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Advanced time-division transition-edge sensor readout development for CMB-S4

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The next generation CMB-S4 survey aims to map the Cosmic Microwave Background (CMB) with unparalleled sensitivity in order to measure and constrain a vast range of fundamental physics including inflation, exotic light relics, and dark energy. To meet its sensitivity goals, the experiment requires fielding about 500,000 photon-noise limited superconducting transition edge sensors (TES) in cryogenic receivers in a diverse set of large and small aperture telescopes. In order to reduce cost, integration complexity, and thermal load on the lowest temperature stages of the cryogenic receivers, the transition edge sensors must be multiplexed using low temperature superconducting quantum interference device (SQUID)-based electronics. Incorporating recent advancements in low temperature SQUID multiplexer technology, we are developing a new SQUID-based time-division multiplexing system for the CMB-S4 project targeting a number of improvements including higher bandwidth and multiplexing factor, lower wire count per sensor, and lower readout noise. These improvements aim in particular to overcome the bandwidth limitations of prior implementations in order to enable higher multiplexing factors and lower total wire counts. We report on the design, characterization, early performance of the first realization of this new cryogenic readout architecture and present our plans for further optimization and development for the CMB-S4 project. The new readout technologies we are developing for CMB-S4 have wide potential applicability to other high energy physics (HEP) efforts.

Early Career

Yes

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