Data Check for He4 Cross section: Separation of Delta/pion and/or quasi-elastic proton production.

With no restriction on the nn-pair p_cm. The M_missing calculated from E_residual with conservation of energy. This contain any excitation and other unobserved energies in the residual system.

Before Reaction	After Reaction
q(w,**q**) He(M_A,0)	p(E_p,**p**) B(E_B,**p_B** = **q-p**) :residual system

1. **p_miss** = **q – p = p_B**
2. E_miss = excitation energy of the whole residual system.

$$E\_miss = w - KE\_p - KE\_B$$

conservation of energy:

$$w + M\_A = E\_p + E\_B$$
$$= m\_p + KE\_p + M\_B^* + KE\_B$$

so

$$E\_miss = w - KE\_p - KE\_B$$
$$= m\_p - M\_A + M\_B^*$$

$$E\_B = w + M\_A - E\_p$$

so

$$M\_B^* = \mathrm{sqrt}(E\_B^{**}2 - \mathbf{p\_B}^{**}2)$$
$$= \mathrm{sqrt}(E\_B^{**}2 - \mathbf{p\_miss}^{**}2)$$
$$= \mathrm{sqrt}[(w + M\_A - E\_p)^{**}2 - \mathbf{p\_miss}^{**}2]$$

$$E\_miss = w - KE\_p - KE\_B$$
$$= m\_p - M\_A + M\_B^*$$
$$= m\_p - M\_A + \mathrm{sqrt}[(w + M\_A - E\_p)^{**}2 - \mathbf{p\_miss}^{**}2]$$

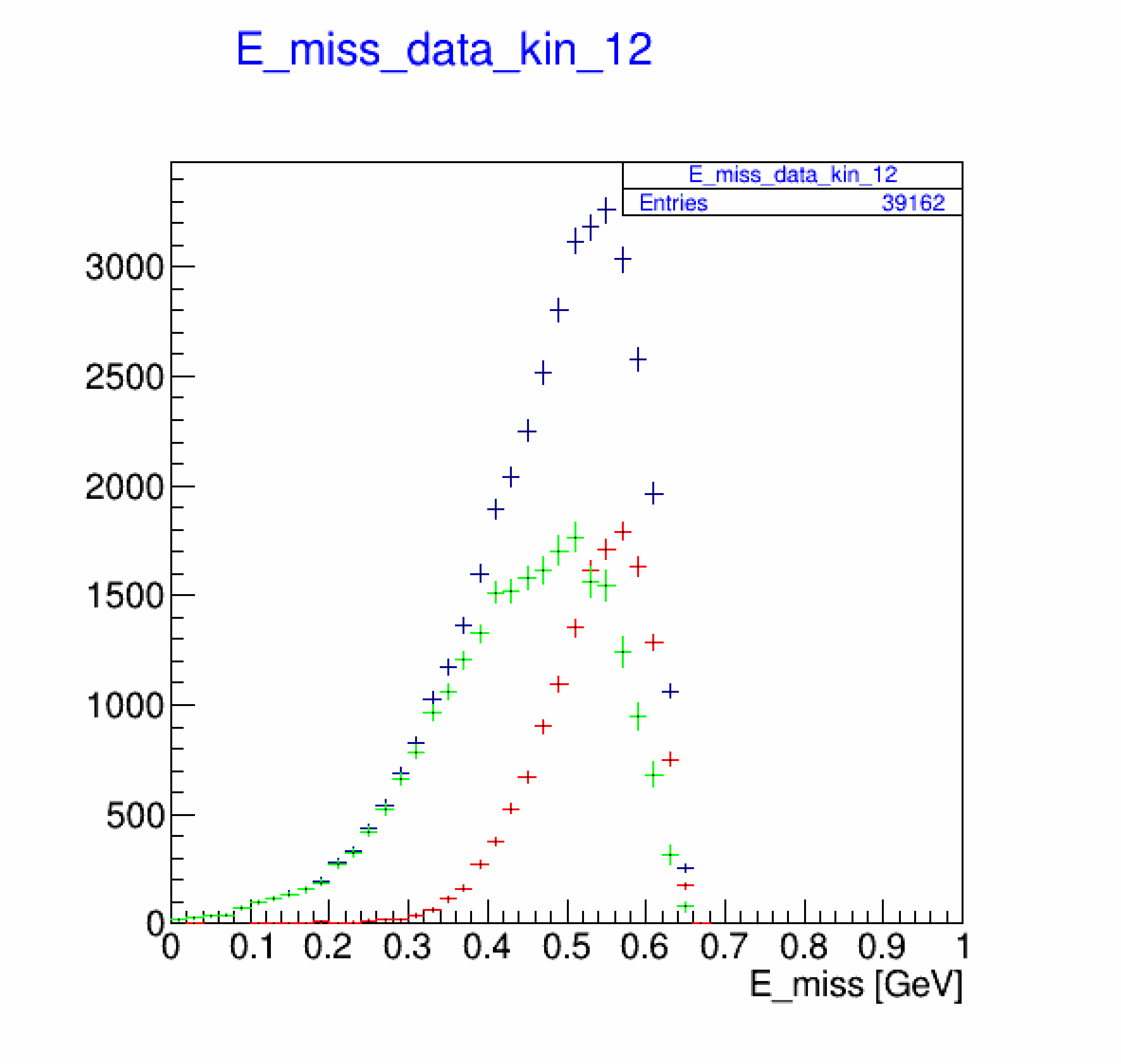

Figure 1: E_miss distribution
blue: proton in CT cut-dependent
red: proton in Background CT
green: proton in CT with background subtracted

E_miss = w - KE_p – KE_B
*= m_p – M_A + M_B**
*= m_p – M_A + sqrt[(w + M_A – E_p)**2-**p_miss****2]*

What E_miss telling us??
The definition suggest it is the excitation energy of the residual system (nnp).
Consider the information from Peter's thesis. His missing energy has two peaks merging together where he **separated the data for the non-detected N in the pair as proton or delta/pion** using w and y-scaling.
The y-scaling is the momentum of the struck nucleon which absorbed the virtual photon.
(y<0 is equivalent to x_Bj>1):

y(**q**,w) = [(M_A+w)*sqrt(Lamda^2 – M_(A-1)^2*W^2) – **q**Lamda] /W^2

where

Lamda = (M_(A-1)^2 – M_A^2+W^2)/2
W = sqrt((M_A+w)^2-q^2)

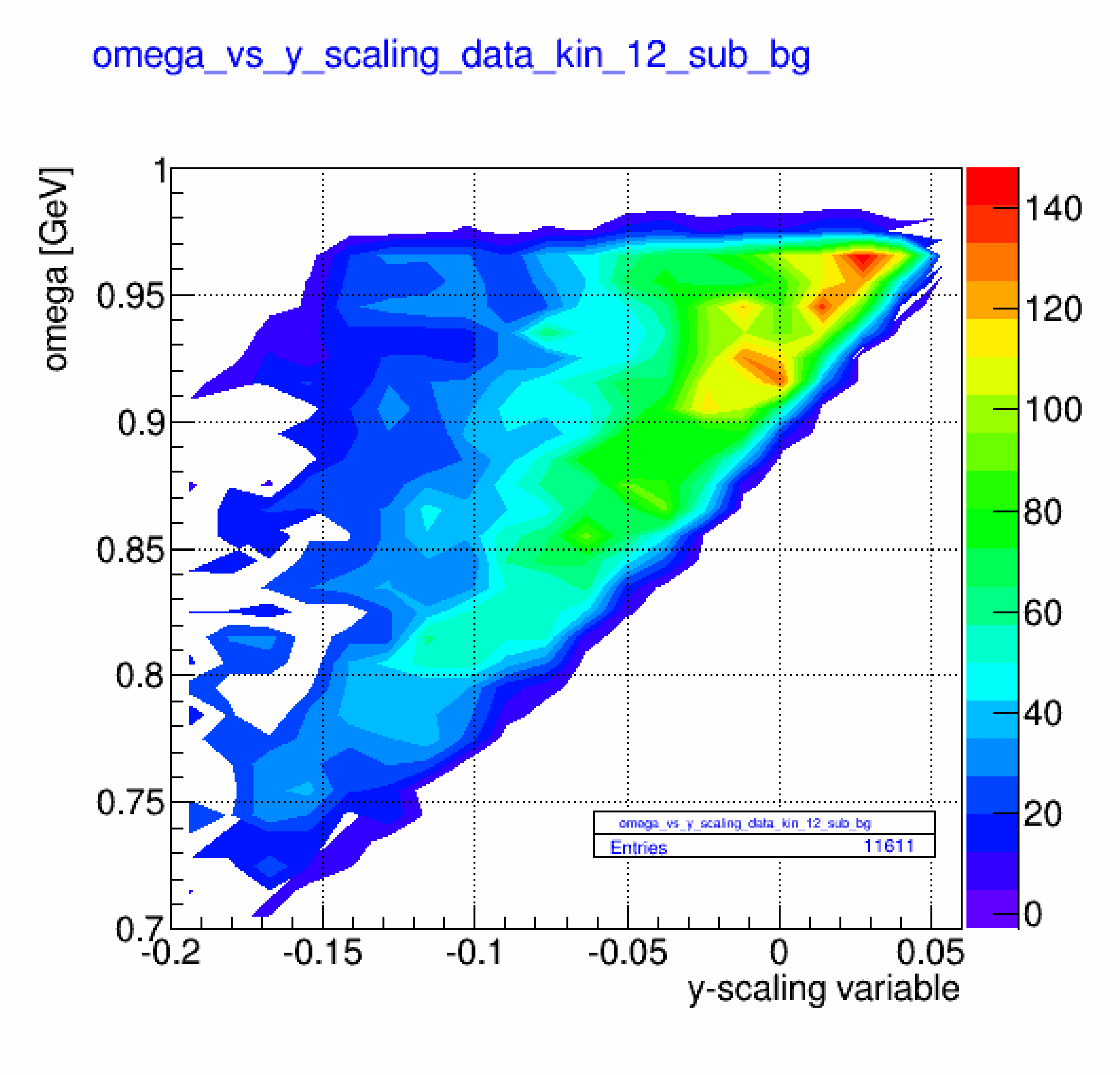

Figure 2: Omega vs y of proton in CT after background subtracted.
The distribution of the omega vs y is shown.
In my case where the backward proton momentum is between 300-1200 MeV/c.
It is not clear where to make the cut to separate the pion and delta production and the proton.

From Peter's thesis. The missing momentum about 400-650 MeV/c (translate to detected momentum in the backward angle).

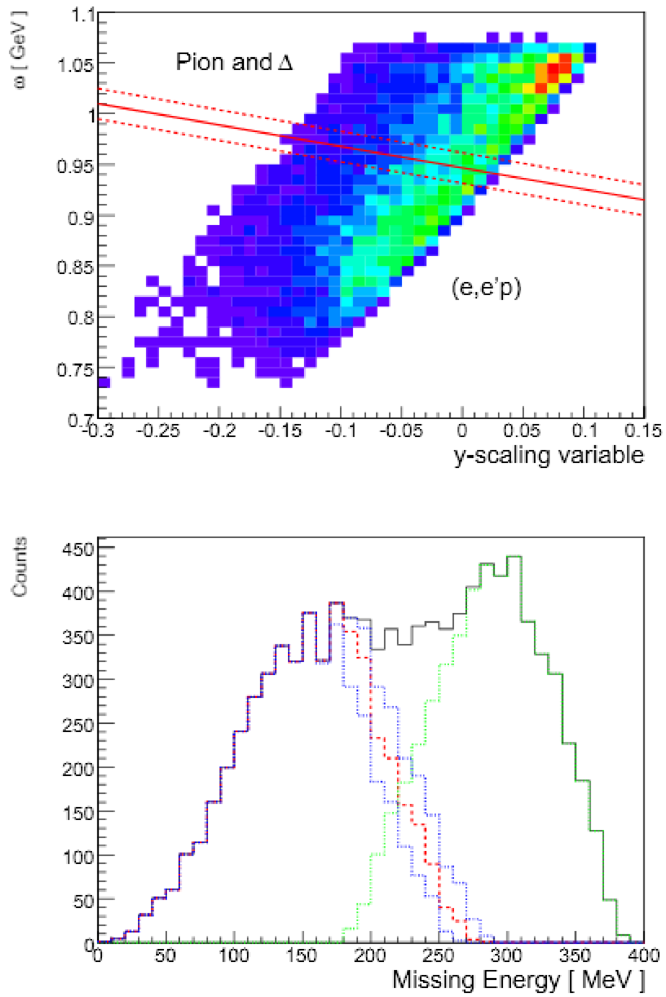

Figure 5-11: Upper Plot: Two-dimensional distribution of events in kinematic III of ω versus y-scaling variable, with empirical cut selected; dotted lines give limits of the systematic check of this cut on the final cross-section result. Lower Plot: Full missing energy distribution for kinematic III; dashed line (red online) shows the distribution after the ω-y cut is applied; dotted line (green online) shows the data rejected by this cut. The two dotted (blue) lines around the dashed (red) line show the effect of the upper and lower limits of the $\omega - y$ cut and are used to evaluate the systematic error associated with this cut.

108

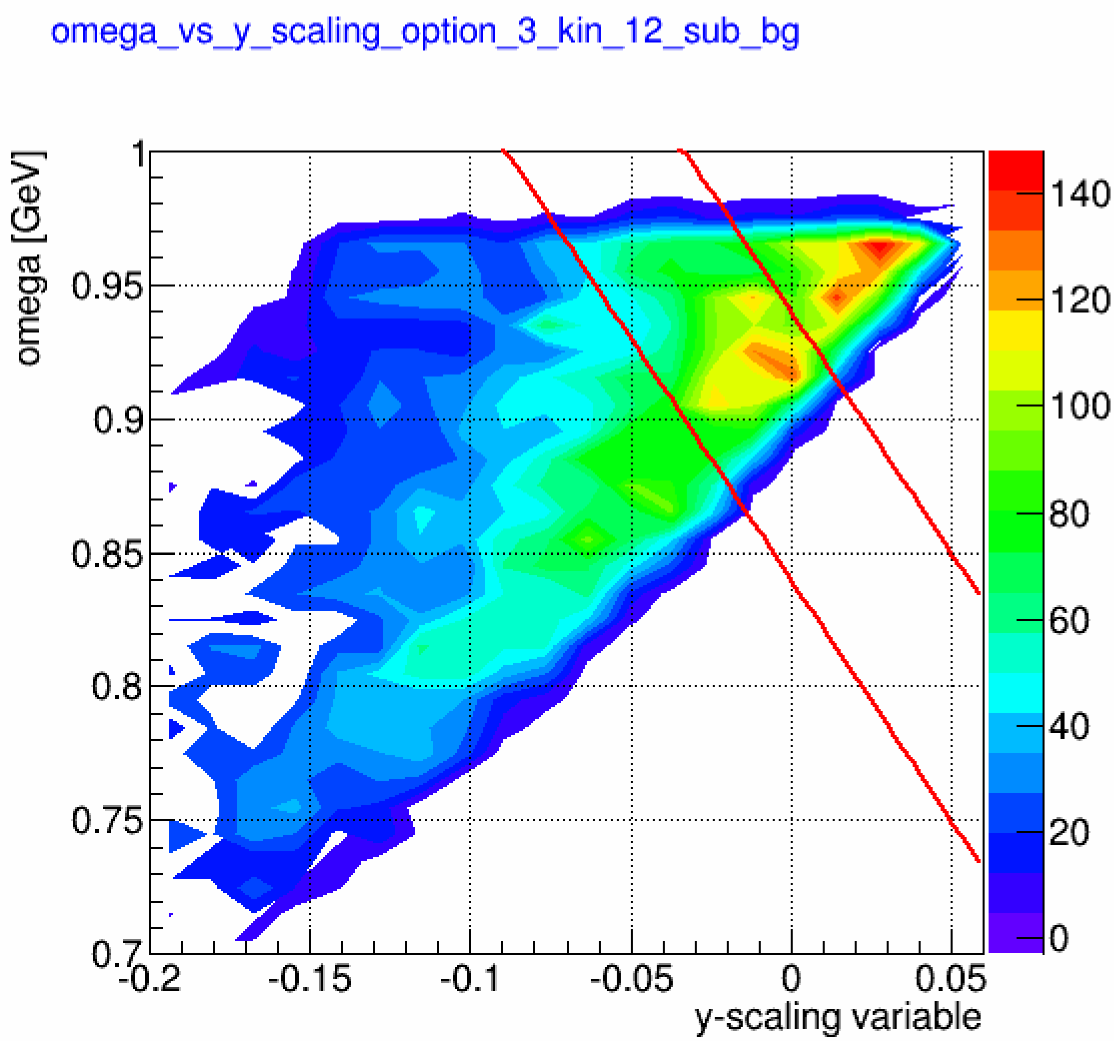

Figure 3: Omega vs y after background subtracted with the section line cuts.
*Section 1: Omega >= 0.94 – 1.8*y*
*Section 2: Omega <= 0.94 – 1.8*y && Omega >= 0.84 – 1.8*y*
*Section 3: Omega <= 0.84 – 1.8*y*

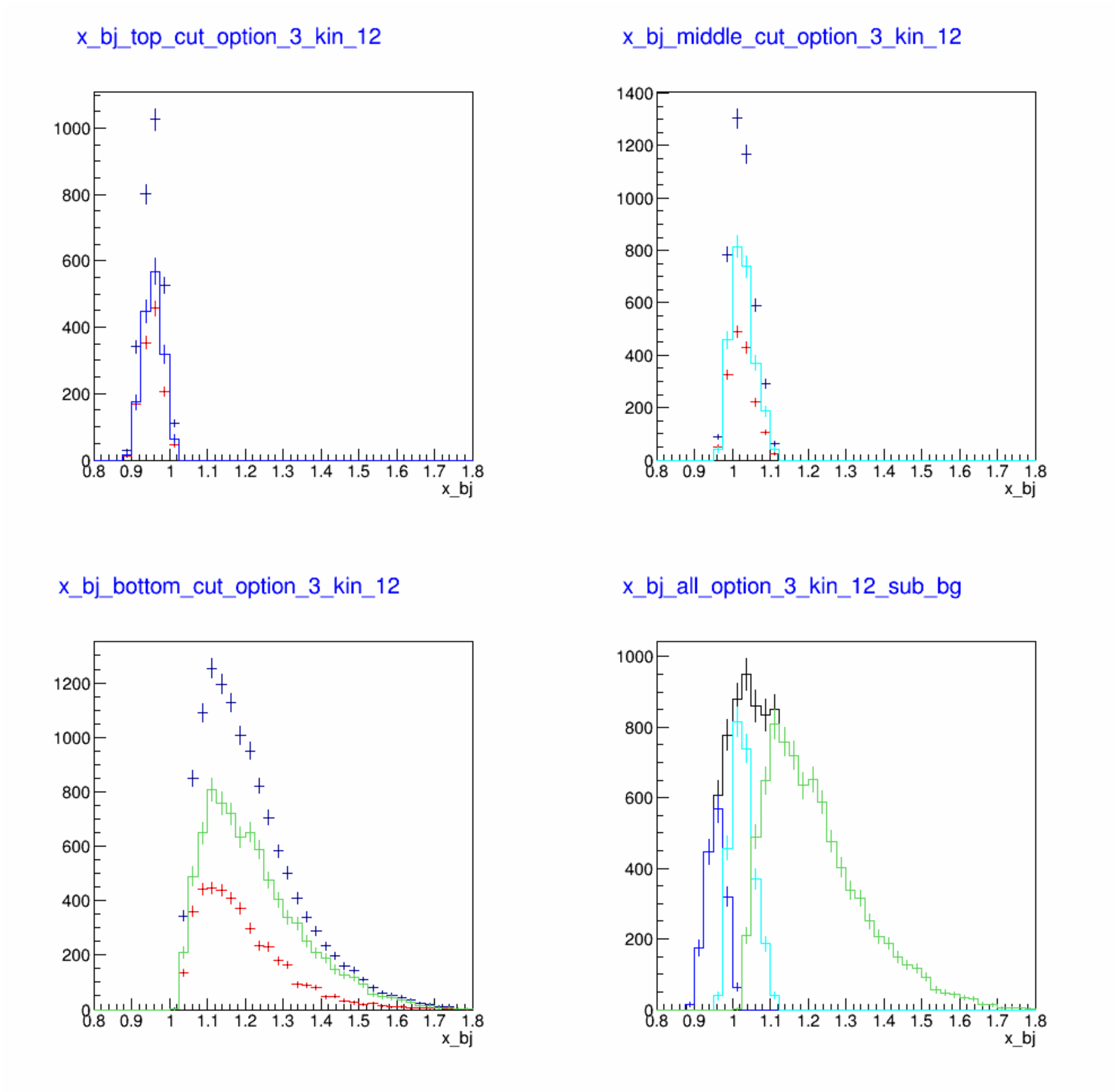

Figure 4: x_bj distribution for all three section
*Top Left: top cut : Omega >= 0.94 – 1.8*y*
*Top Right: middle cut : Omega <= 0.94 – 1.8*y&& Omega >= 0.84 – 1.8*y*
*Bottom Left: lower cut : Omega <= 0.84 – 1.8*y*
Bottom Right: Overlap of all x_bj after background subtracted for each section.

This suggest the data in section 1 (top left) are for Delta/pion production,
the data in section 2 (top right) are for the quasi-elastic proton,
and the data in section 3 (bottom left) are the candidate for the proton/neutron that got knocked out from Np-pair.

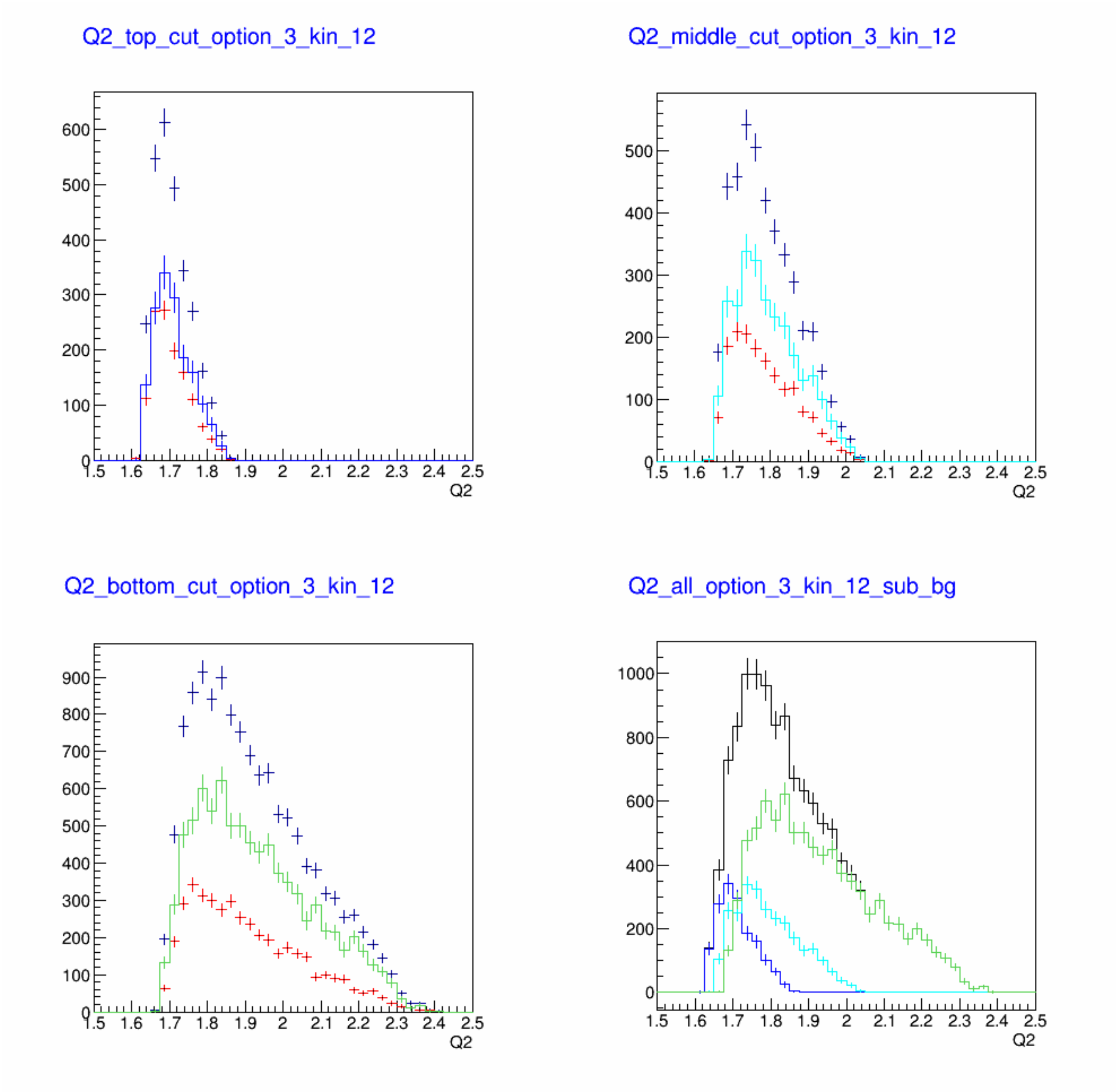

Figure 5: Q2 distribution for all three section
*Top Left: top cut : Omega >= 0.94 – 1.8*y*
*Top Right: middle cut : Omega <= 0.94 – 1.8*y&& Omega >= 0.84 – 1.8*y*
*Bottom Left: lower cut : Omega <= 0.84 – 1.8*y*
Bottom Right: Overlap of all Q2 after background subtracted for each section.

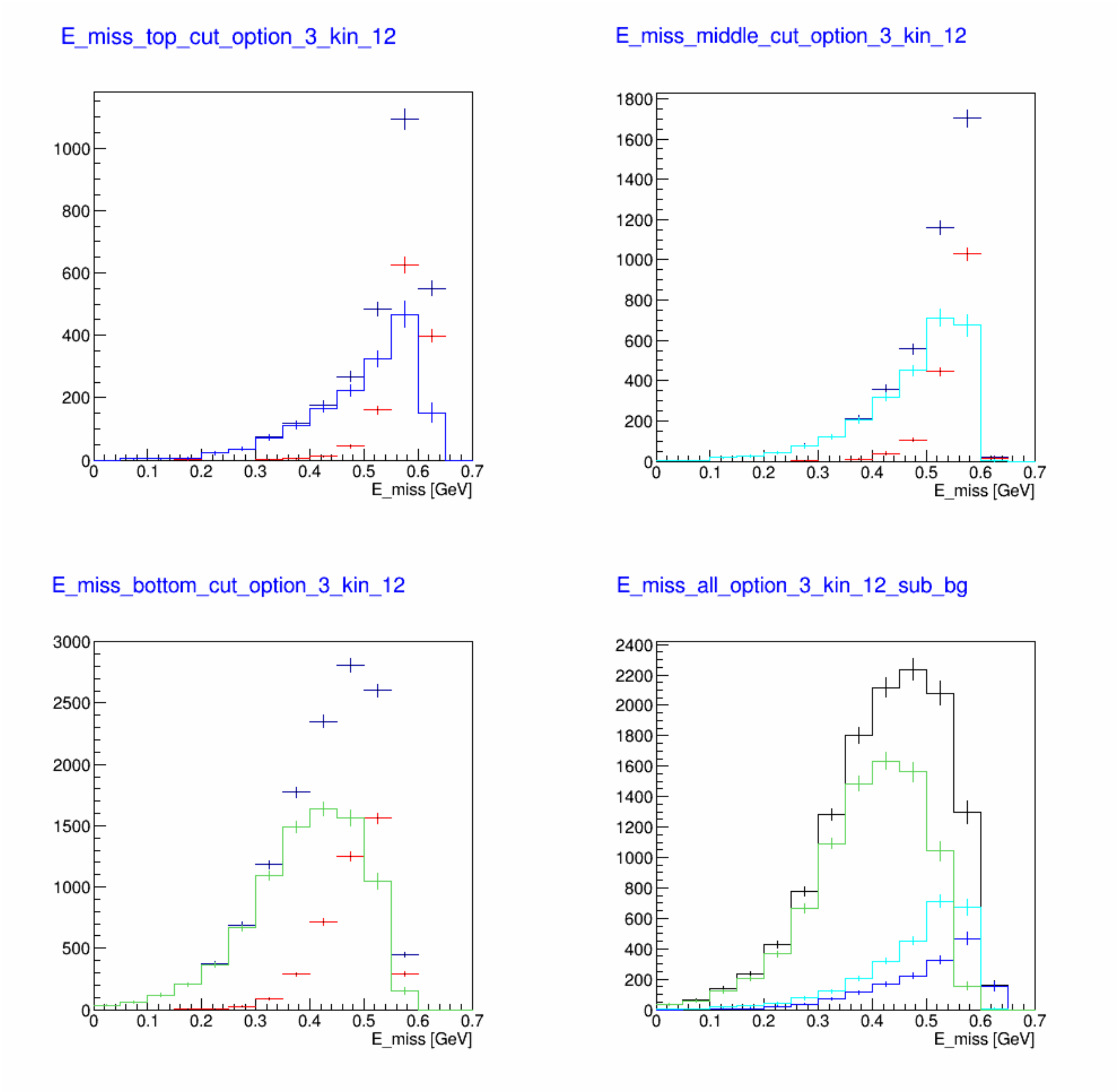

Figure 6: E_miss distribution for all three section
*Top Left: top cut : Omega >= 0.94 – 1.8*y*
*Top Right: middle cut : Omega <= 0.94 – 1.8*y&& Omega >= 0.84 – 1.8*y*
*Bottom Left: lower cut : Omega <= 0.84 – 1.8*y*
Bottom Right: Overlap of all E_miss after background subtracted for each section.

The two section (top left and top right) eliminate most of the higher missing Energy.
We are not able to see the clear separation as what you can see in Peter's case.

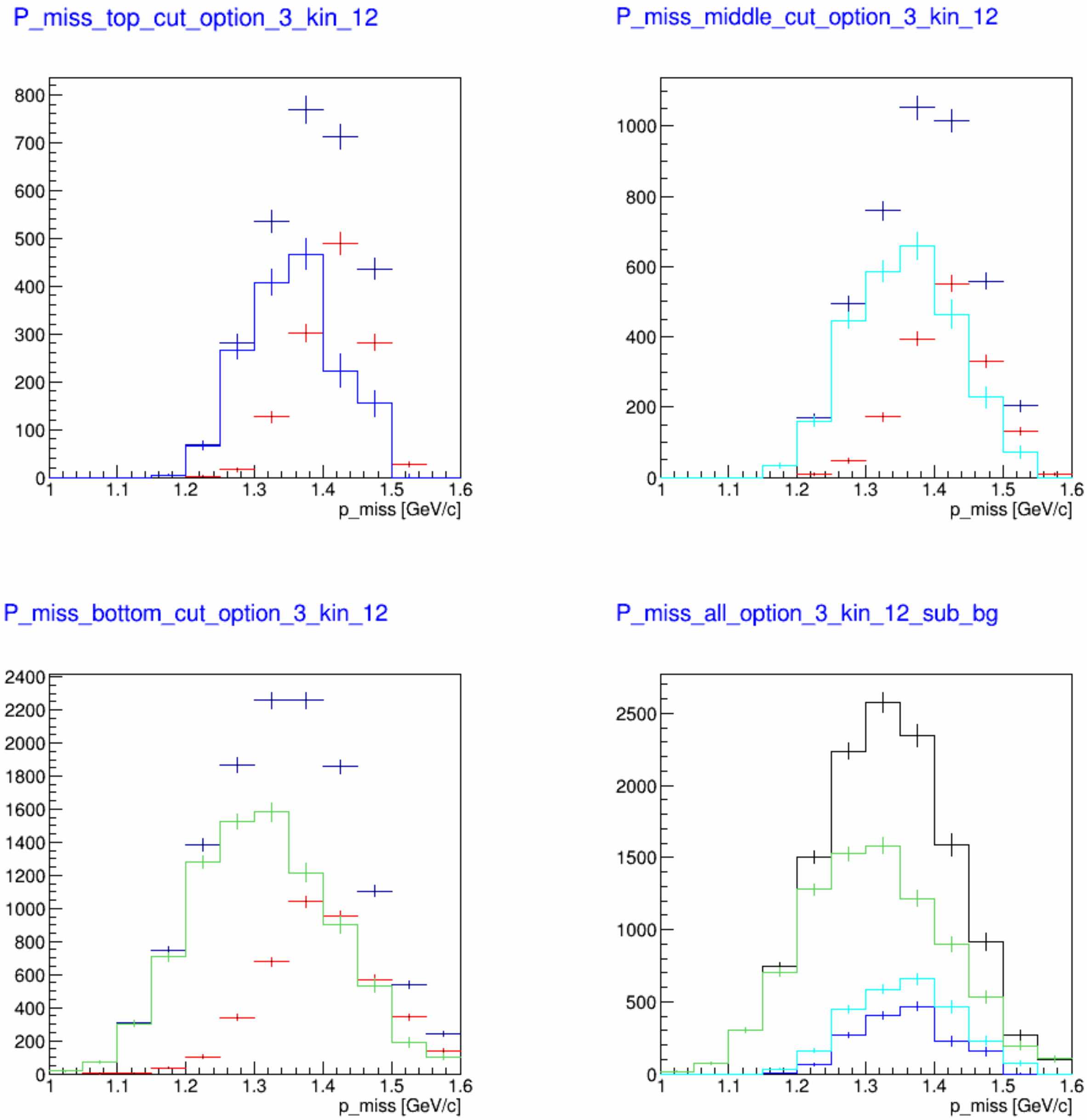

Figure 7: p_miss distribution for all three section
*Top Left: top cut : Omega >= 0.94 – 1.8*y*
*Top Right: middle cut : Omega <= 0.94 – 1.8*y&& Omega >= 0.84 – 1.8*y*
*Bottom Left: lower cut : Omega <= 0.84 – 1.8*y*
Bottom Right: Overlap of all p_miss after background subtracted for each section.

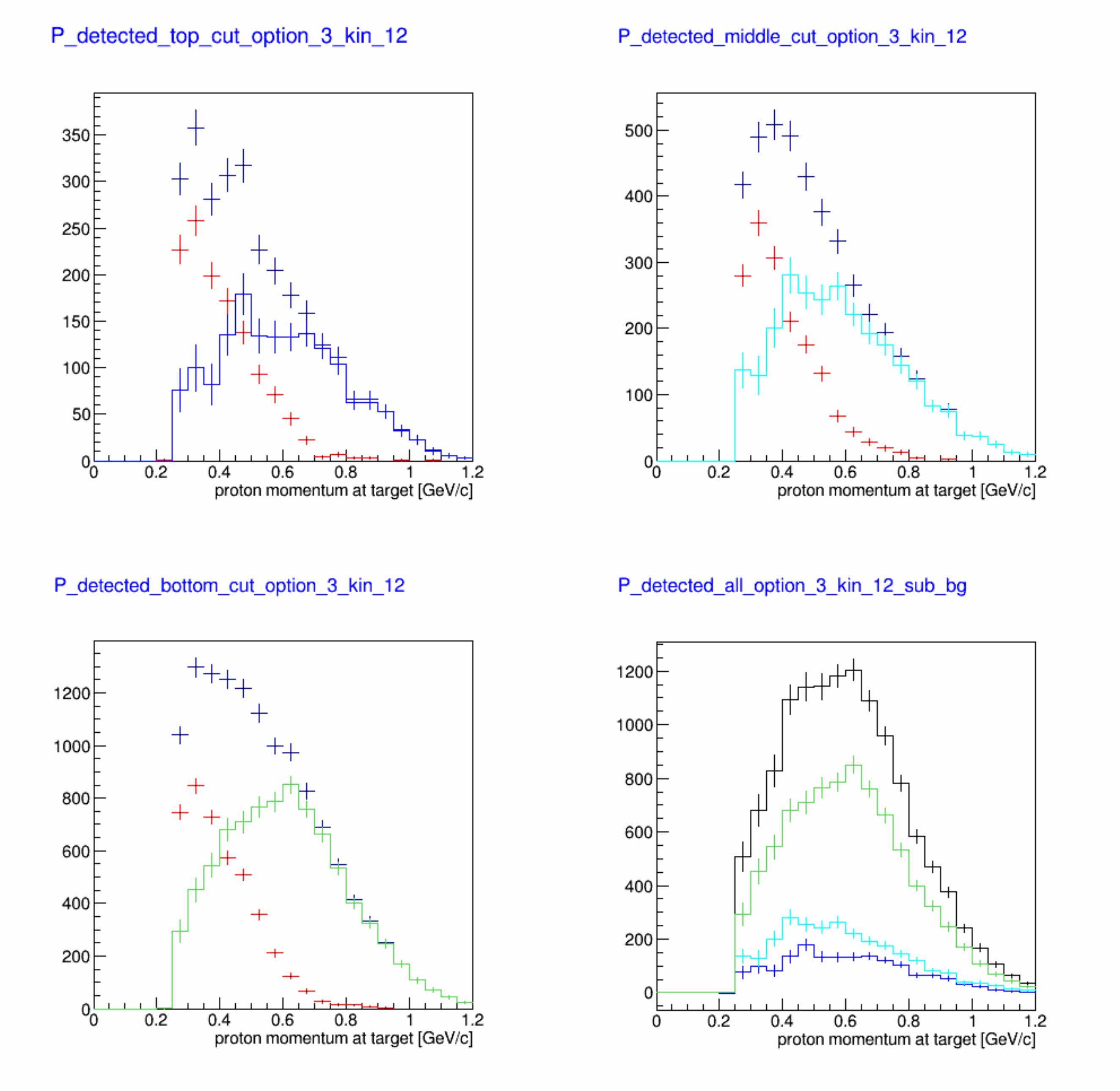

Figure 8: p_detected at target distribution for all three section
*Top Left: top cut : Omega >= 0.94 – 1.8*y*
*Top Right: middle cut : Omega <= 0.94 – 1.8*y&& Omega >= 0.84 – 1.8*y*
*Bottom Left: lower cut : Omega <= 0.84 – 1.8*y*
Bottom Right: Overlap of all p_detected after background subtracted for each section.

The uncertainty of the cut will later be studied.