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Ultrasensitive Quantum-Limited Far-Infrared Detectors[1]

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Superconducting tunnel junction (STJ) direct detectors have been developed for submillimeter astronomy. Photons with energy greater than the superconducting gap of the aluminum absorber break Cooper pairs and generate excess quasiparticles, inducing an extra tunneling current through the STJ. To monitor the response of the STJ with large readout bandwidth and maximal sensitivity, we use a novel readout which uses radio frequency (RF) reflectometry, like the readout invented for the RF-SET.(1) For calibration of the detector, we have developed a in-situ, on-chip, hot-cold submillimeter photon source, a gold microbridge. When it is voltage biased, emitted noise from the microbridge couples via a microstripline to the detector. This provides a calibrated photon source with near unity coupling, very fast ($<$ ns) chopping, and calculable power output. Cooling is by outdiffusion of hot electrons (2). We present recent detection results in the range 100 140 GHz. These demonstrate the expected good responsivity, high sensitivity, and fast response times. The readout approach is easily used with a frequency multiplexed readout, allowing economy of cold electronics. Ultimate sensitivity may require the use of an RF-SET as the readout, for NEP below NEP below 10^{-20} W/(Hz)$^{1/2}$. -Research with J.D. Teufel, M. Shen, L. Frunzio, C. M. Wilson, T.J. Stevenson and R.J. Schoelkopf.

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-(2). D.E. Prober, Appl. Phys. Lett. v. 62 p.2119 (1993).
-(3). D.E. Prober, LTD11 Conf. (2005), invited, to appear.

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