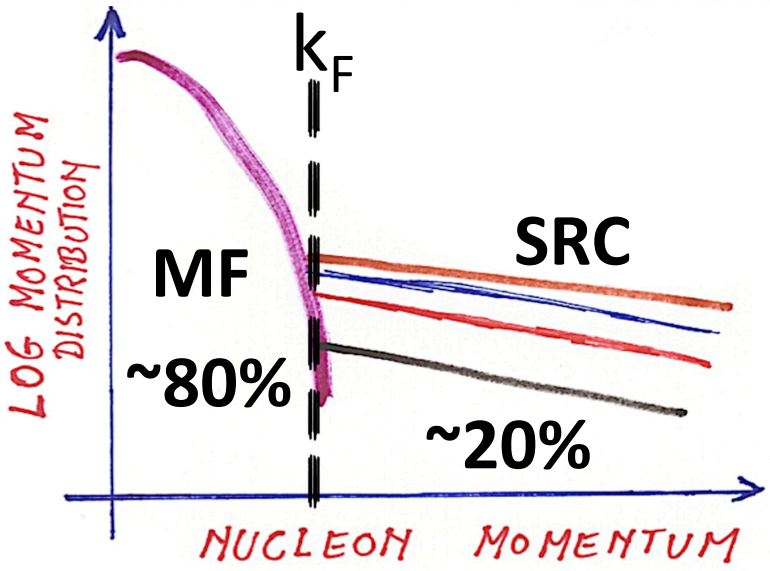
Probing 2N-SRC via (e,e'N) reactions off ^{3,4}He and ^{12}C targets

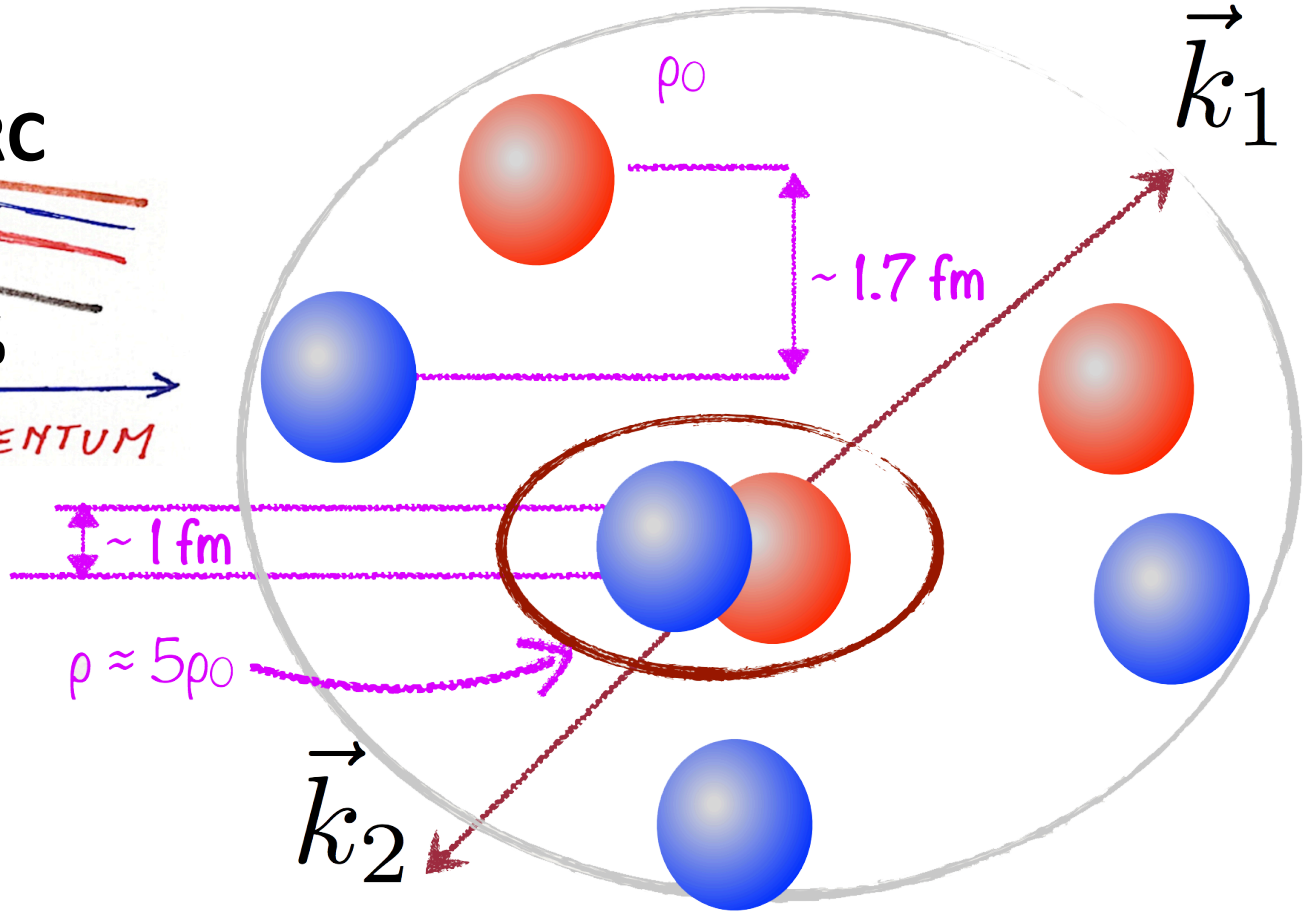
Reynier Cruz Torres

CLAS Collaboration Meeting

March 8, 2018

SRC-101



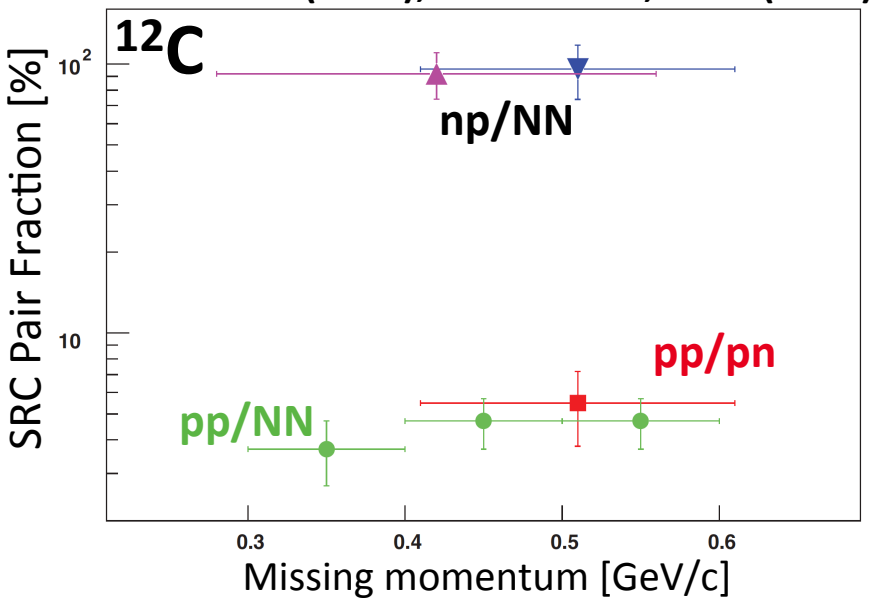


Majority = most abundant nucleon species in an asymmetric nucleus

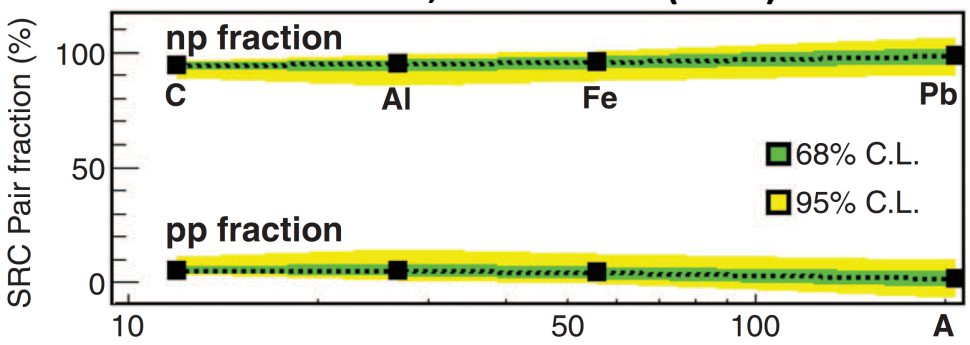
Minority = least abundant nucleon species in an asymmetric nucleus

np-dominance and asymmetric nuclei

PRL 162504 (2006); Science 320, 1476 (2008)

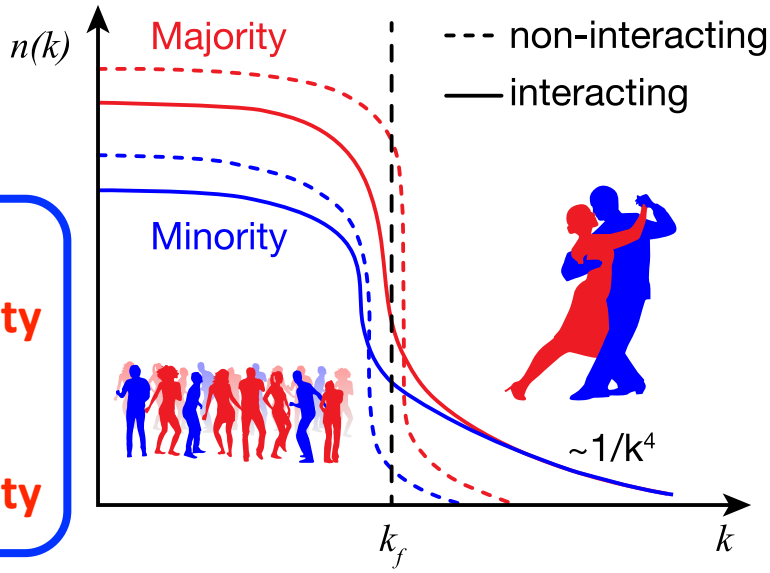


Hen et al., Science 346 (2014)



Pauli principle: $\langle T \rangle_{Minority} < \langle T \rangle_{Majority}$

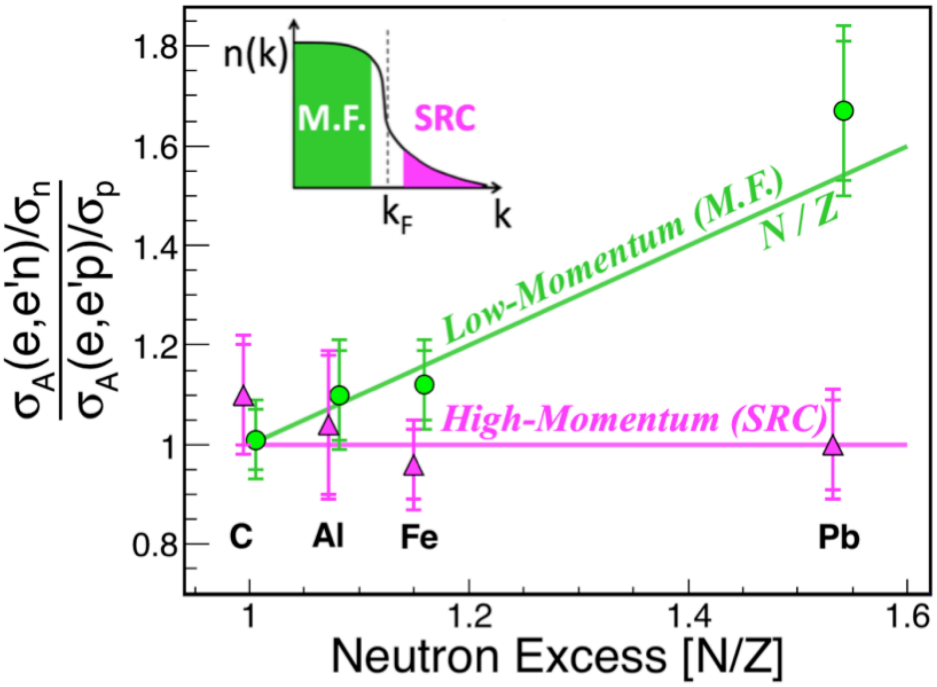
np correlations: $\langle T \rangle_{Minority} ? \langle T \rangle_{Majority}$

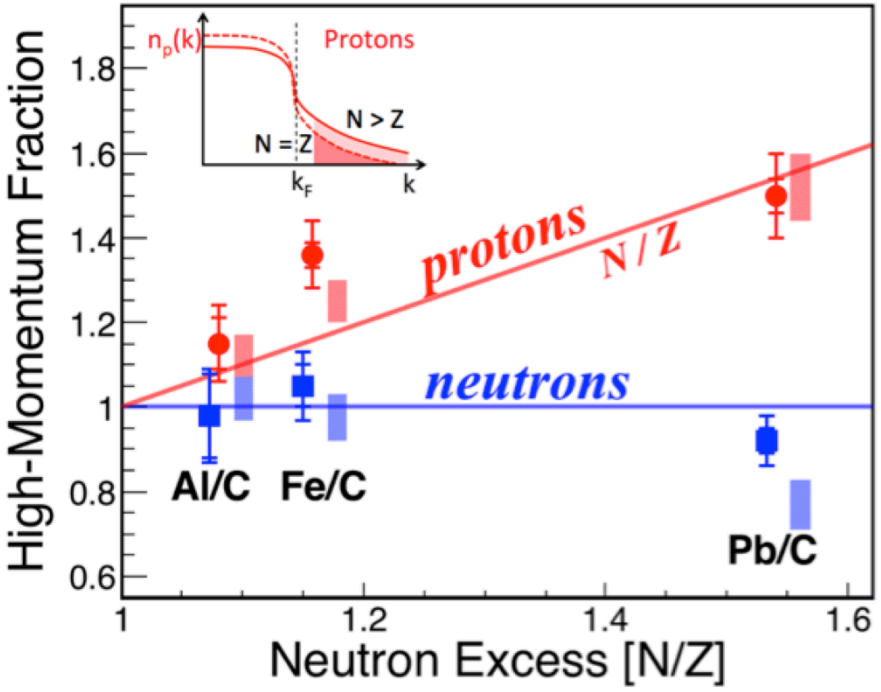


Possible inversion of the momentum sharing

Results in heavy nuclei

Analysis by Meytal Duer (EG2 data)

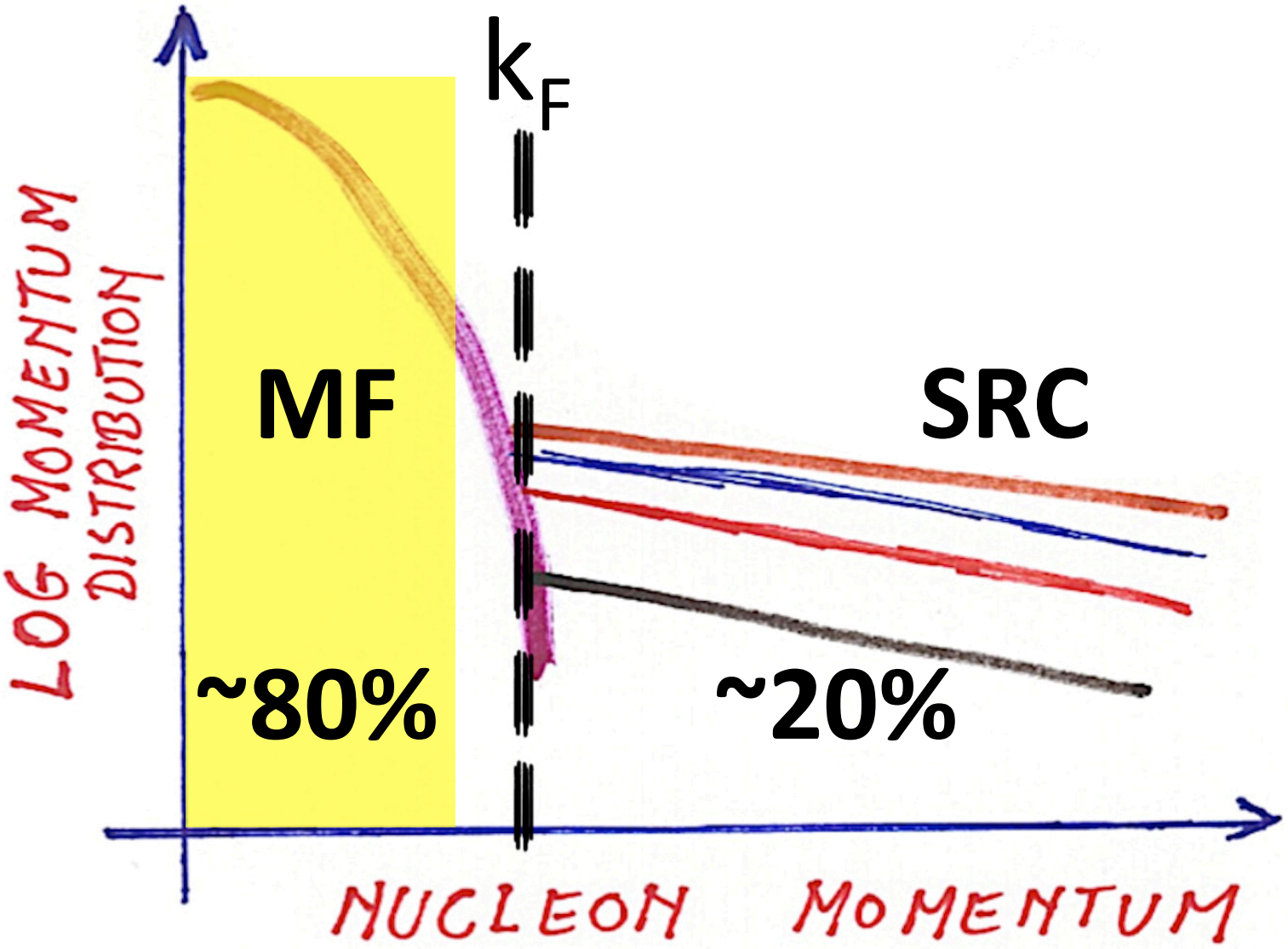




Minority moves faster than majority in heavy nuclei!

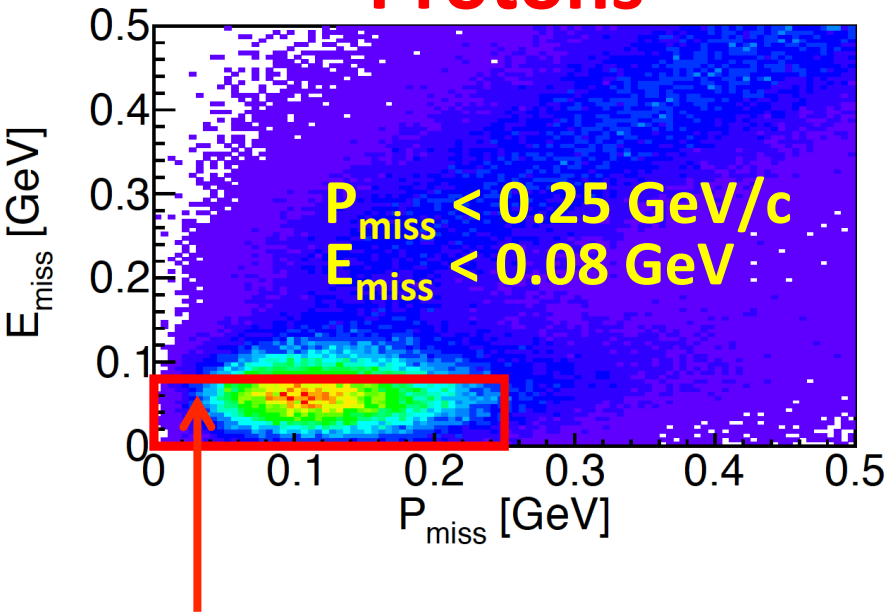
Same goal for this analysis, this time on ^{3,4}He and ^{12}C, E_{beam} = 4.4 GeV (*i.e.* e2a data)

Identifying M.F. QE events



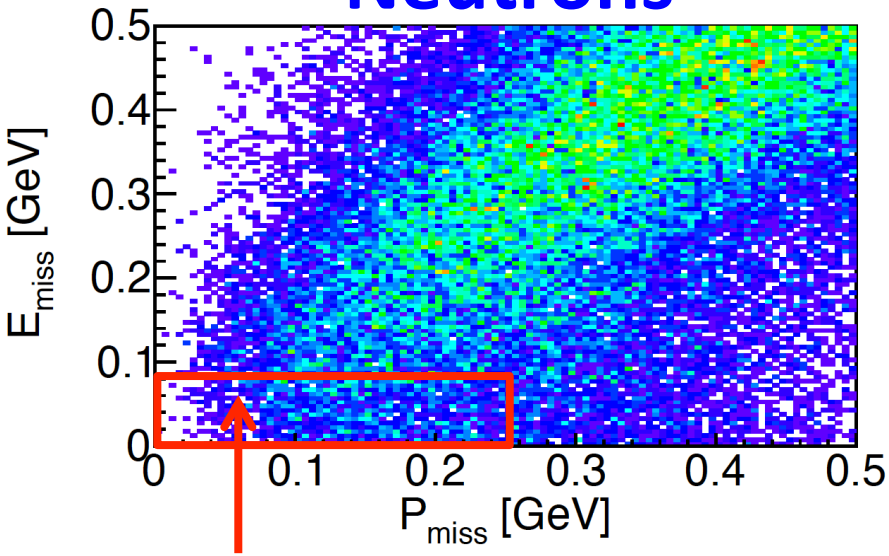
Identifying M.F. QE events

Protons



Quasi-Elastic (QE) peak

Neutrons



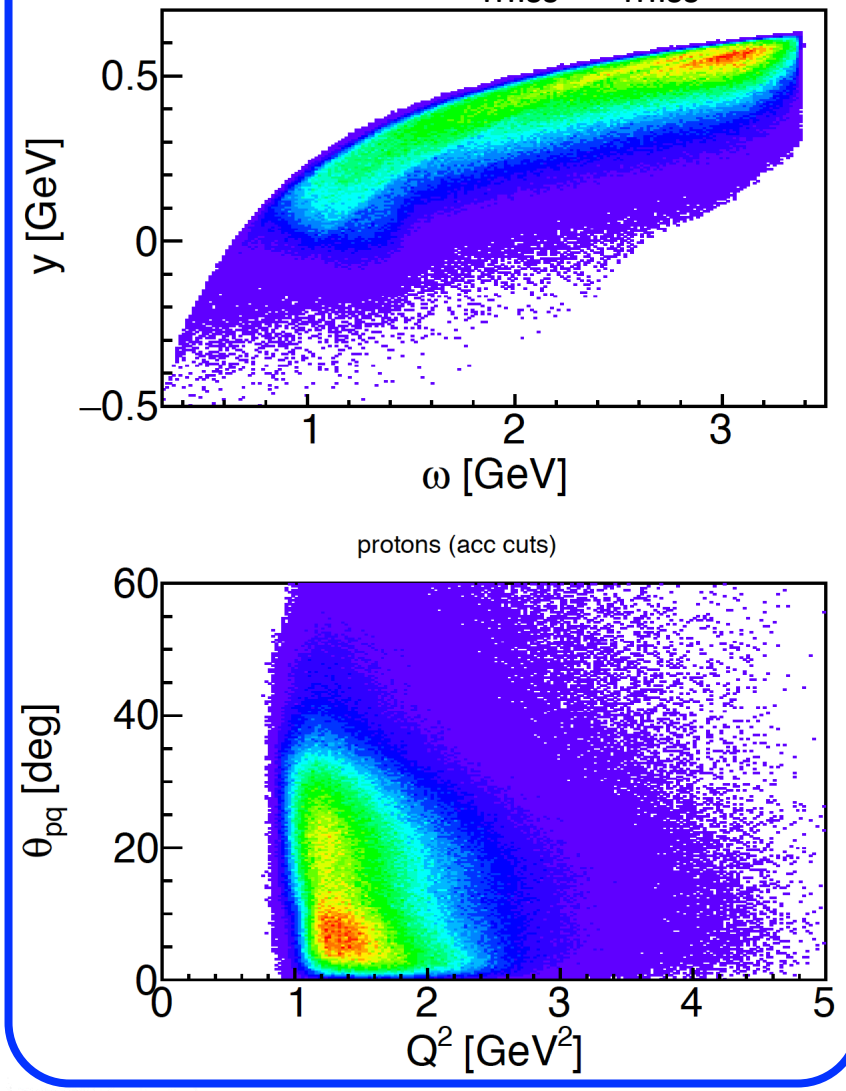
Problem: QE peak washed out by poor EC momentum resolution.

Solution:

- Apply cuts more suitable for the identification of QE events.
- Smear proton momentum with the EC momentum resolution.
- Use information about un-smeared and smeared protons as an equivalent to knocked-out and reconstructed neutrons respectively

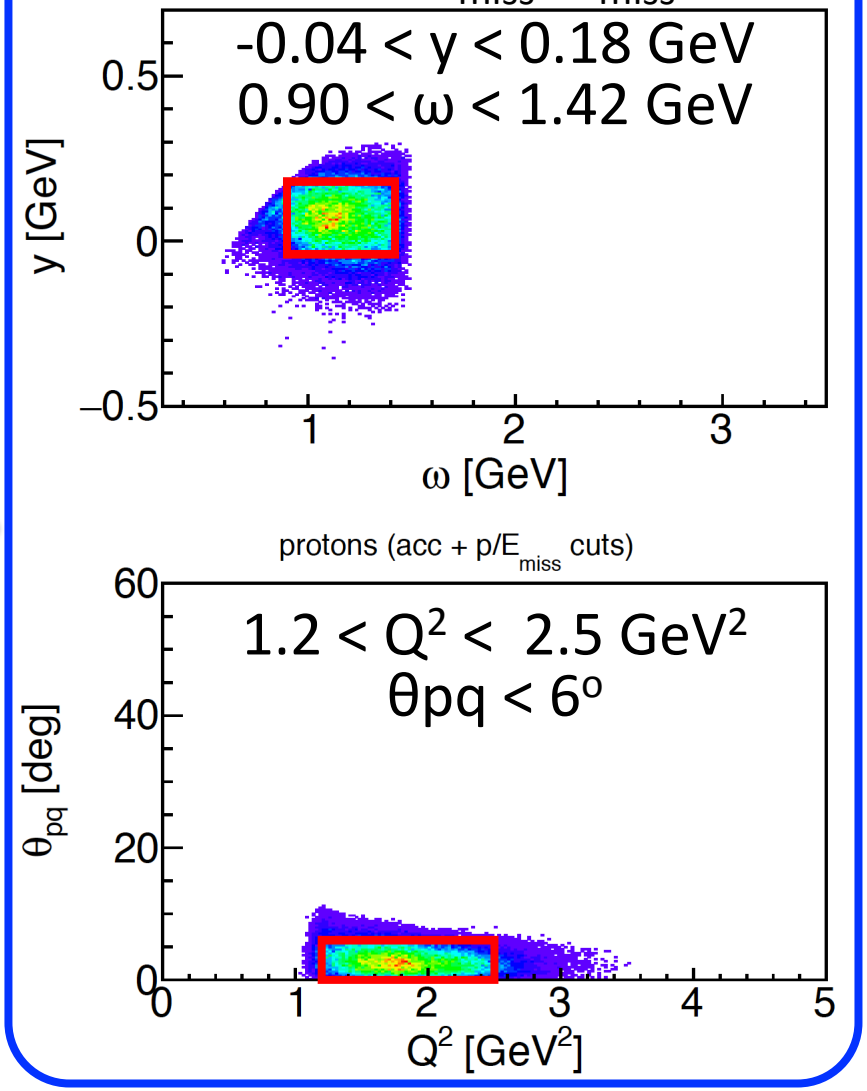
Identifying M.F. QE events

Protons before E_{miss}, P_{miss} cuts



E_{miss}, P_{miss} cuts

Protons after E_{miss}, P_{miss} cuts



Identifying M.F. QE events

P_{miss}, E_{miss} distributions with cuts:

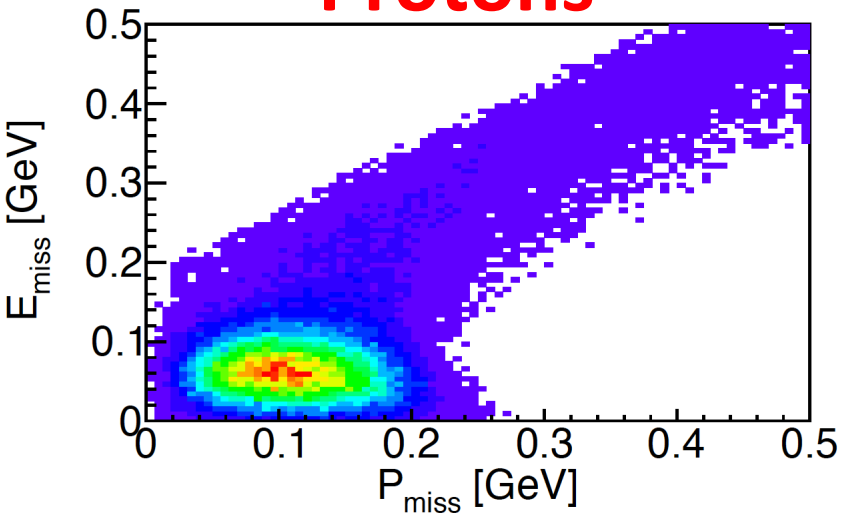
$-0.04 < y < 0.18$ GeV

$0.90 < \omega < 1.42$ GeV

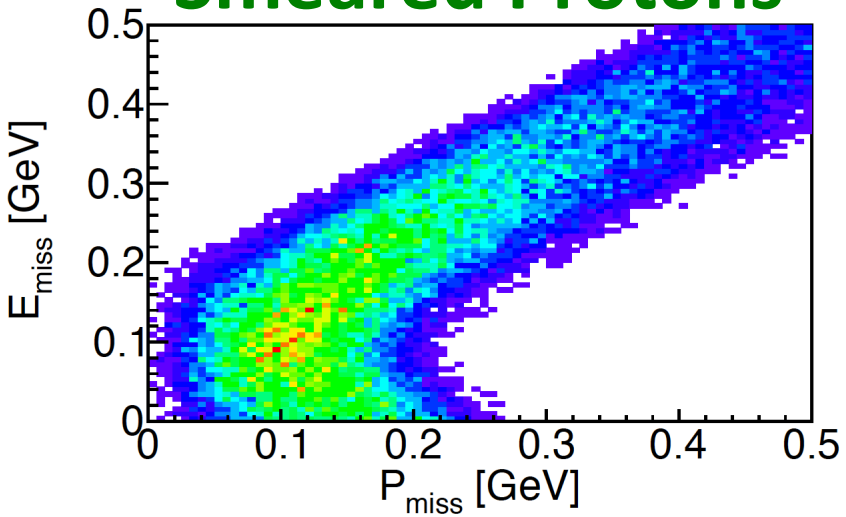
$1.2 < Q^2 < 2.5$ GeV^2

$\theta pq < 6^o$

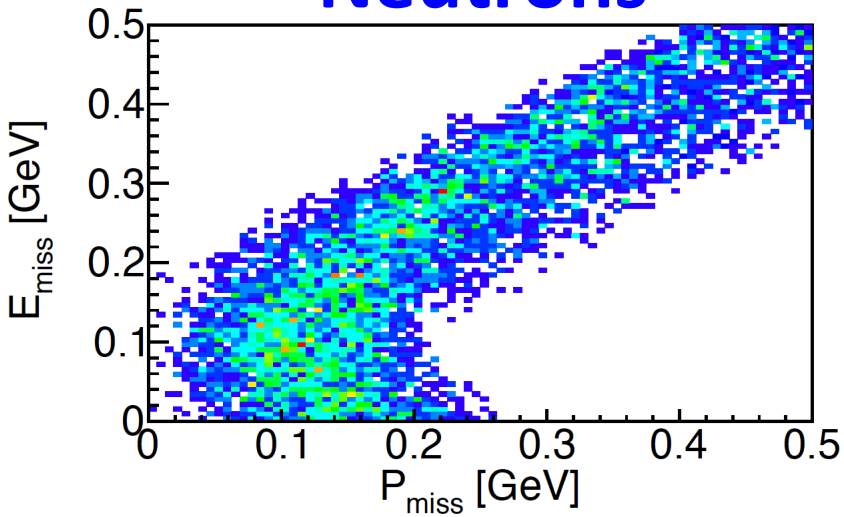
Protons



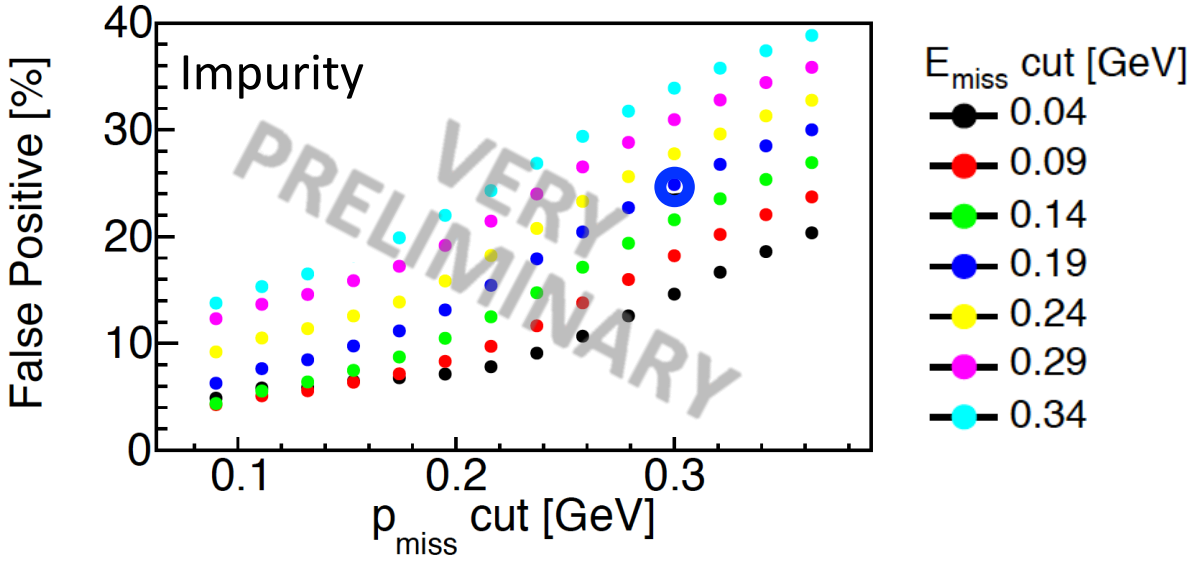
Smeared Protons

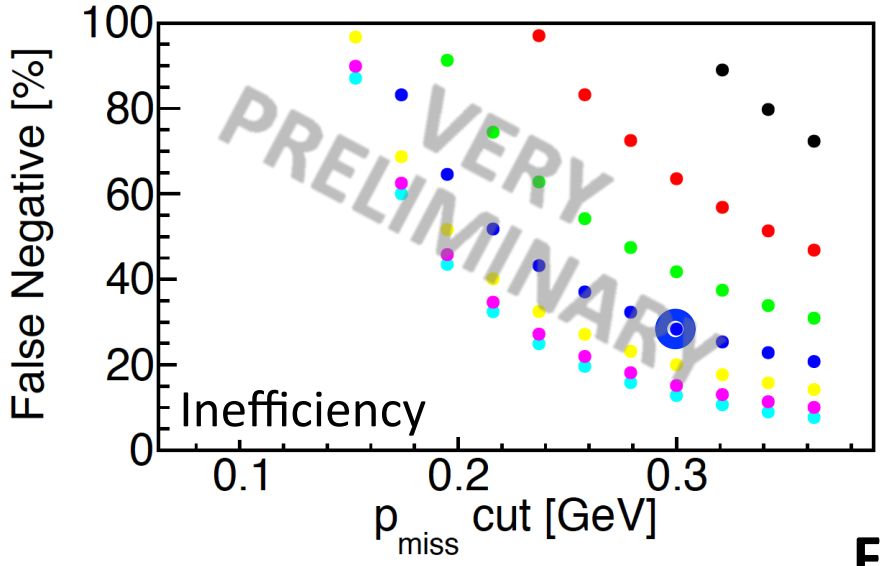


Neutrons



Identifying M.F. QE events



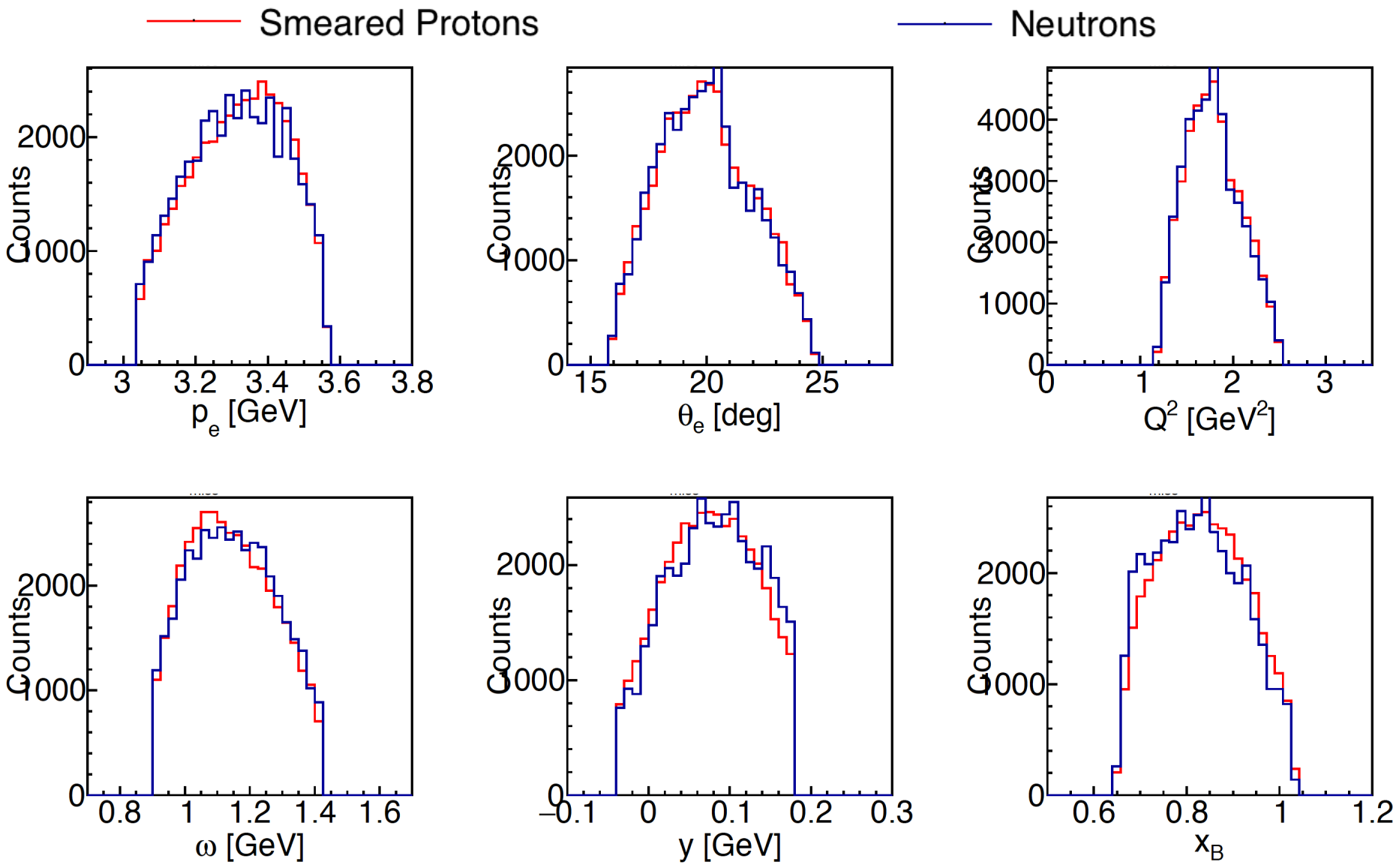


smeared p/n cuts:
$P_{miss} < 0.3$ GeV/c
$E_{miss} < 0.19$ GeV

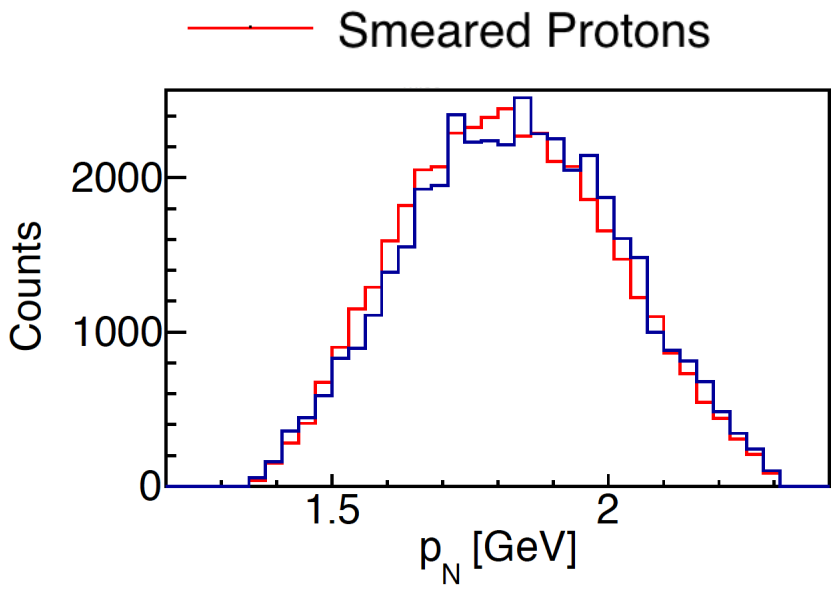
un-smeared p cuts:
$P_{miss} < 0.25$ GeV/c
$E_{miss} < 0.08$ GeV

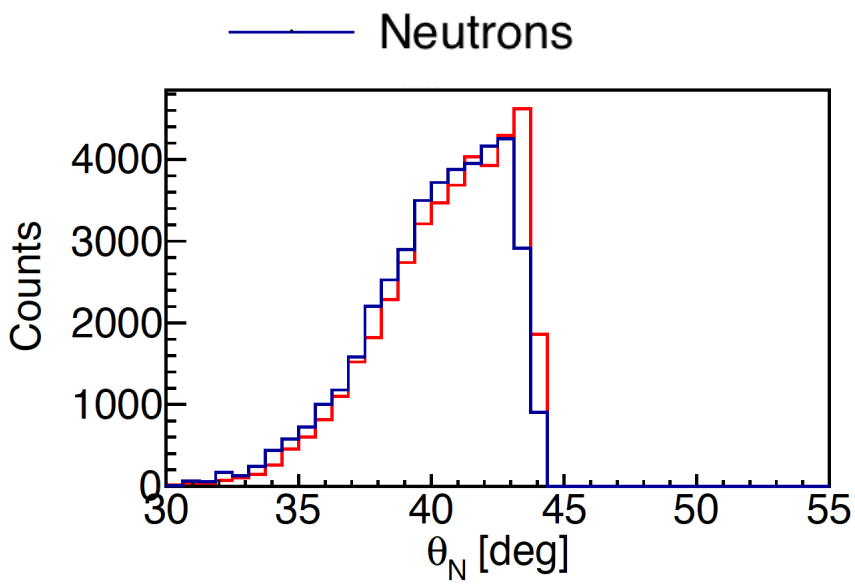
False Positive ≈ False Negative ≈ 25%

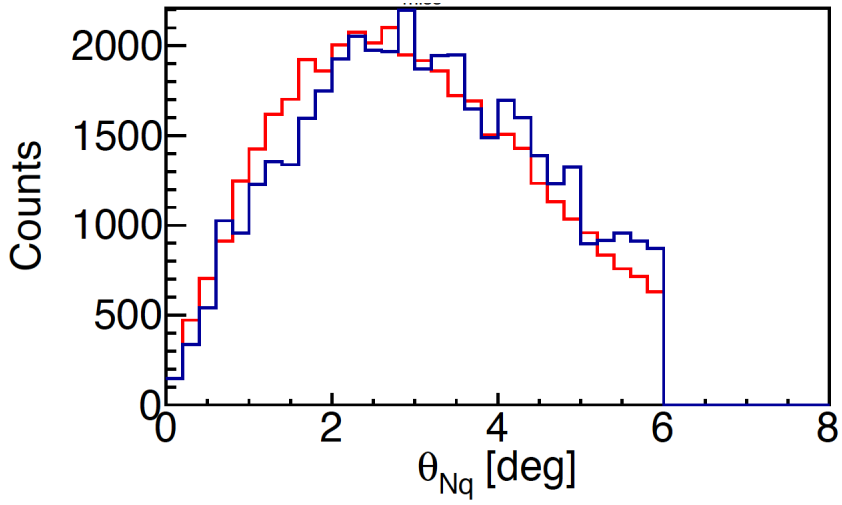
Comparing smeared protons and neutrons (MF)

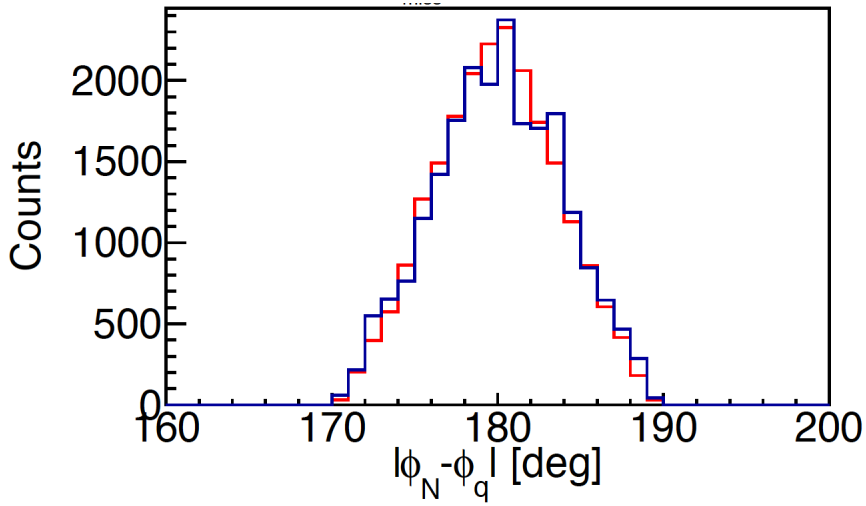


Comparing smeared protons and neutrons (MF)



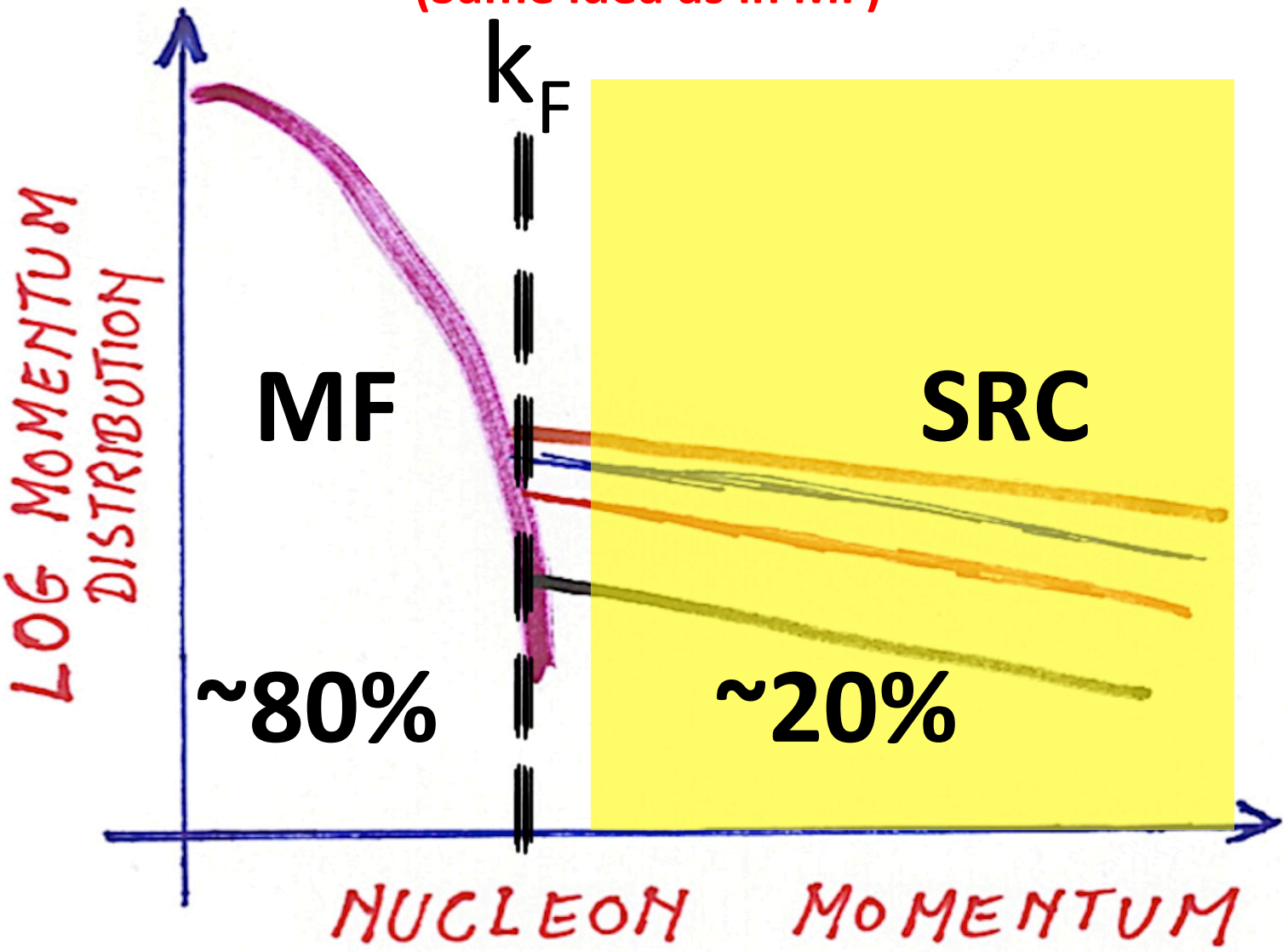




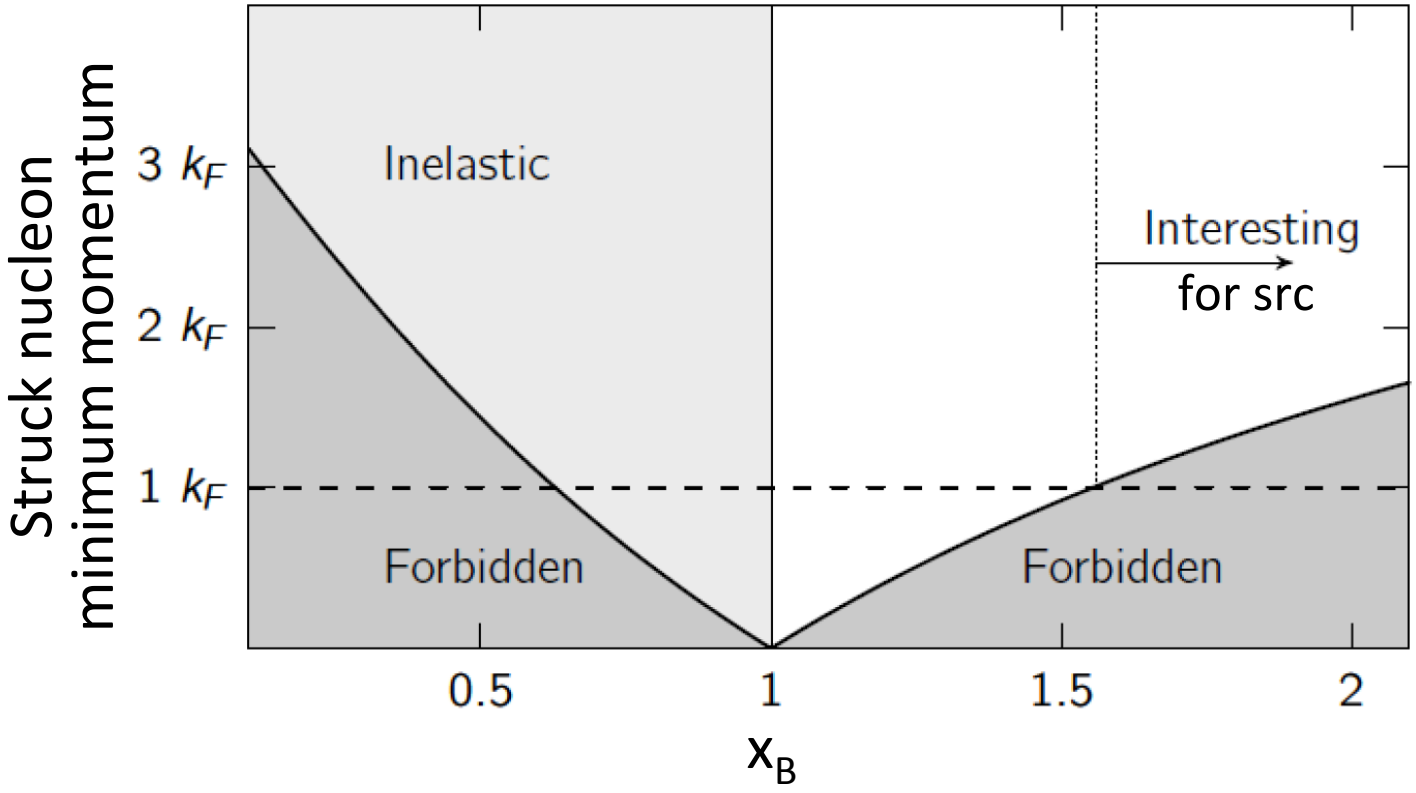


Identifying SRC QE events

(Same idea as in MF)



Identifying SRC QE events

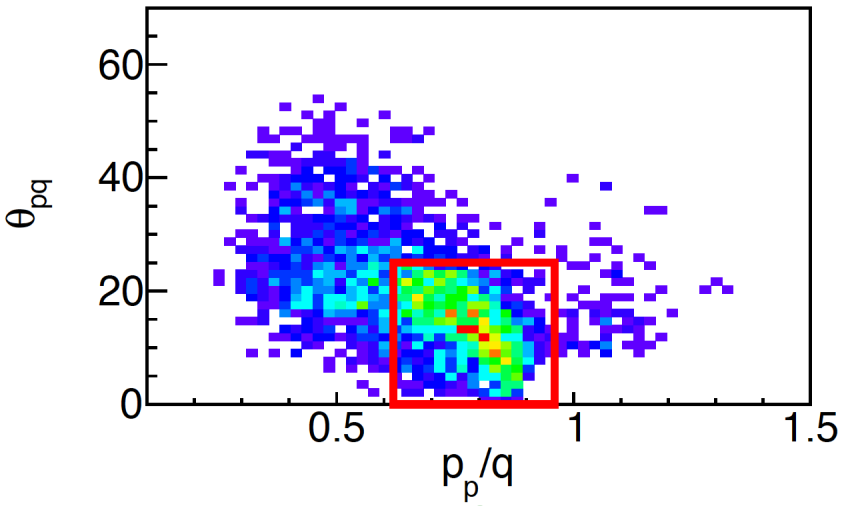


Un-smeared protons:
$x_B > 1.2$

Smeared protons/neutrons:
$x_B > 1.1$

Identifying SRC QE events

Protons



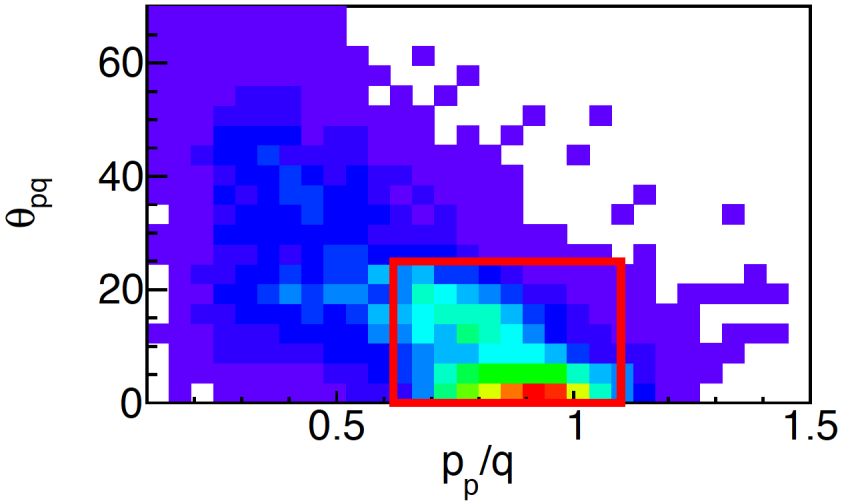
Leading hadron cuts:

$\theta_{Nq} < 25^o$

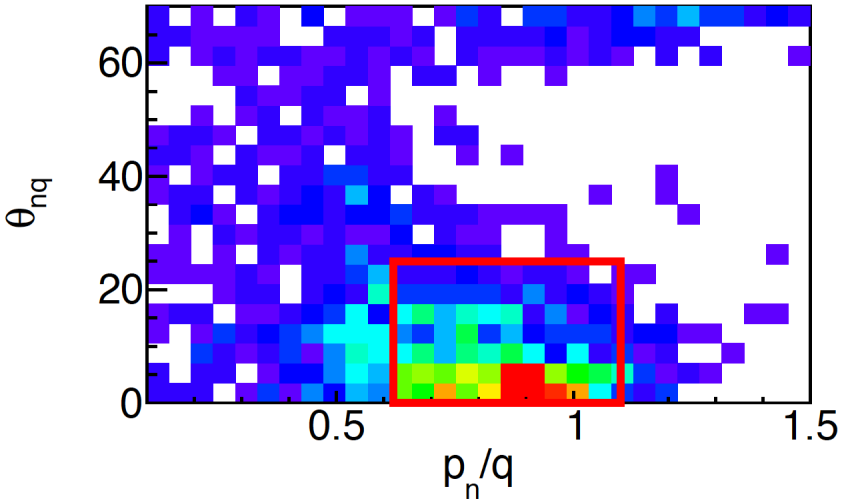
Un-smeared protons:
$0.62 < p/q < 0.96$ GeV

Smeared protons/neutrons:
$0.62 < p/q < 1.10$ GeV

Smeared Protons

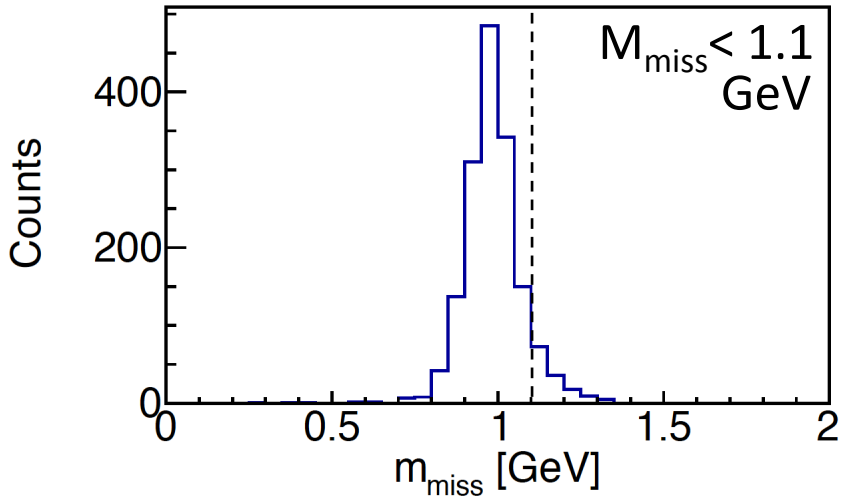


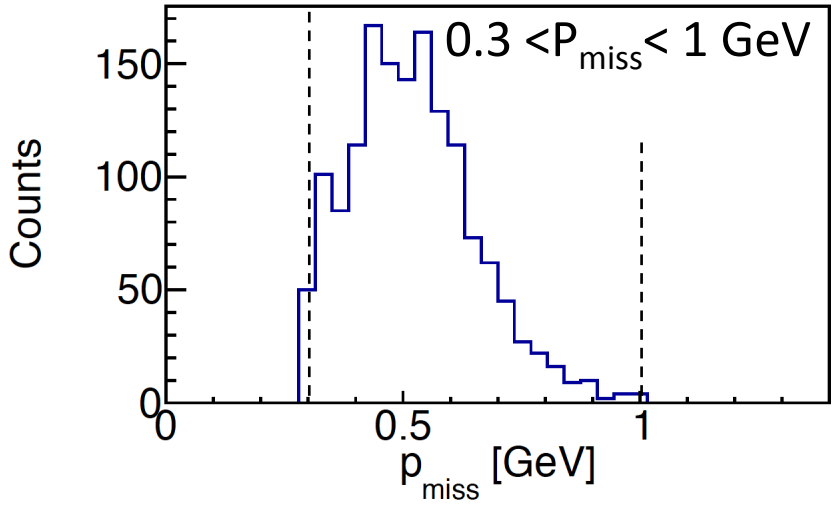
Neutrons



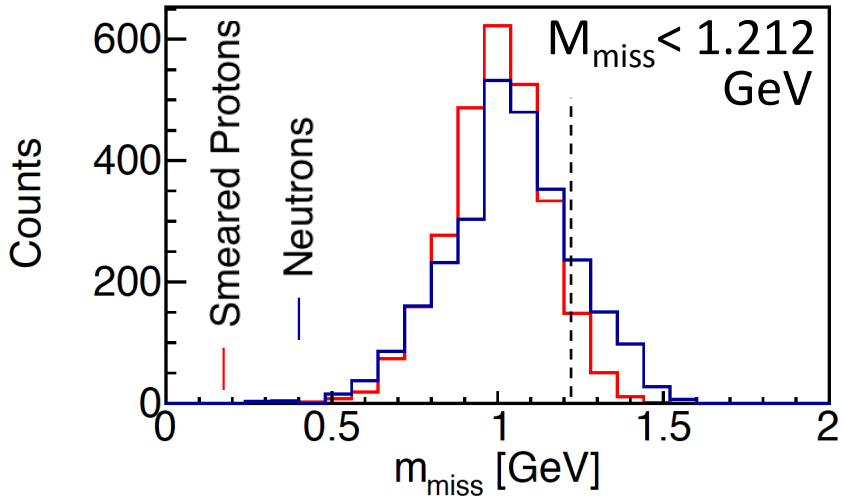
Identifying SRC QE events

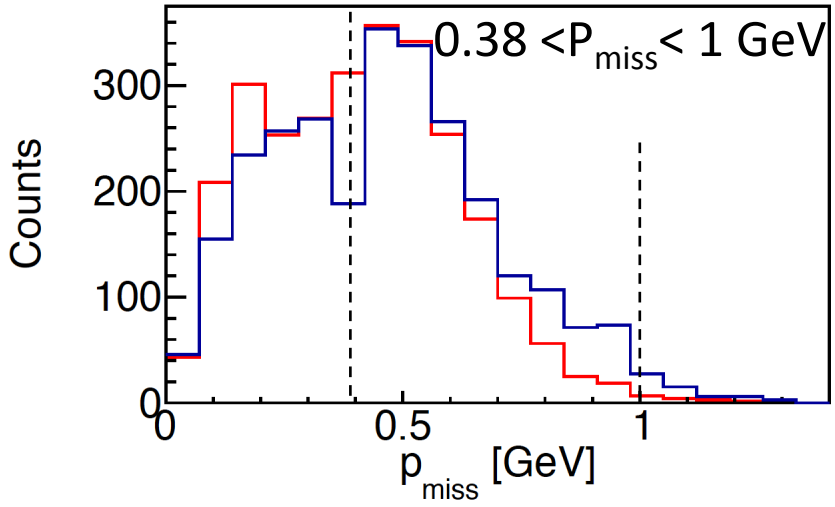
Protons



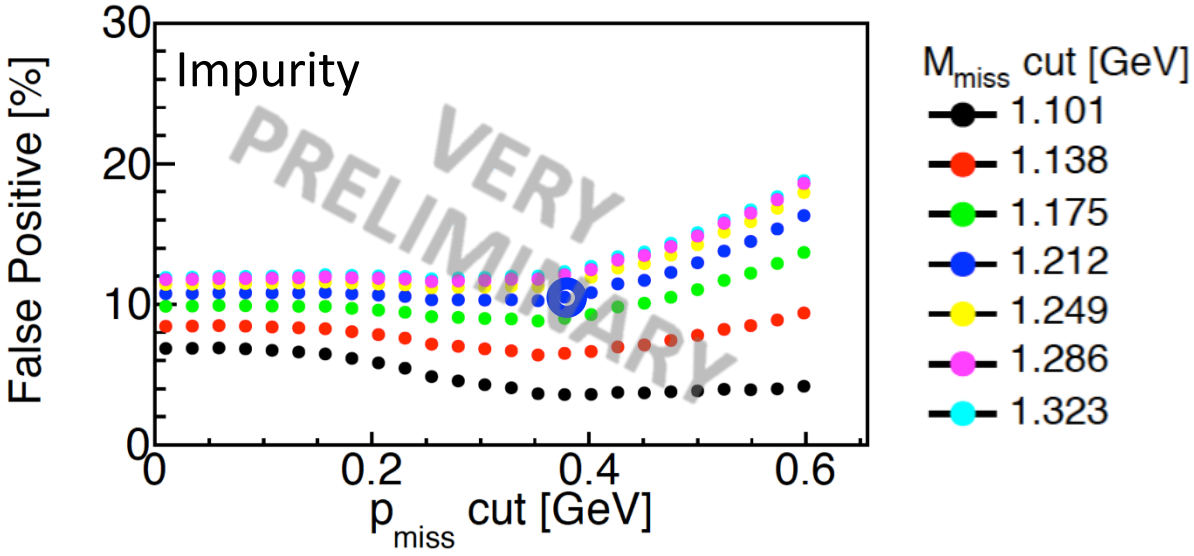


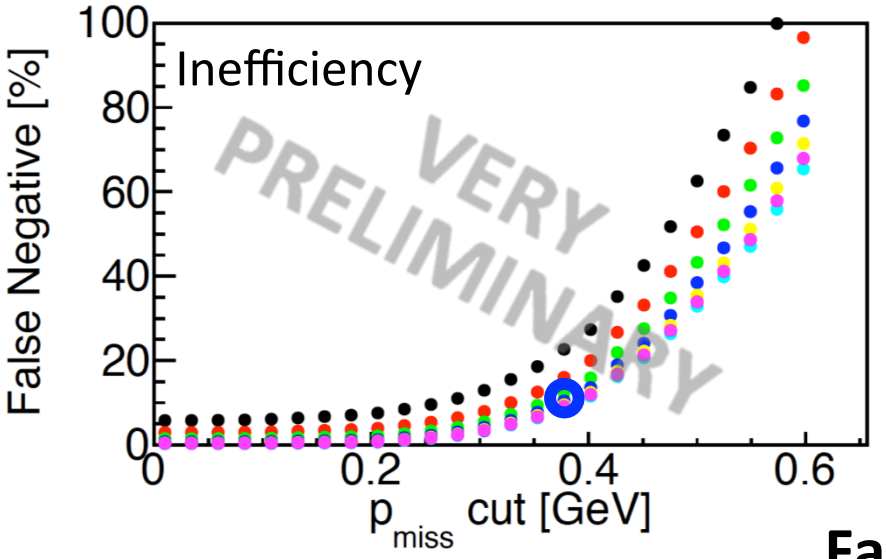
Smeared protons/neutrons





Identifying SRC QE events



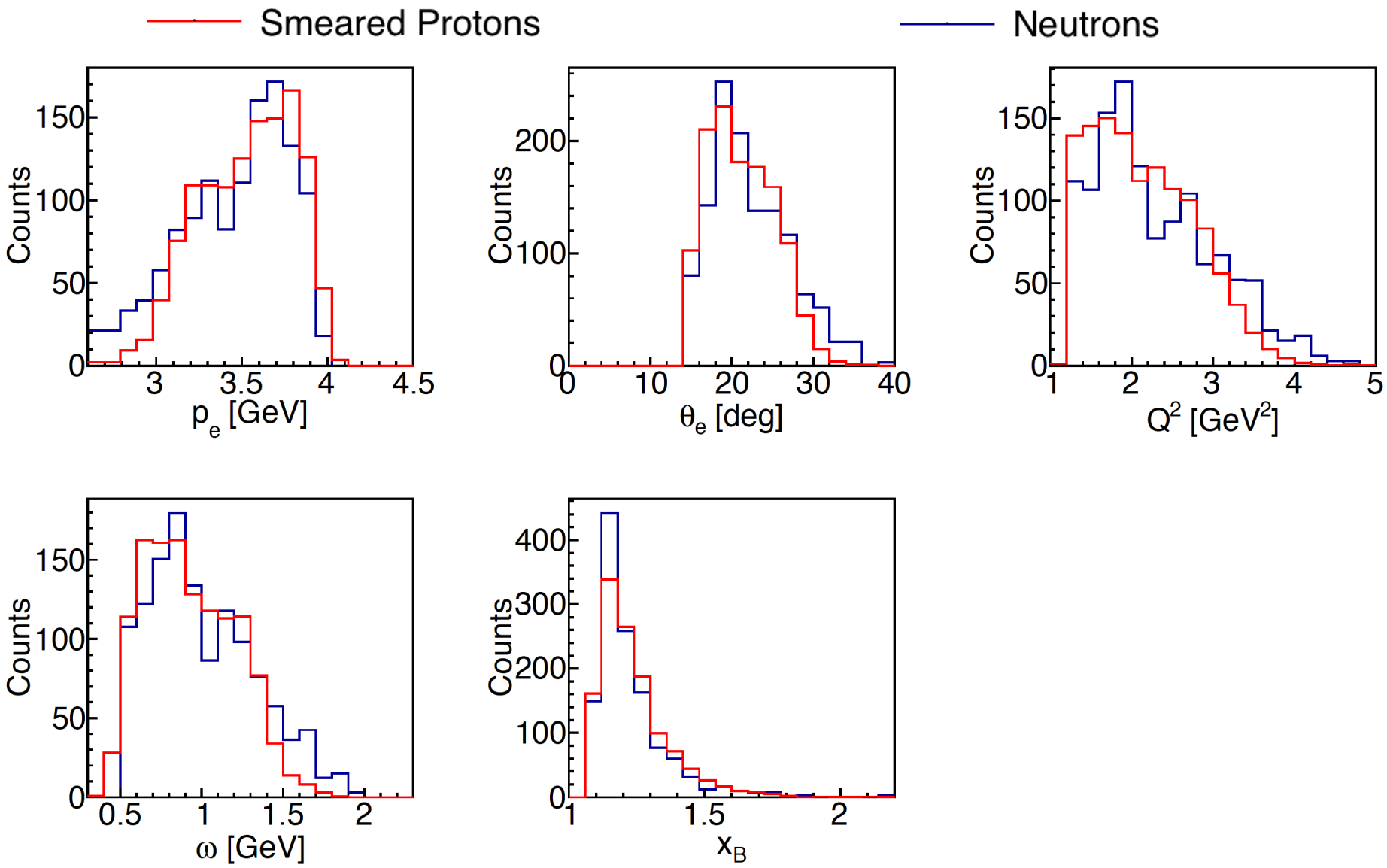


smeared p/n cuts:
$P_{miss} > 0.3775$ GeV/c
$M_{miss} < 1.212$ GeV

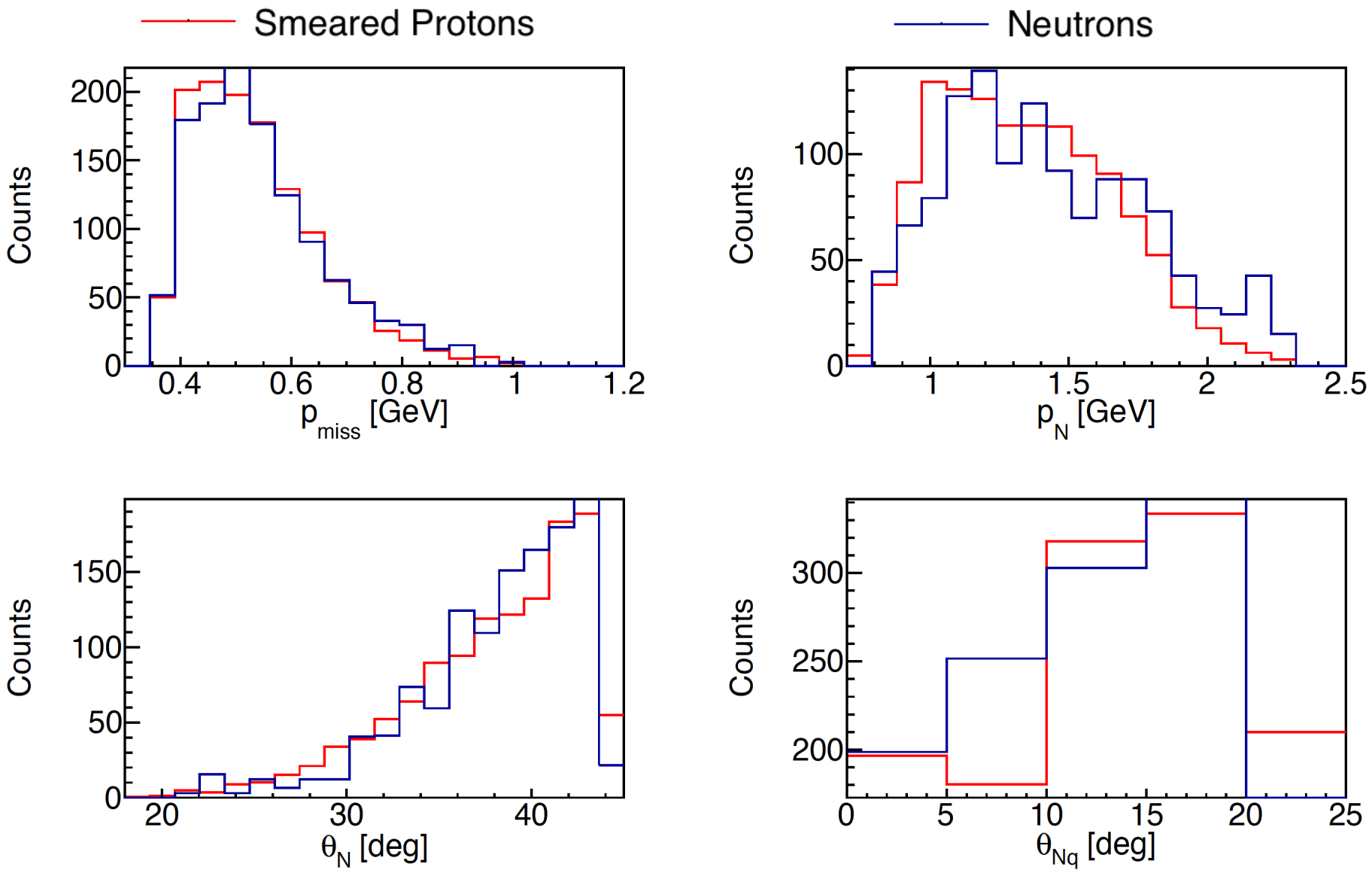
un-smeared p cuts:
$P_{miss} > 0.3$ GeV/c
$M_{miss} < 1.1$ GeV

False Positive ≈ False Negative ≈ 10.5%

Comparing smeared protons and neutrons (SRC)



Comparing smeared protons and neutrons (SRC)



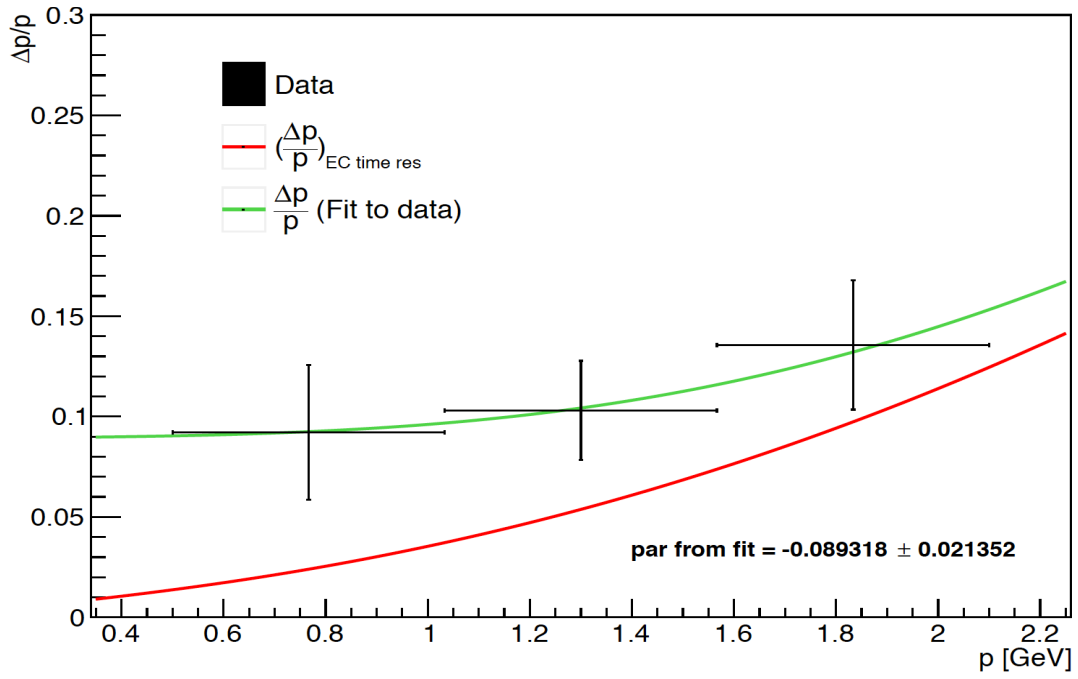
Next Steps

- Calculate and apply e2a proton acceptance/ efficiency maps
- Perform sensitivity study for event selection cuts
- Compare σ(e,e'p)/σ(e,e'n) from data and theoretical calculations as a sanity check
- Extract A(e,e'N)/^{12}C(e,e'N) ratios to benchmark this analysis with Meytal Duer's (EG2)
- Extract A(e,e'n)/A(e,e'p) ratios
- Extract [A(e,e'N) high/low]/[^{12}C(e,e'N) high/low] ratios

Thank you!

Backup slides

Smearing proton momentum



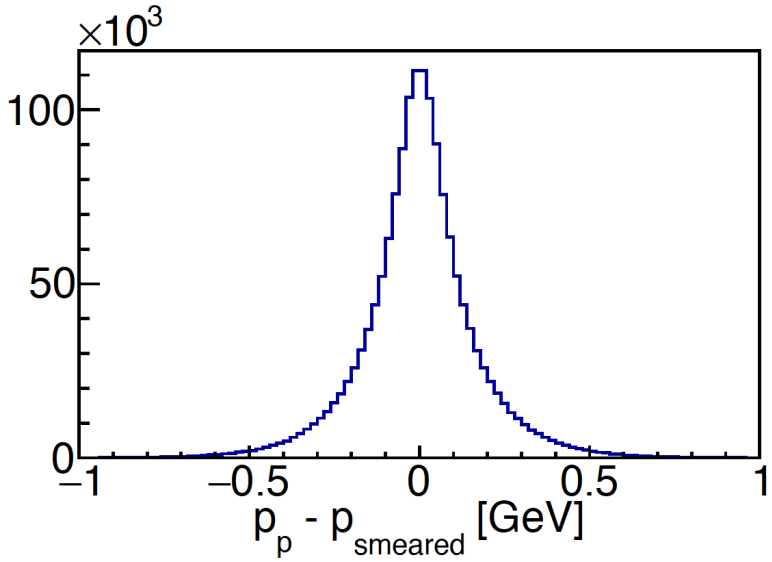
$$\left(\frac{\Delta p}{p}\right)_{EC\ time\ res} = \frac{p}{m_n^2}\sqrt{m_n^2+p^2}\,\frac{\delta t}{x}$$

$$\frac{\Delta p}{p} = \sqrt{\left(\frac{\Delta p}{p}\right)^2_{EC\ time\ res} + (par)^2}$$

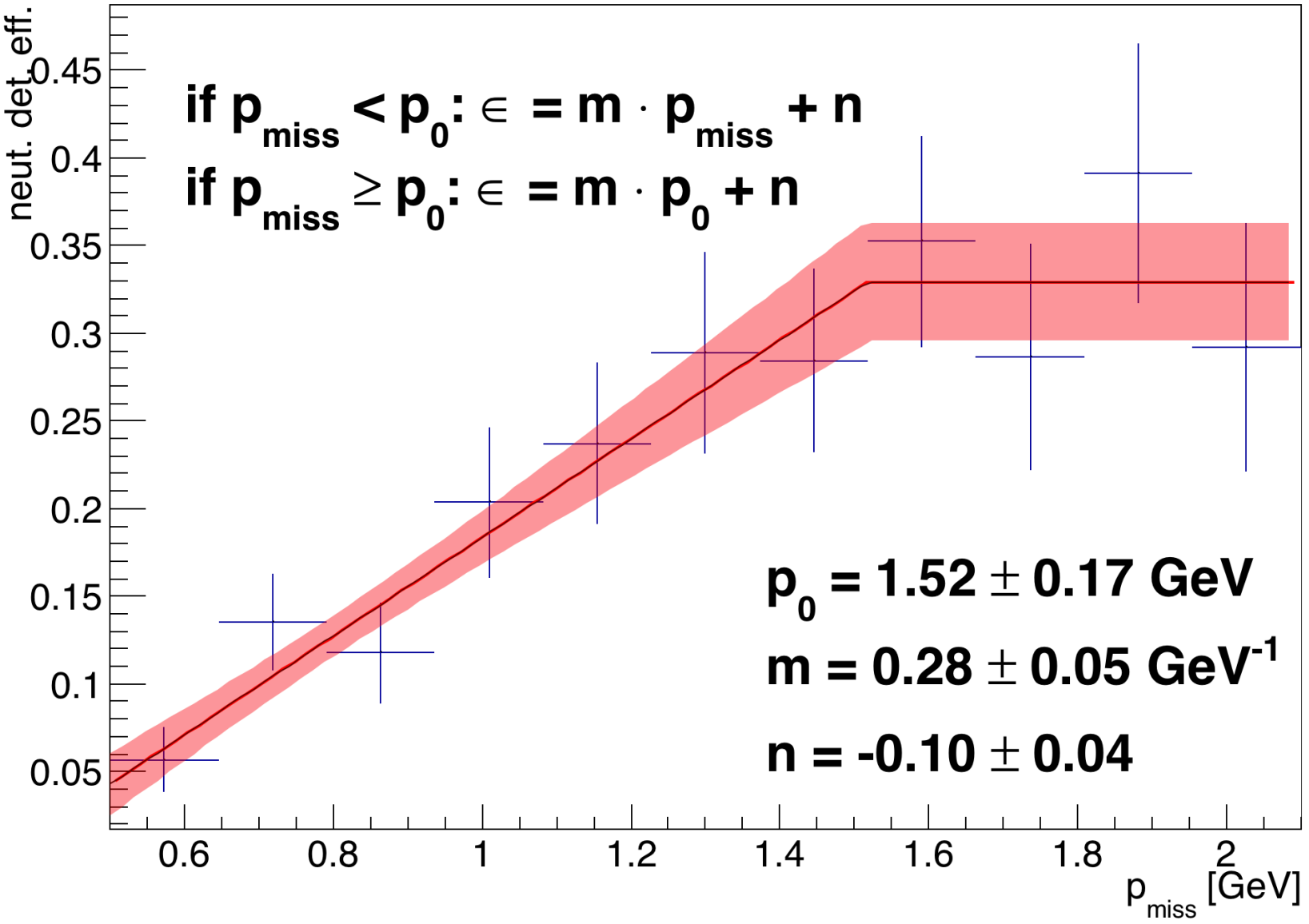
δt = 0.392 ns

$$P_p \rightarrow P_{smeared} = \sum Gauss(P_p, \sigma)$$

Use smeared protons to:
* Define and test the cuts
* Study bin migration

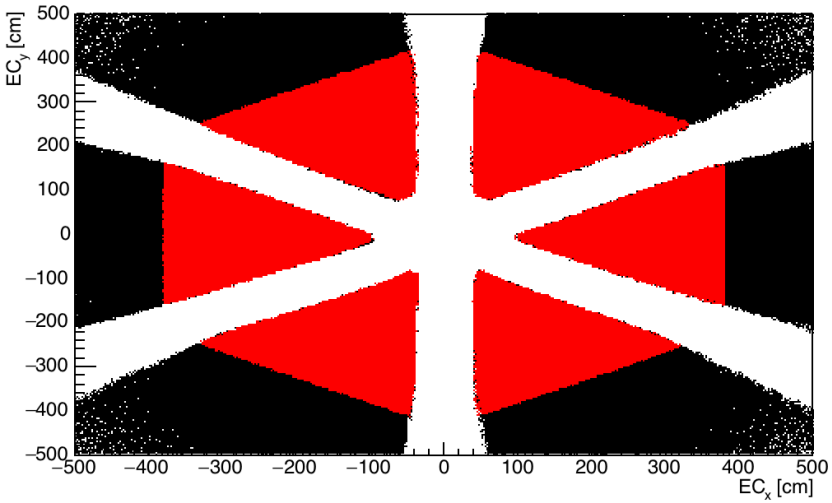


Neutron detection efficiency

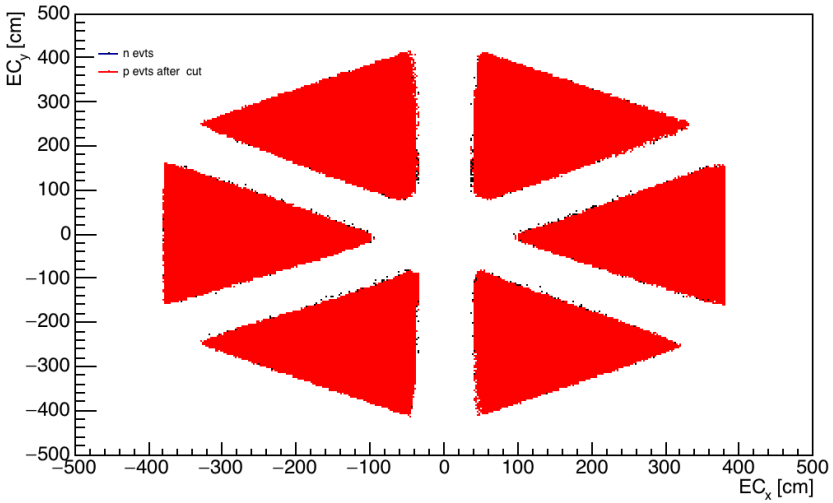


Matching proton and neutron acceptances

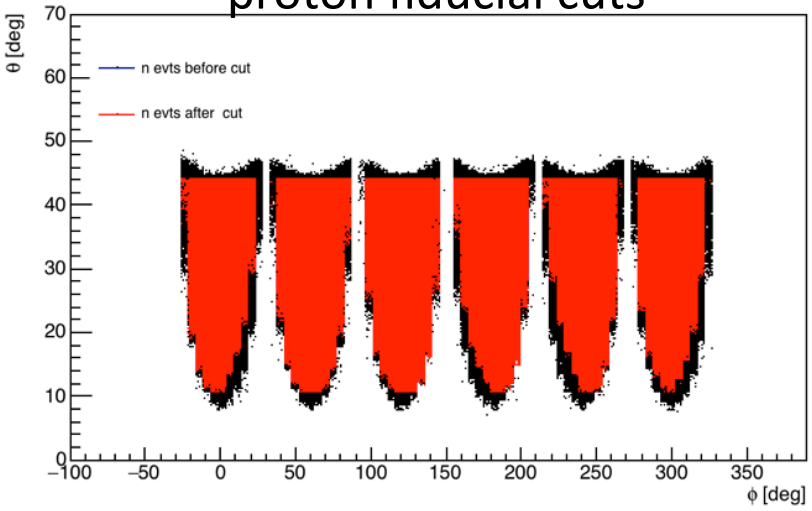
Protons **before** and **after** 10cm EC cut



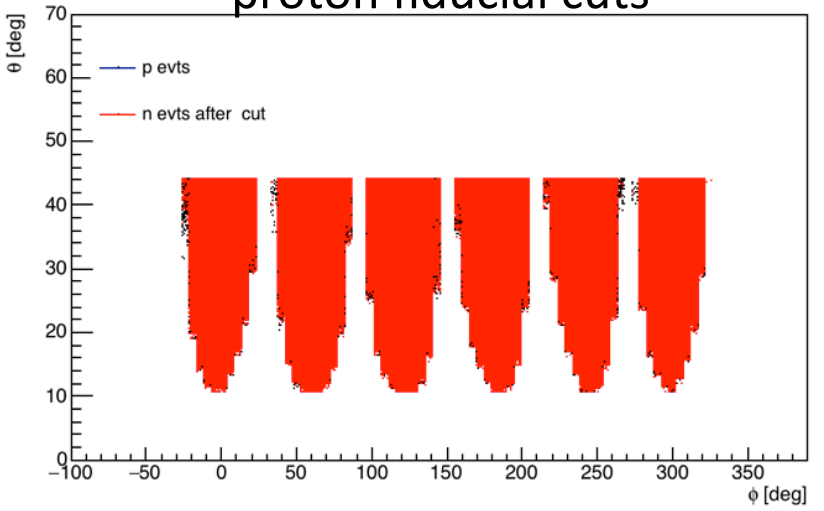
Protons and **neutrons** after 10cm EC cut



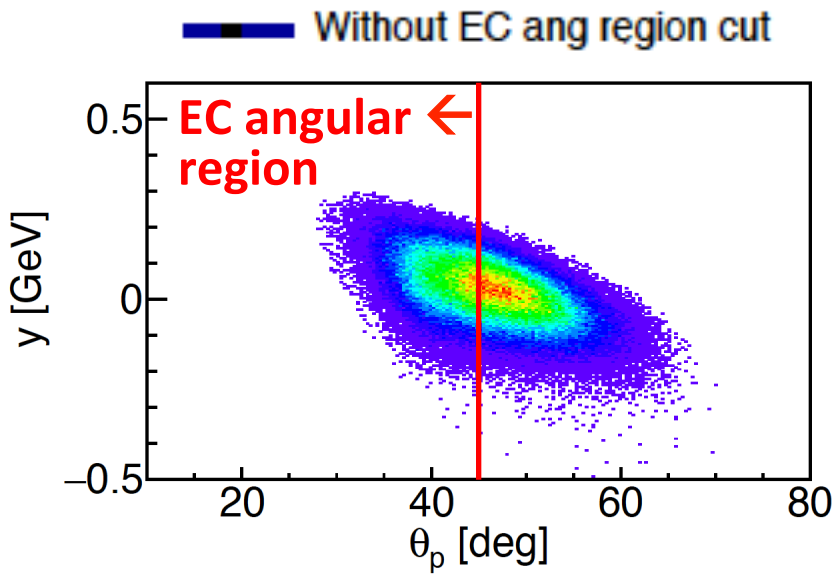
Neutrons **before** and **after** proton fiducial cuts

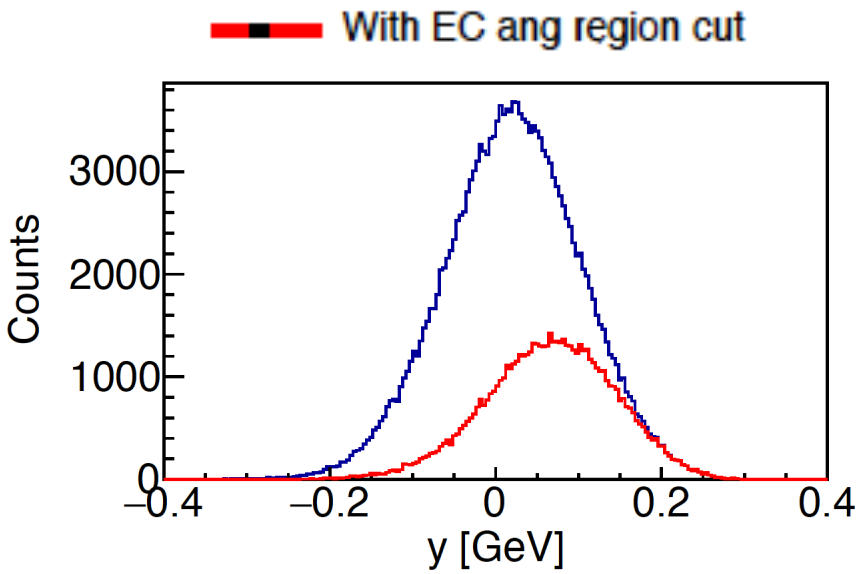


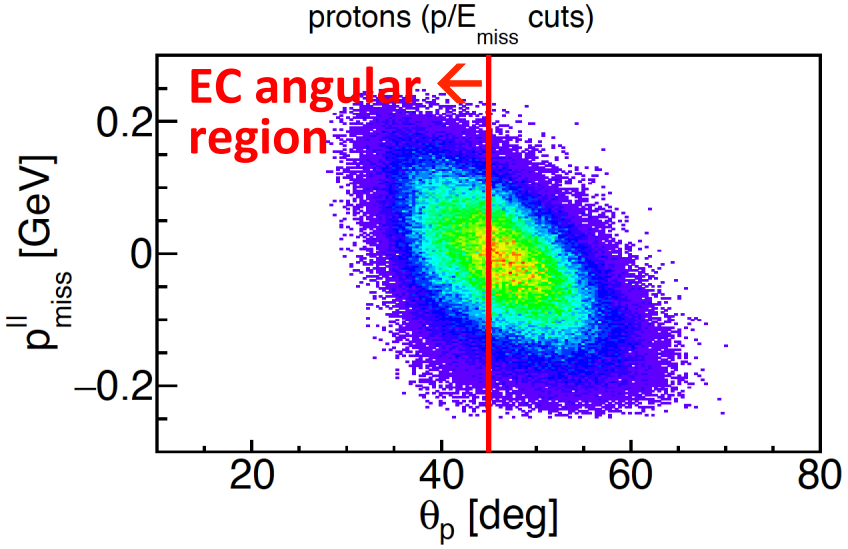
Neutrons and **protons** after proton fiducial cuts

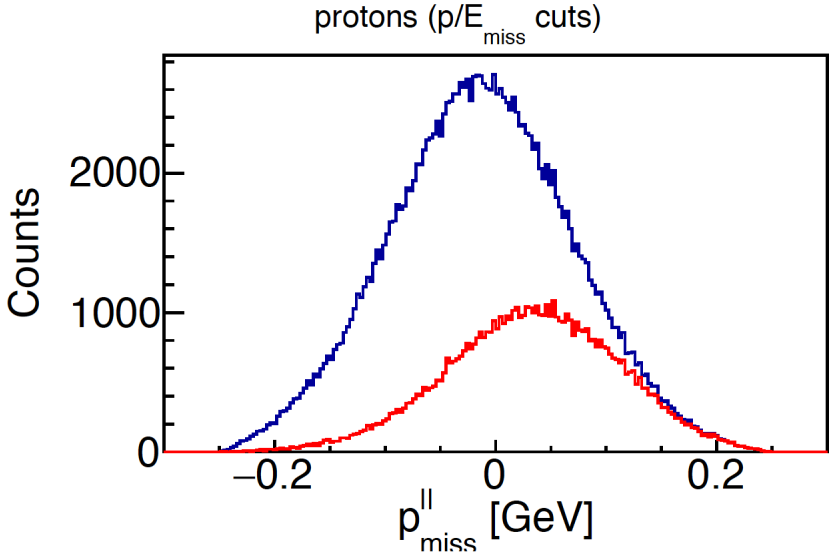


Effect of cutting on the EC angular region (MF)

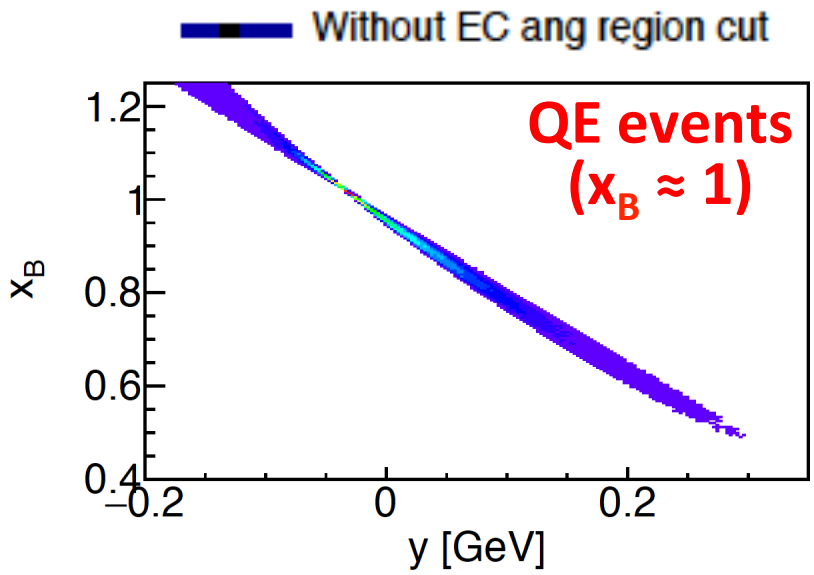


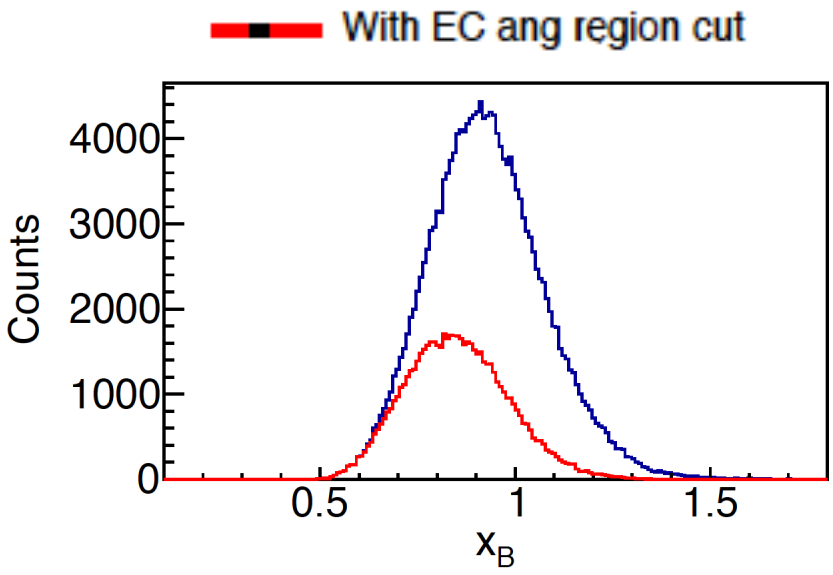


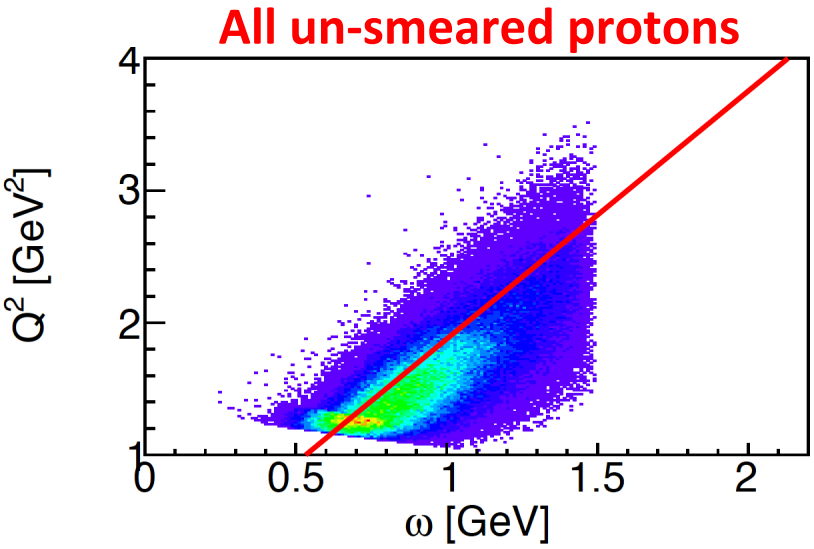


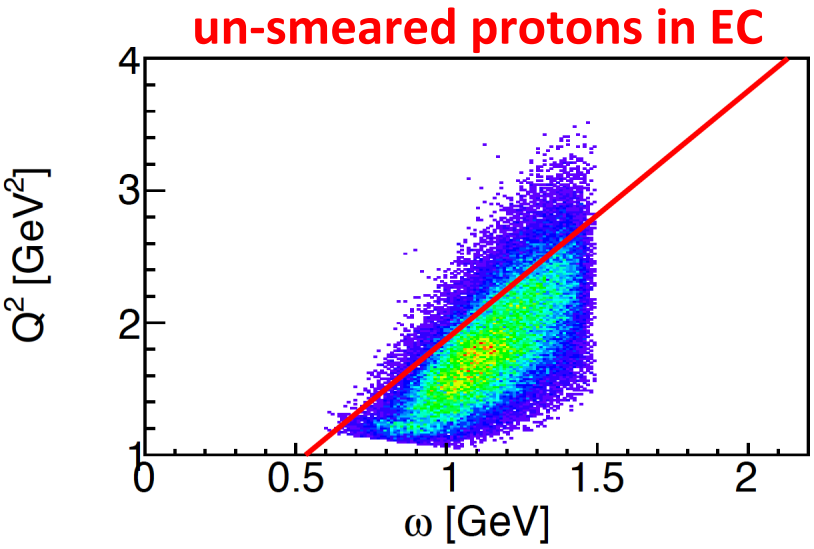


Effect of cutting on the EC angular region (MF)

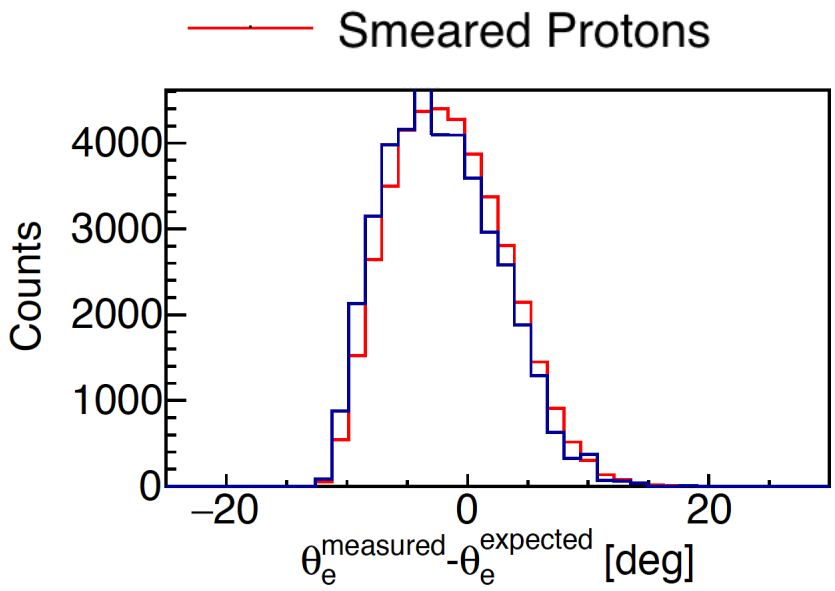


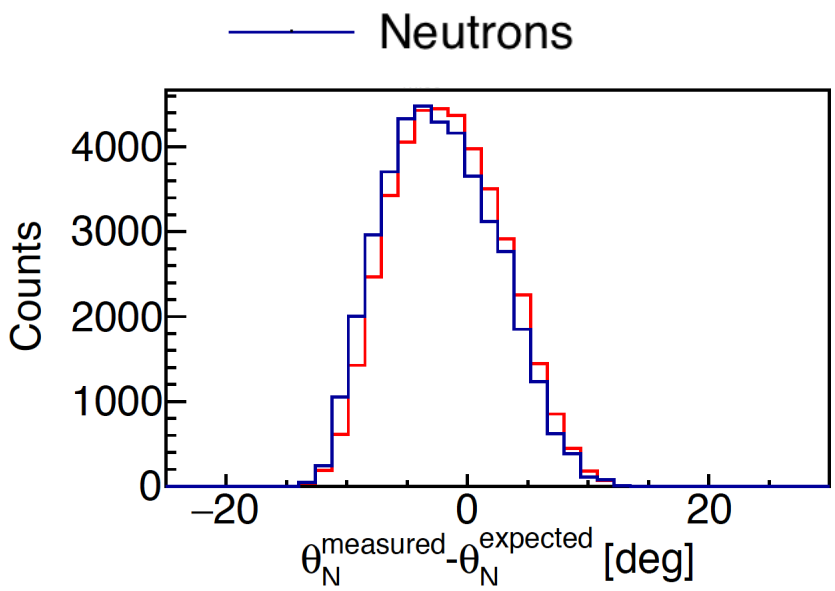


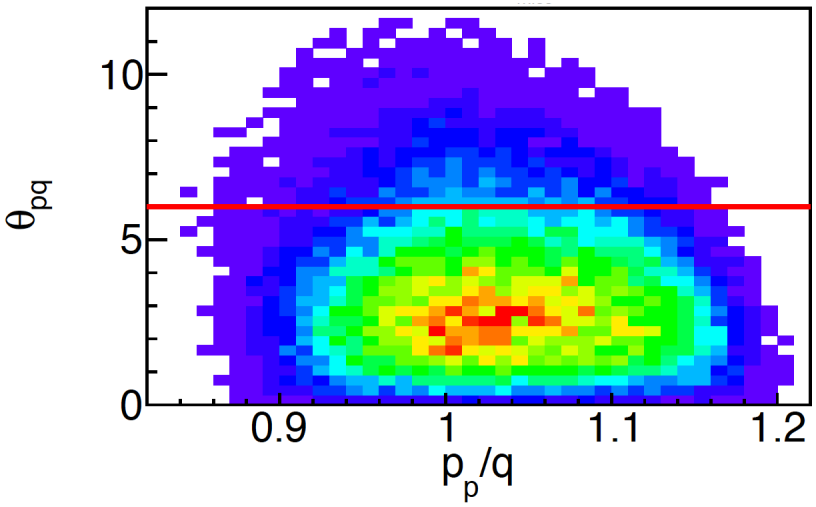


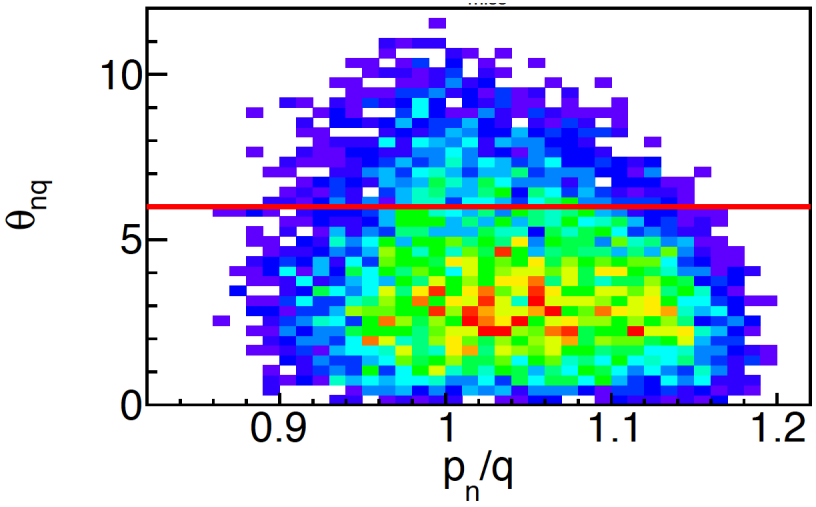


Comparing smeared protons and neutrons (MF)



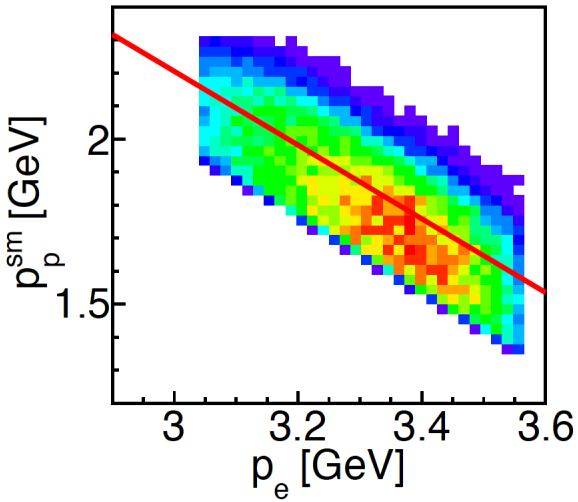


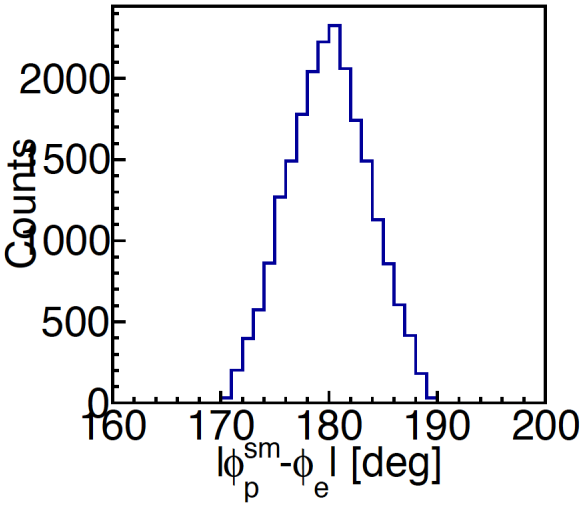




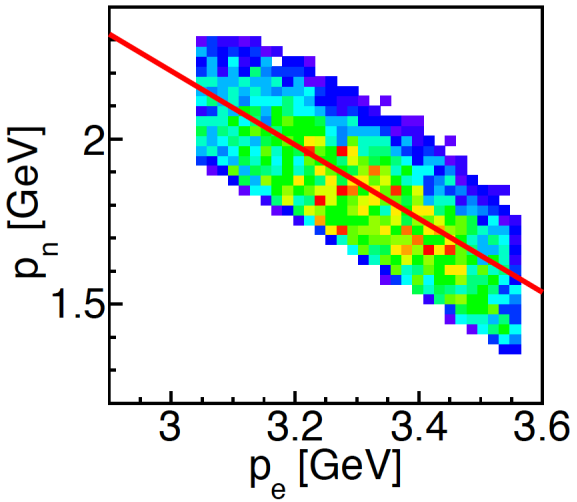
Comparing smeared protons and neutrons (MF)

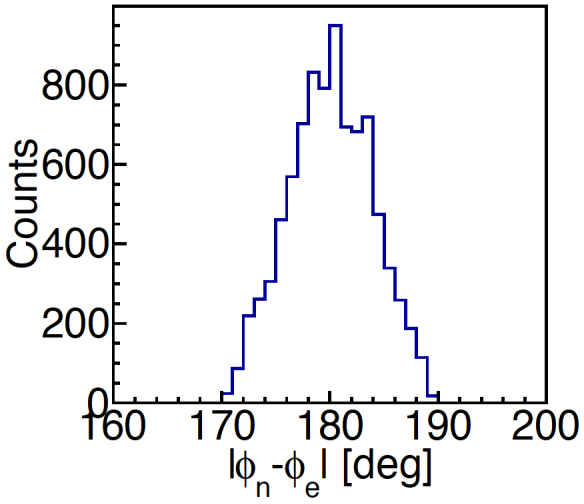
Smeared Protons



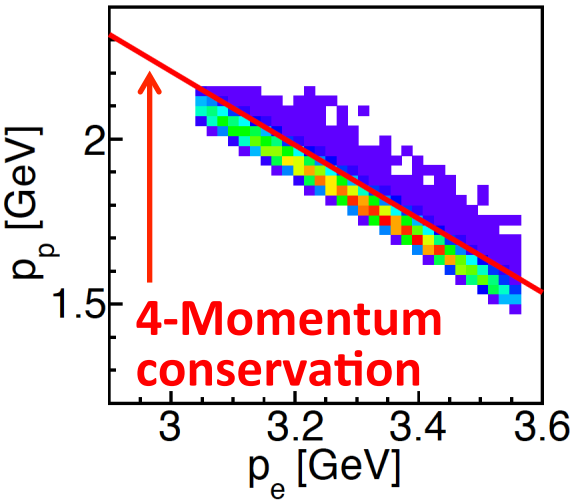


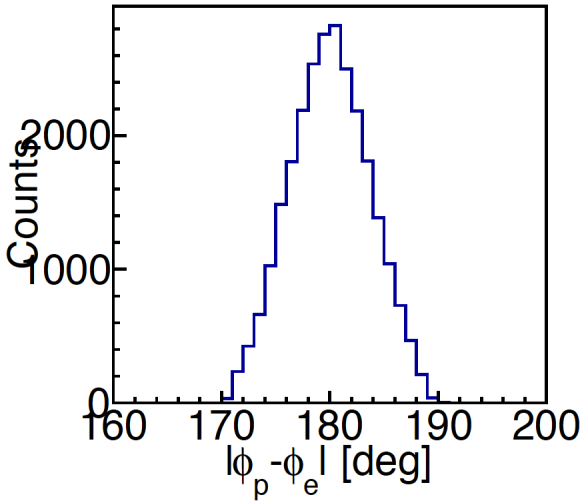
Neutrons





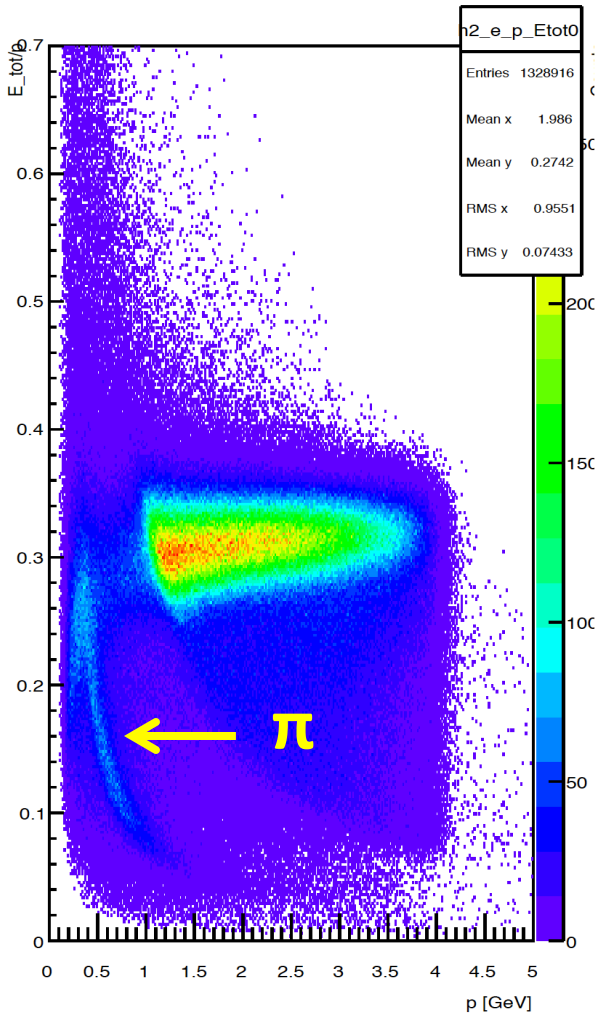
Protons



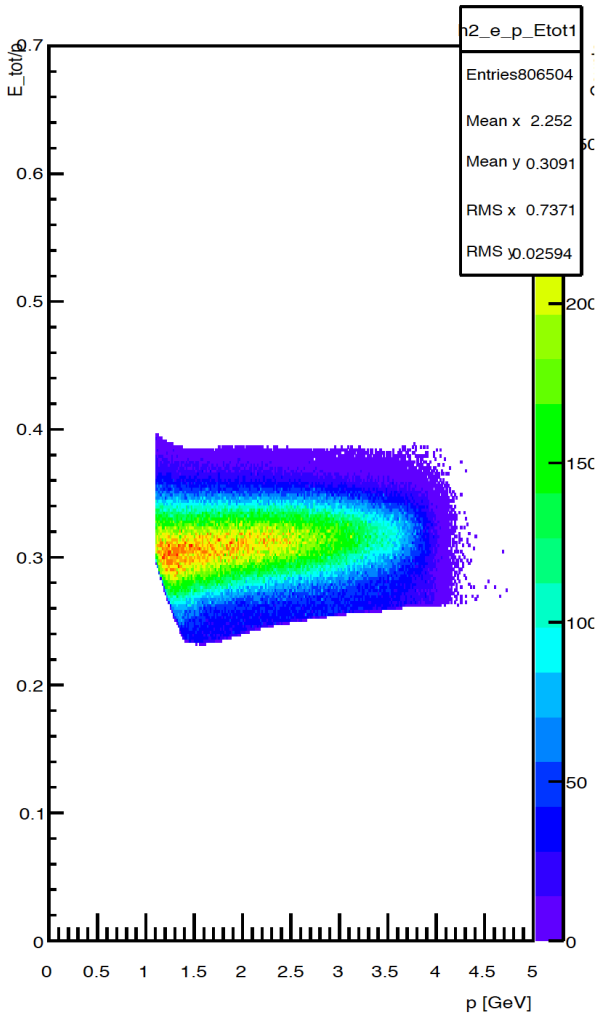


Electron PID and fiducial cuts (Run 17908)

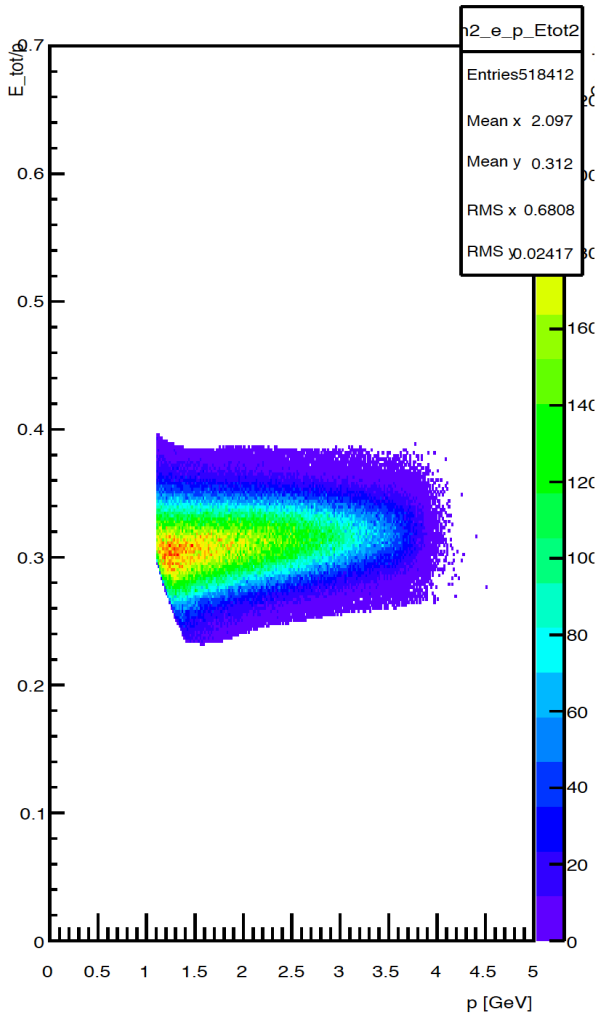
e- before cuts



e- passing PID

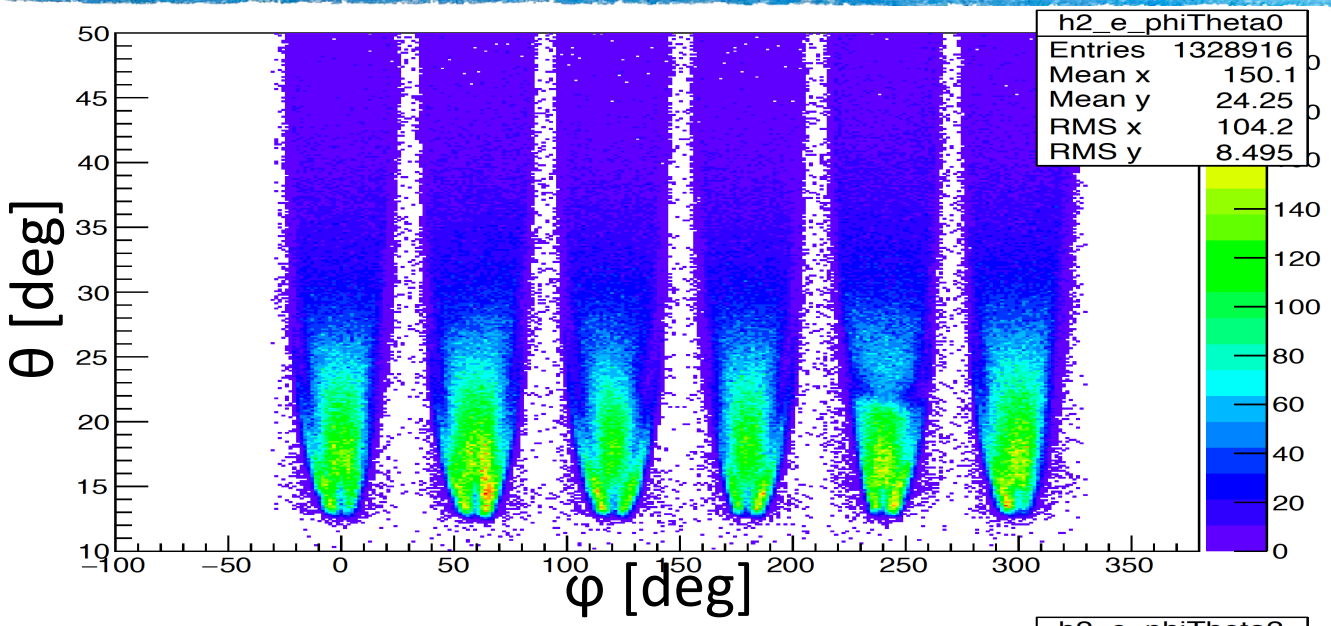


e- passing PID+fid

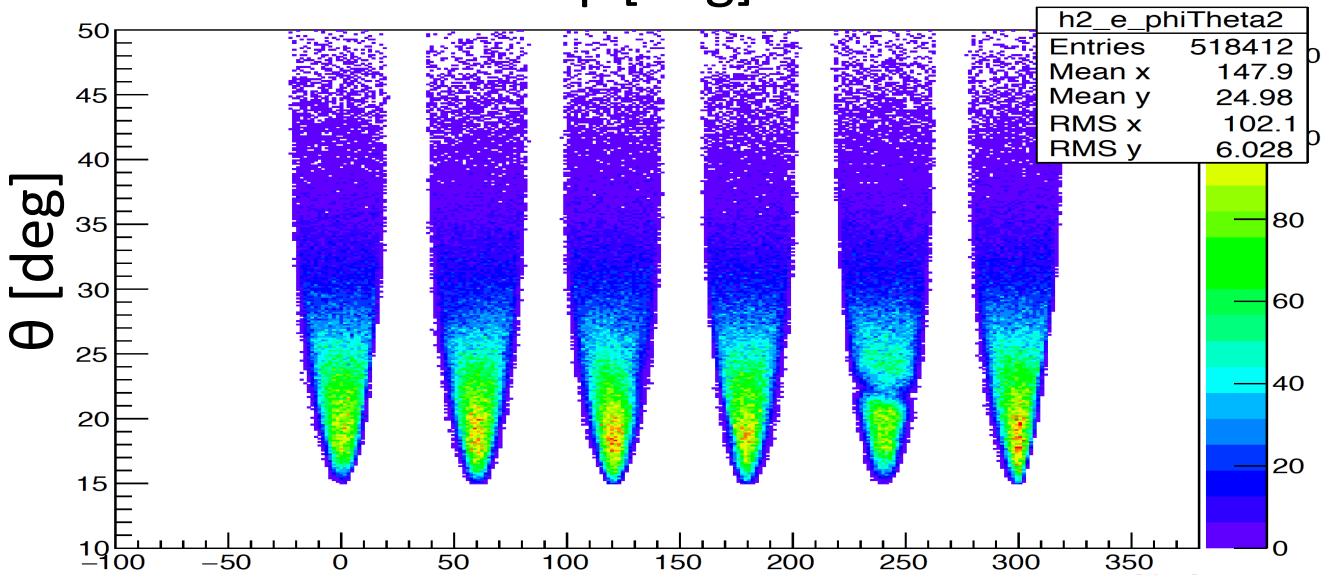


Electron PID and fiducial cuts (Run 17908)

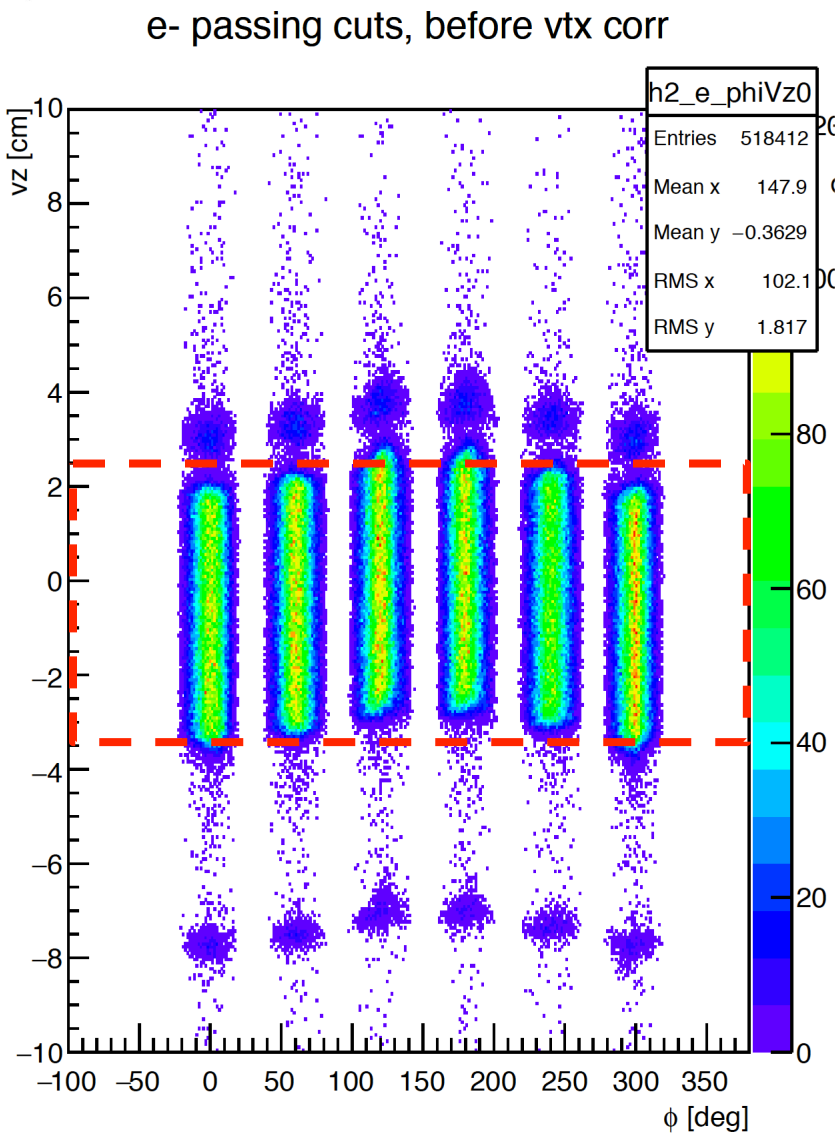
All candidate electrons

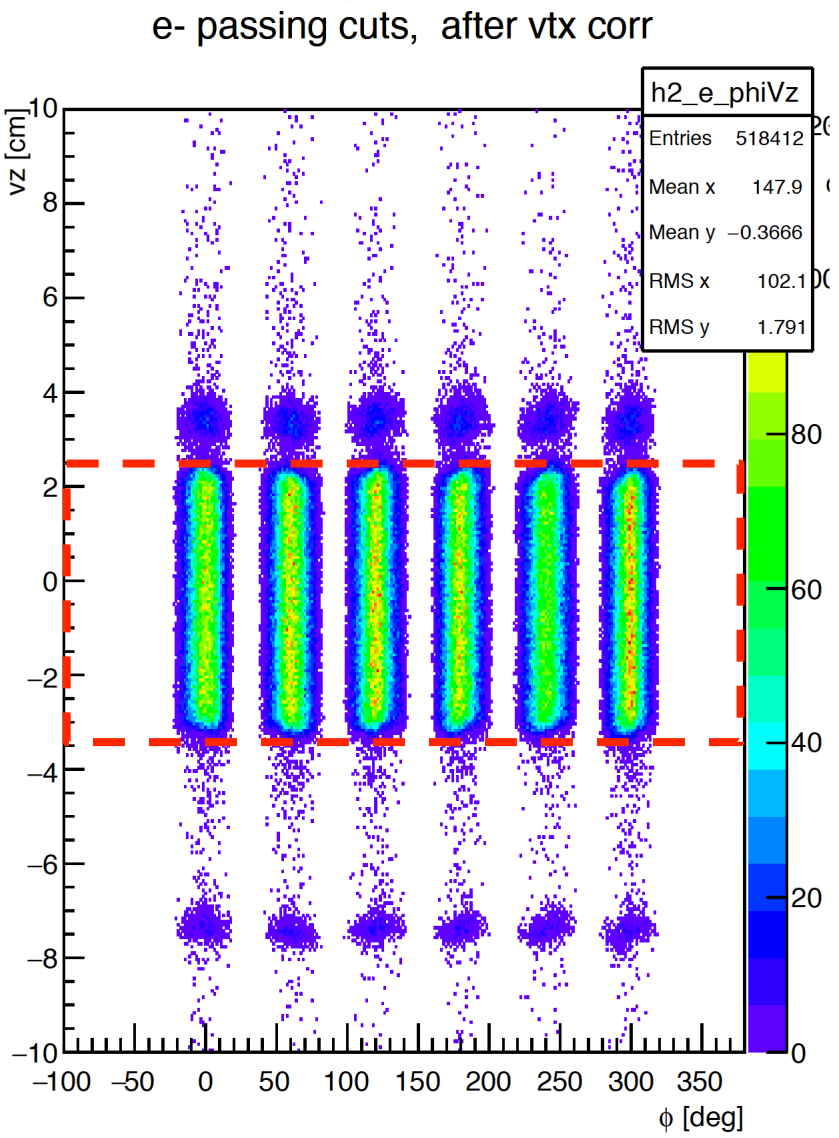


electrons passing pid and fiducial cuts



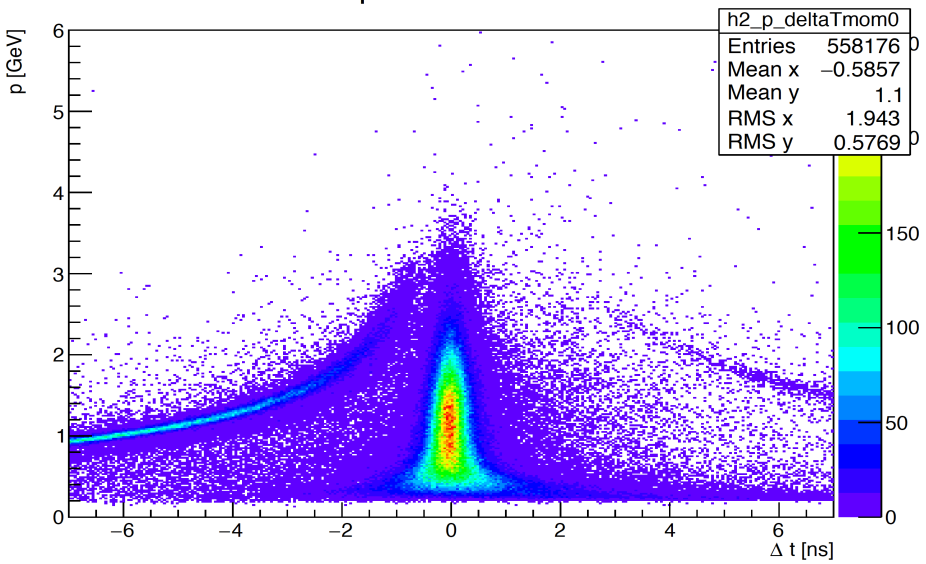
v_z corrections (Run 17908)



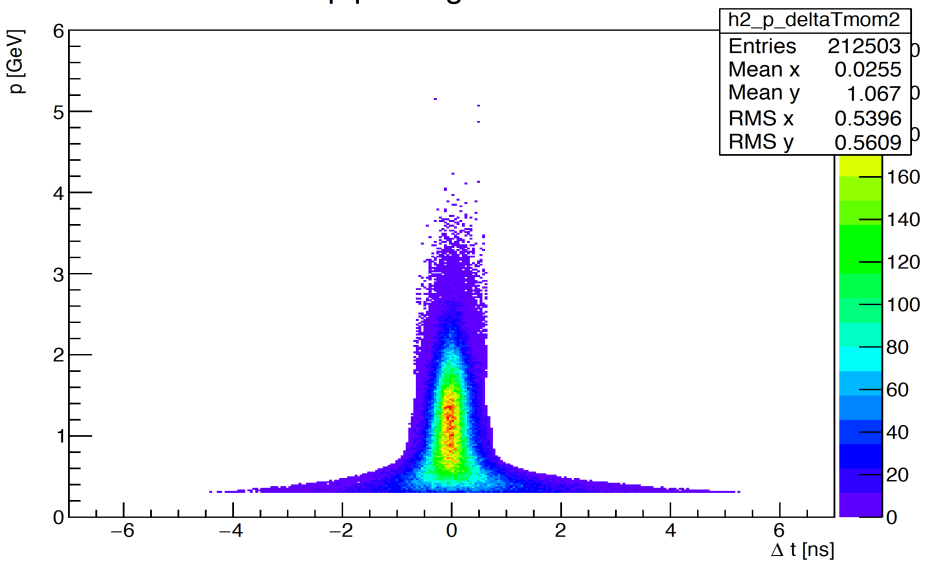


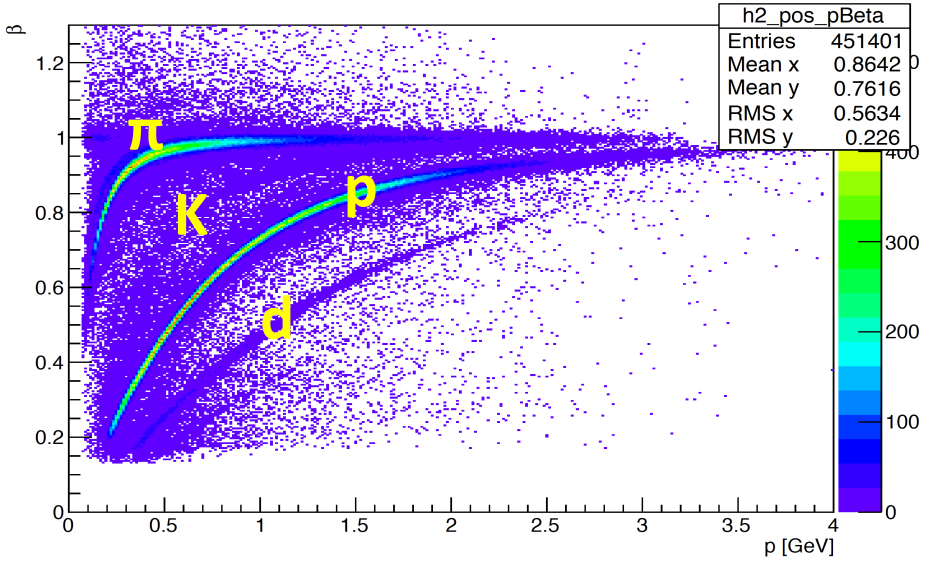
Proton PID and fiducial cuts (Run 17908)

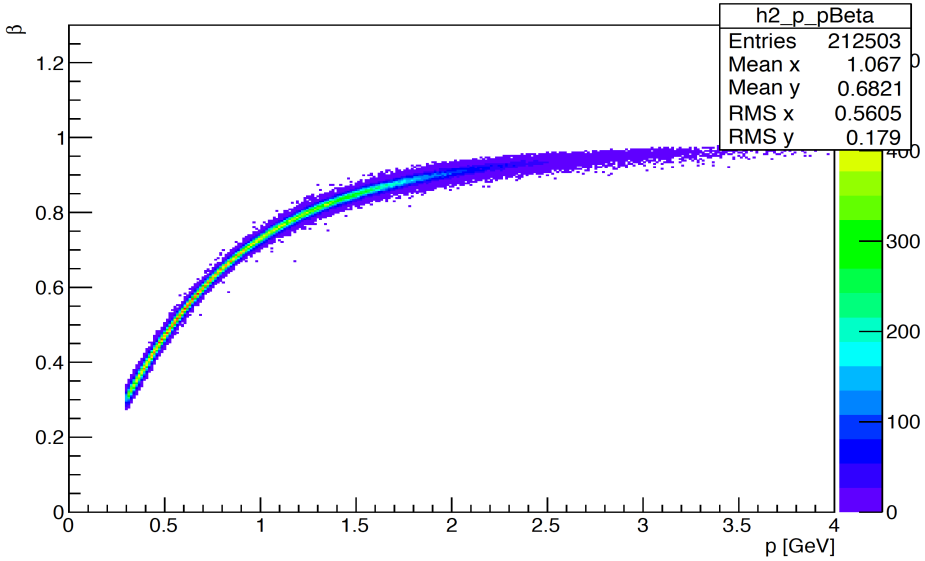
p before cuts



p passing fid+PID

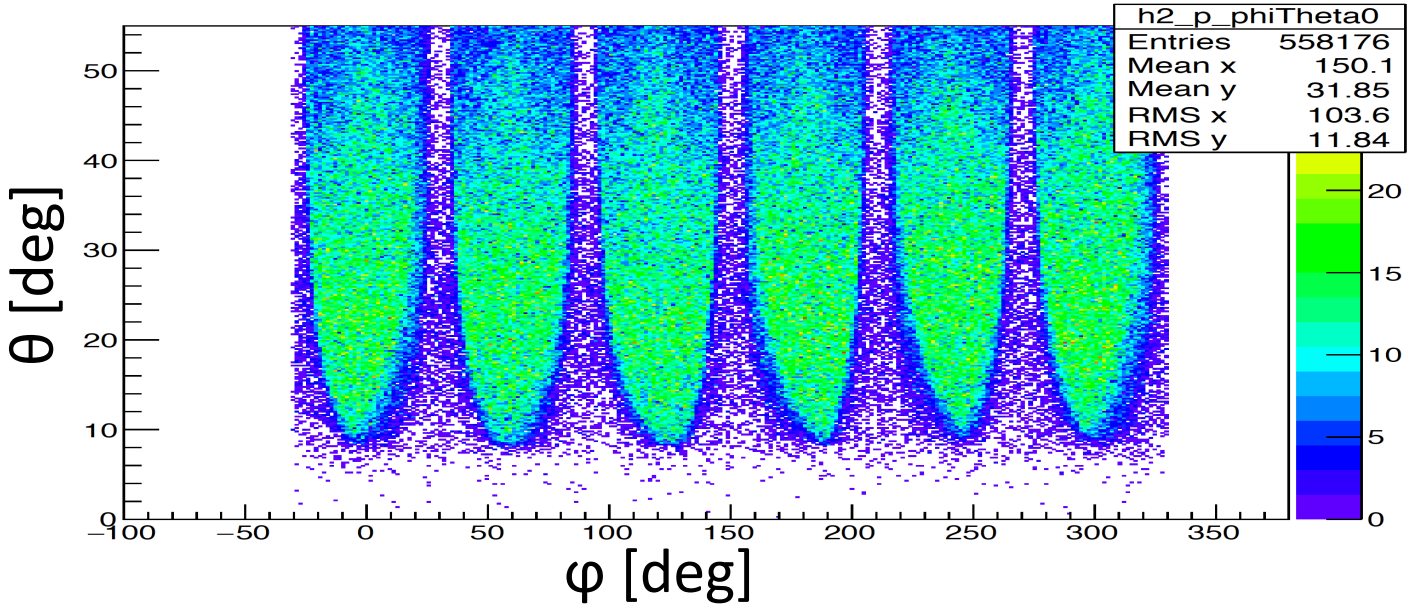




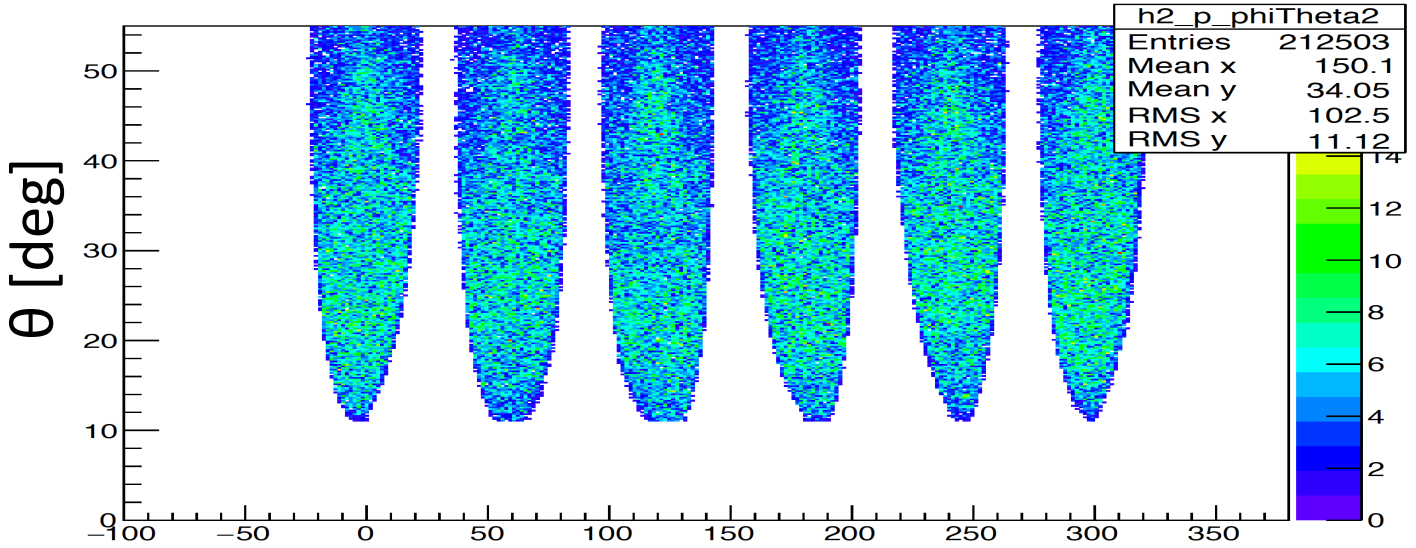


Proton PID and fiducial cuts (Run 17908)

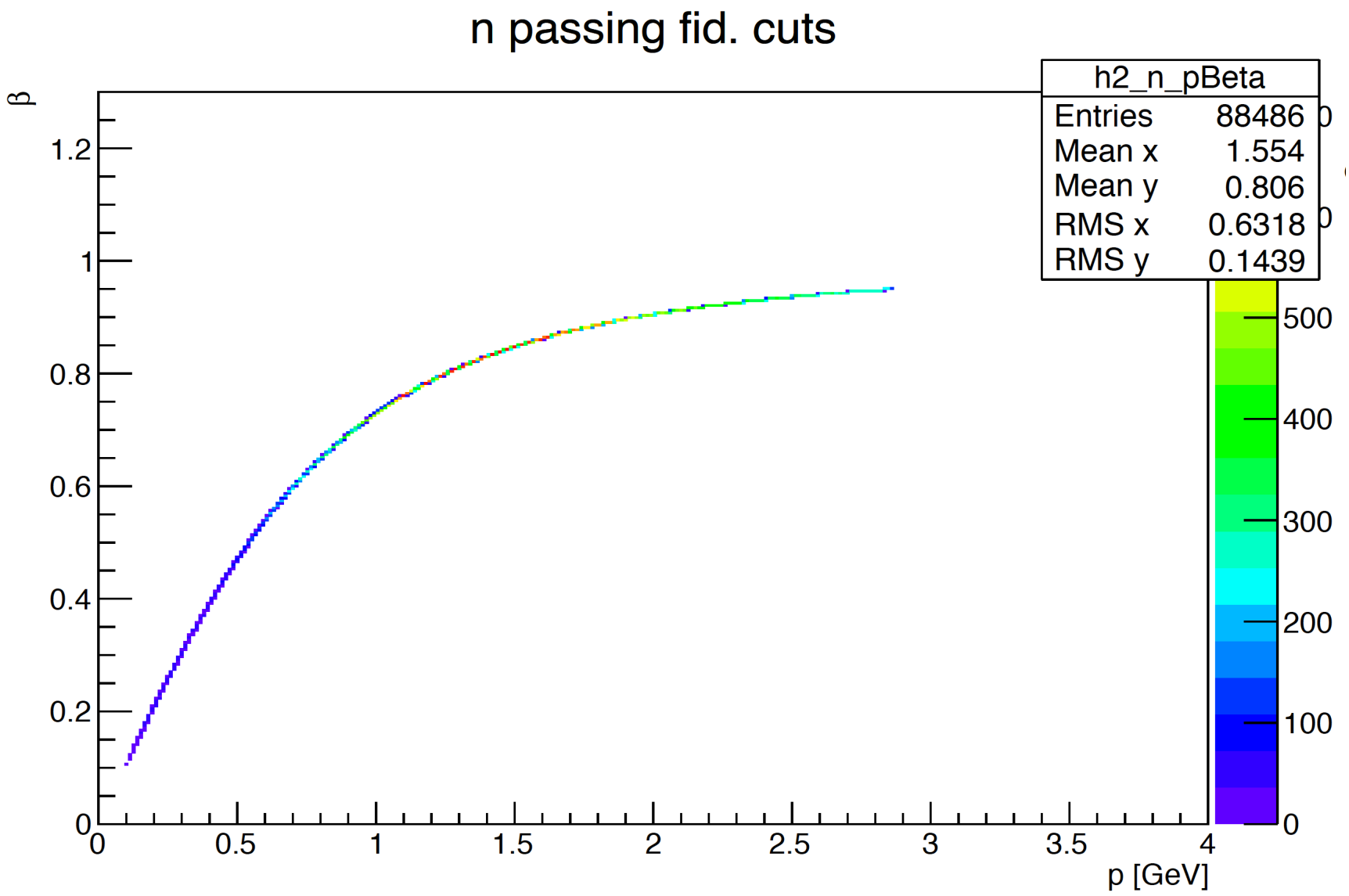
All candidate protons



protons passing pid and fiducial cuts



Neutron PID and fiducial cuts (Run 17908)



Neutron PID and fiducial cuts (Run 17908)