Report from the solid-state cryogenic detectors Group:

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Brief Introduction

- Science Drivers :
  - CMB
  - Dark Matter (wimps, Axions, ALP)
- 12 talks:
  - overview
  - 3 TES talks (CMB, DM and low-TC)
  - 3 MKID talks (2 on CMB, R improvement and Dark Energy)
  - 1 talk on multiplexing readout for superconducting sensors
  - 3 talks on dark matter detectors (ADMX-hifreq, DMradio, CCDs)
  - 1 talk on connection to noble liquid detectors

Findings

- TES
  - CMB sensors are background limited in many different recipes/geometries. The challenge is making large focal planes.
    - Both large-scale fabrication & increased readout multiplexing are active areas of development
  - For DM there are ideas to push TES based detectors to threshold below 10eV.
  - Lower temperature devices provide improved sensitivity in both CMB & DM
    - New materials under investigation for very low TC (Ir)
  - Many TES foundries established
- MKIDs
  - Inherently large MUX factors are appealing for CMB-S4
  - Significant improvements in energy resolution for optical MKIDs.
- Exotic
  - Cryogenic devices enable impressive and creative ideas for axion and dark photon searches.

Comments

- Still striving for fundamental understanding of some material properties and behavior
  - Dielectrics
  - Bilayer & trilayer films
  - Nitrides
- MKIDs are a promising technology for CMB-S4, but need an on-sky demonstration to verify noise performance and systematics
- Commonalities across both TES/MKID talks
  - Coupling schemes are active area of development
  - FPGA electronics development

Identification of Risks and Opportunities

- Opportunities:
  - The US has a leading role in the development of sub-K devices, and we should keep it (TES, MKIDs, amps).
    - Low Tc TES devices have broad applications to both DM & CMB
  - Active and diverse R&D program of novel ideas for next generation of dark matter detection experiments.
  - MKIDS have potential of MKIDs for optical and CMB surveys. R&D in this area will give interesting options for future cosmic surveys.
- Risks:
  - When will control of environmental noise & systematics be dominant?

Possible Grand Challenge Ideas

Last year: *"10-100-1000" rubric:*

- *Over 10-times reduction in noise and threshold*
- *Over 100-times increase in fabrication throughput*
- *Over 1000-times increase in signal bandwidth and readout density*

1. Develop detectors with threshold below 10eV for direct Dark Matter search after Gen2 (nuclear and electron recoil) and neutrino coherent scattering.

2. Nearly 100% efficient detector

3. Develop full potential of optical kinetic inductance detectors for future astronomical surveys (see Cosmic Visions talk by Aaron Roodman).

4. Develop full potential of kinetic inductance detectors as a solution for the CMB multiplexing.