SmallSats @ Goddard

NASA Science Mission Directorate
Heliophysics and Astrophysics Portfolio Management

> 25 Missions

SmallSat Activities Management

Missions

5 CubeSats 1 ISS Payload 4 ESPA-Class (formulation)

Technology Developments

Strategic Partnerships
NASA Heliophysics and Astrophysics SmallSat/CubeSats
We Support the following Heliophysics and Astrophysics Programs

- Heliophysics Flight Opportunities in Research and Technology (H-FORT):
  - Cubesats
  - Hosted Rideshare Payloads
  - International Space Station (ISS)-attached payloads

- Astrophysics Research and Analysis (APRA) Program
  - Cubesats

- Astrophysics Pioneers
  - Perform compelling science at a lower cost (<$20M) than Explorers
  - SmallSats, Balloon payloads, and ISS attached payloads

- ALL MISSIONS MANAGED PER NPR 7120.8, NASA Research and Technology Program and Project Management Requirements
SMD Heliophysics and Astrophysics Portfolio Mission Management

- “Light Touch” mission management for the Astrophysics Pioneers and APRA and Heliophysics H-FORT Programs
  - Status reporting interface/liaison between PI and HQ
  - Maintain portfolio database
- Grants management
- Engineering and Project support as necessary and requested
  - Engineering Peer Review (EPR)
  - Engineering Tech Authority (ETA)
  - Consultation, Analysis, Testing
  - FCC/NTIA licensing, CSLI interface
- Insight into the Smallsat community
  - Technology developments
  - Industry awareness/interaction
## Overall Mission Status

<table>
<thead>
<tr>
<th>Phase</th>
<th>Astrophysics APRA</th>
<th>Astrophysics Pioneers</th>
<th>Heliophysics</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work-In-Progress</td>
<td>4</td>
<td>4</td>
<td>17</td>
<td>25</td>
</tr>
<tr>
<td>On-Orbit</td>
<td>0</td>
<td>0</td>
<td>3 (5 spacecraft)</td>
<td>3</td>
</tr>
<tr>
<td>Decommissioned</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Canceled</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

Total Missions = 33

### Legend for Mission Status

- **On-Orbit**
- **Work-In-Progress**
- **Decommissioned**
- **Canceled**
Astrophysics Division
SmallSat/CubeSat Missions
Astrophysics Pioneers-2020 Selections

• New ROSES-2020 Program, $20M PI cost cap, 39 NOI, 24 Proposals, 22 selectable!
  Community excited and engaged! The future is bright. Four selected this year:

**PUEO:** A Long-duration Balloon-borne Instrument for Particle Astrophysics at the Highest Energies
PI - Abigail Vieregg, University of Chicago
Start date 2/1/21

**Pandora:** Multiwavelength Characterization of Exoplanets and their Host Stars
PI - Elisa Quintana, GSFC
Start date 2/1/21

**StarBurst:** Gamma-ray ASM, Simultaneous detection of NS/NS mergers with LIGO
PI - Daniel Kocevski, MSFC
Start Date 4/1/21

**Aspera:** IGM Inflow/outflow from galaxies via OVI $10^5$K emission line imaging.
PI - Carlos Vargas, Univ. of Arizona,
Start date 3/1/21

---

**Figure 10:** A rendering of the PUEO payload, including a design for the low-frequency drop-down instrument.

**Figure 13:** BCT X-SAT-9 is accommodated by an EELV Secondary Payload Adapter (ESPA) Grande 5-m fairing. The stowed volume is 1.173.7 mm in X-axis, 809.2 mm in Z-axis, and 709.9 mm in Y-axis. Shown here with arrays deployed (left panel) and stowed (right).
<table>
<thead>
<tr>
<th>Project</th>
<th>Status</th>
<th>PI</th>
<th>Organization</th>
<th>Goals</th>
<th>Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>BurstCube</td>
<td>Completed Concept Study Report and authorized to continue in January 2021.</td>
<td>Abe Falcone</td>
<td>Pennsylvania State University</td>
<td>A Soft X-ray Sky Monitor, Transient Finder, and Burst Detector for High-energy and Multimessenger Astrophysics</td>
<td>6U</td>
</tr>
<tr>
<td>CUTE</td>
<td>In final I&amp;T. Delivery to launch provider in July with launch in September.</td>
<td>Kevin France</td>
<td>University of Colorado, Boulder</td>
<td>Use near-ultraviolet transmission spectroscopy to characterize composition and mass-loss rates of exoplanet atmospheres.</td>
<td>6U</td>
</tr>
<tr>
<td>SPRITE</td>
<td>In final preparation for CDR. All long lead items on order.</td>
<td>Brian Fleming</td>
<td>University of Colorado, Boulder</td>
<td>A SmallSat mission to measure ionizing radiation escape from galaxies, map supernova regions, and demo LUV imaging</td>
<td>12U</td>
</tr>
<tr>
<td>SPHERE</td>
<td>In final preparation for CDR. All long lead items on order.</td>
<td>Brian Fleming</td>
<td>University of Colorado, Boulder</td>
<td>A SmallSat mission to measure ionizing radiation escape from galaxies, map supernova regions, and demo LUV imaging</td>
<td>12U</td>
</tr>
<tr>
<td>BlackCAT</td>
<td>Completed Concept Study Report and authorized to continue in January 2021.</td>
<td>Abe Falcone</td>
<td>Pennsylvania State University</td>
<td>A Soft X-ray Sky Monitor, Transient Finder, and Burst Detector for High-energy and Multimessenger Astrophysics</td>
<td>6U</td>
</tr>
<tr>
<td>WORK IN PROGRESS</td>
<td>WORK IN PROGRESS</td>
<td>WORK IN PROGRESS</td>
<td>WORK IN PROGRESS</td>
<td>WORK IN PROGRESS</td>
<td>WORK IN PROGRESS</td>
</tr>
<tr>
<td>Project</td>
<td>University</td>
<td>Type</td>
<td>Goals</td>
<td>Status</td>
<td>PI/Institution</td>
</tr>
<tr>
<td>-----------</td>
<td>-----------------------------------</td>
<td>------</td>
<td>----------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
<td>---------------------------------------</td>
</tr>
<tr>
<td>SPARCS</td>
<td>Arizona State University</td>
<td>6U</td>
<td>Monitor the flares and sunspots of M dwarf stars to determine how habitable the space environment is for planets orbiting them.</td>
<td>Canceled in March 2020 due to cost overruns and ASU not meeting proposed commitments. PI: Evgenya Shkolnik</td>
<td>Arizona State University</td>
</tr>
<tr>
<td>HaloSat</td>
<td>University of Iowa &amp; NASA/GSFC/WFF</td>
<td>6U</td>
<td>Mapping oxygen line emission to constrain the mass and spatial distribution of hot gas around Milky Way.</td>
<td>Re-entered on January 4, 2021 after conducting science operations for over 2 years. PI: Philip Kaaret, University of Iowa</td>
<td>University of Iowa &amp; NASA/GSFC/WFF</td>
</tr>
<tr>
<td>Project</td>
<td>Institution</td>
<td>Size</td>
<td>Goals</td>
<td>Status</td>
<td></td>
</tr>
<tr>
<td>---------</td>
<td>-------------</td>
<td>------</td>
<td>-------</td>
<td>--------</td>
<td></td>
</tr>
<tr>
<td>AERO</td>
<td>MIT Haystack Observatory</td>
<td>6U</td>
<td>To advance our knowledge by examining radio emissions from the auroral acceleration region in near-Earth space.</td>
<td>Building flight instrument and spacecraft (Nano Avionics). PI: Philip J. Erickson</td>
<td></td>
</tr>
<tr>
<td>AEPEX</td>
<td>University of Colorado, Boulder</td>
<td>6U</td>
<td>Perform a comprehensive measurement of Energetic Electron Precipitation</td>
<td>CDR being held on March 25 PI: Robert Marshall</td>
<td></td>
</tr>
<tr>
<td>CeREs</td>
<td>NASA GSFC</td>
<td>3U</td>
<td>To examine how radiation belt electrons are energized and lost, particularly during events called microbursts.</td>
<td>Launched December 2018. Failed to maintain communication after the first week on orbit. PI: Shri Kanakel</td>
<td></td>
</tr>
<tr>
<td>CIRBE</td>
<td>Laboratory for Atmospheric and Space Physics</td>
<td>3U</td>
<td>To provide some of the first advanced resolution of one of Earth’s two Van Allen belts.</td>
<td>Manifested on STP S285 with launch in June 2022 PI: Xinlin Li.</td>
<td></td>
</tr>
<tr>
<td>Codex</td>
<td>NASA GSFC</td>
<td>ISS Inst.</td>
<td>An ISS payload mission to study physical conditions in the solar wind acceleration region.</td>
<td>Heading to CDR in Fall 2021 PI: Jeff Newmark</td>
<td></td>
</tr>
</tbody>
</table>
### CuPID
- **University**: Boston University
- **Goals**: To study the transfer of energy from the sun’s solar wind to the Earth’s space environment. Will carry a wide field-of-view soft X-ray telescope.
- **Status**: In final I&T. Delivery to launch provider in July with launch in September. PI: Brian Walsh

### CURIE
- **University**: University of California, Berkley
- **Goals**: To use radio interferometry to study radio burst emissions from solar eruptive events such as flares and coronal mass ejections (CMEs) in the inner heliosphere.
- **Status**: Scheduled for launch in December 2021. PI: David Sundkvist

### CuSP
- **University**: Southwest Research Institute
- **Goals**: To study the sources and acceleration mechanisms of solar energetic particles that are harmful to astronauts as well as Earth-based technologies.
- **Status**: Delivery to KSC in May for Artemis launch in Fall 2021. PI: Mihir Desai

### DAILI
- **University**: Aerospace Corporation
- **Goals**: To improve the accuracy of operational models for both the neutral density and the ionosphere and will help further the study of wave propagation and transport processes in the lower thermosphere.
- **Status**: Manifested for launch on NG-16 in July 2021. PI: James Hecht

### Dione
- **University**: NASA GSFC
- **Goals**: A pathfinder mission for understanding the Ionosphere-Thermosphere responses to magnetospheric forcing.
- **Status**: Critical Design activities underway. PI: Eftyhia Zesta
<table>
<thead>
<tr>
<th><strong>ELFIN</strong></th>
<th>University of California, Los Angeles (UCLA)</th>
<th>3U (2X)</th>
<th><strong>Goals:</strong> To measure how precipitated electrons vary across space and time</th>
<th><strong>Status:</strong> ELFIN’s A&amp;B launched in September 2018 and both are operational. PI: Vassilis Angelopoulos</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GTOSat</strong></td>
<td>NASA GSFC</td>
<td>6U</td>
<td><strong>Goals:</strong> To measure high-energy particles that likely originate from solar wind and cosmic rays.</td>
<td><strong>Status:</strong> In Development and working to obtain a launch manifest. PI: Larry Kepko</td>
</tr>
<tr>
<td><strong>LAICE</strong></td>
<td>Virginia Tech &amp; University of Illinois</td>
<td>6U</td>
<td><strong>Goals:</strong> Atmospheric gravity wave studies.</td>
<td><strong>Status:</strong> Refurbishing flight hardware in preparation for flight rebuild. PI: Greg Earle, Virginia Tech</td>
</tr>
<tr>
<td><strong>LLITED</strong></td>
<td>Aerospace Corporation</td>
<td>1.5U (2X)</td>
<td><strong>Goals:</strong> To provide first coincident measurements of Earth’s dusk-side at lower altitudes, providing a detailed examination of equatorial temperature and wind anomaly.</td>
<td><strong>Status:</strong> In final I&amp;T and awaiting launch manifest. PI: Rebecca Bishop</td>
</tr>
<tr>
<td><strong>MinXSS-1</strong></td>
<td>University of Colorado</td>
<td>3U</td>
<td><strong>Goals:</strong> To better understand the energy distribution of solar flare SXR (Soft X-ray) emissions and its impact on the Earth’s Ionosphere, Thermosphere, and Mesosphere.</td>
<td><strong>Status:</strong> Deployed from ISS in May 2016. Operated for 1 year as planned. PI: Tom Woods</td>
</tr>
<tr>
<td>Project</td>
<td>Institution</td>
<td>Size</td>
<td>Goals</td>
<td>Status</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------</td>
<td>------</td>
<td>----------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>MinXSS-2</td>
<td>University of Colorado</td>
<td>3U</td>
<td>To better understand the energy distribution of solar flare SXR (Soft X-ray) emissions and its impact on the Earth’s Ionosphere, Thermosphere, and Mesosphere.</td>
<td>Launched in December 2018. Experience an on-orbit anomaly approximately 2 weeks later.</td>
</tr>
<tr>
<td>MinXSS-3</td>
<td>University of Colorado, Boulder</td>
<td>Hosted Payload</td>
<td>To better understand the energy distribution of solar flare SXR (Soft X-ray) emissions and its impact on the Earth’s Ionosphere, Thermosphere, and Mesosphere.</td>
<td>Integrated on INSPIRESat-1 with delivery in April for launch on PSLV C-52 in June 2021.</td>
</tr>
<tr>
<td>petitSat</td>
<td>NASA GSFC</td>
<td>6U</td>
<td>To study density irregularities in the mid and low-latitude ionosphere, which occupies a tiny fraction of the atmosphere.</td>
<td>Manifested on ELaNA 37 for launch in late Fall 2021.</td>
</tr>
<tr>
<td>REAL</td>
<td>Dartmouth University</td>
<td>3U</td>
<td>To improve our understanding of physical mechanisms responsible for scattering radiation belt electrons into Earth’s atmosphere.</td>
<td>Flight instrument and spacecraft builds underway.</td>
</tr>
</tbody>
</table>
## Heliophysics

<table>
<thead>
<tr>
<th><strong>SORTIE</strong></th>
<th><strong>Atmospheric and Space Technology Research Associates</strong></th>
<th><strong>Goals:</strong> To study the complex challenges in discovering the wave-like plasma perturbations in the ionosphere.</th>
<th><strong>Status:</strong> Deployed from ISS in Feb 2020. Science operations ongoing. PI: Geoffrey Crowley</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SPORT</strong></td>
<td><strong>Utah State, MSFC, &amp; Brazil</strong></td>
<td><strong>Goals:</strong> To address the compelling but difficult problem of understanding the preconditions leading to equatorial plasma bubbles.</td>
<td><strong>Status:</strong> Preparing to deliver 4 US instruments to Brazil in April 2021. PI: Charles Swensen</td>
</tr>
<tr>
<td><strong>TBEx</strong></td>
<td><strong>University of Michigan</strong></td>
<td><strong>Goals:</strong> To provide a better understanding of the physics that controls the day-to-day variability in development of EPBs (space weather).</td>
<td><strong>Status:</strong> Currently on-orbit and expected to demise in April 2021. PI: Roland Tsunoda</td>
</tr>
<tr>
<td><strong>VISTA</strong></td>
<td><strong>MIT Haystack Observatory</strong></td>
<td><strong>Goals:</strong> Uses AERO to advance our ability to perform radio interferometry using cubesats in space</td>
<td><strong>Status:</strong> Building flight instrument and spacecraft (Nano Avionics). PI: Frank Lind</td>
</tr>
</tbody>
</table>

15