Principal Investigator Microgravity Services

Software Requirements for Processing Microgravity Acceleration Data from the International Space Station

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Revision History

Revision	Effective Date	Description
Baseline	May 19, 2000	Baseline Release, Signatures Included
A	July 30, 2001	Add appendix A for Increment 2 and Increment 3 operations, update headers to reflect new revision and revision date
B	July 18, 2002	Add appendix B for increment 5 operations with SUBSA and PFMI; Update headers to reflect new revision; Add Appendix Z for tracking open work

Acronyms and Abbreviations

AOS	Acquisition of Signal
ARIS ICE	Active Rack Isolation System ISS Characterization Experiment
CCSDS	Consultative Committee for Space Data Systems
EHS	Enhanced HOSC System
EXPPCS	EXPeriment on Physics of Colloids in Space
GRC	Glenn Research Center
GSE	Ground Support Equipment
HiRAP	High Resolution Accelerometer Package
HOSC	Huntsville Operations Support Center
ISS	International Space Station
LOS	Loss of Signal
MAMS	Microgravity Acceleration Measurement System
MEP	Microgravity Environment Program
MSFC	Marshall Space Flight Center
MSG	Microgravity Science Glovebox
NASA	National Aeronautics and Space Administration
OARE	Orbital Acceleration Research Experiment
OBPR	Office of Biological and Physical Research
OSS	OARE Sensor Subsystem
PAD	PIMS Acceleration Data
PCSA	Principal Component Spectral Analysis
PDSS	Payload Data Services System
PFMI	Pore Formation and Mobility Investigation
PI	Principal Investigator
PIMS	Principal Investigator Microgravity Services
QTH	Quasi-steady Three-Dimensional Histogram
RMS	Root-Mean-Square
RSS	Root-Sum-Square
RTS	Remote Triaxial Sensor System
SAMS-II	Space Acceleration Measurement System-II
SE	Sensor Enclosure
SUBSA	Solidification Using a Baffle in Sealed Ampoules
TMF	Trimmean Filter
TSC	Telescience Support Center
WWW	World Wide Web

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1. Introduction

The NASA Glenn Research Center (GRC) Principal Investigator Microgravity Services (PIMS) project supports NASA microgravity Principal Investigators (PIs) by providing acceleration data analysis and interpretation for a variety of microgravity carriers including the International Space Station (ISS), the Space Shuttle, the Russian Mir Space Station, parabolic aircraft, sounding rockets, and drop towers. The PIMS project is funded by the NASA Headquarters Office of Biological and Physical Research (OBPR) and is part of the NASA Glenn Research Center's Microgravity Environment Program (MEP), which integrates the analysis and interpretation component of PIMS with the various NASA sponsored acceleration measurement systems. For the ISS, these acceleration measurement systems include the Space Acceleration Measurement System-II (SAMS-II) and the Microgravity Acceleration Measurement System (MAMS).

The requirements specified in this document are derived primarily from expertise obtained by the PIMS project during operational support of Space Shuttle microgravity missions and from PI requirements captured in the Experiment Support Requirements Document [1] and the International Space Station Program Microgravity Control Plan [2]. The compilation of the requirements from these sources represents a set of requirements that have been identified primarily from Space Shuttle microgravity missions. In general, the PIMS project's acceleration data support efforts are to archive and disseminate accelerometer data; to support users interested in the microgravity acceleration environment by providing information about activities and acceleration sources; to identify acceleration sources related to vehicle systems, experiment hardware, vibration isolation systems, and other systems; to design data analysis techniques and displays per user requirements; to educate users about the environment and data analysis techniques; to provide standard data interpretation reports; and to characterize the microgravity environment of the ISS in support of PIs.

2. Background and Scope

This document defines the requirements for PIMS ground processing software. Consequently, the requirements must be separated into their logical components based on the broad scope of the PIMS project's responsibilities regarding the management of acceleration data during ISS operations. These logical components have been identified as real time system requirements, near real time requirements, offline system requirements, storage requirements, and general support requirements.

To address any new requirements that originate based on ISS operations, this document will contain sections called *Generic Requirements* (Section 4) and *Increment Specific Requirements* (Section 5). The generic requirements are intended to reflect capabilities that may serve multiple PIs, such as displaying the acceleration data in a specific manner. Increment specific requirements are intended to capture PI requirements that are not adequately addressed by the current set of generic requirements. Both the *Generic Requirements* and the *Increment Specific Requirements* sections of this document will have subsections based on the logical components identified in the top-level paragraph. If deemed appropriate, an increment specific requirement will be added to the generic requirements of this document and be available for operations during subsequent increments.

The increment specific paragraphs that follow consist of two basic parts. The first part summarizes the basic operating concept for generic increment operations. This basic operating concept is intended to describe the basic flow of data from on board the ISS to the PIMS Ground Support Equipment (GSE) and ultimately to PIs. This includes any changes and improved capabilities of the overall acceleration data system that is comprised of the Marshall Space Flight Center (MSFC) Enhanced Huntsville Support Center (HOSC) System (EHS), the Glenn Research Center (GRC) Telescience Support Center (TSC), and the PIMS ISS software. The second part of the increment specific paragraphs serves to summarize any increment specific changes to the PIMS ISS software. As described previously, such a change would be the result of an increment specific requirement being added to the PIMS ISS software for use in subsequent increments.

2.1. PIMS Operations Concept

2.1.1. PIMS Generic Operations

The basic data flow for initial operations involves the transmission and acquisition of SAMS-II and MAMS data in real time. The PIMS GSE will be located at the GRC TSC where acceleration data packets from both accelerometer systems will be received and written to a database in real time. In real time, the display generation software will extract data from the database, decommutate the data, and display the data on PIMS GSE. Periodic electronic snapshots of these plotted images will be obtained and made available to the science community via the PIMS ISS World Wide Web (WWW) page.

The database that is used as a source of data for generating real time displays will similarly receive data from prior Loss of Signal (LOS) periods. The action of writing the LOS data to the database performs a merge of Acquisition of Signal (AOS) and LOS data, resulting in a complete set of data packets for each supported accelerometer system.

In parallel to the real time display of the acceleration data, PIMS GSE will archive the acceleration data in two formats, raw data packets and processed acceleration data. The software responsible for archiving raw data packets or processed acceleration data uses the database described above as its initial source of data for processing. The raw data packets serve as an unprocessed archive of the data packets as received by the PIMS GSE. The processed acceleration data will also serve as an archive, but the data will be stored in engineering units instead of unprocessed, raw data. This processed acceleration data will be available to PIMS data analysts and PIs for subsequent offline analysis and offline experiment to acceleration environment data correlation.

2.1.2. Increment 2-4 PIMS Software Changes

No PIMS software changes have been implemented in support of Increment 2-4 operations.

2.1.3. Increment 5 PIMS Software Changes

No PIMS software changes have been implemented in support of Increment 5 operations. However, the arrival of the Microgravity Science Glovebox (MSG) on the ISS introduces an additional SAMS sensor used to measure the localized vibratory environment of MSG.

3. Document Specific Definitions

Data

As used in this document, the term data alone generically refers to all data types available for processing. Any requirement specific to the processing or manipulation of a particular accelerometer system's data will have the term data preceded by the appropriate descriptor, such as SAMS-II data.

Rates and Angles Data

Refers to the data set composed of the Space Station body angles, body rates, and other parameters required to map the MAMS Orbital Acceleration Research Experiment (OARE) Sensor Subsystem (OSS) data to alternate locations within the Space Station

Real Time Data

Data transmitted from the HOSC containing an indication that the data were received from an ISS AOS period

Near Real Time Data

Data transmitted from the HOSC containing an indication that the data were received from an ISS LOS period

WWW Update Rate

Interval of time between snapshots of acceleration data images

4. Generic Requirements

4.1. Real-Time Requirements

4.1.1. General

The items described here are top-level functions to be performed by the PIMS real-time software. The PIMS real-time software operates on data during AOS periods. PIMS ISS real-time software will perform the following tasks.

4.1.1.1. Communication

PIMS ISS real-time software will initiate, terminate, and re-establish communications with the EHS as required to maintain data flow.

4.1.1.2. SAMS-II Data Acquisition

PIMS ISS real-time software will process, store, and distribute acceleration data from up to 10 SAMS-II Remote Triaxial Sensors Systems (RTS).

4.1.1.3. SAMS-II Configuration

PIMS ISS real-time software will recognize changes in the SAMS-II configuration, including changes in the number of sensor heads, the location/position of the sensor heads, and the sample rate associated with a particular sensor head.

4.1.1.4. MAMS Data Acquisition

PIMS ISS real-time software will process, store, and distribute acceleration data from the MAMS.

4.1.1.5. MAMS Configuration

PIMS ISS real-time software will recognize changes in the MAMS configuration, including changes in the location of the sensor.

4.1.1.6. Rates and Angles GSE Data Packet Acquisition

PIMS ISS real-time software will process and store GSE packets as required to allow mapping of quasi-steady accelerations to any point within the ISS.

4.1.2. Data Inputs

The items listed are data types that will be presented to the PIMS real-time software system.

4.1.2.1. SAMS-II Data

PIMS ISS software will receive SAMS-II Payload Data Services System (PDSS) payload Consultative Committee for Space Data Systems (CCSDS) packets.

4.1.2.2. MAMS Data

PIMS ISS software will receive MAMS PDSS payload CCSDS packets.

4.1.2.3. Rates and Angles Data

PIMS ISS software will receive ISS rates and angles data in the form of EHS GSE packets.

4.1.3. PIMS Operator Inputs

The items listed are inputs that the PIMS operators will be able to select to control limited aspects of the PIMS real-time software system. A requirement that does not reference a particular data type is considered a generic input requirement. The generic input requirements are listed first.

4.1.3.1. Accelerometer System

The PIMS ISS real time software will allow selection of data from the appropriate accelerometer system.

4.1.3.2. WWW Update Rate

PIMS ISS software will allow selection of the time interval between snapshots of plotted real time data that is to be displayed on the PIMS WWW ISS page.

4.1.3.3. Output Format for Data

PIMS ISS software will allow selection of the output format for the processed data, including generation of plotted image data or storage to file.

4.1.3.4. Coordinate System Selection

PIMS ISS software will allow selection of the coordinate system for the data display or data file, including sensor head coordinates and various ISS coordinate systems.

4.1.3.5. Display and Processing Selection

PIMS ISS software will allow selection of the type of processing for the selected data and selection of the display parameters available for a given display option. Section 4.1.4 includes details regarding the options available for each data type.

4.1.3.6. Sensor Enclosure (SE) Selection (SAMS-II Only)

PIMS ISS software will allow selection of a triaxial sensor head or triaxial sensor heads for processing.

4.1.3.7. Mapping to Alternate Locations (MAMS OSS Only)

PIMS ISS software will allow selection of alternate ISS locations for mapping MAMS OSS data.

4.1.3.8. Filtering Type Selection (MAMS OSS Only)

PIMS ISS software will allow selection of the filtering for the MAMS OSS raw data, including trimmean filter (TMF) and interval average.

4.1.4. Processing

This section identifies some low-level processing requirements of the PIMS ISS software. Further, this section identifies the software functions available for execution on the various data types based on user inputs. The function lists below provide a complete list of available options for a given data type. They do not necessarily represent all the functions that will be concurrently executed for a selected data type. For example, even though ten options may be available, all ten options may not be simultaneously executed.

Table 1 lists options available to PIMS operators for control of time domain plot options. Table 2 lists options available to PIMS operators for control of frequency domain plot options. Each plot type is listed with appropriate available options indicated with an 'X'. A brief description of each plot type and its suggested utilization is provided in table 3. A more detailed description of these analysis techniques is available in the Accelerometer Data Analysis and Presentation Techniques document [3].

4.1.4.1. Low-level Processing Requirements

4.1.4.1.1. EHS Communication

PIMS ISS software will maintain communications with the EHS for transfer and processing of data packets.

4.1.4.1.2. Database Insertion

PIMS ISS software will insert all received real time data packets for all available data inputs into the PIMS database.

4.1.4.1.3. SAMS-II Data Decommutation

PIMS ISS software will separate the SAMS-II data stream into data based on SE.

4.1.4.1.4. MAMS OSS Data Decommutation

PIMS ISS software will separate the MAMS OSS data frame into acceleration data and MAMS ancillary data.

4.1.4.1.5. MAMS HiRAP Data Decommutation

PIMS ISS software will decommutate the MAMS High Resolution Accelerometer Package (HiRAP) data frame into acceleration data.

4.1.4.1.6. Rates and Angles Data Decommutation

PIMS ISS software will decommutate the rates and angles GSE data frame into ISS ancillary data (ISS body rates data, ISS body angles data, and ISS center of gravity data) required to support mapping of MAMS OSS data to alternate ISS experiment locations.

4.1.4.1.7. Coordinate System Transformation

PIMS ISS software will be capable of transforming the SAMS-II data or the MAMS data from its sensor coordinate system to another coordinate system.

4.1.4.1.8. Mapping to Alternate ISS Locations

PIMS ISS software will be capable of mapping the MAMS OSS data from the MAMS location to alternate ISS experiment locations.

4.1.4.2. Processing Requirements for SAMS-II Data and MAMS HiRAP Data

4.1.4.2.1. Acceleration Versus Time
The PIMS ISS software shall be capable of generating RSS or XYZ orthogonal axes acceleration versus time.

4.1.4.2.2. Interval Minimum/Maximum Acceleration Versus Time
The PIMS ISS software shall be capable of generating RSS or XYZ orthogonal axes interval minimum/maximum acceleration versus time.

4.1.4.2.3. Interval Average Acceleration Versus Time
The PIMS ISS software shall be capable of generating RSS or XYZ orthogonal axes interval average acceleration versus time.

4.1.4.2.4. Interval RMS Acceleration Versus Time
The PIMS ISS software shall be capable of generating RSS or XYZ orthogonal axes interval gRMS acceleration versus time.

4.1.4.2.5. Power Spectral Density Versus Frequency
The PIMS ISS software shall be capable of generating sum or XYZ orthogonal axes power spectral density versus frequency.

4.1.4.2.6. Color Spectrogram
The PIMS ISS software shall be capable of generating sum or XYZ orthogonal axes color spectrogram.

4.1.4.2.7. Cumulative RMS Versus Frequency
The PIMS ISS software shall be capable of generating RSS or XYZ orthogonal axes cumulative RMS acceleration versus frequency.

4.1.4.2.8. RMS Acceleration Versus Time – Selectable Frequency Band
The PIMS ISS software shall be capable of generating RSS or XYZ orthogonal axes RMS acceleration versus time for user selected frequency band.

4.1.4.2.9. One-third Octave Band RMS Acceleration Versus Frequency
The PIMS ISS software shall be capable of generating RMS acceleration versus time for the ISS one-third octave bands. An optional overlay of the ISS requirement curve can be selected.

4.1.4.3. Processing Requirements for MAMS OSS Data

4.1.4.3.1. Acceleration Versus Time
The PIMS ISS software shall be capable of generating XYZ orthogonal axes acceleration versus time.

4.1.4.3.2. Interval Minimum/Maximum Acceleration Versus Time
The PIMS ISS software shall be capable of generating XYZ orthogonal axes interval minimum/maximum acceleration versus time.

4.1.4.3.3. Interval Average Acceleration Versus Time
The PIMS ISS software shall be capable of generating XYZ orthogonal axes interval average acceleration versus time.

4.1.4.3.4. TMF Acceleration Versus Time
The PIMS ISS software shall be capable of generating XYZ orthogonal axes TMF acceleration versus time.

4.1.4.3.5. MAMS OSS Bias Data Versus Time
The PIMS ISS software shall be capable of generating XYZ orthogonal axes OSS bias acceleration versus time.

4.1.4.4. Processing Requirements for Rates and Angles GSE Packet Data

4.1.4.4.1. Body Rates Versus Time
The PIMS ISS software shall be capable of generating 3 axes (pitch, yaw, and roll) ISS body rates versus time.

4.1.4.4.2. Body Angles Versus Time
The PIMS ISS software shall be capable of generating 3 axes (pitch, yaw, and roll) ISS body angles versus time.

4.1.4.4.3. ISS Ancillary Data Versus Time
The PIMS ISS software shall be capable of generating Other ISS ancillary data versus time.

4.1.5. Outputs
This section identifies the products available as outputs from the PIMS ISS real-time software. They are determined by the input options selected at the PIMS facility at the TSC. All relevant parameters including selected input options will be displayed with the plotted data.

4.1.5.1. PIMS Software Executed at the PIMS facility

4.1.5.1.1. Request for Plotted Data
The PIMS ISS software will distribute processed images of acceleration data via the WWW.

4.1.5.1.2. Requests for Stored Data
The PIMS ISS software will process and store acceleration data to data files. The resultant files will be accessible via a PIMS provided file server.

4.1.5.1.3. Hard Copy Availability

The PIMS ISS software will provide the capability to send displayed images to a local printer or to a stored image file.

4.1.5.2. Additional Outputs

4.1.5.2.1. Expert System Display

The PIMS ISS software will generate an expert system page summarizing vibratory and high frequency realm disturbance sources.

4.1.5.2.2. Quasi-Steady Acceleration Summary Display

The PIMS ISS software will generate a quasi-steady environment summary page, including ISS body rates and body angles.

4.1.5.2.3. MAMS OSS Housekeeping Data Display

The PIMS ISS software will generate a MAMS OSS housekeeping data summary page.

4.1.5.2.4. Packets Stored in PIMS Database

The PIMS ISS software will store received real time data packets in the PIMS database for subsequent access by display processing programs, PIMS Acceleration Data (PAD) file processing programs, and raw data archival programs.

Table 1 – Acceleration Versus Time Plot Control Options

Section	Plot Description	Time Span (min,max,tick)	Amplitude (min,max,tick)	TMF Parameters	Mapping Location	Interval
4.1.4.2.1	Acceleration vs. Time	X	X			
4.1.4.2.2	Interval Min/Max Acceleration vs. Time	X	X			X
4.1.4.2.3	Interval Average Acceleration vs. Time	X	X			X
4.1.4.2.4	Interval RMS Acceleration vs. Time	X	X			X
4.1.4.3.1	Acceleration vs. Time	X	X		X	
4.1.4.3.2	Interval Min/Max Acceleration vs. Time	X	X		X	X
4.1.4.3.3	Interval Average Acceleration vs. Time	X	X		X	X
4.1.4.3.4	TMF Acceleration vs. Time	X	X	X	X	
4.1.4.3.5	MAMS OSS Bias Data vs. Time	X	X			

Table 2 - Frequency Domain Plot Control Options

Section	Plot Description	X-Axis and Y-Axis Limits	Frequency Resolution Δf	Colorbar Limits	Windowing Selection	Frequency Bands	Mode Selection	Temporal Resolution dT
4.1.4.2.5	PSD vs. Frequency	X	X		X			
4.1.4.2.6	Color Spectrogram	X	X	X	X			X
4.1.4.2.7	Cumulative RMS vs. Frequency	X	X		X			
4.1.4.2.8	RMS Acceleration for Selected Frequency Bands	X	X		X	X		X
4.1.4.2.9	One-Third Octave Band		X		X		X[†]	

[†] - Use an interval of T=100 seconds or select a power of 2 number of points such that $T \geq 100$ seconds

Table 3 - Acceleration Data Display Descriptions

Section	Display Format	Regime(s)	Notes
4.1.4.2.1	Acceleration versus Time	Transient, Quasi-Steady, Vibratory	• precise accounting of measured data with respect to time; best temporal resolution
4.1.4.2.2	Interval Min/Max Acceleration versus Time	Vibratory, Quasi-Steady	• displays upper and lower bounds of peak-to-peak excursions of measured data • good display approximation for time histories on output devices with resolution insufficient to display all data in time frame of interest
4.1.4.2.3	Interval Average Acceleration versus Time	Vibratory, Quasi-Steady	• provides a measure of net acceleration of duration greater than or equal to interval parameter
4.1.4.2.4	Interval RMS Acceleration versus Time	Vibratory	• provides a measure of peak amplitude
4.1.4.3.4	Trimmed Mean Filtered Acceleration versus Time	Quasi-Steady	• removes infrequent, large amplitude outlier data
4.1.4.1.8	Quasi-Steady Mapped Acceleration versus Time	Quasi-Steady	• use rigid body assumption and vehicle rates and angles to compute acceleration at any point in the vehicle
4.3.4.3.5	Quasi-Steady Three-Dimensional Histogram (QTH)	Quasi-Steady	• summarize acceleration magnitude and direction for a long period of time • indication of acceleration "center-of-time" via projections onto three orthogonal planes
4.1.4.2.5	Power Spectral Density (PSD) versus Frequency	Vibratory	• displays distribution of power with respect to frequency
4.1.4.2.6	Spectrogram (PSD versus Frequency versus Time)	Vibratory	• displays power spectral density variations with time • identify structure and boundaries in time and frequency
4.1.4.2.7	Cumulative RMS Acceleration versus Frequency	Vibratory	• quantifies RMS contribution at and below a given frequency
4.1.4.2.8	Frequency Band(s) RMS Acceleration versus Time	Vibratory	• quantify RMS contribution over selected frequency band(s) as a function of time
4.1.4.2.9	RMS Acceleration versus One-Third Frequency Bands	Vibratory	• quantify RMS contribution over proportional frequency bands • compare measured data to ISS vibratory requirements
4.3.4.2.10	Principal Component Spectral Analysis (PCSA)	Vibratory	• summarize magnitude and frequency excursions for key spectral contributors over a long period of time • results typically have finer frequency resolution and high PSD magnitude resolution relative to a spectrogram at the expense of poor temporal resolution

4.2. Near Real-Time Requirements

4.2.1. General

The items listed are top-level functions to be performed by the PIMS near real-time software. The PIMS near real-time software receives data from LOS periods for the various data types identified. PIMS ISS near real-time software will perform the following tasks for the playback of data recorded on board the ISS during LOS periods.

4.2.1.1. Near Real-Time Communication

PIMS near real-time software will maintain data flow with the EHS.

4.2.1.2. Near Real-Time SAMS-II Data Acquisition

PIMS near real-time software will process and store acceleration data from up to 10 SAMS-II RTS.

4.2.1.3. Near Real-Time SAMS-II Configuration

PIMS near real-time software will recognize changes in SAMS-II environment, including changes in the number of sensor heads, the location/position of the sensor heads, and the sample rate associated with a particular sensor head.

4.2.1.4. Near Real-Time MAMS Data Acquisition

PIMS near real-time software will process and store acceleration data from the MAMS.

4.2.1.5. Near Real-Time MAMS Configuration

PIMS near real-time software will recognize changes in the MAMS environment, including changes in the location of the sensor.

4.2.1.6. Near Real-Time Rates and Angles GSE Data Packet Acquisition

PIMS near real-time software will process and store GSE data packets as required to allow mapping of quasi-steady accelerations to any point within the ISS.

4.2.2. Data Inputs

The items listed are data types that will be presented to the PIMS near real-time software system. PIMS ISS near real-time software will accept the following data inputs for the playback of data recorded on board the ISS during LOS periods.

4.2.2.1. Near Real-Time SAMS-II Data

PIMS near real-time software will receive SAMS-II PDSS payload CCSDS packets.

4.2.2.2. Near Real-Time MAMS Data

PIMS near real-time software will receive MAMS PDSS payload CCSDS packets.

4.2.2.3. Near Real-Time Rates and Angles Data

PIMS near real-time software will receive EHS GSE data packets.

4.2.3. User Inputs
The near real-time system operates in the background from the real-time system. Its focus is to receive data from LOS periods for eventual merging with AOS data received by the real-time system. As a result of this focus, there are no user inputs for the near real-time system.

4.2.4. Processing
This section identifies the low level processing requirements of the near real-time software. As mentioned previously, the near real-time system operates in the background from the real-time system. The only processing that occurs is the receipt of LOS data packets and their insertion into the PIMS database.

4.2.4.1. Database Insertion
PIMS ISS software will insert all received near real-time data packets for all available data inputs into the PIMS database.

4.2.5. Outputs
This section identifies the products available for output from the PIMS ISS near real-time software.

4.2.5.1. Packets Stored in PIMS Database
The PIMS ISS software will store received near real-time data packets in the PIMS database for subsequent access by PAD file processing programs and raw data archival programs.

4.3. Offline Requirements

4.3.1. General
The PIMS offline software will provide an interface to acceleration data from accelerometer systems specifically supported by the MEP. This interface will allow users to plot acceleration data in a variety of formats or to extract acceleration data into data files for manipulation by user-generated software.

4.3.2. Data Inputs
The items listed are data types that will be available for processing by the PIMS offline software system. PIMS ISS software will be capable of processing the following data types.

4.3.2.1. Offline SAMS-II Data
The PIMS ISS offline software will be able to process requests for SAMS-II data.

4.3.2.2. Offline MAMS Data

The PIMS ISS offline software will be able to process requests for MAMS data.

4.3.2.3. Offline Rates and Angles Data

The PIMS ISS offline software will be able to process requests for ISS body rates and ISS body angles data.

4.3.3. User Inputs

The items listed are user inputs for the PIMS ISS offline software system that will control the manipulation of the data requested and control the format for the data requested (plots, data files, etc.). The generic user inputs for the PIMS ISS offline software are listed first and are common parameters available for control of the data input types available.

4.3.3.1. Offline Processor Graphical User Interface

PIMS ISS offline software will include a graphical user interface to facilitate the offline processing of processed data by PIMS personnel and directly by PIs. The following parameters will be included as graphical user interface options.

4.3.3.1.1. Accelerometer System

The PIMS ISS offline software will allow selection of data from the appropriate accelerometer system.

4.3.3.1.2. Output Format for the Data

The PIMS ISS offline software will allow selection of the output format for the processed data, including generation of plotted image data or storage to file.

4.3.3.1.3. Time Interval

The PIMS ISS offline software will allow selection of the time interval of interest for processing.

4.3.3.1.4. Offline Coordinate System Selection

The PIMS ISS offline software will allow selection of the coordinate system for the display of sensor data (SE coordinate system, ISS module coordinate system, etc.).

4.3.3.1.5. Offline Display and Processing Selection

The PIMS ISS offline software will allow selection of the type of processing for the selected data. Section 4.3.4 includes details regarding the available options for each input data type.

4.3.3.1.6. Offline SE Selections (SAMS-II Only)

The PIMS ISS offline software will allow selection of the triaxial sensor head for processing.

4.3.3.1.7. Mapping to Alternate Locations (MAMS OSS Only)

The PIMS ISS offline software will allow selection of alternate locations for mapping MAMS OSS data.

4.3.3.1.8. Offline Frame of Reference Selection (MAMS OSS Only)
The PIMS ISS offline software will allow selection of the frame of reference for the presentation of the data, including ISS and inertial reference frames.

4.3.3.1.9. Offline Filtering Type Selection (MAMS OSS Only)
The PIMS ISS offline software will allow selection of the filtering type for the MAMS OSS data, including TMF and interval average.

4.3.4. Processing
This section identifies some low-level processing requirements of the software. Further, this section identifies the software functions available for execution on the various data inputs based on user inputs. The functions listed below comprise a complete list of available options, which does not necessarily represent all the functions that will be executed for a given set of inputs.

Table 1 lists options available to PIMS operators for control of time domain plot options. Table 2 lists options available to PIMS operators for control of frequency domain plot options. Each plot type is listed with appropriate available options indicated with an 'X'. A detailed description of these analysis techniques is available in the Acceleration Data Analysis and Presentation Techniques document [3].

4.3.4.1. Offline Low-level Processing Requirements

4.3.4.1.1. Offline Coordinate System Transformation
The PIMS ISS offline software will allow transformation of the SAMS-II data or the MAMS data from sensor coordinate system to another ISS coordinate system.

4.3.4.1.2. Offline Mapping to Alternate ISS Locations
The PIMS ISS offline software will allow mapping the MAMS OSS data from the MAMS location to alternate ISS experiment locations.

4.3.4.2. Processing Requirements for SAMS-II Data and MAMS HiRAP Data

4.3.4.2.1. Acceleration Versus Time
The PIMS ISS offline software shall be capable of generating RSS or XYZ orthogonal axes acceleration versus time.

4.3.4.2.2. Interval Minimum/Maximum Acceleration Versus Time
The PIMS ISS offline software shall be capable of generating RSS or XYZ orthogonal axes interval minimum/maximum acceleration versus time.

4.3.4.2.3. Interval Average Acceleration Versus Time

The PIMS ISS offline software shall be capable of generating RSS or XYZ orthogonal axes interval average acceleration versus time.

4.3.4.2.4. Interval RMS Acceleration Versus Time

The PIMS ISS offline software shall be capable of generating RSS or XYZ orthogonal axes interval gRMS acceleration versus time.

4.3.4.2.5. Power Spectral Density Versus Frequency

The PIMS ISS offline software shall be capable of generating sum or XYZ orthogonal axes power spectral density versus frequency.

4.3.4.2.6. Color Spectrogram

The PIMS ISS offline software shall be capable of generating sum or XYZ orthogonal axes color spectrogram.

4.3.4.2.7. Cumulative RMS Versus Frequency

The PIMS ISS offline software shall be capable of generating RSS or XYZ orthogonal axes cumulative RMS acceleration versus frequency.

4.3.4.2.8. RMS Acceleration Versus Time – Selectable Frequency Band

The PIMS ISS offline software shall be capable of generating RSS or XYZ orthogonal axes RMS acceleration versus time for user selected frequency band.

4.3.4.2.9. One-third Octave Band RMS Acceleration Versus Frequency

The PIMS ISS offline software shall be capable of generating RMS acceleration versus time for the one-third octave bands.

4.3.4.2.10. Principal Component Spectral Analysis (PCSA)

The PIMS ISS offline software shall be capable of generating PCSA plots.

4.3.4.3. Processing Requirements for MAMS OSS Data

4.3.4.3.1. Acceleration Versus Time

The PIMS ISS offline software shall be capable of generating XYZ orthogonal axes acceleration versus time.

4.3.4.3.2. Interval Minimum/Maximum Acceleration Versus Time

The PIMS ISS offline software shall be capable of generating XYZ orthogonal axes interval minimum/maximum acceleration versus time.

4.3.4.3.3. Interval Average Acceleration Versus Time

The PIMS ISS offline software shall be capable of generating XYZ orthogonal axes interval average acceleration versus time.

4.3.4.3.4. TMF Acceleration Versus Time
The PIMS ISS offline software shall be capable of generating XYZ orthogonal axes TMF acceleration versus time.

4.3.4.3.5. Quasi-steady Three-Dimensional Histograms (QTH)
The PIMS ISS offline software shall be capable of generating QTH plots.

4.3.4.3.6. Quasi-Steady Compliance Checking
The PIMS ISS offline software shall be capable of performing quasi-steady acceleration environment compliance checking.

4.3.4.4. Processing Requirements for Rates and Angles GSE Packet Data

4.3.4.4.1. Body Rates Versus Time
The PIMS ISS offline software shall be capable of generating 3 axes (pitch, yaw, roll) ISS body rates versus time.

4.3.4.4.2. Body Angles Versus Time
The PIMS ISS offline software shall be capable of generating 3 axes (pitch, yaw, and roll) ISS body angles versus time.

4.3.4.4.3. ISS Ancillary Data Versus Time
The PIMS ISS offline software shall be capable of generating Other ISS ancillary data versus time.

4.3.5. Outputs
This section identifies the products available for output from the PIMS ISS offline software. The user selects the format of the output products. They are determined by the user-input selections and the selected processing type.

4.3.5.1. Offline Plotted Data Requests
The PIMS ISS offline software will display processed acceleration data at the PIMS offline-processing terminal or at the PIs local machine.

4.3.5.2. Offline Stored Data Requests
The PIMS ISS offline software will process and store acceleration data to data files.

4.3.5.3. Offline Hard Copy Availability
The PIMS ISS offline software will provide the capability to store processed data to file and to print or store displayed images in a variety of formats, including JPG, PDF, and post-script. The resultant files will be available via a PIMS provided file server.

4.4. Storage Requirements

4.4.1. General

The storage requirements for the PIMS software address the issues of data storage relative to the real-time, near real-time, and offline systems. Each of these systems presents unique requirements for the storage of and access to the data from the various accelerometers supported by the Microgravity Environment Program.

The PIMS ISS storage system will store data from each accelerometer system supported. Data will be stored in either raw packet format or in processed acceleration data. Raw packets are stored strictly for archival purposes. Processed data are stored for ready access by the PIMS offline processing system discussed in section 4.3 or by PI specific acceleration data processing software. Section 2.1 provides additional detail about these two data formats. Each of these two data types presents unique storage requirements.

Any discussions of storage requirements apply only to PIMS equipment at the GRC TSC. PIMS software executed at a PI's remote location will have data storage specific functions disabled.

4.4.1.1. SAMS-II Configuration (Processed Acceleration Data Only)

PIMS ISS storage software will recognize changes in the SAMS-II configuration, including changes in the number of sensor heads, the location/position of the sensor heads, and the sample rate associated with a particular sensor head

4.4.1.2. Random Access

PIMS ISS storage software will use storage media that allows random access to acceleration data.

4.4.1.3. Merged AOS/LOS Data

PIMS ISS storage software will process and store AOS/LOS merged data.

4.4.1.4. Universal File Format (Processed Acceleration Data Only)

PIMS ISS storage software will store data in a universal file format, including directory hierarchy, filename, and file content. Details of the PIMS Acceleration Data (PAD) file format are provided in the document PIMS-ISS-101, International Space Station PIMS Acceleration Data File Description Document [4].

4.4.1.5. Data Accessibility

PIMS ISS storage software will store data on a universally acceptable/accessible storage media.

4.4.1.6. Ancillary Data File (Processed Acceleration Data Only)

PIMS ISS storage software will include with each file a descriptive file that describes the circumstances under which the data were obtained, including sampling rate, location, and orientation of sensor heads. Details of the PAD ancillary data file are provided in the document

PIMS-ISS-101, International Space Station PIMS Acceleration Data File Description Document [4].

4.4.2. Data Inputs

The items listed are data types that can be processed by the PIMS ISS storage system.

4.4.2.1. SAMS-II Acceleration Data Storage

PIMS ISS software will be capable of processing SAMS-II data.

4.4.2.2. MAMS OSS Data Storage

PIMS ISS software will be capable of processing MAMS OSS data.

4.4.2.3. MAMS HiRAP Data Storage

PIMS ISS software will be capable of processing MAMS HiRAP data.

4.4.2.4. GSE Packet Data Storage

PIMS ISS software will be capable of processing GSE packet data.

4.4.3. User Inputs

There are no direct user inputs that control the PIMS ISS storage system. The data stored are a function of user inputs made in section 4.1.3. The data are obtained from the PIMS database that contains merged AOS and LOS packets from the various data types available.

4.4.4. Processing

This section identifies some low-level processing requirements of the PIMS ISS storage system.

4.4.4.1. Timestamp Generation

The PIMS ISS storage system will include a timestamp from on-board the ISS for each data record created.

4.4.4.2. SAMS-II Data Decommutation

The PIMS ISS storage system will decommutate the SAMS-II data into XYZ acceleration data.

4.4.4.3. MAMS Data Decommutation

The PIMS ISS storage system will decommutate the MAMS data into XYZ acceleration data.

4.4.4.4. GSE Packet Data Decommutation

The PIMS ISS storage system will decommutate the GSE packet data.

4.4.4.5. Offline Access of Data

The PIMS ISS storage system will move processed data to the offline storage facility for access by the offline processing software.

4.4.5. Outputs

This section identifies the products available for output from the PIMS ISS storage system.

4.4.5.1. Processed Data

The PIMS ISS storage system will provide processed AOS/LOS merged data files in a universal file format accessible for subsequent processing by the PIMS ISS offline processing software.

4.4.5.2. Raw Data Packet

The PIMS ISS storage system will provide merged raw packet data files for storage in the PIMS ISS archives.

4.5. Miscellaneous Requirements

The generic requirements covered under this section represent capabilities that will be provided by PIMS for ISS operations.

4.5.1. Electronic Mail Request System

PIMS will provide an email request system as an electronic method to request processed data.

4.5.2. Automatic Updates to PIMS ISS User Request Database

PIMS will automatically update the PIMS user request database based on requests received via the e-mail request system.

4.5.3. Binary To ASCII Converter

PIMS will provide a binary to ASCII converter universal data file reader for viewing of processed data in an ASCII format.

4.5.4. Accelerometer System Interface Definition Documents

PIMS will develop, as required, interface definition documents between PIMS and the accelerometer systems to document interfaces.

4.5.5. Offline Processing of AOS/LOS Merged Data

Under normal circumstances, offline processing will occur using AOS/LOS merged data to insure that all data are included in the processing. Special circumstances may dictate that processing be performed on ‘all available’ data. PIMS will provide the capability to plot AOS data prior to the availability of all associated LOS data.

4.6. Post-Increment 5 Requirements

The post-increment 5 requirements are scheduled enhancements to the PIMS software system. Based on the scope and identified requirements for initial operations, these are not included in the initial capabilities for PIMS ISS operations. Some of the items below are generic improvement statements while others deal with addressing a particular area of improvement.

4.6.1. New Display Formats

PIMS will develop new display and analysis techniques based on PI input. Such displays will be incorporated into the display systems for both the real-time and offline systems.

4.6.2. Distribution of Unprocessed Acceleration Data

PIMS will develop capabilities to route raw acceleration data packets directly to PIs.

4.6.3. Real-Time Processing of Acceleration Data Directly by PIs

PIMS will develop a real-time processing toolbox for direct use by the PIs. This toolbox will allow the processing and storage of acceleration data to the PI's local machine.

5. Increment Specific Requirements

No increment specific requirements have been identified through Increment 5.

6. References

[1] DeLombard, R., Hakimzadeh, R., Tschen, P., 1995, Experiment Support Requirements Document for Space Acceleration Measurement System-II, PIMS-001
[2] Microgravity Control Plan, International Space Station Program, September, 1998
[3] Rogers, M. J. B., Hrovat, K., McPherson, K., Moskowitz, M., Reckart, T., (1997) Accelerometer data Analysis and Presentation Techniques. NASA Technical Memorandum 113173
[4] PIMS-ISS-101, International Space Station PIMS Acceleration Data File Description Document, February, 2002, Revision - Baseline

Appendix A – Increment 2 through Increment 4

A.1.Increment 2-4 Description

This appendix applies to agreements between the PIMS project and payloads manifested for operations during Increment 2 and Increment 3. This covers the time period from flight 5A.1 through flight 8A. The initial increment 2 ISS configuration is through flight 5A and includes the following main space station hardware components: Zarya, Unity, Zvezda, and the US Lab Destiny. In addition to the ISS microgravity environment characterization effort, the PIMS project will be supporting two payloads during Increment 2 and Increment 3 operations. These are the Physics of Colloids in Space experiment (EXPPCS) and the Active Rack Isolation System-Initial Characterization Experiment (ARIS-ICE). The interaction between these experiments and the PIMS project are described in the experiment specific sections below.

A.2.Experiment Specifics

A.2.1. Experiment Physics of Colloids in Space (EXPPCS)

A.2.1.1. Experiment Description

A.2.1.1.1. Objective

The Experiment on Physics of Colloids in Space (EXPPCS) is a fundamental study in colloid physics. The experiment objective is to study the growth of eight different colloid samples and characterize their properties and structure. The colloid samples self-assemble into different structures or formations based upon the colloid's size, volume fraction, and particle types. These colloidal structures are not fully developed on earth due to sedimentation caused by gravity. The sample growth and sample final structures are predicted to be sensitive to large impulse disturbances and overall acceleration on the order of 1 milli-g and greater. The DC level and the low frequency accelerations (<20 Hz) are of most interest and concern. Each sample will have a unique growth/study period that is continuous once the sample is homogenized/mixed. After homogenization/mixing, each sample will continue to develop into a final structure and will be periodically observed diagnostically. The sample is thus sensitive to the acceleration environment throughout the growth period and not only the defined EXPPCS operational times.

EXPPCS hardware consists of two structural units, the Test Section and the Avionics Section, that occupy 2 Middeck Locker Equivalent (MLE) spaces each. The hardware is accommodated in EXPRESS Rack #2 in the US Lab. The Test Section contains the eight science samples as well as all the diagnostic instrumentation. The Avionics Section provides all the power, control, communication, data acquisition, and storage systems required to run the diagnostics in the Test Section and to interface to the EXPRESS rack. A SAMS-II RTS-SE is mounted on the front cover of the EXPPCS Test Section to provide characterization of the acceleration environment being experienced by the colloid samples.

The EXPPCS experiment will utilize both SAMS-II and MAMS acceleration data.

A.2.1.1.2. Operating Scenario

The EXPPCS operations will be conducted throughout the on-station period from flight 6A through flight UF-2. Since the study of colloidal crystal and structure growth is the main objective, diagnostic measurements are made throughout the growth period. Information on the acceleration environment is desired throughout these growth periods. Diagnostic measurements will be taken several times each week during sample growth periods. The diagnostic measurements would in most cases be taken within a 12-hour operational window with some operational windows extending for 24 to 48 hours. Minimally, EXPPCS needs acceleration data to characterize events that occur during each sample's growth period. The experiment is comprised of different colloidal samples, each having a different sensitivity to the acceleration environment. The most sensitive samples are the two fractal samples. These samples have growth periods of approximately 3-4 weeks each. During their growth period, EXPPCS would require acceleration measurements:

- Throughout Low Angle Dynamic diagnostic runs (lengths up to 48 hours)
- Periodically during the duration of EXPPCS's operations, including time when the experiment is not turned on, but is actively growing a sample
- For planned/known disturbances throughout the sample growth period

For the remaining six colloidal samples, acceleration measurements periodically during any EXPPCS operational period is desired.

The EXPPCS hardware contains some electro-mechanical systems that create g-disturbances. The primary system is the mix/melt motor system. Acceleration data during some of the initial mix/melt operations, hard-drive activity, carousel movement, and rheology is requested to compare to ground measurement data.

A.2.1.2. Utilization of Existing PIMS Capabilities

A.2.1.2.1. Real Time Requirements

The EXPPCS experiment has no real-time plot requirements for acceleration data. However, the PIMS project will provide minimum/maximum acceleration versus time plots and color spectrogram plots as part of their normal real-time operations.

A.2.1.2.2. Offline Requirements

A.2.1.2.2.1. Archival Function

PIMS will serve an archival function for EXPPCS for SAMS-II and MAMS OSS acceleration data. This archival function will allow EXPPCS offline access to both vibratory/transient and quasi-steady acceleration data from the ISS.

PIMS-ISS-001 reference: Section 4.4 Storage Requirements.

A.2.1.2.2.2. Offline Vibratory/Transient Plot Requirements

PIMS will provide XYZ Interval Minimum/Maximum vs. Time and Color Spectrogram plots of the vibratory/transient acceleration environment (SAMS-II data) periodically to EXPPCS for comparison to and correlation with the EXPPCS science data.

PIMS-ISS-001 reference: Section 4.3.4.2 Processing Requirements for SAMS-II Data and MAMS HiRAP Data

A.2.1.2.2.3. Offline Quasi-Steady Acceleration Requirements

PIMS will provide XYZ Interval Minimum/Maximum vs. Time and Quasi-Steady Three-Dimensional Histogram (QTH) plots of the quasi-steady acceleration environment (MAMS OSS data) periodically to the EXPPCS for comparison to and correlation with EXPPCS science data.

PIMS-ISS-001 reference: Section 4.3.4.3 Processing Requirements for MAMS OSS Data

A.2.1.2.2.4. Access to Acceleration Data

EXPPCS will obtain acceleration data from the PIMS ISS web site.

A.2.1.2.3. Identification of New PIMS Capabilities

EXPPCS presents no new requirements for real-time or offline acceleration data processing. EXPPCS does request the capability to transform the SAMS-II and MAMS acceleration data from the as-received sensor coordinate system to a coordinate system defined by the EXPPCS experiment team.

A.2.2. Active Rack Isolation System – ISS Characterization Experiment (ARIS-ICE)

A.2.2.1. Experiment Description

A.2.2.1.1. Objective

The objective of the ARIS-ICE experiment is to characterize the on-orbit operation and performance of a production-unit Active Rack Isolation System. ARIS-ICE uses the Payload On-Orbit Processor (POP) to command and collect measurement data from ARIS and SAMS-II. In addition, ARIS-ICE will utilize MAMS acceleration data to characterize the off-board quasi-steady acceleration environment.

A.2.2.1.2. Operating Scenario

The ARIS-ICE experiment operates in one of two configurations: POP mode and standard mode. While operating in POP mode, ARIS-ICE will collect both ARIS-ICE telemetry and SAMS-II telemetry on the POP on board the ISS. ARIS-ICE will send these data to the ground in the ARIS-ICE telemetry stream. When ARIS-ICE is operating in its standard mode, ARIS-ICE telemetry will be obtained from the Payload Rack Officer (PRO) operating at the MSFC HOSC. During standard mode operations, the POP will be continuously powered and will be used to collect and downlink SAMS-II telemetry. Regardless of the ARIS-ICE configuration, the current plan is for the POP to be continuously powered during ARIS-ICE operations.

The SAMS-II and the MAMS OSS telemetry will be transmitted to the ground through their respective payload telemetry streams. Once received by PIMS on the ground, SAMS-II and MAMS OSS acceleration telemetry data can be obtained from the PIMS project. Any MAMS OSS data required by ARIS-ICE must be obtained through the PIMS project on the ground. There is currently no means of obtaining MAMS OSS data through the POP on board the ISS.

ARIS-ICE will be operational for 16 hours/day, 5 days a week. The experiment is currently scheduled from Flight 6A through Flight UF-1.

A.2.2.2. Utilization of Existing PIMS Capabilities

A.2.2.2.1. Real Time Requirements

The ARIS-ICE experiment has no real-time plot requirements for acceleration data. However, the PIMS project will provide minimum/maximum acceleration versus time plots and color spectrogram plots as part of their normal real-time operations.

A.2.2.2.2. Offline Requirements

A.2.2.2.2.1. Archival Function

PIMS will serve a backup and archival function for ARIS-ICE for SAMS-II acceleration data in the event the ARIC-ICE POP is not available to receive SAMS-II data on board the ISS. The POP would not be available in the event the POP must be de-activated for any reason or in the event the POP is running its own diagnostics and it is not available to capture acceleration data. PIMS will act as the source of MAMS OSS data for the ARIS-ICE experiment.

In addition, SAMS-II and MAMS raw (unprocessed) data files will be available to ARIS-ICE when this data is downlinked to PIMS.

PIMS-ISS-001 reference: Section 4.4 Storage Requirements.

A.2.2.2.2.2. Offline Vibratory/Transient Plot Requirements

PIMS will provide 1/3 Octave band plots, color spectrograms, and power spectral density plots periodically to ARIS-ICE for comparison to their data processing algorithms.

PIMS-ISS-001 reference: Section 4.3.4.2 Processing Requirements for SAMS-II Data and MAMS HiRAP Data

A.2.2.2.2.3. Offline Quasi-Steady Acceleration Requirements

PIMS will provide time versus acceleration of the quasi-steady acceleration environment (MAMS OSS data) periodically to the ARIS-ICE for comparison to and correlation with ARIS-ICE science data.

PIMS-ISS-001 reference: Section 4.3.4.3 Processing Requirements for MAMS OSS Data

A.2.2.2.2.4. Access to Acceleration Data

ARIS-ICE will obtain acceleration data from the PIMS ISS web site.

A.2.2.2.3. Identification of New PIMS Acceleration Data Processing Capabilities

ARIS-ICE presents no new requirements for real-time or offline acceleration data processing.

Appendix B – Increment 5

B.1. Increment 5 Description

This appendix applies to agreements between the PIMS project and payloads manifested for operations during Increment 5. This covers the time period from flight UF-2 through flight 11A. In addition to the ISS microgravity environment characterization effort, the PIMS project will be supporting the Microgravity Science Glovebox investigations Solidification Using a Baffle in Sealed Ampoules (SUBSA) and Pore Formation and Mobility Investigation (PFMI). The interaction between these experiments and the PIMS project are described in the experiment specific sections below.

B.2. Experiment Specifics

B.2.1. Solidification Using a Baffle in Sealed Ampoules (SUBSA)

B.2.1.1. Experiment Description

B.2.1.1.1. Objective

Solidification Using a Baffle in Sealed Ampoules (SUBSA) is a fundamental material science investigation. It concerns the growth of InSb by the gradient freeze technique. There are both scientific and technological objectives. The scientific objectives are:
(i) visualization of the melting process. This will provide information on melt-encapsulant (i.e., two-fluid) interactions and behavior in microgravity. Visualization of the formation of voids and bubbles may also be possible.
(ii) determination of the approximate values of the diffusion coefficients in InSb melts.

The technology demonstration objectives are:
(i) to test the performance of the automatically moving baffle in microgravity (i.e., to demonstrate that expansion of the melt is keeping the baffle at a constant distance from the interface).
(ii) to reproducibly determine the behavior and possible advantages of liquid encapsulation in microgravity conditions.
(iii) to demonstrate that the baffle reduces sensitivity to residual micro-acceleration in two systems with different segregation coefficients and achieve reproducible growth.

B.2.1.1.2. Operating Scenario

SUBSA will be conducted inside the MSG. There are 10 samples (plus 2 spares) that will be processed during increment 5, each taking approximately 16 hours. The crew will load samples, initiate the experiments, and change out the video tapes as needed. During operations, data and video will be downlinked to the ground and changes to experiment parameters can be uplinked. Both low frequency (< 25 Hz) acceleration data from the SAMS-II sensor in the MSG and quasisteady acceleration data from MAMS are required during experiment operations. Minimally, SUBSA requires acceleration data while the InSb is molten, but would prefer to have data for the entire experiment operation.

B.2.1.2. Utilization of Existing PIMS Capabilities

B.2.1.2.1. Real Time Requirements

During operations, SUBSA requires real-time plots of interval minimum/maximum acceleration versus time from the SAMS-II and real-time plots of acceleration versus time from the MAMS OSS sensors.

B.2.1.2.2. Offline Requirements

B.2.1.2.2.1. Archival Function

PIMS will serve an archival function for SUBSA for SAMS-II and MAMS OSS acceleration data. This archival function will allow SUBSA offline access to both vibratory/transient and quasi-steady acceleration data from the ISS for the specific time periods covered by SUBSA operations.

PIMS-ISS-001 reference: Section 4.4 Storage Requirements.

B.2.1.2.2.2. Offline Vibratory/Transient Plot Requirements

PIMS will provide XYZ Interval Minimum/Maximum vs. Time and Color Spectrogram plots of the vibratory/transient acceleration environment (SAMS-II data) for the specific time periods covered by SUBSA operations to the SUBSA investigation for comparison to and correlation with the SUBSA science data.

PIMS-ISS-001 reference: Section 4.3.4.2 Processing Requirements for SAMS-II Data and MAMS HiRAP Data

B.2.1.2.2.3. Offline Quasi-Steady Acceleration Requirements

PIMS will provide plots of the quasi-steady acceleration environment (MAMS OSS data) for the specific time periods covered by SUBSA operations to the SUBSA investigation for comparison to and correlation with SUBSA science data. These quasi-steady acceleration environment plots will be mapped to the SUBSA investigation location.

PIMS-ISS-001 reference: Section 4.3.4.3 Processing Requirements for MAMS OSS Data

B.2.1.2.2.4. Access to Acceleration Data

The SUBSA investigation will obtain acceleration data from the PIMS project using the directions provided through the PIMS WWW page.

B.2.1.2.3. Identification of New PIMS Capabilities

The SUBSA investigation presents no new requirements for real-time or offline acceleration data processing. SUBSA may request the capability to transform the SAMS-II and MAMS acceleration data from the as-received sensor coordinate system to a coordinate system defined by the SUBSA investigation team.

B.2.2. Pore Formation and Mobility Investigation (PFMI)

B.2.2.1. Experiment Description

B.2.2.1.1. Objective

The Toward Understanding Pore Formation and Mobility During Controlled Directional Solidification Investigation (PFMI) is a fundamental materials science investigation. Its objective is to test the performance of directional solidification in microgravity to improve the production of uniform composites and to promote the understanding of detrimental porosity and mobility during controlled directional solidification processing. Directional solidification experiments will be conducted in the microgravity environment with succinonitrile (SCN) contained inside of transparent tubes with the intent of observing porosity formation and its movement. Methods to minimize porosity and its influence will also be examined. Experimental variables to be investigated include, but are not limited to, bubble size, bubble number, imposed temperature gradient and material properties.

B.2.2.1.2. Operating Scenario

PFMI will be conducted inside the MSG. There are 12 samples (plus 3 spares). It is currently planned that 6 of these samples will be processed during increment 5 and the remaining 6 will be processed during increment 6. For the 6 samples processed during increment 5, a SAMS-II sensor will be located inside the MSG. PFMI samples processed during increment 6 will be on top of the g-LIMIT microgravity isolation platform. Each sample is predicted to take about 11 hours but the actual time may be more or less depending on real-time changing of processing parameters. During operations, data and video will be downlinked to the ground and changes to experiment parameters can be uplinked. Both low frequency (< 25 Hz) acceleration data from the SAMS-II sensor in the MSG and quasisteady acceleration data from MAMS are required during experiment operations.

B.2.2.2. Utilization of Existing PIMS Capabilities

B.2.2.2.1. Real Time Requirements

During operations, PFMI requires real-time plots of interval minimum/maximum acceleration versus time from the SAMS-II and real-time plots of acceleration versus time from the MAMS OSS sensors.

B.2.2.2.2. Offline Requirements

B.2.2.2.2.1. Archival Function

PIMS will serve an archival function for PFMI for SAMS-II and MAMS OSS acceleration data. This archival function will allow PFMI offline access to both vibratory/transient and quasi-steady acceleration data from the ISS for the specific time periods covered by PFMI operations.

PIMS-ISS-001 reference: Section 4.4 Storage Requirements.

B.2.2.2.2.2. Offline Vibratory/Transient Plot Requirements

PIMS will provide XYZ Interval Minimum/Maximum vs. Time and Color Spectrogram plots of the vibratory/transient acceleration environment (SAMS-II data) for the specific time periods covered by PFMI operations to the PFMI investigation for comparison to and correlation with the PFMI science data.

PIMS-ISS-001 reference: Section 4.3.4.2 Processing Requirements for SAMS-II Data and MAMS HiRAP Data

B.2.2.2.2.3. Offline Quasi-Steady Acceleration Requirements

PIMS will provide plots of the quasi-steady acceleration environment (MAMS OSS data) for the specific time periods covered by PFMI operations to the PFMI investigation for comparison to and correlation with PFMI science data. These quasi-steady acceleration environment plots will be mapped to the PFMI investigation location.

PIMS-ISS-001 reference: Section 4.3.4.3 Processing Requirements for MAMS OSS Data

B.2.2.2.2.4. Access to Acceleration Data

The PFMI investigation will obtain acceleration data from the PIMS project using the directions provided through the PIMS WWW page.

B.2.2.2.3. Identification of New PIMS Capabilities

The PFMI investigation presents no new requirements for real-time or offline acceleration data processing. PFMI may request the capability to transform the SAMS-II and MAMS acceleration data from the as-received sensor coordinate system to a coordinate system defined by the PFMI investigation team.

Z. Appendix Z – Open Work

Date Opened	**Problem Description**
7/24/02	Consider development of an appendix to provide information on the deployment of SAMS and MAMS sensors on board the ISS