Quick Look Report of Acceleration Measurements on Mir Space Station during Mir-16

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ABSTRACT

The NASA Microgravity Science and Applications Division (MSAD) sponsors the Space Acceleration Measurement System (SAMS) to support microgravity science experiments with microgravity acceleration measurements. In the past, SAMS was flown exclusively on the NASA Orbiters. MSAD is currently sponsoring science experiments participating in the Shuttle-Mir Science Program in cooperation with the Russians on the Mir space station. Included in the complement of MSAD experiments and equipment is a SAMS unit installed on the Mir space station.

On 25 August 1994, the SAMS unit was launched on a Russia Progress vehicle to the Mir space station. The SAMS unit will support science experiments from the U.S. and Russia in a manner similar to the Orbiter missions by measuring the microgravity environment during the experiment operations.

In October 1994, the SAMS unit recorded data on Mir for over fifty-three hours in seven different time periods to survey possible locations for future experiments. This report presents a quick look at the data and the microgravity environment during the time periods in which SAMS data were acquired.

The Mir acceleration data were examined to ascertain gross attributes of the data. This report does not present an exhaustive examination of all possible activities due to the short time available to prepare this quick look report and due to the absence of complete timeline information during the SAMS recording time periods.

Appendices A, B and E provide plots of the SAMS data for an overview of the microgravity environment at the times that data were recorded. Appendix C describes the procedures to access SAMS data by file transfer protocol (ftp) utilizing the internet. Appendix D contains a user comment sheet.

ACRONYM LIST

AVG	average
CNES	Centre National d’Etudes Spatiales
ftp	file transfer protocol
JSC	NASA Johnson Space Center
LeRC	NASA Lewis Research Center
MIPS	Mir Interface to Payload System
MLT	Moscow Local Time (day / hour : minute : second)
MSAD	NASA Headquarters Microgravity Science and Applications Division
NASA	National Aeronautics and Space Administration
PIMS	Principal Investigator Microgravity Services
PSD	power spectral density
RMS	root mean square
SAMS	Space Acceleration Measurement System
SMSP	Shuttle-Mir Science Program
TEPC	Tissue Equivalent Proportional Counter

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1 INTRODUCTION AND PURPOSE

The NASA Microgravity Science and Applications Division (MSAD) sponsors science experiments on a variety of microgravity carriers, including sounding rockets, drop towers, parabolic aircraft, and Orbiter missions. The MSAD sponsors the Space Acceleration Measurement System (SAMS) to support the microgravity science experiments with microgravity acceleration measurements to characterize the microgravity environment to which the experiments were exposed. Between June 1991 and July 1994, the SAMS project participated in ten NASA Orbiter missions with six SAMS flight units.

MSAD is currently sponsoring science experiments participating in the Shuttle-Mir Science Program (SMSP) in cooperation with the Russians on the Mir space station. Included in the complement of MSAD experiments and equipment is a SAMS unit.

The Mir space station was launched in 1984 as a core module and has been expanded since that time to include four modules for continuous manned presence in low-earth orbit. In 1993, a cooperative effort was started between the United States and Russia involving science utilization of the Mir by scientists from the United States and Russia.

The initial U.S. experiments were planned to be a Protein Crystal Growth (PCG) experiment and a material sample for the Russian GALLAR furnace.

On 25 August 1994, the SAMS unit was launched on a Russia Progress vehicle to the Mir space station. The SAMS unit will support science experiments from the U.S. and Russia in a manner similar to the Orbiter missions by measuring the microgravity environment during the experiment operations. This is a part of the NASA / Mir program.

On the Mir-16 mission in October 1994, the SAMS unit recorded data on Mir for over fifty-three hours in seven different time periods to survey possible locations for future experiments. This report presents a quick look at the data and the microgravity environment during the time periods in which SAMS data were acquired.

The Principal Investigator Microgravity Services (PIMS) project at the NASA Lewis Research Center supports principal investigators of microgravity experiments as they evaluate the effects of varying acceleration levels on their experiments.

The Mir acceleration data were examined by PIMS to ascertain gross attributes of the data. This report does not present an exhaustive examination of all possible activities due to the short preparation time and due to the absence of complete timeline information during the SAMS recording periods.

Appendices A, B and C provide plots of the SAMS data for an overview of the micro-gravity environment at the times that data were recorded. Appendix D describes the procedures to access SAMS data by file transfer protocol (ftp) utilizing the internet. Appendix E contains a user comment sheet. Users are encouraged to complete this form and return it to the authors.

2 MIR SPACE STATION

2.1 Configuration

Figure 1 shows the configuration of the Mir space station during Mir-16. The four major components are the Mir core module, the Kvant-1 astrophysics module, the Kvant-2 scientific and airlock module, and the Kristall technological module [1]. The Mir modules may be re-oriented in the future. In the near future, the Spektr and Priroda modules will be installed on the Mir space station in May and November 1995 respectively.

The majority of U.S. experiments in this cooperative program will be flown in the new Russian Priroda module.

2.2 Mir Coordinate Systems

To ease future analysis of SAMS Mir data, a Mir reference coordinate system is under development that will be based on a three-axis system defined for each module with an overall coordinate system for the Mir. This overall system will relate the individual module three-axis systems together. This will enable a system to be defined for each individual module, but allows the overall system to change depending on the configuration of the Mir modules.

For this quick look report, the SAMS data are analyzed in the coordinate system of the individual SAMS triaxial sensor head (TSH). At this time, the data have not been transformed to a Mir reference coordinate system.

3 ACCELEROMETER SYSTEMS

The SAMS accelerometer system measured the microgravity and vibration environment of the Mir space station during the Mir-16 mission. An accelerometer built by the French space agency Centre National d'Etudes Spatiales (CNES) was operated on-board Mir during 1992 and 1993. It also collected data during Mir-16 to compare with the SAMS data.

3.1 Space Acceleration Measurement System

The Space Acceleration Measurement System was developed to monitor and measure the low-gravity environment of Orbiters in support of MSAD-sponsored science payloads. Six flight units were made to support microgravity science experiments in the Orbiter middeck, the Orbiter cargo bay, the Spacelab module and the SPACEHAB module. One of the six flight units was supplied to support the SMSP. The SAMS launch to Mir marked the eleventh flight of SAMS. A SAMS unit typically consists of three remote TSHs, connecting cables, and a controlling data acquisition unit with a digital data recording system using optical disks with 200 megabytes of storage capacity per side.

For Mir, one SAMS unit was modified to operate in the Mir space station environment. Since it was expected that the SAMS unit would remain on Mir for several years, the frequency range of the sensor heads was selected in anticipation of a variety of science requirements. The unit was configured for three remote TSHs (TSH A, TSH B, and TSH C) with low-pass filters applied to the data with cutoffs at 100, 10, and 2.5 Hz. The data were sampled at 500, 50, and 12.5 samples per second, respectively. More detailed descriptions of the SAMS accelerometers are available in the literature [2-5].

The locations and orientations of the SAMS TSHs, with respect to the Mir modules, are given in tables 1 and 2. The Ksenia equipment cited in the table is an apparatus similar to the PCG equipment. It was used to structurally simulate the PCG for environment measurement before the PCG apparatus was installed.

During Mir-16 there is not a continuous record of SAMS data due to science requirements, relocation of the sensor heads and the limited crew time available for SAMS. The chart in figure 2 gives an overview of what SAMS data are available from Mir-16. The recorded SAMS data represents a net 53 hours and fourteen minutes of operation in seven primary time periods.

Appendix D describes the procedures to access SAMS data by file transfer protocol (ftp) utilizing the internet.

3.2 CNES Accelerometer

An accelerometer built by the French space agency CNES [6, 7] was operated on-board Mir during 1992 and 1993. This system is capable of recording camera video data along with the acceleration data. This facilitates correlation between activities and acceleration levels. When data from that accelerometer are made available to PIMS, analyses of the microgravity environment will be developed comparing the environment measured by SAMS and the CNES accelerometer.

4 MISSION OVERVIEW

On 25 August 1994, a Russian Progress vehicle was launched from the Baikonaur launch complex with supplies for the Mir space station and the initial equipment for the SMSP. The U.S. equipment launched were the SAMS unit, the Mir Interface to Payload System (MIPS) and the Tissue Equivalent Proportional Counter (TEPC).

The Progress vehicle successfully docked with the Mir on 2 September. The SAMS unit was brought into the Mir and checked out on 28 September. There were seven periods of time in which the SAMS recorded data between then and when the initial data disks were returned to earth by the Mir-16 crew on 4 November 1994. These disks were transferred to Moscow and presented to an MSAD representative who delivered them to LeRC on 21 November.

The SAMS unit receives its time signal from the MIPS. The MIPS translates the Mir clock signal into a protocol utilized by the NASA Orbiter, allowing Orbiter payloads to interface directly with an Orbiter-like clock signal. The time presented in this report is Moscow local time (MLT) as used by the crew during the Mir-16 mission. The format is *day/hour:minute:second*.

To most fully understand the microgravity environment during Mir-16, the activities during the Mir-16 mission must be identified. A complete as-flown timeline of all activities that occurred during this timeframe is not available at this time. An attempt is being made to obtain additional information concerning the crew and operational activities during Mir-16.

5 ANOMALIES IN THE SAMS DATA

In the initial examination of the SAMS data, two anomalies were found and are briefly described here.

The first was the absence of any on-orbit data from TSH C. The formal failure analysis of this problem is on-going. Based on the expected experiment traffic model, it appears that there will be little data loss since TSH C is the lowest frequency TSH on Mir. Possible loss of science support will come in future operations supporting multiple experiments in the Priroda module.

The second anomaly is that the time embedded in the SAMS raw data has a differential of two days relative to the notes recorded by the crew members after the first day of operation. This problem is also being investigated. In this quick look report, the data plots produced from the SAMS data have not been corrected for this time differential. The time of an event in the data plots is two days less than the time cited in the logbook, table 3.

6 MIR SPACE STATION LOW-GRAVITY ENVIRONMENT–MIR-16

The acceleration environment measured by an accelerometer system on a spacecraft has contributions from numerous sources. All on-going operations of crew life support systems along with activities and operations of the vehicle, crew and experiments tend to have vibratory and / or oscillatory components that contribute to the background acceleration environment.

The logbook pages returned by the Mir-16 crew contained information describing the SAMS operations, the TSH locations and orientations and also when data recording was turned on and off. The data recording periods are shown graphically in figure 2. The several separate sections of acquired data span the twenty-four hours of a day. These data should represent the range of crew activities during that time, such as crew sleep, crew activities, and the operation of experiments and other equipment.

The logbook also contains a description of the SAMS disk changes and a slight procedural problem during the first power-on initialization. Some actions related to the CNES accelerometer were also noted in the logbook pages. A data sharing arrangement has been established for sharing the SAMS and CNES accelerometer data.

There were no specifics in the logbook describing the method of TSH attachment that was used by the crew. The planned method had been for double sided tape to mount the TSH to flat surfaces as was tested with SAMS on STS-60. The Mir crew reported some difficulty with the cables apparently forcing the TSH loose. The crew reported that they attached the TSH in a different manner, but it is not described in the logbook. To ensure that the TSHs were mounted securely to the structure, the low frequency response was examined for a particular time for TSH A and B. The data plots in figures 3a and 3b show that the power spectral density (PSD) for both the TSH showed modes of similar frequencies (below 10 Hertz) indicating that they were both connected to the Mir structure. Notice that the PSD for the 10 Hertz TSH has a roll-off above 10 Hertz.

There were no logbook notes concerning the Mir operational activities which were conducted on-board during the time of SAMS data recording. Because of this, only broad generalizations about the Mir-16 microgravity environment are made.

The appendices provide an overview of the microgravity and vibration environment acquired during the Mir-16 mission. Except where noted, all SAMS data plots shown in this report are from TSH A with a 100 Hertz low-pass filter. Appendix A shows time history plots of root-mean-square (RMS) data. Appendix B provides a frequency domain representation of the same SAMS data. Appendix C shows time history plots of average (AVG) data.

6.1 Data Processing

Various processes have been applied to the SAMS data acquired from the Mir. The typical data representation shown in the report figures is that of x, y, z - axis acceleration versus time and x, y, z - axis power spectral density versus frequency. The PSD is calculated according to Parseval's theorem (equation) to give an indication of the frequency distribution of power in the acceleration signal.

$$\frac{1}{N}\sum_{j=1}^{N}(x(j)-\bar{x})^2 = \sum PSD(k)$$

6.2 General Environment Description

During Mir-16, the SAMS data were obtained only in the Kristall module in the two locations identified in tables 1 and 2.

The environment on Mir during the time periods measured by SAMS are characterized as quiet, moderately active and very active. There are several periods of time in which the environment appears fairly quiet, chiefly from 287 / 14:30 until 288 / 10:00 and from 289 / 23:00 until 290 / 08:00. This is most apparent by examining the data plots in appendix B. During this quiet time, the RMS value was approximately 500 micro-g over the 100 Hertz bandwidth.

There are time periods during which there are periodic high intensity disturbances which last for five to ten minutes and are repeated every ten to fifteen minutes. Examples of this may be seen in the data plots of appendices A and B from 289 / 12:50 to 14:30 and from 298 / 17:20 to 19:35. These times have strong frequency components from quasi-steady up to 50 to 100 Hertz with particularly strong harmonic components from quasi-steady to 20 Hertz (see in particular 299 / 14:25). During some of these high intensity periods, the frequencies stay constant (as at 298 / 17:40), but during other times, the frequencies vary over time (as from 289 / 13:20 to 13:25).

Between the quiet times and the high intensity disturbances, the RMS level is generally at 1 milli-g for the 100 Hertz bandwidth as can be seen in the data plots of appendix A. There are occasional short duration, higher level disturbances, but they are overshadowed by the high intensity periods.

As reported by Granier, et.al. [6, 7], the compressor in the Core module has a 24 Hertz operational frequency. This was evident throughout much of the SAMS data. It has a typical magnitude in the hundreds of micro-g's (figure 4 and appendix B). Other strong components which are present for much of the time are 1, 2, 45, 48, 87, 90, 97, 102 and 140 Hertz and to a lesser degree, 20 and 66 Hertz (figure 5 and appendix B).

There are also events which occur over a short time interval, but with high magnitudes, as in figure 4. There were also times where many distinct frequency components were apparent. Figure 6 has thirteen distinct frequency peaks below 20 Hertz.

6.3 Crew Disturbances

There were six crew members present during the time that SAMS data were recorded on Mir-16. The crew of the Mir space station worked on a single shift schedule based on Moscow local time and the ground control staff daily schedule. The SAMS data are being analyzed in an attempt to identify typical crew activity periods. Several periods of reduced acceleration levels are currently being investigated as possible crew sleep times. Other disturbances in the microgravity environment are being studied for correlation with other crew activities.

The characteristically strong 1 and 2 Hertz components at 289/13:15 may be due to crew exercise, figure 7.

6.4 Kristall Structural Modes

Figure 8 is a PSD composed of the average of four consecutive PSD's, each of which is a two-minute time period of the 100 Hertz TSH. The colors denote the x, y and z axes of the TSH. The purpose of this figure is to show the first structural mode (0.633 Hertz) measured by the SAMS TSH in the Kristall module. This is consistent with previous analyses of the CNES accelerometer data [8].

7 COMPARISON WITH NASA ORBITER ENVIRONMENT

Many of the characteristics of the Mir SAMS data are similar to the characteristics of the SAMS data recorded on the NASA Orbiter. Events such as station-keeping thruster operations, crew activity, and equipment operation are common occurrences on a spacecraft.

The data plots in figures 9a and 9b are from the STS-65 mission during the Second International Microgravity Laboratory operational time period. Figure 9a shows data acquired in a relatively quiet period while the crew were performing a public affairs event. Figure 9b shows data acquired during the regular crew activity of the mission. These data plots have been processed in the same manner as the Mir data plots in this report and so are comparable. Due to the quick nature of this report, detailed comparisons have not been accomplished between these two sets of data.

As more information is gained about operations on board the Mir, further studies will be accomplished to compare the environment of these two carriers.

8 SUMMARY

This report is a quick summary of the SAMS data acquired during the Mir-16 mission on the Mir space station. Further analysis of specific events and comparisons with other missions will be performed and published in future documents.

The SAMS unit on-board the Mir was installed to support the U.S. experiments to be flown on Mir under the SMSP. Three SAMS TSHs were mounted at various locations in Mir. There were two primary payload locations measured during the Mir-16 mission: the PCG dewar and the GALLAR furnace.

A summary of the vector magnitude RMS and average accelerations for the entire data set was produced for the SAMS 100 Hz TSH. Spectrograms were also produced to give a frequency domain summary for the entire mission. These plots are presented in the Appendices. Some characteristics of the SAMS data are outlined.

Future work will continue this initial effort to further correlate activities and operations with environment and also begin to compare the Mir environment with that of the NASA Orbiter.

9 REFERENCES

[1] Bockman, M. W., S. Kelly, et al. (1994). A Russian Space Station: The Mir Complex. Houston, Texas, NASA Johnson Space Center.

[2] DeLombard, R. and B. D. Finley: Space Acceleration Measurement System Description and Operations on the First Spacelab Life Sciences Mission. TM-105301, 1991.

[3] DeLombard, R., B. Finley, et al.: Development of and Flight Results From the Space Acceleration Measurement System (SAMS). TM-105652, AIAA 92-0354, 1992.

[4] Rogers, M. J. B. and R. DeLombard: Summary Report of Mission Acceleration Measurements for STS-62; Launched March 4, 1994. TM-106773, 1994.

[5] Rogers, M. J. B. and R. DeLombard: Summary Report of Mission Acceleration Measurements for STS-60; Launched February 3, 1994. TM-106797, 1994.

[6] Granier, J.-P., Y. Dancet, et al. (1992). Microaccelerometre Experiment Mir Microacceleration Characterization. 1st Symposium International Microdynamique et Pointage de Grande Precision, Nice, France, CNES.

[7] Granier, J.-P., P. Faucher, et al. (1994). MIR Microgravity Environment "Microaccelerometre" Experiment. 24th International Conference on Environmental Systems and 5th European Symposium on Space Environmental Control Systems, Friedrichshafen, Germany, Society of Automotive Engineers.

[8] Granier, J.-P. (1992). “Microaccelerometre” Experiment, Mir Microacceleration Characterization. 10th Microgravity Measurements Group Meeting, Huntville, Alabama.

Table 1: SAMS Triaxial Sensor Head Location and Orientation, Day 289 (16 Oct 94)

Unit E TSH-A Frequency: 0 to 100 Hz Sample Rate: 500 samples/second		Serial no.: 821-23 Location: Kristall Module
ORIENTATION		LOCATION
Sensor Axis	Mir Panel Identification	Mounted on the floor (100 plane)
X_h	Toward the module ceiling (300 plane)	X_0 = TBD m
Y_h	Toward the docking port with Core Module	Y_0 = TBD m
Z_h	Toward the module right side (200 plane)	Z_0 = TBD m

Unit E TSH-B Frequency: 0 to 10 Hz Sample Rate: 50 samples/second		Serial no.: 821-30 Location: Kristall Module
ORIENTATION		LOCATION
Sensor Axis	Mir Panel Identification	Mounted on the Ksenia equipment
X_h	Toward the module ceiling (300 plane)	X_0 = TBD m
Y_h	Toward external docking port adaptor	Y_0 = TBD m
Z_h	Toward the module left side (400 plane)	Z_0 = TBD m

Unit E TSH-C Frequency: 0 to 2.5 Hz Sample Rate: 12.5 samples/second		Serial no.: 821-17 Location: Kristall Module
ORIENTATION		LOCATION
Sensor Axis	Mir Panel Identification	Mounted on the Ksenia equipment
X_h	Toward the module left side (400 plane)	X_0 = TBD m
Y_h	Toward external docking port adaptor	Y_0 = TBD m
Z_h	Toward the module floor (100 plane)	Z_0 = TBD m

Table 2: SAMS Triaxial Sensor Head Location and Orientation, Day 291 (18 Oct 94)

Unit E TSH-A Frequency: 0 to 100 Hz Sample Rate: 500 samples/second		Serial no.: 821-23 Location: Kristall Module
ORIENTATION		LOCATION
Sensor Axis	Mir Panel Identification	Mounted on the right side near Gallar (200 plane)
X_h	Toward the module left side (400 plane)	X_0 = TBD m
Y_h	Toward the module ceiling (300 plane)	Y_0 = TBD m
Z_h	Toward the TBD	Z_0 = TBD m

Unit E TSH-B Frequency: 0 to 10 Hz Sample Rate: 50 samples/second		Serial no.: 821-30 Location: Kristall Module
ORIENTATION		LOCATION
Sensor Axis	Mir Panel Identification	Mounted on the module left side (400 plane)
X_h	Toward the module right side (200 plane)	X_0 = TBD m
Y_h	Toward the module ceiling (300 plane)	Y_0 = TBD m
Z_h	Toward the TBD	Z_0 = TBD m

Unit E TSH-C Frequency: 0 to 2.5 Hz Sample Rate: 12.5 samples/second		Serial no.: 821-17 Location: Kristall Module
ORIENTATION		LOCATION
Sensor Axis	Mir Panel Identification	Mounted on the Gallar furnace right side (200 plane)
X_h	Toward the module right side (200 plane)	X_0 = TBD m
Y_h	Toward module ceiling (300 plane)	Y_0 = TBD m
Z_h	Toward the TBD	Z_0 = TBD m

Table 3: Mir-16 SAMS Events from the Logbook

Activity or Location	Data Record On MLT (day hr:min:sec)	Data Record Off MLT (day hr:min:sec)	Total Recorded Time (day hr:min:sec)
SAMS calibration	277 19:10:00	277 19:56:30	0:46:30
Ksenia equipment	289 12:08:40	289 16:01:30	3:52:50
Ksenia equipment	289 23:13:30	290 10:02:30	10:49:00
Gallar	291 10:57:55	291 20:47:30	9:49:35
Gallar	291 22:45:00	292 08:43:00	9:58:00
Gallar	300 14:58:30	300 23:47:00	8:48:30
Gallar	301 11:50:00	301 21:00:00	9:10:00

Note that the times recorded in the logbook have a time difference of two days with the time electronically recorded with the SAMS data. See section 5 in the report for details.

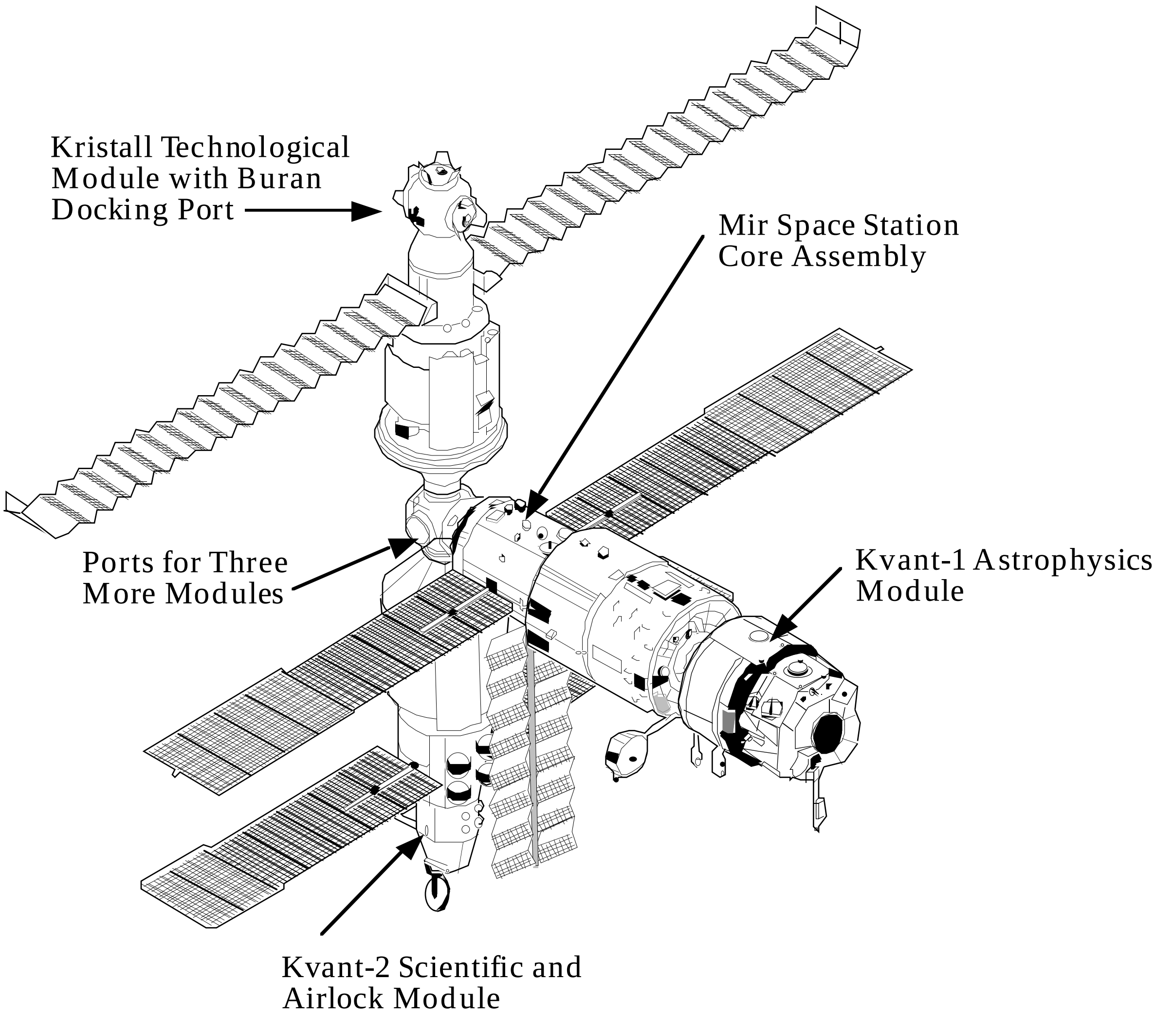


Figure 1: Mir space station configuration during Mir-16 [1]

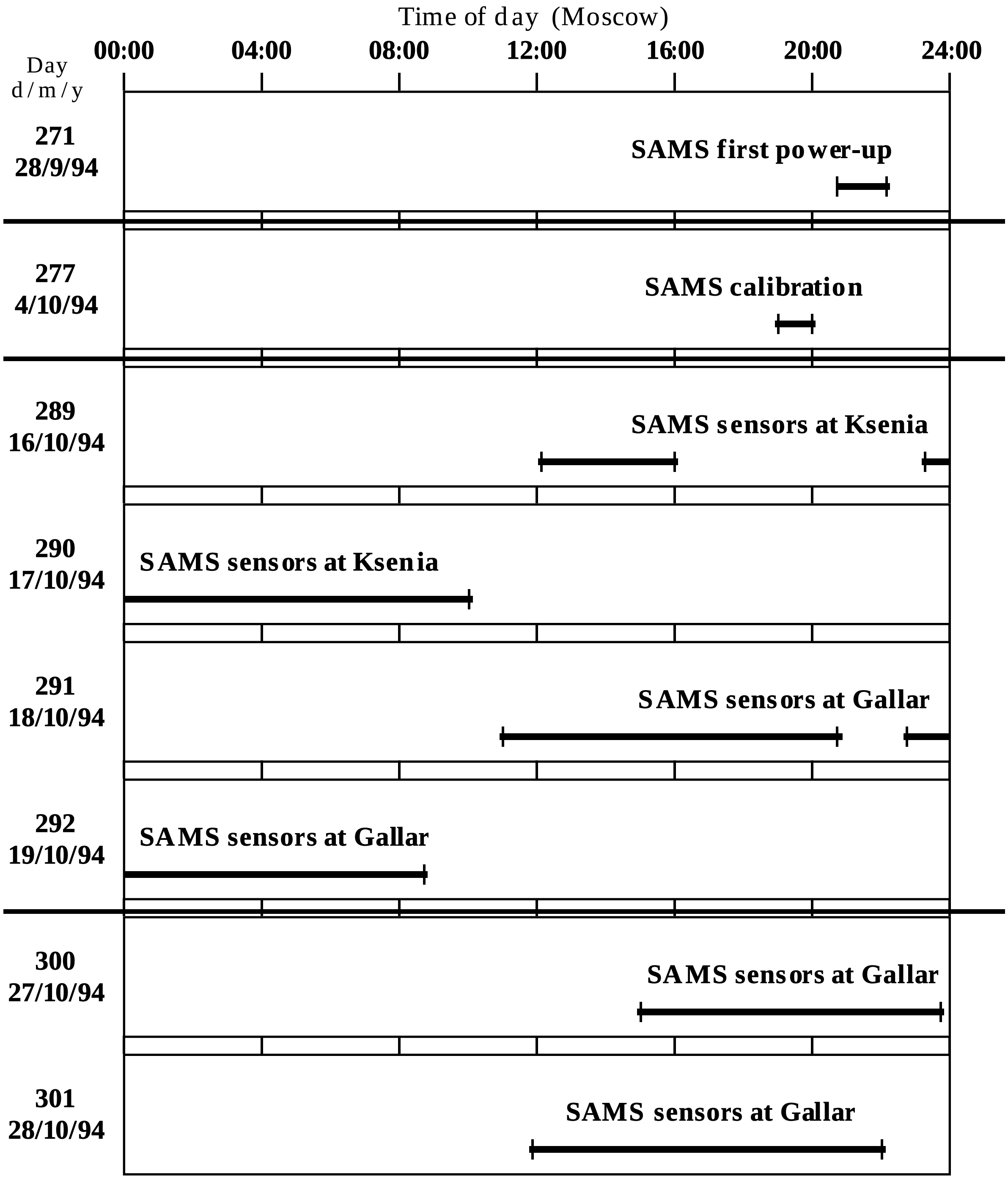


Figure 2: SAMS Recorded Data Intervals

APPENDIX A

ACCELERATION DATA TIME HISTORY

The SAMS data from Mir-16 are presented in Appendices A, B and E to provide users with an overview of the environment during the Mir-16 time period.

The raw data recorded by SAMS are processed to compensate for temperature and gain related errors of bias, scale factor, and axis misalignment. The processing utilizes a fourth order temperature model to compensate the data and convert the raw digitized data into engineering units (Thomas, et al., 1992). The data are formatted into files for distribution via CD-ROM and file server. See appendix C for information on file server access of SAMS data.

The compensated data are further processed to produce the plots included in this appendix. A ten second root mean square (RMS) time history representation of the data are provided. The RMS data are presented in two hour plots. These RMS plots should be used to identify times when oscillatory and/or transient deviations from the background acceleration levels occurred.

The RMS plots were produced by taking the RMS of 10 second intervals within the two hour period. The root mean square of a discrete time series for 10 seconds was calculated using the following equation:

$$RMS = \sqrt{\left(\frac{1}{N}\sum_{j=1}^{N} V_j^2\right)}$$

where,

$$V_j = \sqrt{(x_j^2 + y_j^2 + z_j^2)}\ .$$

Reference

[1] Thomas, J. E., R. B. Peters, B. D., Finley, B. D., Space Acceleration Measurement System triaxial head error budget, NASA TM-105300, January 1992.

APPENDIX B

SAMS COLOR SPECTROGRAMS

The SAMS data from Mir-16 are presented in Appendices A, B and E to provide users with an overview of the environment during the Mir-16 time period.

The raw data recorded by SAMS are processed to compensate for temperature and gain related errors of bias, scale factor, and axis misalignment. The processing utilizes a fourth order temperature model to compensate the data and convert the raw digitized data into engineering units (Thomas, et al., 1992). The data are formatted into files for distribution via CD-ROM and file server. See appendix C for information on file server access of SAMS data.

The SAMS data have been further processed to produce the plots shown here. Color spectrograms are provided as an overview of the frequency characteristics of the SAMS data during Mir-16. Each spectrogram is a two-hour composite of amplitude spectra for consecutive ten second intervals using SAMS TSH A data. These plots should be used to identify times when the frequency character of the acceleration environment changed.

The spectral data were scaled by taking the log of each data point and assigning a color to the integer result. Eight colors were used for eight intervals between 1×10^{-7} g and 1×10^{-3} g. In using this method, a range of acceleration values are assigned to the same color.

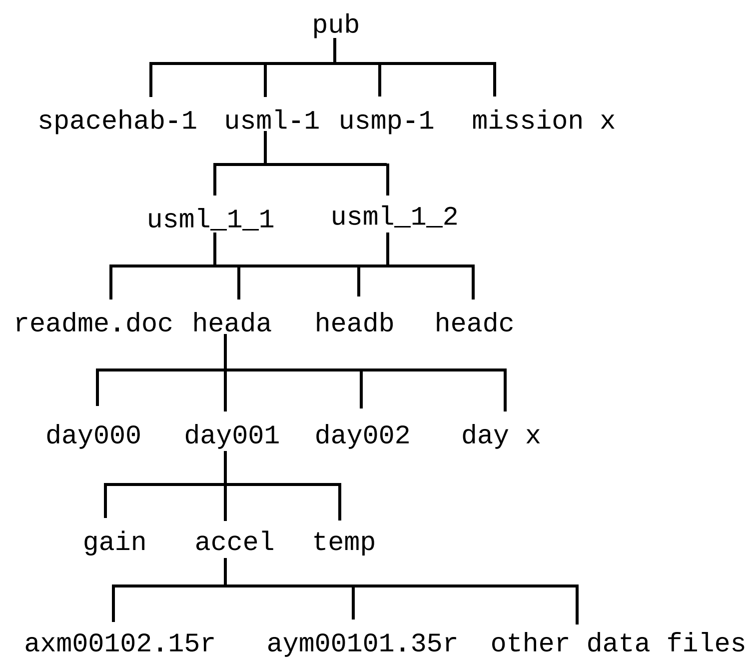
Reference

[1] Thomas, J. E., R. B. Peters, B. D., Finley, B. D., Space Acceleration Measurement System triaxial head error budget, NASA TM-105300, January 1992.

APPENDIX C

ACCESSING SAMS DATA VIA INTERNET

SAMS data are distributed on CD-ROM media and are available on a computer file server. In both cases, files of SAMS data are organized in a tree-like structure as illustrated in the figure. Data acquired from a mission are categorized based upon sensor head, mission day, and type of data. Data files are stored at the lowest level in the tree and the file name reflects the contents of the file. For example, the file named axm00102.15r contains data for sensor head A, the X axis, the time base was Mission Elapsed Time, day 001, hour 02, 1 of 5 files for that hour, and it contains reduced data. The file readme.doc provides a comprehensive description and guide to the data.



SAMS Data File Structure

Also available from the file server are some data access tools for different computer platforms.

SAMS data files may be accessed from a file server at NASA LeRC. The NASA LeRC file server beech.lerc.nasa.gov (tcp / ip address 139.88.19.43) can be accessed via anonymous file transfer protocol (ftp), as follows:

[1] Establish ftp connection to the beech file server.

[2] Login: *anonymous*

[3] Password: *guest*

[4] Change the directory to: *pub*

[5] List the files and directories in the pub directory.

[6] Change the directory to the mission of interest, for example: *usml-1*

[7] List files and directories for the specific mission chosen in previous step.

[8] Use the data file structure shown in the figure to find the files of interest.

[9] Transfer the data files of interest.

If you encounter difficulty in accessing the data using the file server, please send an electronic mail message to the internet address below. Please describe the nature of the difficulty and a description of the hardware and software you are using to access the file server.

pims@lerc.nasa.gov

APPENDIX D

USER COMMENT SHEET

APPENDIX E

ACCELERATION DATA TIME HISTORY

The SAMS data from Mir-16 are presented in Appendices A, B and E to provide users with an overview of the environment during the Mir-16 time period.

The raw data recorded by SAMS are processed to compensate for temperature and gain related errors of bias, scale factor, and axis misalignment. The processing utilizes a fourth order temperature model to compensate the data and convert the raw digitized data into engineering units (Thomas, et al., 1992). The data are formatted into files for distribution via CD-ROM and file server. See appendix C for information on file server access of SAMS data.

The compensated data are further processed to produce the plots included in this appendix. An average (AVG) time history representation of the data is provided. The AVG data are presented in two hour plots. These AVG plots should be used to identify times when the average level of the acceleration signal deviates from the background acceleration level.

The average plots were produced by calculating a ten second moving average of each axis and then combining the results into a vector magnitude representation using the following equation:

$$\mathrm{AVG} = \left\{\left[\sum_{i=1}^{N}\frac{x_i}{N}\right]^2 + \left[\sum_{i=1}^{N}\frac{y_i}{N}\right]^2 + \left[\sum_{i=1}^{N}\frac{z_i}{N}\right]^2\right\}^{\frac{1}{2}} .$$

Reference

[1] Thomas, J. E., R. B. Peters, B. D., Finley, B. D., Space Acceleration Measurement System triaxial head error budget, NASA TM-105300, January 1992.