DEVELOPMENTS IN FREQUENCY DOMAIN MULTIPLEXING FOR LARGE ARRAYS OF TRANSITION EDGE SENSOR BOLOMETERS

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The next generation of bolometric Cosmic Microwave Background (CMB) experiments require large format arrays of 100-1000 sensors to achieve their science goals. Multiplexed readout for these systems in a key technological challenge. Ill discuss the frequency domain multiplexing technique which has been developed for deployment on the APEX-SZ, South Pole Telescope, POLARBEAR, and EBEX experiments. Presently operating systems will be described, as well as the status of new instrumentation developments.

The general structure of the system is as follows. The bolometers are biased with sinusoidal voltages of constant amplitude with frequency in the MHz range. Each bolometer within a readout module is connected in series with a resonant LC circuit so that it can be biased at a different frequency. The sky-signal changes the bolometer resistance and amplitude modulates the bolometer current such that the signal from each bolometer is transferred to sidebands adjacent to its carrier. Thus, the signals from different bolometers within a module are uniquely positioned in frequency, so they can be summed and connected through a single wire to a Superconducting Quantum Interference Device (SQUID). The comb of amplitude modulated carriers output by the SQUID device is transmitted to a bank of demodulators that mix the signals down to base-band, recovering the original sky-signal. The signals are then low pass filtered and digitized, and all outputs in the array are sampled synchronously.

One of the auxiliary advantages of this system is that it is very insensitive to vibrations. This is because the current path through the bolometers is bandwidth limited, and sky signals are modulated up at high frequency where vibrations do not manifest. The first generation frequency domain multiplexer employs primarily analog electronics, and includes a high loop gain feedback loop between a cold SQUID device and warm amplifier. We are pursuing a cold feedback architecture which will increase the system bandwidth and hence increase the channel count, and a new low power digital mux/de-mux that will greatly improve the scalability of the system.

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