

STATUS OF DVCS ANALYSIS FROM E1-6 DATA

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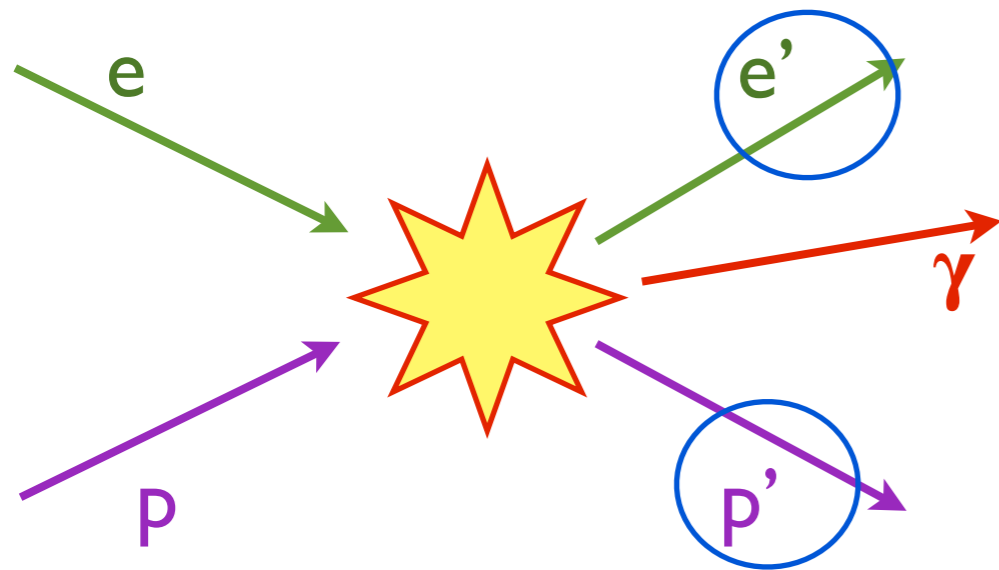
INFN-Ferrara



Collaboration meeting

03.11.2016

Introduction & Motivation



Measurement of DVCS Cross Section, via detection of final state proton p' and lepton e' .

Large statistics & broad kinematic coverage \Rightarrow large coverage of Φ acceptance.

E1-6 experiment:

Data collected in 2001-2002.

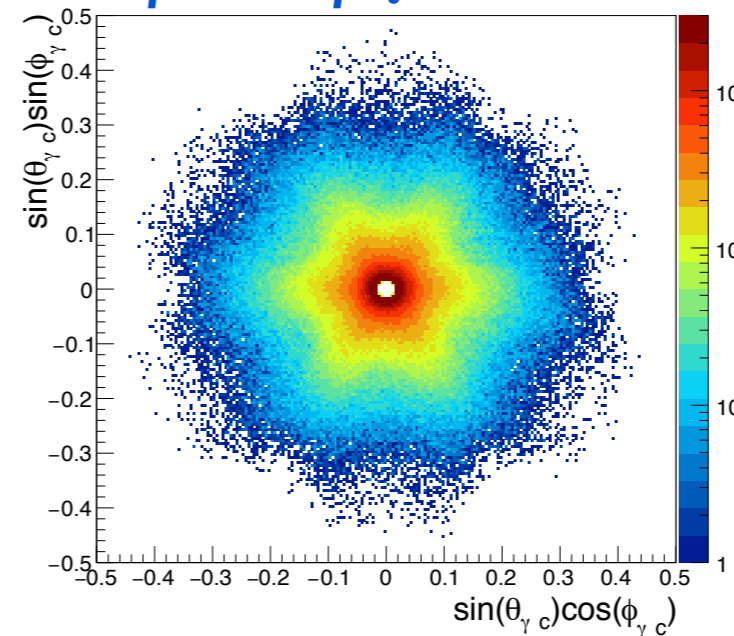
Beam energy 5.754 GeV

5cm long liquid hydrogen target

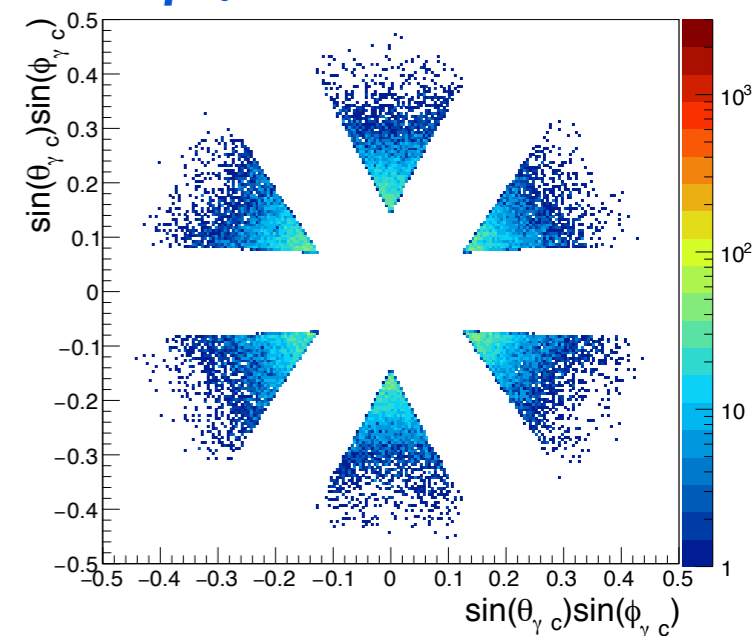
Average beam polarization 70%

spatial distributions of calculated photons

ep & ep γ



ep γ



Event Selection ($e\bar{p}$ (1γ) (2γ) sample)

Primary selection - Events with exactly one negative track with the $id = 11$,
one positive track,
any number of neutral clusters

Requirements on event vertex

Electron identification - EC fiducial cuts
CC fiducial cuts
DC fiducial cuts
CC matching
CC efficiency
Requirements on Calo response

Proton identification - DC fiducial cuts
Requirement on reconstructed ToF mass.

Photon identification - EC fiducial cuts
Requirement on EC time.
Spatial separation from charged tracks on EC.
Minimum energy deposition in Calo.

Corrections
Energy loss correction for electrons & protons
Momentum & angle corrections for electrons
Energy correction for photons

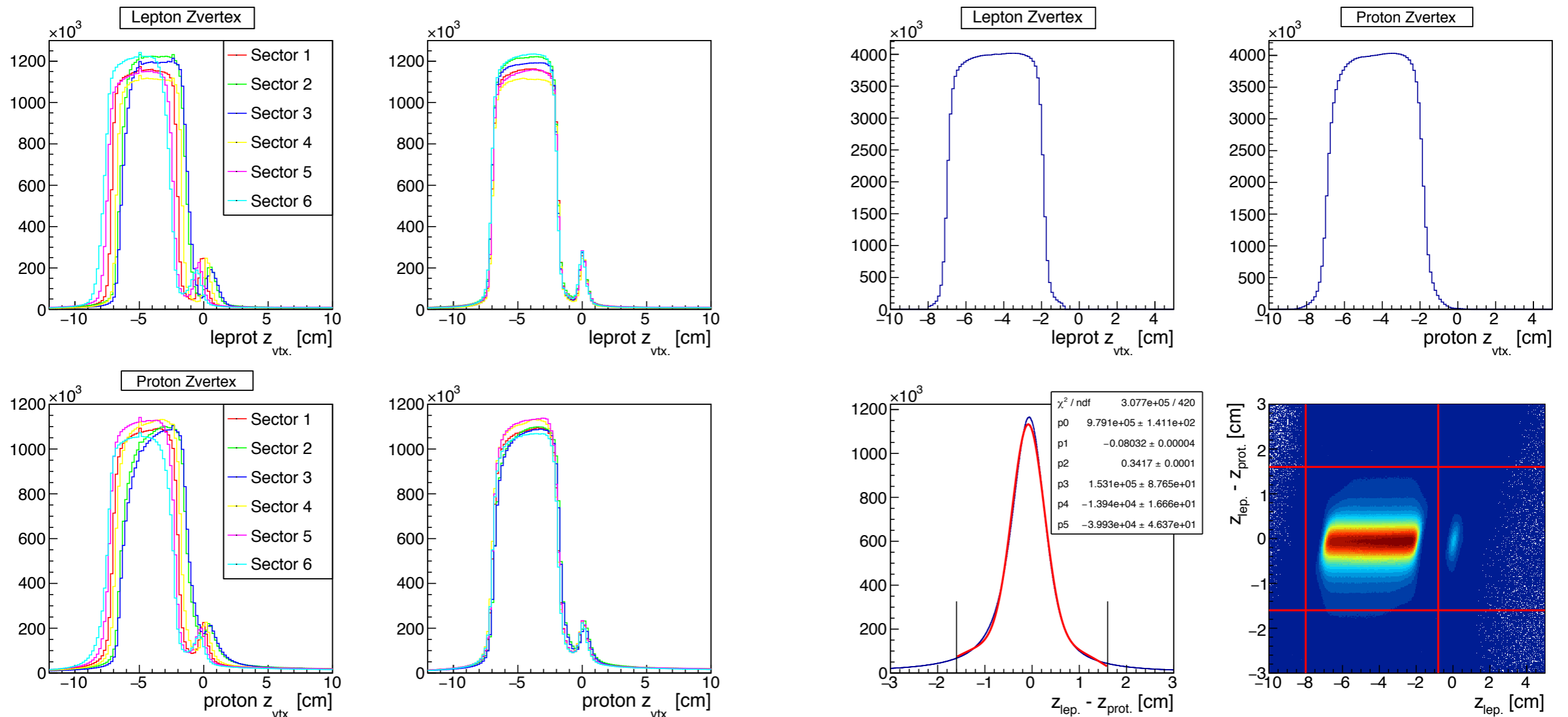
Event Selection (ep (1γ) (2γ) sample)

Requirements on event vertex:

Sector dependent Z-vertex corrections for electron and proton candidates

$$Z_{lep} - Z_{prot.} \in (-1.6, 1.6) [cm]$$

$$Z_{lep} \in (-8.0, -0.8) [cm]$$



Event Selection (ep (1γ) (2γ) sample)

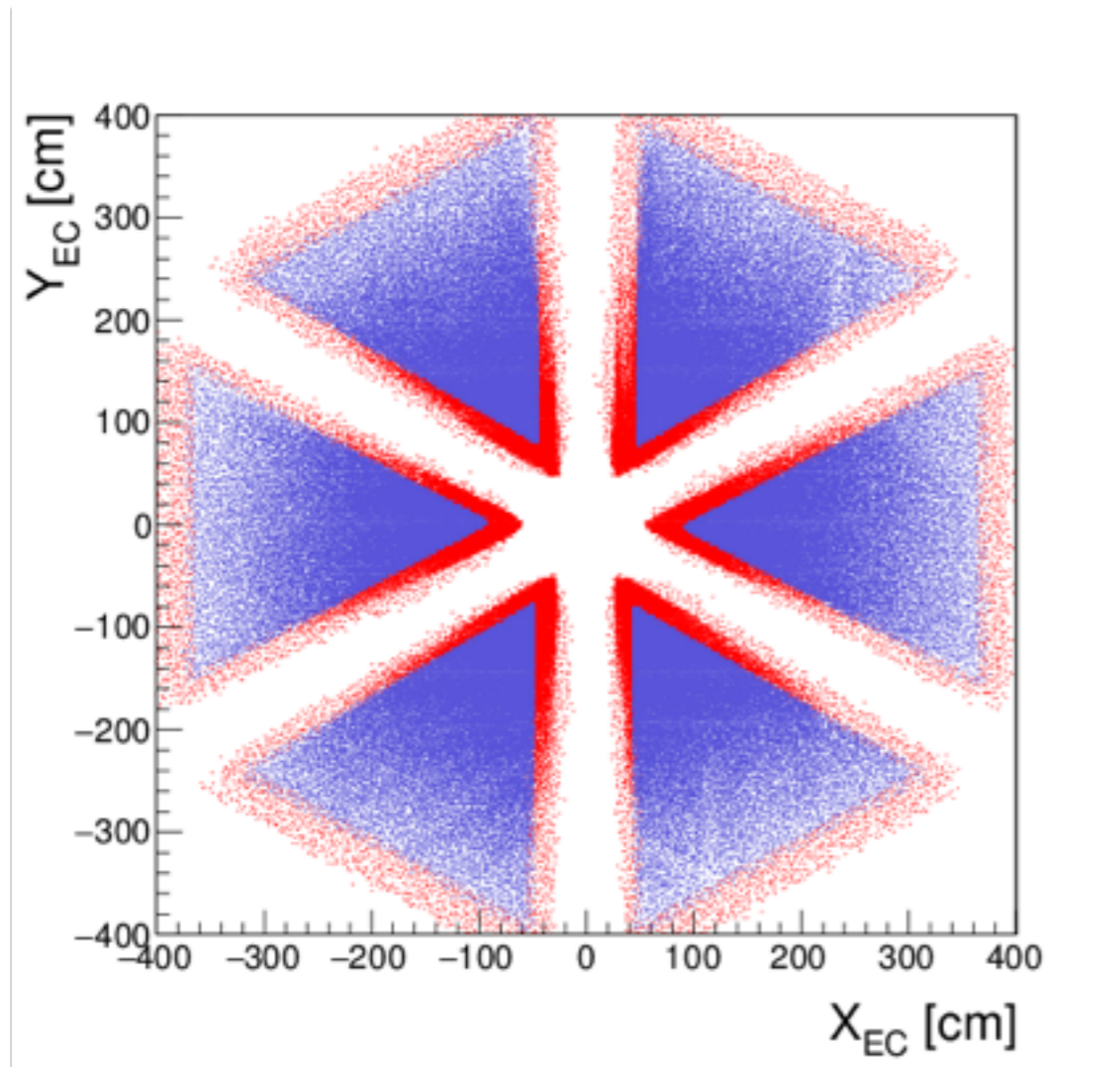
Electron identification - EC fiducial cuts, CC fiducial cuts, CC efficiency

EC fiducial cuts

$$U \in (40, 390)$$

$$W < 390$$

$$V < 360$$



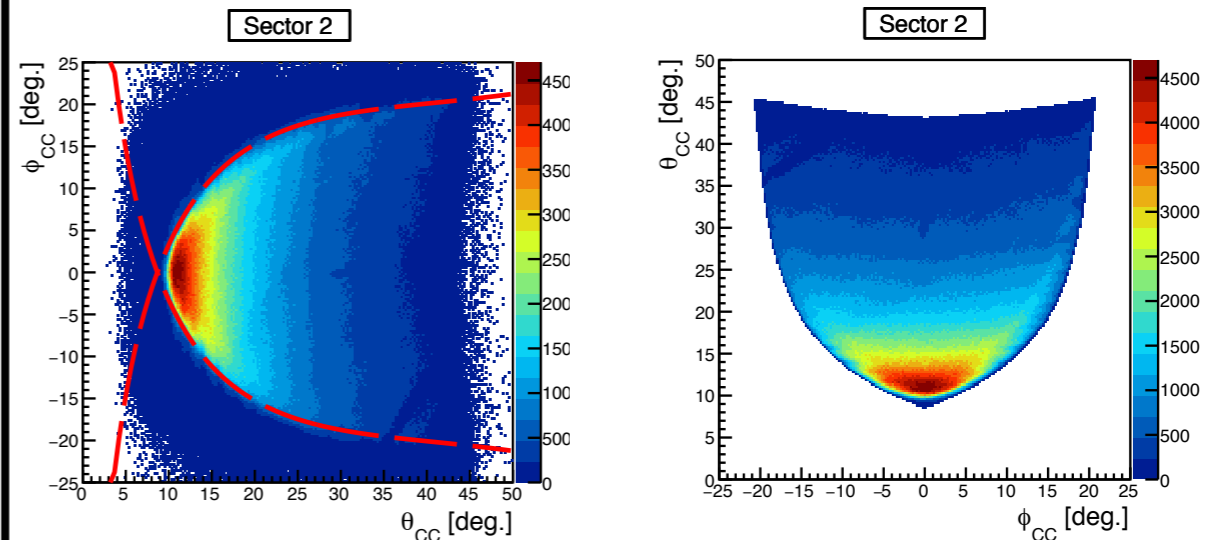
CC fiducial cuts & CC efficiency

$$|\phi_{CC}| < -66.0 + 37.0 \log(\theta_{CC}) - 1.7\theta_{CC} + 0.11\theta_{CC}^2$$

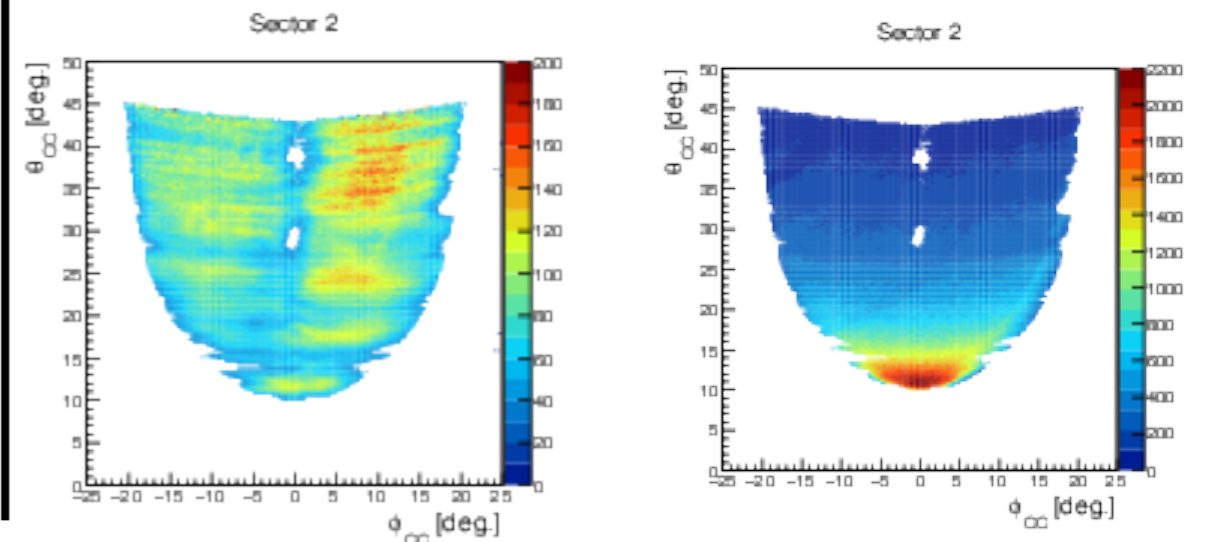
$$|\theta_{CC}| < -43.0 + 0.05|(\phi_{CC})| + 0.003|\phi_{CC}|^2$$

before the cut

after the cut



$\langle nphe \rangle > 4$



Event Selection (ep (1γ) (2γ) sample)

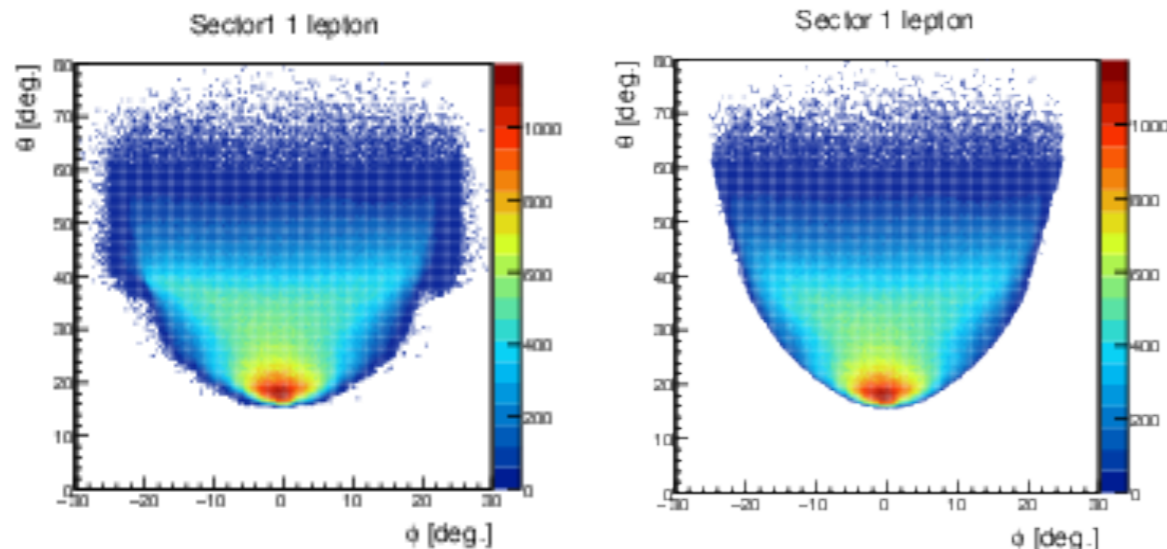
Electron identification - DC fiducial cuts, Requirements on Calo. response

DC fiducial cuts

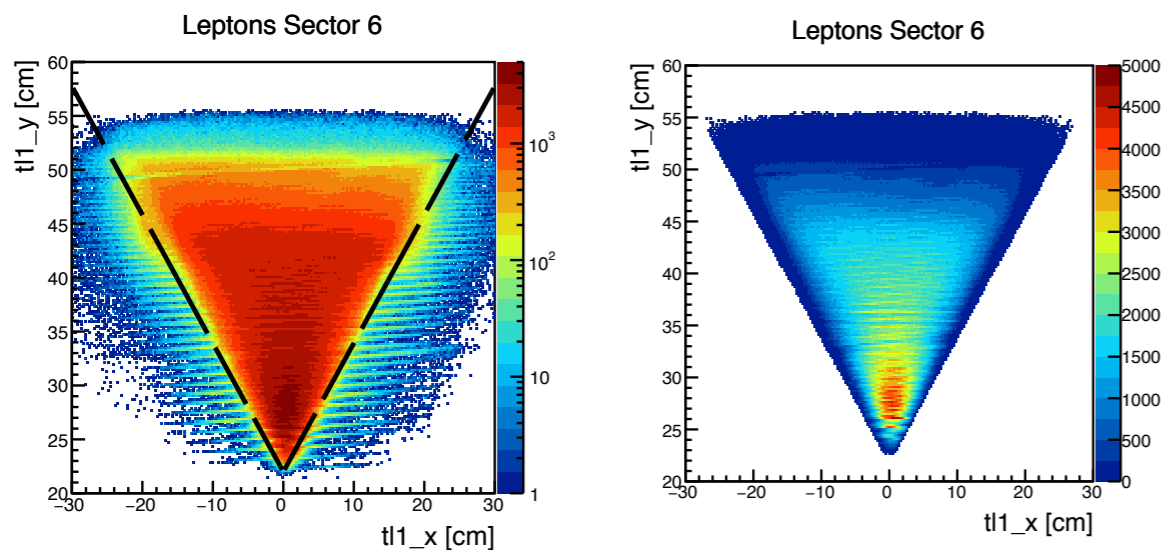
$$f(\theta, p) = C_1 \left[\sin \left(\theta - \left[C_2 + \frac{C_3}{(p + C_4) \frac{B_{max}}{B_{cur.}}} \right] \right) \right]^{C_5 \left(p \frac{B_{max}}{B_{cur.}} \right)^{C_6}}$$

before the cut

after the cut



DC region I



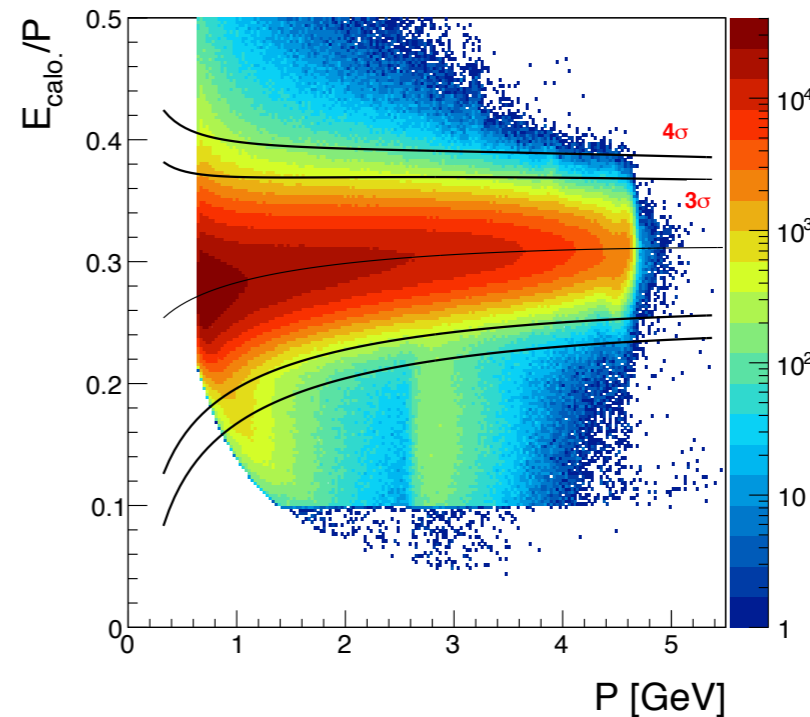
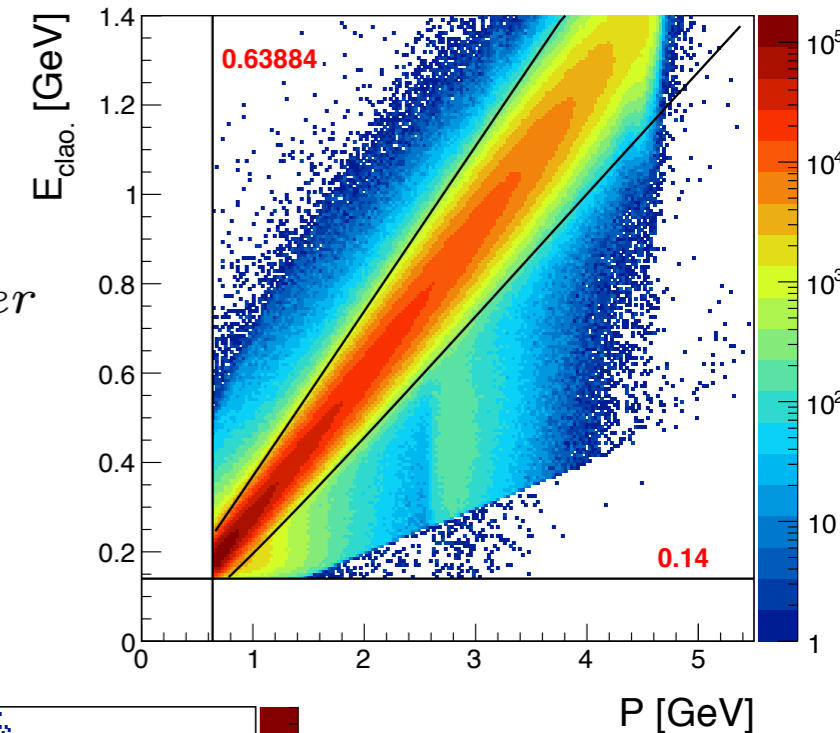
Cuts on energy deposition in Calo.

$$E_{inner} > 0.06$$

$$E_{total} > 0.14$$

$$E_{total} > E_{inner}$$

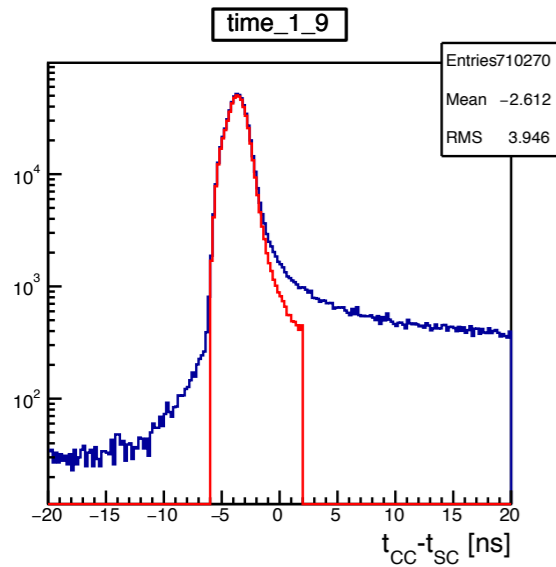
$$E/P < 3\sigma$$



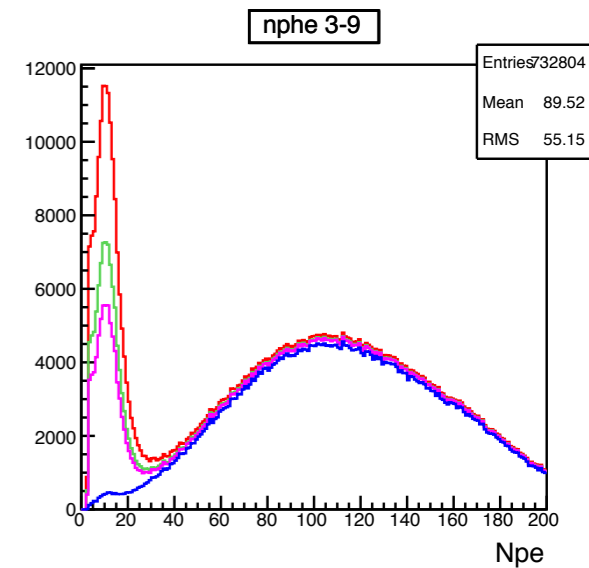
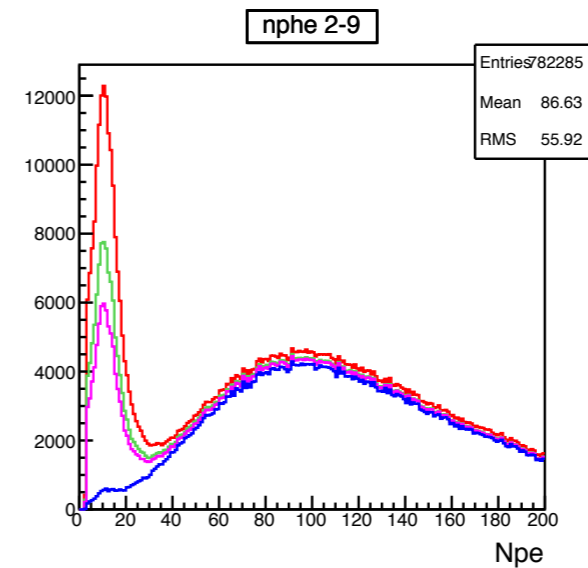
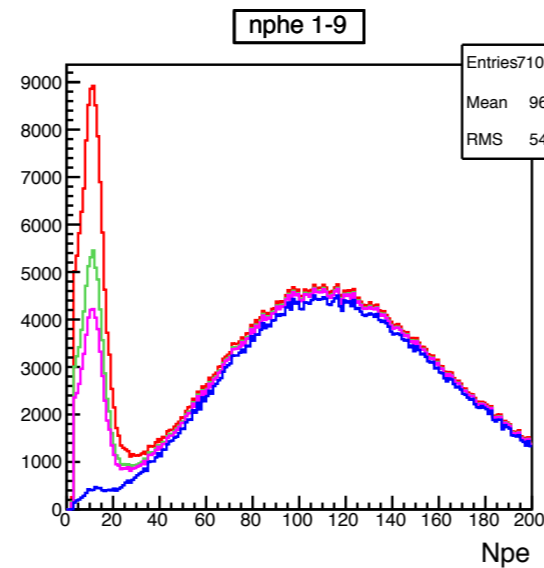
Event Selection (ep (1γ) (2γ) sample)

Electron identification - CC matching (time, theta & phi matching)

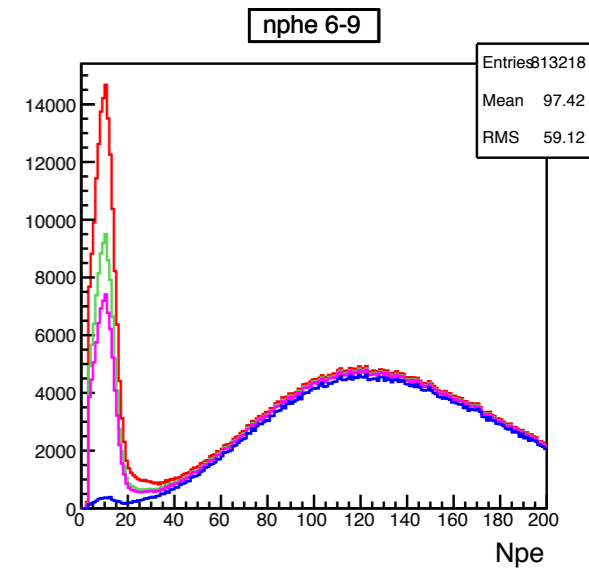
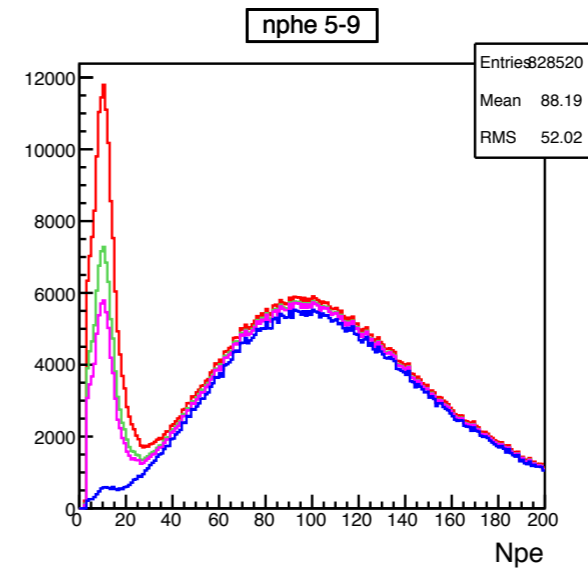
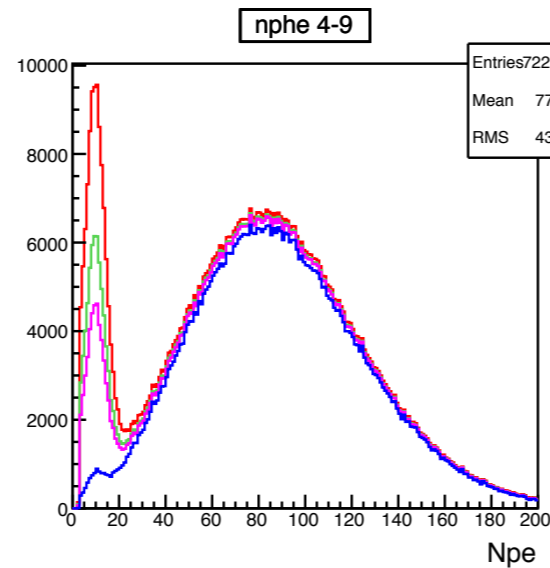
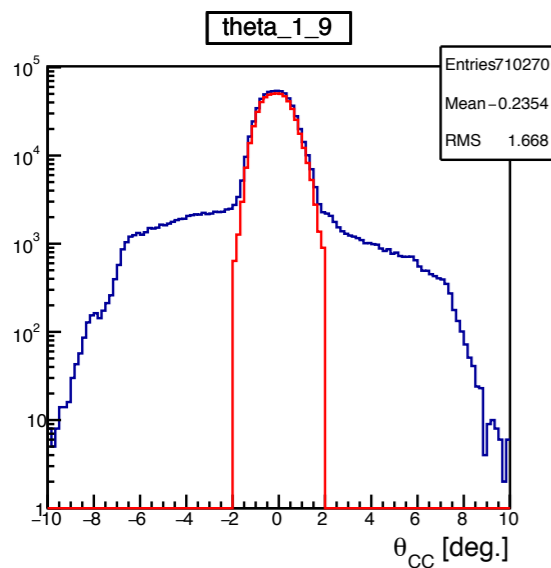
time matching $t_{cc} - t_{sc}$



distributions of Npe in segment 9:



theta matching $\theta_{cc} - \theta_{segment}$



Event Selection (ep (1γ) (2γ) sample)

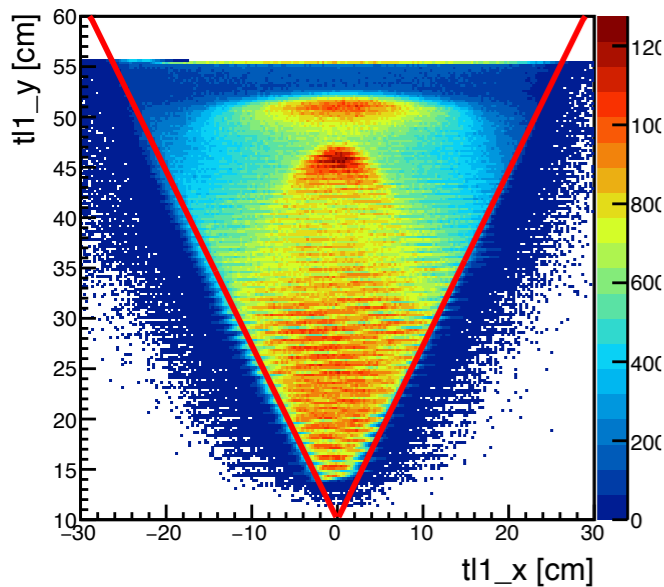
Proton identification - DC fiducial cuts
Requirement on reconstructed ToF mass.

DC fiducial cuts

Cuts on X & Y coordinates of the tracks in first region of DC

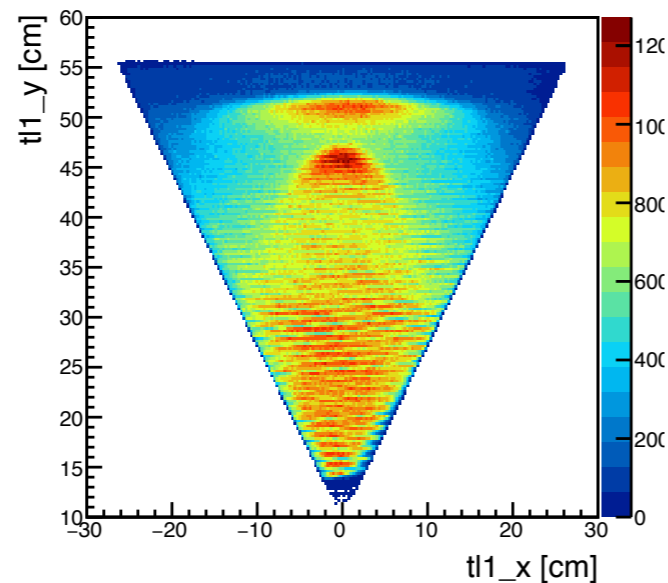
before the cut

Protons Sector 4



after the cut

Protons Sector 4

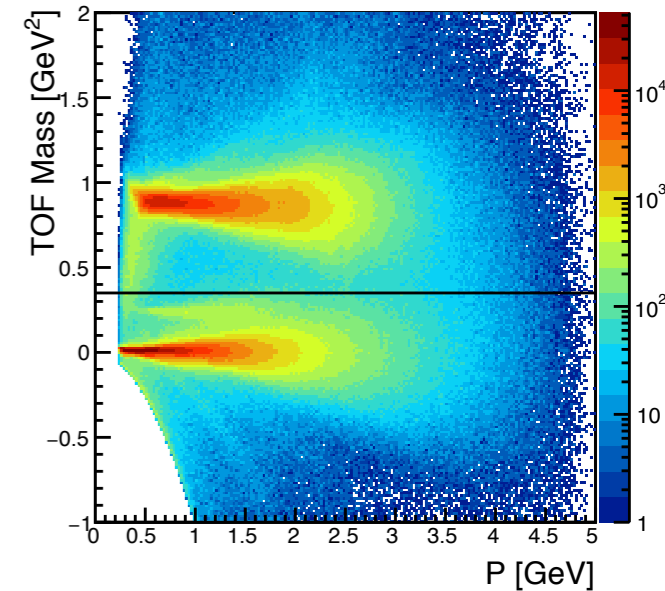


Proton ID

Trigger time recovery &
TOF offset correction

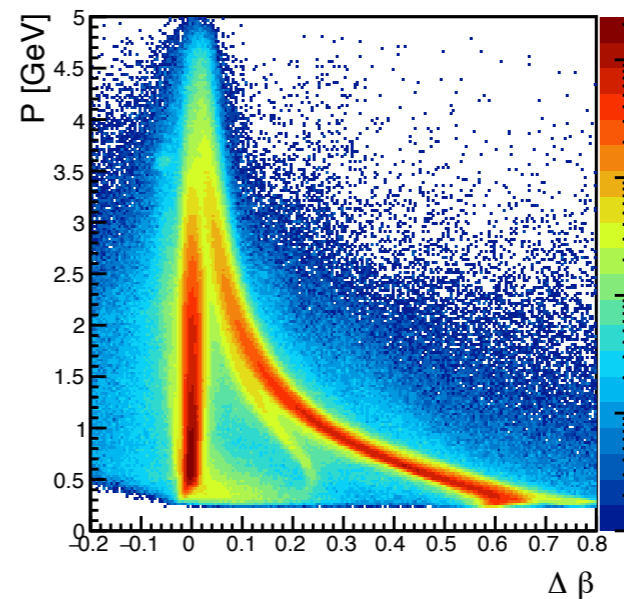
TOF mass > 0.35 [GeV^2]

TOF Mass Sector 5



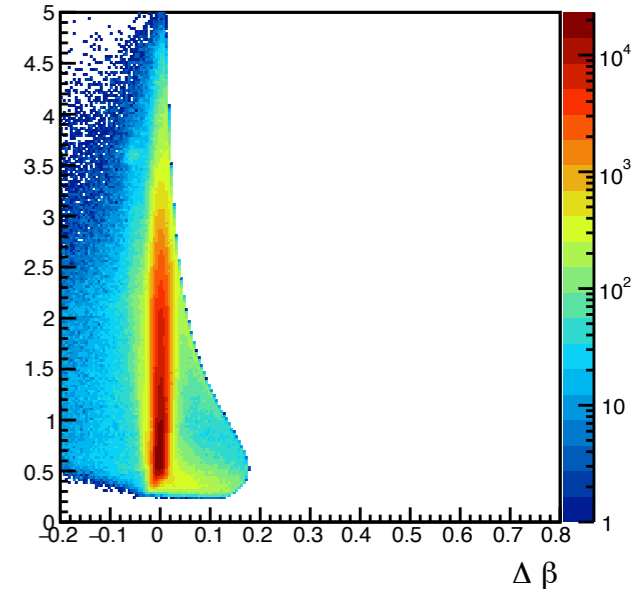
before the cut

$\Delta\beta$ Sector 5



after the cut

$\Delta\beta$ Sector 5



Exclusive pions ($ep(2\gamma)$ sample)

Exclusive Pion Selection: 1 electron, 1 proton & 2 photons

Kinematic requirements:

$$W^2 > 4 \quad [GeV^2]$$

$$t < 0.52 \quad [GeV^2]$$

$$-0.05 < M_X^2(epX) < 0.09 \quad [GeV^2]$$

$$Sector(\gamma_1) = Sector(\gamma_2)$$

$$P_{\pi^0} > 2.4 \quad [GeV]$$

Data - MC normalization & statistics:

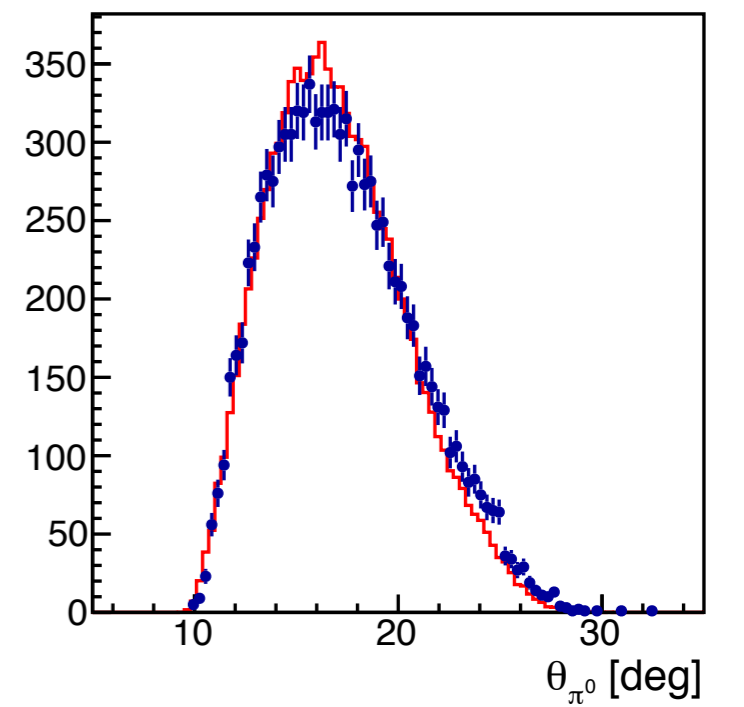
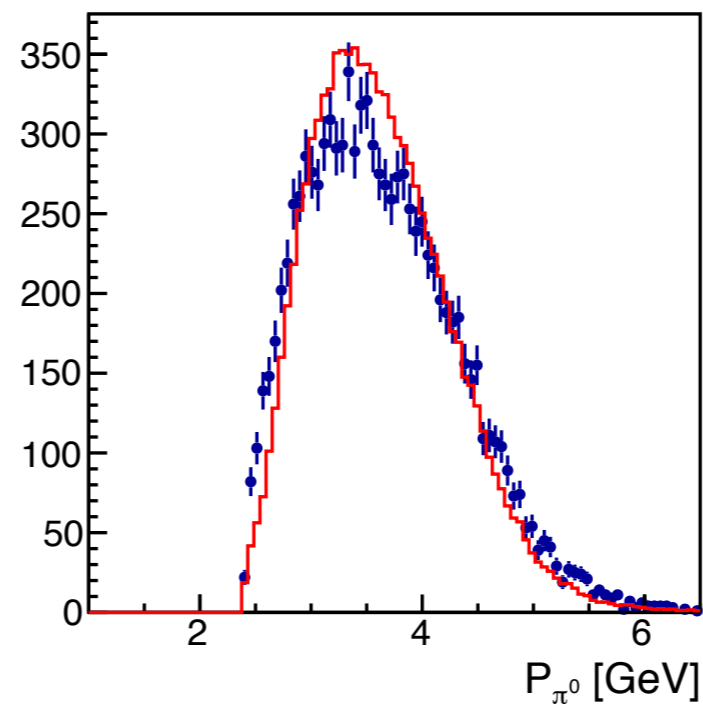
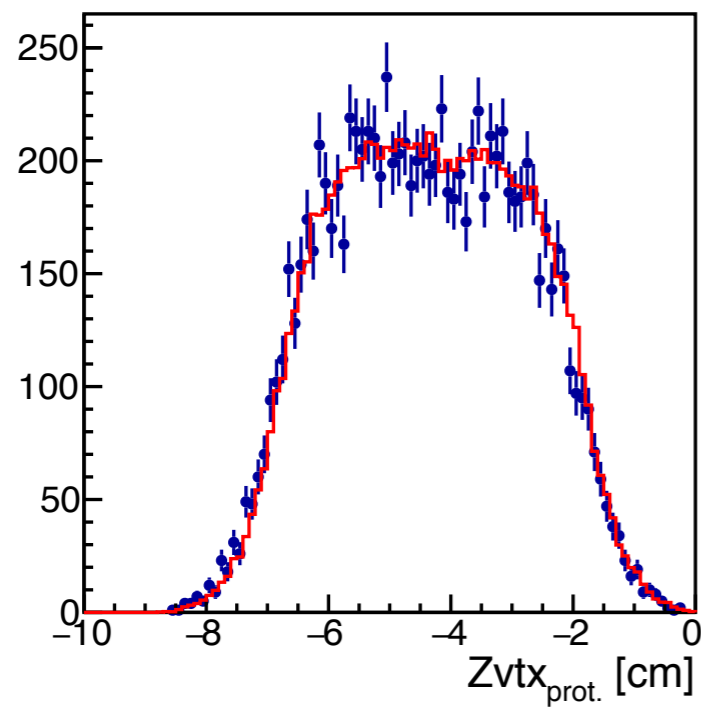
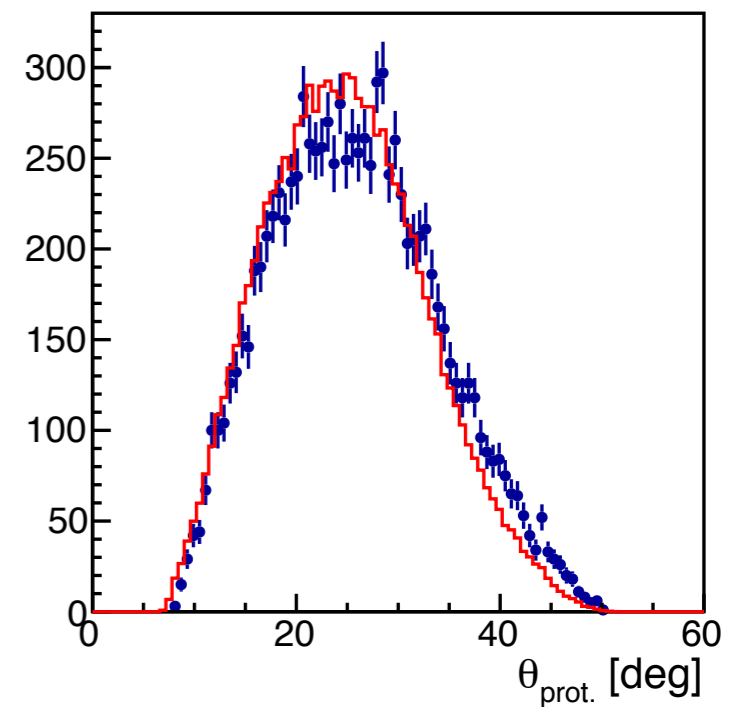
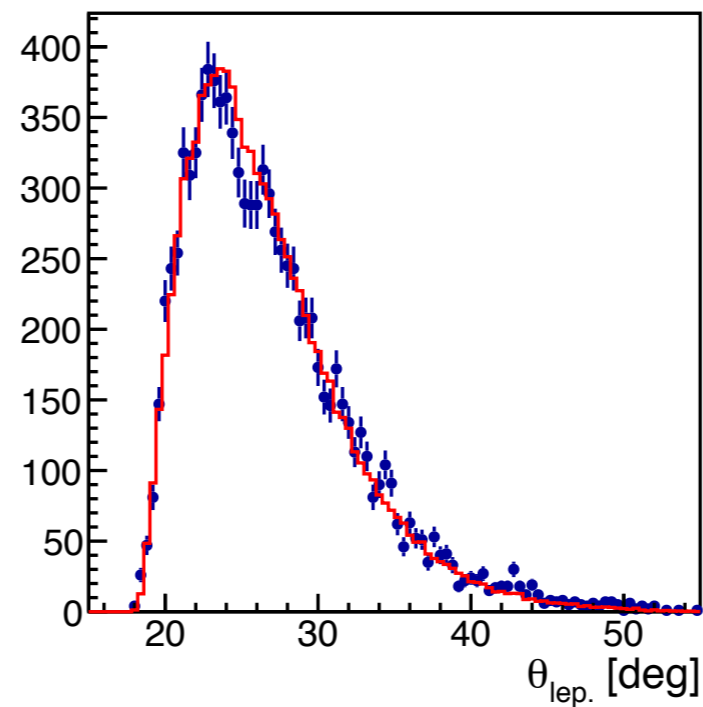
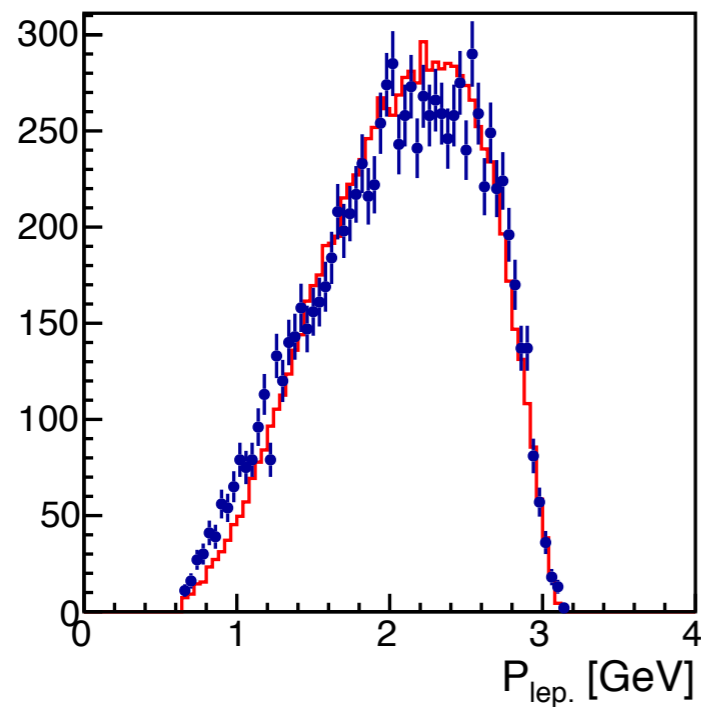
$$\frac{N_{\pi^0}^{Data}}{N_{\pi^0}^{MC}} = \frac{10080}{135060}$$

Data - MC normalization for DVCS process: (0 or 1 γ)

$$N_{0,1\gamma}^{Data \pi^0}(x, Q^2, -t, \phi) = \frac{N_{\pi^0}^{Data}}{N_{\pi^0}^{MC}} N_{0,1\gamma(\pi^0)}^{MC}(x, Q^2, -t, \phi)$$

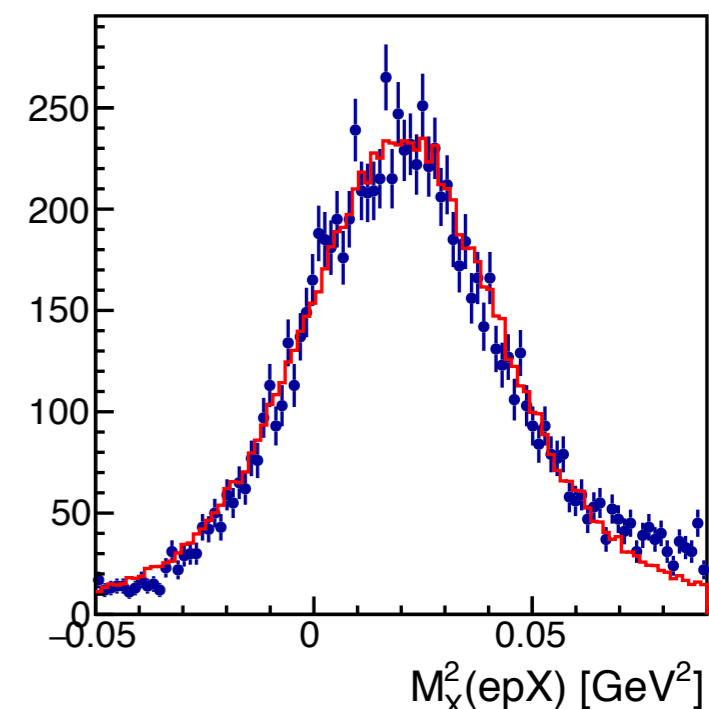
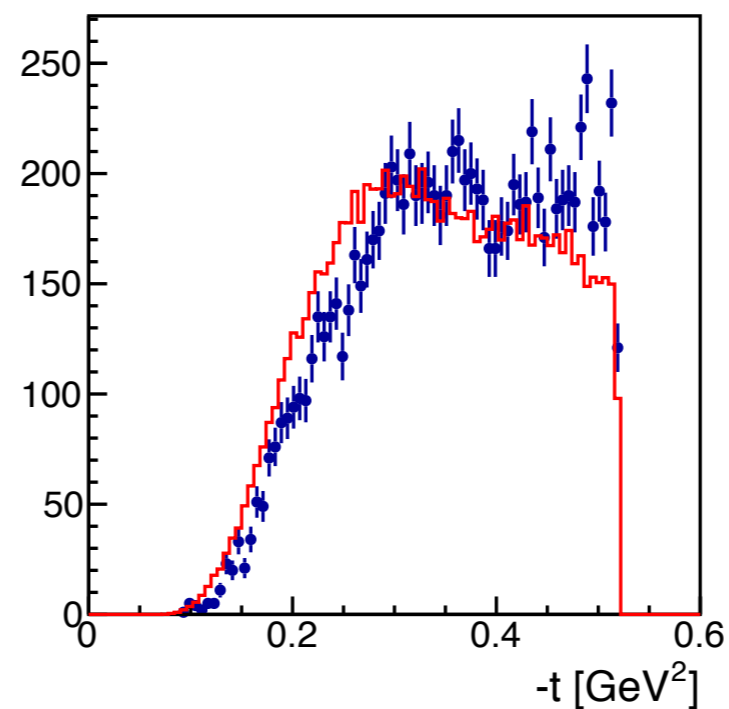
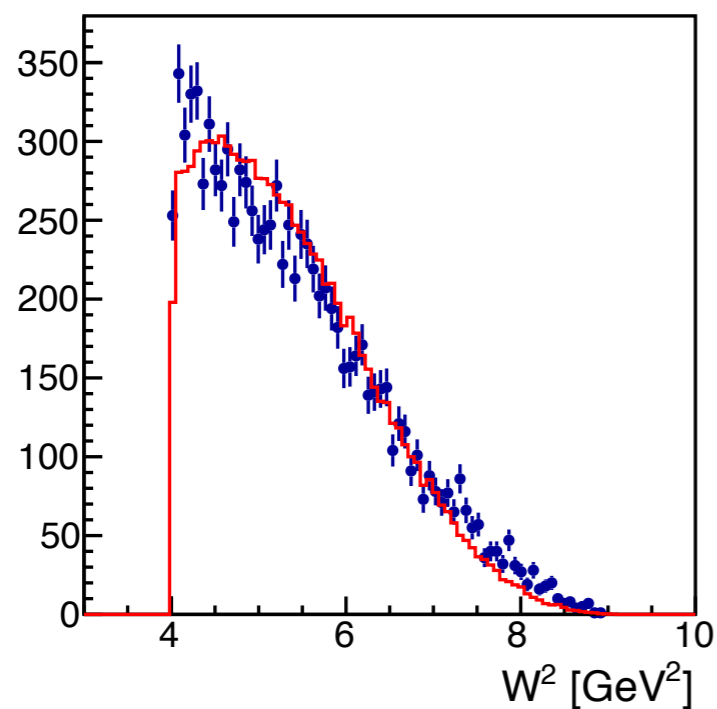
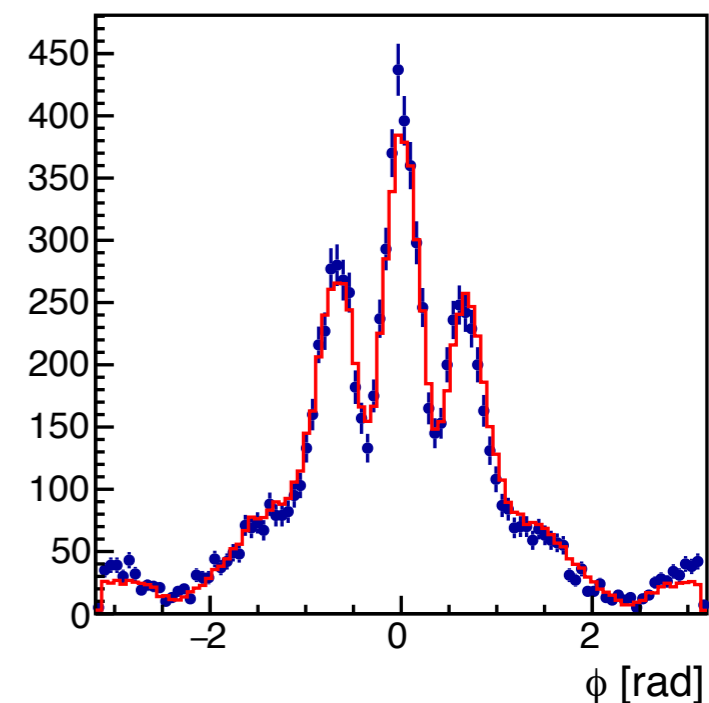
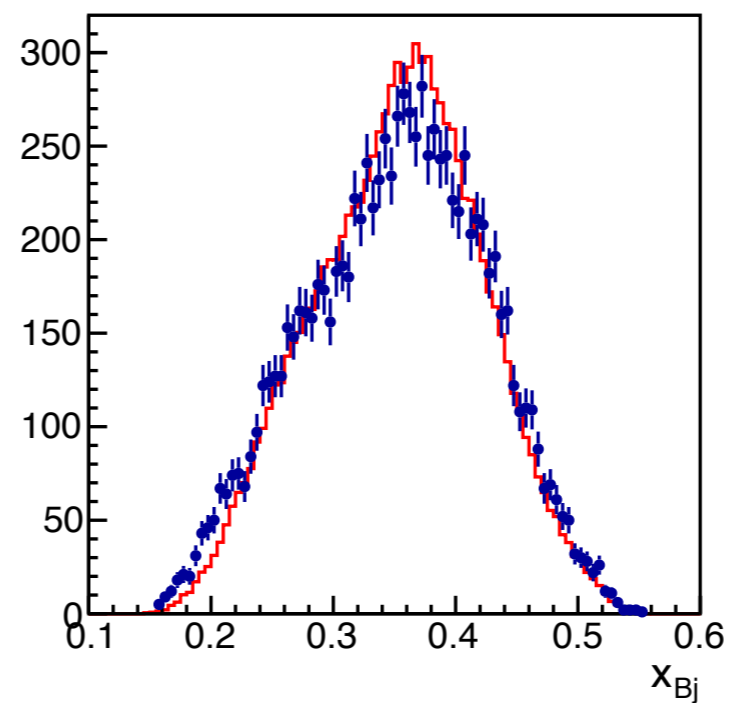
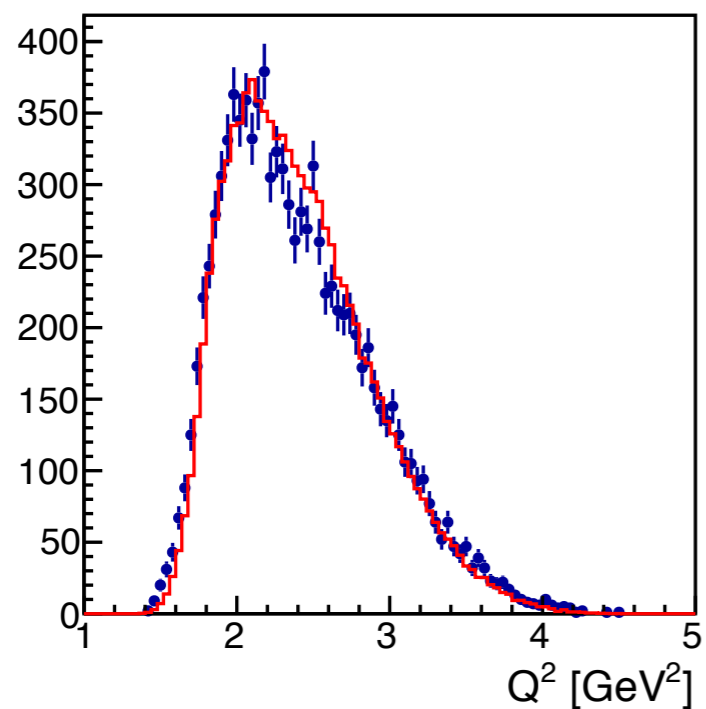
Exclusive pions ($ep(2\gamma)$ sample)

Data - MC comparison exclusive π^0 :



Exclusive pions ($ep(2\gamma)$ sample)

Data - MC comparison exclusive π^0 :



DVCS ($ep + ep\gamma$ sample)

Exclusive Pion Selection: 1 electron, 1 proton & 0 or 1 photon

Kinematic requirements:

$$W^2 > 4 \quad [GeV^2]$$

$$0.07 < t < 0.52 \quad [GeV^2]$$

$$-0.08 < M_X^2(epX) < 0.08 \quad [GeV^2]$$

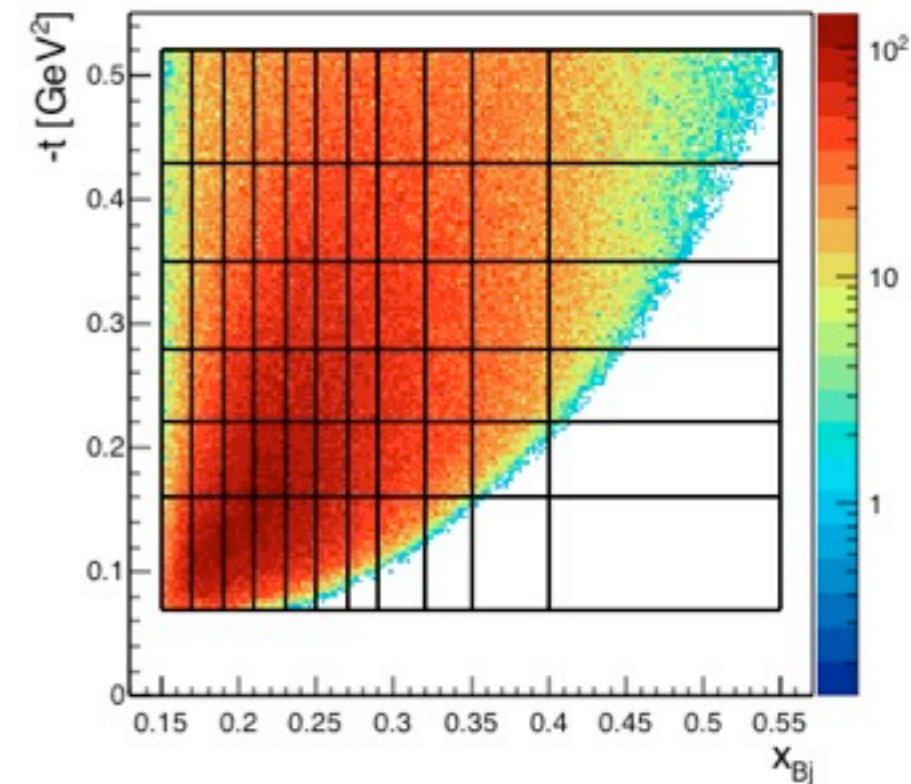
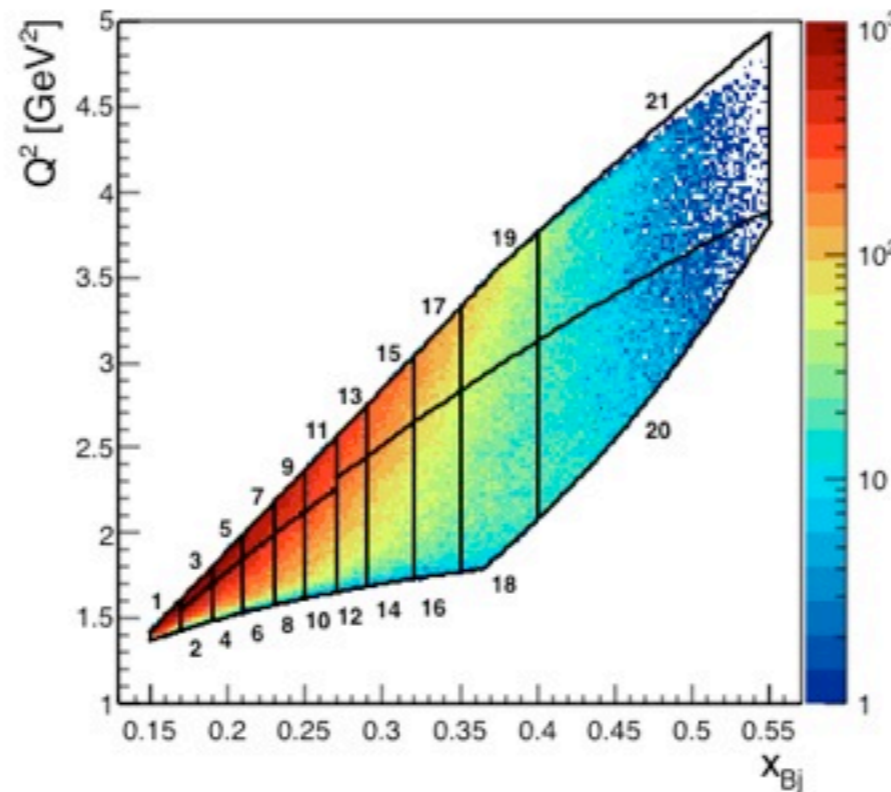
$$P_{ele.} > 0.7 \quad [GeV]$$

$$t < t_{min.}$$

$$\theta_{\gamma_{clac.}} > 2^\circ$$

Statistics:

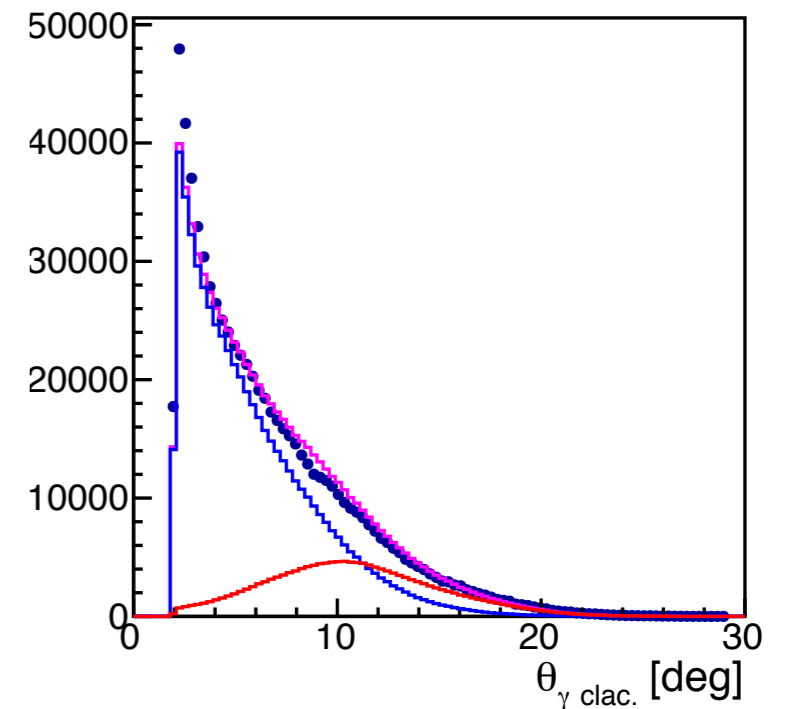
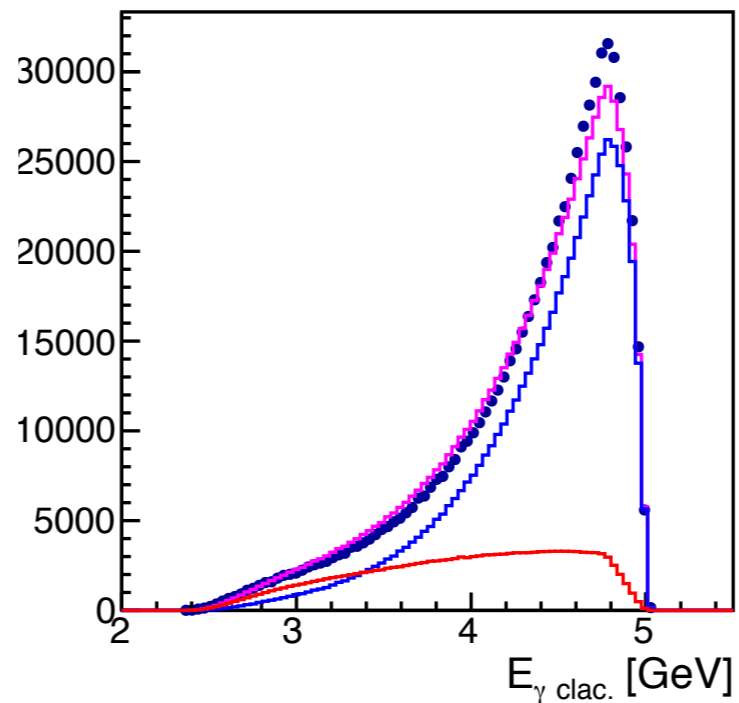
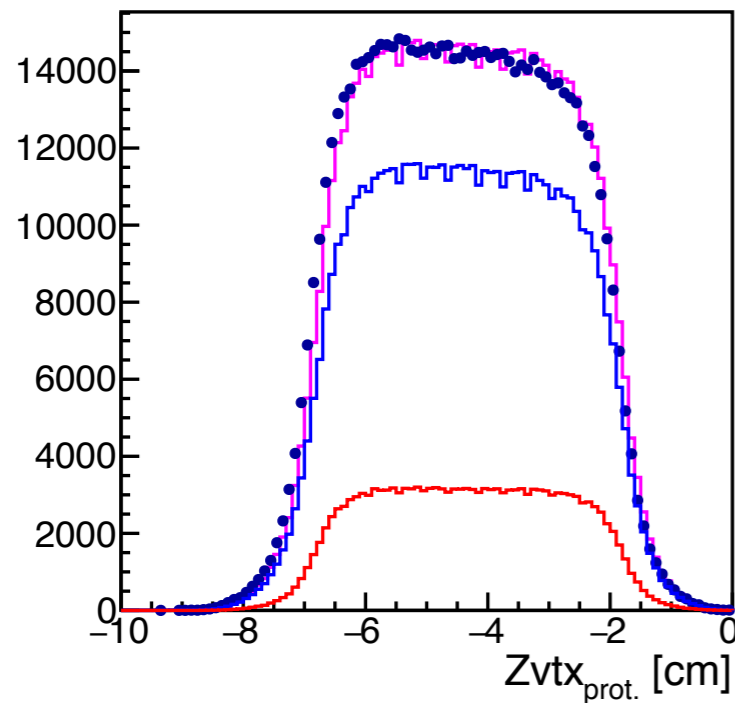
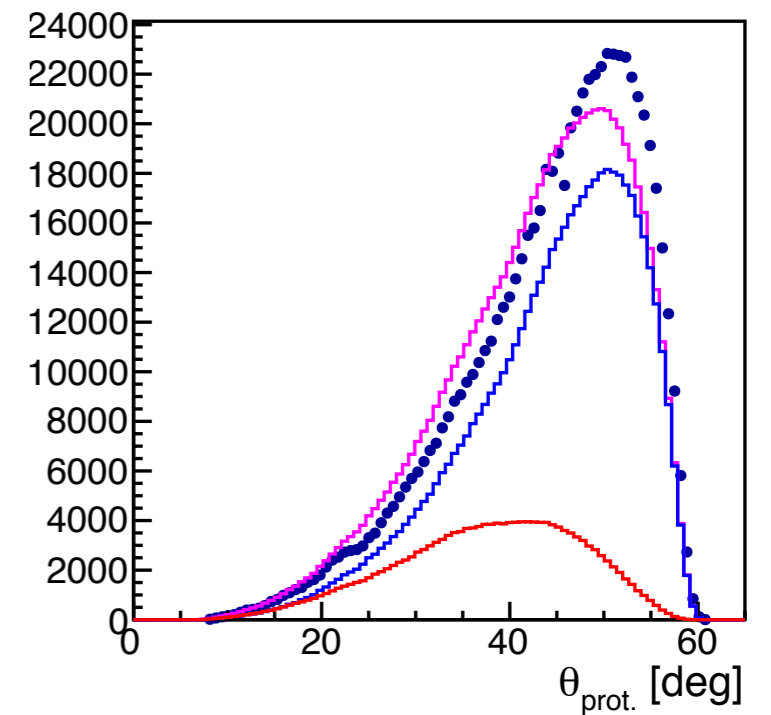
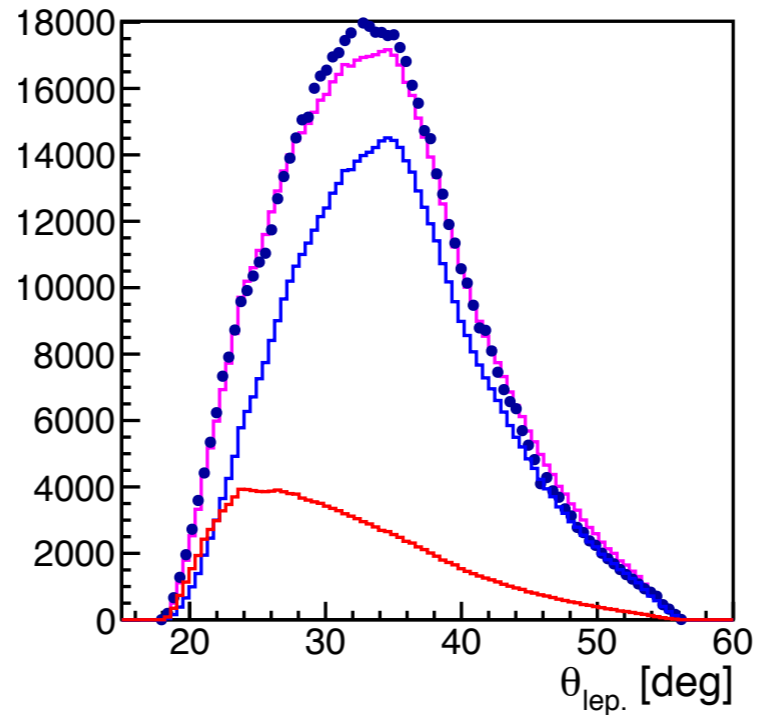
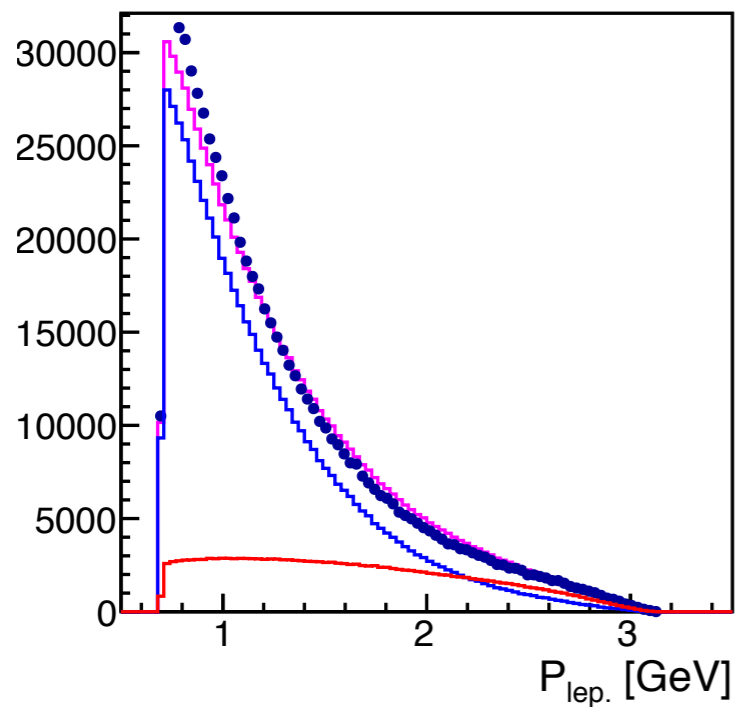
730281 events



x_{Bj}	0.15-0.17	0.17-0.19	0.19-0.21	0.21-0.23	0.23-0.25	0.25-0.27	0.27-0.29	0.29-0.32	0.32-0.35	0.35-0.40	0.40-0.55
$-t$	0.07-0.16	0.16-0.22	0.22-0.28	0.28-0.35	0.35-0.43	0.43-0.52					

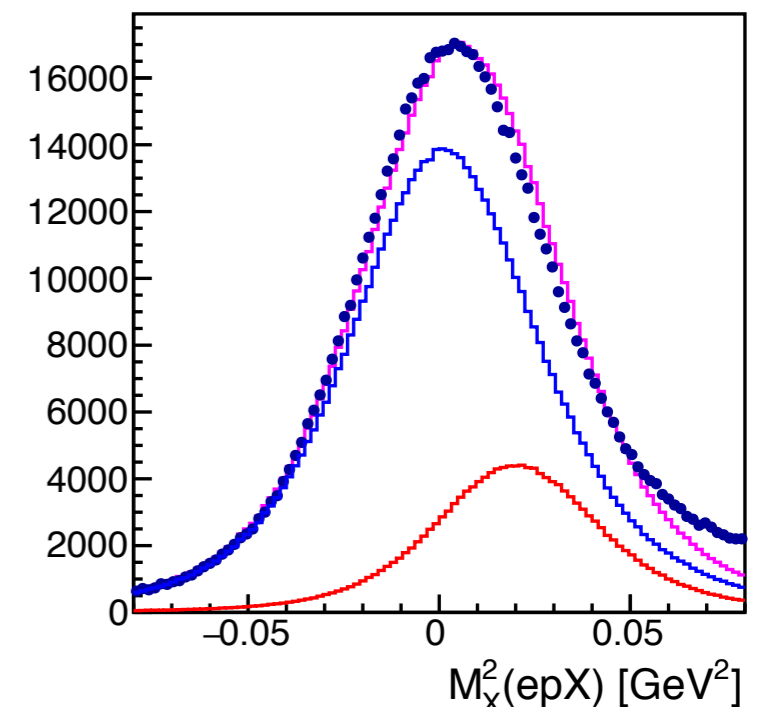
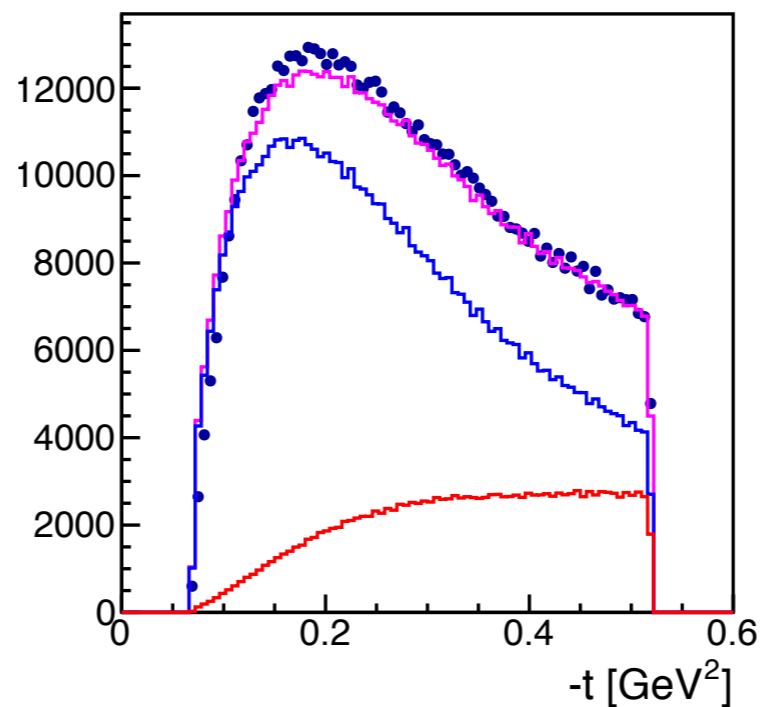
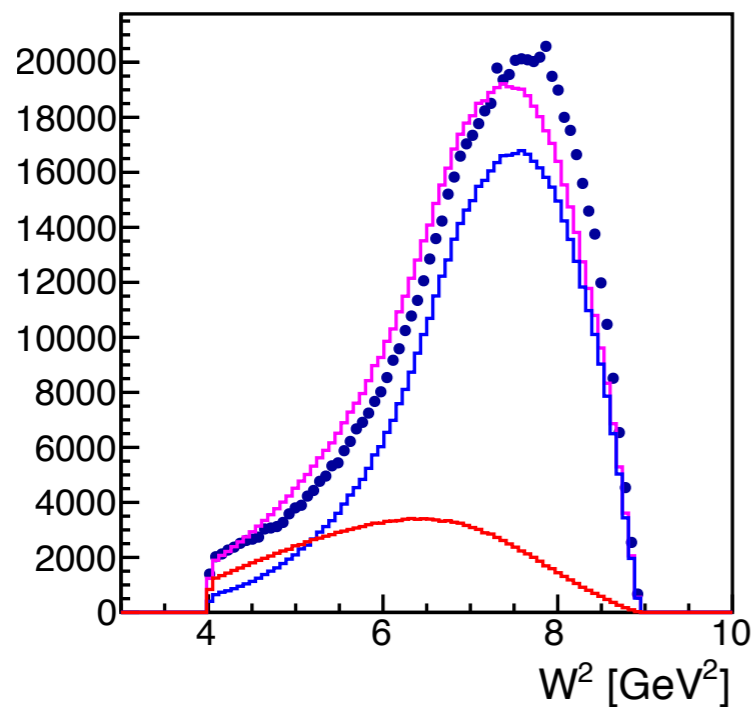
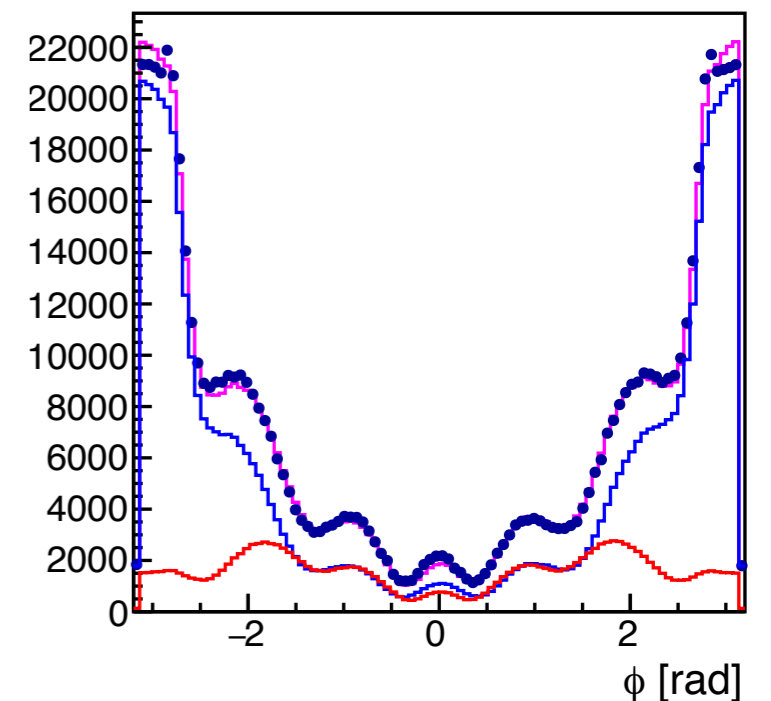
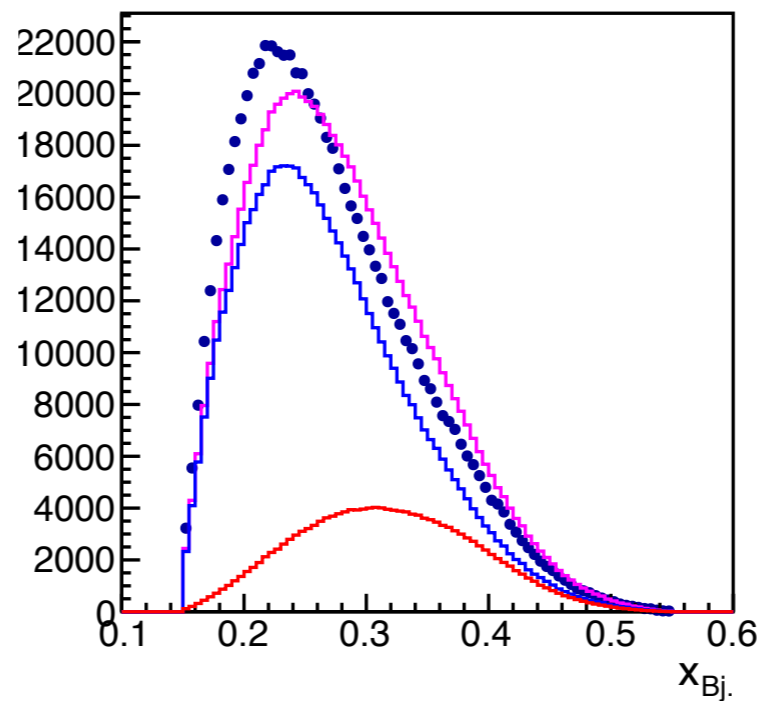
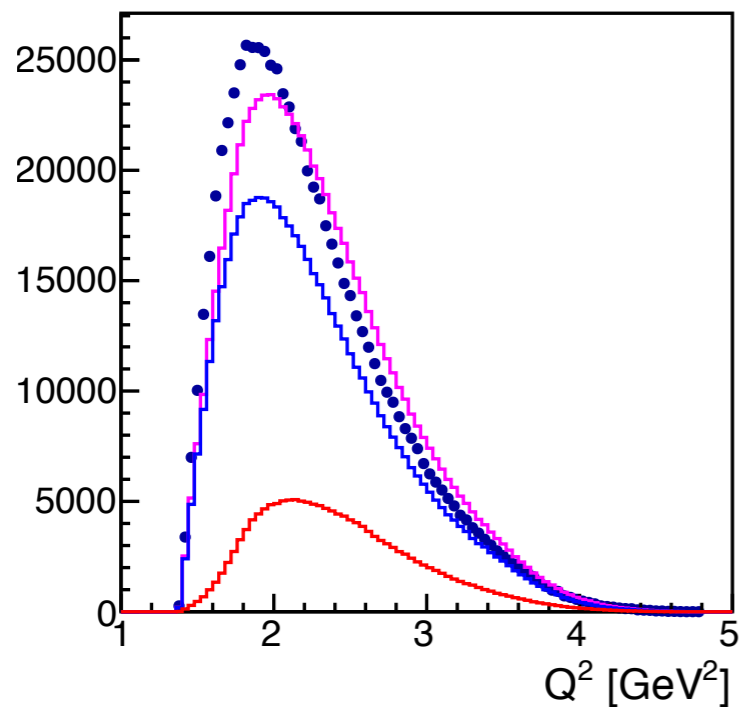
DVCS ($ep + ep\gamma$ sample)

Data - MC comparison (exclusive π^0 , DVCS, MC sum):



DVCS ($ep + ep\gamma$ sample)

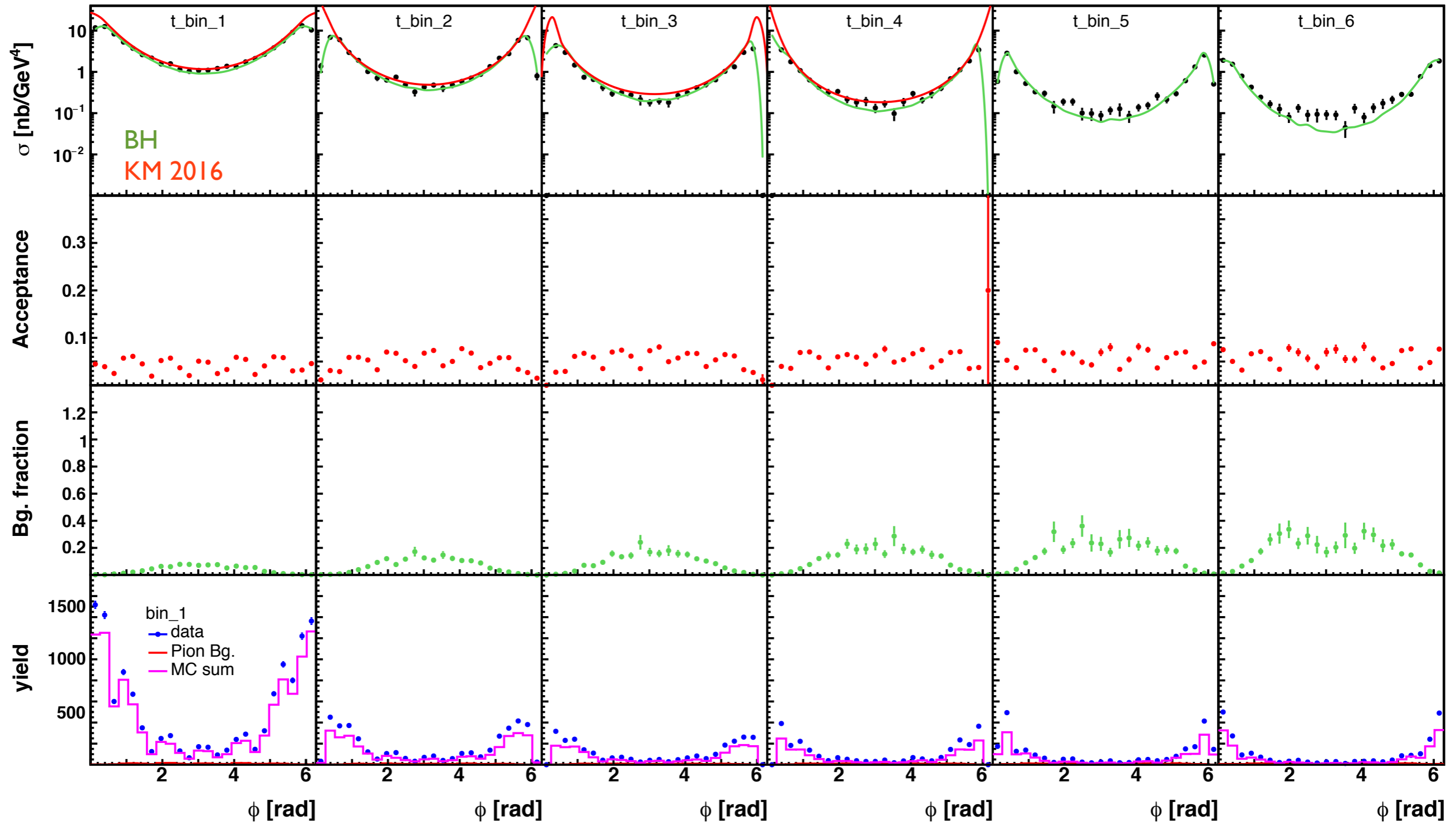
Data - MC comparison (exclusive π^0 , DVCS, MC sum):



DVCS ($ep + ep\gamma$ sample) X-section

Bin 1

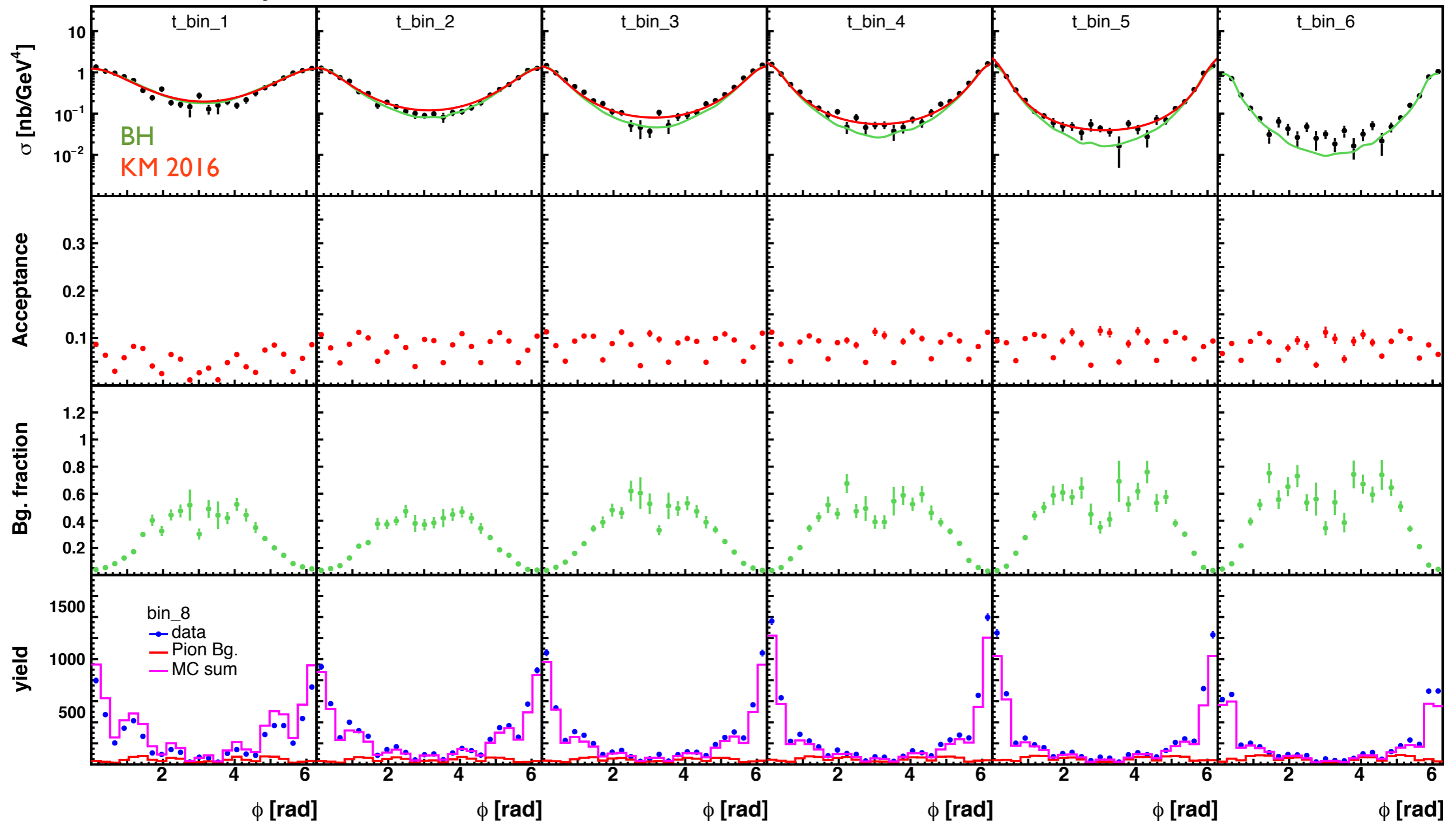
$$0.15 < x_{Bj} < 0.17$$



DVCS ($ep + ep\gamma$ sample) X-section

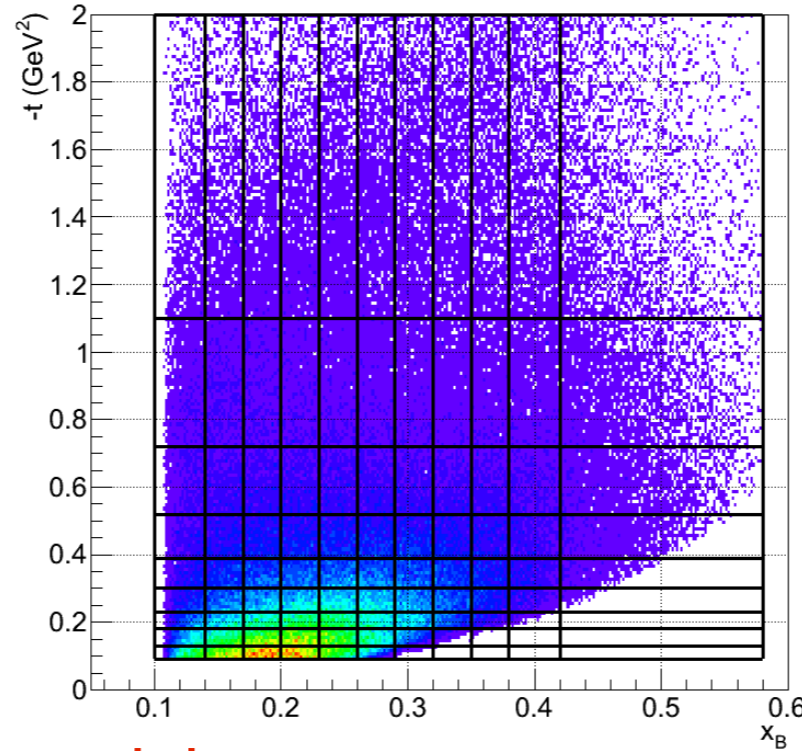
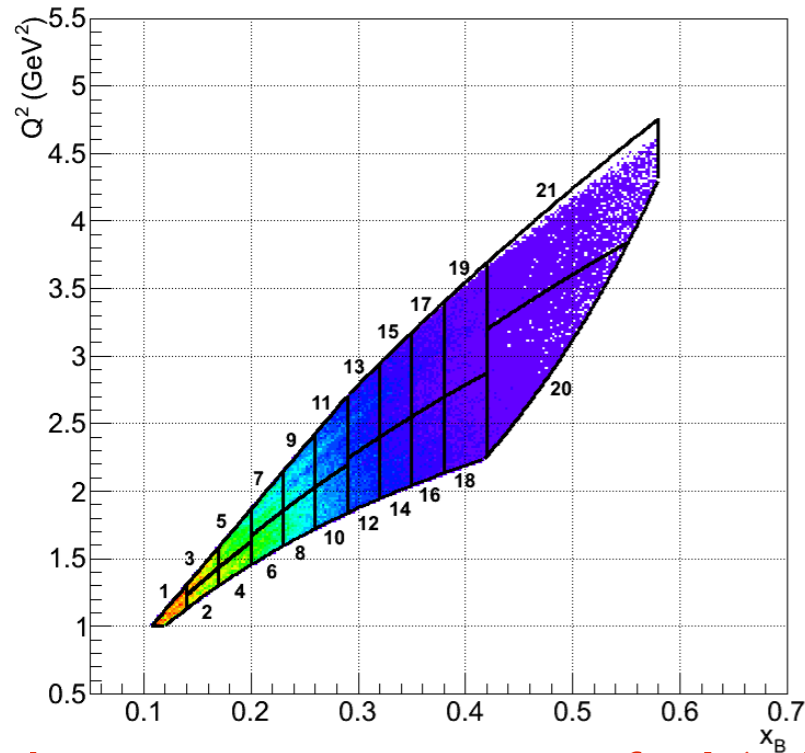
Bin 8

$$0.23 < x_{Bj} < 0.25, \quad \theta < 32^\circ$$

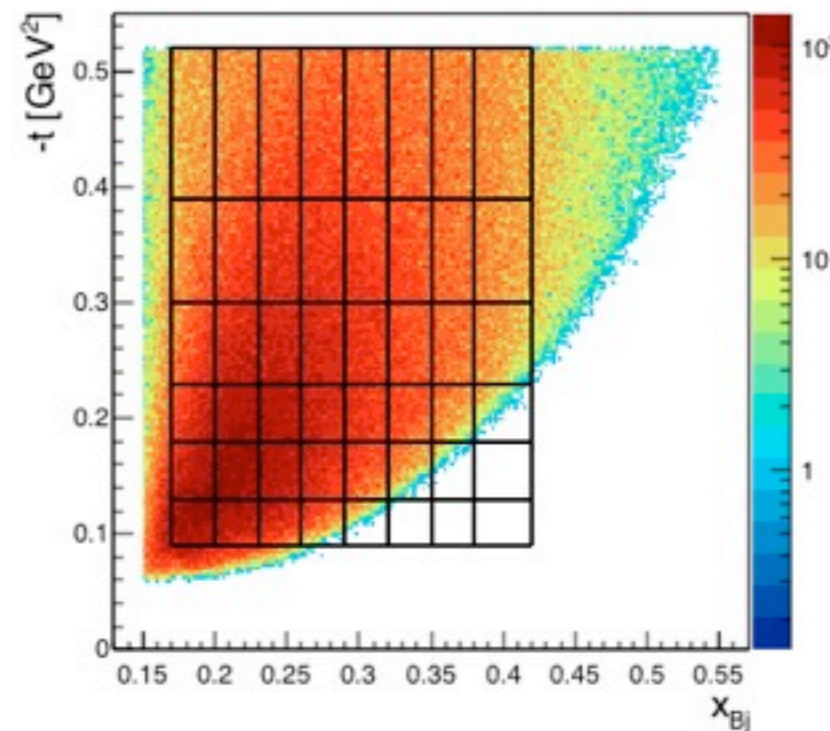
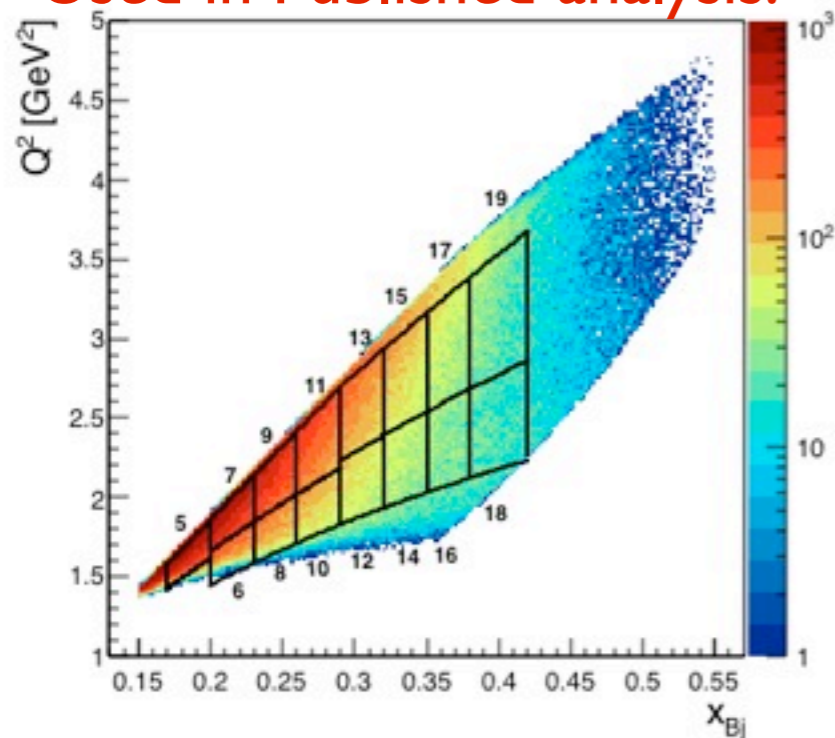


Comparison with Published Results

Binning Used in Published analysis.



kinematic coverage of eI6 data with binning
Used in Published analysis.



Kinematic requirements to
match the conditions of
Published results

$$\theta_{ele} > 21^\circ$$

$$\theta_{ele} < 45^\circ$$

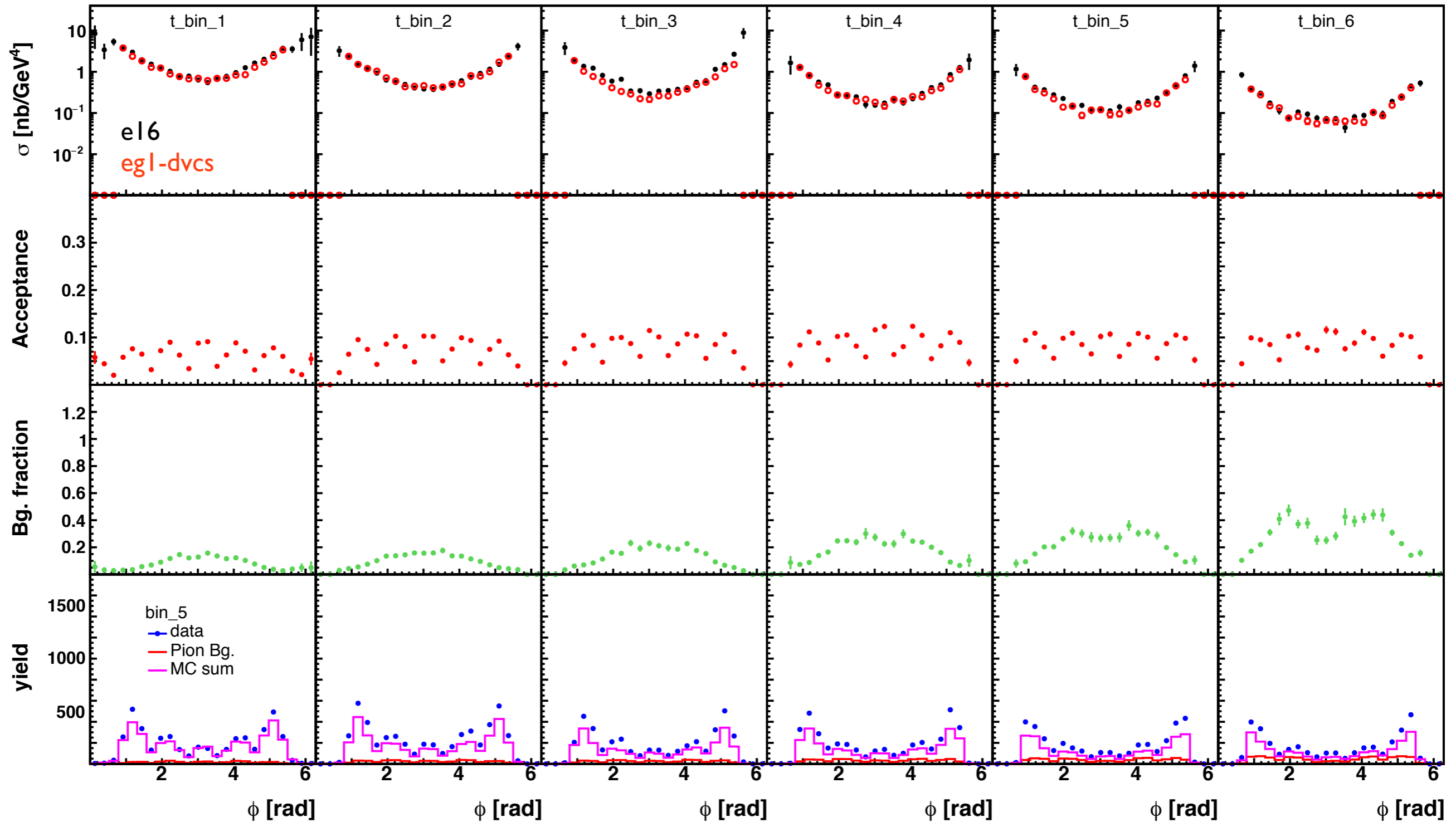
$$P_{ele} > 0.8 \quad [GeV^2]$$

$$\theta_{\gamma calculated} > 5^\circ$$

Comparison with Published Results

$$x_{Bj} - [0.17 - 0.20]$$

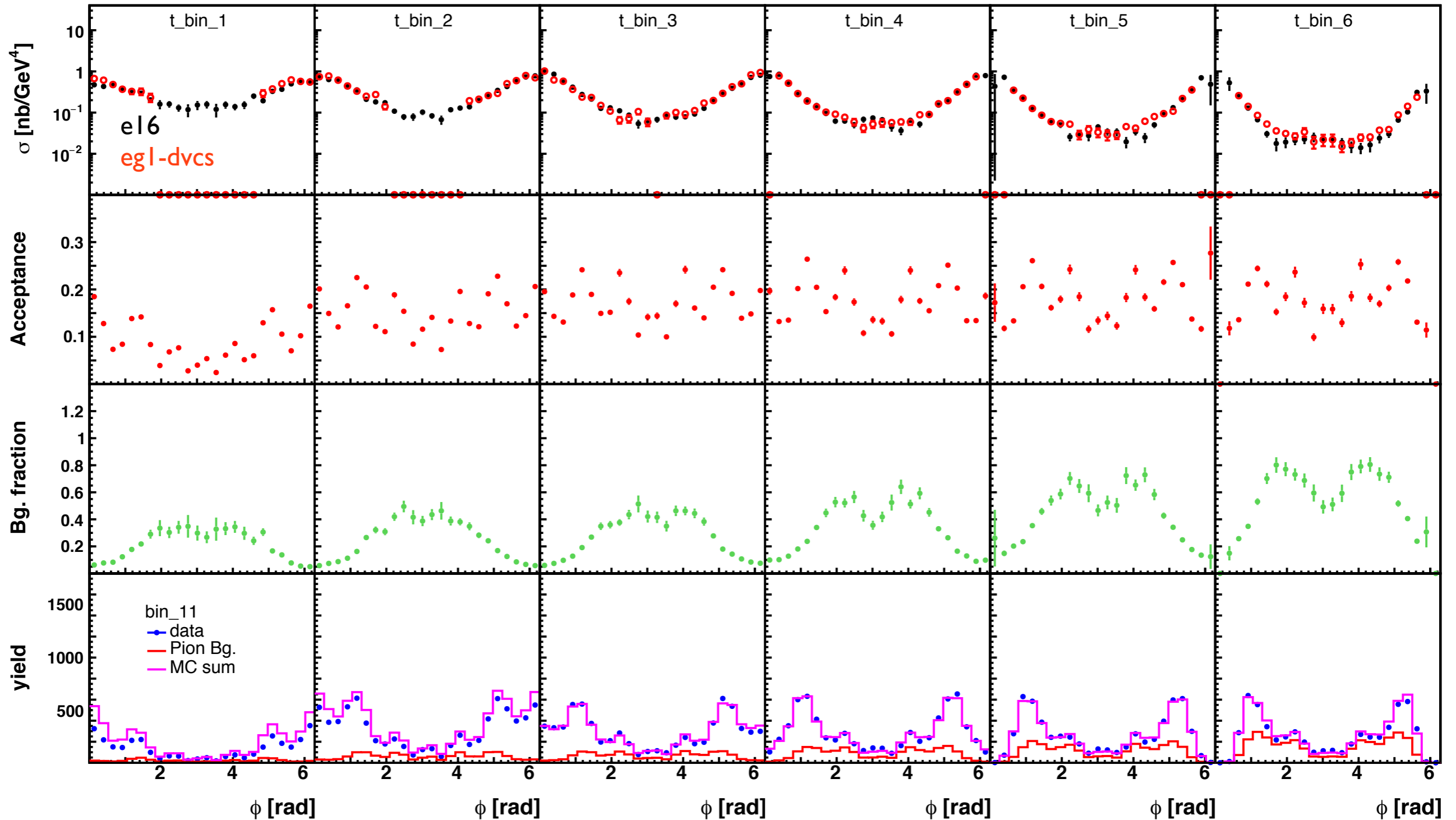
$$\theta_{ele} - [25.5 - 45]$$



Comparison with Published Results

$$x_{Bj} - [0.26 - 0.29]$$

$$\theta_{ele} - [27 - 45]$$



Conclusion & Outlook

- a. Sufficiently good description of exclusive pion production by MC simulation allows to measure DVCS via detection of only electron and proton.
- b. Further improvement of Data-MC comparison can be obtained by improved particle ID and implementation of radiative corrections.
- c. Preliminary results are consistent with published CLAS data.

- a. Improve data-mc comparison.
- b. Radiative Corrections.
- c. Check sensitivity to background subtraction.
- d. Estimation of systematic uncertainties for the measurement of cross sections.

Thank you!