Bartolomeo

New External Payload Platform on the International Space Station
Technical Briefing Part 2
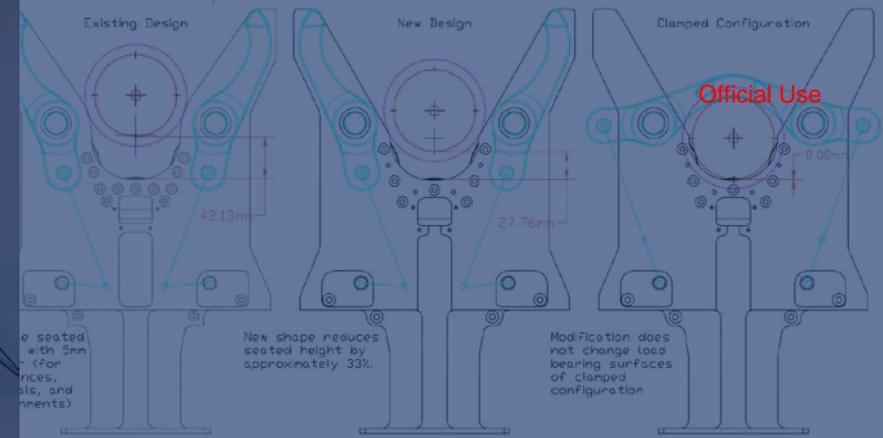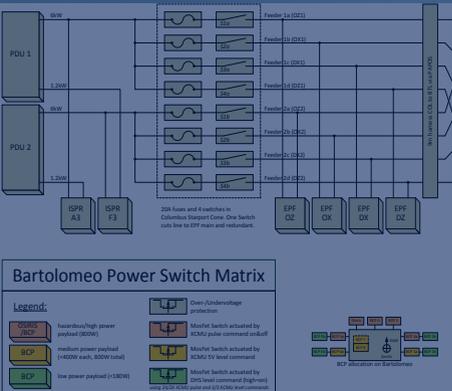
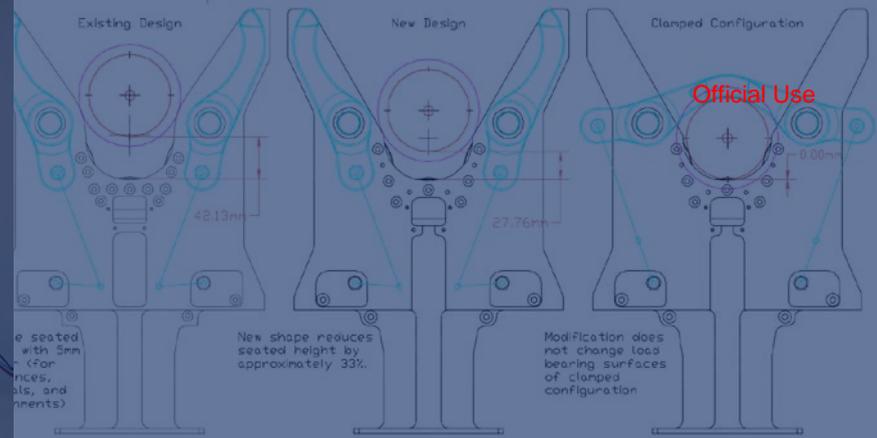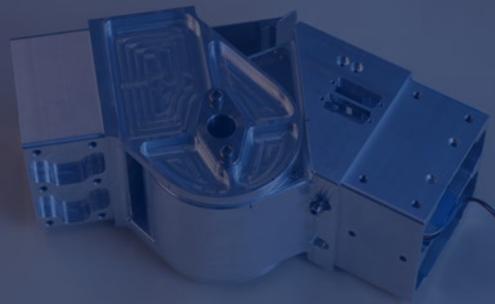DEFENCE AND SPACE

Dr. Christian Steimle
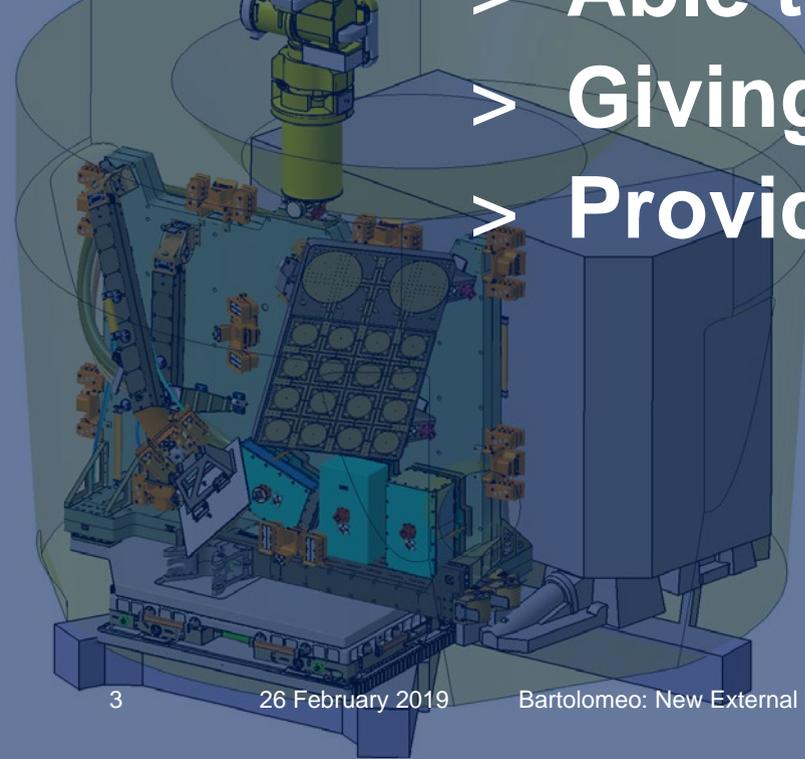26 February 2019

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Overview to Bartolomeo

> Concept of Operations
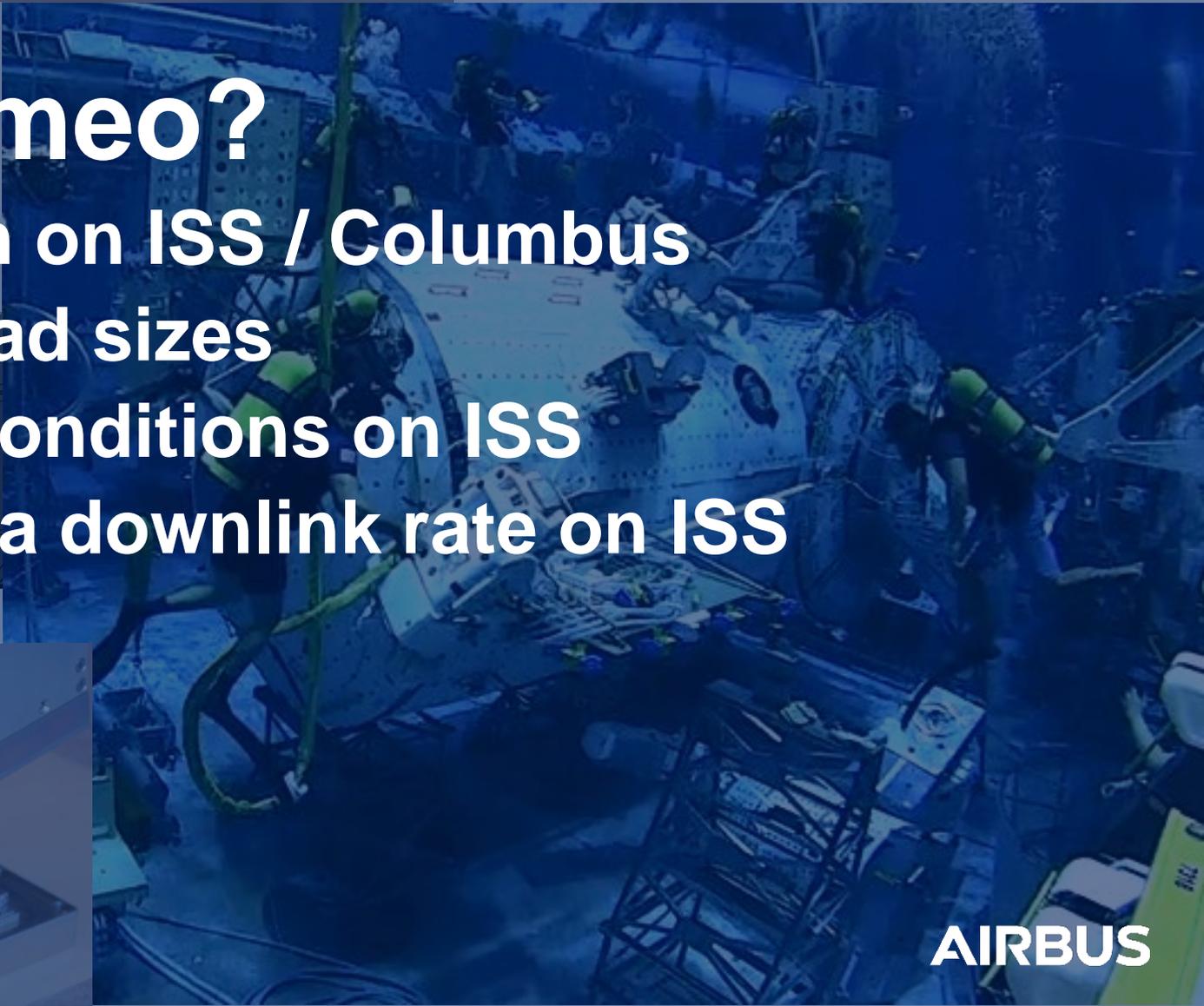
> Platform Design and Capabilities

> All-in-one Space Mission Service

> Capability offered within the UNOOSA cooperation

> Specific Payload Requirements

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Official Use

What is Bartolomeo?

> New external platform on ISS / Columbus
> Able to host all payload sizes
> Giving best viewing conditions on ISS
> Providing highest data downlink rate on ISS

Official Use

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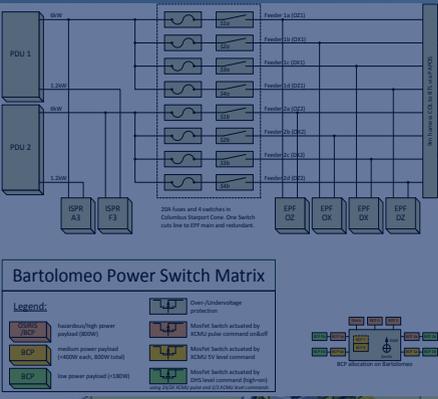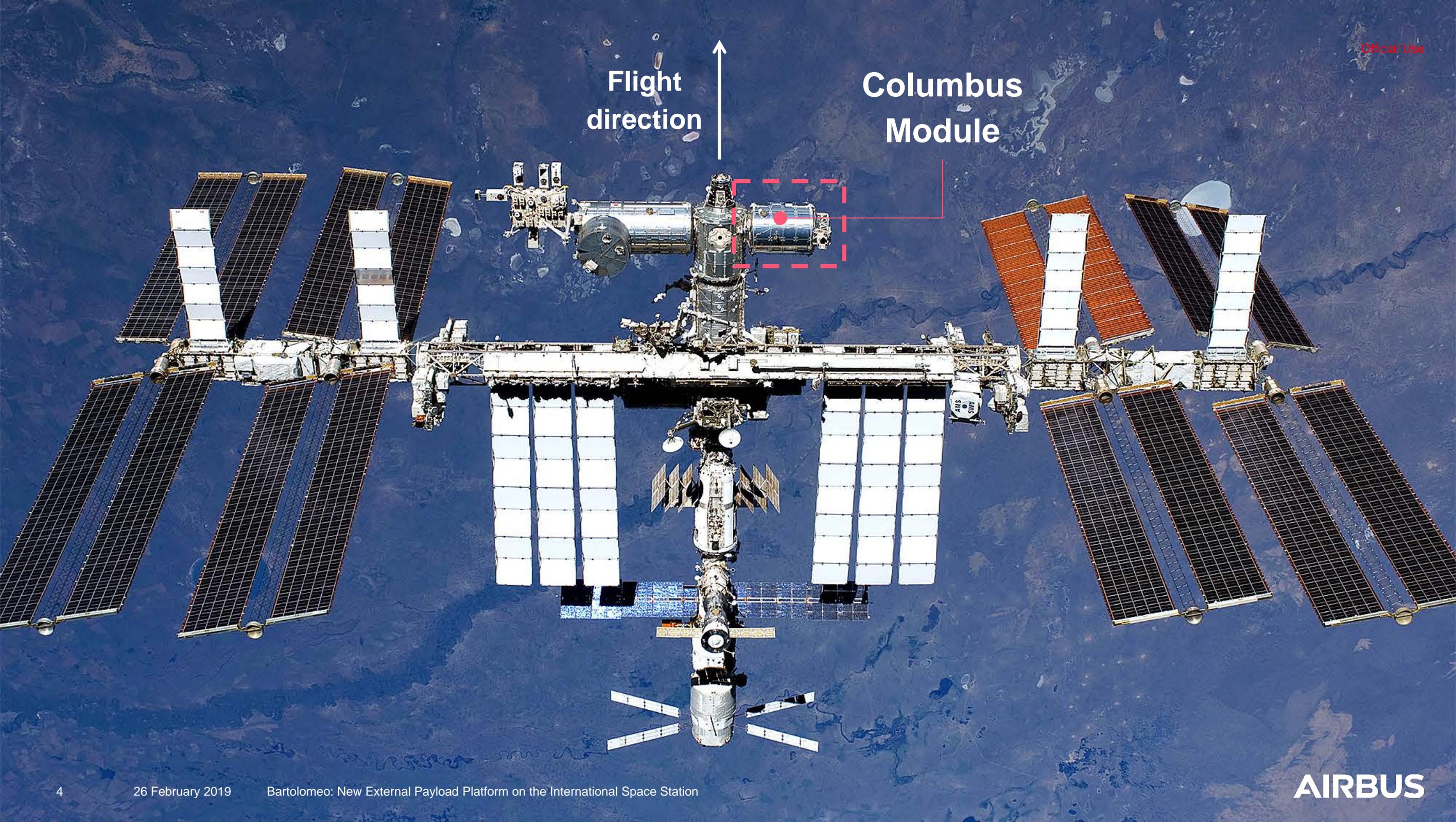
Flight direction

Columbus Module

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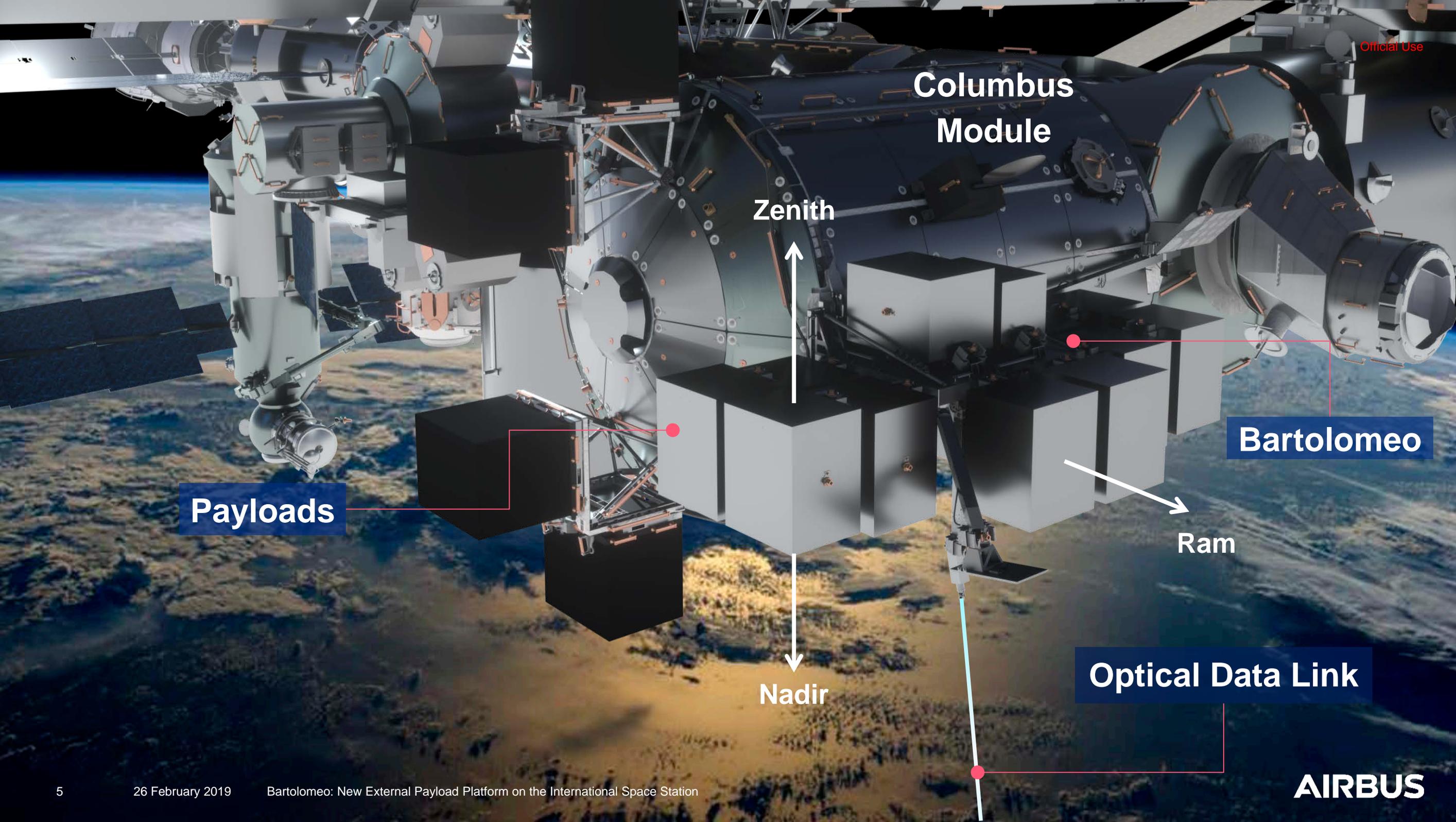
Columbus Module

Zenith

Bartolomeo

Payloads

Ram

Nadir

Optical Data Link

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Columbus Module

ArgUS Multi-Payload Adapter
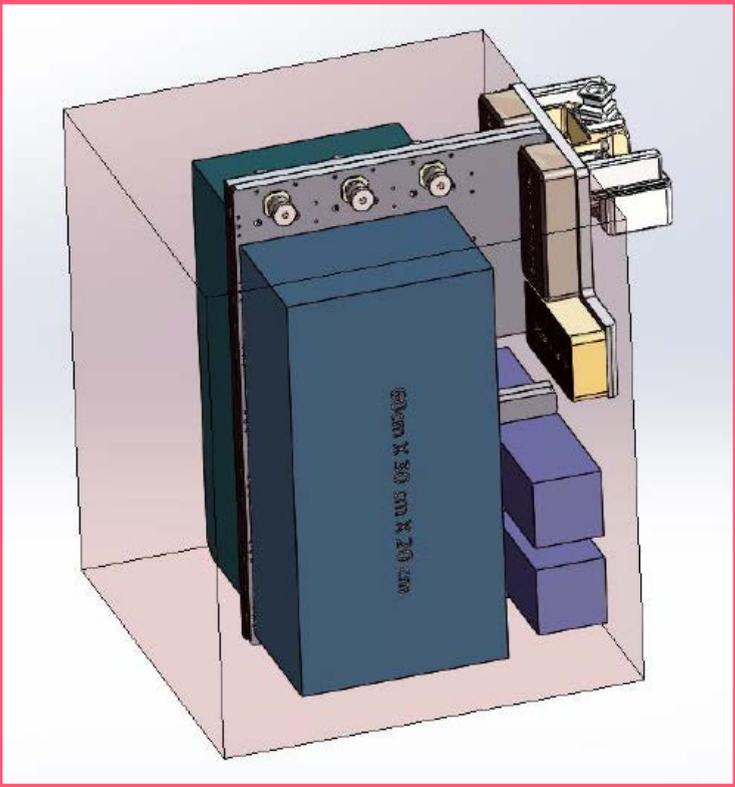
Zenith

Nadir

Bartolomeo

Ram

Optical Data Link

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Bartolomeo Concept of Operations

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Payload Launch
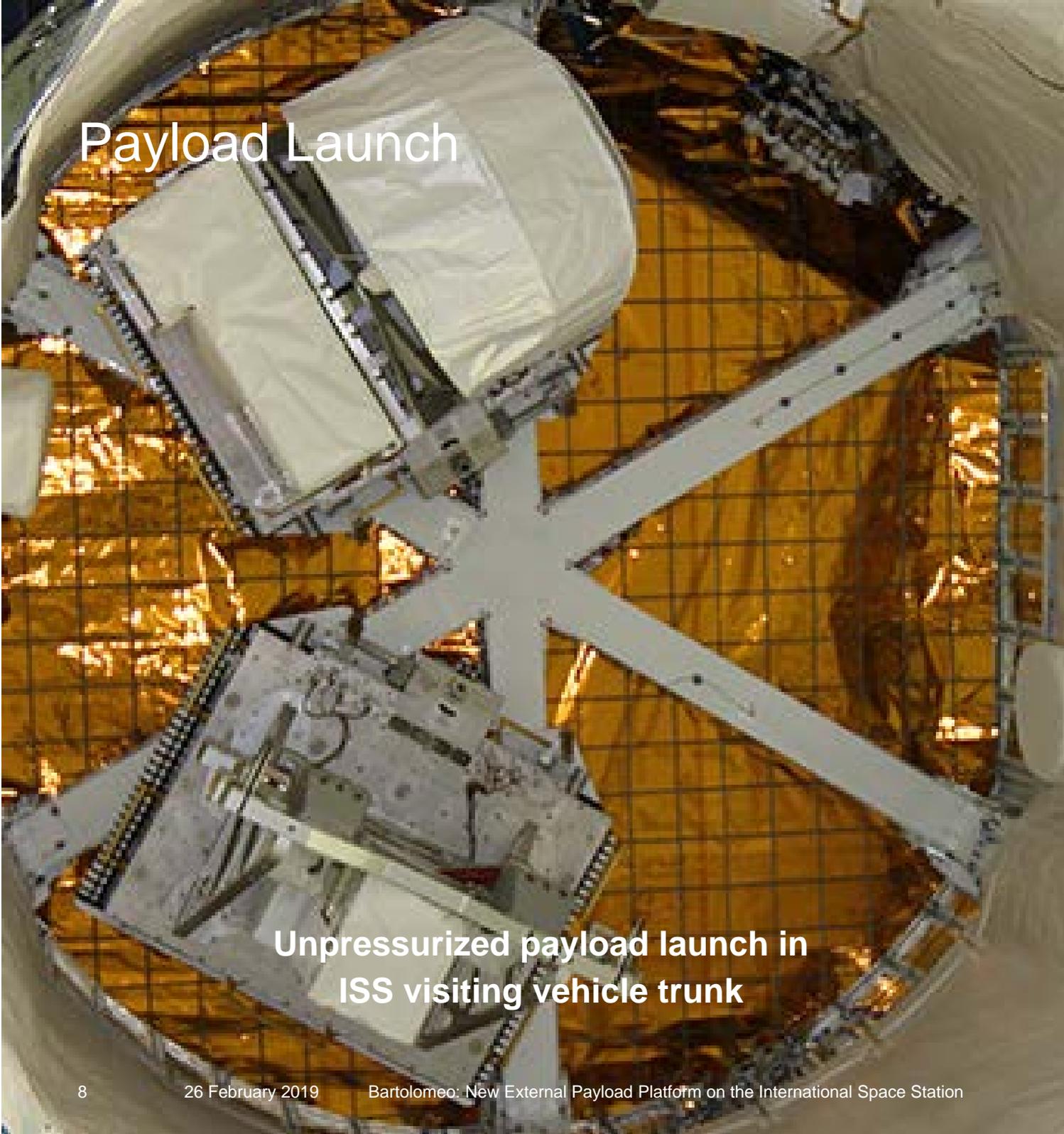
[Image credit: NASA]

**Unpressurized payload launch in
ISS visiting vehicle trunk**

**Pressurized payload launch in ISS
visiting vehicle pressurized compartment**

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Payload Installation

Payload installation by ISS Robotic Manipulation System
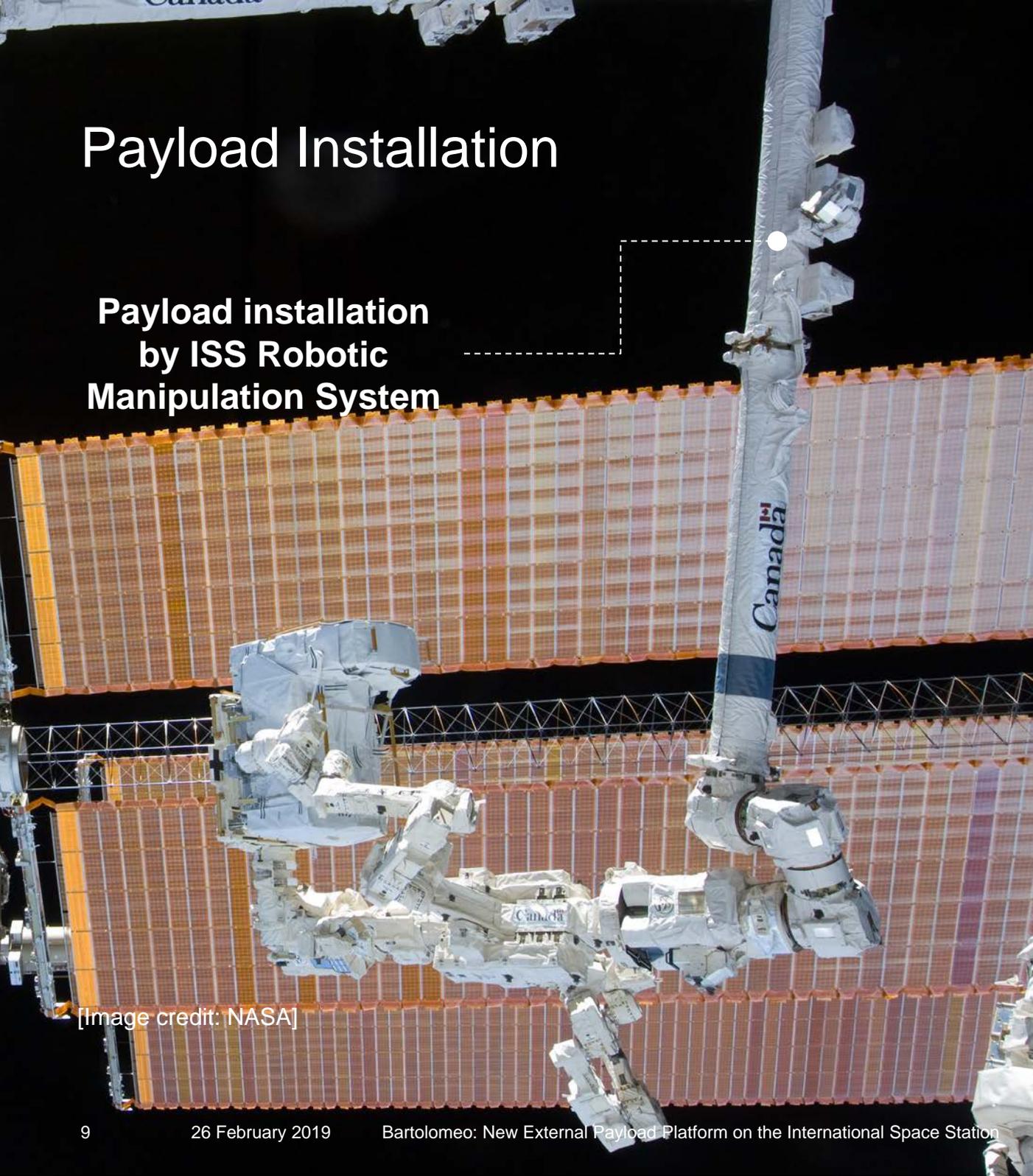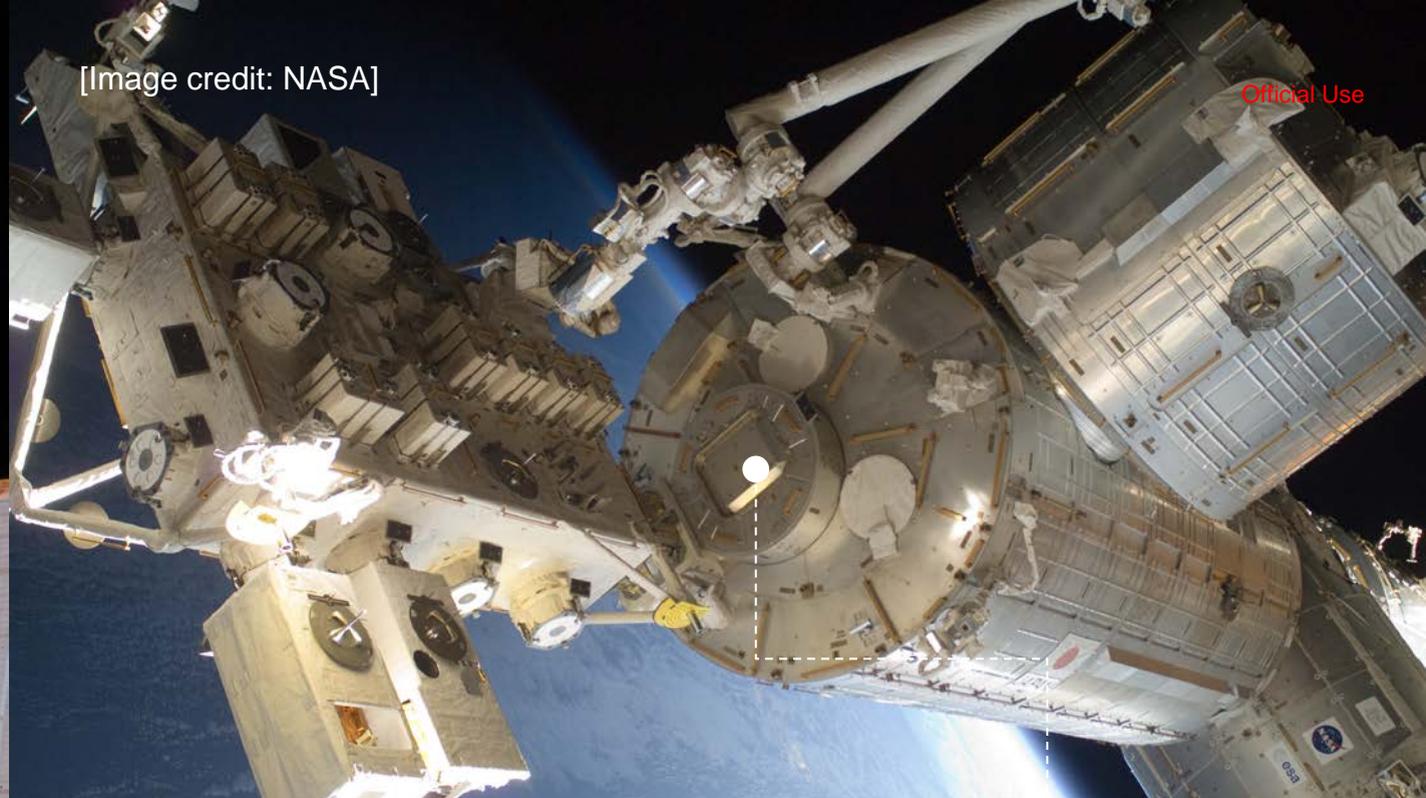
Payload transfer through either ISS payload airlock

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Payload Retrieval

Payload / sample retrieval option through the payload airlock

[Image credit: NASA]

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Payload Operation

Link	NRT Link	HC Link
Downlink	1-10 Mbps	2.5 TB/day
Uplink	1 Mbps	None
Latency	below 1 s	N/A

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Bartolomeo Platform Design and Capabilities

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Payload Accommodation
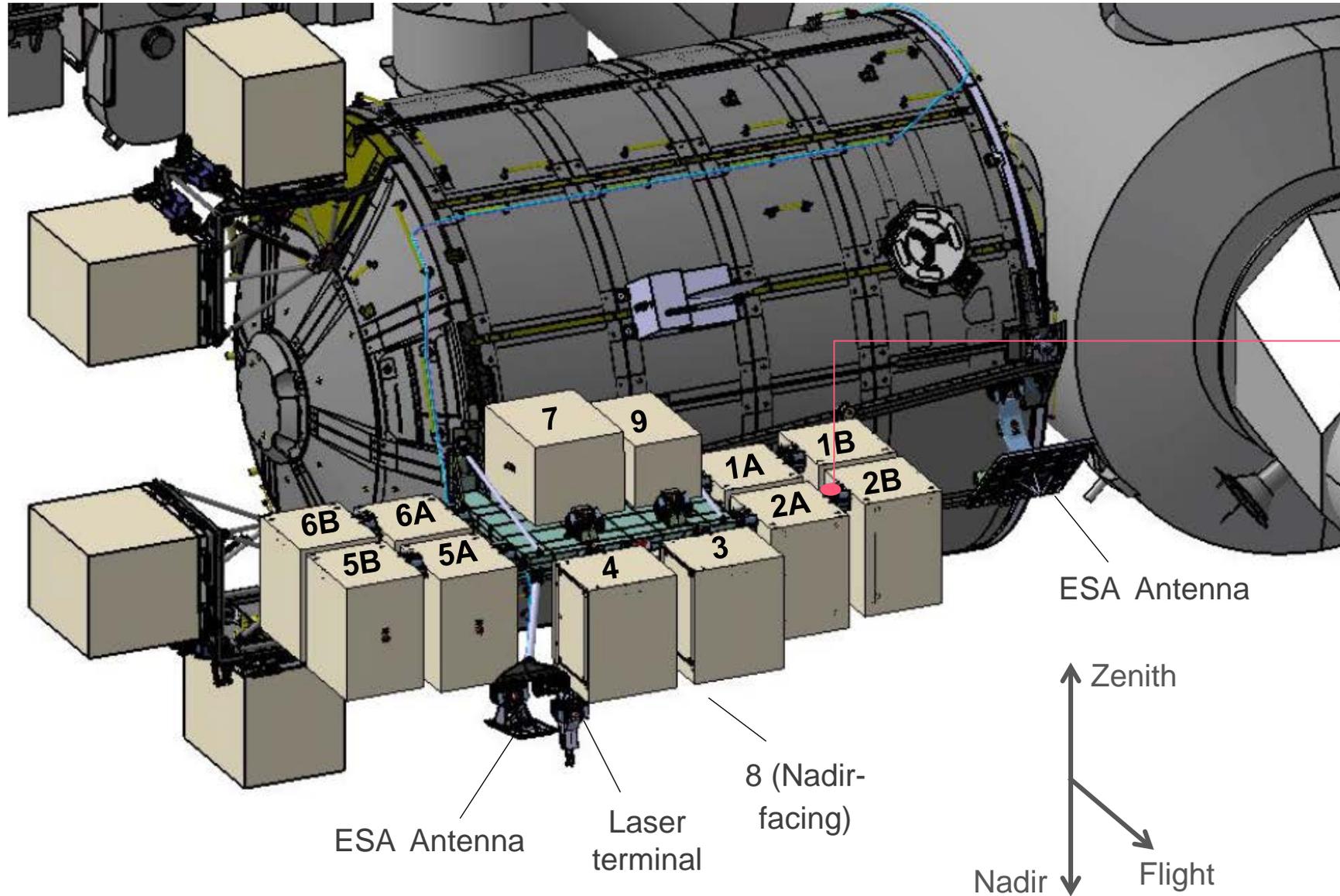
Robotic standard interface used for all payload / platform interfaces

OCEANEERING®

Payload side

Platform side

General-purpose Oceaneering Latching Device-2 (GOLD-2)

7   9

1A   1B

2A   2B

6B   6A

5B   5A

4   3

ESA Antenna

Zenith

8 (Nadir-facing)

Nadir   Flight

ESA Antenna   Laser terminal

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Payload Accommodation

GOLD-2 interface

Payloads

ArgUS Multi-Payload Adapter

Zenith

Nadir

Flight

ESA Antenna

ESA Antenna

Laser terminal

8 (Nadir-facing)
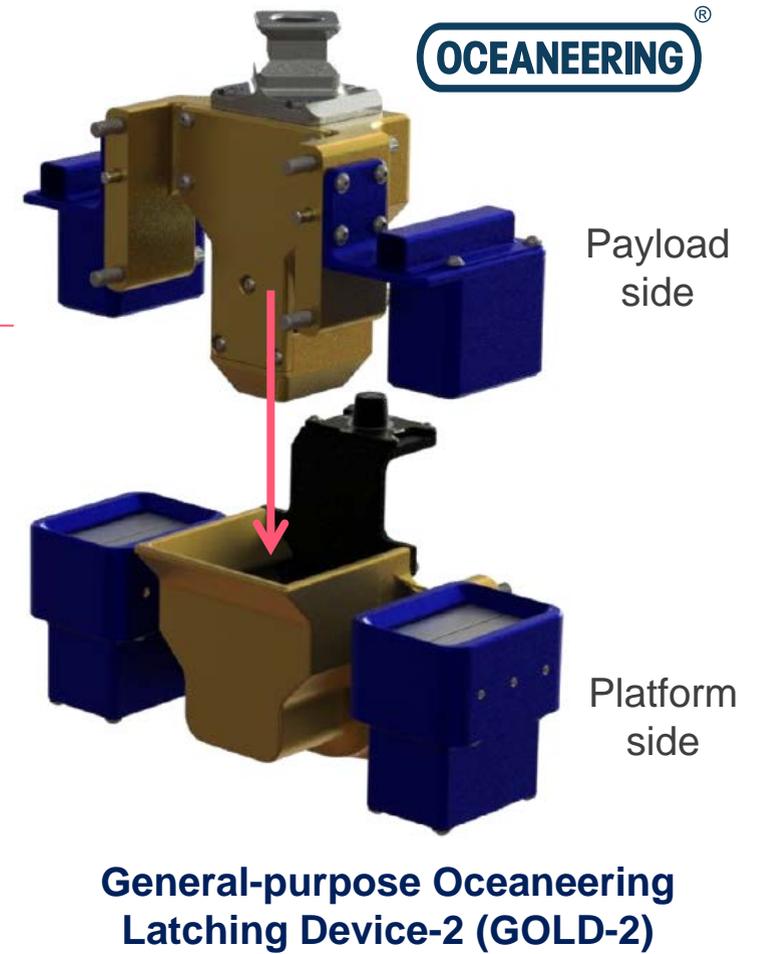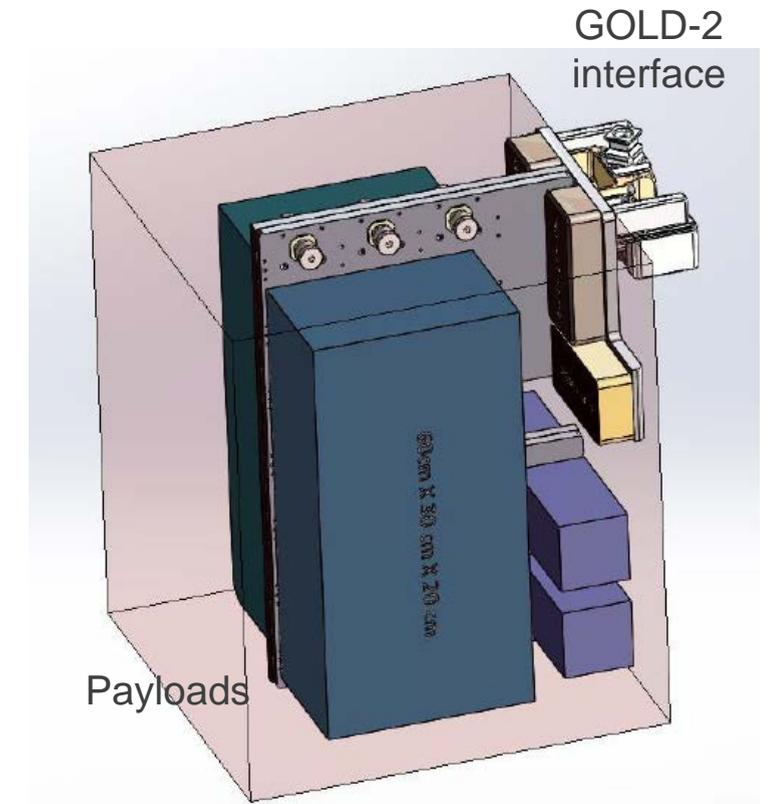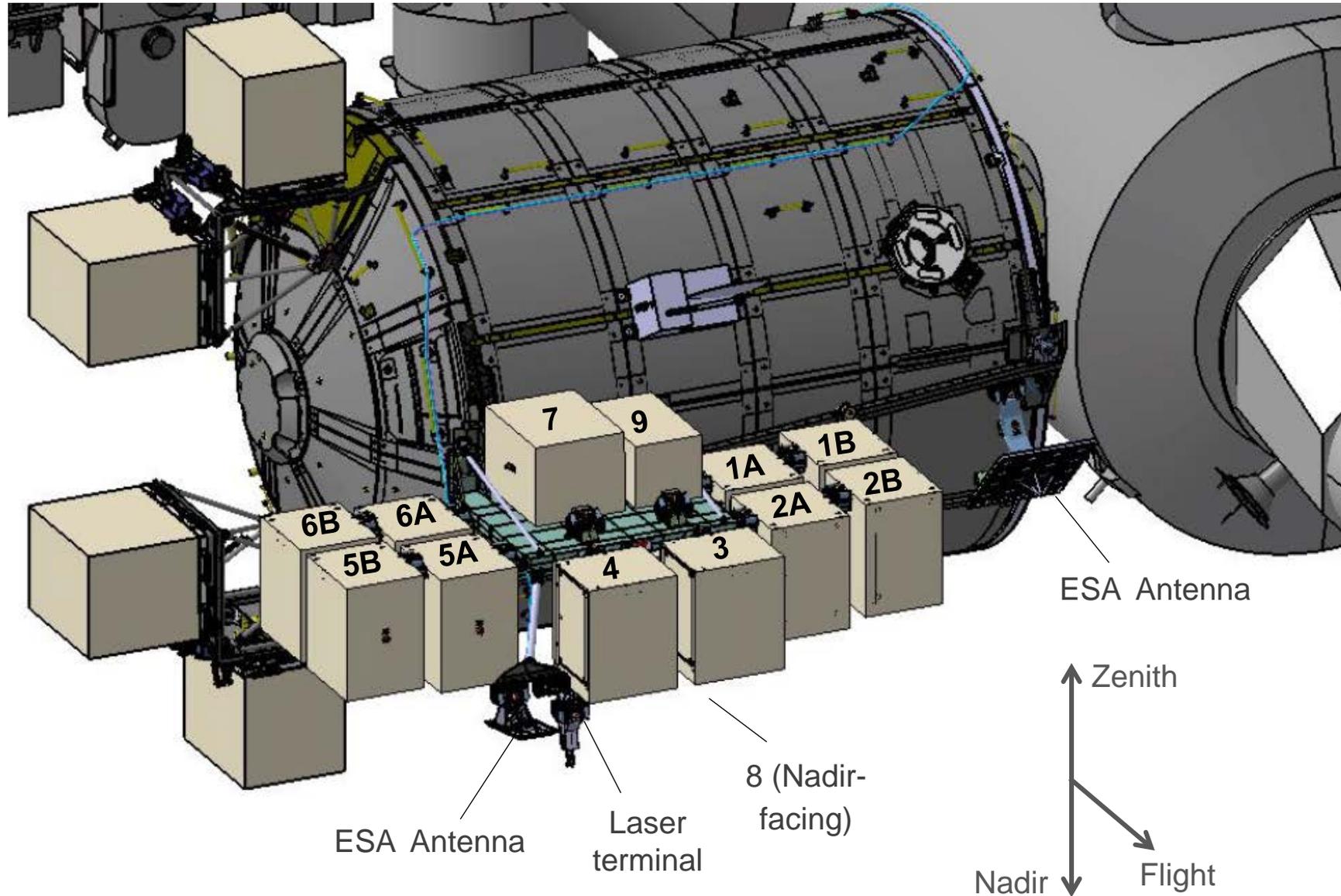
↘ ArgUS can be accommodated on Slot 1, 2, 3, 4, 5, and 6
↘ Slot selected based on payload requirements and overall booking situation

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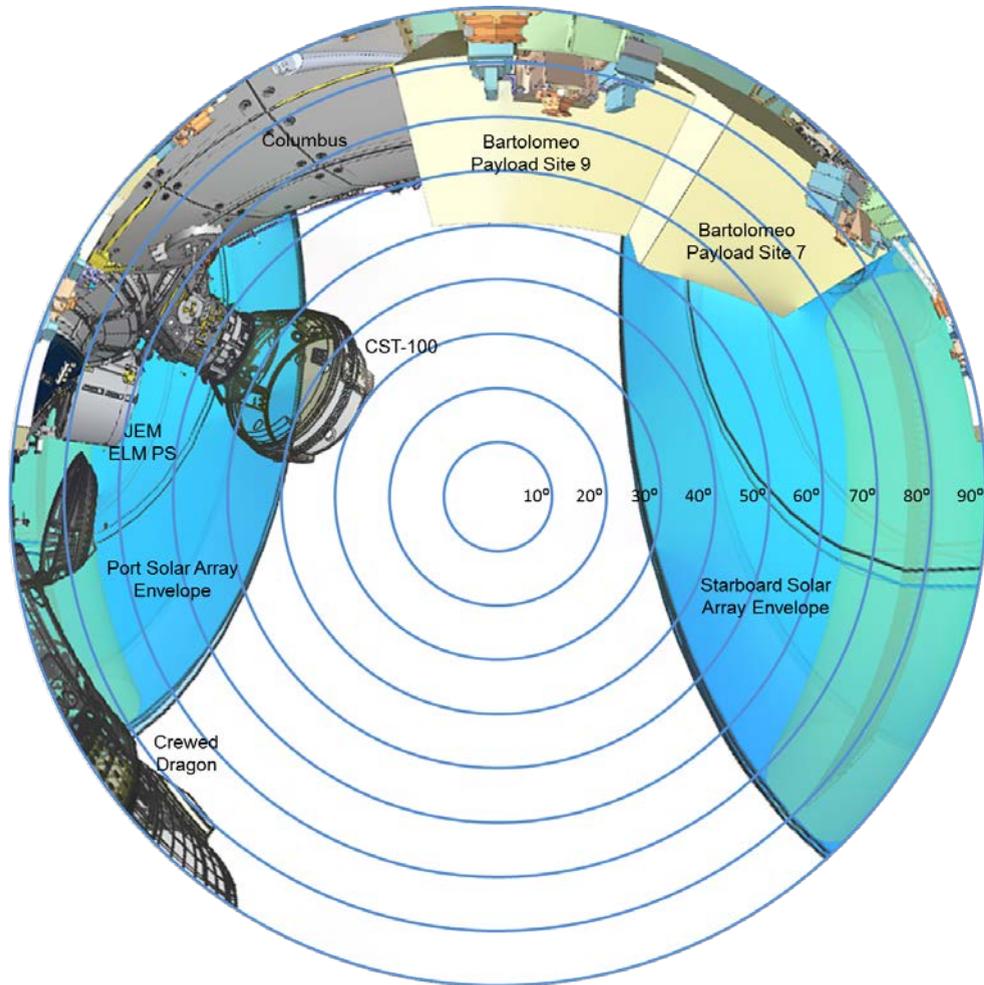
Payload Viewing

Slot 3 Zenith View
[image credit: NASA]
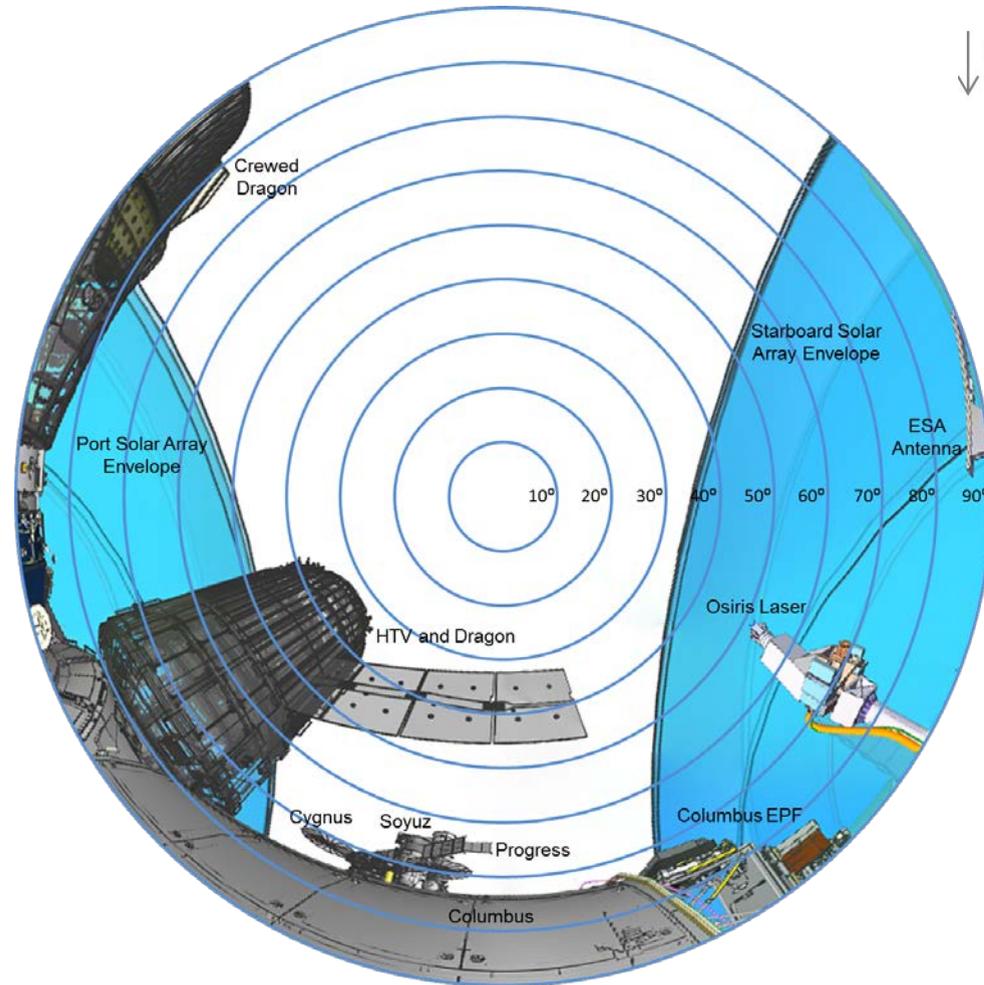
Slot 3 Nadir View
[image credit: NASA]

Payload viewing quality

Slots	Nadir	Zenith	Ram
1A			
1B			
2A			
2B			
3			
4			
5A			
5B			
6A			
6B			
7			
8			

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Bartolomeo All-in-one Space Mission Service

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Bartolomeo All-in-one Space Mission Service

↘ Standard service

Payload transfer
to the outside of the ISS

Payload operation
on the Bartolomeo
platform

L+3 months

L-20 months

Payload launch
on any ISS service
vehicle

Payload installation
using the ISS Robotic Manipulator System

Payload data
Data delivery to the
customer

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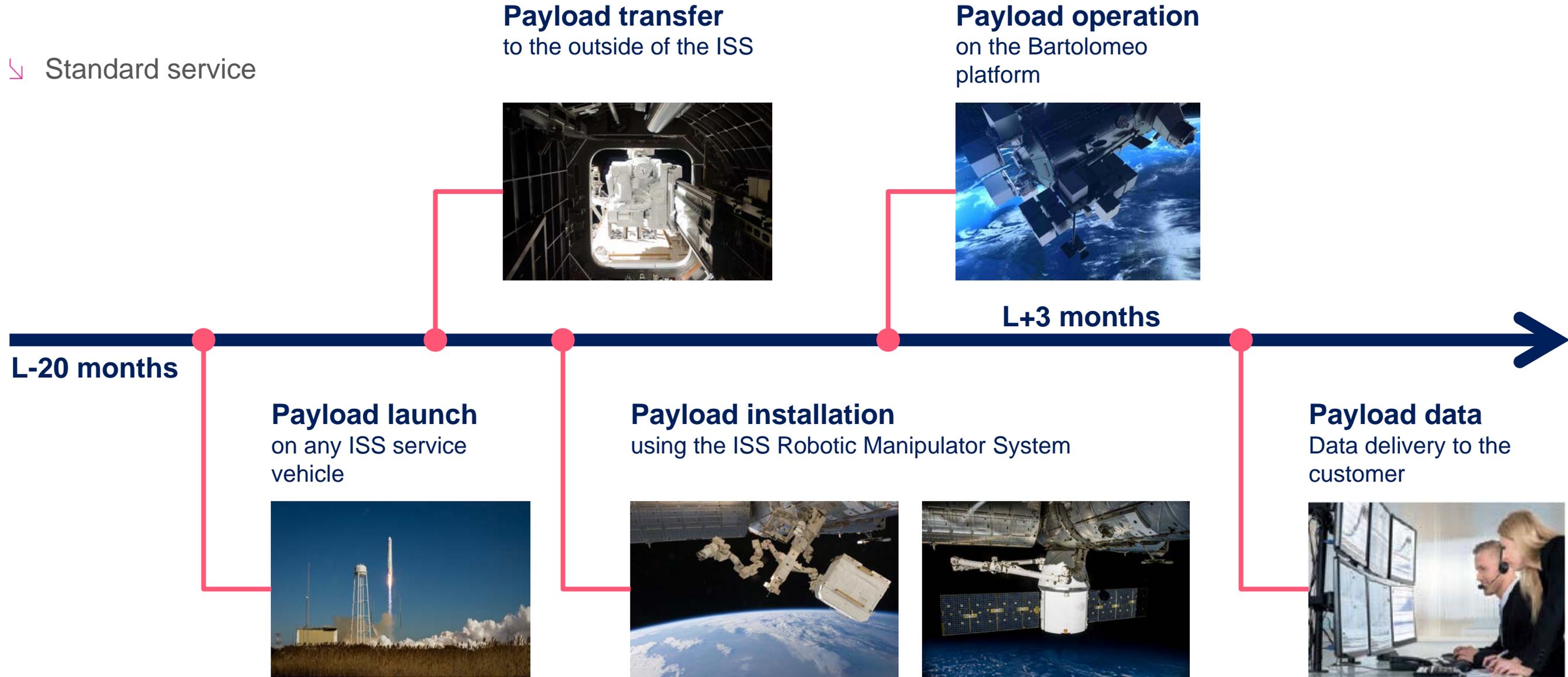
Bartolomeo All-in-one Space Mission Service

↘ Optional services

Payload Return

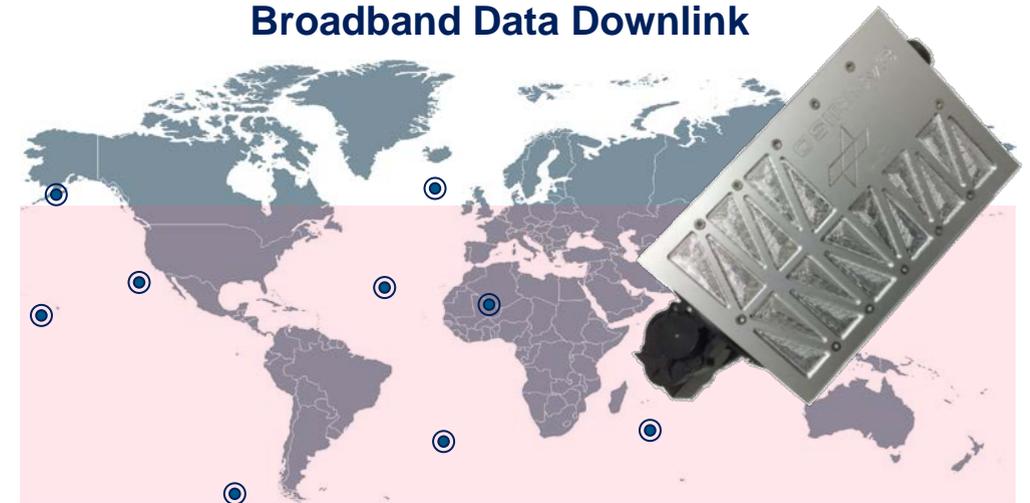| Optional Services |
|---|
| Use of the broadband data downlink |
| Payload / sample return |
| Payload design |

Broadband Data Downlink

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Capability offered within the upcoming 1st Announcement of Opportunity

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Capability offered within the upcoming 1st Announcement of Opportunity

> **3U-sized payload** will be integrated, launched, installed and operated as part of the Bartolomeo / ArgUS Multi-Payload Adapter system free of charge
>> 1U = 10 x 10 x 10 cm

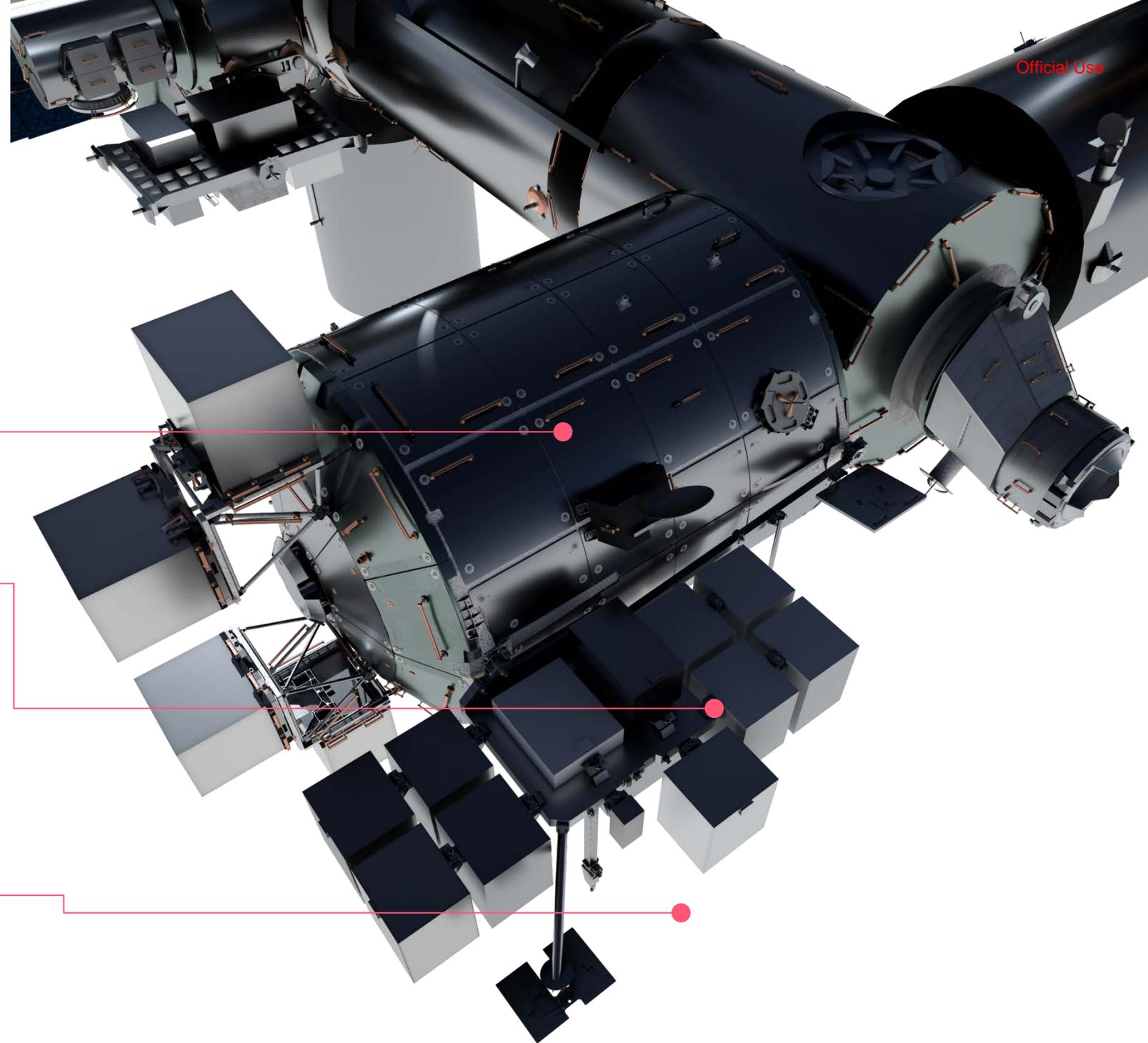> **Mission duration 1 year** is included

Optional Services:
> Larger payload sizes and longer mission durations are available at 80,000 USD / U / year
> Payload return available at 80,000 USD / kg
> Broadband data downlink capability available at extra charge TBD

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Specific Payload Requirements

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Payload Requirements

General Mission Requirements

ISS Orbit Characteristics
Payload Attitude Characteristics

Payload Design Requirements

Mechanical Interfaces
Electrical Interfaces
Data Interfaces
Software Interfaces
Safety Requirements

Environmental Requirements

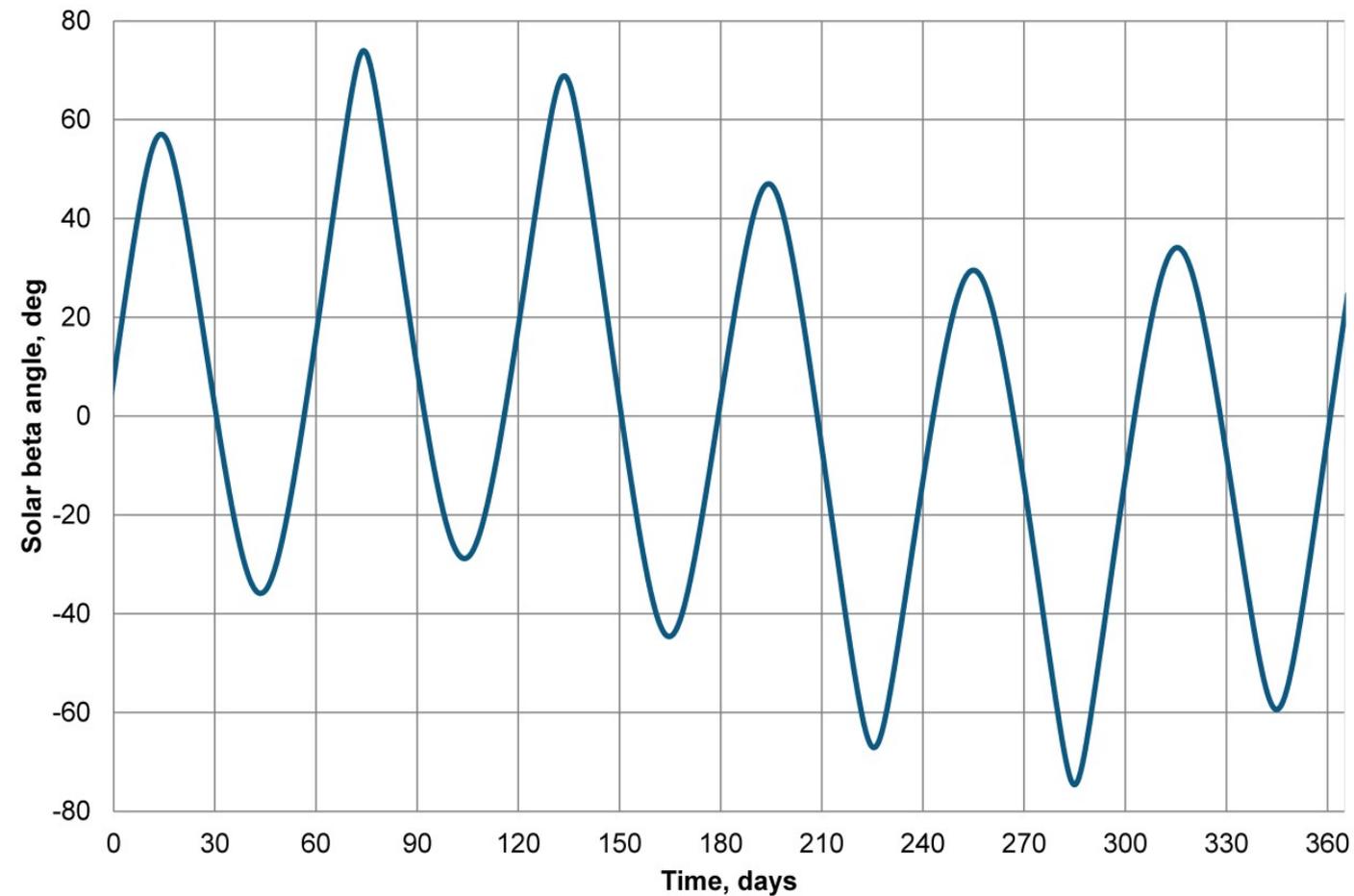| |
|---|
| Mechanical Environment |
| Thermal Environment |
| Electro-magnetic Environment |
| Space Environment |

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General Mission Requirements

> **ISS orbit characteristics**

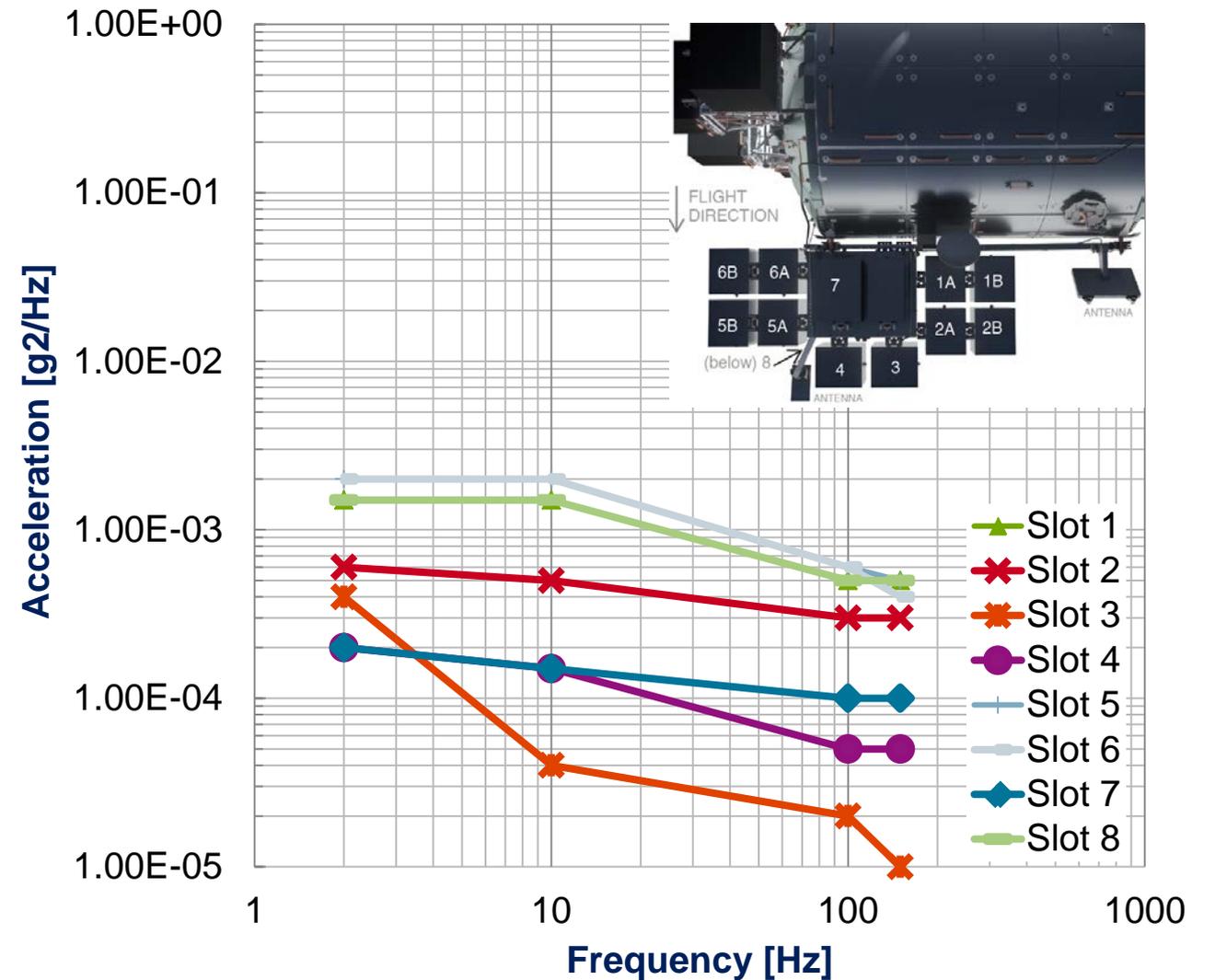| ISS Orbit Parameter	Value
Orbital inclination	51.64 deg
Orbit altitude	403 to 408 km
Orbital period	92.89 minutes
Solar beta angle variation	-75 to +75 deg
Position error	6 m
Semi-major axis error	20 m

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General Mission Requirements

> **Payload attitude characteristics**

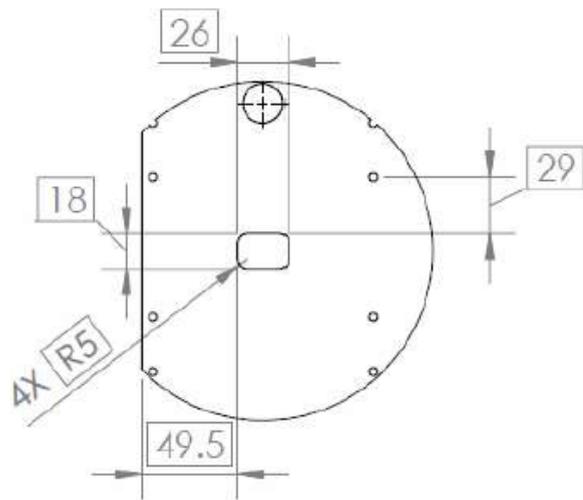| ISS Attitude	Yaw	Pitch	Roll
+XVV +Z Nadir (TEA)	**-15° to +15°**	**-20° to +15°**	**-15° to +15°**
-XVV +Z Nadir	+165° to +195°	-20° to +15°	-15° to +15°
+YVV +Z Nadir	-110° to -80°	-20° to +15°	-15° to +15°
-YVV +Z Nadir	+75° to +105°	-20° to +15°	-15° to +15°
+ZVV -X Nadir	-15° to +15°	+75° to +105°	-15° to +15°
-ZVV -X Nadir	+165° to +195°	+75° to +105°	-15° to +15°

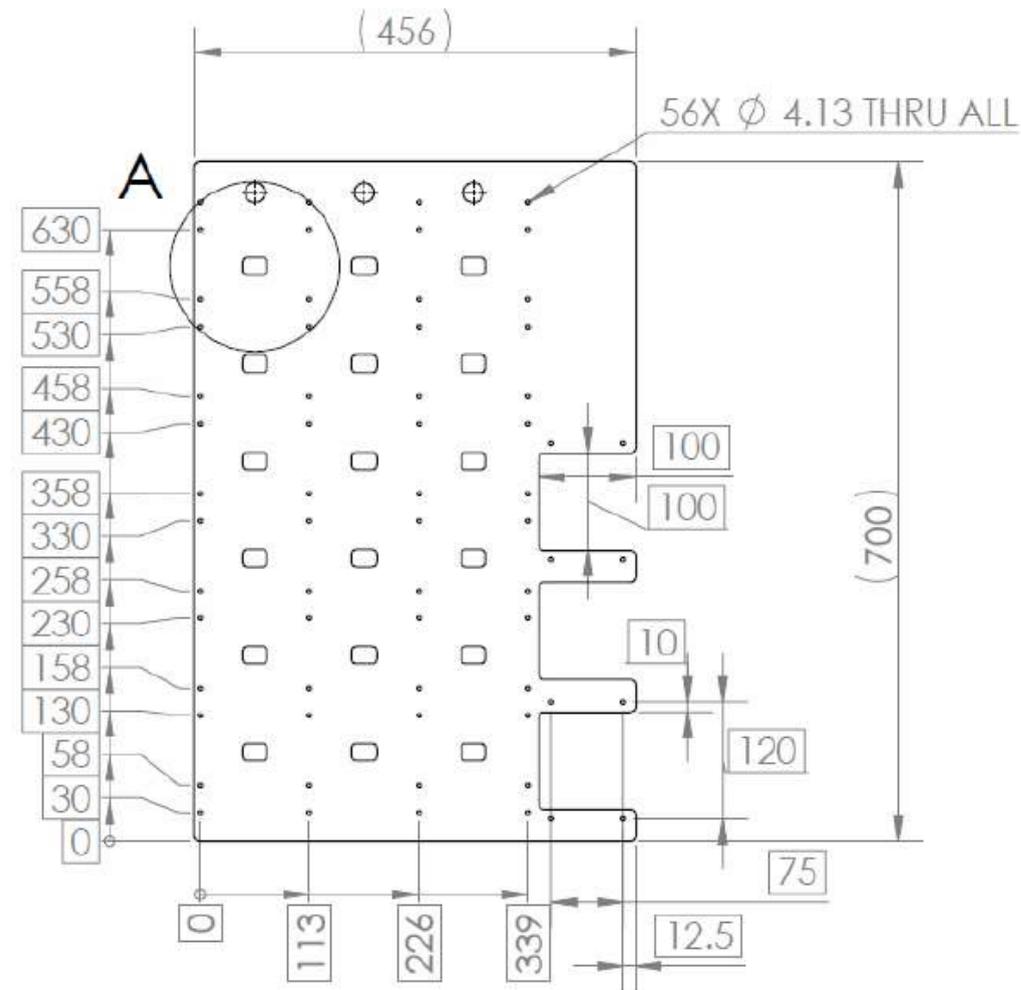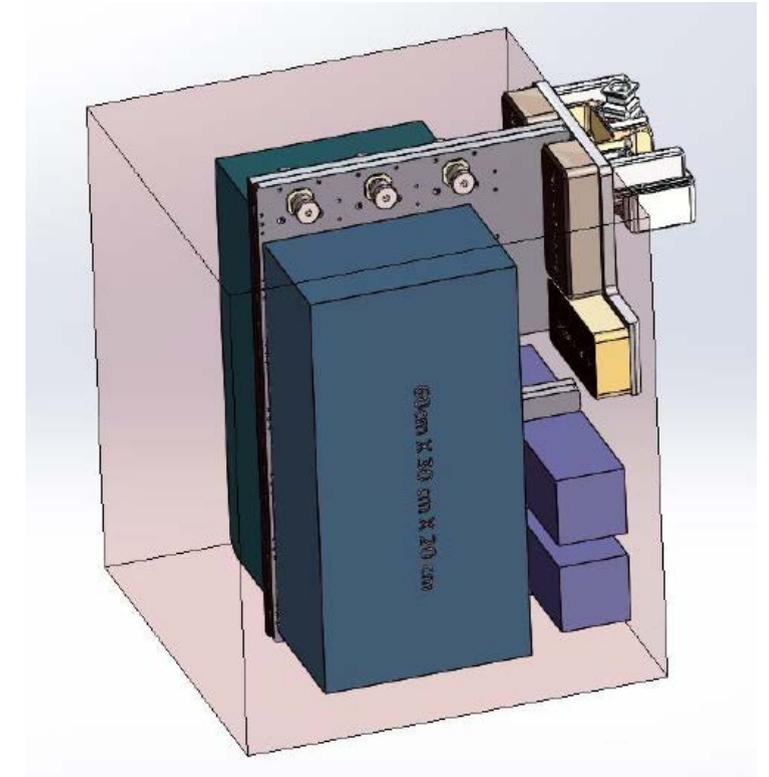| Payload Attitude Parameter	Typical Performance
Attitude rate non-micro-gravity mode	±0.05 deg/s/axis
Attitude knowledge at S0 truss	<0.25 deg/axis (3σ)
Attitude knowledge on Bartolomeo	<1.0 deg/axis (3σ)

On-orbit Vibration Environment

Payload Design Requirements

ArgUS Multi-Payload Adapter

> **Mechanical interfaces**

DETAIL A

SCALE 1 : 4

↘ ArgUS base plate hole pattern to be respected

↘ ArgUS soft dock feature to be implemented

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Payload Design Requirements

ArgUS Multi-Payload Adapter

> **Mechanical interfaces**

DETAIL A
SCALE 1 : 2

DETAIL C
SCALE 1 : 1

SECTION B-B
SCALE 1 : 4

↘ ArgUS base plate hole pattern to be respected

↘ ArgUS soft dock feature to be implemented

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Payload Design Requirements

ArgUS Multi-Payload Adapter

> **Electrical and data interfaces**
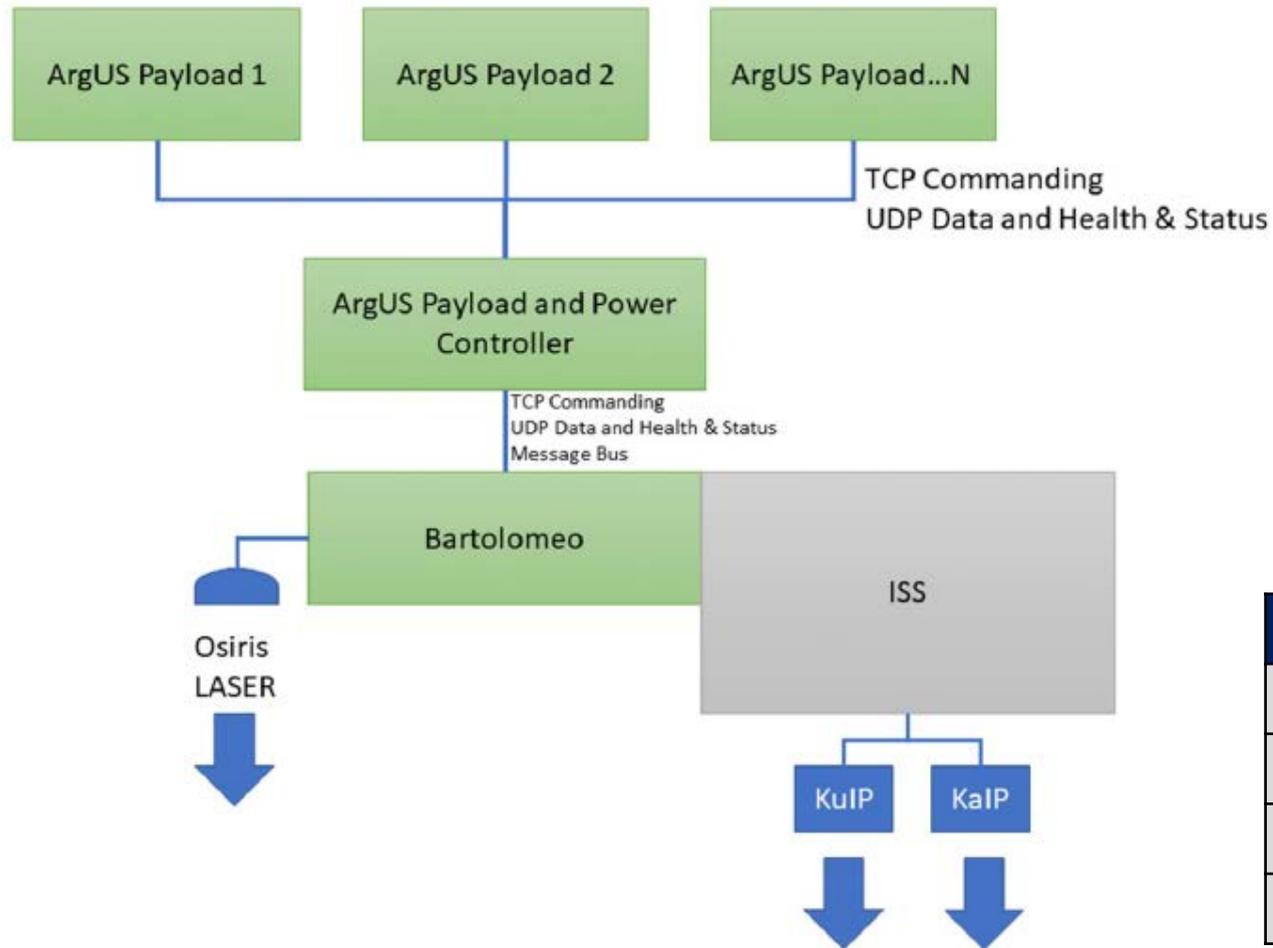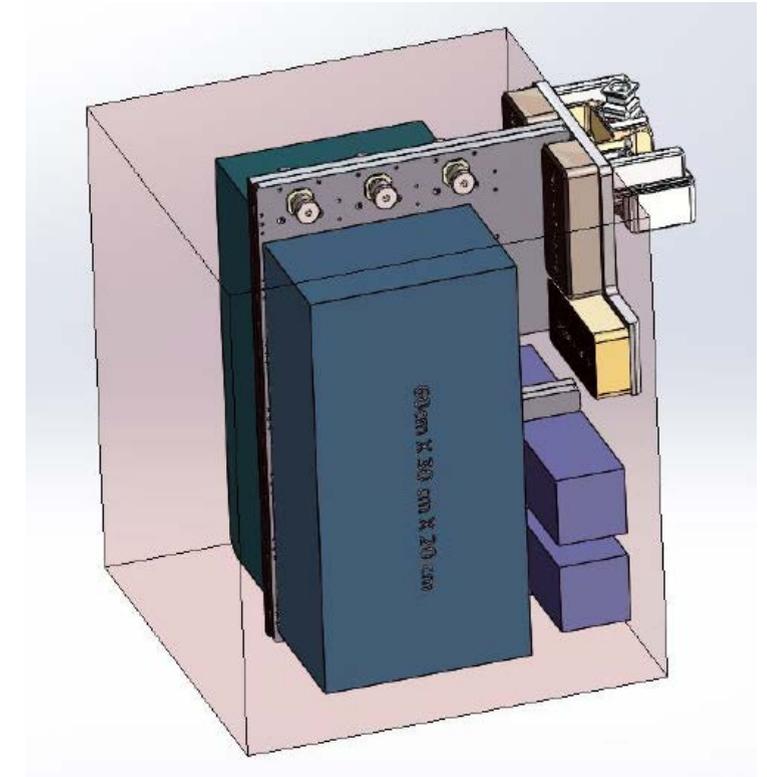

ArgUS Interface Parameters	
Power (operational)	28 VDC up to 140 W
Power (survival)	28 VDC up to 20 W
Data downlink	0.1 Mbit / s
Commanding and Monitoring	Near Real time through Columbus

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Payload Design Requirements

> **Safety requirements**

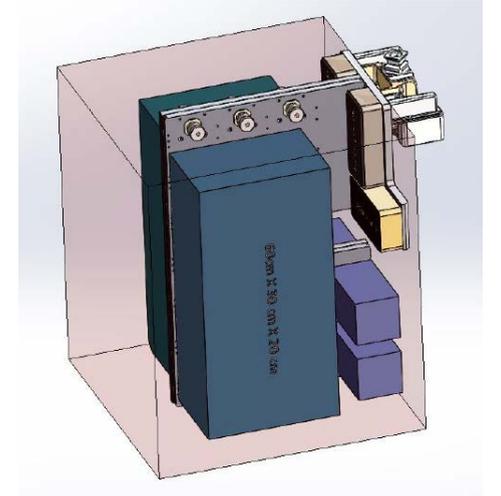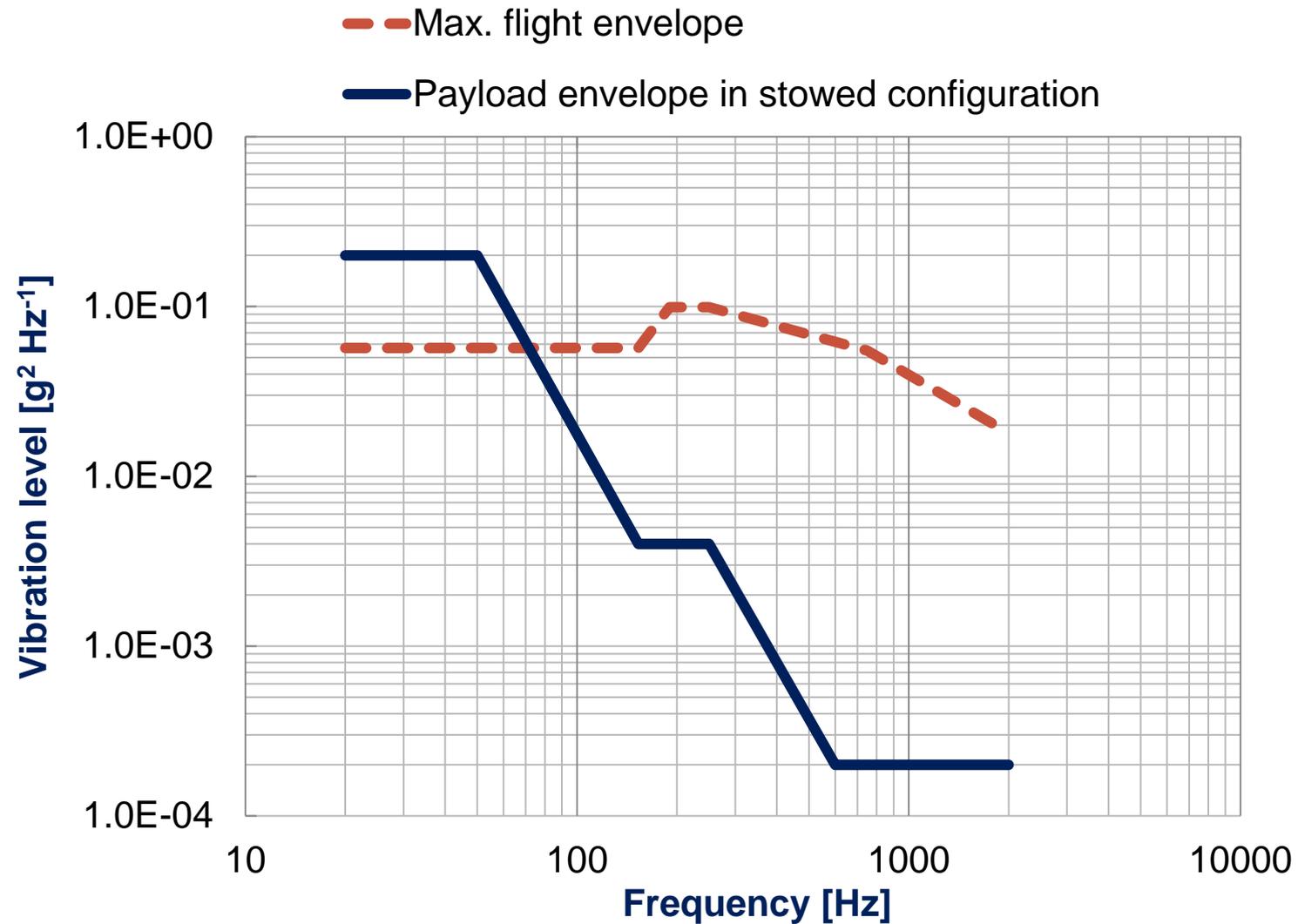| Hazard	Control
Structural hazards	• Application of factor of safety with positive margin; design for minimum risk • Fault tolerance where applicable • Redundant mechanism
Electrically operated systems	• Inhibits to control inadvertent operations appropriate to the hazard level • Redundancy as necessary to perform required functions, Design controls i.e. EMI
Leakage of toxic substances	• Fault tolerance in seals appropriate • Structural strength of containers
Flammable materials	• Elimination of flammable materials • Containment • Wire sizing and fusing
Pressure systems	• Factor of safety
RF systems	• Design to have power below hazard level and frequency in approved range • Inhibits to control inadvertent operations appropriate to the hazard level
Battery hazards	• Containment • Protection circuits

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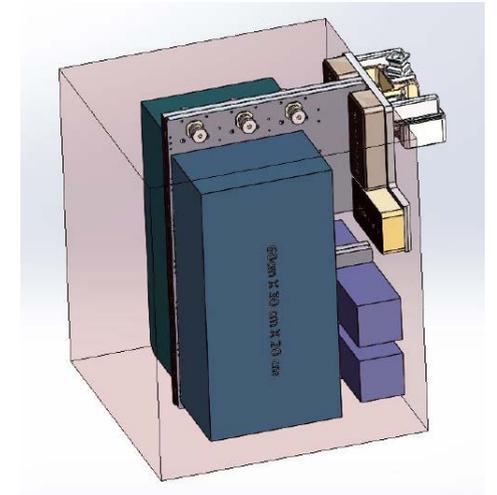
Environmental Requirements

> **Mechanical environment**
>
> ↘ **Launch loads for pressurized launch packed in foam**
>
> ↘ On-orbit loads caused by crew handling, airlock operations, robotic operations

> Electro-magnetic environment

> Space environment
>
> ↘ ATOX environment
>
> ↘ Plasma environment
>
> ↘ Radiation environment

Legend:
- - - Max. flight envelope
——— Payload envelope in stowed configuration

Chart: Vibration level [g² Hz⁻¹] ($g^2\,Hz^{-1}$) vs Frequency [Hz]

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Specific Payload Requirements

> **Documentation to be followed:**
>> ↘ Bartolomeo User Guide (provided in the AO documentation)
>> ↘ ArgUS / Payload Interfaces Definition Document (provided in the AO documentation)

> **Design suggestions:**
>> ↘ Tailor your idea to the environment and interfaces
>> ↘ Simplify your design as much as possible
>> ↘ No pre-qualified hardware expected, qualification will be done through dedicated testing of the integrated hardware

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