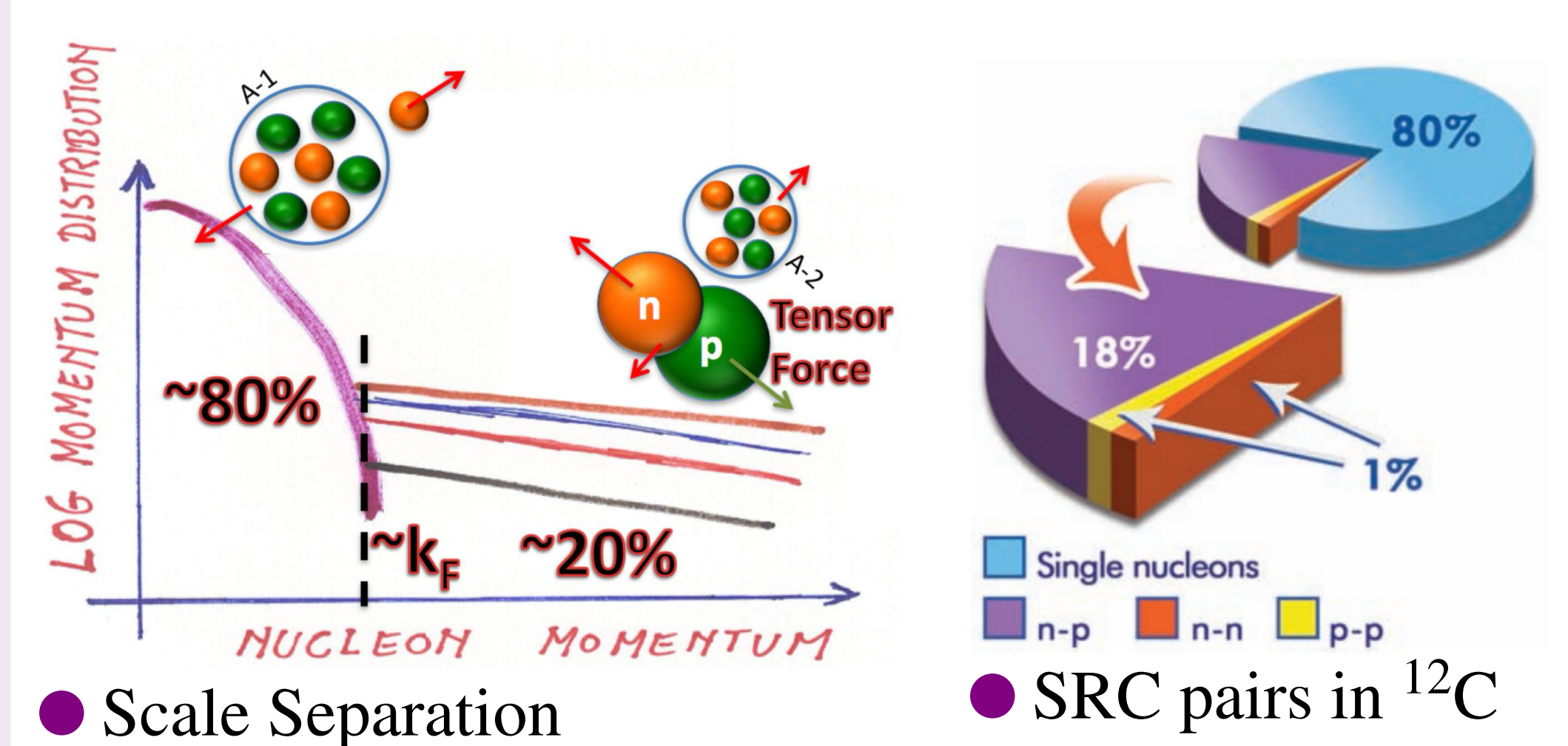


Abstract

ALERT-SRC experiment, which will be carried out in this summer, employs the ALERT (A Low Energy Recoil Tracker) detector, installed inside the central region of CLAS12 in Hall B, to perform high-precision measurements of short-range correlation (SRC) effects in nuclei. The measurement is carried out with a 6.4 GeV electron beam under quasi-elastic kinematics, focusing on the exclusive $^4\text{He}(e, e'pd_S)n$ channel. This study tests the factorization hypothesis for SRC and explores the transition from mean-field momentum to SRC-dominated momentum. Correlations between relative momentum p_{rel} and center-of-mass momentum p_{cm} will be analyzed to validate predictions of generalized contact formalism (GCF) models. ALERT consists of drift chambers and a dual-layer scintillator array, enabling efficient tracking and particle identification of low-momentum recoil nucleons. Due to ALERT's large geometric acceptance and an optimized trigger design, the experiment is expected to achieve nearly two orders of magnitude increase in statistical precision compared to existing outcomes. These results will provide stringent empirical constraints on theoretical SRC models and advance our understanding of nucleon-nucleon correlations in nuclei.

Short-Range Correlation

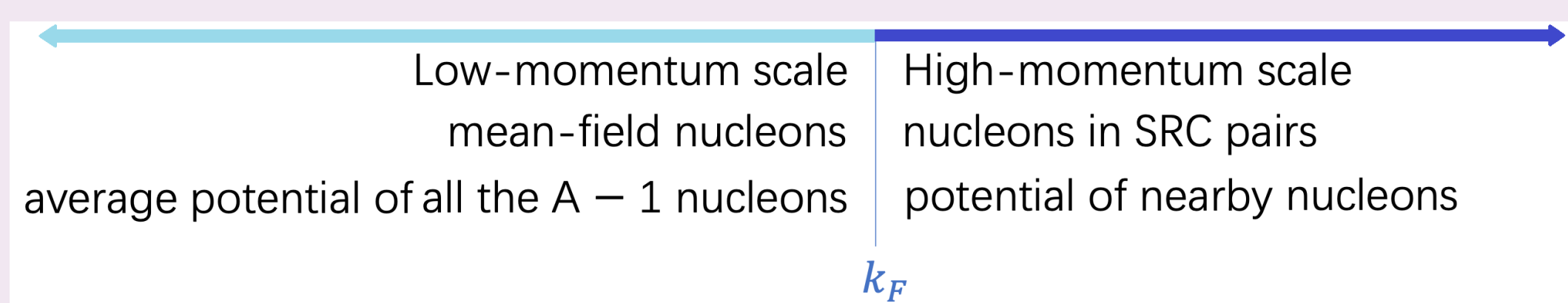
SRC nucleon-nucleon (NN) pairs are pairs of nucleons with large relative momentum (p_{rel}) and smaller center of mass momentum (p_{cm}), whose characteristics, learned from previous experiments, are as following:



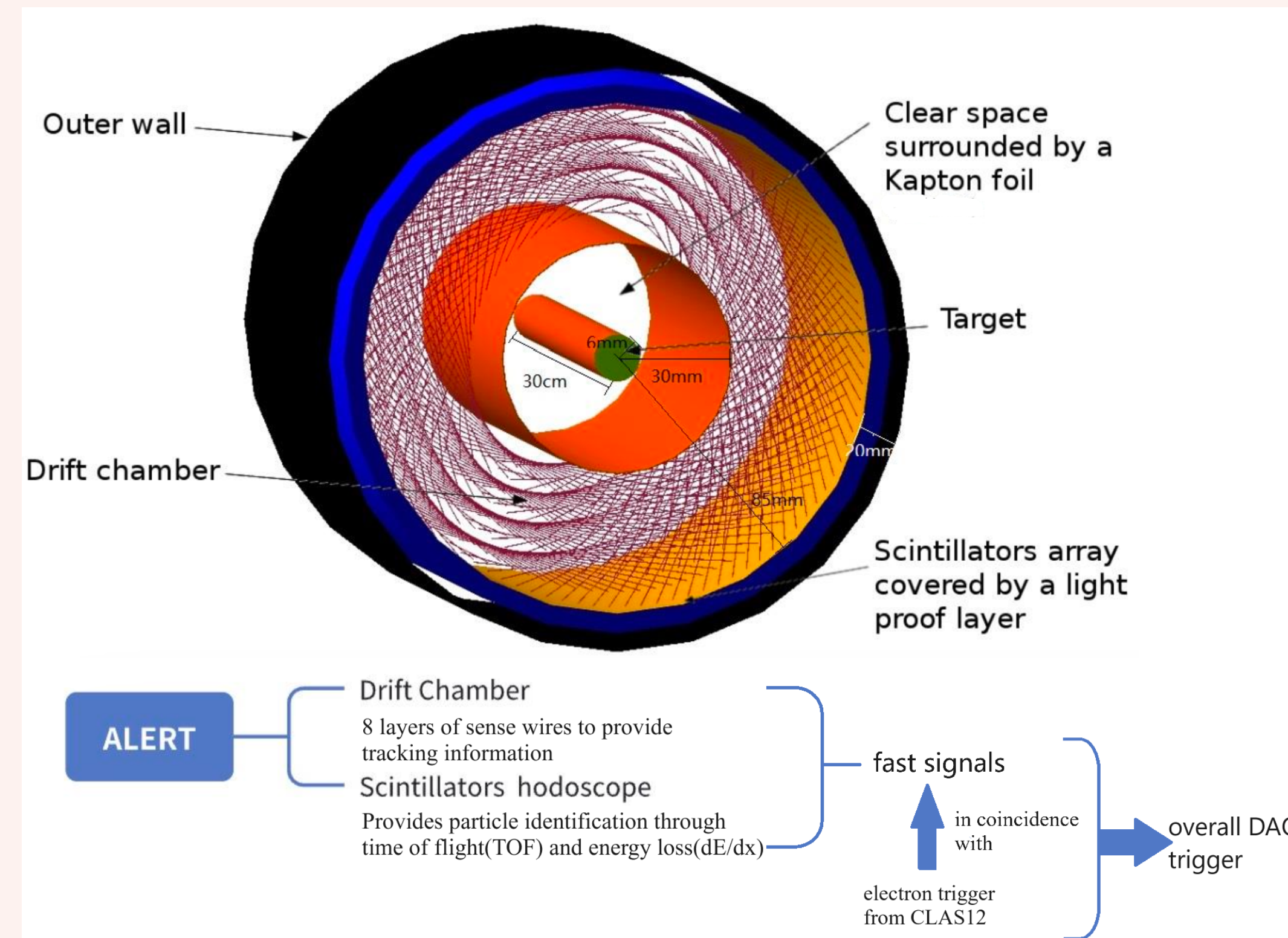
Universality: Momentum distribution of high-momentum nucleons has the same shape in all nuclei.

NP-Dominance: Neutron-proton (np) pairs are nearly 20 times more prevalent than proton-proton (pp) pairs and neutron-neutron (nn) pairs.

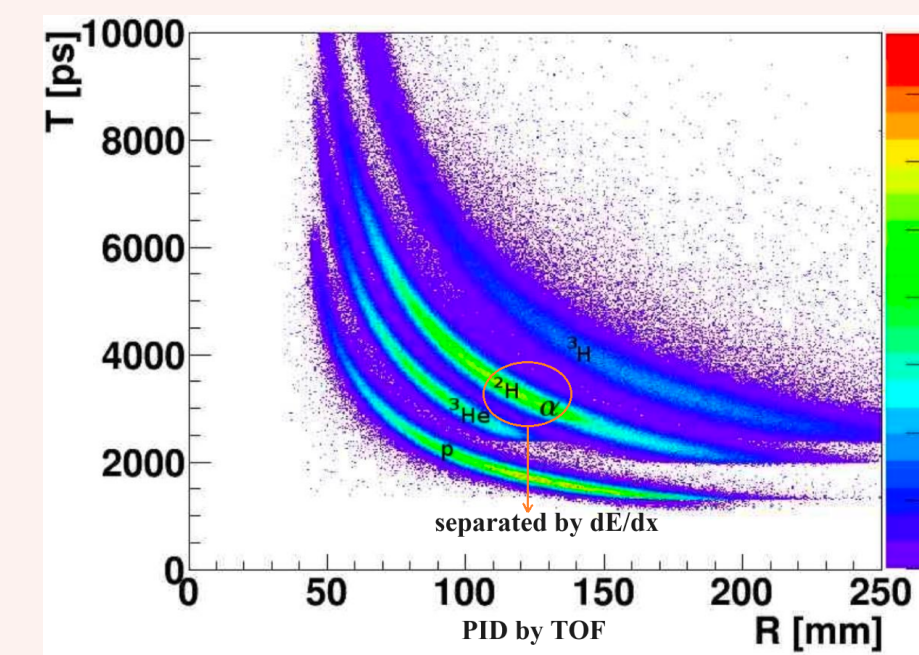
Scale Separation: Nucleons with momentum above and below Fermi momentum (k_F) behave differently.



A Low Energy Recoil Tracker



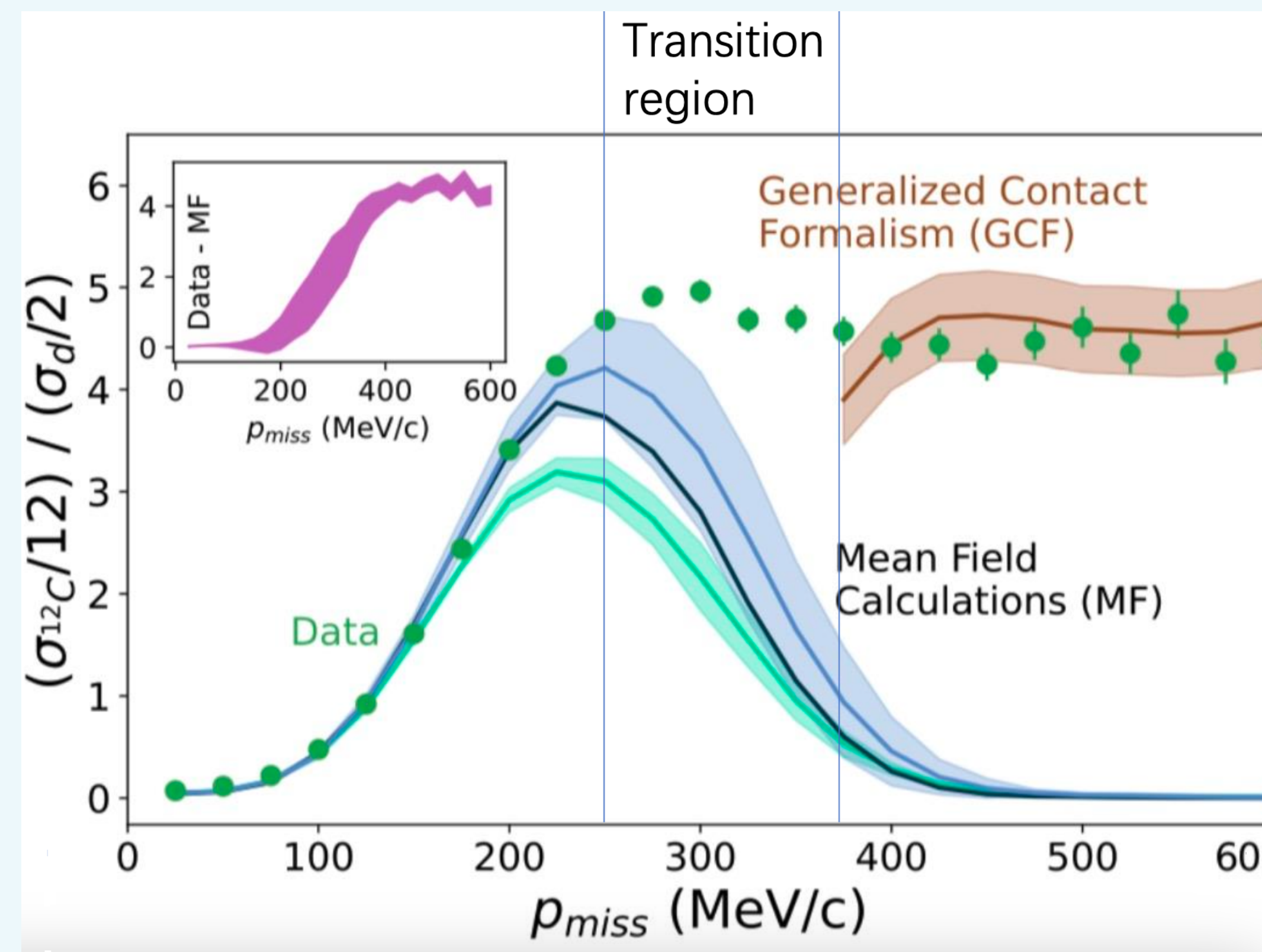
- Lower Detection Threshold For Recoil Particles
- Better Particle Identification
- Lower Background to Handle Higher Luminosity



Physics Goals

The motivation for this fully exclusive measurement is twofold:

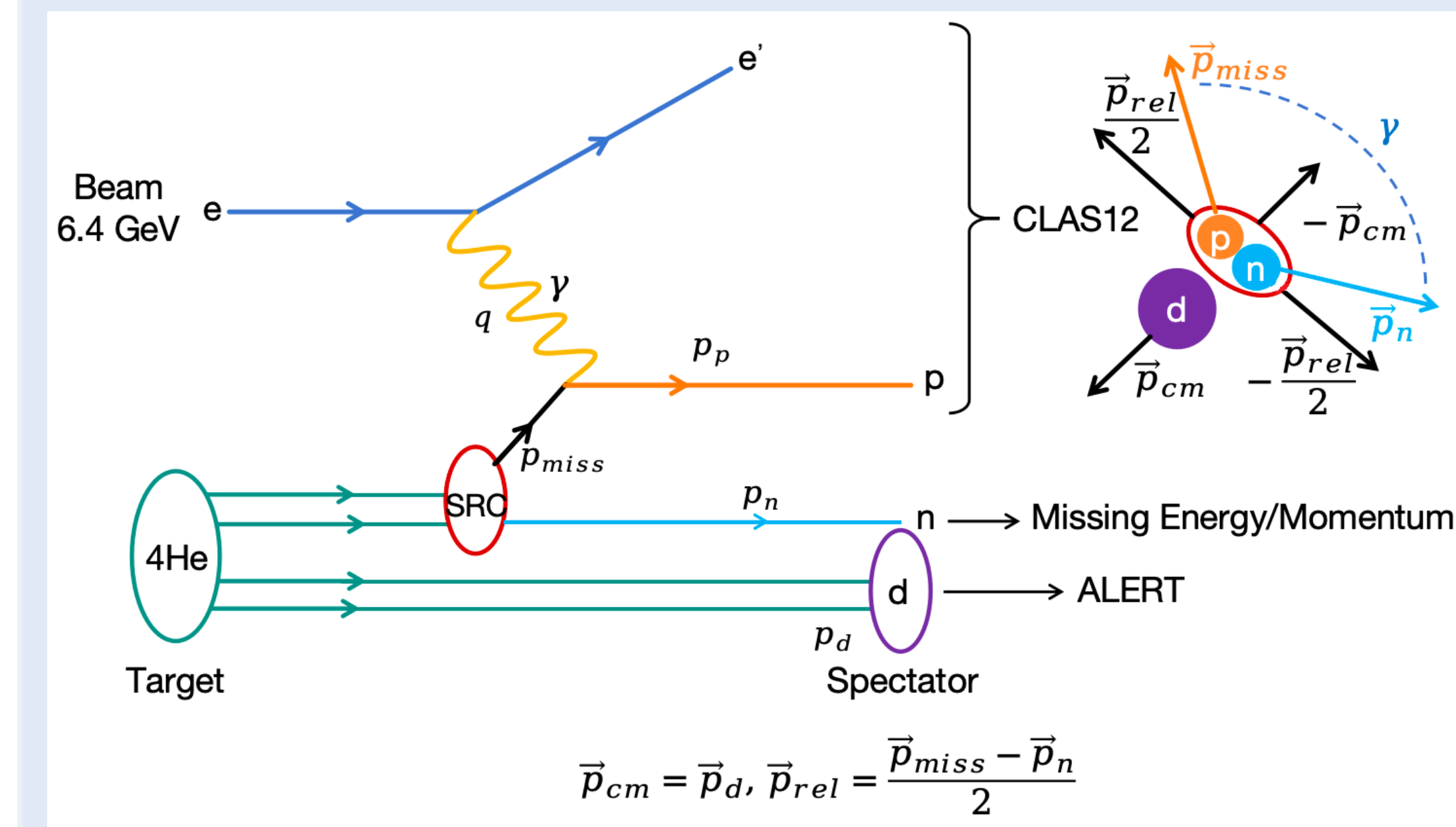
- Test the basic assumption that the two body SRC pairs can be factorized from the residual nuclear system.
- Study the transition from the single nucleons in a mean field to SRC pairs.



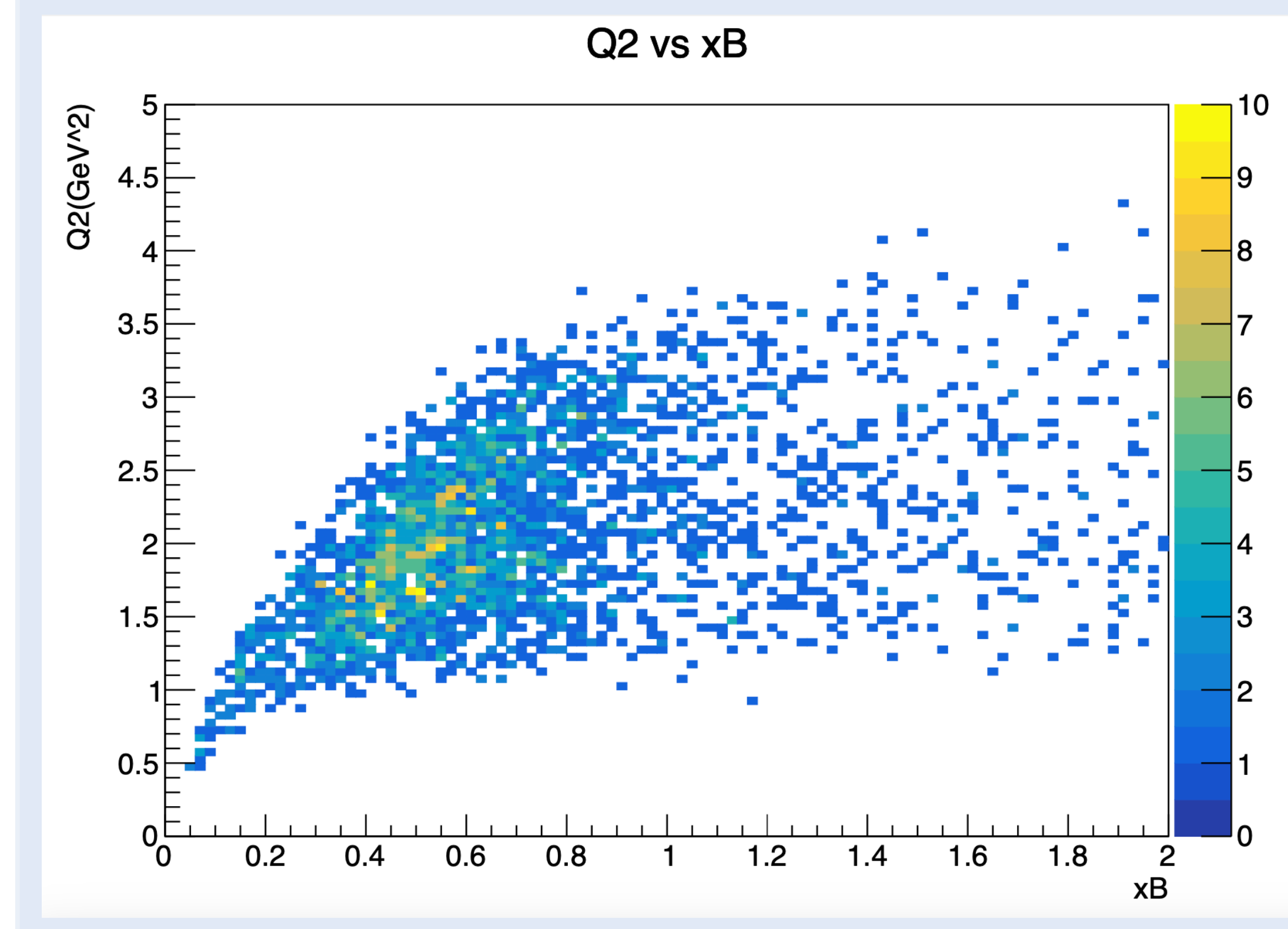
Kinematics

Main reaction channel:

$$^4\text{He}(e, e'pd_S)n$$



Quasi-elastic process, by simulation:



Generalized Contact Formalism

Short-distance many-body wave function factorizes into:

$$\Psi \xrightarrow{r_{ij} \rightarrow 0} \sum_{\alpha} \phi_{\alpha}(r_{ij}) A_{ij}^{\alpha}(\mathbf{R}_{ij}, \{\mathbf{r}\}_{k \neq ij})$$

partial waves

universal two-body function

np, nn, pp

mean-field like many-body function

Asymptotic expressions for the one- and two-body momentum densities can be derived:

$$n_p(\mathbf{k}) = \sum_{\alpha} 2C_{pp}^{\alpha} |\tilde{\phi}_{pp}^{\alpha}(\mathbf{k})|^2 + C_{pn}^{\alpha} |\tilde{\phi}_{pn}^{\alpha}(\mathbf{k})|^2$$

$$F_{ij}(\mathbf{k}) = \sum_{\alpha} C_{ij}^{\alpha} |\tilde{\phi}_{ij}^{\alpha}(\mathbf{k})|^2$$

relative two-body momentum distribution

nuclear contacts: determine the number of pairs in a given two-body channel

wave function in the momentum space

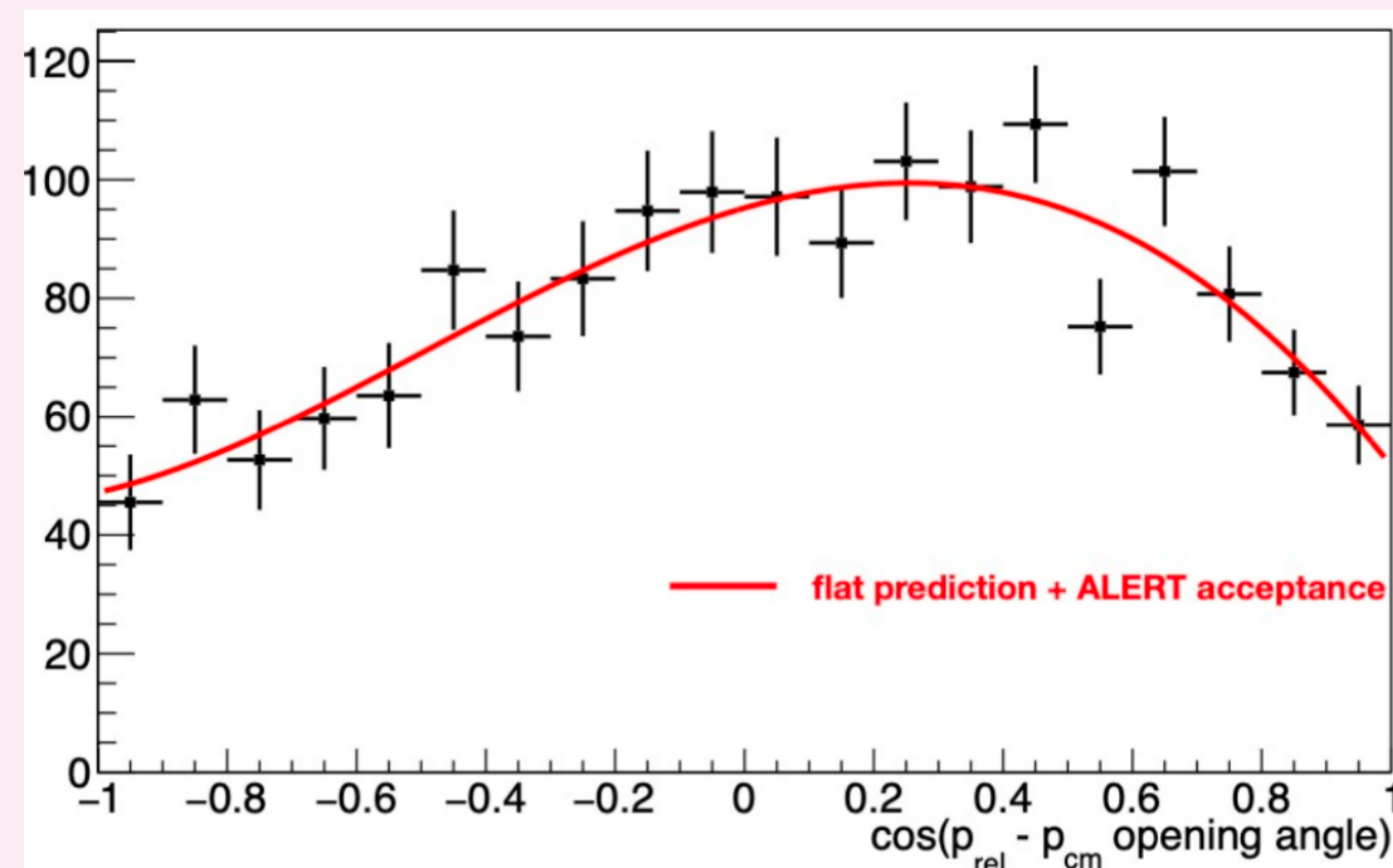
According to GCF, $\vec{p}_{cm}, \vec{p}_{rel}$ should be **uncorrelated**.

References

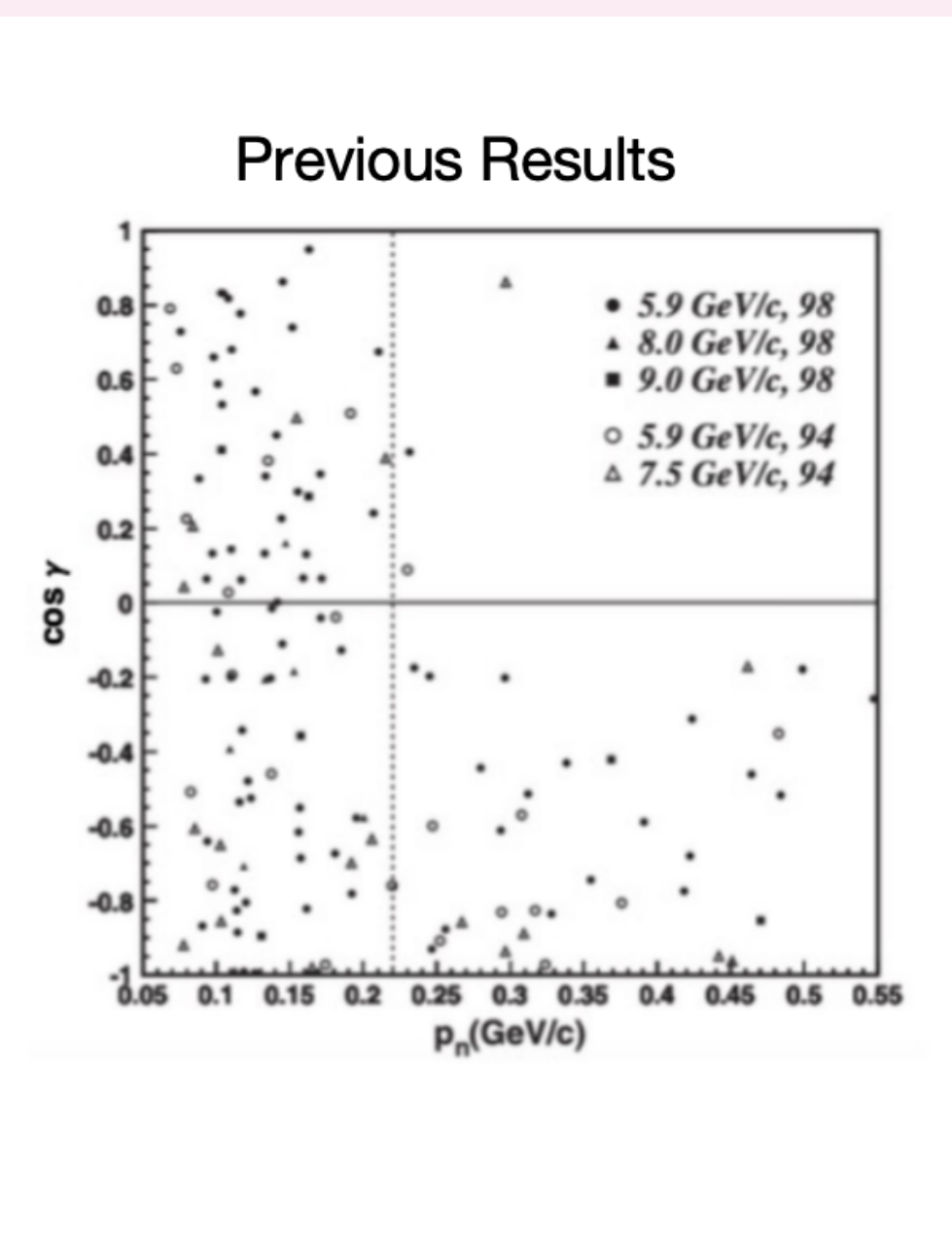
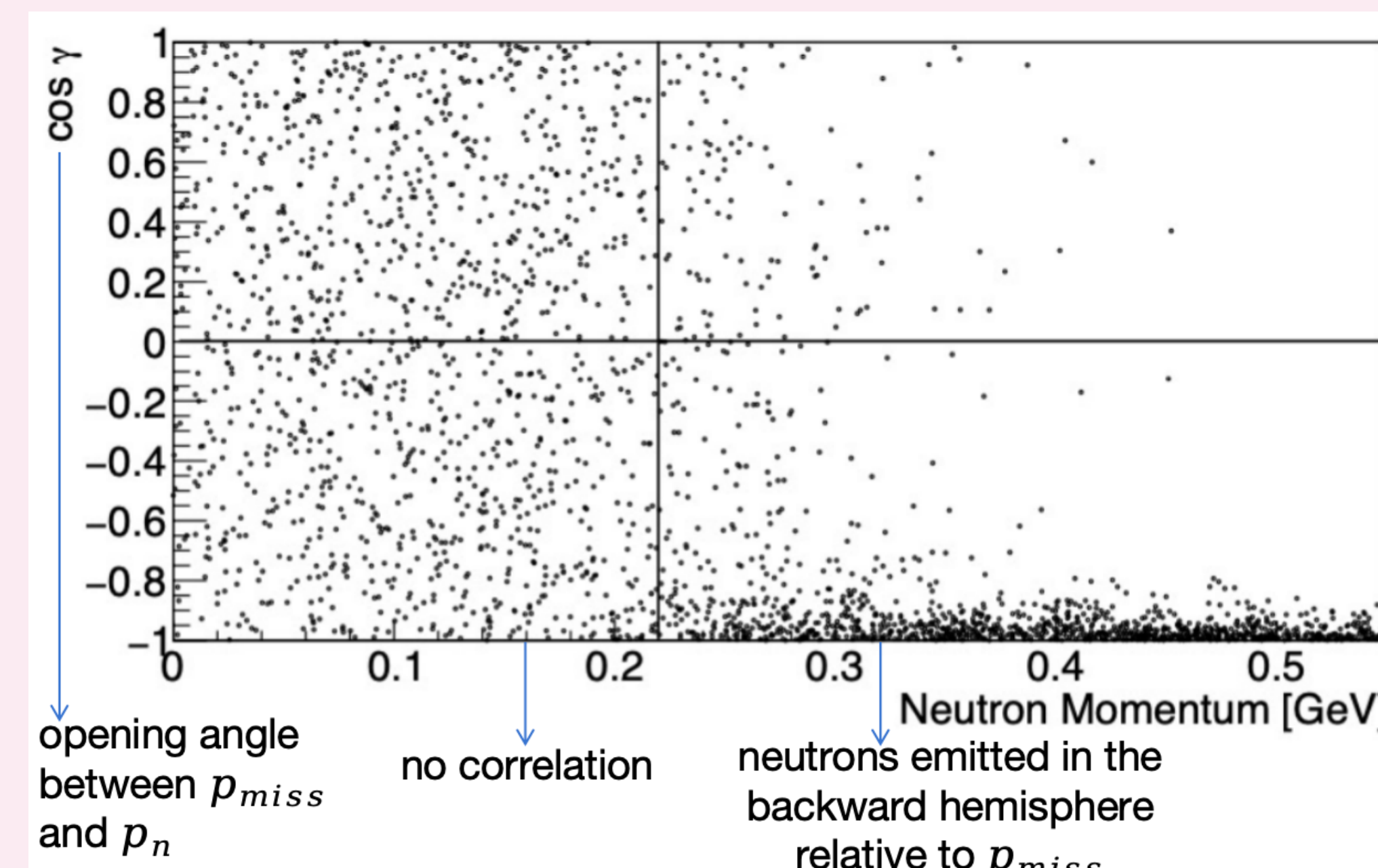
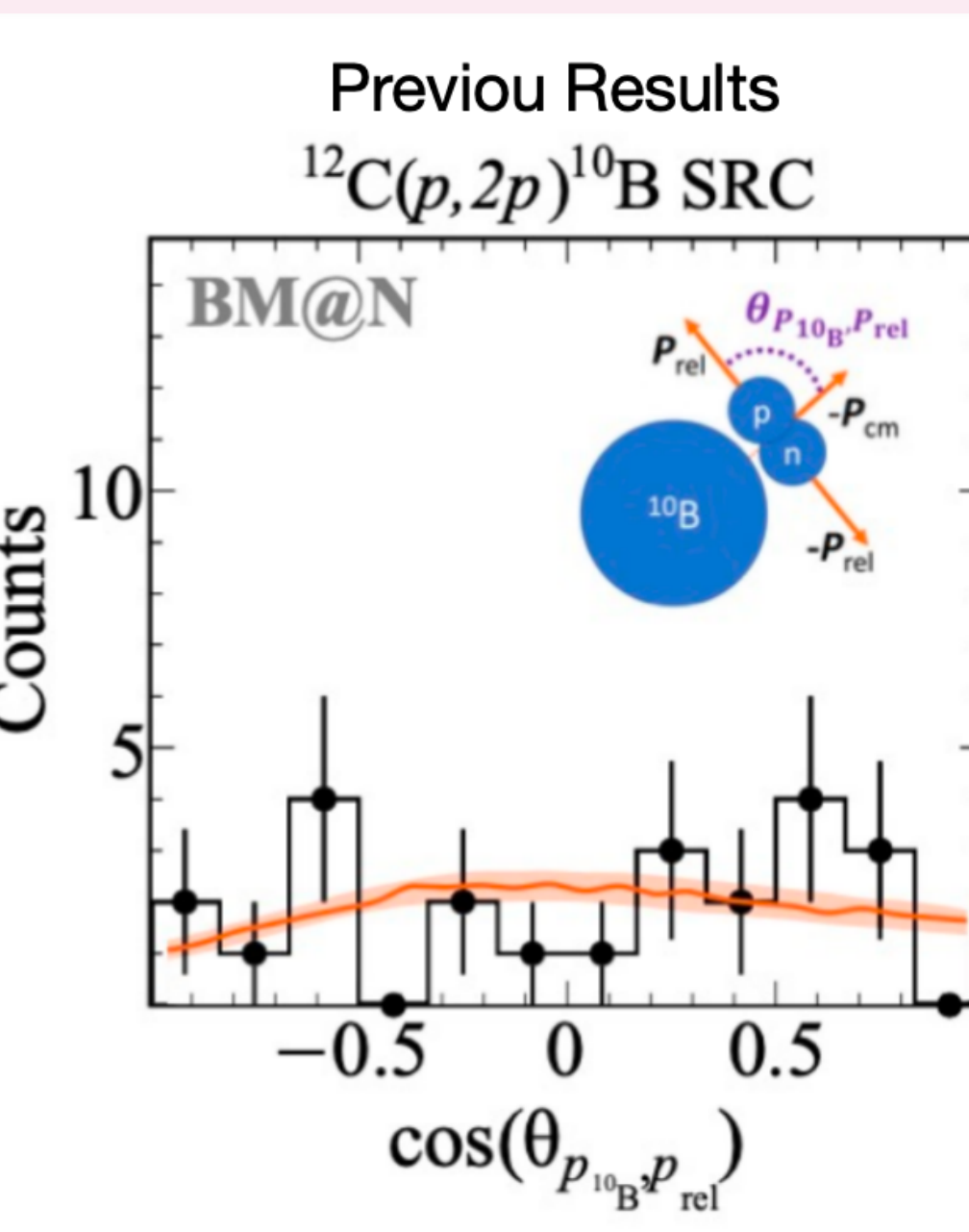
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Expected Results

Independence of \vec{p}_{cm} and \vec{p}_{rel}



Transition from mean-field region to SRC region



Almost two orders of magnitude better than previous results.