

my_EPP



External Payload Platform

New mission opportunities for small size hosted payloads

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Why being outside ISS?



Controlled environment

Commanding of payload from your desk

Microgravity

Radiation environment of low Earth orbit

Vacuum environment

Thermal environment

View on Earth

View to the stars

External Payload Platform on JEM-EF

External Platform

Up to 9 4U cubesat size payloads outside the ISS

Standard mission duration 15 weeks

Excellent viewing conditions for Earth observation

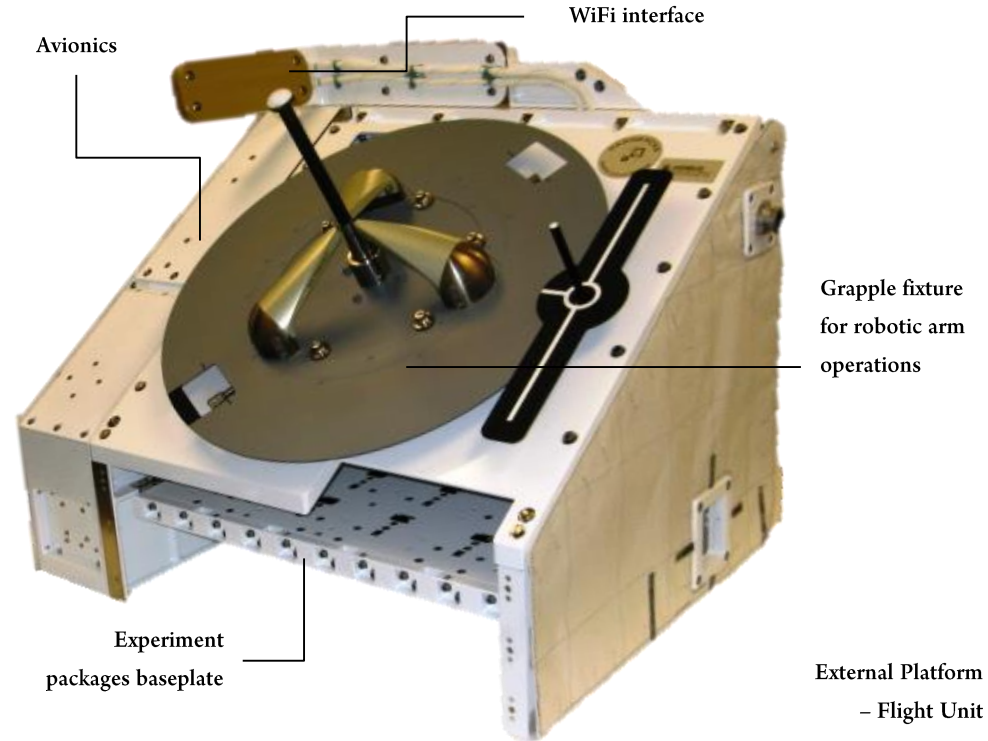
Full end-to-end mission service

External Platform System Design

Standard payload provisions

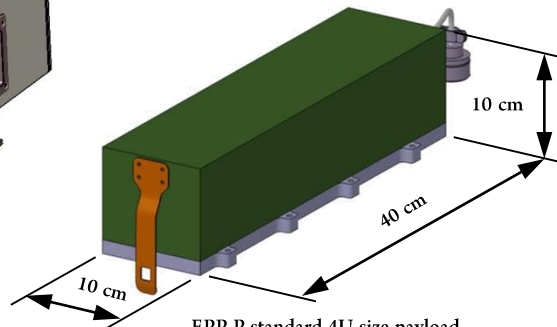
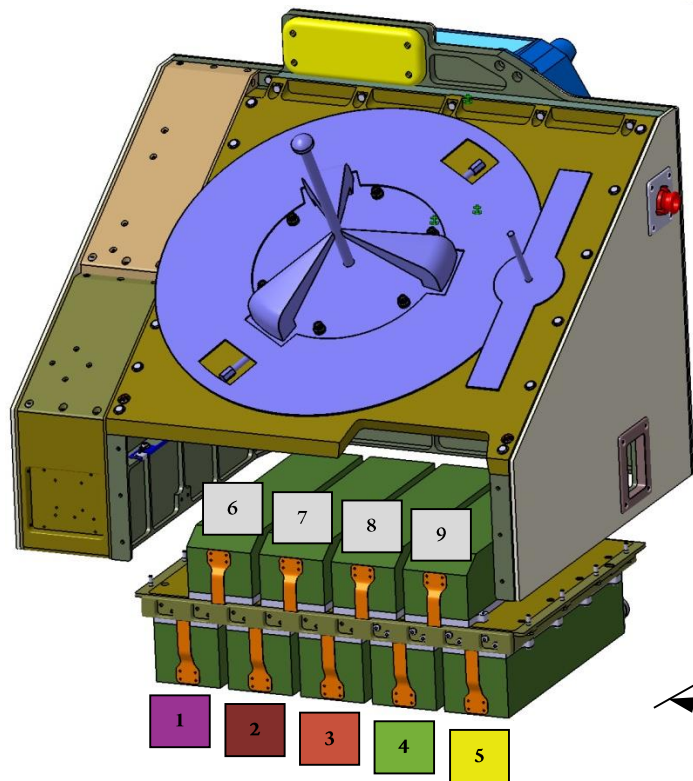
Voltage	28 Vdc \pm 2 V or 120 Vdc as option
Total power	30 W at 28 Vdc
Maximum current	2 A
USB 2.0 bus	5 Vdc / 500 mA, non- switchable
Total payload data rate	up to 8 Mbit/s

- EP provides all functions of the conventional spacecraft bus
- Ideal platform for small size hosted payloads
- No further subsystems necessary
- Improved anomaly resolution by human in the loop

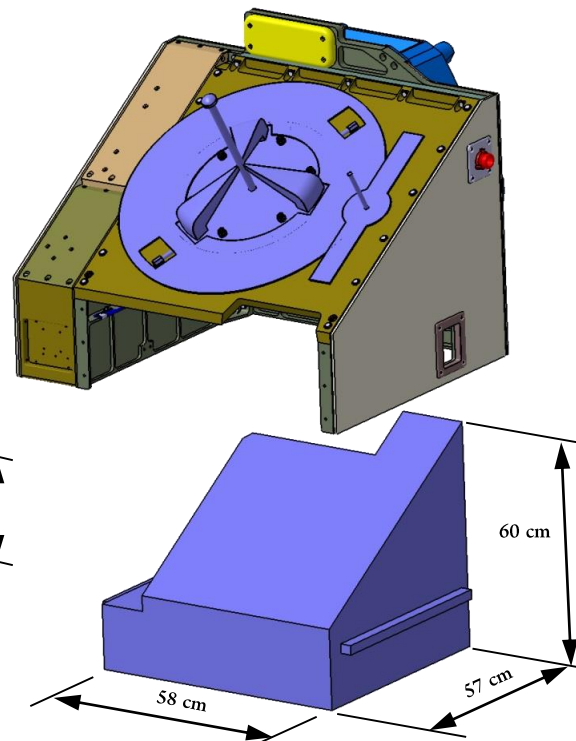


External Platform
– Flight Unit

External Platform Payload Configurations



EPP-P standard 4U size payload package



Unique payload configuration

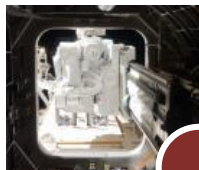
External Platform End-to-end Service



Payload mission



Installation



Transfer outside

Launch



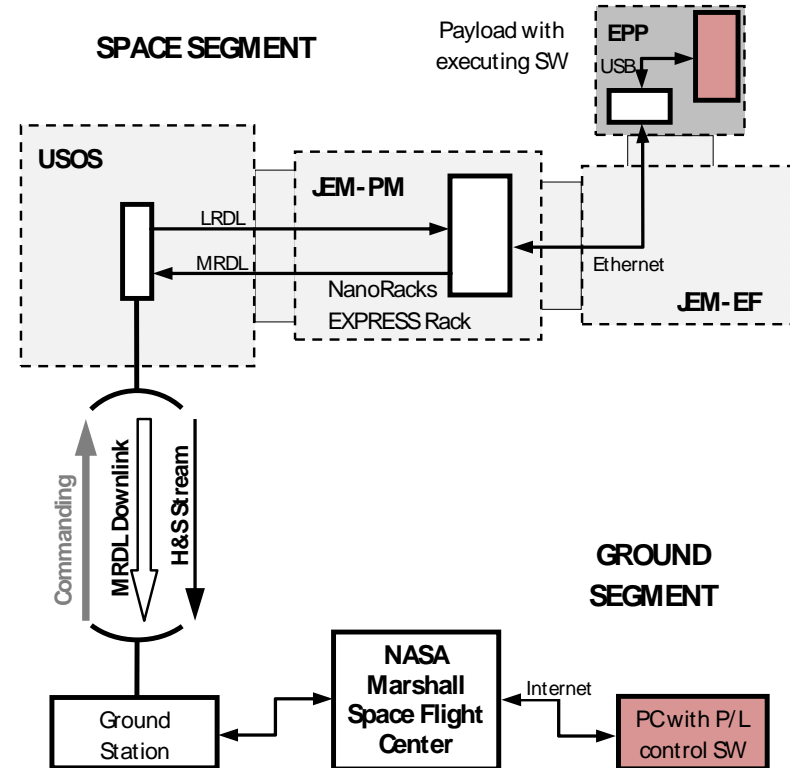
Payload Return

1 year

4+ months

External Platform End-to-end Service

- End-to-end communication with your payload covered by the EP Service
 - Console on your own desk
 - Near-real time data link available
- On-board data management by EP-DMS
 - Data storage in NanoRacks' EXPRESS rack in JEM-PM
 - Handling of downlink data by ISS data management system
- Complete ground segment provided by ISS
 - Communication front end MSFC



EPP-based In-orbit Testing & Demonstration

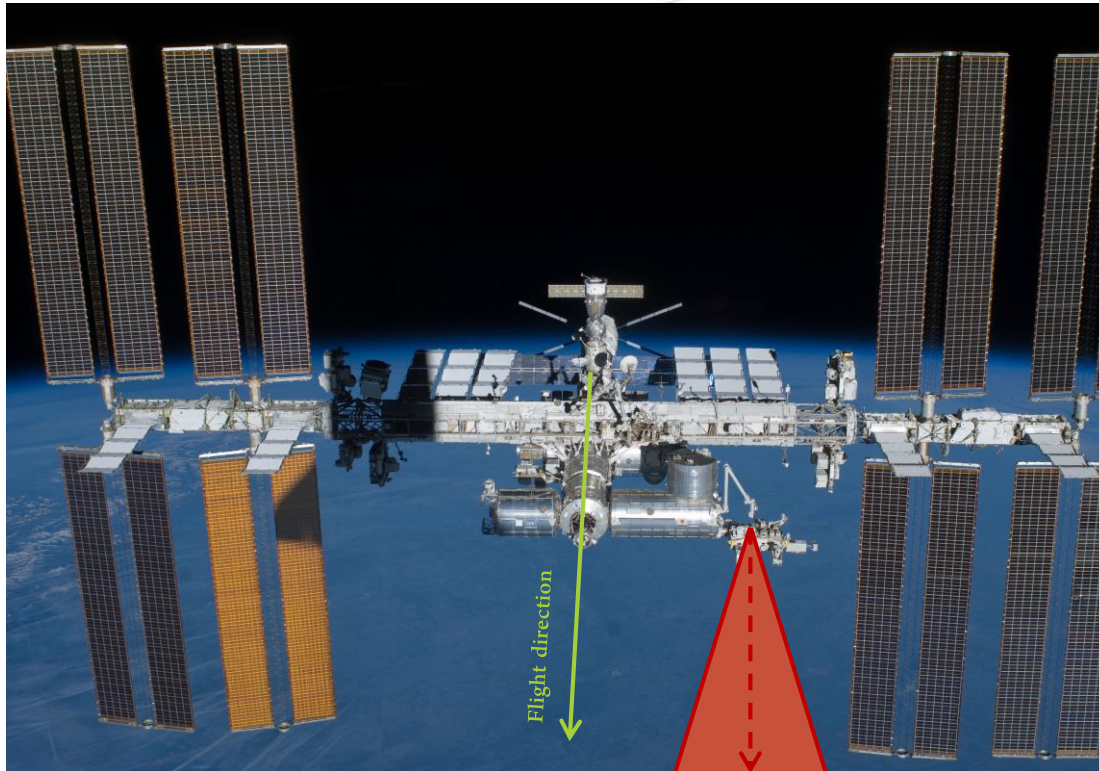


Technology Demonstration	
TRL 1	Basic principle
TRL 2	Technology concept
TRL 3	Experimental proof of concept
TRL 4	Technology validated in lab
TRL 5	Technology validated in relevant environment
TRL 6	Technology demonstrated in relevant environment
TRL 7	System prototype demo in operational environment
TRL 8	System complete and qualified
TRL 9	System in operational environment

- Accelerated improvement of available technologies, system concepts and abilities
- Reduction of the time to market of space-related products
- Cost-optimization of mission scenarios
- Fast demonstrations of mission scenarios



EPP-based Remote Sensing



ISS attitude-related parameters

Nominal attitude	Z Nadir (Only 6 hours per year in other z-orientation)
Operational attitude	Roll, Yaw ± 15 deg Pitch +10 to -20 deg
Attitude accuracy	± 3.5 deg per axis
Attitude estimation	0.5 deg per axis (3 sigma)
Attitude stability	0.01 deg/s per axis (3 sigma)

EPP-based Remote Sensing



Earth visibility

ISS passes over 85% of the surface and 95% of the world's populated landmass every 1 to 3 days.

ISS Nadir range

Latitude = -51.65°

ISS orbit-related parameters

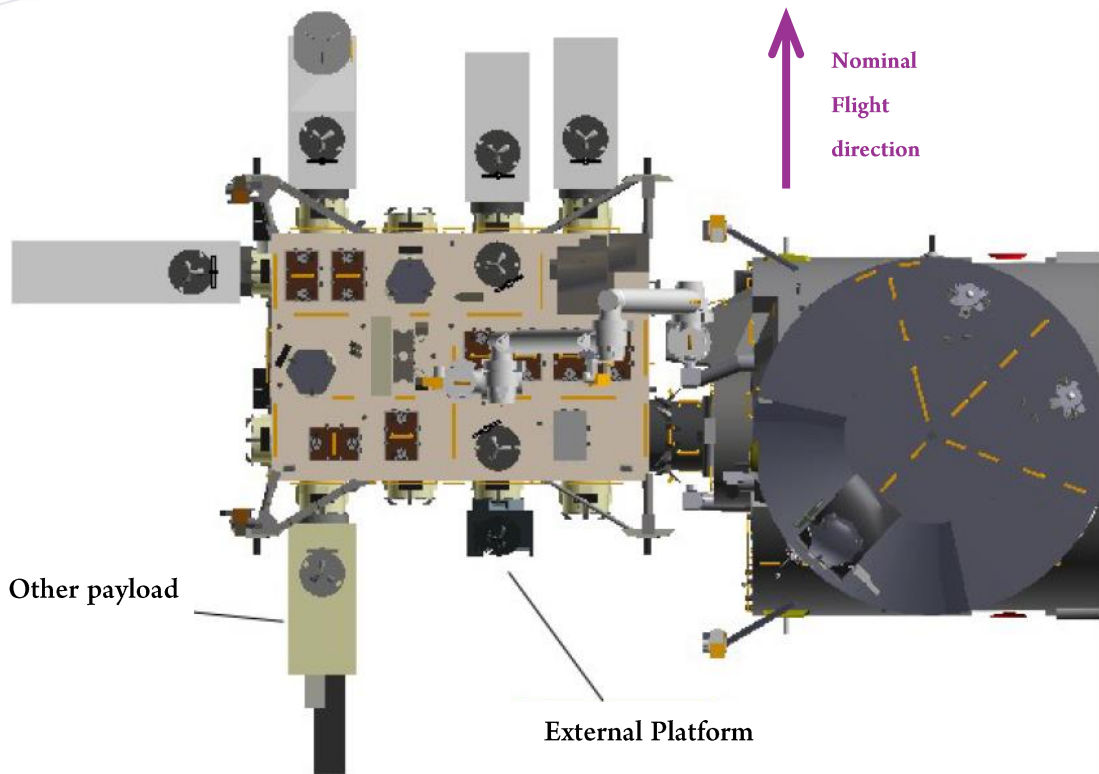
Orbital inclination	51.65 deg
Perigee / apogee altitude	413 km / 417 km
Orbital period	92.89 minutes
Beta angle variation	-75 to +75 deg
Orbit position error	6 m
Semi-major axis error	20 m
Revisit frequency	1 - 3 days depending on latitude

External Platform Field of View



Japanese Exposed Facility (JEM-EF) in currently manifested payload configuration.

[National Aeronautics and Space Administration, JEM EFU Site 4 NanoRacks FOV View, Manipulator Analysis Graphics and Interactive Kinematics (MAGIK) Team, AI 2610, 2012]

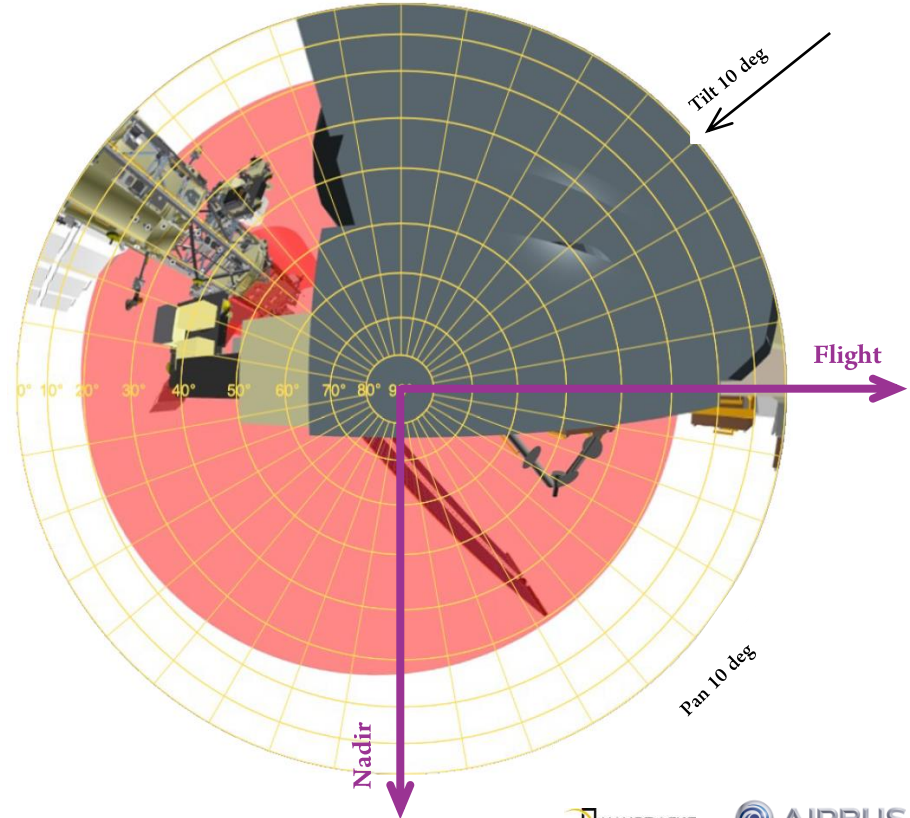


External Platform Field of View



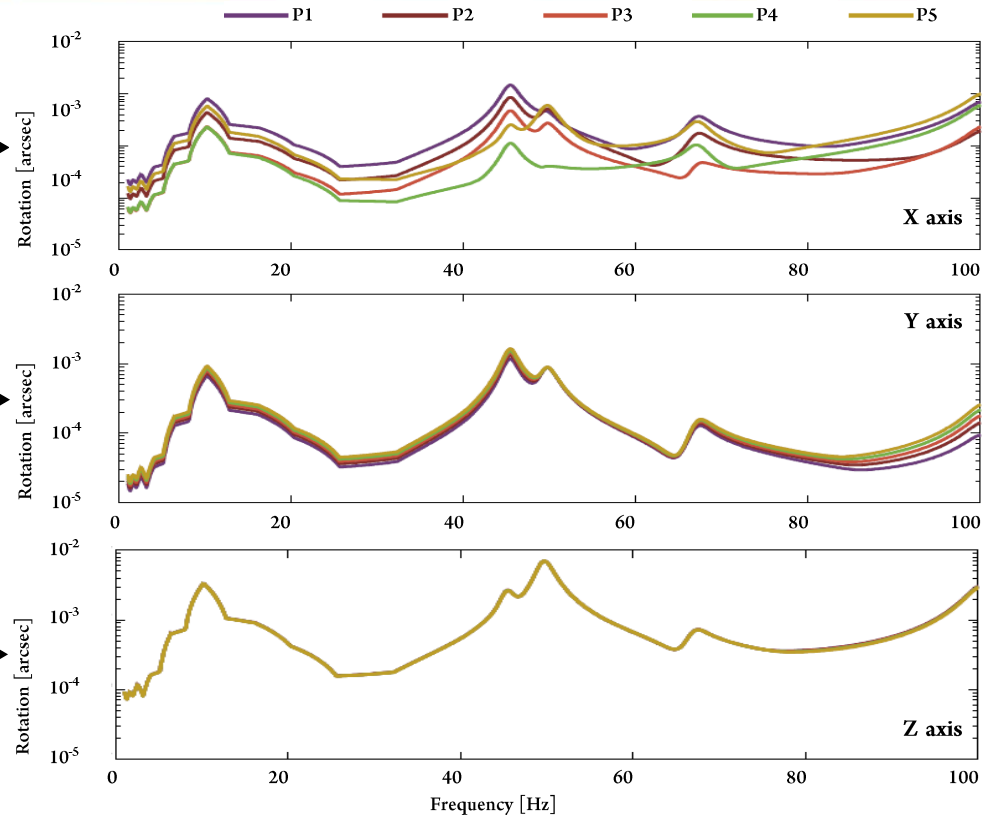
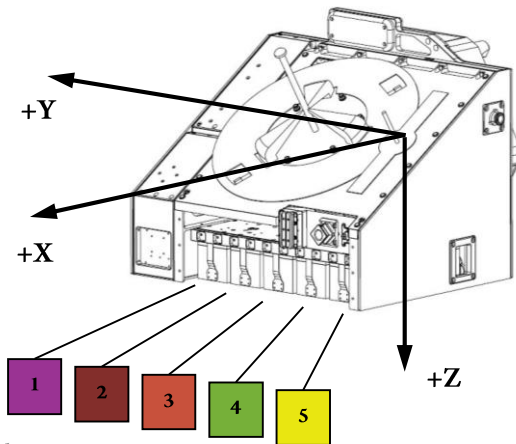
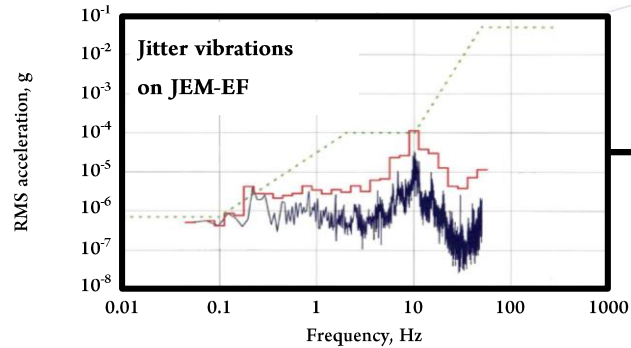
Fisheye Field of View at JEM-EF site 4 towards ISS port side with other payload on JEM-EF Site 8.

[National Aeronautics and Space Administration, JEM EFU Site 4 NanoRacks FOV View, Manipulator Analysis Graphics and Interactive Kinematics (MAGIK) Team, AI 2610, 2012]



External Platform Payload Attitude Stability

Payload rotational responses



Conclusion and outlook



Type of mission	External Platform Opportunity
Remote Sensing	<ul style="list-style-type: none">▪ Nadir view with 40 deg swath▪ Unconstrained view from wake to ram direction▪ Maximum contaminant deposition $1 \times 10^{-14} \text{ g cm}^{-2} \text{ s}^{-1}$
Use of microgravity	Quality up to 10^{-6} g on JEM-EF with single distortion effects
Use of vacuum	Vacuum quality approx. 10^{-5} Pa depending on ISS orbit altitude and solar activity
Meteoroids, space debris monitoring	JEM-EF site no.6 can be made available for ISS ram view
Antenna testing and RF utilization	<ul style="list-style-type: none">▪ Frequency coordination with ISS▪ ITU license necessary
Propulsive element testing	<ul style="list-style-type: none">▪ Pressure vessel use not restricted▪ No toxic propellants

- Flight hardware is ready for hand-over from Airbus DS to NanoRacks
- EPP manifested for upload with HTV-5 in August 2015
- First payload mission preparations have started
- Airbus DS will provide a Flight Environment Verification for permanent installation on the EPP, data will be made available
 - Acceleration in 3 axes
 - Temperature
 - Radiation

➤ **EPP will be ready for service soon!**

What our launching customers do ...



Customer	Payload	Mission scope
Yosemite Space	Gumstix™	<ul style="list-style-type: none">Principal investigator Kathleen Morse, Ph.D.Space-based radiation studies to investigate the feasibility of the Gumstix Computer On Module (COM) technology for use in non-critical computationally intensive space applications
Florida Institute of Technology	Development and Deployment of Charge Injection Device (CID) Sensors for Space-Based Extreme Contrast Ratio Imaging	<ul style="list-style-type: none">Principal investigator Daniel Batchelder, Ph.D.Space-based test of an innovative and novel Charge Injection Device (CID) imager technology in the space environment
A-76 Technologies	Characterization of A-76 Corrosion Inhibitors in the Space Environment	<ul style="list-style-type: none">Characterize effectiveness of A-76 corrosion inhibitors and lubricants for metals in the space environment
Honeywell and Morehead State University, Space Sciences Center	TRL7 Validation of Dependable Multiprocessor (DM) Technology	<ul style="list-style-type: none">Principal investigators John Sampson, Ph.D., Benjamin Malphrus, Ph.D.Benchmark performance and radiation-induced computational errors of DM Technology while conducting computationally intensive processing in the space environment
Arquimea Ingeniería, S.L.U. (Spain)	REsettable Hold-Down and Release ACTuator (REACT)	<ul style="list-style-type: none">EU Horizon 2020 funded project with multiple European project partners (Arquimea Ingeniería, S.L.U., EADS CASA Espacio, Surrey Satellite Technology Ltd., AVS, Universidad del País Vasco, ESR Technology Ltd., Spacetechn GmbH)In-orbit test of SMA-based actuators

Thank you for your attention!



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