Light Dark Matter Searches with DarkMESA

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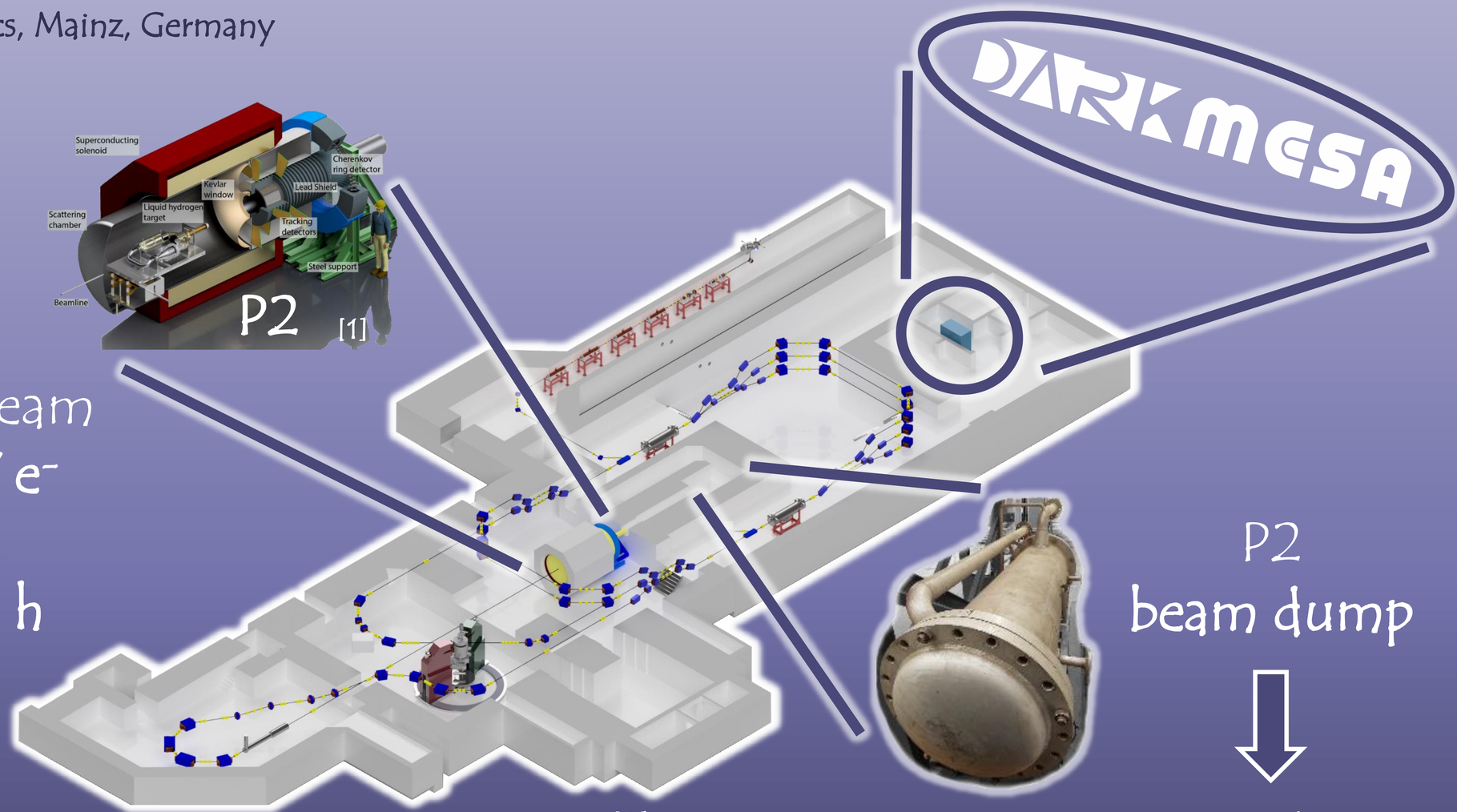
Mainz Energy recovering Superconducting Accelerator (MESA)

Institute for Nuclear Physics, Mainz, Germany

P2 [1]

Extracted beam
< 150 MeV e^-
150 µA
> 10,000 h



MAGIX [2]

P2
beam dump

dark particle source

References: [1] D. Becker et al. The P2 experiment. Eur. Phys. J. A 54, 208. 2018. https://doi.org/10.1140/epja/i2018-12611-6
[2] D. Simon. Autodesk Inventor Data files. Institute for Nuclear Physics Mainz. 2021.
[3] D. Snowden-Ifft. Talk at UCLA Dark Matter. 2018.

EPS-HEP Conference, July 26-30, 2021

DarkMESA Publications:
- NIM A 1012 (2021) 165617
- PoS 360 (2021) 0022
- NIM A 960 (2020) 163665
- NIM A 958 (2020) 162398
- arXiv:1809.07168 (2018)

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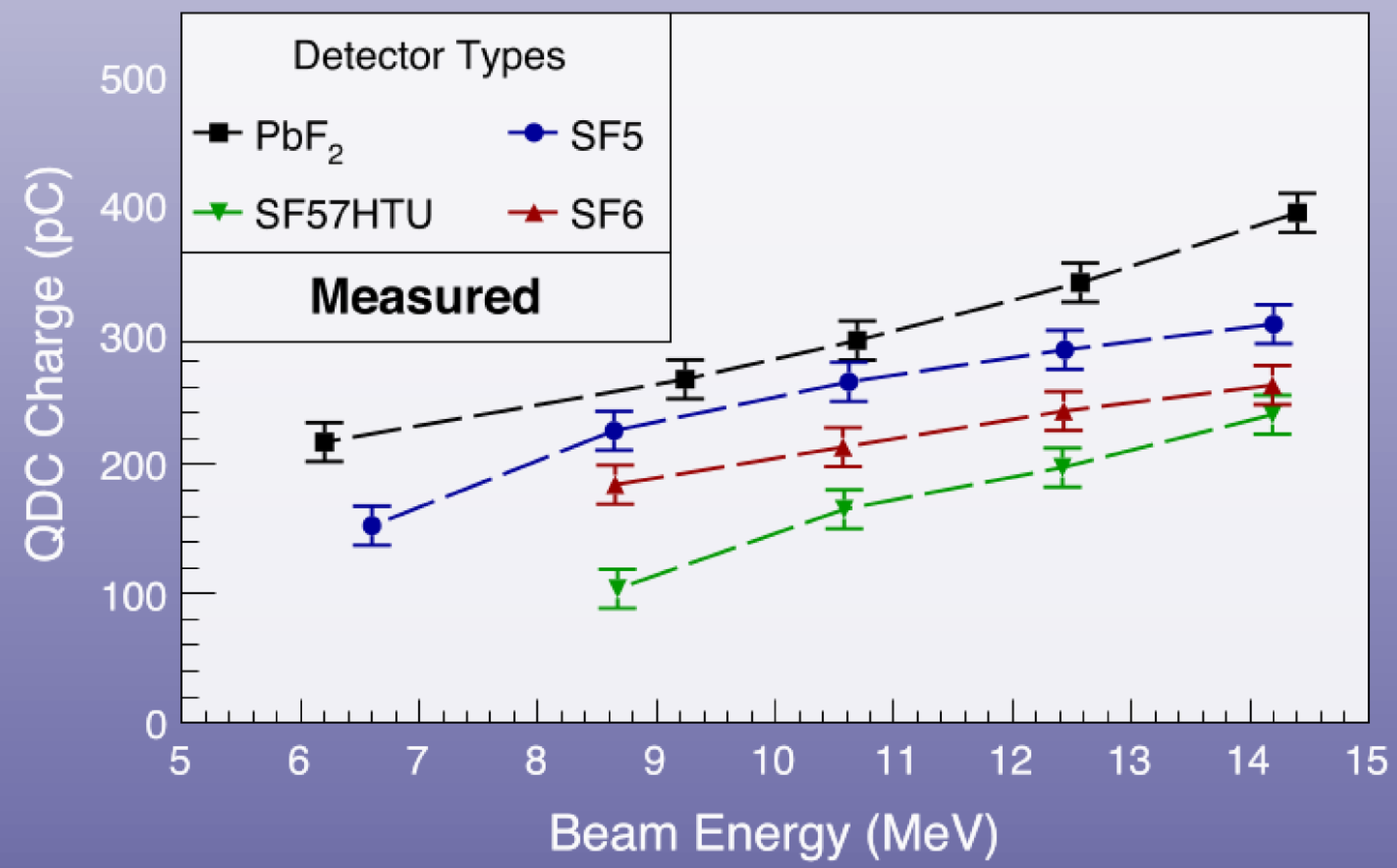
Material Studies

- Prototype studies with 6 – 14 MeV e^- beam
- Geant4 optical photon study
- Ordering of transmittance spectra expected
- PbF_2 and Pb glass SF5
  - ⇨ Good homogeneity
  - ⇨ Best light yield & energy resolution
  - ⇨ Detection efficiency for 10 MeV e^- is above 90 %



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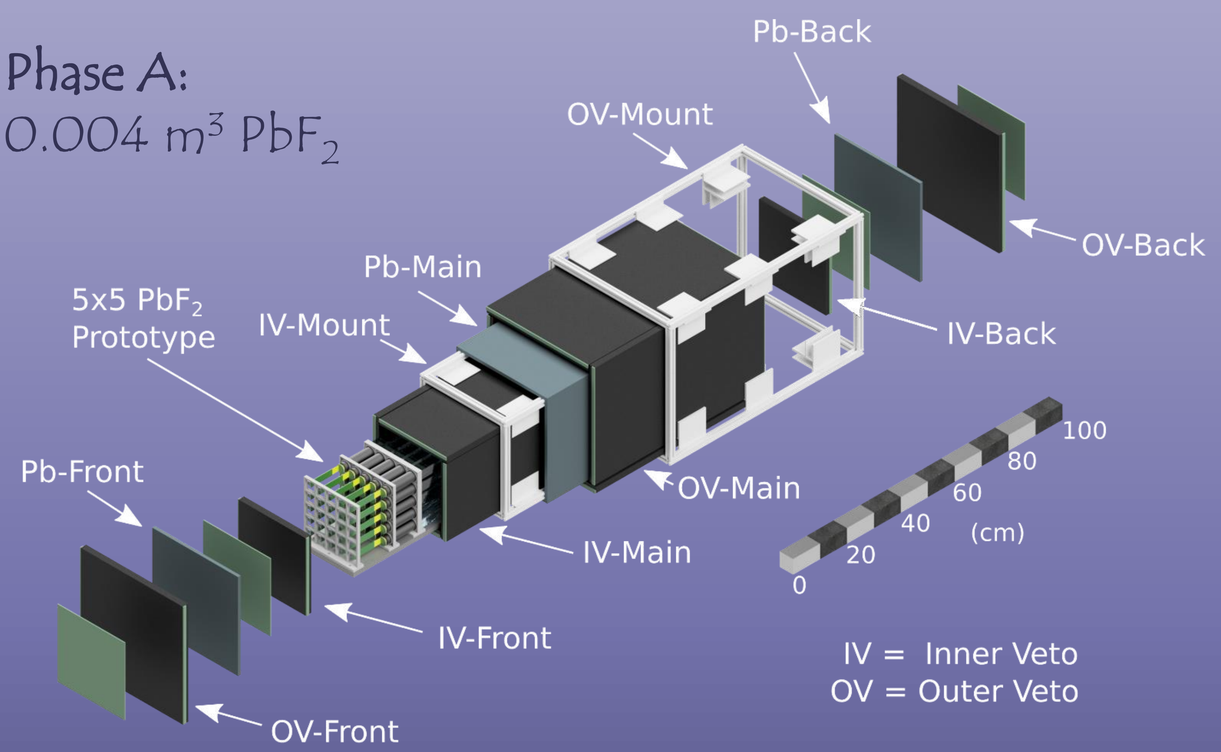
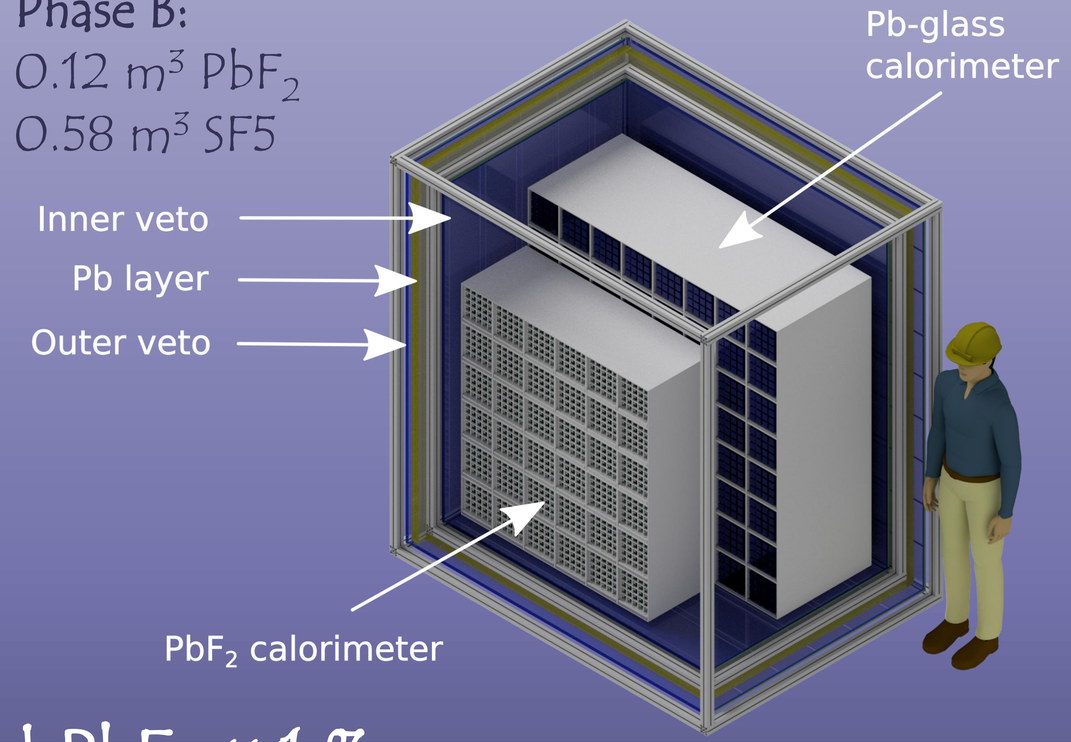
Overall Design and Veto Concept

- **Re-use** of crystals and PMTs from former experiments

Phase A:
0.004 m^3 PbF_2



Phase B:
0.12 m^3 PbF_2
0.58 m^3 SF5



- **Neutron response** study: Sensitivity in **SF5 and PbF_2 « 1 %**
- FLUKA simulation for beam-related neutrons
- **Cosmic-ray simulation** studies

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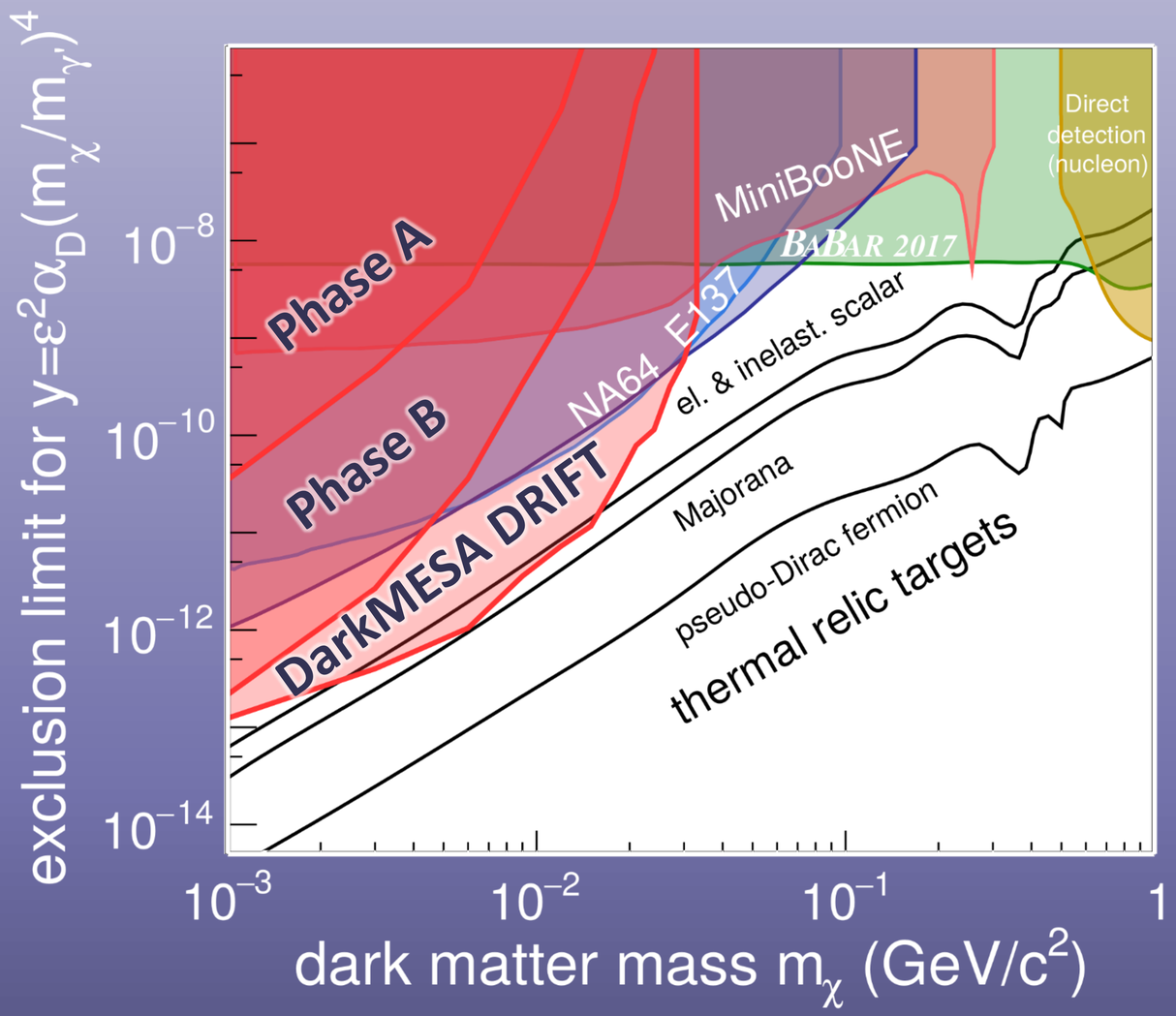
Outlook & Expected Reach

- $m_{\gamma'} = 3 \cdot m_\chi$
- $\epsilon_{Det} = 95\ \%$
- 90 % conf. level
- $\alpha_D = 0.5$
- $E_{thr} = 10$ MeV

- Complementary: **DarkMESA DRIFT**
  Low pressure negative ion TPC with 1 m^3 CS_2 at 40 Torr ($E_{thr} \approx 20$ keV)

[3]

Stage	Scheduled time
Phase A	2,200 h
Phase B	6,600 h
DarkMESA DRIFT	6,600 h



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