Upcoming TES Bolometer Arrays in Cameras for Millimeter Wavelength Astronomy

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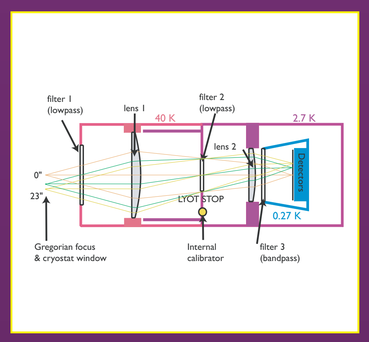
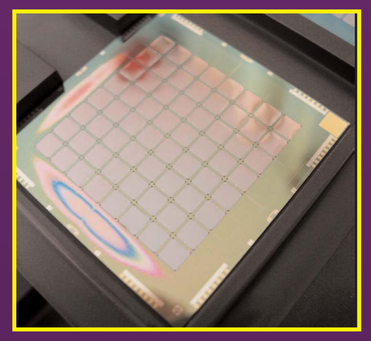
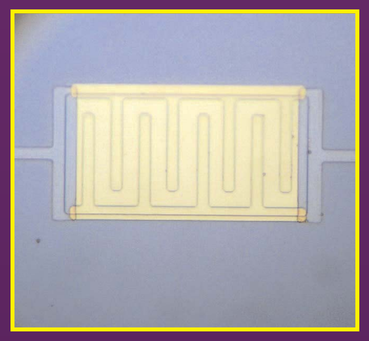
Two instruments are being built for millimeter wavelength ground-base astronomy using TES bolometer arrays built at NASA/GSFC. The first to be fielded is the Penn Array Receiver (PAR) for the 100m Green Bank Telescope. The PAR is a 3mm wavelength camera using an 8x8 array of pixels, and will achieve groundbreaking sensitivity and angular resolution at this wavelength. An engineering run of this instrument is scheduled for September 2006. The second instrument is the Goddard-IRAM Superconducting 2-Millimeter Observer (GISMO), which is slated to be used at the 30m radio telescope at Pico Veleta in November 2006. GISMO operates at 2mm wavelength and features an 8x16 array, providing excellent sensitivity and extremely wide field of view for rapid mapping and surveys. These two instruments will highlight the latest in millimeter-wave TES detector technology being produced at NASA/GSFC.

Penn Array Receiver

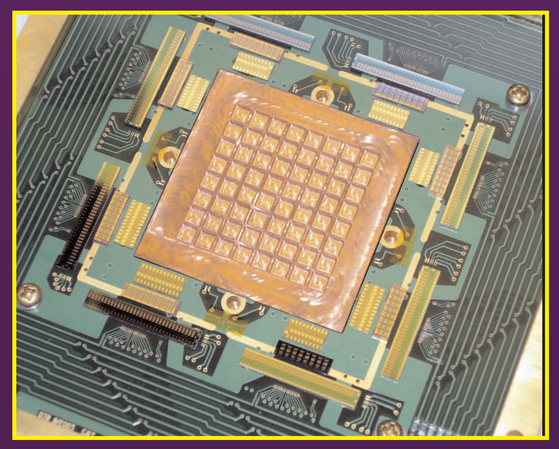


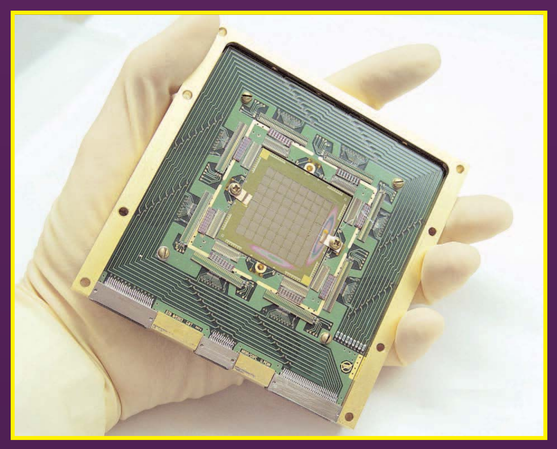
The 100m Green Bank Telescope; at a wavelength of 3.3mm = 90GHz, the mapping speed of the GBT (taking into consideration typical winter weather and expected aperture efficiency) is an order of magnitude faster than other instruments: 130μJy sensitivity in 1 hour over a 15'x15' field. A compact, efficient direct-coupled optics design yields Nyquist-sampled imaging over a 32"x32" field of view.





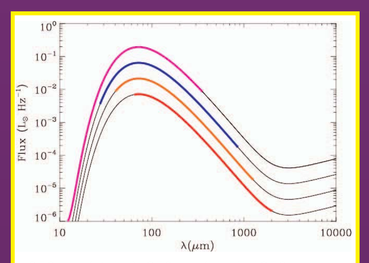
We have produced an 8x8 array of micromachined bolometers. Each detector is a 1μm-thick membrane of silicon with a bismuth absorber, held by four thin legs from a thick silicon frame. The temperature is sensed with a Mo/Au superconducting bilayer transition edge sensor, which has normal metal noise suppression bars.



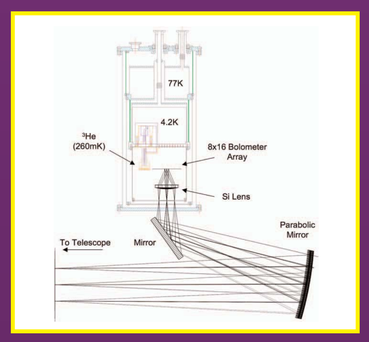


The array of TES thermistors is read out by a SQUID multiplexing network, complete with Nyquist-filtering inductors and biasing shunt resistors. The 3-stage SQUID amplifier system was developed by NIST-Boulder and uses electronics developed at NIST-Boulder and NASA/GSFC. A completed detector package is shown at right, illustrating the connector interface that makes detector packages exchangeable.

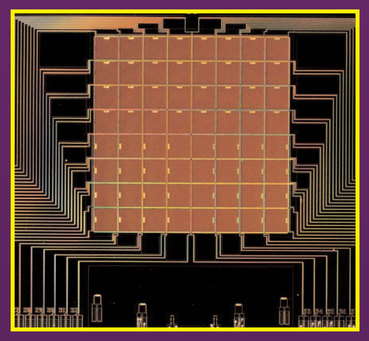
Goddard-IRAM Superconducting 2-MM Observer

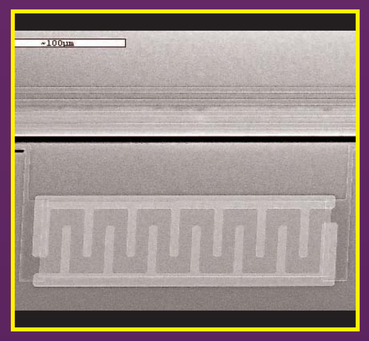


350μm, (violet), 850μm (blue), 1250μm (orange) and 2000 mm (red) coverage for redshifts ranging from z=0 to z=30.

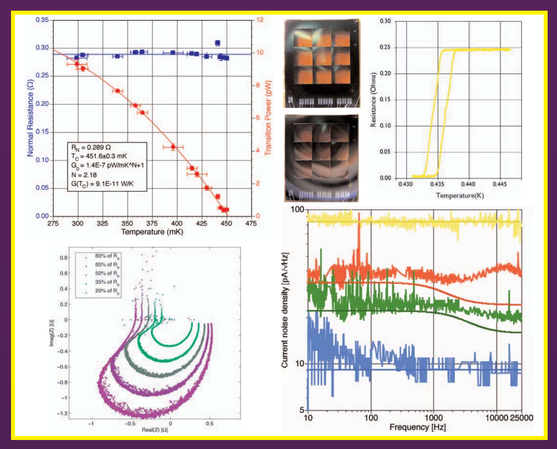


The 30m Millimeter Radio Telescope of IRAM at Pico Veleta, Spain, is the largest existing telescope capable of millimeter operation. At GISMO's wavelength of 2.0mm = 150GHz, the sensitivity achievable is ~10mJy/√Hz, which translates to mapping an area of 5'x5' to a depth of 250μJy in 1 hour. GISMO uses a simple single-lens optical system to provide beam-sampled imaging over a 2.25'x4.50' field of view.





We are producing an 8x16 array of micromachined bolometers of the Backshort Under Grid (BUG) design. Each detector is a 2mmx2mm silicon membrane with bismuth absorber, held by narrow tensile legs from a thin silicon frame. The thermistor is a high normal resistance (~250mΩ) Mo/Au bilayer TES with normal metal bars.



The entire cryogenic, optical, and electronic system are being designed and built simultaneously, for a rapid delivery project. Details of the detector readout are nearly identical to that for the PAR. The detectors are being characterized to demonstrate suitability for observations. We anticipate the completion of a flight detector package in September.