Electron Momentum Corrections for E1-F for $W > 2$ GeV

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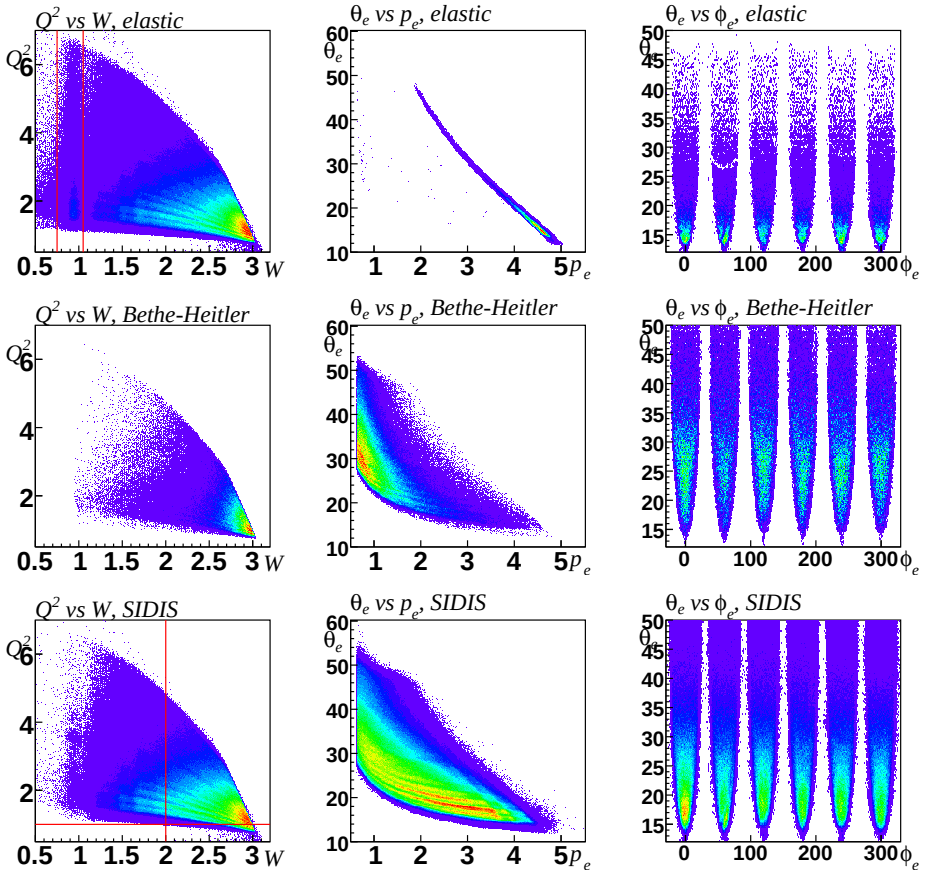
Motivation:

My analysis is for Semi-inclusive pion electroproduction requiring $W > 2$ and $Q^2 > 1$. The momentum correction must be based on a reaction covering a similar phase space to the analysis.

The standard method of doing momentum corrections relies on elastic events, which cover a very small kinematic space. Bethe-Heitler events share much of the SIDIS kinematic phase space.



Left: Q^2 vs W for Elastic events, which are only between the two red lines (top), Bethe-Heitler (middle), and Semi-inclusive π^+ events, which are only for $Q^2 > 1$ and $W > 2$, as illustrated by the two red lines (bottom). Center: θ_e vs p_e for Elastic (top), Bethe-Heitler (middle), and Semi-inclusive π^+ (bottom). Right: θ_e vs ϕ_e for elastic events (top), Bethe-Heitler events (middle), and SIDIS events (bottom).

- Momentum correction for electron was performed for $W > 2$ GeV using Bethe-Heitler events.

- An energy loss correction was first applied to the protons using the eloss program.

- Bethe-Heitler events identified using a cut on $\Delta\phi < 1.5\sigma$ ($\Delta\phi = \phi_e - \phi_P$) and the point where θ_γ drops by a factor of e for events passing the previous cut.

- Correction performed in each bin by fitting $\frac{\Delta p}{p}$ vs ϕ_e with a linear function.

$$\Delta p = p_{measured} - p_{calc}$$

$$P_{calc} = \frac{P'}{1 + \frac{P'(1-cos\theta_e)}{M_P}}$$

with

$$P' = \frac{M_P}{1 - cos\theta_e}(cos\theta_e + \frac{cos\theta_P sin\theta_e}{sin\theta_P - 1})$$

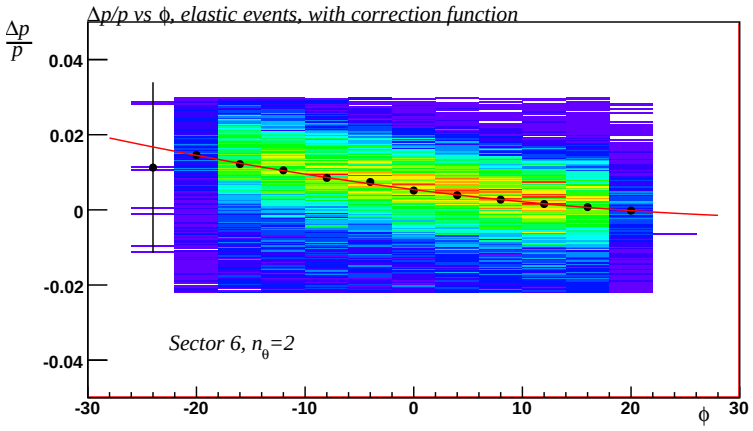
Variable	Bin Size	Number of Bins	Range
W	0.1 GeV	10	$2.0GeV < W < 3.0GeV$
θ_e	5^o	6	$15^o < \theta_e < 45^o$
ϕ_e	4^o	15	$-30^o < \phi_e < 30^o$

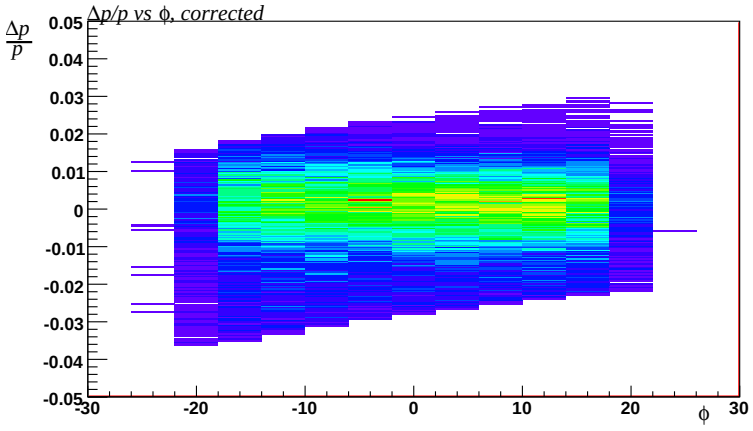
Binning for Bethe-Heitler events. Binning is performed in each sector.

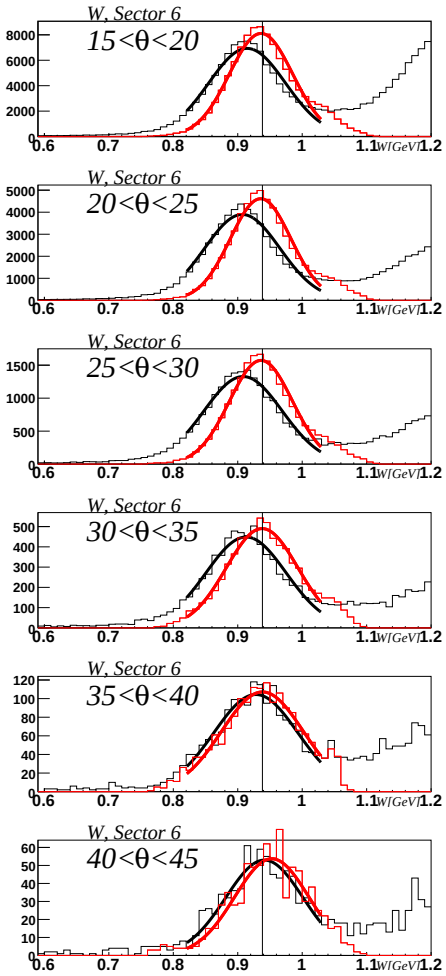
Testing the technique on elastic events.

To test the procedure, we perform the correction for elastic events at low W.

Fit with $\frac{\Delta p}{p}(\phi) = A + B\phi + C\phi^2$.







Uncorrected electron.

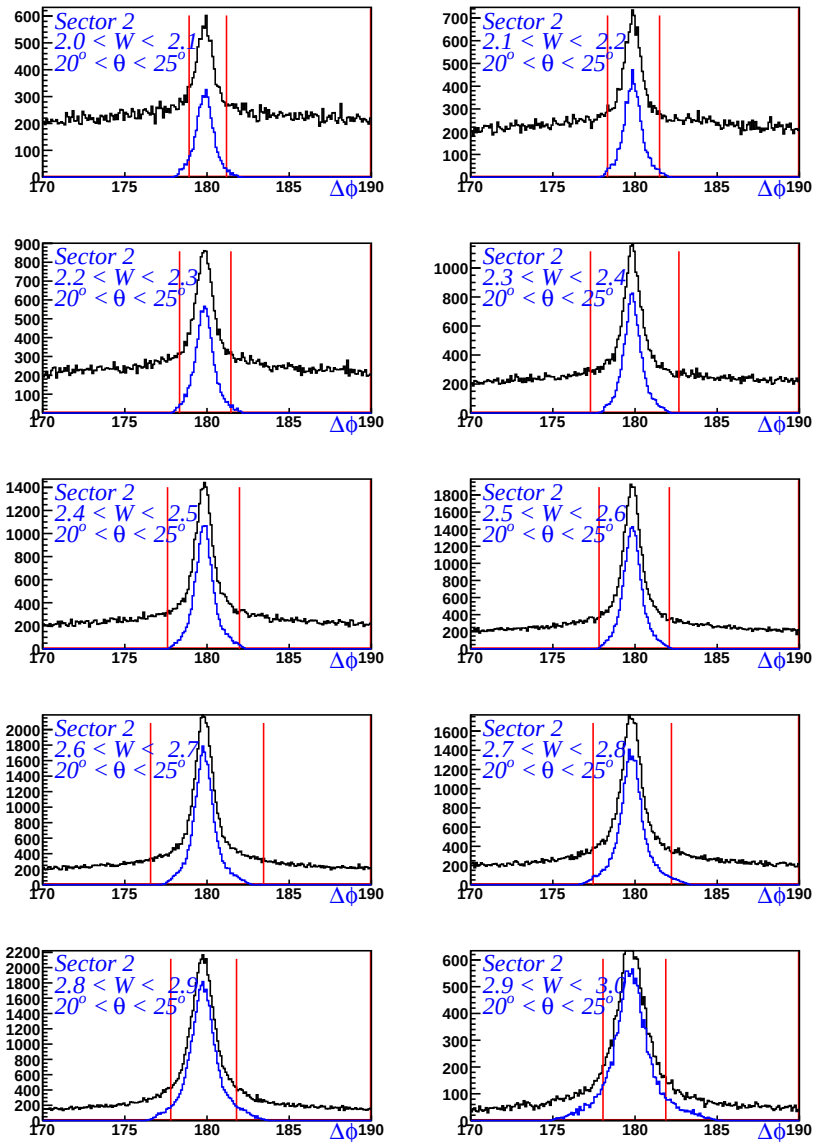
Corrected electron

Both plots have the energy loss correction applied for protons.

Sector	mean W uncorrected	σ_W uncorrected	Mean W corrected	σ_W corrected
1	0.974	0.056	0.939	0.042
2	0.957	0.052	0.938	0.045
3	0.959	0.054	0.938	0.043
4	0.955	0.044	0.939	0.041
5	0.941	0.046	0.940	0.040
6	0.917	0.063	0.939	0.052

Bethe-Heitler Event Selection

$\Delta\phi$ cut. The example shows each W bin for a single bin in ϕ and θ.

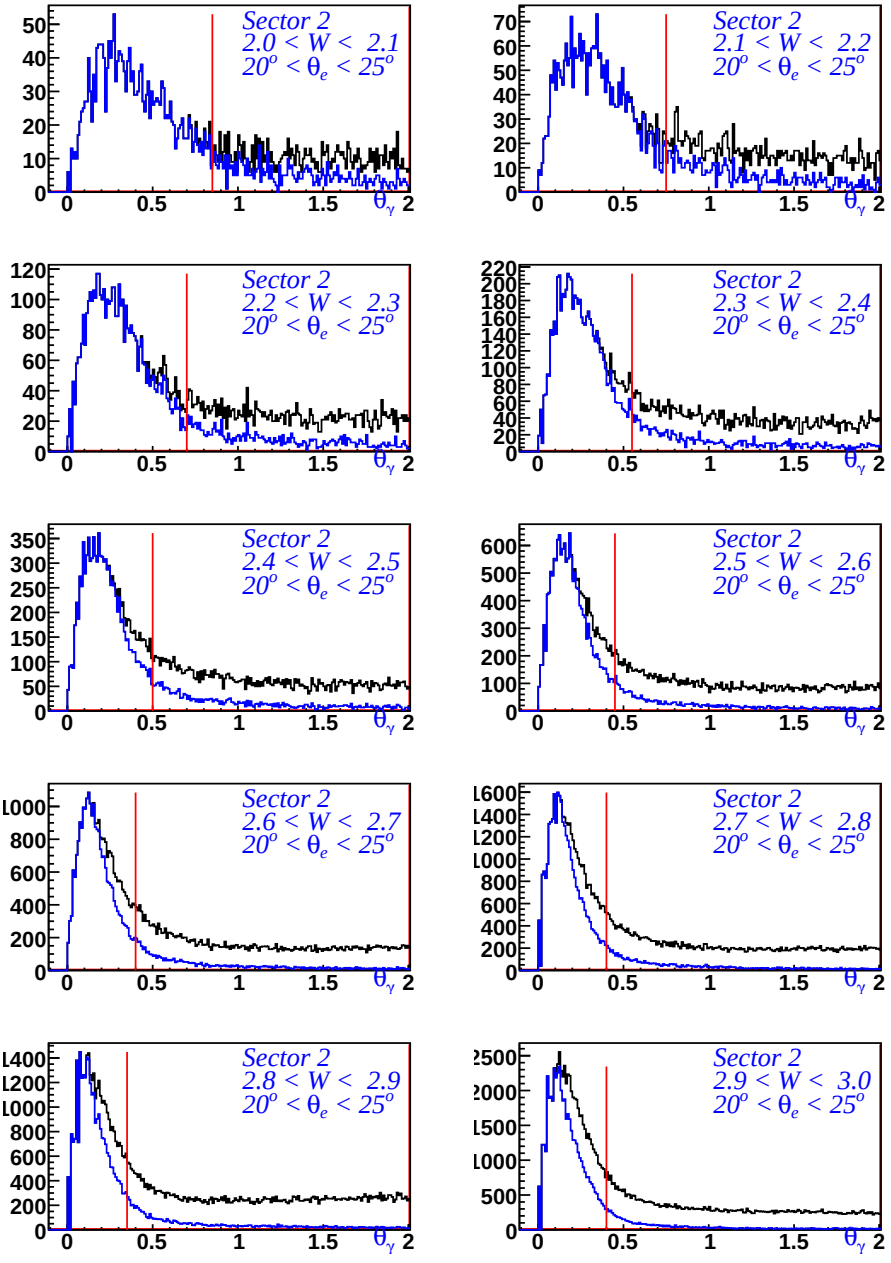


$\Delta\phi = \phi_e - \phi_p$

1.5σ cut around $\Delta\phi$ peak. The blue histograms illustrate $\Delta\phi$ passing the θ_γ cut.

Bethe-Heitler Event Selection

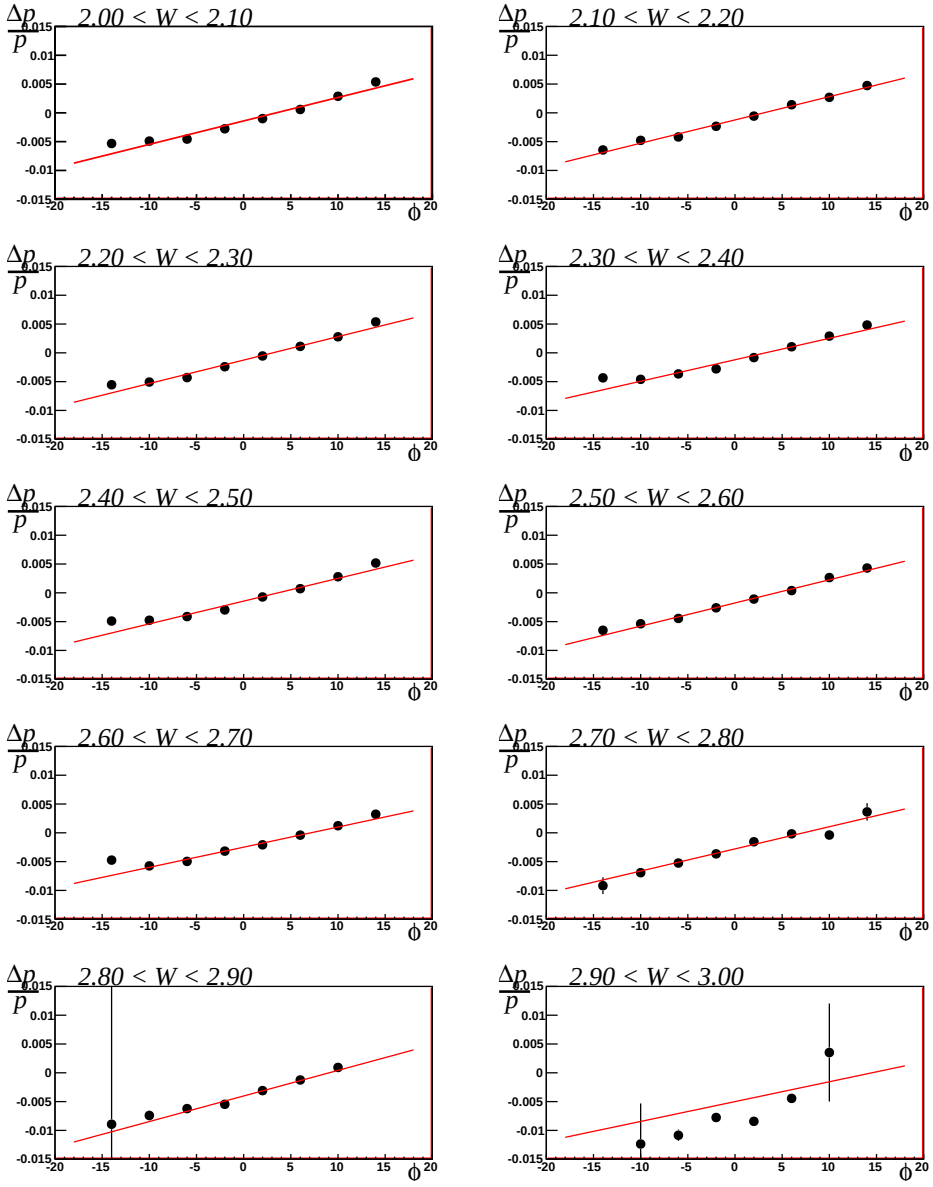
θ_γ cut. The example shows each W bin for a single bin in ϕ and θ.



θ_γ is cut where the value drops by a factor of e from the maximum. The blue histograms illustrate θ_γ passing the $\Delta\phi$ cut.

Example of fits to determine correction function.

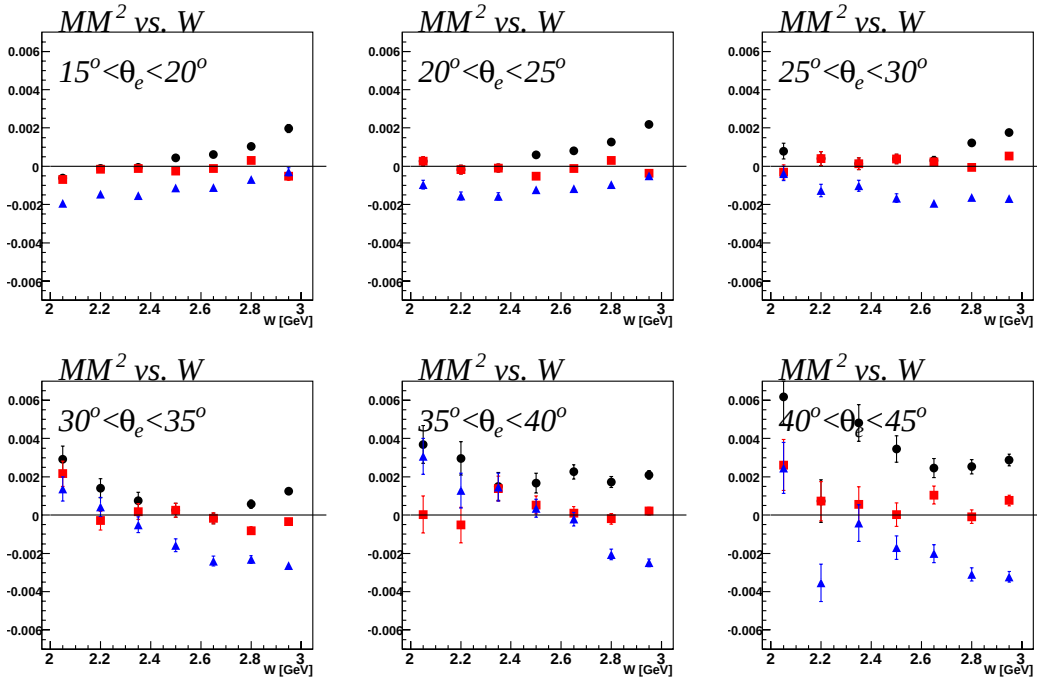
Fit with $\frac{\Delta p}{p}(\phi) = A + B\phi$.



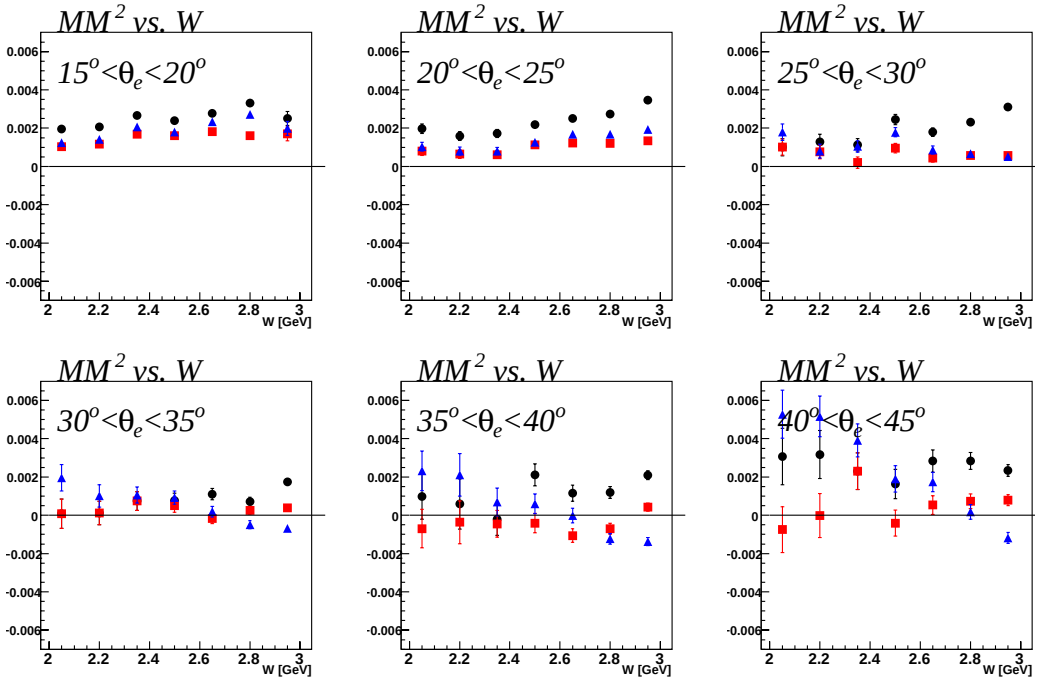
Sector 2, $20^o < \theta_e < 25^o$

Mean of Bethe-Heitler Missing Mass vs. W. Black (circles) show data with the proton energy loss correction applied, but no momentum correction. Red (squares) show the missing mass after applying my correction for electrons. Blue (triangles) show the missing mass after Marco's correction.

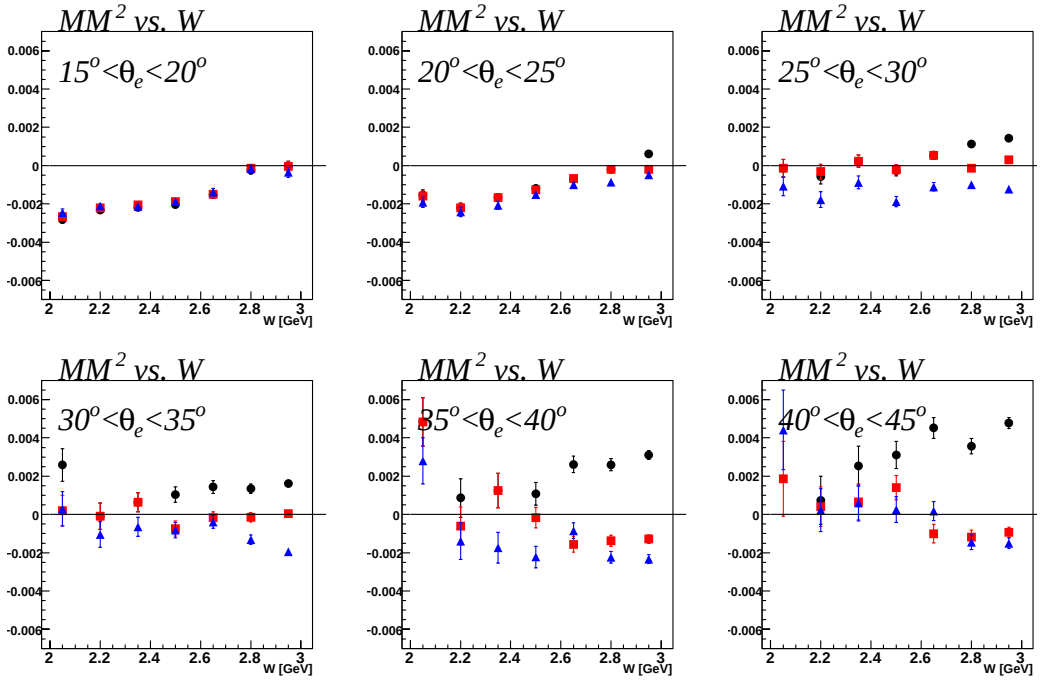
Sector 1.



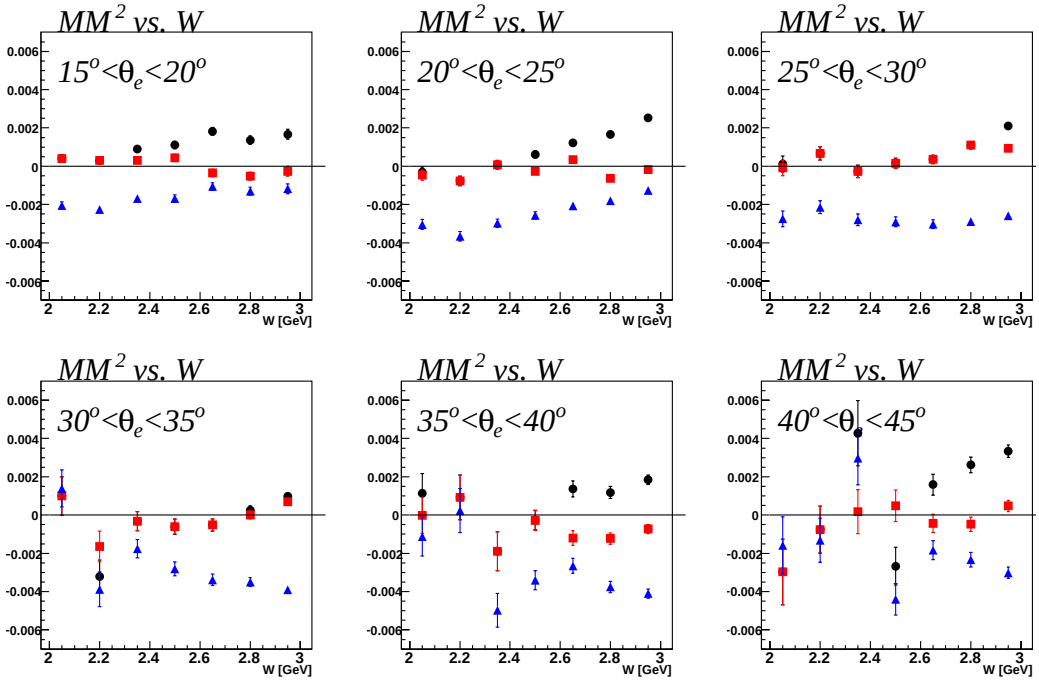
Sector 2.



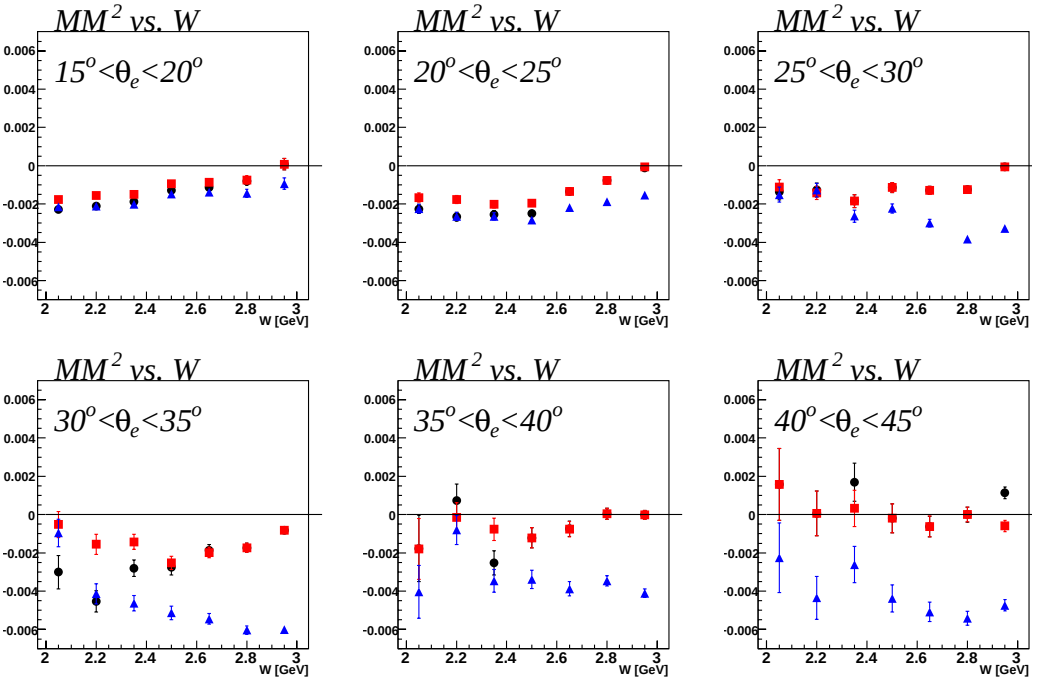
Sector 3.



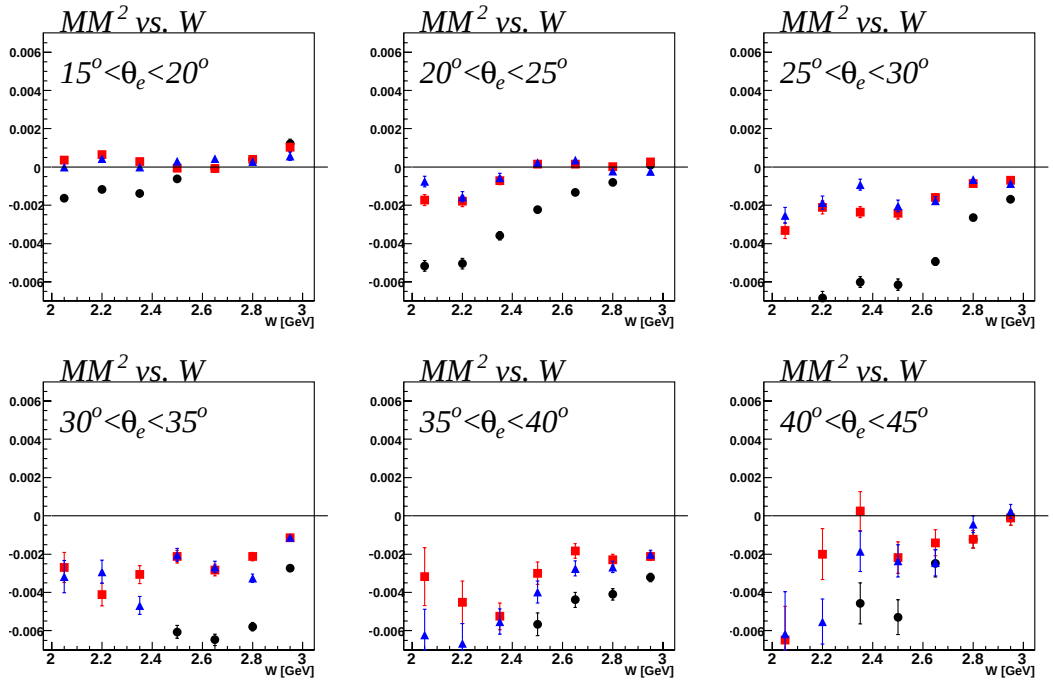
Sector 4.



Sector 5.



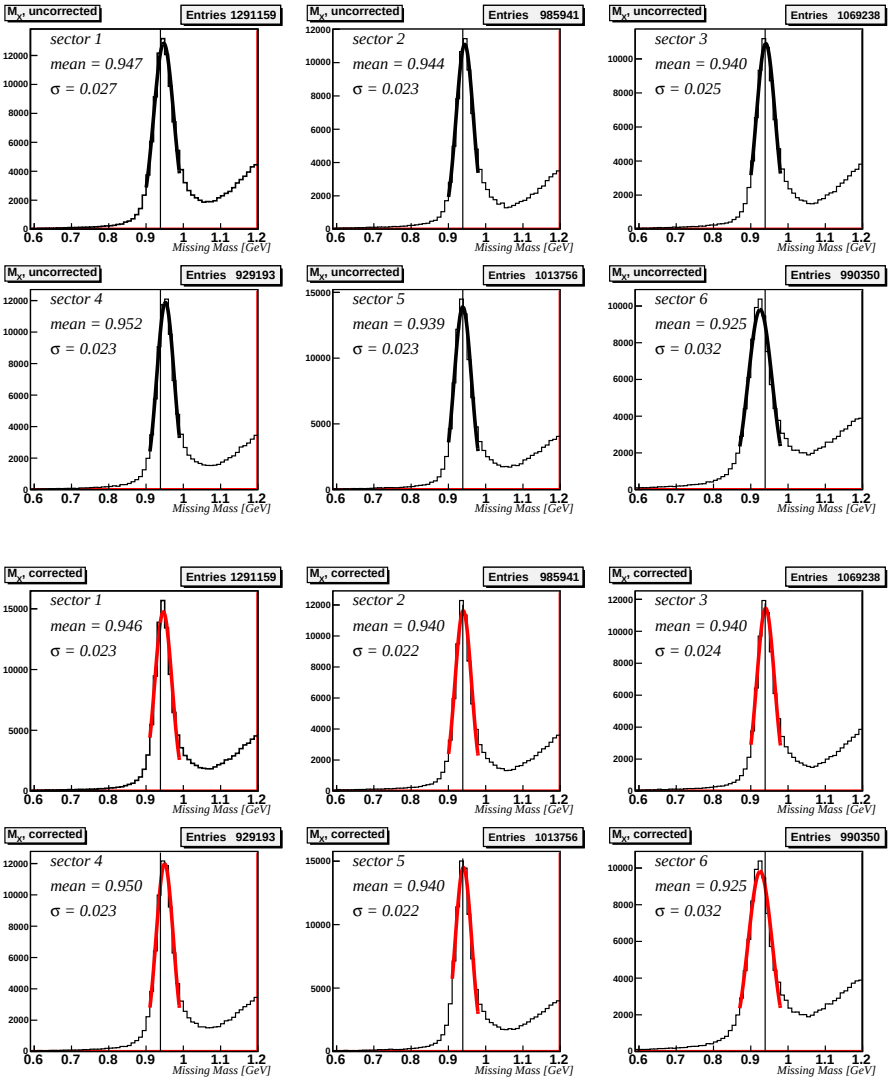
Sector 6.



Sector	Mean, No Correction	σ, No Correction	Mean, My Correction	σ, My Correction	Mean, Marco's Correction	σ, Marco's Correction
1	0.0022	0.0199	-0.0006	0.0194	-0.0018	0.0194
2	0.0022	0.0196	0.0002	0.0191	-0.0006	0.0192
3	0.0016	0.0198	-0.0010	0.0196	-0.0018	0.0199
4	0.0018	0.0198	-0.0005	0.0195	-0.0032	0.0197
5	-0.0004	0.0197	-0.0007	0.0195	-0.0034	0.0195
6	-0.0013	0.0199	-0.0007	0.0198	-0.0010	0.0197

Missing Mass from $ep \rightarrow e\pi^+X$

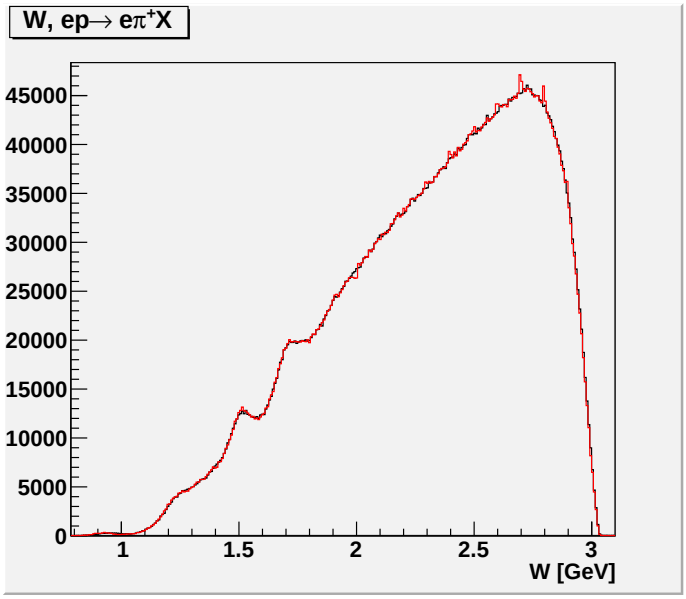
The top set of plots show data with no electron momentum correction, and the bottom six plots show data with my electron momentum correction applied. Both sets have the energy loss correction applied for π^+.

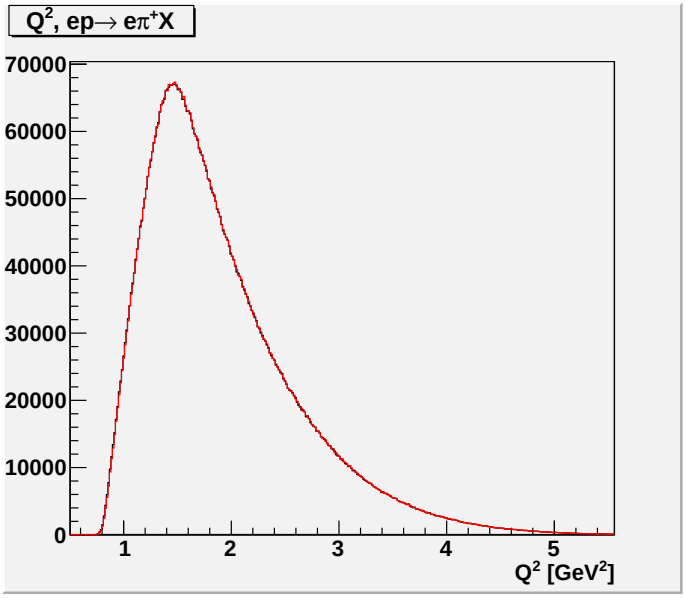


Sector	1	2	3	4	5	6
Uncorrected Mean	0.947	0.944	0.940	0.952	0.939	0.925
Corrected Mean	0.946	0.940	0.940	0.950	0.940	0.925
Uncorrected σ	0.027	0.023	0.025	0.023	0.023	0.032
Corrected σ	0.023	0.022	0.024	0.023	0.022	0.032

Conclusion:

Below are histograms showing distributions of W and Q^2. The black histogram shows each distribution without electron momentum correction, and the red line draws the histogram after the electron momentum correction.





- Electron momentum corrections have been performed individually in each bin
- While in many bins they are comparable to Marco's correction, there are some bins in which this correction gives us Bethe-Heitler missing mass results considerably closer to zero.
- The semi-inclusive missing mass, Q^2, and W spectra are not strongly affected by the correction.

Support Slides

Missing Mass Fits