

Physics opportunities with μCLAS12

In preparation for CEBAF2037

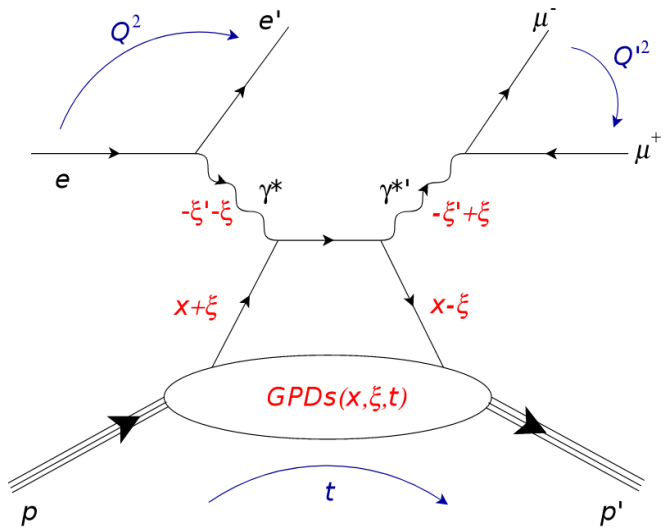
16th of November 2026

Slides made by P. Chatagnon

The flagship measurement of μCLAS12: Double DVCS

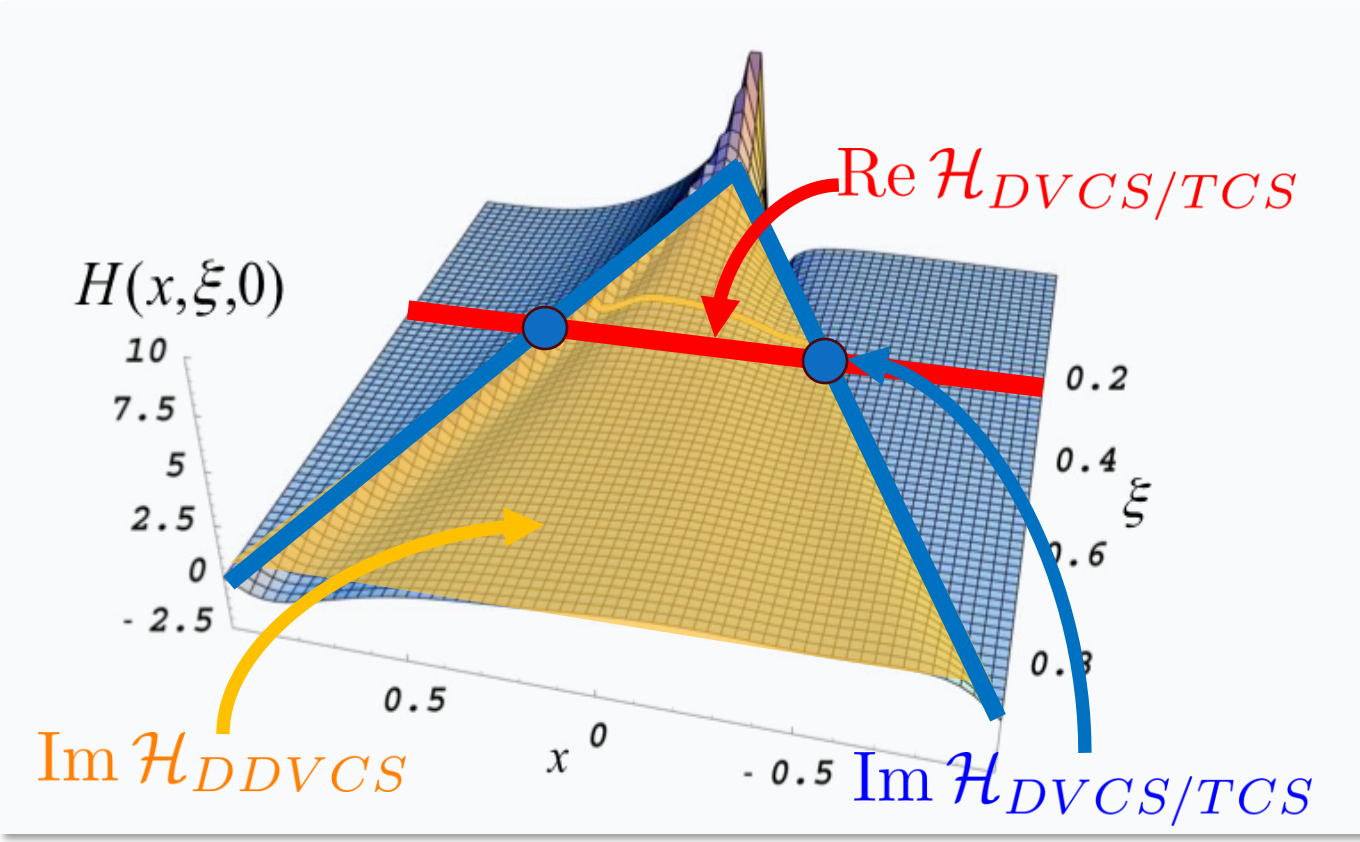
Double Deeply Virtual Compton Scattering

$$ep \to e'\gamma^* p \to e'p'\gamma^* \to e'\mu^+\mu^- p'$$



$$\mathcal{H}_{\mathrm{DDVCS}}(\xi',\xi,t) = \int_{-1}^{1} dx H(x,\xi,t)\left(\frac{1}{\xi'-x-i\epsilon} - \frac{1}{\xi'+x-i\epsilon}\right)$$

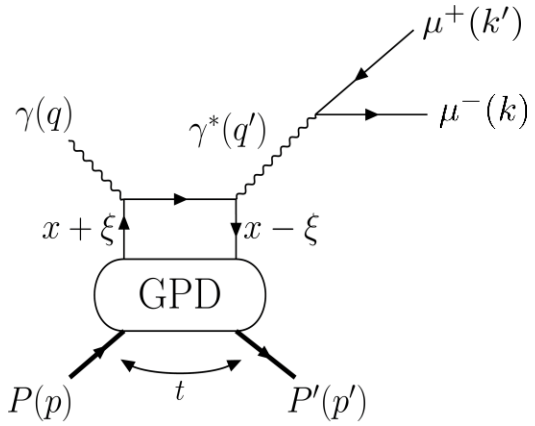
$$\mathrm{Im}\,\mathcal{H}_{\mathrm{DDVCS}}(\xi',\xi,t) \propto H(\xi',\xi,t) - H(-\xi',\xi,t)$$



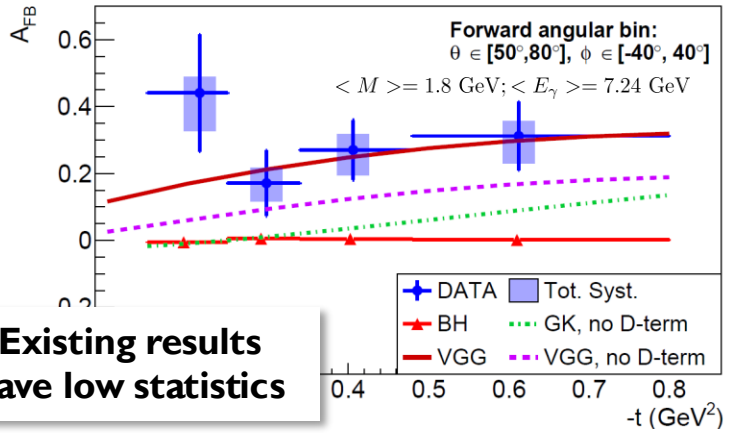
- **Two main requirements:**
  - Large luminosity
  - Excellent muon detection

Other opportunities with high-luminosity and muons

Timelike Compton Scattering as a portal to the real part of CFFs



- TCS probes similar CFFs as DVCS.
- **Direct access to the D-term.**
- TCS is measurable with a muon pair in the final state.
- **Recoil proton detection** is needed to ensure exclusivity.

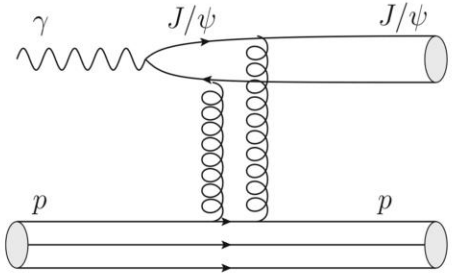


Existing results have low statistics

J/ψ production to probe the gluon content of the proton

$$ep \to e'\gamma^* p \to e'p'J/\psi \to e'\mu^+\mu^- p'$$

Access to the gluon content of the proton…
… if other contributions can be understood.

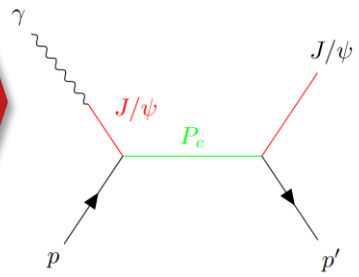


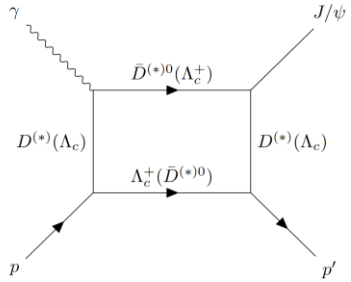
$$\frac{d\sigma}{dt} = \frac{\alpha_{EM} e_Q^2}{4(W^2 - M_N^2)^2} \frac{(16\pi\alpha_S)^2}{3M_V^3} |\phi_{NR}(0)|^2 |G(t,\xi)|^2$$

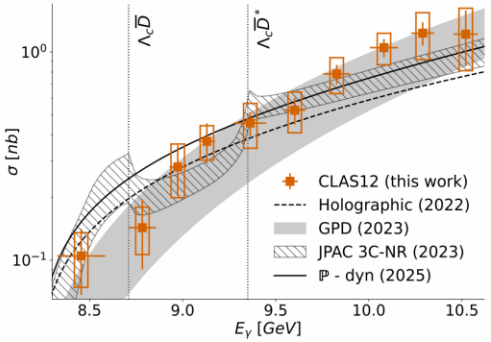
"QCD analysis of near-threshold photon-proton production of heavy quarkonium", Yuxun Guo, Xiangdong Ji, and Yizhuang Liu, Phys. Rev. D 103, 096010, 2021

$$\frac{d\sigma}{dt} = \mathcal{N}^2 \frac{e^2}{64\pi(s - M_N^2)^2} \frac{[A^g(t) + \eta^2 D^g(t)]^2}{A^{g2}(0)} \cdot \tilde{F}(s) \cdot 8$$

"J/ψ near threshold in holographic QCD: A and D gravitational form factors", Kiminad A. Mamo and Ismail Zahed, Phys. Rev. D 106, 086004, 2022



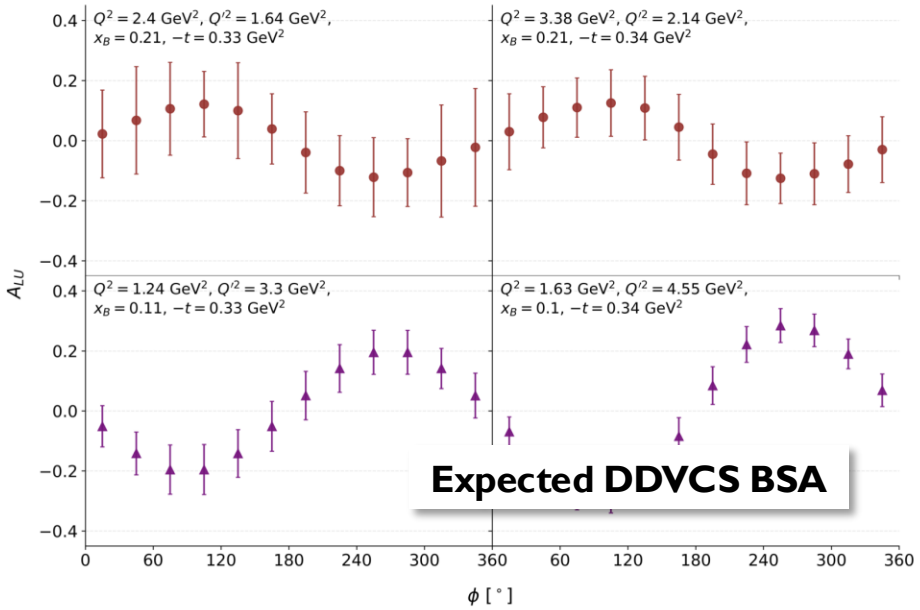


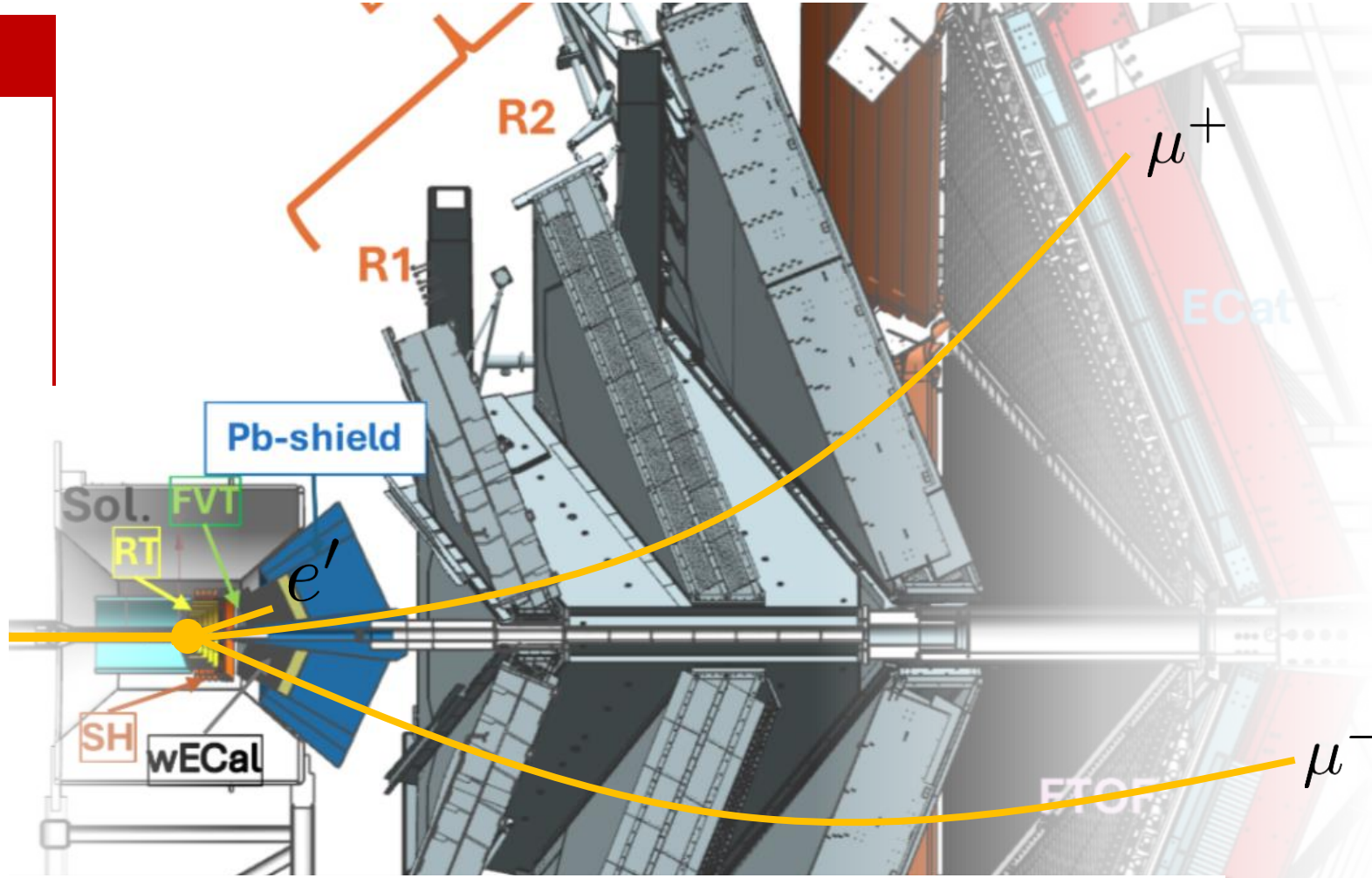


μCLAS12 (see 2605.11690, published in EPJA)

μCLAS12 new additions

- Electron detection in the new wECal
- Muon detection in the Forward detector
- Proton detection in a dedicated detector around the target

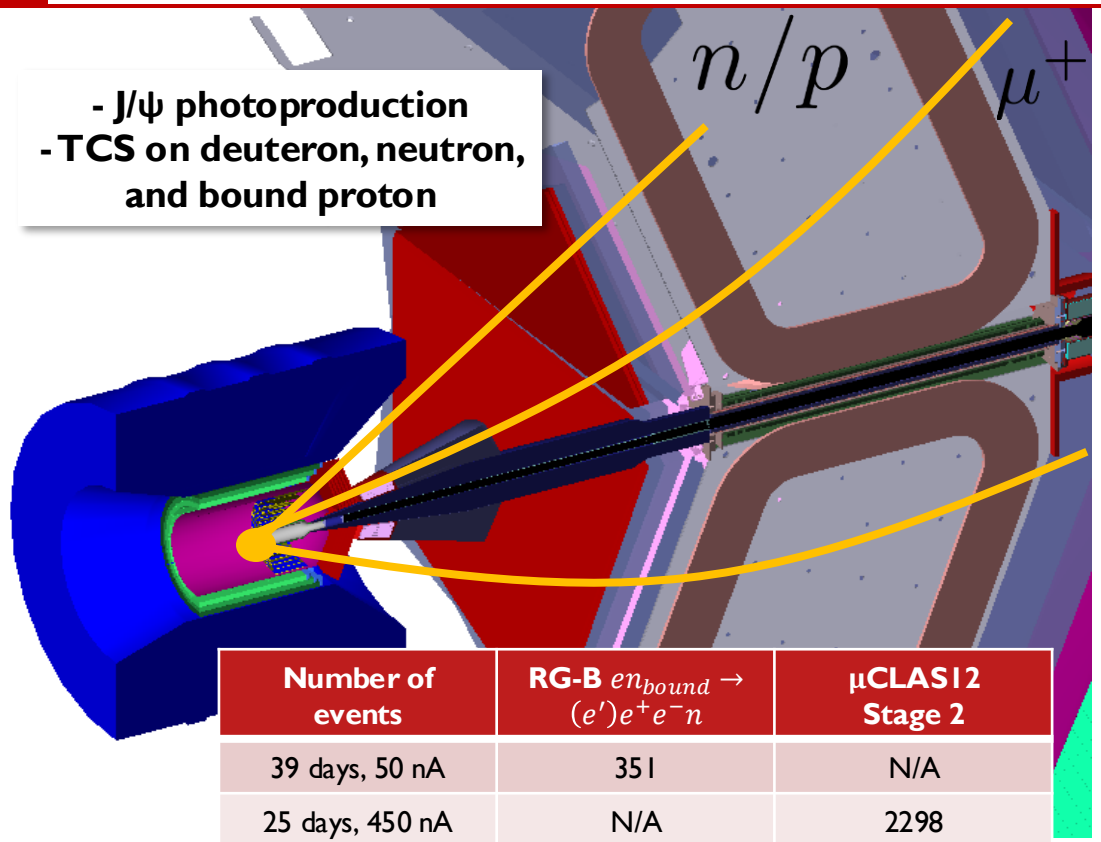




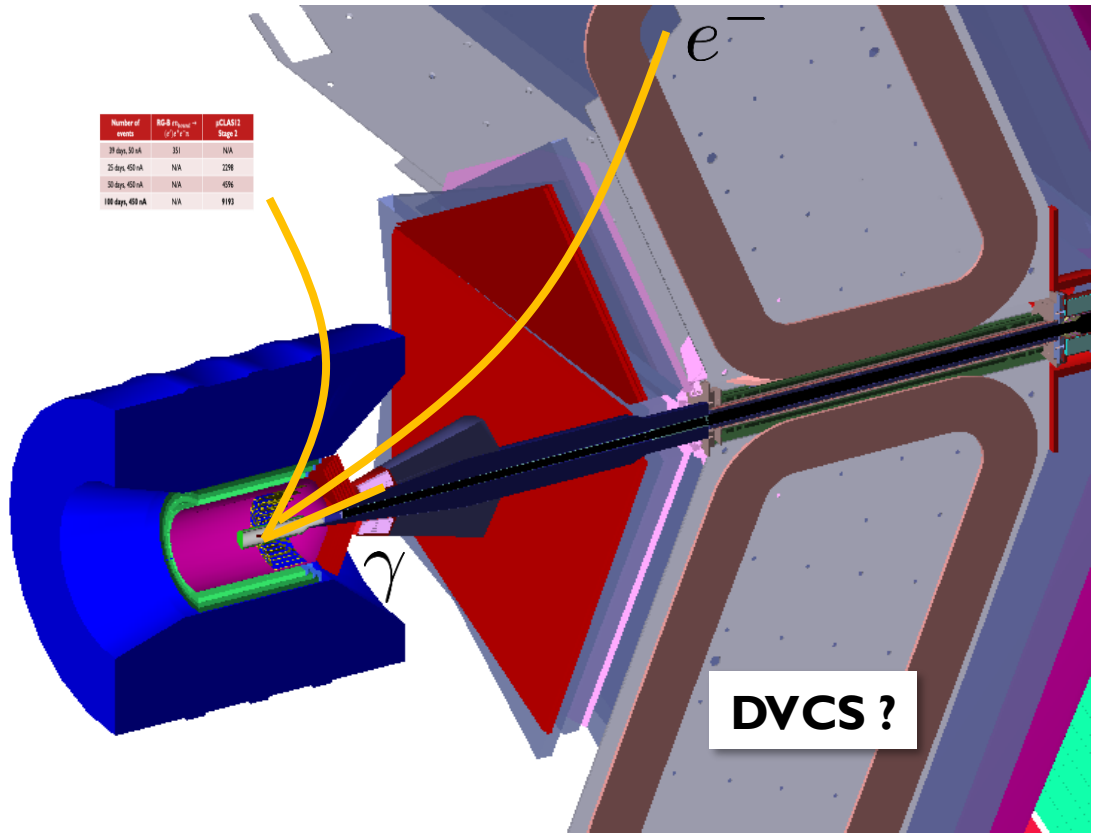
-The **μCLAS12 physics program is strong**, validated by the PAC and a published article.
-What **other measurements** could realistically be performed within the μCLAS12 framework, and **how can their potential impact in these areas be quantified?**

“mini-μCLAS12” - Extending the muCLAS12 program to nuclear targets

- J/ψ photoproduction
- TCS on deuteron, neutron, and bound proton



Number of events	RG-B $en_{bound} \rightarrow (e')e^+e^-n$	μCLAS12 Stage 2
39 days, 50 nA	351	N/A
25 days, 450 nA	N/A	2298
50 days, 450 nA	N/A	4596
100 days, 450 nA	N/A	**9193**



- **Mini-μCLAS12 will broaden the μCLAS12 program**, extending it to **nuclear targets**.
- **Can the mini-μCLAS12 configuration support a broader physics program** beyond its main objectives ? For example, the new calorimeter could enable DVCS measurements, and may be used for high-Q^2 inclusive measurements.