BLISS and Ultrasensitive Bolometers for SPICA

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***Abstract*—We are developing the Background-Limited Infrared-Submillimeter Spectrograph (BLISS) for SPICA to provide a breakthrough capability for far-IR survey spectroscopy. The 3.2-meter, T<6K telescope allows mid-IR to submm observations which are limited only by the natural backgrounds, and BLISS will operate near this fundamental limit as a dispersive spectrograph. BLISS-SPICA will provide a line sensitivity of 10^{-20} W m^{-2}, thereby enabling spectroscopy of dust-obscured galaxies at all epochs back to the first billion years after the Big Bang (redshift 6), and study of all stages of planet formation in circumstellar disks.**

BLISS covers the 35-430 μm waveband at moderate resolving power (400<R<700) in six grating spectrometer bands, each coupling at least 2 sky positions simultaneously. The instrument is cooled to 50 mK with an on-board adiabatic demagnetization refrigerator (ADR) for optimal sensitivity. All technical elements of BLISS have heritage in mature scientific instruments, and many have flown. The instrument is carefully designed to fit within the stringent SPICA resource allocations for mass and heat lift, and to mitigate the impact of cosmic rays. We report on this design and our progress in prototyping the BLISS spectrometers and prototype cooler.

We also report progress in detector development for BLISS. BLISS uses ~4000 transition-edge sensors (TESs) read out with a cryogenic time-domain SQUID multiplexer. Each BLISS bolometer is a metalized micro-mesh silicon nitride (SiN) absorber with a superconducting thin film thermistor suspended by four long, thin SiN support beams. The detectors must have a noise equivalent power (NEP) of 5-10 x10^{-20} W $Hz^{-1/2}$, more than an order of magnitude lower than any previously-fielded far-IR / submm detector. As of this writing, we have measured 2x10^{-19} W $Hz^{-1/2}$ for several devices in a prototype array which uses elemental iridium thermistors (T_c=130 mK) each suspended with (4) 0.25 μm x 0.4 μm cross section SiN legs, read out using the cryogenic multiplexer, and cooled using an ADR. We are improving the fidelity of our 50 mK testbed and are currently measuring devices with MoCu bi-layer thermistors with T_c below 70 mK, with which we expect to exceed the BLISS sensitivity requirement with adequate speed of response.