SmallSats @ Goddard

Goddard SPACE FLIGHT CENTER

NASA Science Mission Directorate
Heliophysics and Astrophysics Portfolio Management

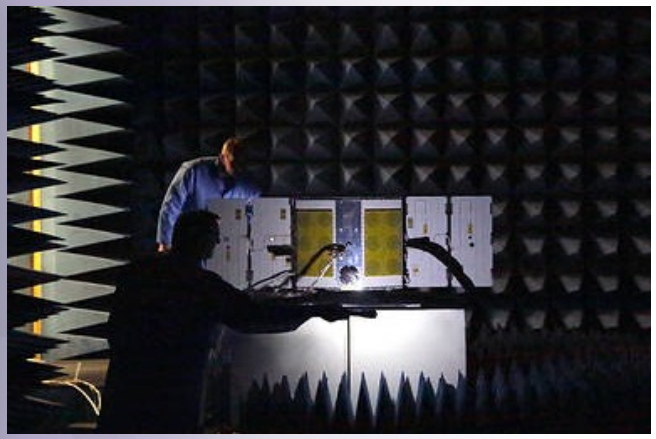
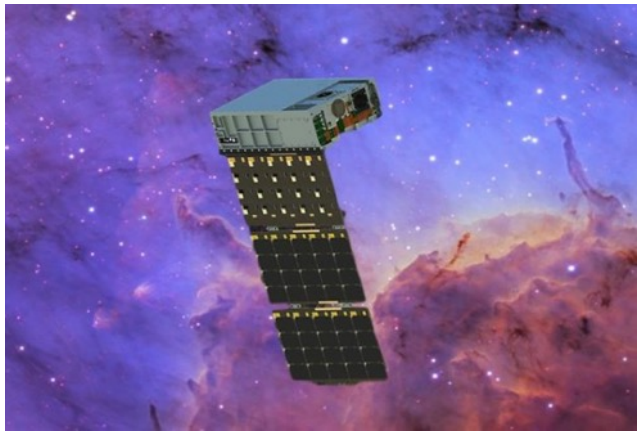
> 25 Missions

SmallSat Activities Management

- Missions
  - 5 CubeSats
  - 1 ISS Payload
  - 4 ESPA-Class (formulation)
- Technology Developments
- Strategic Partnerships

National Aeronautics and Space Administration

NASA Heliophysics and Astrophysics SmallSat/CubeSats

2021 NASA PI/PM Forum

Thomas Johnson
Small Satellite Project Manager
Thomas.E.Johnson@nasa.gov

GSFC Small Satellite and Special Projects Office

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*

GSFC Small Satellite and Special Projects Office

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

Phase	Astrophysics APRA	Astrophysics Pioneers	Heliophysics	Total
Work-In-Progress	4	4	17	**25**
On-Orbit	0	0	3 (5 spacecraft)	**3**
Decommissioned	1	0	3	**4**
Canceled	1	0	0	**1**
				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

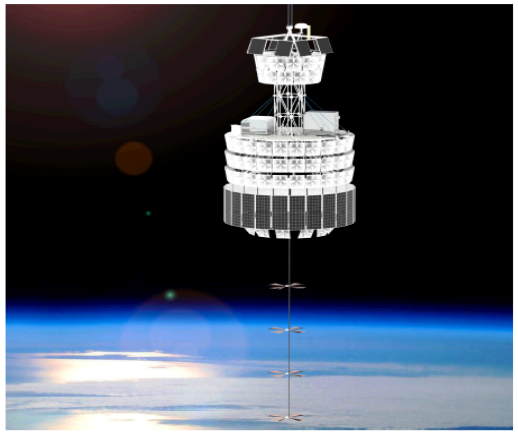
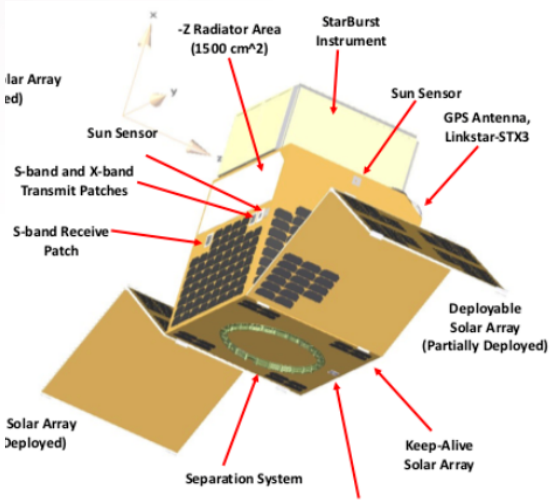


Figure 10: *A rendering of the PUEO payload, including a design for the low-frequency drop-down instrument.*



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

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

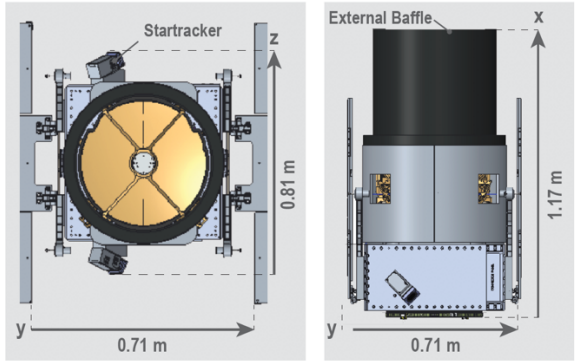
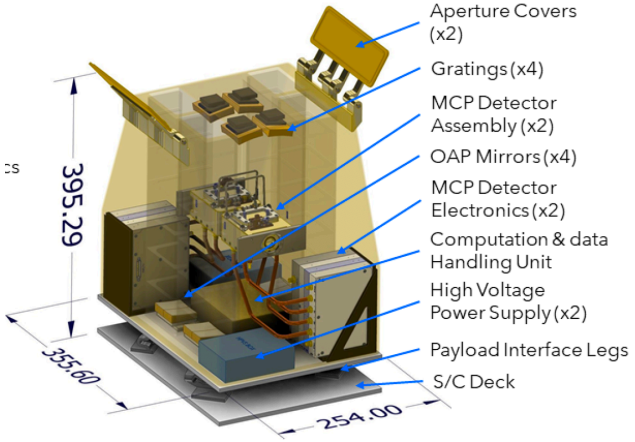
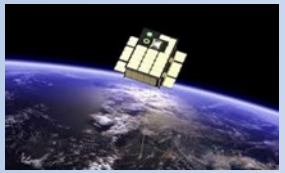
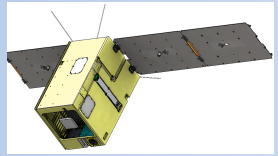
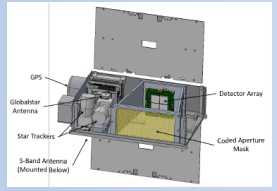


Figure 13: BCT X-SAT-9 is accommodated by an EELV Secondary Payload Adapter (ESPA) Grande 5-m fairing The stowed volume is 1,173.7 mm in X-axis, 809.2 mm in Z-axis, and 709.9 mm in Y-axis. Shown here with arrays deployed (left panel) and stowed (right).

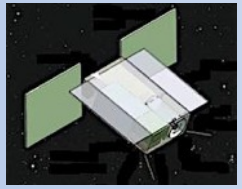
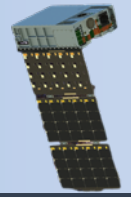


Aspera: IGM Inflow/outflow from galaxies via OVI 10^5K emission line imaging.
PI -Carlos Vargas, Univ. of Arizona,
Start date 3/1/21

Astrophysics – APRA

BurstCube		**NASA GSFC**	**6U**	**Goals:** Detect and localizing gamma-ray bursts generated by amalgamation of orbiting neutron stars and collision of giant stars.	**Status:** Building flight instrument and spacecraft. PI: Jeremy Perkins	WORK IN PROGRESS
CUTE		**University of Colorado, Boulder**	**6U**	**Goals:** Use near-ultraviolet transmission spectroscopy to characterize composition and mass-loss rates of exoplanet atmospheres.	**Status:** In final I&T. Delivery to launch provider in July with launch in September. PI: Kevin France	WORK IN PROGRESS
SPRITE		**University of Colorado, Boulder**	**12U**	**Goals:** A SmallSat mission to measure ionizing radiation escape from galaxies, map supernova regions, and demo LUV imaging	**Status:** In final preparation for CDR. All long lead items on order. PI: Brian Fleming	WORK IN PROGRESS
BlackCAT		**Pennsylvania State University**	**6U**	**Goals:** A Soft X-ray Sky Monitor, Transient Finder, and Burst Detector for High-energy and Multimessenger Astrophysics	**Status:** Completed Concept Study Report and authorized to continue in January 2021. PI: Abe Falcone	WORK IN PROGRESS

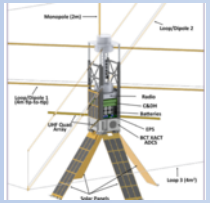
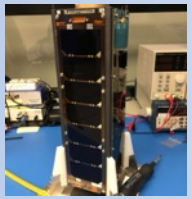
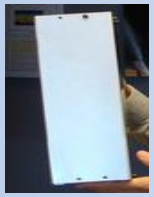
Astrophysics – APRA

SPARCS		Arizona State University	6U	**Goals:** Monitor the flares and sunspots of M dwarf stars to determine how habitable the space environment is for planets orbiting them.	**Status:** Canceled in March 2020 due to cost overruns and ASU not meeting proposed commitments. PI: Evgenya Shkolnik	X
HaloSat		University of Iowa & NASA/GSFC/ WFF	6U	**Goals:** Mapping oxygen line emission to constrain the mass and spatial distribution of hot gas around Milky Way.	**Status:** Re-entered on January 4, 2021 after conducting science operations for over 2 years. PI: Philip Kaaret, University of Iowa	DECOMMISSIONED

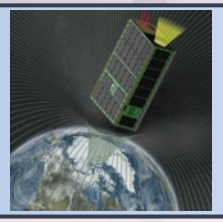
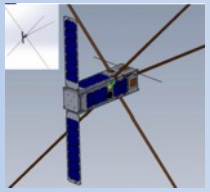
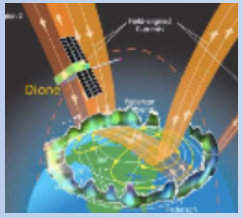
Heliophysics Division

SmallSat/CubeSat Missions

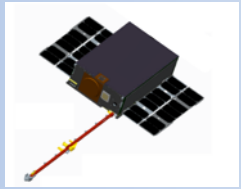
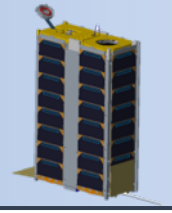
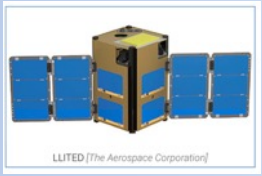
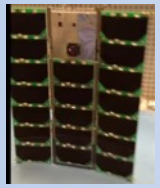
Heliophysics

AERO		**MIT Haystack Observatory**	**6U**	**Goals:** To advance our knowledge by examining radio emissions from the auroral acceleration region in near-Earth space.	**Status:** Building flight instrument and spacecraft (Nano Avionics). PI: Philip J. Erickson	WORK IN PROGRESS
AEPEX		**University of Colorado, Boulder**	**6U**	**Goals:** Perform a comprehensive measurement of Energetic Electron Precipitation	**Status:** CDR being held on March 25 PI: Robert Marshall	WORK IN PROGRESS
CeREs		**NASA GSFC**	**3U**	**Goals:** To examine how radiation belt electrons are energized and lost, particularly during events called microbursts.	**Status:** Launched December 2018. Failed to maintain communication after the first week on orbit. PI: Shri Kanakel	DECOMMISSIONED
CIRBE		**Laboratory for Atmospheric and Space Physics**	**3U**	**Goals:** To provide some of the first advanced resolution of one of Earth's two Van Allen belts.	**Status:** Manifested on STP S285 with launch in June 2022 PI: Xinlin Li.	WORK IN PROGRESS
Codex		**NASA GSFC**	**ISS Inst.**	**Goals:** An ISS payload mission to study physical conditions in the solar wind acceleration region.	**Status:** Heading to CDR in Fall 2021 PI: Jeff Newmark	WORK IN PROGRESS

Heliophysics

CuPID		**Boston University**	**6U**	**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	WORK IN PROGRESS
CURIE		**University of California, Berkley**	**6U (2 x 3U)**	**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	WORK IN PROGRESS
CuSP		**Southwest Research Institute**	**6U**	**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	WORK IN PROGRESS
DAILI		**Aerospace Corporation**	**6U (1x6)**	**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	WORK IN PROGRESS
Dione		**NASA GSFC**	**6U**	**Goals** A pathfinder mission for understanding the Ionosphere-Thermosphere responses to magnetospheric forcing	**Status:** Critical Design activities underway PI: Eftyhia Zesta	WORK IN PROGRESS

Heliophysics

ELFIN		**University of California, Los Angeles (UCLA)**	**3U (2X)**	**Goals:** To measure how precipitated electrons vary across space and time	**Status:** ELFIN's A&B launched in September 2018 and both are operational. PI: Vassilis Angelopoulos
GTOSat		**NASA GSFC**	**6U**	**Goals:** To measure high-energy particles that likely originate from solar wind and cosmic rays.	**Status:** In Development and working to obtain a launch manifest. PI: Larry Kepko
LAICE		**Virginia Tech & University of Illinois**	**6U**	**Goals:** Atmospheric gravity wave studies.	**Status:** Refurbishing flight hardware in preparation for flight rebuild PI: Greg Earle, Virginia Tech
LLITED		**Aerospace Corporation**	**1.5U (2X)**	**Goals:** To provide first coincident measurements of Earth's dusk-side at lower altitudes, providing a detailed examination of equatorial temperature and wind anomaly.	**Status:** In final I&T and awaiting launch manifest. PI: Rebecca Bishop
MinXSS-1		**University of Colorado**	**3U**	**Goals:** 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.	**Status:** Deployed from ISS in May 2016. Operated for 1 year as planned. PI: Tom Woods

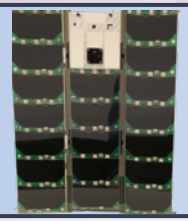
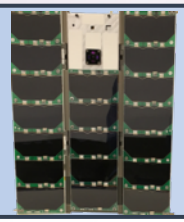
WORK IN PROGRESS

WORK IN PROGRESS

WORK IN PROGRESS

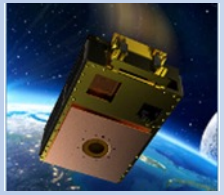
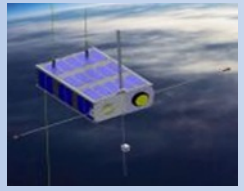
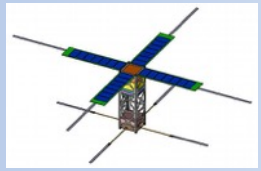
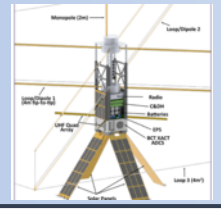
DECOMMISSIONED

Heliophysics

MinXSS-2		University of Colorado	3U	**Goals:** 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.	**Status:** Launched in December 2018 Experience an on-orbit anomaly approximately 2 weeks later. PI: Tom Woods	DECOMMISSIONED
MinXSS-3		University of Colorado, Boulder	Hosted Payload	**Goals:** 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.	**Status:** Integrated on INSPIRESat-1 with delivery in April for launch on PSLV C-52 in June 2021 PI: Tom Woods	WORK IN PROGRESS
petitSat		NASA GSFC	6U	**Goals:** To study density irregularities in the mid and low-latitude ionosphere, which occupies a tiny fraction of the atmosphere.	**Status:** Manifested on ELaNA 37 for launch in late Fall 2021 PI: Jeff Klenzing	WORK IN PROGRESS
REAL		Dartmouth University	3U	**Goals:** To improve our understanding of physical mechanisms responsible for scattering radiation belt electrons into Earth's atmosphere.	**Status:** Flight instrument and spacecraft builds underway. PI: Robyn Millan	WORK IN PROGRESS

Heliophysics

National Aeronautics and Space Administration

SORTIE		Atmospheric and Space Technology Research Associates	6U	**Goals:** To study the complex challenges in discovering the wave-like plasma perturbations in the ionosphere.	**Status:** Deployed from ISS in Feb 2020. Science operations ongoing. PI: Geoffrey Crowley	
SPORT		Utah State, MSFC, & Brazil	6U	**Goals:** To address the compelling but difficult problem of understanding the preconditions leading to equatorial plasma bubbles.	**Status:** Preparing to deliver 4 US instruments to Brazil in April 2021 PI: Charles Swensen	WORK IN PROGRESS
TBEx		University of Michigan	3U (2x)	**Goals:** To provide a better understanding of the physics that controls the day-to-day variability in development of EPBs (space weather).	**Status:** Currently on-orbit and expected to demise in April 2021 PI: Roland Tsunoda	
VISTA		MIT Haystack Observatory	6U	**Goals:** Uses AERO to advance our ability to perform radio interferometry using cubesats in space	**Status:** Building flight instrument and spacecraft (Nano Avionics). PI: Frank Lind	WORK IN PROGRESS