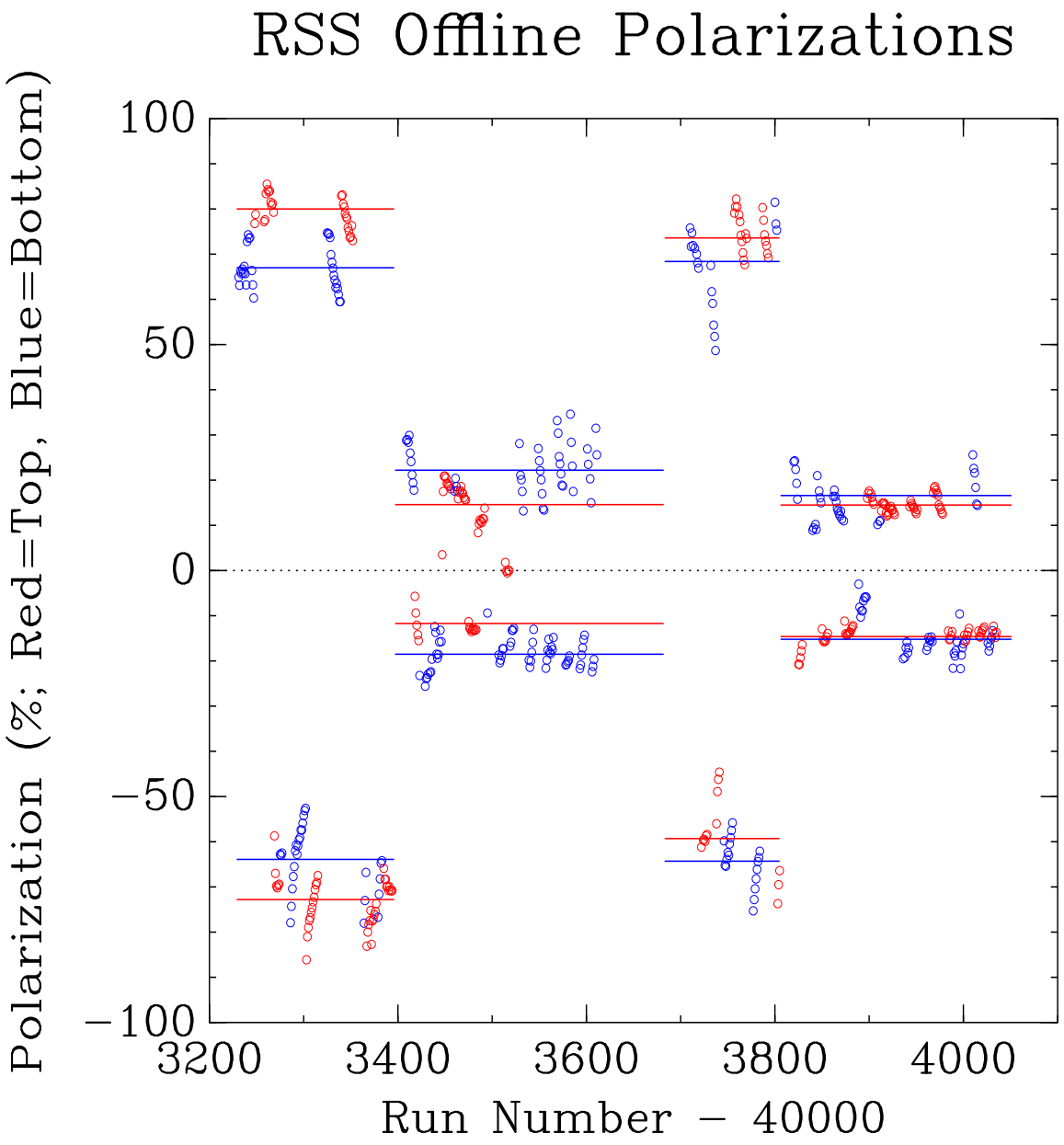
Target Polarizations

- Work by Paul McKee and students at UVa.
- Offline analysis of Thermal Equilibrium data done to get calibration for determining target polarization.
- Determine target polarization for each run

Target	Target Field	Target polarization	
		Pos (charge C)	Neg
Top ND_3	PERP	+14.6 (6.21e-03)	-11.7 (3.54e-03)
Bot ND_3	PERP	+22.2 (1.31e-02)	-18.5 (1.78e-02)
Top ND_3	PARA	+14.5 (1.30e-02)	-14.6 (1.61e-02)
Bot ND_3	PARA	+16.6 (7.59e-03)	-15.2 (9.42e-03)
Top NH_3	PERP	+80.0 (4.44e-03)	-72.8 (8.16e-03)
Bot NH_3	PERP	+67.0 (4.90e-03)	-63.9 (7.28e-03)
Top NH_3	PARA	+73.6 (6.26e-03)	-59.3 (4.99e-03)
Bot NH_3	PARA	+68.4 (4.25e-03)	-64.3 (5.38e-03)

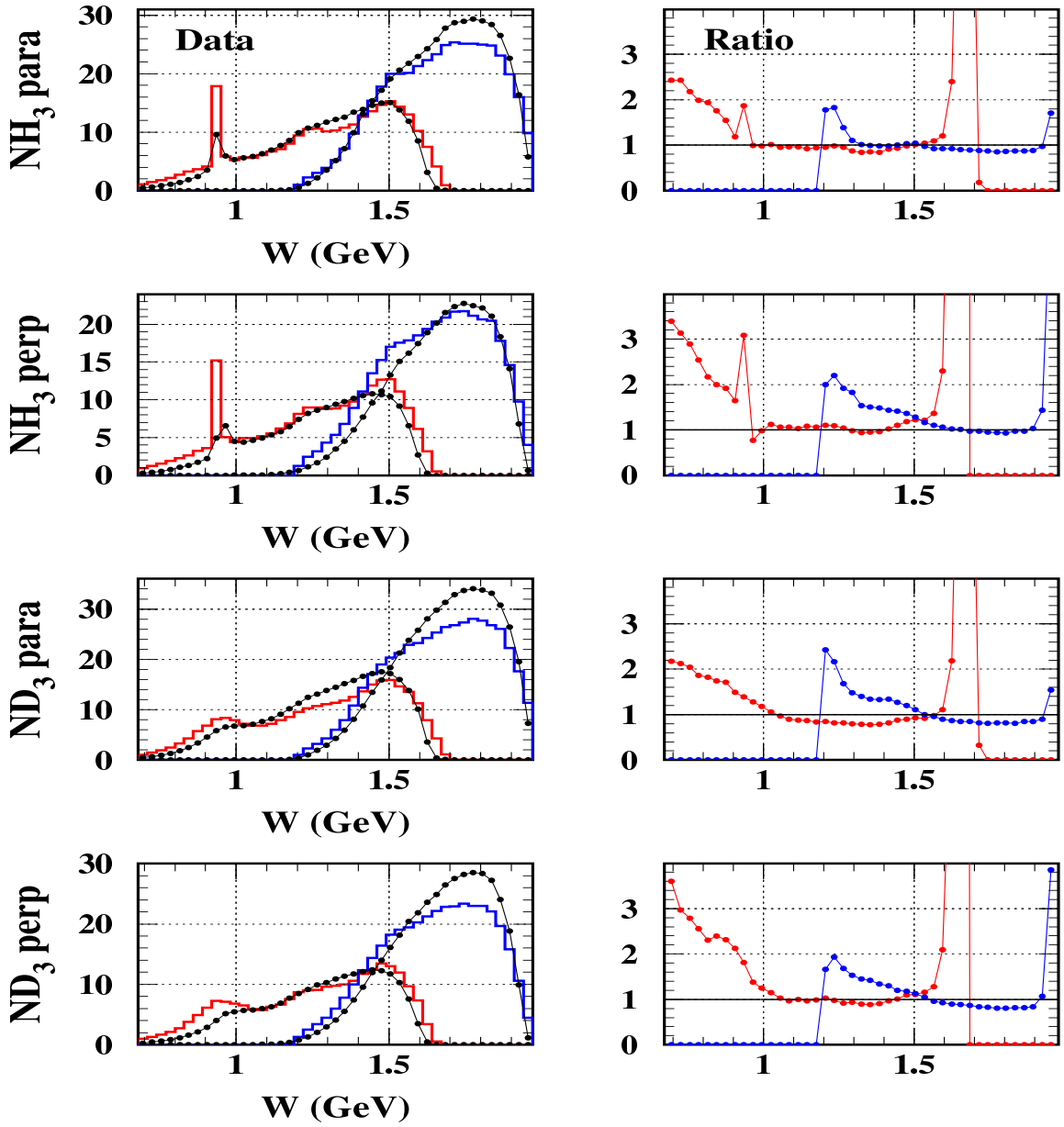
Note: During PERP running Top ND_3 cell could not be fully inserted so data not presently being used.

Summary Plot of Target Polarizations



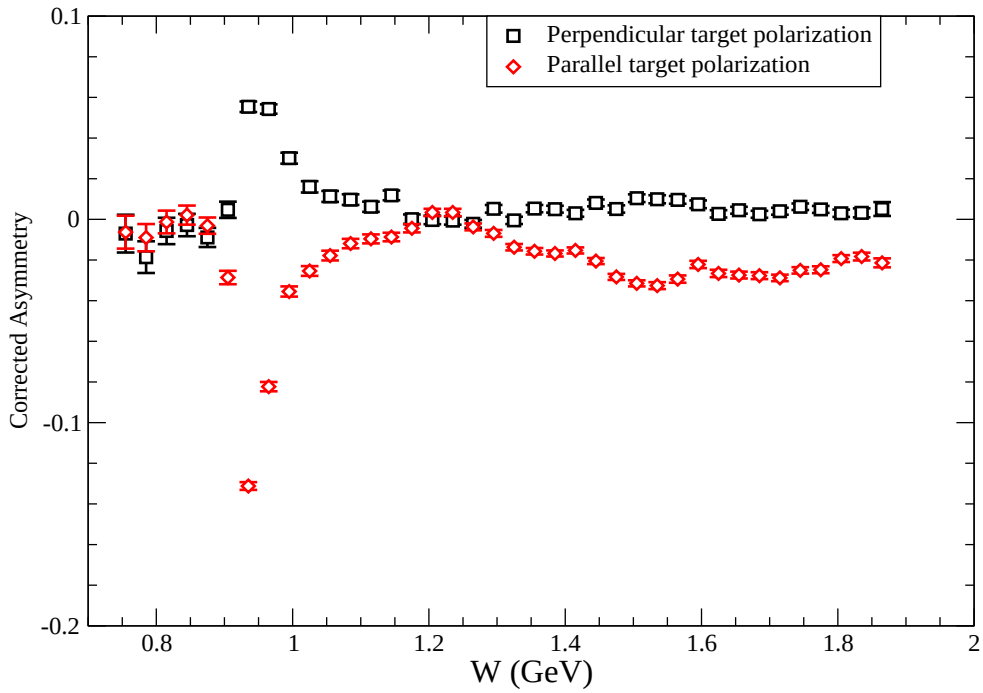
Inelastic scattering on Polarized target

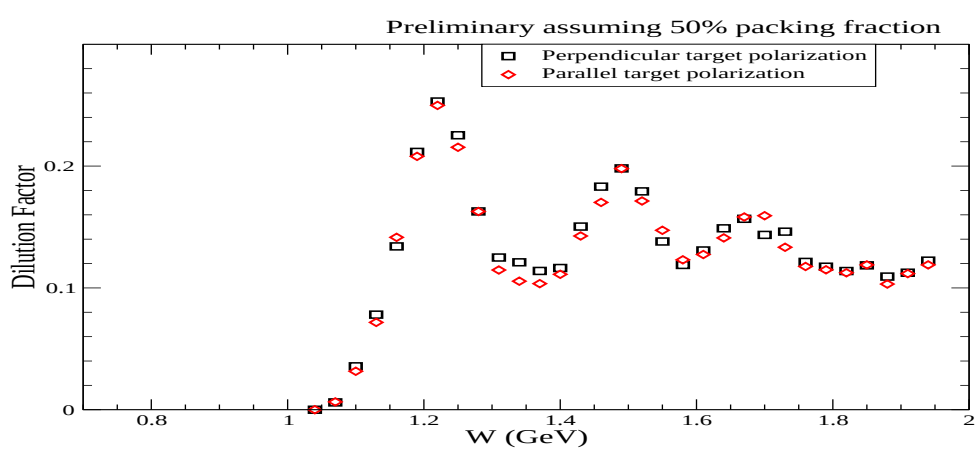
Monte Carlo by Hongguo Zhu



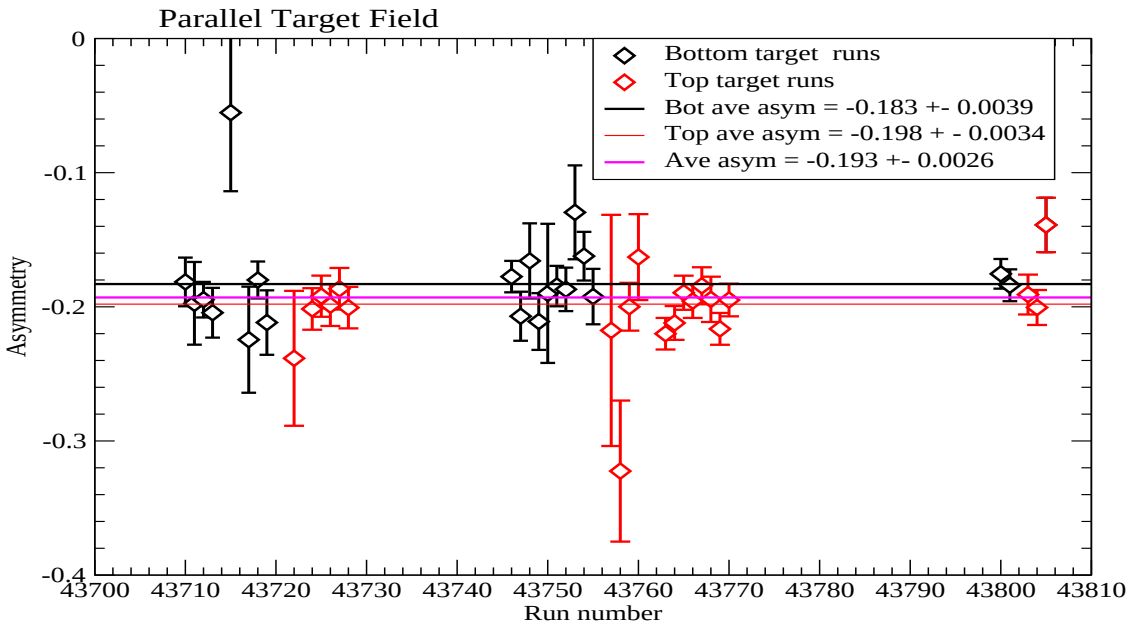
NH_3 corrected asymmetries and dilution factors

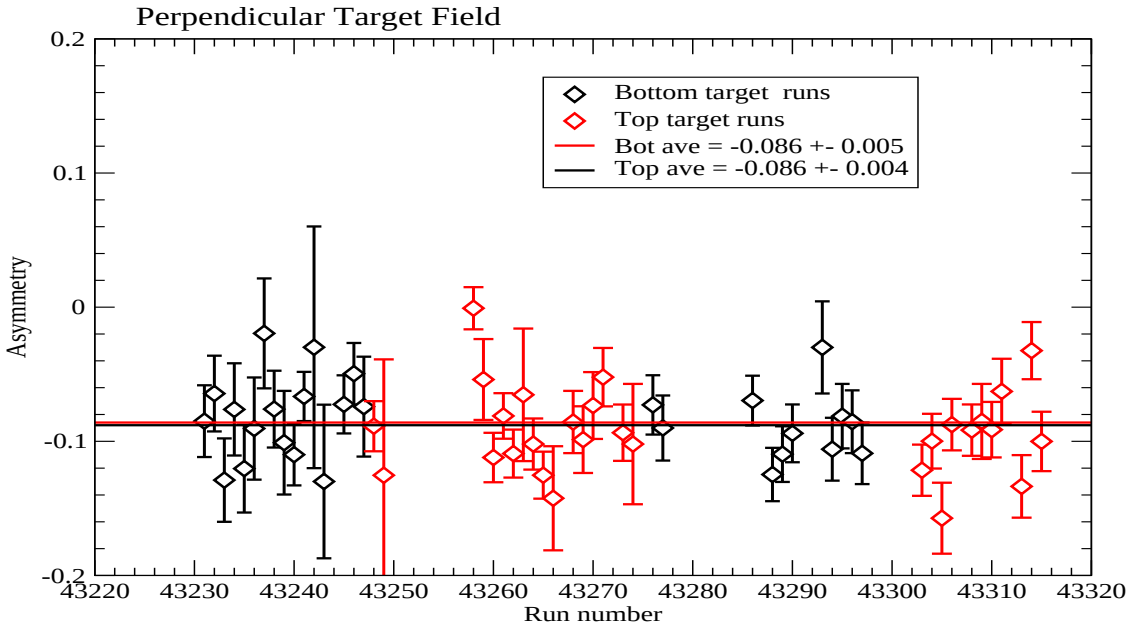
Replay by Frank Wesselmann





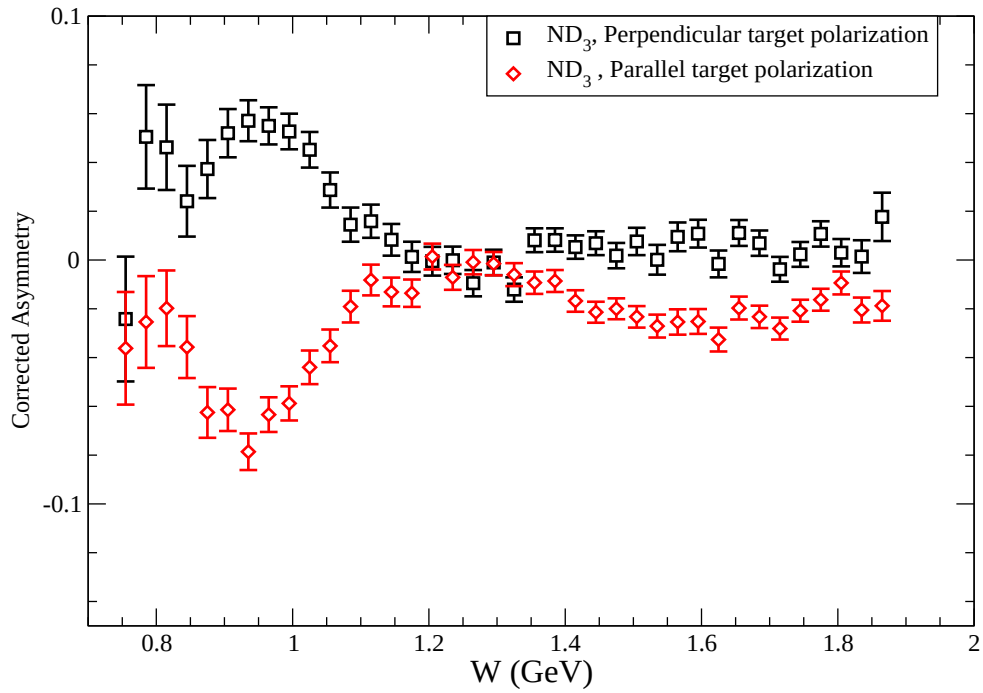
Elastic ep asymmetries

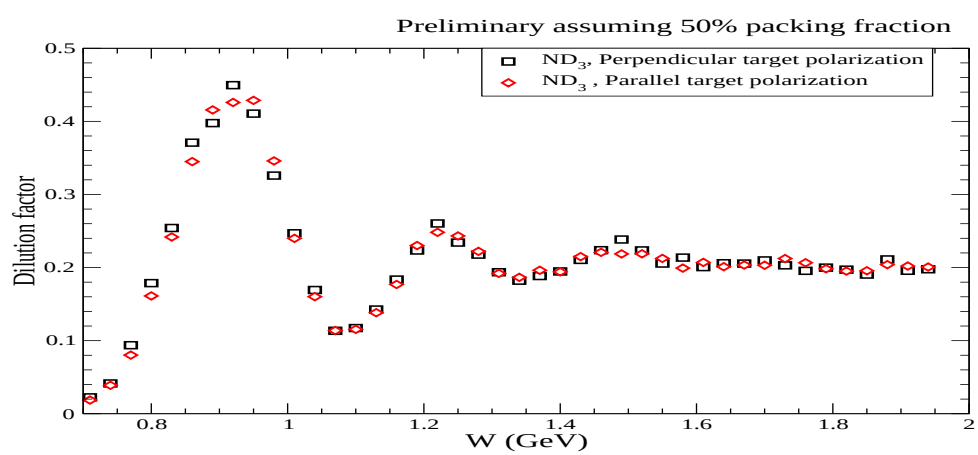




ND_3 corrected asymmetries and dilution factors

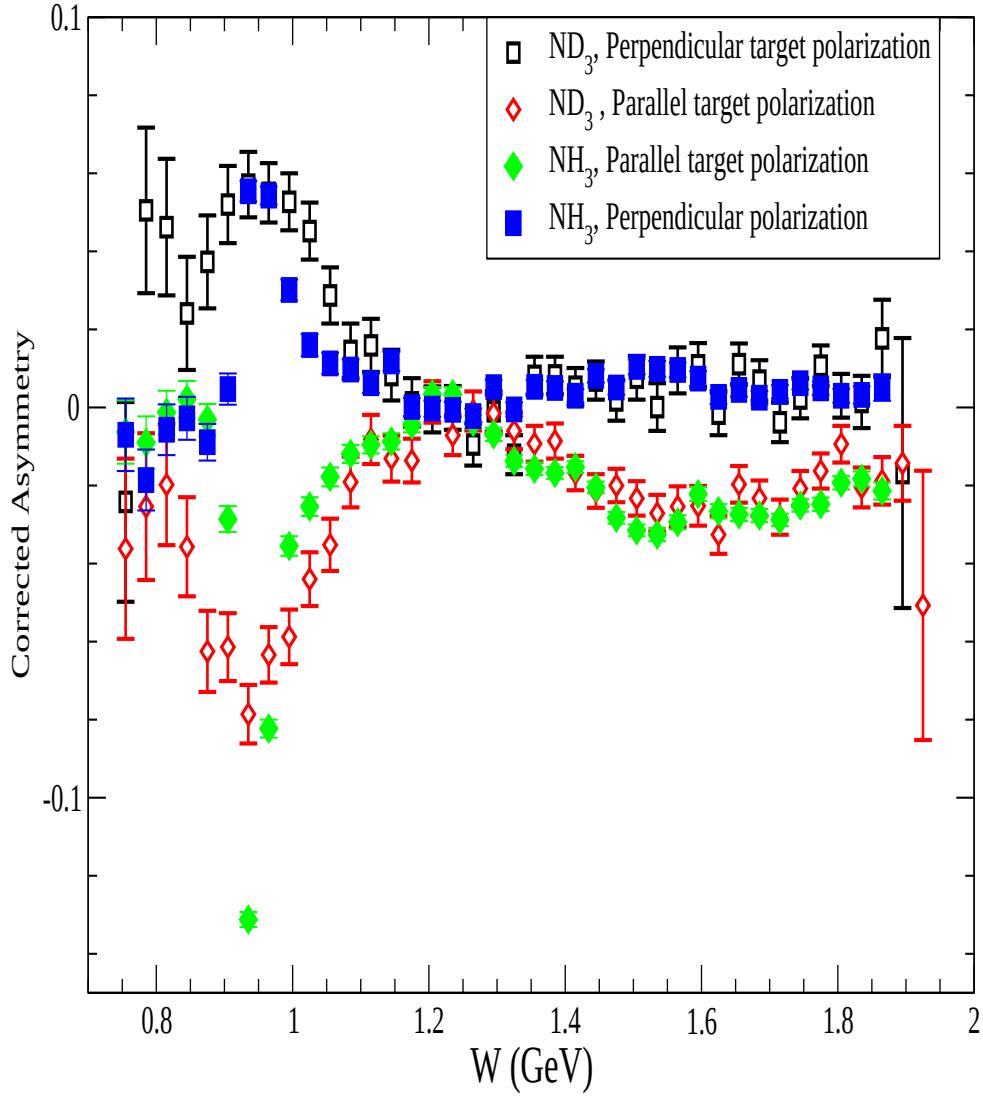
Replay by Frank Wesselmann





Comparison of NH_3 and ND_3 Asymmetries

Replay by Frank Wesselmann



E01-006: Future of Analysis

- Fine tune the Monte Carlo (Hongguo Zhu) .
- Determine packing fraction. Starting from code by Nikolai Savvinov (Hamlet and Yerevan group)
- Radiative corrections (Junho Yun)
- Determine target polarization systematic errors (Paul McKee)
- Run through data analysis another time. (Frank Wesselmann)
- Determine proton elastic asymmetry

Planning on having preliminary results for proton and deuteron $A_{\perp}$ and $A_{||}$ without radiative corrections by April.