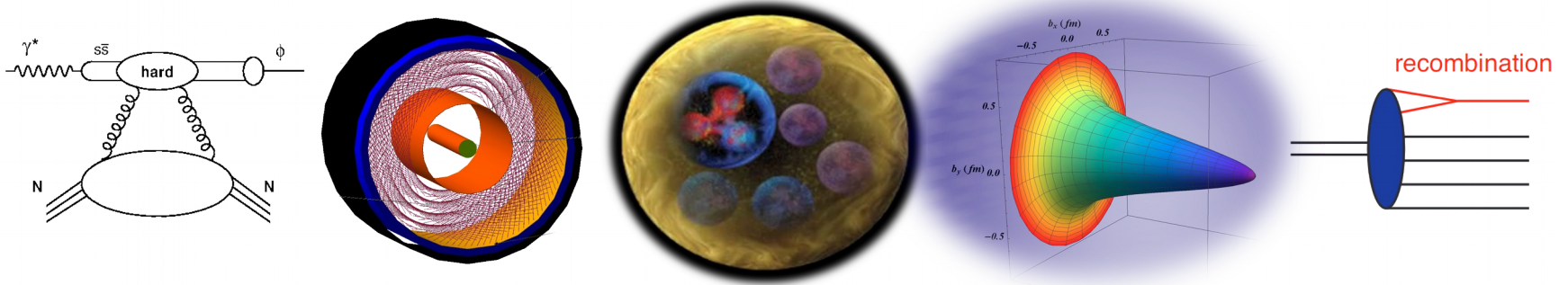


Summary of the Exclusive Reaction Working Group



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Raphaël Dupré

Exclusive WG Session

We have regular weekly meeting

– <https://indico.bnl.gov/category/291>

We had updates from some of the main topics we cover during our dedicated session:

VM production: electrons and muons	<i>Sylvester Joosten</i>	
Online		08:30 - 08:45
DVCS and pi0 kinematics	<i>Maxime DEFURNE</i>	
Online		08:45 - 09:00
CFF extraction from DVCS	<i>Francois-Xavier Girod</i>	
Online		09:00 - 09:15
Suppression of incoherent breakup in e+A	<i>Wan Chang</i>	
Online		09:15 - 09:30
How kinematics should be assessed / discussed	<i>Christian Weiss</i>	
Online		09:30 - 09:40

And shared sessions with other working groups

VM Production: Electrons and Muons (S. Joosten, ANL)

Measurement appears very promising

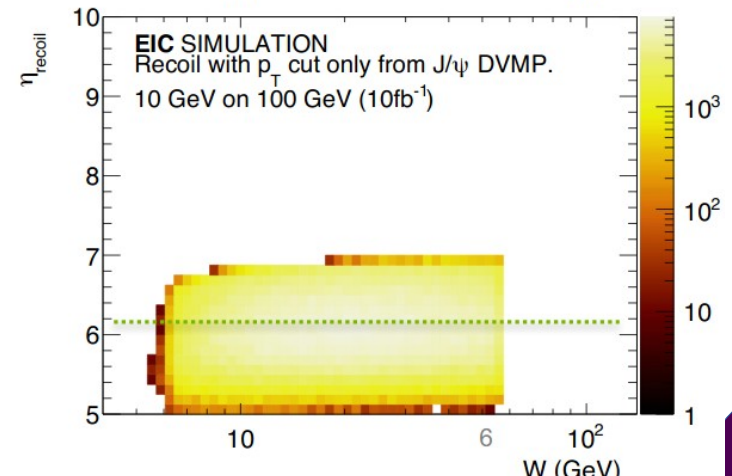
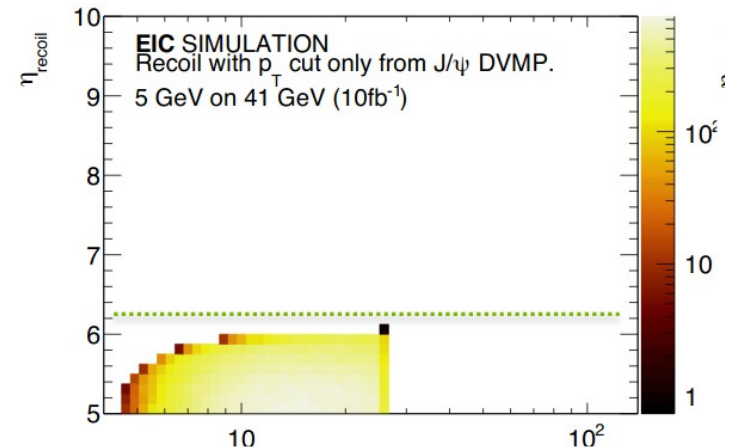
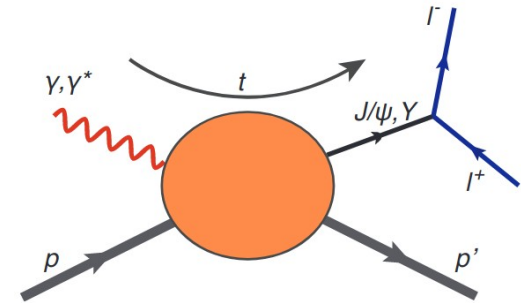
- Large coverage in Q^2 , x and t
- Capability to cover from valence to sea

Issues arise at lower energy settings

- Lower proton rapidity cut kills the low-energy setting
- Makes difficult J/psi threshold physics

Muon decay channel

- Mostly work fine, with the same issue as pointed above
- Acceptance beyond $\eta=3.5$ for muons would help a lot

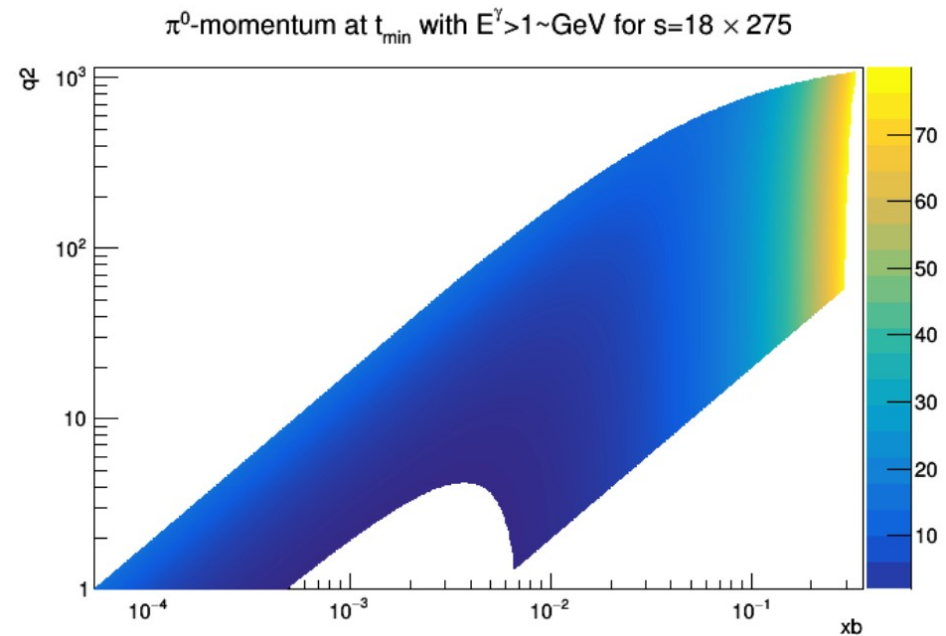


Channel complementary to DVCS

- For itself in term of meson production
- As the main contamination channel into DVCS

Looked at the detection limits in present settings

- Low energy photons at combinations of low Q^2 and large x
 - Mostly resolved in discussion linked to being too conservative on calorimetry
- Capability to separate the two photons of the π^0 decay
 - Issue arising at high x
- Coverage for proton measurement
 - Issue arising at high x for lower s configurations of the machine



Study to estimate the effect of each DVCS observables on CFF extraction at the EIC

- Based on local fits of the CFFs (Compton Form Factors)
- Includes many observables

	$\int \mathcal{L}$	Observables	$A_{e,p}$
unpolarized	200 fb ⁻¹	σ	A_{LU}
L polarized	100 fb ⁻¹	A_{UL}	A_{LL}
T polarized	100 fb ⁻¹	A_{UTx}	A_{UTy} A_{LTx} A_{LTy}
e ⁺	100 fb ⁻¹	A^C	A_{LU}^C

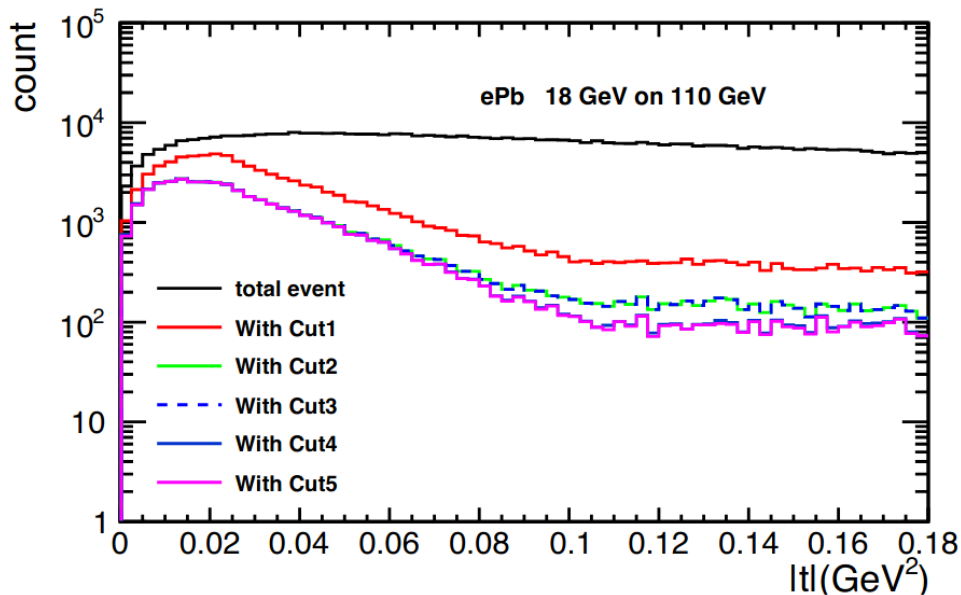
Framework is in place

- Allow to test different energies, observable settings
 - *Include exclude positron beam for instance*
- Basis to update event generator studies

The EIC IR and diffractive eA physics (Wan Chang)

Study how to get rid of incoherent events

- Using the Beagle generator



The impact of the different detectors is studied by adding one requirement / cut after the other.

Cut1:

- no neutron in ZDC

Cut2 :

- Cut1 + no photon $E > 50 \text{ MeV}$ in ZDC

Cut3:

- Cut2 + no proton in Roman Pots

Cut4:

- Cut3 + no proton in off-energy detector

Cut5:

- Cut4 + no proton in B0

Suppression of about two orders of magnitude at best

- Gamma resolution of ZDC below 50 MeV appears irrelevant
- This is not good enough for some of the studies
 - Question is raised about the physics in Beagle and if we can do better

Kinematics of exclusive measurements with EIC :

How to assess and discuss it in the Yellow Reports ? (C. Weiss, JLab)

Process	Objectives	Questions/comments
DVCS γ $x > 0.1$ few $10^{-3} < x < 10^{-1}$ $x \ll 10^{-2}$	valence GPDs spin/flavor nonsinglet/singlet/gluon GPDs spin/flavor gluon/singlet GPDs	rates? overlap JLab12? joint physics with $J/\psi, \phi$
$J/\psi, \phi$ $x > 0.1$ few $10^{-3} < x < 10^{-1}$ $x \ll 10^{-2}$	valence-like gluons gluons gluons	rates? helicity-flip GPD E ? joint physics with γ
ρ^0 $x > 0.1$ few $10^{-3} < x < 10^{-1}$ $x \ll 10^{-2}$	valence quark GPD flavor singlet/gluon GPD singlet/gluon GPD	rates? soft-hard transition? complements $\gamma, J/\psi, \phi$
ρ^+, K^* $x > 0.1$ few $10^{-3} < x < 10^{-1}$ $x \ll 10^{-2}$	valence quark GPD flavor sea GPD flavor —	rates? soft-hard transition? —
π^0, η $x > 0.1$ few $10^{-3} < x < 10^{-1}$ $x \ll 10^{-2}$	valence quark transversity valence/sea transversity odderon?	rates? overlap JLab12? soft-hard transition? rates?
π^+, K^+ $x > 0.1$ few $10^{-3} < x < 10^{-1}$ $x \ll 10^{-2}$	valence quark transversity transversity, π/K form factor —	rates? overlap JLab12? soft-hard transition? —

Proposed organization, to be discussed/refined/continued

Joint sessions between Diffraction & Tagging and Exclusive WGs + DWG

Morning session joint Exclusive/Diffraction & Tagging WGs:

Barak Schmookler: Elastic Hydrogen and Deuteron scattering

Charles Hyde: Initial state radiation as a probe of ep and eA scattering

Mark Strikman: Coherent gamma* ^4He scattering emphasizing t-range for ^4He detection

Sylvester Joosten: VM production: electrons vs muons

Sam Heppelmann: Vector meson production simulations

Wan Chang: Suppression of incoherent background in VM production

Vadim Guzey: Diffractive dijet photoproduction at the EIC

Farid Salazar: Diffractive dijets in DIS

Wenliang Li: u-channel π^0 production

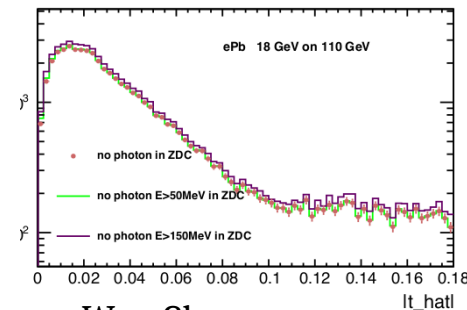
Afternoon session joint Diffraction & Tagging/Exclusive and DWG:

Alex Jentsch: DVCS and e+D spectator tagging in the FF region

Douglas Higinbotham: Magic beam energies for polarized deuteron

Suppression of incoherent VM production

- Needed to isolate coherent contribution; diffractive minima
- We're at least a factor of 10 above where we need to be -> **problem**
- Acceptance for protons and neutrons
 - ZDC $\theta < 5\text{mrad}$ -> larger? -> implies wider bores in magnets etc.
- Decay photons low energy and ~ half of them invisible (Lorentz contraction)
 - Lowest detectable energy?
 - theoretical nuclear structure input needed?
- Explore different nuclei [excitation levels]?
- Photon detection in B0



Wan Chang

The survived events count after Cut2 with different energy cut on photon:

Survived event count	
E>150 MeV	71773
E>50MeV	66101
E>0 MeV	65278

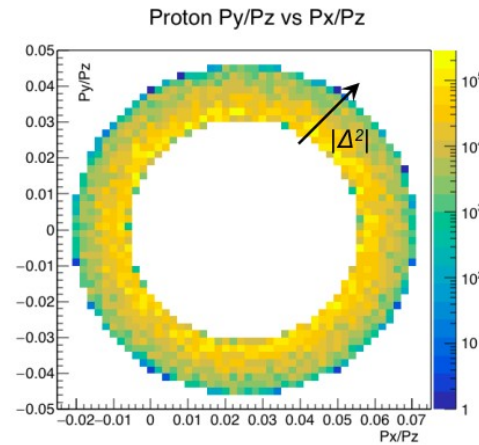
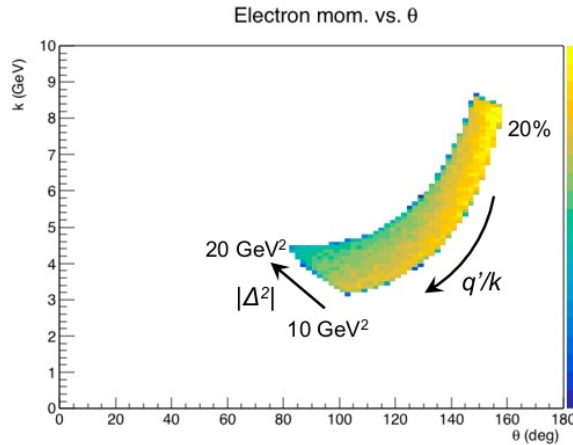
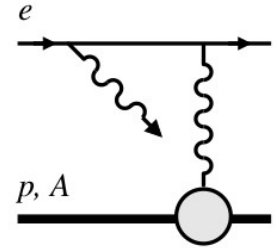
Initial state radiation for exclusive processes with varying \sqrt{s} [Hyde, Weiss]

- Bethe-Heitler process
- Dynamic kinematic range without varying beam parameters

$$ep \rightarrow ep\gamma \quad 10 \otimes 100 \text{ GeV}^2$$

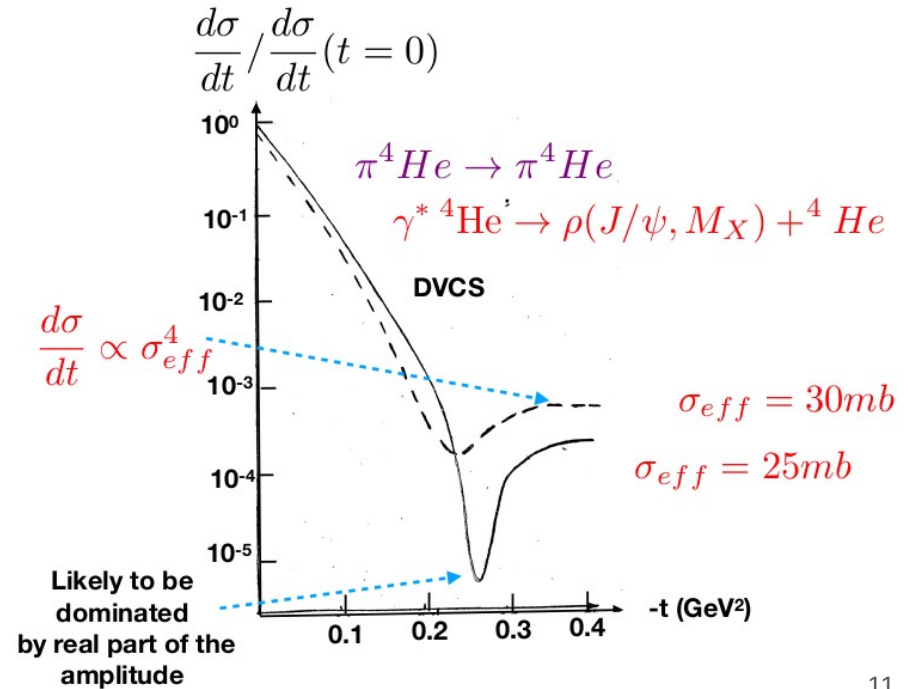
$$10 \leq -\Delta^2 = -(P' - P)^2 \leq 20 \text{ GeV}^2$$

- Radiated photon: $20\% < q'/k_e < 80\%$



Coherent ^4He scattering [Strikman]

- Coherent scattering on nuclei provides info on color fluctuations in probe (soft regime) and LT gluon shadowing (hard regime)
- Hard to measure at EIC for heavy nuclei. ^4He looks feasible
- VM production:
t-range up to 0.5 GeV^2
good resolution for $t \sim 0.01 \text{ GeV}^2$
- Inelastic diffraction:
resolution in M_x
very good resolution in x_{pomeron}



Upsilon Events in EICRoot All-Silicon Detector [S. Heppelmann]

Requires less than 1% momentum resolution

LBL All-Silicon Detector

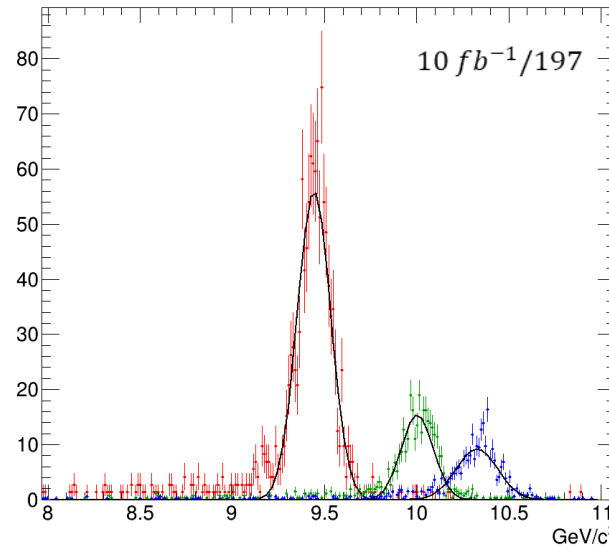
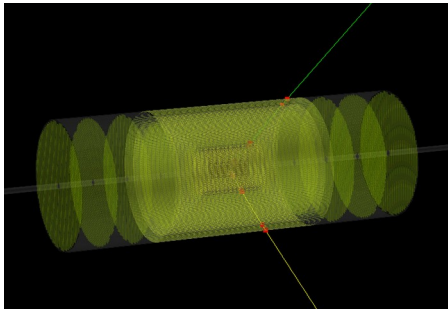
(Developed by LBNL's eRD16 generic EIC detector project)

- Silicon Tracker

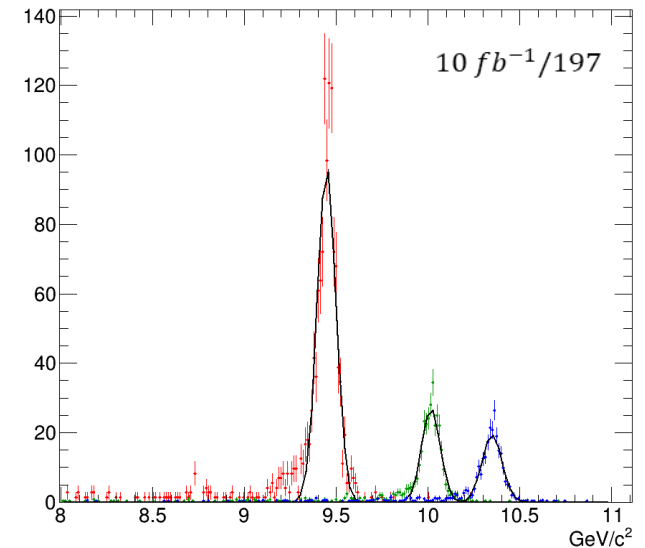
6 layers

- Silicon Endcap Disks

6 disks



1.5 Tesla

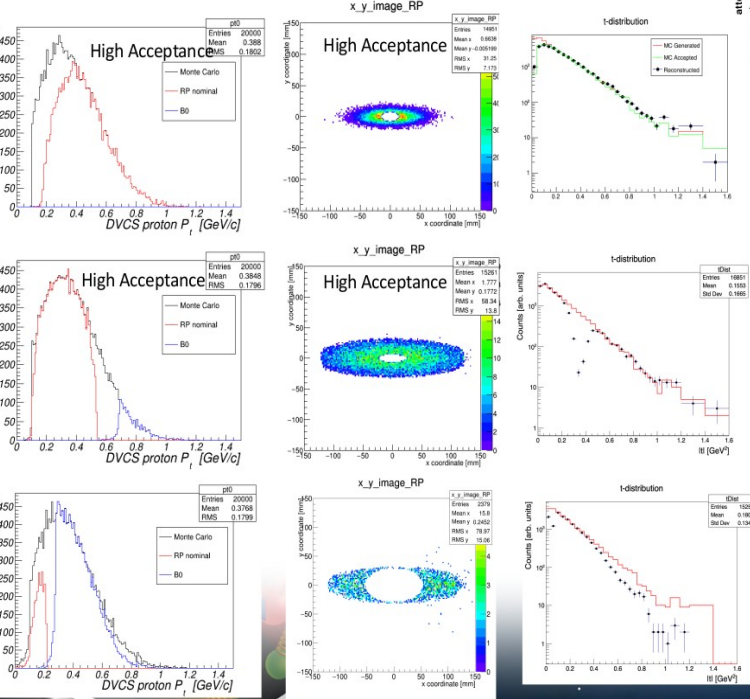


3.0 Tesla

Upsilon peaks are still distinguishable with a lower B-Field

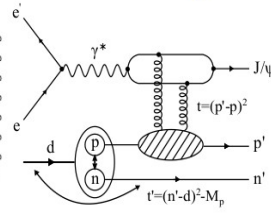
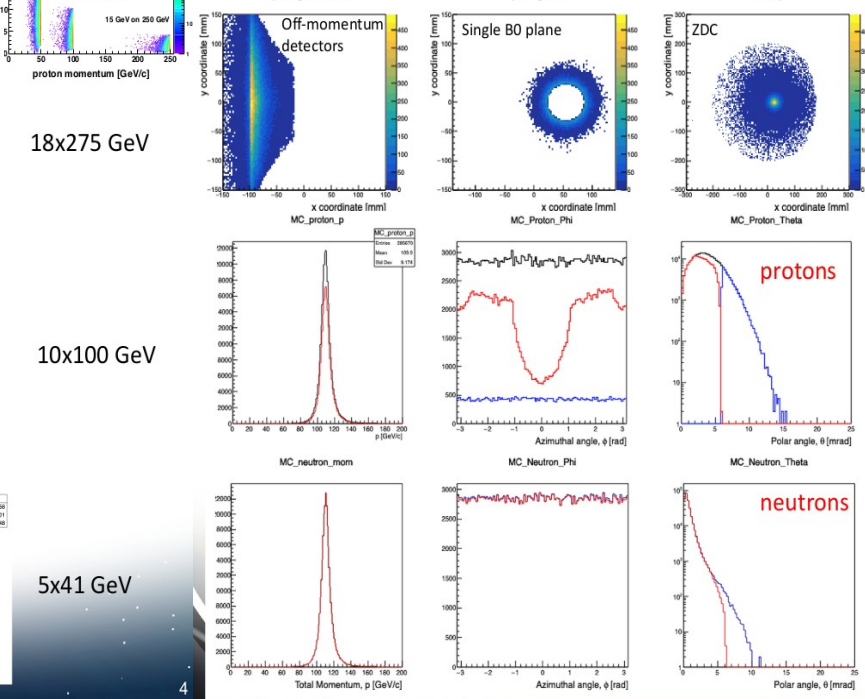
Full simulations for DVCS and e+D spectator tagging by far forward WG [A. Jentsch]

Review of DVCS results



The acceptances for DVCS are quite good across all energies, with low energy requiring some optimization.

Results from e+D nuclear breakup



Particular process in BeAGLE: incoherent diffractive J/psi production off bounded nucleons.

Neutron spectator case.

Measuring off-energy protons from nuclear breakup events challenge Lattice allows for quite good acceptance, with most spectator protons being captured by the Off-momentum detectors.

Other discussed topics

- Quantify lower limit of acceptance of Roman pots [0° quoted]
Understand nuclear fragment PID
- Deuteron polarization preserved at “magic” deuteron energies: 39.4; 118.1 GeV/A
Feasibility of 39.4 GeV from accelerator POV?
- Intermediate \sqrt{s} values [between 100x10 and 275x18] for extraction of (diffractive) F_L
- Implementation of far forward detectors in eic-smear? -> difficult so full simulations
- Collect commonly asked kinematics on Wiki: e.g. t-range in exclusive processes
- VM muon decay [S. Joosten] : muon detection in endcaps -> HCAL good muon detector already?