Inclusive and Elastic Electron Scattering off Protons with CLAS12

CLAS collaboration meeting

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UCONN

Outline

- Elastic cross section measurement at 2.2 GeV
  - Data analysis
  - Simulation
  - Normalization
- Inclusive cross section measurements at 10.6 GeV
  - Physics motivation
  - Data analysis
  - Simulation
  - Future steps
- Plans

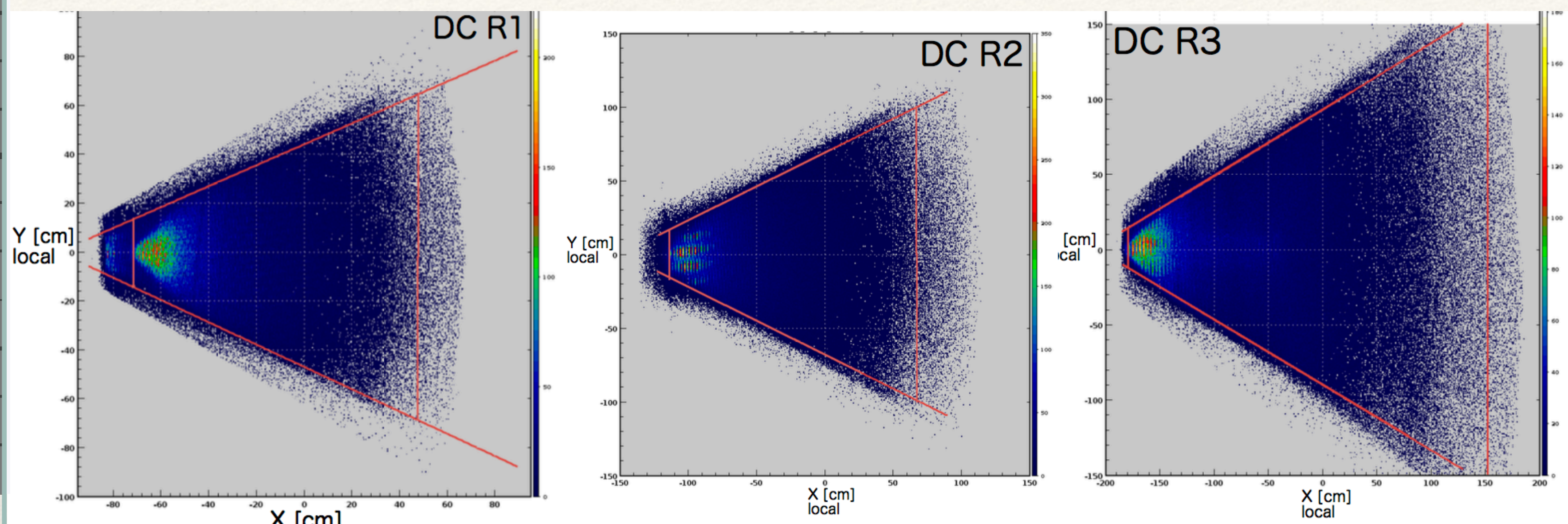
Electron ID and Event Selection

Electron ID

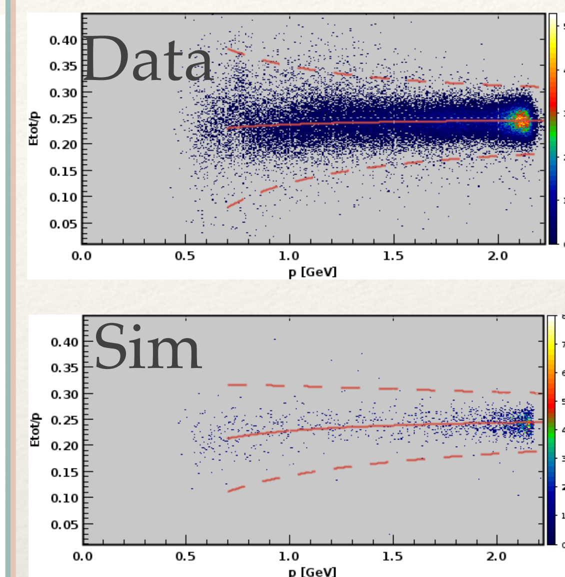
- Negative Charge
- PCAL Fiducial Cut
- DC Region 1 Fiducial Cut
- DC Region 2 Fiducial Cut
- DC Region 3 Fiducial Cut
- Sampling Fraction Cut
- FTOF Hit Response
- HTCC Nphe Cut
- Minimum Momentum Cut
- PCAL Energy Deposited Cut
- Vertex Cut

Same between data simulation
Modified for the simulation

DC fiducial cuts in the local coordinates of the DC R1, DC R2, DC R3

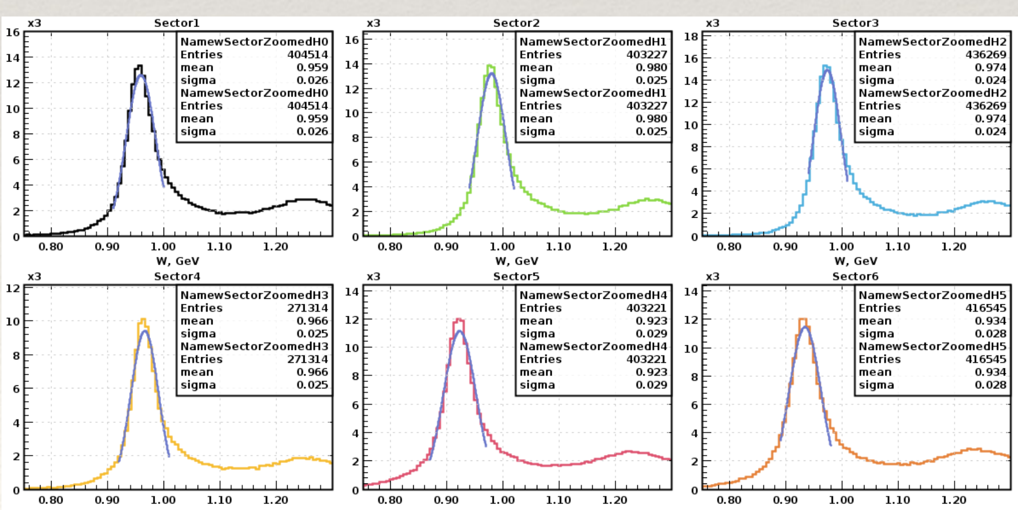


Sampling fraction



3 sigma cut around mean values. Sector dependent

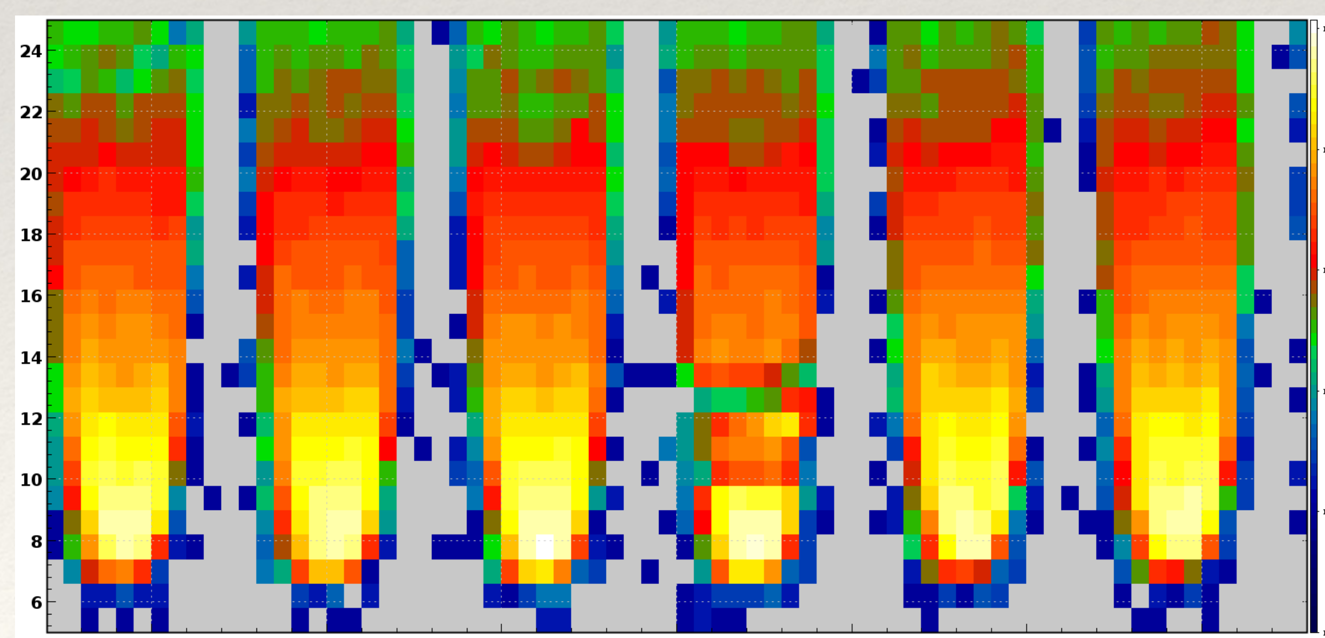
Elastic event selection



Peak + 3 sigma cut to select elastic events
Cut is sector dependent

Elastic events distribution

θ

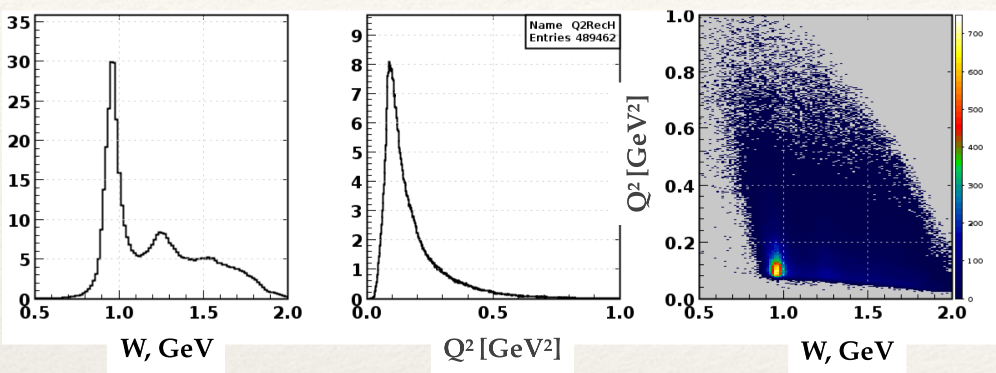


φ

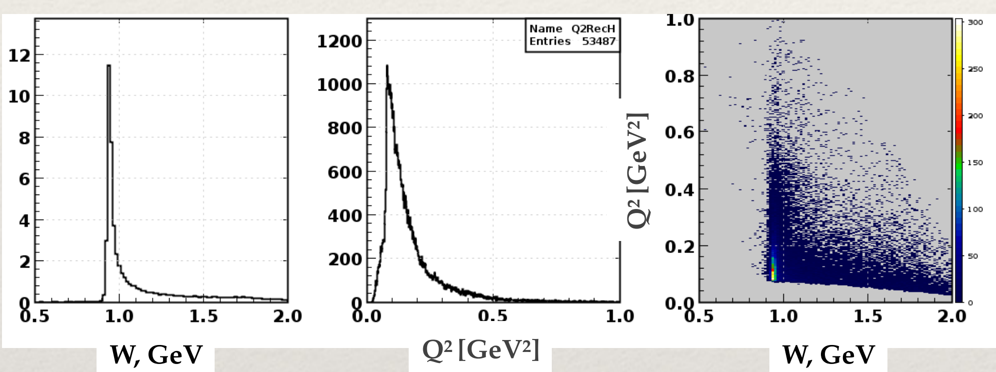
Simulation and data

Kinematics

Data



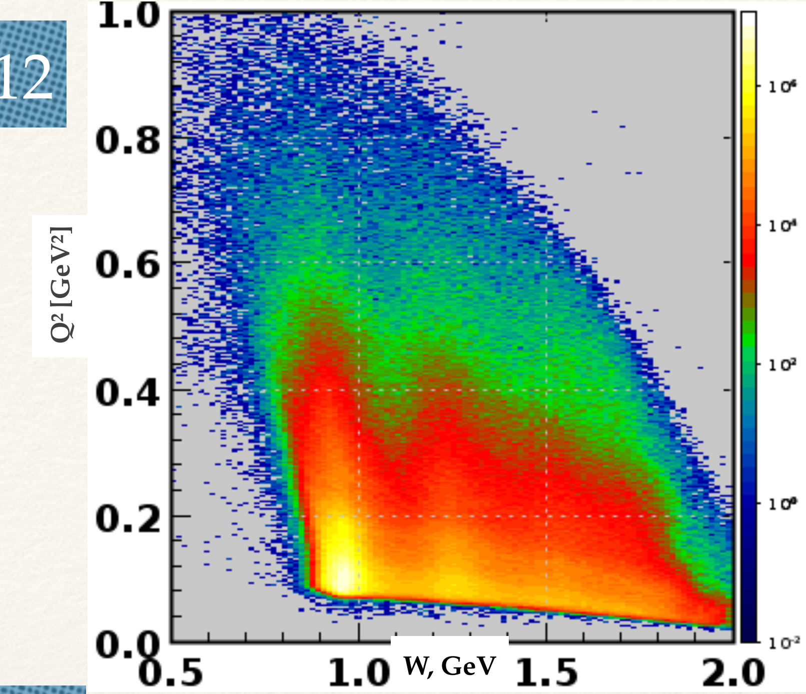
Simulation



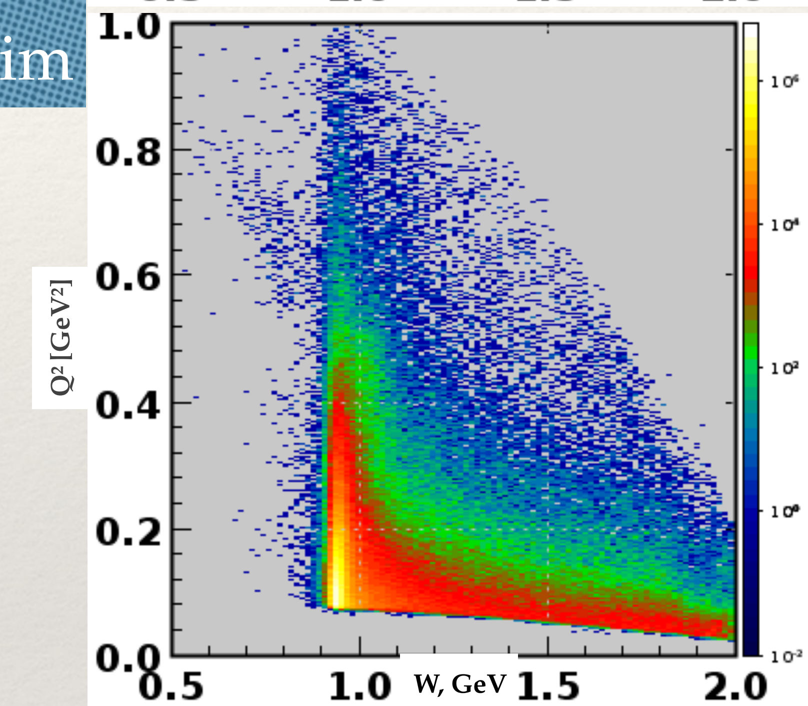
Event generator: elastgen (*includes radiative effect*)

Run:	2476
Field scaling:	T+0.6; S+0.6
Generator:	elastgen
GEMC:	4a.2.3
Coatjava:	5b.4.0

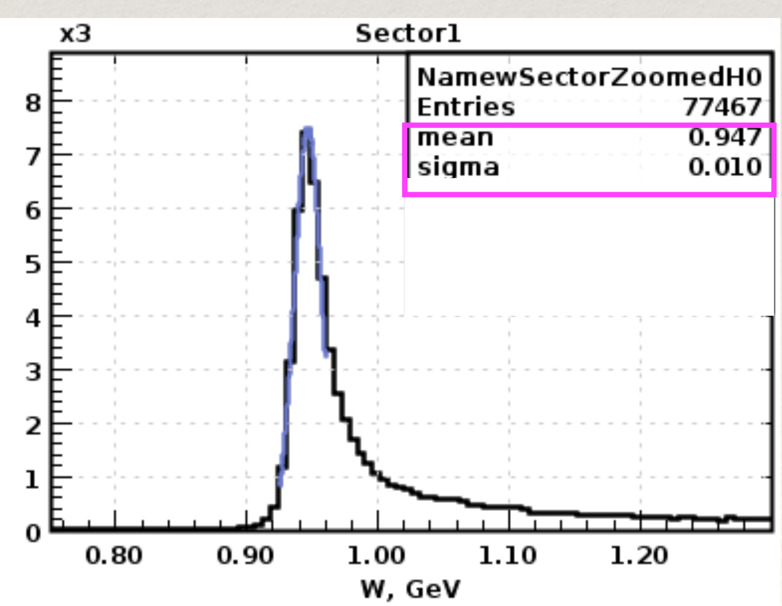
Data, CLAS12



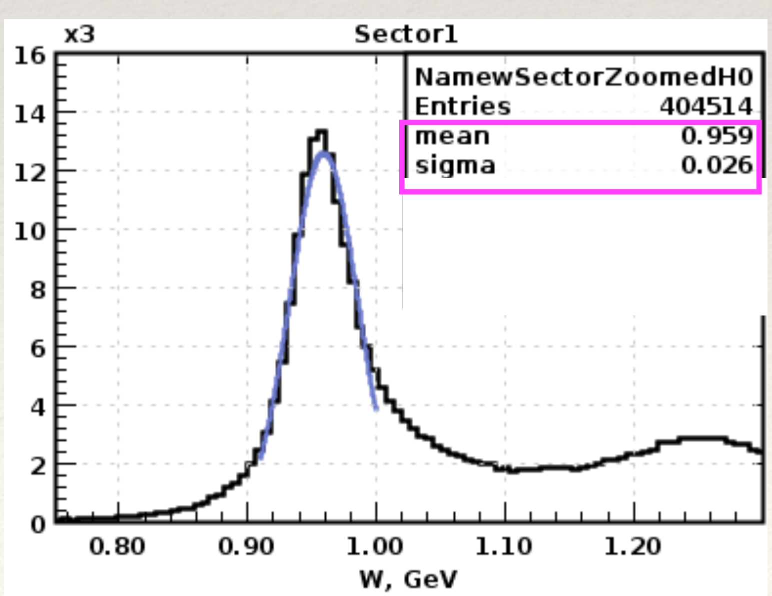
Sim



Simulation

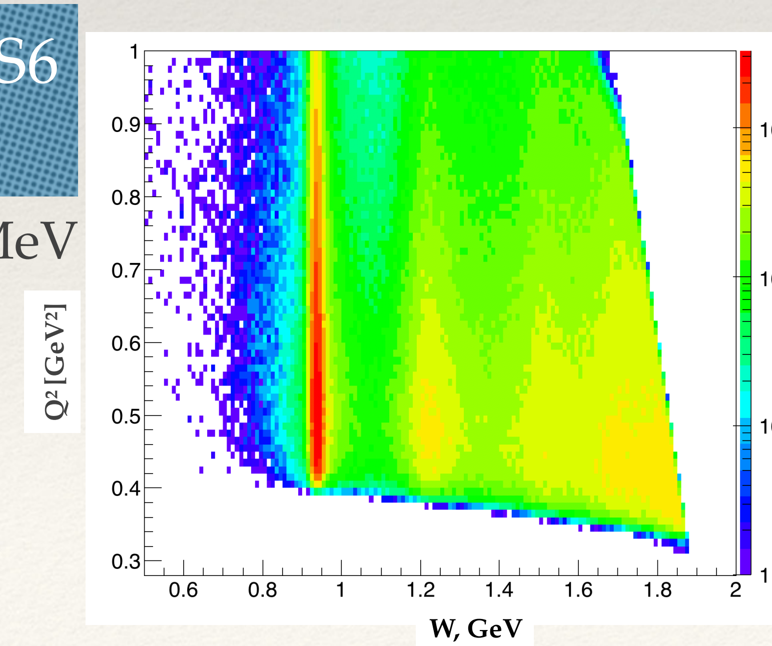


Data



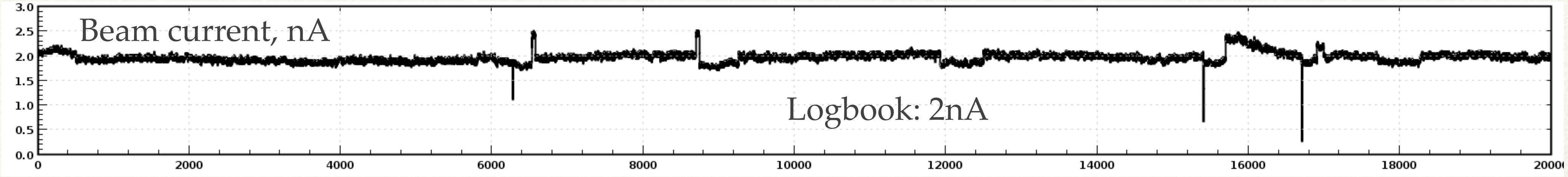
Data, CLAS6 (e1e)

σ(e1e) = 10 MeV

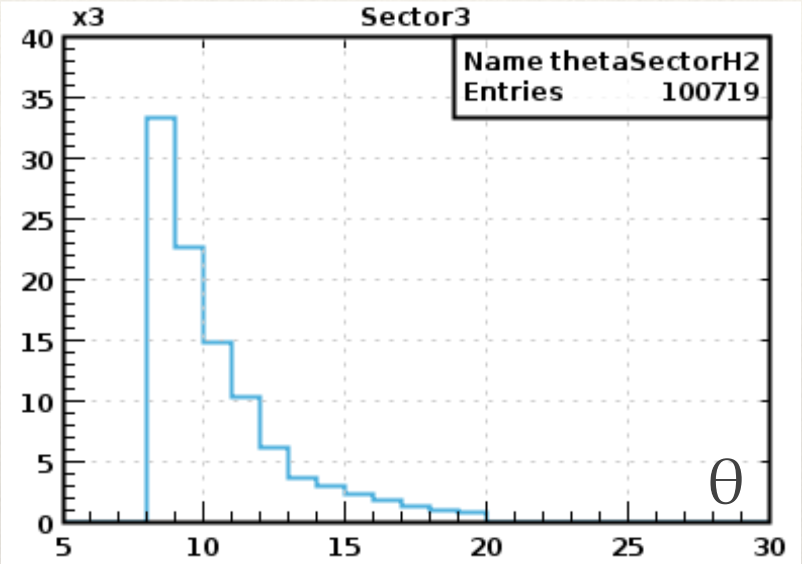


Acceptance Corrections and Normalization

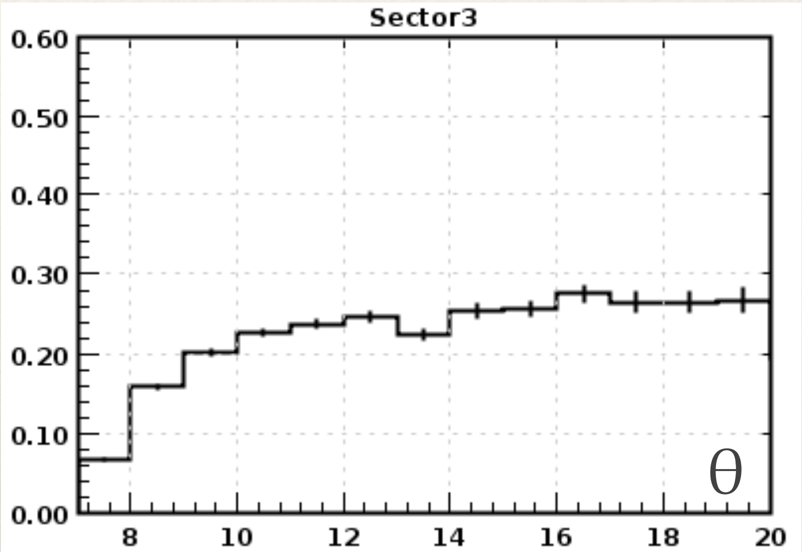
Beam current measurements



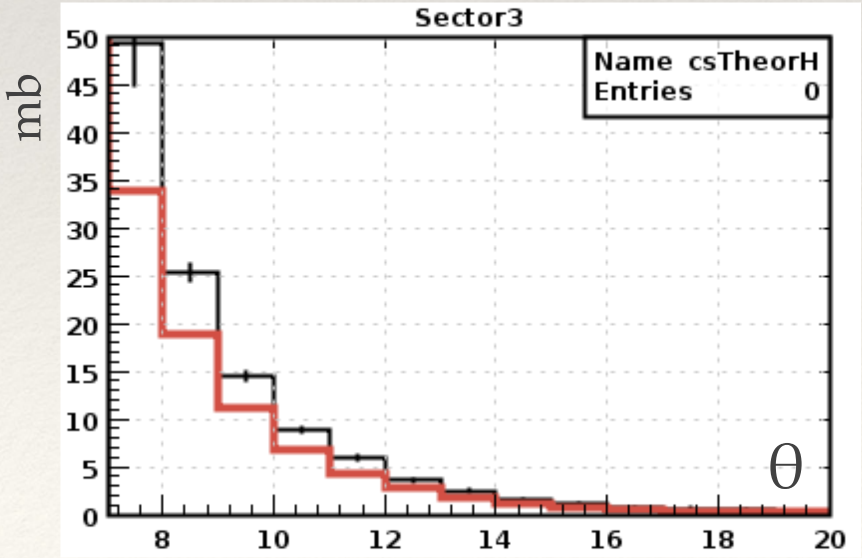
Elastic event



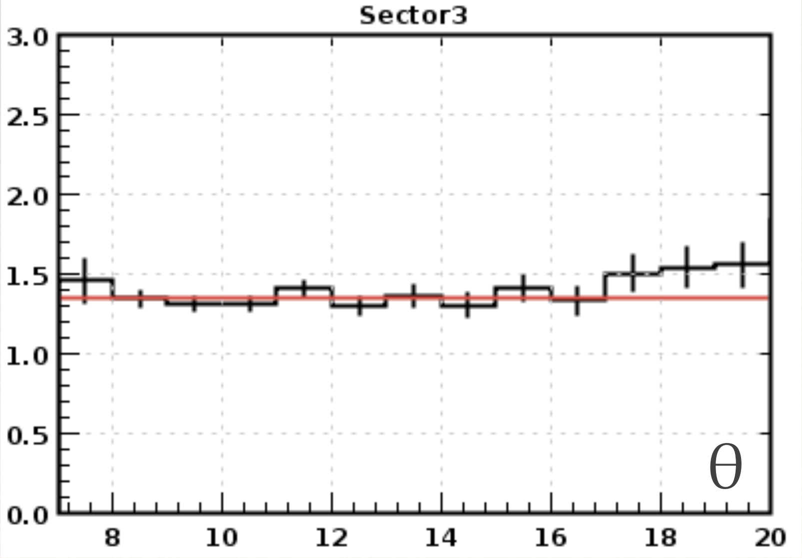
Acceptance correction



Cross section, comparison to the model



Cross section divided by the model



Inclusive Cross Section Measurements at 10.6 GeV

- Physics motivation
- Channel identification (electron ID)
- Detector efficiency and acceptance
- Radiative and bin centering corrections
- Absolute normalization

Motivation

- Measurement of the unpolarized inclusive electron scattering cross section in the resonance and deep inelastic regimes.

- Kinematic coverage: 1.1 GeV < W < 4.0 GeV and Q^2 up to 12 GeV^2 combines interests of the CLAS12 N* structure and DIS physics groups.

- First precise measurements of inclusive cross section evolution with W and Q^2 in the resonance region at Q^2 > 5 GeV^2 and understanding of the W-and Q^2 evolution of the s-channel resonant contribution to the total cross section.

- Needed for exploration of exclusive meson electroproduction channels offering the tests for normalization and electron detection efficiencies.

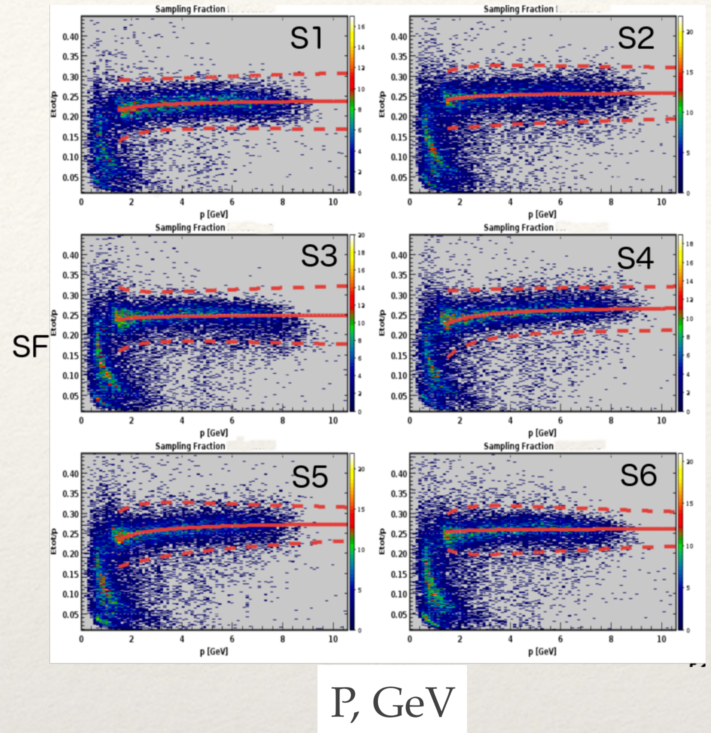
- Extend knowledge on parton distribution functions towards $x_B \to 1$ over the resonance excitation region.

Channel Identification (Electron ID)

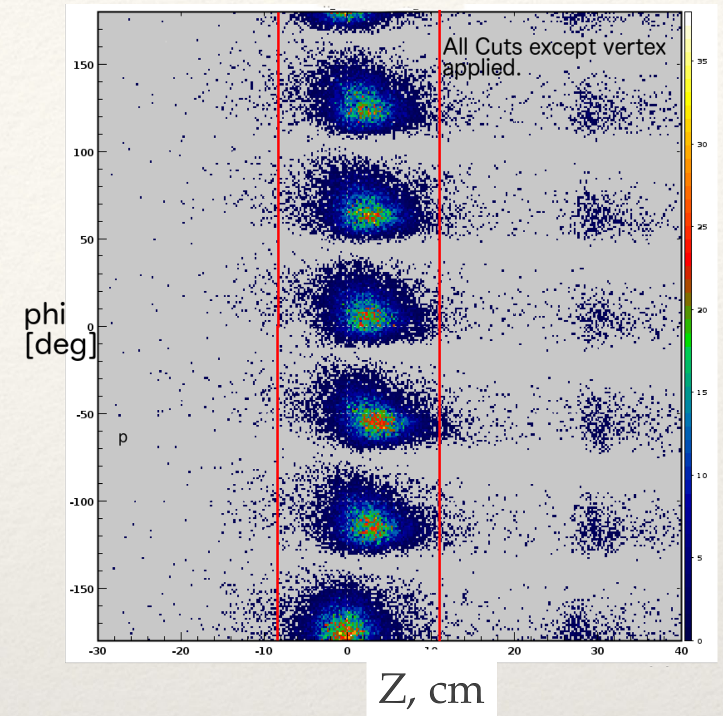
E ID schematic

Cut Name
Negative Charge
DC Region 1 Fiducial Cut
DC Region 2 Fiducial Cut
DC Region 3 Fiducial Cut
PCAL Fiducial Cut
Sampling Fraction Cut
FTOF Hit Response
HTCC Nphe Cut
Minimum Momentum Cut
PCAL Energy Deposited Cut
Vertex Cut

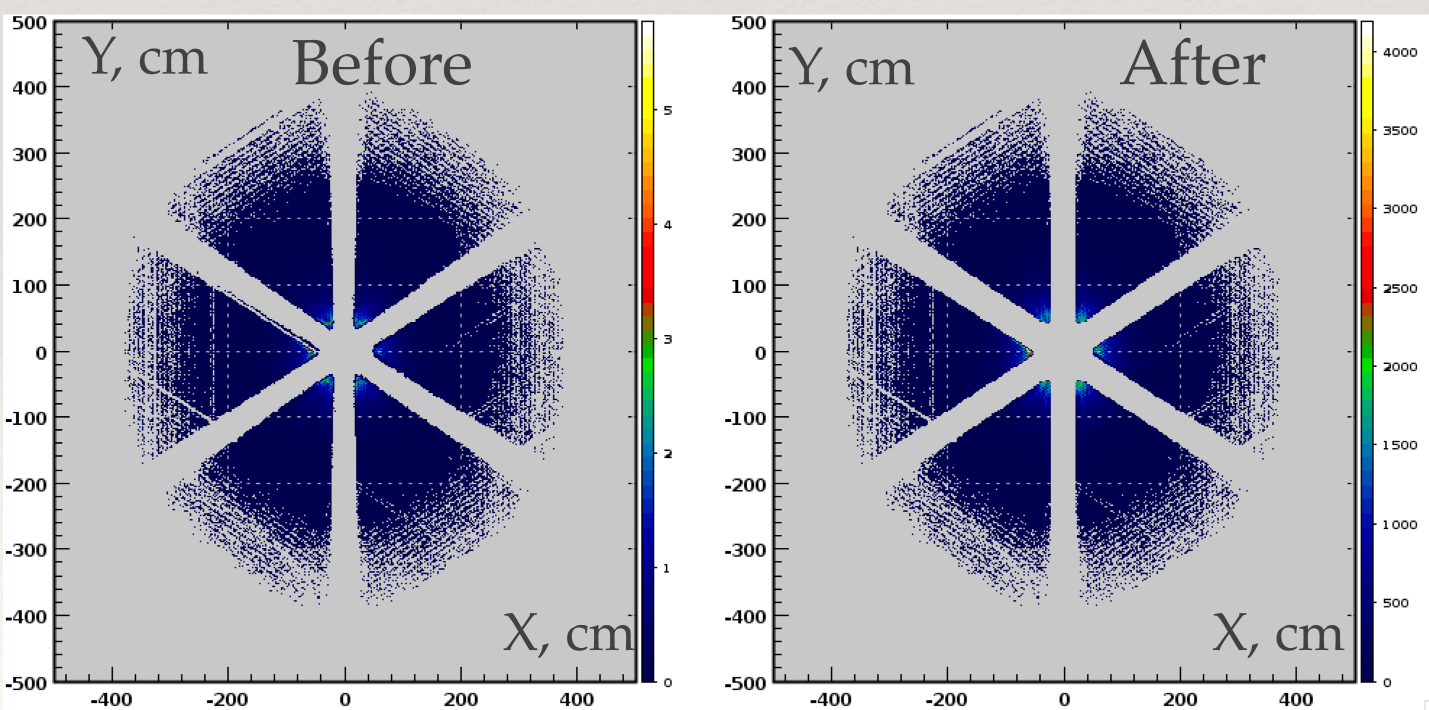
Sampling fraction cut



Vertex cut



PCAL X vs Y cut

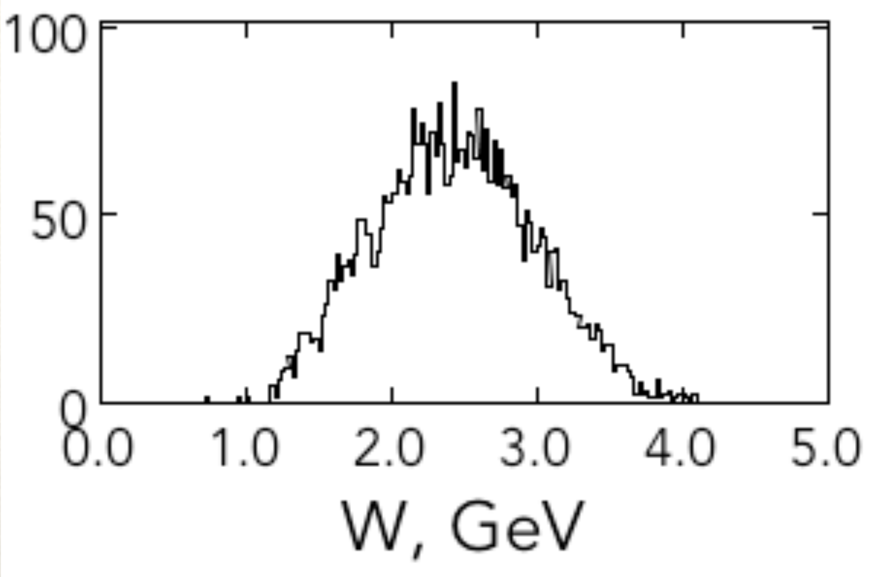


Simulation

Event generators

- In CLAS6, Keppel event generator was used successfully. We cannot use it for the full W range accessible, as it covers only resonance region.
- **Misak Sargsian's** generator with elastic and inclusive events and radiative effects is used for the current and future analysis. It covers the full W region accessible in the experiment.

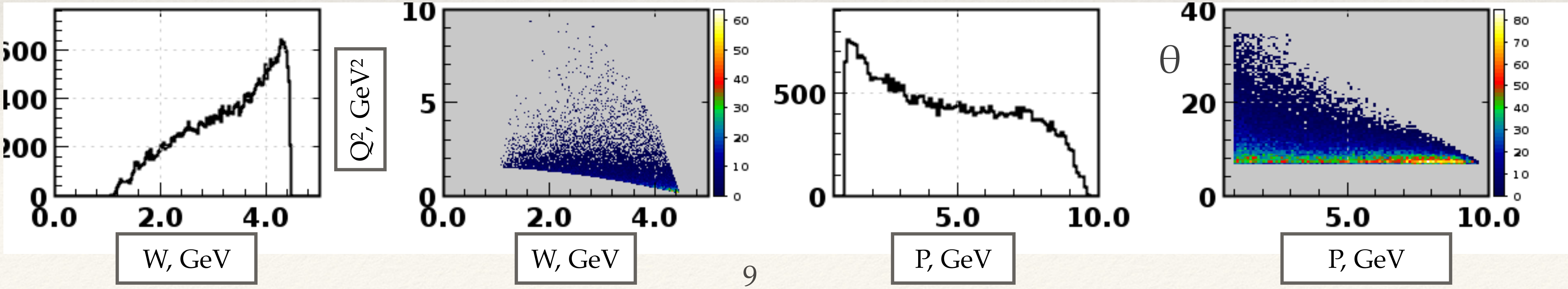
Keppel



Generated events

- gemc: 4a.2.3
- COATJAVA 5a.3.3
- Mag field: -1/-1
- Beam energy: 10.646
- Target: full

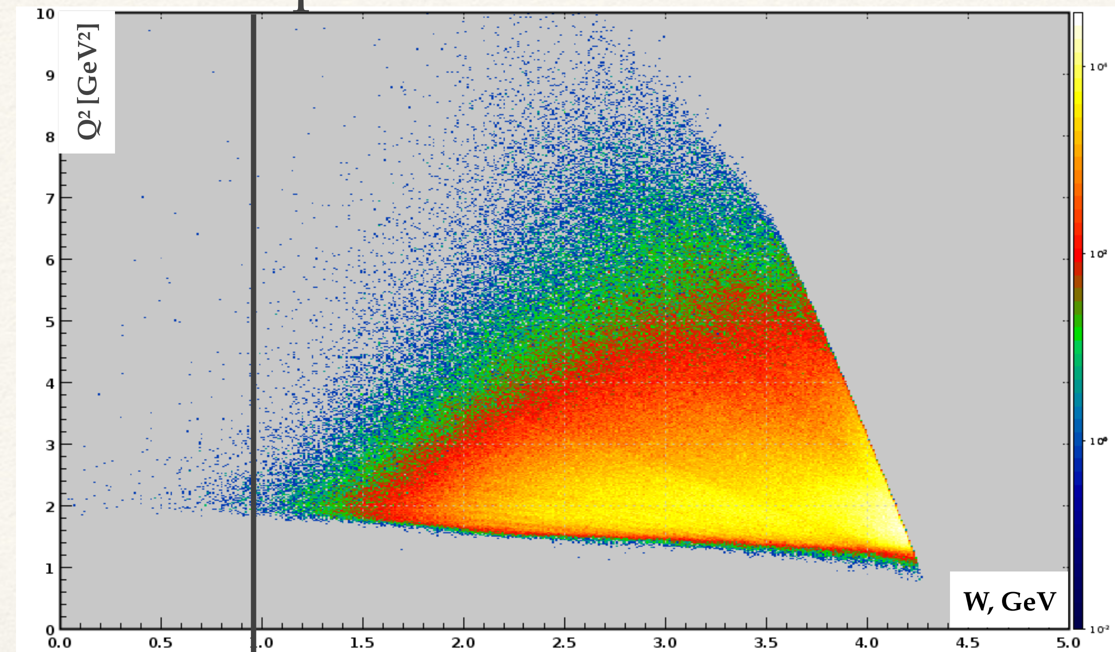
Misak



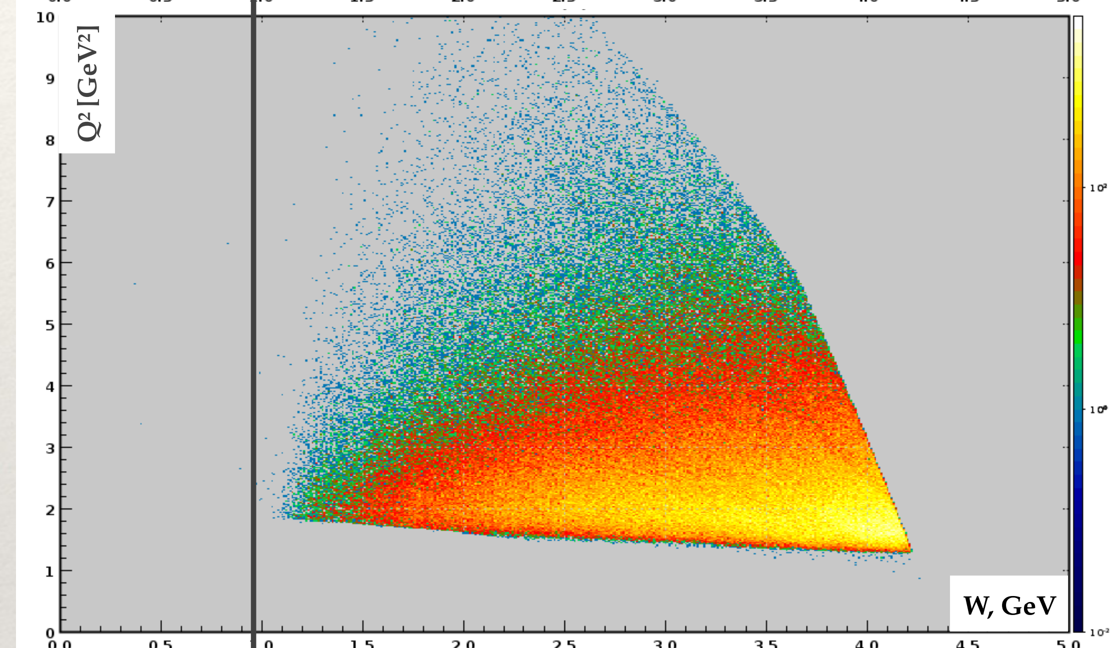
Kinematics overview

Elastic peak

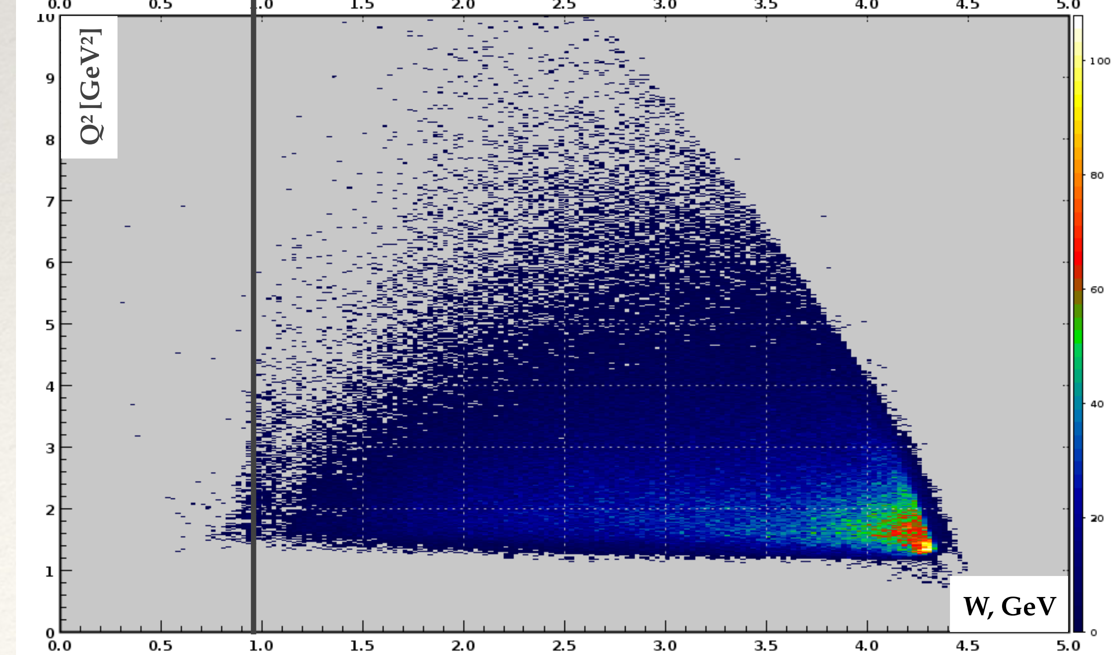
Data



Simulation w/o elastic peak



Simulation with elastic peak



Expect to see somewhat clear elastic peak at 10 GeV

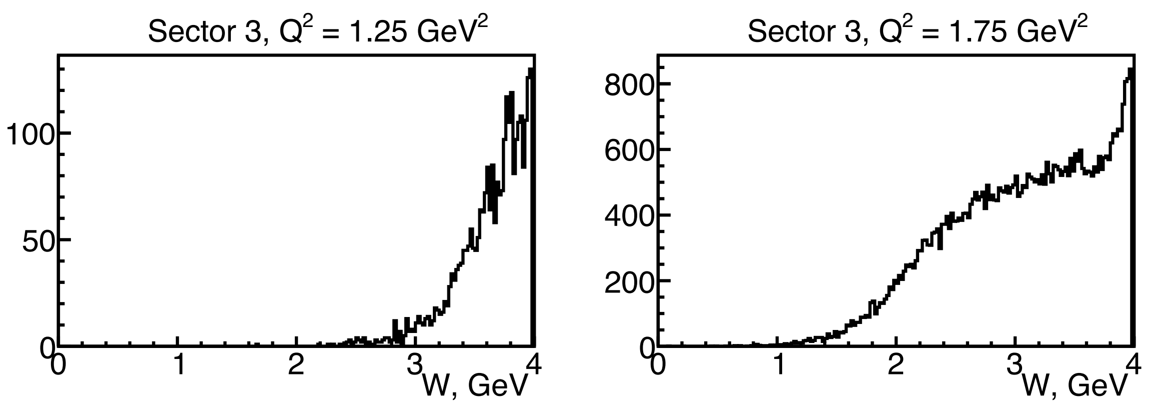
Event Distribution in Q² bins in Sector 3, Data

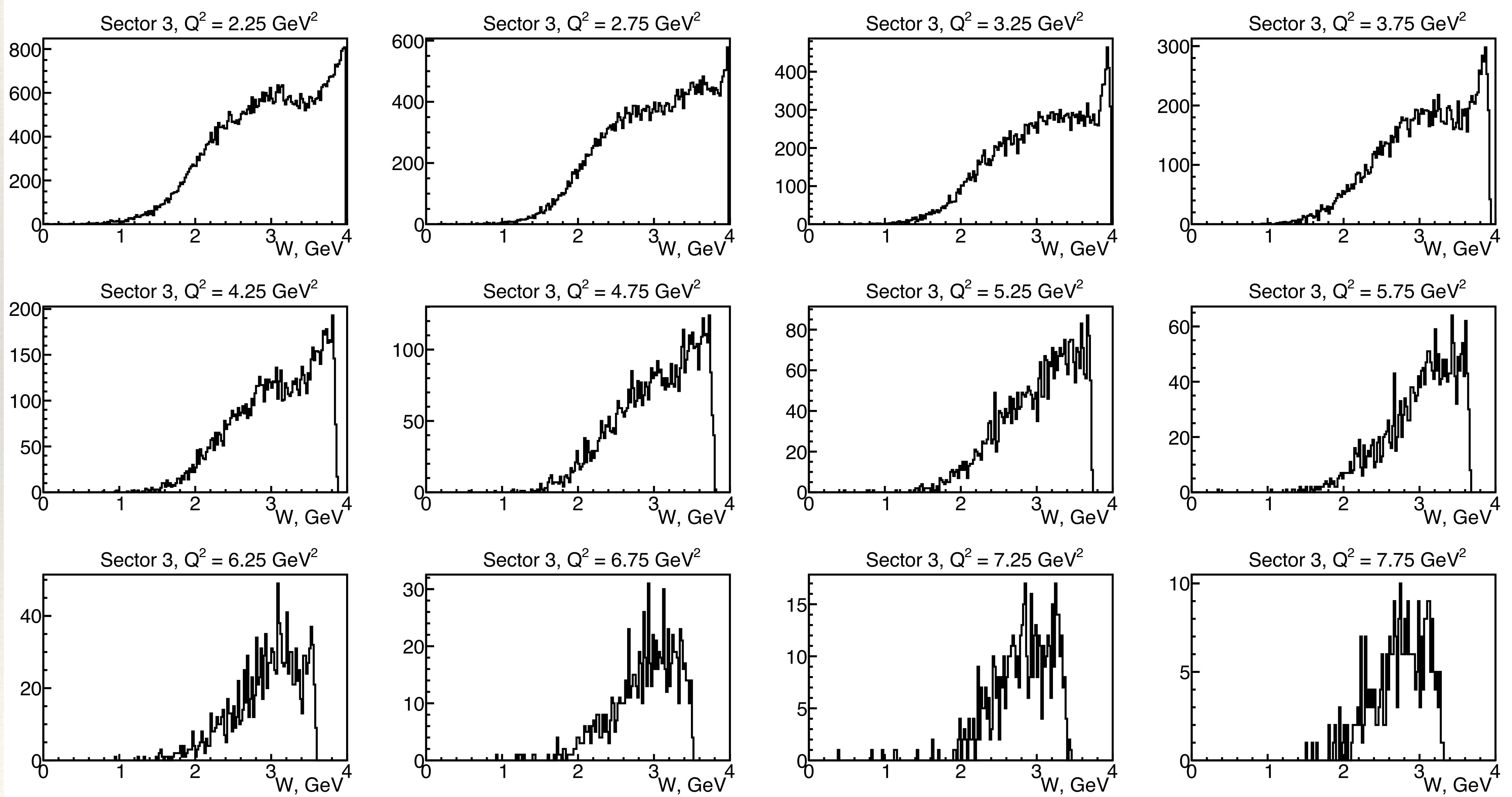
Δ W: 0.025 GeV

Δ Q^2: 0.5 GeV^2

Covers resonance region and beyond in wide Q^2 range

No visible peaks



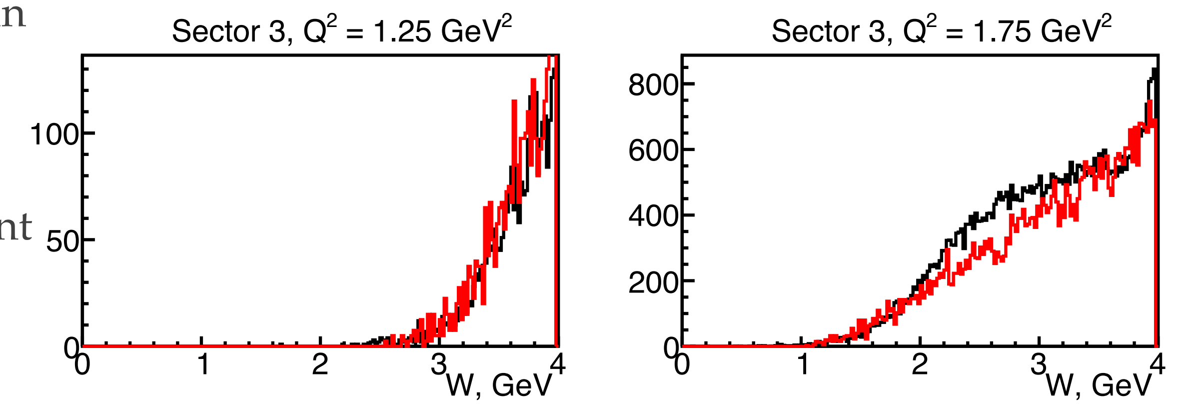


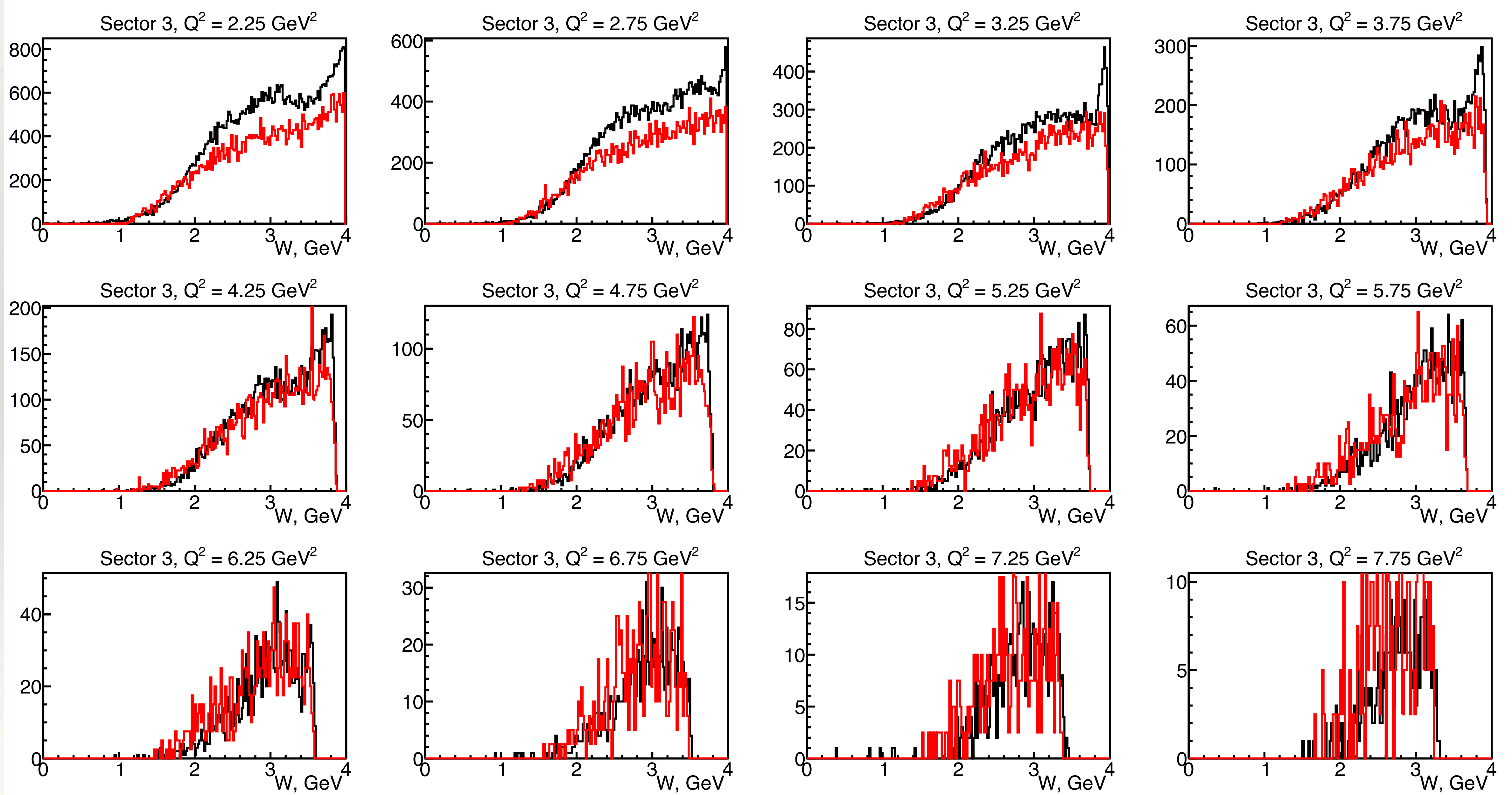
Comparison of Data and Simulation

Δ W: 0.025 GeV
Δ Q^2: 0.5 GeV^2

Covers resonance region and beyond in wide Q^2 range;
Similar between data and simulation.
Adjustment between data and simulation is the same between different bins.

Data
Reconstructed

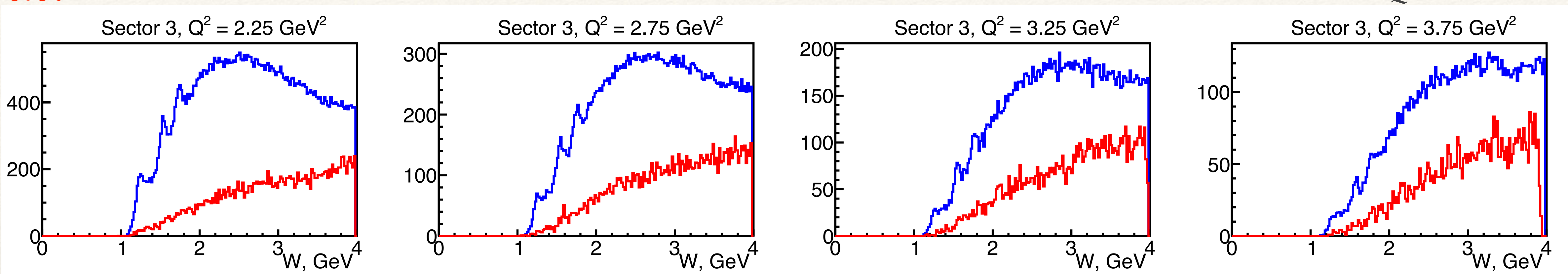




Event Distribution and Acceptance in Q^2 bins in Sector 3

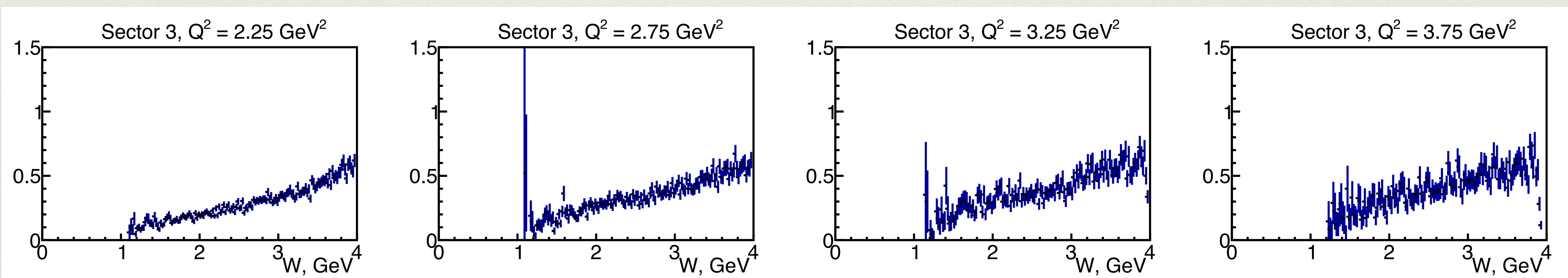
Generated
Reconstructed

Δ W: 0.025 GeV
Δ Q^2: 0.5 GeV^2



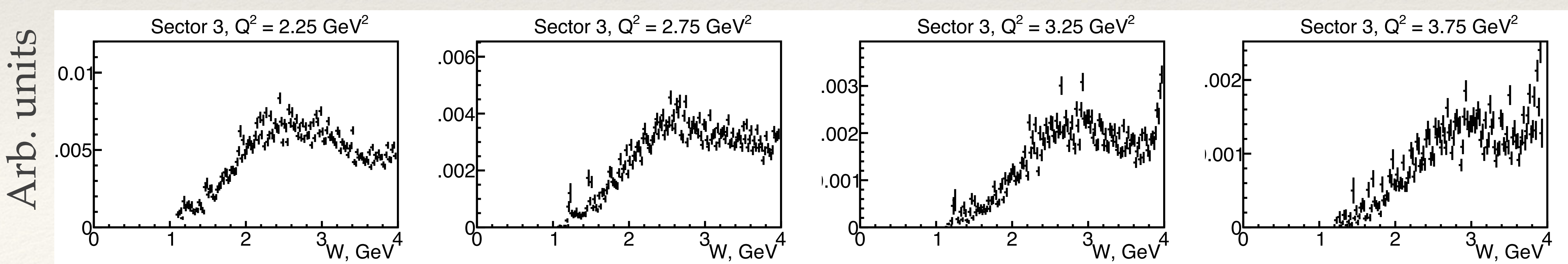
Acceptance

$$\text{Acc} = \frac{\text{Reconstructed}}{\text{Generated}}$$



Normalized yield

$$\text{N\_norm} = \frac{\text{N\_data}}{\text{Acc*Lumi}}$$



Normalized Yield in Sector 3 Compared to World Data

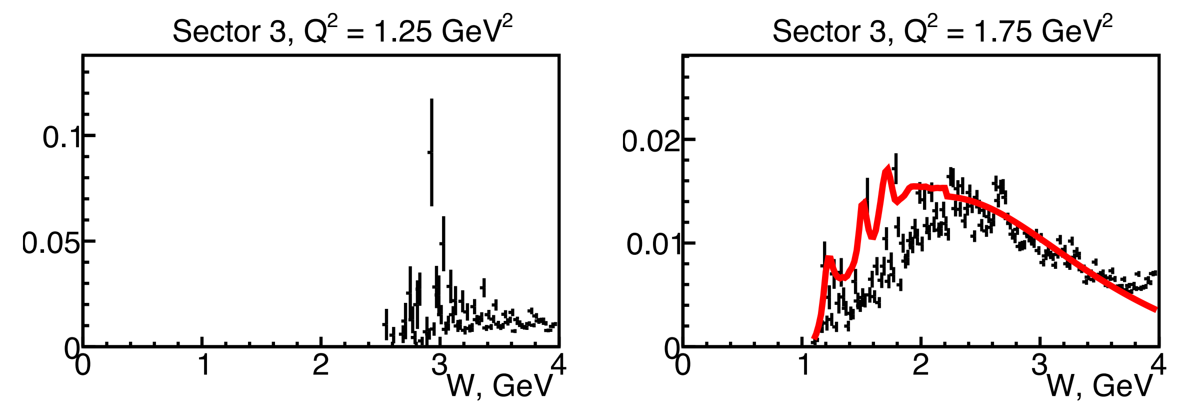
Δ W: 0.025 GeV
Δ Q^2: 0.5 GeV^2

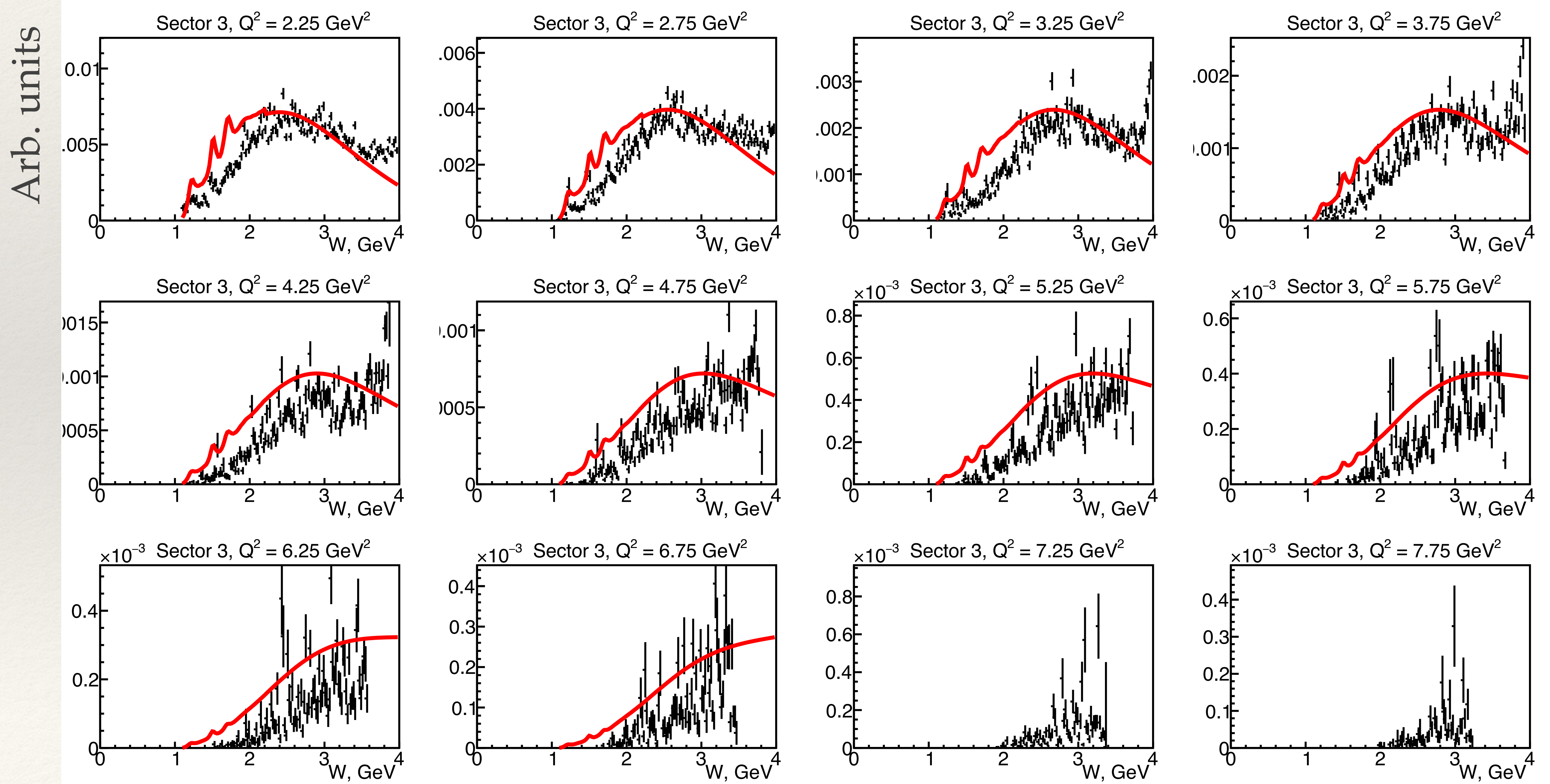
CLAS12

World data

http://clas.sinp.msu.ru/strfun-dev/ (V. Chesnokov)

Normalized data overlaid with the fit to world data.





Normalized Yield in Sector 5 Compared to World Data

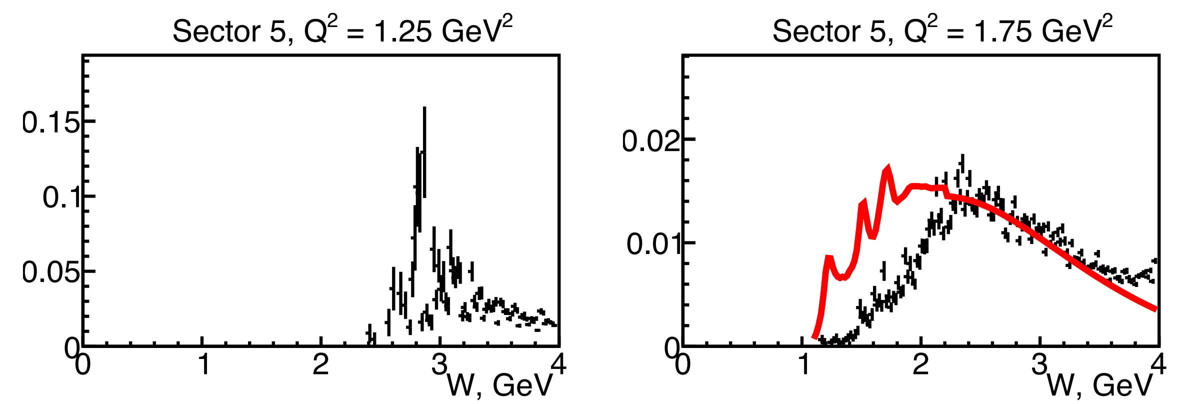
Δ W: 0.025 GeV
Δ Q^2: 0.5 GeV^2

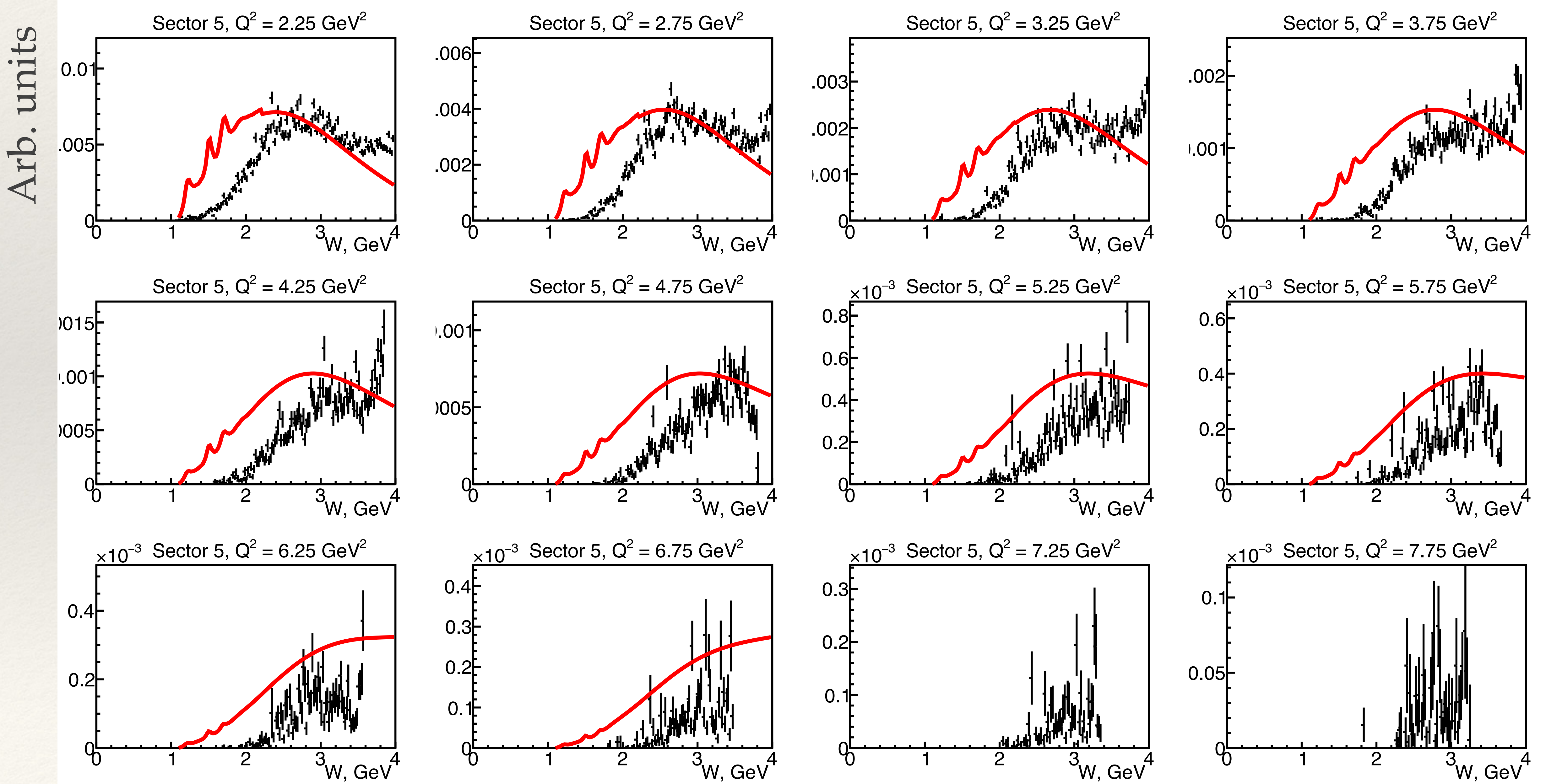
CLAS12

World data

http://clas.sinp.msu.ru/strfun-dev/ (V. Chesnokov)

Normalized data overlaid with the fit to world data.





Significant sector by sector variation

Normalized Yield in Sector 5 Compared to World Data

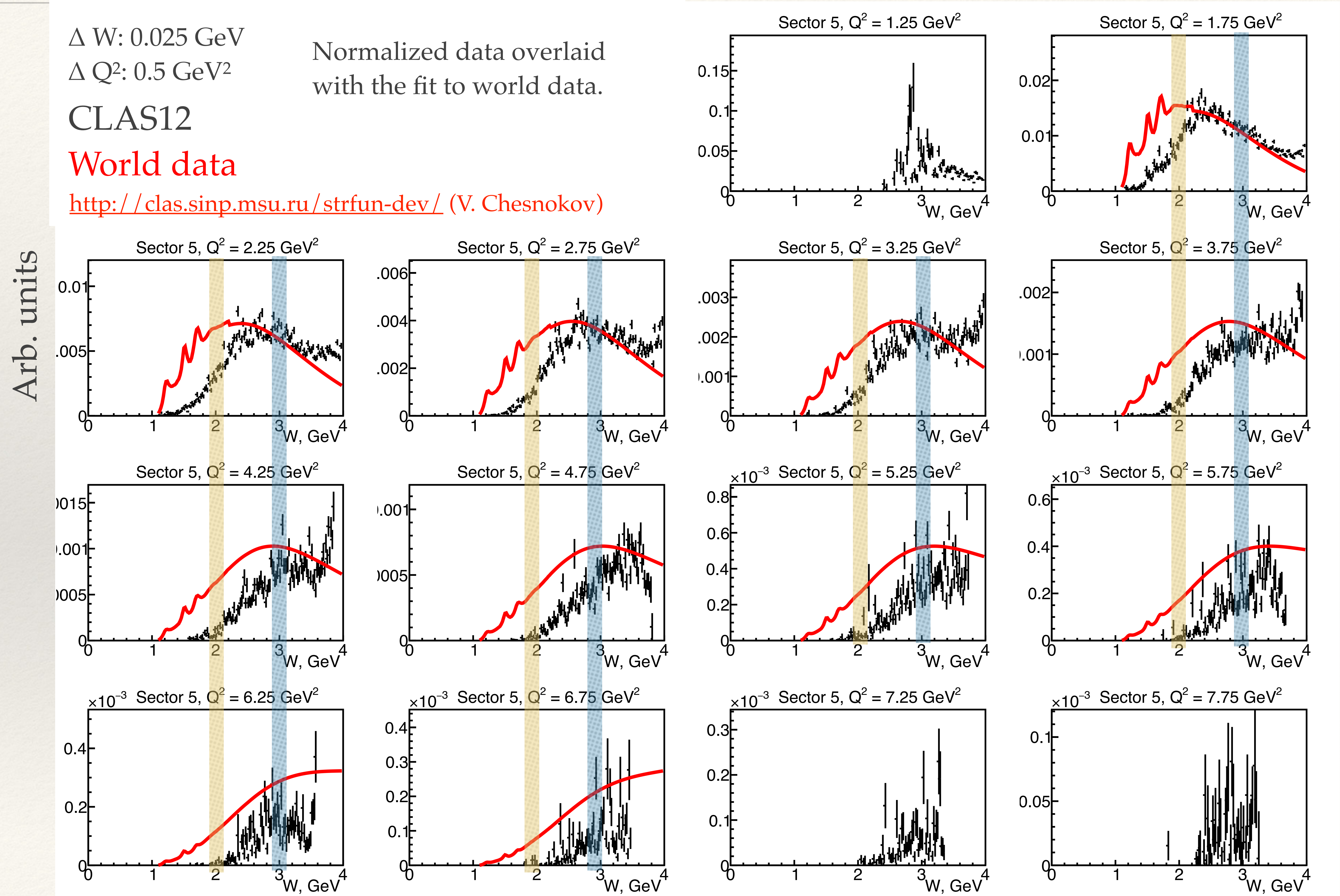
Δ W: 0.025 GeV
Δ Q^2: 0.5 GeV^2

CLAS12

World data

http://clas.sinp.msu.ru/strfun-dev/ (V. Chesnokov)

Normalized data overlaid with the fit to world data.

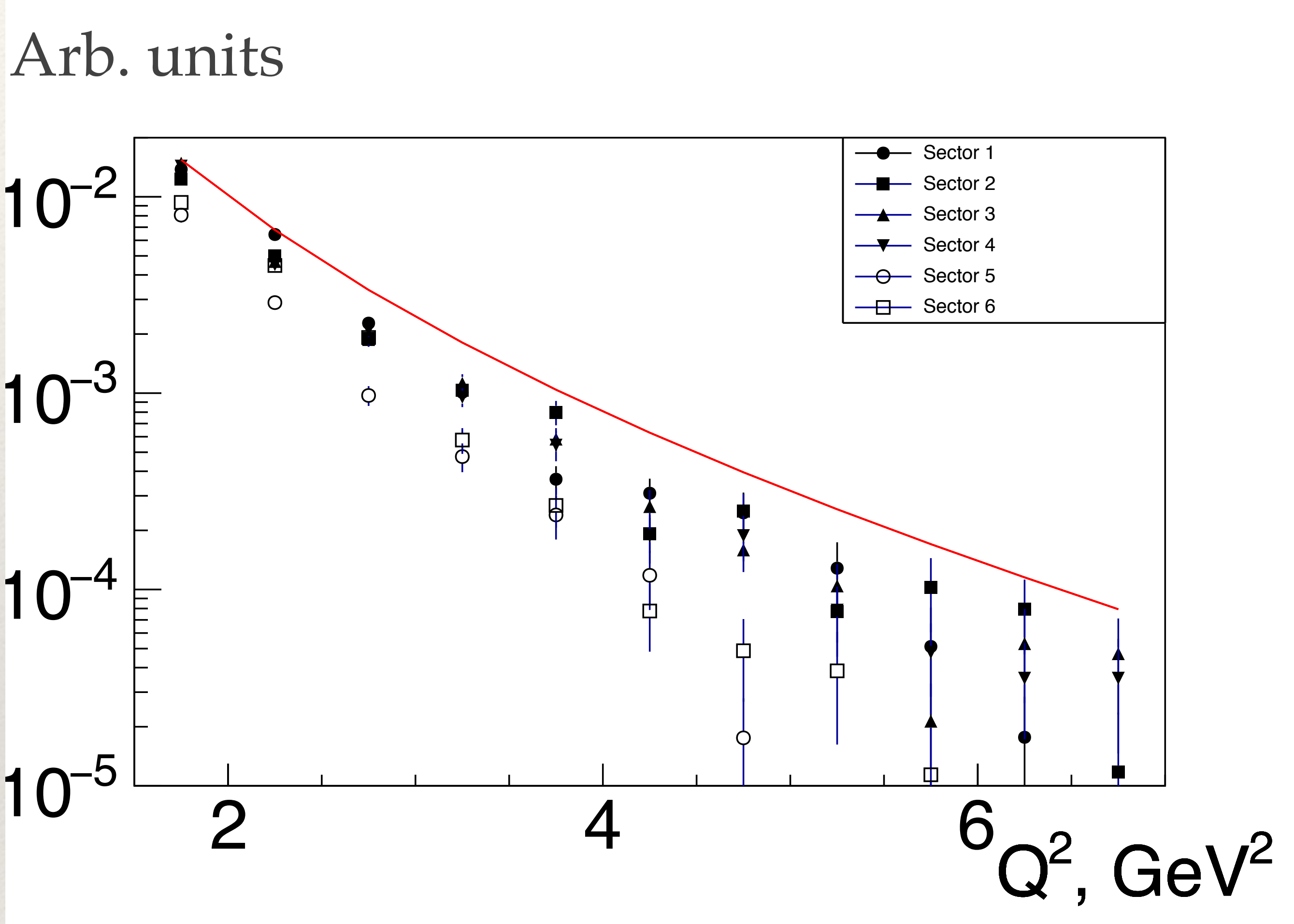


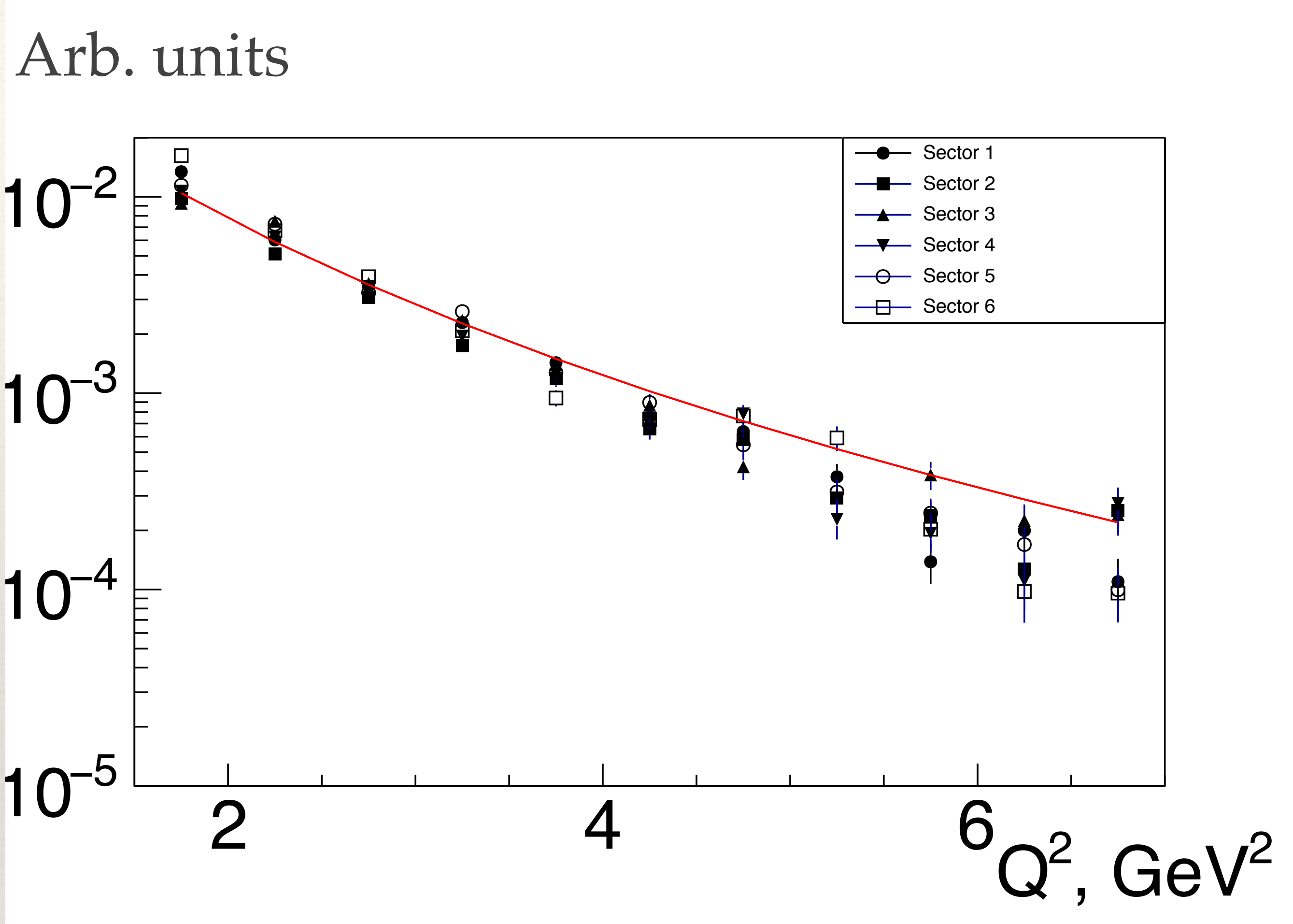
Significant sector by sector variation

Normalized Yield as a Function of Q^2

W = 2.0 GeV

W = 3.0 GeV





Better agreement at higher W
Different sector by sector
Sector 5 is worse

Corrections to the Inclusive Cross Section

- Radiative corrections
  - The code used for the generation is capable to output radiative and non-radiative cross sections in parallel, providing direct access to the inclusive radiative corrections.
- Radiative elastic event subtraction
  - The code used for the generation is capable to output elastic and inclusive events separately or combined, providing direct access for the elastic event contribution.
- Bin centering correction
  - Will use the model to correct for the difference between the value of the cross section in the center of the bin and average value of the cross section in the bin.

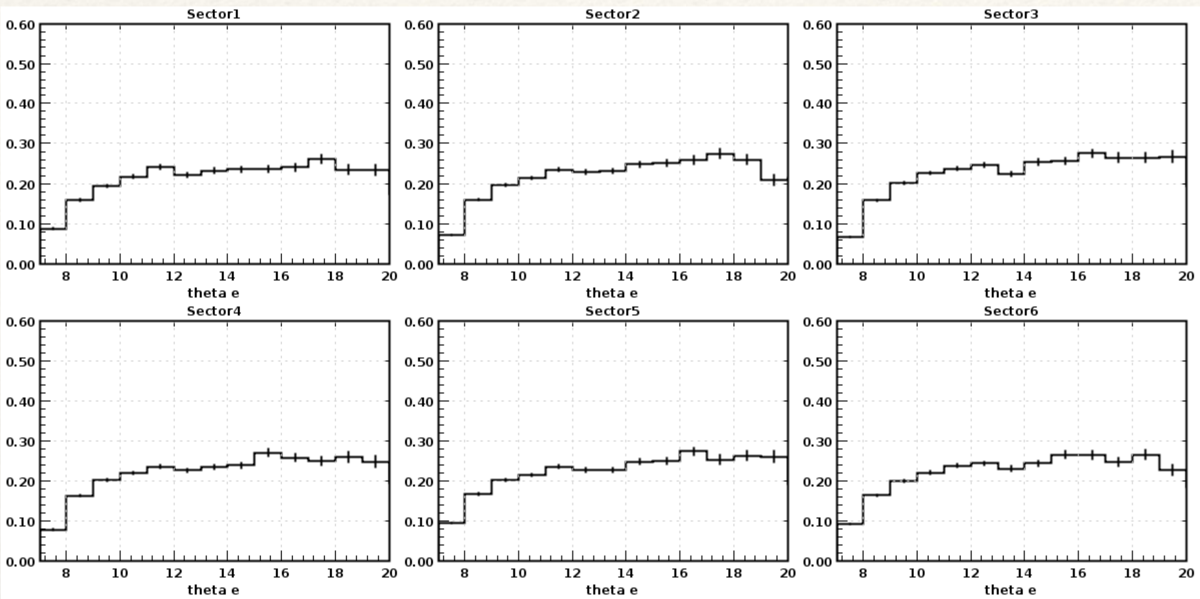
Next Steps

Next steps:

- Elastic:
  - Apply momentum corrections for the 2 GeV elastic data.
- Inclusive:
  - Study and include tracking efficiency.
  - Radiative correction:
    - The code used for the generation is capable to output radiative and non-radiative cross sections in parallel, direct access to the inclusive radiative corrections.
  - Radiative elastic event subtraction:
    - The code used for the generation is capable to output elastic and inclusive events separately or combined, providing direct access for the elastic event subtraction.
  - Absolute normalization:
    - Is similar to one used for the elastic cross section. Shown to work.
  - Estimate resonance contribution to the total cross section.

Backup

Acceptance in the different sectors



Elastic cross section to model ratio in the different sectors