CuSP

CubeSat Mission to Study Solar Particles

"The CuSP interplanetary CubeSat mission"

13th annual CubeSat Developers Workshop
San Luis Obispo, CA
April 21, 2016

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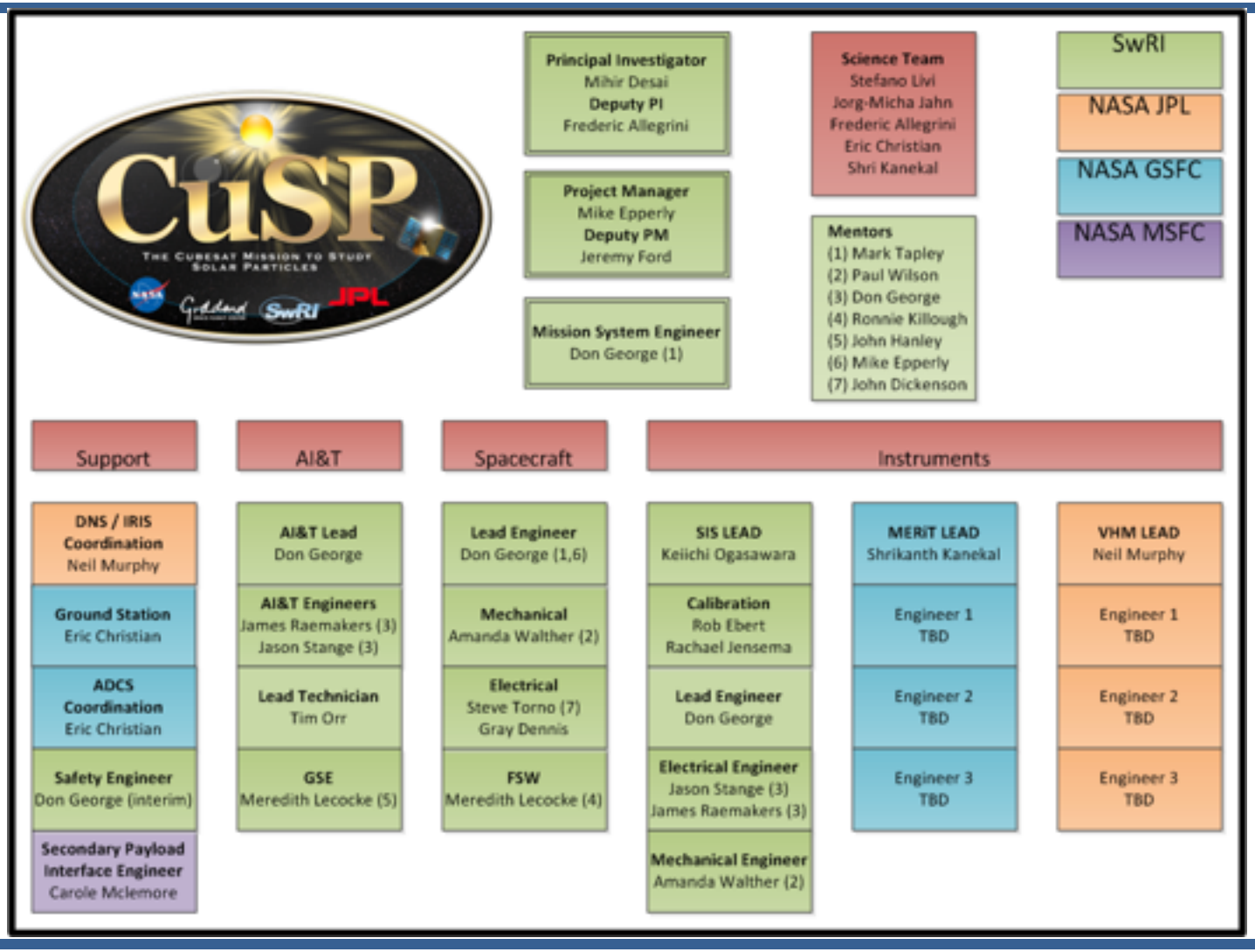
CuSP will …

- Study Solar Particles in interplanetary space
- Be a Pathfinder for creating a network of “Space Weather Stations”
- Strengthen the case for CubeSats as a viable platform for performing ‘High Value’ Science
- Raise the TRL of the SIS instrument for future missions

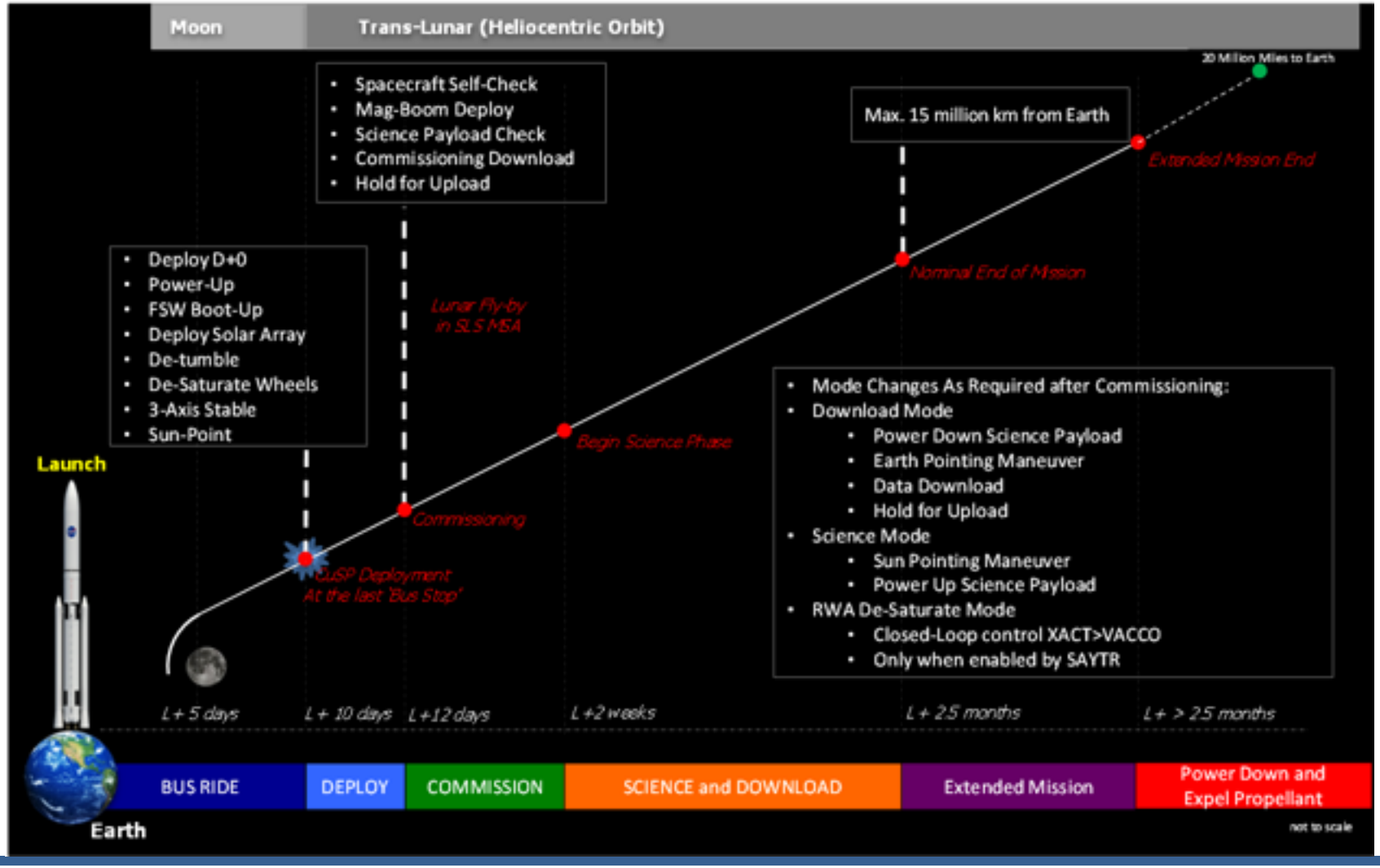
CuSP Overview

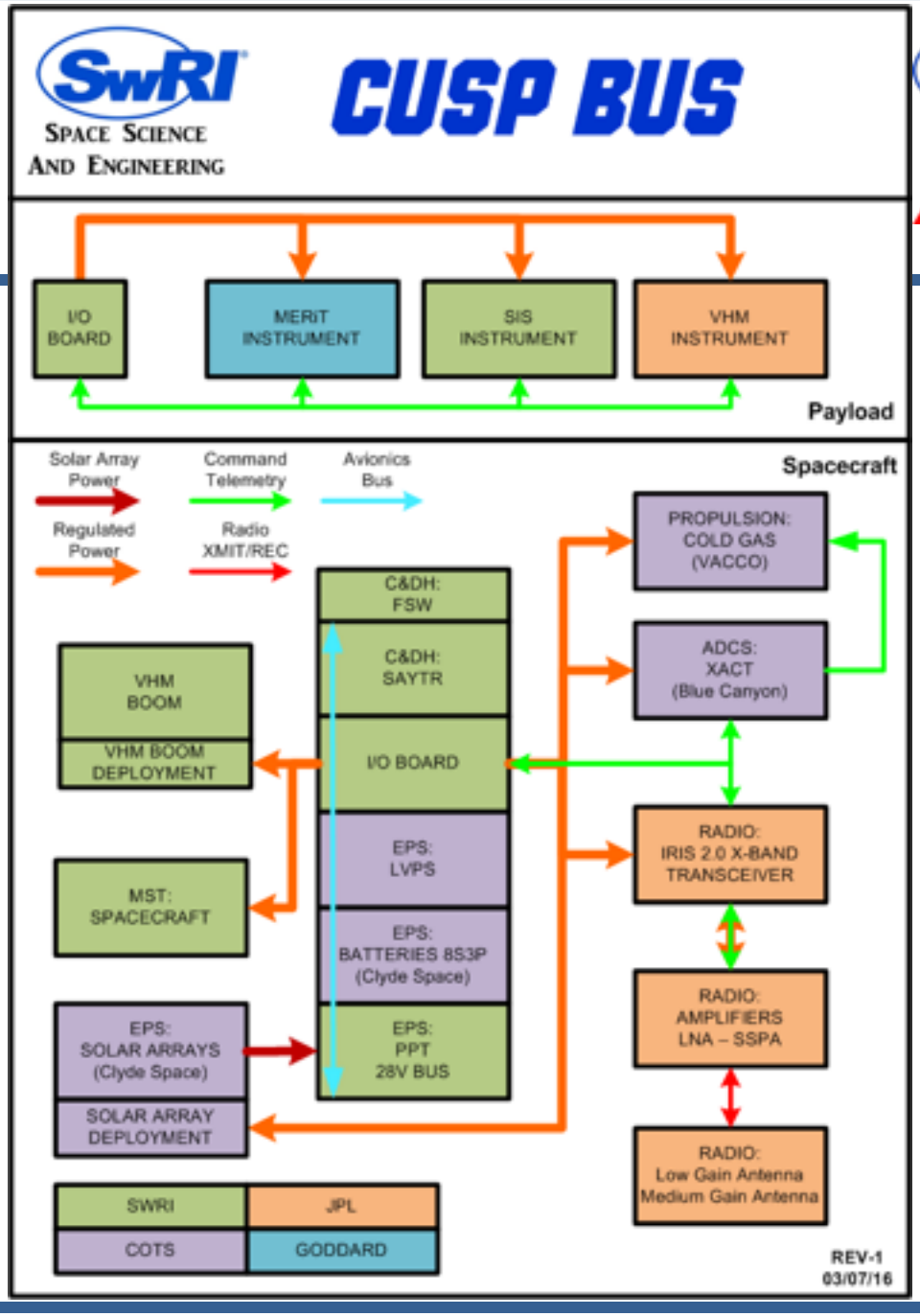
- Spacecraft
  - 6U CubeSat 3-axis Stable Sun Pointing
- SLS EM-1 Secondary Payload
- Trans-lunar, heliocentric orbit at 1AU
- 3 months (bandwidth limited)
- Science Payload:
  - SIS – Suprathermal Ion Spectrograph 3-70 keV/q
  - VHM – Vector Helium Magnetometer
  - MERiT – Miniaturized Electron & pRoton Telescope 2-150 MeV/q

CuSP Team


CuSP
THE CUBESAT MISSION TO STUDY SOLAR PARTICLES
Principal Investigator
Mihir Desai
Deputy PI
Frederic Allegrini
Project Manager
Mike Epperly
Deputy PM
Jeremy Ford
Mission System Engineer
Don George (1)
Science Team
Stefano Livi
Jorg-Micha Jahn
Frederic Allegrini
Eric Christian
Shri Kanekal
Mentors
(1) Mark Tapley
(2) Paul Wilson
(3) Don George
(4) Ronnie Killough
(5) John Hanley
(6) Mike Epperly
(7) John Dickenson
SwRI
NASA JPL
NASA GSFC
NASA MSFC
Support
AI&T
Spacecraft
Instruments
DNS / IRIS Coordination
Neil Murphy
Ground Station
Eric Christian
ADCS Coordination
Eric Christian
Safety Engineer
Don George (interim)
Secondary Payload Interface Engineer
Carole Mclemore
AI&T Lead
Don George
AI&T Engineers
James Raemakers (3)
Jason Stange (3)
Lead Technician
Tim Orr
GSE
Meredith Lecocke (5)
Lead Engineer
Don George (1,6)
Mechanical
Amanda Walther (2)
Electrical
Steve Torno (7)
Gray Dennis
FSW
Meredith Lecocke (4)
SIS LEAD
Keiichi Ogasawara
Calibration
Rob Ebert
Rachael Jensema
Lead Engineer
Don George
Electrical Engineer
Jason Stange (3)
James Raemakers (3)
Mechanical Engineer
Amanda Walther (2)
MERiT LEAD
Shrikanth Kanekal
Engineer 1
TBD
Engineer 2
TBD
Engineer 3
TBD
VHM LEAD
Neil Murphy
Engineer 1
TBD
Engineer 2
TBD
Engineer 3
TBD

Mission Overview





- SwRI
  - Spacecraft
  - C&DH
  - PPT
  - LVPS
  - FSW
  - SIS
- COTS
  - Solar-Arrays
  - Batteries
  - ADCS
  - Cold-Gas

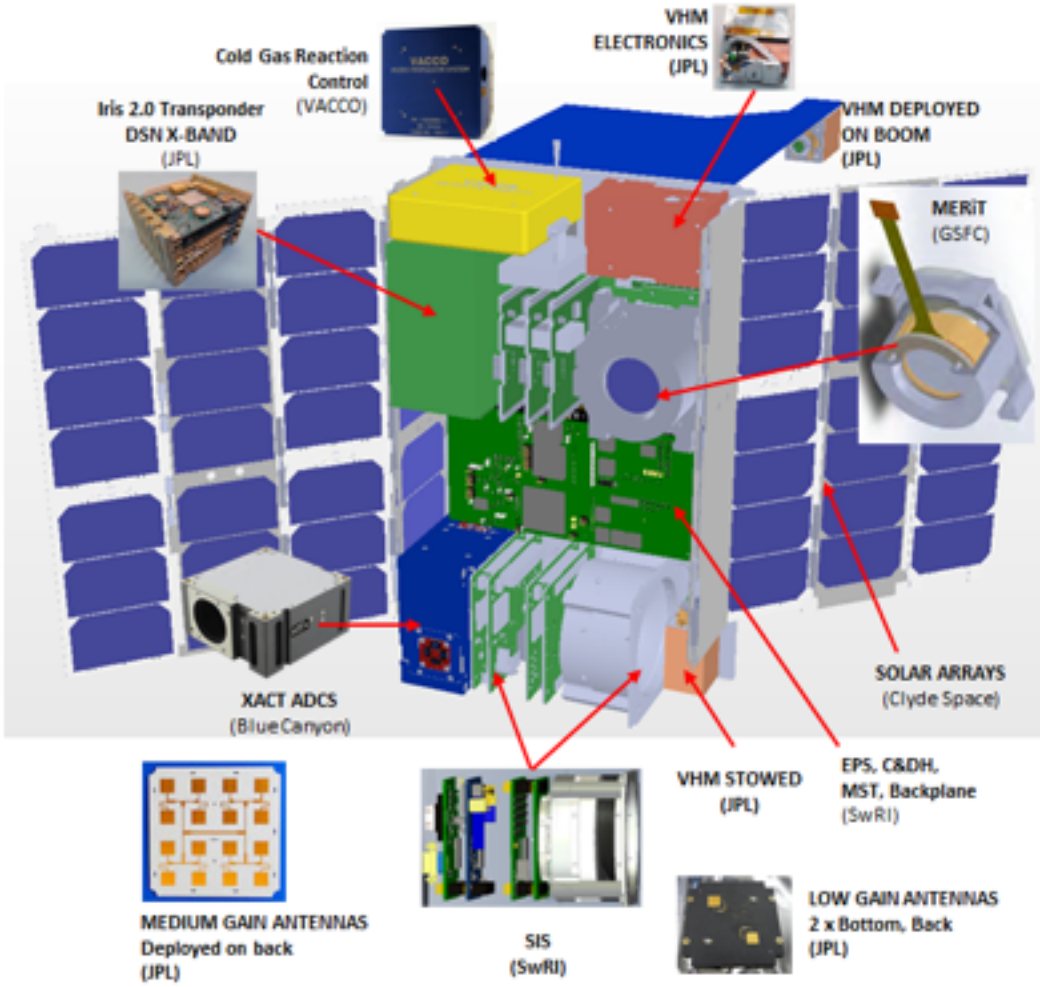
- JPL
  - Radio
  - Amplifiers
  - Antennas
  - VHM
- GSFC
  - MERiT

CuSP at a Glance

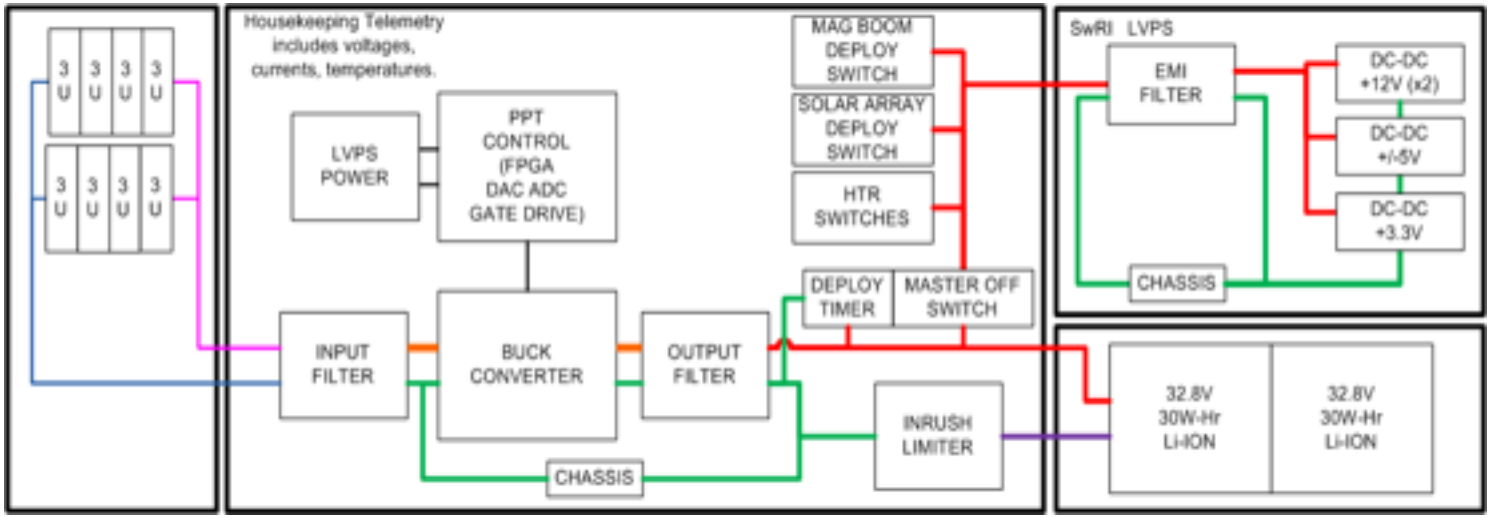
Science Payload	• SwRI SIS • Goddard MERiT • JPL VHM (on a 30cm deployed boom)
Mechanical, Structural, Thermal	• "6U" CubeSat form factor (~10x20x30 cm) • <14 kg total launch mass • Modular flight system concept
COTS Reaction Control	• VACCO Cold Gas Thruster • Inertia Shedding Only • Closed Loop control from XACT
C&DH	• SwRI SAYTR (LEON-3) C&DH

SwRI Electrical Power System (EPS)	• SwRI PPT 28V Main Bus
	• SwRI LVPS +12V, +/-5V, +3.3V
	• Clyde Space Solar Arrays
	  • 6U-Deployed, + 2U-Fixed
	• Clyde Space 60 Whr 8s2p
	  • 18650 Lithium-Ion Cells

COTS Telecom	• JPL IRIS 2.0 X-Band Transponder; 2W RF supports Doppler, ranging, and D-DOR • 2 JPL Low Gain Patch Array Antenna LGA • 1 JPL Medium Gain Patch Array Antenna MGA • ~500 bps to 34m DSN at all times
COTS ADCS	• Blue Canyon XACT ADCS • 3-Axis Stable, Sun-Pointing • Nano StarTracker, Coarse Sun Sensors & MEMS IMU for attitude determination • Propulsion for Inertia Shedding



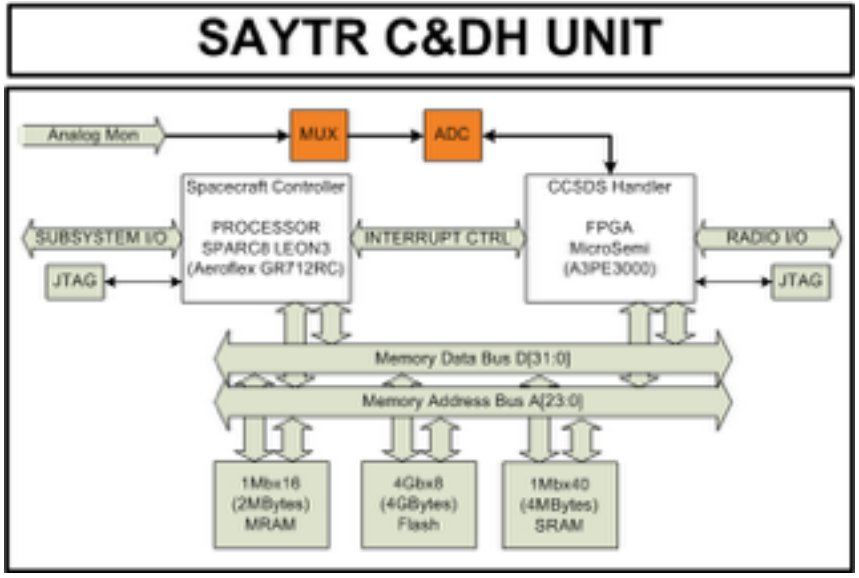
SwRI EPS

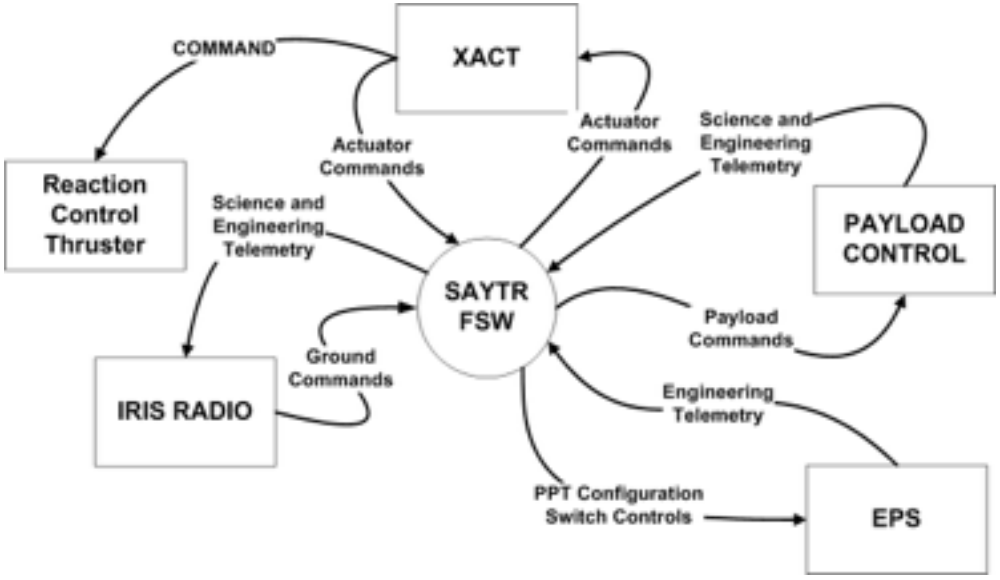


- SwRI EPS with extensive heritage
- 28V Battery Backed Essential Bus
- 80WHr Li-Ion Polymer Batteries
- Delayed Power-Up on deployment
- 50W Solar Array Power

CYGNSS Heritage Centaur and PPT

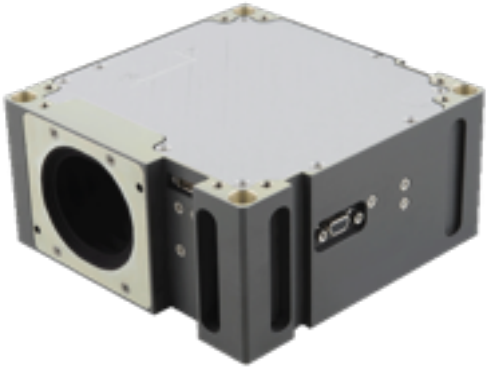
SwRI C&DH

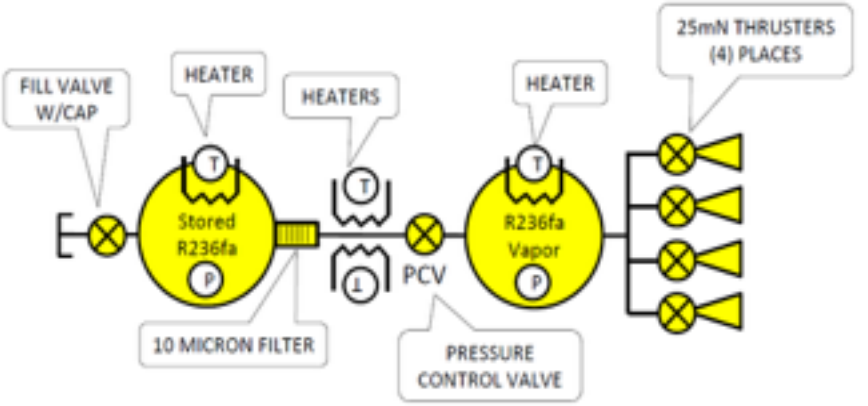


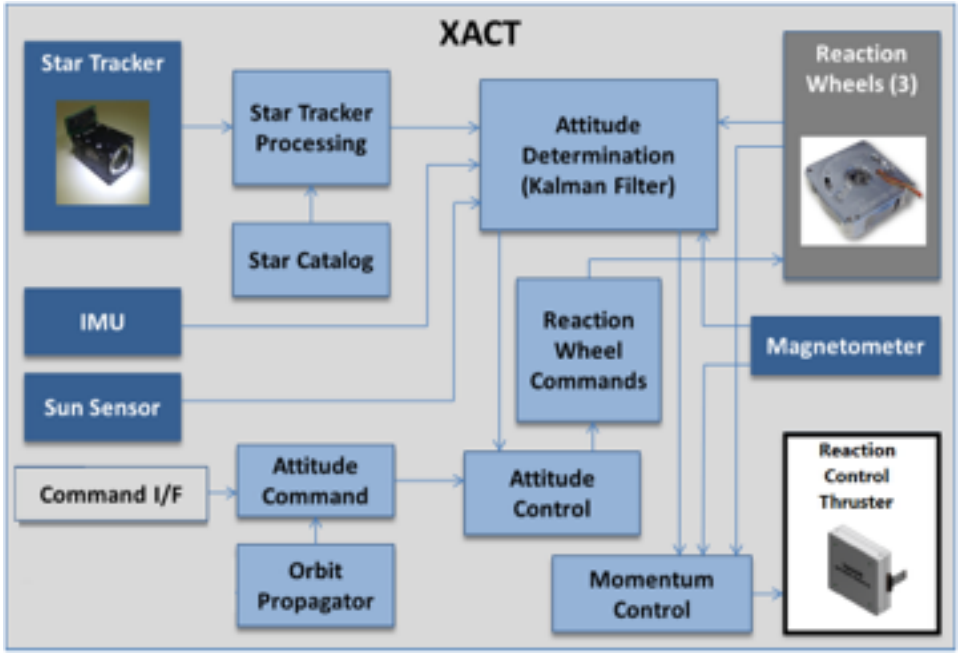


- SAYTR : smaller CubeSat version of the SwRI CENTAUR single board computer
- SwRI CDS Flight Software, Level 0 command capable
- GR712RC : dual-core Leon3FT 32-bit processor (SPARC V8 architecture)
- ProASIC3000 FPGA: Radio Control, CCSDS Handler, Instrument Data Processing
- EDAC-protected Memory : MRAM, SDRAM and Flash (4GB)
- Multiple IO protocols : SpaceWire, I2C, SPI, RS422 UART

COTS ADCS



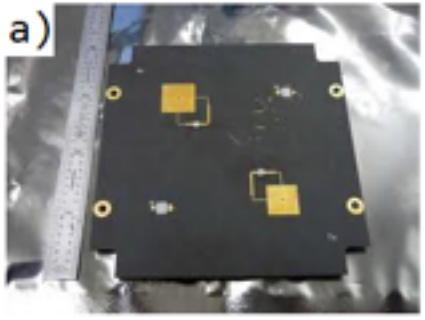




Reaction Control Thruster

JPL Radio

a)



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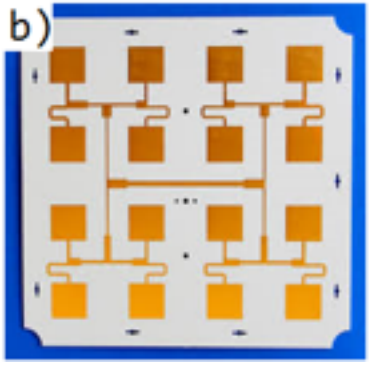
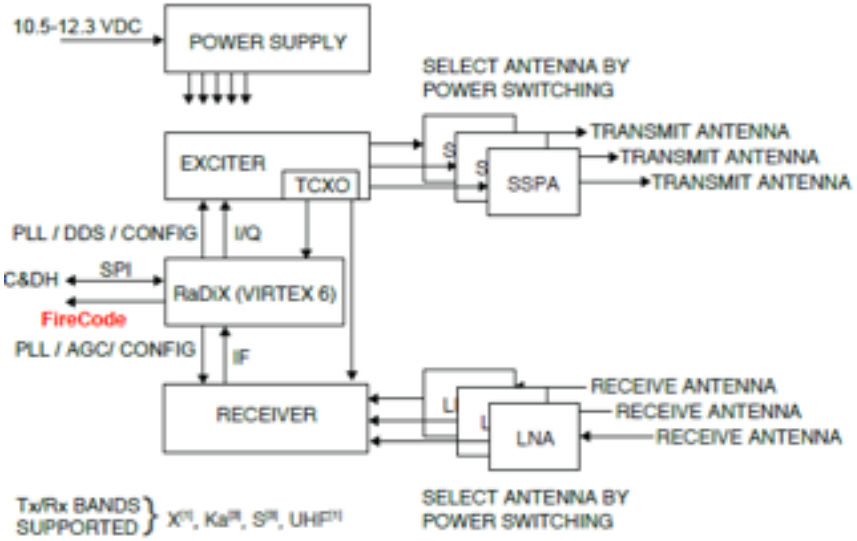
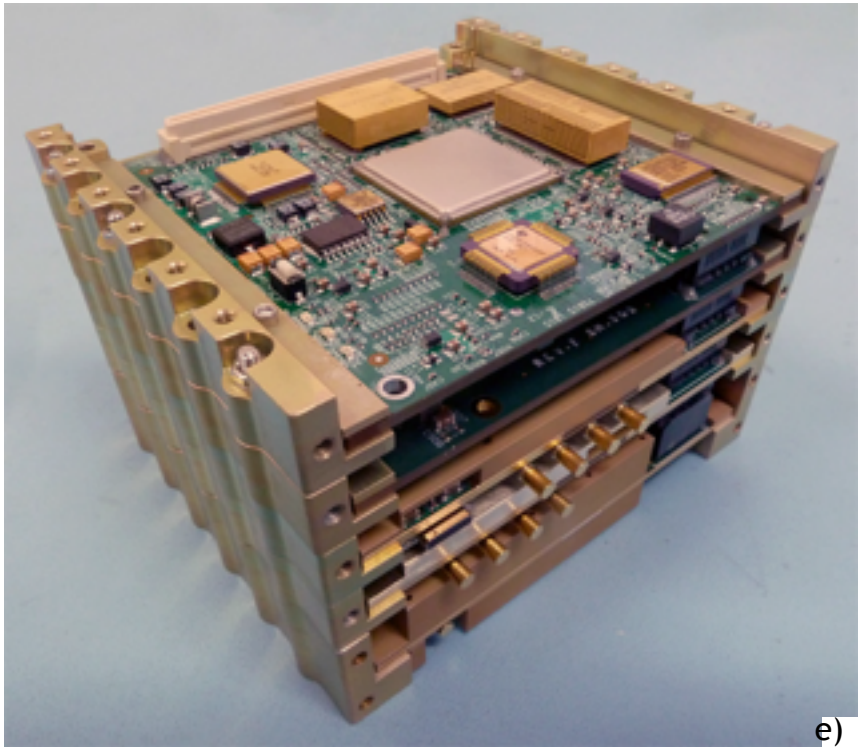


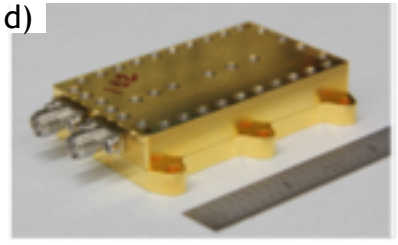




e)

c)

d)

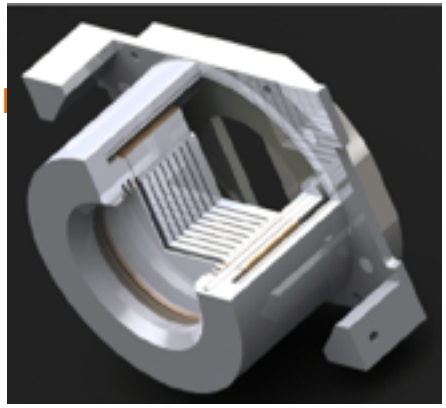


Science Instruments

JPL VHM
Vector Helium Magnetometer

The CuSP VHM is based on the instrument developed for the INSPIRE CubeSat mission, which was developed in under JPL IR&D funding, in collaboration with UCLA. With a sensor mass of 95g, and electronics mass of 250g, it is more than an order of magnitude lighter than previous designs.

Magnetic Fields



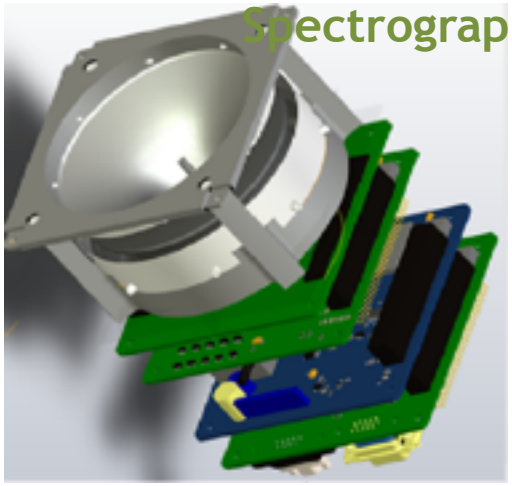
GSFC MERiT
Miniature Electron pRoton Telescope

The MERiT sensor onboard CuSP is a minor modification of the MERiT sensor which will fly on the CeREs CubeSat prior to CuSP. MERiT is currently being assembled in the Energetic Particle Laboratory at NASA/GSFC

~2GeV to 170Gev Ions
100keV to 4MeV electrons

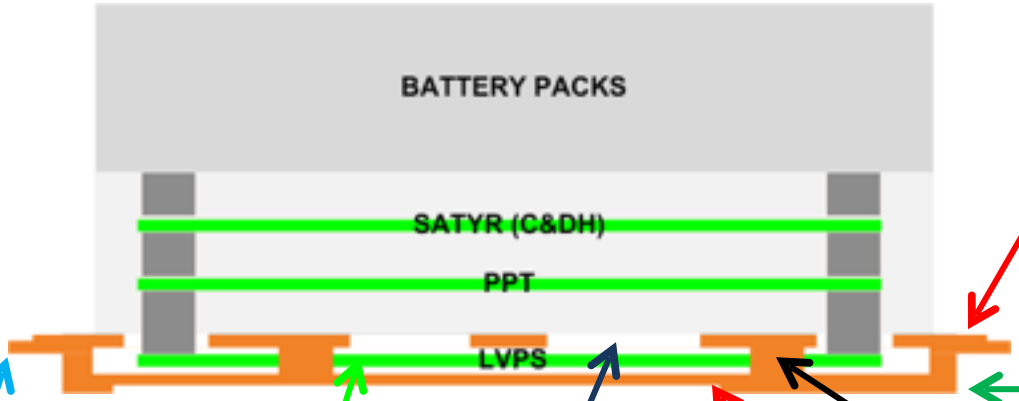
SIS utilizes a novel electrostatic analyzer (ESA) that provides the spectral and angular distributions to measure key signatures of ST ion populations present in the IP medium near Earth orbit, including ST ions from solar and IP activity.

SwRI SIS
Suprathermal Ion Spectrograph



~3keV to 70keV Ions

Baseplate/Backplane



Aluminum Spacecraft Deck
13mm plate machined out to house the backplane PCB

3mm cover to facilitate assembly

Deployment Rails (both sides)

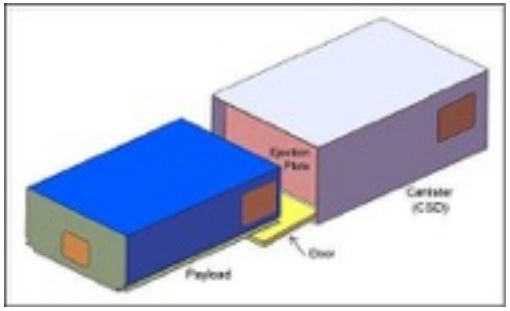
Openings for tall components and electrical interfaces

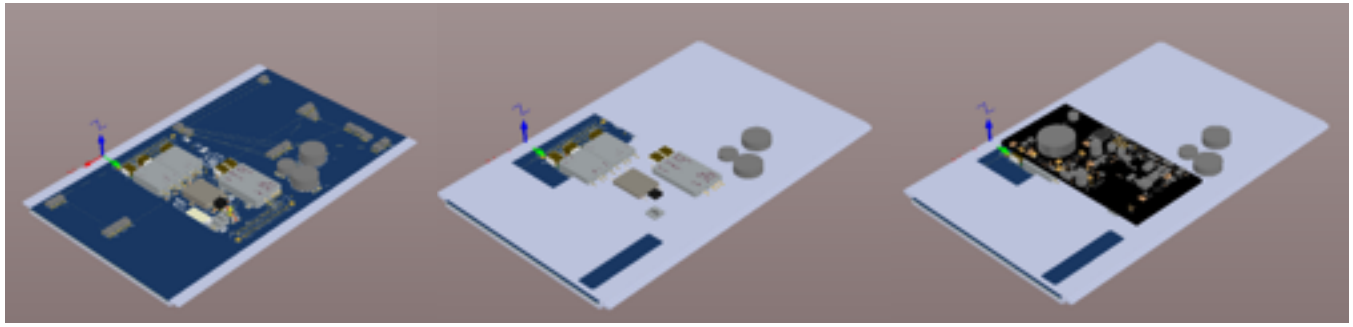
PCB Backplane w/integrated LVPS
Doubles as spacecraft harnessing

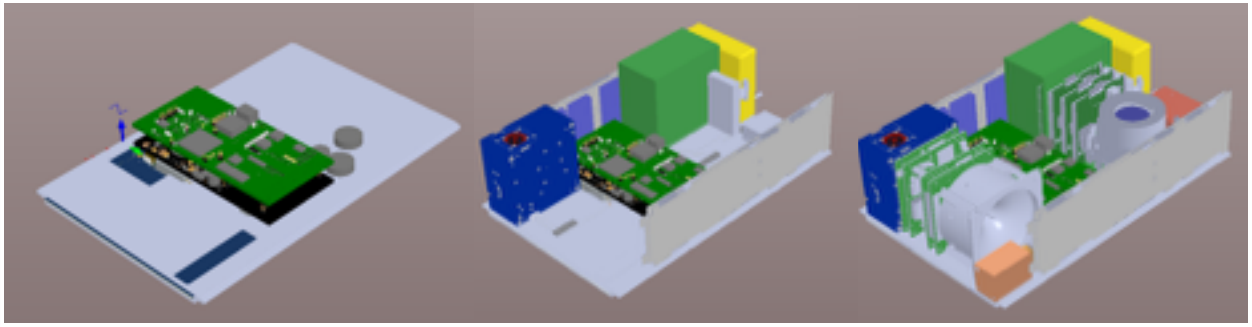
2mm Inset for deployable Antenna/Mag Boom

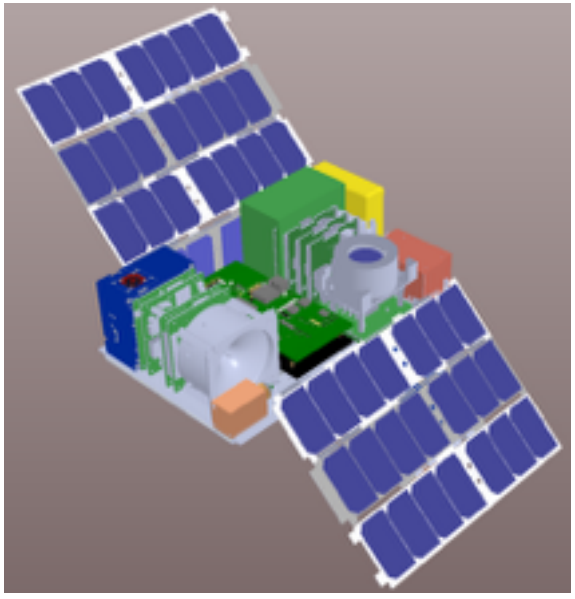
Thermal conduction paths to back face radiator

Integration Buildup









Thank You