QMDraw Data Analysis

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SAMURAI Collaboration

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1. input
2. correlation between p and n
3. cut on unphysical breakup
4. obersevation R
5. obersevation R cut on $P_\perp$

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Input Momentum Analysis (QMD Model)

- **Objective**: Analyze the momentum distribution of breakup products to guide detector configuration.
- **Data Source**: QMD simulation data for ^{208}Pb target.(qmd ypol has Pb208 Xe130, zpol has Sn112 Sn124 Xe130)
- **Methodology**:
  - Analyzed Proton and Neutron momentum in Y-polarization and Z-polarization modes.
  - Used Python/ROOT notebook (`zpol_ypol_show_approx_P.ipynb`) for visualization.
  - Focused on P_z vs $P_\perp$ distributions.

Momentum Statistics & Reference Selection

$P = \sqrt{(E)^2 - (m)^2} = \sqrt{(190 + 938)^2 - (938)^2} MeV/c = 625.5 MeV/c$ **Observed Statistics (from Log)**

- **Proton** P_z: Mean ≈ 600 MeV/c (Y-pol), ≈ 635 MeV/c (Z-pol).
- **Neutron** P_z: Mean ≈ 612 MeV/c.
- $P_\perp$: Typically $50 - 90$ MeV/c.

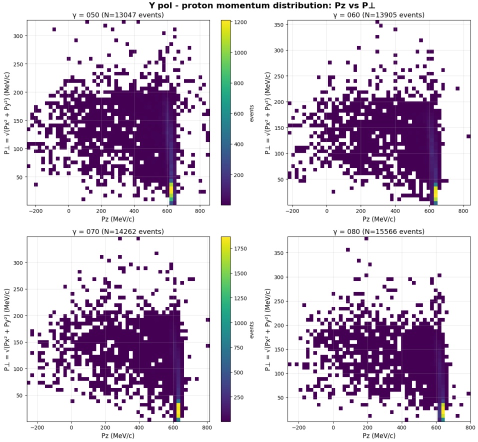
Reference Kinematics

To optimize the detector coverage, we select the following reference momentum for protons:

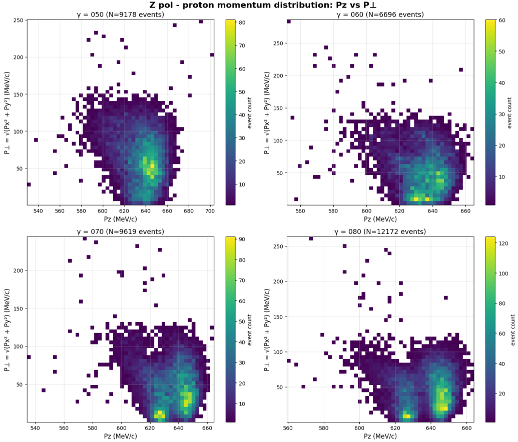
- $P_z = 627$ **MeV/c**
- $P_x = \pm 100, \pm 150$ **MeV/c**

Proton Momentum Distributions

Y-Polarization



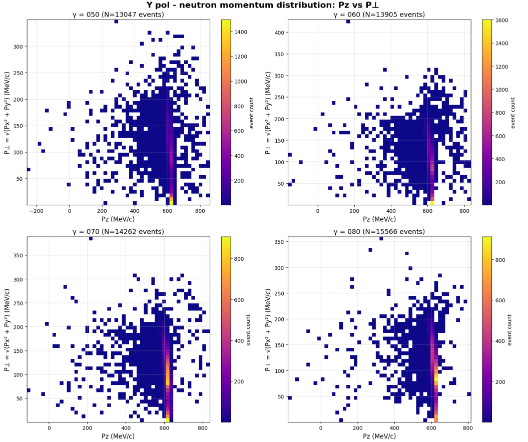
Z-Polarization



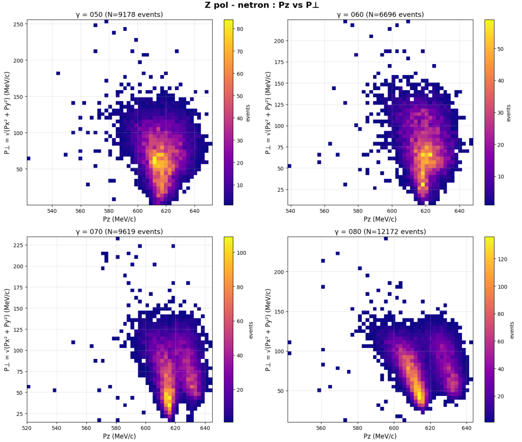
Proton P_z vs $P_\perp$ distributions showing the region of interest around $P_z \approx 600$ MeV/c.

Neutron Momentum Distributions

Y-Polarization



Z-Polarization



Neutron distributions show similar P_z trends.

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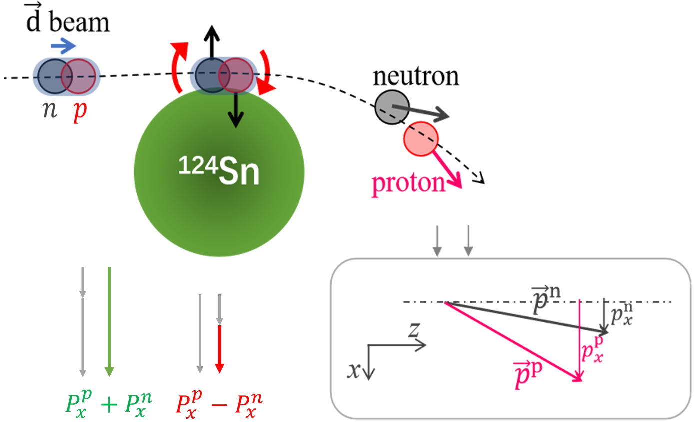
Our Probe: The Isovector Reorientation (IVR) Effect



$$E_{sym}(\rho) = \frac{C_{s,k}}{2}\left(\frac{\rho}{\rho_0}\right)^{2/3} + \frac{C_{s,p}}{2}\left(\frac{\rho}{\rho_0}\right)^{\gamma}$$

$$\gamma \uparrow \Rightarrow \frac{dE_{sym}}{d\rho} \downarrow \Rightarrow F_v \downarrow$$

- In peripheral scattering of a polarized deuteron, the **isovector nuclear force** acts as a torque.
  - Attractive for protons
  - Repulsive for neutrons

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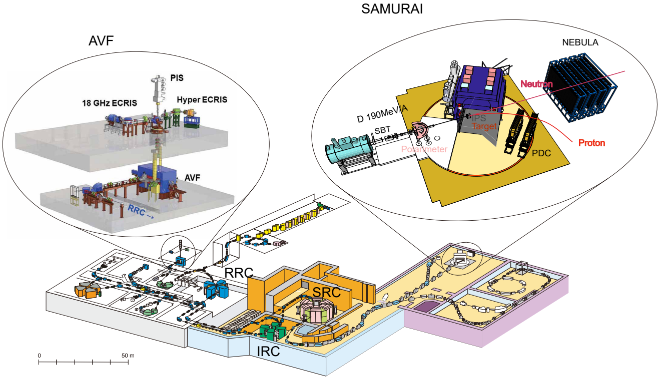
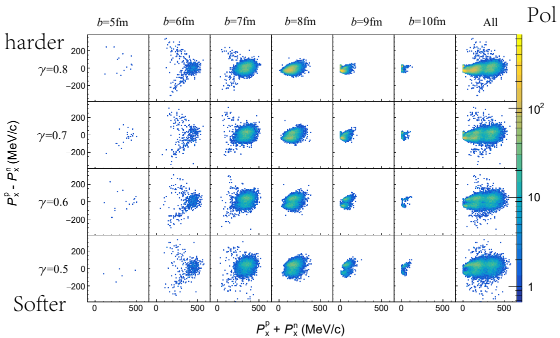
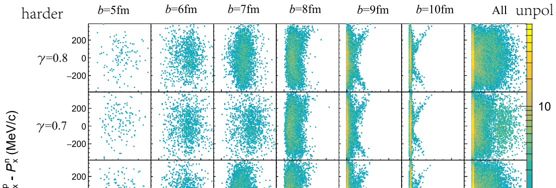


The Signature: Asymmetry in Breakup Momenta





X: total P_x,measures the impact parameter b approximately.

$$\gamma \uparrow \quad \rightarrow \quad P_x^p - P_x^n \downarrow$$

- For a **polarized** beam, the distribution is asymmetric.
- For an **unpolarized** beam, the distribution is symmetric.
- The degree of asymmetry is our signal!

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$P_\perp$ reflects the impact parameter b of the collision as we mentioned before.
Here we concentrate on which range of $P_\perp$ has more significant IVR effect. Thus we can foucus on that range in the reconstruction proton and neutron momenta.