

# Dark matter search with the DarkMESA electron beam-dump experiment

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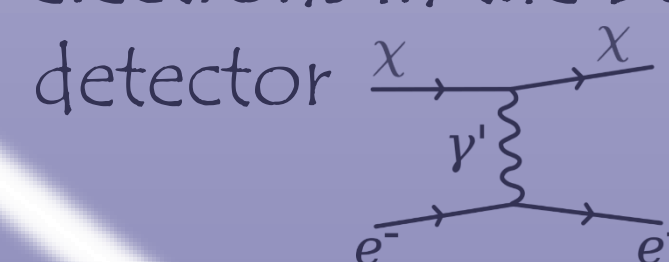
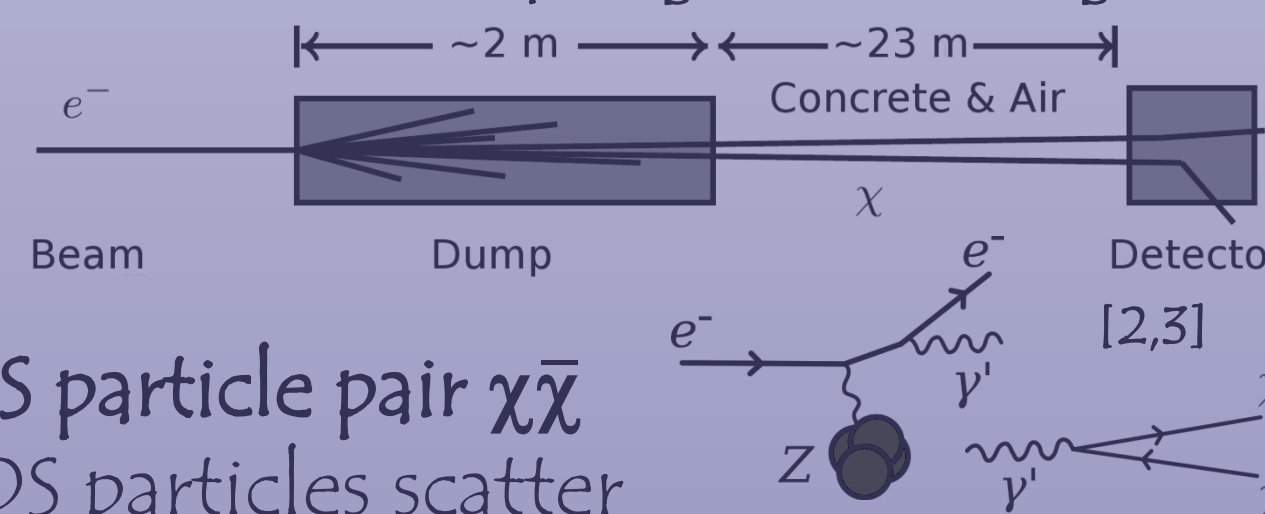
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## DarkMESA Physics

Assumption: Light Dark Matter (LDM) from a Dark Sector (DS) interacts with Standard Model through a massive Dark Photon  $\gamma'$  coupling with strength  $\epsilon$

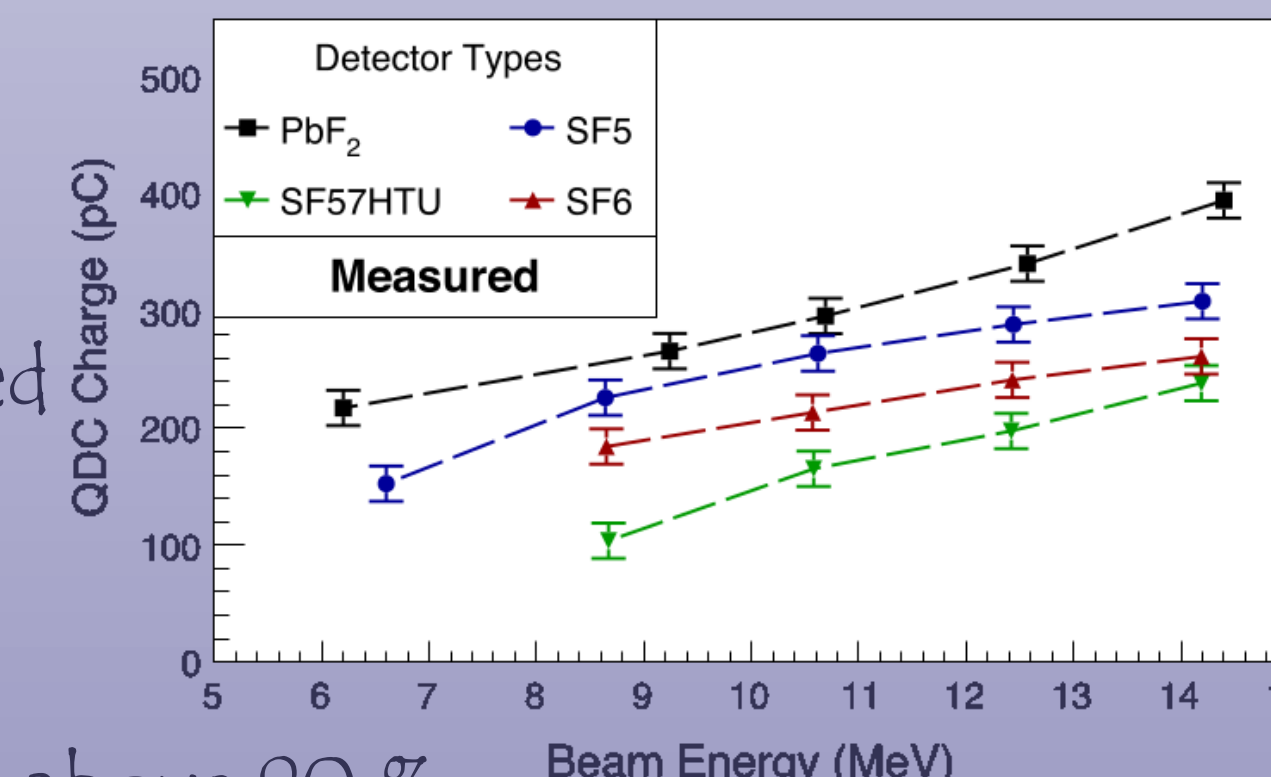
Simplest model:

- Dark photon  $\gamma'$  produced by Dark Bremsstrahlung
- Invisible decay to DS particle pair  $\chi\bar{\chi}$
- Fraction of the DS particles scatter off electrons in the DarkMESA detector



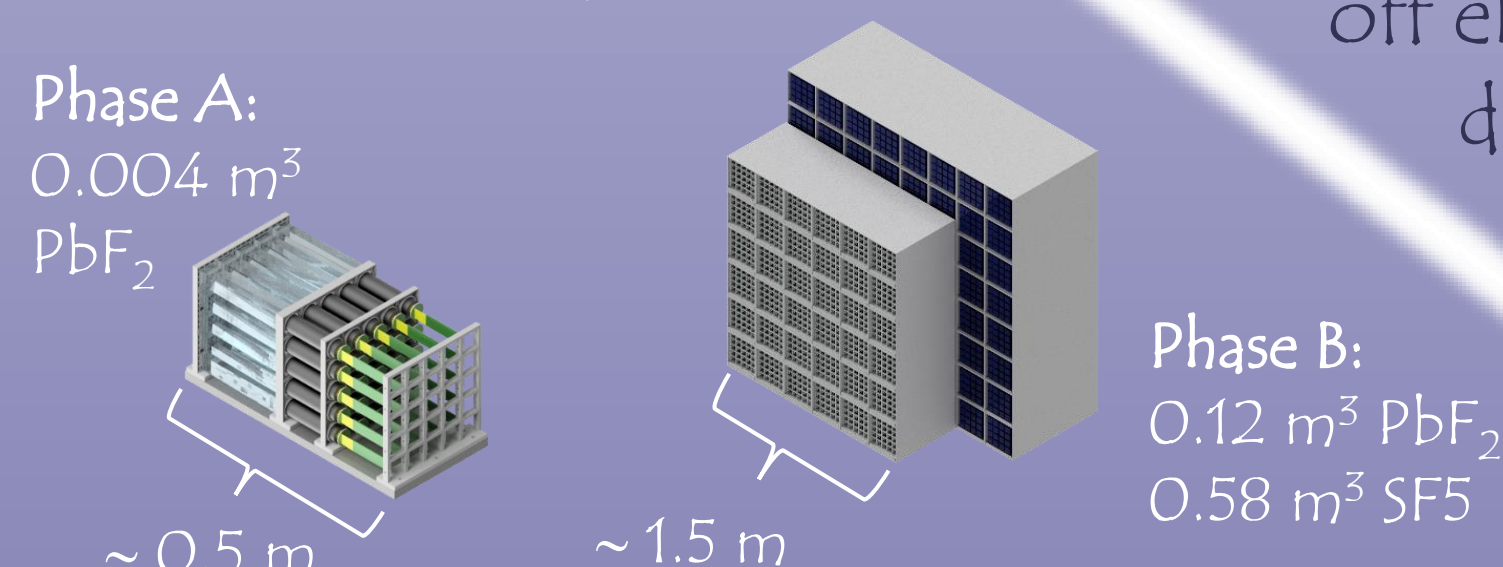
## Material Studies

- Prototype studies with 6 – 14 MeV  $e^-$  beam
- Geant4 optical photon study
- Ordering of transmittance spectra as expected
- PbF<sub>2</sub> and SF5 as calorimeter material
  - Good homogeneity
  - Best light yield & energy resolution
  - Detection efficiency for 10 MeV  $e^-$  is above 90 %



## Staged Approach

- Re-use of crystals and photomultipliers from former experiments

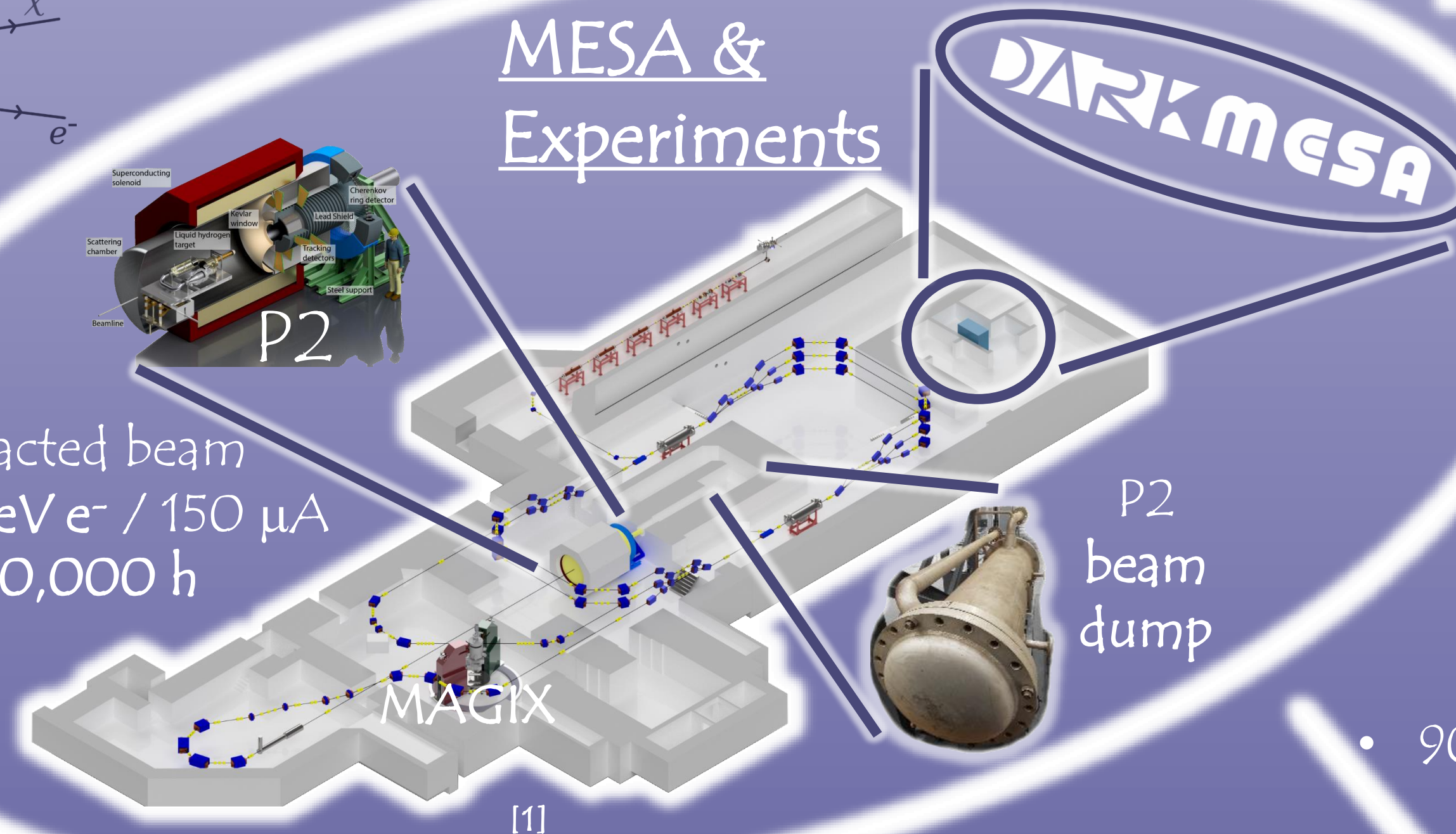


Stage	Description	Period	Scheduled time
Phase A	Prototype	1. – 4. year	2,200 h
Phase B	PbF <sub>2</sub> + SF5	4. – 6. year	6,600 h

- Increase active volume in Phase C

## MESA & Experiments

Extracted beam  
< 150 MeV  $e^-$  / 150  $\mu$ A  
> 10,000 h

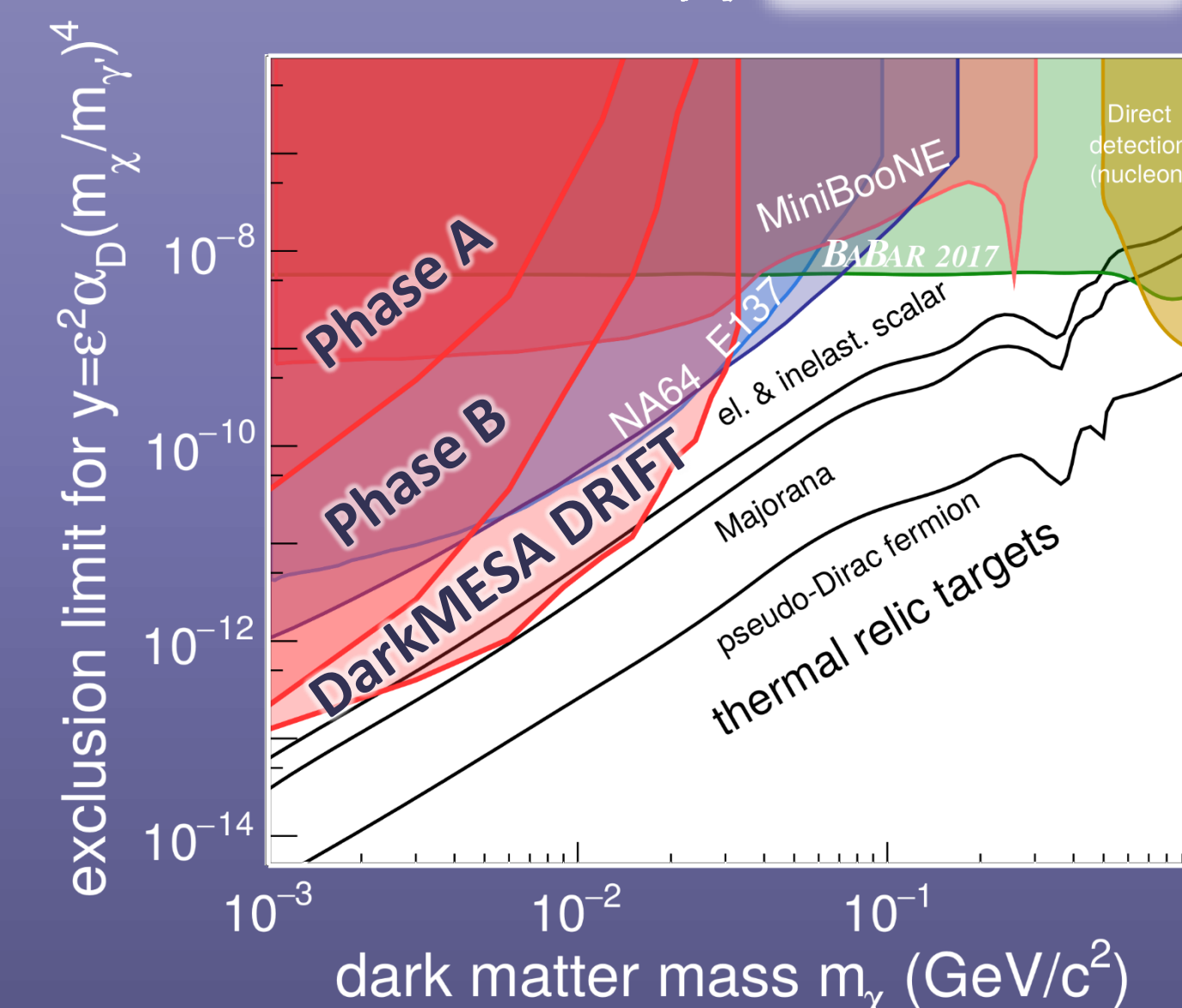


## Outlook & Expected Reach

- Complementary approach: DRIFT
- Low pressure negative ion TPC with 1 m<sup>3</sup> CS<sub>2</sub> at 40 Torr
  - Nuclear recoil detection ( $E_{\text{thr}} \approx 20$  keV)



- Simulation parameters:
- $\alpha_D = 0.5$
  - $m_{\gamma'} = 3 \cdot m_\chi$
  - 90 % conf. level
  - $\epsilon_{\text{Det}} = 95 \%$



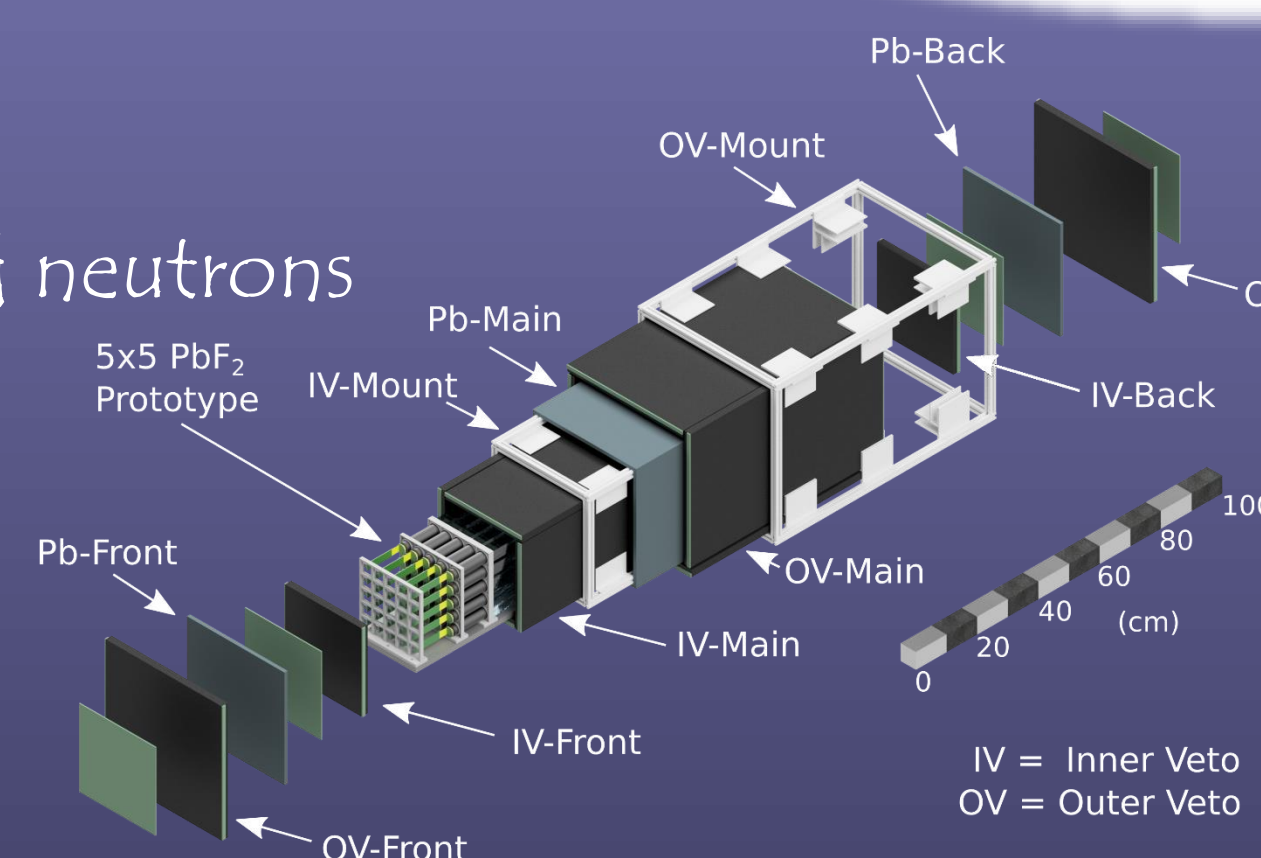
## Radiation Studies and Veto Concept

### Neutron response study

- Sensitivity in SF5 and PbF<sub>2</sub>  $\ll 1 \%$  (for plastic scintillators  $\sim 72 \%$ )
- FLUKA simulation for beam-related neutrons

### Cosmic-ray simulation studies

- Phase A  $\Rightarrow$  0.38 % inefficiency
- Thicker Pb layer for Phase B
- Phase B  $\Rightarrow$  < 0.1 % inefficiency
- 10<sup>5</sup> bkg events in scheduled time

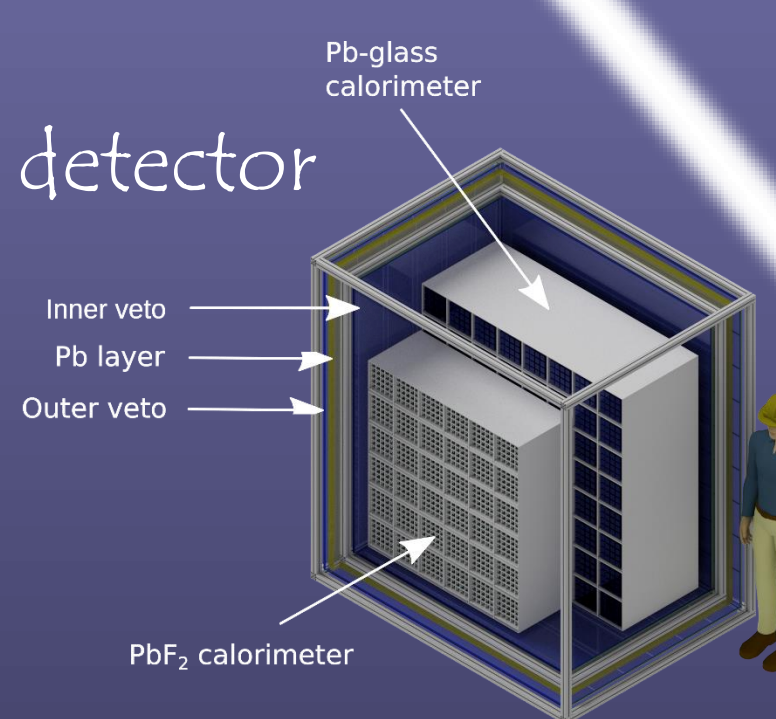


### Study of remaining backgrounds

- Beam-off data
- Beam-on data with rotated detector
- Pulse-shape analysis

### Study of improved concepts

- Additional ceiling veto
- Outer calorimeter as veto



Short-term goal: Completion of the DarkMESA prototype Phase A