Triple coincidence A(e,e'pn)

CLAS data mining analysis

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Motivation

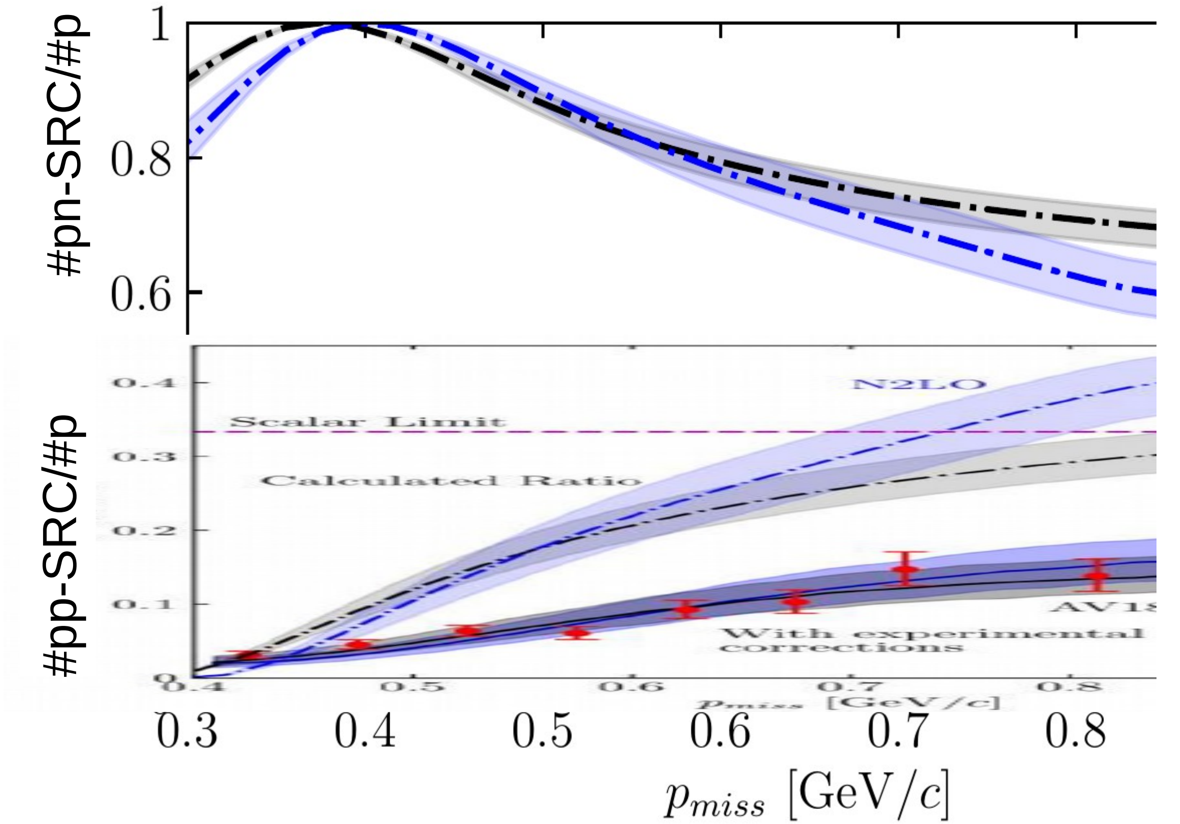
Extract missing momentum dependence of the A(e,e′pn)/A(e,e′p) ratio

Compare theory to data

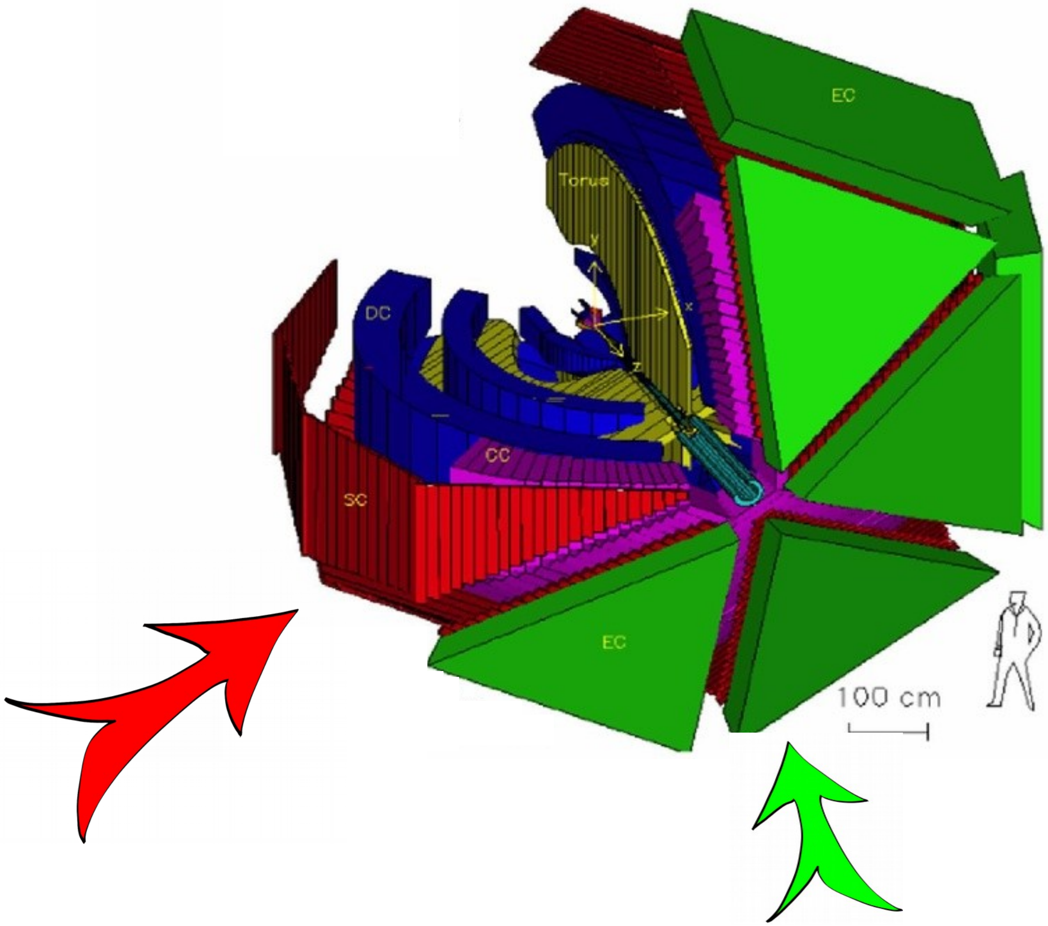
Leading nucleon is a proton

(Good missing momentum resolution)

Most of the 2N-SRC pairs are np pairs



Neutron Extraction



A(e,e'pn)

TOF counters

Advantage:
Large angular acceptance: 8 – 140 deg

Disadvantage:
Low detection efficiency (large correction)

Analysis done by Meytal Duer, A(e,e'np)

Electromagnetic Calorimeter:

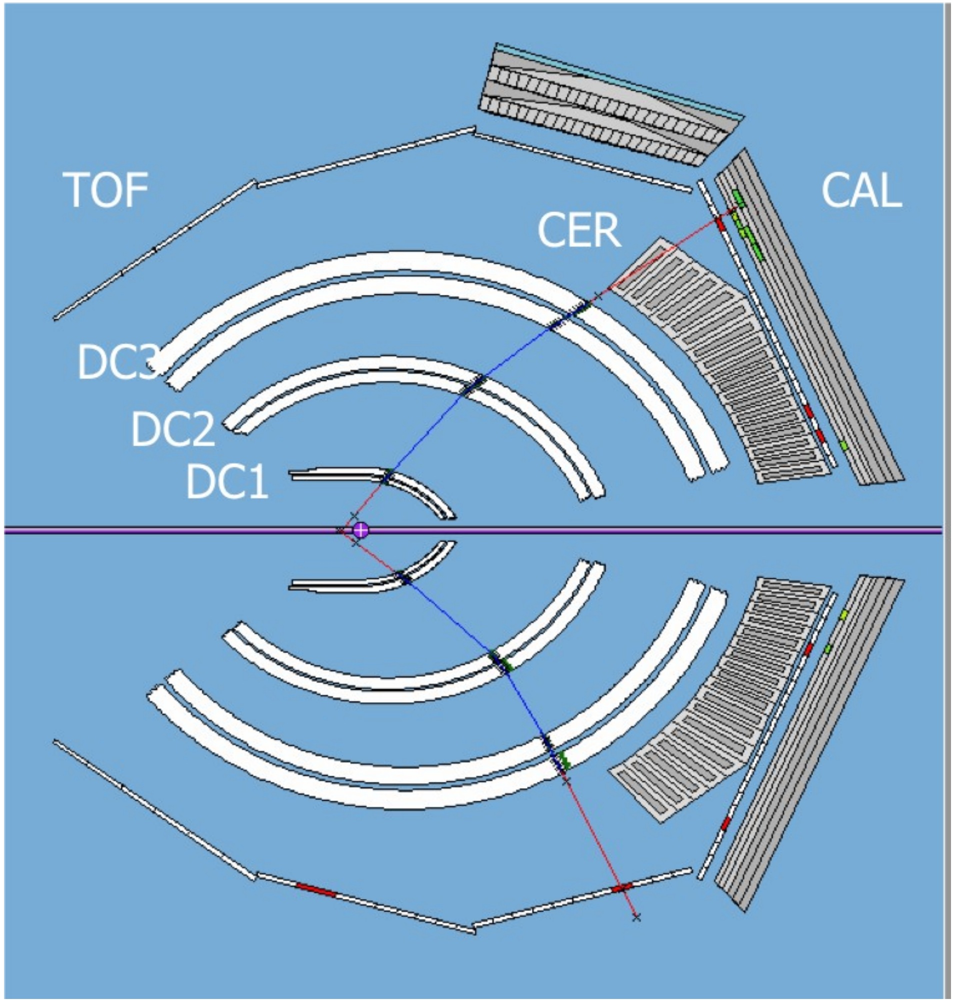
Advantage:
Relatively high efficiency

Disadvantage:
Can't be used for recoiling neutrons

Selection of neutrons in TOF counters – Veto Algorithm

TOF scintillators response: Charge ≈ Neutral

Veto algorithm based on the drift chambers that are sensitive to charged particles.

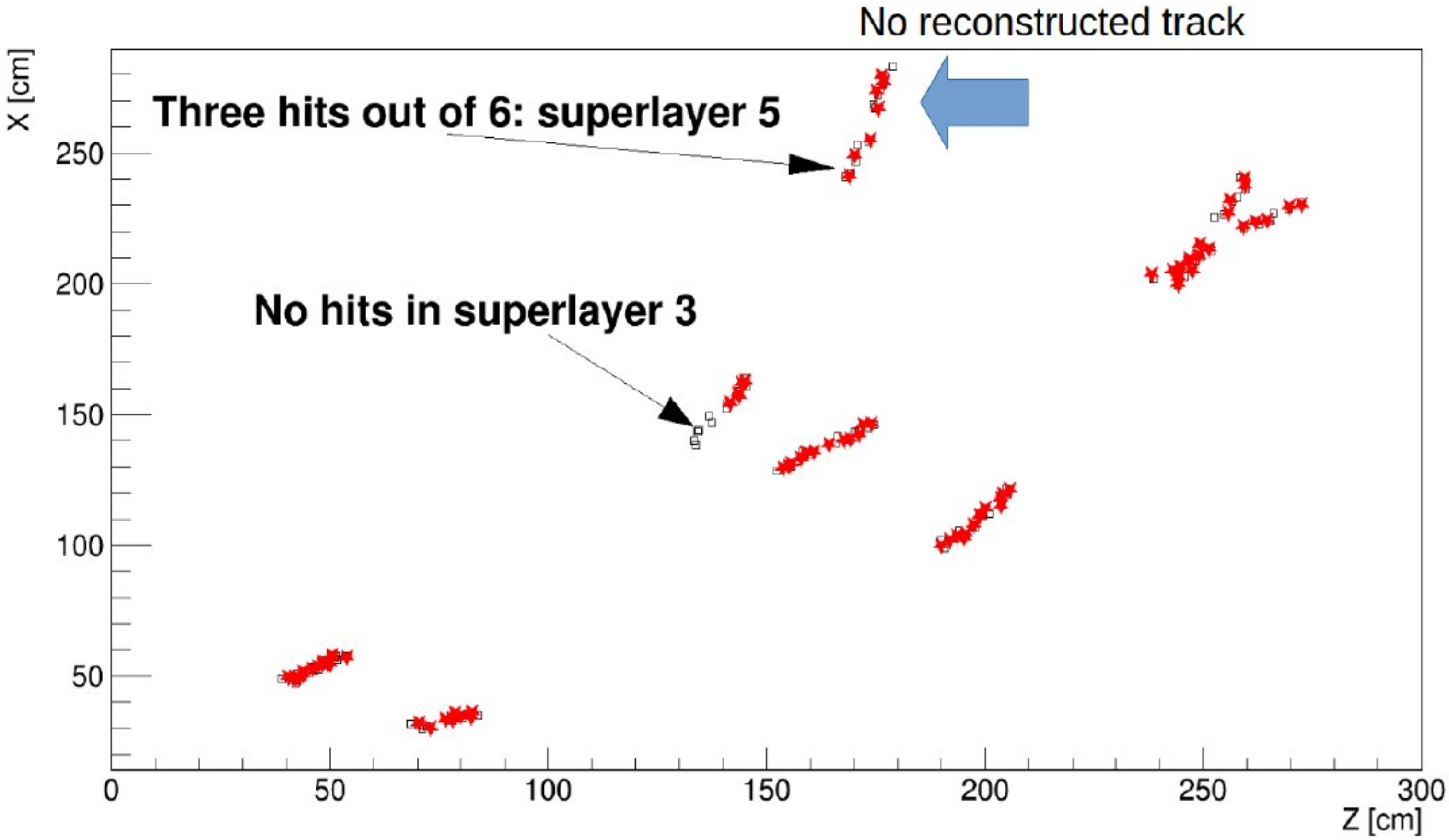


Veto by drift chambers:

All hits with a corresponding track are charged.

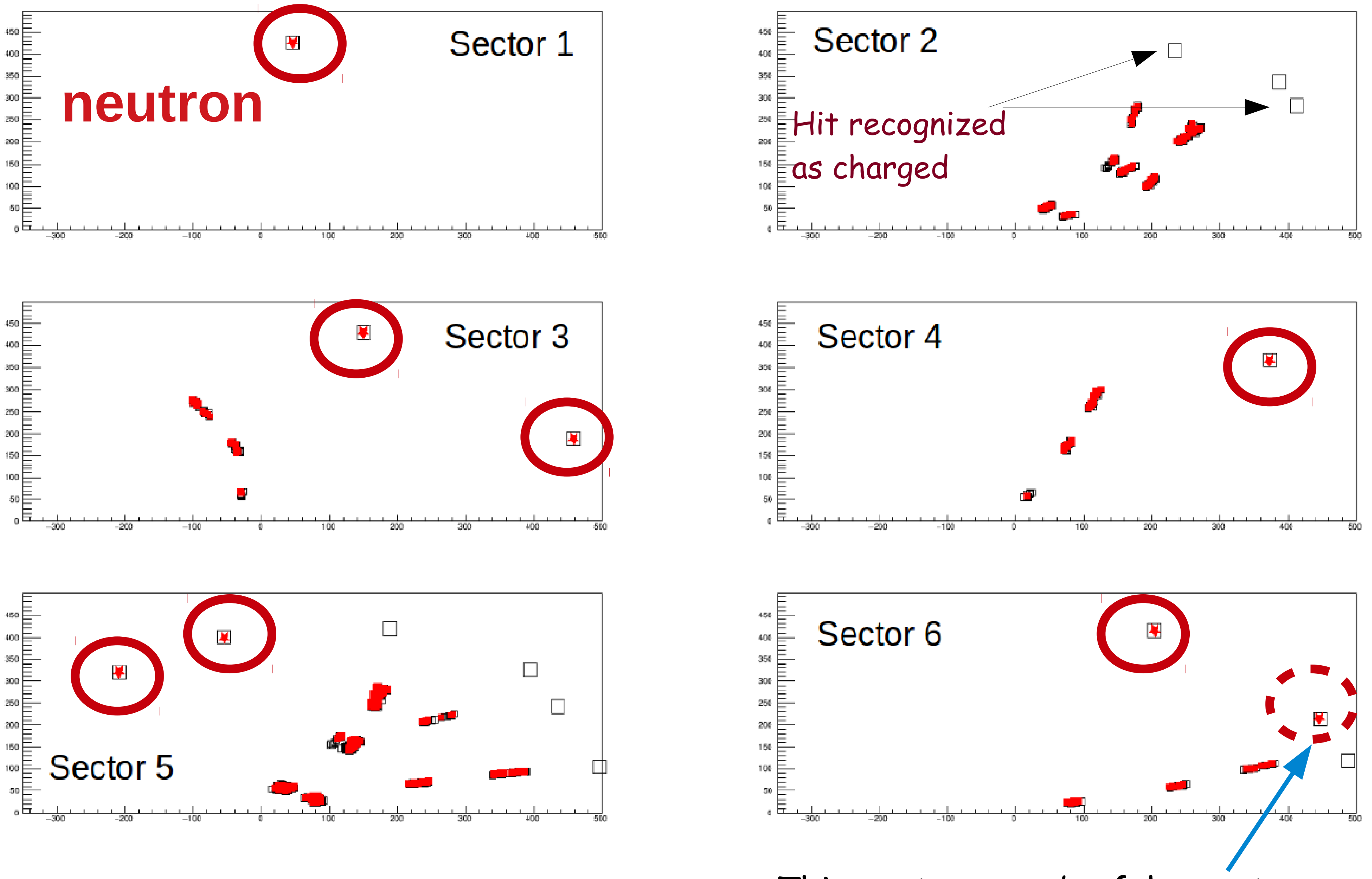
Problem: Standard tracking is optimized to remove false positive

Example for a not reconstructed track



Solution: Correlated track even it's not fully reconstructed

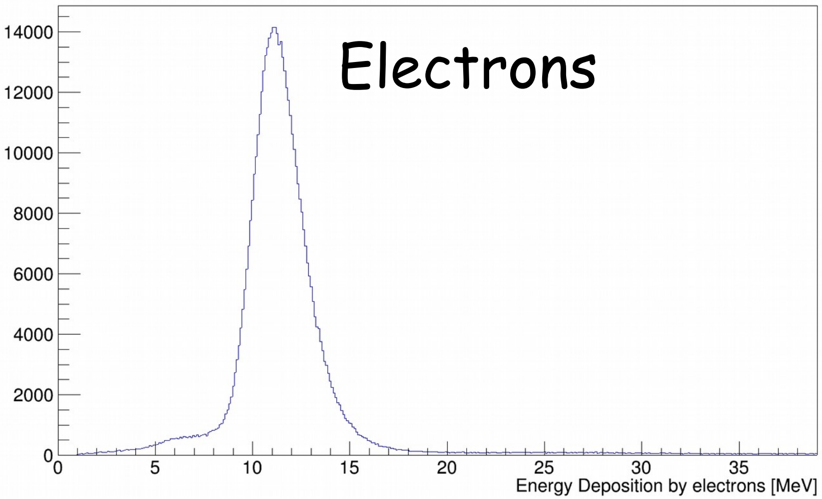
Neutron candidates after the Veto algorithm

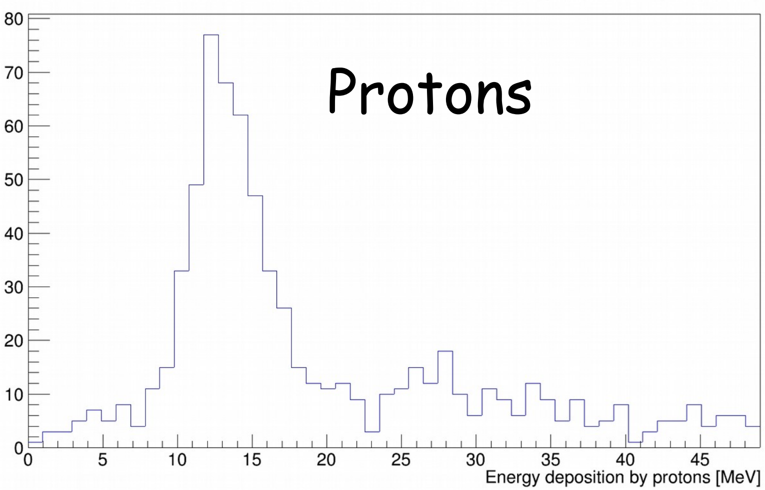


This neutron can be fake neutron
Relatively close to the track

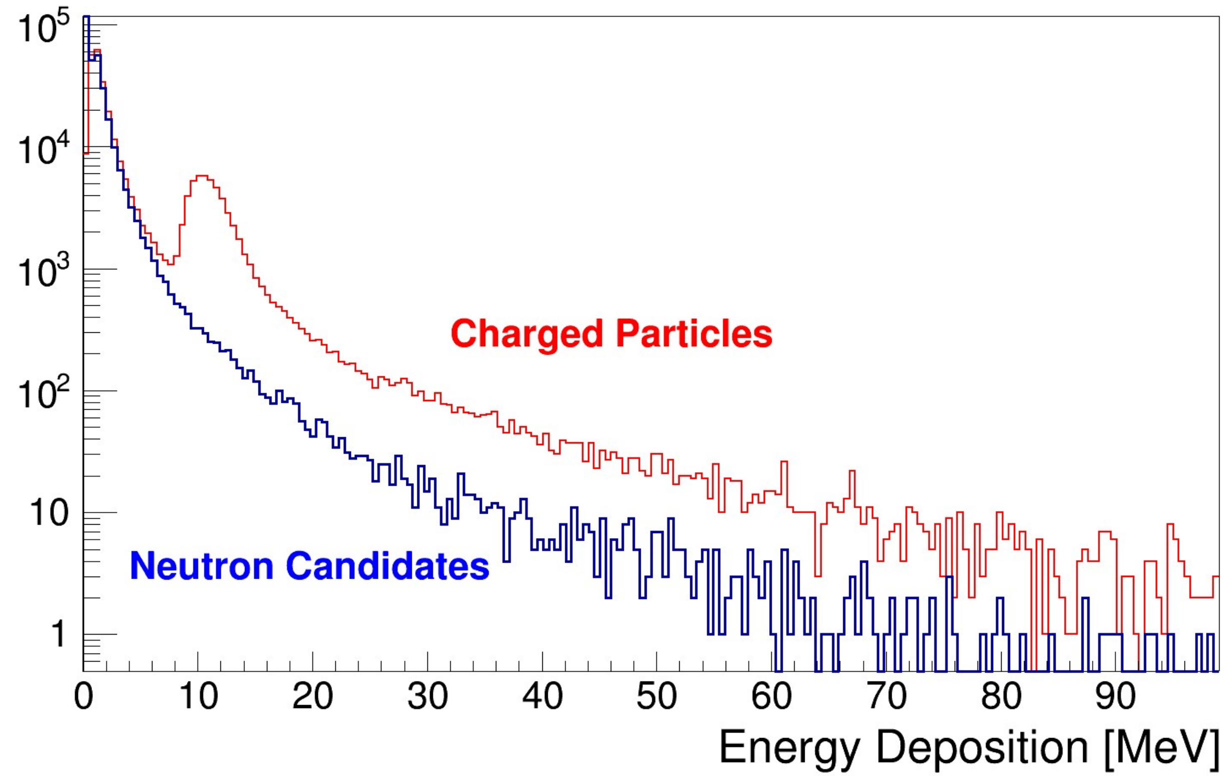
Energy Deposition

Energy Deposition





Veto algorithm remove hits due to charged particles

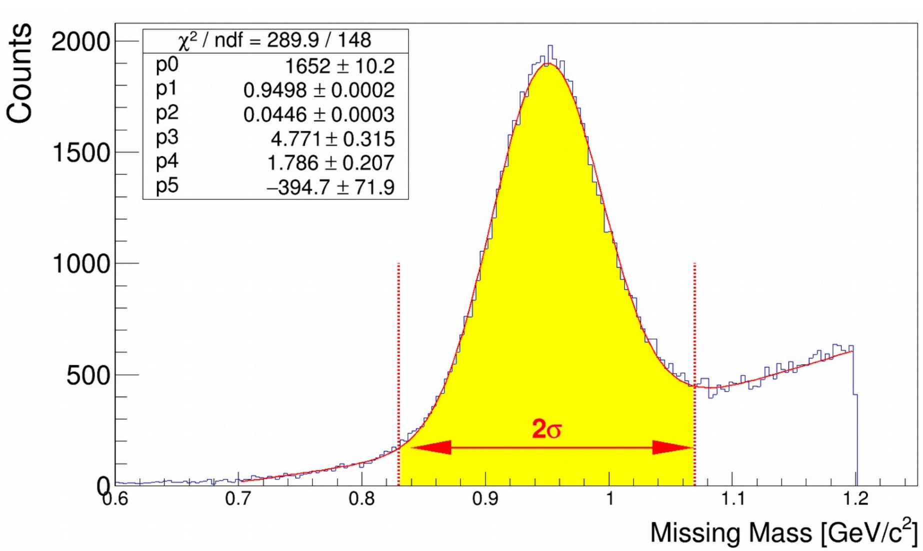


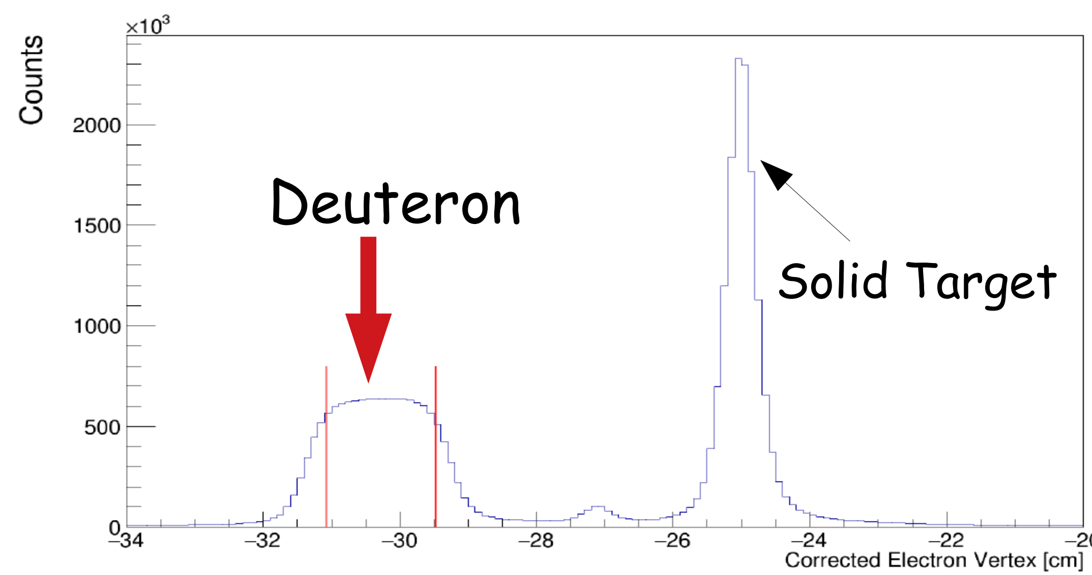
Calibration: Deuteron target

d(e,e'pn)

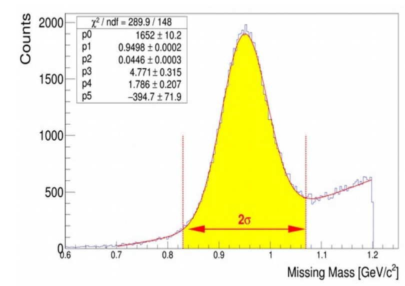
- Detection efficiency
- Momentum resolution
- Test Veto algorithm

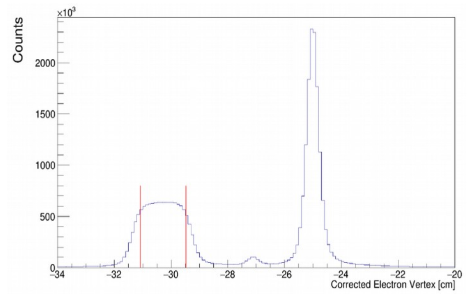
Selection of d(e,e'p)n event

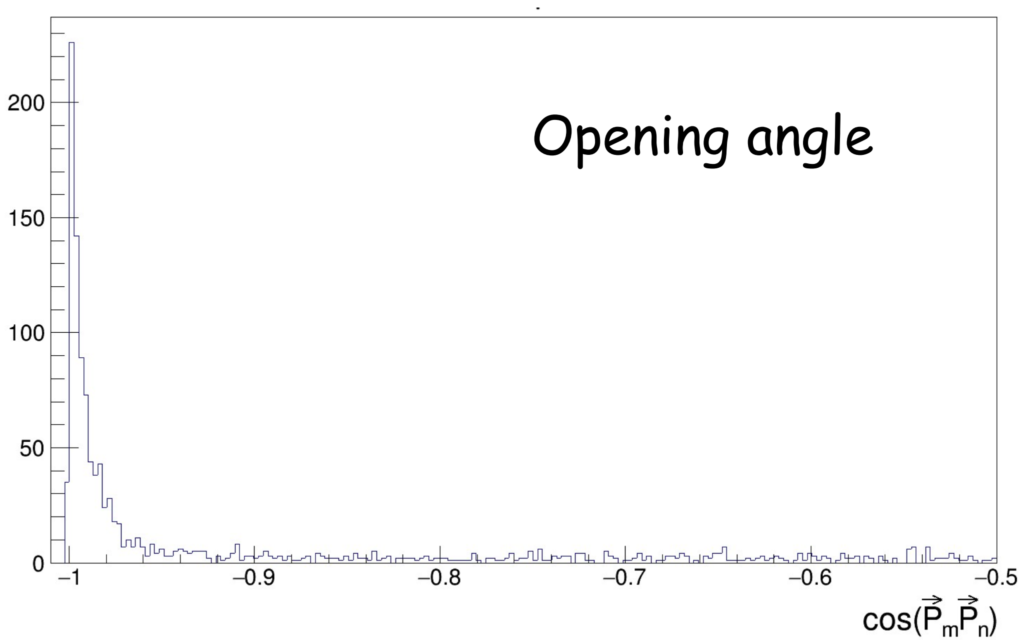




Selection of d(e,e'pn) events

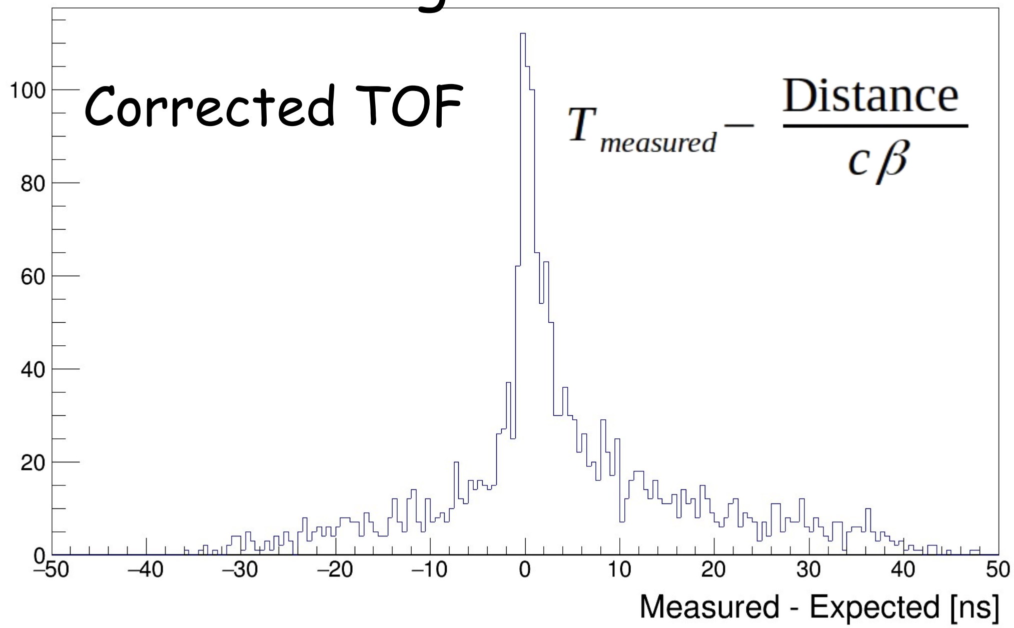




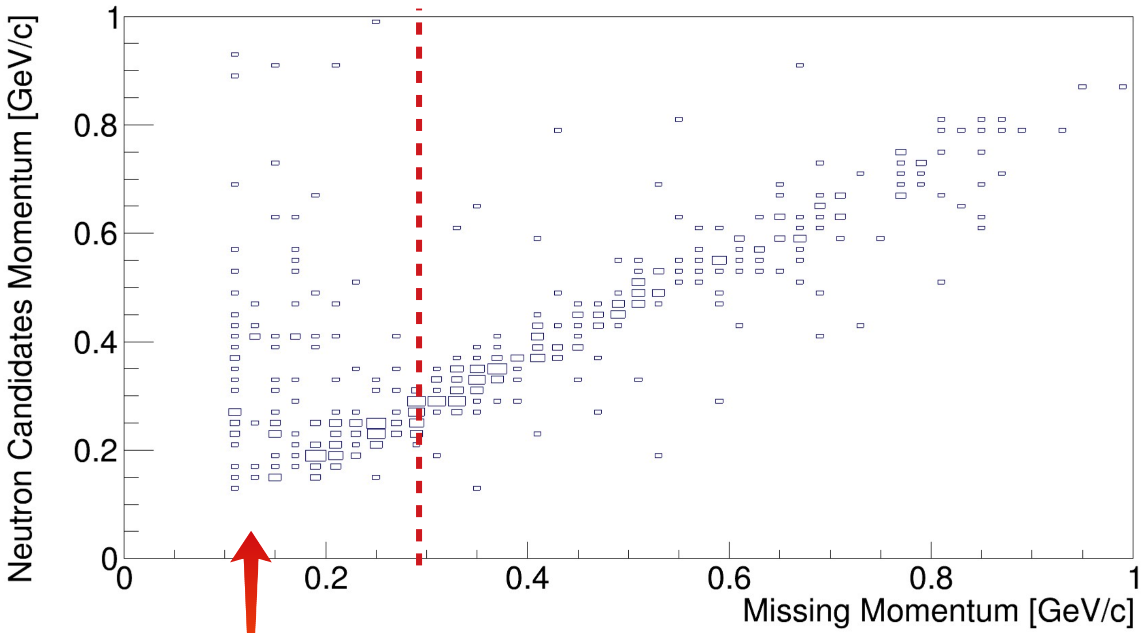


(Missing Momentum = Initial Momentum)

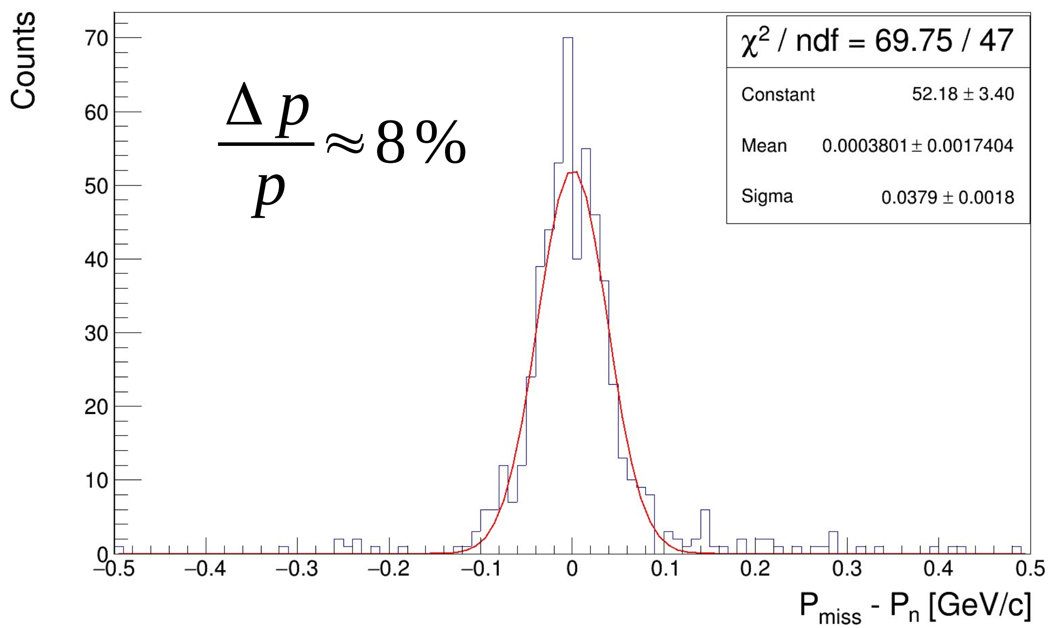
β – Calculated based on missing momentum assuming a neutron mass



Momentum Resolution

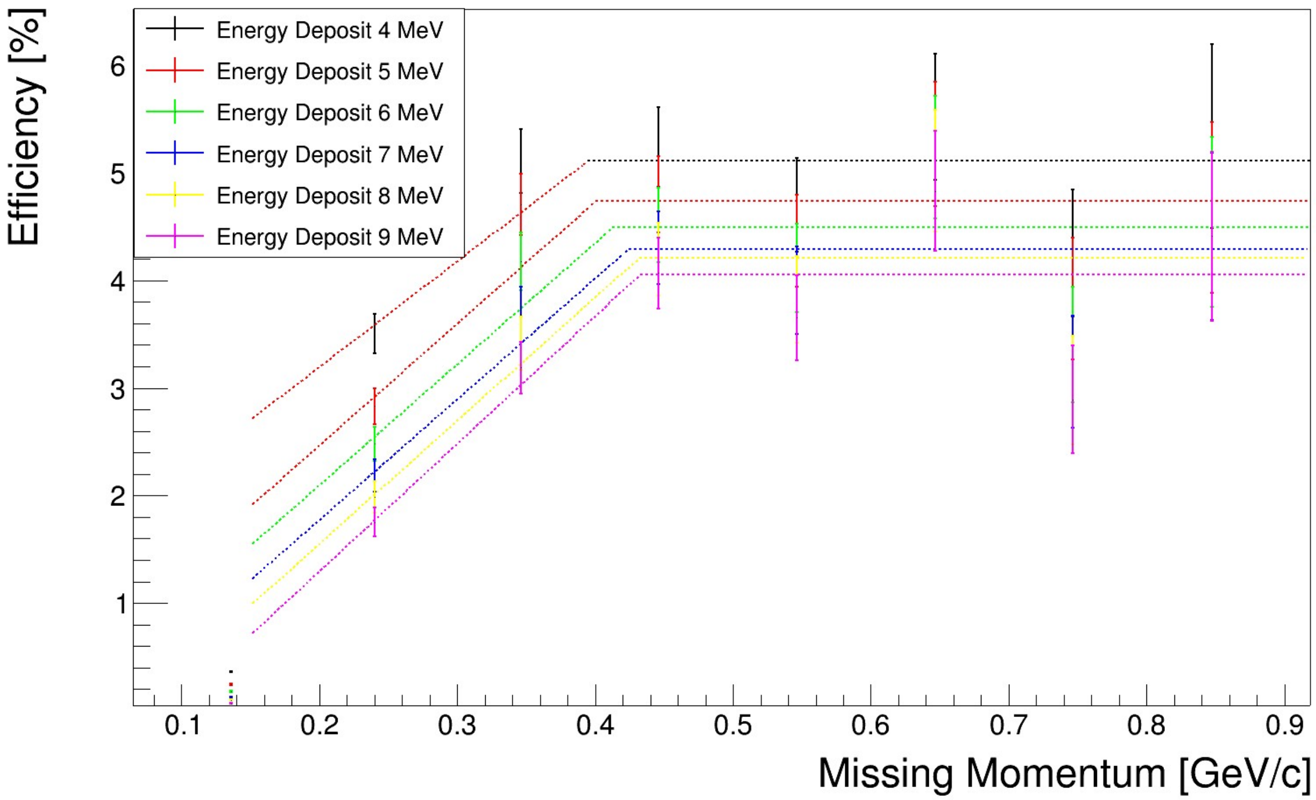


Large background at low
Missing momentum



$$\frac{\Delta p}{p} \approx 8\%$$

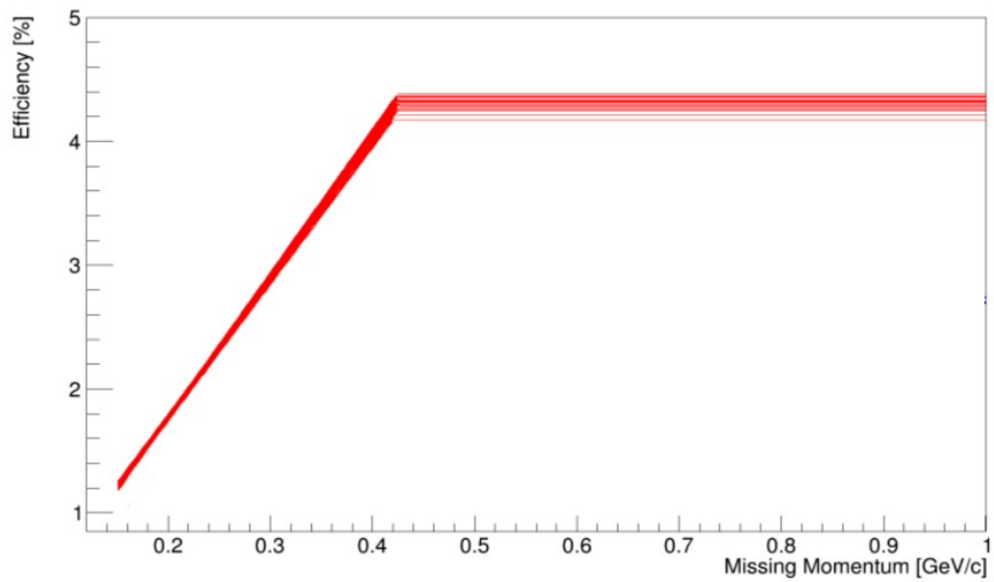
Absolute neutron detection efficiency



$$\eta = \frac{Measured}{Expected} = \frac{d(e,e'pn)}{d(e,e'p)}$$

Test veto algorithm

For a given energy deposition and 30 Veto conditions.



Selection of A(e,e'p) events

Same cuts as for the A(e,e'pp) analysis

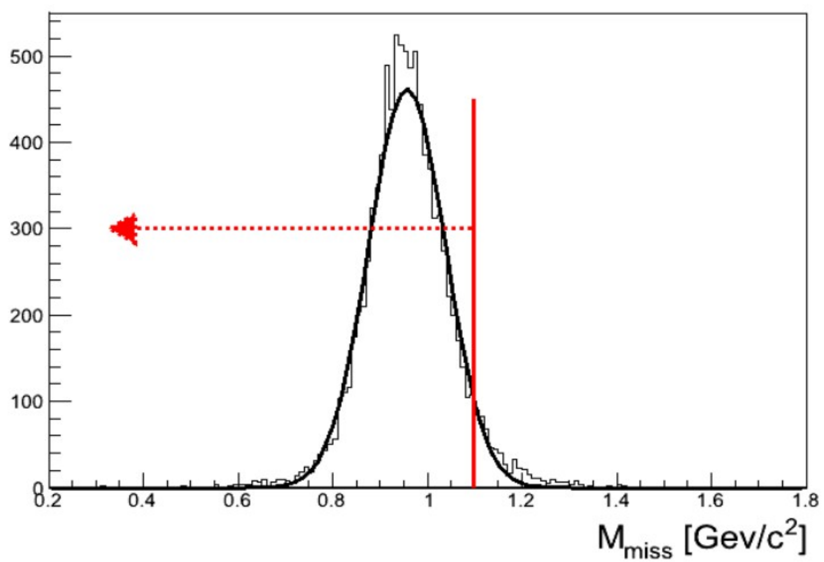
Hen et al., Science 346 (2014)

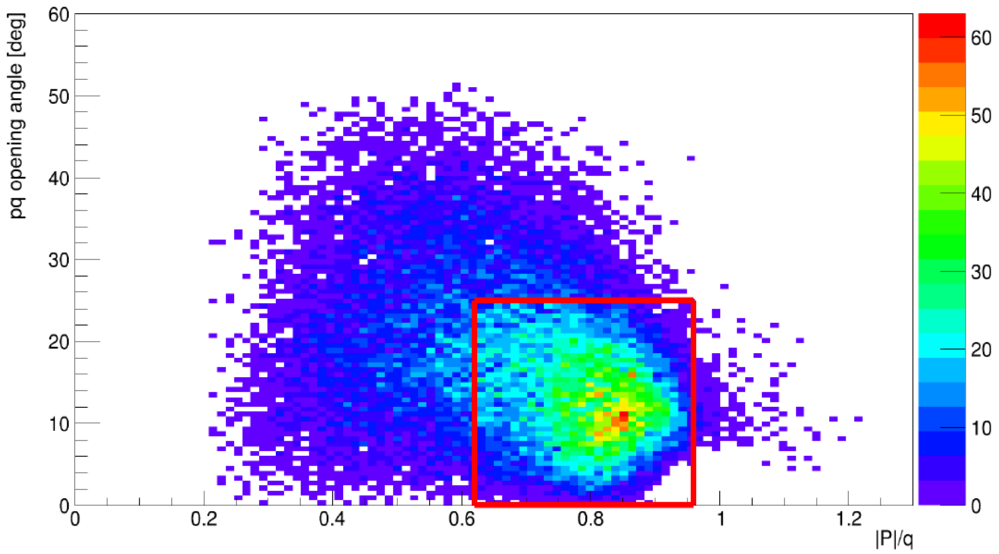
$X_B > 1.2$

Leading Proton: $0.96 > q/p > 0.62$ and acos(pq) <25

Missing Mass < 1.1

300 MeV/c < Missing Momentum < 1 GeV/c



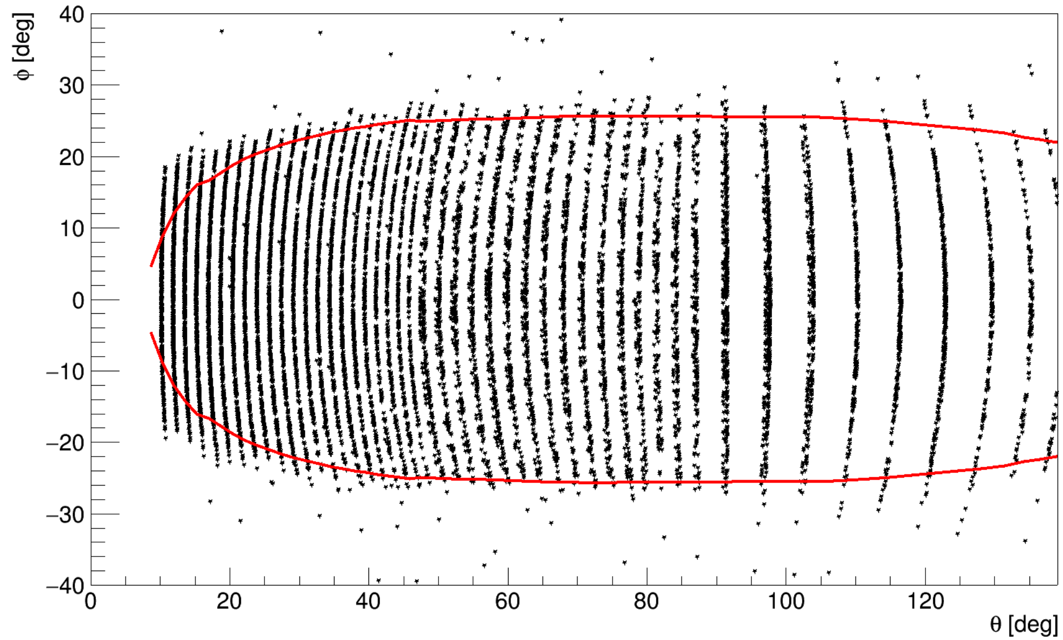


Selection of A(e,e'pn) events

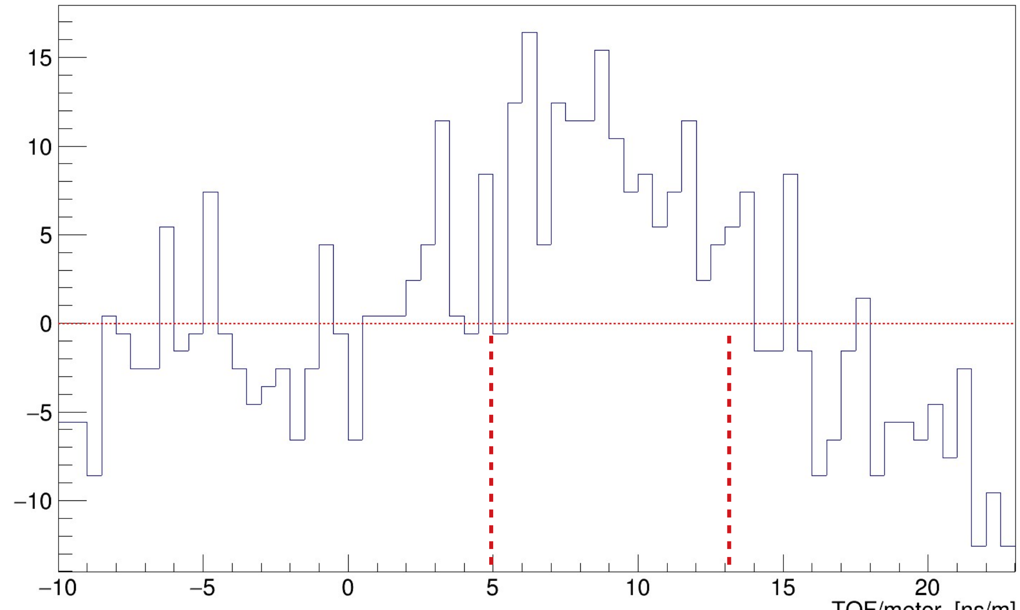
1) A(e,e'p) cuts

2) CLAS fiducial region for neutrons

Individual TOF bars seen



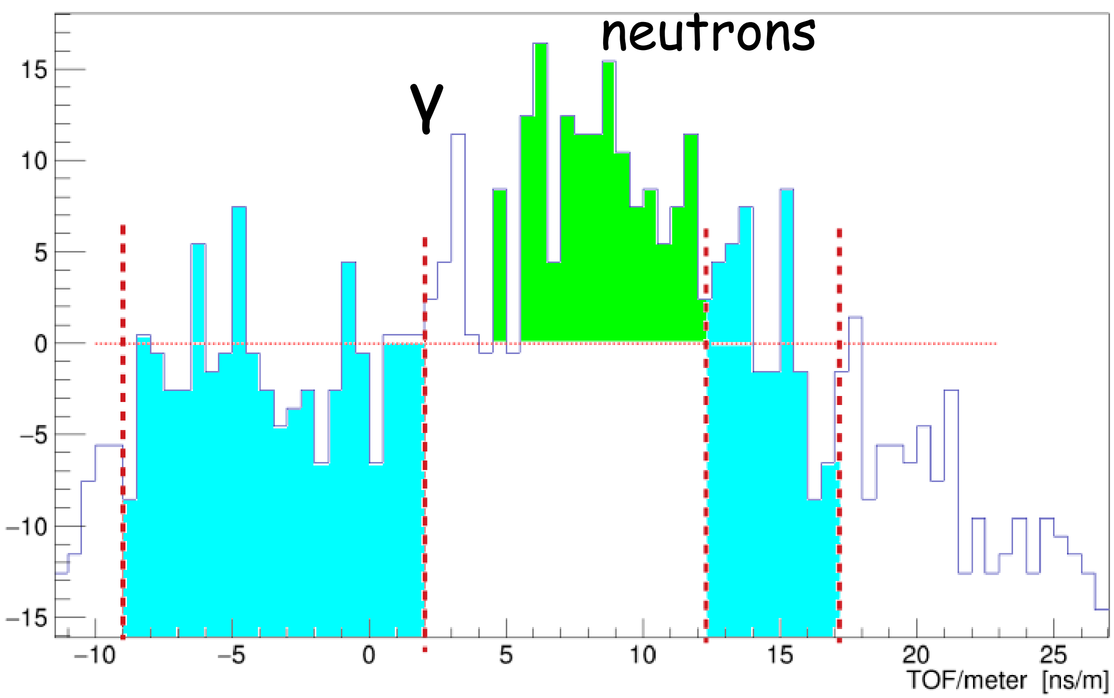
3) Time of flight



Time Window

BG subtraction - Out of time window

Estimate BG using out of time window, assuming Poisson statistics

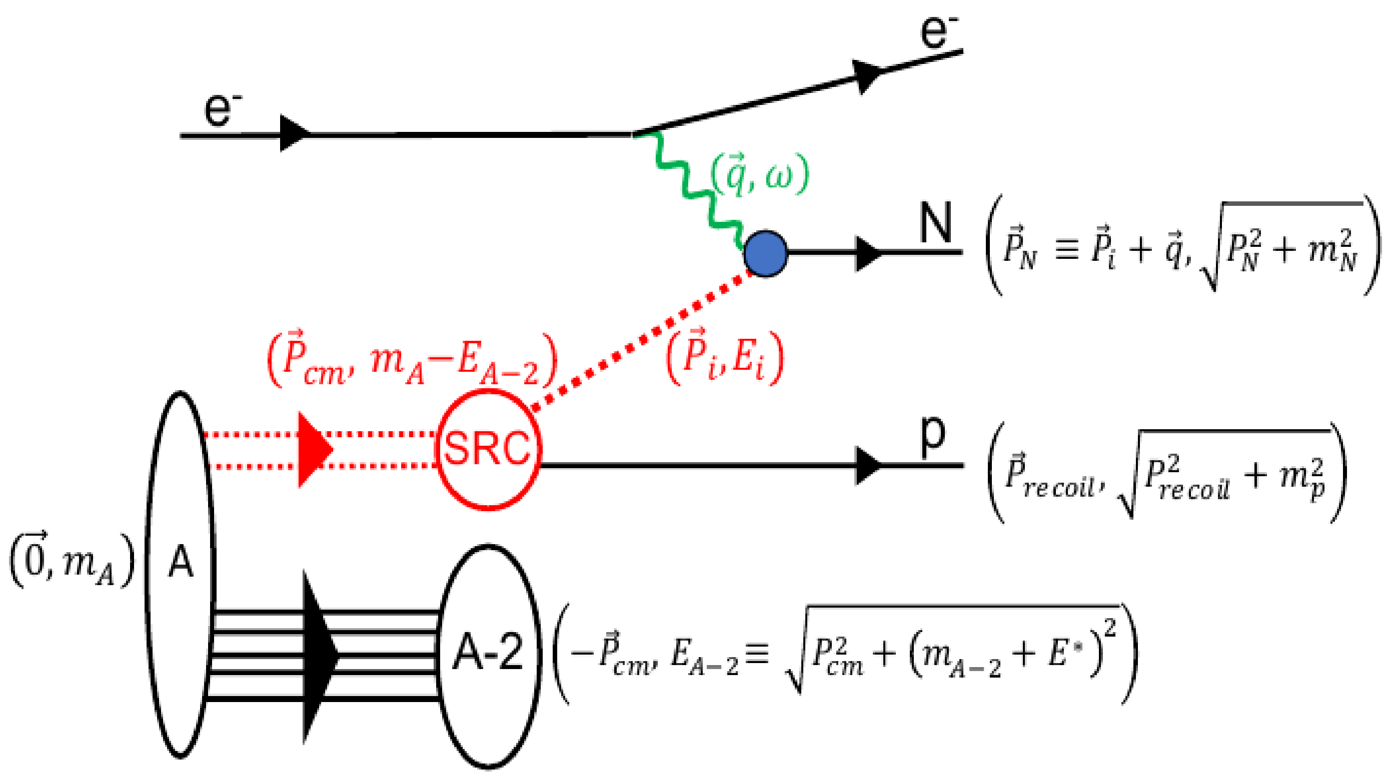


For each bin in the signal region, simulate number of BG events based on the cyan distribution.

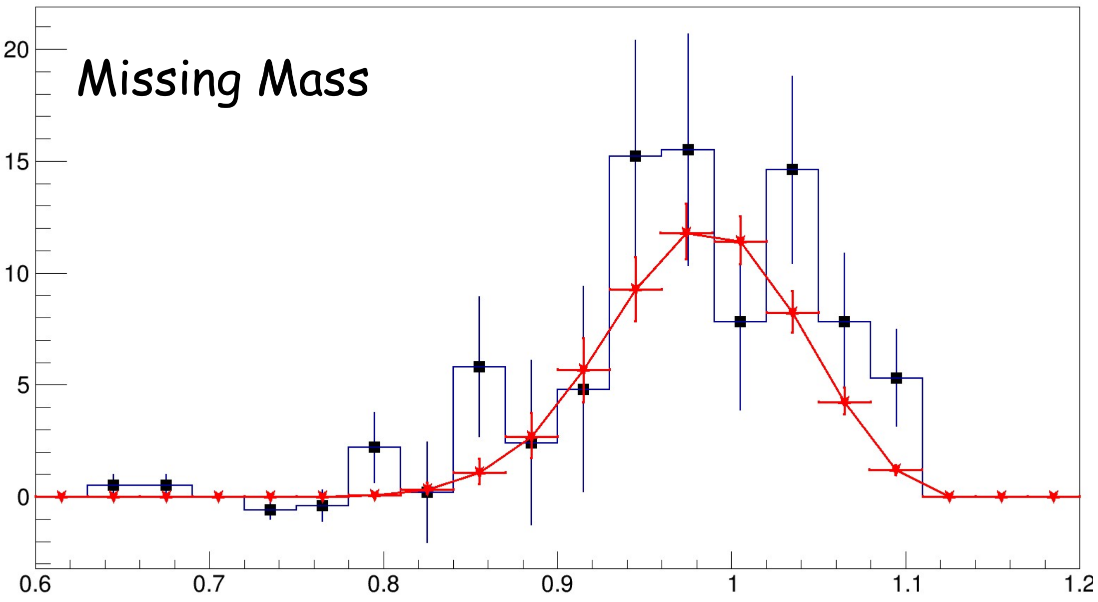
Repeat for N times

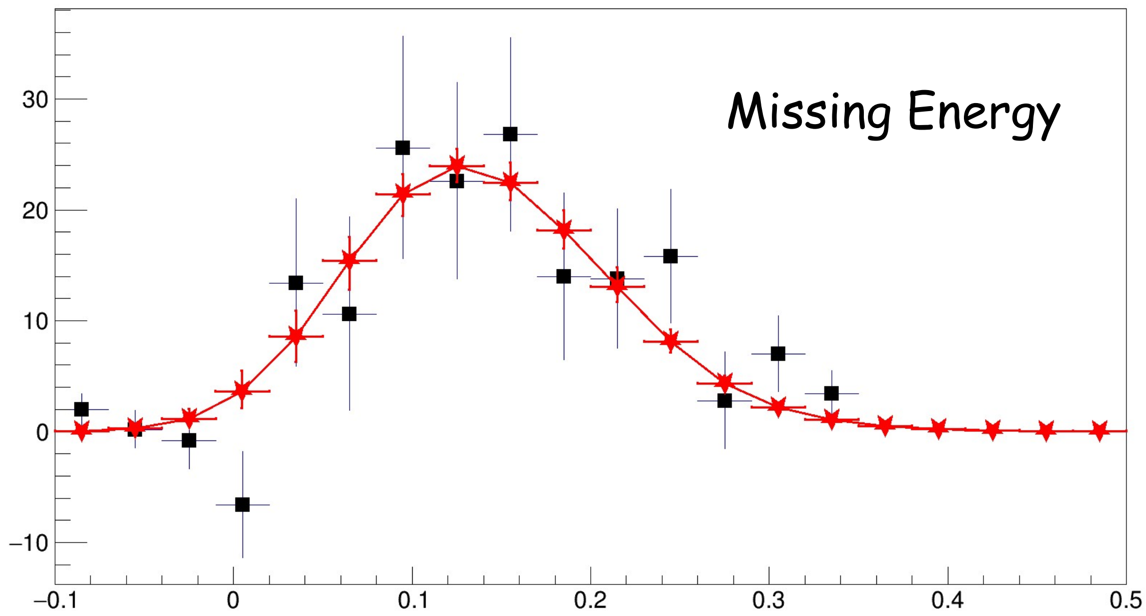
Take the average as a number of Netto neutrons

GCF comparisons

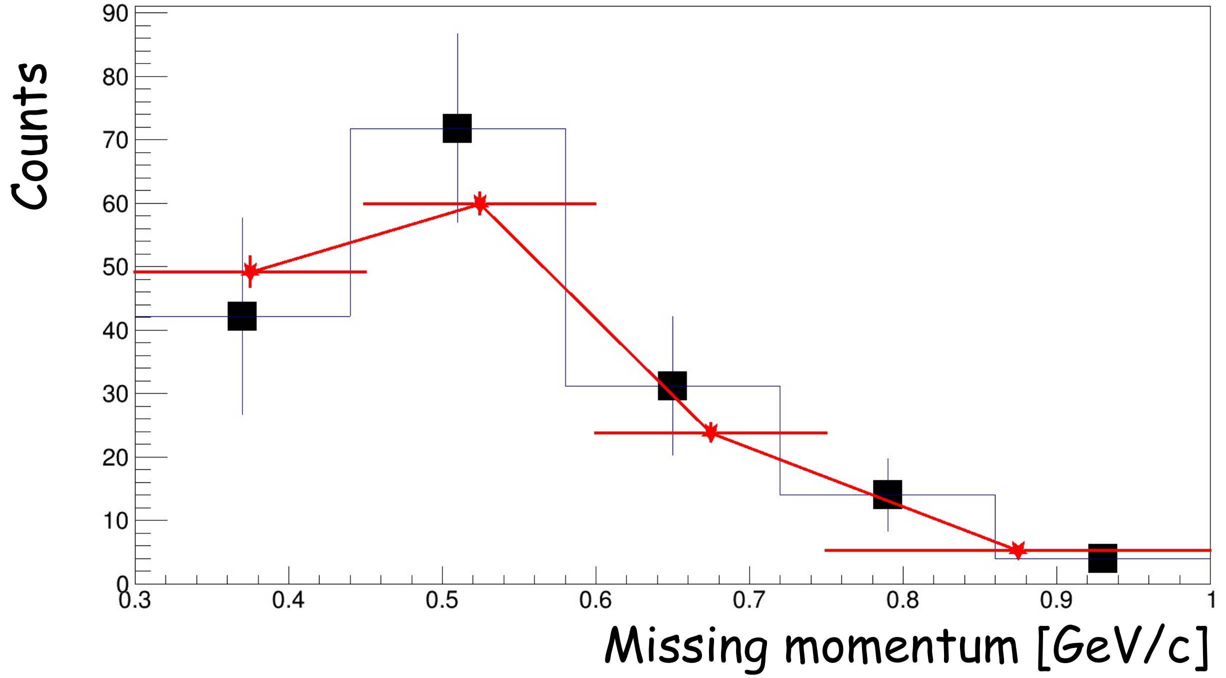


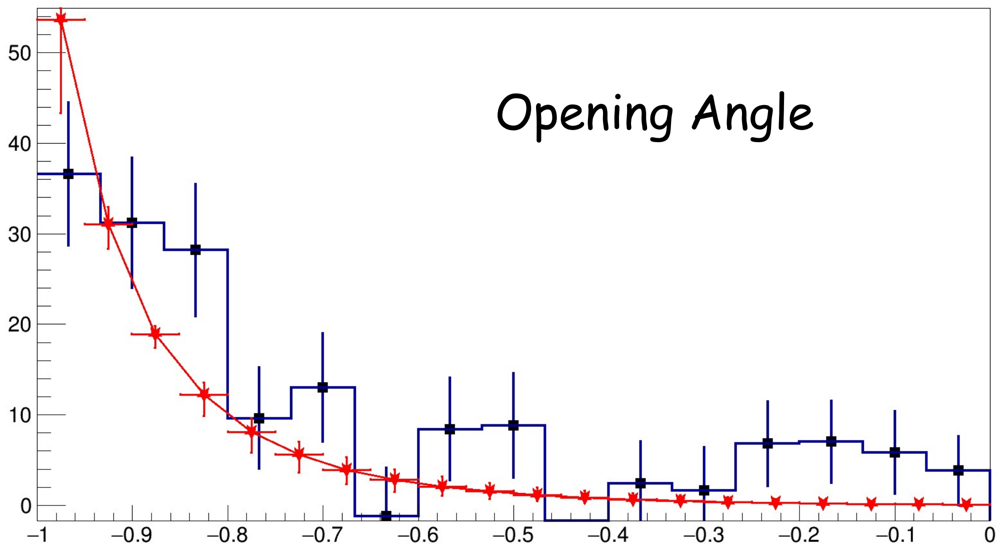
C(e,e'p) quantities (requiring recoil neutron)





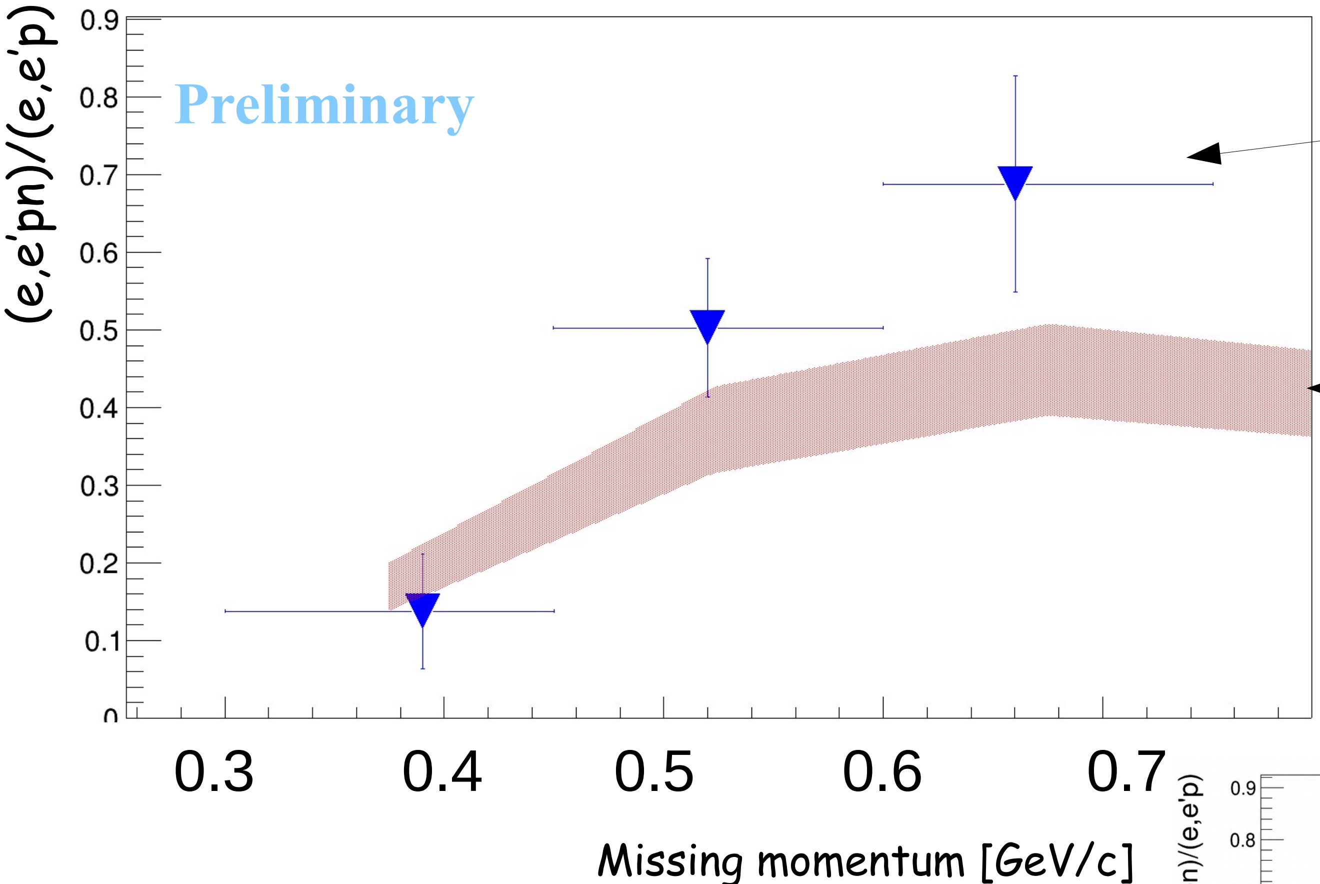
Reconstruction of kinematic variables





C(e,e'pn)/C(e,e'p) Result

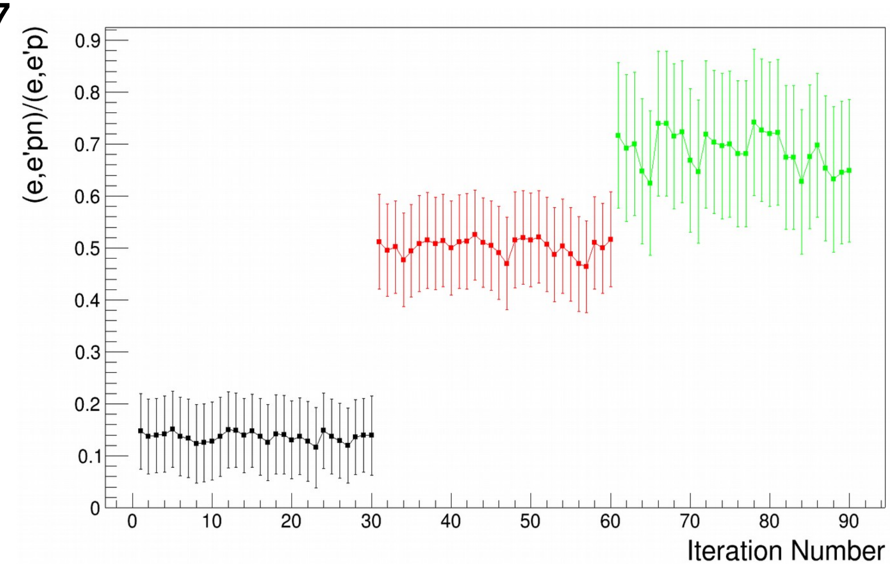
*Data is corrected to the neutron detection efficiency



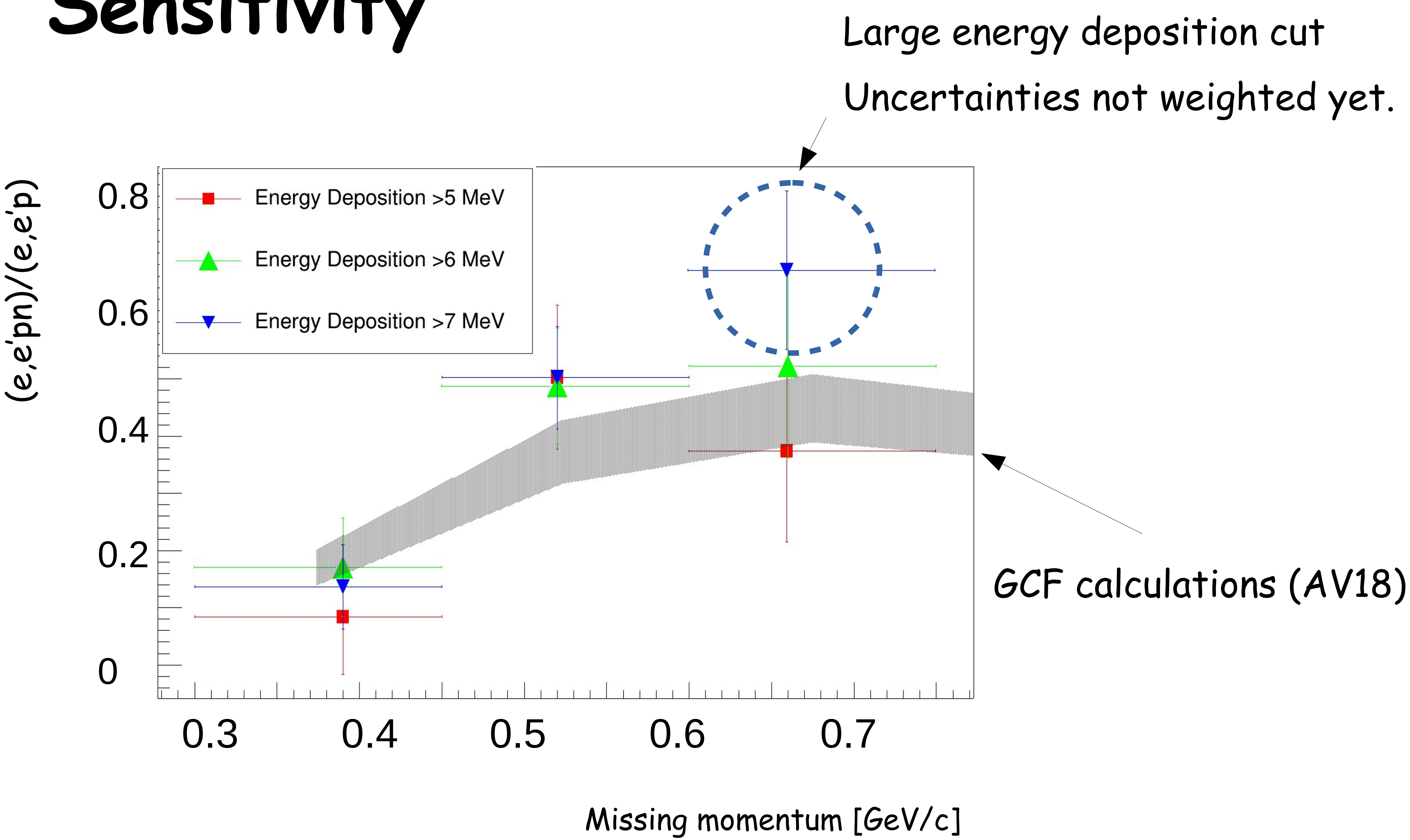
Energy deposition > 7 MeV
(only statistical uncertainties)

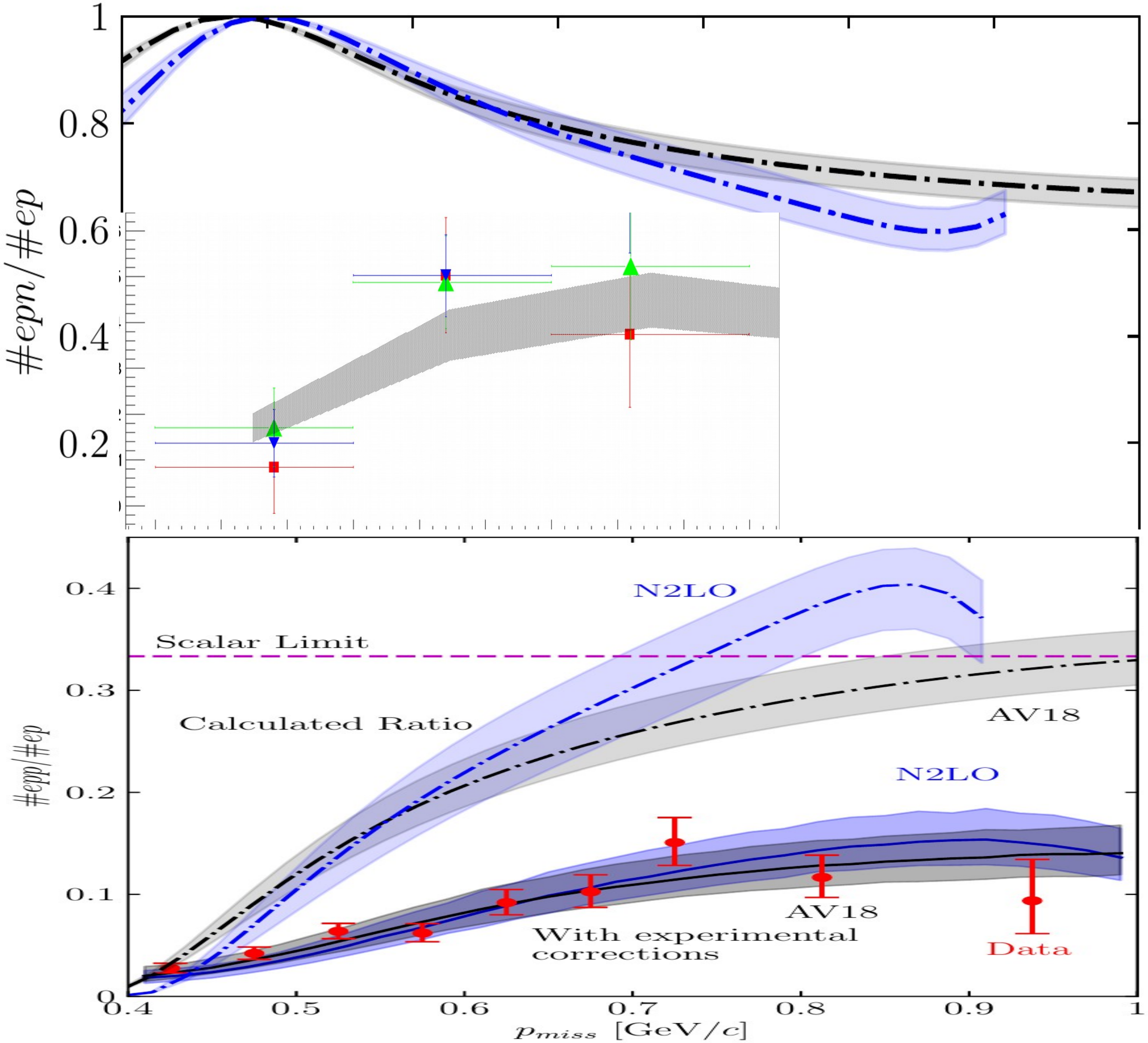
GCF calculations based on AV18

Veto sensitivity test



Sensitivity





Due to large uncertainties,
We can't distinguish between
AV18 and N2LO based on
(e,e'pn) data.

See Axel talk

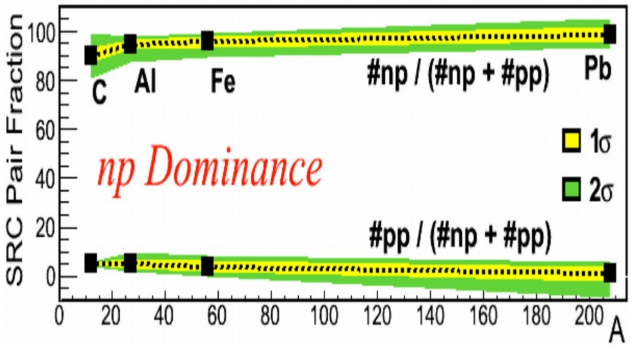
Summary

The measured C(e,e′pn)/C(e,e′p) is consistent with the GCF

pn measurement is less sensitive to the SCX correction

pp + pn pairs up to 750 MeV/c are almost 100%

pp/np is going from ~1/20 to ~1/2



Hen et al., Science 346 (2014)

The total number of neutron events is constant:

Hall A: E05-015, carbon target:	~200 neutrons
Hall A: E07-006, He^4 target:	~200 neutrons
CLAS6: A(e,e′np), EC detector:	~200 neutrons
CLAS6: A(e,e′pn), TOF counters:	~200 neutrons

CLAS 12

Thank you for
you attention