Exclusive π^0, η electroproduction in the resonance region at high Q^2.

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Jefferson Laboratory

for the CLAS collaboration

Outline

- Introduction
- Experiment Overview
- Preliminary Results
- Summary

N* Program in CLAS

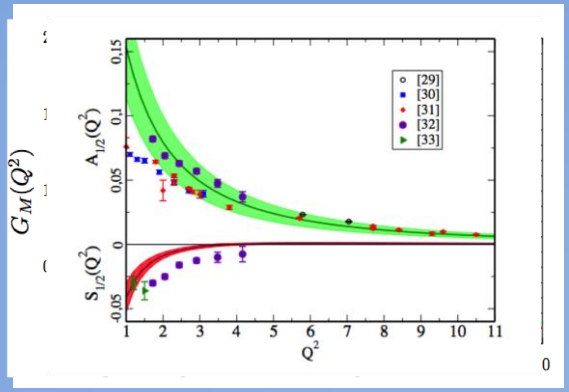
Map the γNN* electrocouplings as a function of photon virtuality with a combined analysis of electroproduction channels

Access active degrees of freedom at various distances

Explore the non-perturbative strong interactions responsible for nucleon formation and the origin of quark confinement

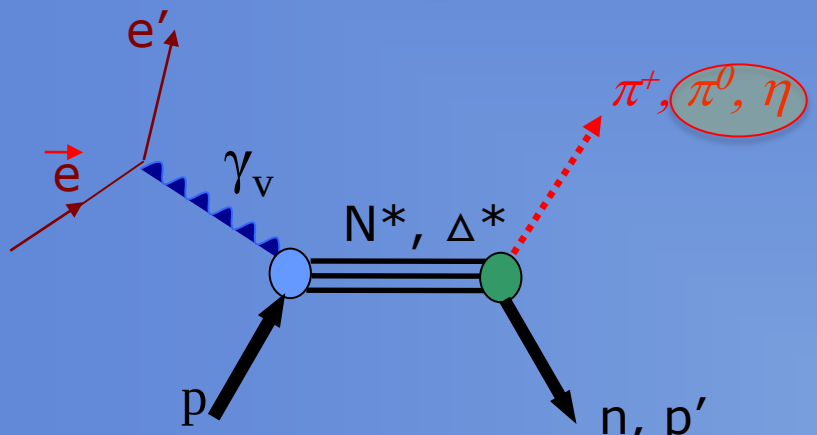
Investigate the origin of 98% of nucleon mass through DCSB

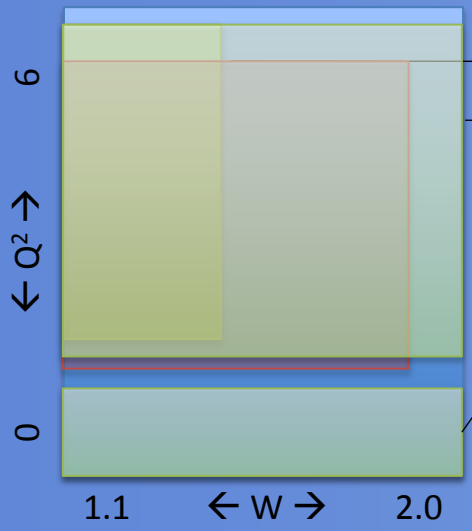
DSE Framework
Carnegie Mellon
Univ. of Maryland
Trinity College (Dublin)



High Q^2 π^0, η electroproduction

Single π^+, π^0, η production

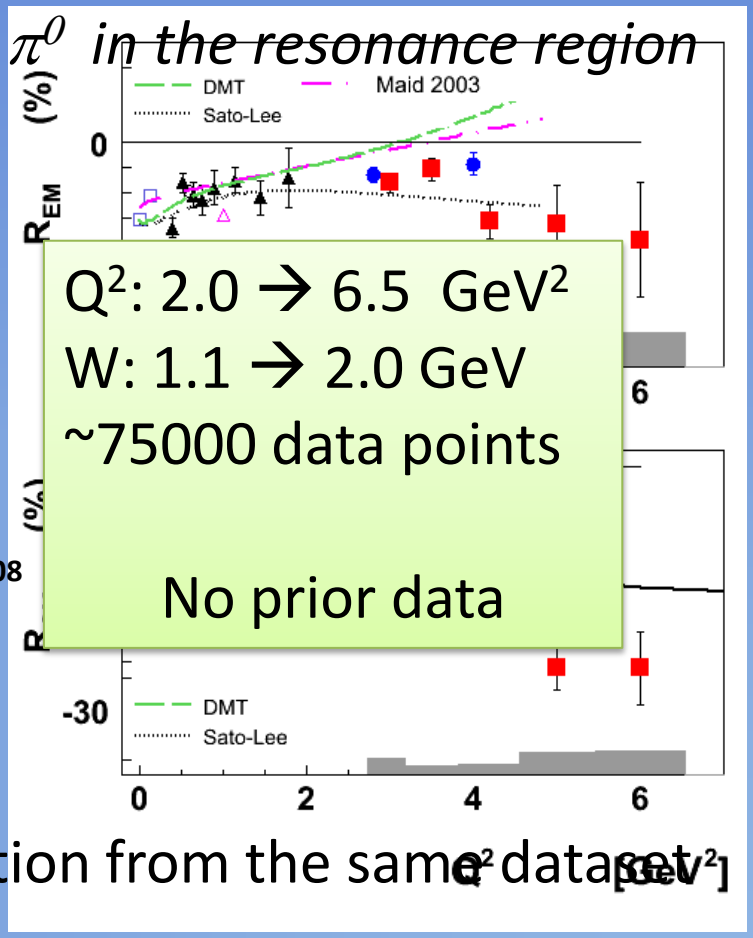




π^+ in the resonance region

Missing! in the Delta

π^0 in the resonance region



Q^2: 2.0 → 6.5 GeV²
W: 1.1 → 2.0 GeV
~75000 data points

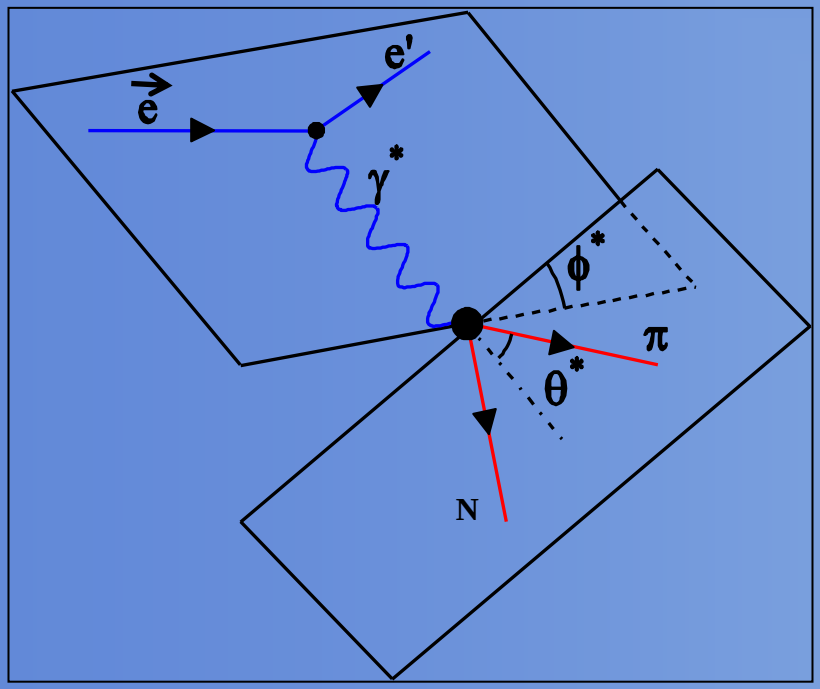
No prior data

η electroproduction from the same dataset

Experiment Overview

$$\sigma = \sigma(W,Q^2,\cos(\theta^*))$$

$$d\sigma/d\Omega_\pi = \sigma_T + \varepsilon\sigma_L + \varepsilon\sigma_{TT}\cos 2\phi + \sqrt{2\varepsilon(\varepsilon+)}\sigma_{LT}\cos\phi + h\sqrt{2\varepsilon(\varepsilon-1)}\sigma_{LT'}\sin\phi$$

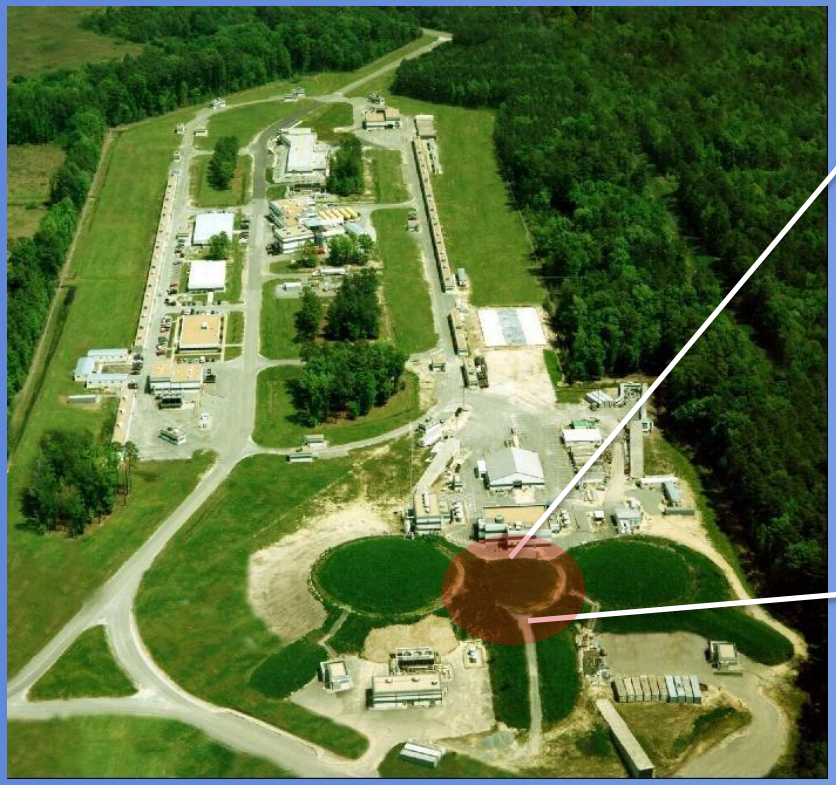


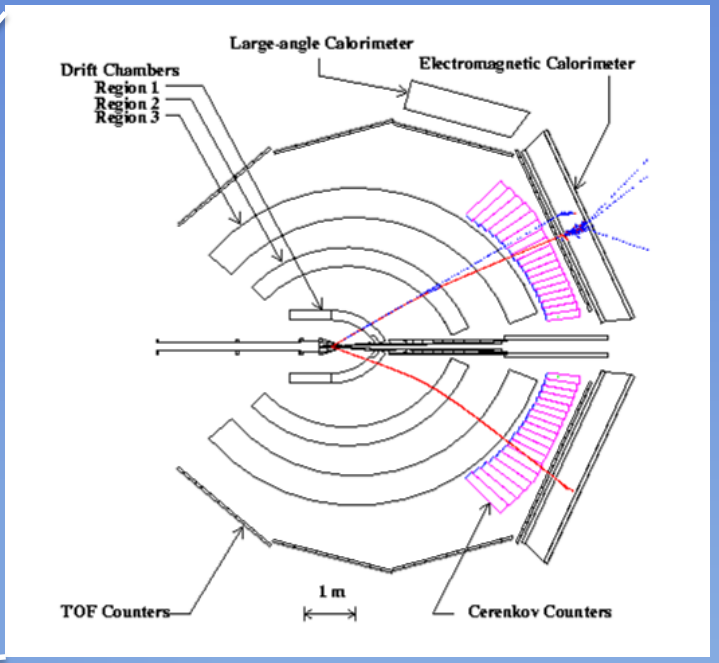
Will detect:
Electron, Proton

Will Extract:

- Cross sections, Structure Functions
- Beam Spin Asymmetries
- Helicity amplitudes and their Q^2 dependence

Experiment Overview



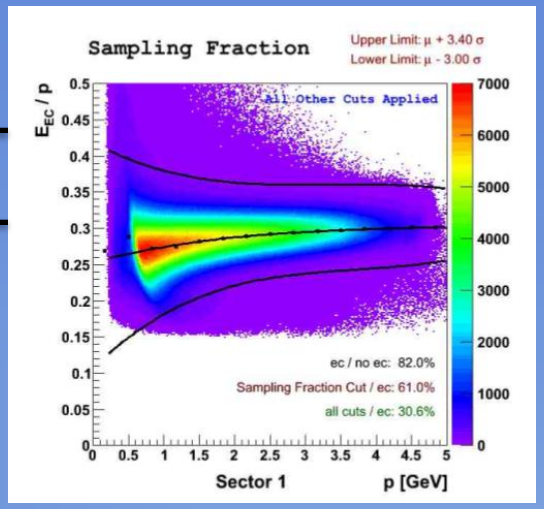


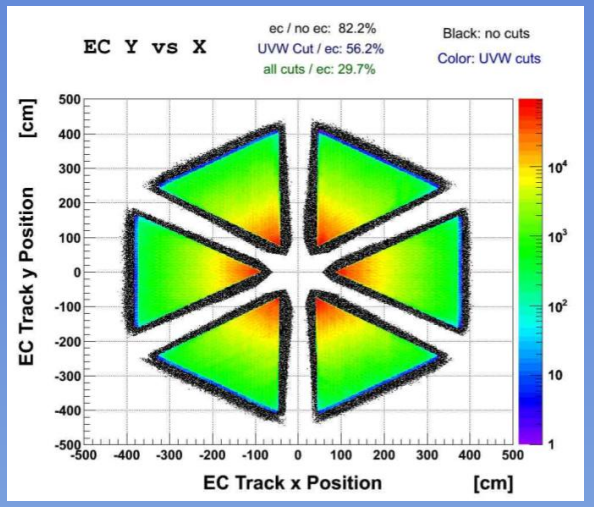
- October 2001 – January 2002
- Beam Energy = 5.75 GeV
- Current Intensity = 10nA ($10^{34}cm^{-2}s^{-1}$)
- 3.7 Billions triggers

Analysis Overview

Data:

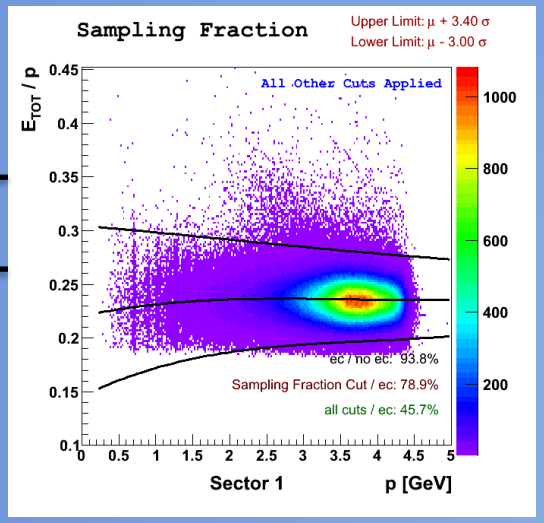
✓ Electron ID
- Sampling Fraction
- EC shower shape/energy
- EC coordinates
- CC matching
- CC timing

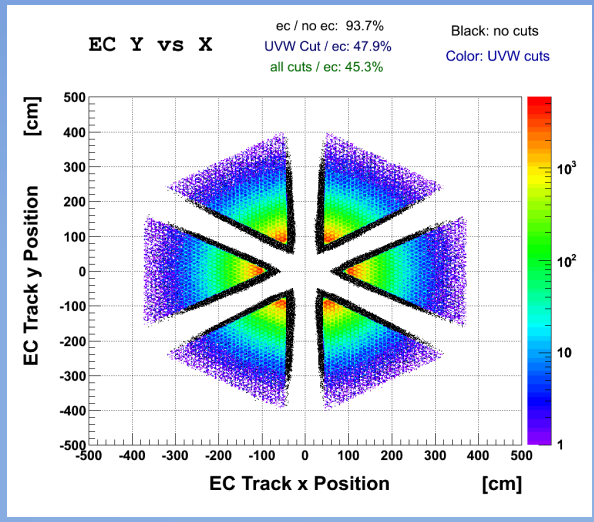




Simulation

✓ Electron ID
- Sampling Fraction
- EC shower shape/energy
- EC coordinates

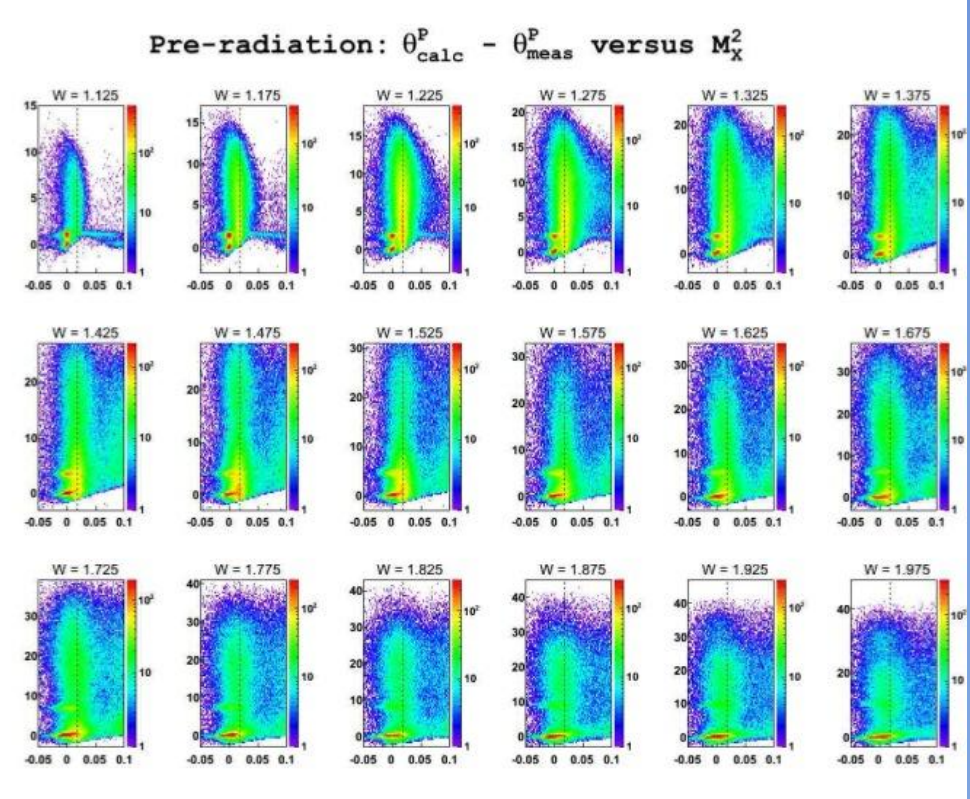


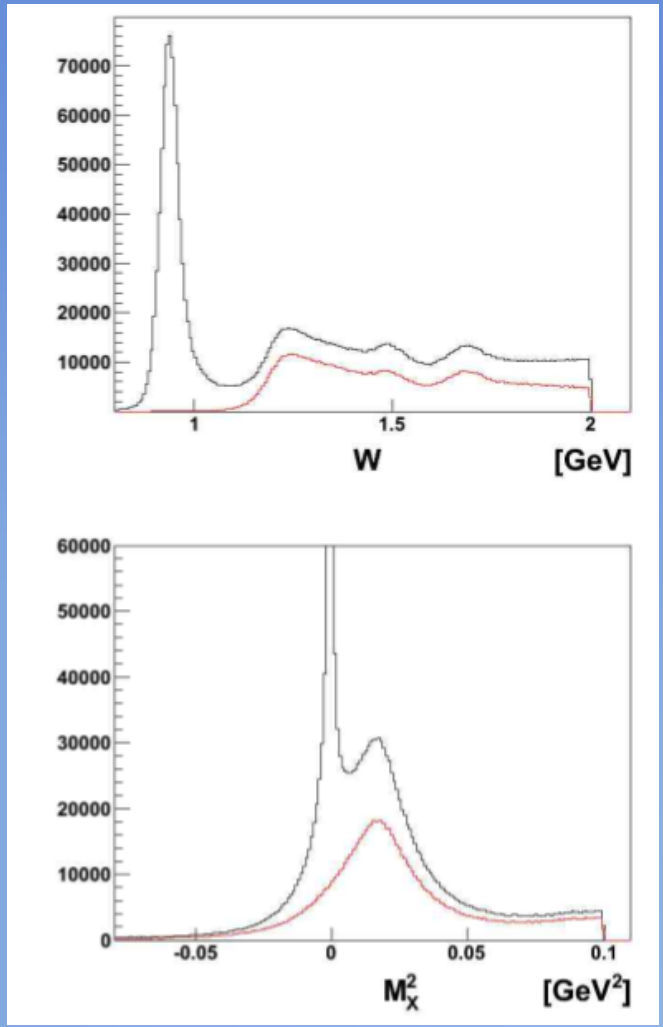


Analysis Overview

B.H. Separation:

The typical angle between the emitted photon and the electron in B.H. processes is $\theta \sim m/E$





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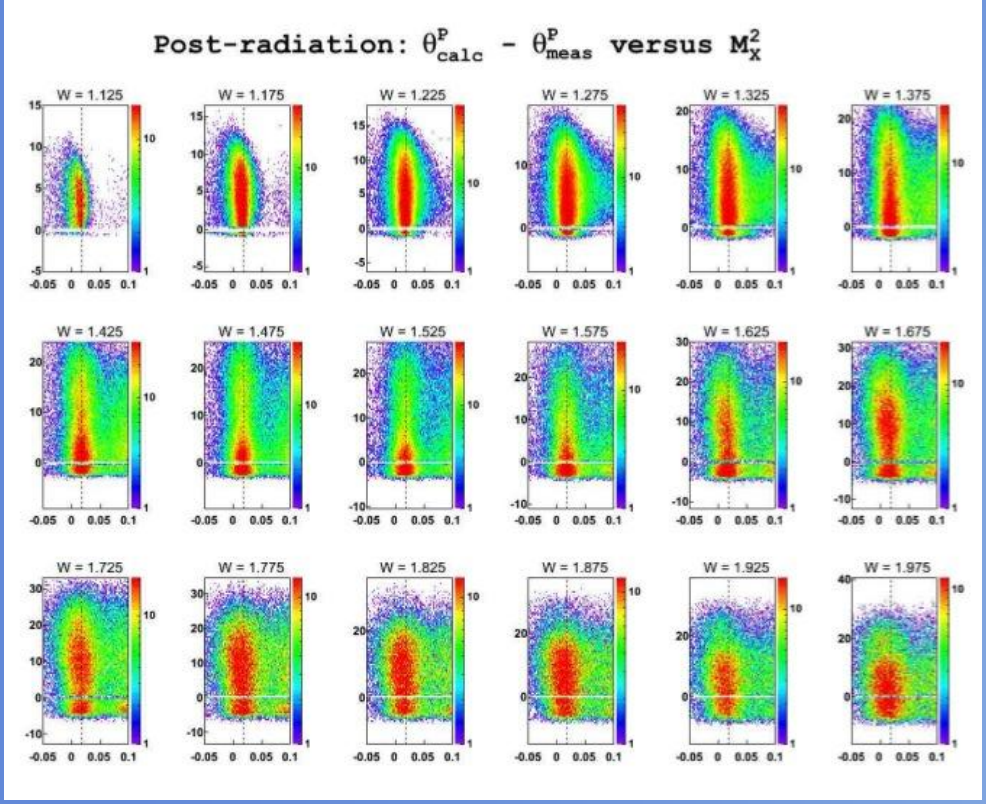
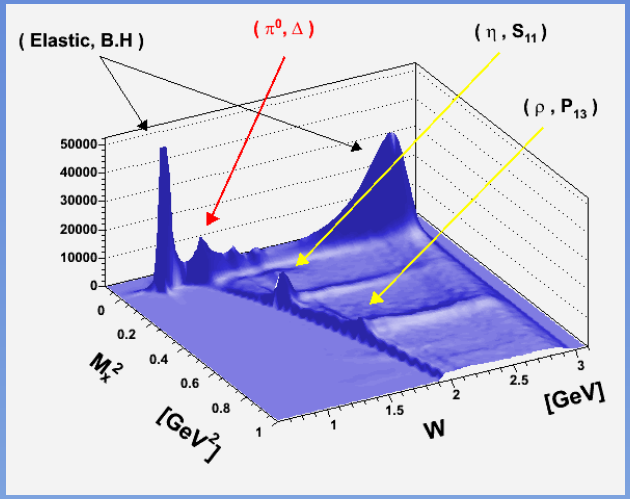
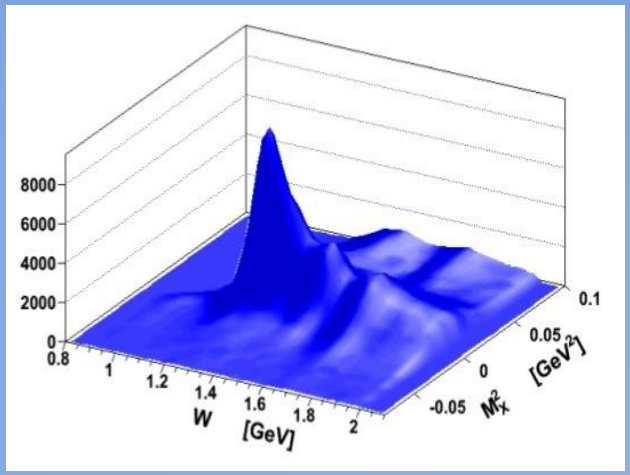
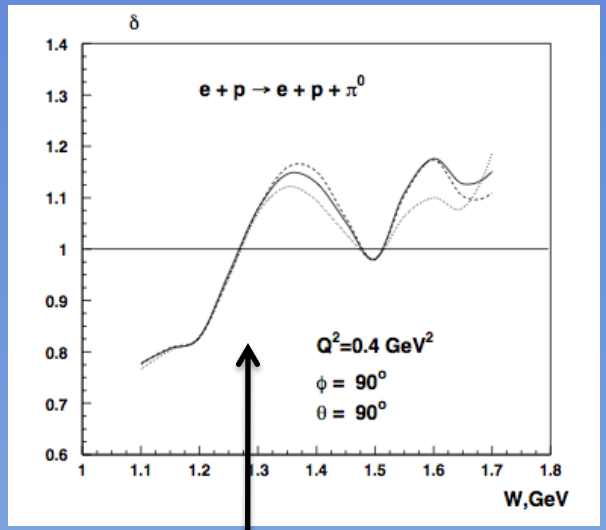






Analysis Overview

Radiative Correction

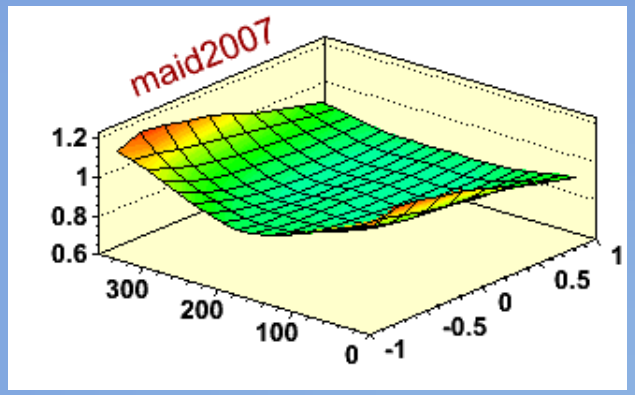


exclurad

(Afanasev, Akushevich, Burkert, Joo)

Input: Exclusive cross section

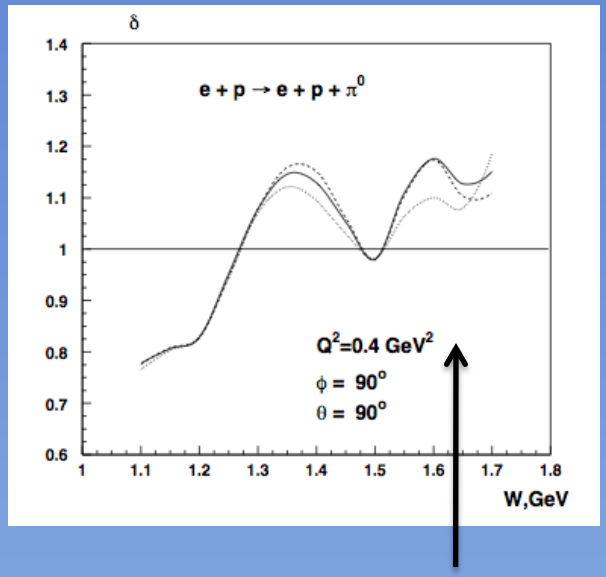
- **No peaking approximation**
- **No soft-hard photon discrimination**
- **Radiation of 4 SF with angular dependence of each one (exclusive electroproduction)**



W=1.29

Analysis Overview

Radiative Correction



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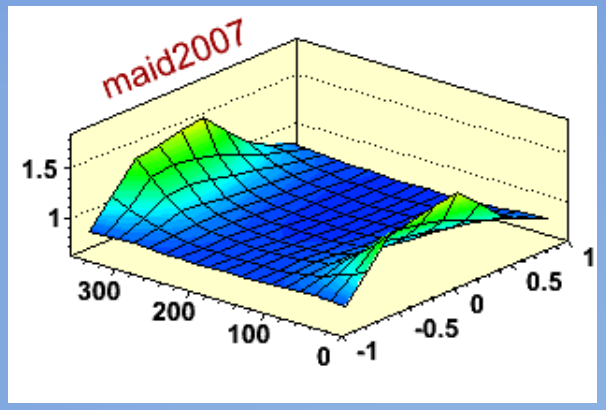
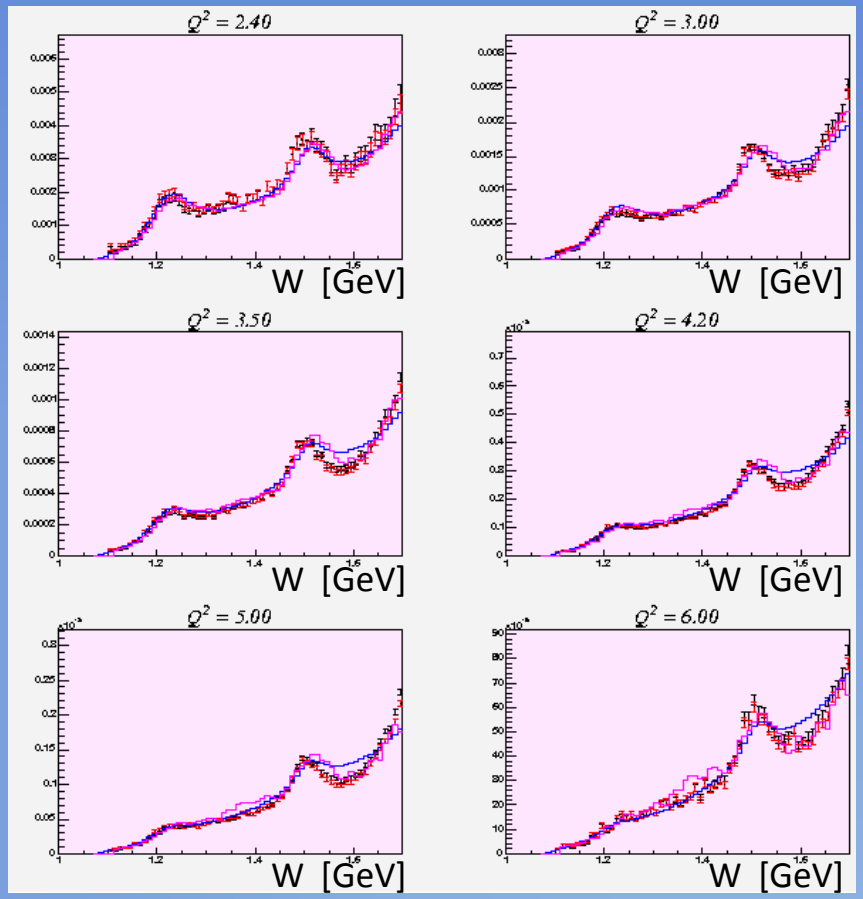


W=1.63

Analysis Overview

Normalization check:

- ✓ Good electron PID, fiducial cut
- ✓ Good acceptance from simulation
- ✓ Vertex Correction, Cuts
- ✓ Kinematic Corrections
- ✓ Elastic Scattering
- ✓ Inclusive scattering



- Data
- Keppel
- Brasse

Analysis Overview

Data:

- ✓ Electron ID
- ✓ Proton ID
- ✓ Vertex Correction, Selections
- ✓ Electron Fiducial Cut
- ✓ Proton Fiducial Cut
- ✓ Electron Momentum Correction
- ✓ Proton Momentum Correction
- ✓ Normalization Check
- ✓ Radiative Correction
- ✓ Bin Averaging Correction
- ✓ π^0, η selection

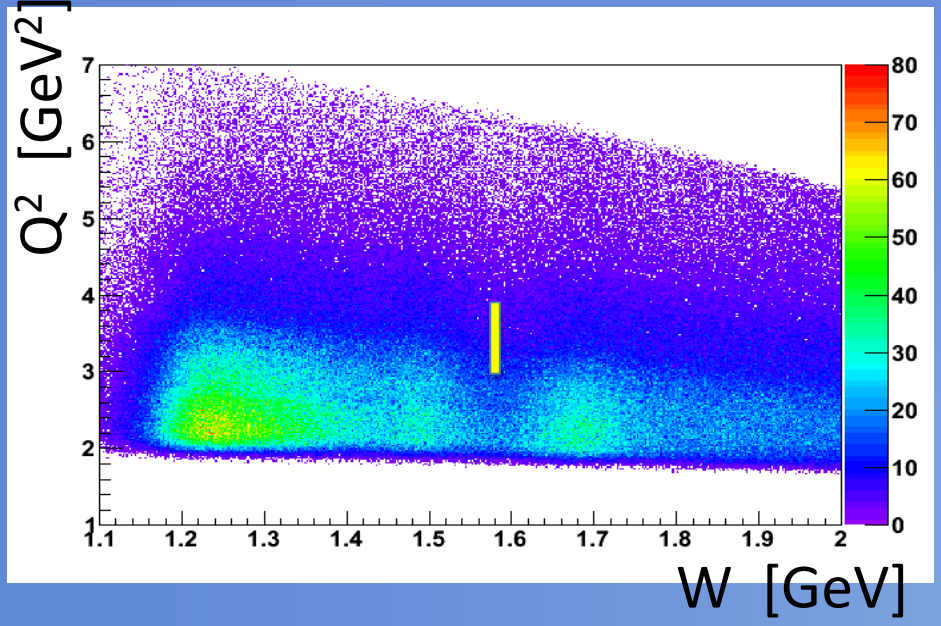
Simulation:

- ✓ Electron ID
- ✓ Proton ID
- ✓ Vertex Correction, Selections
- ✓ Electron Fiducial Cut
- ✓ Proton Fiducial Cut
- ✓ Timing Resolution Match
- ✓ Momentum Resolution Match
- ✓ Acceptance Correction

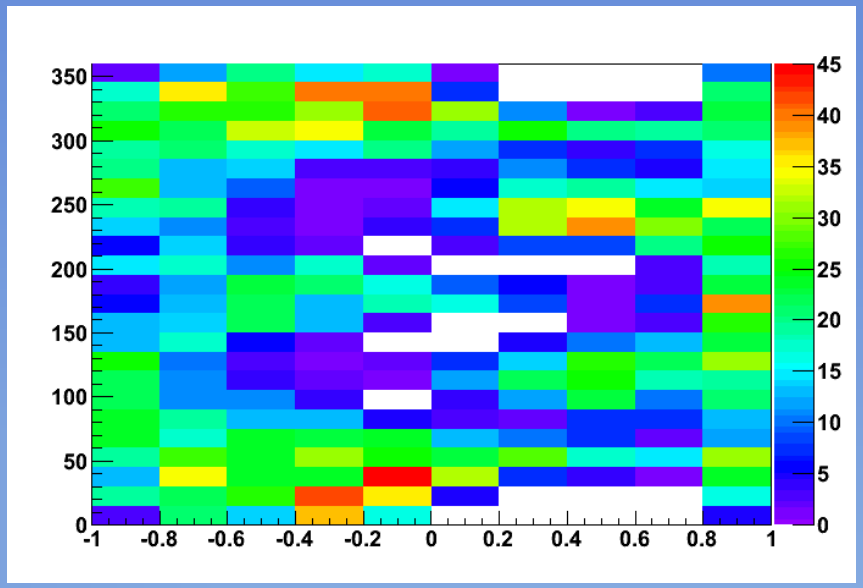
To do list:
Finalize Systematic Errors
Collaboration Review
Amplitudes extraction (JANR, DR, SAID)

Analysis Overview

π^0



W=1.59 Q^2=3.5

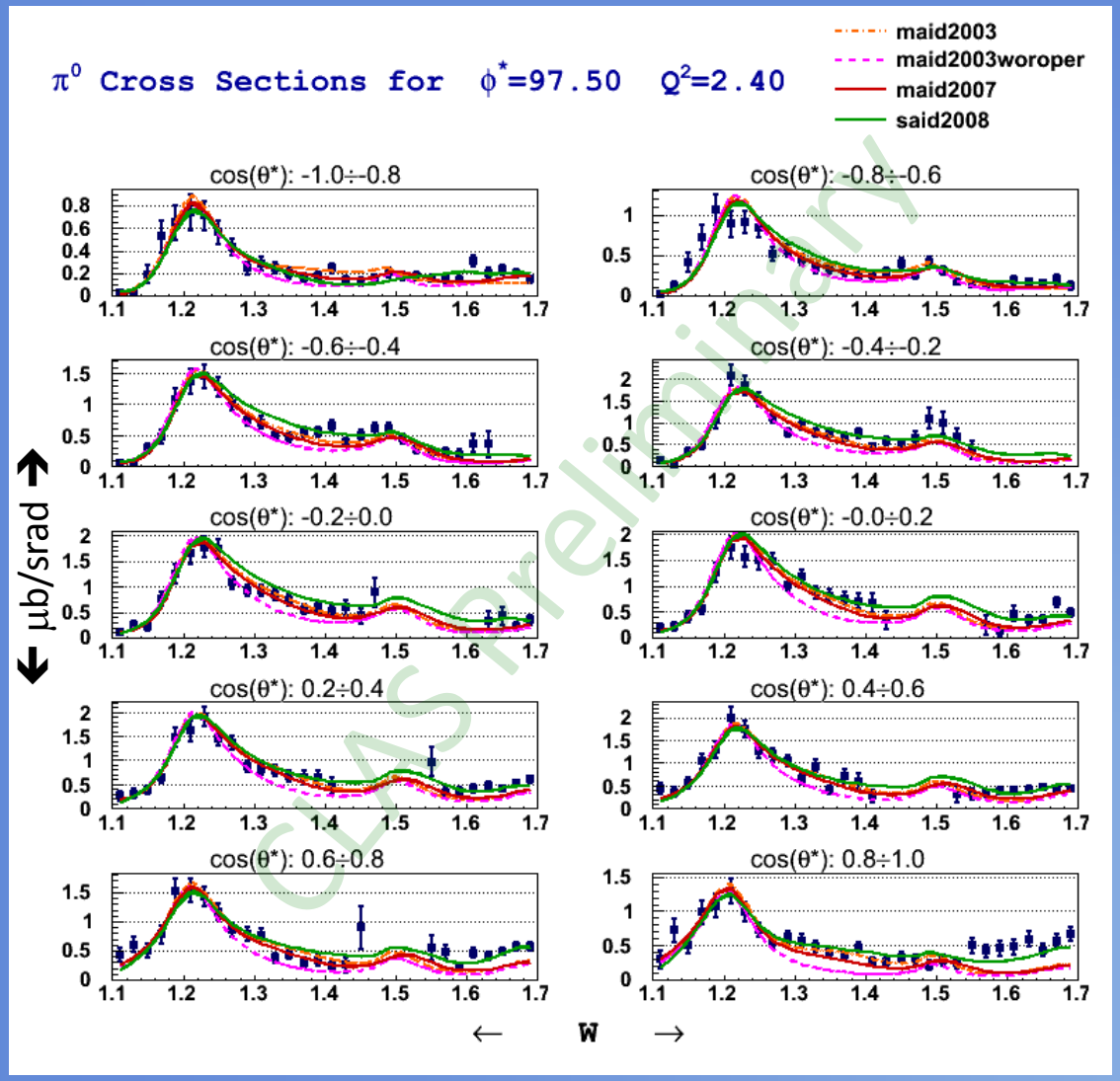


45 bins in W, ΔW=20 MeV
7 bins in Q^2 $DQ^2/Q^2 \sim 0.18$

10 bins in cos(θ*)
24, 48, 96 bins in ϕ*

Total: 75600 CS points

Preliminary Results



$$\frac{d\sigma}{dWdQ^2d\Omega^*} = \Gamma_\chi \frac{d\sigma}{d\Omega^*}$$

350 points
out of 75K

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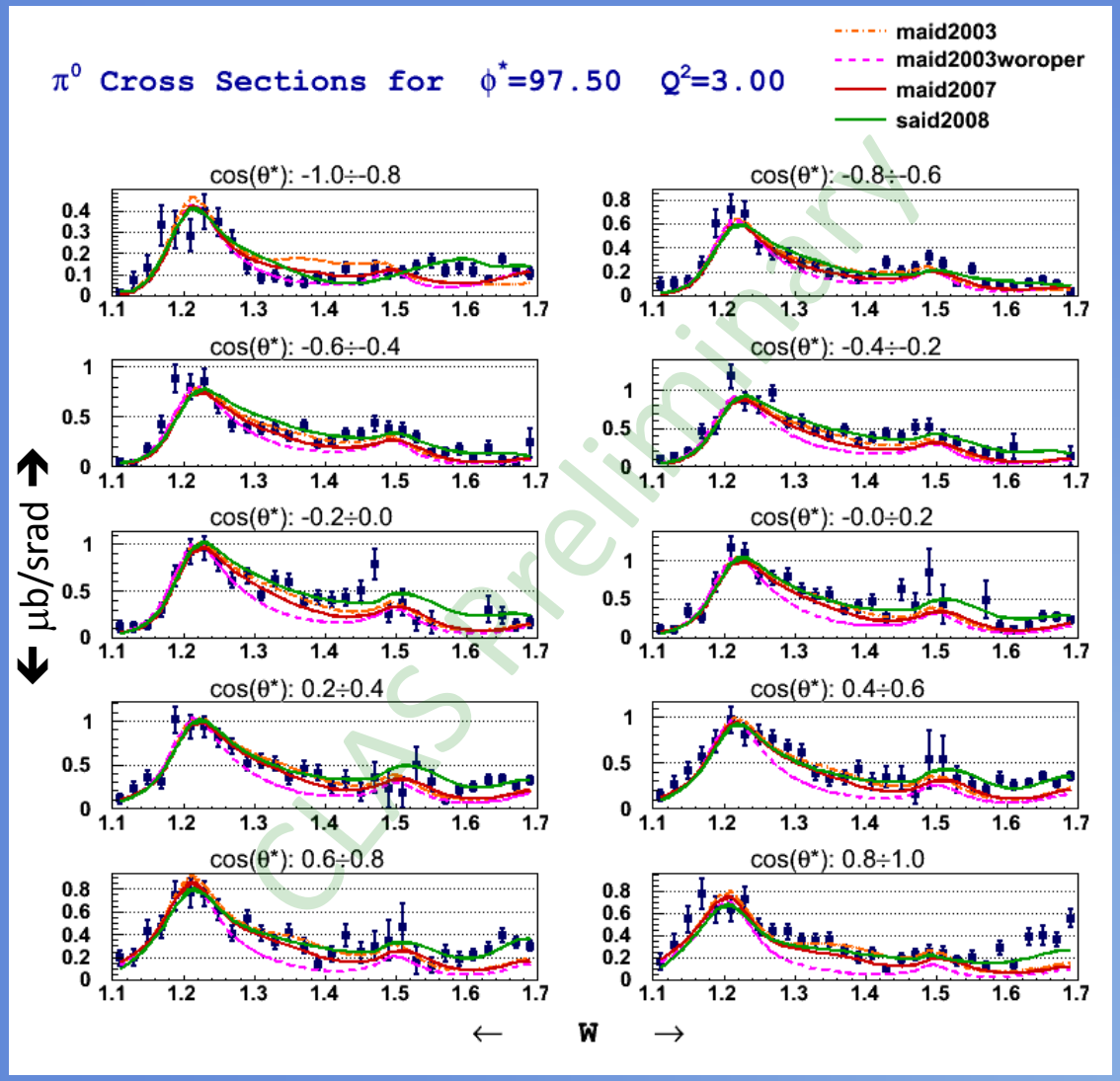

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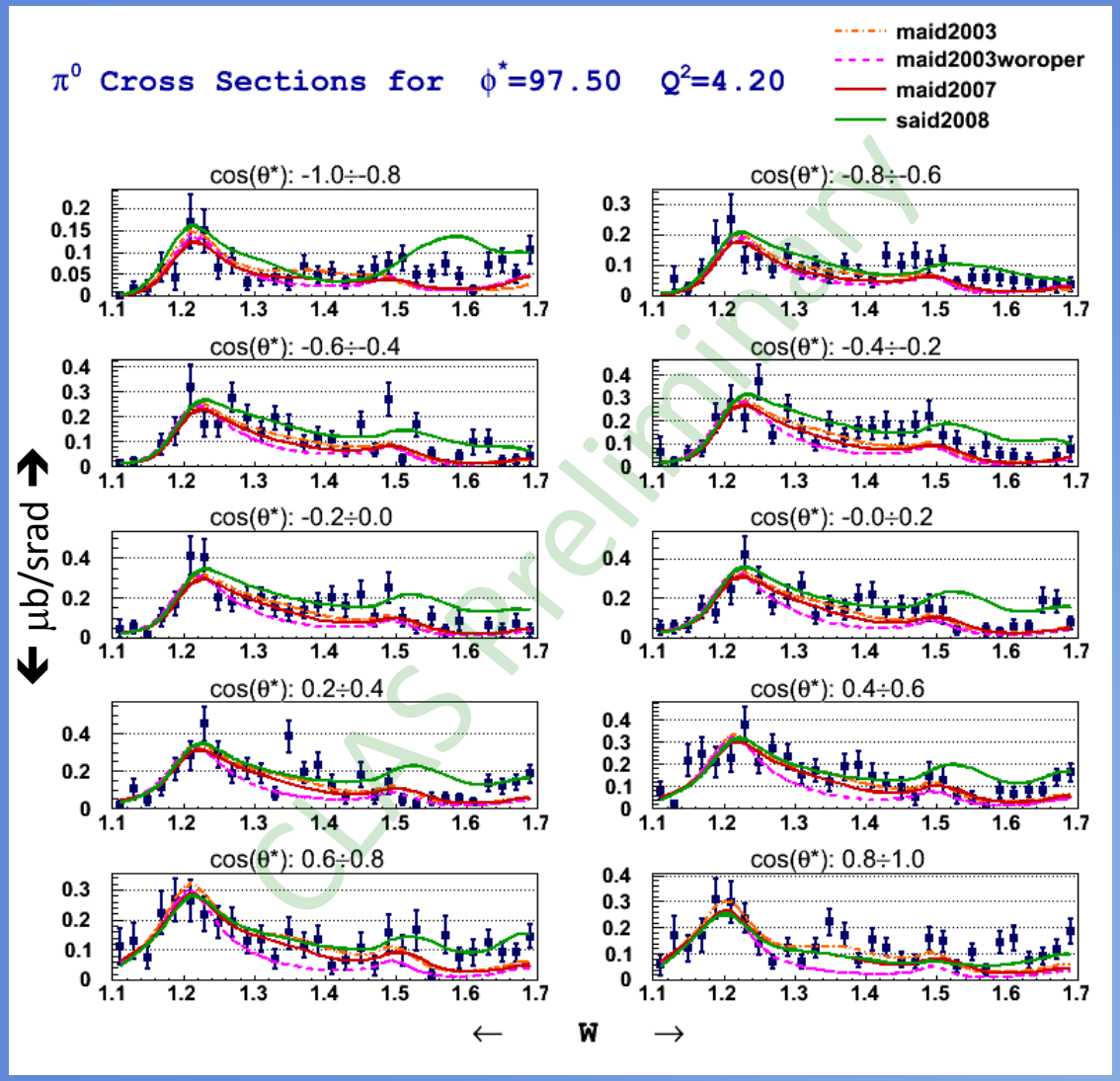

$$\frac{d\sigma}{dWdQ^2d\Omega^*} = \Gamma_\chi \frac{d\sigma}{d\Omega^*}$$

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Preliminary Results

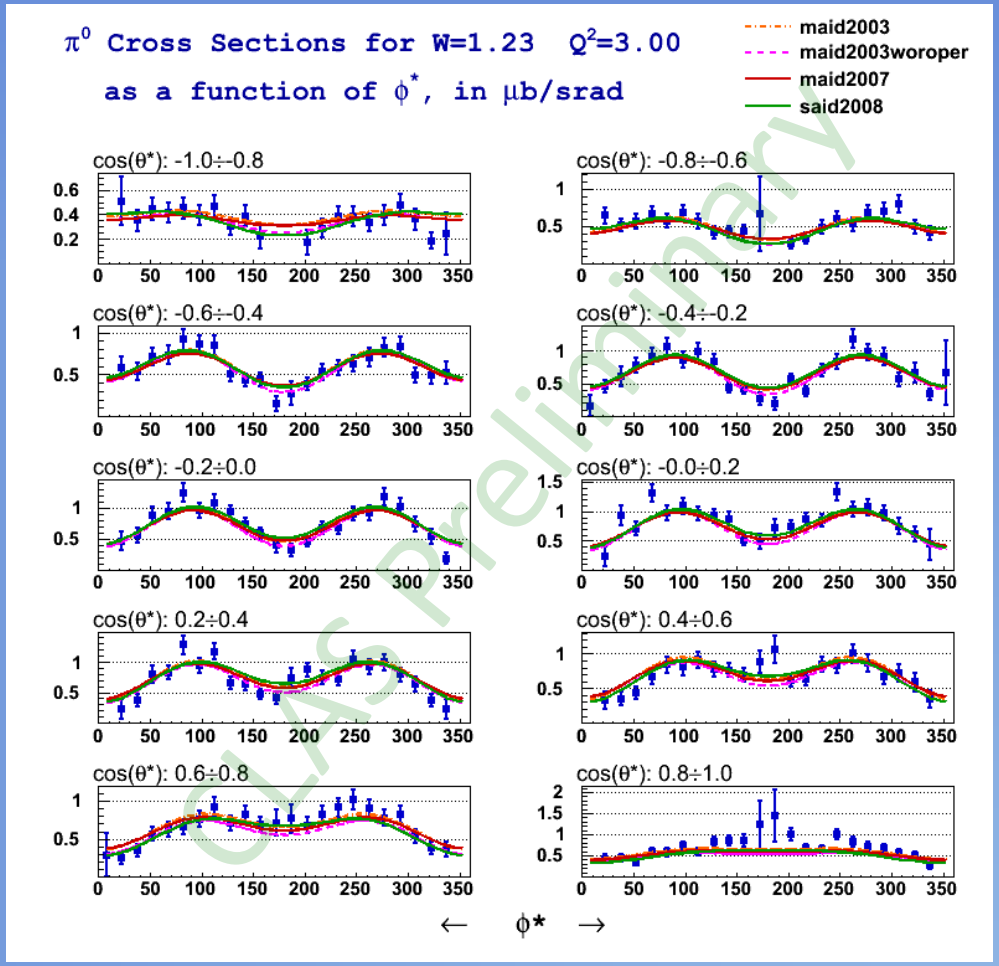
$$d\sigma/d\Omega^* = \sigma_T + \varepsilon\sigma_L + \varepsilon\sigma_{TT}\cos 2\phi + \sqrt{2\varepsilon(\varepsilon+1)}\sigma_{LT}\cos\phi$$

$$\sigma_L + \varepsilon\sigma_T = a$$

$$\sigma_{LT} = \frac{b}{\sin\theta\sqrt{2\varepsilon(\varepsilon+1)}}$$

$$\sigma_{TT} = \frac{c}{\sin^2\theta\varepsilon_T}$$

240 points
out of 75K



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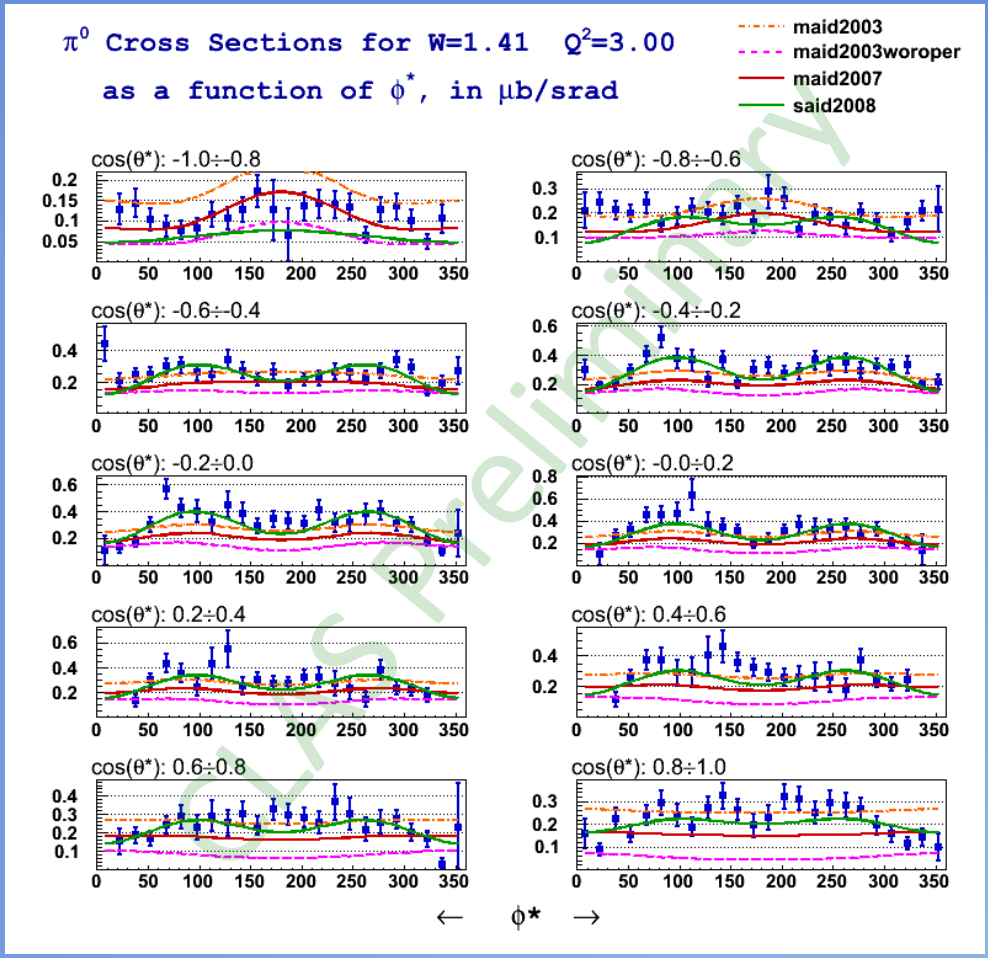

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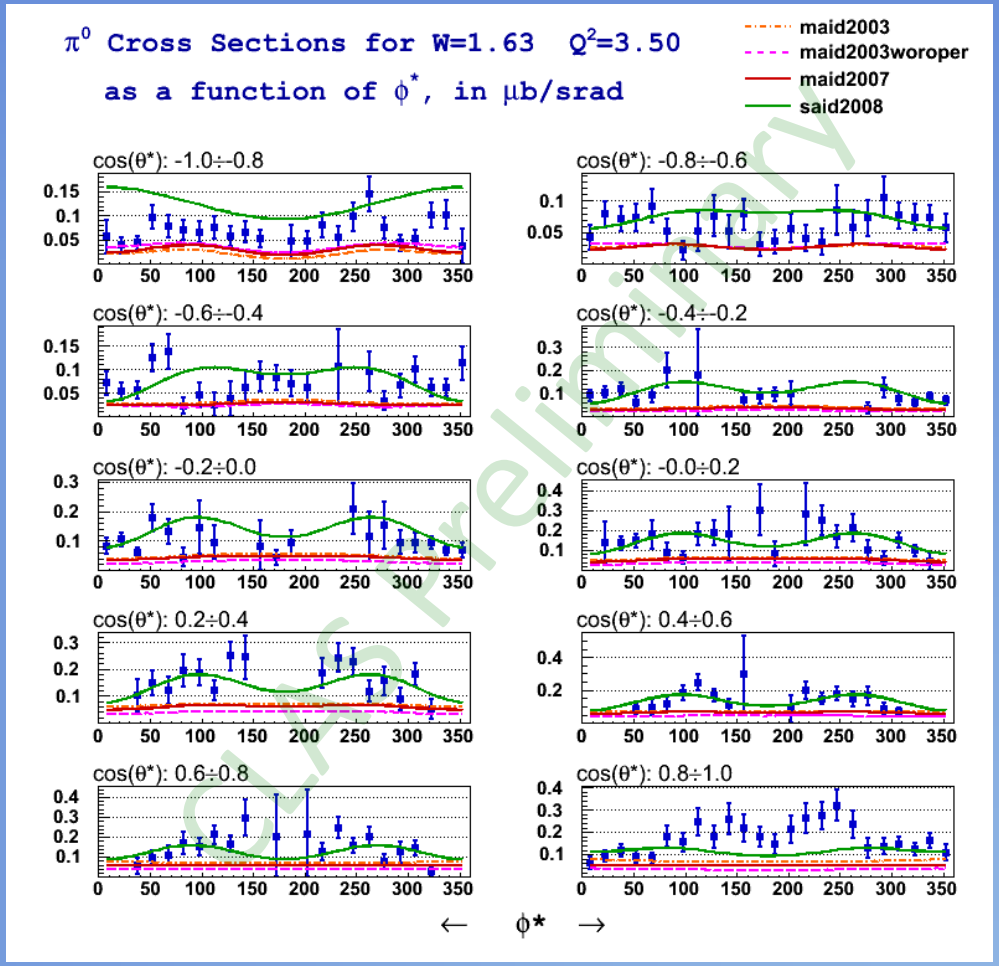

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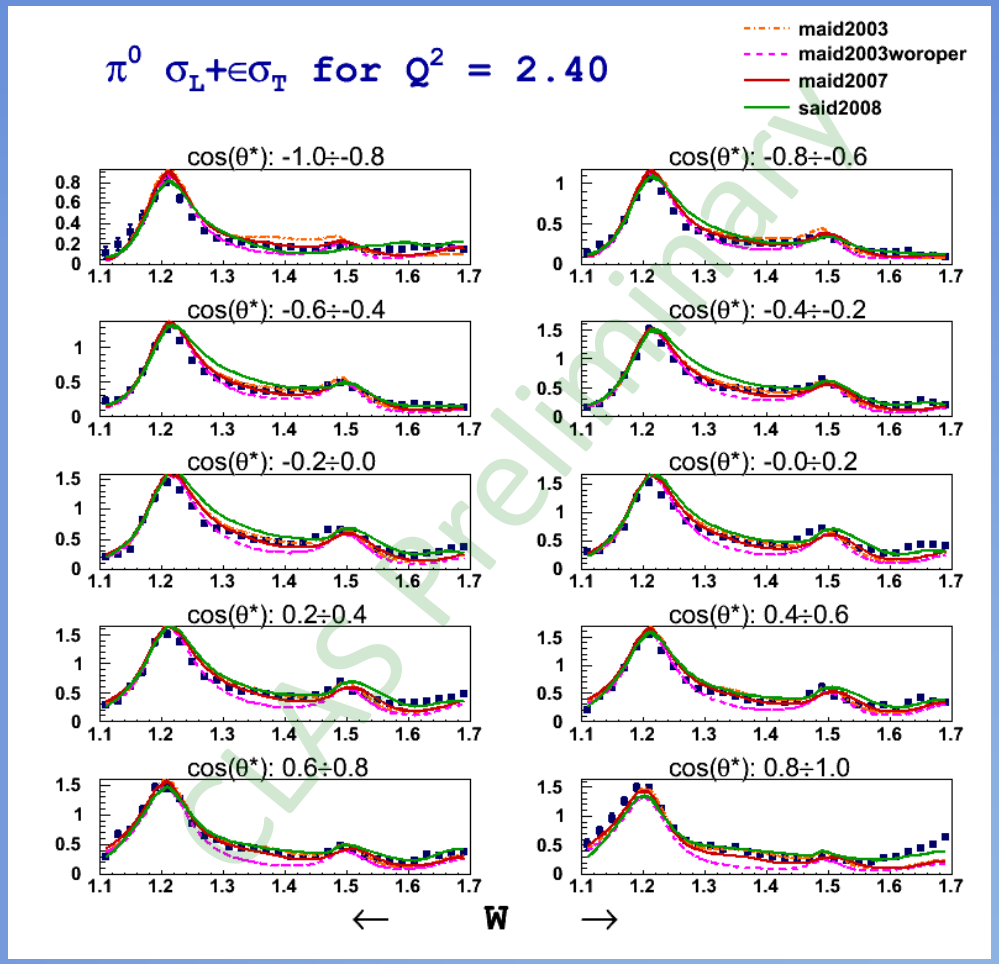

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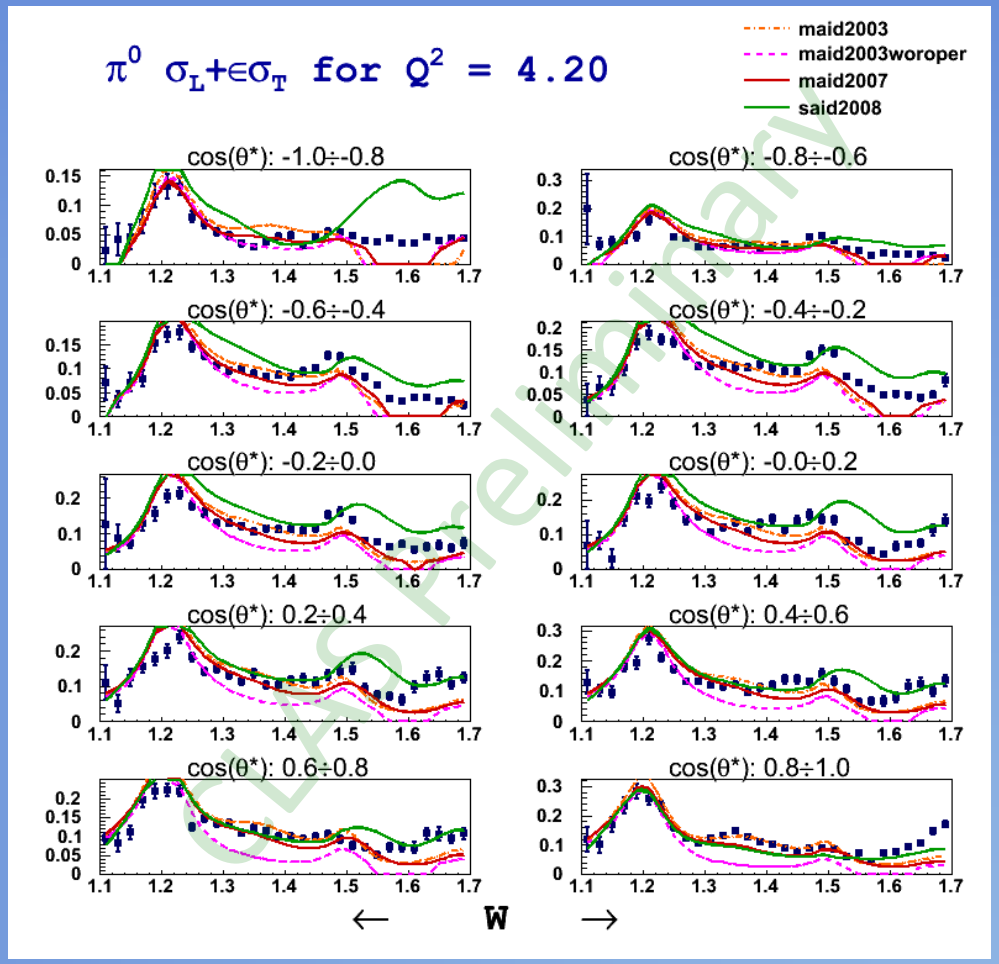

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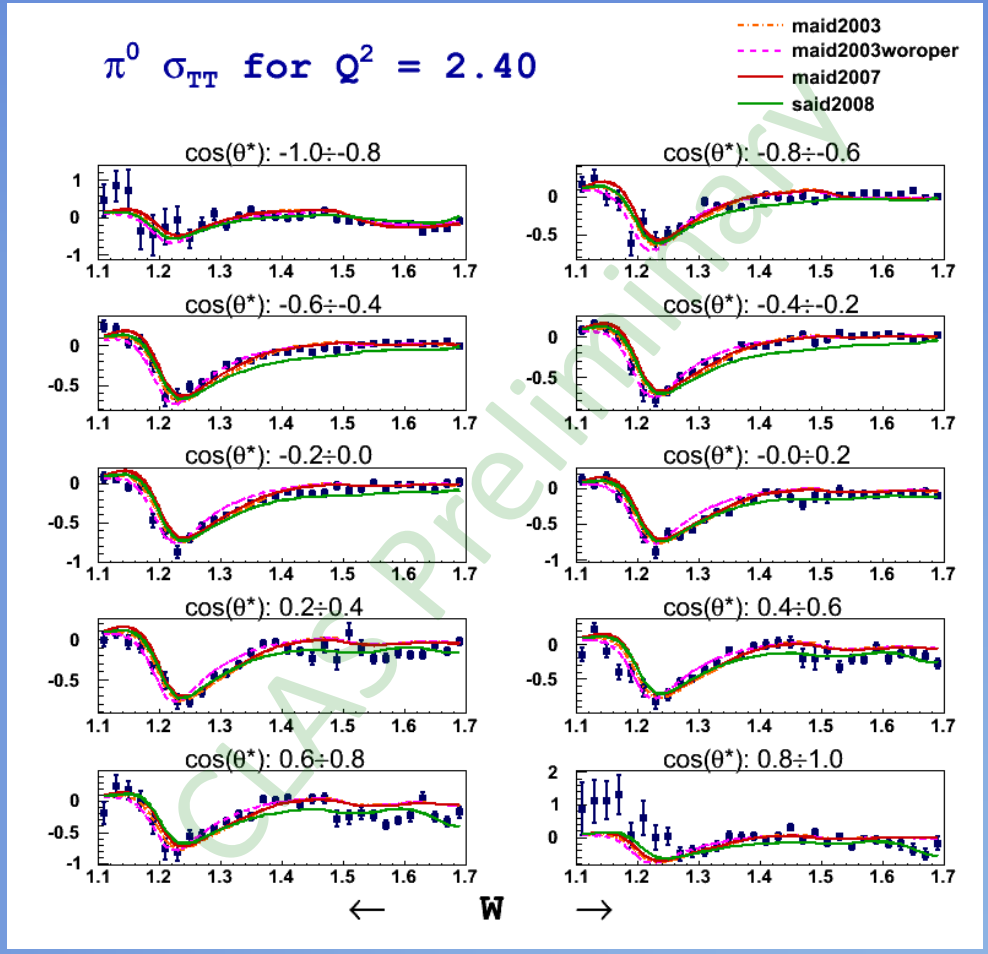

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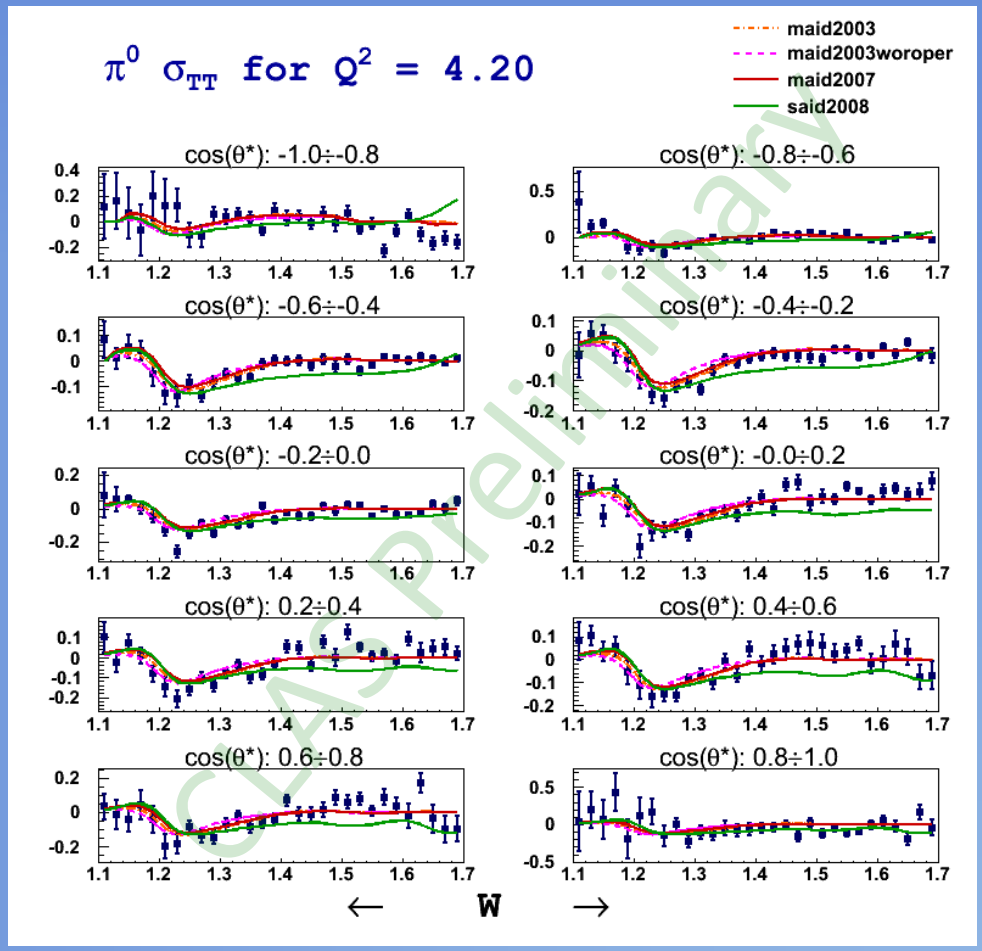

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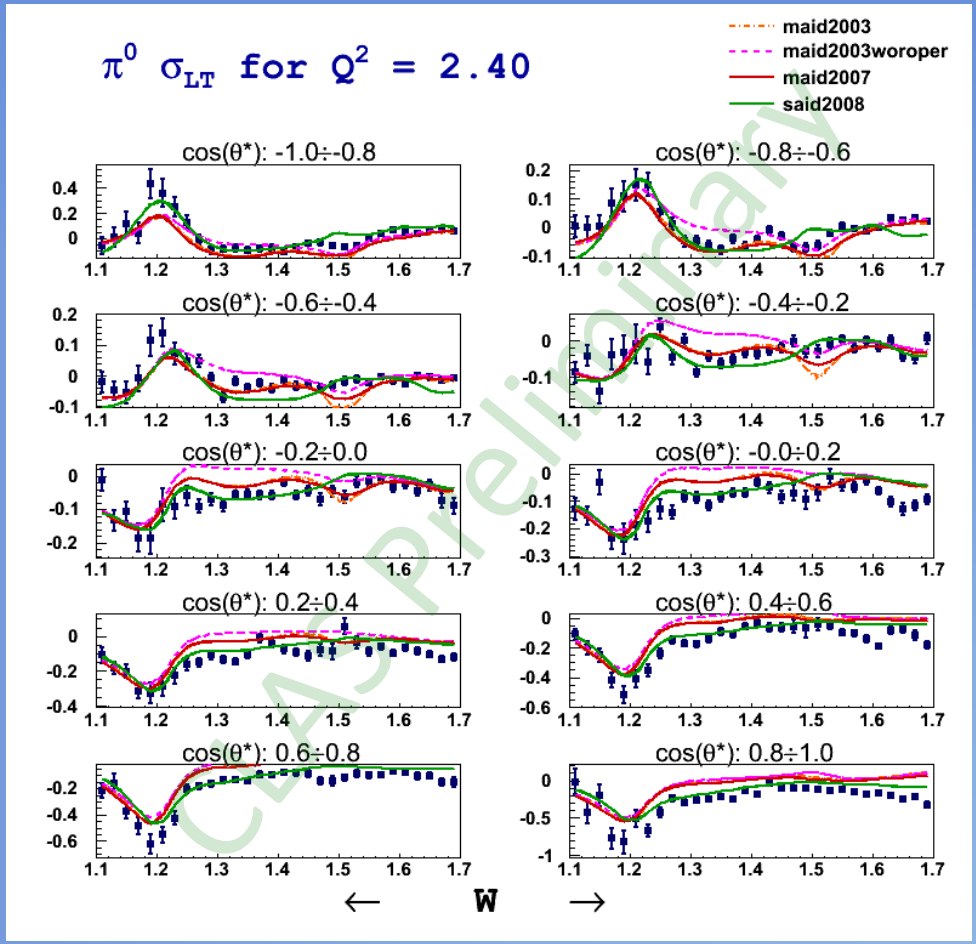

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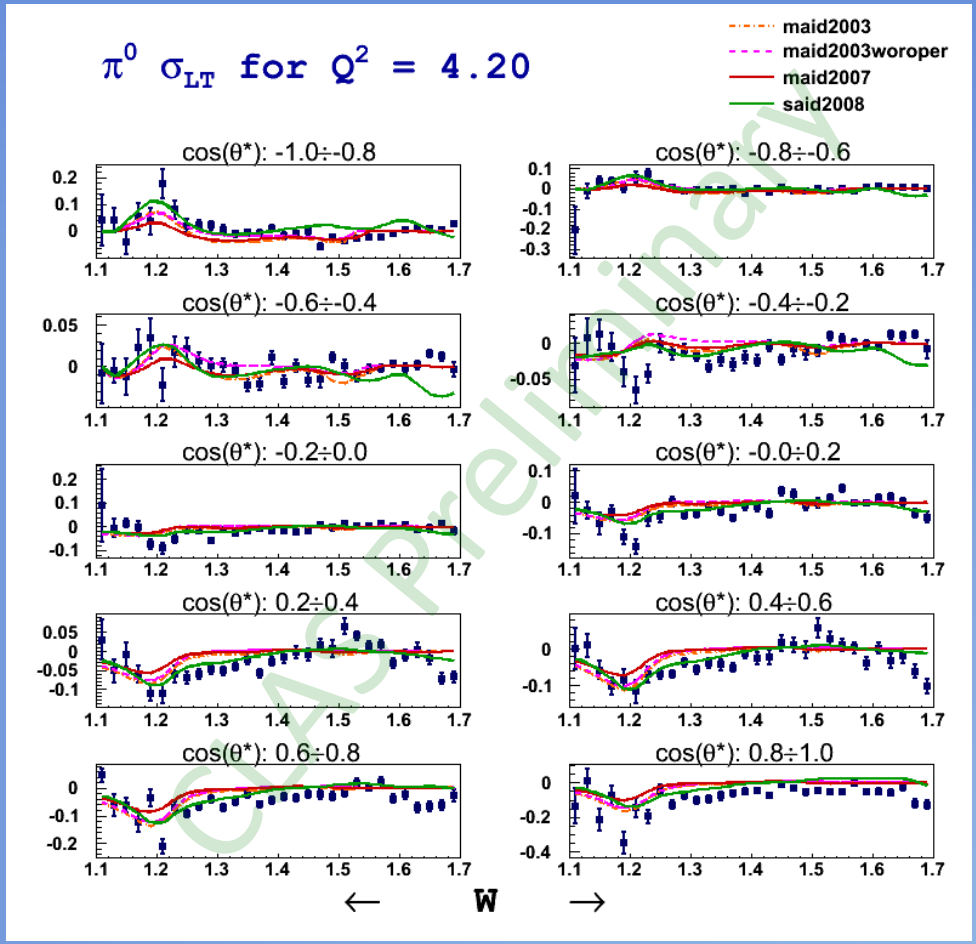
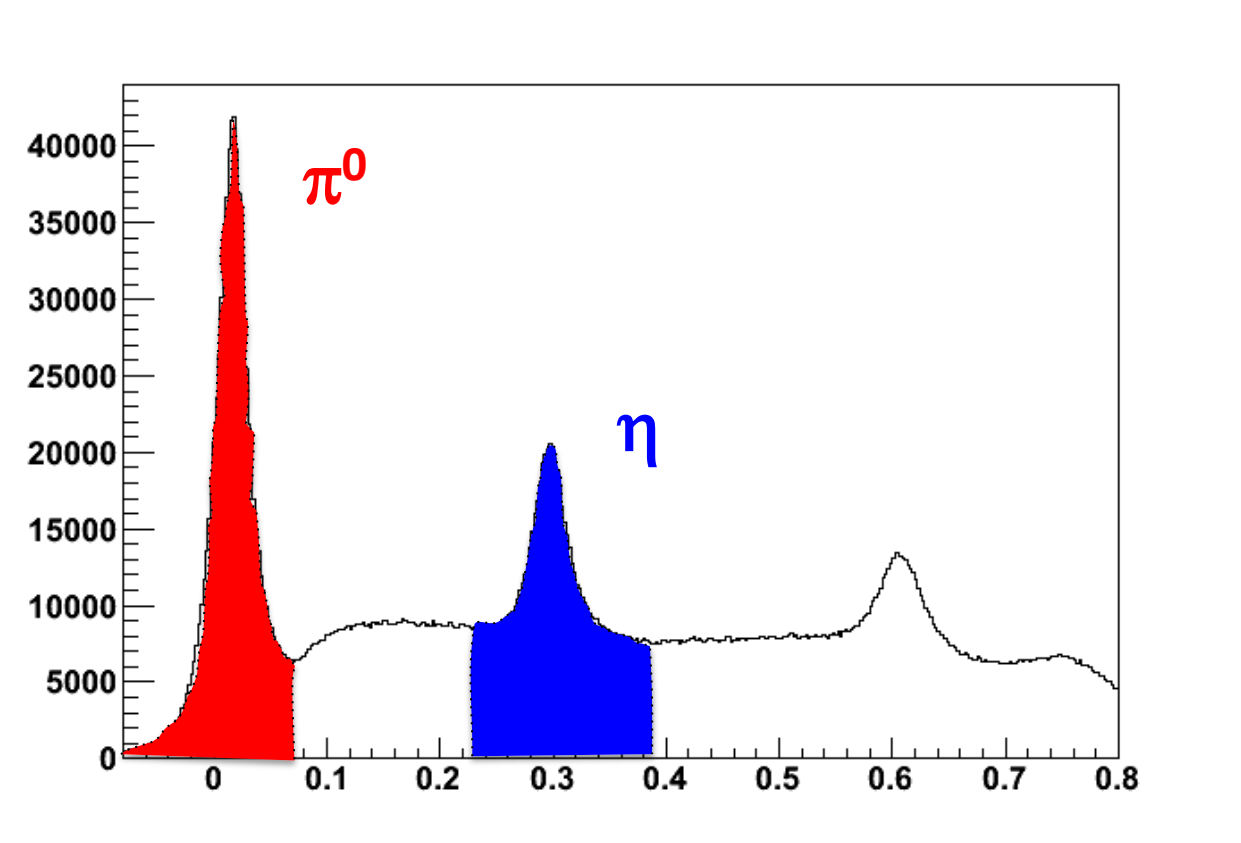


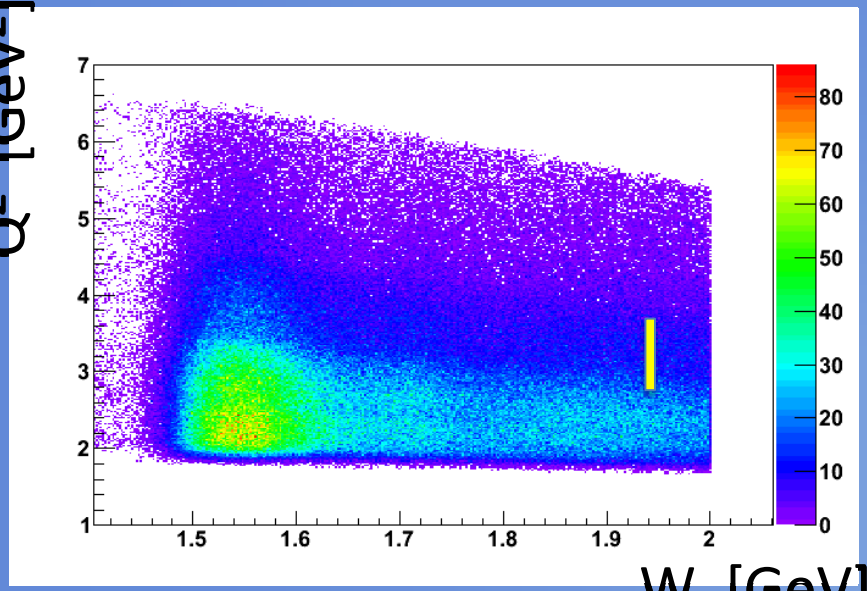
What about η?

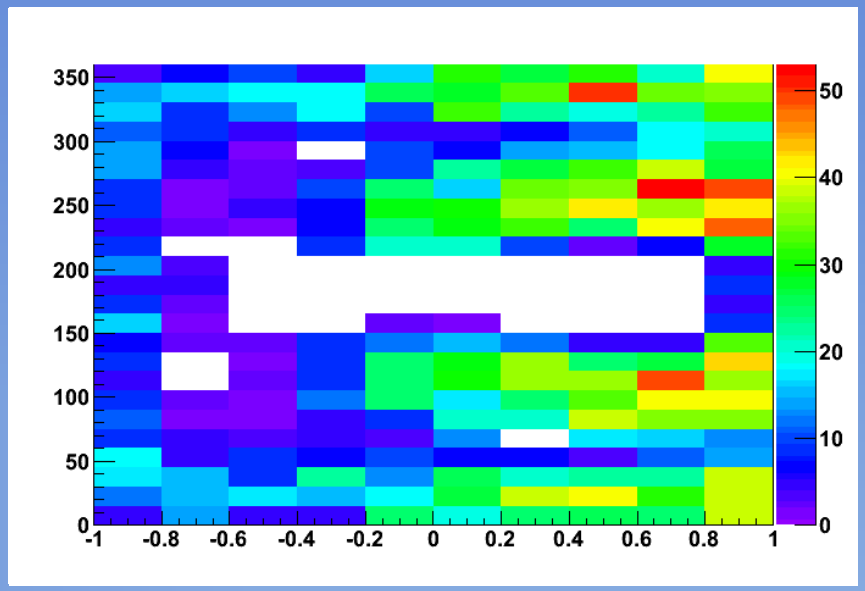


eP missing mass^2 [GeV^2]

What about η?

η



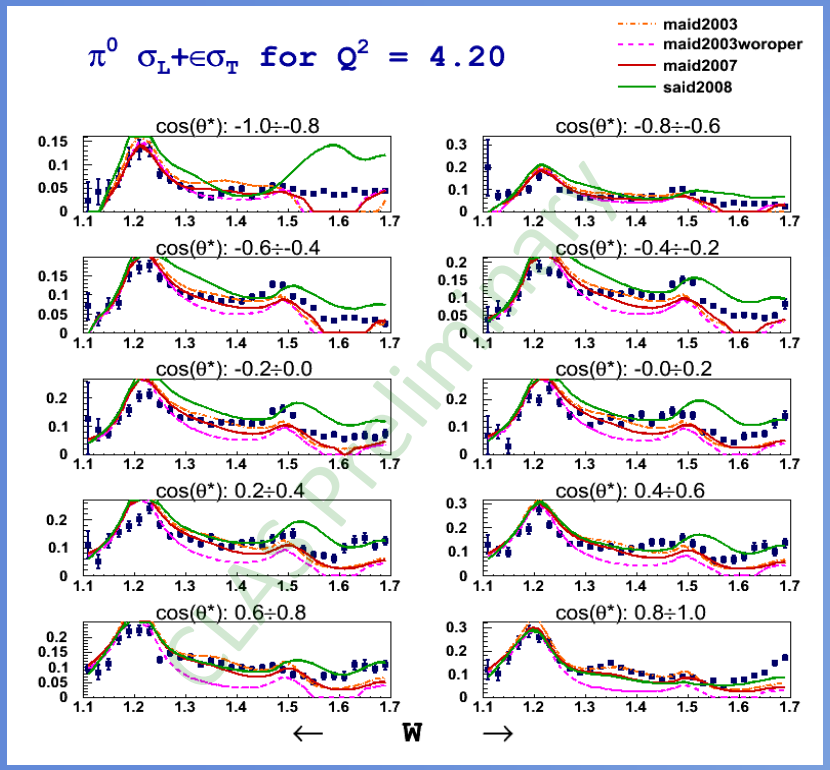


25 bins in W, ΔW=20 MeV
7 bins in Q^2 $DQ^2/Q^2 \sim 0.18$

10 bins in cos(θ*)
24 bins in ϕ*

Total: 43750 points

Summary, Outlook



To do list:
JANR, DR, SAID analysis

Review:
π^0 (by this summer)
η (by this fall/winter)

The combined analysis of single and double meson channels is key to the N* program and to provide a high definition picture of the nucleon

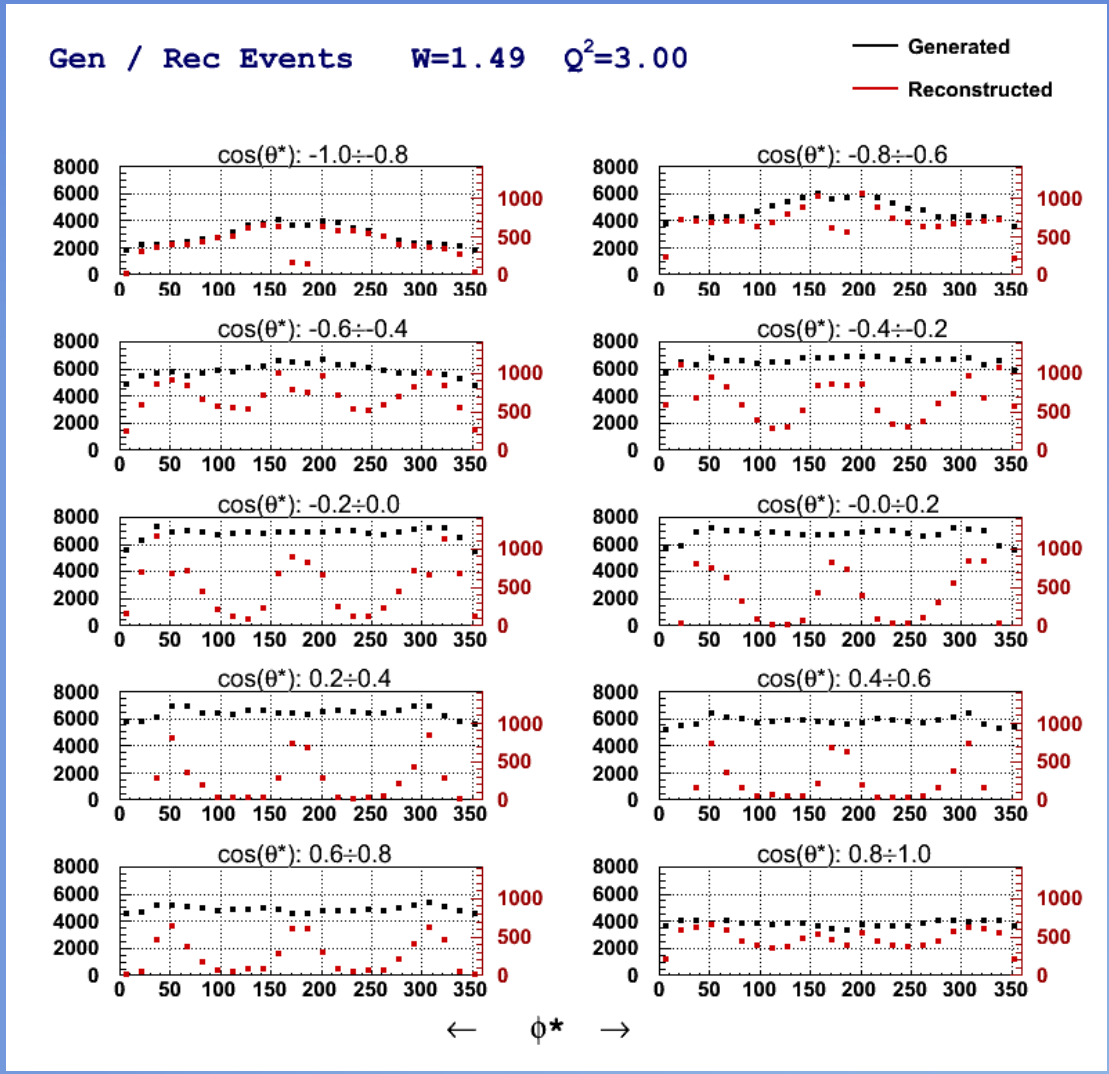
Access active degrees of freedom at various distances

Explore the non-perturbative strong interactions responsible for nucleon formation and the origin of quark confinement

Analysis Overview

24 ϕ bins
200M Generated Events
MAID2007
AAO_RAD

- ✓ Electron ID
- ✓ Proton ID
- ✓ Vertex Correction, Selections
- ✓ Electron Fiducial Cut
- ✓ Proton Fiducial Cut
- ✓ Timing Resolution Match
- ✓ Momentum Resolution Match
- ✓ Drift Chamber Efficiencies
- ✓ π^0 selection



Analysis Overview

96 ϕ bins
200M Generated Events
MAID2007
AAO_RAD

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- ✓ Proton ID
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- ✓ Proton Fiducial Cut
- ✓ Timing Resolution Match
- ✓ Momentum Resolution Match
- ✓ Drift Chamber Efficiencies
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