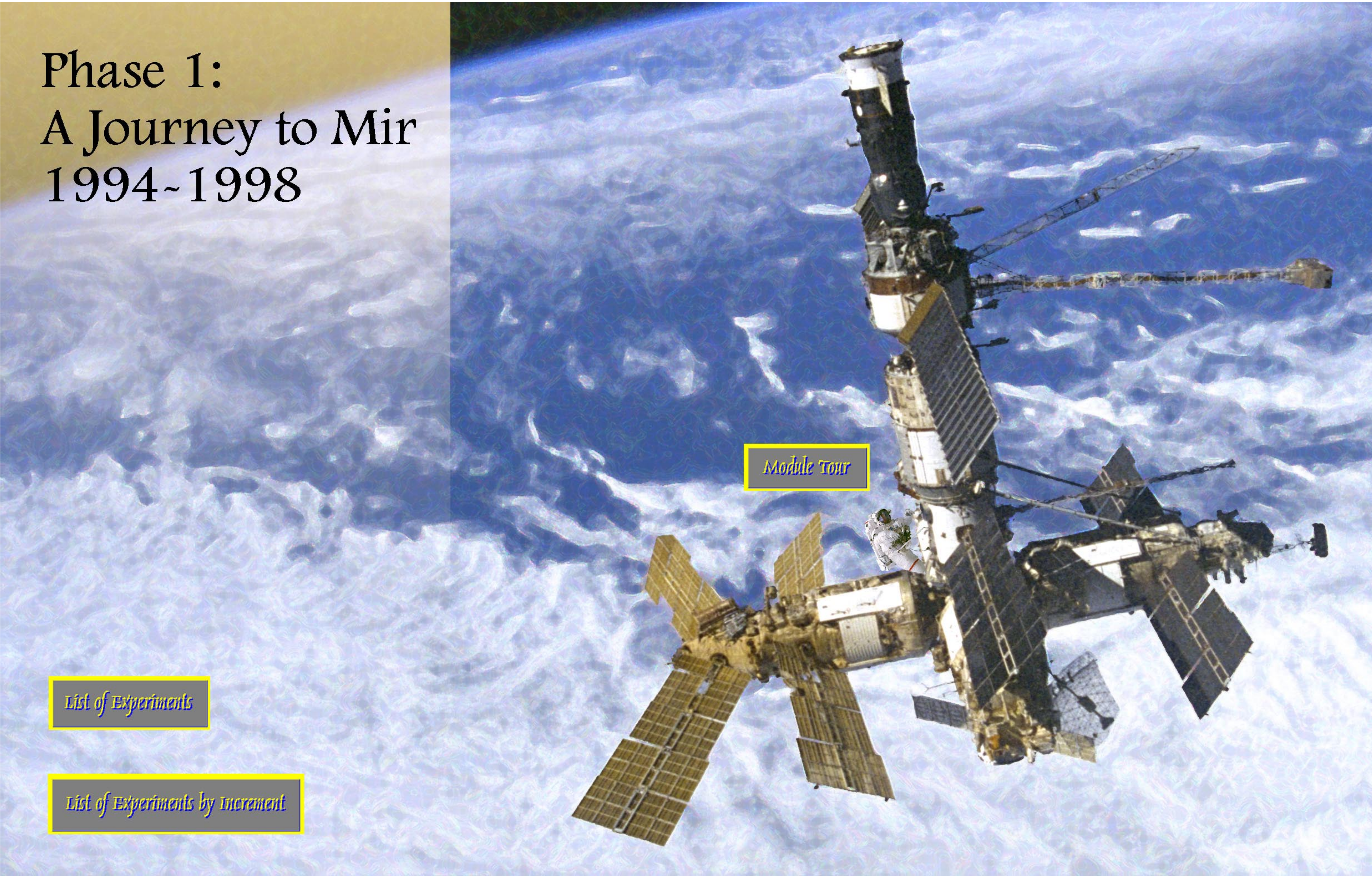
Phase 1:
A Journey to Mir
1994~1998



ASTROCULTURE (ASC-7)

EXPERIMENT DESCRIPTION

The Astroculture-7 (ASC-7) flight experiment series was developed to evaluate the various environmental control subsystems necessary to support plant growth in space. Completion of these experiments has resulted in a space-qualified plant growth chamber for gravitational plant biology research. Spin-offs of this technology could also have potential applications on Earth, including more energy-efficient irrigation systems.

The ASC-7 unit to be flown on Mir will be a functional growth unit, providing humidity and temperature control, lighting, water and nutrient delivery, atmospheric control, and control and data acquisition subsystems.

The ASC-7 experiment will be a "seed-to-seed" experiment, growing wheat plants in the autonomously controlled chamber from seeds through germination and seed development.

SCIENCE OBJECTIVES

- Determine if plants can grow from seed to maturity and produce seed in a microgravity environment (conduct a seed-to-seed plant experiment.)
- Following return from space, compare the plants derived from the seeds produced in space with plants derived from seeds produced on Earth.

TABLE ADV.1
ASC-7 HARDWARE LIST

NAME	PART NUMBER	QTY.
Flight Experiment Insert	ASC-7-000, without foam	1
3.5", 1.44 MB Floppy Disk	ASC-7-001 thru-002	2
ASC-7 Video Cable	ASC-7-003	1
ASC-7 MIPS Cable	ASC-7-004	2

HARDWARE DESCRIPTION

The primary experiment hardware for Astroculture is called the Flight Experiment Unit. It is packed in foam and was designed as a Middeck locker experiment with a modified locker door.

The Flight Experiment Unit contains the following systems and subsystems:

1. Plant Growth Chamber System
   - Temperature Control Subsystem
   - Humidity Control Subsystem
   - Lighting Control Subsystem
   - Nutrient Delivery Subsystem
   - Atmospheric Control Subsystem
2. Power Conditioner System
3. Computer Control System
4. Front Panel

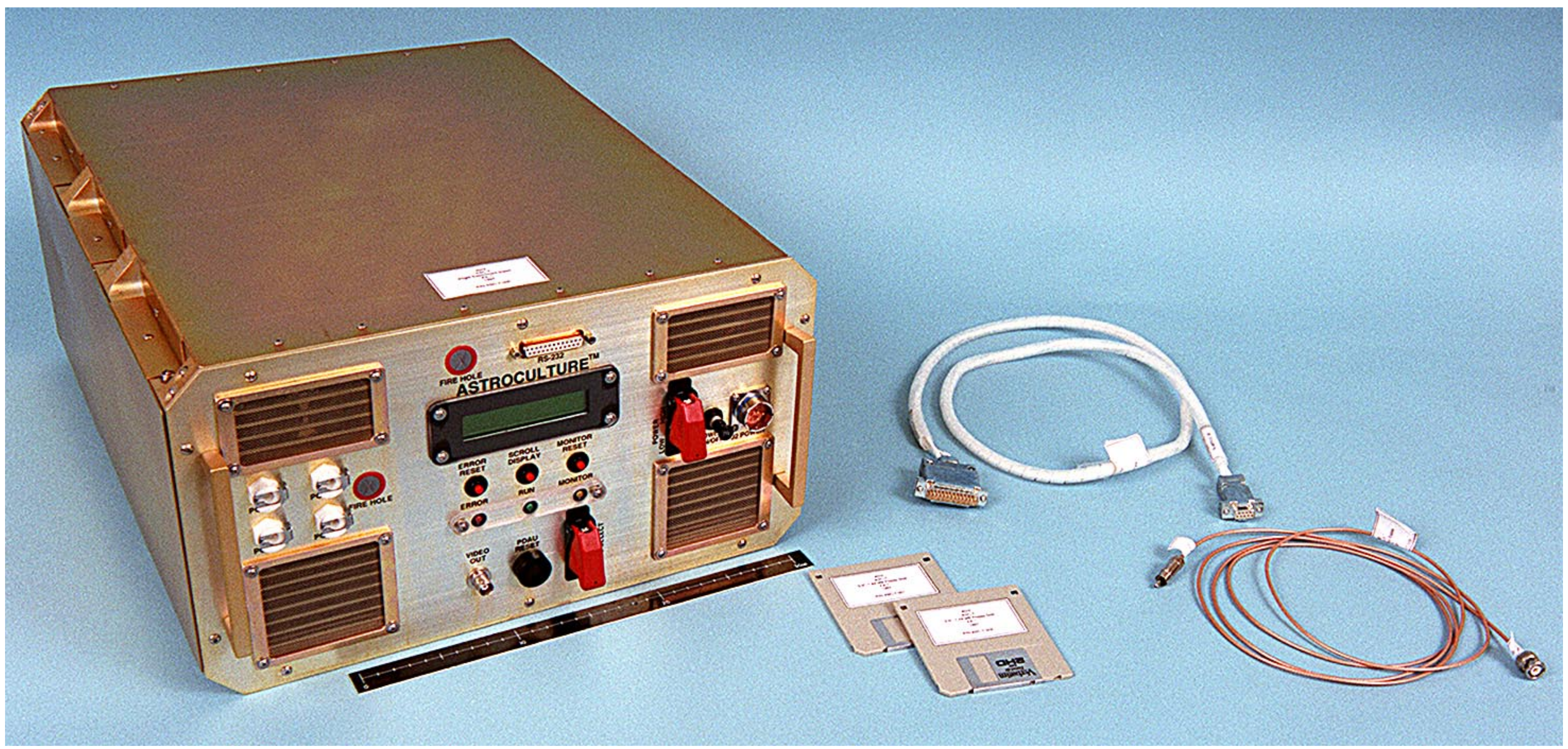
The interior of the Plant Growth Chamber is not accessible by the crew.

The Flight Experiment Unit uses 12 fans for thermal/humidity control, none of which are crew accessible:

- 4 fans for temperature/humidity control unit
- 2 to cool the Power unit
- 2 to cool the light unit
- 4 for internal circulation in the growth chamber

Condensation of water evaporated from the plant leaves is recycled, which holds the amount of water required to a minimum.

The ASC-7 experiment is contained in a unit capable of being stowed in a standard Priroda locker. All interfaces for crew interaction are located on the ASC-7 front panel. The ASC-7 Middeck locker possesses a modified front door which contains openings to allow access to the ASC-7 front panel without opening the locker itself. The ASC-7 experiment flight and back-up system deliverables are listed in Table ADV.1.



S97-10382

Figure ADV-1 Astroculture Hardware

D.I.D.

ASC-7 Flight Experiment Unit

Principal Investigators:
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WSCAR College of Engineering University of Wisconsin-Madison
Director
(608)262-5526

Dr. Weijia Zhou
(608)265-5528

ASC-7 FLIGHT EXPERIMENT INSERT (including Foam)

P/N: 7150076
Qty: 1
Mass: 24.2 kg (54 lbs.)
Power: 117 W
x,y,z: 51.6 x 43.97 x 25.77 cm
Loc: Priroda, SIC3-III-11
DID #: SLM46116050

Power Consumption:
117 Watts
Start-Up Current:
35A, 100 μsec
max: 80 A; 15 msec
Onboard Electrical Supply:
DC source 23-32 V
Insulation Resistance:
20 Mohm (1 Mohm high humidity)
Temperature:
+5° C to +40° C
Gas Environment:
78% Nitrogen
40% Oxygen
3% CO_2
2% H
.01% He

MECHANICAL CHARACTERISTICS

The ASC-7 experiment unit consists of the following major components:

- a power conditioner to reduce the voltage from the Mir power supply from 28 Vdc to the operating levels required by the pumps, valves, fans, and electronic components.
- a single-board computer for environmental control, data collection, and data storage.
- a plant growth chamber which contains a nutrient delivery system, rooting matrix, and an illumination system.

Components of the ASC-7 flight unit are enclosed in an aluminum frame support covered by a thin aluminum shell. The unit is designed to be packed in foam in a middeck-type locker with a modified locker access door to allow crew access to the front panel and to allow air to circulate through the flight unit.

Cooling for the mechanical and avionics subsystems is provided by eight interior valve axial fans, which operate continuously, to circulate cabin air through the experiment apparatus container when the experiment is energized.

A modified locker door is used which allows air to be taken in from the front panel, through the payload, and exhausted from the back panel of the middeck locker.

The ASC-7 Flight Experiment Insert measures 51.6 x 43.97 x 25.77 inches with a weight of 54 pounds. Touch temperature of crew-accessible panels and controls shall not exceed -40 °C, and the temperature of inaccessible external surfaces shall not exceed 49 °C.

OPERATION MODES

The ASC-7 system is designed to operate in a fully automated mode. The PDAU will function autonomously except for power. Crew interaction with ASC-7 will be done through the MIPS, built-in LCD displays and LED indicators, and the ASC-7 Video System.

S97-10383

Figure ADV-2 Astroculture Back Face

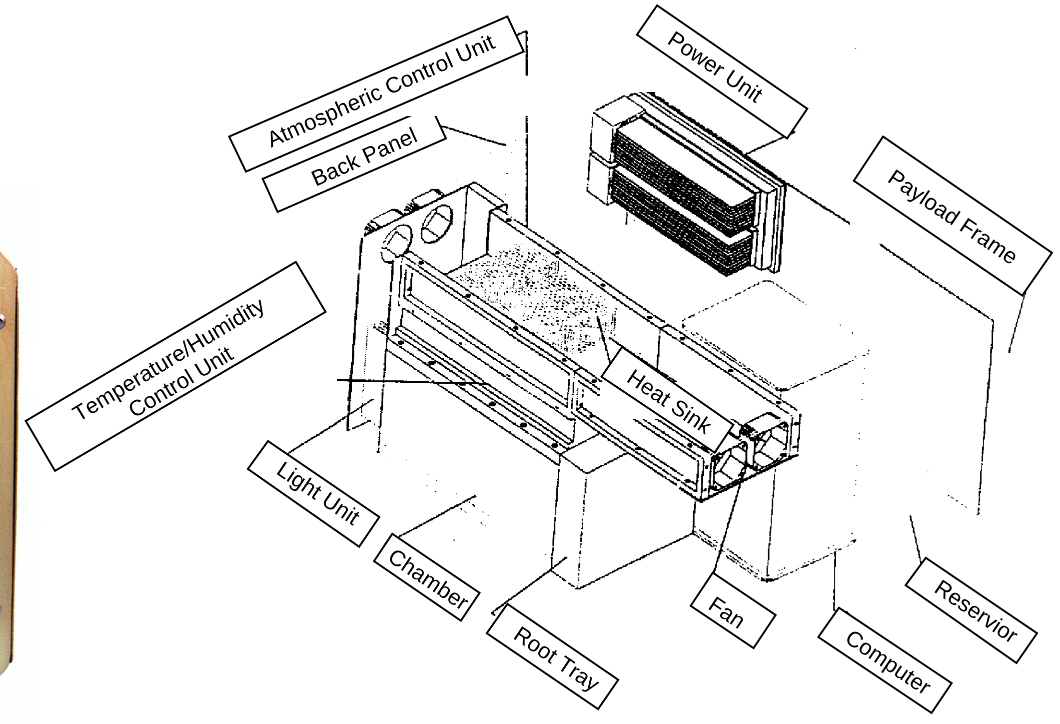

Figure ADV-3 ASC-7 Hardware Layout

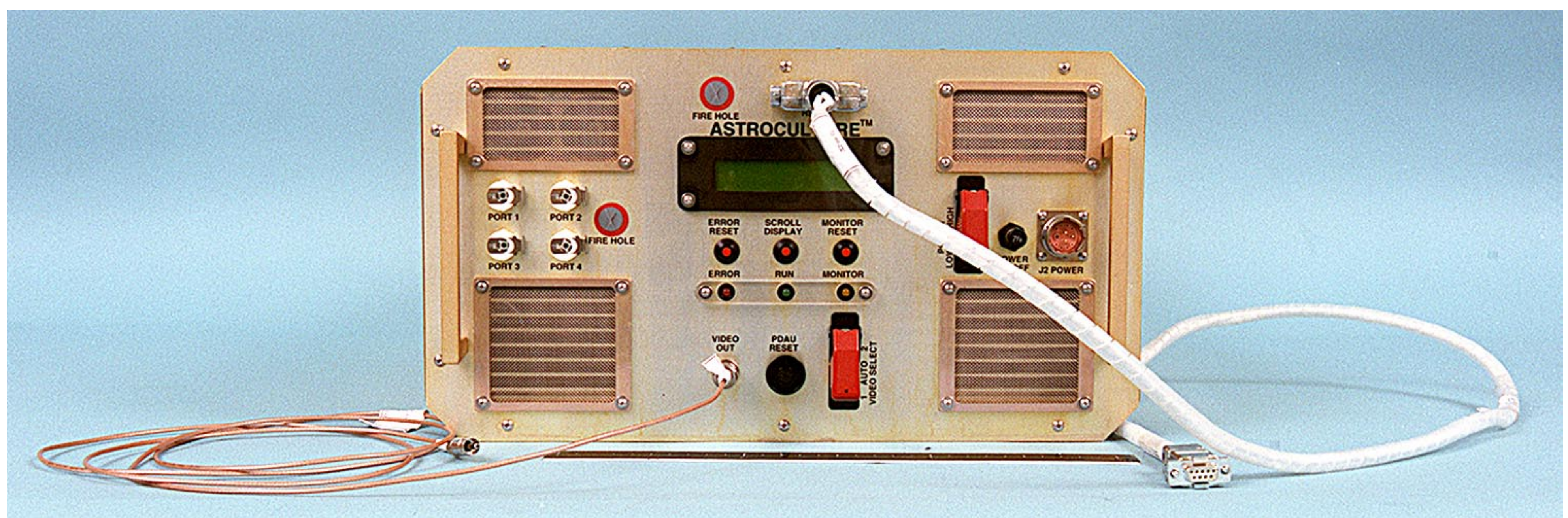

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Figure ADV-4 Astroculture with Cables Attached

Air Pressure:
450 - 970 mm Hg
Humidity:
10-80% (at nominal temp.)
95% for 3 hours
Vibration: per US/R-002
Noise Generation:
<60 Db at 1 meter
Operational Life:
≥10,000 hours (6 mo.)
Shelf Life:
5 years

Interaction will be limited to monitoring the front panel display of the ASC-7 unit.

FRONT PANEL DESCRIPTION

Table ADV.2 identifies the functions of the controls and indicators on the Front Panel of the ASC-7.

TABLE ADV.2
ASC-7 FRONT PANEL CONTROLS

ITEM	TYPE DEVICE	FUNCTION
PWR ON/OFF	Circuit breaker closed (on) open (off)	 Applies power to ASC-7 unit Removes all power from ASC-7 unit
PWR LO/HI	Switch	PWR HI for nominal operations; PWR LO for pre-deactivation operations
VID SEL	Switch	Not utilized
PDAU RESET	Momentary push button	Restarts control and monitoring protocol in the event an error interrupts experiment
SCROLL DISPLAY	Momentary push button	Used to reset DMT
MONITOR RESET	Momentary push button	Used to reset DMT
ERROR RESET	Momentary push button	Resets ERR light after error condition resolved; used to reset DMT
RUN	Green status light	Indicates run cycle
ERR	Red status light	Indicates error condition
MON	Yellow status light	Not utilized
ASC-7 display	LCD	Displays general experiment data
VIDEO OUT	Connector (coax, BNC)	Provides video signal to NASA camcorder
PORT 1	Quick disconnect	Not utilized
PORT 2	Quick disconnect	Not utilized
PORT 3	Quick disconnect	Not utilized
PORT 4	Quick disconnect	Not utilized
RS-232	25-pin connector	Provides interface to orbiter MIPS
J2 PWR	28 Vdc connector	Connects unit to orbiter (Mir) power

TABLE ADV.3
ASTROCULTURE PLANT GROWTH PARAMETERS

temperature	25°C - 26.5°C
relative humidity	65% - 75%
light intensity	250 - 350 µmols
CO2 concentration	500 - 1000 ppm

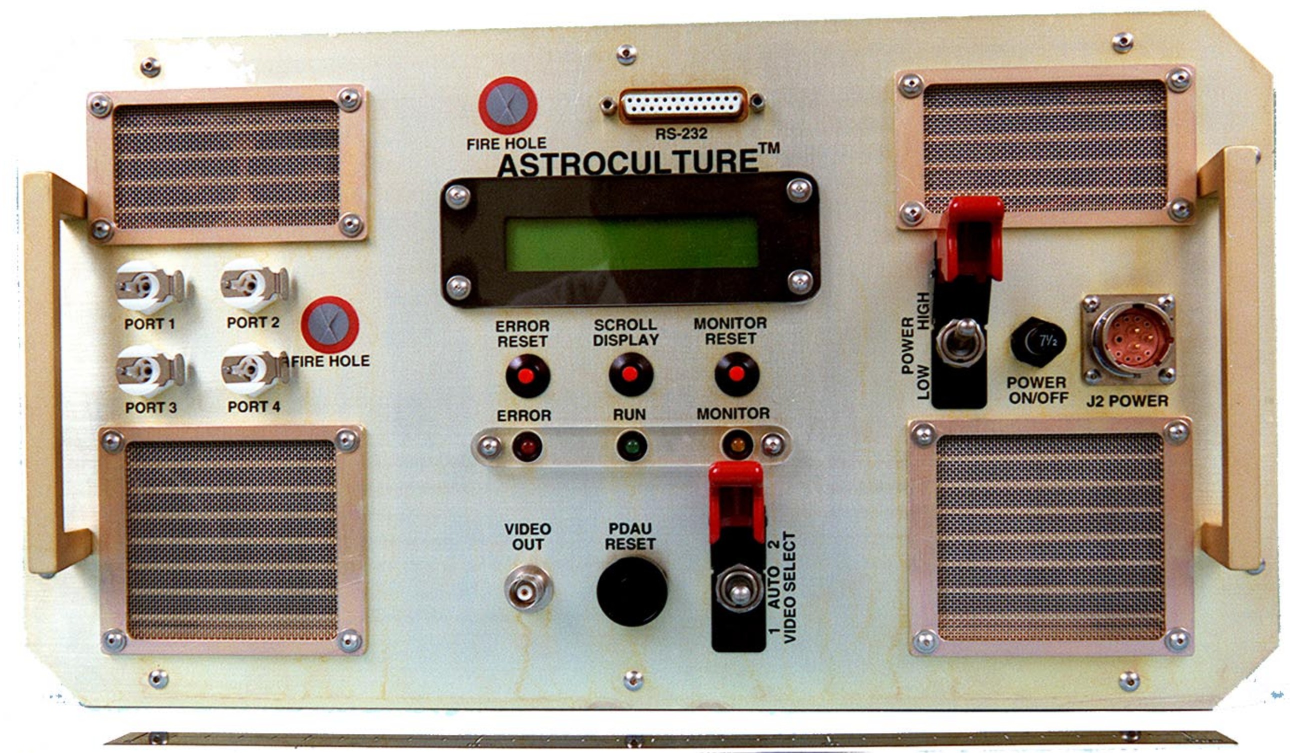

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Figure ADV-5 Astroculture Front Panel

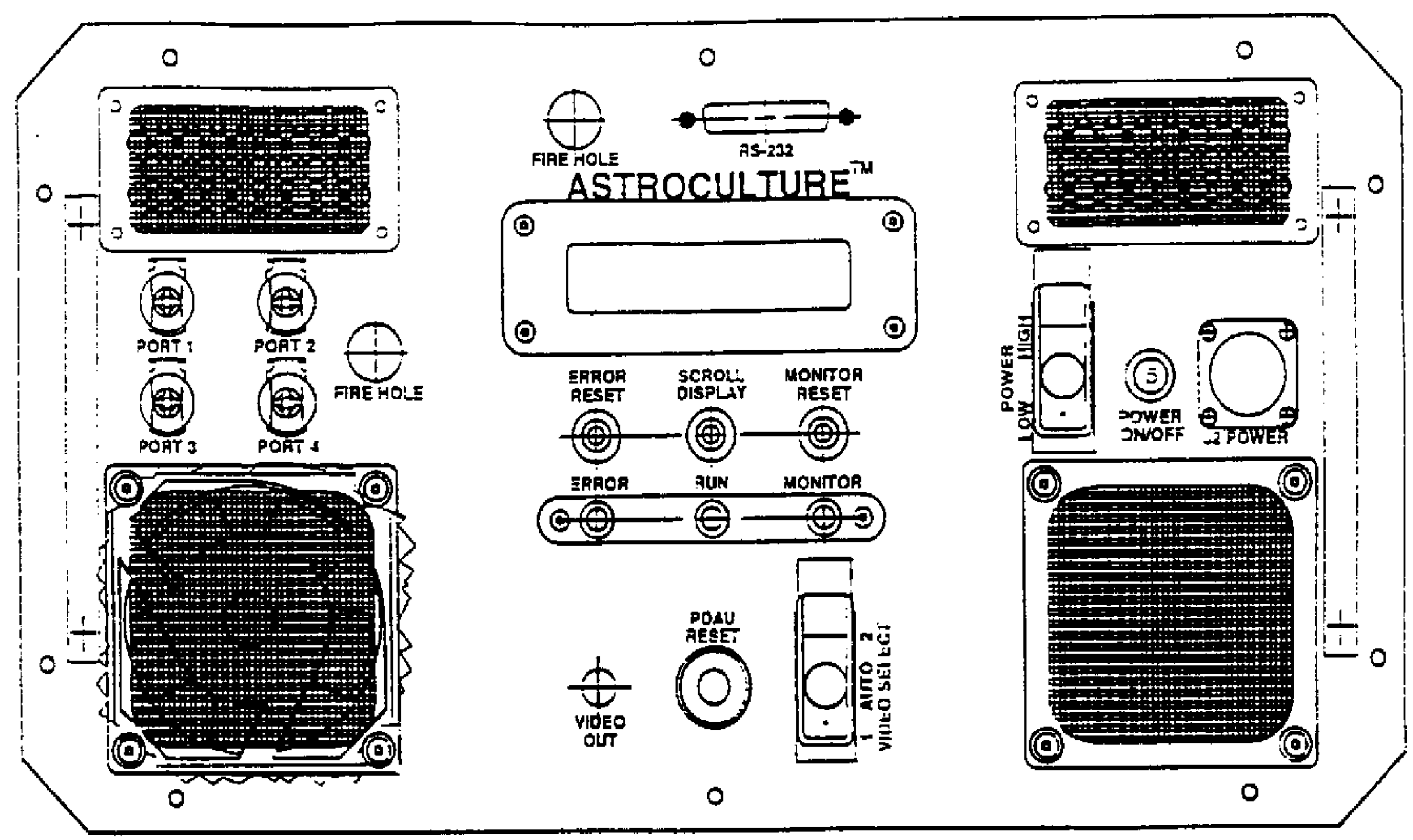
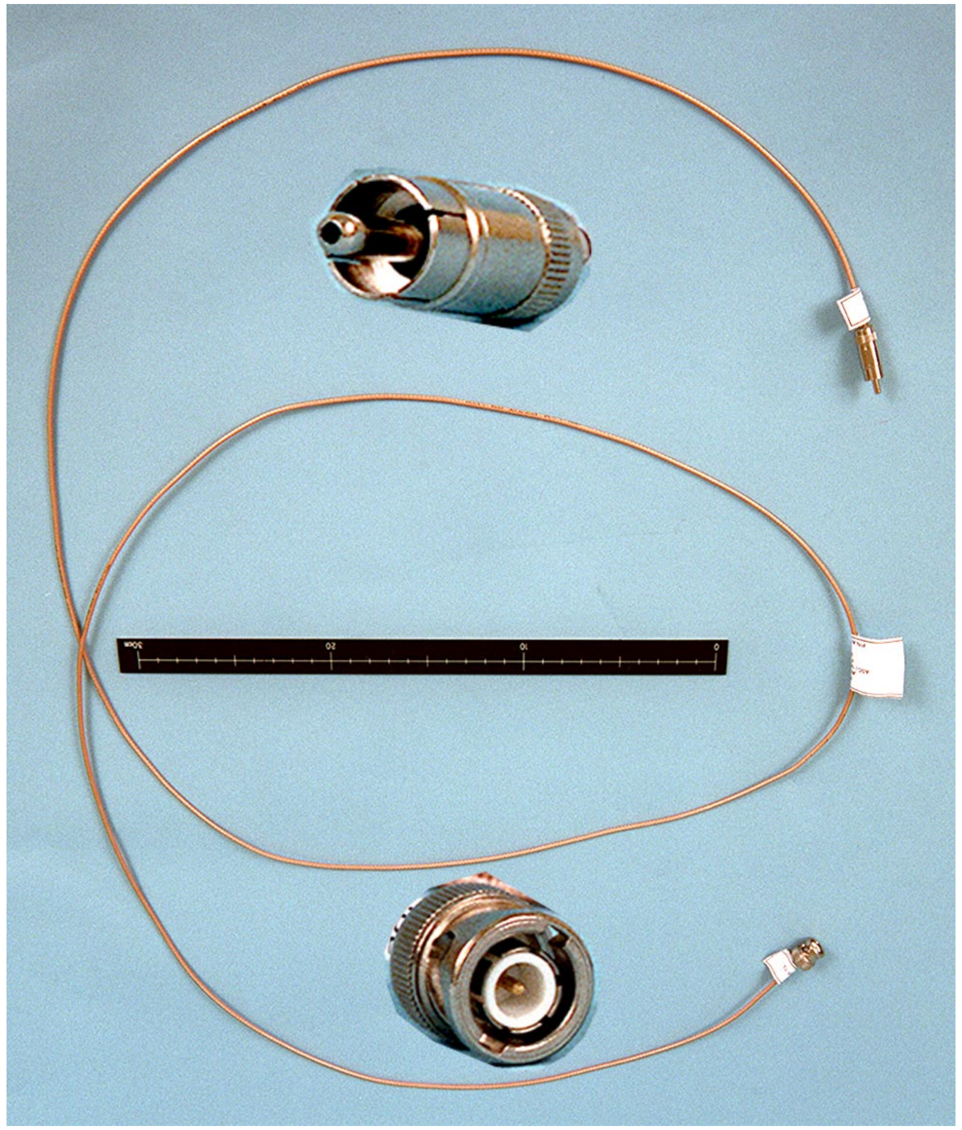
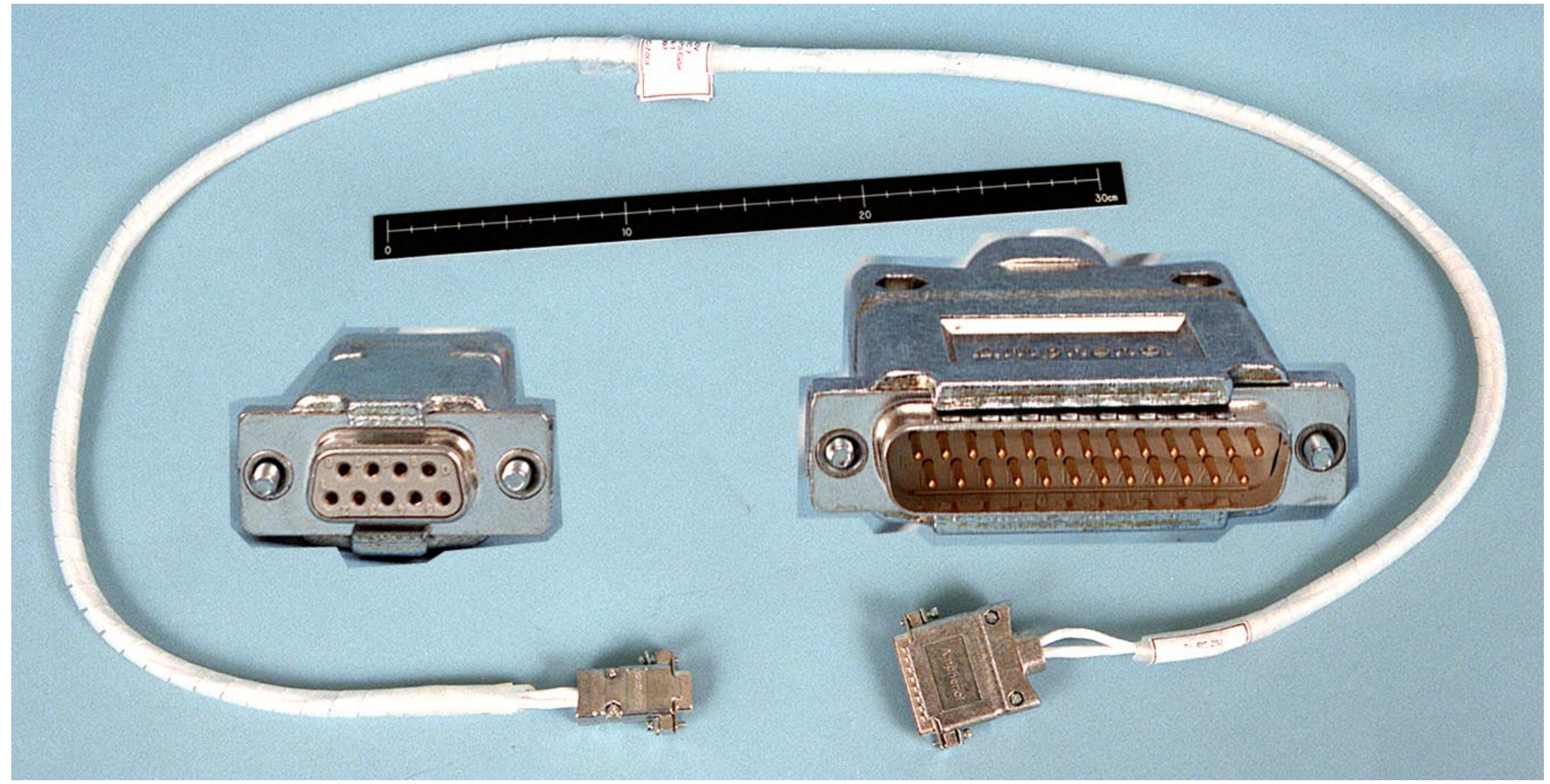


Figure ADV-6 ASC-7 Front Panel Layout



S97-10386

Figure ADV-7 Astroculture Video Cable



S97-10385

Figure ADV-8 Astroculture MIPS Cable

S97-10390

Figure ADV-9 Astroculture Floppy Disks

HARDWARE INTERFACE WITH SYSTEMS

The ASC-7 is designed to fit into a Middeck locker configuration. It is powered by 28 Vdc input, with a max power draw of 117 Watts using a standard Middeck connector. The interface with the MIPS computer is an RS-232 connector. The crewmember willl play back the video on the COSS System (See OPS). The L2 (NASA) Camcorder which interfaces with the coax, BNC connector will be used. ❋

3.5", 1.44 MB FLOPPY DISK

P/N: ASC-7-001, 002
Qty: 2
Mass: .02 kg
Power: 0
x,y,z: 8.99 x 9.38 x .33 cm
Loc: SLM
DID #: SLM46116050

ASC-7 VIDEO CABLE

P/N: ASC-7-003
Qty: 1
Mass: .047 kg
Power: N/A
x,y,z: 237.5 cm (lgth)
Loc: Priroda
DID#: SLM46116050

ASC-7 MIPS CABLE

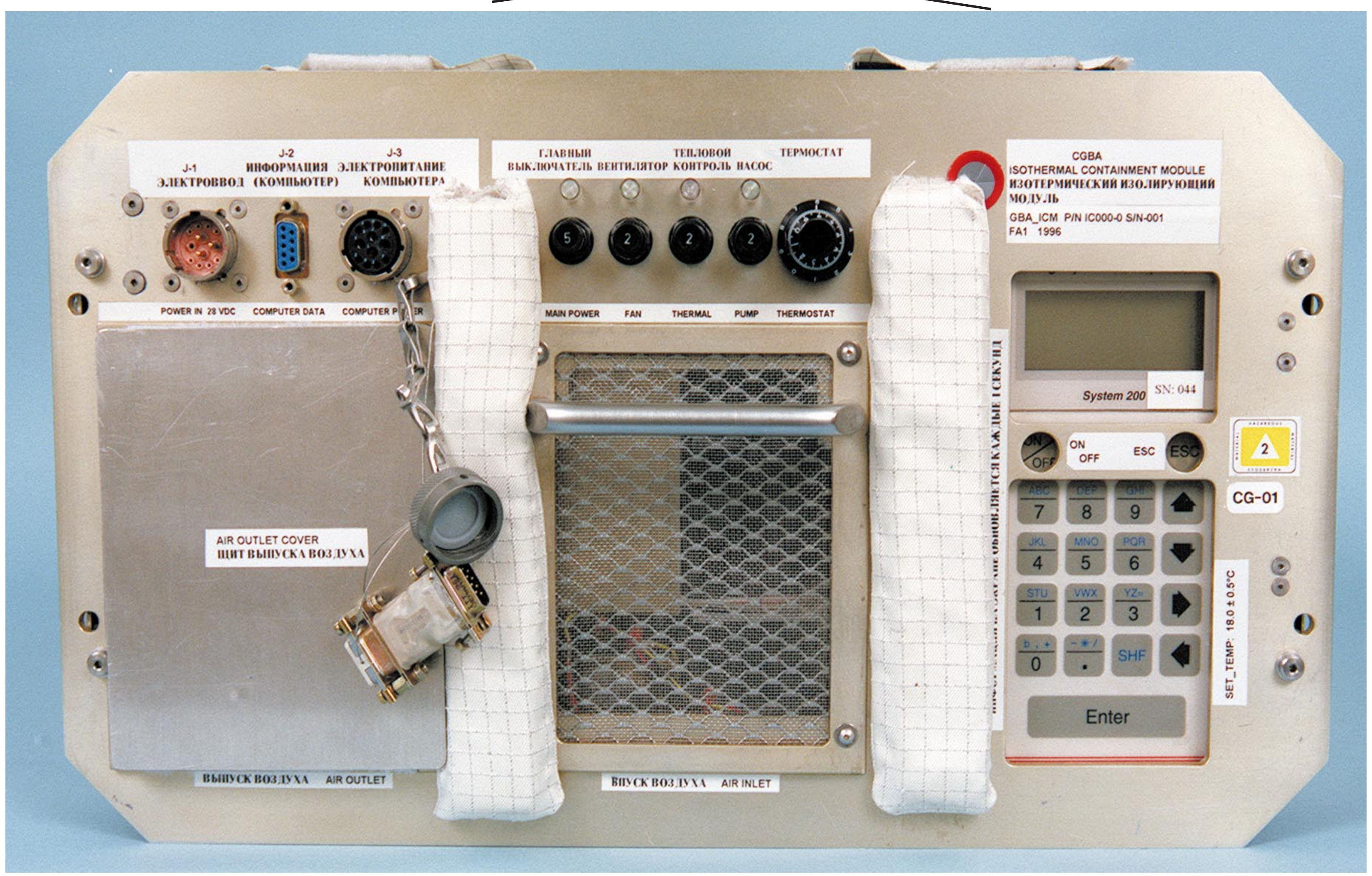
P/N: ASC-7-004
Qty: 1
Mass: .278 kg
Power: 0
x,y,z: 136.0 cm (lgth)
Loc: Priroda
DID#: SLM46116050

Commercial Generic Bioprocessing Apparatus

EXPERIMENT DESCRIPTION

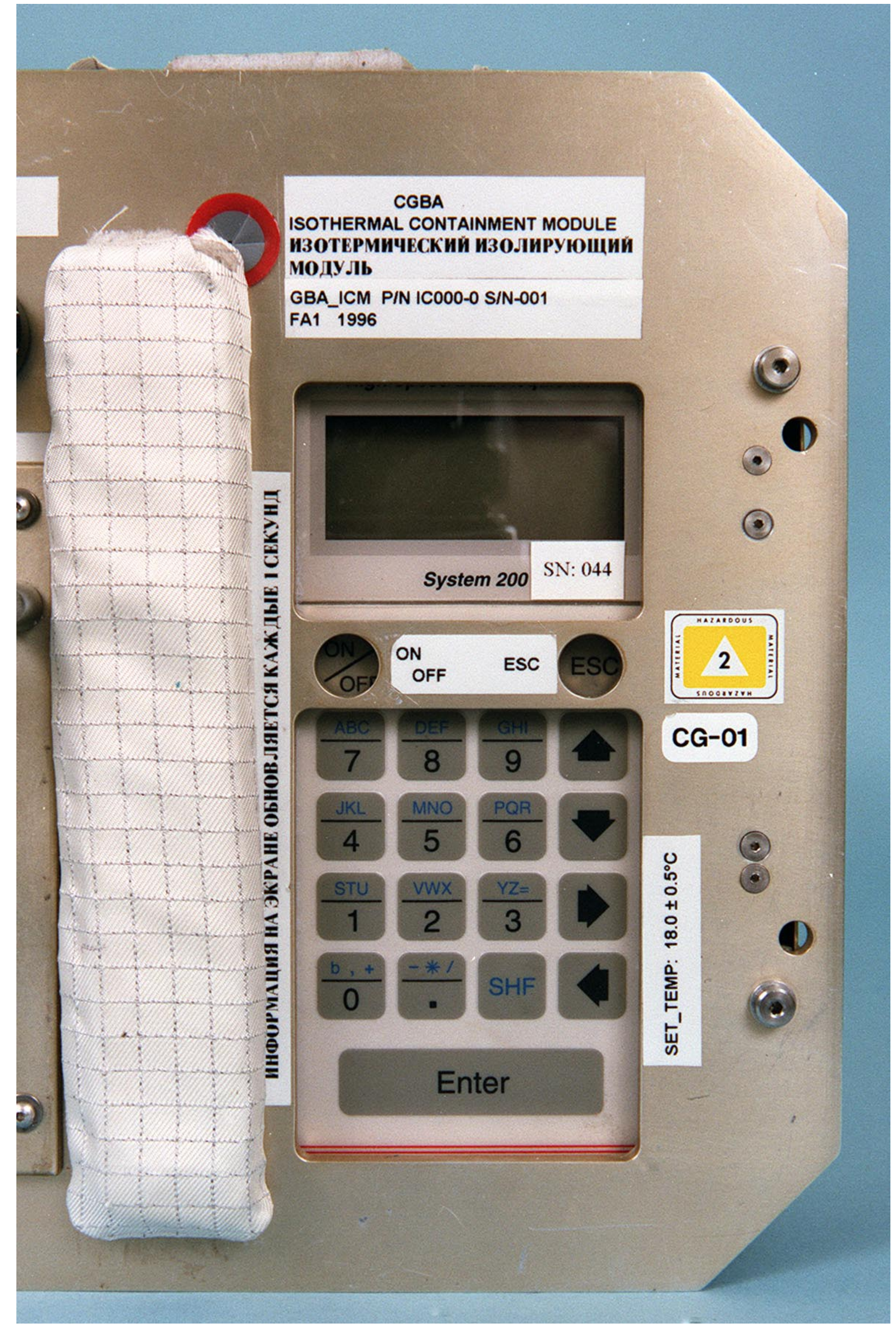
The CGBA is a generic, versatile research tool which supports a wide variety of life sciences research. Using simple hardware, experiments can be supported in biochemistry, biophysics, microbiology, cellular biology, developmental biology and physiology. In previous missions, up to 30 investigators with more than 400 individual samples have been accommodated. The main payload components include a generic, temperature-controlled containment (GBA-ICM) compatible with the Mir Standard Interface Drawer (SID). For our proposed mission, each Isothermal Control Module (ICM) would contain up to 8 Group Activation Packs (GAPs) in support of life sciences research. However, any other experiment requiring a highly controlled and documented temperature environment around typical ambient temperatures could be accommodated. The ICM is easily accommodated on Mir and easily moved from one system to another.

3.5" Floppy Disk



S97-05746

Figure ADV-10 Front Panel of the CGBA Unit



S97-05745

Figure ADV-11 CGBA Right Face

D.I.D

Commercial Generic Bioprocessing Apparatus

Principal Investigators:
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University of Colorado at Boulder
BioServe Space Technologies
Associate Director
Technical Affairs
(303) 492-8883

Dr. David Klaus
(303)492-1005

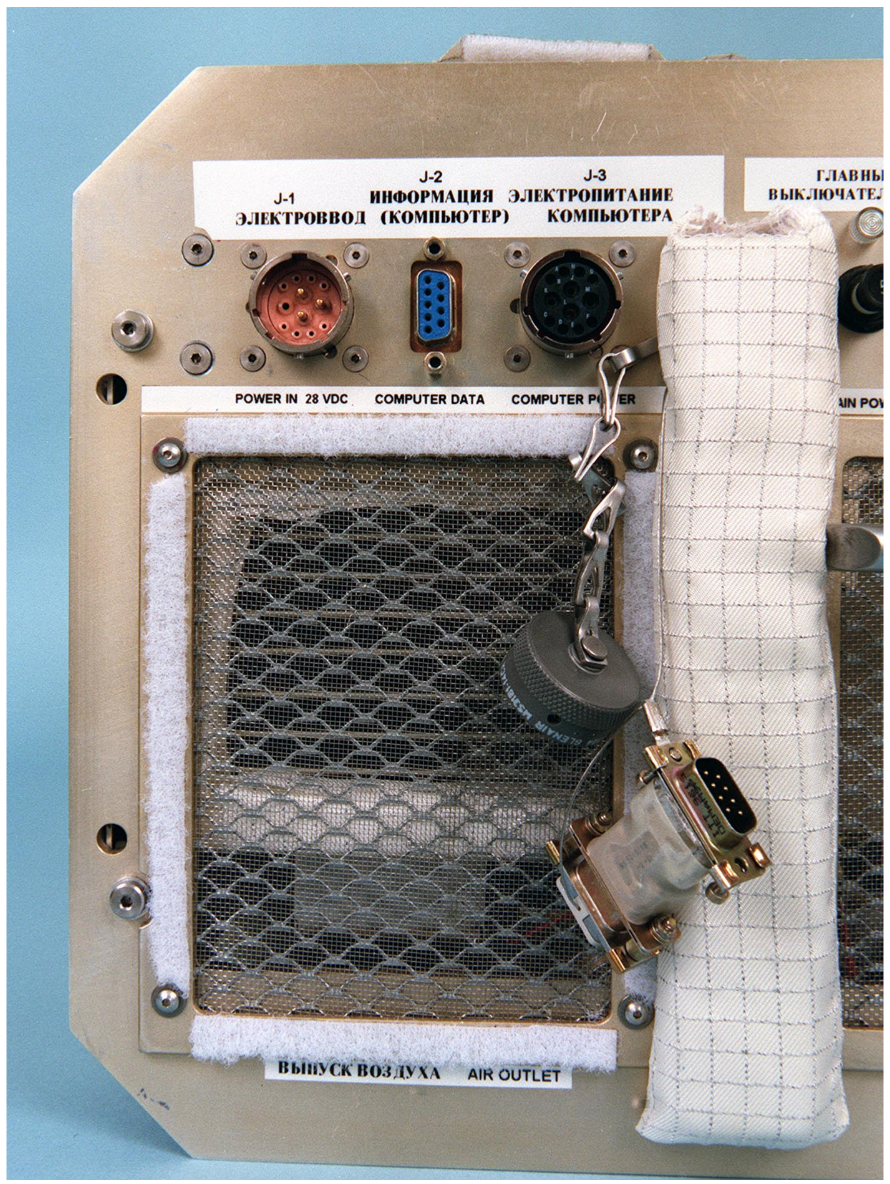
ISOTHERMAL CONTROL MODULE (ICM)

P/N:	IC000-0
Qty:	3
Mass:	28.84 kg
Power:	48.5 W/60 W peak (for single ICM)
x,y,z:	50.8 x 43.4 x 25 cm
Start-Up Current:	12 amps/5 msec
Onboard Elect.Supply:	DC Source: 23 - 32V
Insulation Resistance:	20 MOhm (1 MOhm high humidity)
Powered-Down Timeframe:	1 hour
Internal Adjusted Temperature Range:	4° - 37°C

The CGBA payload consists of two ICM each containing up to 8 GAPs that each contain 8 fluid processing apparatus (FPAs). A 3.5” floppy disk is stowed in the sleeve of each ICM insulation. These can be used in a contingency situation for program upload to the ICM.

SCIENCE OBJECTIVES

1. Synthesize biomedical materials
2. Analyze cell receptor sites and channels
3. Investigate evolution of permutation process
4. Oligonucleotide crystal growth



S97-05748

Figure ADV-12 CGBA Front Left Panel

HARDWARE DESCRIPTIONS

The CGBA payload configuration for Mir consists of a temperature-controlled, self-contained, autonomous system for storing, mixing, and processing biological fluid samples in a microgravity environment. The main component is the ICM: a temperature-controlled, modular unit that fits inside a standard locker enclosure. Stored within the ICM are eight GAP-II units.

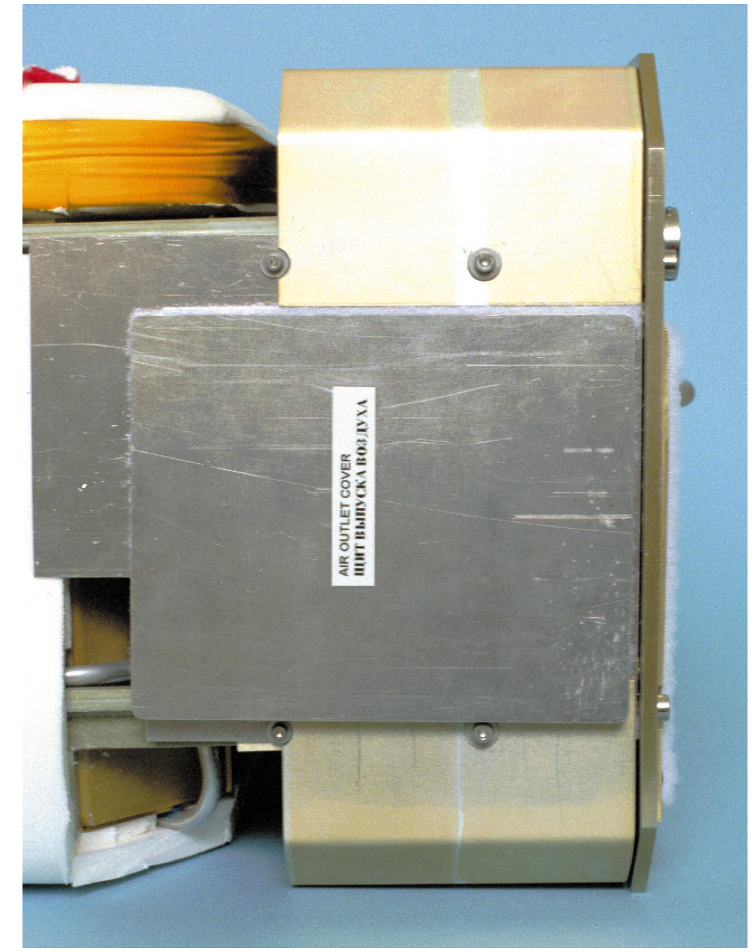
The GAP-IIs each house eight FPAs which are individual sample containers housing up to three separate fluids that are used to contain and mix the fluids in microgravity. Two identical locker equivalents are flown for a total of two ICM modules, 16 GAP-IIs, and 128 FPAs.

ICM

The ICM unit is installed, powered, and launched in a locker on Space Shuttle. The function of the ICM is to: house the GAP-II units and control system; maintain a preset isothermal temperature environment; detect, launch, and start an internal timer; control the activation and termination of the GAP-II units; provide an interface for crew interaction, control, and data transfer.

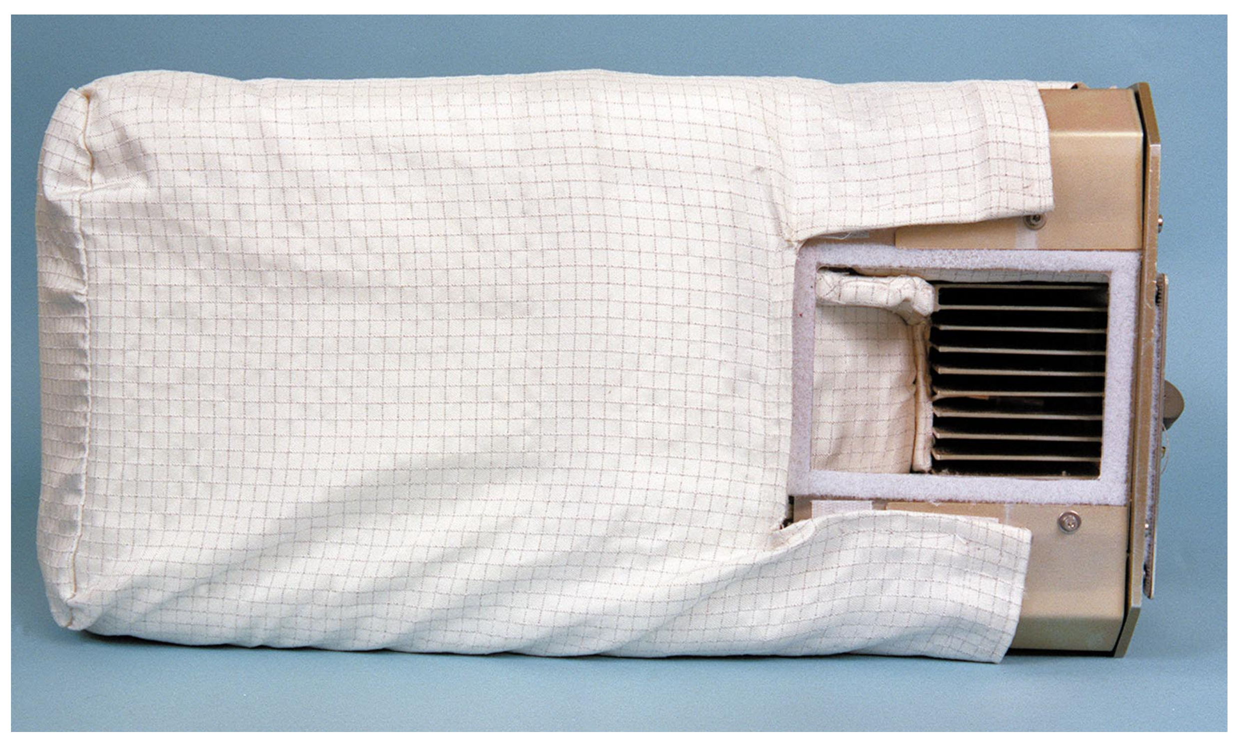
The housing for ICM is a lightweight aluminum and insulation-clad structure designed to fit inside a standard Space Transportation System Middeck locker assembly. It takes advantage of the existing structural strength of the locker. It is a modular insert that can be easily transferred to another locker. The front portion of the housing contains the electronics, thermal, and interface subsystems. The rear portion of the unit is temperature controlled and houses the GAP-IIs.

The 28-Vdc Orbiter power is supplied through a connector on the front of the housing. Airflow ports (inlet and outlet) are on the front for Space Shuttle configuration. For the Mir configuration, the airflow inlet is on the front with the outlet reconfigured to exhaust on the side.



S97-01189

Figure ADV-14 Training Unit with Panel Attached



S97-05747

Figure ADV-13 Flight Unit Side View of CGBA

S97-05752

Figure ADV-15 3.5” Floppy Pockets

GAP-II

A GAP II provides a third level of fluid containment composed of Lexan and aluminum. It allows autonomous, simultaneous activation of eight FPAs via an external dc motordriven mechanism. Each ICM contains eight GAP IIs, providing a total of up to 64 FPA samples per locker.

The GAP-IIs also autonomously activate and terminate the FPAs. A high-torque motor and a gear drive rotate a lead screw that drives a plate downward to cause the FPA fluid to mix.

An optical sensor measures the amount of lead screw rotation and turns off the motor after a preset travel distance. The pressure plate travel can be programmed for varying amounts of fluid volume within the FPAs.

The GAP-II control system is designed to automatically control experiment activation and termination at preset time intervals. An accelerometer-based system is incorporated to detect launch and activate an internal timer. This starting point provides a reference for the preset initiation and termination times. The time intervals can be altered by the crew in the event of a changed end of mission time or to accommodate science objectives.

Activation refers to the operation of the GAP-II in such a way as to cause active mixing of the fluids inside the FPA. Termination is a similar operation causing additional fluid to be mixed to fix or terminate the reaction.

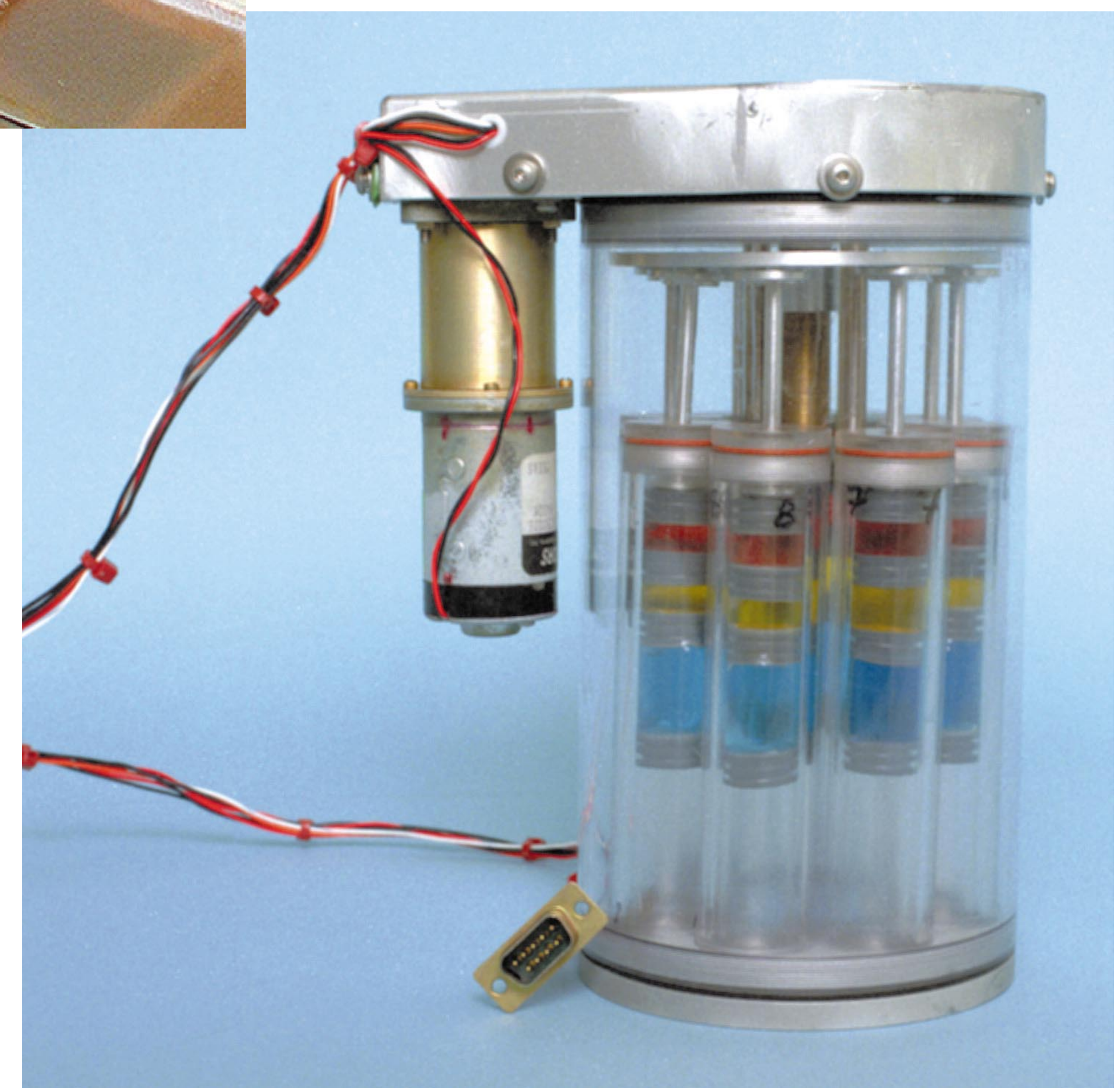
The T-GAP is a GAP-II modification which allows for a light source located near the T-GAP and a specialized insert for ecosystem growth and development. A light source is necessary for plants which require light to germinate and also for ecosystems which require light as an energy source. The base plate of the T-GAP is weight relieved and modified to allow a cylindrical Lexan insert to be used. The bulb is a commercially available compact fluorescent unit and is contained in a Lexan cylinder. Since the light is separated from the T-GAP and it's insert, there is no hazard associated with potential volatiles inside the T-GAP. The fluorescent light contains less than 5 mg of Mercury. All frangible materials are contained within the Lexan containment cylinder.

The thermal control system uses solid-state cold-plate thermoelectric devices to heat or cool the experiment volume. An active heat exchange system directs cabin air over cold plates to maintain the set temperature over a range of ambient temperatures. Water loops circulate on all six sides to maintain consistent (isothermal) temperature inside. When the module is at temperature, a relatively small amount of current is needed to maintain thermal equilibrium. Backup batteries maintain control system memory to prevent loss of stored data.

Interface with the ICM is accomplished with a keypad, Liquid Crystal Display (LCD), and RS-232 data port. Various messages are displayed on the LCD, depending on the operating mode. Crewmembers interface directly with the unit to status the performance, transfer data (Space Shuttle operation) or other operations.

Most sample activation occurs, as soon after launch as possible, while the GBA-ICM is still on board the Space Shuttle. This precludes the need for larger amounts of power to be drawn on Mir where available power is at a premium.

Termination of FPAs occurs at varying times throughout the mission, some on Mir. The majority of the terminations take place on the



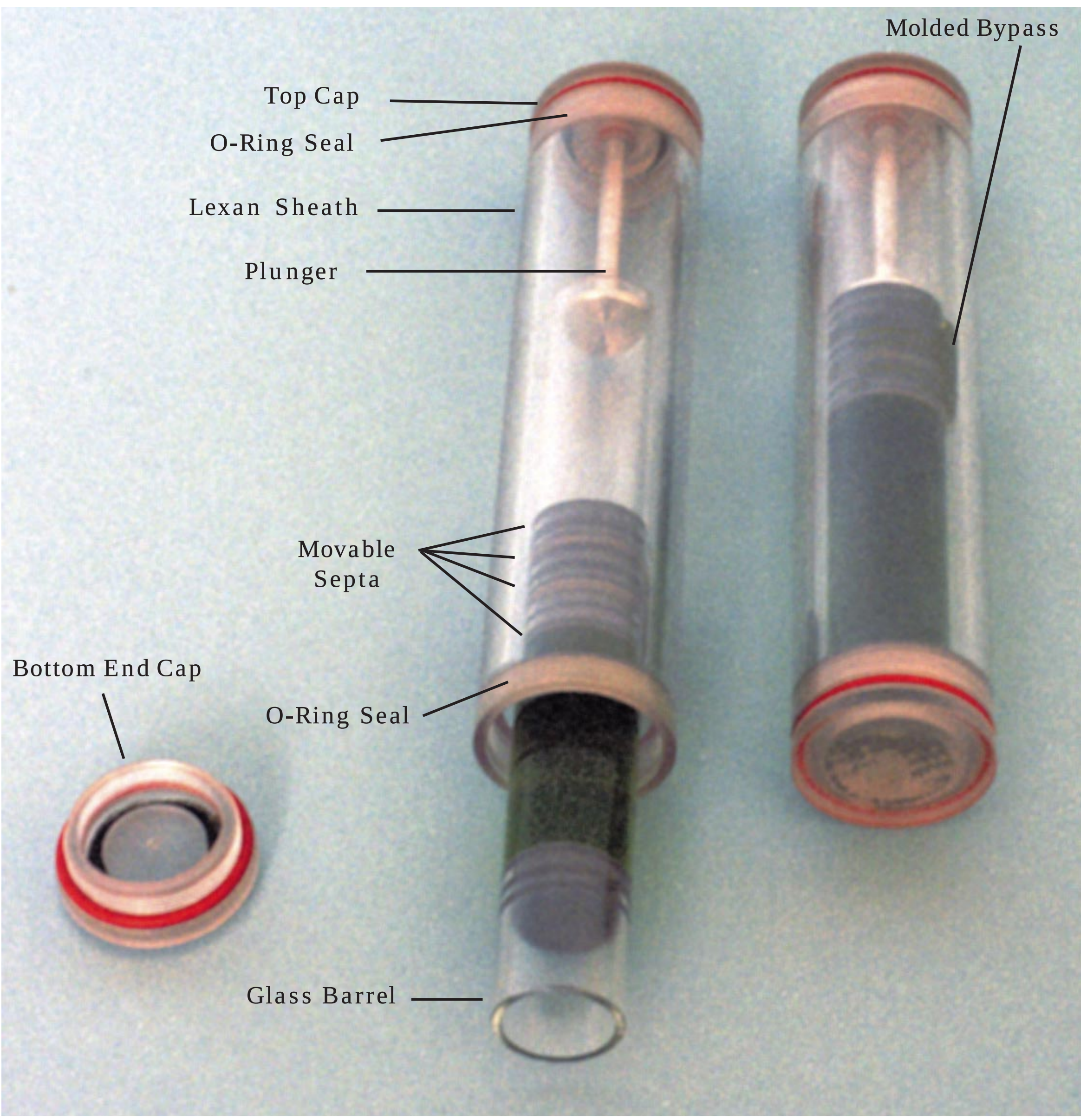
S97-01185

Figure ADV-16 GAP Unit

Space Shuttle after it is transferred from Mir for return flight. Some samples are self-limiting and do not require termination.

FPA

There are three types of FPAs. They are the Standard FPA, EV-FPA, and GE-FPA. An FPA contains a glass barrel (1.35 cm I.D. by 11.7 cm) with movable rubber septum used to confine the fluids in separate chambers within the barrel. The design provides initial isolation of 2 or 3 fluids (or solid material) and allows subsequent, on-orbit mixing. Mixing is achieved as the fluid and septa are pushed forward until the fluid reaches a molded bypass in the glass barrel. The fluid then flows around the forward septum and actively mixes into the adjacent chamber. The glass barrel is sealed in a Lexan sheath with a plunger mechanism designed to move the septa, thus enabling the activation and termination processes.



S97-01180

Figure ADV-17 Standard FPAs

S97-05751

Figure ADV-18 CGBA Unit

The EV-FPA is operated in exactly the same manner as the standard FPA. The Standard FPA has been modified to allow for a larger volume (6.75ml) of initiation fluid, while maintaining the standard three levels of containment. The EV-FPA glass barrel is larger in diameter, and the standard Lexan sheath is used. An additional modification removes the bypass of the glass barrel, and replaces it with a dimple in the glass. A check valve is used to allow the fluid to pass from one chamber to the next. This allows for activation when pressure is applied to the plunger. The containment of the materials within the glass barrel remains the same as those for the standard FPA design.

The GE-FPA is operated in exactly the same manner as the standard FPA. The Gas Exchange Fluids Processing Apparatus is an evolution of the original FPA and the sealed volume of the Group Activation Pack. In the GE-FPA, the last rubber septum is replaced with a Lexan insert. The insert has three holes drilled through it and is sealed within the glass barrel by an O-ring. A hydrophobic PTFE membrane is attached to the insert and allows the passage of gases into or out of the A chamber without allowing liquids to pass (gas-permeable, water-tight). This membrane serves as the first level of containment inside the glass barrel as a replacement for the rubber stopper. The outer Lexan sheath provides the second level of containment.

After the GBA-ICM accelerometer system detects that orbit has been achieved, the FPAs are autonomously activated by the GAP-IIs at predetermined time intervals. The FPAs are subsequently terminated in a similar fashion at various times throughout the mission depending on the experimental processing requirements.

HARDWARE INTERFACE WITH SYSTEMS

Interface with the ICM for Space Shuttle operations is accomplished with an LCD display and keypad on the Polycorder/Datafielder (P/D) and an RS-232 data port. Various messages are displayed on the LCD, depending on the operating mode. Crewmembers may interface directly with the unit to transfer data, troubleshoot malfunctions, or update experiment processing times, as needed.

Interface with the ICM for Mir operations is accomplished with an LCD display and keypad. Various messages are displayed on the LCD, depending on the operating mode. Crewmembers may interface directly with the unit for status checks.

For Space Shuttle and Mir, the unit must be supplied with 28-Vdc electrical power to the main power connector on the ICM front panel. The main power circuit breaker serves as surge protection, as well as a means to apply and remove power from the unit. Flight and training units have identical electrical interfaces.

DISPLAYS AND CONTROLS

The front panel of the ICM contains connector interfaces, displays, and crew interfaces. The connectors include 28-Vdc power, RS-232 data, and Payload and General Support Computer (PGSC) power (Space Shuttle operations). The display includes Light-Emitting Diode (LED) display for main power, thermal control, fan, and pump. The crew may remove power to the fan, pump, thermal control, and main power using circuit breakers on the front panel. The air inlet/outlet is also on the front panel. For Space Shuttle operations, the air outlet is reconfigured to vent to the side to accommodate Mir.

The front panel of the ICM contains connector interfaces, displays, and crew interfaces. The crew uses the P/D to upload software or download data. The P/D will nominally display the temperature and MET. These interfaces are summarized below:

Quantity	Description
1	MAIN POWER circuit breaker
1	THERMAL CONTROL circuit breaker
1	FAN circuit breaker
1	PUMP circuit breaker
1	P/D keypad
1	P/D LCD display
1	Thermostat

The P/D will nominally display the temperature, the temperature set point, Mission Elapsed Time (MET), and Decreed Moscow Time (DMT). The crew may also interface with the P/D to upload software or download data. Each ICM will be capable of interfacing with the Mir Interface to Payload System (MIPS)-2L for data download. Software may be loaded onto the P/D in case all of the software is either erased or corrupted (contingent procedure).

DISPLAYS

The main power LED is illuminated whenever power is available and the main circuit breaker is closed.

The P/D LCD displays current MET, DMT, temperature, and temperature set point during nominal operations. Various other status messages are displayed, depending on the operational mode, but will return the nominal display when complete. The P/D LCD display descriptions and quantities are listed below:

Quantity	Description
1	MAIN POWER on/off green LED display
1	FAN on/off green LED display
1	THERMAL CONTROL on/off red (heating)/green (cooling) LED display — off - (neutral)
1	PUMP on/off green LED display
1	P/D LCD display with temperature and temperature set point and MET and DMT indication

CONTROLS

The main power circuit breaker is also used as the main power on/off switch. Opening this circuit breaker removes all power from the locker. During nominal operations, this circuit breaker will remain closed. The Control descriptions and quantities are summarized below:

Quantity	Description
1	MAIN POWER Circuit Breaker
1	FAN Circuit Breaker
1	THERMAL CONTROL Circuit Breaker
1	PUMP Circuit Breaker
1	P/D keypad
1	P/D LCD display

The LEDs that are displayed on the front panel identify main power, thermal control, pump and fan. Also displayed is the thermostat which is used to control the temperature inside the ICM. The crew may remove power from the fan, pump, thermal control, and main power using the circuit breakers. These interfaces are summarized below:

Quantity	Description
1	MAIN POWER on/off green LED display
1	THERMAL CONTROL heating/cooling yellow/green LED display
1	FAN on/off yellow LED display
1	PUMP on/off yellow LED display
1	P/D LCD display with temperature and MET indication

MIR STANDARD Y-CABLE

P/N: SEM46115598-301
Qty: 1
Mass: .63 kg
Power: N/A
x,y,z: 304 x 0 x 3 cm

Optizon Liquid Phase Sintering Experiment (OLiPSE)

EXPERIMENT DESCRIPTION

The experiment consists of heating samples of compressed metal powders to the melting point of one of the metal constituents, holding the temperature approximately 50 °C above the melting point for a predetermined period of time and then letting the samples cool. The following type of materials are planned to be used in the Optizon furnace on Mir: Copper (melting point 1375 K), silver, (melting point 1243 K), and mixtures of copper and silver in different mixtures with iron and cobalt. These mixtures are cold compressed at high pressures at the University of Alabama in Huntsville (UAH) and are stable compacts when shipped. The compacted metals are installed in ampoules.

Previous experiments were conducted in Argon gas, but vacuum is requested for the Optizon furnace. A vacuum during the furnace processing could vent the ampoules. It would be best to vent the furnace to vacuum during the entire heat up phase and cool down phase with heating and cooling following ONYX programs.

SCIENCE OBJECTIVES

1. To study the formation of defects (voids) in the sintered products.
2. To analyze the effects of wetting and alloy formation.
3. To study grain sizes and shapes.
4. Ground studies for ampoule certifications and flight procedures development are required in parallel with training sessions.

HARDWARE DESCRIPTION

Flight Hardware for the OLiPSE experiment is summarized below:

Hardware Title	Part #/Serial #
High Temperature Liquid Phase Sintering Kit	600008
Camcorder System (NASA)	390043
8 mm Video Tape	840255
Multi-Use Bracket	852238
Multi-Use Clamp	852239
Ampoule/Tape Bag Assembly	97-OLiPSE-09, 10

There are four component classifications associated with this experiment: the 18 ampoules of the 18 specimens, ampoule bags, transportation container, and transportation pouch.

S97-10205

Figure ADV-20 OLiPSE Bag 10 Contents

S97-10211

Figure ADV-19 OLiPSE Bags

D.I.D.

Ampoule Bag Assembly

D.I.D.

Optizon Liquid Phase Sintering Experiment

Principal Investigator:

James Smith Jr., Ph.D.
University of Alabama (Huntsville)
(205) 890-6439

AMPOULE/TAPE BAG ASSEMBLY

P/N: 97-OLiPSE-09
Qty: 1
Mass: 2.31 kg
Power: 0
x,y,z: 20.02 x 14.02 x 20.02 cm

AMPOULE/TAPE BAG ASSEMBLY

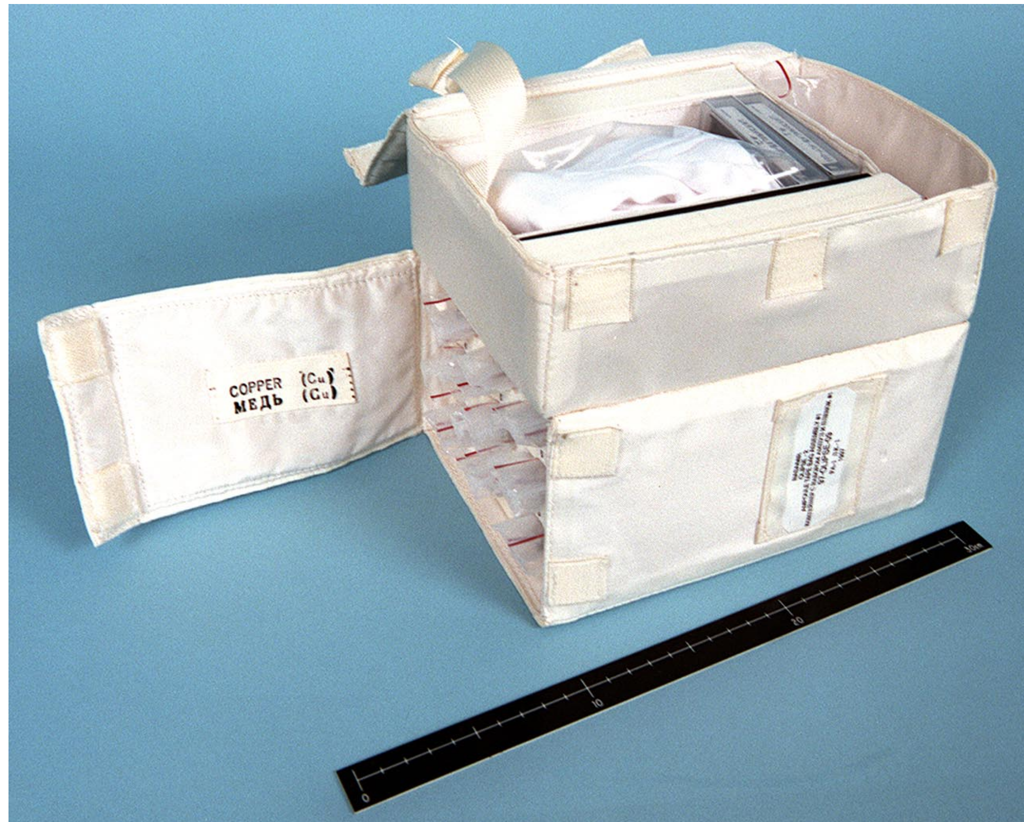
P/N: 97-OLiPSE-10
Qty: 1
Mass: 2.31 kg
Power: 0
x,y,z: 20.02 x 14.02 x 20.02 cm

The Liquid Phase Sintering (LPS) samples are enclosed in an ampoule of quartz that is ported to the atmosphere. Each ampoule has a stainless steel screw and filter of ceramic fiber to contain any loose powder that breaks free of the composite during vibration and shipping. Each ampoule is sealed in a separate plastic bag in the event the quartz ampoule fractures.

Each ampoule is cradled in a formed foam enclosure within a transportation container. The transportation container is enclosed by a SpaceHab integration pouch. All containers pass vibration requirements.

HARDWARE INTERFACE WITH SYSTEMS

The ampoule has been designed to interface with the central collet of the Optizon Furnace. The Optizon Furnace uses the Onyx control system architecture.



S97-10212

Figure ADV-22
OLiPSE Copper Bag 9 Opened

S97-10213

Figure ADV-21 OLiPSE Bag 9 From Above

S97-10214

Figure ADV-23 OLiPSE Bag 9 Contents

S97-10215

Figure ADV-24 Copper Control Sample

PACKAGING AND PROTECTION

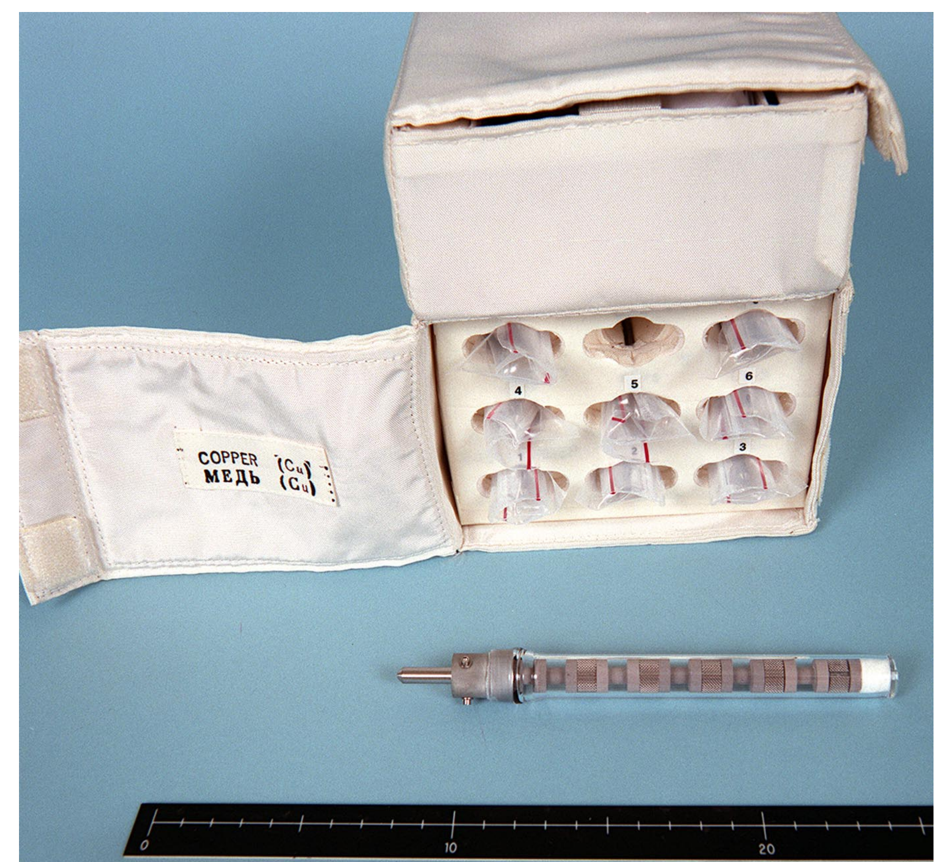
A foam transportation pouch is used to contain and protect the quartz ampoules. The ampoules are stored in Ziploc clear plastic bags while inside the foam container for inspection purposes. ⋇

S97-10216

Figure ADV-25 Copper Sample 5

S97-10206

Figure ADV-26 Silver Sample 14



S97-10203

Figure ADV-27 Copper Sample 8

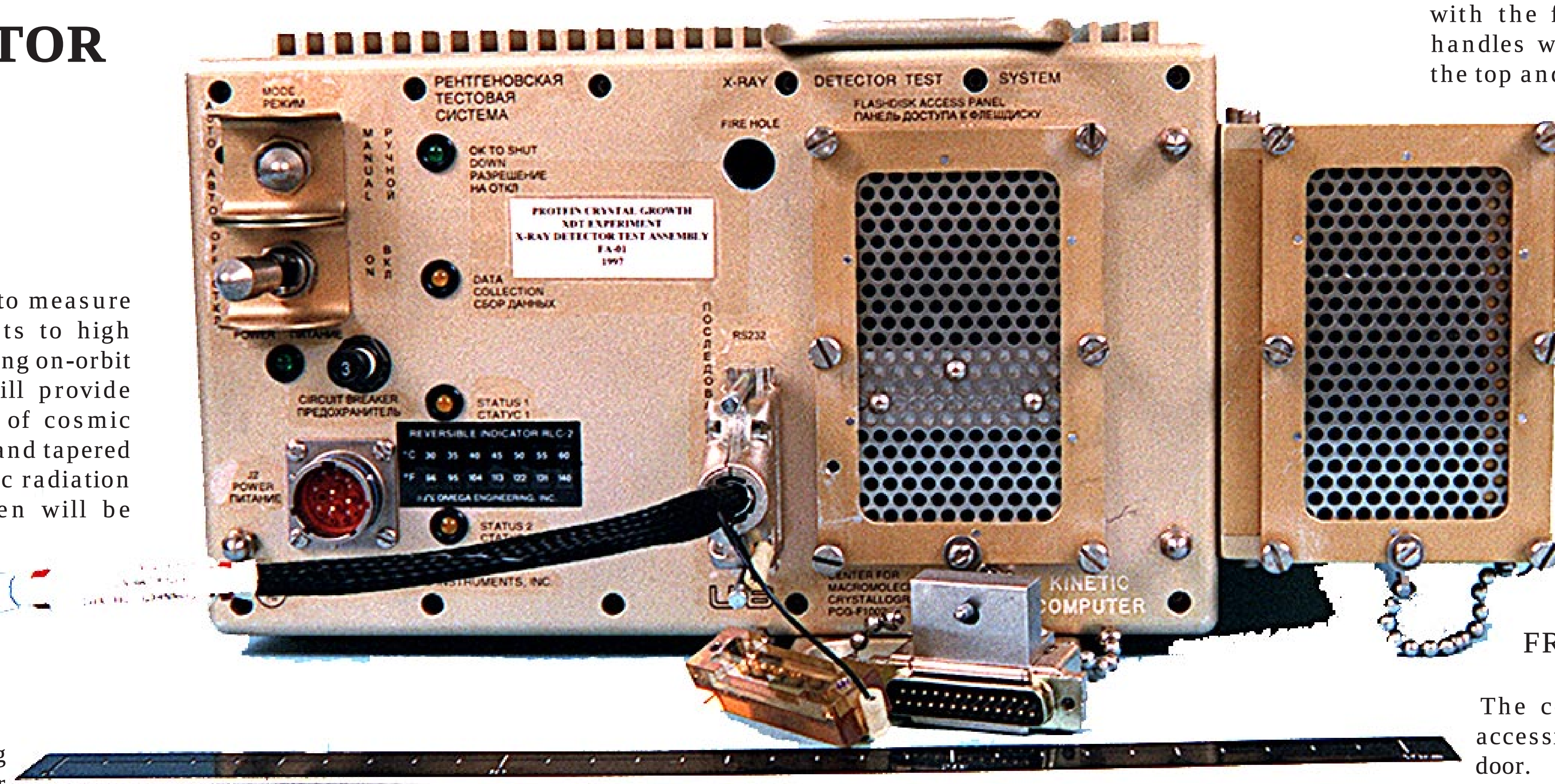
X-RAY DETECTOR TEST

EXPERIMENT DESCRIPTION

The purpose of the XDT experiment is to measure the sensibility of detector components to high energy background space radiation during on-orbit operations. The XDT experiment will provide valuable information on the effects of cosmic ionizing radiation on a phosphor screen and tapered fiber optic bundle. The effects of cosmic radiation passing through the phospor screen will be measured and a tapered optic bundle provides a larger area for detecting diffracted x-rays from the crystal.

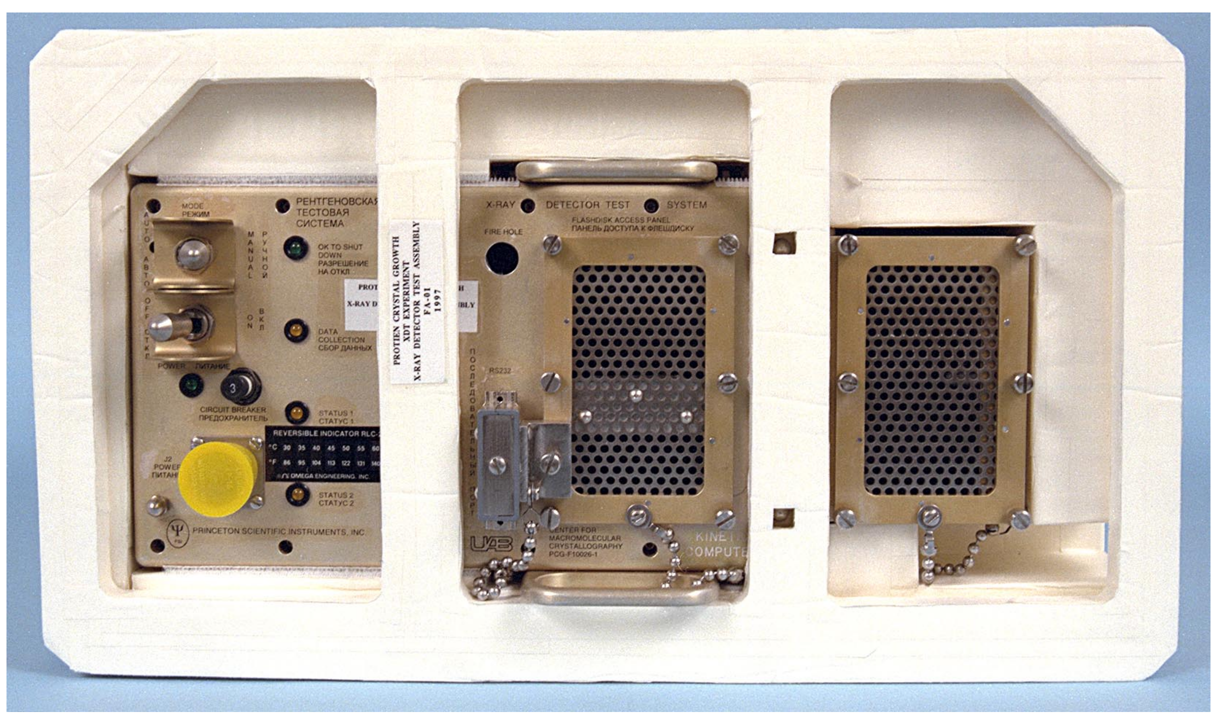
SCIENCE OBJECTIVES

Determine the effect of cosmic ionizing radiation passing through a phosphor screen and tapered fiber optic bundle. This information will help determine how to remove this noise from the x-ray diffractor pattern of a protein crystal.



S97-10402

Figure ADV-29 XDT Front Panel



S97-11804

Figure ADV-28
XDT Packed in Foam for Flight (the right side will have a panel over it during the mission)

XDT HARDWARE DESCRIPTION

The X-ray Detector Test (XDT) Experiment Assembly is being designed to fit inside a SpaceHab locker with a modified access door and all three door panels removed. XDT will be surrounded by at least 1.3 cm of foam. The controls and indicator LEDs will be accessible through the openings in the locker door. The locker door will be closed during Mir operations to ensure correct airflow. XDT will be actively cooled by a fan in the rear of the unit.

ENCLOSURE

The XDT enclosure consists of two Kinetic Computer Corporation RCC15 rugged card cages bolted back to back, with an air duct attached to the right side of the assembly for air discharge. The rugged card cages are an off-the-shelf item with the following modifications: the front handles were removed; handles were added to the top and bottom of the unit; the rubber gasket was removed; holes were cut in the back of both card cages for air flow and wire pass-throughs; a hole was added in the back card cage for mounting the fan.

In addition, the mounting flange on the right side of the unit was modified to attach the air duct, vent and mounting holes were added to the front panel, and various screw holes were added. The air duct was constructed from 6061-T6511 aluminum. Both of the card cages and the air duct are alodined to provide a conductive external surface.

FRONT PANEL

The controls and indicator LEDs will be accessible through the openings in the locker door.

The power connector (J2) will be connected to a SpaceHab-provided power cable for operations in SpaceHab and a Mir-provided power cable for operations on Mir.

The circuit breaker (3A) (push on, pull off) provides circuit protection for the XDT power distribution system and provides a secondary means of removing power from the experiment. The power switch (2 position toggle switch) provides a primary means of removing power from the experiment. The circuit breaker and main power switch break the hot line only. The mode switch will be in auto mode during operation. It will be moved to manual mode to reconfigure the experiment using the MIPS-2L on Mir.

The RS-232 connector (25 pin) is used to connect the MIPS-2L to the XDT experiment using a RS-232 cable (Mir-provided). A tethered connector cover is provided for the RS-232 connector, which must be in place for the hardware to function correctly.

The flashdisk access panel is the screened air inlet vent for XDT. It is also a cover for the

D.I.D

X-Ray Detector

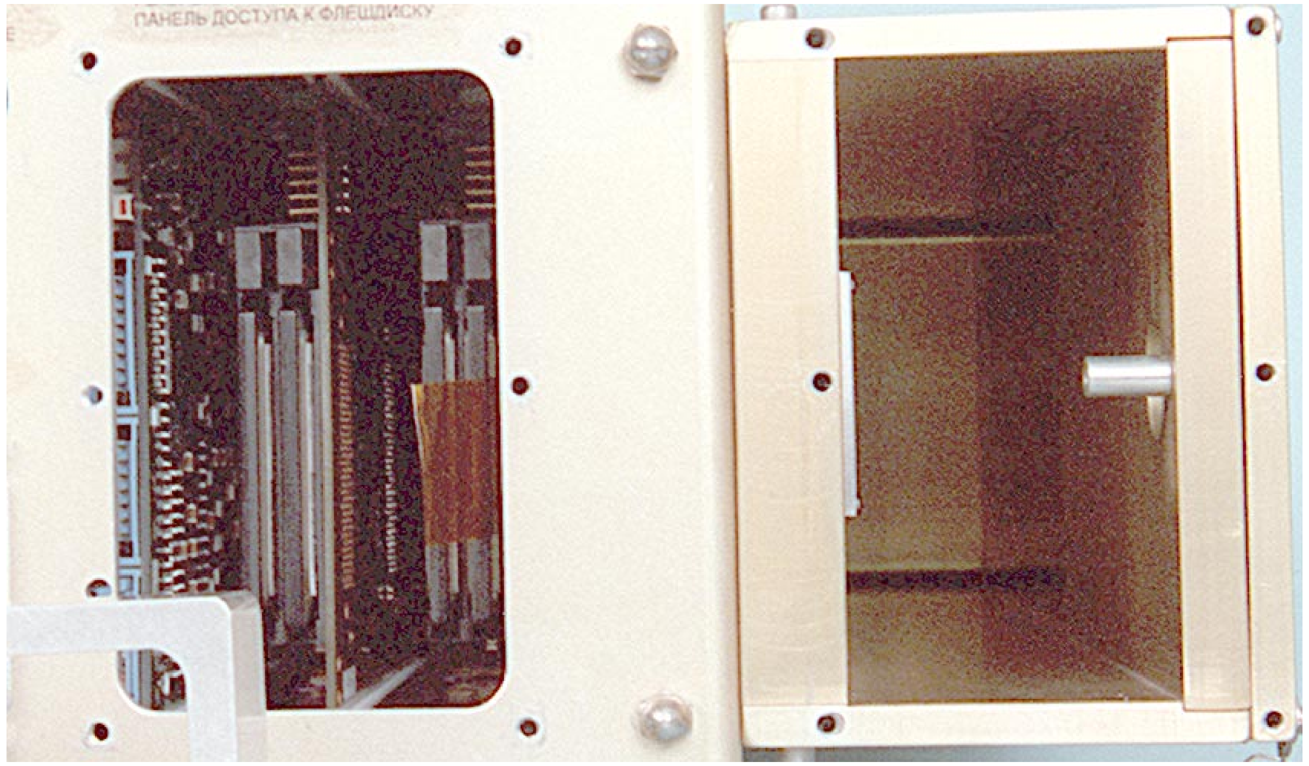
Principal Investigator:
Dr. Lawrence J. DeLucas, O.D., Ph.D., D.Sc. hon
Center for Macromolecular Chrystalography
Director
(205)934-5329

Dr. Bill McDonald
(205)581-2904

X-RAY DETECTOR

P/N: PCG-F10026-1
Qty: 1
Mass: 23.30 kg
Power: 17 W
x,y,z: 50.9 x 43.5 x 24.8 cm
Loc: Priroda, SIC3-III-8
DID#: SLM46116051

Power Consumption:
15.68 W
Start-Up Current:
4.8A, 2.1 msec
Onboard Electrical Supply:
DC source 23-32 V
Insulation Resistance:
20 Mohm (1 Mohm high humidity)
Temperature:
+5° C- +40° C
Gas Environment:
78% Nitrogen
40% Oxygen
3% CO$_2$
2% H
.01% He
Air Pressure:
450 - 970 mm Hg
Humidity:
10-80% (at nominal temp.) 95% for 3 hours
Vibration: per US/R-002
Noise Generation:
<60 Db at 1 meter
Operational Life:
≥14320 hours (6 mo.)
Shelf Life:
5 years



S97-06873

Figure ADV-30 XDT Interior Slots

PCMCIA flash memory card, which will be removed from XDT prior to the Shuttle undocking from Mir and returned on the Shuttle.

The air outlet panel is the screened air outlet vent for XDT. It is also a cover for the drawer holding the program diskettes which will be removed from XDT and used to adjust the parameters of the hardware on Mir. Both screens are tethered to the front panel.

Light-Emitting Diodes (LEDs)

The temperature indicator will indicate the temperature of the XDT front panel. The XDT front panel has five LEDs. The power LED (green) serves as a positive indication of power. It will be illuminated when XDT has power.

The Data Collecting LED (yellow) is illuminated during data collecting. It blinks slowly (2 second period) during the core of data histogram building and is continuously illuminated during other parts of the data collecting cycle; e.g., while creating or writing data files to the flash disks.

The OK-to-Shutdown LED (green) is illuminated continuously when data collection has been completely stopped (usually by moving the mode switch from "Automatic" to "Manual"). Removing power from XDT without waiting for the OK-to-Shutdown LED to light, including accidental power interruptions, will generally cause the last of the data files to be lost. This LED will occasionally flash briefly (for less than half a second) during automatic data collecting. This should be ignored.

TABLE ADV.4
EXPERIMENT FLIGHT HARDWARE

HARDWARE TITLE	QUANTITY	PART# / SERIAL#
XDT Assembly	1	PCG-F100026-1
PCMCIA Memory Card	4	PCG-F10028-1&-3
Program Diskette	2	PCG-F10027-1
XDT PGSC Cable	1	PCG-F50029-1

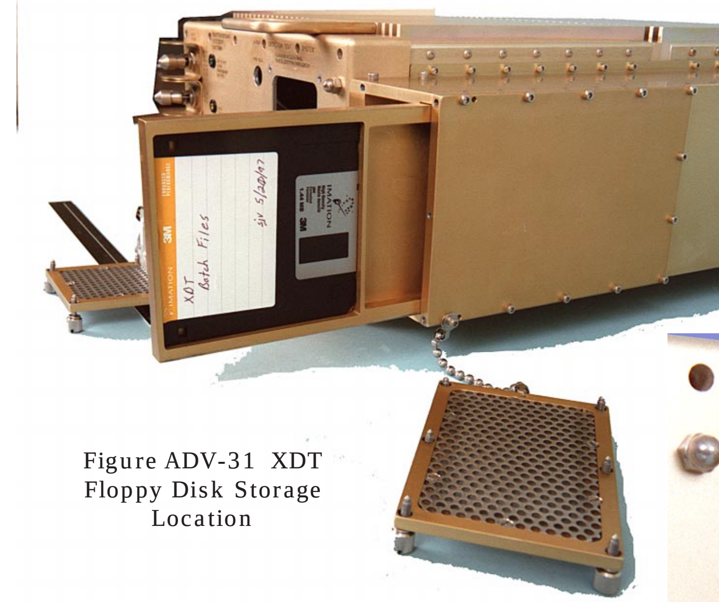


Figure ADV-31 XDT Floppy Disk Storage Location

S97-06876

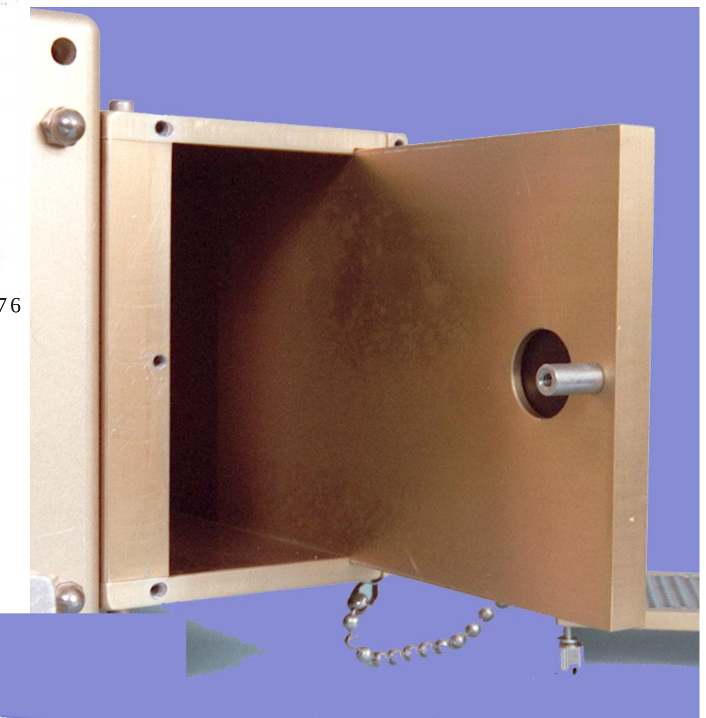


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Figure ADV-33 XDT Sliding Panel Extended

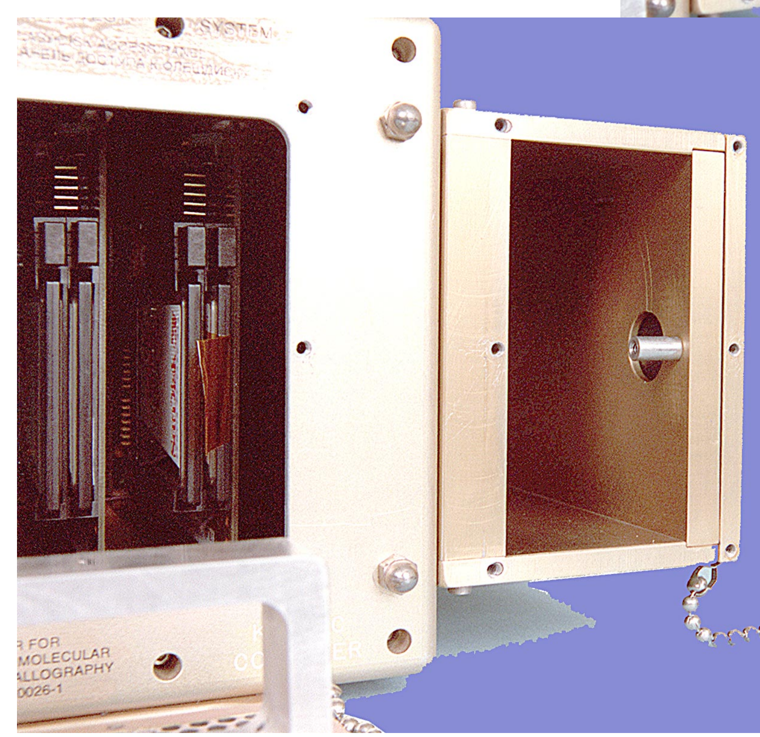

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Figure ADV-32 XDT Sliding Panel Closed

The Data Collection LED and the OK-to-Shutdown LED are complementary in that the illumination of one implies the extinction of the other; so, excluding momentary blinks, one or the other is always illuminated if the XDT system is working correctly.

The Status 1 LED and the Status 2 LED (both yellow) are never illuminated by the present software. However, the software-to-hardware interface to illuminate these LEDs is in place if a need for these indicators should be developed.

HARDWARE SUBSYSTEMS

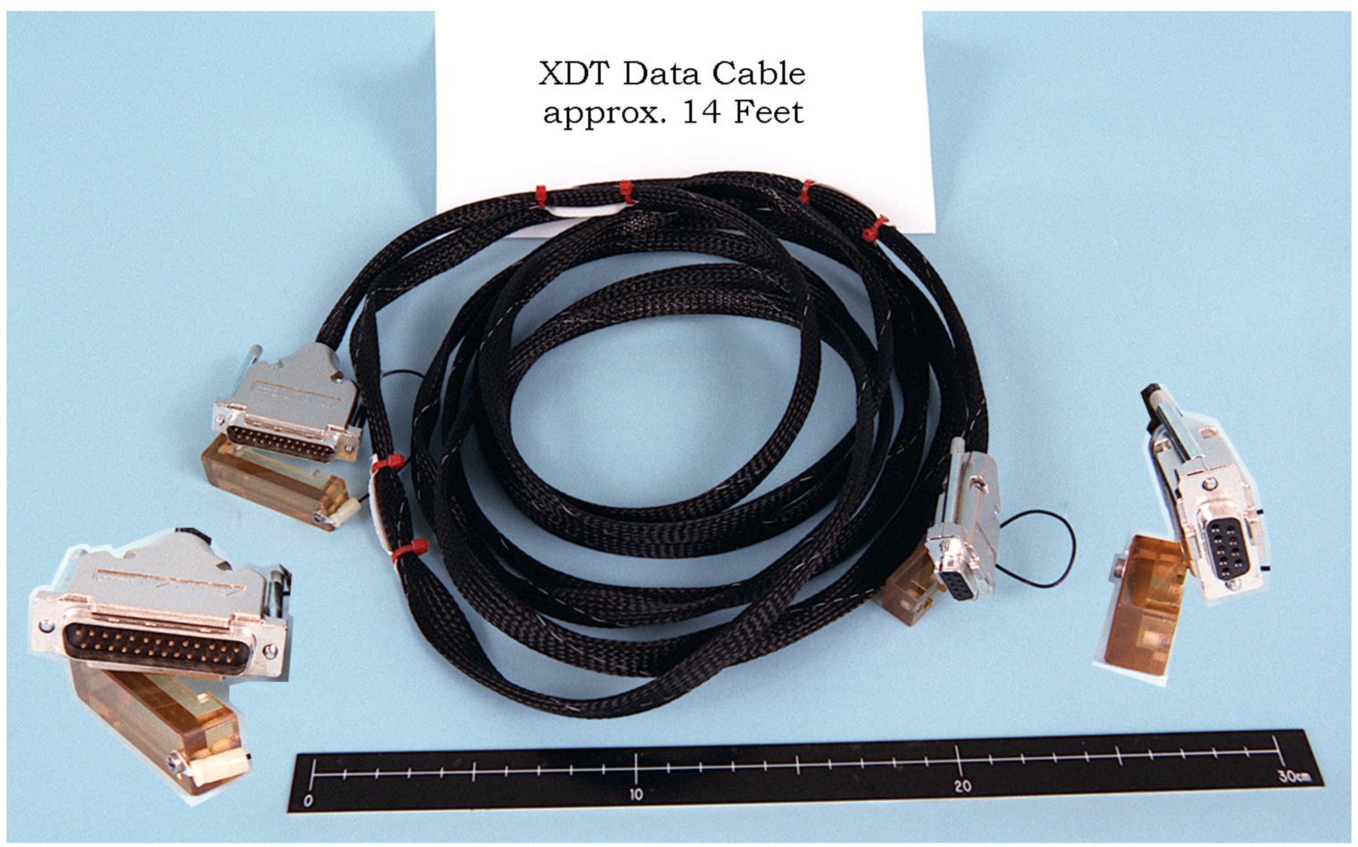
The front card cage houses the computer, power conditioning/circuit protection (low voltage), and the PCMCIA flash Random Access Memory (RAM). The rear card cage houses three Photomultiplier Tube/Power Supply (PMT/PS) Card Assemblies. The air duct houses the fan and a drawer for the program diskettes.

COMPUTER SUBSYSTEM

The computer consists of a single board computer, two PCMCIA interface cards, four PCMCIA flash memory cards, one interface Printed Circuit Board (PCB), and three PMT channel PCBs. The front card cage has a 12 slot backplane that all of the PCBs plug into. All of the PCBs are held rigidly in place. The four PCMCIA flash memory cards are accessible through the flashdisk access panel without removing the XDT front panel. One of the PCMCIA flash memory cards will be removed from XDT after four days of operation and returned on the Shuttle, the other three will remain in the hardware.

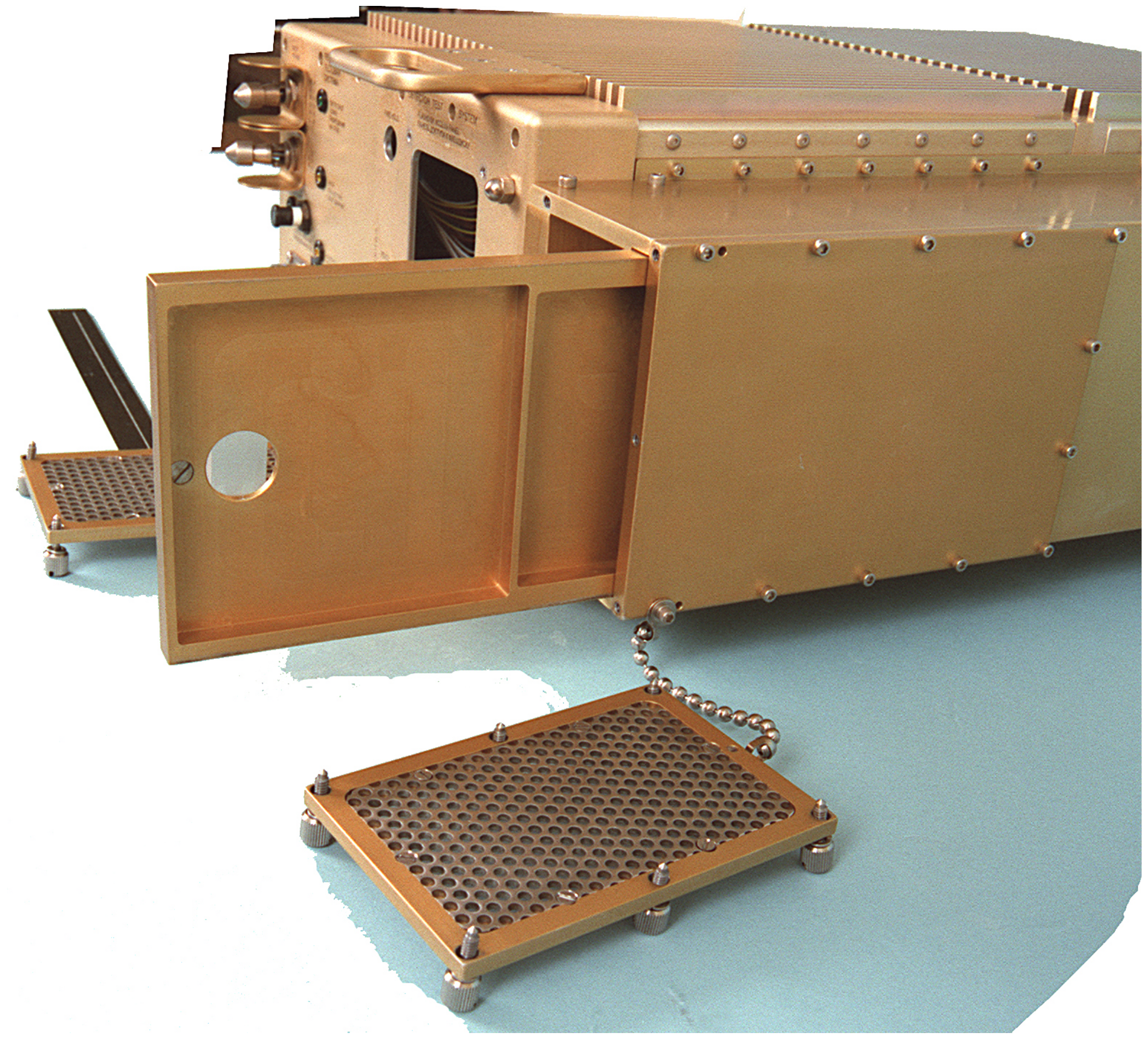
PMT/PS CARD ASSEMBLY

The rear card cage does not have a backplane. Three PMT/PS card assemblies are installed with Wedge-Lok card retainers, which hold the assemblies rigidly in place against the side walls.



S97-10441

Figure ADV-34 XDT Data Cable



S97-06877

Figure ADV-35 XDT Empty Floppy Disk Slot

All of the high voltage circuitry is located in the rear card cage and will NEVER be accessible during training or flight operations.

The Photo Multiplier Tube (PMT), fiber optic coupler, and x-ray phosphor screen (separated by Teflon spacers) is installed into the PMT/fiber optic housing. A compression spring and shim stock is added to fill the housing. Brass retainer rings are used to keep the components inside of the PMT/fiber optic housing. This assembly is not accessible during the mission. The PMT/fiber optic housing is attached to the PMT isolation plate, which is a piece of G11 fiberglass.

The PMT/fiber optic housing is covered with the PMT/fiber optic housing cover. The PMT/fiber optic housing cover serves two purposes: it prevents light from entering the compartment with the PMT and it provides an enclosure around the PMT/fiber optic housing. The PMT/fiber optic housing cover has a hole in it for an LED for ground calibration purposes. There is a gap between the PMT/fiber optic housing cover and the PMT isolation plate for pressure relief. The PMT isolation plate with the PMT/fiber optic housing cover attached is mounted on one side of a PMT/PS mounting plate.

RS-232 DATA CABLE

P/N: PCG-F50029-1
Qty: 1
Mass: .60 kg
Power: 0
x,y,z: 426 cm
Loc: Priroda, SIC3-III-8
DID#: SLM46116051

The High Voltage Power Supply (HVPS) is mounted on the other side of the PMT/PS mounting plate. The HVPS is connected to the PMT with a short piece of coax cable, which is potted into the HVPS. The high voltage never leaves the PMT/PS card assembly. There are 2 connectors on this assembly for low voltage power (<28Vdc) and signal wires, which connect to the internal computer.

The High Voltage Power Supply (HVPS) (PMT-30C-N) can produce up to 3,000V with a current of up to 1mA. Automatic current limiting occurs at approximately 120% of maximum rated output current at maximum rated output voltage. The HVPS output voltage is used to adjust the sensitivity of the PMTs, and will be controlled by the internal computer. The PMT/fiber optic housing will be connected to the negative output of the HVPS to eliminate surface leakage problems near the sensitive cathode end of the PMT. The PMT/fiber optic housing cover and PMT/PS mounting plate provide a shield around the PMT/fiber optic housing, and will be connected to chassis ground. The rear compartment of the experiment will not be accessible to the crew at any time.

PMT

The PMTs will be used in all three PMT/PS card assemblies. The PMT is a space-quality, end-on photomultiplier tube with a 25mm diameter sensitive area. The PMT has an epoxy fiberglass shell with a sapphire window material.

PMT/fiber optic housing has a screen on one end to block particles greater than 50 microns from leaving the housing. The fiberglass end of the PMT is at the other end of the PMT/fiber optic housing. Each PMT (4.25 inches long) is fitted to its mating cylinder to a slip fit of <1/2 turn of .001 inch mylar tape in precision. The x-ray phosphor screen, fiber optic coupler, and the frangible end of the PMT are contained between the screen and the precision fit of the PMT to the housing. This construction prevents the release of any frangible materials into habitable areas.

FIBER OPTIC COUPLER

The fiber optic couplers will be used in two of the three PMT/PS card assemblies. It is a piece of glass 25mm in diameter and 66mm long. The PMT/fiber optic housing has a screen on one end to block particles greater than 50 microns from leaving the housing. The fiberglass end of the PMT is at the other end of the PMT/fiber optic housing. Each PMT (4.25 inches long) is fitted to its mating cylinder to a slip fit of <1/2 turn of .001 inches mylar tape in precision. The x-ray phosphor screen, fiber optic coupler, and the frangible end of the PMT are contained between the screen and the precision fit of the PMT to the housing. This construction prevents the release of any frangible materials into habitable areas.

X-RAY PHOSPHOR SCREEN

The phosphor screen will be used in only one of the three PMT/PS card assemblies. The phosphor layer was deposited on a 0.001 inches thick aluminized Mylar substrate having an outer diameter of 1.375 inches. The information on the phosphor material has been provided to the JSC toxicologist. PMT/fiber optic housing has a screen on one end to block particles greater than 50 microns from leaving the housing. The fiberglass end of the PMT is at the other end of the PMT/fiber optic housing. Each PMT (4.25 inches long) is fitted to its mating cylinder to a slip fit of <1/2 turn of .001 inches mylar tape in precision. The x-ray phosphor screen, fiber optic coupler, and the frangible end of the PMT are contained between the screen and the precision fit of the PMT to the housing. This construction prevents the release of any frangible materials into habitable areas.

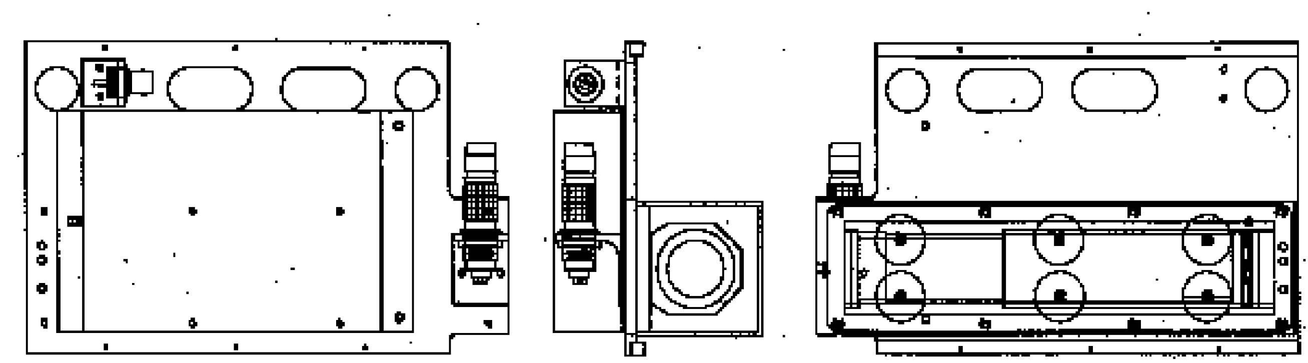


Figure ADV-37 XDT Rear Card Cage Assembly

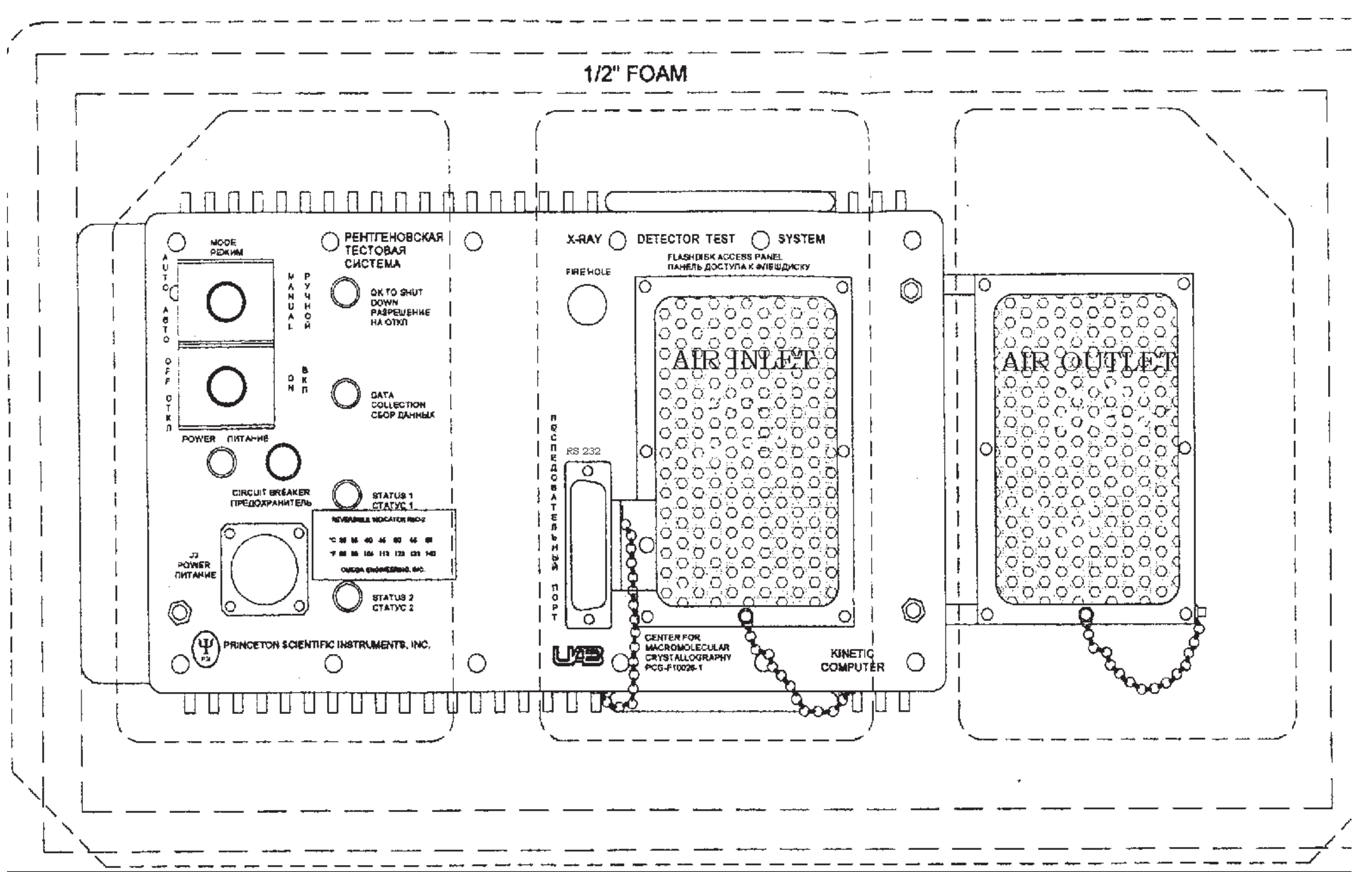


Figure ADV-36 XDT Air Inlet

FORCED AIR COOLING SUBSYSTEM

Forced air cooling enters the XDT experiment through an air inlet in the center of the front panel (labeled flashdisk access panel). The air passes over the computer and through a hole in the back left of the front card cage to the rear card cage. The air then passes over the three PMT/PS card assemblies to the fan. The fan is a Comair Rotron flight II 90 series brushless DC fan (P/N: 031171). The Fan is operated from the ±12Vdc power supply at 24 Vdc. The fan is 3.62 x 3.62 x 1 inches deep and runs at 2350 RPM. From the fan, the air is exhausted out the right side of the front panel. The air will exhaust out the front of the locker for SpaceHab operations. When XDT is transferred to Mir, the right panel on the locker door will be installed, and the front panels on the right side of the locker will be removed to allow the air to exhaust out the side of the locker for operations on Mir. The two program diskettes are located in a drawer behind the front panel air outlet screen.

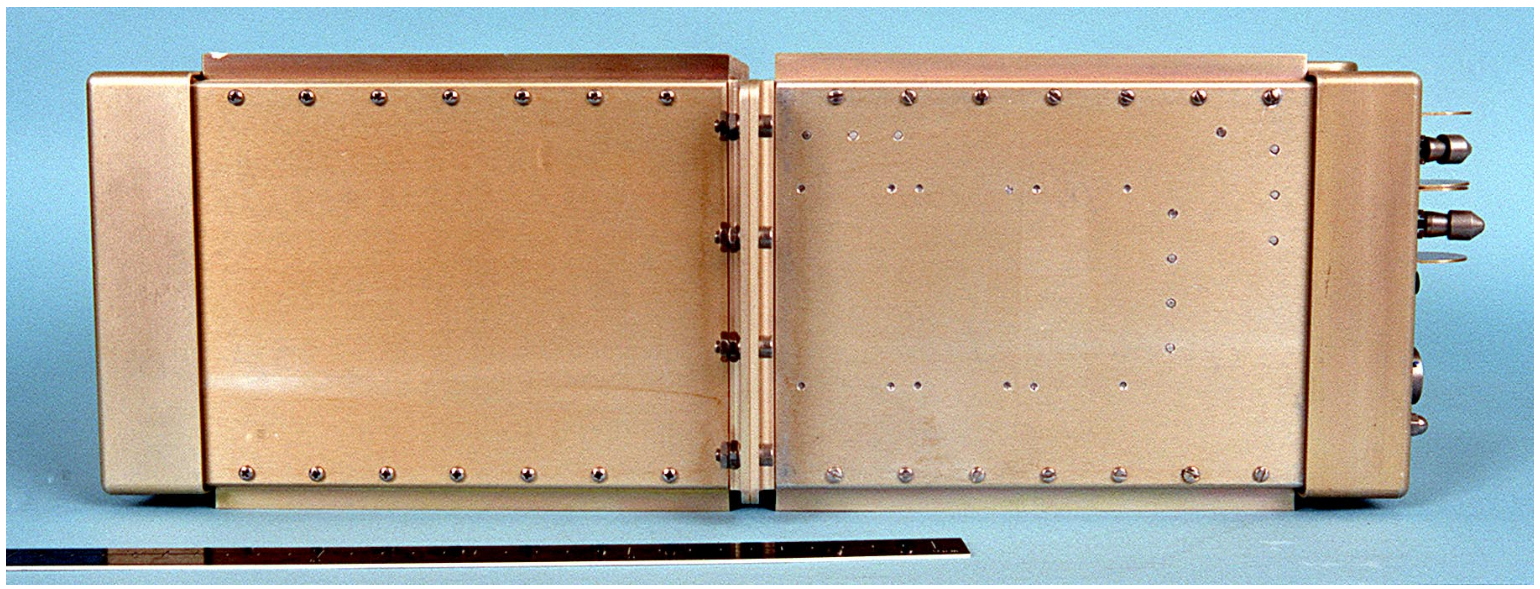


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Figure ADV-38 XDT Left Side

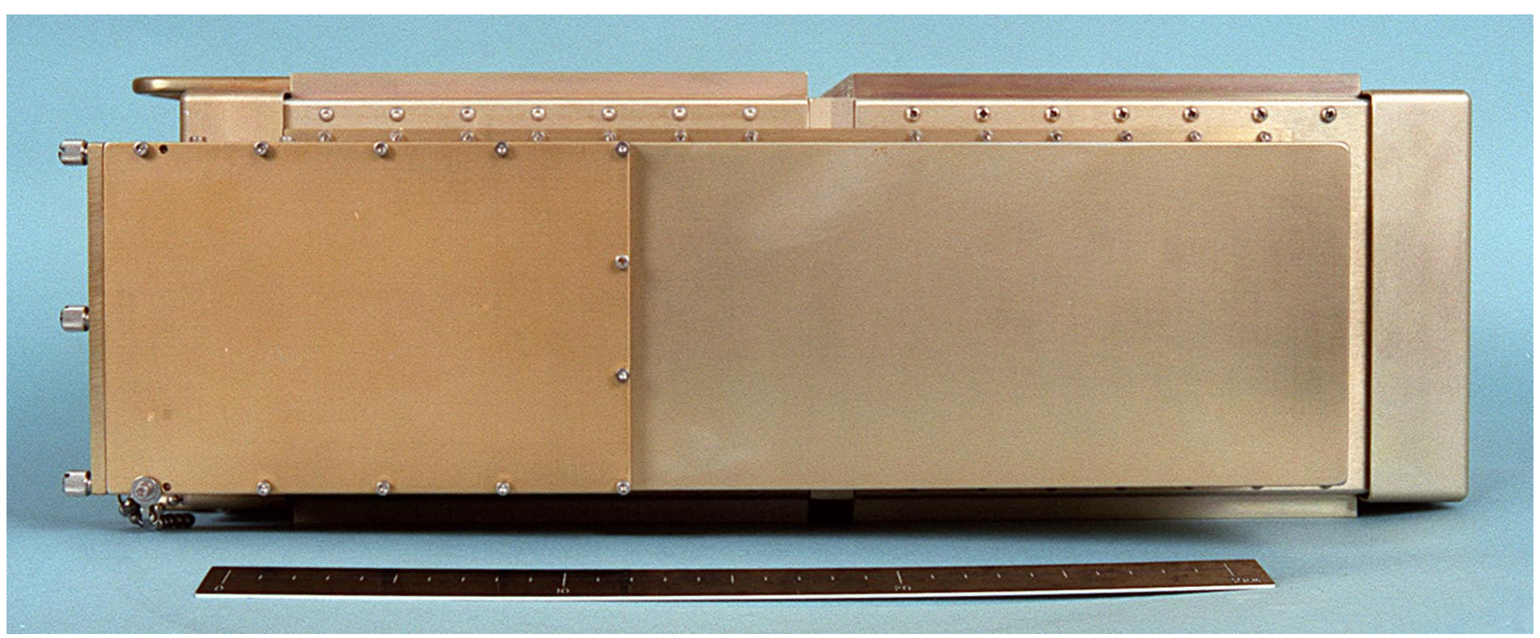

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Figure ADV-39 XDT Right Side

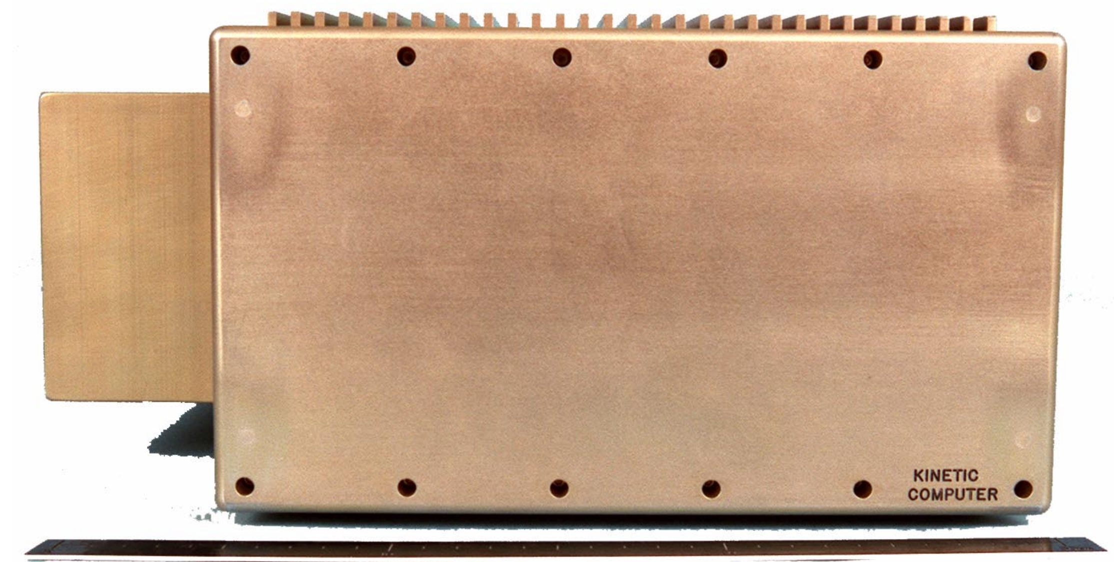

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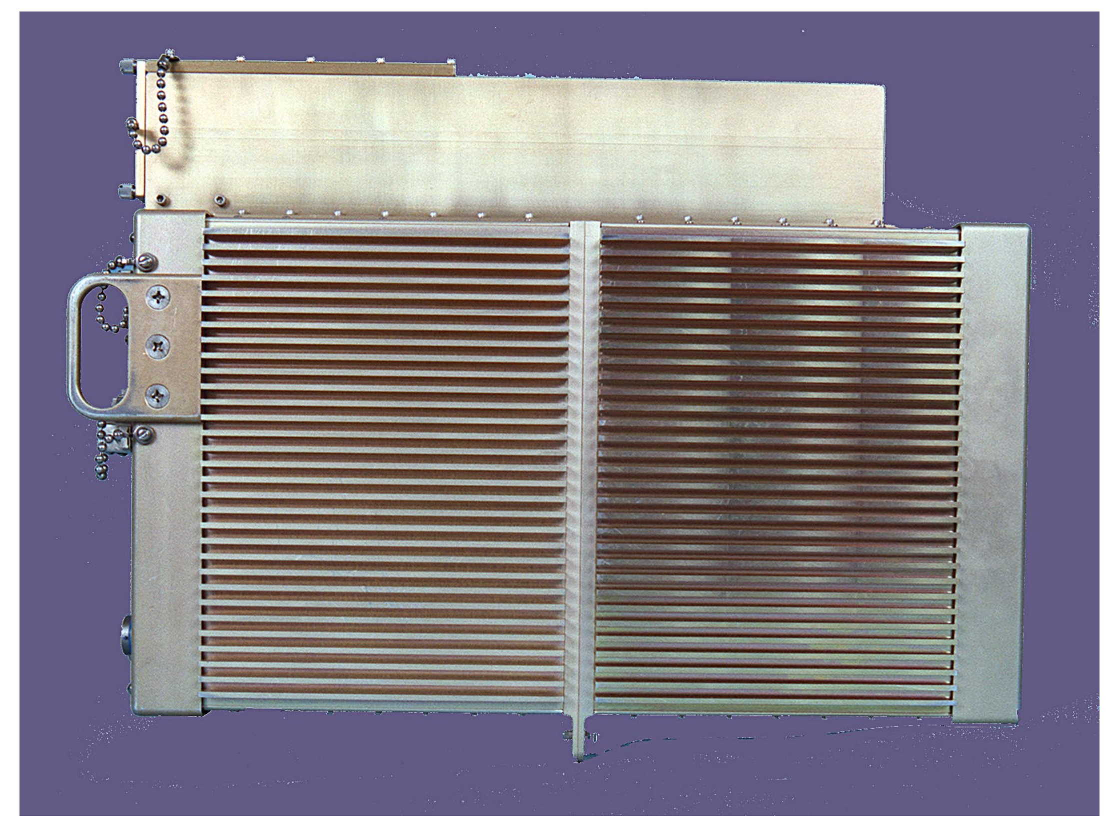
Figure ADV-40 XDT Back Side



S97-06882

Figure ADV-41 XDT Top Panel

POWER CONDITIONING / CIRCUIT PROTECTION (LOW VOLTAGE)

XDT has a 3 amp circuit breaker and a main power switch, both of which break the hot line only. The 28 Vdc power is conditioned by two Interpoint DC/DC converters (+5Vdc and ±12Vdc). An LED is provided from the output of the 5 Vdc DC/DC converter for positive indication of power status. The +5Vdc and ±12Vdc outputs are used by the computer subsystem. The ±12Vdc output is also used to power the three High Voltage Power Supplies (HVPSs). XDT has EMI filters and a soft start circuit to help meet the EMI requirements.

BATTERIES

The backup battery from the single board computer has been replaced with a Ray-O-Vac model 844 4.5V alkaline computer battery. A carbon composition resistor and blocking diode are used to ensure that the battery is not charged.

HARDWARE INTERFACE WITH SYSTEMS

The XDT hardware has two primary interfaces with the Shuttle: structural and power. The XDT is housed in a middeck locker with a layer of foam on six sides. The controls and displays are accessible through the front panel of the Middeck Locker door. The XDT requires 28 ± Vdc power to operate on board the Shuttle and Mir.

The XDT experiment parameters can be adjusted by connecting the MIPS with the XDT through the RS-232 interface. This interface requires the MIPS unit, RS-232 cable (part of XDT Assembly) and power to the MIPS unit, all of which are supplied by the National Space Transportation System (NSTS). ☀

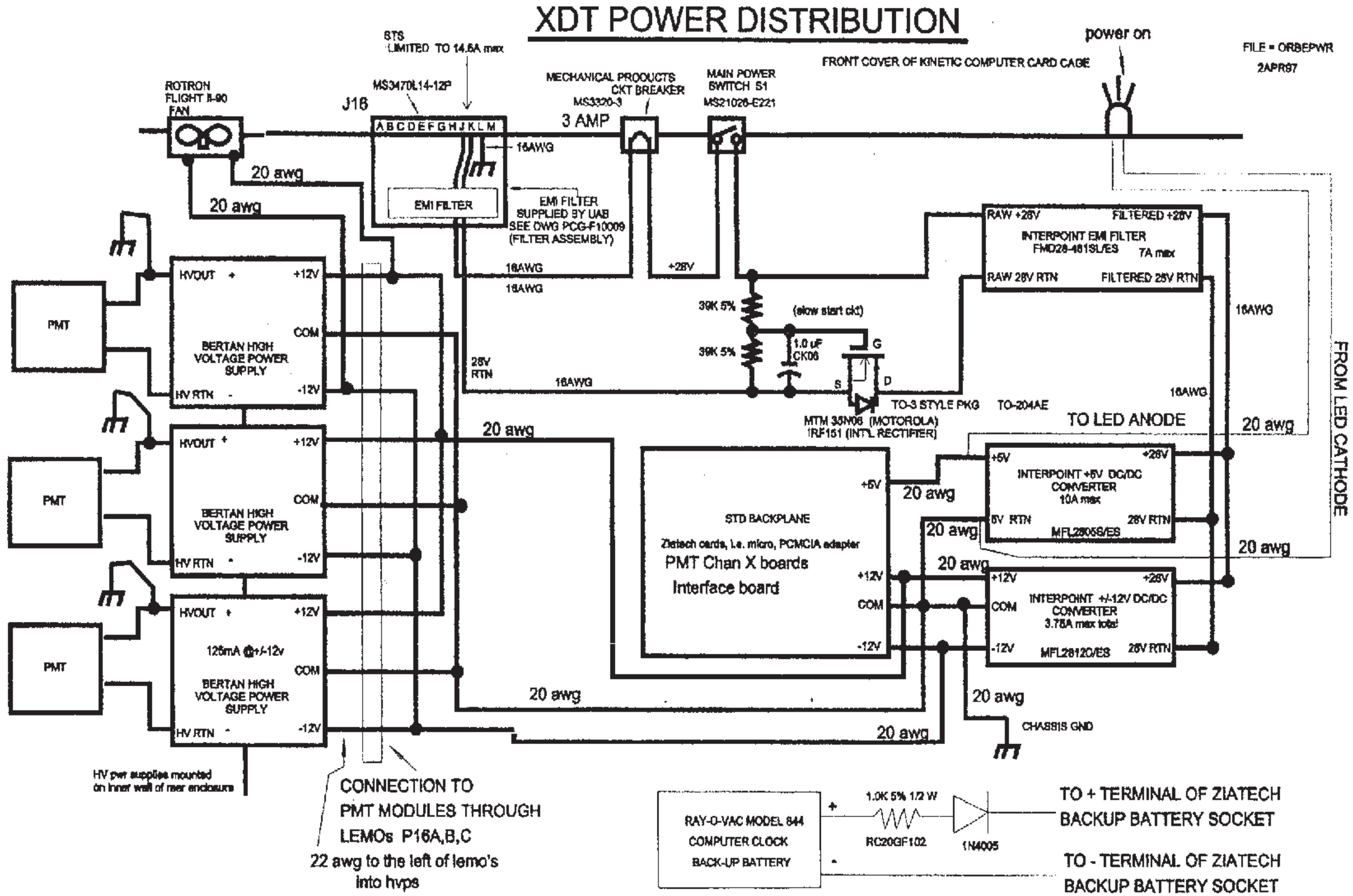


Figure ADV-42 XDT Power Conditioning/Circuit Protection Schematic

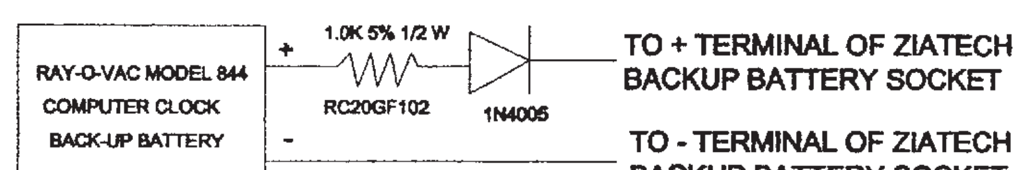


Figure ADV-43 XDT Battery Schematic