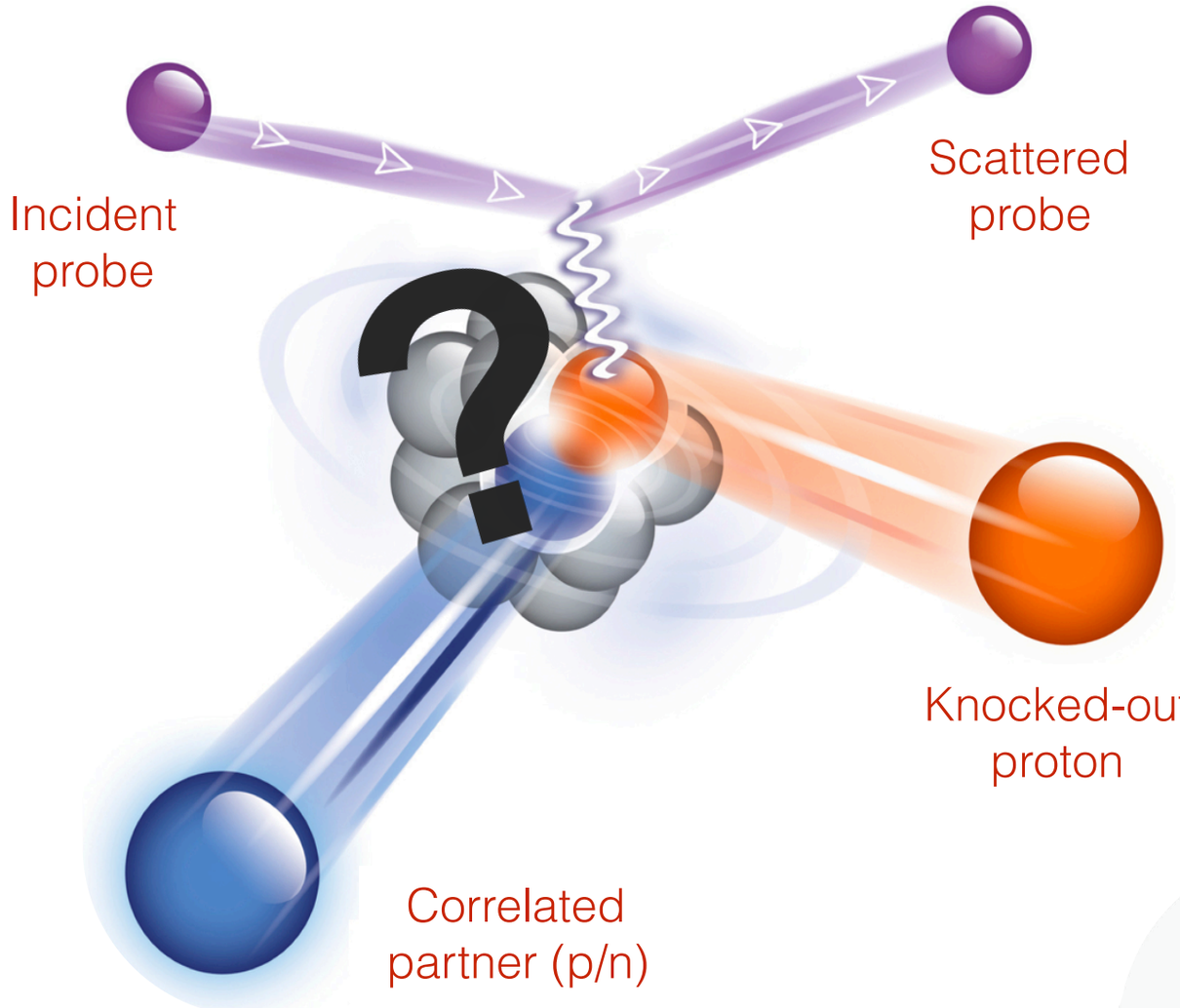
SRC Physics at Joint Institute for Nuclear Research

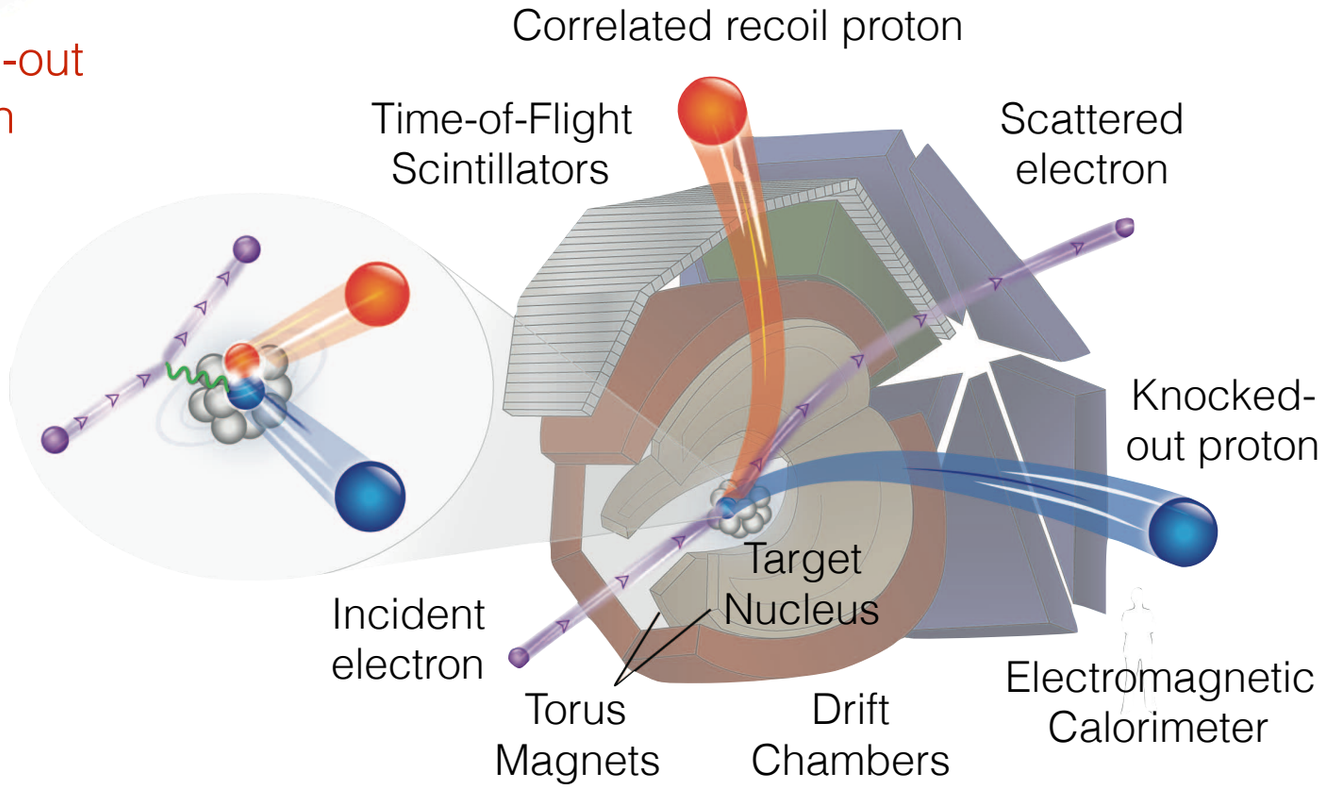
Efrain Segarra

2nd Workshop on Quantitative Challenges in SRC and EMC Research

We've all heard a lot about the studies of SRC nucleons…

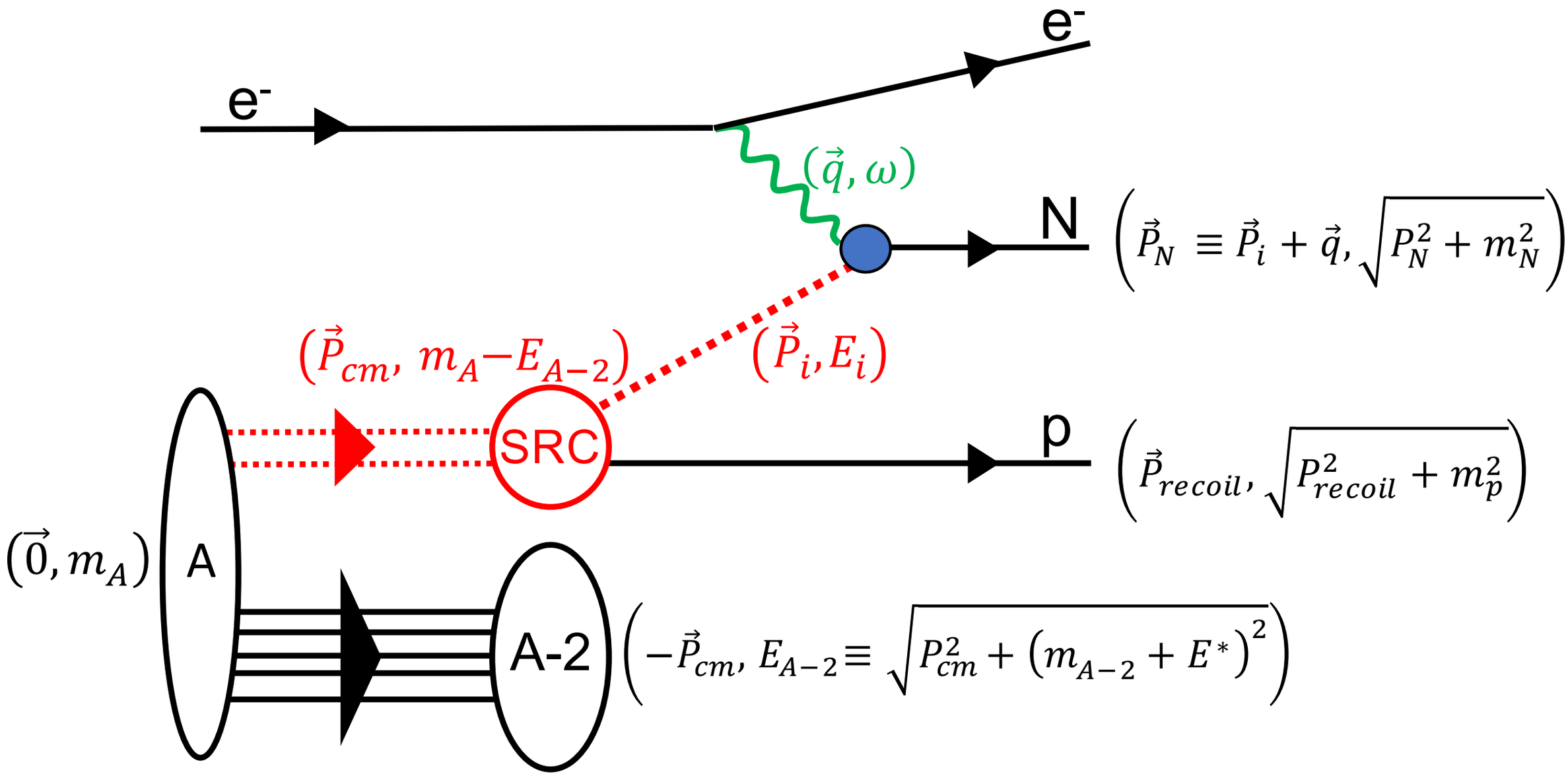


Previous Studies: Fixed Target

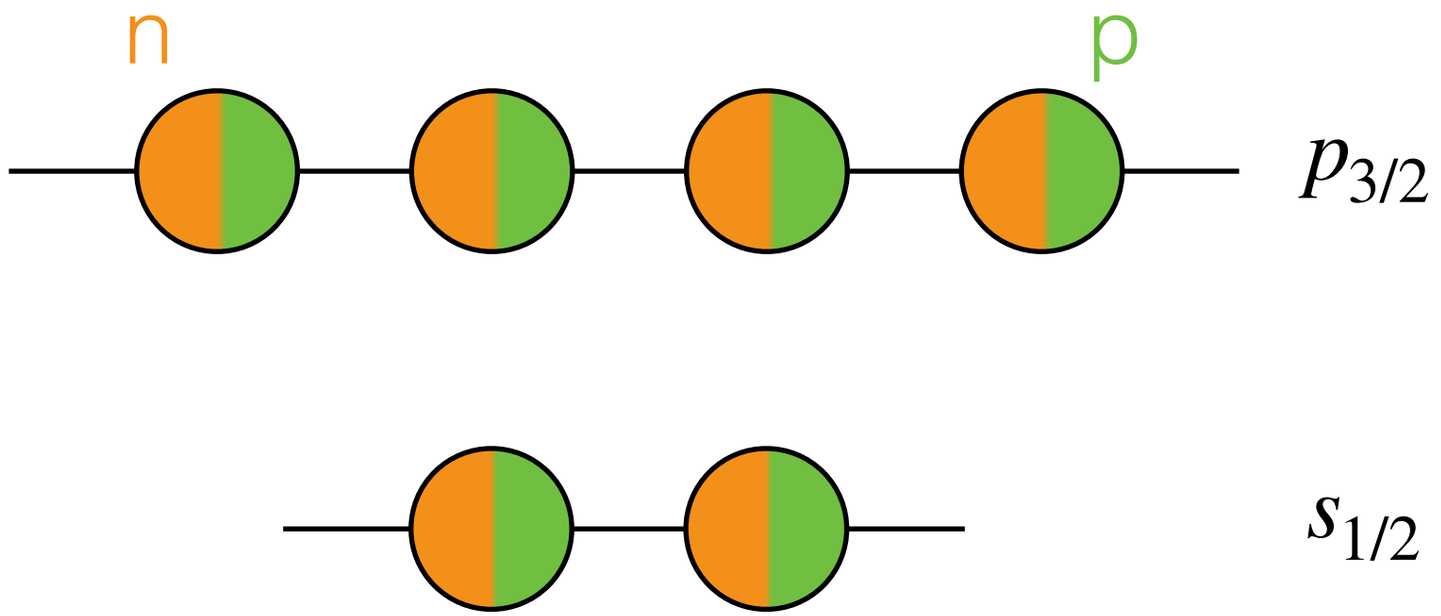


CLAS 6 (Hall B) Jefferson Lab

The state of the A-2 residual nucleus impacts SRC kinematics



We can learn how SRC pairs form from residual system state



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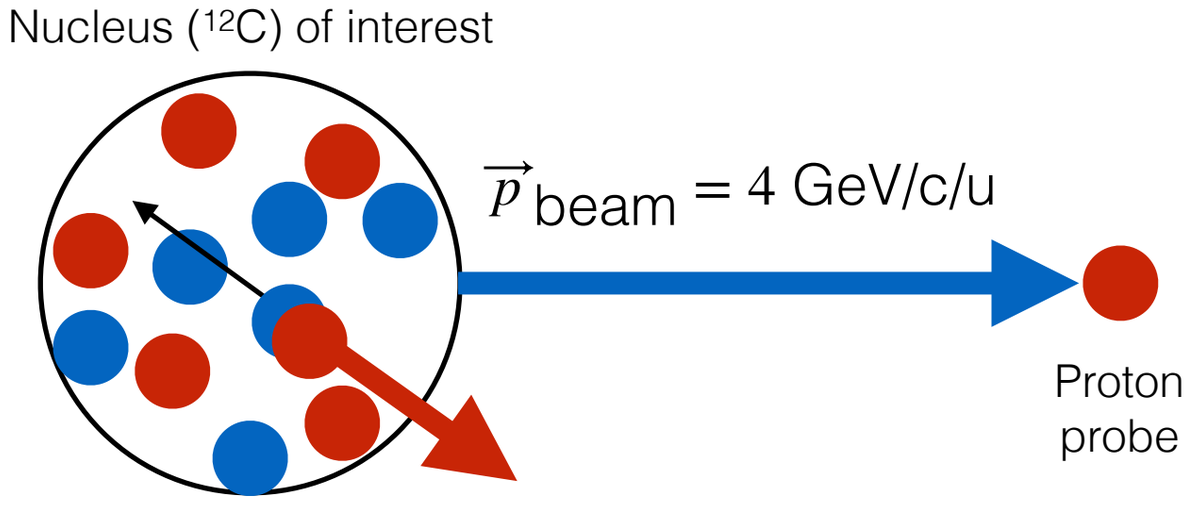
Structure and decay of the s-hole state in ^{11}B studied via the ^{12}C$(p, 2p)^{11}$B* reaction

M. Yosoi [a], H. Akimune [b], I. Daito [c], H. Ejiri [d,e], H. Fujimura [f], M. Fujiwara [f,g], T. Ishikawa [a,1], M. Itoh [a,2], T. Kawabata [a,3], M. Nakamura [a], T. Noro [f,4], E. Obayashi [f], H. Sakaguchi [a], H. Takeda [a], T. Taki [a], A. Tamii [h], H. Toyokawa [d], N. Tsukahara [a], M. Uchida [a], T. Yamada [i], H.P. Yoshida [f]

Now we've done the first study of target beam on probe…

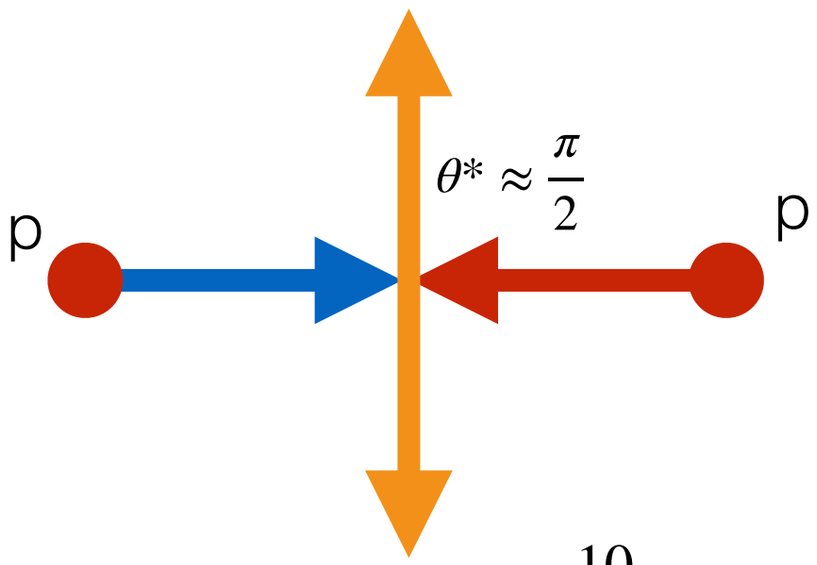
Lab Frame:



To study SRC pairs: $|p_{miss}| \geq 250$ MeV/c

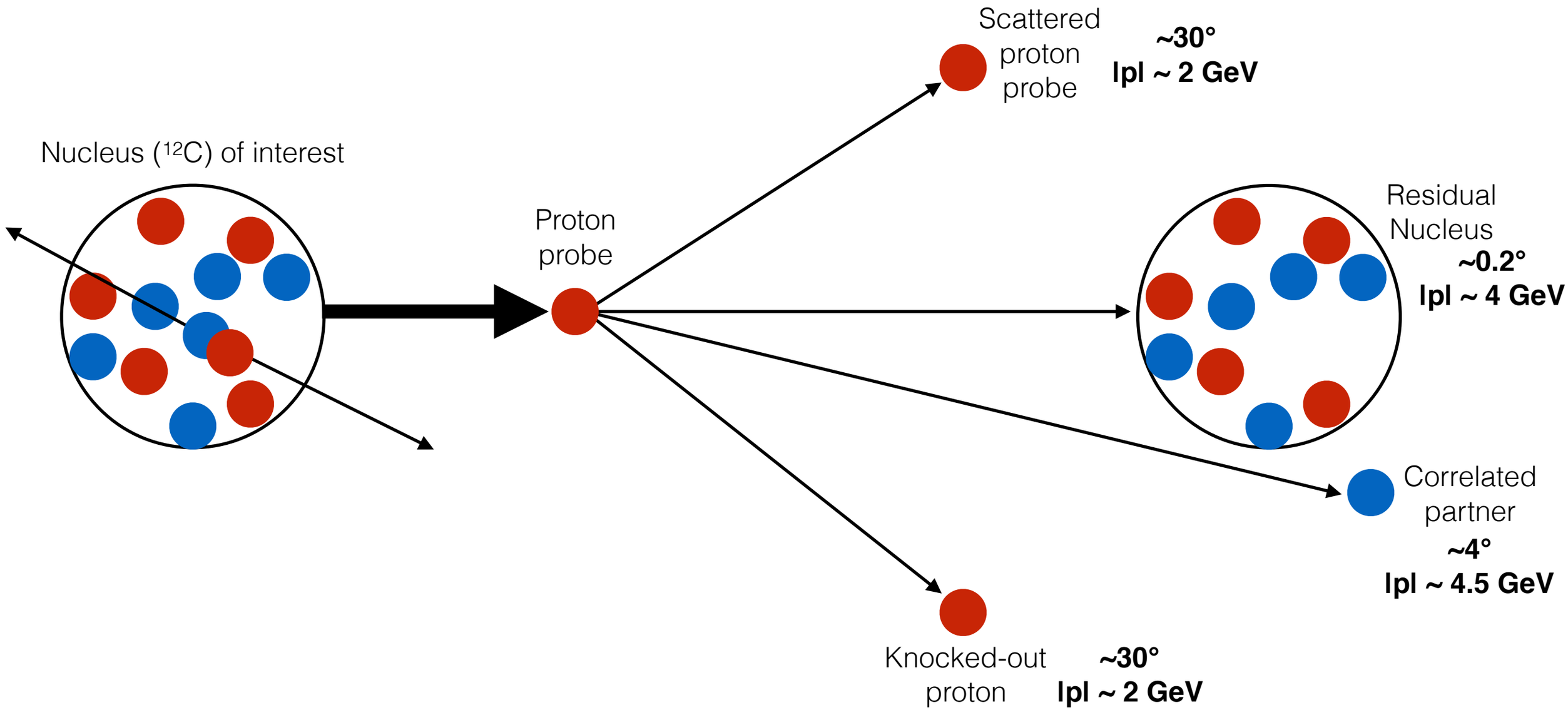
$|s,t,u| > 2$ (GeV/c)^2 (Hard process)

CM Frame:

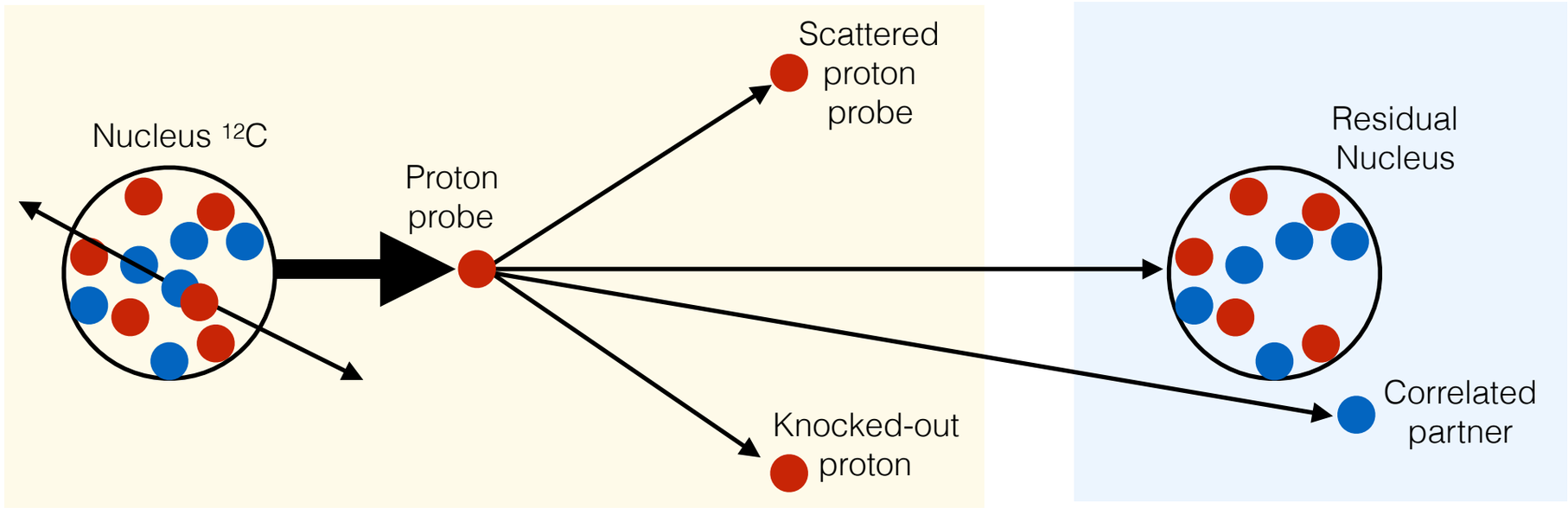


$\sigma_{pp\to pp} \propto s^{-10}$ (Gain higher SRC statistics with proton probe)

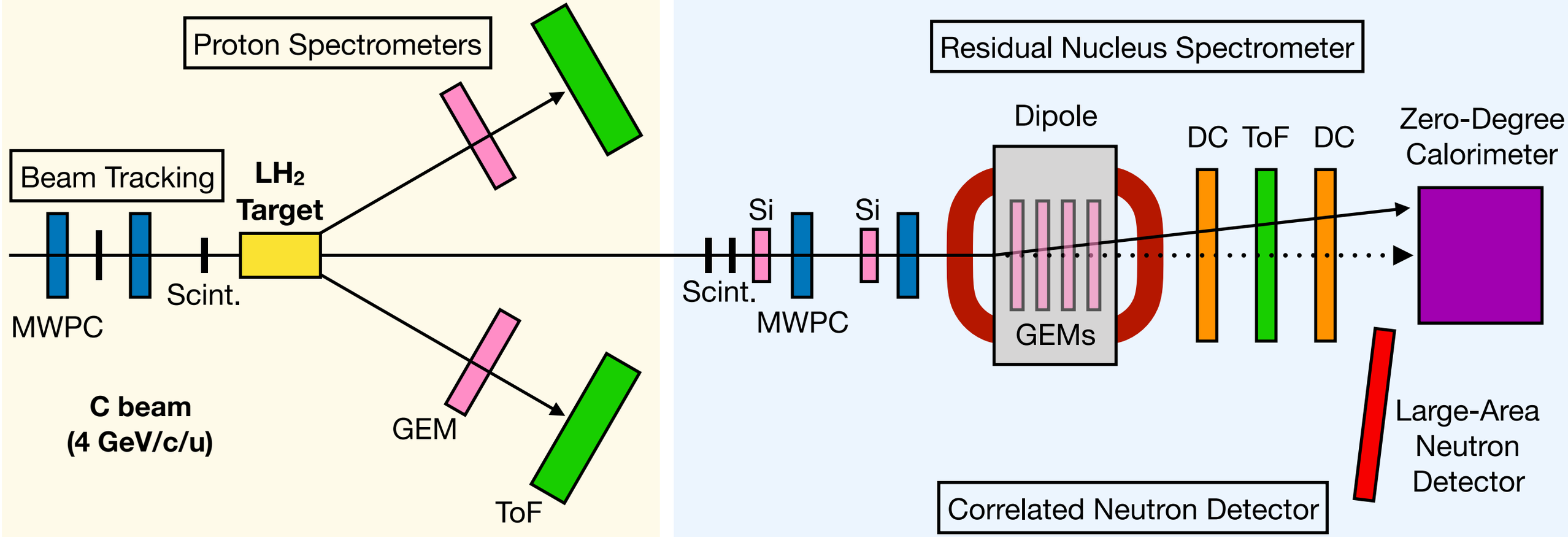
Boost back to our lab frame,



Inverse Kinematics Setup for SRC Studies at Joint Institute for Nuclear Research (JINR)



(Not drawn to scale)



ToF

GEMs

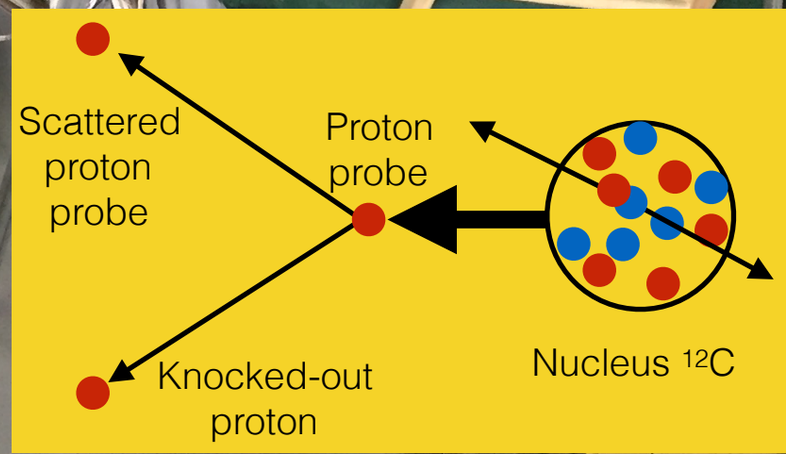
Dipole Magnet

MWPC

Target

GEMs

ToF



LAND

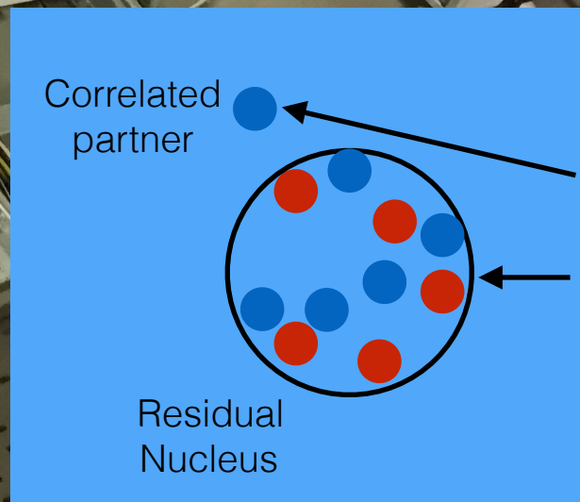
Residual Nucleus

ZDC

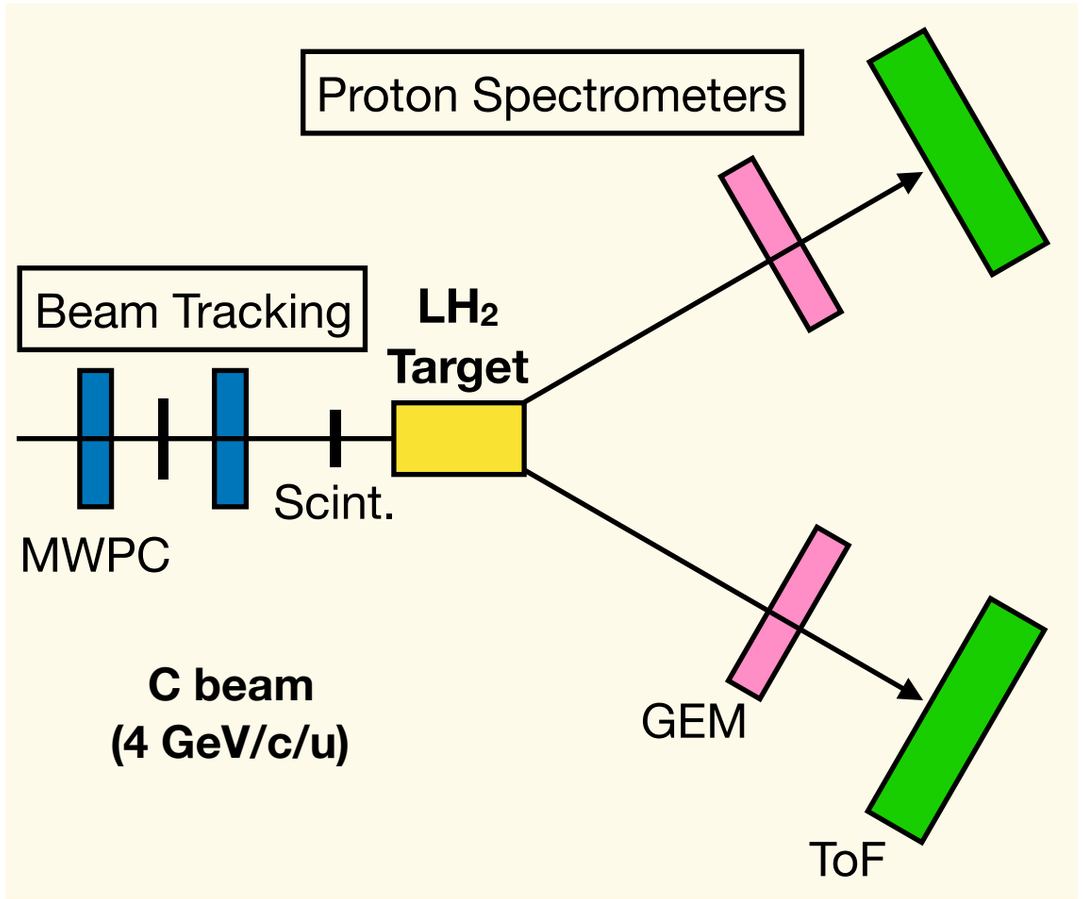
DCH

ToF

DCH



SRC Tagging

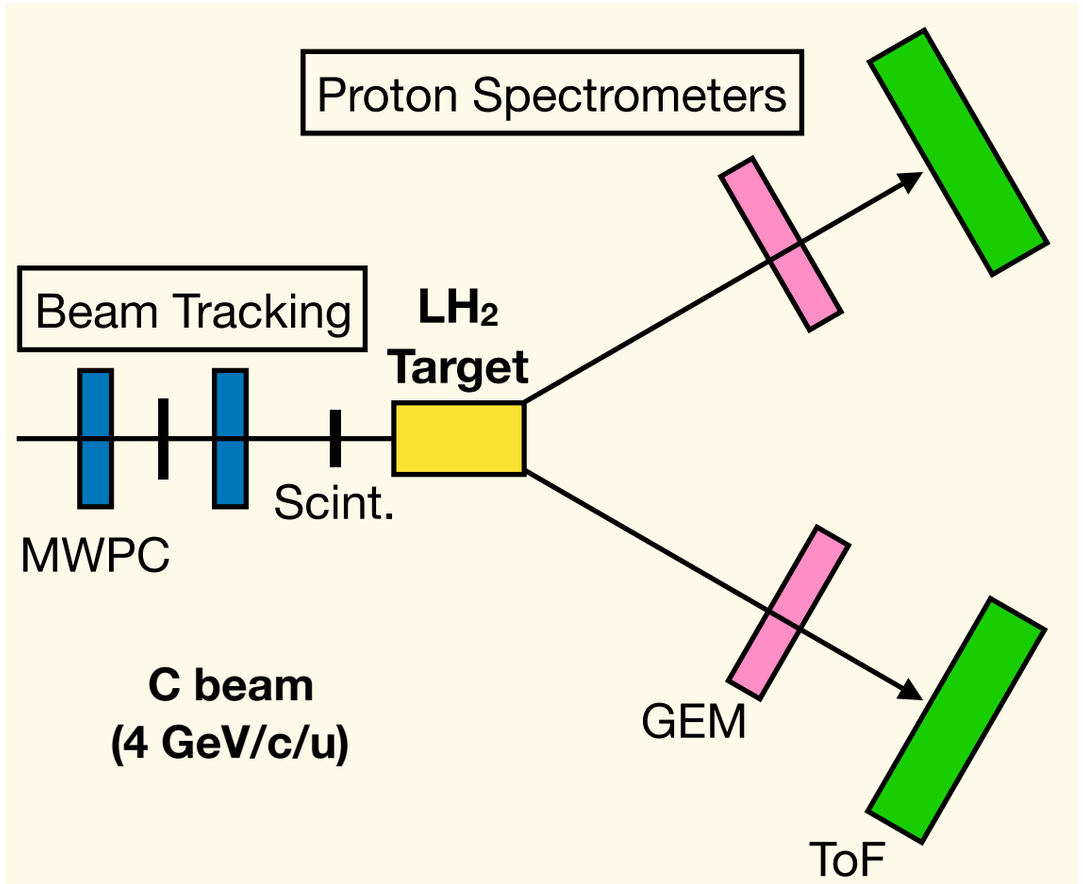


$$\beta = \frac{x}{c_{\text{air}} \cdot \text{ToF}}$$

$$|\vec{p}_1| = \frac{m_p}{\sqrt{1/\beta^2 - 1}}$$

$$\vec{p}_{\text{miss}} = \vec{p}_1 + \vec{p}_2 - \vec{p}_{\text{beam}}$$

SRC Tagging



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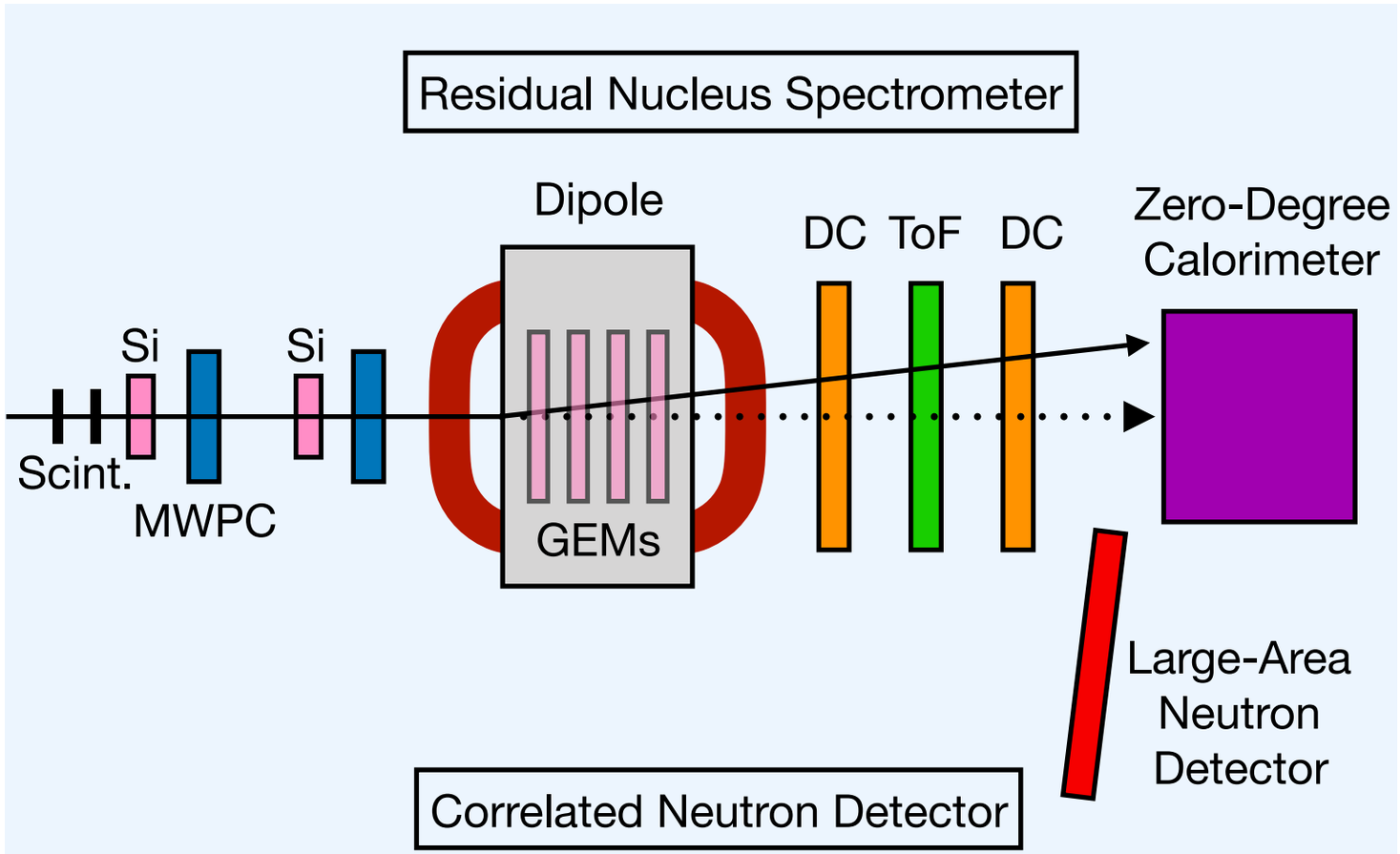
- Cannot discriminate pion from proton event-by-event in arms
- Need to have precise optics (for position measurement) & timing
- Need beam vector

A-2 Identification



$$\text{ADC} \propto \frac{dE}{dx} \propto Z^2_{\text{sum}}$$

$$\theta_{\text{bend}} \approx \frac{0.3\ Z\ BL\ \ [\text{T}\cdot\text{m}]}{A\ p\ \ [\text{GeV/c/u}]} \propto Z/A$$

$$\text{ToF} \approx \frac{\Delta x}{c_{\text{air}}} + \frac{1}{2}\frac{\Delta x}{c_{\text{air}}}\left(\frac{mc_{\text{air}}}{p}\right)^2$$

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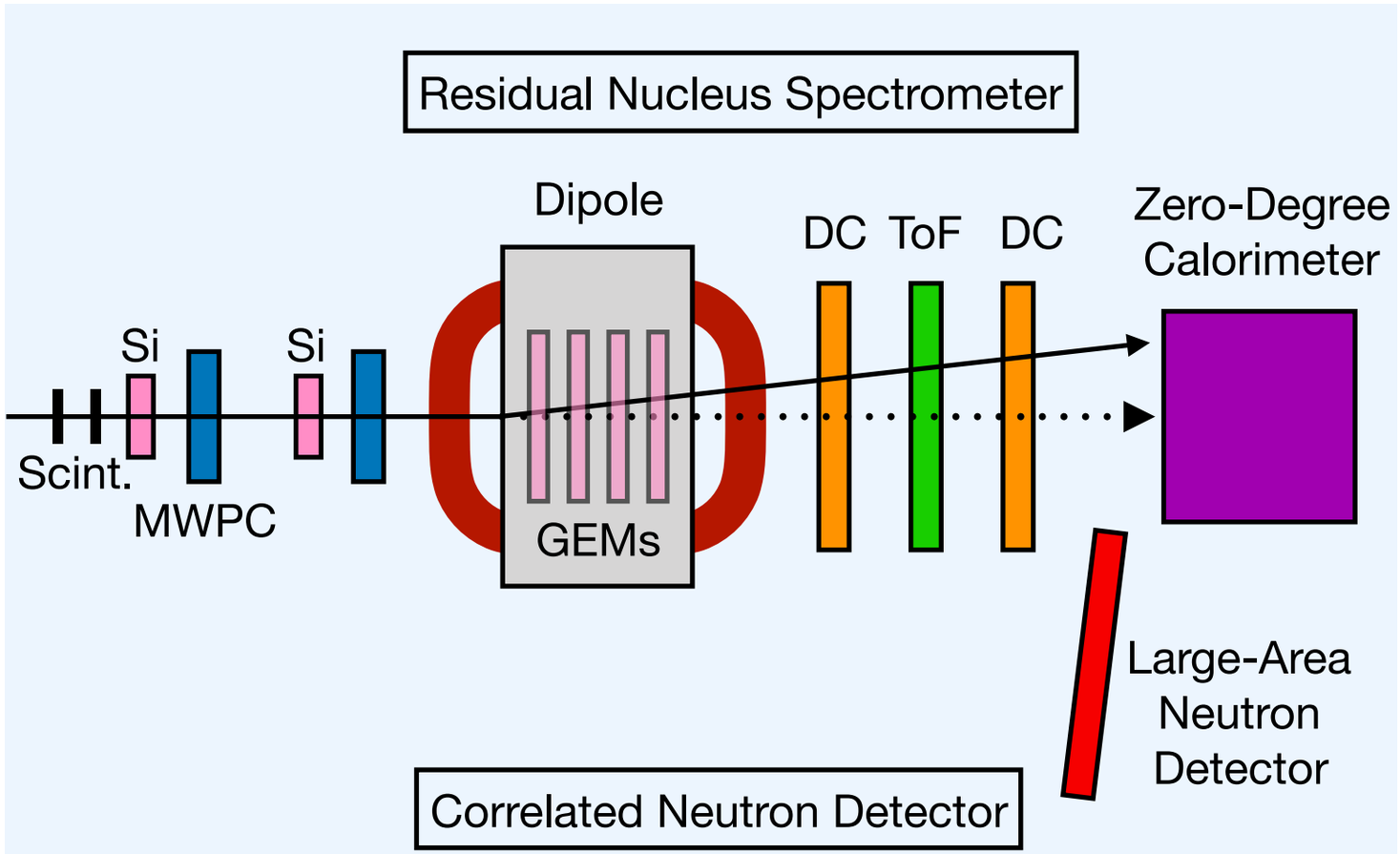

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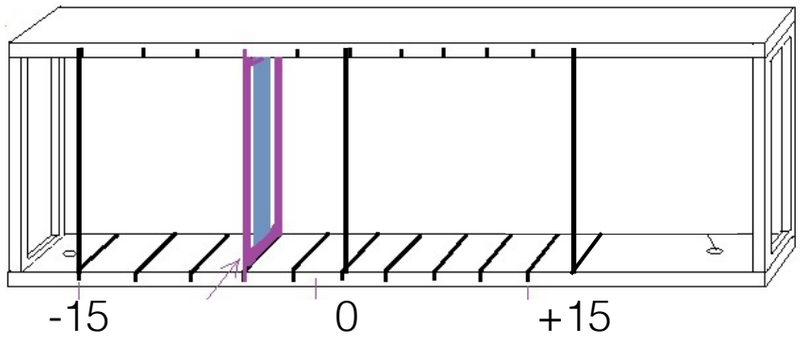
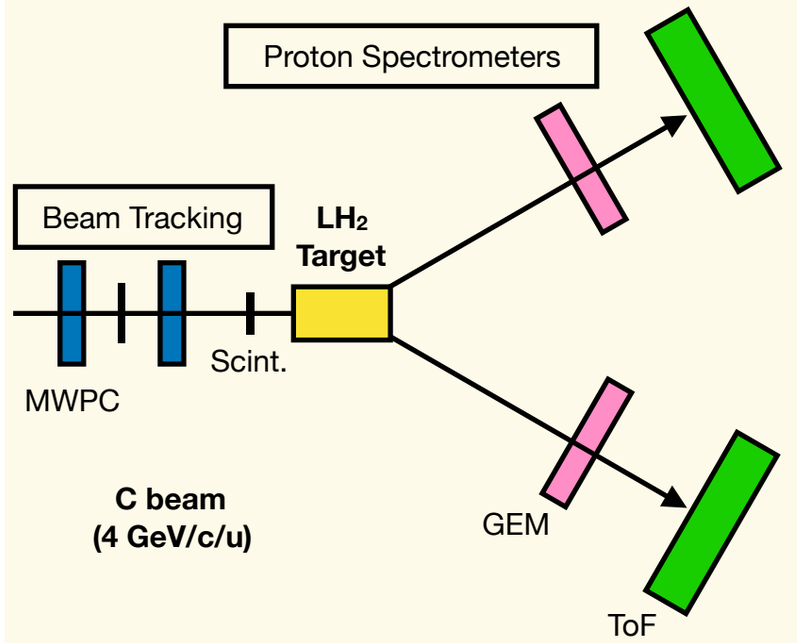
- Z^2_{sum} from pair of scintillators
- Number of A-2 fragments from MWPC / Si tracks / DC tracks
- (A,Z) separation from bending angle in dipole field & ToF
- *(Wish list) independent momentum measure with GEMs in dipole magnet*

In my talk today

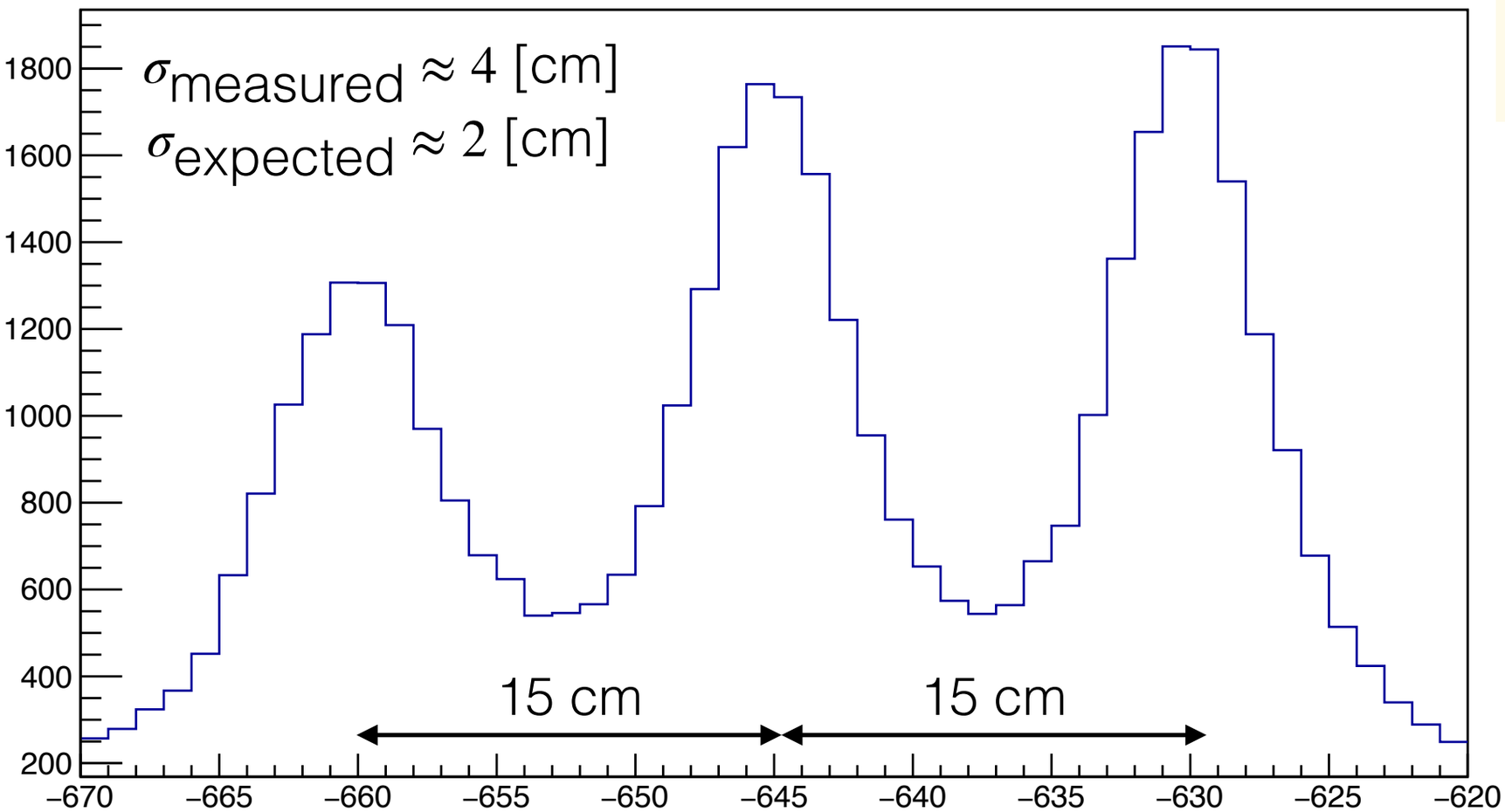
- Highlight status of calibration work
- Preliminary results on (p,2p) and A-2 System

Calibrating our ToF and GEM System

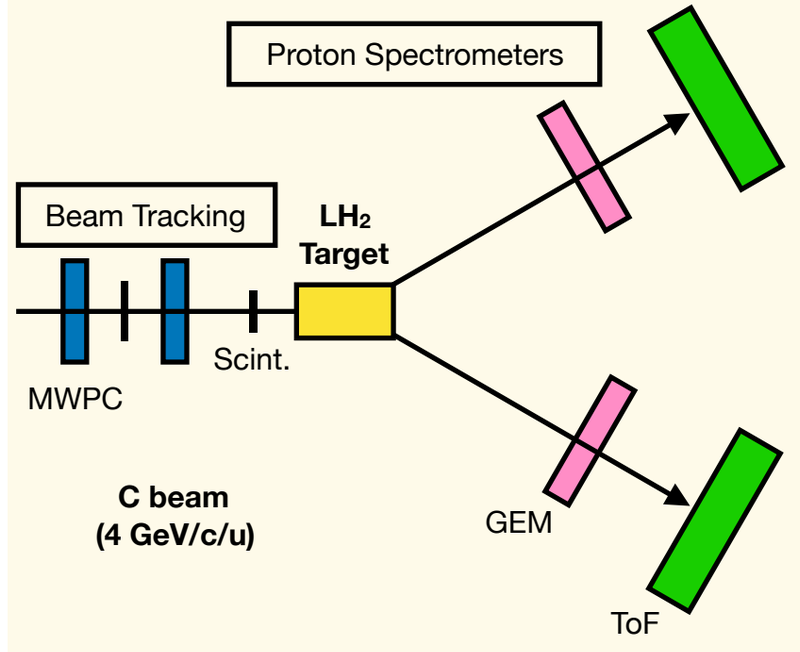




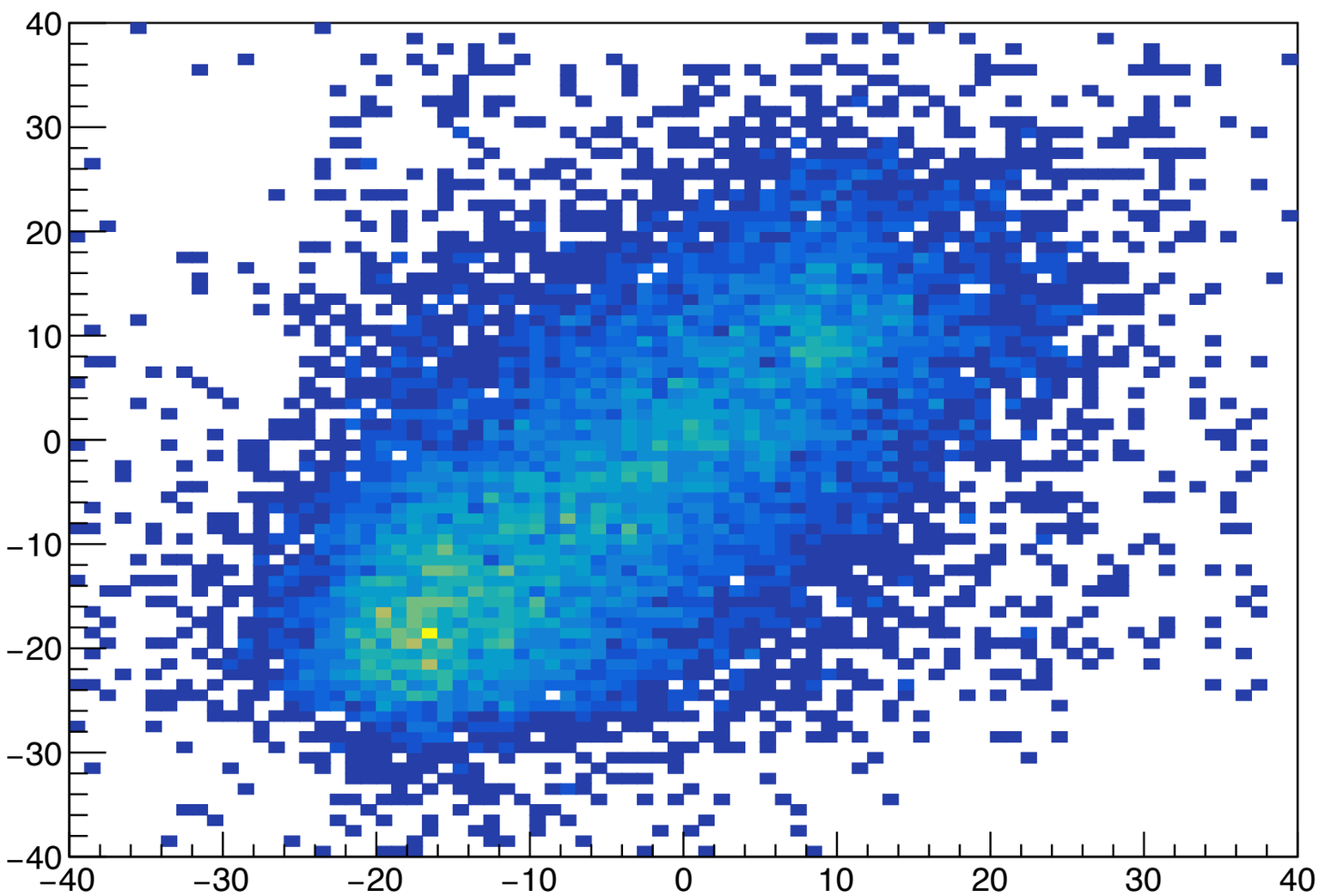
Reconstructing Target Position



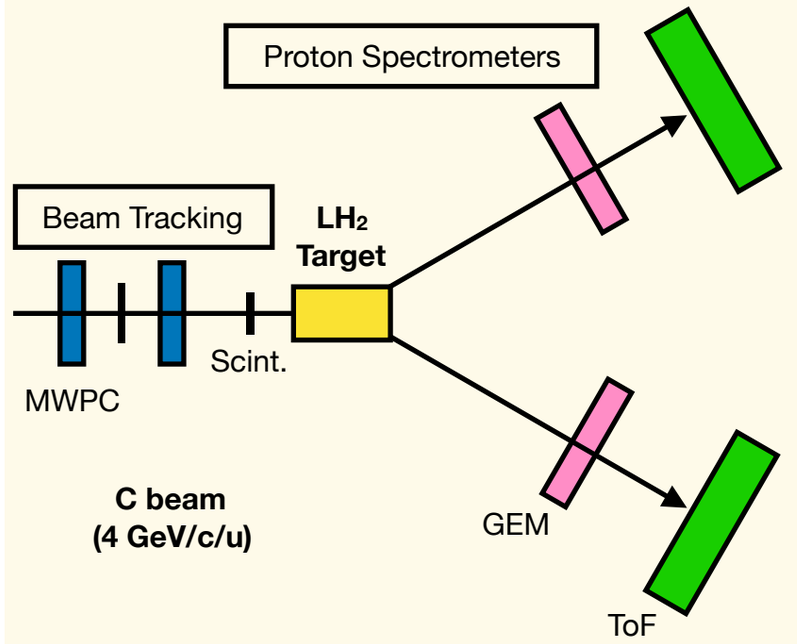
Target Reconstruction on Production Data



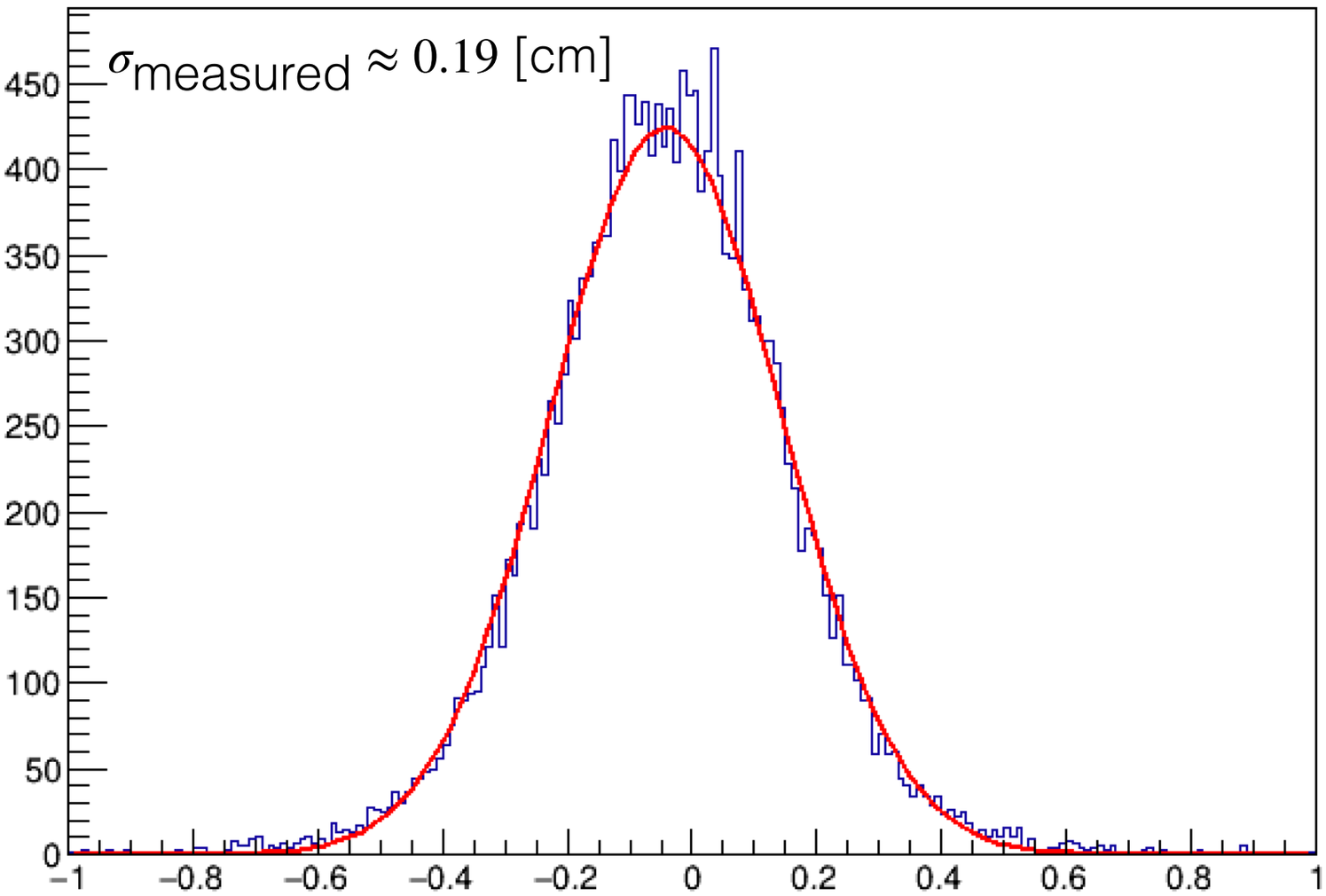
LH_2 Target 30cm



Extracting Beam Vector



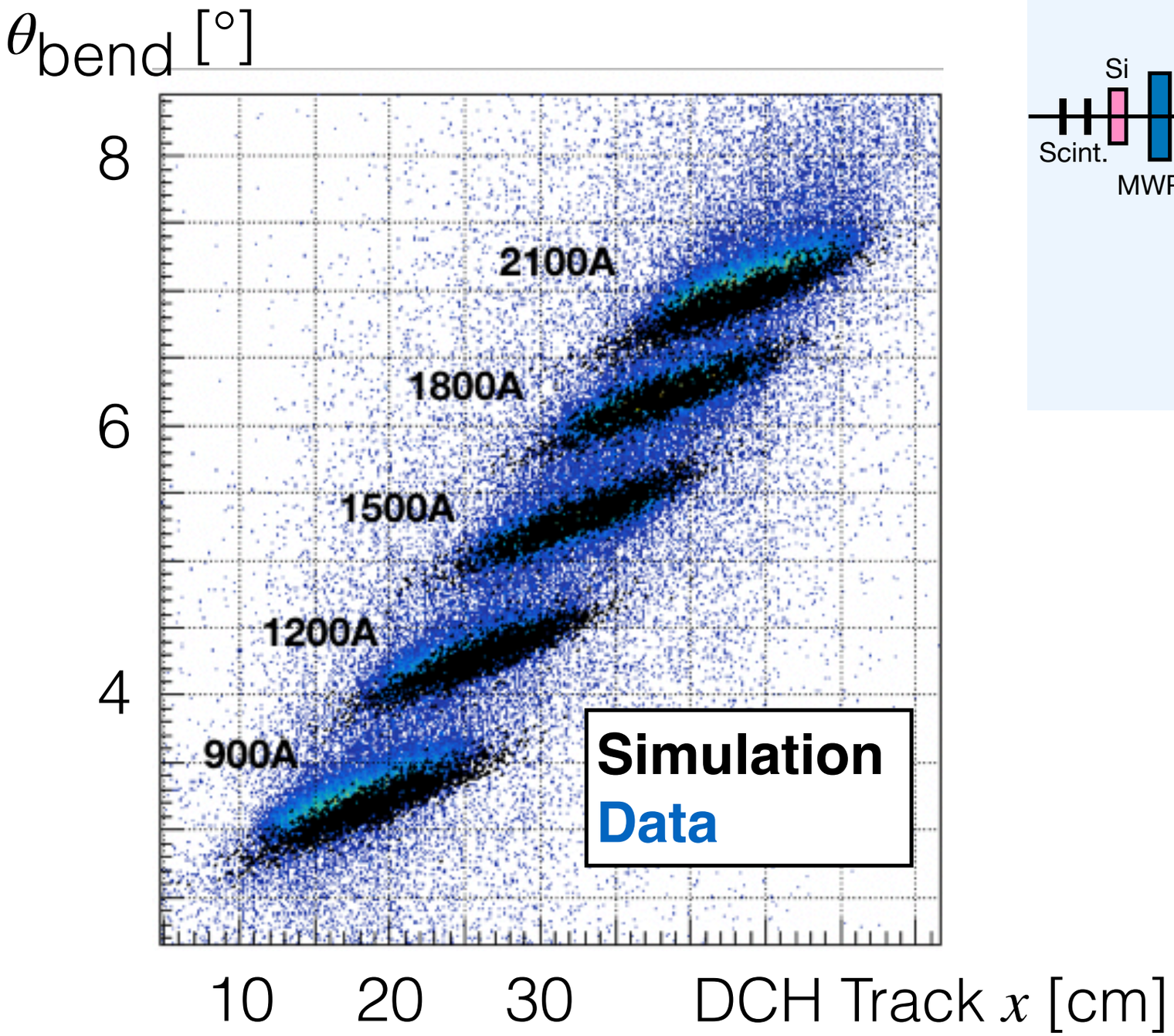
(Track Projection - Measured Hit)

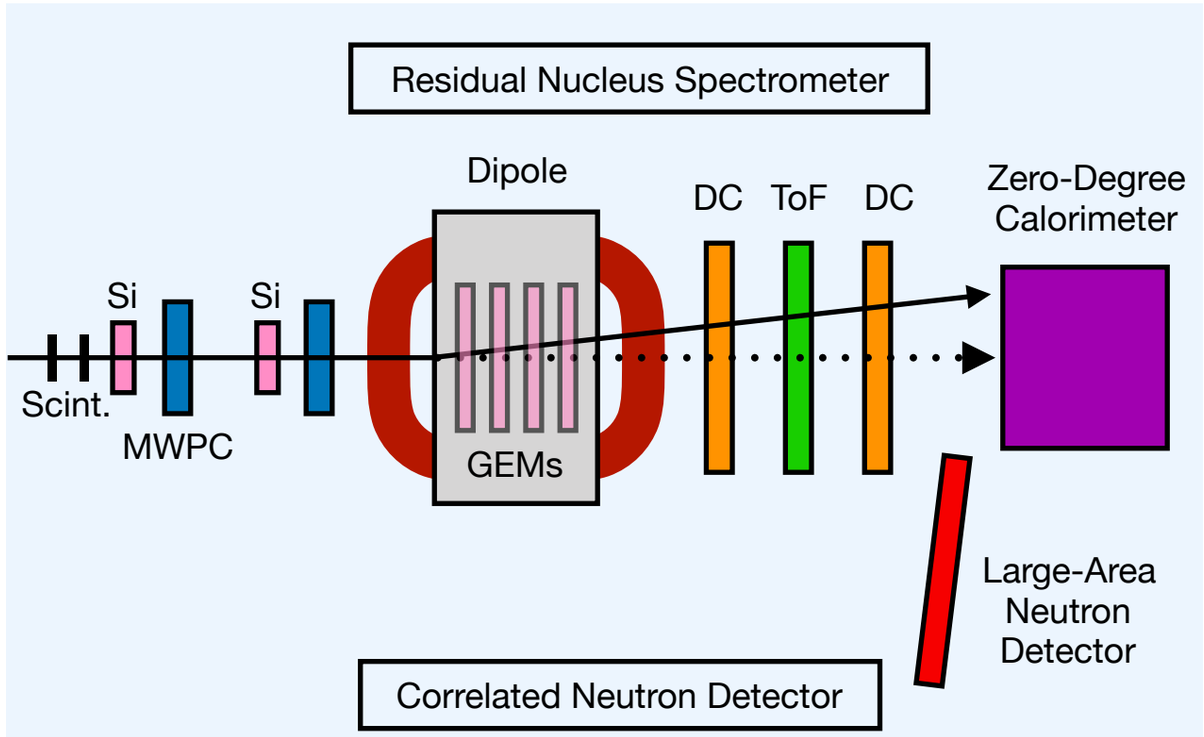


$\left(x_{\text{projected}} - x_{\text{measured}}\right)$ [cm]

Drift Chamber Tracking Calibrations with ^{12}C beam

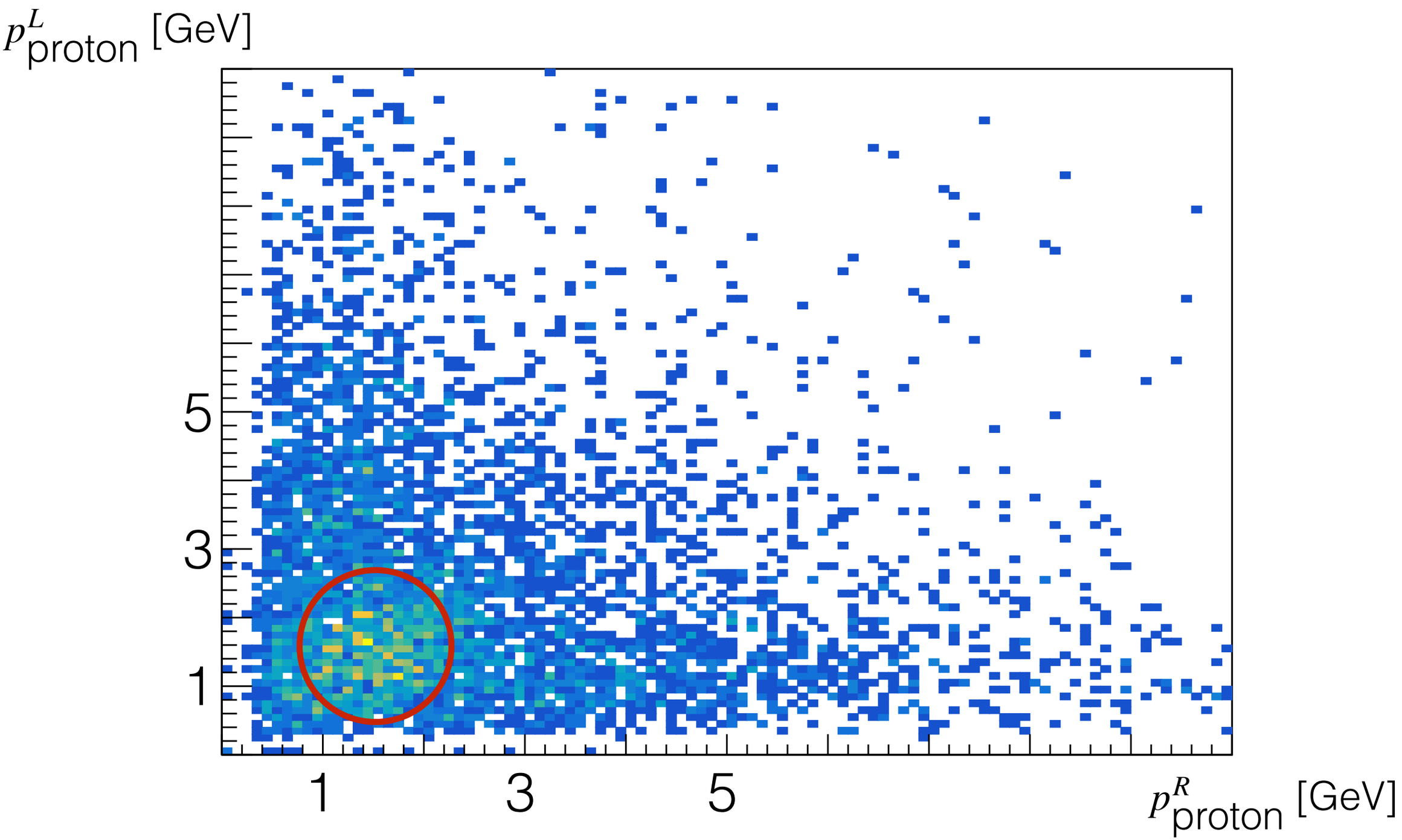
DC Matched Tracks





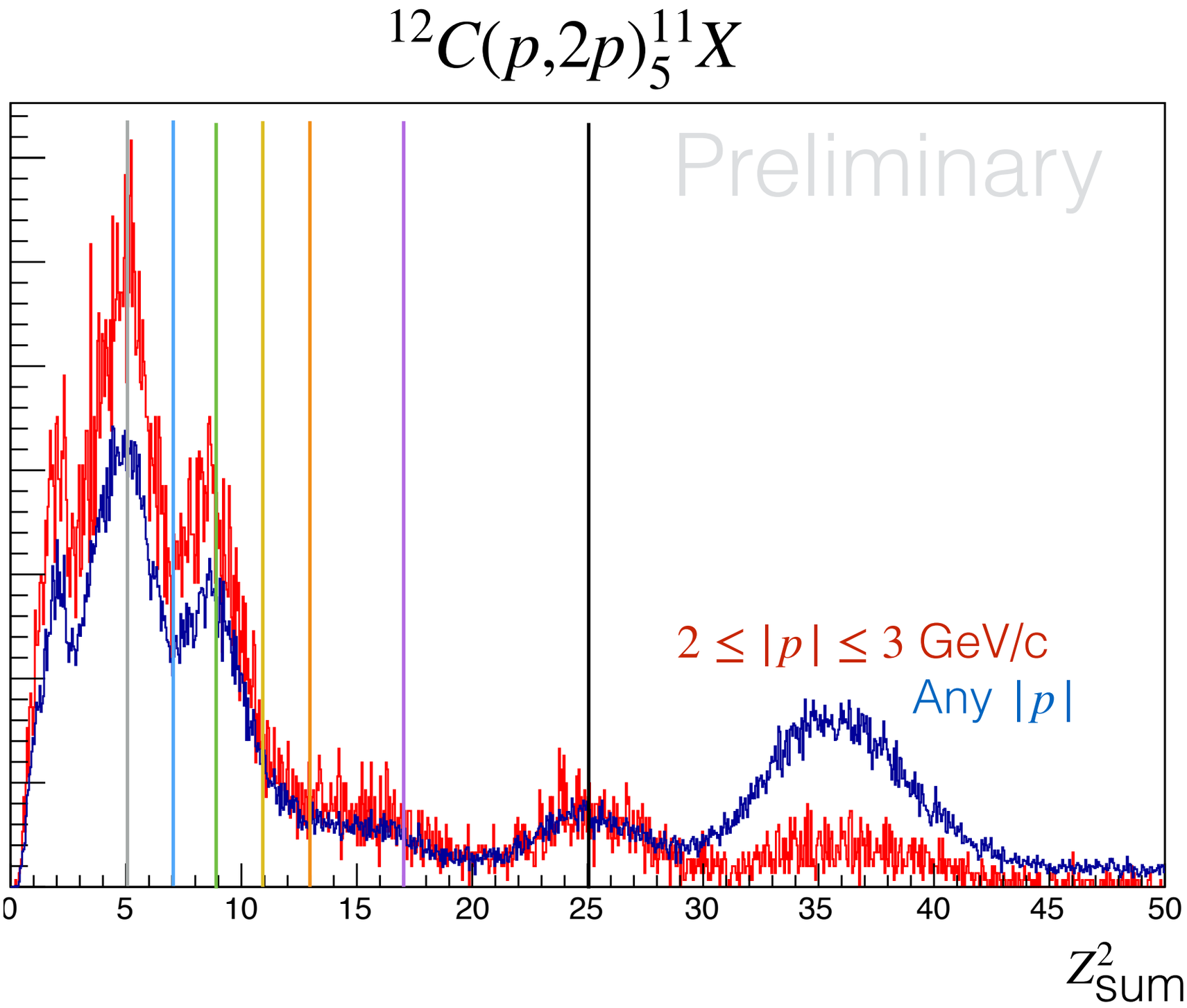
Looking at preliminary physics

Looking at the $(p,2p)$ reaction



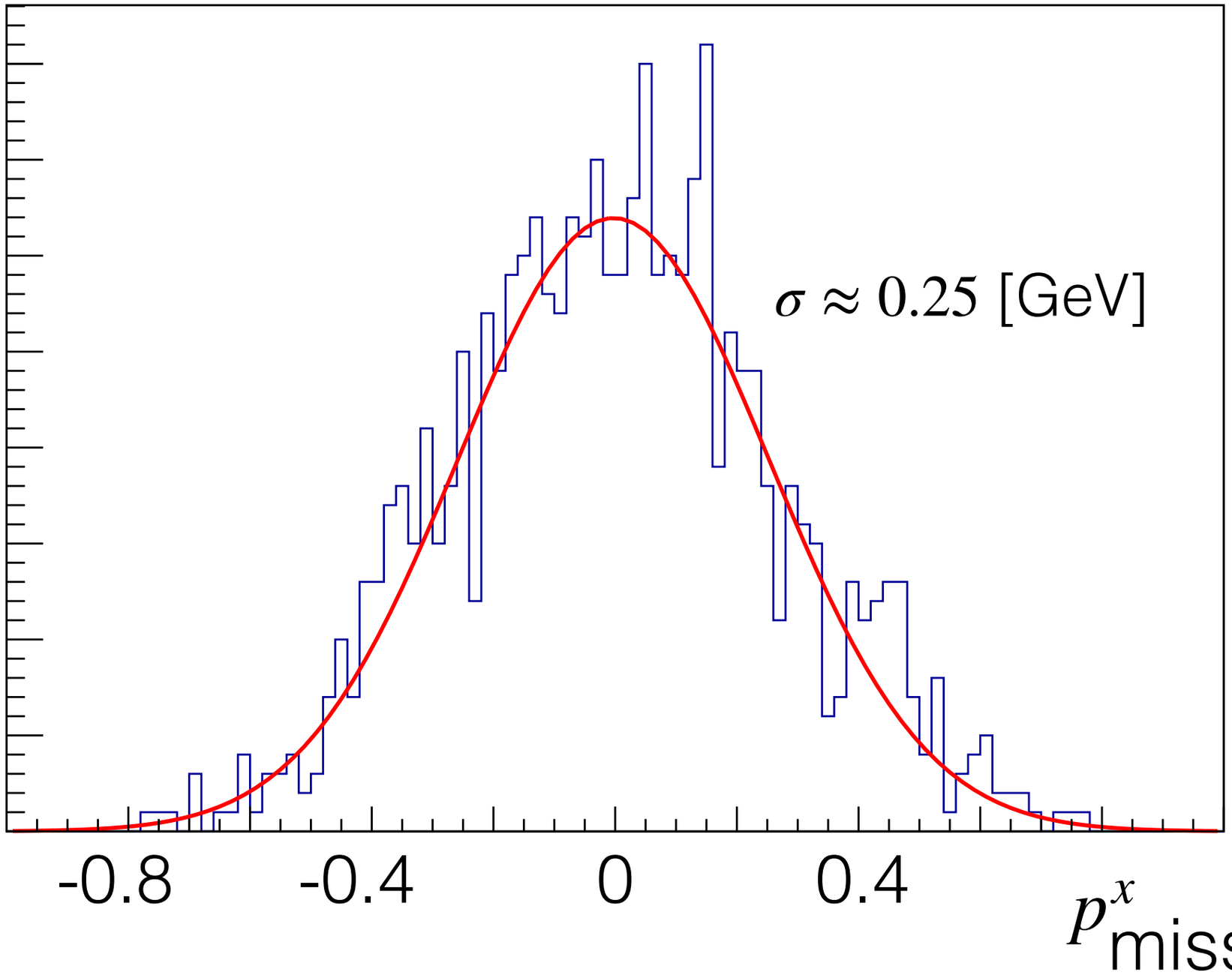
Using Residual Z-Tag with Proton Arms

Possible Z^2_{sum} of X
25
17
13
11
9
7
5

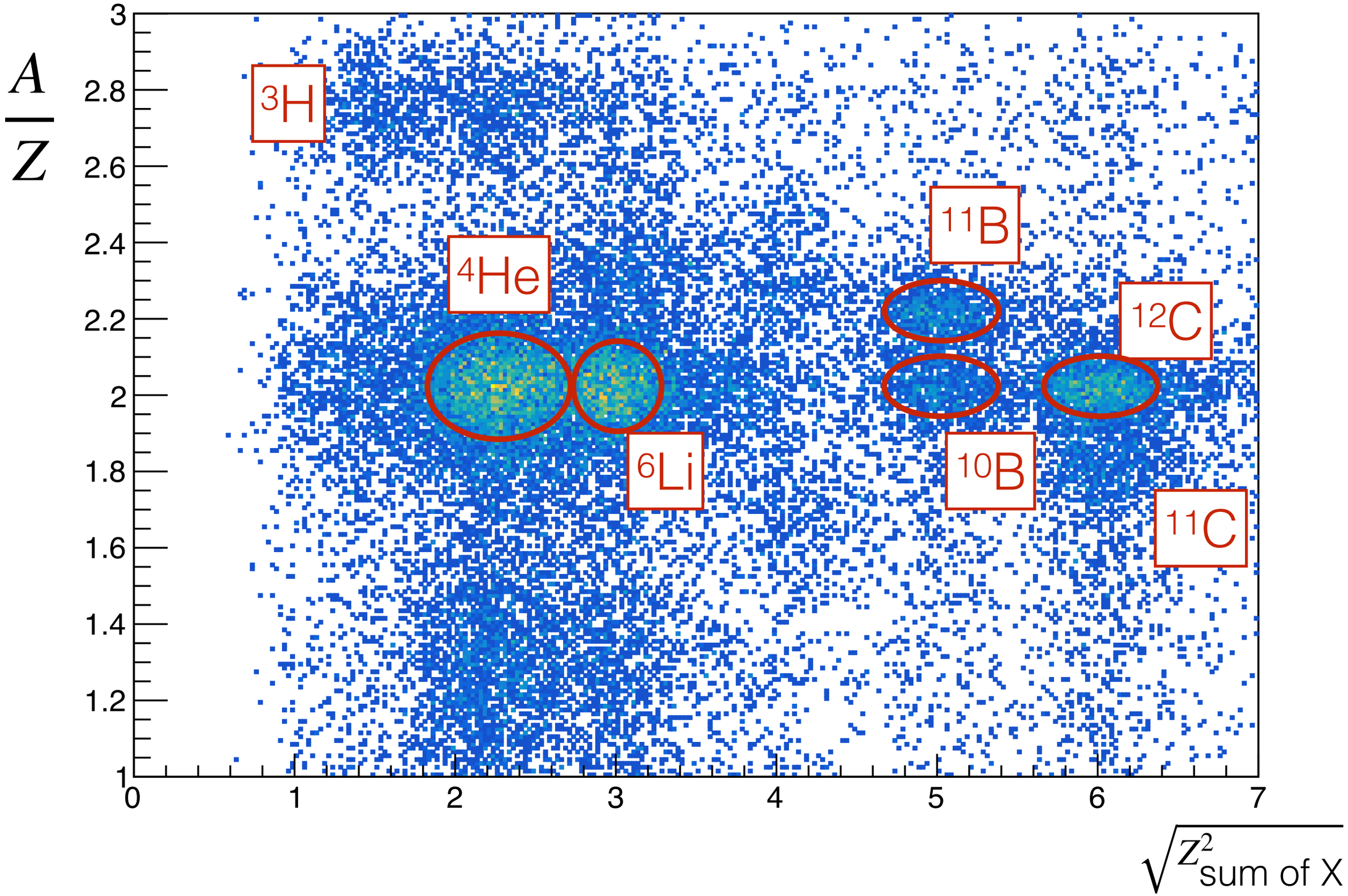


Looking at the $(p,2p)$ reaction

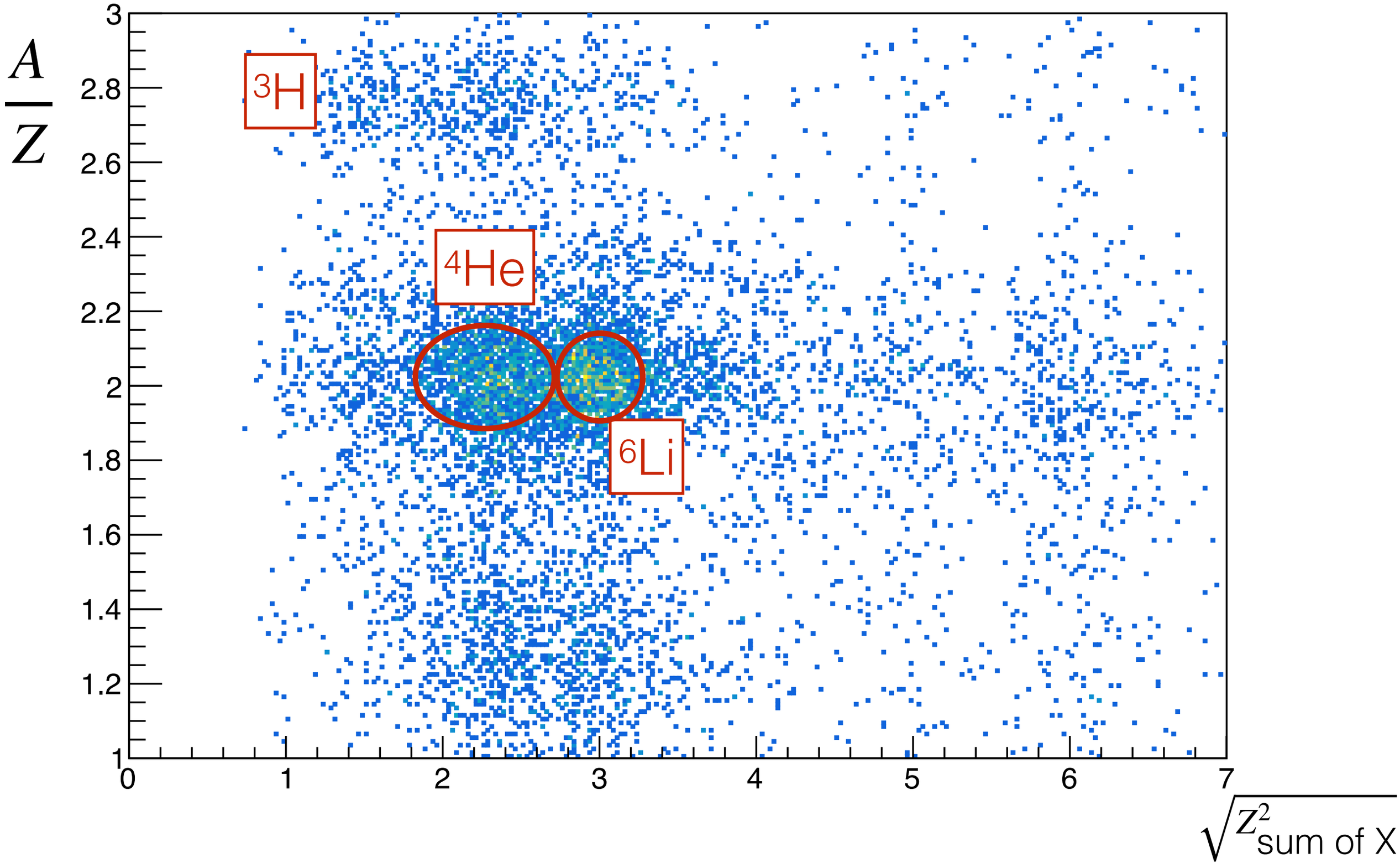
$$\vec{p}_{\text{miss}} = \vec{p}_1 + \vec{p}_2 - \vec{p}_{\text{beam}}$$



Looking at Residual System



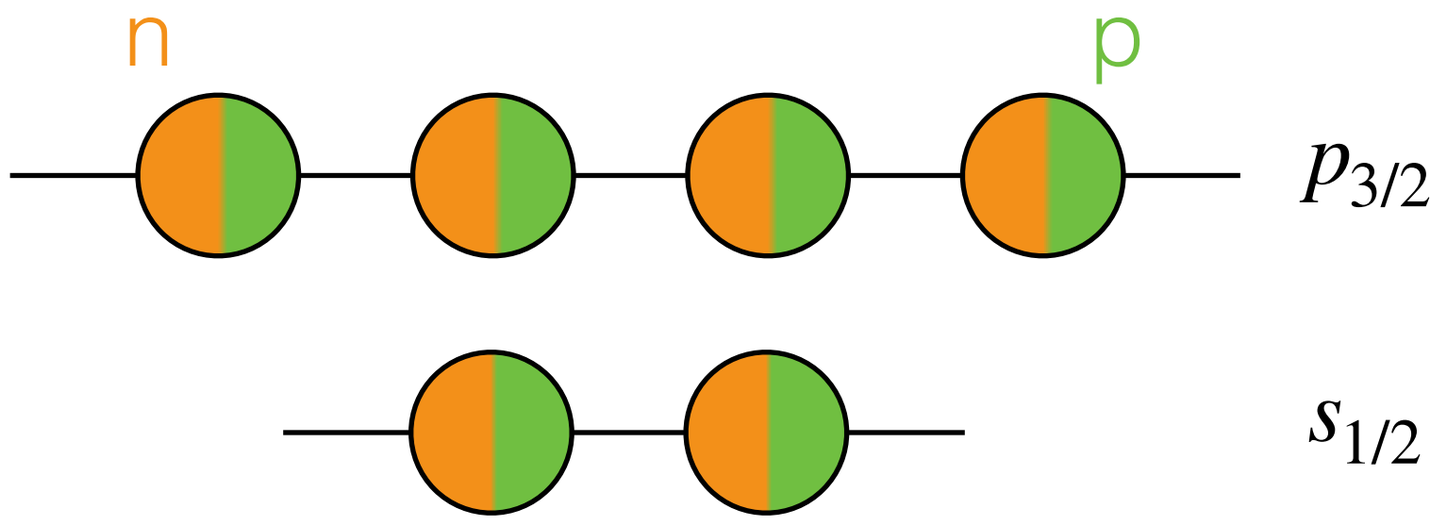
Looking at Residual System (2 Tracks)



What we are moving towards next

- Integrating all of these components to identify QE and SRC knock-out events
- Continue calibrations
- Unpacking other detector systems

Residual system and SRC pair formation



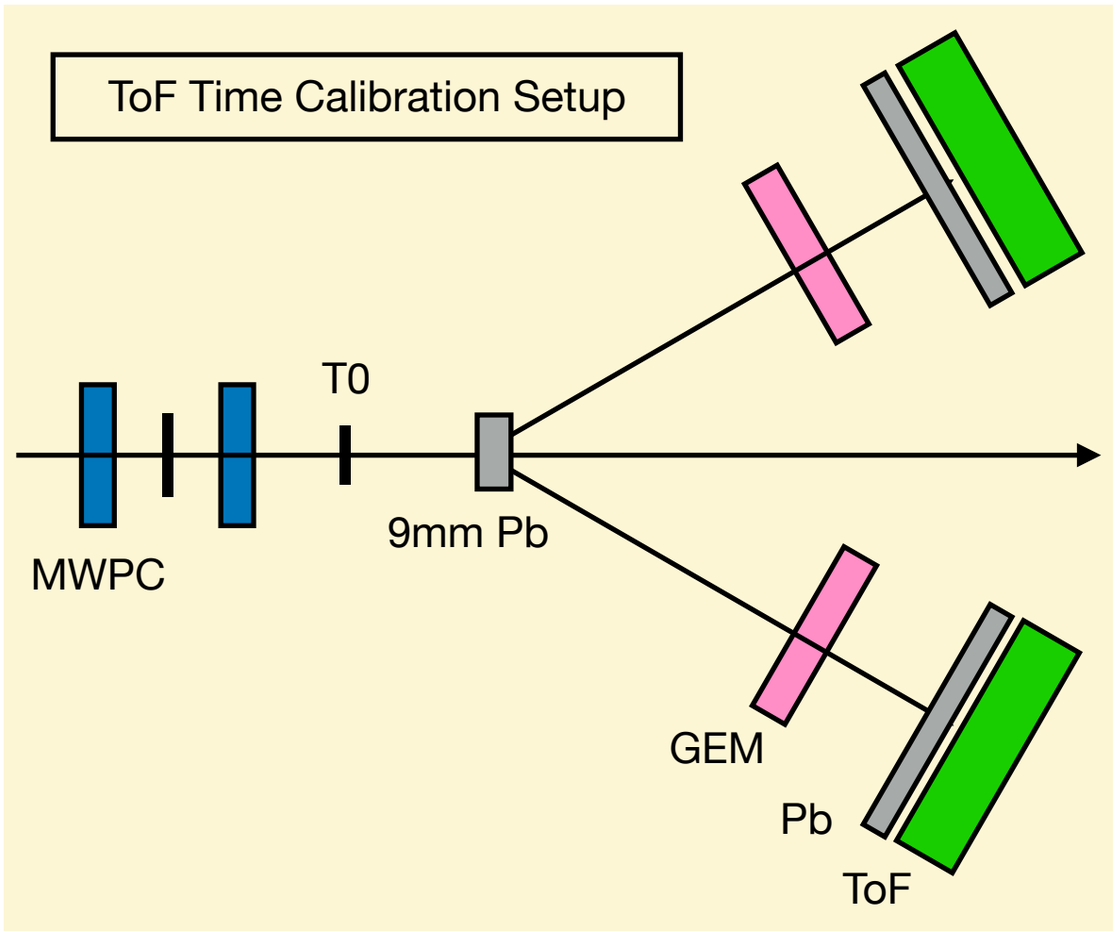
Thank you!

Back ups

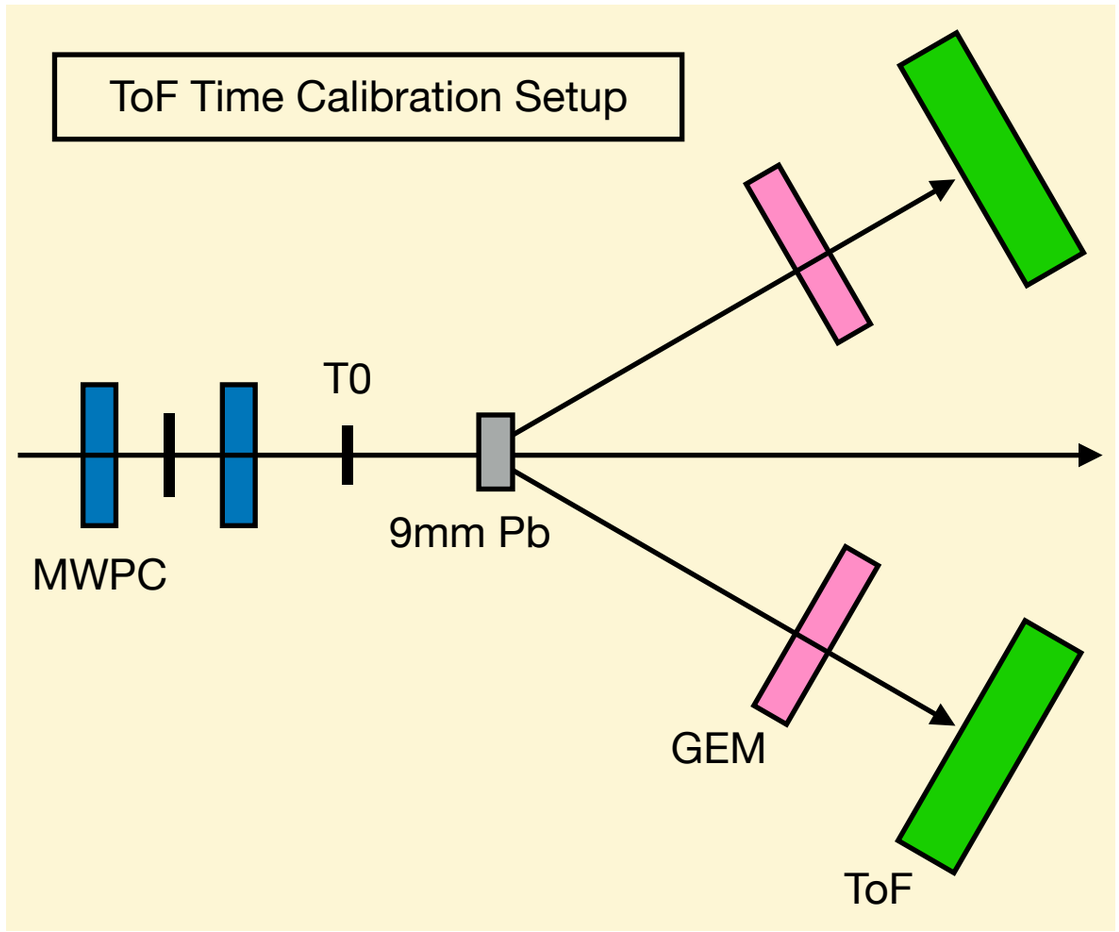
Time-of-flight Calibration

$$|\vec{p}_1| = \frac{m_p}{\sqrt{1/\beta^2 - 1}} \quad , \quad \beta = \frac{x}{c_{\text{air}} \cdot \text{ToF}}$$ (Need global time shift)

What ToF will see: $\pi^0 \to 2\gamma, \pi^{\pm}, \ldots$



What ToF will see: $\pi^{\pm}, \ldots$



γ = (Pb Wall Data) – (No Pb Wall Data)

(Pb Wall) - (No-Pb Wall)

$$\sigma_{\text{ToF-T0}} = \sqrt{\sigma^2_{\text{measured}} - \sigma^2_{\text{strip-position}}} - \delta = \sqrt{\sigma^2_{\text{T0}} + \sigma^2_{\text{ToF}}}$$

~130ps ~175ps ~60ps ~35ps ~120ps ~60ps

(Self consistent with measured resolutions of ToF and T0 separately)