Optical characterization at 1.5-3 THz of high sensitivity TES detectors designed for future Far-Infrared Space missions

P. D. Mauskopf[1*], D. Morozov[1], P. A. R. Ade[1], D. Griffin[2], D. Goldie[3], D. Glowacka[3], A. Velichko[3] and S. Withington[3]

1 Cardiff University, School of Physics and Astronomy, Cardiff, UK CF24 3AA*

2 Rutherford Appleton Laboratory, Harwell Science and Innovation Campus, Didcot OX11 0QX

3 Cambridge University, Astrophysics Group, Cavendish Laboratory, Cambridge, UK CB3 0HE

* Contact: Philip.mauskopf@astro.cf.ac.uk, phone +44-2920-876 170

***Abstract*—High sensitivity TES detectors are being developed for use in future Far-Infrared (FIR) space missions such as SPICA, FIRI, SAFIR, SPIRIT and SPECS. These missions plan on implementing actively cooled telescope optics to minimize the level of background radiation in the instrument and allow several orders of magnitude increase in sensitivity over current space missions such as HERSCHEL and SPITZER. The combination of low emission from the cooled telescope and the low-background environment from space results in a photon flux of on order several thousands of photons per second in a 50% bandwidth and a level of photon noise equivalent power (NEP) in the range NEP=10^{-20} – 10^{-18} W/√Hz depending on the details of the instrument design. In this paper, we describe the optical characterization of high-sensitivity TES detectors designed for operation in the wavelength range from 100-200 μm (1.5-3 THz). A detector consists of a TES thermometer (MoCu or MoAu) and an optical absorber fabricated from a thin Tantalum (Ta) film deposited on a thermally isolating silicon nitride (SiN) structure. The TES thermometers have a transition temperatures of approximately 100 mK and the measured thermal conductance agrees with the design values of G = 0.2-0.5 pW/K corresponding to a phonon limited detector NEP < 10^{-18} W/√Hz. We measure the absorbed optical power from a blackbody source as a function of source temperature through a set of two high pass and two low pass filters defining a pass band from 1.5-3 THz. The radiation from the blackbody source is coupled to an integrating cavity containing the TES and absorber using an electroformed conical horn. We find that this system has good optical performance and the dependence of absorbed power on blackbody temperature agrees with the values calculated from the combination of the blackbody emission spectrum and the measured filter transmission. We compare the measured optical efficiencies for different absorber geometries and impedances.**