Advances in Multichroic Feedhorn-Coupled TES Polarimeter Arrays for CMB Measurements

Main author:

HUBMAYR Johannes

Co-authors:

Austermann Jason, NIST
Beall James, NIST
Becker Daniel, NIST
Cho Hsiao-Mei, SLAC
Datta Rahul, University of Michigan
Duff Shannon, NIST
Hilton Gene, NIST
Hubmayr Johannes, NIST
Irwin Kent, Stanford/SLAC
Li Dale, SLAC
McMahon Jeff, University of Michigan
The Advanced ACTPol Collaboration ,
Ullom Joel, NIST
Van Lanen Jeff, NIST

NIST-fabricated feedhorn-coupled polarimeter arrays have been implemented in a number of ground-based experiments that make near photon-noise-limited measurements of the cosmic microwave background (CMB). CMB measurements may provide the first quantum probe of gravity, constrain cosmological inflation, and determine the neutrino mass sum. Our design proves to be scalable in pixel count and frequency coverage, while simultaneously guards against polarization systematic error contamination. In this paper, we describe advances in both design and implementation of silicon-platelet, feedhorn-coupled TES focal planes for next-generation CMB instruments such as Advanced ACTPol, the second flight of SPIDER, and a future satellite mission. The use of multichroic detectors, 150 mm diameter detector wafers, and spline-profiled feedhorns increases the detection bandwidth and packing density of the focal plane. The monolithic, dual-band 150/230 GHz array of Advanced ACTPol has 503 horns and 2012 TES channels, which results in a 40% increase in mapping speed at

150 GHz over previous designs and adds an entirely new second frequency channel within the same focal plane footprint. We show proof of principle measurements on proto-type devices and comment on the challenges of scaling beyond this realization given current SQUID multiplexing technology. In addition, we describe our plans to tailor the technology for satellite-based observing. These plans include the development of a four-frequency channel pixel envisioned for astrophysical foreground monitoring in the frequency range 300-600 GHz, and a new feedhorn-coupled architecture that achieves 3.3:1 bandwidth ratio.