

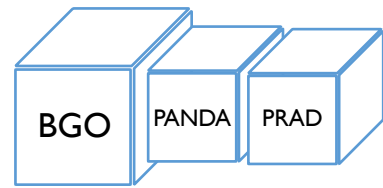
JLAB12@LNF

Dec 15 2025

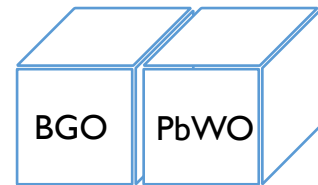
The Beam Dump eXperiment and beyond: an update

M.Battaglieri (INFN-GE), M. Bondì (INFN-CT)

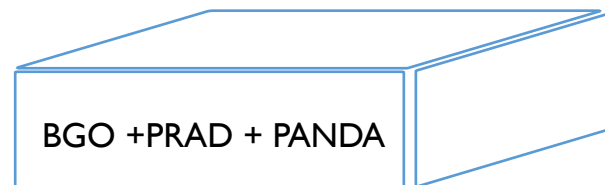
BDX detector



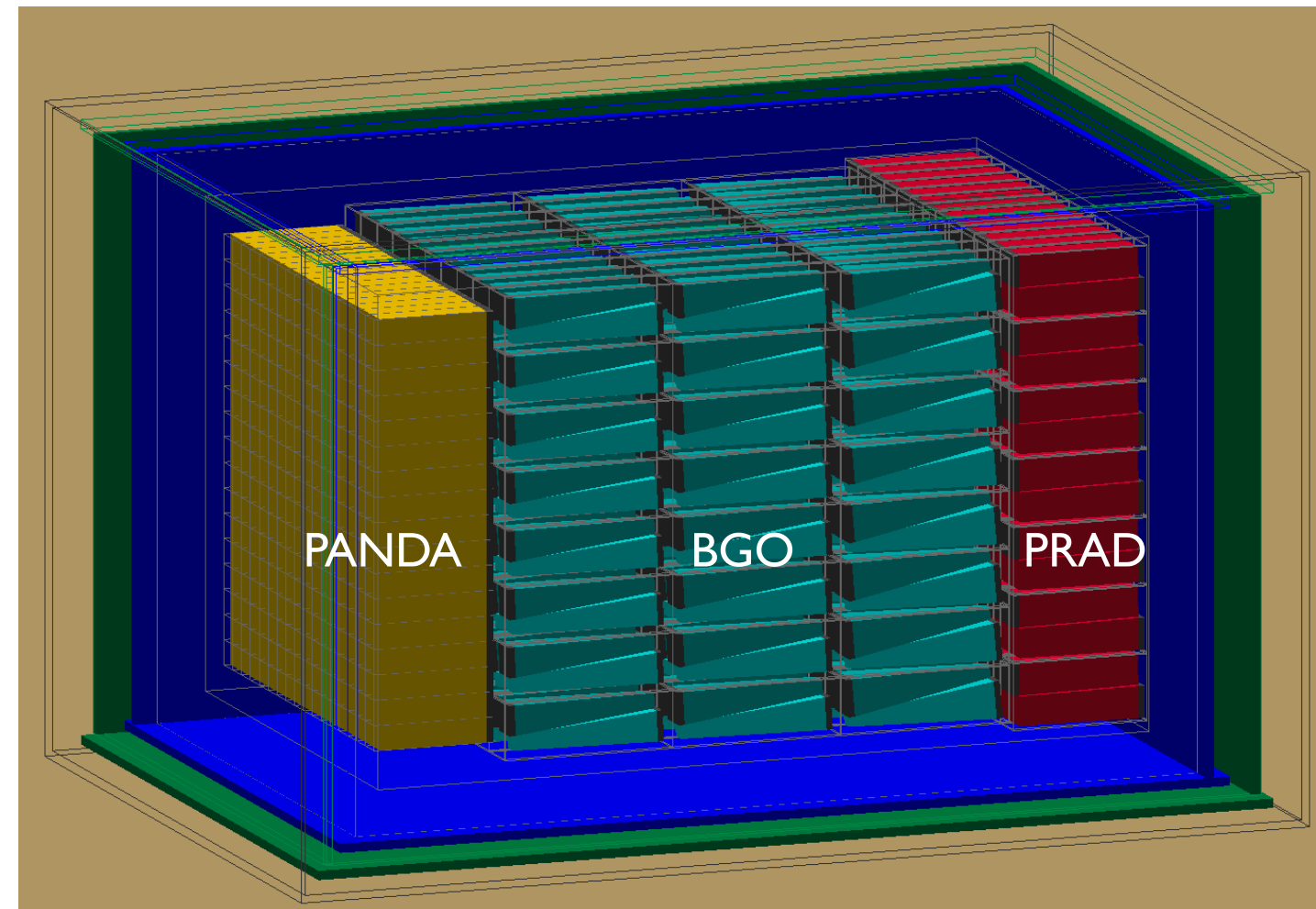
- Option I:
- 3 different modules (BGO+PRAD+PANDA)
 - presented to CSN3 in April 25 to CSN3
 - PANDA (+PRAD) NOT funded in Sept 25



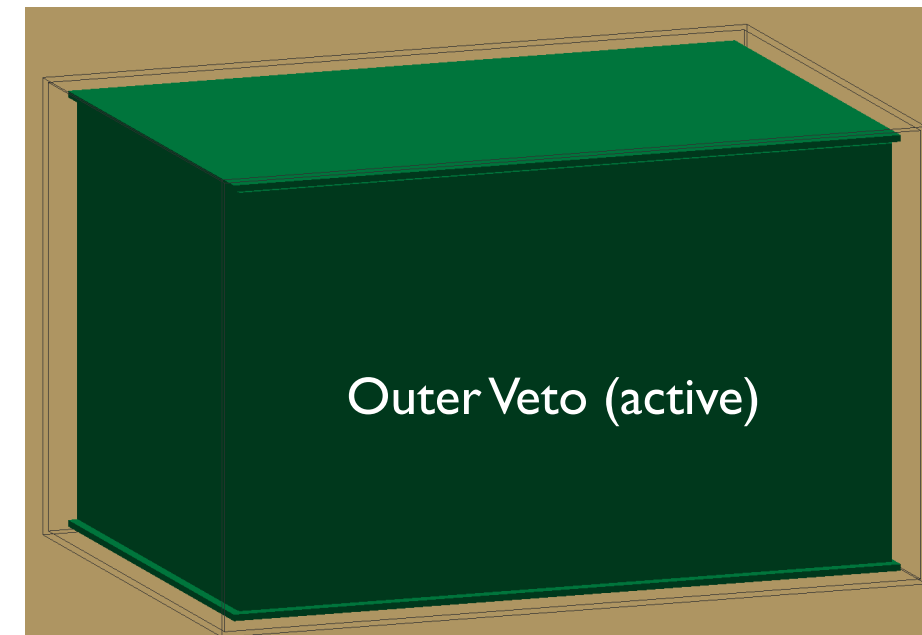
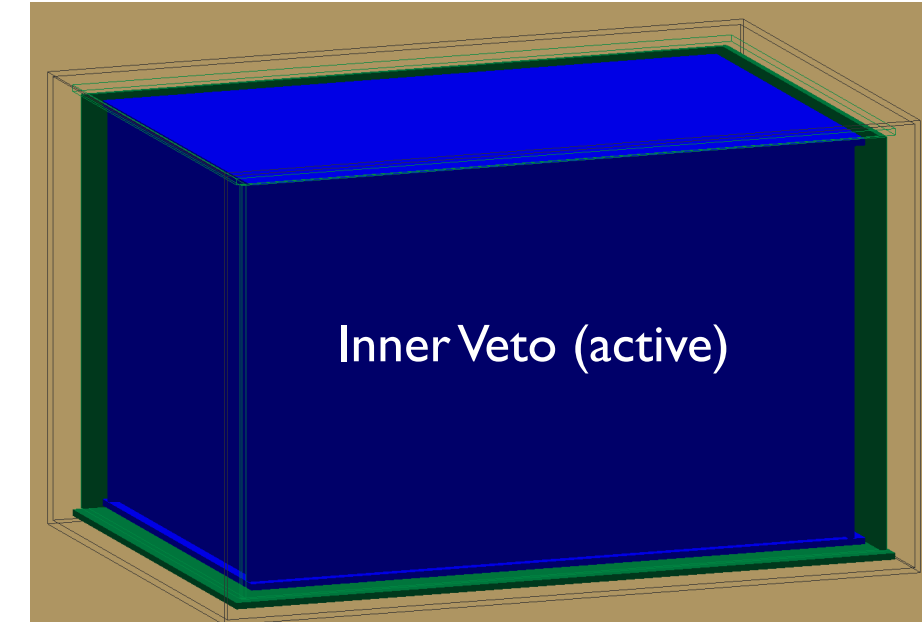
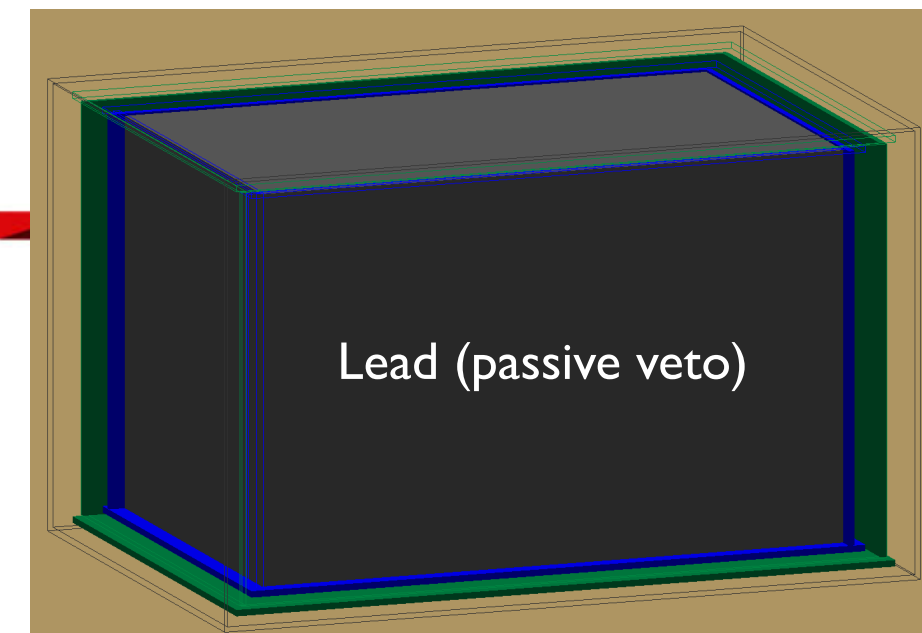
- Option II:
- 2 different modules (BGO+PbWO)
 - to be presented for an MRI
 - NO DOE/NSF MRI submission in 2025



- Option III:
- a single IV/OV veto, BGO+PANDA+PRAD
 - more expensive but more secure
 - Stageable
 - added funds from PNRR, DOT3-CT, others

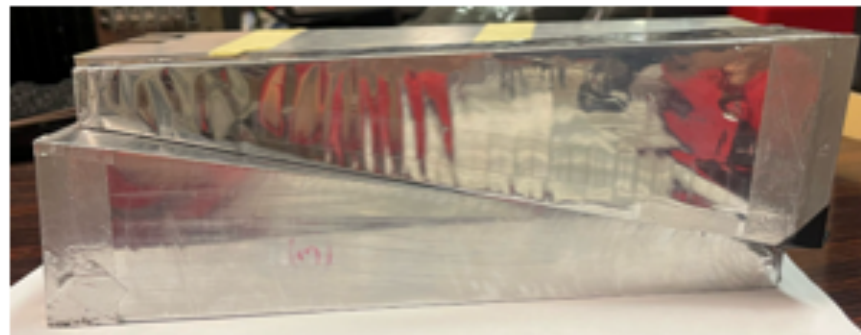


- Total veto size: 1.6 x 1.2 x 1.1 m³
- Stage I: 480 BGO-OD BGO crystals (1/2 BDX volume)
- Stage II: 1200 PRAD PbWO crystals (+1/4 BDX volume)
- Stage III: 800 PANDA PbWO crystals (+1/4 BDX volume)



BDX calorimeter

BGO-OD crystals at Bonn



- According to German regulation, the lab can not release material irradiated on a particle beam
- There are two different limits: radiological ($>$ Threshold) and radio-emission (>0)
- To be declared 'clean' test for radiation requires a detailed mass spectroscopy analysis on ALL crystals ...
- Found an agreement: Bonn will release the crystals as 'possible radioactive material,' (UN 2610) only testing radiation for radio protection limits
- Bonn will test 10-15 of them representative of the whole batch (expected to be all clean!)
- INFN-GE will accept the crystals and as soon as in house, our expert will declare ALL crystal clean
- Crystals will be repurposed (sipm readout) and sent to JLab with the veto
- Pickup tentatively set for last week of Feb 26
- Repurposing planned at INFN-GE (sipm readout+minimal test)

PANDA crystals at Giessen

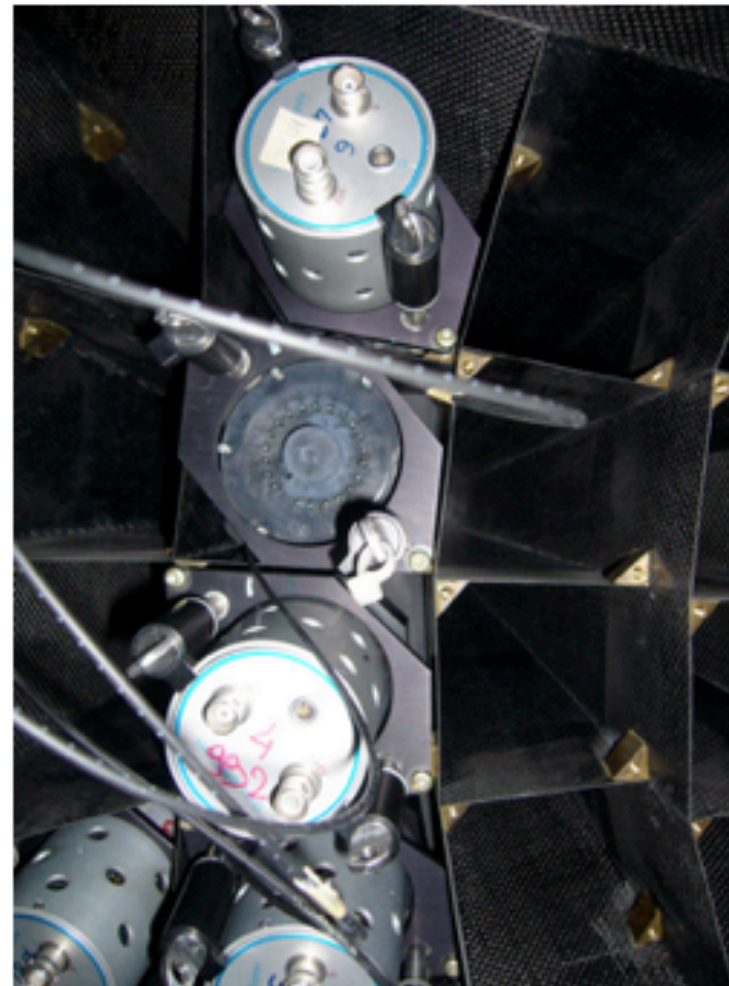
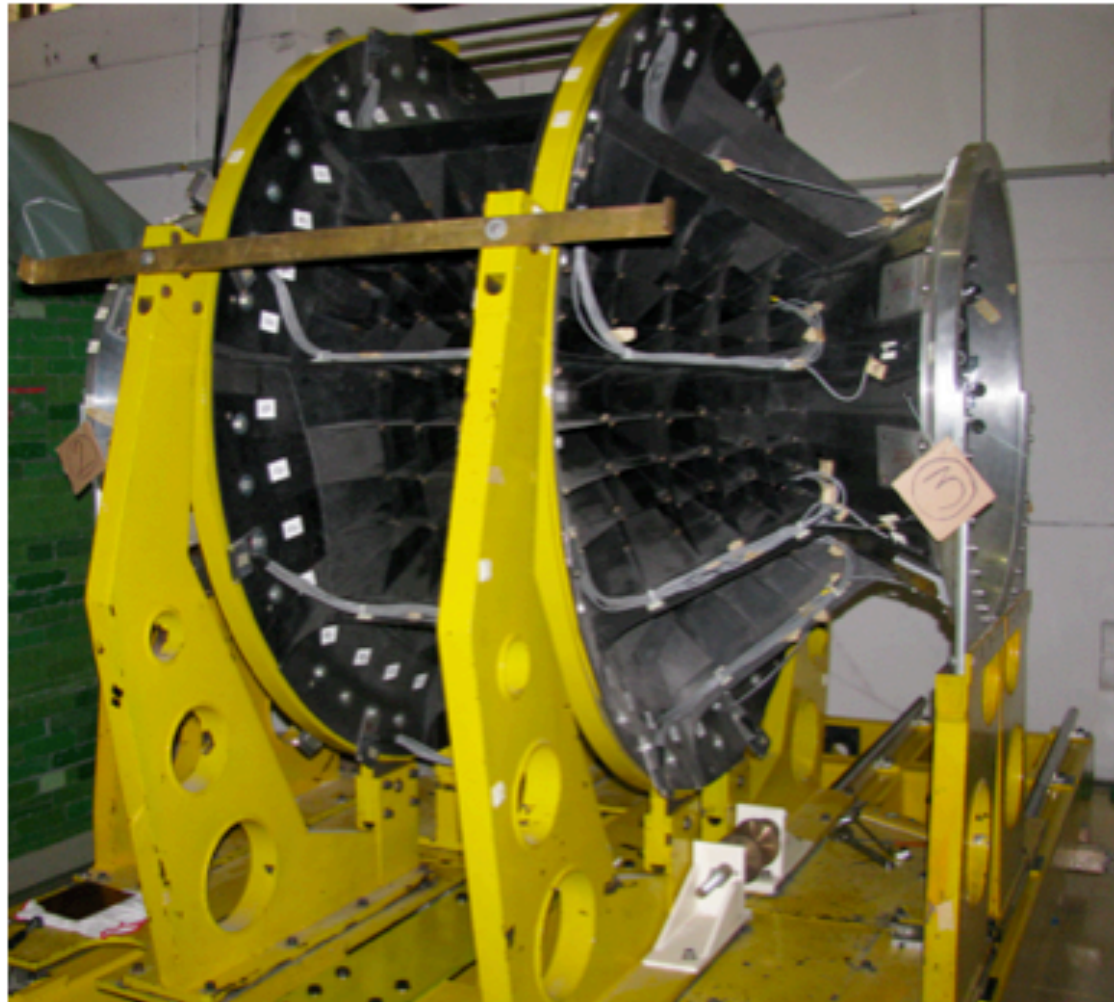
- 100 crystals are already available (picked up last week of Feb 26)
- the other are currently (with ALL PANDA crystals at Bochum for site office check)
- PANDA collaboration alerted
- Working with UBochum/W&M (Meike Küssner) will be the link point for a common grant shared with UGiessen, FAIR and

PRAD crystals at JLab

- Asked D.Highbotham to confirm PhysDiv commitments (PRAD crystals+FEE) once the experiment will be over
- All repurposing work (disassembling the PRAD Cal + sipm readout replacement) on-site

BG-OOD crystals

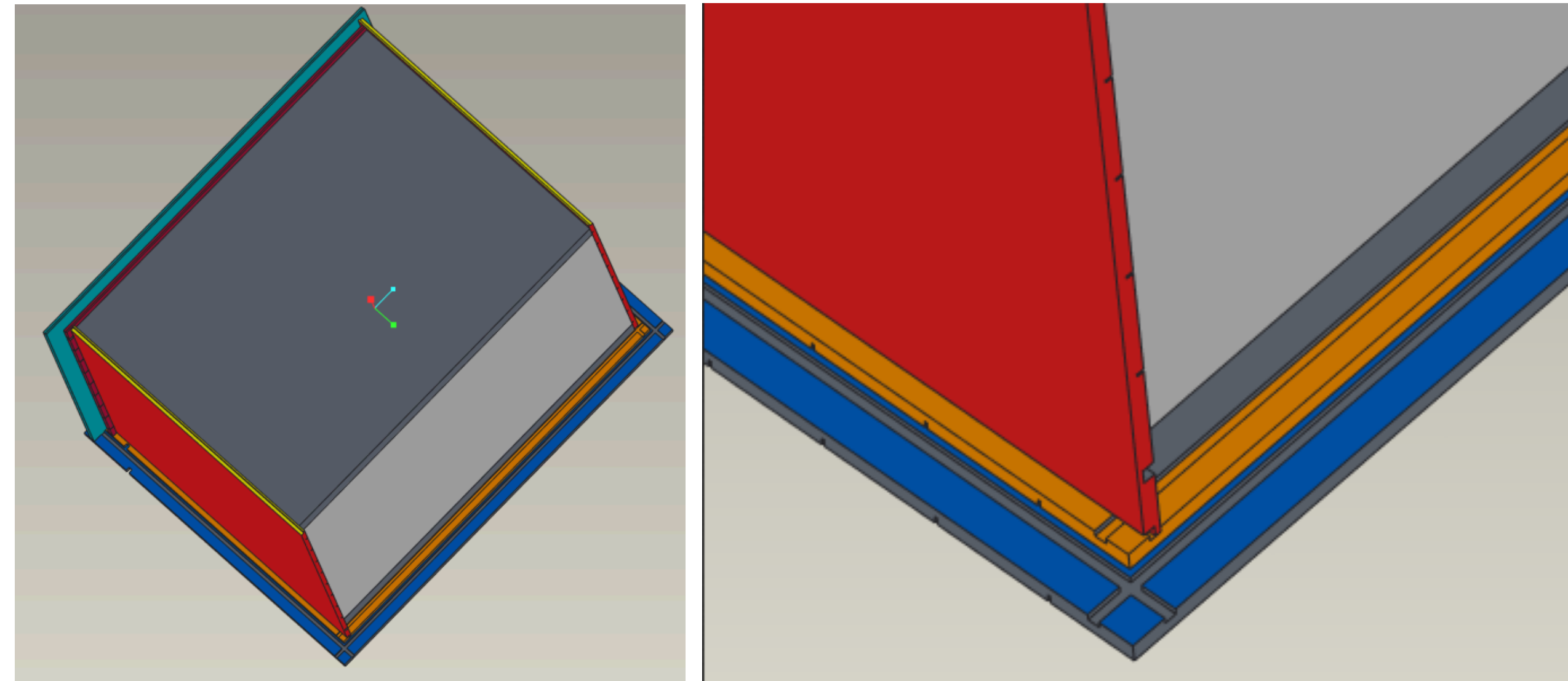
- 480 BGO crystals formerly mounted in the GRAAL experiment in Grenoble
- Lately used in the BG-OOD experiment at Boon (INFN-MAMBO)



- Crystals and alveoli need to be removed, PMTs detached (~1week of 2 CTER + 2 researchers) and moved to Genova (by truck) for check (integrity, LY, att. lenght,), refurbishing (SiPM glueing) and assembly in new alveoli
- BG-OOD decommissioning expected last week of February 2026
- Full support of RM-TV researchers involved in MAMBO

BDX veto

Inner/outer veto



- Sound design to maximise hermeticity and avoid dead-areas
- Due to the large size, each paddle will be split in two halves (longer size)
- The vendor does not machine any groove
- Grooves will be machined by INFN-PV (and INFN-GE?)
- WLS fibers and SIPMs will be glued in Genova
- Minimal functional test in
- Final tests at JLab (>200 ch requires full DAQ)

Lead

- Procured and installed at JLab

External vessel

- Designed by PROMEC in Genova in coordination with with JLab engineers (light tight+structurtal in detector deployment in to the facility)

Procurement status

IV/OV Vetos

- Plastic scintillator paddles (whole module)
- WLS fiber
- Hamamatsu I3360-3075 SiPMs
- Wrapping foils (reflector + Tedlar)
- Connectors (MCX I) on the patch panel (detector/electronics)
- inner cables (MCX-MCX 2.5m)
- external cables (MCX-MCX 15m)
- electronics cables (MCX-Lemo 2m)
- FEE (preamplifiers + power supplies)
- microPCB for SiPM mounting
- Mechanical structure

Calorimeter (BGO)

- Hamamatsu I3360-6025 SiPMs
- Optical glue/cement
- inner cables (MCX-MCX 2.5m)
- external cables (MCX-MCX 15m)
- electronics cables (MCX-Lemo 2m)
- FEE (preamplifiers + power supplies)
- microPCB for SiPM mounting

Calorimeter (PbWO)

- Hamamatsu I3360-6075 SiPMs
- inner cables (MCX-MCX 2.5m)
- external cables (MCX-MCX 15m)
- electronics cables (MCX-Lemo 2m)
- FEE (preamplifiers + power supplies)
- microPCB for multiple SiPM mounting

Vessel

- PROMEC INFN-GE in coordination with JLab

DAQ

- Server and accessories
- slow controls

Ordered (full/partial)
Designed

Workforce & plans

Workforces

- INFN-CT: HichTech (cables, plastic scintillator, crystals)
- INFN-GE: PROMEC + Electronic + Machinshop (plastic scintillators, crystals, cables, DAQ)
- INFN-PV: Machinshop (plastic scintillator, cables)
- INFN-TV: Electronic (crystals, cables)
- JLab (DAQ): Sergey Boiarinov for SRO setup
- FIU (DAQ): Holly Szmila-Vance appointed a student on BDX
- Canisius College (Rec sw): Mike Wood fully committed
- W&M (Calorimeter) : Meike Küssner is willing to appoint a student + link with UGiessen/UBochem for a grant
- Mainz (Calorimeter): Patrick Achenbach
- UEdinburgh: Frédéric Duch Clerici Master thesis

Timelines

- End of Feb: decommissioning of BGO-OD BGO crystals at Bonn and transport to Genova (+ some PbWO from Giessen)
- March-April: BGO repurposing (GE) + plastic scintillator grooving (PV, GE, CT) + mini SRO DAQ (JLab)
- April-May: plastic scintillator readout (GE) + cables (CT, GE, PV,TV)
- Jun-Jul: plastic + crystals commissioning (GE)
- Aug-Sept: shipping to JLab + Cal and veto's assembly (JLab)
- Sept-Dec: BDX detector commissioning (JLab) [+ repurposing of PRAD crystals (JLab) + full DAQ (JLab) as soon as available]

Milestones

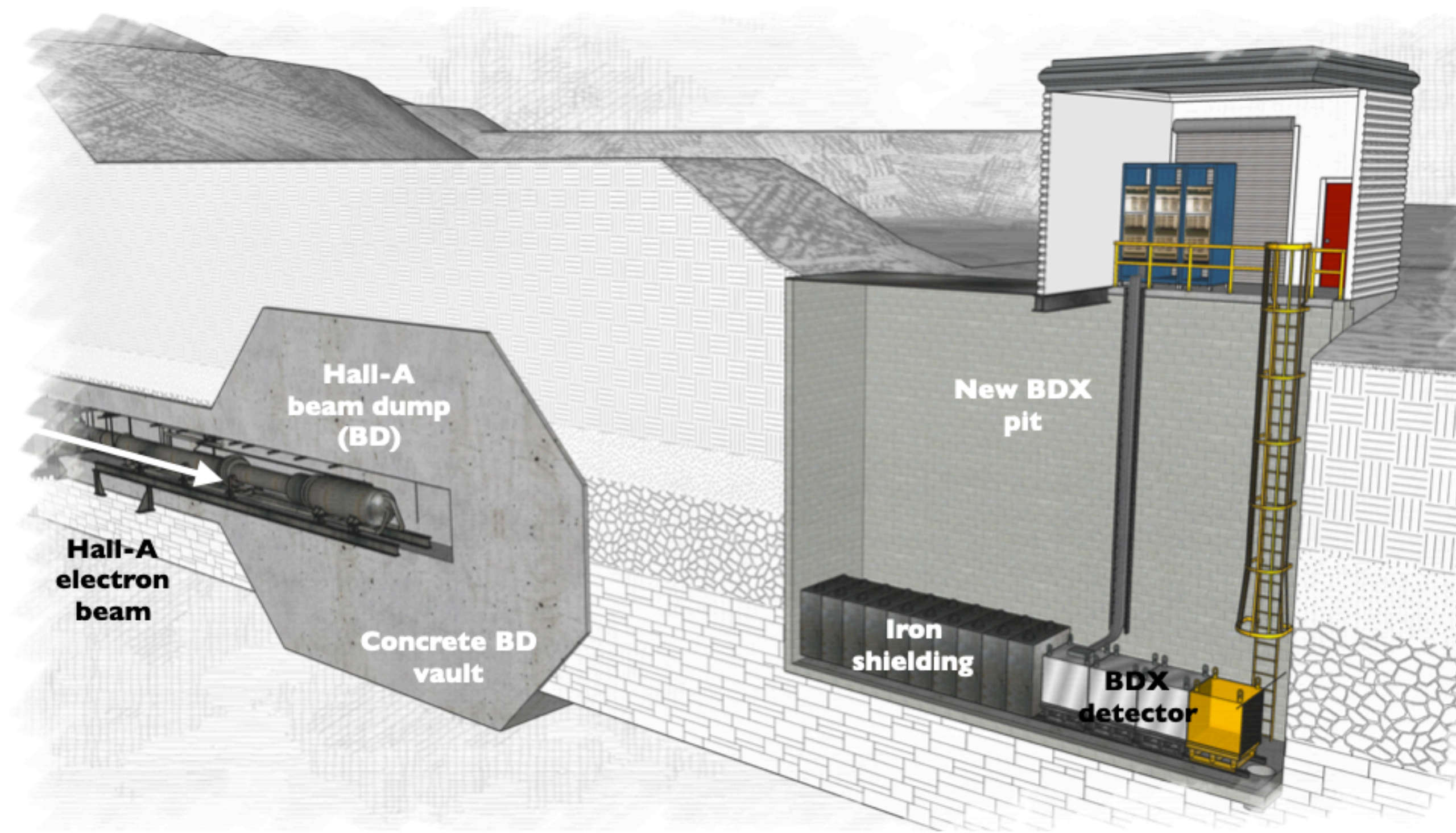
- July: detector components commissioned in Italy
- Sept: detector moved to JLab
- Dec: BDX detector (at least BGO) ready to be installed in the BDX facility

Timelines and workforces shared with D.Higinbotham (appointed PhysDiv AD). Requested for a coordination meeting in person in January at JLab

The Beam Dump eXperiment - BDX

BDX infrastructures

★ New underground pit, ~20m downstream of the Hall-A beam-dump to host the BDX detector to detect hypothetical DM produced in the interaction of CEBAF 11 GeV electron beam with the beam dump. A massive passive shielding (150tons of iron) is expected to absorb the most part of SM particles (but neutrinos)



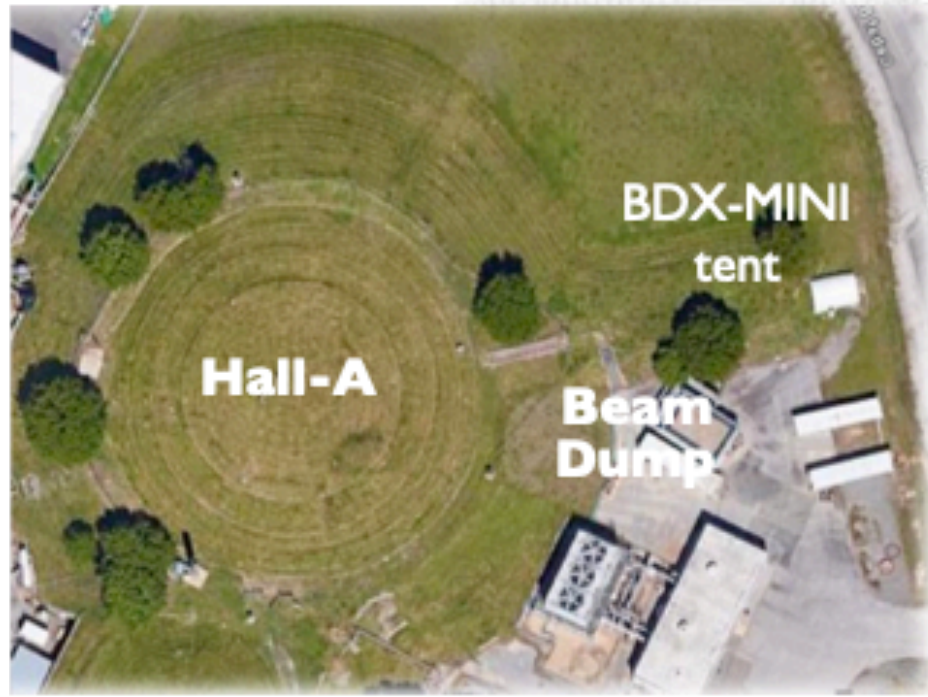
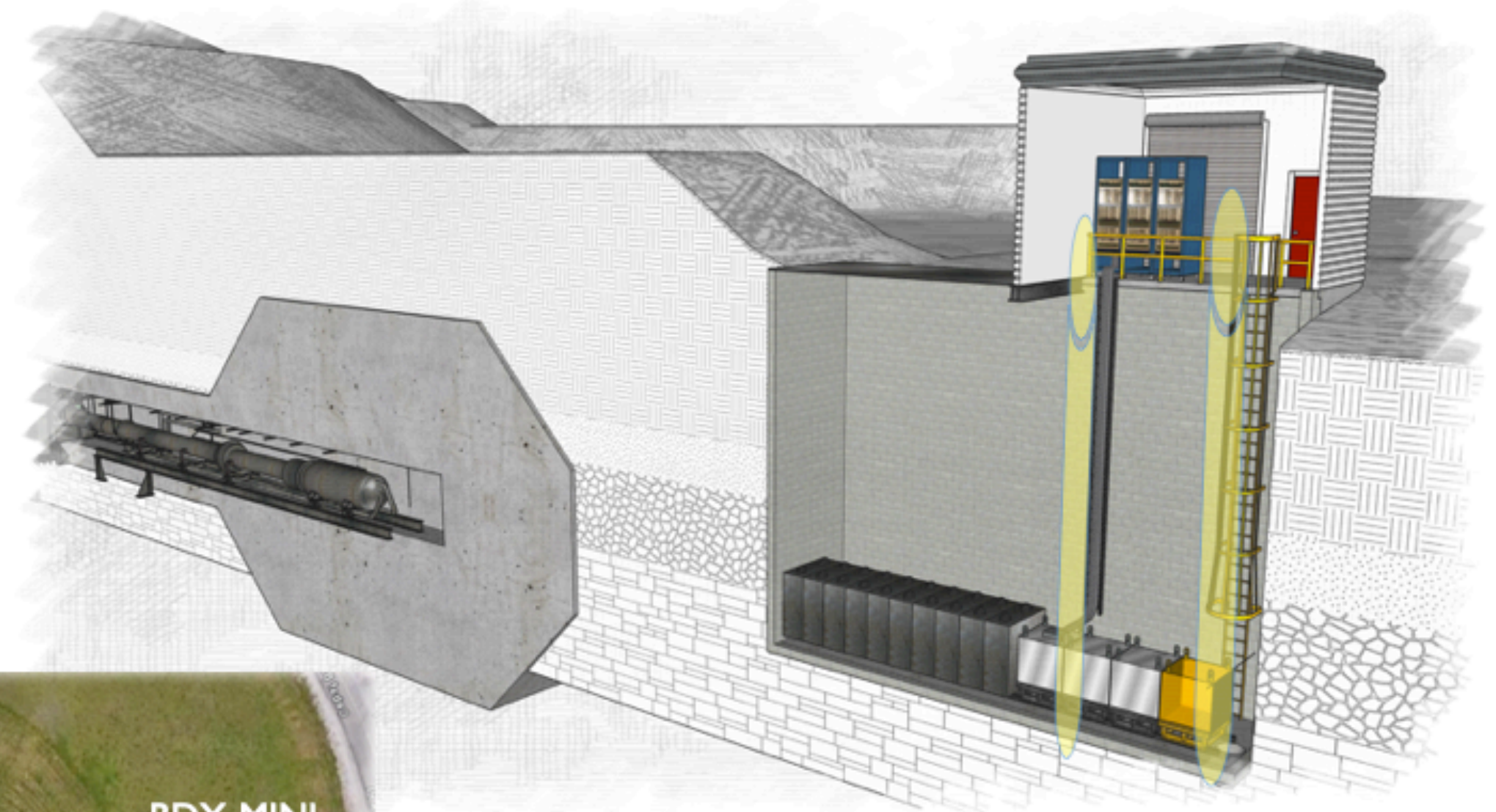
BDX infrastructures

AtkinsRéalis

Concept Report
 Jefferson Science Associates, LLC
 April 10, 2024
 100088820

CONCEPTUAL DESIGN FOR A BEAM DUMP EXPERIMENT UNDERGROUND VAULT

- ★ Preliminary cost estimate ~\$1.5M
- ★ Design and realisation will be done at JLab
- ★ Mechanical design underway (JLab-Facility Management and INFN-GE MachDesign)



BDX Experiment: Thermal Behavior Simulation of the Underground Vault

Federico Silenzi¹, Cecilia Rossi¹, Rosanna Puppo¹, Antonello Marcenaro¹, Marco Battaglieri¹, Franco Parodi²
 INFN, Genoa Section, Via Dodecanneso 33, 16100 Genoa

Scope
 This document aims to present the results obtained during the study of the thermal behavior of the underground vault to be realized for the BDX experiment. The vault has been simulated using different hypothesis.

- Case 1: vault + shelter ($T_{ext} = 27\text{ °C}$);
- Case 1: vault + shelter ($T_{ext} = 3\text{ °C}$);
- Case 1: shielded vault ($T_{ext} = 37\text{ °C}$);
- Case 1: shielded vault ($T_{ext} = -10\text{ °C}$);

The four scenarios have been simulated using a FEM analysis / CFD software (Ansys workbench and Ansys Fluent). While there is no experimental validation, all the results converge towards the same scenario.

A preliminary set of simulations have been performed using Ansys workbench, to investigate the influence of the convective air coefficient. Then the problem was investigated using Ansys fluent.

Geometrical Model
 The first step is to obtain information on the space domain geometrical features. For the first two cases, this includes the overground vault, the concrete base upon which it is placed and the vault itself. For the third and fourth case, only the vault has been considered, but with the introduction of a metallic coverage that is necessary to decouple the vault from the rest of the shelter volume.

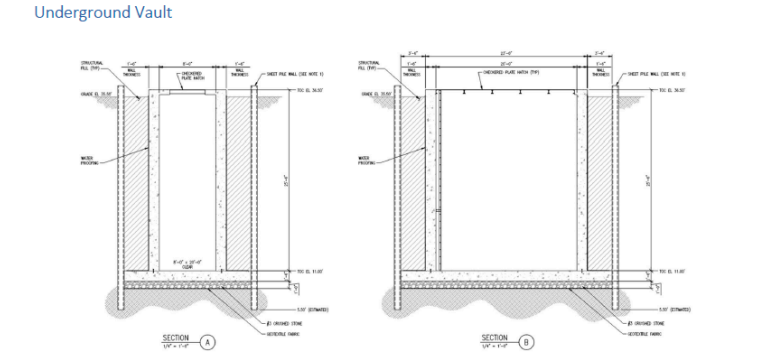
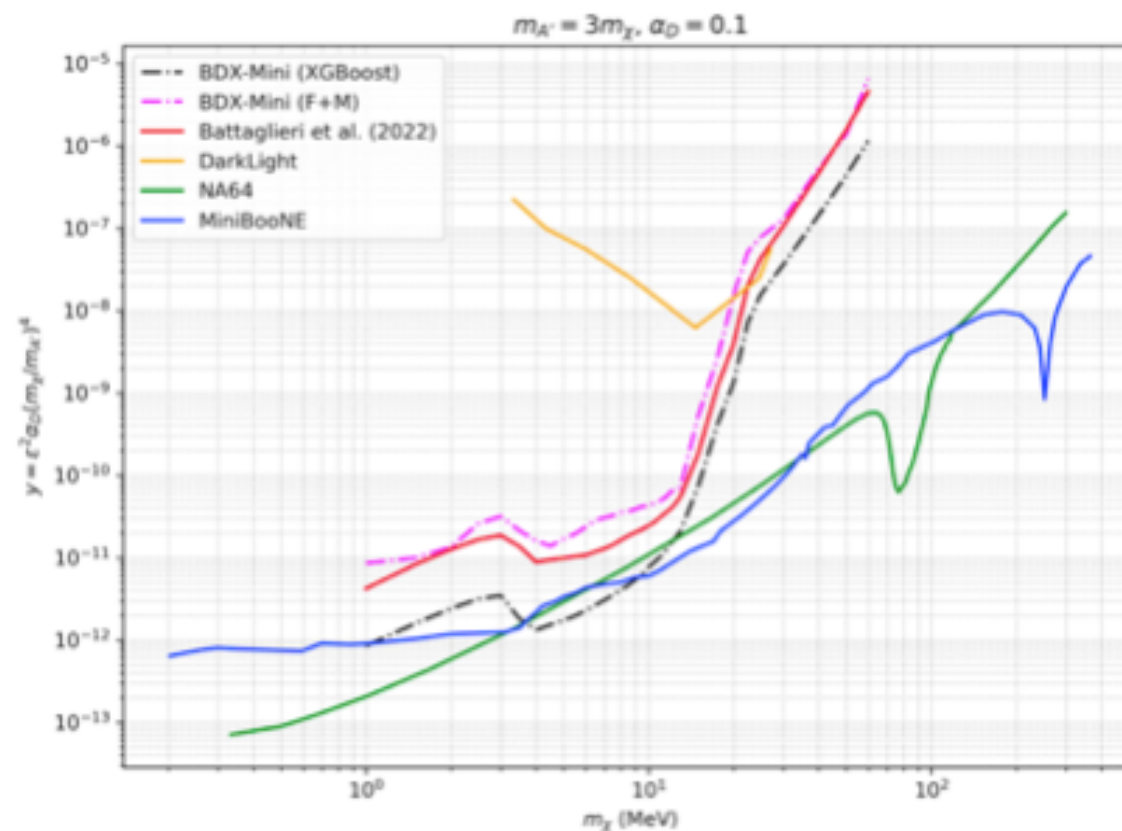


Figure 1: Vault geometrical model

BDX Physics

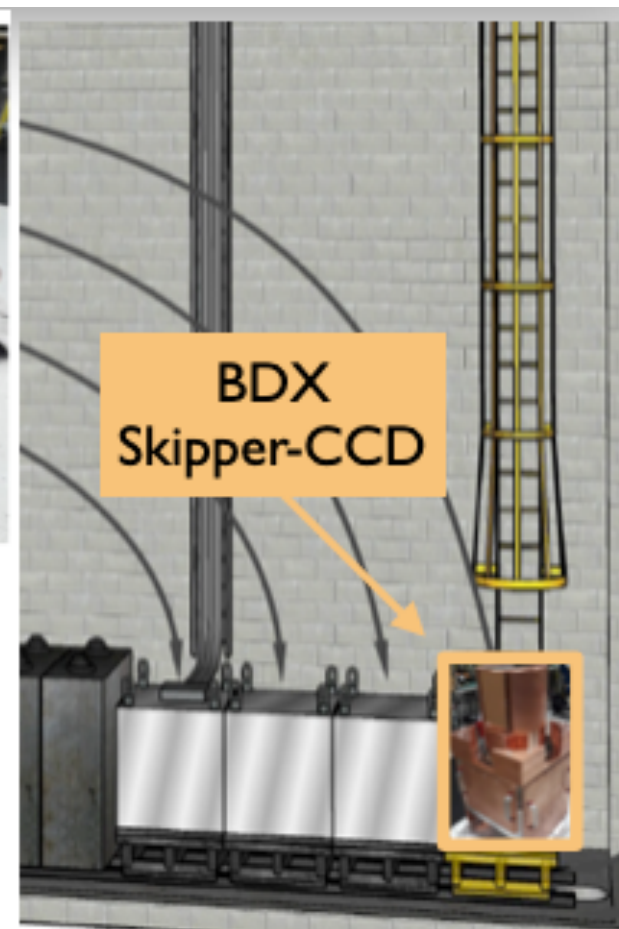
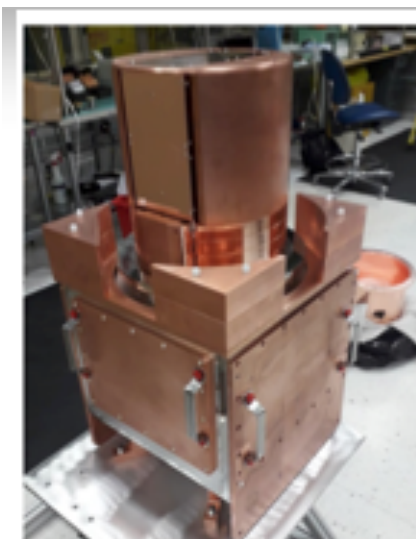
Revisit current limit of BDX-MINI with AI-assisted algorithms

- extended sensitivity with same model assumptions (A')
- Model-independent anomaly detection
- PRL in preparation



Extending BDX detector to test other models

- Addition of Skipper-CCD by SBU/ FNAL groups
- LOI presented at PAC53
- Full proposal encouraged

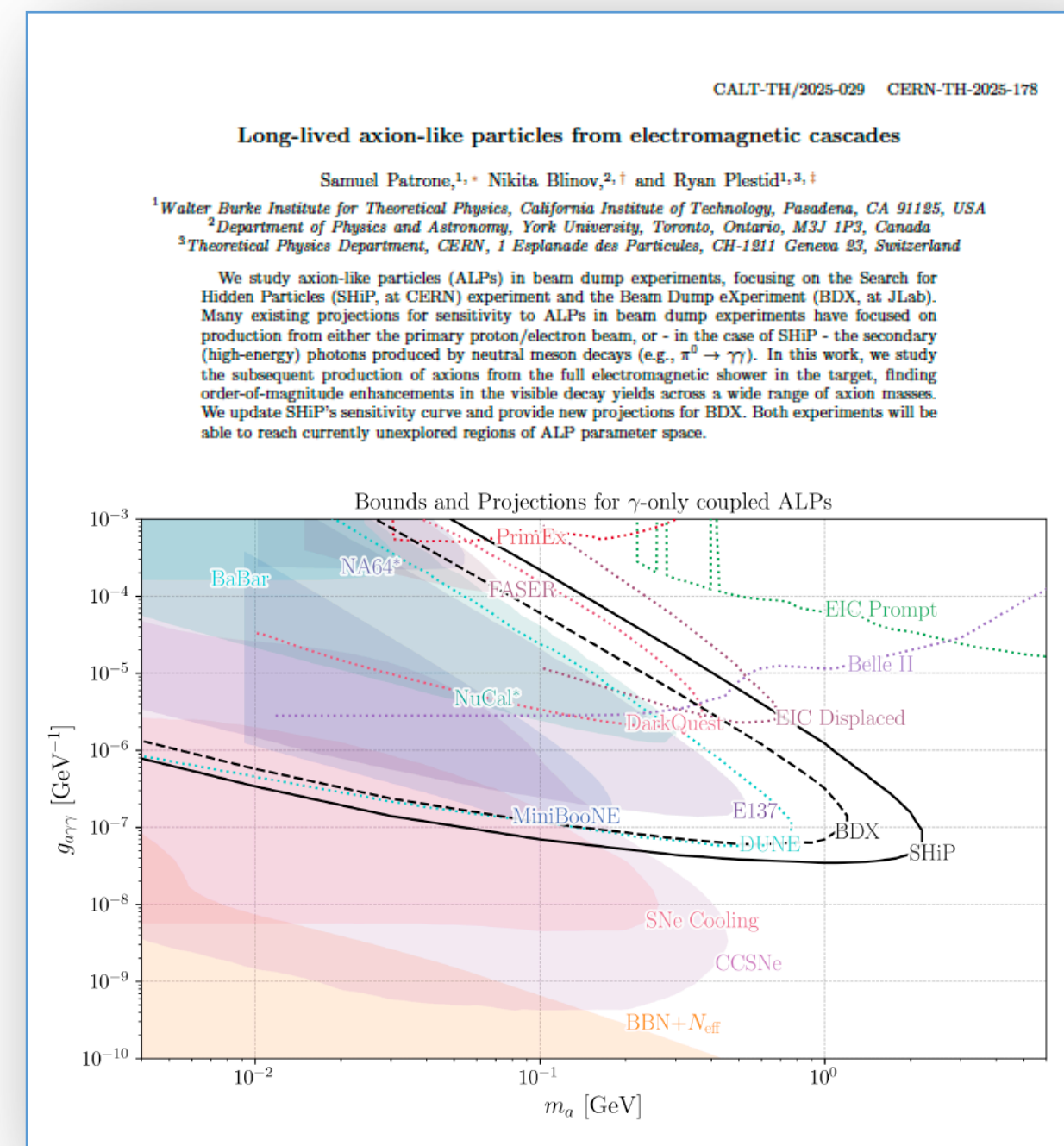


Summary: This LOI describes a compelling, low-cost addition to extend the BDX program into a new regime of sensitivity to light dark-sector particles, especially mCPs. We recommend proceeding to a full proposal after consultation with JLab management to determine whether this should be considered as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

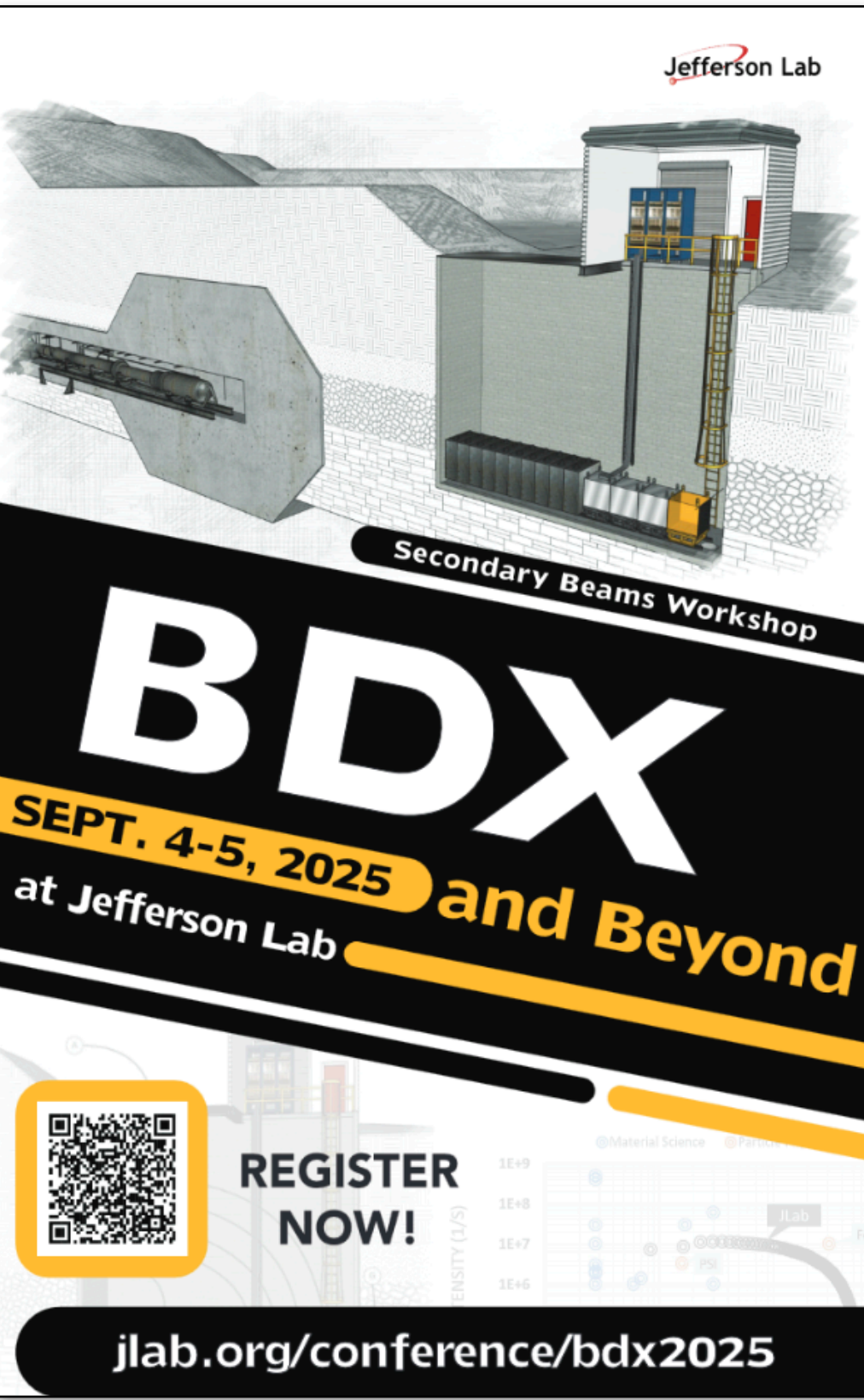
More in Marco's talk!

Extending BDX sensitivity to further models

- Axion-Like Particles (ALPS)
- Interest at HEP experiments (SHIP)



BDX & beyond



Jefferson Lab

Secondary Beams Workshop

BDX

SEPT. 4-5, 2025 and Beyond

at Jefferson Lab

REGISTER NOW!

jlabs.org/conference/bdx2025

Goal

explore opportunities offered by secondary beams at Jefferson Lab to leveraging BDX infrastructures

Format

sharing thoughts and ideas on muon, neutrino, neutron and LDM beams @ JLab

Program

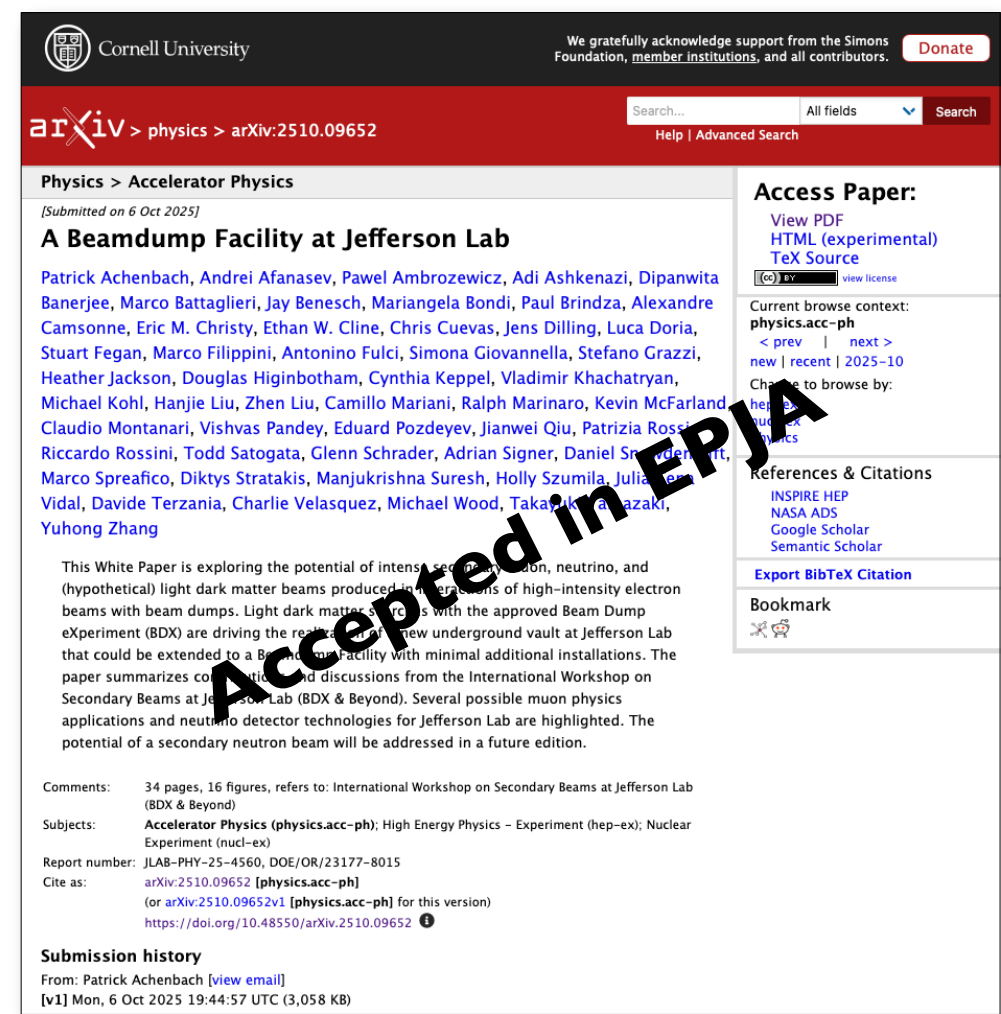
two days of presentations, discussion time, flash talks

(Expected) outcome

to build a new user community e deliver soon after a white paper with results of the brainstorming

Opportunities with secondary beams

- muons
- neutrinos
- neutrons



Cornell University

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[Submitted on 6 Oct 2025]

A Beamdump Facility at Jefferson Lab

Patrick Achenbach, Andrei Afanasev, Pawel Ambrozewicz, Adi Ashkenazi, Dipanwita Banerjee, Marco Battaglieri, Jay Benesch, Mariangela Bondi, Paul Brindza, Alexandre Camsonne, Eric M. Christy, Ethan W. Cline, Chris Cuevas, Jens Dilling, Luca Doria, Stuart Fegan, Marco Filippini, Antonino Fulci, Simona Giovannella, Stefano Grazzi, Heather Jackson, Douglas Higinbotham, Cynthia Keppel, Vladimir Khachatryan, Michael Kohl, Hanjie Liu, Zhen Liu, Camillo Mariani, Ralph Marinaro, Kevin McFarland, Claudio Montanari, Vishvas Pandey, Eduard Pozdeyev, Jianwei Qiu, Patrizia Rossi, Riccardo Rossini, Todd Satogata, Glenn Schrader, Adrian Signer, Daniel Smeiser, Marco Spreafico, Diktys Stratakis, Manjukrishna Suresh, Holly Szumila, Julia Vidal, Davide Terzania, Charlie Velasquez, Michael Wood, Takahiro Yamazaki, Yuhong Zhang

This White Paper is exploring the potential of intense secondary muon, neutrino, and (hypothetical) light dark matter beams produced in experiments of high-intensity electron beams with beam dumps. Light dark matter searches with the approved Beam Dump Experiment (BDX) are driving the realization of a new underground vault at Jefferson Lab that could be extended to a Beam Dump Facility with minimal additional installations. The paper summarizes contributions and discussions from the International Workshop on Secondary Beams at Jefferson Lab (BDX & Beyond). Several possible muon physics applications and neutrino detector technologies for Jefferson Lab are highlighted. The potential of a secondary neutron beam will be addressed in a future edition.

Comments: 34 pages, 16 figures, refers to: International Workshop on Secondary Beams at Jefferson Lab (BDX & Beyond)

Subjects: Accelerator Physics (physics.acc-ph); High Energy Physics - Experiment (hep-ex); Nuclear Experiment (nucl-ex)

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