Stratospheric Terahertz Observatory 2016, Sub-orbital flight from McMurdo, Antarctica

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Abstract—The Interstellar Medium within our galaxy is constantly mixed by stellar winds and replenished by supernovae. It consists of ionized and neutral atoms, molecules, and dust. Warm diffuse regions form first, followed by denser, cooler regions containing neutral atoms and molecules, such as CO. From these molecular regions, nascent stellar systems form. Typical molecular clouds contain enough matter to form thousands of new star systems. A number of astrophysically important transitions of atoms and molecules occur at terahertz frequencies, beyond the reach of most, if not all ground-based observatories. It is this frequency region that is the focus of the Stratospheric Terahertz Observatory (STO).

We describe here the major subcomponents of STO, including the *cryogenic system*, *detector system* consisting of focal plane and local oscillator, *backend electronics*, and the *telescope and gondola* pointing system. The cryogenic system consists of a Ball Aerospace Lightweight Low-Cost cryostat with a liquid Helium volume of 94 liters and a Sunpower CT cryocooler. The cryogenic hold time in flight was more than 21 days. The detector focal plane was provided by SRON and contained 2x 1.46 THz and 2x 1.9 THz, and 1x 4.7 THz HEB mixers. The lower frequency bands were coupled to the telescope by twin-slot antennas and hemispherical silicon lenses, while the 4.7 THz channel is a similar HEB coupled via a spiral antenna. The local oscillator was delivered by the NASA – JPL Submillimeter-Wave Technology group. The 1.46 and 1.9 THz LO channels are active multiplier chains multiplying a synthesizer frequency by 108 times. At 4.7 THz, the LO was a Quantum Cascade Laser designed and constructed by MIT and packaged with a second Sunpower CT cryocooler at 50 K by SRON.

In this paper we describe the performance of the flight instrument. The telescope optics and gondola pointing system developed by Johns Hopkins Applied Physics Laboratory will also be reviewed. While data reduction is ongoing, preliminary data and first-light results from the commissioning phase are shown.