ASTHROS - Astrophysics Stratospheric Telescope for High-Spectral Resolution Observations at Submillimeter-Wavelengths: Architecture Design and Subsystem Level Integration & Test Status

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***Abstract*—We report on the overall architecture design and subsystem level integration & test status of the ASTHROS mission. ASTHROS is a 2.5-m long duration balloon-borne observatory for high-spectral resolution observations in the 1.4-2.7 THz range, the largest balloon telescope ever built for terahertz science. It is planned to belaunched from Antarctica in December 2023 and fly for at least 3-4 weeks, studying the impact of stellar feedback on star formation in the Milky Way and other galaxies.**

Keywords—suborbital, balloon missions, far-infrared, terahertz, Antarctica, HEB, Schottky diodes.

I. Introduction

ASTHROS builds on the success of heterodyne instruments and technology on Herschel and SOFIA, STO-2, ALMA, etc., providing a low-cost stepping stone for future heterodyne missions. The first Antarctic flight will focus on determining the key mechanisms by which stellar feedback (e.g. supernovae explosions) affects the interstellar medium and regulates star formation, which is a key parameter in galactic evolution. We will map two template Galactic star forming regions and the entire disk of the M83 barred spiral galaxy at high angular resolution, complementing existing datasets from SOFIA, WISE, Herschel, Spitzer and HST. We will simultaneously observe and use the ratio of the [NII] 205um and [NII] 122um to determine the electron density distribution in these regions.

ASTHROS will also be capable of tuning to nearby spectral lines (OH, HDO, HF, HD, CO) for Target of Opportunity observations. One compelling target is the HD 112µm (2.674 THz) line that traces the gas mass in protoplanetary disks. ASTHROS' angular resolution of 12” at 122 µm and 20” at 205 µm correspond to 0.2 pc and 0.35 pc at 122µm and 205µm, respectively, for a source 4 kpc from the Sun. This high angular resolution will enable us to resolve structures ~750 times smaller than the typical size of star forming regions (~150 pc). Combined with large-scale mapping, we will begin to understand how different stellar feedback mechanisms affect ionized gas over a wide range of spatial scales in the Milky Way and other galaxies.

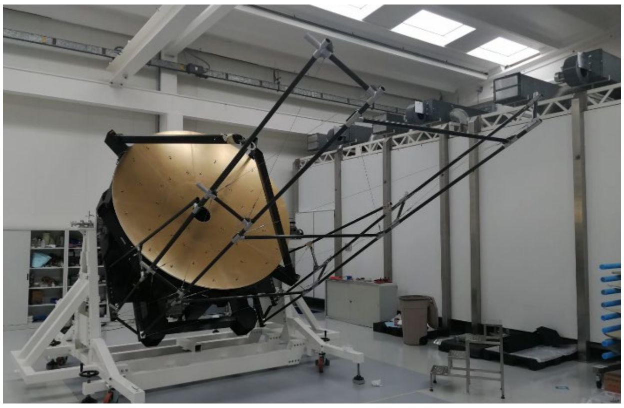

Fig. 1. ASTHROS payload under I&T, showing the 2.5-m primary mirror and the ~4.5-m long sunshade frame,

II. Architecture Overview

The overall architecture of ASTHROS has been designed with the intention of providing NASA with a robust far-infrared platform that allows multiple flights and instrument upgrades. This posed big challenges to the design of both the gondola and the telescope itself. The ASTHROS payload consists of two 8-pixel heterodyne receiver channel, covering the 1.4 THz to 2.7 THz range, and featuring waveguide HEB mixers pumped by Schottky diode based local oscillators. The HEB mixers are cryogenically cooled using a low-power 4K-class cryocooler which allows ASTHROS to perform long duration flights without being limited by the cryogenics on board. The 2.5-m antenna unit features a 9-panel segmented telescope based on ALMA light-weight panel technology. The backing structure and cradle are based on high-modulus carbon fiber, not only to reduce weight, but also to decouple the science instrument from the mirror and to overcome the gravity pull in order to maintain the overall surface RMS below 8 µm during flight. The gondola is designed to support science payloads of more than 1000 kg and over 1500 W. It also provides ~2-5” pointing capability. More details of the design and I&T status will be presented at the conference.

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