Acceptance Corrections: Bin-by-Bin Method vs. Matrix Conversion Method

Nikolay Markov, Brandon Clary and
Kyungseon Joo
University of Connecticut

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Acceptance Corrections

Unfold true distributions from measured distributions


2000


Acceptance Corrections

1. Bin-by-bin method

$$\boldsymbol{D_i = A_i\, T_i}$$

D_i is # of measured events in i^{-th} bin
T_i is # of true events in i^{-th} bin
A_i is the acceptance of i^{-th} bin
where $\mathbf{A_i = N_{REC} / N_{GEN}}$ for i^{-th} bin

2. Matrix Method

$$\mathbf{D_i = \sum M_{ij}\, T_j}$$

M_{ij} is the acceptance matrix
where $M_{ij} = N_{REC}^{i} / N_{GEN}^{j}$

Bin-by-Bin Method

$$D_i = A_i \, T_i$$

D_i is # of measured events in i-th bin
T_i is # of true events in i-th bin
A_i is the acceptance of i-th bin
where

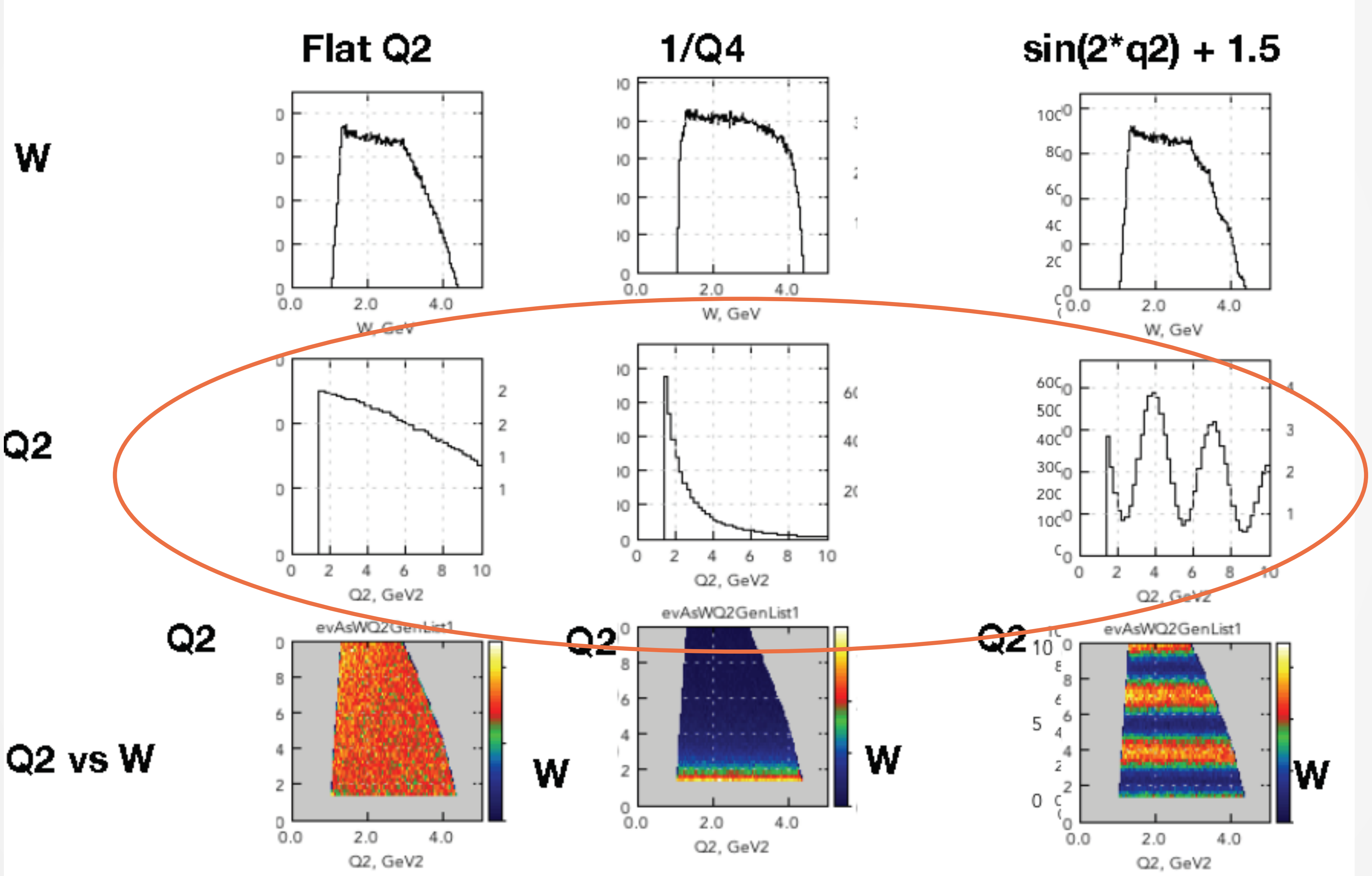
1. $A_i = N_{REC} / N_{GEN}$ for i-th bin

2. $A_i = M_{ii}$ from $M_{ij} = N_{REC}^{i} / N_{GEN}^{j}$

3 Simple Event Generators (Inclusive scattering)

1. Beam energy: 10.6 GeV
2. W flat, [1.0: 5.0] GeV
3. Electron lab ϕ angle flat, [0: 360] degrees
4. Q^2 [1.0: 10.0] GeV^2
    - Flat
    - 1/ Q^4
    - $\sin(2*Q^2) + 1.5$

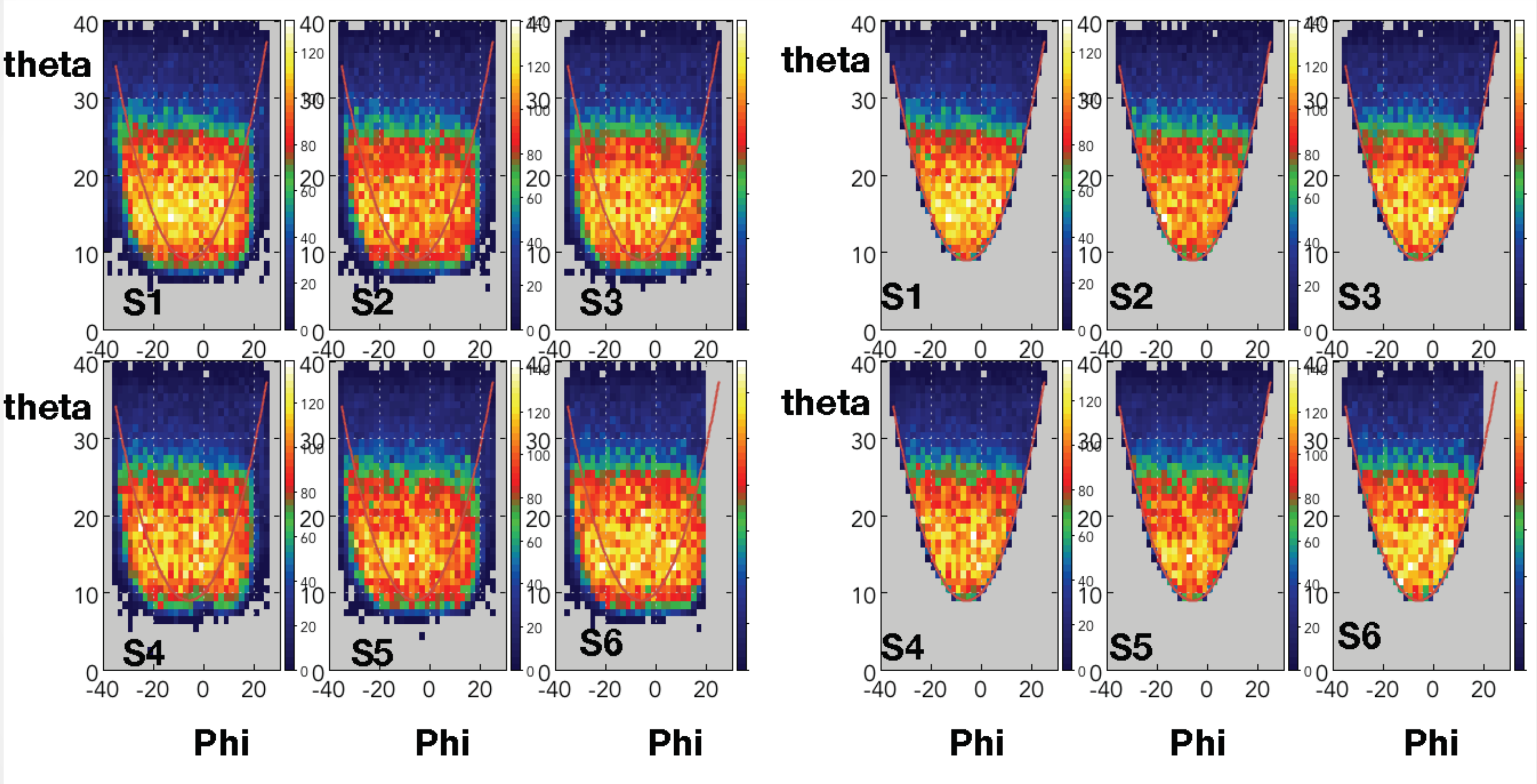
Generated Events



Simulation and reconstruction

1. GEMC 4a.2.1
2. Coatjava 4a.8.3
3. Torus - 100%
4. Solenoid - 100%
5. MICROMEGAS in
6. Electron PID:
    - EB electron id
    - Fiducial cut

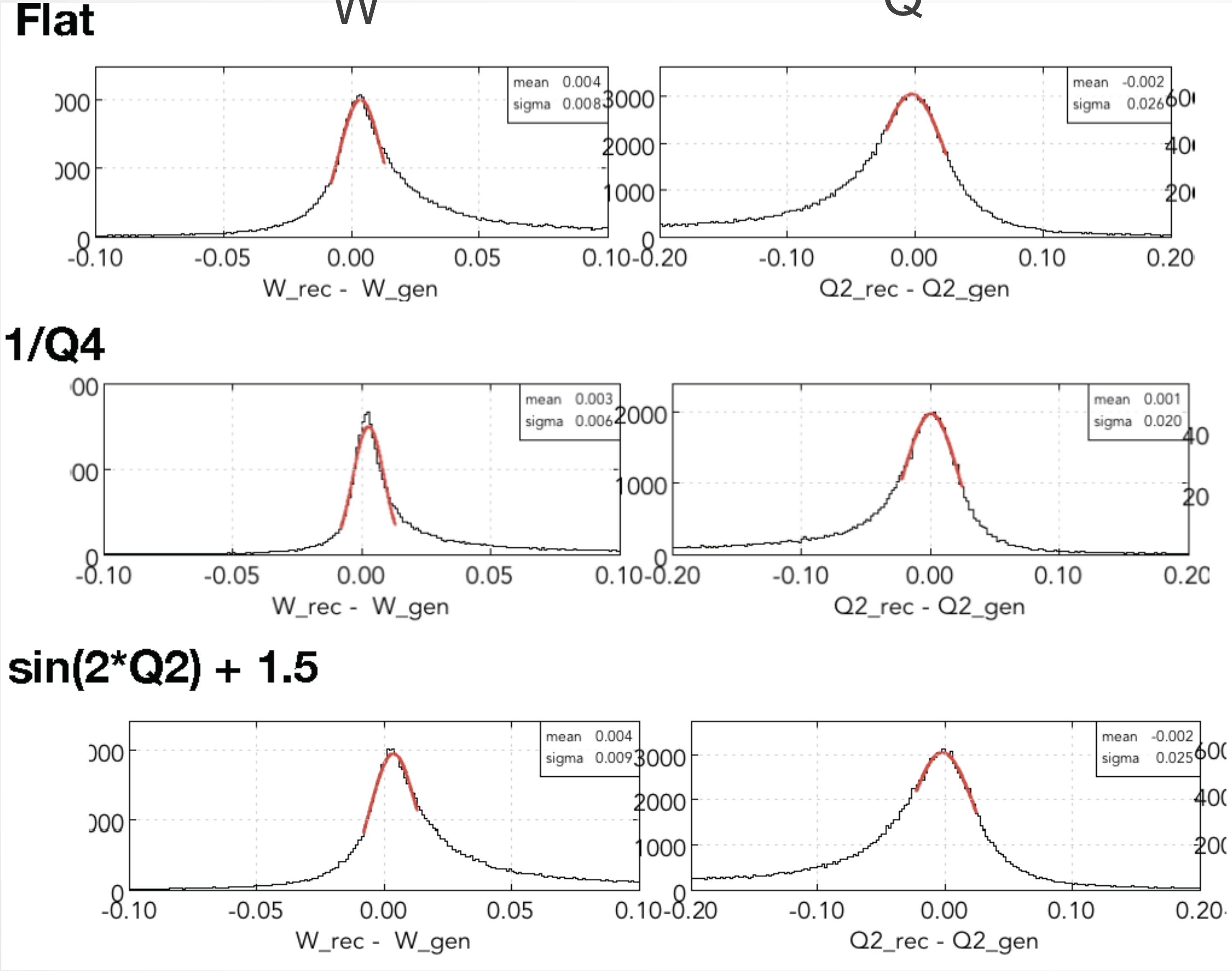
Fiducial Cut



Resolutions

W

Q^2



σ_{Q2} = 0.02 GeV^2

σ_W = 10 MeV

Acceptances and Purity

$$ACC_T = N_{rec}/N_{gen} = \frac{N_{rec}^{gen} + N_{rec}^{migrated}}{N_{gen}}$$

: Total acceptance

$$ACC_P = \frac{N_{rec}^{gen}}{N_{gen}}$$

: Pure acceptance

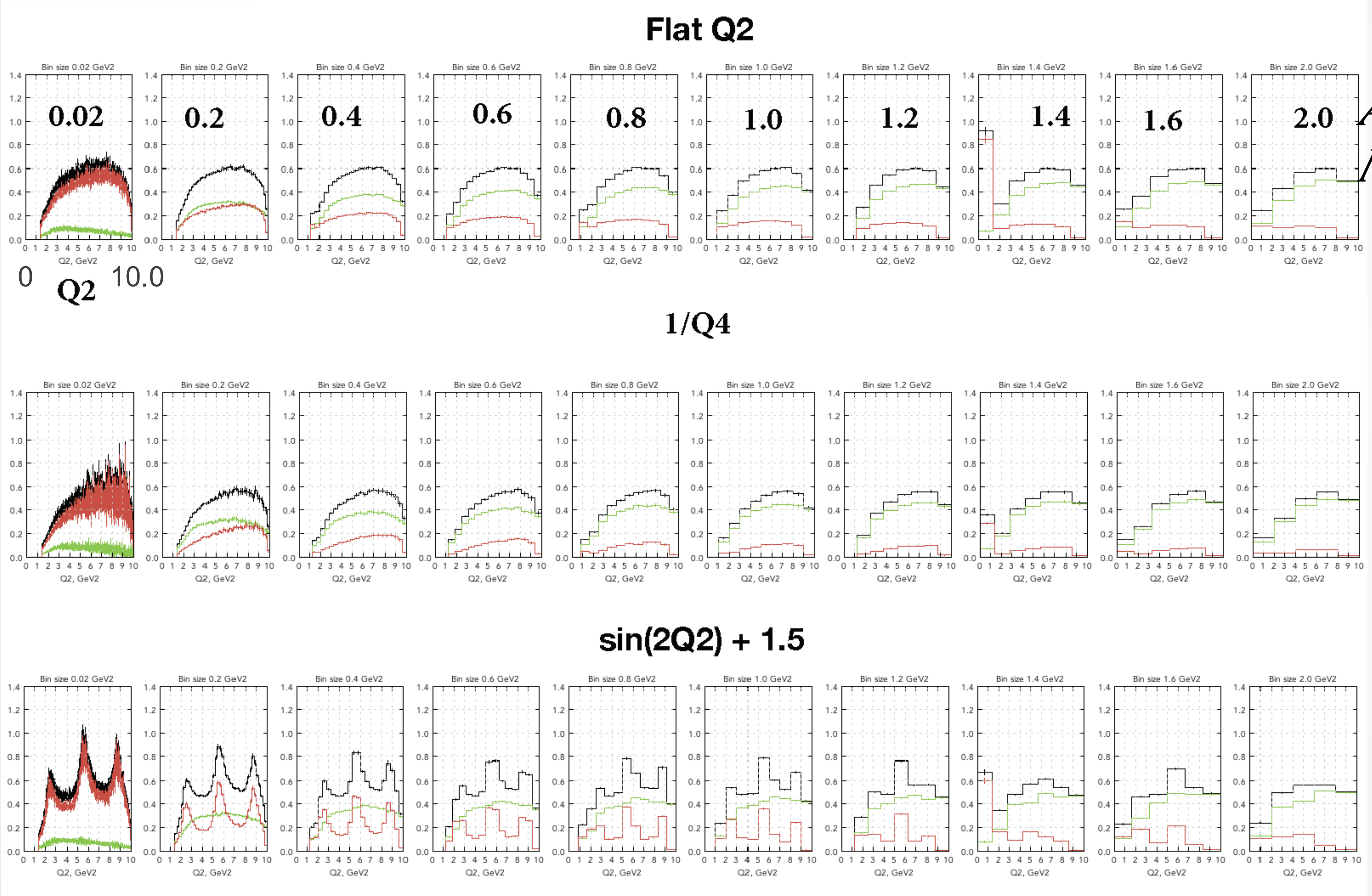
$$ACC_M = \frac{N_{rec}^{migrated}}{N_{gen}}$$

: Migrated acceptance

$$ACC_T = ACC_G + ACC_M$$

$$Purity = N_{rec}^{gen}/N_{rec} = \frac{N_{rec}^{gen}}{N_{rec}^{gen} + N_{rec}^{migrated}}$$

Acceptances vs. Models $\sigma_{Q2} = 0.02\ \mathrm{GeV}^2$

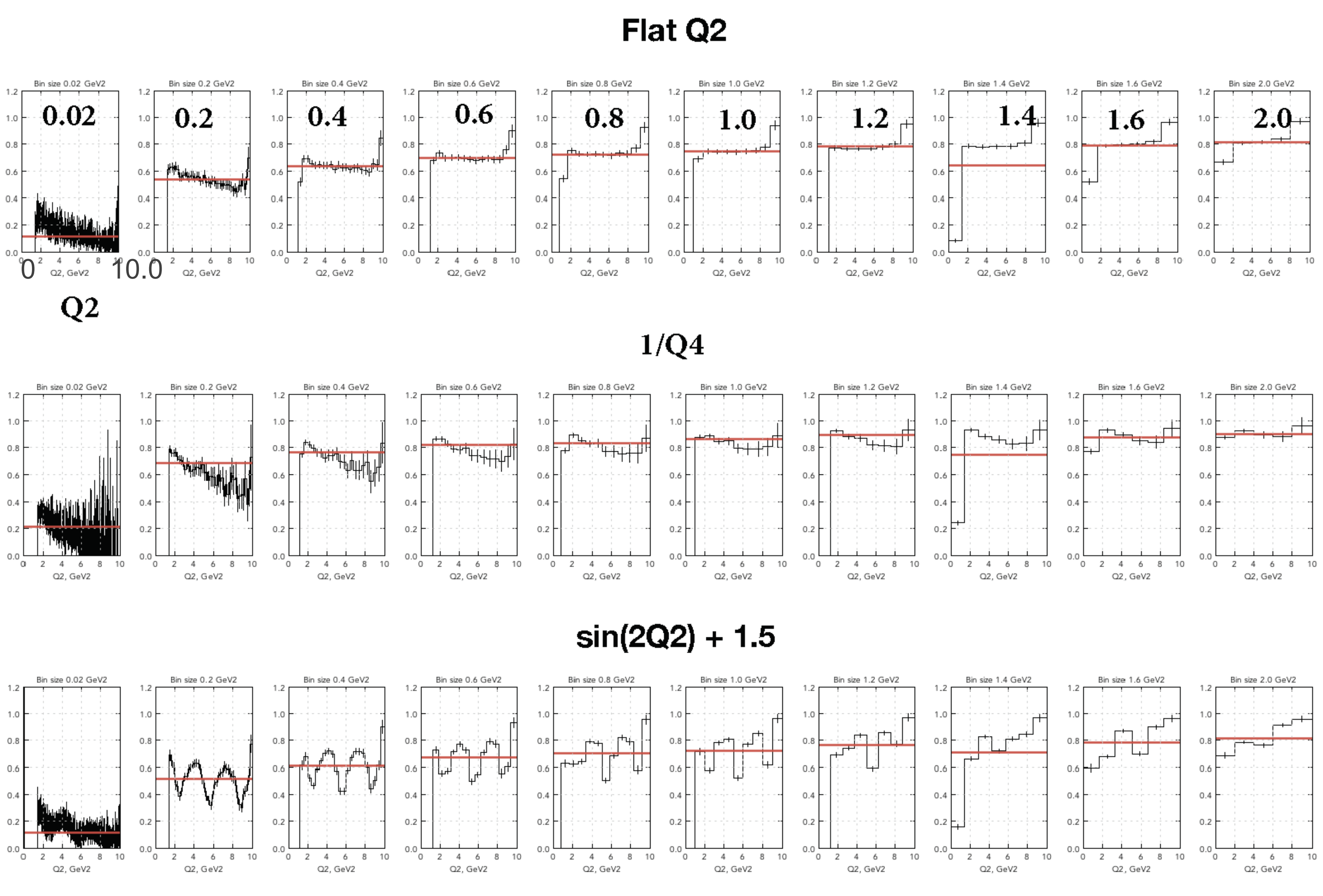


$ACC_T = N_{rec} / N_{gen}$

$ACC_P = N_{rec}^{gen} / N_{gen}$

$ACC_M = N_{rec}^{migrated} / N_{gen}$

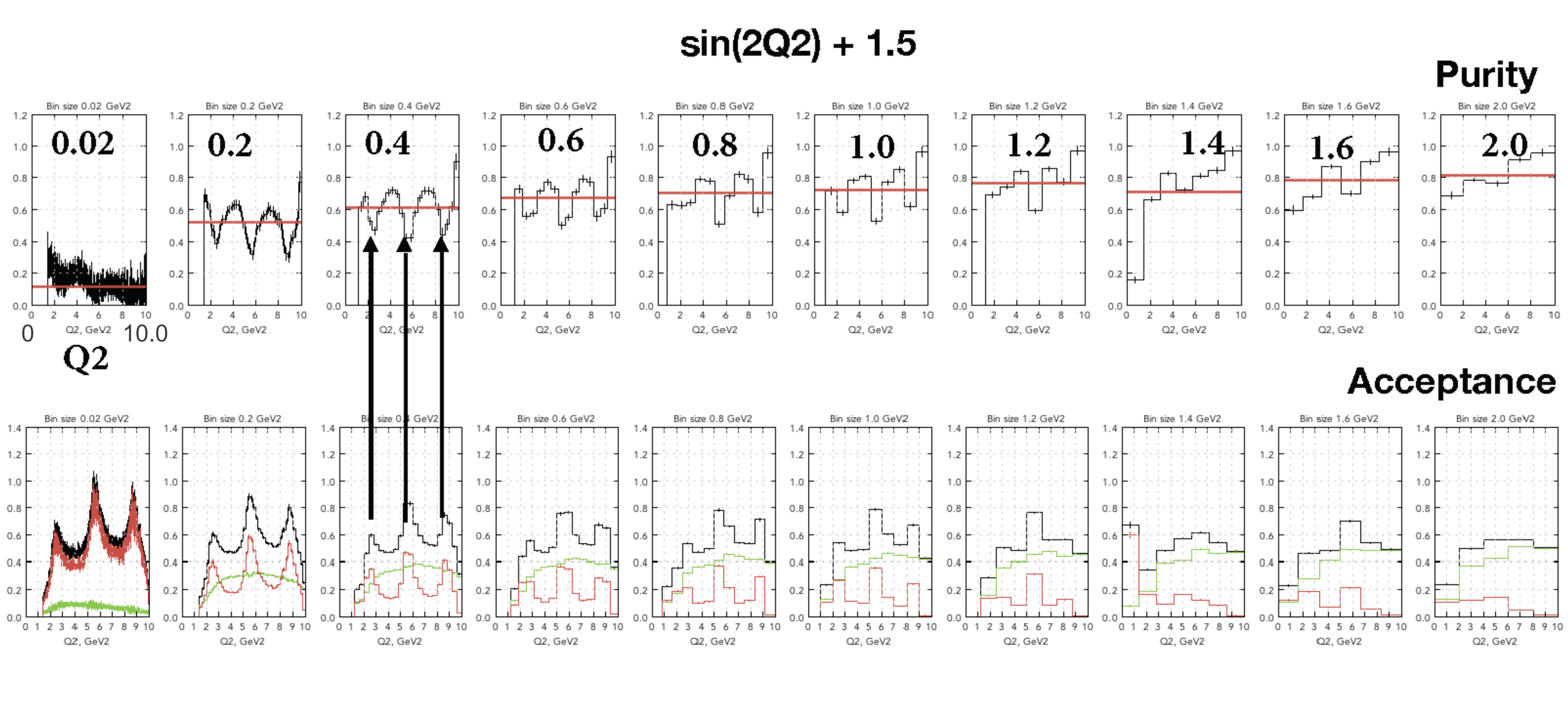
Purity vs. Models



$\sigma_{Q2} = 0.02\ \mathrm{GeV}^2$

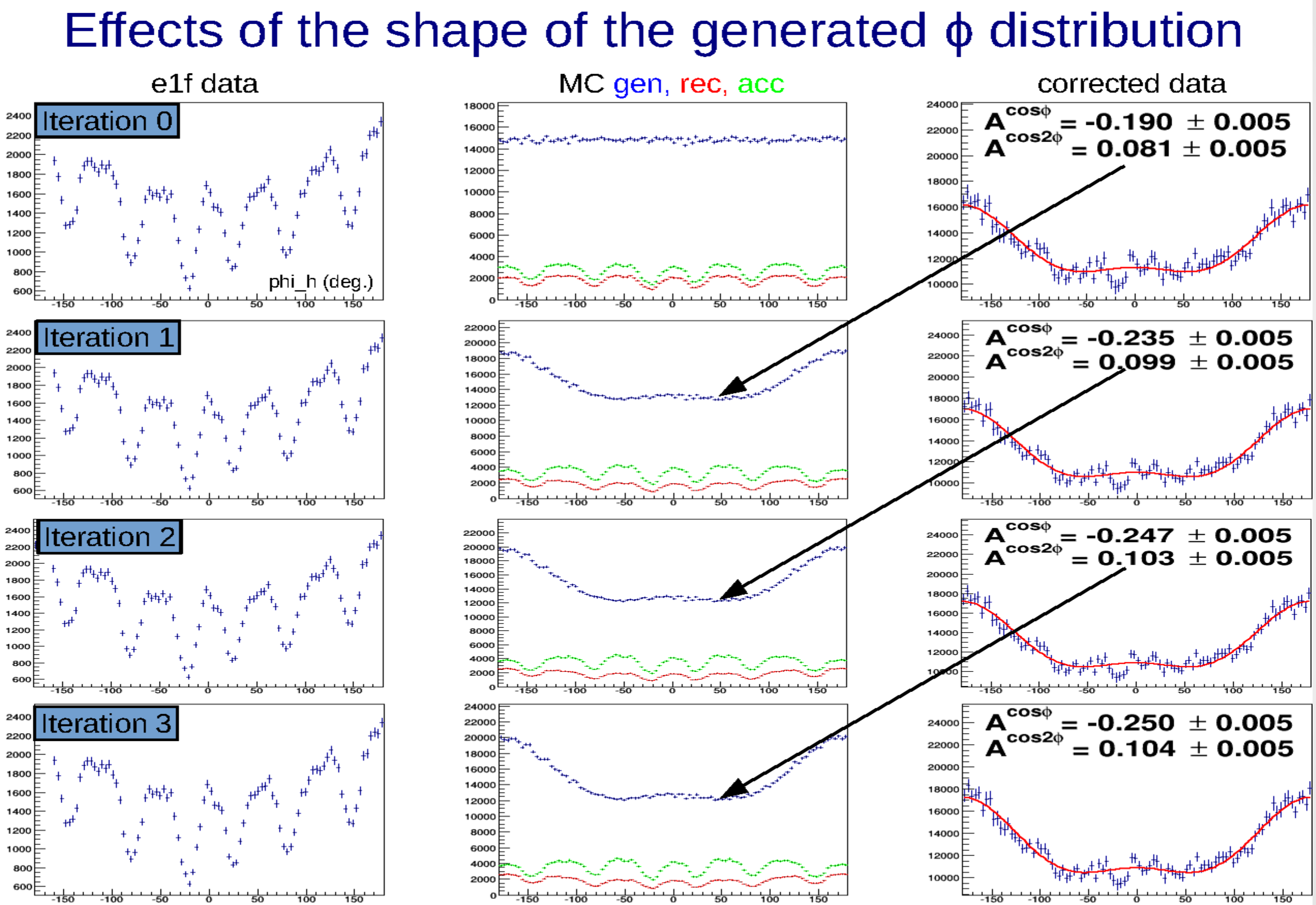
$Purity_{\downarrow} = N_{\downarrow rec}^{\uparrow gen} / N_{\downarrow rec}$

Purity vs. Acceptances σ_{Q2} = 0.02 GeV^2



Iterative Unfolding using Bin-by-Bin Method

N. Harrison PhD Thesis for pion SIDIS



Bin Size Matters

1. Large bin size may result in a loss of sensivity to high frequency components or acute changes.

2. Small bin size may create high sensitive to bin migrations and event generator dependence.

Matrix Method

$$D_i = \sum M_{ij} T_j$$

where $M_{ij} = N_{REC}^{i} / N_{GEN}^{j}$

Metrix Method 10 Bins

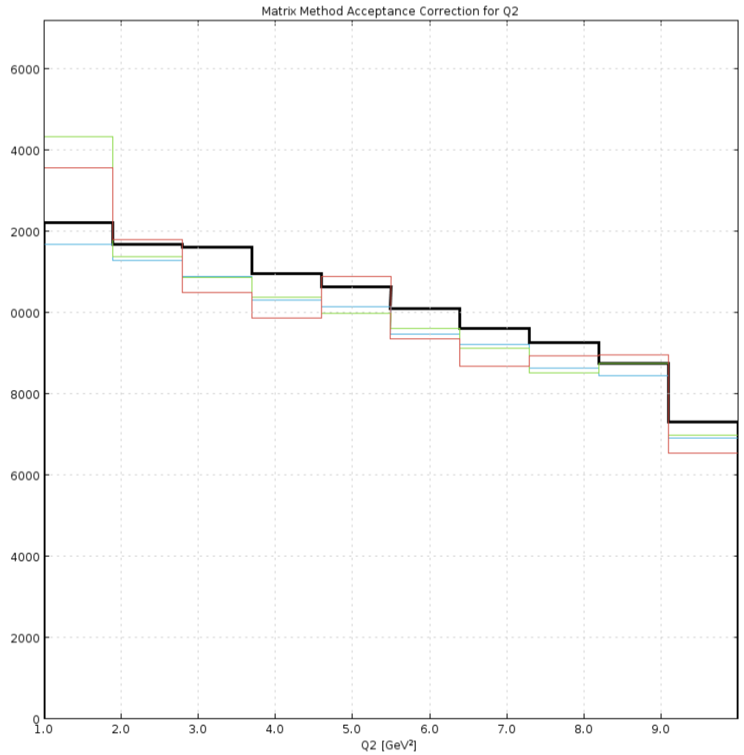


Figure: Solid black line is the generated Q^2 data, the blue line is using the matrix from the flat distribution, red is the result from the sinusoidal matrix, and the green is for the Q^{-4} distribution.

Metrix Method 50 Bins

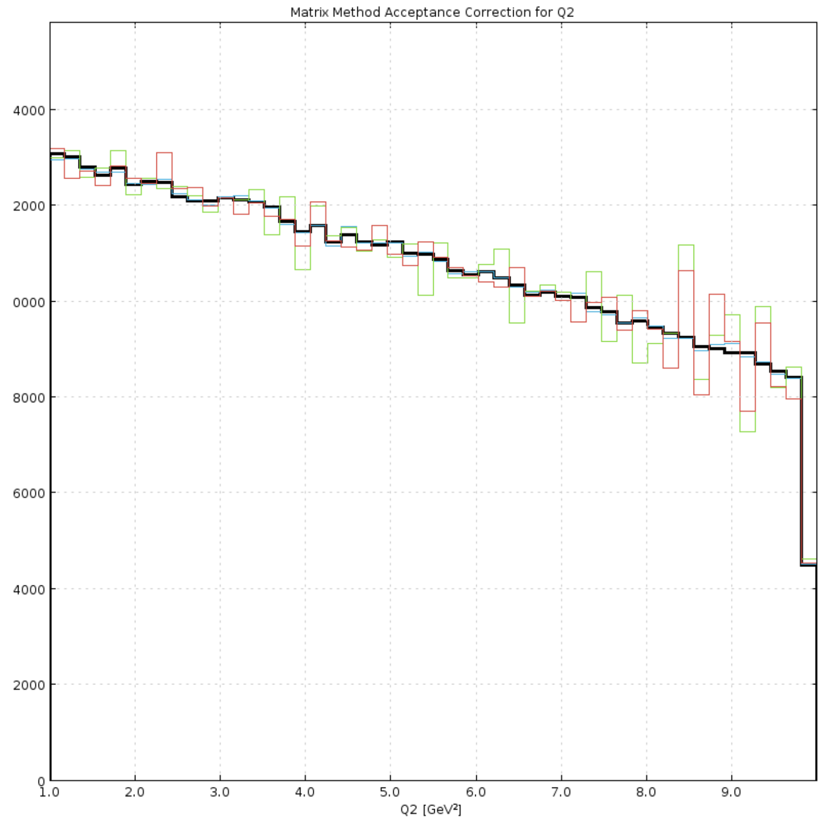


Figure: Solid black line is the generated Q^2 data, the blue line is using the matrix from the flat distribution, red is the result from the sinusoidal matrix, and the green is for the Q^{-4} distribution.

Summary

1. We showed that acceptance is sensitive to event generator models due to bin-migrations even for binnings with much larger than tracking resolution bin sizes.

2. We need to avoid bins with very low purity values to minimize systematic errors.

3. We showed that matrix conversion method is less sensitive to event generator models due to bin-migrations, but it is difficult to implement it for multi-dimensional analysis.

Generated Events vs. Reconstructed Events