WIMP Dark Matter Detection with DarkSide-50

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arxiv:1410.0653

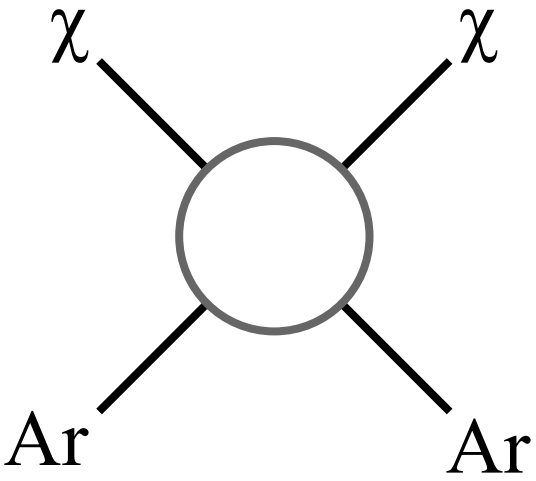
The DarkSide Experiment

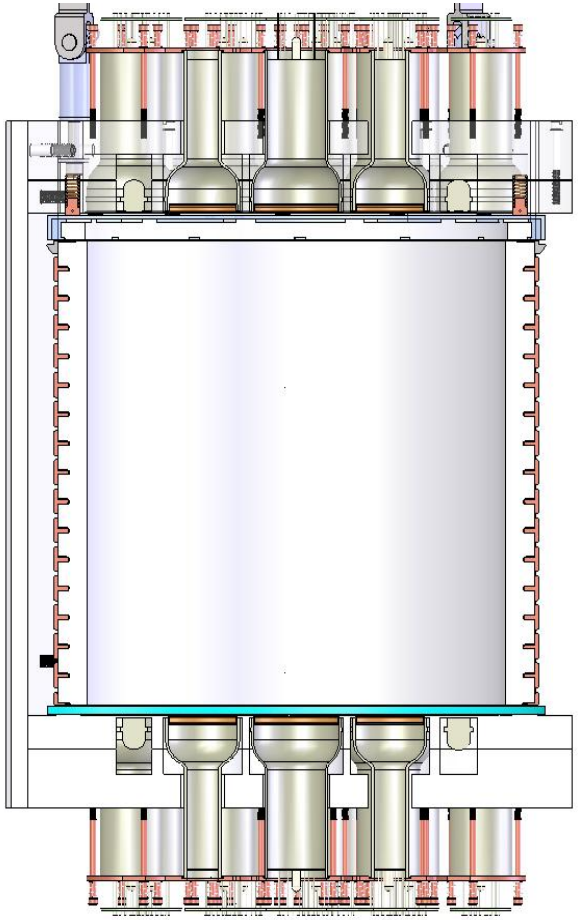
Liquid argon TPC for direct detection of WIMPs

Dark matter signature:

Nuclear recoil

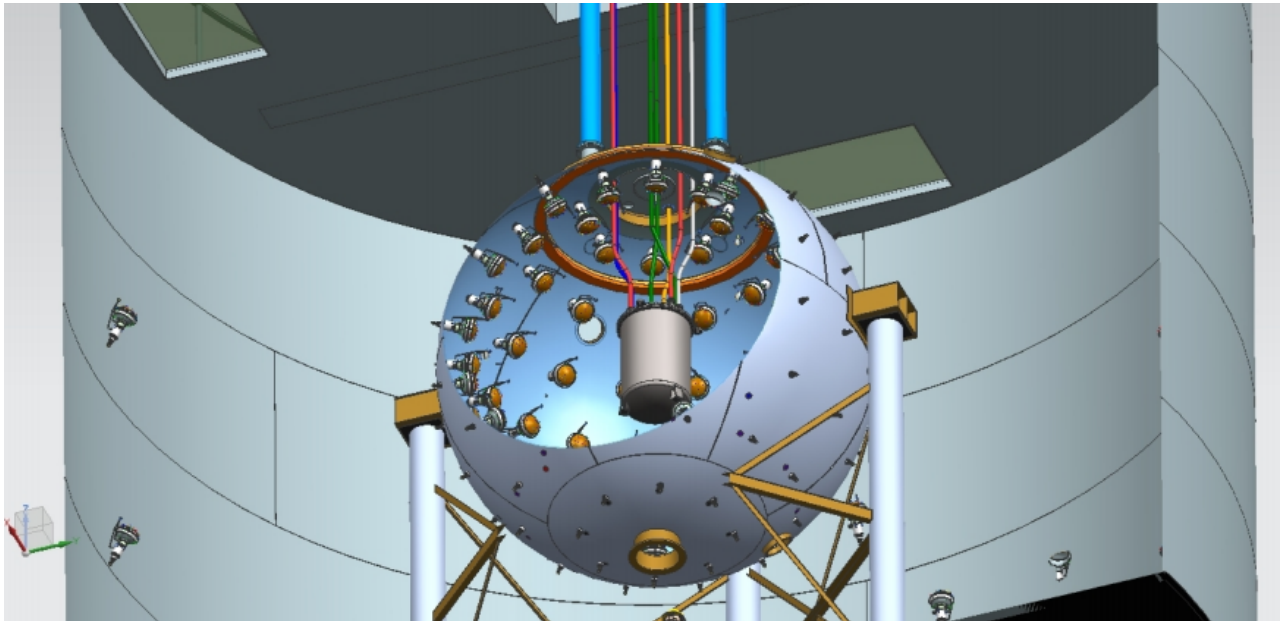
Cut γ/β/n/α/etc.





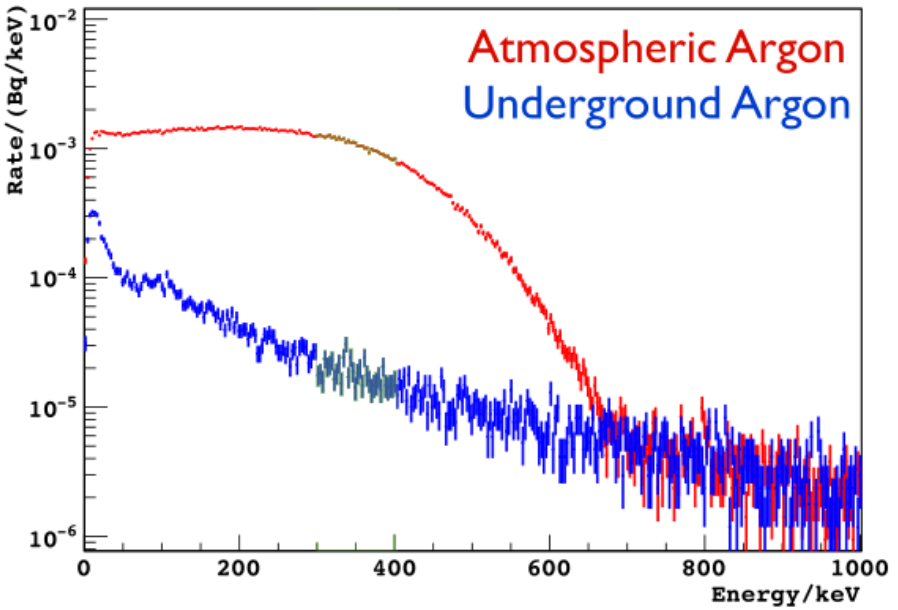
DarkSide-50

- Three nested detectors
- Inner detector: 50 kg of instrumented argon
- 4 m diameter organic scintillator neutron detector
- 850 ton water cosmic muon detector



DarkSide-50

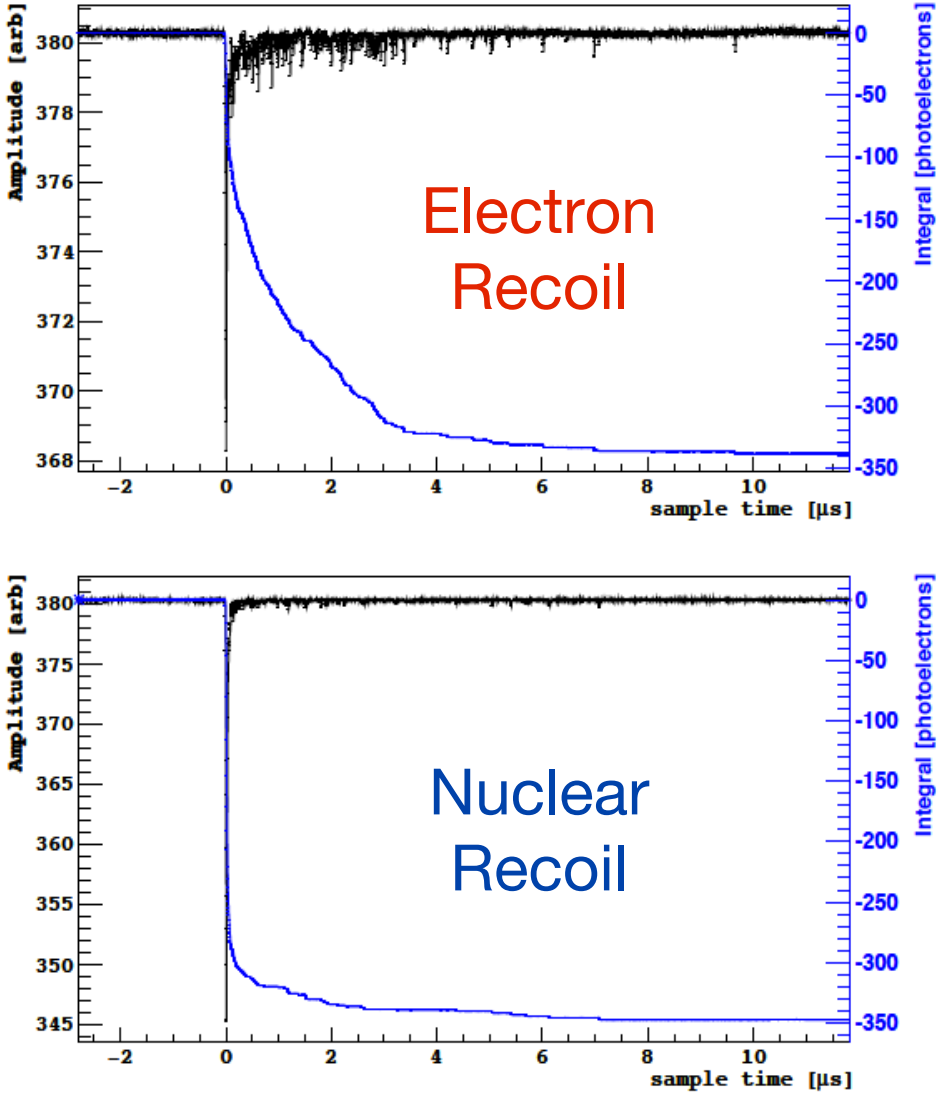
- Underground argon program (UAr deployed soon): >150x reduction in ^{39}Ar background
- Built extremely radiation-clean
- Designed for significant background-free exposure



DarkSide-50 Timeline

- Oct. 2013: LArTPC, Neutron Veto and Muon Veto commissioned.
  - TPC filled with atmospheric argon
- Thru June 2014: 47.1 live days of data in full WIMP search mode (1422 ± 67 kg d)
  - With atmospheric argon, corresponding to underground argon background of >19.4 years
- Ongoing:
  - Improvements to the neutron and muon detectors
  - External source calibration
  - Underground argon deployment

Liquid Argon Background Rejection: Pulse Shape Discrimination



WIMPs (and neutrons) cause nuclear recoils

Beta/gamma backgrounds cause electron recoils

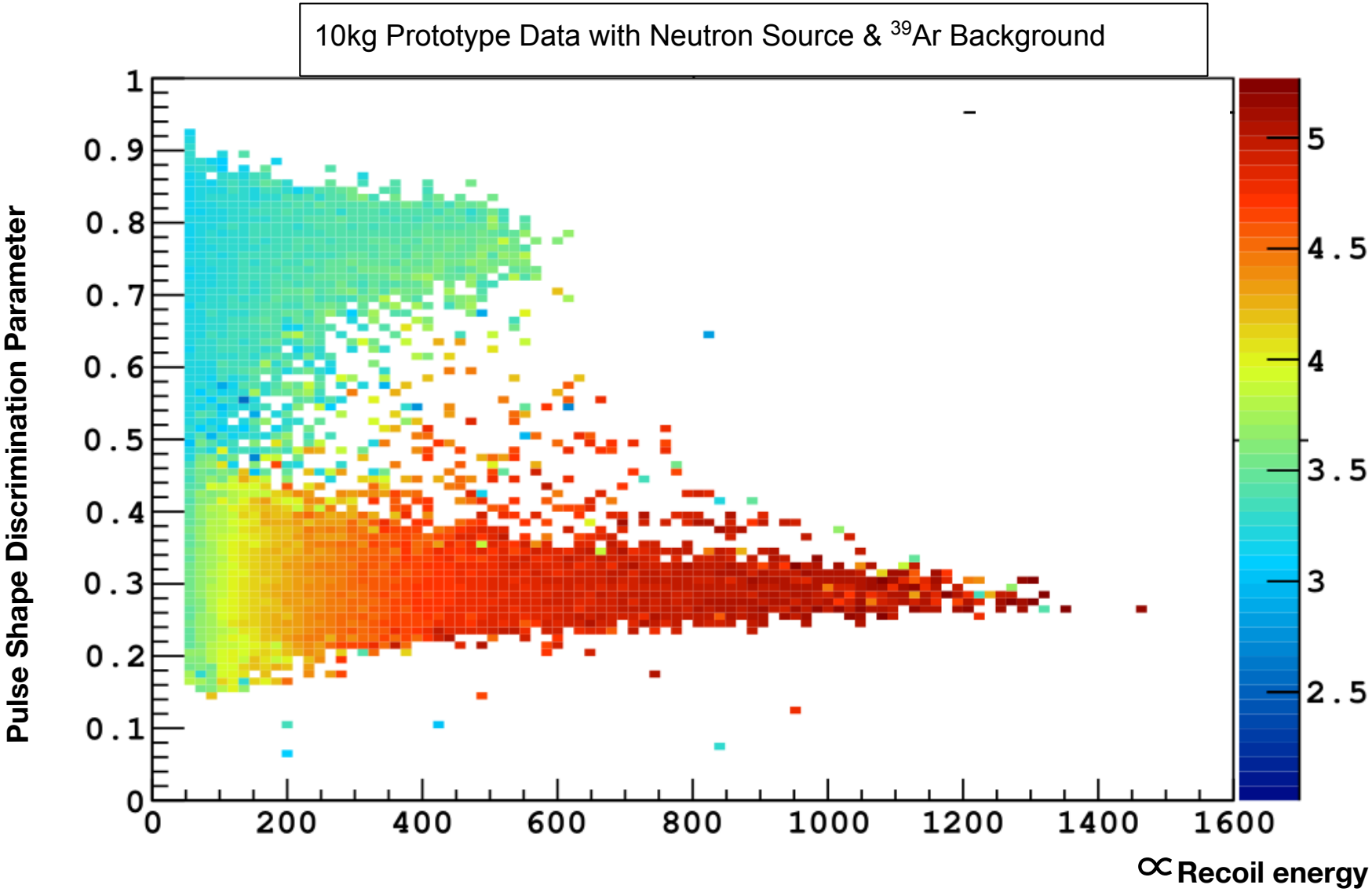
Different recoils preferentially excite different states of argon, with different decay times

Replaces S2/S1 or Light/Charge

10^7 - 10^{10} power

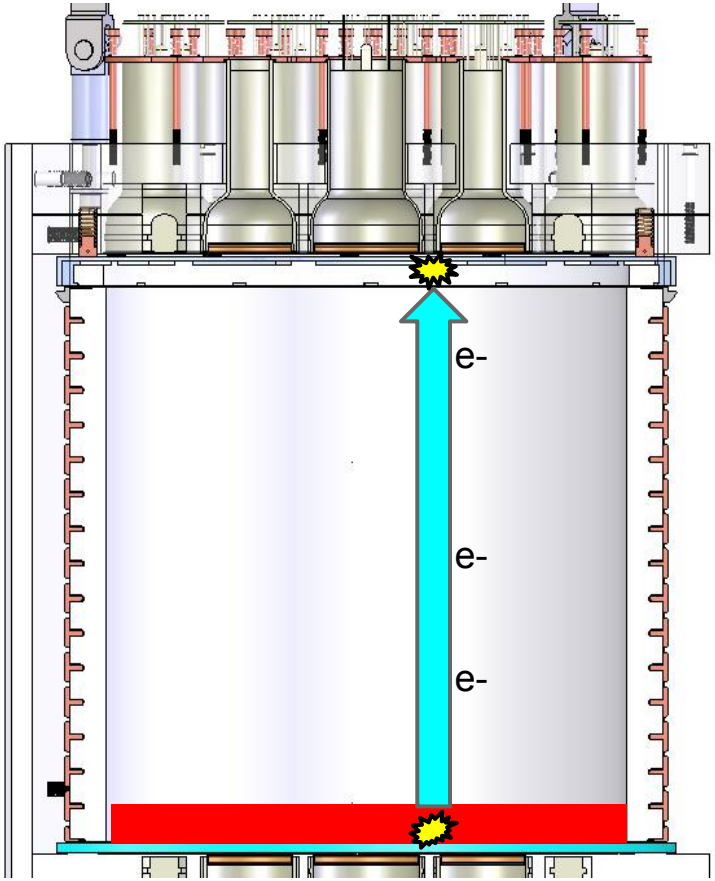
Thanks: M. Wada

Liquid Argon Background Rejection: Pulse Shape Discrimination



Time Projection Chamber Background Rejection

Exclude surface background



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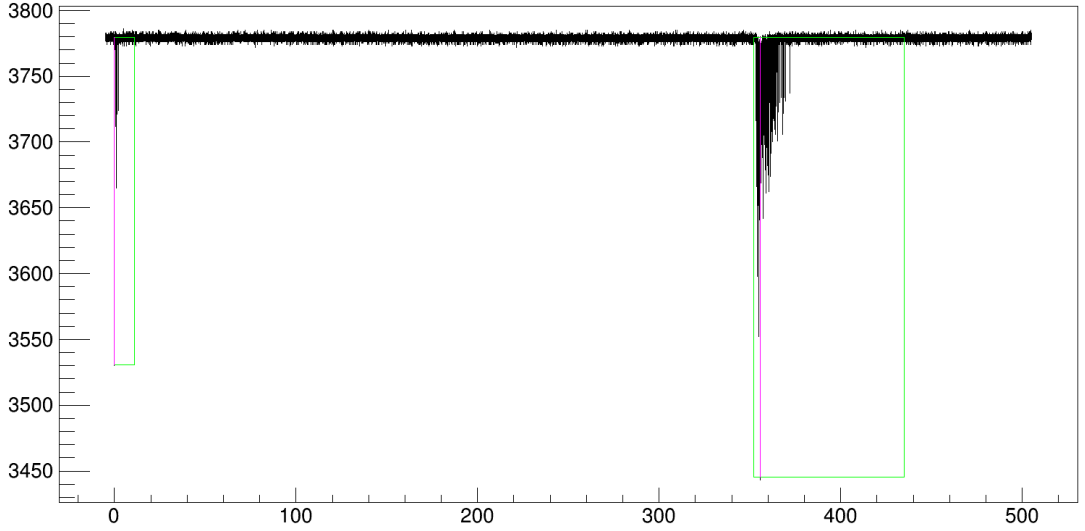
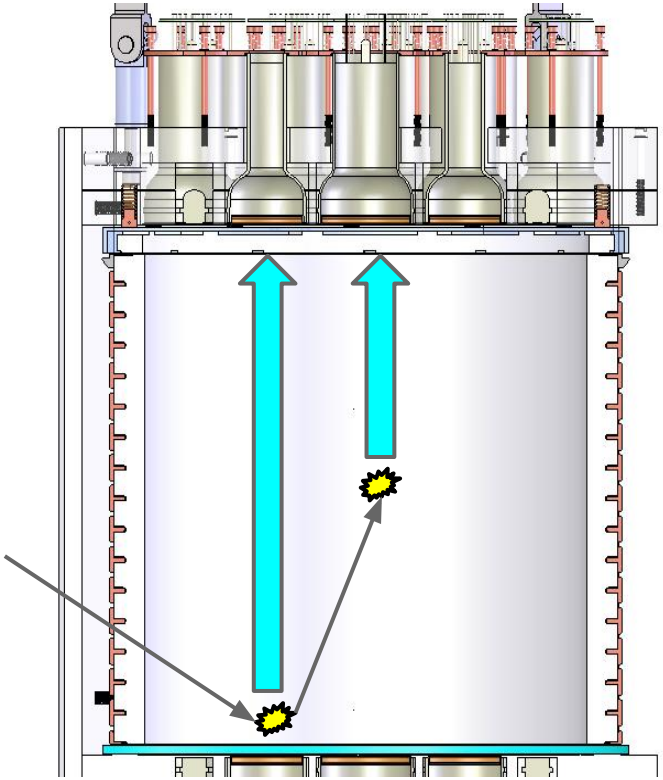


Time Projection Chamber Background Rejection

Exclude multiple scatters



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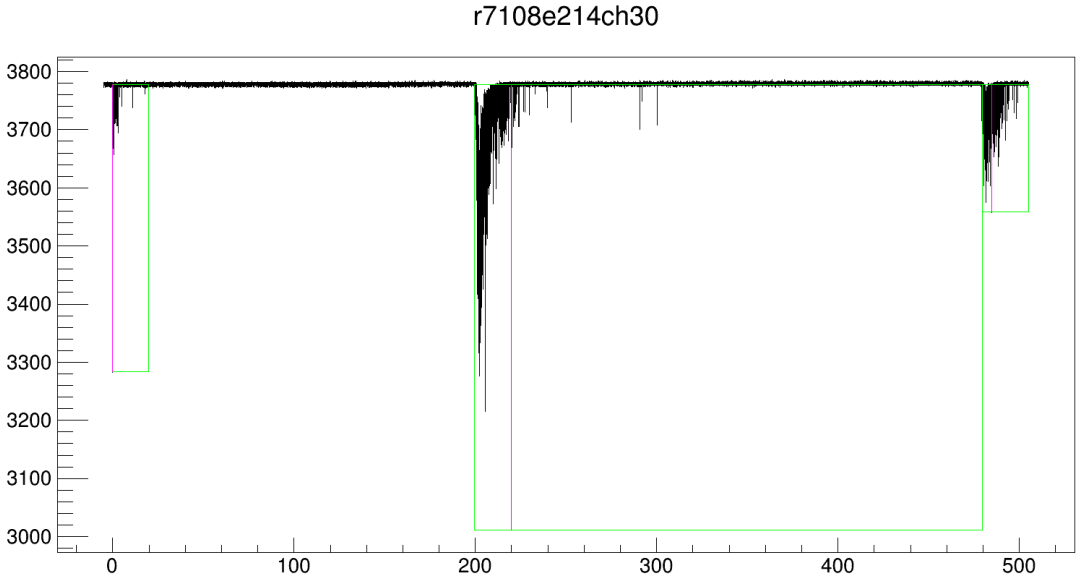
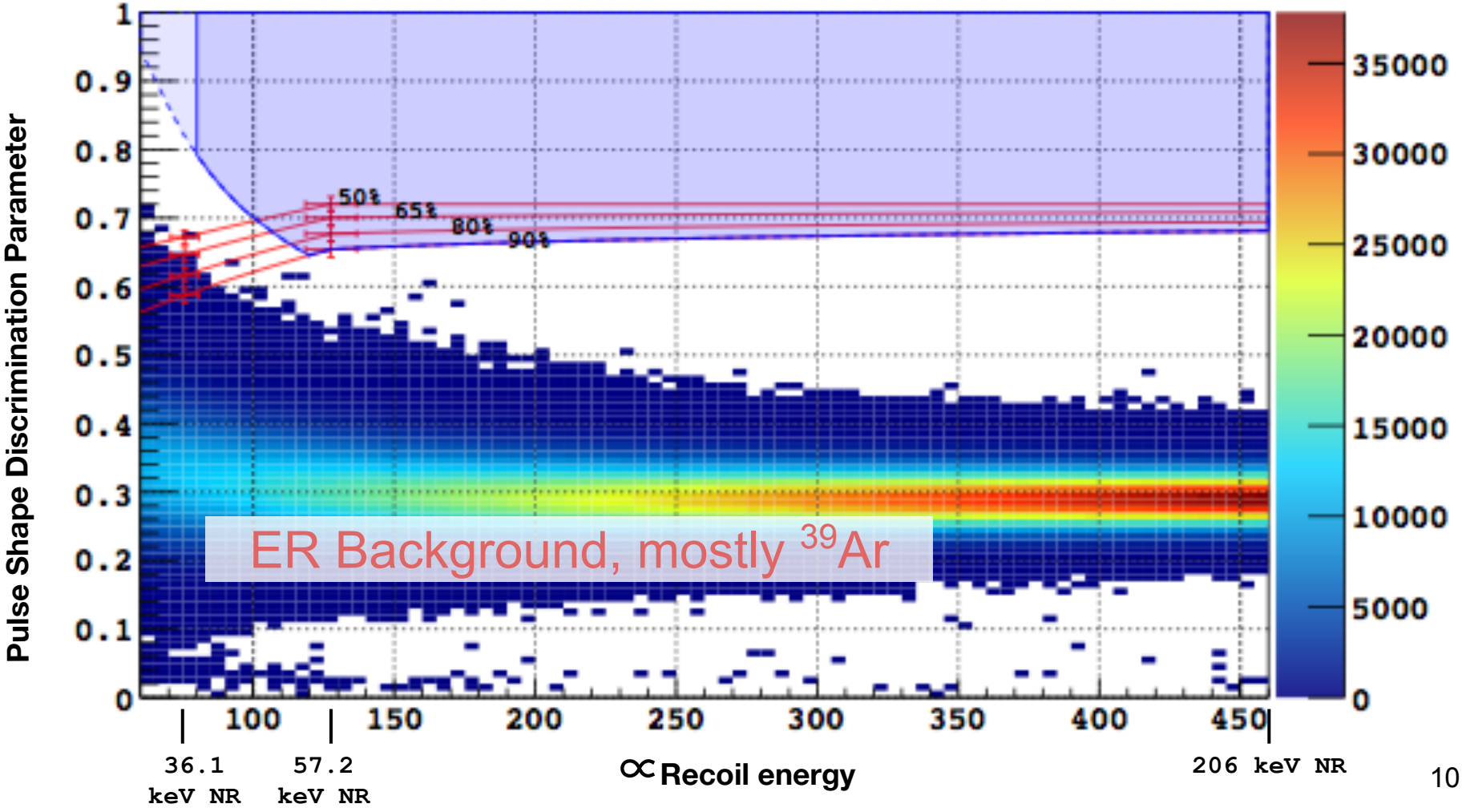


First Physics Result

Demonstrates even a ton-scale detector will be ^{39}Ar-background free (with underground argon)



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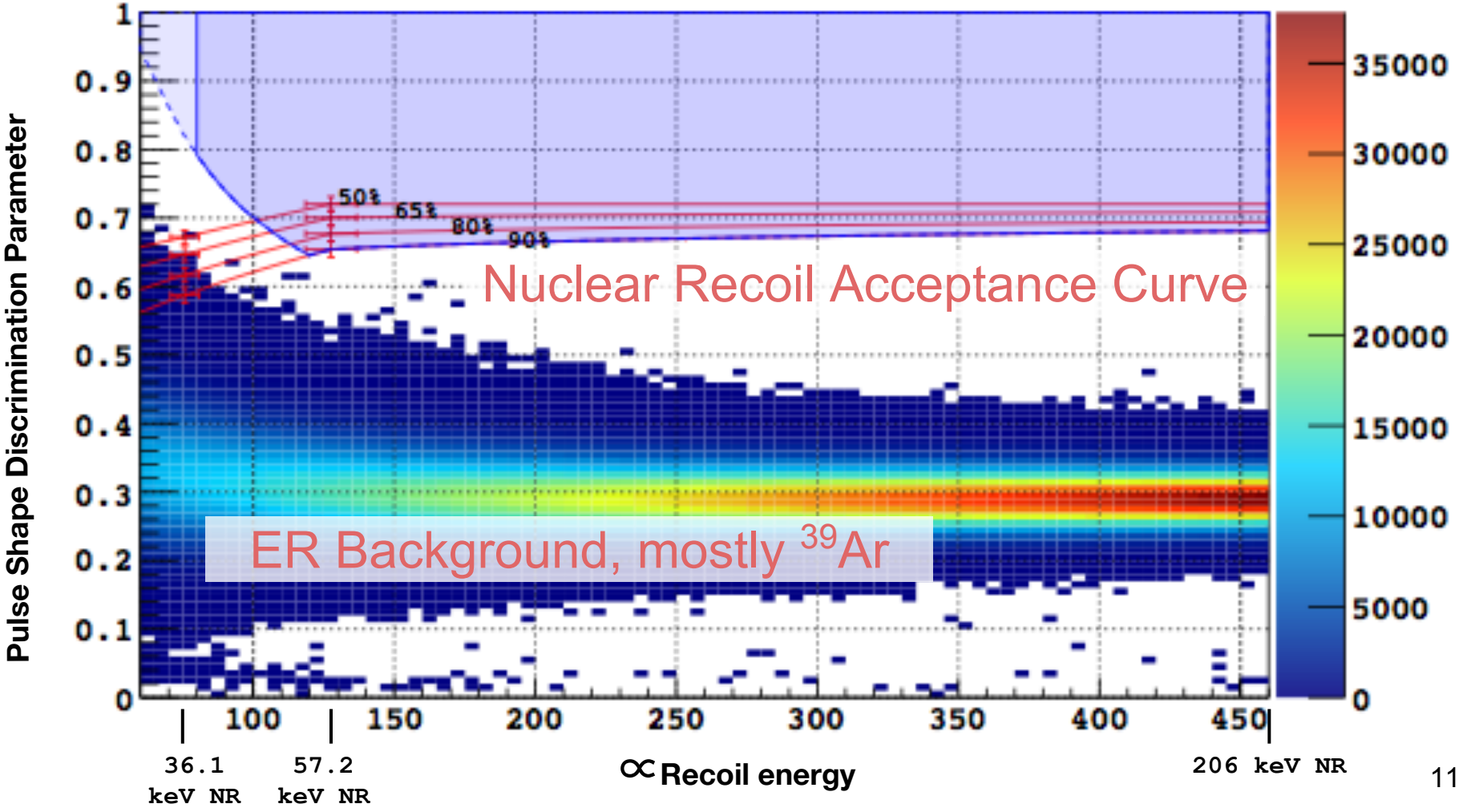

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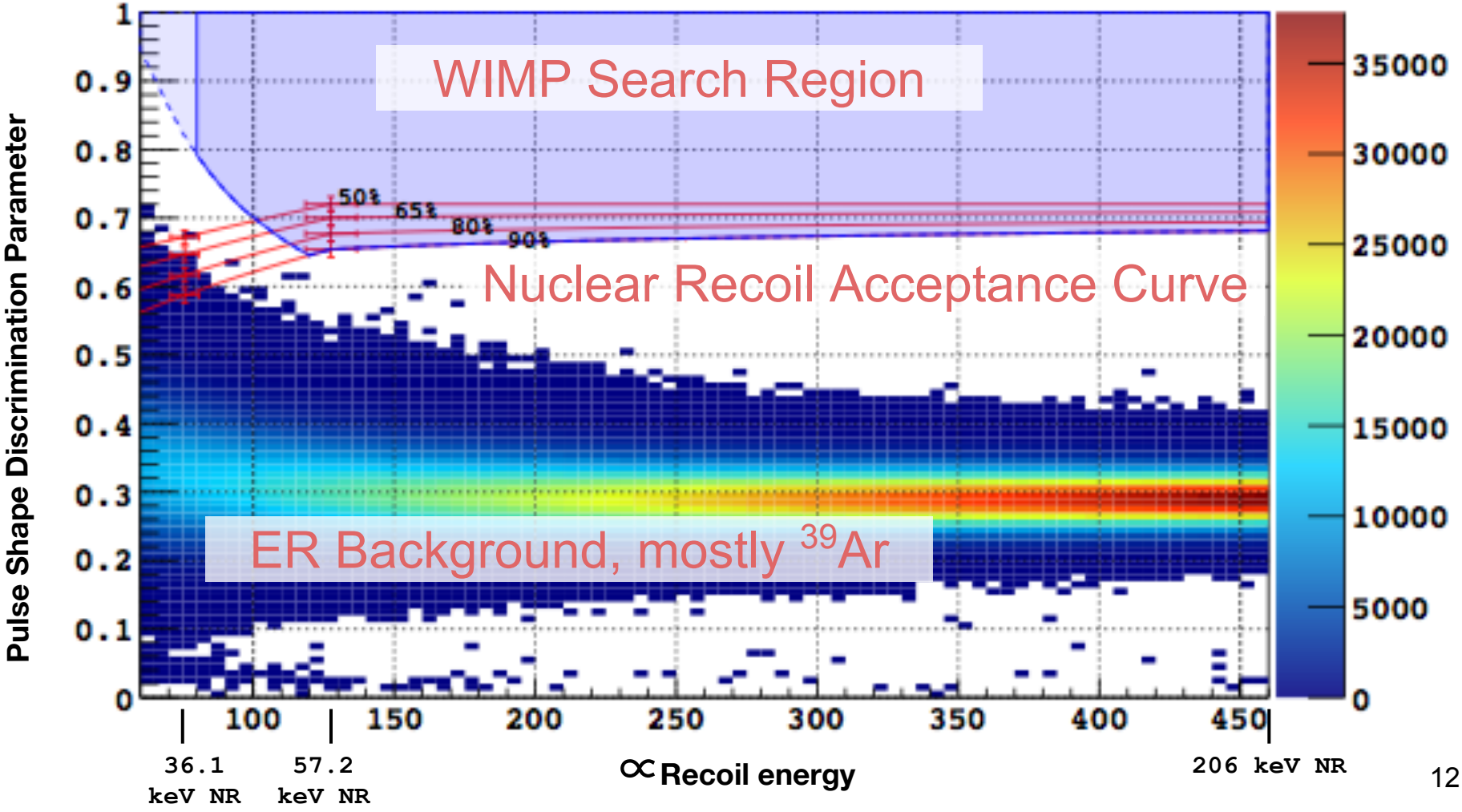
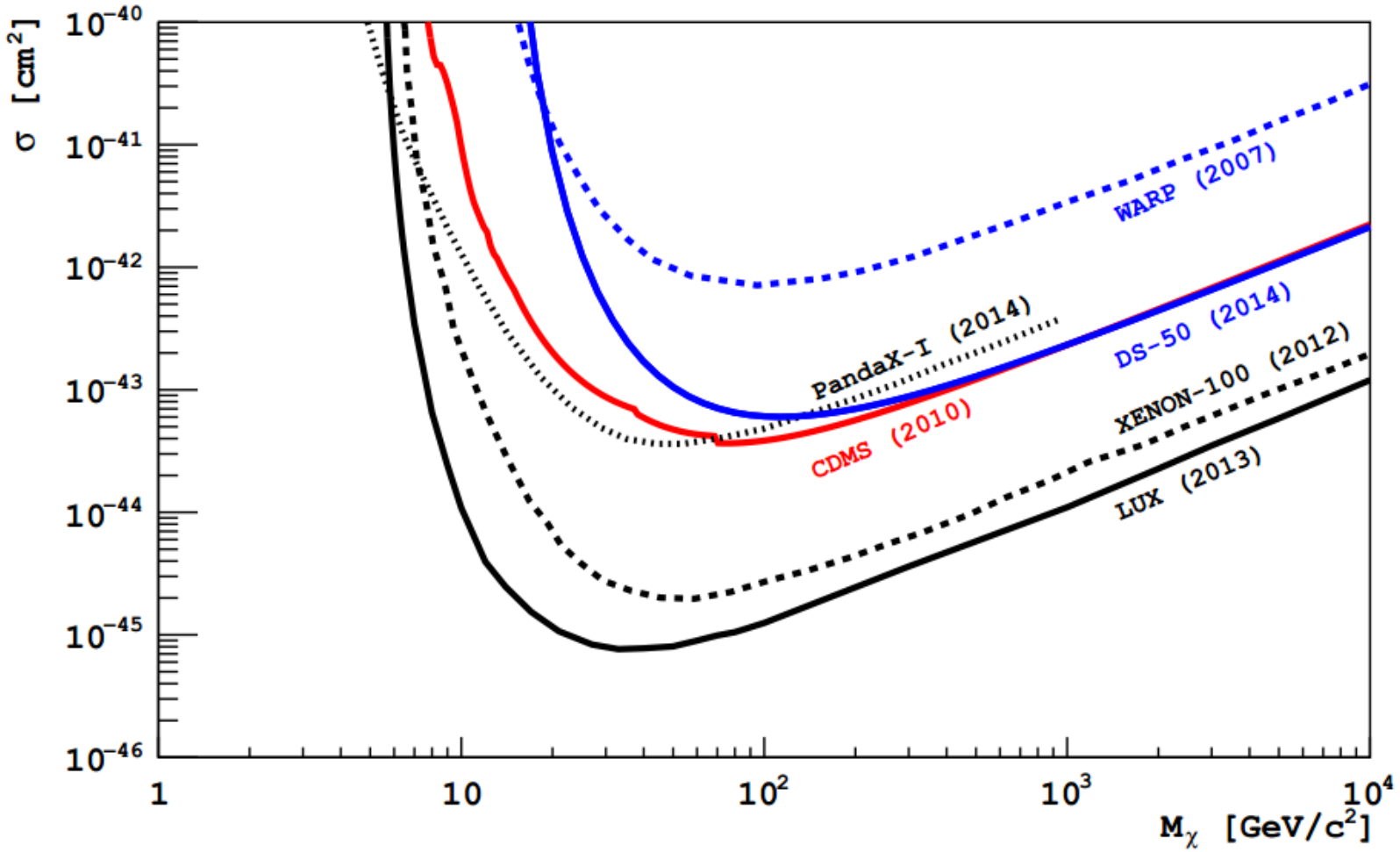


First Physics Result

Most sensitive search with an argon target




Thank you!