1.0 STATUS OF MAMS DATA ANALYSIS

1.1.1 BACKGROUND

The MAMS HiRAP is located along with the MAMS OSS in Lockers 3 and 4 of LAB1O2 (EXPRESS Rack #1). HiRAP and OSS alignment relative to the Space Station Analysis Coordinate System is shown in Figure 1-1. HiRAP axes are indicated by the blue labels and OSS axes are indicated by the orange labels.

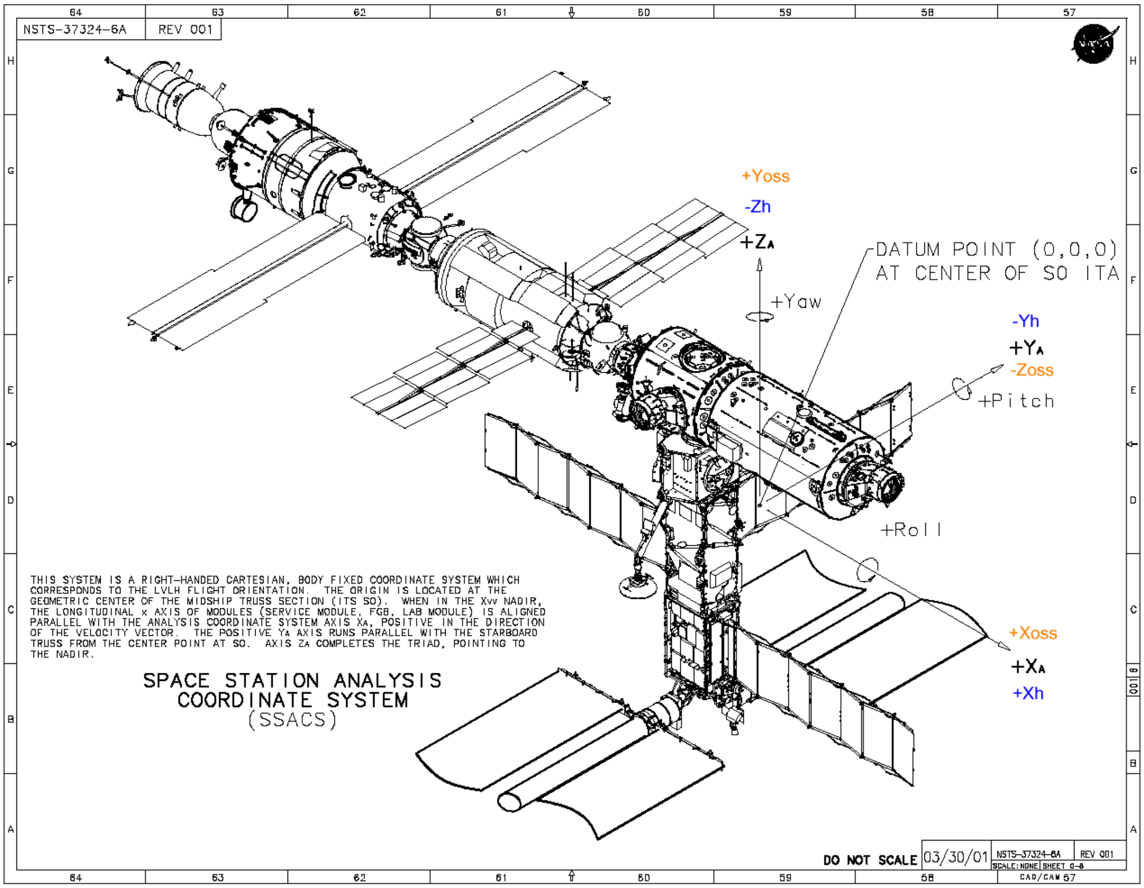

Figure 1-1 Relative Alignment of MAMS Sensors and Space Station Analysis Coordinates

1.2 HIGH RESOLUTION ACCELEROMETER PACKAGE (HiRAP)

1.2.1 INITIAL DATA SET (GMT 131)

PIMS had planned to collect vibratory data from the MAMS HiRAP during the Soyuz undocking on GMT 126, but as indicated in the PIMS console logbook at GMT 124/21:20:54:

> "POD announced only commands that are absolutely necessary will be allowed. This means no HiRAP data for Soyuz undocking. POD does not want high rate data to fill up MCOR. Writing OCR to ask to send 'Start OSS Stored Data Flow' as a critical command. There will be no commanding for GMT 125."

Note that the PIMS logbook references GMT 125 for commanding because Soyuz undocking occurred early on GMT 126. The MAMS collected HiRAP data at a rate of 1000 samples/second from about GMT 131/01:24:09 until deactivation at about 131/03:33:40. There was one significant gap in this span from about GMT 131/01:54:44 to 131/02:08:22). The data gap is the result of data processing problems as the data were received by the PDSS. This resulted in approximately 116 minutes (about 106 MB) of HiRAP acceleration data. These HiRAP data were collected during a crew sleep period, so the acceleration environment was expected to be relatively quiet. The histograms of Figure 1-2, however, show that the HiRAP X_H-Axis accelerometer registered acceleration levels approaching 10 mg.

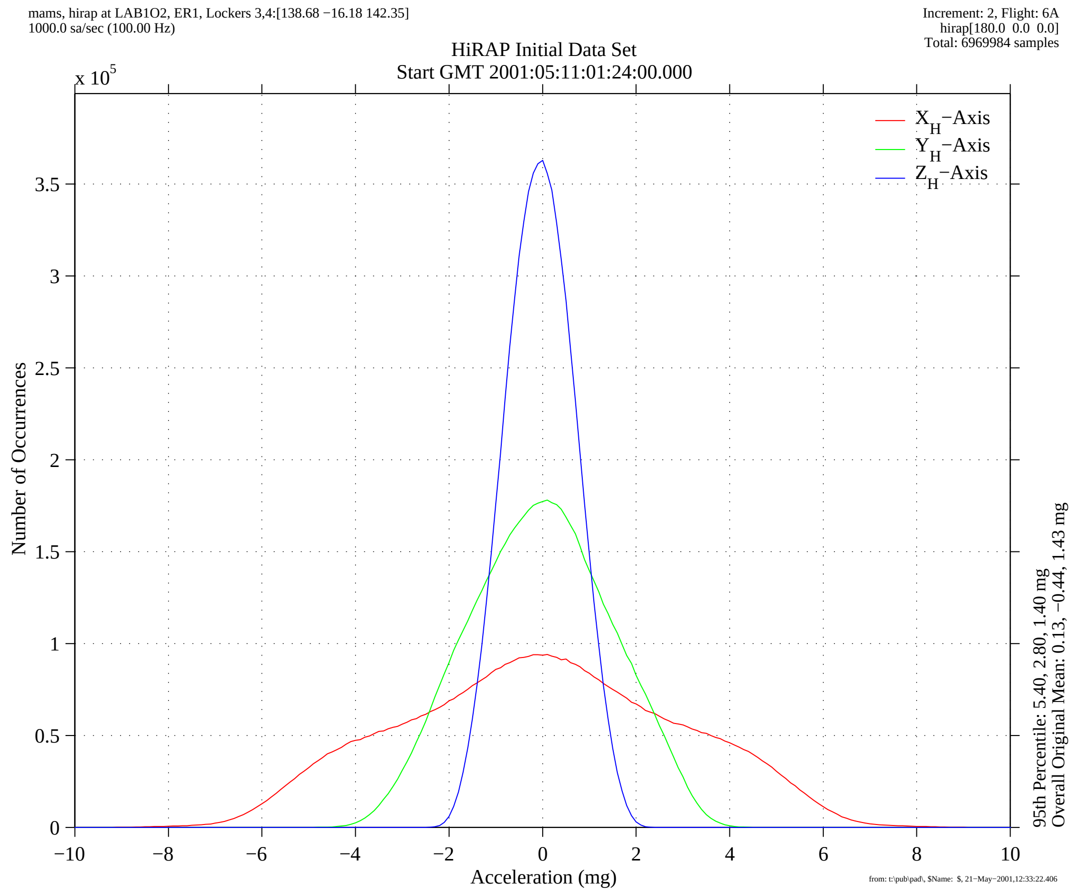

Figure 1-2 MAMS HiRAP Histograms

The peak-to-peak Y_H- and Z_H-Axis excursions were approximately half and a quarter that of the X_H-axis, respectively. The reason for these differences is not well understood as of yet, but further frequency domain analysis should at least be able to put a finer point on the discrepancy Furthermore, comparison to SAMS data (once it is activated) will help in this regard.

A closer look at the vibratory acceleration environment from the frequency domain can be seen in the color spectrogram of Figure 1-3. This shows that a major contributor to the vibratory environment was the disturbance centered at around 95 Hz.

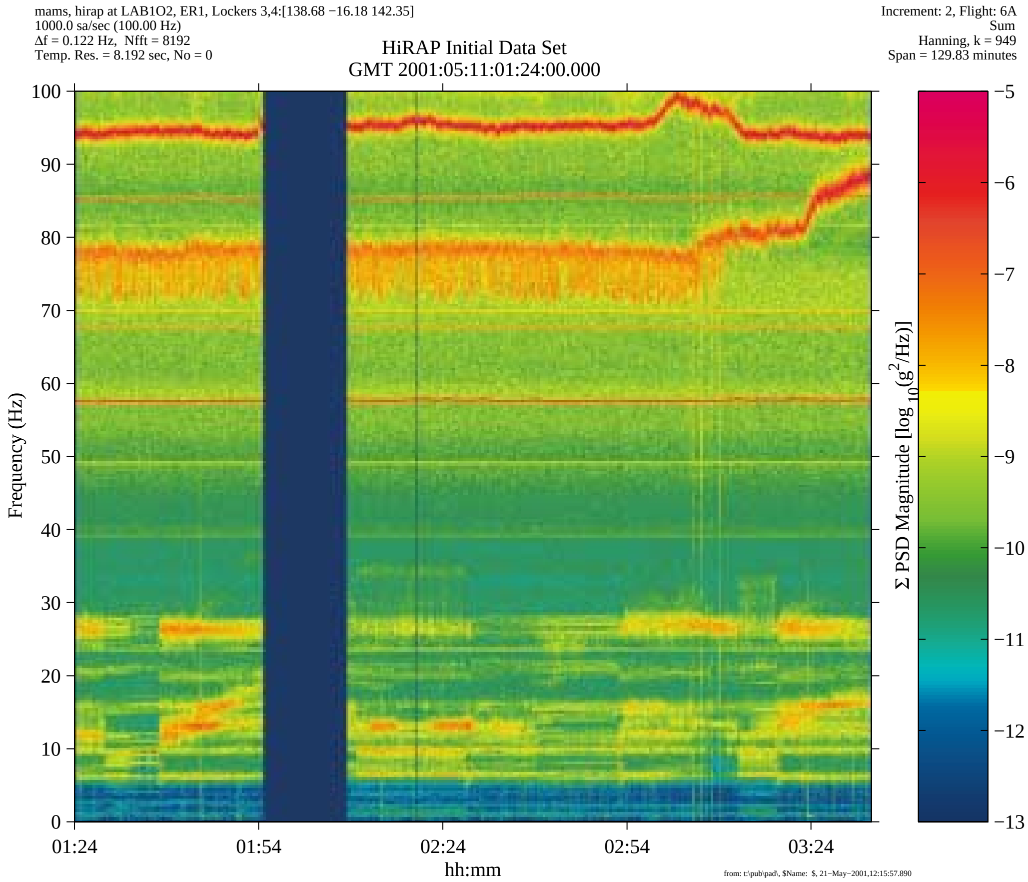

Figure 1-3 MAMS HiRAP Spectrogram

The region of the acceleration spectrum where this disturbance appears along with the broadband disturbance between 70 and 80 Hz is reminiscent of the life-support equipment measured by the SAMS on Mir. The actual source of these disturbances is to be determined.

Power spectral densities (PSDs) were computed to serve in a quantitative examination of HiRAP's 3 orthogonal axes' spectra. These PSDs are shown in Figure 1-4.

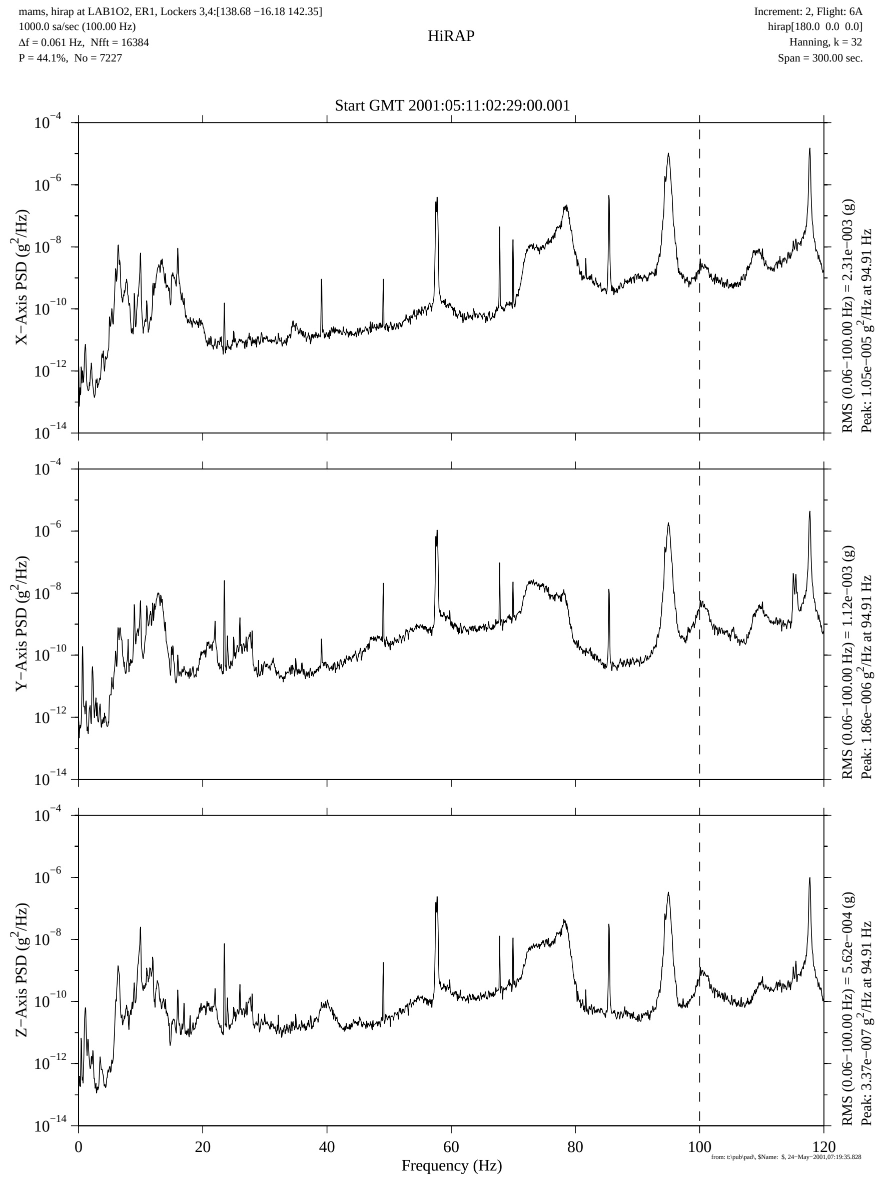

Figure 1-4 HiRAP Power Spectral Densities

Note that the passband of HiRAP is below 100 Hz as delimited by the vertical dashed lines. These PSDs were plotted out to 120 Hz to show the strongest narrowband spectral component observed in this set of HiRAP data was at about 117.6 Hz. Table 1-1 enumerates other significant vibratory components.

Table 1-1 HiRAP Key Spectral Contributors for GMT 131

Center Frequency (Hz)	Observations
117.6	Strongest spectral component, above HiRAP passband.
94.8	Strongest spectral component in HiRAP passband, suspect this is life-support equipment.
85.3	Tightly controlled in frequency, source unknown.
75.1	Broadband disturbance, suspect this is life-support equipment.
69.9	Tightly controlled in frequency, source unknown.
67.7	Tightly controlled in frequency, source unknown.
57.6	Tightly controlled in frequency, source unknown.
49.1	Tightly controlled in frequency, source unknown.
23.4	Tightly controlled in frequency, suspect this is similar to Mir's BKV-3.

The last disturbance listed in this table (center frequency about 23.4 Hz) is likely attributable to an air conditioning unit/dehumidifier in the Service Module. An excerpt from a NASA TM titled "SAMS Acceleration Measurements on Mir from March to September 1996" states:

> The most intense disturbance recorded in the SAMS data from Mir is the 24 Hz signal, related to the operation of the BKV-3 compressor, which is housed in the Mir Core Module. The microgravity disturbances caused by this system have been documented in the past by the French CNES and the American SAMS accelerometer systems. The function of this system is to compress and remove humidity from the Mir atmosphere. This unit had been in operation all of the time, but its use is now determined based upon the humidity levels aboard the station.

Next, the PSDs of Figure 1-4 were integrated and Parseval's theorem was employed resulting in the cumulative RMS acceleration versus frequency plot (for all 3 axes) shown in Figure 1-5.

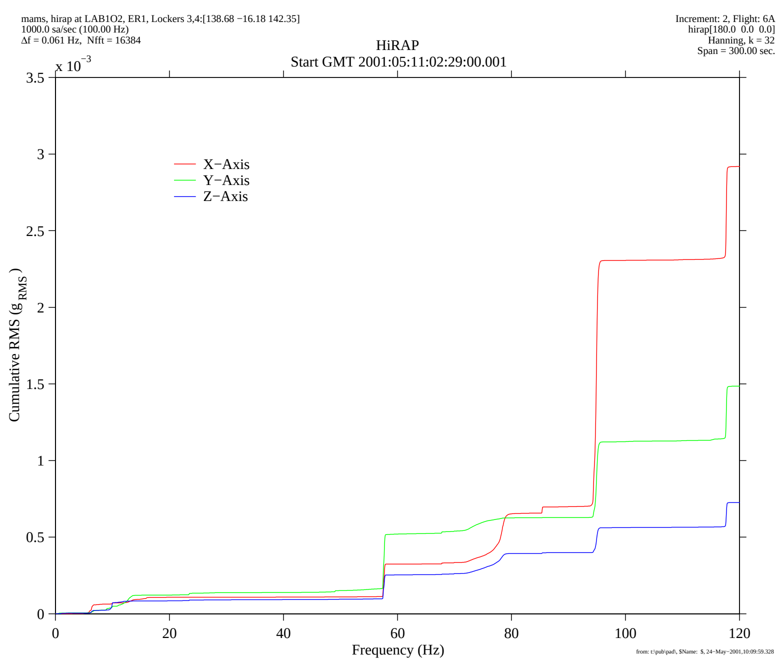

Figure 1-5 HiRAP Cumulative RMS Acceleration vs. Frequency

These traces clearly show where the differential comes from when comparing the 3 orthogonal axes. The disturbances centered at about 94.8 and 57.6 Hz are much stronger on the X_H-axis than the other 2 axes and the component centered at about 117.6 Hz is also more pronounced on the X_H-axis. This directional preference warrants further investigation and comparison to measurements soon to be collected by the SAMS.

1.2.2 PROGRESS VEHICLE DOCKING (GMT 143)

The PIMS console logbook indicates that the Progress vehicle docked at GMT 143/00:24:00, and as seen in the playback data of Figure 1-6, this large transient occurred at about GMT 143/00:24:20. The 20-second timing discrepancy will be investigated further. Preliminary results show that the peak amplitude of this docking event was approximately 13 mg and aligned primarily in the X_A-Z_A plane as expected as the Progress vehicle docked at the aft end of the Service Module (see Figure 1-1).

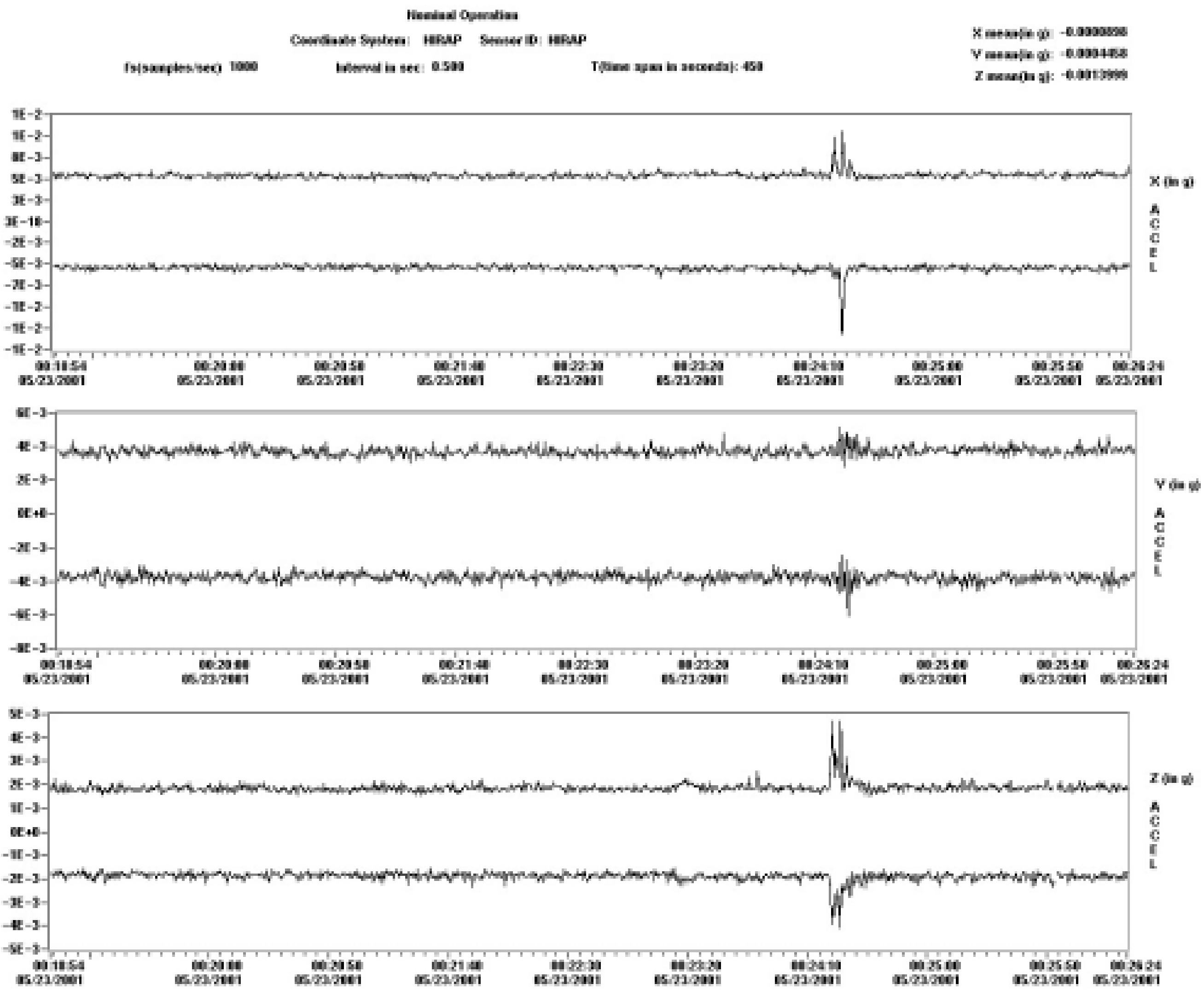

Figure 1-6 HiRAP Playback Screenshot of Interval Min/Max

An acceleration spectrogram of the Progress docking is shown in Figure 1-7 and will be another focus for further study.

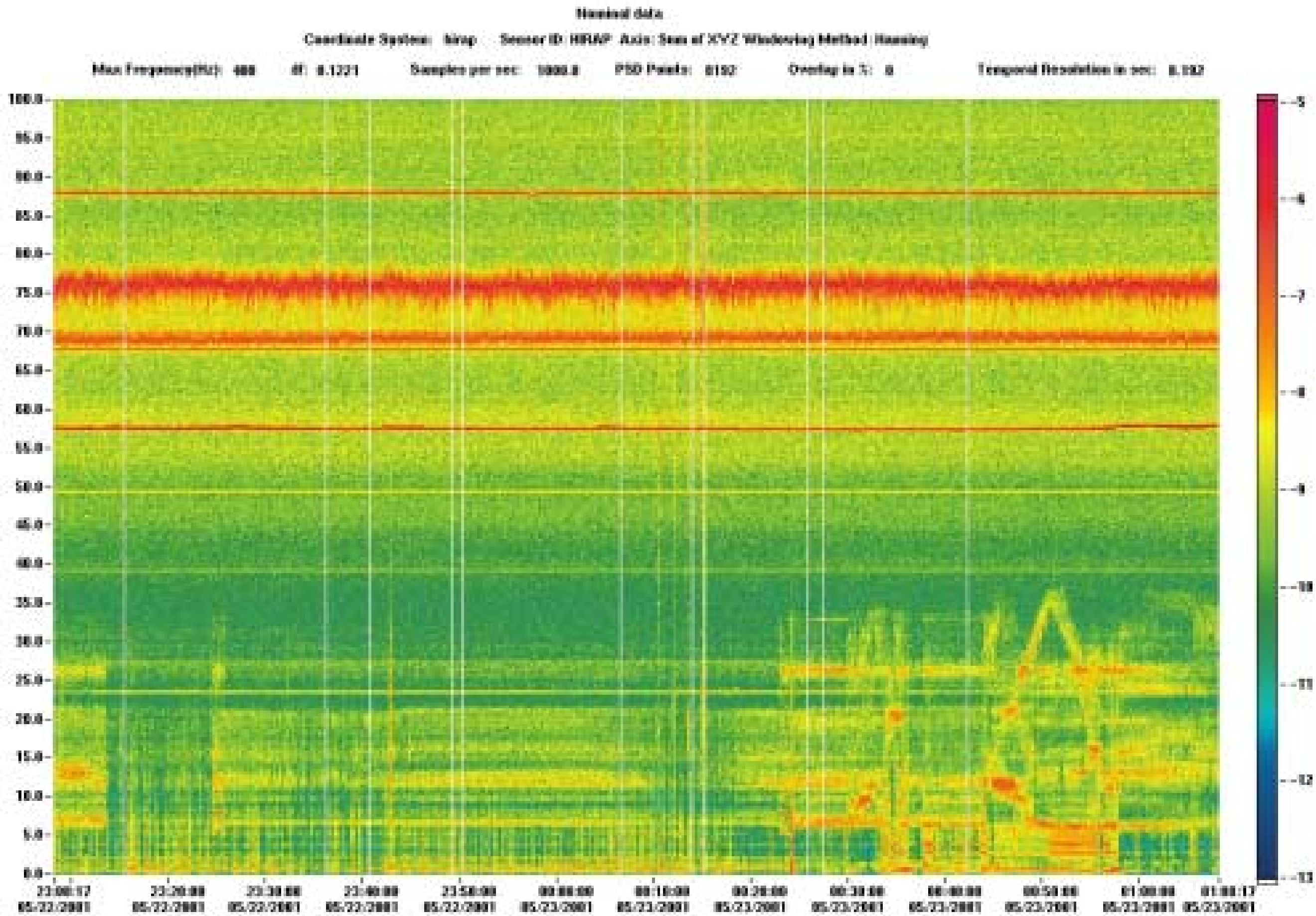

Figure 1-7 HiRAP Spectrogram of Progress Vehicle Docking

1.3 OARE SENSOR SUBSYSTEM (OSS)

OSS data recording started soon after MAMS initial activation at GMT 123/15:57:00, and continued until turn off occurring at GMT 131/16:08:25. MAMS collected nearly 8 days of 10 samples/sec, 1Hz filtered OSS data.

In order to capture a detailed profile of the bias associated with OSS, the MAMS unit was left in the default configuration of a C-range bias calibration every hour. There were 170 bias measurements taken, 84 of them valid. Nearly all of the invalid results were due to a noisy environment causing the OSS sensor to up range to the B-range. Most of the valid bias points occurred during crew sleep periods. None of the bias settling that was present in OARE data on shuttle operations is apparent in the MAMS data. Possible reasons for this are the time delay between MAMS activation and launch and a more static temperature environment provided for MAMS. Figure 1-8 shows the consistency of the valid bias measurements. Further investigation into temperature sensitivity of OSS is planned.

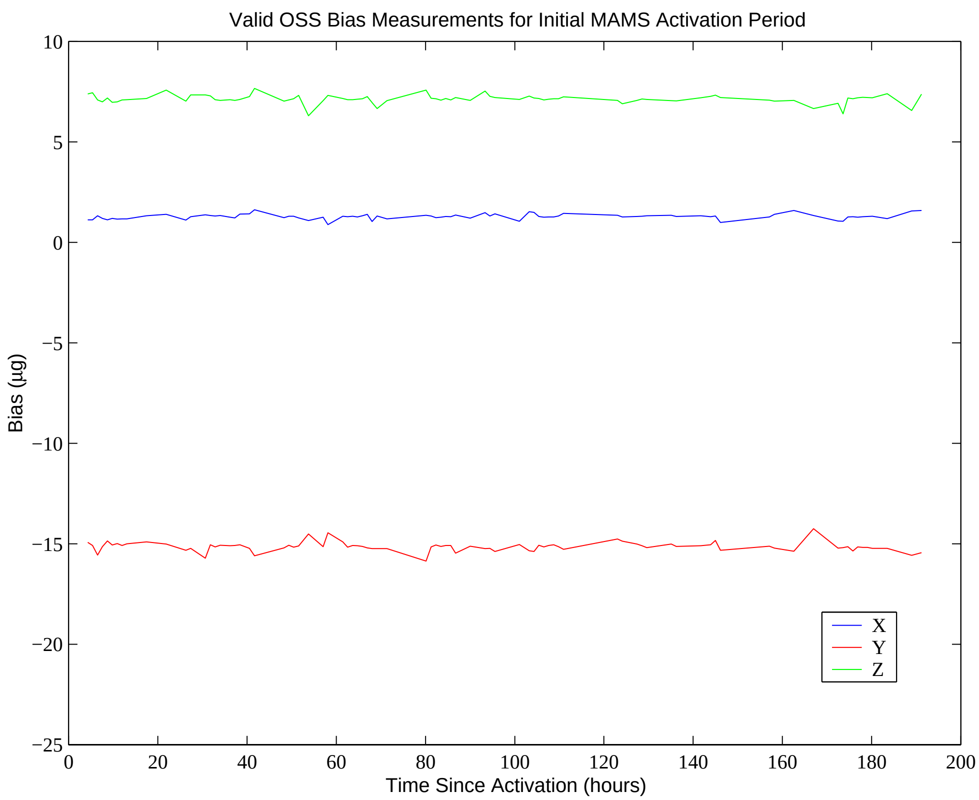

Figure 1-8 OSS Valid Bias Measurements

Figure 1-9 is a representative sample of the quasi-steady environment recorded during the initial MAMS activation period. It can be seen how the noisier environment during crew awake periods masks the quasi-steady profile.

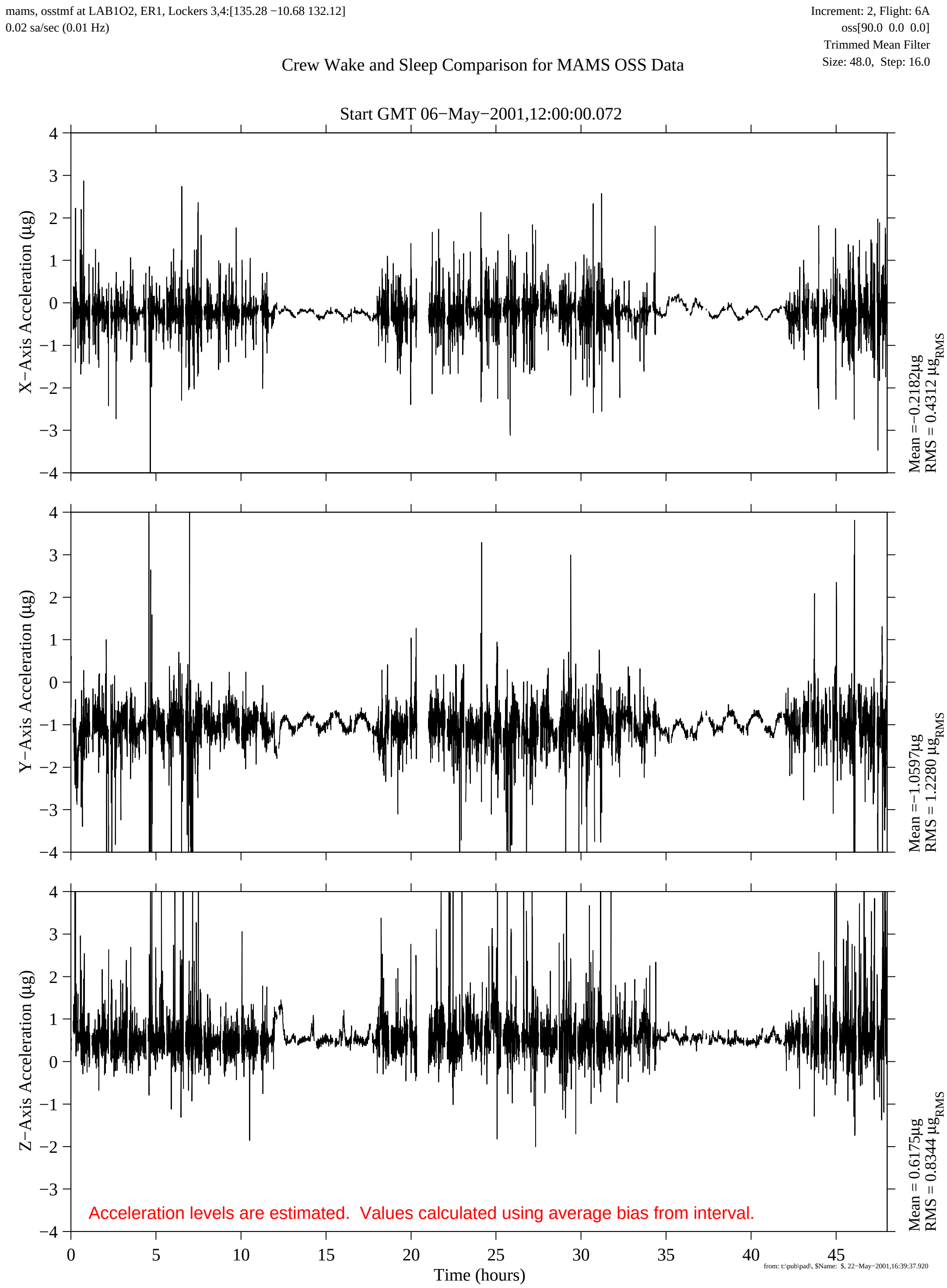

Figure 1-9 MAMS OSS Comparison of Crew Wake and Sleep Periods

A closeup of the sleep period for GMT 127 can be seen in Figure 1-10 . According to timelines available attitude during this period was maintained at +XVV / +ZLV (LVLH). The $+X_{OSS}$-Axis is aligned with the $+X_A$-Axis, and is in the direction of flight. The $+Y_{OSS}$-Axis is aligned with $+Z_A$-Axis pointing towards nadir, and the $+Z_{OSS}$-Axis is aligned with $-Y_A$-Axis, pointing out of the port side. Detailed analysis of the drag and gravity gradient components of the quasi-steady environment is pending accurate ISS rates and angles data. Gaps in the data are bias periods extracted for scaling purposes. The bias interval for the current MAMS activation period (start at GMT 141/07:33) was set to every 4 hours at GMT 143/17:36 to alleviate the problems introduced by data gaps the result from the bias operations.

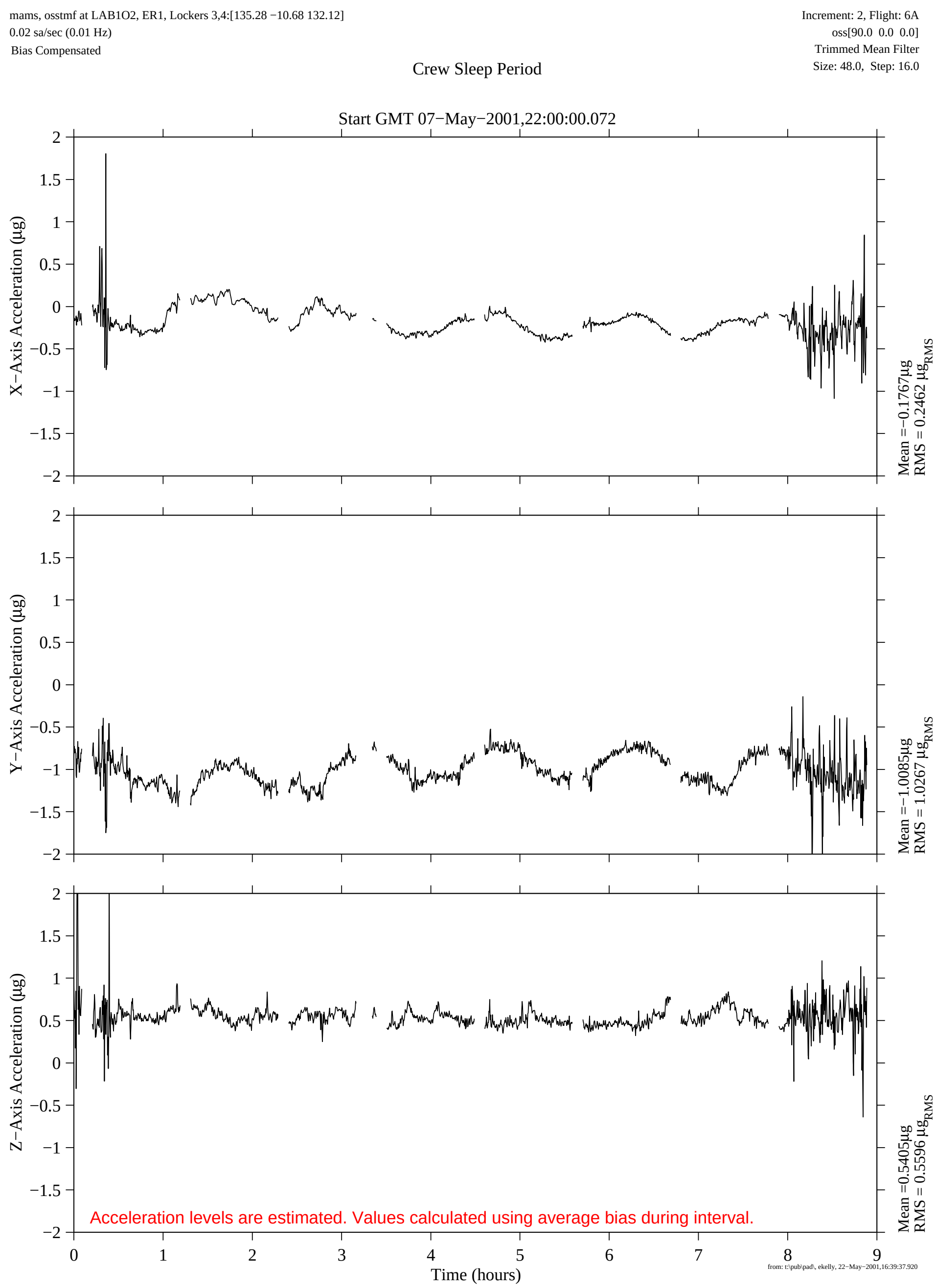

Figure 1-10 Quasi-steady Environment Measured During Crew Sleep

Figure 1-11 shows an acceleration vs time plot of the Progress docking event on GMT 124. HiRAP data for this same time period is not yet available, but should show elevated levels, because OSS data is filtered above 1 Hz.

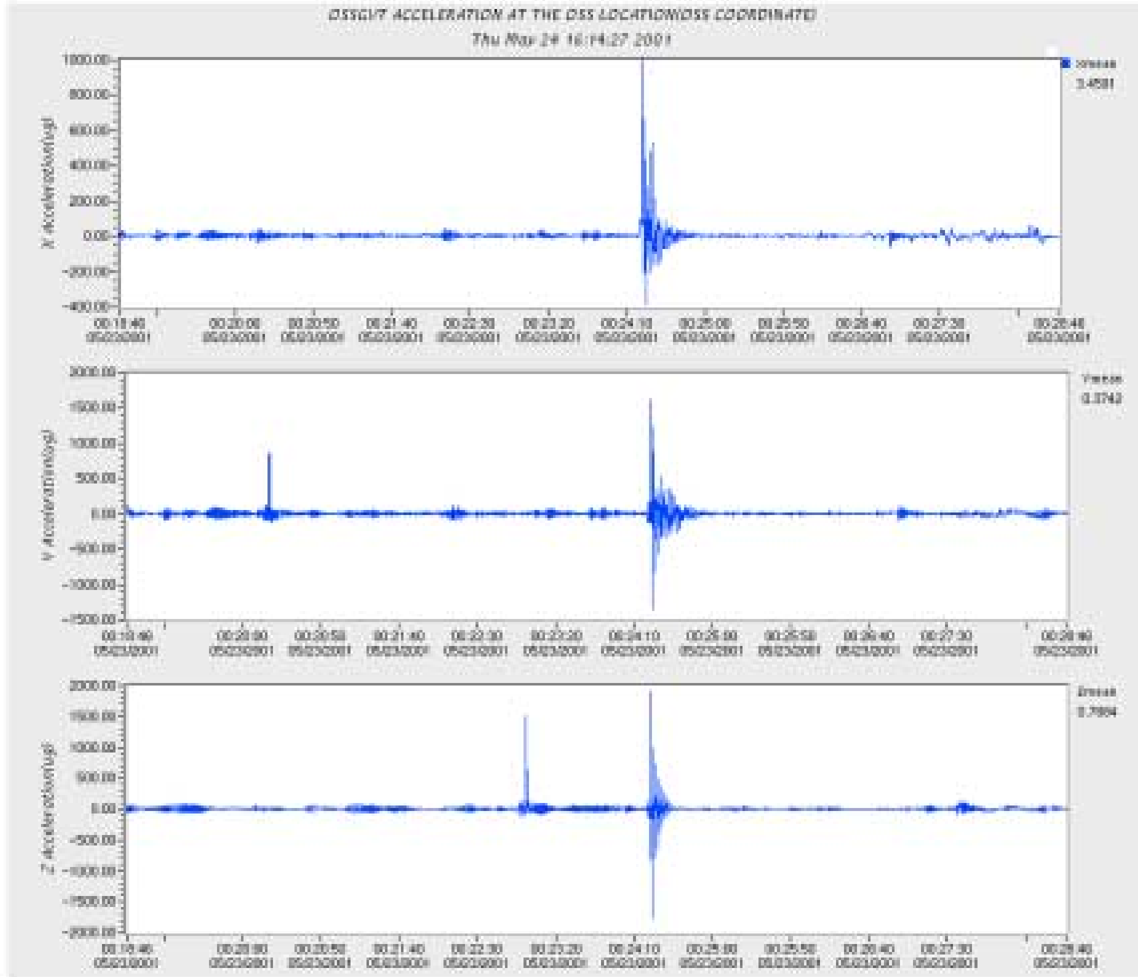

Figure 1-11 Progress Docking Event

1.4 FUTURE WORK

Currently a quick look report for SAMS and MAMS initial operations data is planned. A complete analysis and description of MAMS OSS bias operations will be included in this report, as well as some classification of vibratory disturbances and quasi-steady attitude profiles.