THz Suborbital Payload Optical System Pointing Stability for Target Studies of Compact Sources

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Abstract—Previous suborbital missions to observe line emission surveys in the terahertz (THz) frequency spectrum have focused on large survey mapping observing modes or all-sky imaging. These observing modes require highly accurate pointing knowledge, but require only a modest degree of pointing stability. In contrast, target surveys of compact sources, for instance for future missions to observe planetary atmospheres, proto-planetary disks, etc. require both pointing accuracy and stability. Even for balloon-borne survey missions, pointing stability is a concern especially during the commissioning phase of a mission, where problems with pointing stability can stall the process and result in a loss of valuable observing time. Sub-arcsecond pointing stability through motion control of optical subsystem components has been developed outside the THz frequency regime, as in [1] and [2]. However, requirements at those frequencies make the pointing control system cost prohibitive due to the requirement of either cryogenic actuators or large mass and power consuming actuators to independently move the instrument cryostat. For line emission surveys using hot-electron bolometer (HEB) receiver instruments, detector noise in the 1-5 Thz regime is higher than thermal emission at these frequencies, and so the mission requirements do not necessitate cold optics. It is therefore possible to design a low cost and complexity pointing stability system using a simple tip/tilt mirror in a control loop with commercial off-the-shelf gyroscopes, such as those demonstrated on STO-2 or BRRISON/SSIPP [3]. We present the design constraints for a pointing system for the case of a 2.5 m class observatory set to observe the 2.7 THz emission from hydrogen-deuteride (HD) in nearby protoplanetary disks.

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