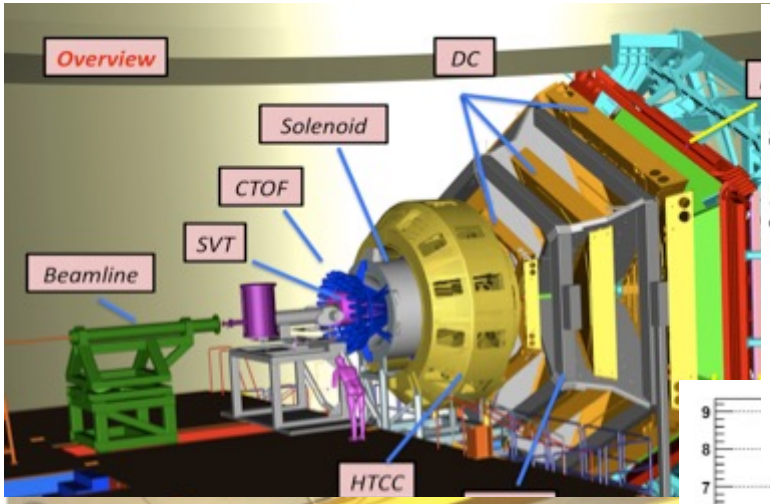
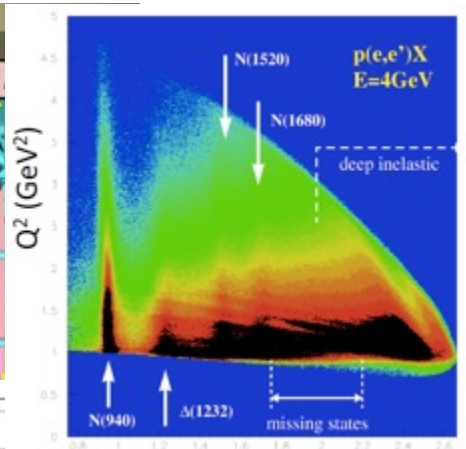
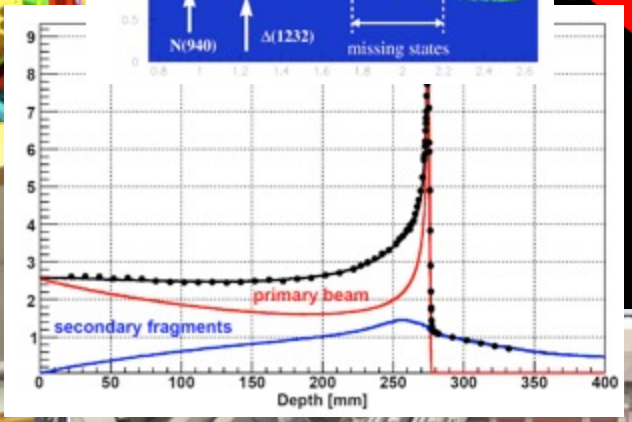
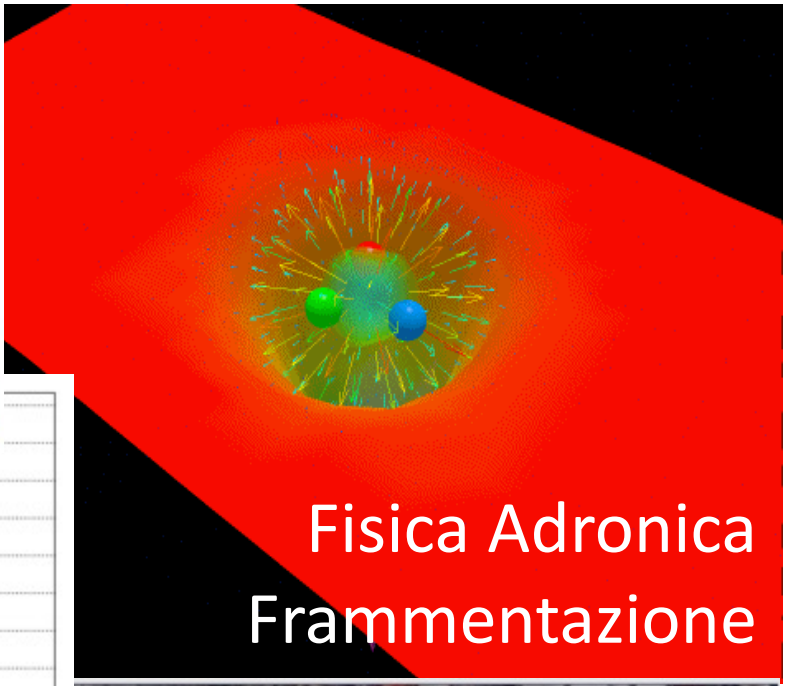
Gruppo III Roma Tor Vergata



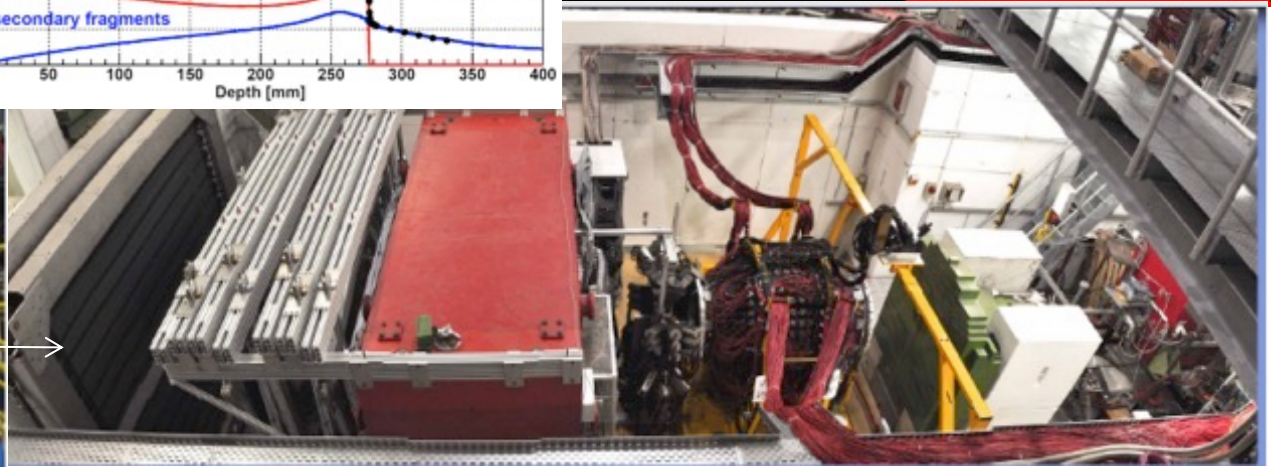






Fisica Adronica
Frammentazione

FOOT
JLAB12
MAMBO
EIC-NET



MAMBO

MAMBO (MAMi-BOnn)

Cognome	Nome	Note	Struttura	Modulo	Contratto	Profilo	Stato	Aff.	%
Di Salvo	Rachele Anna		ROMA2	G1	Dipendente	Primo Ricercatore	Attivo	CSN3	90%
Fantini	Alessia		ROMA2	G1	Associato	Incarico di Ricerca scientifica	Attivo	CSN3	80%
Nobili	Giovanni		ROMA2	G3	Dipendente	Collaboratore Tecnico E.R.	Attivo	CSN3	40%
Pecchi	Daniele		ROMA2	G3	Associato	Associazione Tecnica	Attivo	CSN3	40%
Romaniuk	Mariia		ROMA2	G1	Associato	Scientifica Enti stranieri	Attivo	CSN3	100%
Vitali	Gianni		ROMA2	G3	Associato	Associazione Tecnica	Attivo	CSN3	60%

2.7 FTE

MAMBO (MAMi-BOnn)

La sigla MAMBO si articola su due attività:

BGOOD a ELSA (Bonn) □ Coinvolgimento della sezione TOV

- Fascio di fotoni di energia 0.3-3.2 GeV
- Polarizzazione lineare e circolare del fascio
- **Spokespersons: P. Levi Sandri (INFN-LNF)** e H. Schmieden → New: Tom Jude

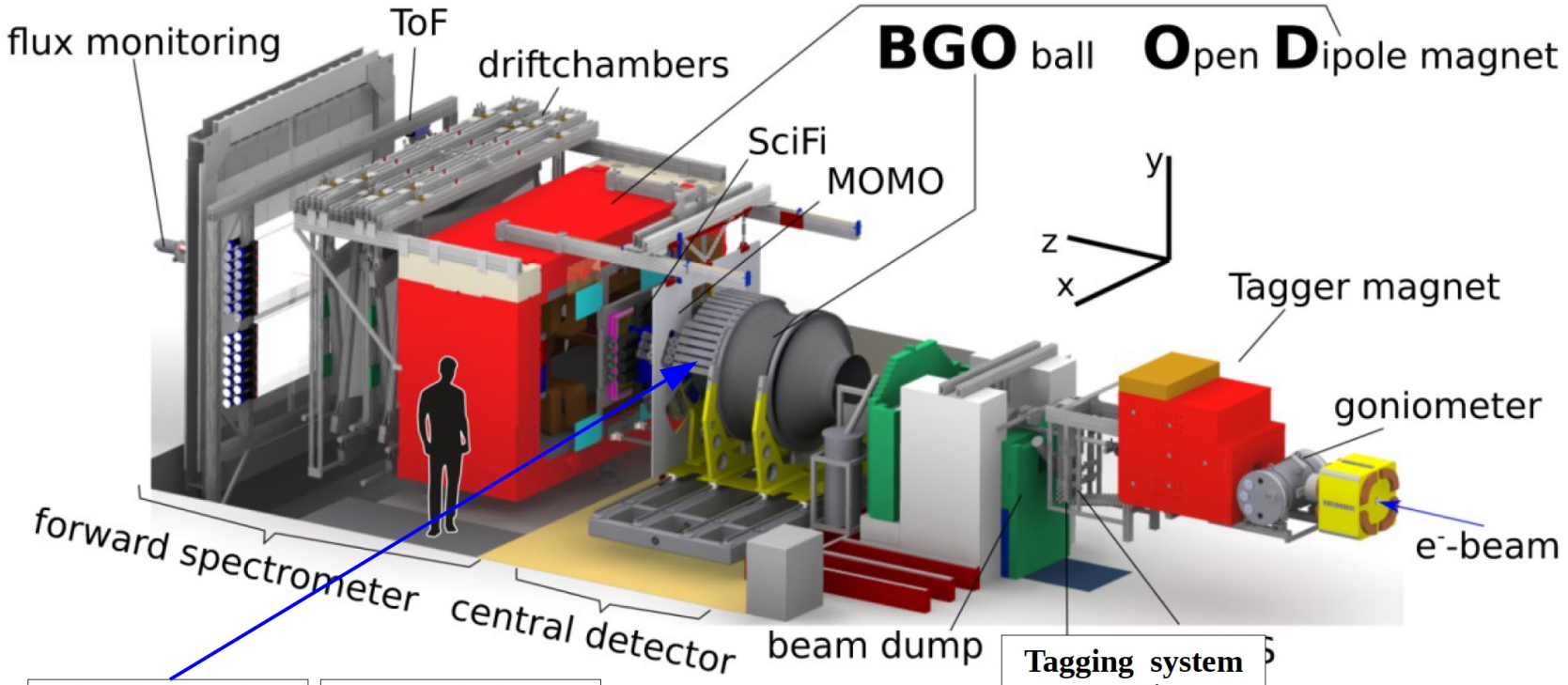
A2@MAMI (Mainz)

- Fascio di fotoni polarizzati di energia fino a 1.6 GeV
- Polarizzazione lineare e circolare del fascio
- Bersaglio polarizzato
- **Spokespersons: P. Pedroni (INFN-PV)** e A. Thomas

Obiettivi di fisica:

- Studio delle proprietà delle risonanze nucleoniche attraverso la fotoproduzione di mesoni con e senza stranezza, pseudoscalari e vettoriali con fasci e/o bersagli polarizzati

BGOOD Detector



Attività BGOOD

-**Periodo giugno 2022-giugno 2023**:

- **Sett. 2022:**
  3 settimane presa dati con bersaglio di Idrogeno (11cm)+ intervento manutenzione BGO

- **Nov. 2022:**
  Intervento di manutenzione sulla BGO (fototubi, HV)

- **Nov-Dic. 2022:**
  2 settimane presa dati con bersaglio di Deuterio (11cm)

- **Marzo 2023**:
  2 settimane presa dati con bersaglio di idrogeno (11cm

Pubblicazioni & Conferenze

Pubblicazioni

1) **"Evidence of a dibaryon spectrum in coherent $\pi^0\pi^0$ d photoproduction at forward deuteron angles"**
Pubblicato su PLB a settembre 2022

2) **Photoproduction of $K^+\Lambda(1405)\rightarrow K^+\pi^0\Sigma^0$ extending to forward angles and low momentum transfer**
Pubblicato su PLB ad ottobre 2022

3) **Un articoli su arXive :**
Measurement of the γ n$\rightarrow$K$^0\Sigma^0$ differential cross section over the K* threshold
Sottomesso a EPJA

Conferenze

1) **The BGOOD experiment at ELSA Exotic structures in the strange quark sector?**
T. Jude for BGOOD collaboration ,EPJ Web Conf. **Volume** 271, 2022

2) **Recent Results From BGOOD**
R. Disalvo for BGOOD collaboration, NSTAR 2022

……..

7

Physics Letters B
Volume 832, 10 September 2022, 137277

Evidence of a dibaryon spectrum in coherent $\pi^0\pi^0 d$ photoproduction at forward deuteron angles

T.C. Jude [a], S. Alef [a,2], R. Beck [b], A. Braghieri [d], P.L. Cole [e], D. Elsner [a], R. Di Salvo [f], A. Fantini [f,g], O. Freyermuth [a], F. Frommberger [a], F. Ghio [h,i], A. Gridnev [c], K. Kohl [a], N. Kozlenko [c], A. Lapik [j], P. Levi Sandri [k], V. Lisin [j], G. Mandaglio [l,m], D. Moricciani [f,k,1], V. Nedorezov [j,1]... V. Tarakanov [c]

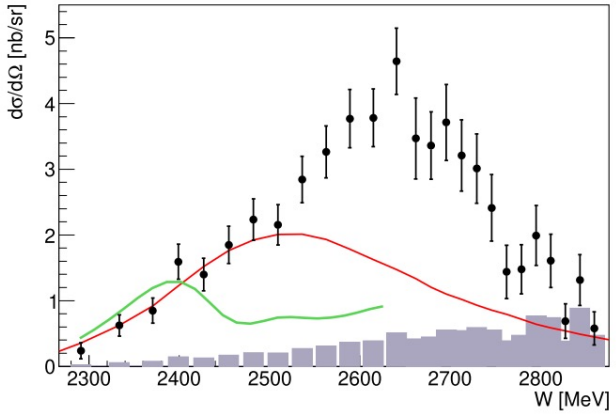


Fig. 5. $\gamma d \to \pi^0\pi^0 d$ differential cross section for $\cos\theta^d_{CM} > 0.8$. Systematic errors are the grey bars on the abscissa. Superimposed is the model prediction from Fix, Arenhövel and Egorov [30,31] scaled by a factor of five (green line), and the toy pickup model set at an arbitrary scale (red line, see text for details).

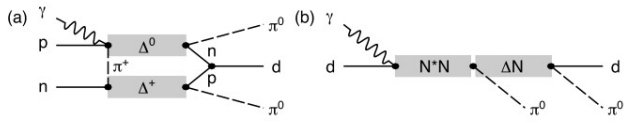


Fig. 6. Possible mechanisms contributing to the $\gamma d \to \pi^0\pi^0 d$ reaction. (a) The *Toy pickup model* described in the text. (b) A sequential dibaryon decay mechanism.

Physics Letters B 833 (2022) 137375
Contents lists available at ScienceDirect
Physics Letters B
www.elsevier.com/locate/physletb

Photoproduction of $K^+\Lambda(1405) \to K^+\pi^0\Sigma^0$ extending to forward angles and low momentum transfer

G. Scheluchin [a], T.C. Jude [a,*], S. Alef [a], P. Bauer [a], D. Bayadilov [b,c], R. Beck [b], A. Braghieri [d], P.L. Cole [e], D. Elsner [a], R. Di Salvo [f], A. Fantini [f,g], O. Freyermuth [a], F. Frommberger [a], F. Ghio [h,i], A. Gridnev [c], D. Hammann [a,1], J. Hannappel [a,2], K. Kohl [a], N. Kozlenko [c], A. Lapik [j], P. Levi Sandri [k], V. Lisin [j], G. Mandaglio [l,m], R. Messi [f,g], D. Moricciani [k,3], A. Mushkarenkov [j], V. Nedorezov [j,3], D. Novinskiy [c], P. Pedroni [d], A. Polonskiy [j], B.-E. Reitz [a,1], M. Romaniuk [f,n], H. Schmieden [a], V. Sumachev [c,3], V. Tarakanov [c]

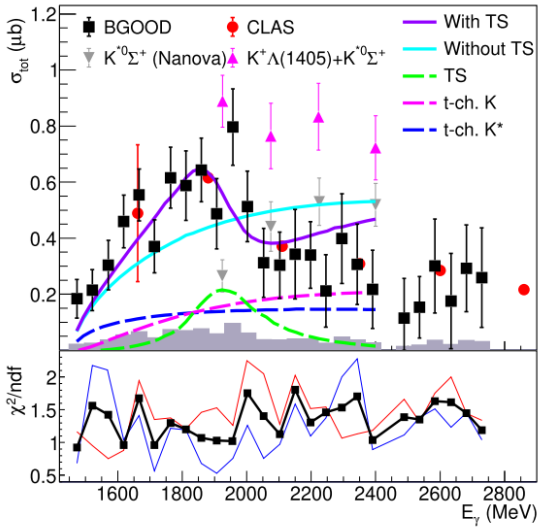


Fig. 6. Integrated $\gamma p \to K^+\Lambda(1405)$ cross section, with the same labelling as in Fig. 5. The additional cyan line is the model of Wang et al. without the triangle singularity, the $K^{*0}\Sigma^+$ data from CBELSA/TAPS [32] are the grey triangles and the sum of the $K^{*0}\Sigma^+$ and the BGOOD $K^+\Lambda(1405)$ data are the magenta triangles. The reduced χ^2 of the two dimensional fits to extract the yield are shown below. The red and blue lines correspond to the reduced χ^2 for the one dimensional $\gamma\Lambda$ and $\pi^0\Sigma^0$ projections respectively, and the black squares with the thick black line are the combined reduced χ^2 for both dimensions.

Analisi dati

Estrazione delle asimmetrie di fascio nella fotoproduzione dei mesoni pseudoscalari su protone e su neutrone quasi libero

Confronto con dati esistenti in letteratura (GRAAL)

- $\boldsymbol{\gamma p \rightarrow \eta p}$

Studio di tutti i decadimenti dell' η con protone zona intermedia (SciRi) o al centro (BGO+barrel)

  - $\eta \rightarrow 2\,\gamma$ $\eta \rightarrow 3\,\pi^0 \rightarrow 6\,\gamma$ $\eta \rightarrow \pi^+\pi^-\pi^0$

- $\boldsymbol{\gamma p \rightarrow \eta' p}$

In attesa di ulteriore statistica per lo studio di tutti i decadimenti dell' η'

  - $\eta' \rightarrow 2\,\gamma$ $\eta' \rightarrow 3\,\pi^0 \rightarrow 6\,\gamma$ $\eta' \rightarrow \eta\,\pi^+\pi^-$

- $\boldsymbol{\gamma n \rightarrow \pi^0 n}$

Neutrone al centro (BGO)

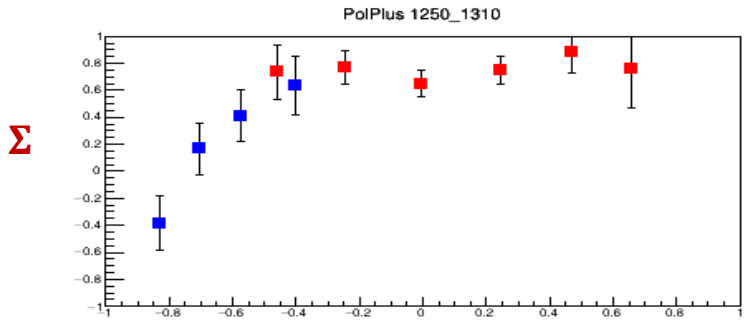
- Sviluppo di un nuovo algoritmo di calibrazione del rivelatore a scintillatori plastici (Barrel)

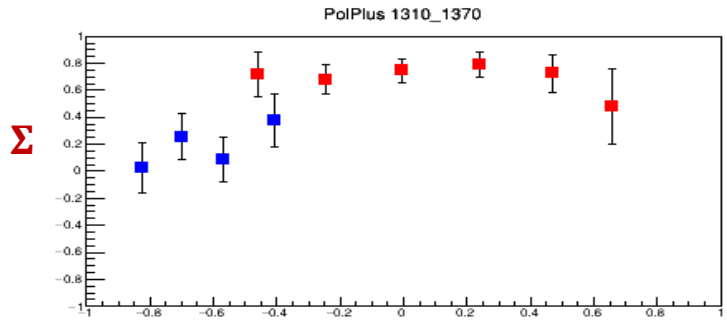
Risultati preliminari $\gamma p \rightarrow \eta p$ – Asimmetrie di fascio vs $cos\theta_{CM}$

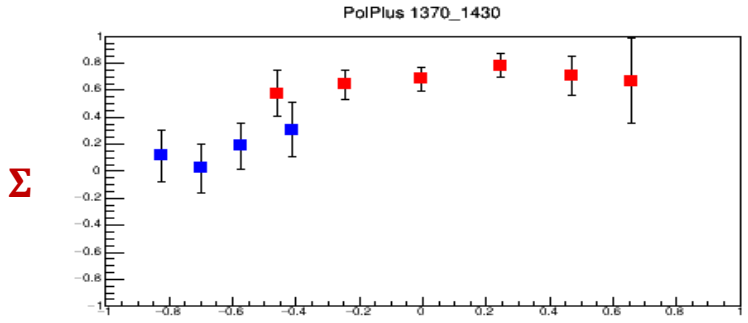
Blue Points = Proton in SciRi

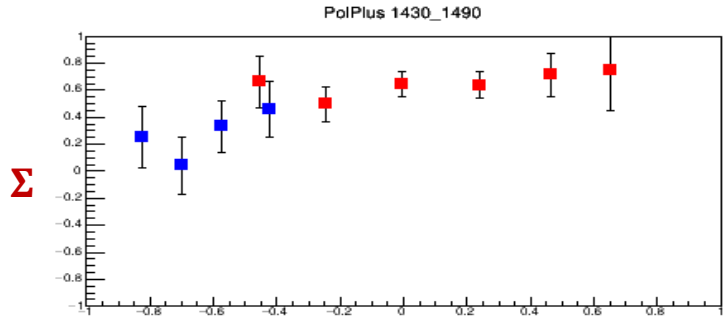
Red Points = Proton in BGO

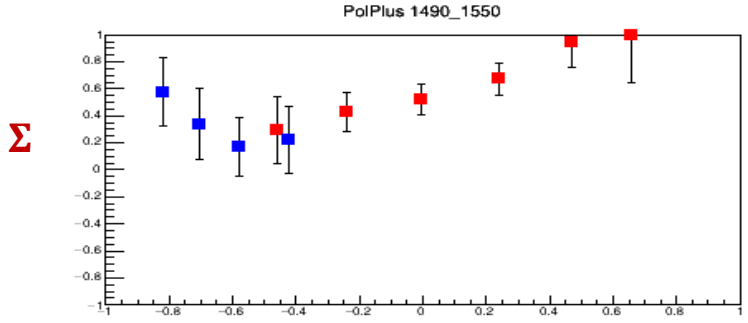
Squares = PolPlus 15 Bins in φ

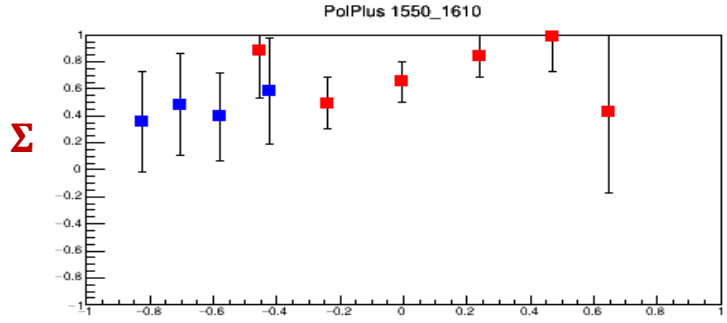












Σ

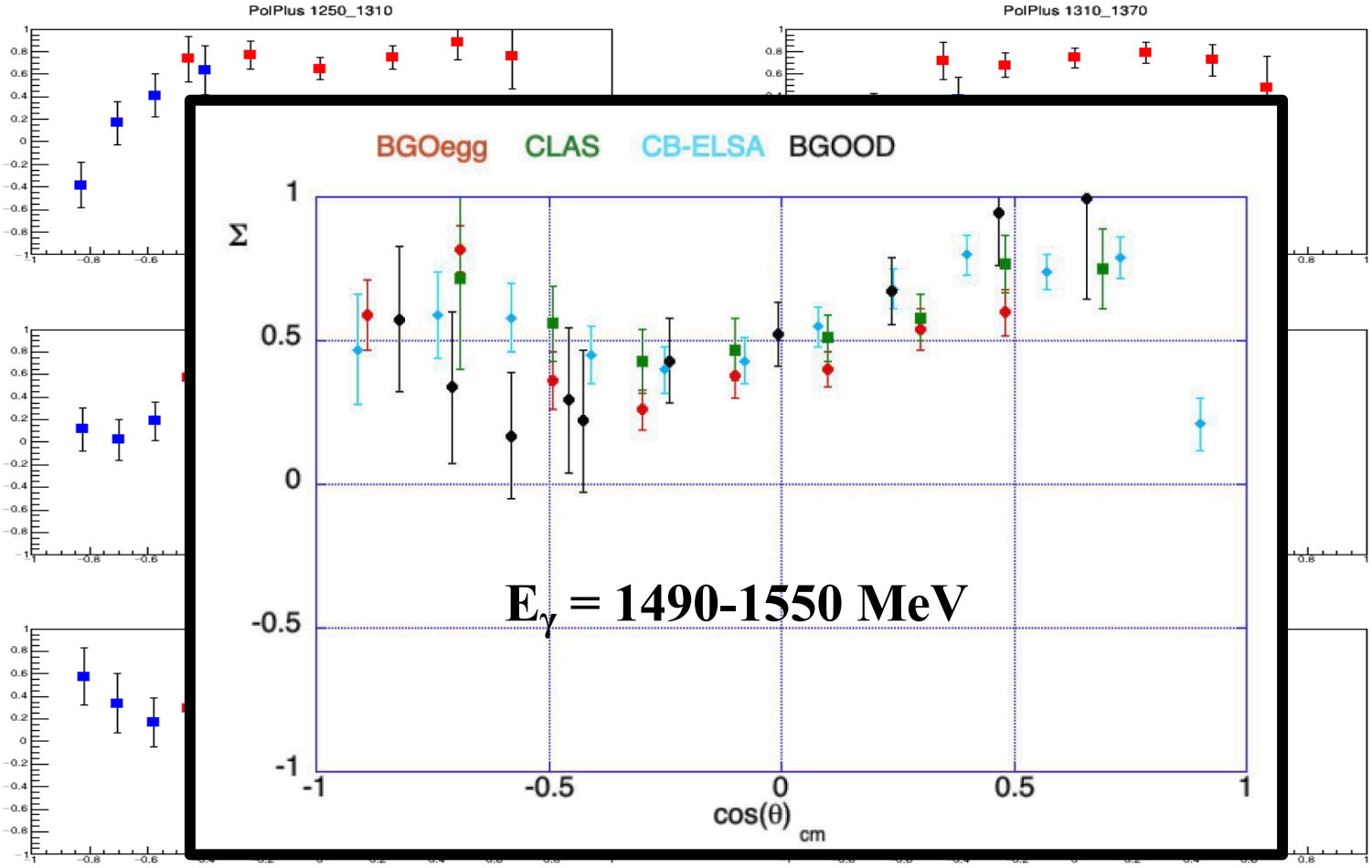
$cos\theta_{CM}$

Risultati preliminari $\gamma p \rightarrow \eta p$ – Asimmetrie vs $cos\theta_{CM}$

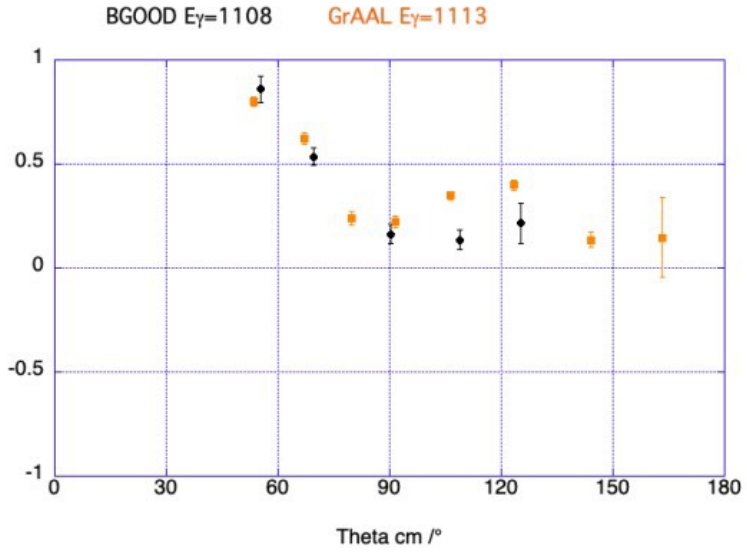
Blue Points = Proton in SciRi

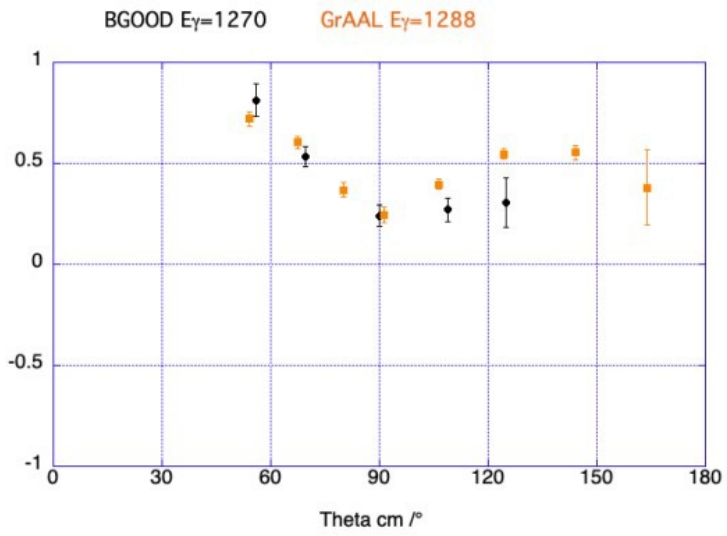
Red Points = Proton in BGO

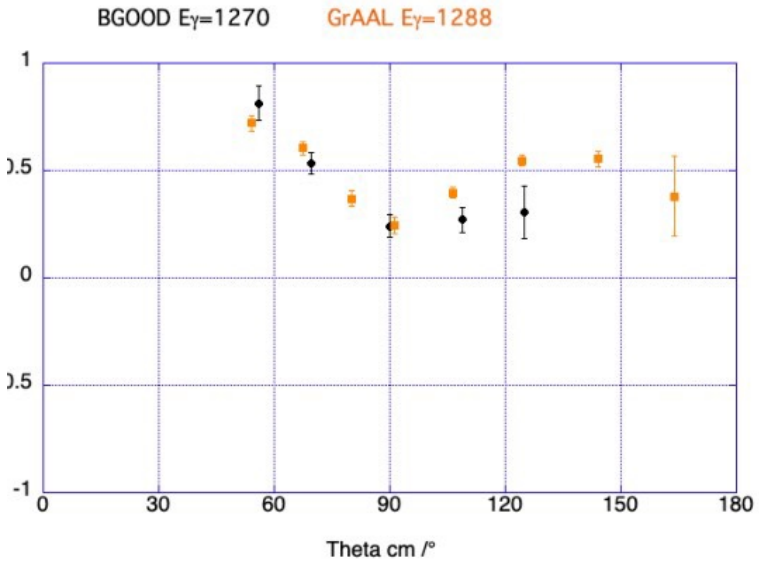
Squares = PolPlus 15 Bins in ϕ

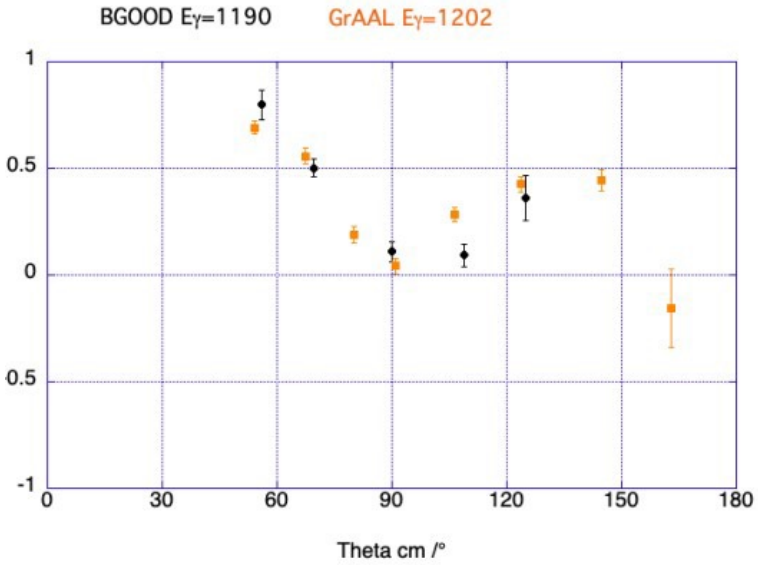


Risultati preliminari $\gamma n \rightarrow \pi^0 n$ – Asimmetrie di fascio vs θ_{CM}









Attività prevista 2023-2024

➢Esperimento BGOOD in corso:

•Agosto-2023: Sostituzione della cella del bersaglio (passaggio da 11cm a 6cm) e manutenzione del sistema criogenico con sostituzione dell'absorber e di eventuali componentistiche obsolete o deteriorate

Il passaggio da 11cm a 6 cm è necessario per migliorare la risoluzione nella misura di canali completamente neutri

•Sett-2023: Presa dati di 2 settimane su deuterio (bersaglio 6 cm) per incrementare la statistica di fotoproduzione di η ed η'

•Nov.-Dic. 2023: presa dati di 2-3 settimane bersaglio 6 cm (in funzione della disponibilità di fascio)

•2024: prese dati su bersaglio di deuterio (bersaglio 6cm) per migliorare la risoluzione nella misura di canali completamente neutri

➢ Attività della sezione per il 2024:

•Partecipazione ai lavori per la ripartenza dell'apparato e alle prese dati

•Analisi dei nuovi dati per l'estrazione delle asimmetrie di fascio di η ed η' su neutrone

PREVENTIVI MAMBO 2023	
Missioni	
$1.5\ MU\ x\ 2.7\ FTE = 22k€$ a Bonn per Presa Dati + Manutenzione apparato calorimetro BGO-Target-MRPC	22 K€
Trasporti	
Trasporto Materiale da Roma a Bonn e viceversa	1.5 K€
Manutenzione	
Manutenzione/ riparazione schede HV CAEN	3.0 K€
Inventario	
Acquisto 2 unità power supply (una primaria una secondaria) per SYx527	4.5 K€
Totale Richieste	**29.5 k€**

valutazione costo $MU(Mese\ Uomo) = 30\ gg \times 155 \frac{€}{die} + 2\ viaggi \times 0.4\ k€$

JLAB12

Anagrafica – JLAB12 Roma Tor Vergata

cognome	nome	contratto	profilo	aff	perc	
D'Angelo	Annalisa	Associato	Incarico di Ricerca scientifica	3		70%
Lanza	Lucilla	Associato	RTDa	3		70%
Sidoretti	Elena	Associato	Dottoranda	3		100%
Rizzo	Alessandro	Associato	Scientifica Dipendenti altri enti	3		100%
				Totale	3.4 FTE	
			Personale Tecnico			
Nobili	Giovanni	Dipendente	Collaboratore Tecnico E.R.	3		50%
Pecchi	Daniele	Associato	Associazione Tecnica			30%
Reali	Enzo	Associato	Incarico di Collaborazione Tecnica	2		30%
Tusi	Enrico Maria	Associato	Incarico di Collaborazione Tecnica			30%
				Totale	1.4 FTE	

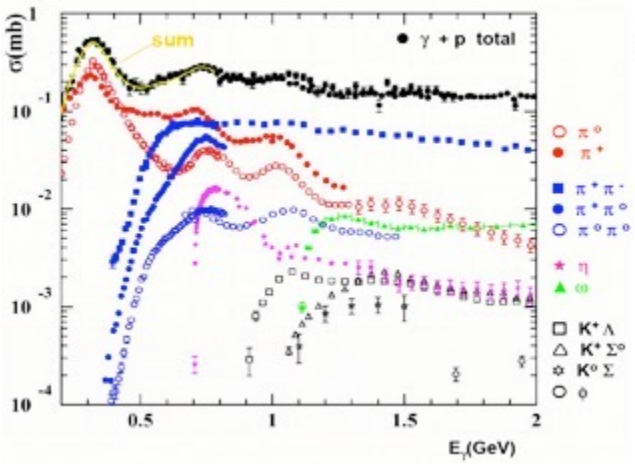
Percentuale di partecipazione 3.4 FTE / 4 RIC = 85%

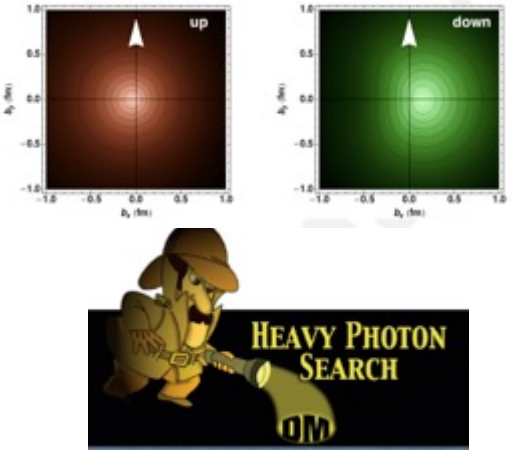
Esperimento JLAB12

JLAB12 Jefferson Laboratory at 12 GeV

Motivation. Photo- and electro-production reactions on nucleons and nuclei with polarized beams and targets for:

- ✓ Hadron spectroscopy
- ✓ Nucleon Structure
- ✓ HPS – Heavy Photon Search & BDX (Beam Dump Experiment)





Bari, Brescia, Cagliari, Catania, Ferrara, Genova, LNF, LNS, Padova, Pavia, Roma1, Roma Tor Vergata, Torino

Thomas Jefferson National Accelerator Facility – Virginia, USA

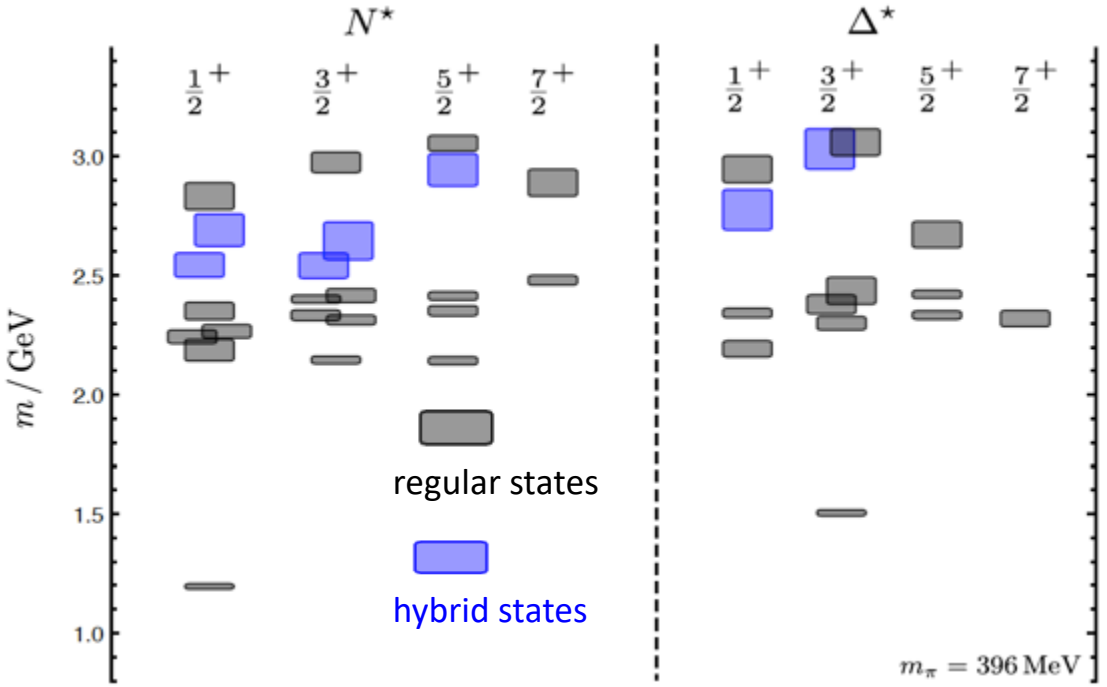
People: 45 researchers, (24,53 FTE) + 7 Technological Res. (3 FTE) + 10 technical staff

Data taking 2024-2032@ JLAB, Virginia

Esperimento JLAB12 Experimental Program

Hadron Spectroscopy: search for hybrid baryons at CLAS12

Hybrid Baryons in LQCD



First published results in 2022

PHYSICAL REVIEW C **105**, 065201 (2022)

Beam-recoil transferred polarization in K^+Y electroproduction in the nucleon resonance region with CLAS12

D. S. Carman,[40,*] A. D'Angelo,[19,34] L. Lanza,[19] V. I. Mokeev,[40] K. P. Adhikari,[14] M. J. Amaryan,[31] W. R. Armstrong,[1] H. Atac,[38] H. Avakian,[40] C. Ayerbe Gayoso,[26,42] N. A. Baltzell,[40] L. Barion,[15] M. Battaglieri,[17,40] I. Bedlinskiy,[21] B. Benkel,[39] A. Bianconi,[2,18] A. S. Biselli,[7] M. Bondi,[17] S. Boiarinov,[40] F. Bossù,[35] W. J. Briscoe,[12] S. Bueltmann,[31] D. Bulumulla,[31] V. D. Burkert,[40] R. Capobianco,[6] J. C. Carvajal,[9] A. Celentano,[17] P. Chatagnon,[32] V. Chesnokov,[36] T. Chetry,[26,30] G. Ciullo,[8,15] L. Clark,[13] P. L. Cole,[24] M. Contalbrigo,[15] G. Costantini,[2,18] V. Crede,[10] N. Dashyan,[43] R. De Vita,[17] M. Defurne,[35] A. Deur,[40] S. Diehl,[6,11] C. Djalali,[30] R. Dupre,[32] M. Ehrhart,[1,32] A. El Alaoui,[39] L. El Fassi,[26] L. Elouadrhiri,[40] S. Fegan,[44] A. Filippi,[20] G. Gavalian,[40] Y. Ghandilyan,[43] G. P. Gilfoyle,[33] F. X. Girod,[40] D. I. Glazier,[13] A. A. Golubenko,[36] R. W. Gothe,[37] Y. Gotra,[40] K. A. Griffioen,[42] K. Hafidi,[1] H. Hakobyan,[39,43] M. Hattawy,[31] F. Hauenstein,[40] T. B. Hayward,[6,42] A. Hobart,[32] M. Holtrop,[27] Y. Ilieva,[37] D. G. Ireland,[13] E. L. Isupov,[36] H. S. Jo,[23] K. Joo,[6] D. Keller,[41] A. Khanal,[9] A. Kim,[6] W. Kim,[23] V. Klimenko,[6] A. Kripko,[11] V. Kubarovsky,[40] M. Leali,[2,18] S. Lee,[25] P. Lenisa,[8,15] K. Livingston,[13] I. J. D. MacGregor,[13] D. Marchand,[32] L. Marsicano,[17] V. Mascagna,[2,38] M. Mayer,[31] B. McKinnon,[13] S. Migliorati,[2,18] T. Mineeva,[39] M. Mirazita,[16] R. A. Montgomery,[13] C. Munoz Camacho,[32] P. Nadel-Turonski,[40] K. Neupane,[37] J. Newton,[31,40] S. Niccolai,[32] M. Osipenko,[17] P. Pandey,[31] M. Paolone,[28,38] L. L. Pappalardo,[8,15] R. Paremuzyan,[27,40] E. Pasyuk,[40] S. J. Paul,[3] N. Pilleux,[32] O. Pogorelko,[21] J. W. Price,[4] Y. Prok,[31] B. A. Raue,[9] T. Reed,[9] M. Ripani,[17] J. Ritman,[22] A. Rizzo,[19,34] P. Rossi,[40] F. Sabatié,[35] C. Salgado,[29] A. Schmidt,[12,25] Y. G. Sharabian,[40] E. V. Shirokov,[36] U. Shrestha,[6,30] P. Simmerling,[6] D. Sokhan,[13,35] N. Sparveris,[38] S. Stepanyan,[40] I. I. Strakovsky,[12] S. Strauch,[37] N. Tyler,[37] R. Tyson,[13] M. Ungaro,[40] S. Vallarino,[15] L. Venturelli,[2,18] H. Voskanyan,[43] E. Voutier,[32] D. P. Watts,[44] K. Wei,[6] X. Wei,[40] R. Wishart,[13] M. H. Wood,[5] B. Yale,[42] N. Zachariou,[44] J. Zhang,[41] and V. Ziegler[40]
(CLAS Collaboration)

Approved experiment:
A⁻ rating + 100 PAC days beam time

Hybrid states have same J^P values as qqq baryons. How to identify them?

- Overpopulation of N $1/2^+$ and N $3/2^+$ states compared to QM projections.
- **$A_{1/2}$ ($A_{3/2}$) and $S_{1/2}$ show different Q^2 evolution. Can we do it?**

Study of Q^2 evolution of resonances electro-couplings from $K^+\Lambda$ electro production from the proton

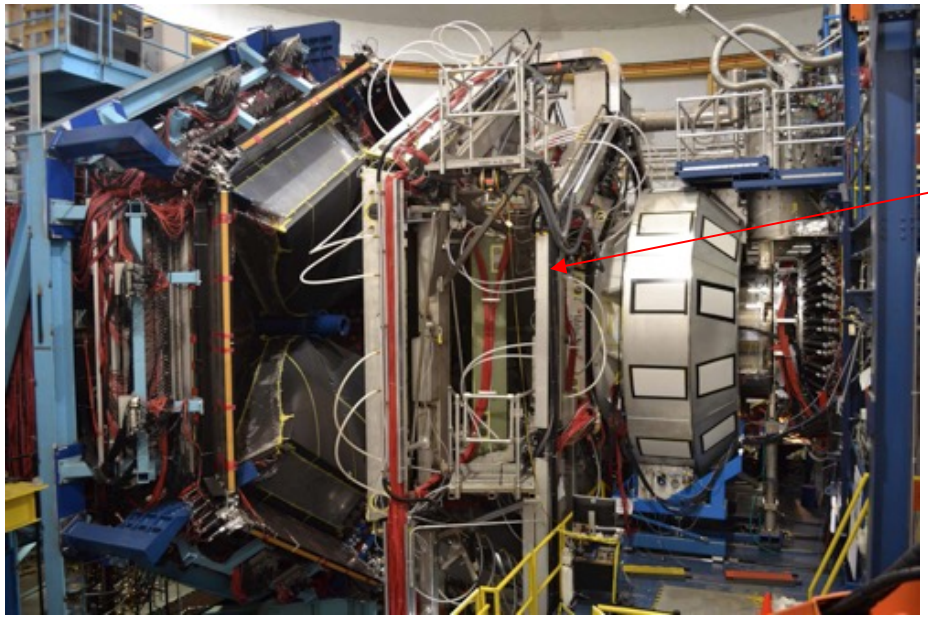
20 days of data taking have been collected by the experiment in 2018

additional 86 days have been allocated from November 2023 to March 2024

Esperimento JLAB12

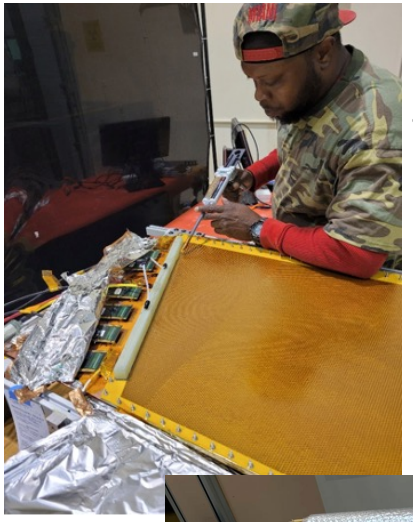
Detector

CLAS12



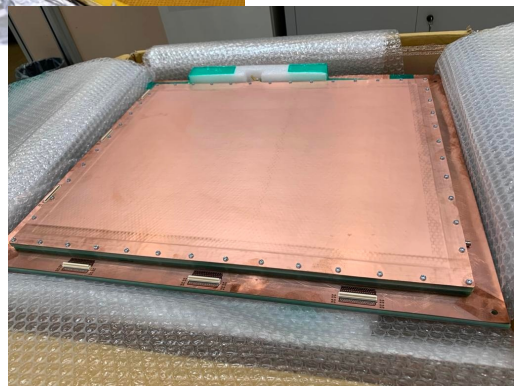
High Luminosity Upgrade:
μ-Rwell tracking detector

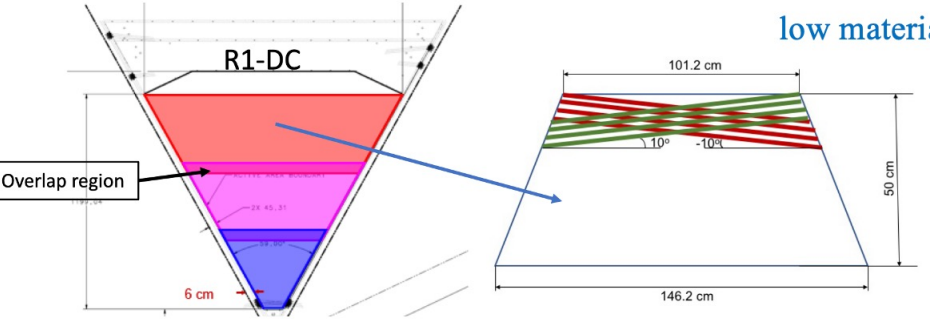
To be positioned in front of the drift chambers



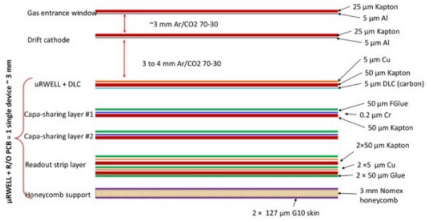
Jlab prototype

INFN prototype





low material budget detector



$\mu - Rwell$ for HI-LUMI

Progress since last year.
TEST BEAM at CERN SPS North Area H8: 14 – 28 June 2023 has been completed

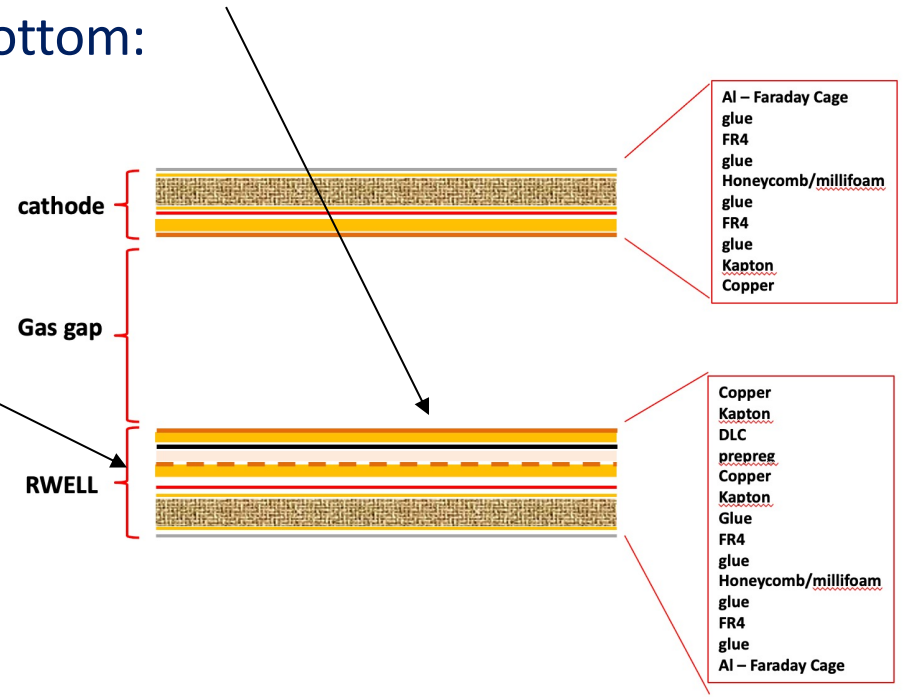
2D – readout: step by step approach

1. One prototype reads the 2-nd coordinate on the "top" copper layer

Same readout geometry on the top and the bottom:

- 780 μm pitch
- 300 μm width
- 10 x 10 cm^2 active surface
- 128 channels

The effect charge collection on the «top» layer is the object of investigation.



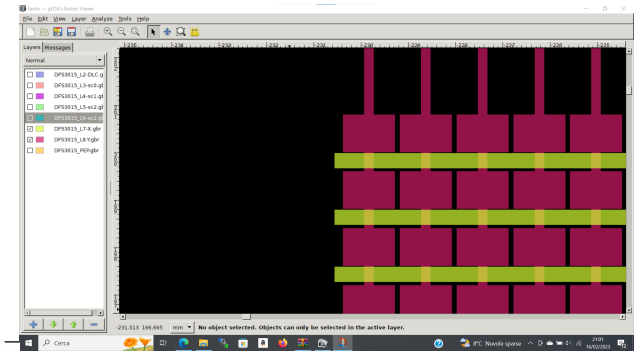
$\mu - Rwell$ for HI-LUMI

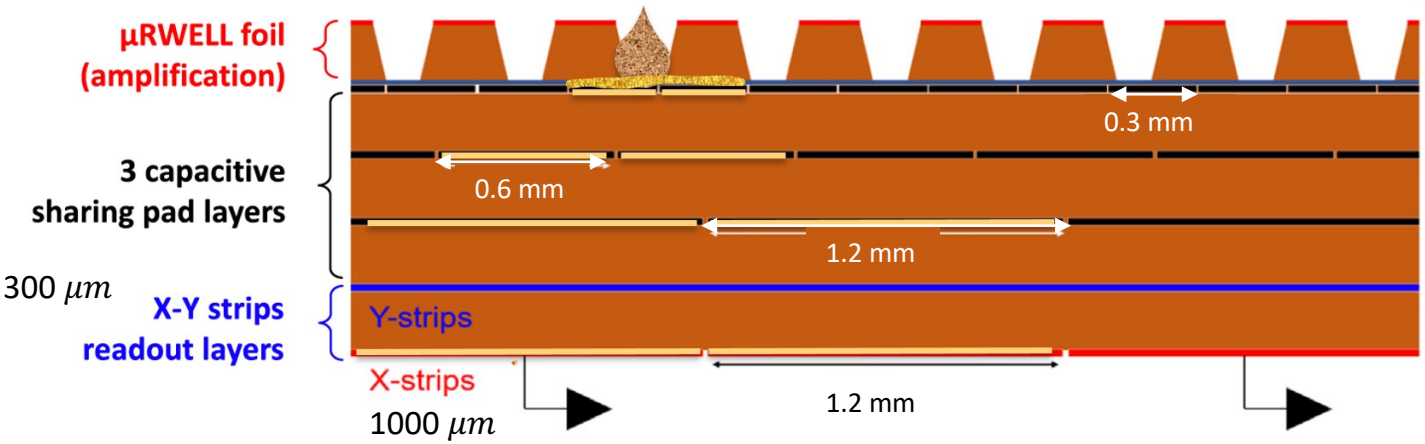
Progress since last year.
TEST BEAM at CERN SPS North Area H8: 14 – 28 June 2023

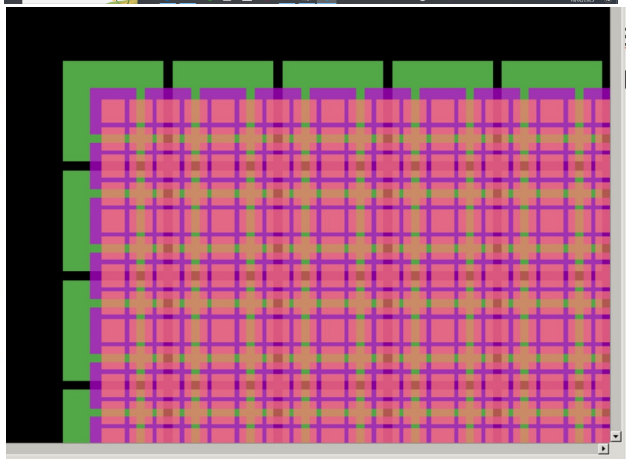
2D – readout: step by step approach

2. A second prototype reads both coordinates on the bottom in "COMPASS-like" strips configuration with capacity sharing read-out:

- 1200 μm pitch
- 300 μm vs 1000 μm strips width
- 10 x 10 cm^2 active surface
- 83 channels



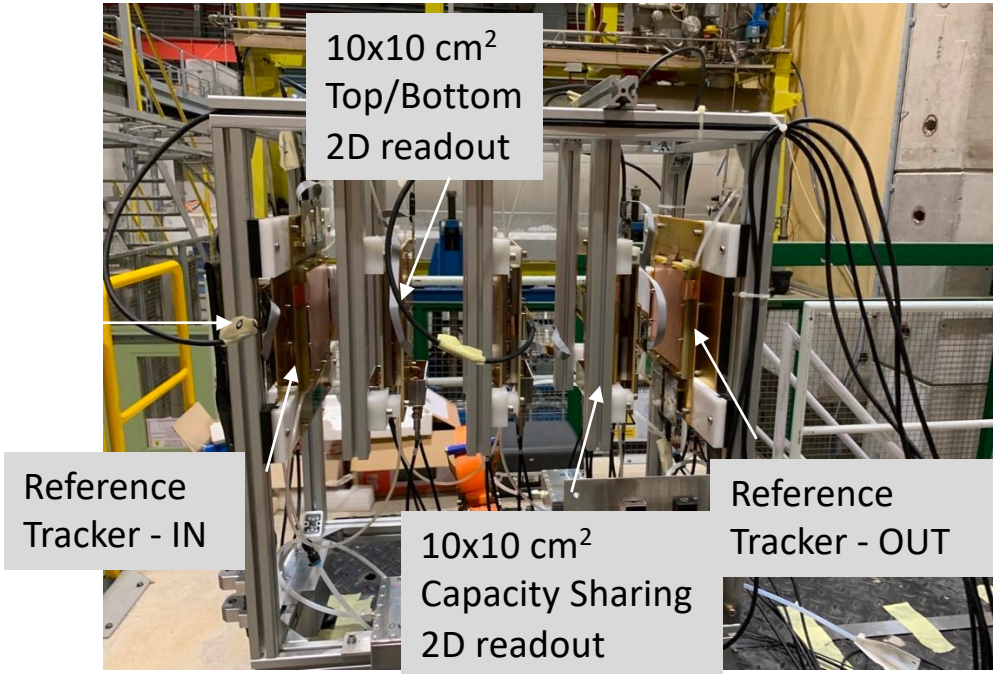




$\mu - Rwell$ for HI-LUMI

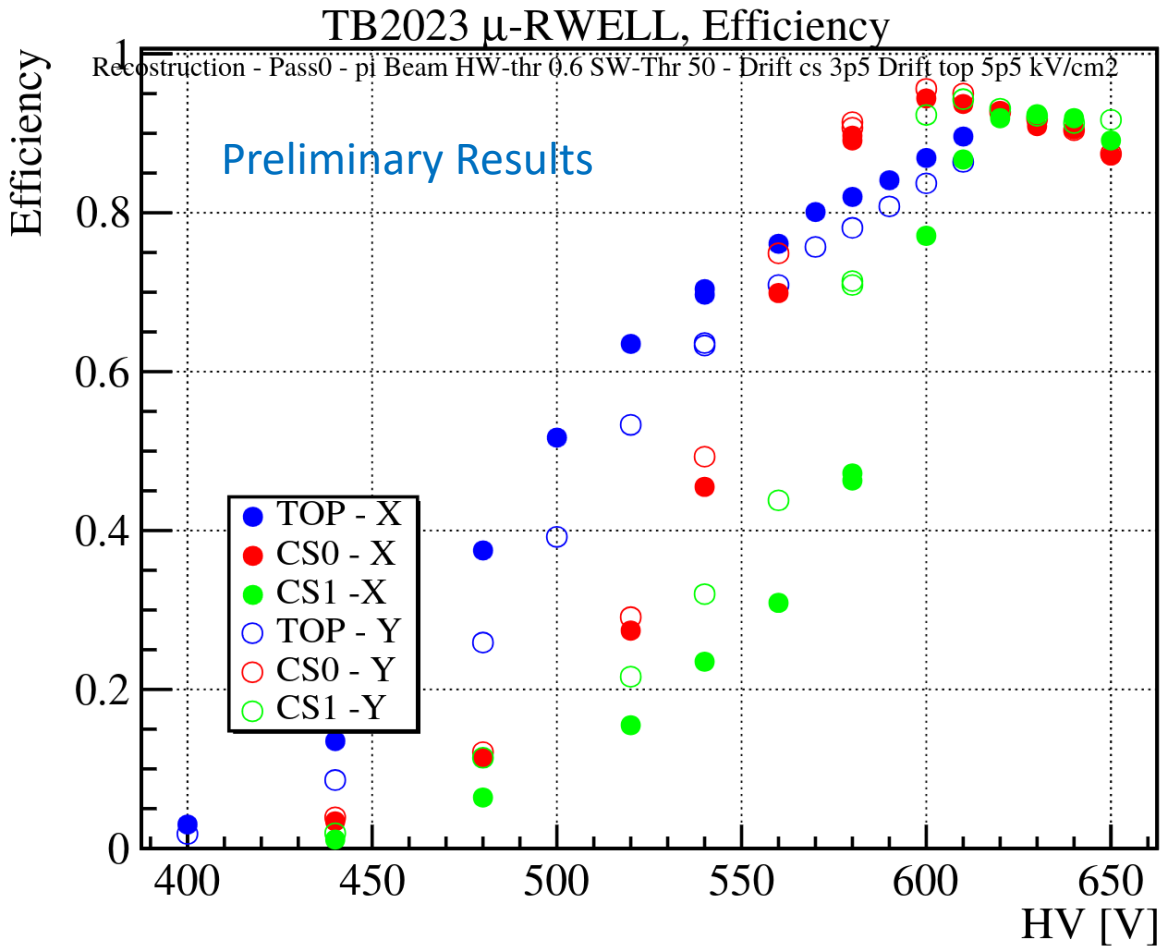
Progress since last year.
TEST BEAM at CERN SPS North Area H8: 14 – 28 June 2023

π/μ



Set-up

$\mu - Rwell$ for HI-LUMI

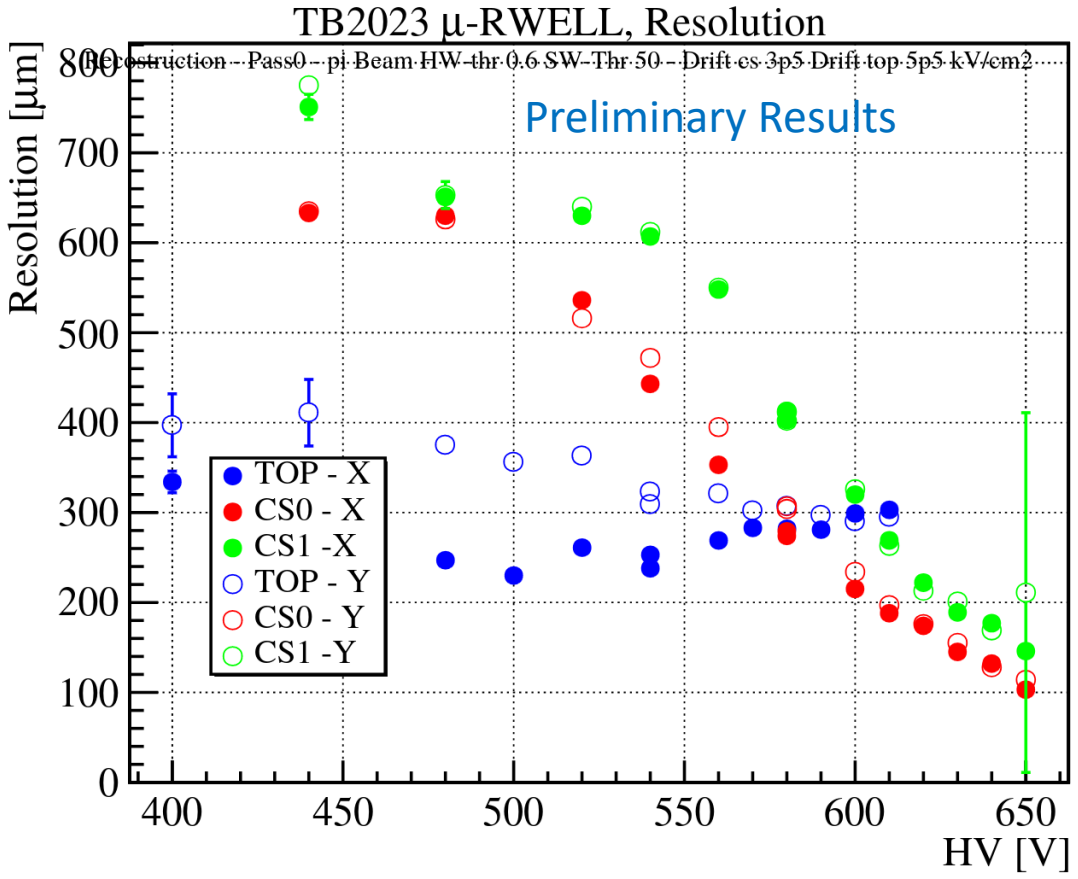


Efficiency

- CS readout reaches a plateau at higher HV values than standard readout scheme.
- TOP readout is not yet at plateau at 600 V

(HV was chosen to to be raised to higher values)

$\mu - Rwell$ for HI-LUMI



Resolution

- CS readout reaches 100 μm resolution at highest HV values (starting from 1200 μm pitch)
- TOP readout resolution is fixed at 250-300 μm (pitch is 780 μm)

$\mu - Rwell$ for HI-LUMI

Summary of Results

TOP read-out

- The Top-readout efficiency is 80-82% (compatible with the geometrical acceptance of 87%).
- The efficiency does not show the plateau below 600V HV. The signal produced does not suffer from sharing between the 2 readout views.
- Spatial resolution is 250-350 µm, compatible with pitch/√12

Capacity Sharing read-out

- The CS shows an efficiency plateau at 92-93% as a function of HV from 600 to 660V (too high!)
- The charge spread allows a very good spatial resolution, <100 µm (at high HV).
- The average cluster size increases with HV.

FUTURE ACIVITIES

2D read-out optimization:

- The CS readout could be improved by eliminating one layer of sharing, going from the actual 3 capacitive ones (0.3 - 0.6 - 1.2 mm) down to 2 (0.4 - 0.8 mm).

Attività sperimentali previste

Hi-Lumi

Il laboratorio PP1 attrezzato per test rivelatori micro-R well.

Sviluppo di prototipi in collaborazione con LNF (G. Bencivenni)

Partecipazione a run di presa dati:

- CLAS (12 GeV) – 86 giorni assegnato a RG-K

Le richieste maggiori sono relative al progetto Hi-luminosity:

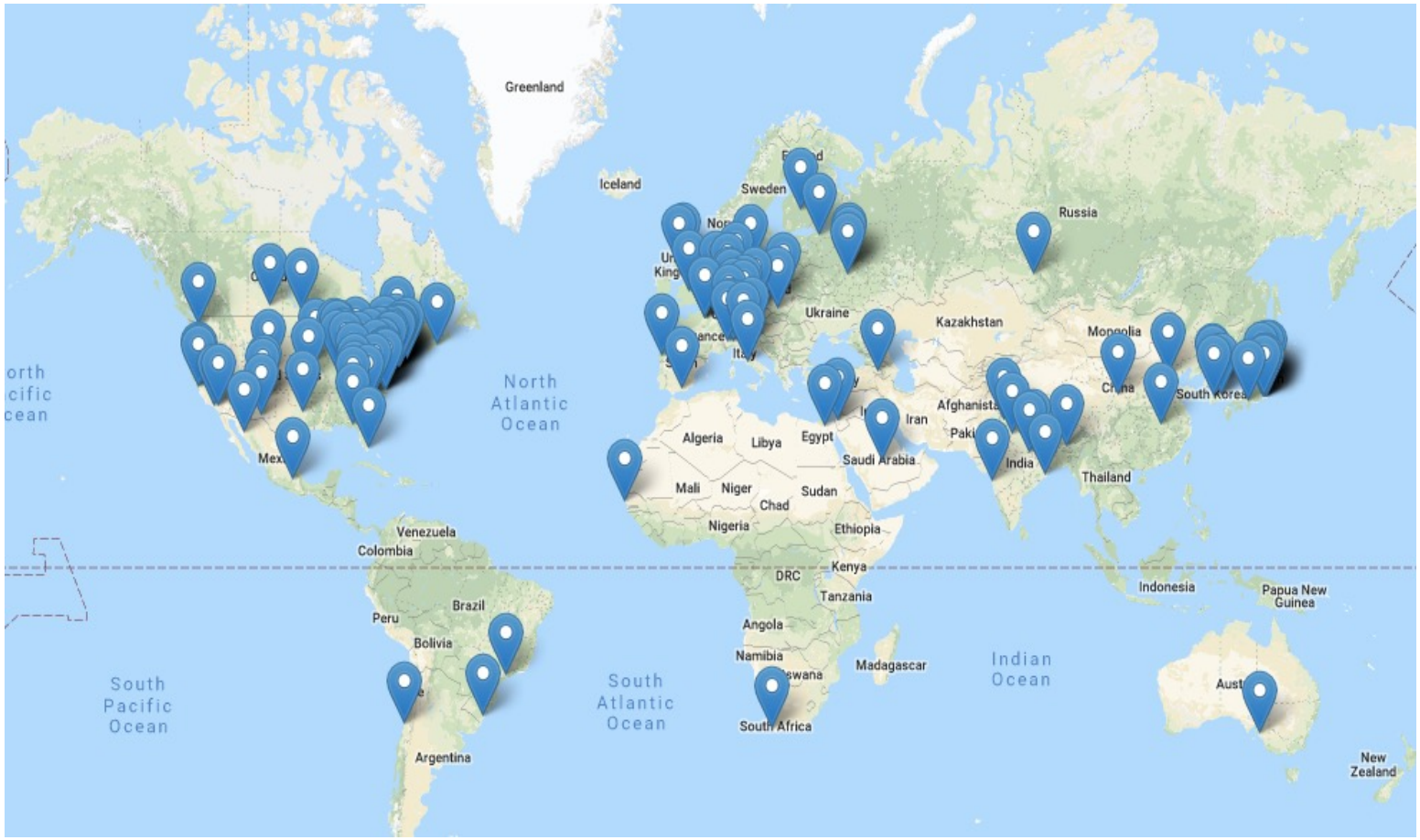
- Ottimizzazione del read-out su prototipi 10x10 cm^2
- Implementazione della soluzione su rivelatori a grande area 50x50 cm^2

RICHIESTE

Capitolo	Descrizione	Parziali (k€)		Rimuovi	Modifica	Totale (k€)	
		Richieste	SJ			Richieste	SJ
altri_cons	2 Bombole di gas pre-miscelato Ar:CO2:CF4 (45:15:40) e 2 bombole Azoto per flussaggio	3.00	0.00			3	0
apparati	2 RWELL prototypes Layout 50x50 2D readout costo 7500 Euro ciascuno + 2500 Euro design +1650 Euro tooling + IVA= (2x7500 Euro + 4150 Euro)x1.22= 23.4 KEuro	23.50	0.00			27.5	0
	2 prototipi 10x10 cm2 con 2 layer capacity sharing 1D + 2 prototipi 10x10 cm2 con 2 layer capacity sharing 2D, costo 1 KEuro ciscuno senza catodo	4.00	0.00				
consumo	n.1 batch DLC (7 foils 1m x 0.6m) 250M +/-30M on 50um Apical NP (other side already covered with copper) for 2D micro- RWELL production = 5500 Euro	5.50	0.00			7.5	0
	Catodo (250 Euro) +Cornice in PEEK (250 Euro) per 4 prototipi 10cm x 10 cm = 4 X 500 Euro = 2 KEuro	2.00	0.00				
missioni	Turni di Misura CLAS12 - RGK 2 turni x 4 persone per 14 giorni = 8 x(14*130Euro/gg+1300Euro viaggio)=8x3120Euro = 25kEuro	25.00	0.00			34.5	6.5
	2 settimane x 3 persone per test beam al CERN di prototipi micro-Rwell = 3 x (14*140Euro+200Euro)=3x2160Euro=6.5kEuro	6.50	6.50				
	Missioni Genova/Catania per collaborazione su progetto Hi-lumi 3 persone per 7 giorni = 3k Euro	3.00	0.00				
inventario	CAEN SY4527LC - 10 Slot LOW COST Universal Multichannel Power Supply System + AG561H 12 Channel 6 kV/20 ÂµA Common Ground Board	20.00	0.00			20	0
Totale						92.5	6.5

EIC NET

EIC - NET



I. EIC User Group:

- **795** members
- **170** institutions
- **29** countries (7 world regions)

EIC-NET Roma Tor Vergata

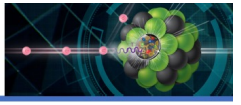
Roberto Ammendola
Gaetano Salina
(Bruno Benkel)

Annalisa D'Angelo
Rachele Di Salvo
Alessia Fantini
Lucilla Lanza

Experiment Scientists: **453**, Theory Scientists: **158**, Accelerator Scientists: **142**, Support: **3**, Other: **39**

EIC - NET

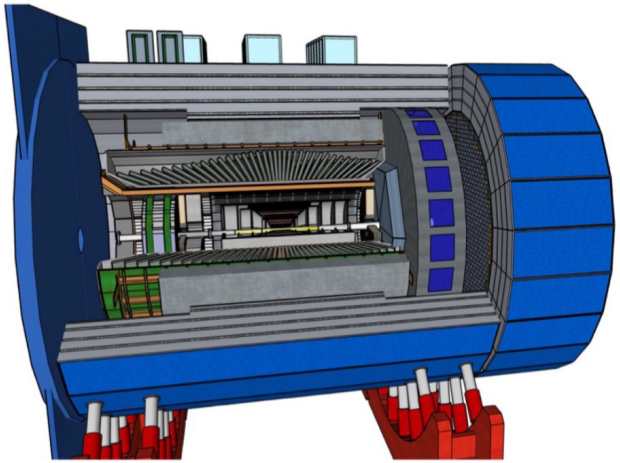
The EIC detector status



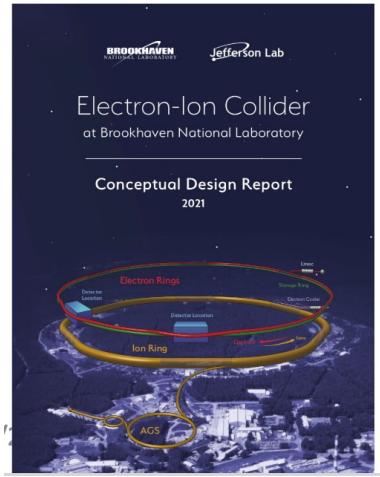
Yellow Report process 2020/2021 (detector requirements to deliver EIC physics) → released March 2021
Call for detector proposals issued March 2021 → deadline 1/12/2021

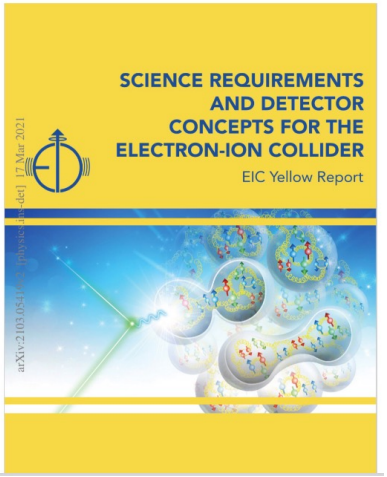
- ECCE was general purpose detector for IP6 re-using 1.4 T Babar magnet (bore diameter 2.8)
- ATHENA was general purpose (full EIC science) for IP6 with new 3T solenoidal magnet (and larger bore diameter – 3.2 m)
- CORE was a more "compact" proposal, potentially for IP8 (3T solenoid as well)

ECCE selected as reference design (March 2022) → Community working over one general purpose detector for IP6: **ePIC**



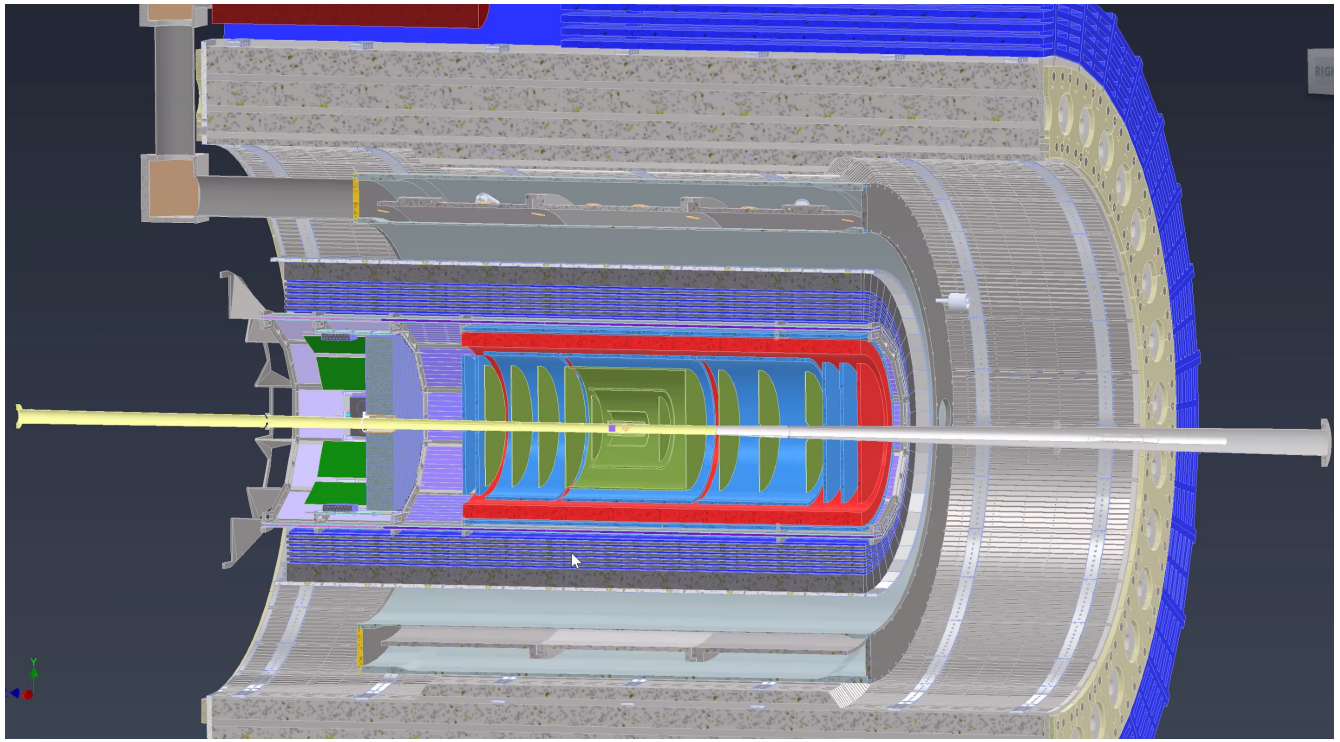
key differences on design: bore diameter and magnet





TDR – End of 2024
Critical Decisions 2 & 3 2025 → construction begins
2033 – Start of operations

The Latest Configuration of ePIC detector tracking



Colour code:

green → silicon trackers

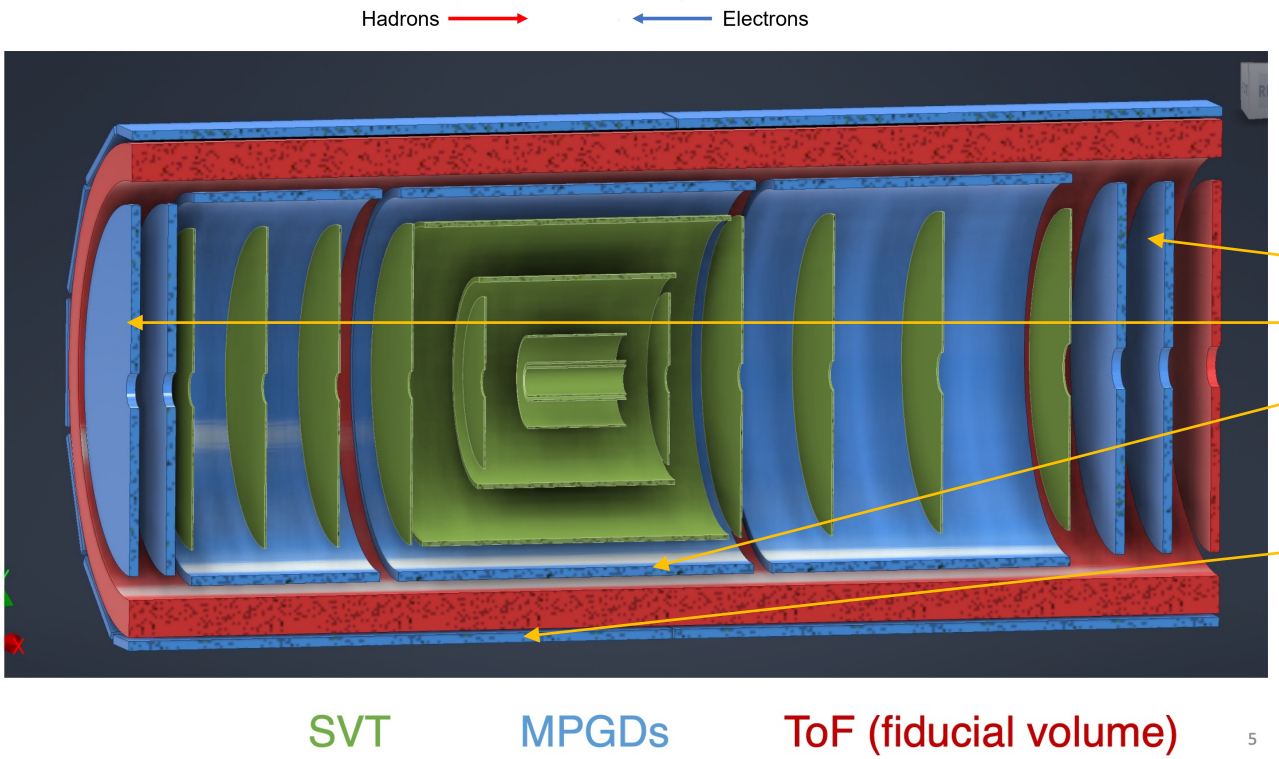
light blue → MicroPatternGasDets

red → Time of Flight

purple → DIRC

June 15th 2023 – Tracking working group meeting – re-inforced role of MPGD

The Latest Configuration of ePIC detector tracking



Colour code:

green → Silicon Vertex Trackers

red → Time of Flight

light blue → MPGDs

- Two forward discs
- Two backward discs
- Cylinder inside the ToF, segmented in three longitudinal sectors
- Barrel inside the DIRC: same DIRC segmentation in planar tiles, divided into two longitudinal sectors

re-inforced role of MPGD

Its primary roles are : - Provide additional fast points for pattern recognition

- Aid PID subsystems tracking

Possible collaboration with EIC MPDG group

INFN Manpower:

- **Roma Tor Vergata:** A. D'Angelo (PO), R. Di Salvo (I ric), A. Fantini (RU), L. Lanza (RTDa), E. Sidoretti (PhD)
- **Genova:** M. Battaglieri (DR), Paolo Musico (INFN) -> Readout electronics (VMM3/SALSA)
- Roma 1: Evaristo Cisbani (GEM expert) – Catania: Mariagela Bondi'
- The work would be performed in close connection with the group of Gianni Bencivenni @ LNF and with the Jlab detector group (Kondo Gnanvo)

Manifestation of Interest

- We are exploring a possible space for INFN in the EIC MPGD working group:
  - A number of informal meetings proved a positive response to a collaboration proposal
  - INFN could contribute to the construction of part of the MPGD EIC tracking (i.e. two forward discs facing the Dual-RICH)
  - **~ 500 Keuro in-kind INFN budget could be possible** (detector only – manpower is already available)
  - INFN has participated to the DOE eRD108 call

EIC-NET - Roma Tor Vergata

Attività prevista:

- Triggerless DAQ – implementazione di codici basati su reti neurali su FPGA per riconoscimento segnali Dual-RICH nel fondo
- Verifica della possibilità di sviluppare μ-Rwell detector per tracciatori – sinergia con JLAB12 in collaborazione con INFN – Genova e Catania

Partecipanti: Annalisa D'Angelo 20% Rachele Di Salvo 10%
Alessia Fantini 20% Lucilla Lanza 30%
Gaetano Salina 10%
Roberto Ammendola 10% (+Bruno Benkel 100% da settembre 2023)

Richieste di Finaziamento:

Capitolo	Descrizione	Parziali (k€)		Rimuovi	Modifica	Totale (k€)	
		Richieste	SJ			Richieste	SJ
apparati	2 prototipi micro-Rwell detector "D-shaped" 5 cm raggio costo 2 KEuro ciscuno senza catodo	4.00	0.00			4	0
consumo	2 catodi per micro-Rwell "D- shaped" 5 cm raggio	1.00	0.00			1	0
missioni	EICUG meeting USA 2 persone 2.5 KEurox2 = 5 KEuro	5.00	0.00			6	0
	Partecipazione a Giornate Nazionali EIC_NET 2 persone	1.00	0.00				
Totale						11	0

FOOT

FOOT Purposes

p + C, O, N
C + C, O, Si
Fe + C, Si, Al

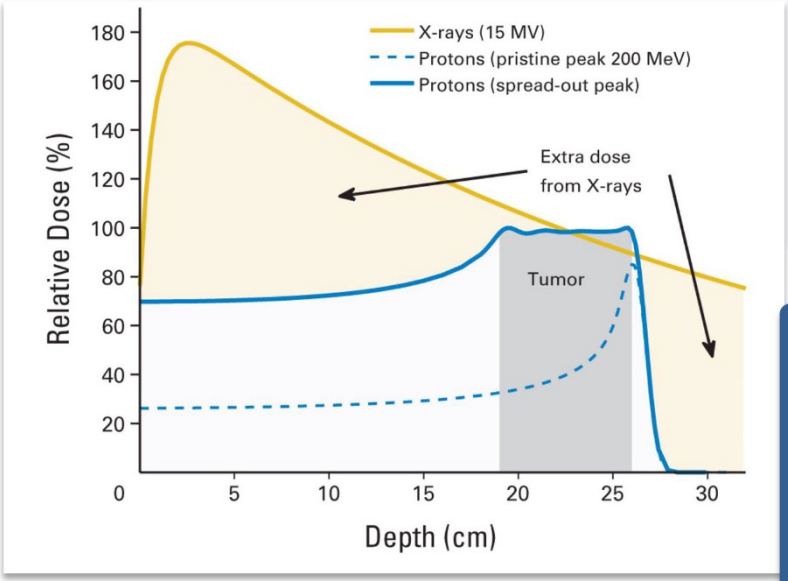
$\frac{d\sigma}{d\Omega}, \frac{d\sigma}{dE_{kin}}$

Goal accuracy <5%

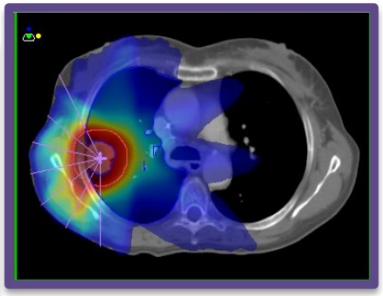
Measurement of fragmentation cross sections for **Hadrontherapy** and **deep space radioprotection**

$80\ \mathrm{MeV/N} < E_{kin} < 400\ \mathrm{MeV/N}$

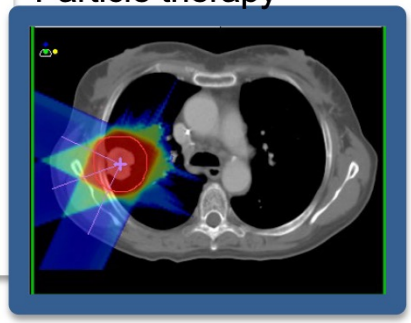
$0.5\ \mathrm{GeV/N} < E_{kin} < 2\ \mathrm{GeV/N}$



Traditional radiotherapy



Particle therapy



Spacecraft shielding
Radio-protection in Space

The FOOT Physics Program

Specific measurements related with Particle Therapy & Radioprotection in Space

- Using C, C_2H_4 ➔ cross sections on C and H
- Using C, C_2H_4, PMMA ➔ cross sections on C, O and H

PMMA is a combination of C,O,H.

Phys	Beam	Target	Energy (MeV/u)	Inv/direct
Target Frag. PT	^{12}C	C, C_2H_4	200	inv
Target Frag. PT	^{16}O	C, C_2H_4	200	inv
Beam Frag. PT	^{12}C	C, C_2H_4, PMMA	350	dir
Beam Frag. PT	^{16}O	C, C_2H_4, PMMA	400	dir
Beam Frag. PT	^{4}He	C, C_2H_4, PMMA	250	dir
Rad. Prot.space	^{4}He	C, C_2H_4, PMMA	700	dir
Rad. Prot.space	^{12}C	C, C_2H_4, PMMA	700	dir
Rad. Prot.space	^{16}O	C, C_2H_4, PMMA	700	dir

open to other possible physics programs

E.g. C + C → 3α + X

The FOOT Collaboration

93 Authors

33 Institutions

Italy, France, Germany, Japan, Cuba

3 Continents (Europe, Asia, America)

INFN:

10 units (Bo, LNF, Mi, Na, Pg, Pi, Rm1, Rm2, TIFPA, To)

65 researchers & 9 technologists

28.55 FTE (26.5 researchers, 2.05 technologists)

2024:

Add Bari and maybe University of Miami

Tor Vergata:

M.Cristina Morone 100%
L. Narici 30%
T.Minniti 100%

+ M.Massa laureanda mag.

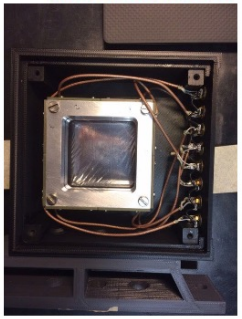
The FOOT experiment: the electronic spectrometer

Permanent magnets

Target

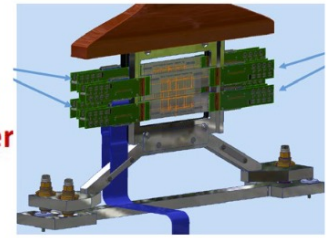
Beam Monitor

Start Counter

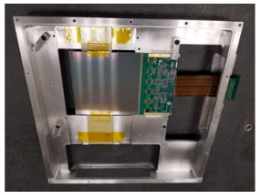


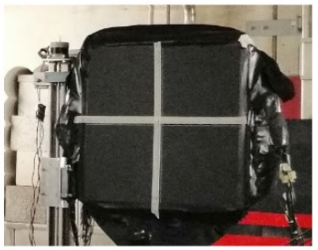
Silicon Pixel
Vertex Detector

Silicon Pixel
Inner Tracker



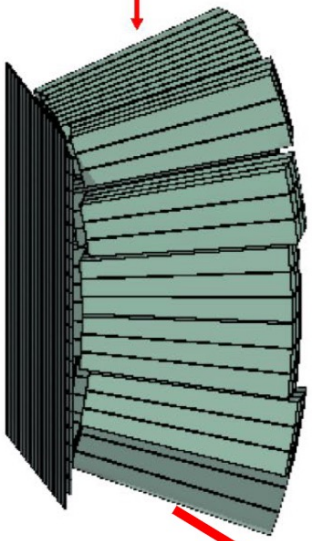
Si microStrips





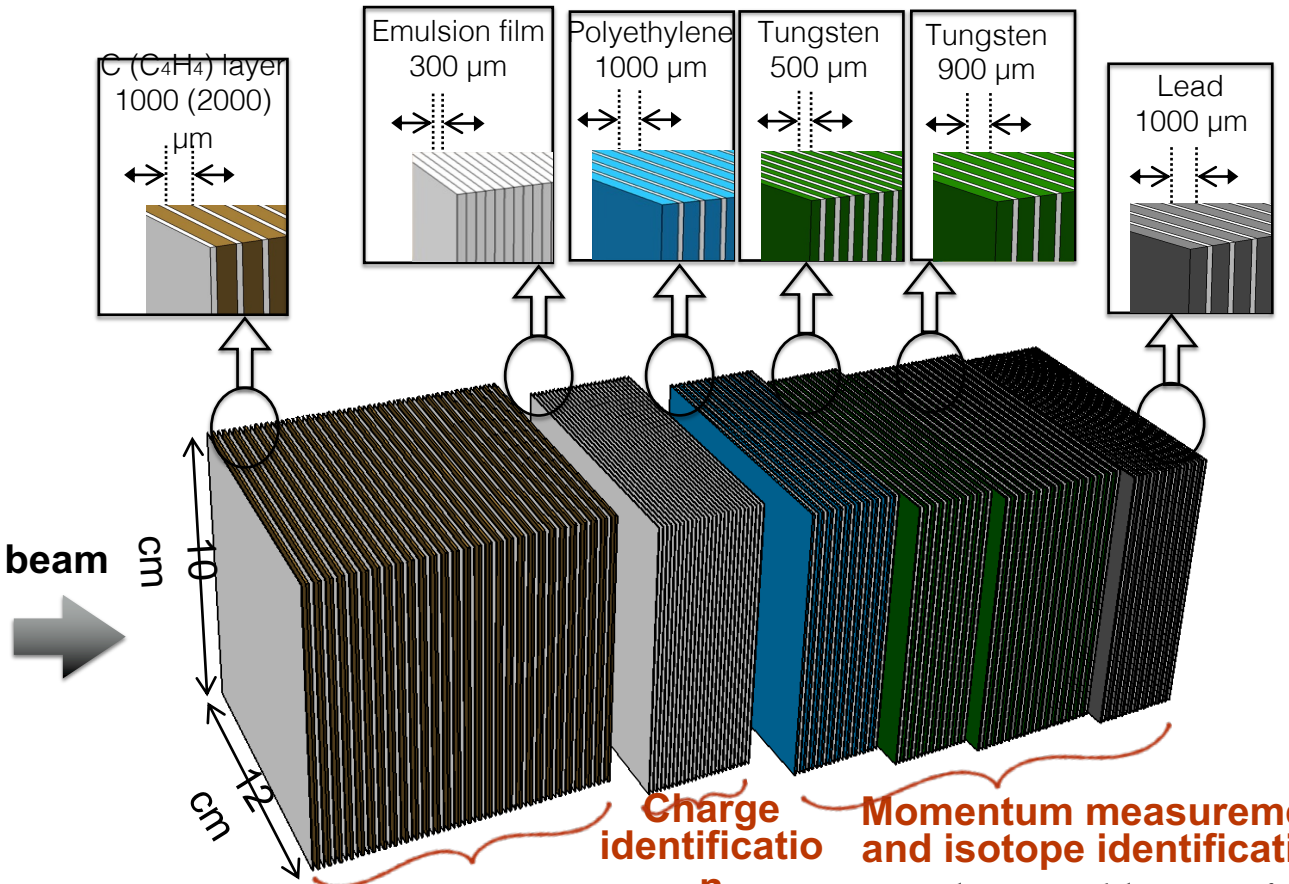
ΔE & TOF
Scintillation Bars

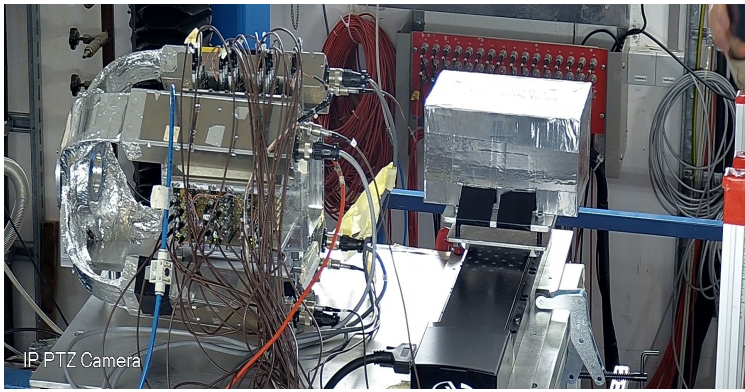
BGO Calorimeter



To be completed

The FOOT experiment: the emulsion spectrometer





Vertexing
alternated layers of emulsions and target (C or C_2H_4)

Charge identification
only emulsion layers

Momentum measurement and isotope identification
alternated layers of emulsions and passive material (plastic, tungsten and lead)

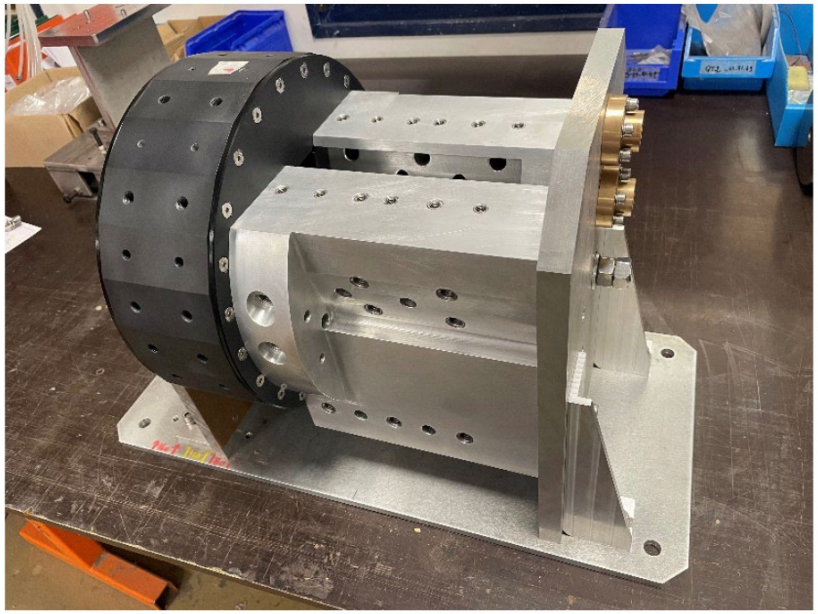
FOOT Highlights 2022-2023

Pandemic hit FOOT delaying key components and reducing data taking time. We're recovering from this situation. Data takings at GSI in 2021, Heidelberg and CNAO in 2022. Working for CNAO in autumn

- ✓ Increased experience on several detectors.
- ✓ Rumping on calorimeter module production. Completion for this summer → already working on spares
- ✓ Biggest critical element: permament magnet. Changed the magnetic elements. Delays due to many reasons. Assembly started last week. Delivery expected for mid september
- ✓ Tests on Drift Chamber to stand high rates; tested a second, smaller Drift chamber
- ✓ DAQ system has been tested on all detectors. IT and VTX complete integration still pending
- ✓ Several significant progresses on reconstruction software; several analyses in parallel
- ✓ GSI Emulsion data analyses near the end. NIT emulsions tested in Trento
- ✓ Several published articles; some in the preparation stage.
- ✓ New measurement proposals and detector upgrades financed via PRIN2022 (VTX, TW, Emulsions)
- ✓ CNAO beam tuning for very low intensity (1 kHz particle rate, as smooth as possible)
- ✓ Currently we're preparing the CNAO data taking with ^{12}C beam (27 oct-7 nov)

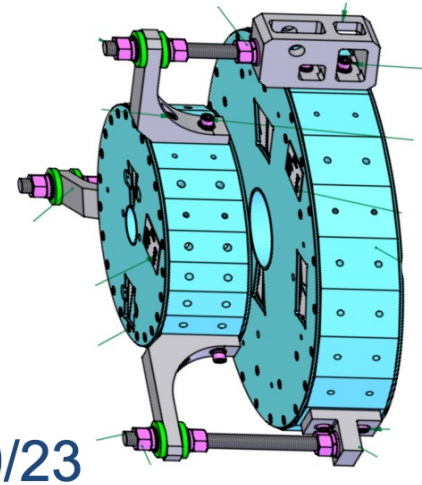
Status of Magnet

- New design
- Full analysis done
- Yokes, tools and elements ready



Schedule:

- Manifacturing M1: up to 27/06/23
- Manifacturing M2: up to 19/07/23
- Assembly M1+M2: up to 26/07/23
- Measurements @ SigmaPhi: up to 02/08/23
- Assembly and packing: from 03/08 to 30/08/23 (vacation time)
- Shipment: 31/08/23
- Arrival at LNF: 13/09/23



Measurements at LNF:

- one week from 13/09 to 15/10/23

Papers published in 2022

1. M. Toppi, et al, *Elemental fragmentation cross sections for a 16O beam of 400 MeV/u kinetic energy interacting with a graphite target using the FOOT ΔE-TOF detectors*, Front. Phys., 2 November 2022, Sec. Medical Physics and Imaging, Research Topic: Breakthrough in Particle Therapy: At the Edge of Physics, Biology and Medicine, See https://doi.org/10.3389/fphy.2022.979229
2. G. Silvestre et al, *Characterization of 150 micrometer thick silicon microstrip prototype for the FOOT experiment*, accepted in JINST 2022 https://jinst.sissa.it/jinst/author/docPage.jsp?docPgType=work&docId=JINST_070P_0922

Proceedings published:

1. K. Kanxheri6,1 et al, *The Microstrip Silicon Detector (MSD) data acquisition system architecture for the FOOT experiment* 2022, Journal of Instrumentation, Volume 17, March 2022 DOI 10.1088/1748-0221/17/03/C03035 (Topical Workshop on Electronics for Particle Physics 2021, 20–24 September, 2021)
2. L. Galli, et al, *The fragmentation trigger of the FOOT experiment*, Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, Volume 1046, 2023, 167757. 15th Pisa Meeting on Advanced Detectors, Elba, 2022, https://doi.org/10.1016/j.nima.2022.167757
3. A.C. Kraan et al, *Calibration and performance assessment of the TOF-Wall detector of the FOOT experiment*, NIMA:,Volume 1045, 2023, 167615, 15th Pisa Meeting on Advanced Detectors, Elba, 2022, https://www.sciencedirect.com/science/article/abs/pii/S016890022200907X
4. A. De Gregorio, *Measurements of the ^{16}O cross section on a C target with the FOOT apparatus, Nuovo Cim.C* 45 (2022) 6, 194, Contribution to: SIF 2021, 194

Papers published in 2023

Proceedings:

1. R. Zarrella, *Nuclear fragmentation cross section measurements with the FOOT experiment*, EPJ Web of Conferences 284, 10001 (2023)
2. Gianluigi Silvestre , *Characterization of the Microstrip Silicon Detector for the FragmentatiOn Of Target experiment*, Nuclear Instruments and Methods in Physics Research Section A: Volume 1047, February 2023, 167717 https://www.sciencedirect.com/science/article/pii/S0168900222010099
3. Riccardo Ridolfi, *Nuclear fragmentation cross section measurements with the FOOT experiment*, proceeding from EuNPC conference in 2022, publication to come.
4. Giacomo Ubaldi, *The FOOT experiment: a first measurement for nuclear fragmentation cross section for hadrontherapy*, proceeding from SIF 2022, publication to come.

In writing stage

FOOT for the Moon, Mars and beyond: current status and first cross section measurements for space radioprotection

Charge identification of fragments produced by interaction of 16-O beam at 200 and 400 MeV/u on C and C_2H_4 target , emulsion group, to be submitted to frontiers

A new photon calibration method for silicon microstrip sensors

Il gruppo di ToV si occupa dell'analisi dei dati acquisiti ad Heidelberg nel 2022

Heidelberg, from July 17 to July 25 (2022)

^{4}He(100-140-200-220 MeV/u) on ^{12}C { 11 Mevts (min bias) / 4 Mevents (frag. trig) }

The FOOT HIT 2022 setup

- Start Counter
- Beam Monitor
- Micro Strip Detector
- ToF-Wall
- 7 modules (63 crystals) of the calorimeter

Available Fragmentation Channels

Using ^{4}He projectiles, the only final state channels (excluding target fragmentation) are:

~as many 3He as t are expected

$^4He \rightarrow$

- $n + {}^3He$
- $p + {}^3H$
- $^2H + {}^2H$
- $n + p + {}^2H$
- $n + n + p + p$
- $^4He + X, {}^4He + X^*$

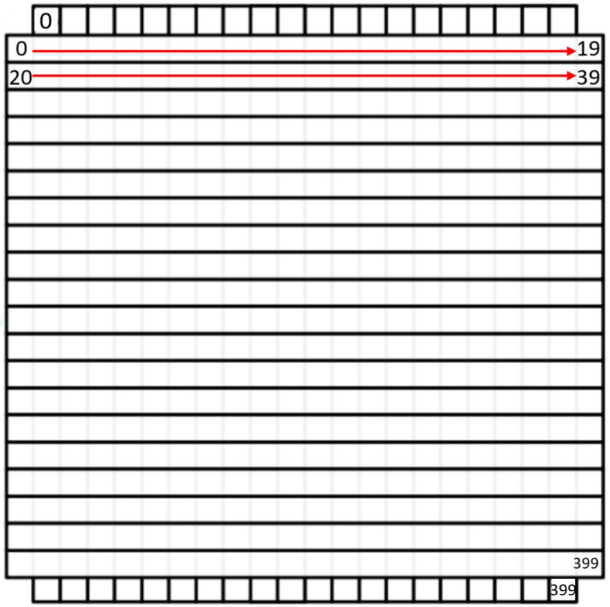
$X^* \rightarrow X + \gamma$

It would be fundamental to aim to both Z & A identification using the BGO modules, even in a limited solid angle

$E_{sep}(^4He \rightarrow n+{}^3He) = E_{bind}(^4He) - E_{bind}(^3He) = 28.3 - 7.7 = 20.6$ MeV

$E_{sep}(^4He \rightarrow {}^2H + {}^2H) = E_{bind}(^4He) - E_{bind}(^2H) = 28.3 - 2.23 = 26.07$ MeV

TW Calibration Map



- Each of the two layers was ideally divided into 400 equal regions with an area of 2×2 cm^2 that we called ***pixels***
- A pixel is identified as the area of intersection between a horizontal bar on the front layer and a vertical bar on the rear layer
- The pixel numbering for both layers goes from 0 to 399
- At the end we will obtain 800 well-calibrated positions

Il TOF e' stato calibrato sia in energia che in tempo.
Per la prima volta questo rivelatore ha misurato p (era stato ottimizzato per frammenti pesanti)
Ottenuti spettri in massa combinando informazioni misurate dal Calorimetro
Il prossimo passo sara' la stima delle sezioni d'urto

Next data takings and tests

- BTF - **July 2023**
- Tests and DAQ Integration of ITR &VTX

- CNAO **October/november 2023 – 52 h, ^{12}C @ 200 – 400 MeV/n**
- Apparatus: fully completed! (goal! Doubts on magnet), emulsions
- Beam test goals:
  - Calibration of new modules of calorimeter
  - Integration, tests and threshold calibration of VTX & IT
  - Measurement of the production cross sections for light & «heavy» fragments
  - Measurements of **p-C Fragmentation**
    (with electronics and emulsions set-ups)

Richieste finanziarie FOOT per il 2024

Capitolo	Descrizione	Parziali (K-EU	Parziali SJ (K	Totale/Cap (
consumo	Metabolismo gruppo	1.00	0.00	1
interno	2 meeting di collaborazione di 3g	1.50	0.00	7
interno	20 gg Presa dati al CNAO x 2 per	4.00	0.00	7
interno	Partecipazione a conferenza inte	1.50	0.00	7
Totale	/	0	0	8

GR 3 TOV

Totale Afferenti al gruppo 3 TOV ed FTE

cognome	nome	modulo	contratto	profilo	aff	EIC_NET	FOOT	J_LAB12	MAMBO	perc	tot
Totale(FTE)						0.90	2.30	4.80	4.00		12
Ammendola	Roberto	G2	Dip	Tecnologo	5	10				EIC_NET - 10%	10
D'Angelo	Annalisa	G1	Ass	Incarico di Ri	3	20		70		EIC_NET - 20%	90
Di Salvo	Rachele Anna	G1	Dip	Primo Ricerc	3	10			90	EIC_NET - 10%	100
Fantini	Alessia	G1	Ass	Incarico di Ri	3	20			80	EIC_NET - 20%	100
Lanza	Lucilla	G1	Ass	Scientifica Ri	3	30		70		EIC_NET - 30%	100
Minniti	Triestino	G1	Ass	Scientifica Ri	3		100			FOOT - 100%	100
Morone	Maria Cristina	G1	Ass	Incarico di Ri	3		100			FOOT - 100%	100
Narici	Livio	G1	Ass	Incarico di Ri	2		30			FOOT - 30%	30
Nobili	Giovanni	G3	Dip	Collaboratore	3			50	30	JLAB12 - 50% M	80
Pecchi	Daniele	G3	Ass	Associazione	3			30	40	JLAB12 - 30% M	70
Reali	Enzo	G3	Ass	Incarico di Co	2			30		JLAB12 - 30%	30
Rizzo	Alessandro	G1	Ass	Scientifica Di	3			100		JLAB12 - 100%	100
Romaniuk	Mariia	G1	Ass	Scientifica Er	3				100	MAMBO - 100%	100
Sidoretti	Elena	G1	Ass	Scientifica Di	3			100		JLAB12 - 100%	100
Tusi	Enrico Maria	G3	Ass	Incarico di Co	1			30		JLAB12 - 30%	30
Vitali	Gianni	G3	Ass	Associazione	3				60	MAMBO - 60%	60

Tot FTE: 9,4

Richieste dtz Gr3 TOV per 2024

Applicando algoritmo ad hoc della CSN3, che dipende dagli FTE:

Sez./Lab	nFTE	coordinatore	Interno	Estere	Missioni met.	Consumo	Seminari	Pubblicazioni	Inventario	Totole NON mission	TOTALE
Roma Tor Vergata	9,4	1	4,50	3,00	7,50	4,50	1,00	2,00	12,00	19,50	27,00

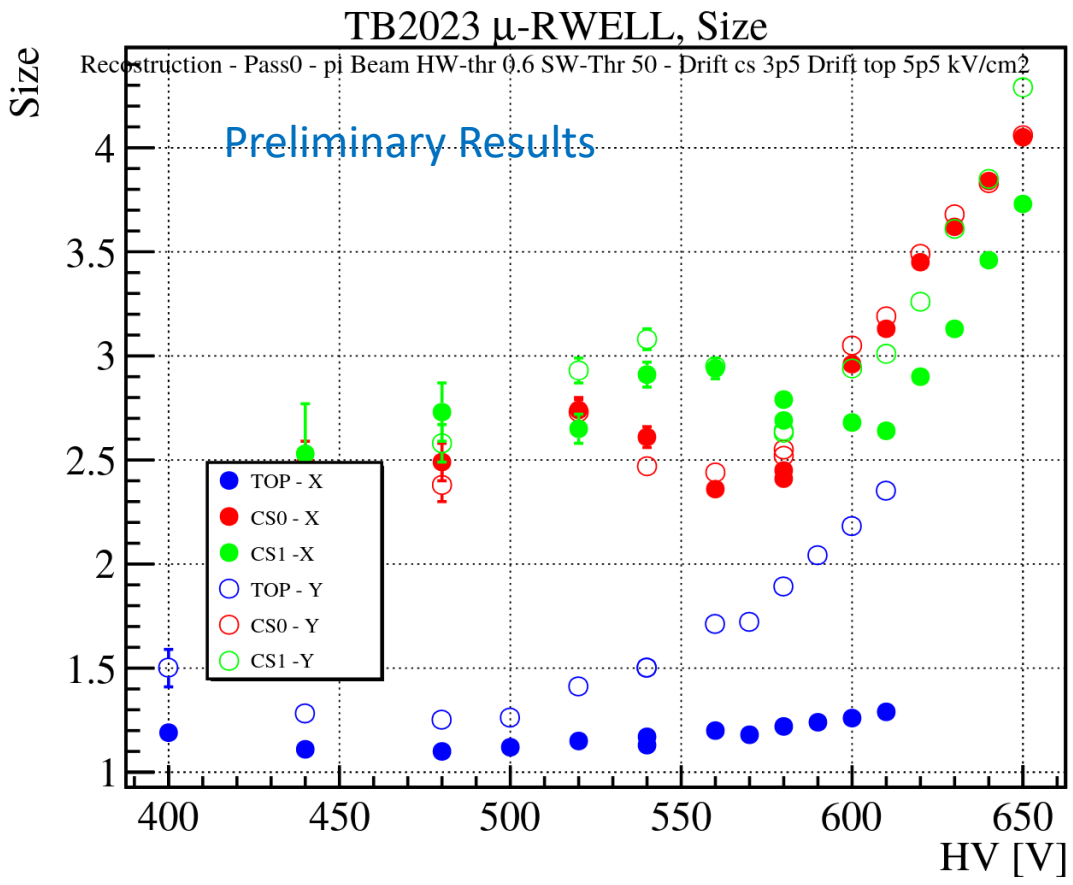
Totale Richieste Gr3 TOV per 2024

struttura	missioni	missioni_sj	consumo	altri_cons	seminari	pubbli	inventario	apparati	totali	totali_sj
EIC_NET-ROMA2	6		1					4	11	
FOOT-ROMA2	7		1						8	
J_LAB12-ROMA2	34.5	6.5	7.5	3			20	27.5	92.5	6.5
DOTAZIONI-ROMA	7.5		4.5		1	2	12		27	
Totale	55	6.5	14	3	1	2	32	31.5	138.5	6.5

Grazie per l’attenzione!

Spare slides

$\mu - Rwell$ for HI-LUMI

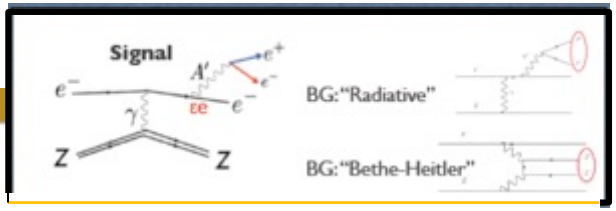


Cluster Size

- CS readout Cluster Size is not lower than 2.5 strips and increases to 4 at higher HV.
- higher cluster size → better resolution
- TOP readout cluster size is fixed at 1.3
- Bottom readout cluster size increases from 1.5 to 2.3 with HV

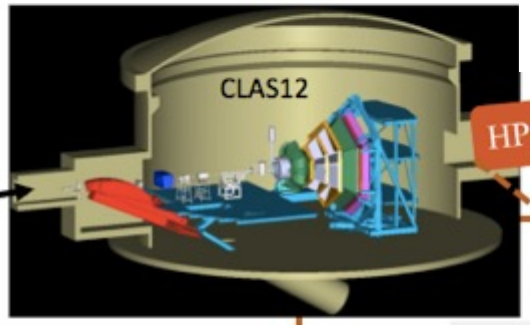
HPS Experiment

Detector



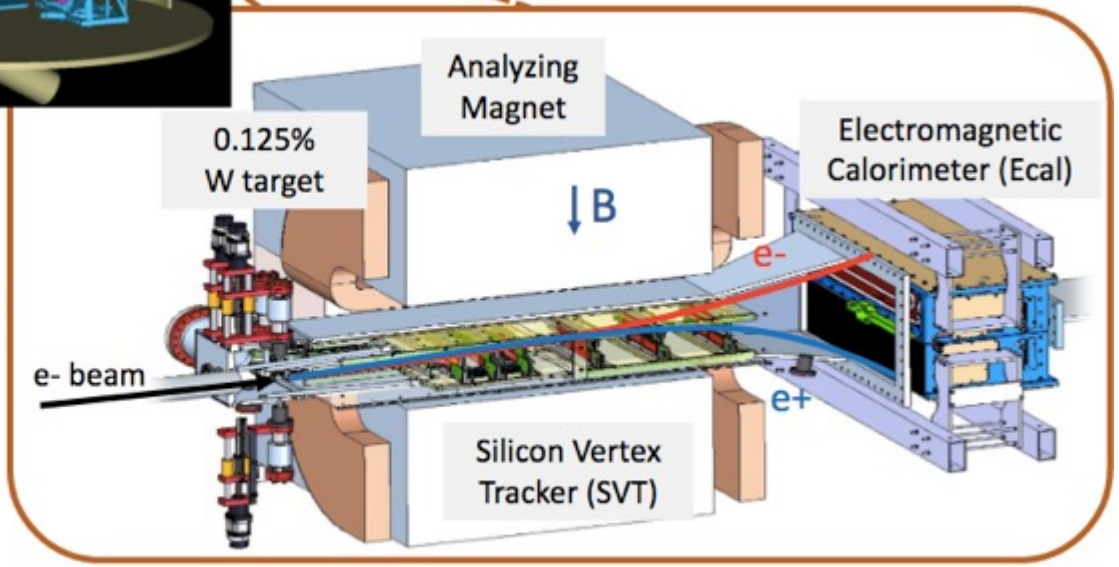
- Searches for A' with **prompt** and **displaced** vertices
- Downstream Hall B alcove
- 2015 Engineering Run, 1 GeV beam at 50 nA
- 2016 Physics Run, 2,3 GeV beam at 200 nA
- 2019 Physics Run **completed.**
- **2021** Physics Run **completed.**

Hall B



Silicon Vertex Tracker:
- Tracks particles
- Momentum and vertex reconstruction

EM Calorimeter:
- Triggers events
- Energy and timing

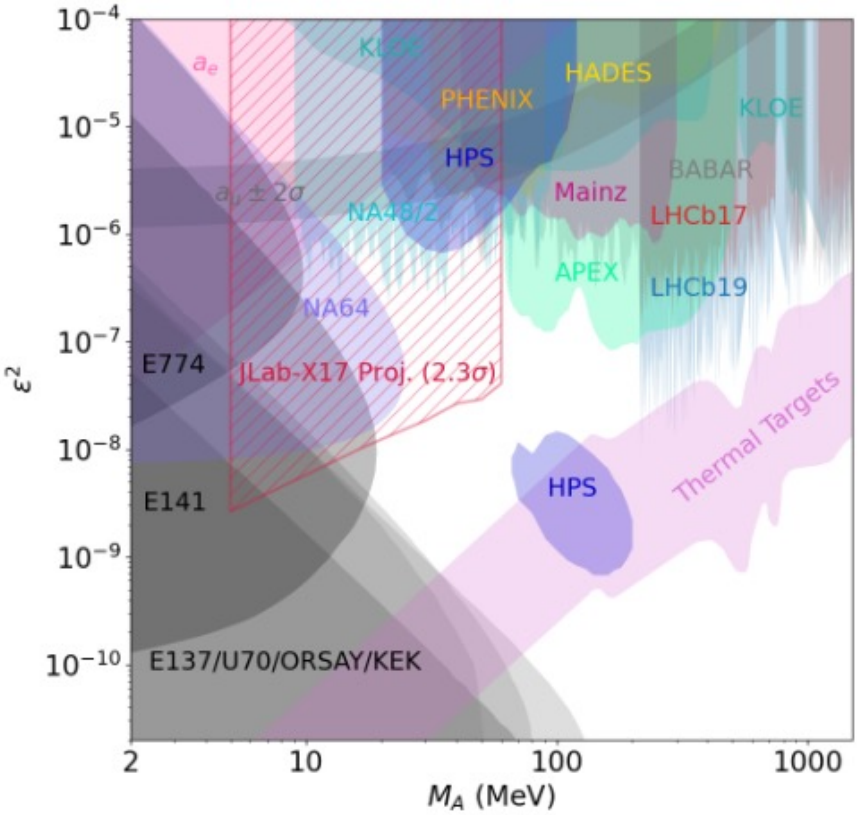


HPS Experiment

Searching for Prompt and Long-Lived Dark Photons in Electro-Produced e^+e^- Pairs with the Heavy Photon Search Experiment at JLab

P. H. Adrian,[1] N. A. Baltzell,[2] M. Battaglieri,[3] M. Bondí,[4] S. Boyarinov,[2] C. Bravo,[1,*] S. Bueltmann,[5] P. Butti,[1]

- **2015 data published**
  Phys Rev D98, 091101(R) 2018
  First Publication on PRD
  Editor's suggestion
- 2019 – data taken
- 2021 – data taken
- 2023 – Long publication including displaced vertex reconstruction events



[P. H. Adrian et al. (HPS Collab.), accepted for publication in Phys. Rev. D (2023)]