

Multipixel 2-color Superconducting Receiver for ASTHROS

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Abstract—We describe the receiver package for the ASHTROS mission: a 2-color 4-pixel THz superconducting receiver that targets a pair of ionized nitrogen fine-structure lines at 1.46 THz and 2.46 THz. The latter mixer will be able to operate at ~ 2.7 THz in order to observe HD. The design of the receiver package allows observations in both polarizations toward a source to maximize sensitivity. The receiver is operated near 6 K physical temperature using a mechanical cryocooler. A bank of low-power commercially sourced ASIC spectrometers are used to produce astronomy data.

Keywords—superconducting mixers, array receivers, cryocoolers.

I. THE ASTHROS RECEIVER

The Astrophysics Stratospheric Telescope for High Spectral Resolution Observations at Submillimeter-wavelengths is a high-altitude balloon-borne astronomy project that will map the sky in two key spectroscopic lines of ionized nitrogen at 1.46 THz and 2.46 THz. The key requirements for the receiver package include ability for simultaneous observations at the two frequencies and in two polarizations using 2 spatial pixels for a total of a simultaneous operation of 8 mixers. The number of pixels is largely determined by the constraints of the thermal system: on its projected 21-day flight, the receiver package will be cooled by a low-power mechanical refrigerator.

At the heart of the receiver are waveguide-based NbN hot-electron bolometer mixers, which are coupled to free-space by densely packed cylindrically symmetric drilled horns. The output is coupled to a low-noise first-stage SiGe cryogenic amplifier placed on the third stage of the cryocooler. Following conditioning at room temperature, the microwave signal is processed using an advanced ASIC-based low-power polyphase filter bank with ~ 4 GHz bandwidth.

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