Dark Matter

Sho Uemura

Fermilab



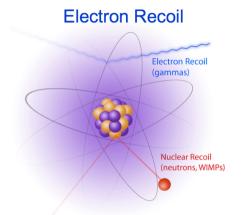
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Sho Uemura

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Dark matter searches at Fermilab

- We host and build a wide and complementary range of particle-like DM experiments:
 - Nuclear-recoil and electron-recoil searches
 - R&D, pathfinders, and full-scale experiments





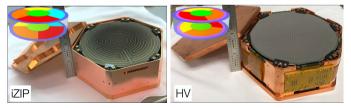
MINOS cavern

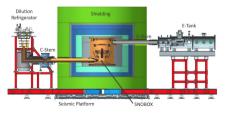


SuperCDMS at SNOLAB

- Large-scale cryogenic detector with Si and Ge targets and two detector types
 - iZIP: charge+phonon readout, for ER/NR discrimination
 - HV: NTL amplification, for low thresholds
- Fermilab plays a leading role and delivers major subsystems
- Under construction, commissioning next year



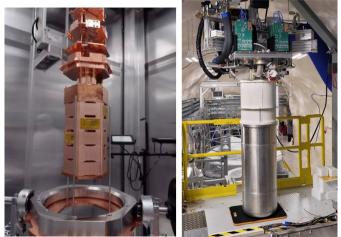




Dark Matter

SuperCDMS: detectors

- All detectors (4 towers) are underground, low-radon cleanroom is operational
- Operated one tower in the CUTE cryostat for a 151-day test run
 - Shake down operational procedures, calibration, analysis
 - Early science results expected next year

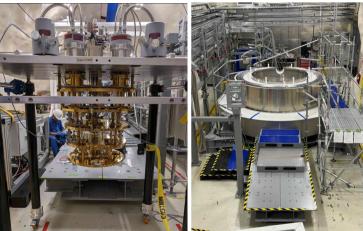


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SuperCDMS: cryostat and shield

 Cryostat and shield assembly well underway





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SuperCDMS: Kelly Stifter

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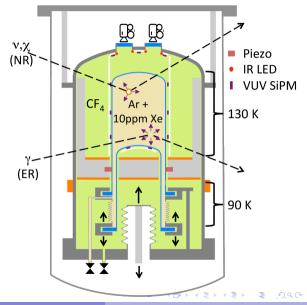
NEXUS/QUIET at MINOS

- Low-background R&D facilities for cryogenic detectors
- NEXUS: SuperCDMS, MKIDs, qubits, and more
 - Identifying and reducing backgrounds for SuperCDMS HVeV detectors with single-electron charge resolution
 - Measuring impact of ionizing radiation on superconducting qubits and investigating possibilities for qubit-based DM detection
 - Now transitioning to a dedicated facility for NR calibration
- QUIET: new dedicated facility for quantum detectors, with a companion surface facility (LOUD)



SBC

- First physics-scale deployment of a new technique for low-threshold (O(100eV))
 NR detection
- Inherently blind to electron recoils; further background discrimination with scintillation signal



SBC



SBC-LAr10









SBC: Eric Dahl

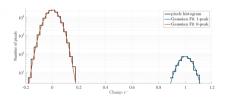
SBC in MINOS

- Demonstrate operation of the physics-scale detector
- Determine maximum superheat for ER-blind operation
- Calibrate NR threshold

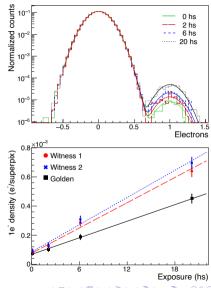


Skipper CCDs

- "Skipper" readout enables repeated measurement of charge packets for sub-electron charge resolution
- SENSEI: first application, for electron-recoil searches
 - World-leading sensitivity for sub-GeV DM
 - Record-low dark currents for a semiconductor detector, 1.39(11) × 10⁻⁵ e/pix/day (preliminary)



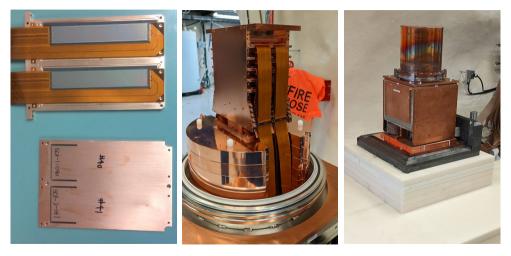




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Skipper CCDs: SENSEI

• First Skipper-CCD experiment, with DM results from SiDet, MINOS, now SNOLAB



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Skipper CCDs: Oscura

- Large-scale Skipper-CCD experiment: 24576 CCDs, 10 kg active mass
- R&D and design under DMNI program, on track for construction FY26
 - Highly multiplexed analog readout
 - Radiopure cabling and assembly
 - Convective nitrogen cooling

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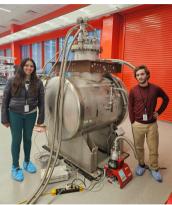


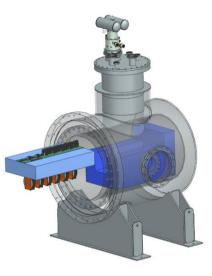
Oscura: Brenda Cervantes

Skipper CCDs: Oscura

• Scaling up to a 1/16-scale integration test







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Skipper CCDs: millicharge

- Low-threshold, pixelized detectors ideal for millicharged-particle searches
 - Competitive limits from 2-gram SENSEI run at MINOS; what if we leverage Oscura technology?
- MOSKITA now running at CERN; DarkBeaTS soon in MINOS



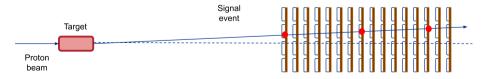
Dark BeaTS (Dark Beam Tracker with Skipper-CCDs)





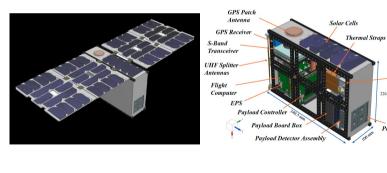
50 g (120 g) skipper-CCD array with 7 (16) layers (21.6 MPix each)

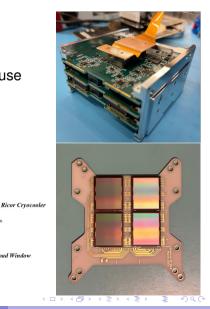
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Skipper CCDs: DarkNESS

- 6U CubeSat with four Oscura CCDs
- Search for strongly-interacting DM and peaks in the diffuse X-ray sky
- Preparing for launch slot in late 2025-early 2026





DarkNESS: Nate Saffold

226.3 mm

Payload Window

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