Attivita' della Collaborazione Italiana al Thomas Jefferson National Accelerator Facility

Contalbrigo Marco - INFN Ferrara

Jefferson Lab

JLab12 Projects

Sala-B	Tracker SBS HCAL-J (Pre-assembling)	**Nucleon 3D** RM1, CT, BA	E12-07-109 Proton form factor E12-17-004 Neutron form factor E12-09-018 SIDIS off neutron (^{3}He)	2022 2022 2023
Sala-A	RICH1 (Installed) RICH2 (Costruction) HD-Ice (Test)	FE, LNF,GE	E12-06-112 Quark dynamics E12-12-008 TMDs C12-11-111 TMDs C12-12-009 Dihadron probes	2018- 2018- 2021 2021
Sala-B	Forward Tagger (installed)	**Spectroscopy** GE, RM2, TO, PV	E12-11-005 MESONX E12-12-001A J/psi and penta-quark E12-16-010 Hybrid Baryons	2018- 2018- 2018-
	Cristal Calorimetry (Readout Develop.)	**Dark Sector** GE, CT, PV, LNS RM2, TO, PD	E12-11-006 HPS E12-16-001 BDX	2017- 2019-
Sala-A		**Nuclear Potentials** RM1	E12-17-003 Lambda-nn off trithium (^{3}H) E12-11-101 PREX-II: neutron skin E12-15-008 Lambda hypernuclei	2018 2019 2024

A multi-channel digitiser for BDX experiment

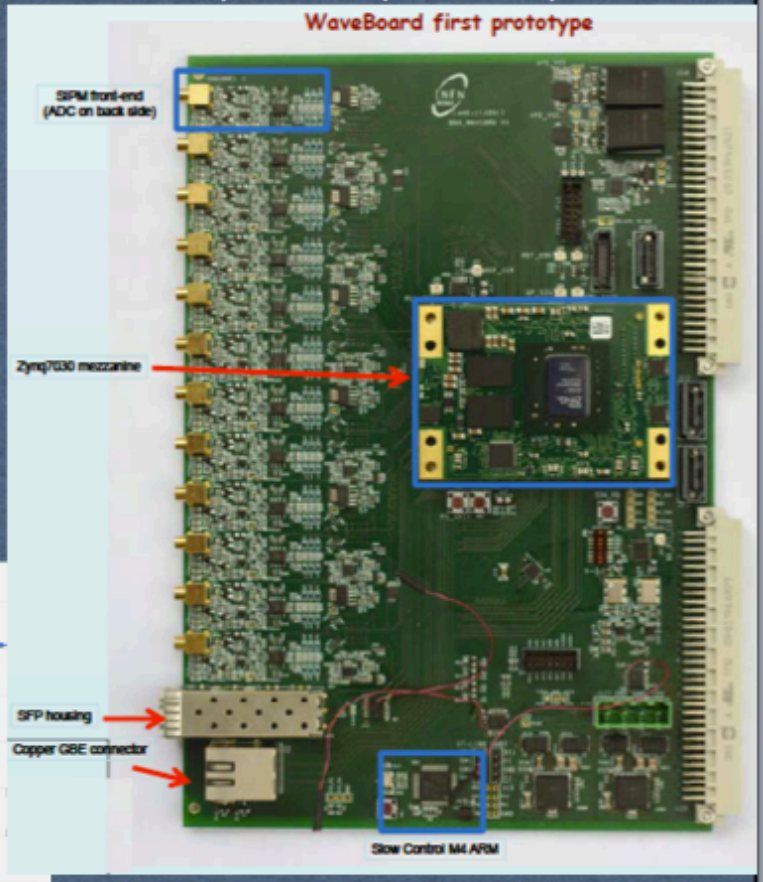
Requirements:

- Streaming readout capability
- high speed, multi-channel, multi interface (optical/ethernet)
- low-cost
- modular design (FE, sampling rate, n. bits, …)

Joint effort:
INFN-RM, INFN-GE, INFN-BO, INFN-CT

WaveBoard

- Architecture inherited from KM3NET (FastADC, trigger-less FE, scalable event building)
- FE: 12ch, MCX, SiPM dual gain amplifiers, HV on-board, individually controlled
- Sampling unit: 6x dual 65MHz/125MHz /160MH/250MHz, 12 or 14 bit
- Timing: external clock/timestamp (GPS), internal PLL (jitter<0.4ps)
- Board control: SoM (Zynq 7030 or 7040 or 7045 FPGA),
- Slow controls: M4 ARM to control DAC, ADC, HV, EPICS interface
- Network: GbE, MGT tranceiver, USB 2.0, TCP/IP, WhiteRabbit
- VME connector only for power (+5V, -5V) and mechanical support
- Board cost depends on the configuration (range: 1.5k to 3k per board)



Status of the project

- Four prototype boards produced and under test (v1.0)
- Firmware development underway
- v2.0 expected by the endow 2018
- Next step: test on 50ch BDX calorimeter module (CsI(Tl) crystal + SiPM)

F. Ameli, M. Battaglieri, M. Bondì, M. Capodiferro, A. Celentano, T. Chiarusi, G. Chiodi, R. Lunadei, M. Napoli, L. Marsicano, Paolo Musico, L. Recchia, D. Ruggieri, L. Stellato

CLAS News

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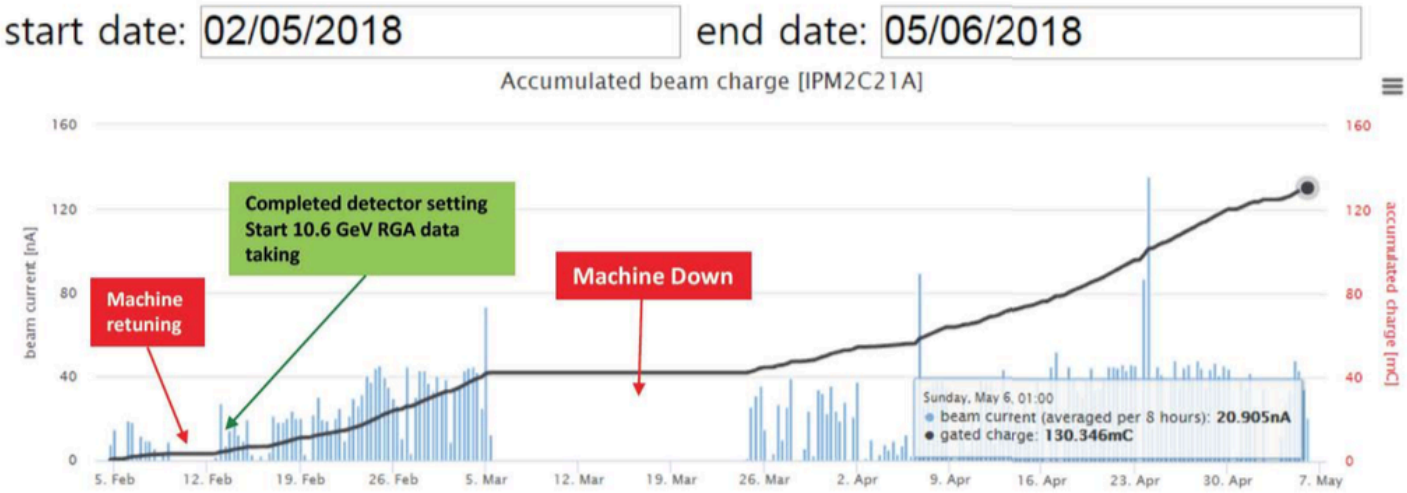
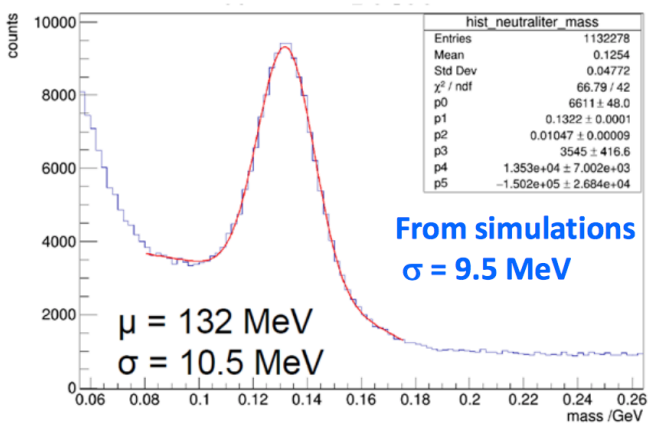
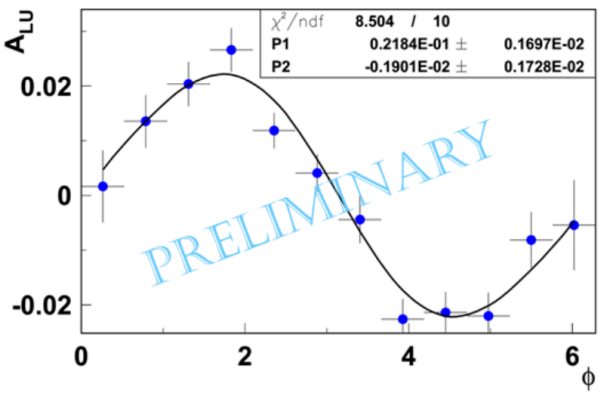
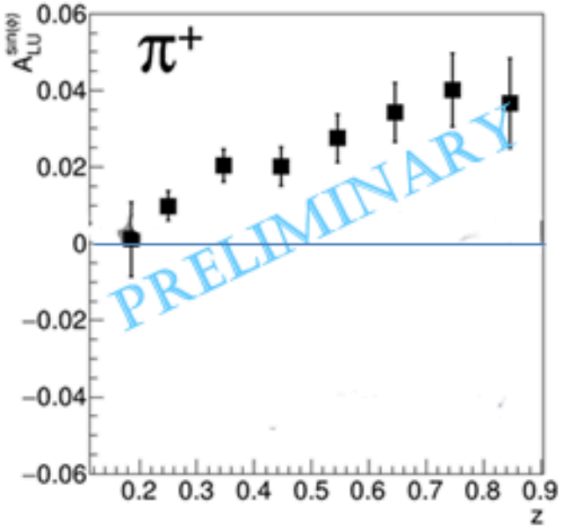


M. Mirazita at SPIN2018:







CLAS News

PORTALE INFN SERVIZI ELENCO TELEFONICO Info Cerca...

INFN Istituto Nazionale di Fisica Nucleare

HOME ISTITUTO STRUTTURE ESPERIMENTI PROGETTI COMUNICAZIONE OPPORTUNITÀ DI LAVORO

omunicazione

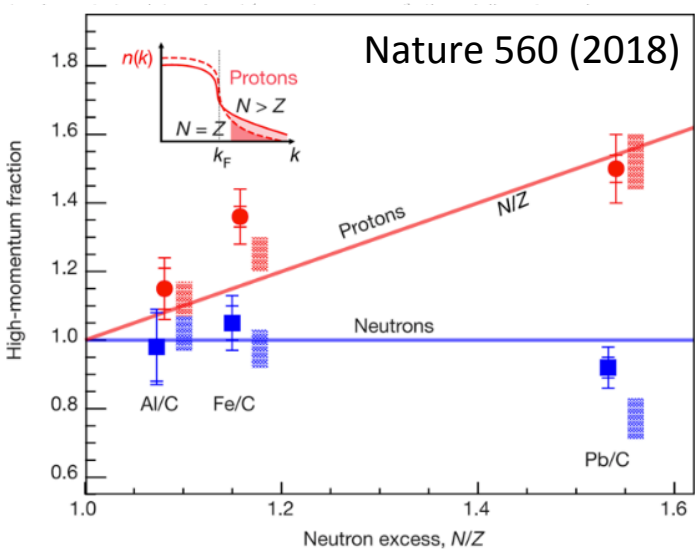
- Ufficio Comunicazione
- Comunicati stampa
- News
- Newsletter
- Rassegna Stampa
- Mostre e Installazioni
- Eventi
- Approfondimenti
- Infografiche e poster
- Brochure
- Editoria
- Asimmetrie
- Immagini
- Video
- Social network

14 AGOSTO 2018

DALL'ESPERIMENTO CLAS NUOVI RISULTATI SUL RUOLO DEI PROTONI NELLE STELLE DI NEUTRONI

Sono i protoni responsabili della componente più energetica del cuore delle stelle di neutroni. Lo studio, riportato il 13 agosto sulla rivista scientifica Nature, è stato ottenuto in laboratorio grazie alle osservazioni dell'esperimento CLAS all'acceleratore CEBAF del Jefferson Lab, negli Stati Uniti, con il contributo dei ricercatori italiani dell'INFN.

Il nucleo ator
per descriver
indipendente
e neutroni) aumenta. Questa semplice descrizione rende
stato provato che circa il 20% dei nucleoni non vivono in
coppie il cui comportamento non è descritto dal modello
nucleoni della coppia correlata, interagendo, hanno medi



In alcune condizioni estreme, come quelle che si incontra
nucleoni, la dinamica dei nuclei viene di solito descritta fa
nei nuclei asimmetrici (in cui il numero di neutroni è mag
elevata) aumenti, diminuisca o resti costante è importan
dell'energia nel nucleo è portata dai protoni e che il loro r

L'esperimento CLAS impiega elettroni di alta energia (5 G
diversi, come i nuclei di carbonio, ferro e piombo, con nu
collisione con un nucleo l'elettrone colpisce una coppia c
selezionare per la prima volta quegli eventi in cui si sono
quindi provenienti da coppie protone-neutrone interagenti.

"Grazie a queste osservazioni, – spiega **Marco Battaglieri**, della sezione INFN di Genova che lavora a CLAS e ha preso parte allo studio – è

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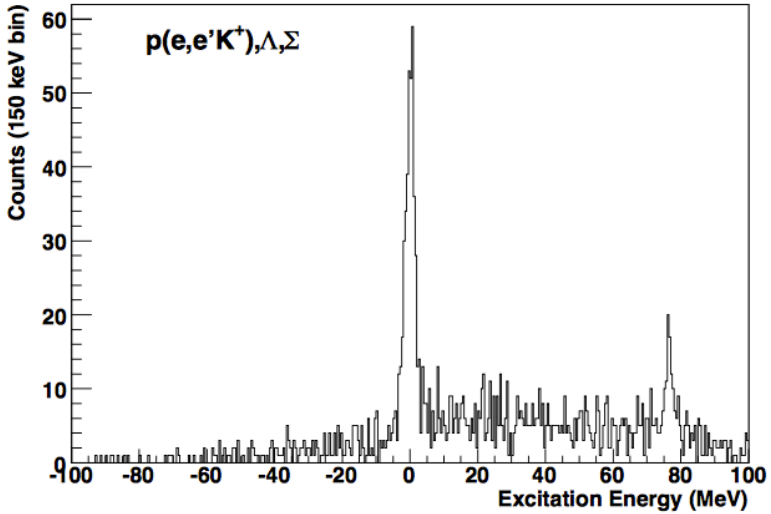
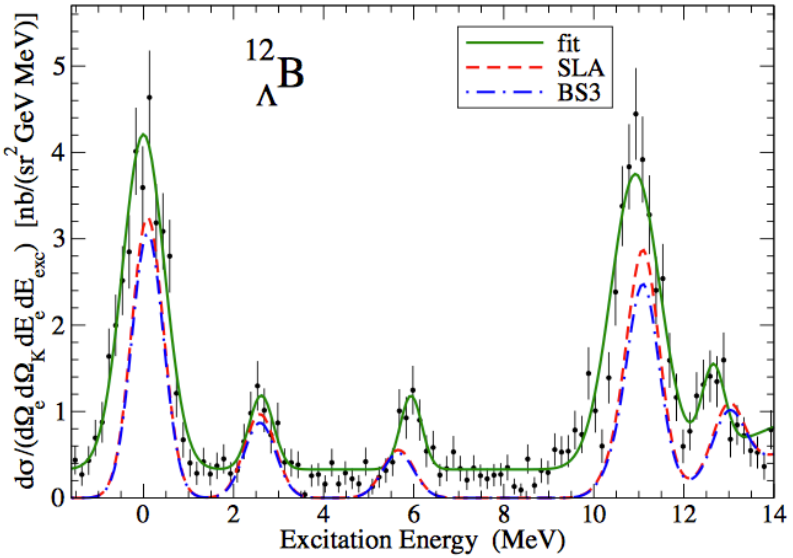
High-resolution hypernuclear spectroscopy at Jefferson Lab, Hall A

F. Garibaldi,[1] A. Acha,[2] P. Ambrozewicz,[2] K.A. Aniol,[3] P. Baturin,[4] H. Benaoum,[5] J. Benesch,[6] P.Y. Bertin,[7] K.I. Blomqvist,[8] W.U. Boeglin,[2] H. Breuer,[9] P. Brindza,[6] P. Bydžovský,[10] A. Camsonne,[7] C.C. Chang,[9] J.-P. Chen,[6] Seonho Choi,[11] E.A. Chudakov,[6] E. Cisbani,[12] S. Colilli,[12] L. Coman,[2]

Calibration reaction





HPS News

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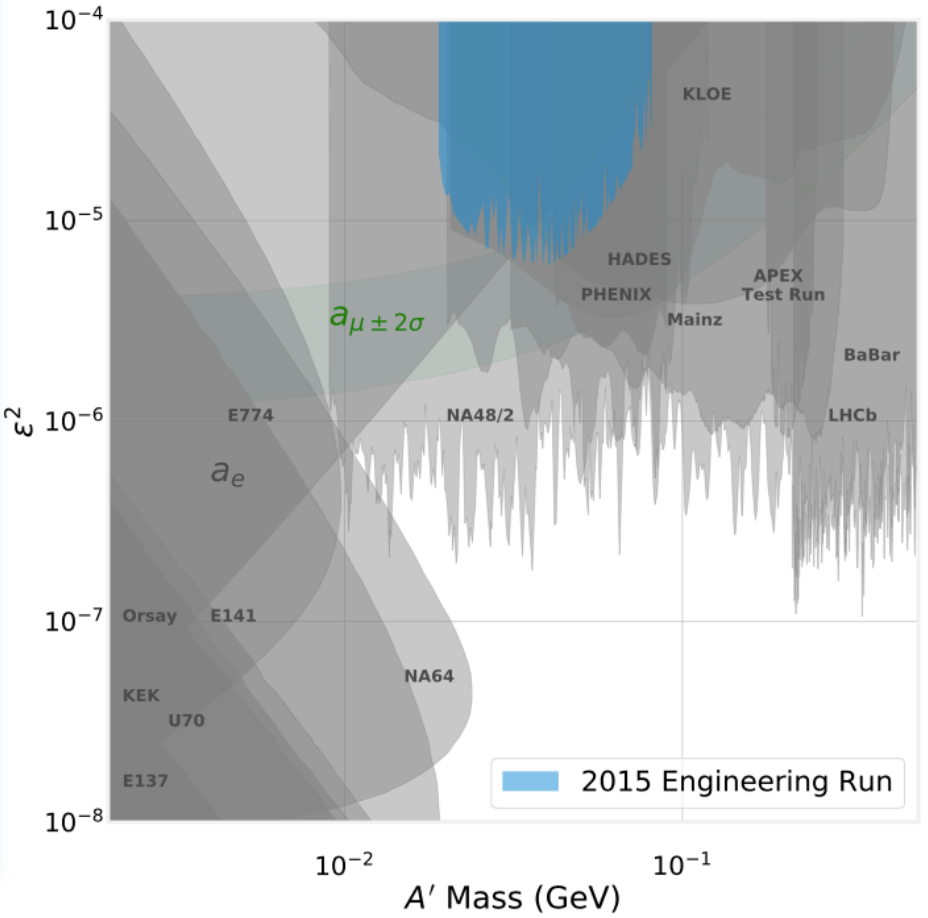
The first HPS physics paper has been submitted to PRD Rapid Communications

Based on ~1 % approved data-taking



Search for a Dark Photon 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] S. Bueltmann,[5] V. D. Burkert,[2] D. Calvo,[6] M. Carpinelli,[7,8] A. Celentano,[3] G. Charles,[9] L. Colaneri,[10,11] W. Cooper,[12] C. Cuevas,[2] A. D'Angelo,[10,11] N. Dashyan,[13] M. De Napoli,[4] R. De Vita,[3] A. Deur,[2] R. Dupre,[9] H. Egiyan,[2] L. Elouadrhiri,[2] R. Essig,[14] V. Fadeyev,[15] C. Field,[1] A. Filippi,[6] A. Freyberger,[2] M. Garçon,[16] N. Gevorgyan,[13] F. X. Girod,[2] N. Graf,[1] M. Graham,[1] K. A. Griffioen,[17] A. Grillo,[15] M. Guidal,[9] R. Herbst,[1] M. Holtrop,[18] J. Jaros,[1] G. Kalicy,[5] M. Khandaker,[19] V. Kubarovsky,[2] E. Leonora,[4] K. Livingston,[20] T. Maruyama,[1] K. McCarty,[18] J. McCormick,[1] B. McKinnon,[20] K. Moffeit,[20] O. Moreno,[1,15,*] C. Munoz Camacho,[9] T. Nelson,[1] S. Niccolai,[9] A. Odian,[1] M. Oriunno,[1] M. Osipenko,[3] R. Paremuzyan,[18] S. Paul,[17] N. Randazzo,[4] B. Raydo,[2] B. Reese,[1] A. Rizzo,[10,11] P. Schuster,[1,21] Y. G. Sharabian,[2] G. Simi,[22,23] A. Simonyan,[9] V. Sipala,[7,8] D. Sokhan,[20] M. Solt,[1] S. Stepanyan,[2] H. Szumila-Vance,[2,5] N. Toro,[1,21] S. Uemura,[1] M. Ungaro,[2] H. Voskanyan,[13] L. B. Weinstein,[5] B. Wojtsekhowski,[2] and B. Yale[18]

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[6]*INFN, Sezione di Torino, 10125 Torino, Italy*
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[10]*Università di Roma Tor Vergata, 00133 Rome Italy*
[11]*INFN, Sezione di Roma Tor Vergata, 00133 Rome, Italy*
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[14]*C. N. Yang Institute for Theoretical Physics, Stony Brook University, Stony Brook, NY 11794, USA*
[15]*Santa Cruz Institute for Particle Physics, University of California, Santa Cruz, CA 95064, USA*
[16]*IRFU, CEA, Université Paris-Saclay, F-91191 Gif-sur-Yvette, France*
[17]*College of William & Mary, Williamsburg, Virginia 23187, USA*
[18]*University of New Hampshire, Durham, New Hampshire 03824, USA*
[19]*Idaho State University, Pocatello, ID, 83209, USA*
[20]*University of Glasgow, Glasgow G12 8QQ, United Kingdom*
[21]*PerimeteVr Institute, Ontario, Canada N2L 2Y5*
[22]*Università di Padova, 35122 Padova, Italy*
[23]*INFN, Sezione di Padova, 16146 Padova, Italy*

(Dated: August 7, 2018)

The Heavy Photon Search experiment took its first data in a 2015 engineering run at the Thomas Jefferson National Accelerator Facility, searching for a prompt, electro-produced dark photon with a mass between 19 and 81 MeV/c^2. A search for a resonance in the e^+e^- invariant mass distribution, using 1.7 days (1170 nb^{-1}) of data, showed no evidence of dark photon decays above the large QED background, confirming earlier searches and demonstrating the full functionality of the experiment. Upper limits on the square of the coupling of the dark photon to the Standard Model photon are set at the level of 6×10^{-6}. Future runs with higher luminosity will explore new territory.

PACS numbers: 14.70.Pw, 25.30.Rw

News from JLab

BDX (Hall-A) approvato dal PAC46
Complimenti alla collaborazione per l'ottimo lavoro di preparazione

Alessandro Bacchetta e' nuovo membro del PAC

Andrei Seryi nuovo Associate Director degli acceleratori al posto di A.Hutton
Fulvia Pilat (Deputy Director degli acceleratori) si e' trasferita a Oak Ridge

Volker Burkert (Leader di sala-B) ha deciso di passare la mano, nominato il comitato per la successione

Visita INFN al JLab (A.Masiero, E.Nappi, M.Taiut, P.Campana) 23/24 maggio 2018

Stefano Lami (Attache' scientifico all'Ambasciata Italiana di Washington) sta organizzando un incontro col management JLab all'ambasciata (4/5 dicembre)
All'ordine del giorno: borse summer-students + mini workshop sulla fisica al JLab

Collaborazione Italiana:

Un caloroso benvenuto al nuovo gruppo **Pavia-Brescia**

Ricercatori						
	Nome	Età	Contratto	Qualifica	Aff.	%
1	Bianconi Andrea		Associato	Prof. Associato	CSN III	100
2	Evans Craig William		Associato	Assegnista	CSN III	50
3	Mascagna Valerio		Associato	Ricercatore Tempo Determinato Tipo A	CSN III	10
4	Solazzi Luigi		Associato	Ricercatore	CSN III	50
5	Venturelli Luca		Associato	Prof. Ordinario	CSN III	30
				Numero Totale Ricercatori	5	FTE: 2.4

Tecnologi						
	Nome	Età	Contratto	Qualifica	Aff.	%
1	Leali Marco		Associato	Tecnico Categoria B	CSN III	50
				Numero Totale Tecnologi	1	FTE: 0.5

Marco Contalbrigo eletto Responsabile Nazionale JLab12 prossimo triennio
RN unico risultato di anni di programmi sostenibili e condivisi

Raffaella De Vita eletta spokeperson della Collaborazione CLAS
e nominata responsabile ad interim del software

Marzio De Napoli eletto nell'Executive Committee di HPS

News

Da gennaio 2018: presa dati in contemporanea in tutte e 4 le sale sperimentali

run di primavera esteso di circa un mese fino a maggio 2018
run di autunno 2018 iniziato a meta' agosto (sofferenze su missioni)

Hall-A:

Dec 17 - Nov 18:	Esperimenti con bersaglio di trizio
Spring 19:	Esperimento APEX (fotone pesante)
Summer 19:	PREX-II (raggio neutroni piombo)
Fall 19:	CREX (raggio neutroni calcio 48)
2020:	SBS era

Hall-B:

CLAS12 installed and fully operational

Dec 17 – Jan 18	Engineering run
Feb 18 – May 18	RGA: fascio a 10.6 GeV, bersaglio di idrogeno (22/139 PAC days)
Aug 18 – Nov 18	RGA: seconda parte
Nov 18 – Dec 18	RGK: fascio a 6.5 e 7.5 GeV
Jan 19 – Mar 19	RGB: fascio a 10.6 GeV, bersaglio di deuterio
Jun19 – Sep 19	HPS

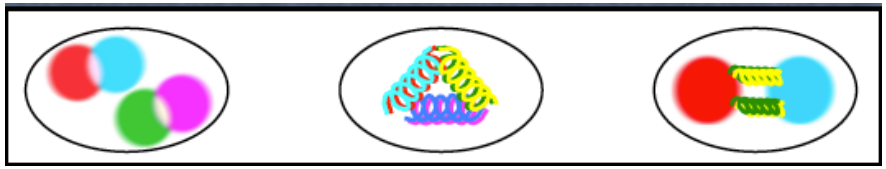
Spectroscopy

Unprecedented precision with electro-production at very low-Q^2

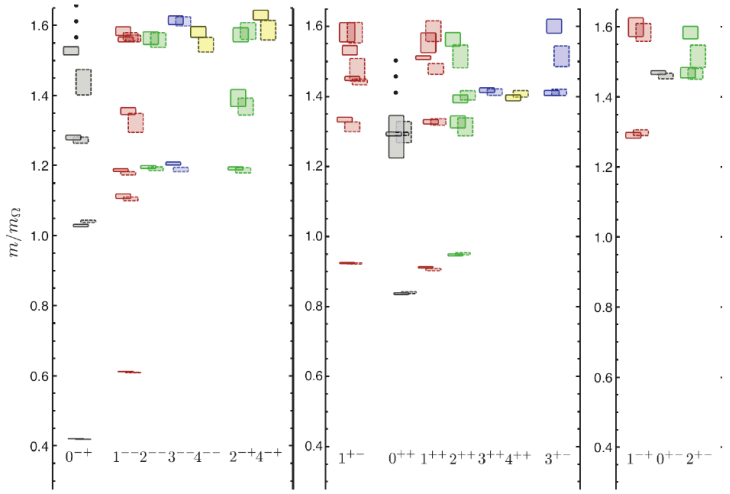
E12-11-005 **MesonEx** Study the meson spectrum in the 1-3 GeV mass range to identify gluonic excitations of meson (hybrids) and other quark configurations beyond the CQM

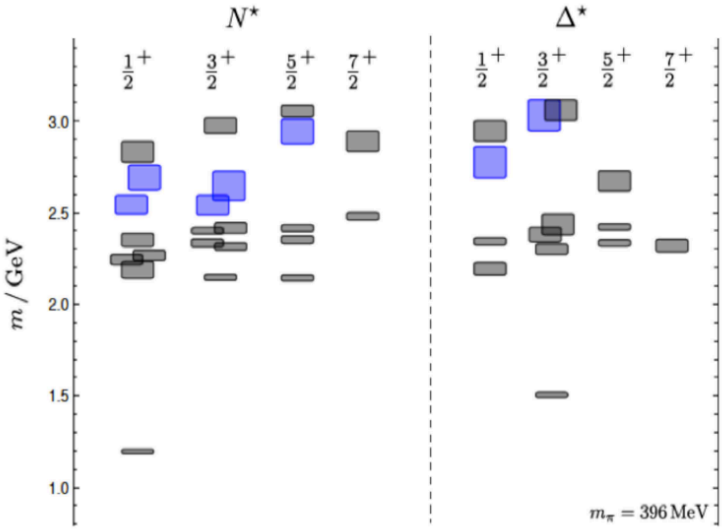
E12-16-010 **Hybrid Baryons** Study the nucleon excitation spectrum with emphasis on the high mass region and gluonic excitations

Mesons



Baryons





Forward Tagger Project Status

Coordination: INFN-Genova

Contributors: CEA, INFN-Ge, INFN-Roma2, U. Edinburg, U. Glasgow, JLab, James Madison U., Norfolk State U., Ohio U.

Full Forward Tagger installed in CLAS12 in July 2017

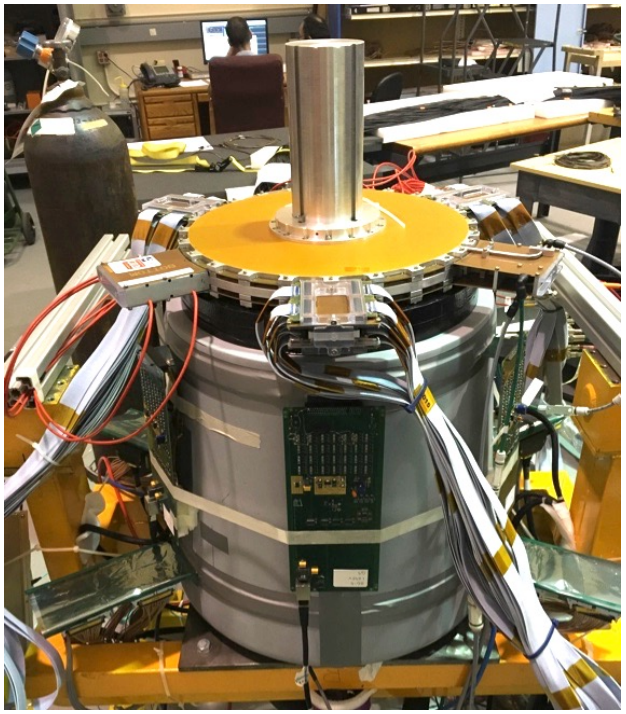
Commissioned with cosmic ray data in July- November 2017 to study:

- Response of individual detectors
- Efficiency and energy calibration
- Relative timing

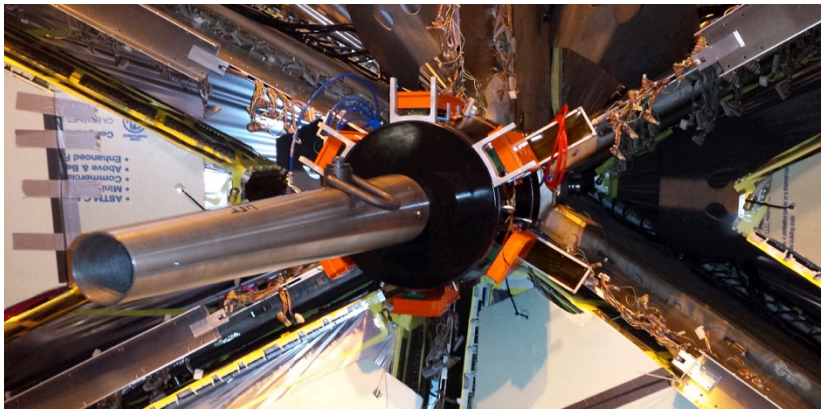
Delayed start of on-beam commissioning due to defective fitting in calorimeter cooling circuit, repaired in January 2018

On-beam commissioning during CLAS12 engineering run in January 2018

First physics from February to May 2018 at 10.6 GeV



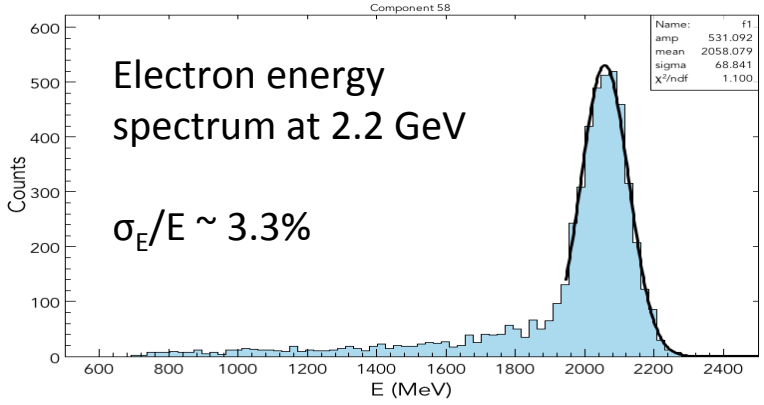
Forward Tagger during cosmic ray tests



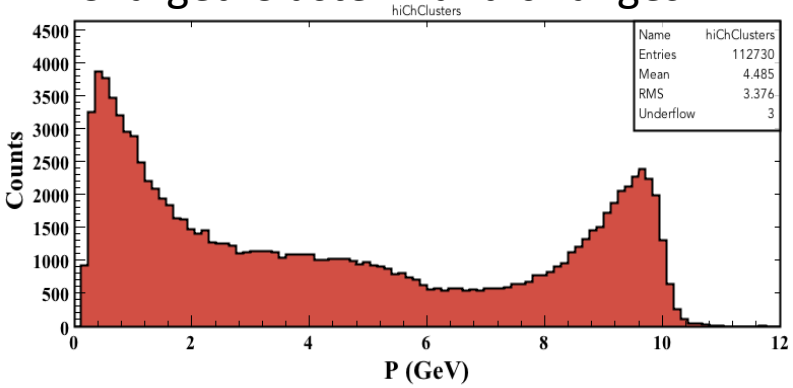
Forward Tagger Calorimeter during the installation in CLAS12

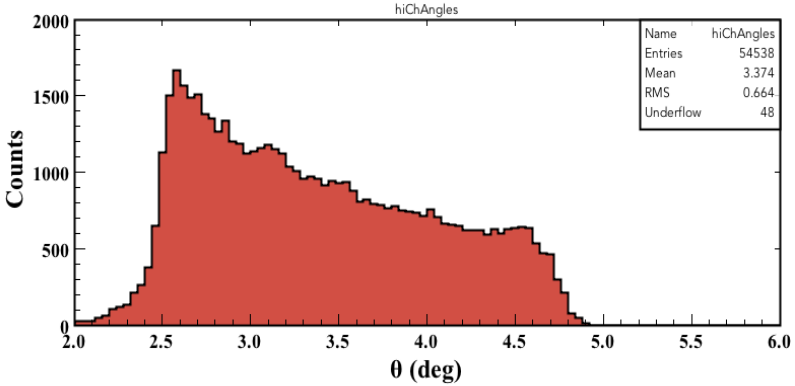
FT Performances

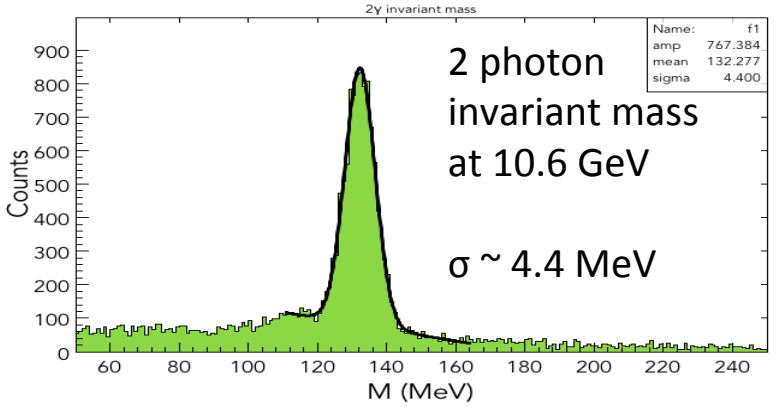
Performance	Expected Value	Measured Value
Azimuthal angular coverage	2.5° to 4.5°	2.6° to 4.6°
EM shower energy range	(0.5-8) GeV	(0.3 – 9.5) GeV
Energy resolution	$\sigma_E/E \leq 2\%/\sqrt{E(GeV)} \oplus 1\%$	3.3% @ 2 GeV
Angular resolution	$\sigma_\theta/\theta \leq 1.5\%$, $\sigma_\phi \leq 2°$	tbd
Time resolution	≤ 300 ps	200 ps



Charged Cluster E and θ ranges

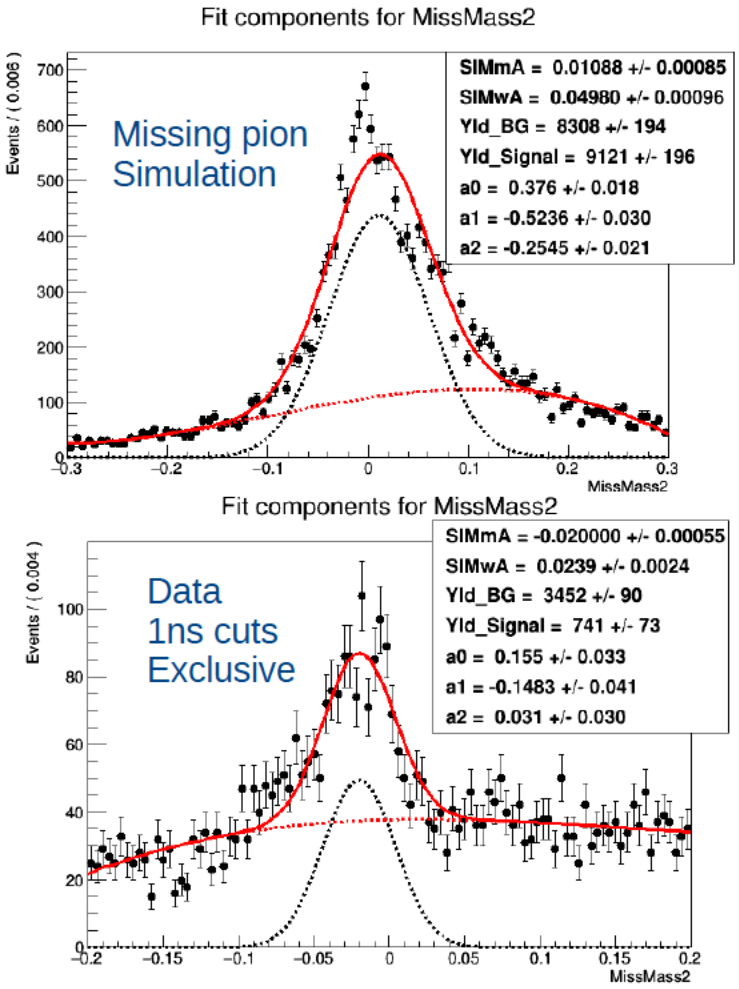






- Energy and angular acceptance match or exceed design ranges
- Initial energy calibration based on elastic electrons at 2.2 GeV: 3.3 % resolution @ 2 GeV still limited by accuracy of calibration (being improved) and energy threshold (20 MeV) used at 2.2 GeV
- Timing resolution on spec

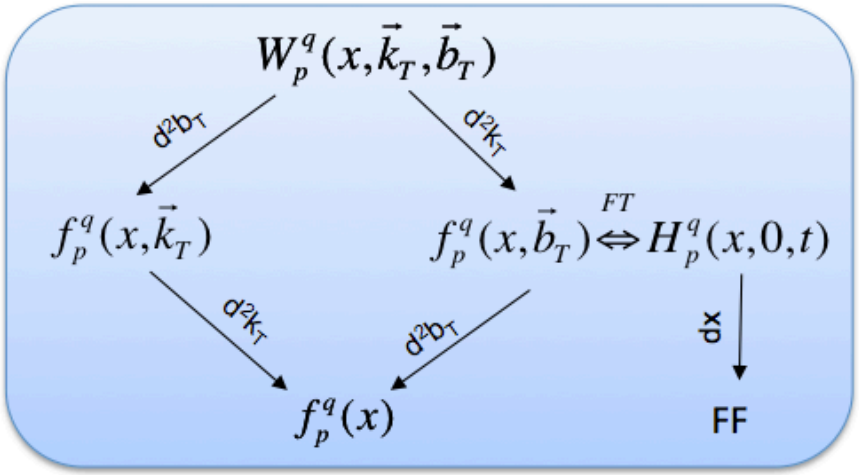
First analysis of 2018 data focusing on 2-pion production at 10.6 GeV, with electron detected in the FT and hadrons in CLAS12



2019 Activities:

- First analysis on meson spectroscopy and strangeness rich states from 2018 data
- Continue data taking at 10.6 GeV
- FT in use for exotic baryons search (experiment with INFN leadership)
- NIM paper in preparation

JLab12 able to provide x 1000 luminosity (vs HERMES) at large x



RICH Project Status

Coordination: INFN-FE

Contributors: INFN-FE,LNF,RM1,BA,GE, JLab, ANL, GWU, Duquesne U., UCONN, Glasgow U, UTFSM (Chile), KNU (Korea)

Supported by premiale CLASMED

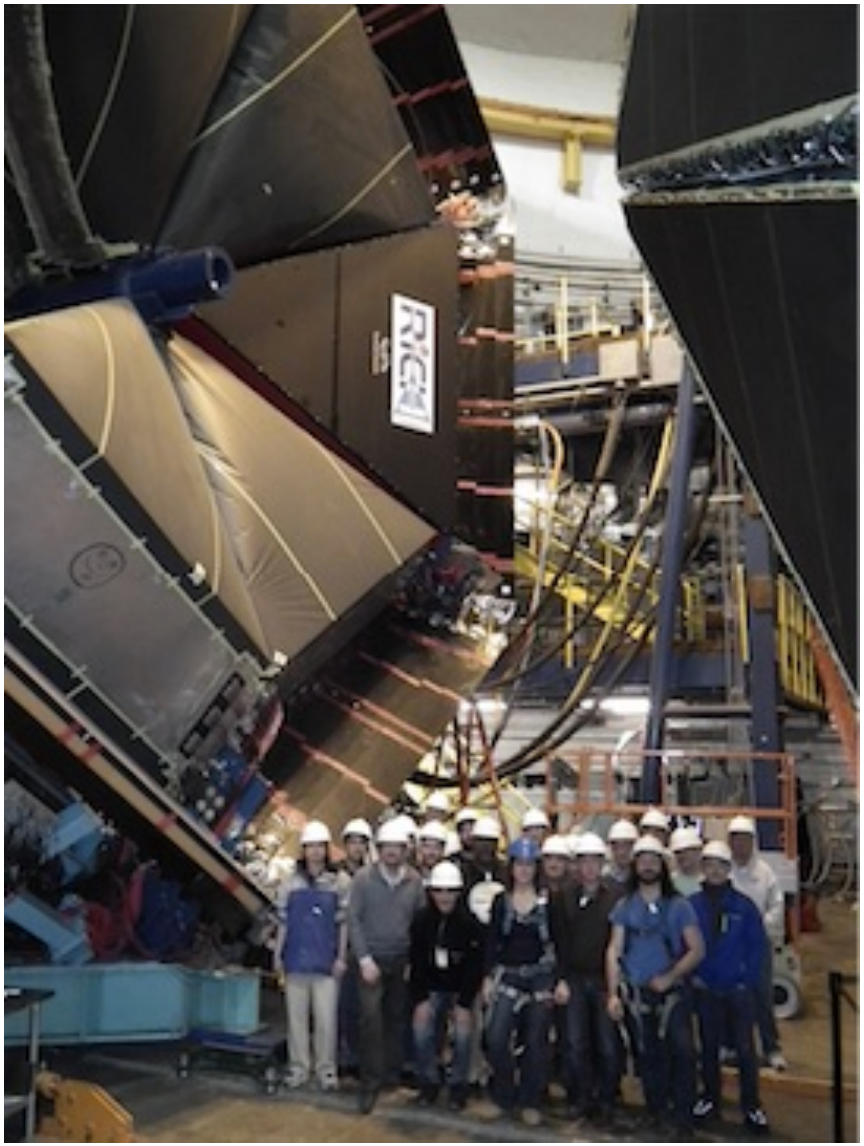
RICH 1st Module Installed in January 18

Commissioning with cosmic ray data in November 17

Commissioning with beam during CLAS12 engineering run in January 18

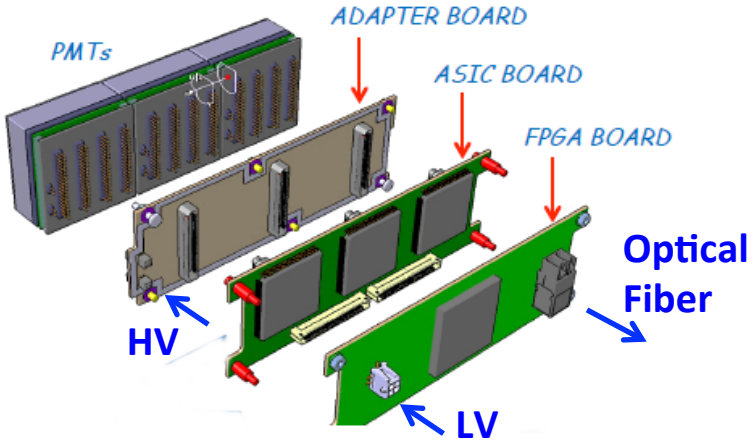
First physics run from February to May 2018 at 10.6 GeV

RICH 2nd Construction ongoing
Module expected to be ready in 2021



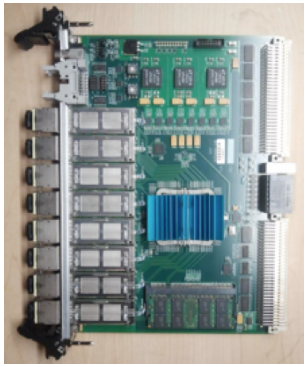
Readout Electronics

Compact (matches sensor area)
Modular Front-End (Mechanical adapter, ASIC, FPGA)
Scalable fiber optic DAQ (TCP/IP or SSP)
Tessellated (common HV, LV and optical fiber)

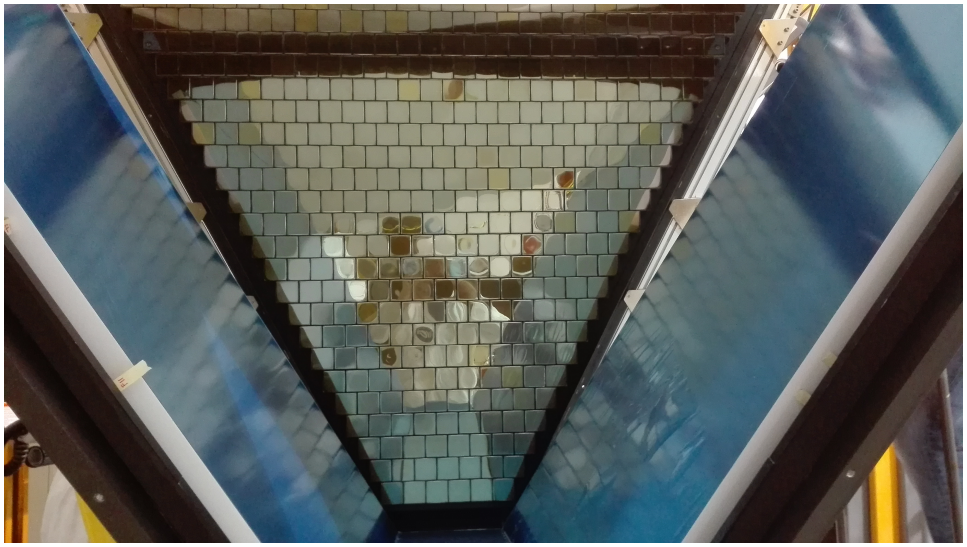


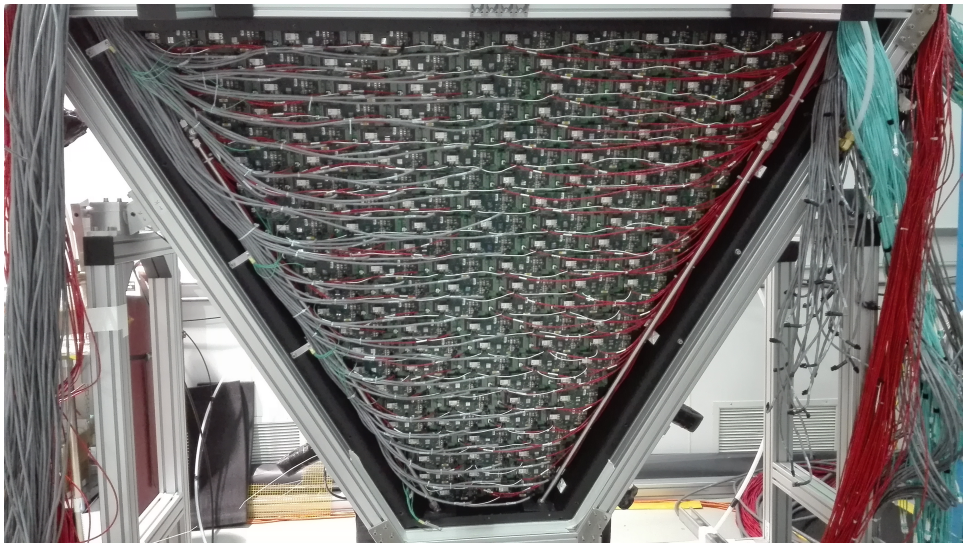
Applications:

- Gluex DIRC
- EIC R&D
- SOLID
- Medical Imaging
- Homeland Security



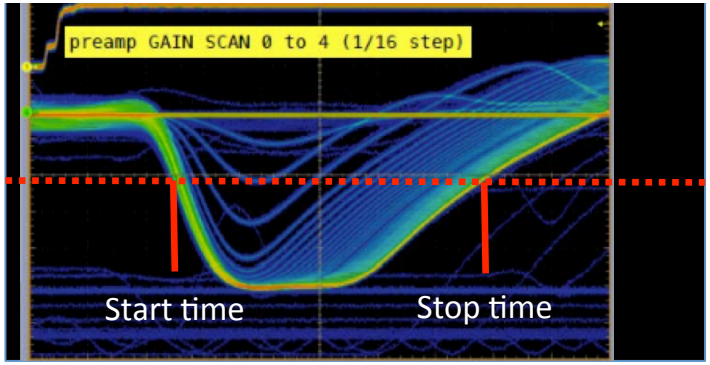
SSP Fiber-Optic DAQ

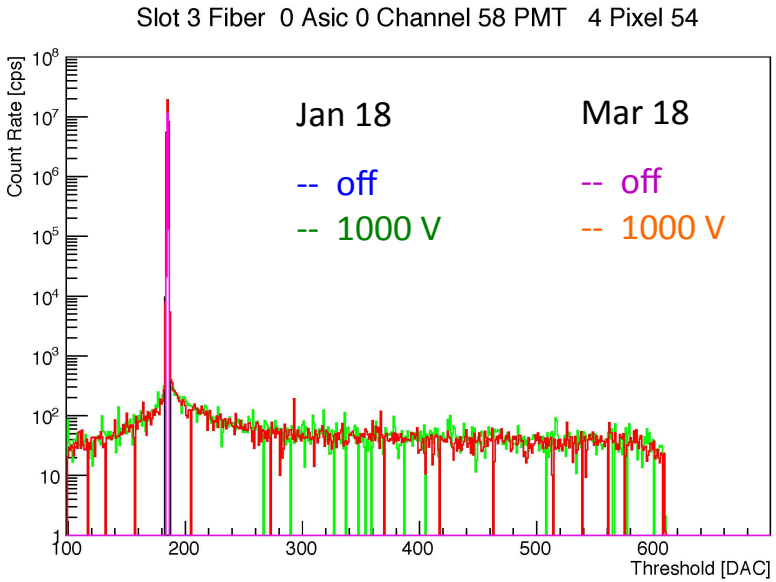




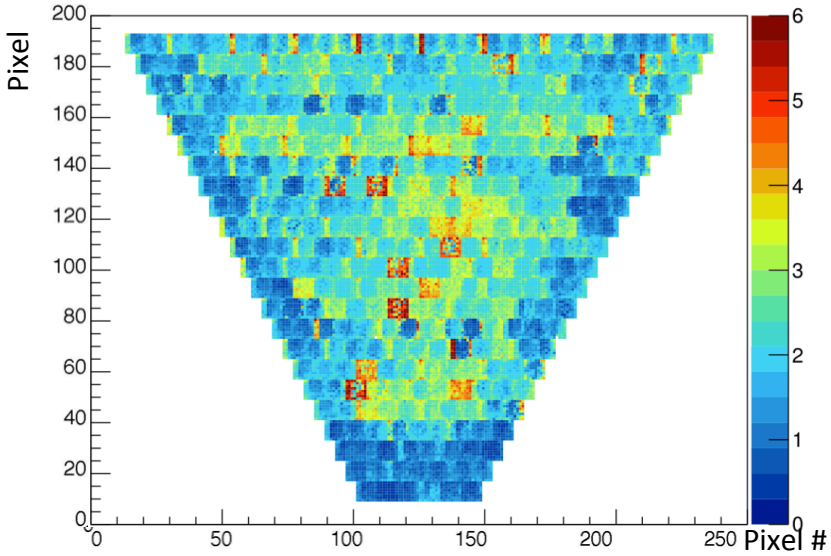
Electronic Pedestals

Digital readout requires fine control of the pedestals and efficiency

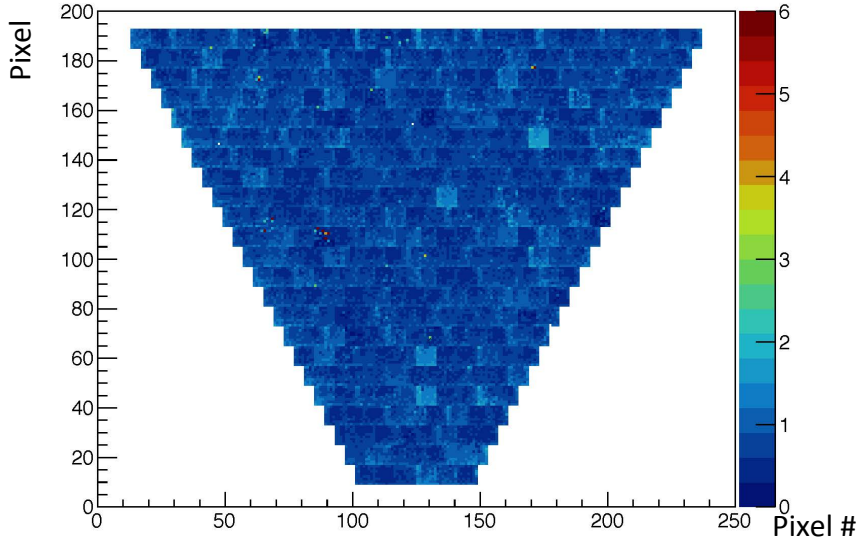




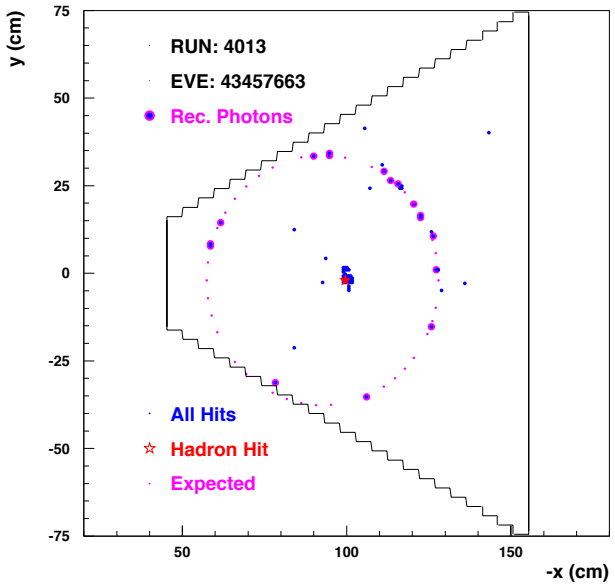
Pedestal rms [DAC unit]: without

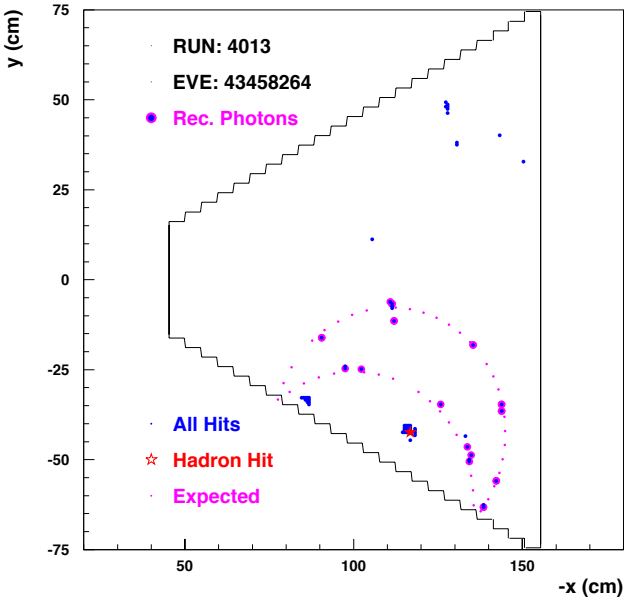


and with grounding grid

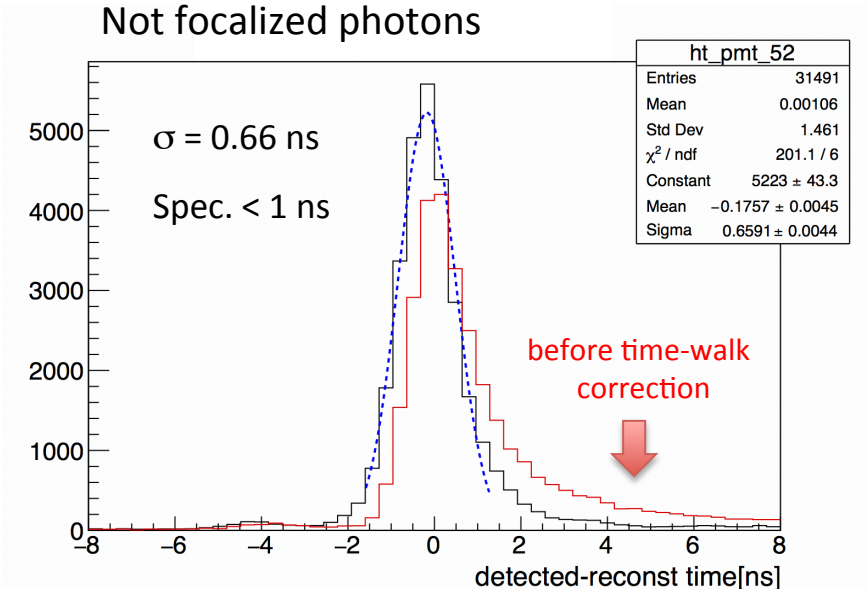


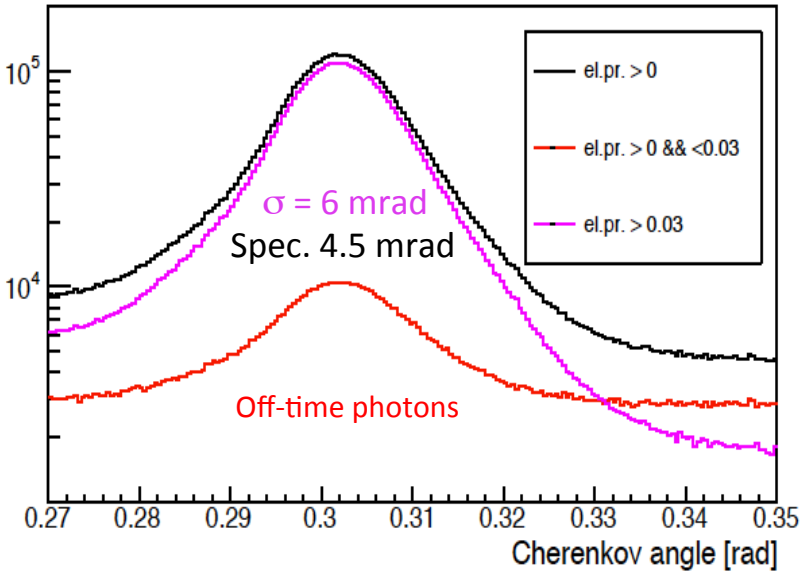
Single-photon Time Resolution





Not focalized photons





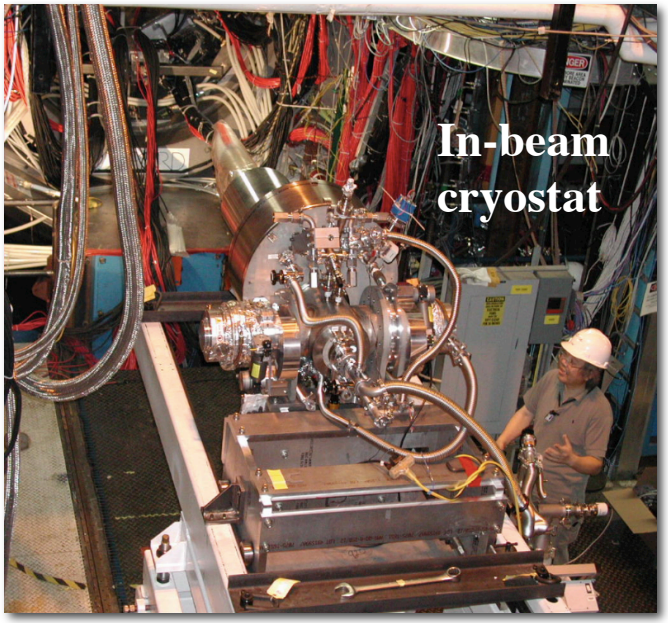
HD-ice: Frozen Spin Polarized Target

Polarized targets of solid HD in frozen spin mode.
Longitudinal and Transverse Polarizations: up to 60% H or 35% D.

Solid Deuterium-Hydride:
- condensed in a Production Dewar (PD);
- transferred to a Dilution Fridge and polarized at T=25 mK and B= 17 T - spins freeze over time (3 months);
- transferred in an in-beam refrigerator for experiments.

Advantages:
- ✓ Dilution factors ~ 1
- ✓ Low holding magnetic fields
- ✓ Relaxation time T_1 ~ 1 year

Physics Program:
CLAS6 – g14 resonance photoproduction on polarized neutron. PRL118,242002(2017). PRC sub.
CLAS12 proposals (High Impact – A ratings):
- SIDIS C12-11-111 **P.I.** M. Contalbrigo
- Di-hadron C12-10-009 P.I. H. Avakian
- DVCS C12-12-101 L. Elouadrhiri

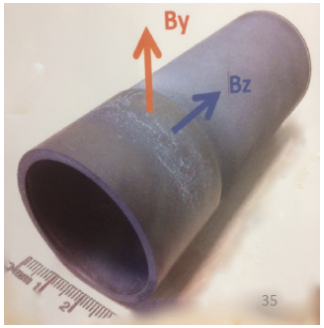


C.D. Bass, A. D'Angelo et al. NIM A737(2014)107–116
M. Lowry, A. D'Angelo et al., NIM A 815 (2016), 31-41.

On-going INFN Contributions
1. **Magnetic Vari-Temp Cryostat** used for HD condensation and NMR measurements (PD2). Participation to the In-beam cryostat construction.
2. **Raman** analysis of ortho-hydrogen and para-deuterium impurities in HD gas and realization of a new compact Raman spectrometer.
3. Design and construction of a new MgB_2 superconducting magnet for transverse polarization.
4. **HD gas distillation:** INFN-Jab contract for the realization of a new still and its installation in Rome.

2019 Activity:
1. New **HALO Counter** for beam alignment and validation of 10 MeV electron test-beam interaction with HD target and in-beam cryostat.
2. New **NMR** polarization measurements with frequency sweeping

MgB_2 Superconducting Magnet

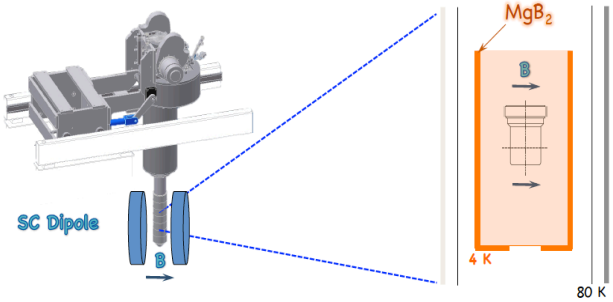


Transverse Polarization inside a Solenoid

Need of a magnet able to **cancel** the longitudinal magnetic field from CLAS12 Solenoid (2T) and to **generate** a transverse field to hold the target polarization (1T).
Longitudinal and Transverse Polarizations: up to 60% H or 35% D.

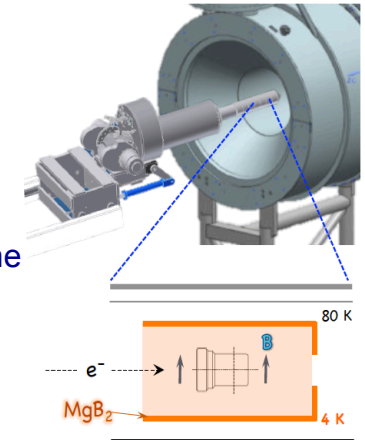
Solution: MgB_2 high temperature superconducting cylinder.

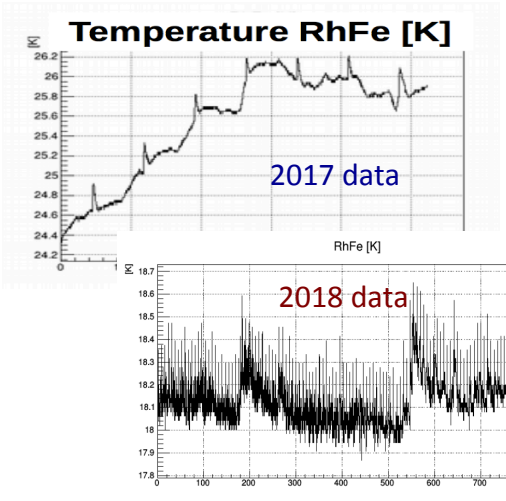
M. Statera et al. NIM A882(2018)17-21



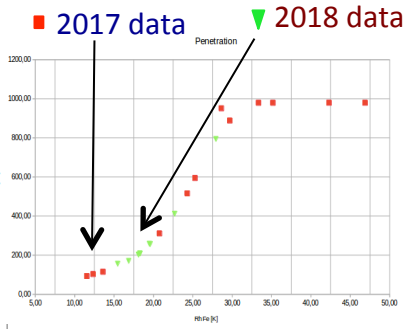
Procedure:

1. Application of an **external transverse magnetic field**
2. **Cooling** at 4 K
3. **Ramping down** the external magnetic field .
4. **Diamagnetic currents** are generated which hold the field
5. In-beam Cryostat is **rotated and inserted** in CLAS12 solenoid
6. Currents in **MgB_2** are spontaneously modified to hold the transverse field and to screen the longitudinal one.





Stability Tests in Ferrara



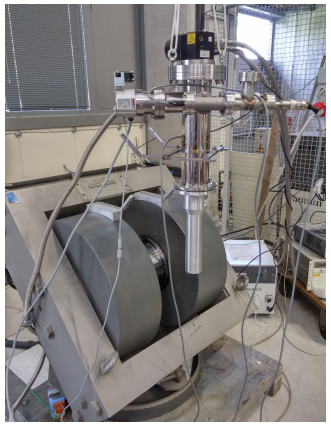
Planned activities

Cryostat modifications:

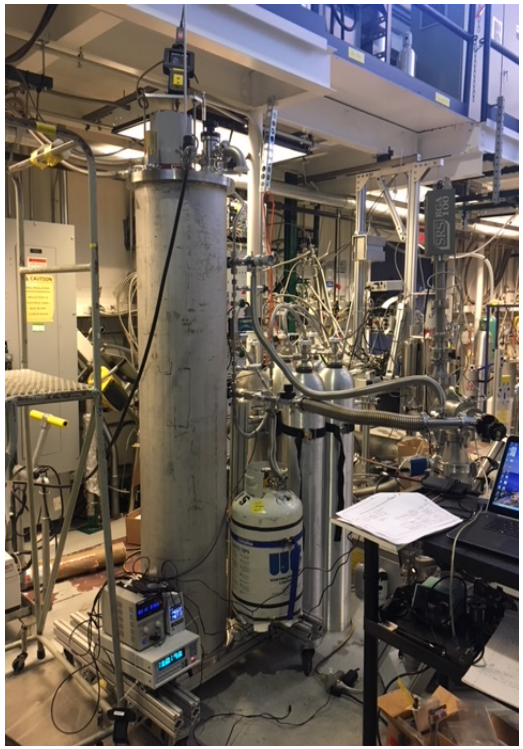
- dipole magnetic field in solenoid measurements
- new cold-head installation for stable performances at 4K

New mechanical handling system:

- to mimic the procedure foreseen inside CLAS12.



HD Gas Distillation and Raman Analysis



HD gas distillation

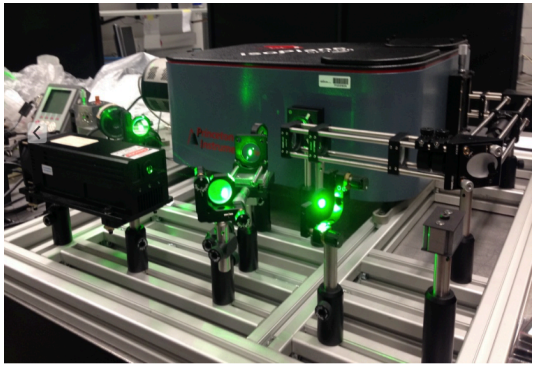
Very pure HD gas is needed to produce polarized targets.

JLAB Still

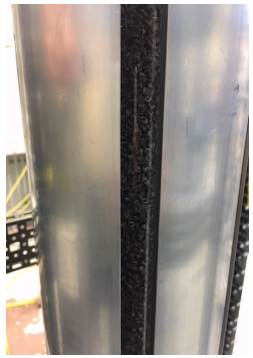
A new Still had been designed and constructed at JLAB and it will be installed in Rome.
It is designed to reduce the purity of the commercially available HD gas from 99.99% to 99.9999%, as needed.

Raman spectroscopy is used in Rome to analyze the content of H_2 and D_2 contaminants in the HD gas.

A new **compact Raman spectrometer** has been designed and assembled in collaboration with ISAS in Berlin. It will be able to analyze the gas purity during the HD distillation process.



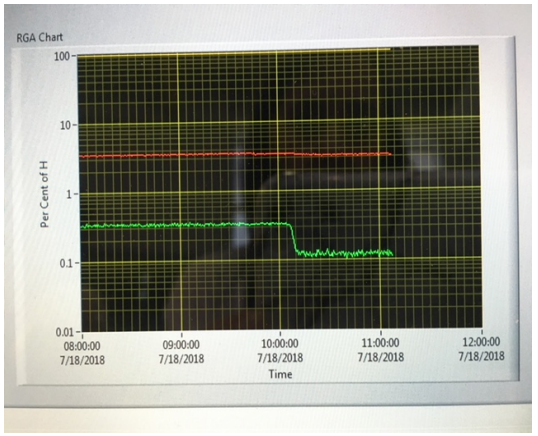
Top : 18.5 K



Bottom : 19.5 K

Still Commissioning:

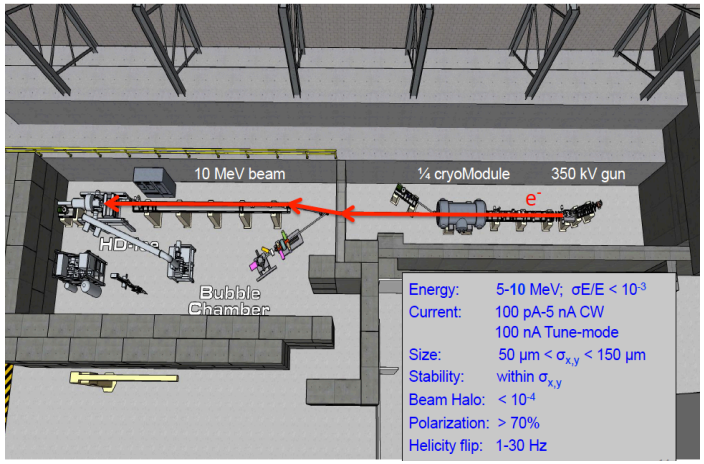
1. **HD condensation** in the still column at **T= 16.7 K p=124 mbar**
2. Establishing a **gas/liquid mixture separation: T= 18.5 K** at the top (condenser) **T=19.5 K** at the bottom (boiler) of the still column, by heating the bottom with 2W power.
3. **Gas extraction:** 0.05 ltr/min controlled flow
4. **RGA** on-line measurement shows D2 drop as a proof of successful distillation.

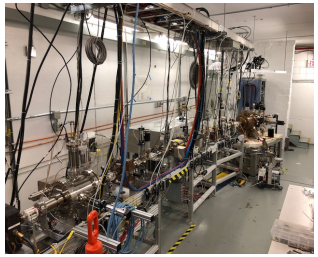


e-HD Test Beam

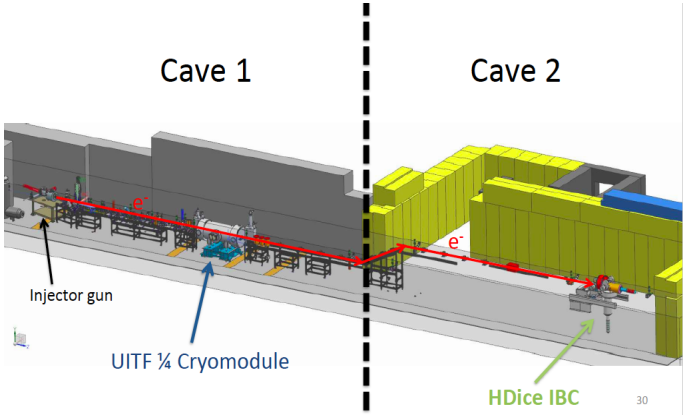
- Polarization measurements under **electron beam** are needed to measure relaxation time as a function of accumulated electron current.
- **A dedicated 10 MeV electron beam is being constructed :** Upgraded Injector Test Facility (**UITF**)

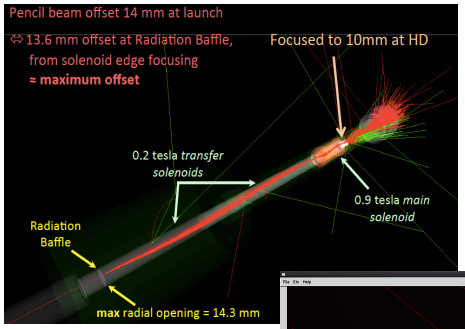
The accelerator construction is complete

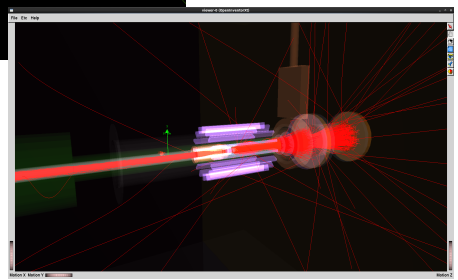




Beam is expected on target in summer 2019







Planned activities: test diagnostics

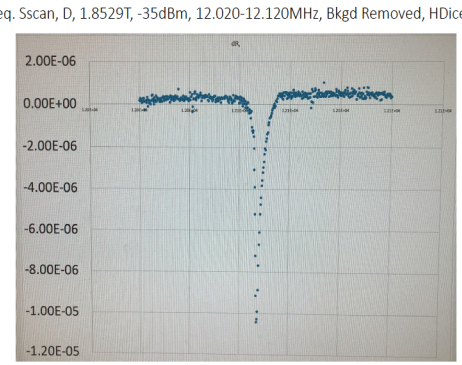
HALO counter for beam monitoring:

- 16 scintillators with magnetic field resistant optical read-out.
- new cold-head installation for stable performances at 4K

New **NMR** set-up :

- frequency sweep at high field to monitor target polarization.

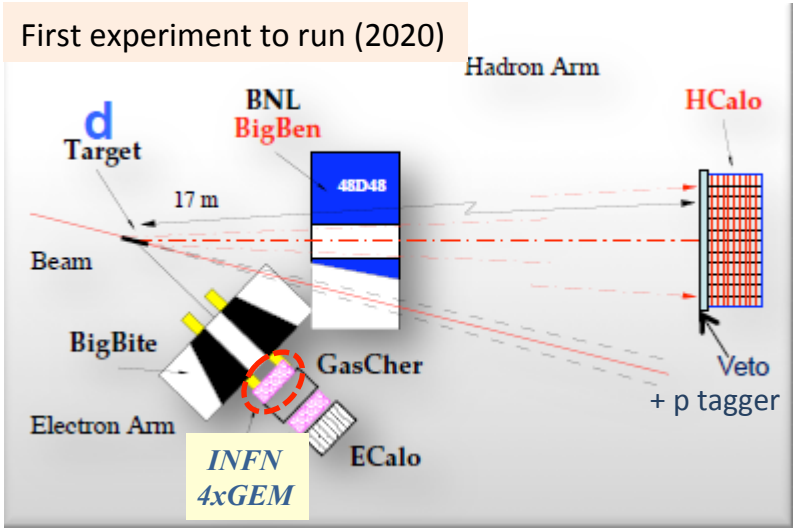
UHFLI Zurich Instruments double lock-in amplifier - 600Mz RF



INFN Tracker in SBS/BB Experiments

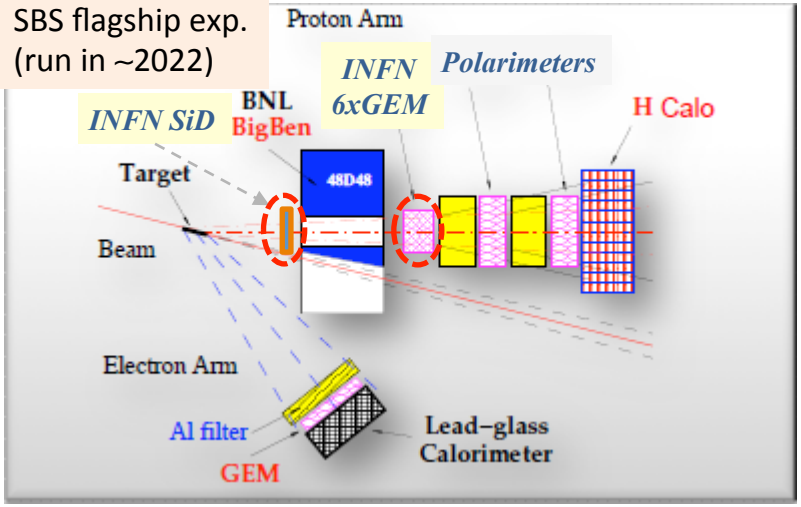
E-12-09-019: GMn - Cross section ratio

First experiment to run (2020)



E-12-07-109: GEp - Polarization transfer

SBS flagship exp.
(run in ~2022)



SBS-BB project has originally proposed for Form Factors experiments at high momentum transfer (Q^2~14 $[GeV/c]^2$), at the **luminosity frontier (>10^{38}/cm^2/s)**

SBS-BB is a **configurable detectors facility** (sort of «LEGO detectors») optimized for the specific experimental needs

Layouts have evolved and improved; additional experiments have been submitted and approved

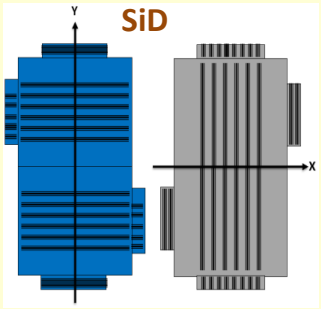
Exp. program expected to starts in 2020 and continue till 2023, at least

SBS-BB experiments	
(A1n	2006)
GEp*	**2007**
GEn	**2009**
GMn	**2009**
SIDIS*	2009
TDIS-pi	2015
TDIS-K	2017
WACSpol	2017
GEN-RP*	2017

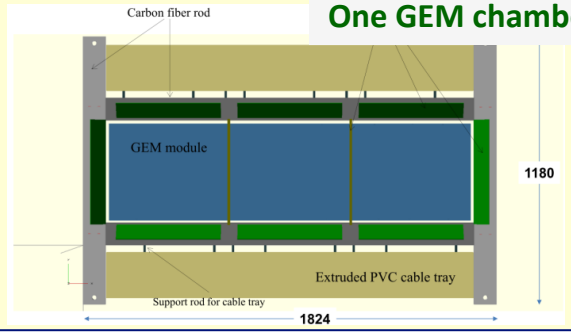
(* INFN spokespersonship)

RM1+BA+CT+GE responsible for the **Front Tracker** made of:

- **2 silicon ustrip (SiD) detector planes (2 sensors each)**
- **6 large chambers (made of 3 GEM modules each)**



One GEM chamber



Tracker (GEM+SID) Status and Plan

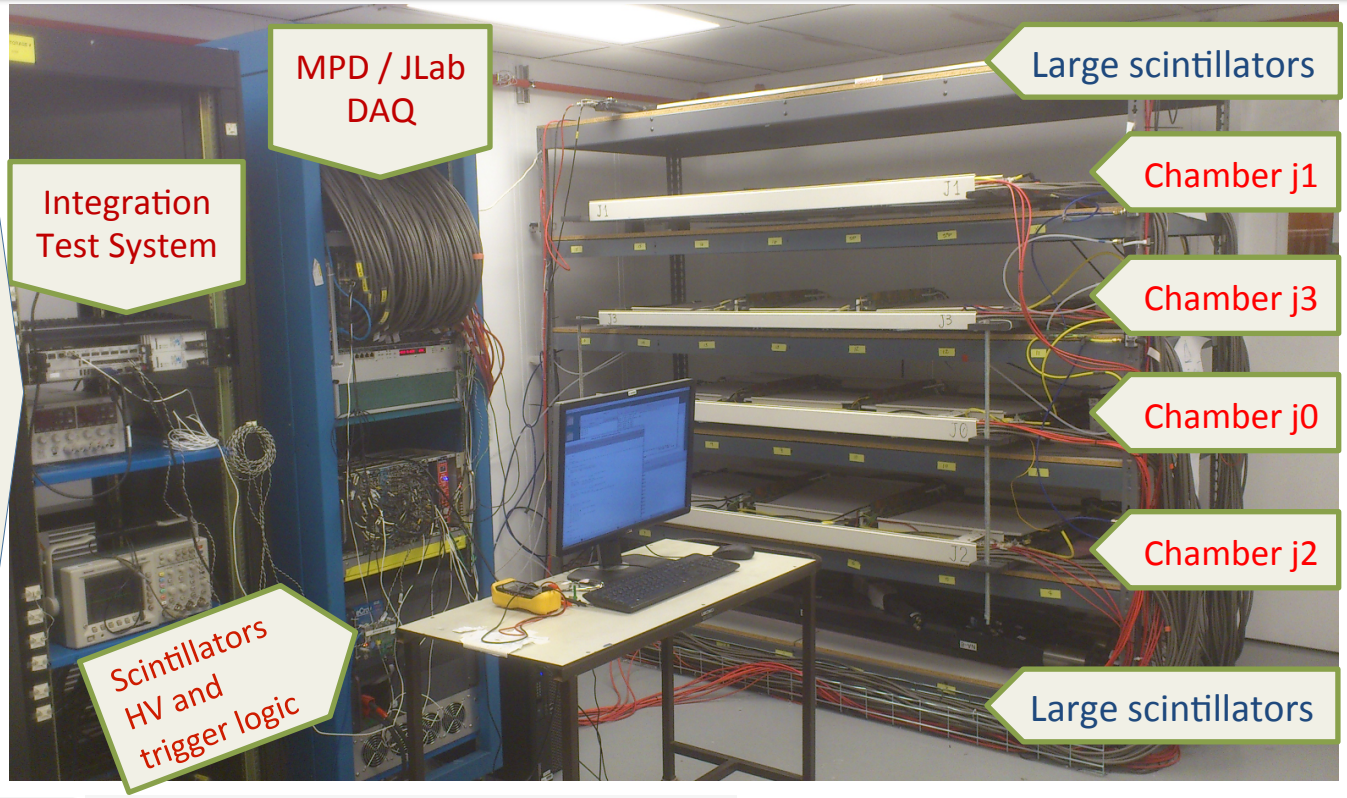
GEM:

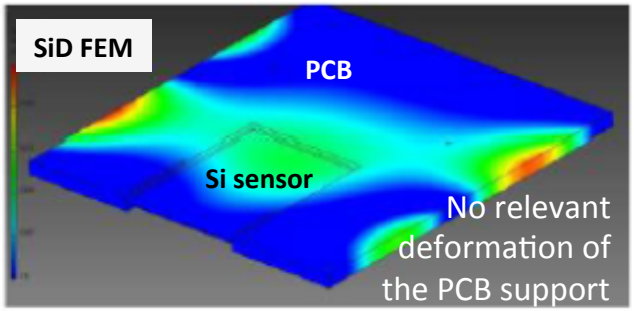
Jul/2018: 4 chambers under cosmic test @JLab; 1 chamber ready for assembling; components under finalization for last chamber

1st half 2019: Continue testing and fixing.

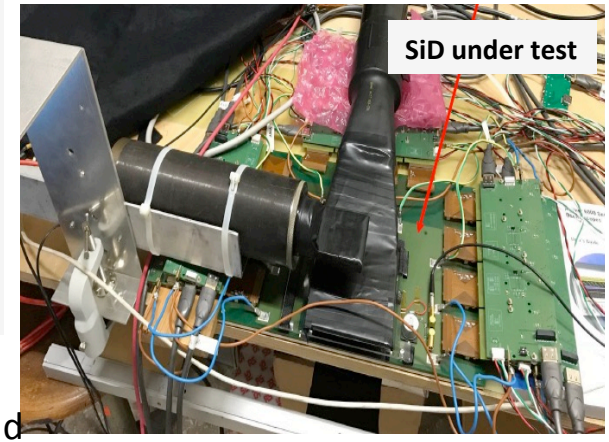
2nd half 2019: 4 GEMs in BigBite spectrometer for experiment GMn.

2020: commissioning and run GMn experiment





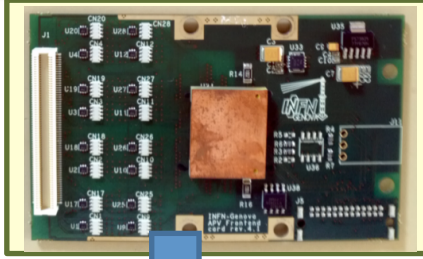
2018: Excessive wire-bonding breaking in the prototype investigated by FEM (CT) and real test; new transportation box designed and validated. Production (bounding) started at BA using automatic bonding machine; 1X + 1Y plane sensors produced so far.



First planes under laser and cosmic test stand in Rome

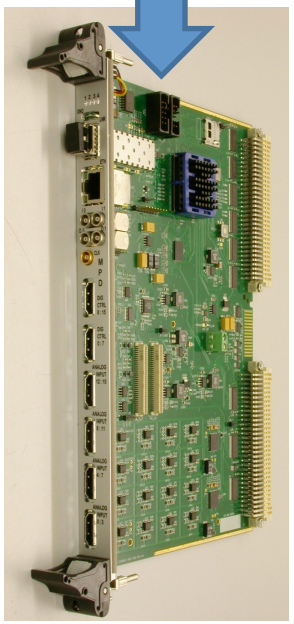
2019: tested detector shipped to Jlab and integrated into the GEM cosmic stand

Electronics and Data Suppression by A.I.



- **128 analog ch / APV25 ASIC**
- **3.4 μs trigger latency** (analog pipeline)
- Capable of sampling signal at 40 MHz
- Multiplexed analog output (**100 kHz readout rate**)

Readout electronics based on APV25 ASIC; developed for the GEM and SiD. ***Highly configurable, fast optical and VME interface.***
Prototype used in the Olympus exp.



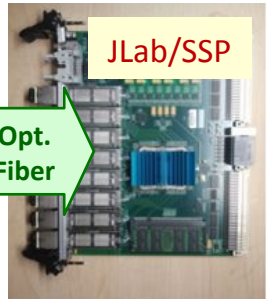
MPD Main Block

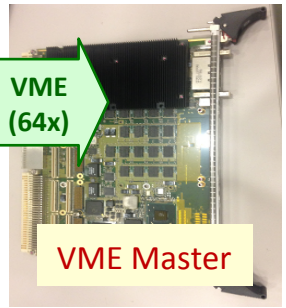
Arriga GX FPGA
128 MB DDR2-RAM
Firmware V4.0 (74% resources):

FIR Filter (16 param)
Zero Suppression
Common mode and pedestal subtraction
Remote config,
≈2 ns trigger time resolution

MPD-SSP Interface → SSP-Protocol → Aurora Protocol → Opt. Fiber

MPD-VME Interface → VME-Protocols → 2eSST, 2eVME, VME32 …, VXS → VME (64x)





Front Tracker		
Chs	FEC	MPD
50 k	400	30

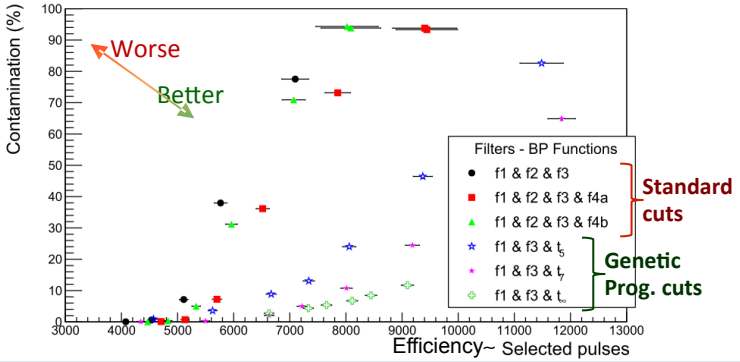
Adopted by University of Virginia (>100k chs), Hampton University/ MUSE (~15k chs) and USTC (~10k chs)

Expected data rate about 10x larger than sustainable (due to the high luminosity)

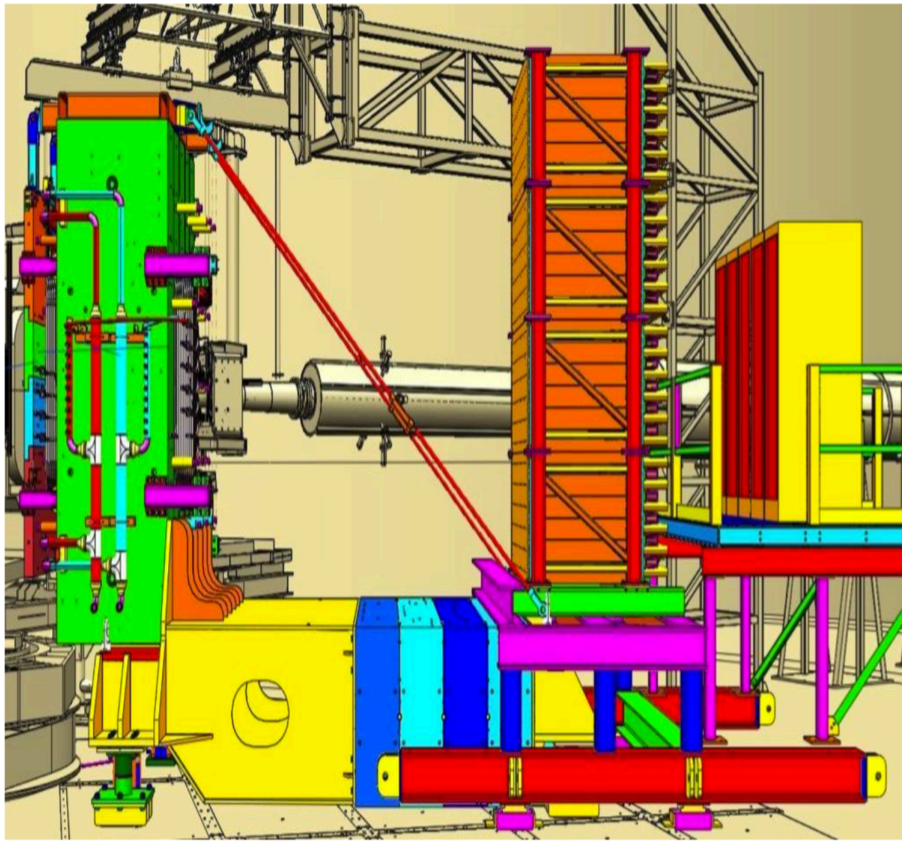
Need reliable real-time data suppression in firmware

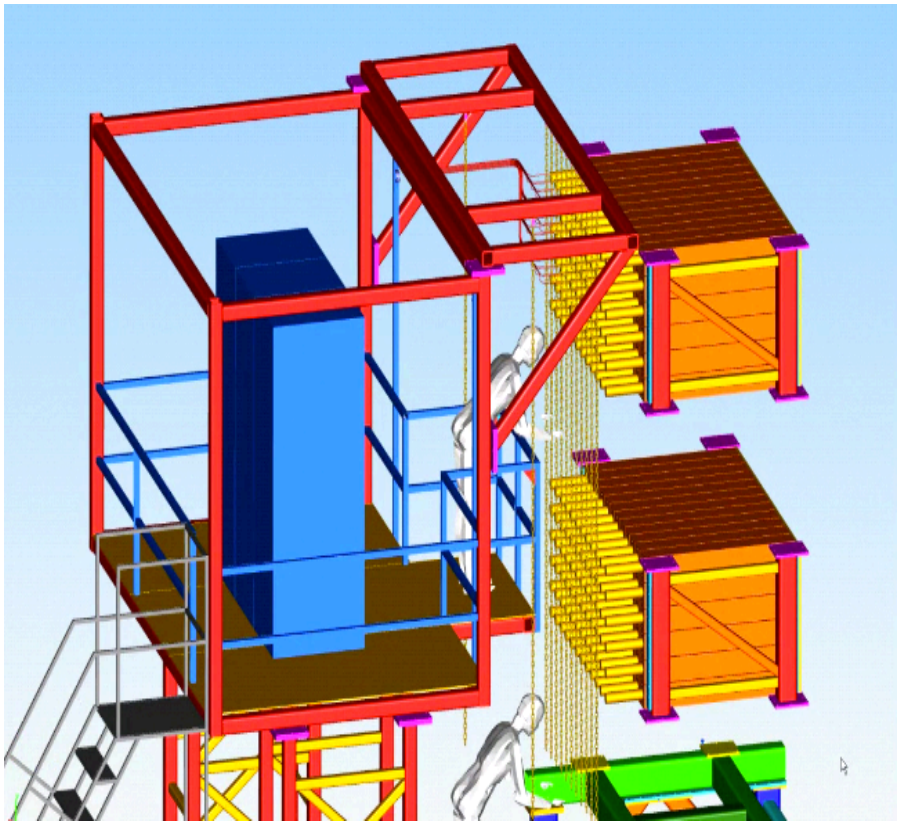
Working on noise discriminating functions ($t_{\#}$ in plot) generated by Genetic Program. Tools (M.Russo/CT)

BP functions performances on unfiltered data



HCAL-J Stand and Cable Gantry

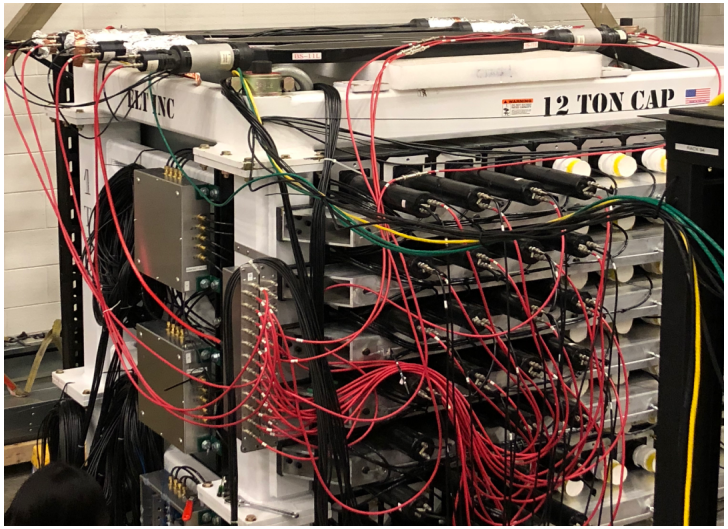




Rollable stand to move gantry + HCAL-J together without need to disconnect cables

HCAL-J: INFN-CT Contribution

Cosmic test-stand



HCAL-J modules ready for assembling

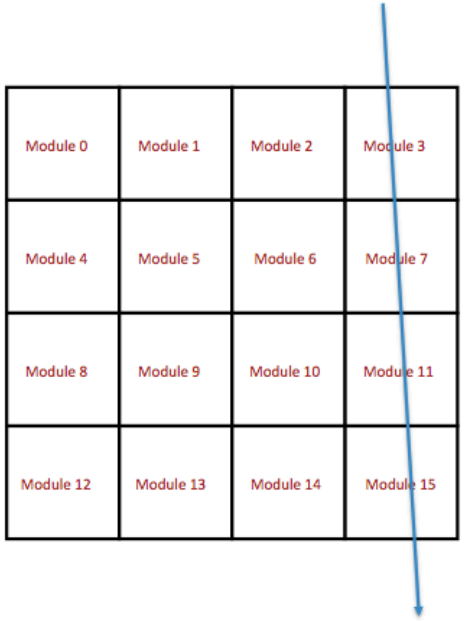
PAST ACTIVITY

- Development of the HCAL-J concept in the framework of the Consortium CMU/ INFN-CT/JLab (working group of the Hall A Collaboration)
- Organize the construction:
  - procuring of the WLS
  - procuring of the LG
  - procuring of the iron absorbers
- PMTs' test

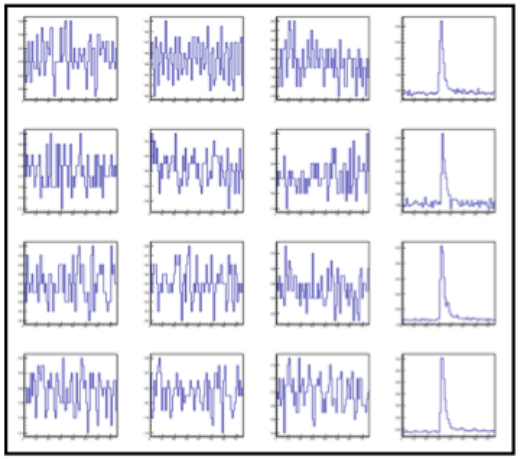
CURRENT AND FUTURE ACTIVITY

- Procuring part of the electronics module
- Contributing to electronics setup of HCAL
- Procuring of the mobile platform
- Complete the cable gantry and rollable stand
- Testing detector modules at Jlab
- Contributing to electronics setup of HCAL
- Procuring part of the Electronics modules

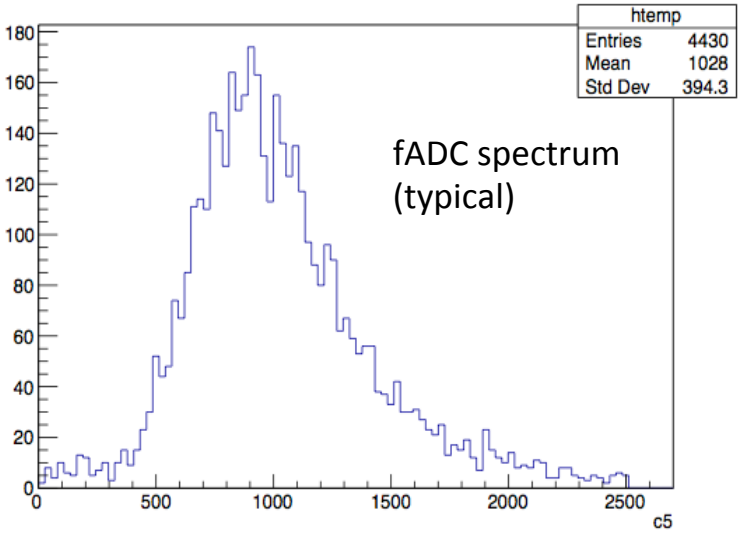
HCAL-J: Cosmic Test



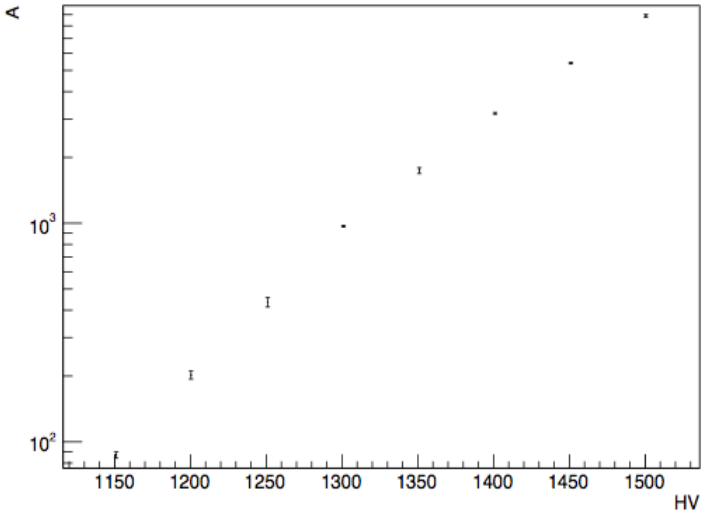
"Good event" (Triggered by only 1 paddle)



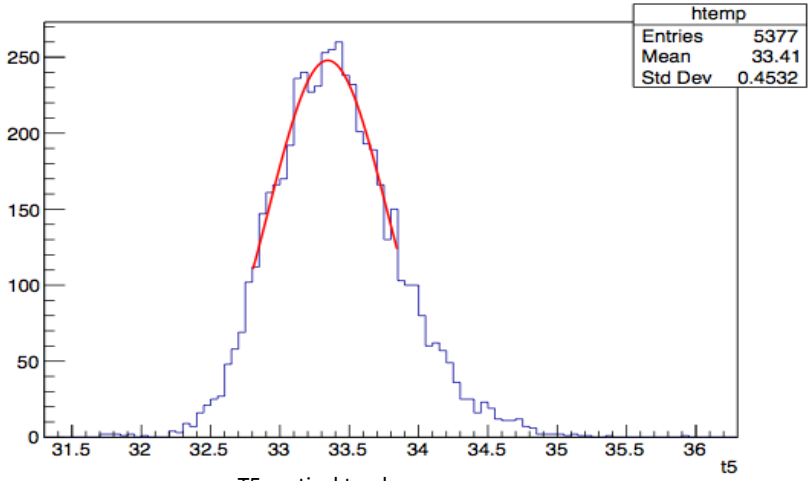
Event Display: vertical path (3, 7, 11, 15). Here the inverted PMT signals, as sampled by the fADC, are shown.



Avg. amplitude vs HV (module 5)

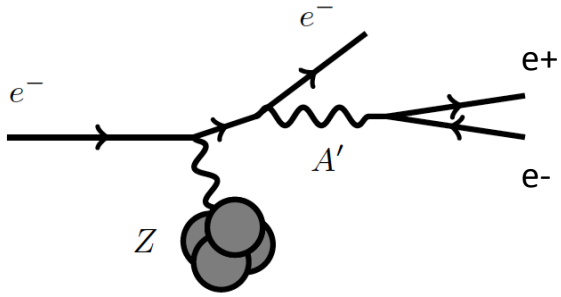


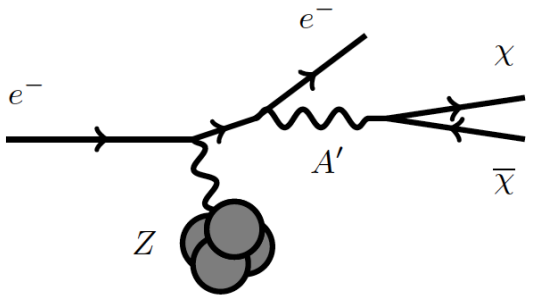
Estimated time resolution 1.4 ns (15 cm track)

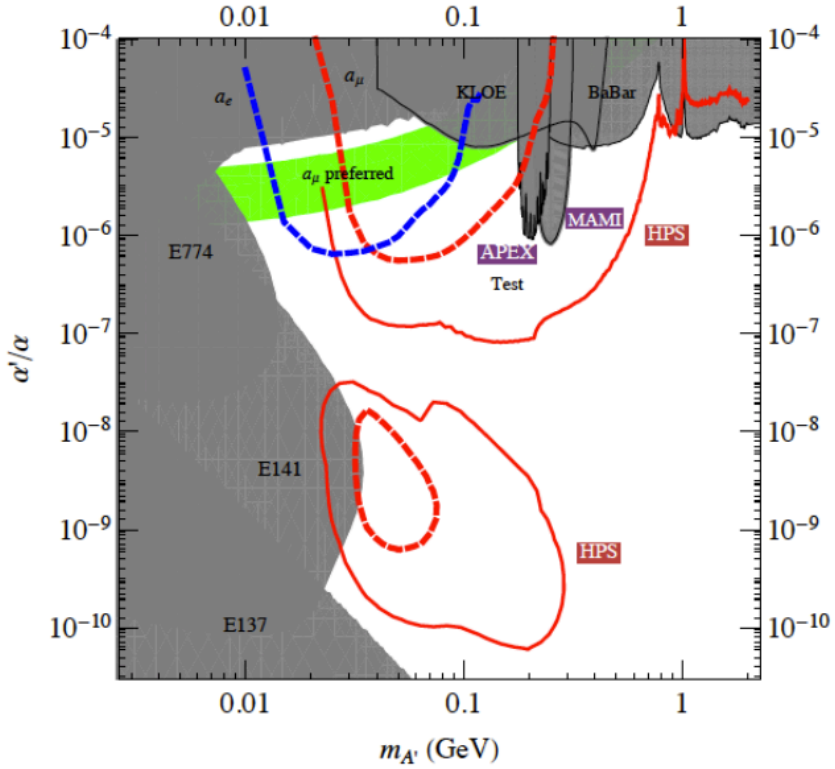


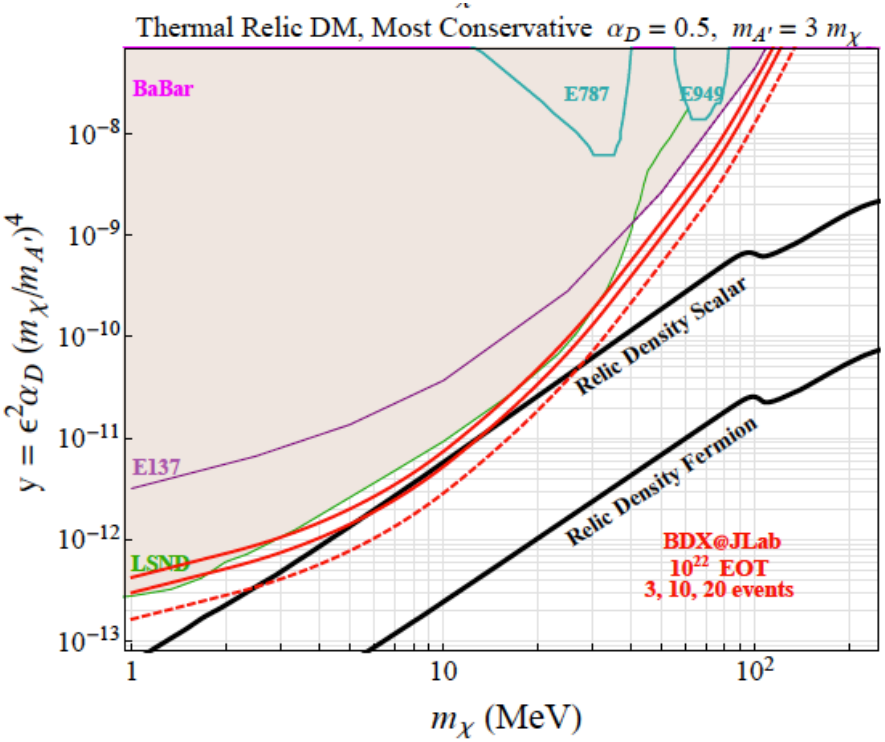
T5 vertical track

CEBAF intense high-energy electron beam allows to cover unexplored regions







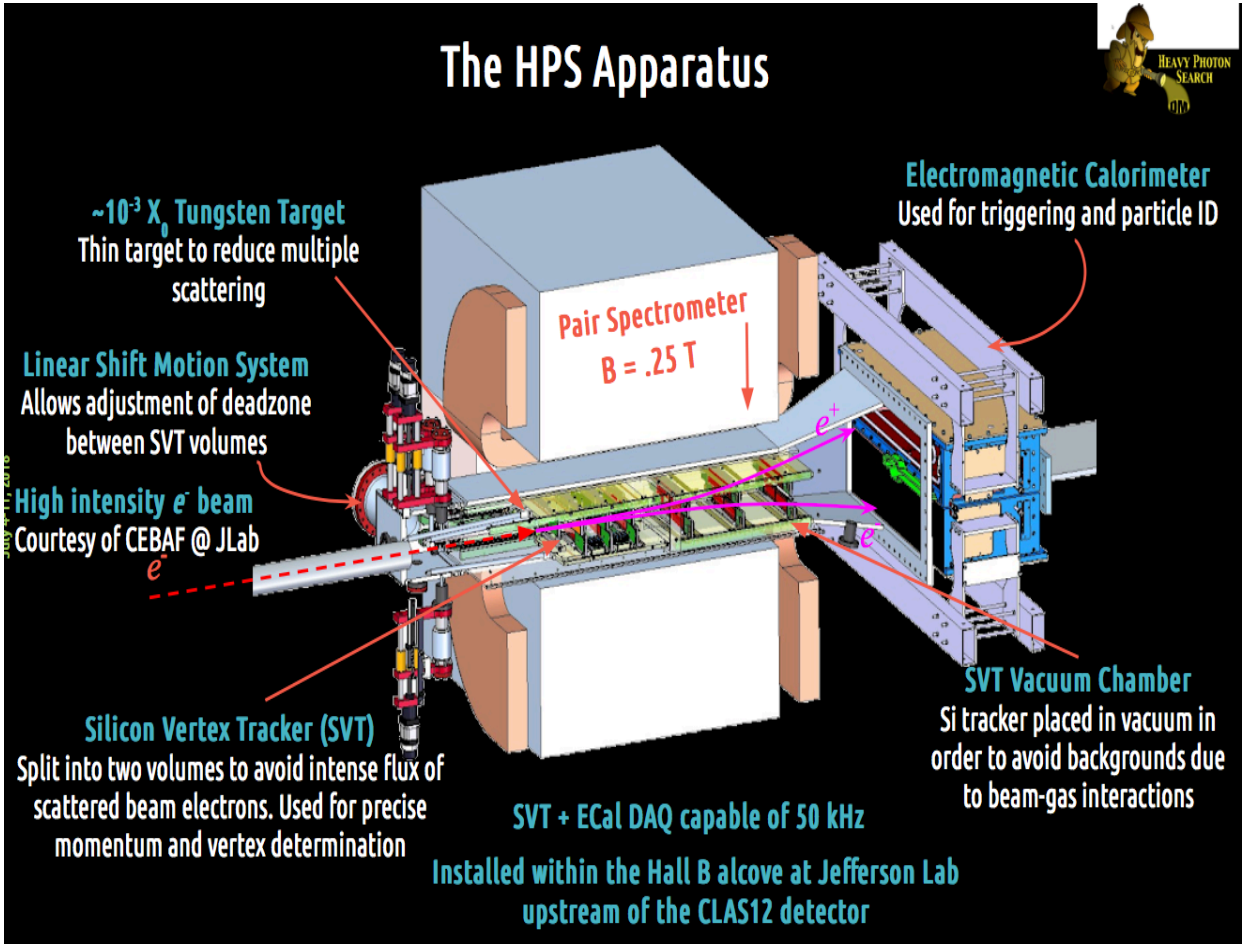


HPS Latest News

New DATA TAKING in 2019 !

From June to August

Ebeam : 4.55 GeV



- The data analysis for the 2015 run is is completed
- Analysis of the 2016 data is in progress (plan to complete it before the new data taking)
- Hardware upgrade in progress (INFN researchers not directly involved): 1 more SVT layer + positron trigger detector

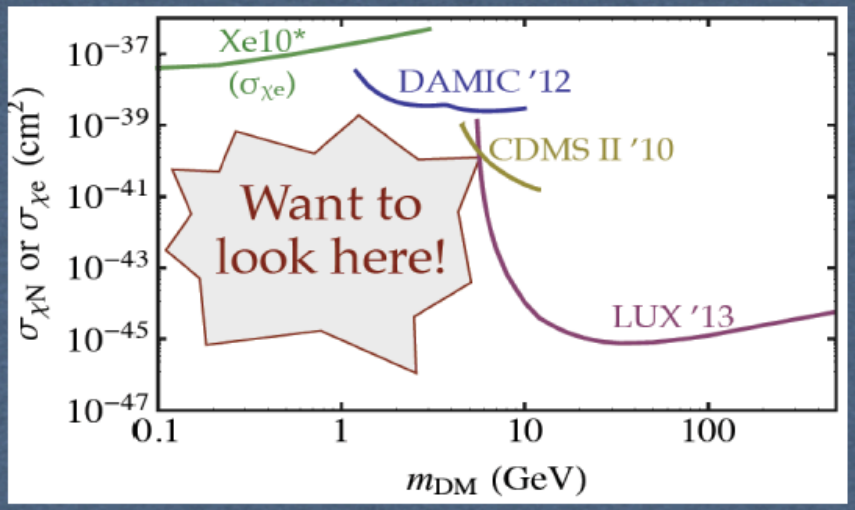
INFN responsibility roles

Andrea Celentano elected Chair of the Publications and Presentations Committee

Marzio De Napoli elected member of the Executive Committee

- The 2019 funding request is basically for travels needed to cover the run shifts (no request for new equipment)

BDX - Dark matter search in a Beam Dump eXperiment at JLab



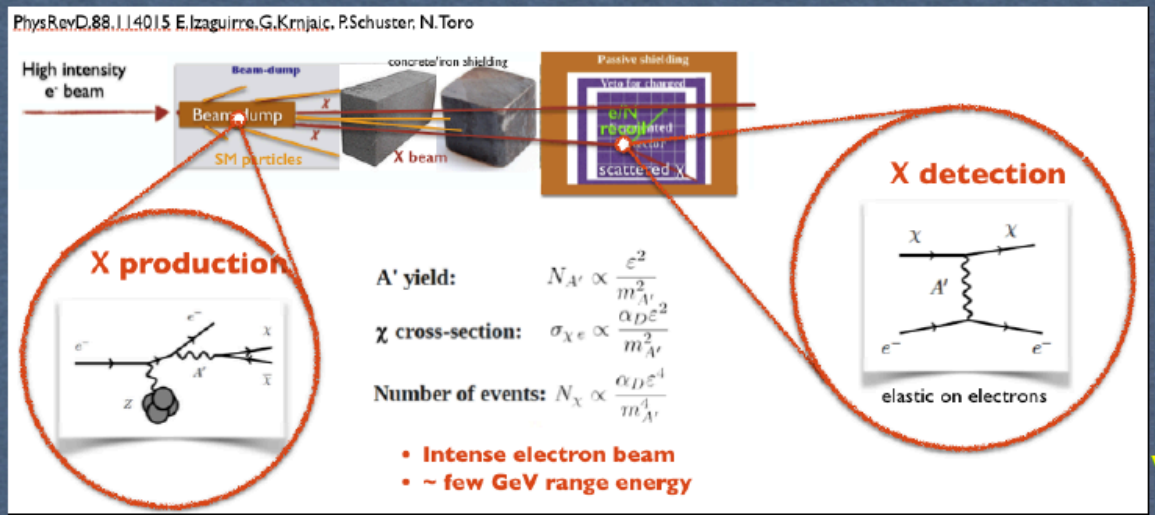
- Dark matter (DM) direct search focused in the mass region 10 GeV -10 TeV
- Many theoretical suggestions and exp attempts to extend the search to low masses (<1 GeV)

Beam dump (e-) experiments can provide unprecedented sensitivity to light dark matter Jefferson Lab can play a significant role in light DM search

Two step process

I) An electron radiates an A' and the A' promptly decays to a χ (DM) pair

II) The χ (in-)elastically scatters on a e-/nucleon in the detector producing a visible recoil (GeV)



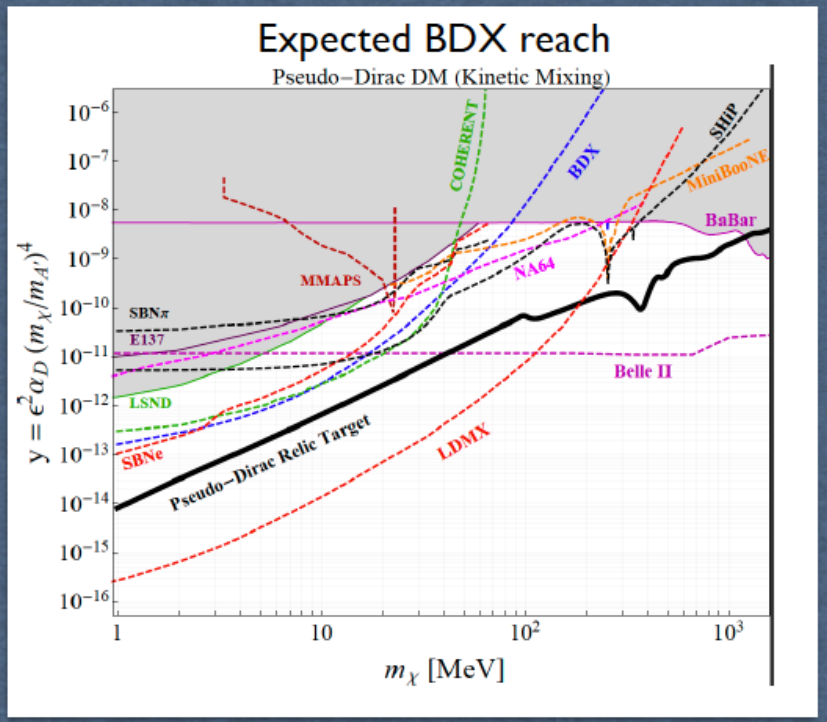
Experimental signature in the detector:
X-electron → EM shower
~GeV energy

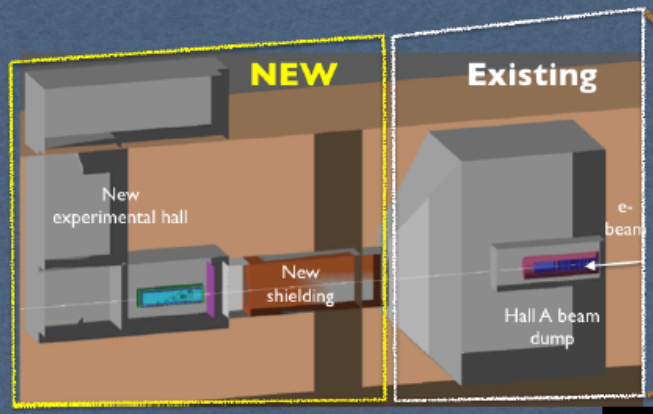
BDX experiment has been approved by JLab PAC in July '18 with maximum scientific rating (A)

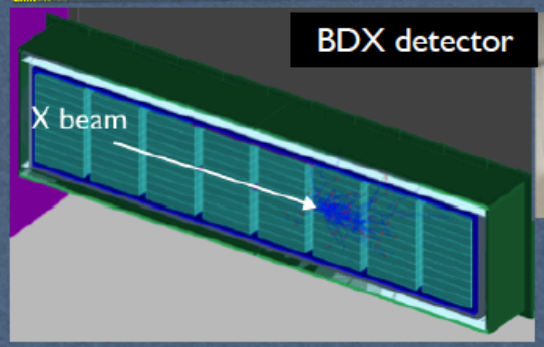
BDX

BDX @ JLab

- ★ High energy beam available: 11 GeV
- ★ The highest available electron beam current: ~65 uA
- ★ The highest integrated charge: 10^{22} EOT (41 weeks)
- ★ New experimental hall (~2$M) at JLab
- ★ BDX detector (recycling BaBar CsI crystals) ~$1M
- ★ Expected to run in ~2y







Accumulating 10^{22} EOT in ~1y BDX sensitivity is 10-100 times better than existing limits on LDM

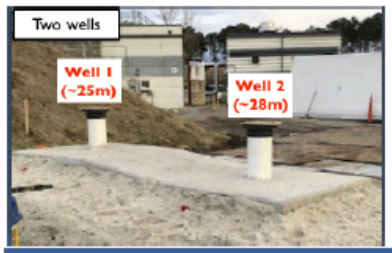
BDX detector: E.M. Calorimeter + Veto
- 8 modules 10x10 crystals each
- 800 CsI(Tl) crystals (from BaBar EMCal)
- 6x6 mm² Hamamatsu SiPM readout
- Plastic scintillator + WLS fibres, sips RO

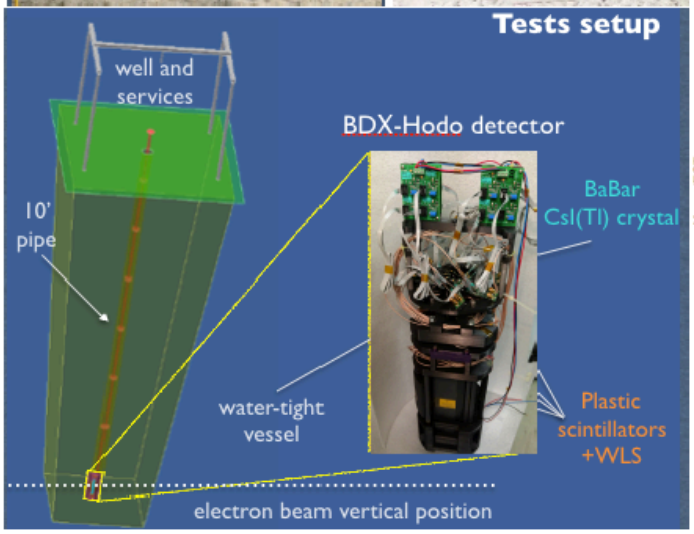
BDX background assessment

Bg estimated using FLUKA and GEANT4, for particles with $E>E_{Thr}$

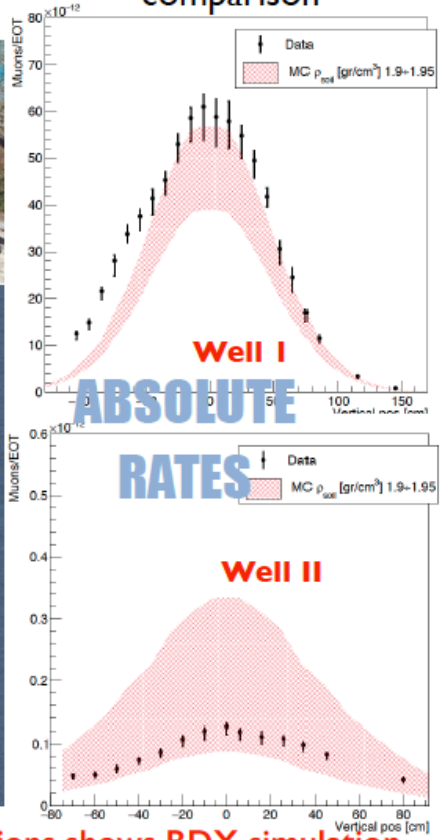
- ★ Cosmic background measured with the BDX detector prototype in CT
- ★ Muon bg: assessed by a dedicated measurement at JLab in spring '18
- ★ Neutrino bg: massive, high stat, FLUKA/GEANT simulations

Muon background measurement at JLab

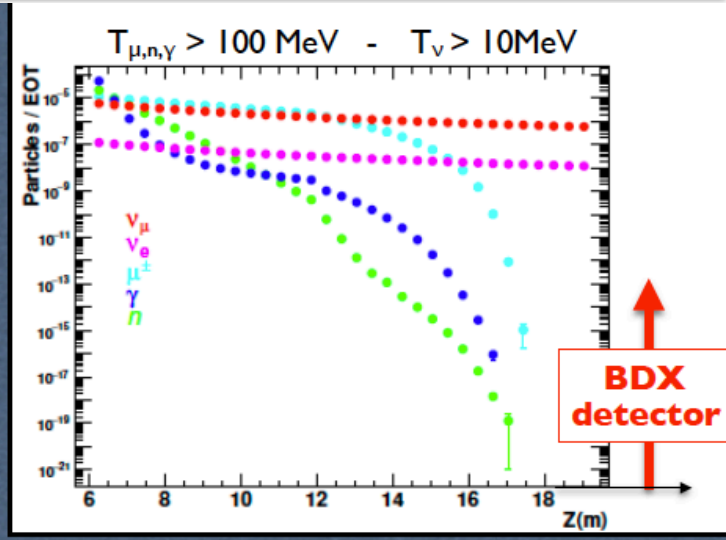




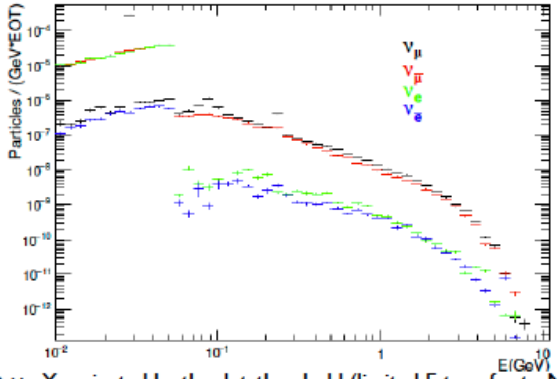
data/sim comparison



Good agreement between data and simulations shows BDX simulation framework is reliable and no significant contribution from neutron bg



Neutrino background simulation



$\nu_\mu + N \rightarrow \nu_\mu X$: rejected by the det. threshold (limited E transfer to N)

$\nu_e + N \rightarrow \nu_e X$: rejected by the det. threshold (limited E transfer to N)

$\nu_\mu + N \rightarrow X + \mu$: aejected by identifying the scattered muon

$\nu_{e^-} + N \rightarrow X + e^-$: the largest contribution to over-tresh. hits in BDX

High stat FLUKA simulations confirm that BDX is only limited by ν *irreducible* bg (~5 events)

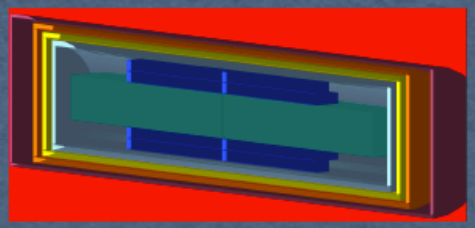
BDX

A roadmap towards BDX	Completion
Theory and physics case	100%
Detector R&D: signal detection and BG rejection	100%
Detector prototyping: cosmic BG assessment	100%
Detector prototyping: beam-related BG assessment	100%
BDX proposal submission to JLab Program Advisory Comm	Full approval, A-grade
Costs estimate	baseline fully defined
Funds procurement	Planning request to DOE and NSF for 2019
The BDX Collaboration	Chart defined
Costs optimization	custom electronics in progress (prototyping)
TDR	2019
Infrastructure and detector construction	2020-2022 (?)
Running BDX	2022-2025 parasitic

2014	2015	2016	2017	2018	2019	2020 - 2022
Theory and physics case	BDX prototype	R&D cosmic bg assessment	R&D cosmic EM shower	R&D BDX-Hodo	R&D Triggerless DAQ	BDX detector construction
BDX Conceptual design	R&D cosmic bg assessment	R&D 16ch CsI matrix	R&D custom fADC	R&D beam-on assessment	BDX TDR	

BDX-MINI (experiment) at JLab

- take advantage of two wells dug for muon tests
- E_{beam}=2.2 GeV, 5^{20} EOT expected for 2019, no muons at well locations
- limited reach but first BDX result!

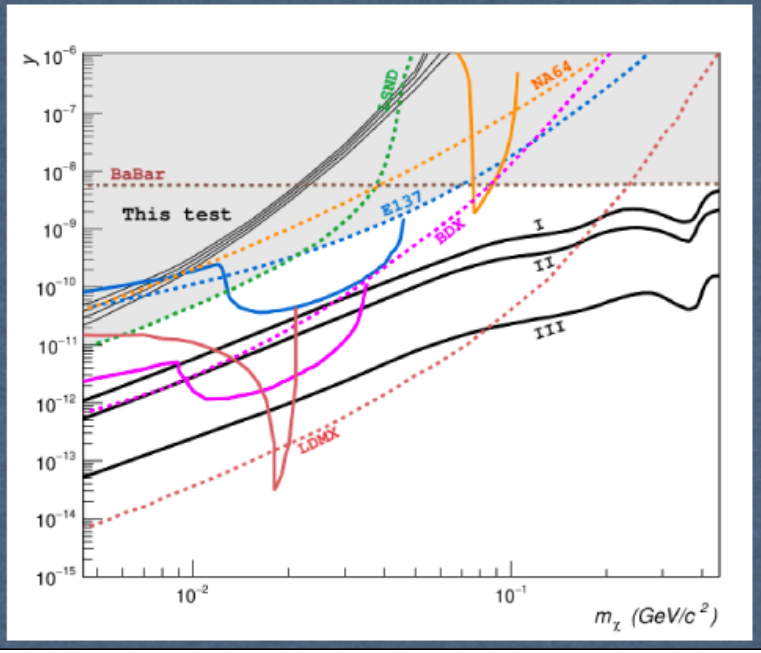


- BDX-MINI fits in BDX-HODO vessel
- 28 PbWO4 PANDA ECal crystals (higher ρ)
- 2 active vetos (same as BDX)
- 1 passive W shielding

BDX requests for 2019 to build and run BDX-MINI exp

What next?

- Discuss with JLab management to get resources for:
  - new facility design
  - lobbying to DOE-HEP for funds
- Formalise the BDX Collaboration
- Seek funds for infrastructure (full) and detector (partial) → MRI di Istituti Americani
- Conclude electronics R&D
- Run a (mini) BDX at low energy in 2019
- Be ready for new hall/detector construction in 2020



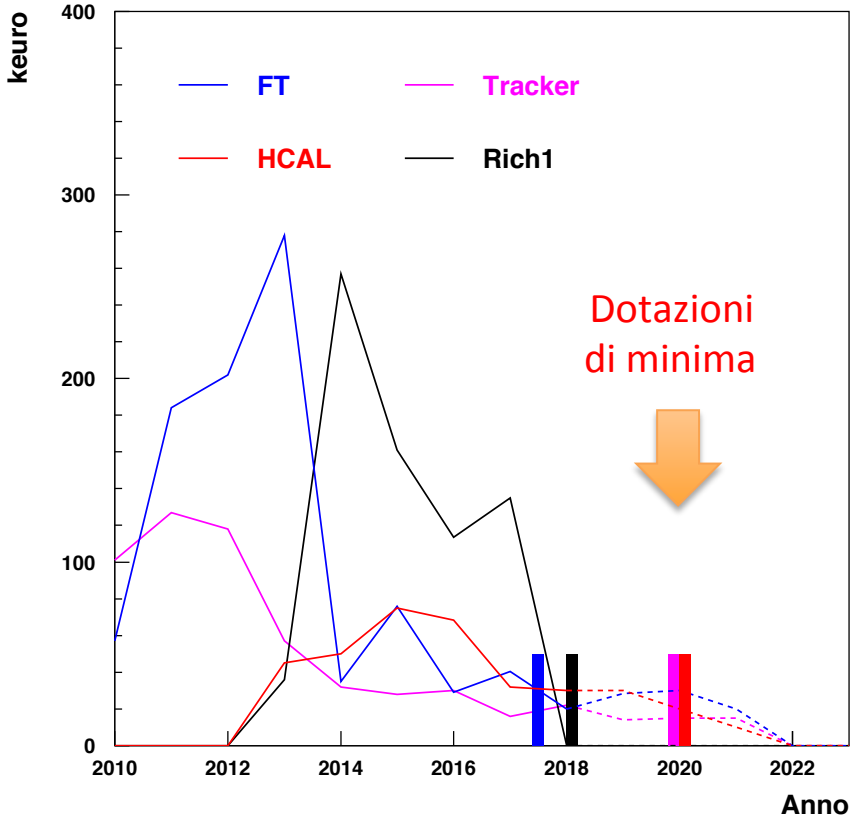
Milestones 2018

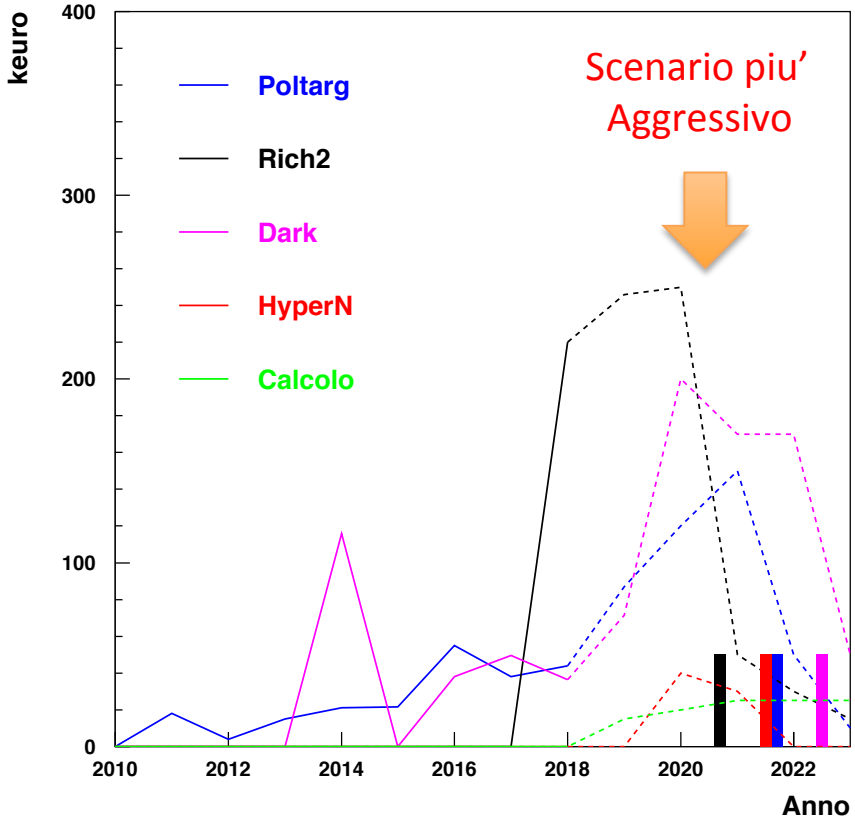
Milestones Concordate		
Data	**Descrizione**	Completamento
30-06-2018	HCAL: progettazione piattaforma mobile HCAL 	100 %
30-06-2018	POLTARG: sottomissione articolo test MgB2 	100 %
30-06-2018	RICH: completamento assemblaggio I modulo 	100 %
30-06-2018	BDX: assemblaggio e commissioning BDX-Hodo 	100 %
31-12-2018	HCAL: checkout detector nella sala sperimentale 	80 %
31-12-2018	FT: checkout detector nella sala sperimentale 	100 %
31-12-2018	BDX: simulazioni FLUKA fondo muoni e neutrini 	80 %
31-12-2018	POLTARG: commissioning distillatore di gas di HD 	100 %
31-12-2018	RICH: calibrazione I modulo 	50 %
31-12-2018	HPS: calibrazioni ECal 	80 %
31-12-2018	TRK: integrazione 4 camere 	90 %

Milestones 2019

Milestones Proposte	
Data	**Descrizione**
30-03-2019	HPS: Sottomissione articolo di fisica dati 2015
30-06-2019	POLTARG: Disegno nuovo holder per mappatura campo con doppio magnete
30-06-2019	RICH: Completamento software di tracciamento per la ricostruzione degli eventi
30-06-2019	BDX: Progettazione, costruzione e commissioning BDX-Mini
30-06-2019	FT: completamento calibrazioni del primo run di fisica
31-08-2019	Tracker: Completamento caratterizzazione con cosmici delle 4 camere in commissioning presso JLab
31-12-2019	RICH: Inizio costruzione struttura meccanica secondo modulo
31-12-2019	POLTARG: Test fotosensori, disegno e realizzazione dell'HALO COUNTER
31-12-2019	BDX: Sottomissione articolo misure flusso di muoni
31-12-2019	HCAL: Completamento dell'acquisizione dei moduli per la piattaforma mobile di HCAL

Funding Plan (2018)





Funding Plan (2018)

(All but ME)	2017 Assigned	2018 Assigned	2019 Expected	2020 Expected	2021 Expected
Tracker (Hall-A)	20	25	20	15	10
FT (HallB)	40	20	30	15	20
RICH (HallB)	135 (+200)	220	240	240	50
HCAL-J (HallA)	35	30	30	20	10
PolTarg (HallB)	30	45	105	120	150
HPS+BDX (HallA+B)	50	70	80	30+170	170
Calc (HallA+B)	-	-	15	15	15
Hyper + WACS (Hall-A)	-	-	-	-	40
Total (HallA+B)	310 (+200)	410	520	625	465

Overview 2019

Sezioni INFN	Resp. Locale	Ric+Tec	FTE 2019	FTE 2018	Richieste	Proposte
Bari	R. Perrino	5	1.6	1.8	19.5	13.5 + 4.5 sj
CT_hadron	C. Sutera	12	7.6	9.0	134	89 + 37 sj
CT_DM	M. De Napoli	4	3.1	3.1	66.5	24 (+11)
FE	M. Contalbrigo	8	4.2	4.2	166	144 + 5 sj
GE	R. DeVita	11	6.7	7.8	149	87.5 (+25)
LNF	M. Mirazita	4	2.2*	3.2	218	207
LNS	D. D'Urso	4	2.0	3.2	23	20
PD.Dtz	A. Simi	1	0.3	0.3	4.5	4
PV	A. Bianconi	6	2.9	0	43.5	20 (+8.5)
RM1	E. Cisbani	4	2.3**	4.4	51	24.5 + 2 sj
RM2	A. D'Angelo	3	2.7	2.9	109	38 + 31 sj
TO	A. Filippi	2	1	1	14	10.5
Totali		63	36	41	998	737.5 (+44.5)

* nuovo Borsista per stranieri da settembre 2018 (Orlando Soto)

** nuovo assegnista di ricerca da ottobre 2018

Costs

BDX detector	~0.725M (0.475M)
Infrastructure at JLab	~1.5M

Calorimeter					120k
	CsI(Tl) crystals	~900	refurbishing, wrapping	20k	(new CsI ~3.5M!)
	(6x6) mm2 SiPM	~900	new procurement	50k	
	Front-End RO and cables	~900ch	new procurement	35k	
	Mechanical		design, procurement	15k	
Inner Veto					35k
	Plastic scintillator	~4 m^2, 8 paddles	new procurement	25k	
	(3x3) mm^2 SiPM	~90	new procurement	5k	
	mechanical		design, procurement	5k	
Outer Veto					65k
	Plastic scintillator	~12 m^2, 30 paddles	new procurement	50k	
	PMT	28	refurbishing	5k	
	mechanical		design, procurement	10k	
DAQ					
	CAEN V1725	1000	procurement (custom boards)		500k (250k)
Shielding	Lead bricks	~500	refurbishing		5k

Milestones 2017

Milestones Proposte		
Data	**Descrizione**	**Completamento**
30-06-2017	HCAL: completamento assemblaggio rivelatore	100
30-06-2017	FT: progettazione e procurement Hardware interlock	100
30-06-2017	RICH: completamento della produzione deli specchi del primo modulo	100
30-06-2017	POLTARG: Completamento caratterizzazione campo critico verso temperatura magnete MgB2 a bulk di superconduttore	100
31-12-2017	HCAL: progettazione e procurement componenti CDET	100
31-12-2017	FT: installazione in CLAS12	100
31-12-2017	HPS: sottomissione a rivista articolo esperimento	100
31-12-2017	BDX: misure di sciami em con prototipo del calorimetro	50
31-12-2017	Analisi dati: sottomissione arxiv E94-107	100
31-12-2017	TRK:completamento integrazione ultime due camere GEM e spedizione al JLab Le 4 richieste del primo run del 2020 sono pronte	80
31-12-2017	RICH: completamento dell'assemblaggio del pannello dell'elettronica del primo modulo	100
31-12-2017	POLTARG: Installazione del distillatore di gas di HD presso Roma Tor Vergata Commissioning del distilaltore anticipato al JLab	90

Addendum 1

CONCERNING NUCLEAR PHYSICS RESEARCH AT THE THOMAS JEFFERSON NATIONAL ACCELERATOR FACILITY

Under the

PROJECT ANNEX TO THE IMPLEMENTING ARRANGEMENT BETWEEN THE DEPARTMENT OF ENERGY OF THE UNITED STATES OF AMERICA AND THE MINISTRY OF EDUCATION, UNIVERSITIES AND RESEARCH OF THE ITALIAN REPUBLIC FOR COOPERATION IN HIGH ENERGY, ASTROPARTICLE, AND NUCLEAR PHYSICS RESEARCH AND RELATED FIELDS AND TECHNOLOGIES CONCERNING NUCLEAR PHYSICS RESEARCH

Signed January 14th, 2016

FOR THE UNITED STATES DEPARTMENT OF ENERGY

Dr. Timothy Hallman,
The Associate Director of the DOE Office of Science for Nuclear Physics

Date: September 11, 2017
Place: Germantown, MD, USA

FOR THE MINISTRY OF EDUCATION UNIVERSITIES AND RESEARCH OF THE ITALIAN REPUBLIC

Prof. Fernando Ferroni
President of the
Istituto Nazionale di Fisica Nucleare

ISTITUTO NAZIONALE FISICA NUCLEARE PRESIDENTE INFN

Date: 29 GIU. 2017
Place: ROME