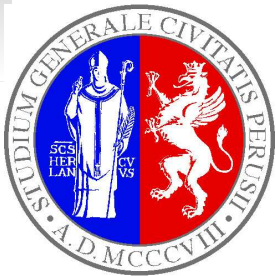


Update on coherent DVCS off ^4He



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in collaboration with

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A short update

The nucleus: *“a Lab for QCD fundamental studies”*

Coherent DVCS off light nuclei:



Kinematics:

A note on the relevant t -range



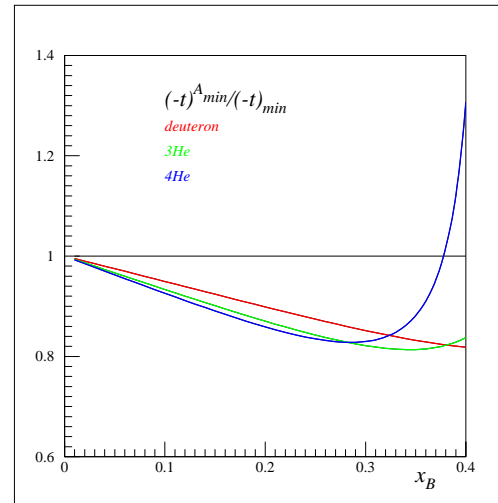
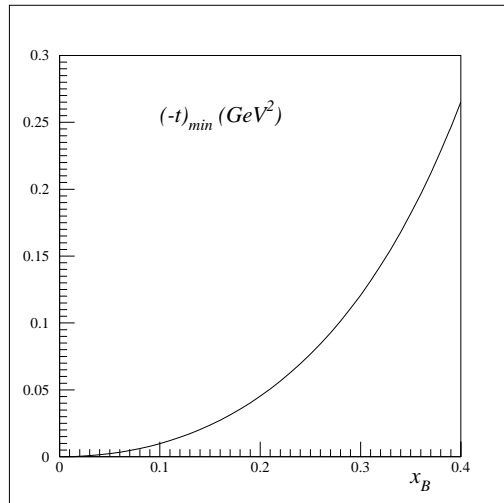
An event generator (work in progress):

- * The Orsay-Perugia Event Generator (TO-PEG) for DVCS off light nuclei
(Dupré, Fucini, Scopetta)
- * Preliminary results for DVCS off ^4He
based on S. Fucini, S.S., M. Viviani, Phys.Rev. C98 (2018) no.1, 015203

Relevant $-t$ range: $(-t)_{min}$?



For light nuclei, at the EIC, very similar to that of the proton



$\xi_A \simeq \frac{x_A}{2-x_A}$ for a generic target A with $0 \leq x_A = \frac{Q^2}{2P_A \cdot q} \leq 1$;

For $A = N$ one has $x_A = x_N = x_B = Q^2 / (2m\nu)$;

For a nucleus with A nucleons and $m_A \simeq Am_N$, we have $x_A \simeq x_B / A$;

Minimum value of $-t$ for a given ξ :

$$(-t)_{min} = \frac{4\xi^2 m^2}{1 - \xi^2} \quad (-t)_{min}^A = \frac{4\xi_A^2 m_A^2}{1 - \xi_A^2} \xrightarrow{x \rightarrow 0} (-t)_{min}$$

Since $\xi_A \simeq \xi / A$ and $m_A \simeq Am_N$, @EIC $(-t)_{min}^A \simeq (-t)_{min}$

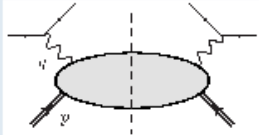
Relevant $-t$ range: $(-t)_{min}$?

Motivation Kinematic corrections Soft corrections Genuine higher twists

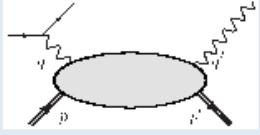
Coherent DVCS on nuclei

- Target mass corrections

DIS



DVCS



Nachtmann variable:

$$\xi = \frac{2x}{1 + \sqrt{1 + 4x^2 m^2 / Q^2}}$$

On a nucleus

$m \mapsto Am \quad x \mapsto x/A$

\Rightarrow TMC unaffected

Braun, Manashov, Pirnay: PRD 86 (2012) 014003

All twist-4 TMC are absorbed in


$$t_{min} = -4m^2 \xi^2 / (1 - \xi^2)$$

On a nucleus

$m \mapsto Am \quad \xi \mapsto \xi/A$

\Rightarrow TMC unaffected

- Extend to all twists?
- TMC and finite- t corrections are intertwined

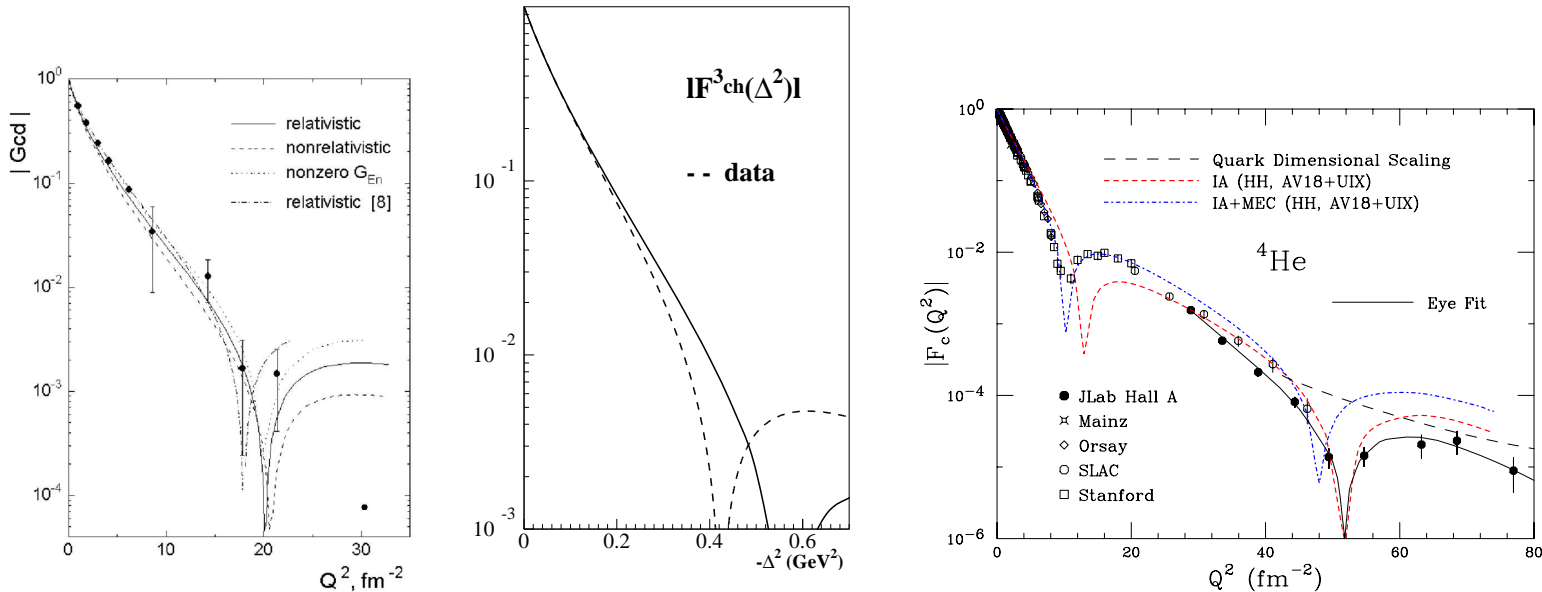


V. M. Braun (Regensburg) Power Corrections in DVCS INT, Seattle, 10/01/2018 7 / 8

Same argument in a slide from a talk of V. Braun at "Probing Nucleons and Nuclei in High Energy Collisions", INT, Seattle, October-November 2018.

$(-t)_{max}$? Beyond the first FFs minimum?

 $d, {}^3\text{He}, {}^4\text{He}$ Charge FFs (look at the data)



A	$(-t)_{diff}$ [GeV ²]
deuteron	0.75
${}^3\text{He}$	0.42
${}^4\text{He}$	0.48

To have nuclear tomography in \mathbf{b} space, $(-t)_{min} = 0$, $(-t)_{max}$ as high as possible...

For ${}^3\text{He}$, $0 \leq -t \leq 0.5 - 0.6 \text{ GeV}^2$ promising for Fourier inversion to \mathbf{b} space.

Besides, elusive nuclear dynamics studied at parton level...

TO-PEG event generator

- Mandatory for the EIC setup
- To realize the feasibility of relevant measurements (e.g., at ξ and $-t$ high enough, look for non-nucleonic degrees of freedom at parton level (Berger, Cano, Diehl and Pire PRL 2002))
- Very useful in general (JLAB @ 12 GeV!)
- Initial Plan:
 - Raphaël's idea already in October
 - Sara supposed to work to the project in April-June in Orsay
 - Minor contribution from my side
 - at a given point, overlap with the YR activity
- Ultimate Goal:

a *new* event generator, based on the FOAM library, *flexible* (different light nuclei (d , ^3He , ^4He ... ^7Li ?); different setups (fixed target, collider)), *open* (different available models to be implemented), *accessible* to interested colleagues for their studies

A process and a model to start

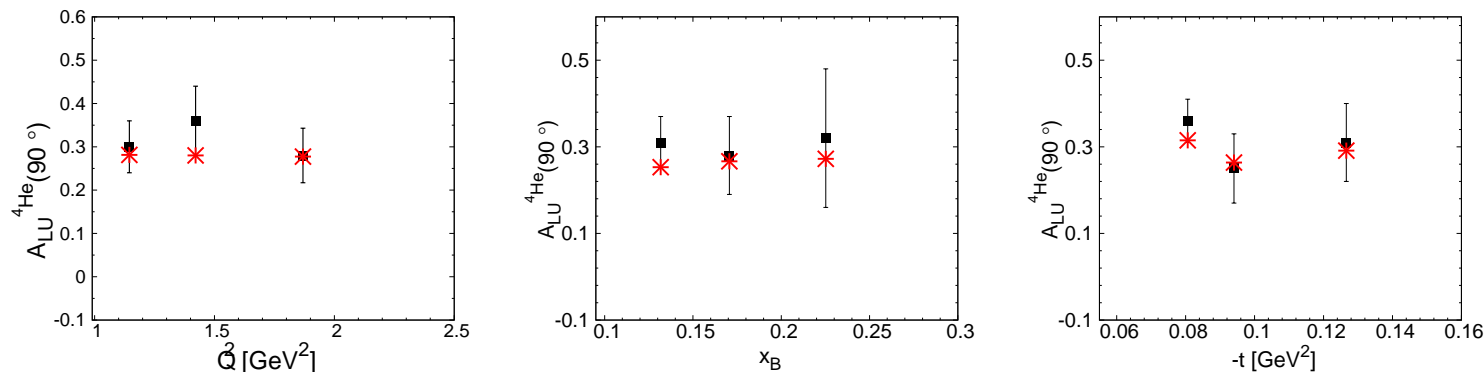
● Coherent DVCS off ^4He (key process for the YR)

● Model presented here by Sara 4 weeks ago

S. Fucini, S.S., M. Viviani PRC 98 (2018) 015203

- * I.A. calculation of the GPD H within a non-diagonal spectral function based on the **AV18 + UrbanaIX** interaction, realistic only in the ground part; Nucleonic model: GK
- * Forward limit and nuclear FFs recovered, momentum SR slightly violated
- * Numbers for CFFs, X-sections, BSA

Comparison with EG6 data (**Hattawy et al PRL 2017**): $A_{LU}(\phi) = \frac{d\sigma^+ - d\sigma^-}{d\sigma^+ + d\sigma^-}$

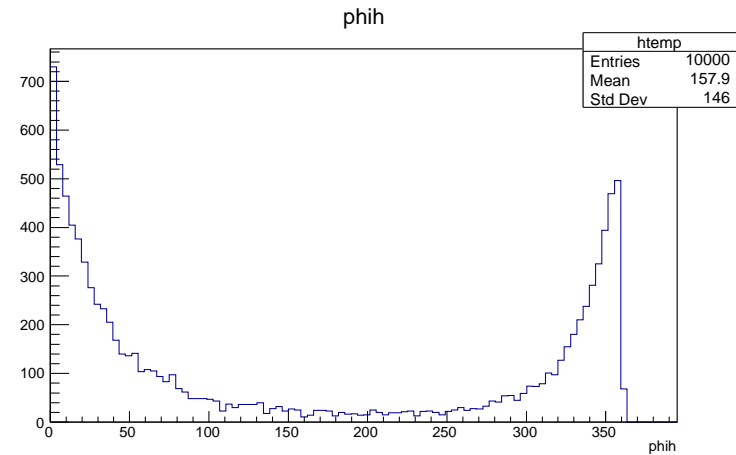
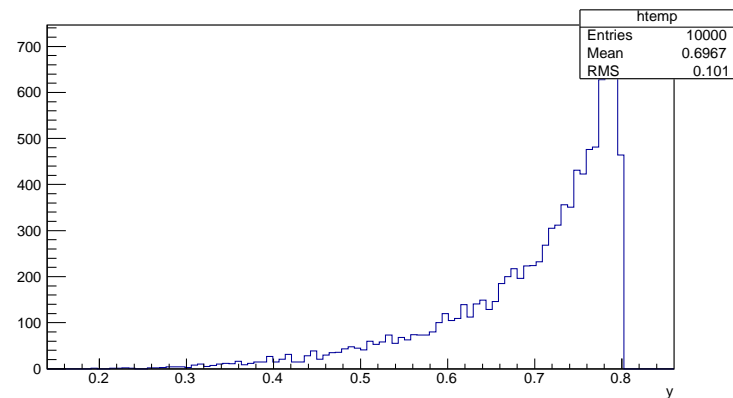
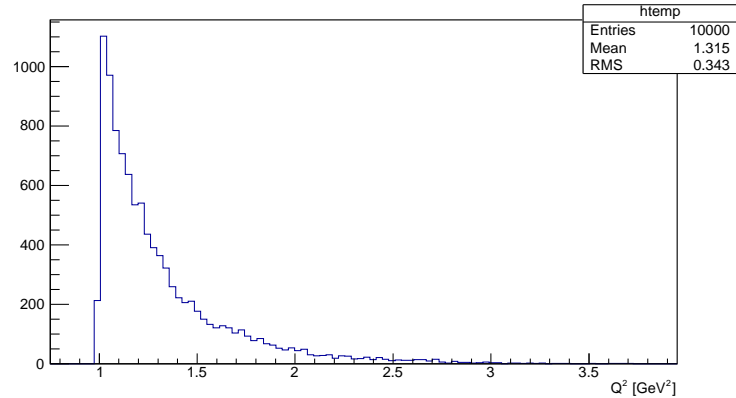
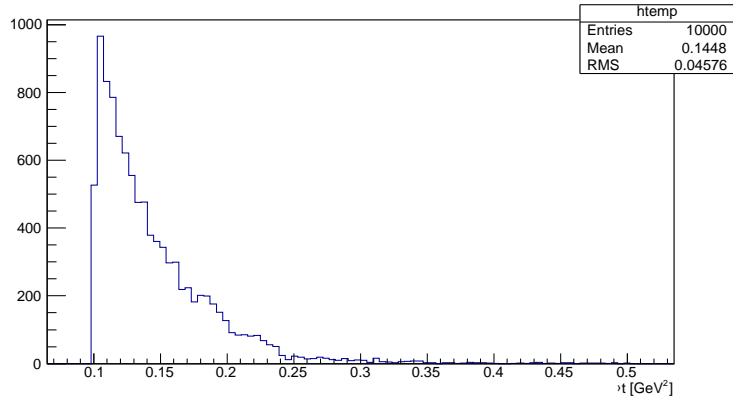


Let us see some output! (mainly Sara's work following Raphaël suggestions)

JLab KIN (preliminary!) $d\sigma^+ / (dQ^2 dx_B dt d\phi_h)$



@6 GeV, kinematics of the EG6 experiment



Everything looks reasonable: we are checking.

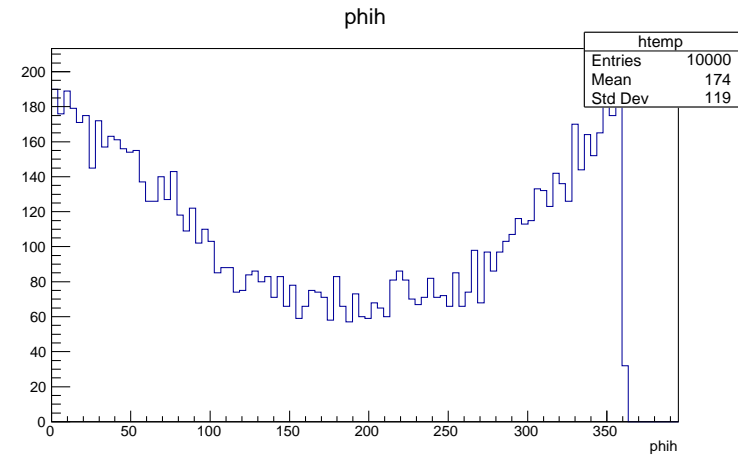
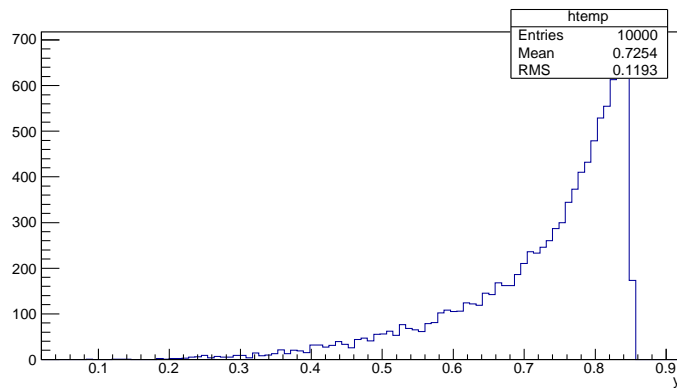
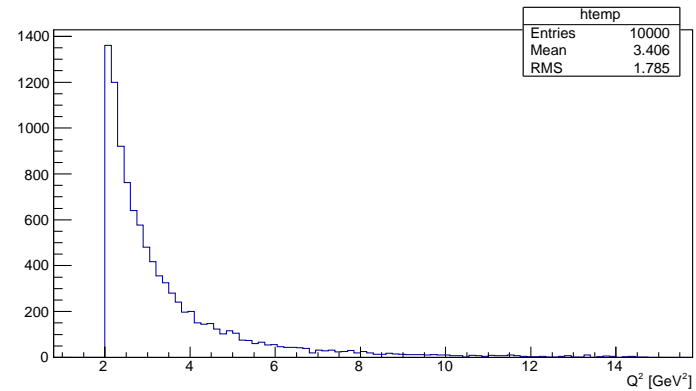
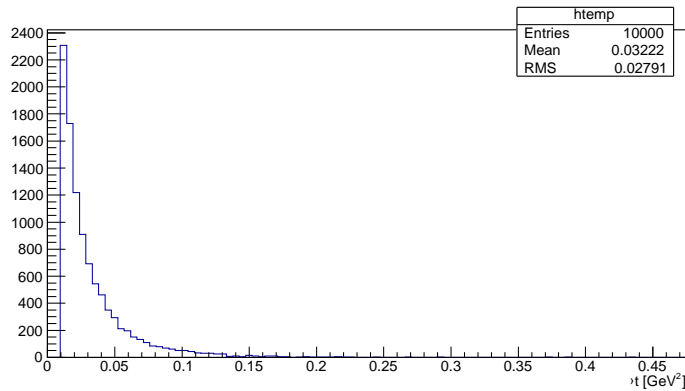
If we recover results here, we can plan something else

EIC KIN (preliminary!)

$$d\sigma^+ / (dQ^2 dx_B dt d\phi_h)$$



5 GeV + 50 GeV



Yesterday's results. With a simplified model to have a fast convergence.
To be checked! But it works and looks reasonable.

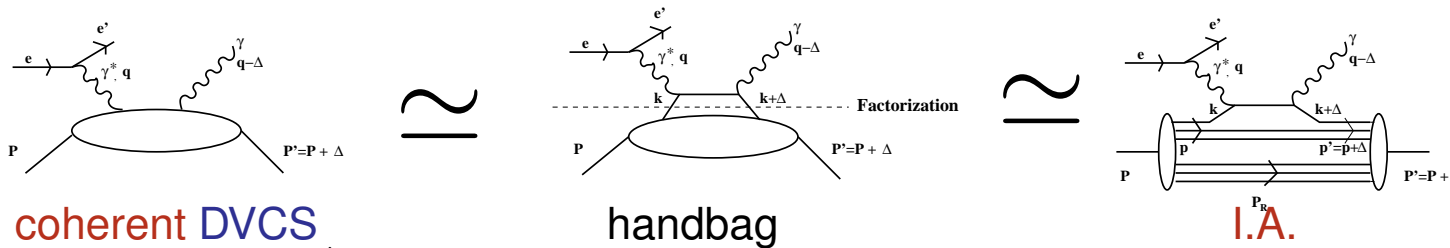
Next steps

These plots are not “Pavia plots” (2-dimensional plots for particles angles vs particles momenta, if I understand) but demonstrate that “Pavia plots” can be produced (defining other variables and running the generator)

- Short term (days? Weeks?):
Check everything and produce the expected plots for the YR
- Medium term (weeks? Months?):
 - introduce shadowing in the description
(a discussion with M. Strikman has started);
 - introduce other nuclei
(^3He cross section evaluation in progress from our GPDs (with M. Rinaldi));
 - incoherent channels (**S. Fucini, S.S., M. Viviani, Phys. Rev. C101 (2020) no.7, 071501**)
 - other people’s models for the cross sections
- Long term:
Document the usage of the Monte-Carlo, have it accessible to interested colleagues, have it maintained...

Backup: Our IA approach to coherent DVCS off ^4He

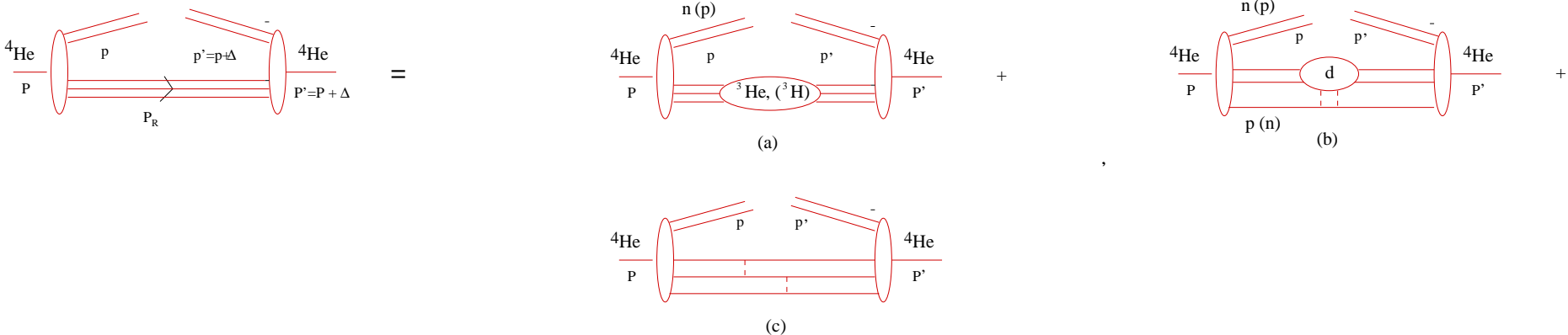
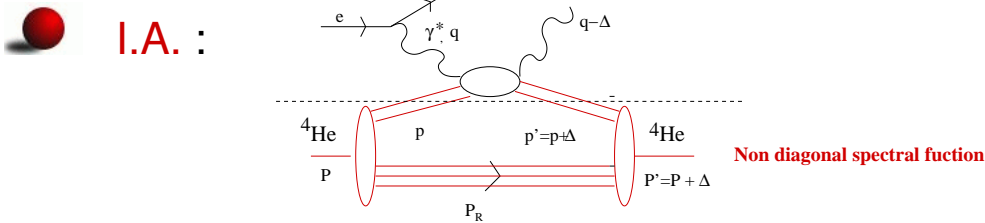
- Realistic microscopic calculations are necessary. A collaboration is going on with Sara Fucini (Perugia, Ph.D. student), Michele Viviani (INFN Pisa).
- coherent DVCS in the Impulse Approximation (I.A.) to the handbag contribution:



coherent DVCS

handbag

I.A.



a) worked out; b) is feasible; c) is really challenging