

Light Dark Matter Searches with DarkMESA

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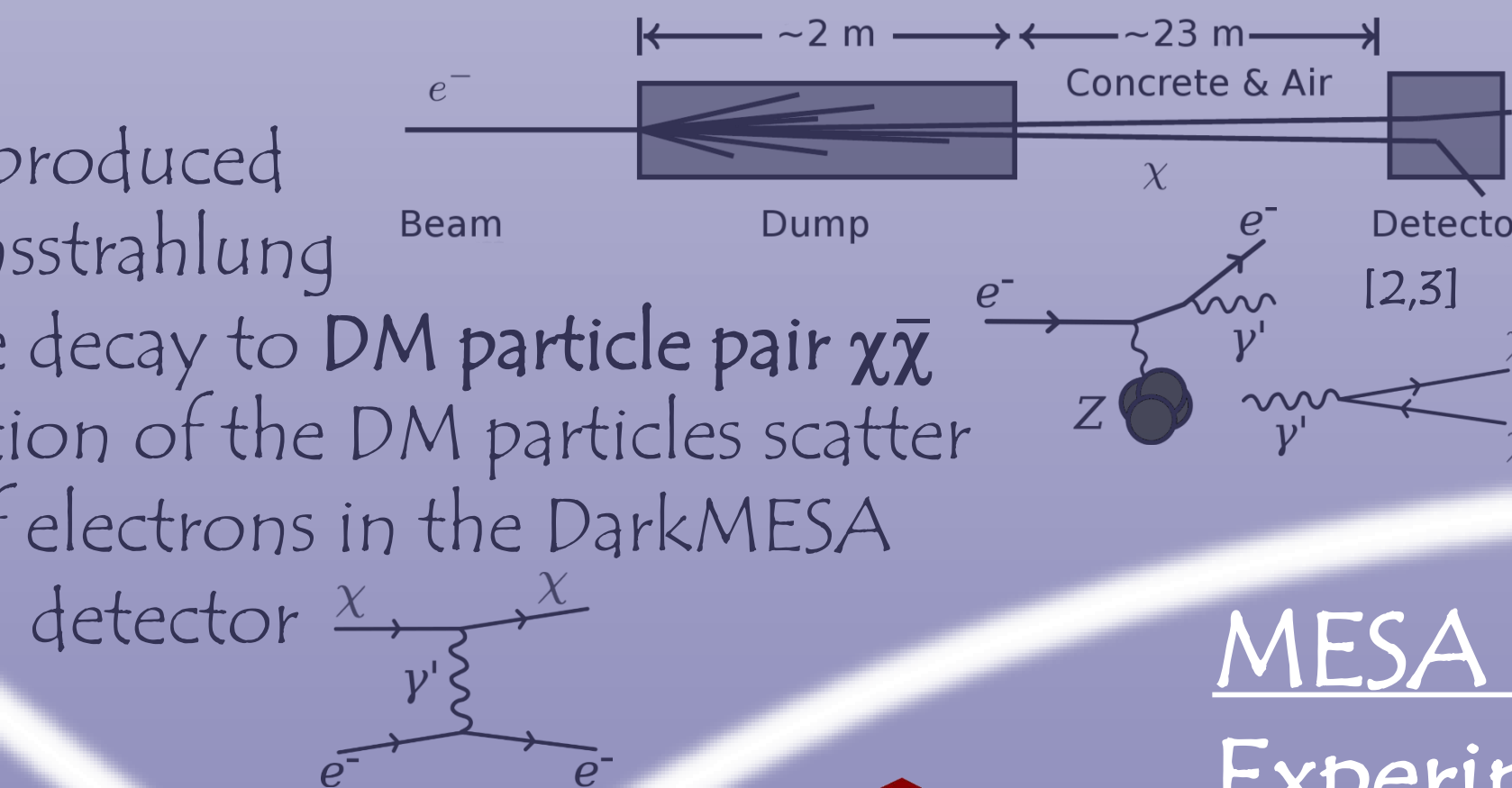
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DarkMESA Physics

- Assumption: Light Dark Matter (LDM) interacts with the Standard Model through a (massive) dark photon γ' coupling with strength ϵ

Simplest model:

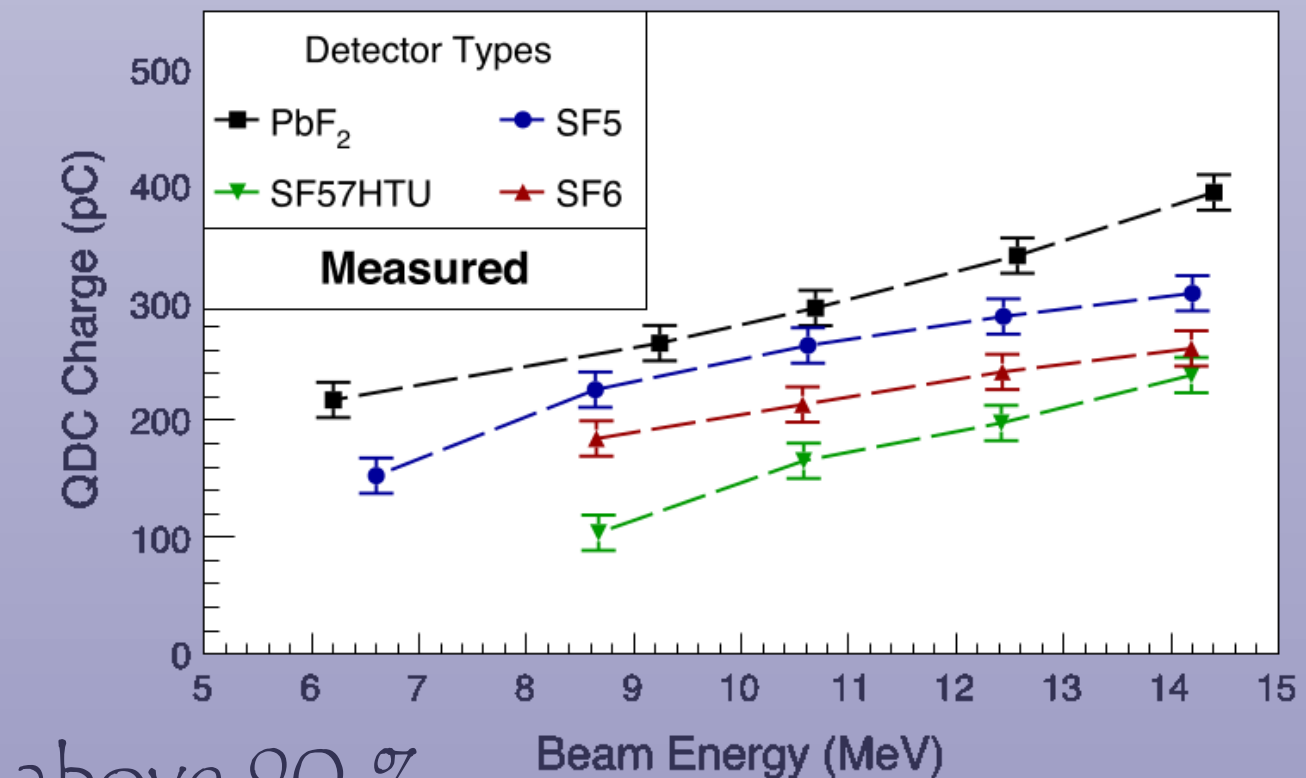
- Dark photon γ' produced by Dark Bremsstrahlung
- Invisible decay to DM particle pair $\chi\bar{\chi}$
- Fraction of the DM particles scatter off electrons in the DarkMESA detector



Material Studies

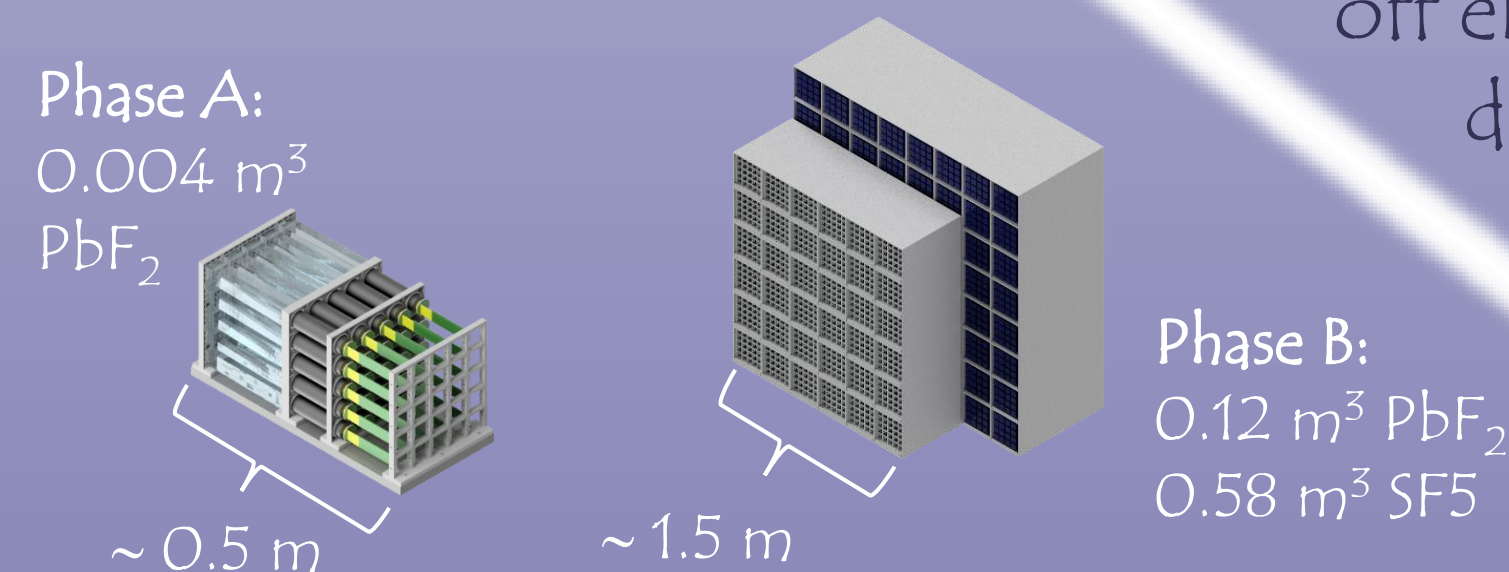
- Prototype studies with 6 – 14 MeV e^- beam
- Geant4 optical photon study
- Ordering of transmittance spectra expected
- PbF₂ and SF5

- 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



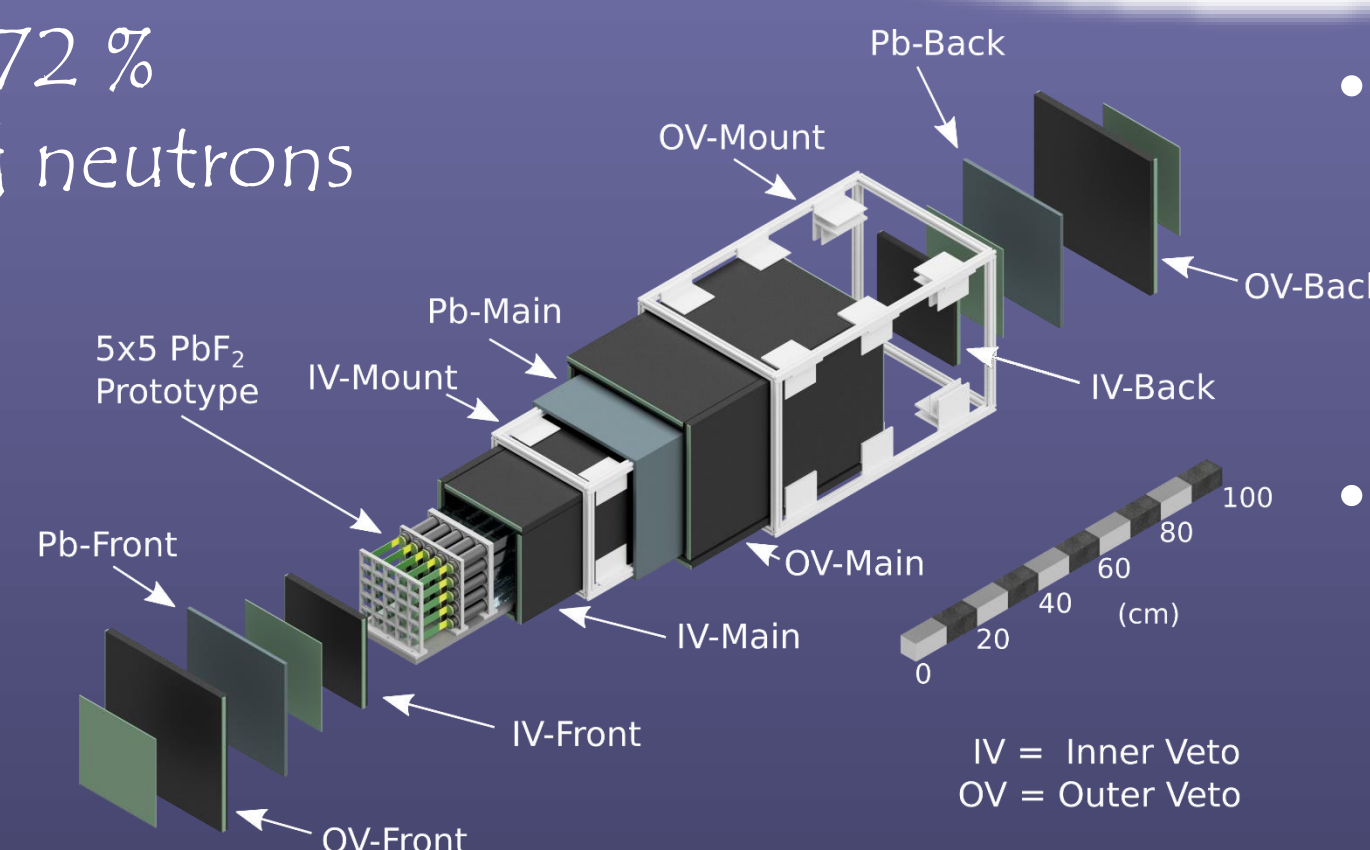
Stage	Description	Period	Scheduled time
Phase A	Prototype	1. – 4. year	2,200 h
Phase B	PbF ₂ (A4) + SF5 (Münster)	4. – 6. year	6,600 h

- Increase active volume in Phase C

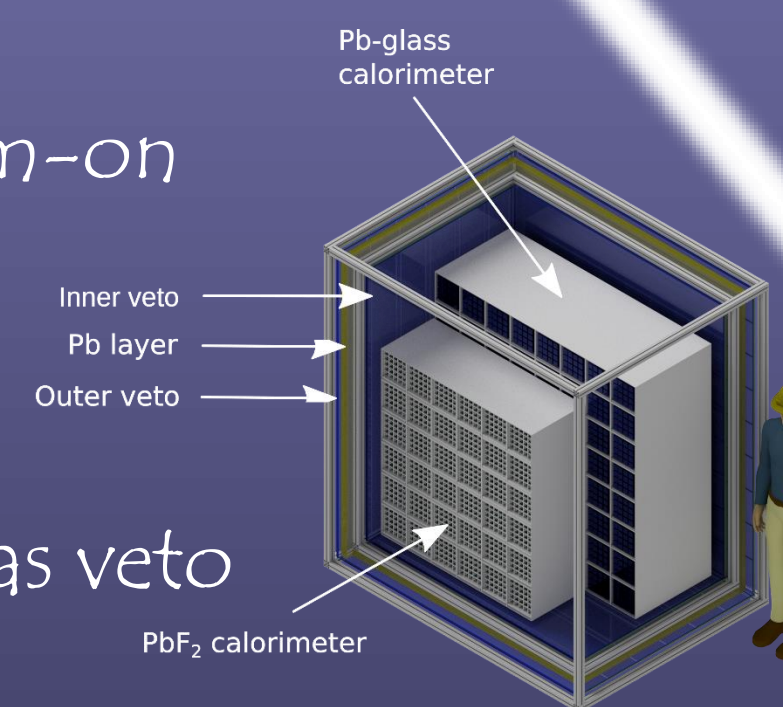
Radiation Studies and Veto Concept

- Neutron response study: Sensitivity in SF5 and PbF₂ \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
- Still 10^5 events in scheduled time

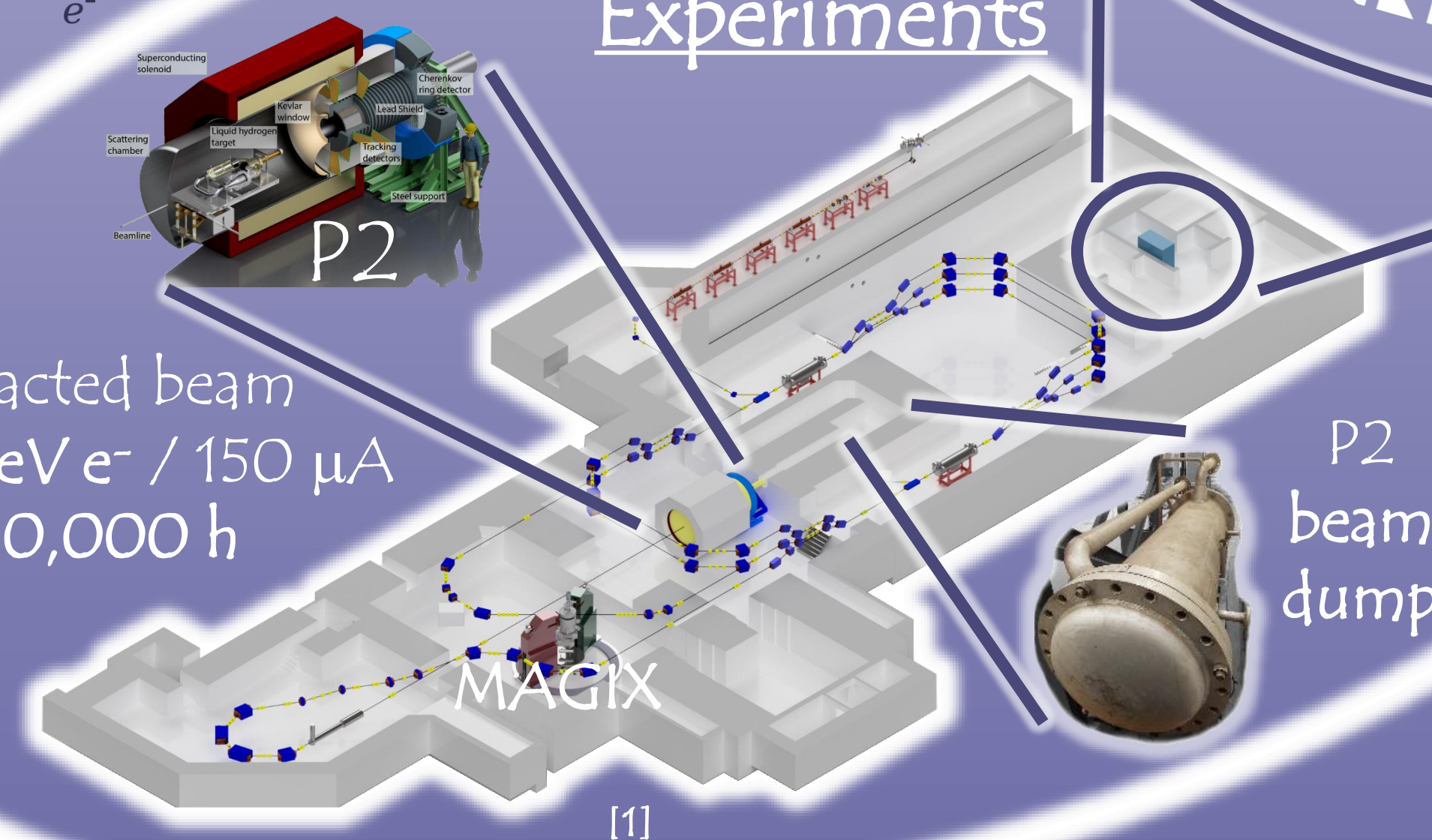


- Study of remaining backgrounds
- Analysis of beam-off data
- Rotated detector with beam-on
- Signal shape
- Study of improved concepts
- Additional ceiling veto
- Outer calorimeter crystals as veto



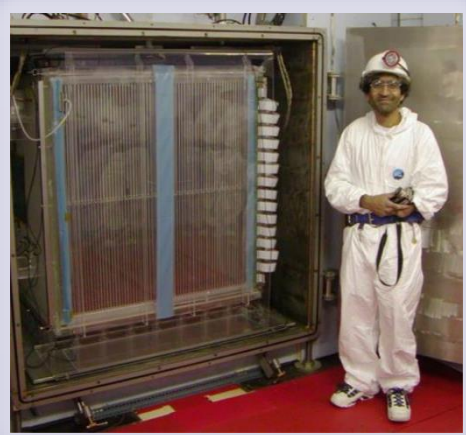
MESA & Experiments

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

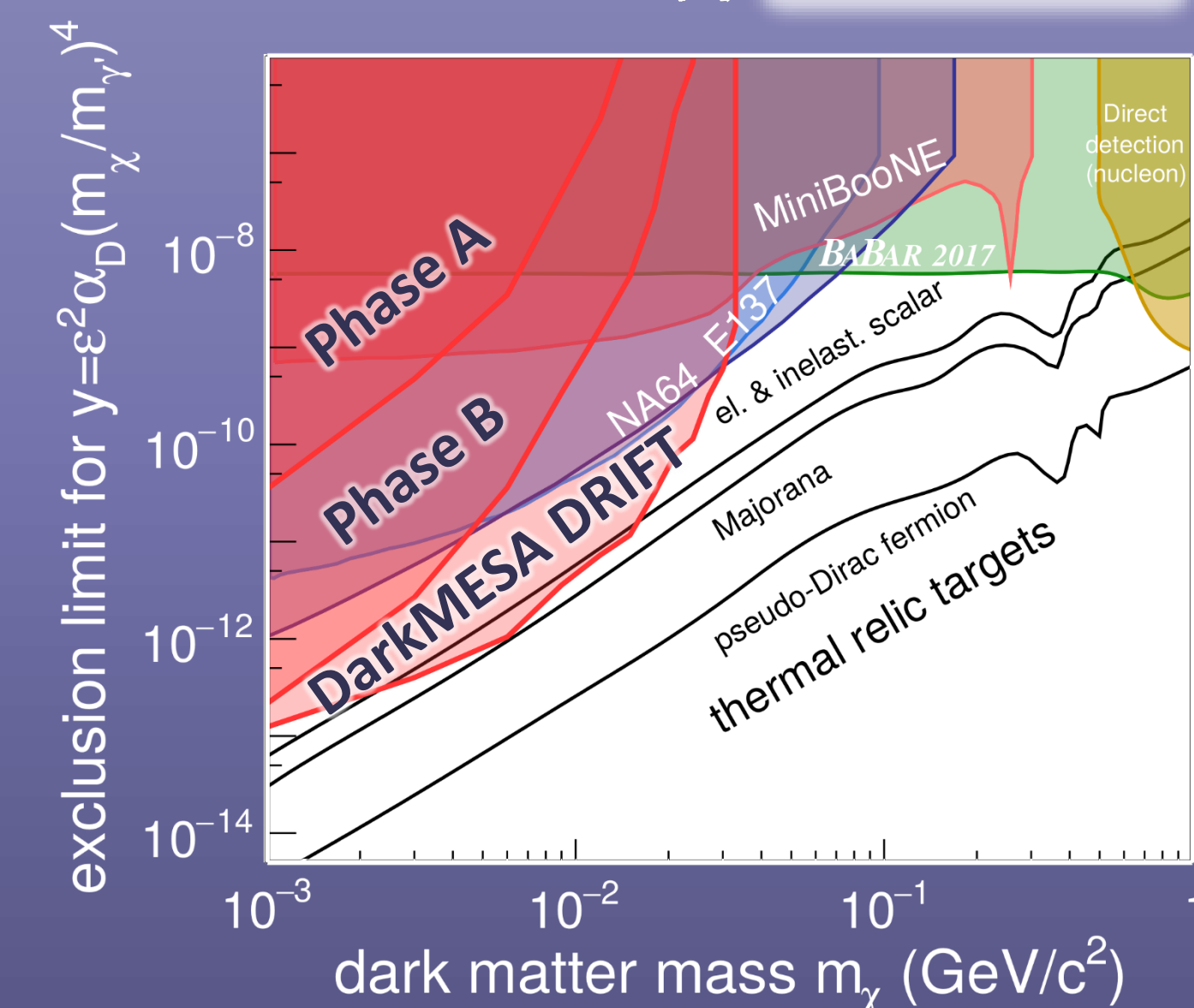


Outlook & Expected Reach

- Complementary: DarkMESA Drift
- Low pressure negative ion TPC with 1 m³ CS₂ at 40 Torr
- Nuclear recoil detection ($E_{thr} \approx 20$ keV)



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



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