Report from the Solid State Detectors Group:

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Brief Introduction

- Strong tilt towards superconducting devices
  - kT ~10^{-5}-10^{-6} eV quanta
  - New phenomena at ultra-low temperatures: flux quantization, dissipation-free measurement
- Science Drivers
  - Low-threshold superconducting detectors for low-mass DM and Coherent neutrino scattering
  - Resonant cavity searches for Axion/hidden photon DM
  - Beta decay (& Neutrinoless Double Beta Decay) calorimeters
  - TES & KIDs for CMB
  - Microwave-based multiplexing
  - Solid-state detectors for applied physics (e.g.: gamma ray imaging)
- Discussion on "Grand Challenges"

Findings

- Low-threshold calorimeters directly improve low-mass DM sensitivity (also coherent neutrino scattering)
- Quantum and sub-quantum limited amplifiers (over decades of bandwidth) directly improve sensitivity to Axion and hidden photon DM
- More sensitive detectors improve beta decay measurements (neutrino mass and neutrinoless double beta decay)
- Increased fabrication, testing, and assembly throughput directly improves CMB sensitivity
- Microwave readout techniques increase multiplexing capabilities (e.g. microwave SQUID, Kinetic Inductance resonators, Kinetic Inductance detectors)

Comments

- Broad spectrum of scientific applications
    - HEP: DM (low-mass WIMPs, axions, hidden sector photons), CMB, DE, sterile neutrinos via coherent neutrino scattering
    - Other: neutrino mass via “beta endpoint,” neutrino-less double beta decay
    - Interest in “other” technologies (e.g. Noble liquids for DM) and science drivers (e.g. spectroscopy for DE)
- Significant overlap in experimental infrastructure and techniques
    - Microfabrication resources for detector production
    - Cryogenic infrastructure for sub-Kelvin measurements
    - Utilizing microwave readout techniques
    - Strong coupling between development efforts

Identification of Risks and Opportunities

- Few commercial implementations of technologies
  - Success with applied physics technologies utilizing ionization technology
  - Technology development supported almost entirely by basic science research
- Exploiting exceptional sensitivity will also require developing additional technology
  - E.g.: cavity searches for Axion and hidden photon DM require large magnets. Future experiments will need technology for high density B-field magnets
  - E.g.: large CMB detector arrays will need development of meta-materials and cryogenic laminates
- Overlap and common techniques provides opportunity for synergy among different efforts

Recommendations

- Superconducting technologies have a long history with HEP. Current R&D efforts focus on opportunities unique to superconducting devices. Advances in technology have direct connections to advancing science. A strong superconducting detector program will be broad and unique in impact.
- R&D transcends traditional agency boundaries (HEP-NP-BES, DOE-NASA-DOC). Strengthening collaborations promises high returns on investment.

Possible Grand Challenge Ideas

- quantum & sub-quantum limited amplifiers spanning three orders of magnitude in bandwidth (functionally coupled to cavities and detector systems)
- Reducing calorimeter threshold by 2 orders of magnitude while preserving background rejection: ~1 Debye phonon/mol of atoms
- Improve multiplexing by 100X over currently fielded systems
- Exponential increase in detector production & testing throughput to stay on "Moore's law"
- 10X increase in magnetic field density beyond currently available