my_EPP

External Payload Platform

A new Cubesat testbed and payload hosting platform on the International Space Station with reliable fast-track and low-cost mission scenario

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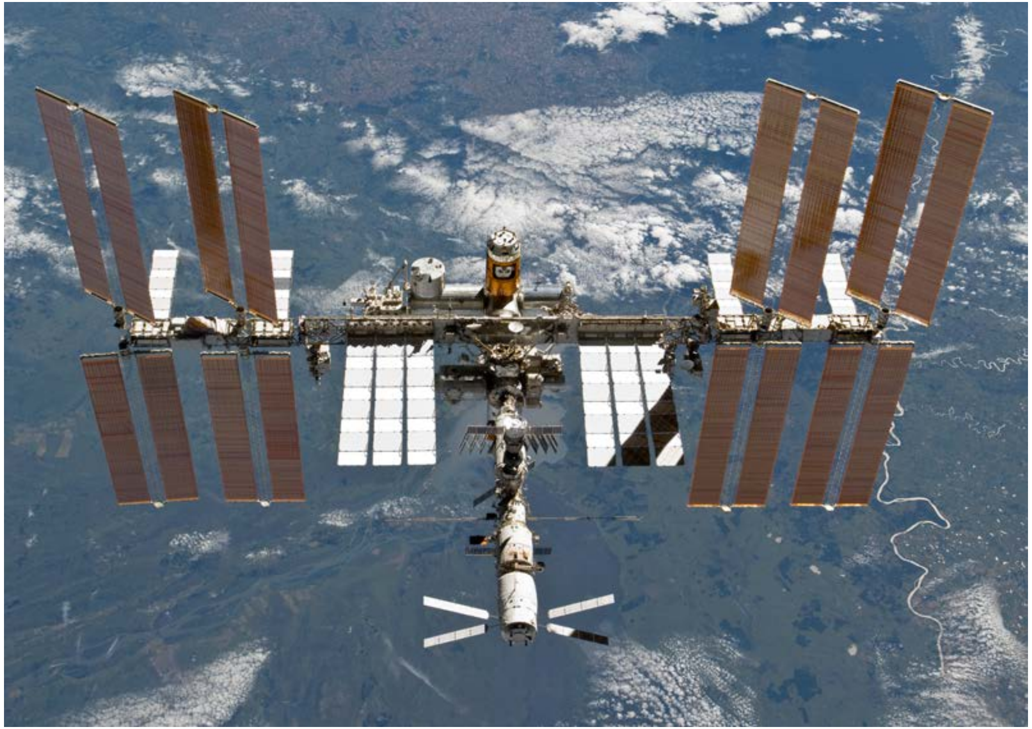
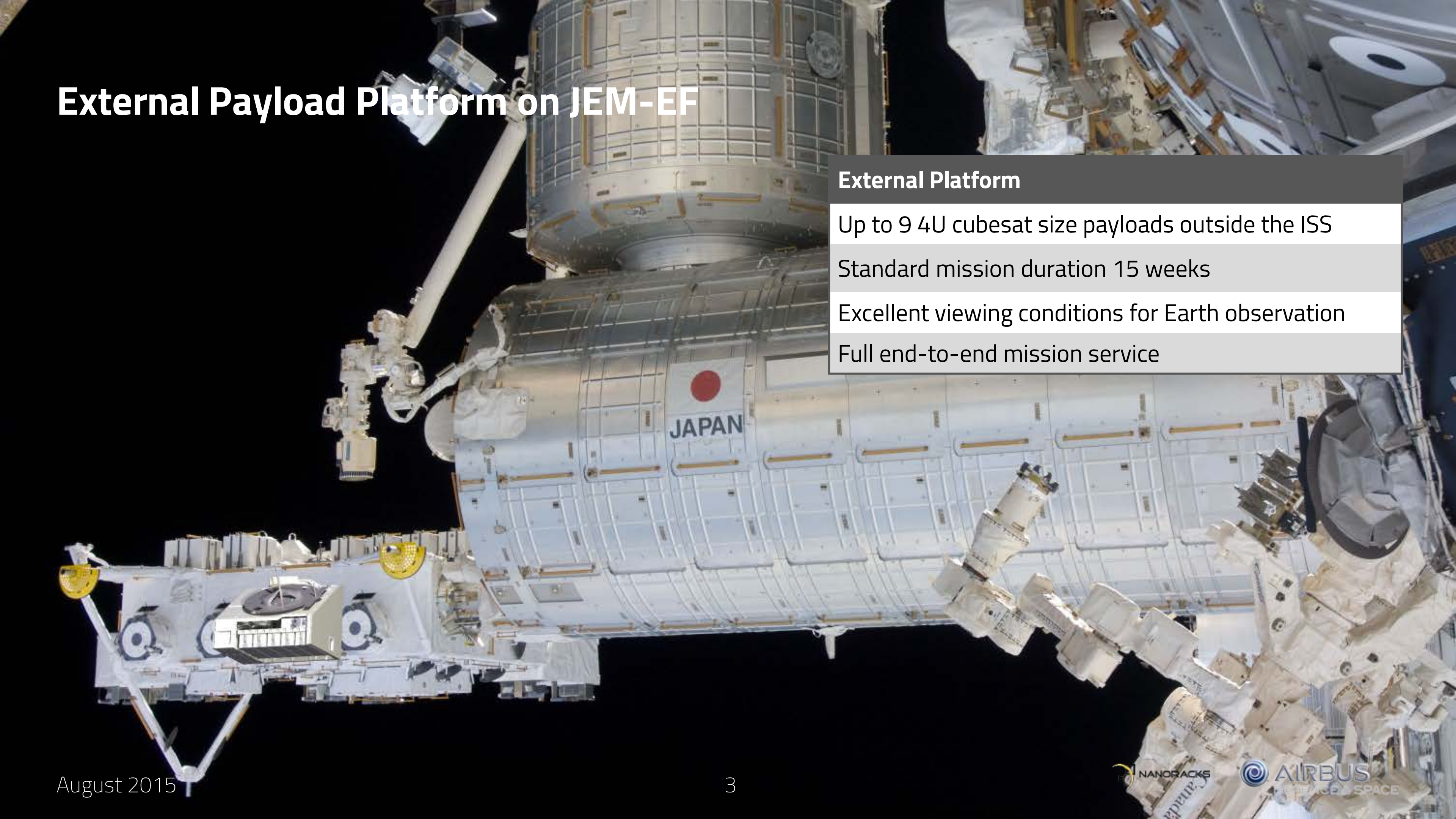
Why being outside ISS?



- 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



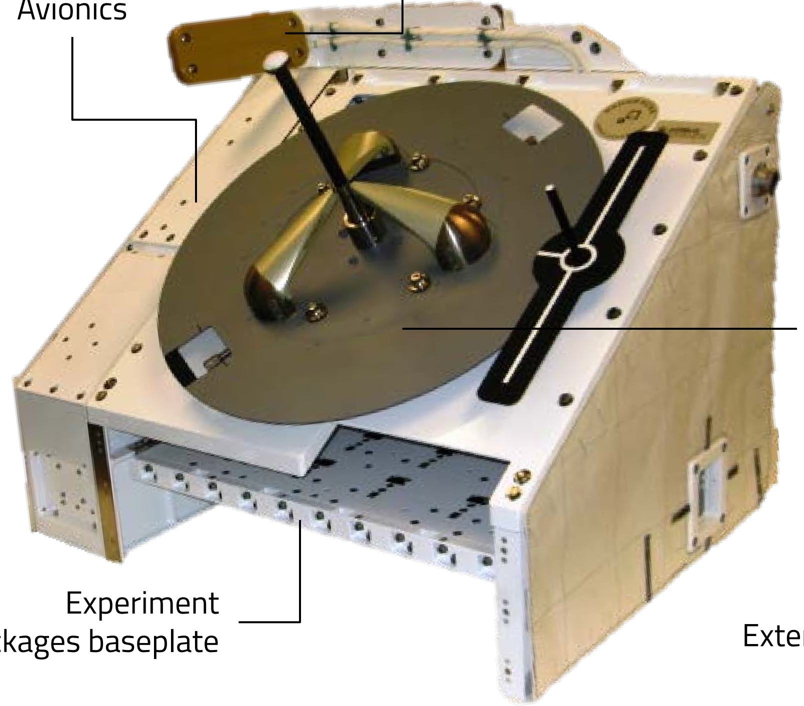
External Payload Platform on JEM-EF

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

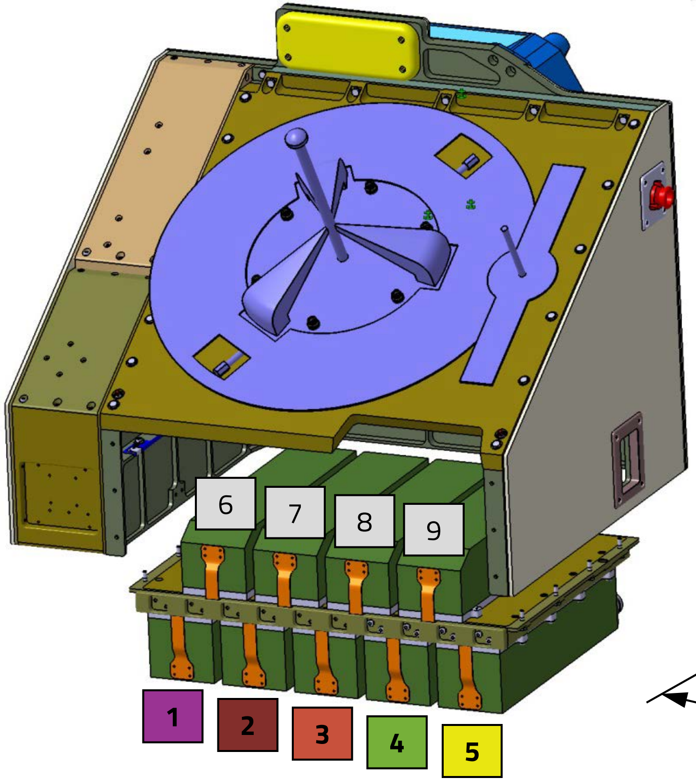
Standard payload provisions	
Voltage	28 Vdc ± 2 V or 120 Vdc as option
Total power	30 W at 28 Vdc
Maximum current	2 A
USB 2.0 bus	5 Vdc / 500 mA, non-switchable
Total payload data rate	up to 8 Mbit/s

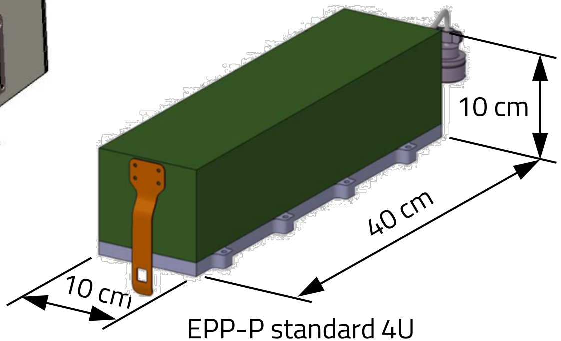
- EP provides all functions of the conventional spacecraft bus
- Ideal platform for small size hosted payloads
- No further subsystems necessary
- Improved anomaly resolution by human in the loop



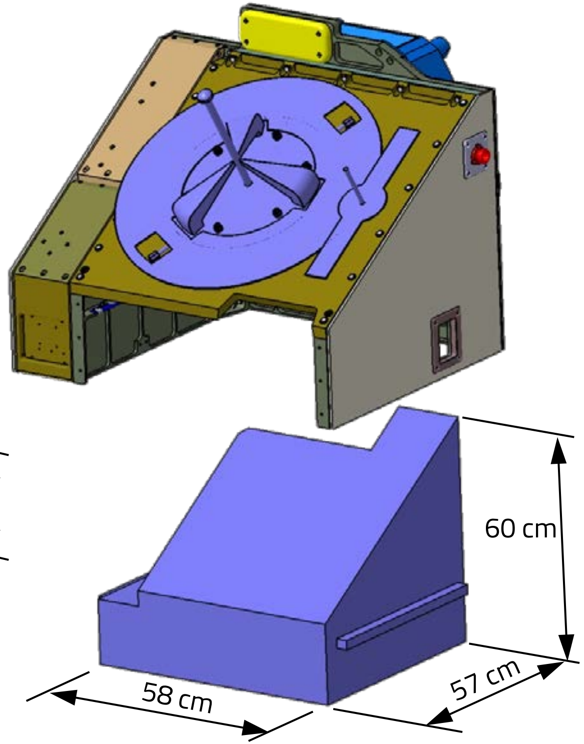
External Platform – Flight Unit

External Platform Payload Configurations





EPP-P standard 4U size payload package



Unique payload configuration

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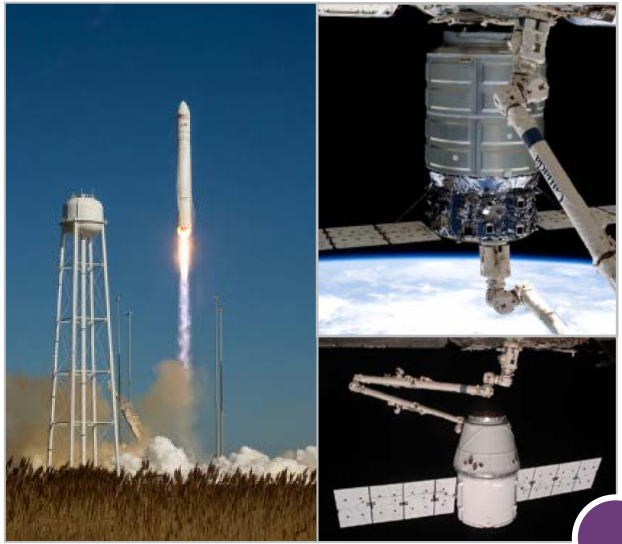
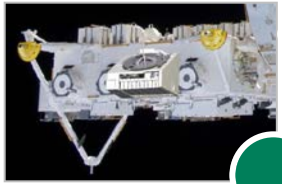
External Platform End-to-end Service





Payload mission

Installation

Transfer outside

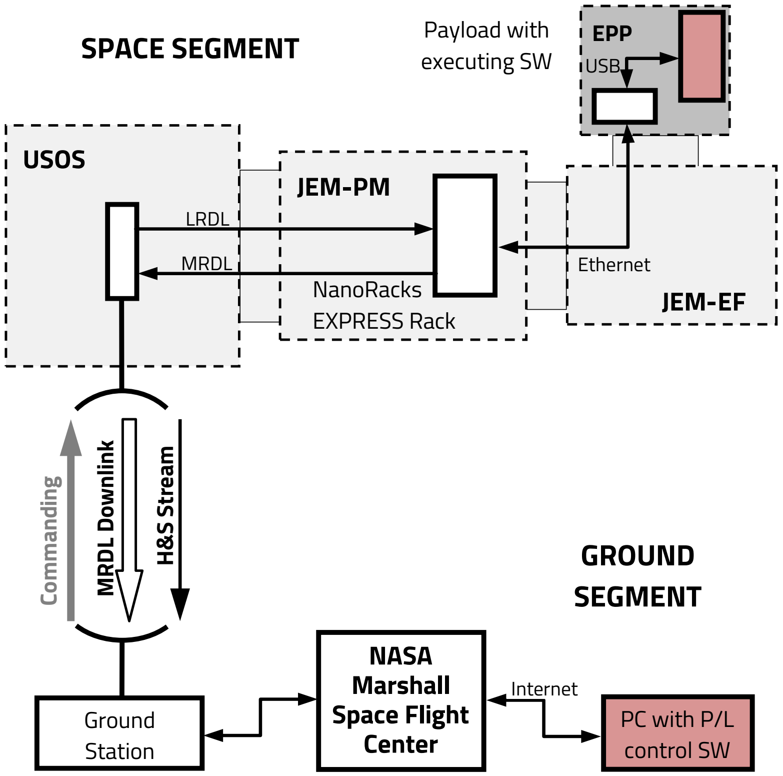
Launch

Payload Return

1 year → → → 4+ months

External Platform End-to-end Service

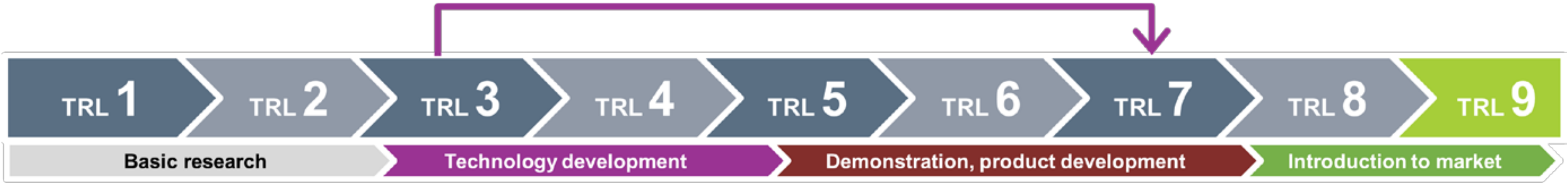
- End-to-end communication with your payload covered by the EP Service
  - Console on your own desk
  - Near-real time data link available
- On-board data management by EP-DMS
  - Data storage in NanoRacks' EXPRESS rack in JEM-PM
  - Handling of downlink data by ISS data management system
- Complete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



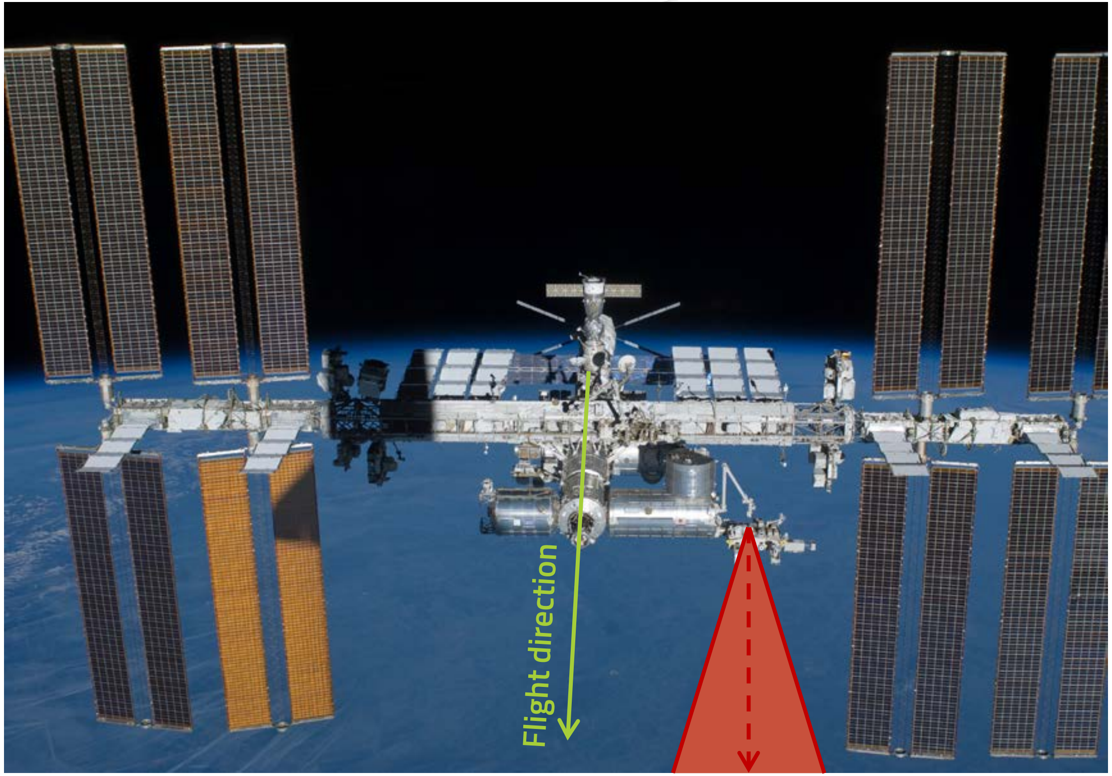
EPP-based In-orbit Testing & Demonstration

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
- Test your satellite components, sensing concept etc. at low risk and low cost



EPP-based Remote Sensing

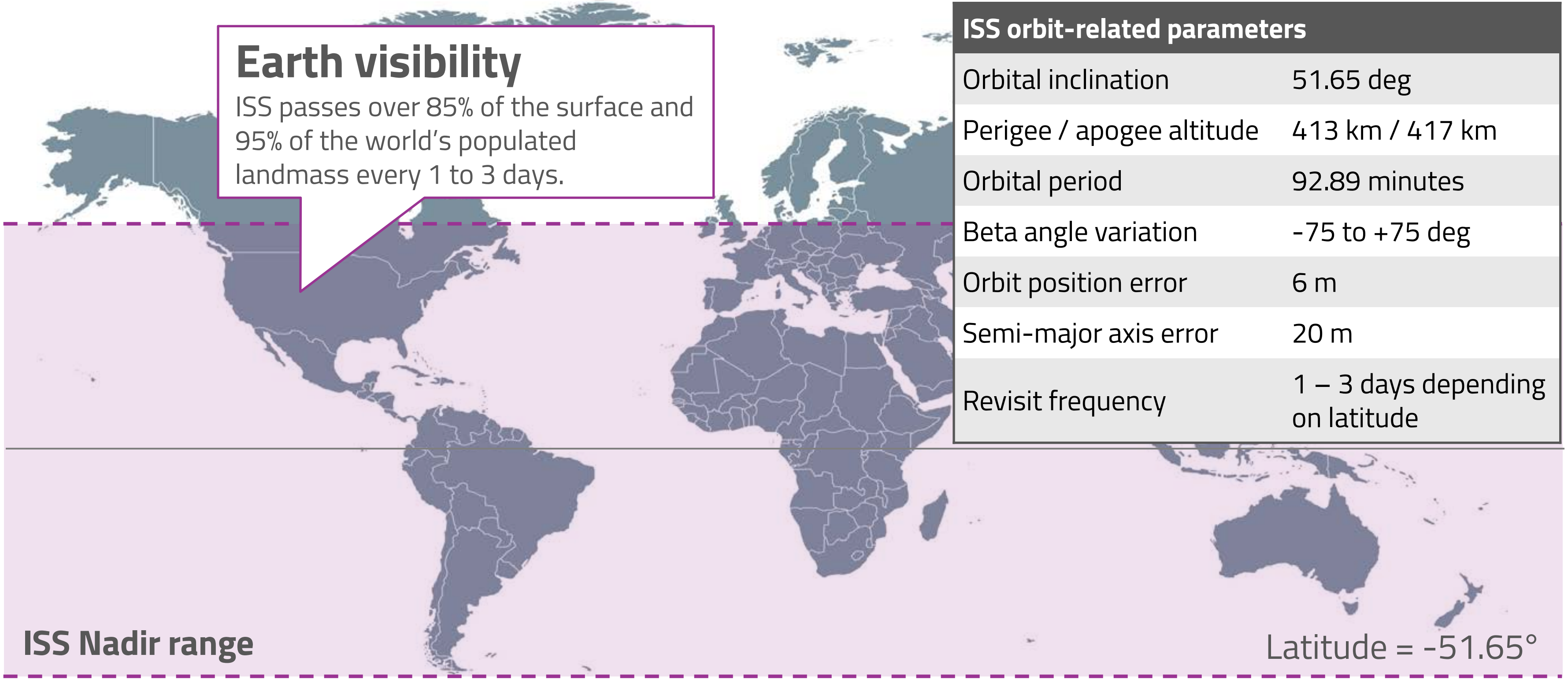


ISS attitude-related parameters	
Nominal attitude	Z Nadir (Only 6 hours per year in other z-orientation)
Operational attitude	Roll, Yaw ±15 deg Pitch +10 to -20 deg
Attitude accuracy	±3.5 deg per axis
Attitude estimation	0.5 deg per axis (3 sigma)
Attitude stability	0.01 deg/s per axis (3 sigma)

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.

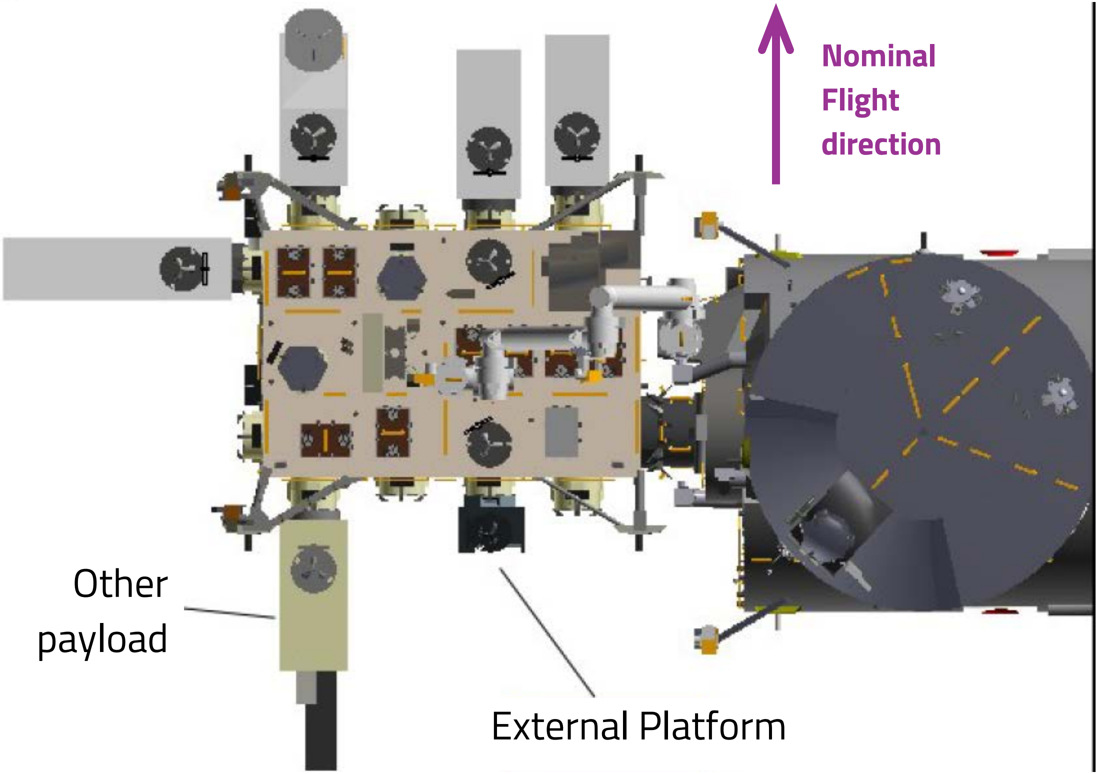


ISS orbit-related parameters	
Orbital inclination	51.65 deg
Perigee / apogee altitude	413 km / 417 km
Orbital period	92.89 minutes
Beta angle variation	-75 to +75 deg
Orbit position error	6 m
Semi-major axis error	20 m
Revisit frequency	1 – 3 days depending on latitude

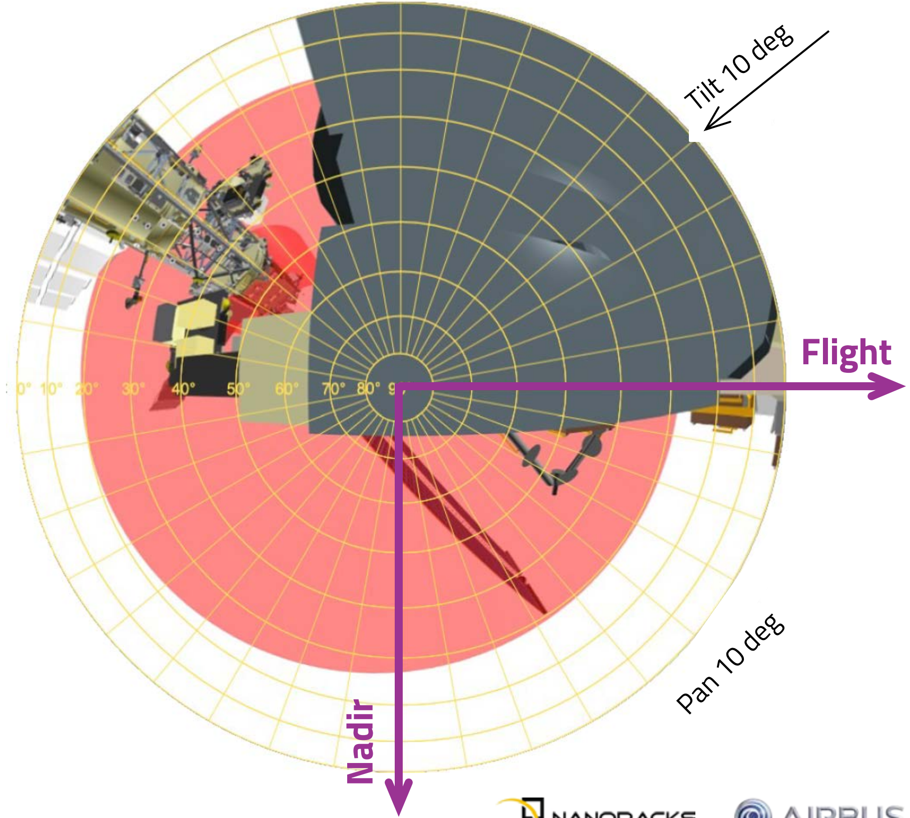
External Platform Field of View

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]



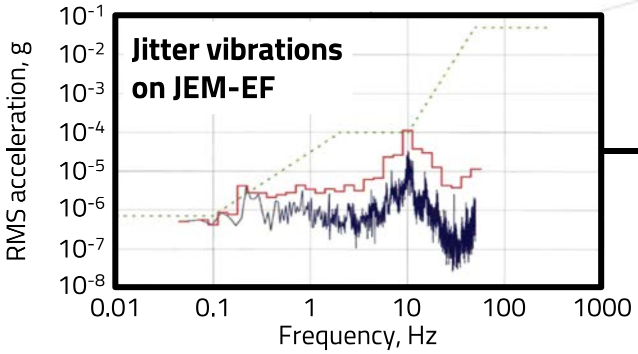
External Platform Field of View

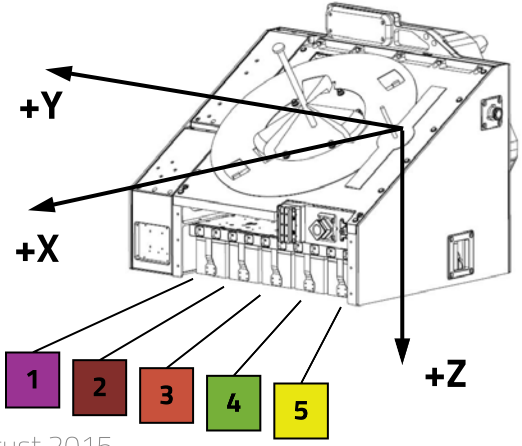


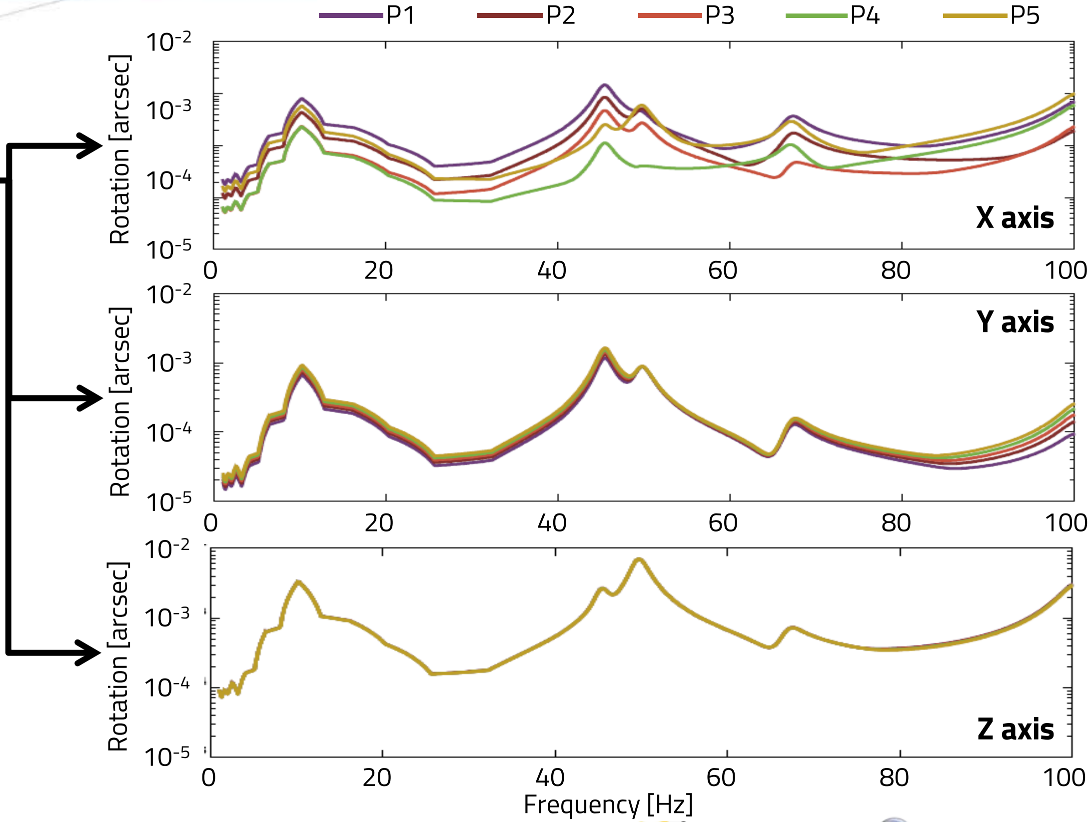
Fisheye Field of View at JEM-EF site 4 towards ISS port side with other payload on JEM-EF Site 8.

[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







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Conclusion and outlook

Type of mission	External Platform Opportunity
Remote Sensing	▪ Nadir view with 40 deg swath ▪ Unconstrained view from wake to ram direction ▪ Maximum contaminant deposition $1x10^{-14}$ g $cm^{-2}s^{-1}$
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	▪ Frequency coordination with ISS ▪ ITU license necessary
Propulsive element testing	▪ 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 very soon!

What our launching customers do ...

Customer	Payload	Mission scope
Yosemite Space	GumstixTM	▪ 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	▪ Principal investigator Daniel Batcheldor, 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	▪ 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	▪ 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)	▪ 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 Pais Vasco, ESR Technology Ltd., Spacetech GmbH) ▪ In-orbit test of SMA-based actuators

Thank you for your attention!

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