Preliminary Spin Asymmetry Results from SANE

James Maxwell
Univ. of Virginia Polarized Target Group

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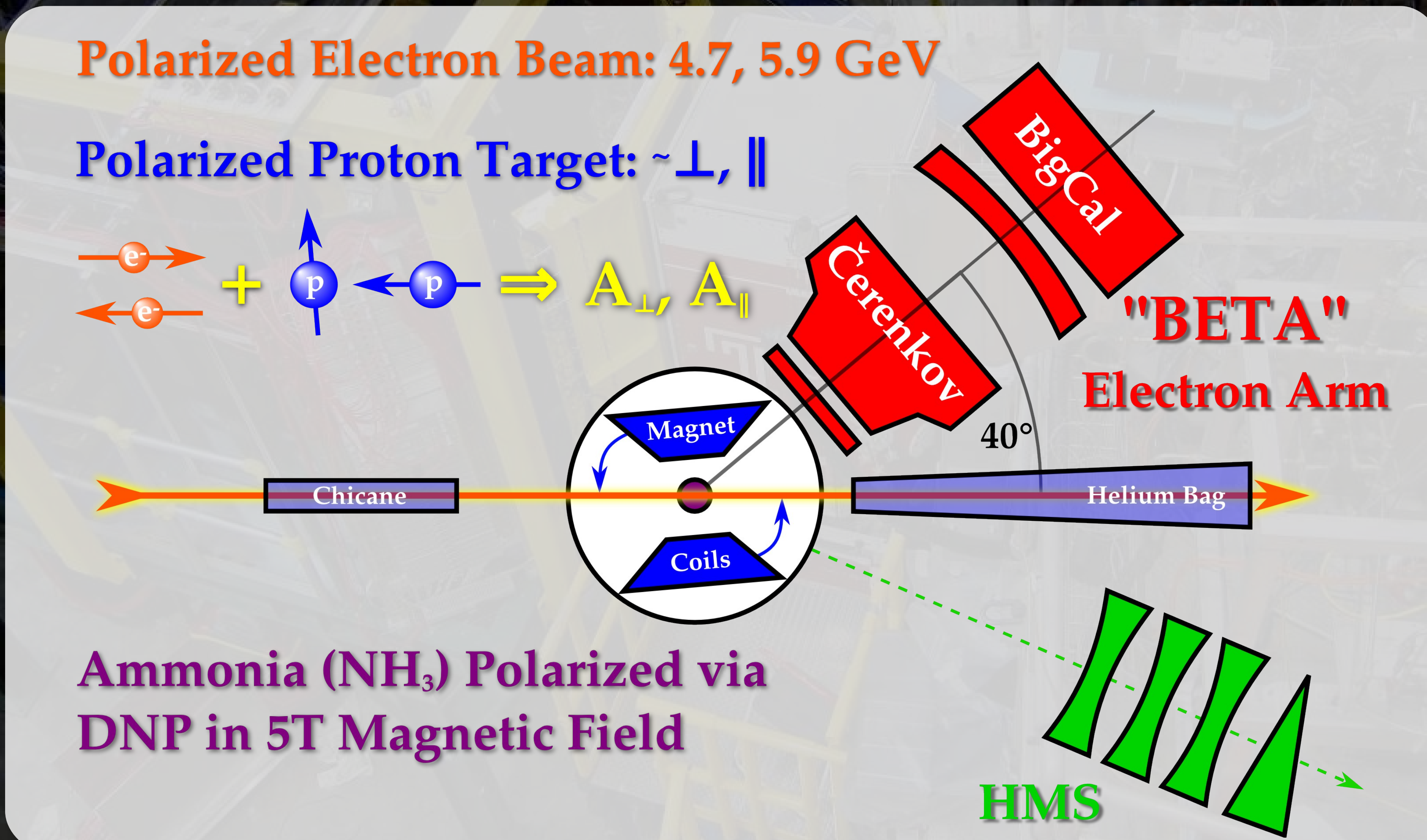
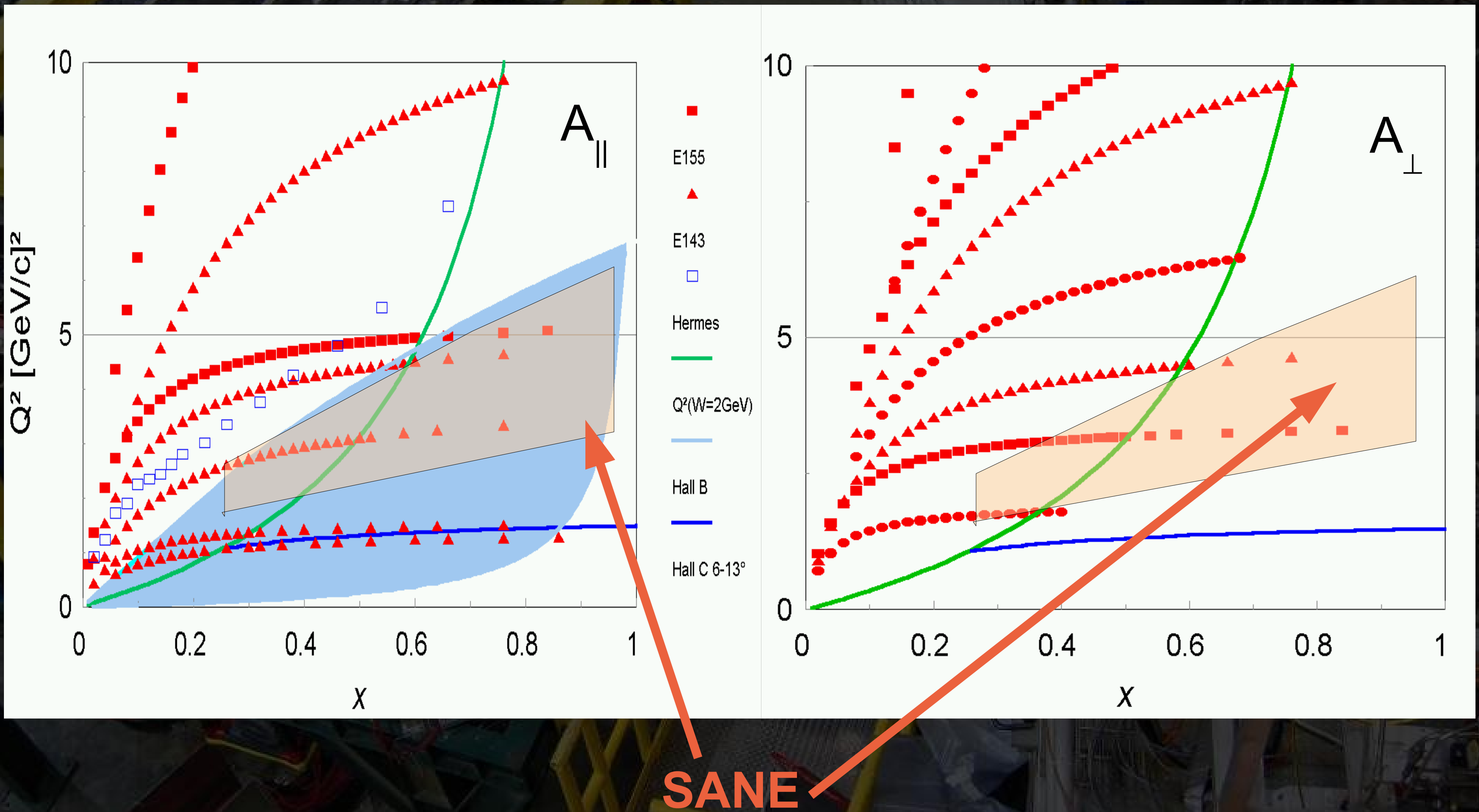
Spin Asymmetries on the Nucleon Experiment

- Spin Asymmetry $A_1(x,Q^2)$, Spin Structure Function $g_2(x,Q^2)$ at $2.5<Q^2<6.5$ and $0.3<x<0.8$. Ran in JLab's Hall C in 2009.



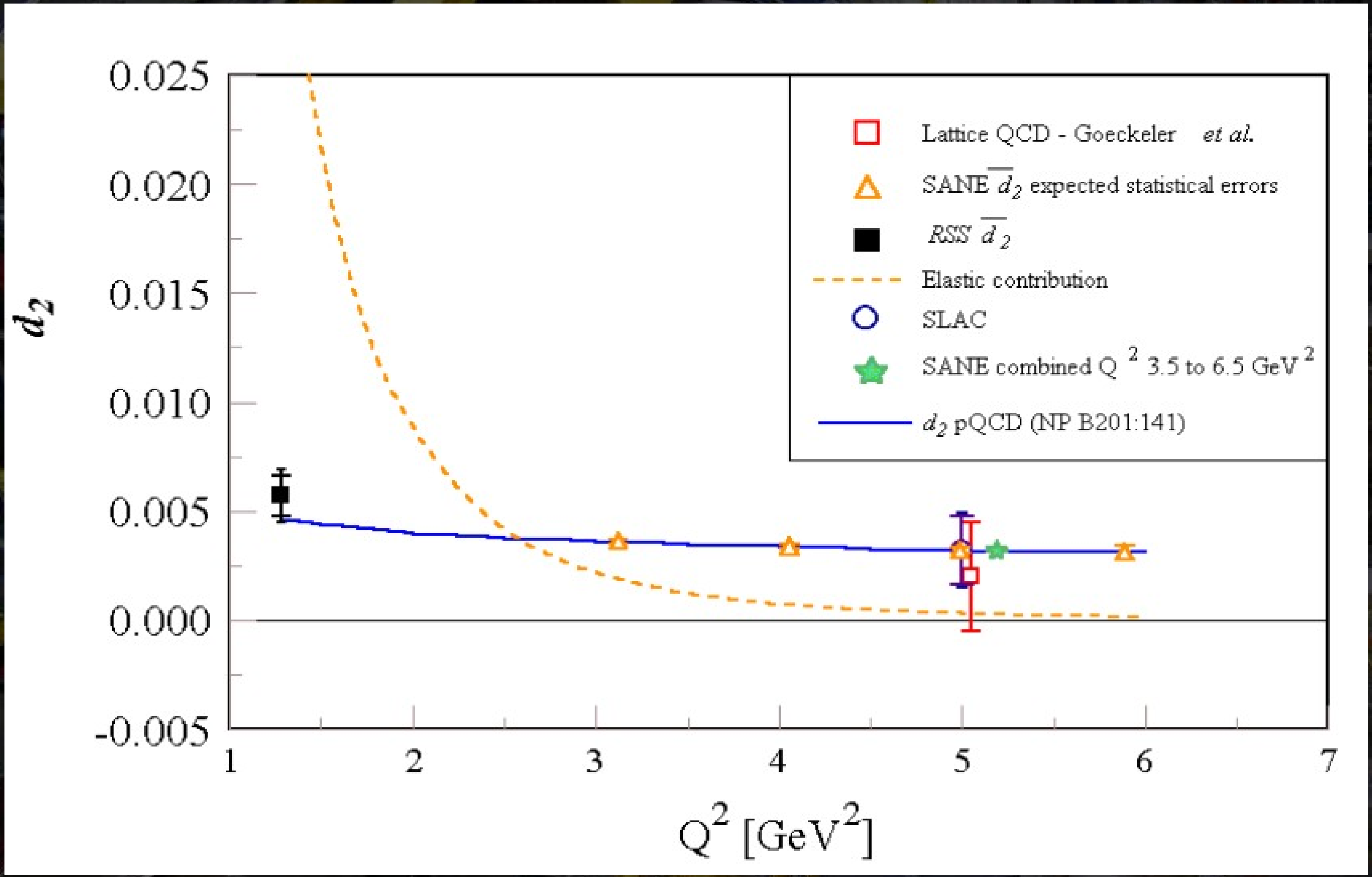
SANE Kinematic Coverage



- $A_{\perp}$ largely unexplored, particularly at high x

Matrix Element d_2

$$d_2 = \int_0^1 x^2 (2g_1 + 3g_2) dx$$



Preliminary Results

- Preliminary cuts for asymmetries
  - Reconstructed cluster energies >1.0 GeV
  - Single cluster events in calorimeter
  - Electrons tagged by Čerenkov to match cluster in calorimeter

$$A_{\parallel,\perp} = \frac{1}{C_N f P_B P_T} \left(\frac{N^{\uparrow\downarrow} - N^{\uparrow\uparrow}}{N^{\uparrow\downarrow} + N^{\uparrow\uparrow}} \right) + A_{RC}$$

- In addition to counting yields (N), need corrections due to:
  - P_B – Beam Electron Polarization
  - P_T – Target Proton Polarization
  - f – Dilution Factor: Packing fraction, Protons in $^{14}NH_3$

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  - P_T – Target Proton Polarization
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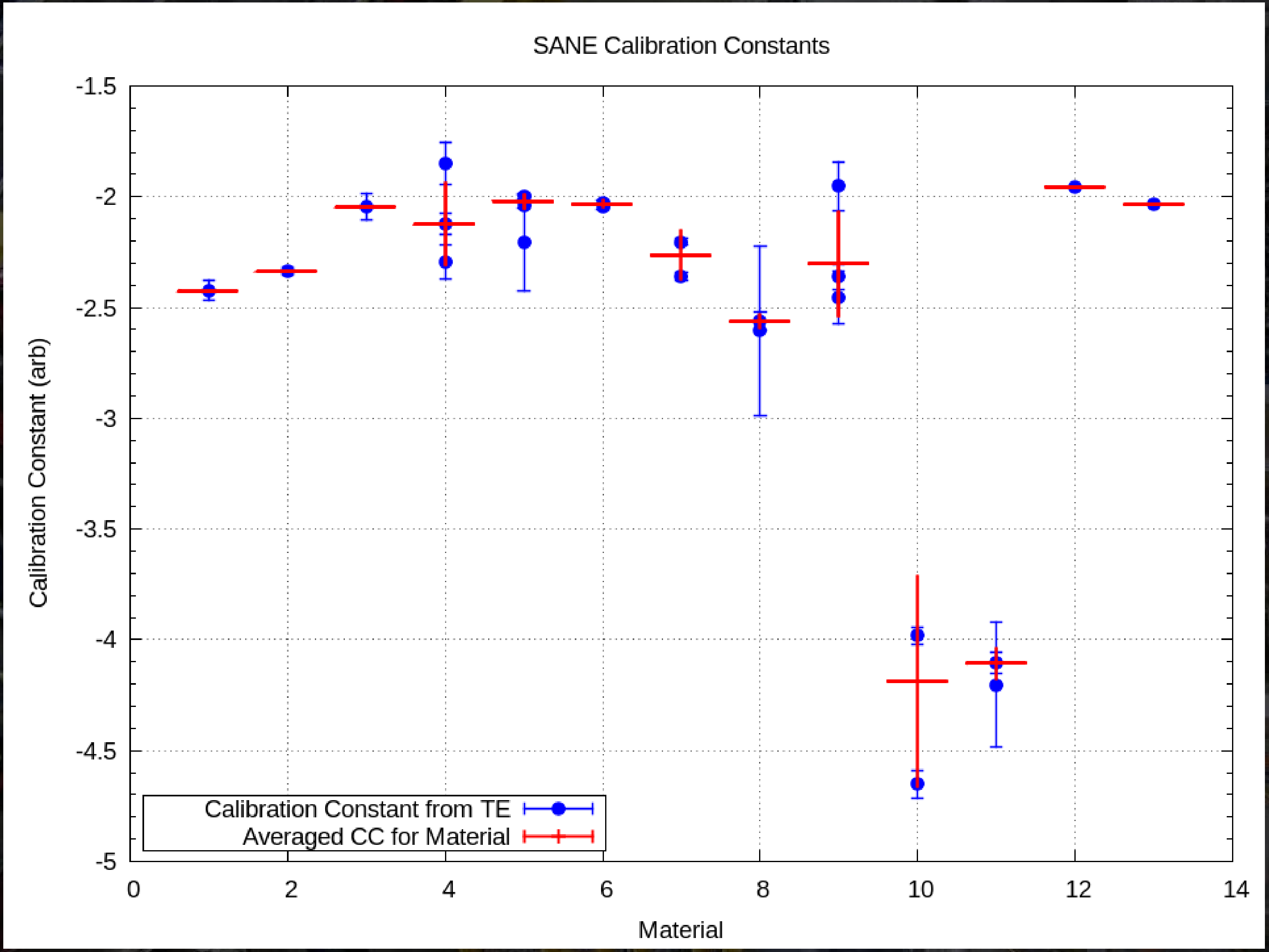
Preliminary Results: Target Polarization



- "Error" on averaged CC is standard deviation of CCs

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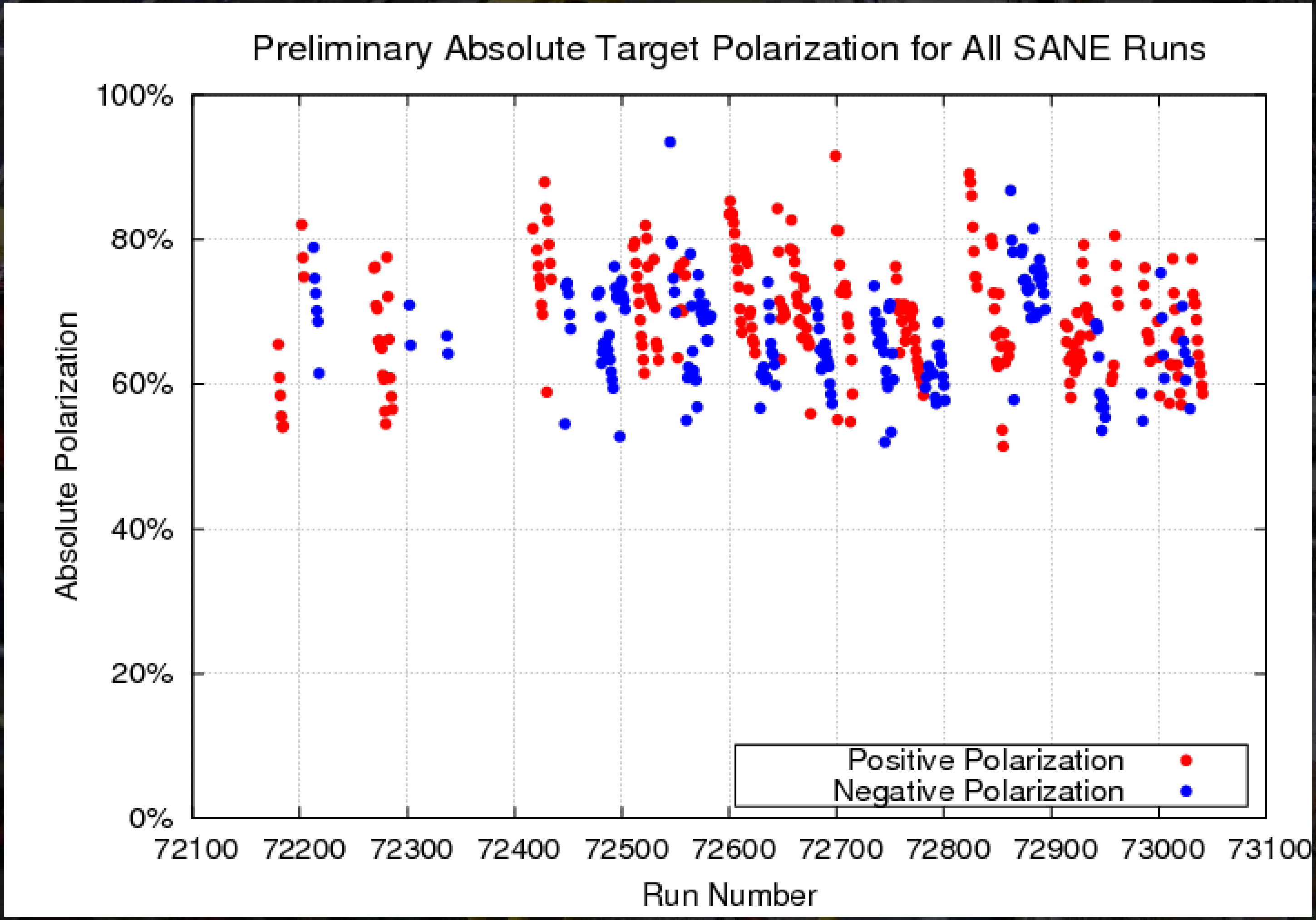
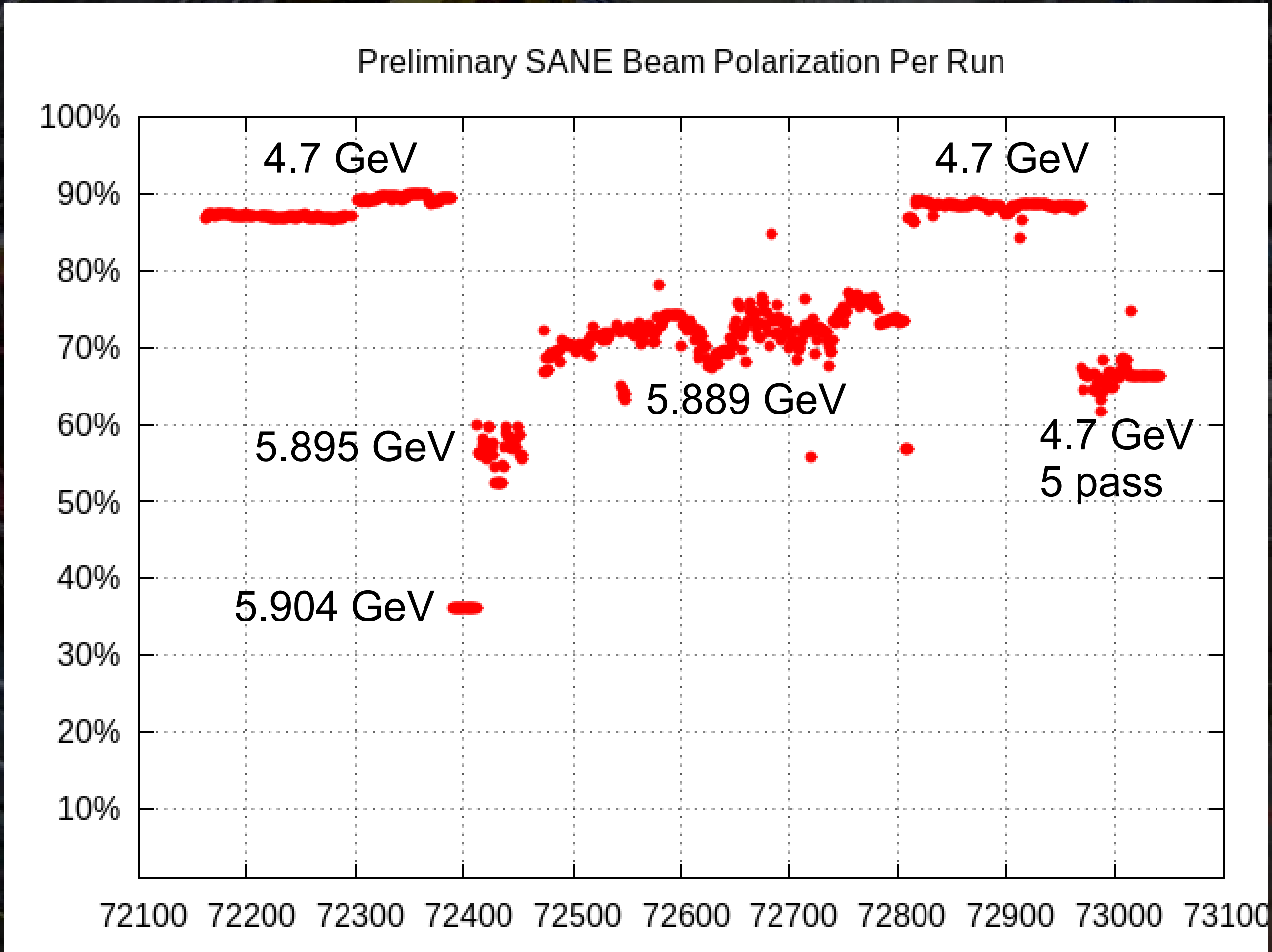


- Charge averaged absolute target polarization per configuration:

5.9-perp: 69% 4.7-perp: 66% 5.9-para: 66% 4.7-para: 68%

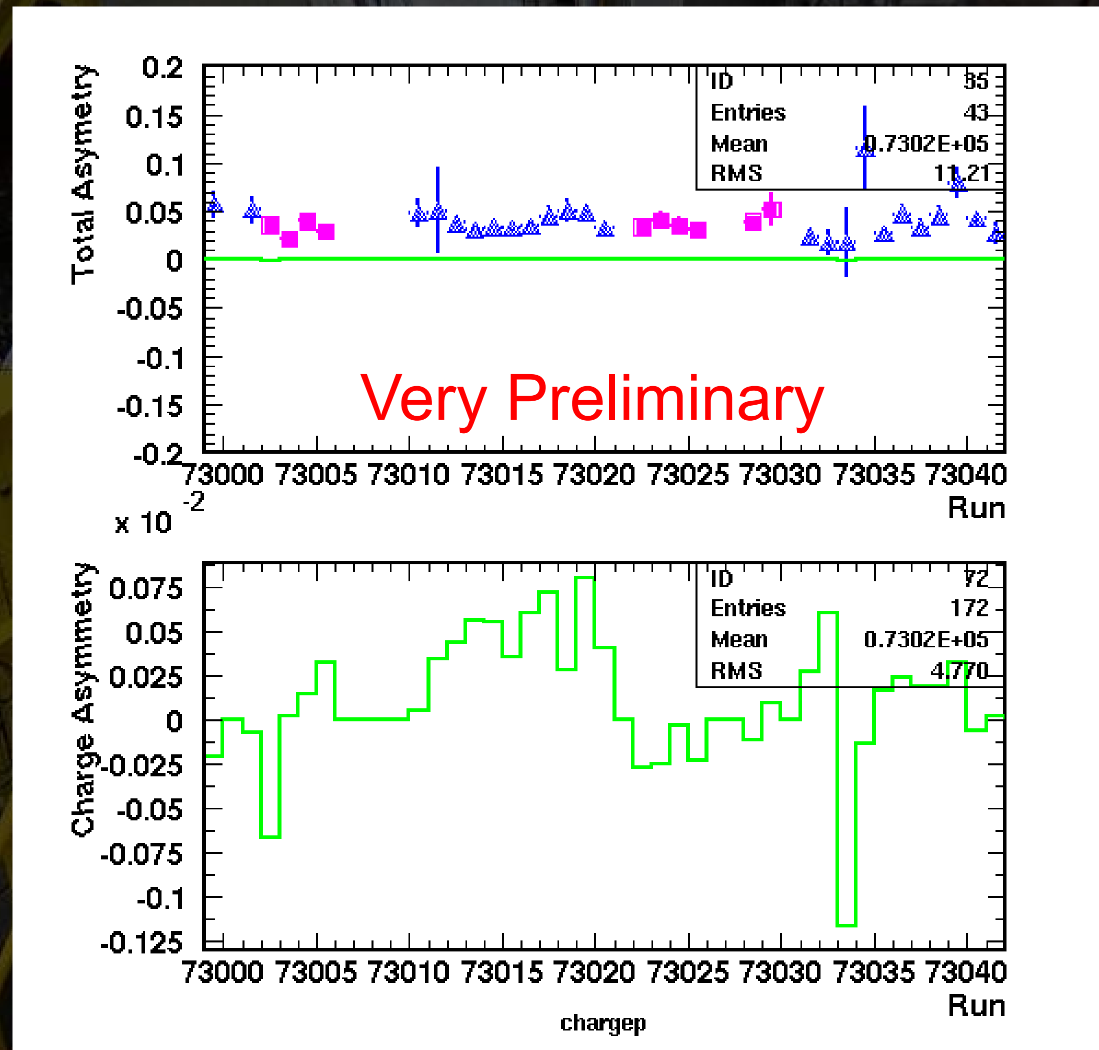
Preliminary Results: Beam Polarization



- Beam polarization highly dependent on beam energy
  - Labels: beam energies for sets of runs

From Packing Fraction to Dilution Factor: HMS

- Runs 73000-73041
  - Beam E = 4.7 GeV
  - Parallel field
- HMS_P = 3.2 GeV
- HMS_θ = 20.2 º
- Stable total asymmetries, small charge asymmetries

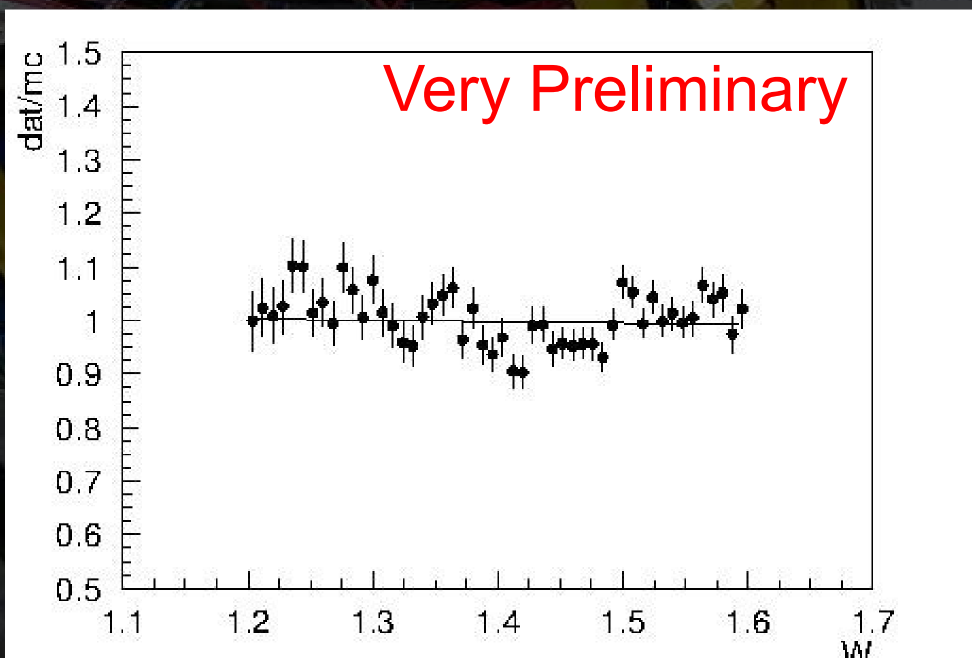


Blue – Total asymmetry of each run
(corrected by dead time, polarization, and charge)
Green – Charge asymmetry

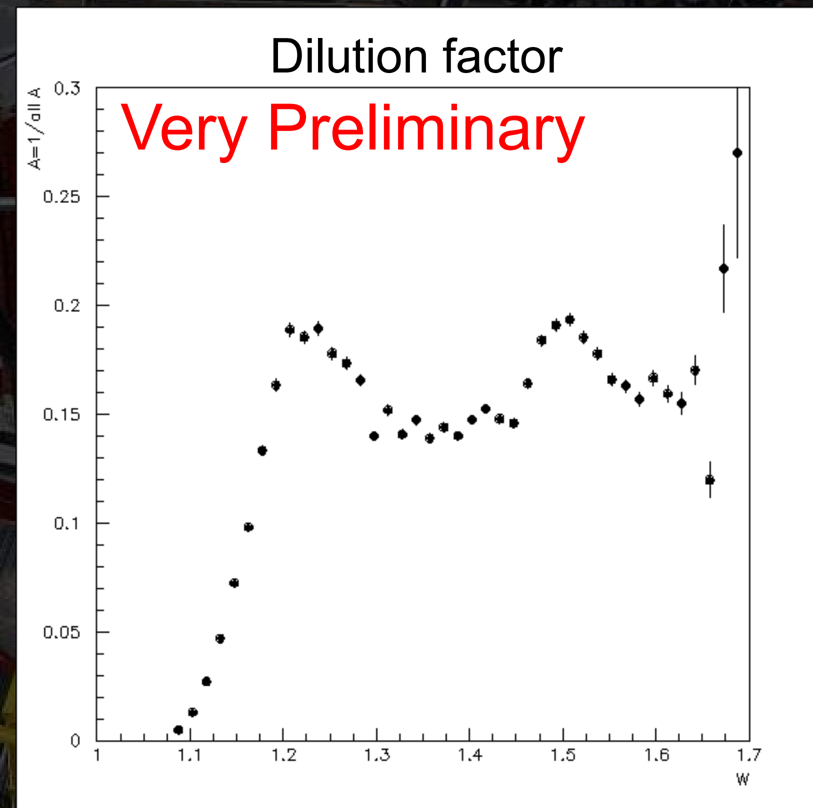
* Slide from Hoyoung Kang

From Packing Fraction to Dilution Factor: HMS

- Comparing data with Monte Carlo results assuming 50% and 60% packing fraction of target, 60.4% packing fraction is determined for this target.
- MC directly gives the dilution factor as below.



Data to MC ratio assuming 60.4% PF



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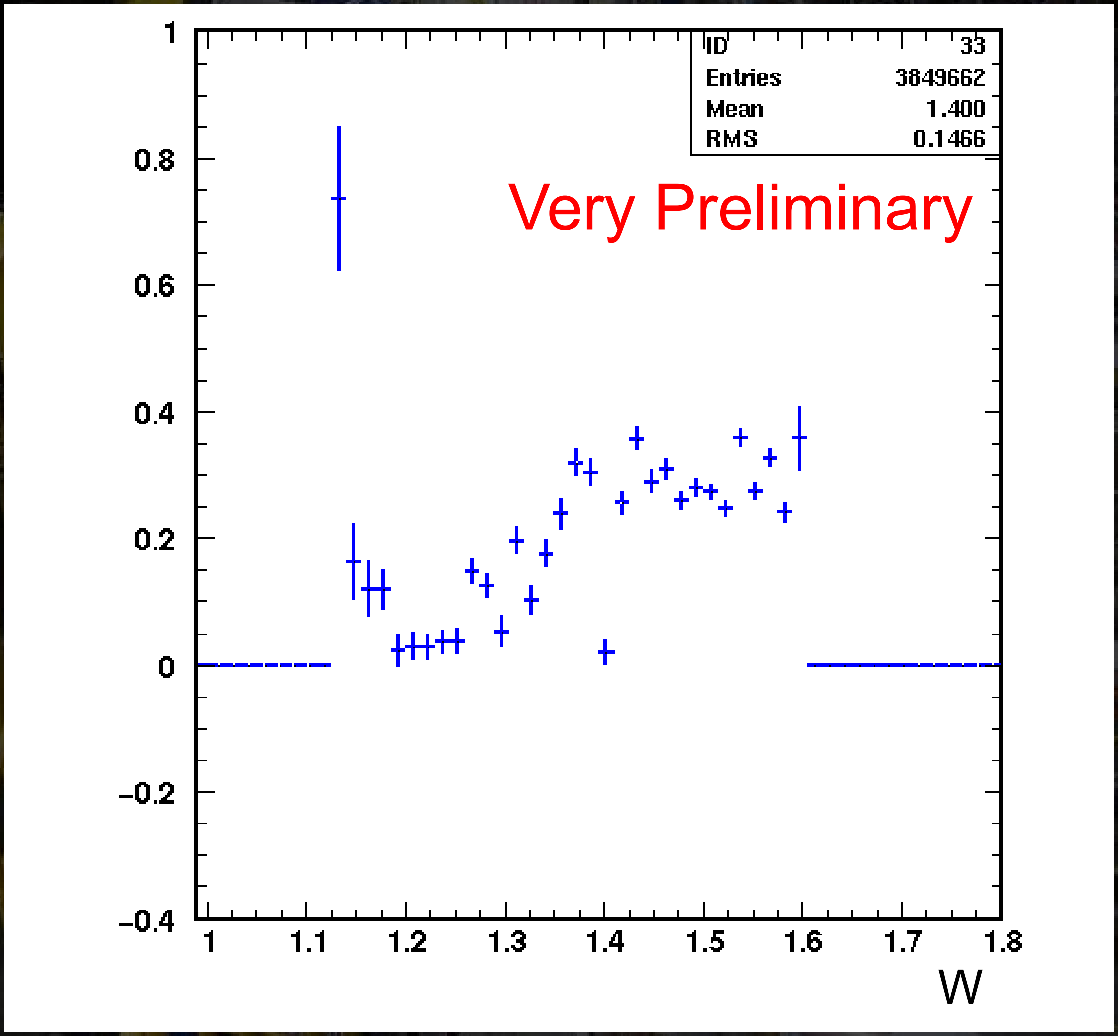
Preliminary Parallel Asymmetry: HMS

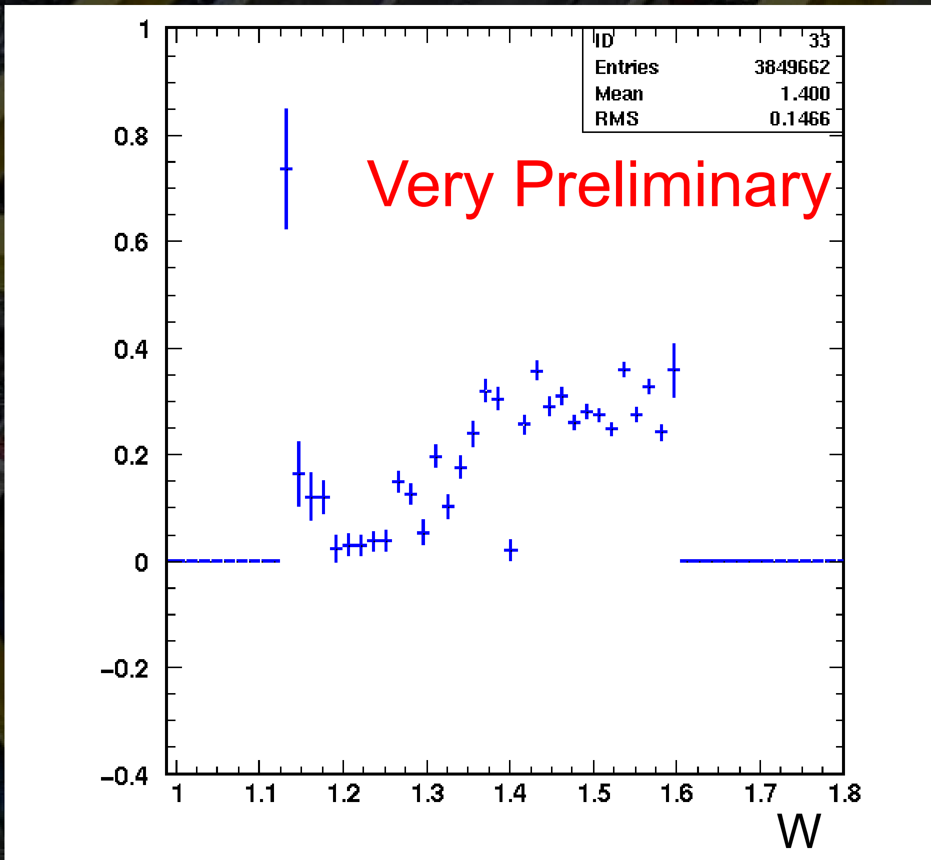
- Applying this dilution factor to the data of runs 73000-73041 shows the following very preliminary parallel asymmetry. (no radiative correction included)
    - The tendency and scale are roughly similar to Hall B eg1 result and RSS at $Q^2 = 1.3\ GeV^2$

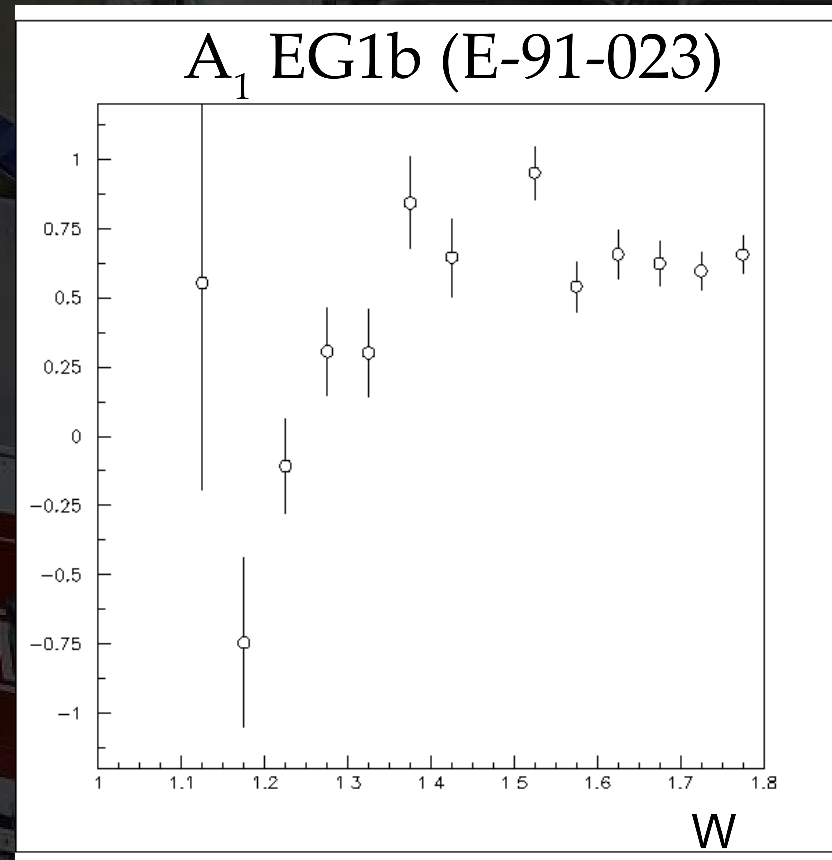


$Q^2 = 1.862\ GeV^2$
$1.087\ GeV < W < 1.612\ GeV$

* Slide from Hoyoung Kang

Preliminary Parallel Asymmetry: HMS, Hall B





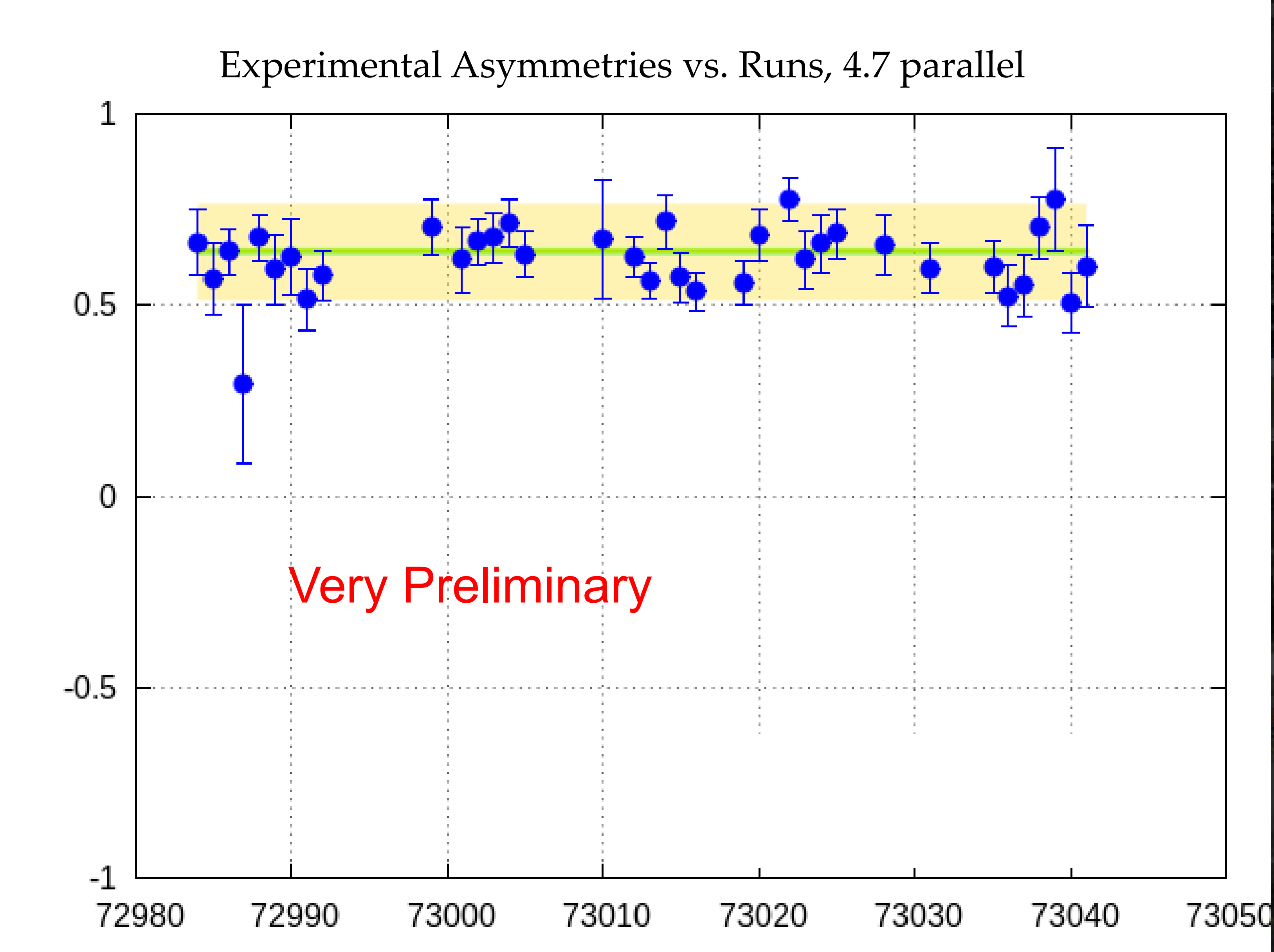
- $A_\parallel$ from SANE HMS (left) and A_1 from CLAS EG1b (right)
  - Q^2 ~1.862 GeV^2 on left, Q^2 ~1.71 GeV^2 on right
  - For A_2~0, $A_\parallel$ ~ DA_1, where D is a kinematic factor

* Slide from Hoyoung Kang

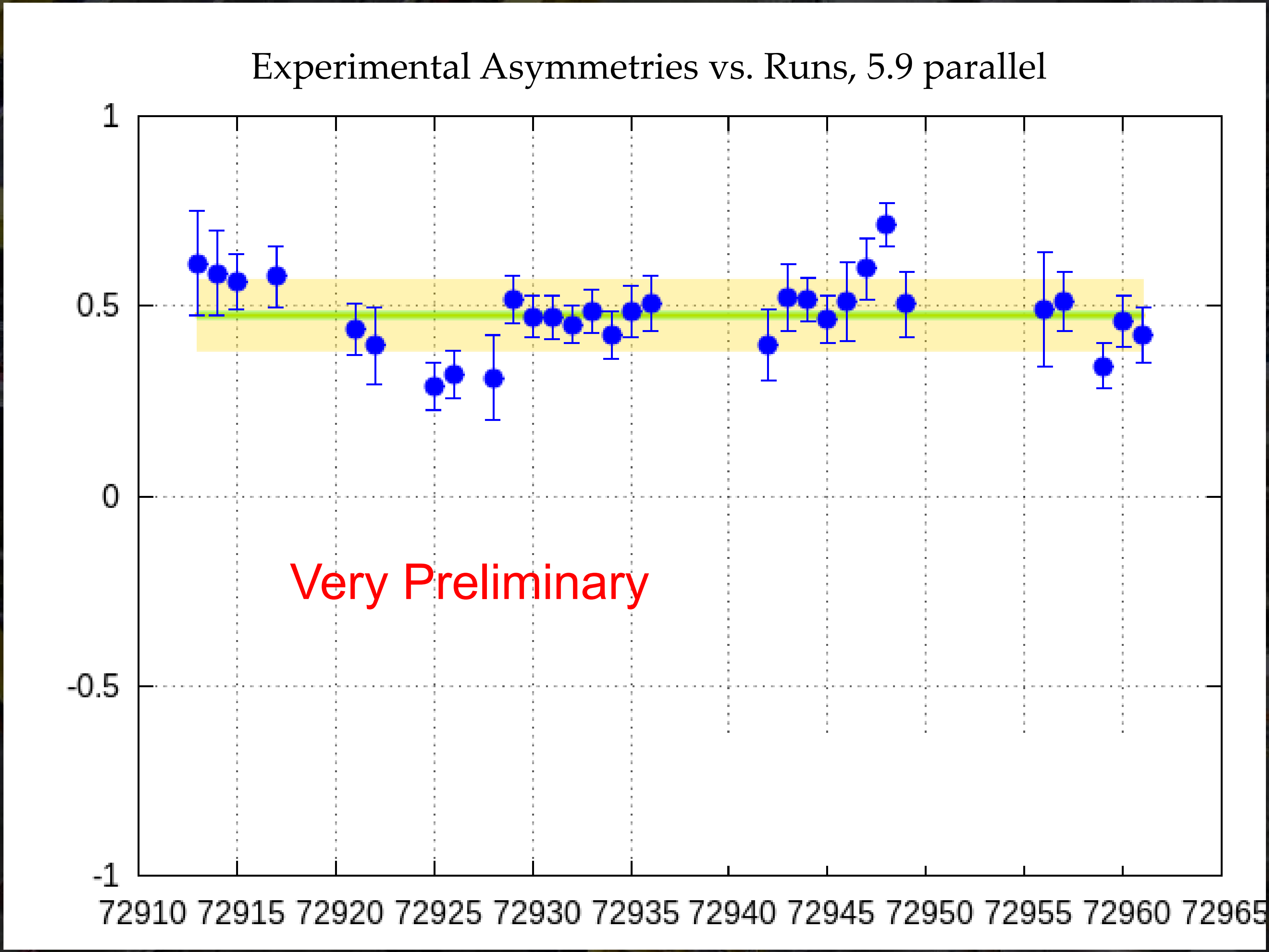
Preliminary Results: Parallel Asymmetries

- Parallel Experimental Asymmetries shown next:
  - Integrated over all kinematics for each run
  - Charge normalization applied, no deadtime correction here
  - "Good" electron yields, passed cuts mentioned before
  - Uses crude, preliminary dilution factor for each target load
    - Finalized dilutions are forthcoming, but this approximation is most likely good to within a few percent
- After these, will show a very preliminary look at parallel asymmetries in kinematic bins, x and W
  - The placeholder dilution factor is particularly misleading at high x, low W

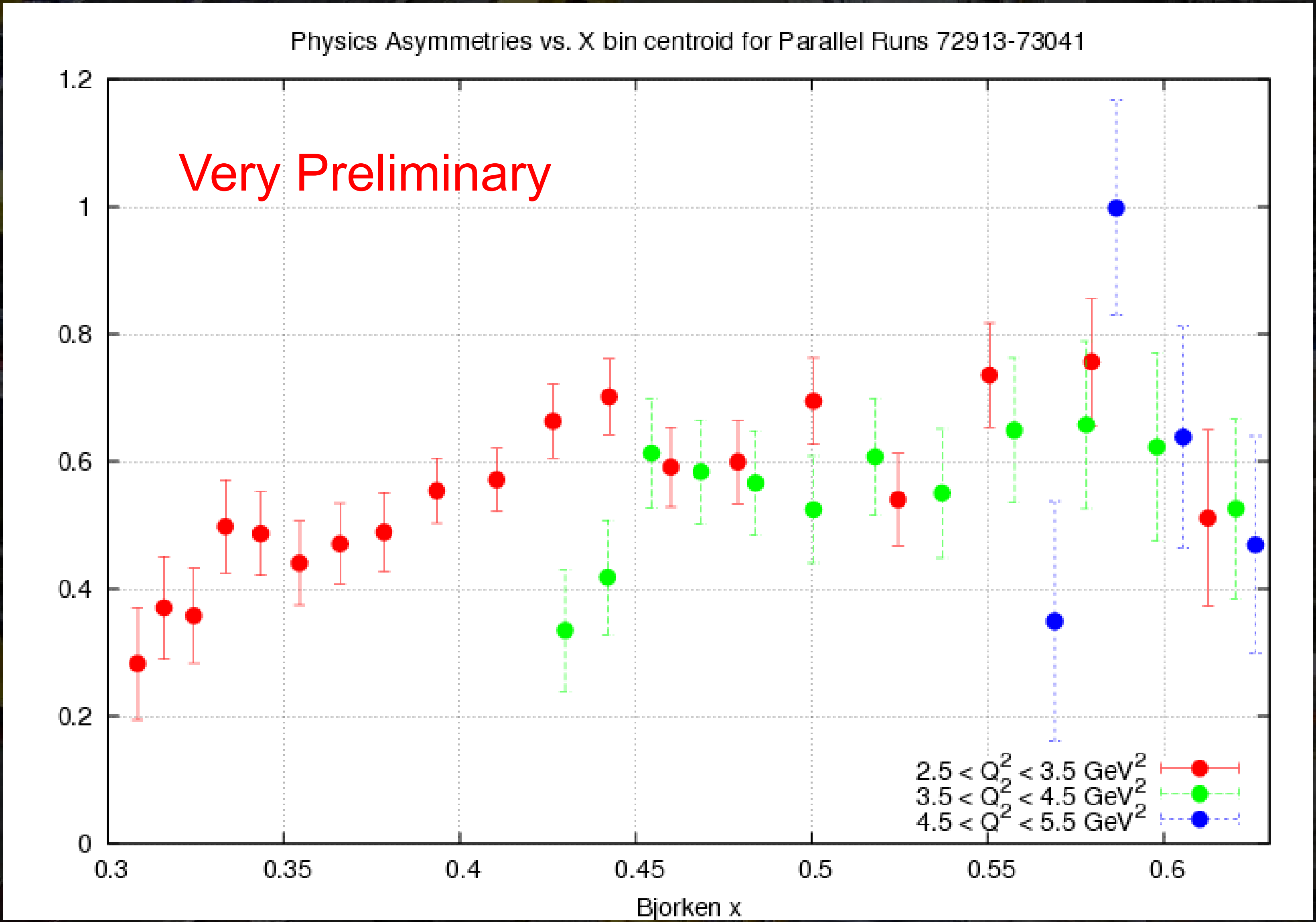
Preliminary Results: 4.7 GeV Parallel Asymmetries



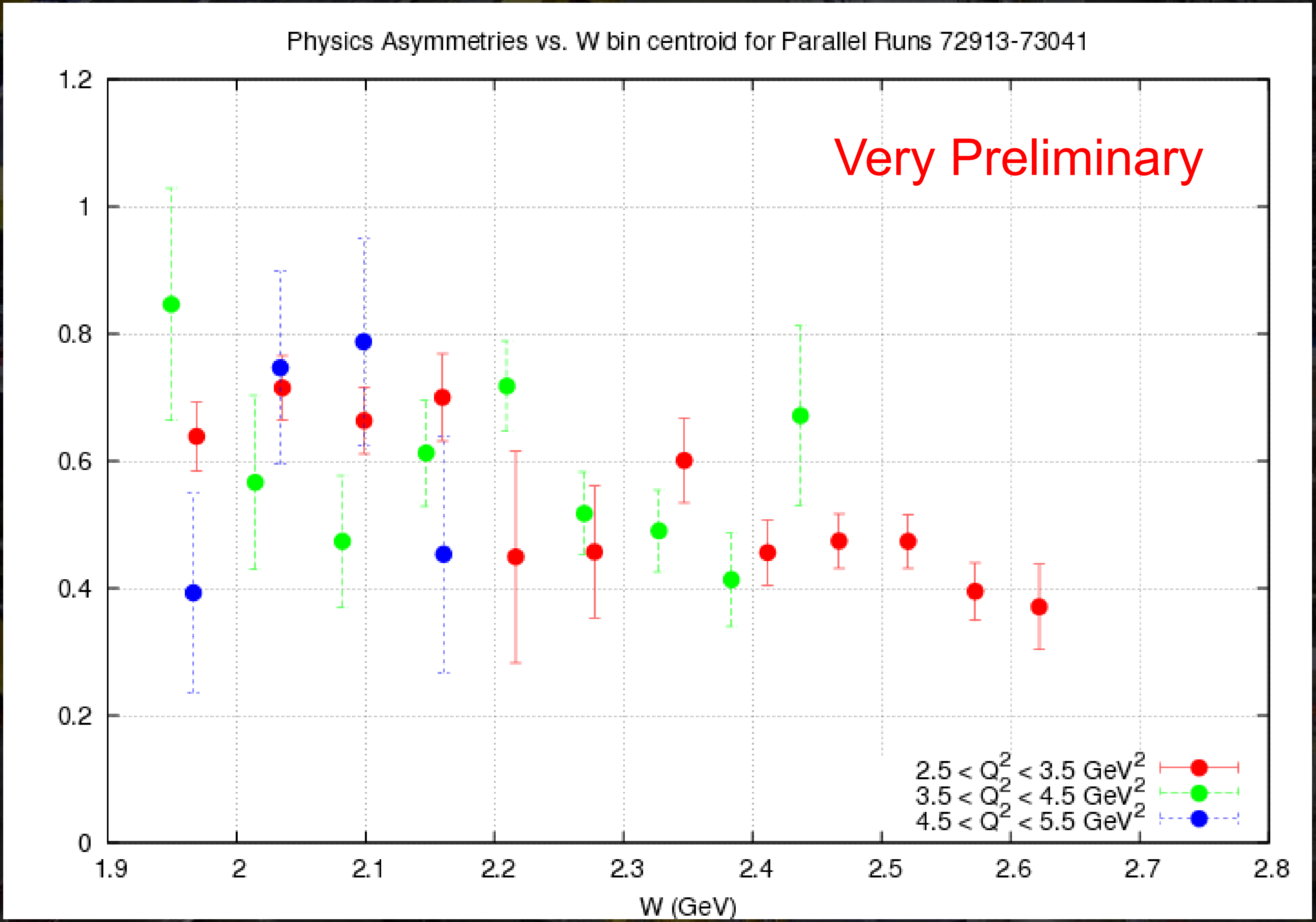
Preliminary Results: 5.9 GeV Parallel Asymmetries



Preliminary Experimental Asymmetries vs. Bjorken x



Preliminary Experimental Asymmetries vs. W



Work in Progress and to Come

- Dilution factors being finalized with BETA data
- Parallel field configuration runs well understood
- Perpendicular field configuration runs analysis well underway
- A_1 and A_2 from measured asymmetries
    - Radiative Corrections to these asymmetries
- g_1 and g_2 from A_1 and A_2
    - Use Bosted-Christy world F_1^p data parametrization
- Systematic error study
- Host of related Physics: sum rules, matrix elements, models


Hall C Winter Meeting, 1.15.2011

SANE Physics

- Spin structure functions describe proton's inner workings

$$g_1(x,Q^2) = \frac{1}{2}\sum e_i^2\left[q_i^+(x,Q^2) - q_i^-(x,Q^2)\right]$$

$$g_2(x,Q^2) = g_2^{WW}(x,Q^2) + \overline{g_2}(x,Q^2)$$

- Where g_2^{WW} depends on g_1, and $\bar{g}_2$ depends on transversity SSF and quark-gluon correlations

- Expressed in terms of spin asymmetries:

$$\gamma = \frac{2xM}{\sqrt{Q^2}}$$

$$g_1 = \frac{F_1}{1+\gamma^2}(A_1 + \gamma A_2) \qquad g_2 = \frac{F_1}{1+\gamma^2}\left(\frac{A_2}{\gamma} - A_1\right)$$

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- We access A_1 and A_2 via asymmetry measurements with longitudinal and transverse polarizations:

$$A_1 = \frac{1}{(E + E'D')}\left((E - E'cos\theta)A_{\parallel} - \frac{E'sin\theta}{cos\phi}A_{\perp}\right)$$

$$A_2 = \frac{\sqrt{Q^2}}{(2ED')}\left(A_{\parallel} - \frac{E - E'cos\theta}{E'sin\theta cos\phi}A_{\perp}\right)$$

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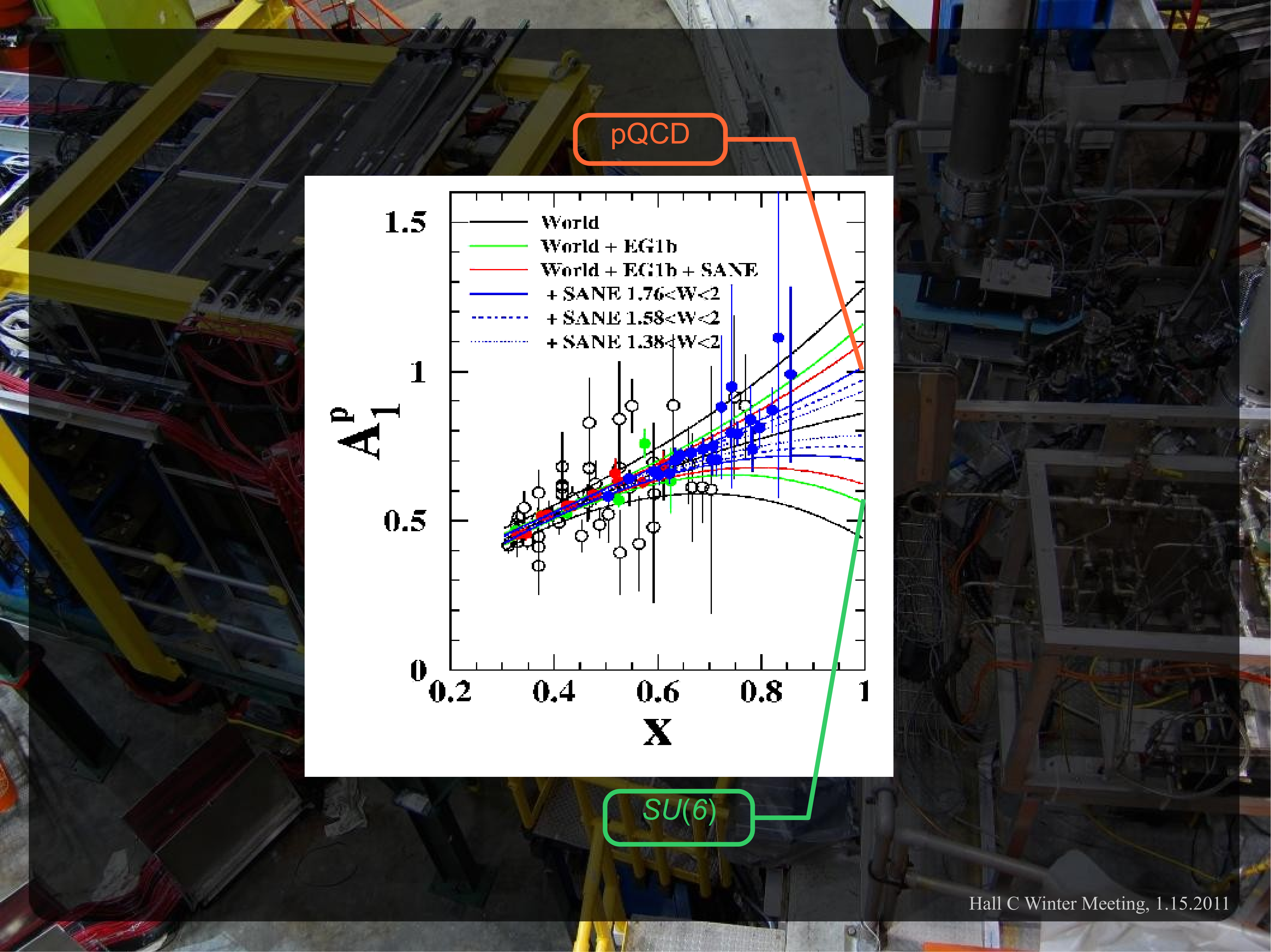
pQCD
SU(6)
World
World + EG1b
World + EG1b + SANE
+ SANE 1.76<W<2
+ SANE 1.58<W<2
+ SANE 1.38<W<2
A_1^p
x
1.5
1
0.5
0
0.2
0.4
0.6
0.8
1

Preliminary Results: Parallel w/ Kinematic Cuts

4.7 GeV Beam

5.9 GeV Beam

W>1.9GeV

W<1.9GeV