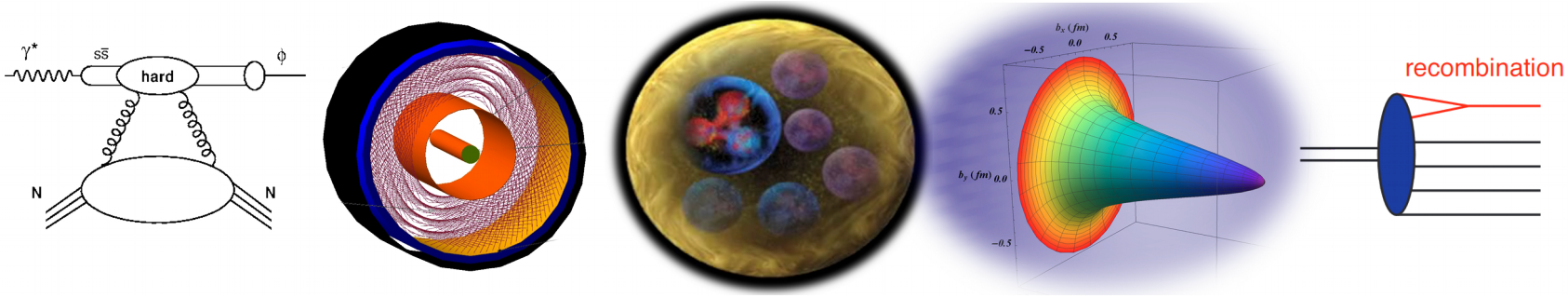
Helium DVCS at EIC



Raphael Dupre
with S. Fucini and S. Scopetta

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cnrs IN2P3 Les deux infinis
erc European Research Council Established by the European Commission

GPDs & Nuclei

Nuclei give control over the spin

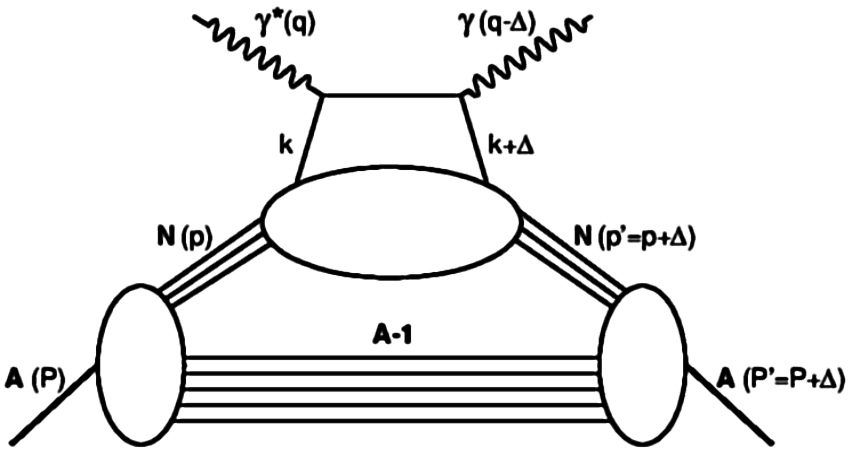
- Spin-0 → 2 GPD
- Spin-1/2 → 8 GPDs
- Spin-1 → 18 GPDs
- Half only intervene in DVCS

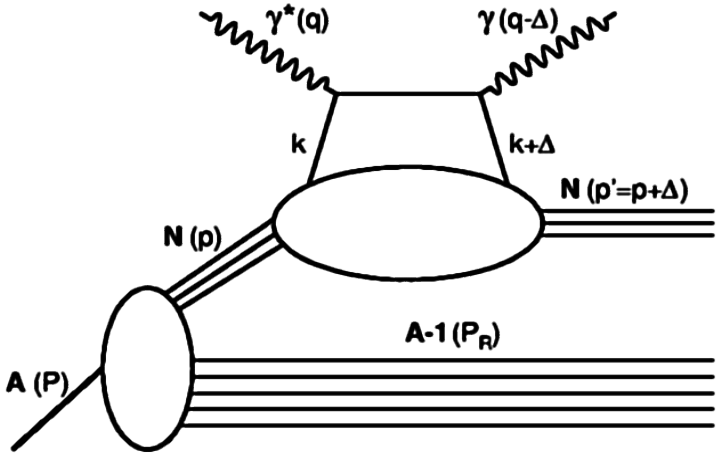
In the nucleus two processes

- Coherent and incoherent channels
  - *Similar to elastic and quasi-elastic*
- Give a global view and a probe of the components

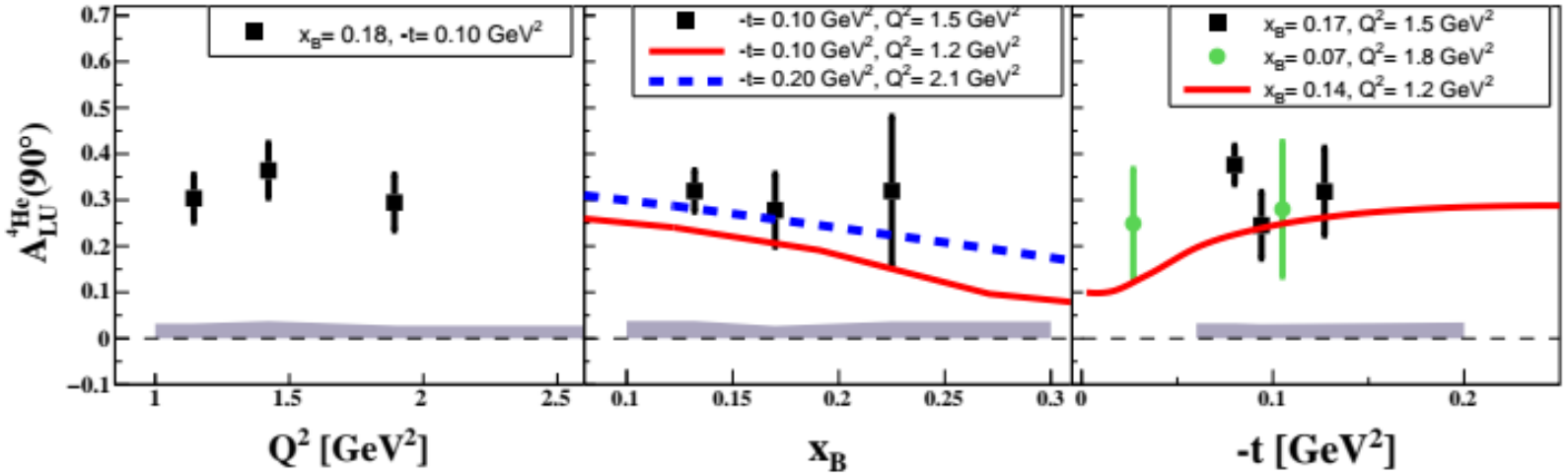
A perfect tool to study nuclear effects

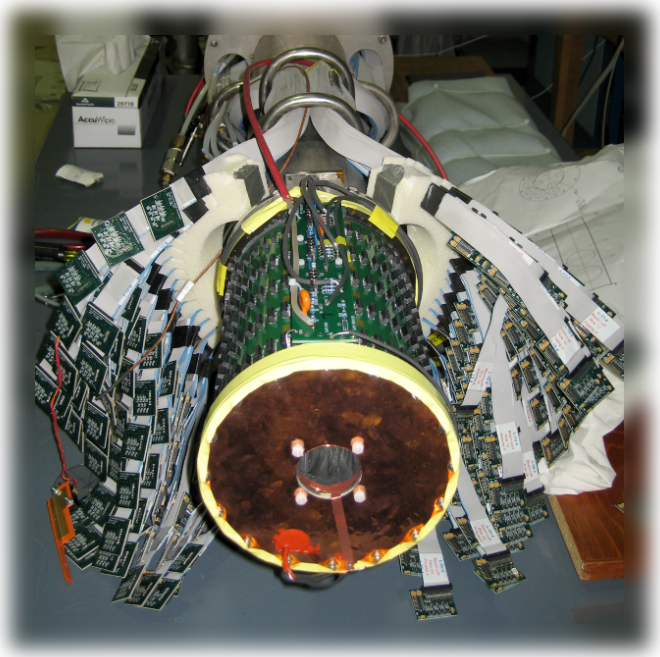
- Offer localization with the *t* dependence
- Coherent DVCS gives access to non-nucleonic degrees of freedom
- Incoherent DVCS gives access to the modifications of the nucleon





CLAS Coherent DVCS





Coherent DVCS on helium

- **Measured at CLAS**
  - *Unlike HERMES previous measurement we use a recoil detector to ensure exclusivity*
- **We observe the expected larger beam spin asymmetry**

Interpretation

- **Very strong signal proves that we have the nuclei as a whole**

Easy direct GPD extraction

- **Helium has a single GPD**

Extraction of the CFF

Helium allows for a simple extraction

- Spin-0 → 1 GPD/CFF

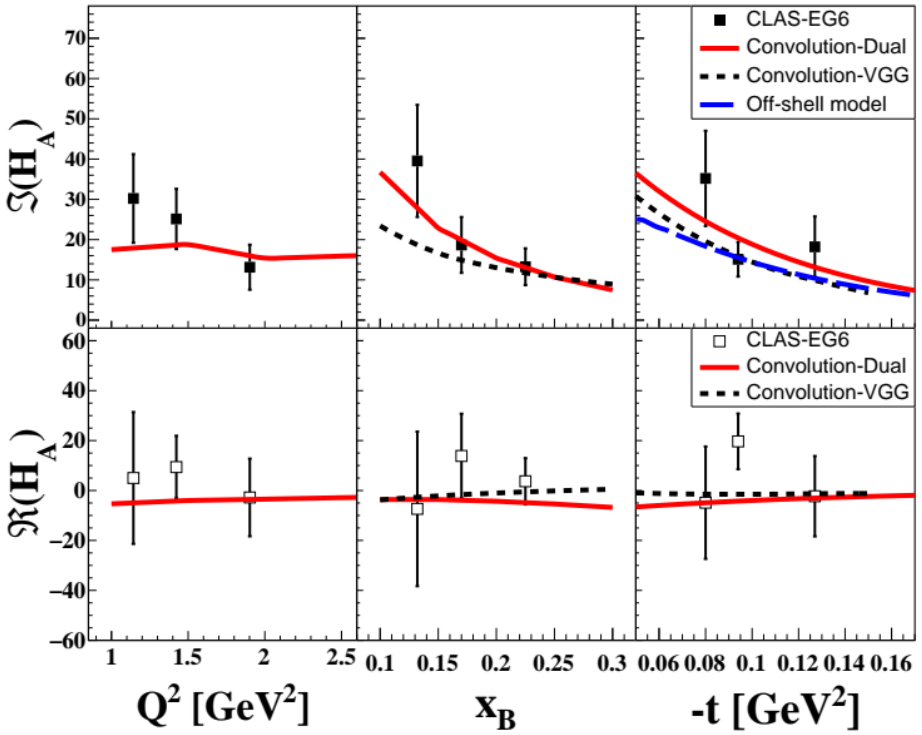
Different contributions from *Im* and *Re* in phi

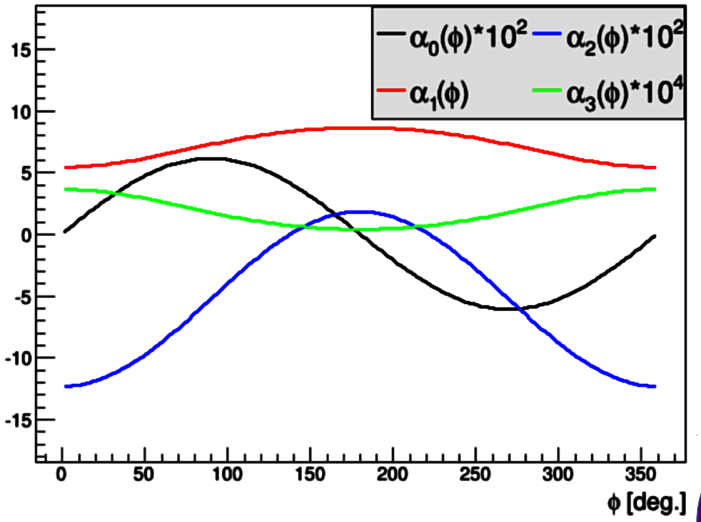
- These are calculable within perturbative QCD
- Allows to separate their contributions

$$A_{LU}(\phi) = \frac{\alpha_0(\phi)\,\Im m(\mathcal{H}_A)}{\alpha_1(\phi) + \alpha_2(\phi)\,\Re e(\mathcal{H}_A) + \alpha_3(\phi)\,(\Re e(\mathcal{H}_A)^2 + \Im m(\mathcal{H}_A)^2)}$$

Works very well

- We are mostly sensitive at the imaginary part
- More statistics will help with binning and the real part of H





A New Monte-Carlo Event Generator

ROOT based event generator

- **Use the TFoam class to generate a grid and then events**
- **Use of a recent model tested against data**

Sara Fucini, Sergio Scopetta, Michele Viviani Phys.Rev.C 98 (2018) 1, 015203

- **We named it TOPEG (The Orsay Perugia Event Generator)**

We have a version 1.0

- **It works at the level we want for the Yellow Report**
- **What I present here runs with Re(CFF) = 0**
  - *This limitation is linked to computing capacity*
  - *We are looking at improvements and possible parallelization to resolve this*

Upgrades planned in time for the YR

- **Some shadowing included and addition of the proton target**

Longer term

- **Include more light nuclei and incoherent processes…**

Nuclear DVCS Kinematic

Generated for all helium configurations

- 5x41, 10x110 and 18x110 GeV
- All results on the wiki

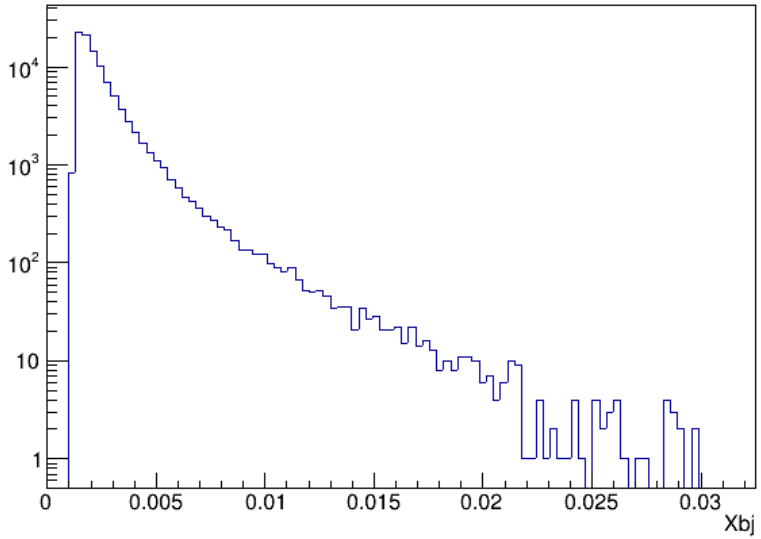
https://wiki.bnl.gov/eicug/index.php/Yellow_Report_Physics_Exclusive_Reactions

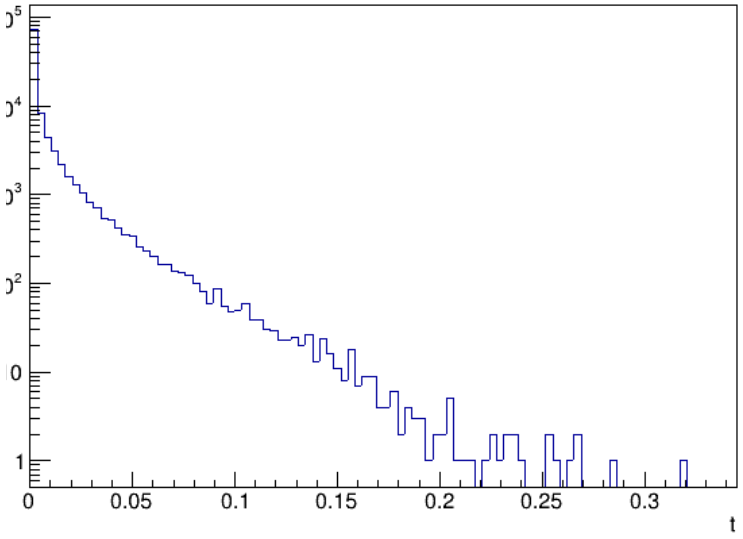
Cross section ~1000 nb

- Significantly reduced (at least 95%) when accounting for -t acceptance

Low energy configurations are necessary for high x

- Important for valence physics (EMC effect for instance)



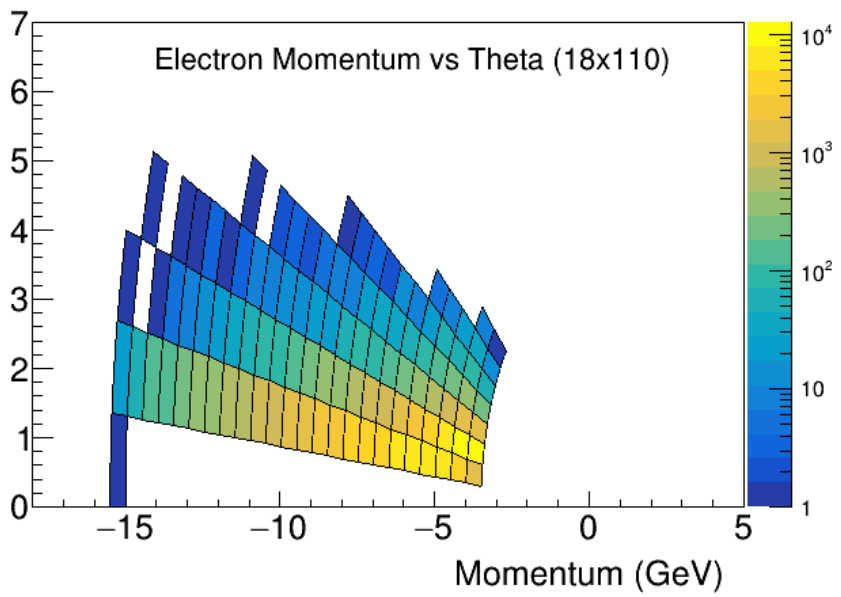


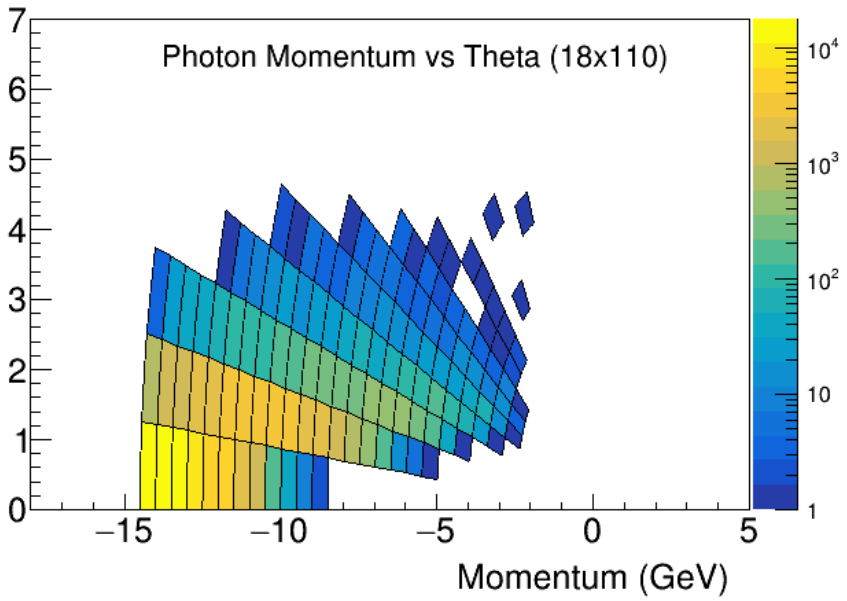
Electron and photon

Generation for $Q^2 > 2\ GeV^2$ and $y < 0.8$

- 99%+ electrons and photons are in the acceptance as described by the detector matrix
- This is true for all energy configurations

The base central detector is great for nuclear DVCS



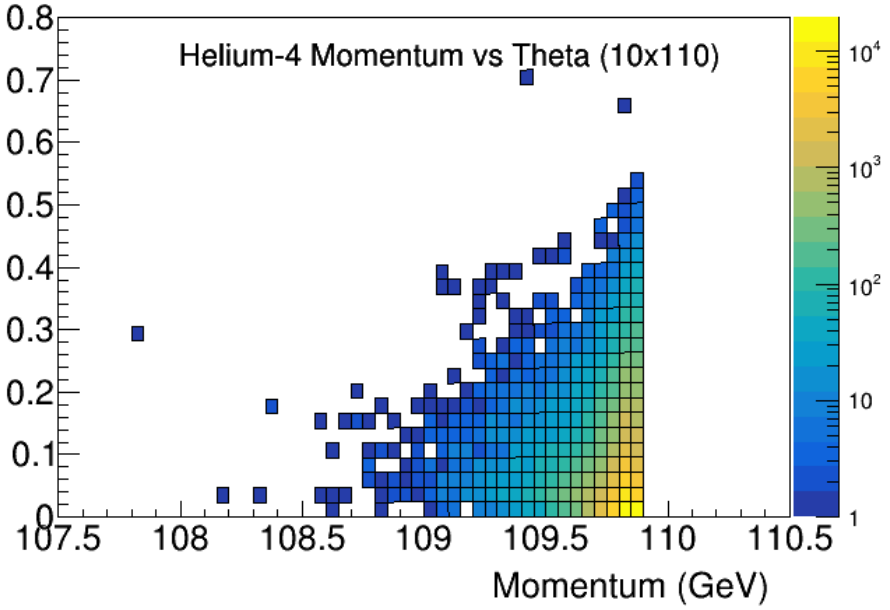


Helium Nuclei

Acceptance at low -t will be cut

- p_T > 0.2 GeV → 96% of cross section is cut
- p_T > 0.4 GeV → 99.9% of cross section is cut
- This is relatively independent of the energy configuration

It remains unclear to me which to chose for helium



Summary and Next Steps

We have a generator for helium DVCS

- **Electrons and photons are produced well within the central detector acceptance**
- **The -t distribution will be cut, it remains unclear how much**

Run events through eic-smear

- **We just made scripts to generate files for eic-smear**
- **Eic-smear needs to accept the nuclear beam**
  - *Issue has been submitted*
- **We need a far forward detector parametrization for this beam**

Generate Final Results

- **We plan to show projections for the nuclear profile**
  - *Showing the impact of various -t acceptance*
- **We plan to look into the impact of non nucleonic d.o.f.**
  - *See if this physics is accessible in EIC*