

## **Suggested R&D longterm priorities for ASTRO**

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These are the R&D topics discussed in our recent cosmic planning effort, ordered by the priorities set for conditions with budget constraints.

### **CMB**

CMB stage IV :

- **CMB sensor packaging/characterization**
- **readout electronics for superconducting detectors**
- **TES / MKID**

### **Dark Matter:**

Next generation axion detector development :

- **single-photon detectors TES / KIDs /SNSPDs (below IR)**
- **readout electronics for superconducting detectors**
- **photon concentrators (new for FNAL)**

Low threshold detectors for sub-GeV dark matter :

- **cryogenic bolometers**
- **silicon detectors (CCD-in-CMOS skipper)**
- **TES**

### **Cosmic Surveys:**

Stage V DE spectroscopic survey :

- **CCD-in-CMOS skipper**
- **MKIDs**
- **readout electronics for superconducting detectors**
- **multi-fiber positioner (new for FNAL)**
- **Ge-CCD (new for FNAL)**

### **R&D priorities:**

Here I map the R&D needs with research priorities, to produce R&D priorities. If some R&D has synergy between research priorities as shown in the table, it is given more weight. If FNAL has already demonstrated technical leadership in an specific R&D are, it is given more weight.

1. **sensor packaging/characterization (CMB-S4)**
2. **readout electronics for SC detectors (CMB-S4 + Axions + DE)**
3. **TES/KIDs/MKIDs/SNSPDs (CMBS4 + Axions + DM + DE)**
4. **CCD-in-CMOS for DM and DE (DM + DE)**
5. **cryogenic bolometers (DM)**

	<b>CMBsensor Test/Pack</b>	<b>readout elect. for SC</b>	<b>TES/KIDs/ MKIDs/SNSPDs</b>	<b>CCD-CMOS (skipper)</b>	<b>cryogenics bolometers</b>
<b>CMBS4</b>	✓	✓	✓		
<b>axion+</b>		✓	✓		
<b>sub-GeV DM</b>			✓	✓	✓
<b>DE Spectroscopy</b>		✓	✓	✓	