The Small Attached Payloads Working Group

February 9-10, 1988
Goddard Space Flight Center
Greenbelt, Maryland

Volume I: Minutes

for

Astrophysics Division
Code EZ
National Aeronautics and
Space Administration
Washington, D.C. 20546

March 1988

(NASA-CR-190375) THE SMALL ATTACHED PAYLOADS WORKING GROUP. VOLUME 1: MINUTES (Battelle Columbus Labs.) 43 p

N92-70694

Unclas
Z9/18 0091459

Battelle
Columbus Division
505 King Avenue
Columbus, Ohio 43201-2693

Astrophysics Division
Code EZ
National Aeronautics and Space Administration
Washington, DC 20546
USA

THE SMALL ATTACHED PAYLOADS WORKING GROUP

MEETING
FEBRUARY 9-10, 1988
GODDARD SPACE FLIGHT CENTER, MARYLAND

Volume I: MINUTES

MARCH 1988

BATTELLE
Columbus Division
505 King Avenue
Columbus, Ohio 43201-2693

This report is a work prepared for the United States by Battelle. In no event shall either the United States or Battelle have any responsibility or liability for any consequences of any use, misuse, inability to use, or reliance upon the information contained herein, nor does either warrant or otherwise represent in any way the accuracy, adequacy, efficacy, or applicability of the contents hereof.

CONTENTS

Page

1. INTRODUCTION 1

2. ORGANIZATION OF THE WORKSHOP 2

3. MINUTES OF THE WORKSHOP 4

Session 1, Tuesday, February 9, 1988, 8:30 am 4
Introduction and NASA's Perspective 4
ESA's and Canada's Perspective 9
Plasma Interactions Monitoring System (PIMS) 11
Small Attached Payload Guidelines 12
The National Aero-Space Plane (NASP) 13
Space Station Environmental Data 13
Available Space Station User Resources 14
The Gunterville Workshop 15
Attached Payload Announcement of Opportunity 16
Programmatic Issues 17
Flight Telerobotic Servicer 18

Session 2, Wednesday, February 9, 1988, 8:30 am 20
Robotic Servicing 20
Small Attached Payload Development 21
Action Items 21
Attached Payload Accommodation Equipment 22
Input for Interim Report 23

APPENDIX A. SPACE STATION SMALL ATTACHED PAYLOADS WORKING GROUP ADDRESS LIST A-1

FIGURES

Page

Figure 1. Space Station Small Attached Payloads Working Group, Agenda for the Second Meeting, 9-10 February 1988, Goddard Space Flight Center, Greenbelt, Maryland, Building 16W, Room N76 3

Figure 2. Space Station Small Attached Payloads Working Group - Names and Affiliations 5

Figure 3. Meeting Schedule for the Space Station Small Attached Payloads Working Group 6

Figure 4. Draft Charter, Small Attached Payloads Working Group, November 10, 1987 7

Figure 5. "Quick" Experiment Parameter Ranges 8

Figure 6. Definition of Small Attached Payloads 8

Figure 7. Interim Report Outline 23

Figure 8. Report Schedule 24

TABLES

Table 1. Space Station Small Attached Payload Summary 25

Table 2. Proposed Small Attached Payloads (Preliminary) 26

Table 3. Space Station Small Attached Payloads (Preliminary). 27

Minutes

of

The Small Attached Payloads Working Group

held February 9-10, 1988 at Goddard Space Flight Center

1. INTRODUCTION

This document represents the minutes of the second meeting of the Small Attached Payloads Working Group. This meeting was conducted by the Battelle Columbus Division under Contract No. NASw-3736 to the National Aeronautics and Space Administration.

These minutes consist of two volumes. Volume I consists of three sections and one appendix:

1. Introduction
2. Organization of the Workshop
3. Minutes of the Meeting

Appendix A - Members of the Small Attached Payloads Working Group.

Volume II consists of 14 appendices, giving handouts and supplementary information for the meeting.

2. ORGANIZATION OF THE WORKSHOP

The second meeting of the Small Attached Payloads Working Group was held February 9-10, 1988 at the Goddard Space Flight Center, Greenbelt, Maryland. The working group consisted of

Name	Affiliation
Joe Barfield	Southwest Research Institute
John David Bartoe	NASA HQ/Code S
Marilyn Bruner	Lockheed, Palo Alto Res Lab
Alan Bunner	NASA HQ/Code EZ
David Carter	NASA/SSU (SARR)
Phil Cressy	NASA HQ/Code EM
Michel Faucherre	LPSP/CNRS in France
Allan Frandsen	NASA HQ/Code ES
Neil Gehrels	NASA GSFC
Gary Heiligman	MIT Lincoln Lab
Jim Hesser	DAO/HIA/NRC
Bill Hibbard	NASA Goddard
Hugh Hudson	UCSD
Vernon Jones	NASA HQ/Code ES
Chris Martin	Columbia University
Dan McCammon	University of Wisconsin
Henk Olthof	ESTEC, Holland
Bill Priedhorsky	Los Alamos National Lab
George Ricker	MIT
Ed Saenger	McDonnell-Douglas
Jeff Scargle	NASA Ames
Gerry Skinner	University of Birmingham (UK)/ESA
Fritz Von Bun	NASA
Jake Waddington	University of Minnesota.

Thomas J. Kuzma and Donna L. Griffith represented the Battelle Columbus Division. Also in attendance were Peter Cline and Jerry Kull, NASA/GSFC, and Captain Les Strawn (USAF) of NASP JPO.

The purposes of this meeting were to present the current status of the Space Station to the working group, define NASA's perspective, and to allow the working group members to define preliminary parameters for suitable small attached payloads. The agenda for the meeting is shown in Figure 1.

Tuesday, 9 February

8:00 - 8:30	Continental Breakfast	
8:30 - 8:40	Welcome	(V. Jones)
8:40 - 8:50	Announcements and Agenda Discussion	(G. Ricker)
8:50 - 9:10	NASA's Current Perspective of the Study	(V. Jones)
9:10 - 9:30	ESA's Current Perspective of the Study	(H. Olthof)
9:30 - 9:50	Canada's Current Perspective of the Study	(J. Hesser)
9:50 - 10:10	----------Coffee Break----------	
10:10 - 11:10	Space Station Utilization Opportunities	(D. Carter)
11:10 - 12:00	Small Payload Flight Opportunities on the National Aerospace Plane	(L. Strawn/ E. Saenger)
12:00 - 1:00	----------Working Lunch----------	
1:00 - 1:30	Report on the LaJolla IFSUSS Meeting	(G. Ricker)
1:30 - 2:00	OSSA Small Attached Payloads Discussed at the Guntersville Meeting	(V. Jones/ P. Cressy)
2:00 - 3:00	Status of "Quick-is-Beautiful" Study; Q&A on Guntersville Discussions	(J.D. Bartoe)
3:00 - 3:20	Plans for Astrophysics Panel	(W. Priedhorsky)
3:20 - 3:40	Plans for Space Physics Panel	(J. Waddington)
3:40 - 4:00	----------Break----------	
4:00 - 5:00	Planning for Tuesday Splinter Discussions	(Group)
6:30 -	Reception and Group Dinner	(N. Gehrels)

Wednesday, 10 February

8:00 - 8:30	Continental Breakfast	
8:30 - 8:40	Announcements and Agenda Discussion	(G. Ricker)
8:40 - 10:00	Astrophysics Splinter Discussions	
8:40 - 10:00	Space Physics Splinter Discussions	
10:00 - 10:15	----------Coffee Break----------	
10:15 - 11:00	General Discussion by Core Committee	(Group)
11:00 - 11:30	Writing Assignments	(Group)
11:30 - 12:00	Summary and Action Items	(G. Ricker)
12:00 - 1:00	----------Working Lunch----------	
1:00	Adjourn	

FIGURE 1. SPACE STATION SMALL ATTACHED PAYLOADS WORKING GROUP, AGENDA FOR THE SECOND MEETING, 9-10 FEBRUARY 1988, GODDARD SPACE FLIGHT CENTER, GREENBELT, MARYLAND, BUILDING 16W, ROOM N76

3. MINUTES OF THE WORKSHOP

Session 1, Tuesday, February 9, 1988, 8:30 am

The first session of the second meeting of the Small Attached Payloads Working Group began at 8:30 am, February 9, 1988, at the Goddard Space Flight Center.

Introduction and NASA's Perspective

After a welcome and introduction by Vernon Jones and a review of the agenda by George Ricker, Vernon Jones and Alan Bunner presented a short history of the working group and NASA's current perspective of the study. It was noted that:

- DCL issued 2/87 soliciting membership in Small Attached Payloads Working Group
- Team members selected 10/87 (see Figure 2 and Appendix A, Volume I)
  - Represents all disciplines
  - Use of subcommittee approach
- Will meet for 1-2 years (see Figure 3)
- Coordinate with other Space Station groups
- Expanded to include
  - Space physics
  - Foreign
    - -- ESA
    - -- Canada
    - -- Japan.

Following the draft Charter shown in Figure 4, the working group will issue a final report by December 1989, specifying strawman payloads.

Currently, many aspects of the Space Station and small attached payloads are not well defined. However, certain guidelines do exist as shown in Figures 5 and 6.

It was emphasized that we need a program that will allow selection and development of a candidate list of payloads that fit in with the limitations of the Space Station, yet fulfill the required scientific objectives.

Core Committee

George Ricker - Chairman	MIT
Joe Barfield	Southwest Research Institute
Marilyn Bruner	Lockheed
Alan Bunner	NASA Headquarters
Rick Chappell	NASA/MSFC
Michel Faucherre	LPSP/CNRS
Allan Frandsen	NASA/Headquarters
Neil Gehrels	NASA/GSFC
Gary Heiligman	MIT Lincoln Laboratory
Jim Hesser	Dominian Astrophysical Observatory
Bill Hibbard	NASA/GSFC
Hugh Hudson	University of California, San Diego
W. Vernon Jones	NASA Headquarters
Bill Mahoney	JPL
Chris Martin	Columbia University
Dan McCammon	University of Wisconsin
Henk Olthof	ESTEC-PU
Bill Priedhorsky	Los Alamos National Laboratory
Jeff Scargle	NASA AMES
Gerald Skinner	ESA/Birmingham
Jake Waddington	University of Minnesota

Space Physics Subcommittee

Jake Waddington - Chairman	University of Minnesota
James Beatty	Boston University
Ed Chupp	University of New Hampshire
Mark Giampapa	NOAO
David Kendall	National Research Council of Canada
Steve Mende	Lockheed
W. John Raitt	Utah State University
Roger Williamson	Stanford University
John Wefel	Louisiana State University

Astrophysics Subcommittee

Bill Priedhorsky - Chairman	Los Alamos National Laboratory
Krishna Apparao	TIFR
Elena Aprile	Columbia University
Tom Ayres	Colorado
George Carruthers	NRL
Alan Clark	University of Calgary
Tom Cline	NASA/GSFC
Steve Kahn	University of California, Berkeley
Howard Smith	NRL
Mark Stier	Perkin-Elmer
Kurt Weiler	NRL

FIGURE 2. SPACE STATION SMALL ATTACHED PAYLOADS WORKING GROUP - NAMES AND AFFILIATIONS

1987 November 9/10	Initial Meeting
1988 February 9/10	Meeting #2
1988 June 9/10	Meeting #3--Interim Report Due
1988 October 4/5	Meeting #4
1989 February 14/15	Meeting #5
1989 June 15/16 (tentative)	Meeting #6
1989 October 17/18	Meeting #7--Draft of Final Report
1990 January 1	FINAL REPORT DUE

FIGURE 3. MEETING SCHEDULE FOR THE SPACE STATION SMALL ATTACHED PAYLOADS WORKING GROUP

The **Small Attached Payloads Working Group** is to identify classes of high priority Astrophysics and Space Physics payloads that might be carried out as small attached payloads on the Space Station; in particular, in categories analogous to the Shuttle-based Get-Away-Specials (GAS), Hitchhikers, Spartans, or other minimum-impact payloads. A written report describing the results of the group's deliberations is to be submitted to the Director of the Space Physics Division and the Director of the Astrophysics Division. An interim report should be submitted by June 1988, and the final report is due by December 1989. The following tasks are to be addressed:

1. Review the recommendations of the relevant Space Science Board Committees and the NASA advisory groups for the high priority scientific investigations during the coming decade for each of the Space Physics/Astrophysics Disciplines.

2. Review the suggestions that have been made or will be made in reports of the relevant Space Physics and Astrophysics discipline working groups regarding high priority scientific investigations.

3. Identify the Space Physics and Astrophysics goals and objectives that could be achieved with sustained Space Station opportunities for small attached payloads, rapid-response missions, long-term monitors, and short-duration co-orbiting spacecraft.

4. Determine realistic envelopes for the physical requirements, including size, power, locations, and other features which characterize small attached payloads capable of accomplishing the Space Physics and Astrophysics goals identified in Item 3.

5. Provide strawman configurations of small attached payloads that could accomplish representative high priority science objectives for each of the Astrophysics and Space Physics Disciplines, and identify compatible experiments, if any, that might be carried out simultaneously on the same single-payload attached platform.

6. Review the current payload integration and operation procedures and suggest methods for providing opportunities for small payloads on quick-response time scales when appropriate, as well as for general accommodation of small payload experiments on "graduate student time scales".

7. Suggest low-cost approaches that satisfy small payload accommodation and safety considerations, and specify any requirements not currently provided as part of the standard Space Station Interfaces.

8. Consider options for international participation and for participation by non-NASA U.S. agencies in a small attached payload program.

FIGURE 4. DRAFT CHARTER, SMALL ATTACHED PAYLOADS WORKING GROUP, NOVEMBER 10, 1987

- Number of payloads -- ~25 during first 3 yrs?
- Duration
  - 6 months between launch and recovery
  - ~3 months as basic exposure unit
- Weight -- ~100 kg/experiment (to permit delivery of ~10 per shuttle flight)
- Dimensions -- ~1 m^3
- Power -- ~100 watt/experiment
- Telemetry -- ~10 kbit/experiment
- Location -- Standardized attachments to provide a variety of look directions
- Contamination -- Low thermal and electromagnetic emissions per experiment
- Safety -- Emulation of GAS approach, if possible

Source: TFSUSS white paper (6/6/86; Fazio, Garriot, Hudson, Oda, and Ruffini)

FIGURE 5. "QUICK" EXPERIMENT PARAMETER RANGES

A) No major impact on Space Station operation

B) No major STS requirements

C) No major cost impact

But they could be:

- moderate in mass and volume

Interfaces:

- Standardized
- Modest telemetry/power requirements

FIGURE 6. DEFINITION OF SMALL ATTACHED PAYLOADS

In defining candidate payloads, this group needs to provide estimates of power, size, weight, etc., and to identify any special requirements such as fine pointing or manned intervention. These parameters are needed for further Space Station design developments. In addition, there is pressure from Congress to define Space Station experiments.

The AO for selection of Polar Platform payloads has already been issued, and the AO for the rest of the Space Station is due to be released shortly with proposals expected to be due in August of this year.

As currently envisioned, the Space Station will have slots for four big attached payloads, but only two of these will have Station Interface Adapters (SIA) provided by the Space Station; the users could provide SIAs for the other two. There are possibly many other attachment points for the small payloads which would be more along the lines of Hitchhiker or GAS can experiments.

Of the many possibilities for these payloads, the final choice will be guided both by financial constraints and Space Station limitations, including safety considerations. By the end of this meeting, we need to define preliminary ranges of payload requirements, and to determine the level of effort of the program.

In summary,

- We need to define payload requirements
- Payload requirements will guide Space Station design
- Space Station design will guide payload definition
- Within the framework of budgetary limitations, we need to develop a program that will fulfill science requirements.

ESA's and Canada's Perspective

A short overview of ESA's viewpoint was then presented by Henk Olthof. He stated that ESA's perspective was similar to NASA's and that ESA is glad of the opportunity to work with OSSA, and looks forward to the scientific opportunities offered by the Space Station. ESA wants to become involved as soon as the infrastructure is in place, but it must be noted that resources are limited, and that no money is available for experiment development. Rather, this funding must come from member states.

A similar overview of Canada's viewpoint was then given by Jim Hesser. Unlike ESA, however, Canada is supplying part of the infrastructure, and has access to 3 percent of Space Station resources. They, too, are looking forward to the scientific opportunities offered by Space Station but once again budgetary considerations will limit the magnitude of experiments to be performed.

A review of Space Station utilization opportunities, including small and rapid response (SARR) payloads was then presented by David Carter. (See Appendix B, Volume II.) This concept is aimed at providing small, inexpensive experiments that could be manifested within 6 to 24 months of launch.

These payloads would be based on such existing programs as Hitchhiker and Get-Away Specials, and would require standard interfaces for attachment to the Space Station. Initial presentation of this concept was well received, and with strong backing at this stage it is felt that experiments could be on board as early as the first three shuttle building flights.

Many aspects of Space Station accommodations still need to be defined, and the requirements of these payloads could pay a role in these definitions. For example, current Space Station design does not include attachment points for Hitchhiker or GAS-type experiments. However, such accommodations are not ruled out if the need arises.

It is anticipated that several constraints will apply to the payloads. These include

- Minimal planned EVA
- Minimal planned servicing during mission
- Minimal venting to the outside
- Payload unit removed upon completion of mission.

As envisioned, the Space Station truss will be composed of 5 x 5 x 5 meter cubes. It should be feasible for a port for mechanical attachment, data, power, telemetry, etc., to be installed on each unit. It is also possible to develop a multipayload adapter to accommodate more than one payload at a given site.

Many problems exist that need to be solved. For example, the Space Station will undergo many attitude changes during construction, so pointing will be a problem. In addition, only rough (several arcminutes) attitude knowledge will be available.

However, Carter stressed that the input of this working group is needed for design definition, and although not every wish can be met, these wishes should be made known.

Plasma Interactions Monitoring System (PIMS)

One potential type of payload, the Plasma Interactions Monitoring System (PIMS), was presented by Joe Barfield and Allan Frandsen (see Appendix C, Volume II). PIMS is envisioned to be a Space Station environmental monitoring system, with possible applications as a science experiment, and will obtain measurements of

- Neutral gas composition and velocity distribution
- Ion composition and velocity distribution
- DC electric field
- DC magnetic field
- Plasma potential
- AC Electric field
- AC magnetic field
- Electrons
- Ions
- Thermal Electrons.

Current design calls for ten identical modules to monitor the entire Space Station environment, although it may be possible to obtain adequate coverage with fewer modules.

PIMS does not require active cooling which allows for more flexibility in the placement of the modules such as on the remote arm or on the solar panels.

Although the PIMS is not complex, it is estimated that the first module would cost $25 to 30M, with each additional module in the $15M price range.

It is obvious that this price range is incompatible with the desired costs of small attached payloads. Since seven disciplines need to be covered, the cost for individual payloads needs to be drastically reduced. Standard interfaces that are simple, inexpensive, and versatile will have to be defined. In some cases, where a discipline requires an expensive payload, only one experiment could be flown every few years, where a discipline with cheaper payloads could fly an experiment every year. OSSA has not put hard limits on small attached payloads, so some flexibility exists in defining these payloads.

Small Attached Payload Guidelines

After a short lunch, Fritz von Bun presented a set of guidelines for the small attached payloads. These include

mass	100 kg nominal; 500 kg maximum
size	1 m^3
power	150 watts nominal; 300 watts maximum
telemetry	10 to 100 kbps.

- On-Board Storage
  - Do not want to jettison payloads from the Space Station
  - Need to define any required on-board storage
  - Want to be able to store and reuse at a later date
  - Must design instruments for return to Earth
- Attachments
  - Do not use APAE (Attached Payload Accommodation Equipment) attachment points
  - Need to define standard interfaces
  - Want to define many small attachment points
- Need to define requirements
  - Attitude
    - -- $\pm\alpha$, $\dot{\alpha}$, $\ddot{\alpha}$
  - Vibration
    - -- x, $\dot{x}$, $\ddot{x}$
  - Communications
    - -- TDRSS
    - - Direct to ground
  - Contamination
    - -- Effects of Space Station environment on payloads
    - -- Effect of payloads on Space Station environment
  - Servicing requirements
    - -- Robotics
    - -- Manned intervention
  - Reliability
    - -- Can fail if fail safe to Space Station
    - -- An experiment within 20 km of Space Station must be man rated and have triple redundancy.

The National Aero-Space Plane (NASP)

Capt. Les Strawn and Ed Saenger presented information regarding the National Aero-Space Plane (see Appendix D, Volume II). The NASP, or X-30, program, is a joint research effort of the USAF, DARPA, and NASA, with participation from SDIO, the Navy, and industry. The objectives of the program are to develop airbreathing propulsion technology for flight in the Mach 0-25 regime, to develop airframe and engine designs, and to fabricate and flight test a research vehicle. Approximately 75 percent of the government funding is from DOD, with the other 25 percent from NASA. Industry participation is approximately $7 for every $1 of government money.

The goal of the X-30 program is to develop a manned single-stage-to-orbit airbreathing vehicle with hypersonic cruise on the order of 4000 to 8000 mph, subsonic ferry, horizontal take-off and landing on conventional runways, full reusability, and powered go-around capabilities. Reduced cost of payload delivery (an order of magnitude reduction is desired) for a NASP-derived vehicle is the ultimate goal of the program.

NASP is pushing technology barriers, particularly in the area of materials development. New ultralight materials with good strength and thermal capabilities are required.

The concept definition phase (Phase 1) was completed in the mid-1980s. The program is currently in Phase 2, where on-going activities include design, fabrication, and ground test of the engine; development of the airframe and components; and applications studies. The decision whether or not to proceed to Phase 3 will be made in May 1990, with first flight of the experimental vehicle planned for 1994.

It is evident from the schedule that at this time, there is no overall design for the vehicle. Therefore, specific details, such as payload size and mass limitations, turnaround time, and other operational issues, are unknown. Input from the user community is desired to define design requirements.

Space Station Environmental Data

A summary of the Space Station environmental characteristics was presented. Environmental data are available on the orbital environment and on Space Station motion, vibration and acoustics, EMI, microbial and toxic

contaminants, surface interaction, and molecular contamination. Information which may be of particular interest to working group members include:

(1) Outgassing rates are estimated at 10^{-13} gm/cm²/s, which equates to approximately 30 A/yr deposition

(2) OH emission in the infrared spectrum will be comparable to that at sea level on Earth.

Several requests were made for additional information on environmental requirements. A report on contamination will be distributed by Battelle to the working group (see Appendix E, Volume II). Carter will provide payload safety requirements and information regarding stability, vibration, and angular acceleration to all participants.

Available Space Station User Resources

Phil Cressy provided an introduction to Space Station resources available to users (see Appendix F, Volume II). These user resources include:

- Payload-related upmass -- labs and attached (payloads, resupply, APAE, Rack, and FSE mass)
- Mechanical interfaces for external attach points (Attached Payload Accommodation Equipment) and for the pressurized volume (racks)
- Power
- Data management system
- Altitude/attitude
- Crew time
- Thermal.

The standard structural/mechanical system architecture for the external attach points is the Attached Payload Accommodation Equipment (APAE). Standard APAE hardware includes the payload interface adapter and the Station interface adapter. Optional equipment include multiple payload adapters, deck carriers, and the Payload Pointing System (PPS). The PPS will provide 3-axis pointing, CG-yoke design, and 30 arcsecond peak-to-peak stability to the attached payload. Four ports will be available on the truss for large attached payloads. Not all of the ports will be identical; e.g., one will point up, one will point down, one will be for multiple experiments, etc.

Utility will be available for the APAE (power, thermal control, command and data, video and high-rate data, GN&C data, etc.) through each of the four ports on the truss. The maximum power available to all users will be 45 kW, similarly the Station thermal control system will provide a maximum heat-rejection capacity of 45 kW for all users. Direct-user interface provides 208 V, 20 kHz, single phase electrical power; however, Station-provided converters will be available at each payload in the form of 120/208 V, 60 Hz, single phase, or 28 VDC. Users will be charged for conversion losses (i.e., users are charged according to power required at converter input). Maximum power available at each external attach point is 10 kW for the payload and 2 kW for Station-provided subsystems.

The Space Station data management system (DMS) will provide a communication path which will be transparent to the users and will provide remote control and monitoring of payloads. The DMS will employ local area networks and local buses. Both low-rate (e.g., RS 232 at 9600 baud) and high-rate (e.g., MS 1553 at 1 Mbps) serial data links will be available. The user allocation of downlink capacity is TBD. Data storage will be 125 GB at Flight 20, but a significant portion of this will be required for Station subsystems use.

The Gunterville Workshop

Phil Cressy also presented results of a workshop to synthesize OSSA's Space Station requirements which was held in Gunterville, Alabama, from January 25 through 29, 1988. The workshop was part of Code E's Space Station/platform payload planning process and its objectives were to identify payloads for four Station assembly phases:

1) Initial Shuttle flights (unmanned)
2) Construction phase (man-tended)
3) Phase I (permanently manned)
4) Post Phase I (after first 36 months).

Several general observations were made following the Gunterville workshop. First, the Space Station is already overly subscribed. Second, materials processing activities will be very large consumers of available Station power and this could impact power availability to other users. Additional information on this meeting is contained in Appendices F through J, Volume II.

Attached Payload Announcement of Opportunity

Phil Cressy continued his Space Station briefing by providing some insight into NASA's attached experiment solicitation strategy. NASA's plans are to begin with simple payloads and grow in complexity as Space Station performance becomes better defined. Experiment simplicity and heritage will be emphasized.

An Announcement of Opportunity (AO) on Space Station attached payloads will be released in the March/April 1988 time frame. This single AO will solicit proposals for astrophysics, solar system exploration, space physics, and life sciences. (An Earth science attached payload announcement was incorporated into the recently released Earth Observing System AO.) Experiments will be selected for the initial one to three years of Space Station operation. Selection of experiments is scheduled for March/April 1989.

The science community would like the release date for this AO to be delayed, since so many Space Station requirements and constraints are unknown. However, the attached payload AO will be aimed at illustrative payloads, rather than definitive payloads. The AO will solicit world-wide participation.

FY 88 funds for experiment definition are limited. NASA has conducted an attached payload definition study with input from OSSA Division Directors in each of the four major disciplines. Examples of attached payloads which were defined include:

<u>Earth Science and Applications</u>
- Tropical Rain Measurement Mission
- Earth Radiation Budget

<u>Solar System Exploration</u>
- Cosmic Dust Collector
- Astrometric Telescope Facility

<u>Space Physics</u>
- Astromag
- PIMS
- Pinhole Occultation Facility (POF)
- Solar Terrestrial Observatory

<u>Astrophysics</u>
- LAMAR

Programmatic Issues

Three issues were agreed to be of importance to Space Station attached experiment users: resources, interfaces, and management. Two of these concerns (Space Station resources and interfaces) were addressed at length during this working-group meeting. Important question were raised, such as: what level of resource reserves needs to be defined? (It was concluded that the Space Station is resource-rich and, since the Station cannot be run at full capacity, there will always be resources available, but at what level?) What are "standard interfaces"?

John-David Bartoe, Space Station Chief Scientist, and Phil Cressy discussed relevant programmatic issues, such as schedule, funding, and the political environment. Some of this information is detailed in Appendix K, Volume II, Space Station Science Operations Issues. Summaries of these discussions are outlined below.

SCHEDULE CONCERNS

- At the current rate, there is a nine-month period between release of an AO and selection. For rapid-access payloads, this schedule will have to be accelerated.
- There may not be benefits for Small Attached Payloads during the first four launches, but we would like to try. Power will be available, since pressurized modules would not be launched yet. Later, Small Attached Payloads will be a permanent part of Space Station.
- The first three years of Space Station launches will be the assembly phase, so we cannot do anything "exotic".
- Small detached payloads will have to wait until after the first 36 months.

FUNDING ISSUES

- There are no line item resources reserved for Small Attached Payloads, but there will be (we hope).
- Payload carrier must be paid for.
- Payload operations will be charged to experiment offices.
- Use of arm, e.g., for experiment placement, will be charged to someone (experiment offices?).

POLITICAL CLIMATE

- There has been pressure on NASA from Congress for a "showcase" instrument.
- There is no lack of good ideas for Small Attached Payloads.
- NASA will begin to accommodate Small Attached Payloads, if OSSA receives a number of good proposals.
- Major break-throughs have occurred in science from small experiments.

Flight Telerobotic Servicer

The Flight Telerobotic Servicer (FTS) is part of Space Station Work Package 3. The system delivered to NASA will include a remotely controlled, teleoperated programmable dexterous manipulator; FTS control station for STS and Space Station; and operating software and procedures.

The FTS will be used for Space Station assembly and maintenance. Specific tasks will include (1) Truss assembly, (2) SIA installation, (3) ORU changeout, (4) mating of thermal utility connectors, and (5) inspection. Eventually, the FTS may evolve into a tool for assembly, inspection, and servicing of payloads and platforms.

The day's discussion was concluded with a brief summary of important considerations and questions raised.

- We have to define the requirements that will support the experiments.
- Assign payloads into types of requirements
  - Type 1 - totally passive, self contained
  - Type 2 - Power and telemetry requirements
  - Type 3 - Power, telemetry, and coarse pointing (arc min) requirements.
- How would having many utility ports situated along the truss impact the small attached payloads?

- Do we want to continue using only space-qualified materials or would ease of access for replacement allow more inexpensive material to be used.

- Can assume utility ports will supply

  - Power, circuit breaker, etc.
  - Telemetry - uplink, downlink
  - Should settle on an industry standard for command link

The meeting was adjourned at 5:00 pm.

Session 2, Wednesday, February 10, 1988, 8:30 am

The second session of the Small Attached Payloads Working Group began at 8:30 am, Wednesday, February 10, 1988.

After announcements and a brief discussion of the day's agenda, George Ricker distributed forms to be filled out that would summarize requirements for each payload.

Robotic Servicing

Peter Cline spoke on NASA's plans for utilization of robotics for attached payload servicing. Experiment modules, such as focal-plane instruments, will be plugged in and changed out. These modules will necessarily utilize standard connectors to interface with the Space Station attach points.

As a result, standardization of interfaces and servicing tools is an important facet of module design. To facilitate on-orbit servicing, Orbital Replacement Units (ORU), interchangeable spacecraft subsystem modules, have been designed for use on the Orbital Maneuvering Vehicle (OMV) and other spacecraft. (See Volume II for additional information on Polar Platform servicing--Appendix L; and OMV/ORU--Appendix M.) A user guide for on-orbit assembly, outlining types of connectors, etc, should be available in about six to nine months.

Two separate telerobotic servicing systems are planned as part of the Space Station: the Flight Telerobotic Servicer (FTS) and the Mobile Servicing System (MSS). The FTS is part of Space Station Work Package 3. The system delivered to NASA will include a remotely-controlled, teleoperated programmable dexterous manipulator; FTS control station for STS and Space Station; and operating software and procedures.

The FTS will be used for Space Station assembly and maintenance. Specific tasks will include (1) Truss assembly, (2) SIA installation, (3) ORU changeout, (4) mating of thermal utility connectors, and (5) inspection. Eventually, the FTS may evolve into a tool for assembly, inspection, and servicing of payloads and platforms.

The first phase of the MSS will be operation on the Phase I Space Station. The MSS will consist of the Canadian Mobile Remote Servicer, including base, remote manipulator system (RMS), and EVA workstation, and a

U.S.-supplied mobile transporter (U.S.). Functions of the MSS include construction and assembly, transportation of Space Station elements and payloads, deployment and retrieval, and support of attached payload servicing, external Space Station maintenance, EVA operations, and safe haven support.

The FTS will handle systems up to approximately 100 kg. Larger items will be changed out with the RMS. The servicer may move along a rail system; many different concepts exist, but the servicer will not be fixed.

Small Attached Payload Development

Vernon Jones then announced that $100K is available from Code EM to do hard studies on small attached payloads. The money will be managed by GSFC, and proposals will be solicited to perform short-term projects to define probable activities. This money would be for general studies, rather than for a particular payload. It is hoped that the proposals would be received by March 7, and the selection, by the Division chiefs, would be made by March 15.

Action Items

After a tour of the GSFC Robotics Lab, the following action items were discussed.

- Carter will supply a list of safety requirements for payloads attached to the Station.
- Carter will supply information on the state-of-the-art concerning stability, vibration, and angular acceleration of the Station.
- Von Bun will send a copy of the contamination report to Battelle for distribution.
- NASA's attitude on standard interfaces--power, mechanical, etc., needs to be defined.
- Hibbard will arrange input from someone from the GAS office.
- Subcommittee reports need to be developed.

Attached Payload Accommodation Equipment

Jerry Kull provided information on the Space Station Attached Payload Accommodation Equipment (APAE). (See Appendix J, Volume II.) Attached payloads will be supported during launch and structurally attached to the Station truss assembly via the APAE. The APAE will also provide access Station utilities and pointing of payloads toward specific targets.

Four utility ports are planned for the APAE. For each port, APAE provide a maximum of 10-kW power (208 V, 20 kHz) for the payload and 2 kW for the Station-provided subsystems, 10-kW heat rejection, and data transfer capability from 10 to 50 Mbps.

As currently envisioned, APAE will be available for (1) small single payloads, (2) multiple small payloads, (3) large self-supported and carrier-mounted payloads, and (4) articulated (pointed) payloads. The multiple small payload arrangement will be such that four or more Small Attached Payloads (each in the 100-500-kg range) will be accommodated at a single attach point.

For the payload pointing system APAE, electrical power will be available at 5 kW, heat transfer at 15 kW, and data communications at 50 Mbps. Also, the payload pointing system will accommodate only large payloads; a smaller version will be needed for Small Attached Payloads.

Input for Interim Report

An outline and writing assignments for the interim report was developed (see Figures 7 and 8).

The rest of the session was devoted to developing requirements for potential small attached payloads. In all, 28 payloads were described. A summary of these payloads is given in Tables 1, 2, and 3.

The committee was thanked for their time and effort, and the meeting was adjourned at 1:00 pm.

0.	Executive Summary (3 year horizon)	(Ricker, Jones)
1.	Introduction	(Ricker, Jones)
	1.1 International character	
	1.2 What is a small payload?	
	Rapid Response	
	1.3 Relation to major attached payloads	
2.	Space Physics Concepts	(Waddington)
	[NAS Report]	
	Relation to major free flyers	
3.	Astrophysics Concepts	(Priedhorsky)
	[Field Commission]	
	Relation to major free flyers	
4.	Concept for Small Payload Standard Interfaces	(McCammon)
	4.1 Individual Instruments	(McCammon)
	4.1.1 Autonomous	(McCammon)
	4.1.2 Power, telemetry, etc. from Space Station (Ethernet)	(Brunner)
	4.1.3 Coarse Pointing	(Skinner)
	4.2 Telescope facilities	(Scargle, Hesser)
	4.3 Clusters	(Gehrels)
5.	Small Payload Management Philosophy	(Heilegman)
	International	
	Reliability	
6.	Summary	(Ricker)
	Appendices	
	A. Strawman Space Physics	(Waddington)
	B. Strawman Astrophysics	(Priedhorsky)

FIGURE 7. INTERIM REPORT OUTLINE

	February	March	April	May	June
2nd Meeting	9-10				
1st Draft Due to Ricker, McCammon (Sec 4), Jones		10			
Comments Due		20			
2nd Draft Due - Submitted to Everyone			20		
Comments Due				1	
3rd Draft Due - Submitted to Everyone				10	
Interim Report Due					10

FIGURE 8. REPORT SCHEDULE

TABLE 1. SPACE STATION SMALL ATTACHED PAYLOAD SUMMARY

		Type* 1	Type* 2	Type* 3	1-Meter General Purpose Imaging Telescope
Number of Payloads**		2	16	9	1
Power -	Nominal	-0-	10-200W	50-150W	1000W
	Maximum	-0-	10-200W	100-200W	1500W
Mass -	Nominal	$\geq$500 kg	20-450kg	30-160kg	2000kg
	Maximum	--	20-500kg	50-450kg	4000kg
Volume -	Nominal	0.2-0.8m^3	0.1-6m^3	0.1-2m^3	10m^3
	Maximum	--	0.1-6m^3	0.6-6m^3	20m^3
Observing Time -	Nominal	0.25-6 yrs	0.2-3 yrs	0.25-11 yrs	Continuous
	Maximum	0.5-6 yrs	0.25-10 yrs	0.5-11 yrs	Continuous
Cost -	Nominal	$5M	$1.5M-25M	$1.5-10M	$100M
	Maximum	--	$2.5-30M	$5-15M	

- Many of the Type 2 payloads could be redesigned as Type 1 payloads
- All but two requested placement on outside of truss
- Robotic servicing requested only for installation, replacement/changeout, and removal
- Many requests for "permanent" observing time
- Several requests for on-orbit storage of spare/replacement units

* Type 1 - Totally passive, self-contained
Type 2 - Power and telemetry requirements
Type 3 - Power, telemetry, and coarse pointing (arc min) requirements.

** Payload summary does not represent a definitive count of specific payloads since descriptions of generic classes of payloads were also included.

TABLE 2. PROPOSED SMALL ATTACHED PAYLOADS (PRELIMINARY)

Payload	Proposers
TYPE 1	
1) Heavy Nuclei Collector	Price/Berkeley; Tarle/Michigan
2) Passive High Energy	Wefel/LSU; Parnell/MSFC
TYPE 2	
1) γ-Ray Burst Spectrometer	Gehrels/GSFC
2) γ-Ray Diffuse Background Spectrometer	Gehrels/GSFC
3) Sub-mm/IR Spectrometer Heliostat	Heiligman/MIT
4) All-Sky X-Ray Monitor	Priedhorsky/Los Alamos
5) All-Sky Monitor	Skinner/Birmingham
6) Unpointed Astrophysics Payloads - Generic Summary	Priedhorsky/Los Alamos
7) Diffuse Background Calorimeter	McCammon/Wisconsin
8) C-Shell	Waddington/Minnesota
9) Super Heavy Experiment	Waddington/Minnesota
10) Plasma Interactions Monitoring System (PIMS)	Barfield/Southwest Research Institute
11) Solar Plasma Diagnostics Experiment (Unpointed)	Bruner/Lockeed
12) Solar High Resolution UV Imaging System	Bruner/Lockheed
13) Sub-mm Cometary Spectrometer	Heiligman/MIT
14) UV Spectroscopic Survey	Martin/Columbia
15) UV Emission Line Spectrometer (Diffuse Background)	Martin/Columbia
16) Broad Band Transient Monitor	Ricker/MIT
TYPE 3	
1) Coded Mask Telescope	Skinner/Birmingham
2) Crudely Pointed Astrophysics Payloads - Generic Summary	Priedhorsky/Los Alamos
3) Small Focal Plane Instruments - Generic Summary	Priedhorsky/Los Alamos
4) Solar Plasma Diagnostics Experiment (Pointed Version)	Bruner/Lockheed
5) Solar γ-Ray Spectroscopy Monitor	Gehrels/GSFC
6) Heliospheric Imager	Hudson/UCSD
7) Flare Energy Budget Experiment	Hudson/UCSD
8) Solar Irradiance Package	Hudson/UCSD
9) Michelson UV Stellar Interferometry Carrier (MUSIC)	Faucherre/LPSP
1-M Gen.-Purpose Imaging Telescope	Scargle/NASA-Ames

TABLE 3. SPACE STATION SMALL ATTACHED PAYLOAD (PRELIMINARY)

Payload	Astrophysics (A) Space Physics (S)	Number of Modules	Power (W)		Mass (kg)		Volume (M^3)		Observation Time (yr)	
			Nom.	Max.	Nom.	Max.	Nom.	Max.	Min.	Max.
TYPE 1										
1) Heavy Nuclei Collector	S	1	0	0	≳500	-	0.8	-	6	-
2) Passive High Energy	S	1	0	0	≳500	-	0.2	-	0.25	0.5
TYPE 2										
1) γ-Ray Burst Spectrometer	A	1	50	200	50	200	<1	-	1	3
2) γ-Ray Diffuse Background Spectrometer	A	1	50	200	100	500	1	-	1	-
3) Sub-mm/IR Spectrometer Heliostat	A	1	100	150	100	-	1	-	0.25	1
4) All-Sky X-Ray Monitor	A	6+2 spares	10	10	20	20	0.13	0.13	permanent	
5) All-Sky Monitor	A	3-4	80	80	88	100	0.4	-	0.5	10
6) Unpointed Astrophysics Payloads - Generic Summary	A	1	-	100	100	300	1	-	indefinite	
7) Diffuse Background Calorimeter	A	1	160	180	110	150	0.3	0.4	0.17	0.25
8) C-Shell	S	2-2500	15	20	25	25	0.2	1.5	3	10
9) Super Heavy Experiment	S	1	200	200	450	500	6	-	3	8
10) Plasma Interactions Monitoring System (PIMS)	S	≲10	100	125	100	125	0.5	1	continuous	
11) Solar Plasma Diagnostics Experiment (Unpointed)	S	1	150	200	150	250	1.0	1.2	0.25	0.75
12) Solar High Resolution UV Imaging System	S	1	100	200	150	250	0.8	1.5	0.25	-
13) Sub-mm Cometary Spectrometer	A,S	1	100	150	80	100	1	-	0.5	-
14) UV Spectroscopic Survey	A	1	100	200	150	-	1	-	0.5	1.0
15) UV Emission Line Spectrometer (Diffuse Background)	A	1	100	150	100	-	0.2	0.4	0.25	0.5
16) Broad Band Transient Monitor	A	1	50	100	70	100	<1	-	-	10
TYPE 3										
1) Coded Mask Telescope	A	1	120	150	160	450	2	6	0.25	3
2) Crudely Pointed Astrophysics Payloads - Generic Summary	A	1	-	100	100	300	2	-	indefinite	
3) Small Focal Plane Instruments - Generic Summary	A	1	-	100	-	50	0.5	-	0.25	0.5
4) Solar Plasma Diagnostics Experiment (Pointed Version)	S	1	150	200	150	200	0.8	1.0	0.25	0.75
5) Solar γ-Ray Spectroscopy Monitor	S	1	50	-	100	500	1	2	1	-
6) Heliospheric Imager	S	1	100	-	30	-	0.2	-	11+	11+
7) Flare Energy Budget Experiment	S	1	100	-	30	-	0.1	-	0.5	-
8) Solar Irradiance Package	S	1	100	-	30	-	0.1	-	permanent	
9) Michelson UV Stellar Interferometry Carrier (MUSIC)	A	1	80	100	100	150	0.5	0.63	continuous	
1-M Gen.-Purpose Imaging Telescope	A	1	1000	1500	2000	4000	10	20	continuous	

TABLE 3. (Continued)

Payload	Look Direction	Attachment Method	Attitude Know.	Attitude Rate	Attitude Acc.	Vibration Tol.	Vibration Rate	Vibration Acc.
TYPE 1								
1) Heavy Nuclei Collector	Up	Any	None	-	-	-	-	-
2) Passive High Energy	Up	Any	None	-	-	-	-	-
TYPE 2								
1) γ-Ray Burst Spectrometer	All Sky	Can	$\pm 1^\circ$	-	-	-	-	-
2) γ-Ray Diffuse Background Spectrometer	Sky	Can	$\pm 0.2^\circ$	-	-	-	-	-
3) Sub-mm/IR Spectrometer Heliostat	Up	Any	$\gtrsim \pm 1^\circ$	0.1°/sec	$0.05^\circ/s^2$	-	-	-
4) All-Sky X-Ray Monitor	Outward from faces of a cube	Any	$\pm 1^\circ$	N/A	N/A	N/A	-	-
5) All-Sky Monitor	All	Modules looking different directions	$\pm 0.1^\circ$	$\pm 0.1^\circ$/s	N/A	-	-	TBD
6) Unpointed Astrophysics Payloads - Generic Summary	Anti-Earth	Standard Small PL Carrier	$\pm 1^\circ$	-	-	"What we get"	"What we get"	"What we get"
7) Diffuse Background Calorimeter	Anti-Earth	-	$\pm 3^\circ$			-	-	$\pm$0.1g,10g max
8) C-Shell	Up	Own Substructure	$\pm 1^\circ$	-	-	-	-	-
9) Super Heavy Experiment	Up	Any	$\pm 1^\circ$	-	-	-	-	-
10) Plasma Interactions Monitoring System (PIMS)	TBD	TBD (Nonstandard I/F)	$\pm 5^\circ$	TBD	TBD	TBD	TBD	TBD
11) Solar Plasma Diagnostics Experiment (Unpointed)	Toward Sun	Fixed to upper side of truss	$\pm 1^\circ$	N/A	N/A	N/A	N/A	$< \pm 0.1$ g
12) Solar High Resolution UV Imaging System	Toward Sun	Fixed to upper side of truss	$\pm 1^\circ$	N/A	N/A	insensitive	insensitive	$< \pm 0.1$ g
13) Sub-mm Cometary Spectrometer	Up (30-45° away from Sun)	Any	$\pm 1^\circ$	-	-	-	-	-
14) UV Spectroscopic Survey	Zenith	Any	$\pm 1^\circ$	$\pm 0.1^\circ$/s	-	no req't	no req't	no req't
15) UV Emission Line Spectrometer (Diffuse Background)	Zenith	Any	$\pm 1^\circ$	$\pm 0.5^\circ$/s	-	no req't	no req't	no req't
16) Broad Band Transient Monitor	Up	Can	$\pm 20^\circ$	$\pm 1^\circ$/hr	N/A	-	-	-
TYPE 3								
1) Coded Mask Telescope	Up	Any standard I/F	$\pm 0.5^\circ$	$\pm 1^\circ$/s	-	-	-	TBD
2) Crudely Pointed Astrophysics Payloads - Generic Summary	Up	Standard Small PL carrier on crude pointer	30"	-	-	-	-	-
3) Small Focal Plane Instruments - Generic Summary	Anywhere in deep space	-	1"	-	-	-	-	-
4) Solar Plasma Diagnostics Experiment (Pointed Version)	Toward Sun	On Coarse Pointer	$\pm 0.01^\circ$	$\pm 3\times10^{-3}{}^\circ$/s	N/A	N/A	N/A	$< \pm 0.1$ g
5) Solar γ-Ray Spectroscopy Monitor	Sun	On Pointer	$\pm 0.2^\circ$	-	-	-	-	-
6) Heliospheric Imager	Toward Sun	Coarse Pointer	$\pm 1^\circ$	N/A	N/A	N/A	N/A	N/A
7) Flare Energy Budget Experiment	Toward Sun ($\pm 10^\circ$)	On Coarse Pointer	$\pm 1^\circ$	N/A	N/A	N/A	N/A	N/A
8) Solar Irradiance Package	Toward Sun ($< 10^\circ$)	On Coarse Pointer	$\pm 1^\circ$	N/A	N/A	N/A	N/A	N/A
9) Michelson UV Stellar Interferometry Carrier (MUSIC)	Whole Sky	Payload Pointing System (PPS)	$\pm 1/60^\circ$	$\pm 1/60^\circ$/s	$10^\circ/s^2$	$\pm$0.1 mm	$\pm$0.05 mm/s	$\pm$0.01 g
1-M Gen.-Purpose Imaging Telescope	Upper Hemisphere	Coarse pointer	$\pm 1^\circ$	TBD	TBD	TBD	TBD	TBD

TABLE 3. (Continued)

Payload	Communications: Commands (cmd/day)	Communications: TM to SS (kbps)	Communications: TM to Ground (kbps)	On-Board Storage: Photo-Graphic	On-Board Storage: Magnetic	On-Board Storage: Other	Cost ($): Nom.	Cost ($): Max.	Servicing: None	Servicing: Robotic
TYPE 1										
1) Heavy Nuclei Collector	None	None	None	None	None	None	5M	-	X	
2) Passive High Energy	None	None	None	Possible	-	-	5M	-	X	
TYPE 2										
1) γ-Ray Burst Spectrometer	$\lesssim 1$	< 10	-	-	-	On-board memory for transients	Few M	-	X	
2) γ-Ray Diffuse Background Spectrometer	1-10	< 10	-	-	-	-	Few M	-	X	
3) Sub-mm/IR Spectrometer Heliostat	20-100	10	-	-	-	-	-	-	X	
4) All-Sky X-Ray Monitor	2	5	5	No	No	No	2M	-	X	
5) All-Sky Monitor	1-50	50-100	0	X	X	X	4M	?	X	
6) Unpointed Astrophysics Payloads - Generic Summary	< 5	10-100	10-100	X	X	Optical disk	1.5M	5M	X	
7) Diffuse Background Calorimeter	10	15	-	-	-	-	200K rocket	-	X	
8) C-Shell	10	1xn	-	-	-	Spare Modules	50Kxn	100Kxn		X
9) Super Heavy Experiment	10	2	-	-	-	Spare Subassemblies	8M	10M		X
10) Plasma Interactions Monitoring System (PIMS)	-	1	100	None	45MB	Optical?	25M (1st) 3M (2-10)	30M (1st) 15M (2-10)		X
11) Solar Plasma Diagnostics Experiment (Unpointed)	Few tens of kbits/day	2×10^3	-	-	6×10^9 bits/orbit	-	10M	15M	X	
12) Solar High Resolution UV Imaging System	Few tens of kbits/day	$\sim 10^3$	-	-	3×10^9 bits/orbit	-	8M	15M	X	
13) Sub-mm Cometary Spectrometer	-	10	-	-	-	-	10M	30M		?
14) UV Spectroscopic Survey	10	10-50	-	None	None	None	2M	4M	X	
15) UV Emission Line Spectrometer (Diffuse Background)	10	5000	-	None	None	None	1.5M	2.5M	X	
16) Broad Band Transient Monitor	< 1	< 10	< 0.1	None	None	Optical disk + RAM	Few M	-	X	
TYPE 3										
1) Coded Mask Telescope	50	50	-	X	X	X	?			X
2) Crudely Pointed Astrophysics Payloads - Generic Summary	10	10-100	10-100	X	X	Optical Disk	1.5M	5M	X	
3) Small Focal Plane Instruments - Generic Summary	10	10-100	10-100	X	X	Optical Disk	1.5M	5M	X	
4) Solar Plasma Diagnostics Experiment (Pointed Version)	Few tens of kbits/day	2×10^3	-	-	6×10^9 bits/orbit	-	10M	15M	X	
5) Solar γ-Ray Spectroscopy Monitor	< 10	< 10	-	-	-	On-board memory for transients	Few M	-	X	
6) Heliospheric Imager	Few kbits/day	10	-	-	-	-	-	-		X
7) Flare Energy Budget Experiment	Few kbits/day	10	-	-	-	-	-	-		X
8) Solar Irradiance Package	Few kbits/day	10	-	-	-	-	-	-		X
9) Michelson UV Stellar Interferometry Carrier (MUSIC)	TBD	TBD	-	-	X	-	~ 2M	-	X	
1-M Gen.-Purpose Imaging Telescope	TBD	~ 1 Mbps	-	-	Significant	-	100M	-		X

TABLE 3. (Continued)

Payload	Cryogenics: LN_2	Cryogenics: LHe	Cryogenics: Closed Cycle Cooler	Location on Truss: Inside	Location on Truss: Outside	On-Orbit Storage	Contamination Effects	Heritage
TYPE 1								
1) Heavy Nuclei Collector	None	None	None		X	None	None	HNC
2) Passive High Energy	None	None	None		X	-	None	JACEE
TYPE 2								
1) γ-Ray Burst Spectrometer			X		X	-	Possible contam. of cold surface of passive radiator	ISEE 3, WIND
2) γ-Ray Diffuse Background Spectrometer			X		X	-	Possible contam. of cold surface of passive radiator	Balloon
3) Sub-mm/IR Spectrometer Heliostat		For Far IR not sub-mm			X	-	Sensitive to HC	-
4) All-Sky X-Ray Monitor	None	None	None		X	Spare Modules--standby heat only	None	Ariel 5, ASM
5) All-Sky Monitor	X	X	X	X	X	N/A	X	Phase A study - Soviet S/C
6) Unpointed Astrophysics Payloads - Generic Summary	X	X	X		X	N/A	Small outgassing	Diverse
7) Diffuse Background Calorimeter		X		Okay w/ 20° FWB clear FOV	X	After observation only	$<30\mu g/cm^3$/3 mo. condensation on anti-Earth surface	Rocket PL
8) C-Shell	None	None	None		X	None	None	New
9) Super Heavy Experiment	None	None	None	Either		None	None	HEAO-3
10) Plasma Interactions Monitoring System (PIMS)	None	None	None		X	Possible Replacement Unit	None	All components flown/qualified
11) Solar Plasma Diagnostics Experiment (Unpointed)	None	None	None		X	Not Required	Sensitive to HC	Solar Sounding Rocket Program
12) Solar High Resolution UV Imaging System	None	None	None		X	Not Required	Sensitive to HC	Solar Sounding Rocket Program
13) Sub-mm Cometary Spectrometer	-	-	-		X	Stored until comet observed	Sensitive to HC and H_2O	-
14) UV Spectroscopic Survey	None	None	None	Not critical		If necessary	Line-of-sight column densities and condensables are serious concerns	New
15) UV Emission Line Spectrometer (Diffuse Background)	None	None	None	Either		No	Line-of-sight column densities and condensables are serious concerns	Sounding Rocket
16) Broad Band Transient Monitor	None	None	None		X	-	Possible contamination of radiator surface	HETE

TABLE 3. (Continued)

Payload	Cryogenics			Location on Truss		On-Orbit Storage	Contamination Effects	Heritage
	LN_2	LHe	Closed Cycle Cooler	Inside	Outside			
TYPE 3								
1) Coded Mask Telescope	X	X	X	X		N/A	N/A	Spacelab 2 XRT
2) Crudely Pointed Astrophysics Payloads - Generic Summary	X	X	X		X	-	Small outgassing	Diverse
3) Small Focal Plane Instruments - Generic Summary	X	X	X		X	Standby	Outgassing	Space and ground-based experiments
4) Solar Plasma Diagnostics Experiment (Pointed Version)	None	None	None		X	N/A	Sensitive to HC	Solar Sounding Rocket Program
5) Solar γ-Ray Spectroscopy Monitor			X		X	-	Possible contam. of cold passive radiator	SMM, HEAO3
6) Heliospheric Imager	None	None	None		X	1 spare unit	Sensitive to "Shuttleglow"	SMM, ACRIM
7) Flare Energy Budget Experiment	None	None	None		X	-	-	SMM, ACRIM
8) Solar Irradiance Package	None	None	None		X	1 spare unit	-	SMM
9) Michelson UV Stellar Interferometry Carrier (MUSIC)	None	None	None		X	N/A	No UV absorption in Lyα	Proposal for EURECA
1-M Gen.-Purpose Imaging Telescope	None	None	None		X	-	Warm optics would minimize	-

APPENDIX A

SPACE STATION SMALL ATTACHED PAYLOADS WORKING GROUP ADDRESS LIST

APPENDIX A

SPACE STATION SMALL ATTACHED PAYLOADS WORKING GROUP ADDRESS LIST

Core Committee

George Ricker - Chairman
MIT
Room 37-535
MIT Center for Space Research
Cambridge, MA 02138
Telephone: (617)253-7532,7555,7501
OMNET/TELEMAIL: grr @ space.mit.edu
FAX: (617)253-0861
TELEX: 921473 MITCAM

Joe Barfield
Southwest Research Institute
P.O. Drawer 28510
San Antonio, TX 78284
Telephone: (512)522-2748
OMNET/TELEMAIL: J.BARFIELD/OMNET
SPAN: SWRI::JOE
FAX: (512)647-4325

Marilyn Bruner
Lockheed
3251 Hanover Street, Bldg. 295 Org 91-20
Palo Alto, CA 94306
Telephone: (415)493-8142 (home phone); (415)424-3273 (work)
(415)424-3270 (secretary)
SPAN LOCKHD::BRUNER
LACTON(NASAMAIL)
OMNET/TELEMAIL: [MABRUNER/NASA]NASAMAIL/USA
Stanford Solarmail (Corona::) MBRUNER

Alan Bunner, Code EZ
NASA Headquarters
Washington, DC 20546
OMNET/TELEMAIL: [ABUNNER/NASA]NASAMAIL/USA
FAX: 202-755-9234

Rick Chappell
DS01
Marshall Space Flight Center, AL 35812
Telephone: (205)544-3033 or FTS 824-3033
OMNET/TELEMAIL: CCHAPPELL
FAX: (205)544-5893 or FTS 824-5893

Core Committee (Continued)

Michel Faucherre
LPSP/CNRS
B.P. No. 10
91371 Verrieres-le-Buisson
FRANCE Cedex
Telephone: (33)-1-64474386
TELEX: 600252 - LPSPVEB F
FAX: (33)-1-69203907
SPAN: IAPOBS::FAUCHERRE
BITNET = FAUCHERRE@FRIAP51

Allan Frandsen, Code ES
NASA/Headquarters
Washington, DC 20546
Telephone: (202)453-1676
OMNET/TELEMAIL: [AFRANDSEN/NASA]NASAMAIL/USA
FAX: (202)755-9235

Neil Gehrels, Code 661
NASA/GSFC
Greenbelt, MD 20771
Telephone: (301)286-6546, FTS 888-6546
OMNET/TELEMAIL: [NGEHRELS/NASA]NASAMAIL/USA
FAX: (301)286-3391, FTS 888-3391
TELEX: 89675 answer back NASCOM GBLT

Gary Heiligman, Code AN1-4D
MIT Lincoln Laboratory
244 Wood St.
Lexington, MA 02173-0073
Telephone: (617)981-2843
OMNET/TELEMAIL: Arpanet: XRAY@LL.ARPA
FAX: (617)862-9057
TELEX: 923355

Jim Hesser
Dominian Astrophysical Observatory
5071 W. Saanich Rd.
Victoria, BC V8X 4M6 CANADA
Telephone: (604)388-0007 (office); 388-0001 (secretary)
OMNET/TELEMAIL: Bitnet: HESSER@UVPHYS (until 1 Apr 88); HESSER@NRCDAO
TELEX: 0497295
FAX: (604)388-0045

Bill Hibbard, Code 402
NASA/GSFC
Greenbelt, MD 20771
Telephone: (301)286-7510
OMNET/TELEMAIL: [BHIBBARD/GSFCMAIL]GSFC/USA
FAX: (301)286-2027

Hugh Hudson
CASS C-011
University of California, San Diego
LaJolla, CA 92093
Telephone: (619)534-4476
OMNET/TELEMAIL: [HUHUDSON/NASA]NASAMAIL/USA
SPAN: CASS01:HUDSON
FAX: (619)534-2294

W. Vernon Jones, Code ES
NASA Headquarters
Space Physics Division
Washington, DC 20546
Telephone: (202)453-1520
OMNET/TELEMAIL: [WVJONES/NASA]NASAMAIL/USA
FAX: 202-755-9235, 755-4786, 755-9234
TELEX: 89530 NASA WSH

Bill Mahoney, MS 169-327
JPL
4800 Oak Grove Dr.
Pasadena, CA 91109
Telephone: FTS 792-6606
OMNET/TELEMAIL:
FAX: FTS-792-8895

Chris Martin
Physics Department, Columbia University
538 West 120th Street
New York, NY 10027
Telephone: (212)280-0604
BITNET: DCM@CUTHRY
FAX: (212)749-0397
TELEX: 220094 - COLU UR

Dan McCammon
Physics Department, University of Wisconsin
Madison, WI 53706
Telephone: (608)262-5916
SPAN: 43317::MCCAMMON
BITNET: McCAMMON@WISCPSL
ARPANET: MCCANNON%WISP.DECNET@VMS.MACC.WISC.edu
FAX: (608)262-8628
TELEX: 265452 UOFWISC MDS

Core Committee (Continued)

Henk Olthof
ESTEC-PU
Postbus 299
2200 AG NOORDWIJK
THE NETHERLANDS
Telephone: 1719-84350
OMNET/TELEMAIL: ESA.HOLTHOF
FAX: 1719-17400
TELEX: 39098

Bill Priedhorsky, Mail Stop D436
Los Alamos National Laboratory
Los Alamos, NM 87545
Telephone: (505)667-5204, FTS 843-5204
OMNET/TELEMAIL: SPAN - ESSDR2:: 087799
FAX: (505)667-3494, FTS 843-3494

Jeff Scargle, MS 245-3
NASA AMES
NASA-AMES Res. Ctr.
Moffett Field, CA 94035
Telephone: (415)694-6330
OMNET/TELEMAIL: [JDSCARGLE/NASA]NASAMAIL/USA
FAX: (415)694-6997, FTS 464-6997

Gerald Skinner
ESA/Birmingham
University of Birmingham
Dept. of Space Research
Edgbaston, Birmingham B15 2TT
ENGLAND
Telephone: (UK) 21 414 6450
FAX: (UK) 21 471 4691
TELEX: (UK) 338938
Janet: GKS @ UK.AC.BHAM.SR.STAR
DTE: 000020013301

Jake Waddington
116 Church St., S.E.
University of Minnesota
Minneapolis, NM 55455
Telephone: (612) 624-2566
FAX: (612)625-7330
TELEX: 910 576-2955

Space Physics Subcommittee

James Beatty
Boston University
Laboratory/ODA
Hanscom AFB, MA 01731
Telephone: (617) 353-9393
OMNET/TELEMAIL: SPAN/HEPNET

Ed Chupp
University of New Hampshire
Physics Department, DeMeritt Hall
Durnham, NH 03824
Telephone: (603)862-2750
OMNET/TELEMAIL: [EChupp/NASA]NASAMAIL/USA
FAX: (603)862-2755

Mark Giampapa
NOAO National Solar Observatory
950 N. Cherry Ave.
P.O. Box 26732
Tucson, AZ 85726-6732
Telephone: (602)325-9236

David Kendall
Space Division
National Research Council of Canada
100 Sussex Dr.
Ottawa ON KIA OR6
CANADA

Steve Mende
Lockheed
Department 9120, Building 255
3251 Hanover St.
Palo Alto, CA 94304
Telephone: (415)424-3282
OMNET/TELEMAIL: SPAN-Lockhd::Mende
FAX: (415)424-3333

W. John Raitt
CAAS/UMC 4405
Utah State University
Logan, UT 84322-4405
Telephone: (801)750-2983
OMNET/TELEMAIL: SPAN: USU::RAITT
FAX: (801)750-2992
TELEX: 3789426
ANS.Back UTAHSTATE U LOGAN

Space Physics Subcommittee - (Continued)

Roger Williamson
Star Lab/SEL
Stanford University
Sanford, CA 94305-4055
Telephone: (415)723-9774
OMNET/TELEMAIL: SPAN-*::Williamson
FAX: (415)723-0010

John Wefel
Louisiana State University
Department of Physics and Astronomy
202 Nicholson Hall
Baton Rouge, LA 70803-4001
Telephone: (504)388-8696
OMNET/TELEMAIL: SPAN LSUOVX::Wefel
FAX: (504)388-5855

Astrophysics Subcommittee

Krishna Apparao
Space Physics Group
Tata Institute of Fundamental Research
Homi Bahbah Rd.
Bombay - 400 005
INDIA

Elena Aprile
Physics Department, Columbia University
538 West 120th St.
New York, NY 10027
Telephone: (212)280-8416 Lab; (212)280-3258 Office
Bitnet: AGE @ Cuthry

Tom Ayres
University of Colorado, Boulder
Center for Astrophysics and Space Astronomy
Campus Box 391
Boulder, CO 80309-0391
Telephone: (303)492-4051

George Carruthers, Code 4109
Naval Research Lab
Washington, DC 20375-5000
Telephone: (202)767-2764
FAX: (202)767-6473

Astrophysics Subcommittee (Continued)

T. Alan Clark
Physics Department, University of Calgary
2500 University Drive NW
Calgary, Alberta T2N1N4
CANADA

Tom Cline, Code 661
NASA/GSFC
Greenbelt, MD 20771
Telephone: (301)286-8375
FAX: (301)286-3391
TELEX: 89675

Steve Kahn
Physics Department, UC Berkeley
Berkeley, CA 94720
Telephone: (415)642-4391
FAX: (415)643-8245
Bitnet: SKAHN @ SSL.Berkeley.edu

Howard Smith, Code 4138
Naval Research Lab
Washington, DC 20375
Telephone: (202)767-3058/2775
OMNET/TELEMAIL: SPAN: 6550::11334::SMITH
FAX: (202)767-6473

Mark Stier, Mail Stop 813
Perkin-Elmer
100 Wooster Heights
Danbury, CT 06810
Telephone: (203)797-5708
FAX: (203)797-5071

Kurt Weiler, Code 4131
Naval Research Lab
Washington, DC 20375-5000
Telephone: (202)767-0292
OMNET/TELEMAIL: BITNET: WEILER% SSDO.DECNET% NRL.ARPA @
UCBVAX.BERKELEY.EDU