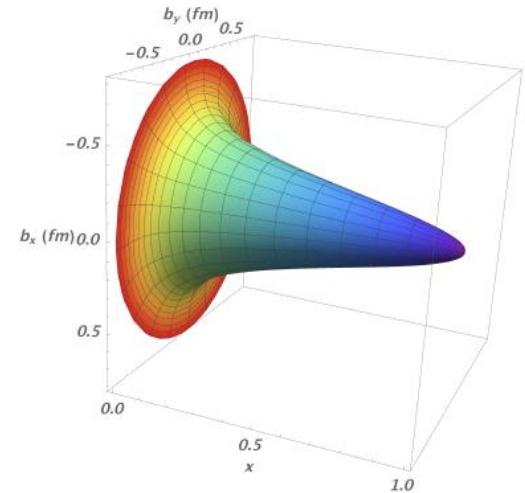


IJCLab activities at JLab

- Overview of our collaboration
- Physics and technical highlights
 - Ongoing projects
 - Plans for JLab and EIC

Meeting with Jens Dilling
IJCLab 5/21/2026



Our team's involvement at JLab

30+ years of study of nucleon structure, mainly via measurements of
Generalized Parton Distributions (GPDs):

Correlations between position, momentum, and spin of partons in the nucleon
→ **nucleon tomography, quarks' angular momentum,...**

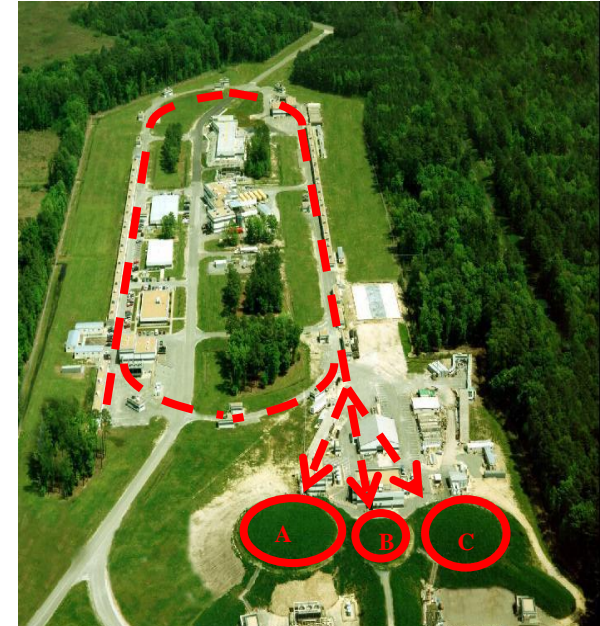
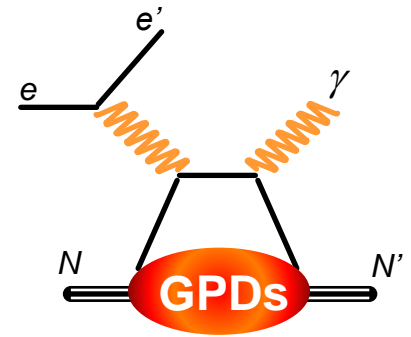
GPDs are accessed in **exclusive electroproduction** at high momentum transferred
→ **virtual photons scattering on quarks**

DVCS (Deeply Virtual Compton Scattering) $eN \rightarrow e'N'\gamma$

- The IN2P3 team has been leading the JLab experimental program on GPDs for the last ~25 years
- Most approved proposals on GPD physics at JLab have at least one IJCLab spokesperson
- IJCLab lead author on > 40 articles on DVCS, meson electroproduction, GPD extraction and modeling

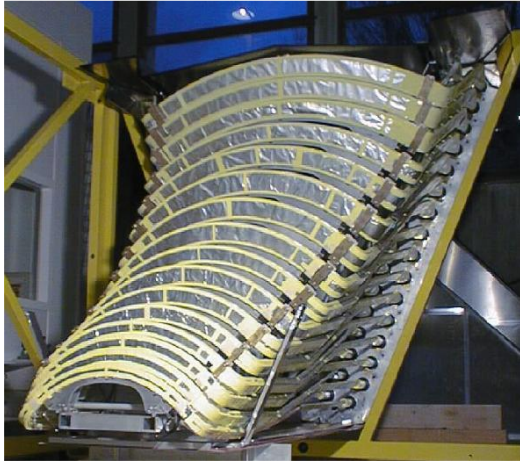
Direct involvement in all aspects of the experiments:
proposition, detector conception and development,
data taking, analysis, phenomenological interpretation
of the results

- **4/6 of the current team staff obtained their PhDs working on JLab physics**
- **24 PhDs on JLab physics**
- **Various leadership roles in the users community**



Involvement in 3 out of 4 experimental halls at Jefferson Lab

The G0 experiment in Hall C (2004)



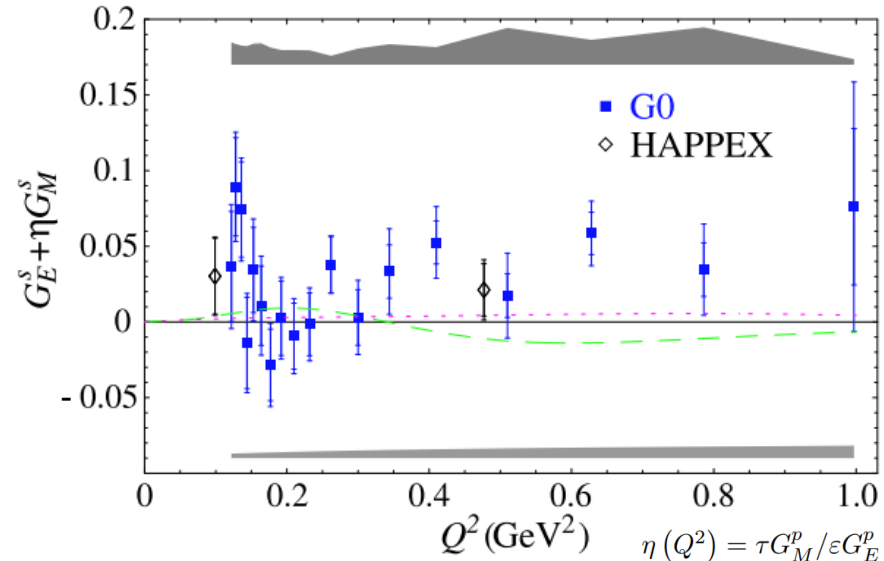
Orsay/Grenoble collaboration to build the « **French octants** » of the focal-plane detectors for G0: scintillators and long light guides, for **proton detection at forward angles**



Time-encoding custom electronics working at high rate (~2 Mhz)
DMCH-16X Module
Made in Orsay

NIM A586 (2008)

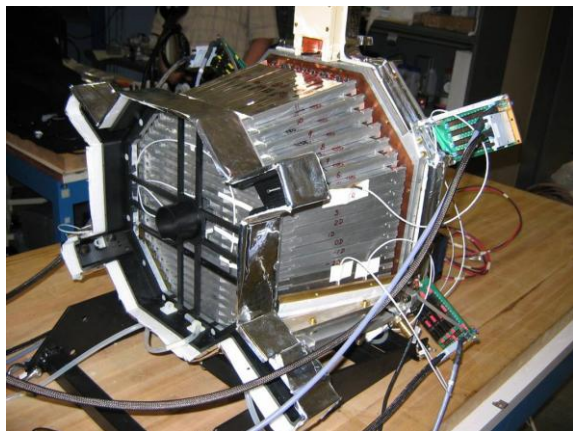
Strange Quark Contributions to Parity-Violating Asymmetries



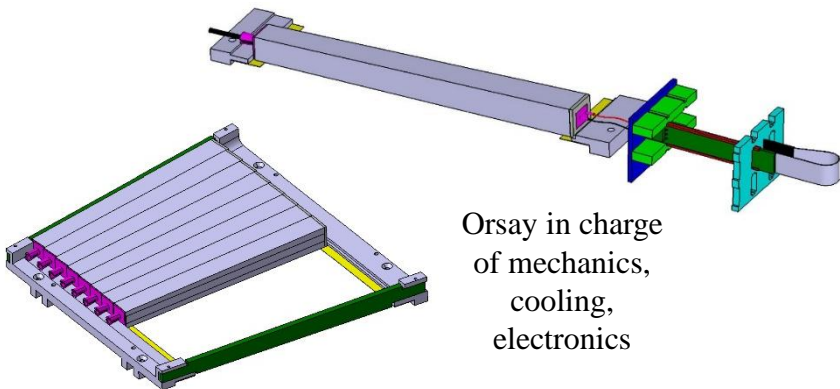
→ strange quark contributions are non-zero and Q^2 dependent

PRL 95 (2005)

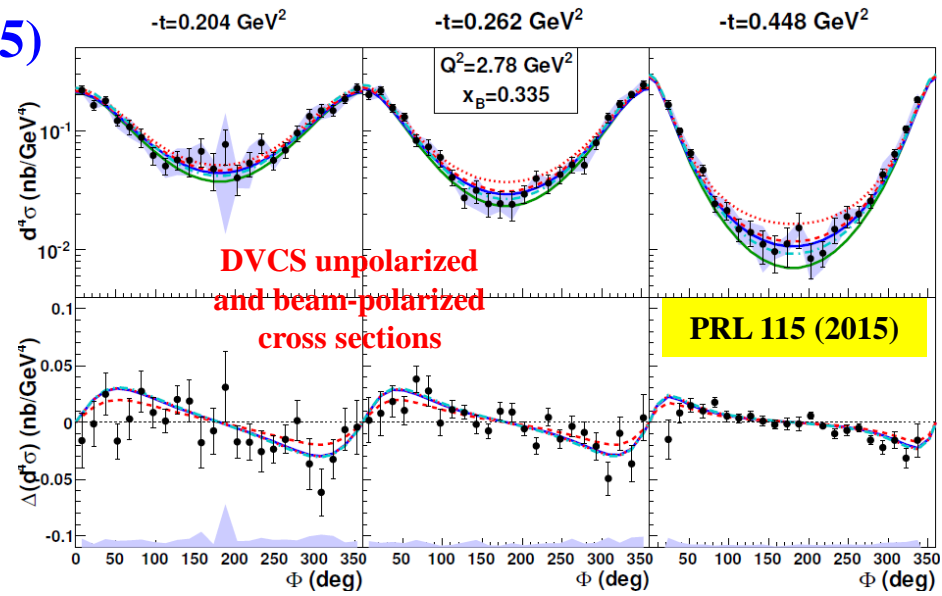
The e1-dvcs experiment with CLAS (2005)



Inner Calorimeter:
 Collaboration
 JLab-ITEP-
 Orsay-Saclay
 424 PbWO4
 crystals + APDs
**Detection of
 low-angle
 photons from
 DVCS/BH**

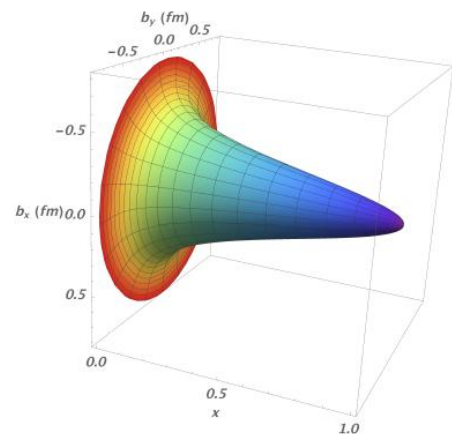


Orsay in charge
 of mechanics,
 cooling,
 electronics



Proton tomography
 from *local fits* to
 HERMES, CLAS, and
 Hall-A data (**ImH** +
model dependent
 assumptions for x
 dependence)

PRD 95 (2017)



Heavy Photon Search (HPS)

PRD 98 (2018)

HPS experiment in Hall B

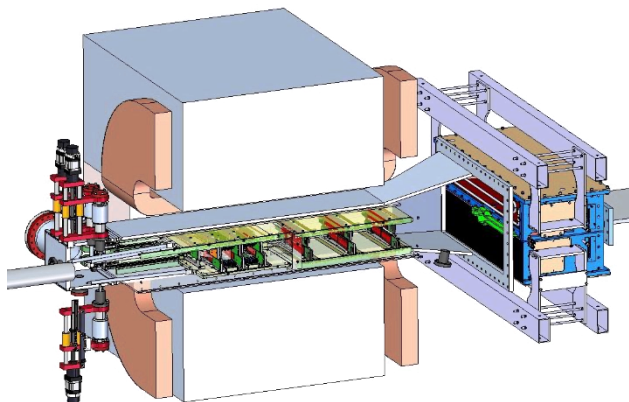
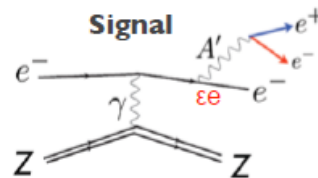
Search for a **new vector boson** (A') :

- mass between 20 MeV and 1000 MeV
- decay in electron-positron pair

Possible connection with **dark matter**

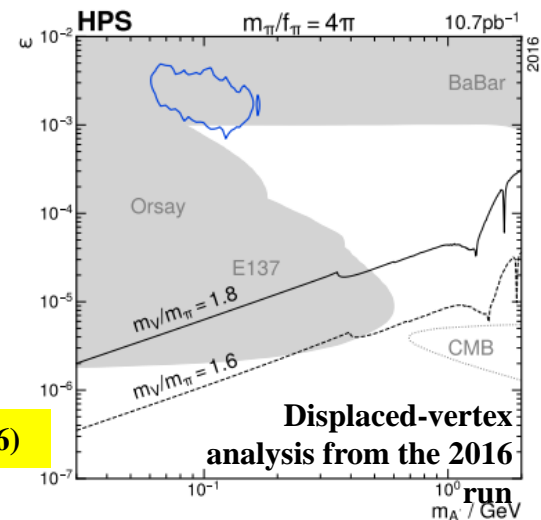
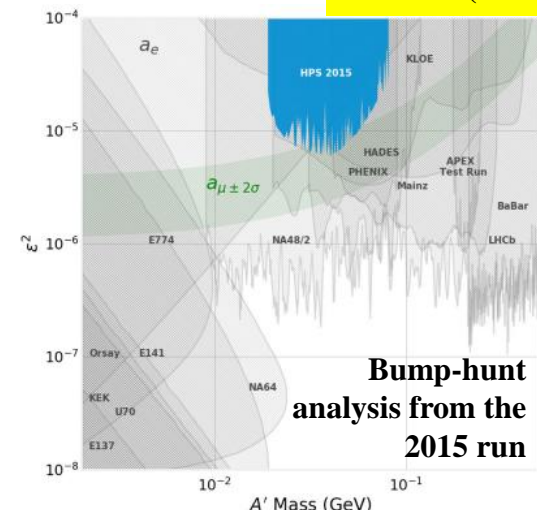
Weak theoretical constraints \rightarrow big space to sample in masses and coupling to ordinary matter

\rightarrow **Data takings: 2015, 2016, 2019**

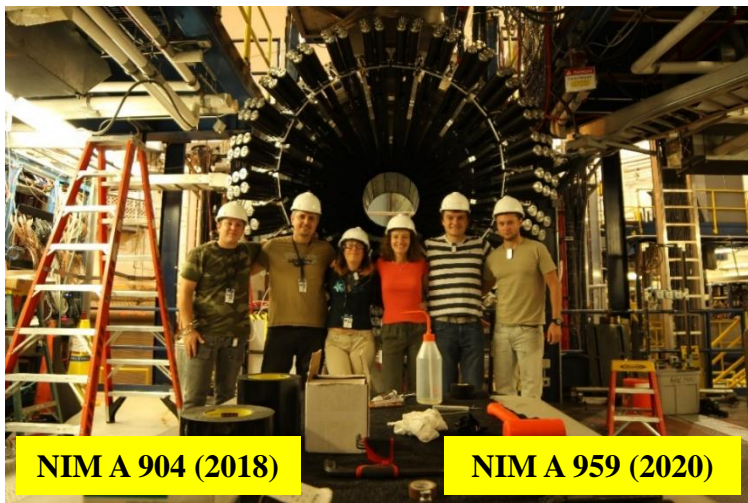


- **Orsay constructed the calorimeter** (project leader) along with INFN
 - Preamplifiers and mechanical structure, benefiting from the experience of the IC for CLAS
- **Data analysis: 1 PhD**

PRD 113 (2026)



Central Neutron Detector (CND) for CLAS12



nDVCS measured with
RGB (2019-2020) data
Cross-section analysis
underway

Analysis ongoing on
RGC (2022-2023) data
with longitudinally
polarized target

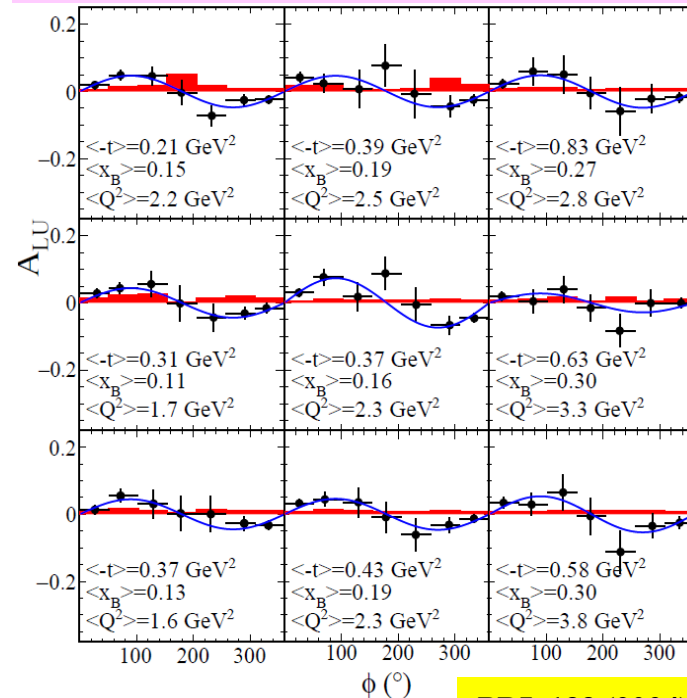
Purpose: detect the **recoiling neutron in nDVCS**

Requirements/performance:

- neutron/photon separation $\rightarrow \sim 150$ ps time resolution ✓
- momentum resolution $\delta p/p < 10\%$ ✓
- neutron detection efficiency $\sim 10\%$ ✓

CND: **scintillator barrel** - 3 radial layers, 48 bars per layer **coupled two-by-two** downstream by a **“u-turn” lightguide**, 144 long light guides with PMTs upstream
Conceived and constructed at Orsay

Beam-spin asymmetries for neutron DVCS

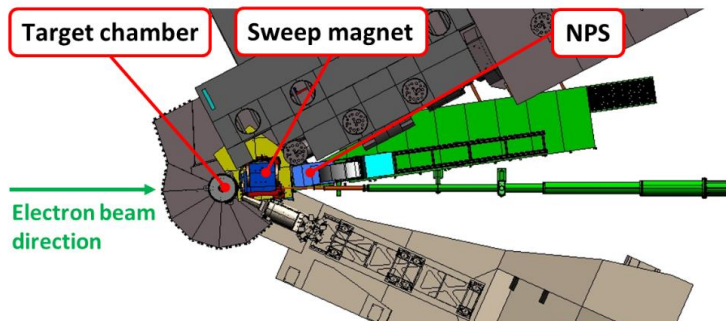


PRL 133 (2024)

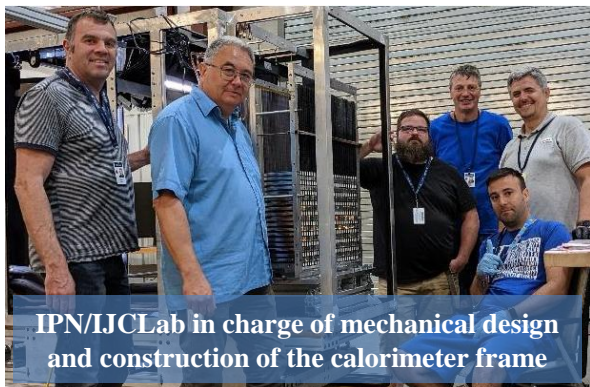
The CLAS12 nDVCS data allow the quark-flavor separation of both **Im \mathcal{H}** and **Im \mathcal{E}**

<https://physicsworld.com/a/inner-workings-of-the-neutron-illuminated-by-jefferson-lab-experiment/>

NPS experiment in Hall C (2023-2024)



- Neutral Particle Spectrometer (NPS)
- Detect emitted photon with high resolution
- Array of 1080 PbWO_4 crystals
- Installed on a platform attached to Super HMS

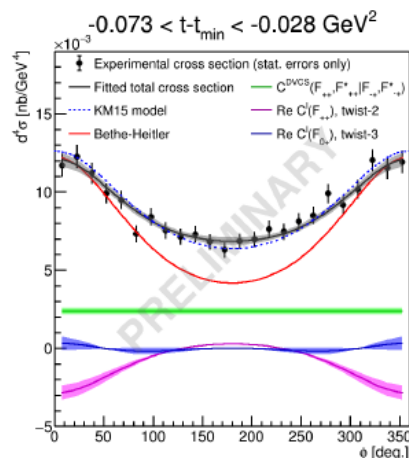


IPN/IJCLab in charge of mechanical design and construction of the calorimeter frame

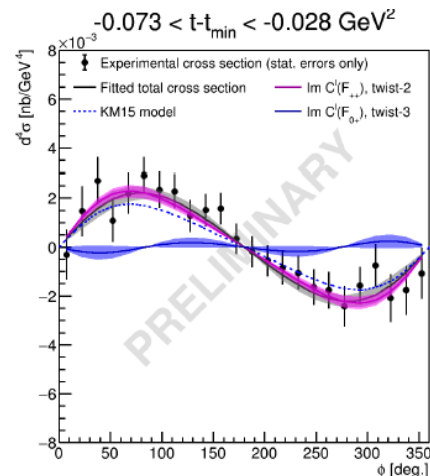
NIM A 1086 (2026)

- Data analysis being finalized
- LH2 and LD2 targets
- Three different beam energies
- Low- x_B coverage

Hao HUANG's PhD Graduation this fall



Unpolarized cross sections



Beam-polarized cross section differences

Results presented at the DIS2026 conference last week

The ALERT Detector for CLAS12

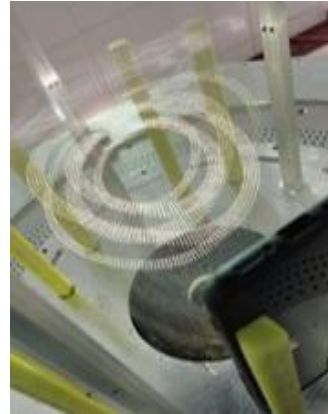
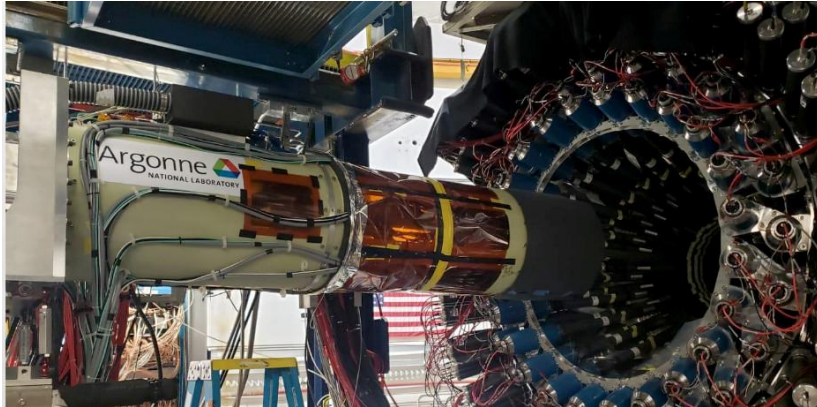
A Low Energy Recoil Tracker

- Joint effort of CLAS Collaboration and Hall B
- Hyperbolic **drift chamber** (by IJCLab)
- **Time-of-Flight** array (by ANL)

Motivation:

- Quark and gluon structure of **light nuclei**
- Measure of **PDFs and GPDs of nuclei** and bound nucleons

The ALERT experiment run in Hall B between April and September 2025, calibrations ongoing

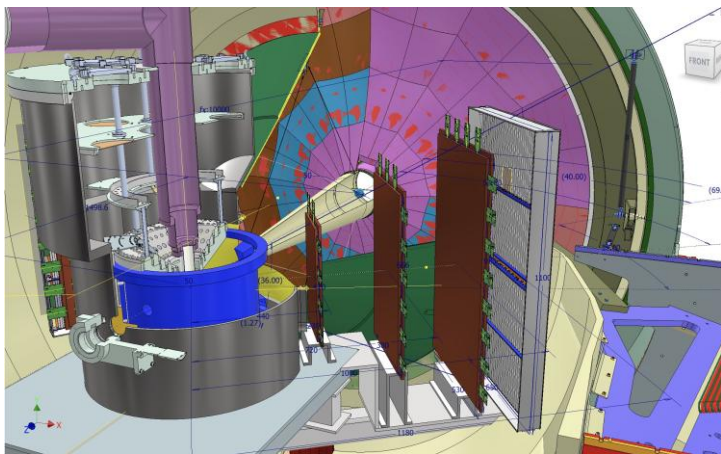


$$\vec{e}\uparrow \rightarrow e\gamma$$

In preparation: pDVCS on transversely polarized target with CLAS12

pDVCS on a transverse target is complementary to nDVCS for its sensitivity to the GPD E

$$\Delta\sigma_{UT} \sim \cos\phi \sin(\phi_s - \phi) \text{Im}\{k(F_2\mathcal{H} - F_1\mathcal{E})\}$$

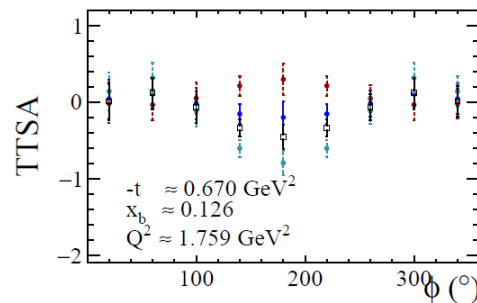


- Dynamically polarized NH_3 (5T/1K) target
- New equipment:
 - Polarizing magnet to maximize the acceptance
 - A chicane of magnets in the beamline
 - **A recoil detector for DVCS protons**
- Uncertainty on $\text{Im}\mathcal{E}$ will be reduced by > 3
- Experiment will run in ~ 4 years

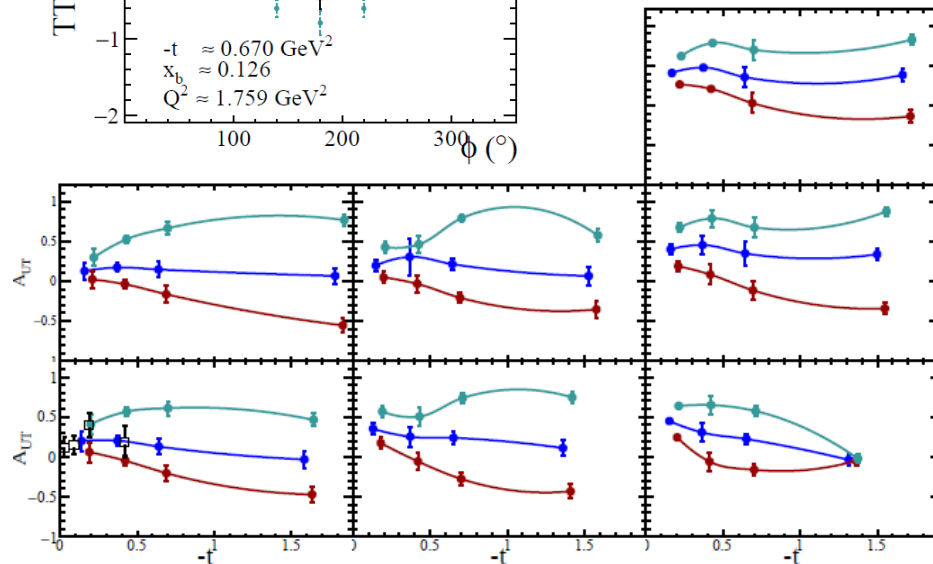
Projections for pDVCS

- 100 days of beam time
- $L = 5 \times 10^{33} \text{ cm}^{-2} \text{ s}^{-1}$
- VGG model: different values of J_u, J_d

Approved by
JLab PAC

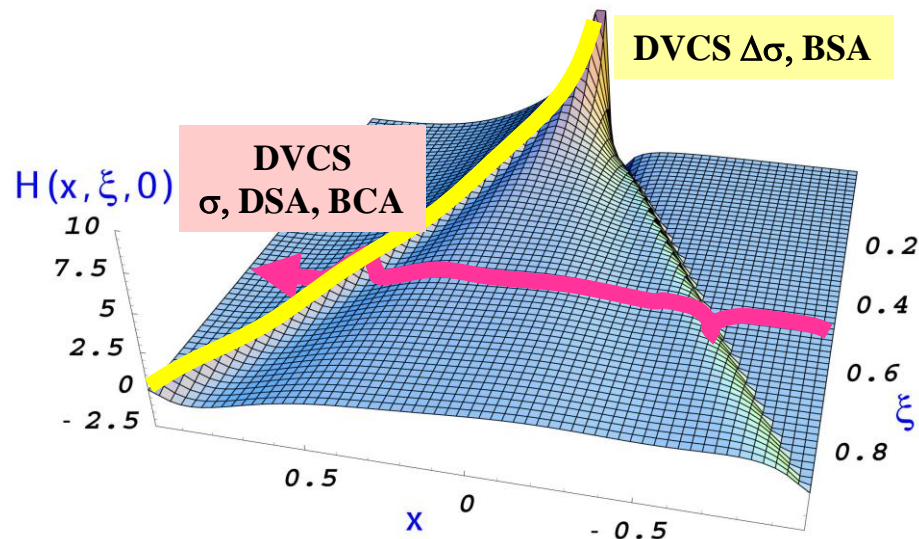
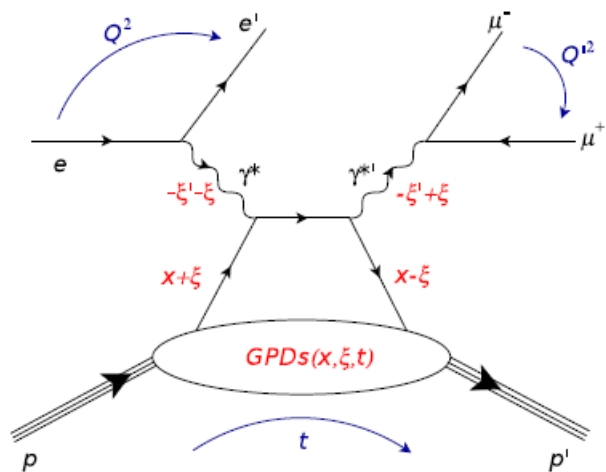


- $J_u = 0.5, J_d = 0.1$
- $J_u = -0.5, J_d = -0.1$
- $J_u = 0.2, J_d = 0$



Black points: HERMES data

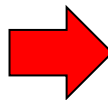
Perspective: DDVCS, the gateway to the full kinematic mapping of GPDs



Thanks to the virtuality of the final photon, Q'^2 , **DDVCS** allows a unique direct access to GPDs at $x \neq \pm\xi$, which is fundamental for their modeling

Experimental challenges:

- Small cross section (300 times less than DVCS)
- Need to detect muons



CLAS12 upgrade (PAC approved):

- “μCLAS12” for DDVCS and J/ψ
- $ep \rightarrow e'p'\mu^+\mu^-$ at $L \sim 10^{37} \text{ cm}^{-2}\text{s}^{-1}$
- New tracker, calorimeter, shielding

Phenomenological studies for DDVCS
PRC 111 (2025)



Ce⁺BAF: a polarized positron beam for JLab

PEPPo @ Ce⁺BAF

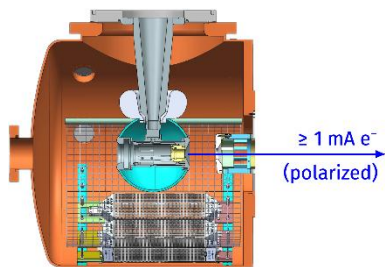
JLab Positron Working Group (E. Voutier et al.) and Ce⁺BAF Working Group (J. Grames et al.)

- The **JLab positron beam physics program** continues to develop at high energy (**471 days** of approved experiments) and to enrich with new perspectives at low energy for Atomic Physics, Materials Science, and Fundamental Physics.
- A strong **R&D** activity is taking place at **JLab** addressing the critical risk areas (**electron source**, **high power target**, **capture cavities**) of the **Ce⁺BAF** CW polarized positron source.

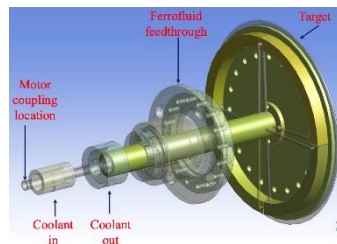
(JLab Positron Working Group) A. Accardi et al. EPJ A 57 (2021) 261

(CLAS Collaboration and JLab Positron Working Group) PR12+23-002 E. Voutier et al. – Beam charge asymmetries in DVCS @ CLAS12

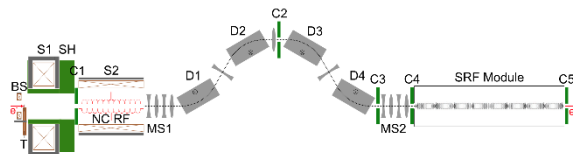
(NPS Collaboration and JLab Positron Working Group) PR12+23-006 C. Muñoz Camacho et al. – Positron cross section in DVCS @ NPS



Polarized electrons source
M. Bruker et al.



Positrons production target
S. Covrig Dusa et al.

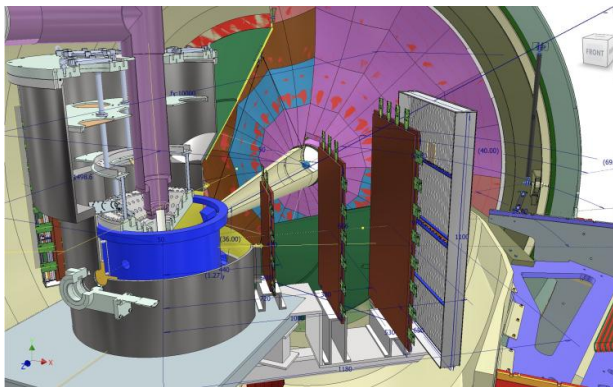


Beam collection and shaping
A. Ushakov et al.

Mise à Disposition of E. Voutier at Jefferson Lab planned to start on June 1st, 2026

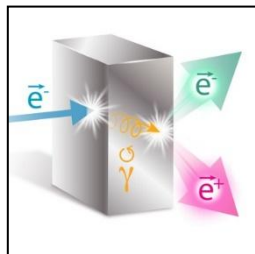
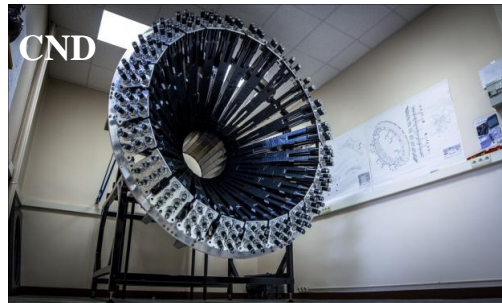
Plan for data taking at JLab@12 GeV...and beyond

All these experiments have **IJCLab** spokespersons and/or a **technical contribution** of IJCLab



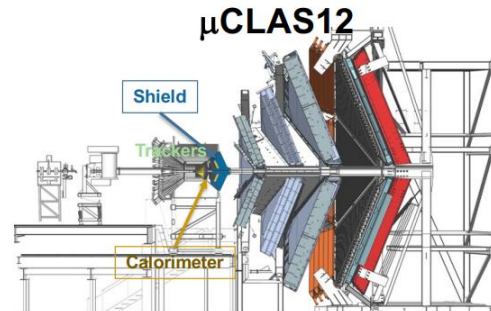
DVCS on transversely polarized target @ CLAS12 (~2030)

Neutron DVCS on polarized and unpolarized target @ CLAS12 – 2nd half of « RGB » and « RGC » (~2027-2028)



GPDs with polarized positrons beam (~ 2036?)

Double DVCS @ CLAS12 (~2032)



Longer term: Electron-Ion Collider (EIC) (>2036)

IJCLab involvement in EIC

2014: Participation to the EIC White Paper



2019: EICUG Meeting in Paris



2020: Expressions of Interest

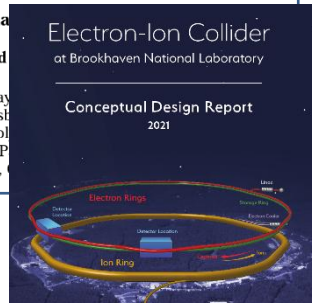
Expression of Interest (EOI)

Laboratories of CNRS-IN2P3 (France)

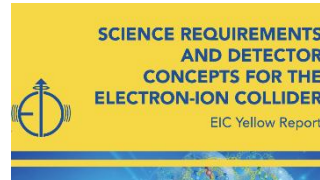
Questionnaire

Please indicate all institutions collectively involved

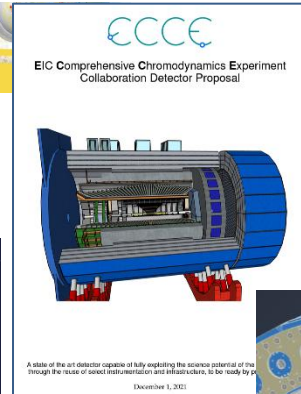
IJCLab, Université Paris-Saclay, CNRS-IN2P3, Orsay
 IPHC, Université de Strasbourg, CNRS-IN2P3, Strass
 LLR, CNRS-IN2P3, Ecole Polytechnique, Institut Pol
 OMEGA - Centre de Microélectronique, CNRS-IN2P
 SUBATECH, IMT Atlantique, Université de Nantes,



2020: Co-conveners and leadership roles in Yellow Report



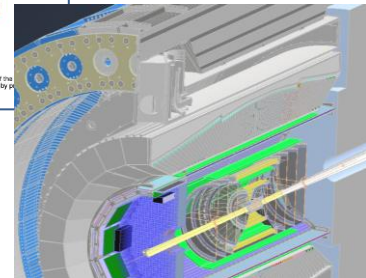
2020: Physics co-convenor in the ECCE detector proposal



IJCLab physicists are **experts in nucleon 3D imaging**, central to the EIC science, with a fruitful experimental program being carried out at Jefferson Lab

ePIC Collaboration:

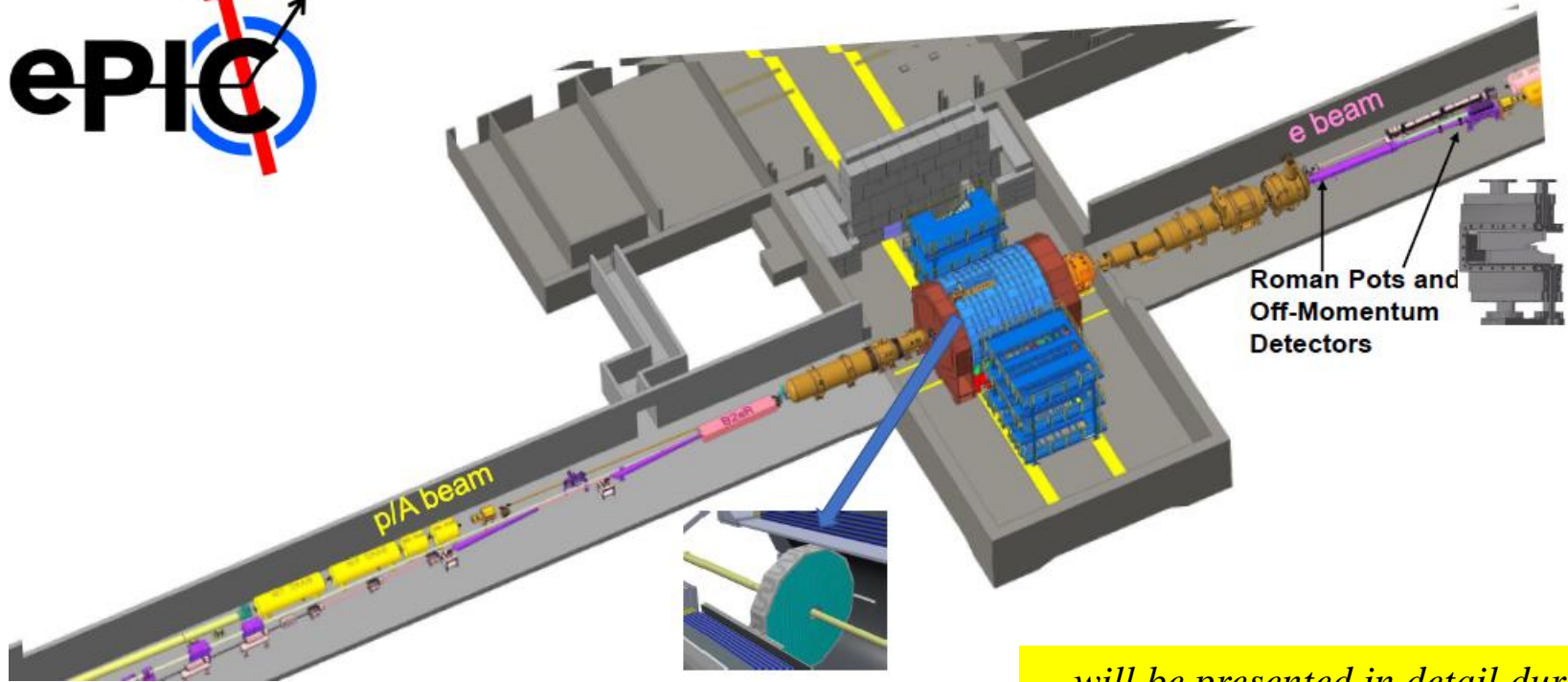
- Calorimetry co-convenor
- Exclusive processes WG co-convenor
- Backward ECAL Technical Coordinator
- Membership Committee
- Outreach Committee



Also, IJCLab members serve in several EICUG committees and in the new EIC-related generic detector R&D advisory panel

2021: Contribution to the EIC CDR

IJCLab technical contributions to ePIC



Backward ECal

...will be presented in detail during the visit to the R&D labs

Our team as of today...

6 staff: Raphael Dupré, Mostafa Hoballah, Dominique Marchand, Carlos Munoz-Camacho, Silvia Niccolai, Eric Voutier

4 PhDs:

- Felix Touchte-Codjo, 2nd year, ALERT experiment
- Hao Huang, 3rd year, NPS@Hall C
- Chung Ting Kuan, 1st year, EIC Calorimeter
- Lorena Bucuru Rodriguez, 1st year, CLAS12-RGB analysis + EIC Calo

2 postdocs arriving in the next months (ALERT and EIC RP)

...and memories of the early days ☺

February 2000

ON TARGET

THOMAS JEFFERSON NATIONAL ACCELERATOR FACILITY • A DEPARTMENT OF ENERGY FACILITY

► **Into the machine**
feature delves into EPICS software

► **New video shines**
spotlight on Lab mission, special programs

► **JAG seeks entries**
Lab-wide for Spring Arts Festival

► **HR&S plans annual**
Benefits Fair March 2-3

Experiment 10 years in the making off and running in Hall A

In 1989, the Berlin Wall came down and the post Cold War science scene was changing dramatically. That same year saw the planning completed for one of Jefferson Lab's original and defining research initiatives.

Now, more than a decade after its formal proposal, the Hall A "electron-disintegration at high momentum transfer" experiment is alive and thriving, having begun its run in December. Ten days of research have already been conducted and data taken. The run continues this month and will conclude in March. One hundred fifty physicists from all over the world are directly or indirectly involved. Participating are researchers from the United States, Algeria, China, France, Germany, Italy, Japan, the Netherlands, Russia, Slovenia, Ukraine, Israel, Sri Lanka, and Jordan.

These researchers are using the Lab's electron beam to shatter the atomic nucleus of a gaseous isotope of helium known as helium-3. Hall A's pair of high-resolution spectrometers allows data to be gathered simultaneously on different types of subatomic particles, a process known as "in coincidence." The examination of what comes flying out in the aftermath — in this case, electrons and protons in coincidence — could redefine the understanding of nucleon interaction at extremely high rates of motion. Under such conditions, a nucleon pair could merge, forming a kind of supersized, six-quark "bag." If so, the implications would be profound for nuclear physics theory.

continued on page 2



Several members of Experiment E-89-044 pose in front of the modified target assembly in Hall A, before their experiment resumed in early February. From left are Arun Saha, JLab scientist; Michael Kurs, JLab postdoc; Jean Mougey, Grenoble physicist; Fatima Benflokhtar, Algiers Ph.D. candidate; Eric Voutier, Grenoble physicist; and Marat Ryachev, MIT Ph.D. candidate.