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Superconducting Detector Development for the SPT-3G Cosmic Microwave Background Experiment

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Transition-edge sensor (TES) bolometers continue to enable exceptionally sensitive observations of the Cosmic Microwave Background (CMB). The CMB contains the imprint of physical mechanisms occurring in both the early and late universe, making it a powerful probe of our cosmological model. CMB experiments are currently focused on measuring the B-mode polarization signature, as it has the potential to constrain inflationary gravitational waves as well as the effect of massive neutrinos on structure formation in the late universe. Technological advances in the fabrication and operation of TES bolometers have resulted in detectors that are background-limited. The instrumental sensitivity needed to further probe the faint CMB polarization signal therefore requires at least an order of magnitude more detectors than in current experiments. Additionally, galactic foregrounds are now known to produce polarized signals at a similar amplitude as the CMB making multi-wavelength observations crucial to isolating the CMB signal.

The millimeter-wavelength South Pole Telescope (SPT) is dedicated to mapping the CMB. Here, we present the development of TES bolometers for the third generation SPT receiver, SPT-3G. The SPT-3G focal plane will have ˜16,000 TES bolometers, an order of magnitude increase from the current receiver. The detectors are grouped into 2,710 pixels, each of which is sensitive to orthogonal linear polarizations and three frequency bands (90, 150, 220 GHz). Development of the SPT-3G pixel includes refining the properties of the superconducting microstrip, filters, and TES sensor as well as ensuring the uniformity of a large number of pixels. We discuss the architecture and current laboratory performance of these pixels as they are integrated with readout electronics into the receiver. SPT-3G will deploy to the telescope in late 2016, opening a new regime of sensitivity in mapping the CMB.

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