Dark Matter Search @ JLAB

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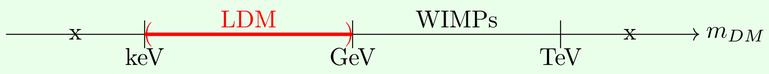
Light Dark Matter

Many astophysical observations suggest Dark Matter (DM) existence

→ No constrain on DM particle properties
→ Further hypothesis needed: thermal origin
→ Constrain of DM nature and interaction

⇒ LDM requires new interaction

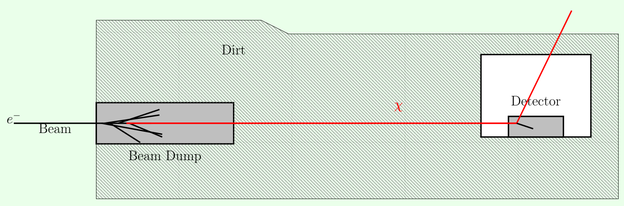


BDX @ JLab

In beam dump experiments we aim at detecting DM produced by a medium-high energy beam impinging on a thick target (beam dump)

→ DM can be produced along SM particles
→ Most SM particles absorbed in dump and surrounding material
→ eventual DM particles can be revealed in a detector downstream the dump

→ DM-e scattering ⇒ EM shower



Key features of experiment:

- High intensity, medium energy beam
- Backgrounds:
  - Beam background (except νs) shielded by passive material
  - Cosmogenic background not shieldable ⇒ rejected using veto system
- Detector (o(1) m^3) = EM calorimeter + veto system

BDX future experiment to probe LDM

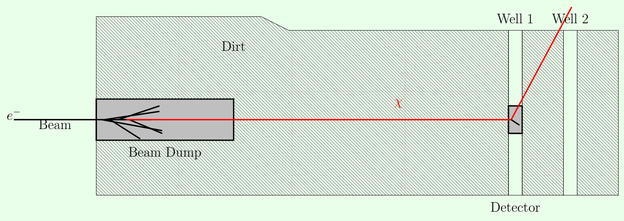
- Run between 2026 and 2029
- Sensitivity to large number of DM models

[1] Battaglieri M. et al. arXiv:1607.01390

BDX-MINI @ JLab

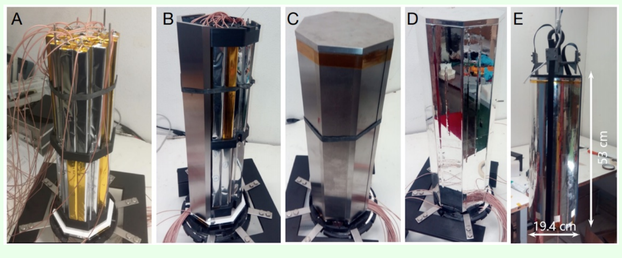
Performed small-scale experiment: BDX-MINI

→ Took data for 6 months (2.53×10^{21} EOT)



Detector = small scale version of BDX (0.15% total volume):

- EM Calorimeter for DM detection
- Veto to reject cosmogenic background

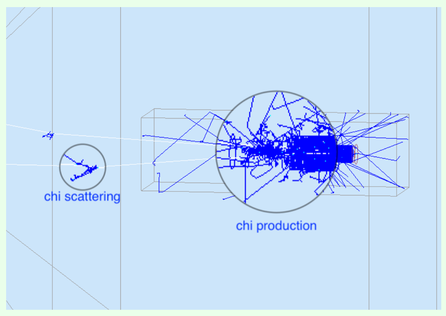


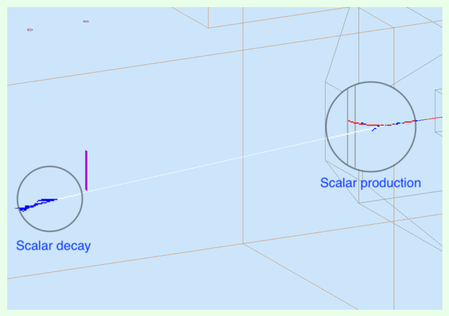
[1] Battaglieri M. et al. Eur. Phys. J. C (2021) 81: 164

Simulation

Implemented DM production and interactions mechanisms in MC simulations:

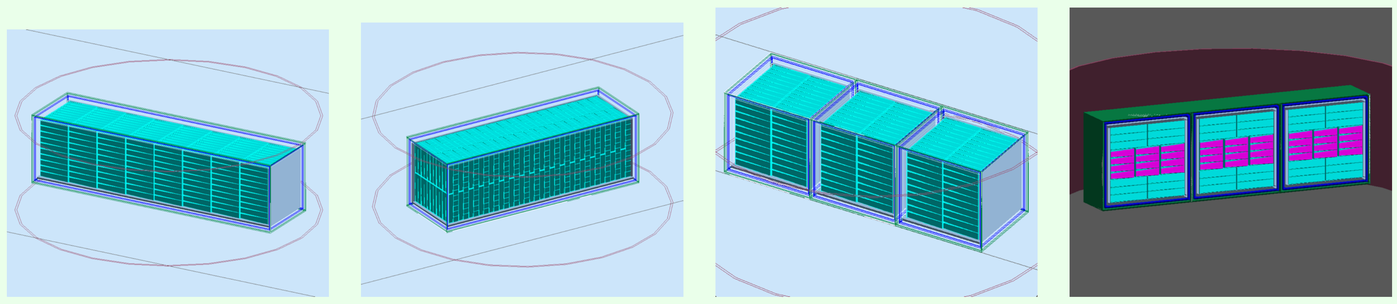
- *Dark Photon* model
- *Scalar DM* coupled only to μ





Performed simulations to assess the best detector layout

→ maximize signal efficiency
→ optimize background rejection

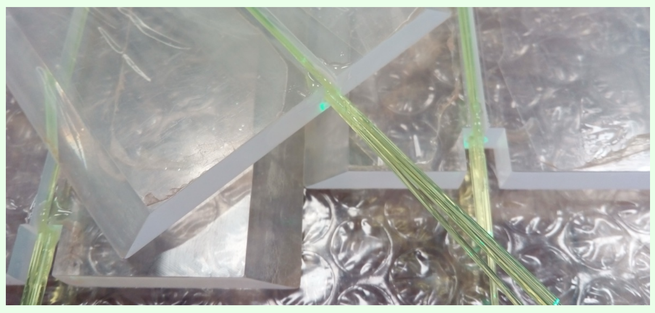


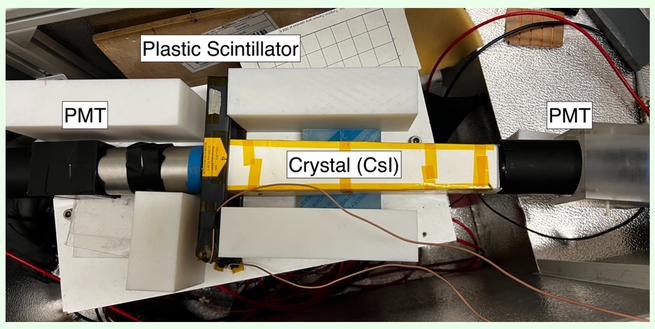
Prototype commissioning

Building a prototype to test BDX design

EM calorimeter: CsI(Tl) crystals read using SiPM
Performed crystal characterization:

- Light yield
- Scintillation time





Streaming readout is the continuous collection of data from the detector without any selection by a hardware trigger

→ SRO is a must to fully unlock BDX scientific protential
→ Built a prototype and used for on-beam test

Veto system: hermetic plastic scintillator box read by WLS fibers and SiPM

DM exclusion limits

BDX-MINI set exclusion limits on DM parameter space

- BDX-MINI achieved result comparable to flagship experiments
- Proof of high sensitivity of beam dump experiments
- Test and validation of BDX technology
- BDX will be able to improve by up to two order of magnitude existing exclusion limits