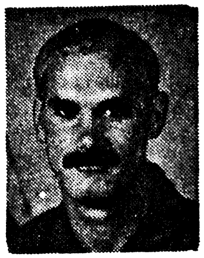

STS-42
Payload
Handbook

STS-42 CREW

Ronald S. Grabe
(Commander)

Stephen S. Oswald
(Pilot)



William F. Readdy
(Mission Specialist)

Norman E. Thagard
(Mission Specialist)

David C. Hilmers
(Mission Specialist)

Roberta L. Bondar
(Payload Specialist)

Ulf D. Merbold
(Payload Specialist)

STS-42 PAYLOAD HANDBOOK

NASA
National Aeronautics and
Space Administration
John F. Kennedy Space Center

STS-42 PAYLOAD SUMMARY

ORBITER BAY

Spacelab

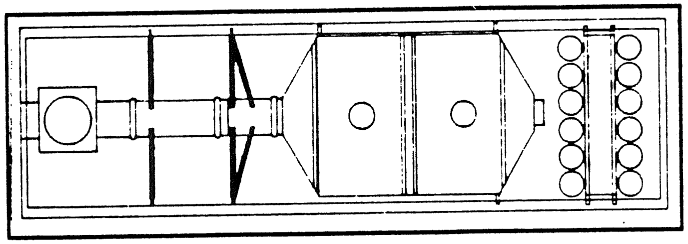
- IML-1 Long Module
- GAS Bridge

SCIENCE EXPERIMENT PAYLOADS

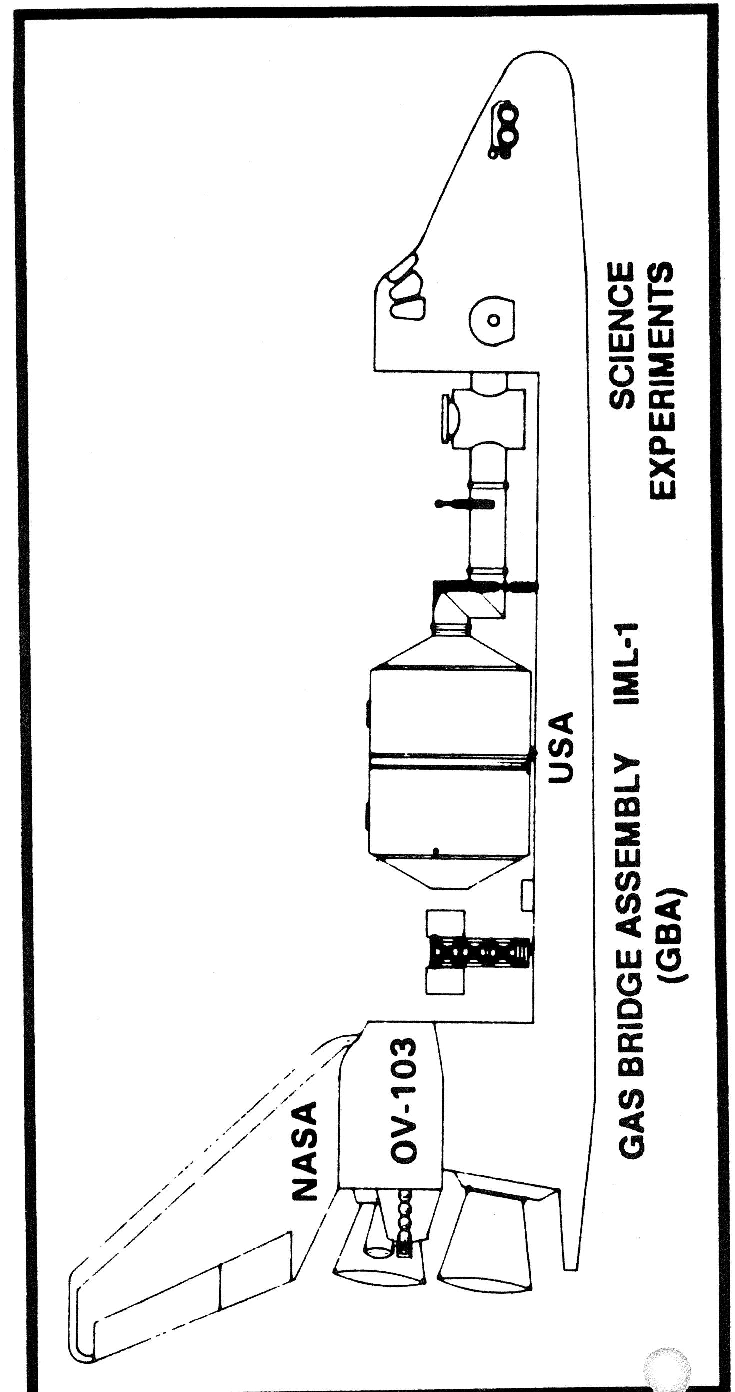
- GOSAMR-1
- IPMP
- RME III
- SE81-09
- SE83-02

TABLE OF CONTENTS

STS-42 FACT SHEET

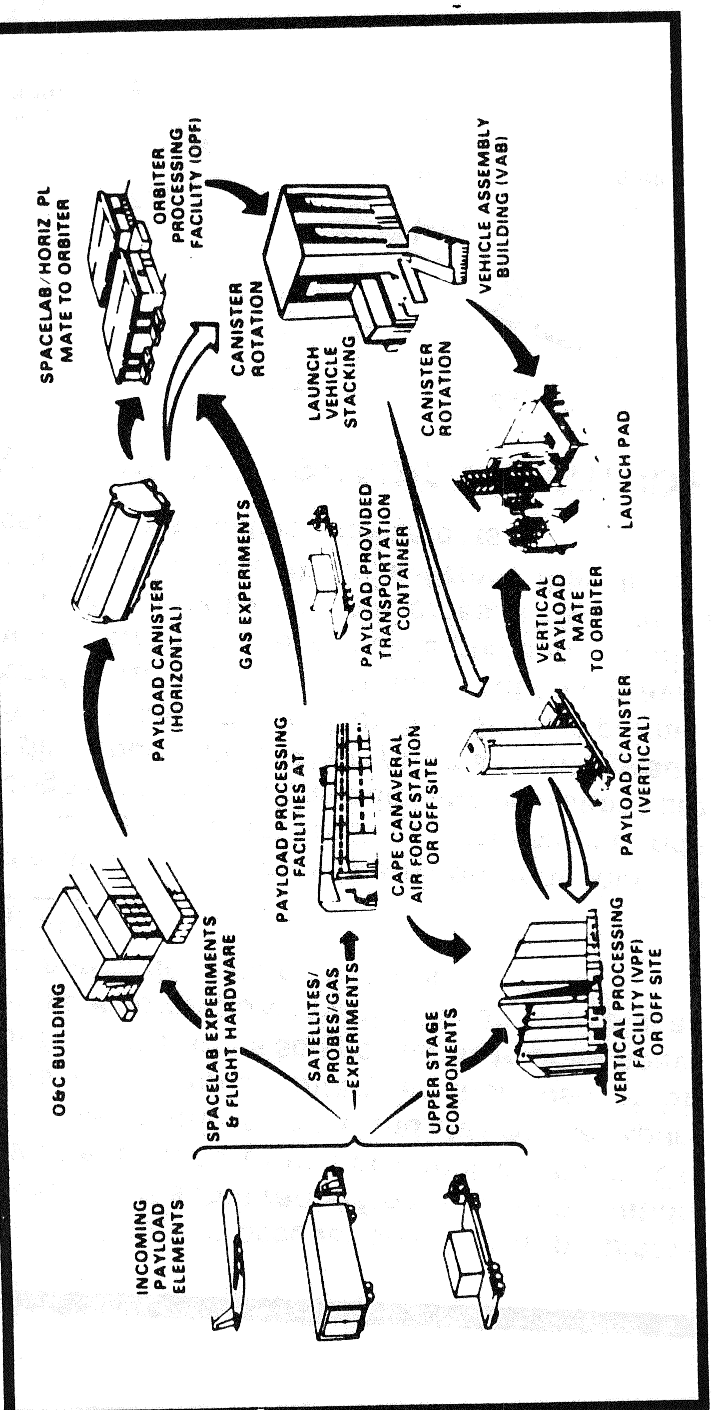


STS Flight Number	42
Target Launch Date	January 22, 1992
Orbiter	Discovery
Mission Duration	7 days
Crew Size	7
CDR:	Ronald J. Grabe
PLT:	Stephen S. Oswald
MS:	William J. Readdy
MS:	David C. Hilmers
MS:	Norman E. Thagard
PS:	Roberta L. Bondar
PS:	Ulf D. Merbold
PS: (Backup)	Roger K. Crouch
PS: (Backup)	Kenneth E. Money
Inclination	57°
Altitude	163 nmi
Scheduled Landing	DFRF



STS-42 PAYLOADS IN ORBITER BAY

PAYLOAD PROCESSING OVERVIEW



ORBITER BAY PAYLOADS

FIRST INTERNATIONAL MICROGRAVITY LABORATORY (IML-1)

Overview:

This mission is the first in the IML series of Spacelab (SL) flights designed to accommodate research in a microgravity environment. The IML concept enables scientists to apply results from one mission to the next and to broaden the scope and variety of investigations between missions. Data from the IML missions will contribute to the space station research base.

As the name implies, IML-1 is an international mission. Through six international space science research organizations, more than 200 scientists from 13 countries are collaborating with NASA on the IML-1 mission to provide the worldwide science community with a variety of complementary facilities and experiments.

Objective:

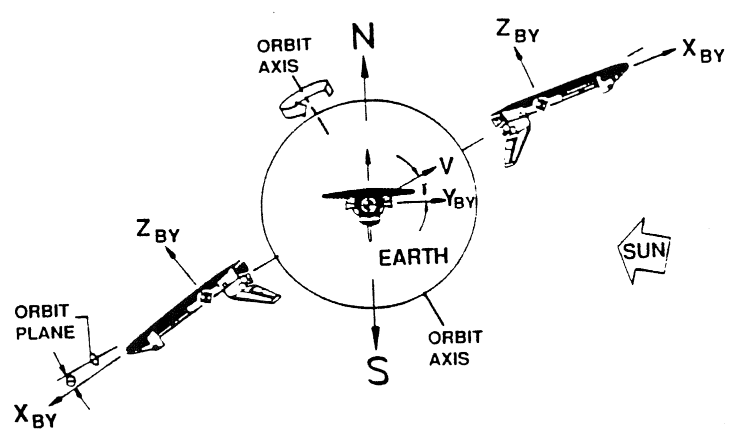
Research on IML-1 is dedicated to materials and life sciences. Materials science covers a broad range of activities, from understanding the fundamental physics involved in material behavior to using those effects to generate materials which otherwise cannot be made in the gravitational environment of the Earth.

In life science research, a reduction of gravitational effects allows certain characteristics of cells and organisms to be studied in isolation. These reduced gravitational effects also pose poorly understood occupational health problems for space crews that range from space adaptation syndrome to long-term hormonal changes. On IML-1, the material science and life science experiments are complementary in their use of SL resources. Materials science tends to draw heavily on spacecraft power while life science places the greatest demand on crew time.

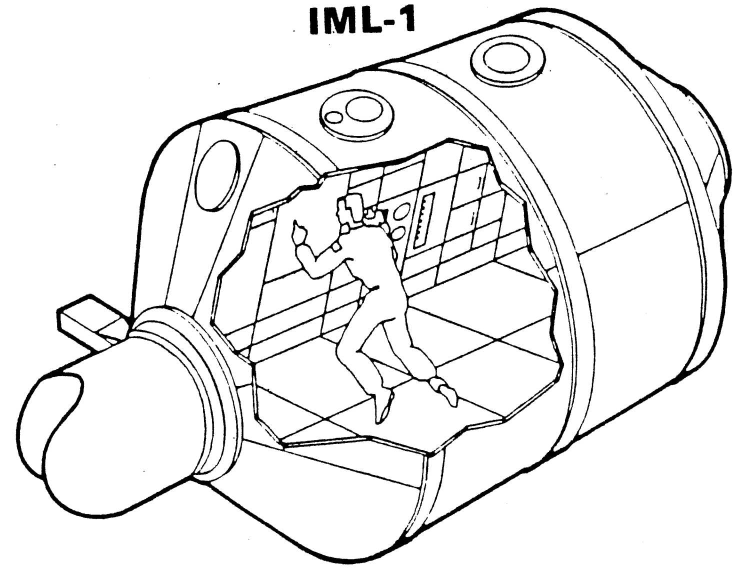
Attitude

In addition to a low-gravity environment, many of the IML-1 experiments require a very smooth ride through space so that their delicate operations are not disturbed. The best way to maintain a stable drift is to keep the tail of the Shuttle pointed toward Earth. In this orientation, called a gravity gradient attitude, the vehicle's position is maintained primarily by natural forces. This reduces the need for orbiter thruster firings that disturb acceleration-sensitive experiments.

IML-1 GRAVITY GRADIENT ATTITUDE



IML-1



MATERIALS SCIENCE EXPERIMENTS

Fluids Experiments System (FES)

Developed by Marshall Space Flight Center, the FES experiment performs a dual role. One experiment studies the growth of triglycine sulfate (TGS) crystals in low gravity. The other experiment, Casting and Solidification Technology (CAST), optically studies grain formation in the solidification of ammonium chloride and water (NH_4C1-H_2O).

The TGS experiment produces triglycine sulfate crystals along with video and holographic film records of their growth. CAST produces video and holographic data on material solidification.

The FES is comprised of two rack-mounted modules: the experiment modules (EM) and the support module (SM). Because many of the functions of the FES and the VCGS experiments are similar, some equipment in the SM is shared between the two.

Vapor Crystal Growth System (VCGS)

VCGS is an attempt to grow more perfect mercuric iodide crystals in a low-gravity environment by taking advantage of diffusion-controlled growth conditions and by avoiding the problem of strain dislocations produced by the weight of the crystal. This experiment was developed by the Marshall Space Flight Center.

This experiment produces a mercuric iodide (H_gI_2) crystal, along with video imaging of its growth.

Mercuric Iodide Crystal Growth (MICG)

The MICG experiment, developed by the National Space Research Center in France, is also an attempt to grow high quality, single crystals of mercuric iodide. The microgravity environment decreases the convection effects on crystal growth which are caused by density differences and helps to accomplish the objective of producing nearly perfect monocrystals.

MICG experiment hardware includes a furnace, support electronics, and eight flight cartridges containing 25 grams of mercuric iodide in compound form.

At specific times during each MICG experiment, the crew records the furnace temperature. These temperature records, along with the crystals produced, are returned to Earth for study.

Protein Crystal Growth (PCG)

Located in the middeck, the PCG experiment is designed to grow protein crystals in microgravity. Two refrigerator/incubator modules (R/IM's)

each the size of a middeck locker, are used: one operating at a temperature of 22° C, and the other at 4° C. PCG was developed by the Marshall Space Flight Center.

The PCG experiment produces large, high-quality protein crystals formed through a vapor diffusion method of crystal growth. These protein crystals are returned to earth and analyzed using X-ray crystallography.

IMAX Camera

The IMAX (maximum image) camera, provided by the Johnson Space Center, is a 70 mm color motion picture camera equipped with a fish-eye lens and five additional lenses used for different scene requirements. The camera is stored in an oversized locker with two loaded film magazines and extra rolls of film. Other equipment includes the 150-W caged photo floodlights, window shroud, and the audio-cassette recorder. All equipment is stowed in the SL module for use during SL activities. Ten rolls of film are carried onboard for camera use.

The camera can also be gimbal-mounted to the orbiter aft starboard window and both overhead windows for external views, and hand held for internal views.

Organic Crystal Growth with G-Jitter Preventative Measurement (OCGP)

In the OCGP, two large crystals of organic superconductor are grown in separate cells while on orbit. One cell is mounted with vibrational damping while the other cell is undamped. This allows additional investigation into the effects of damping on the crystals which are produced in the microgravity environment. Japan's National Space Development Agency developed this experiment.

Space Acceleration Measurement System (SAMS)

SAMS measures and records the small accelerations that the Spacelab (SL) module experiences during typical on-orbit activities. SAMS, provided by Lewis Research Center, is composed of three accelerometer sensor heads and a data acquisition system. Each sensor head is attached in a different location within the SL module.

SAMS will provide a better picture of small structural disturbances for future SL customers by providing data on: the accelerations caused by crew motion, the vernier reaction control system, venting, aerodynamics, and gravity that can have major impacts on many experiments.

Cryostat (CRY)

Cryostat, developed by the German Aerospace Research Establishment, will grow large protein crystals from protein, salt, and buffer solutions in a microgravity environment. Microgravity conditions allow the growing of large crystals that are required to perform X-ray crystallography analysis of the molecular structure. The IML-1 crystals will be compared to those grown on Earth in the cryostat and other facilities.

Critical Point Facility (CPF)

The analysis of critical point phenomena reveals a deeper insight into the physical properties of matter. Provided by the European Space Agency, CPF will investigate the enhanced critical point of fluid under microgravity. In an ordinary gravitational environment, the critical point of a fluid is difficult to maintain because of the density variations caused by gravity.

The CPF consists of four experiments. Each one will examine the physics at the critical point of the fluid by carefully controlling the temperature of the sample. Data is returned on the change in fluid properties through the use of video, still photos, and direct observations.

LIFE SCIENCES EXPERIMENTS

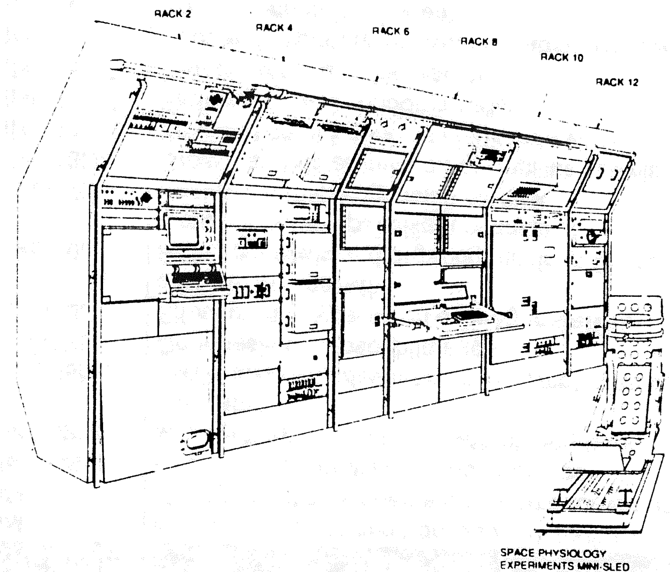
Gravitational Plant Physiology Facility (GPPF)

The gravity-sensing and light-response mechanisms of plants, an area heavily studied but poorly understood, will be explored in this experiment provided by Ames Research Center.

Two separate experiments make up GPPF, using artificial gravity and blue light as their sources of stimulation. Young oat and wheat plants, not influenced by the Earth's gravity in a microgravity environment, will be exposed to varying degrees of stimuli and studied.

Hardware for the GPPF consists of a culture rotor assembly, a test rotor assembly, two video tape recorders, a recording and stimulus chamber, a plant holding compartment, a control unit, a cube support panel, and a Mesocotyl Suppression Box.

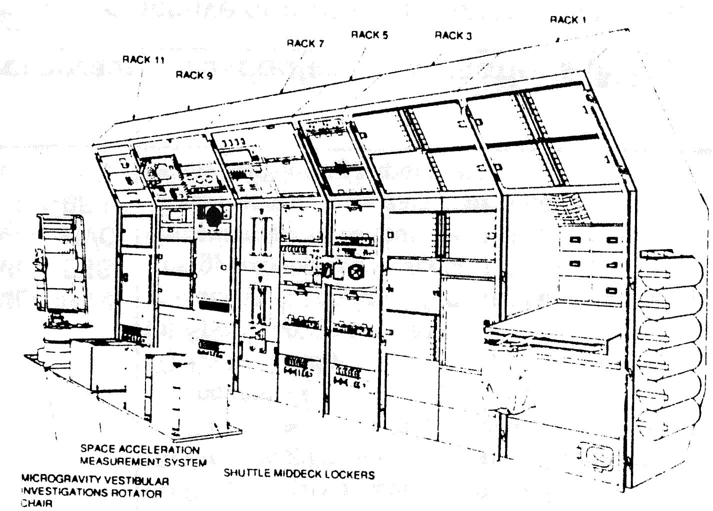
IML-1 SPACELAB CONFIGURATION



CENTER AISLE
Space Physiology Experiments Mini-sled
Space Acceleration Measurement System
Microgravity Vestibular Investigations Rotator Chair
Shuttle Middeck Lockers

STARBOARD RACKS	
Rack 2:	Control Center Rack
Rack 4:	MPE Fluid Loop Pump/Controls Video Cassette Records
Rack 6:	OCGP Experiment Stowage
Rack 8:	Mental Workload and Performance Experiment Stowage
Rack 10:	Fluids Experiment System
Rack 12:	Vapor Crystal Growth System

IML-1 SPACELAB CONFIGURATION



PORT RACKS	
Rack 1:	Workbench
Rack 3:	Stowage
Rack 5:	Biorack
Rack 7:	Gravitational Plant Physiology Facility MVI Experiment Control and Data Interface Biorack Incubator C
Rack 9:	Critical Point Facility Cryostat Experiment Biostack Experiment LSLE Freezer Stowage
Rack 11:	Mercury Iodide Crystal Growth Experiment IMAX Power Panel Stowage

Biorack

Biorack is a multipurpose facility that will enable biological investigations of such life forms as plants, tissues, cells, bacteria, and insects during space flight. It was provided by the European Space Agency and will support 17 different experiments.

Hardware consists of a single preintegrated rack (rack 5) with an additional incubator located in rack 7. Rack 5 contains a cooler/freezer unit, two incubator units, a glove box, and standard SL facilities for electrical power distribution, data acquisition, and rack cooling.

Biorack Configuration

EXPERIMENT	PURPOSE
7-IML-US1	Effect of HZE radiation on Caenorhabditis
7-IML-US2	Microgravitational effects on chromosome behavior
7-IML-US3	Effect of microgravity on chondrocytes
7-IML-02NL	Microgravity effects on growth of long-bone rudiments
7-IML-05NL	Fertilization and development of amphibian eggs
7-IML-07E	Oogenesis of Drosophila eggs
7-IML-08DK	Effect of microgravity on cell regeneration, division, and growth
7-IML-10D	Embryogenesis and organogenesis of Carausius morosus under spaceflight conditions
7-IML-12D	Dosimetric mapping inside biorack
7-IML-13D	Growth and differentlation of Cacillus subtills
7-IML-14.1CH	Proliferation of Friend cell leukemia virus
7-IML-14.2CH	Prolliferation of hybridoma cells
7-IML-14.3CH	Test of automated bioreactor
7-IML-15UK	Root and hypocotyl growth of Arabidopsis seedlings
7-IML-20F 24UK	Root growth of lentil seeds
7-IML-22D	Frequency of vein contraction and protoplasmic streaming of Physyarum polycephalum
7-IML-23F	Effects of antiobiogics on proliferation of E.coli

Space Physiology Experiments (SPE)

The Canadian Space Agency has designed six investigations. Five of these study the effects of weightlessness on the human body. A sixth experiment studies the separation of immiscible fluids in the absence of gravity.

Several SPE experiments involve the mini-sled mounted in the center aisle of the SL module. The sled provides up to 18 inches of linear oscillatory motion of the subject and serves as a test stand for further physiological experiments.

Space Physiology Experiments

EXPERIMENT	PURPOSE
8-IML-1-SASE	Space adaptation syndrome experiments (1) Sled experiment (2) Rotation experiment (3) Visual stimulator experiment (4) Proprioceptive testing in relaxed limb (5) Proprioceptive testing during active pointing (6) Proprioceptive testing - illusions during movement (7) Tactile actuity (8) Space motion sickness
8-IML-1-PSN	Evaluation of positional and spontaneous nystagmus
8-IML-1-EES	Energy expenditure in spaceflight
8-IML-1-MVC	Measurement of venous compliance
8-IML-1-BPA	Assessment of back pain in astronauts
8-IML-1-PPE	Phase partitioning experiment

Microgravity Vestibular Investigations (MVI)

The main objective of these experiments is to determine what effects the absence of usable information from the vestibular system has on the sensory mechanisms of the body. Normally the vestibular system provides information on head position and motion relative to the local gravitational field. MVI examines the effects on the vestibular system brought about by the absence of gravity. MVI also investigates the adaption to sensory input responses which occurs during prolonged exposure to microgravity.

Tests are performed using a rotator chair. The chair used for MVI is designed to allow for subject rotation in the pitch, yaw, and roll planes.

Biostack (BSK)

The biostack experiment studies the effects of cosmic radiation on biological organisms. Previous BSK experiments flown on Apollo and SL-1 have demonstrated that high atomic number high energy cosmic radiation (HZE) particles can have serious biological effects upon an organism.

Each BSK container consists of layers of different biological samples sandwiched between different types of heavy particle and cosmic radiation detectors. This permits the localization of trajectory of each HZE particle in the biological layer and the correlation of the biological damage with the responsible HZE particle.

Mental Workload and Performance Experiment (MWPE)

The projected operational environment of a space station with its complex systems requirements will involve large-scale, direct computer interface. MWPE will measure the operator's workload and performance in display interpretation and cursor

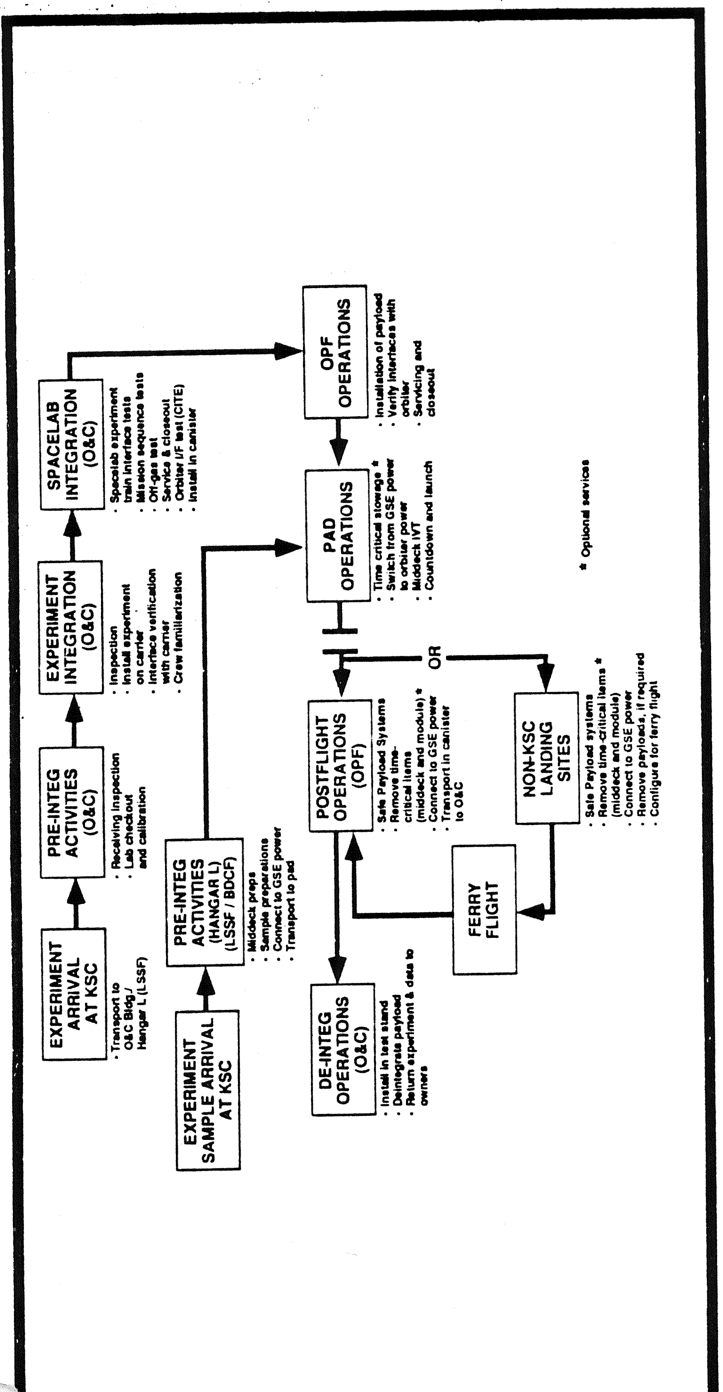
positioning (using various input devices) to determine the best display design and input device for the space environment.

MWPE hardware includes a Grid computer, a trackball, and a joystick. Additional hardware includes the anthropometric workstation, multiuse arm assembly, multiuse clamp assembly, and the multiuse mount assembly.

Radiation Monitoring Container and Dosimeter (RMCD)

The radiation monitoring container and dosimeter (RMCD) is a set of primary and secondary radiation-monitoring devices which are unstowed while on orbit in order to monitor the cosmic radiation environment of the SL module. The radiation monitoring container is a completely sealed 12.5 cm aluminum cube containing biological specimens layered between solid-state nuclear track detectors. The specimens used include bacillus subtilis spores, brine shrimp eggs, and maize seeds. Four dosimeters are attached to the outside of the aluminum container with Velcro.

IML-1 PAYLOAD PROCESSING FLOW



GET-AWAY SPECIAL (GAS) BRIDGE

The following experiments are scheduled for the GAS bridge.

G-086

Booker T. Washington High School intends to determine behavioral and physiological effects of microgravity on brine shrimp cysts hatched in space. Thermal conductivity and bubble velocity of air and water in microgravity will also be studied.

G-102

TRW and Explorer Scouts are conducting seven experiments focusing on:

1. Capillary pumping
2. Cosmic ray detection and measurement
3. Crystal growth
4. Oil and water emulsion
5. Record shape of fluid droplets
6. Effect of low level radiation on floppy disks
7. Degradation of fiber optics

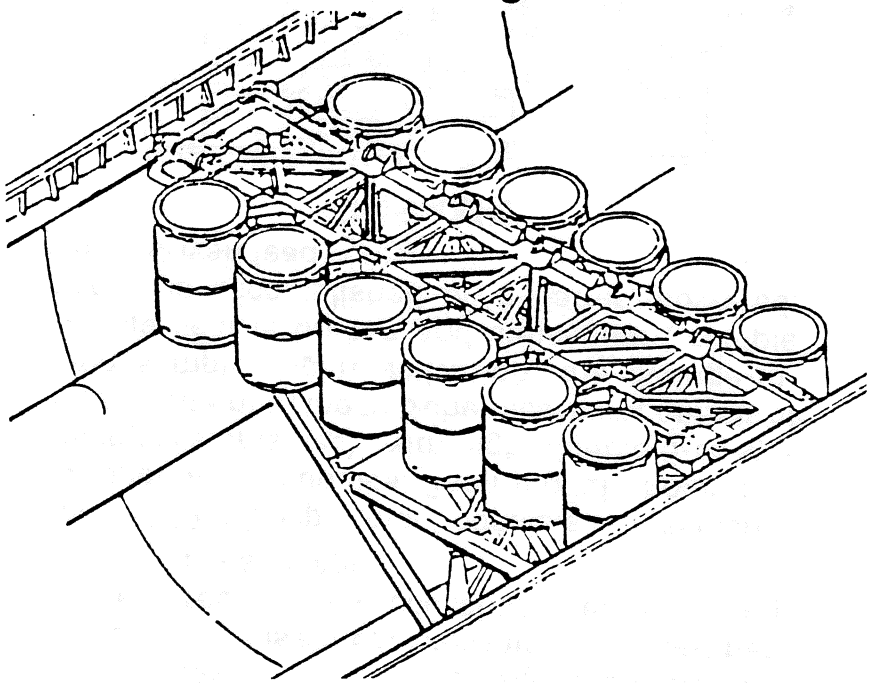
G-140

Deutsche Forschungs-und Versuchanstalt Fur Luft-und Raumfahrt (DFVLR) is sponsoring a payload titled Marangoni Convection (the effect that a disturbance of the liquid-liquid interface [due to interfacial tension] has on mass transfer in a liquid-liquid extraction system) in a Floating Zone.

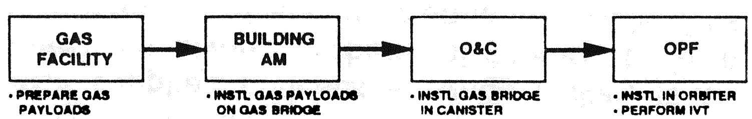
G-143

DFVLR's objective is to gain insight into the process of glass fining, the removal of all visible gaseous inhomogeneities from glass melt, with an experiment titled Gas Bubbles in Glass Melts.

GAS Bridge



GAS Bridge Ground Processing Flow



G-329

The Swedish Space Corporation is studying solidification phenomena in metal alloys by looking at the dentrite growth in cadmium-tin alloy.

G-336

A USAF Geophysics Laboratory sponsored experiment that will measure the diffuse zodiacal and galactic emissions at the B, R, and V standard astronomical wavelengths.

G-337

An experiment by the U.S. Naval Postgraduate School to measure the performance of a thermoacoustic refrigerator under microgravity conditions.

G-456

Sponsored by the Society of Japanese Aerospace Companies, this experiment involves the separation of three colored biologically active enzymes by electrophoresis. The separation patterns of the samples will be compared to earth based patterns.

G-457

The Society of Japanese Aerospace companies will cultivate cellular slime mold in microgravity as a preliminary study of a method of gas-liquid separation under conditions of microgravity.

G-609/G-610

This experiment consists of instruments co-sponsored by the Australian Space office and Australian Space Limited (AUSPACE) that will observe deep space or nearby galaxies in the ultraviolet wavelength.

G-614

Co-sponsors of this dual objective experiment are The Chinese Society of Astronautics and The American Association for Promotion of Space in China. The experiment objectives are to photograph the motion of simulated debris in the Shuttle under microgravity and to remelt various low melting point mixtures of paraffin and Wood's metal while on orbit. The experiment was developed and fabricated by the Chinese Academy of

Science Technology, Beijing Institute of Environment Test Engineering.

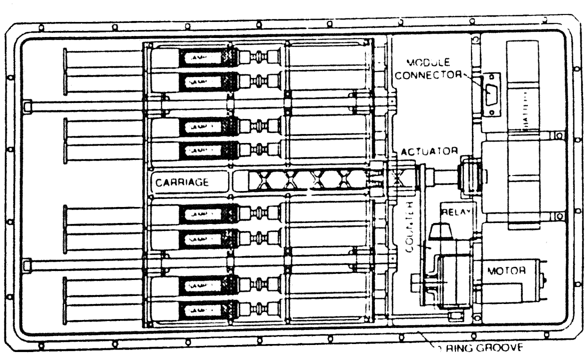
SCIENCE EXPERIMENT PAYLOADS

Gelation of Sols: Applied Microgravity Research (GOSAMR)

The GOSAMR payload, occupying one standard NASA-supplied middeck stowage locker, is an experiment involving chemical gelation to form precursors for advanced ceramic materials. This materials processing experiment was suplied by Space Research and Applications Laboratory/ 3M. GOSAMR is a prepacked middeck experiment and requires no KSC processing other than installation and destowage.

The GOSAMR experiment consists of five identical apparatus modules. Each module holds two mixing systems each with eight double 5-cc syringes containing the two chemical components of each sample. Upon activation, the syringe-to-syringe seal is broken and subsequent sample mixing is accomplished by a battery-powered, motor-driven lead screw.

GOSAMR

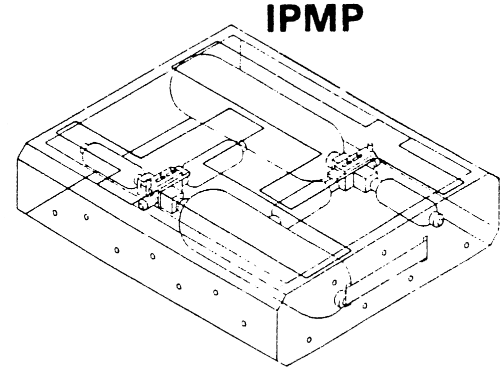


Investigations into Polymer Membrane Processing (IPMP)

The objective of the IPMP is to investigate the formation of polymer membranes in microgravity. The experiment, occupying .25 of a middeck locker, consists of two units, each with three cylinders connected to a three-way valve. Experiment durations are from 5 minutes for the first unit to approximately 8 hours for the second unit. IPMP is a prepacked middeck experiment and requires no KSC processing other than installation and destowage.

This mission will represent the second flight of IPMP, managed by the Battelle Advanced Materials Center for the Commercial Development of Space, and was first flown aboard STS-31. During that mission, the IPMP experiment was activated by initiating the evaporation process and then left alone for the process to come to rest. The new configuration permits further insight into the evaporation process by removing the time and gravity factors through a water quenching process that will set the membrane structure and complete the experiment while in microgravity.

IPMP

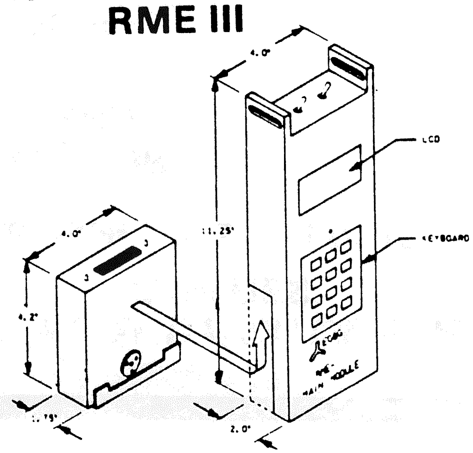


Radiation Monitoring Equipment III (RME III)

The RME III is a small instrument which measures ionizing radiation over repeated intervals and digitally stores the resulting data. The unit was initially designed to be used in a reactor environment and was later selected as a radiation monitor for use during shuttle missions due to its gamma ray detection capability. RME III has replaced two previous configurations of the same experiment-RME I and RME II.

The RME III is a state-of-the-art measurement/storage device which consists of a main module and interchangeable memory modules. The main module is a small hand-held device which contains the electronics for measuring radiation and time-tagging the data with mission elapsed time. The memory modules snap in or out of the main module and can store a maximum of 32,765 intervals (records) of radiation data. The RME III is stowed onboard in a middeck locker. RME III previously flew on STS-31R, STS-37, STS-39, STS-41, and STS-48.

RME III



SHUTTLE STUDENT INVOLVEMENT PROJECTS (SSIP'S)

SE 81-09, CONVECTION IN ZERO GRAVITY

In this experiment, surface tension induced flows in microgravity will be studied. The various boundary conditions to be investigated were chosen because they are extremely difficult or impossible to study in 1-g. The coupling of surface tension and buoyancy flow in 1-g is also difficult to untangle.

The apparatus is self-powered by 40 "D" cell alkaline batteries. The experiment hardware is prepacked by JSC facilities and is stored in one modular middeck stowage locker.

SE 83-02, ZERO-G CAPILLARY RISE OF LIQUID THROUGH GRANULAR POROUS MEDIA

The second SSIP will study the flow of liquid through granular porous media. The 53-pound flight unit is to be carried within a middeck locker. The apparatus consists of an aluminum box supporting three 5mm ID glass columns each densely packed with one of three series of glass beads (.25mm, 1.0mm and 3.0mm dia.). A pressure vessel (25 psig) will drive deionized water tinted with food coloring as a working fluid. Other components include a fluid expansion tank, pressure readout, fluid temperature indicator, toggle valves, pressure regulators and associated pneumatic and fluid system hardware.

This component was prepacked by Boeing. It contains no electronics and data will be recorded using the on-board video camera and recorder.

LANDING AND POSTLANDING ACTIVITIES

STS-42 is scheduled to land at DFRF

DFRF OPERATIONS

- Orbiter rollout
- Safing
- Crew egress
- Remove science experiments
- Remove module science stowage
- Tow orbiter to mate/demate device and mate orbiter to 747
- Fly to KSC

SLF OPERATIONS

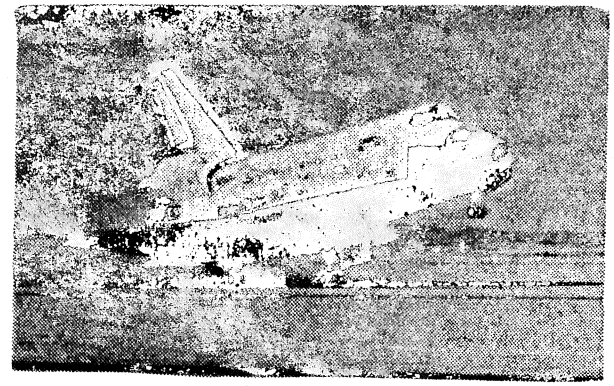
- Tow orbiter to mate/demate device and demate from 747
- Tow orbiter to OPF

OPF OPERATIONS

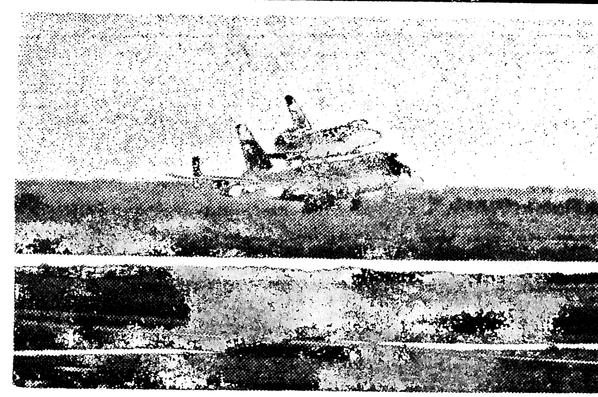
- Safe systems
- Using strongback, remove IML-1 and GAS Bridge; transport to O&C in the canister

O&C OPERATIONS

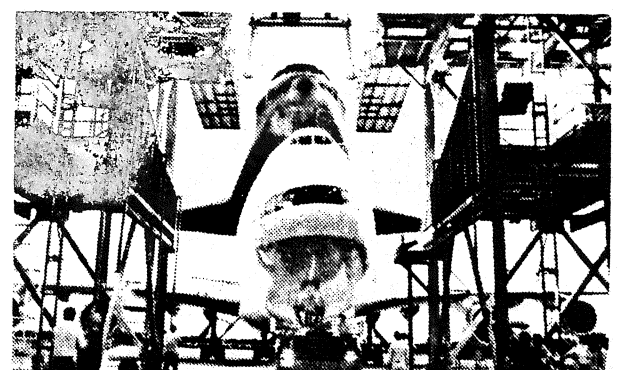
- IML-1
  - Remove from canister, transfer into workstand, and deintegrate
- GAS Bridge
  - Remove from canister, transfer to Building AM



LANDING AT DFRF



747 FLIGHT



MATE/DEMATE DEVICE