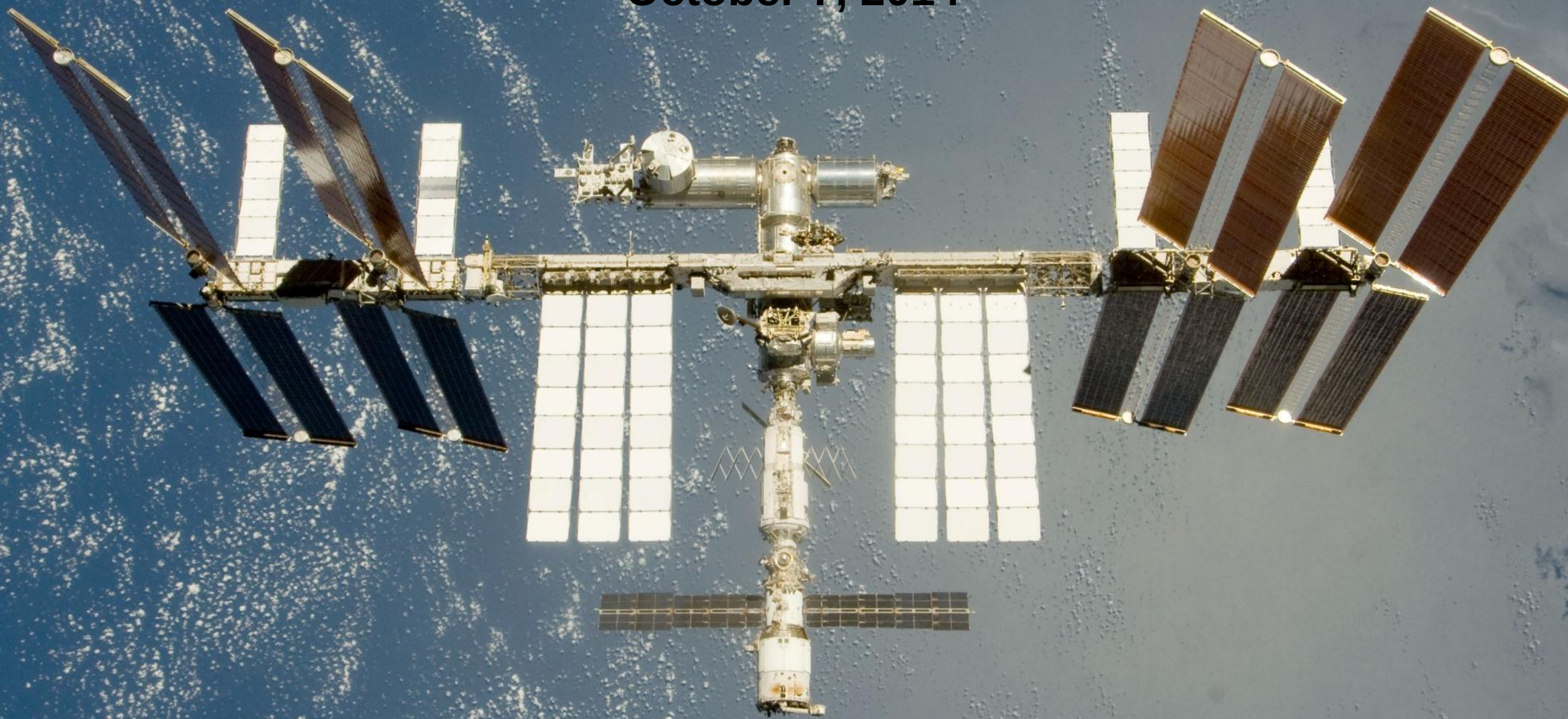
International Space Station External Payload Accommodations

October 7, 2014



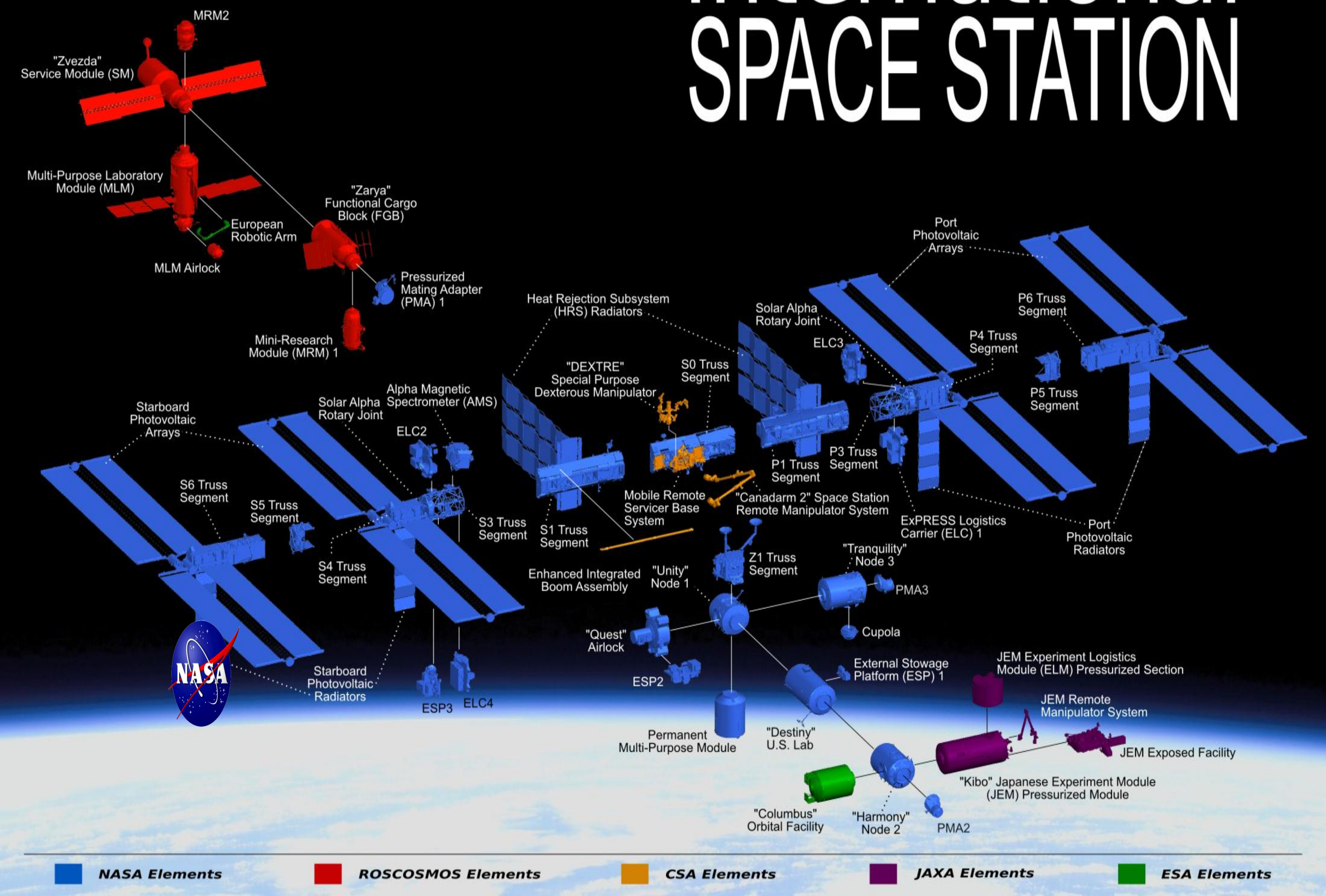
NASA Research Office (NRO) at JSC
Research Integration Office

SMD Astrophysics Explorers Pre-proposal Conference, Arlington, VA

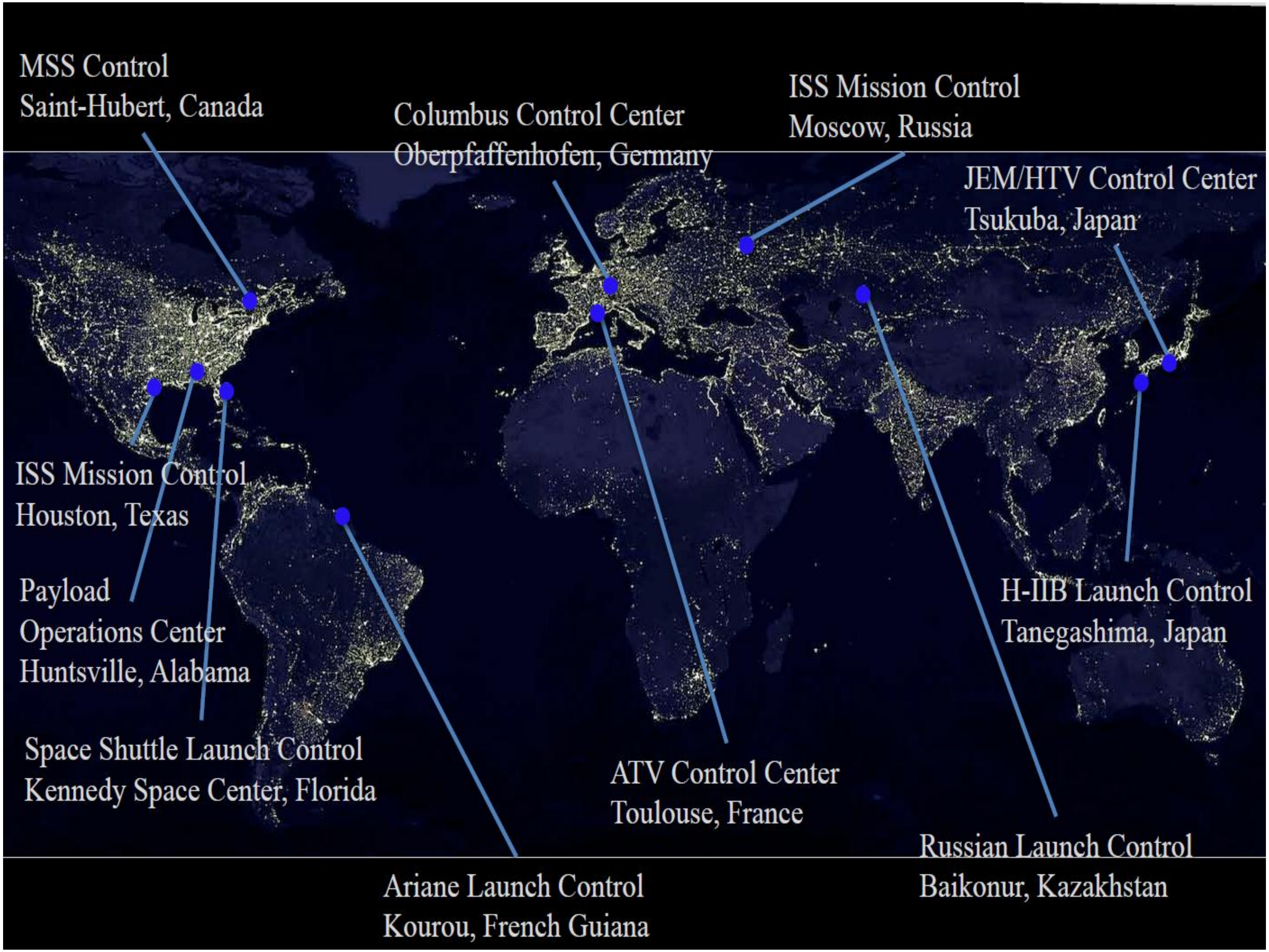
Kenol Jules/NASA-JSC

MAGIK
Based on MIM Rev K

International SPACE STATION



Global Ground-Based Infrastructure



Research Sponsors on ISS

International Space Station

The largest peace time effort
amongst the most countries in recorded human history.

Over 10 years and 32 missions to assemble

Creating knowledge that improves life here on earth and provides a stepping stone for humans to push further into space

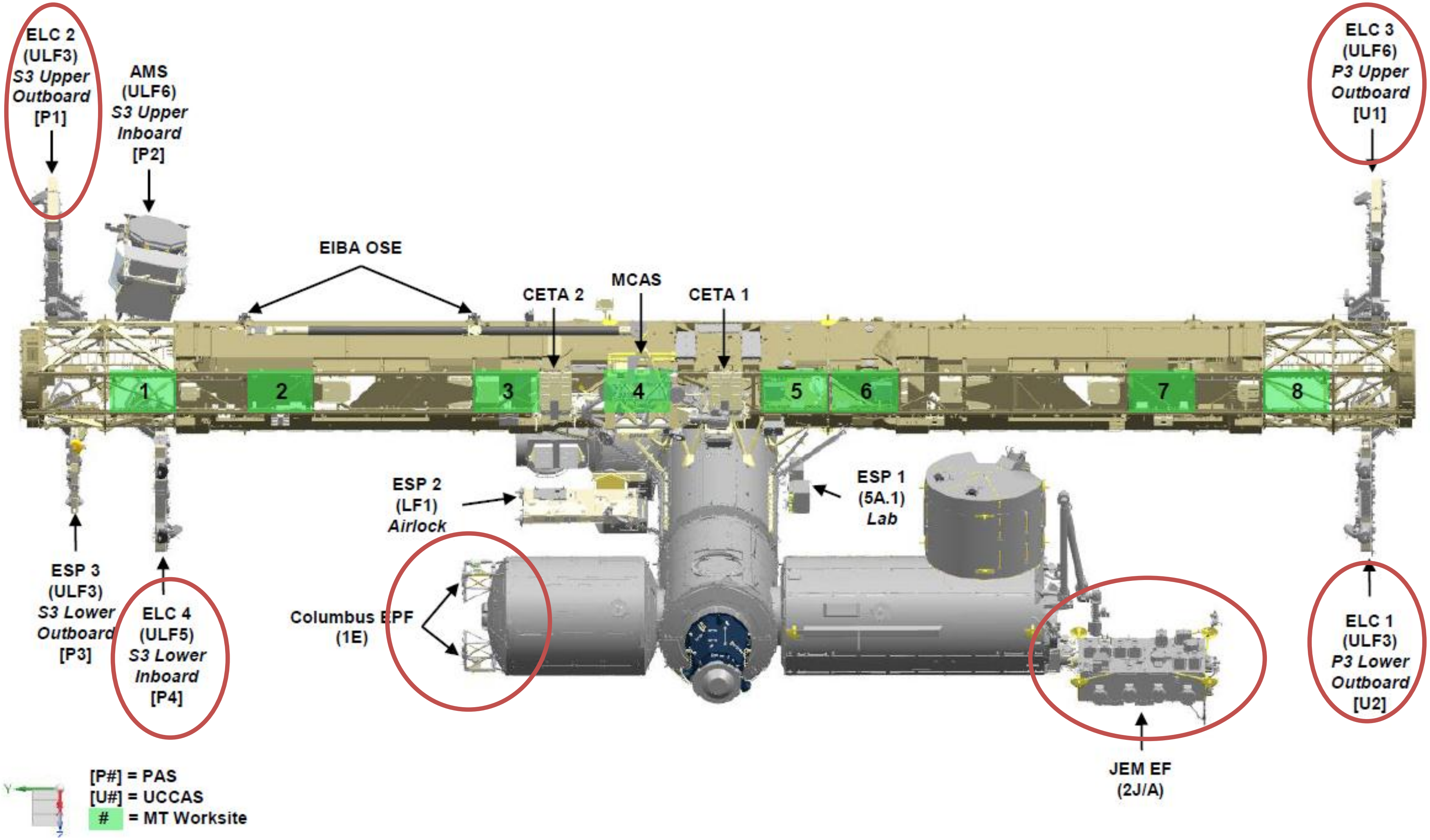
ISS Payload Philosophy

Our goal is to fly and operate a payload as soon as it is ready

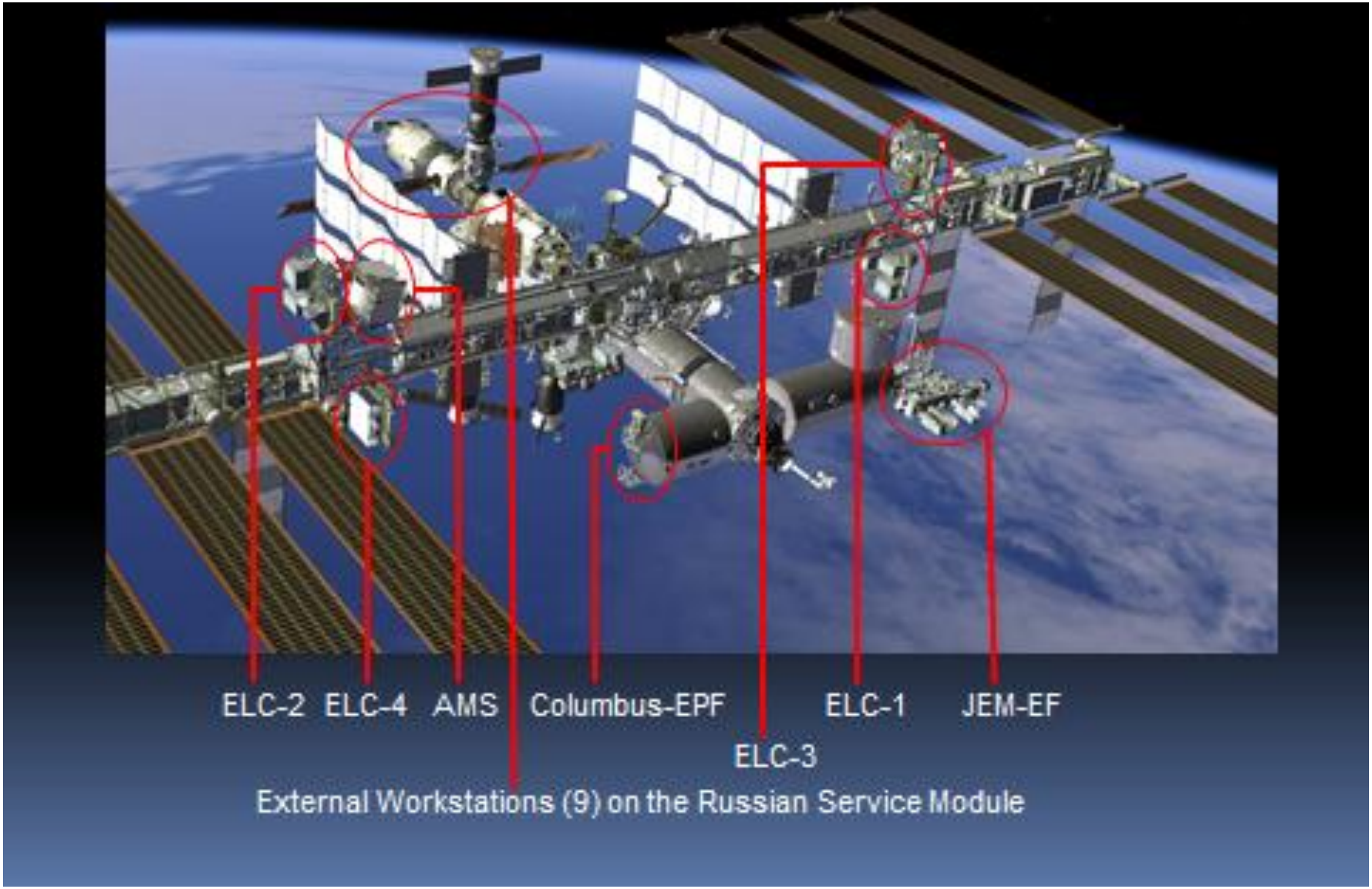
To operate the ISS like a laboratory to enable the flexibility for investigators to adapt their research plan based on new and unexpected findings

To continue to make the integration and operation of payloads on ISS as simple and ground like as possible

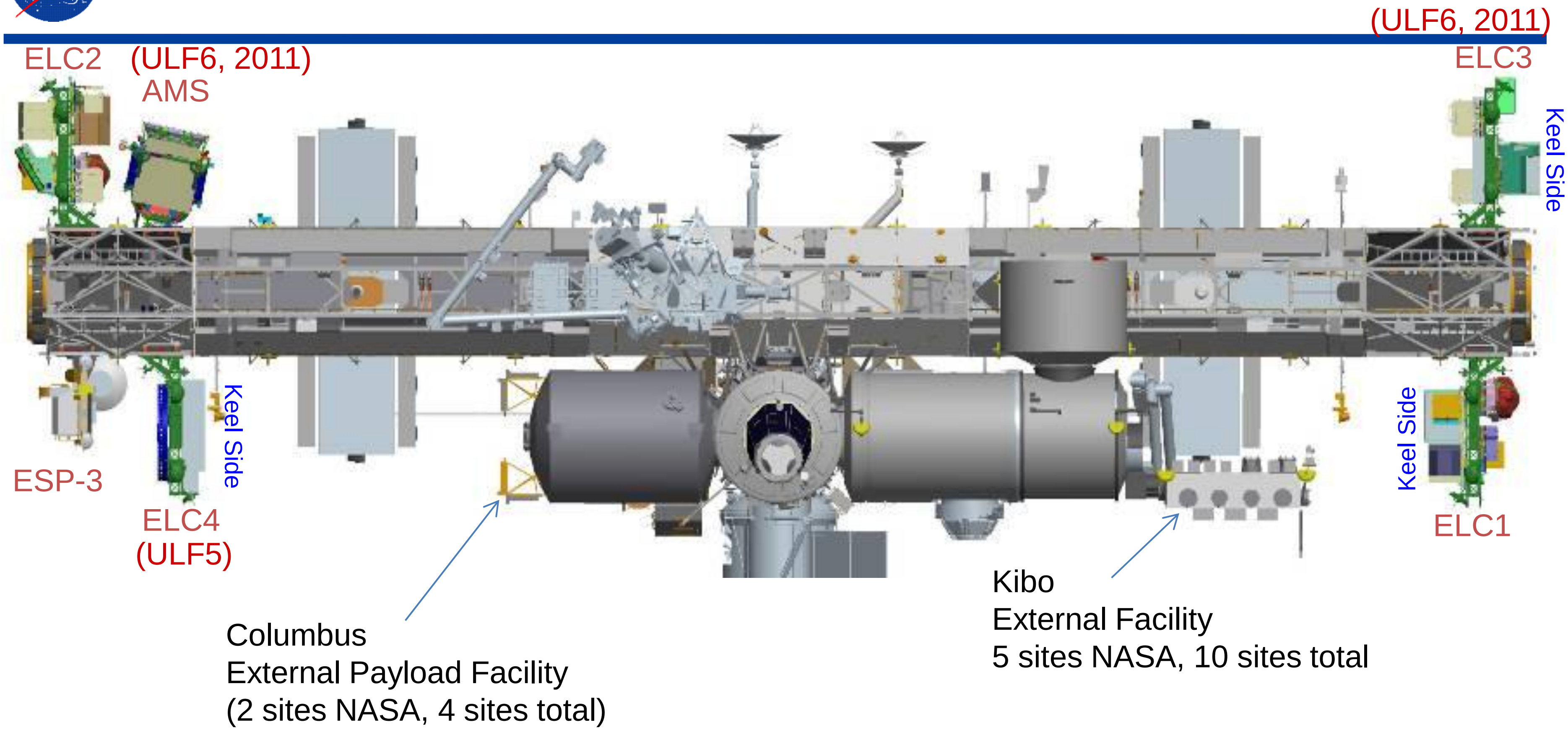
ISS Attached Sites

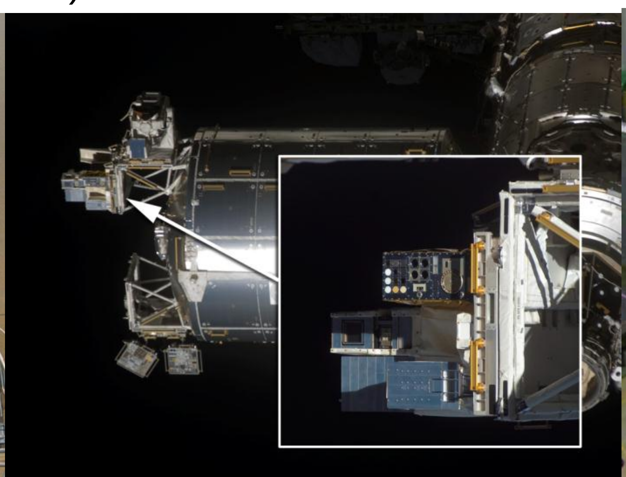


External Payload Attached Sites



International Space Station (ISS) External Research Facilities

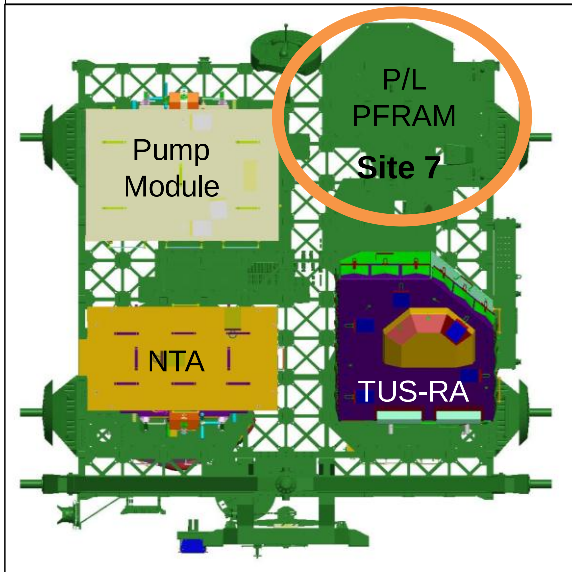


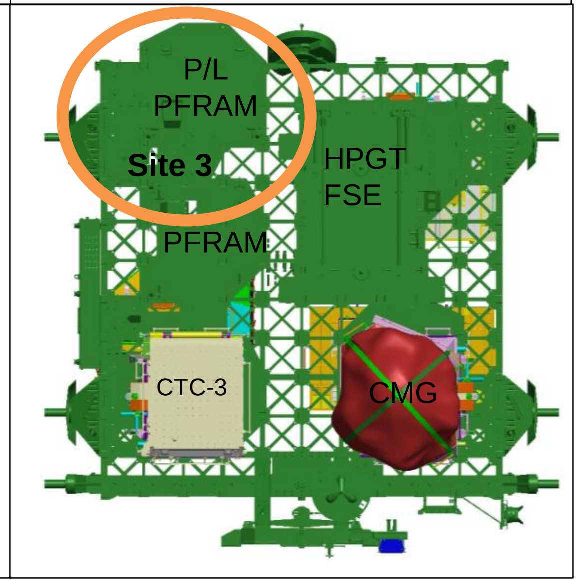


Express Logistics Carriers Overview

Payload Locations Circled

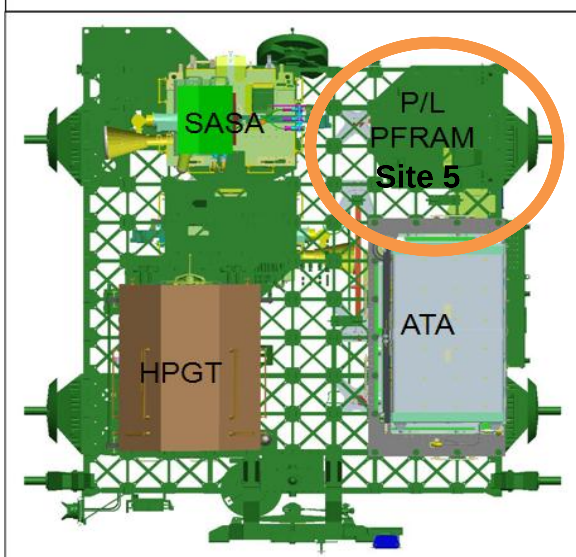
Outboard Side	***Inboard Side***

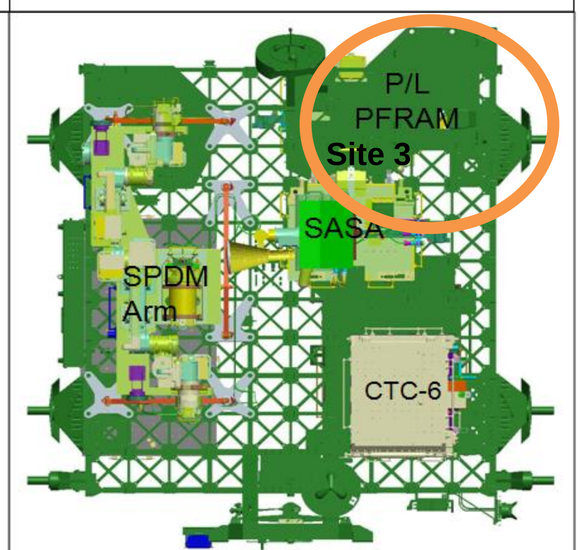




ELC-2 (Both Ram)
Starboard upper
2 Zenith payload sites

Outboard Side	***Inboard Side***

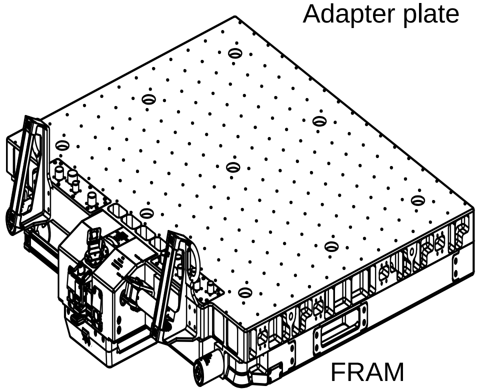




ELC-3 (3-Ram;5-Wake)
Port upper
2 Zenith payload sites

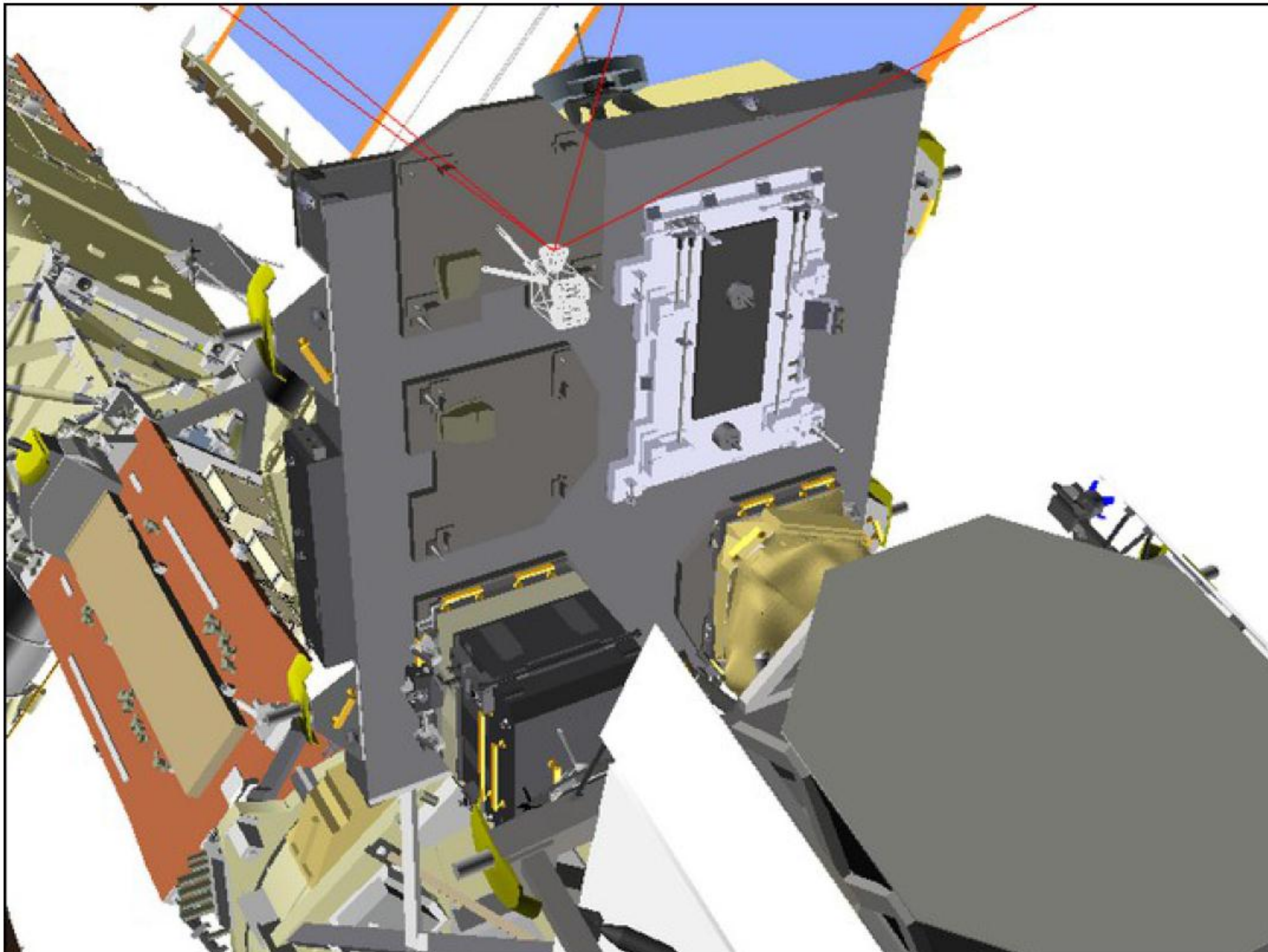
Express Pallet Adapter (ExPA) Assembly (GFE)

Express Pallet Adapter (ExPA) Assembly



ExPA overall Mass	255 lb
ExPA overall dimension	46.05" x 47" x 13.06" (H)
ExPA payload carrying capability	34" x 46" x 49" (H) and 500 lb"
Payload electrical interface	Power(120VDC & 28VDC): Four NATC connectors Data (1553, Ethernet): Six NATC connectors
Payload thermal interface	Active heating, passive cooling
Payload structural interface	2.756" X 2.756" Grid with 250-28 UNF Locking Inserts and 1.625" diameter Shear Boss Provisions
EVA compatibility	EVA handrail provisions
EVR compatibility	All EVR interfaces on ExPA

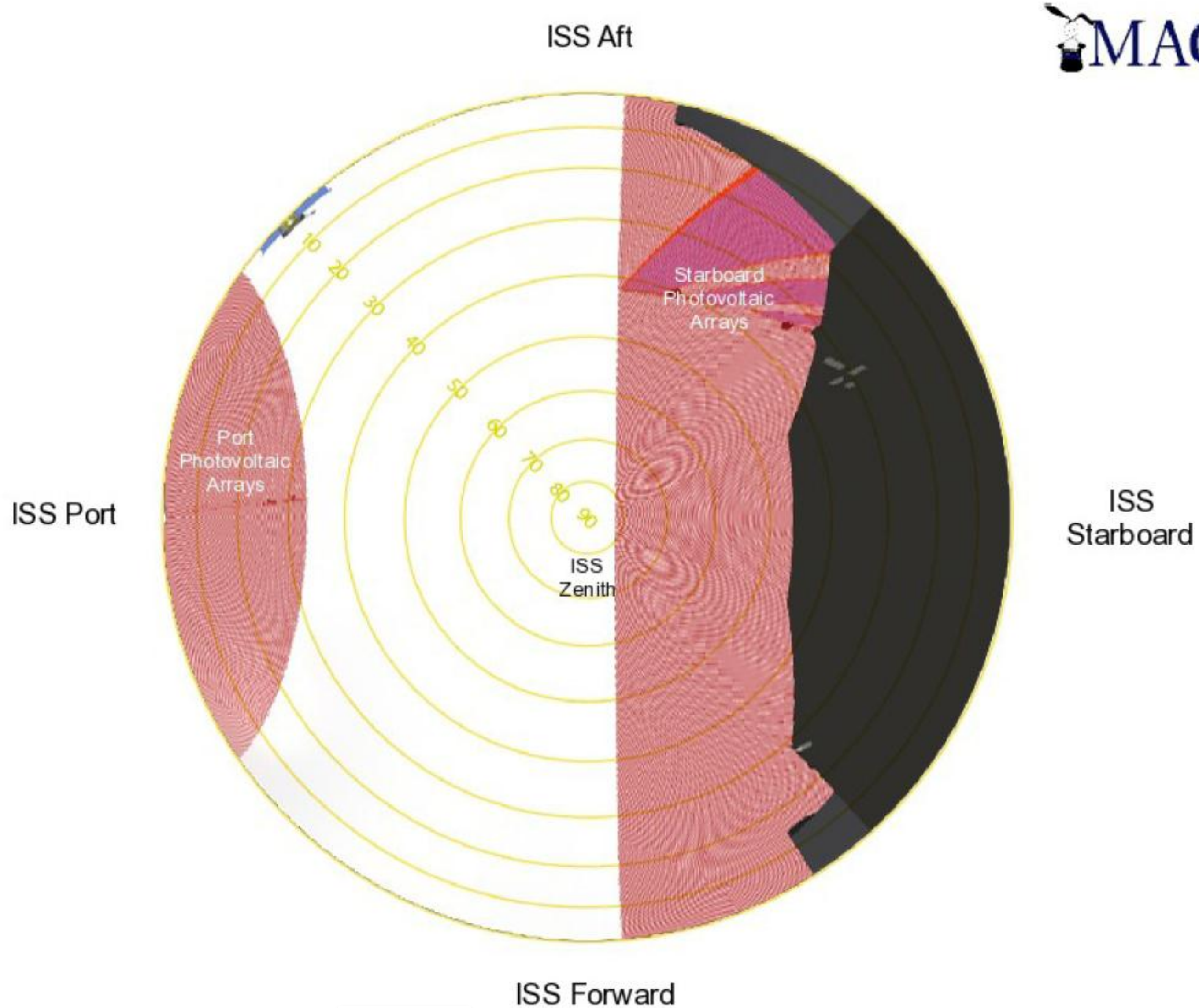
Placement of “Eye” Point for Sensor Viewing for Field of View Analysis



ELC2 PFAP3 Zenith Viewing Direction

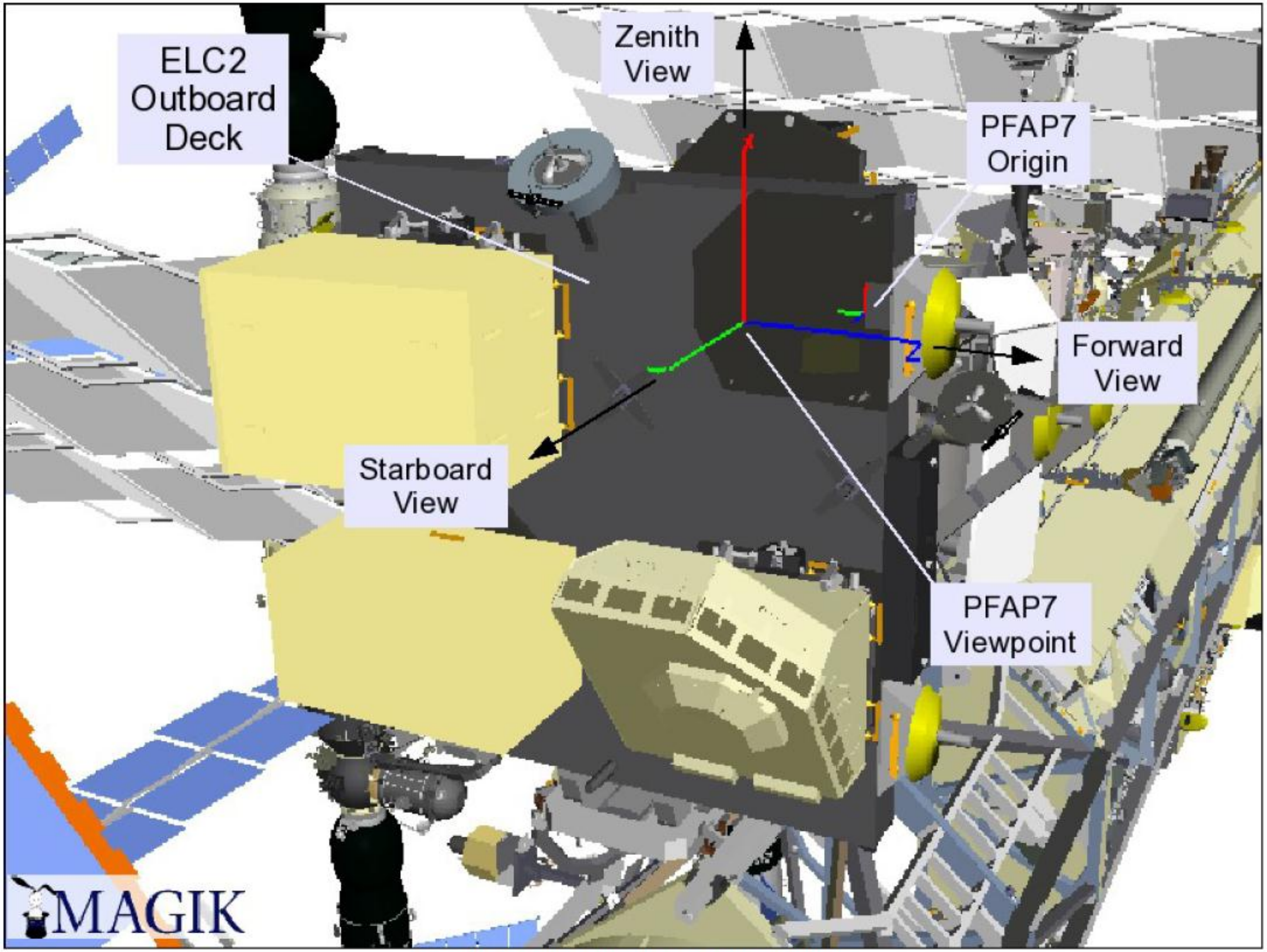
Isometric View Looking ISS Aft-Starboard-Nadir

Zenith Looking Field of View Analysis for ELC2/3



ELC2 PFAP3 Zenith Facing Fish-eye FOV

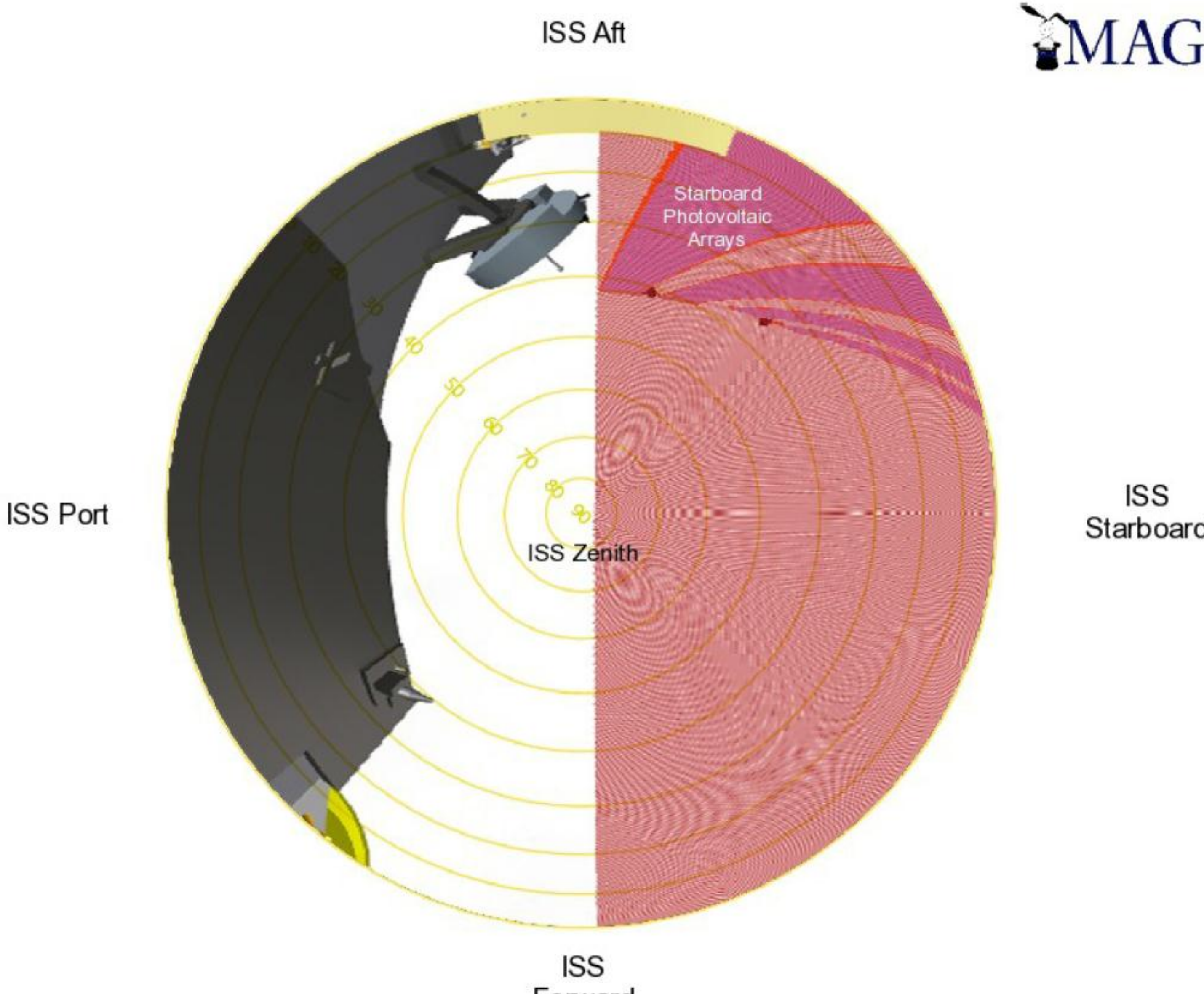
Placement of “Eye” Point for Sensor Viewing for Field of View Analysis



ELC2 PFAP7 Viewing Location

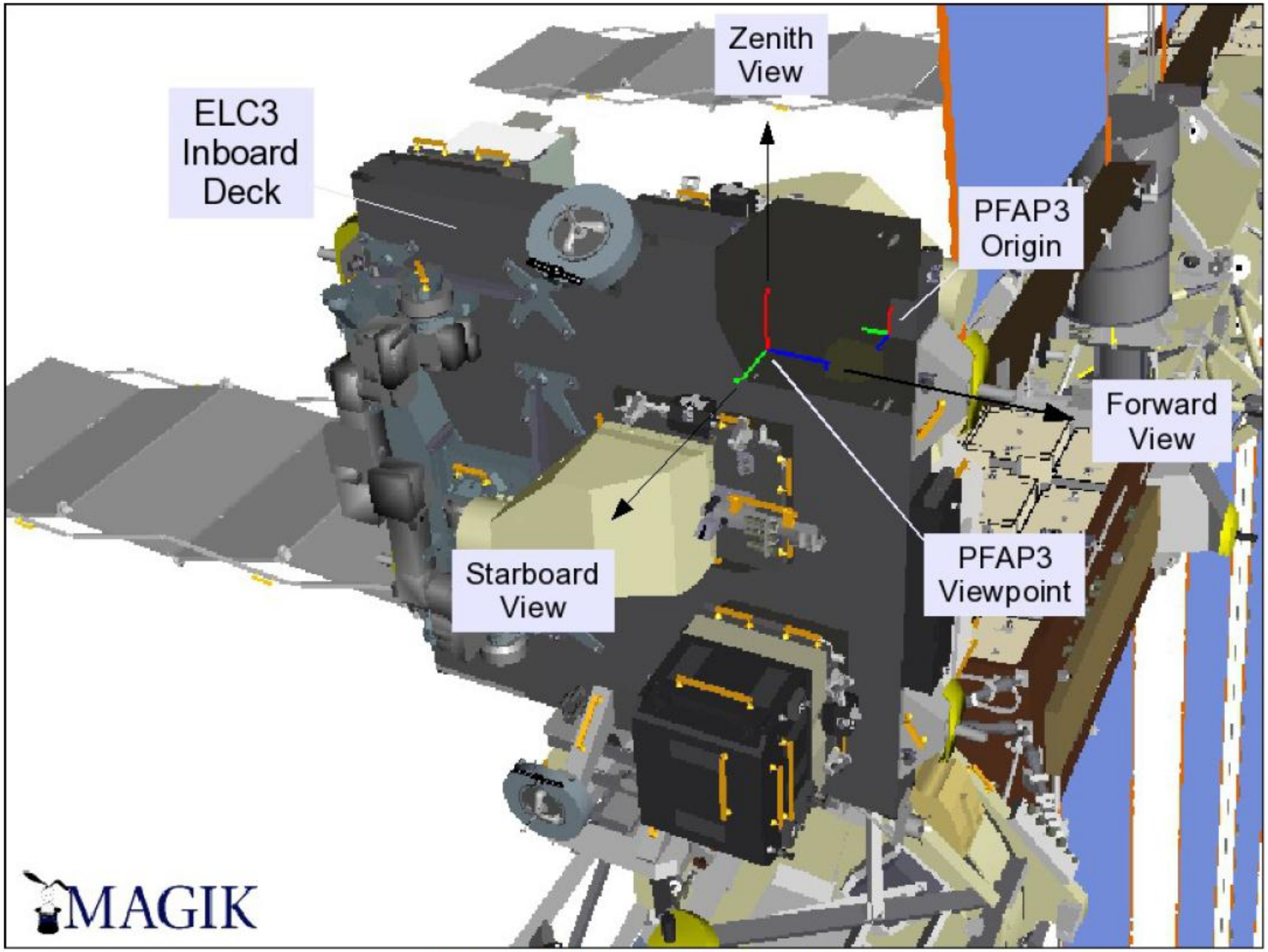
Isometric View Looking ISS Aft-Port-Nadir

Zenith Looking Field of View Analysis for ELC2/7



ELC2 PFAP7 Zenith Facing Fish-eye FOV

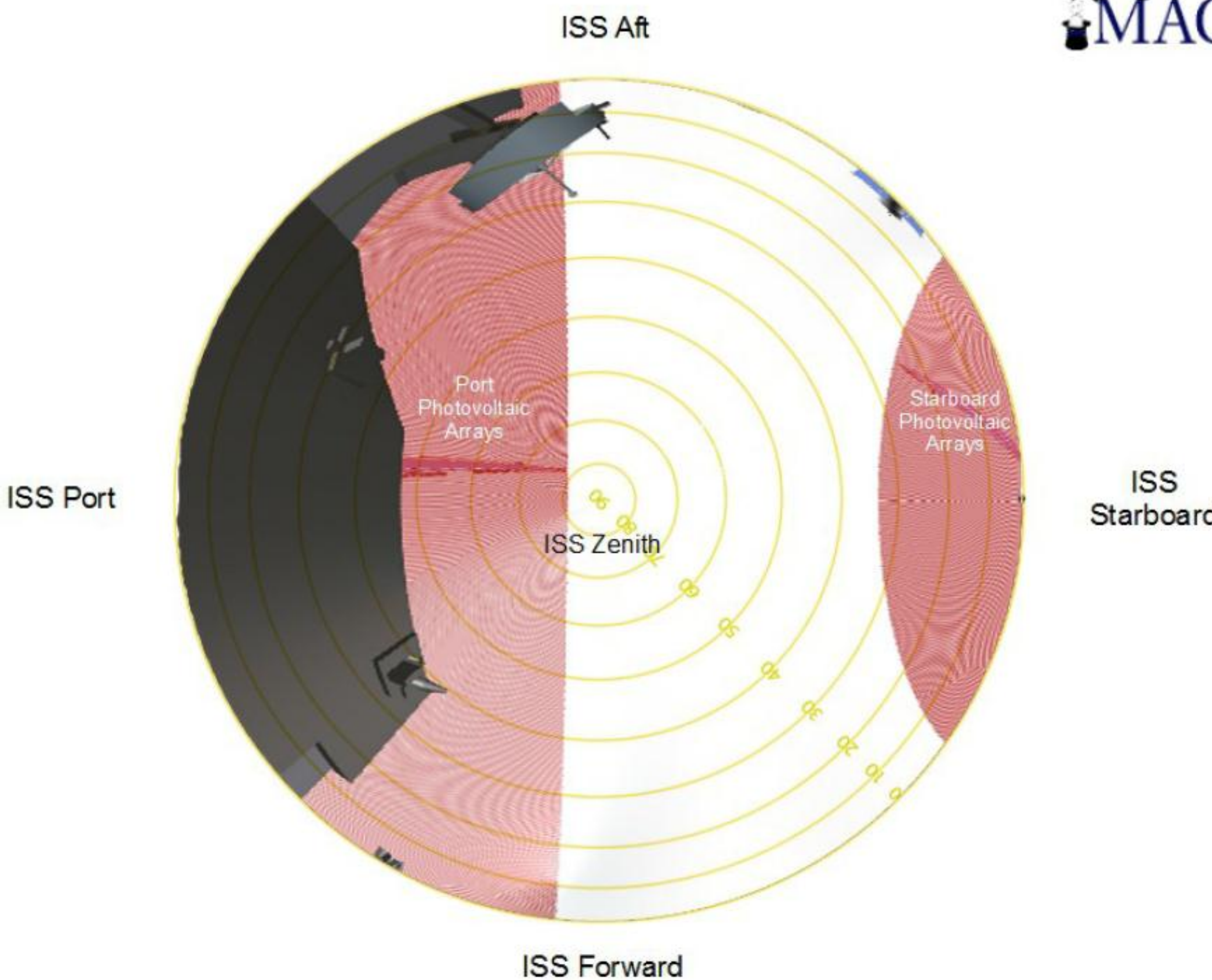
Placement of “Eye” Point for Sensor Viewing for Field of View Analysis



ELC3 PFAP3 Viewing Location

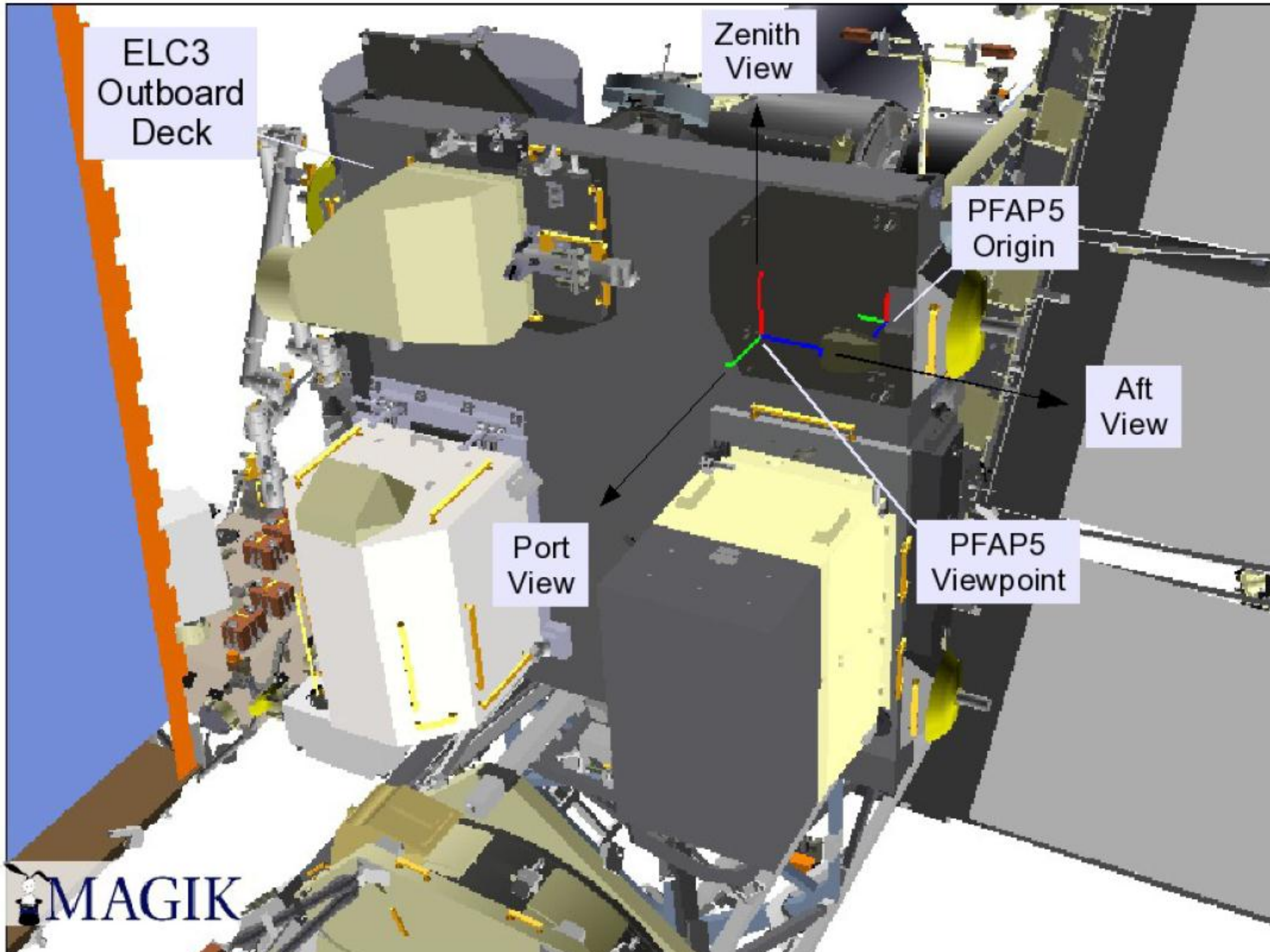
Isometric View Looking ISS Aft-Port-Nadir

Zenith Looking Field of View Analysis for ELC3/3



ELC3 PFAP3 Zenith-Facing Fish-eye FOV

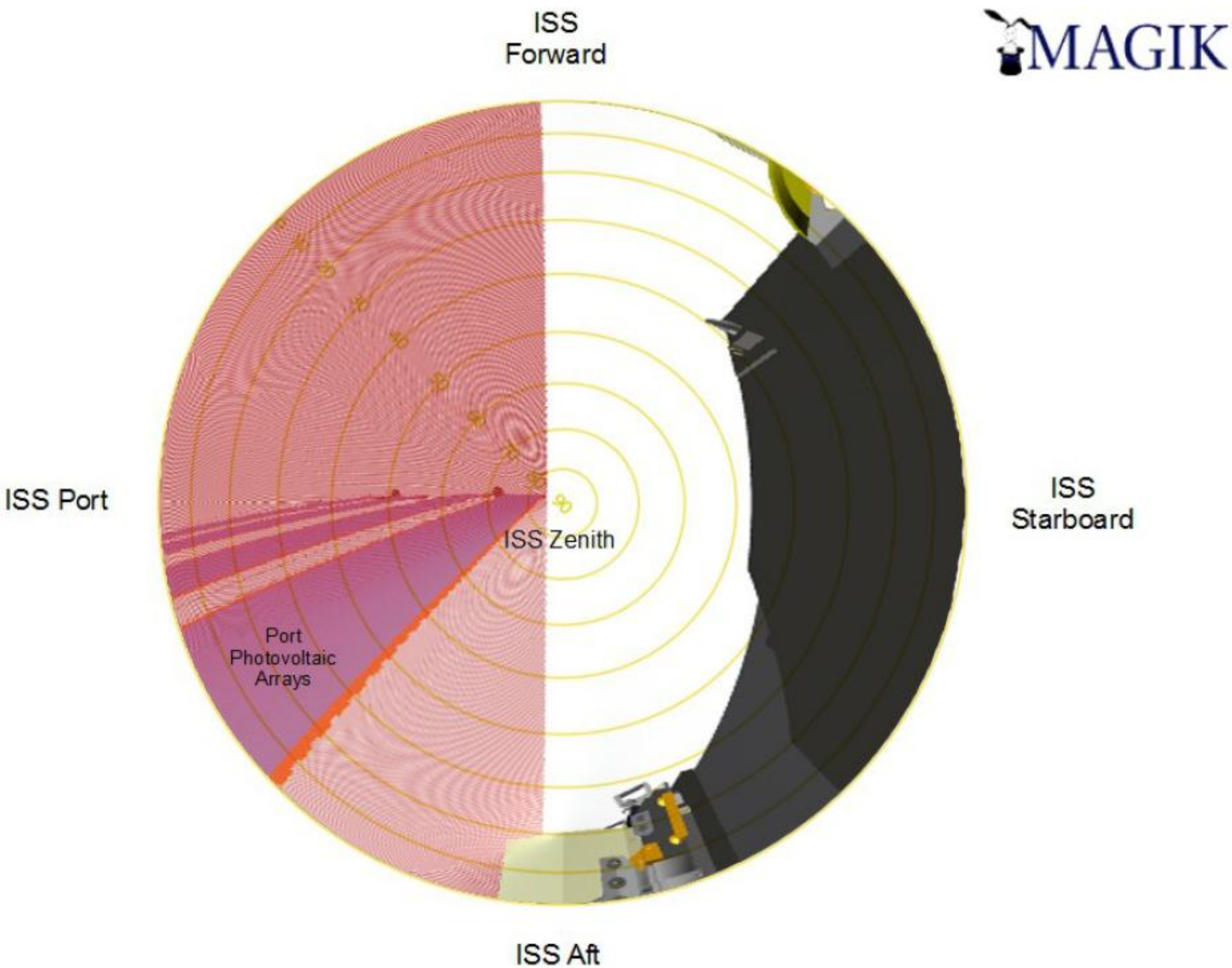
Placement of "Eye" Point for Sensor Viewing for Field of View Analysis



ELC3 PFAP5 Viewing Location

Isometric View Looking ISS Forward-Starboard-Nadir

Zenith Looking Field of View Analysis for ELC3/5



ELC3 PFAP5 Zenith-Facing Fish-eye FOV

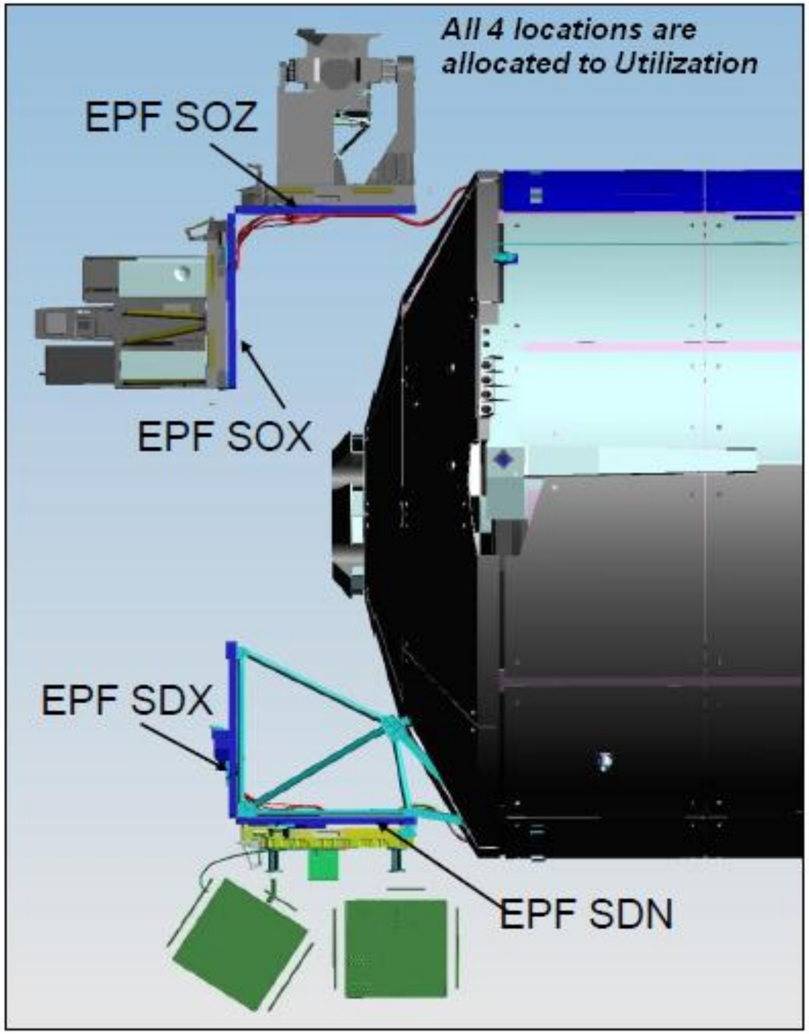
External Research Accommodations

Columbus External Resources

Mass capacity	230 kg (500 lb)
Volume	1 m^3
Power	2.5 kW total to carrier (shared)
Thermal	Passive
Low-rate data	1 Mbps (MIL-STD-1553)
Medium-rate data	2 Mbps (shared)
Sites available to NASA	2 sites

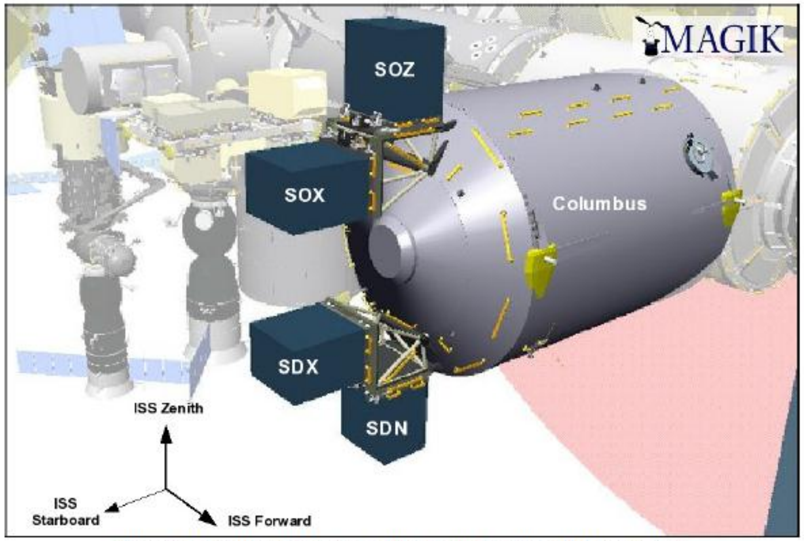
Columbus EF

Columbus EF Overview

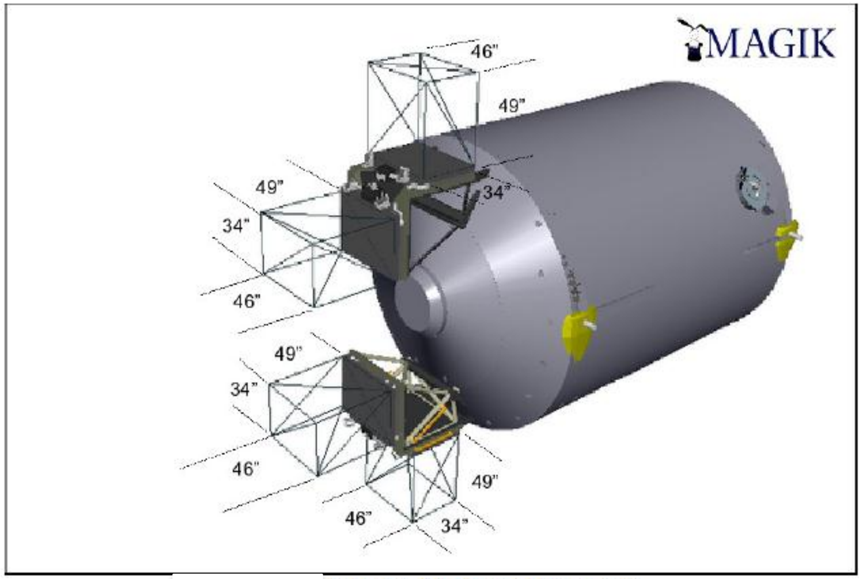


Location	Viewing	Payload Size	Power	Data
SOZ	Zenith	226 kg + CEPA	1.25 kW at 120 VDC 2.5 kW max	Ethernet, 1553
SOX	Ram			
SDX	Ram			
SDN	Nadir			

Placement of “Eye” Point for Sensor Viewing for Field of View Analysis

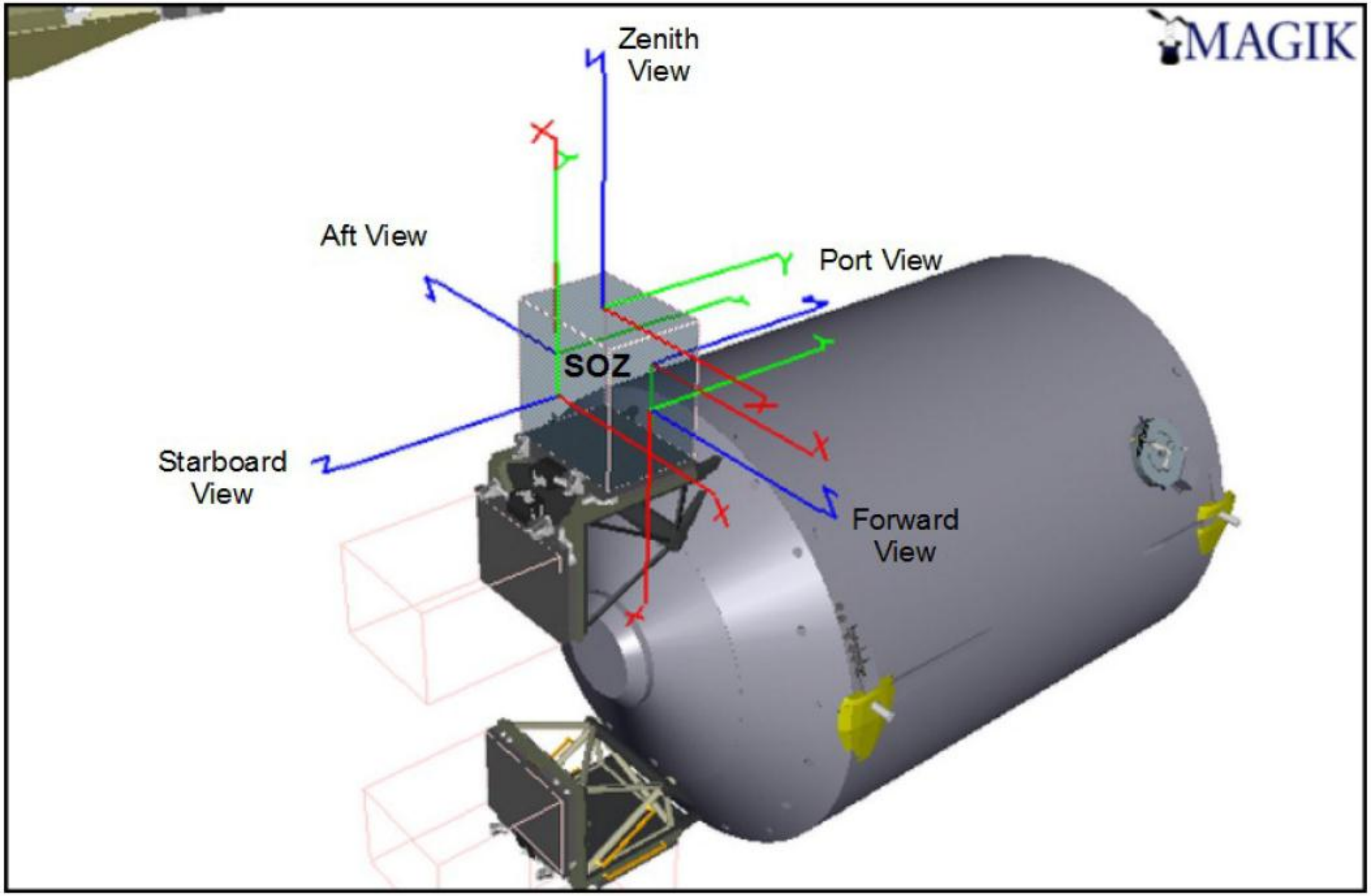


Columbus External Payloads Facility (EPF) Overview



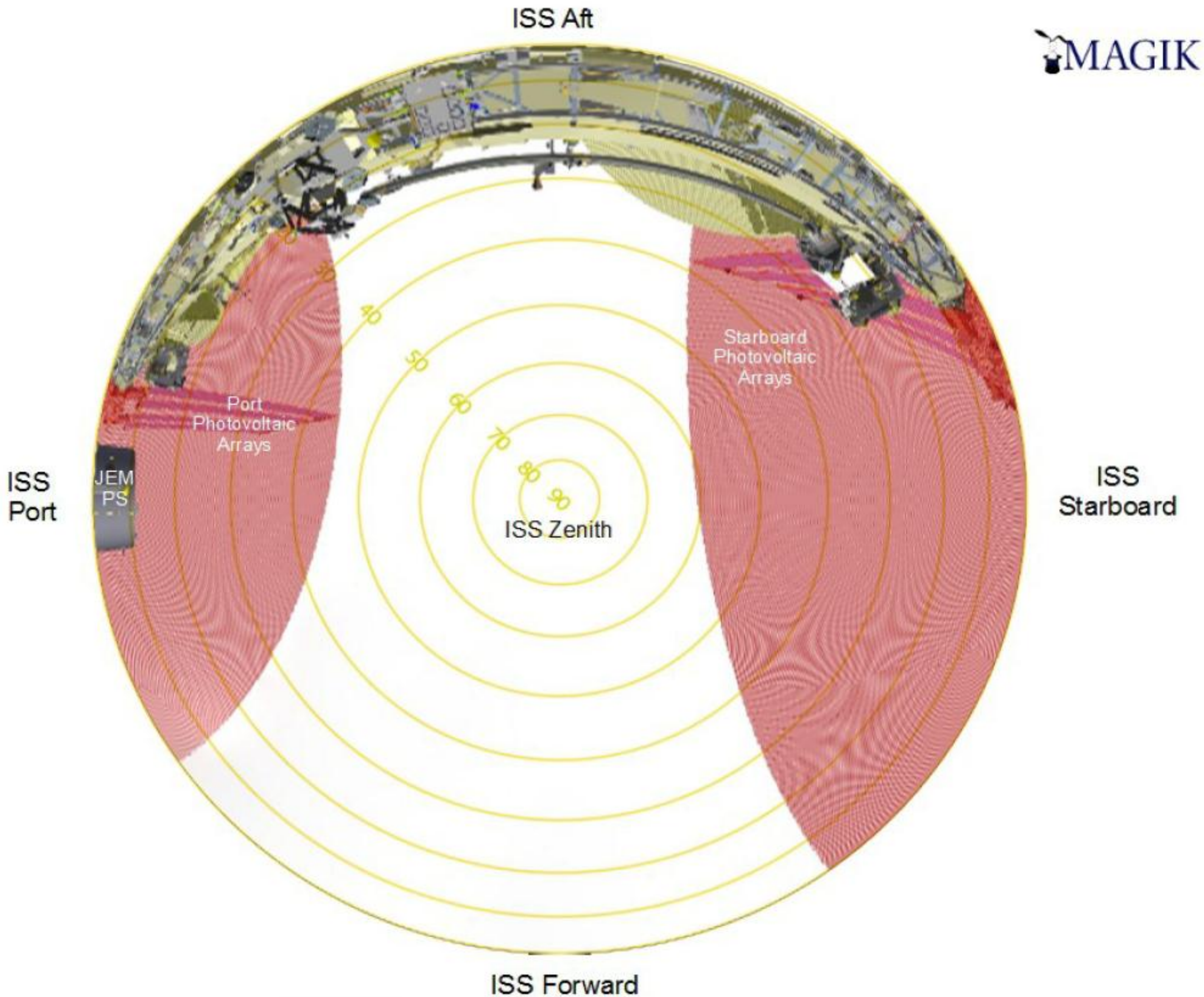
Columbus EPF Payload Dimensions

Placement of "Eye" Point for Sensor Viewing for Field of View Analysis



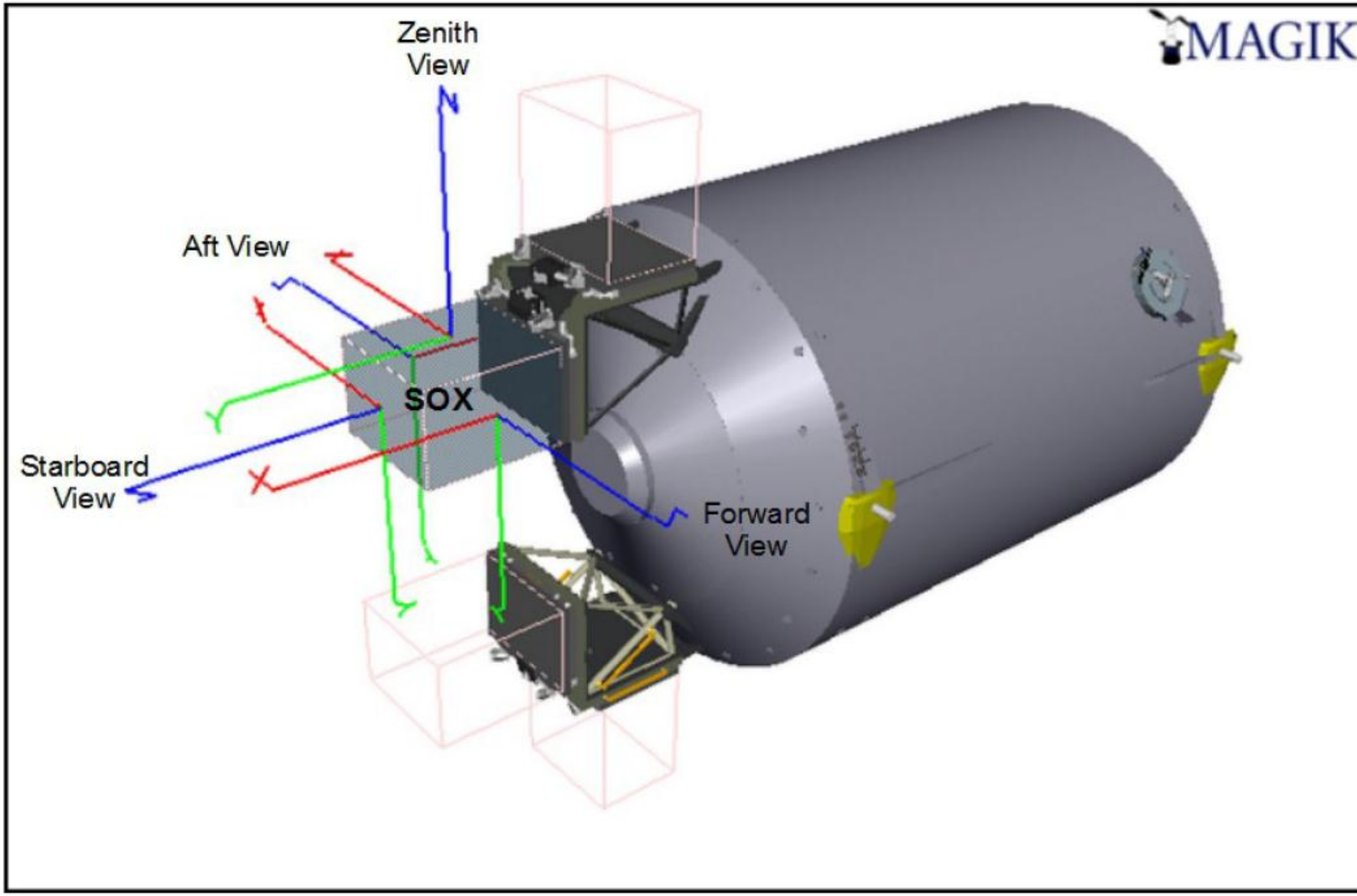
Columbus External Payloads Facility (EPF) Starboard Overhead Zenith (SOZ) Site Viewing Directions

Zenith Looking Field of View Analysis for Columbus SOZ



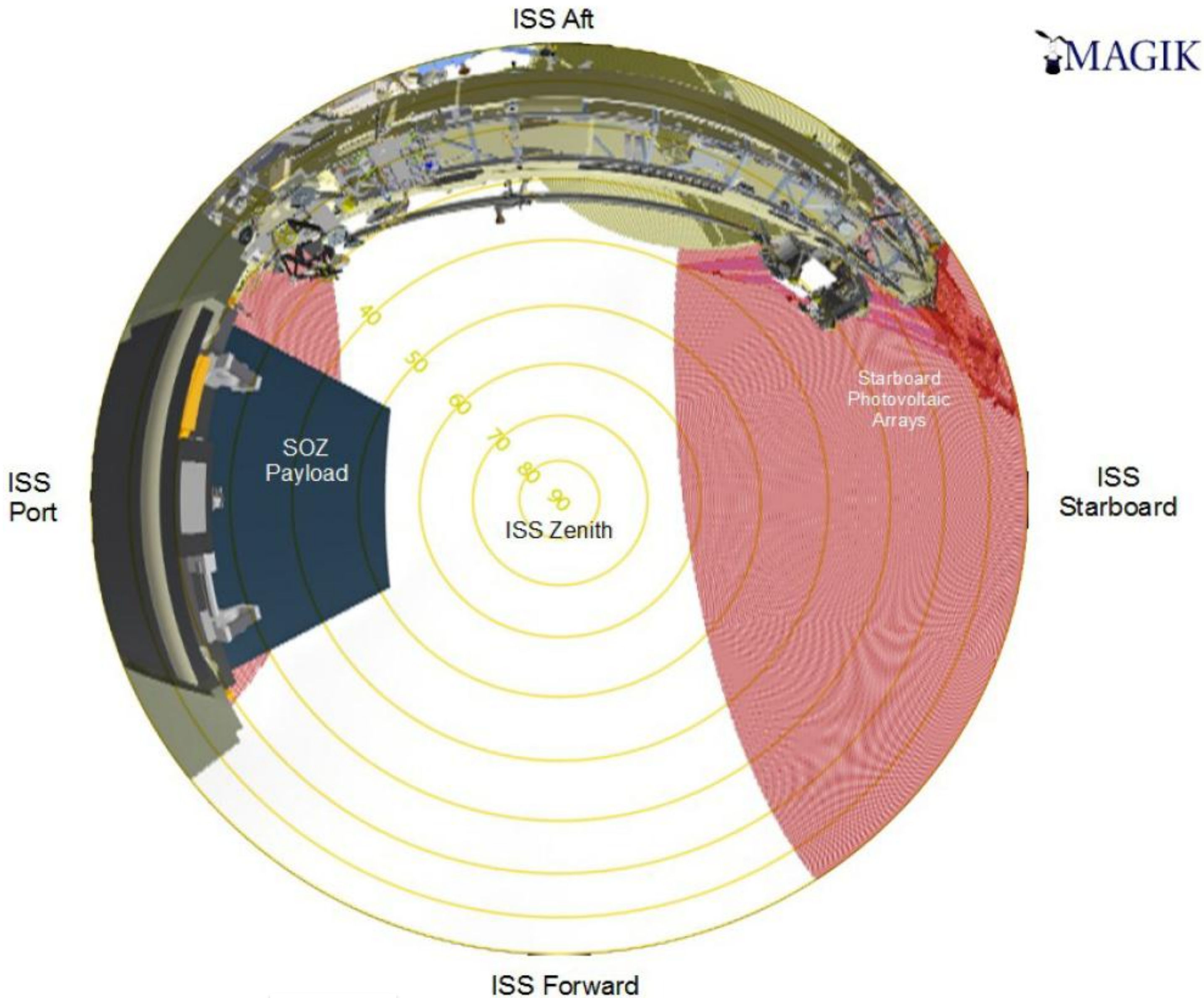
Columbus SOZ Zenith-Facing Fish-eye FOV

Placement of “Eye” Point for Sensor Viewing for Field of View Analysis



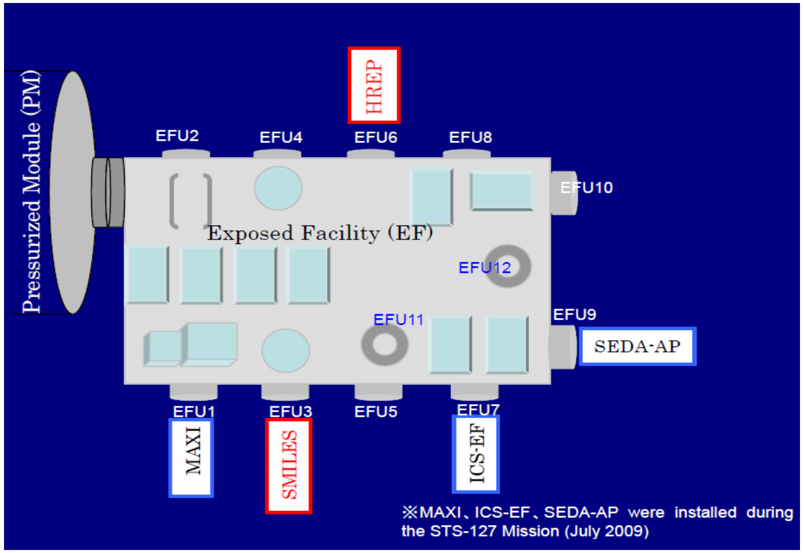
Columbus External Payloads Facility (EPF) Starboard Overhead X-Direction (SOX) Site Viewing Directions

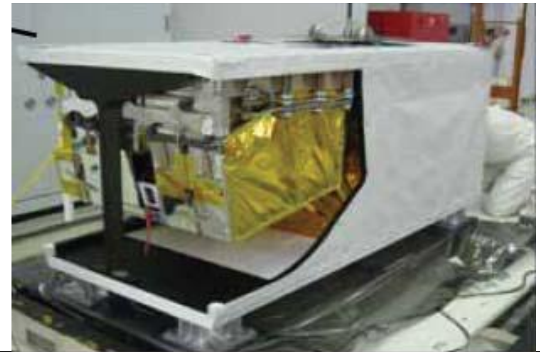
Zenith Looking Field of View Analysis for Columbus SOX



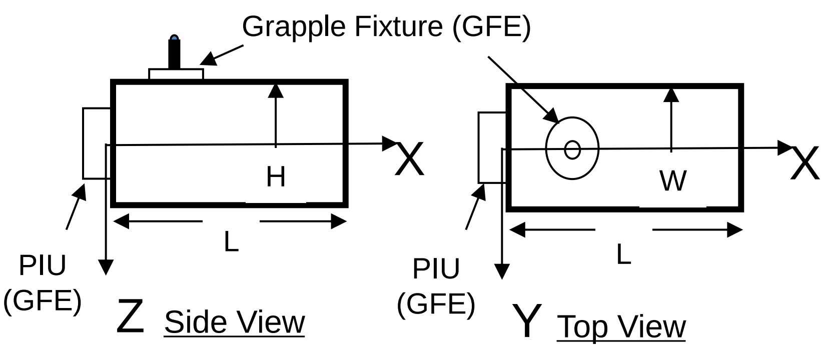
Columbus SOX Zenith-Facing Fish-eye FOV

JEM EF External Research Accommodations





NASA/DOD HREP payload

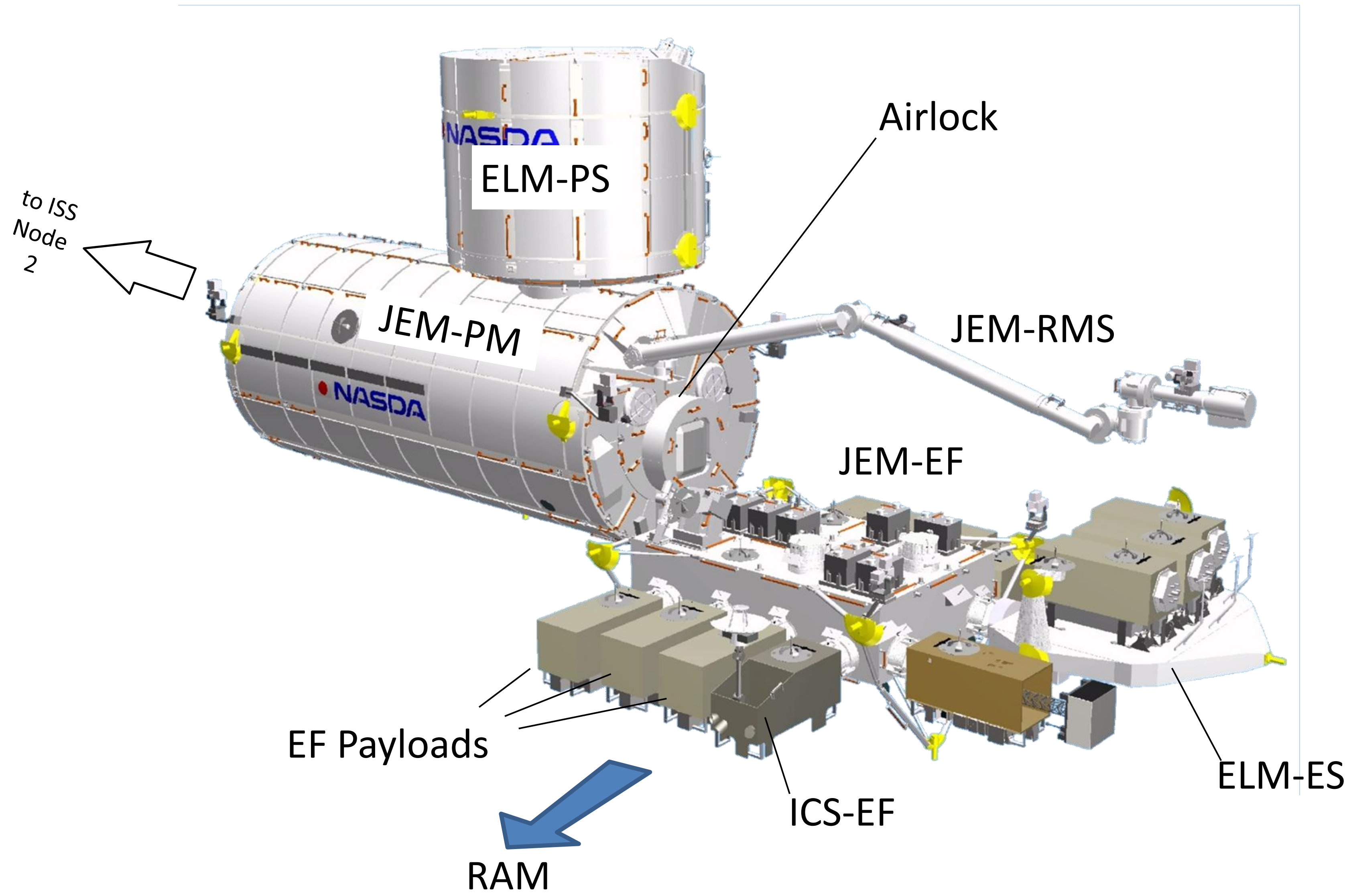


Axis	mm	ft	inch
W	800	2	7.50
H	1000	3	3.37
L	1850	6	0.83

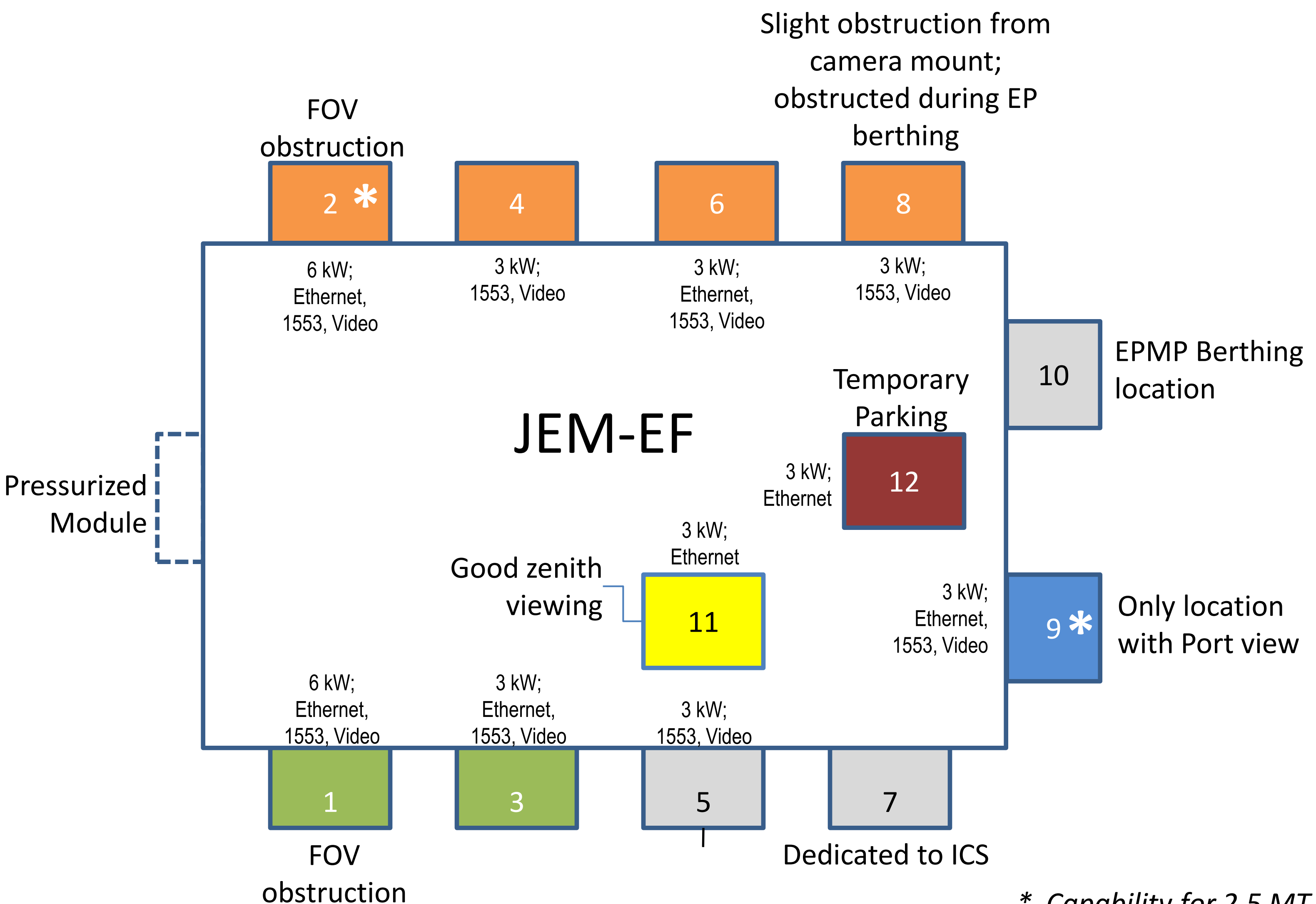
Mass capacity	550 kg (1,150 lb) at standard site 2,250 kg (5,550 lb) at large site
Volume	1.5 m^3
Power	3-6 kW, 113 – 126 VDC
Thermal	3-6 kW cooling
Low-rate data Medium-rate data	1 Mbps (MIL-STD-1553, two way) 1EEE-802.3(10BASE-T, two way) *
High-rate data	43 Mbps (shared, one way downlink)
Sites available to NASA	5 sites

- **Ethernet bus is tested to 100BASE-T capacity.**
- **Upgrade to 100BASE-T is being worked by JAXA**

Japanese Experiment Module Exposed Facility (JEM EF) Overview



JEM EF EFU Location Overview

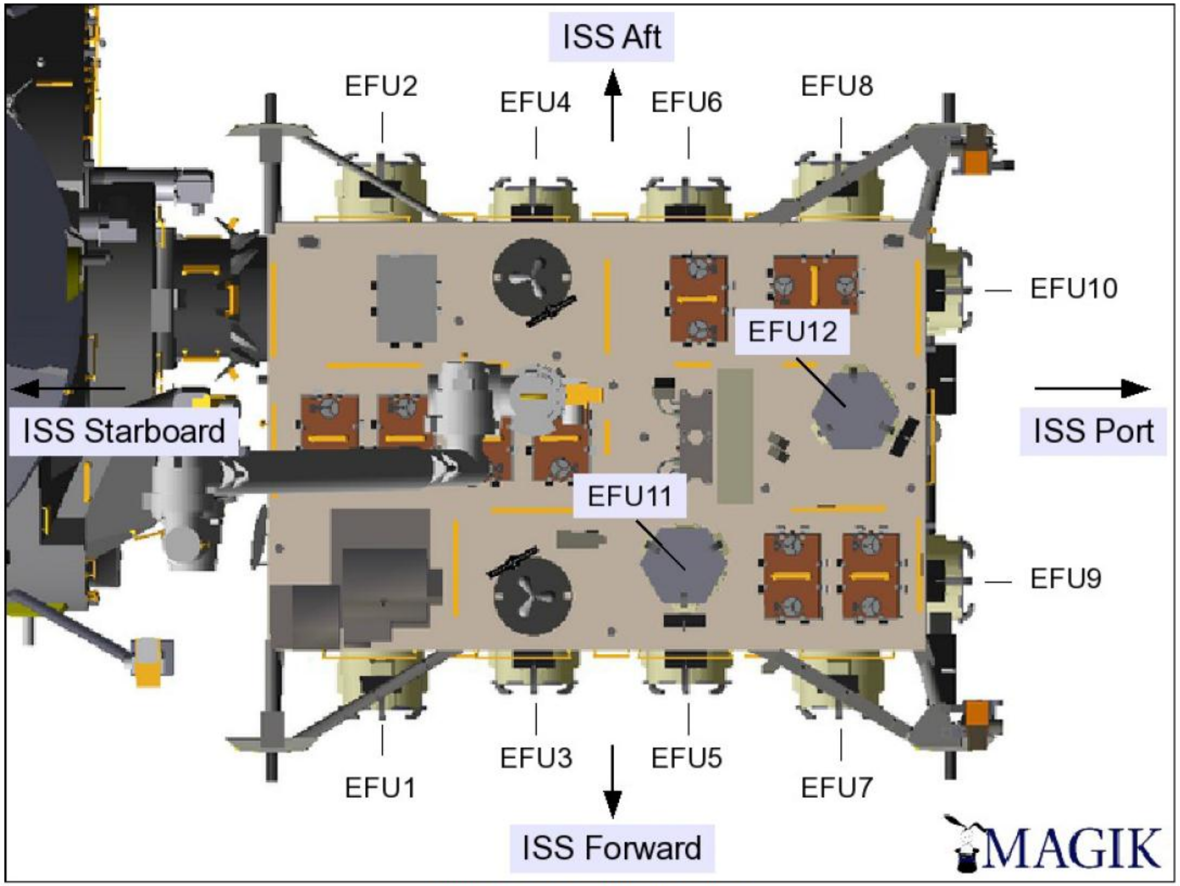


** Capability for 2.5 MT payload*

JEM-EF Detailed Accommodations by Site

Location	Viewing	Payload Size	Description / Notes	Power	Data
1	Ram, Nadir, Zenith	500 kg	Ram field of View (FOV) obstruction by JEM module	6 kW	Ethernet, 1553, Video
3	Ram, Nadir, Zenith	500 kg	Clear view	3 kW	Ethernet, 1553, Video
5	Ram, Nadir, Zenith	500 kg	ICS System back-up site (negotiable?)	3 kW	1553, Video
7	Ram, Nadir, Zenith	500 kg	ICS-dedicated	-	-
9	Port, Zenith, Nadir	2.5 MT	Best volumetrically for large payloads (up to 2.5 MT), but not necessarily the best viewing	3 kW	Ethernet, 1553, Video
2	Wake, Nadir, Zenith	2.5 MT	Can hold large payloads, but has an FOV obstruction by JEM module	6 kW	Ethernet, 1553, Video
4	Wake, Nadir, Zenith	500 kg	Clear view	3 kW	1553, Video
6	Wake, Nadir, Zenith	500 kg	Clear view	3 kW	Ethernet, 1553, Video
8	Wake, Nadir, Zenith	500 kg	Obstruction during EP berthing, slight obstruction from camera mount	3 kW	1553, Video
10	Wake, Nadir, Zenith	500 kg	EPMP berthing site	-	-
11	Zenith only	500 kg	Good Zenith viewing	3 kW	Ethernet
12	Zenith only	500 kg	Temporary stowage location	3 kW	Ethernet

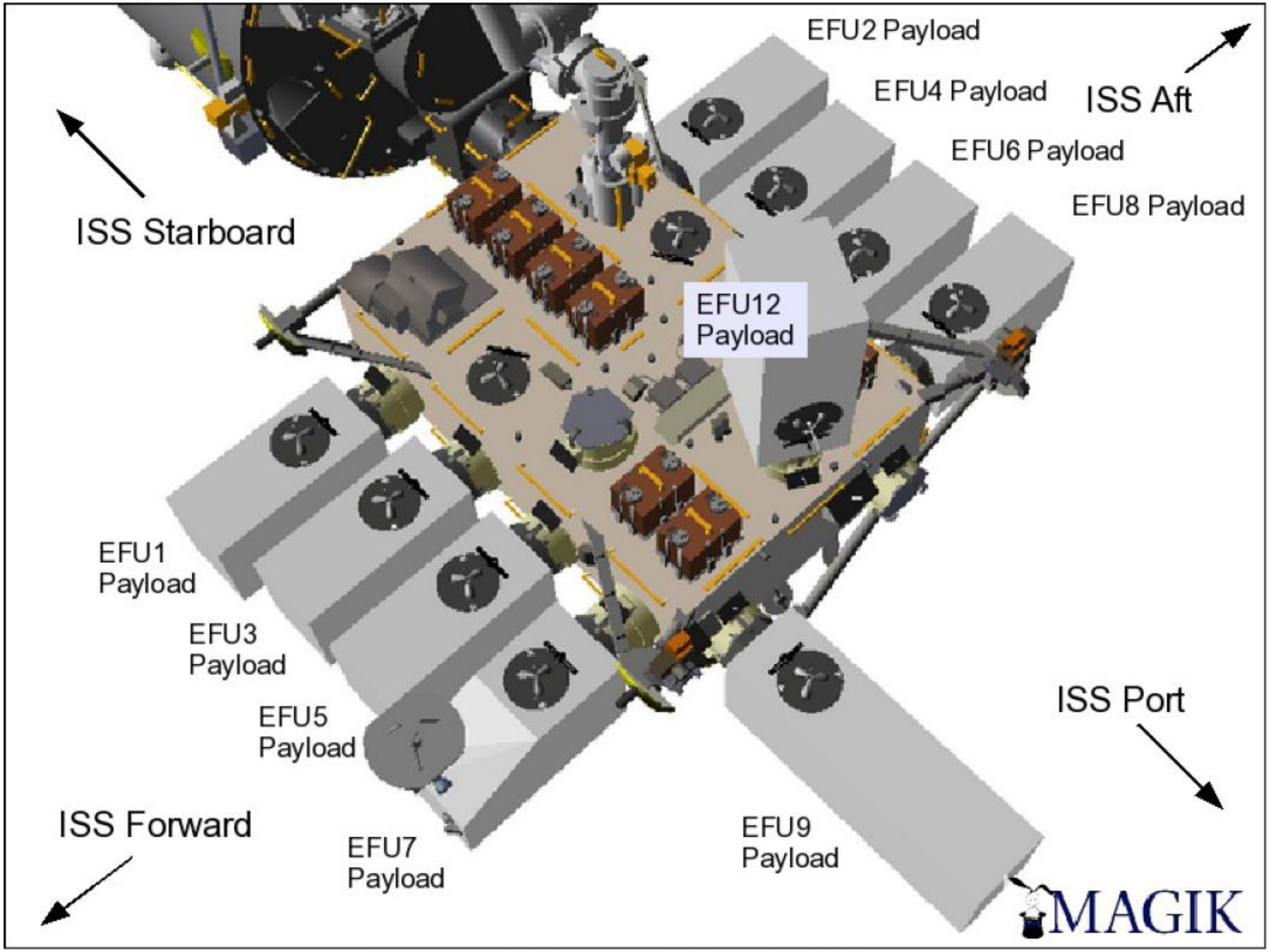
JEM-EF External Sites Locations



EFU Location on JEM-EF
Orthographic View Looking ISS-Nadir

http://iss-www.jsc.nasa.gov/nwo/pio/magik/web/ - MAGIK AI 2514, Rev A 4

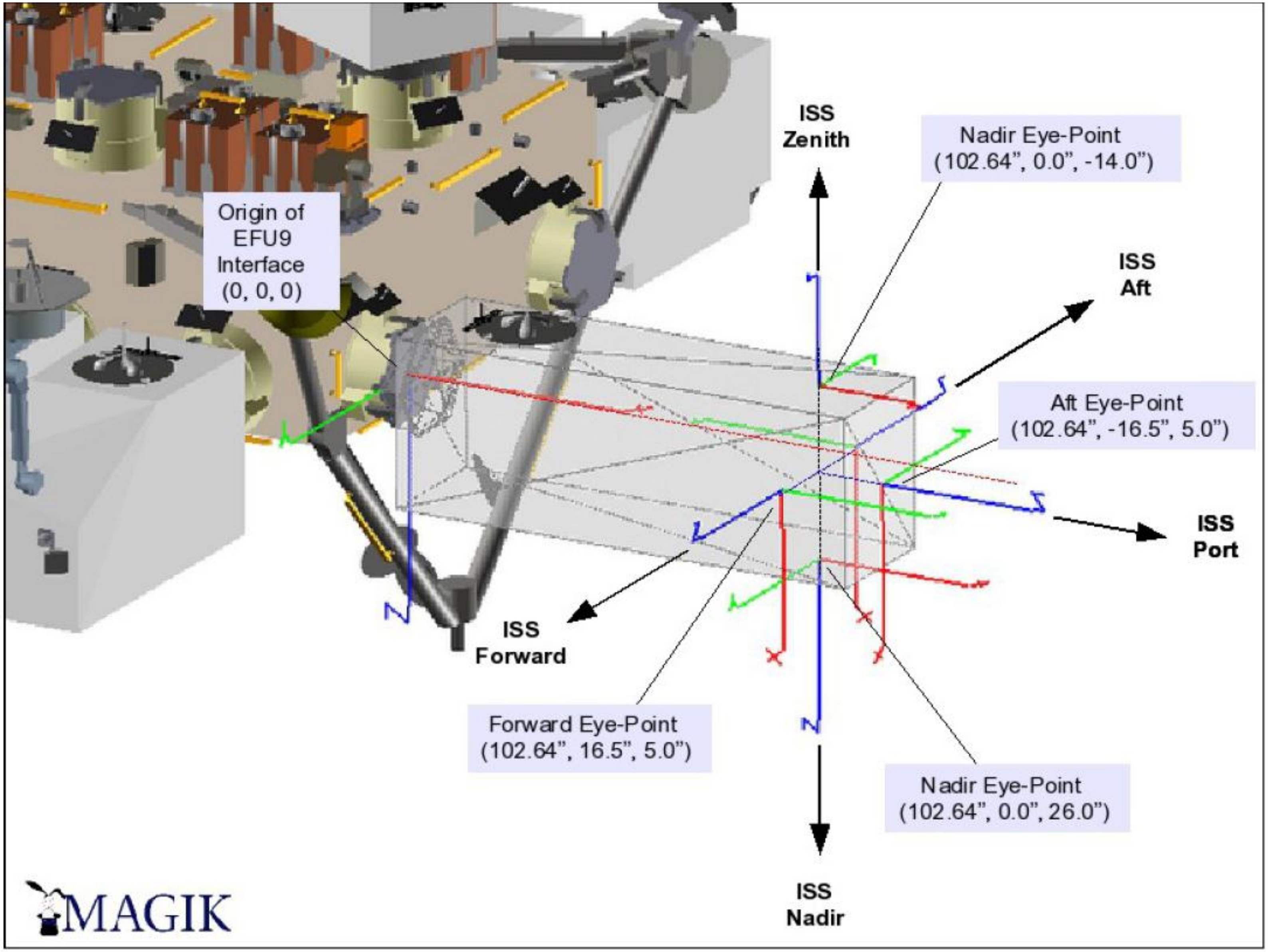
JEM-EF External Sites Locations



EFU Payload Locations on JEM-EF

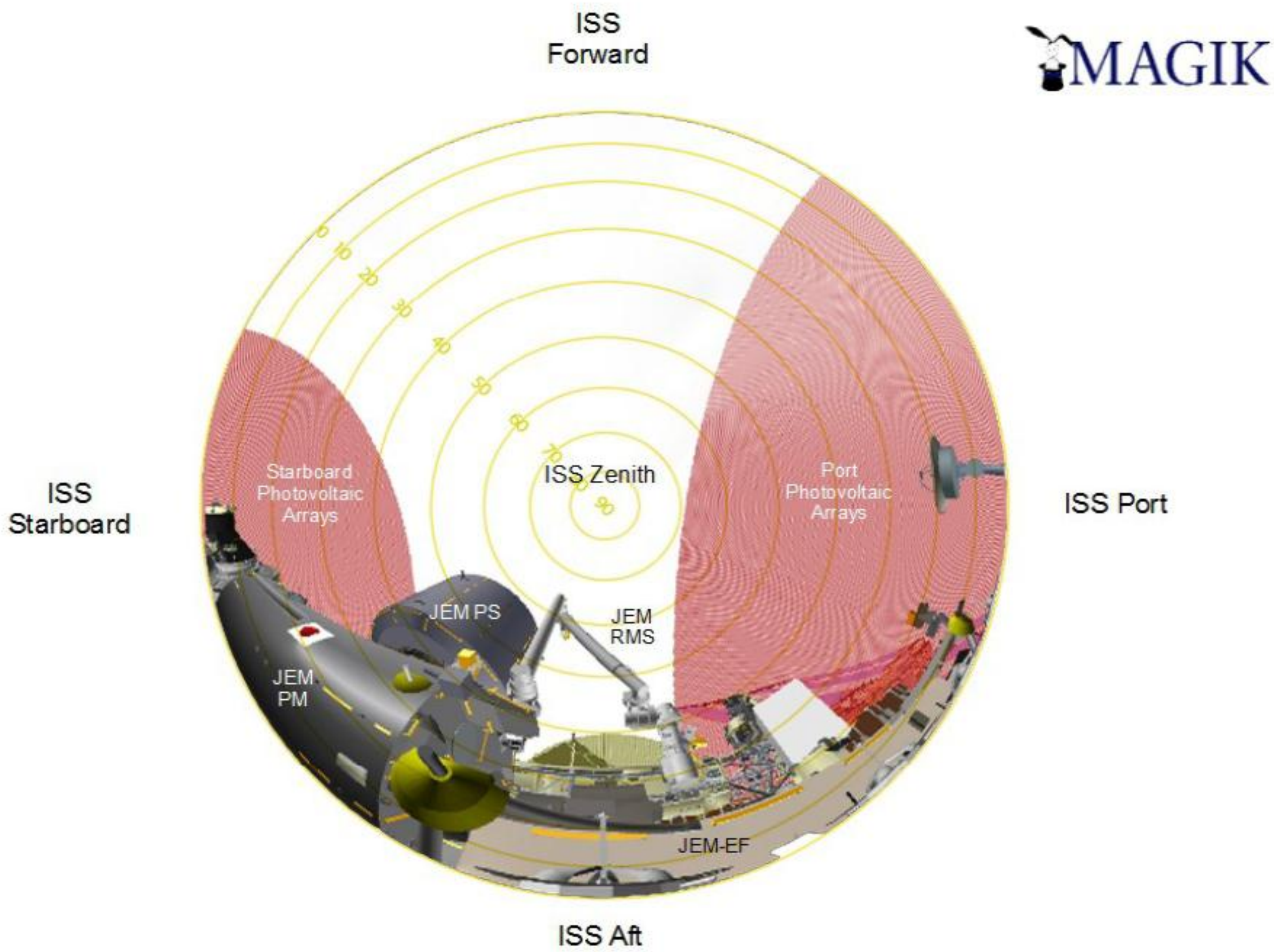
Isometric View Looking ISS-Aft-Starboard-Nadir

Placement of "Eye" Point for Sensor Viewing for Field of View Analysis



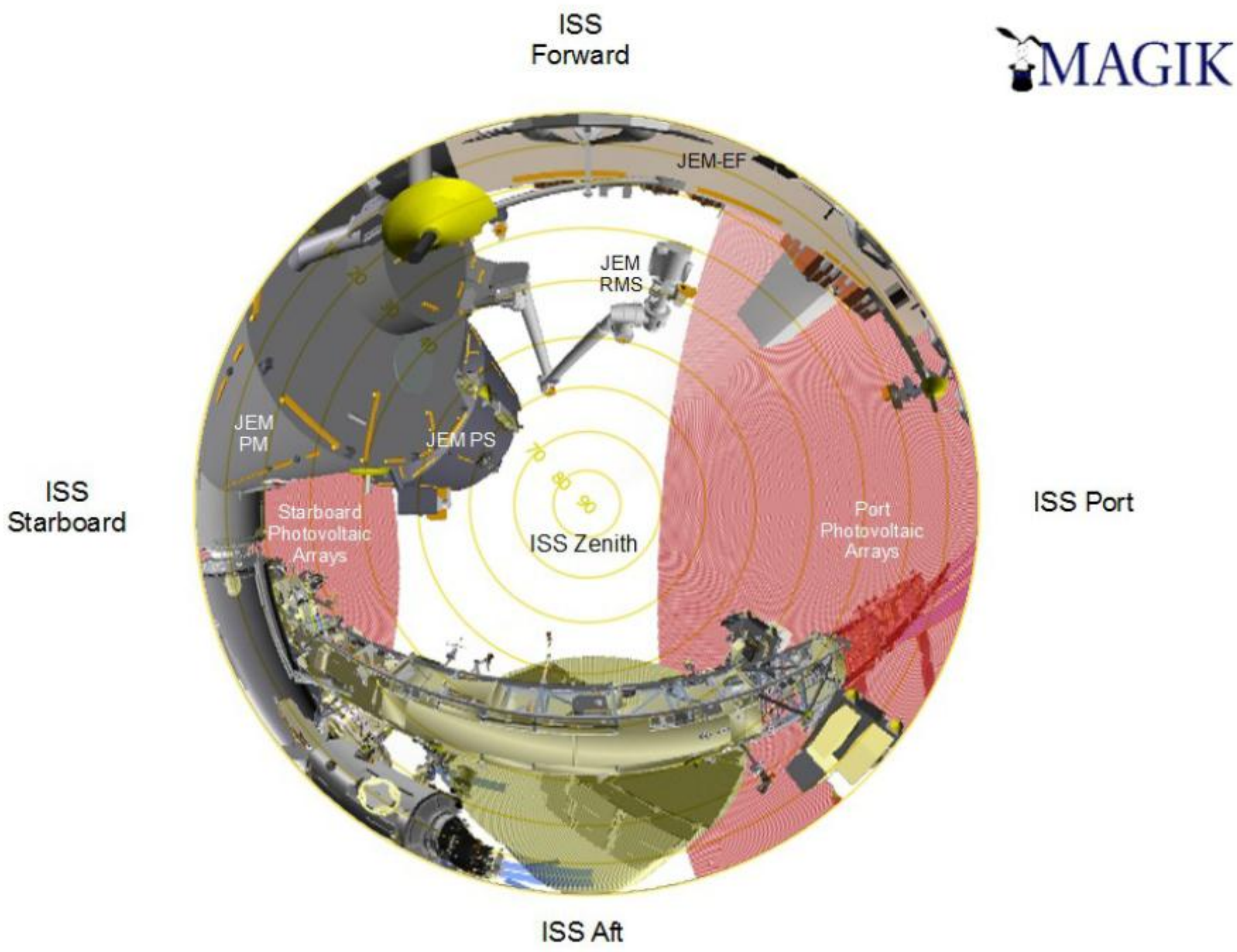
Placement of Eye-Point for Sensor Located on Zenith Face of Generic EFU9 Payload Facing ISS-Nadir

Zenith Looking Field of View Analysis for JEM-EF 1



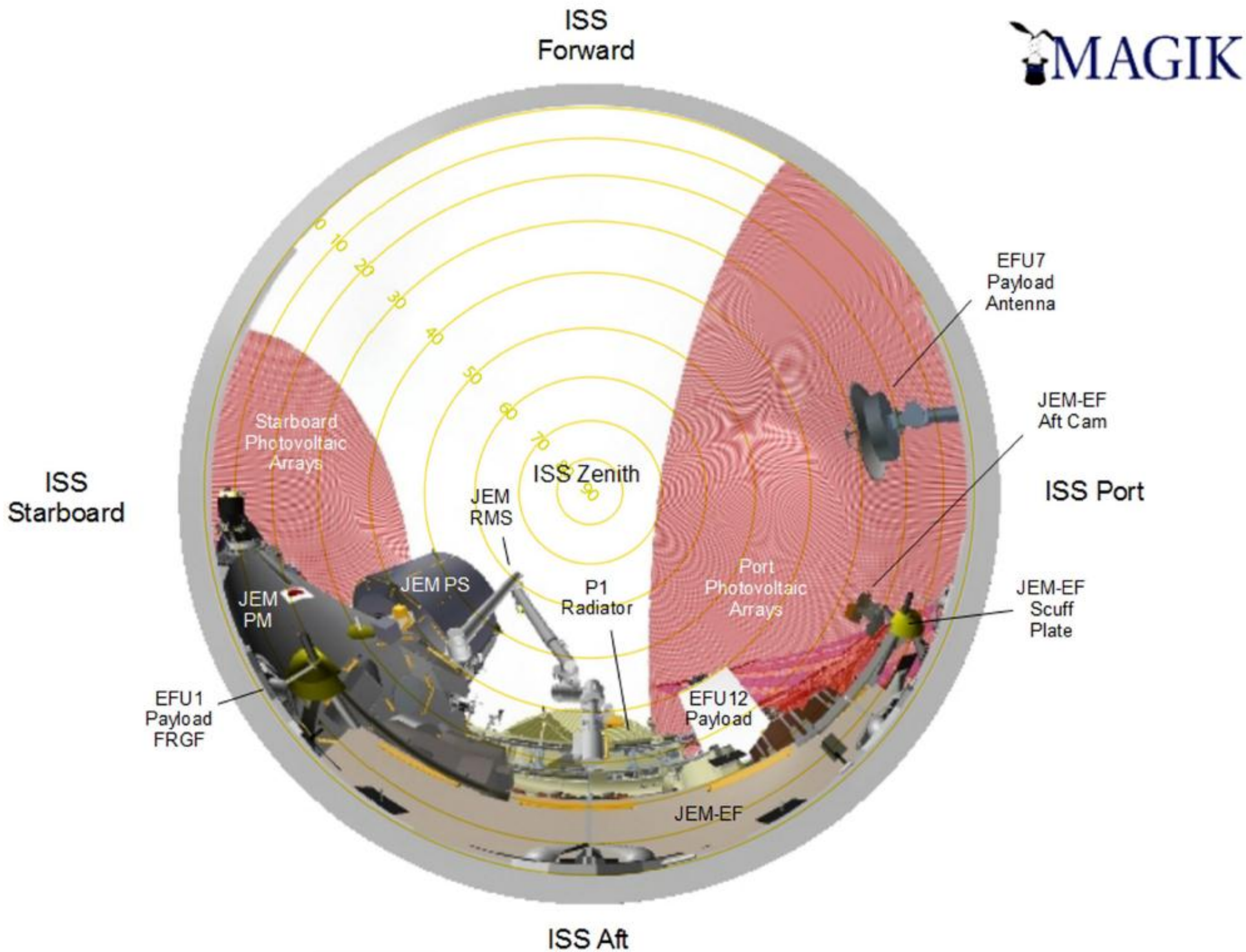
JEM EFU1 Payload Zenith Face Fish-eye FOV

Zenith Looking Field of View Analysis for JEM-EF 2



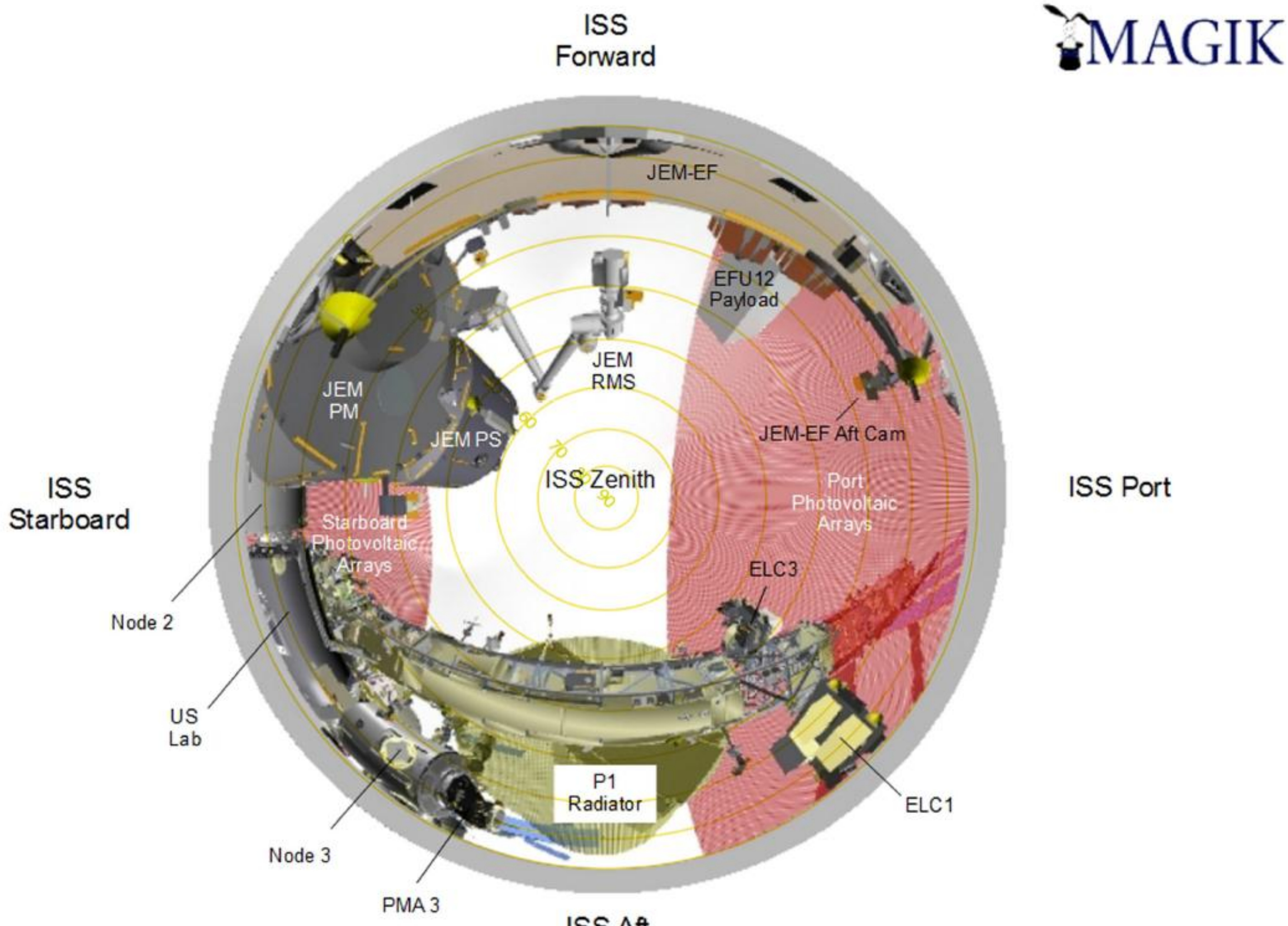
JEM EFU2 Payload Zenith Face Fish-eye FOV

Zenith Looking Field of View Analysis for JEM-EF 3



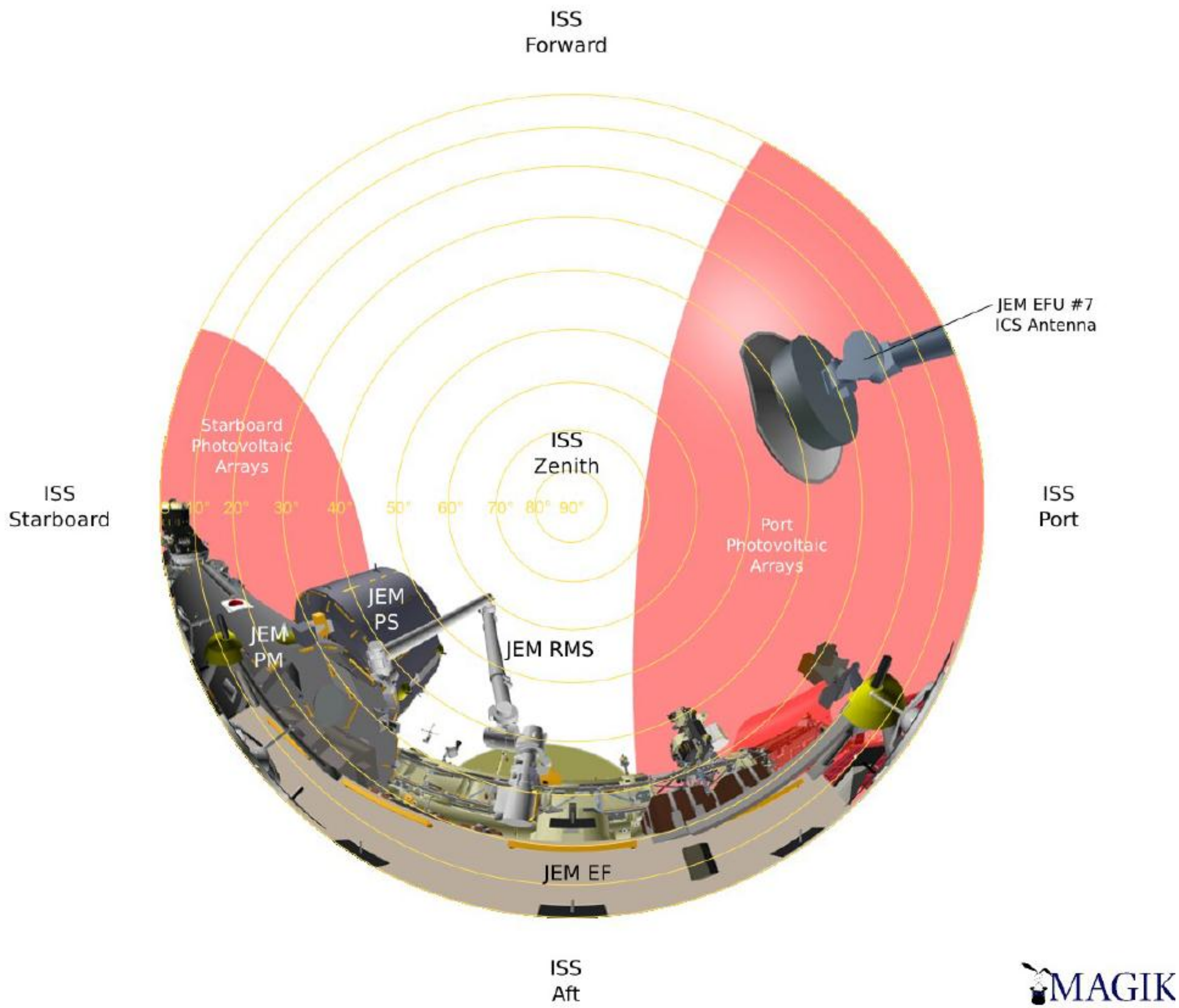
JEM EFU3 Payload Zenith Face Fish-eye FOV

Zenith Looking Field of View Analysis for JEM-EF 4



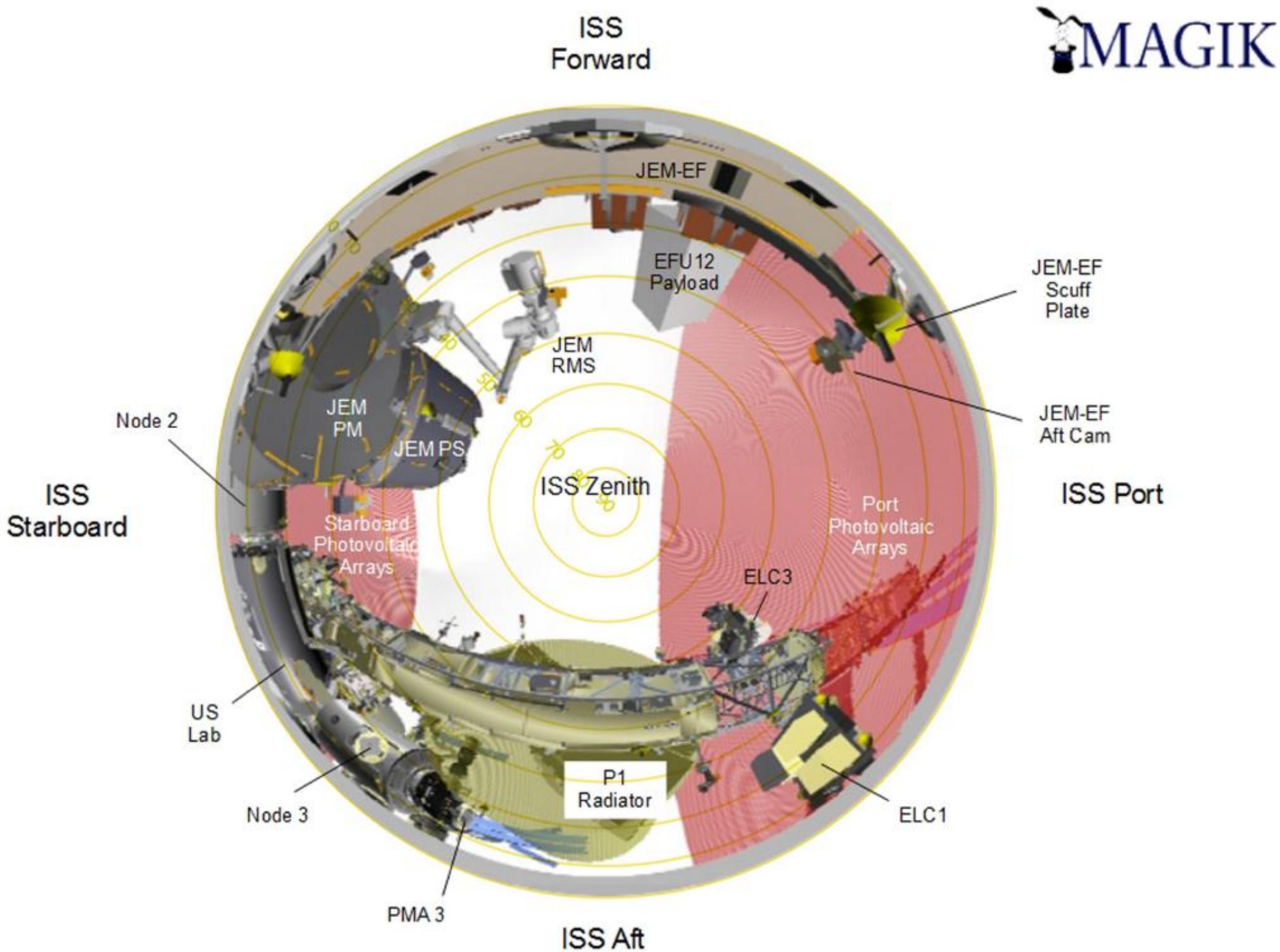
JEM EFU4 Payload Zenith Face Fish-eye FOV

Zenith Looking Field of View Analysis for JEM-EF 5



JEM EFU5 Payload Zenith Face Fish-eye FOV

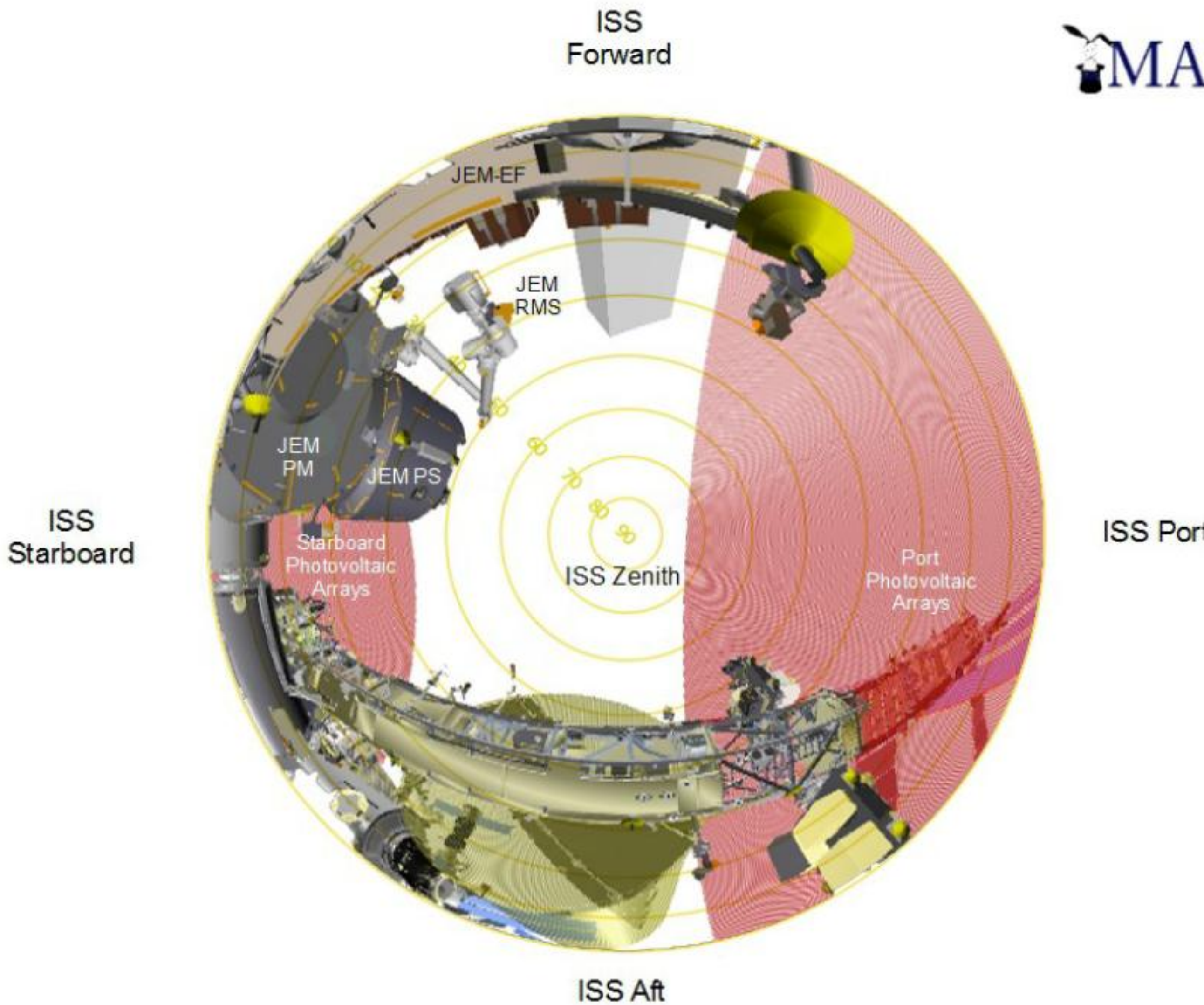
Zenith Looking Field of View Analysis for JEM-EF 6



JEM EFU6 Payload Zenith Face Fish-eye FOV

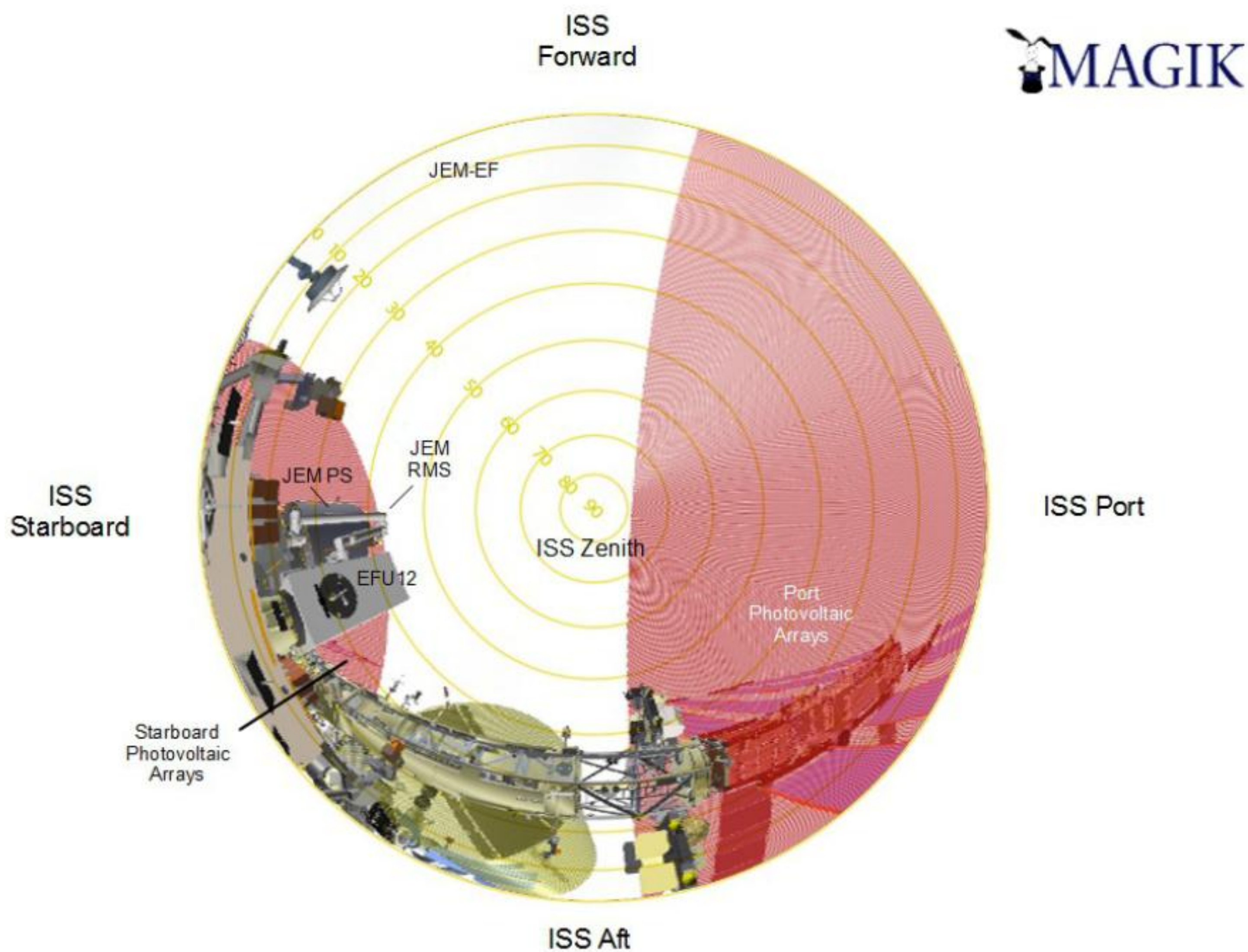
Zenith Looking Field of View Analysis for JEM-EF 8

MAGIK



JEM EFU8 Payload Zenith Face Fish-eye FOV

Zenith Looking Field of View Analysis for JEM-EF 9



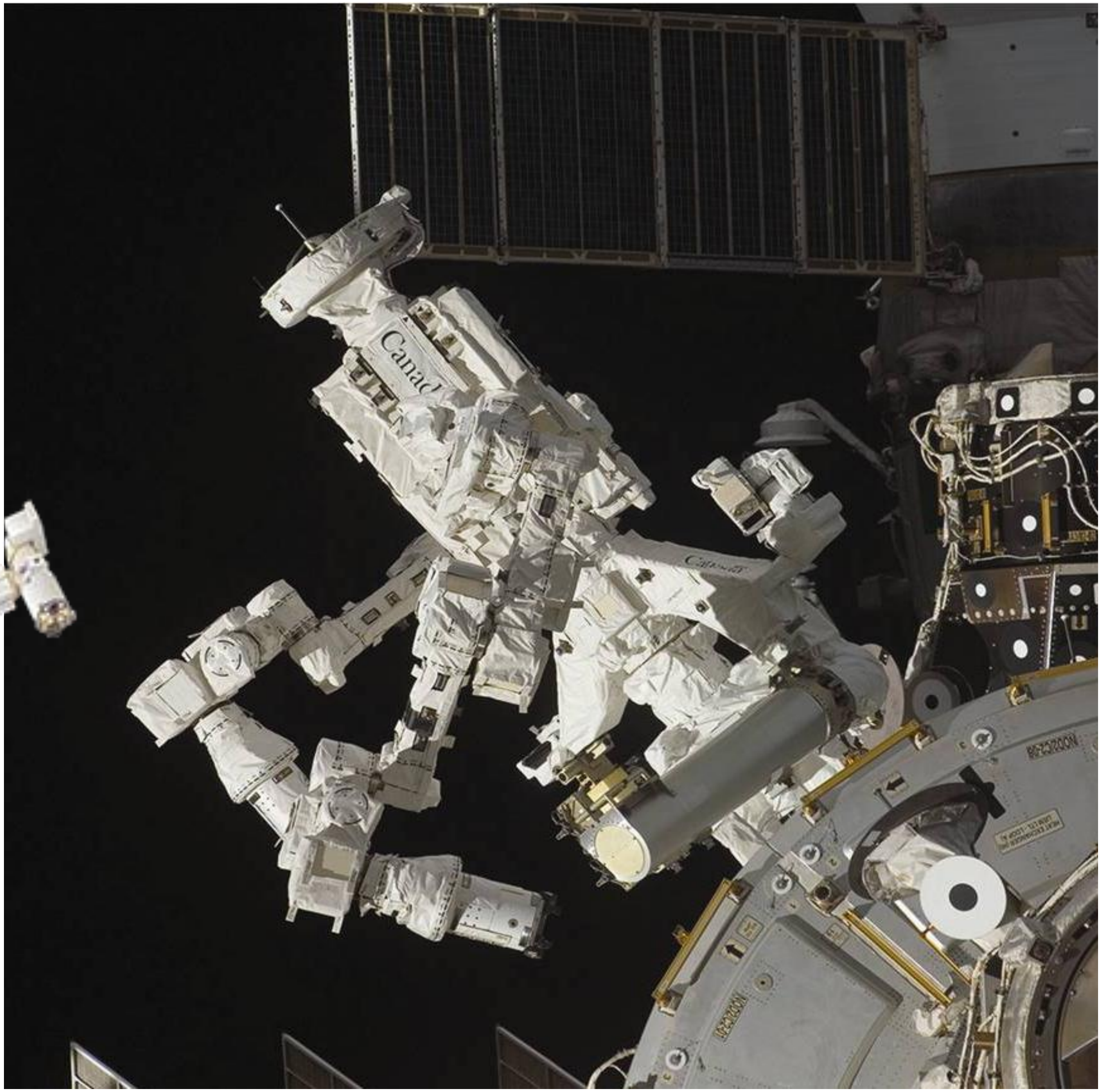
JEM EFU9 Payload Zenith Face Fish-eye FOV

Payload Allowable Up-Mass & Volume Summary Table

Attach Payload Location	Allowable Payload Weight (including Flight Support Equipment)	Accommodation Weight (including adapter plate)	Total Weight	Payload Volume (W x H x L)
HTV Exposed Pallet (JEM EF Payload)	979 Lb (445 Kg)	121 Lb (55 Kg)	1100 Lb (500 Kg)	31.5" x 39.4" x 72.8" (800mm x 1000mm x 1850 mm)
HTV Exposed Pallet (ExPA, CEPA Payload)	See ExPA & CEPA payload specification for ELC & CEF	See ExPA & CEPA payload specification for ELC & CEF	*See ExPA & CEPA payload specification for ELC & CEF	*See ExPA & CEPA payload specification for ELC & CEF
ELC (ExPA)	490 Lb (222 Kg)	250 Lb (114 Kg)	740 Lb (336 Kg)	34" x 49" X 46" (863mm x 1244mm x 1168 mm)
Columbus (CEPA)	388 Lb (176Kg)	250 Lb (114 Kg)	638 Lb (290 Kg)	34" x 49" X 46" (863mm x 1244mm x 1168 mm)
JEM-EF	979 Lb (445 Kg)	121 Lb (55 Kg)	1100 Lb (500 Kg)	31.5" x 39.4" x 72.8" (800mm x 1000mm x 1850 mm)

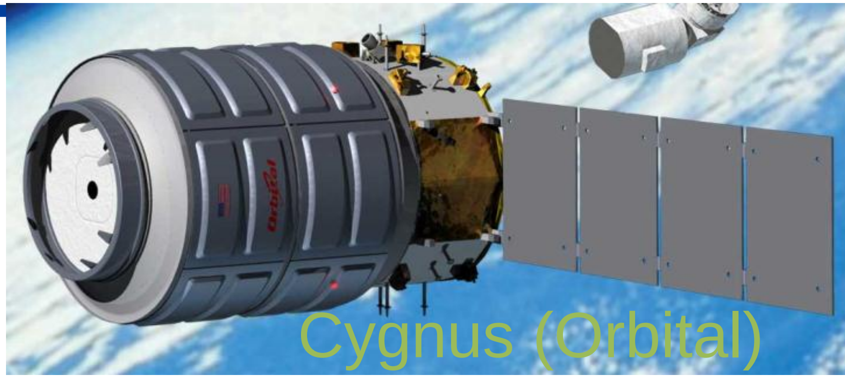
* Location constraint applies in HTV Exposed Pallet

Dexterous End Effector



SSRMS attachment which the ground team or on-orbit crew can use robotically to install, remove and replace payloads and failed components

ISS Visiting Vehicles Post-Shuttle

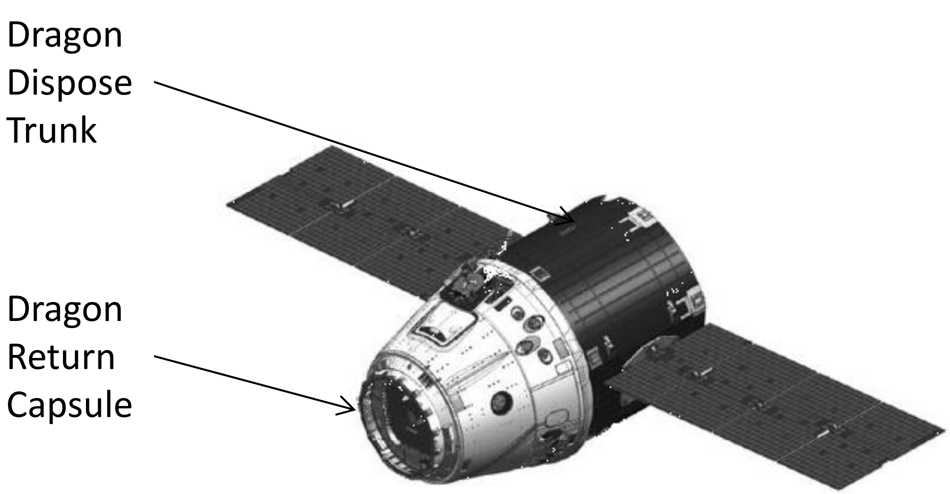


Progress/Soyuz (Energia)

HTV (JAXA)

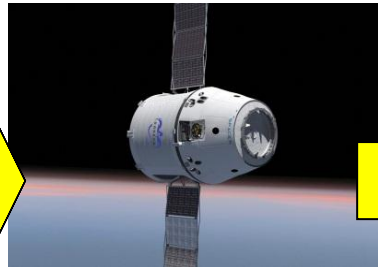
SpaceX Dragon Launch Vehicle

- **Space X Dragon Launch Vehicle**
  - The Commercial Resupply Contract (CRS) is a vehicle to provide up-mass to ISS using commercial services Space X “Falcon 9” rocket and Dragon spacecraft
  - Trunk behind Dragon for unpressurized cargo (no return capability – disposal only)
  - Dragon Trunk Capacity is ~ 1700 Kg.
  - Total Dragon cargo heater power is 200 watts

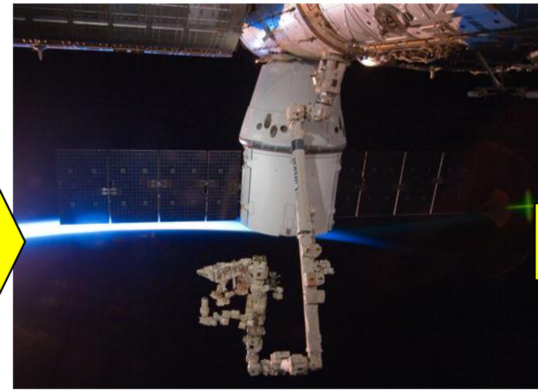


Launch and Installation

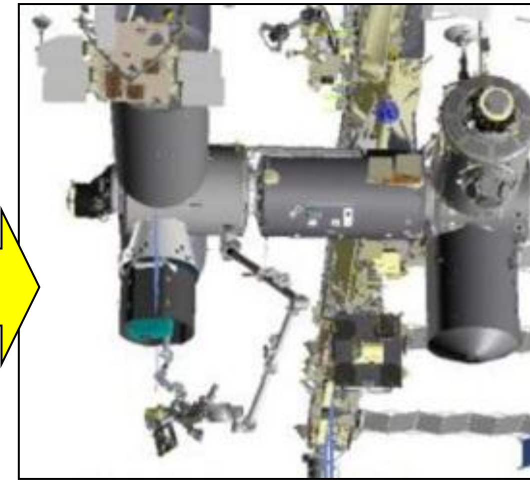
Dragon Launch



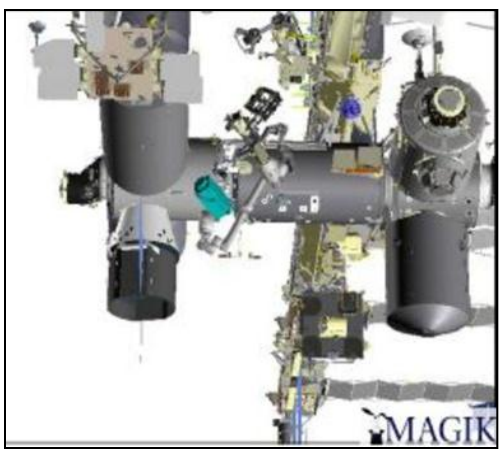
Dragon travels in lower rendezvous orbit for 2-3 days



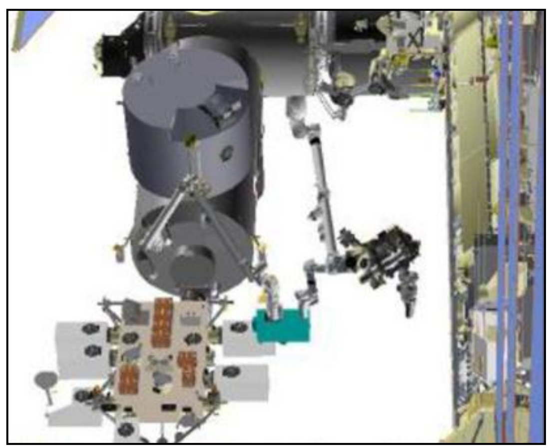
Dragon rendezvous with ISS; captured and berthed at Node 2



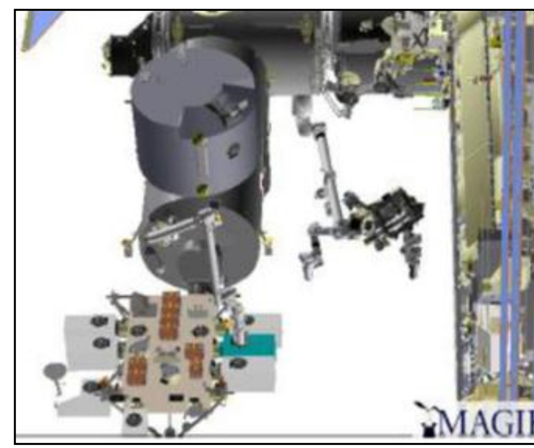
Instrument is removed from Dragon trunk by the SSRMS



Instrument is moved over to JEM

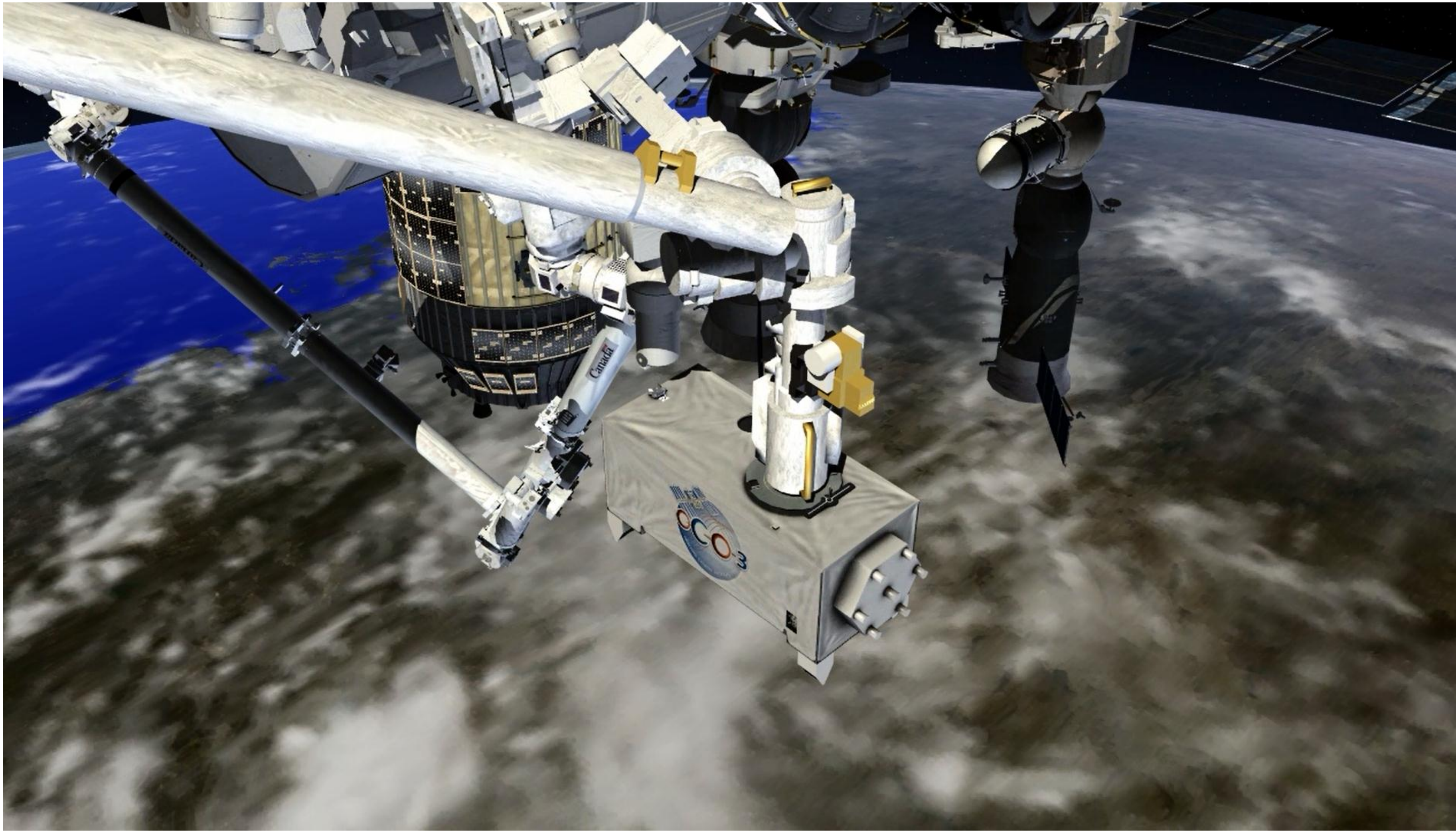


Instrument is handed off to JEM-RMS



Instrument is berthed at EFU

Robotic Installation of Instrument to ISS



ISS Feasibility Accommodation Assessment Evaluation Criteria

- In performing the accommodation feasibility assessments, the ISS Integration Research office (RIO/OZ) looks at whether or not the proposed instrument meets the standard interfaces or requires significant non-standard integration
- For example, the volumes are defined for each platform but there are specific dimensions that make up those volumes
  - Working with the proposer, we will evaluate the dimensions and determine if the instrument is within the standard dimensions or exceeds those dimensions in one or more areas
  - If it exceeds the standard interfaces, we will provide an evaluation of how simple or hard it will be to accommodate those non-standard interfaces
  - The proposers will be made aware of any non-standard interfaces to determine if they can modify their design to stay within the standard interfaces
  - A lot of times, non-standard interfaces CAN be accommodated but it requires additional work during the integration process

ISS Accommodation Feasibility Assessments

Nominal Data Required From Proposer Team

- Payload Upmass (Includes both instrument and ISS Interface Hardware
- Volumetric Dimensions (both static and dynamic)
- Power consumption (includes peak power)
- Data rates (includes any data latency requirements)
- Pointing/viewing needs
- Lifetime required on orbit
- Instrument readiness date (date payload is ready to fly to ISS)
- Return plan

Astrophysics Explorers ISS Feasibility Assessment Process

1. Contact the NASA Research Office (NRO) (in the Space Station Research Integration Office (RIO/OZ), NASA JSC) to start a dialogue and arrange an assessment telecon or meeting:
    - Kenol Jules (Kenol.jules-1@nasa.gov, 281-244-5516)
    - Sharon Conover (sharon.c.conover@nasa.gov, 281-244-8158)
2. Provide background information on the AO that your team is responding to, HQ Program Scientist name and your instrument, such as:
    - Description of instrument concept and preliminary design approach
    - Estimate of launch/on-orbit mass, on-orbit volume/dimensions, power, data downlink requirements, need for cooling, and your preliminary assessment of possible ISS site locations for your proposed instrument
    - Any mass or volume/dimensions that exceed ISS standard operational instrument envelopes for a particular site will require a waiver---small deviations can often be accommodated
    - The NRO will assess your overall design approach and let you know the suitability of your proposed design concept for accommodation on ISS. If your design concept has envelope exceedances, we will let you know possible options related to them.

Science Mission Explorer ISS Feasibility Assessment Process

3. To complete the assessment several follow-up telecons may be needed, email exchanges and additional data requests are to be expected
4. Once the ISS assessment team has reviewed all potential ISS accommodations and interfaces issues and had had discussions about them with the proposer team, a draft preliminary ISS accommodation feasibility letter will be generated by NRO
5. The draft feasibility letter will be reviewed with the proposer team for any comment. The content of the letter focuses on the issues identify by the assessment team, which were discussed with the proposer team and it is solely based on the information provided by the proposer at that time
6. The feasibility letter is signed by the RIO manager and issued to the proposer team
7. The whole process can take 6 to six weeks, depending on the complexity and maturity of the design concept from the proposer team

Science Mission Explorer ISS Feasibility Assessment Process

8. Once the proposals are submitted to NASA, the ISS specific proposals will be reviewed again (in depth this time around) by the ISS NRO in order to issue a final ISS accommodation feasibility letter, using information provided in the proposals
9. When a proposal is selected for funding, SMD will initiate contact with NRO, which in turn will initiate contact with the proposer team or vice versa to start discussion leading to the instrument integration process to be flown to ISS
10. An authorization to proceed (ATP) will be provided to the ISS office by SMD to official assigned that instrument on ISS at a specific site, launch vehicle with readiness to fly date
11. An ISS integration team will be activated to support the integration process of that instrument on ISS
12. Once the proposer/PI/PD team is under contract with SMD, an ISS kick-off meeting will be held at the Johnson Space Center to start the ISS integration process

ISS Payload Requirements

- ISS payload requirements do not flow from NPR 8705.4 and thus the Class A/B/C/D levels are not directly applicable
- For the ISS requirements, the instrument successful on-orbit operation is not part of the requirements set, although it may very well be a requirement for the Science Mission Directorate
- Many requirements of Class D payloads are acceptable to ISS, however, in a number of areas, the man rating requirements will be stricter and more like Class A requirements
- If a payload is selected for an ISS mission of opportunity, the ISS Research Integration Office (RIO) will work with the proposer team to develop the set of requirements that must be verified to fly on an ISS transportation vehicle and operate on ISS

Questions?

Contact Information:

Kenol Jules (NASA-JSC):

Tel. 281-244-5516

Email: Kenol.jules-1@nasa.gov