Development of readout electronics for POLARBEAR-2 Cosmic Microwave Background experiment

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For the next generation Cosmic Microwave Background (CMB) experiments, kilopixel arrays of Transition Edge Sensor (TES) bolometers are necessary to achieve the required sensitivity and their science goals. We are developing readout electronics for PLARBEAR-2 CMB experiment, which multiplexes 40 TES bolometers through a single superconducting quantum interface device (SQUID). POLARBEAR-2 is an upgraded experiment based on POLARBEAR-1, which had first light in January 2012. For POLARBEAR-2, we will build a receiver that has 7,588 TES bolometers coupled to two-band (95 and 150 GHz) polarization-sensitive antennas.

At POLARBEAR-1, we adopted a readout system with a multiplexing factor of 8 in the frequency domain.. Extending that architecture to 40 bolometers requires an increase in the bandwidth of the SQUID electronics. To this end, we use Digital Active Nulling (DAN) on the digital frequency multiplexing platform. With DAN, digital feedback is calculated for each bolometer, extending the useful bandwidth of the SQUID amplifier.

At high frequencies, performances of a voltage-biased TES bolometer are limited by parasitic inductance of a cold wiring and series resistance of cryogenic readout electronics. Controlling these parameters allows reduction of systematic errors of CMB observation, such as cross talk and non-linearity. Optimizing resonant frequencies of LC filters in series with TES bolometers also suppresses cross talk. We are developing 40-channel LC filters and low-inductance superconducting cables with low-impedance connectors. We will give an overview of the developments and discuss optimization of these cryogenic readout electronics. Using the new readout components and the modified wiring, we will show performances of TES bolometers biased at high frequency up to 4 MHz.