Superconducting Detector Session Summary

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Science Cut

Dark Matter

•	SuperCDMS	TES	Nader Mirabolfathi
•	Light DM, superfluid helium	TES	Dan McKinsey
•	Light DM, superconductor	MKID	Miguel Daal
•	Axion	Resonant cavity/SQUID, Param amp	Gianpaolo Carosi
•	Axion, Hidden Photon	SQUID	Dale Li

Dark Energy

•	Mid z-resolution/ sky coverage	MKID	Juan Estrada

Neutrino

•	Neutrinoless ββ decay	NTD Ge, TES	Raul Hennings-Yeomans
•	Neutrino Mass	TES, MMC, Theory	Mark Croce

Cosmic Microwave Background

•	CMB Polarization	TES	Clarence Chang
•	CMB Polarization	MKID	Phil Mauskopf

Readout

•	Micro-wave multiplexed readout	TES	Ben Mates
•	Frequency Multiplexing readout	TES	Aritoki Suzuki
•	Warm electronics	MKID / TES	Gustavo Cancelo
•	Warm electronics	TES / MKID	Josef Frisch

Facilities

•	Cryogenic facilities	TES/MKID	Brad Benson
•	Microfabrication Facilities	TES/MKID	Johannes Hubmayr

Technology Cut

TES
- SuperCDMS
- Light DM, superfluid helium
- Neutrinoless ββ decay
- Neutrino Mass
- CMB Polarization
- Micro-wave multiplexed readout
- Frequency Multiplexing readout
- Warm electronics
- Cryogenic facilities
- Microfabrication facilities

MKID
- Light DM, superconductor
- Dark Energy, Mid-Z res
- CMB Polarization
- Warm electronics
- Cryogenic facilities
- Microfabrication facilities

SQUID
- SuperCDMS
- Light DM, superfluid helium
- Axion
- Hidden Photon
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- Microfabrication facilities

Param Amp
- Axion

RF electronics
- Warm electronics – Cancelo
- Warm electronics – Frisch

Technology Needs

Microfabrication

- Reliability
- Uniformity

Simplified packaging

Rapid high reliability cryogenic testing capability

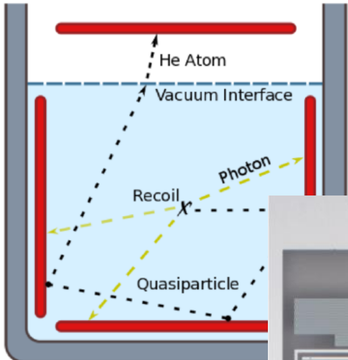
- Calibration

RF electronics

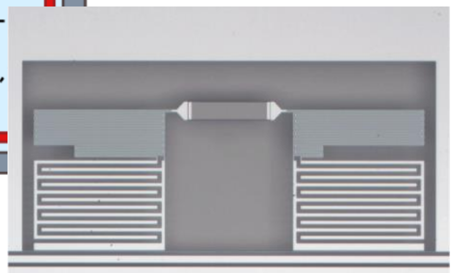
- Tone control
- HEMT
- Coax cable

Understand MKID physics

Highlight with Figures

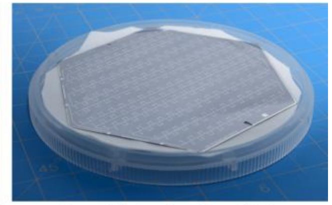


Light DM
Superfluid He

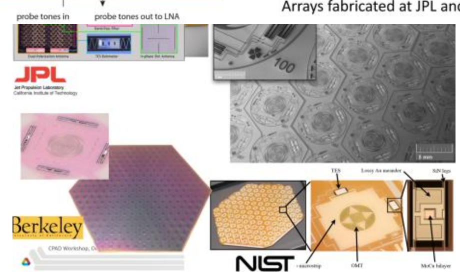


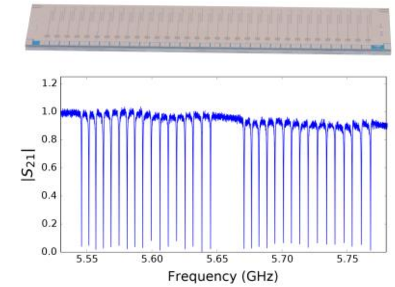
Light DM
Al + MKID

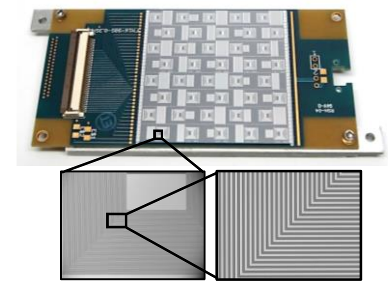
CMB MKID/ TES



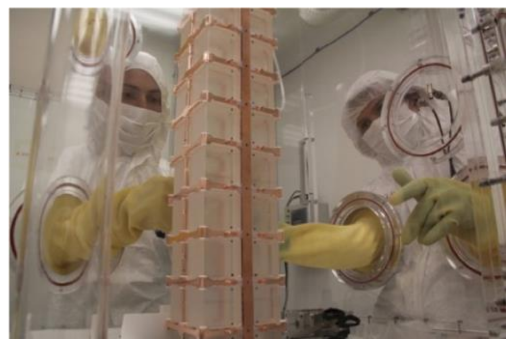
Arrays fabricated at JPL and BNL.



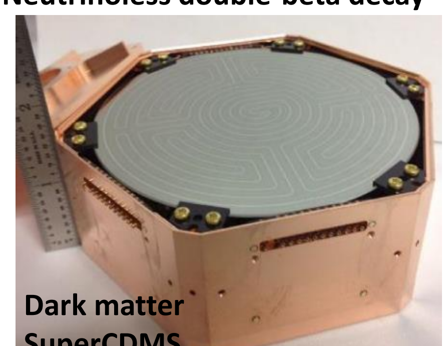




Readout electronics (cryo/ warm)



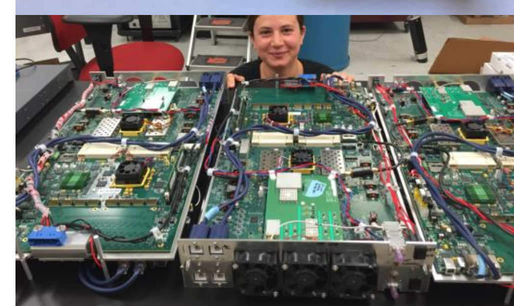
Neutrinoless double-beta decay



Dark matter
SuperCDMS

Axion
Resonator cavity

Axion/ Hidden photon
SQUID



Summary

1. Superconducting circuits provide ready access to quantum phenomena**. A good system for quantum sensors.** KL emphasized that reaching quantum limit is start, not end. Ideas for surpassing quantum limit based on squeezing and non-destructive single photon measurements. Exciting for axion searches.

2. Increasing interest in search for dark matter at masses below 100 GeV. Requires sensors with lower energy threshold (<20 eV). Good ideas based on detection of scintillation light or helium atoms using sensors physically separated from dark matter target. Also, sensors based on LC resonators for dark photons. **Opportunity for fruitful exploration of multiple concepts with small investments.**

3. Technology for CMB-S4 isn't settled, but there are good options to choose from. Production of detectors is hard, but not overwhelmingly. Other areas (integration & test, readout, cryogenics & dewars & optics) will also be difficult and deserve attention.

4. **Microwave readout techniques (for both MKIDs and TESs) will be broadly enabling for HEP mission: CMB, dark energy, dark matter, 0nBB, neutrino mass.** Capabilities and precise implementation still evolving in good directions.

5. MKID sensors are appealing (ease of integration), but single sensor performance needs to be better understood. Efforts are underway to do this but could be expanded.