Credits

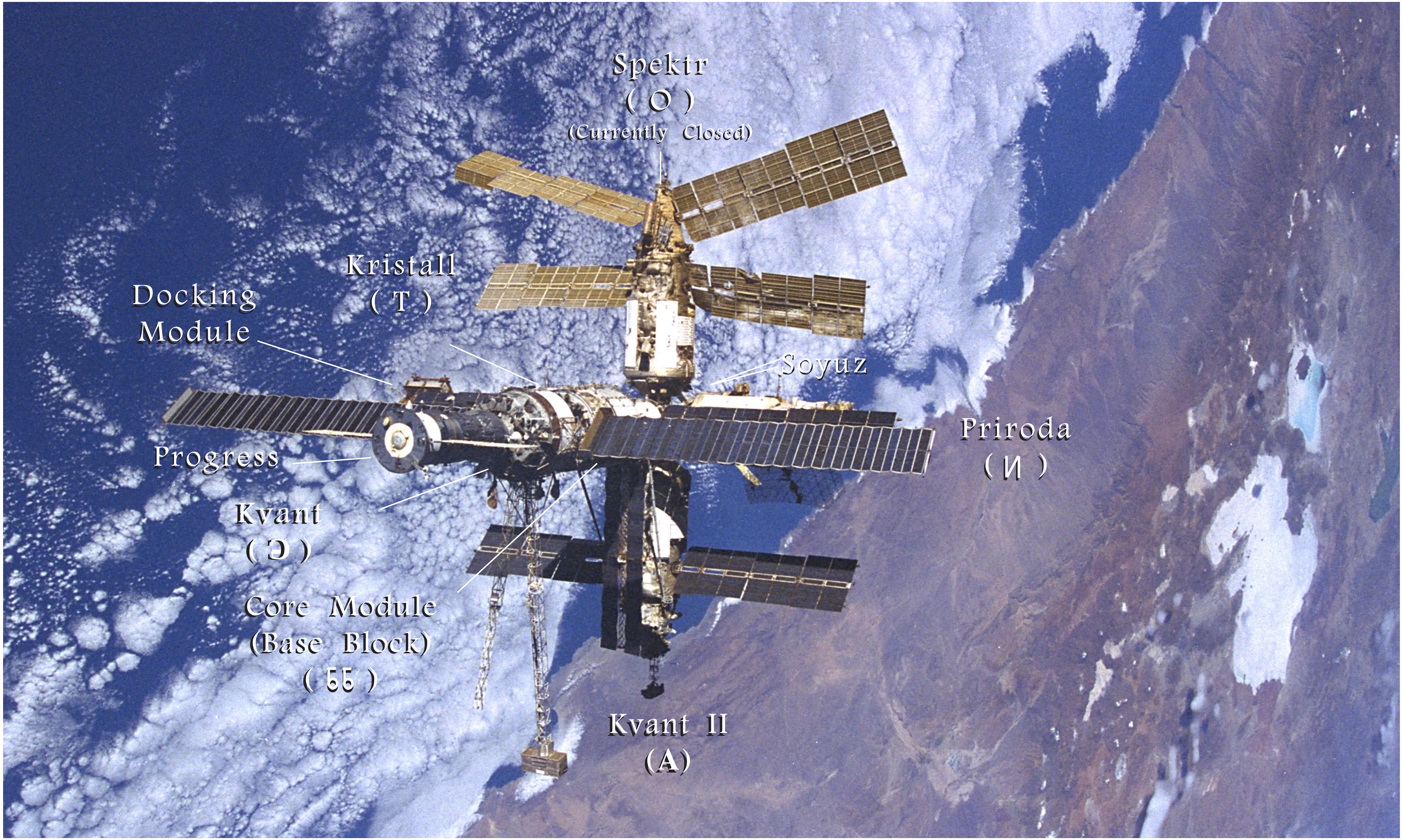
Phase 1:
A Journey to Mir
1994~1998

Module Tour

Introduction

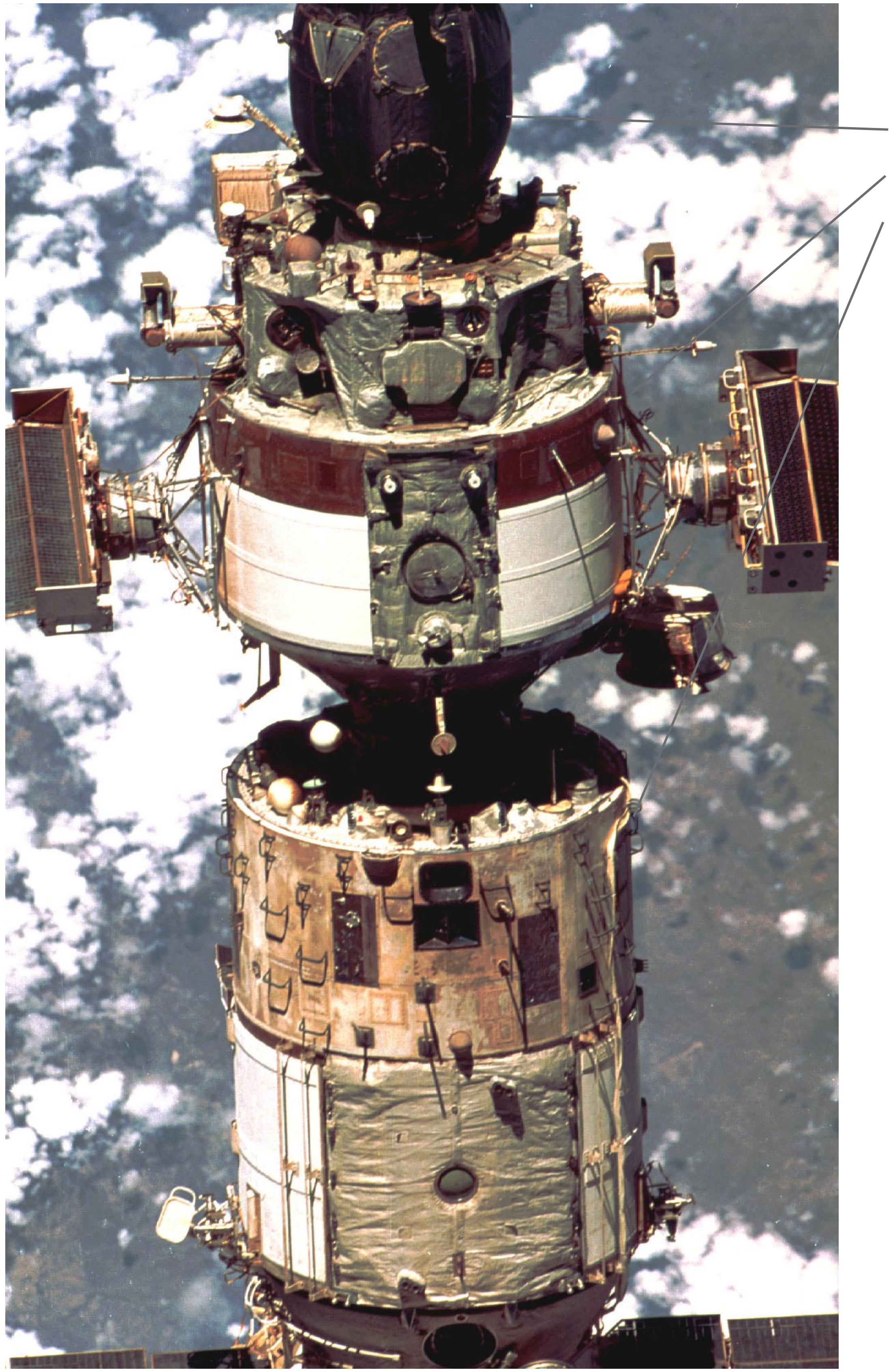
List of Experiments

List of Experiments by Increment



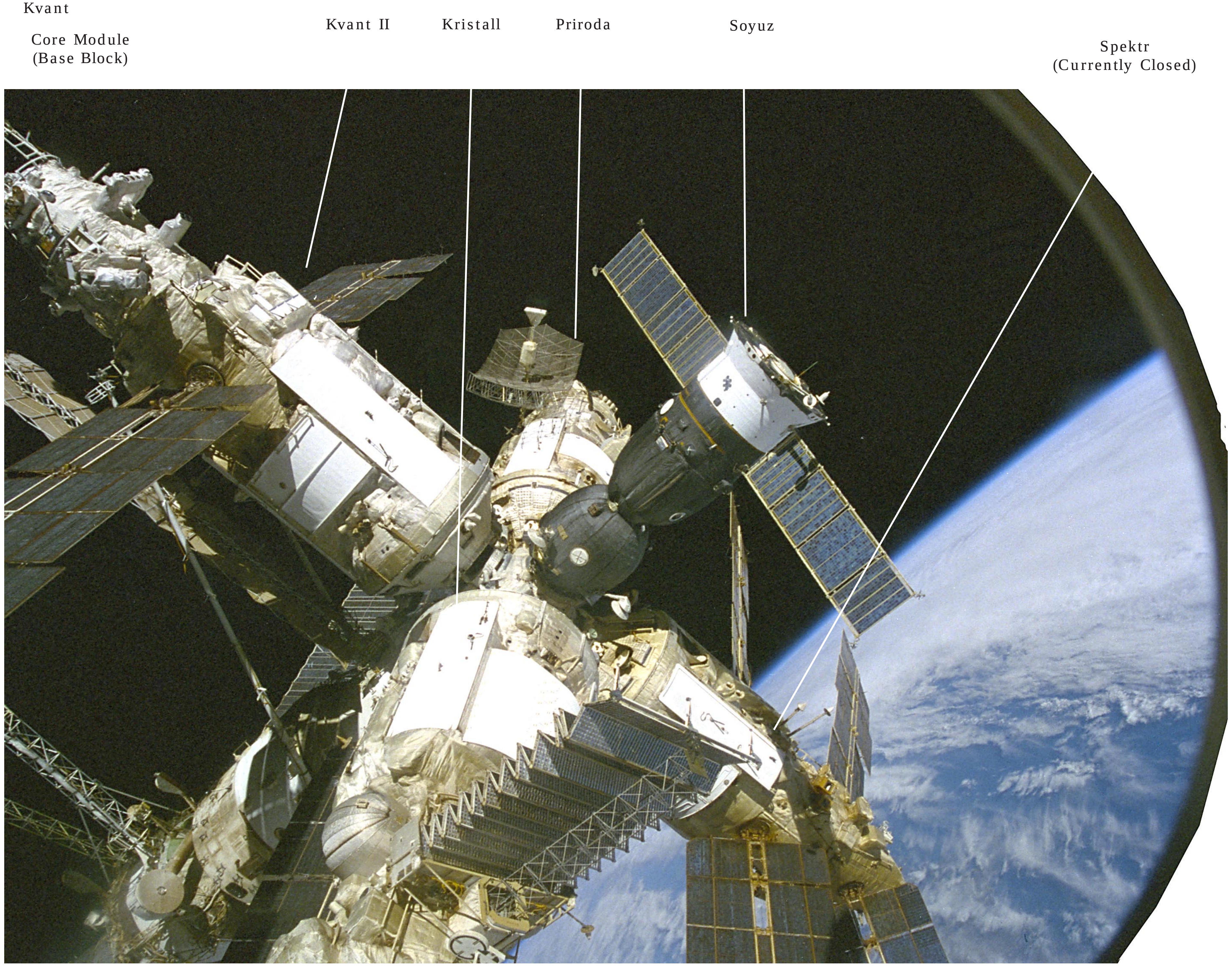
Russian Space Station Mir with Individual Modules Identified

STS86-370-25



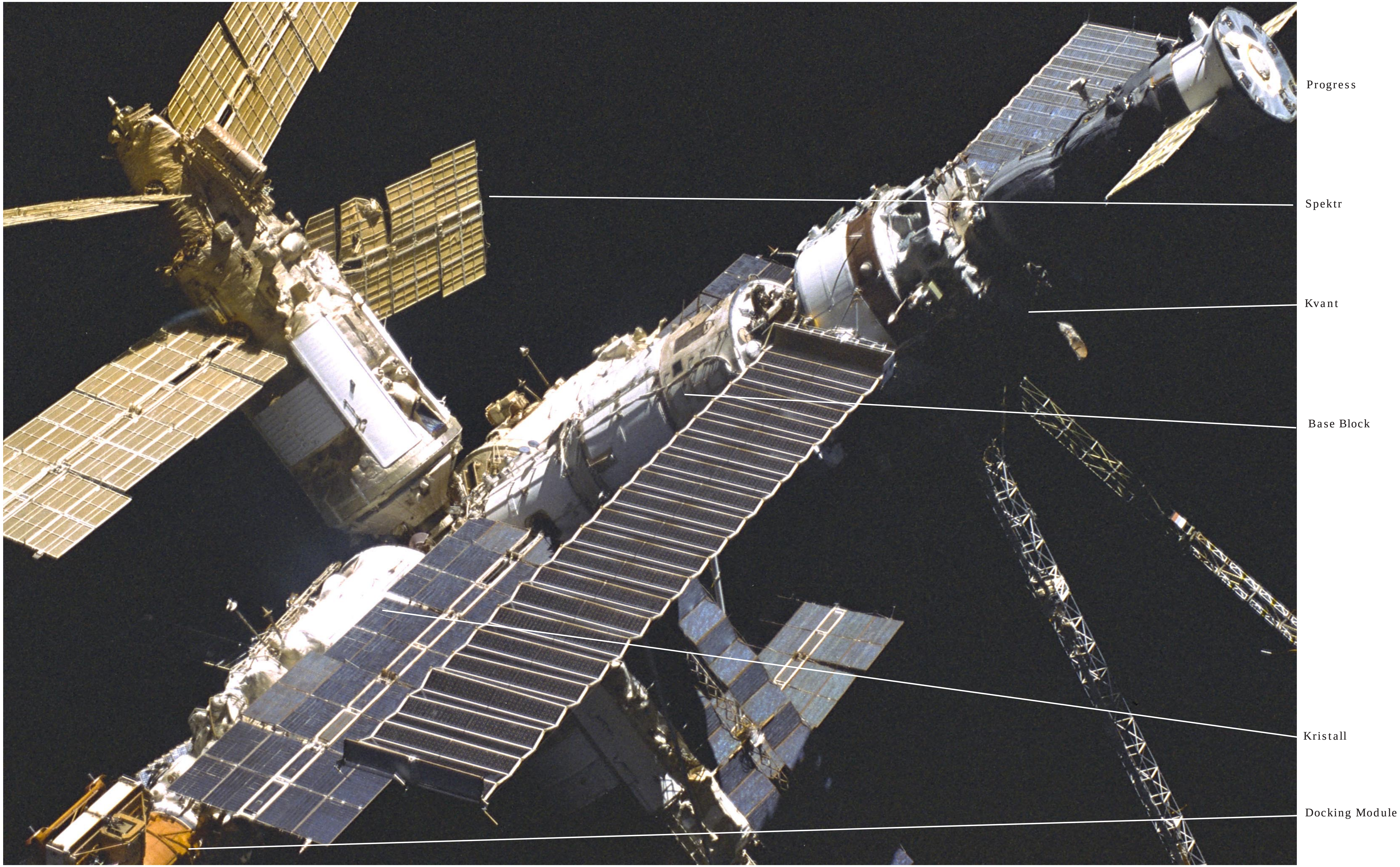
STS81-328-025

Figure MOD-1 Exterior View of Mir Core Module



STS86-301-11

Figure MOD-2 Exterior View of Mir



STS86-375-29

Figure MOD-3 Mir Space Station

STS86-377-24

Figure MOD-4 Mir Space Station

MIR
CORE MODULE
(BASE BLOCK)

NOTE: The photo numbers will not only indicate how recent the photo is, by Mir or NASA mission number, but will also indicate the progression of the photos through the modules.

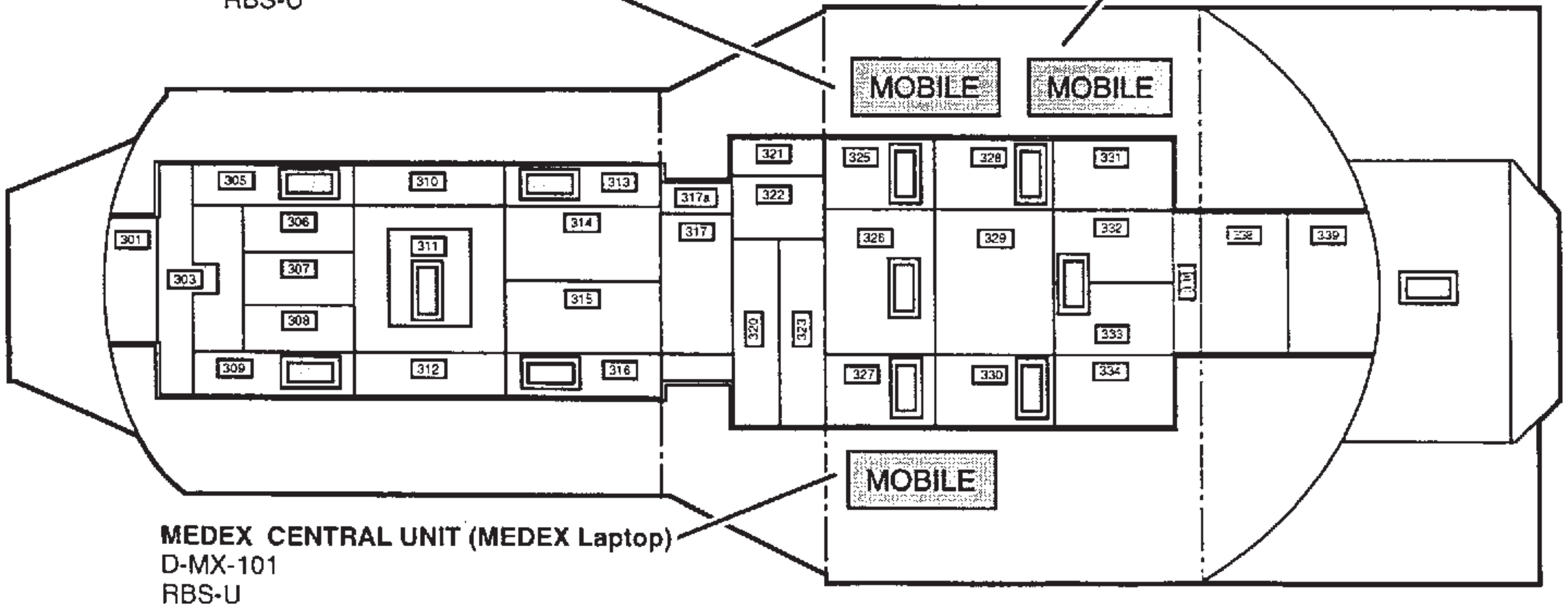


Figure MOD-5 Mir Core Module Ceiling

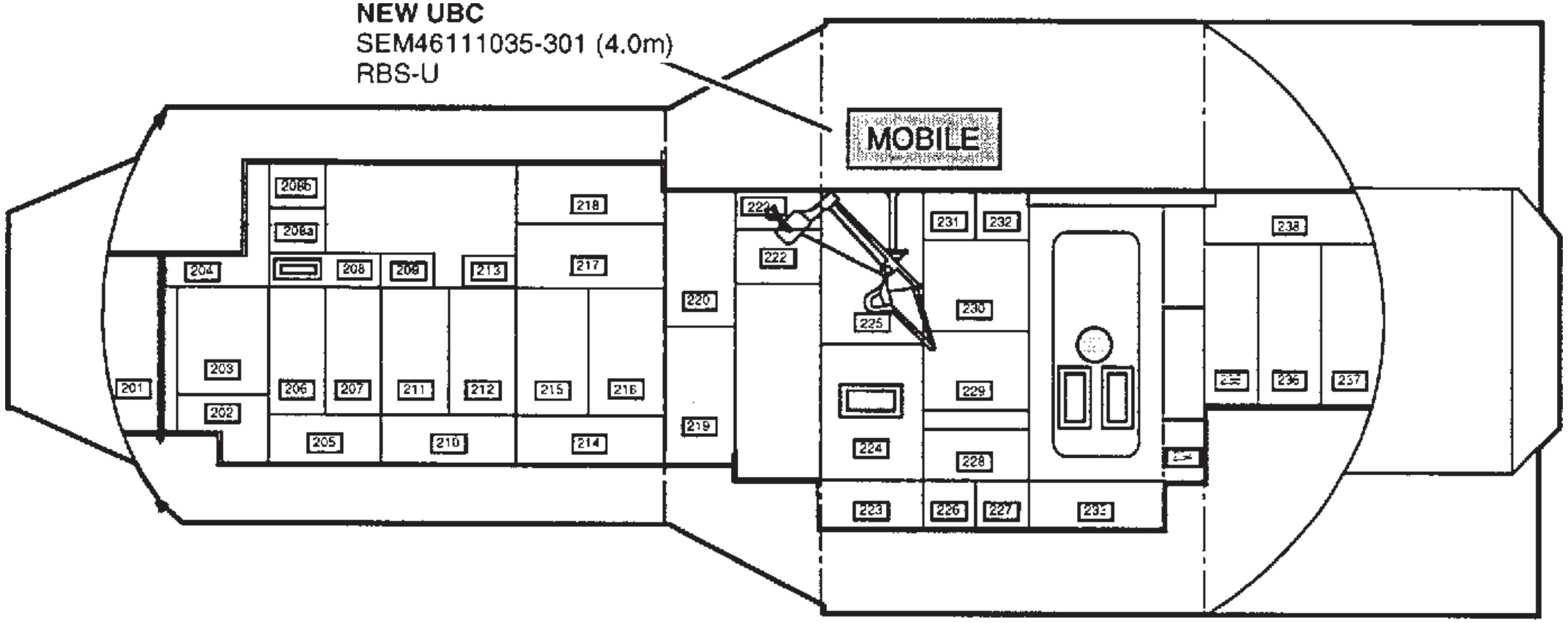


Figure MOD-6 Mir Core Module Port

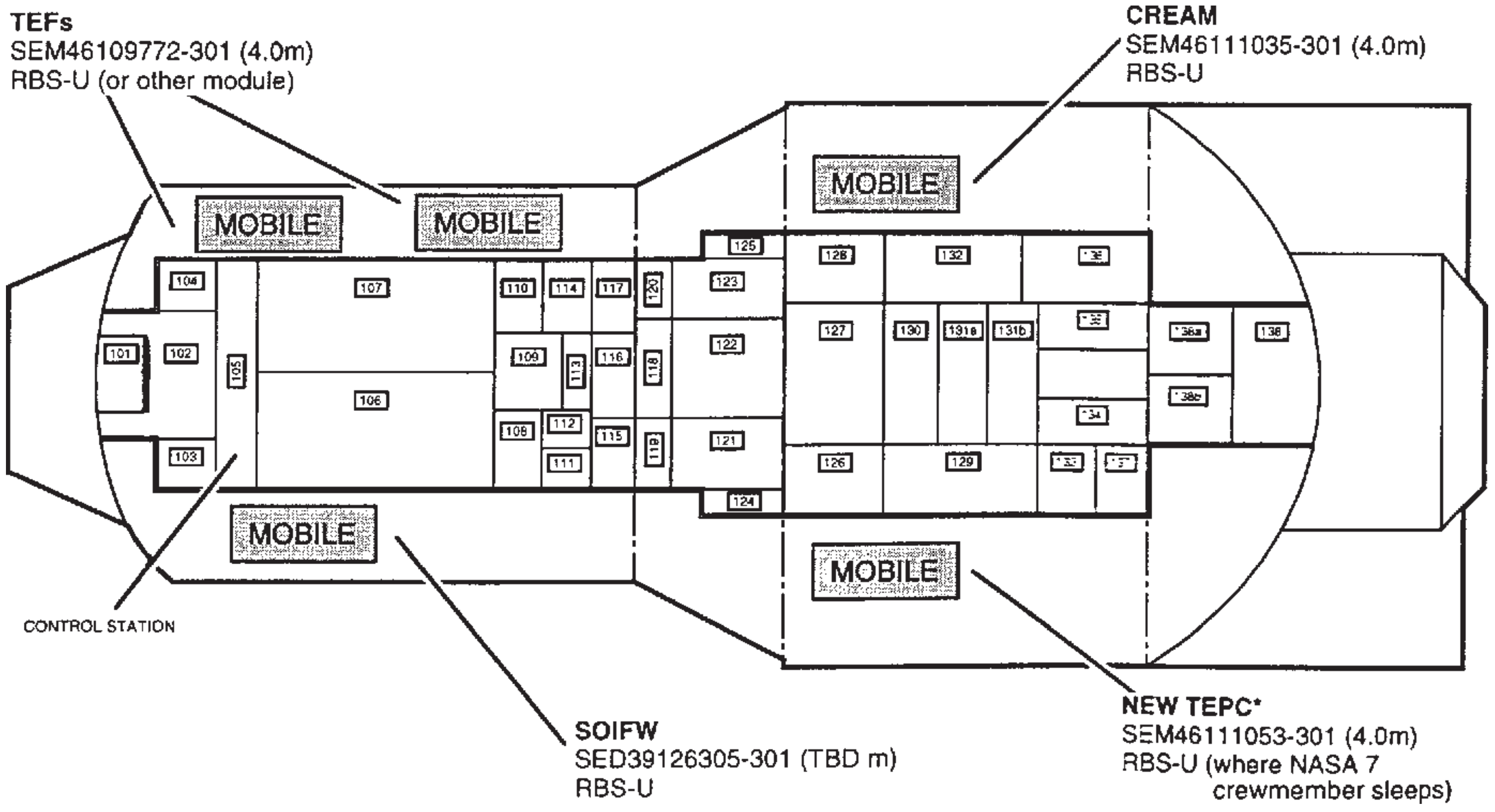


Figure MOD-7 Mir Core Module Floor

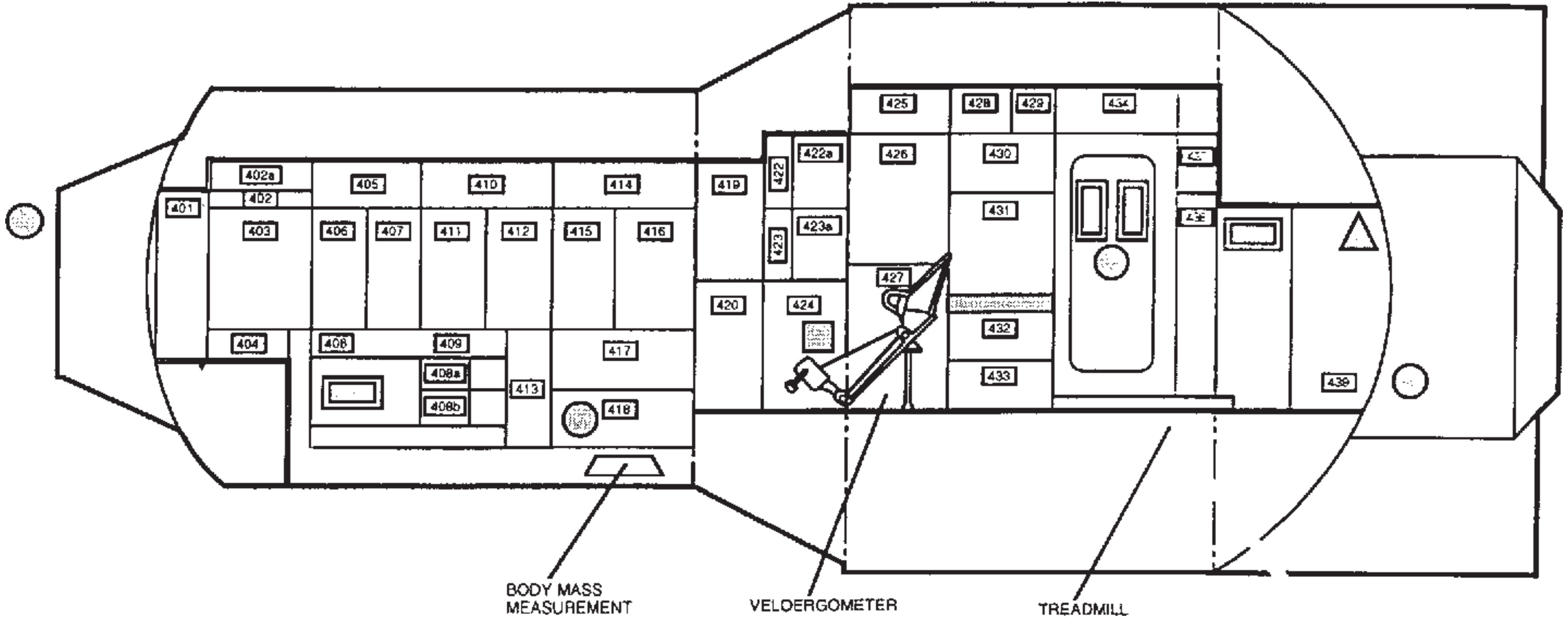
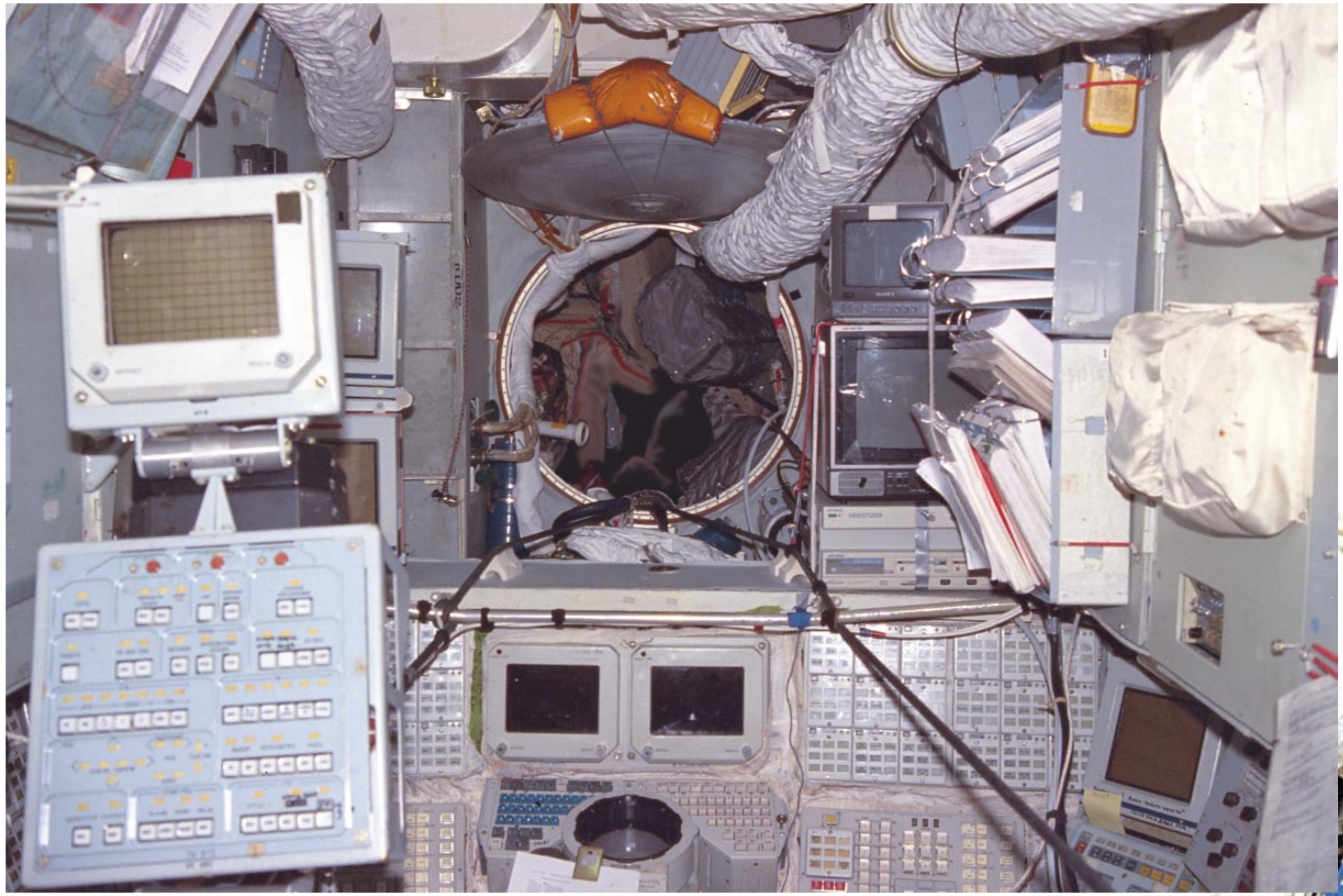


Figure MOD-8 Mir Core Module Starboard

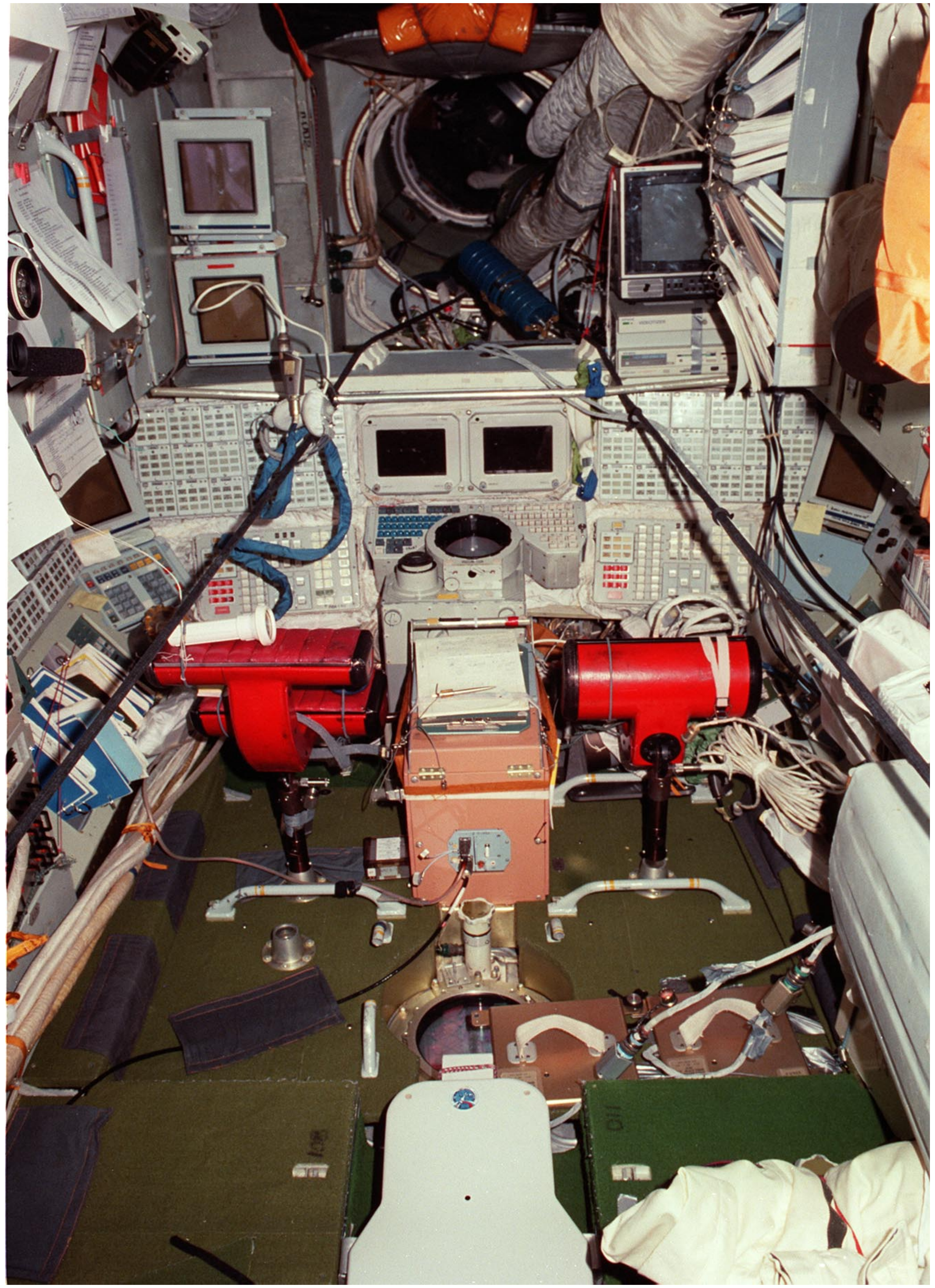


NASA 5

Figure MOD-9 Mir Control Station Towards the Transfer Node

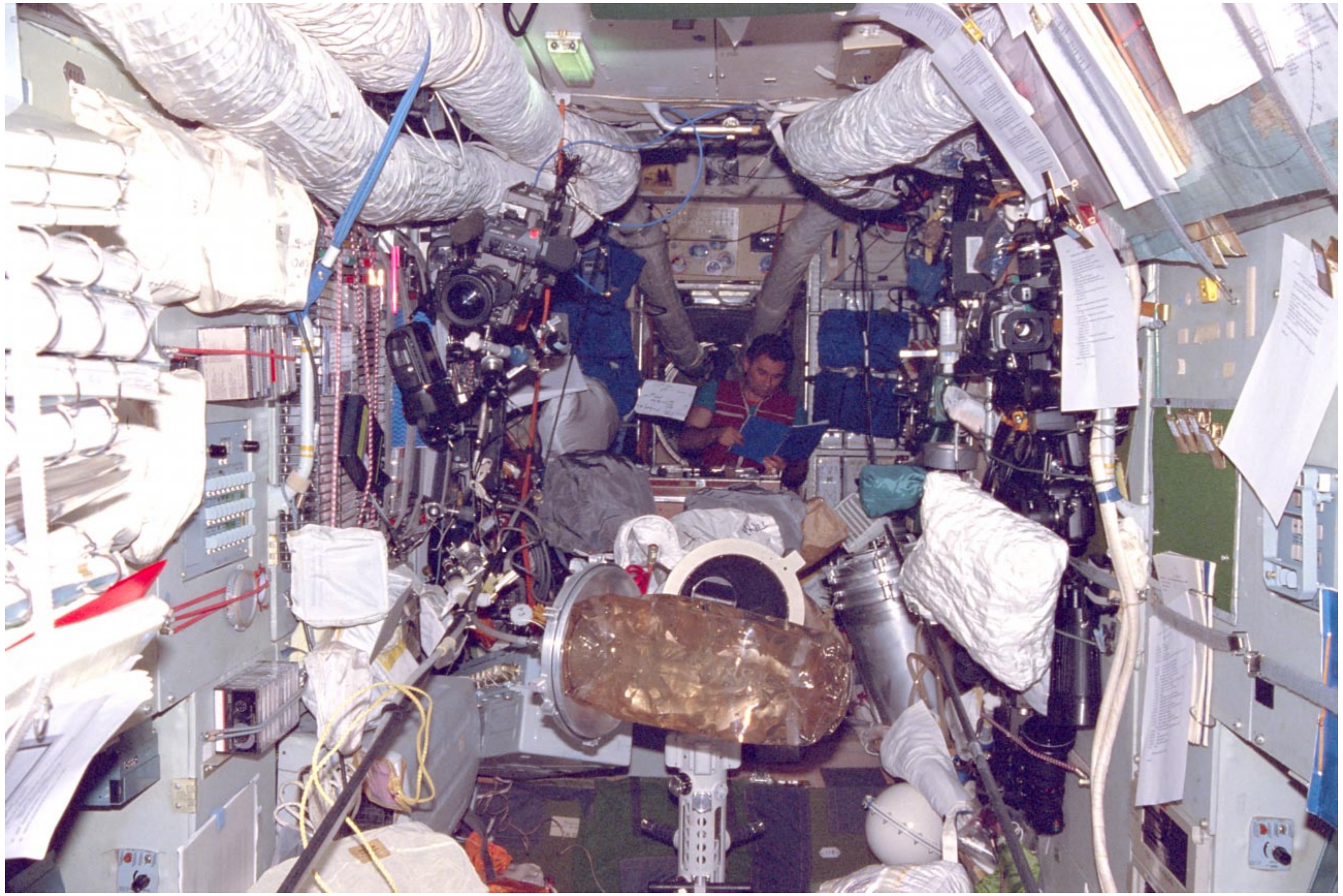
STS84-305-029

Figure MOD-10 Mir Core Module Towards Kvant



NM22-038-20

Figure MOD-11 Mir Control Station



NASA5-310-15

Figure MOD-12 Mir Core Module Towards Kvant with EDV in Foreground


STS86-336-36

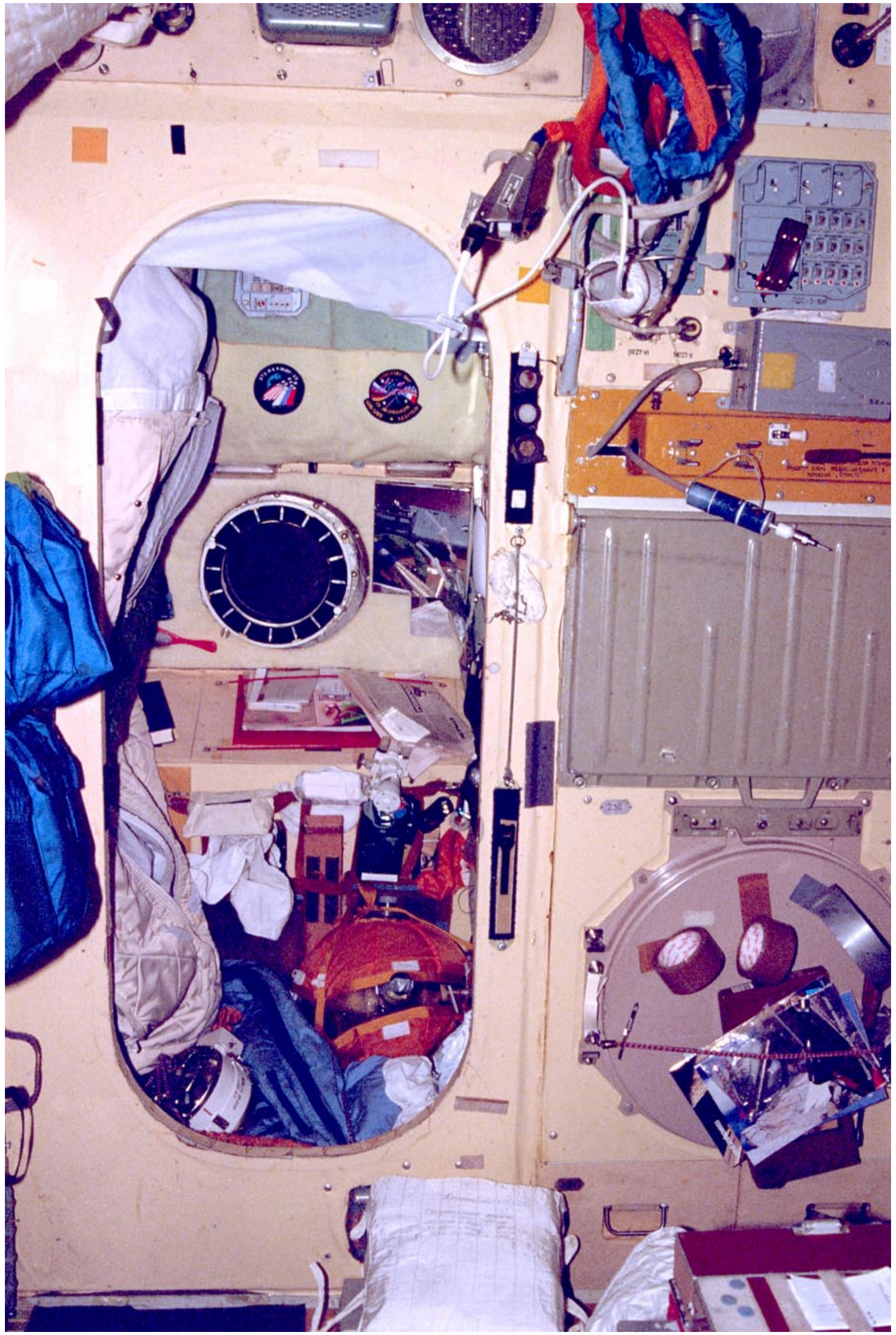
Figure MOD-14 Commander's Sleep Station


STS86-347-10

Figure MOD-13 Commander's Sleep Station in the Base Block (Starboard)

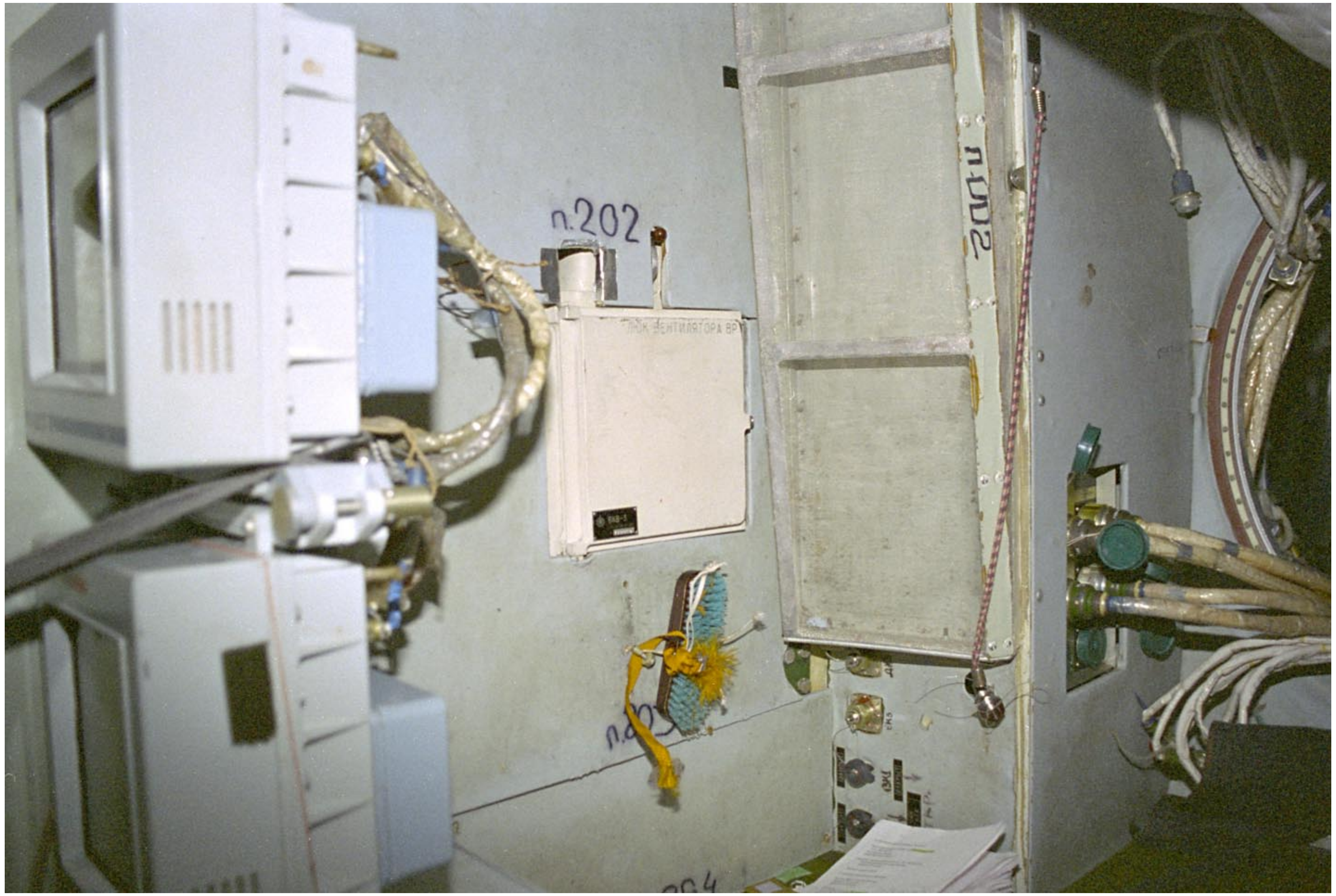

STS86-336-35

Figure MOD-15 Commander's Sleep Station Window



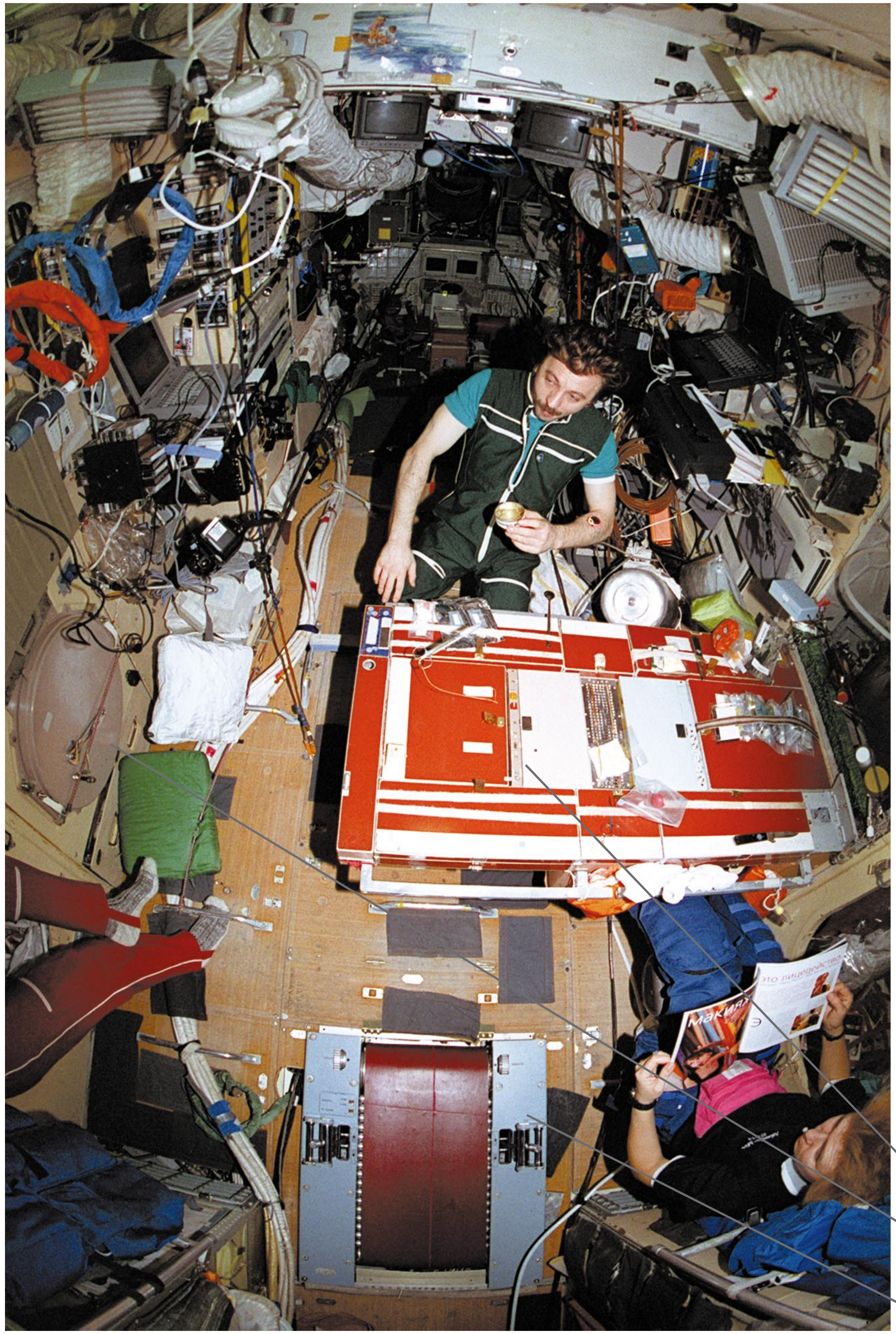
NASA5-310-18

Figure MOD-16 Board Engineer's Sleep Station (Port)



STS86-373-8

Figure MOD-17 The Port Side of the Core Module in Front of the Control Station Near the Transfer Node



STS84-319-036

Figure MOD-18 Core Module Floor by the Galley

STS86-400-22

Figure MOD-19 Core Module Towards Kvant Over the Treadmill

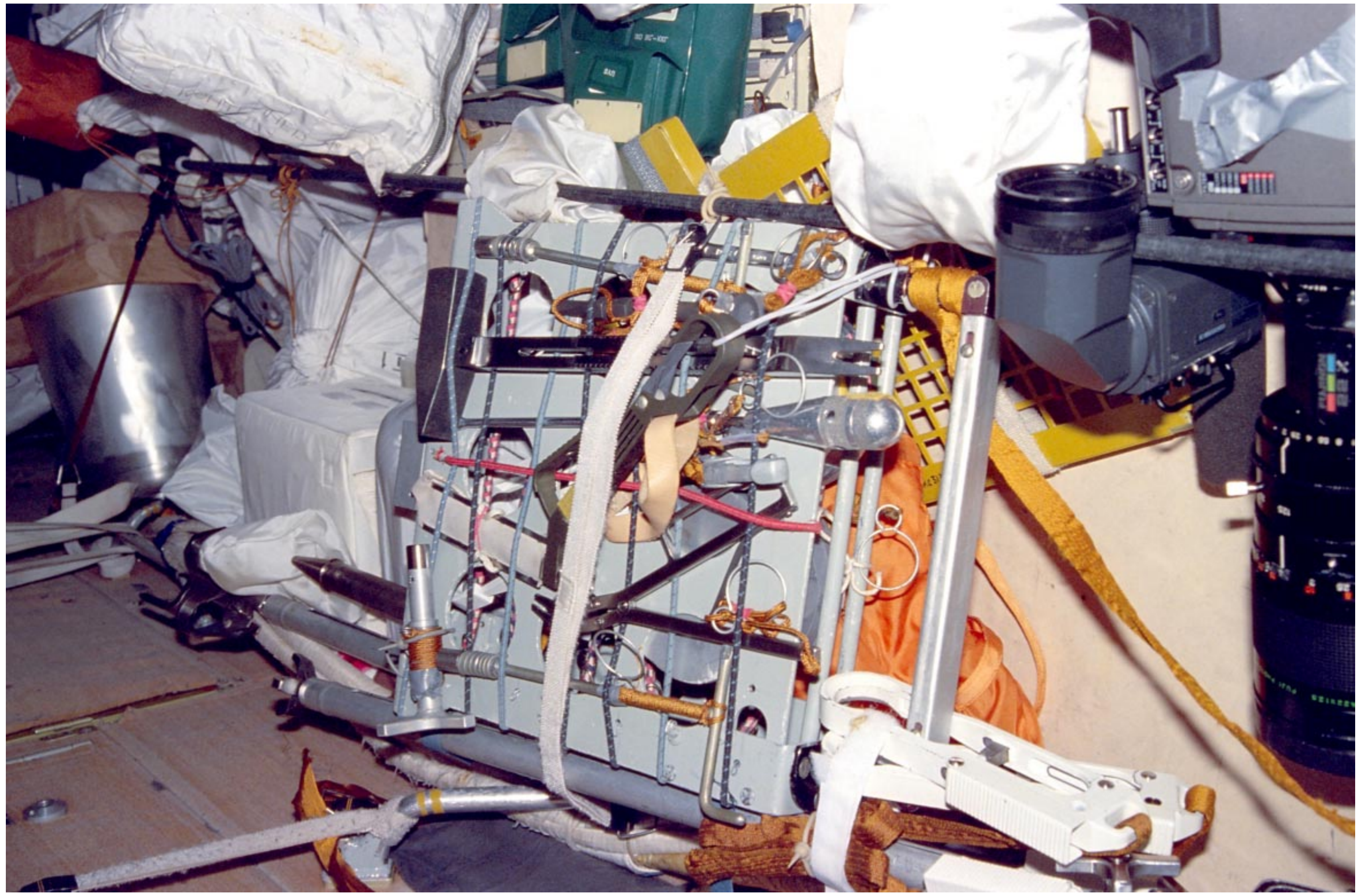
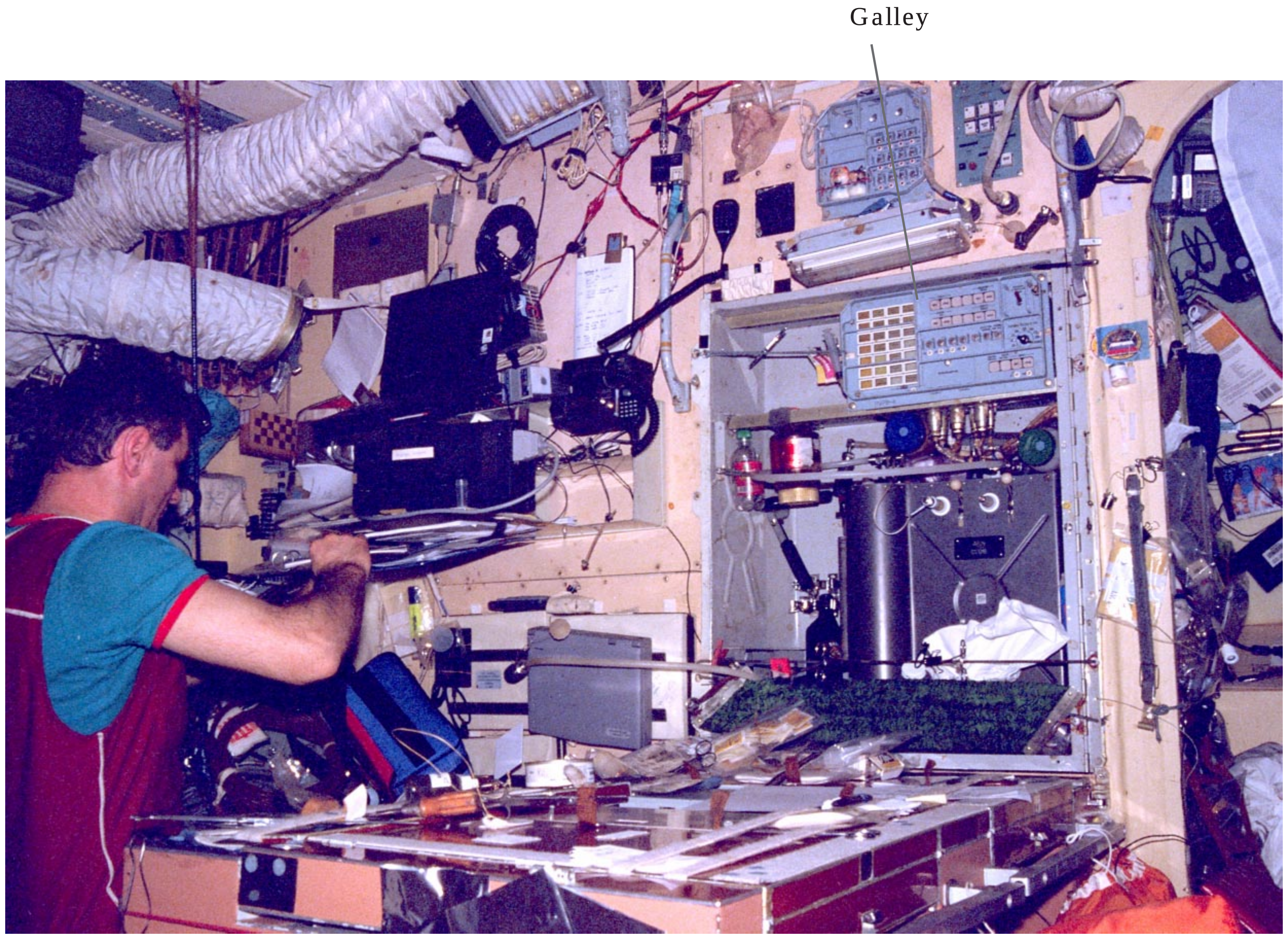
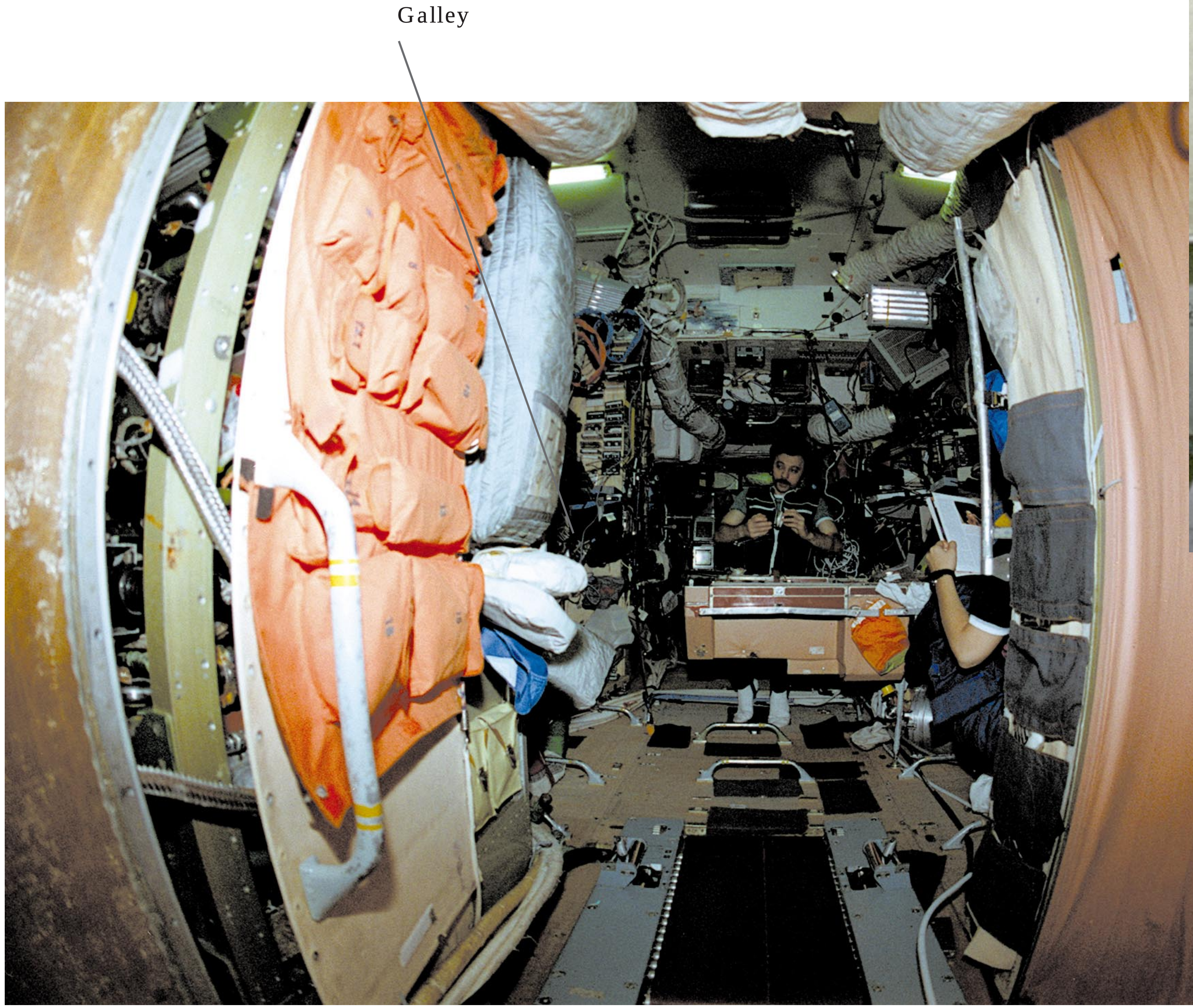

NASA5-321-31

Figure MOD-20 Mir Tools



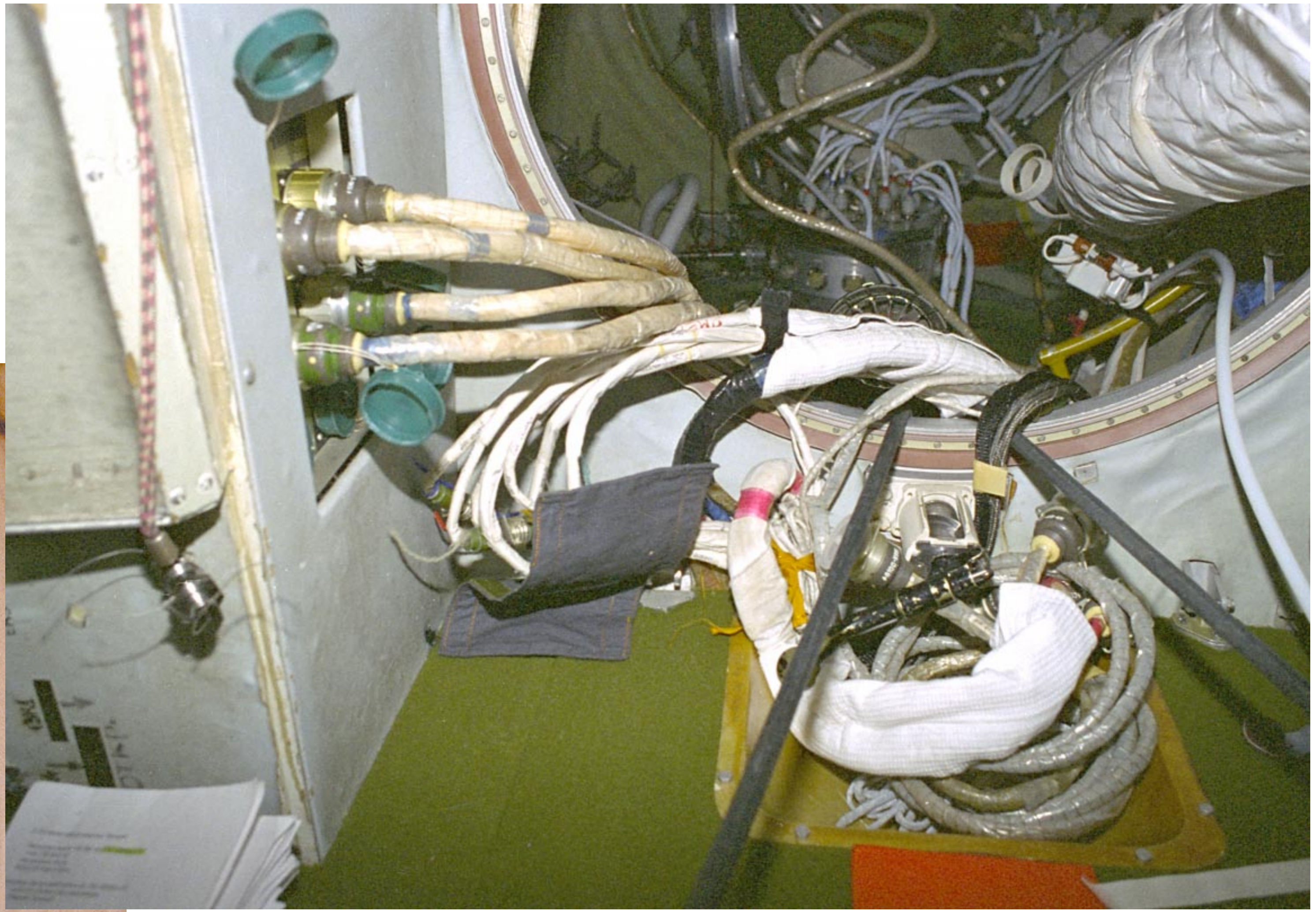
NASA5-310-019

Figure MOD-21 Work Table in the Core Module



STS84-319-035

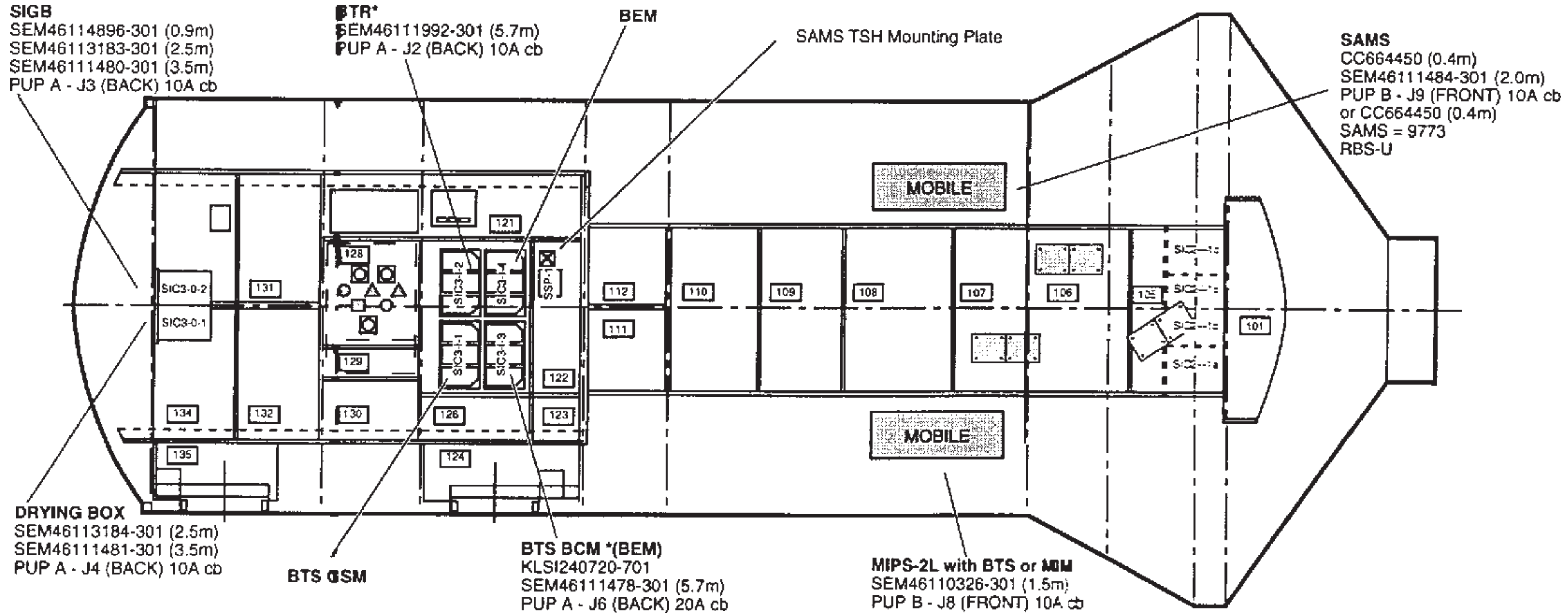
Figure MOD-22 Core Module's Treadmill Facing Transfer Node



STS86-373-14

Figure MOD-23 Mir Behind the Computers Near Kvant

PRIRODA



SIGB
SEM46114896-301 (0.9m)
SEM46113183-301 (2.5m)
SEM46111480-301 (3.5m)
PUP A - J3 (BACK) 10A cb

BTR*
SEM46111992-301 (5.7m)
PUP A - J2 (BACK) 10A cb

BEM

SAMS TSH Mounting Plate

SAMS
CC664450 (0.4m)
SEM46111484-301 (2.0m)
PUP B - J9 (FRONT) 10A cb
or CC664450 (0.4m)
SAMS = 9773
RBS-U

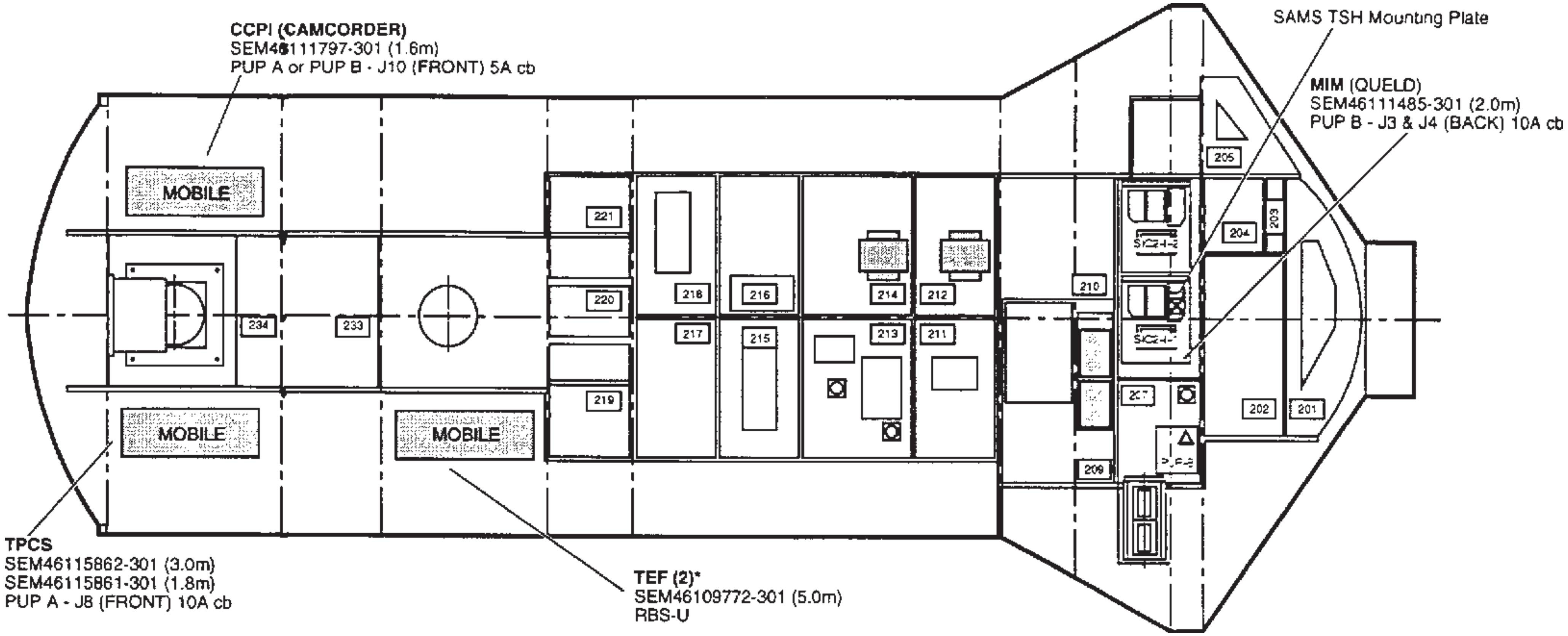
DRYING BOX
SEM46113184-301 (2.5m)
SEM46111481-301 (3.5m)
PUP A - J4 (BACK) 10A cb

BTS GSM

BTS BCM *(BEM)
KLSI240720-701
SEM46111478-301 (5.7m)
PUP A - J6 (BACK) 20A cb

MIPS-2L with BTS or MIM
SEM46110326-301 (1.5m)
PUP B - J8 (FRONT) 10A cb

Figure MOD-24 Priroda Ceiling



CCPI (CAMCORDER)
SEM46111797-301 (1.6m)
PUP A or PUP B - J10 (FRONT) 5A cb

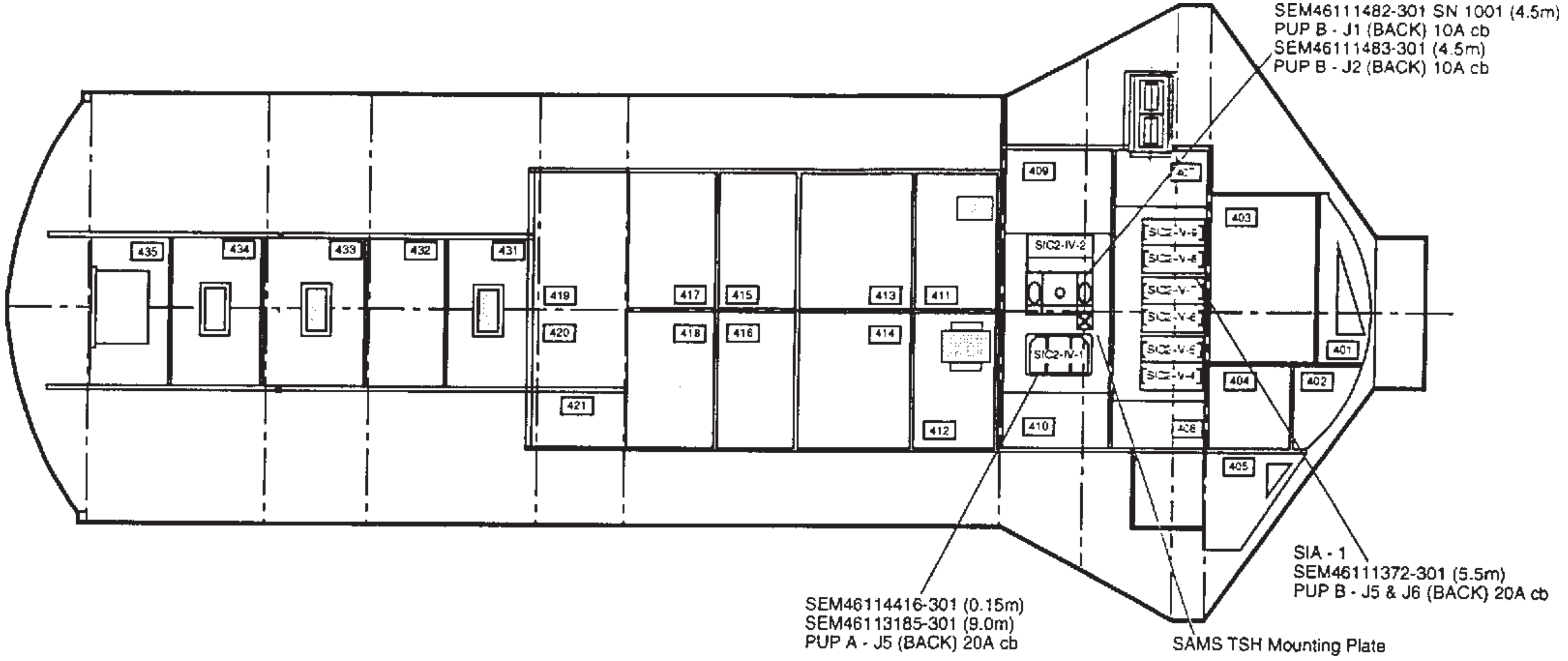
SAMS TSH Mounting Plate

MIM (QUELD)
SEM46111485-301 (2.0m)
PUP B - J3 & J4 (BACK) 10A cb

TPCS
SEM46115862-301 (3.0m)
SEM46115861-301 (1.8m)
PUP A - J8 (FRONT) 10A cb

TEF (2)*
SEM46109772-301 (5.0m)
RBS-U

Figure MOD-25 Priroda Starboard



SEM46111482-301 SN 1001 (4.5m)
PUP B - J1 (BACK) 10A cb
SEM46111483-301 (4.5m)
PUP B - J2 (BACK) 10A cb

SIA - 1
SEM46111372-301 (5.5m)
PUP B - J5 & J6 (BACK) 20A cb

SEM46114416-301 (0.15m)
SEM46113185-301 (9.0m)
PUP A - J5 (BACK) 20A cb

SAMS TSH Mounting Plate

Figure MOD-26 Priroda Floor

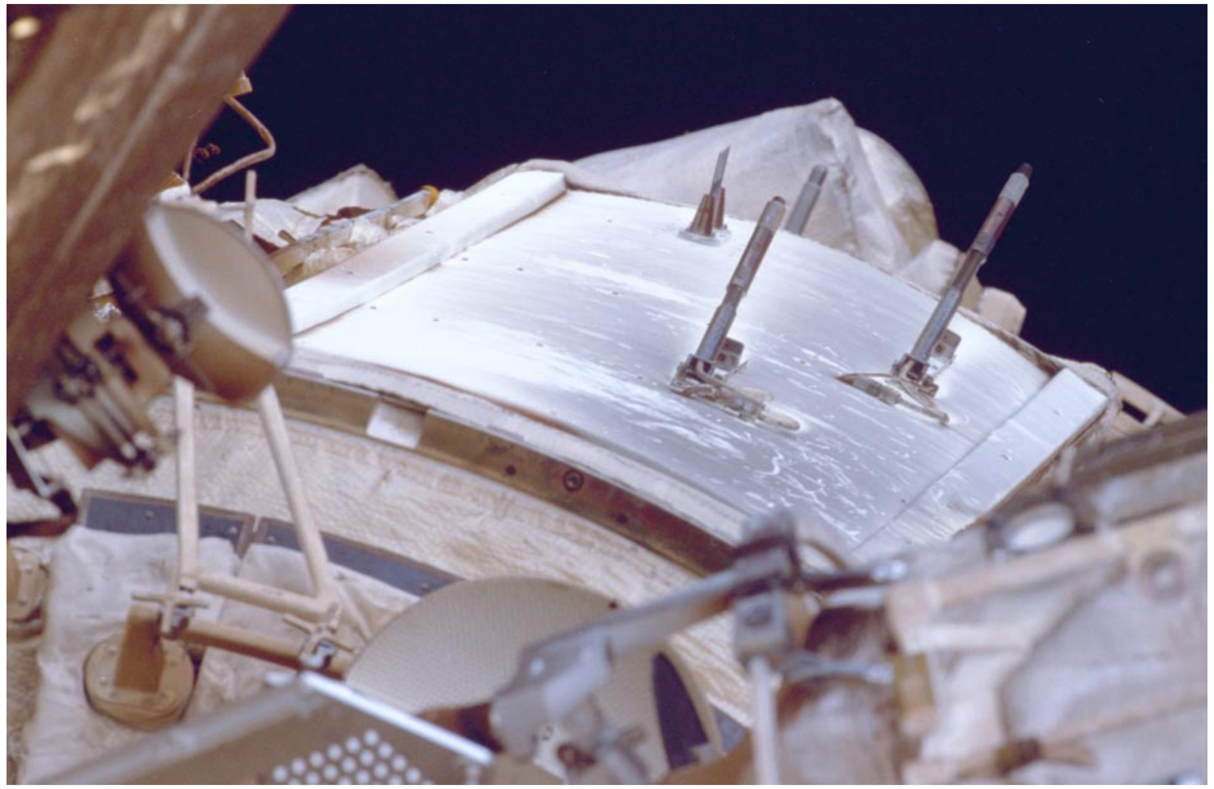

STS86-346-1

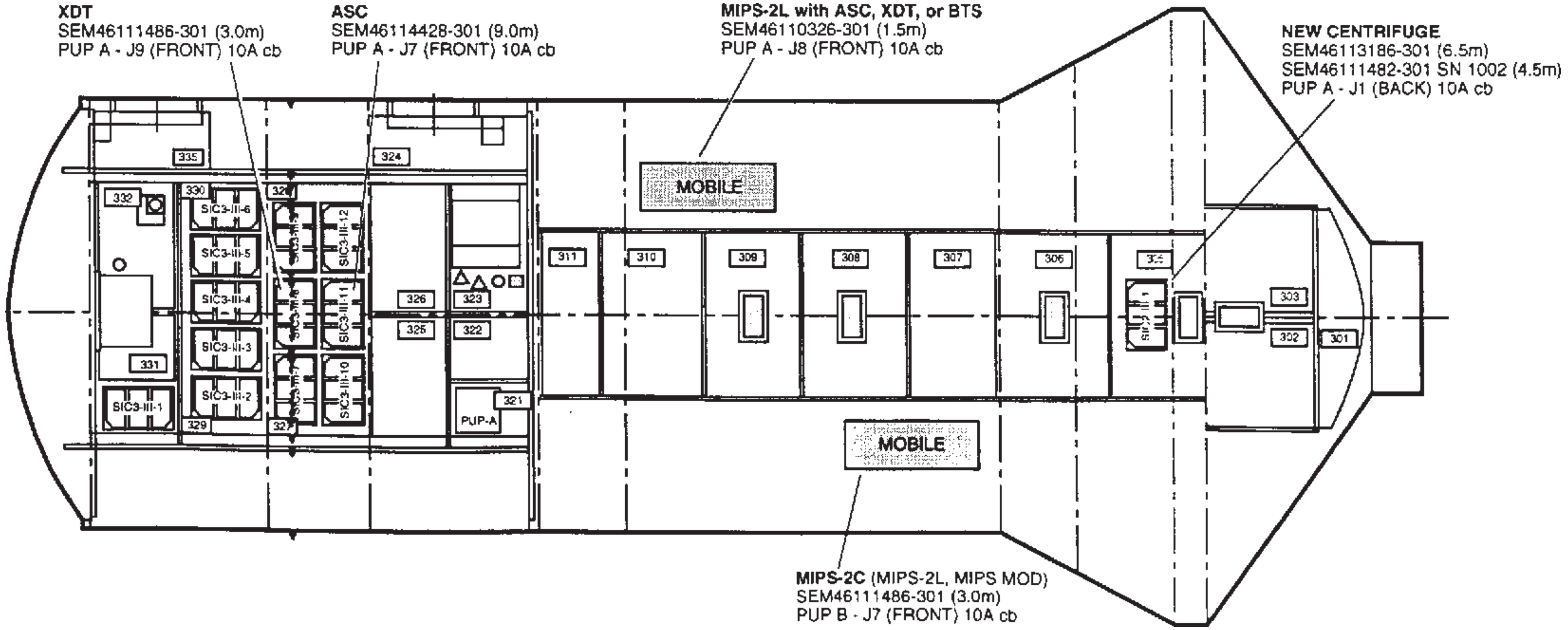
Figure MOD-28 Priroda Radiator Showing Space Deposition

XDT
SEM46111486-301 (3.0m)
PUP A - J9 (FRONT) 10A cb

ASC
SEM46114428-301 (9.0m)
PUP A - J7 (FRONT) 10A cb

MIPS-2L with ASC, XDT, or BTS
SEM46110326-301 (1.5m)
PUP A - J8 (FRONT) 10A cb

NEW CENTRIFUGE
SEM46113186-301 (6.5m)
SEM46111482-301 SN 1002 (4.5m)
PUP A - J1 (BACK) 10A cb

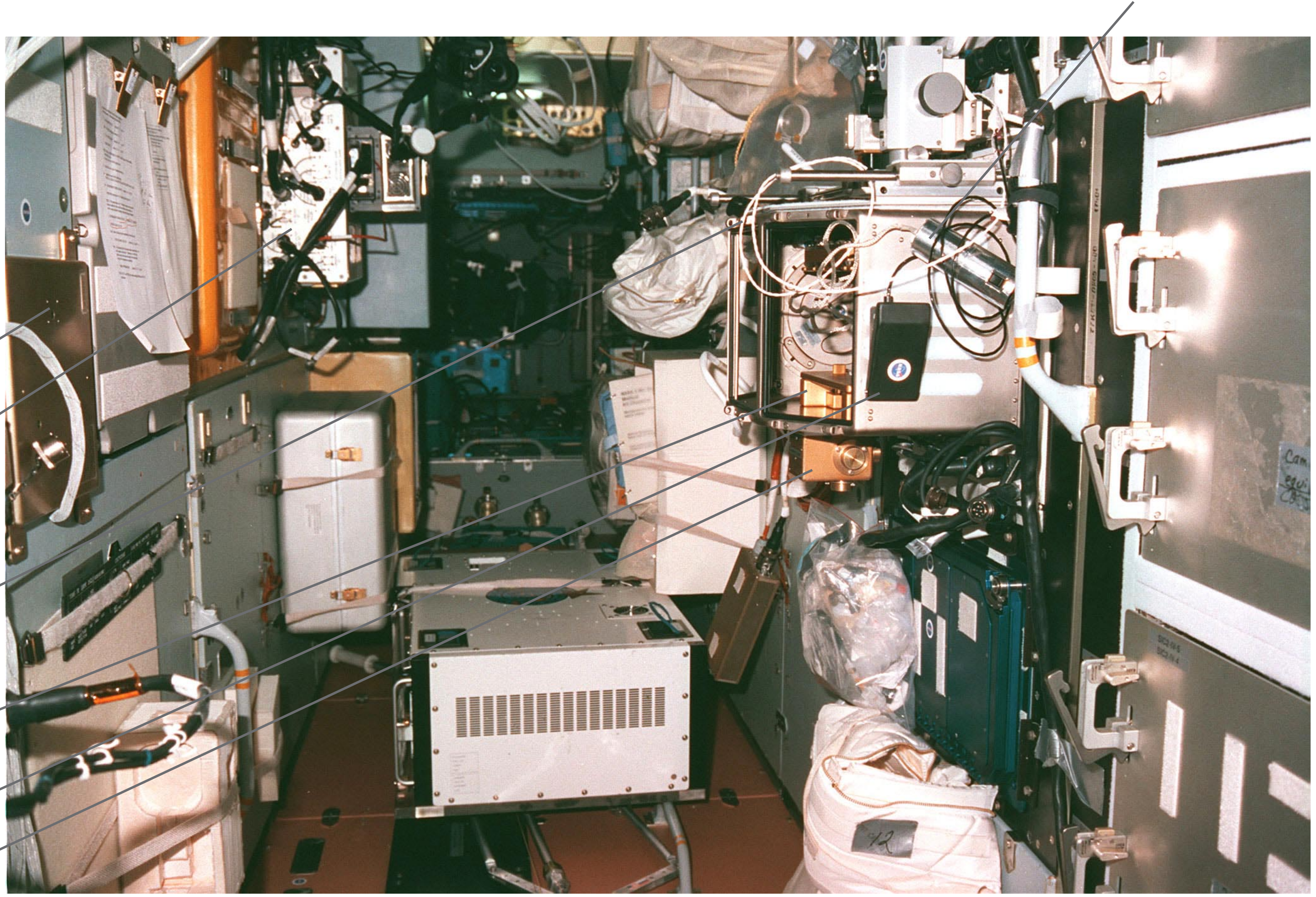


MIPS-2C (MIPS-2L, MIPS MOD)
SEM46111486-301 (3.0m)
PUP B - J7 (FRONT) 10A cb

Figure MOD-27 Priroda Port

STS79-350-32

Figure MOD-29 Priroda Towards the Transfer Node

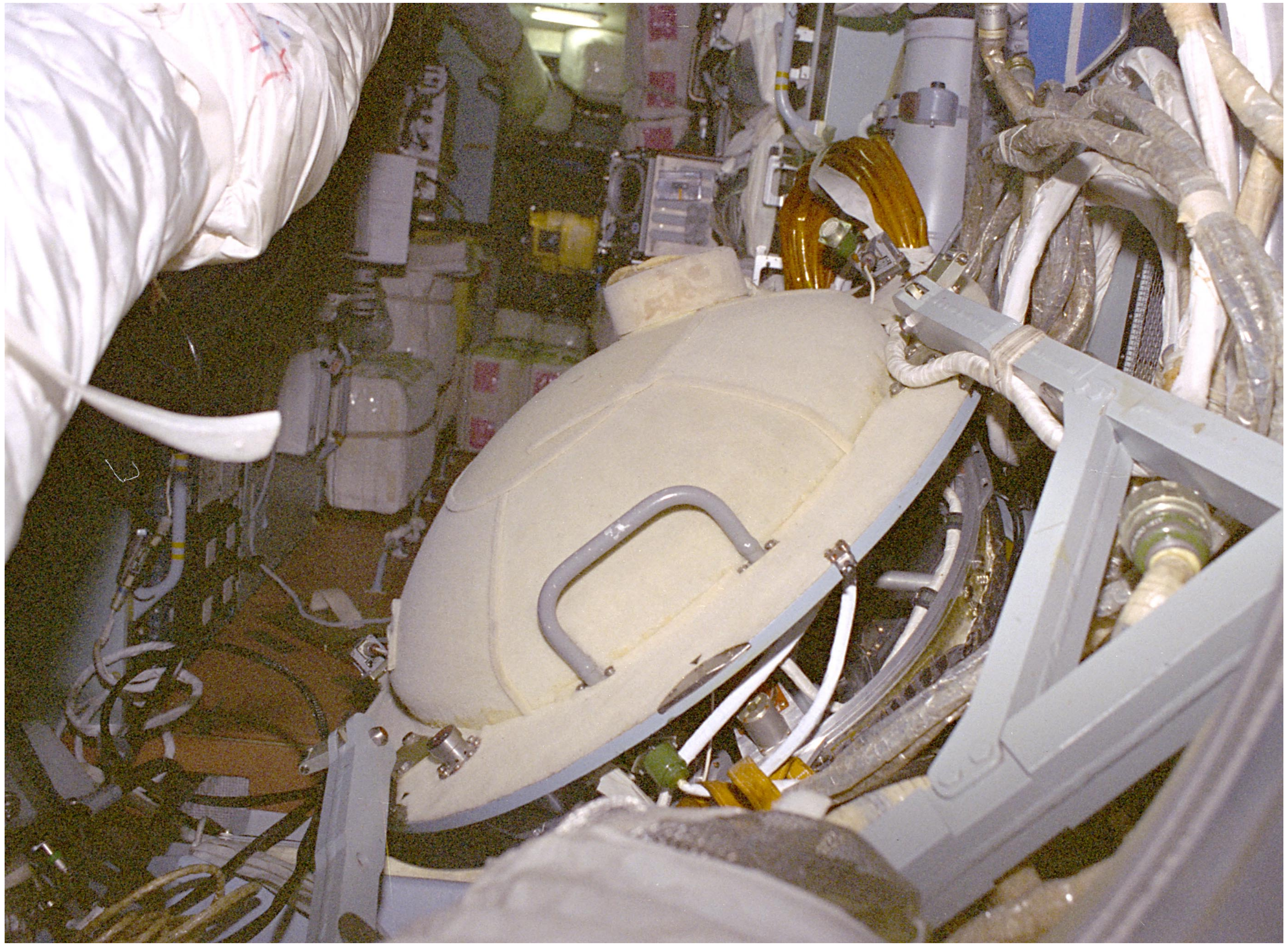


NM22-060-01

Figure MOD-30 Priroda Towards Aft End

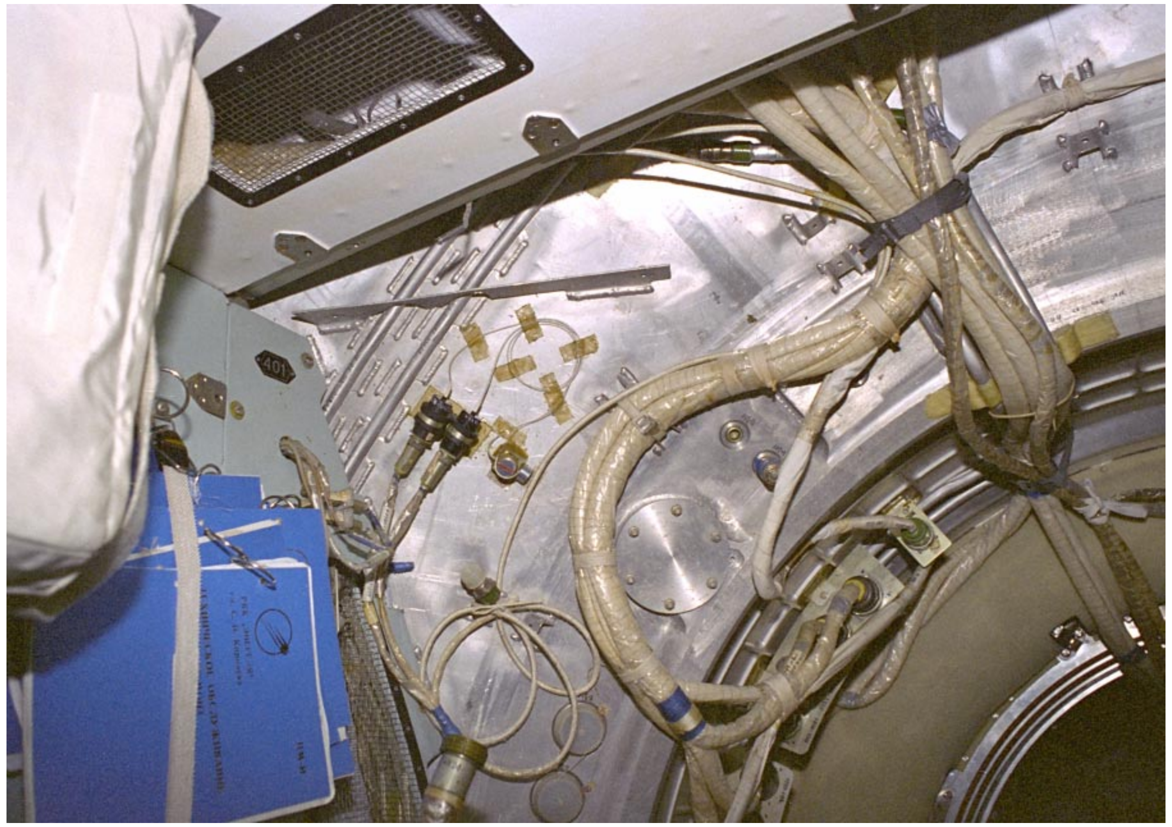
STS86-404-26

Figure MOD-31 Priroda Facing Towards Transfer Node



STS86-373-23

Figure MOD-32 Priroda Towards End Cone with the Hatch in the Foreground

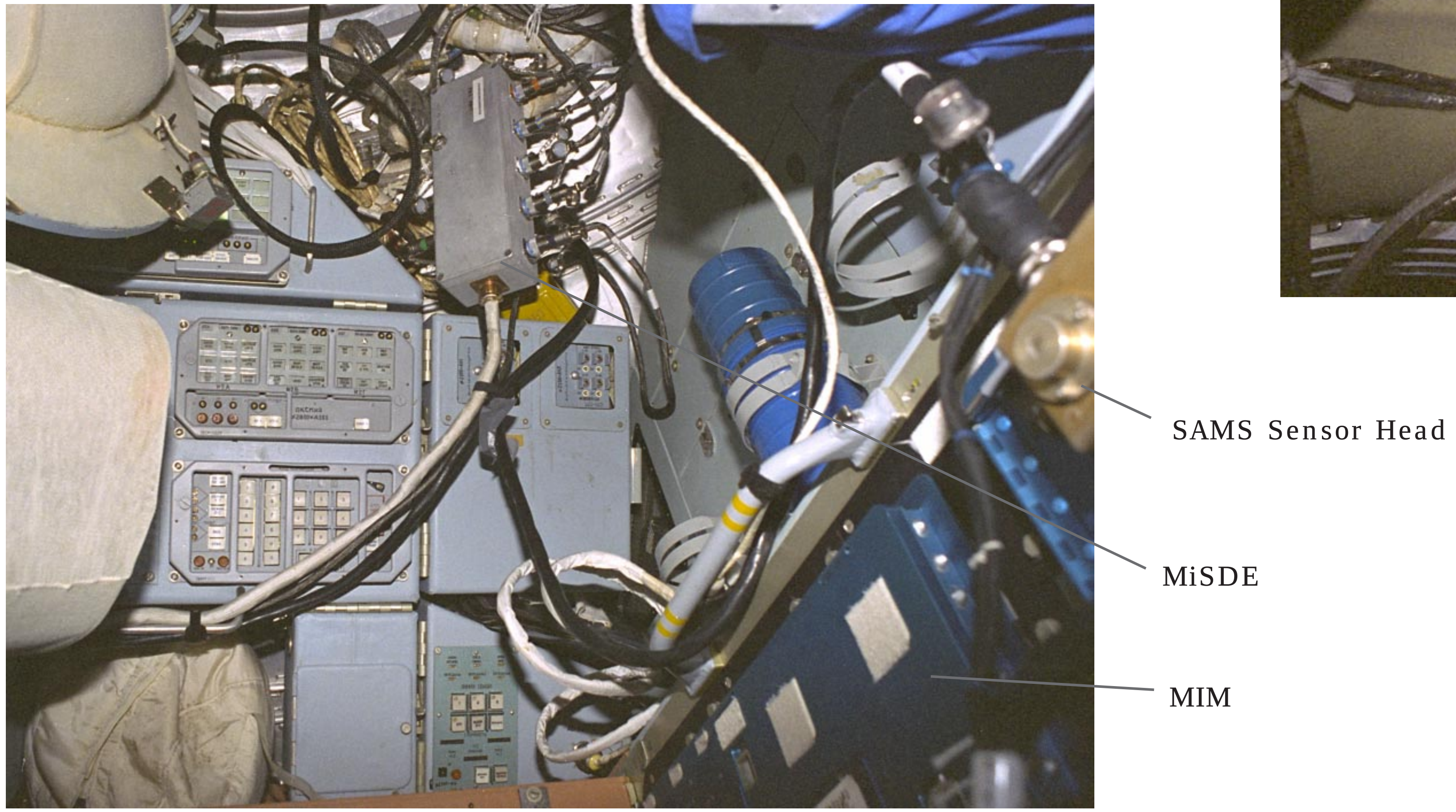


STS86-373-29

Figure MOD-33 Priroda Towards the Transfer Node

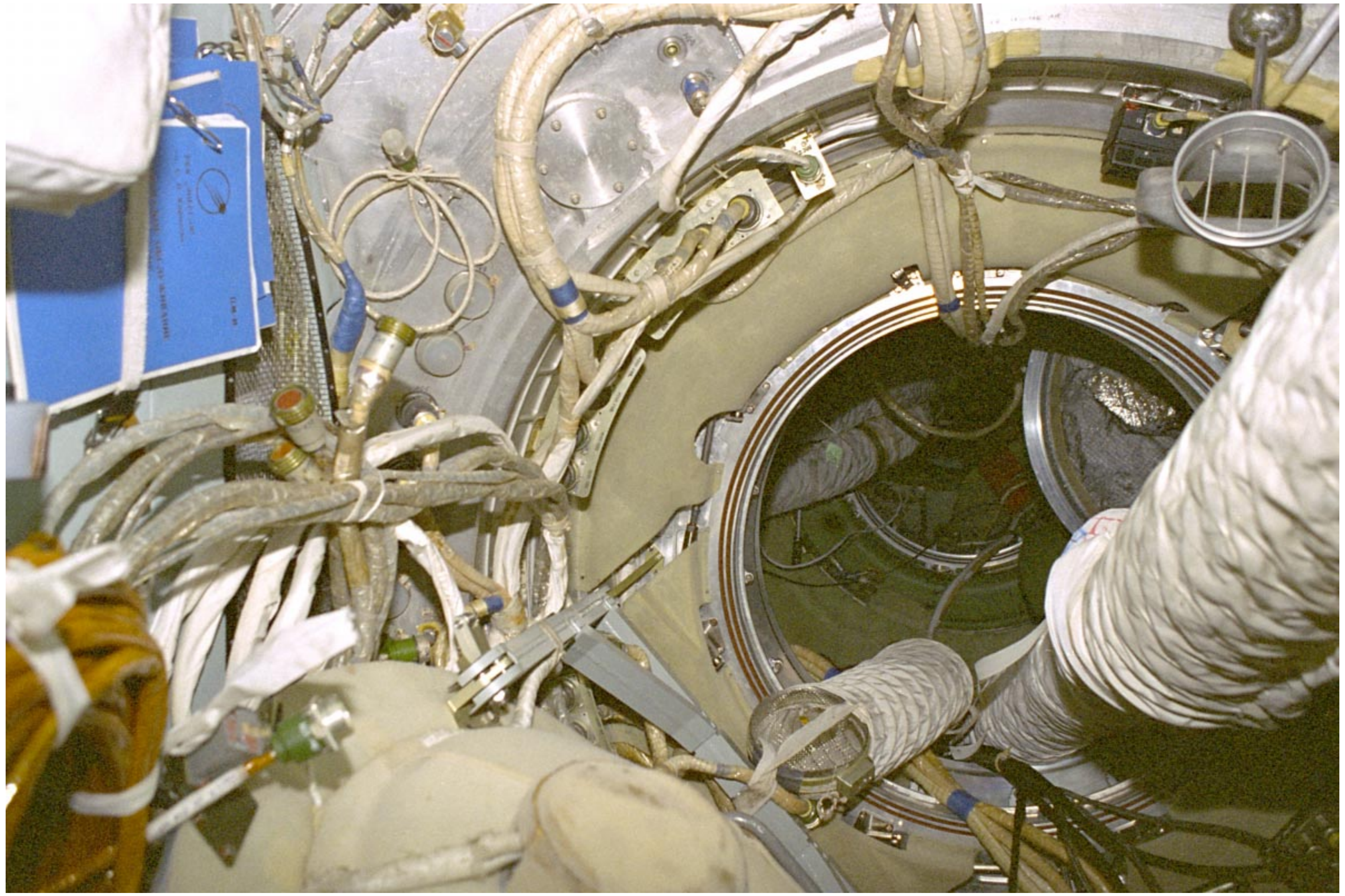
STS86-373-30

Figure MOD-35 Directional Air Vent in the Transfer Node End of Priroda



STS86-373-25

MOD-34 Priroda Module Viewing Towards the End Cone

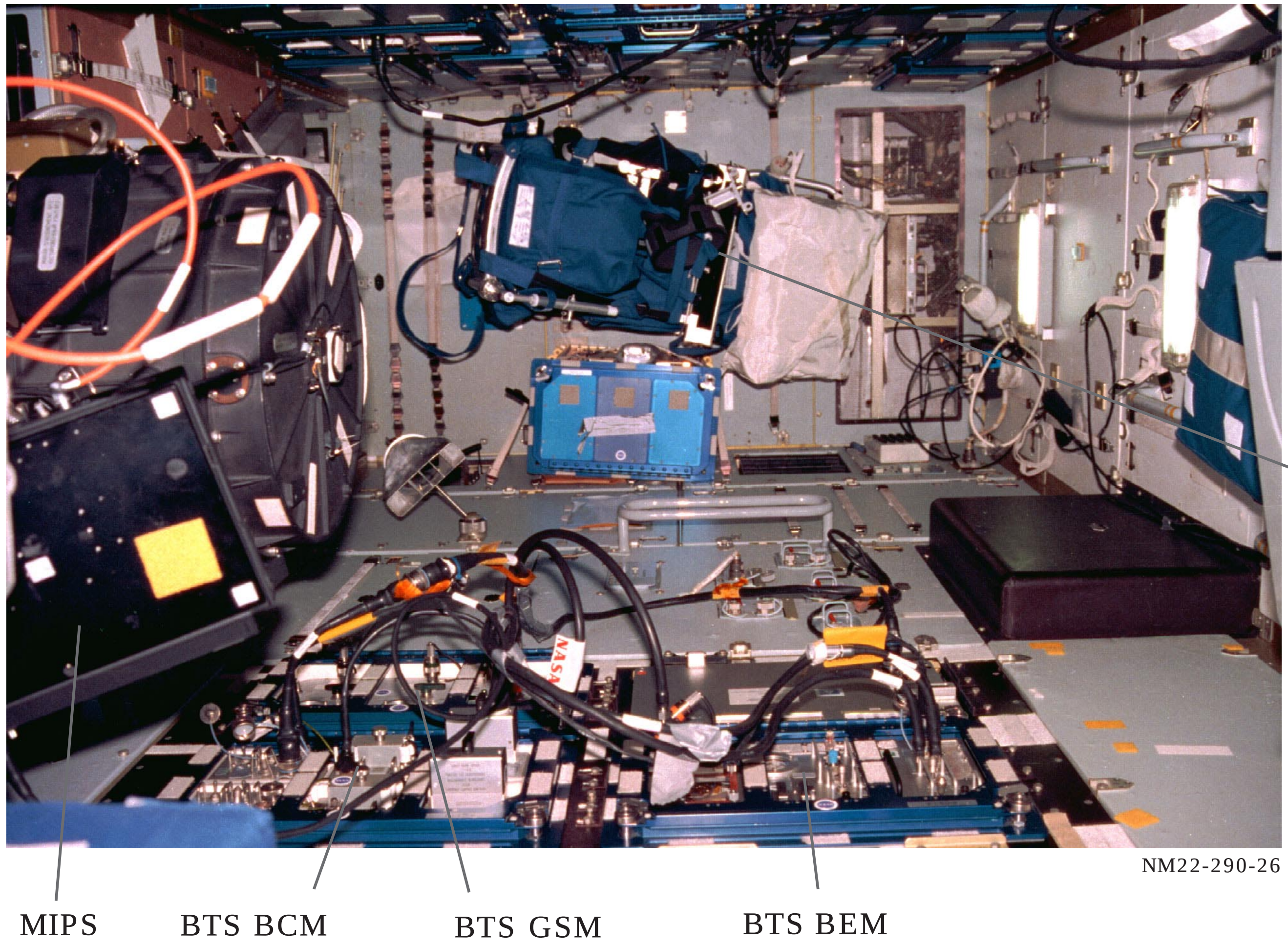


STS86-373-27

MOD-36 Priroda Looking Towards the Transfer Node

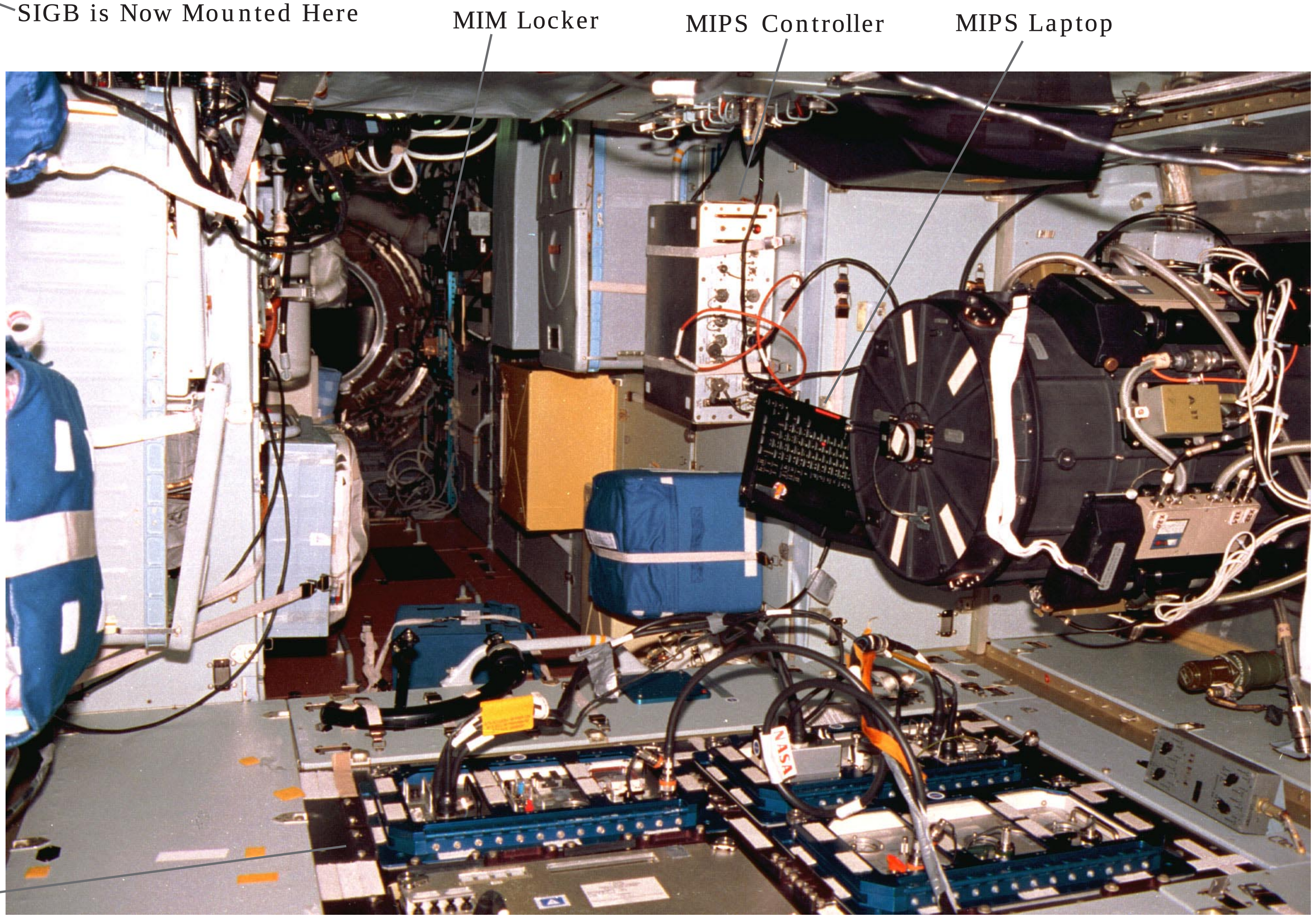
STS84-305-021

MOD-37 Priroda Stowage Lockers on Top and RBS-Us, RBS-20, and RBS-50 on Bottom



NM22-290-26

Figure MOD-38 View Towards the Aft End Cone of Priroda

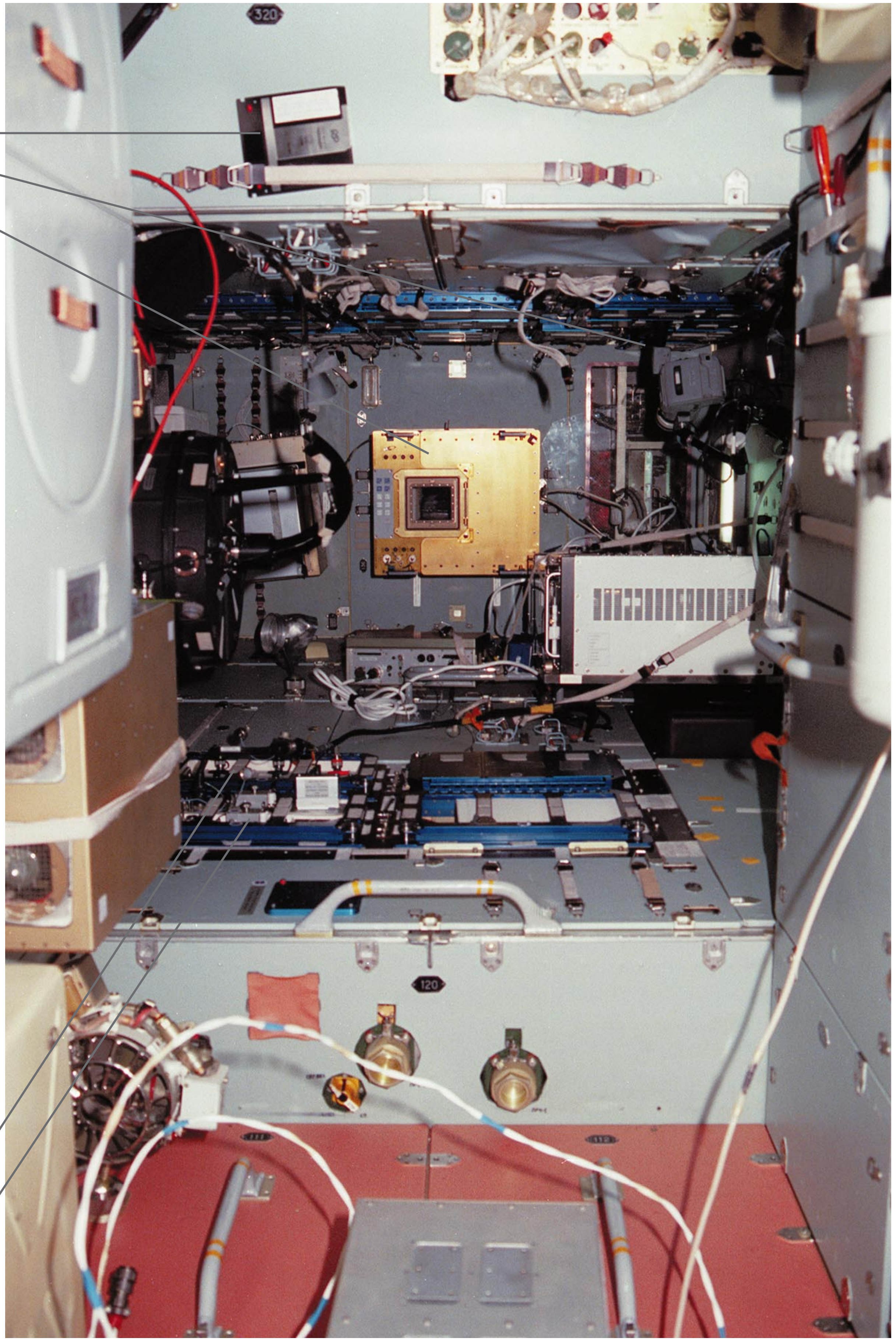


NM22-290-27

Figure MOD-39 View Towards the Front of Priroda (Transfer Node)

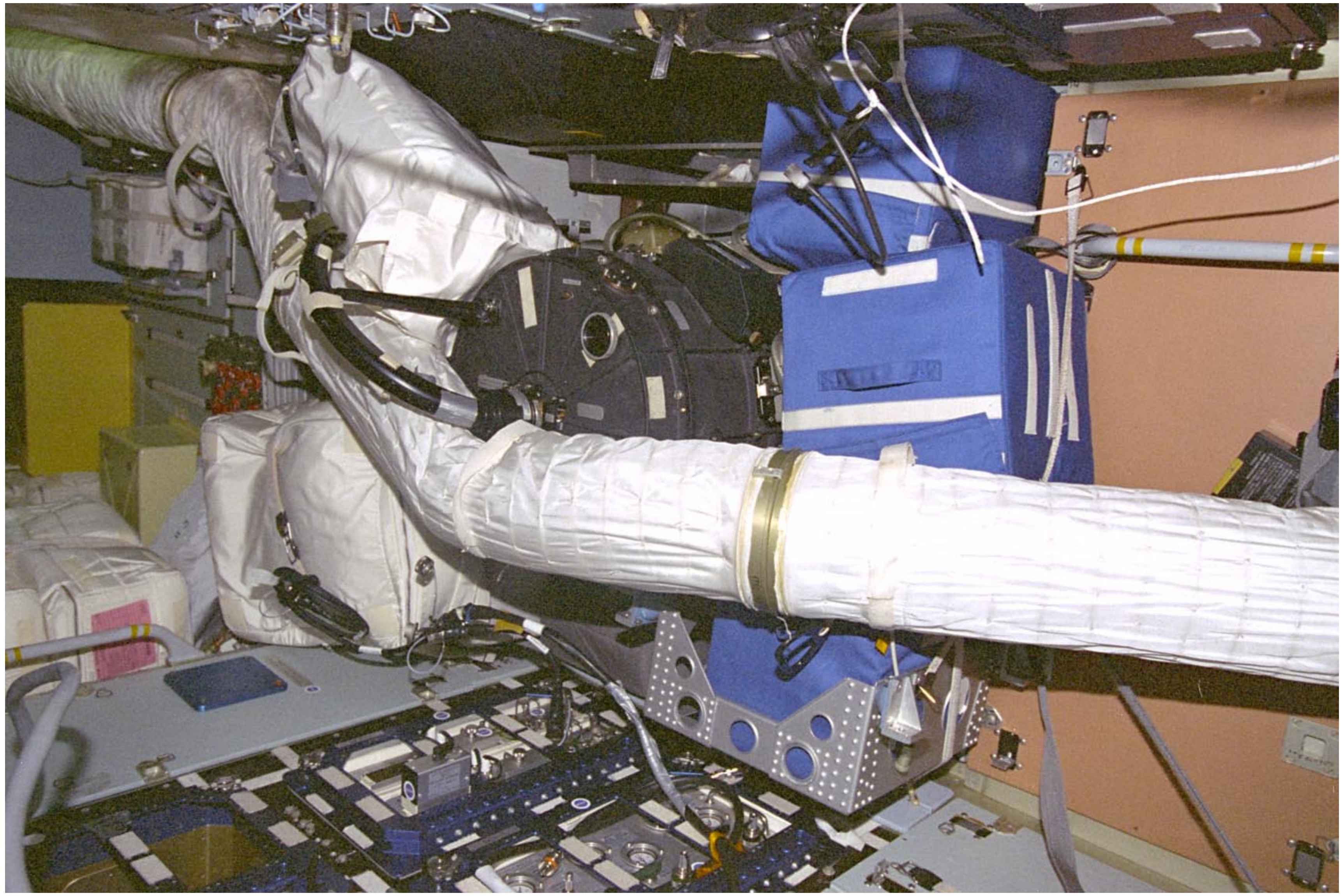
STS84-305-022

Figure MOD-40 Priroda's "Reorientation Point" Towards Transfer Node



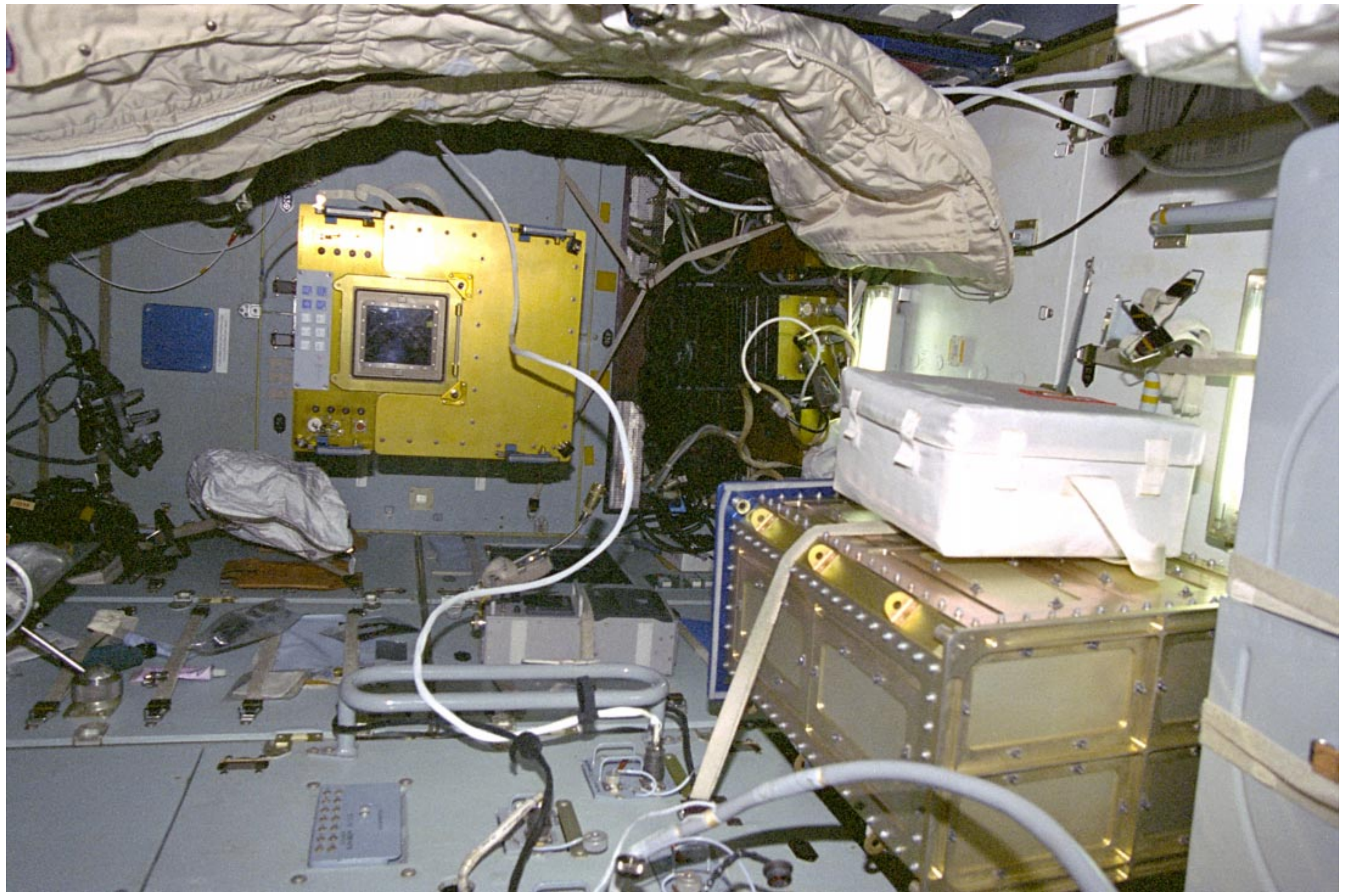
NM22-039-29

Figure MOD-41 Reorientation Point of Priroda Facing Aft



STS86-404-28

Figure MOD-43 Hardware in Priroda



STS86-404-29

Figure MOD-42 Priroda Aft End Cone Area with RBS-Us, RBS-20, and RBS-50 on the Floor

PRIRODA ICD

PRIRODA SINGLE LOCKER

The internal volume of a Priroda Single Locker is exactly equivalent to a standard middeck locker. Experiments are typically stowed directly in the locker using vibration isolating foam. The foam may be developed either by the PED or WG-6. Experiments will be packed such that the equipment will not float out of the locker during on-orbit activities

Experiments that require access for power or cooling will utilize the removable panel spaces. Panel types A and D are interchangeable. The foam will be designed and cut by the PEDs according to the experiment venting requirements, unless special arrangements are made with WG-6.

PRIRODA DOUBLE LOCKER

The Priroda Double Locker provides approximately 4 cu. ft. of stowage volume. Experiments will either be stowed directly in the locker using vibration isolating foam, or will be hard mounted to the special mounting plate. Experiments will be packed such that the equipment will not float out of the locker during on-orbit activities.

Experiments that require access for power or cooling will utilize the panel spaces. The foam will be designed and cut by the PEDs according to the experiment venting requirements unless special arrangements are made with WG-6.

PRIRODA SOFT STOWAGE BAGS

Experiments may be contained within vibration isolating foam and stowed inside the Soft Stowage Bag. Experiments will be packed such that the equipment will not float out of the bag during on-orbit activities.

PRIRODA SAP

Experiments may attach directly to the Single Adapter Plate using a universal hole pattern for attachment. Two alignment pin holes are also provided at opposite corners of the plate to facilitate installation of experiments. The PED shall provide for sealing between the experiment front face and the decorative panel. The Priroda SAP duplicates exactly the structural interface of the Orbiter Middeck Wire Tray for a single middeck locker equivalent hardware unit, as defined in NSTS-21000-IDD-MDK. All single lockers are mounted to an SAP.

Experiments that require access for cooling may utilize the plate openings shown in Figure MOD-53.

Experiments attaching directly to the Priroda SAP shall not exceed the maximum launch weight of 79 lbs.

PRIRODA DAP

Experiments may attach directly to the Double Adapter Plate using a universal hole pattern for attachment. Four alignment pin holes are also provided to facilitate installation of experiments. The PED shall provide for sealing between the experiment front face and the decorative panel. The Priroda DAP duplicates exactly the structural interface of the Orbiter Middeck Wire Tray for two vertically adjacent middeck locker equivalent hardware units (or one double middeck locker equivalent unit). All double lockers are mounted to a DAP.

Experiments that require access for cooling may utilize the plate openings shown in Figure MOD-54.

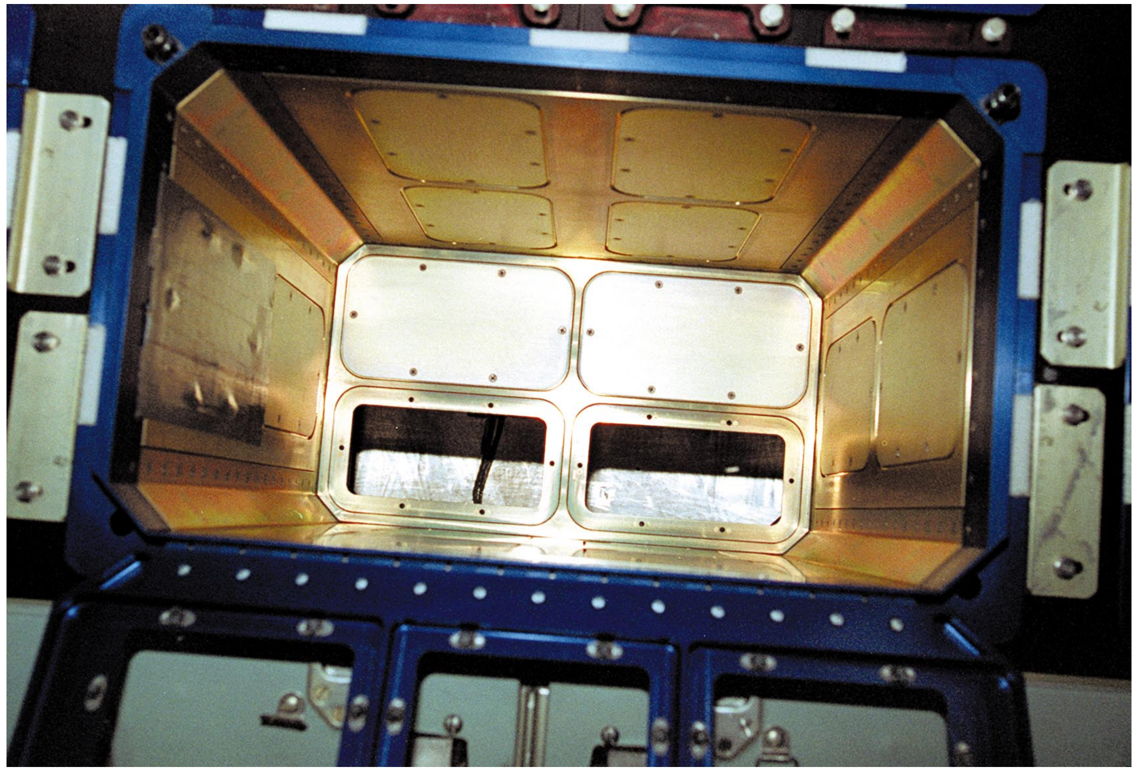
Experiments attaching directly to the Double Adapter Plate shall not exceed the maximum launch weight of 160 lbs.

Powered SIA

The Powered SIA provides structural interfaces for experiments designed to mount within an SIA. It also provides data interfaces through the MIPS-2C and power interfaces through the PUP. The basis for the mechanical interface of the SIA is a set of slide guides with fixed connector support bars, which locate the data and power connector receptacles. The Powered SIA will accommodate two 4 Panel Unit (PU) drawers or one 8PU drawer at a maximum launch weight of 133 lbs. (drawer plus contents). The 4PU drawer provides internal experiment dimensions of 16.41 inches (width) by 6.26 inches (height) by 22.50 inches (depth). The 8PU drawer provides the same internal dimensions except that the height is 13.26 inches. An example of an 8PU drawer mounted within a Powered SIA is shown in Figure MOD-51.

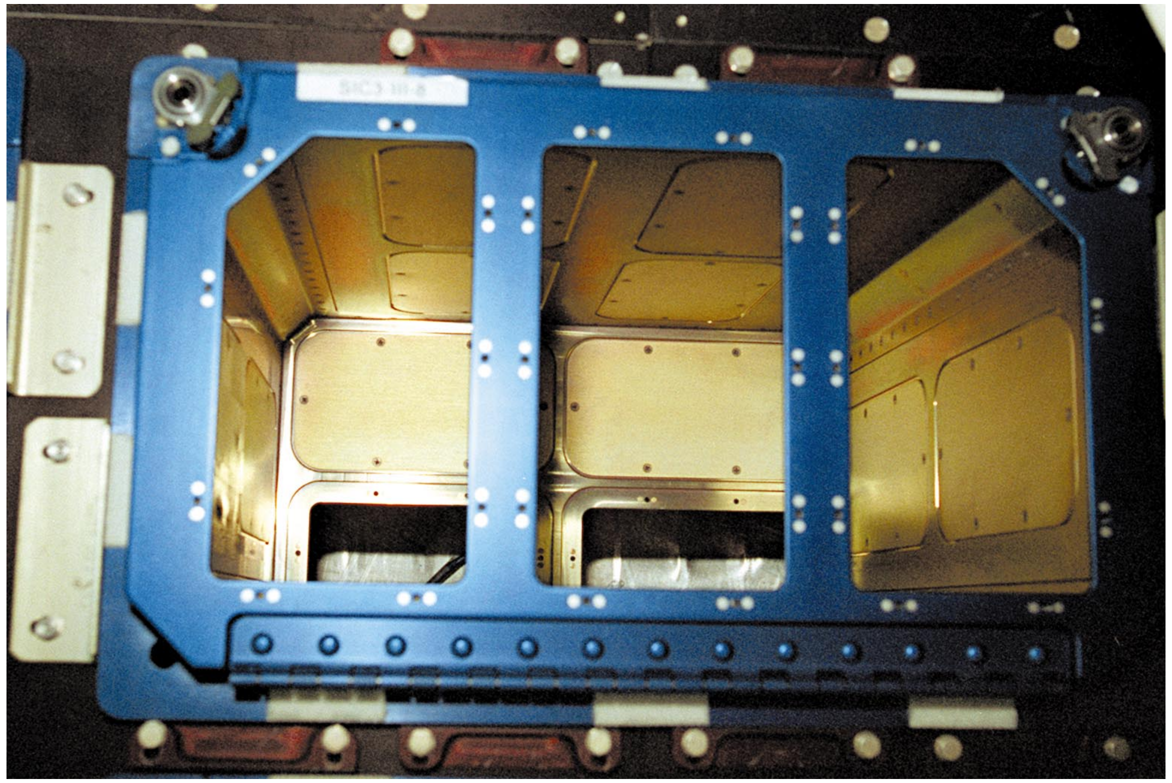
PASSIVE SIA

The Passive SIA is mechanically identical to the Powered SIA, except that it does not provide data or power interfaces. The Passive SIA will accommodate two 4PU drawers or one 8PU drawer at a maximum launch weight of 133 lbs. (drawer plus contents). A Passive SIA frame is shown in Figure MOD-52.



STS84-363-011

Figure MOD-44 Priroda Single Locker Open

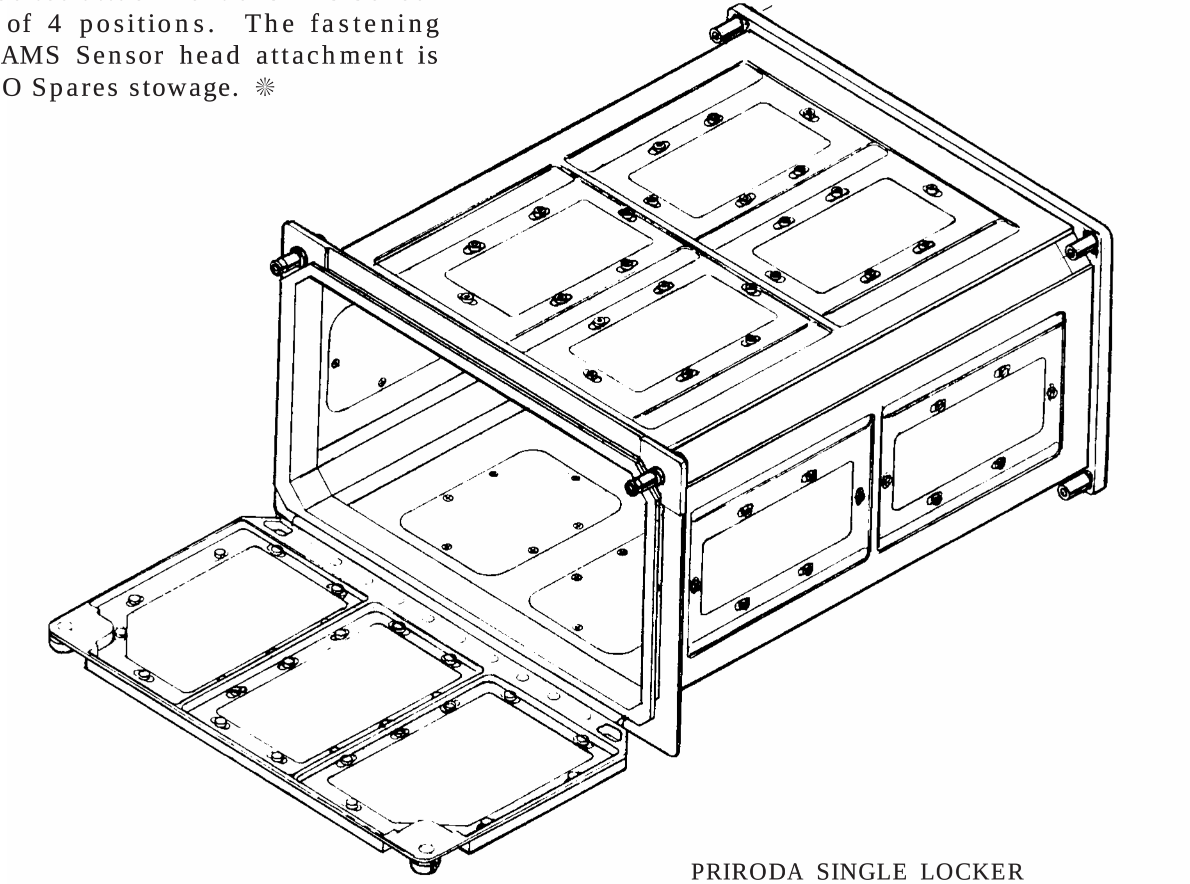


STS84-363-020

Figure MOD-45 Priroda Single Locker Closed

SAMS SENSOR HEAD MOUNTING PLATE

There are two SAMS Sensor Head Mounting Plates permanently attached to the interior panels in the Priroda Module. One is near the 4 Single Stowage Lockers at location SIC3-I, and the other is near the Double Adapter Plate at location SIC-3-0. These plates have threaded inserts in a pattern that allows the bolted attachment of SAMS Sensor Heads in any of 4 positions. The fastening hardware for SAMS Sensor head attachment is included in MMO Spares stowage. ❋



PRIRODA SINGLE LOCKER
Aluminum 7075-T7351

INTERNAL
Width = 17.34 inches
Height = 9.97 inches
Depth = 20.32 inches
Volume = 1.98 cu. ft.

Total Mass = 16.1 lbs (est)
Maximum allowable content mass for launch = 60 lbs

Figure MOD-46 Priroda Single Locker Characteristics

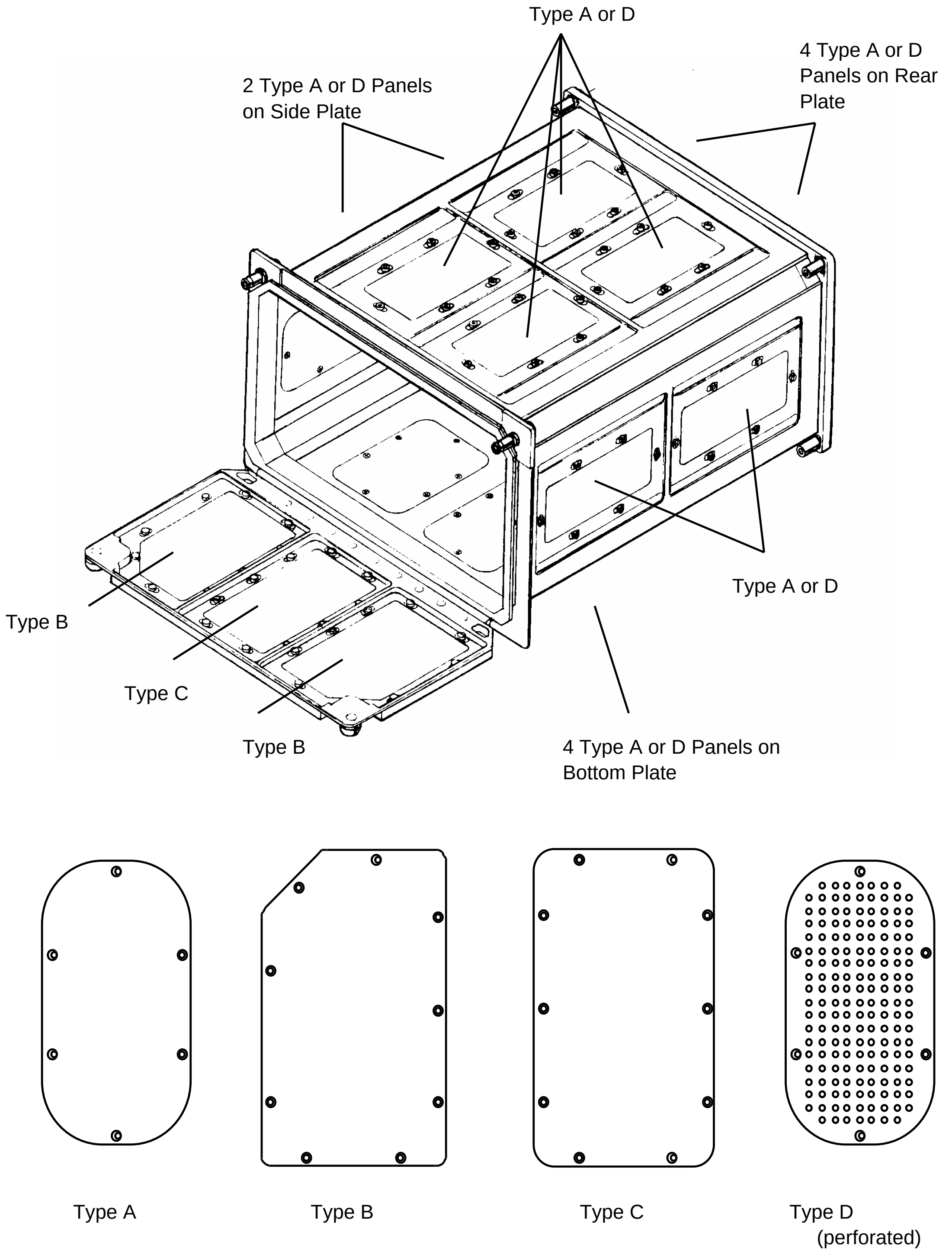
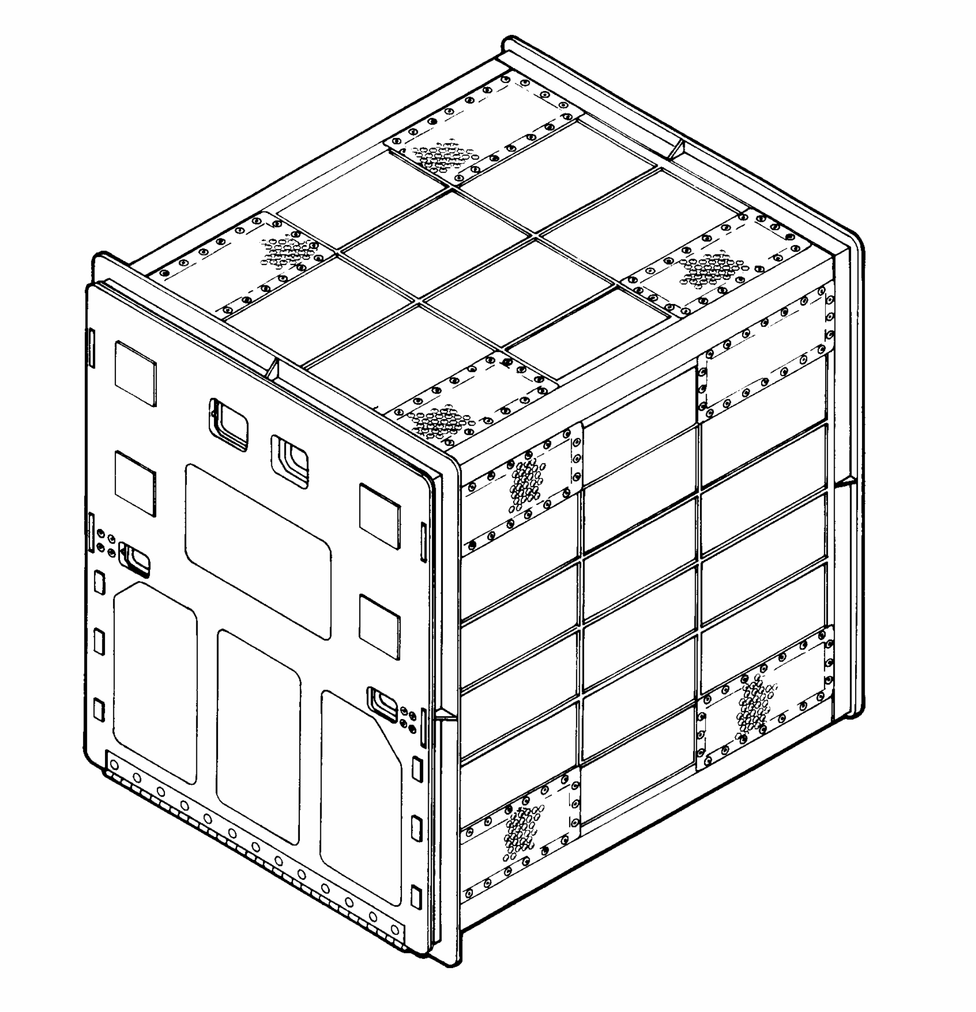


Figure MOD-47 Priroda Single Locker Panels



PRIRODA DOUBLE LOCKER
Aluminum 7075-T7351

INTERNAL
Width = 17.34 inches
Height = 21.1 inches
Depth = 22.5 inches
Volume = 4.76 cu. ft.

Total Mass = 32.0 lbs (est)
Maximum allowable content mass 120.0 lbs for launch

Figure MOD-48 Priroda Double Locker Characteristics

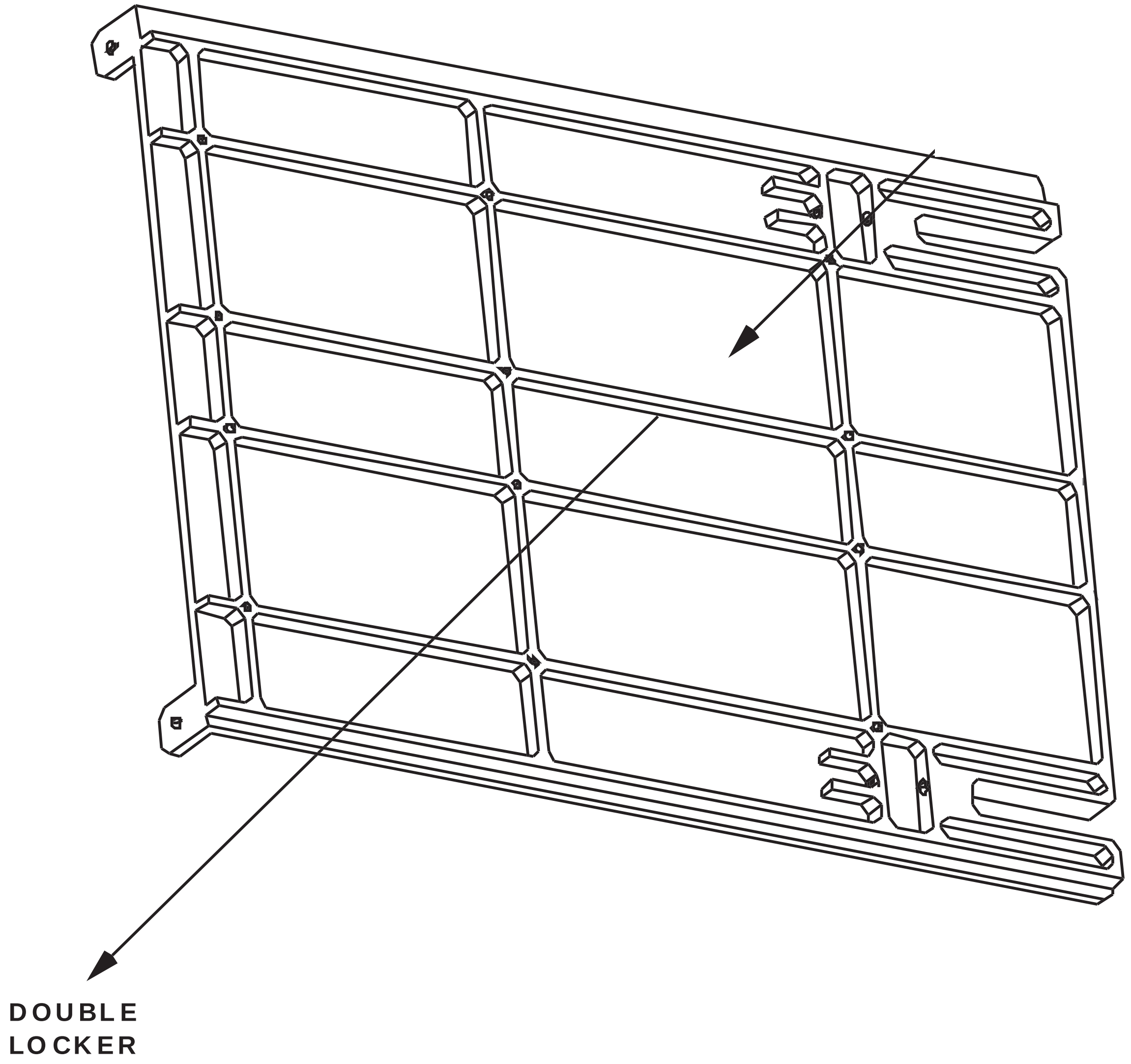


Figure MOD-49 Priroda Double Locker Interior Mounting Plate

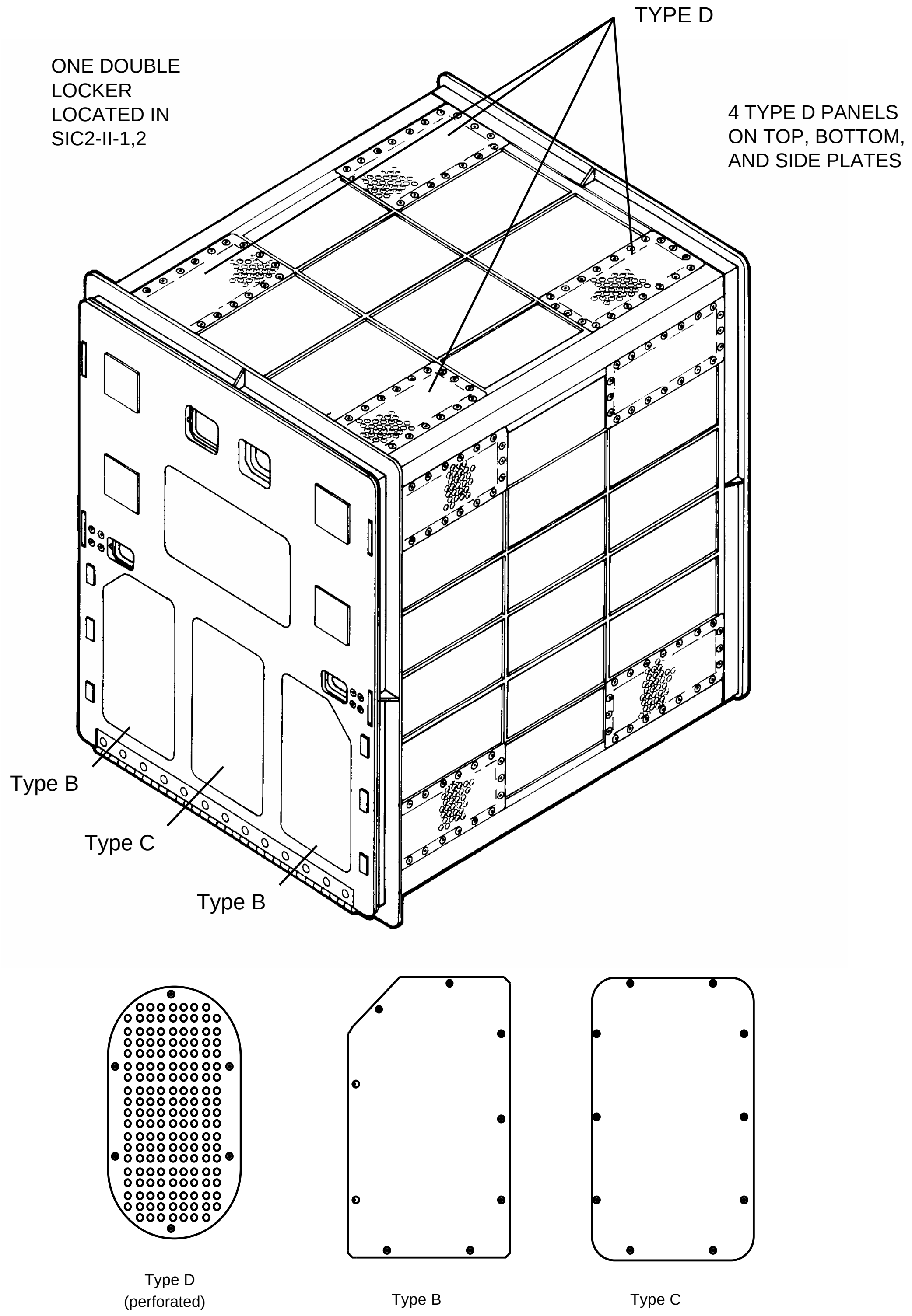


Figure MOD-50 Priroda Double Locker Panels

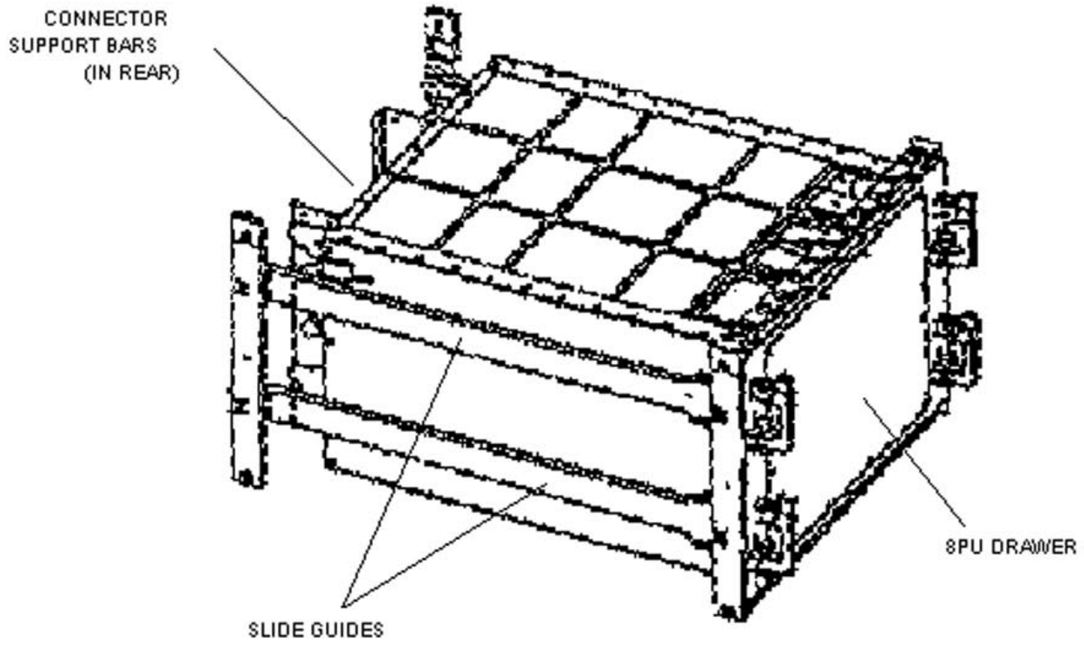


Figure MOD-51 Powered SIA With 8PU Drawer

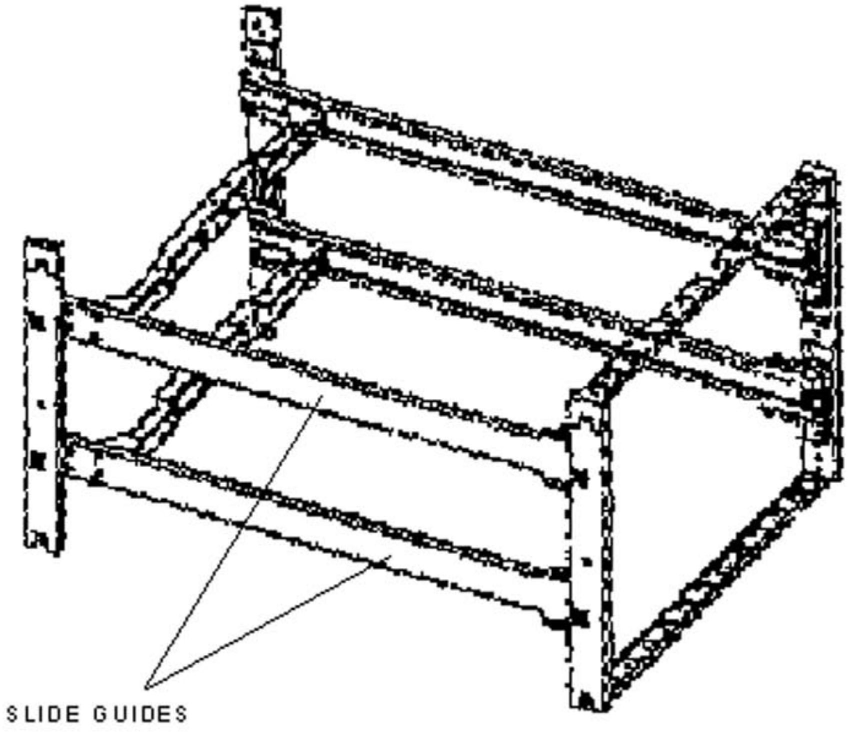
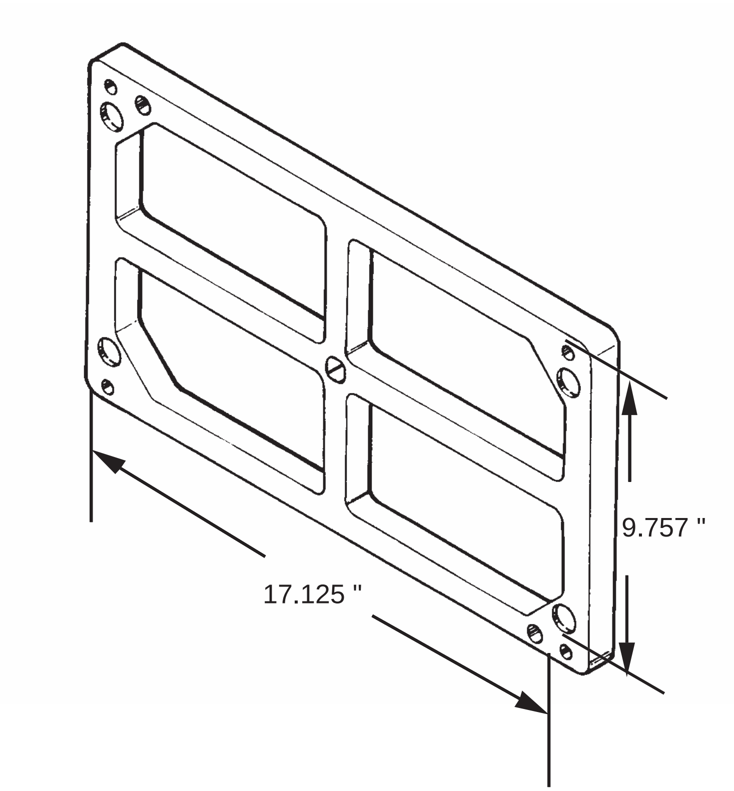


Figure MOD-52 Passive SIA

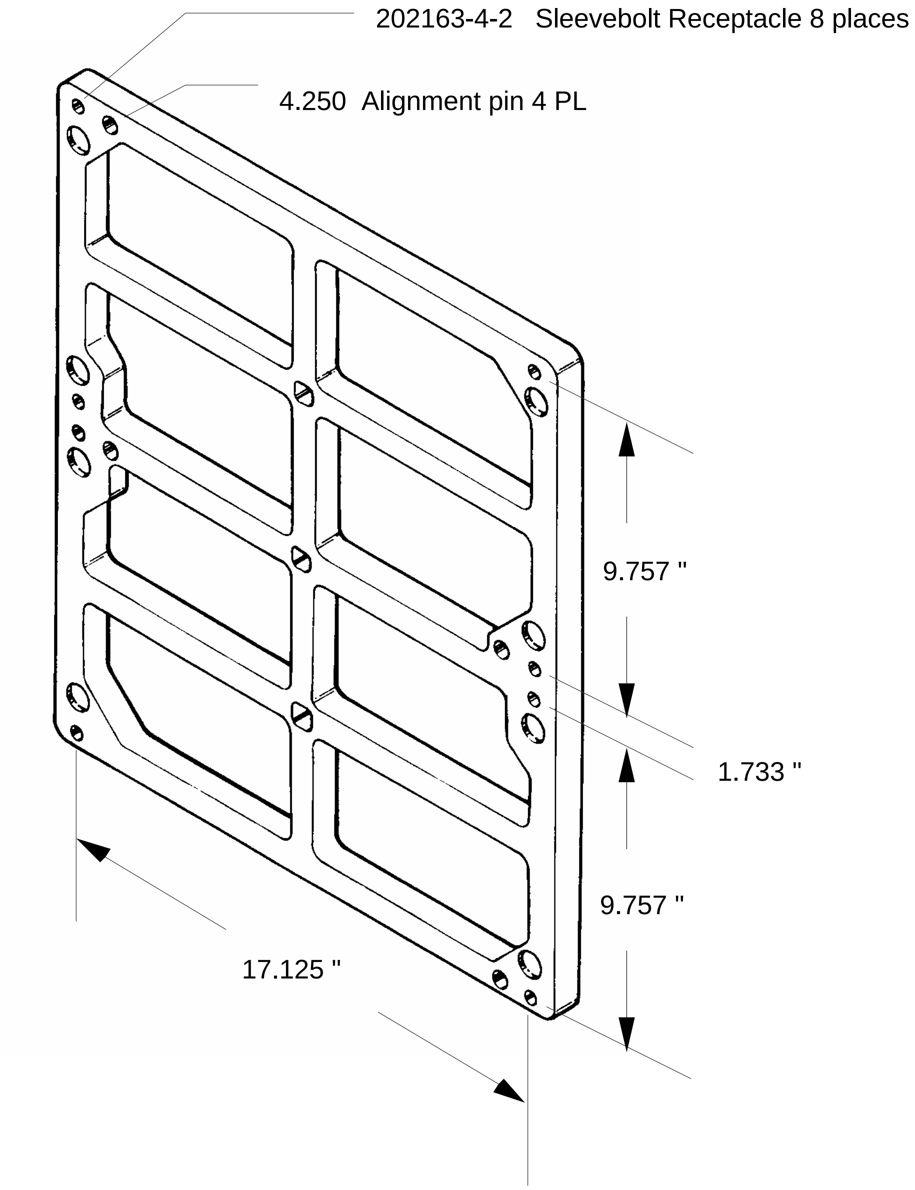


PRIRODA SINGLE ADAPTER PLATE
Aluminum 7075-T7351

Width = 18.3 inches
Height = 10.4 inches
Thickness = 0.875 inches
Mass = 3.24 lbs

Distance between experiment/plate mounting holes shown above

Figure MOD-53 Priroda Single Adapter Plate Characteristics



PRIRODA DOUBLE ADAPTER PLATE
Aluminum 7075-T7351

Width = 18.3 inches
Height = 19.9 inches
Thickness = 0.875 inches
Mass = 5.74 lbs

Distance between experiment/plate mounting holes shown above

Figure MOD-54 Priroda Double Adapter Plate Characteristics

SPEKTR
(CLOSED)

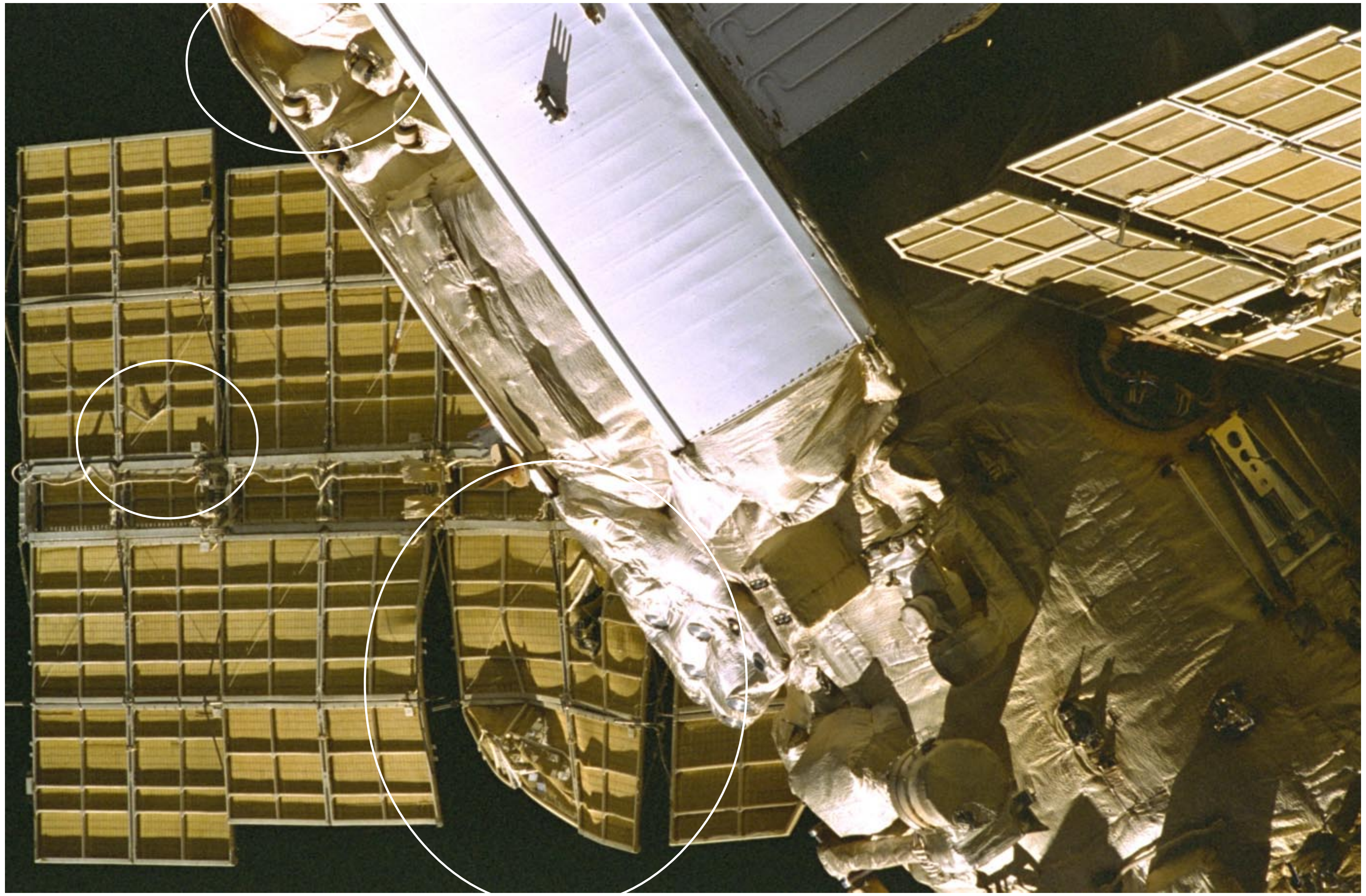


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Figure MOD-55 Damaged +Z_B SP#1 Array

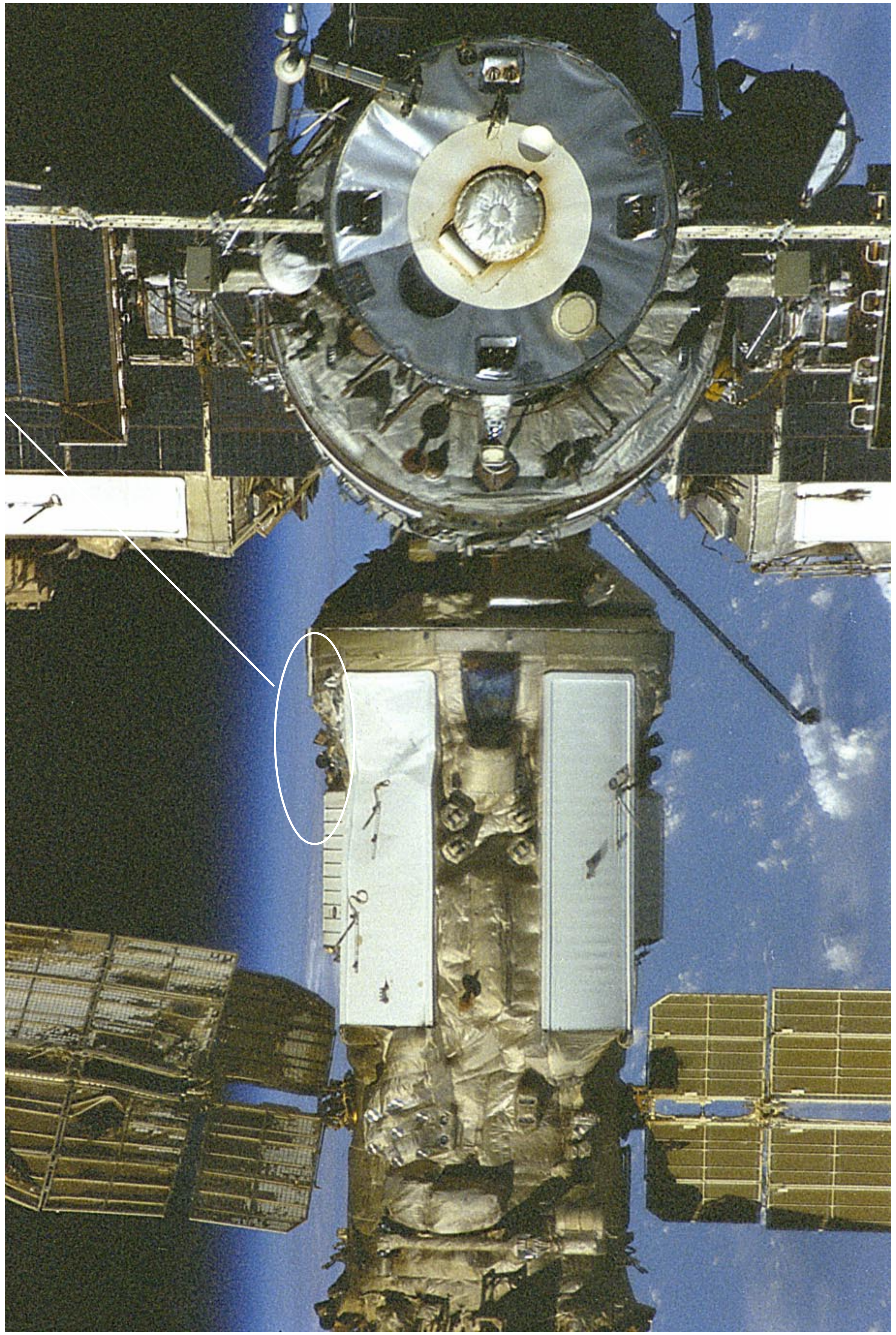

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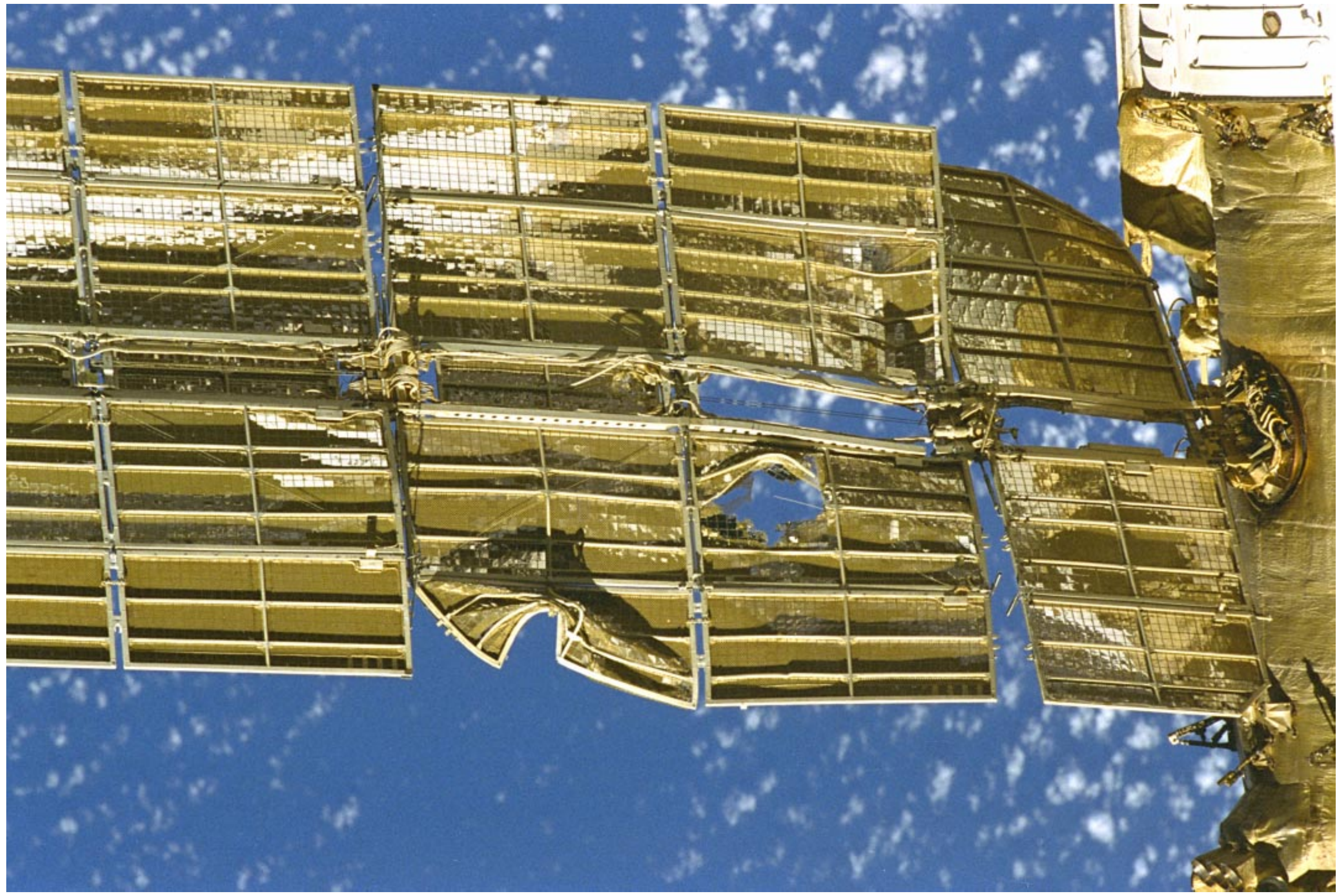
Figure MOD-56 View of Progress and Damaged Area of Spektr



STS86-387-14

Figure MOD-58 Damaged $+Z_B$ Array

STS86-371-33

Figure MOD-57 Spektr's Solar Array Drive

STS86-388-32

Figure MOD-59 Damaged Radiator on Spektr and MLI Cut to Find the Leak

STS86-717-44

Figure MOD-60 Close-up of the Damaged Radiator on the +X+Z Side

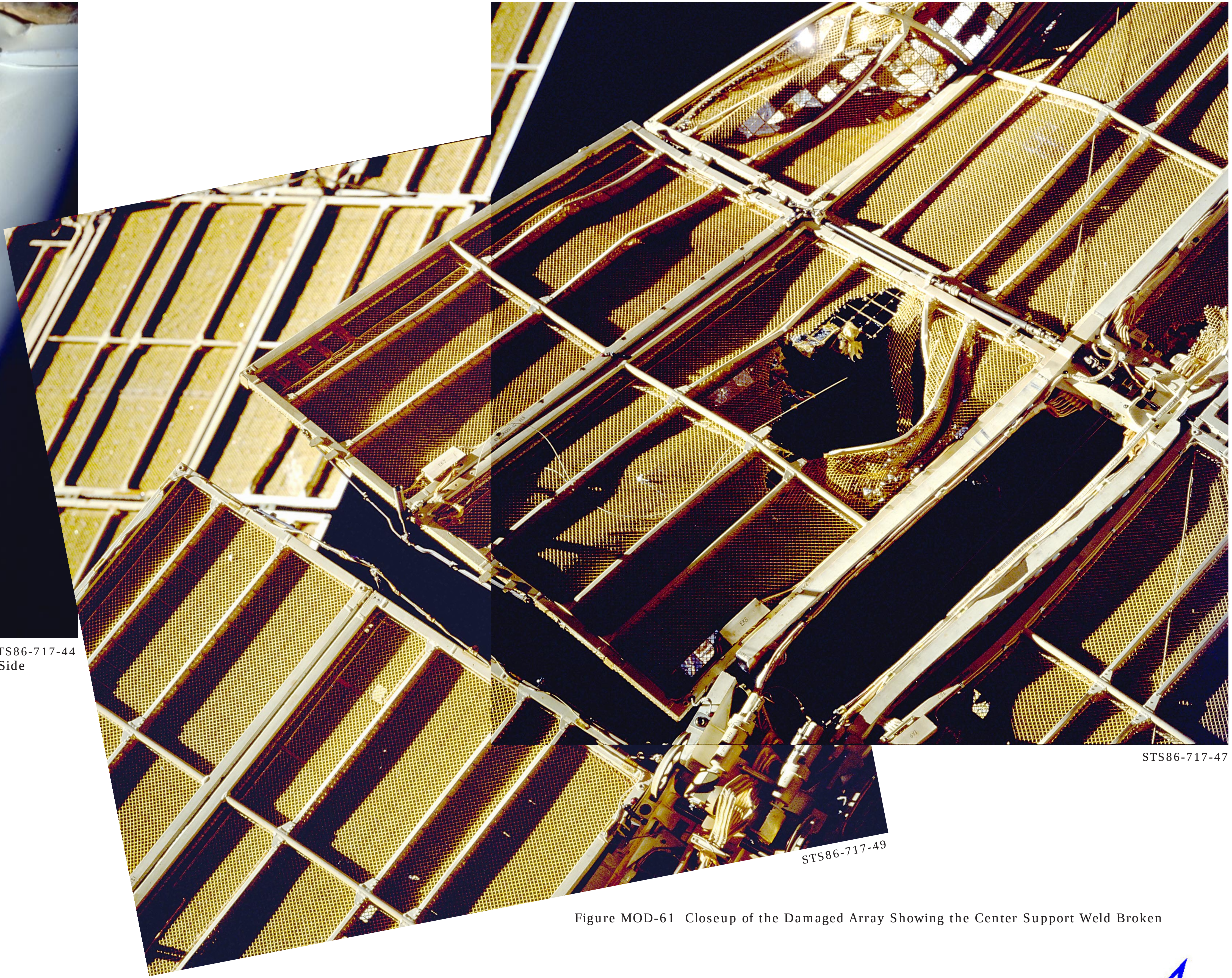


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Figure MOD-61 Closeup of the Damaged Array Showing the Center Support Weld Broken

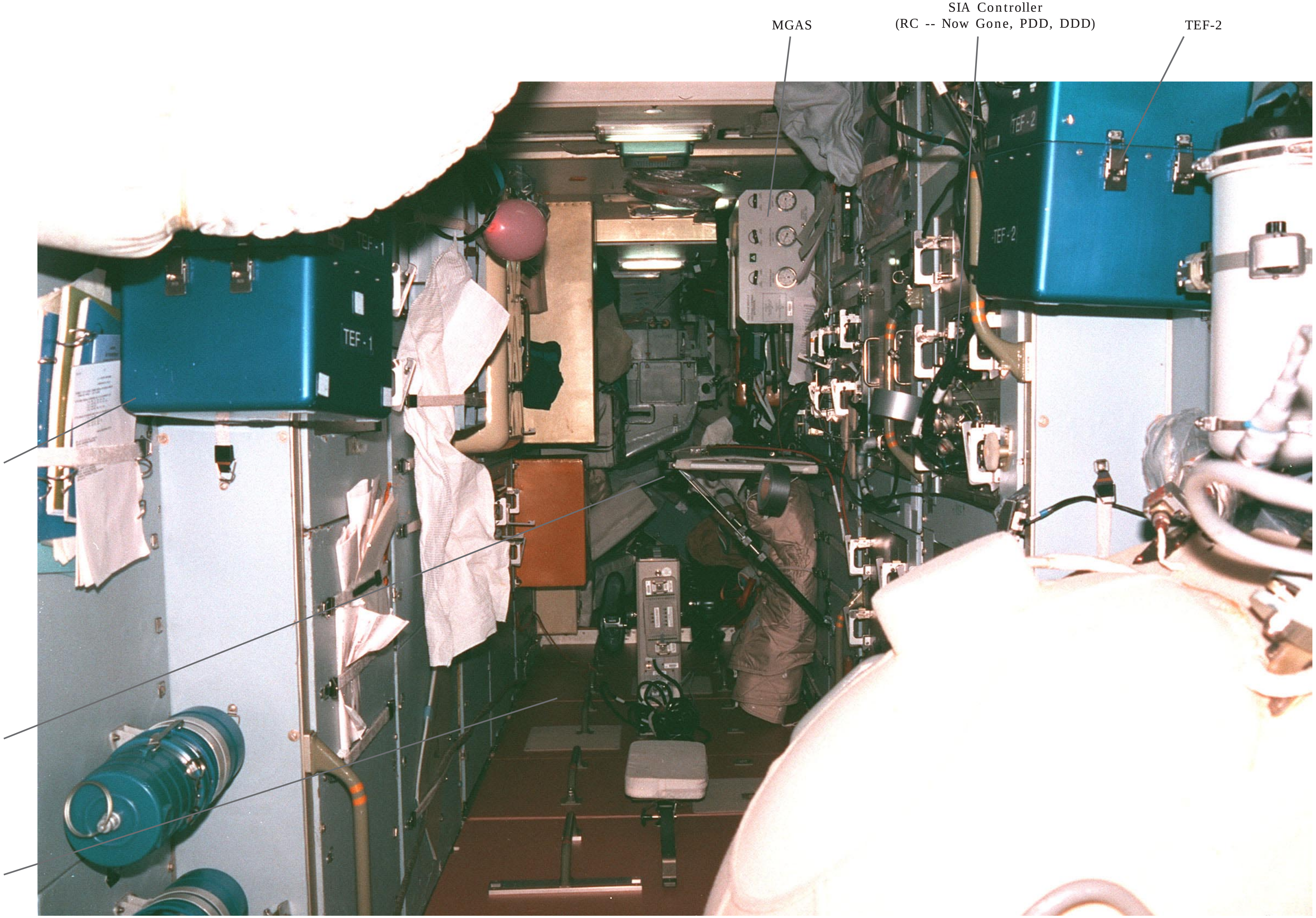
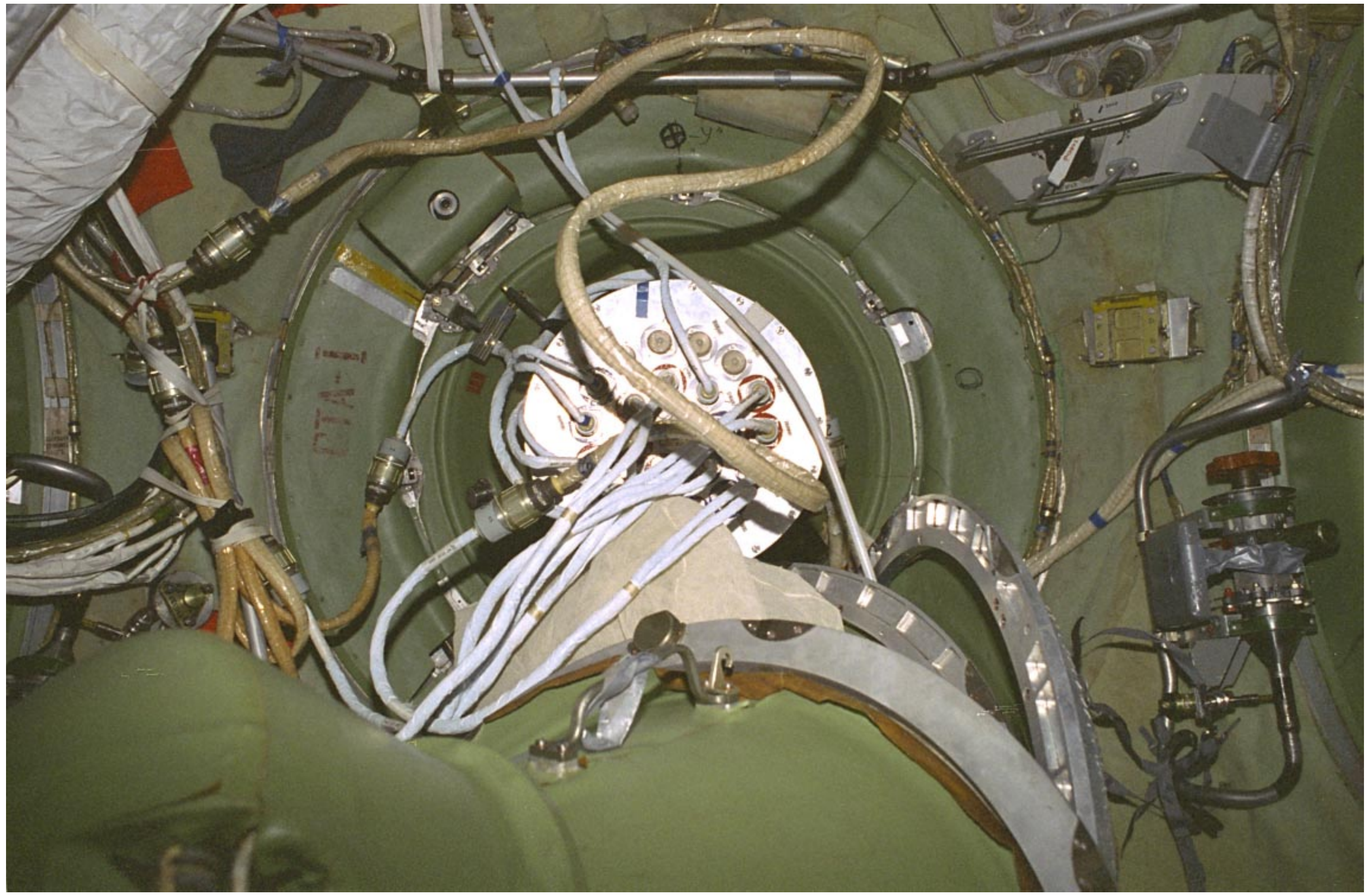


Figure MOD-62 Spektr Towards Aft of Cone

NM22-160-18

STS86-373-15

Figure MOD-64 New Hermoplate Closing off Spektr with the Power Cables Connected



STS86-372-2

Figure MOD-63 Spektr's New Hermoplate Viewed from the Transfer Node

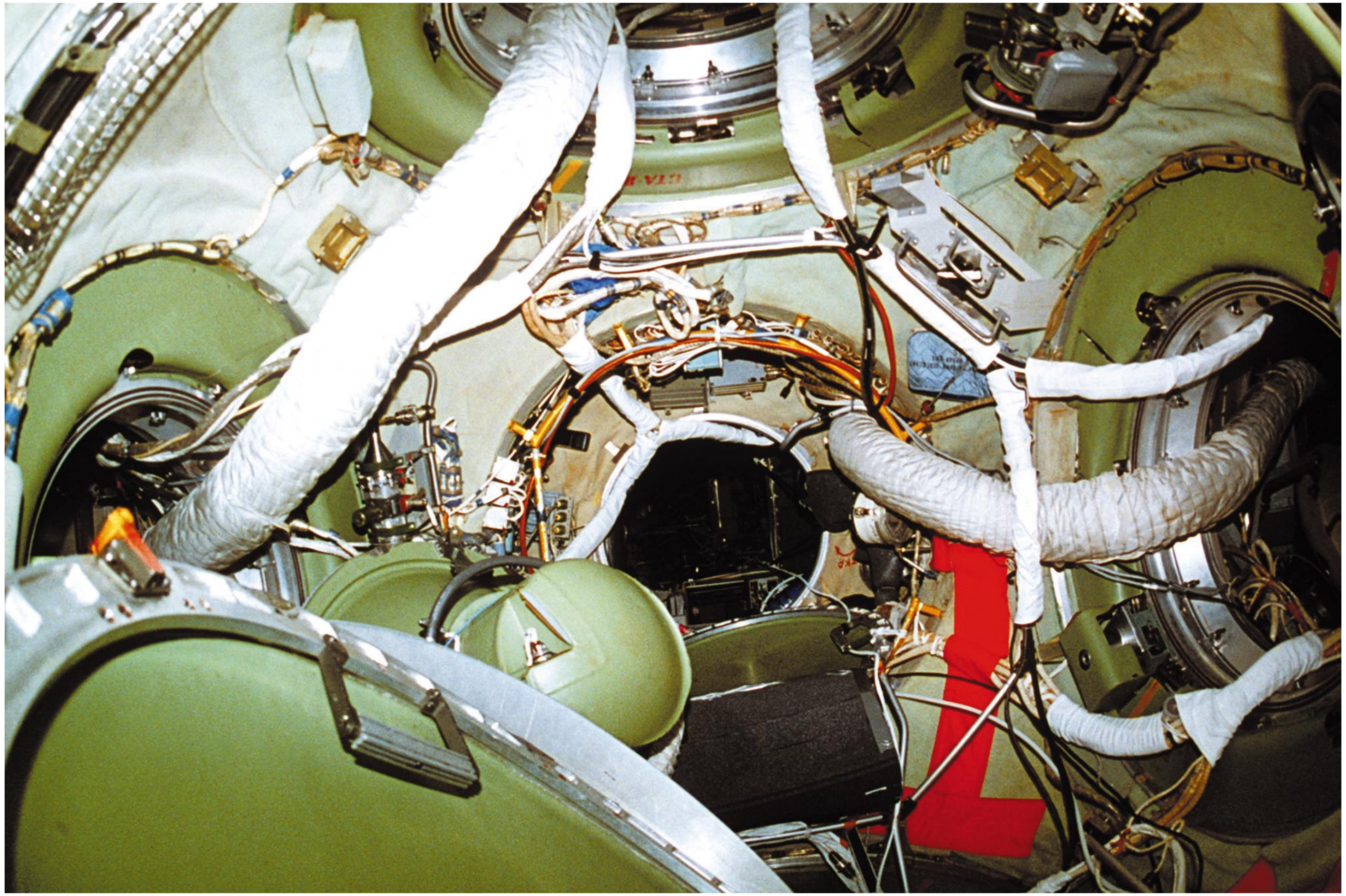


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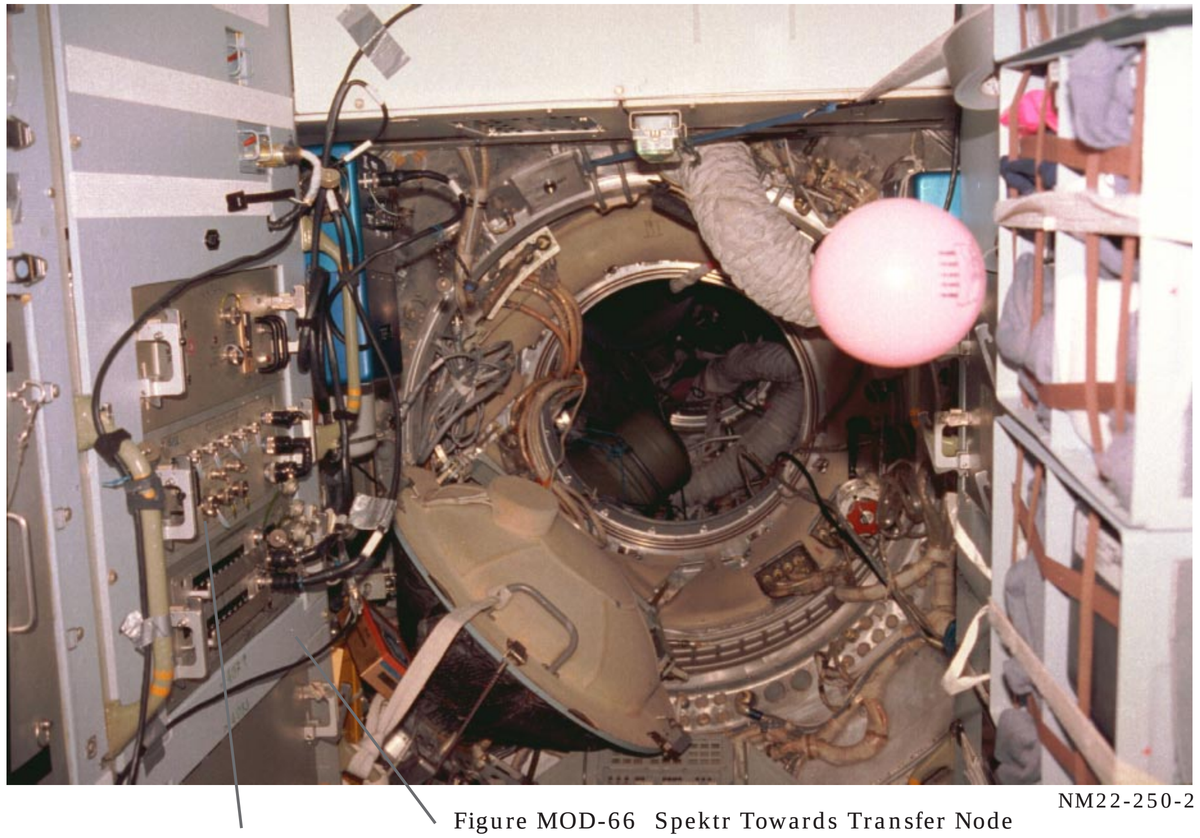
Figure MOD-65 Inside Transfer Node Facing the Spektr Module (Pre-Collision)



NM22-250-2

Figure MOD-66 Spektr Towards Transfer Node

KRISTALL

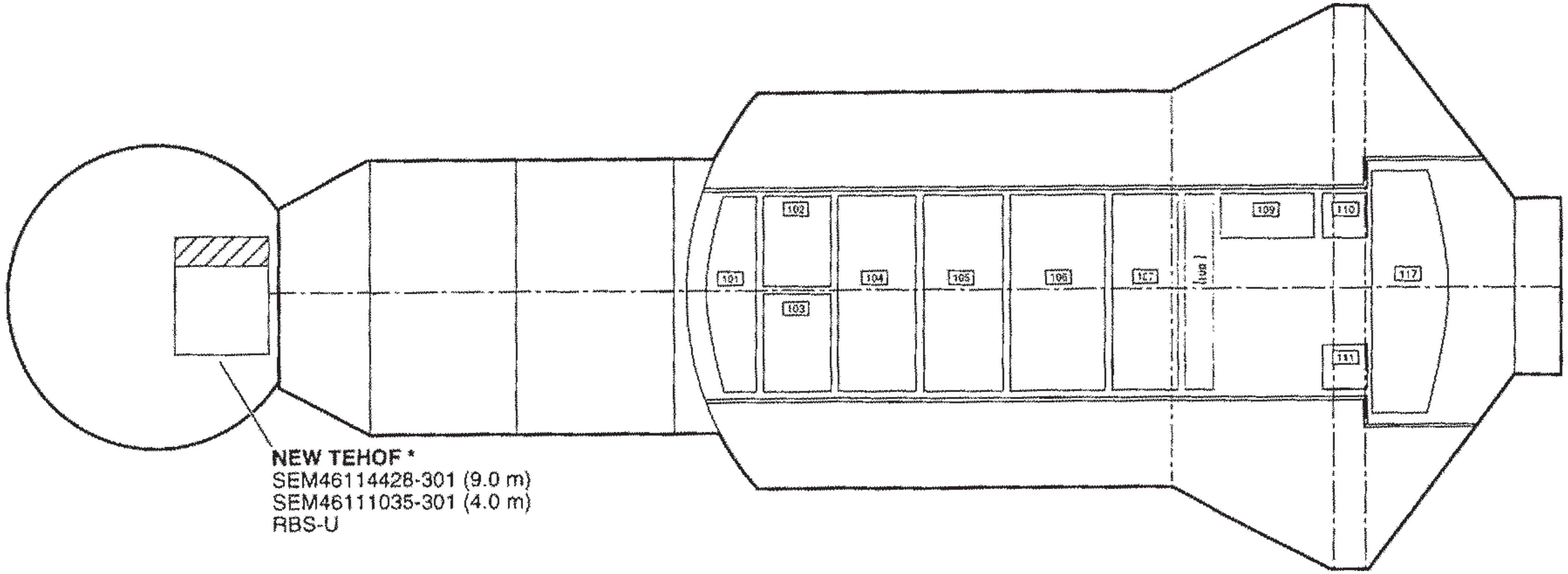


Figure MOD-67 Kristall Ceiling

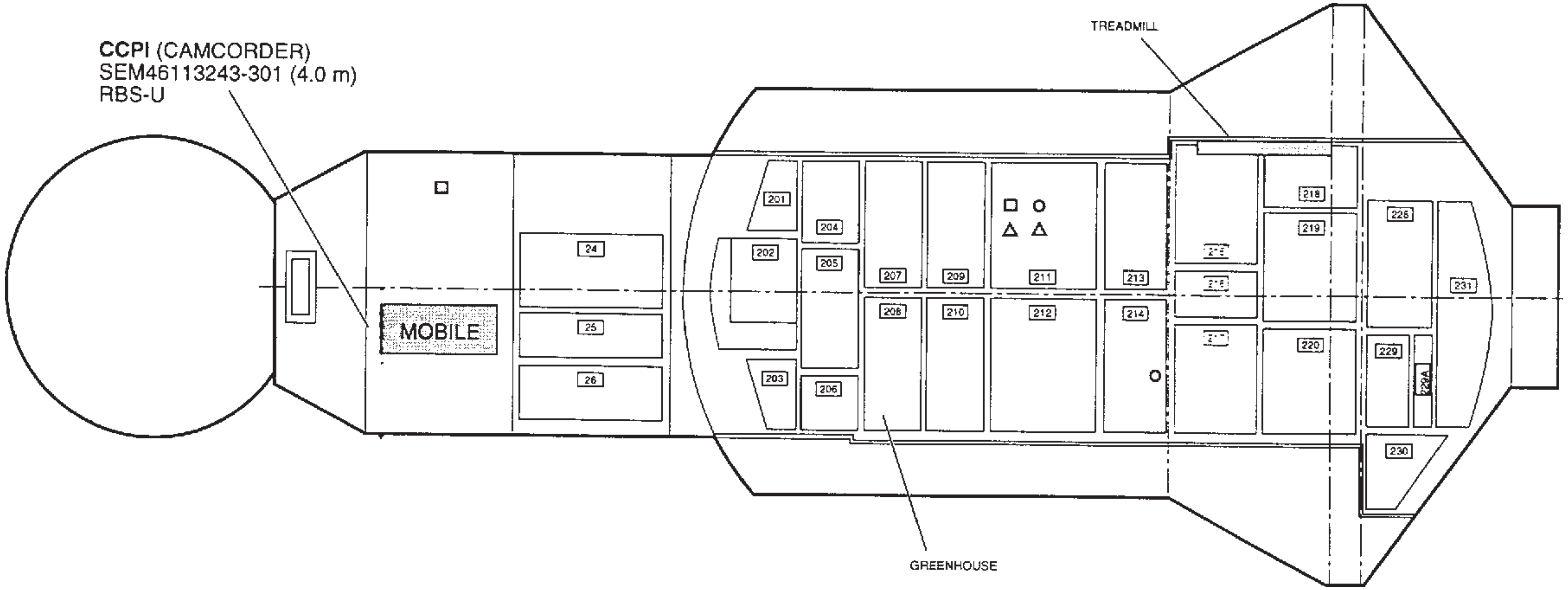


Figure MOD-68 Kristall Starboard

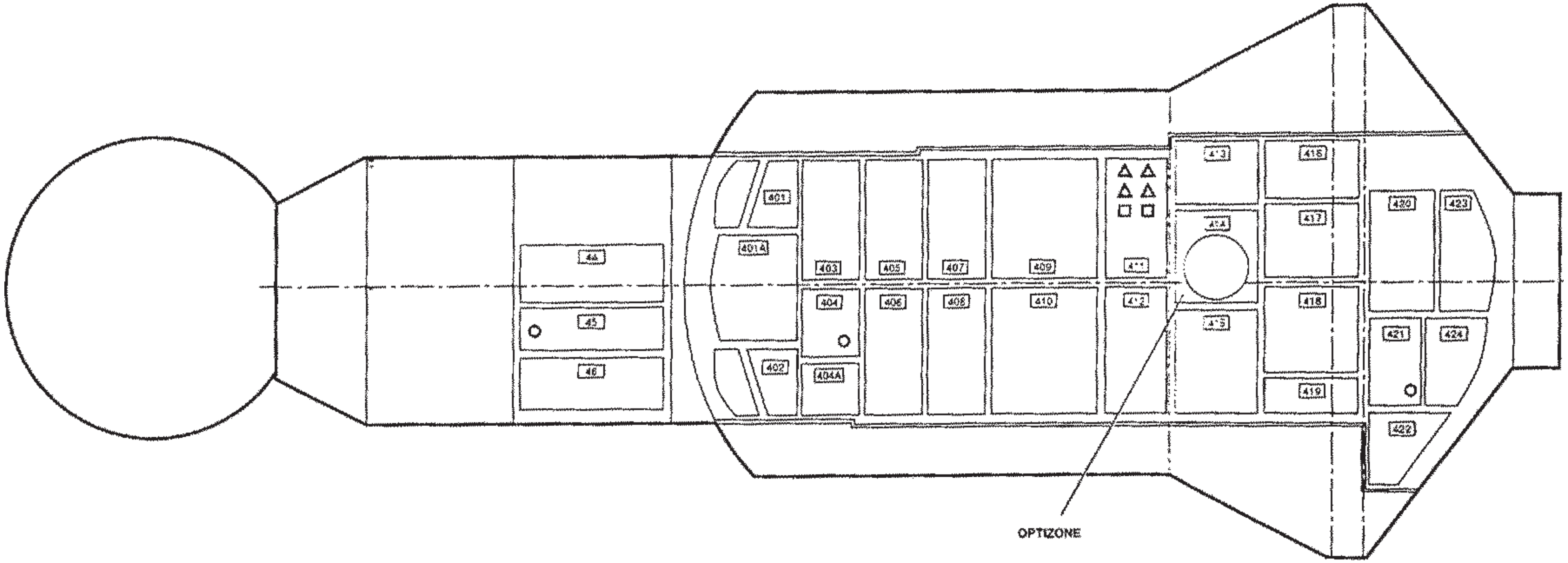


Figure MOD-69 Kristall Floor

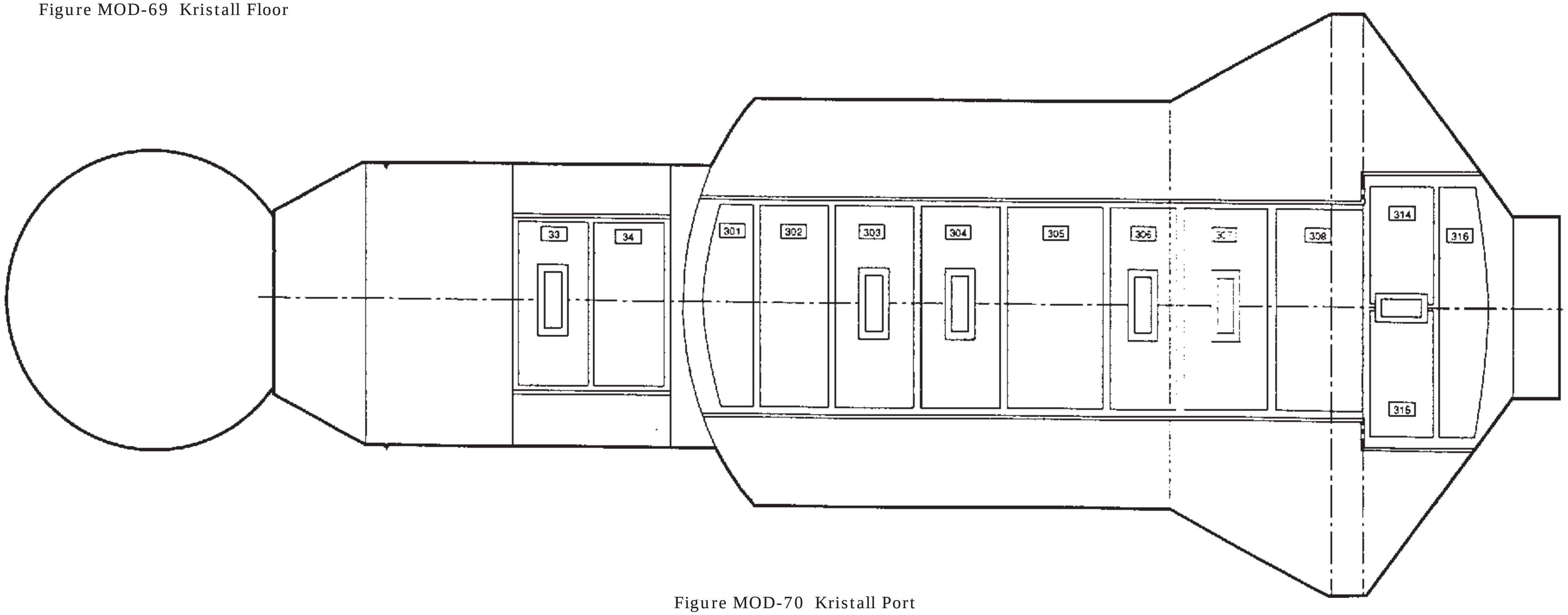


Figure MOD-70 Kristall Port

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Figure MOD-71 End of Kristall with Wendy Emerging from the Docking Module

STS84-305-006

Figure MOD-72 View into Kristall from the Docking Module

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Figure MOD-73
View Progressing from the Docking Module towards Kristall's Middle Hatch

SVET Greenhouse

STS84-305-008

Figure MOD-74 Kristall Near the Mid-Point Towards the Transfer Node

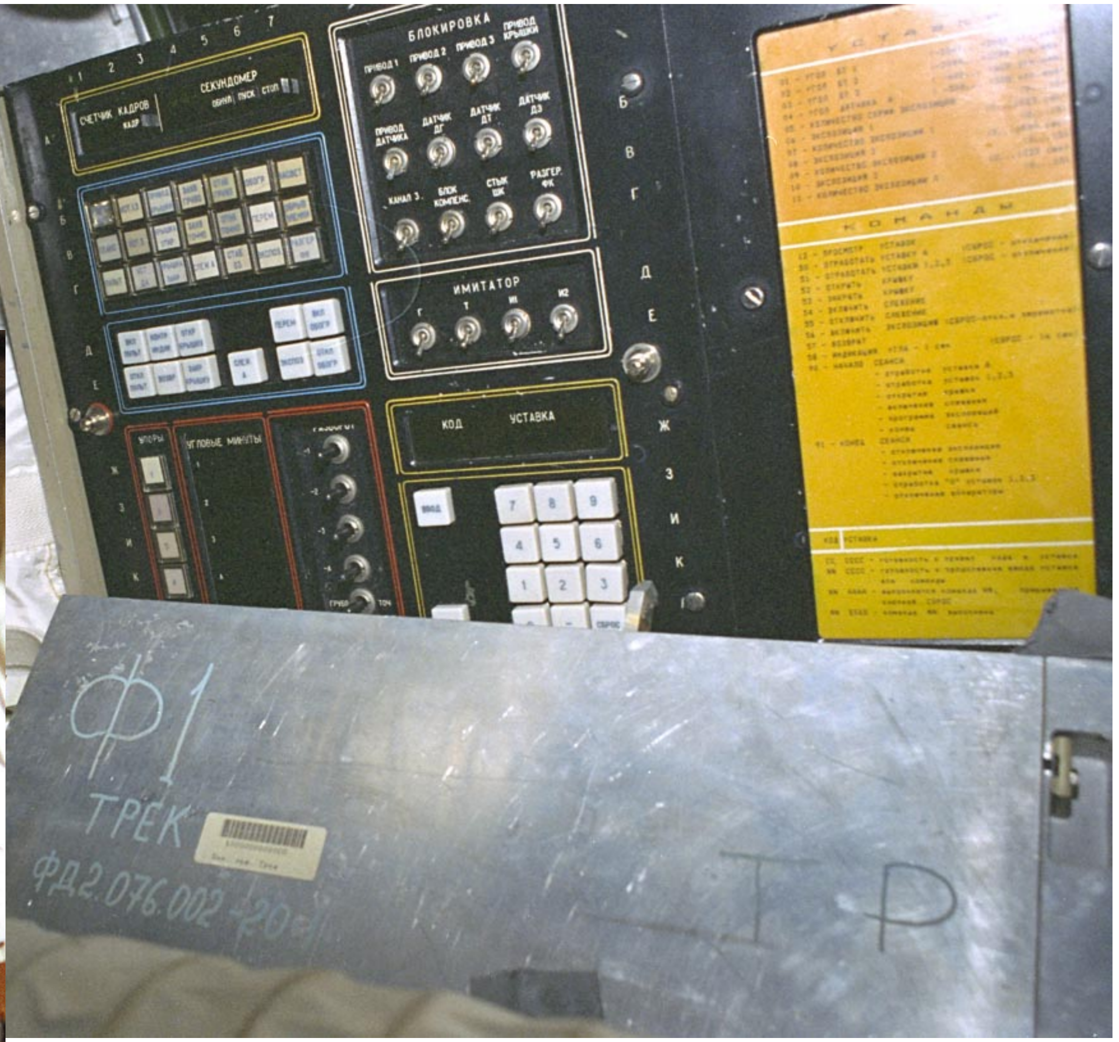

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Figure MOD-75 A Kristall Control Panel

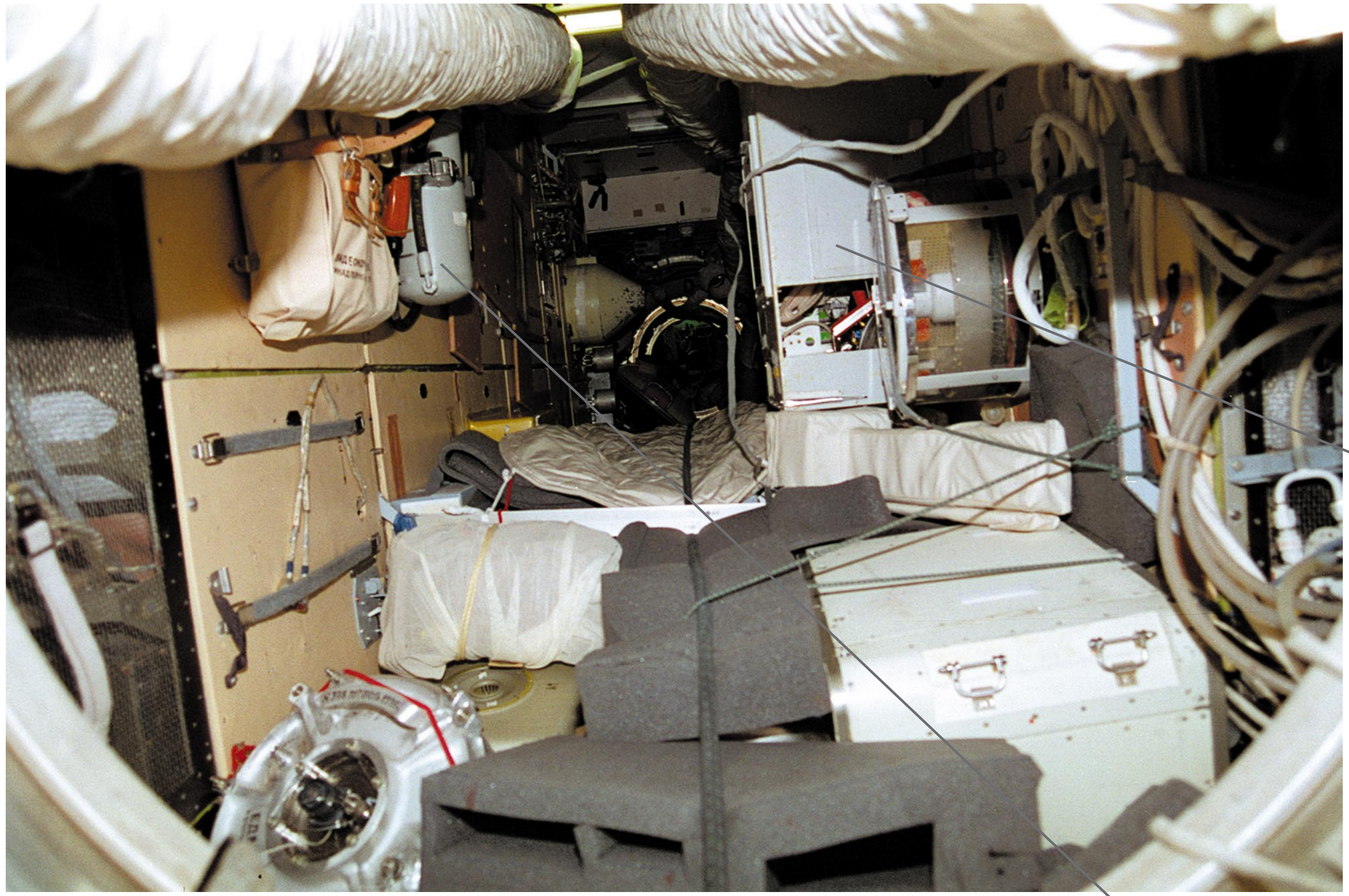

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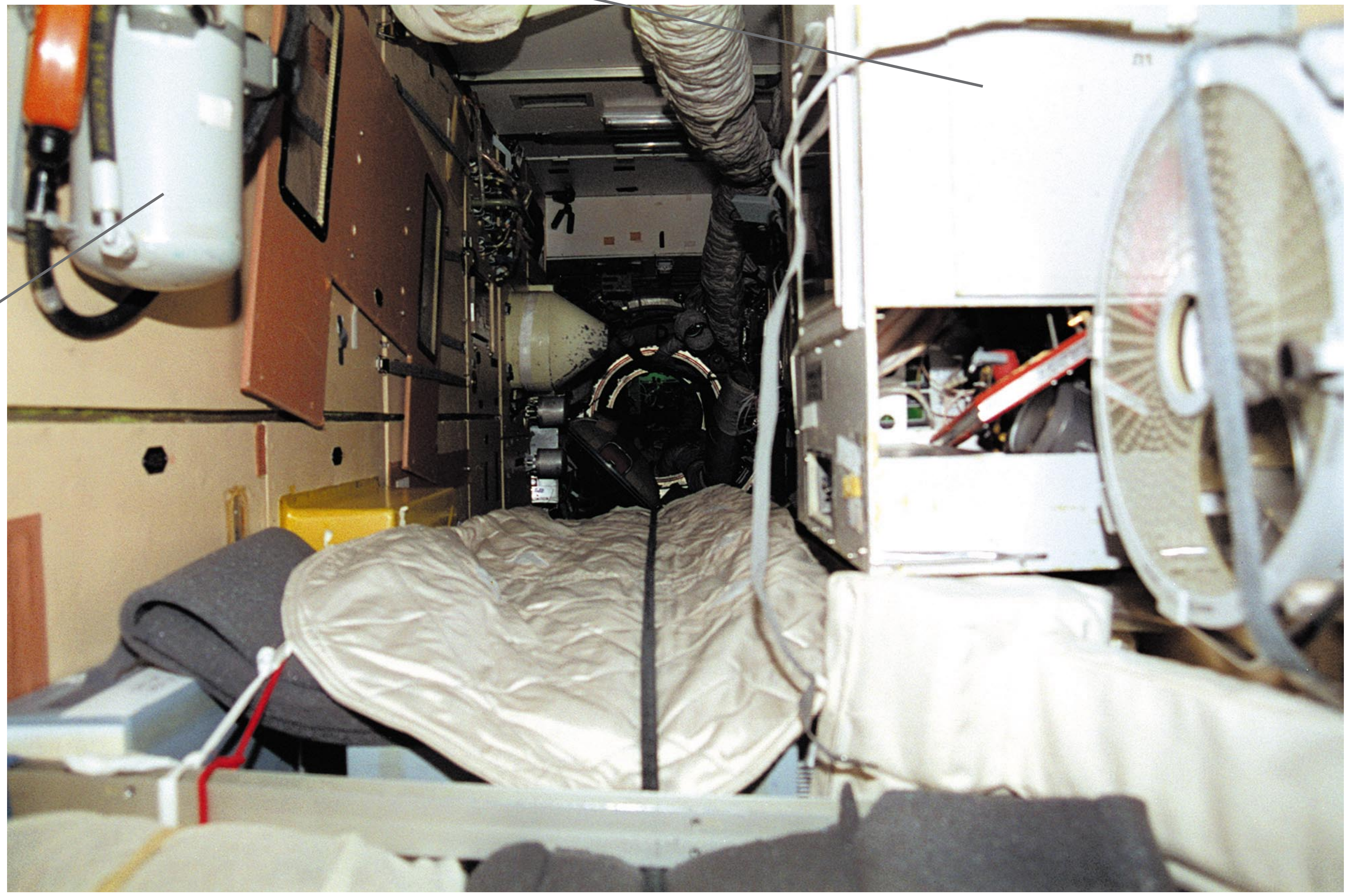
Figure MOD-76 Kristall Near the Greenhouse



STS84-305-010

Figure MOD-77 Kristall's Greenhouse Facing the Transfer Node

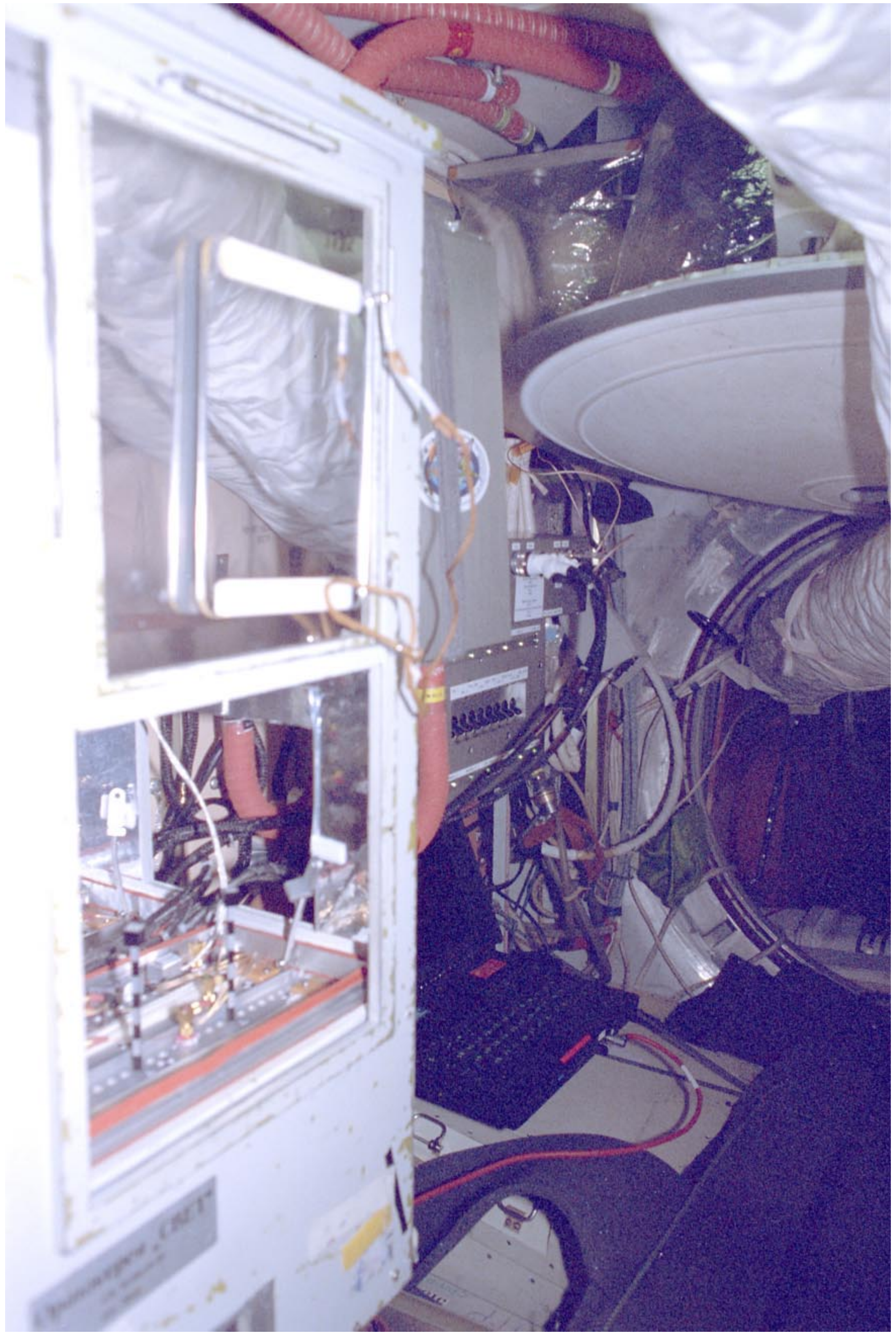


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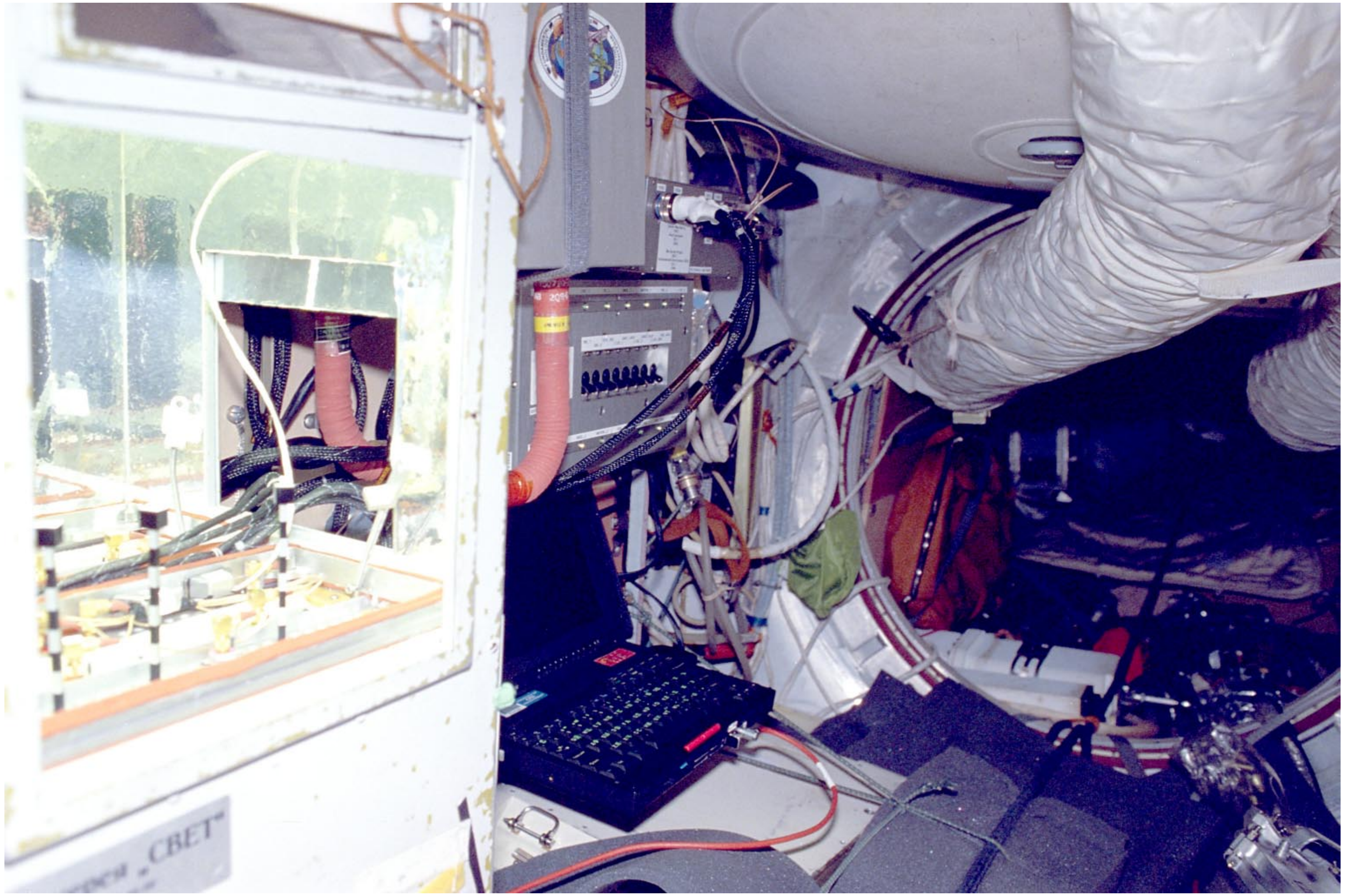
Figure MOD-78 Kristall's Svet Greenhouse and FB Laptop



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Optizon Furnace Cover

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Figure MOD-82 Kristall Near the Transfer Node

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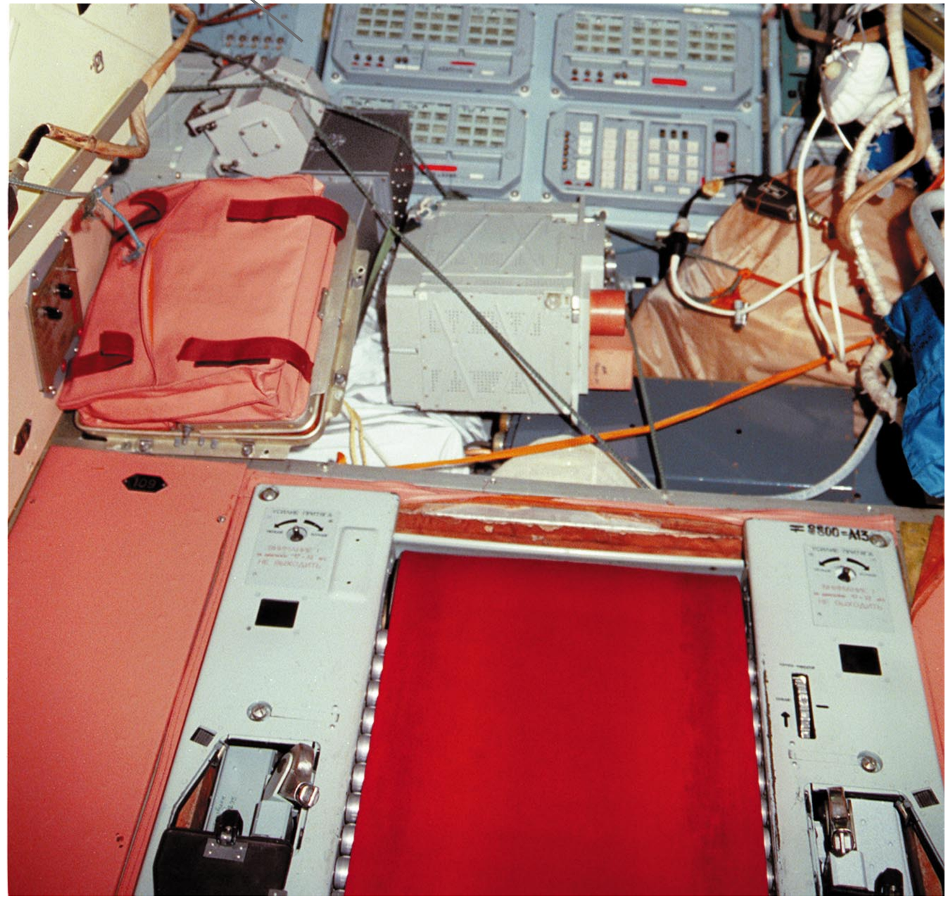
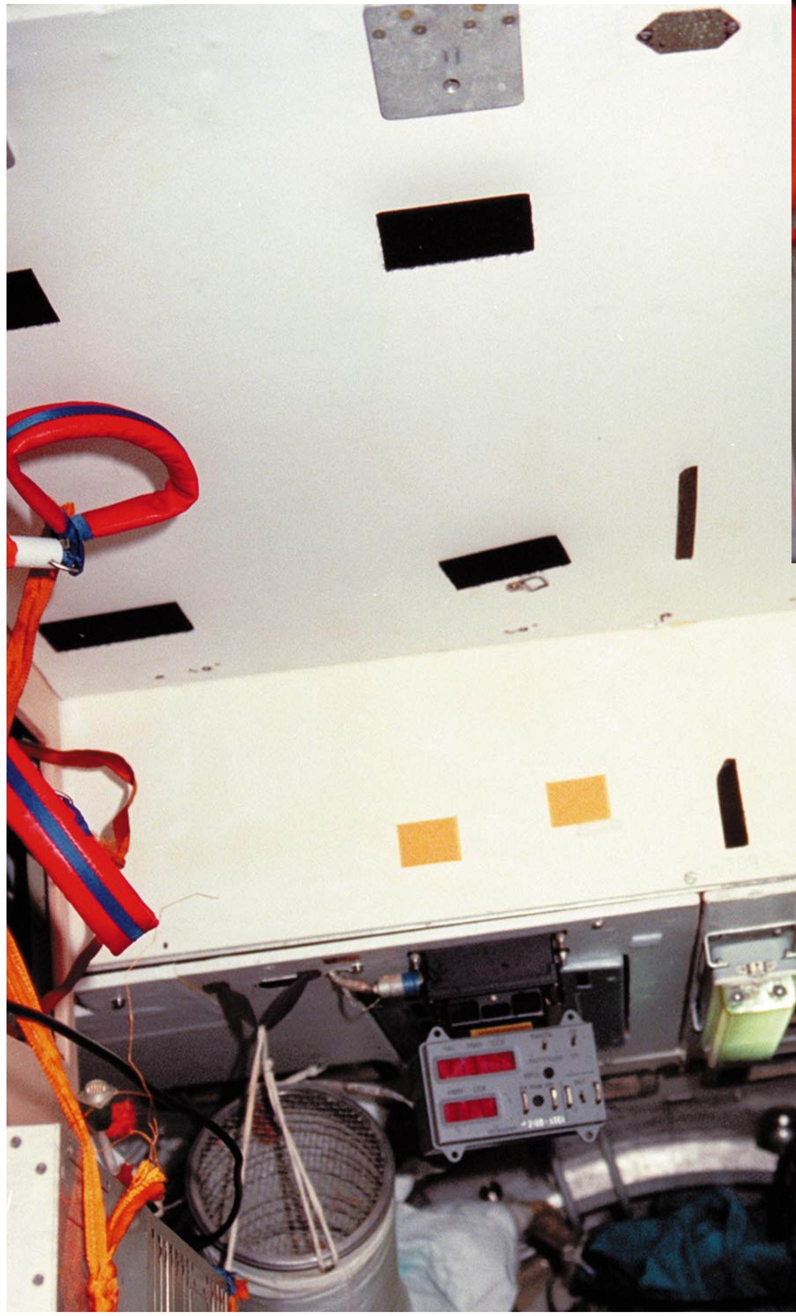


NM22-039-018

Figure MOD-85 Kristall's Treadmill

NM22-039-17

Figure MOD-87 Ceiling of Kristall



NM22-039-16

Figure MOD-86 Ceiling Panel Removed in Kristall by Ceiling Panel 309

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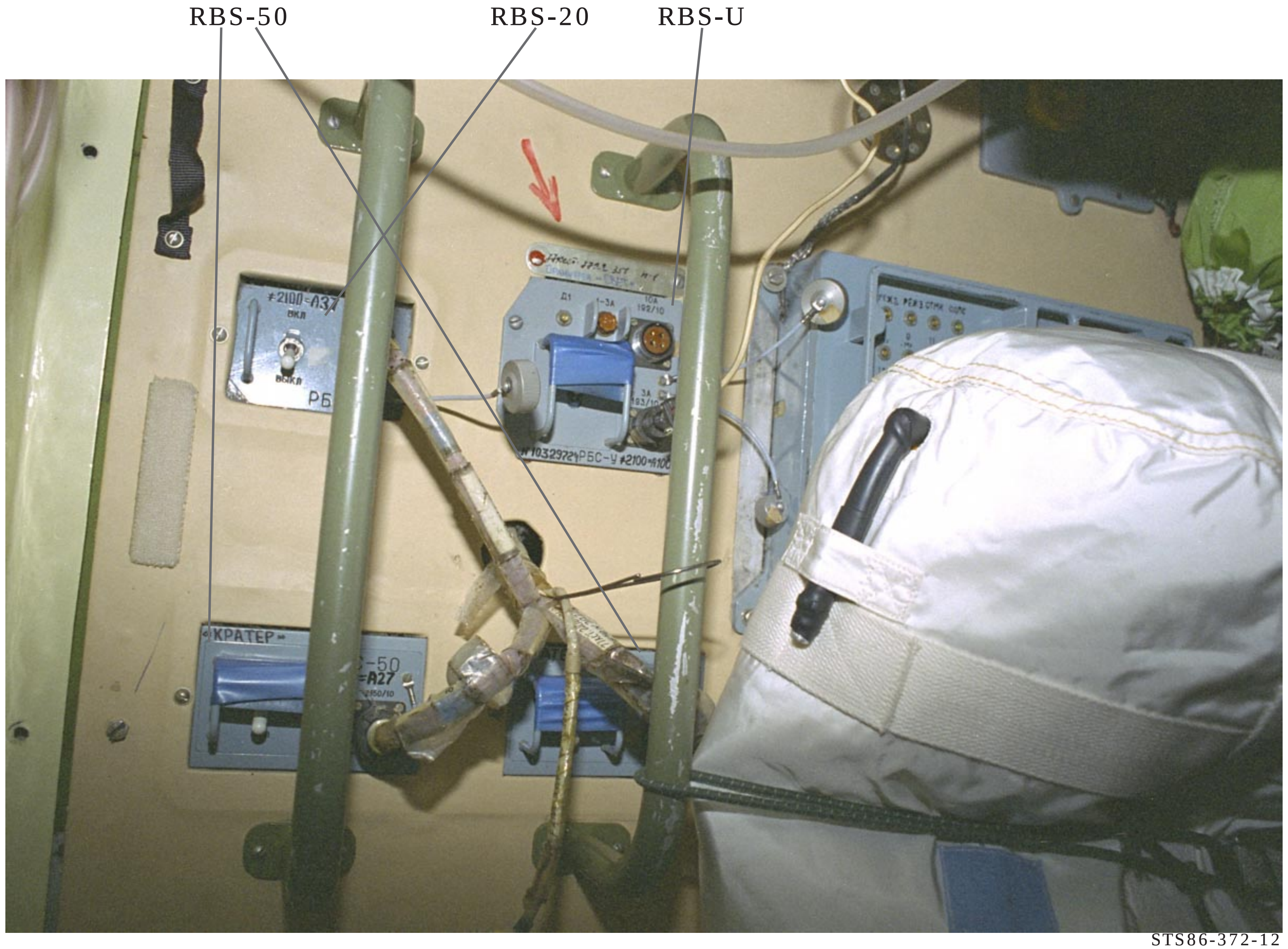

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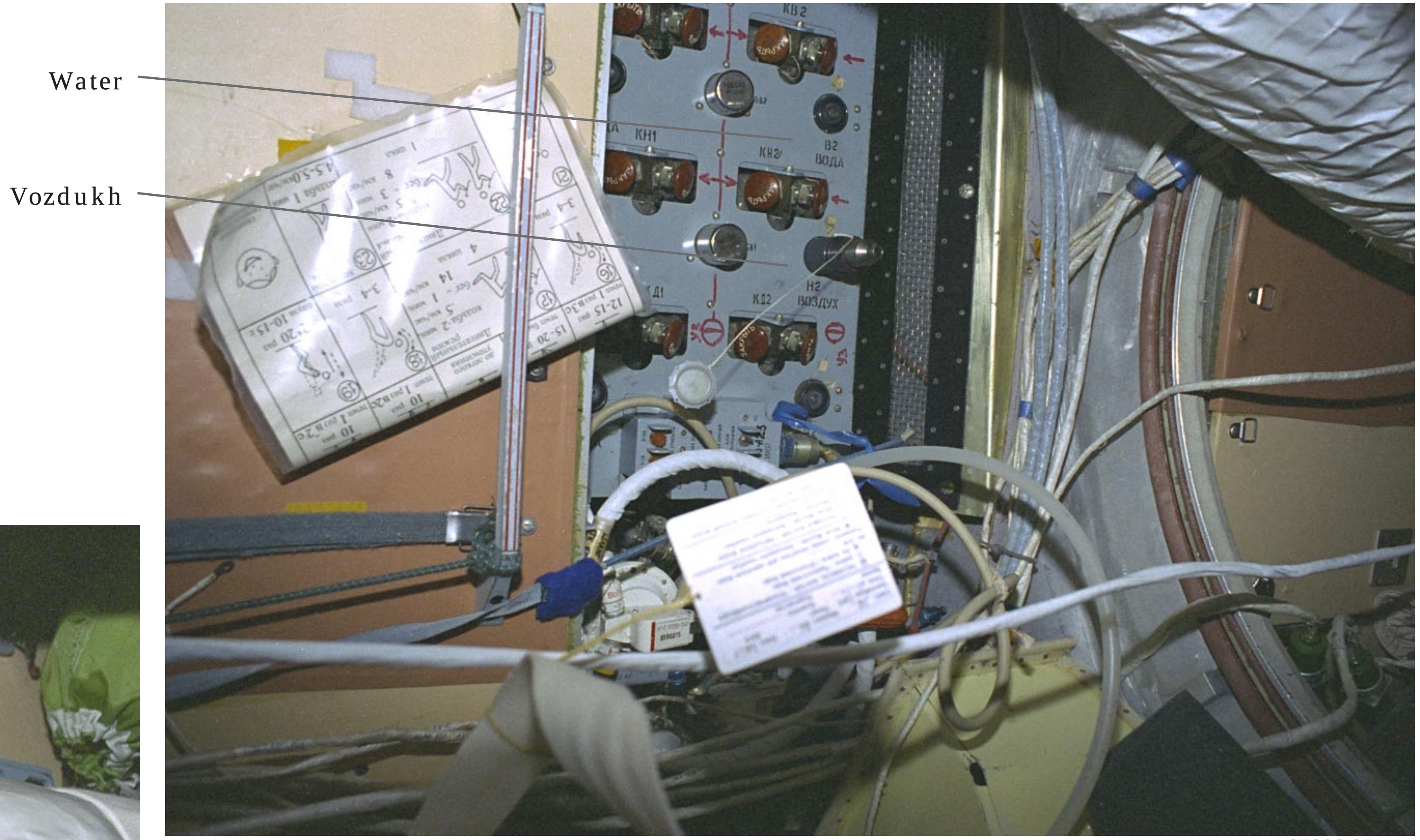

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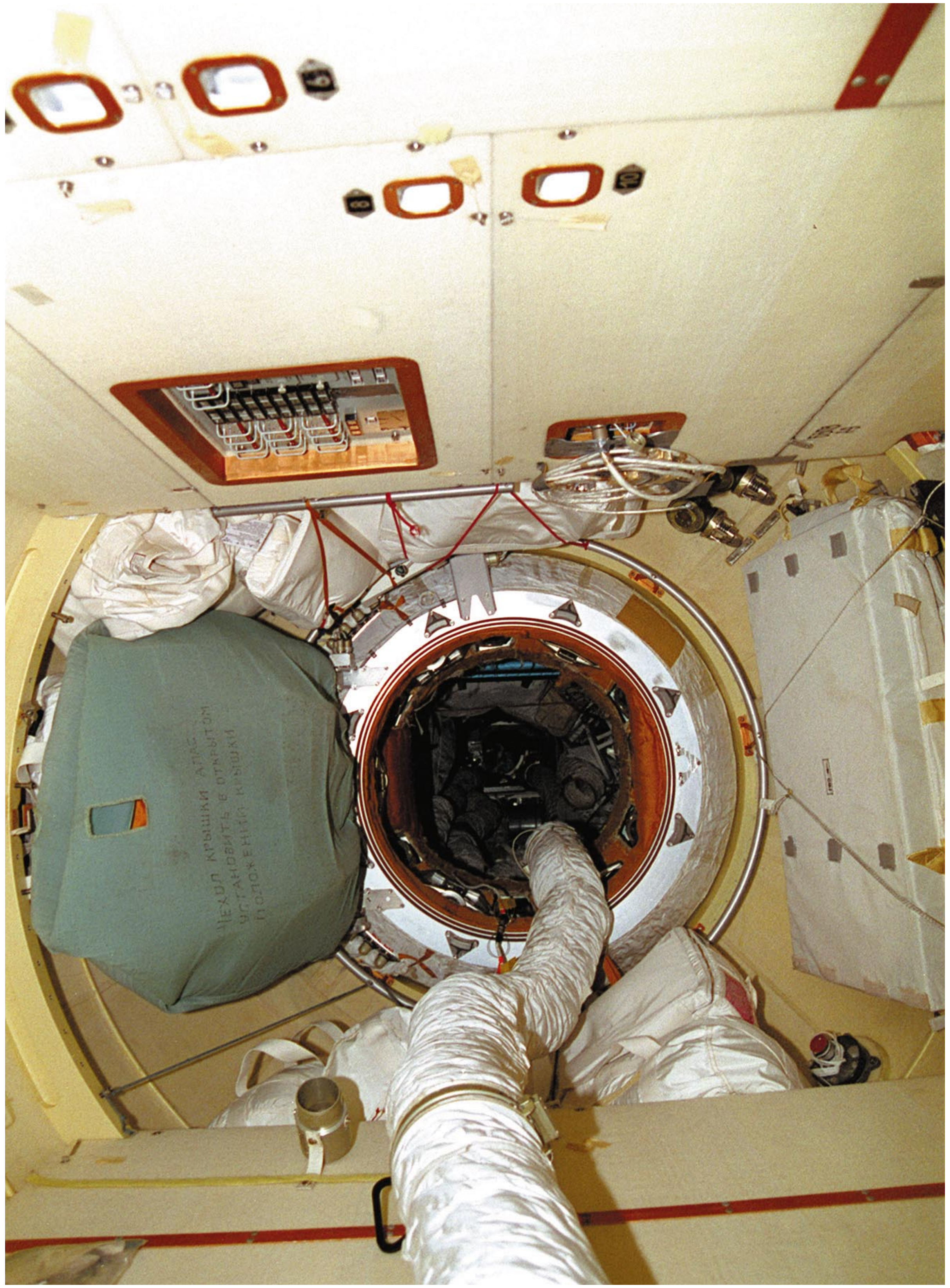

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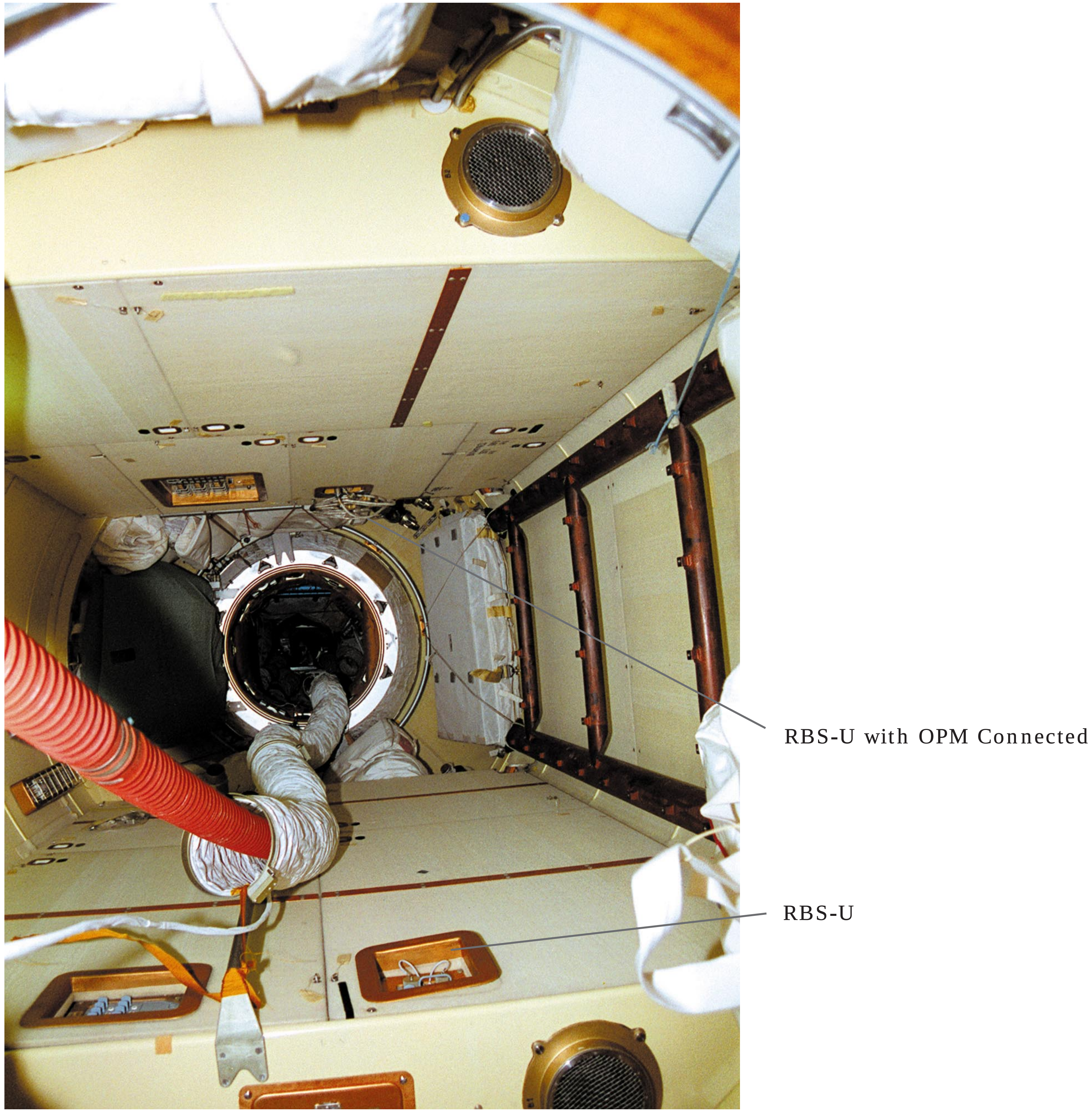

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Figure MOD-92 Docking Module Towards Kristall from the Shuttle Hatch

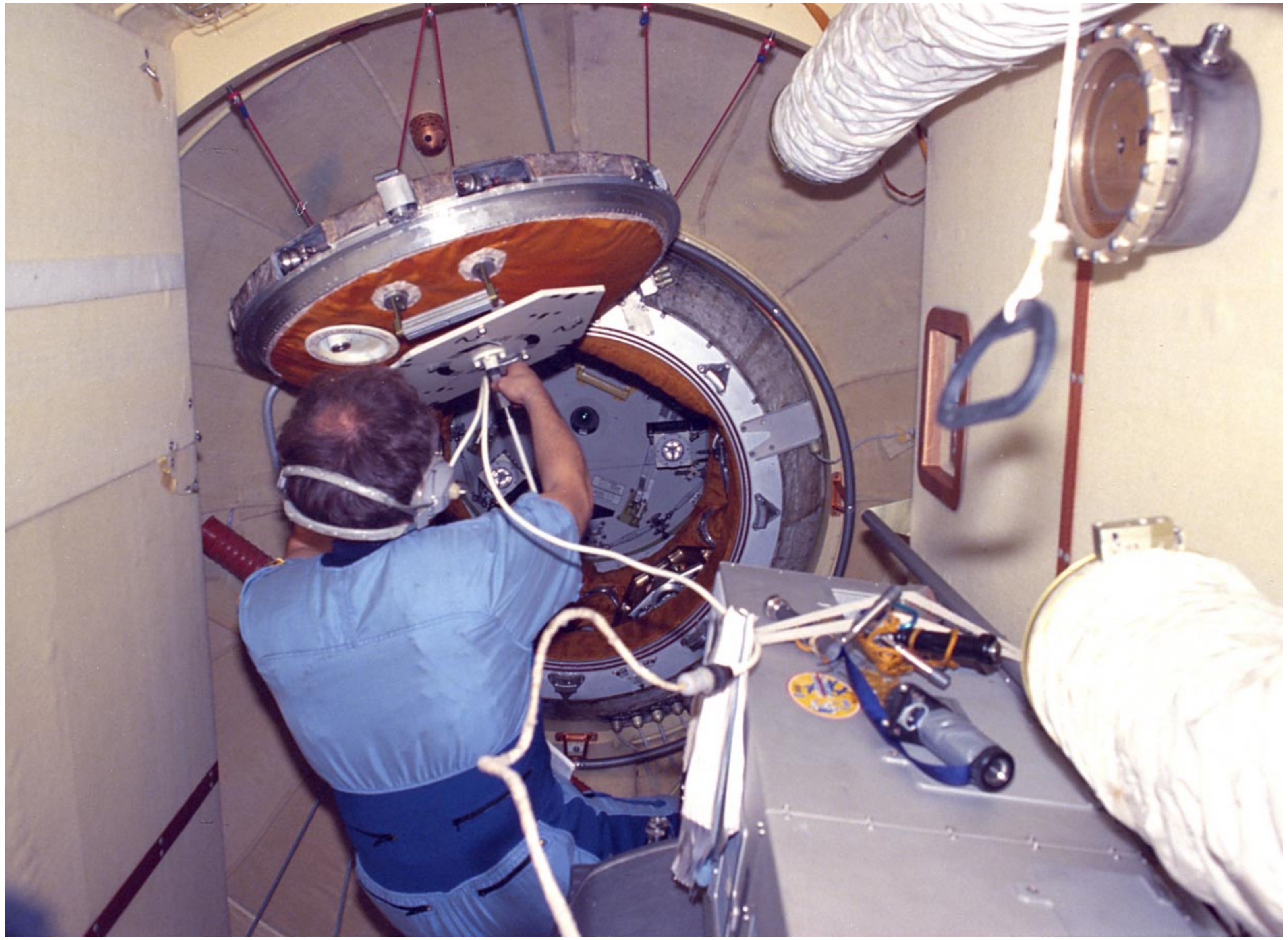
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Figure MOD-93 Docking Module with the Hatch Open and Shuttle Hatch Closed

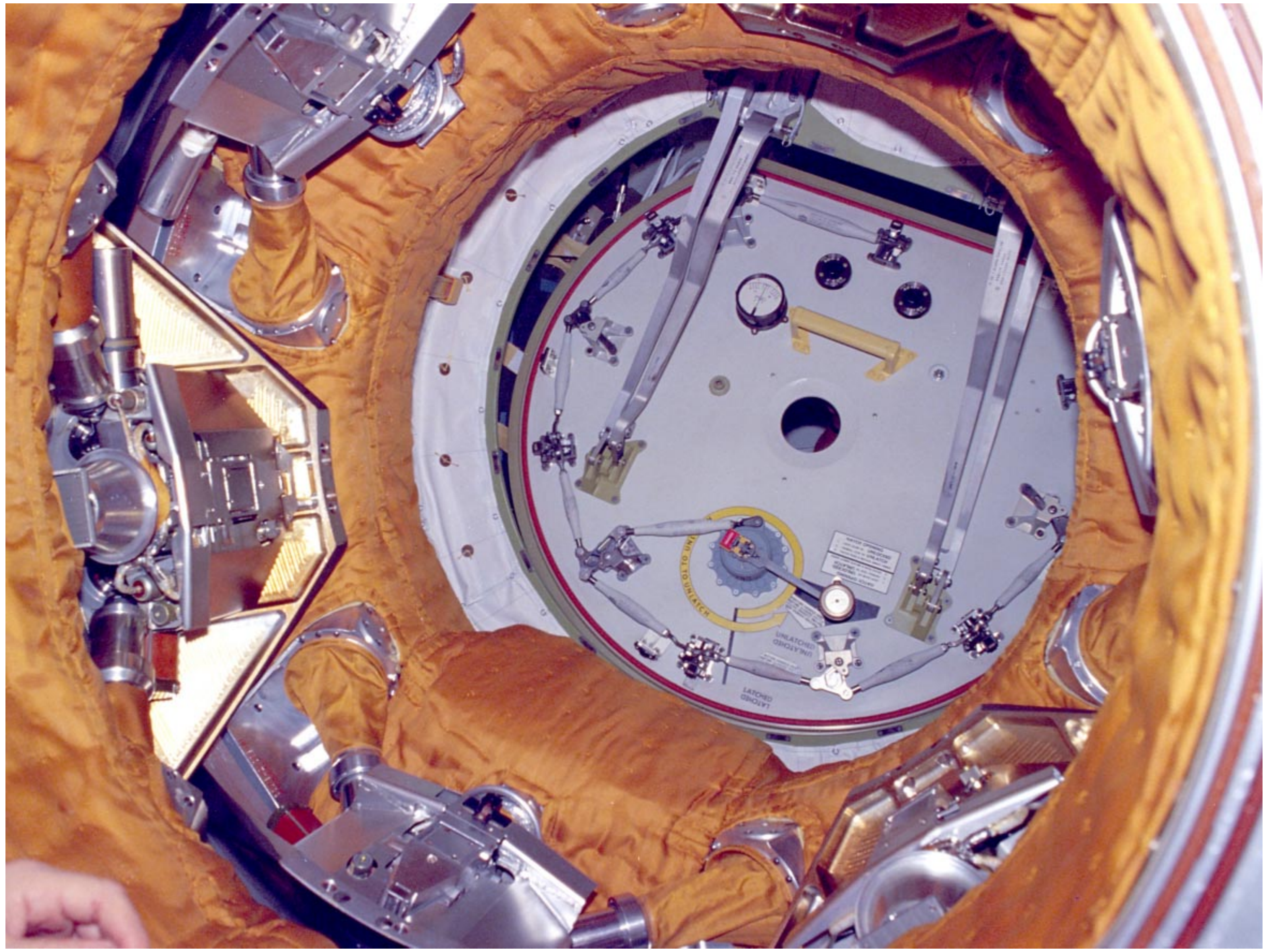
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Figure MOD-95 Docking Module's APDS Panel

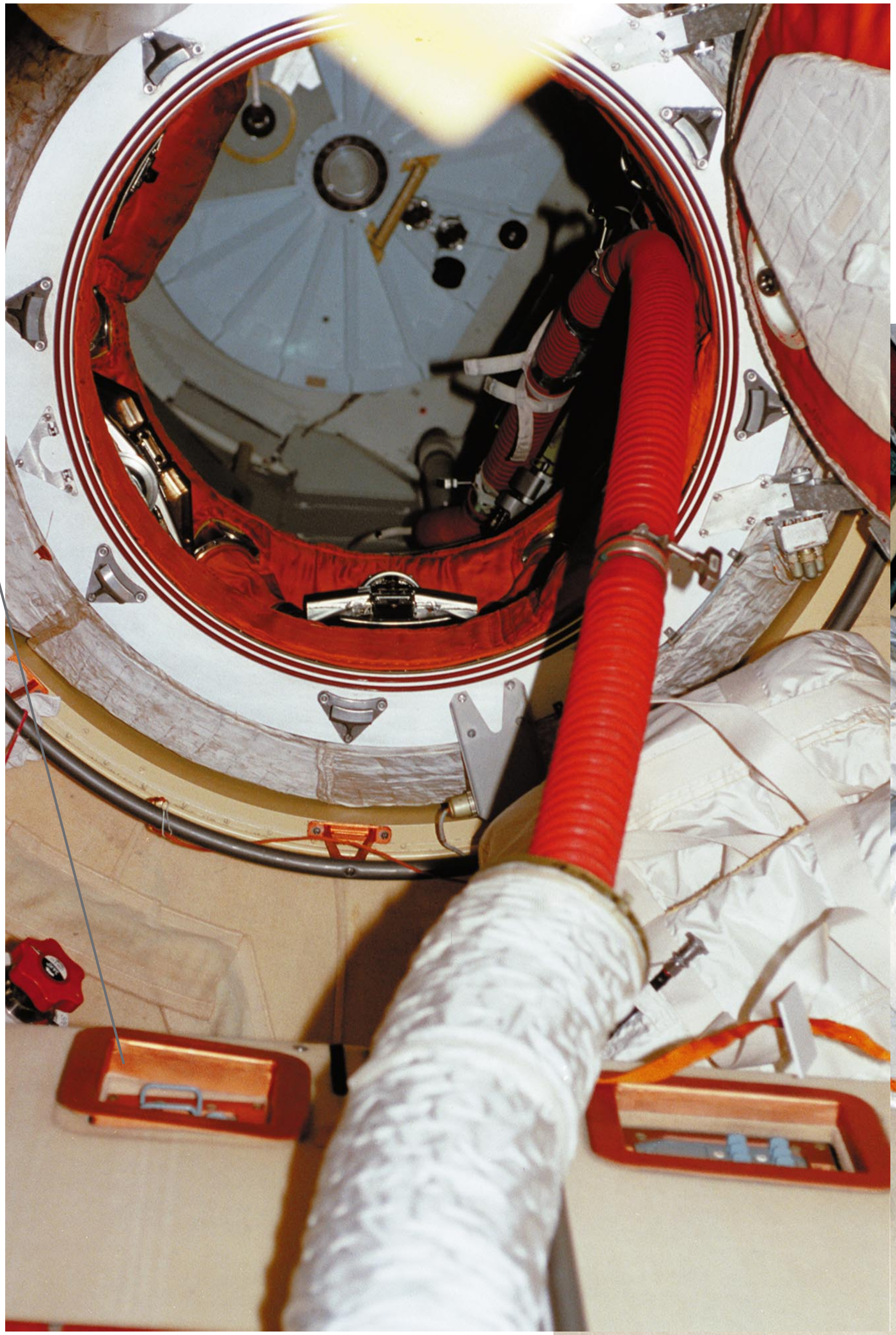

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Figure MOD-96
Docking Module Showing Shuttle Hatch

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Figure MOD-100 Kvant's Interior

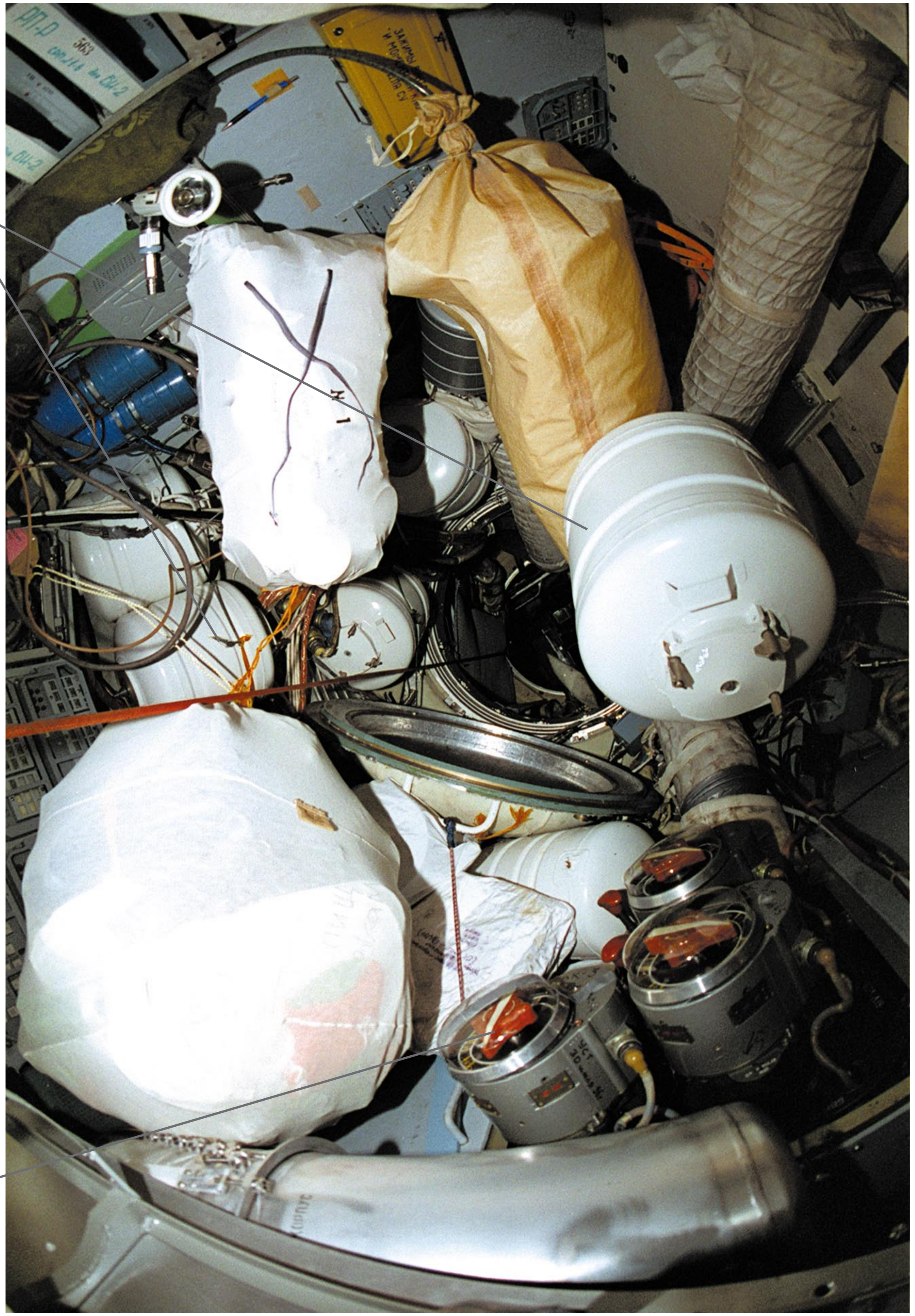

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Figure MOD-101 Kvant Interior with the Vozdukh

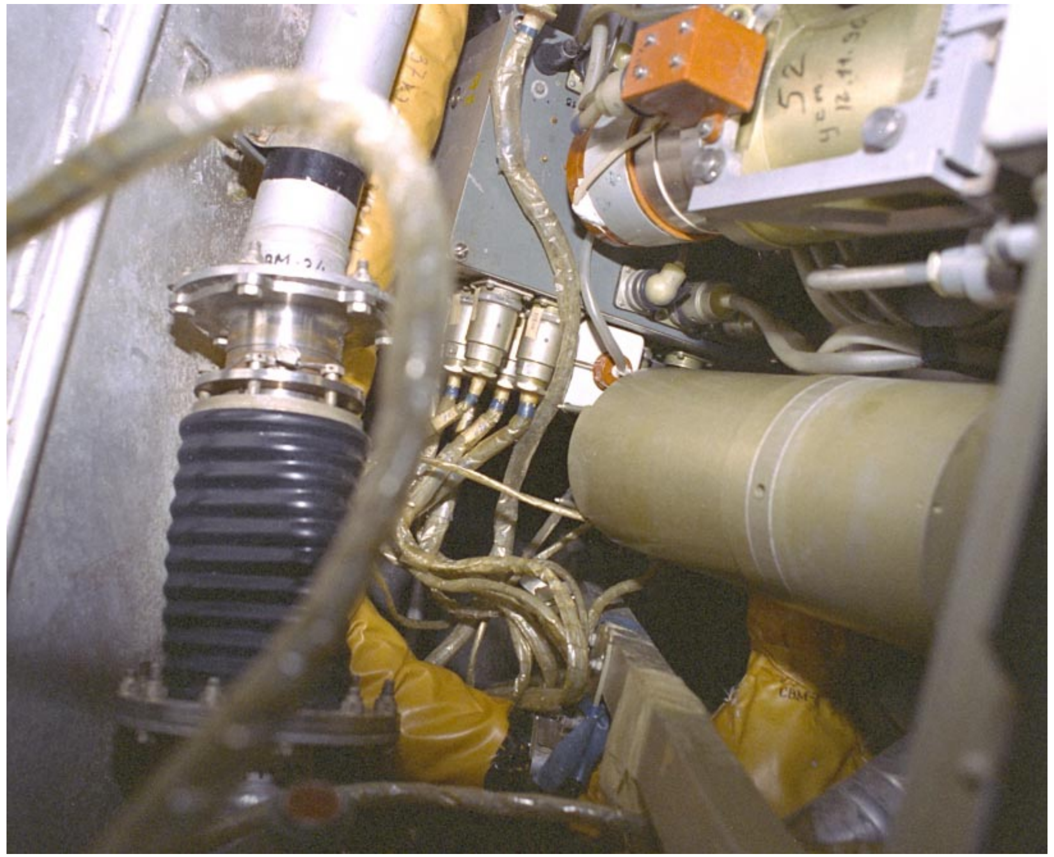

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Figure MOD-102 Kvant

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Figure MOD-103 Kvant Burn Area

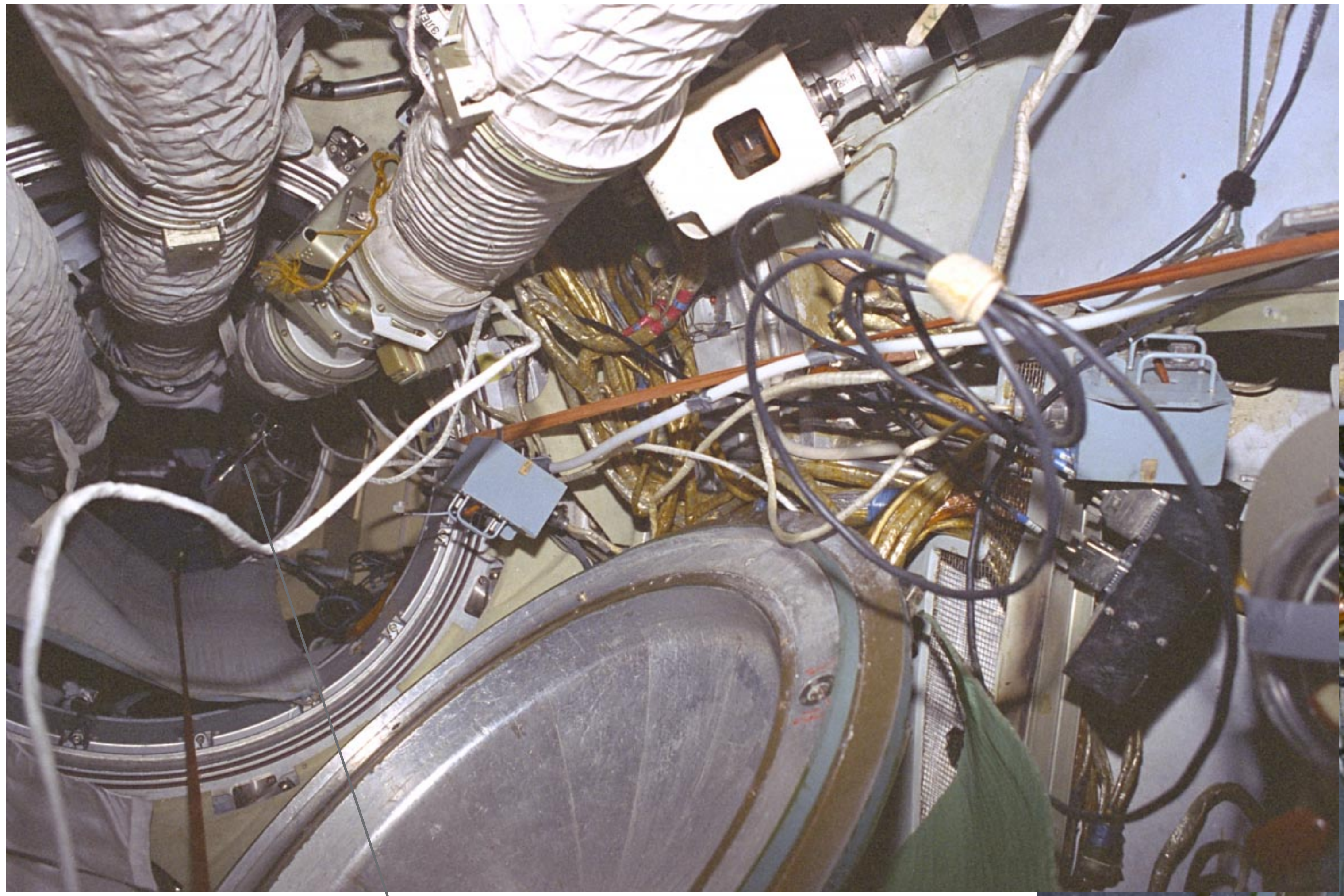

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Figure MOD-104 Kvant Towards the Transfer Area Between the Kvant and the Core Module

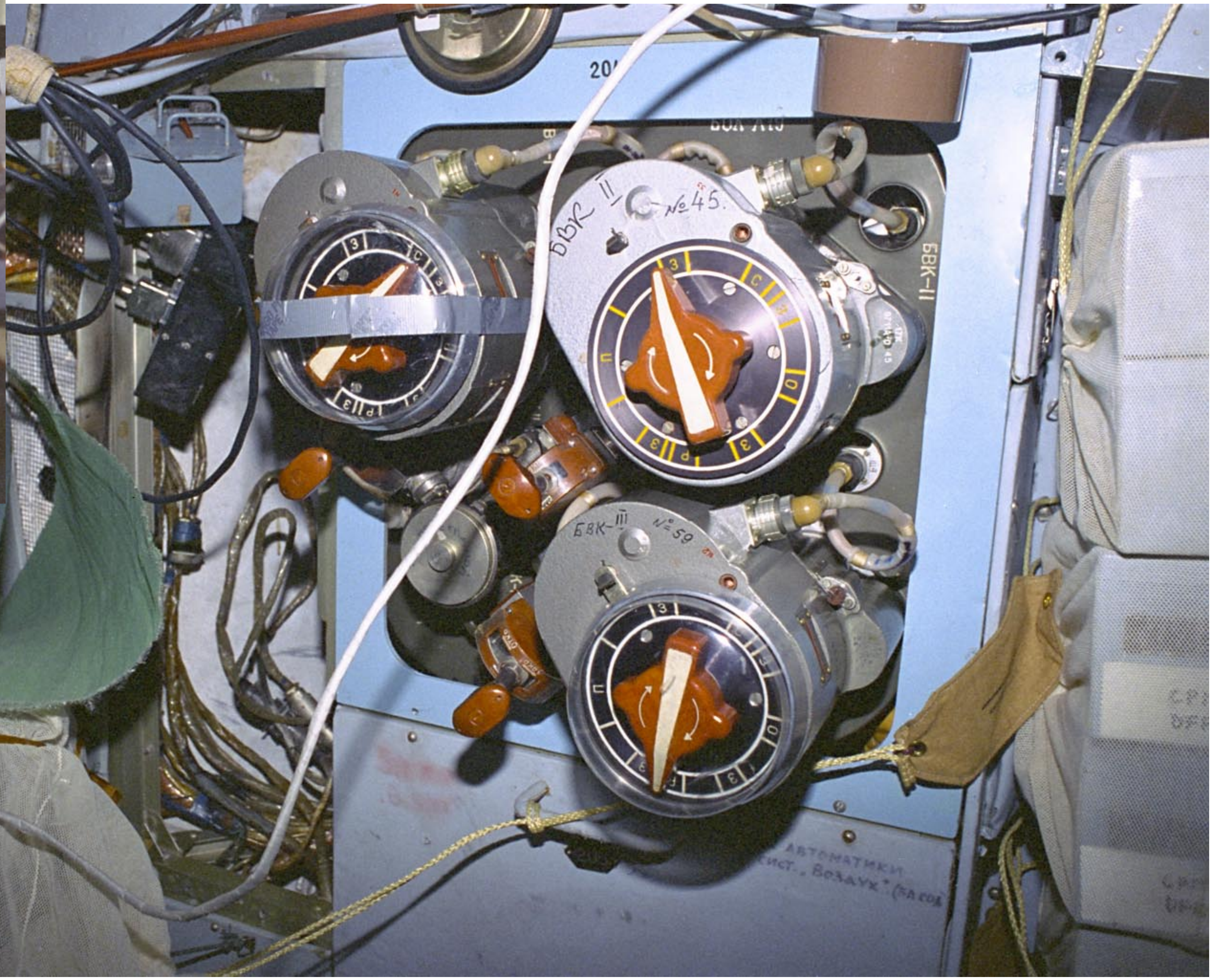

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Figure MOD-105 Kvant's Vozdukh (BVK-I, BVK-II, BVK-III Vacuum Valves)

KVANT II

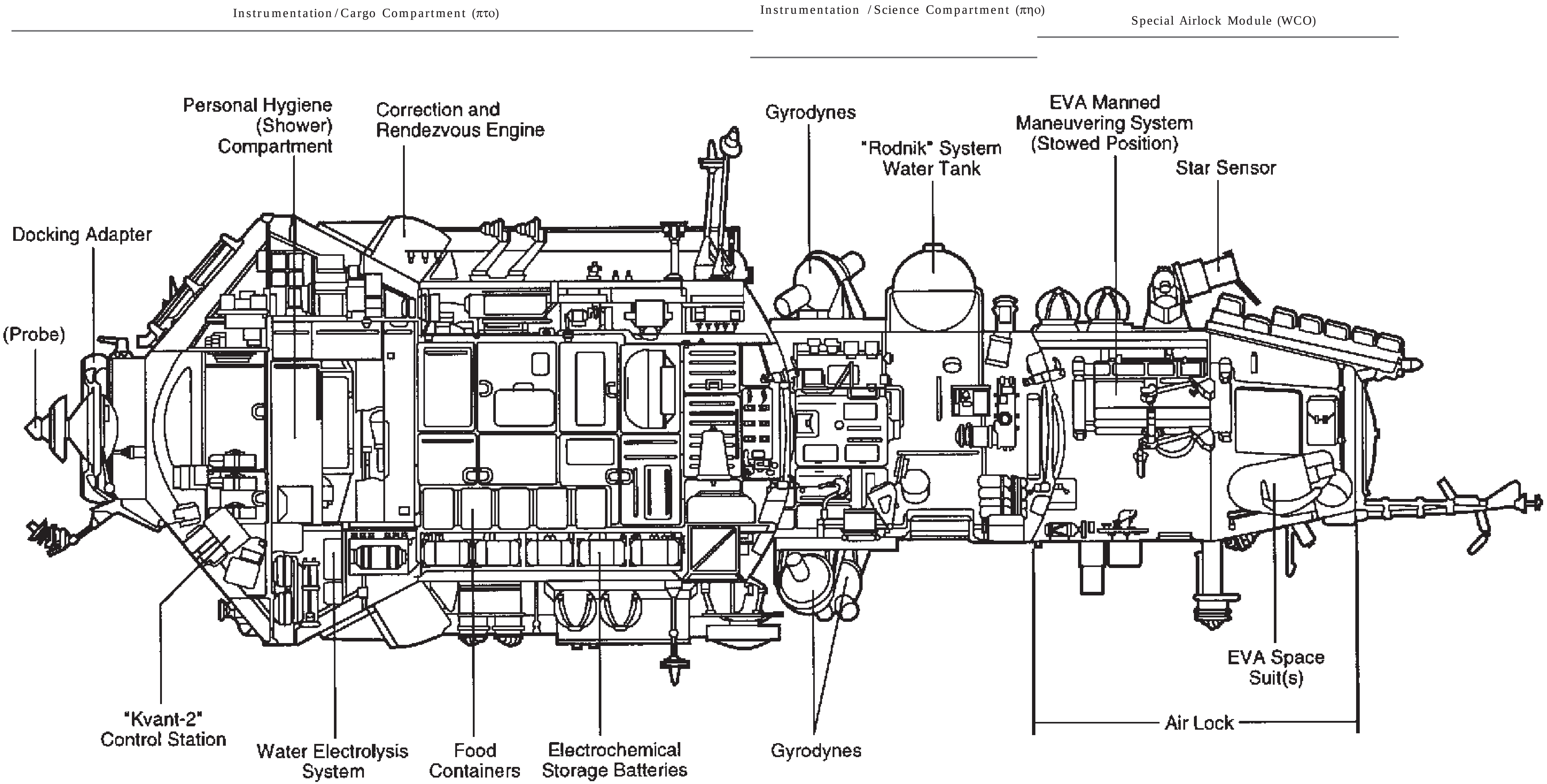

Figure MOD-106 Kvant II

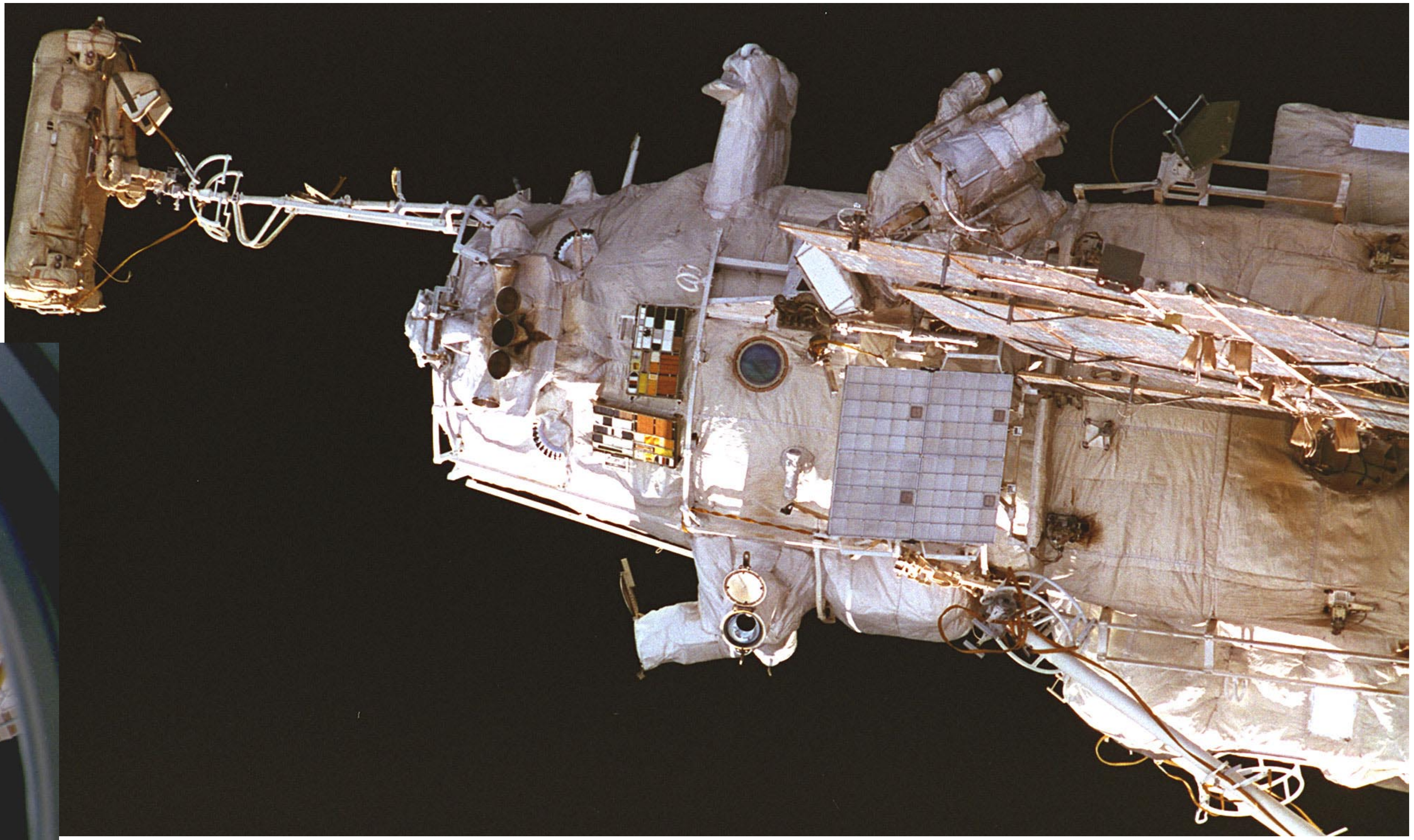

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Figure MOD-108 Kvant II

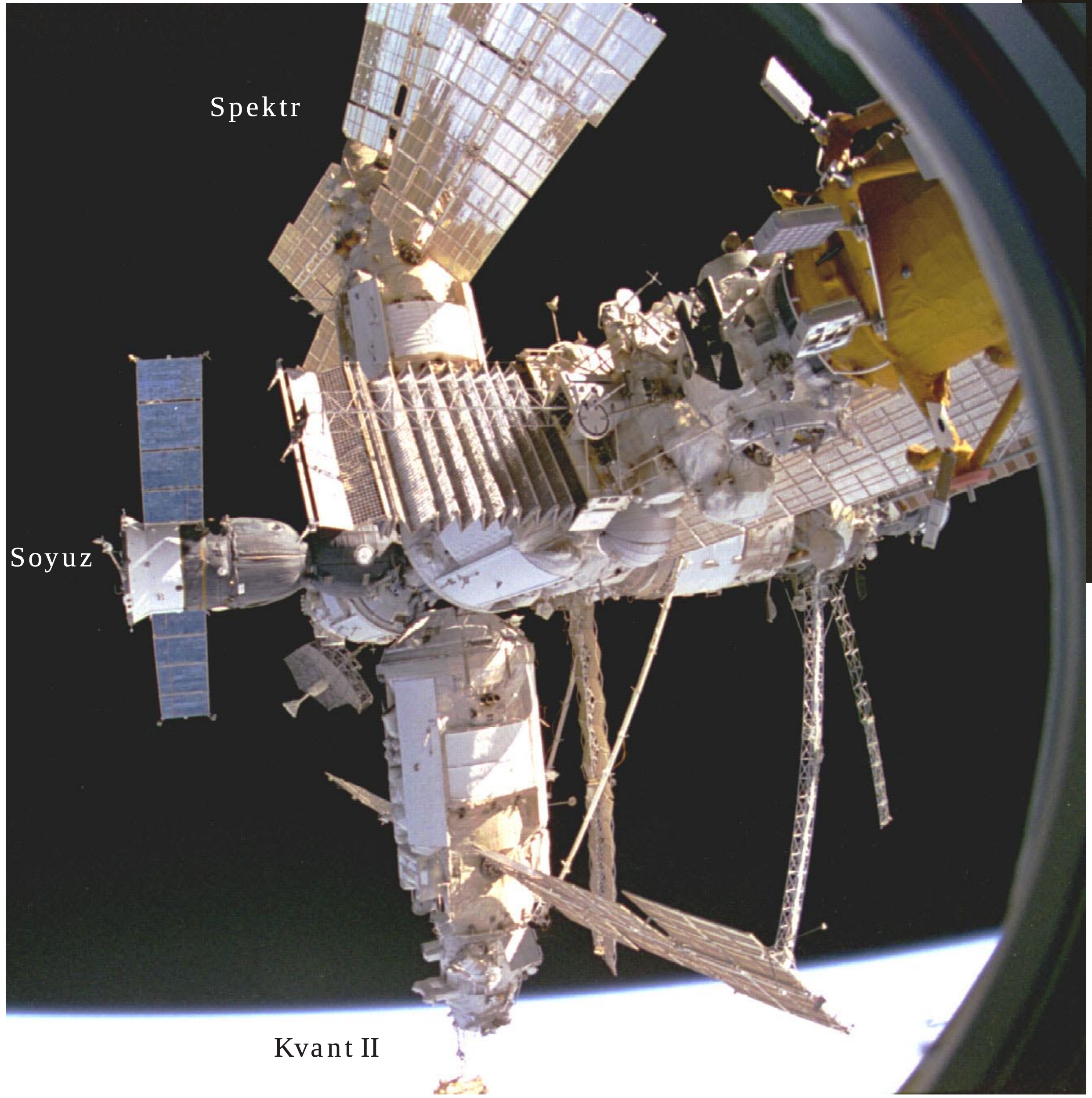

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Figure MOD-107 Soyuz and Kvant II

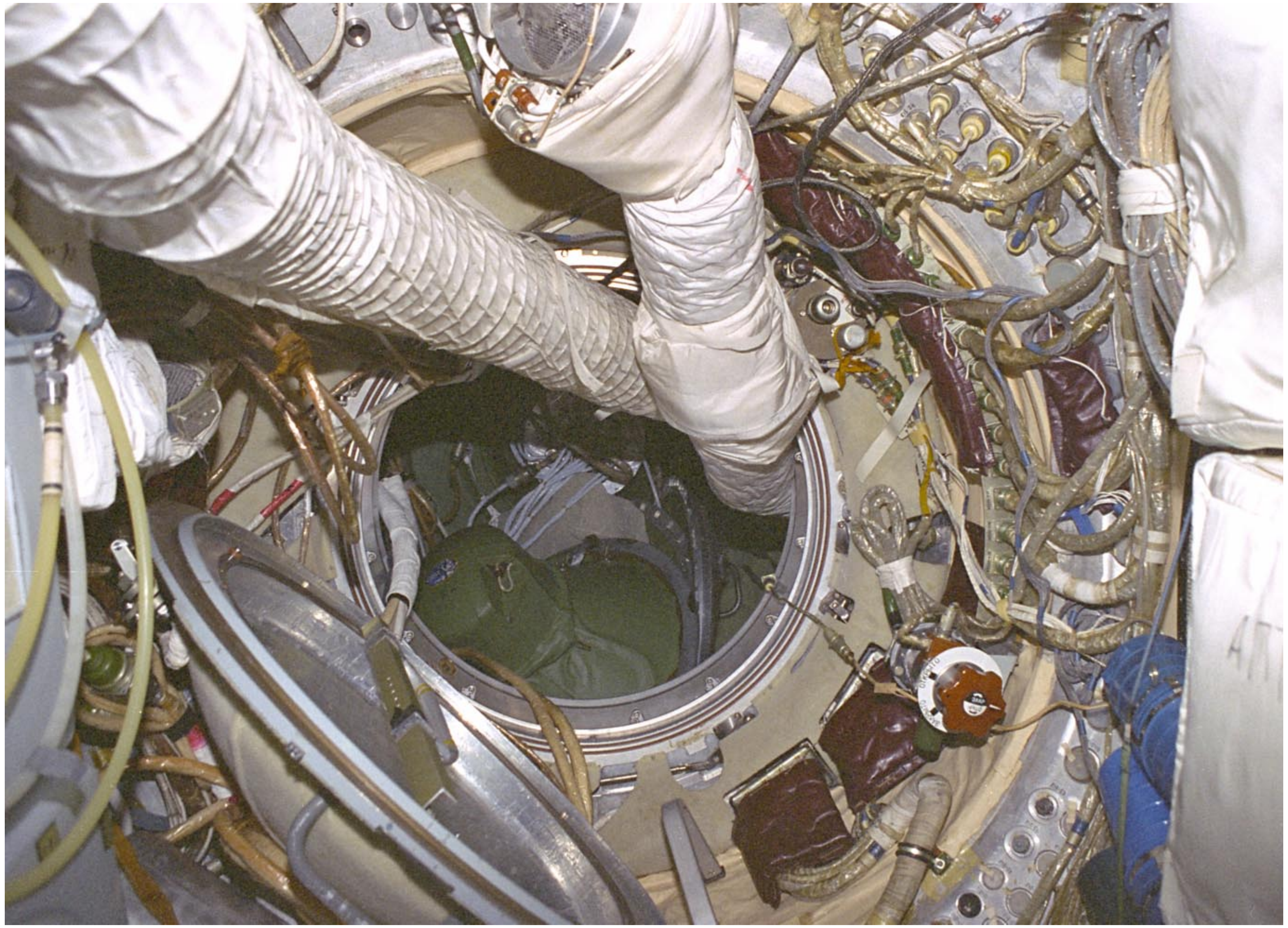

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Figure MOD-109 Kvant II Hatch Viewing into the Transfer Node

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Figure MOD-110 Kvant II Hatch

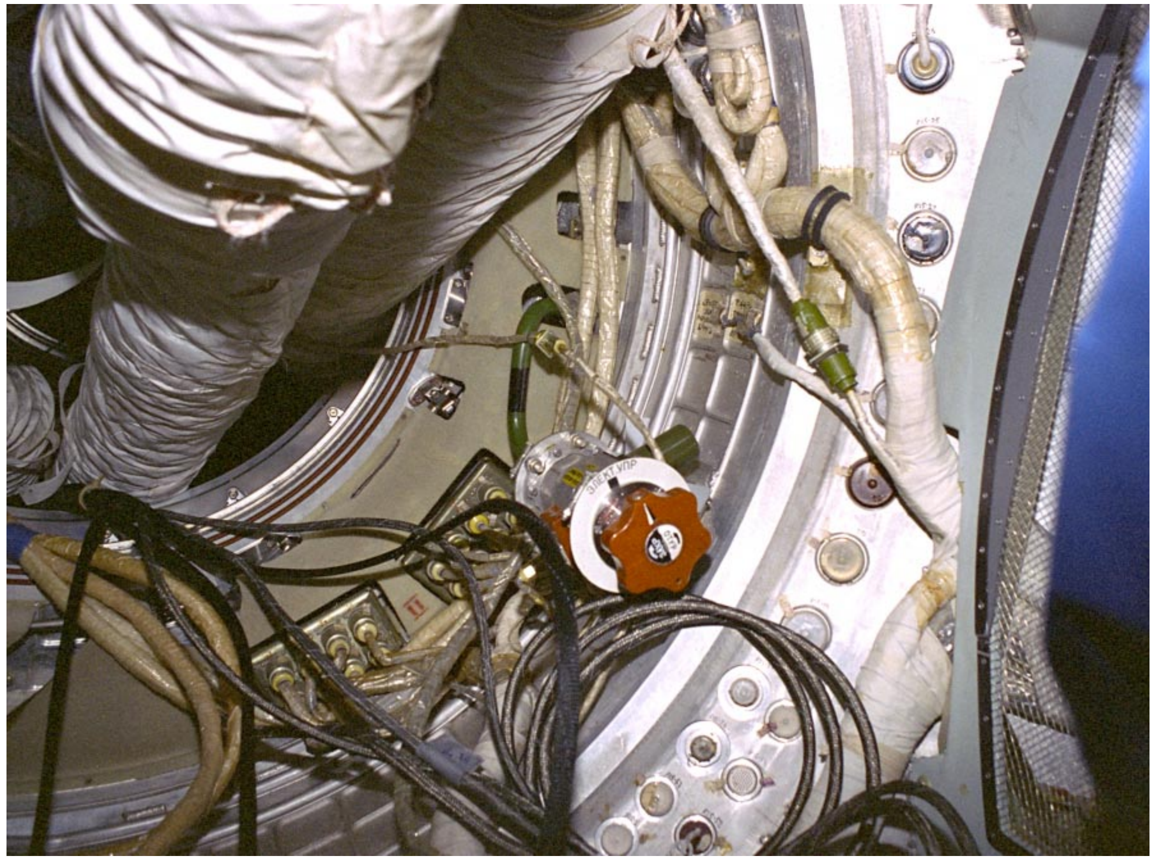

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Figure MOD-111 Kvant II Hatch

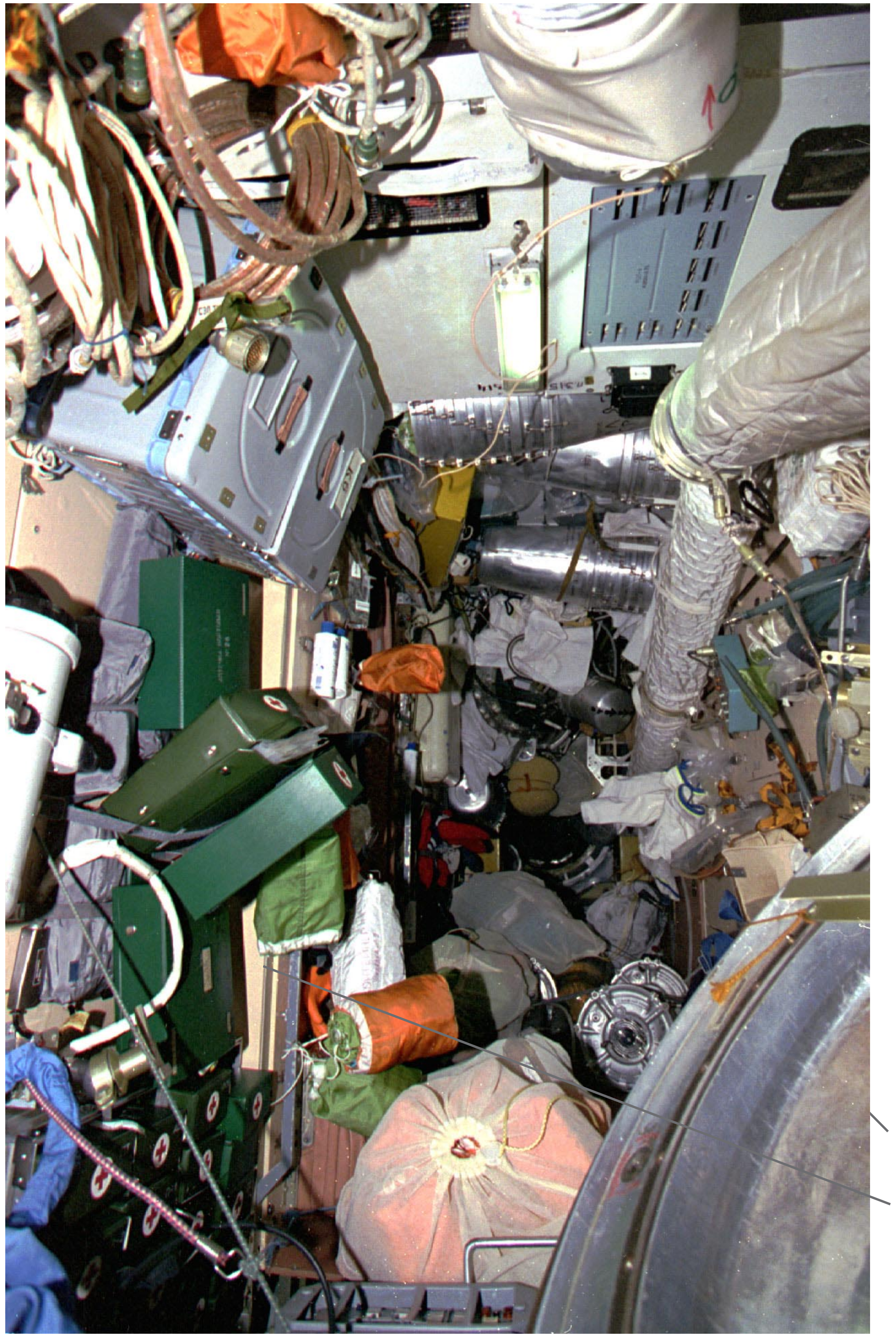

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Figure MOD-112 Kvant II Towards Transfer Node

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Figure MOD-113 Kvant II Towards Transfer Node

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Figure MOD-114 Toilet and Gyrodyne Behind the Shower Curtain

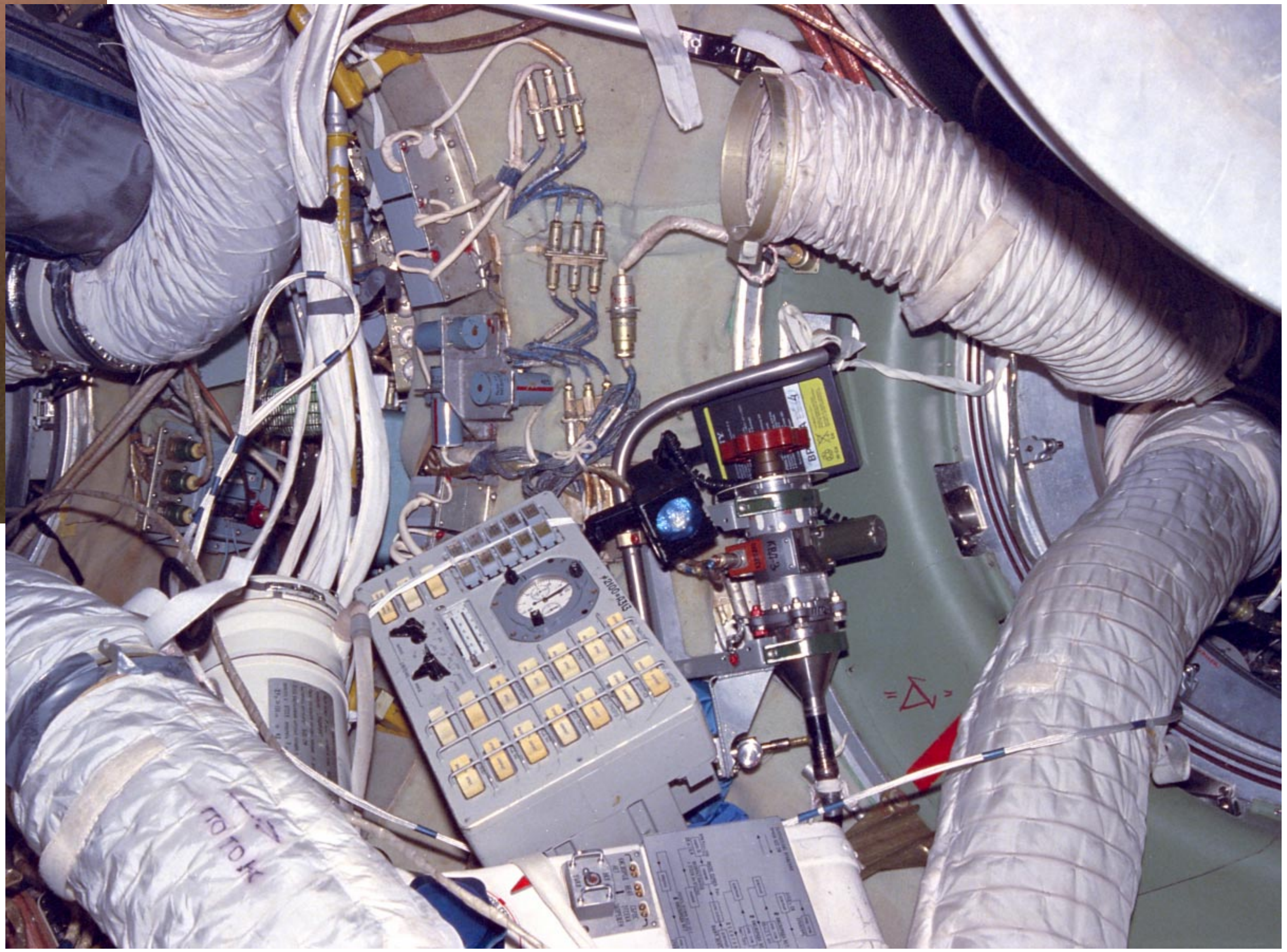

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Figure MOD-115 Kvant II Instrumentation/Science Compartment (πηο) with the Egress EVA Support Console

STS84-306-001

Figure MOD-116 Kvant II Towards the Transfer Node

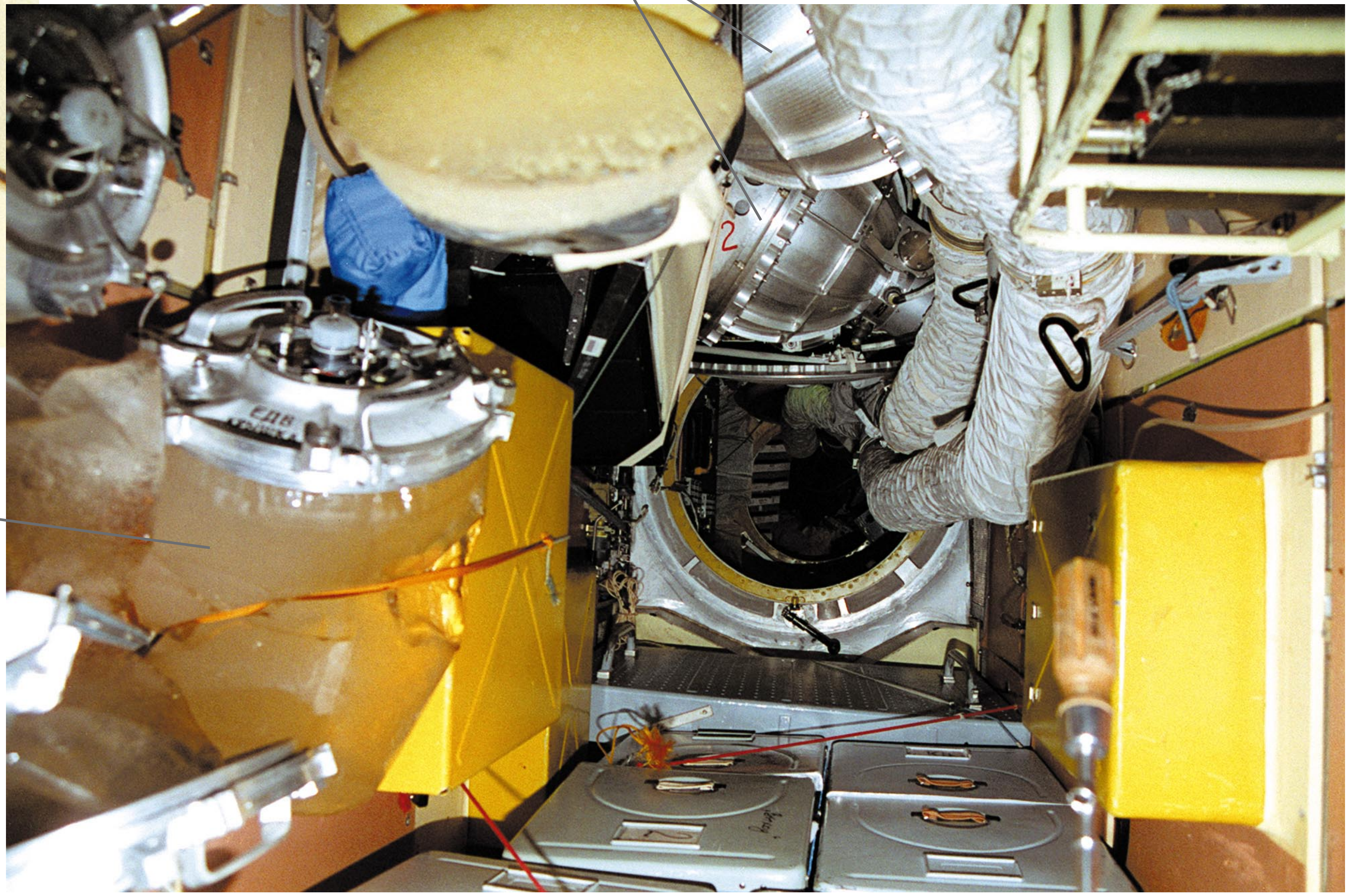

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Figure MOD-117 Kvant II Near the Transfer Node

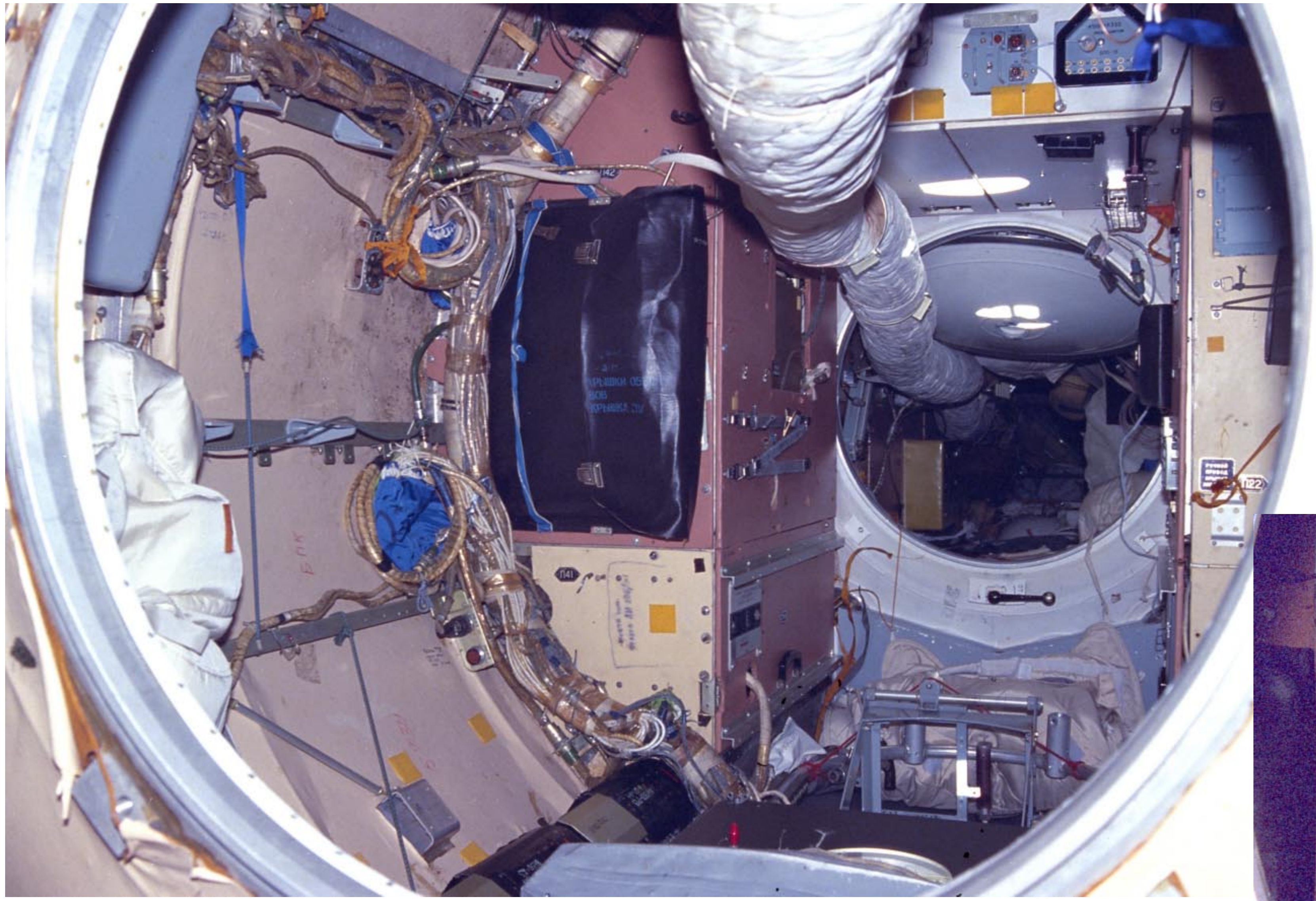

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Figure MOD-118 View into the Special Airlock Module (WCO) from Kvant II's Airlock

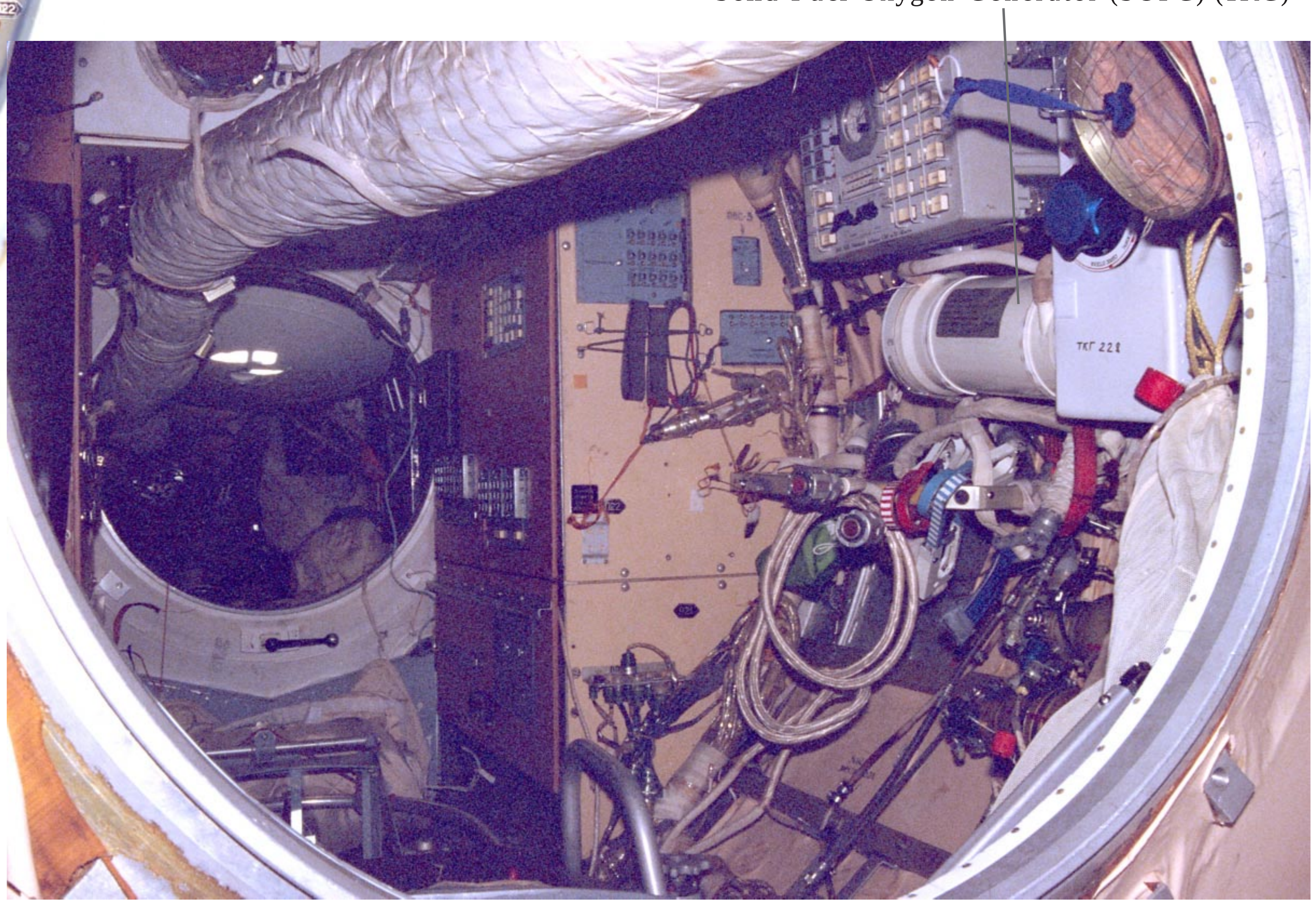

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Figure MOD-119 View Towards the Special Airlock Module (WCO)

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STS84-306-005

Figure MOD-120 Toward Kvant II's Instrumentational Science Compartment (πηο)

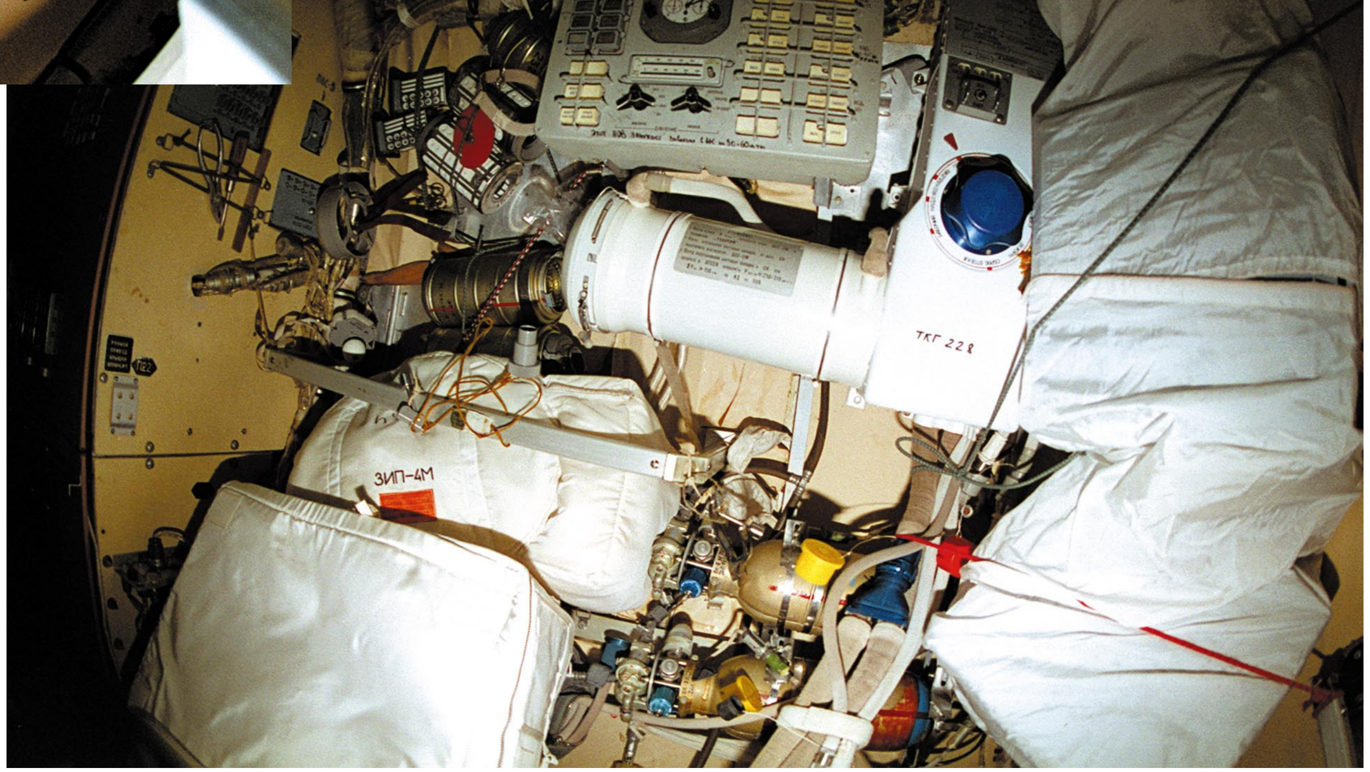

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Figure MOD-122 Solid Fuel Oxygen Generator Stowed (TKG) in Kvant II

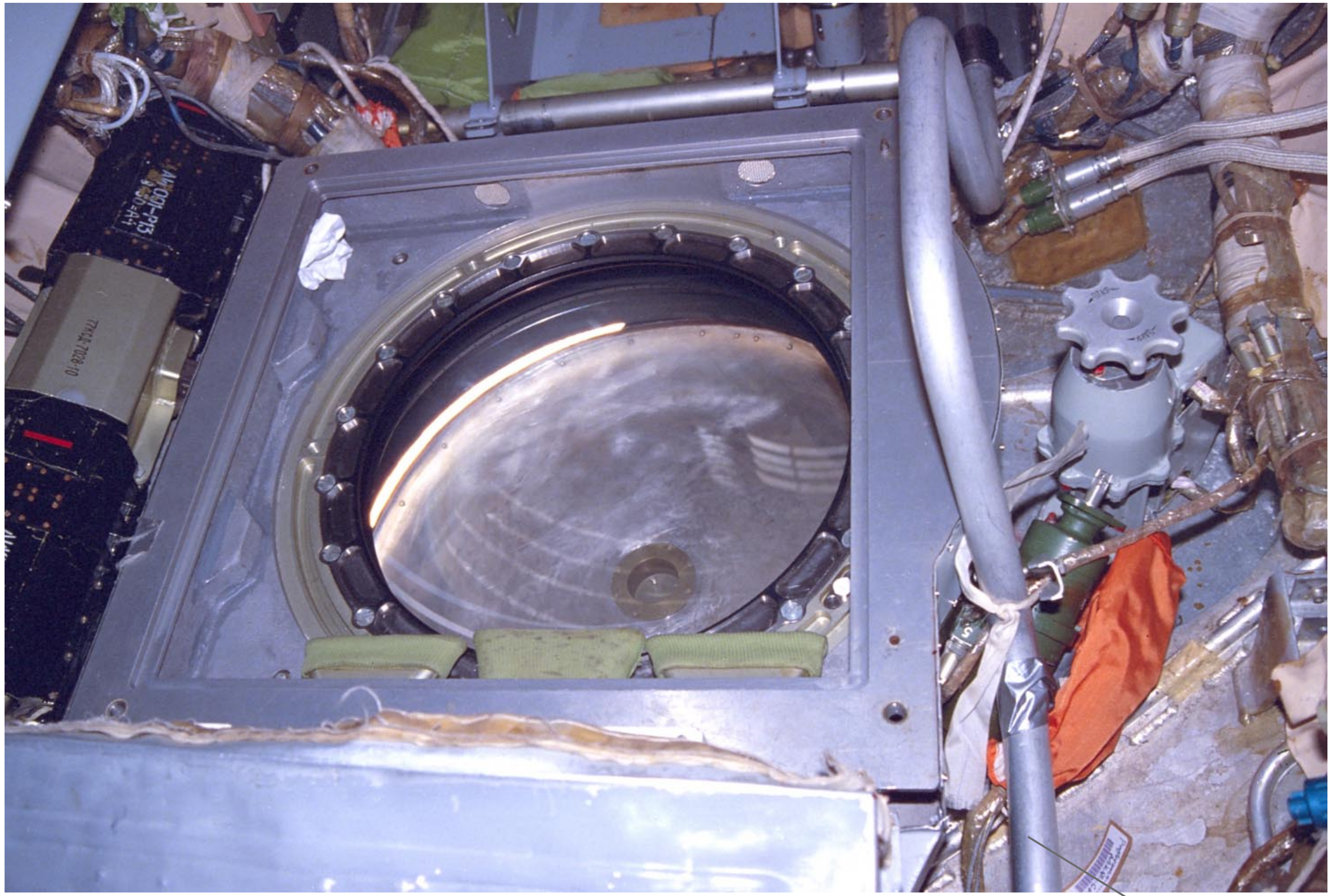

NASA5-308-5

Figure MOD-123 Kvant II Window

Same Bar

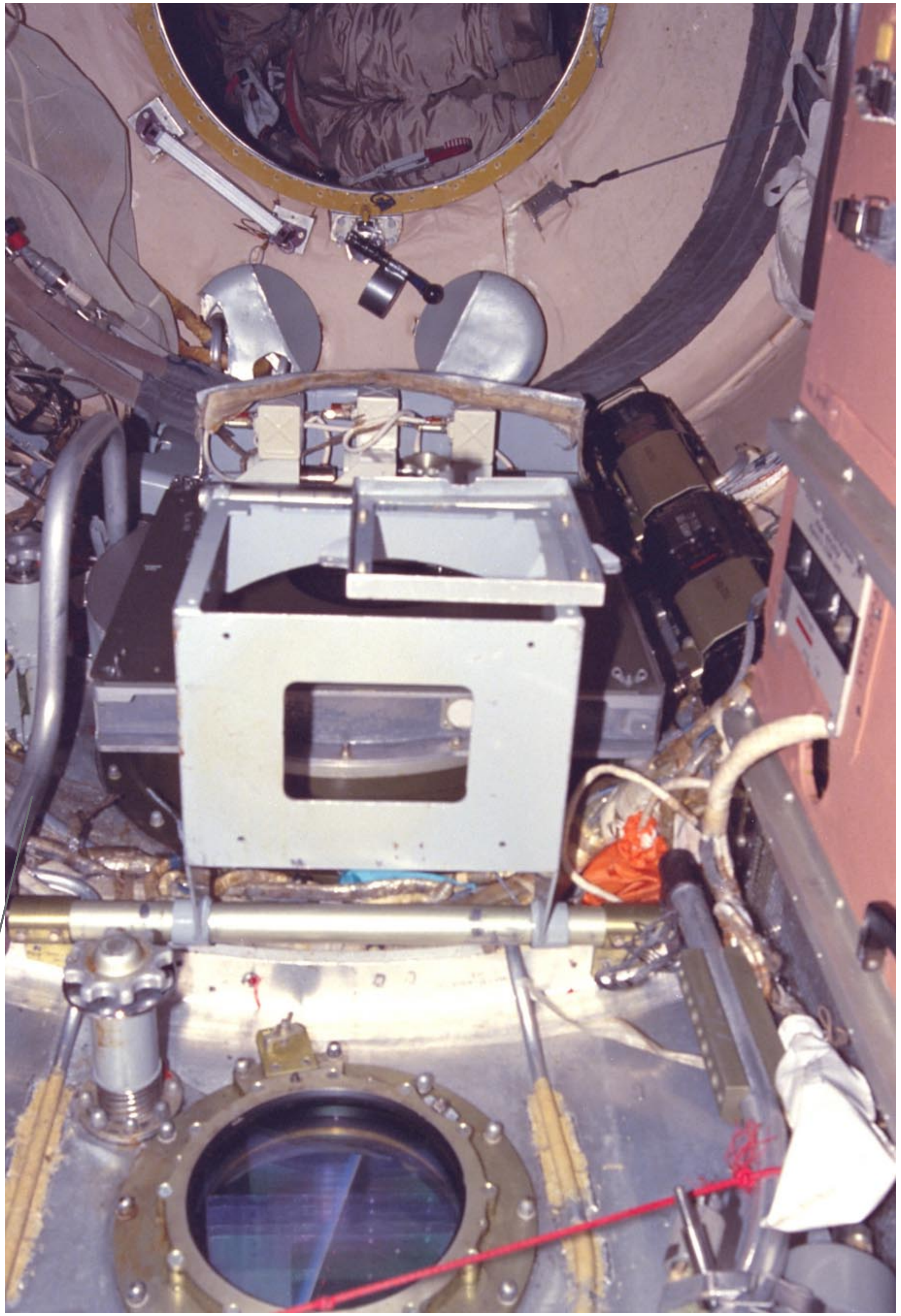
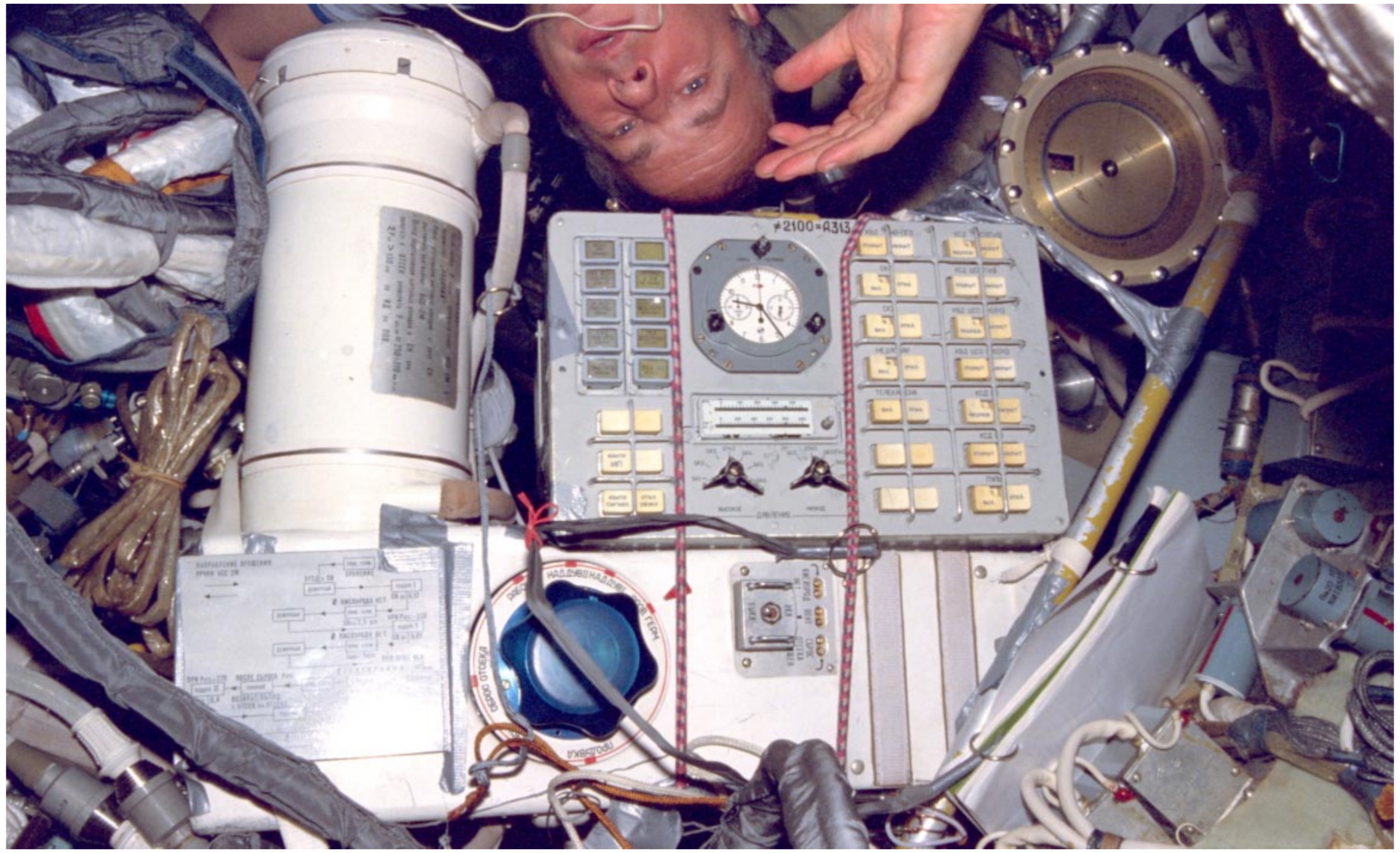

NASA5-321-2

Figure MOD-124 Kvant II in the Secondary Airlock (πηο)



NASA5-326-22

Figure MOD-125 SOFG (TKG) in Kvant II

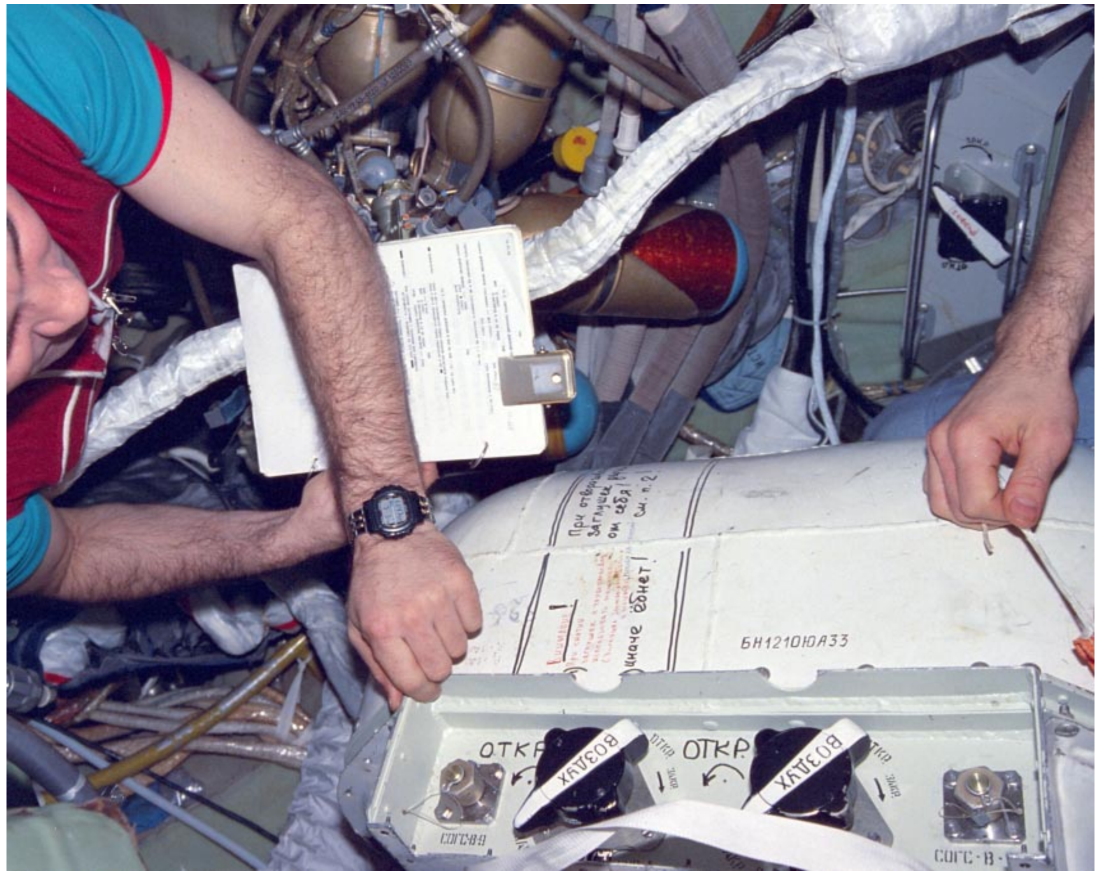


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Figure MOD-126 Vozdukh Hardware in Kvant II

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Figure MOD-127
The SOFG and the Egress EVA Support Console in the Instrumentation/Science Compartment (πηο)

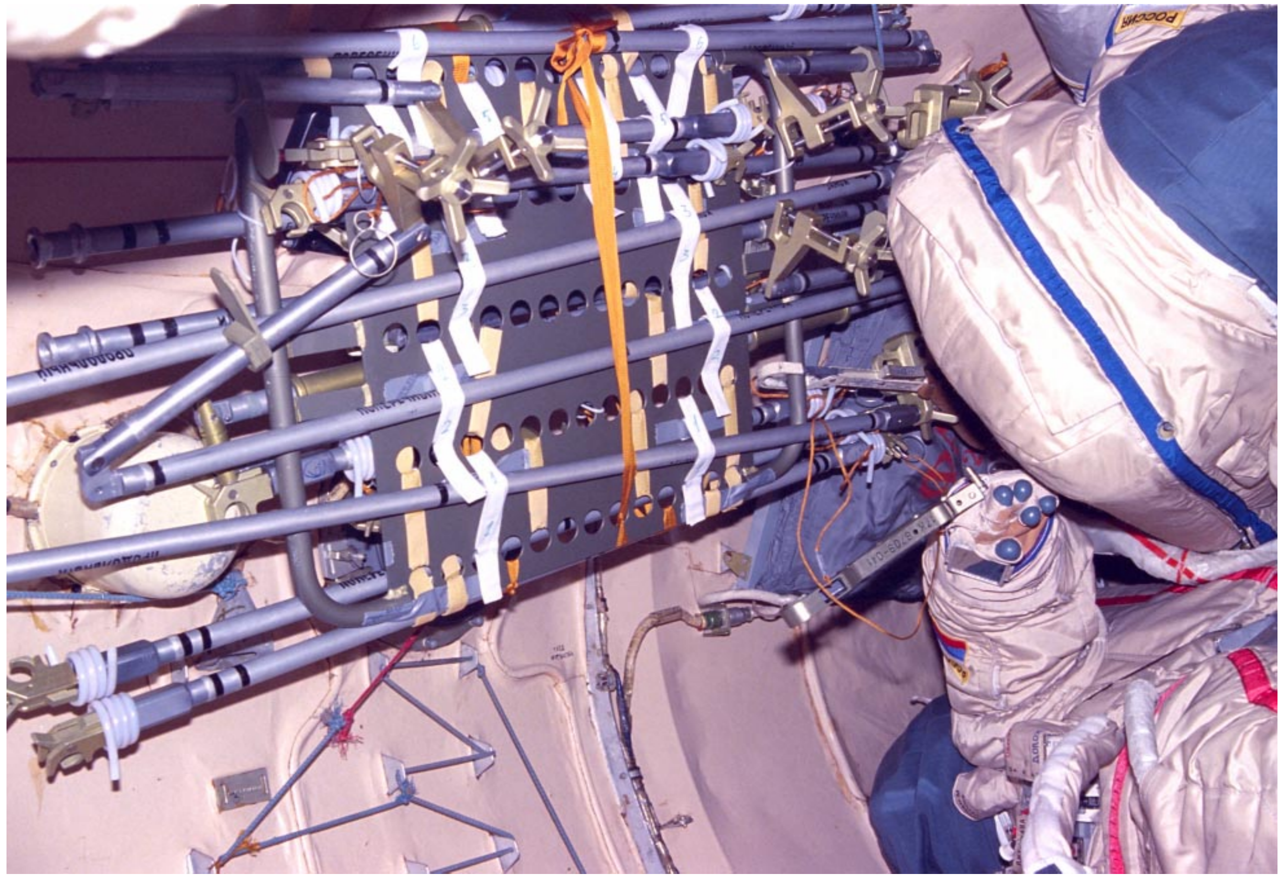

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Figure MOD-128 Kvant II Special Airlock Compartment (WCO)

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Figure MOD-129 EVA Camera with EVA Cover

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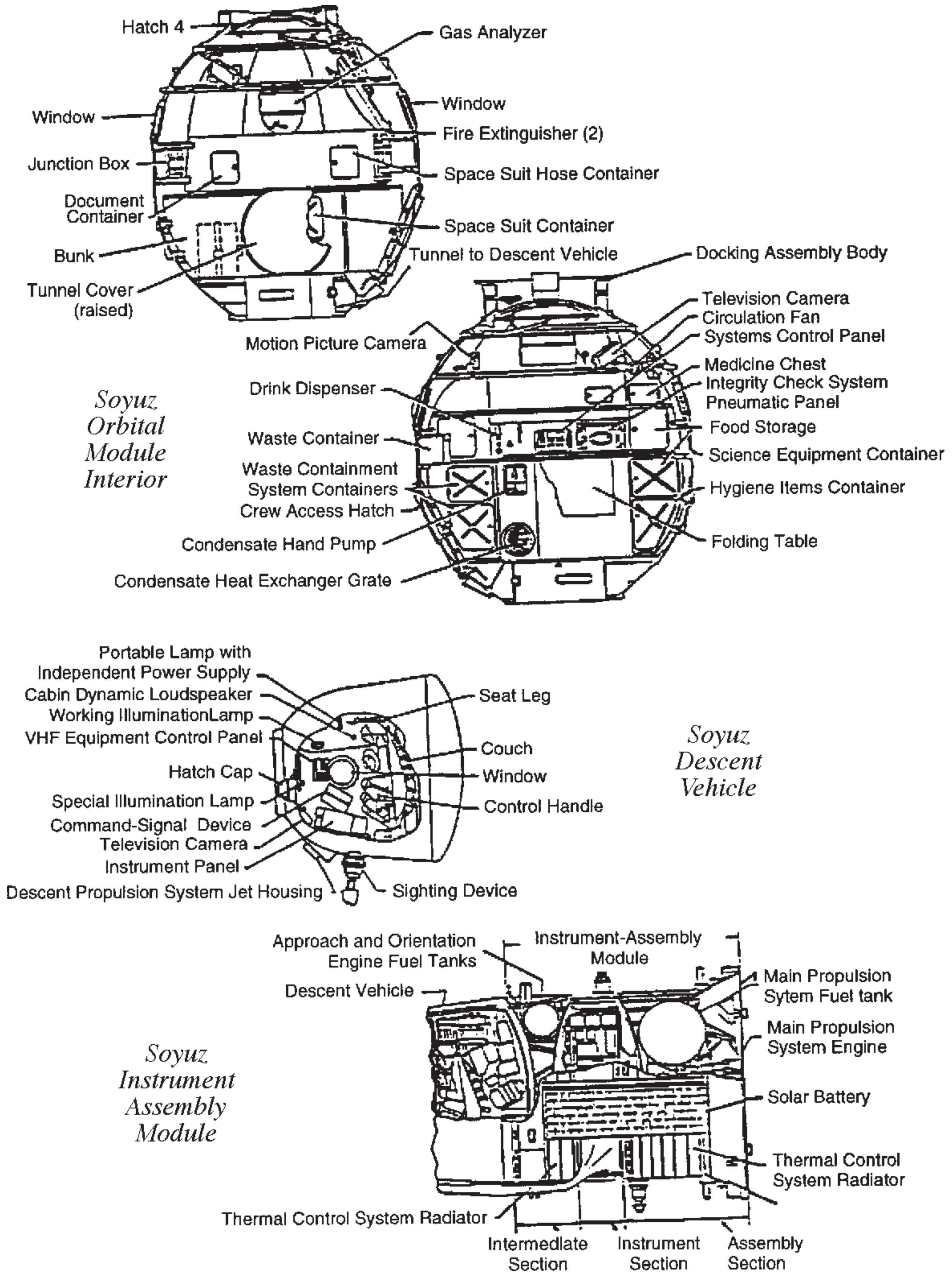
SOYUZ



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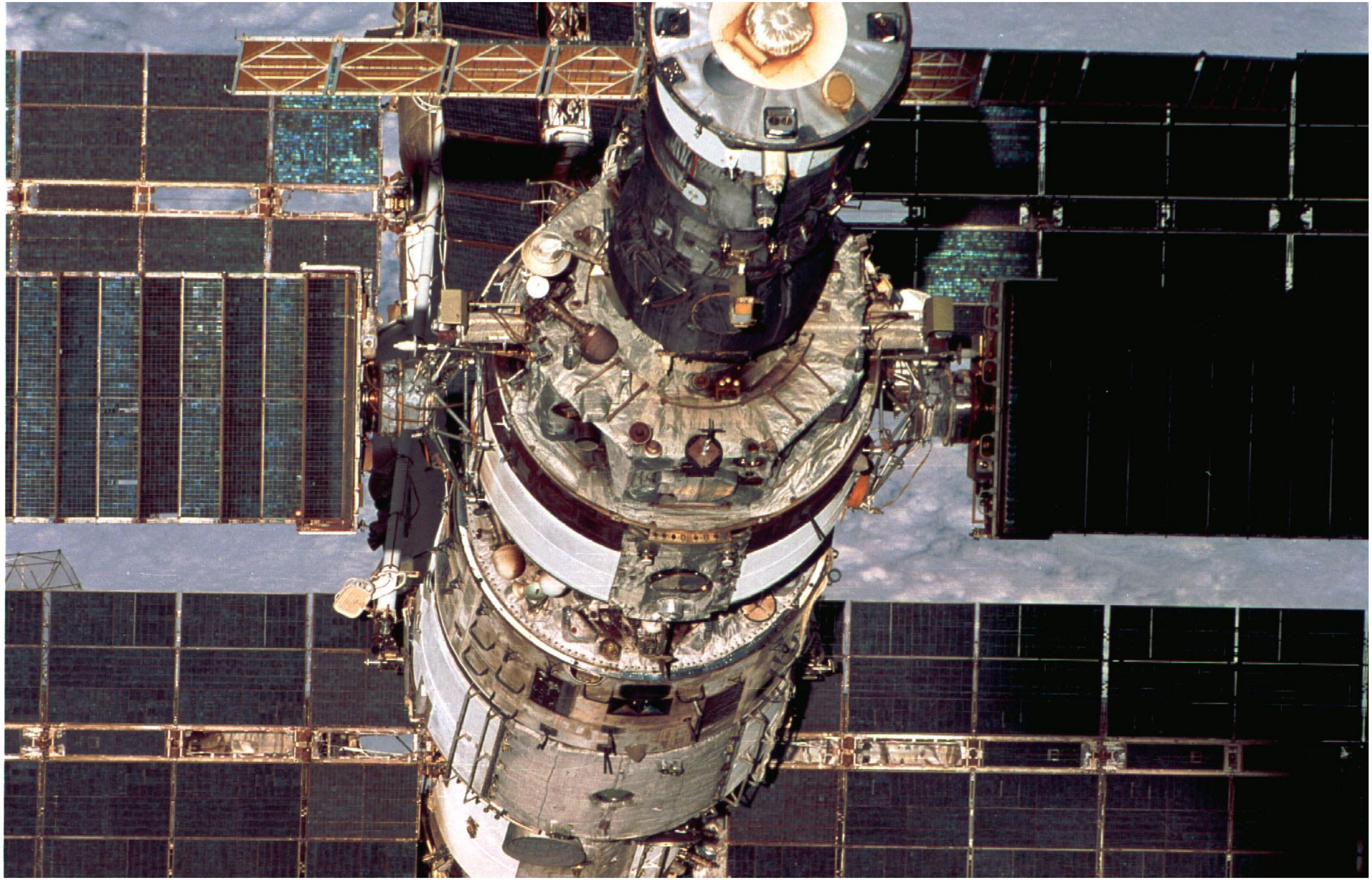

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Figure MOD-133 Progress Attached to Kvant and the Core Module

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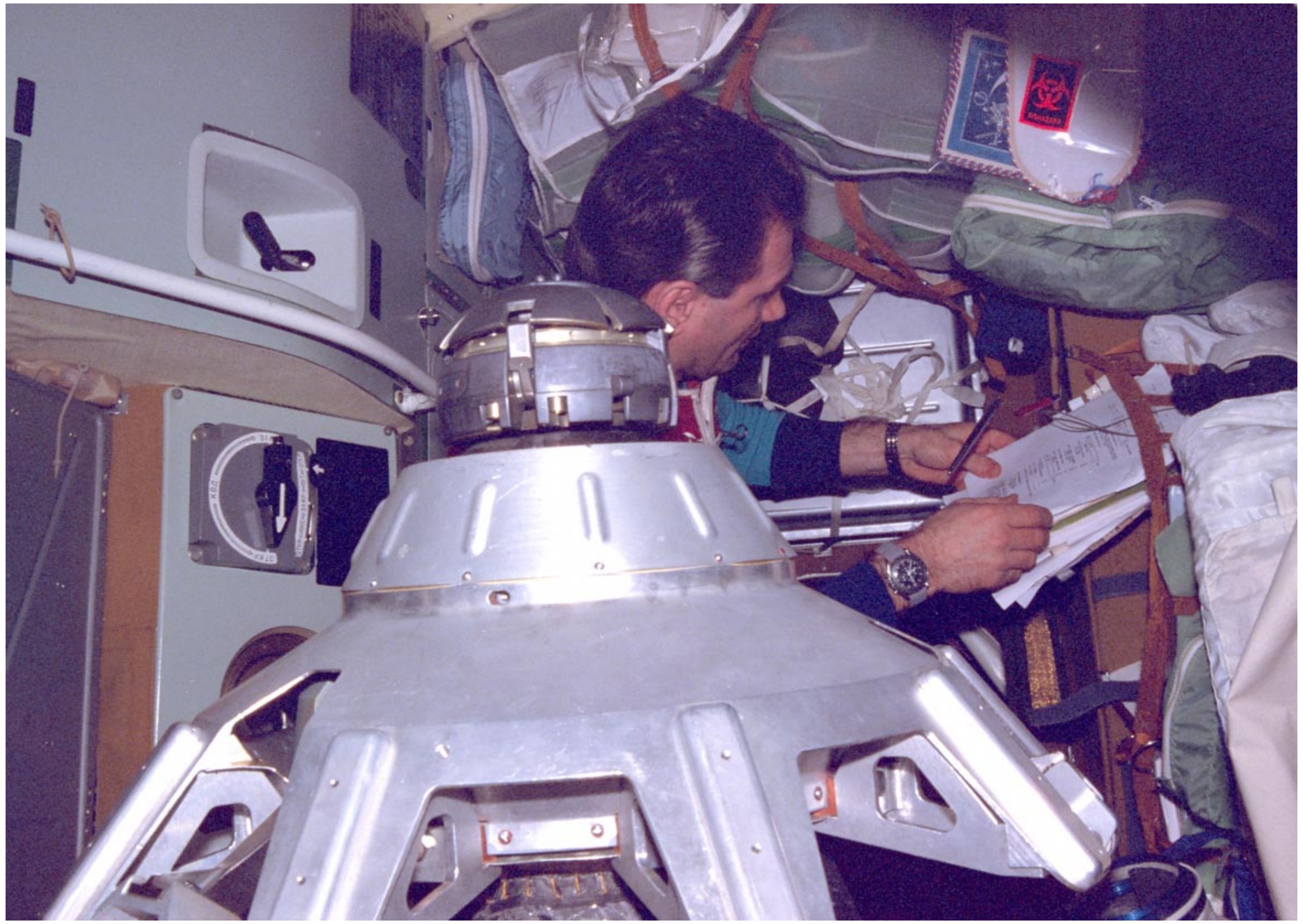

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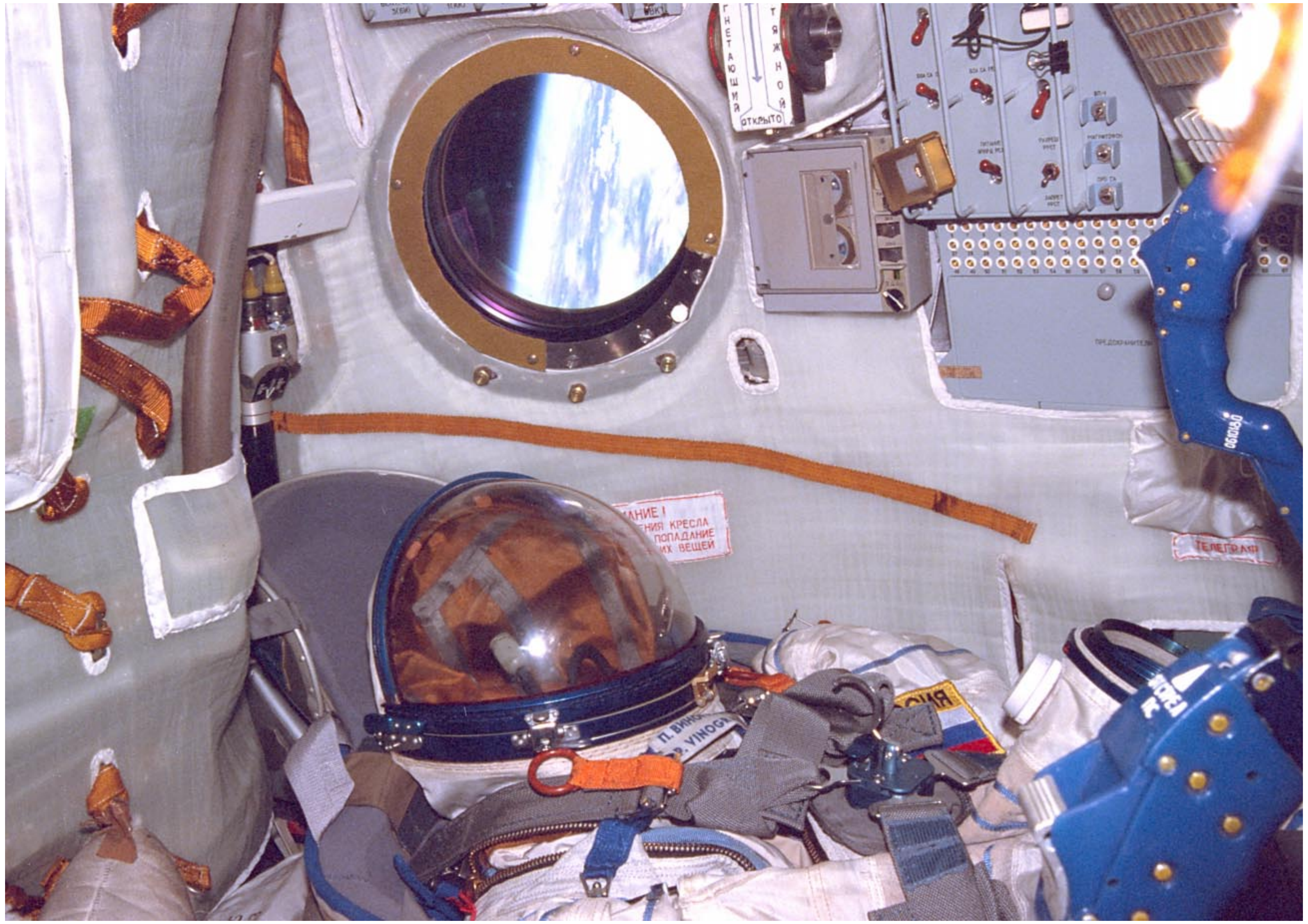
Figure MOD-136 Right Side of the Descent Module of the Soyuz



NASA5-326-28

Figure MOD-137 Left Side of the Descent Module of the Soyuz

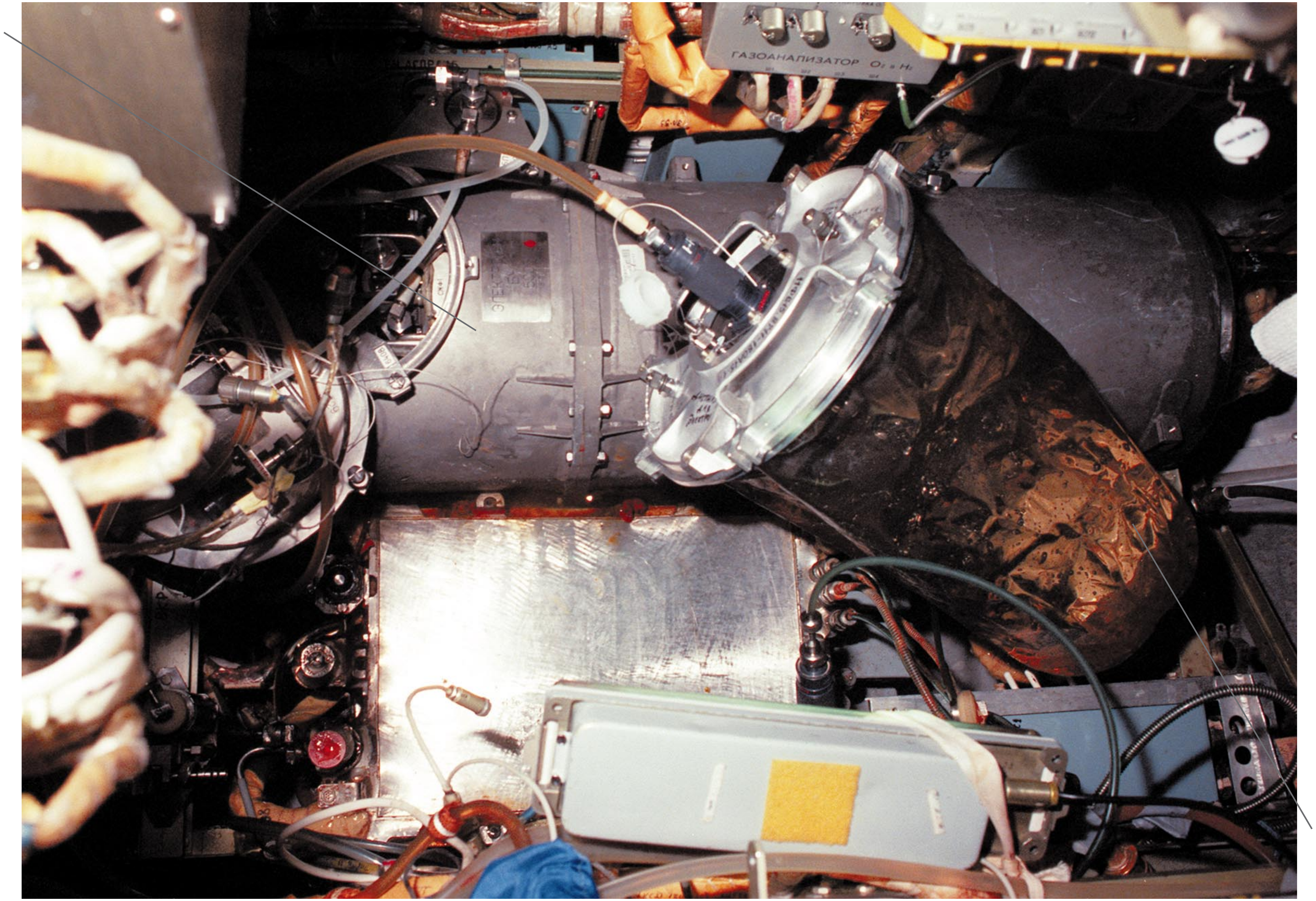


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Figure MOD-138 Elektron in Mir

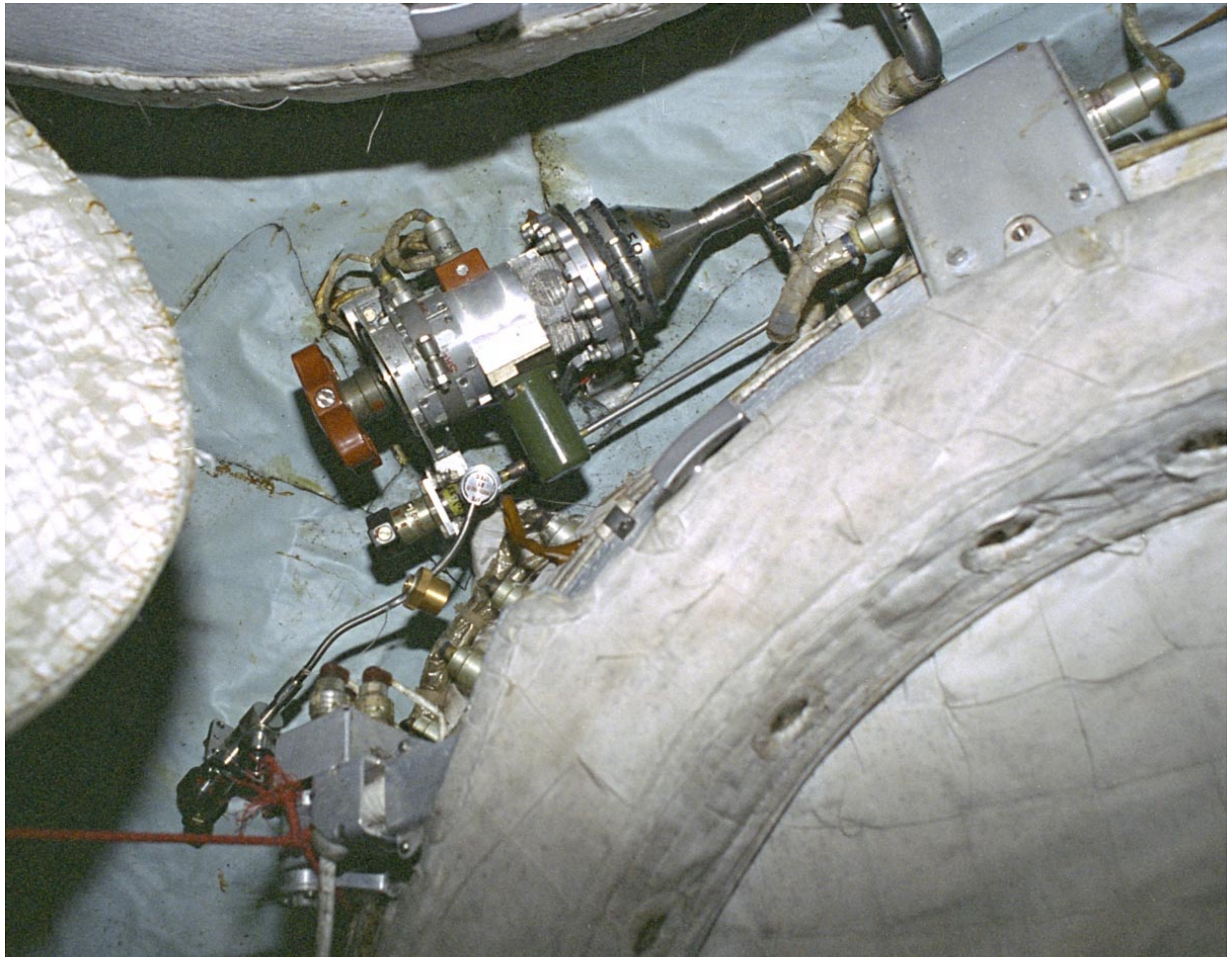

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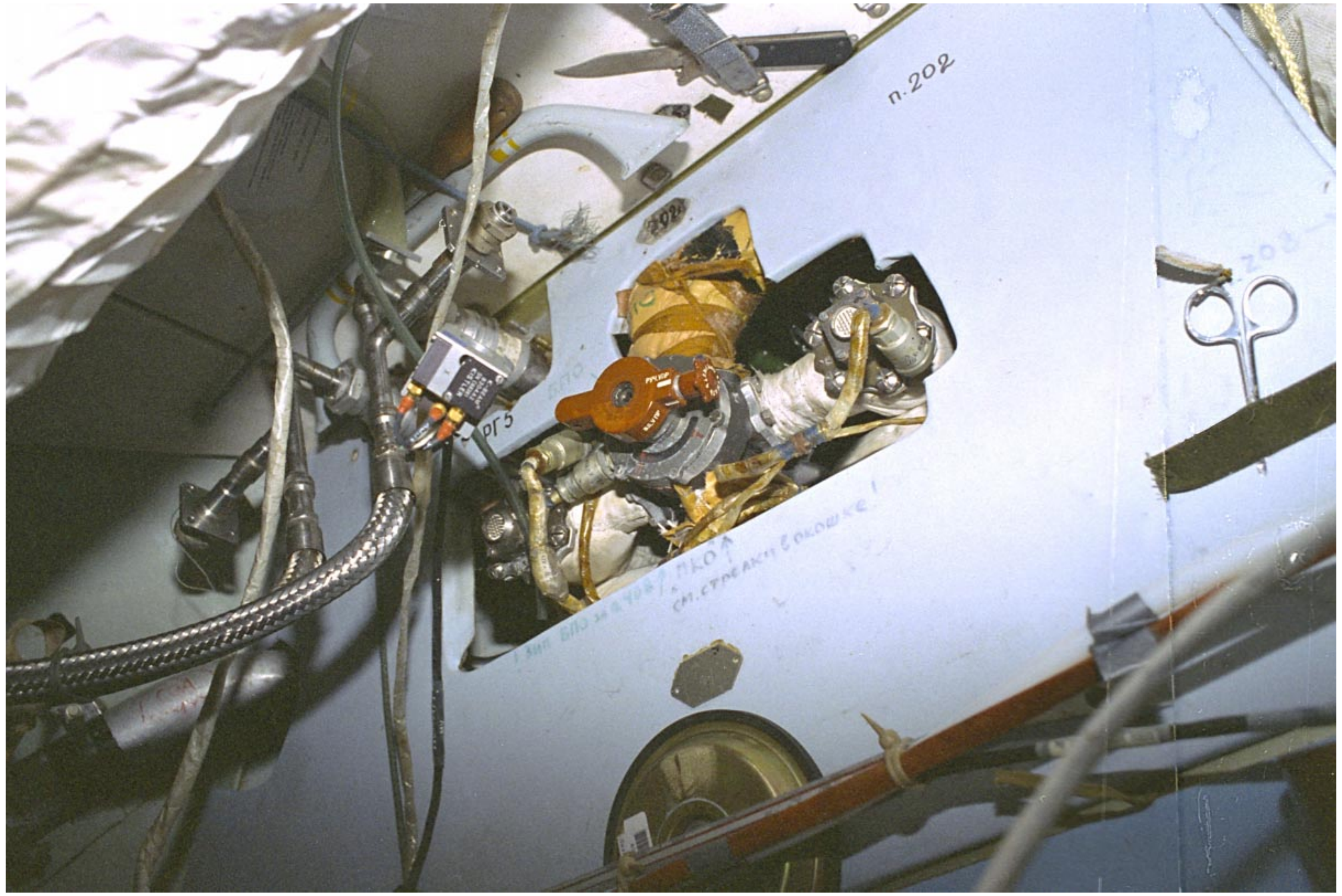
Figure MOD-139 Air Pressure Gauge in the Transfer Node



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- Developmental Analysis of Seeds Grown on Mir (Greenhouse)
- Earth Sciences (ES)
- Effective Dose Measurement at EVA (E704) (TLD)
- Effects of Gravity on Insect Circadian Rhythmicity (E698)
- Enhanced Dynamic Load Sensors (EDLS) (E18)
- Environmental Radiation Measurements on Mir (E620) (APD)
- Frames of Reference for Sensori-motor Transformation (E701)
- Gas Analyzer System for Metabolic Analysis Physiology (GASMAP)
- Greenhouse-Integrated Plant Experiments on Mir (E1020)
- Incubator - Integrated Quail Experiments on Mir (E1010)
- Inflight Stand Test: Mir Lower Body Negative Pressure Device (LBNP) (MSD008)
- Interferometer Protein Crystal Growth (IPCG)
- Inventory Management System (IMS): Bar Code and Data Logger (BDL) (RME1319)
- Liquid Metal Diffusion Experiment - MIM (LMD)
- Magnetic Resonance Imaging After Exposure to Microgravity (MRI) (E586)
- Microgravity Glovebox Facility Operations (MGBX)
- Microgravity Vibration Isolation Mount Facility Operations (MIM)
- Mir Centrifuge (CENT)
- Mir Defibrillator/Crew Medical Restraint System (DEFIB/CMRS)
- Mir Experiment Integrated Cold Stowage: Thermoelectric Freezer (TEF)/Thermoelectric Holding Facility (TEHOF)
- Mir Interface to Payload Systems (MIPS)
- Mir Oscilloscope
- Mir Sample Research Return System (MSRE)
- Mir Structural Dynamics Experiment (MiSDE)
- MSD007: Toxicological Assessment of Airborne Volatile Organic Compounds (SSAS, GSC)
- MSD022/MSD021: Microbial Investigations of Mir and Crew (SSK, GSC, CMK)
- Nutritional Status Assessment (MSD011)
- Opposed Flow Flame Spread on Cylindrical Surfaces - MGBX (OFFS)
- Optical Properties Monitor (OPM) (RME1307)
- Optizon Liquid Phase Sintering Equipment (OLiPSE-02)
- Particle Impact Experiment (PIE)
- Payload Mounting Panels (PMP)
- Payload Utility Panel (PUP)
- Phase 1B Sleep Experiments Combined (E639C)
- Photo/Video: Camcorder, Hasselblad, Nikon
- Photodocumentation of Skin Injuries and Allergic Reactions (MSD076)
- Physical Fitness Assessment (MSD077)
- Priroda Inflight Maintenance (IFM) Tool Kit
- Protein Crystal Growth Gaseous Nitrogen Dewar (PCG-GN$_2$)
- Queens University Experiment for Liquid Diffusion - MIM (QUELD)
- Radiation Monitoring (Dosimeters)
- Regional and Temporal Variability of Primary Productivity in Ocean Shelf Waters (EO3)
- Renal Stone Risk Assessment: Dried Urine Chemistry System (E651B)
- Shuttle Orbiter Inflight Food Warmer (SOIFW)
- Space Acceleration Measurement System Operations (SAMS)
- Space Medicine Program: U.S. Medical Operations (SMP-US)
- Space Portable Spectroreflectometer (SPSR) (RME1303)
- Spaceflight-Cognitive Assessment (S-CAT)
- Special Environmental Assessment (ENV)
- Standard Interface Adapter (SIA)
- Standard Interface Glovebox Operations (SIGB)
- Technological Evaluation of MIM-2 (TEM2)
- Test of Portable Computer System Hardware (TPCS) (RME1332)
- Test Site Monitoring (EO5)
- Treadmills
- Universal Battery Charger (UBC)
- Validation of Biosphere-Atmosphere Interchange Model for Northern Prairies (EO2)
- Validation of Priroda Rain Observations (EO6)
- Visual Earth Observations (EO9)
- Water Stowage Containers
- Watershed Hydrologic Studies (EO4)
- X-Ray Detector Test (XDT)

INCREMENT 2

Fundamental Biology (FB)

- Incubator-Integrated Quail Experiments on Mir (E1010)

INCREMENT 3

Advanced Technology (ADV)

- Commercial Generic Bioprocessing Apparatus (CGBA-01)

Earth Sciences (ES)

- Calibration and Validation of Priroda Microwave Sensors (EO7)
- Comparison of Atmospheric Chemistry Sensors on Priroda and American Satellites (EO8)
- Regional and Temporal Variability of Primary Productivity in Ocean Shelf Waters (EO3)
- Test Site Monitoring (E05)
- Validation of Biosphere-Atmosphere Interchange Model for Northern Prairies (EO2)
- Validation of Priroda Rain Observations (EO6)
- Visual Earth Observations (EO9)
- Watershed Hydrologic Studies (EO4)

Fundamental Biology (FB)

- Environmental Radiation Measurements on Mir (APD) (E620)
- Greenhouse-Integrated Plant Experiments on Mir (Greenhouse)

Human Life Sciences (HLS)

- Assessment of Humoral Immune Functon During Long-Duration Spaceflight (E621)
- Bone Mineral Loss and Recovery After Shuttle/Mir Flights (E598)
- Crew Medical Restraint System (CMRS)
- Crewmember and Crew-Ground Interactions During NASA/Mir (E628)
- Gas Analyzer System for Metabolic Analysis Physiology (GASMAP) Facility Operations
- Magnetic Resonance Imaging After Exposure to Microgravity (MRI) (E586)
- Renal Stone Risk Assessment During Long-Duration Spaceflight (E651)

International Space Station (ISS)

- Enhanced Dynamic Load Sensors (EDLS) on Mir (E18)
- Inventory Management System (IMS): BDL, BCR (RME1319)
- Mir Structural Dynamics Experiment (MiSDE)

Microgravity (MG)

- Ambient Diffusion-Controlled Crystallization Apparatus for Microgravity (DCAM)
- BioTechnology System Facility (BTS)
- Microgravity Glovebox Facility Operations (MGBx)
- Microgravity Vibration Isolation Mount (MIM) Facility Operations
- Protein Crystal Growth Gaseous Nitrogen Dewar (PCG-GN_2)
- Queens University Experiment for Liquid Diffusion Furnace Experiment - MIM (QUELD)
- Space Acceleration Measurement System Operations (SAMS)
- Technological Evaluation of MIM-2 (TEM 2)

INCREMENT 4

Earth Sciences (ES)

- Calibration and Validation of Priroda Microwave Sensors (EO7)
- Comparison of Atmospheric Chemistry Sensors on Priroda and American Satellites (EO8)
- Regional and Temporal Variability of Primary Productivity in Ocean Shelf Waters (EO3)
- Test Site Monitoring (E05)
- Validation of Biosphere-Atmosphere Interchange Model for Northern Prairies (EO2)
- Validation of Priroda Rain Observations (EO6)
- Visual Earth Observations (EO9)
- Watershed Hydrologic Studies (EO4)

Fundamental Biology (FB)

- Active Dosimetry of Charged Particles (E681)
- Cellular Mechanisms of Spaceflight-Specific Stress to Plants: Biological Research in a Canister (BRIC)
- Developmental Analysis of Seeds Grown on Mir (Greenhouse)
- Effective Dose Measurement at EVA (TLD) (E704)
- Environmental Radiation Measurements on Mir (APD) (E620)
- Standard Interface Glovebox Facility Operations (SIGB)

Human Life Sciences (HLS)

- Assessment of Humoral Immune Functon During Long-Duration Spaceflight (E621)
- Autonomic Investigations (E712/E709)
- Bone Mineral Loss and Recovery After Shuttle/Mir Flights (E598)
- Crew Medical Restraint System (CMRS)
- Crewmember and Crew-Ground Interactions During NASA/Mir (E628)
- Frames of Reference for Sensori-motor Transformations (E701)
- Gas Analyzer System for Metabolic Analysis Physiology (GASMAP) Facility Operations
- Magnetic Resonance Imaging After Exposure to Microgravity (MRI) (E586)
- Sleep Experiments Combined (E639)

International Space Station (ISS)

- Enhanced Dynamic Load Sensors (EDLS) on Mir (E18)
- Inventory Management System (IMS): BCR, BDL (RME1319)
- Mir Structural Dynamics Experiment (MiSDE)
- Optical Properties Monitor (OPM) (RME1307)

Microgravity (MG)

- Ambient Diffusion-Controlled Crystallization Apparatus for Microgravity (DCAM)
- Angular Liquid Bridge Experiment - MGBX (ALB)
- BioTechnology System Facility (BTS)
- Liquid Metal Diffusion (LMD) - MIM
- Microgravity Glovebox Facility Operations (MGBx)
- Microgravity Vibration Isolation Mount (MIM) Facility Operations
- Opposed Flow Flame Spread on Cylindrical Surfaces - MGBX (OFFS)
- Protein Crystal Growth Gaseous Nitrogen Dewar (PCG-GN_2)
- Queens University Experiment for Liquid Diffusion Furnace Experiment - MIM (QUELD)
- Space Acceleration Measurement System Operations (SAMS)
- Technological Evaluation of MIM-2 (TEM 2)

Operations (OPS)

- Bar Code and Data Logger (BDL)
- Crew On-Orbit Support System (COSS)
- Crew Utilization Printer System (CUPS)

- Mir Centrifuge (CENT)
- Mir Experiment Integrated Cold Stowage: Thermoelectric Freezer (TEF)/Thermoelectric Holding Facility (TEHOF)
- Mir Interface to Payload Systems (MIPS)
- Photo/Video: Camcorder, Hasselblad, Nikon
- Standard Interface Adapter (SIA)
- Universal Battery Charger (UBC)

Space Medicine Program (SMP)

- Analysis of Mir Archival Water Samples (MSD053)
- Crew Microbiological Assessment (MSD021)
- Mir Microbiological Assessment (MSD022)
- Radiation Monitoring (RAD)
- Space Medicine Program: U.S. Medical Operations (SMP-US)
- Toxicological Assessment of Airborne Volatile Organic Compounds (MSD007)

Space Sciences (SS)

- Mir Sample Research Return System (MSRE)
- Particle Impact Experiment (PIE)

INCREMENT 5

Earth Sciences (ES)

- Calibration and Validation of Priroda Microwave Sensors (EO7)
- Comparison of Atmospheric Chemistry Sensors on Priroda and American Satellites (EO8)
- Regional and Temporal Variability of Primary Productivity in Ocean Shelf Waters (EO3)
- Test Site Monitoring (E05)
- Validation of Biosphere-Atmosphere Interchange Model for Northern Prairies (EO2)
- Validation of Priroda Rain Observations (EO6)
- Visual Earth Observations (EO9)
- Visual Observations (E11)
- Watershed Hydrologic Studies (EO4)

Fundamental Biology (FB)

- Developmental Analysis of Seeds Grown on Mir (Greenhouse)
- Effects of Gravity on Insect Circadian Rhythmicity (E698)
- Standard Interface Glovebox Facility Operations (SIGB)

Human Life Sciences (HLS)

- Bone Mineral Loss and Recovery After Shuttle/Mir Flights (E598)
- Crewmember and Crew-Ground Interactions During NASA/Mir (E628)
- Frames of Reference for Sensori-motor Transformations (E701)
- Gas Analyzer System for Metabolic Analysis Physiology (GASMAP) Facility Operations
- Magnetic Resonance Imaging After Exposure to Microgravity (MRI) (E586)
- Sleep Experiments Combined (E639)

International Space Station (ISS)

- Enhanced Dynamic Load Sensors (EDLS) on Mir
- Mir Structural Dynamics Experiment (MiSDE)
- Optical Properties Monitor (OPM) (RME1307)

Microgravity (MG)

- Ambient Diffusion-Controlled Crystallization Apparatus for Microgravity (DCAM)
- BioTechnology System Facility (BTS)
- Colloidal Gelation (CGEL)
- Microgravity Glovebox Operations (MGBx)
- Microgravity Vibration Isolation Mount Facility Operations (MIM)
- Protein Crystal Growth Gaseous Nitrogen Dewar (PCG-GN$_2$)
- Queens University Experiment for Liquid Diffusion - MIM (QUELD)
- Space Acceleration Measurement System Operations (SAMS)

Operations (OPS)

- Bar Code and Data Logger (BDL)
- Crew On-Orbit Support System (COSS)
- Crew Utilization Printer System (CUPS)
- Mir Centrifuge (CENT)
- Mir Experiment Integrated Cold Stowage: Thermoelectric Freezer (TEF)/Thermoelectric Holding Facility (TEHOF)
- Mir Interface to Payload Systems (MIPS)
- Photo/Video: Camcorder, Hasselblad, Nikon
- Standard Interface Adapter (SIA)
- Universal Battery Charger (UBC)

Space Medicine Program (SMP)

- Analysis of Mir Archival Water Samples (MSD053)
- Crew Microbiological Assessment (MSD021)
- Mir Defibrillator/Crew Medical Restraint System (DEFIB/CMRS)
- Mir Microbiological Assessment (MSD022)
- Radiation Monitoring (RAD)
- Space Medicine Program: U.S. Medical Operations (SMP-US)
- Toxicological Assessment of Airborne Volatile Organic Compounds (MSD007)

Space Sciences (SS)

- Mir Sample Research Return System (MSRE)
- Particle Impact Experiment (PIE)

INCREMENT 6

Advanced Technology (ADV)

- Commercial Generic Bioprocessing Apparatus (CGBA-01)

Earth Sciences (ES)

- Calibration and Validation of Priroda Microwave Sensors (EO7)
- Comparison of Atmospheric Chemistry Sensors on Priroda and American Satellites (EO8)
- Regional and Temporal Variability of Primary Productivity in Ocean Shelf Waters (EO3)
- Test Site Monitoring (E05)
- Validation of Biosphere-Atmosphere Interchange Model for Northern Prairies (EO2)
- Validation of Priroda Rain Observations (EO6)
- Visual Earth Observations (EO9)
- Visual Observations (E11)
- Watershed Hydrologic Studies (EO4)

Fundamental Biology (FB)

- Active Dosimetry of Charged Particles (E681)
- Environmental Radiation Measurements (APD) (E620)
- Standard Interface Glovebox Operations (SIGB)

Human Life Sciences (HLS)

- Adaptive Changes in Cardiovascular Control at μG and Autonomic Mechanisms During Prolonged Weightlessness (E712/709)

- Assessment of Humoral Immune Function During Long-Duration Spaceflight (E621)
- Bone Mineral Loss and Recovery After Shuttle/Mir Flights (E598)
- Crewmember and Crew-Ground Interactions During NASA/Mir (E628)
- Magnetic Resonance Imaging After Exposure to Microgravity (MRI) (E586)
- Phase 1B Sleep Experiments Combined (639C)
- Renal Stone Risk Assessement: Dried Urine Chemistry System (E651B)

International Space Station (ISS)

- Cosmic Radiation Effects and Activation Monitor (CREAM)
- Mir Structural Dynamics Experiment (MiSDE)
- Optical Properties Monitor (OPM) (RME1307)
- Space Portable Spectroreflectometer (SPSR) (RME1303)
- Test of Portable Computer System Hardware (TPCS) (RME1332)

Microgravity (MG)

- Binary Colloidal Alloy Test-2 - MGBX (BCAT2)
- Biochemistry of 3-D Tissue Engineering - BTS (BIO3D)
- BioTechnology System Facility (BTS)
- Canadian Protein Crystallization Experiment - MIM (CAPE)
- Interferometer Protein Crystal Growth (IPCG)
- Microgravity Glovebox Facility Operations (MGBx)
- Microgravity Vibration Isolation Mount Facility Operations (MIM)
- Queens University Experiment for Liquid Diffusion Furnace Experiment - MIM (QUELD)
- Space Acceleration Measurement System Operations (SAMS)

Operations (OPS)

- Mir Centrifuge (CENT)
- Mir Experiment Integrated Cold Stowage: Thermoelectric Freezer (TEF)/Thermoelectric Holding Facility (TEHOF)
- Mir Interface to Payload Systems (MIPS)
- Payload Utility Panel (PUP)
- Photo/Video: Camcorder, Hasselblad, Nikon

Space Medicine Program (SMP)

- Analysis of Mir Archival Water Samples (MDS053)
- Crew Status and Support Tracker (CSST)
- Inflight Stand Test: Mir Lower Body Negative Pressure Device (LBNP) (MSD008)
- Microbial Investigations of Mir and Crew (MSD022/MSD021)
- Mir Defibrillator/Crew Medical Restraint System (DEFIB/CMRS)
- Nutritional Status Assessment (MSD011)
- Physical Fitness Assessment (MSD077)
- Radiation Monitoring (RAD)
- Space Medicine Program: U.S. Medical Operations (SMP-US)
- Special Environmental Assessment (ENV)
- Toxicological Assessment of Airborne Volatile Organic Compounds (MSD007)

INCREMENT 7

Advanced Technology (ADV)

- Astroculture-7 (ASC-01)
- Commercial Generic Bioprocessing Apparatus (CGBA-01)
- Optizon Liquid Phase Sintering Equipment (OLiPSE-02)
- X-Ray Detector Test (XDT)

Earth Sciences (ES)

- Calibration and Validation of Priroda Microwave Sensors (E07)
- Comparison of Atmospheric Chemistry Sensors on Priroda and American Satellites (E08)
- Regional and Temporal Variabilty of Primary Productivity in Ocean Shelf Waters (E03)
- Test Site Monitoring (E05)
- Validation of Biosphere - Atmosphere Interchange Model for Northern Prairies (E02)
- Validation of Priroda Rain Observations (E06)
- Visual Earth Observations (EO9)
- Watershed Hydrologic Studies (E04)

Fundamental Biology (FB)

- Standard Interface Glovebox Facility Operations (SIGB)

Human Life Sciences (HLS)

- Adaptive Changes in Cardiovascular Control at μG and Autonomic Mechanisms During Prolonged Weightlessness (E712/E709)
- Assessment of Humoral Immune Function During Long-Duration Spaceflight (E621)
- Bone Mineral Loss and Recovery After Shuttle/Mir Flights (E598)
- Crewmember and Crew-Ground Interactions During NASA/Mir (E628)
- Frames of Reference for Sensori-motor Transformations (E701)
- Magnetic Resonance Imaging After Exposure to Microgravity (MRI) (E586)
- Renal Stone Risk Assessment: Dried Urine Chemistry System (E651B)

International Space Station (ISS)

- Cosmic Radiation Effects and Activation Monitor (CREAM)
- Space Portable Spectroreflectometer (SPSR) (RME1303)
- Test of Portable Computer System Hardware (TPCS) (RME1332)

Microgravity (MG)

- Ambient Diffusion-Controlled Crystallization Apparatus for Microgravity (DCAM)
- BioTechnology System CoCulture (COCULT)
- BioTechnology System Facility (BTS)
- Microgravity Vibration Isolation Mount Facility Operations (MIM)
- Protein Crystal Growth Gaseous Nitrogen Dewar (PCG-GN$_2$)
- Queens University Experiment for Liquid Diffusion Furnace Experiment - MIM (QUELD)
- Space Acceleration Measurement System Operations (SAMS)

Operations (OPS)

- Bar Code Reader (BCR)
- Crew On-Orbit Support System (COSS)
- Mir Centrifuge (CENT)
- Mir Experiment Integrated Cold Stowage: Thermoelectric Freezer (TEF)/Thermoelectric Holding Facility (TEHOF)
- Mir Interface to Payload Systems (MIPS)
- Payload Utility Panel (PUP)
- Photo/Video: Camcorder, Hasselblad, Nikon
- Universal Battery Charger (UBC)

Space Medicine Program (SMP)

- Acoustic Noise Measurement of the Mir Audio Environment
- Analysis of Mir Archival Water Samples (MSD053)
- Crew Status and Support Tracker (CSST)
- Effective Dose Measurement at EVA (E704) (TLD)
- Inflight Stand Test: Mir Lower Body Negative Pressure Device (LBNP) (MSD008)
- Microbial Investigations of Mir and Crew (MSD022/MSD021)
- Mir Defibrillator/Crew Medical Restraint System (DEFIB/CMRS)
- Nutritional Status Assessement (MSD011)
- Photodocumentation of Skin Injuries and Allergic Reactions (MSD076)
- Physical Fitness Assessment (MSD077)
- Radiation Monitoring (RAD)
- Space Medicine Program: U.S. Medical Operations (SMP-US)
- Spaceflight-Cognitive Assessment (S-CAT)
- Special Environmental Assessment (ENV)
- Toxicological Assessment of Airborne Volatile Organic Compounds (MSD007)

Advanced Technology (ADV)

- Astroculture-7 (ASC-01)
- Commercial Generic Bioprocessing Apparatus (CGBA-01)
- Optizon Liquid Phase Sintering Equipment (OLiPSE-02)
- X-Ray Detector Test (XDT)

Earth Sciences (ES)

- Calibration and Validation of Priroda Microwave Sensors (EO7)
- Comparison of Atmospheric Chemistry Sensors on Priroda and American Satellites (EO8)
- Regional and Temporal Variability of Primary Productivity in Ocean Shelf Waters (EO3)
- Test Site Monitoring (E05)
- Validation of Biosphere-Atmosphere Interchange Model for Northern Prairies (EO2)
- Validation of Priroda Rain Observations (EO6)
- Visual Earth Observations (EO9)
- Visual Observations (E11)
- Watershed Hydrologic Studies (EO4)

Fundamental Biology (FB)

- Active Dosimetry of Charged Particles (E681)
- Cellular Mechanisms of Spaceflight-Specific Stress to Plants: Biological Research in a Canister (BRIC)
- Developmental Analysis of Seeds Grown on Mir (Greenhouse)
- Effective Dose Measurement at EVA (TLD) (704)
- Effects of Gravity on Insect Circadian Rhythmicity (E698)
- Environmental Radiation Measurements (APD) (E620)
- Greenhouse-Integrated Plant Experiments on Mir (Greenhouse)
- Incubator-Integrated Quail Experiments on Mir (E1010)
- Standard Interface Glovebox Operations (SIGB)

Human Life Sciences (HLS)

- Adaptive Changes in Cardiovascular Control at µG and Autonomic Mechanisms During Prolonged Weightlessness (E712/E709)
- Assessment of Humoral Immune Function During Long-Duration Spaceflight (E621)
- Bone Mineral Loss and Recovery After Shuttle/Mir Flights (E598)
- Crewmember and Crew-Ground Interactions During NASA/Mir (E628)
- Frames of Reference for Sensori-motor Transformations (E701)
- Gas Analyzer System for Metabolic Analysis Physiology (GASMAP) Facility Operations
- Magnetic Resonance Imaging After Exposure to Microgravity (MRI) (E586)
- Renal Stone Risk Assessment During Long-Duration Spaceflight (E651)
- Renal Stone Risk Assessement: Dried Urine Chemistry System (E651B)
- Sleep Experiments Combined (E639)
- Phase 1B Sleep Experiments Combined (E639C)

International Space Station (ISS)

- Cosmic Radiation Effects and Activation Monitor (CREAM)
- Enhanced Dynamic Load Sensors (EDLS) on Mir (E18)
- Inventory Management System (IMS): BDL, BCR (IMS) (RME1319)
- Mir Structural Dynamics Experiment (MiSDE)
- Optical Properties Monitor (OPM) (RME1307)
- Space Portable Spectroreflectometer (SPSR) (RME1303)
- Test of Portable Computer System Hardware (TPCS) (RME1332)

Microgravity (MG)

- Ambient Diffusion-Controlled Crystallization Apparatus for Microgravity (DCAM)
- Angular Liquid Bridge Experiment - MGBX (ALB)
- Binary Colloidal Alloy Test-2 - MGBX (BCAT2)
- Biochemistry of 3-D Tissue Engineering - BTS (BIO3D)
- BioTechnology System CoCulture (COCULT)
- BioTechnology System Facility (BTS)
- Canadian Protein Crystallization Experiment - MIM (CAPE)
- Colloidal Gelation (CGEL)
- Interferometer Protein Crystal Growth (IPCG)
- Liquid Metal Diffusion (LMD) - MIM
- Microgravity Glovebox Facility Operations (MGBx)
- Microgravity Vibration Isolation Mount Facility Operations (MIM)
- Opposed Flow Flame Spread on Cylindrical Surfaces - MGBX (OFFS)
- Protein Crystal Growth Gaseous Nitrogen Dewar (PCG-GN$_2$)
- Queens University Experiment for Liquid Diffusion Furnace Experiment - MIM (QUELD)
- Space Acceleration Measurement System Operations (SAMS)
- Technological Evaluation of MIM-2 (TEM 2)

Operations (OPS)

- Bar Code and Data Logger (BDL)
- Bar Code Reader (BCR)
- Crew On-Orbit Support System (COSS)
- Crew Utilization Printer System (CUPS)
- Mir Centrifuge (CENT)
- Mir Experiment Integrated Cold Stowage: Thermoelectric Freezer (TEF)/Thermoelectric Holding Facility (TEHOF)
- Mir Interface to Payload Systems (MIPS)
- Payload Utility Panel (PUP)
- Photo/Video: Camcorder, Hasselblad, Nikon
- Standard Interface Adapter (SIA)
- Universal Battery Charger (UBC)

Space Medicine Program (SMP)

- Acoustic Noise Measurement of the Mir Audio Environment
- Analysis of Mir Archival Water Samples (MSD053)
- Crew Microbiological Assessment (MSD021)
- Crew Status and Support Tracker (CSST)
- Effective Dose Measurement at EVA (TLD) (E704)
- Inflight Stand Test: Mir Lower Body Negative Pressure Device (LBNP) (MSD008)
- Microbial Investigations of Mir and Crew (MSD022/MSD021)
- Mir Defibrillator/Crew Medical Restraint System (DEFIB/CMRS)
- Mir Microbiological Assessment (MSD022)
- Nutritional Status Assessment (MSD011)
- Photodocumentation of Skin Injuries and Allergic Reactions (MSD076)

- Physical Fitness Assessment (MSD077)
- Radiation Monitoring (RAD)
- Space Medicine Program: U.S. Medical Operations (SMP-US)
- Spaceflight-Cognitive Assessment (S-CAT)
- Special Environmental Assessment (ENV)
- Toxicological Assessment of Airborne Volatile Organic Compounds (MSD007)

Space Sciences (SS)

- Mir Sample Research Return System (MSRE)
- Particle Impact Experiment (PIE)

Supplemental Hardware (SH)

- Oscilloscope
- Payload Mounting Panel (PMP)
- Shuttle Orbiter Inflight Food Warmer (SOIFW)
- Tool Kits
- Treadmills
- Water Stowage Containers

Phase 1:
A Journey to Mir
1994~1998

Contents were taken from
the Increment 3 through
Increment 7 NASA/Mir Station
Configuration Photobooks.

NASA Phase 1
in Accordance
with NASA9-19100
Schedule B, Part 2

Project Manager:	**Cherice Moore**
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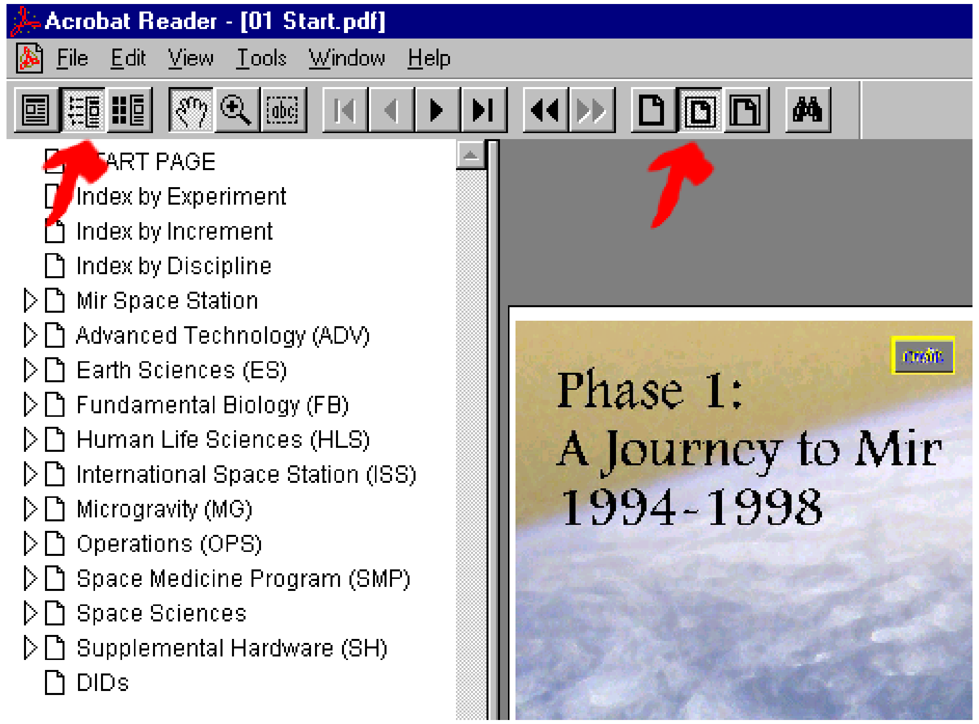
	Angie Campbell
Research Assistant:	**Suzanne Todd**

LOCKHEED MARTIN

Phase 1:
A Journey to Mir
1994-1998



Suggested Viewing Setup

INTRODUCTION

The files on this CD will lead you through a visual "tour" of the Mir Space Station, the American experiment equipment, and a few experiment descriptions with details about the hardware.

The experiments covered are those which occurred during Increments 4 through 7 with selected experiments from Increments 2 and 3.

If you have difficulty viewing the movie, you may download Quicktime 3.0 for free from the following website:

http://www.apple.com/quicktime/download/index.html

The recommended system requirements (as listed on the back of the CD case) for running on Windows 95 are as follows: an i386, i486, Pentium, or a Pentium Pro processor-based personal computer or better; Windows 95 or Windows NT 3.51 or later; 8MB of RAM available for Acrobat Reader; and 10MB of available hard-disk space.

Adobe Acrobat will also run on the following systems:

- Macintosh and Power Macintosh
- Windows NT 3.51 or later
- MS Windows 3.1 or later
- UNIX
- SunSPARCstation
- HP Series 9000 Model 700 or later
- IBM RS/6000 workstation
- Silicon Graphics workstation
- Digital UNIX workstation

PROGRAM OVERVIEW

-- The following discussion was copied and updated from the November 1, 1993 "Addendum to Program Implementation Plan" document.

GOALS

Four primary goals and objectives were established for the NASA/Mir Program :

1) To obtain engineering and operational experience conducting research on an orbital space station.

2) To characterize the Mir environment relative to microgravity and life science research on Mir as well as conduct demonstrations and peer-reviewed investigations in medical support, life sciences, microgravity sciences, Earth observations, and life support.

3) To identify and implement experiments demonstrating selected technologies and equipment to validate ISS design and operations.

4) To provide EVA demonstrations for Space Station hardware and tasks.

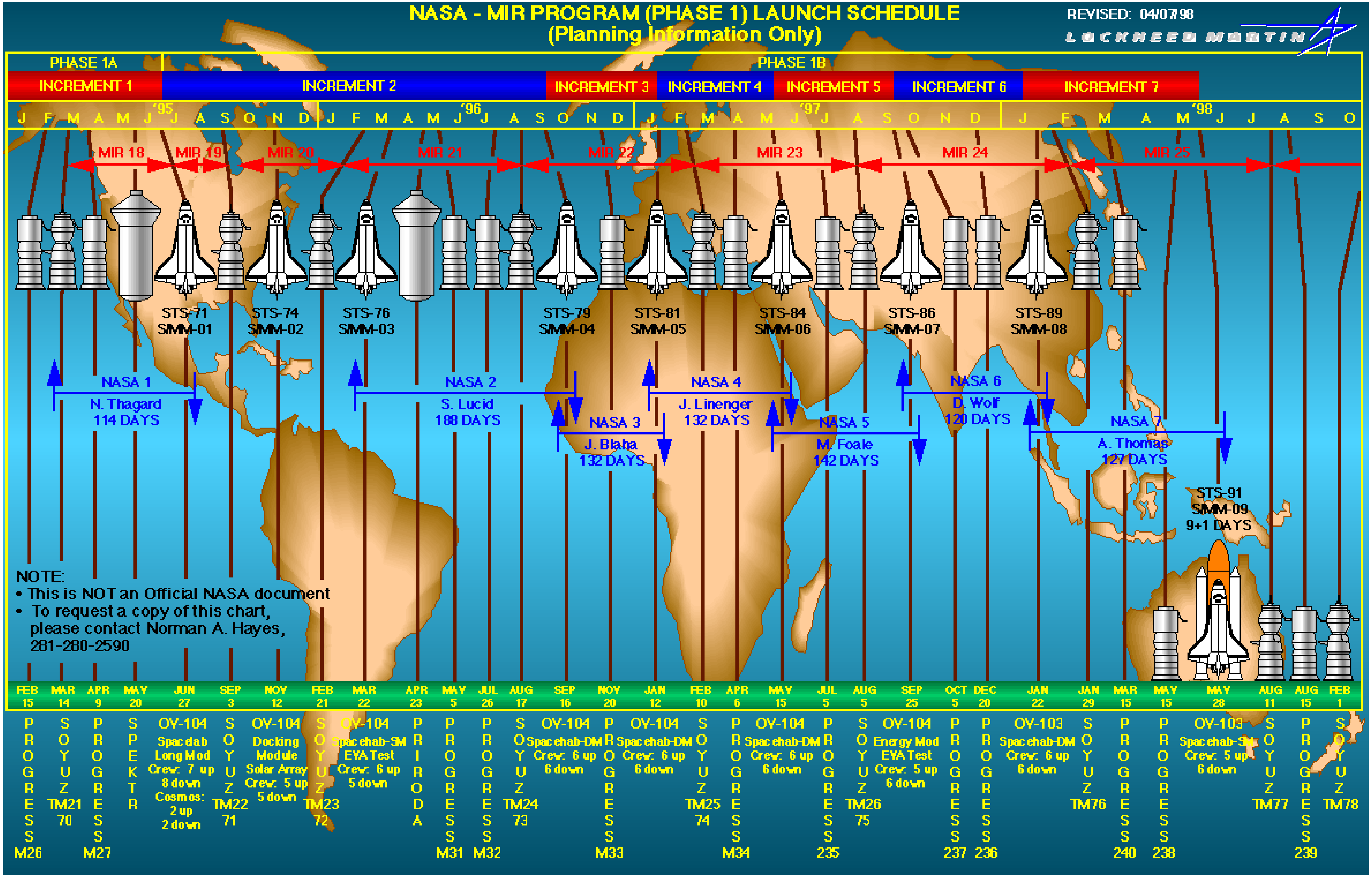
OVERALL CONCEPT

In October 1992, Russia and the U.S. formally agreed to conduct a fundamentally new program of human cooperation in space. The "Shuttle-Mir" Program involved combined astronaut-cosmonaut crew activities on the Shuttle, Soyuz, and Mir spacecraft. Shuttle flight STS-60 for the first time ever carried a Russian cosmonaut into orbit. Subsequently, in 1995, a U.S. astronaut was launched aboard the Russian Soyuz 18 space vehicle and spent three months on-board Russia's Mir Space Station. In a third set of planned activities, a joint U.S.-Russian crew flew to the Mir space station aboard STS-71, docked, and performed cooperative science experiments. STS-71 then returned to the U.S. with the entire Mir 18 crew aboard.

CONCEPT

The plan described a new relationship between the U.S. and Russian Space Agencies which advanced their national space

NASA/ Mir Launch Schedule



NASA - MIR PROGRAM (PHASE 1) LAUNCH SCHEDULE
(Planning Information Only)

REVISED: 04/07/98

LOCKHEED MARTIN

NOTE:
- This is NOT an Official NASA document
- To request a copy of this chart, please contact Norman A. Hayes, 281-280-2590

FEB 15	PROGRESS M26
MAR 14	SOYUZ TM21 70
APR 9	PROGRESS M27
MAY 20	SPEKTR
JUN 27	OV-104 Spacelab Long Mod Crew: 7 up 8 down Cosmos: 2 up 2 down
SEP 3	SOYUZ TM22 71
NOV 12	OV-104 Docking Module Solar Array Crew: 5 up 5 down
FEB 21	SOYUZ TM23 72
MAR 22	OV-104 Spacehab-SM EVA Test Crew: 6 up 5 down
APR 23	PRIRODA
MAY 5	PROGRESS M31
JUL 26	PROGRESS M32
AUG 17	SOYUZ TM24 73
SEP 16	OV-104 Spacehab-DM Crew: 6 up 6 down
NOV 20	PROGRESS M33
JAN 12	OV-104 Spacehab-DM Crew: 6 up 6 down
FEB 10	SOYUZ TM25 74
APR 6	PROGRESS M34
MAY 15	OV-104 Spacehab-DM Crew: 6 up 6 down
JUL 5	PROGRESS 235
AUG 5	SOYUZ TM26 75
SEP 25	OV-104 Energy Mod EVA Test Crew: 5 up 6 down
OCT 5	PROGRESS 237
DEC 20	PROGRESS 236
JAN 22	OV-103 Spacehab-DM Crew: 6 up 6 down
JAN 29	SOYUZ TM76
MAR 15	PROGRESS 240
MAY 15	PROGRESS 238
MAY 28	OV-103 Spacehab-SM Crew: 5 up 6 down
AUG 11	SOYUZ TM77
AUG 15	PROGRESS 239
FEB 1	SOYUZ TM78

NASA/Mir Launch Schedule Table

INCREMENT NO.	MISSION	MISSION START EVENT	DATE	MISSION END EVENT	DATE	CREW	MISSION INFORMATION
1	STS-60 (Orbiter)	STS-60 Launch	2/3/94	STS-60 Landing	2/11/94	Cmdr: Charlie Bolden Pilot: Ken Reightler MS: Franklin Chang-Diaz MS: Jan Davis MS: Ron Sega MS: Sergei Krikalev	Krikalev is first cosmonaut on Shuttle.
1	STS-63 (Orbiter)	STS-63 Launch	2/3/95	STS-63 Landing	2/11/95	Cmdr: Jim Wetherbee Pilot: Eileen Collins MS: Janice Voss MS: Bernard Harris MS: Mike Foale MS: Vladimir Titov	Rendezvous with Mir; Cosmonaut Titov on Shuttle.
1		Progress TM-26	2/15/95				
1	Mir 18/ NASA 1	Soyuz 70 Launch (Soyuz TM-21/ Mir-18)	3/14/95	STS-71 Landing	7/7/95	Cmdr: Vladimir Dezhurov Eng: Gennady Strekalov NASA 1: Norman Thagard	First U.S. Astronaut to launch on Russian Soyuz; First U.S. Astronaut on Mir.
1		Progress TM-27	4/9/95				
1	Spektr	Spektr Launch	5/20/95	N/A		Unmanned	Carries U.S. Research Hardware.
2	STS-71 (Atlantis)	STS-71 Launch	6/27/95	STS-71 Landing	7/7/95	Cmdr: Robert “Hoot” Gibson Pilot: Charlie Precourt MS: Ellen Baker MS: Greg Harbaugh MS: Bonnie Dunbar MS: Norman Thagard Cosmonaut: Anatoly Soloviev Cosmonaut: Nikolai Budarin Cosmonaut: Vladimir Dezhurov Cosmonaut: Gennadiy Streklov	First Shuttle-Mir Docking; Mir 19 cosmonauts delivered to Mir; Mir 18 cosmonauts returned to earth; Spacelab mission, Thagard, Dezhurov, Strekalov return to earth; Soloviev, Budarin remain on Mir. Payload: Mir #1.
2	Mir 19	STS-71 Launch/ Docking #1	6/27/95	Soyuz 70 Landing (Soyuz TM-21/ Mir 18)	9/11/95	Cmdr: Anatoly Soloviev Eng: Nikolai Budarin	
2	Mir 20	Soyuz 71 Launch	6/27/95	Soyuz 71 Landing	2/29/96	Cmdr: Yuri Ghidzhenko Eng: Sergei Avdeev ESA: Thomas Reiter	Space Shuttle Mission STS-74 docks with Mir during this mission; Reiter returned to Earth 9/11/95 with Soyuz 70.
2		Progress TM-28	7/20/95				
2		Soyuz TM-22 (Mir-20)	9/3/95	Soyuz TM-22 Return	9/29/96		
2				Soyuz TM-21 (Mir-19 Return)	9/11/95		
2		Progress M-29	10/8/95				
2	STS-74 (Atlantis)	STS-74 Launch	11/1/95	STS-74 Landing	11/8/95	Cmdr: Kenneth Cameron Pilot: James Halsell MS: Jerry Ross MS: William McArthur MS: Chris Hadfield	Second Shuttle-Mir docking; delivers Docking Module and Cooperative Solar Array. Payload: Mir #2.
2		STS-74 Docking #2	11/12/95				
2		Progress TM-30	12/18/95				
2	Mir 21	Soyuz 72 Launch (Soyuz TM-23/ Mir-21)	2/21/96	Soyuz 72 Landing	9/2/96	Cmdr: Yuri Onofriyenko Cosmonaut: Yuri Usachyov	
2	STS-76 (Atlantis)	STS-76 Launch/ Docking #3	3/22/96	STS-76 Landing	3/31/96	Cmdr: Kevin Chilton Pilot: Kevin Searfoss MS: Rich Clifford MS: Linda Godwin MS: Shannon Lucid MS: Ron Sega	Third Shuttle/Mir docking; First EVA during docked operations; Lucid delivered to Mir; First Spacehab mission to Mir. Payload: Mir #3.
2	NASA 2	STS-76 Launch	3/22/96	STS-79 Landing	9/26/96	NASA 2: Shannon Lucid	Stay lengthened approximately 6 weeks due to launch slip.
2	Priroda	Priroda Launch	4/23/96	N/A		Unmanned	Carries 1000 Kg U.S. research hardware.
2		Progress M-31	5/5/96				
2		Progress M-32	8/1/96				
2	Mir 22	Soyuz 73 Launch (Soyuz TM-24/ Mir-22)	8/17/96	Soyuz 73 Landing	3/2/97	Cmdr: Valeri Korzun Eng: Aleksandr Kaleri CNES: Claudie Deshays	Deshays returned to Earth 9/2/96 with Soyuz 72.
3	STS-79 (Atlantis)	STS-79 Launch/ Docking #4	9/16/96	STS-79 Landing	9/26/96	Cmdr: Bill Readdy Pilot: Terrence Wilcutt MS: Tom Akers MS: Jay Apt MS: Carl Walz MS: John Blaha MS: Shannon Lucid	Blaha delivered to Mir; Lucid returned to Earth; First Double Spacehab Module. Payload: Mir #4.
3	ST-79 (Atlantis)	STS-79 Launch/ Docking #4	9/16/96	STS-79 Landing	9/26/96	Cmdr: Bell Readdy Pilot: Terrence Wilcutt MS: Tom Akers	Blaha delivered to Mir; First Double Spacehab Module. Payload Mir #4.
3		Progress M-33	11/19/96				
4	STS-81 (Atlantis)	STS-81 Launch	1/12/97	STS-81 Landing	1/22/97	Cmdr: Mike Baker Pilot: Brent Jett MS: John Grunsfeld MS: Marsha Ivins MS: Peter “Jeff” Wisoff MS: Jerry Linenger MS: John Blaha	Linenger delivered to Mir; Blaha returned to Earth; Double Spacehab Module and SAREX-II. Payload Mir#5.
4	NASA 4	STS-81 Launch/ Docking #5	1/12/97	STS-84 Landing	5/25/97	NASA 4: Jerry Linenger	Linenger EVA in Russian Suit.
4	Mir 23	Soyuz 74 Launch (Soyuz TM-25/ Mir-23)	2/10/97	Soyuz 74 Landing	8/14/97	Cmdr: Vasily Tsibliev Eng: Alexander Lazutkin DARA: Reinhold Ewald	Ewald returned to Earth 3/2/97 with Soyuz 73.
4		Progress M-34	4/6/97				
5	STS-84 (Atlantis)	STS-84 Launch/ Docking #6	5/15/97	STS-84 Landing	5/24/97	Cmdr: Charlie Precourt Pilot: Eileen Collins MS: Carlos Noriega MS: Edward Lu MS: Mile Foale MS: Jerry Linenger MS: Elena Kondakova ESA: Jean-François Clervoy	Foale delivered to Mir; Linenger returned to Earth; Cosmonaut (Kondakova) on Shuttle; Double Spacehab Module; SAREX-II-21. Payload: Mir #6.
5	NASA 5	STS-84 Launch	5/15/97	STS-86 Landing	10/6/97	NASA 5: Mike Foale	
5		Progress TM-35	6/27/97				
5	Mir-24	Soyuz 75 Launch (Soyuz TM-26/ Mir-24)	8/5/97	Soyuz 75 Landing	2/15/98	Cmdr: Anatoly Soloviev Eng: Pavel Vinogradov	
6	STS-86 (Atlantis)	STS-86 Launch/ Docking #7	9/25/97	STS-86 Landing	10/6/97	Cmdr: James Wetherbee Pilot: Mike Bloomfield MS: Wendy Lawrence MS: Scott Parazynski MS: Mike Foale MS: David Wolf Cosmonaut: Vladimir Titov CNES: Jean-Loup Chrétien	Wolf delivered to Mir; Foale returned to Earth; U.S. EVA; Cosmonaut (Titov) on Shuttle, first Cosmonaut to EVA in U.S.suit; Double Spacehab Module. Payload: Mir #7.
6	NASA 6	STS-86 Launch	9/25/97	STS-89 Landing	1/25/98	NASA 6: David Wolf	
6		Progress TM-37	10/5/97				
6		Progress TM-36	12/20/97				
7	STS-89 (Discovery)	STS-89 Launch	1/15/98	STS-89 Landing	1/25/98	Cmdr: Terrence Wilcutt Pilot: Joe Frank Edwards, Jr. MS: Bonnie Dunbar MS: Michael Anderson MS: James Reilly MS: David Wolf Cosmonaut: Shakirovich Sharipov	Thomas delivered to Mir, Wolf returned to Earth; Double Spacehab Module; OV-105, Endeavour. Payload: Mir #8.
7	NASA 7	STS-89 Launch/ Docking #8	1/22/98	STS-91 Landing	6/7/98	NASA 7: Andy Thomas	
7		Soyuz TM-27/ Mir-25	1/29/98	Soyuz TM-27/ Mir-25 Return	8/10/98		
7	Mir 25	Soyuz 76 Launch	2/7/98	Soyuz 76 Landing	8/10/98	Cmdr: Talgat Musabayev Eng: Nikolai Budarin	
7				Soyuz TM-26 Return	2/19/98		
7		Progress M-38	3/14/98				
7		Progress M-40	5/15/98				
7	STS-91 (Discovery)	STS-91 Launch/ Docking #9	5/29/98	STS-91 Landing	6/7/98	Cmdr: Charlie Precourt Pilot: Dominic Pudwill Gorie MS: Wendy Lawrence MS: Franklin Chang-Diaz MS: Janet Kavandi MS: Andy Thomas Cosmonaut: Valeriy Ryumin	Thomas return to Earth; Single Spacehab Module, OV-103, Discovery; Alpha Magnetic Spectrometer payload. Payload: Mir#9.
7		Soyuz TM-28/ Mir-26	8/2/98				
7		Progress M-39	8/15/98				
7		Progress M-41	11/10/98				

programs and benefited their respective national aerospace industries. This new relationship also benefited the existing partnership involved in the International Space Station program. The plan was segmented into three phases, some of which were to be conducted in parallel.

Phase One

Phase One, agreed upon in October 1992, expanded the joint participation by U.S. and Russian crews in Mir and Shuttle operations. This expanded program combined the Shuttle-Mir program with additional Shuttle flights to Mir and U.S. crews aboard Mir.

In addition to the STS-60, Soyuz 18, and STS-71 missions, planned missions included additional Russian cosmonauts on STS-63, STS-84, STS-86, STS-89, and STS-91: seven U.S. astronaut flights aboard the Mir station for a total on-orbit stay time of just over two years, and ten Shuttle flights to Mir between 1995 and 1998. The role of the U.S. Shuttle was to assist with crew exchange, resupply, and payload activities for Mir.

Mir capabilities were enhanced by contributions from both the U.S. and Russia. The Shuttle brought new solar arrays to replace existing arrays on Mir. Russia added Spektr and Priroda modules to Mir. These modules were equipped with U.S. and Russian scientific hardware to support science and research experiments.

One of the primary advantages of Phase One was to provide valuable experience and test data that would reduce the technical risks associated with the construction and operation of the International Space Station. The Space Station Program was also enhanced by combined space operations and joint space technology demonstrations. Moreover, Phase One provided early opportunities for extended scientific and research activities.

Phase Two

Phase Two combines hardware developed by the U.S., Russia, Japan, European nations, and Canada to create an entirely new, advanced orbital research facility with early human-habitation capability. This facility will significantly expand the scientific and research activities initiated in Phase One and will form the core around which the International Space Station will be constructed.

Phase Two also develops the systems capabilities, support, and other infrastructure to complete the International Space Station. This phase will explore ways to reduce programmatic risks and to increase scientific return.

The U.S. Shuttle and Russian launch vehicles will be used to carry the various elements.

Phase Three

Phase Three completes the construction of the International Space Station. The station will support a permanent human presence and will have full operational and research capability. After completion, the station will have an operational lifetime of approximately ten years.

Phase Three assembly starts following delivery of the first U.S. truss element and concludes when the station is ready for delivery of the U.S.-Russian jointly developed Solar Dynamic power element.

In terms of assembly, this phase completes the truss, adds the U.S. habitation, service, and power modules, completes all distributed systems architectures, delivers the station robotics system, and integrates the International Partner elements.

The responsibilities for station elements are shown below:

U.S. Components

- Node 1, Pressurized Mating Adapters 1& 2 (PMA)
- Spacehab Double Cargo Module
- Integrated Truss Structure (ITS) Z1, Control Moment Gyros (CMGs), Ku-band and S-band Equipment, and PMA 3
- ITS P6
- Lab
- Mini Pressurized Logistical Module (MPLM) (Lab outfitting flight), Ultra High Frequency (UHF) antenna, and Space Station Remote Manipulating System (SSRMS)
- Joint Airlock, High Pressure Gas Assembly
- MPLM

U.S. Components (Continued)

- MPLM (ISPRs) and PV Module batteries
- ITS S0 and Mobile Transporter (MT)
- MPLM (ISPRs), MBS Lab System
- ITS S1, Crew and Equipment Translation Aid (CETA) Cart A
- Science Power Platform with 4 solar arrays
- ITS P1, CETA Cart B
- ITS P3/P4
- ITS S3/S4, Node 2, Nitrogen Tank Assembly
- MPLM (ISPRs)
- Express Pallet with Payloads and Spacelab Pallet (SLP) (ATA, 1 O_2 tank, SPDM)
- 4 SPP Solar Arrays (on EDO truss), Cupola (on SLP), Port Rails (on SLP)
- MPLM (ISPRs), Express Pallet with Payloads
- Node 3
- Node, Lab racks and MPLM (ISPRs)
- CRV 1
- MPLM
- ITS S6, PV Array (4 battery sets), MT/CETA rails
- MPLM (ISPRs), 2 PV battery sets (on SLP)
- Centrifuge Accommodations Module (CAM)
- US Habitation Module

Russian Components

- FGB (Launched on PROTON launcher)
- Service Module
- Soyuz
- Docking Compartment 1 (DC1)
- Universal Docking Module (UDM)

Russian Components (Continued)

- Docking Compartment 2 (DC2)
- Docking & Stowage Module 1 (DSM1)
- Docking & Stowage Module 2 (DSM2)
- Research Module 1 (RM-1)
- Research Module 2 (RM-2)
- Life Support Module 1 (LSM 1)
- Life Support Module 2 (LSM 2)

International Partner Components

- Japanese Experiment Module (JEM) ELM PS (4 JEM Sys, 3 ISPRs, 1 JEM Stowage racks), P5, High Pressure O_2 Tanks, JEM RMS
- JEM EF, ELM-ES with Payloads, 4 PV battery sets
- APM (5 ISPRs), 1 O_2 tank (on SLP)
- Canadian Space Agency Mobile Servicing System

OPERATIONS

The capability to sustain a large orbital facility operationally is developed and refined in each phase of the program. The International Space Station will benefit from a mature operations capability that has been flight tested in Phases One and Two.

PHASE ONE

In Phase One the ten Shuttle flights to Mir used the Shuttle, Mir, and other Russian vehicles as test beds to develop techniques applicable to the assembly and operation of the International Space Station. These activities included command and control, flight control team operations, logistics support and resupply, extravehicular activity, robotics, maintenance, habitability, human factors, workloads, damage control/emergency return, rendezvous, proximity operations, and docking.

Command and Control for Mir

The existing Mir is controlled from the Mission Control Center in Moscow; the Shuttle is controlled from the Mission Control Center in Houston.

Communications

Communications between the Shuttle and Houston are provided through the U.S. Tracking and Data Relay Satellite (TDRS) system. Communications between Mir and Moscow are provided through the Russian communications system. To support the proximity operations and docking between the Shuttle and Mir, equipment was installed on-board the vehicles to allow vehicle-to-vehicle communications.

Logistics

The U.S. and Russia jointly developed a logistics plan. The plan made use of the unique capabilities of Russian and U.S. Vehicles. Each country was responsible for its respective logistics. Mutual logistics support was provided where appropriate. Shuttle down mass capabilities were used as required.

Training

Crew and flight controller training for the Shuttle flights to Mir had unique requirements. They included training in languages, combined operations, docking, systems, and payload operations. Based on lessons learned from the NASA/Mir Program, plans, techniques, and equipment will be developed to support the International Space Station requirements.

Payload Operations

U.S. and Russian science payloads were located on both the Shuttle and Mir and were operated by U.S. and Russian astronauts. Those payloads operated on Mir were controlled through Moscow, and Shuttle-based payloads were controlled through Houston.

PHASE TWO

Operations will include the launch, assembly, and use of a human-habited orbital laboratory. Operations will be a joint U.S. and Russian responsibility. International Partners will participate within the scope of the existing Intergovernmental Agreement (IGA) and Memoranda of Understanding (MOUs).

Command and Control

A unified command and control center for the International Space Station will be comprised of the Mission Control Center (MCC)-Houston and the Mission Control Center (MCC)-Korolev. MCC-Houston will be the prime site for the planning and execution of integrated system operations of the space station with exclusive command and control authority. All command and control operations of the International Space Station will be under the direction of MCC-Houston. MCC-Korolev, as part of the unified command and control center, will participate in back-up operations to support the space station. Specfic command and control functions, their implementing procedures, and the interactions between the command and control centers will be determined on a case-by-case basis, with due regard to safety, operational necessity, and the lead responsibilities of MCC-Houston.

MCC-Houston will have the capability to monitor and control all system functions of the space station in the U.S., International Partner, and Russian-provided elements. The Russian MCC will have a similar capability for Russian-provided elements and other elements of the station within its responsibility as the back-up Mission Control Center. The Russian MCC shall perform, in coordination with MCC-Houston, the launch, docking, and support operations for the Russian-provided station elements, flights of Russian crews and transport ships, and control of the Russian payloads and experiments.

Communications

Dual communications links from both Moscow and Houston will support control activities. The station will use the TDRS system as the primary communications link. Russian elements will be TDRS-compatible to interface with the U.S. control center. Russian communications links will be used to support Russian vehicle launch and rendezvous activities, assembly of Russian elements, and backup capability to command the station.

Logistics

The U.S. and Russia are individually responsible for those logistics requirements which are unique to their elements of the station.

Logistics requirements which support the ability to use and operate the orbital facility will be shared by the U.S. and Russia. This sharing will be on the basis of mass in orbit or other appropriate measures.

The U.S. and Russia each will be responsible for its respective operations costs, including payload processing, launch services, communications, flight control, and other ground support activities.

Training

Russia will be responsible for training its flight controllers. Russian controllers will be assigned to the U.S. mission control team and U.S. controllers will be assigned to the Russian mission control team as required. Russia will provide appropriate training to U.S. controllers assigned to Moscow. The U.S. will be responsible for training the entire flight control team in the U.S. Mission Control Center. Flight controllers will be trained to operate the station as a single integrated vehicle.

Russia will be responsible for training all crew members on the operation of Russian equipment. Russia will also be responsible for providing vehicle training to all crew members launched or returned on Russian vehicles.

The U.S. will be responsible for training all crew members on U.S. equipment including training as a crew member on-board the Shuttle.

Crewmembers will be trained on station systems, operations, and other activities expected during a mission. Contingency training will be conducted, and requirements for this and other training will be determined by emergency and time-critical scenarios, and by inter-operability of station elements.

Crew training will be accomplished through whole systems training and integrated simulations. Part-task and full hardware mockups and simulators will be used to provide adequate training for the crew prior to flight.

Integrated team training for the crew and ground personnel will include simulation of operations involving all station elements, all control centers, and U.S. and Russian launch vehicles. These scenarios will exercise the operational, technical, and management functions which support station activities.

Payload Operations

A single utilization authority within the Space Station Program will integrate payload operations. This authority will be responsible for the planning and control of payload activities in the overall integrated station plan. Under this utilization authority, execution of payload operations will be distributed to multiple payload operations centers. Centralized enabling of payload commands will be maintained.

PHASE THREE

In Phase Three, the framework of the IGA and MOUs will apply to all issues of operations. The operational structure developed in Phase Two is intended to continue through the completion of the International Space Station.

SCIENCE AND TECHNOLOGY UTILIZATION

The U.S. and Russia are developing a science and technology utilization program which will provide continuity across all three phases.

PHASE ONE

Phase One set the foundation for the space station science and technology utilization program. It provided opportunities for environmental characterization and payload operations experience which better defined science and utilization requirements. The expanded Shuttle-Mir Program used Mir capabilities to enable early long duration science research and validation of key technology systems.

Scientific Research

The NASA/Mir science program included research activities from many science disciplines: microgravity sciences, materials science, environmental health, earth sciences, biomedical science, and fundamental biology. These experiments are detailed in other files on this CD.

Technology and Systems Validation

Selected station technologies and subsystems were evaluated to lower the risks of future station developments. Their components, interfaces, and integrated operations were tested. The primary areas of interest have been systems engineering and crew support.

1. Systems Engineering. Systems engineering tests were performed to validate subsystem design.

a) Life Support. U.S.-developed life support hardware was tested in long-duration missions, monitoring and characterizing the performance of Russian operational life support equipment to determine the possibility of its use in subsequent phases.

b) EVA Technology. Comparative testing of U.S. and Russian space suit and airlock hardware was performed to identify an optimal space suit design. One airlock was developed that provideD the necessary services and ingress/egress capabilities for both countries' suits.

c) Vibration Isolation/Microgravity Environment. By measuring Mir vibration levels and by developing and testing various active and passive vibration systems, an appropriate microgravity environment for sensitive scientific experiments was assured.

d) Assembly and Maintenance. Space tested and validated hardware and operations associated with Station build up and maintenance including robotics, EVA tools, and EVA/IVA procedures.

e) Loads and Dynamics. Validated dynamics models through characterization of Mir structural responses, tested a common docking mechanism, and evaluated the impact of Shuttle plume and docking loads on the station.

f) Data Processing System. Evaluated the performance of off-the-shelf computer components in the space environment. Integrated the U.S. and Russian components on Mir to develop and test interface concepts for a joint station.

g) Contamination. Validated models and determined the environmental effects on Mir materials and optical surfaces by exposing test samples and in-situ measurement.

h) Radiation. Measured the radiation environment of Mir to determine possible environmental impacts on space station hardware.

i) Micrometeoroid/Orbital Debris. Improved micrometeoroid/orbital debris models and determined the effects of impacts by surveying Mir's external surfaces and by deploying an aerogel capture media to catch and characterize debris.

2. Crew Support. Standards for medical care, environmental health, and other health factors that could limit human space flight duration were established. These standards include:

a) Medical Support. Developed medical care, environmental health systems, biomedical monitoring, and countermeasures.

b) Habitation. Provided a safe and consistent crew interface across all station systems and ensured a stable crew health environment. Habitation systems included crew quarters, galley, food, clothing, portable emergency provisions, personal hygiene provisions, personal equipment, restraints and mobility aids, stowage, portable and task lighting, housekeeping, trash management, and consumable items requiring resupply.

c) Environmental and Advanced Life Support. Characterized the Russian environmental support systems to qualify life support systems for crew operations, such as precise control of CO_2 concentrations to enhance both human well-being and science investigations.

Life Support

Risks involved in developing the space station life support systems have been mitigated by demonstrating microgravity-sensitive components on Mir and the Russian Module prior to their use on space station.

The collection of data on Russian life support system performance was initiated much earlier since the required monitoring systems could be developed and delivered to Mir in a relatively short amount of time. The life support components tested on Mir included elements necessary for water and air monitoring, and EVA support.

PHASE TWO

The Phase Two laboratory provides a test bed and microgravity research environment to continue validation of many operational standards required for a human space flight program. The science assets developed during Phase Two will be used on the International Space Station.

The launch of the U.S. laboratory in Phase Two and the availability of adequate power will initiate the outfitting of the racks and the conduct of the human-habitation phase of the utilization of the International Space Station. The initial emphasis will be given to the microgravity sciences specifically in the area of biotechnology, bioprocessing, materials science followed by combustion sciences and fluid physics. In addition, fundamental biological research will be conducted. This will be done by phasing in the research facilities which will be operated primarily while the crew is present and, in some instances, between the crew visits. During this phase, biological studies and technology validation (such as EVA inter-operability, life support, proximity operations, and deployment of complex structures) will be conducted.

PHASE THREE

Phase Three implements the science and technology utilization outlined in the Alpha Program Implementation Plan (September 1993). Use of Russian systems and laboratory elements will enhance the performance and capability of the International Space Station.

Performance/Capability Assessment

Russian participation in the International Space Station provides the following enhancements:

1) Power. Total power generation will be increased on the International Space Station with Russian elements which will add over 45 kW. This increase will enhance research capability by adding flexibility to the scheduling of power demands.

2) Volume. The Russian laboratory modules will provide additional pressurized volume.

3) Crew. Crew size is 6 to support additional Russian elements and scientific laboratories.

4) Microgravity. The static microgravity environment has portions of all international laboratory facilities within a 1-microgravity envelope. Concurrent scheduling of U.S. and Russian resupply flights may provide longer periods which will be conducive to microgravity research.

5) Earth Observation. At a 51.6-degree inclination, the space station will overfly a large portion of the Earth's surface, increasing opportunities for Earth observation.

PROGRAM MANAGEMENT

Phase One was implemented with a Protocol to the October 5, 1992, Implementing Agreement on Human Space Flight Cooperation between NASA and the Russian Space Agency (RSA). NASA and the RSA shared responsibility for management, development, and operations as defined in the Agreement and Protocol. NASA has managed its part of Phase One under the Space Station Program. For Phases Two and Three, Russia will become a full international partner in the Space Station Program and will assume the obligations of the existing IGA. Russian adherence to the IGA is being finalized in conjunction with the parties to the IGA. Russian participation is further defined in a MOU between NASA and the RSA. The roles and responsibilities of the other International Partners as determined by the IGA and MOUs remains unchanged.

PHASE ONE ROLES AND RESPONSIBILITIES

U.S./Russian working groups were established to manage activities of the Shuttle-Mir program for all related flights. Management groups lead Safety, Crew Training, Flight Operations and Systems Integration, Science and Technology Utilization, and Public Affairs for Phase One. The responsibilities were divided as follows:

- WG-1 Public Affairs Office
- WG-2 Safety
- WG-3 Flight Operations and System Integration
- WG-4 Mission Science
- WG-5 Crew Training
- WG-6 Mir Operations and Integration Working Group
- WG-7 Extra-Vehicular Activity
- WG-8 Medical Operations

WG-9 Joint Institutional Communications Requirements

PHASE TWO AND THREE ROLES AND RESPONSIBILITIES

Russia will join the team which is developing the International Space Station. Key responsibilities within the management structure are as follows:

NASA

- Overall program coordination, systems engineering integration, and safety
- Prime integrator for the international elements: NASA's single prime contractor will support this task.

RSA

- Design, development, and support of their flight elements and ground support facilities
- Cost, schedule, and technical performance of Russian elements
- Designation of a program manager for their program activities
- Implementation of all contractual arrangements with Russian suppliers for U.S. funded Russian activities

NASA and the partners, in accordance with the IGA, participate in project management activities in which decision-making by consensus is the goal.

The Space Station Control Board (SSCB) is the primary management mechanism for design and development activities. It controls overall program requirements. The SSCB consists of representatives of the International Partners and is chaired by NASA.

Liaison

RSA will be represented along with other International Partners at the Johnson Space Center. They will participate in technical, operational, utilization, and other management activities necessary for the execution of the program.

NASA will establish a Liaison Office in Moscow with a permanent staff. This office will be responsible for monitoring U.S.-funded Russian activities and Russian contributions for coordinating for integration into the International Space Station. RSA will provide the NASA Liaison Office with reporting on total performance as outlined in program control plans, and has access to information on the status and progress in the implementation of the project as a whole.

FINANCIAL MANAGEMENT

Phase One responsibilities were negotiated in a Protocol to the implementing Agreement on Human Space Flight Cooperation of October 5, 1992. This Protocol discussed additional Shuttle flights to Mir, joint scientific and other payload operations, and technology development activities in support of the International Space Station program.

To purchase the hardware and services in Phases One and Two, NASA awarded a firm fixed price contract to RSA for the period FY 1994-97. This contract tied payments to a schedule of deliverable items. The contract contained options to expand the deliverables and extend the period of performance beyond FY 97.

For the execution of Phases Two and Three, NASA and RSA will negotiate MOUs which will define respective roles and responsibilities of both countries. The MOUs will list Russian and U.S. contributions to the station program and all reimbursable products and services that Russia will provide, including flight hardware and software elements, systems, and other end items.

NASA and RSA will develop and negotiate a Statement of Work (SOW) covering each item listed in the Supplies and Services Section of the contract and the schedule against which these items are provided.

A work breakdown structure adequate to provide evaluation of schedule performance will be defined in the contract. Milestones will be consistent with other elements of the program. Reporting will be in a consistent format.

Periodic reviews of RSA's technical and schedule performance will be conducted by NASA's program manager. ❋