Galactic/Extragalactic ULDB Spectroscopic-Stratospheric Terahertz Observatory (GUSTO)

Project Update

Principle Investigator: Christopher Walker
Deputy PI: Craig Kulesa
Project Manager: Kieran Hegarty
Payload Manager: Doug Kelly
Project Scientist: Paul Goldsmith
Mission Systems Engineer: Pietro Bernasconi
Science Objectives
1. Determine the constituents and the life cycle of interstellar gas in the Milky Way
2. Witness the formation and destruction of star-forming clouds
3. Understand the dynamics and gas flow into and within the Galactic Center
4. Understand the interplay among star formation, stellar winds and radiation, and the structure of the interstellar medium in the Large Magellanic Cloud (LMC)
5. Construct Milky Way and LMC templates for comparison to distant galaxies.

GUSTO Highlights
Instrument
- 0.90-m telescope
- Terahertz heterodyne array receivers
- Cryostat cooled detectors

Gondola
- 2.5 axis stabilized

Launch site
- McMurdo Stn. Antarctica

Key Mission Requirements

<table>
<thead>
<tr>
<th>Mission Design Life</th>
<th>75 day Baseline, 55 day Threshold</th>
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<tbody>
<tr>
<td>Altitude</td>
<td>Sub-orbital, nominal 33.2 km</td>
</tr>
<tr>
<td>Launch Vehicle</td>
<td>Zero Pressure Balloon (ZPB)</td>
</tr>
<tr>
<td>Observatory Mass</td>
<td>1,600 kg maximum</td>
</tr>
<tr>
<td>Power Usage</td>
<td>850 W minimum average</td>
</tr>
<tr>
<td>Data Downlink</td>
<td>300 kbps minimum average</td>
</tr>
<tr>
<td>Storage</td>
<td>1.6 Tb</td>
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</tbody>
</table>

Mission Programmatics

$47.167M Cost Cap
Project Category 3, Risk Class D streamlined
December 2023 launch readiness date
Sponsored by NASA-GSFC Explorers Program Office

Instrument: University of Arizona (UA)
Gondola: Johns Hopkins Applied Physics Lab (APL)
Mission Operations: APL
Science Operations: UA

Principal Investigator: Christopher Walker, UA
Project Manager: Kieran Hegarty, APL
Mission System Engr.: Pietro Bernasconi, APL
Life Cycle of ISM

1.9 THz

1.4 THz

4.7 THz

1 THz = 1,000,000 MHz

Atmospheric Absorption makes it difficult or impossible to see...
**GUSTO Observational Objectives:**

**Far-IR Line Surveys of MW and LMC**

**Galactic Plane Survey**

**LMC Survey**

Dist: 158,000 ly
GUSTO Flight to Antarctica
Only 7.5 hours... if you are lucky.

- Free sack lunch
- Toilet... don’t ask.

Christchurch, NZ

Time to Go....
About a month or so later....
Long Duration Balloon (LDB) Hangar#2, Antarctica

Stowed Telescope
- 0.9 m Cassegrain
- 2 Star Cameras

Instrument
- 4.7, 1.9, & 1.4 THz
- Heterodyne Receivers

CSBF/NASA Telecom Unit

TDRSS, Iridium, Starlink telecom antennas
Pre-Flight Checkouts: *Hang Test*
Pre-Flight Checkouts
GUSTO Science Operations Center (SOC)
Massive Star Forming Region

Dist: ~20,000 ly
Mass: ~10^5 M_{sun}
Luminosity: ~10^6 M_{sun}

G333.6-2
• Data products on track to meet or exceed Threshold Requirements
  - Angular resolution & coverage, spectral resolution & coverage, sensitivity
• 62 square degrees of Galactic Plane mapped in Bands 1 and 2
  - Easily exceeds mission success criteria, and 100% of Threshold mission!
  - > 1 Million Lines of Sight through the Milky Way!
  - Data processing ongoing
LMC Survey: 30 Doradus & N11

Fully Surveyed in [CII] & [NII]

LMC Survey in Bands 1 and 2
- 1.1 deg² map of 30 Dor region (100% complete)
- 0.6°x0.5° map around N11 (100% complete)
- 0.9 deg² map, molecular ridge south of 30 Dor

First Extragalactic GUSTO spectrum (30 Dor in LMC)
Payload position as of: 20:31:07Z 02/27/24

Latitude: 71°12.54 S
Longitude: 61°59.47 E

https://www.csbf.nasa.gov/map/balloon8/flight736N
Payload position as of: 20:31:07Z 02/27/24

Latitude: 71°12.54 S
Longitude: 61°59.47 E

Parachute
Gondola