



JLAB12

Status update April 2026

Alessandra Filippi
INFN Torino



CSN3 April 2026 Meeting, Firenze, Apr. 23, 2026

- Introduction: JLAB12 Collaboration Business
- Business at Jefferson Lab
- Projects status and 2025 milestones fulfillment
 - BDX construction
 - CLAS12: Hi-Lumi & RG-H R&D
 - Hall A/C: SBS & Hypernuclear Collaboration
 - 2025 publications
 - New projects in the pipeline (>2028)
- Synergies with other CSN3 projects
- Budget profile and 2027 plan
- Conclusions

- **2026 INFN/JLAB12 group composition**
 - Several INFN units: BA, CT, FE, GE, LNS, LNF, PV, RM1, RM2, TO
 - 54 researchers, 24.1 FTE
 - 8 technologists, 2.85 FTE
 - 9 technicians + some “hidden” FTEs (PNRR synergic activities) + theory collaborators
 - 5 PhD students

LEADERSHIPS AT THE LAB

P. Rossi, Deputy Associate Director

LEADERSHIPS IN SBS & Hypernuclear Collaboration

E. Cisbani, Coordinating Committee member and Front Tracker leader

G. M. Urciuoli, F. Garibaldi spokespersons of all Hyp. Coll. Experiments

LEADERSHIPS IN CLAS12

M. Battaglieri

- Forward Tagger Project Leader
- CLAS12 data processing validation committee Chairperson

M. Contalbrigo

- RICH Project Leader
- CLAS12-RGH Chairperson
- DPWG Chairperson

A. D'Angelo

- CLAS12 RGK Chairperson and Analysis Coordinator
- Hadron Spectroscopy Working Group Chairperson

R. De Vita

- Forward Tagger project Leader

L. Lanza

- CLAS12 Speakers' Committee (CSC) Chairperson

M. Mirazita

- RICH Project Leader
- CLAS12 data processing validation committee member

A. Filippi

- CLAS12 CSC Member

LEADERSHIPS IN HPS

M. Battaglieri

- HPS-ECAL Project Leader

A. Celentano

- PPC member

A. Filippi

- Publication and Presentations Committee (PPC) Chairperson
- Executive Committee (EC) member

LEADERSHIPS IN BDX

M. Battaglieri

- BDX Spokesperson,
- BDX Project Leader

M. Bondi

- BDX spokesperson
- BDX Project Leader

R. De Vita, A. Celentano, M. De Napoli

- BDX Spokespersons

LEADERSHIPS IN MOLLER

G.M. Urciuoli, International Board member

The Italian group is present at JLAB since the very beginning of CEBAF operations

Many leaderships roles covered

- **More than 20% of approved experiments has Italian spokespersonship**

- **Latest news, Mar. 31, 2026:** new lab contractor appointed: SURATECH (Southeastern Universities Research Association + Virginia Tech)
 - Currently in protest term - in operation from June, 1
 - The current Director will remain in position, ensuring continuity and transparency for personnel (contracts renewal)
- Mid March 2026: Merge of DOE-HEP and NP: HENP
 - Budgets separated for the two coming years
- Second half of 2025: critical contingencies
 - General reduction of Lab budget in 2025 + restructuring plan of Lab started in August 2025 (7% of JLab personnel)
 - **Severe reduction of NSF budget: freeze-out of NSF MRI program for 2025**
 - **Strong impact of Federal Government Shutdown at the beginning of FY26 (November-December 2026)**
 - Most of the activities in experimental Halls suspended in the last months: furlough risk
 - Targeted leadership replacements driven by budget management practices (non-strategic)
 - The financial situation is now being restored, still requiring some restrictions

**The laboratory activity plan remains unchanged from the 2022 roadmap, aside from any adjustments made during implementation
NO CHANGE IN STRATEGY OR MISSION**

Looking Forward

FY2026

- Funding for DOE Office of Science Passed (Water & Energy Bill)
- Fully Funded for FY26 - No risk of Government Shutdown for DOE
- Planned 24 weeks of CEBAF Operations / 20 Weeks of Physics
- Construction Projects: JLDC & CRE
- MOLLER, EIC, HPDF & Genesis Mission...

CEBAF full activity foreseen until 2033 at least

... and Beyond (this is what we presented in 2022, and we will update guided by the community)

Notional CEBAF and EIC Efforts on One Chart

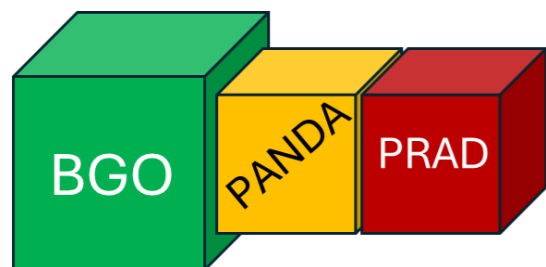
- Accelerator team has worked up an early schedule and cost estimate
 - Schedule assumptions based on a notional timing of when funds might be available (near EIC ramp down based on EIC V3 profile)
 - For completeness, Moller and SoLID (part of 12 GeV program) are shown; positron source dev shown
- EIC Project is shown

Activities	Fiscal Year																			
	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
Moller (MIE, 413.3B, CD-2/3)	█	█	█	█	█															
SoLID (LRP, Rec 4)			█	█	█	█	█	█												
Positron Source (R&D)	█	█	█	█	█	█	█	█	█											
CEBAF Upgrade preCDR/preplan	█	█	█																	
Positron Project (potential)									█	█	█	█								
Transport e+													█	█	█	█				
22 GeV Development (R&D)				█	█	█	█	█	█	█	█									
22 GeV Project (potential)													█	█	█	█	█			
EIC Project (V4.2, CD-1, CD-3A)	█	█	█	█	█	█	█	█	█	█	█	█								
CEBAF Up	█	█	█	█	█	█	█	█	█	█	█			█	█	█	█		█	

Ongoing projects status



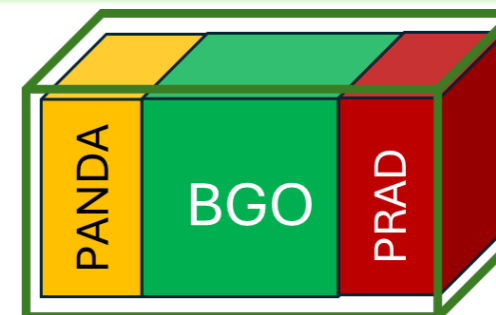
BDX: detector update



- Option 1 (apr. 25)
 - 3 different modules (BGO, PANDA, PRAD)
 - BDX-BGO funded by CSN3
 - PANDA+PRAD not funded (sep. 25)



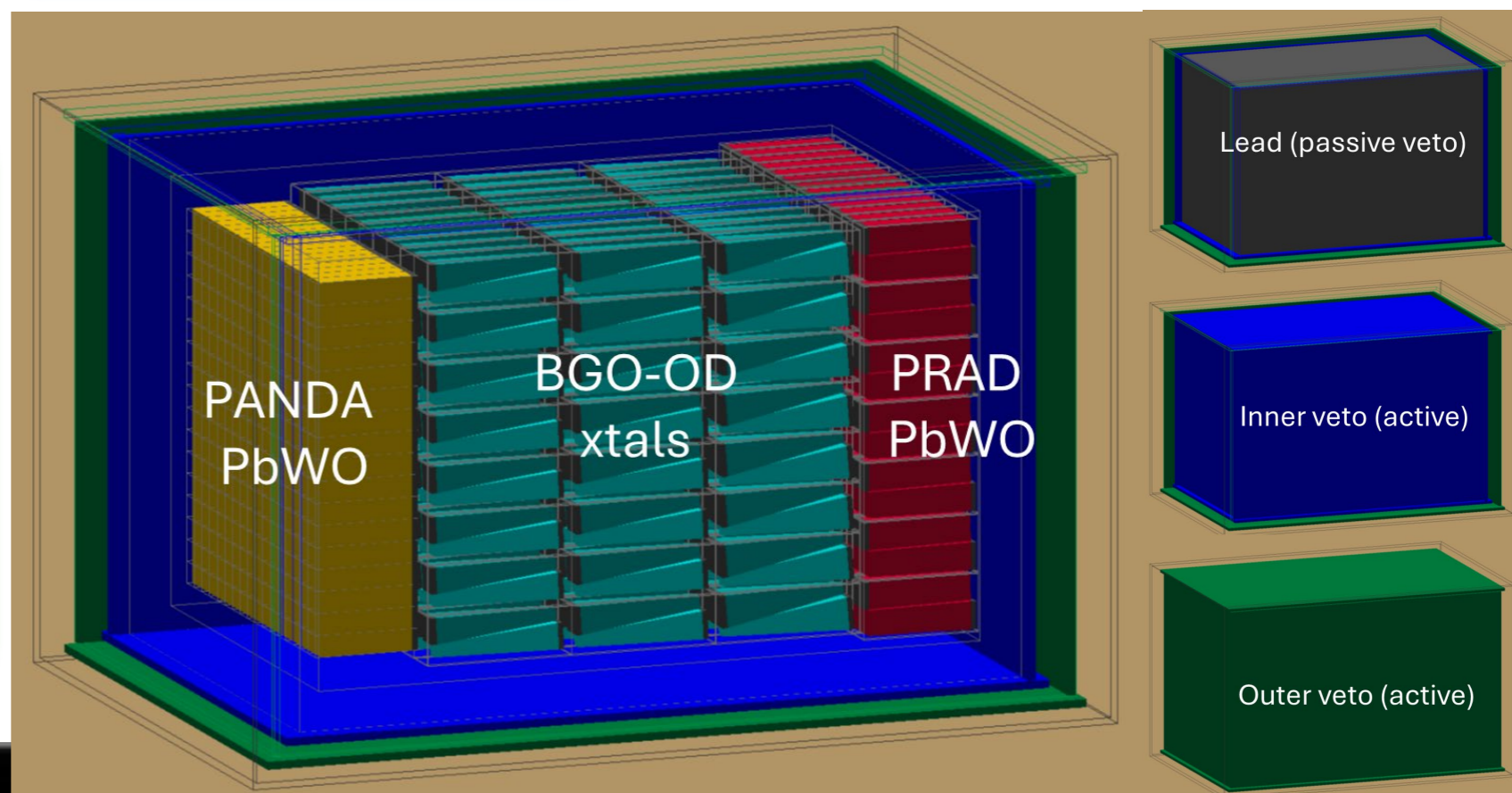
- Option 2 (sep. 25)
 - 2 different modules (BGO, all PbWOs)
 - Intended for MRI
 - No DOE/NSF MRI application possible in 2025 😞



- Option 3 (latest)
 - 1 single large module: 1x IV/OV
 - Stageable
 - Mechanically safer
 - Some funds found from external sources (PNRR, ...)

Option 3:

- Total VETO size: 1.6 x 1.2 x 1.1 m³
- 3 stacks of xtals – SAME active volume
 - Stage I: 480x BGO-OD BGO (1/2 BDX active volume)
 - Stage II: 800x PbWO₄ PANDA (1/4 BDX volume)
 - Stage III: 1200 PbWO₄ PRAD (1/4 BDX volume)



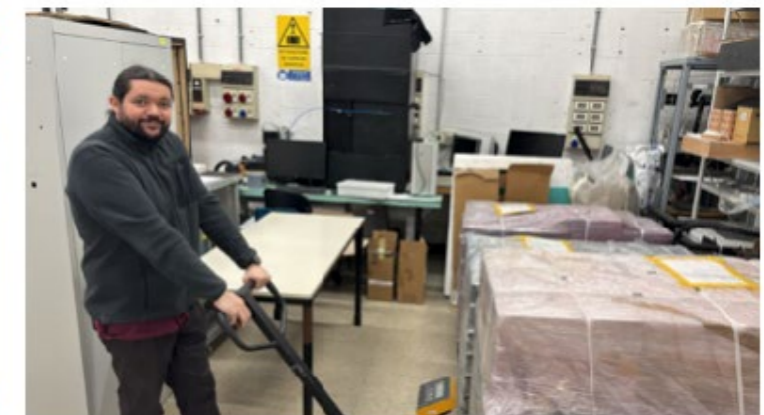
- **BDX_BGO: 480 BGO-OD crystals (1/2 BDX active volume) procured in Feb. 2026 and now stored at INFN-GE**
- Ready for repurposing
 - All SiPMs procured, mechanical holder in construction
- Tests in GE in summer, ship to JLab in Fall 26/Winter 27
- Veto plastic/fibers expected delivery in few months

- **800 PbWO_4 crystals from PANDA (which did not meet PANDA specs): 100 procured and moved to INFN-GE**
 - Contacts with K. Brinkmann (Gießen) for the release of the remainder of the batch
 - Nihil obstat for their usage from PANDA Collaboration
- **1200 PbWO_4 from PRAD experiment @ JLAB, available at the end of its run (> Sep. 2026)**

- Each PbWO_4 crystal read by a SiPM; signals are grouped in sets of four and fed into a single fADC channel

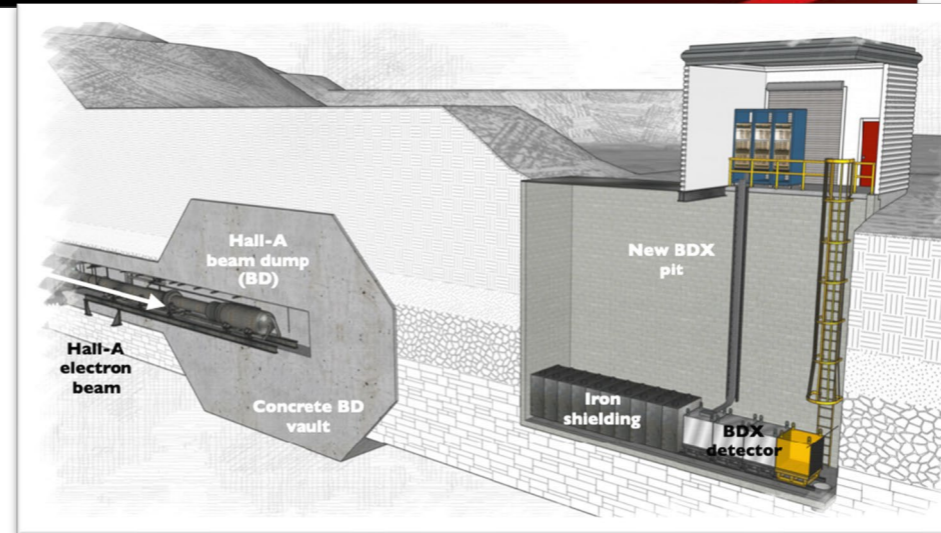


crew from GE, CT, RM2



BDX project timeline

- **BDX updated plan presented to the Director in Jan. 2026**
 - Resuming interactions after the new contractor's assignment, meetings planned
- JLab Facility Div. producing the final quote of the BDX facility
- The Pb shielding design was finalized
- Timelines and funding as presented to INFN-CSN3



Beam Dump eXperiment (BDX) at JLab: Status and Plans - January 2026

M. Battaglieri*¹, A. Celentano¹ Istituto Nazionale di Fisica Nucleare, Sezione di Genova e Dipartimento di Fisica dell'Università, 16146 Genova, Italy

M. Bondi¹, M. De Napoli¹ Istituto Nazionale di Fisica Nucleare, Sezione di Catania e Dipartimento di Fisica dell'Università, Catania, Italy

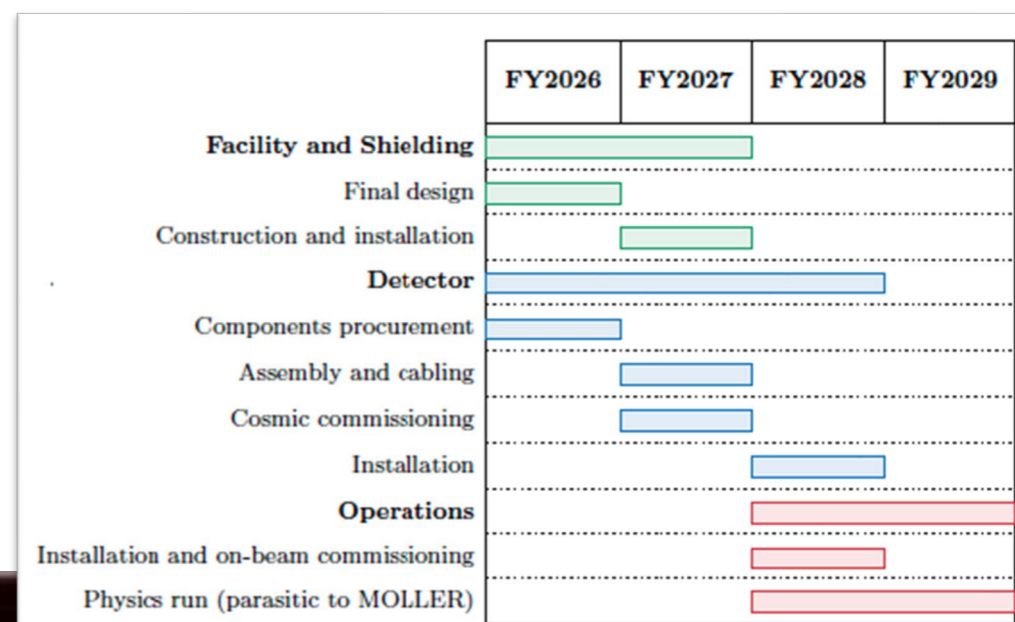
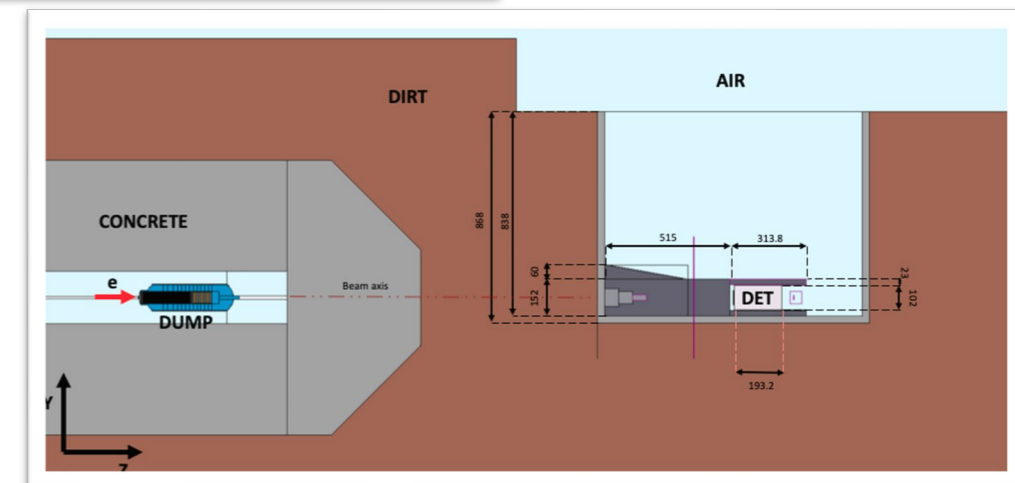
R. De Vita¹ Jefferson Lab, Newport News, VA 23606, USA

G. Krnjaic¹ Center for Particle Astrophysics, Fermi National Accelerator Laboratory, Batavia, IL 60510

and the BDX Collaboration
18 January 2026

* Contact Person, email: Marco.Battaglieri@ge.infn.it
¹ Spokesperson

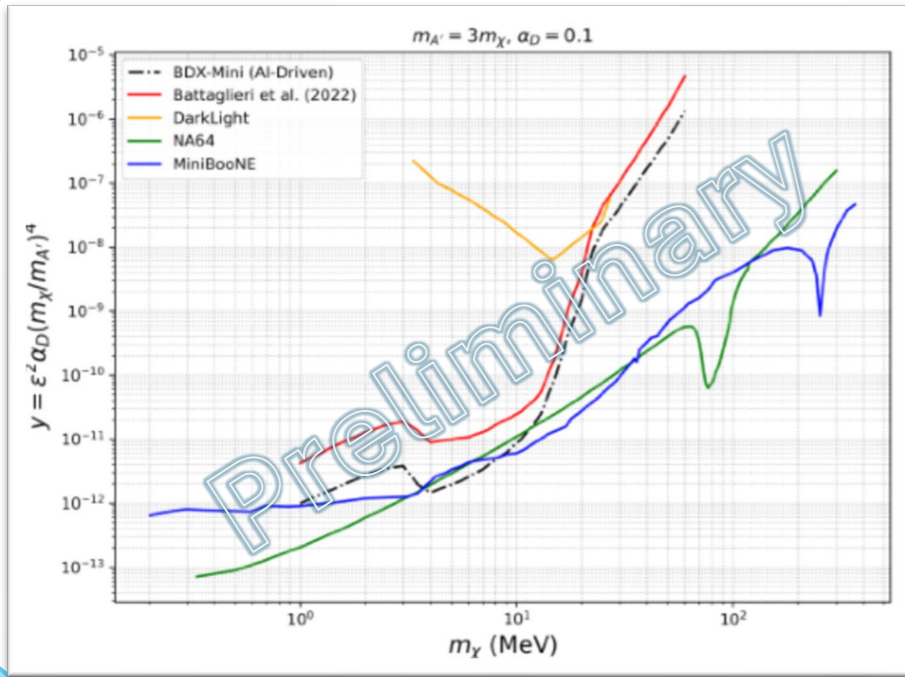
Item	Cost	Institution
Infrastructure Hall and Shielding (including labour)	\$2.5M	JLab
Detector (all but crystals, CE only)	\$400k	INFN
Electronics	repurposed PRAD-II	JLab (in-kind)
BGO Crystals	repurposed BGO-OD	INFN (in-kind)
PANDA PbWO ₄ Crystals	repurposed PANDA	GiessenU (in-kind)
PRAD-II PbWO ₄ Crystals	repurposed PRAD-II	JLab (in-kind)



- Collaborations/synergies

- Collaboration with Gießen/Mainz/Bonn on FE (synergistic with ePiC bECAL)
- Collaboration within GENESIS Mission for SRO DAQ (“Streaming Trigger and Real-time Intelligent Data Engine - STRIDE”)
- Collaborations with CSN3-NUSDAF on SRO DAQ

BDX physics: update and extensions

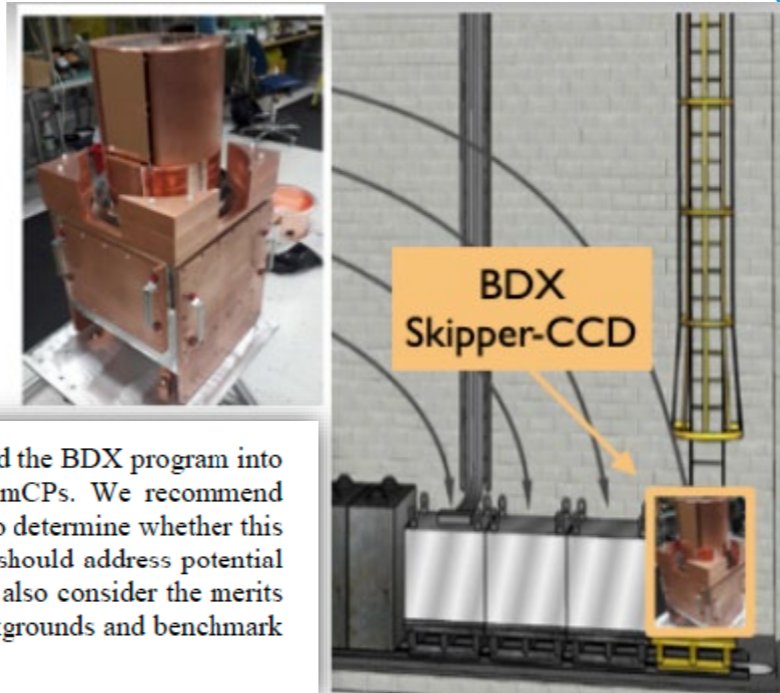


- Revisit current BDX-MINI limits with AI-assisted algorithms
 - Extended sensitivity with same model assumptions
 - Model-independent anomaly detection
 - PRL in preparation

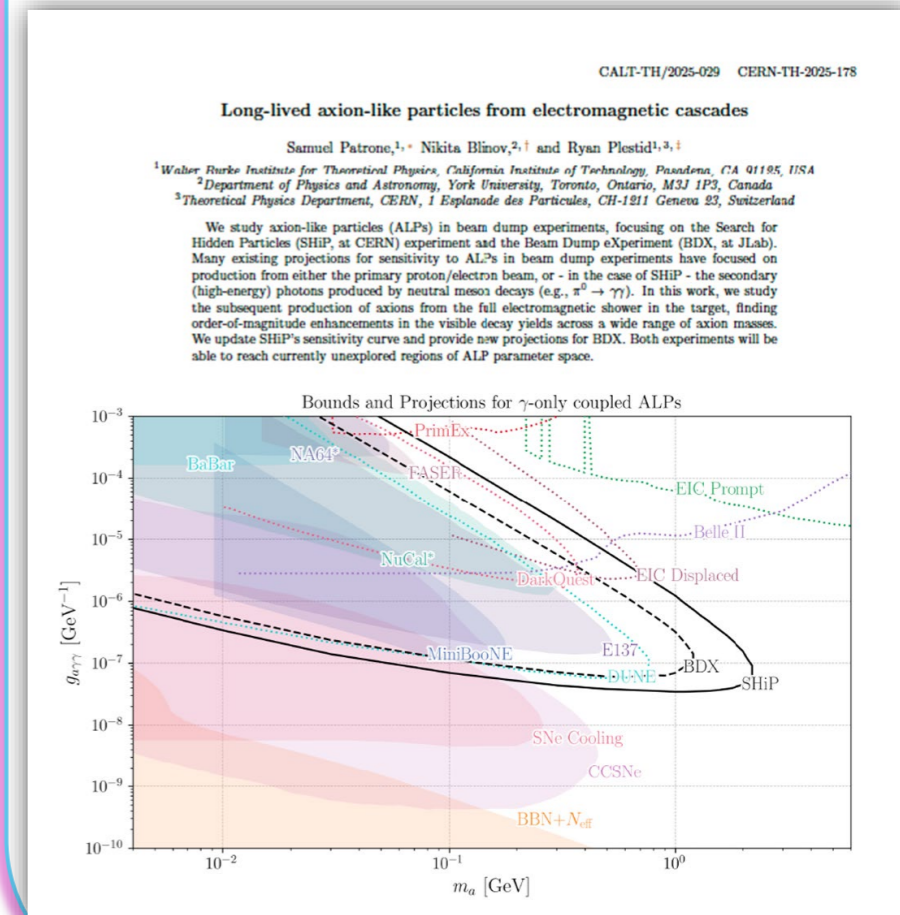
- Extending BDX sensitivity to other particles
 - Axion-Like Particles (ALPs)
 - Interest at HEP experiments (SHIP)

- Extending BDX detector to test other models

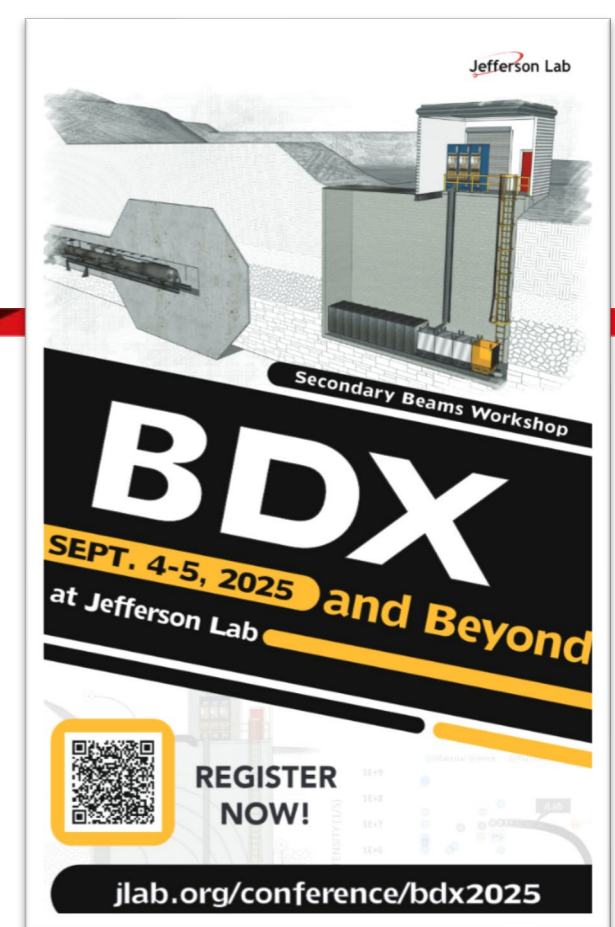
- Addition of Skipper-CCD (SBU/FNAL)
- LOI presented at PAC53
- Full proposal encouraged



Summary: This LOI describes a compelling, low-cost addition to extend the BDX program into a new regime of sensitivity to light dark-sector particles, especially mCPs. We recommend proceeding to a full proposal after consultation with JLab management to determine whether this should be considered as a run group addition with BDX. The proposal should address potential backgrounds through continued simulation and the collaboration should also consider the merits of a staged plan with a small-scale prototype demonstrator to assess backgrounds and benchmark the simulations.



- Workshop organized and held in Sep. 2025
- **Goal:** explore opportunities of secondary beams at JLab leveraging BDX infrastructures
- **Format:** sharing thoughts and ideas on muon, neutron, neutrino and LDM beams @JLAB
- **Program:** two days of presentations, discussion time flash talks
- **Attendance:** more than 50 ppl
- **Expected outcome:** build a new user community, deliver a white paper with the results of the brainstorming (published on *Eur. Phys. J.* **A61** (2025) 285)
- **A new round with focus on BDX physics to be organized shortly**
- Opportunities with secondary beams:
 - **Muons, neutrinos:**
<https://doi.org/10.3390/instruments8010001>
 - **Neutrons:** in preparation



BDX financial plan update

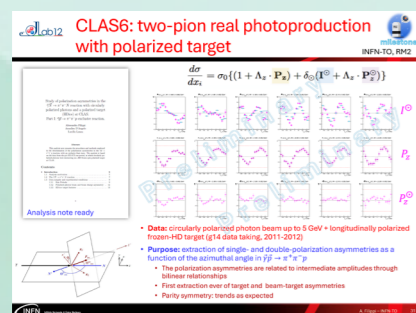
- **2025 plan: total cost 510 k€/3y (opt-1), 245 k€/BDX_BGO (INFN)**
 - BDX_BGO 2025: 95 k€ assigned + 65 k€ extra (NBD+restituzioni) = 160 k€
 - BDX_BGO 2026: 65 k€ assigned
 - **Total effective (2025/26) BDX_BGO: 225 k€**
 - Enough to complete the module (opt 3: one veto only, 1/2 sensitive volume)
- **total cost opt-3: 325 k€/3y (cost saving: ~200 k€)**
 - 100 k€ still needed to instrument the two PbWO crystal walls

	Tecnologia	Origine	Volume target	Percentuale rispetto proposal	Costo	Deployment
Modulo BGO	BGO	Bonn - B-GOOD	1.5 tons	50%	232k+13k trasporto	2027
Modulo PbWO	PbWO4	PANDA + PRAD	1.4 tons	50%	250k+15k trasporto	2028

2025		2026	2027	commenti
Aprile (sblocco sj)	Sett/Dic NDB (restituzioni)	Richieste	Richieste	
95,000.00 €	65,000.00 €	85,000.00 € 65000 €	130,000 € (sj) 130,000 € (sj)	Modulo BGO
		135,000 € (sj)	130,000 € (sj)	Modulo PbWO (sj NO MRI)
160,000.00 € ✓		220,000.00 €	130,000 €	Tot

• Additional extraordinary funding request of 100k to complete the full apparatus (opt3, one module only)

- Can be split in two:
 - June 26?
 - September 26?
 - 2027?



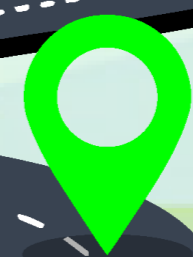
Jul 1

CLAS6: Completamento dell'analisi delle osservabili di polarizzazione nella fotoproduzione di 2π su protone con i dati del run g14 (HD-ice): 90%

jun 29

Hi-Lumi: Caratterizzazione di prototipi GEM-uRwell 10x10 cm²: 100%

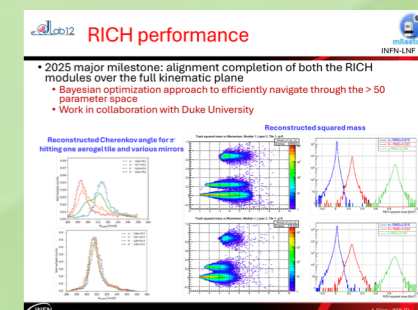
dec 31
Hi-Lumi: realizzazione GEM- μ Rwell a grande superficie: 100%



jun 29

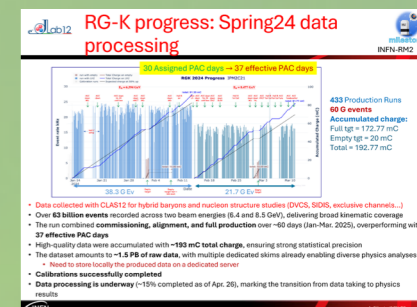
CLAS12 RGK: completamento calibrazioni dati Spring24: 100%

dec 31
RICH: completamento integrazione del RICH nelle simulazioni di CLAS12: 100%

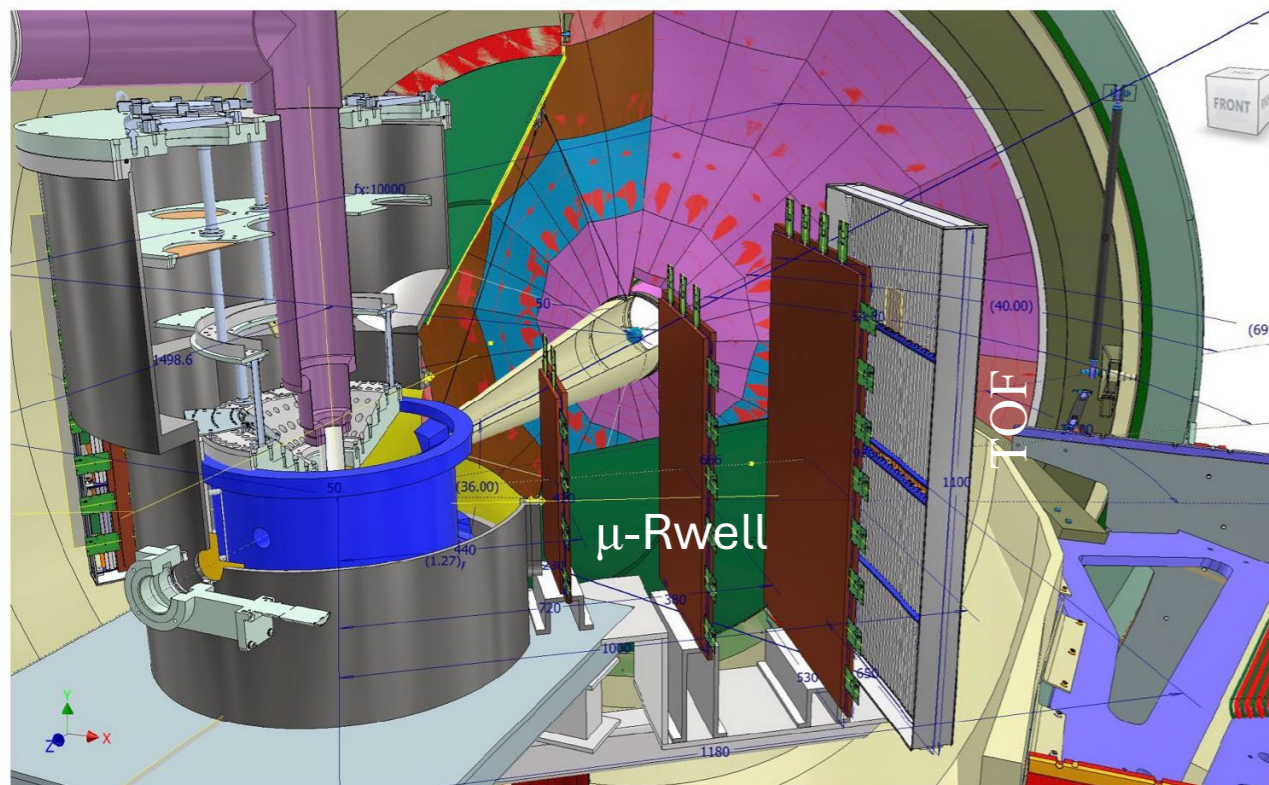


oct 30

Hall A: studio di fattibilità della misura del fattore di forma assiale: 100%



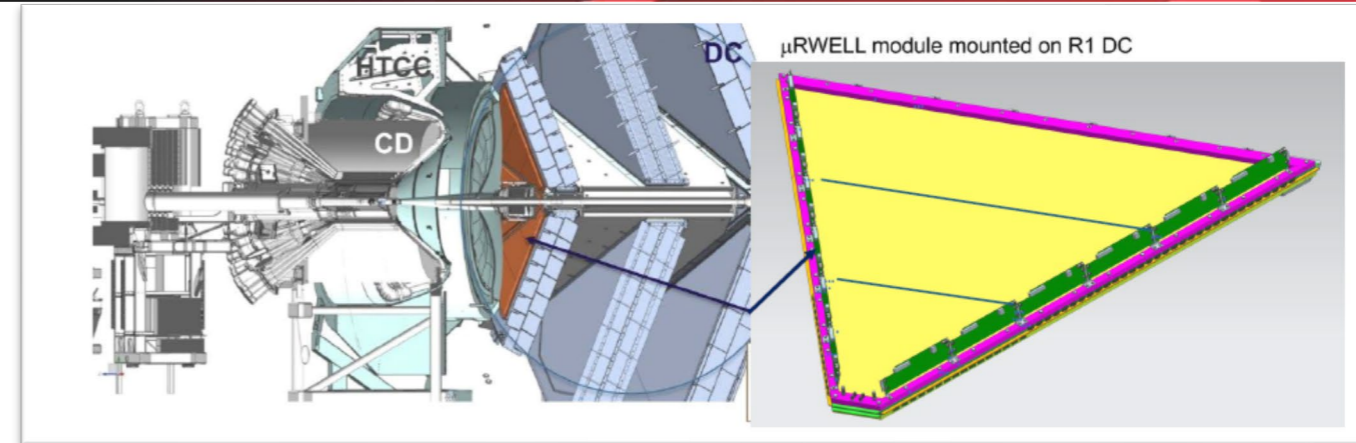
- **RG-H: experiments with transversely polarized targets to measure inclusive, semi-inclusive and exclusive DIS**
 - Comprehensive program aiming to three-dimensional nucleon imaging and access to transverse degrees of freedom \Rightarrow *HIGH IMPACT MEASUREMENTS*
 - Transversity, tensor charge, Sivers functions (spin-orbit correlations), Compton Form Factors, \mathcal{E} GPD
- NH_3/ND_3 conventional targets need a 5T magnet to provide dynamical polarization
 - Funds for magnet purchase allocated at JLab beginning of 2026
 - New liaison appointed \Rightarrow the project is moving forward!



- Recoil detector replacing the CLAS12 central detector to pursue exclusive measurements
 - Tracker:
 - 100 μm spatial resolution
 - μR -well chambers (synergy with Hi-Lumi)
 - Time of flight
 - 100 ps time resolution
 - scintillating fibers
 - Data-taking foreseen no sooner than 2029
 - Studies ongoing on FE electronics performance:
 - re-use of RICH or ALERT FE for TOF
 - re-use of APV-25 (SBS-GEM) for tracker

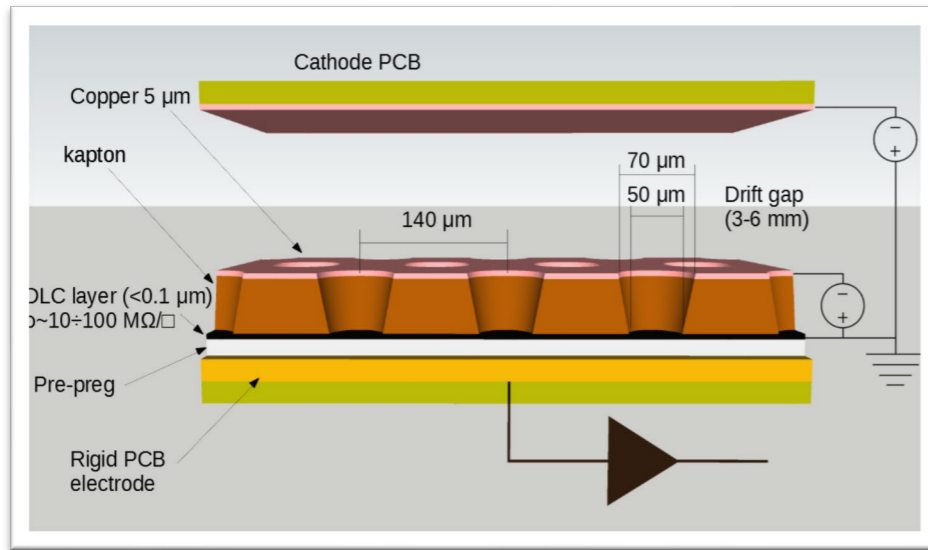
HI-Lumi project: CLAS12 with CEBAF luminosity upgrade

- CEBAF at the luminosity frontier: natural continuation of JLAB physics program complementary to the EIC
- Two phases:
 1. $2 \times \mathcal{L} \Rightarrow 2 \times 10^{35} \text{ cm}^{-2} \text{ s}^{-1}$
 - Fast tracking layers
 - CLAS12/RG-H tracker
 2. $10 \times \mathcal{L}$ and more \Rightarrow up to $10^{37} \text{ cm}^{-2} \text{ s}^{-1}$
 - CLAS forward detector converted into a muon detector: μ CLAS12



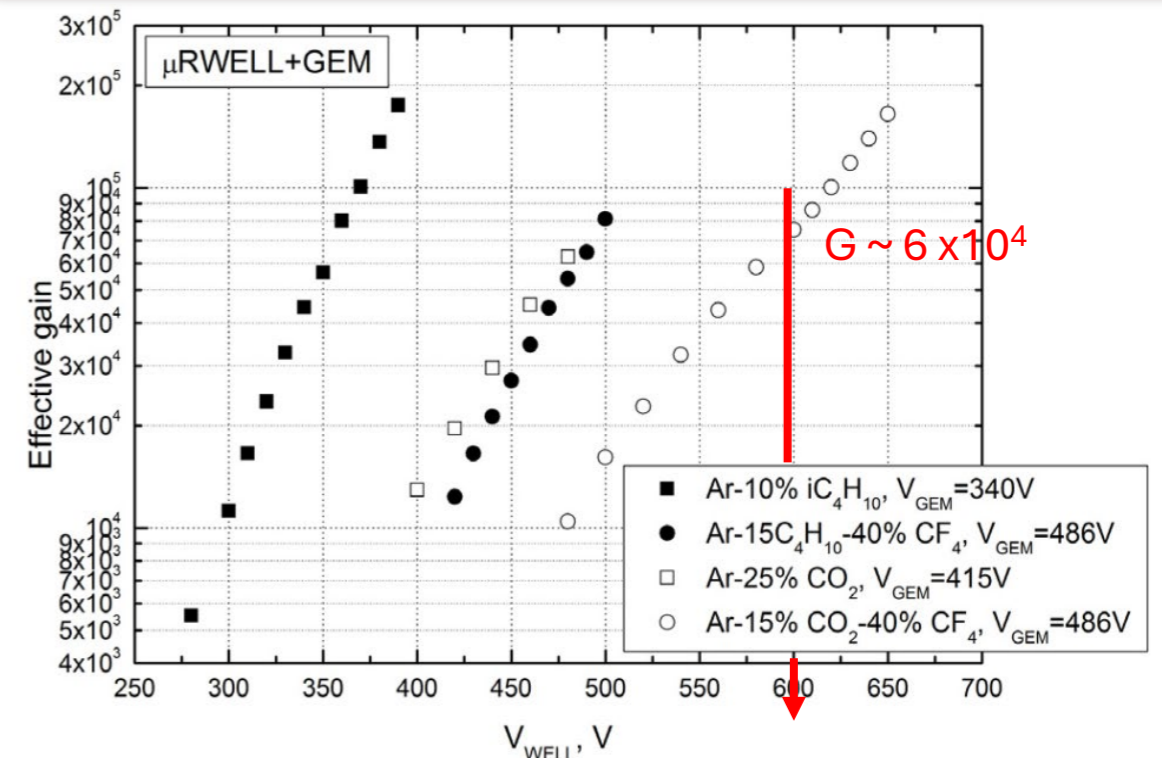
2025 R&D activity:

- Capacity sharing AND μ TPC studies on large area G-Rwell detectors
- Gas mixture optimization

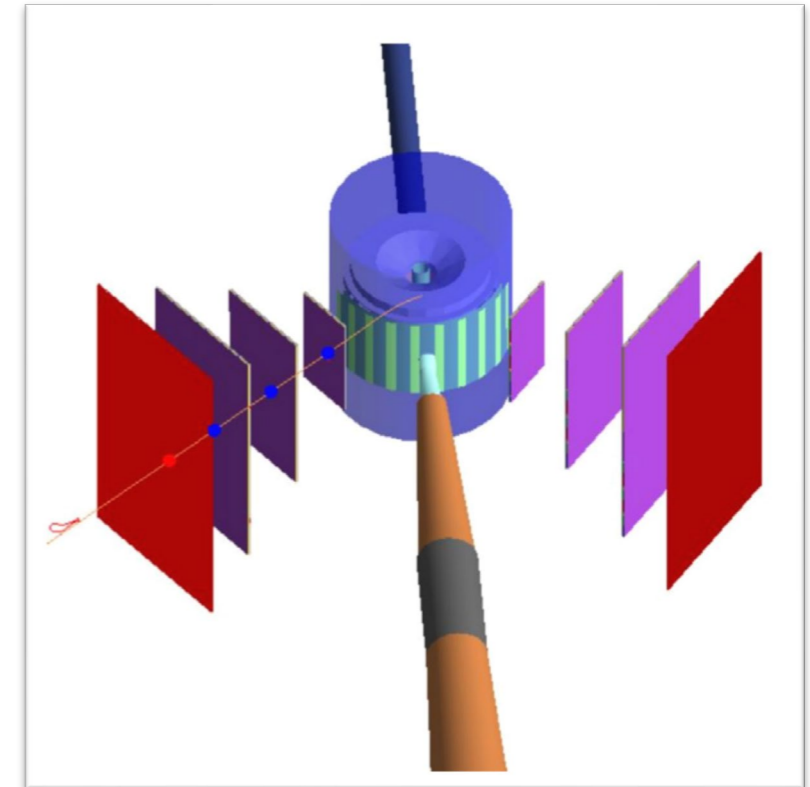


Solution: optimized hybrid GEM+ μ -Rwell detectors (G-Rwell)

- Capacity sharing to minimize electronic channels and μ TPC studies for inclined tracks reconstruction



- Tracker for RG-H equipment must be compliant to the magnetic field necessary for the polarized target
- SVT tracker to be replaced new MPGD recoil tracker
 - **G-Rwell technology**
- six tracking chambers for the recoil detector with 2D readout
 - **Low material budget**
 - **100 μm position resolution**
 - **< 10 ns time resolution**
- New test-beam programmed in July 2026 @CERN-SPS for last tunings and additional gas mixture optimization studies
- Dedicated MPGD laboratory being set up at RM2



CERN Test beam set-up in preparation

@ CERN SPS
H4 Beam Line
15/7-3/8

Rail mounted TRK+TRG
Already in production

DET	Pitch (μm)	Active Area	Readout	Capacitive Sharing
TRK	400	10x10 cm^2	2D XY	No
QUAD	600	R = 45 cm	2D XY	No
CS	1200	46x40 cm^2	2D XY	3 Layers (300 μm)
TRG	NA	15x15 cm^2	SiPM	NA

Same as TB 2025

Mixer unit for gas studies

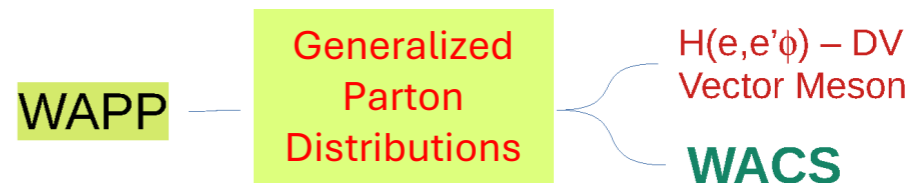
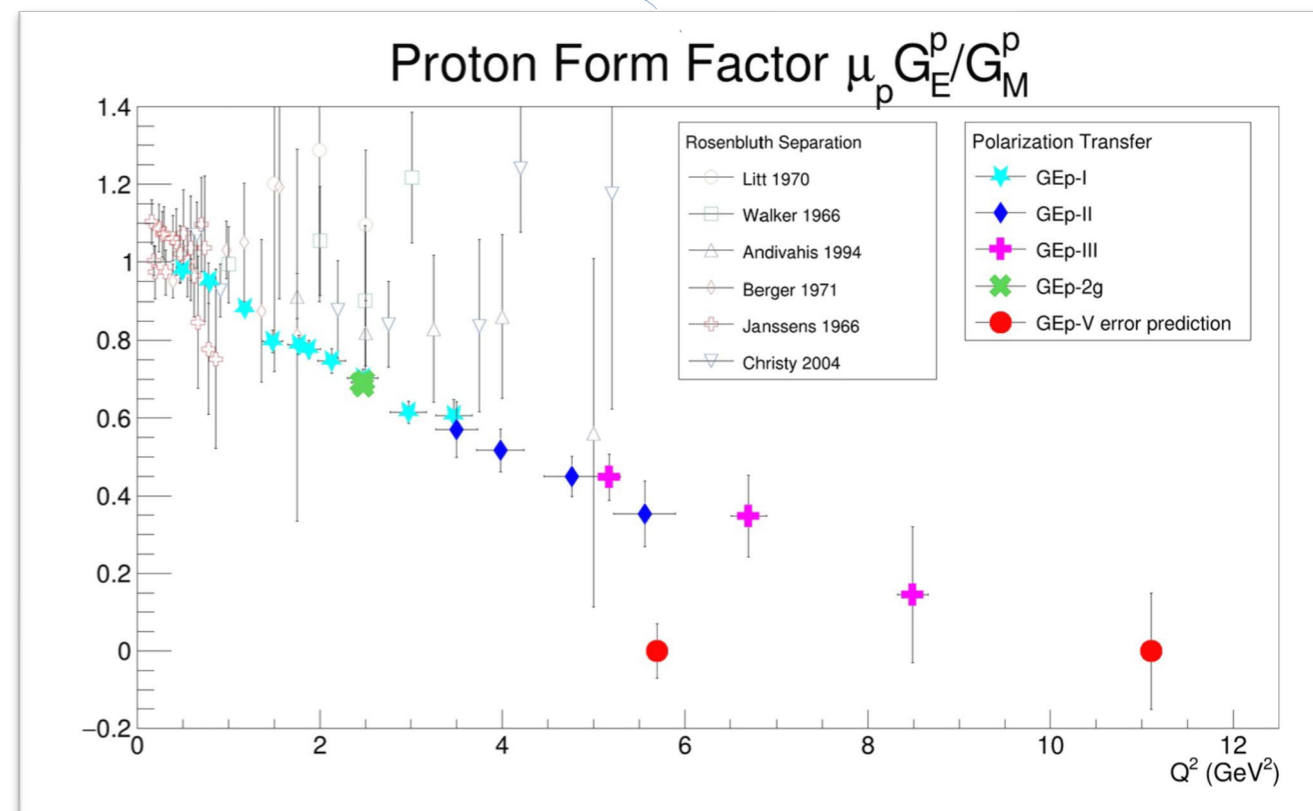
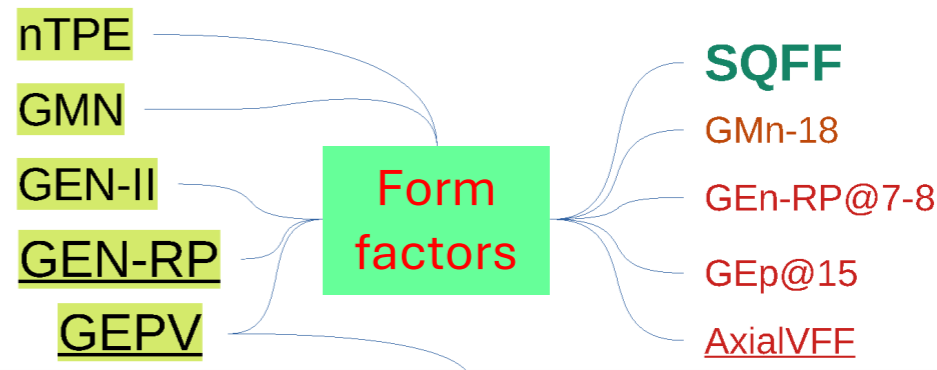
Components procurement ongoing

Color Legend

- Mass flow controllers
- Filters
- Check valves
- Control valves
- Pipes
- Fittings
- Mixing volume
- Pressure gauge
- Electrical
- Mechanics

Hall A-C: SBS program status

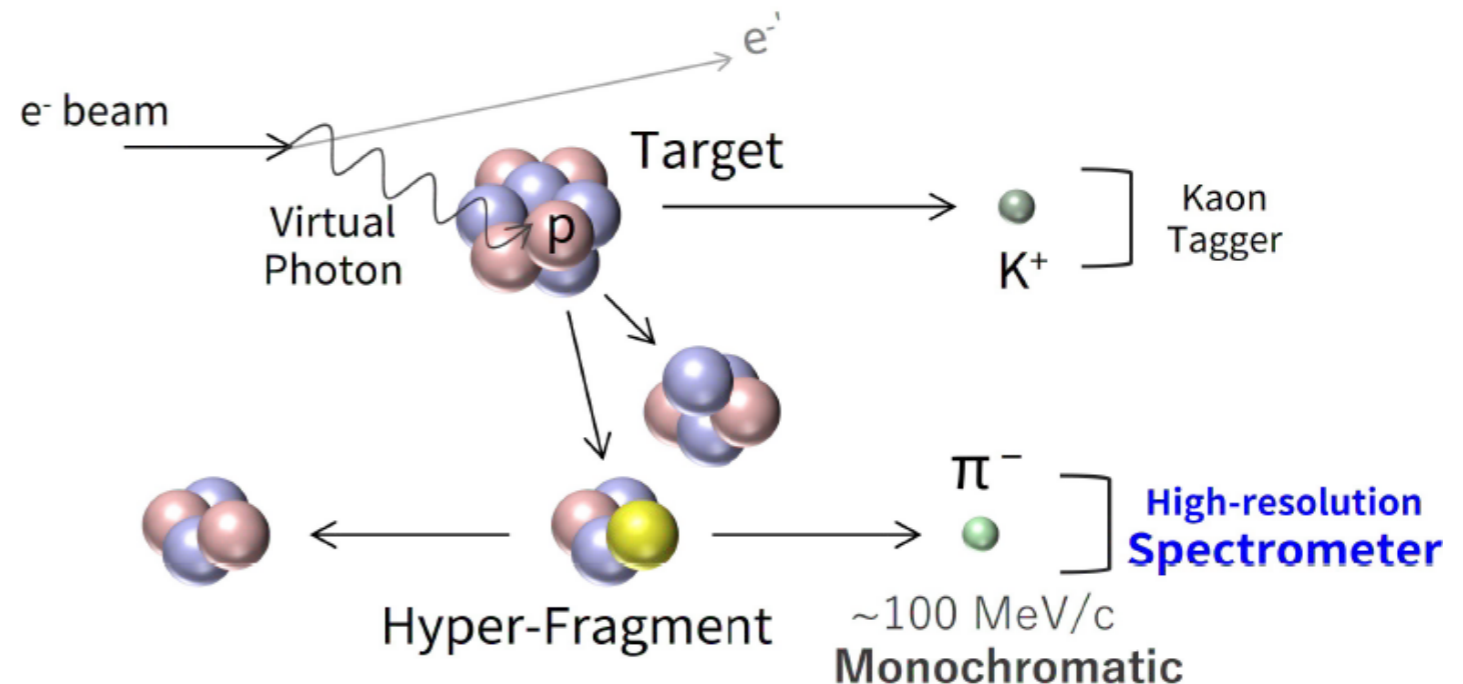
- SBS data taking started in 2021 after ~10 years of R&D and construction
- Ongoing analyses also preparatory for next approved experiments and triggering new proposals
- Experiment status:
 - **Completed (2021-2025), analysis in progress**
 - **Approved, jeopardy required (>2027)**
 - **In development, toward proposal submission**
- Italian involvement:
 - SBS coordination committee
 - Data analysis
 - Equipment R&D, preparation, repurposing
 - GEM readout electronics for RG-H
 - MPD used in MOLLER
 - SiD for Hypernuclear experiments



Hypernuclear Collaboration experimental program

- 5 experiments with INFN co-spokespersonship
 - Hypernuclear spectroscopy
 - Hyperon puzzle of massive neutron stars
 - CSB in YN interaction
 - Probe triaxially deformed nuclei with Λ s
- Experiments approved in Hall A will run in Hall C
- Final Experiment Readiness Review on June 5-6, 2026
- Plan (pending positive ERR)
 - 2027: installation
 - 42 weeks of data taking, in 2 periods

Experiment	Title
E12-24-003 42 PAC days	Studying Λ interactions in nuclear matter with the $^{208}\text{Pb}(e, e' K^+)^{208}_{\Lambda}\text{Tl}$ reaction
E12-24-004 24 PAC days	Study of charge symmetry breaking in p-shell hypernuclei
E12-24-011 28 PAC days	Study of a triaxially deformed nucleus using a Λ particle as a probe
E12-24-013 55 PAC days	An isospin dependence study of the Λ -N interaction through the high precision spectroscopy of Λ -hypernuclei with electron beam
Run Group parasitic	High-resolution spectroscopy of light hypernuclei with the decay-pion spectroscopy (ENGE magnet)



2025 publications/2026 1st quarter

- **Hall A**
 - S. Li et al., *Inclusive studies of two- and three-nucleon short-range correlations in ^3H and ^3He* , *Phys. Lett. B* **868** (2025) 139734
 - D. Abrams et al. [Jefferson Lab Hall A Tritium Collaboration], *EMC Effect of Tritium and Helium-3 from the JLab MARATHON Experiment*, *Phys. Rev. Lett.* **135** (2025) 062502
 - Y.P. Zhang et al., *Measuring short-range correlations and quasi-elastic cross sections in $A(e, e')$ at $x > 1$ and modest Q^2* , *Phys. Lett. B* **872** (2026) 140087
- **Instrumentations + R&D (shared w/ ePIC)**
 - E. Sidoretti et al., *The hybrid μ -RWell for ePIC Endcap tracking*, *Nucl. Instr. Methods A* **1080** (2025) 170622
 - E. Sidoretti et al., *The G-RWell for ePIC Endcap Tracking*, *J. Instr.* **20** (2025) C06059
 - T. Horn et al., *Scintillating glass for precision calorimetry in nuclear physics*, *Eur. Phys. J.* **A61** (2025) 72
- **Hall B – dark matter & secondary beams**
 - P. Achenbach et al., *A Beamdump facility at Jefferson Lab*, *Eur. Phys. J.* **A61** (2025) 285
 - P.H. Adrian et al. [HPS], *First displaced vertex search for electroproduced dark-sector strongly interacting massive particles by the HPS experiment*, *Phys. Rev. D* **113** (2026) 032019
- **Hall B**
 - S.J. Paul et al. [CLAS], *Dihadron Azimuthal Correlations in Deep-Inelastic Scattering Off Nuclear Targets*, *Phys. Rev.* **C111** (2025) 035201
 - A. Deur et al. [CLAS], *Measurement of the nucleon spin structure functions for $0.01 < Q^2 < 1 \text{ GeV}^2$ using CLAS*, *Phys. Rev.* **C111** (2025) 035202
 - L. Clark et al. [CLAS], *Photoproduction of the Σ^+ hyperon using linearly polarized photons with CLAS*, *Phys. Rev.* **C111** (2025) 2, 025204
 - A.V. Sarantsev et al. [CLAS], *Photoproduction of two charged pions off protons in the resonance region*, *Phys. Rev.* **C111** (2025) 2, 035203
 - V. Klimenko et al. [CLAS], *Inclusive Electron Scattering in the Resonance Region off a Hydrogen Target with CLAS12*, *Phys. Rev.* **C112** (2025) 025201
 - P. Roy et al. [CLAS], *Measurement of single- and double-polarization observables in the photoproduction of $\pi^+\pi^-$ meson pairs off the proton using CLAS at Jefferson Laboratory*, *Phys. Rev.* **C112** (2025) 035201
 - T. Mineeva et al. [CLAS], *Suppression of neutral pion production in deep-inelastic scattering off nuclei with the CLAS detector*, *Phys. Rev.* **C112** (2025) 035203
 - D.S. Carman et al. [CLAS], *Recoil polarization in K^+Y electroproduction in the nucleon resonance region with CLAS12*, *Phys. Rev.* **C112** (2025) 035206
 - A. Kripko et al. [CLAS], *Multidimensional measurements of beam single-spin asymmetries in semi-inclusive deep-inelastic charged-kaon electroproduction off protons in the valence region*, *Phys. Rev.* **C112** (2025) 055202
 - S. Adhikari et al. [CLAS], *Measurement of beam-recoil observables C_x and C_z for $K^+\Lambda$ photoproduction*, *Phys. Rev.* **C112** (2025) 065211
 - S.J. Paul et al. [CLAS], *First study of the nuclear response to fast hadrons via angular correlations between pions and slow protons in electron-nucleus scattering*, *Phys. Lett.* **B874** (2026) 140250

+5 non-ISI publications, +7 submitted

Nucleon Axial Form factor measurement at $Q^2 = 1 \text{ (GeV/c)}^2$

A Proposal to Jefferson Lab PAC53

The Nucleon Axial-Vector Form Factor from the $p(\bar{\nu}_e, n)\nu_e$ Reaction

X. Bai, A. Camsonne, S. Covrig, P. Degtarenko, A. Deur, C. Ghosh, O. Hansen, W. Henry, D. Higinbotham, D. Jones, M. Jones, C. Keppel, D. Mack, D. Meekins, B. Raydo, R. Suleiman, A. Tadepalli, M. Ungaro, B. Wojtsekhowski (spokesperson-contact)
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William & Mary, Williamsburg, VA 23185

M. Li, W. Xiong (spokesperson), Yi Yu
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Astronomy and Applied Computer Science, Jagiellonian University, PL-30348 Kraków, Poland

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M. Mirzazita, S. Tomassini
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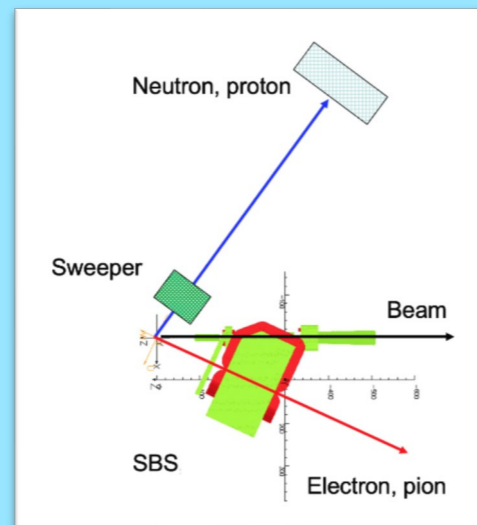
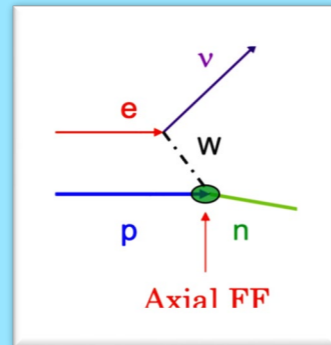
A. Bianconi (1)(2), L. Venturelli (1)(2), V. Mascagna (1)(2)
(1) INFN Sezione di Catania, 95123 Catania, Italy and
(2) Università di Pavia, 27100 Pavia, Italy

M. Bondi (1), G. Foti (1)(2), A. Puci (1)(2), A. Pilloni (1)(2), M. Filippini (1)(2)
(1) INFN Sezione di Catania, 95123 Catania, Italy and
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(1) INFN, Sezione di Ferrara, 44100 Ferrara, Italy and
(2) Università di Ferrara, 44121 Ferrara, Italy

G. Cates, R. Lindgren, N. Liyanage, H. Nguyen, V. Nelyubin, K. Paschke
University of Virginia, Charlottesville, VA 22904

A. Kakoyan, S. Mayilyan, A. Shahinyan
AANI, 2 Akhkanian Brothers Street, 0036, Yerevan, Armenia



- $H(e^-, \nu_e)n$ reaction with highly polarized electron beam
 - Weak asymmetry 100%, EM asymmetry 0%
- **Deferred:** improve neutron detector resolution!
- Alternative paths under study: Δ excitations (charged particles only)

- Challenge:
 - improve nTOF wall resolution from 100 ps to 50 ps
 - improve nCAL resolution down to 400 ps (BNL/E864)
- Strategy:
 - Study new scintillator & collimator geometries
 - Increase flight path TOF/nCAL [hi-res bunch ID]
 - reduce material budget for target, windows, ...
- First tests performed by S. Betto (INFN/RM1), CSN3 fellowship
 - Timing test of 200 cm long scintillator slab
 - Further test planned with new scintillators delivered at Rome-ISS

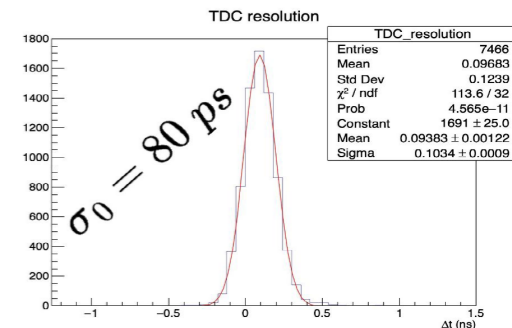

 Scintillator: EJ-200 200x6x6 cm³

PMT: Hamamatsu R13089

$$\Delta t = \frac{1}{2}(\bar{t}_1 + \bar{t}_3) - \bar{t}_2$$

$$\bar{t}_k = \frac{1}{2}(TDC_{CL} + TDC_{CR})_k$$

publication-quality results



$$\sigma_{\Delta t}^2 = \frac{1}{4}\sigma_1^2 + \frac{1}{4}\sigma_3^2 + \sigma_2^2$$

$$\sigma_2 = \sqrt{\frac{2}{3}}\sigma_{\Delta t}$$

Future projects in the pipeline (≥ 2030): μ CLAS12 in Hall B

Electro/photoproduction of $\mu^+\mu^-$ pairs with μ CLAS12

Electro- and photo-production of muon pairs with μ CLAS12: Double Deeply Virtual Compton Scattering, Timelike Compton Scattering, and J/ψ production

A Proposal to PAC 53

N. Baltzell, V. Burkert, T. Cao, R. De Vita, L. Elouadrhiri, K. Gnanvo, F. Hauenstein, V. Kubarovskiy, R. Parenduzyan, B. Raydo, Y.G. Sharabian, S. Stepanyan, R. Tyson, M. Ungaro, and X. Wai

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M. Hobbalah, S. Nicolai, E. Voutier, and J. S. Alvarado
Université Paris-Saclay, CNRS/IN2P3, IJCLab, 91195 Orsay, France

P. Chatagnon, M. Defurne, and F. Bossù

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D. Glazier and B. McKinnon

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University of Virginia, Charlottesville, VA 22904

S. Bueltmann, C. Fogler, and M. Hattawy

Old Dominion University, Norfolk, Virginia 23529

S. Schadmand

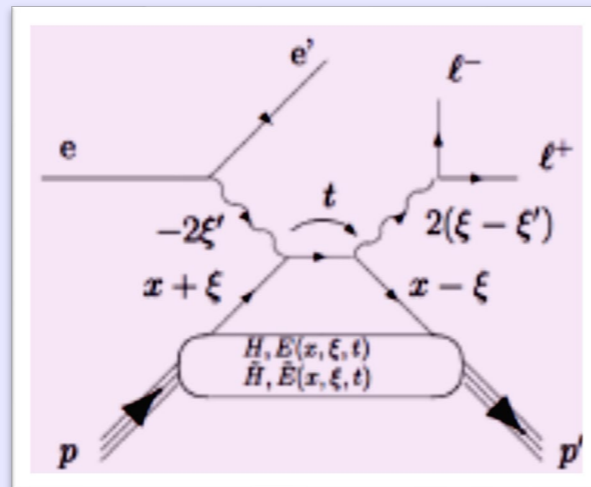
GSI Helmholtzzentrum für Schwerionenforschung GmbH, D-64291 Darmstadt, Germany

L. El Fassi

Mississippi State University, Mississippi State, MS 39762-5167

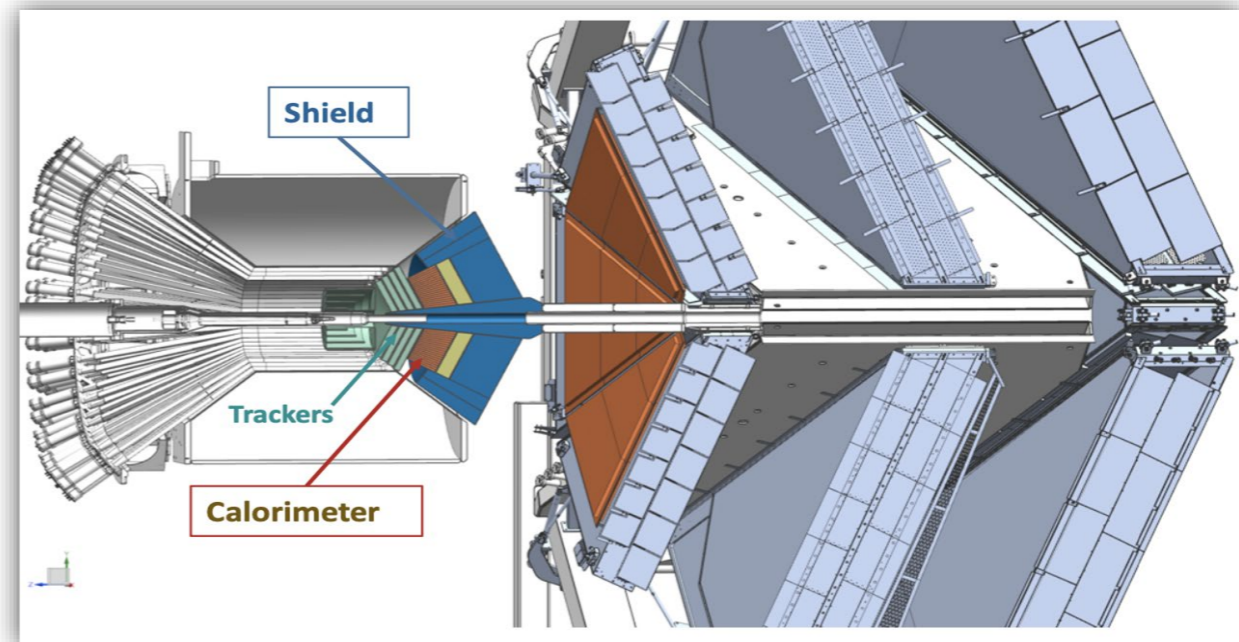
A. Vossen and Z. Zhao

1



- Exploring GPD's through DDVCS at high luminosities ($10^{37} \text{ cm}^2\text{s}^{-1}$): $ep \rightarrow e'p'\mu^+\mu^-$
- Approved: "A" rating
- Two Italian spokespersons

- GPD's and nucleon femtography to an upper level with μ CLAS12
 - Two facilities only worldwide (CLAS12 and SoLID in Hall A) to carry out such measurements
- Why Double Deeply Virtual Compton Scattering?
 - Allows a better imaging through $x \neq \xi$ exploration
 - The cross section is 3x order of magnitude smaller than DVCS
 - Use of di-muon electroproduction with an upgraded CLAS12 at high luminosity



**Synergies with other
CSN3 projects**

Finance & budget plan



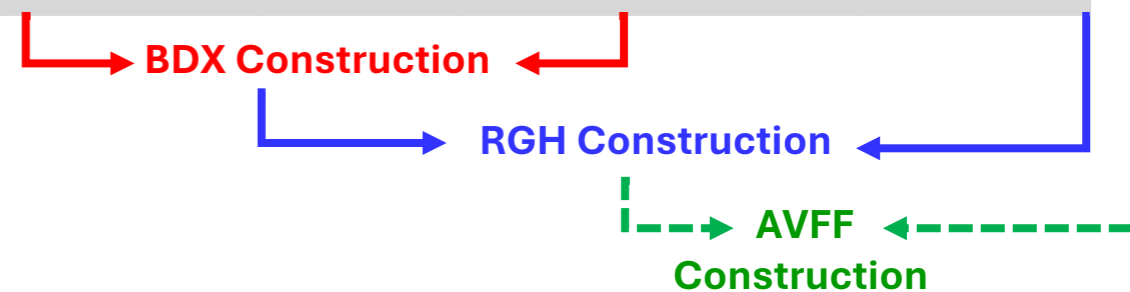
Synergies with other CSN3 projects

- Involvement and collaboration ongoing with some CSN3 projects for common developments of innovative detectors/techniques and spin-offs
- ePIC
 - End-cap trackers with Hybrid G-Rwell
 - well-established collaboration with LHCb LNF group
 - part of DRD1 WG1 CERN program (European Strategy for Particle Physics)
 - dRICH (**spin-off** based on CLAS12 RICH expertise):
 - Front-End Electronics for Cherenkov detectors, SiPM characterization and R&D
 - New mirrors/aerogel R&D
 - ALCOR Streaming Readout with ~50 ps time resolution
 - Innovative photodetectors with extreme time resolution
 - bECAL: contacts with German groups for PANDA crystals repurposing (after BDX)
 - Streaming readout and streaming computing with AI-assisted techniques
- SYSTERSE (NUSDAF)
 - Streaming Readout DAQ for experiments at FRIB: based on pioneering BDX R&D
- NUMEN
 - Analysis of CLAS12 data for e.m. background estimates and preparation of a future proposal for a LFV experiment at CEBAF



Funding plan (metal) 2020-2027

	2020 Assigned	2021 ass.	2022 ass.	2023 ass.	2024 ass.	2025 ass.	2026 ass.	2027 Proj.	2028 Proj.	2029 Proj.
SBS + AVFF	30	44	25	36	5	5.5	1	5	20	50
FT	10	10	6	40	1	5	0	10	10	10
RICH	300	290	35	18	1	1	5.5	5	5	5
PolTarg/ RGH	35	40	70	70	21	13	17	100	100	80
Hi-Lumi	-	-	-	-	43	25.5	74	20	-	-
HPS+BDX	60 [40 ret]	12	26	5 [ret]	16.5	95+ 65ex	65 + 100ex?	100?	-	-
Hyper- nuclei	-	10	-	-	-	-	-	20	5	5
Total	435	424	180	300	71.5	210	162.5 +?	160- 260	150	150



- After falling to ~72 kEur in 2024 following the completion of the RICH installation, funding had only partially rebounded with the resumption of construction

Conclusions and Outlook

- Jefferson Lab: advancing non-perturbative QCD frontier
 - **A unique national facility for nuclear physics in the U.S.**, with strong capability for cross-disciplinary expansion
 - Demonstrated **operational resilience and adaptability** in dynamic research environment
 - Ready to adapt to diversification of disciplines

- Sustained and Synergistic Scientific program
 - **The 12 GeV program continues at full strength, with no anticipated reduction in activity**
 - Complementary programs will maintain a high-level scientific output over the next decade
 - Strong synergy (but no anticipated drain) with the EIC program

- Strategic Vision for the future
 - A robust long-term plan, including targeted facility upgrades
 - Proposed energy upgrade to 22 GeV to access new regimes of hadronic physics
 - Development of new experimental programs with high-intensity positron beams



Backup slides



The scientific involvement of Italian groups at Jefferson Lab

Nucleon 3D structure @HALL A (RM1, BA)

E07-109 Proton Form Factor
 E17-004 Neutron Form Factor
 E17-008 WACS for GPDs (Hall C)
 E09-018 SIDIS off neutron (^3He)
 PR25-009 Nucleon Axial Vector FF

E06-112 Quark Dynamics
 E09-008 TMDs
 E11-111 SIDIS on transv. pol. targ.
 E12-009 Dihadron probes for transversity
 PR25-001 DDVCS & TCS with μCLAS12

Nucleon 3D structure @HALL B (CT, FE, LNF, GE)

Nuclear structure & Hypernuclei (RM1, BA)

E24-003 ΛNN off ^3H
 E11-101 PREX-II: neutron skin
 E15-008 Λ hypernuclei on ^{40}Ca
 E24-013 Λ hypernuclei on ^{208}Pb
 E24-004 + E20-013A/E15-008A Λ hyper. on Li, Be, B for CSB studies
 E24-011 triaxially deformed nuclei

Spectroscopy (CT, GE, RM2, PV, TO)

E11-005 MesonEx
 E12-001A J/ψ and pentaquarks
 E16-010 Hybrid Baryons



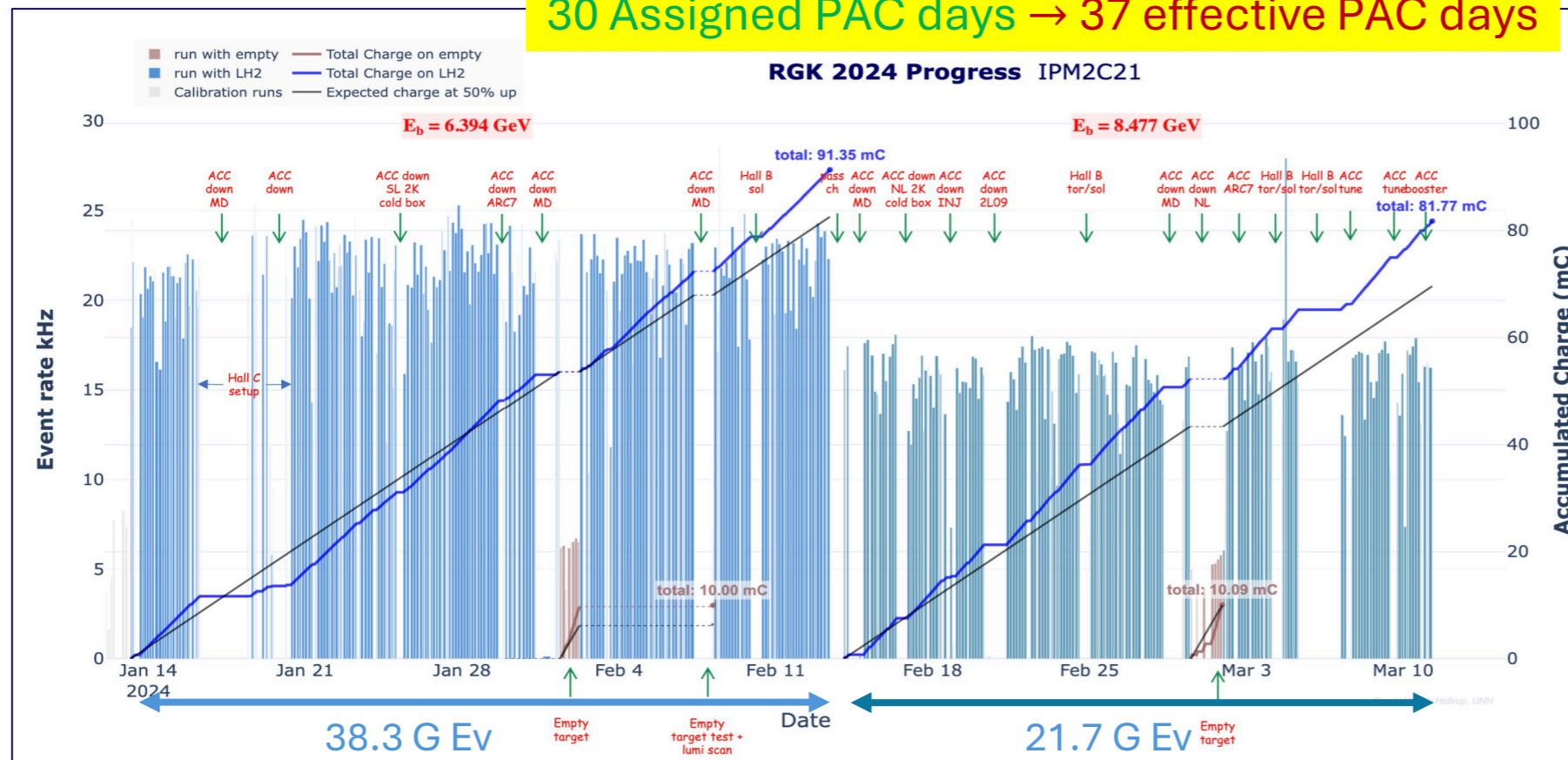
Light Dark Matter searches (GE, CT, PV, LNS, RM2, TO)

E11-006 HPS
 E16-001 BDX

RG-K progress: Spring24 data processing



30 Assigned PAC days → 37 effective PAC days

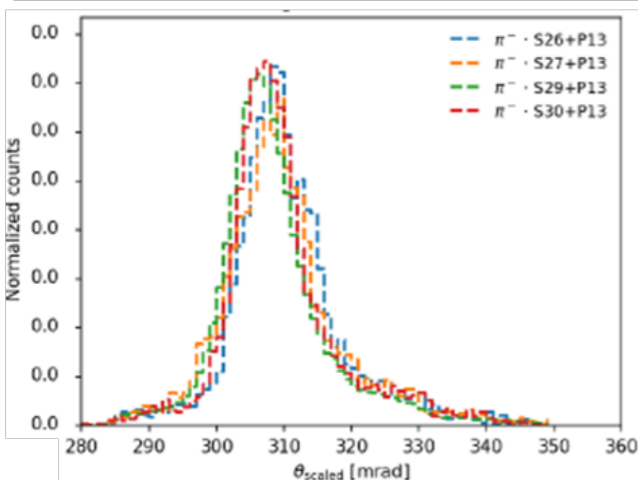
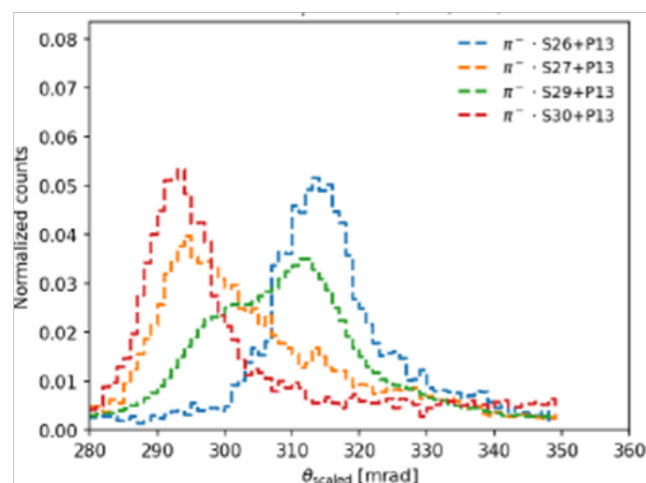


433 Production Runs
60 G events
Accumulated charge:
 Full tgt = 172.77 mC
 Empty tgt = 20 mC
 Total = 192.77 mC

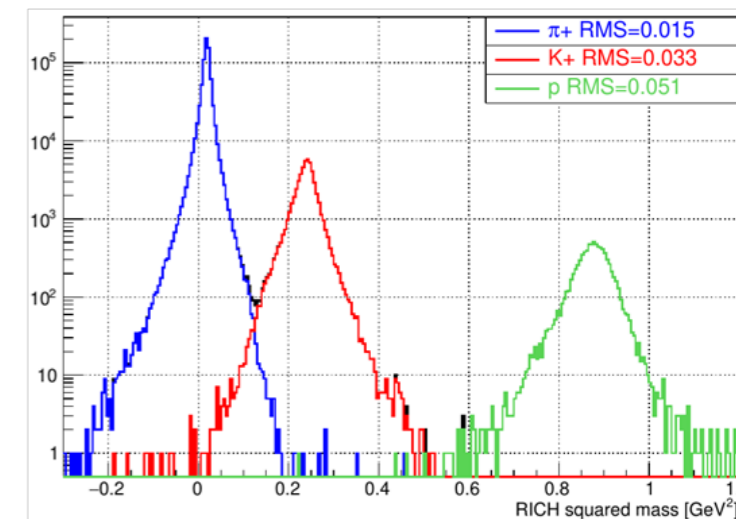
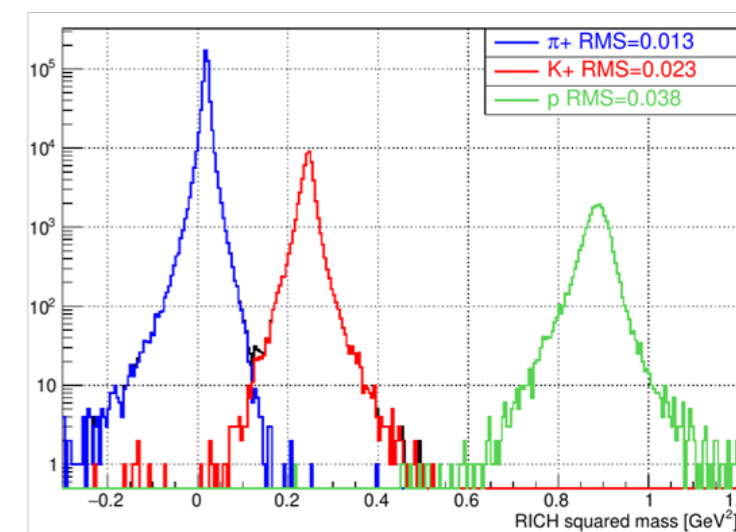
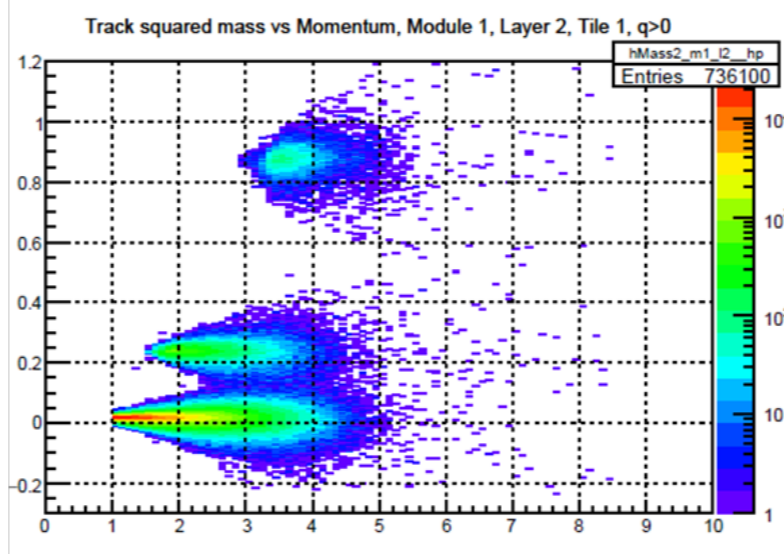
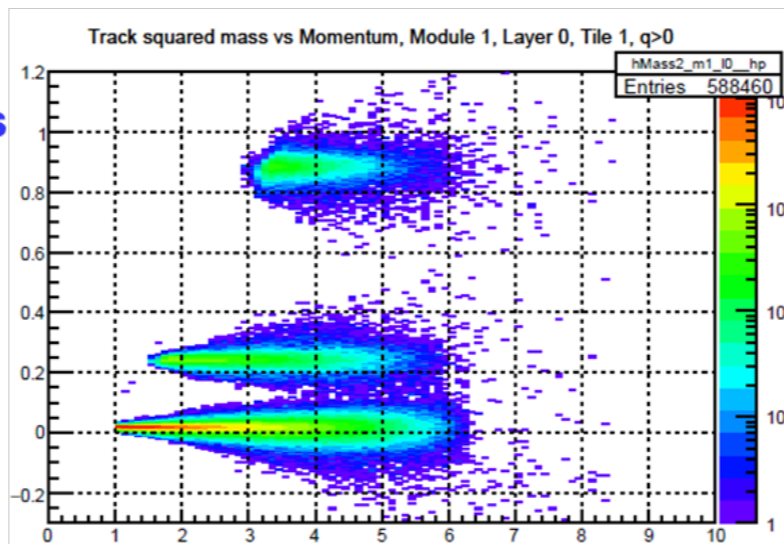
- Data collected with CLAS12 for hybrid baryons and nucleon structure studies (DVCS, SIDIS, exclusive channels...)
- Over **63 billion events** recorded across two beam energies (6.4 and 8.5 GeV), delivering broad kinematic coverage
- The run combined **commissioning, alignment, and full production** over ~60 days (Jan-Mar. 2025), overperforming with **37 effective PAC days**
- The dataset amounts to **~1.5 PB of raw data**, with multiple dedicated skims already enabling diverse physics analyses
 - Need to store locally the produced data on a dedicated server
- **Calibrations successfully completed**
- **Data processing is underway** (~15% completed as of Apr. 2026), marking the transition from data taking to physics results

- 2025 major milestone: alignment completion of both the RICH modules over the full kinematic plane
 - Bayesian optimization approach to efficiently navigate through the > 50 parameter space
 - Work in collaboration with Duke University

Reconstructed Cherenkov angle for π^- hitting one aerogel tile and various mirrors



Reconstructed squared mass



CLAS6: two-pion real photoproduction with polarized target



Study of polarization asymmetries in the $\vec{\gamma}N \rightarrow \pi^+\pi^-N$ reaction with circularly polarized photons and a polarized target (HDice) at CLAS.

Part I: $\vec{\gamma}p \rightarrow \pi^+\pi^-p$ exclusive reaction.

Alessandra Filippi
Annalisa D'Angelo
Lucilla Lanza

Abstract

This analysis note presents the procedures and methods employed in the determination of the polarization asymmetries in the $\vec{\gamma}p \rightarrow \pi^+\pi^-p$ reaction, with an exclusive final state. The analysis is based on the data from the g14 HD-ICE run period, in which circularly polarized photons were interacting on a HD frozen spin polarized target at CLAS.

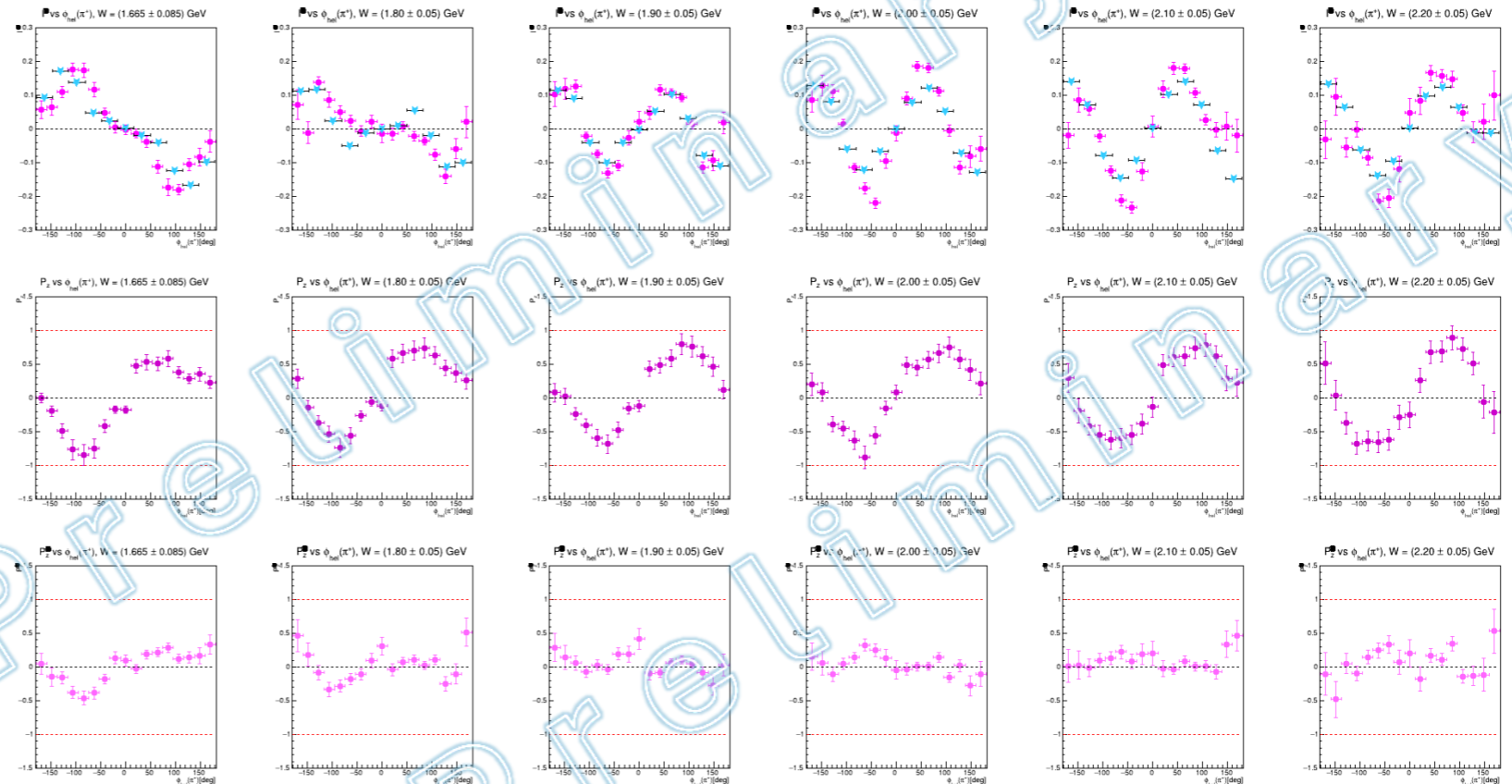
Contents

- 1 Introduction 5
- 1.1 Analysis motivation 5
- 1.2 The $\vec{\gamma}N \rightarrow \pi^+\pi^-N$ reaction 7
- 1.3 Data samples and experimental conditions 9
- 1.3.1 Run Periods 9
- 1.3.2 Polarized photon beam and beam charge asymmetry 12
- 1.3.3 HD-ice target features 14

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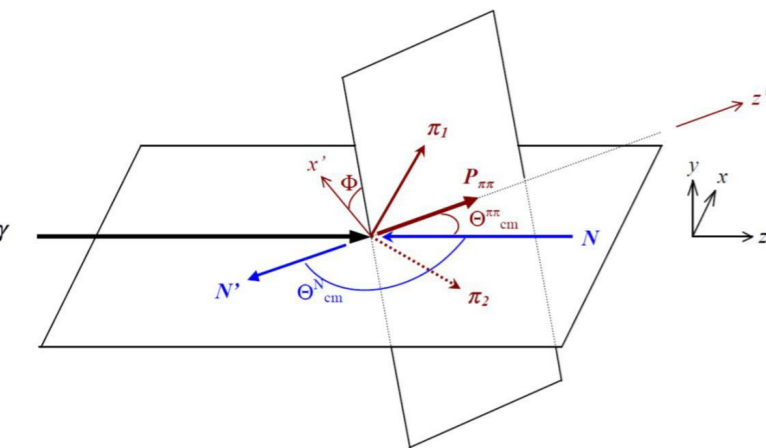
Analysis note ready

$$\frac{d\sigma}{dx_i} = \sigma_0 \{ (1 + \Lambda_z \cdot \mathbf{P}_z) + \delta_{\odot} (\mathbf{I}^{\odot} + \Lambda_z \cdot \mathbf{P}_z^{\odot}) \}$$



Preprint

- **Data:** circularly polarized photon beam up to 5 GeV + longitudinally polarized frozen-HD target (g14 data taking, 2011-2012)
- **Purpose:** extraction of single- and double-polarization asymmetries as a function of the azimuthal angle in $\vec{\gamma}p \rightarrow \pi^+\pi^-p$
 - The polarization asymmetries are related to intermediate amplitudes through bilinear relationships
 - First extraction ever of target and beam-target asymmetries
 - Parity symmetry: trends as expected



Publications Highlight: first results on SIMPs search with HPS

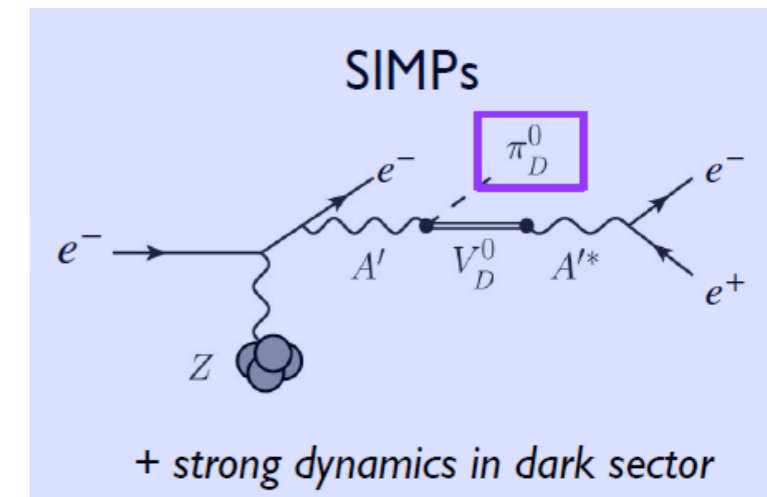


	Signal			
	Minimal A'	Minimal A'	SIMPs	iDM
Signature	$\epsilon^2 \gtrsim 10^{-7}$	$\epsilon^2 \lesssim 10^{-8}$	SIMPs	iDM
$x = \frac{ p_{e^+} + p_{e^-} }{E_{\text{beam}}}$	high	high	low	low
resonance	yes	yes	yes	no
prompt/displaced	prompt	displaced	displaced	displaced

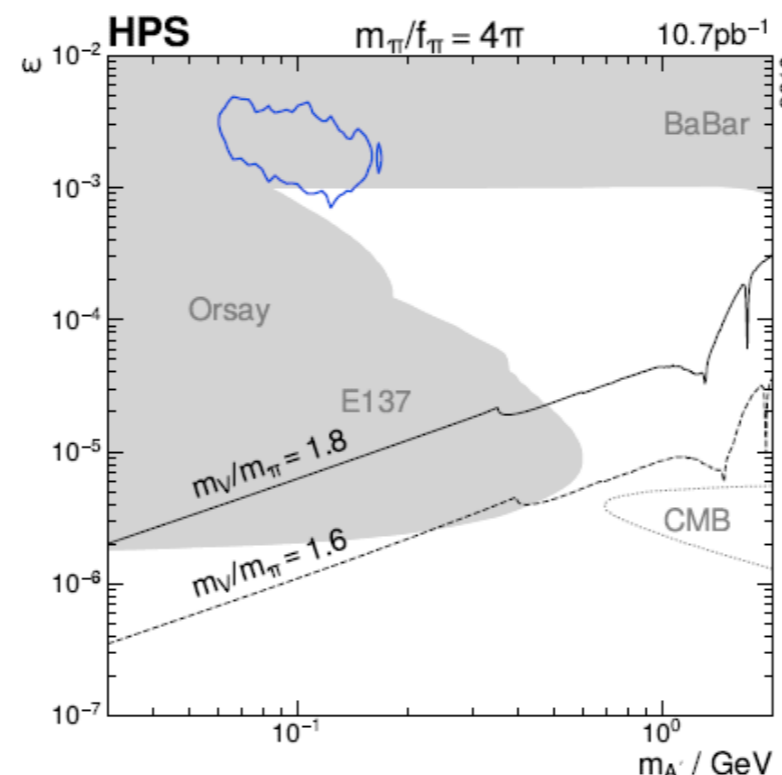
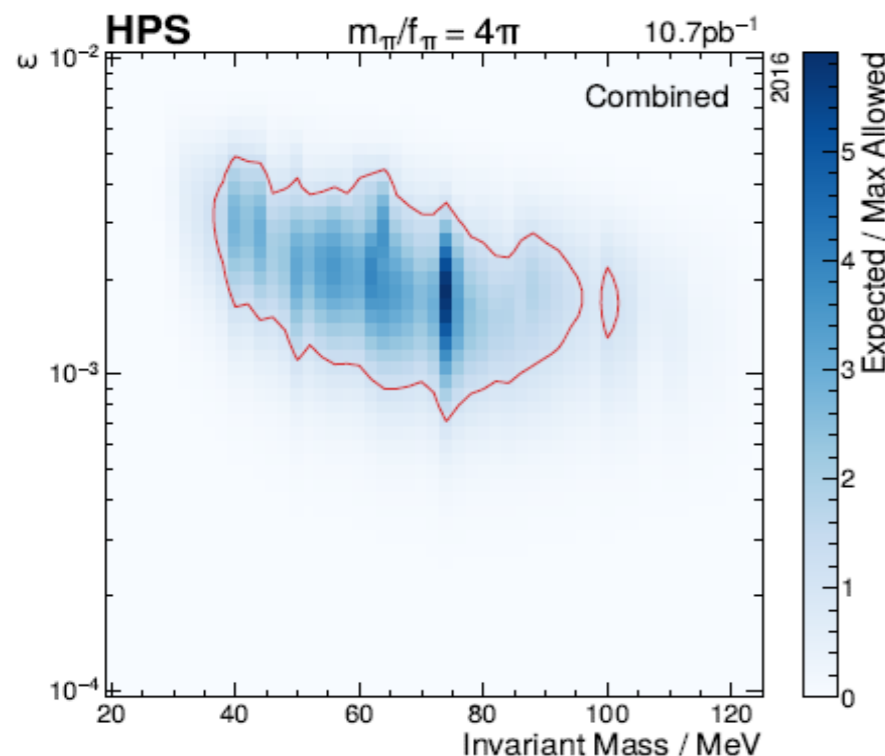
HPS may also be sensitive to richer dark sectors coupled to dark photons by suitably selecting the fractional energy of the event: **low x**

• SIMPs: Strongly Interacting Massive Particles

- Resonant, displaced e^+e^- decay vertex, missing energy



- No signature observed
- Tiny unexplored region of parameter space is reached
- First results on 2016 dataset published in February 2026
PR D113, 032019 (2026)



External fundings

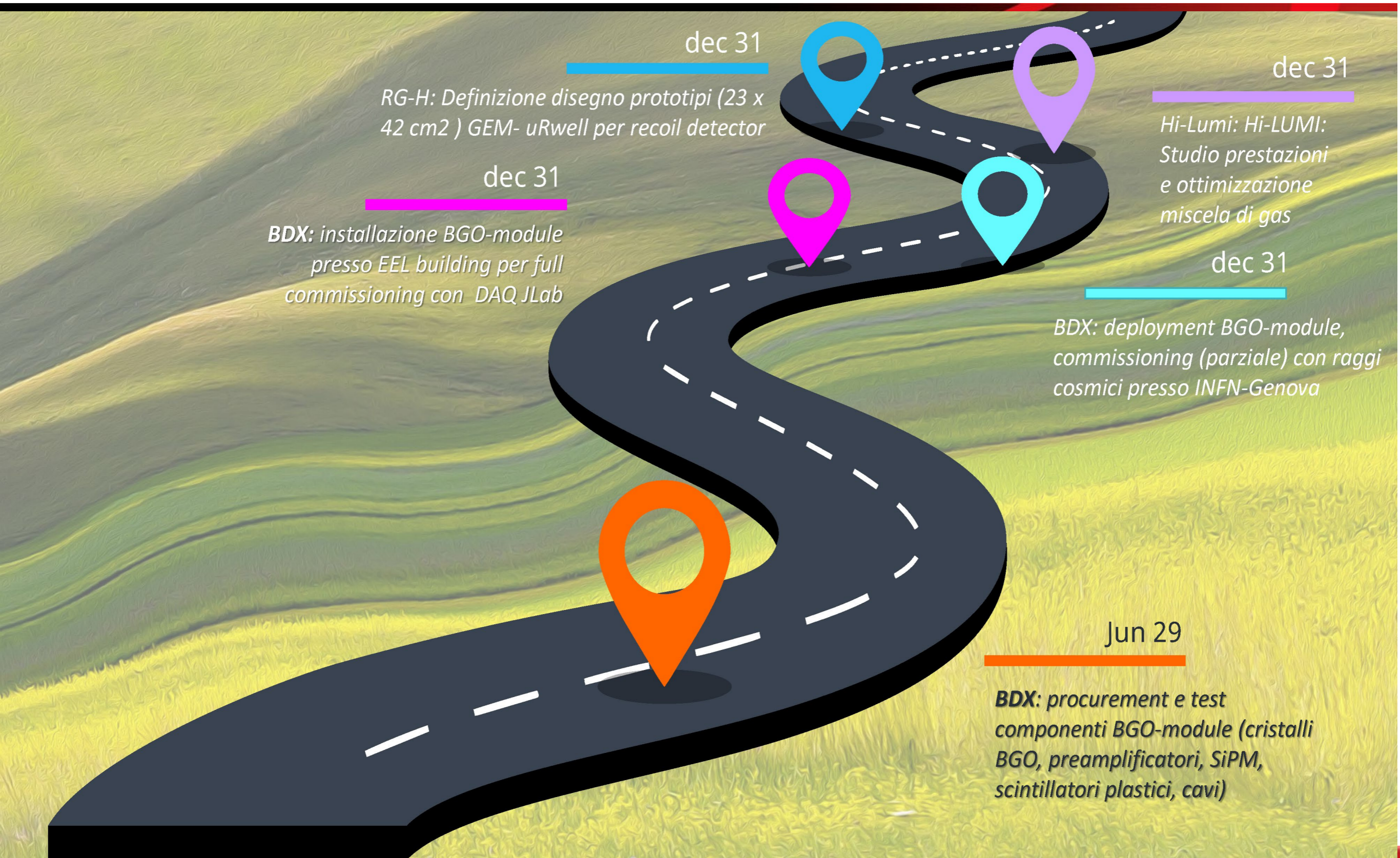
- **2021-2026 PROBES:** EU RISE program supporting secondments for research and innovation in cooperation with neutrino and gravitational interferometers experiments
 - **Started March 1, 2021 (+deferred one year), ended feb. 28, 2026**
 - PROBES covered part of the travel expenses for operations and analyses related stays at JLAB: 100 €/day
 - The money saved at end of October can be stored to form a budget for contracts

End of year accounting	2022 (k€)	2023 (k€)	2024 (k€)	2025 (k€)	Total (k€)
Spent on PROBES	38	38	40	52	168
Savings	14	20	5	9	48

Still available for contracts as of Apr. 2026: ~20 k€

- **2026-2029 BEYOND:** EU RISE program supporting secondments for research and innovation in cooperation with neutrino experiments (@ Fermilab, PSI, J-PARC)
 - **Started in Jan 1, 2026, ends Dec 31, 2029**
 - Same secondments conditions (100 €/day)
 - Less than half available budget compared to PROBES

2026 milestones



dec 31

RG-H: Definizione disegno prototipi (23 x 42 cm²) GEM- uRwell per recoil detector

dec 31

BDX: installazione BGO-module presso EEL building per full commissioning con DAQ JLab

dec 31

Hi-Lumi: Hi-LUMI: Studio prestazioni e ottimizzazione miscela di gas

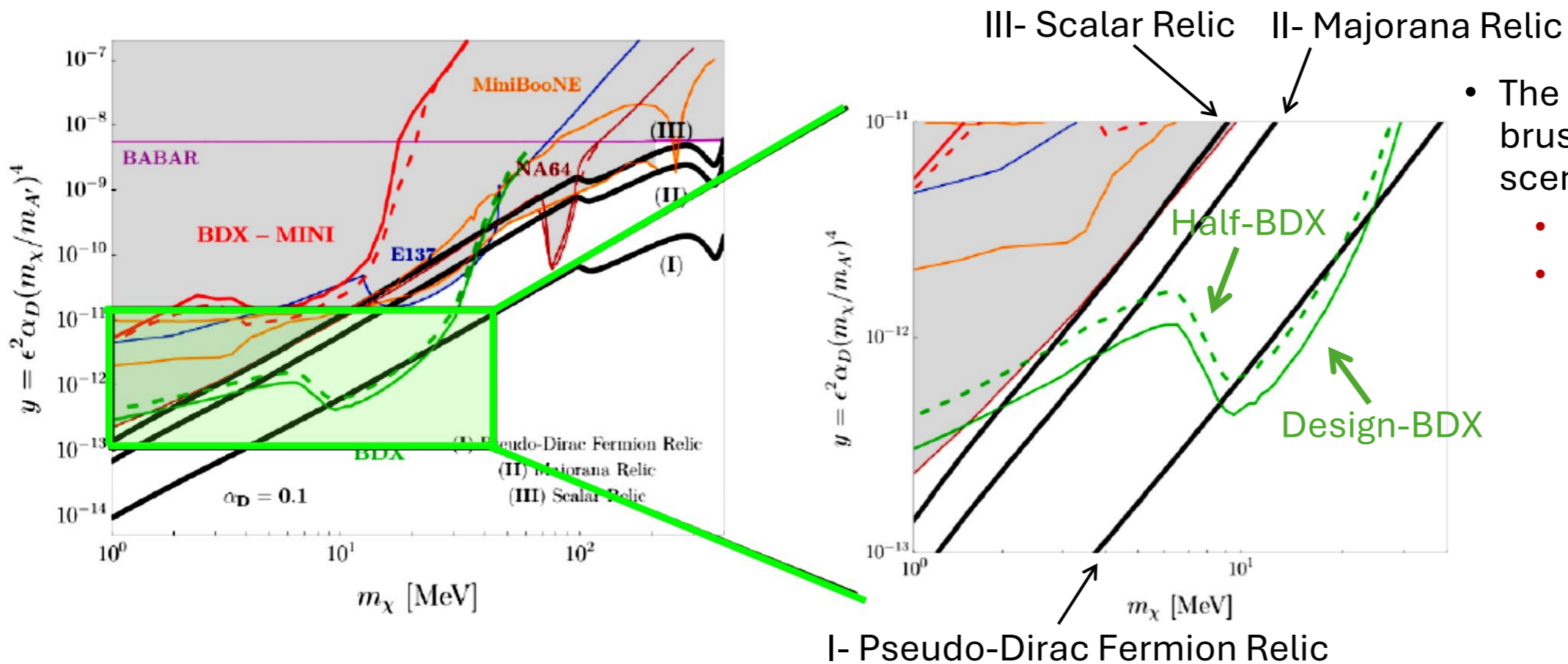
dec 31

BDX: deployment BGO-module, commissioning (parziale) con raggi cosmici presso INFN-Genova

Jun 29

BDX: procurement e test componenti BGO-module (cristalli BGO, preamplificatori, SiPM, scintillatori plastici, cavi)

BDX: Half vs full-detector sensitivity



- The sensitivity still slightly brushes the Pseudo-Dirac scenario hypothesis
 - Reach at the very limit
 - High possibility of (downward) fluctuations of the sensitivity curves related
 - detection thresholds and efficiencies
 - effective background yields

- Modified set-up: half the sensible volume (1.4 tons)
- The signal yield scales as the sensitive volume
- The exclusion limit scales as $y \propto \varepsilon^2 \propto \sqrt{N_{sig}}$
- If the volume mass is halved, the exclusion limit is reduced by a factor $\sim \sqrt{2}$
- Note the bi-logarithmic scale
- Larger effect for $m_\chi < \sim 50$ MeV

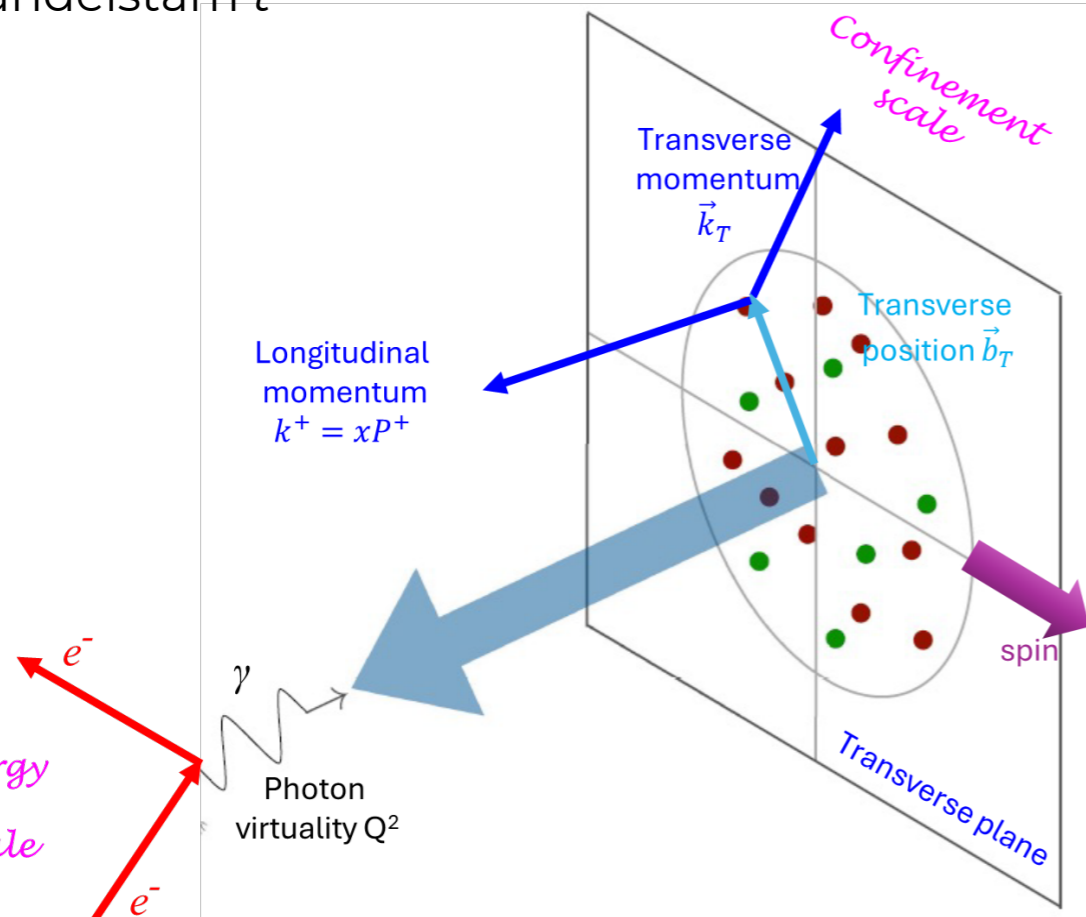
- Halving the sensitive target halves the event count: the loss can't be compensated by longer runs due to constraints from concurrent MOLLER operations
- BDX experiment was approved by PAC51 with the target volume of ~ 3 tons and the reported design-reach

RG-H: getting information on nucleon structure through polarization

For a multidimensional mapping of the nucleon all the GPD distributions must be measured

4x chiral-even + 4 chiral-odd, depending on:

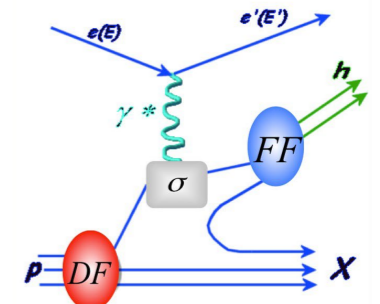
- x (average momentum of the hit quark)
- ξ transferred momentum fraction
- Mandelstam t



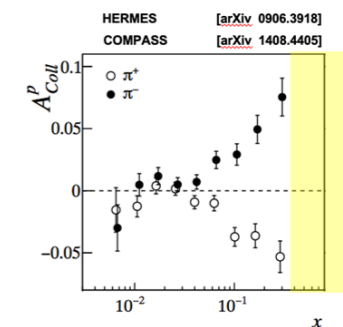
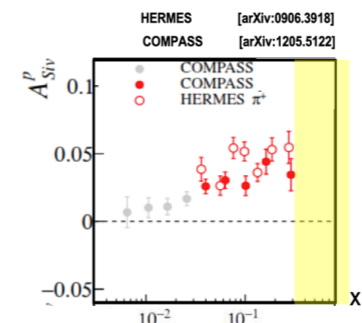
GPD's are universal and the same functions may parameterize different processes

Semi-Inclusive DIS: $ep \rightarrow e'hX$

- Hadron kinematics and type determine parton kinematics and flavor
- Information on longitudinal and transverse (space & mom) distributions of partons



Spin-orbit related effects



- **Sivers effect**: correlation between nucleon spin and collective motion of the partons
- **Transversity and tensor charge** \Rightarrow related to BSM searches

Hard exclusive processes

- Transverse size and nucleon tomography
- Impact parameter derived from the transferred momentum to the nucleon
- Extraction of GPD's from several final states

