

## Fermi National Accelerator Laboratory LDRD Project Data Sheet - FY14

**Project ID:** FNAL-LDRD-2014-010

**Project title:** Cosmic Microwave Background Detector Development at Fermilab

**Principal investigator:** Bradford Benson

**Project description:** (short description and explanation of cutting edge, high-risk, high-potential science or engineering)

The project proposes R&D to establish a high-throughput, high-quality characterization, packaging, and testing of prototype transition edge sensors (TES) and arrays of sensors at a scale never before performed for demonstration towards meeting the requirements of the next generation cosmic microwave background (CMB-S4) experiment that will have greater than 10 times the scale and sensitivity compared with current experiments.

**Tie to Mission:** (explain the project's relevance or anticipated benefits to Fermilab's and DOE's missions)

The proposed work is related to transformative science in particle physics as affirmed recently as Recommendation 18 from the P5 report: "Support CMB experiments as part of the core particle physics program." The CMB detector development will ultimately enable experimentation that aims to answer some of the most exciting questions in cosmology including inflationary physics at grand-unified theory energy scales, measure the sum of the neutrino masses, constrain the relativistic energy density of the universe and determine any "dark radiation" component.

**Previous year's accomplishments:** (as applicable)

CMB detector packaging R&D has been performed and 30 wafers have been packaged. Ten of these will be utilized for characterization in SPT-3G. Better than 10 micron alignment of the lenslet to the detector has been achieved. More than 120 LC boards for SQUID readout has been done. On detector and readout R&D, two sub-K cryostats are in use for measurements. Integration into the SPT-3G cryostat has allowed for testing.

**Work proposed for current fiscal year and anticipated / desired results:**

A new low temperature adiabatic demagnetization refrigerator is in the process of being procured to assist in future CMB detector characterization. Additional "optical" characterization capabilities will be developed. A complete detector readout system will be developed for array characterization. Continued development will continue in the area of detector assembly, design, and characterization. This work will continue (within the 36 months maximum) into FY17 that is well matched to anticipated Pre-CD0 for CMB-S4 allowing for this work to be realized as a future experiment with a strong Fermilab role.

**Project funding profile:** (costs, budgets, projected budgets, and total)

Prior year(s) costs	FY14	FY15	FY16	FY17 budgeted	Total
	18,568	442,591	773,106	350,000	1,584,265

Project Start Data: 7/15/2014

Total Approved Project funds: \$ 2,183,900