Diffractive Measurements and Tagging

YR Chapter 8.5

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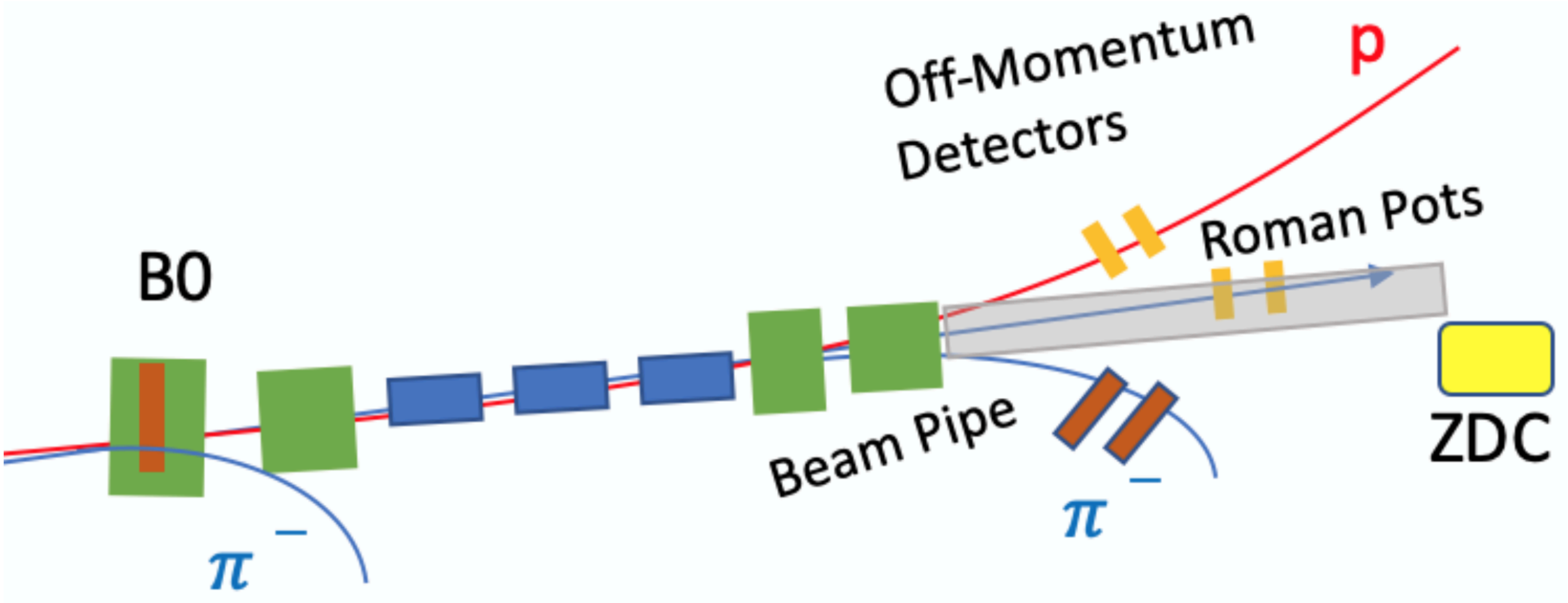
Spencer Klein, and Wim Cosyn

Executive summary:
while on more ‘solid ground’ our requirements did not change much since the CUA meeting.

Far Forward Region: Overview

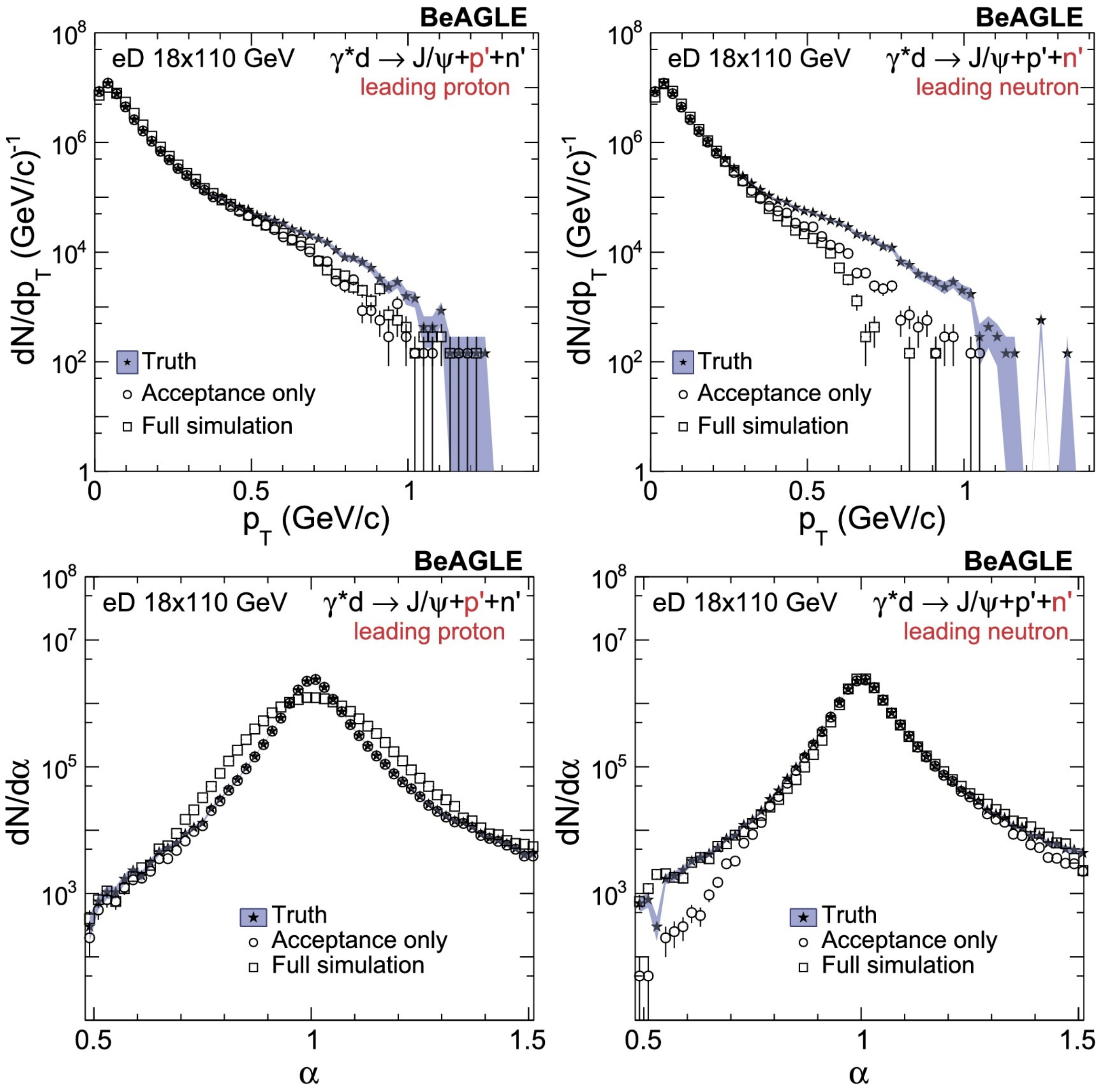


Far Forward Region: Requirements

- B0 sensors: 3.4 cm inner radius, 20 cm outer radius, 50 x 50 μm2 pixel.
- Off momentum tracker: 10 cm inner radius, 10 x 30 cm^2 sensor, 500 x 500 μm^2 pixel pitch.
- Roman pots: 10 σ from beam halo, 20 x 10 cm2 sensor, 500 x 500 μm^2 pixel pitch.
- ZDC: At least 60 x 60 cm^2 low & high granularity EMCal + 10 x 10 cm^2 HCal. Energy res. 35%/√E (< 50%/ √*E)*.
- Polarized 3He and Deuterium.
- Inclusive diffraction: rapidity gap method requires vetoing forward activity, i.e., detector setup hermiticity. B0 helps a lot but not enough.
- Proton acceptance gap between B0 & Roman pots. Difficult to close, perhaps complementary detector design could place the gap in different angles.

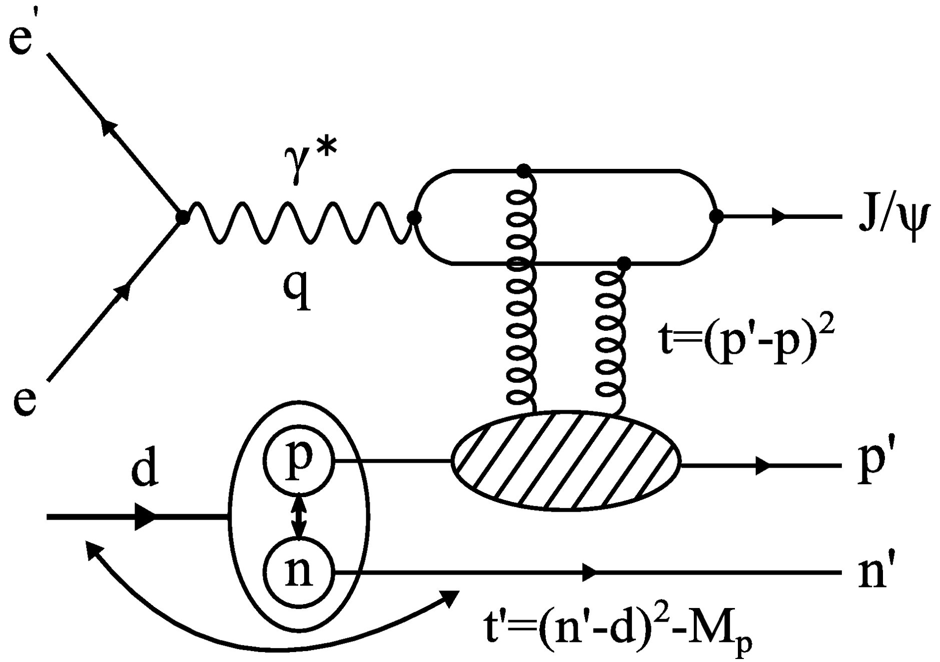
Diffractive J/psi

[Tu+ Phys. Lett. B (2020)]



incoherent diffractive J/psi production as a Deuteron wave-function probe at high momentum.

Provide luminosity and detector requirements necessary to study SRCs in the deuteron at an EIC



Diffractive J/psi

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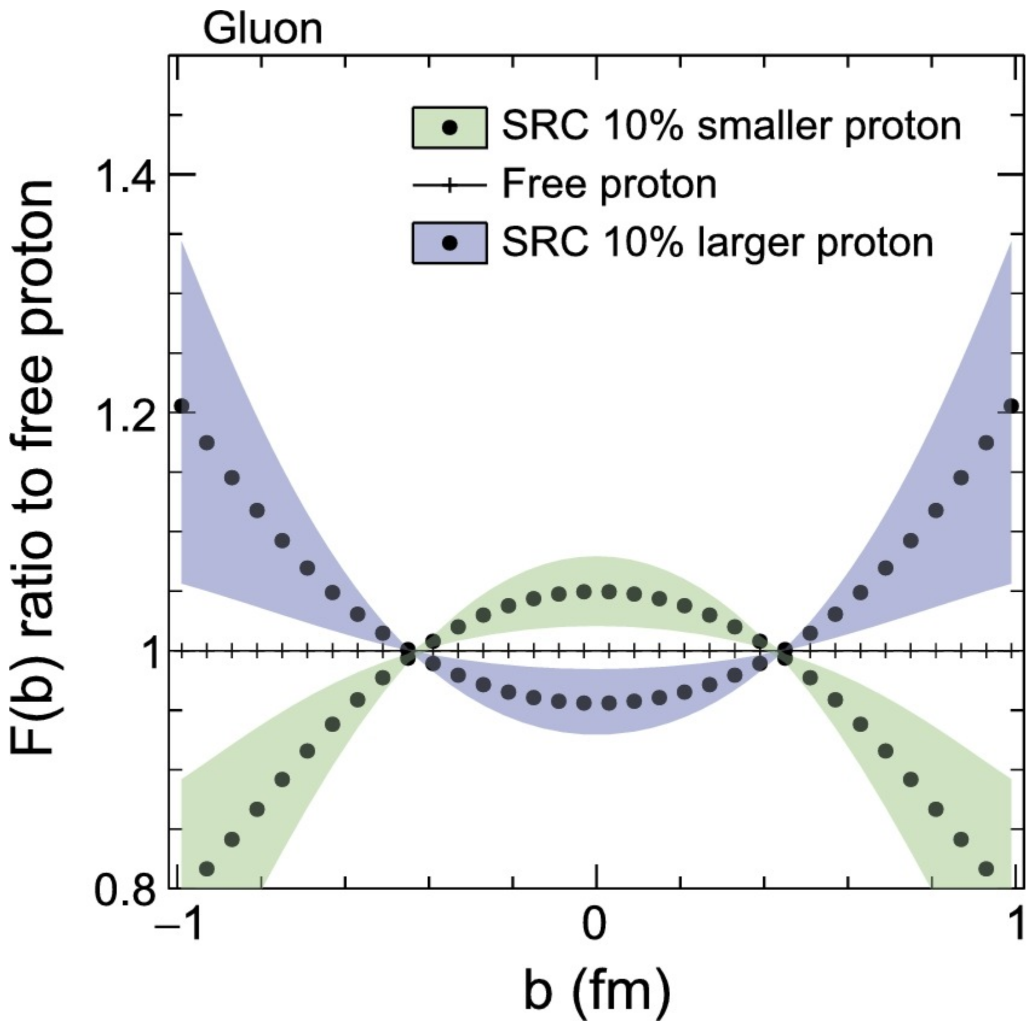

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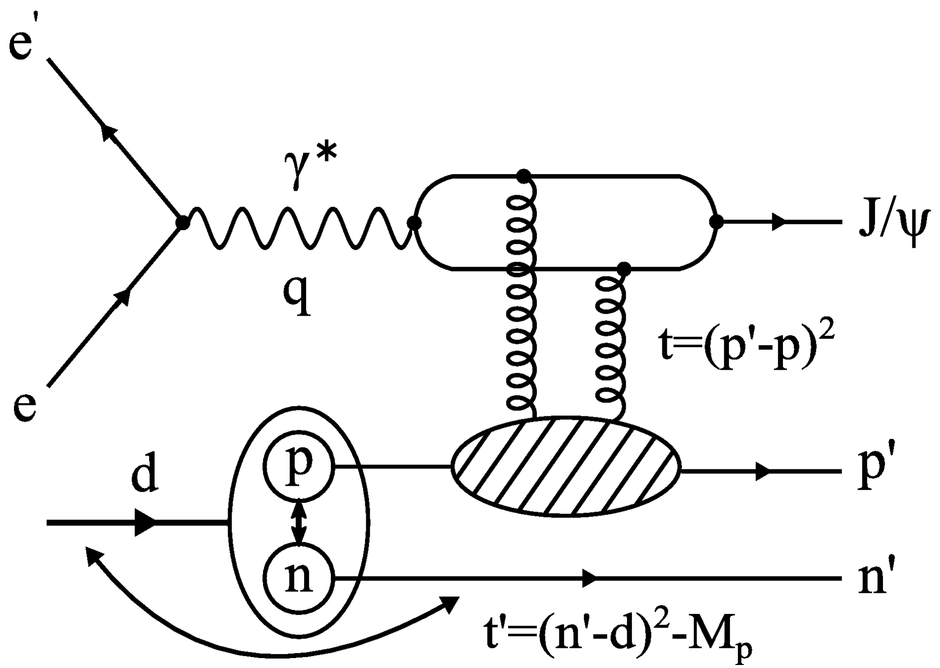
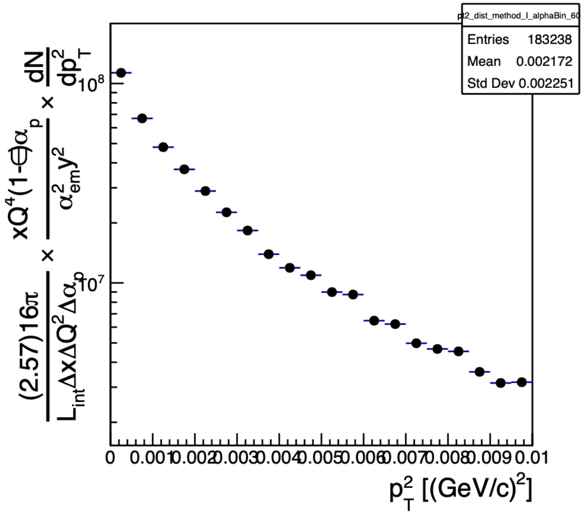
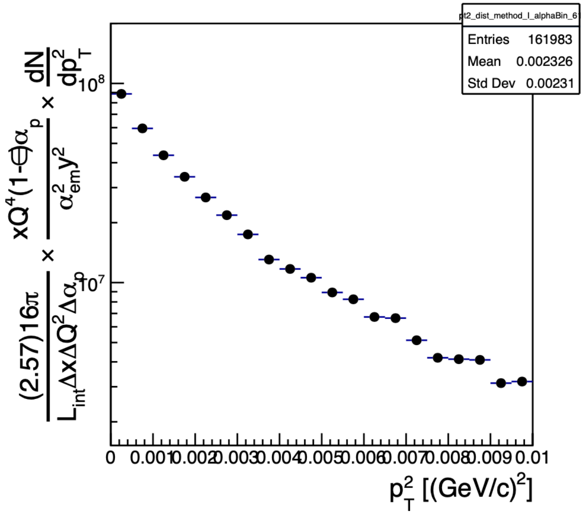
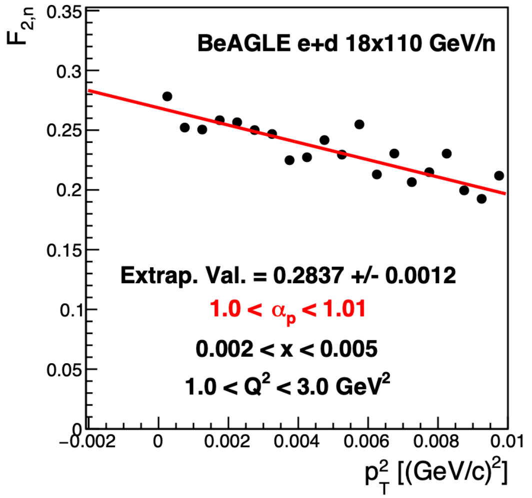


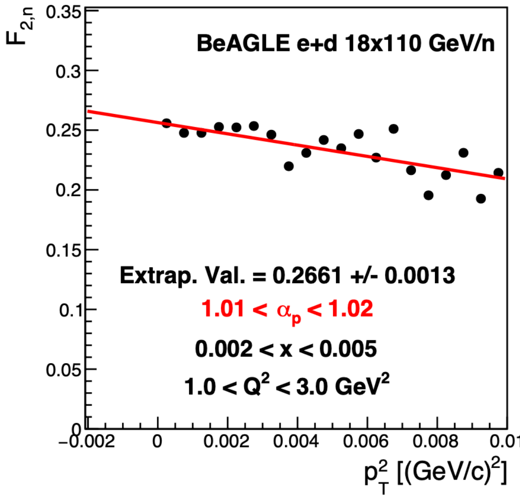
Tagged Structure Functions: Deuteron

Contact: Jentsch, Tu, and Weiss









Free and deeply bound nucleon structure from spectator tagging in the deuteron.

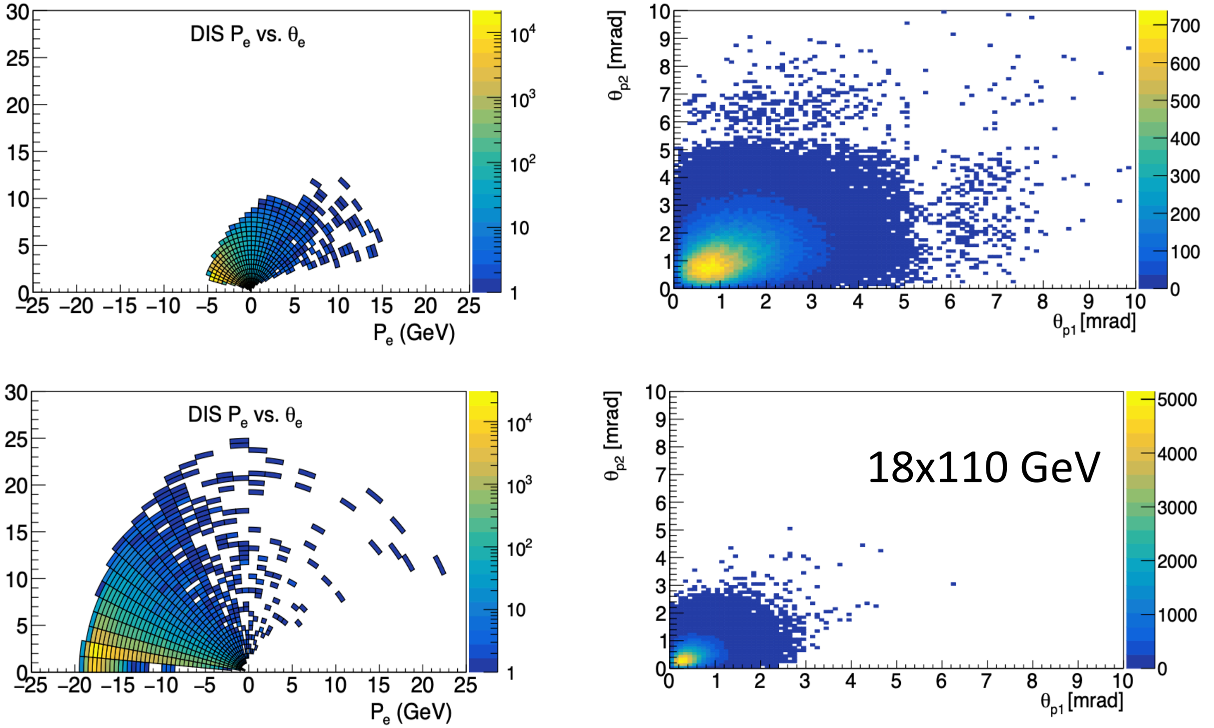
Require excellent forward spectator acceptance for precise pol extrapolation of the free nucleon and high reach in the off-shellness for bound nucleons

Tagged Structure Functions: 3He

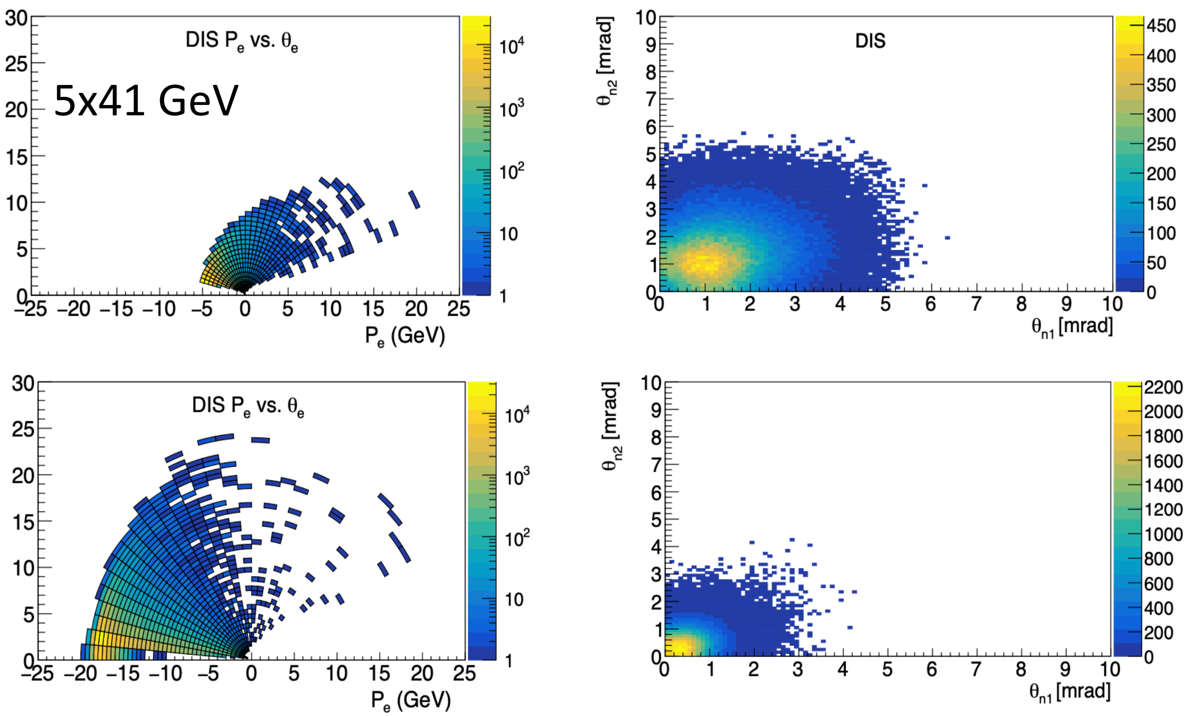
Contact: Dien Nguyen, Ivica Friscic & Jackson Pybus

Double tagging off 3He offers an independent test of the deuteron studies \w different nuclear effects and *polarization* observables.

3He(e,e'pp) DIS



3He(e,e'nn) DIS



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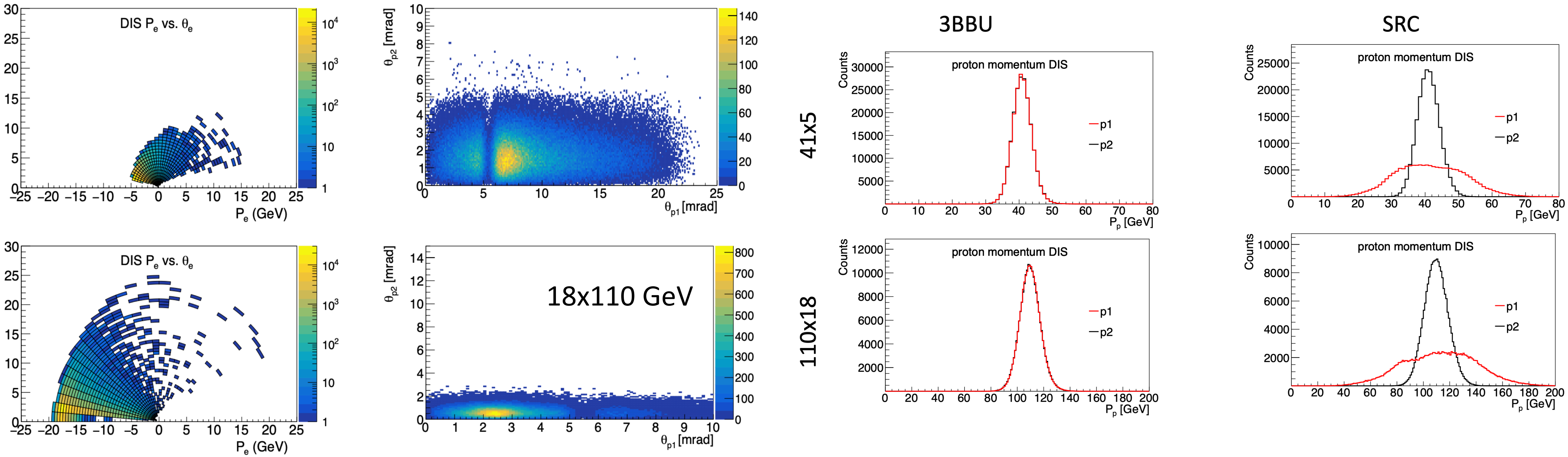
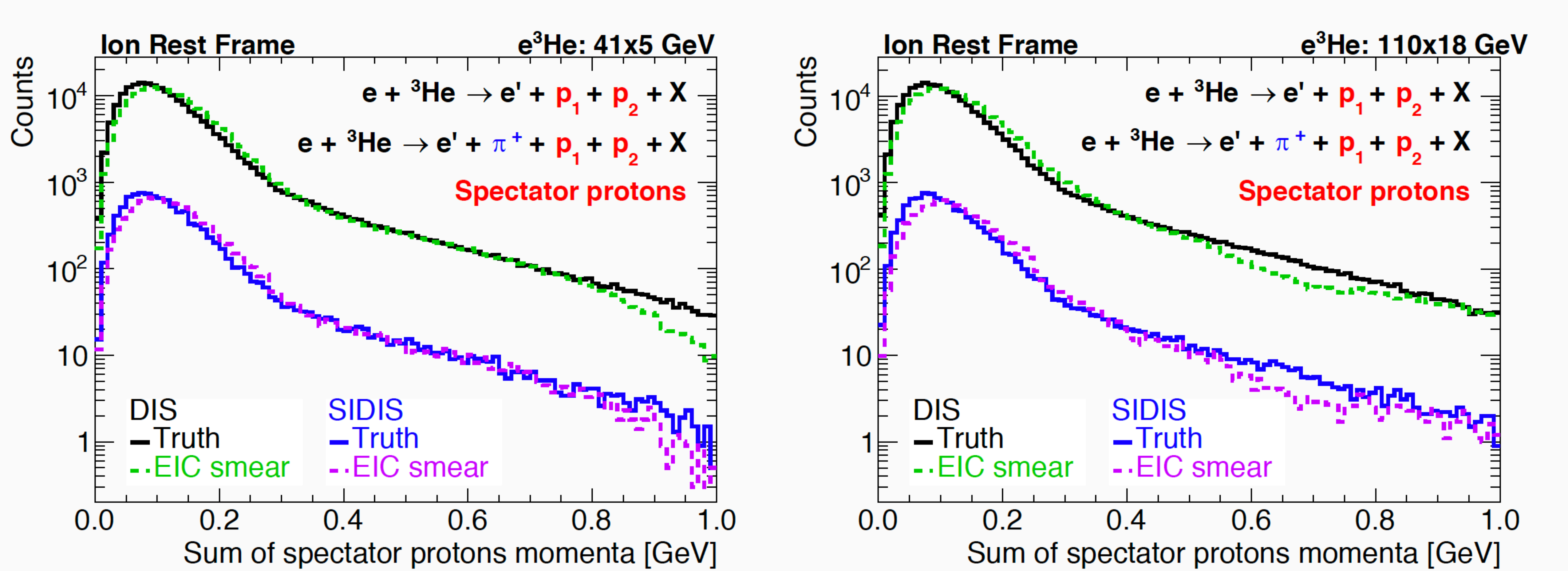
3He(e,e’pp) DIS-SRC



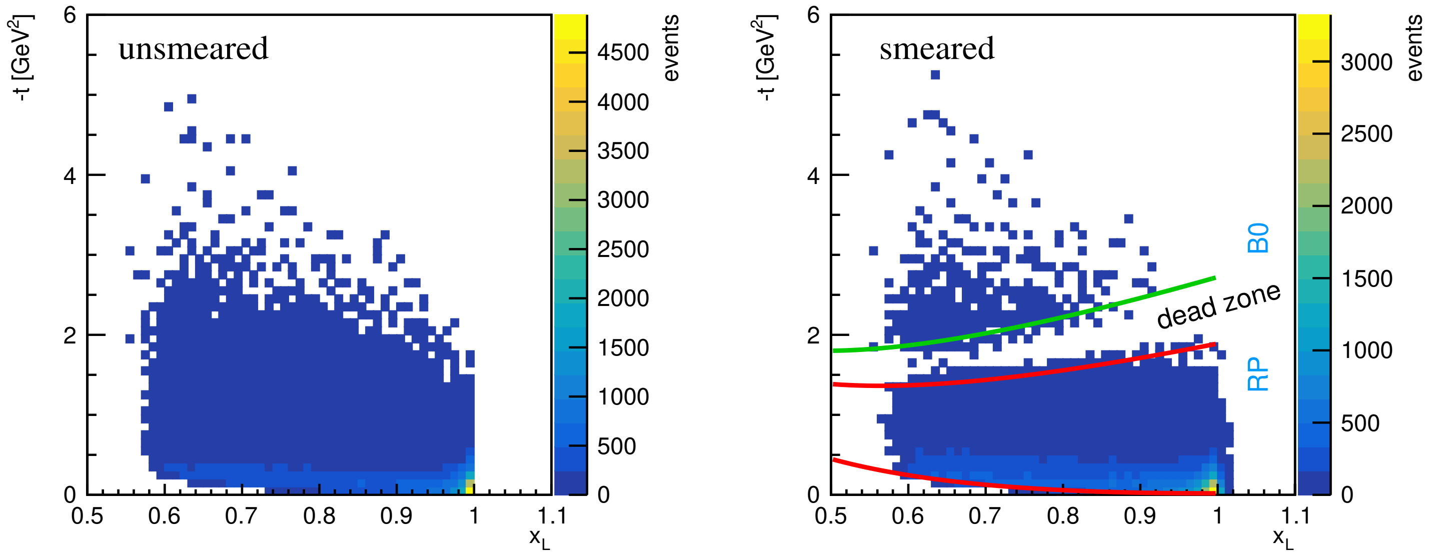
Tagged DIS and Tagged SIDIS with ^{3}He



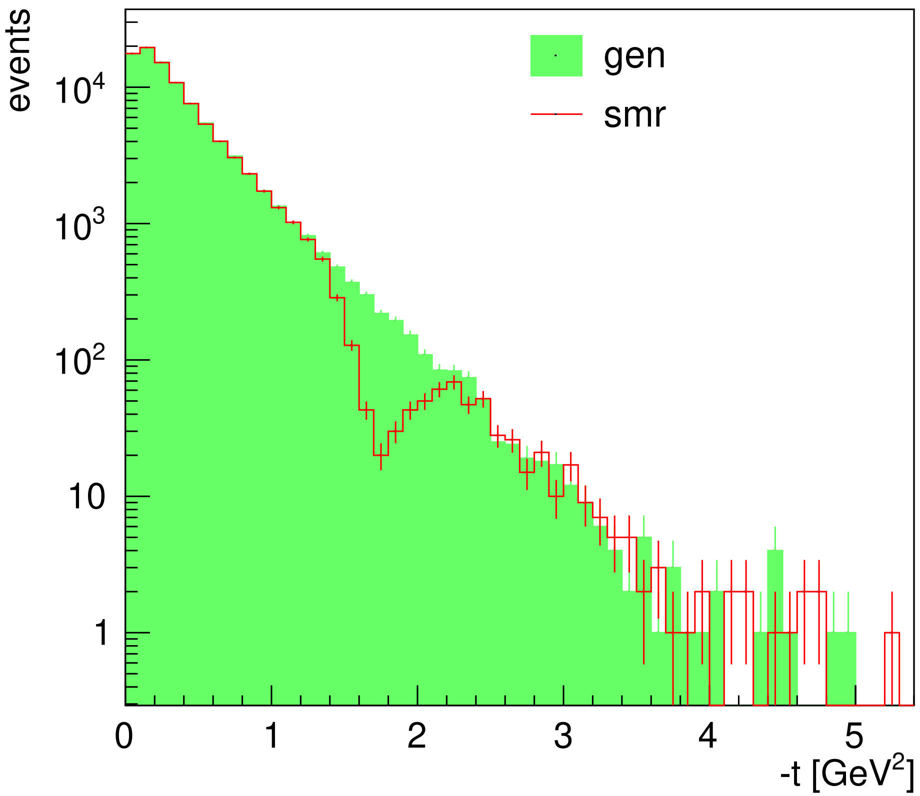
Inclusive Diffraction

Contact: Wojtek Slominski

- Simulations of diffractive processes using RapGap Monte Carlo (tuned to HERA data) with fast simulation EIC Smear
- Available space in the beamline (assuming it goes into few mrad) gives sufficient range in –t. HERA went only to $|t|<1\ GeV^2$
- Handbook resolutions for xL in RP are sufficient

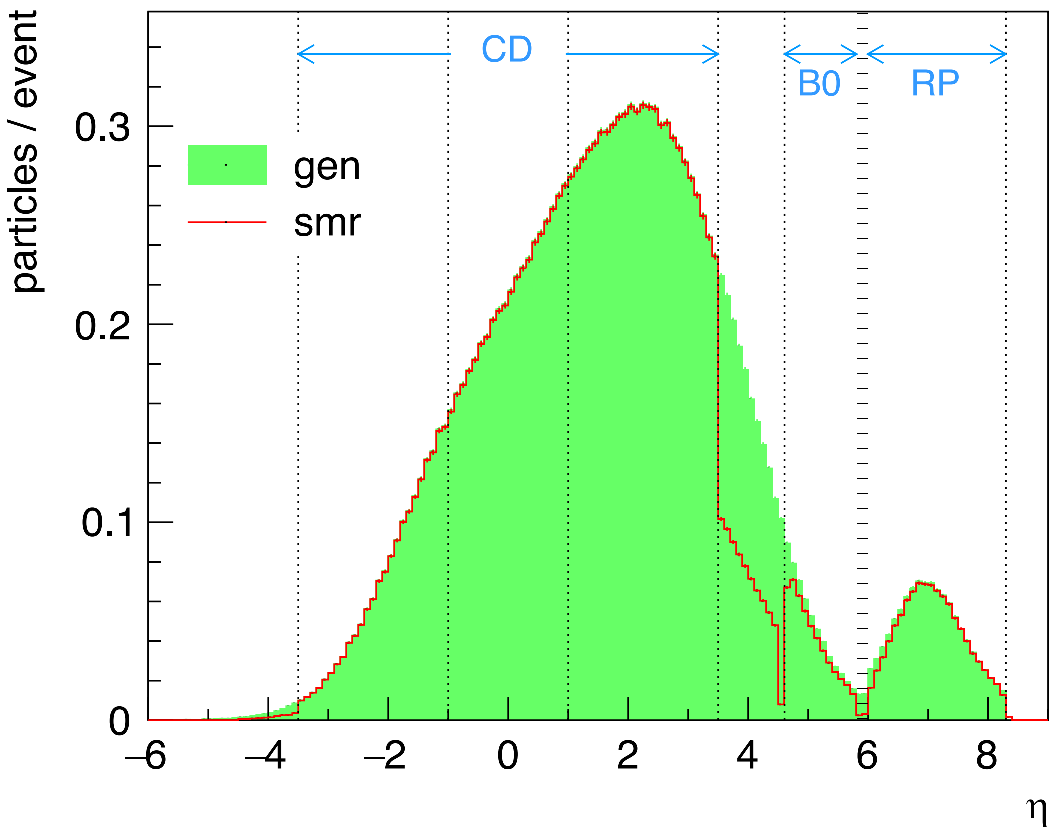


Inclusive Diffraction



Dead zone problematic for the leading proton physics studies. Translates into region in |t|=1.4-2.6 GeV^2 .
Will be difficult or impossible to extract precisely t slope in large range.

All particles w/o scattered lepton



For rapidity gap detection any information on the lack of hadronic activity at η>3.5 will be very beneficial. Two detectors can help here.

Vector Meson Production

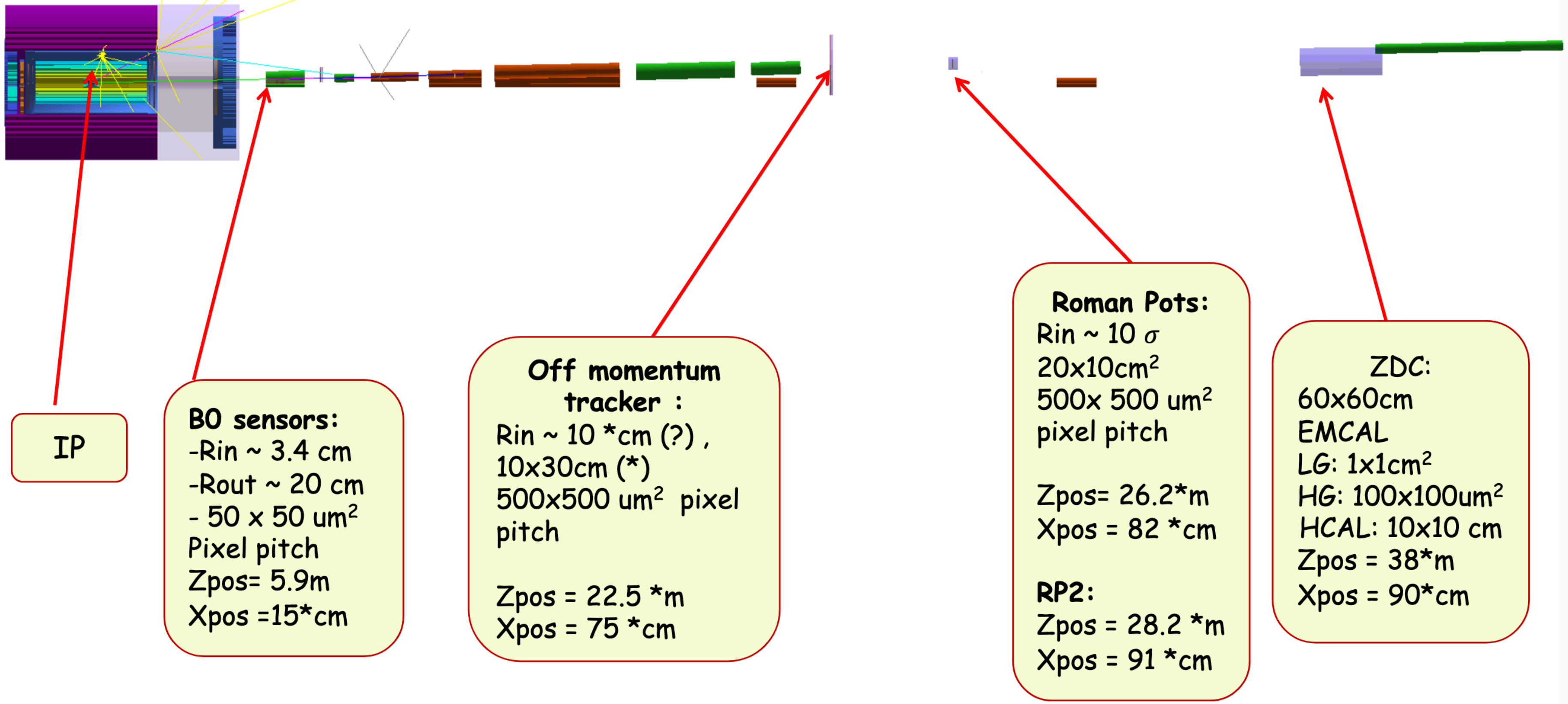
Contact: Spencer Klein, Sam Heppelmann

- Detection of 300 MeV pions from rho decay at pseudo-rapidity |eta|= 5
  - ρ rapidity maps directly into Bjorken x: x_{bj}-=$M_V/(2\gamma_{ion}\ m_{proton})\ \exp(-y)$
    - Within kinematic bounds (maximum photon energy); for ep, this bound is at y=-4.
    - We need ~ 1 additional unit of pseudorapidity for good acceptance, to determine the cross-section ratio for longitudinal to transverse production.
    - Second kinematic limit is near threshold (x_{bj-}>1); this is around y=+2, so less stringent.
- Resolution requirement on separation of three Upsilon states slides. Handbook resolutions ok.
- Phi production requires detection of 135 MeV/c Kaons at mid rapidity.
  - Kaon velocity ~ 0.2 c, so these kaons are highly ionizing and lose energy rapidly.
- Soft photons:
  - It is critical to see photons from nuclear excitation to separate coherent and incoherent photoproduction. For gold (lead) these photons extend down to 270 keV (2.6 MeV) in the lab frame. Requires a commensurate threshold. For now, we request a ~50MeV for nuclear breakup (Far forward) slides, study is still in progress. Also of order 50 MeV proton detector for radiative decays in spectroscopy in the central region [needs detailed study, ballpark number for now]
- Some of these requirements are very challenging (perhaps impossible?). But, they are directly linked to important physics studies. Tradeoffs will be needed, but, to make good decisions, it is important to know what we are giving up

Detailed Studies of Meson Structure Functions Provided Requirements for four far forward detector regions.

Contact: Tanja Horn

https://indico.bnl.gov/event/9275/contributions/40865/attachments/30149/47098/Lambda_Aug27.pdf



Hcal: Resolution: 35%/√E (goal), <50%/√E (acceptable)*, 3mrad/√E (goal)

Hadron endcap calorimeter: Good resolution for x-resolution (large-x processes) also 35%/√E

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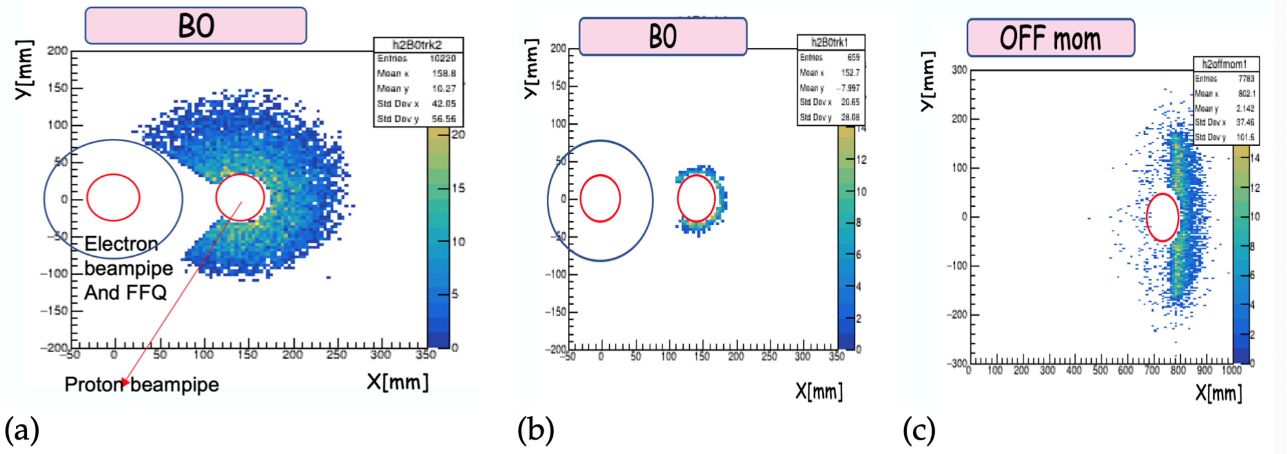

Figure 8.87: Occupancy plots for energy setting 5×41 (a) for π^- in the B0 tracker, (b) for protons in the B0 tracker and (c) in Off-Momentum detectors. The red circle shows the beam pipe position and the blue circle shows the electron Final-Focus Quadrupole (FFQ) aperture inside the B0 dipole.

Neutron Acceptance in ZDC