5.4 SPACE SHUTTLE PROGRAM (SSP) AND ISS PROGRAM PROVIDED HARDWARE

All Shuttle and ISS Program supplied hardware is being utilized consistent with the hardware ICDs and certifications.

5.4.1 Shuttle Program Hardware

The AMS-02 will utilize a number of Space Shuttle Program (SSP) supplied components. This hardware includes:

- Two Orbiter Interface Units (OIUs)
- One Payload General Support Computer (PGSC) with expansion assembly and power cable,
- One middeck locker,
- One Flight Releasable Grapple Fixture (FRGF)
- One Payload Disconnect Assembly (PDA) for the Remotely Operated Electrical Umbilical (ROEU).

The AMS-02 will interface structurally with the Shuttle cargo bay by way of four Payload Releasable Latch Assemblies (PRLAs), one Keel Latch, and the ROEU. AMS-02 will electrically interface with the standard switch panel. The locations of the dedicated switches on the standard switch panel are circled as shown in Figure 5.4-1. The AMS-02 payload will also require the use of the Shuttle Remote Manipulator System (SRMS) and the power from dual Assembly Power Converter Units (APCU).

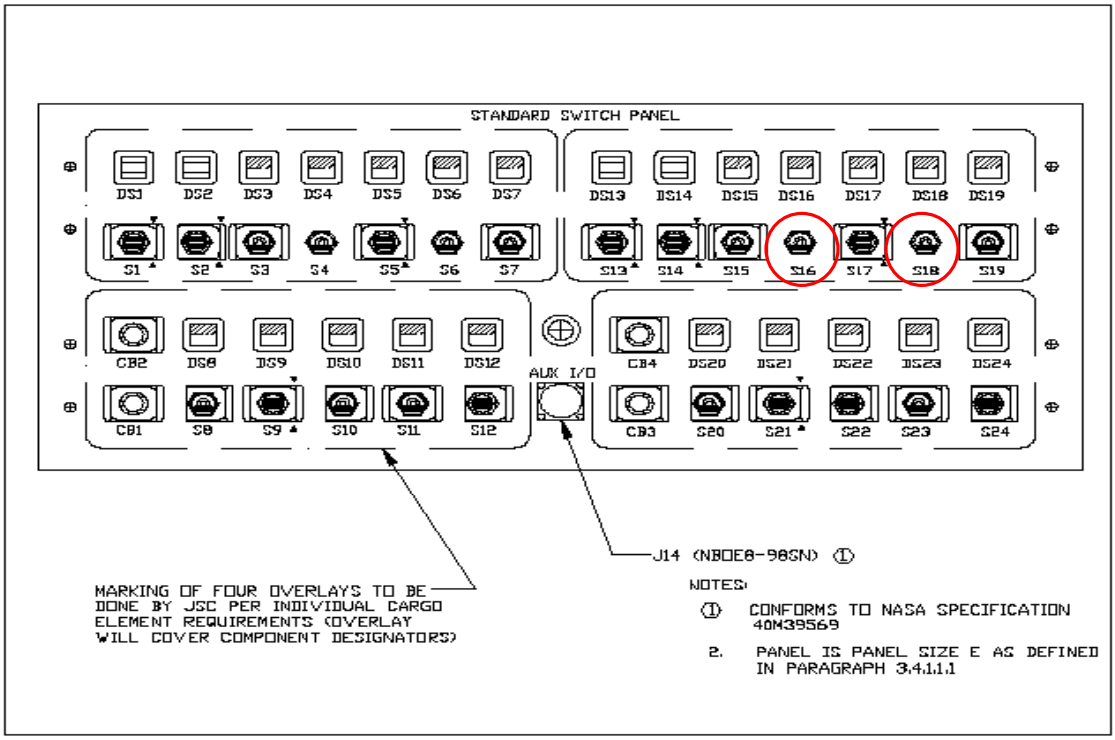

Figure 5.4-1 AMS-02 Switch Locations on Standard Switch Panel

5.4.1.1 Orbiter Interface Units

The two OIUs (one will be a backup) will be used as 1553 bus controllers and will serve as the uplink/ downlink interface for housekeeping data and commands. The OIUs will be mounted in the Payload Station L11 Console in the Orbiter aft flight deck, as designed as shown in Figure 5.4-2. The OIUs provide an interface between PGSC and the ROEU connected payload.

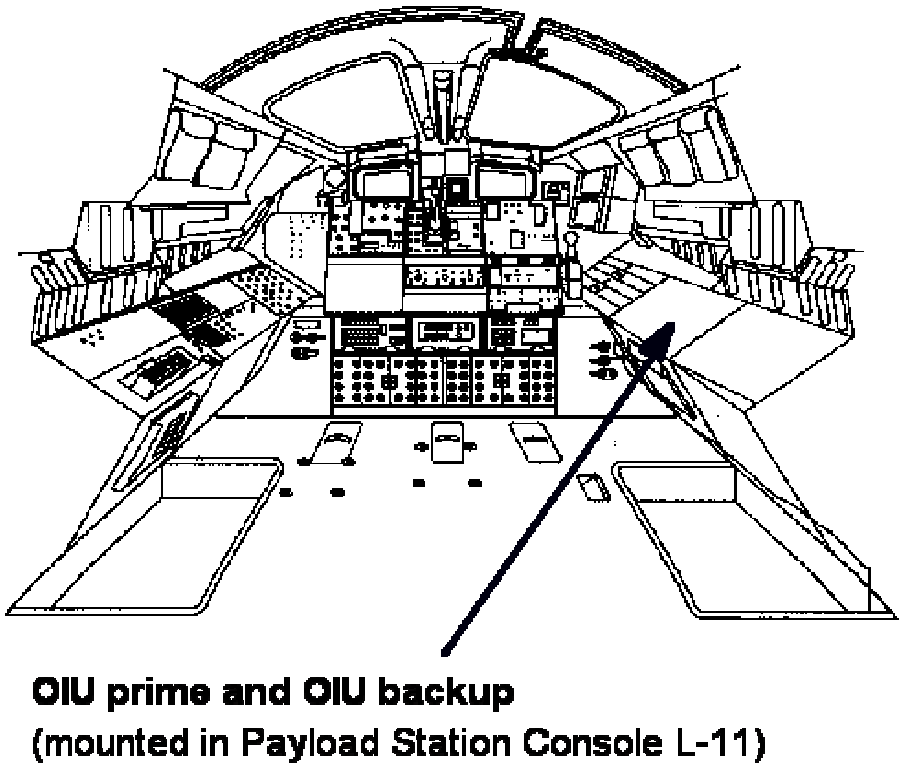

Figure 5.4-2 Orbiter Interface Unit Location on Console L-11

5.4.1.2 Middeck Locker

The middeck locker will be used for stowage of the Digital Data Recorder System (DDRS-02) hardware which includes the PGSC and cables.

5.4.1.3 Flight Releasable Grapple Fixture (FRGF)

A FRGF, mounted to the AMS-02 payload, will be used by the SRMS to lift the AMS-02 out of the Orbiter payload bay. The FRGF is mounted to the FRGF Bracket using 6 high strength (200 ksi ultimate) ⅜" diameter bolts. The FRGF Bracket is bolted to the forward face of the port Upper Trunnion Bridge Beam using 24 high strength (180 ksi ultimate) ¼" diameter bolts. The FRGF placement on the USS-02 is shown in Figure 5.4-3. An exploded view of the attachment hardware is shown in Figure 5.4-4.

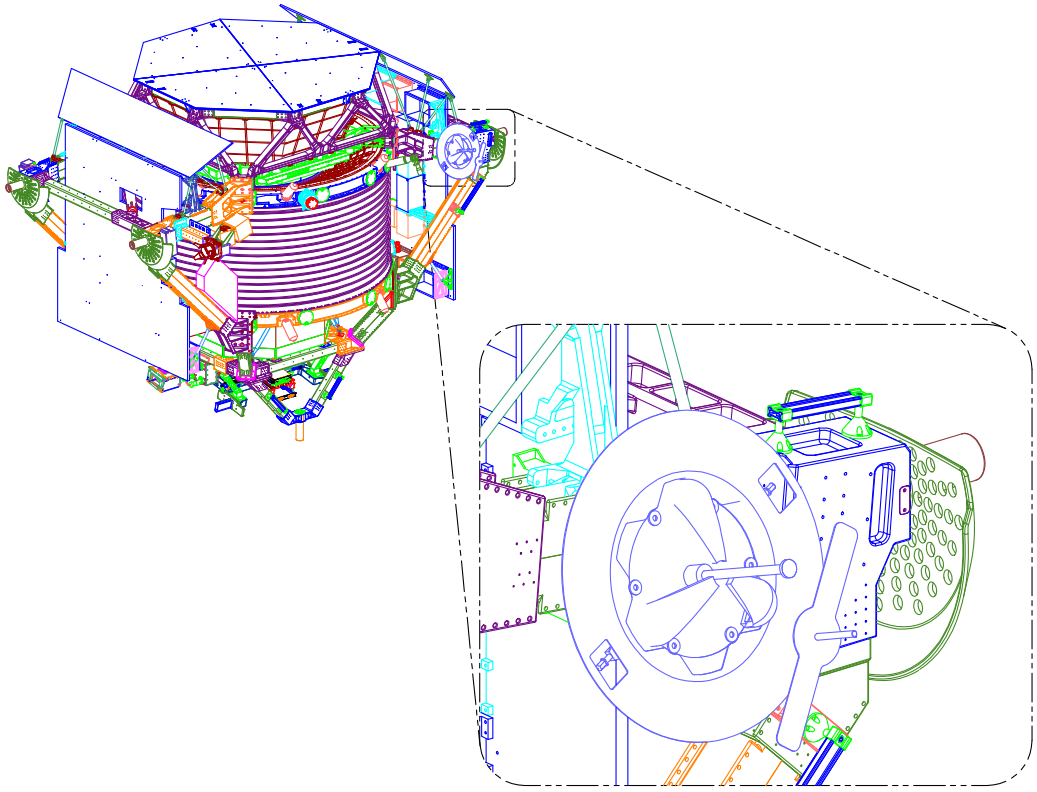

Figure 5.4-3 The FRGF Mounted to the Upper Trunnion Bridge Beam USS-02

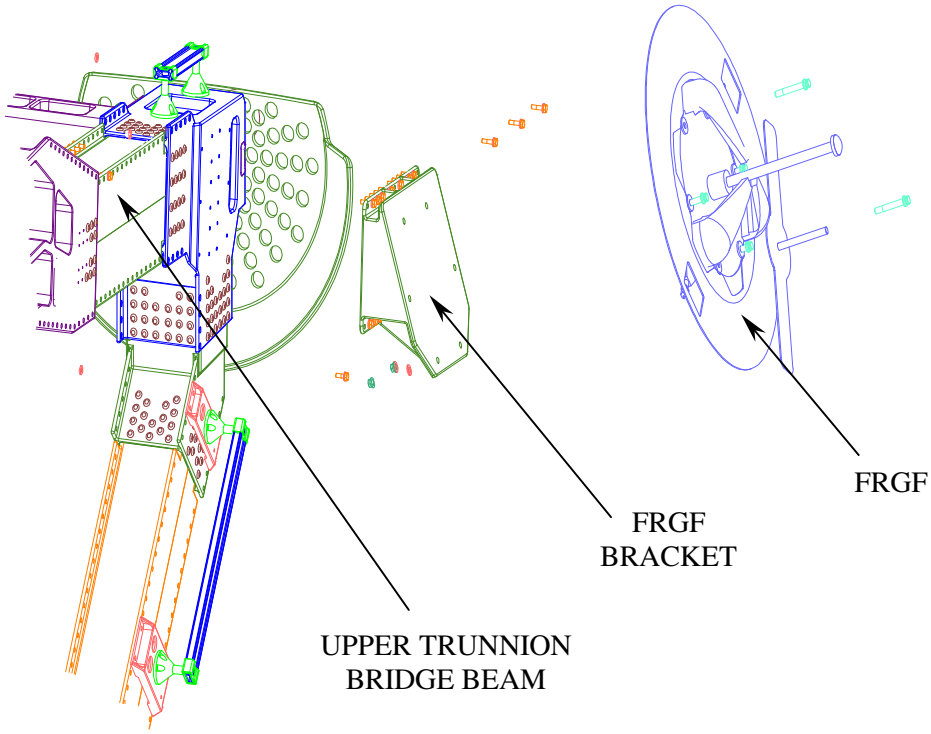

Figure 5.4-4 The FRGF to USS-02 Mounting Hardware

5.4.1.4 Payload Disconnect Assembly (PDA)

The PDA for the ROEU is the AMS-02 half of the ROEU system. This will be used to make the electrical interface between the Shuttle and the AMS-02 payload. The PDA will be mounted to the ROEU bracket that is attached to both the Primary Sill Joint and the Upper Trunnion Bridge Beam with 12 high strength (180 ksi Ultimate Strength) ¼" diameter bolts. The PDA mounted to the ROEU Bracket Assembly is shown in Figure 5.4-5.

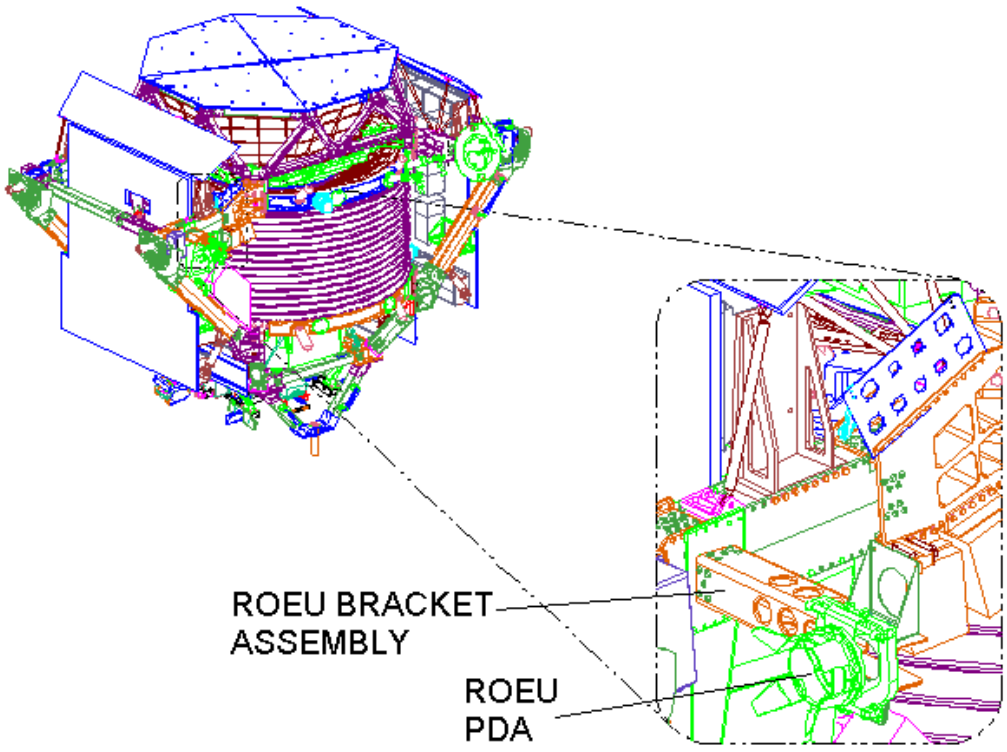

Figure 5.4-5 PDA Mounted on the Upper USS-02

5.4.1.5 Scuff Plates

The scuff plates are manufactured from aluminum and mount to the front face of the Sill Trunnion Joints, as shown in figure 5.4-6. The scuff plates are meant to preclude excessive port/starboard motion for berthing/unberthing operations using the SRMS and SSRMS operations. The scuff plates are designed to meet the requirements specified NSTS-21000-IDD-ISS.

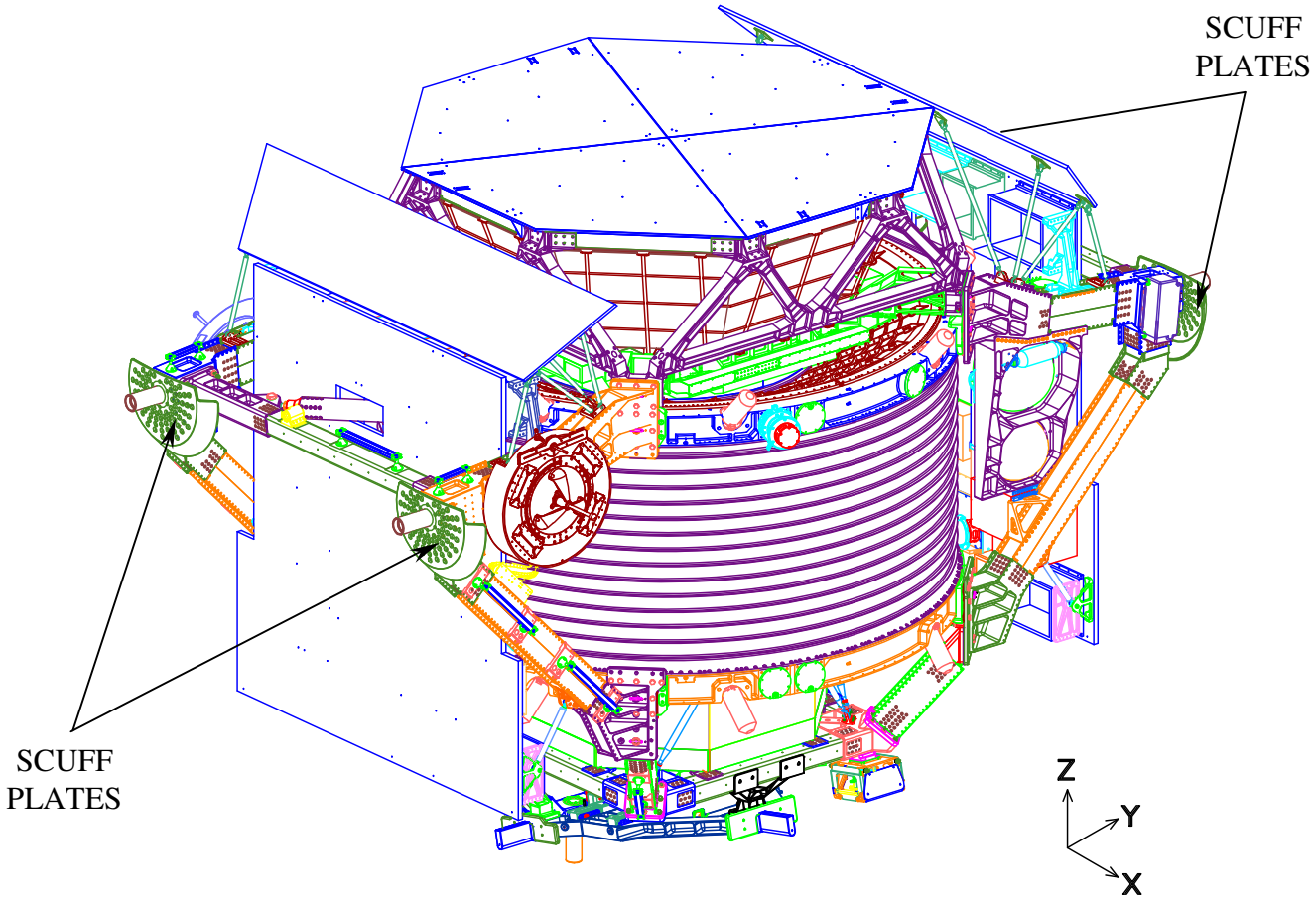

Figure 5.4-6 Scuff Plate Locations on AMS-02

5.4.2 ISS Provided Hardware

The ISS Program provided hardware that will be used with the AMS-02 includes:

- Two Shuttle installed Assembly Power Converter Units (APCUs),
- One Power Video Grapple Fixture (PVGF)
- One passive Umbilical Mechanism Assembly (UMA)
- One External Berthing Camera System (EBCS)

The AMS-02 payload will also require the use of the Space Station Remote Manipulator System (SSRMS). The SSRMS attaches to the Power Video Grapple Fixture and moves AMS-02 from the SRMS to the upper inboard payload attach site two, located on the ISS S3 truss shown in Figure 5.4-7.

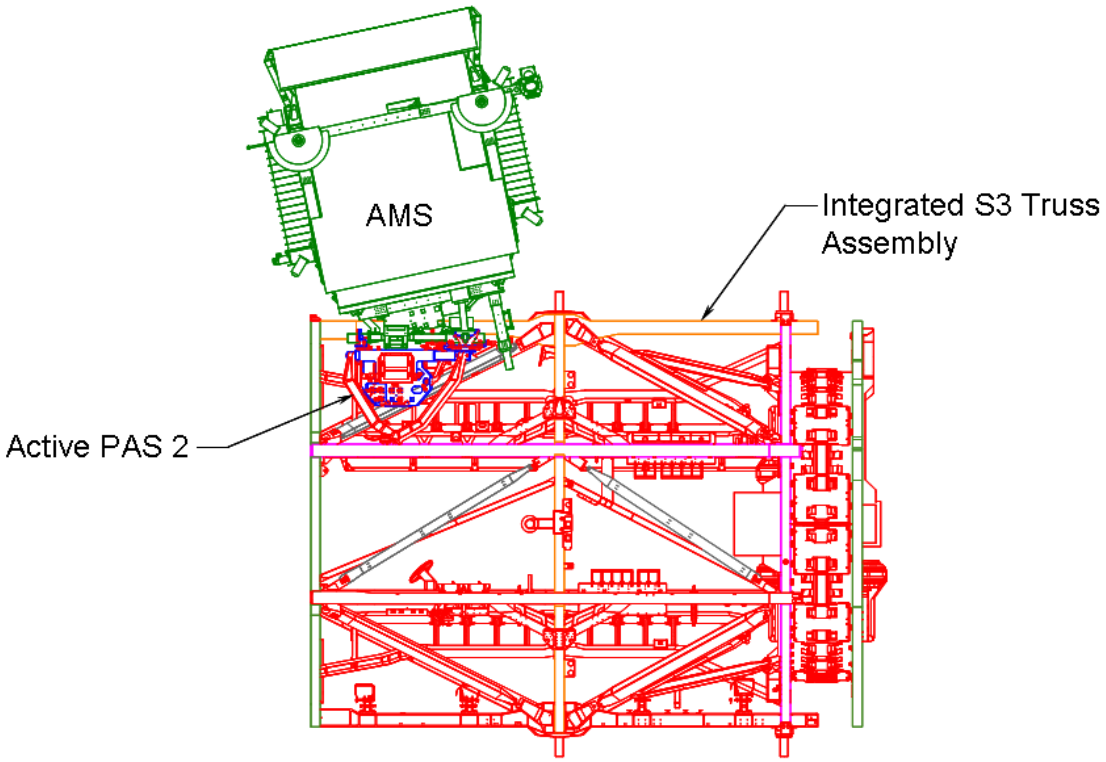

Figure 5.4-7 AMS Mounted to ISS S3 Truss

5.4.2.1 Assembly Power Converter Units

The APCUs (one will be a backup) will be used to supply 120v DC power to the AMS while operating on the Orbiter. Two APCUs are being used for redundancy. They will be mounted in bay 5 on the port side of the Orbiter, as designed, per the APCU Interface Control Document (ICD).

5.4.2.2 Power Video Grapple Fixture (PVGF)

A PVGF, mounted on the aft port side of the Upper Trunnion Bridge Beam of the AMS-02 payload, provides an additional structural/mechanical interface with the Mobile Servicing System allowing the SSRMS or the Payload/Orbiter Replacement Unit (ORU) Accommodation to grapple the payload. The PVGF mounts to the PVGF Bracket using 6 high strength (200 ksi ultimate) ⅜" diameter bolts. The PVGF Bracket is mounted to the Upper Trunnion Bridge Beam with 24 high strength (180 ksi ultimate) ¼" diameter bolts. The PVGF attachment location on AMS-02 is shown in figure 5.4-8. An exploded view of the attachment hardware is shown in Figure 5.4-9. Electrically the PVGF will supply power but not data communication to AMS-02. Power supplied to AMS-02 during this operation is for heater operations only.

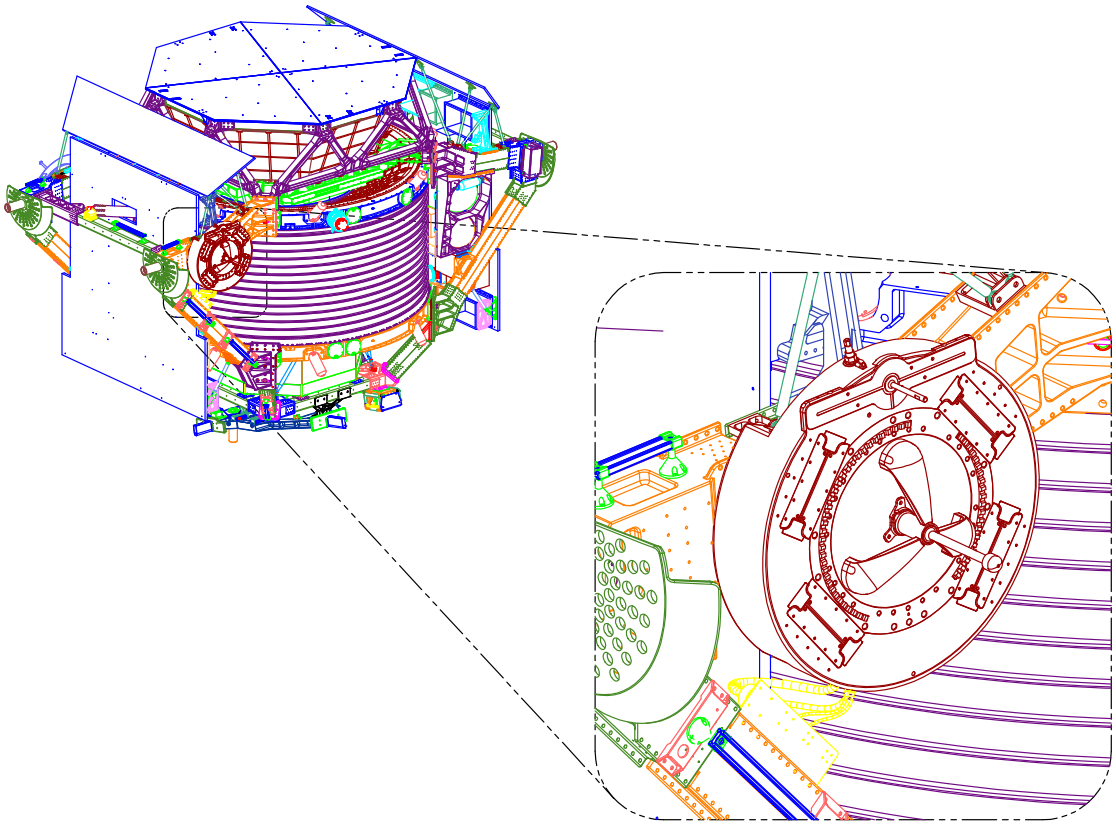

Figure 5.4-8 PVGF Mounted to the Upper Trunnion Bridge Beam USS-02

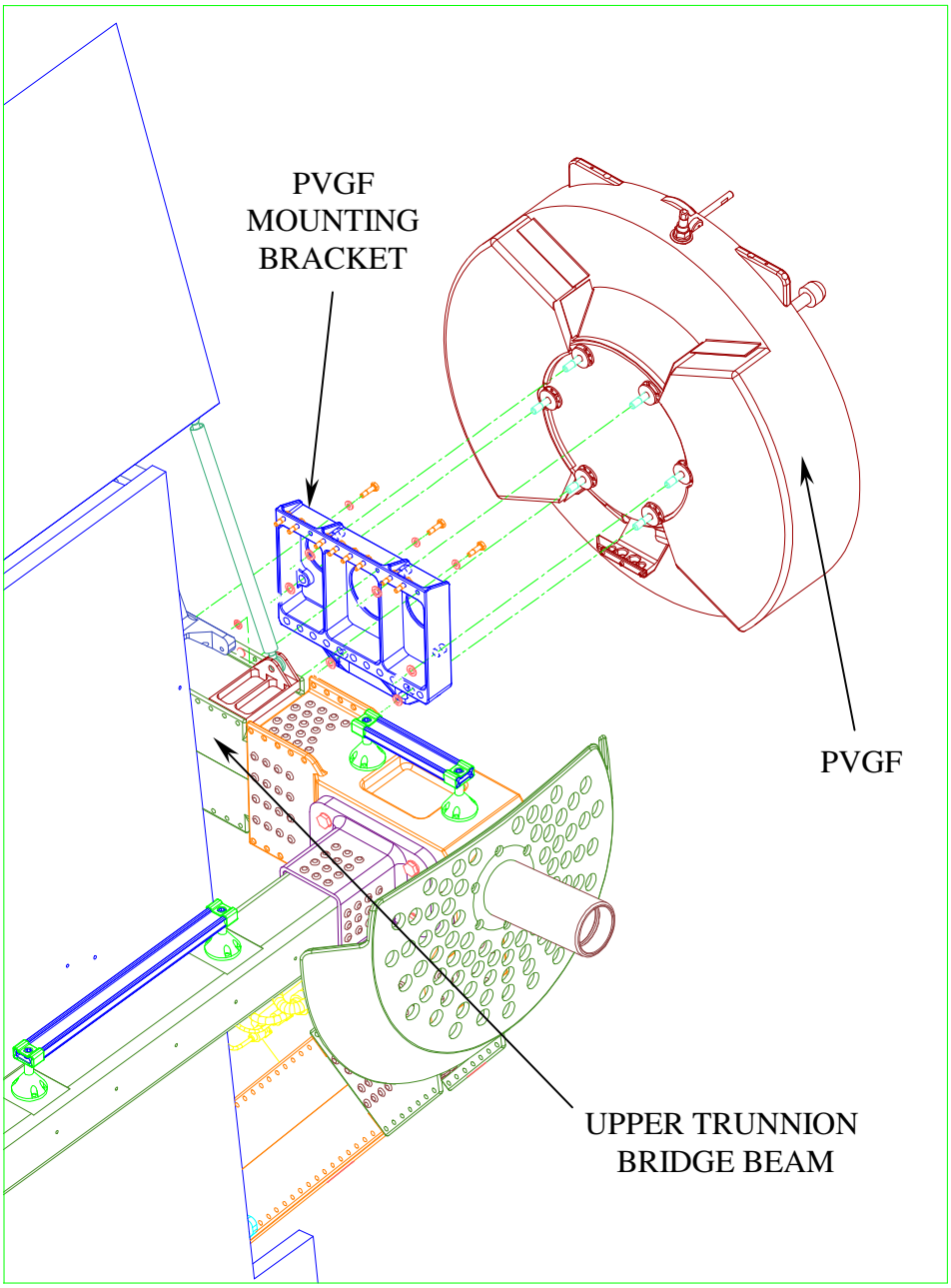

Figure 5.4-9 The PVGF to USS-02 Mounting Hardware

5.4.2.3 Passive Umbilical Mechanism Assembly (UMA)

The passive UMA will be used to electrically connect the AMS-02 payload to the ISS truss attach site. The UMA attaches to the lower USS-02, as shown in figure 5.4-10, and will interface with the active UMA mounted to the ISS PAS site as per SSP-57003.

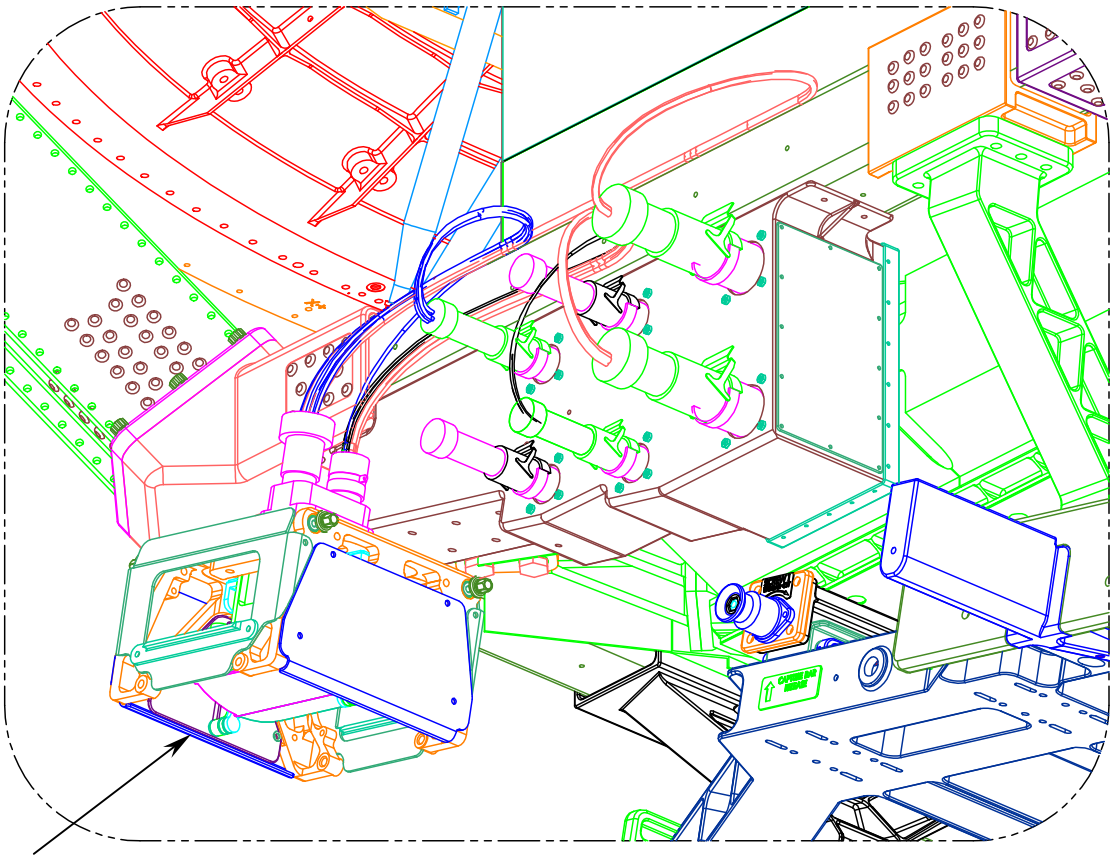

Figure 5.4-10 The UMA Mounted to the EVA Connector Panel

5.4.2.4 External Berthing Camera System (EBCS)

The EBCS is a camera and avionics package provided by the ISS Program that is electrically connected to the PVGF and structurally mounted to the passive PAS assembly on the AMS-02. The EBCS provides visual cues to robotic workstation monitors to assist ISS Mobile Servicing System operators in berthing AMS-02. The system is comprised of an avionics package which contains both a primary and secondary video camera and an EBCS Target which his mounted on the PAS site. The electrical services of EBCS include video, power, heater power and AMS-02 heater power. The EBCS Avionics mounting is the responsibility of AMS-02. The mounting requirements are defined in SSP 57003 Section 3.7.6.1, SSP 57004 Figures 3.1.2.2-1 and SSP 57004 Figures 3.7.1-1. Additional mounting data is contained in MDR-BCS-TM-7498, EBCS Avionics Package Detailed Installation Instructions produced by MD Robotics per NASA contract NAS9-00089.

Refer to Figure 5.4-11 for the location of the EBCS mounted on the PAS Assembly.

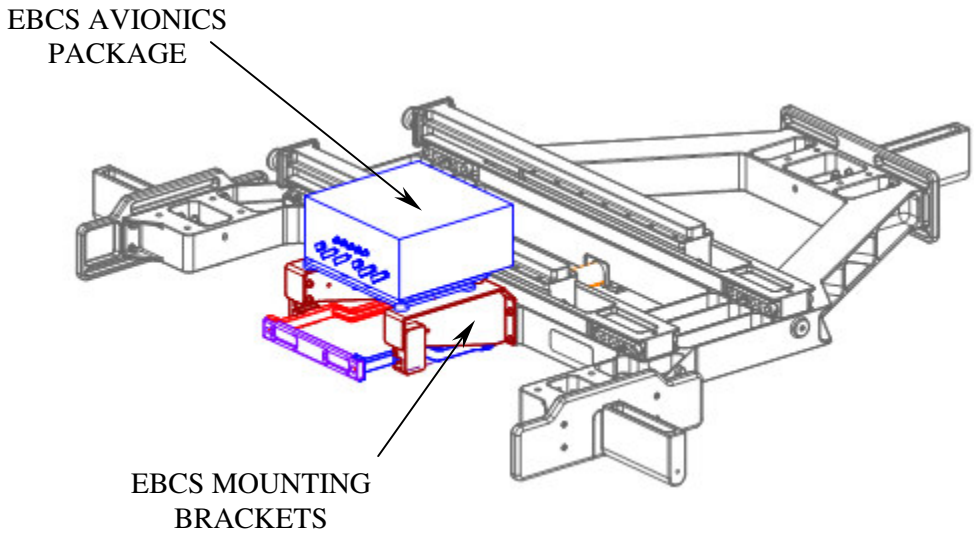

Figure 5.4-11 The EBCS Mounted on the AMS-02 Passive PAS

5.4.3 EVA Hardware

The AMS-02 has been designed to support contingency EVAs to the AMS-02. These potential contingency EVAs include:

- ROEU Manual Release/Mate
- UMA Manual Release/Mate
- FRGF Release
- PVGF Release
- PAS Capture Bar Release
- EVA Connector Panel Operation
- ROEU Bracket Folding Operation

Each of the above EVAs may include multiple EVA work locations. These sites have been identified and work site aids have been positioned to facilitate EVA operations. Payload hardware associated with these EVA operations is described and shown in the sections that follow.

5.4.3.1 UMA EVA Bolts

The passive UMA can be released from the active half via four EVA bolts shown in figure 5.4-12. Once this is complete the EVA Connectors are uncoupled, the AMS-02 will be free from the UMA leaving only the UMA Bracket attached to the EVA Connector Panel.

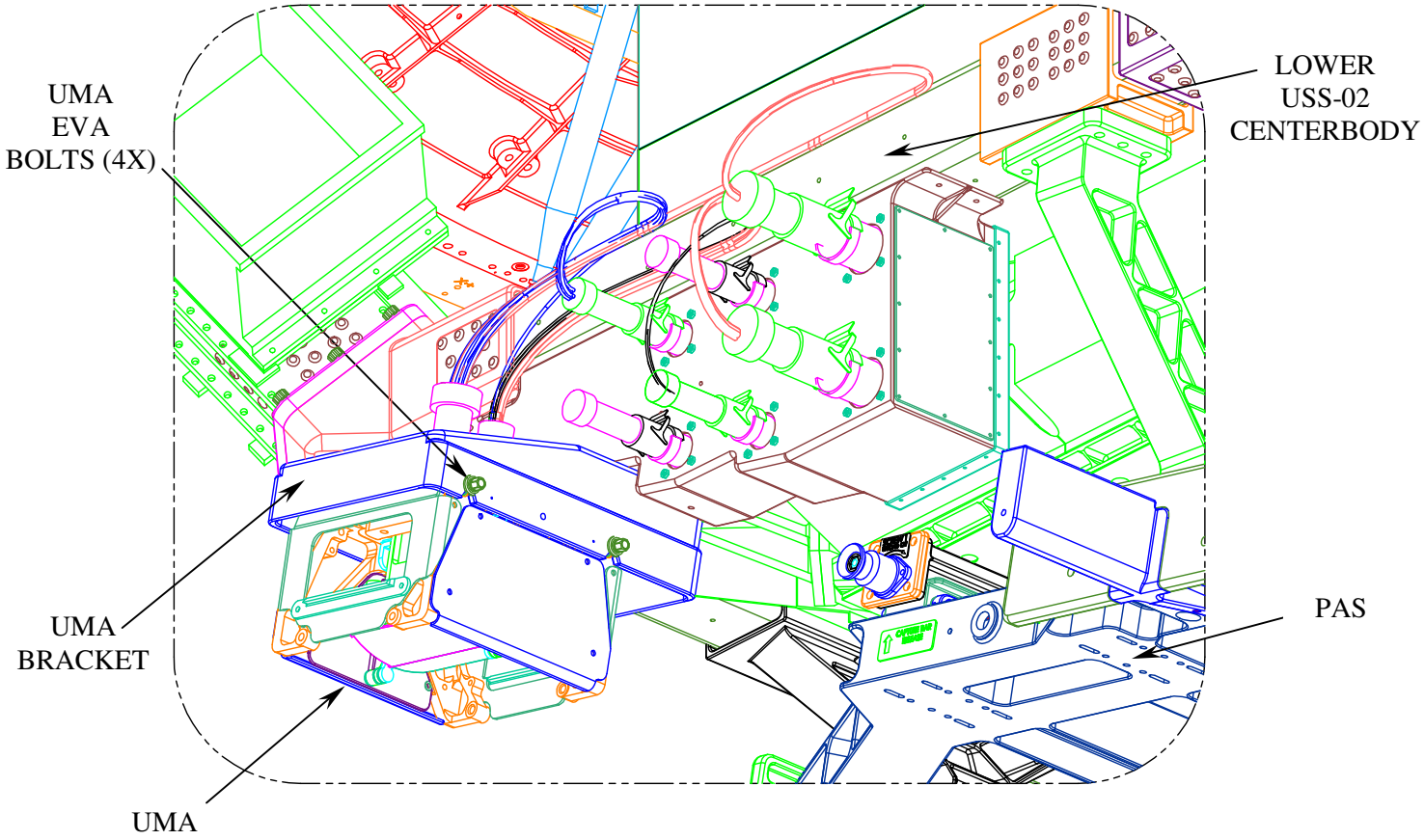

Figure 5.4-12 UMA EVA Bolt Locations

5.4.3.2 FRGF Release

The AMS-02 payload can be a manually released from the FRGF by way of the Rod Release. The Rod Release is a standardized ISS EVA process which AMS-02 is compatible with. The locations of the EVA bolts and Rod Release are shown in figure 5.4-13.

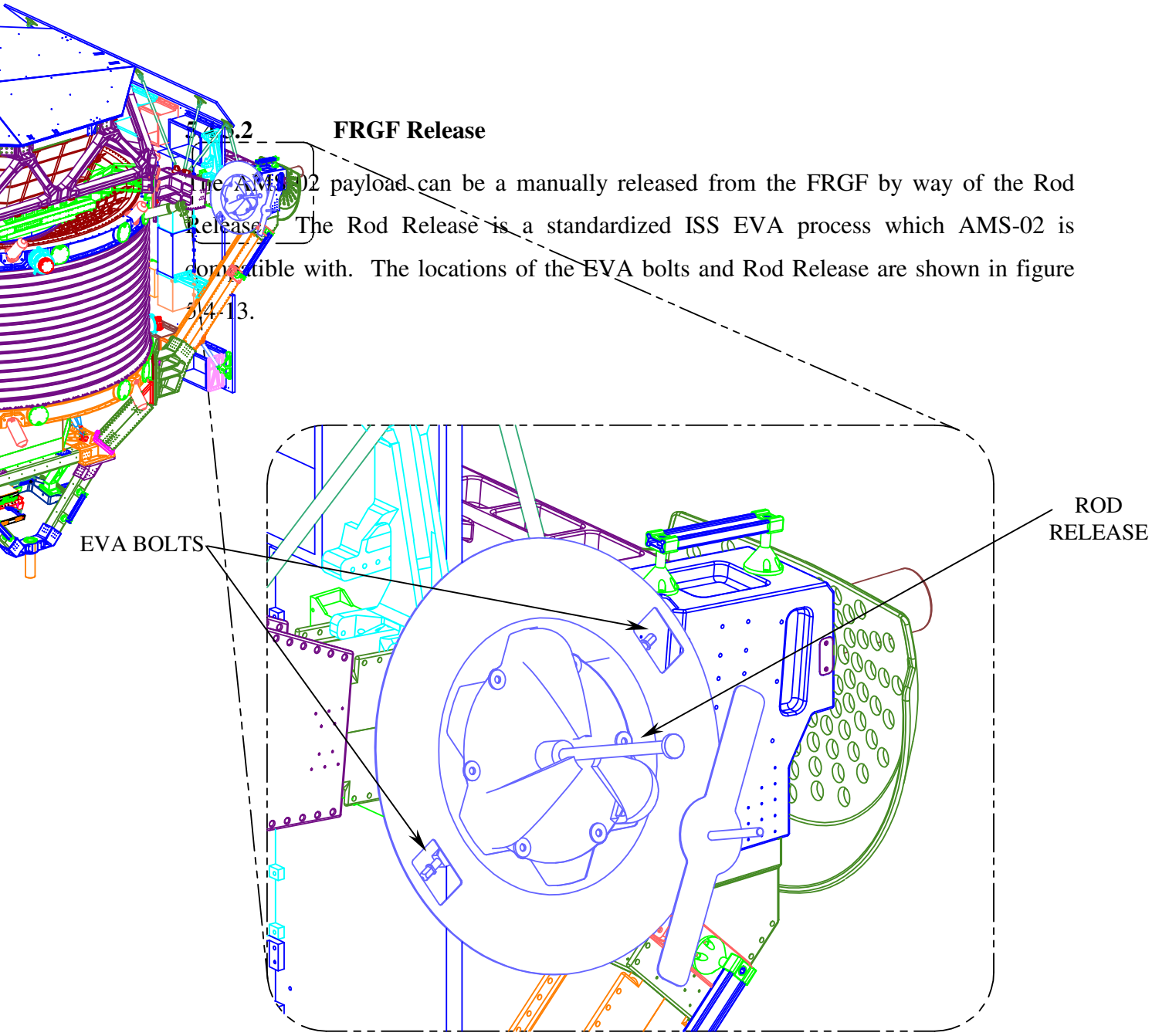

Figure 5.4-13 FRGF Rod Release Location

5.4.3.3 PVGF Release

The AMS-02 payload can be manually released from the SSRMS by removing the Rod Release from the PVGF bracket. The Rod Release is a standard shuttle program EVA process that the AMS-02 is compatible with. Locations of the PVGF EVA bolts and Rod Release are shown in figure 5.4-14.

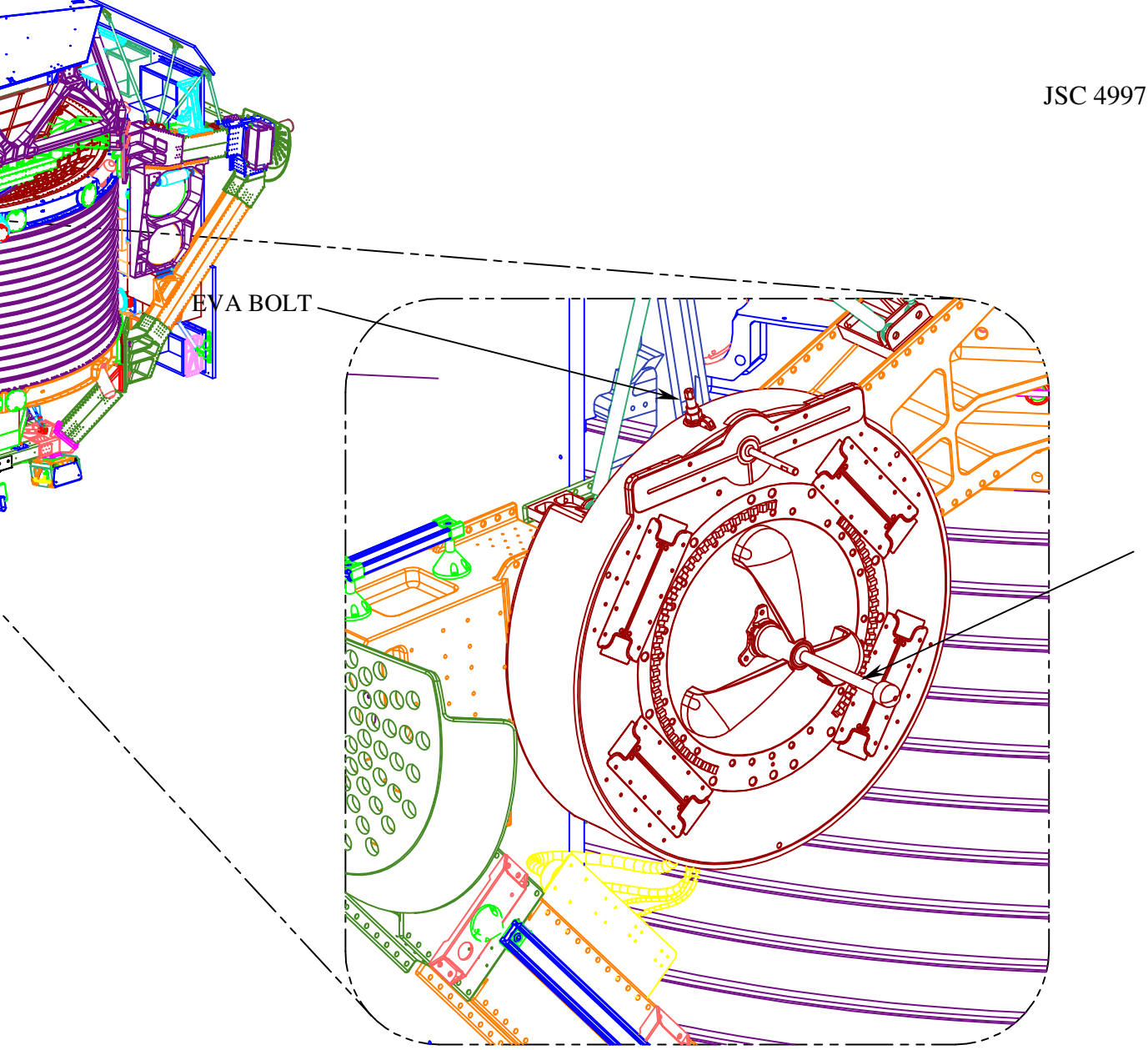

Figure 5.4-14 PVGF Rod Release Location

5.4.3.4 The PAS Capture Bar Release Mechanism

The PAS Capture Bar Assembly's preload is released mechanically by unloading the two Drive Screws using an EVA Pistol Grip Tool. After the Capture Bar is unloaded and lowered the crew member pulls the Capture Bar Assembly out from the Bearing Assemblies using the Capture Bar Removable Handle. Figure 5.4-15 shows the location of the PAS Assembly mounted to AMS-02. Figure 5.4-16 shows the location of the drive screw interface on the PAS. Labels indicating the location of the release mechanisms and the direction required to release the capture bar are noted with the appropriate decals. The Capture Bar Assembly's removal from the PAS Assembly is shown in Figure 5.4-17.

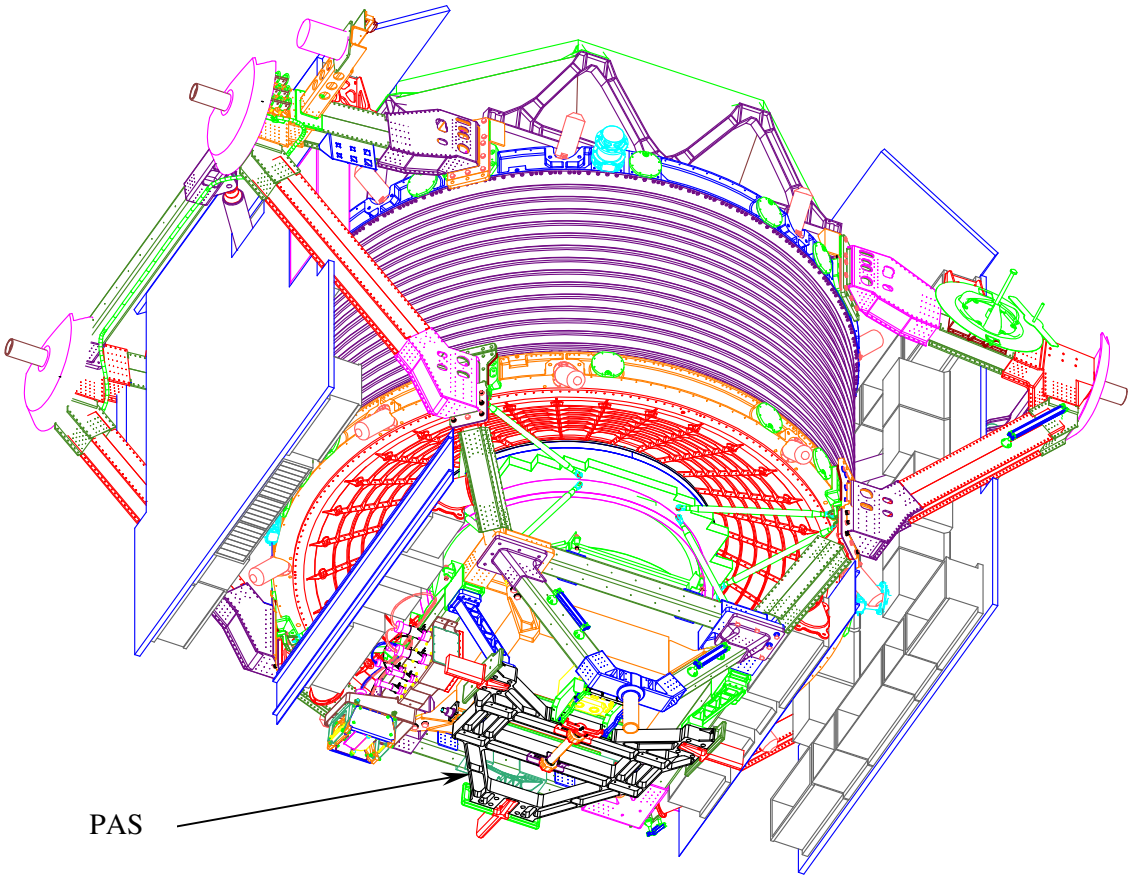

Figure 5.4-15 PAS Location on AMS-02

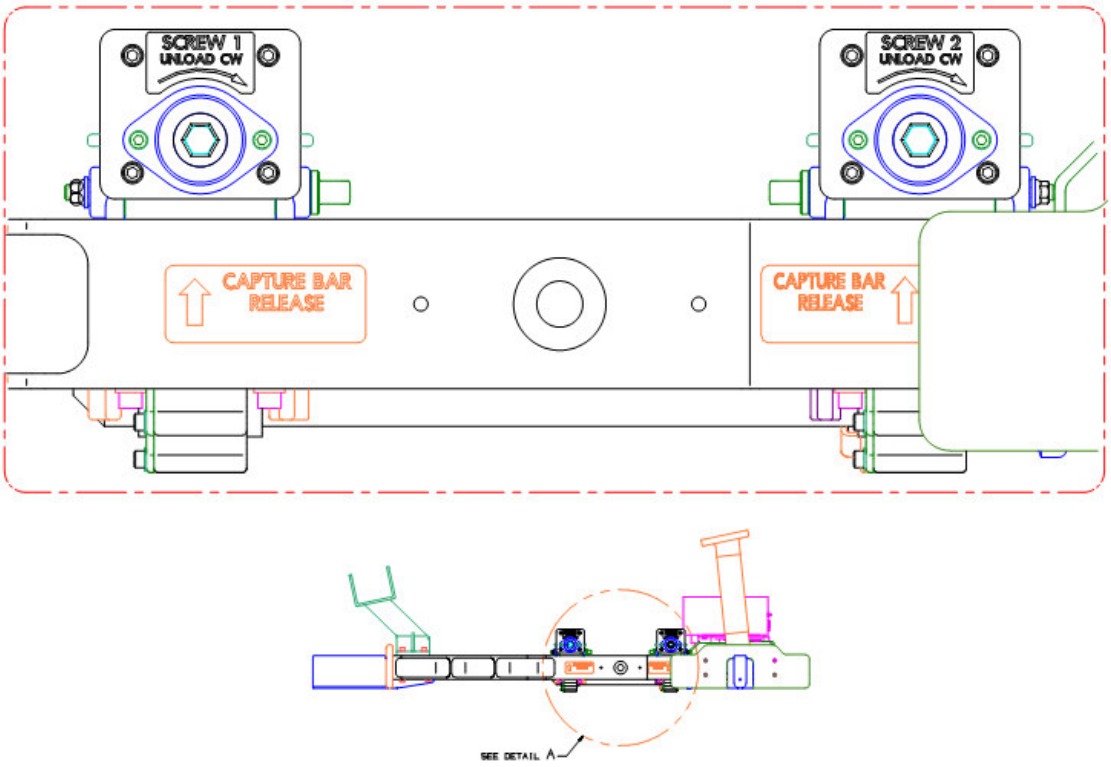

Figure 5.4-16 Drive Screw Location on the PAS

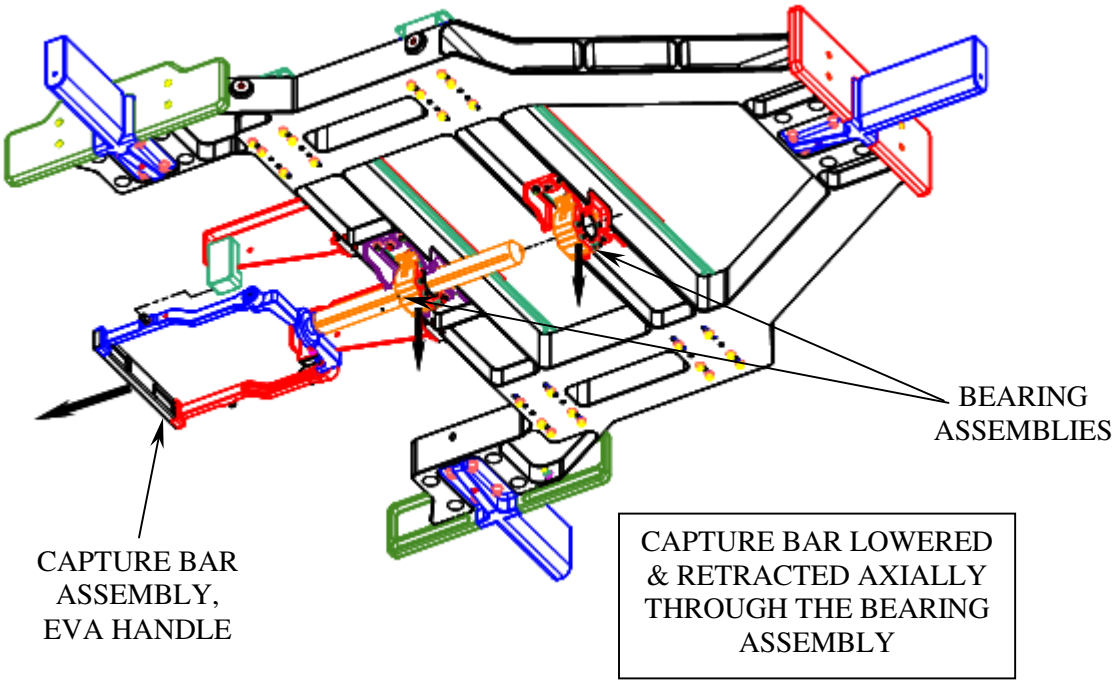

Figure 5.4-17 Capture Bar Assembly from AMS-02 Passive PAS

5.4.3.5 EVA Compatible Electrical Connectors

The connectors used to connect to the EVA panel are EVA compatible lever-actuated connectors per SSG-21635. The unused connectors on the EVA panel are protected by connector caps that are tethered to the panel. The power and data cables connect the UMA to the EVA panel with sufficient length to be routed to either channel A or channel B. The EVA Panel Assembly is bolted to the Lower Centerbody of the USS-02 with 16 ¼" high strength fasteners (160 ksi ultimate) as shown in figure 5.4-17.

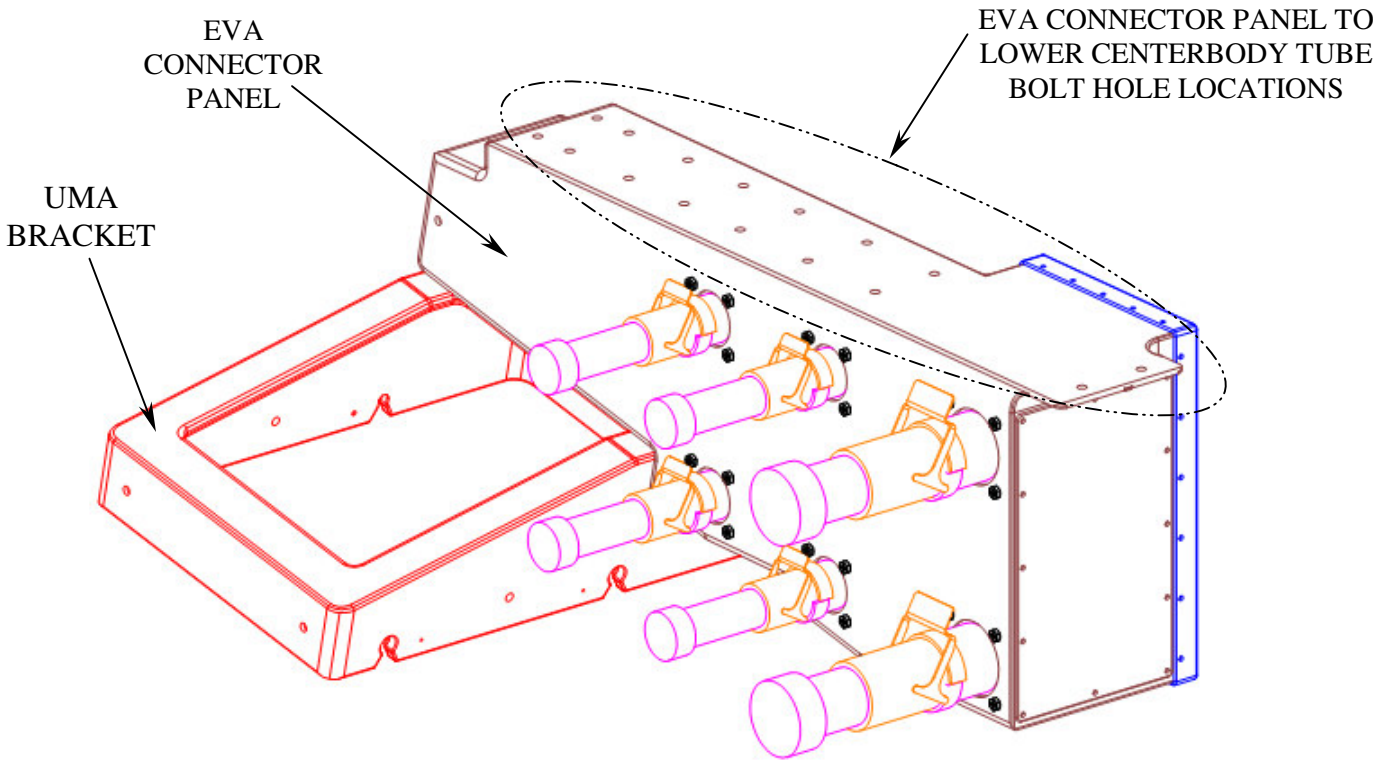

Figure 5.4-17 EVA Connector Panel with UMA Bracket

5.4.3.6 Worksite Interface Fixture (WIF) Socket

A Worksite Interface Socket is mounted to the starboard Sill Tube with 8 high strength (160 [illegible] 4 fasteners, as shown in figure 5.4-18 This work site location will be used during the [illegible] operations to release either the FRGF from the SRMS or the PVGF from the SSRMS. A proposed second WIF socket located on the port Sill Tube would be necessary for foldable ROEU operations. The exact location of this second WIF would be determined by conducting a Worksite Assessment (WSA).

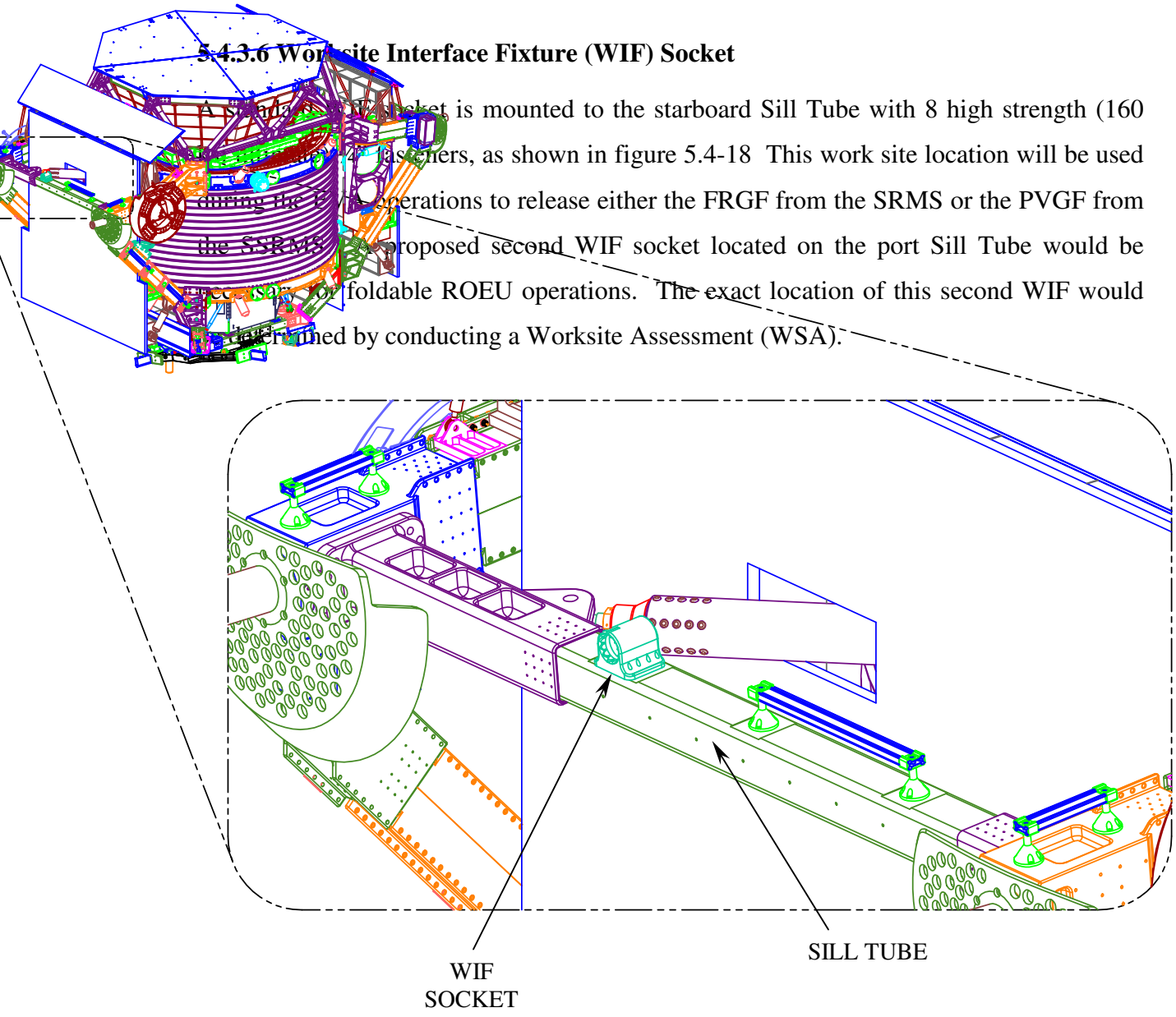

Figure 5.4-18 WIF Socket Location on Sill Tube

5.4.3.7 Foldable ROEU Bracket Assembly

The EVA operated ROEU Bracket Assembly is designed to fold down to prevent any potential interference with the installation of a payload adjacent to AMS-02 while on the S3 truss of the ISS. The primary components of the ROEU Bracket Assembly are the Arm Flange, Arm, PDA Bracket, a pivot pin and a two EVA compatible pip pins. The pip pins are space-qualified Double-acting Space Pins (1/2" Diameter, Ring Handle, 1.8" Grip, Drive Out Option, 6" Lanyard) manufactured by Avibank. The ROEU arm is allowed to rotate to the folded position by releasing the two pip pins which prevent the arm from rotating about the pivot pin. Once the arm is in the final folded position, the two pip pins are then reinserted through the arm flange and arm to prevent any "spring back" due to the bending of the cables about the arm. Figures 5.4-19 and 5.4-20 show the ROEU Bracket Assembly in the nominal configuration. Figures 5.4-21 and 5.4-22 show the ROEU Bracket Assembly in the folded position.

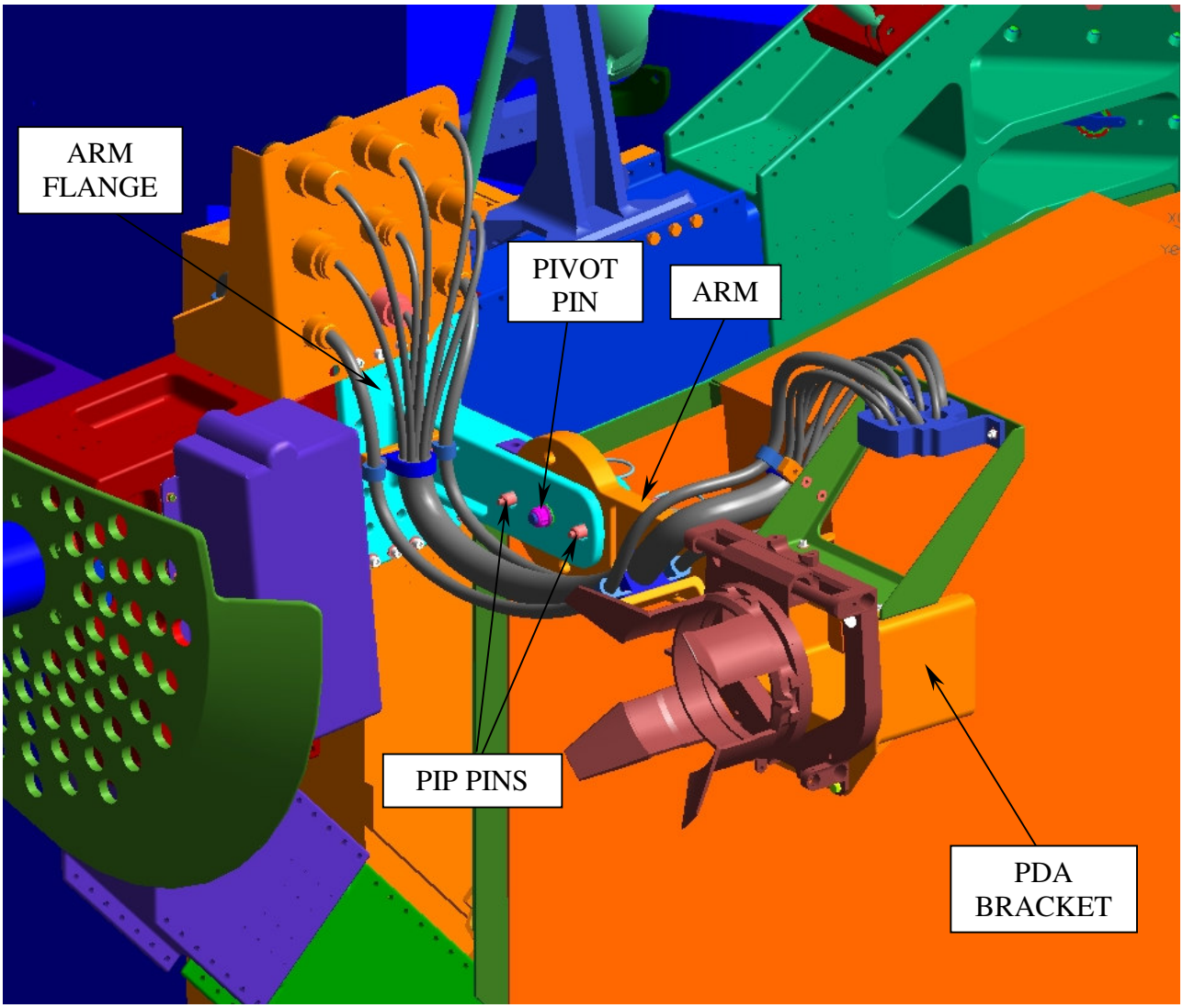

Figure 5.4-19 ROEU Assembly Nominal Configuration (Iso View from Starboard Side)

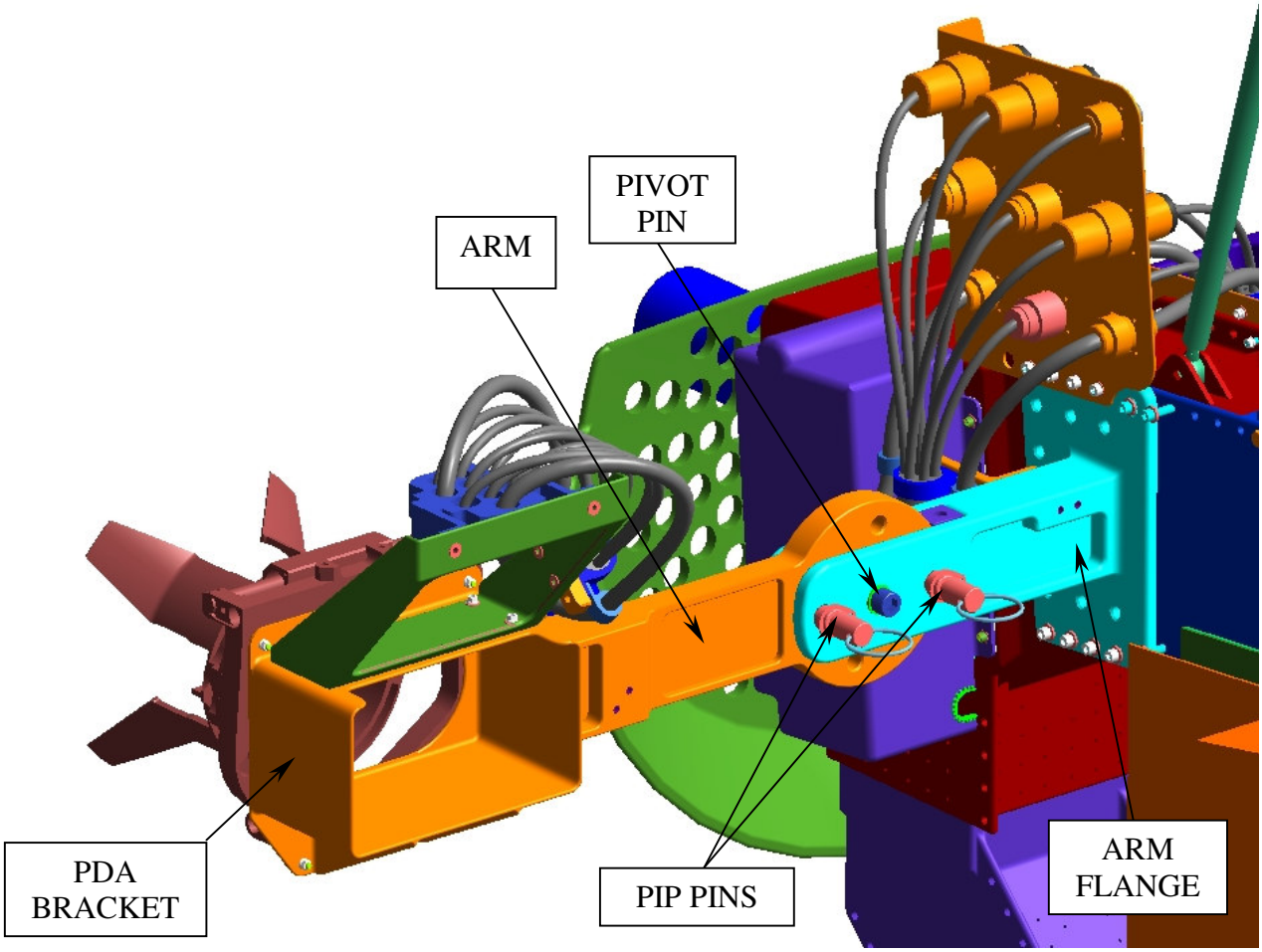

Figure 5.4-20 ROEU Assembly Nominal Configuration (Iso View from Port Side)

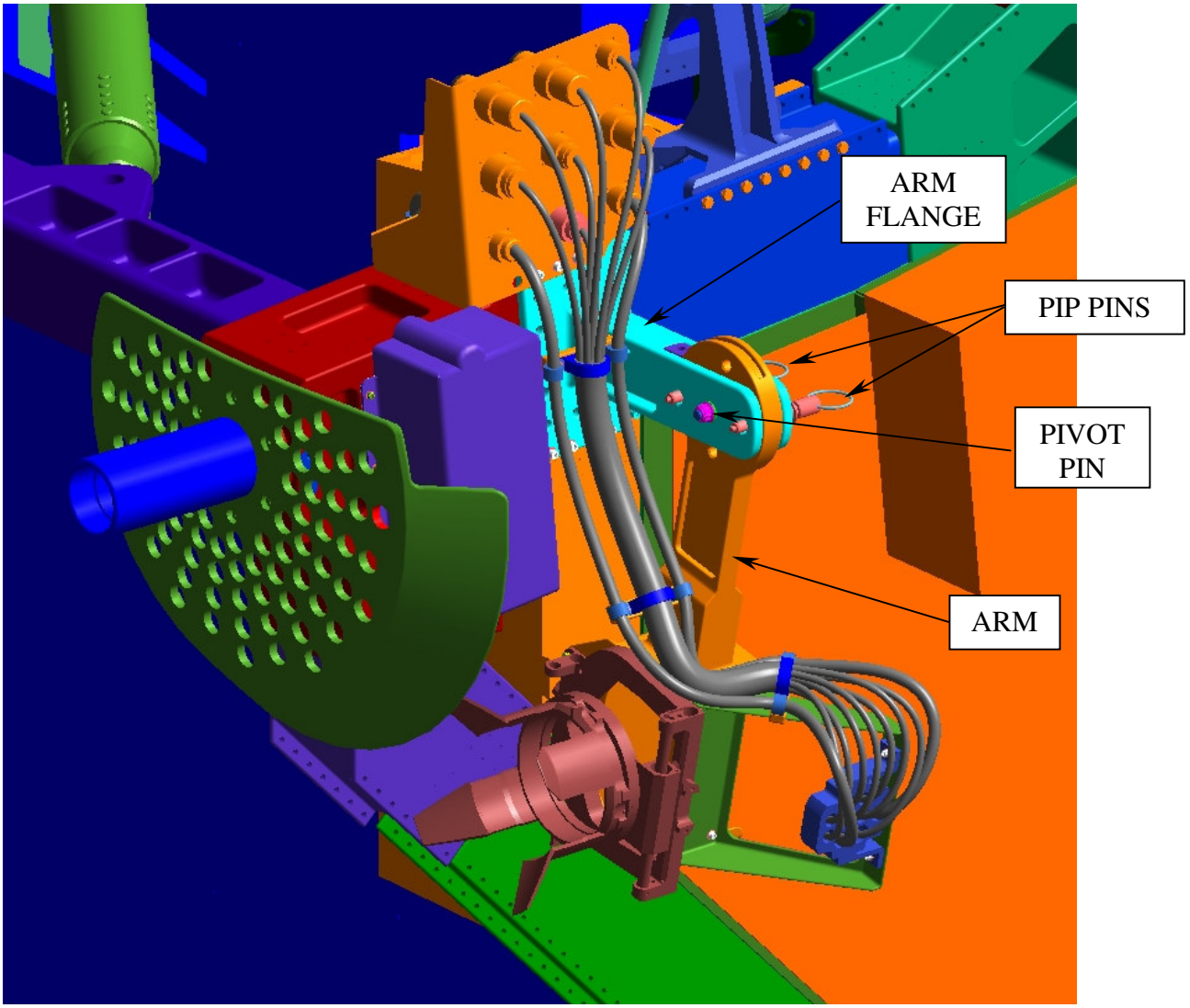

Figure 5.4-21 ROEU Assembly Folded Configuration (ISO View from Starboard Side)

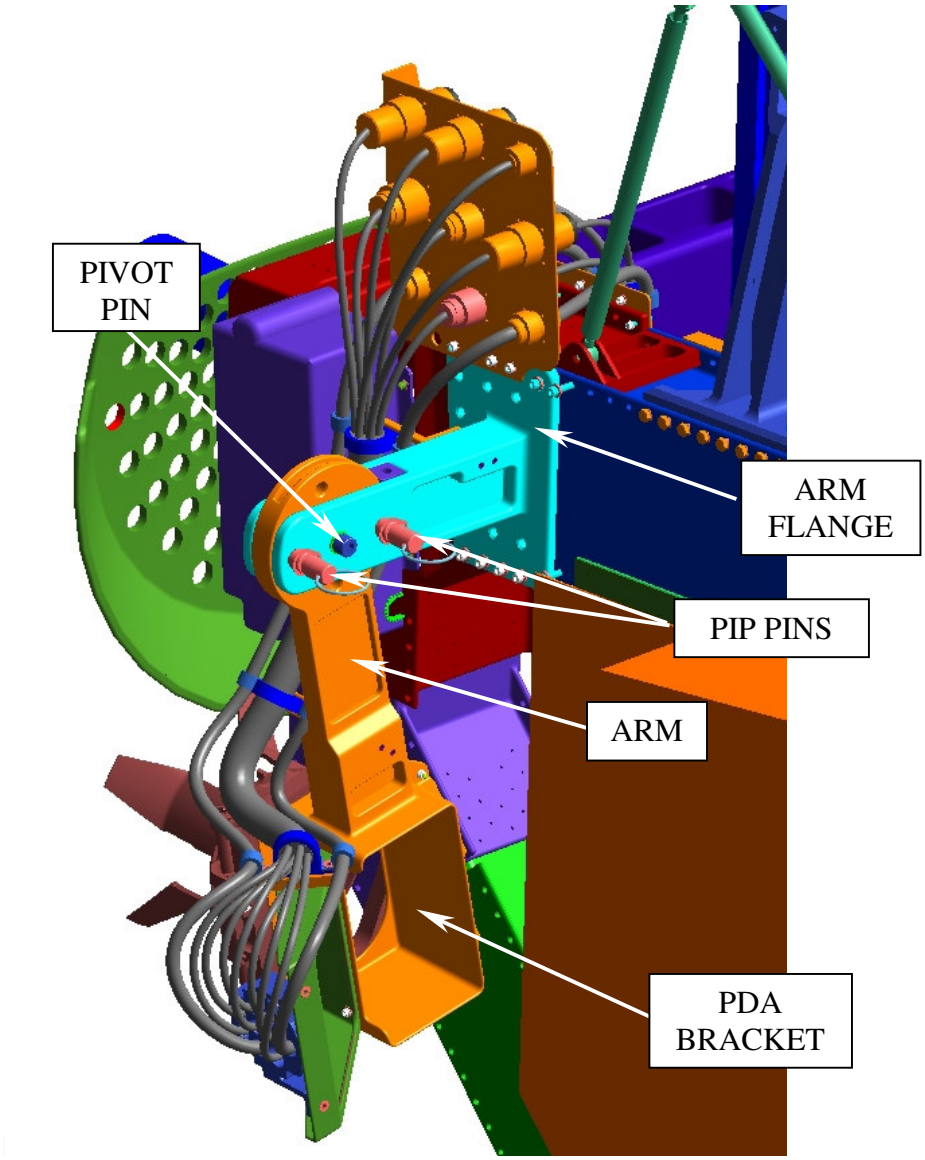

Figure 5.4-22 ROEU Assembly Folded Configuration (ISO View from Port Side)

5.4.3.8 EVA Handrails

EVA handrails are mounted to the USS-02 as shown in figures 5.4-23 through 5.4-25. The EVA handrails provide a crew member access to the WIF socket used as a worksite to release the grapple fixtures. EVA handrails will also be used for crew translation during contingency EVA operations on AMS-02. The locations of the handrails were assessed by either an EVA simulation by computer or weightless environment exercises. The locations of additional EVA handrails for on-orbit ROEU access would be determined by performing a WSA. All handrails and the WIF interface are provided by the JSC Extravehicular Activity Office (XA) to the AMS-02 Project for installation on the USS-02.

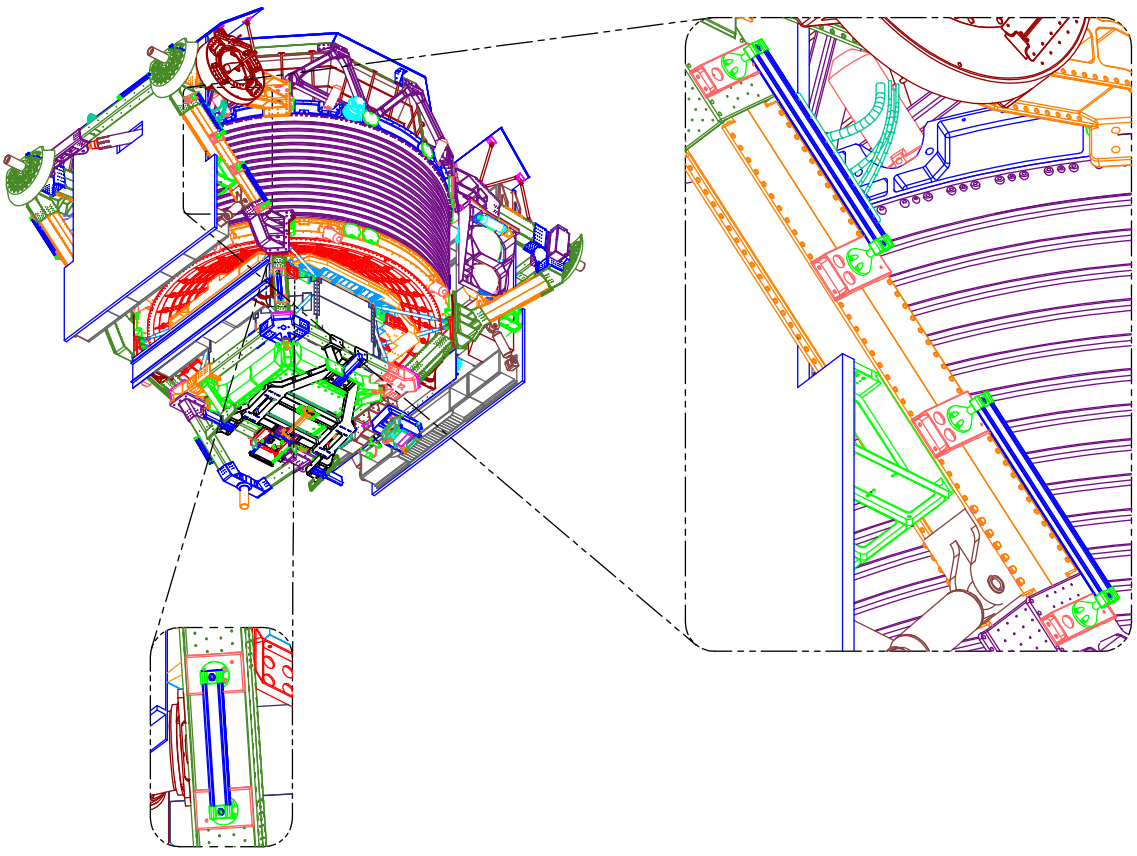

Figure 5.4-23 EVA Handrails Used To Access WIF Socket On-Orbit

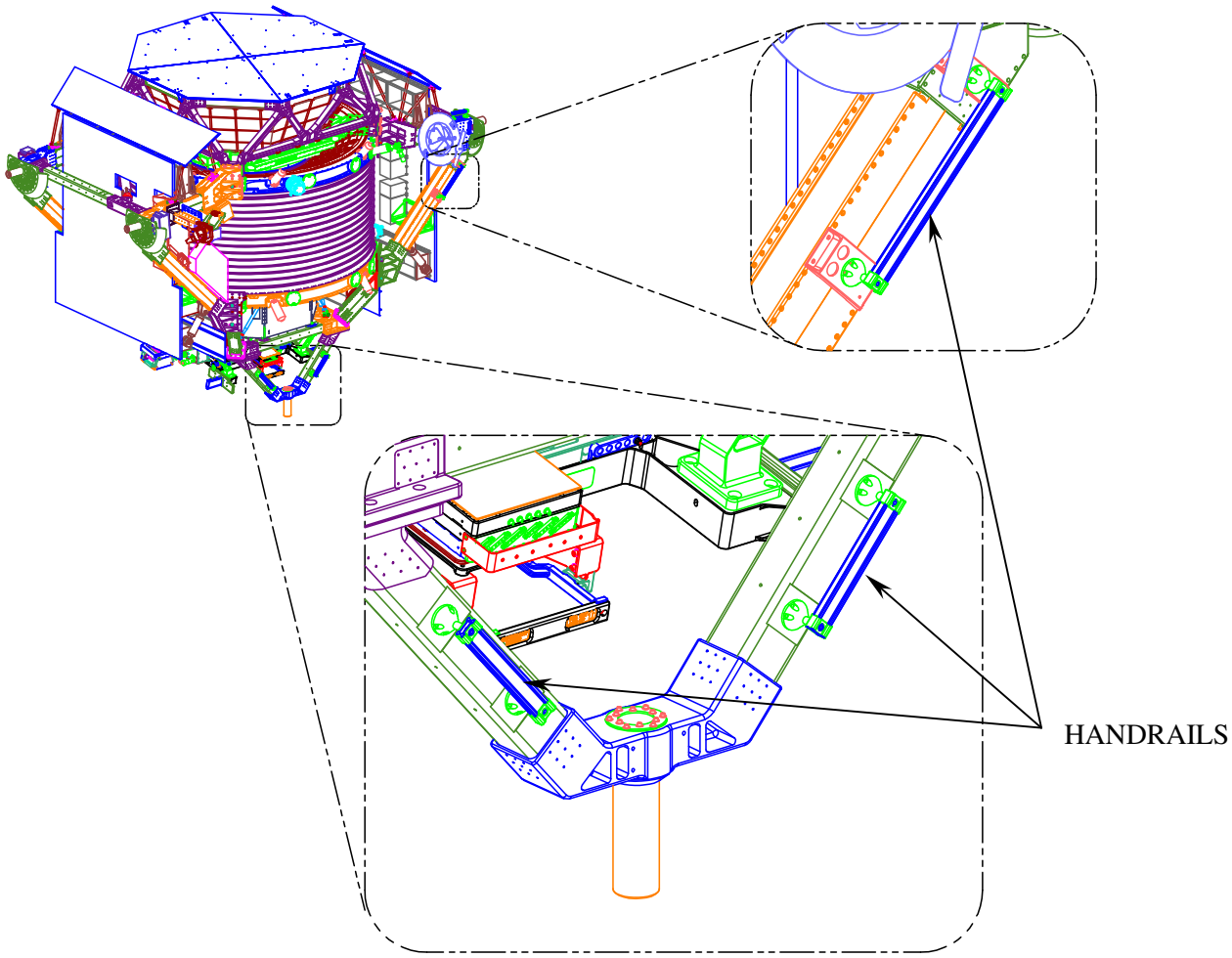

Figure 5.4-24 EVA Handrails for PAS Capture Bar Removal and FRGF Access

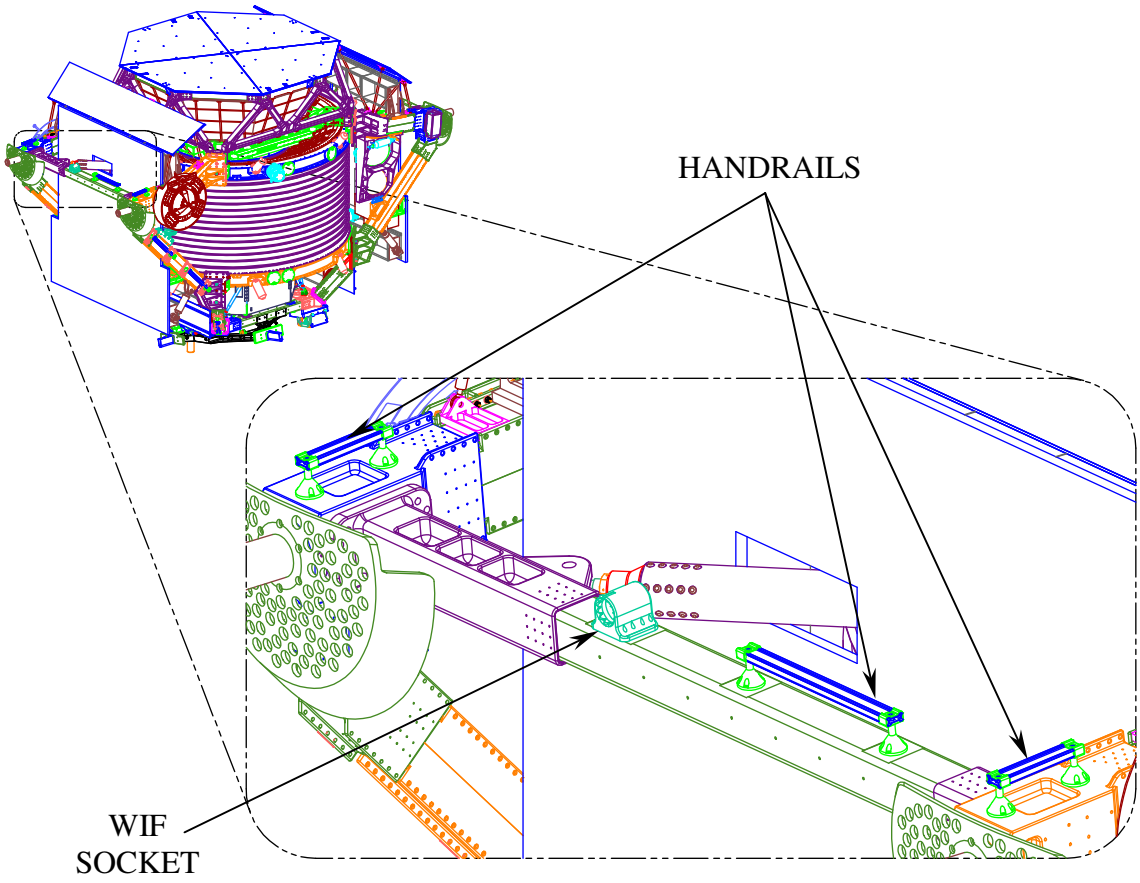

Figure 5.4-25 EVA Handrails Used for WIF Access