Nuclear DVCS

Science at the Luminosity Frontier: Jefferson Lab at 22 GeV
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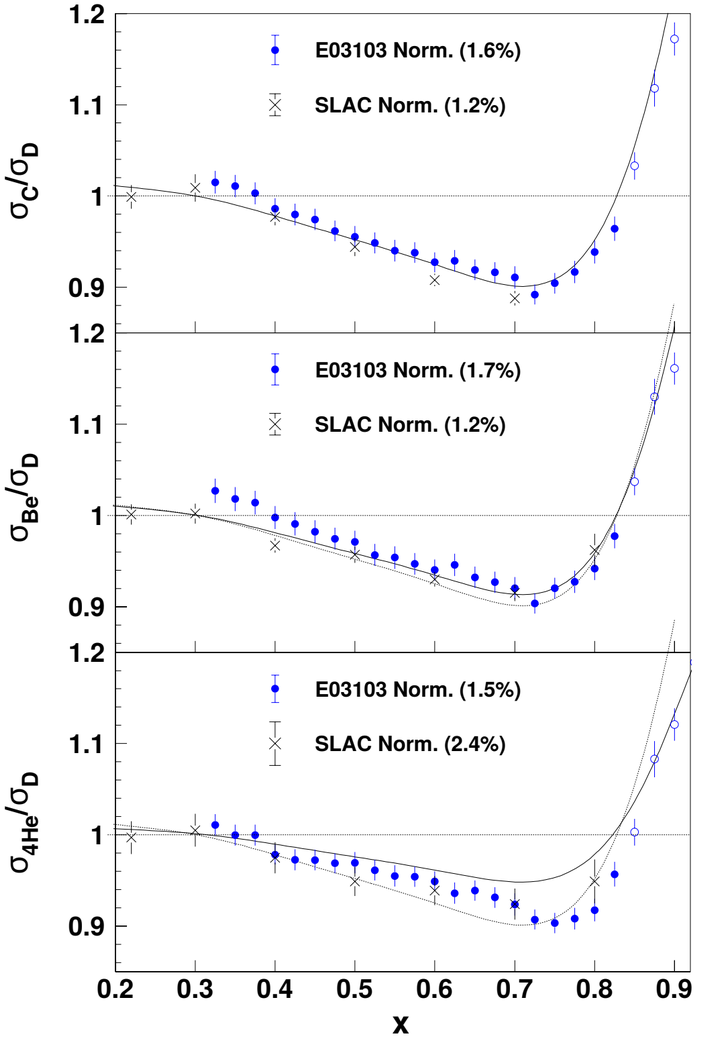
Mikhail Yurov
Mississippi State University

Nuclear Effects in QCD

- Modification of bound nucleons properties and dynamics
  - EMC effect at intermediate x, shadowing at smaller x, …
  - studied in DIS, significant change in longitudinal momentum distribution of quarks inside the bound nucleon
  - theoretically, no unifying physical picture of the EMC origin

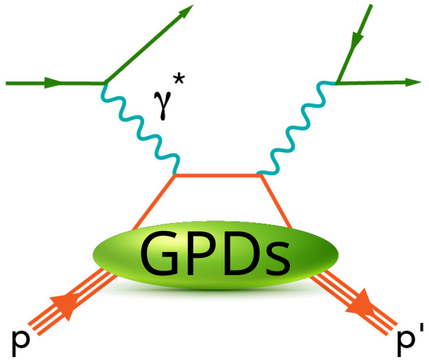
- Would the exploration of transverse spatial structure in nuclei provide a new insight?
  - hard exclusive processes - DVCS, DVMP, …
  - comparison to free proton results - novel experimental method of understanding the properties of bound nucleons

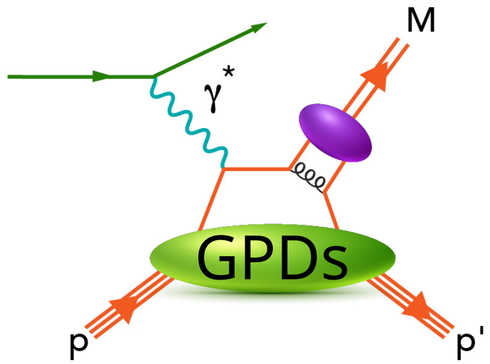


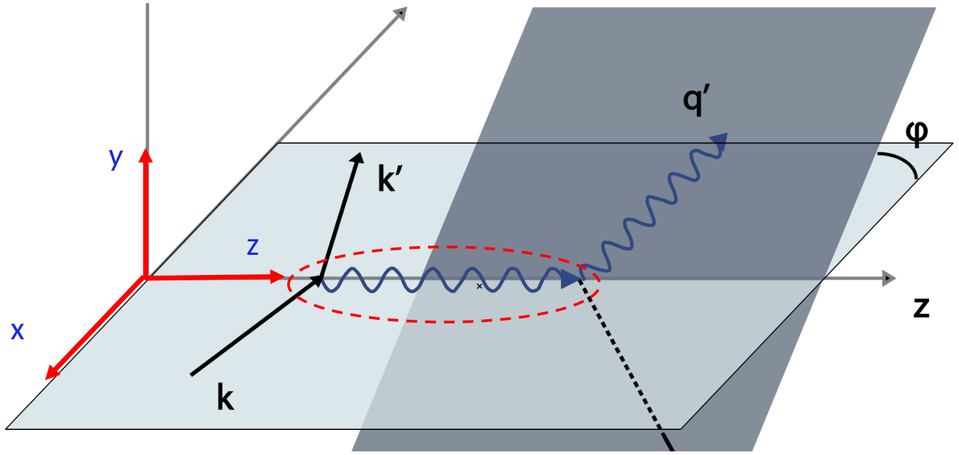
J. Seely et al. Phys.Rev.Lett. 103 (2009) 202301

Generalized Parton Distributions

- GPD framework
  - information about the momentum and spatial degrees of freedom of the quarks and gluons inside hadrons
  - experimental efforts (JLab, HERA, CERN) predominantly focus on proton (neutron) studies
  - DVCS is the cleanest probe (DVMP, TCS, DDVCS)

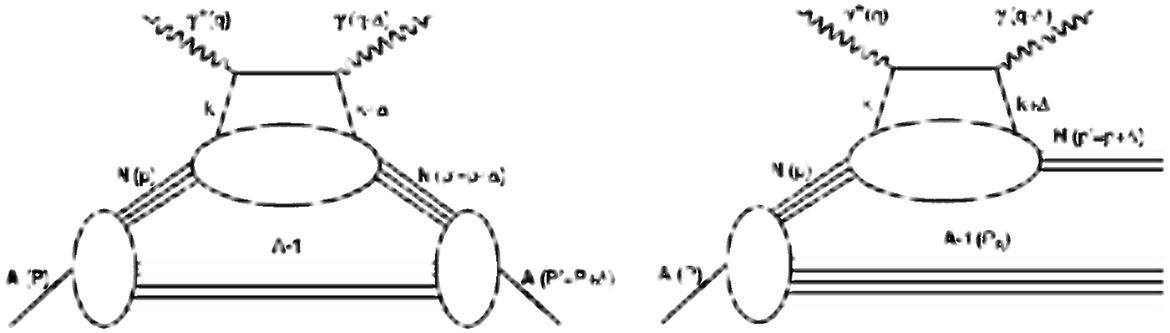






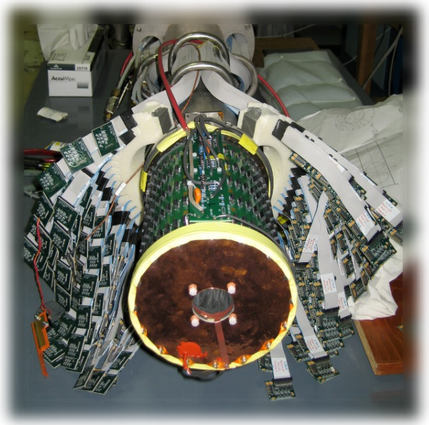
Nuclear DVCS

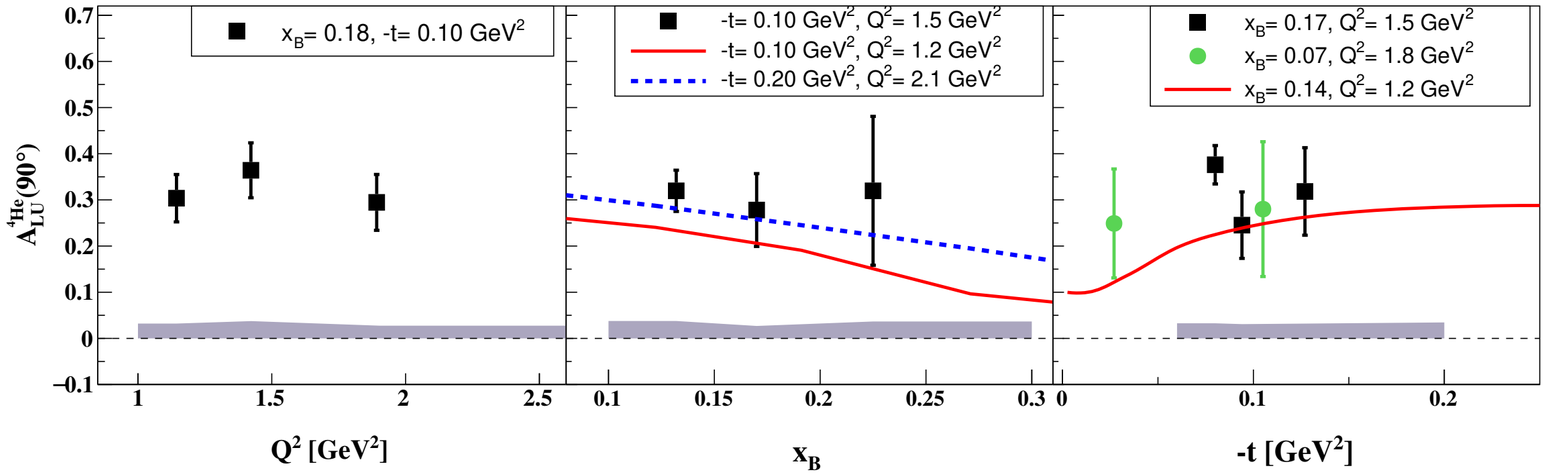
- Recent technology advances provide new prospects of studying DVCS in nuclei
- Nuclei allow access to the spin
  - nuclei allow access to the spin: Spin-0 2 GPD; Spin-1/2 8 GPDs; Spin-1 18 GPDs
  - 4He nucleus - spin-0, large EMC, high core density and binding energy
- Exclusive electro-production of a photon in nuclear target via two distinct processes
  - coherent scattering - nucleus recoils as awhole
  - incoherent scattering - nucleus breaks up



Nuclear DVCS

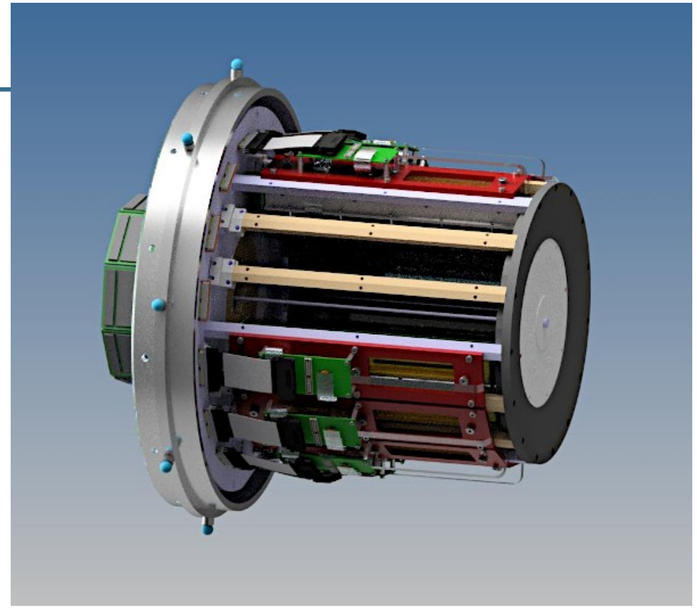
- Coherent DVCS experimental status
  - detection of the low energy recoil nucleus is very challenging
  - Hermes, JLab - sizeable asymmetries, not fully exclusive, limited reach
  - CLAS (E08-024) pioneered measurements of exclusive coherent DVCS off ^{4}He



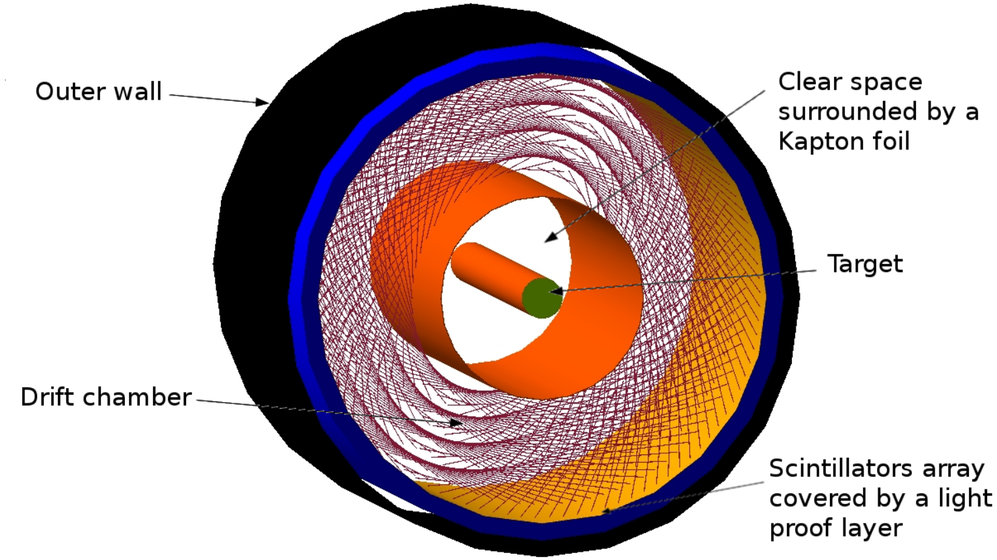


M. Hattawy, PRL 119, 202004 (2017)

ALERT Project

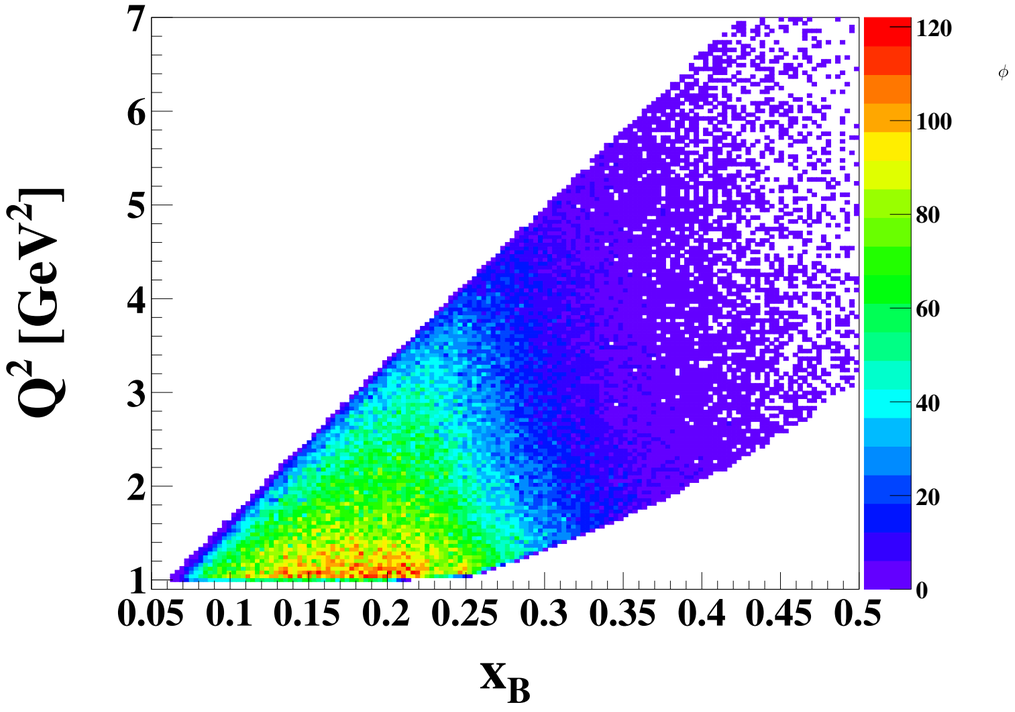


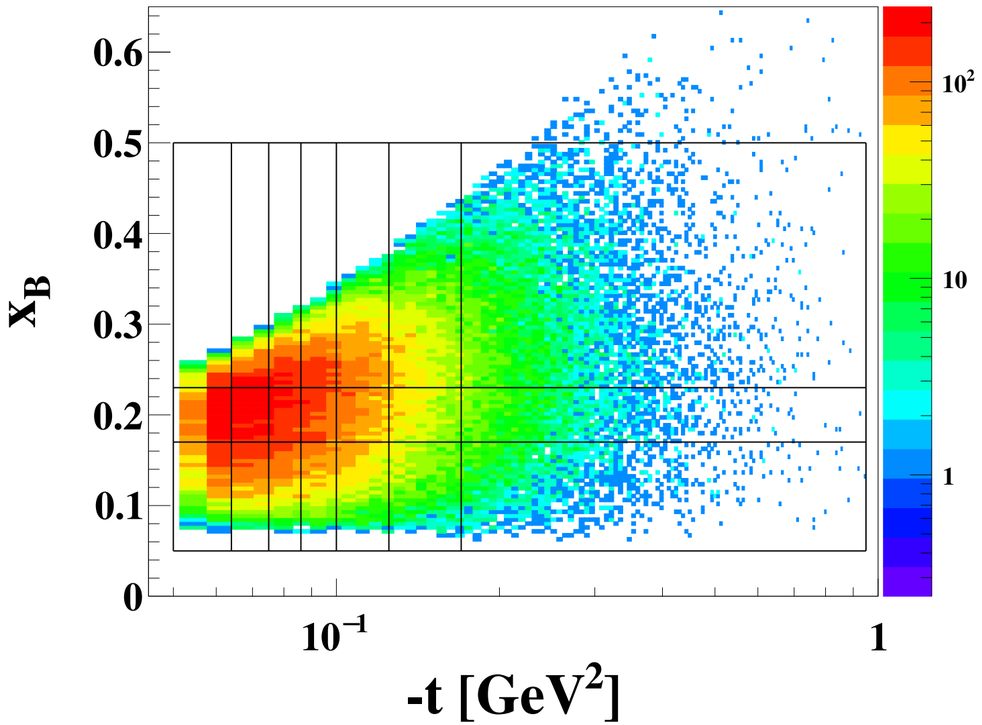
- Centered around A Low Energy Recoil Tracker
  - nuclear DVCS and DVMP on helium-4
  - tagged DVCS on helium-4 and deuterium
  - tagged DIS on helium-4 and deuterium
- experimental setup: CLAS12 + ALERT + ^{4}He gas target straw
  - Hyperbolic drift chamber + Time-of-Flight array
  - Provides PID for: H, ^{2}H, ^{3}H, ^{3}He, and ^{4}He
  - included in trigger for background rejection
- ALERT collaboration
  - ANL, IJCLab, JLab, NMSU, Temple, MSState



Proposed Measurements at 12GeV

- Beam spin asymmetry A_{LU} with CEBAF polarized beam
  - assumed beam polarization 80%
  - estimates for 20 days at 0.75×10^{34} $cm^{-2}s^{-1}$ and 10 days at 0.75×10^{34} $cm^{-2}s^{-1}$
  - 3 bins in x_B, 7 bins in -t, 12 bins in ϕ





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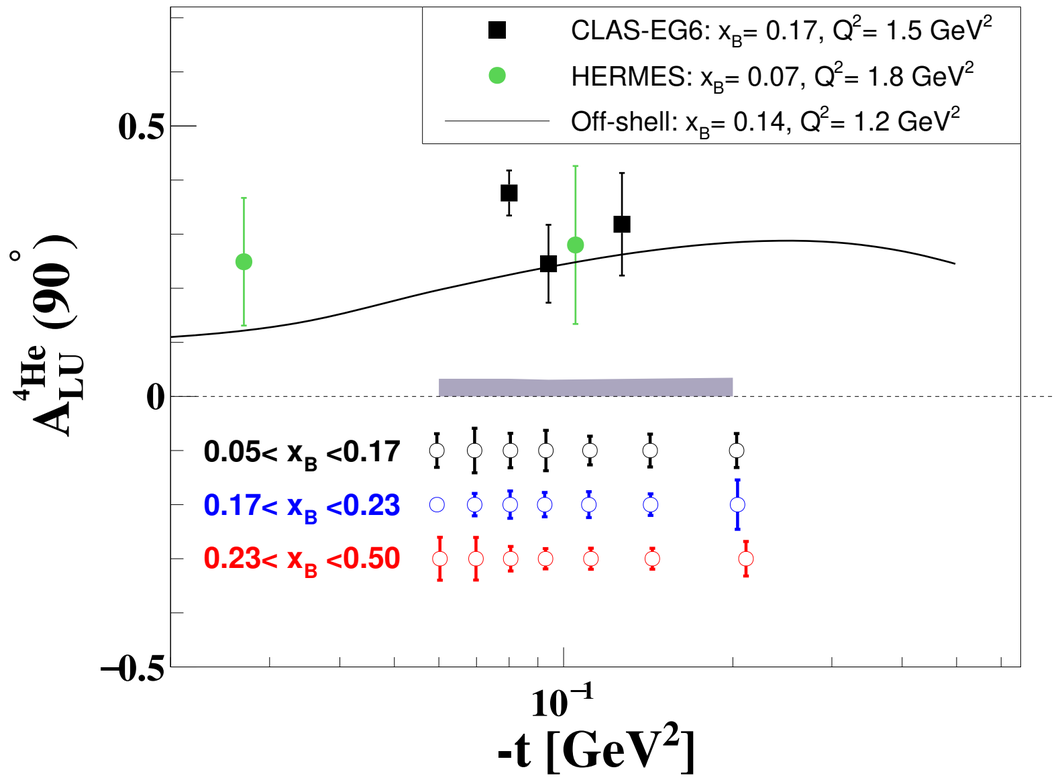
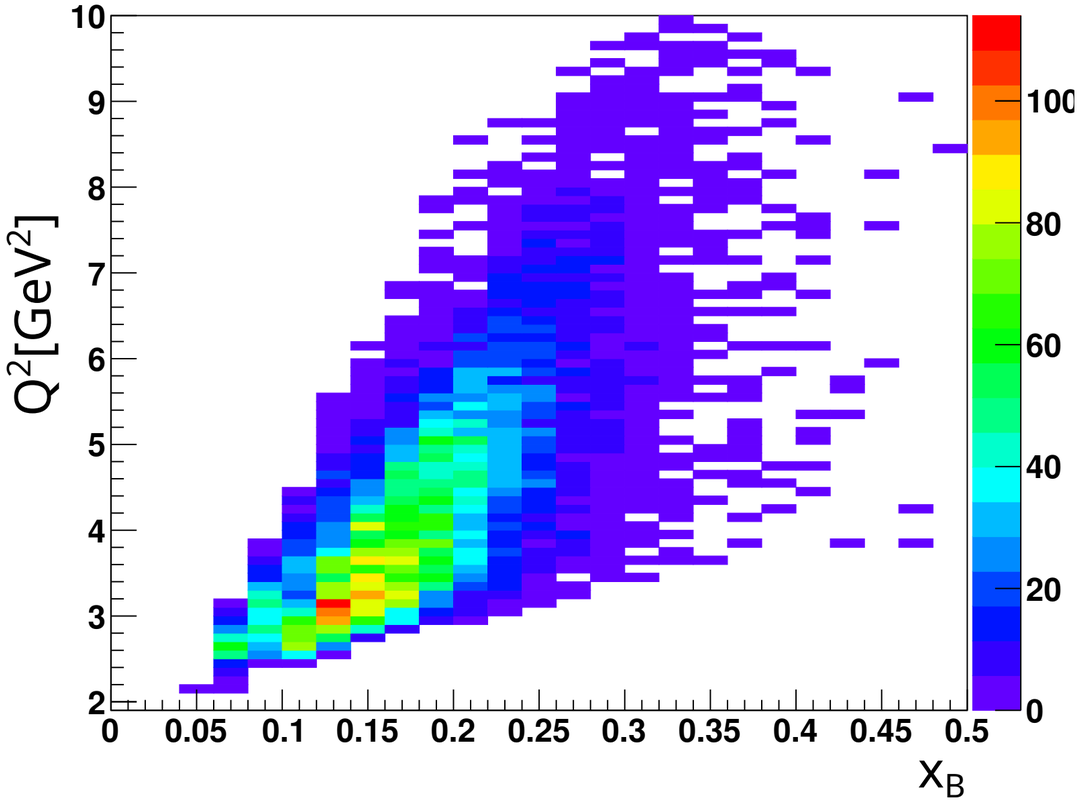
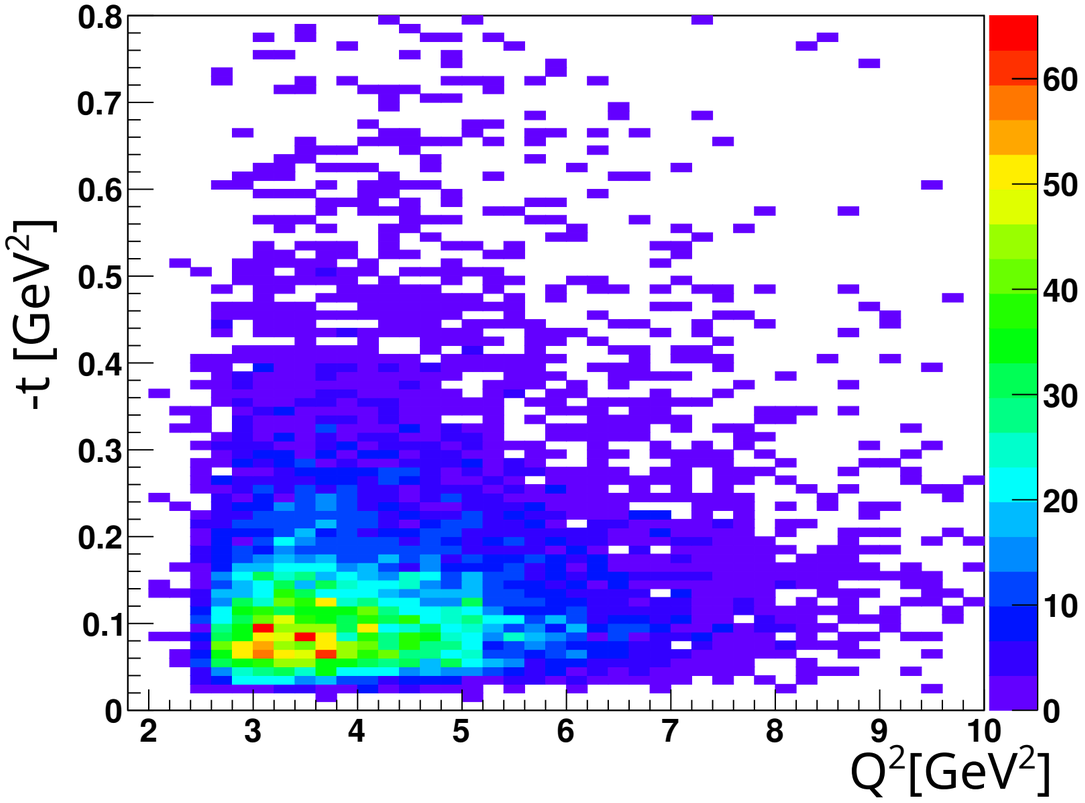
- ALU projected precision
- Real & imaginary ^{4}He CFF extraction
- Gluonic structure of nuclei via exclusive coherent ϕ meson electroproduction



Expectations at 22GeV

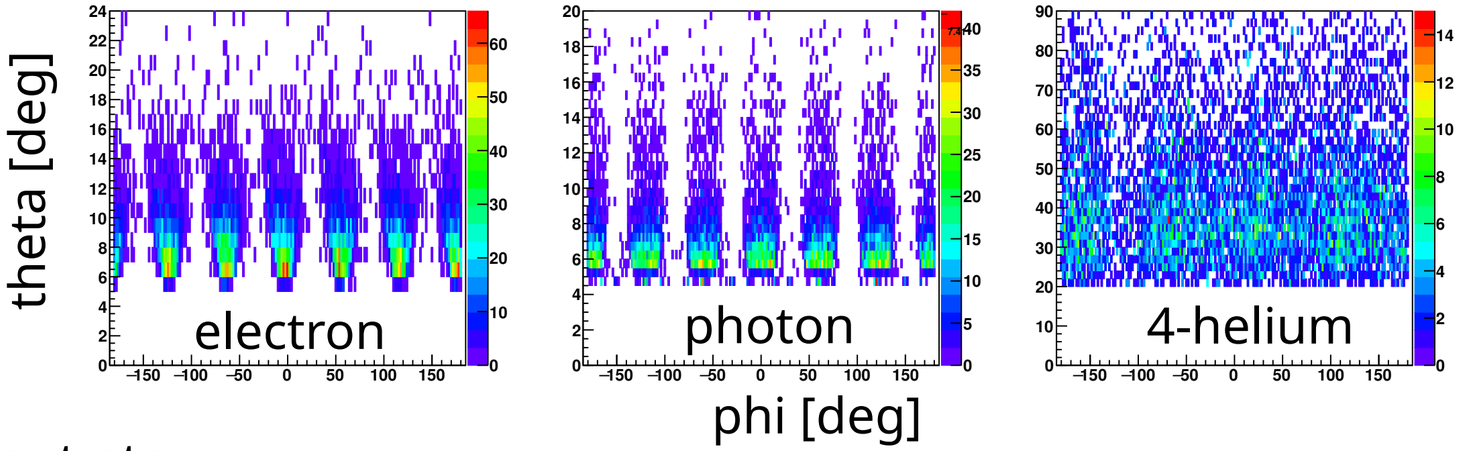
- Work in progress - using full G4 simulation of coherent DVCS on ^{4}He
  - New MC Event Generator - TOPEG (The Orsay Perugia Event Generator) by Raphaël Dupré
  - GEMC for CLAS12,+ALERT and CLAS12 recon



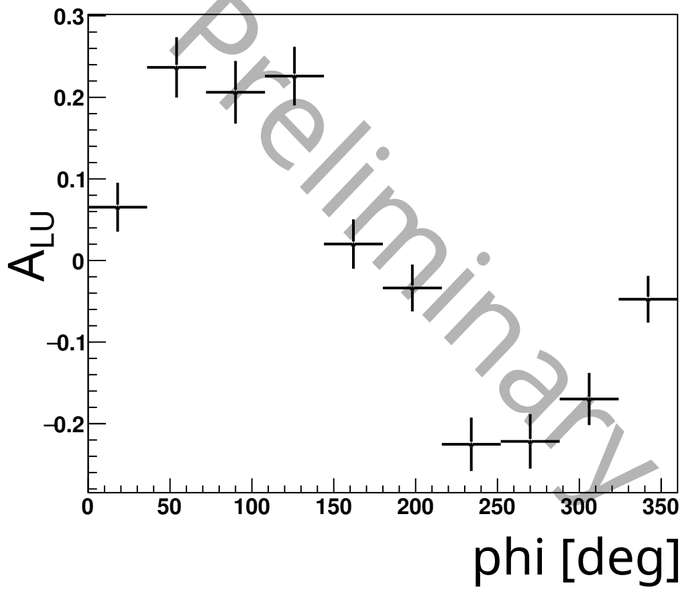


Expectations at 22GeV

- Current results
  - higher energies may give access to larger Q^2 and lower x_B
  - however, less than 1.5% event detected
  - low angle forward photon detection



- Next steps
  - tune MC and complete analysis
  - A_{LU} precision projections



THANK YOU