First Science Observations with MUSTANG on the GBT

B.S. Mason[1], S.R. Dicker[2], M.J. Devlin[2], P.M. Korngut[2], W.D. Cotton[1], P.A.R. Ade[3], J. Aguirre[2], T.J. Ames[4], D.J. Benford[4], J.A. Chervenak[4], E. Figueroa-Feliciano[5], K.D. Irwin[6], S.Maher[4], M.J. Mello[7], S.H. Moseley[4], J. Staguhn[4], D.J. Tally[4], C. Tucker[4], and S.D. White[7]

[1] National Radio Astronomy Observatory, Charlottesville VA, 22903
[2] University of Pennsylvania, Dept. of Physics & Astronomy, 209 S. 33rd St Philadelphia, PA 19104
[3] School of Physics and Astronomy, Cardiff University, 5 The Parade, Cardiff CF24 3AA, UK
[4] NASA Goddard Space Flight Center, Greenbelt, MD 20771
[5] Dept. of Physics, Massachusetts Institute of Technology, Cambridge, MA 02139
[6] National Institute of Standards and Technology, 325 Broadway, Boulder, CO 80303
[7] National Radio Astronomy Observatory, Green Bank, WV 24944

The Multiplexed SQUID TES Array for Ninety Gigahertz (MUSTANG) is a 90 GHz bolometer camera built for use as a facility instrument on the 100-meter Robert C. Byrd Green Bank Telescope (GBT). MUSTANG comprises an 8 by 8 focal plane of transition edge superconductor bolometers read out using time-domain multiplexed SQUID electronics. It operates at the Gregorian focus of the GBT in a rotating turret housing seven other receivers. The pixels are used without feeds: reimaging optics form a nearly fully-sampled image of the sky ($32'' \times 32''$) on the detector array, and illuminate the primary to a radius of 45 meters, resulting in a diffraction-limited beam of $8''$ (FWHM). A series of capacitative mesh filters define the receiver bandpass of $81 - 99$ GHz. The detectors are cooled to 300 mK using a two-stage, closed-cycle He-3/He-4 sorption fridge. These in turn are operated off of a two stage (3K, 40K) pulse tube cooler which eliminates the need for operationally cumbersome liquid cryogenics without introducing the vibrations that a traditional cryo-mechanical refrigerator would. Engineering observations were collected on the GBT in fall of 2006. Initial observations were hampered by substantial $1/f$ noise, uncorrelated between pixels, which was subsequently associated with low-level vibrations introduced by the pulse tube cooler and successfully mitigated. Subsequent observations have demonstrated that MUSTANG, and the GBT at 90 GHz, are remarkably stable. In winter 2008 MUSTANG was used on the GBT over a period of about 3 months, collecting over forty hours of useful data in a series of early science projects focused primarily on the nearby Orion molecular cloud. Two open calls for shared-risk proposals have been made in 2008, with the first of these to be carried out on the telescope early in 2009. In the near future we aim to install a lower-noise detector array in MUSTANG. Since the multiplexing electronics have substantial unused capacity, this detector array could readily have 4 times as many pixels as the current array and would require minimal ancillary changes to the receiver. MUSTANG is a pathfinder for a large-format bolometer array on the GBT. Having successfully dealt with the major risks such an instrument would face we are now seeking funding to construct it.