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Summary Report of Mission Acceleration Measurements for STS-65

Launched July 8, 1994

ORIGINAL CONTAINS
COLOR ILLUSTRATIONS

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MEASUREMENTS FOR STS-65**

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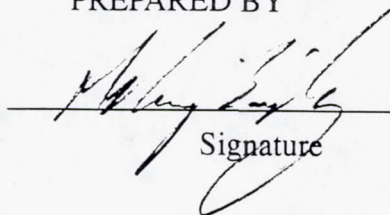
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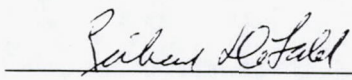
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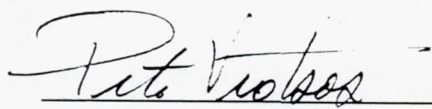


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ABSTRACT

The second flight of the International Microgravity Laboratory payload on-board the STS-65 mission was supported by three accelerometer instruments: the Orbital Acceleration Research Experiment (OARE) located close to the Orbiter center of mass, the Quasi-Steady Acceleration Measurement experiment in the Spacelab module, and the Space Acceleration Measurement System (SAMS) in the Spacelab module. A fourth accelerometer flew on the mission; the Microgravity Measuring Device recorded data in the middeck in support of exercise isolation tests. OARE and SAMS are both managed by the NASA Lewis Research Center. Data collected by these systems during IML-2 are displayed in this report. The OARE data represent the microgravity environment below 1 Hz. The SAMS data represent the environment in the 0.01 Hz to 100 Hz range. Variations in the environment caused by unique activities are presented in the report. Specific events addressed are crew activity, crew exercise, experiment component mixing activities, experiment centrifuge operations, refrigerator/freezer operations, and circulation pump operations. The analyses included in this report complement analyses presented in other mission summary reports.

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ACRONYM LIST

BDPU	Bubble, Drop and Particle Unit
DLR	German Aerospace Research Establishment
DSO	Detailed Supplementary Objective
DTO	Development Test Objective
EEPROM	electrically erasable programmable read only memory
GMT	Greenwich Mean Time (day/hour:minute:second)
IML-2	second International Microgravity Laboratory
IVIS	Inertial Vibration Isolation System
JSC	NASA Johnson Space Center
KSC	NASA Kennedy Space Center
LeRC	NASA Lewis Research Center
MET	Mission Elapsed Time (day/hour:minute:second)
MMD	Microgravity Measuring Device
MSAD	Microgravity Science and Applications Division
NIZEMI	Slow Rotating Centrifuge Microscope
OARE	Orbital Acceleration Research Experiment
OMS	Orbital Maneuvering System
PCIS	Passive Cycle Isolation System
PIMS	Principal Investigator Microgravity Services
POCC	Payload Operations Control Center
PSD	power spectral density
QSAM	Quasi-steady Acceleration Measurement
SAMS	Space Acceleration Measurement System
X_A, Y_A, Z_A	SAMS sensor head A axes
X_B, Y_B, Z_B	SAMS sensor head B axes
X_C, Y_C, Z_C	SAMS sensor head C axes
X_0, Y_0, Z_0	Orbiter structural coordinate system axes
X_b, Y_b, Z_b	Orbiter body coordinate system axes

1. Introduction and Purpose

Fluid physics, materials sciences, combustion, fundamental sciences, and life sciences experiments are conducted on the NASA Space Shuttle Orbiters to take advantage of the reduced gravity environment resulting from the continuous free fall state of low earth orbit.

Accelerometer systems are flown on the Orbiters to record the microgravity environment which is composed of quasi-steady accelerations and vibrations of the Orbiter, equipment, and local structures.

The second International Microgravity Laboratory (IML-2) flew on the Orbiter Columbia on mission STS-65 in July 1994. The IML-2 payload on STS-65 was dedicated to microgravity experiments. Two accelerometer systems managed by the NASA Lewis Research Center (LeRC) flew to support these experiments. The Orbital Acceleration Research Experiment (OARE) and the Space Acceleration Measurement System (SAMS) are sponsored by the Microgravity Science and Applications Division (MSAD) of the NASA Office of Life and Microgravity Science and Applications. The Quasi-steady Acceleration Measurement (QSAM) experiment, sponsored by the German Aerospace Research Establishment (DLR), also collected acceleration data as part of IML-2. The Microgravity Measuring Device (MMD) sponsored by NASA Johnson Space Center (JSC) was used in the middeck to record vibration levels associated with crew exercise.

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. This report is provided by PIMS to furnish interested experiment investigators with a guide to evaluating the acceleration environment during STS-65 and as a means of identifying areas which require further study. To achieve this purpose, we present various pieces of information. Section 2 of this report provides an overview of the STS-65 mission, the payloads, and the experiments manifested on the payloads. Section 3 describes the accelerometer systems flown on STS-65 and the means by which they recorded data and provided data to the user. Section 4 discusses some specific analysis of the MSAD accelerometer data in relation to various activities which occurred during the mission. Appendix A describes how OARE and SAMS data can be accessed through the internet. Appendices B and C provide plots of SAMS data as an overview of the microgravity environment during the entire mission. Appendix D contains a user comment sheet. Users are encouraged to complete this form and return it to the authors.

2. Mission Overview

At 12:43:00 pm EDT on 8 July 1994 the Space Shuttle Columbia launched on the STS-65

mission from NASA Kennedy Space Center (KSC). Landing was at KSC on 23 July at 6:38 am EDT. In terms of other time conventions used in this report, launch was at Greenwich Mean Time (GMT) 189/16:43 or Mission Elapsed Time (MET) 000/00:00 and landing was at GMT 204/10:38 or MET 14/17:55. Both GMT and MET are recorded in day/hour:minute:second format. The primary objective of the STS-65 mission was to perform science experiments on the IML-2 payload. IML-2 is an international payload with scientists from the European Space Agency, Canada, France, Germany, and Japan collaborating with NASA to provide the worldwide science community with a variety of complementary facilities and experiments. Research on IML-2 was dedicated to microgravity and life sciences. IML-2 experiments and facilities are listed in Table 1, some facilities have multiple experiments and principal investigators. Other payloads on STS-65 are listed in Table 2. Fourteen development test objectives (DTO) and seventeen detailed supplementary objectives (DSO) were accomplished on STS-65; they are listed in Tables 3 and 4.

3. Accelerometer Systems

Four accelerometer systems measured the microgravity and vibration environment of the Orbiter Columbia during the STS-65 mission: the Orbital Acceleration Research Experiment, the Space Acceleration Measurement System, the Quasi-steady Acceleration Measurement experiment, and the Microgravity Measuring Device

3.1 Orbital Acceleration Research Experiment

The OARE was designed to measure quasi-steady accelerations from below 10 nano-g up to 25 milli-g. OARE consists of an electrostatically suspended proof mass sensor, an in-flight calibration subsystem, and a microprocessor which is used for in-flight experiment control, processing, and storage of flight data [1-4]. The sensor output acceleration signal is filtered with a Bessel filter with a cut-off frequency of 1 Hz. The output signal is digitized at 10 samples per second and is processed and digitally filtered onboard the OARE instrument with an adaptive trimmed-mean filter prior to storage in electrically erasable programmable read only memory (EEPROM). Simultaneously, the unprocessed data are recorded on the Orbiter payload tape recorder. OARE payload tape recorder data were downlinked from the Orbiter about every three hours and were then available in the POCC for analysis.

The OARE system is mounted to the floor of Columbia's cargo bay on a keel bridge. The location and orientation of the sensors with respect to the Orbiter structural coordinate system are given in Table 5 and Fig. 1. For STS-65, the sign convention is such that when there is a forward acceleration of the Orbiter (such as the OMS firing), then this is reported as a positive X_b .

(negative X_0) acceleration. Where the subscript 0 represents the Orbiter structural coordinate system and the subscript b represents the Orbiter body coordinate system. OARE data are available from MET 000/00:10 to 014/17:06. Appendix A describes how these data can be accessed via the internet.

3.2 Space Acceleration Measurement System

The Space Acceleration Measurement System was developed to measure the low-gravity environment of Orbiters in support of MSAD-sponsored science payloads. STS-65 was the tenth flight of a SAMS unit. A SAMS unit typically consists of three remote triaxial sensor heads, 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. On STS-65, a SAMS unit and three remote triaxial sensor heads were located in the Spacelab module in support of IML-2 experiments. The three sensor heads recorded data at 50, 25, and 500 samples per second after lowpass filters were applied to the data with cutoffs at 10, 5, and 100 Hz, respectively. The sign convention is such that when there is a forward acceleration of the Orbiter (such as the OMS firing), then this is reported as a positive X_b (negative X_0) acceleration. The locations and orientations of the SAMS heads, with respect to the Orbiter structural coordinate system, are given in Table 6 and Fig. 2. More detailed descriptions of the SAMS accelerometers are available in the literature [5-10].

On STS-65, 5.17 gigabytes of SAMS data are available between MET 000/09:21 and 013/08:59. SAMS data for STS-65 are available on CD-ROM from the PIMS project at LeRC. Appendix A describes how these data can be accessed via the internet.

3.3 Quasi-Steady Acceleration Measurement Experiment

The Quasi-Steady Acceleration Measurement (QSAM) experiment was developed by DLR to verify a technique to measure low frequency accelerations. The system is designed to detect accelerations below 0.01 Hz by means of signal modulation applied by rotating the sensor's sensitive axis. QSAM is also equipped with a set of triaxial accelerometers to measure vibrations up to 50 Hz [11]. Most of the high frequency data were transmitted to the ground for analysis in the POCC. QSAM was located in the Spacelab module as indicated in Fig. 2.

3.4 Microgravity Measuring Device

On STS-65, the Microgravity Measuring Device was used to collect acceleration data in conjunction with crew exercise activity. The data, representing frequencies up to 10 Hz, are being used by the JSC Medical Science Division to evaluate the effectiveness of exercise

vibration isolation systems and to evaluate the ease of use of the MMD System. MMD data were observed in real-time by the crew via the Payload General Support Computer. Information obtained from this display was used in decisions to adjust the exercise ergometer isolation system.

4. Columbia Microgravity Environment—STS-65

The acceleration environment measured by an accelerometer system on the Orbiter is contributed to by numerous sources. All ongoing operations of crew life support systems and activities and operations of the Orbiter, crew, carrier and experiments tend to have vibratory and/or oscillatory components that contribute to the background acceleration environment. In this report we are concerned with the identification of activities that cause acceleration levels above this background. The remainder of this section discusses the environment related to crew exercise, experiment component mixing activities, NIZEMI centrifuge operations, refrigerator/freezer operations and circulation pump activity. The Appendices provide an overview of the microgravity and vibration environment during the STS-65 mission. Appendix B shows time history plots of SAMS Head A (10 Hz filter) data. Appendix C provides a frequency domain representation of the SAMS Head A data.

4.1 Crew Activity—Reference Plots

The seven member crew of STS-65 worked on a dual shift schedule. Because of this schedule, the variation in the microgravity environment between the crew sleep and awake periods that is seen in data from single shift missions is not seen in STS-65 OARE or SAMS data [10]. Fig. 3 shows OARE data for the extent of the STS-65 mission. Note that the quasi-steady environment represented by these data is relatively constant throughout the mission.

Fig. 4 shows an example of the vibration environment of the Spacelab as recorded by SAMS during a period when the entire crew was in the flight deck. The data plots in column a) of Fig. 4 are time histories of the three axes of SAMS Head A data starting at MET 009/04:30:00. The data plots in column b) of Fig. 4 show power spectral density (PSD) representations of the column a) data. For each axis the PSD is calculated according to Parseval's theorem to give an indication of the frequency distribution of power in the acceleration signal. These plots represent the microgravity and vibration environment in the Spacelab during STS-65, related to the various equipment and life support systems that were operational at the time. Fig. 5 shows SAMS Head C data in the same time period. Figs. 4 and 5 can be used as a basis of comparison for other activities discussed in this section. All SAMS data are displayed in terms of the Orbiter structural coordinate system.

4.2 Crew Exercise

Crew exercise on STS-65 was performed in the middeck and flight deck on an ergometer. The equipment was used in configurations isolated from the Orbiter structure using the Inertial Vibration Isolation System (IVIS) and the Passive Cycle Isolation System (PCIS). One period of exercise using the IVIS hardmounted to the flight deck was performed late in the mission for comparison purposes. Table 7 is a list of crew exercise times during STS-65. The vibration environment related to exercise is consistent with that observed on previous missions [7-10]. Exercise is characterized by excitation of frequency components related to the pedalling or rowing frequency of the crew member. Fig. 6 shows the time history and PSD of SAMS Head A data taken when the Pilot was exercising on the ergometer with the IVIS hardmounted to the flight deck. Note the increase of microgravity environment compared to Fig. 4. Comparison of other crew members exercise periods indicate that exercise motion frequency and intensity levels varies among crew members. The disturbance caused by crew exercise may be seen in the Appendix C plots at the times listed in Table 7. MMD data collected in support of Medical Science Division are being analyzed by their personnel. No report is available at this time.

4.3 Experiment Component Mixing Activities

On MET 008, experiment operations required a crew member to mix experiment components. In live video of these activities, PIMS members observed the crew member both vigorously shaking a sample "up and down" and swinging the sample around, making full circles with his arm. Investigation of the SAMS data collected during this time indicates clear oscillations in the X_0 and Z_0 axes. The data suggest about seven to eight circles were made in about ten seconds in the XZ-plane. Fig. 7 shows SAMS Head B data collected during this activity. The swinging frequency suggested by the SAMS data shown in Fig. 7 correlates well with recorded downlink video of this event.

4.4 NIZEMI Operations

The Slow Rotating Centrifuge Microscope (NIZEMI) experiments in the Spacelab module exposed matter to levels of gravity ranging from 10^{-3} g to 1.5 g. The experiment support module contained an electric motor drive for the centrifuge used to produce the differing g-levels. The SAMS Head C data shown in Fig. 8 were collected when the NIZEMI centrifuge was operating. Note the strong frequency component at 80.3 Hz and that the scales of the time history and PSD plots of Fig. 8 are different than the other Head C data plots. This frequency component is not present at times when the NIZEMI centrifuge was not operating. It is believed that the component is related to the drive motor of the centrifuge.

4.5 Refrigerator/Freezer Operations

As on previous Spacelab missions, refrigerator/freezer units were flown on STS-65 to support life sciences experiments. In the color spectrogram of Fig. 9, note the strong 22.5 Hz signal and upper harmonics of this frequency. This type of signal is typical of refrigerator/freezer compressor cycling seen on STS-47. It is believed that this signal is related to a refrigerator in the Spacelab or middeck. This is under investigation.

4.6 Circulation Pump Operations

Three pumps are used on orbit to circulate hydraulic fluid to maintain the temperature of the hydraulic subsystem [10,12]. During STS-65, the BDPU principal investigators were concerned about the potential impact of circulation pump operations on their experiments. STS-65 OARE data were analyzed by PIMS team members, in near real-time, but no effect was seen. This was as expected because of the low frequency content of the OARE data and assumed high frequency nature of pump operations. During STS-65, the PIMS team at the LeRC User Operations Facility provided STS-62 SAMS data collected during circulation pump operation activation to the POCC Orbit Analysis Engineer. Using this information and near real-time data obtained from QSAM, the Mission Scientist team decided that circulation pump operation would not have a deleterious effect on IML-2 experiments.

Fig. 10 shows SAMS Head C data collected during a circulation pump activation. Analysis of STS-65 data indicates that a 6 Hz frequency previously identified as related to circulation pump operations[10] is not characteristic of this activity. The circulation pumps operate at 10,000 rpm which corresponds to a frequency of 167 Hz. This distinct frequency is not seen in associated SAMS data, while other frequencies in the 9300-11700 rpm range are. The PIMS group is investigating the possibility of a variable speed operation of the pumps.

5. Summary

This report serves as a road map to the SAMS and OARE data acquired during the STS-65 mission. Further analysis of specific events and comparisons with other missions will be performed and published in future documents.

The primary payload on the STS-65 mission was the second flight of the International Microgravity Laboratory in the Spacelab module. One SAMS unit was manifested in the Spacelab module with three triaxial sensor heads mounted on experiments in Spacelab racks. The OARE instrument was mounted in the Orbiter cargo bay to support the IML-2 experiments.

A summary of the vector magnitude rms and average accelerations for the entire mission was produced for the SAMS 10 Hz triaxial sensor head (Head A). Spectrograms were also

produced to give a frequency domain summary for the entire mission. These plots are presented in the Appendices B and C. Significant events were chosen to give a more detailed look at the acceleration disturbances at the SAMS and OARE sensor head locations. These events were crew exercise, experiment component mixing activities, NIZEMI centrifuge operations, refrigerator/freezer operations, and circulation pump activity.

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Table 1 IML-2 Experiments and Facilities

Life Sciences Experiments and Facilities	Location
Aquatic Animal Experiment Unit (AAEU)	Rack 3
Biorack (BR)	Rack 5
Biostack (BSK)	Rack 9
Extended Duration Orbiter Medical Program (EDOMP)	Center Aisle
Spinal Changes in Microgravity (SCM)	Center Aisle
Lower Body Negative Pressure Device (LBNPD)	middeck
Microbial Air Sampler (MAS)	middeck
Performance Assessment Workstation (PAWS)	middeck
Slow Rotating Centrifuge Microscope (NIZEMI)	Rack 7
Real Time Radiation Monitoring Device (RRMD)	Rack 3
Thermoelectric Incubator (TEI)	Rack 3

Microgravity Experiments and Facilities	Location
Applied Research on Separation Methods (RAMSES)	Rack 6
Bubble, Drop and Particle Unit (BDPU)	Rack 8
Critical Point Facility (CPF)	Rack 9
Electromagnetic Containerless Processing Facility (TEMPUS)	Rack 10
Free Flow Electrophoresis Unit (FFEU)	Rack 3
Large Isothermal Furnace (LIF)	Rack 7
Quasi Steady Acceleration Measurement (QSAM)	Rack 3
Space Acceleration Measurement System (SAMS)	Center Aisle, Racks 8,9,10
Vibration Isolation Box Experiment System (VIBES)	Rack 3

Table 2 Other STS-65 Payloads

Payloads	Acronym
Advanced Protein Crystalization Facility	APCF
Commercial Protein Crystal Growth	CPCG
Air Force Maui Optical Site	AMOS
Orbital Acceleration Research Experiment	OARE
Military Application of Ship Tracks	MAST
Shuttle Amateur Radio Experiment-II	SAREX-II

Table 3 STS-65 Development Test Objectives

DTO's	Description
DTO 251	Entry Aerodynamic Control Surfaces Test
DTO 301D	Ascent Structural Capability Evaluation
DTO 307D	Entry Structural Capability Evaluation
DTO 312	External Tank Thermal Protection System Performance
DTO 319D	Orbiter/Payload Acceleration and Acoustics Environment Data
DTO 414	Auxiliary Power Unit Shutdown Test
DTO 623	Cabin Air Monitoring
DTO 655	Foot Restraint Evaluation
DTO 63	Acoustic Noise Dosimeter Data
DTO 665	Acoustic Noise Sound Level Data
DTO 667	Portable In-Flight Landing Operations Trainer
DTO 674	Thermo-Electric Liquid Cooling System Evaluation
DTO 805	Crosswind Landing Performance
DTO 913	Microgravity Measuring Device

Table 4 STS-65 Detailed Supplementary Objectives

DSO's	Description
DSO 314	Acceleration Data Collection
DSO 326	Window Impact Observations
DSO 484	Assessment of Circadian Shifting in Astronauts by Bright Light
DSO 485	Inter Mars TEPC
DSO 487	Immunological Assessment of Crewmembers
DSO 491	Characterization of Microbial Transfer Among Crewmembers During Space Flight
DSO 603B	Orthostatic Function During Entry, Landing and Egress
DSO 604	Visual-Vestibular Integration as a Function of Adaptation
DSO 605	Postural Equilibrium Control During Landing/Egress
DSO 608	Effects of Space Flight on Aerobic and Anaerobic Metabolism During Exercise
DSO 610	In-Flight Assessment of Renal Stone Risk
DSO 614	The Effect of Prolonged Space Flight on Head and Gaze Stability During Locomotion
DSO 621	In-Flight Use of Florinef to Improve Orthostatic Intolerance Postflight
DSO 626	Cardiovascular and Cerebrovascular Responses to Standing Before and After Space Flight
DSO 901	Documentary Television
DSO 902	Documentary Motion Picture Photography
DSO 903	Documentary Still Photography

Table 5. STS-65 OARE Head Location and Orientation

OARE Sensor		Sample Rate: 10 samples/second
Location: Orbiter Cargo Bay Keel Bridge		Frequency: 0 to 1 Hz
ORIENTATION		LOCATION
Orbiter Structural Axis	Sensor Axis	Structural Axis
X ₀	-X _{OARE}	X ₀ = 1153.3 in
Y ₀	Z _{OARE}	Y ₀ = -1.3 in
Z ₀	Y _{OARE}	Z ₀ = 317.8 in

Table 6. STS-65 SAMS Head Location and Orientation

Unit D Head A (TSH-A)		
Serial no.: 821-32		Sample Rate: 50 samples/second
Location: Spacelab - Rack 8		Frequency: 0 to 10 Hz
ORIENTATION		LOCATION
Orbiter Structural Axis	Sensor Axis	Structural Axis
X ₀	-Y _A	X ₀ = 1044.5 in
Y ₀	-X _A	Y ₀ = 42.5 in
Z ₀	-Z _A	Z ₀ = 366.2 in

Unit D Head B (TSH-B)		
Serial no.: 821-14		Sample Rate: 25 samples/second
Location: Spacelab - Rack 9		Frequency: 0 to 5 Hz
ORIENTATION		LOCATION
Orbiter Structural Axis	Sensor Axis	Structural Axis
X ₀	Y _B	X ₀ = 1086.6 in
Y ₀	X _B	Y ₀ = -42.2 in
Z ₀	-Z _B	Z ₀ = 418.7 in

Unit D Head C (TSH-C)		
Serial no.: 821-8		Sample Rate: 500 samples/second
Location: Spacelab - Rack 10		Frequency: 0 to 100 Hz
ORIENTATION		LOCATION
Orbiter Structural Axis	Sensor Axis	Structural Axis
X ₀	-Y _C	X ₀ = 1086.5 in
Y ₀	-X _C	Y ₀ = 42.4 in
Z ₀	-Z _C	Z ₀ = 373.2 in

Table 7. Crew exercise log [13]

Start MET	Stop MET	Crewmember	Location
000:20:24:47	000:20:56:27	MS3	Middeck
000:21:45:40	000:22:20:03	MS2	Middeck
001:04:50:31	001:05:15:08	PLT	Middeck
001:07:08:15	001:07:16:15	CDR	Middeck
002:05:15:29	002:05:42:15	CDR	Flight Deck
002:06:36:51	002:06:48:51	PLT	Flight Deck
007:07:43:50	007:08:15:50	MS3	Flight Deck
008:06:39:15	008:07:47:34	MS2	Flight Deck
013:01:30:50	013:01:44:51	PLT	Flight Deck, Hard Mounted

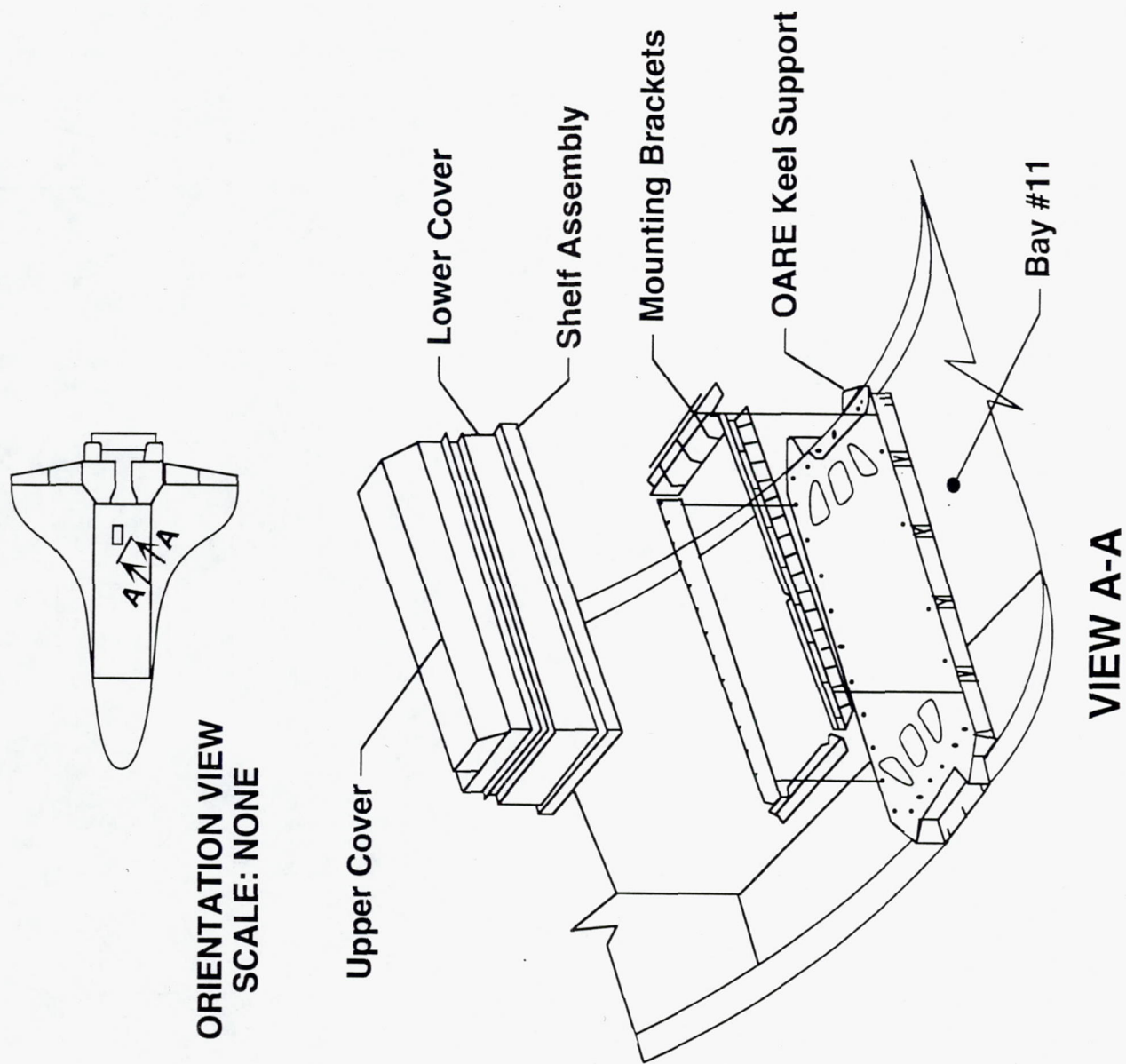


Figure 1 OARE instrument location on Columbia, STS-65

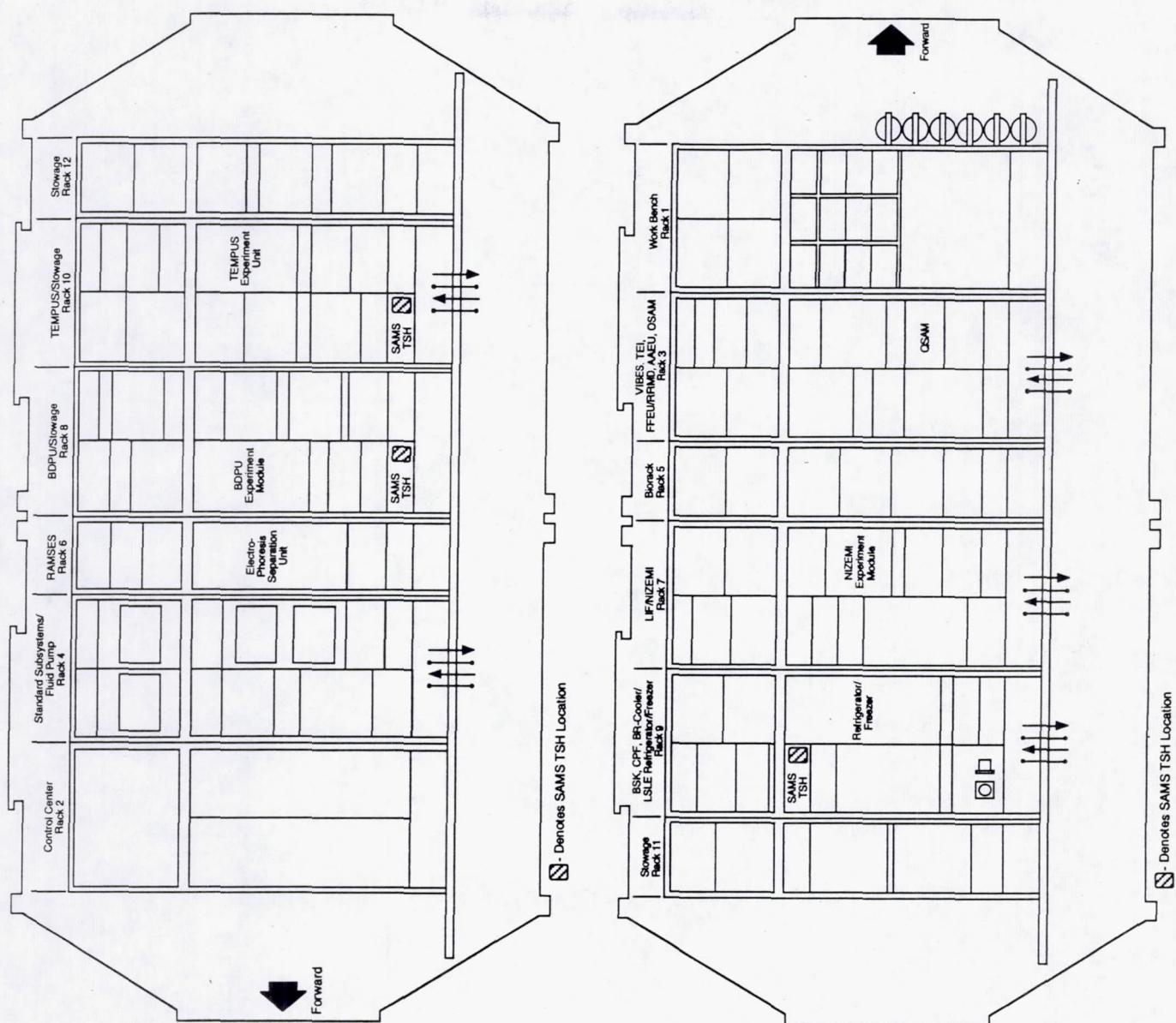


Figure 2 SAMS sensor locations on Columbia, STS-65

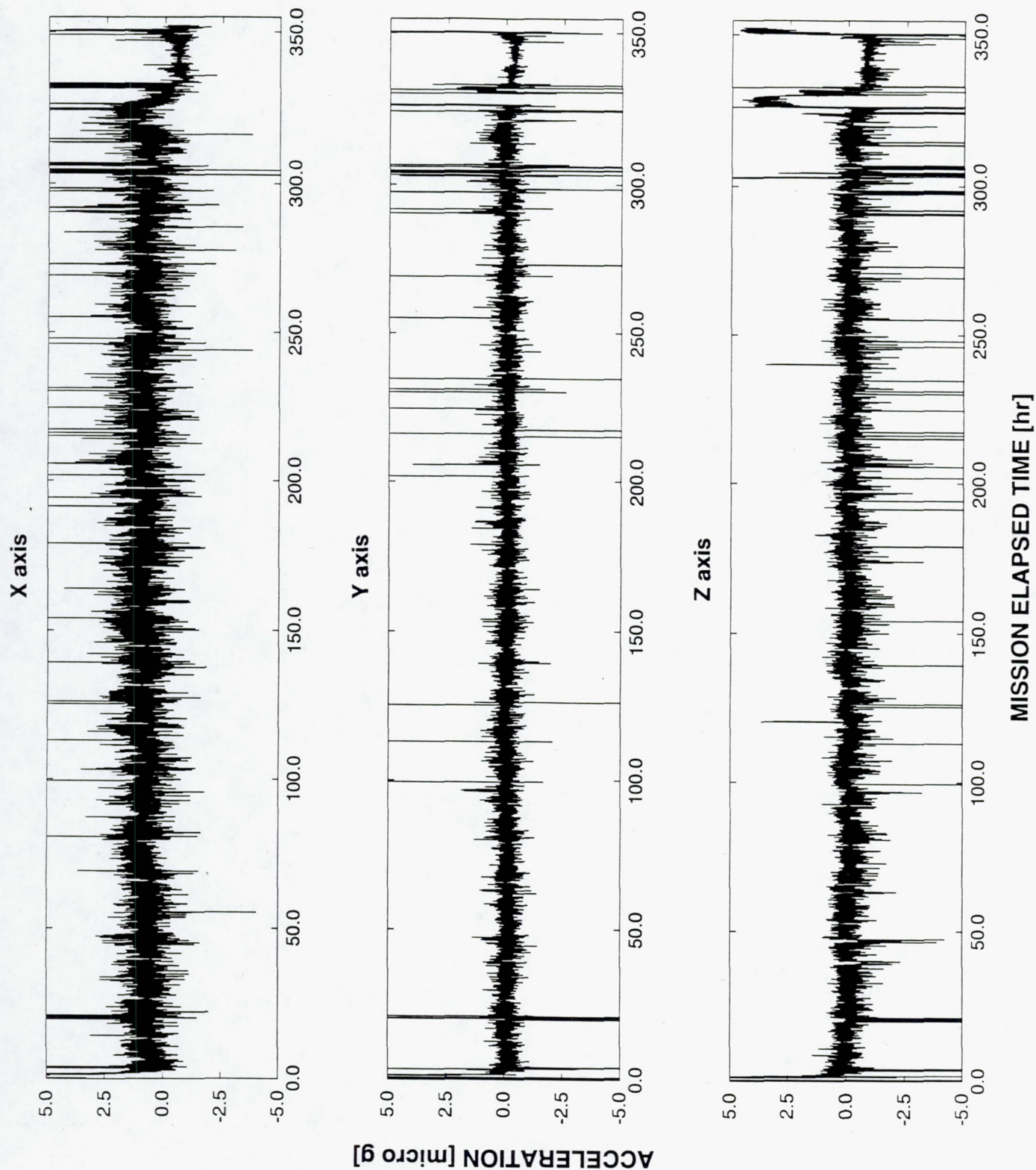


Figure 3 OARE data with trimmed-mean filter applied, STS-65, Orbiter body coordinate system.

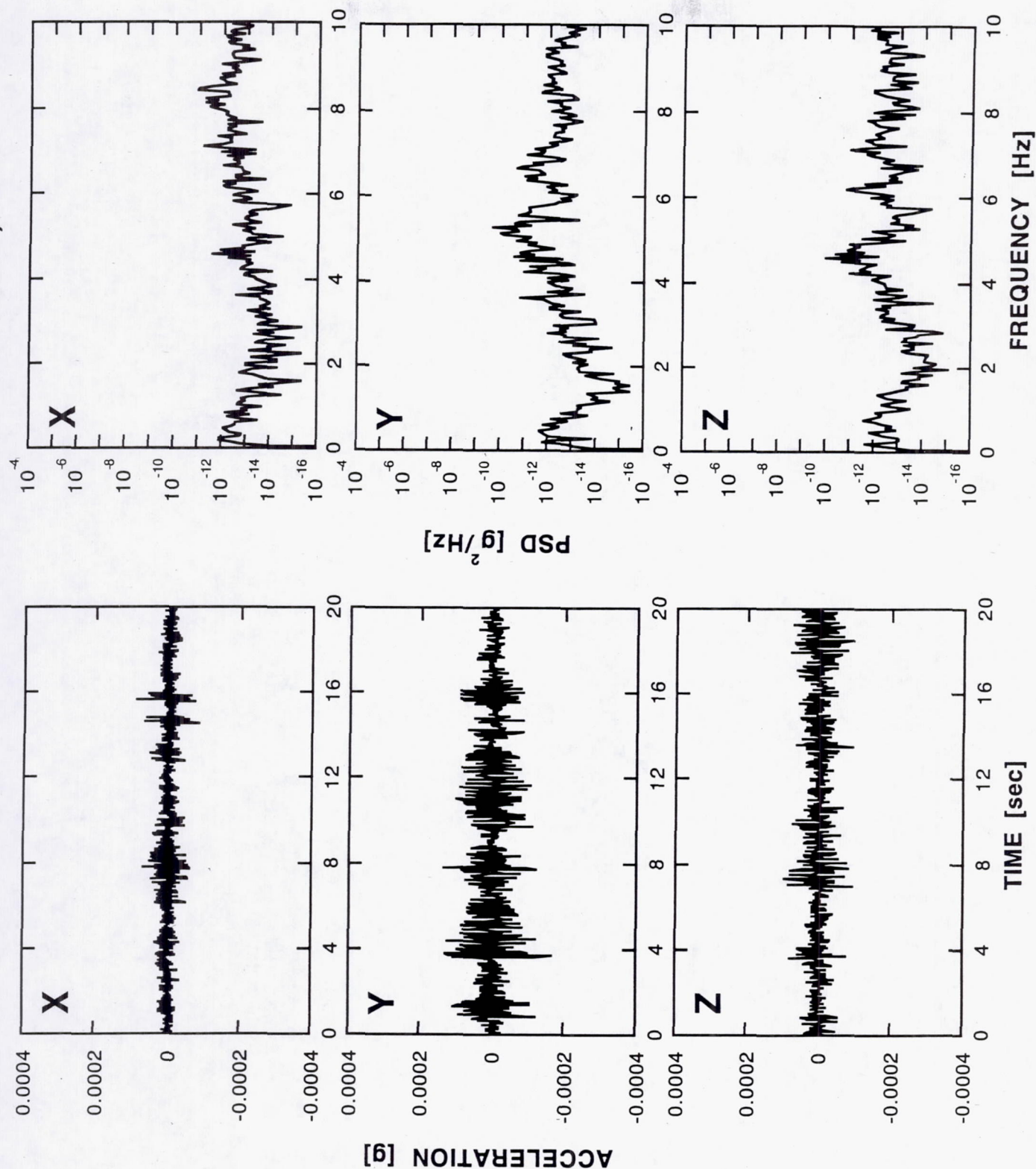


Figure 4 SAMS Head A data starting at MET 009/04:30:00, STS-65, Entire crew in Flight Deck. Column a) acceleration vs. time, column b) power spectral density vs. frequency.

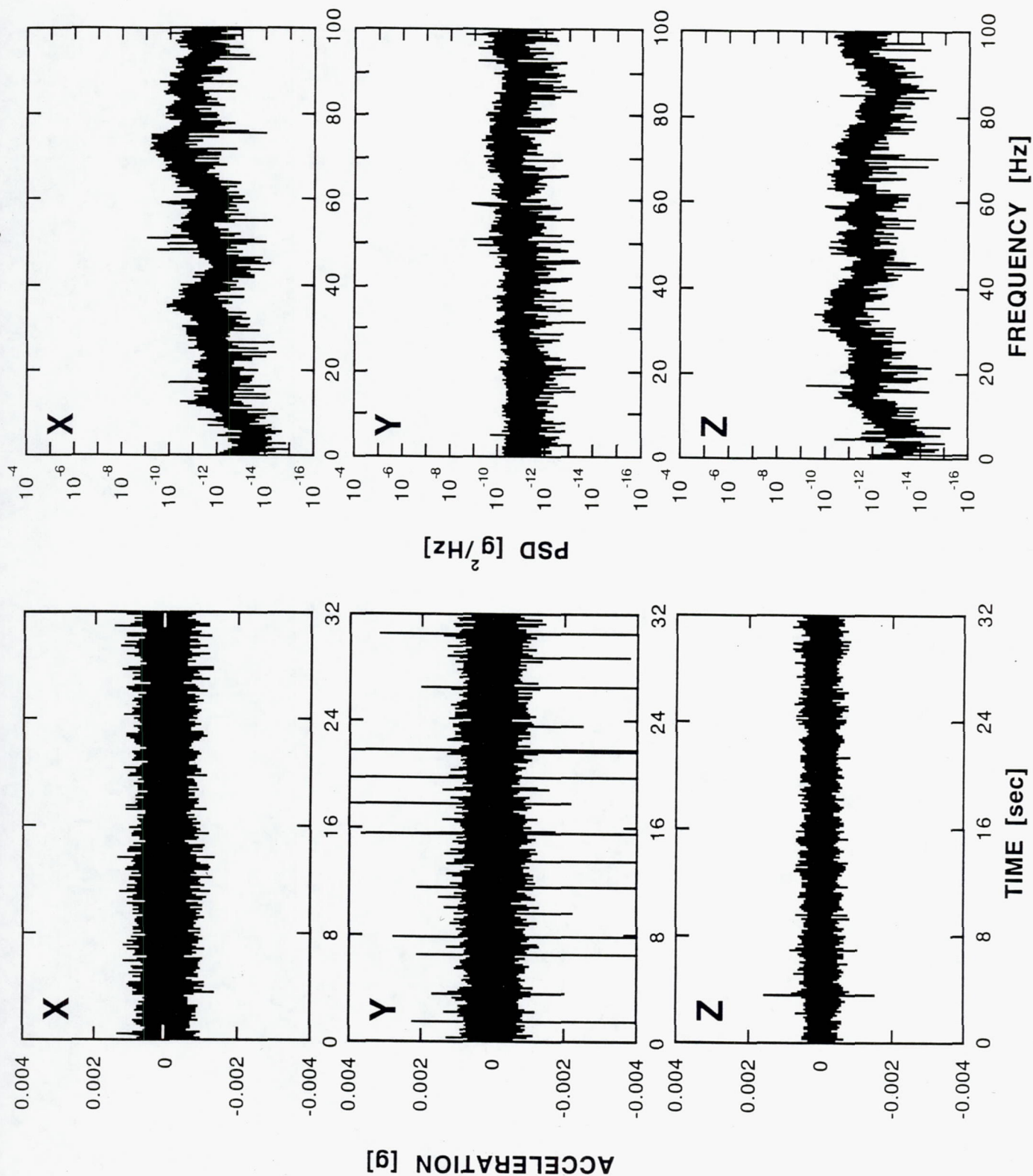


Figure 5 SAMS Head C data starting at MET 009/04:30:00, STS-65, Entire crew in Flight Deck. Column a) acceleration vs. time, column b) power spectral density vs. frequency.

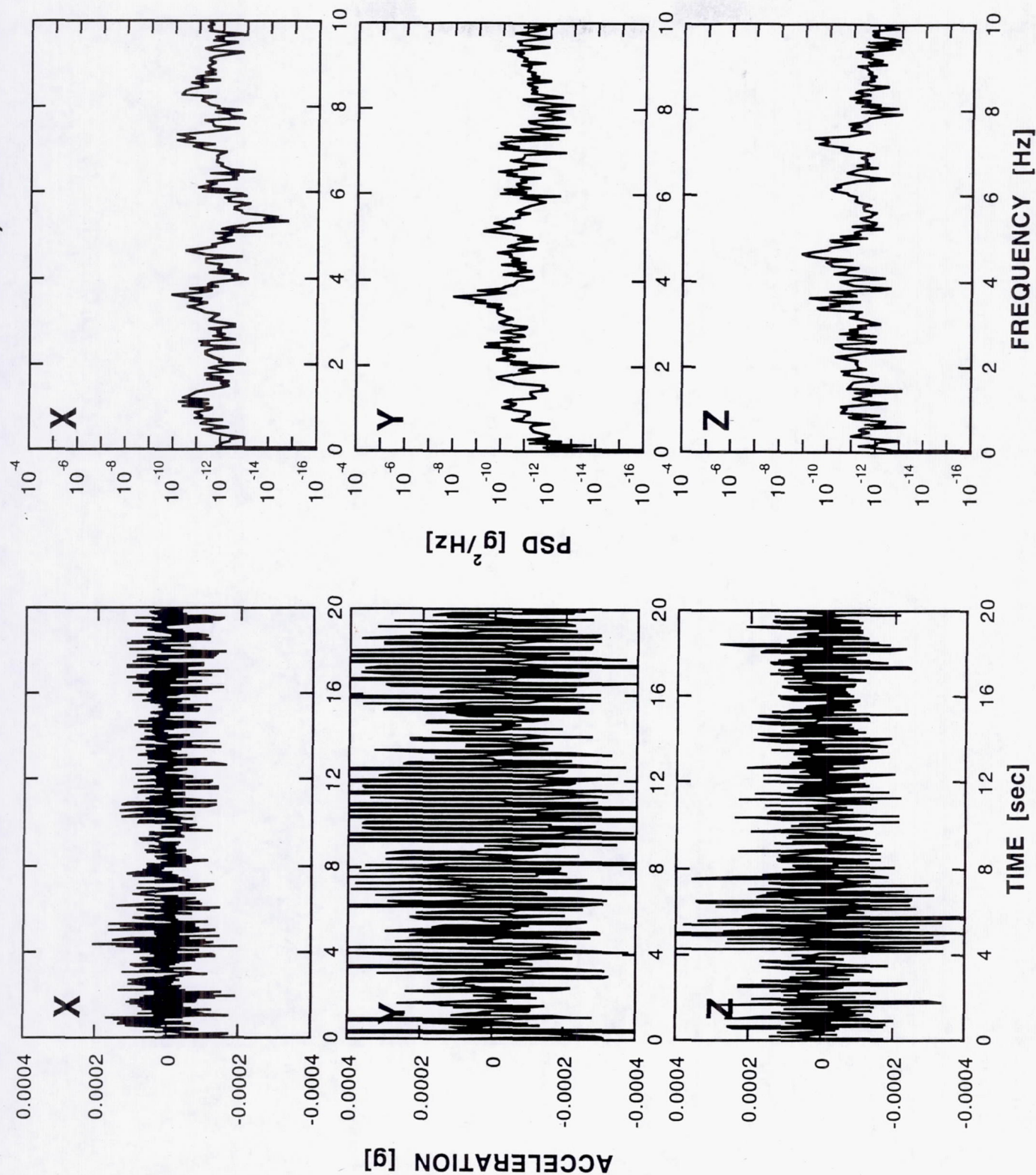


Figure 6 SAMS Head A data starting at MET 013/01:35:00, STS-65, Pilot exercising on hard-mounted ergometer in Flight Deck. Column a) acceleration vs. time, column b) power spectral density vs. frequency.

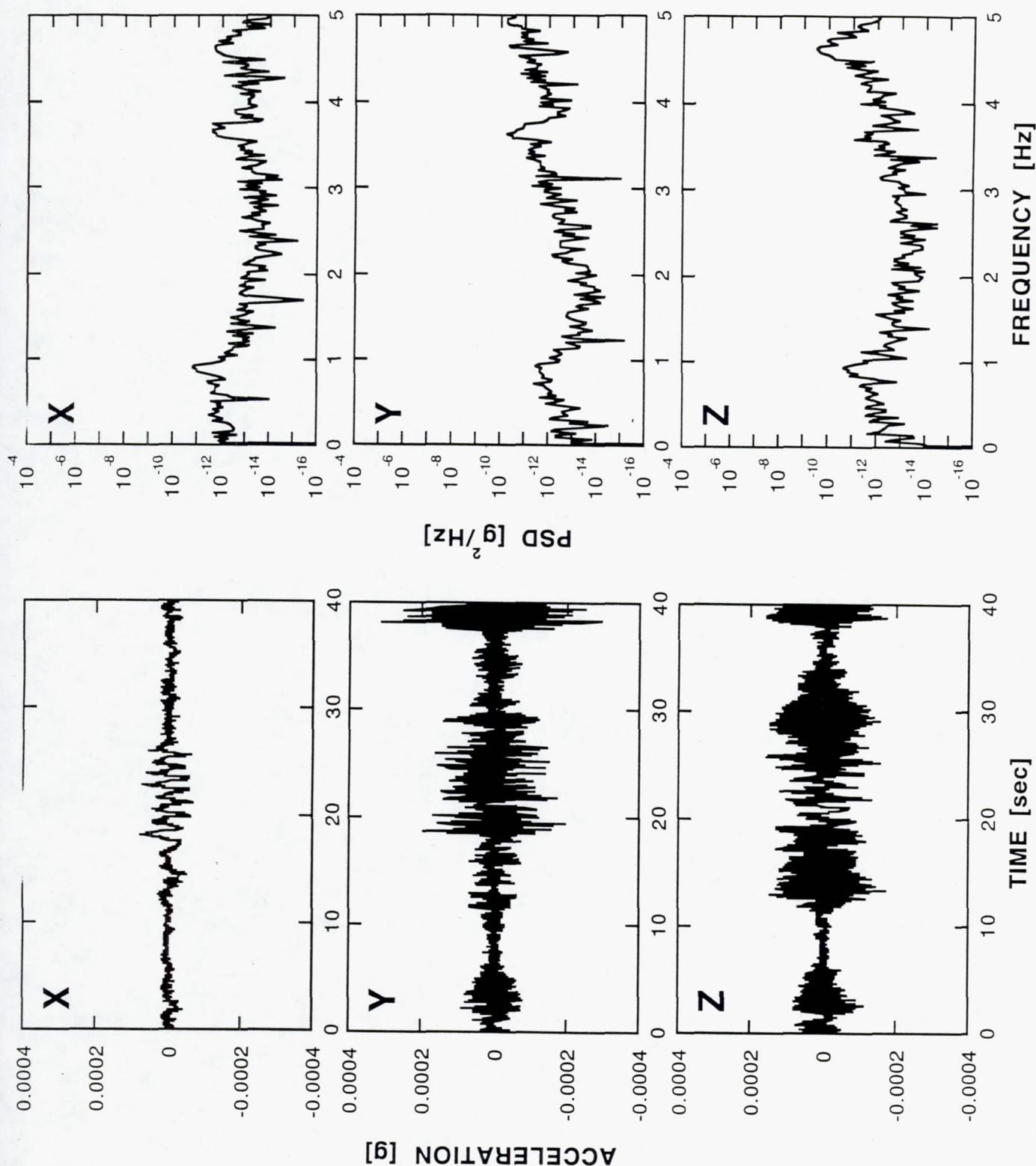


Figure 7 SAMS Head B data starting at MET 008/22:09:24, STS-65, crew member swinging experiment sample in circles. Column a) acceleration vs. time, column b) power spectral density vs. frequency.

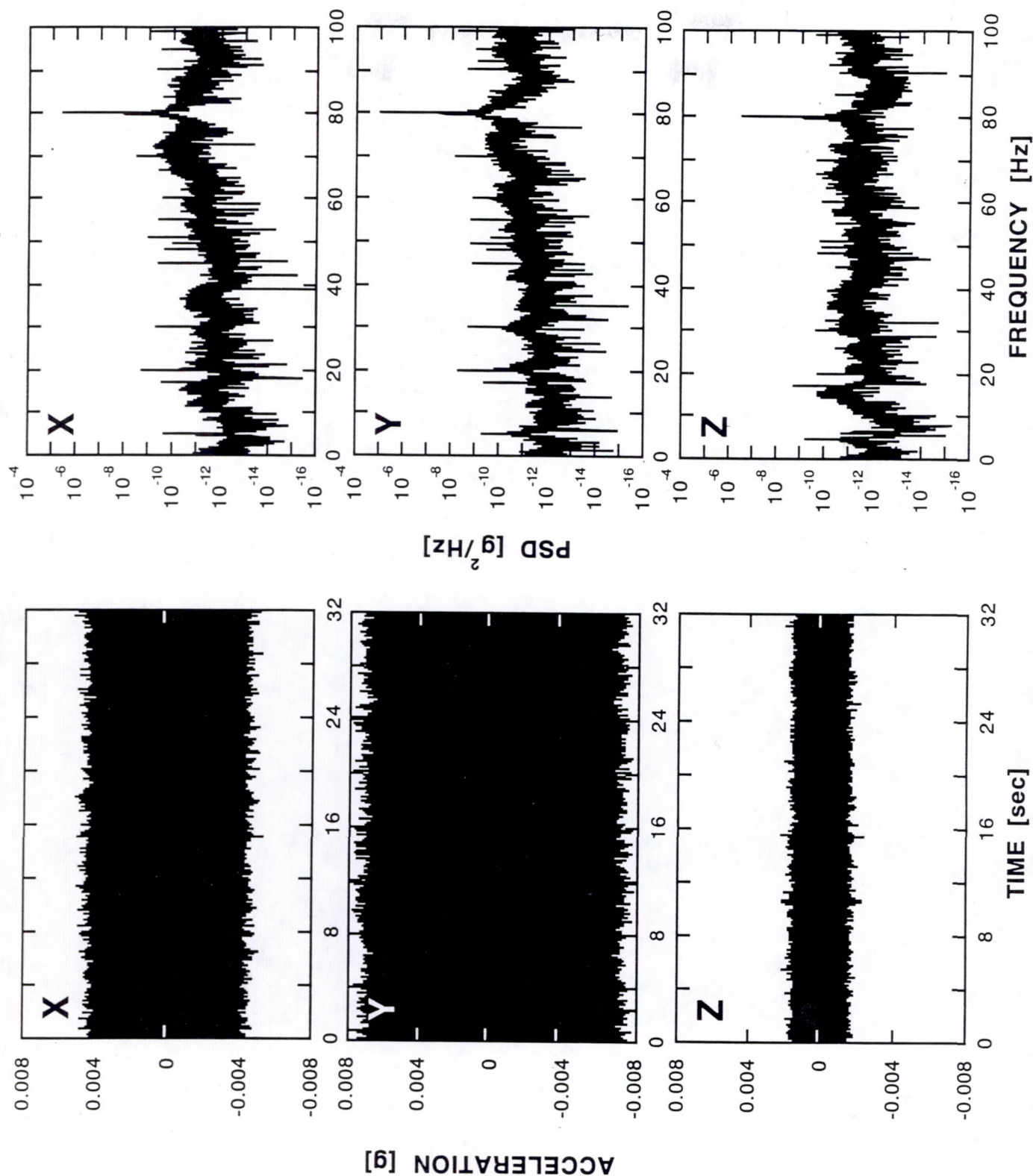


Figure 8 SAMS Head C data starting at MET 001/00:11:27, STS-65, NIZEMI centrifuge active. Column a) acceleration vs. time, column b) power spectral density vs. frequency.

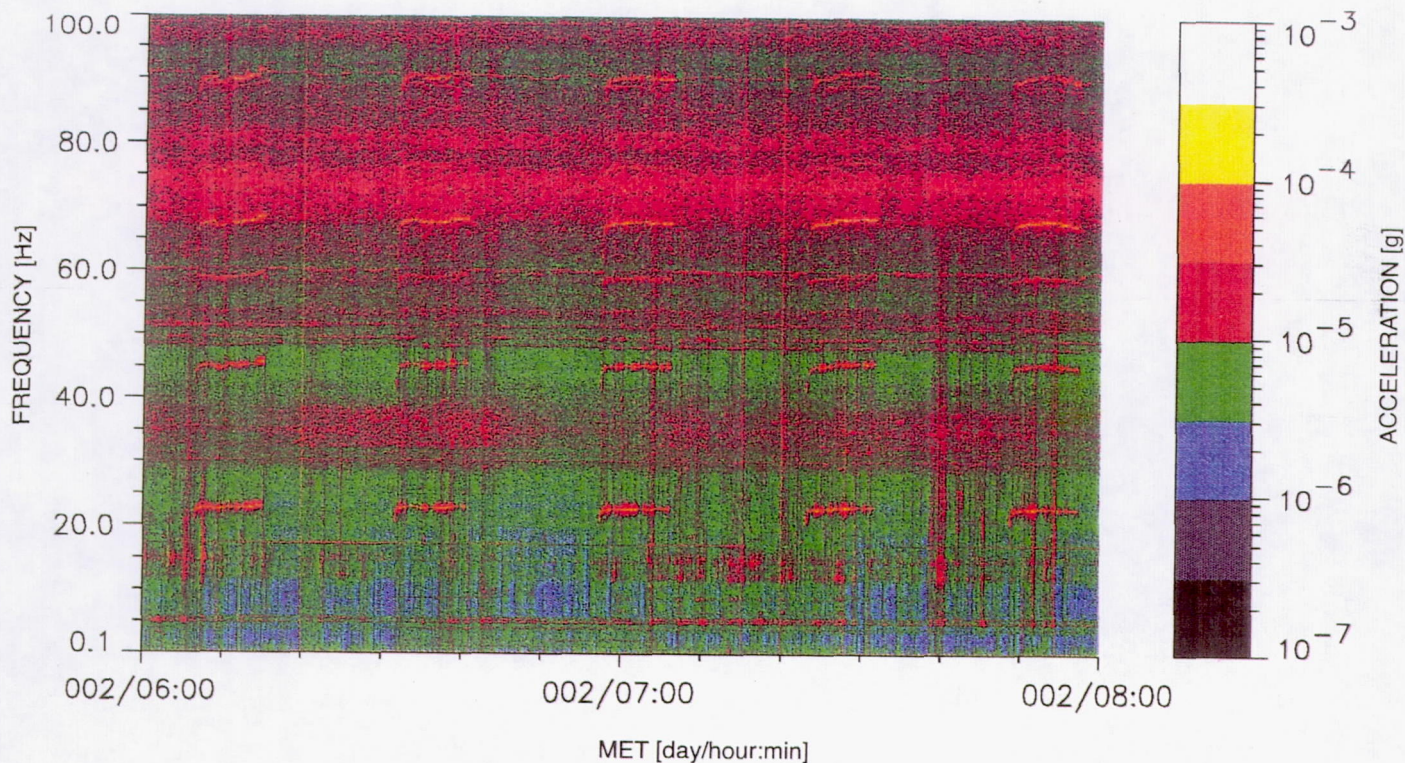


Figure 9 Two hour color spectrogram of SAMS Head C data starting at MET 002/06:00:00, STS-65. Horizontal axis is time, vertical axis is frequency, color variations represent magnitude of amplitude spectra. Note on/off cycle of 22.5 Hz and its upper harmonics, assumed to be a refrigerator compressor.

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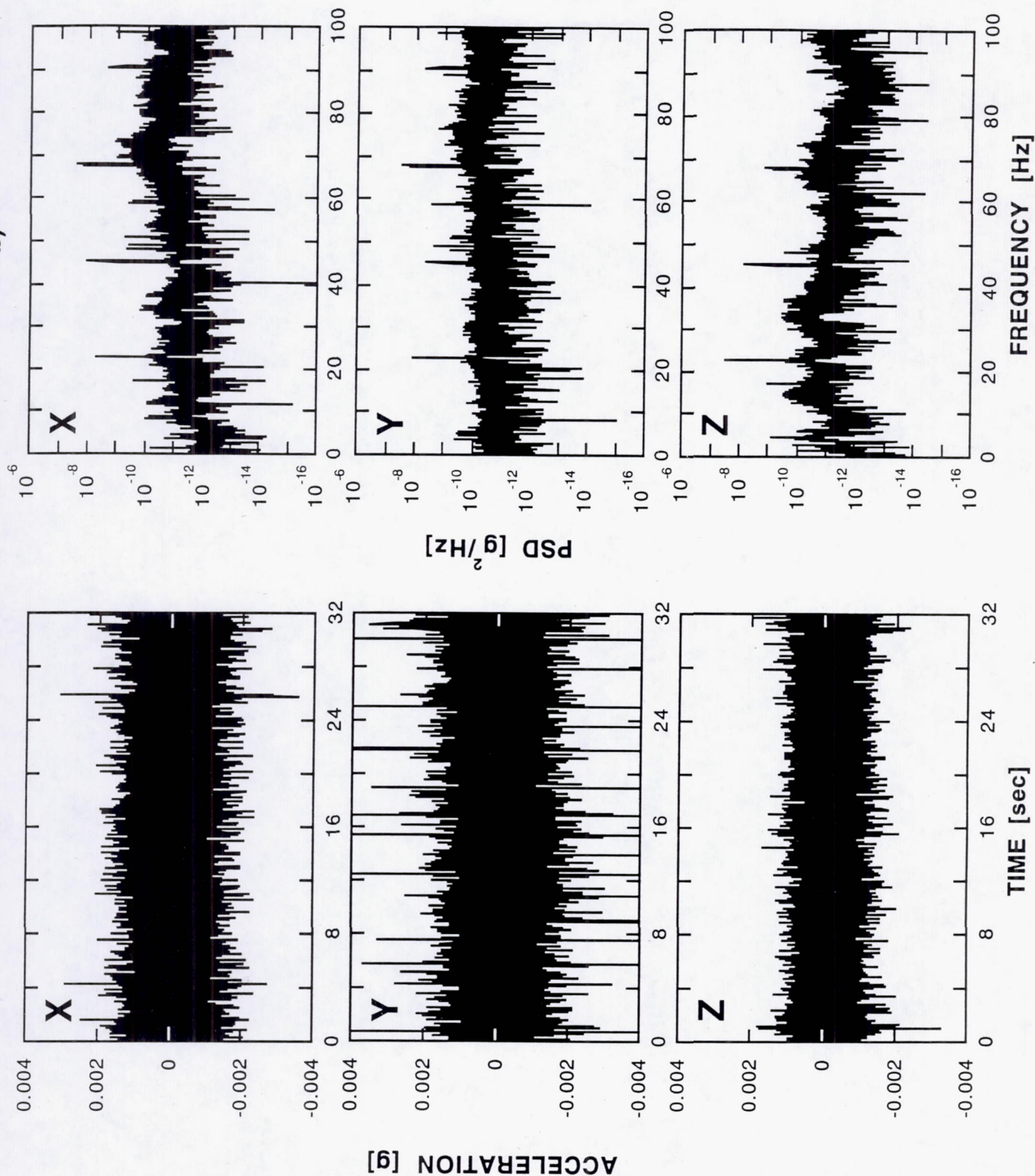


Figure 10 SAMS Head C data starting at MET 001/07:34:42, STS-65, circulation pump activation. Column a) acceleration vs. time, column b) power spectral density vs. frequency.

APPENDIX A 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.

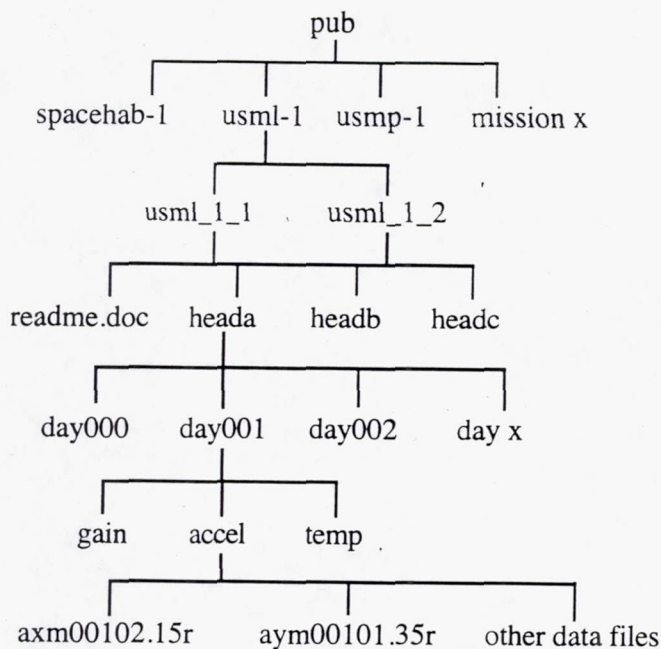


Figure A1 SAMS Data File Structure

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 B SAMS TIME HISTORIES

Accelerometer data collected on Orbiter missions are generally analyzed by the principal investigator or experiment team responsible for the system. The PI Microgravity Services (PIMS) project at the NASA Lewis Research Center was formed in part to support microgravity PI's in the evaluation of acceleration effects on their experiments and to characterize the vibrational environment of the microgravity carriers and vehicles. The primary continual source of accelerometer data from mission to mission is SAMS. Some of the SAMS data from STS-65 are presented in Appendices B and C to provide PI's with an overview of the environment during the mission.

The raw data recorded by SAMS is 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 transformed to the shuttle structural coordinate system and formatted into files for distribution via CD-ROM and file server. See Appendix A for information on file server access to SAMS data.

The compensated data are further processed to produce the plots shown here. Two time history representations of the data are provided: ten second average and ten second root mean square (rms) plots. These calculations are presented in two hour plots with the corresponding average and rms plots on one page. The ten second average plots should be used to identify times when the steady level of the acceleration signal deviates from the background level. The ten second rms plots should be used to identify times when oscillatory and/or transient deviations from the background acceleration levels occurred.

Average and Root Mean Square Calculations

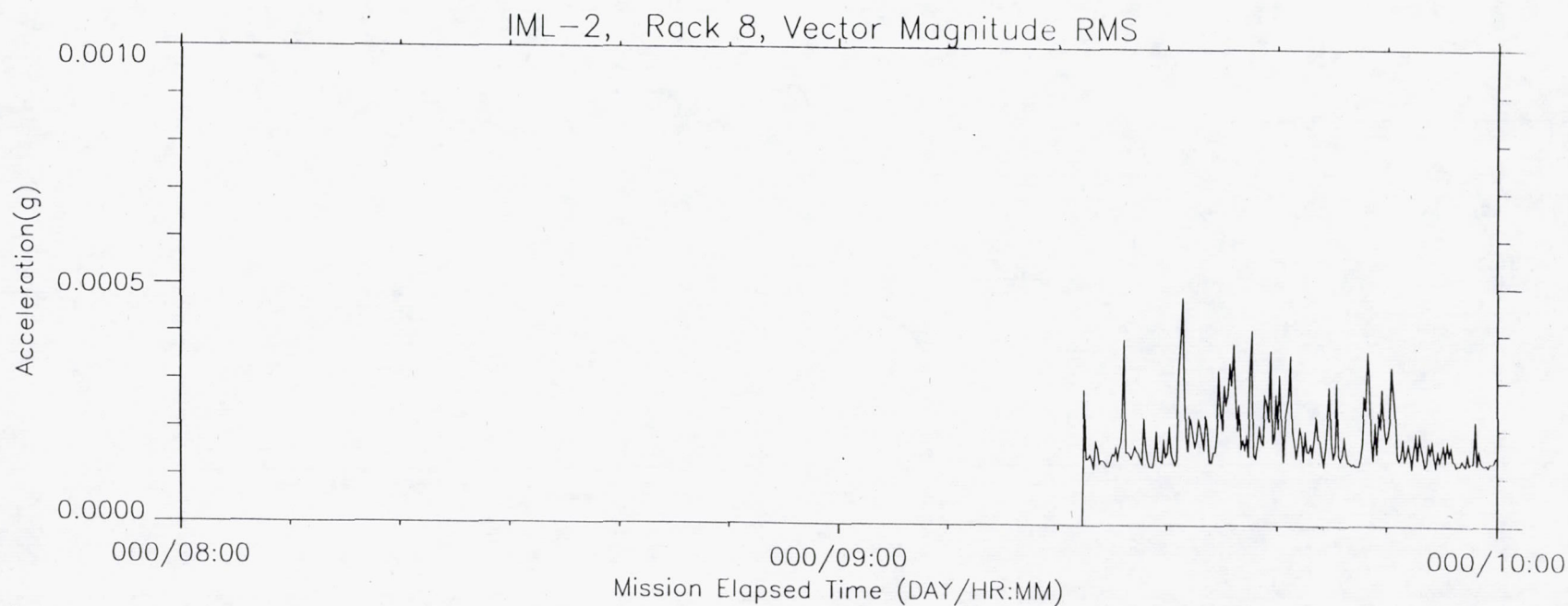
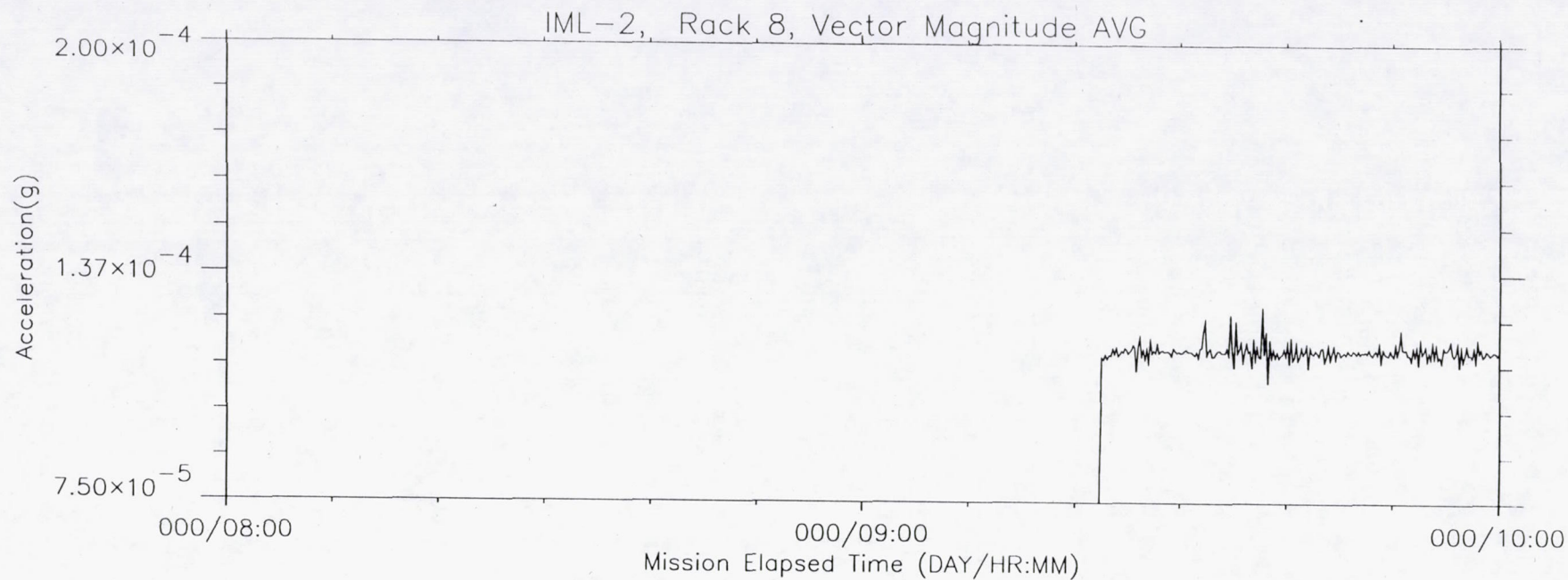
The average plots were produced using STS-65 SAMS, Head A data. Head A data were collected at 50 samples per second and a 10 Hz low pass filter was applied to the data by the SAMS unit prior to digitization. The plots were produced by calculating the average of ten second intervals of data for each axis and forming a vector magnitude with the resulting data streams.

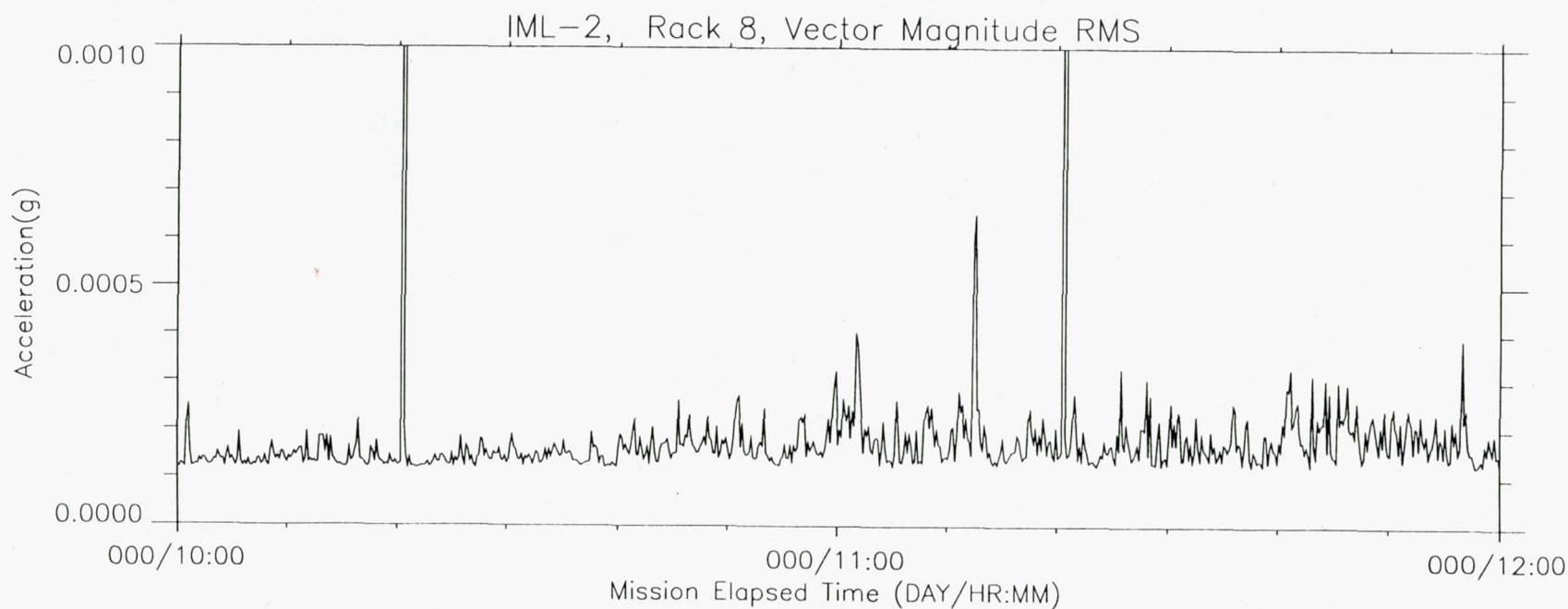
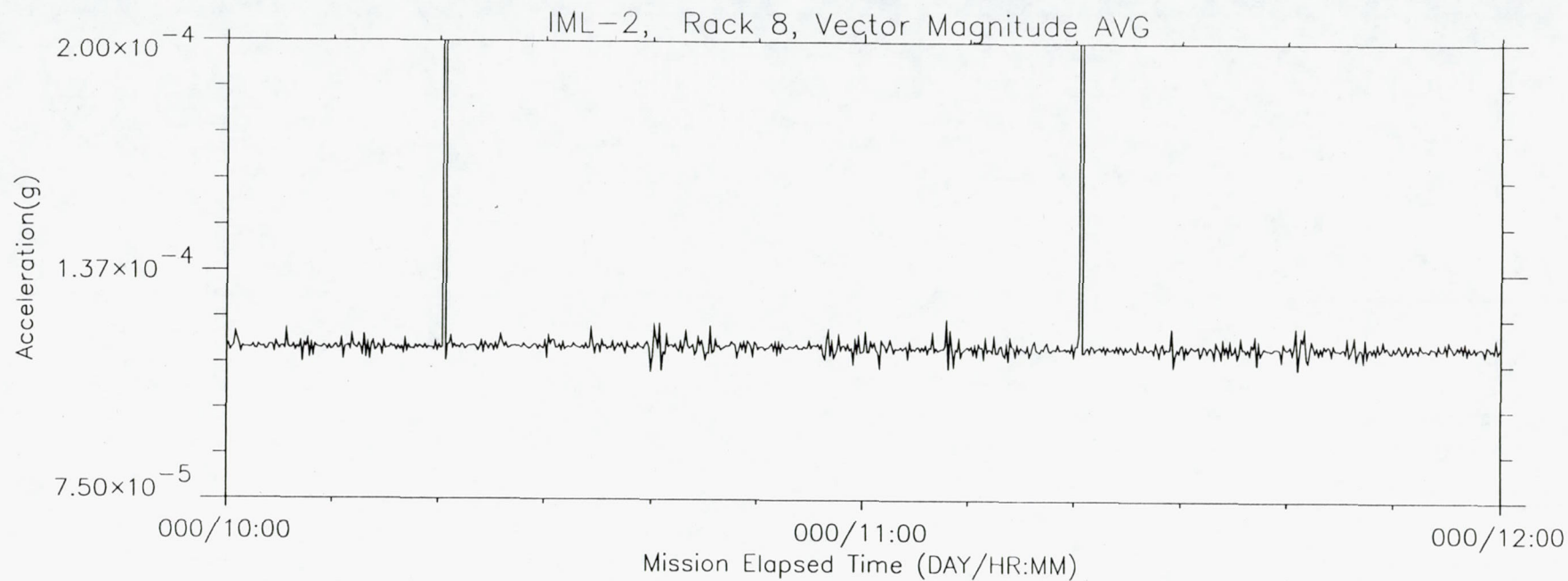
The rms plots were produced by taking the root-mean-square of ten second intervals of data for each axis and forming a vector magnitude with the resulting data stream.

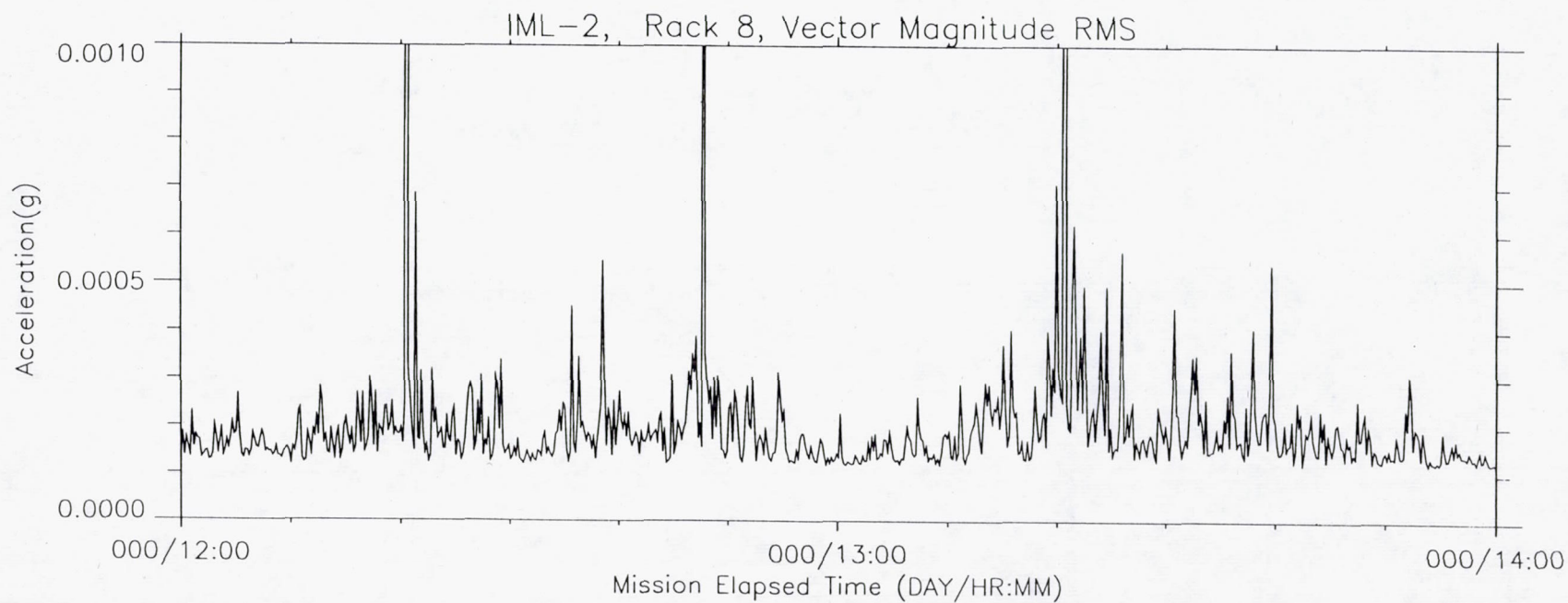
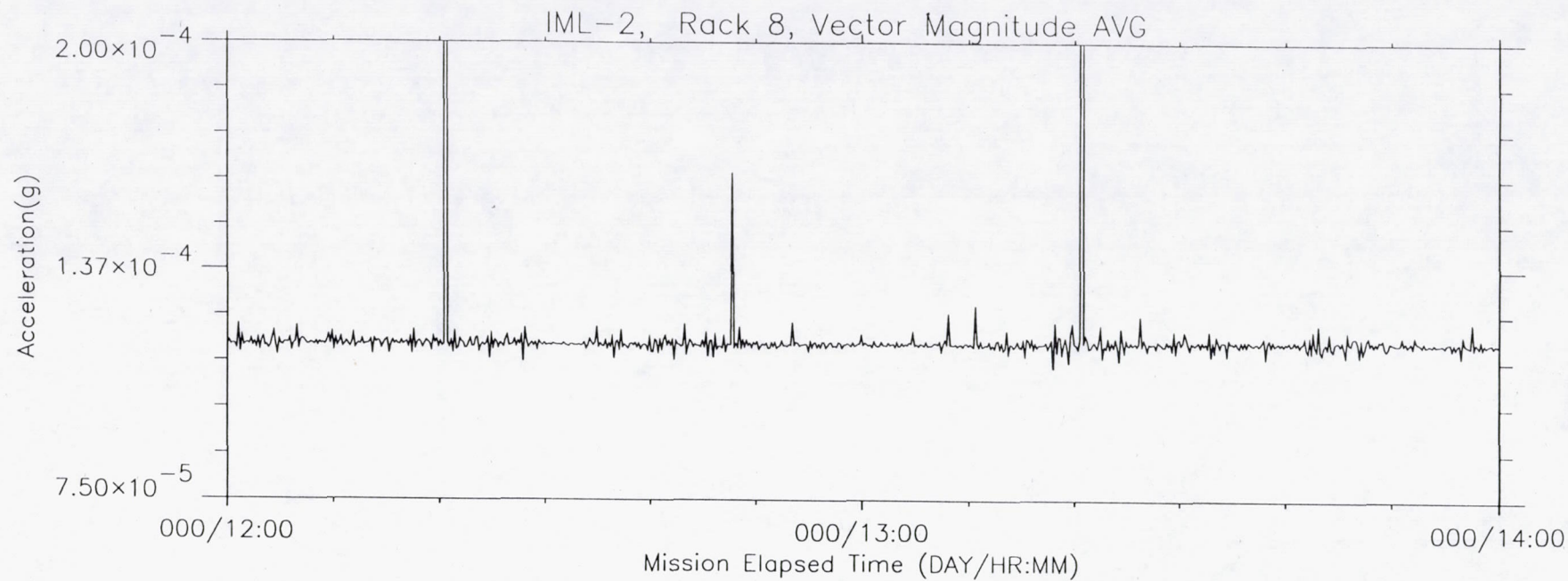
References

Thomas, J. E., R. B. Peters, and B. D. Finley, Space Acceleration Measurement System triaxial head error budget. NASA Technical Memorandum 105300, January 1992.

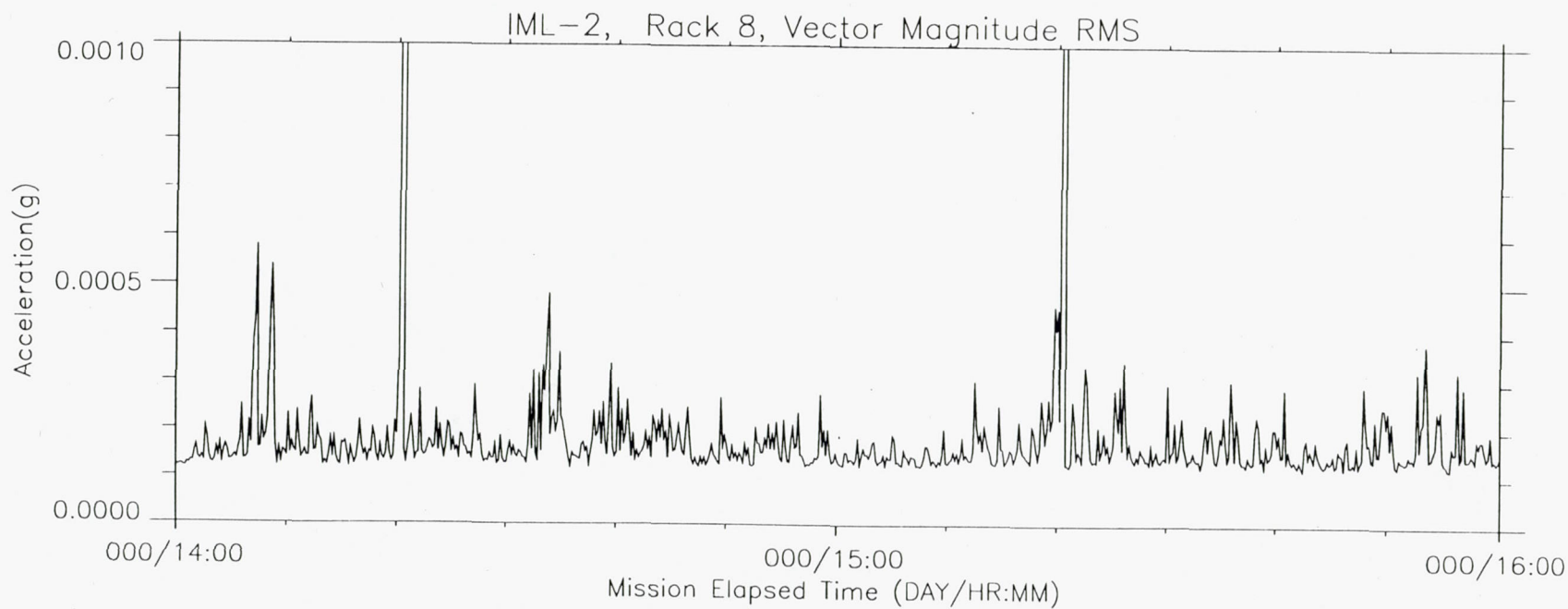
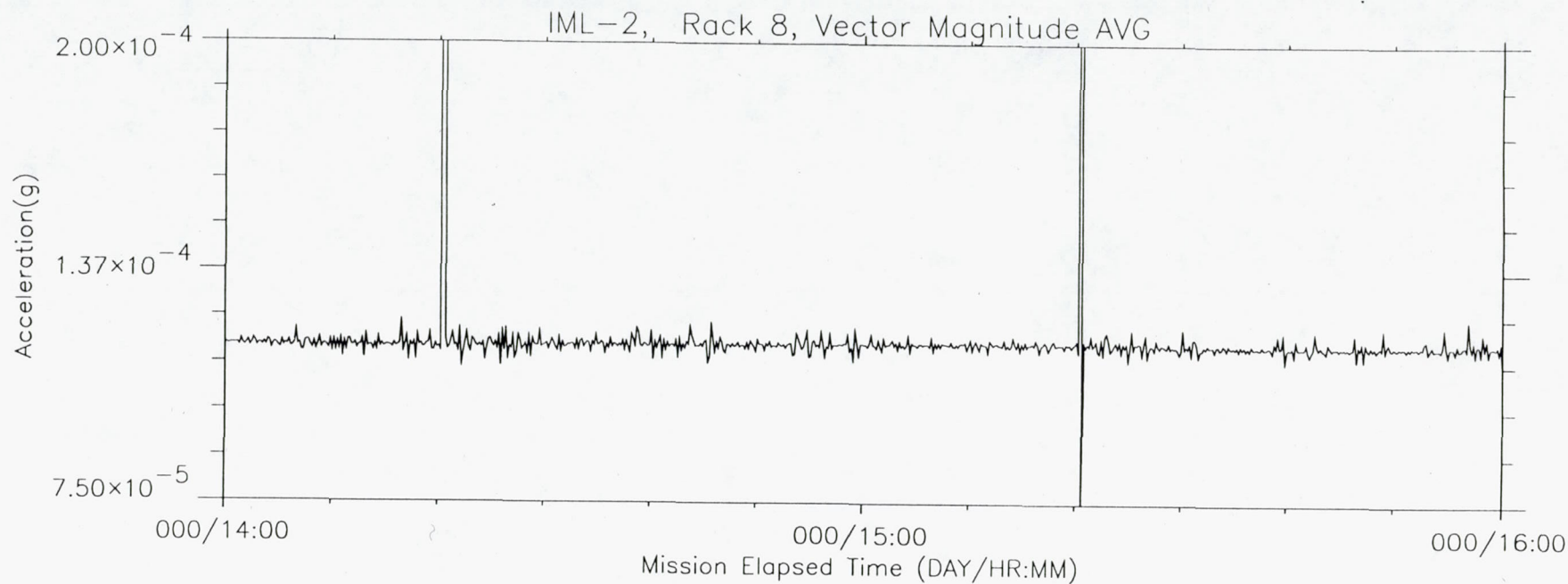
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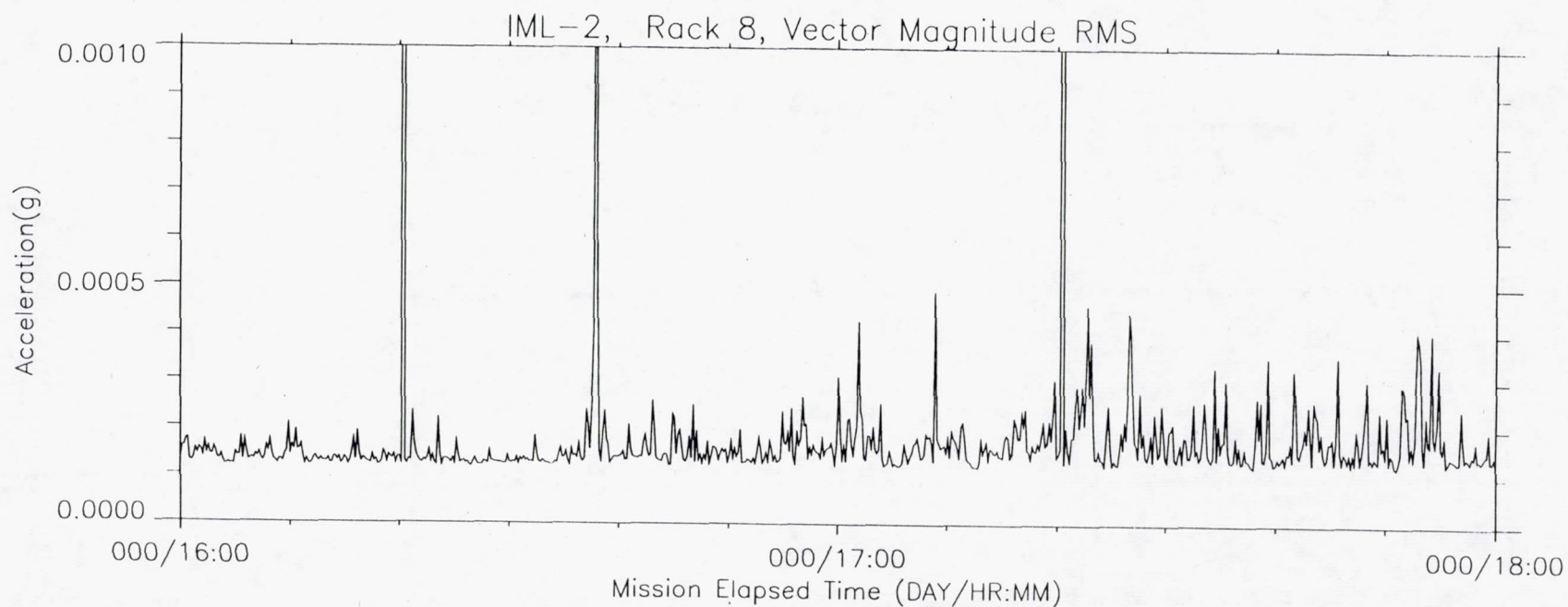
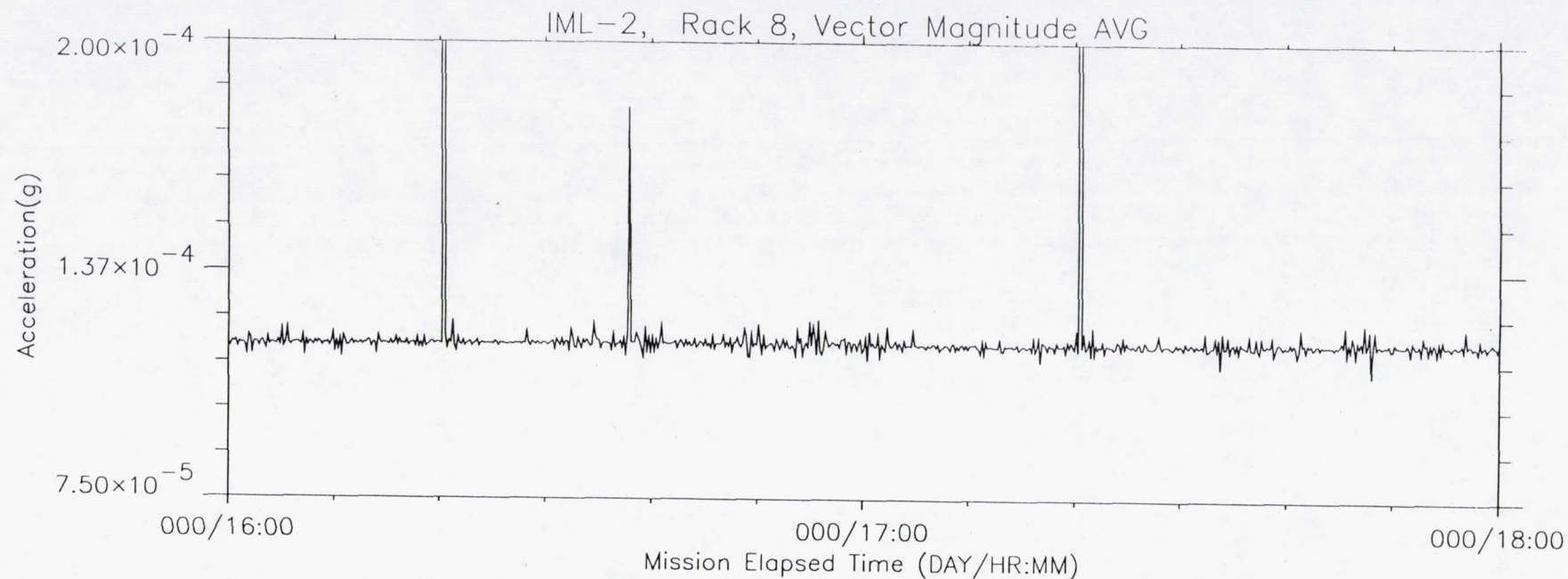


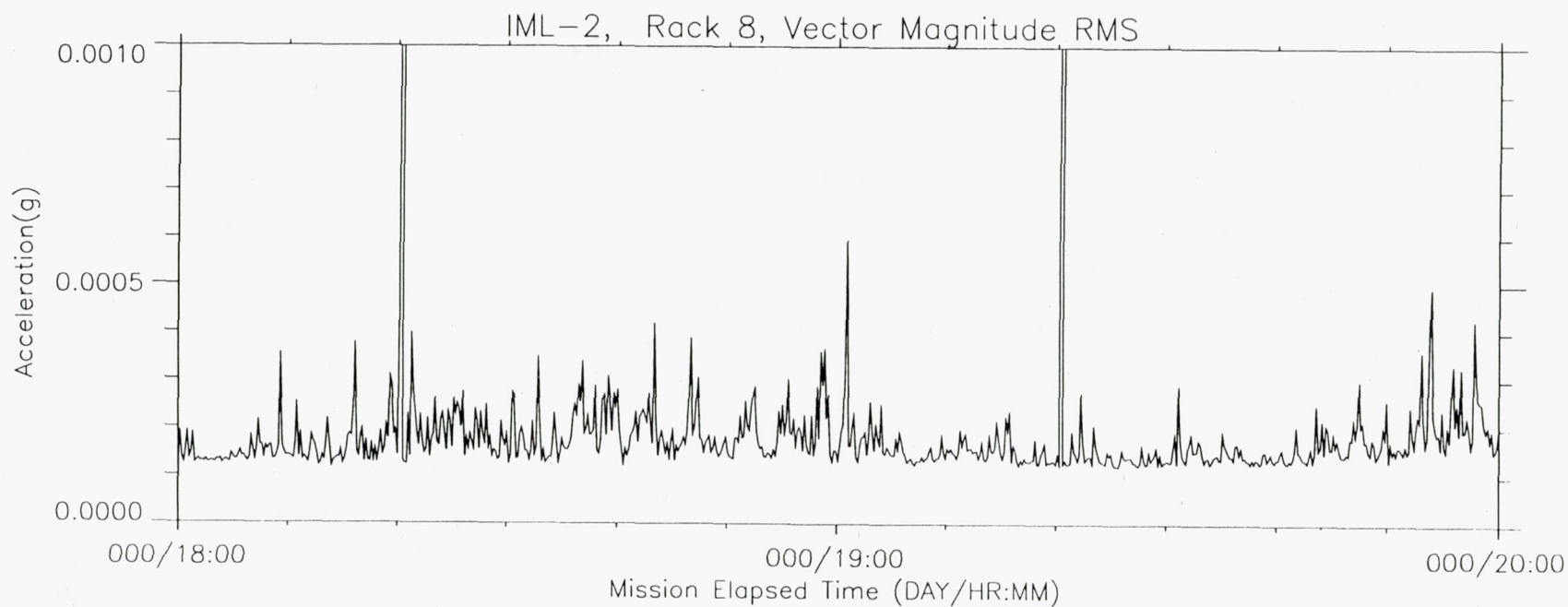
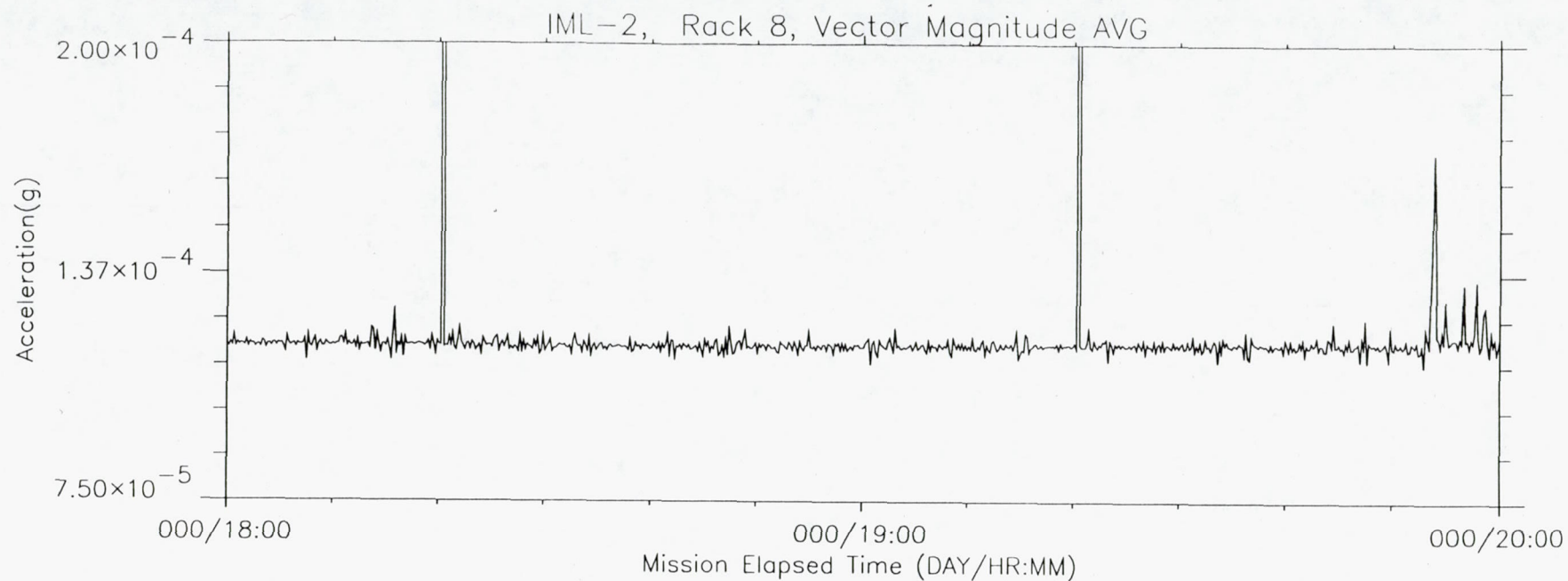


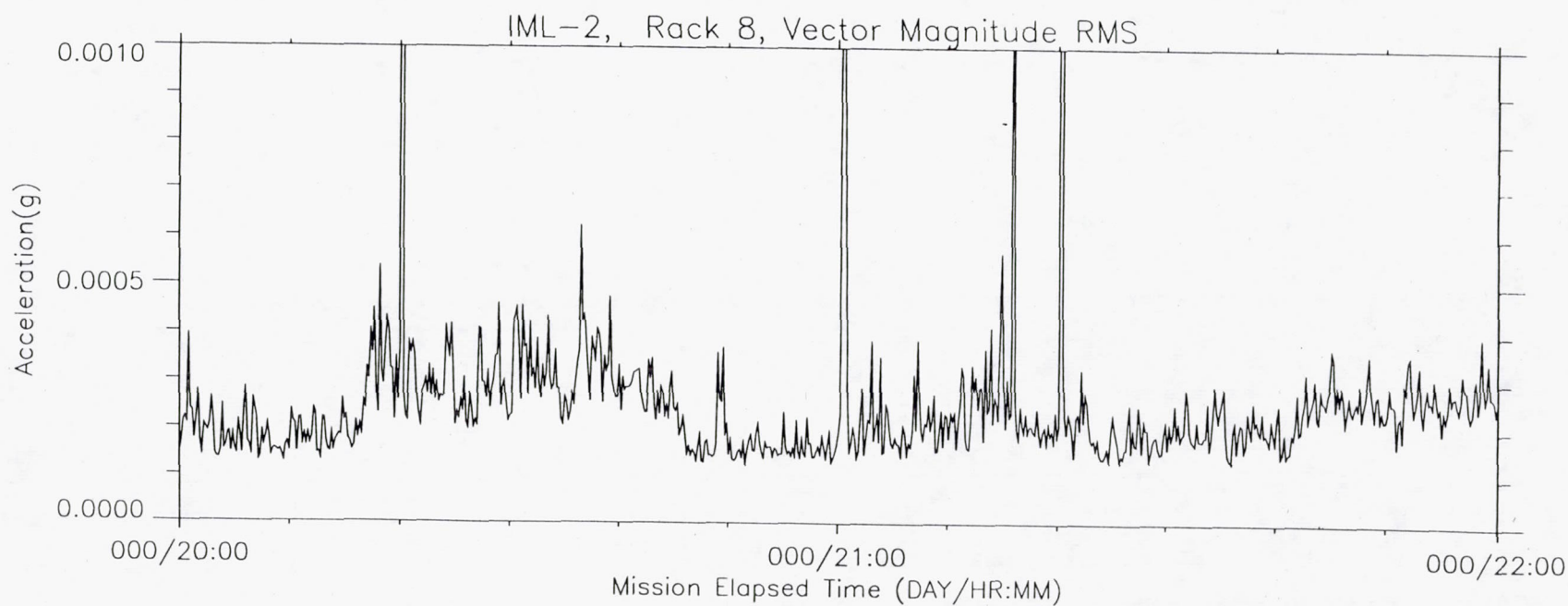
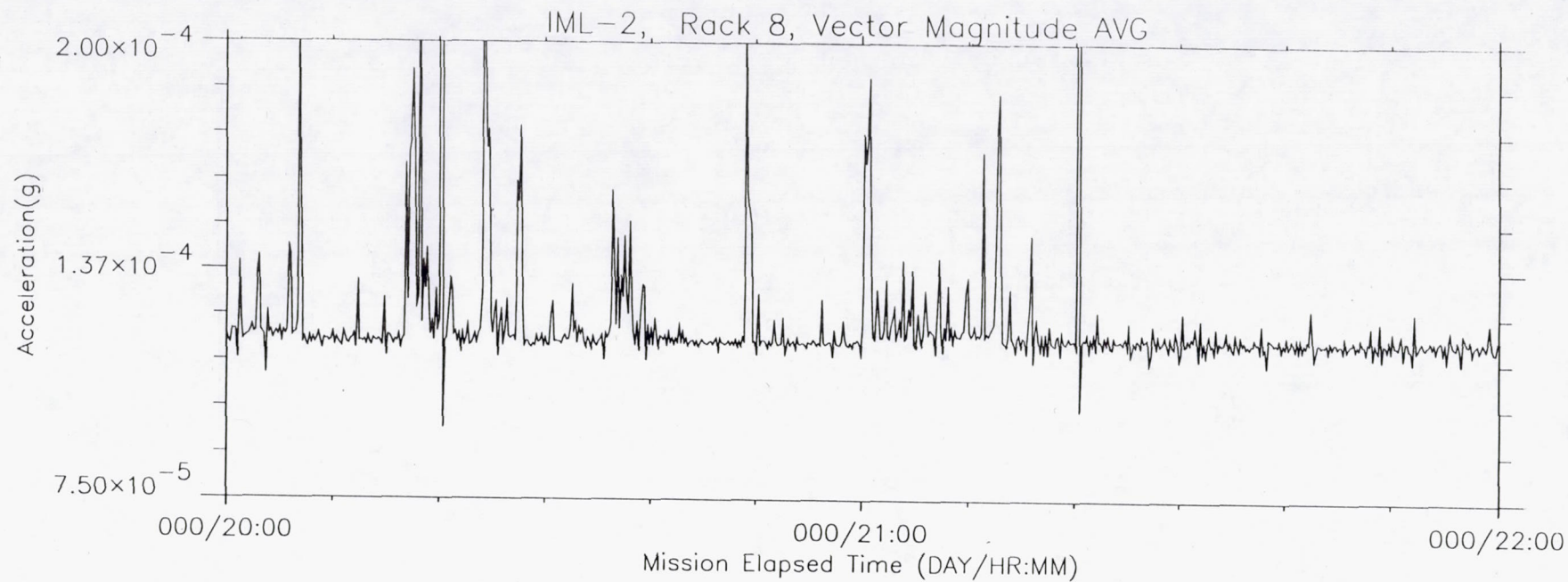


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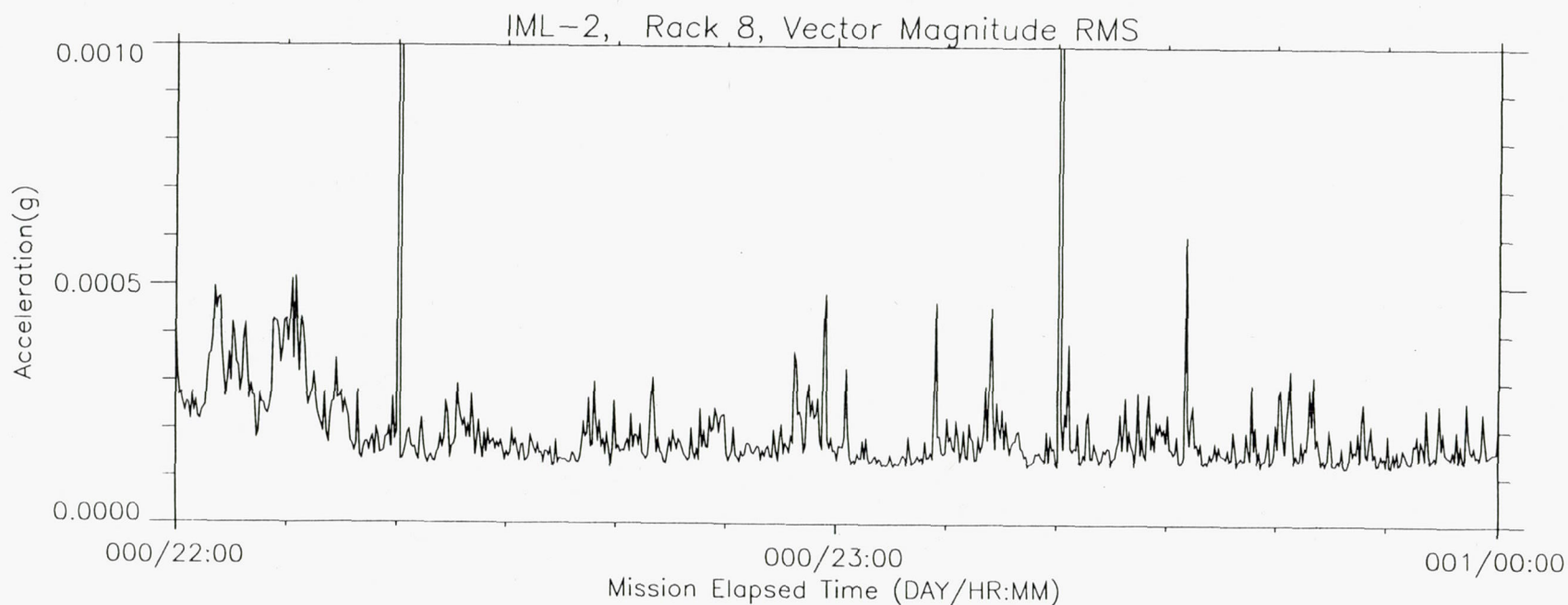
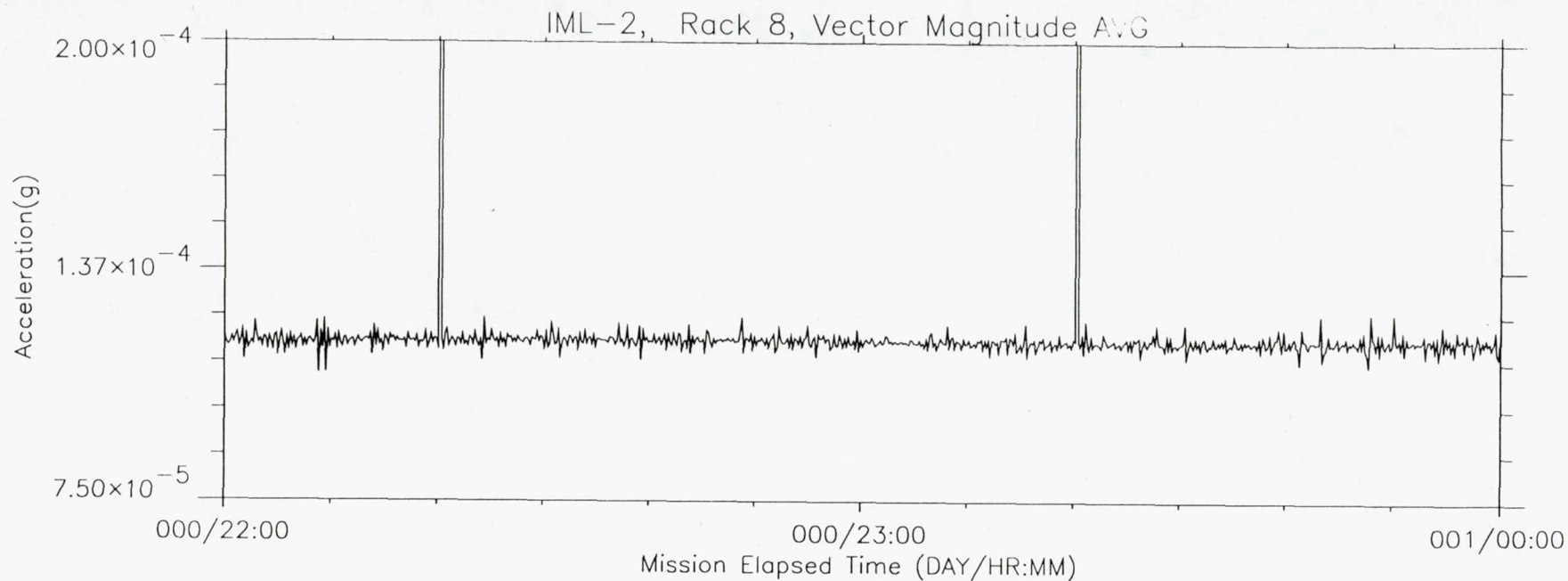


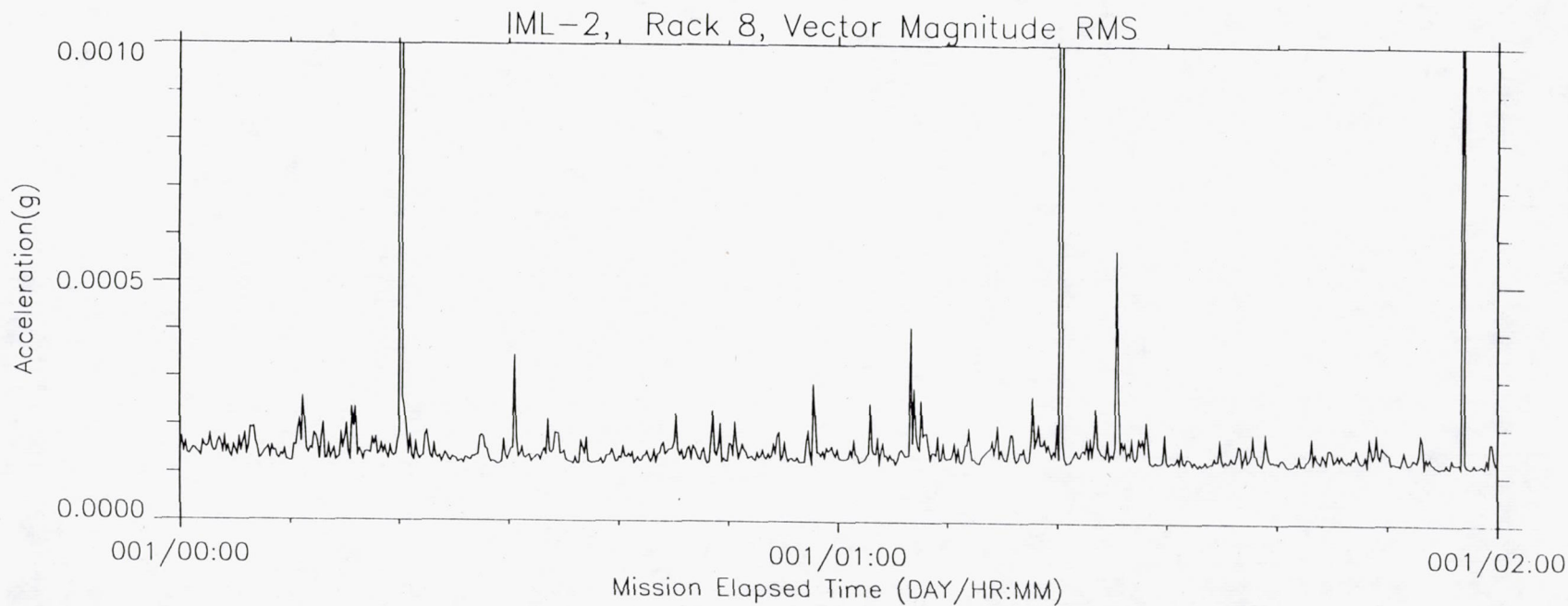
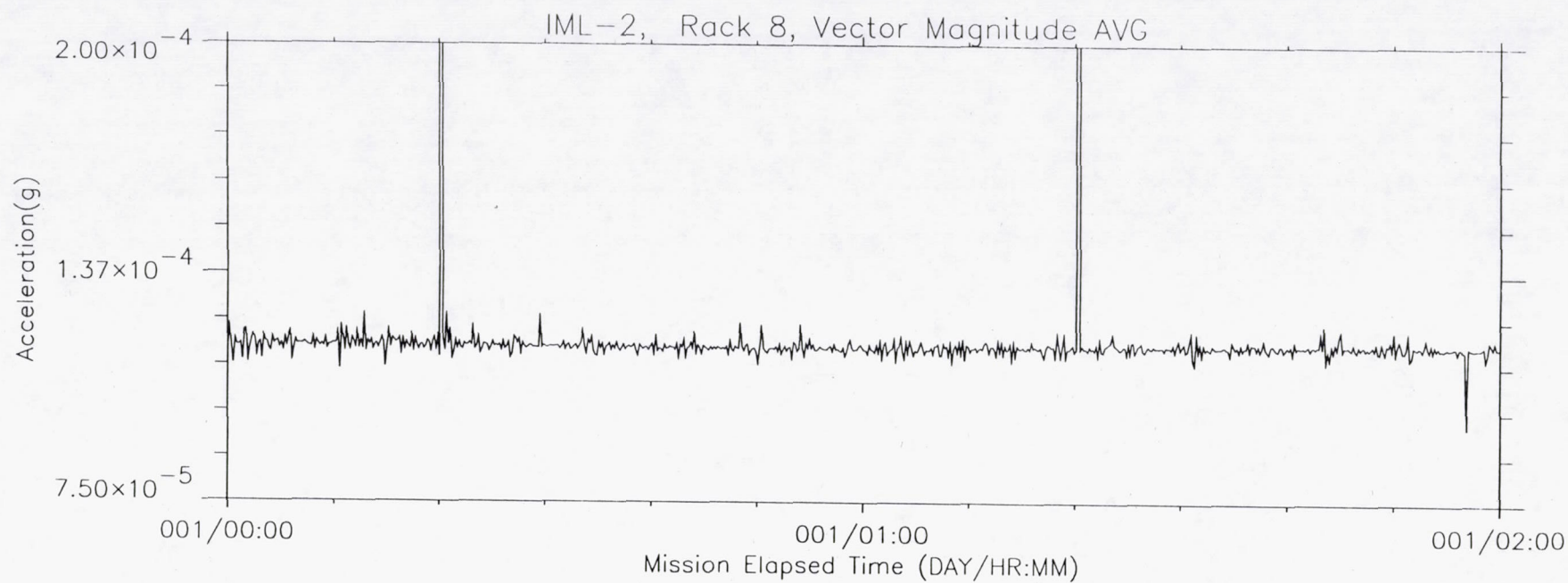


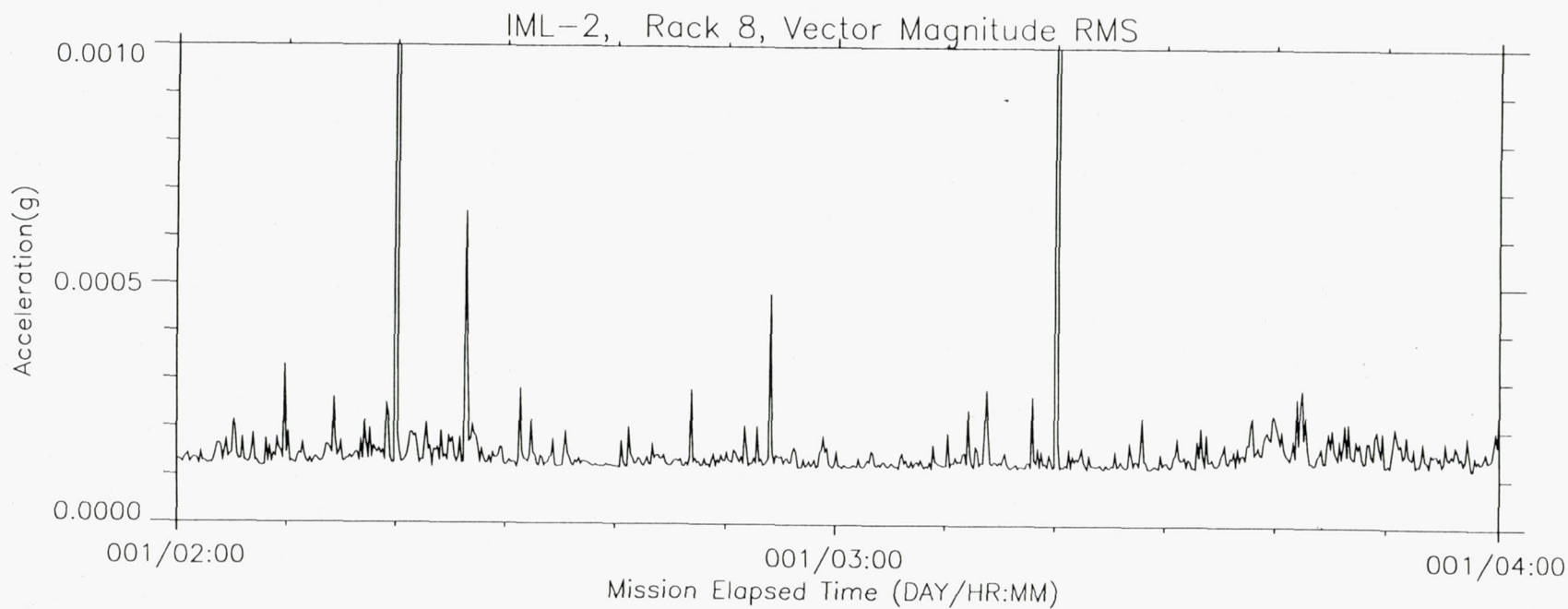
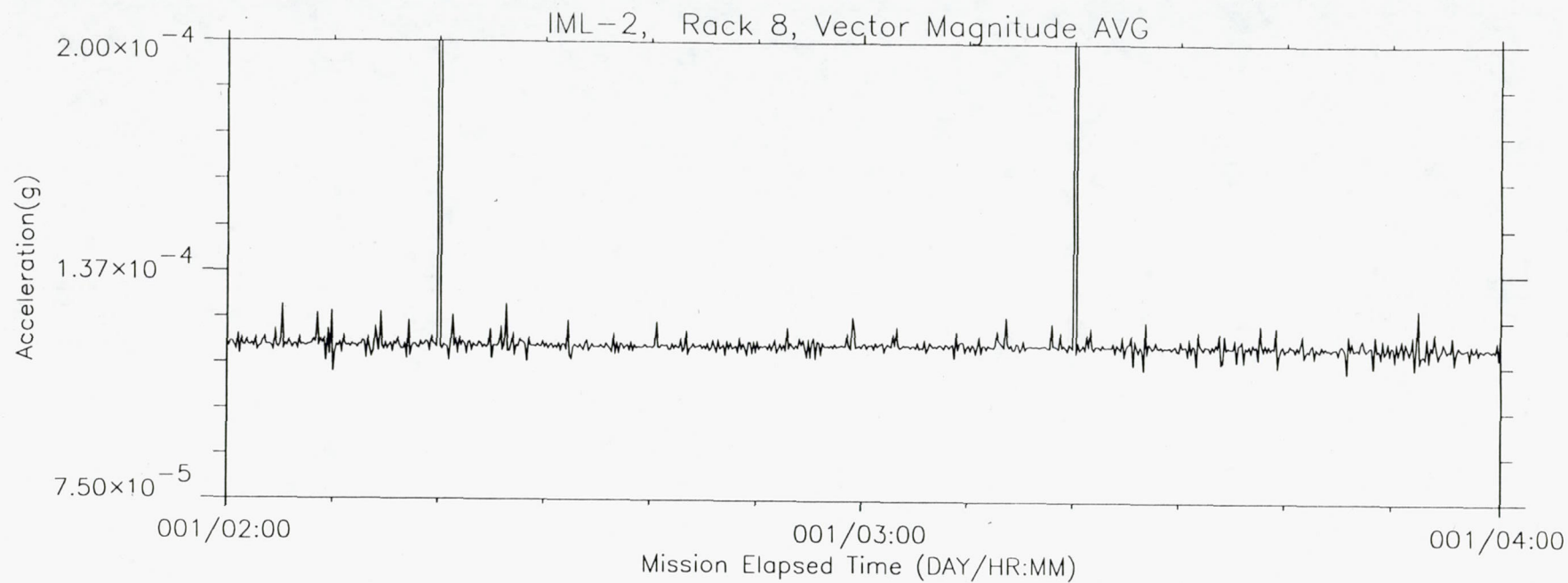


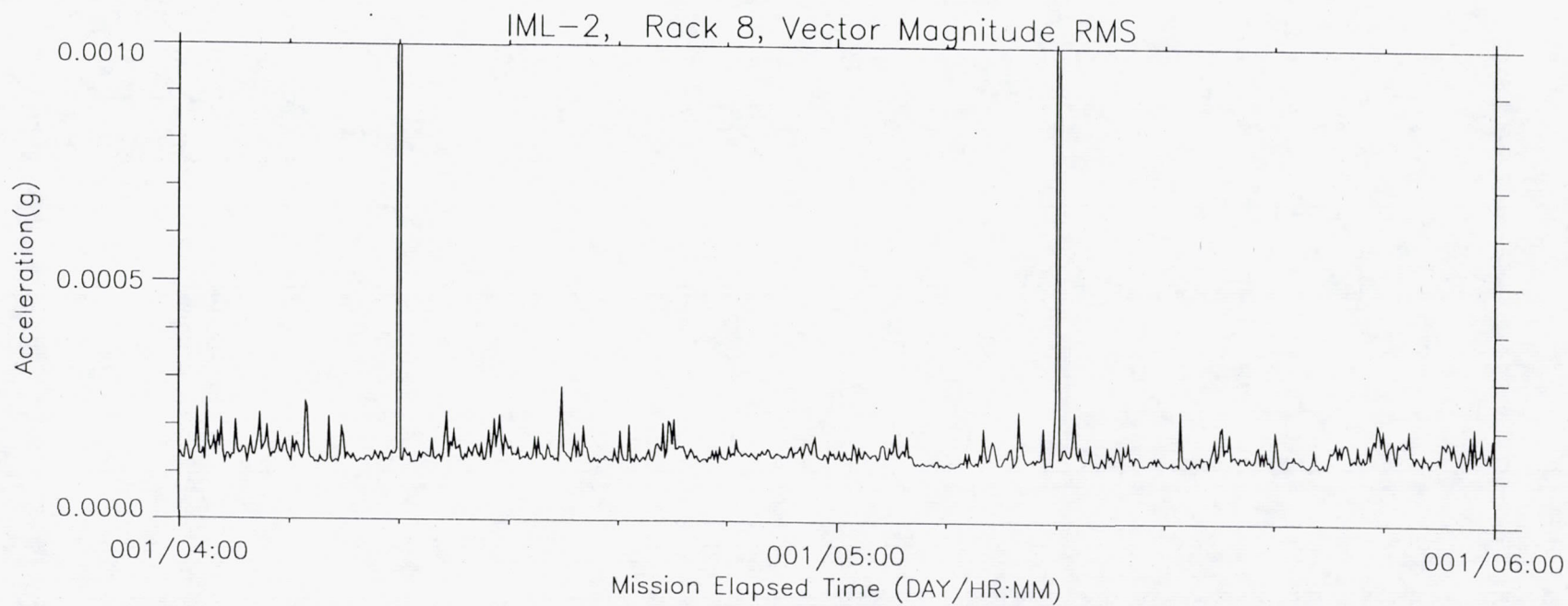
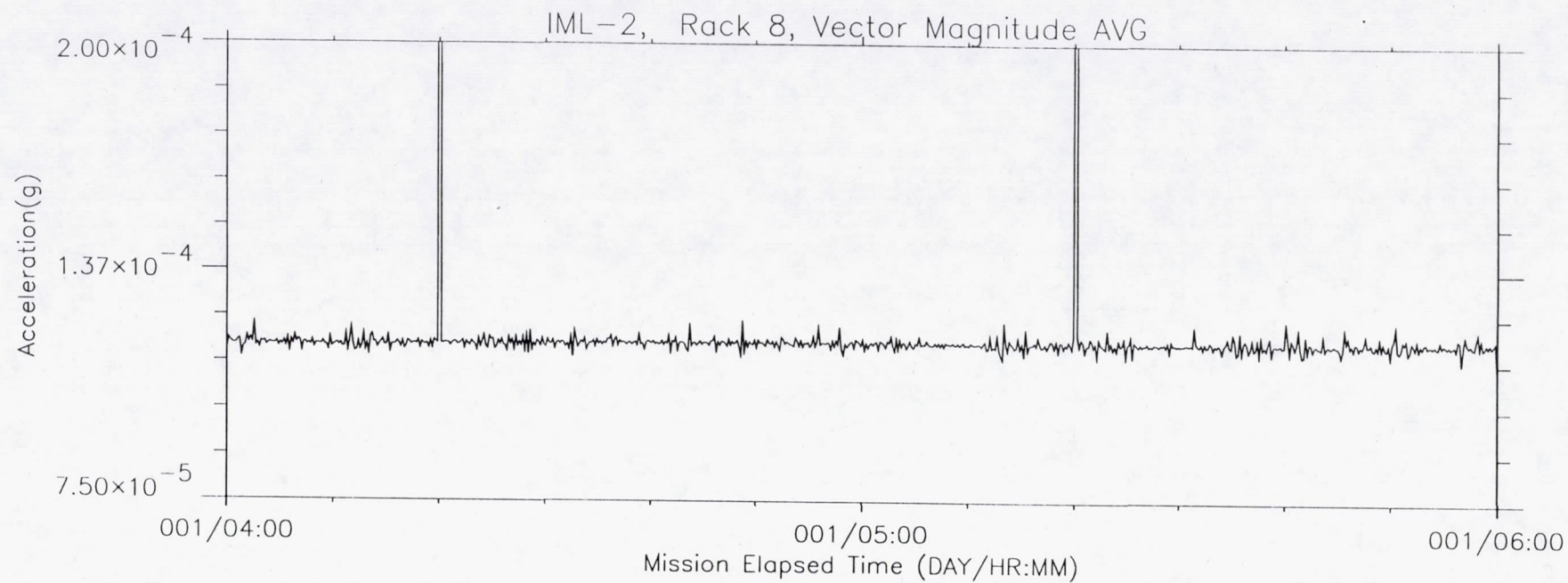


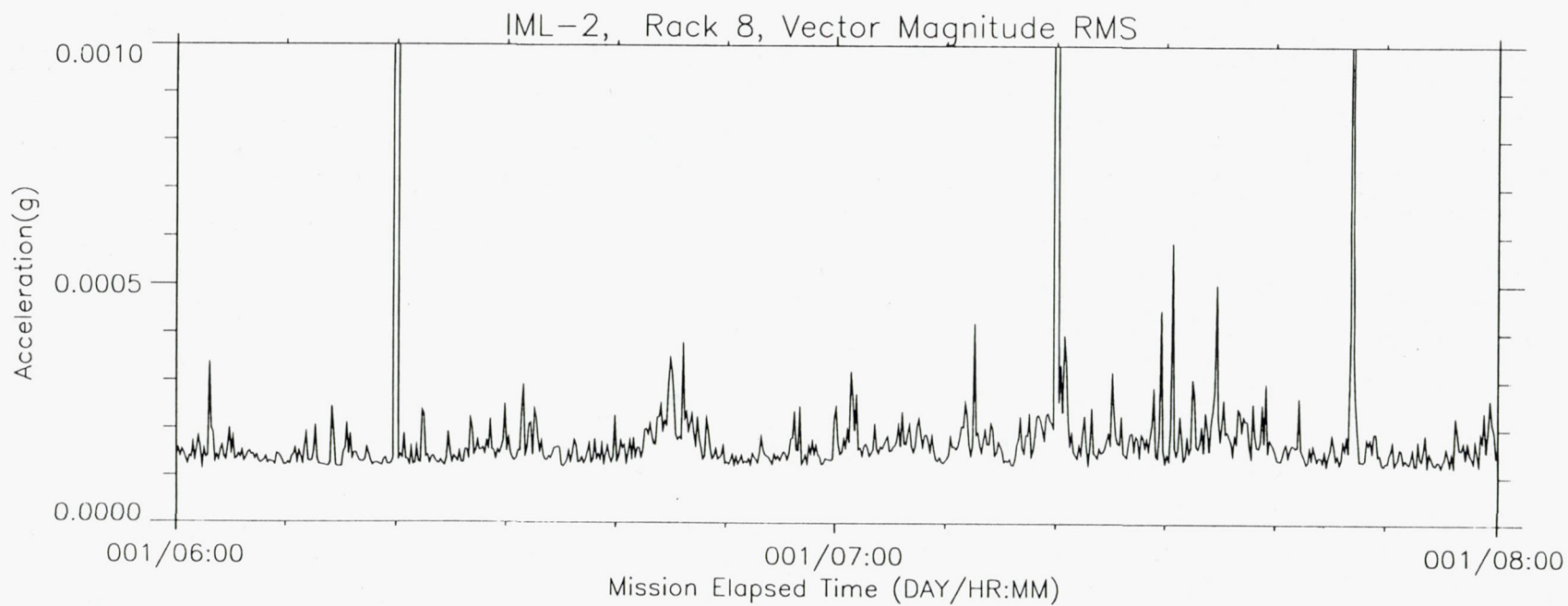
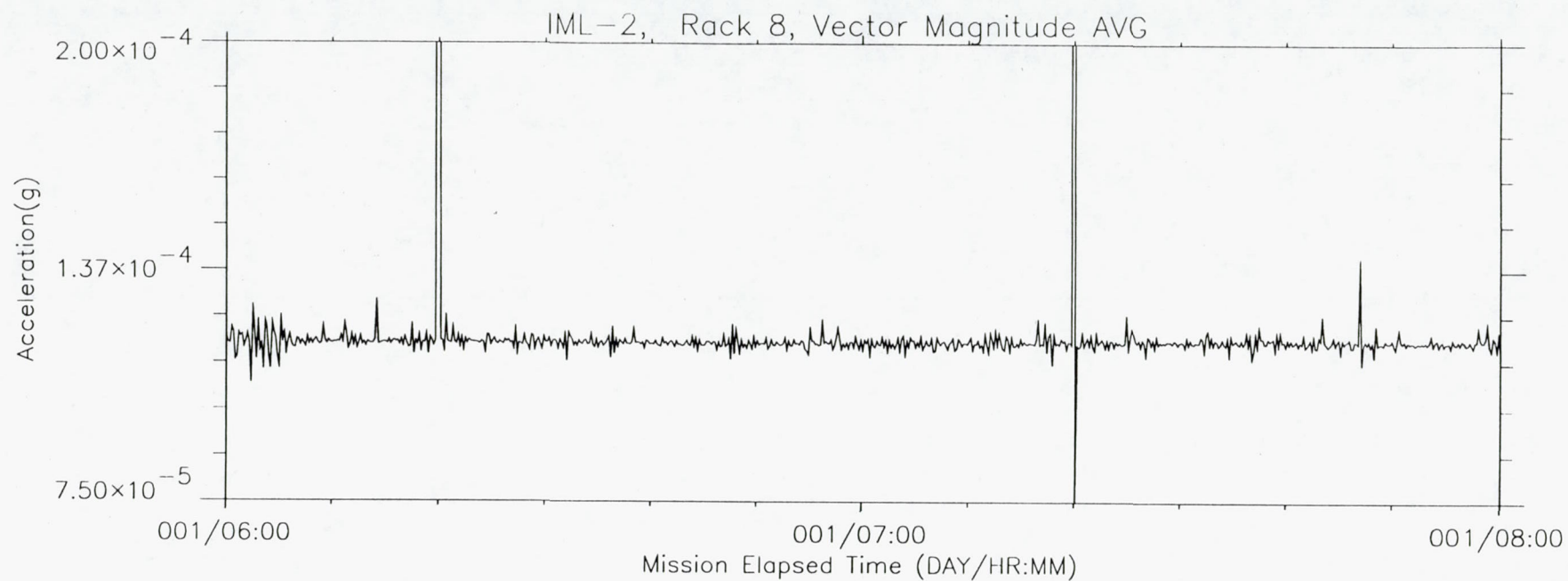
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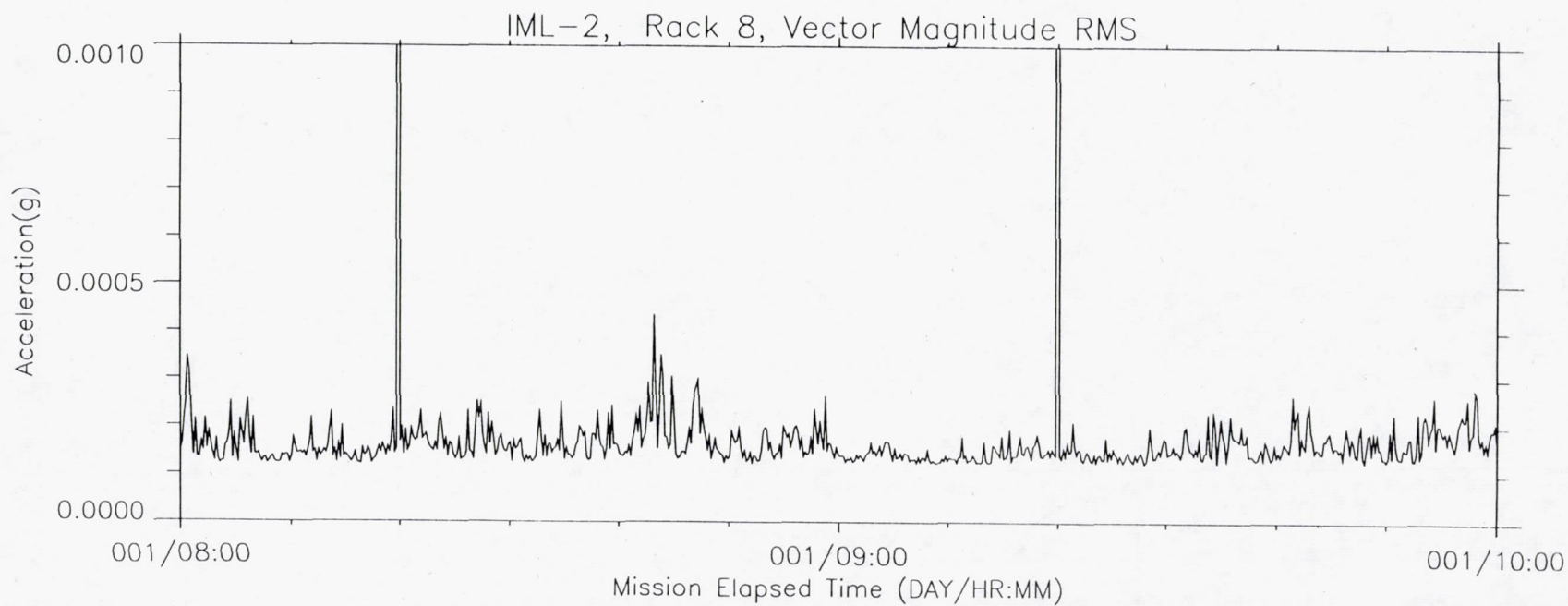
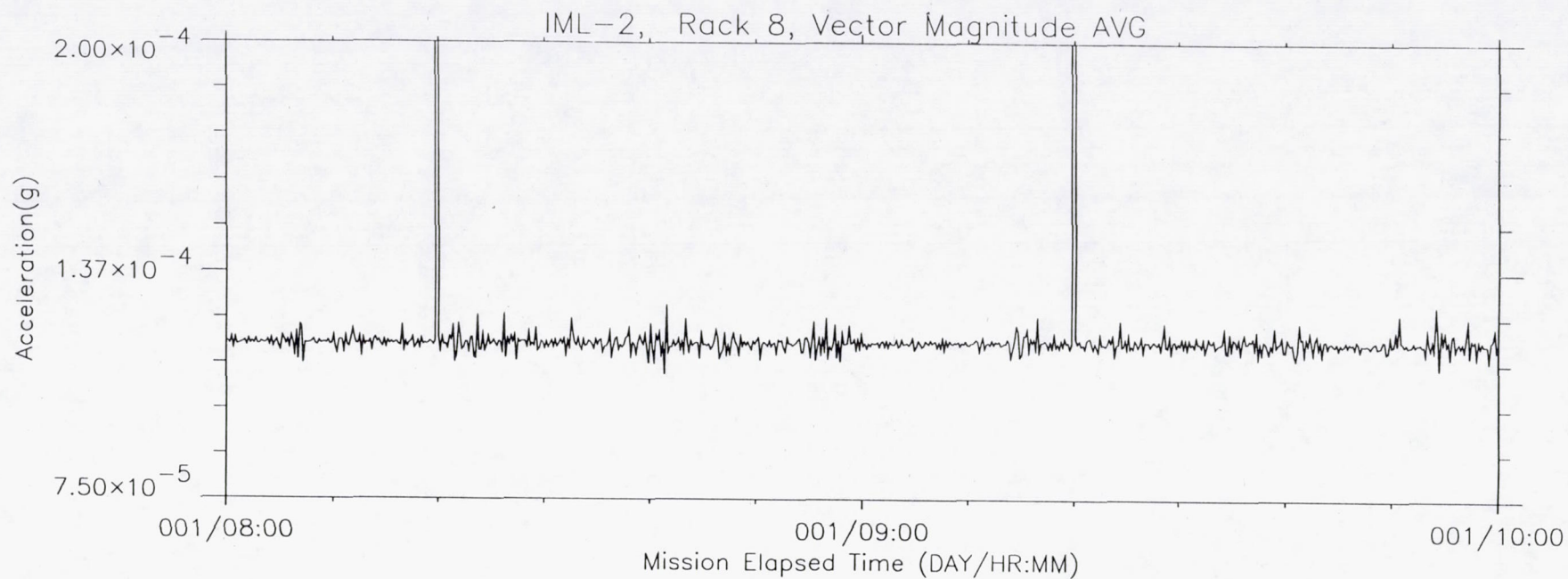


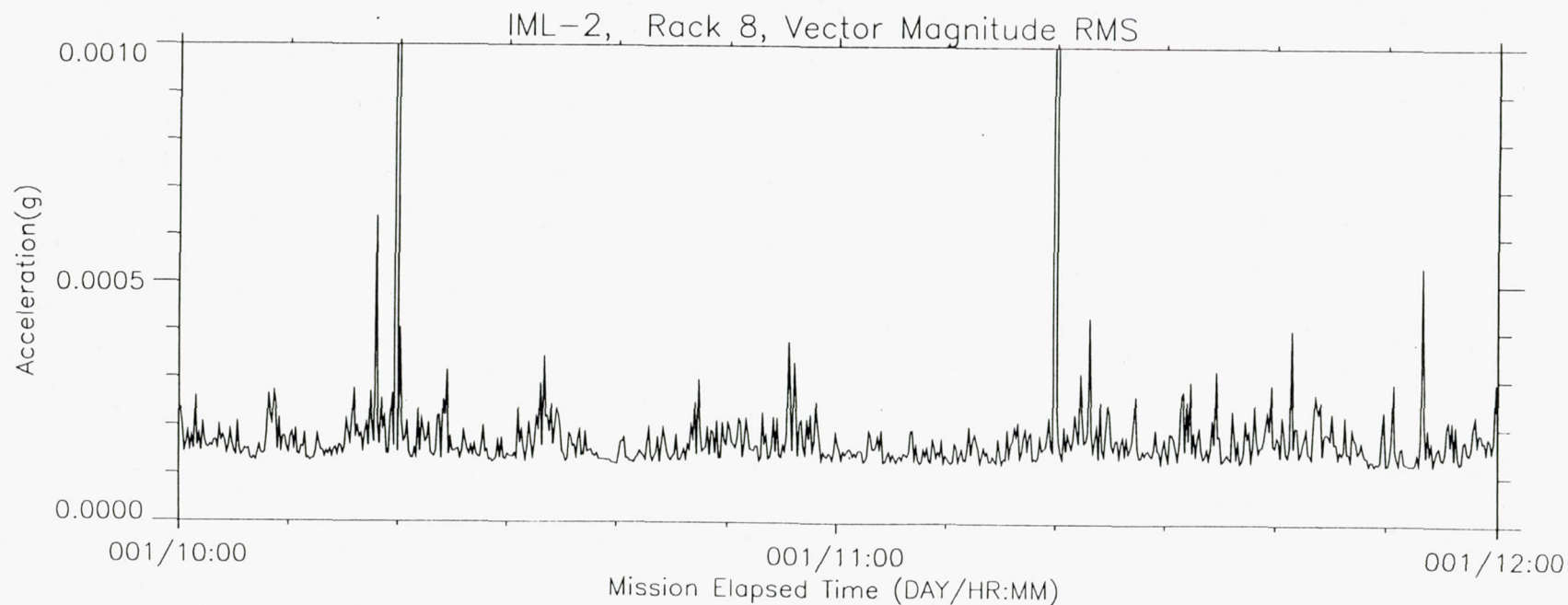
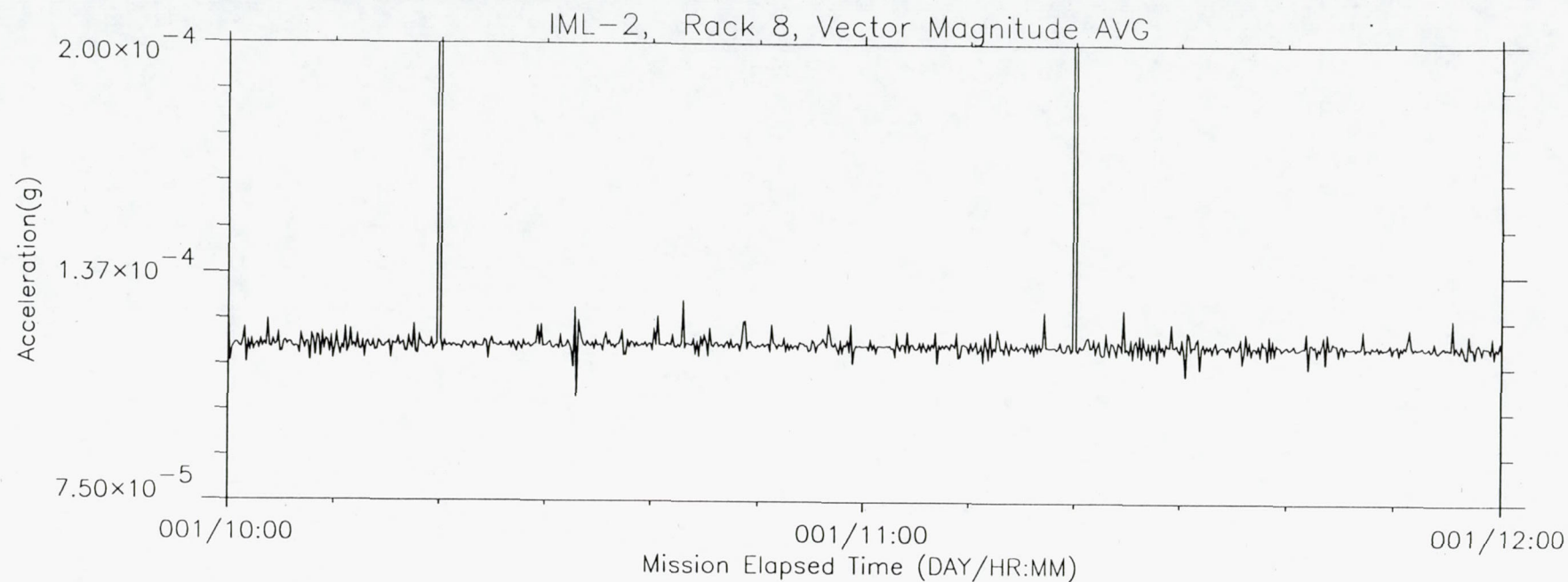


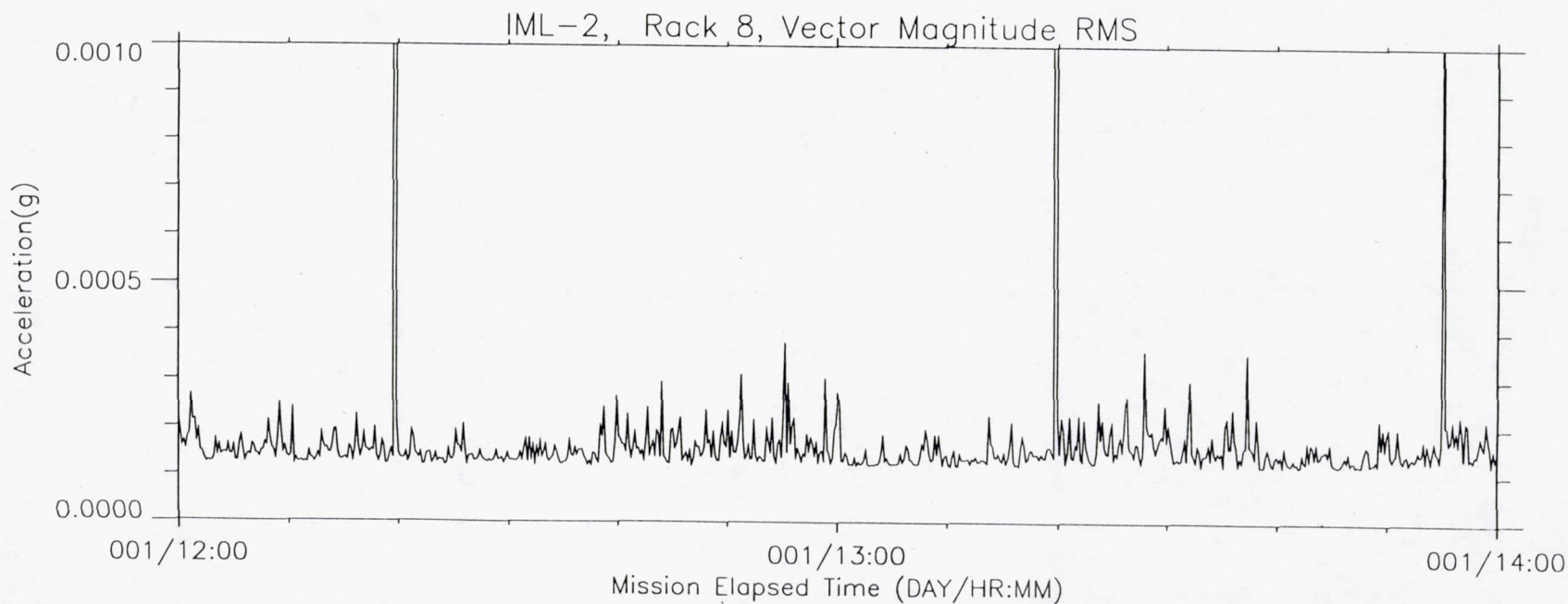
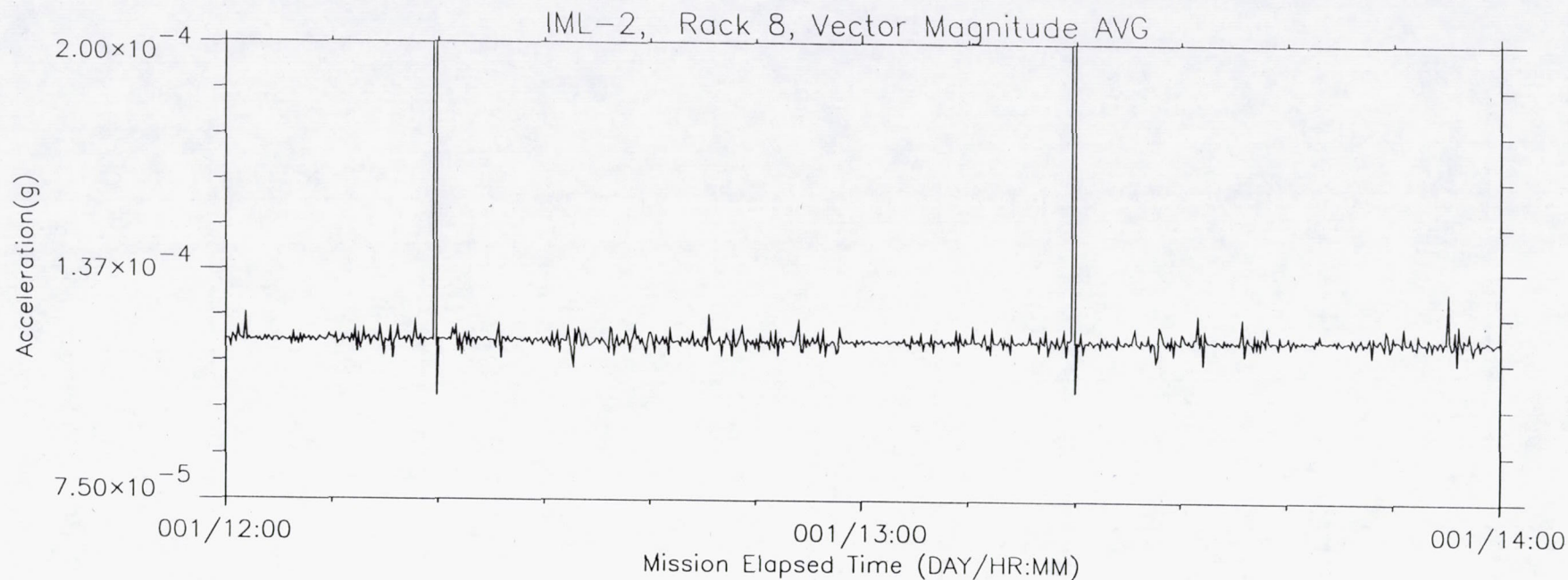


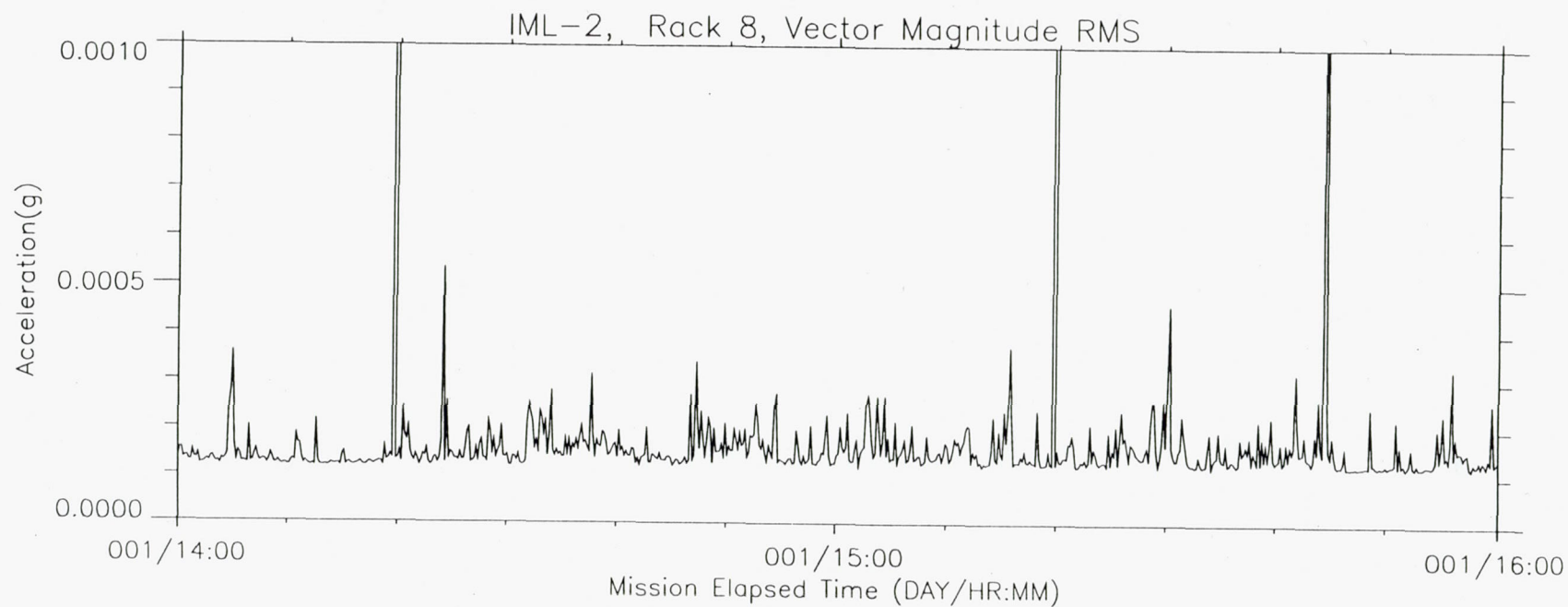
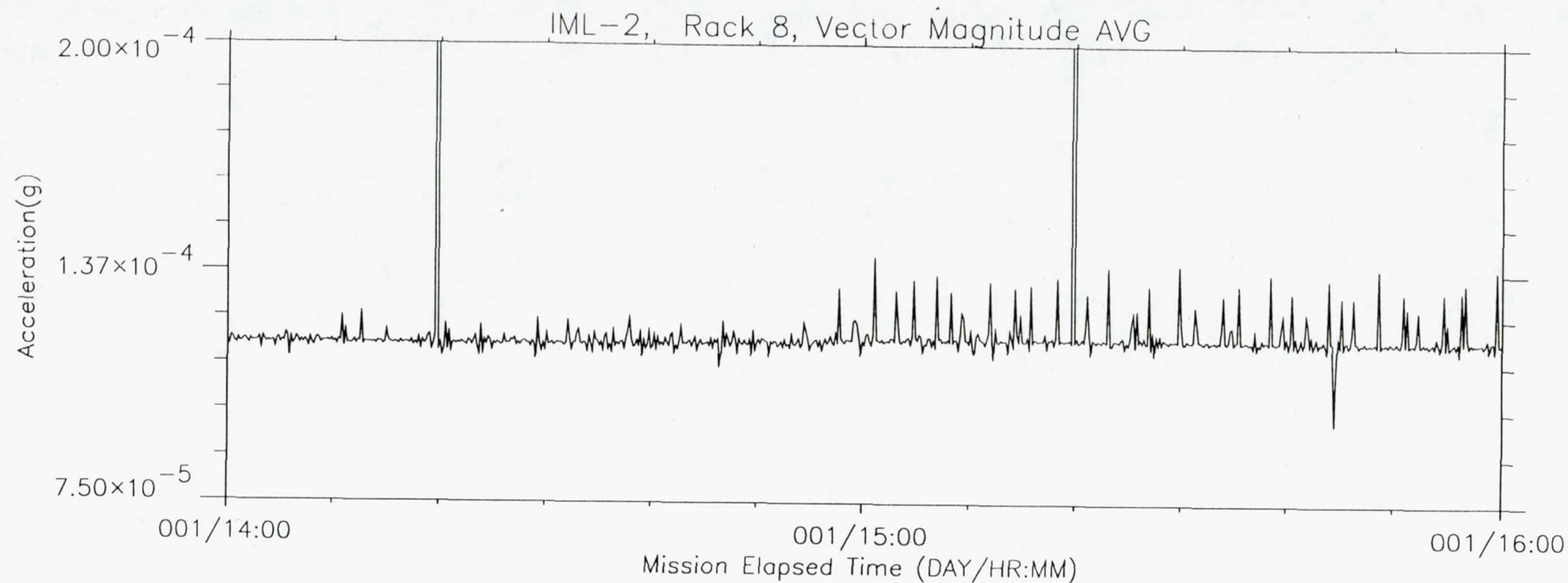


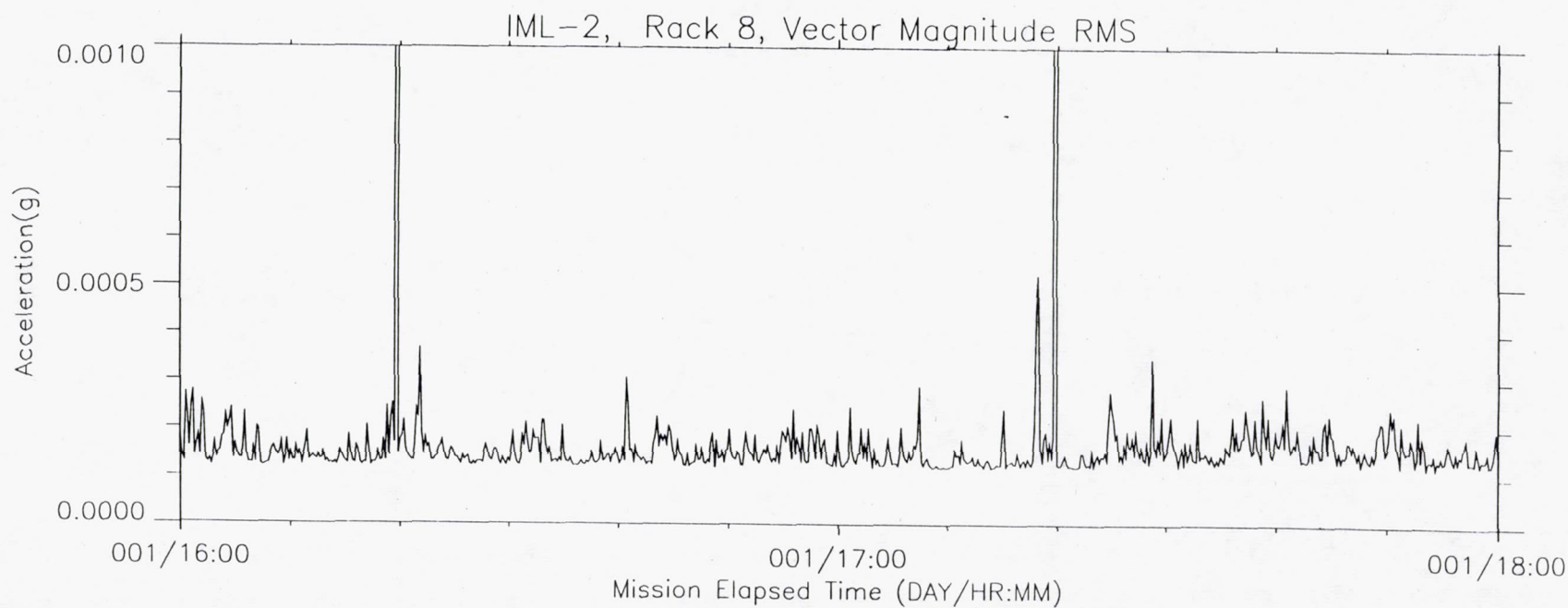
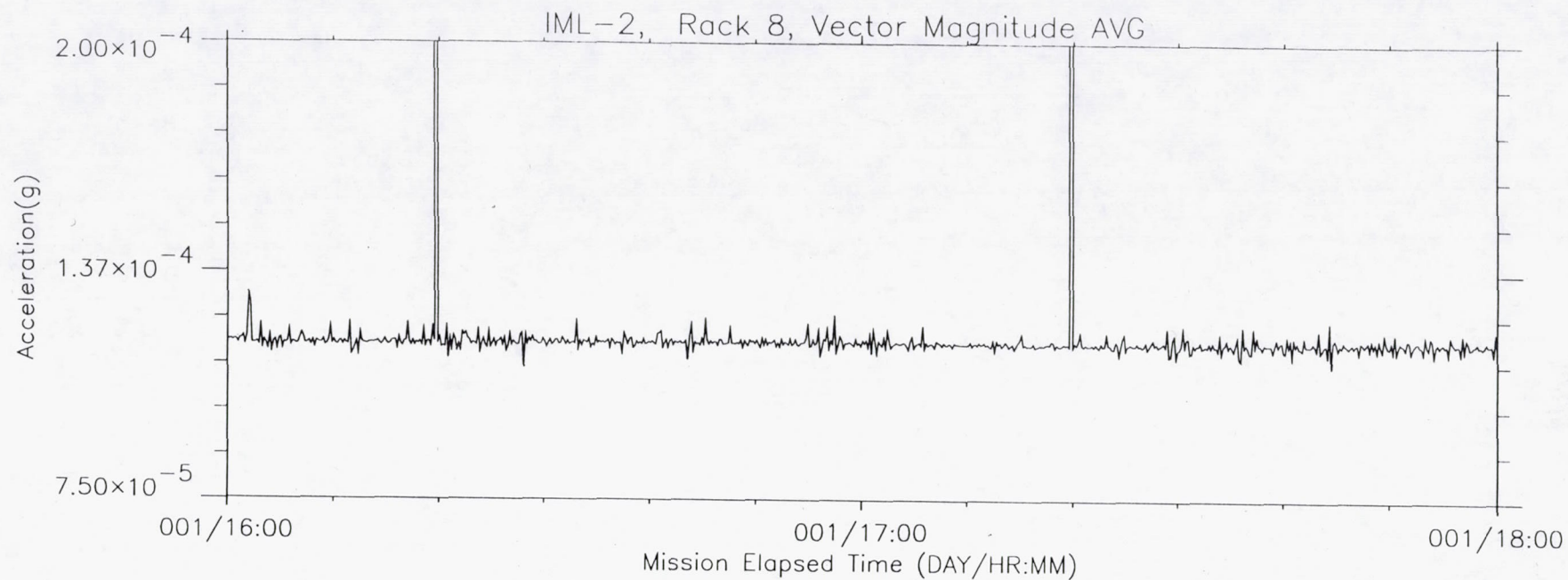


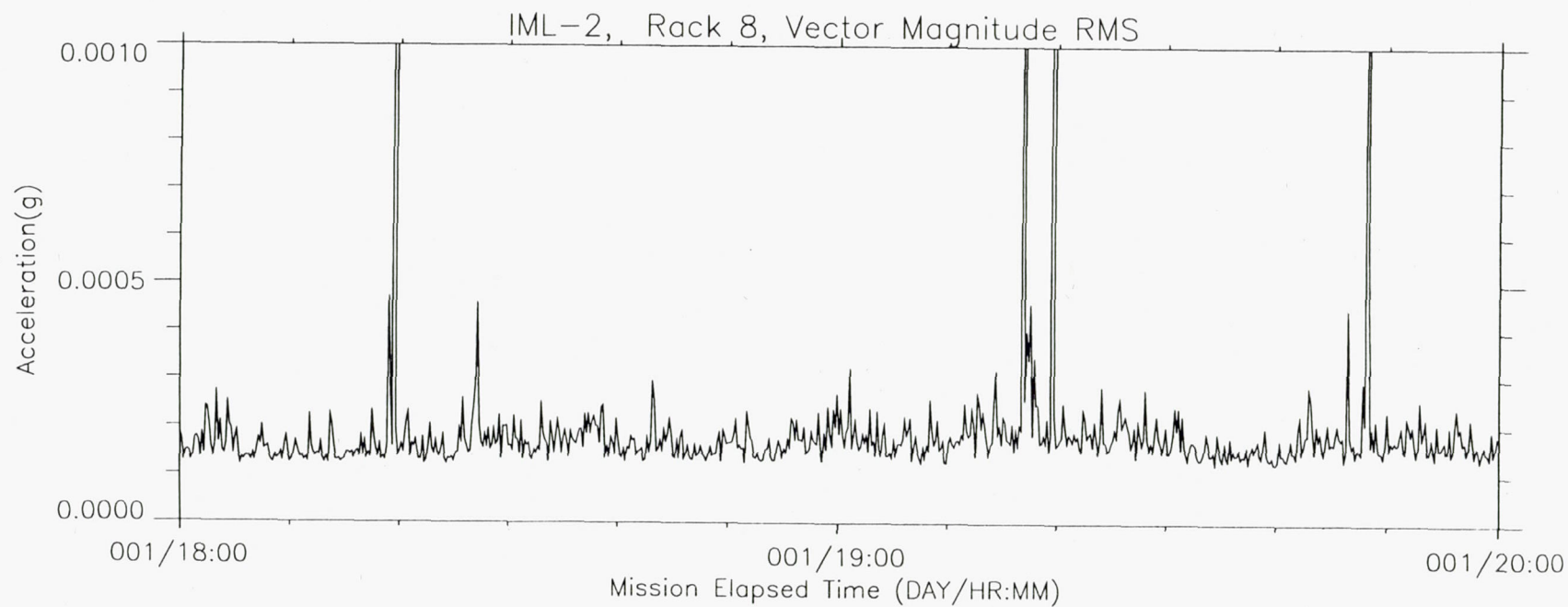
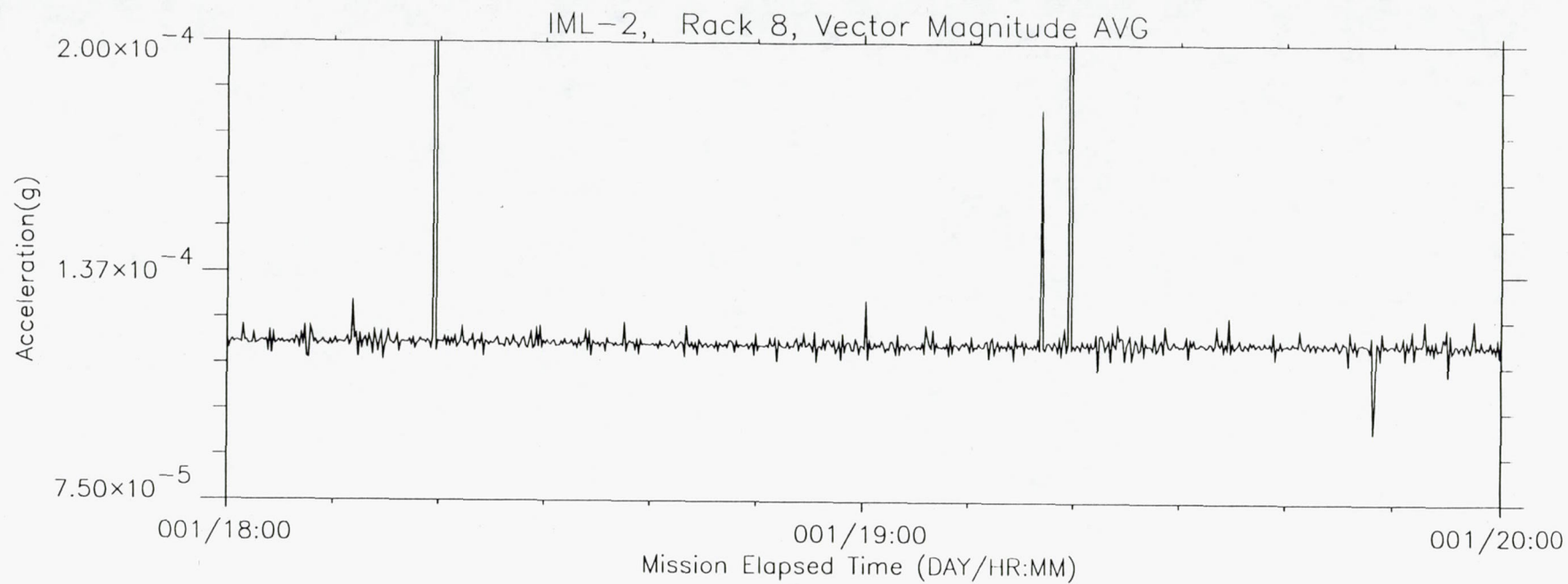


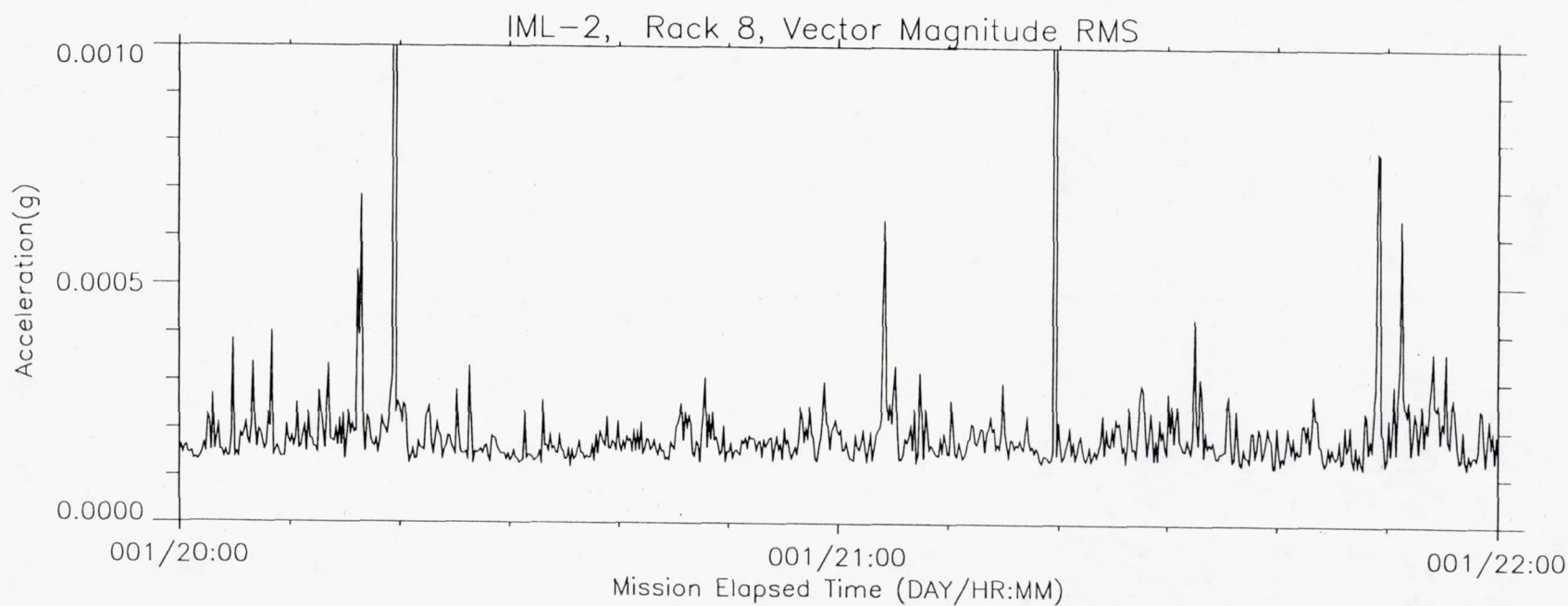
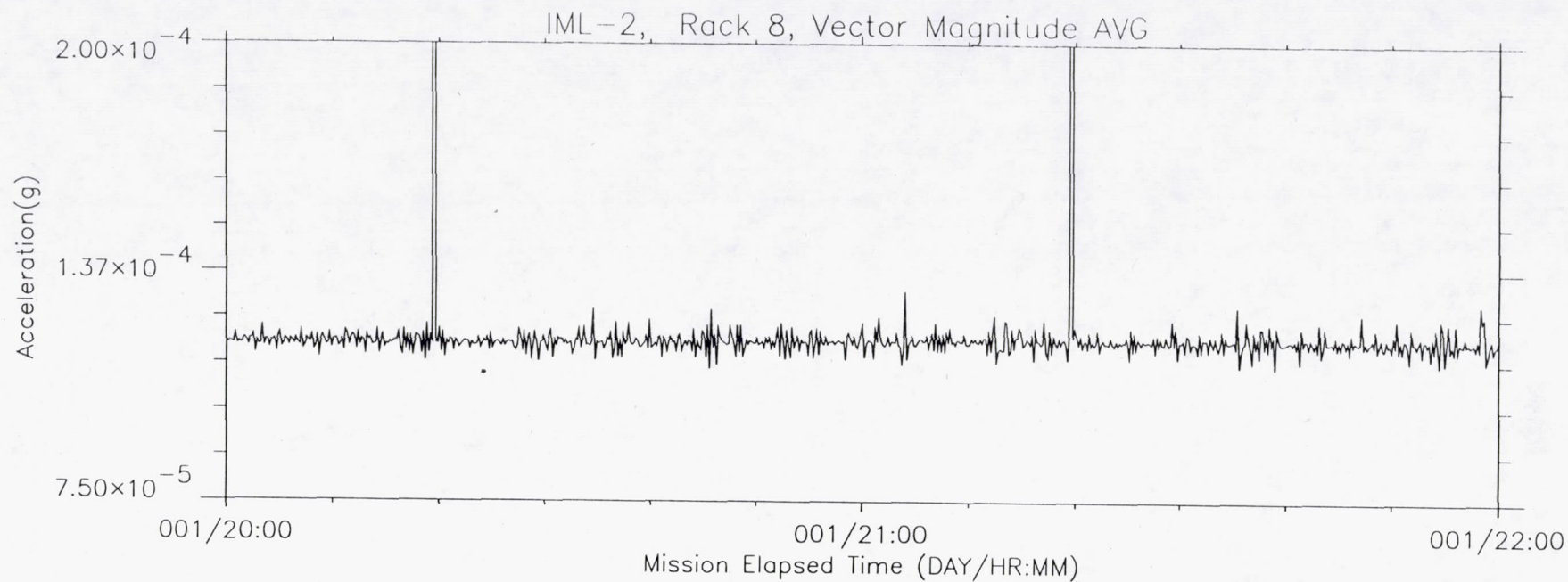


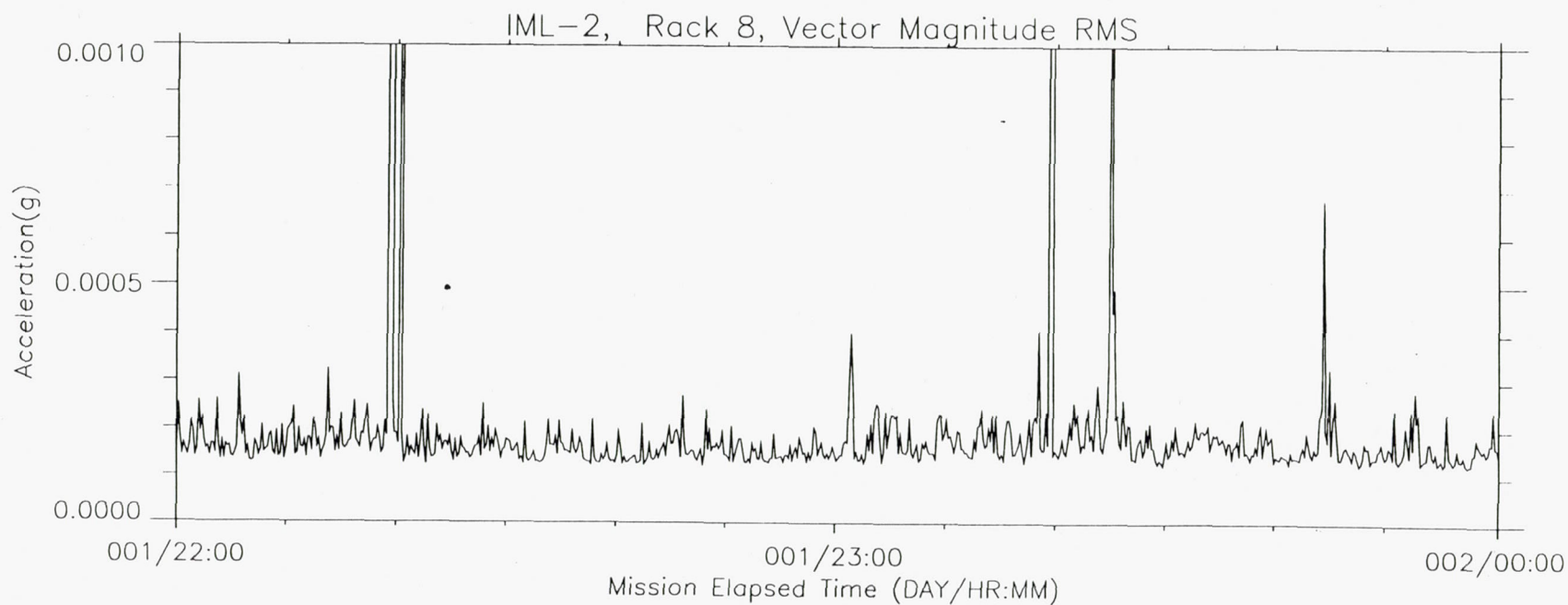
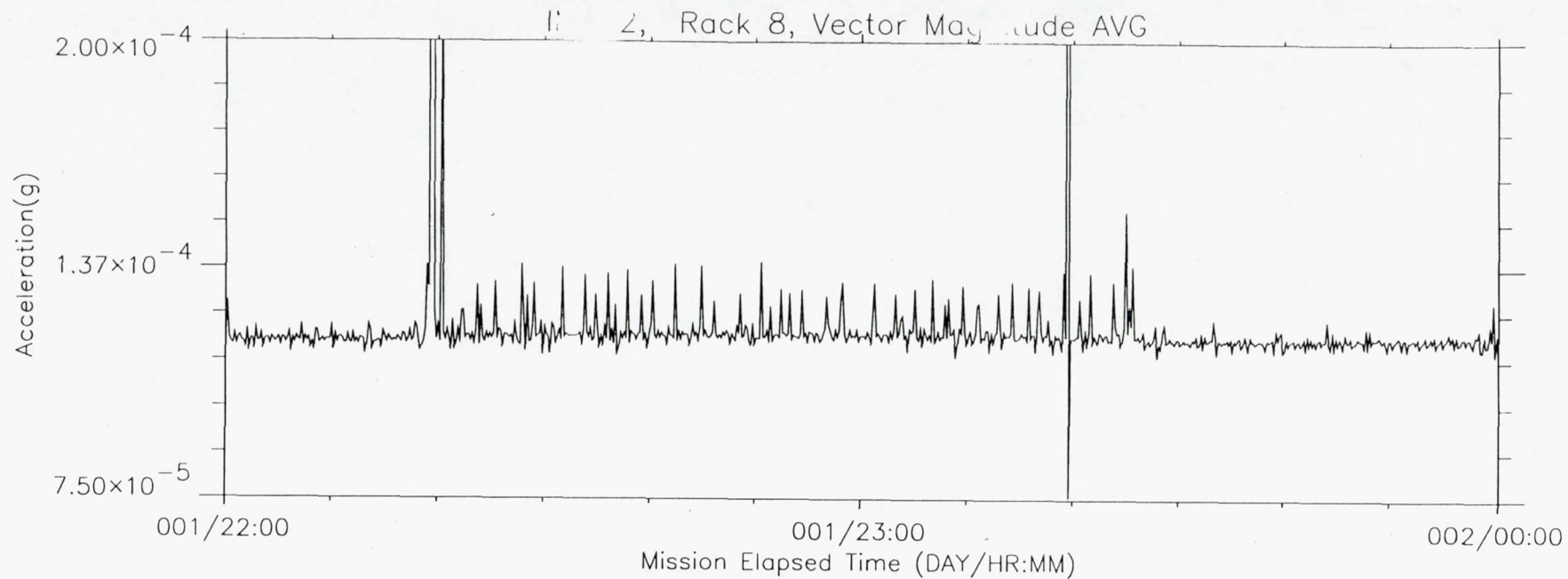


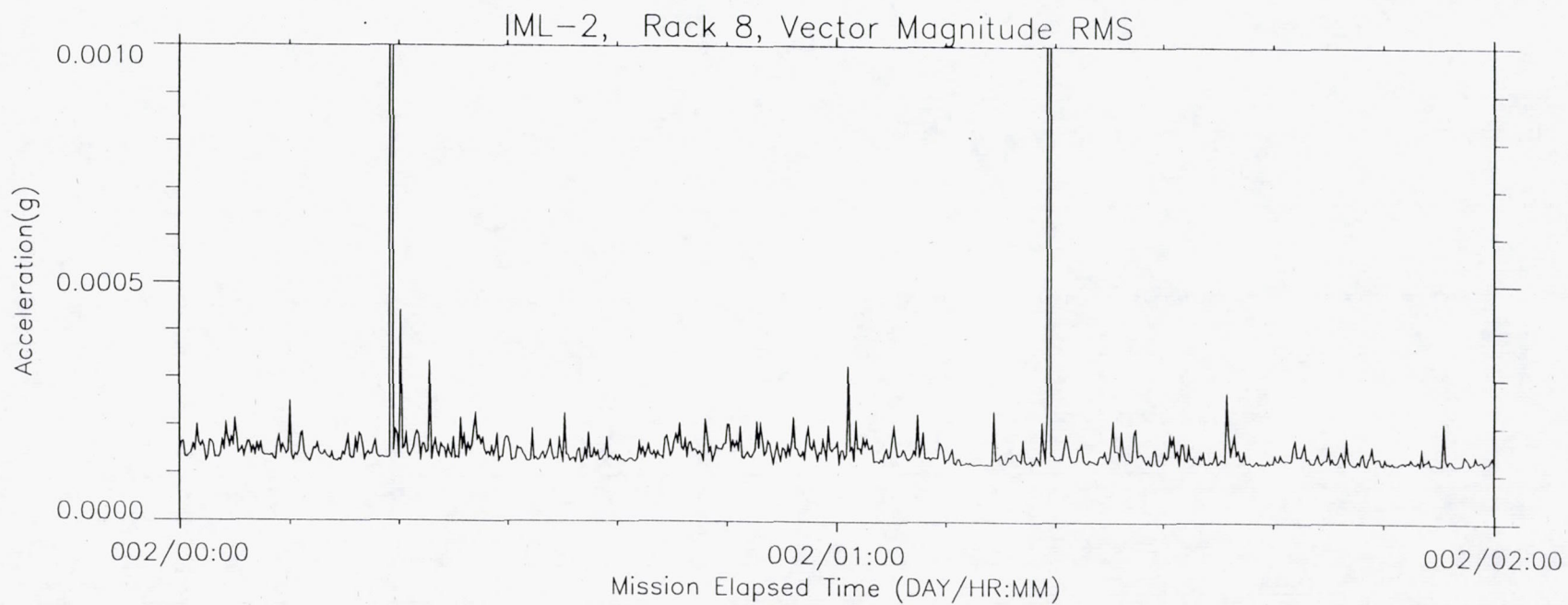
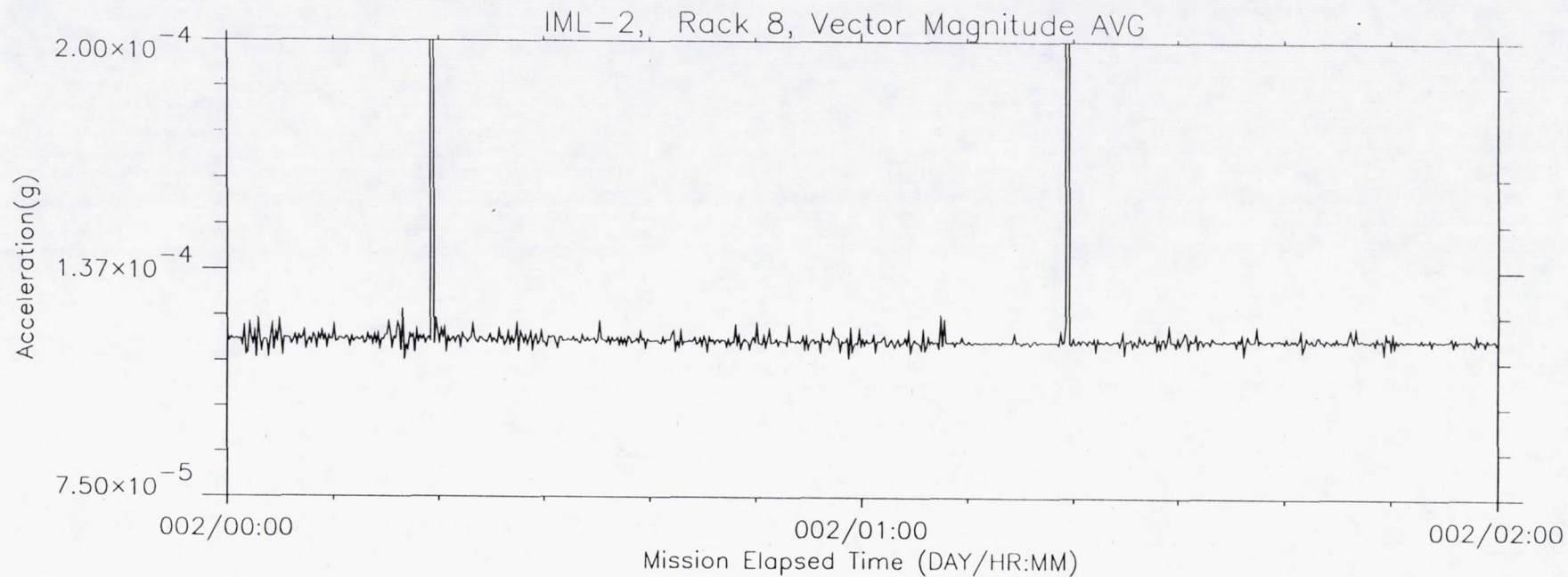


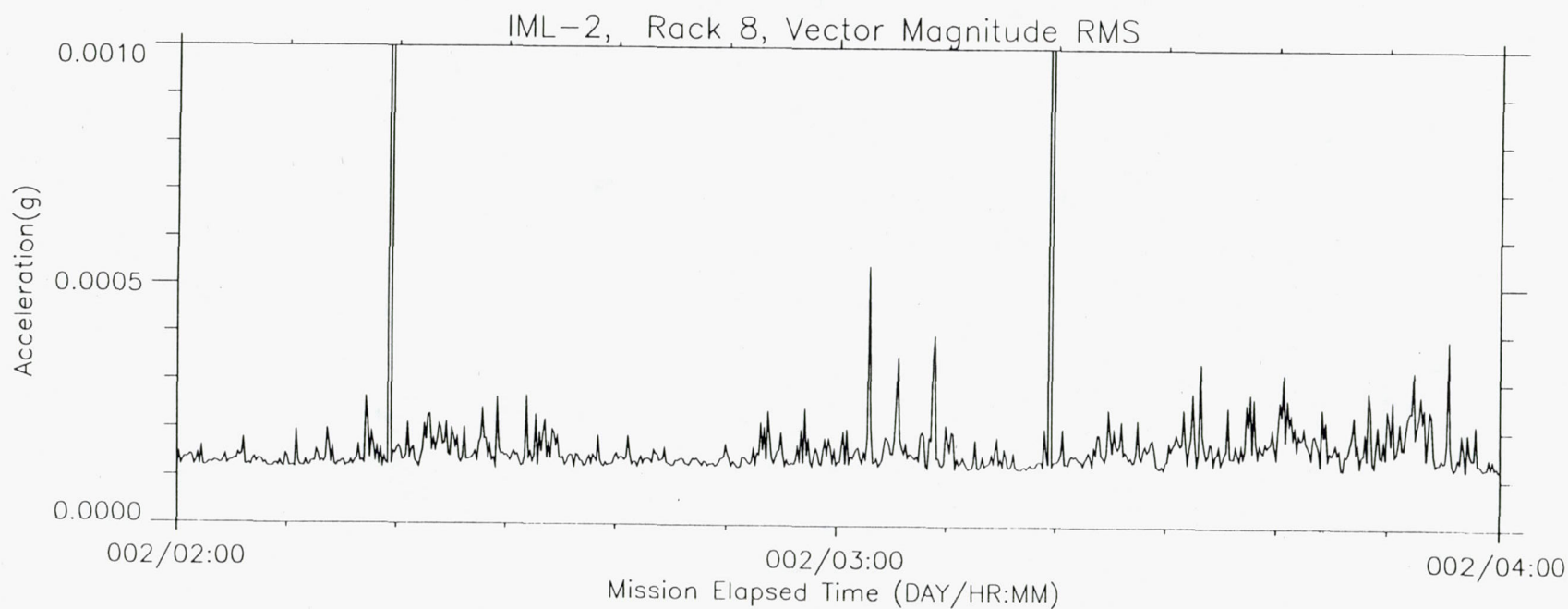
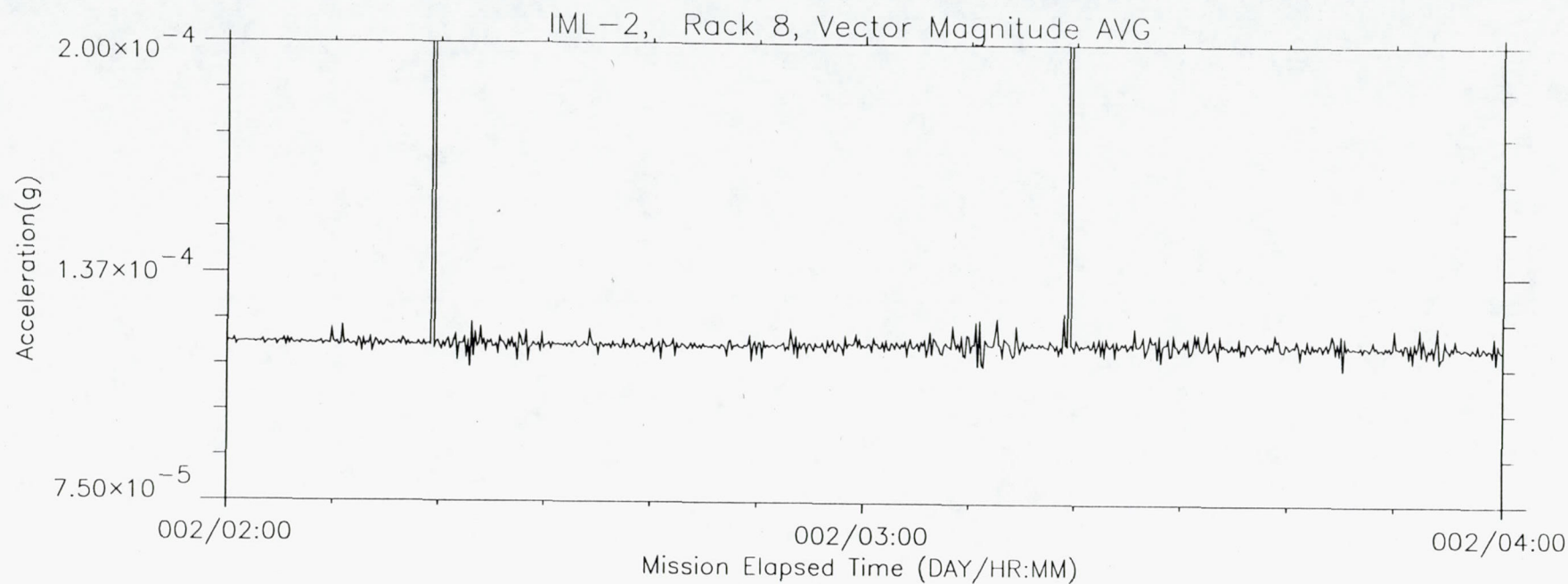


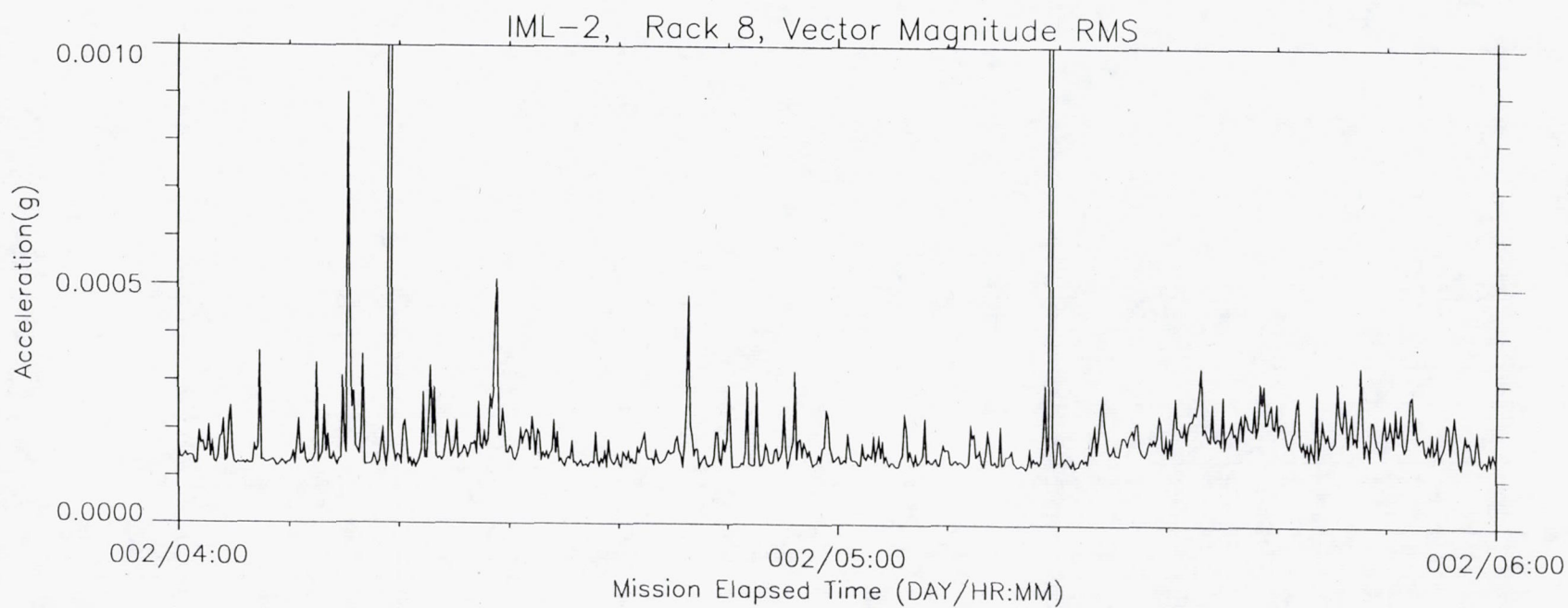
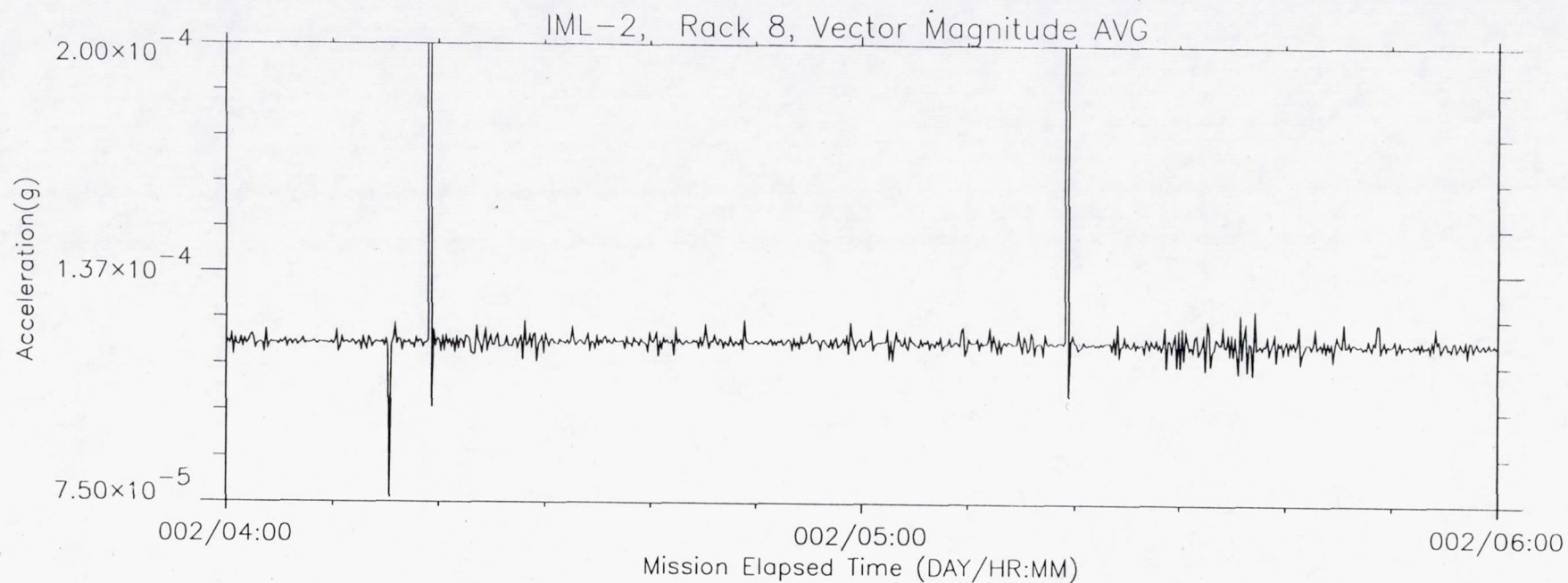


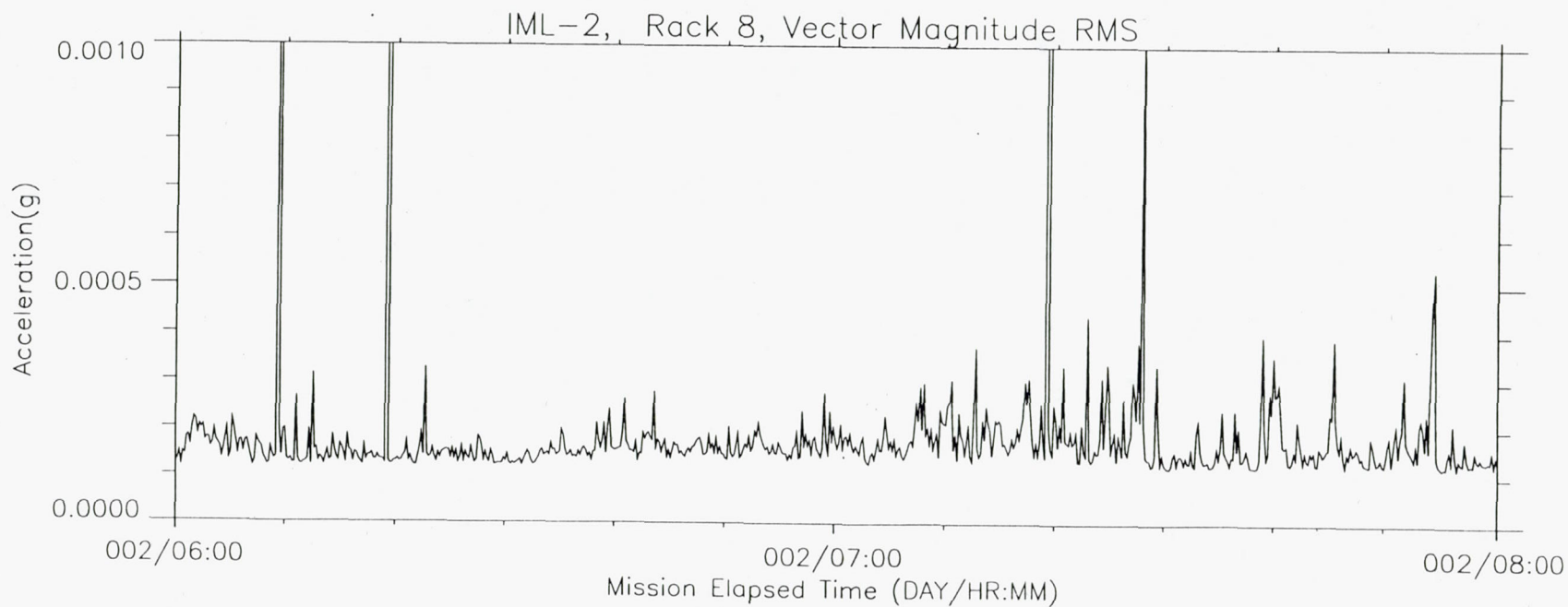
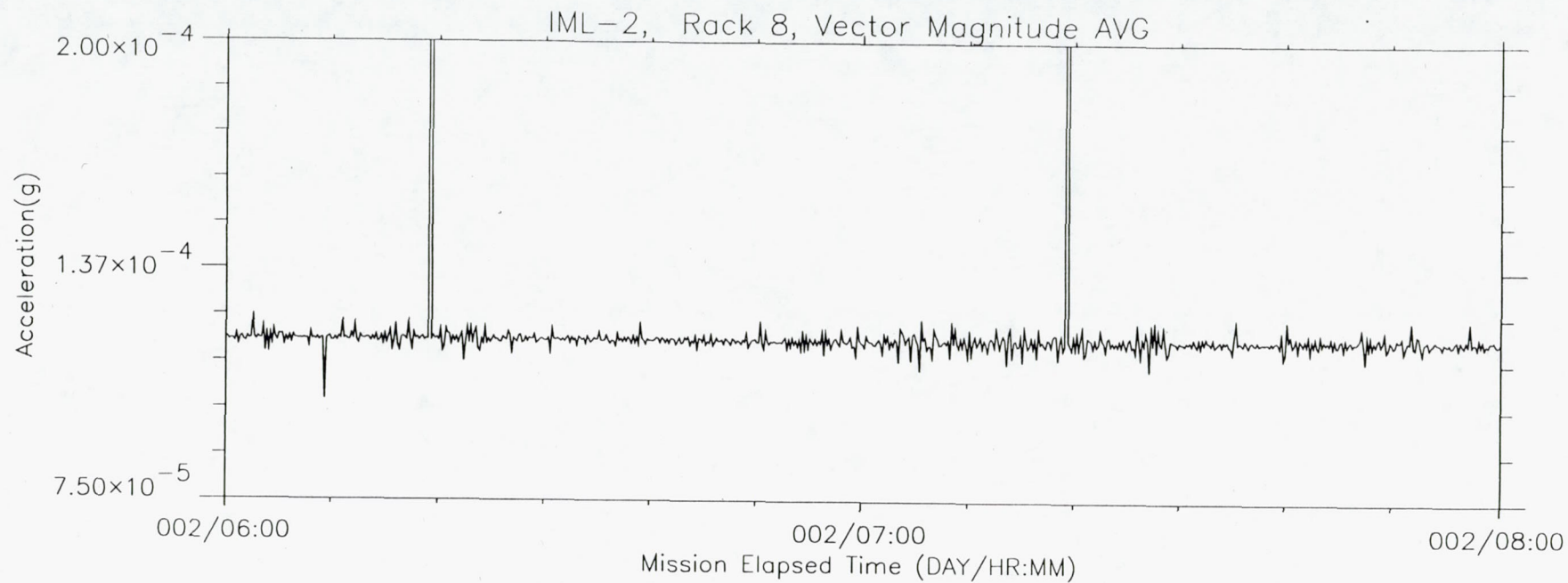


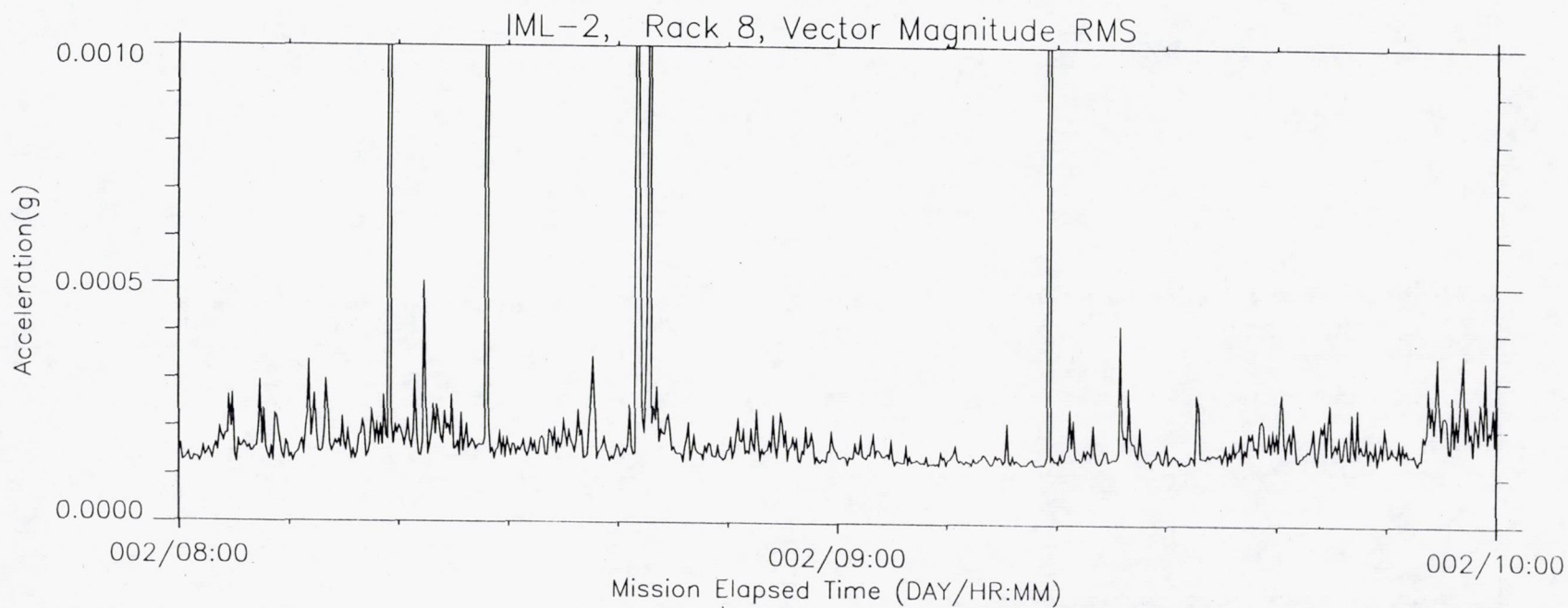
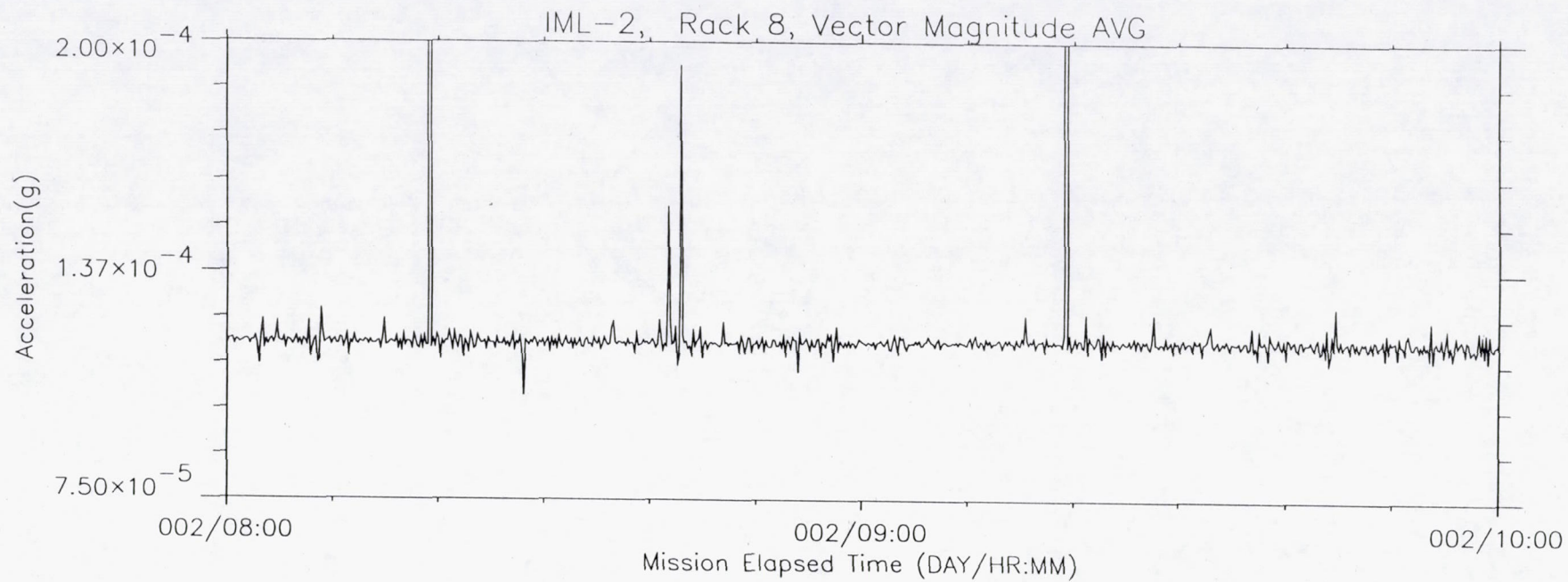


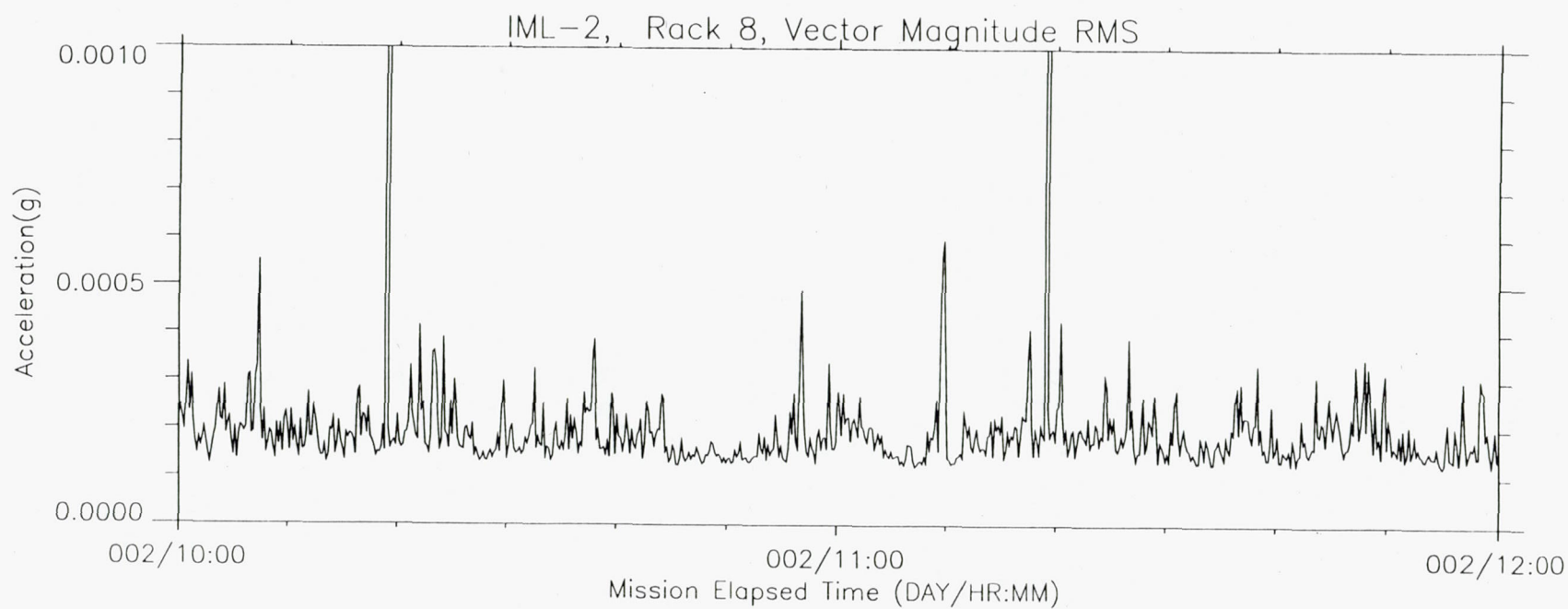
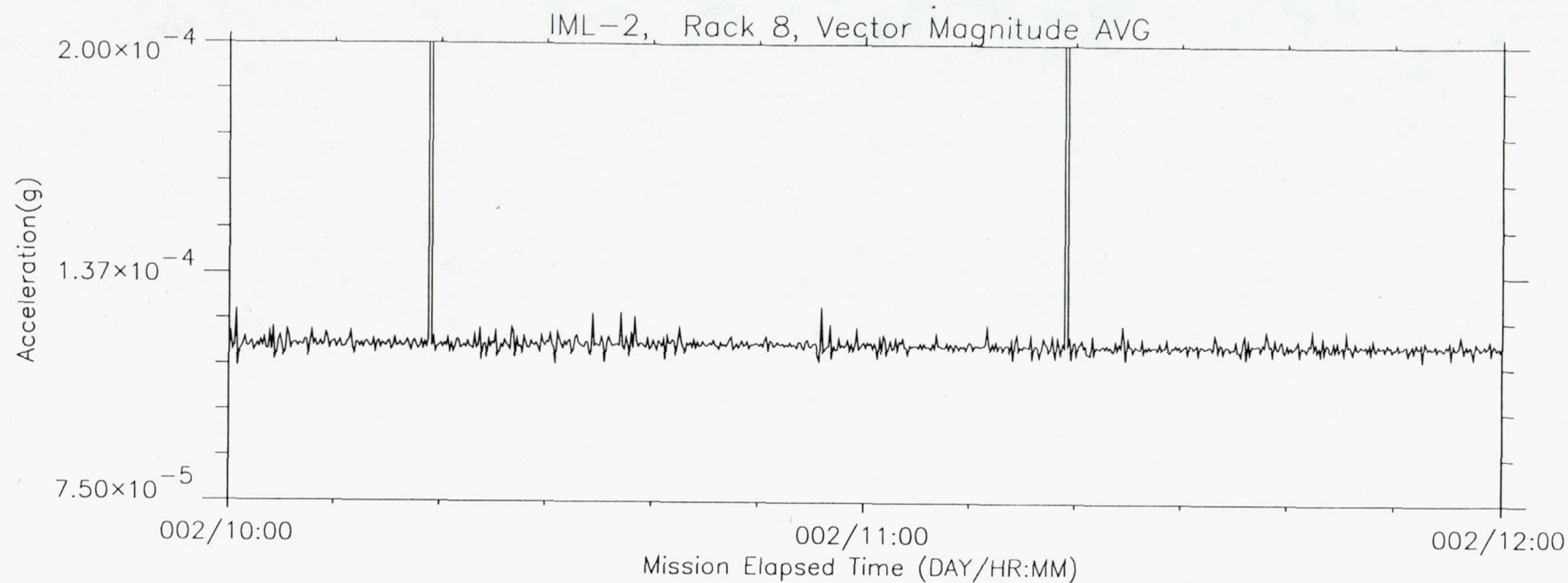


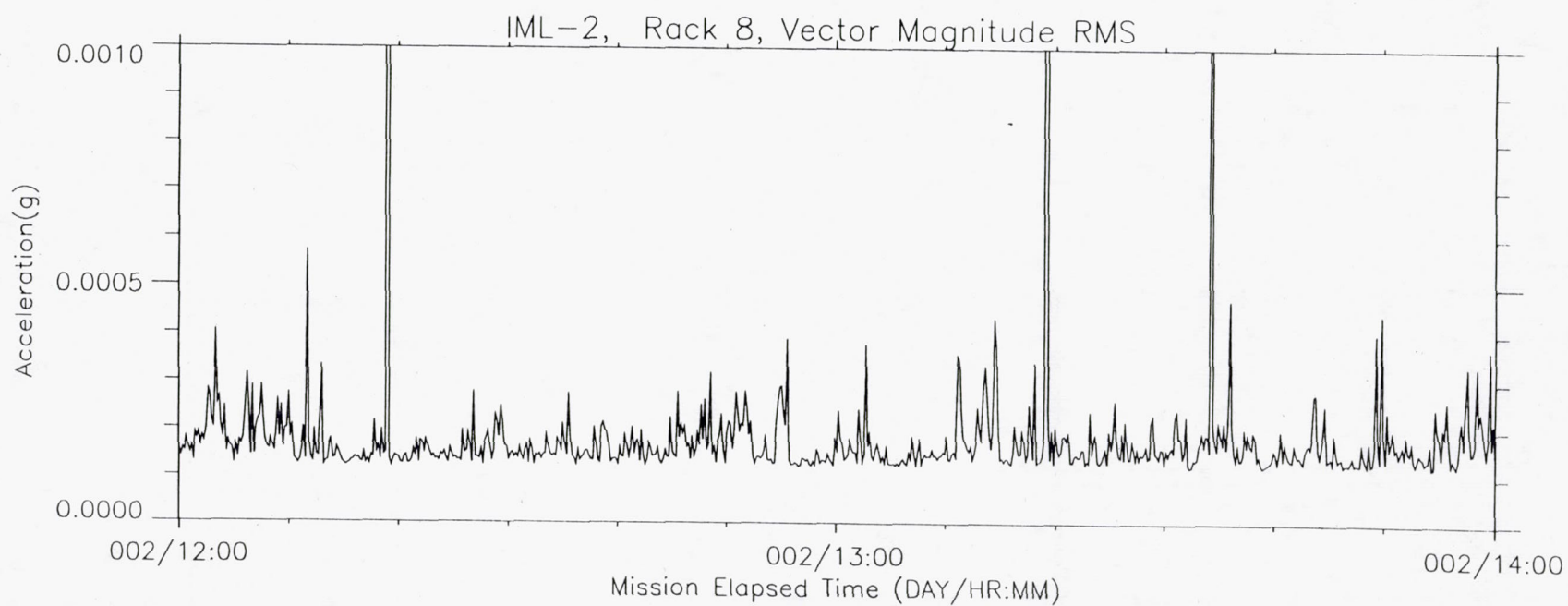
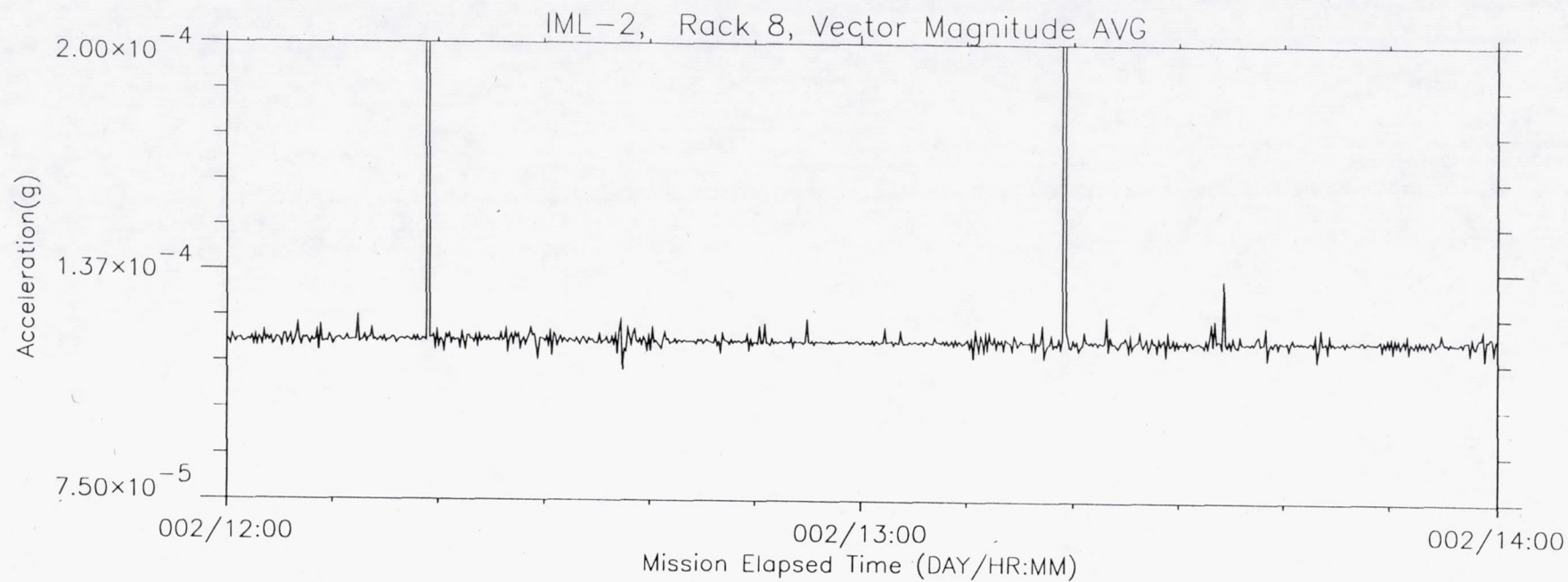


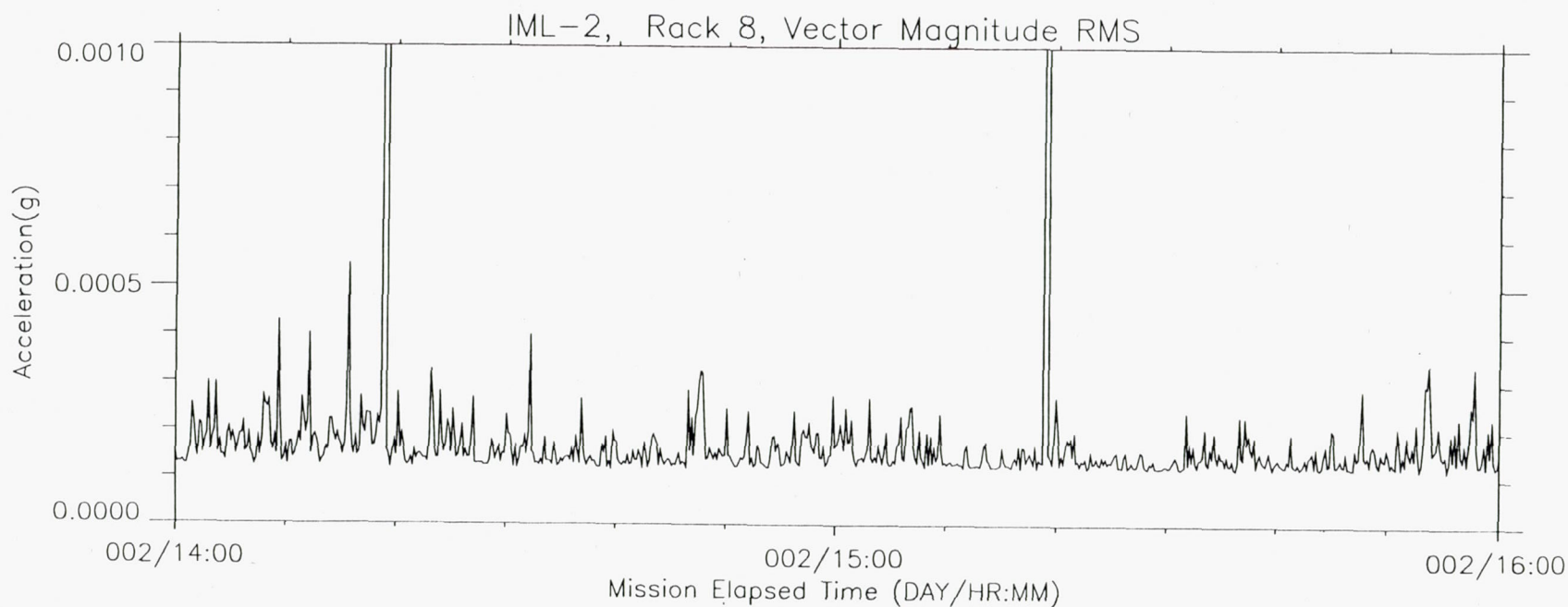
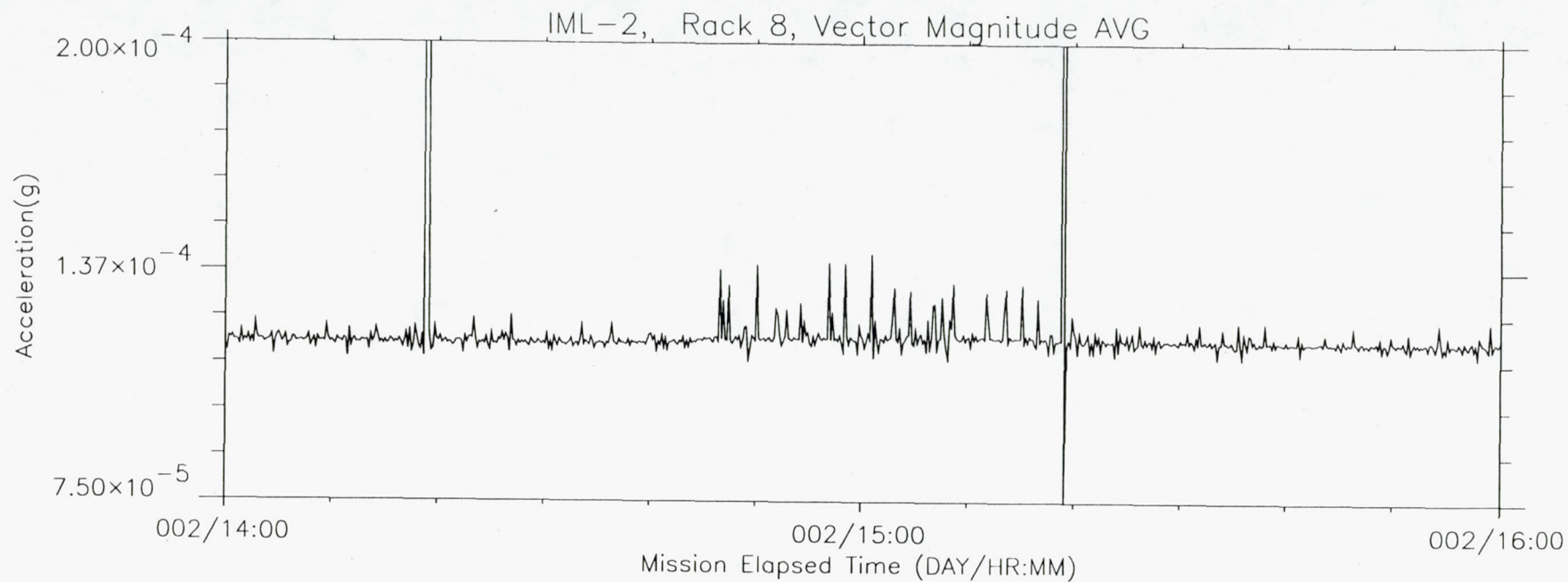


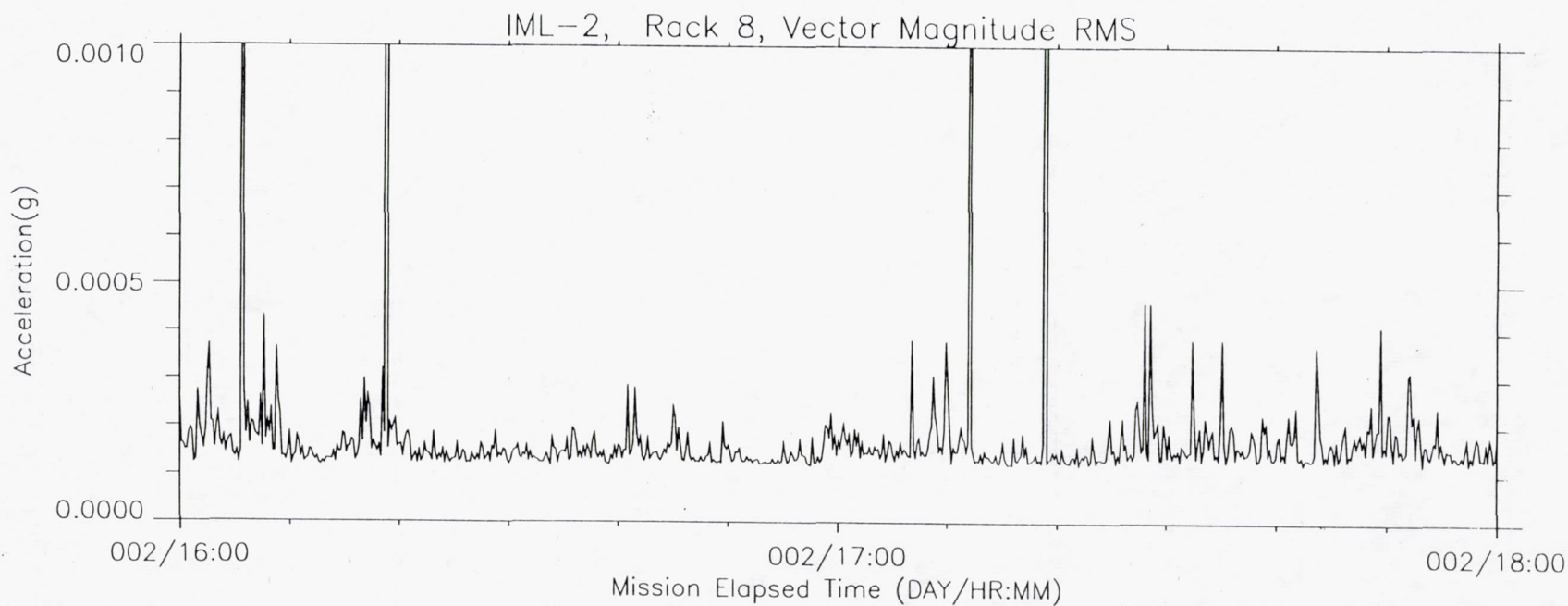
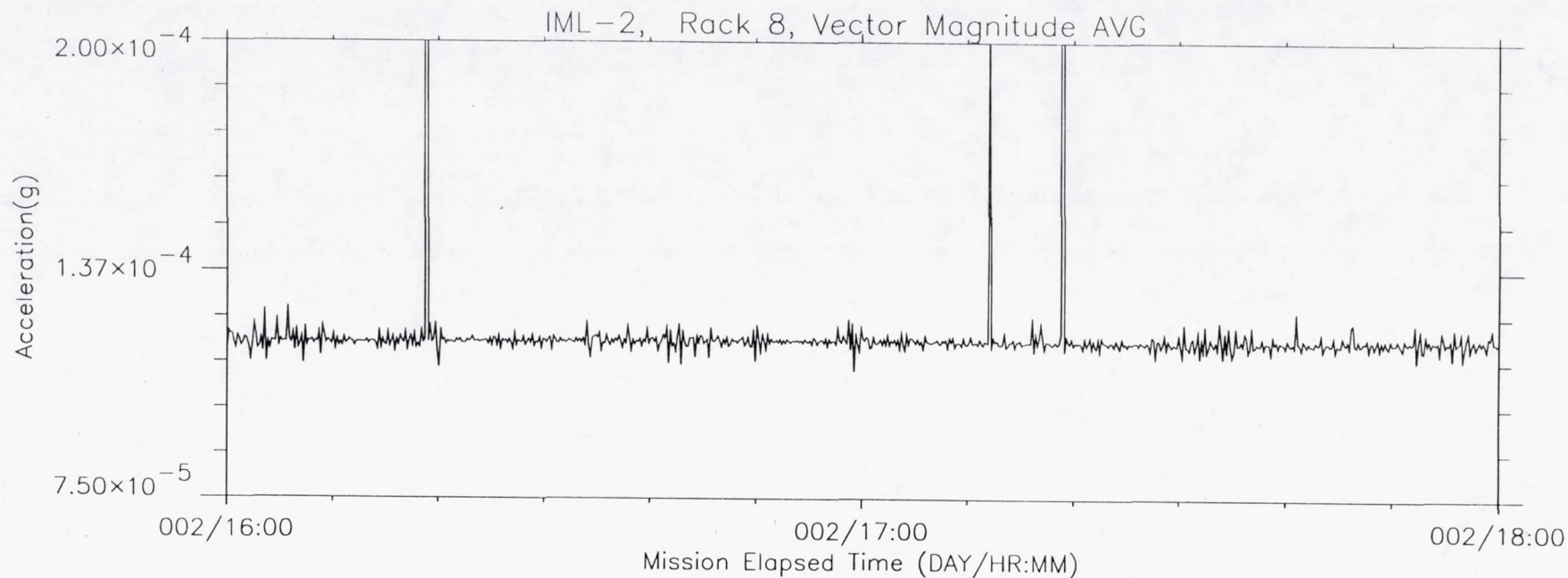


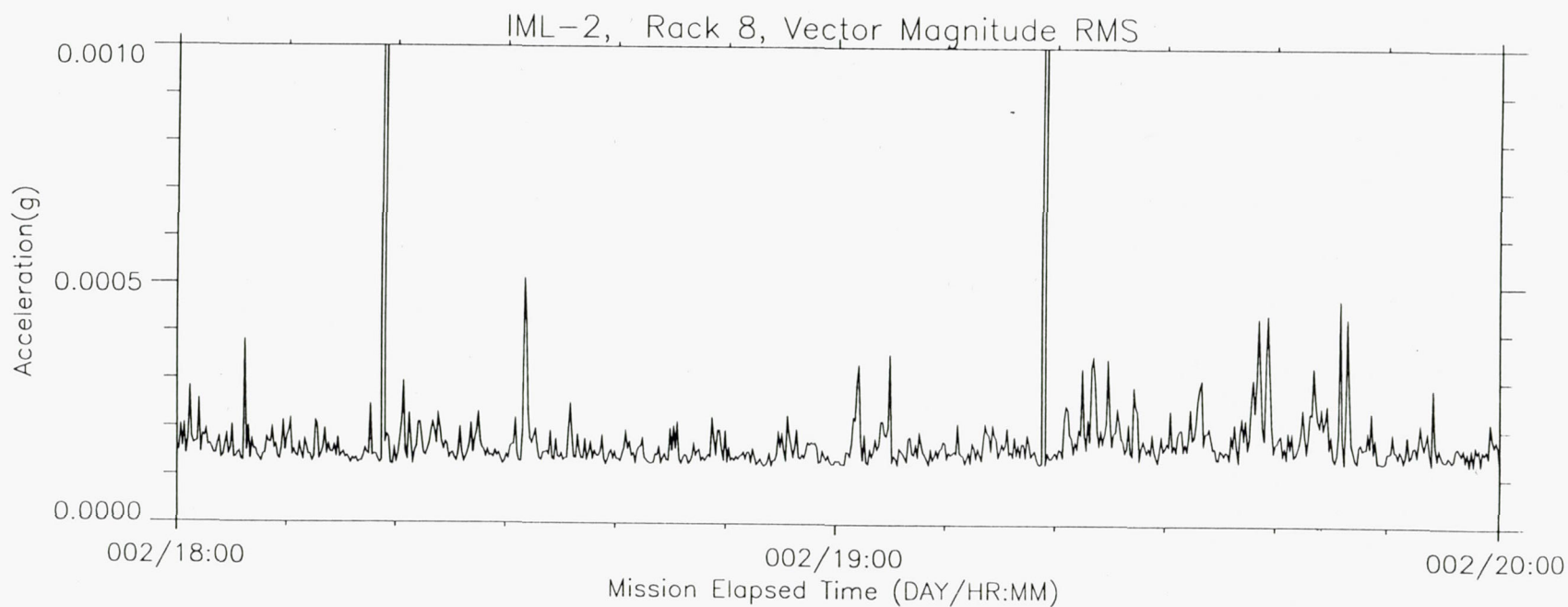
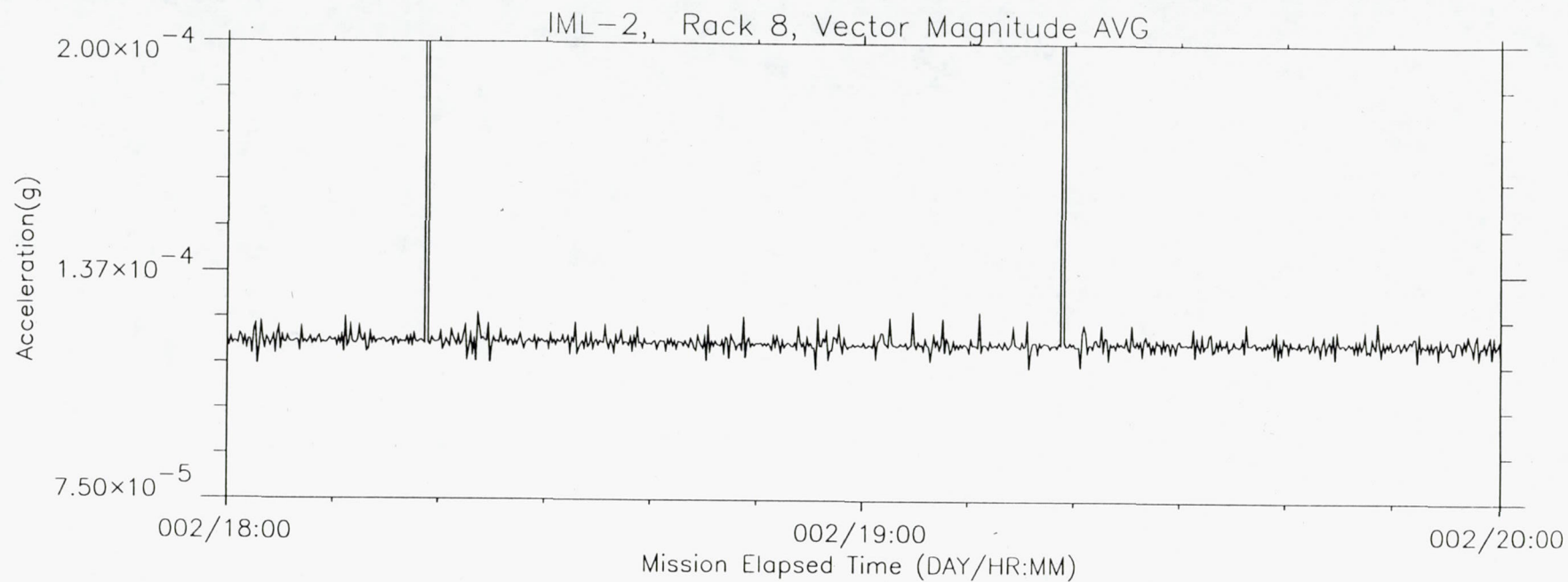


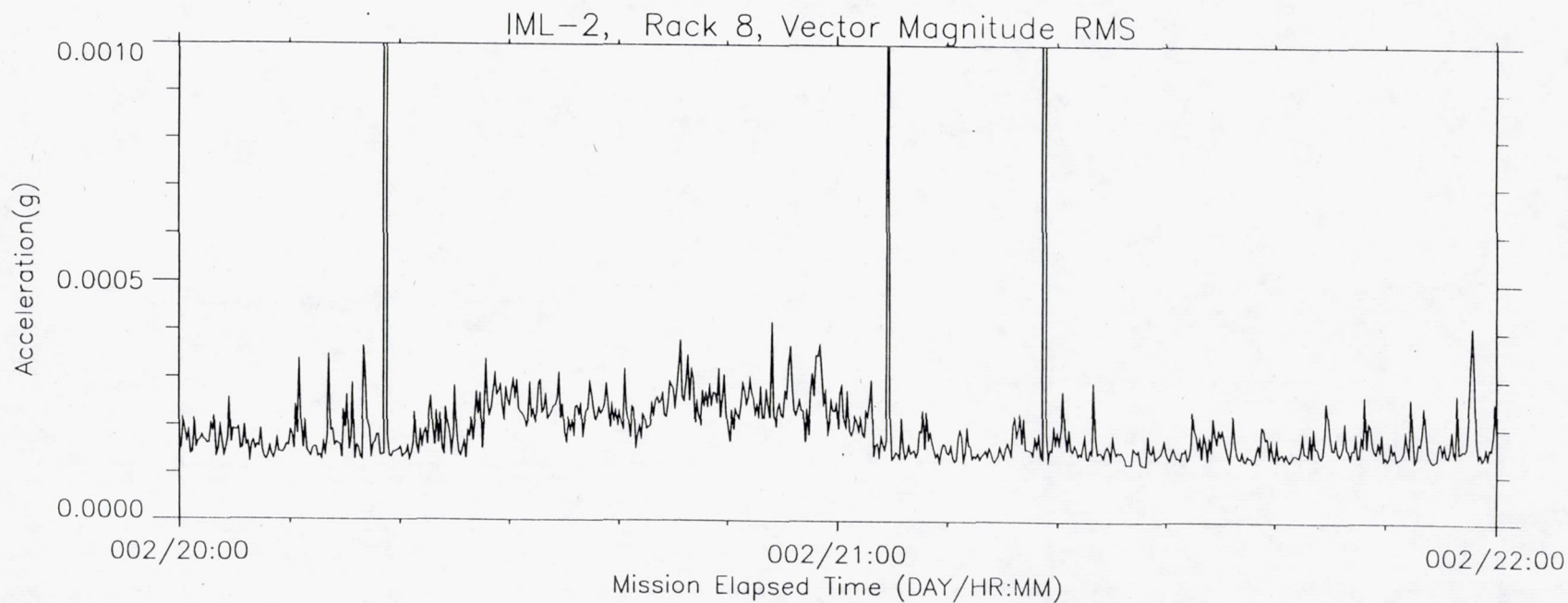
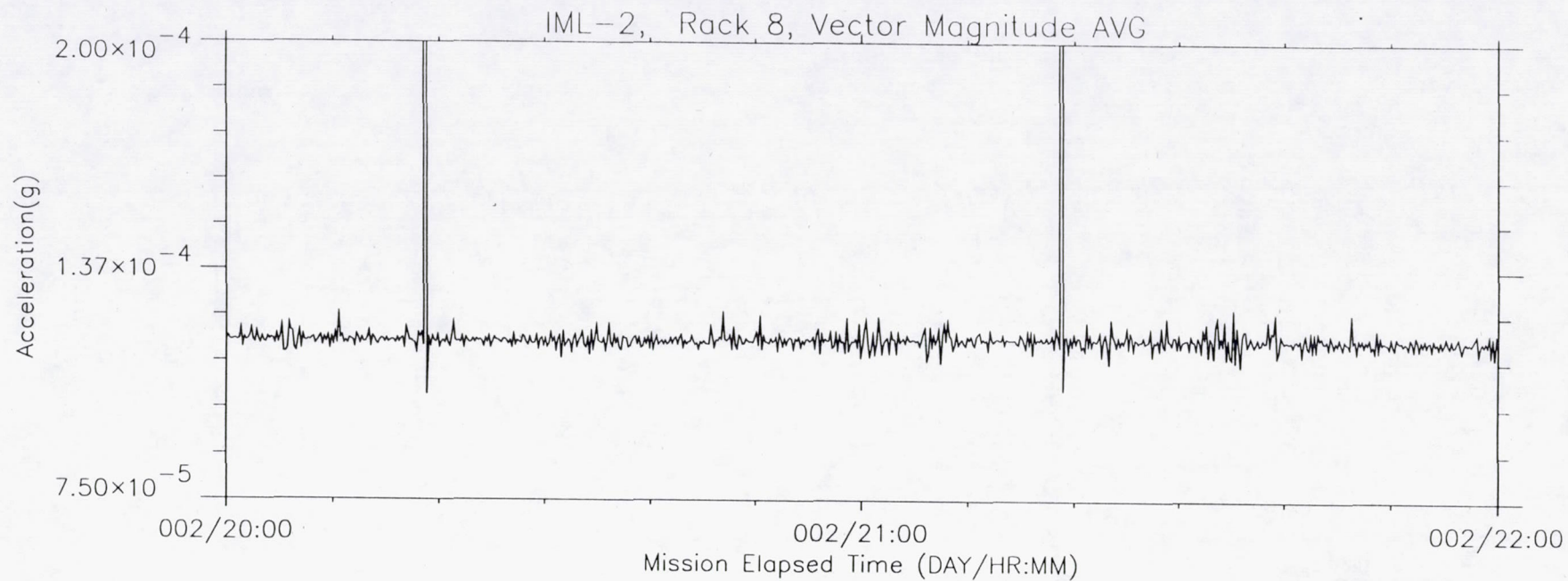


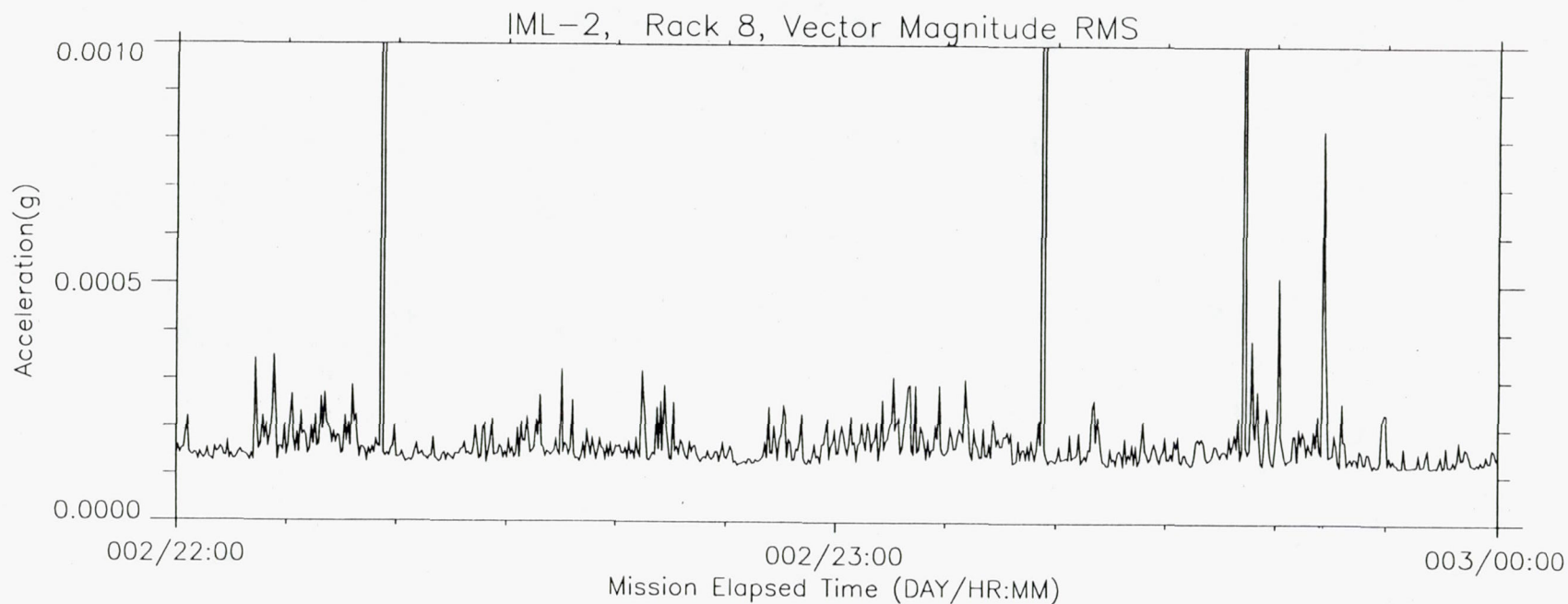
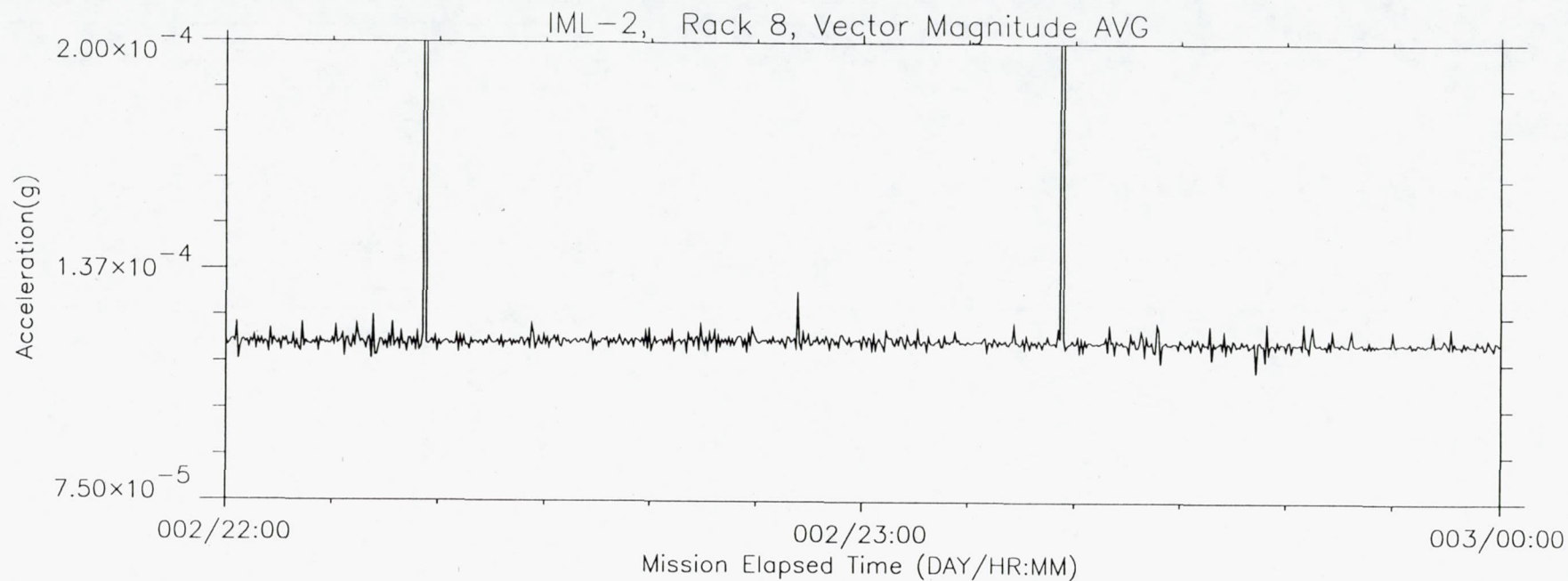


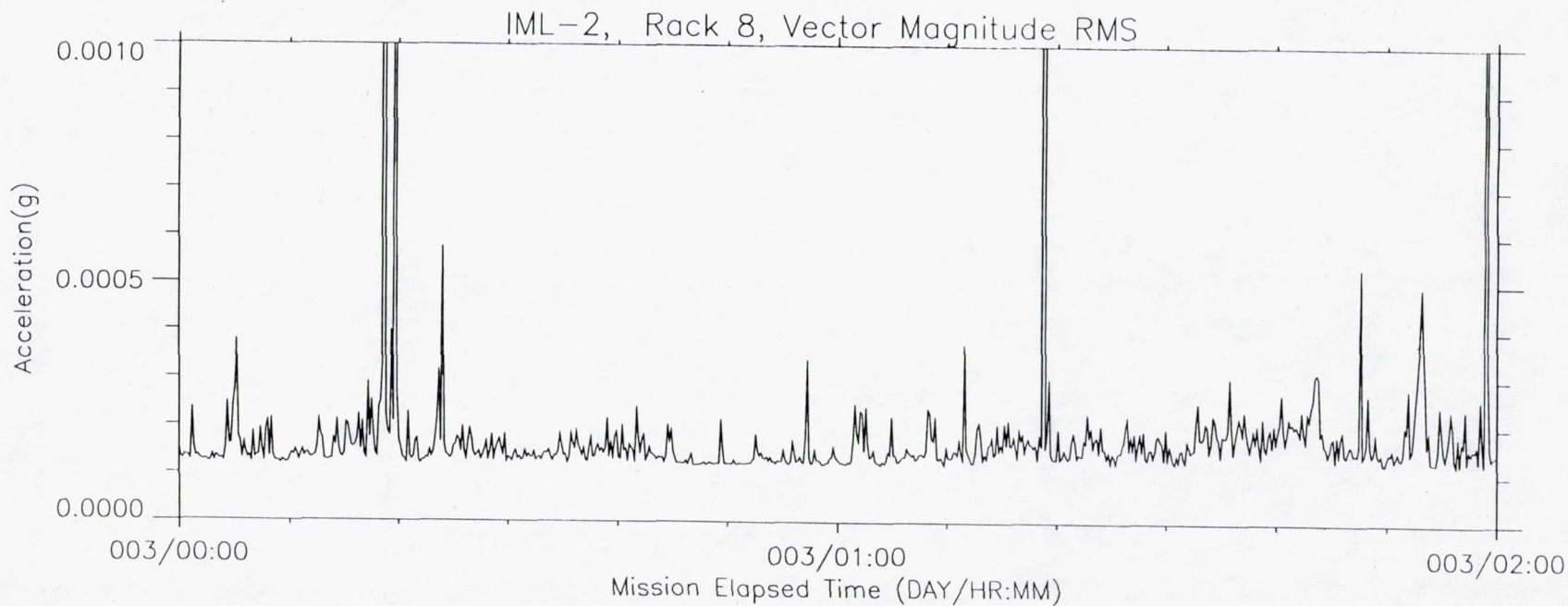
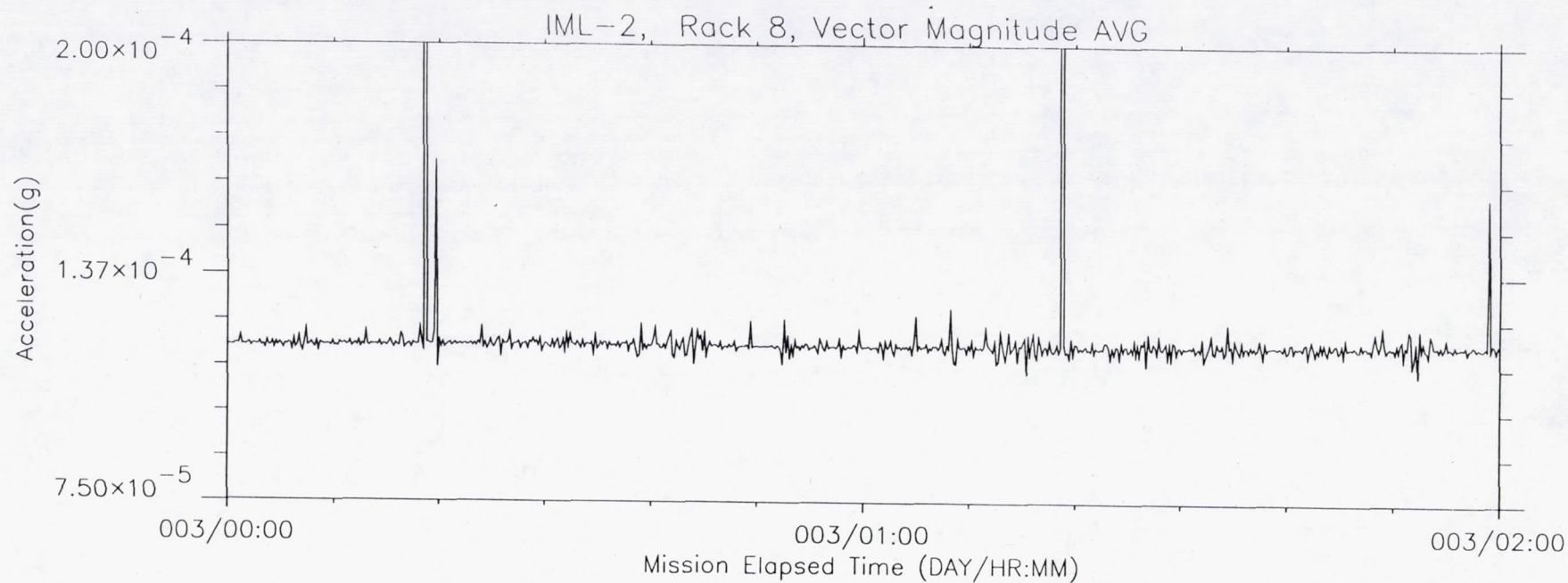


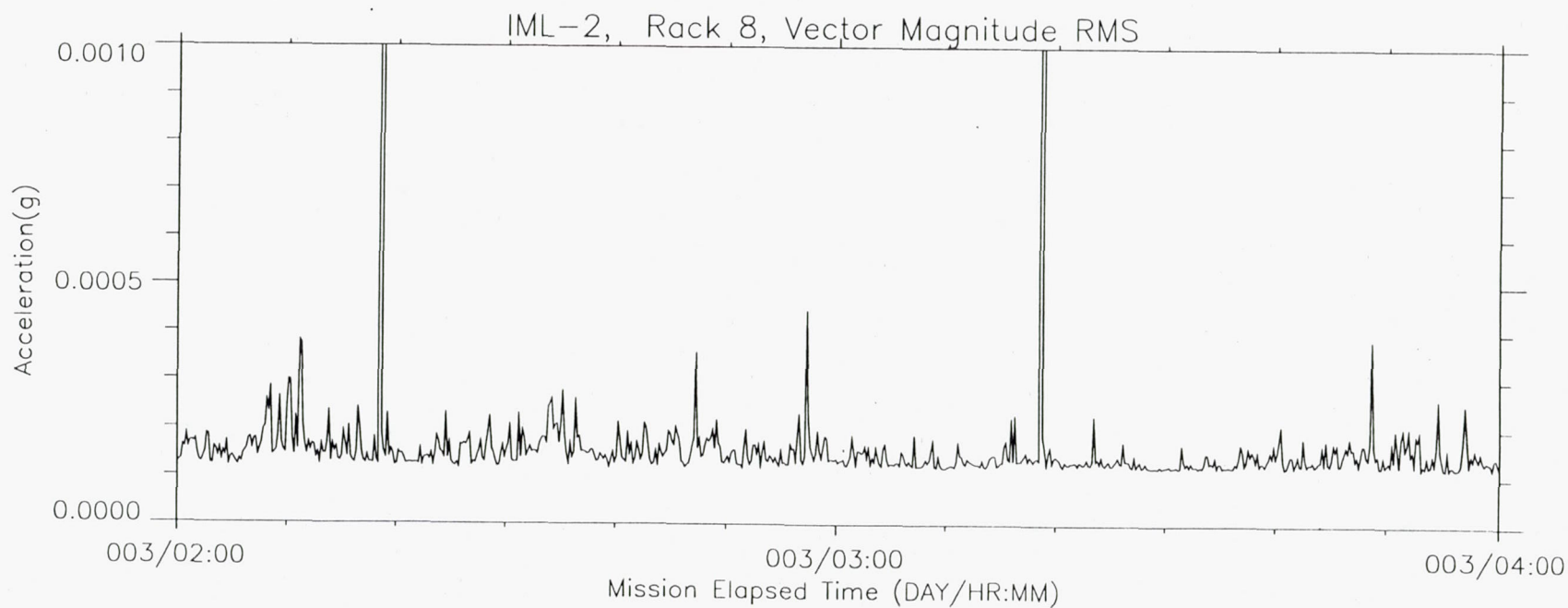
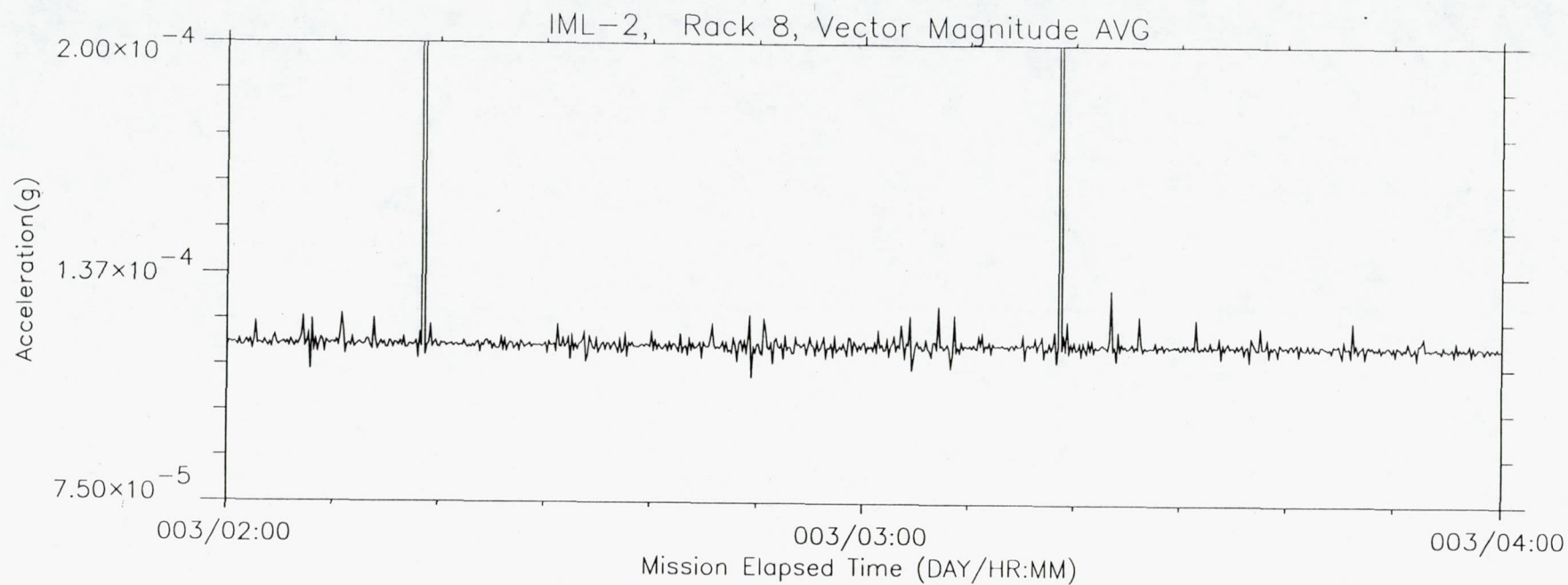


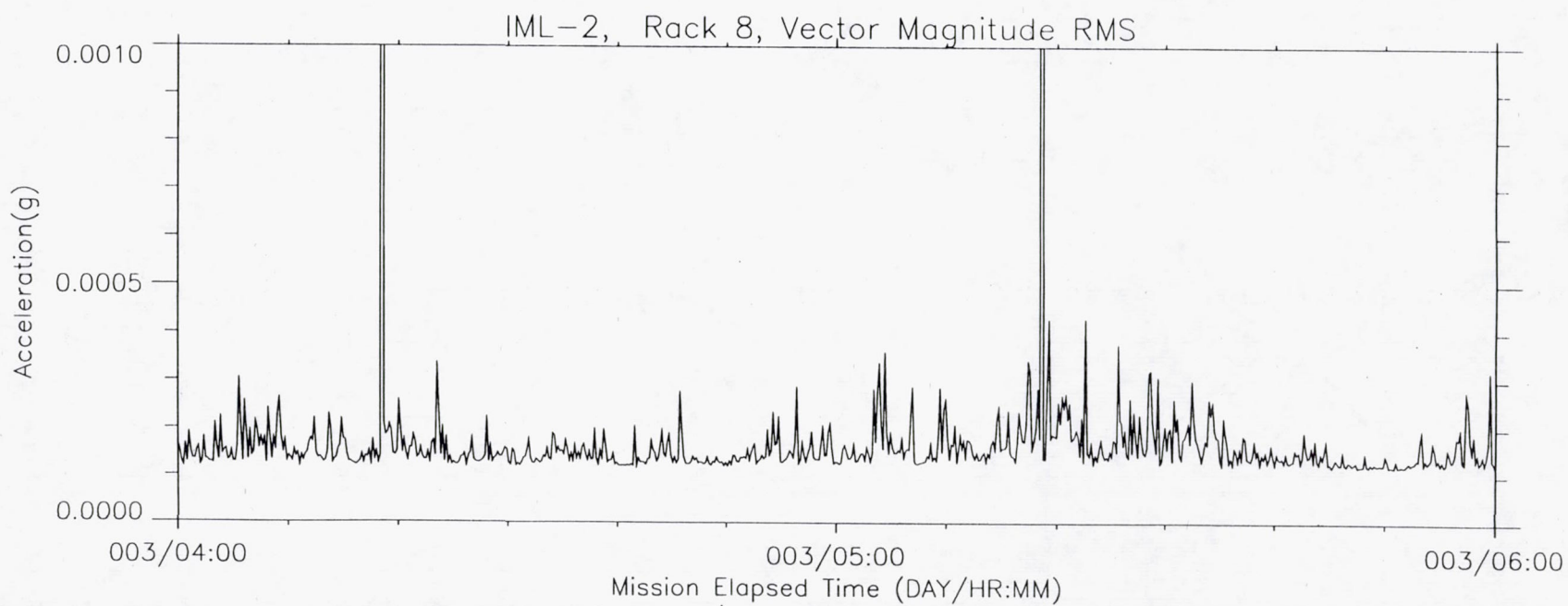
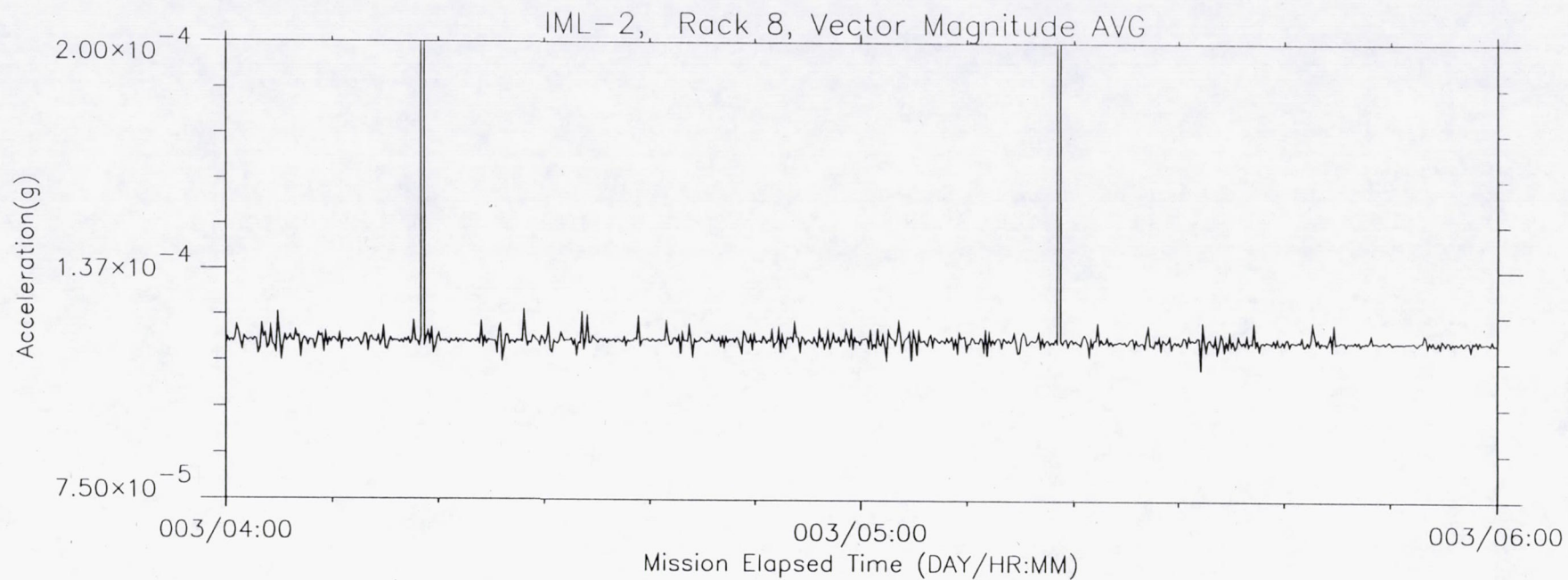


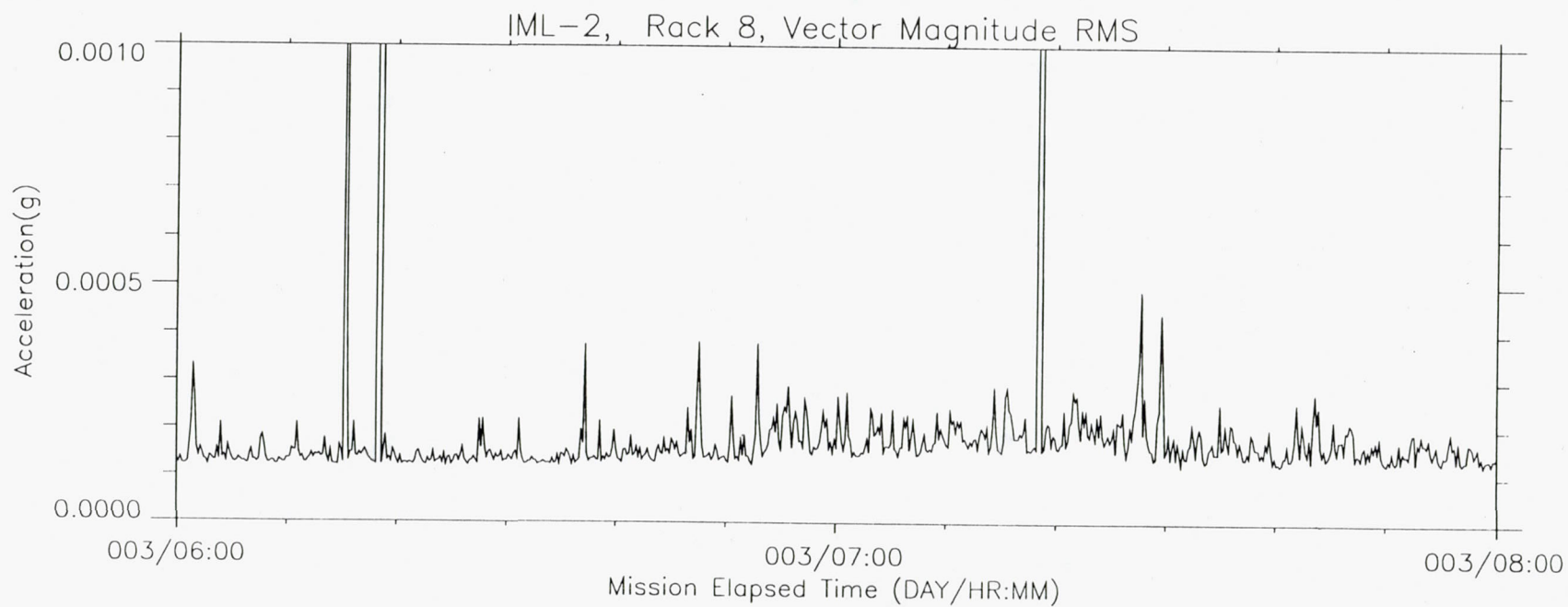
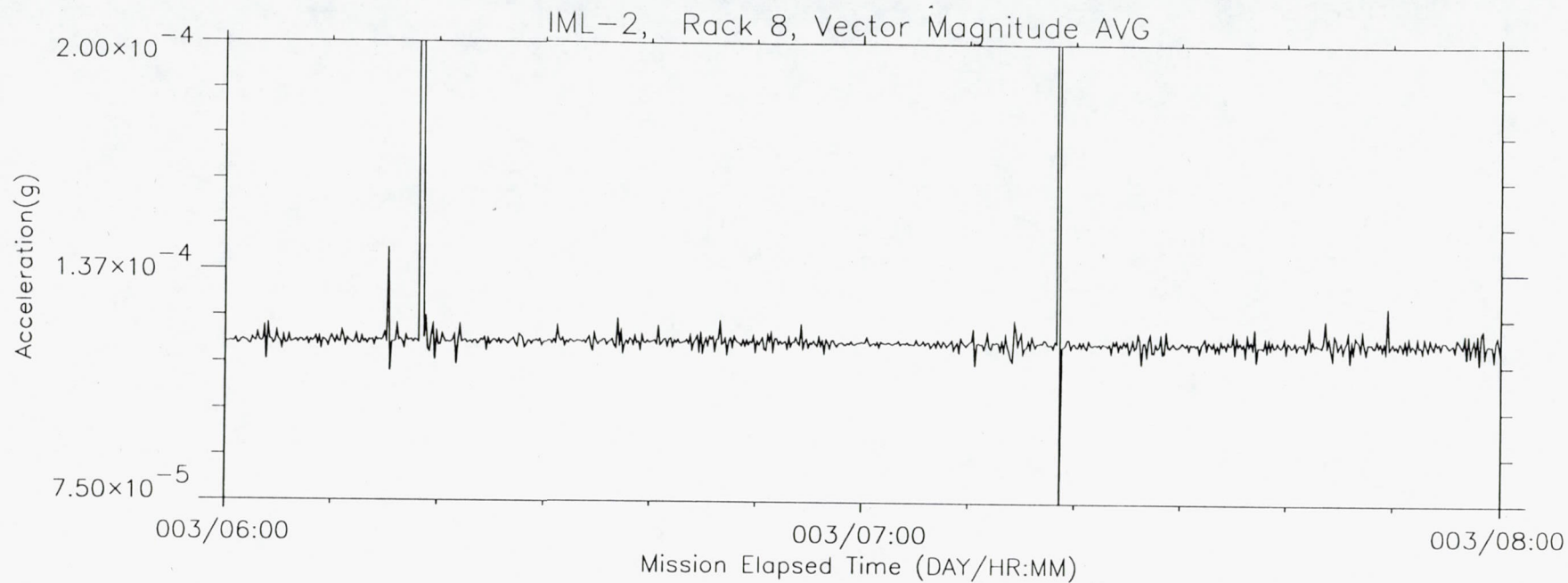


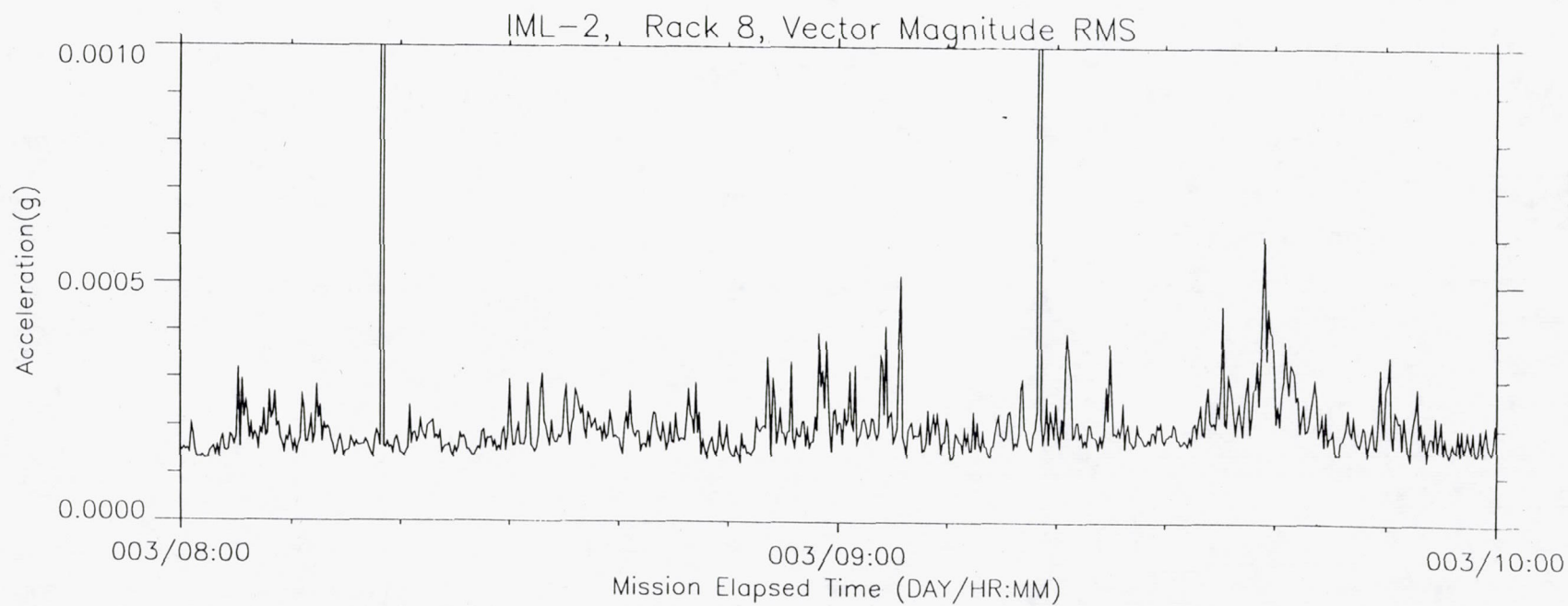
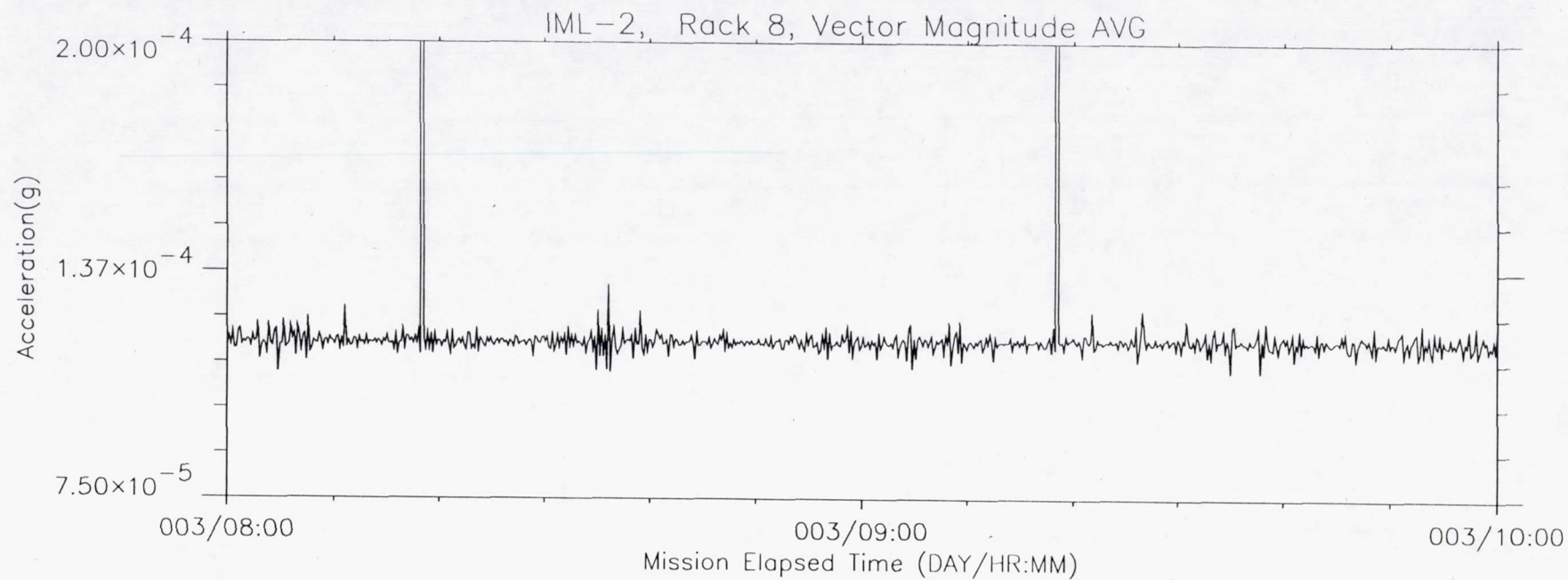


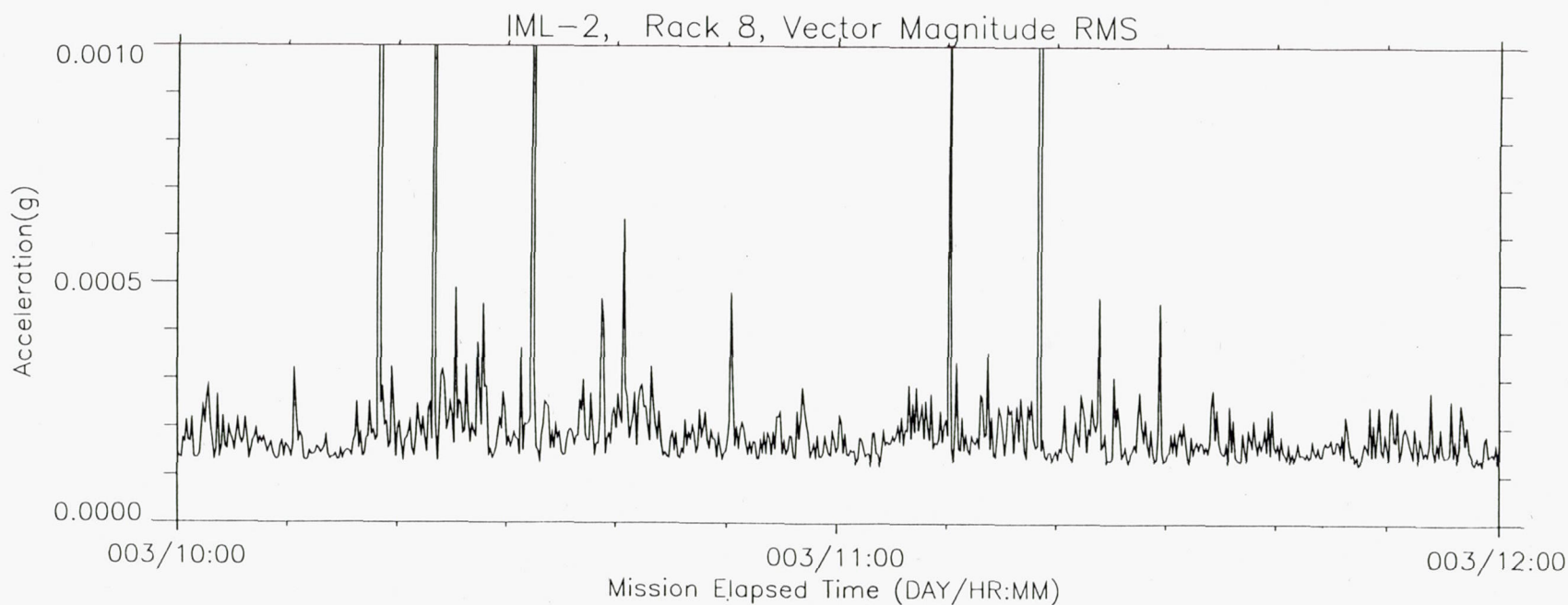
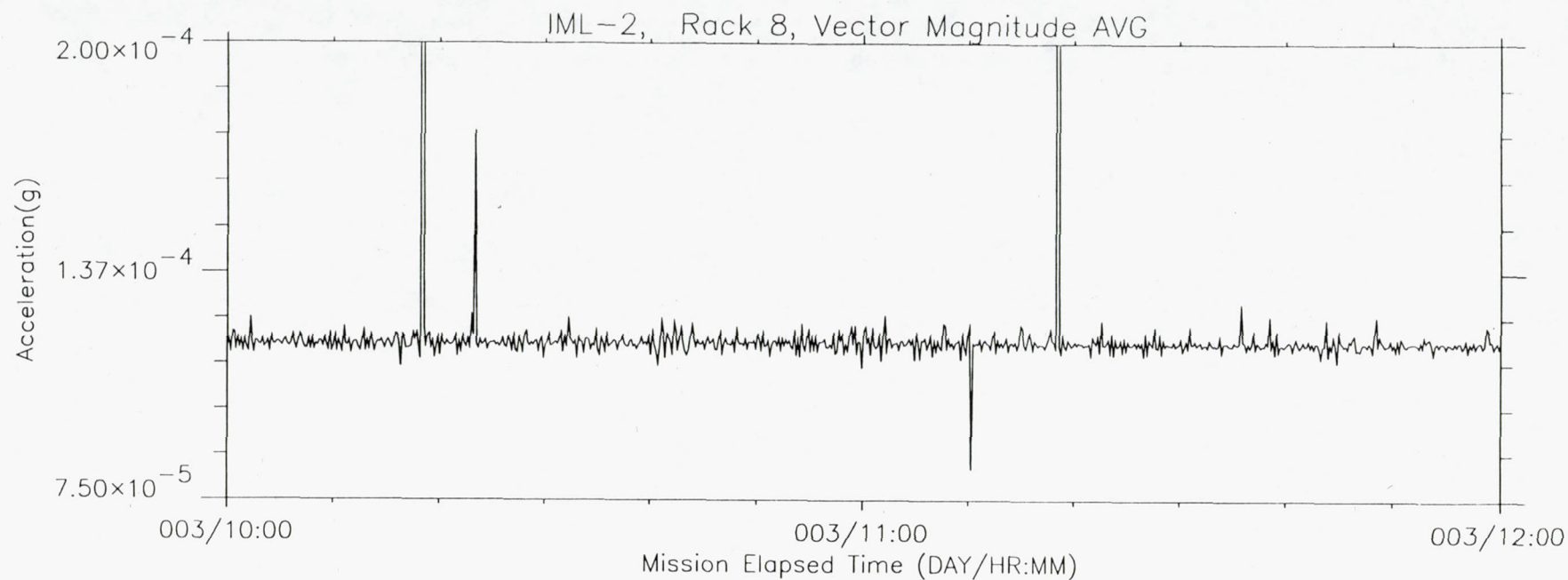


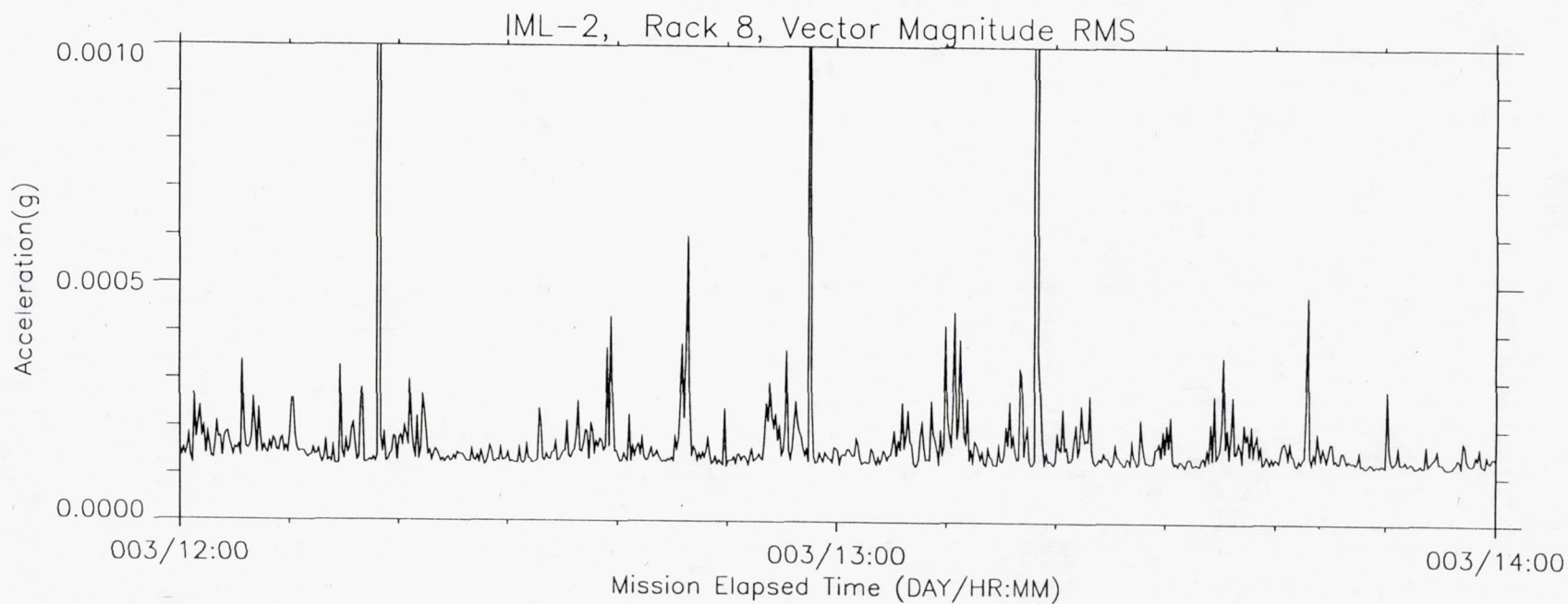
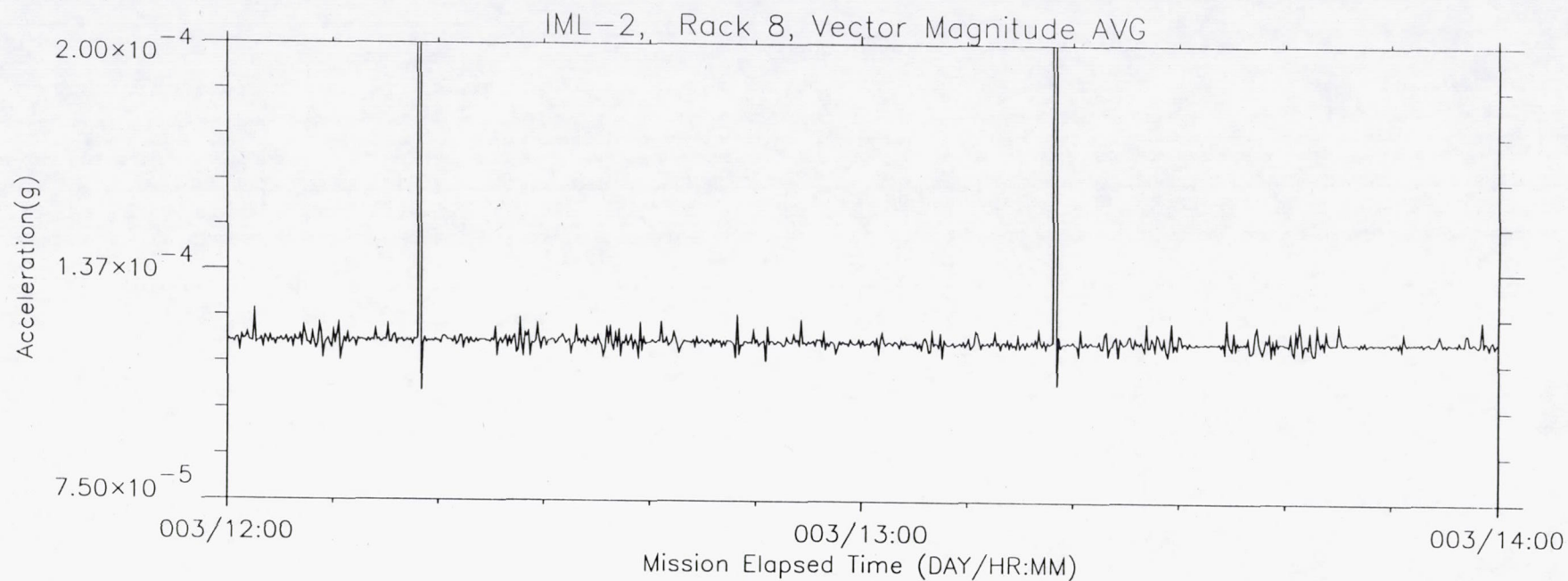


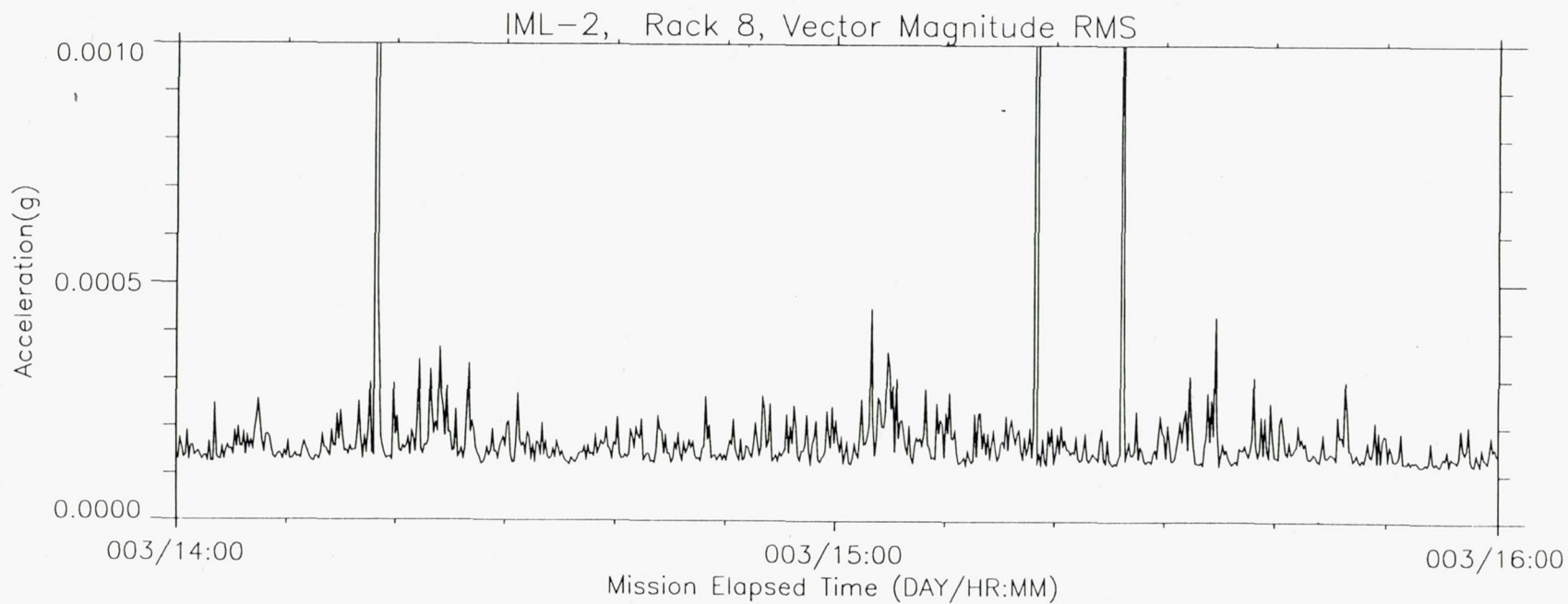
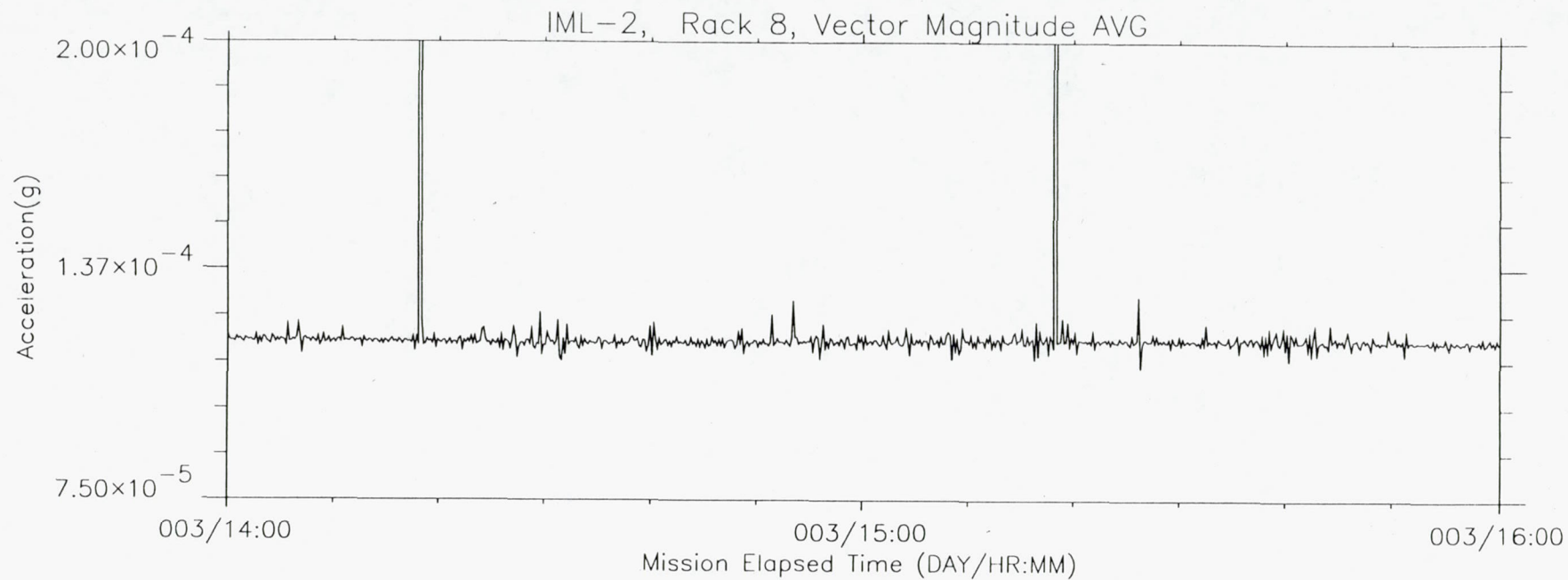


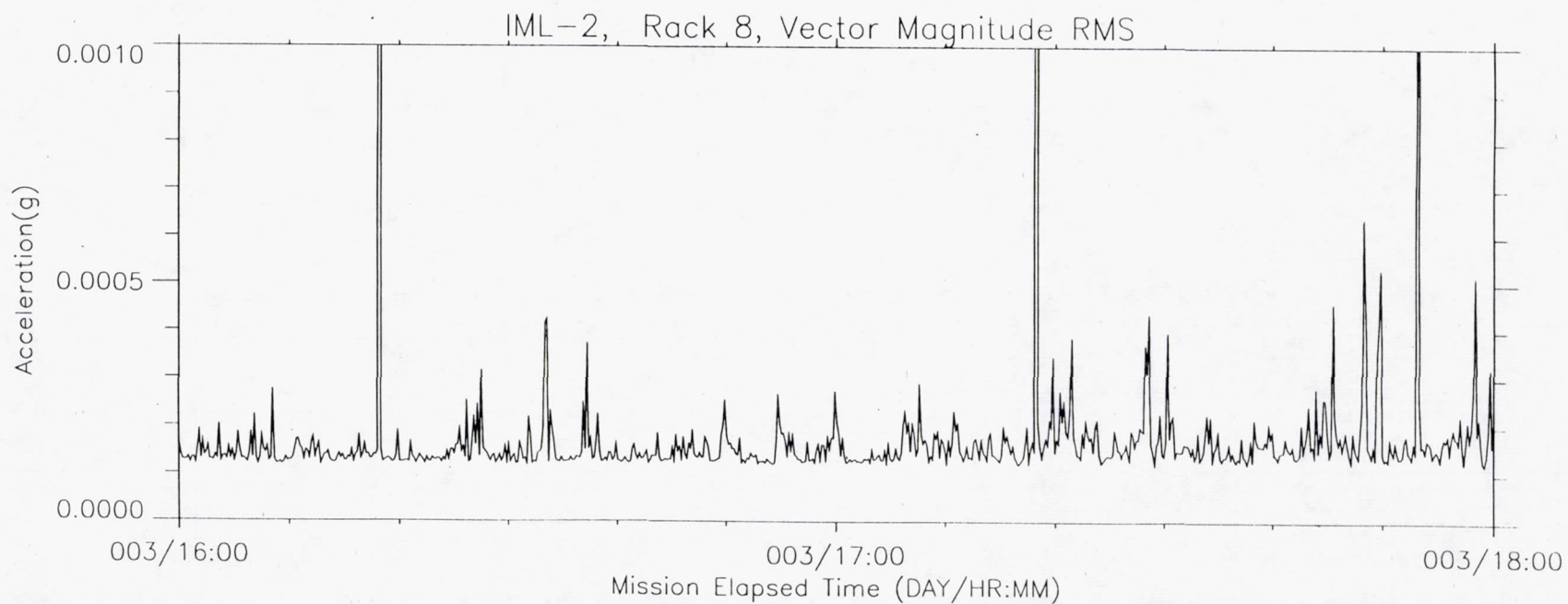
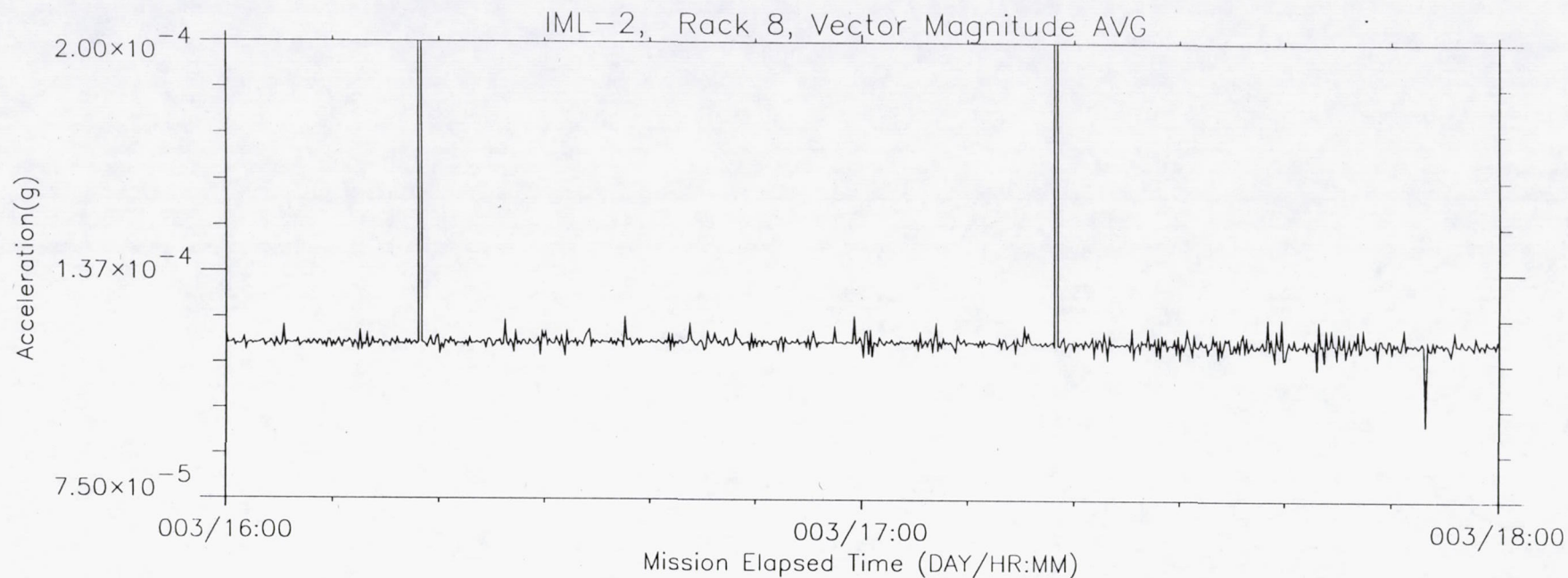


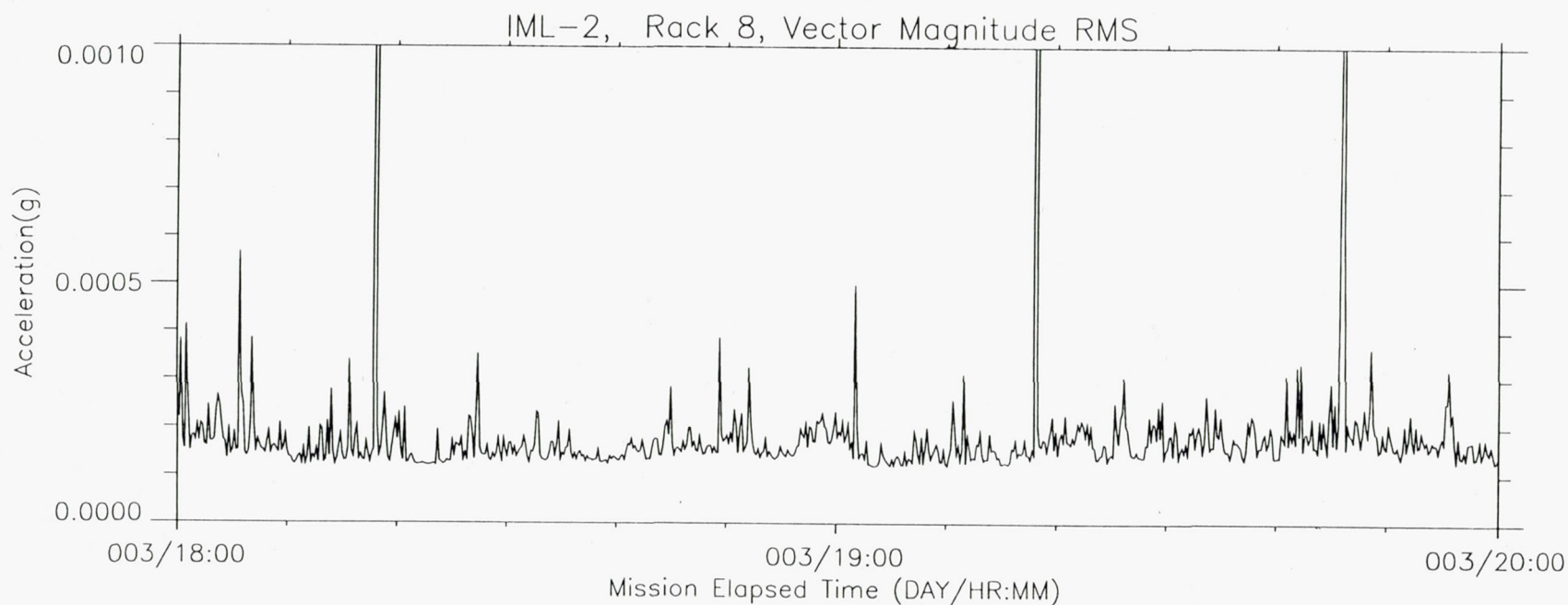
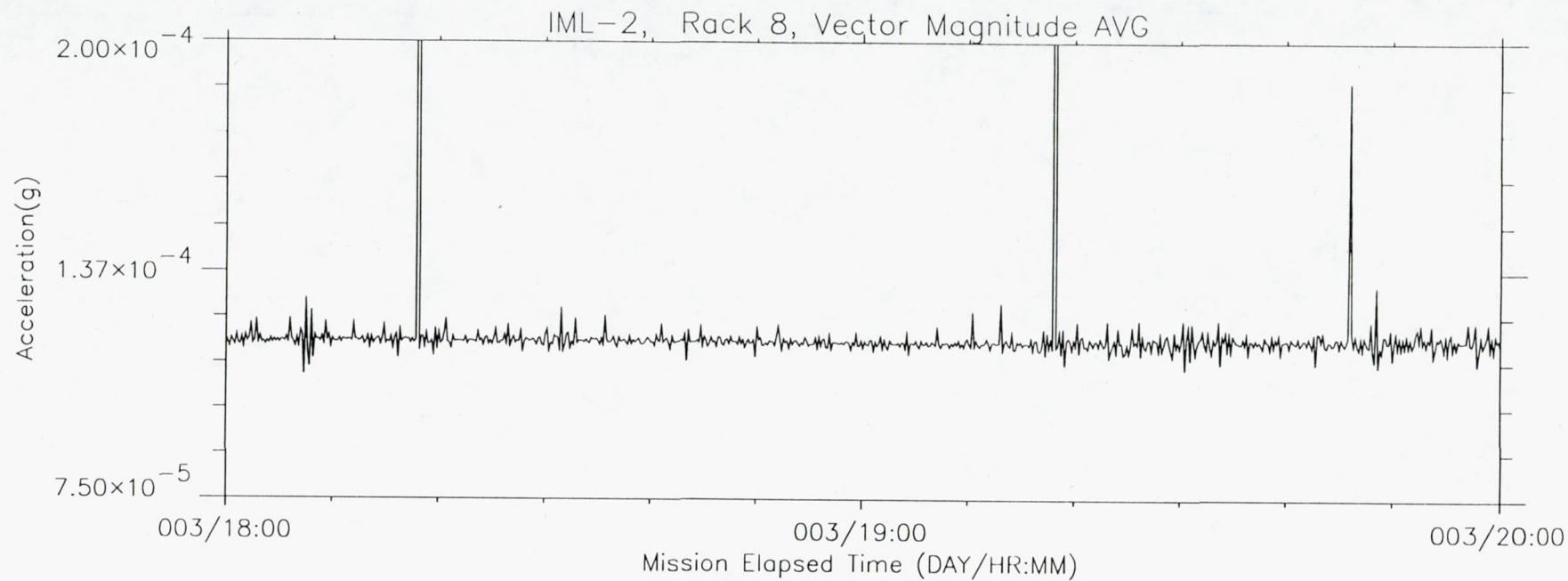


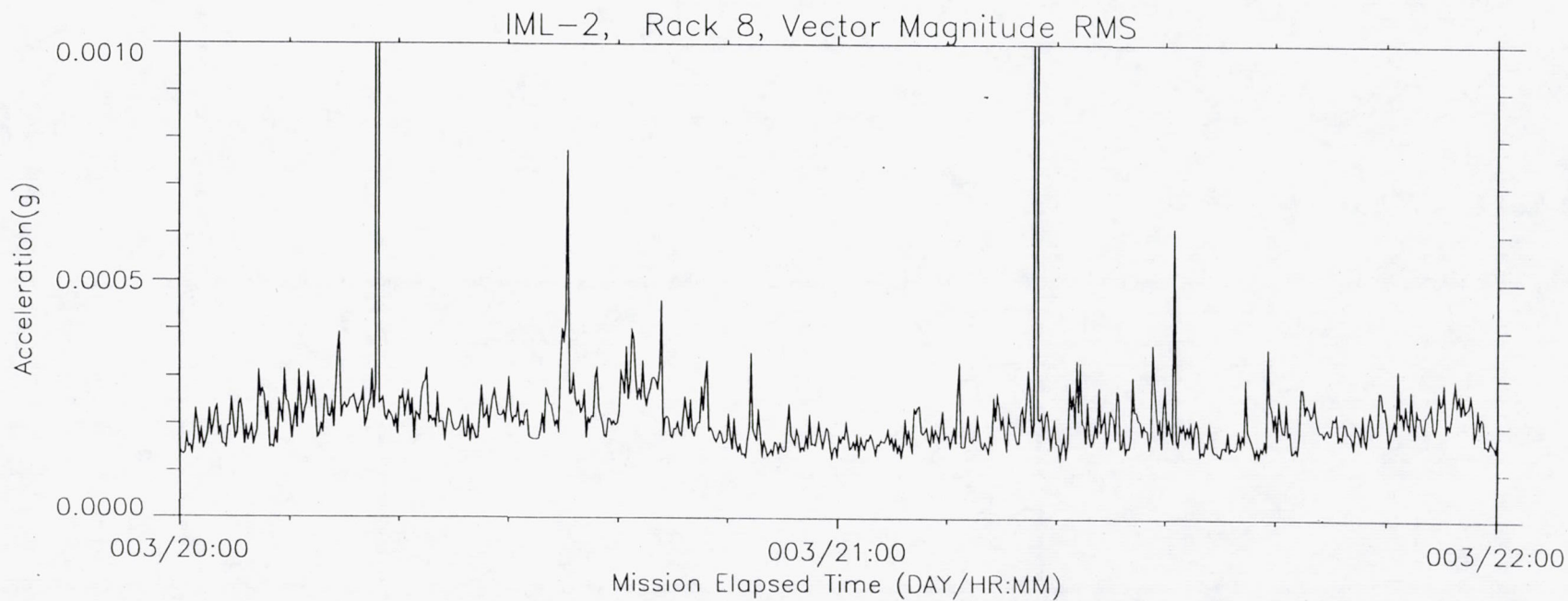
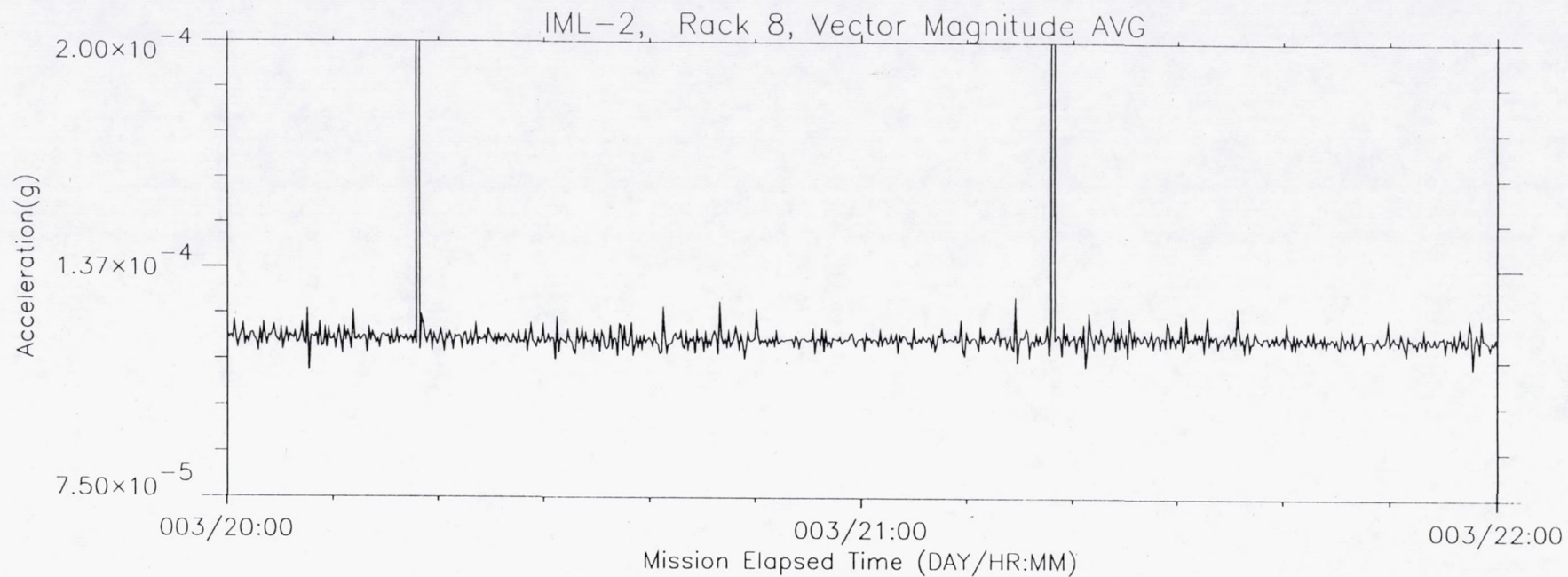


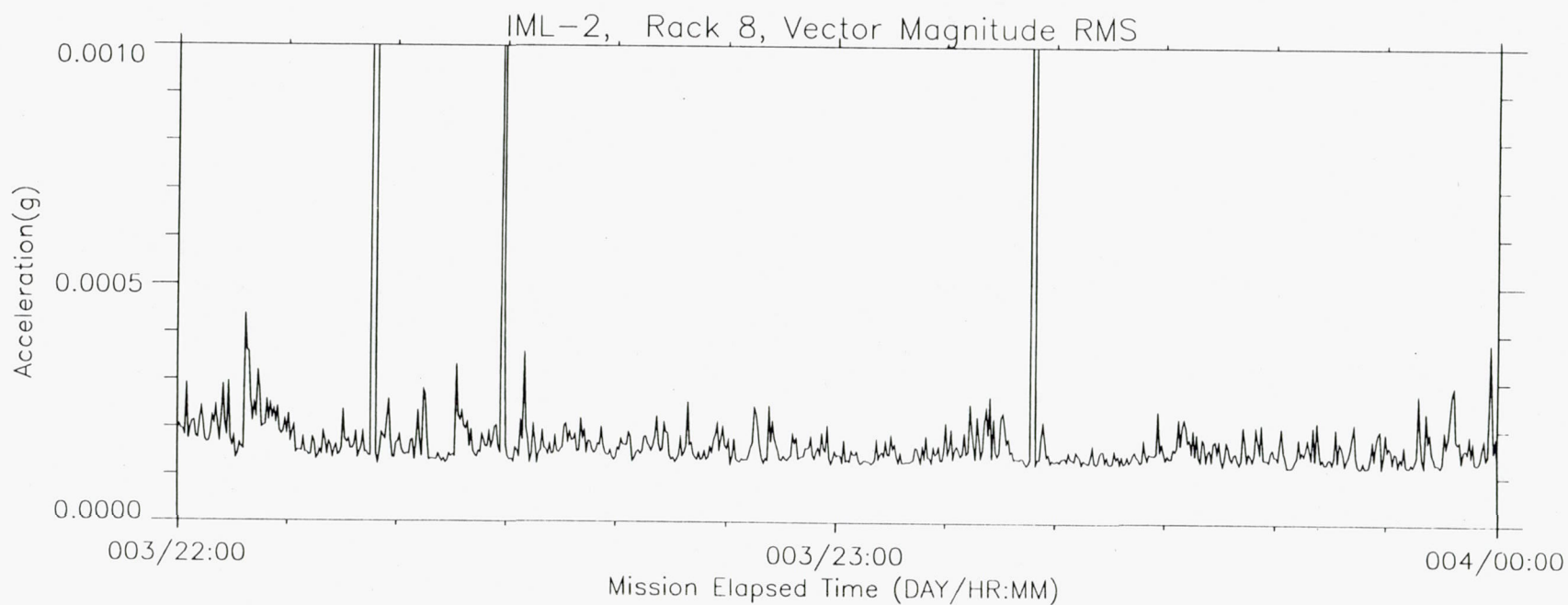
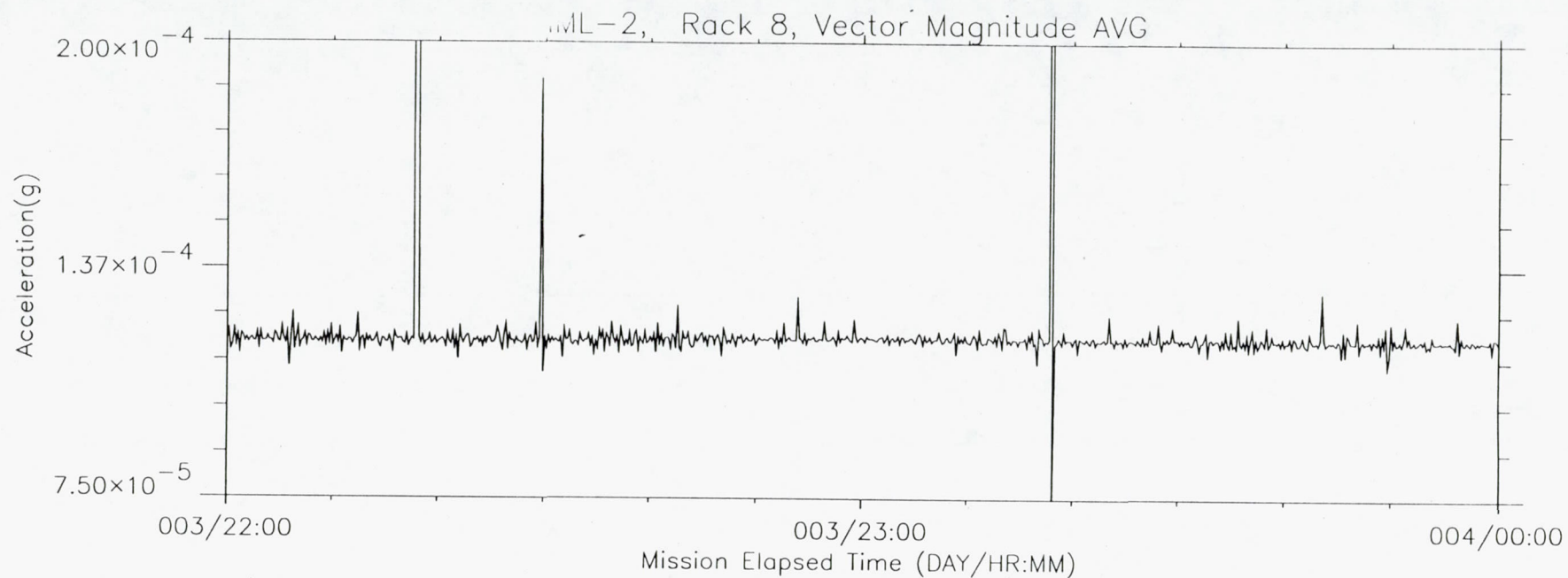


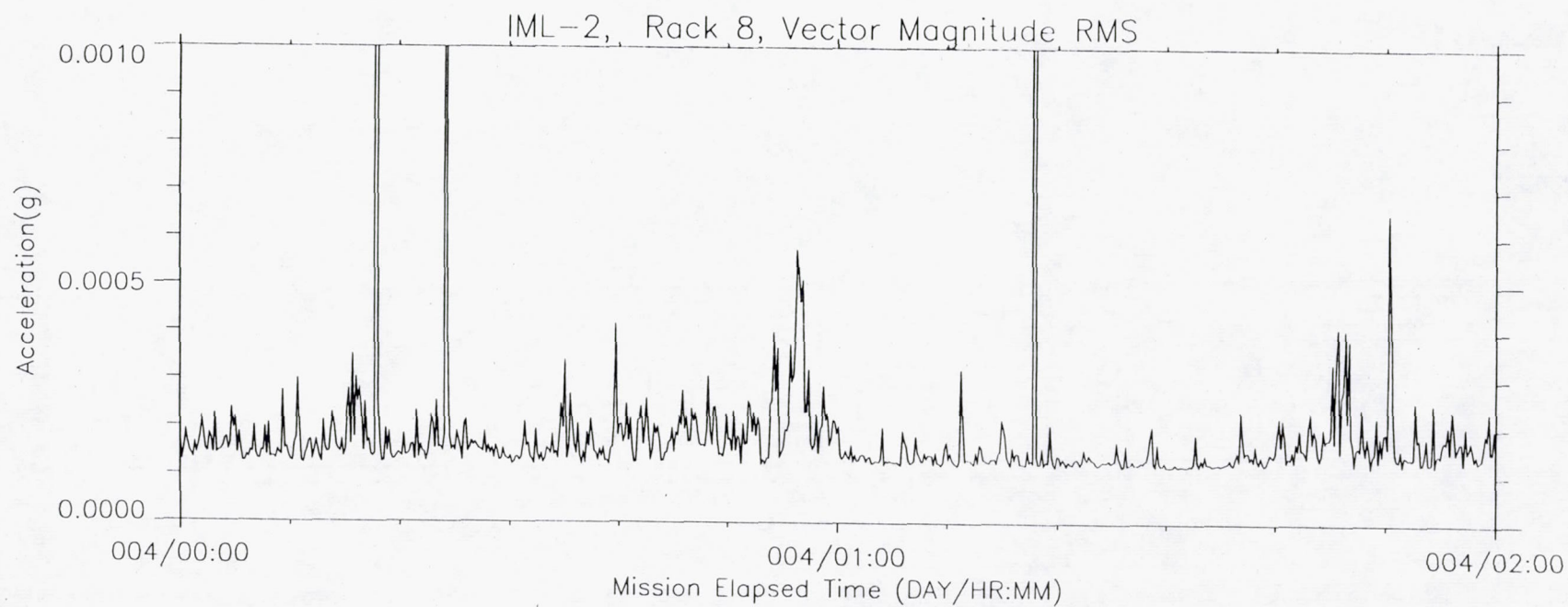
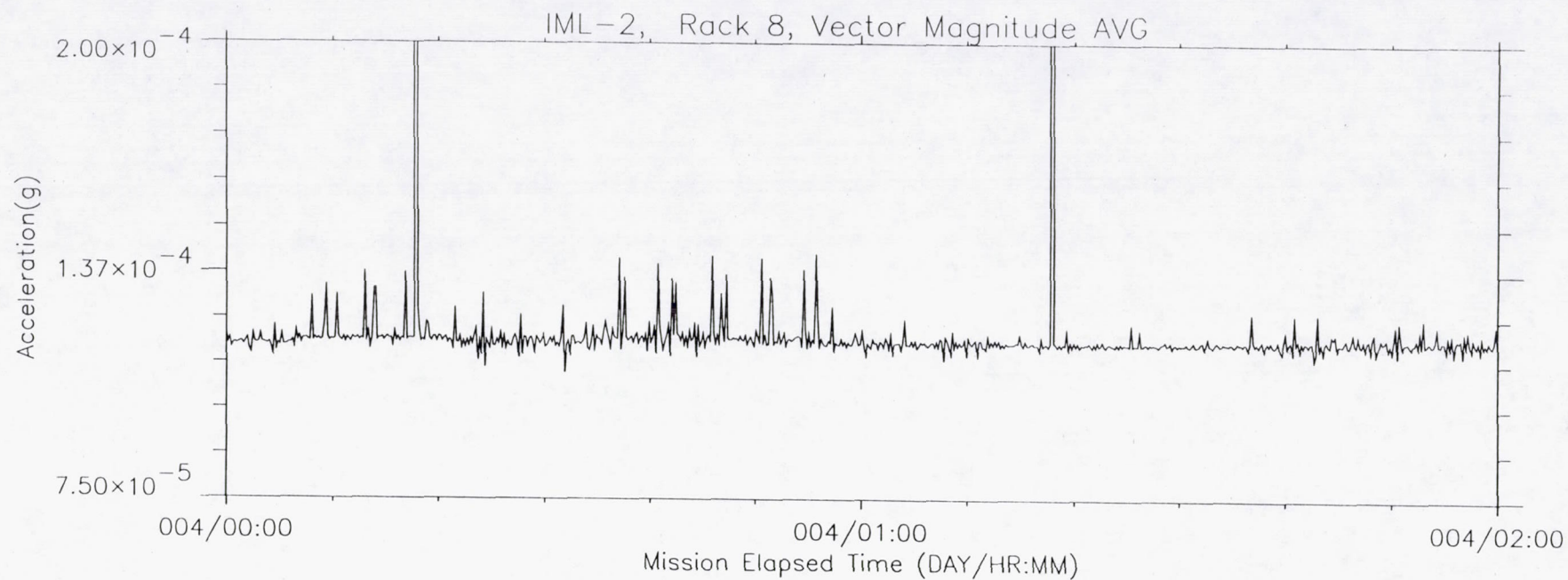


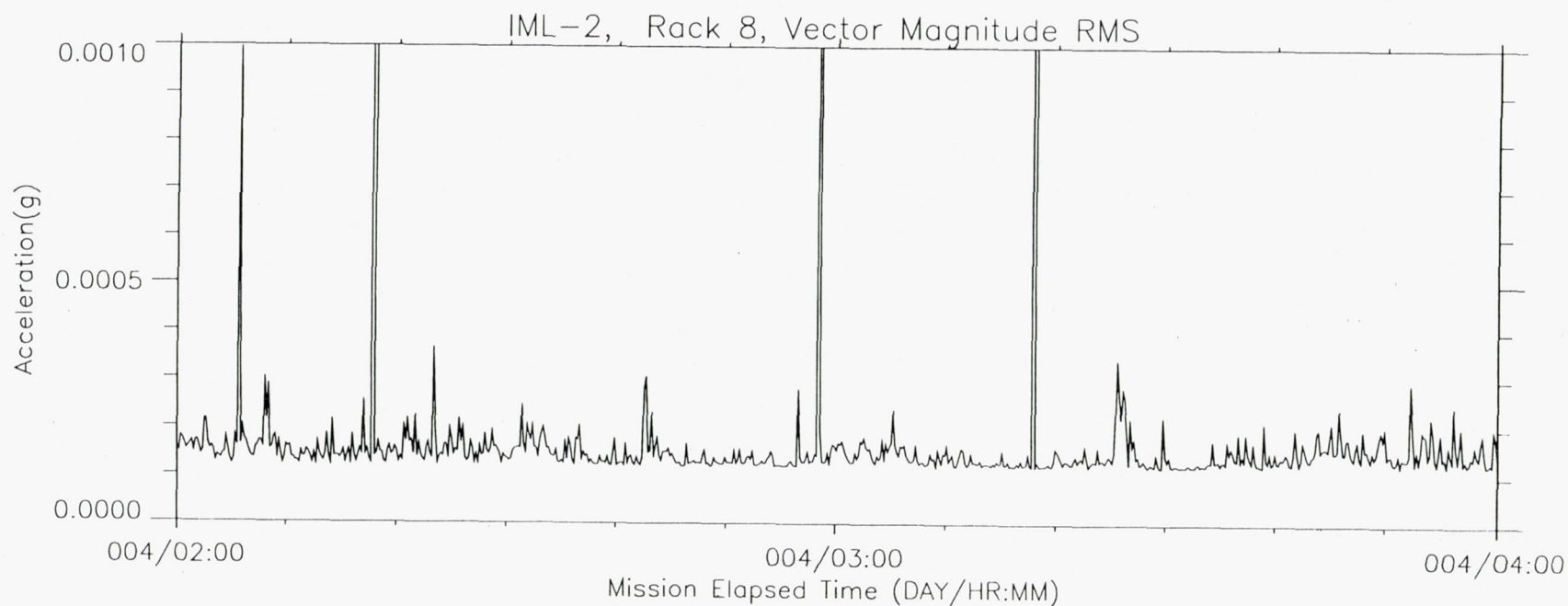
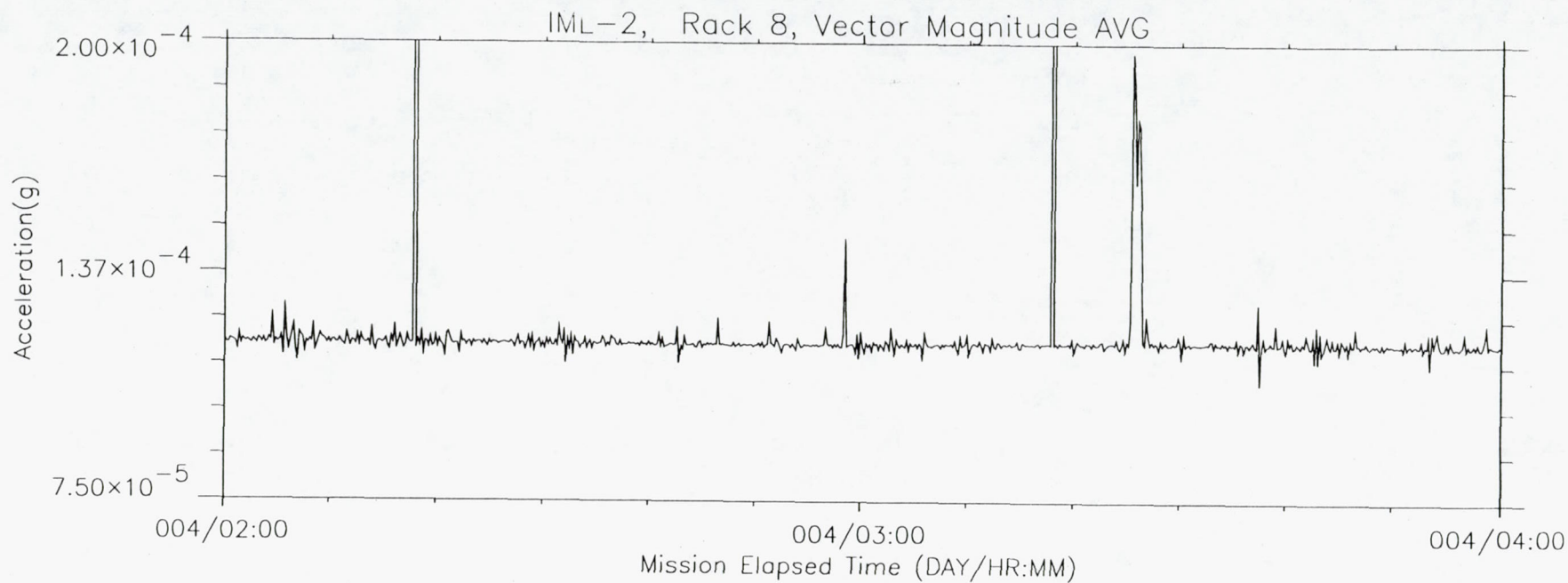


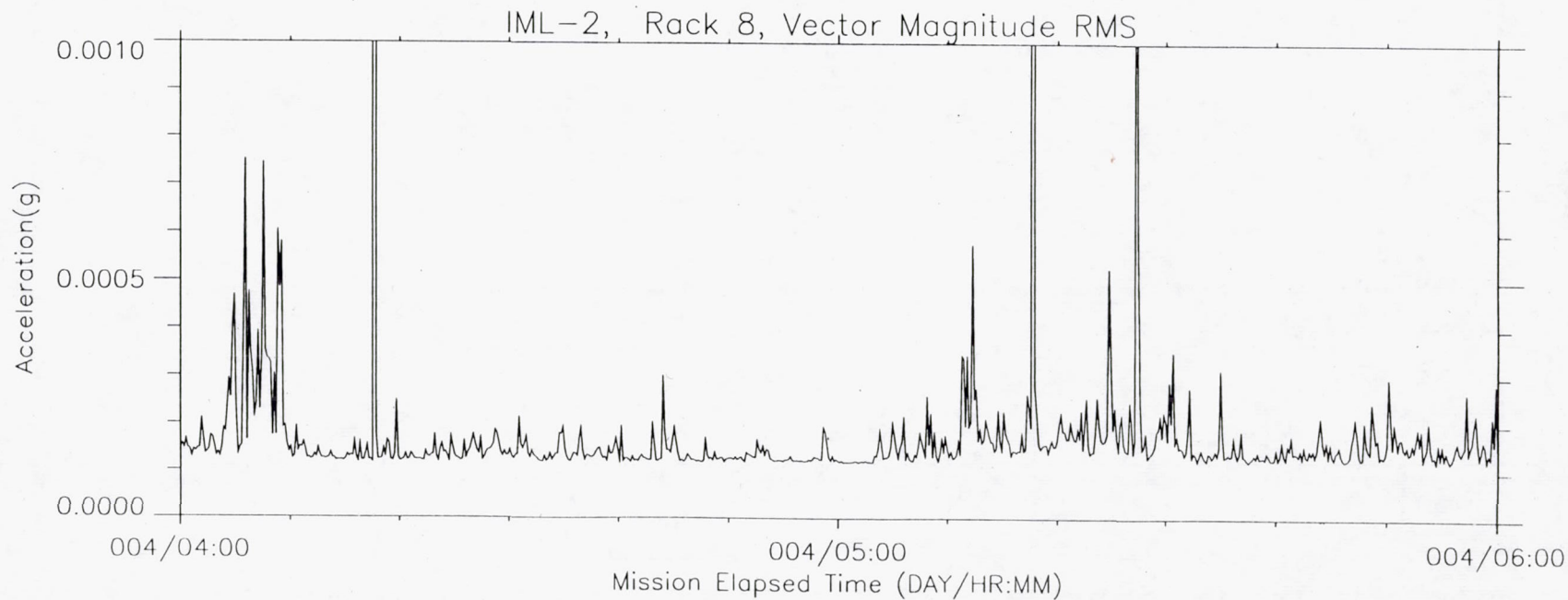
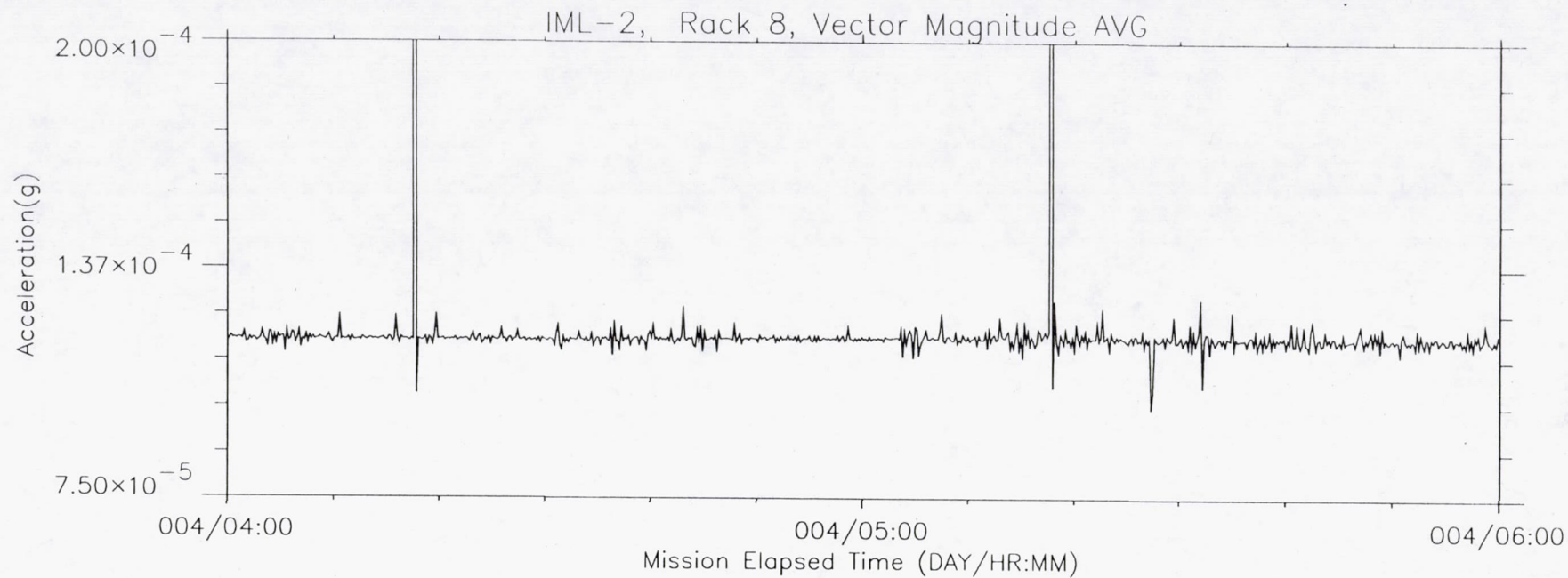


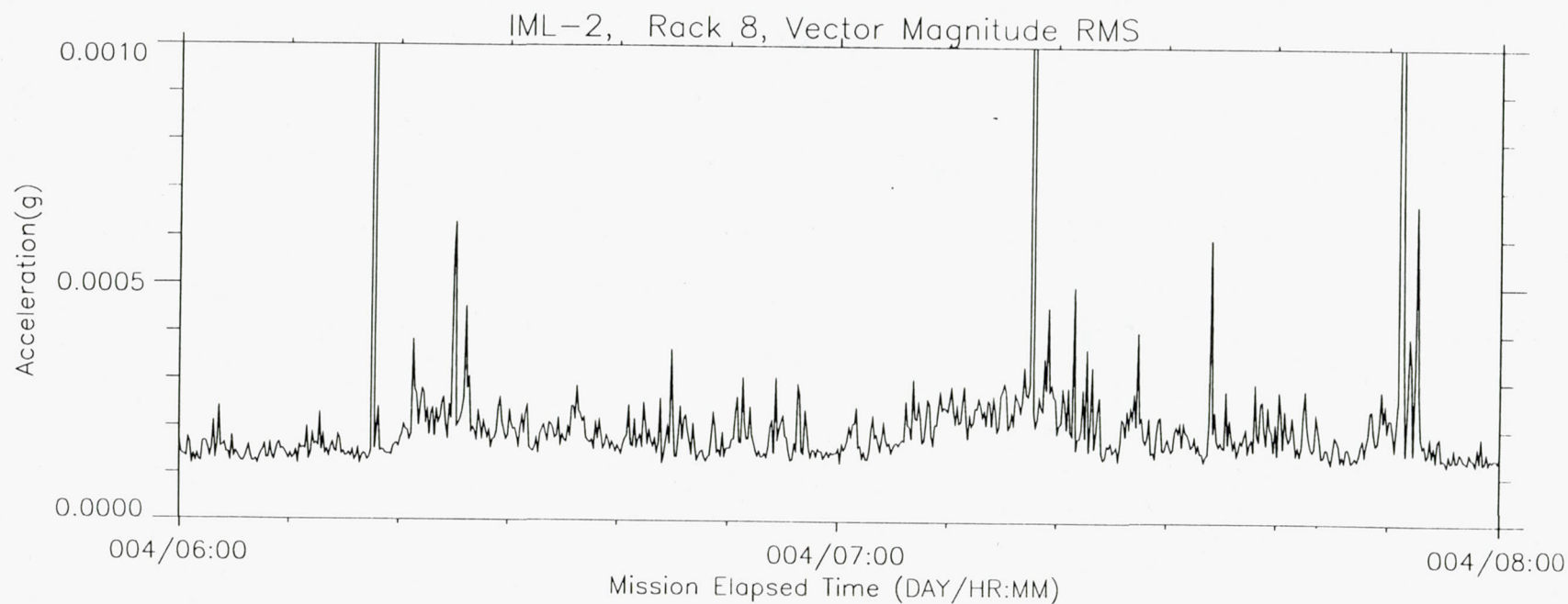
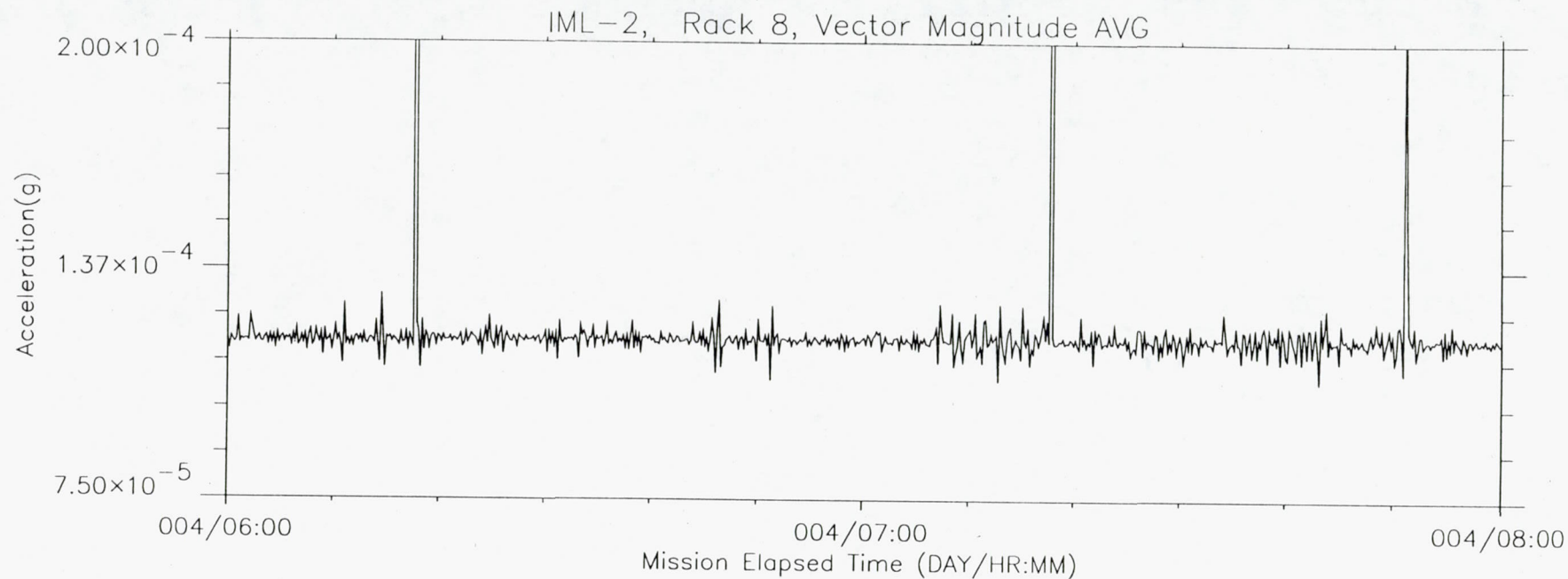


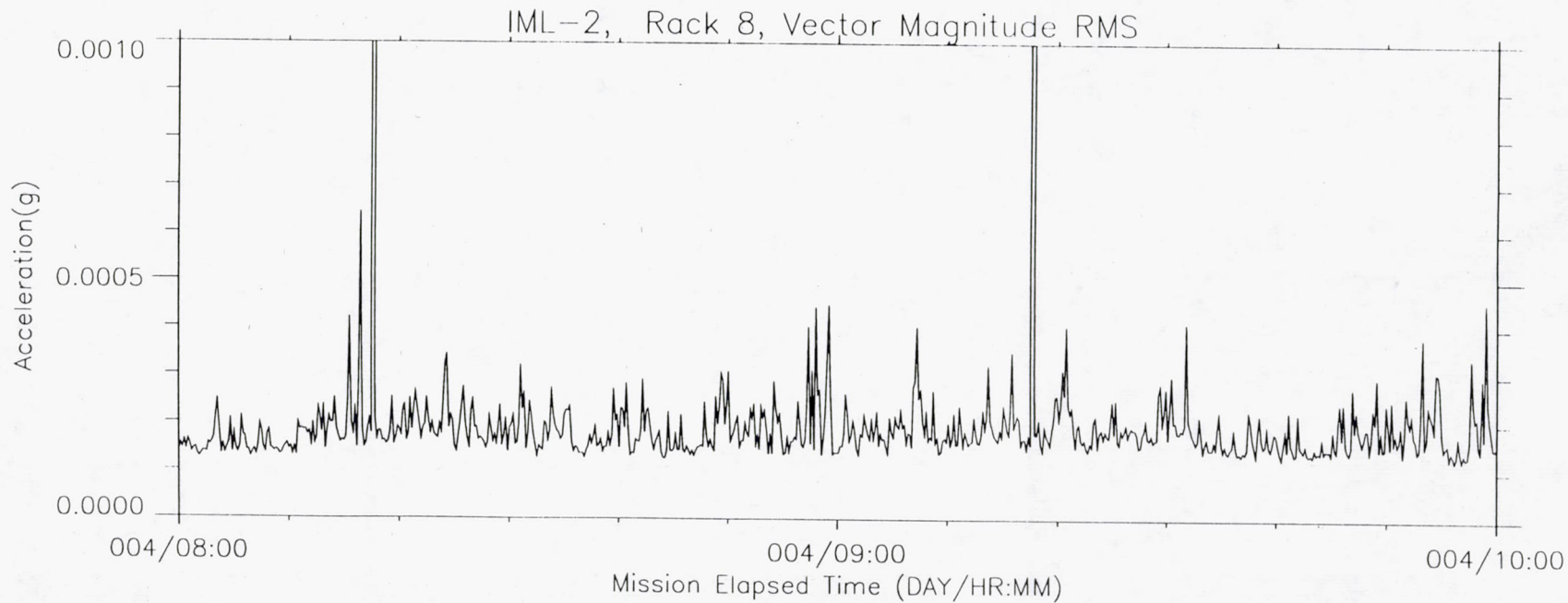
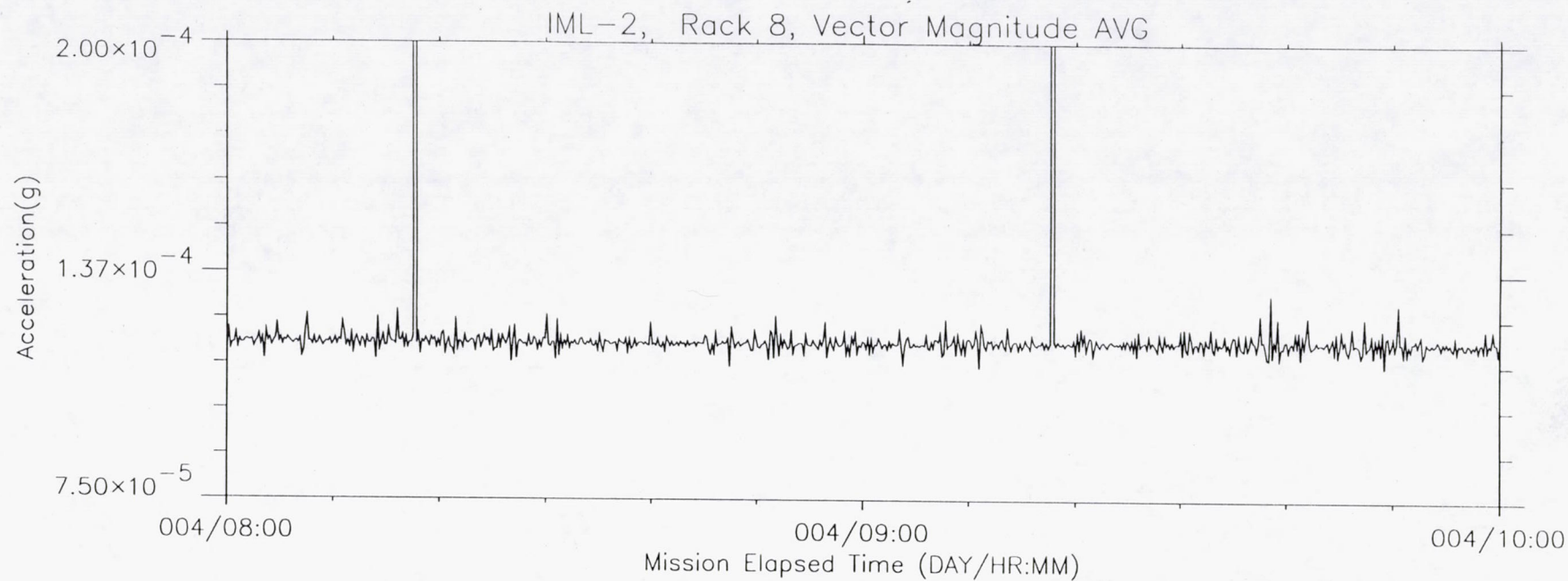


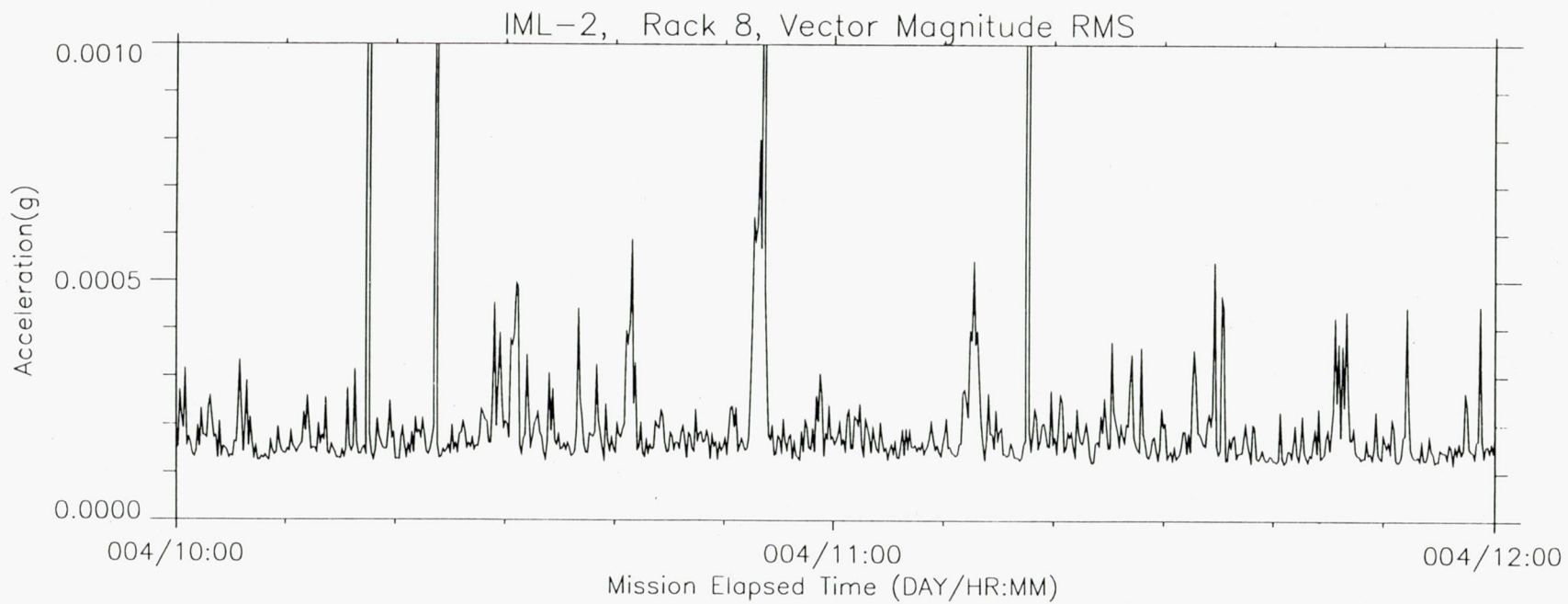
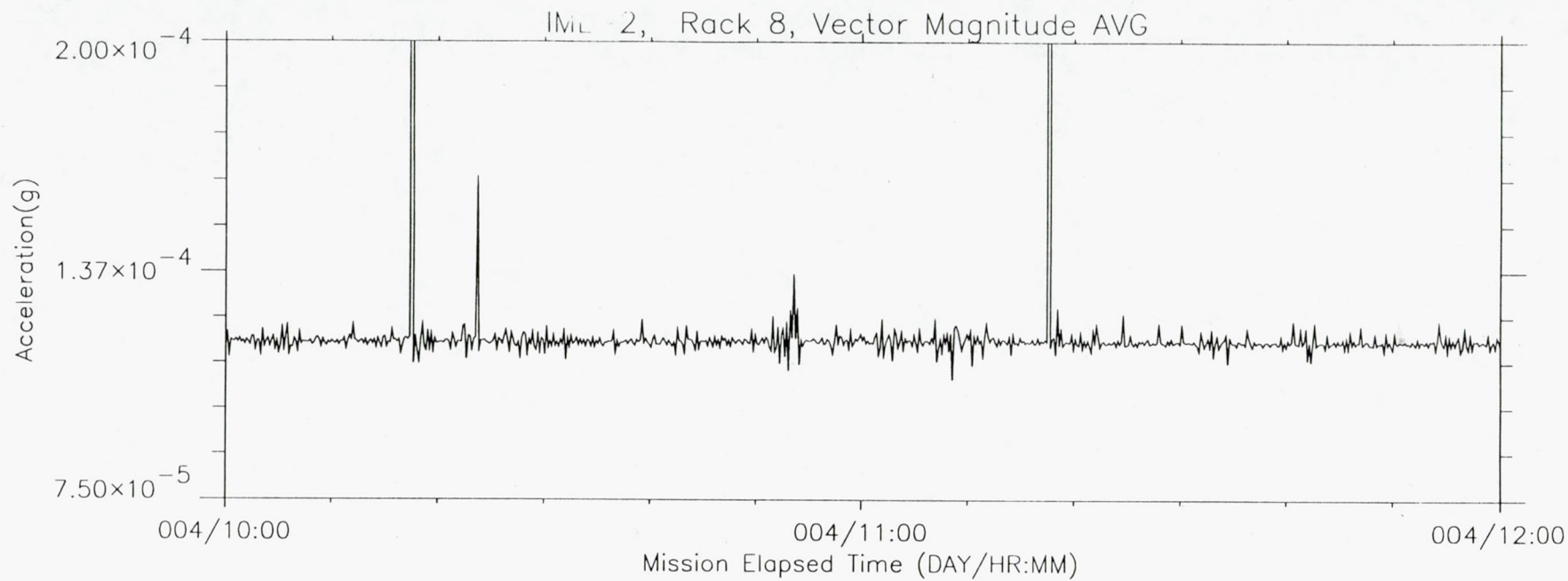


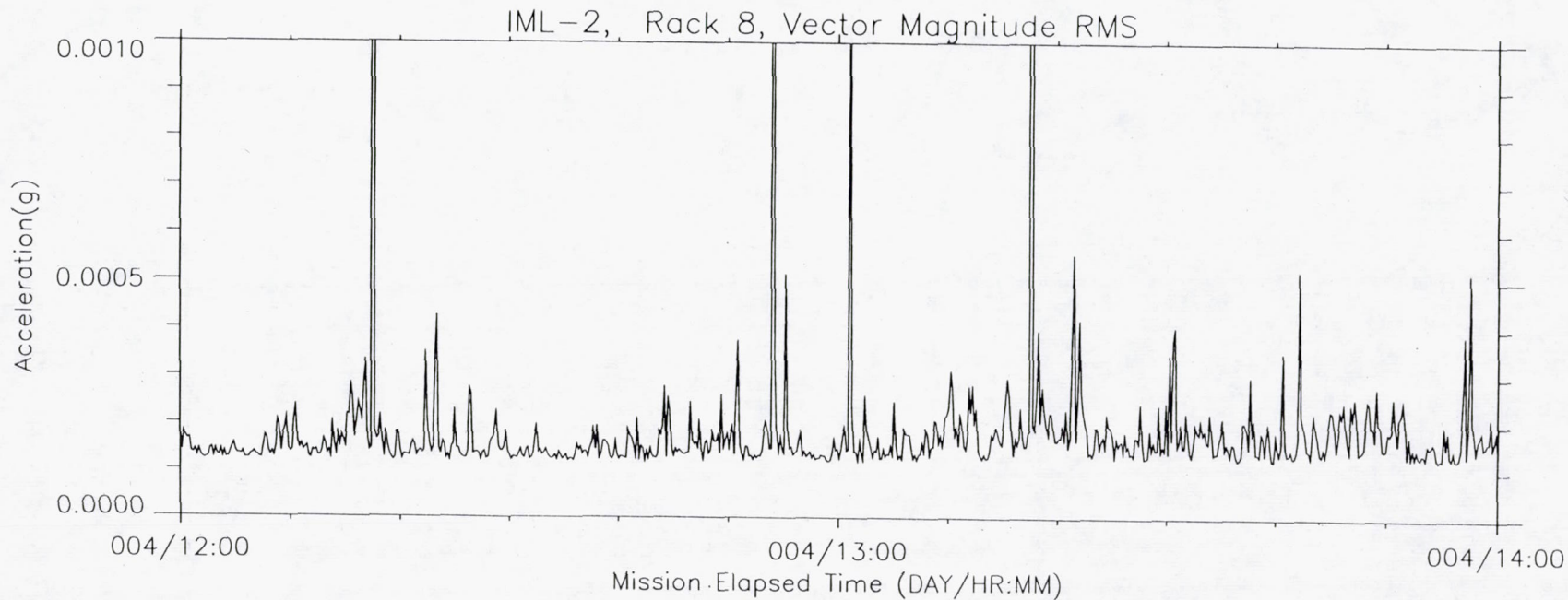
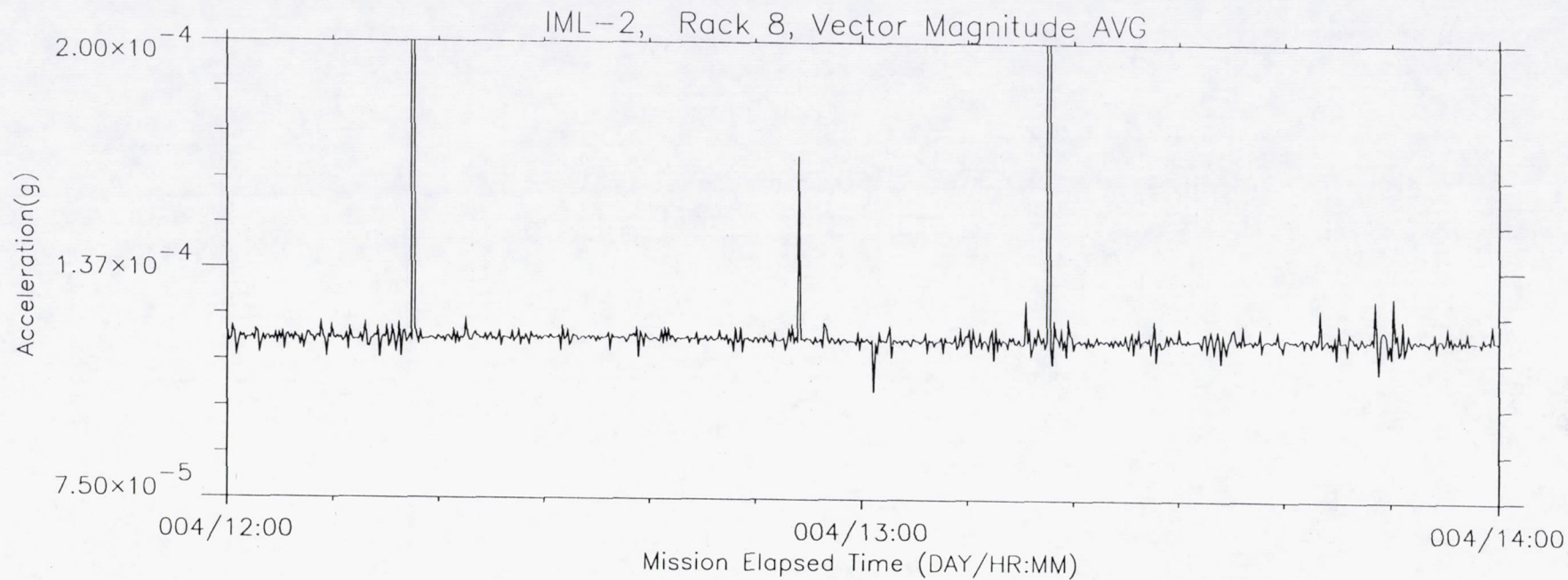


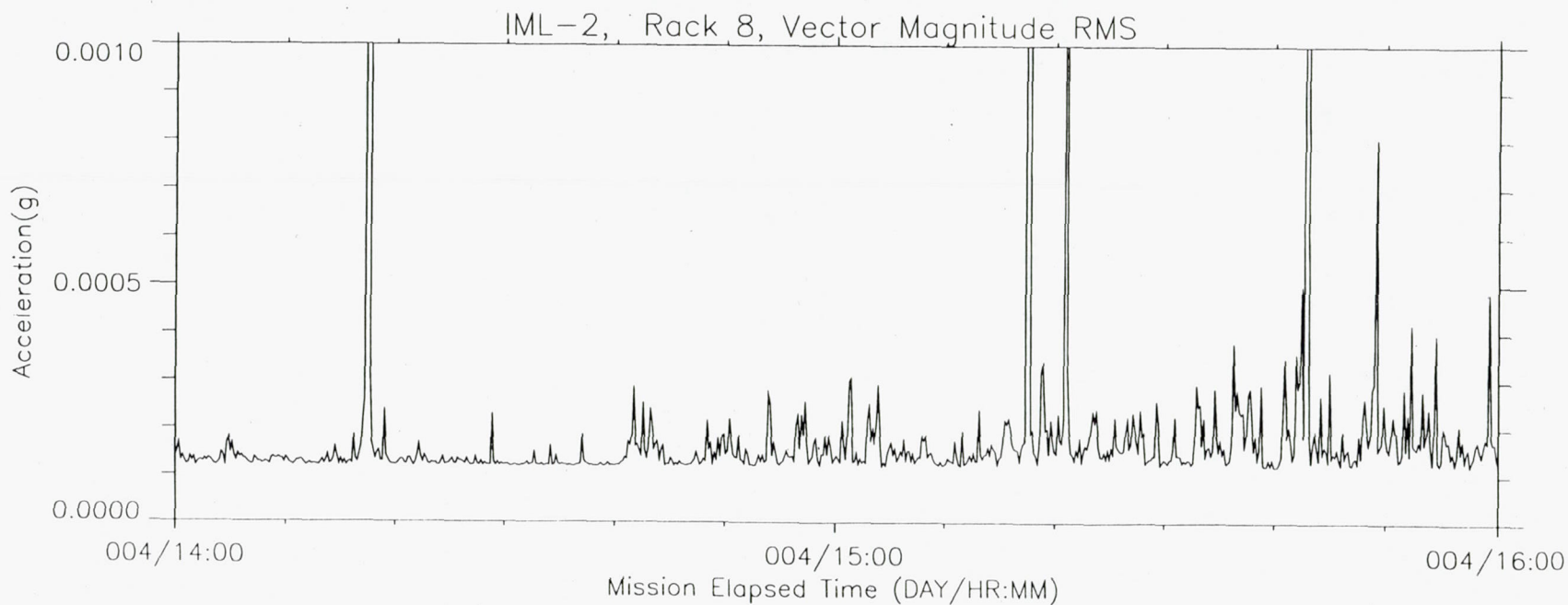
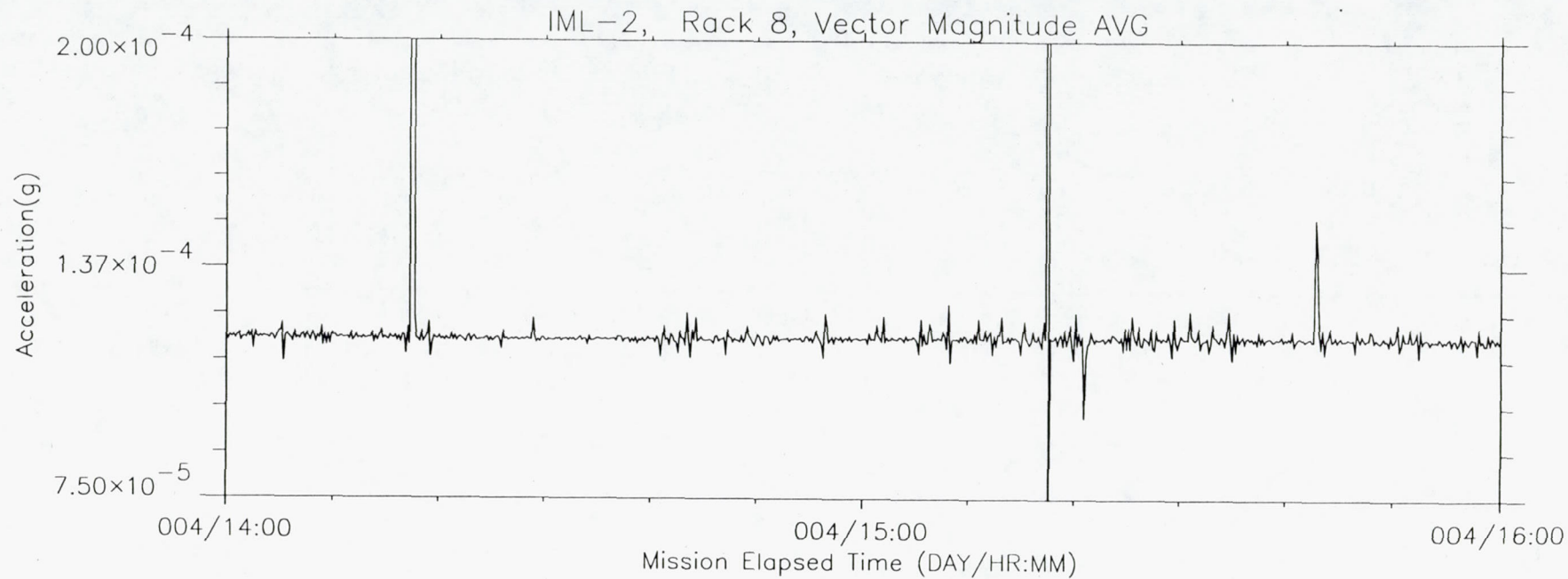


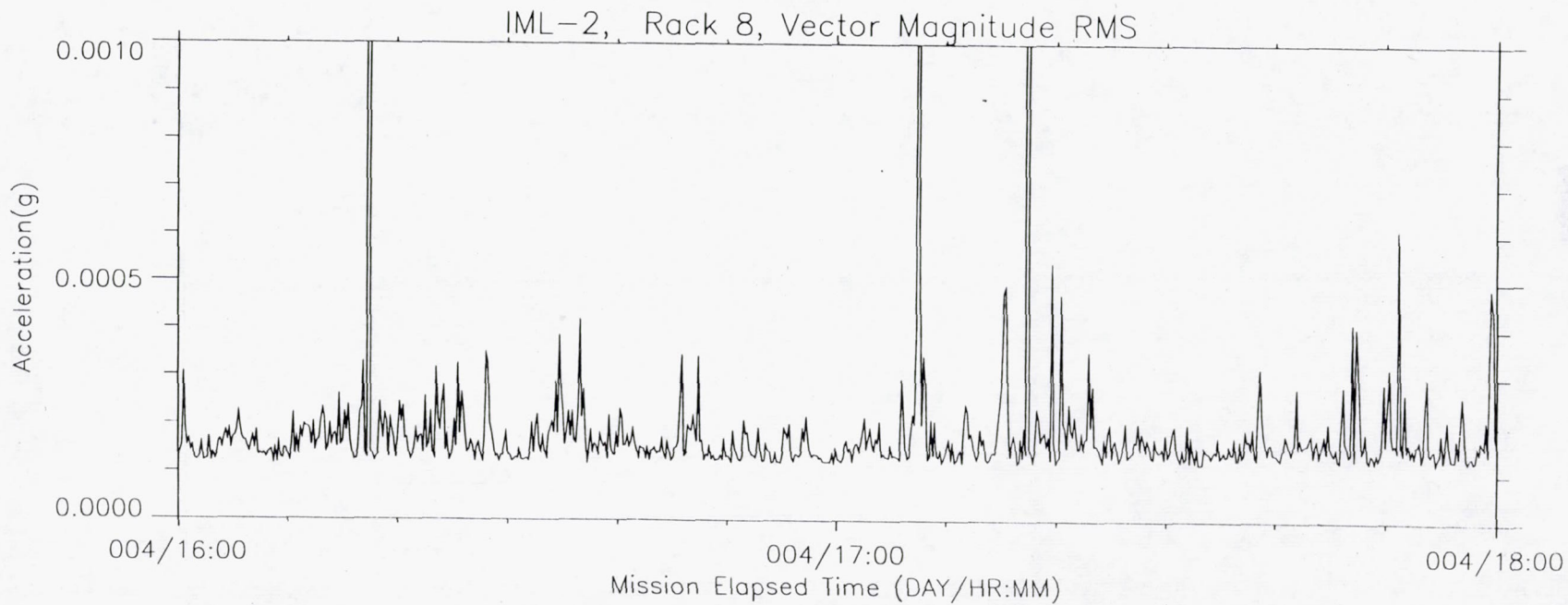
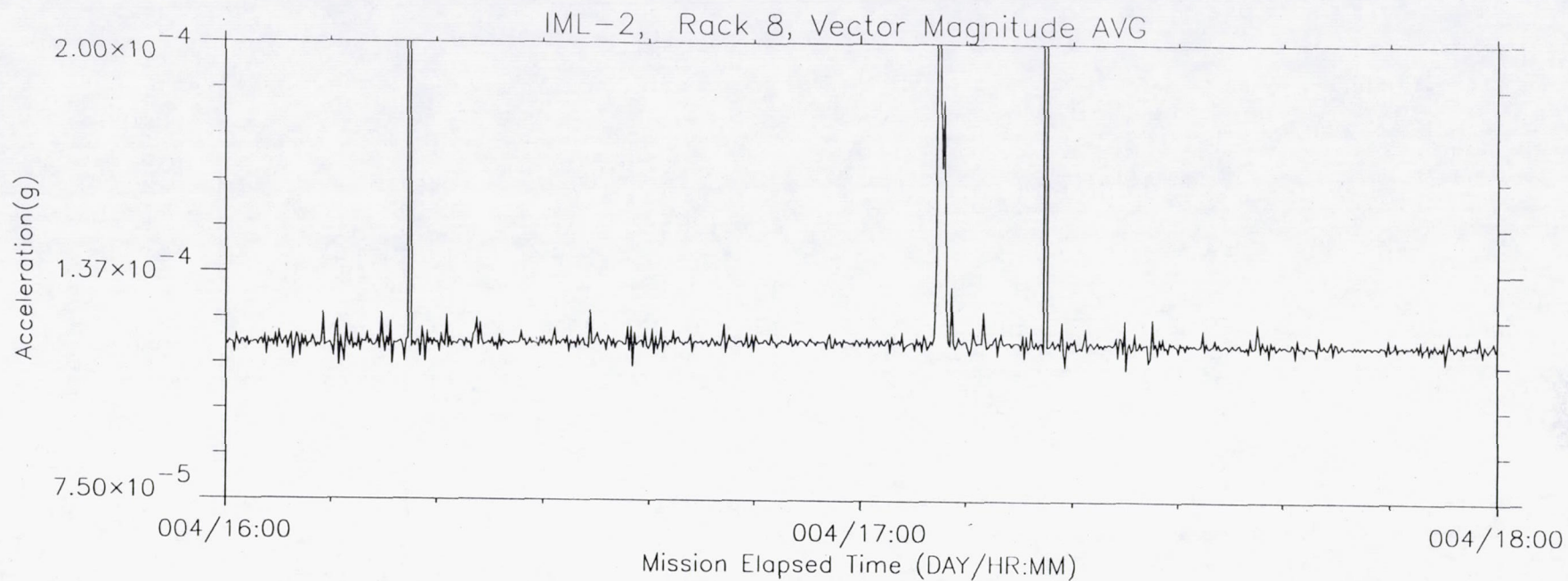


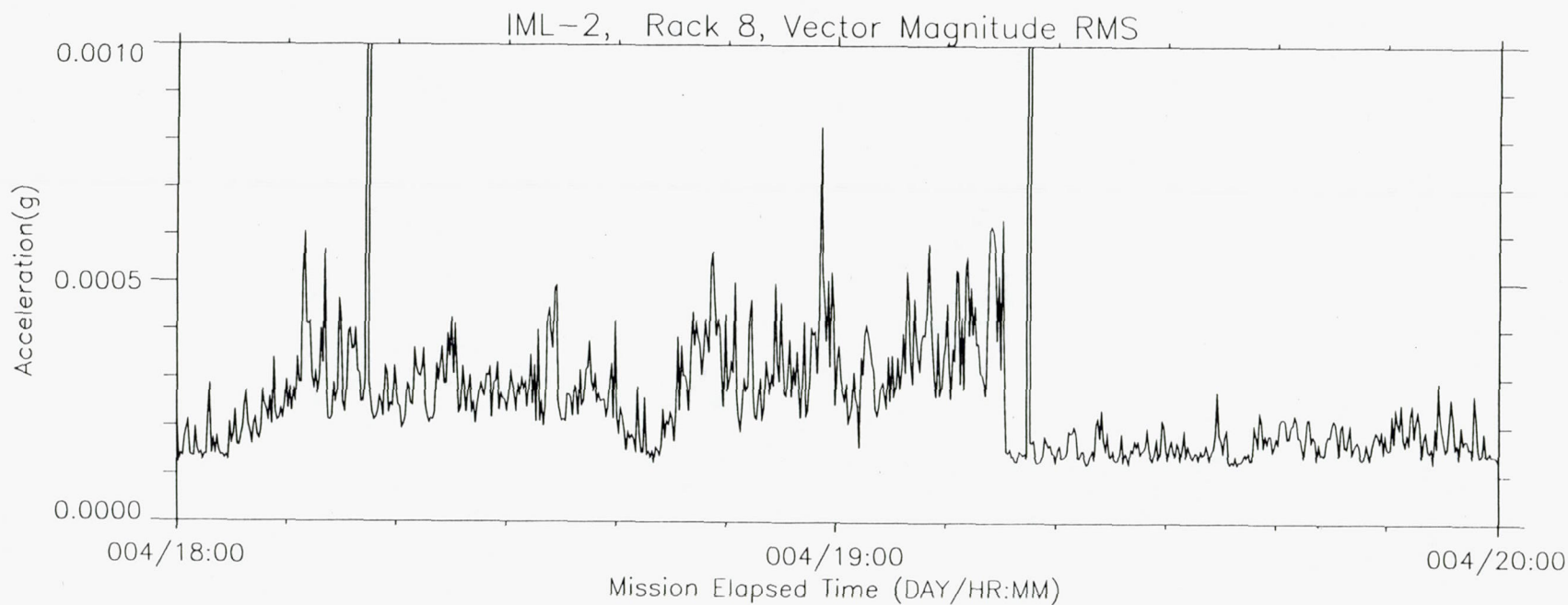
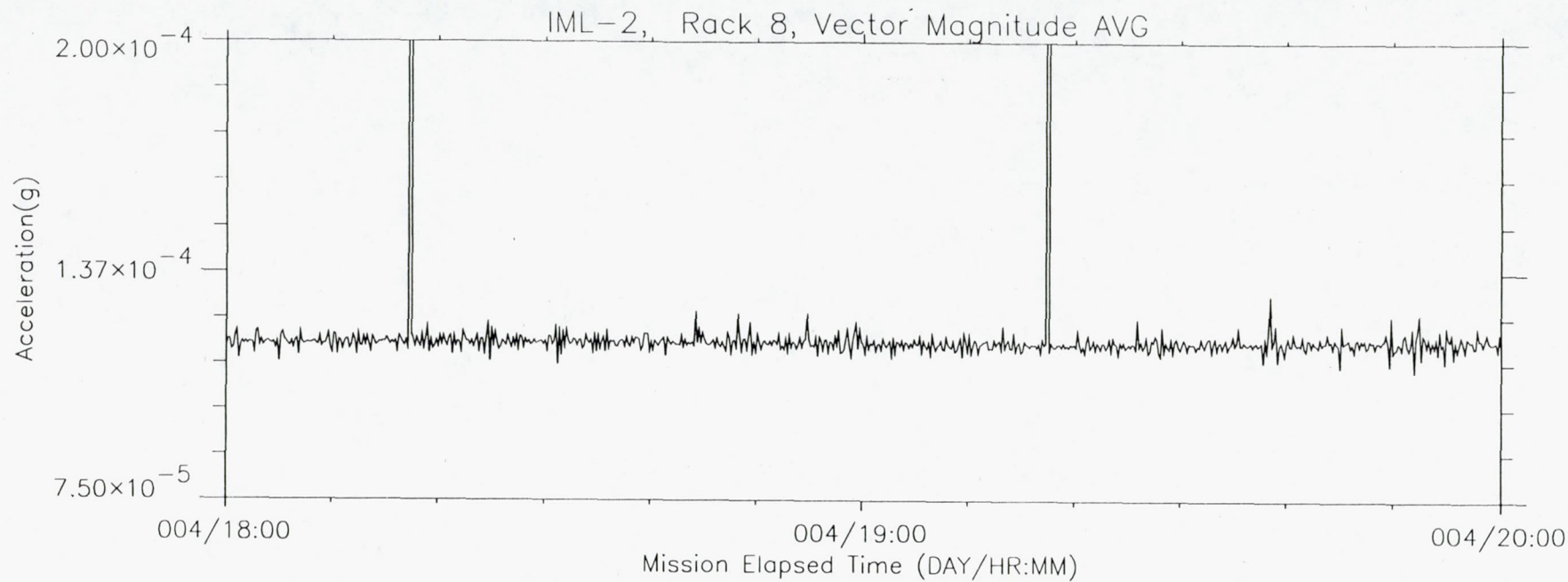


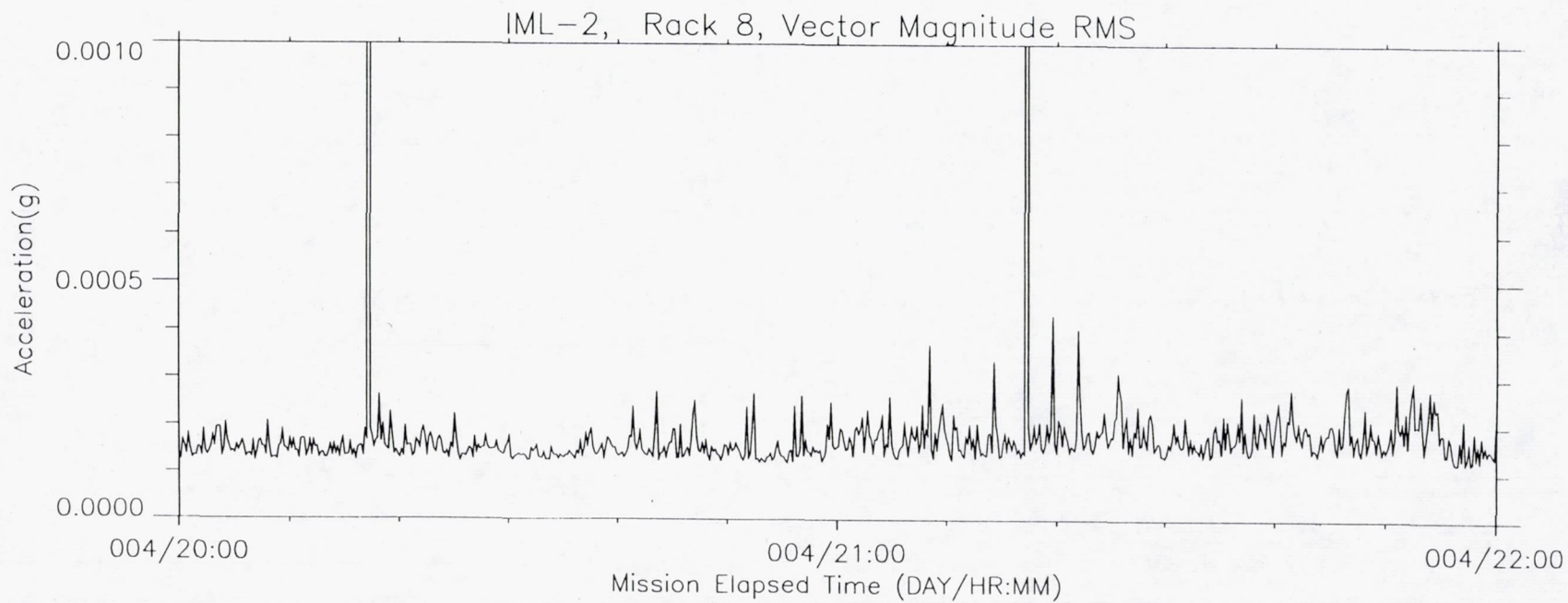
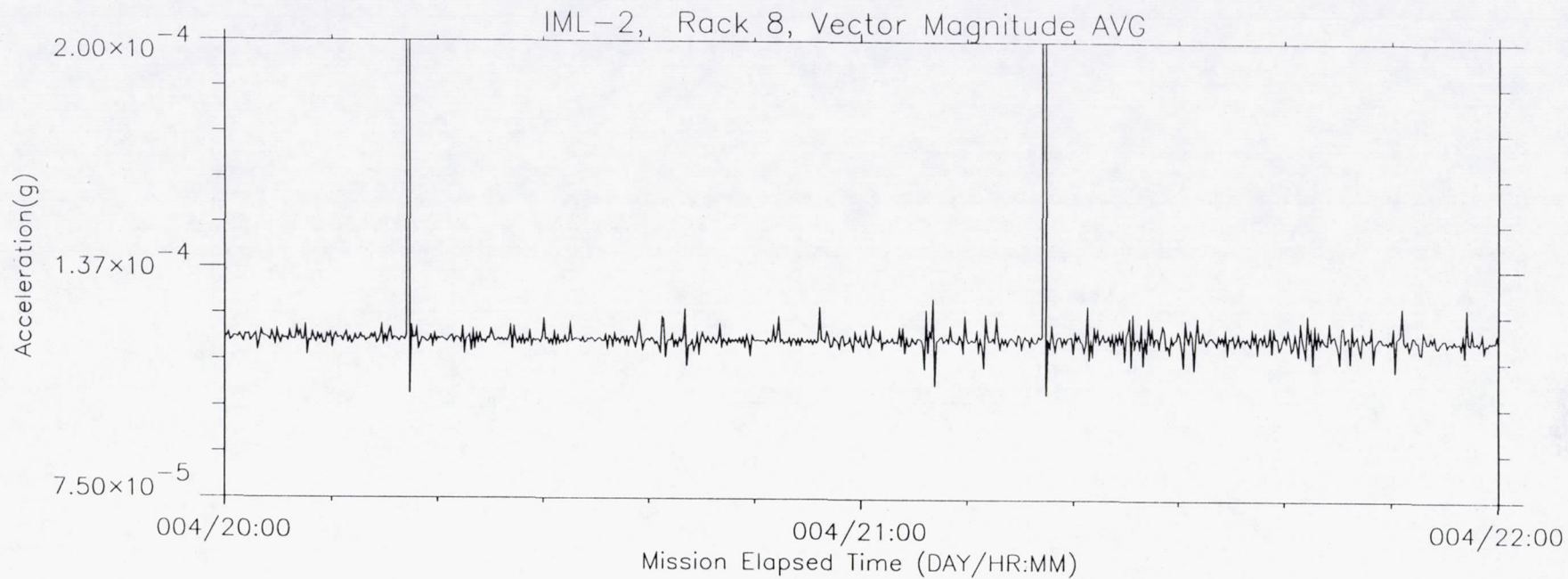


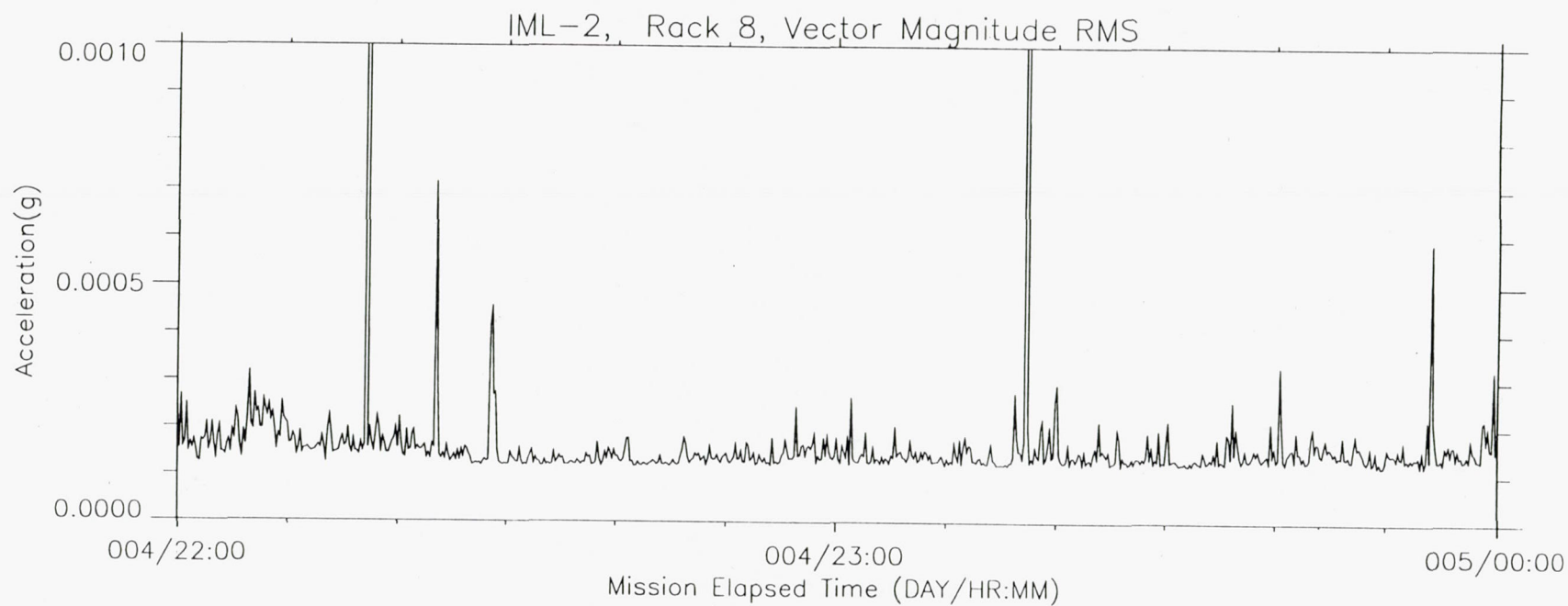
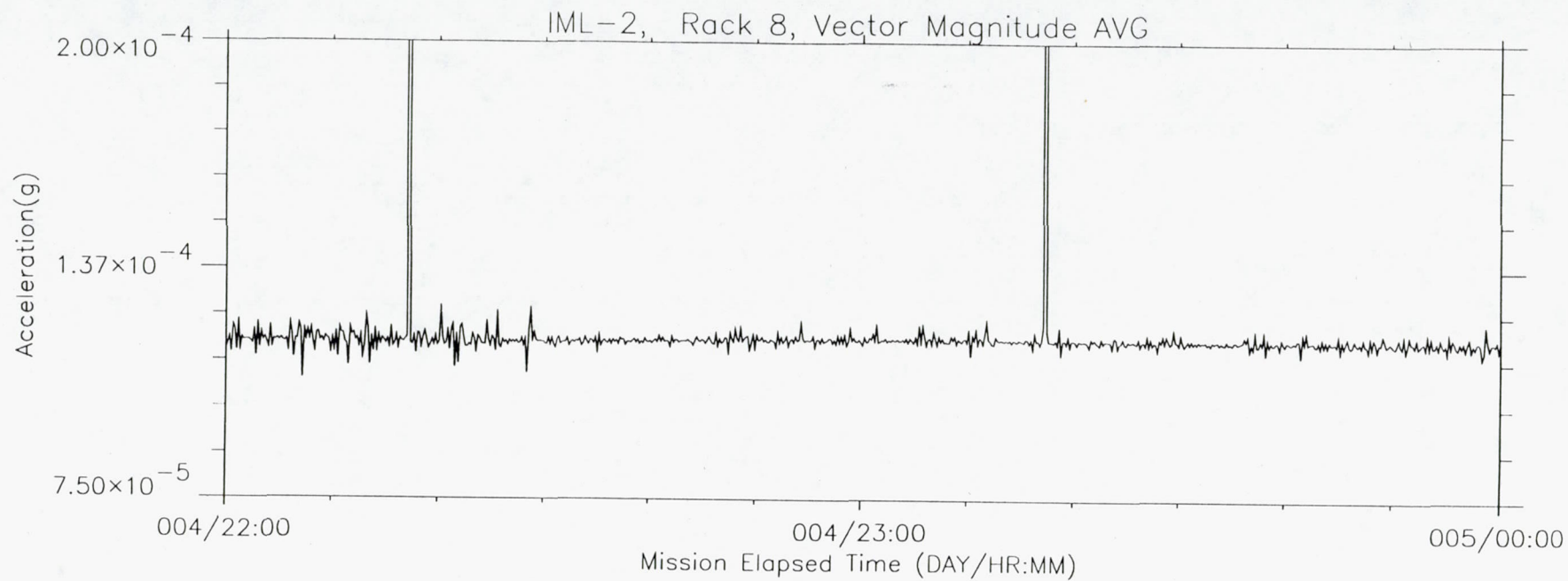




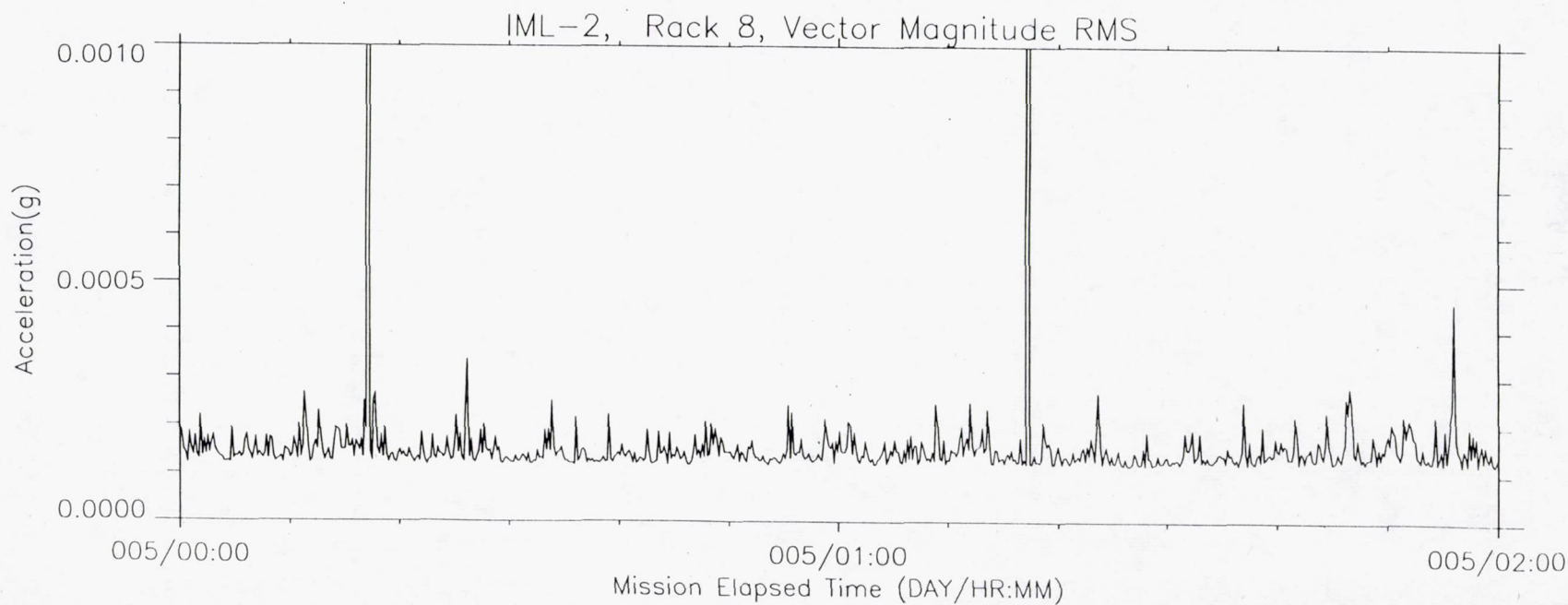
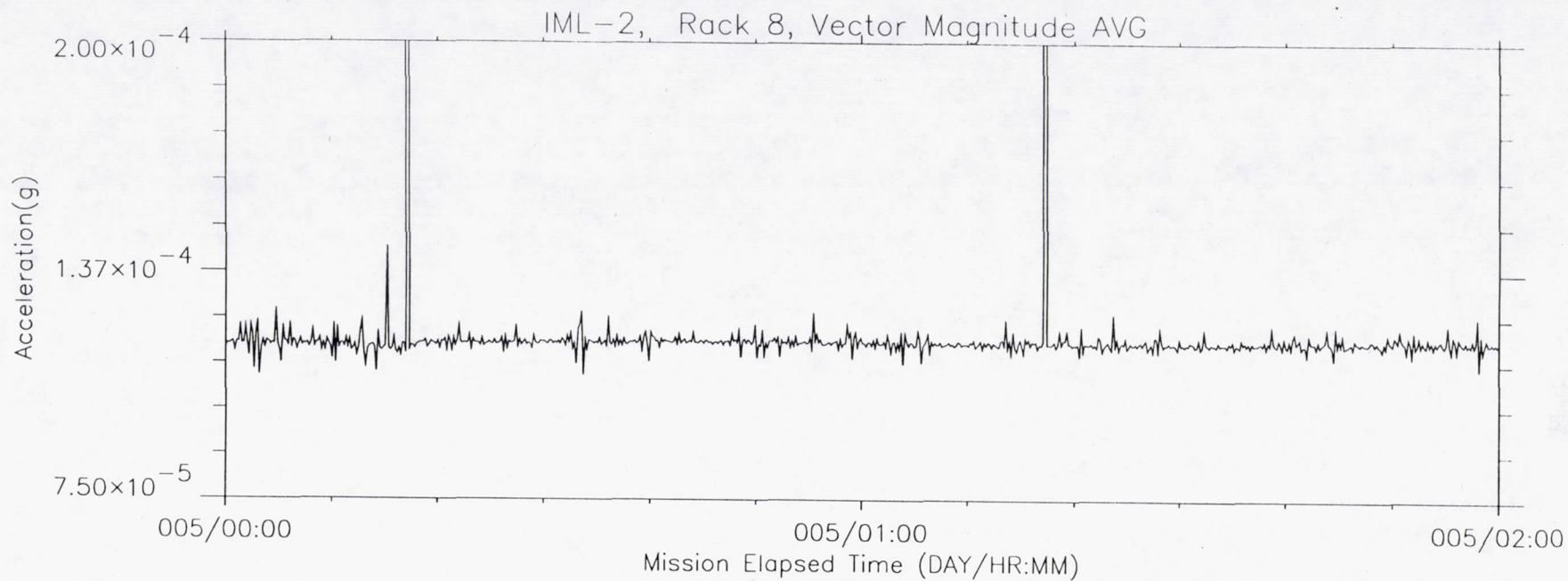


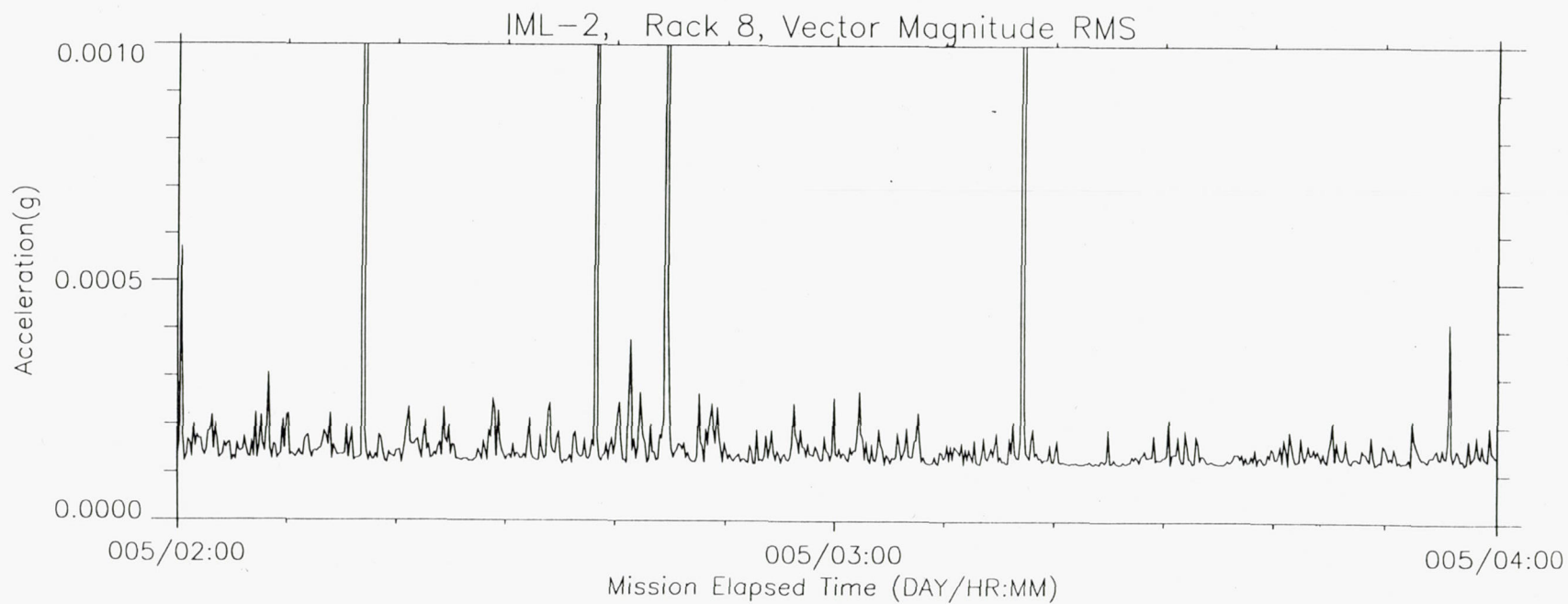
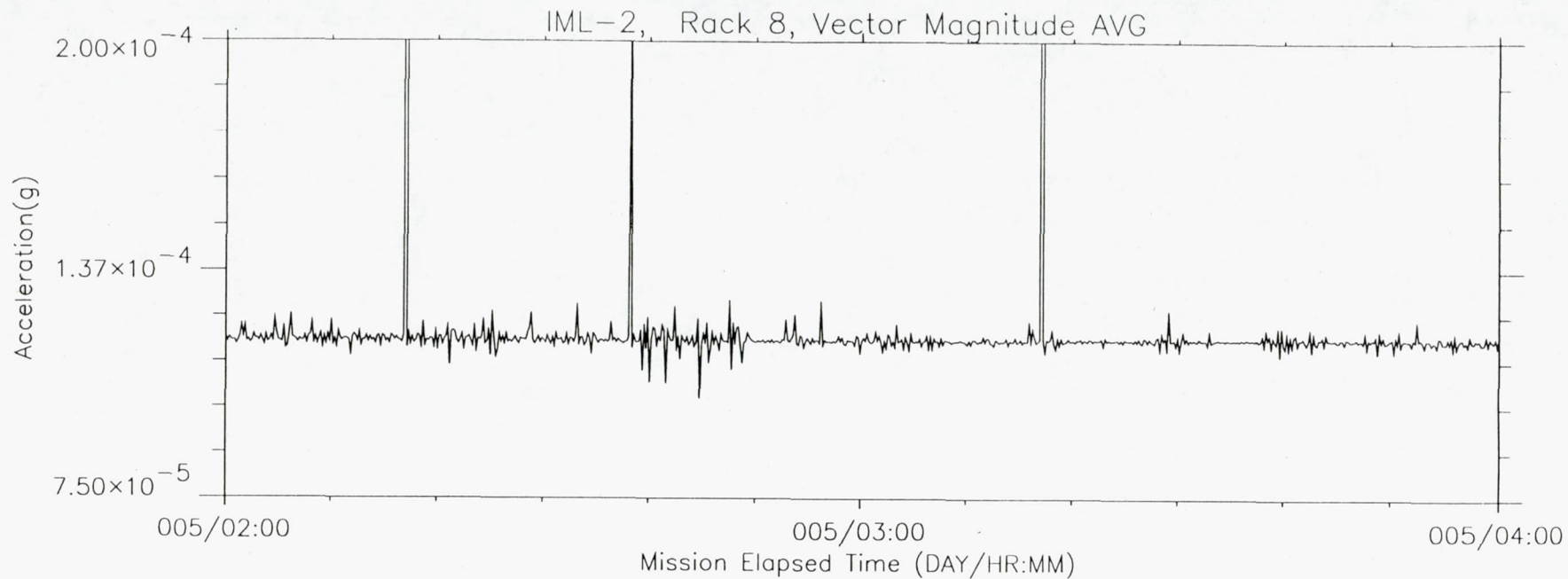


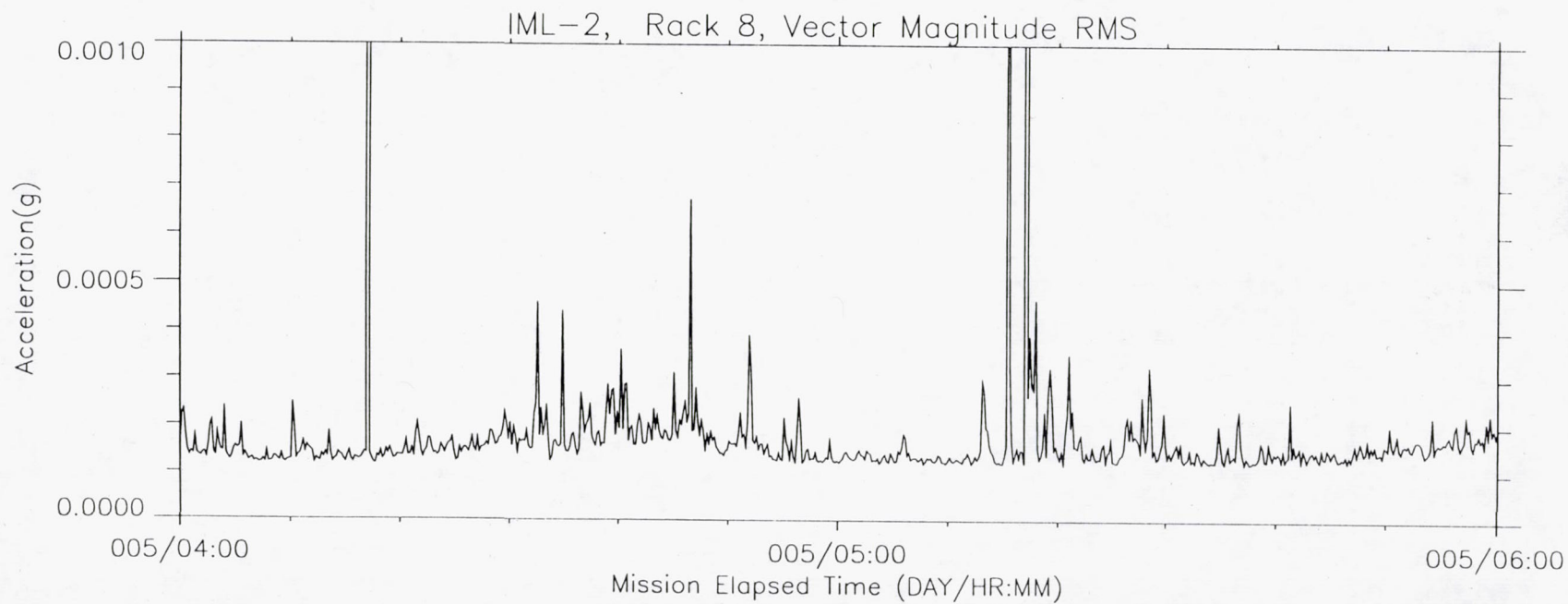
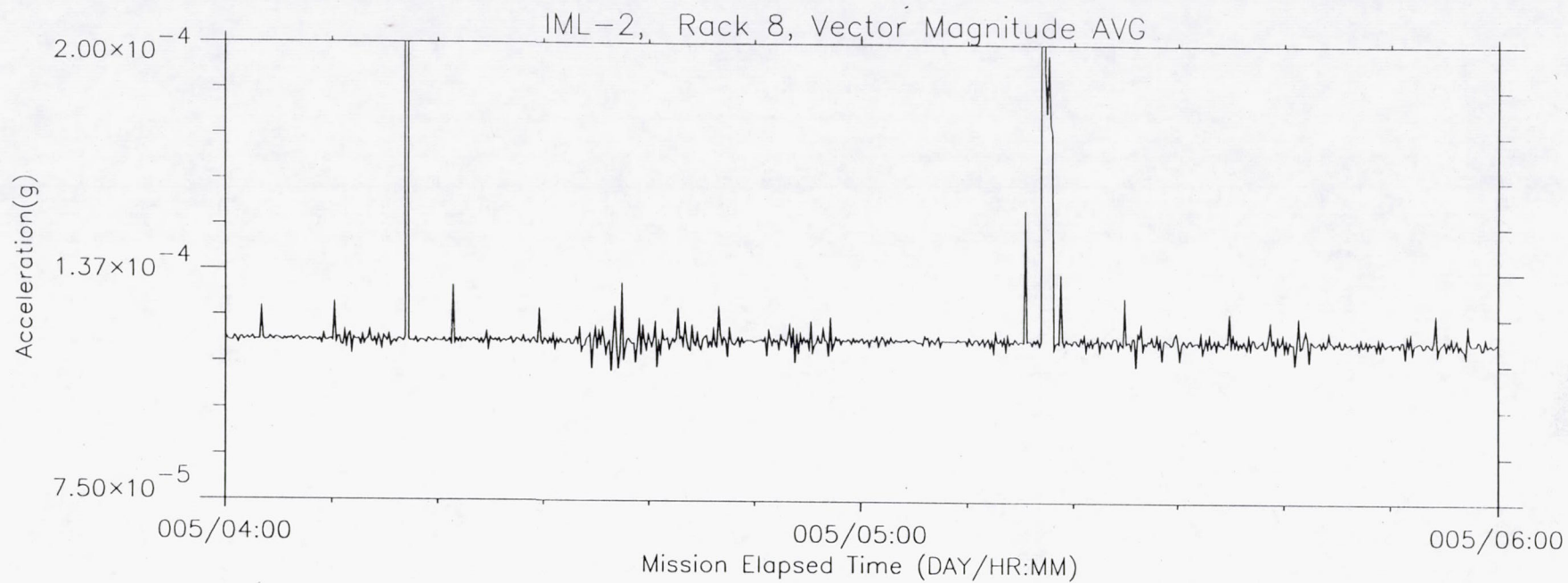


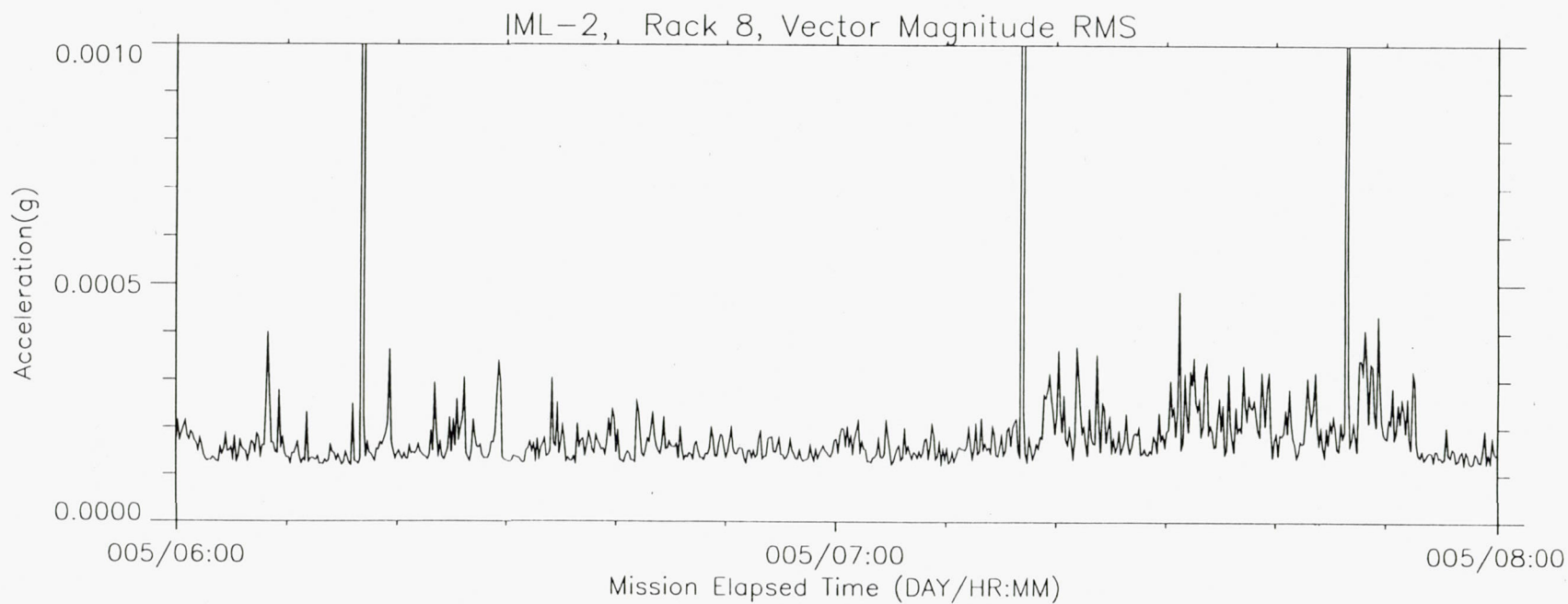
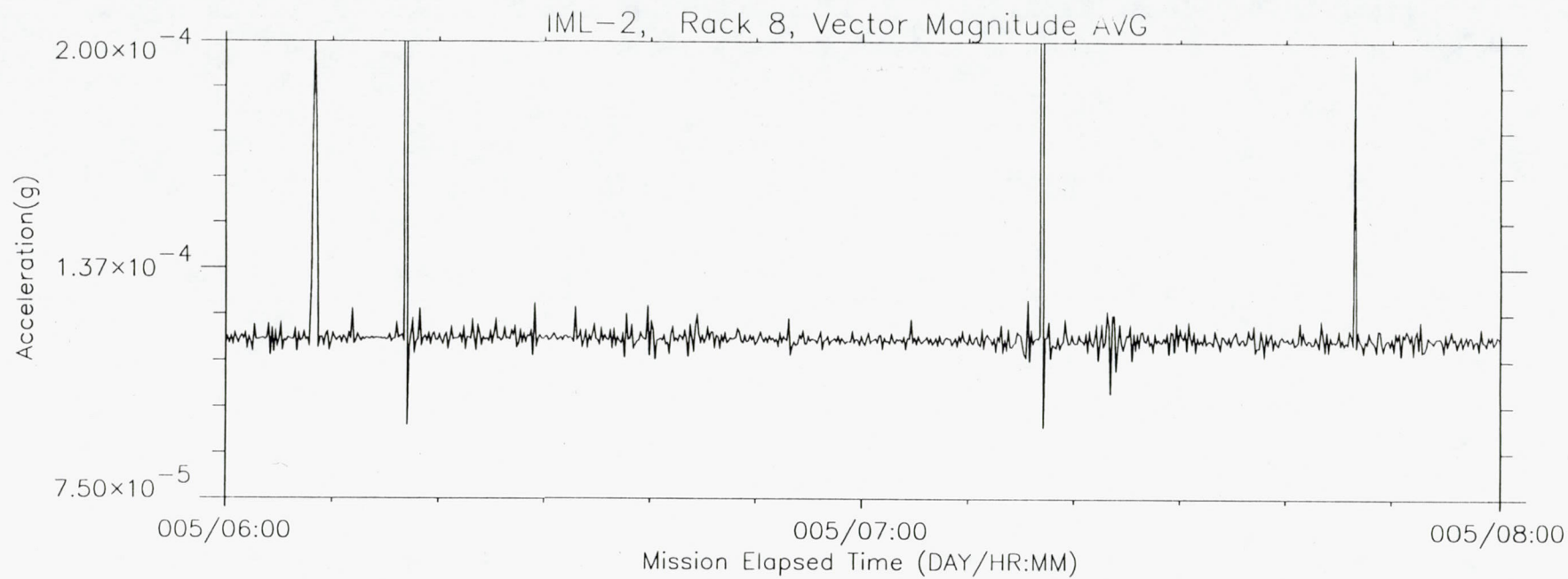


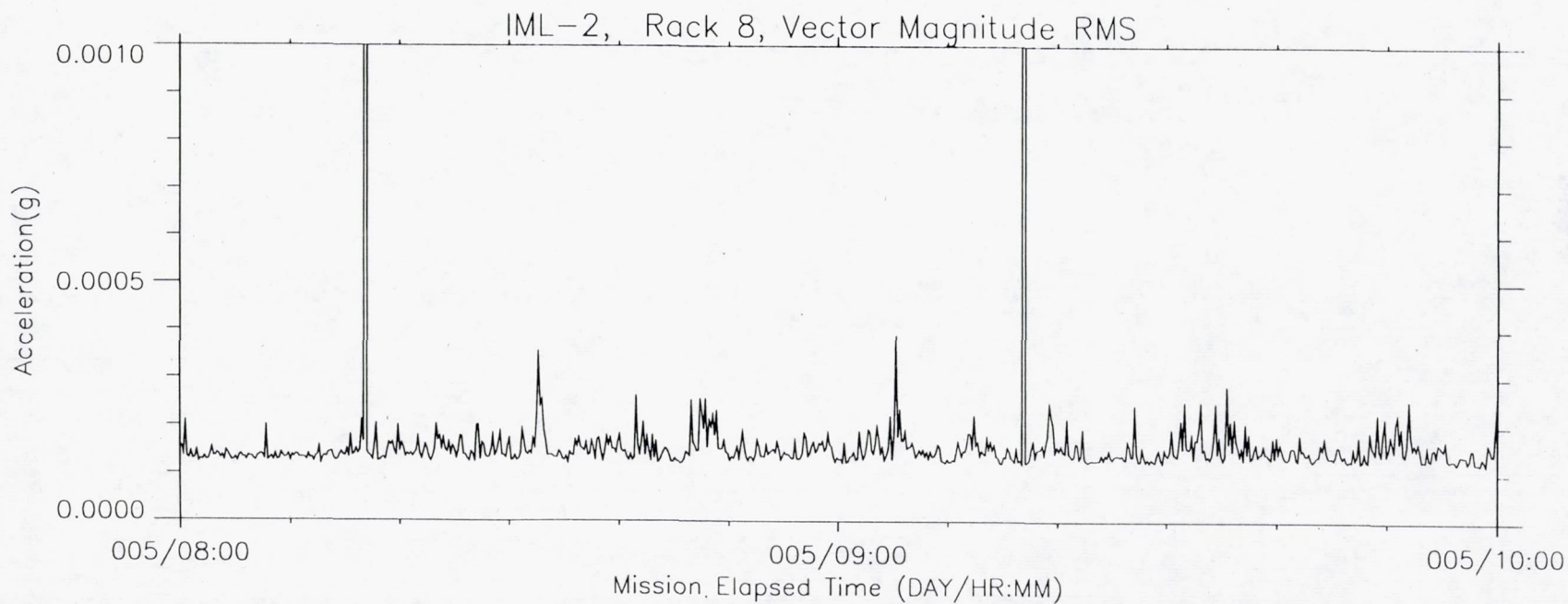
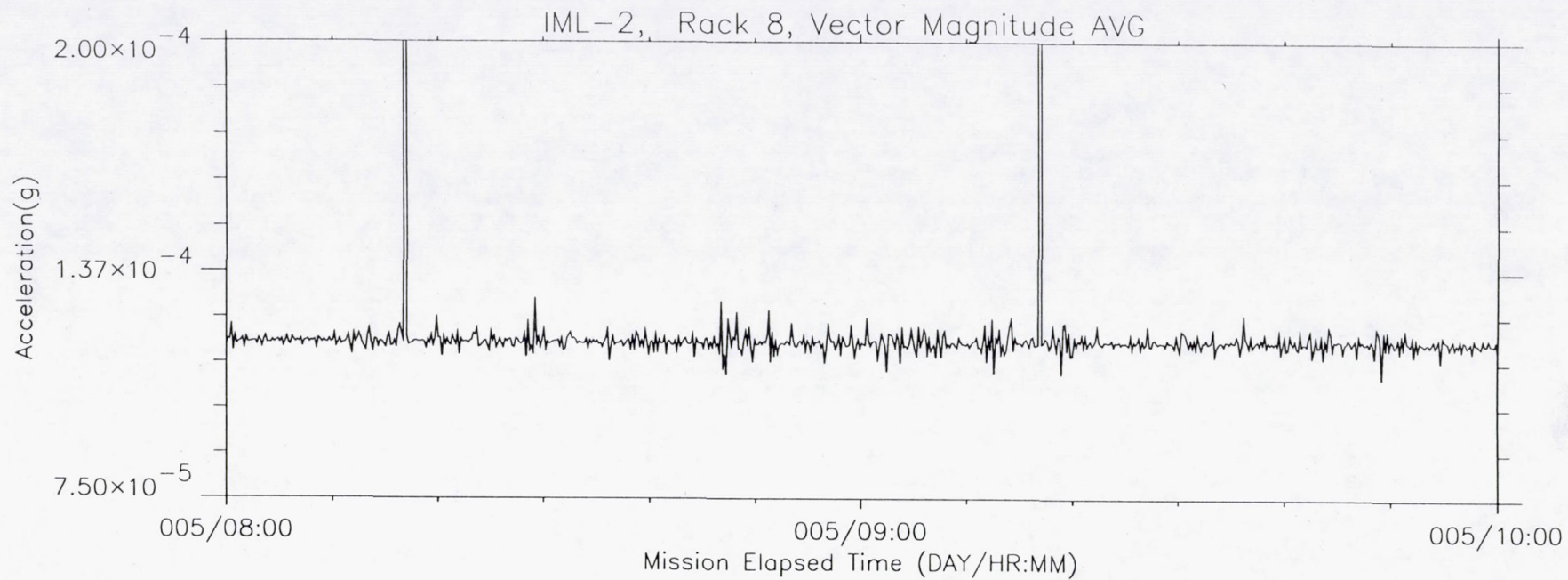
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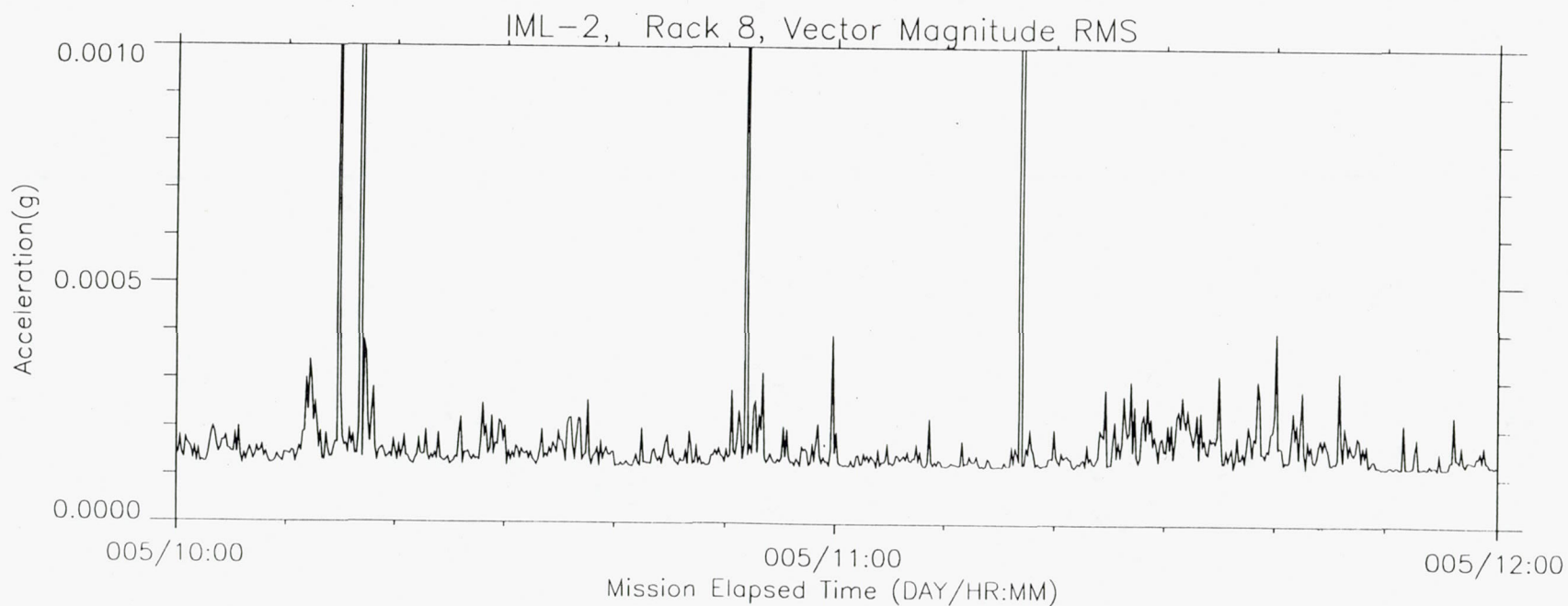
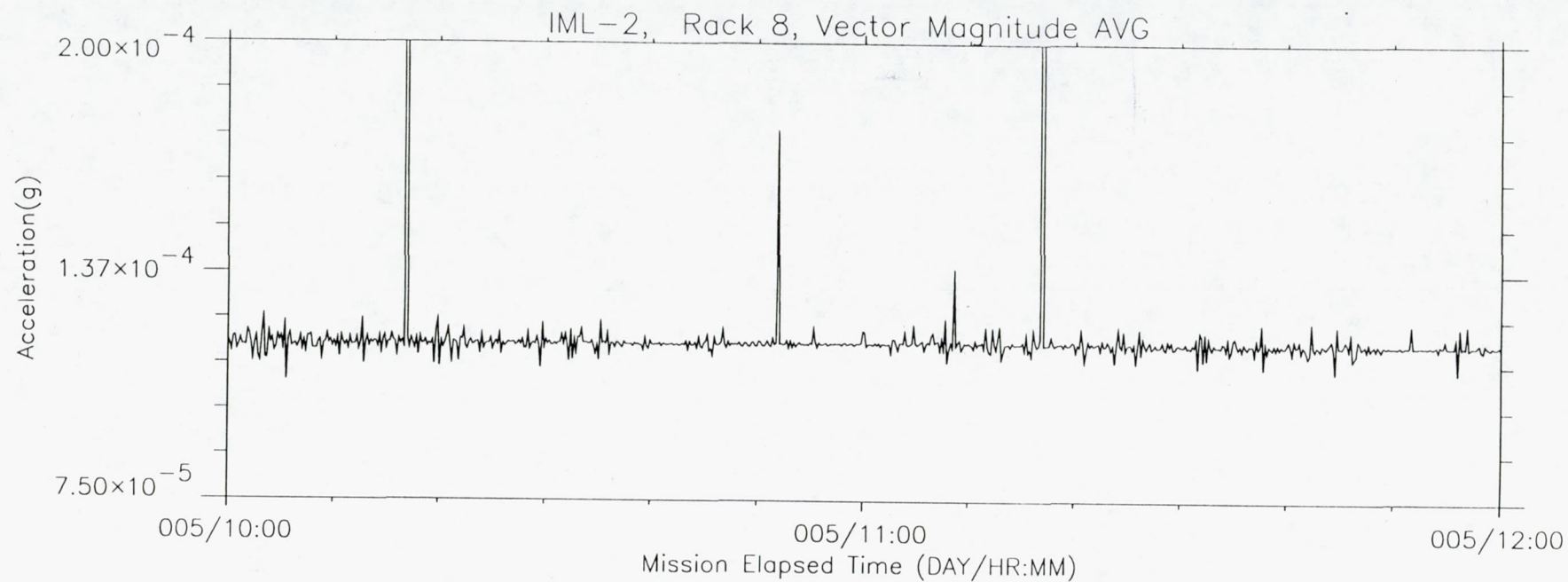


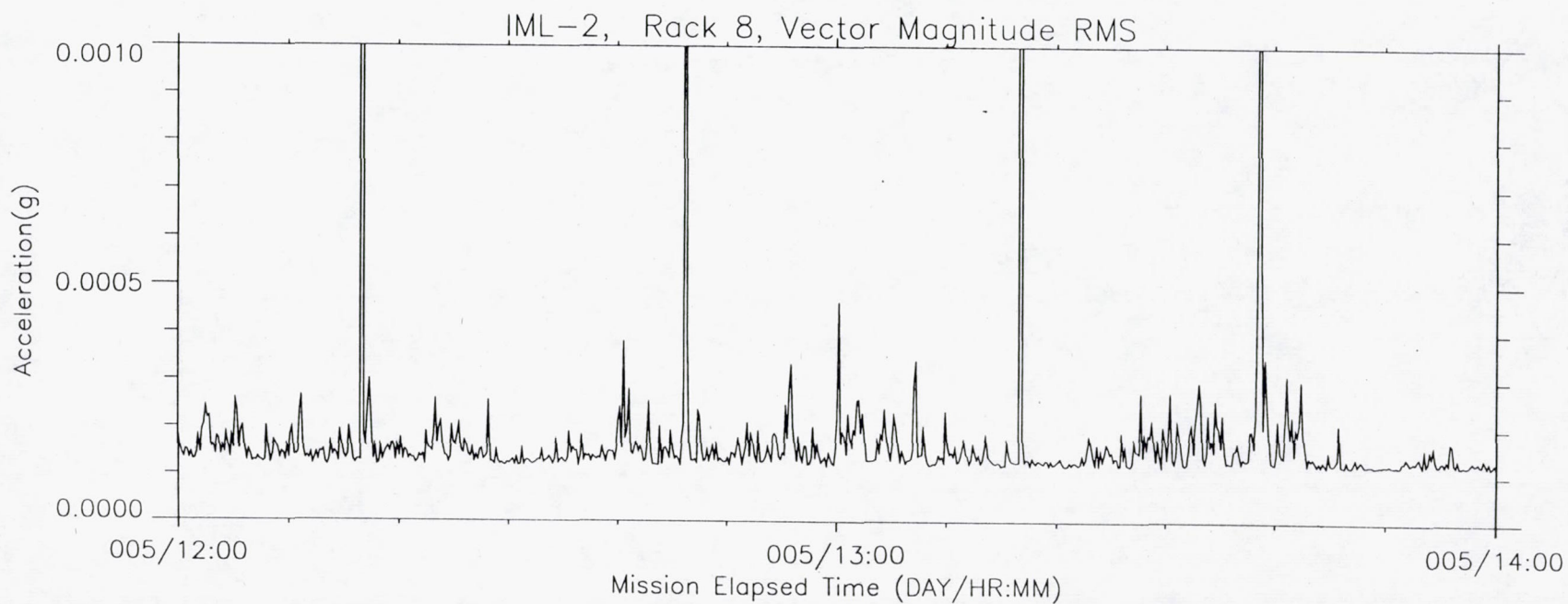
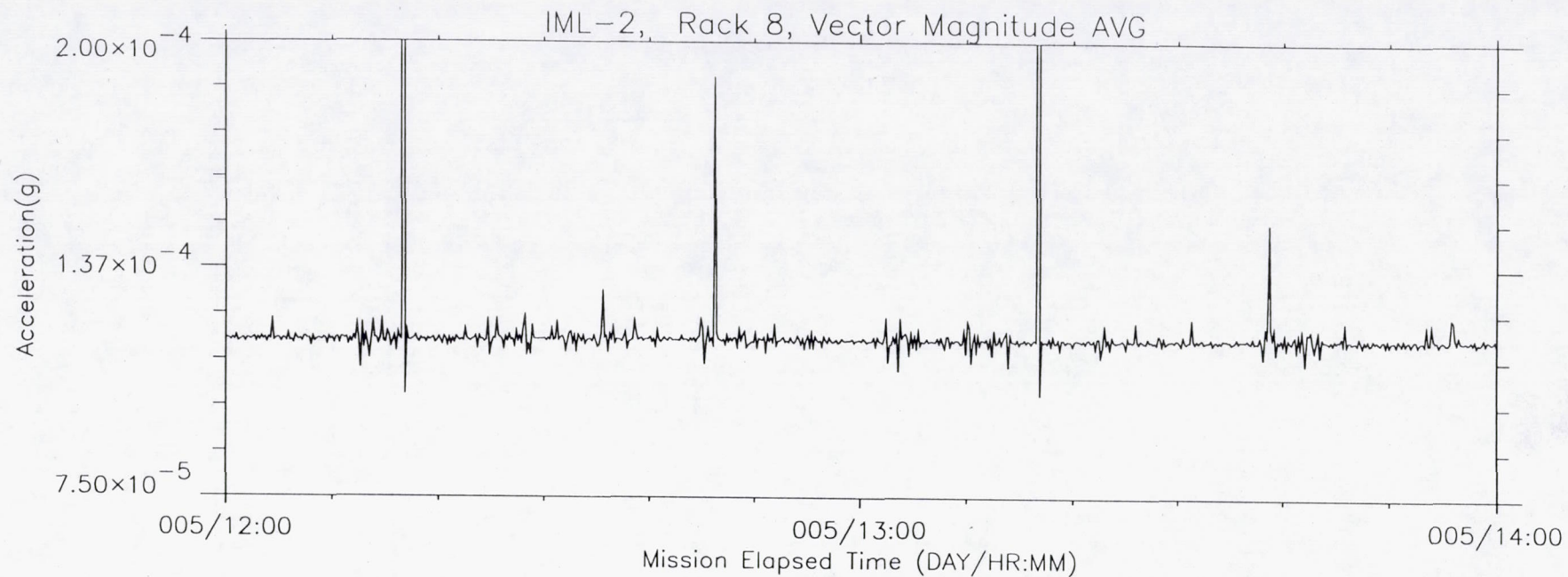


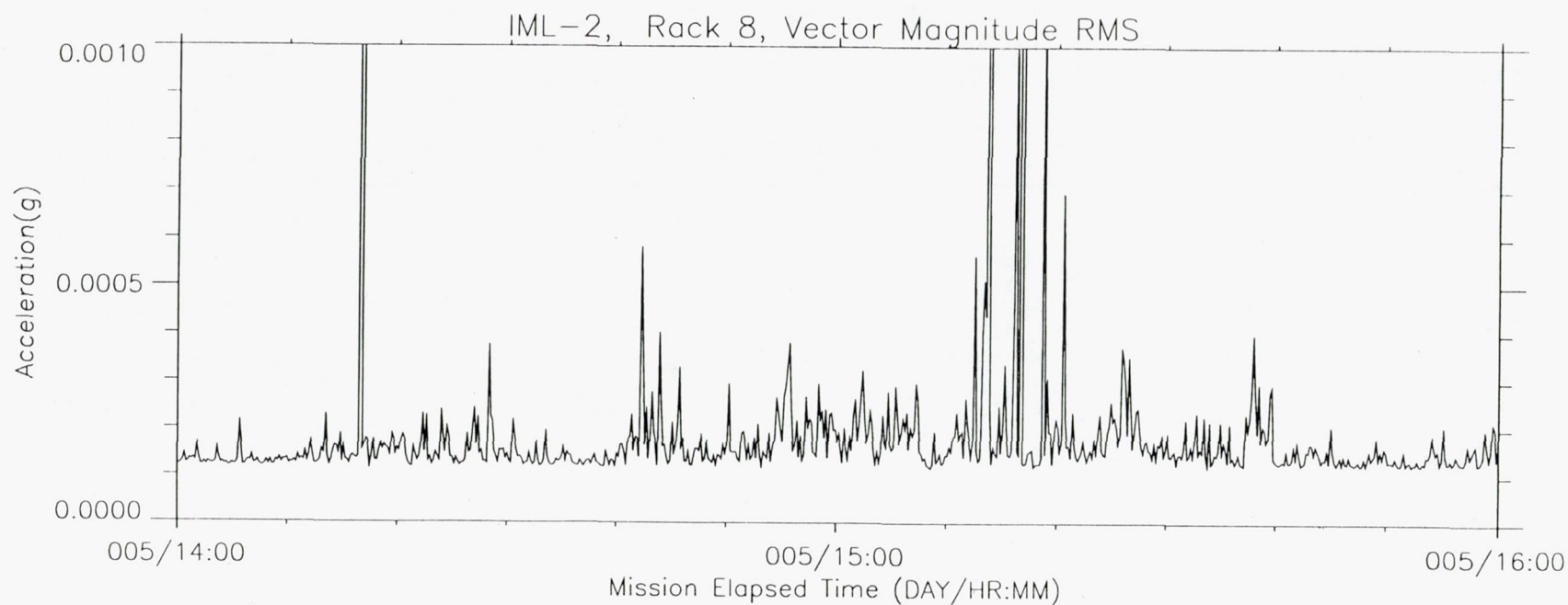
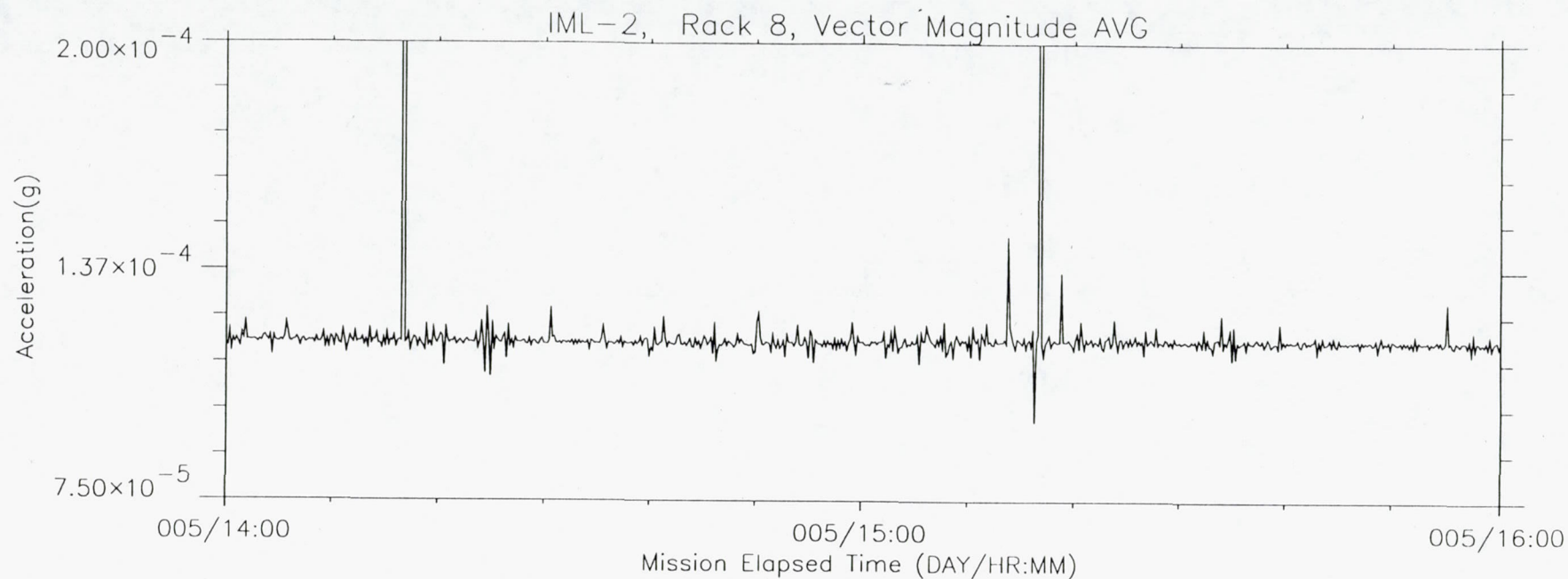


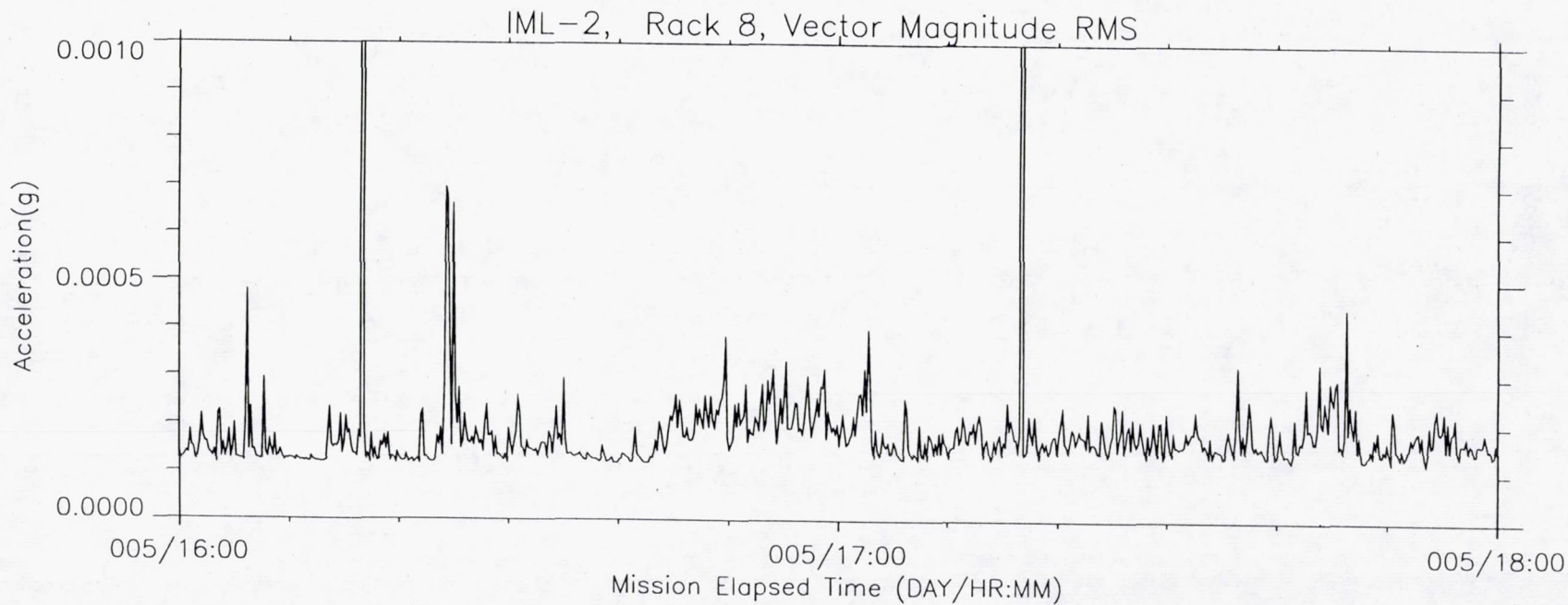
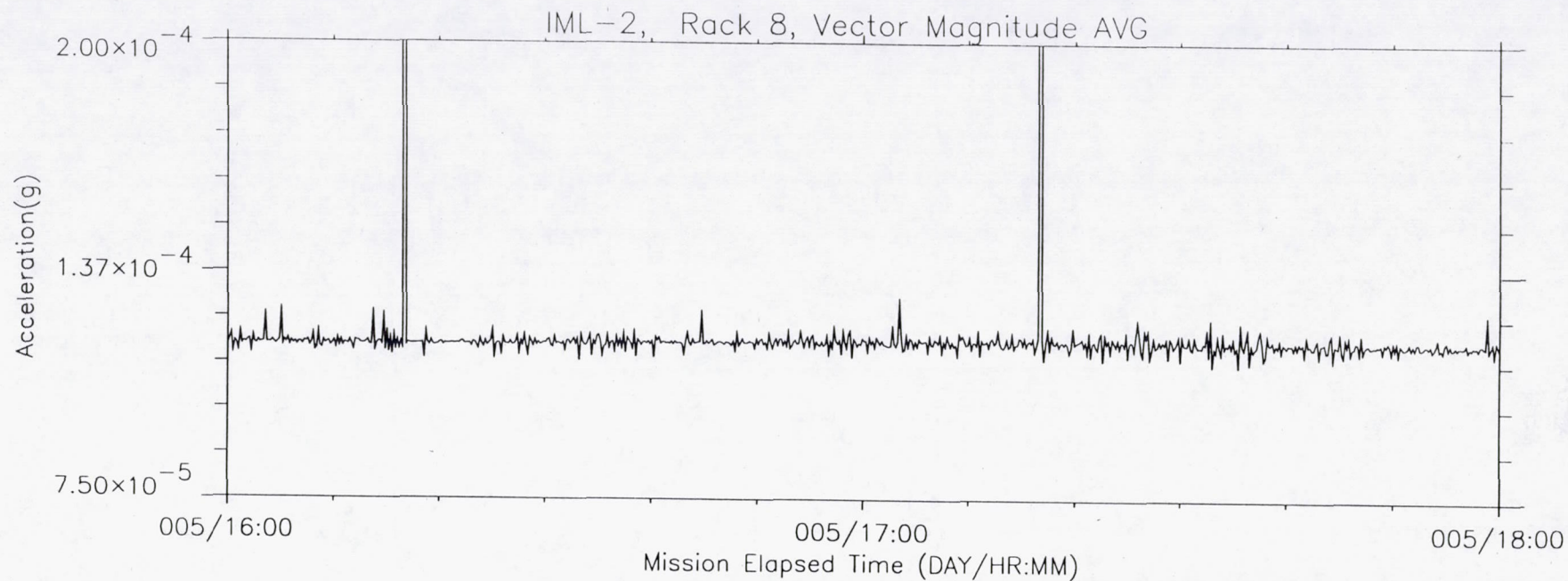


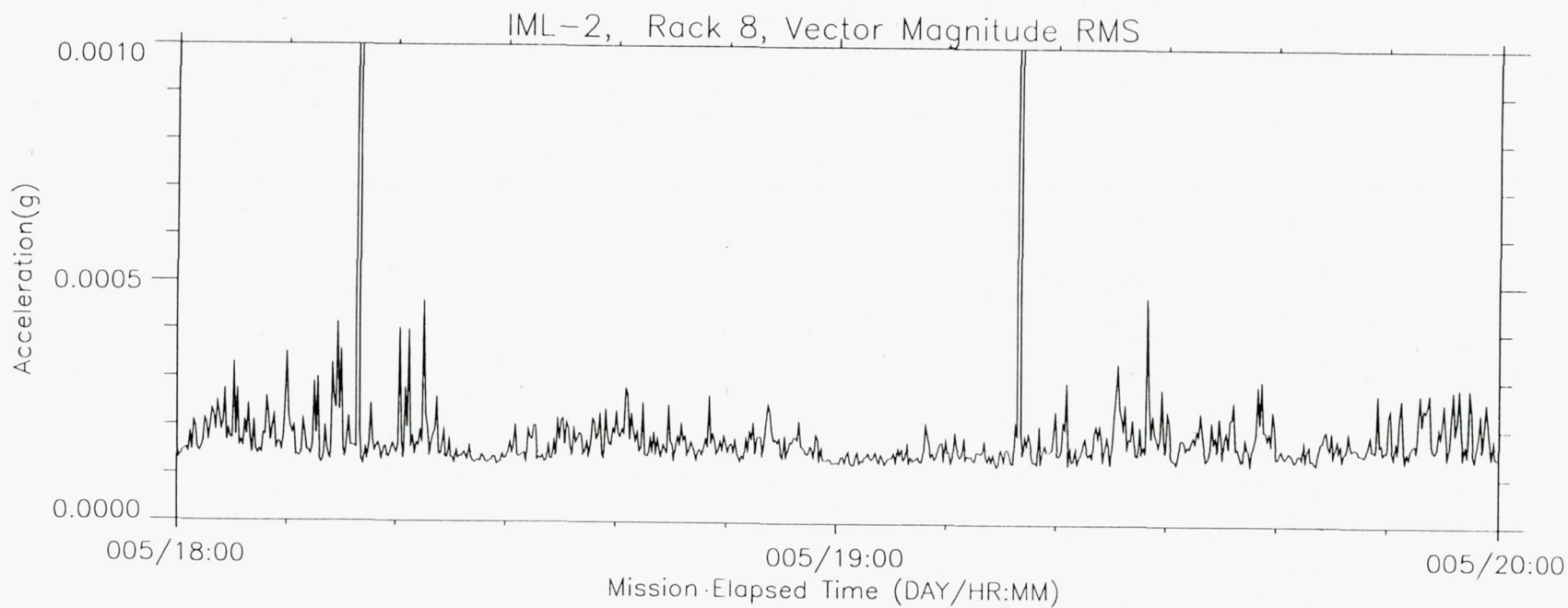
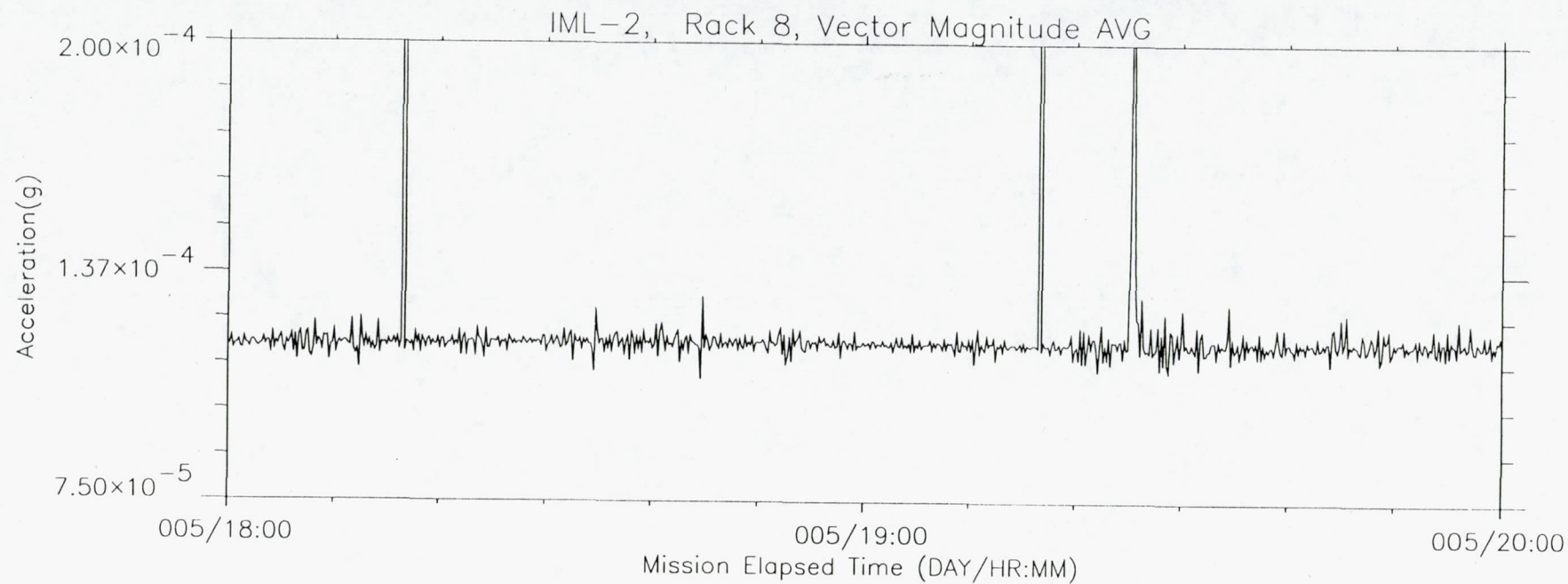


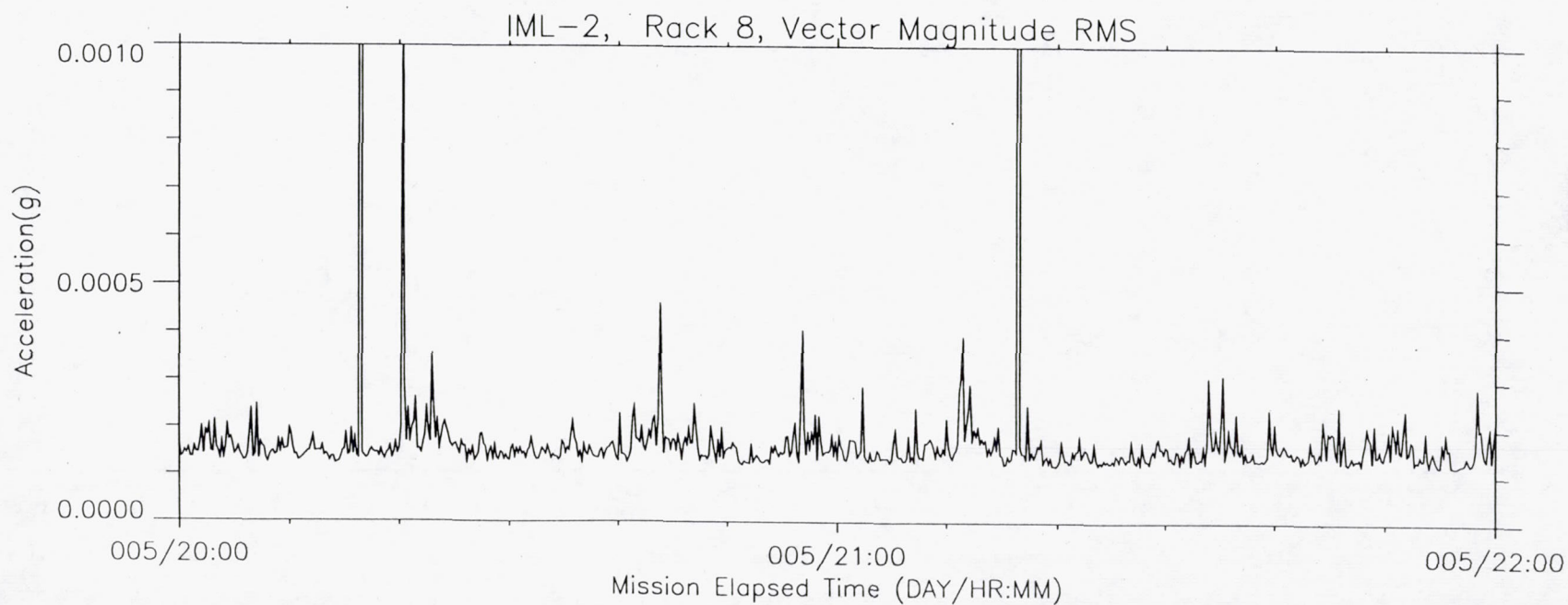
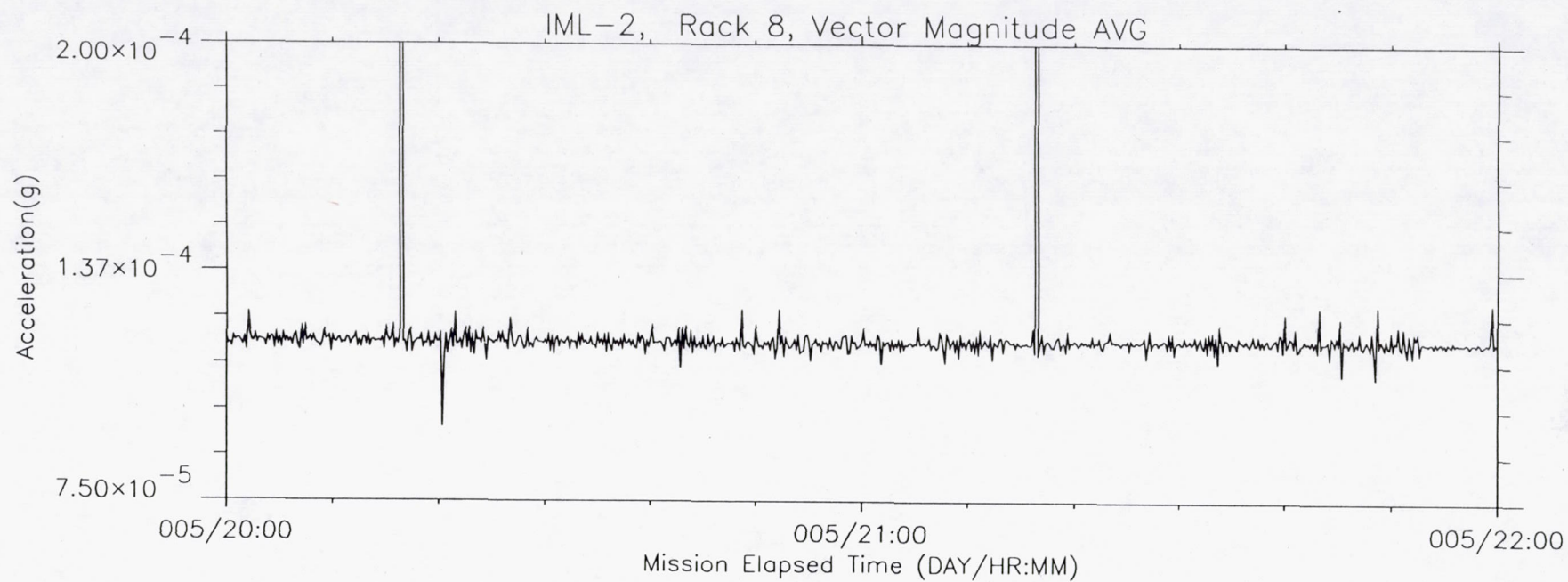


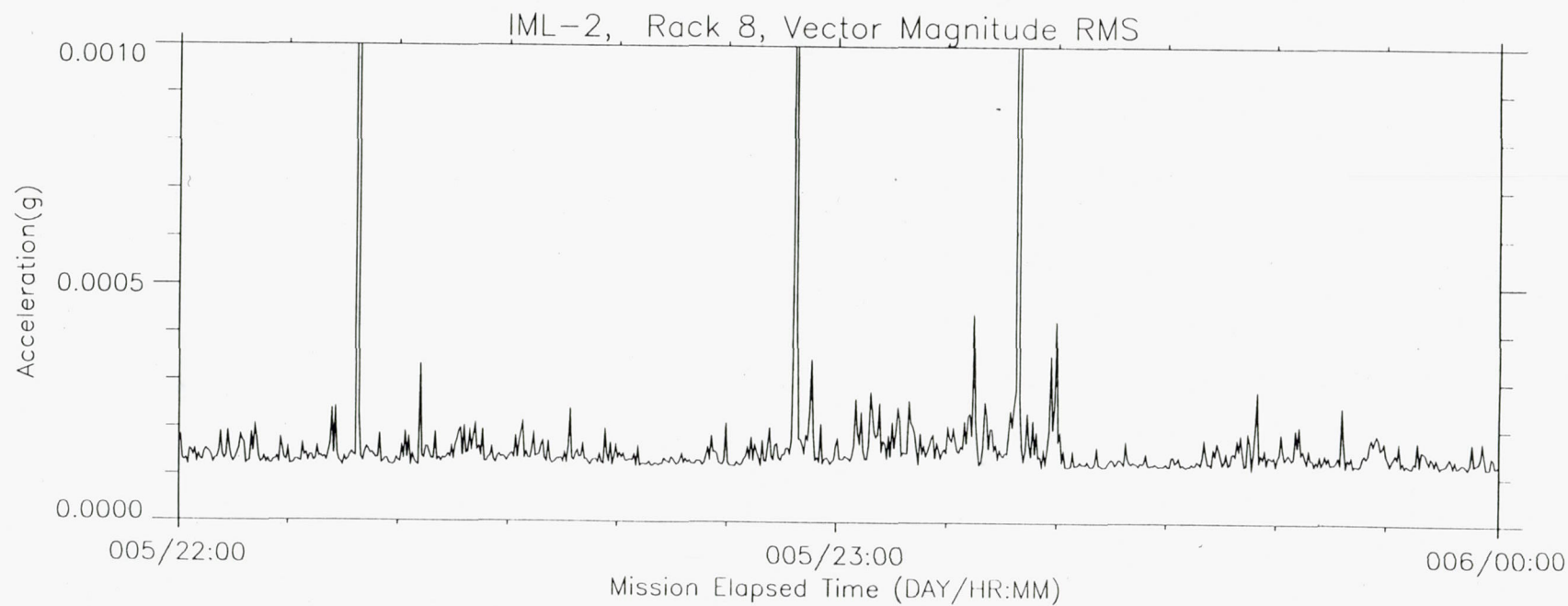
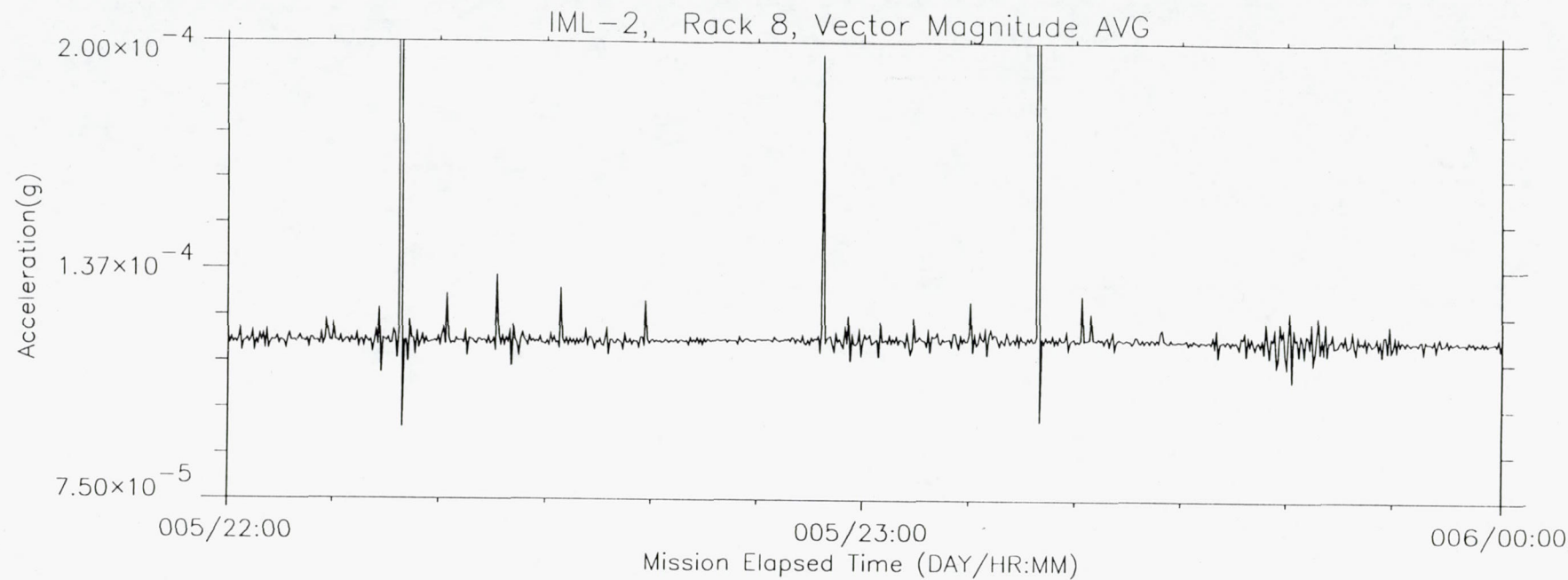


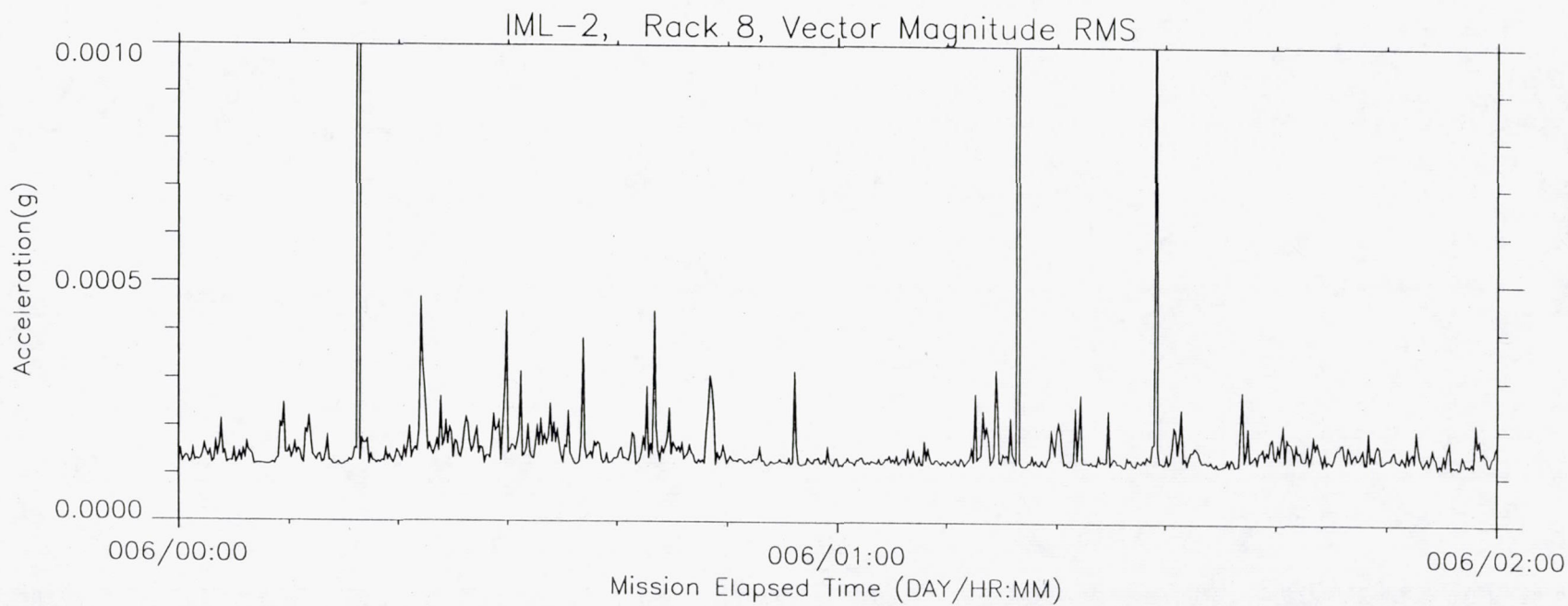
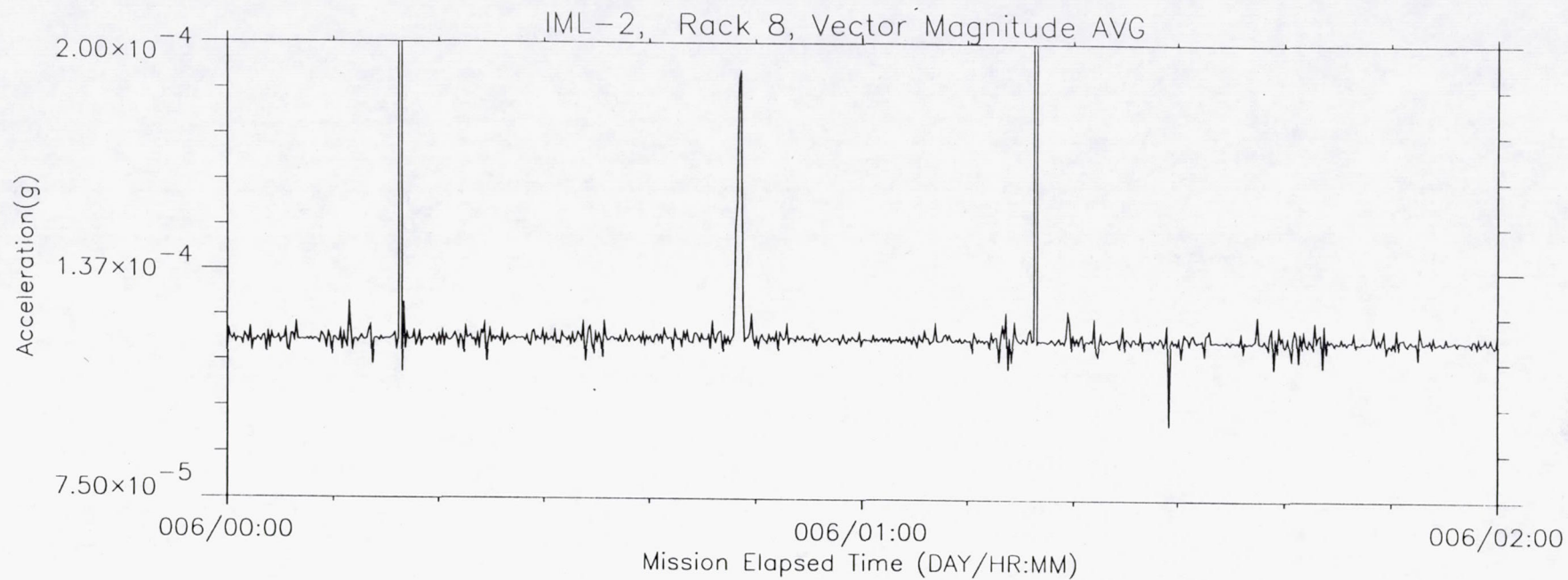


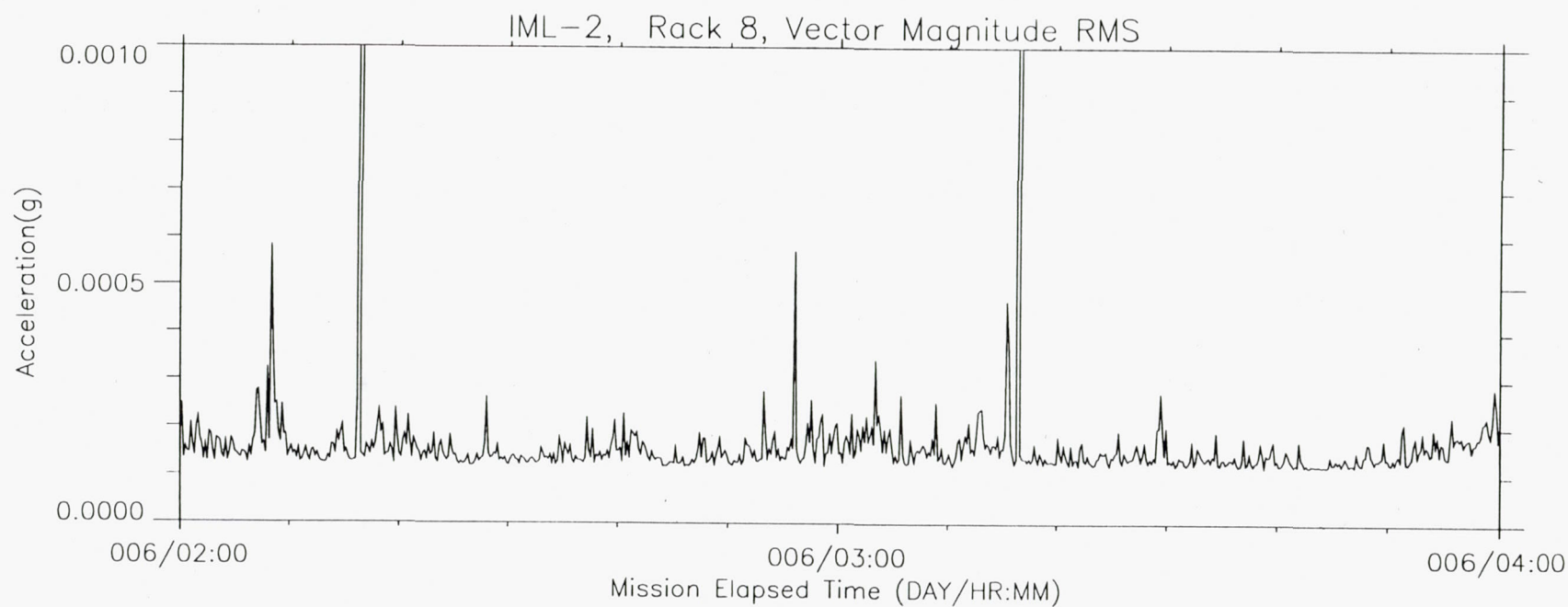
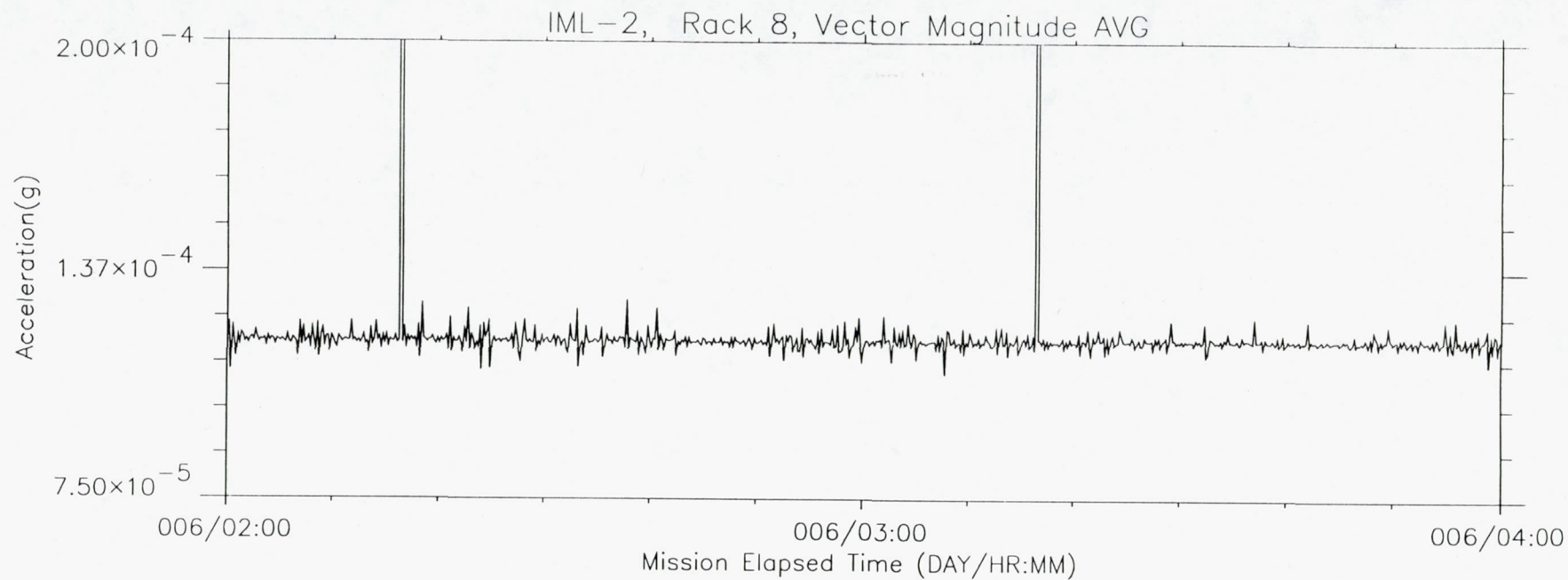


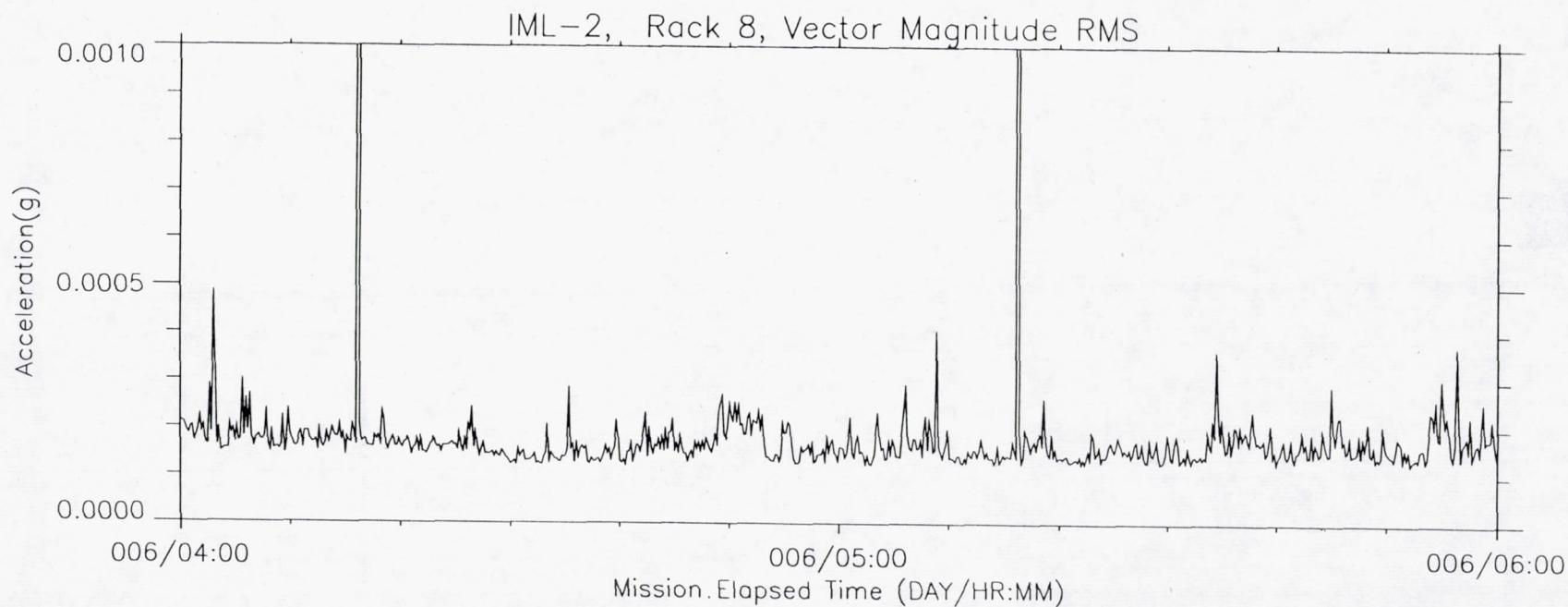
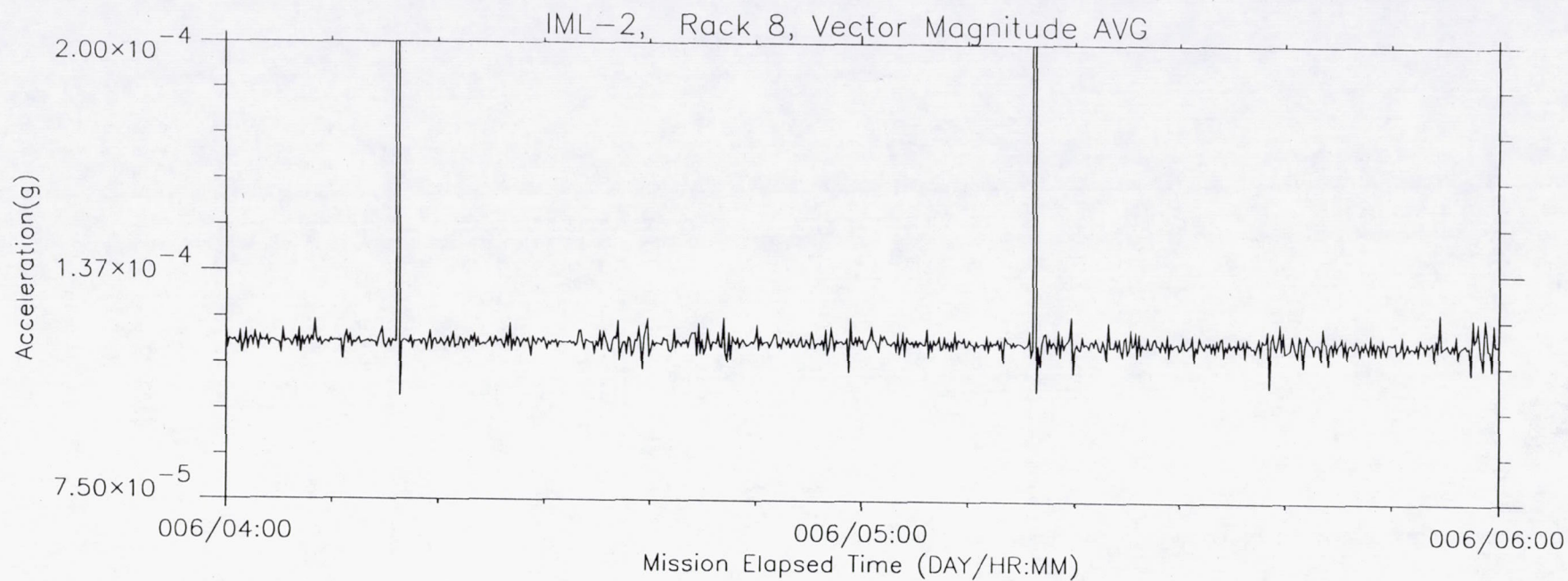


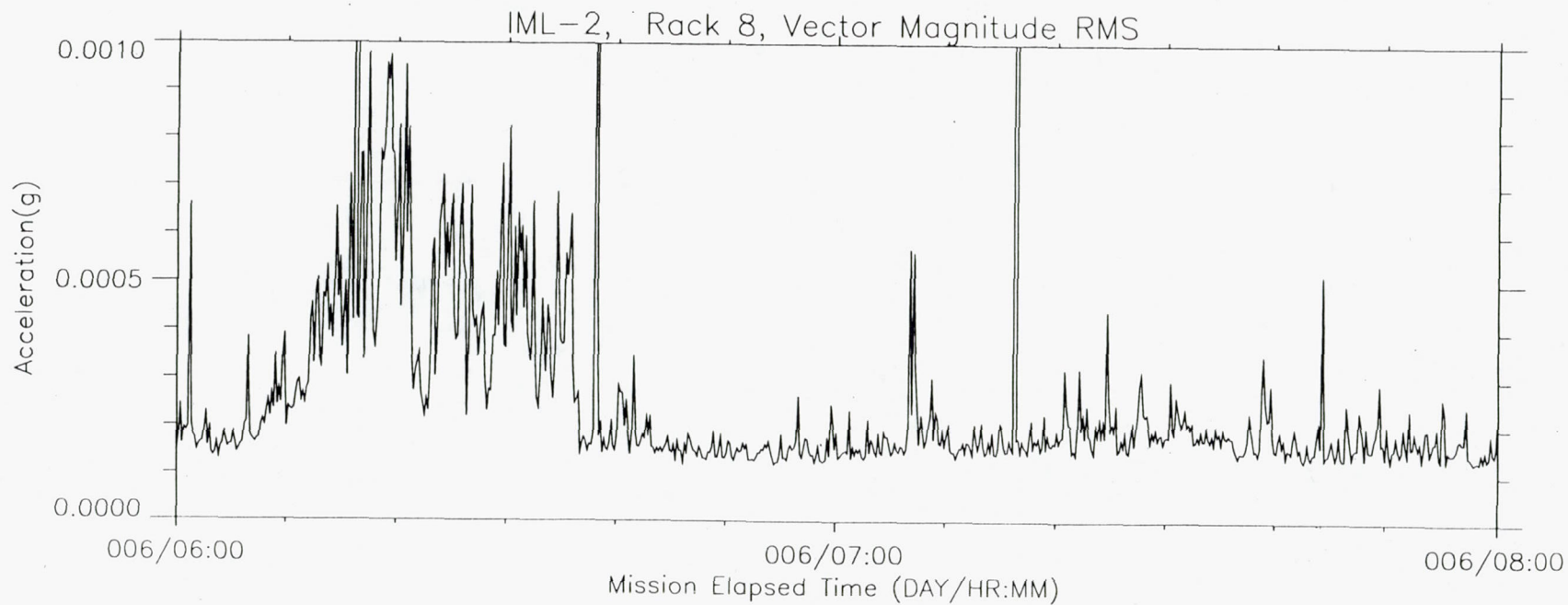
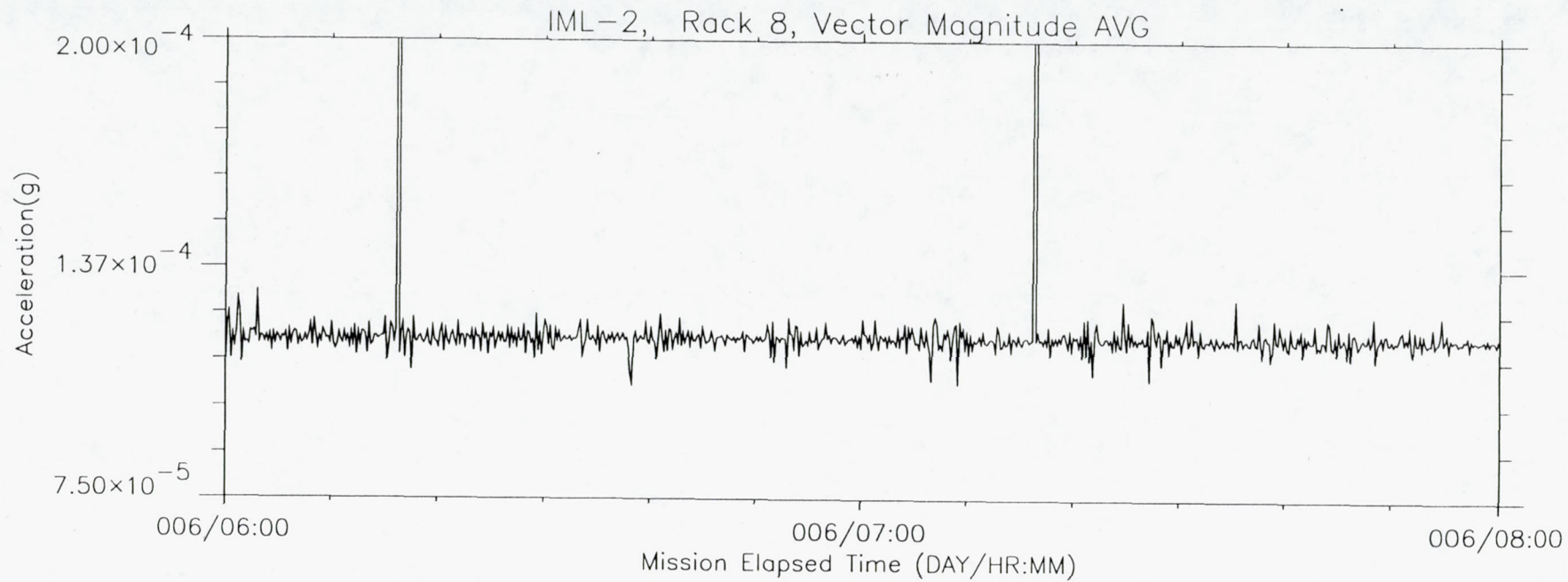


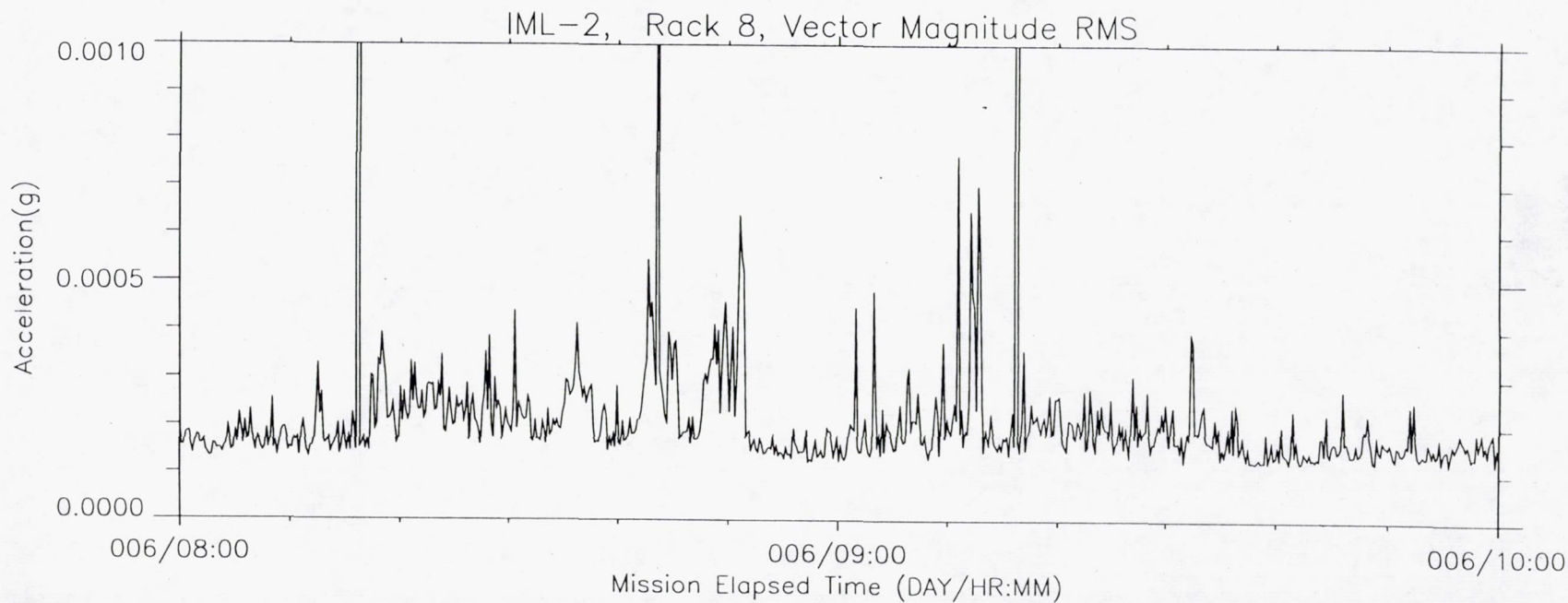
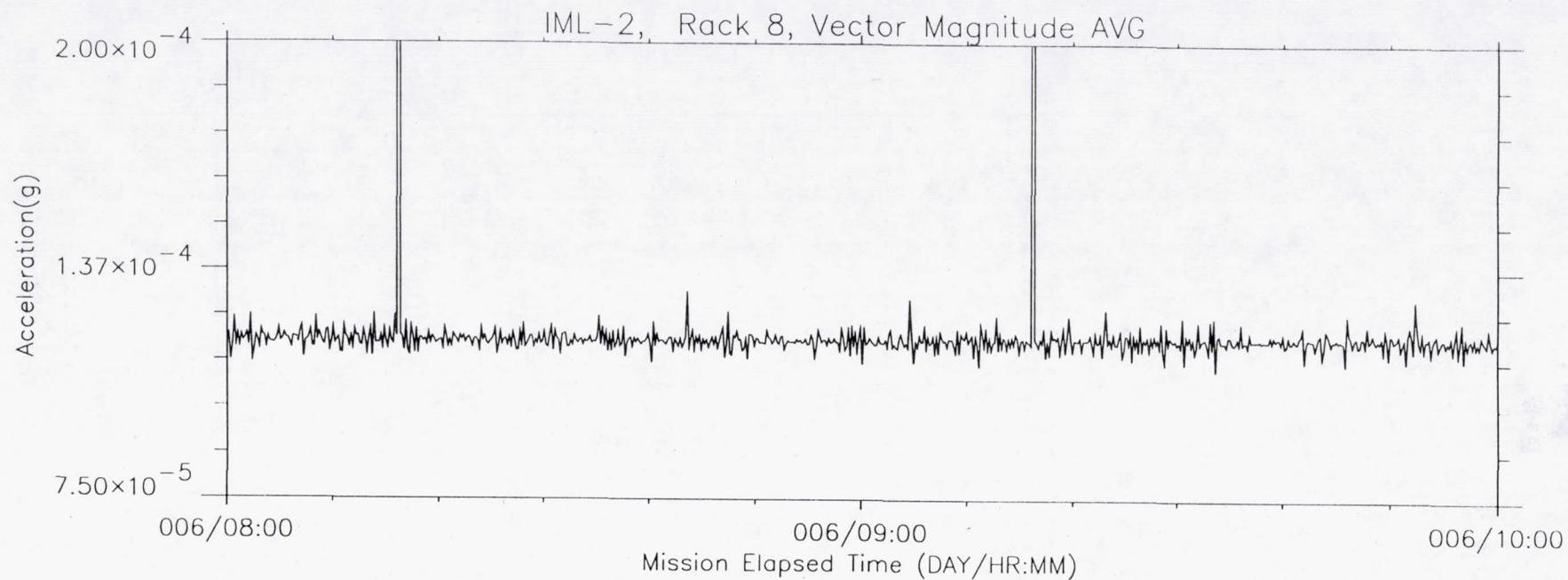


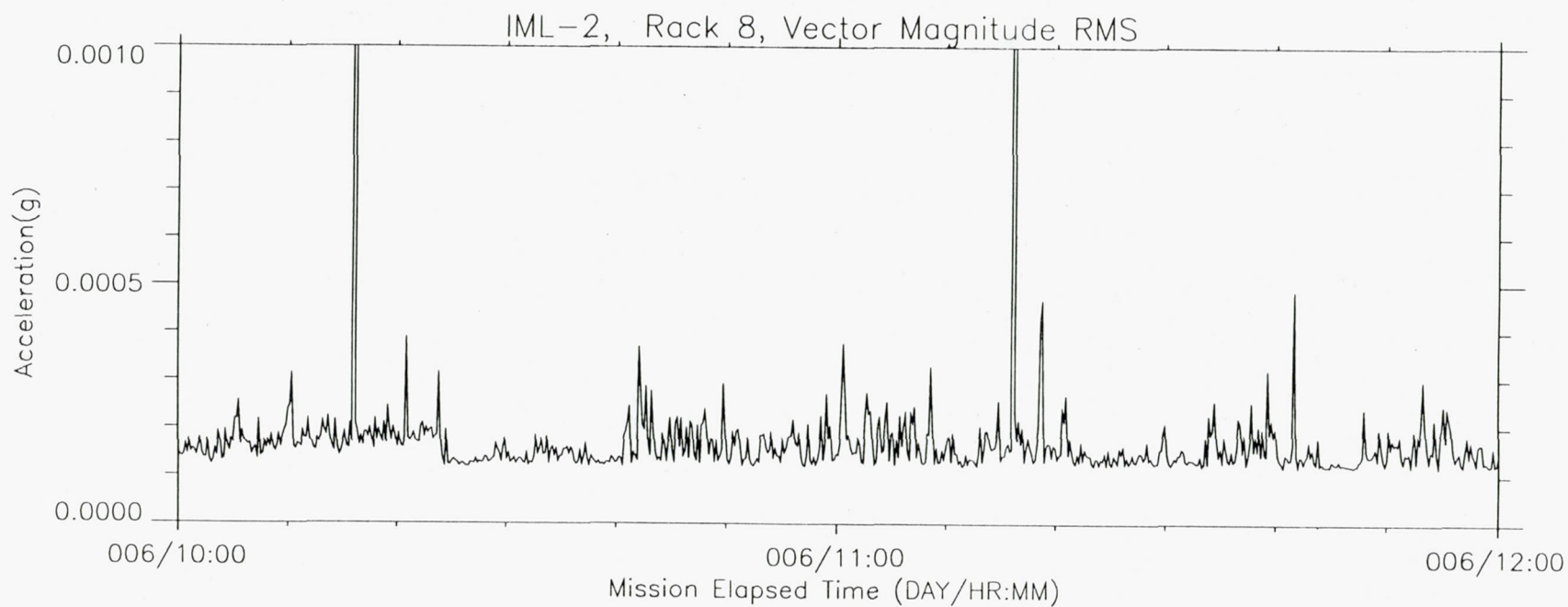
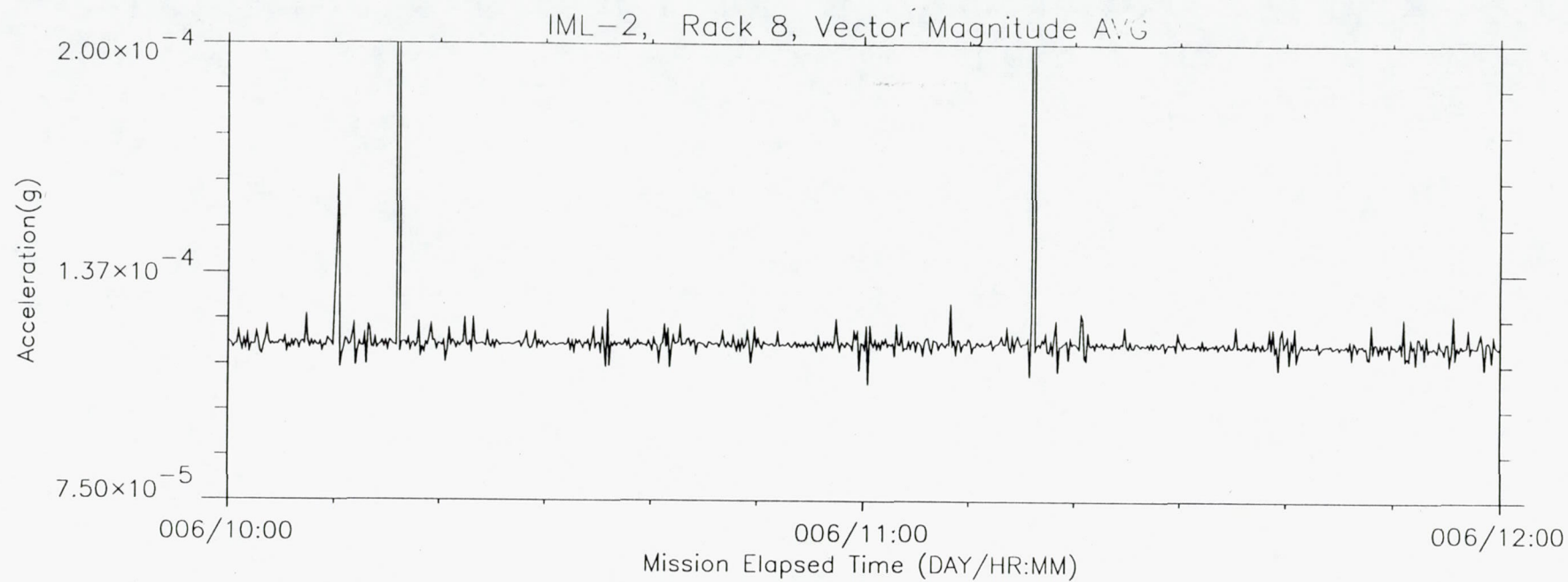


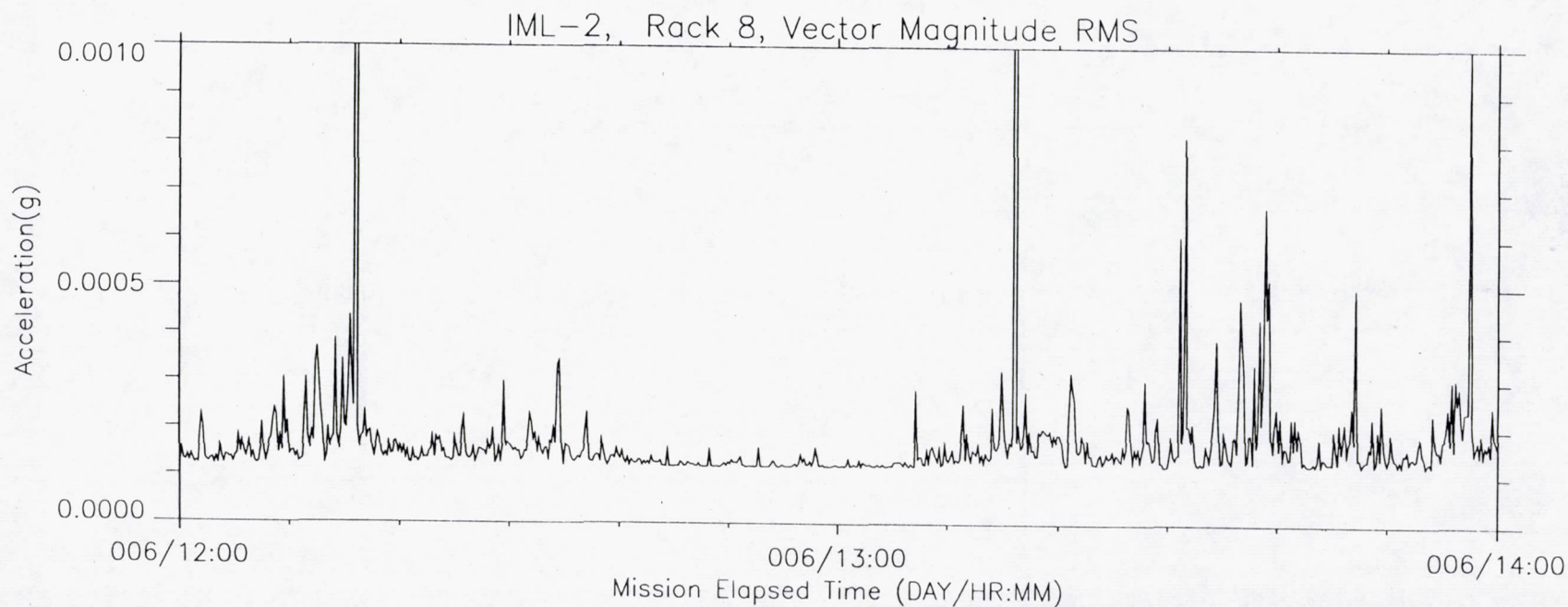
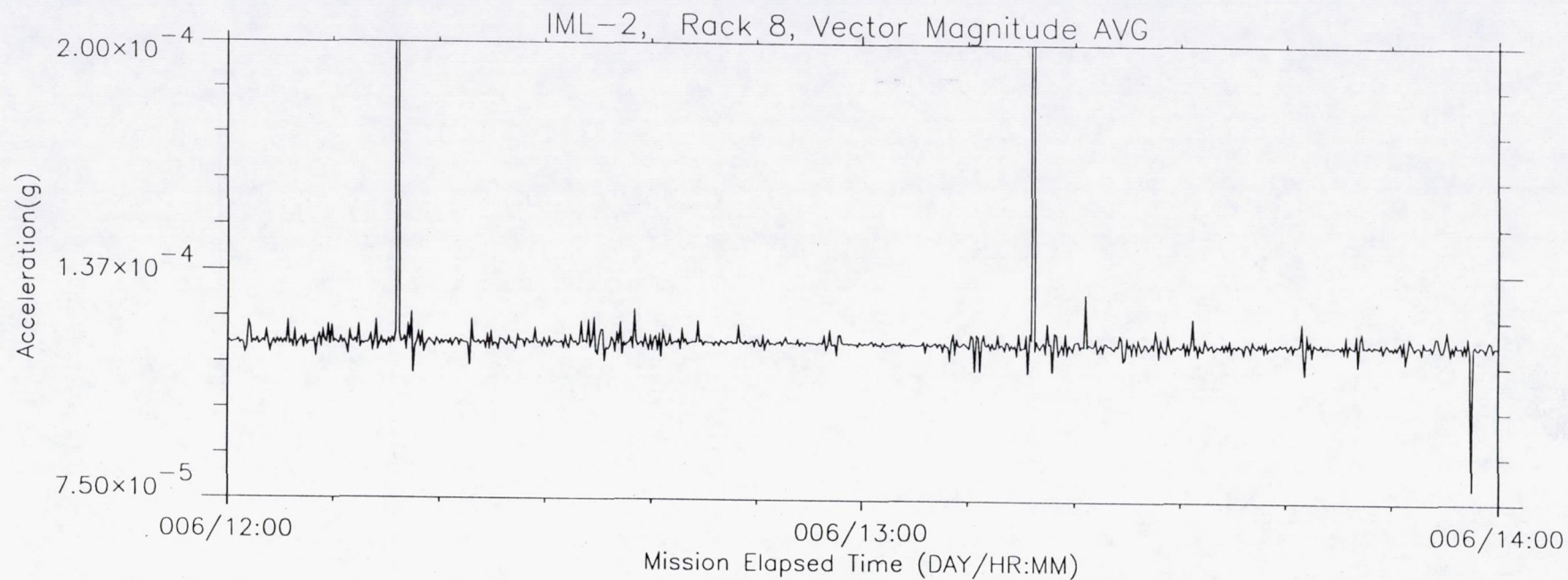


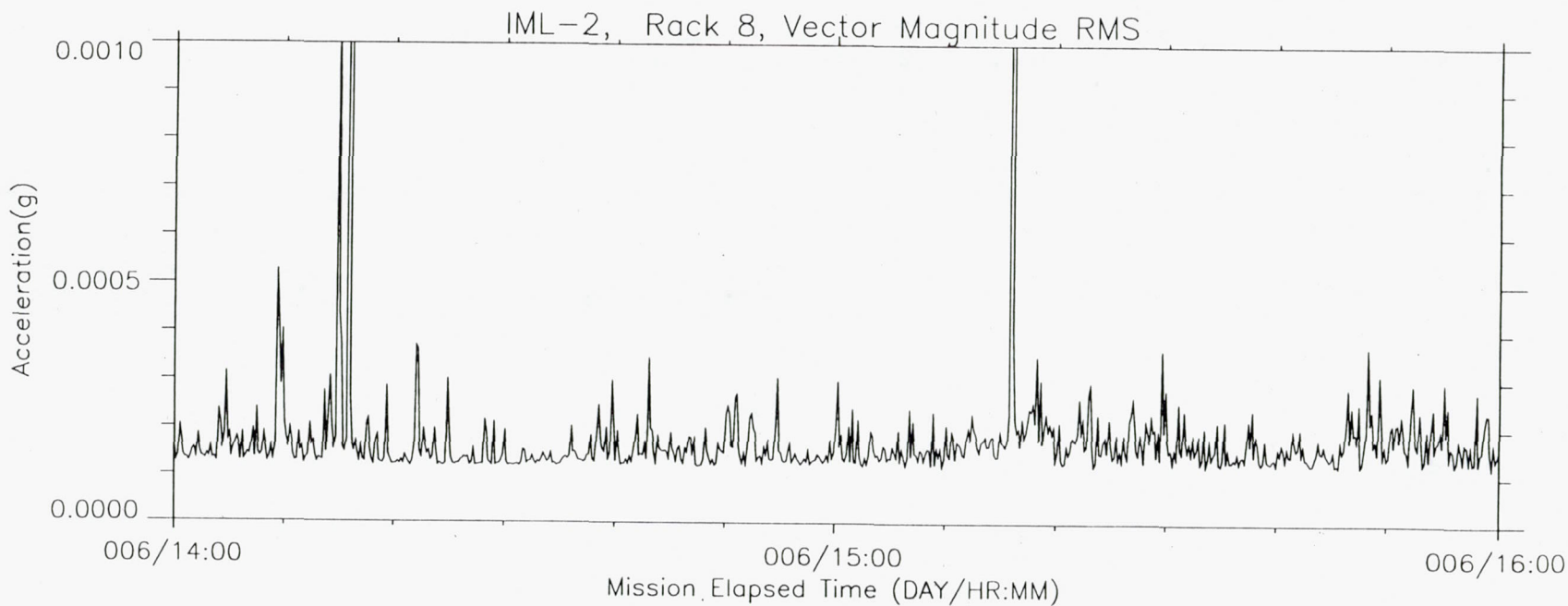
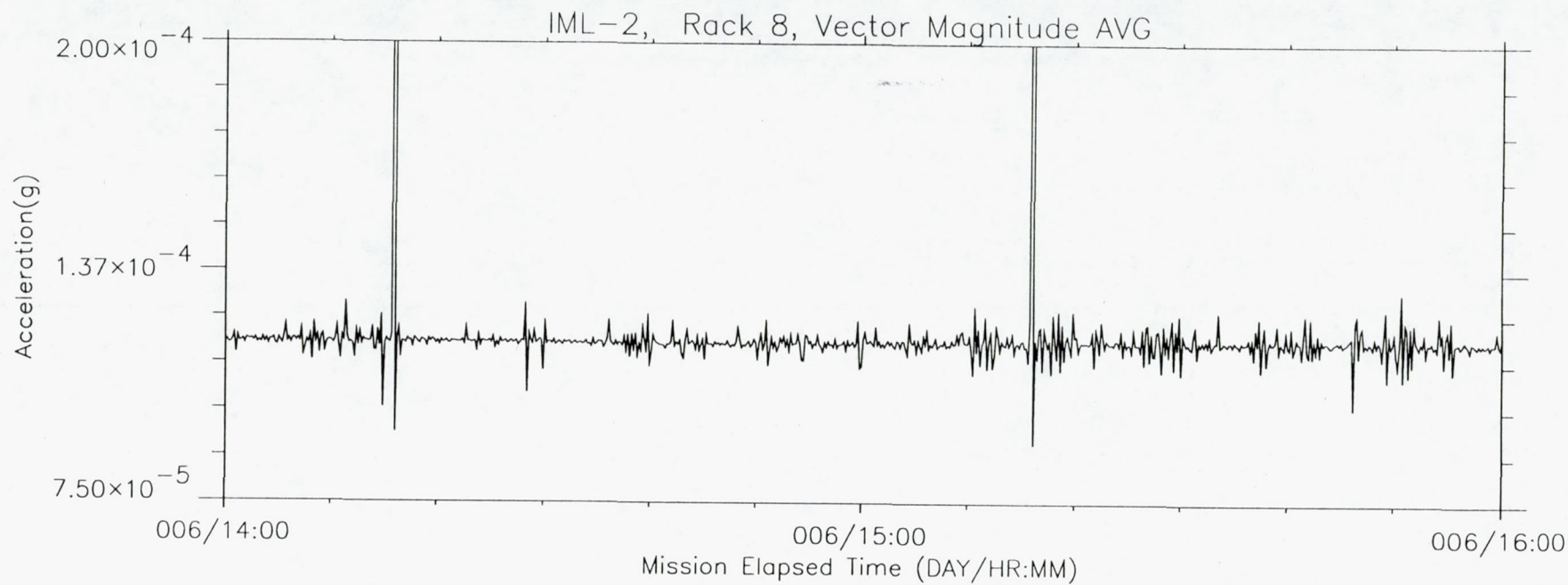


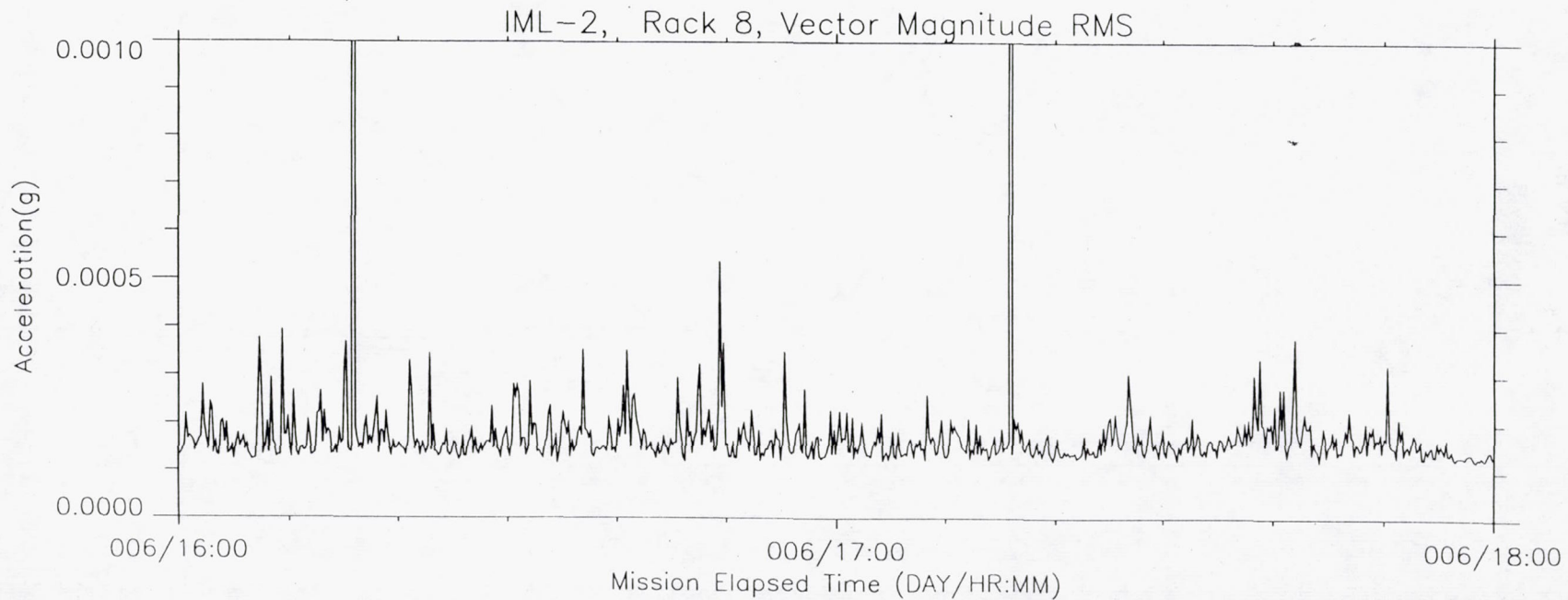
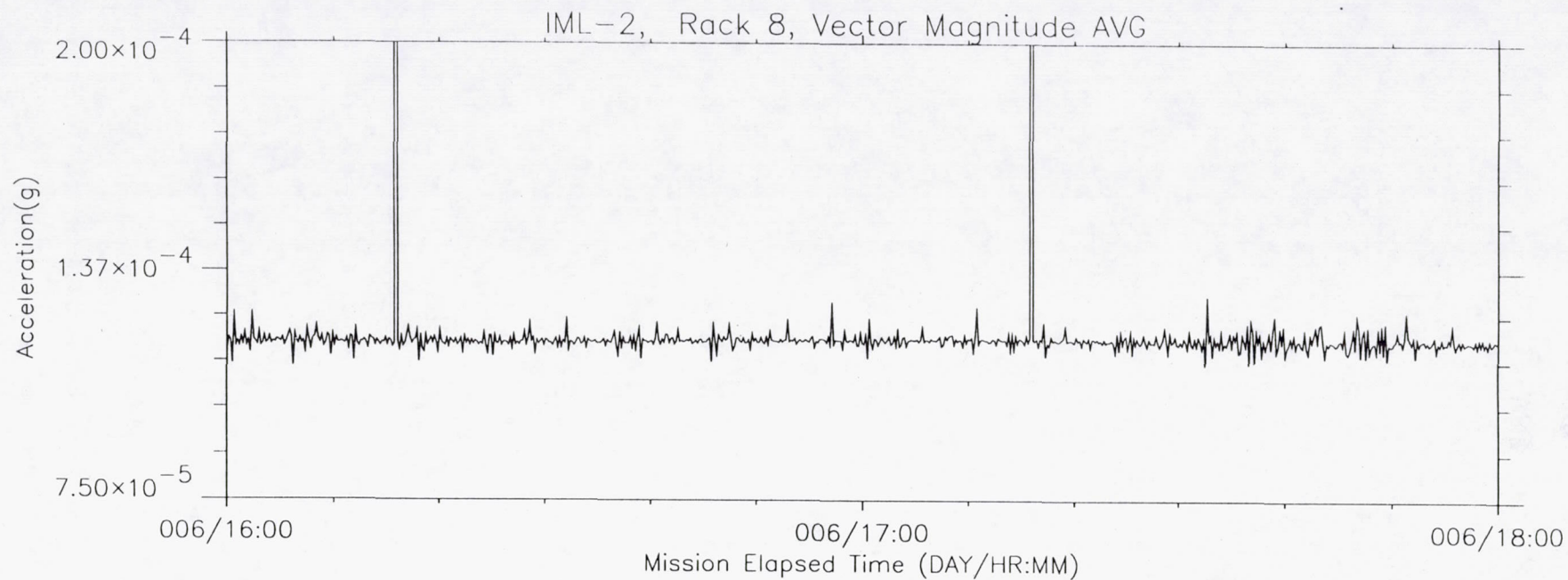


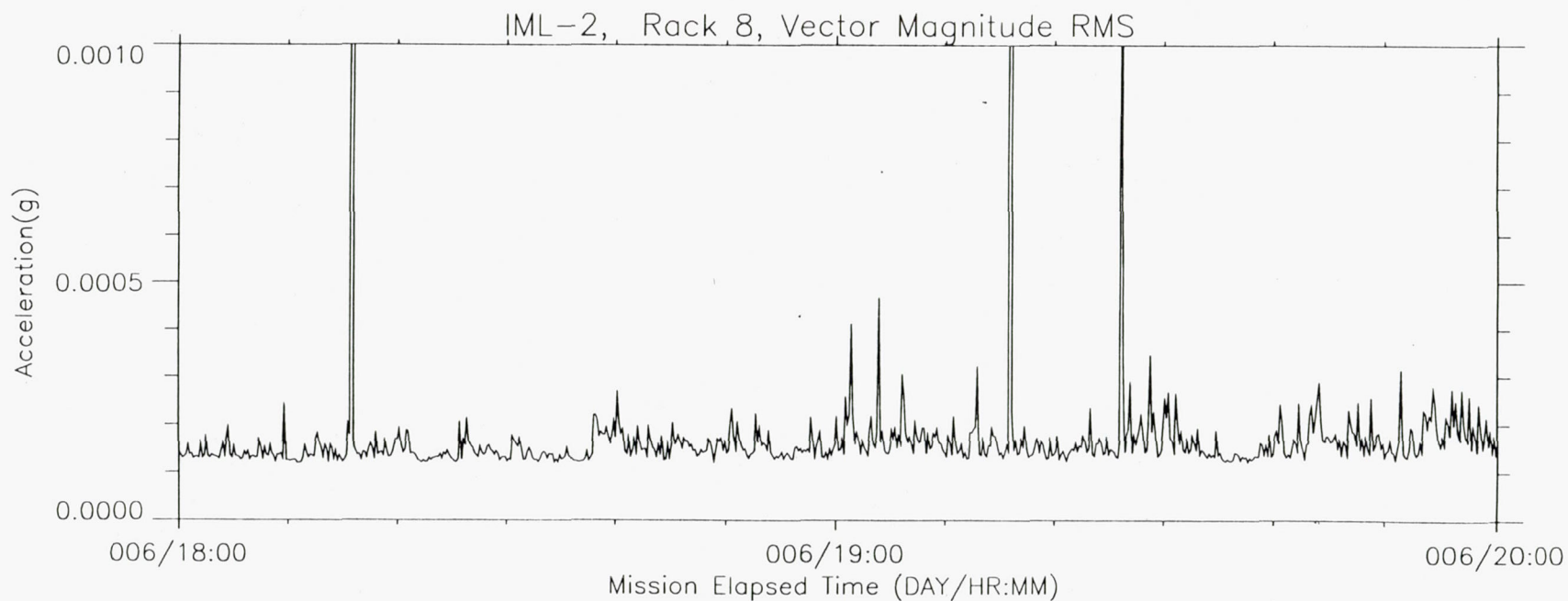
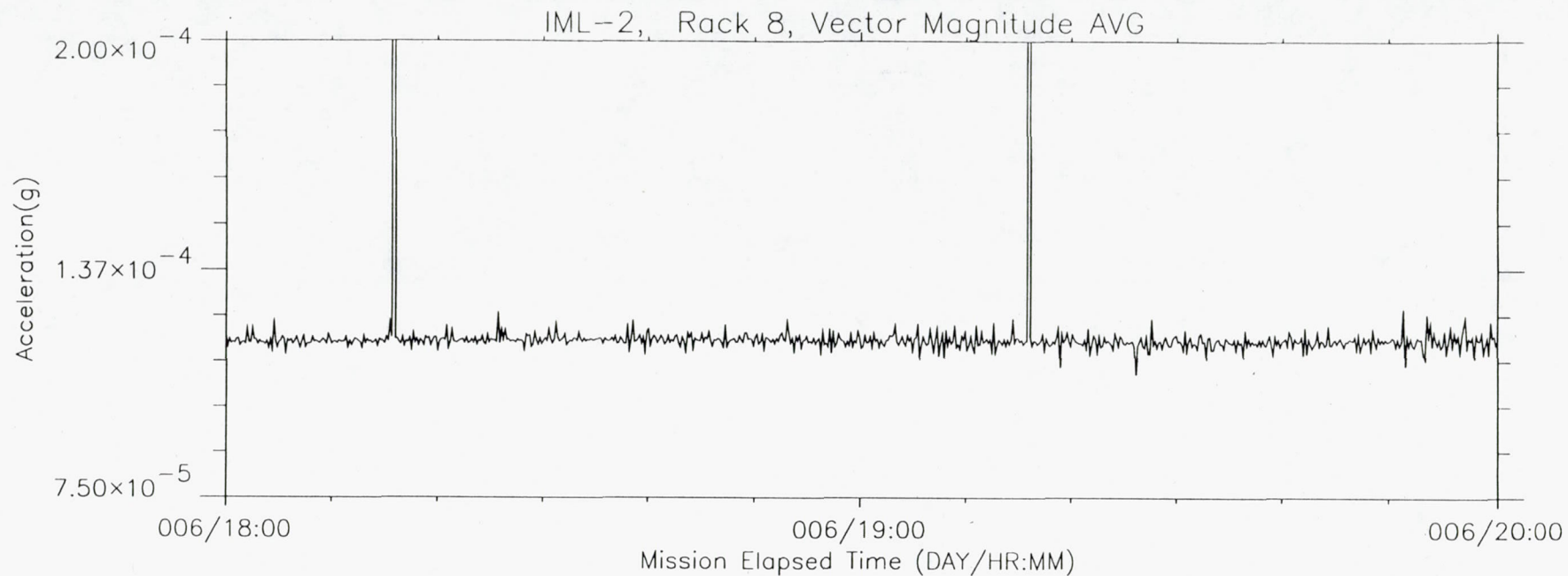


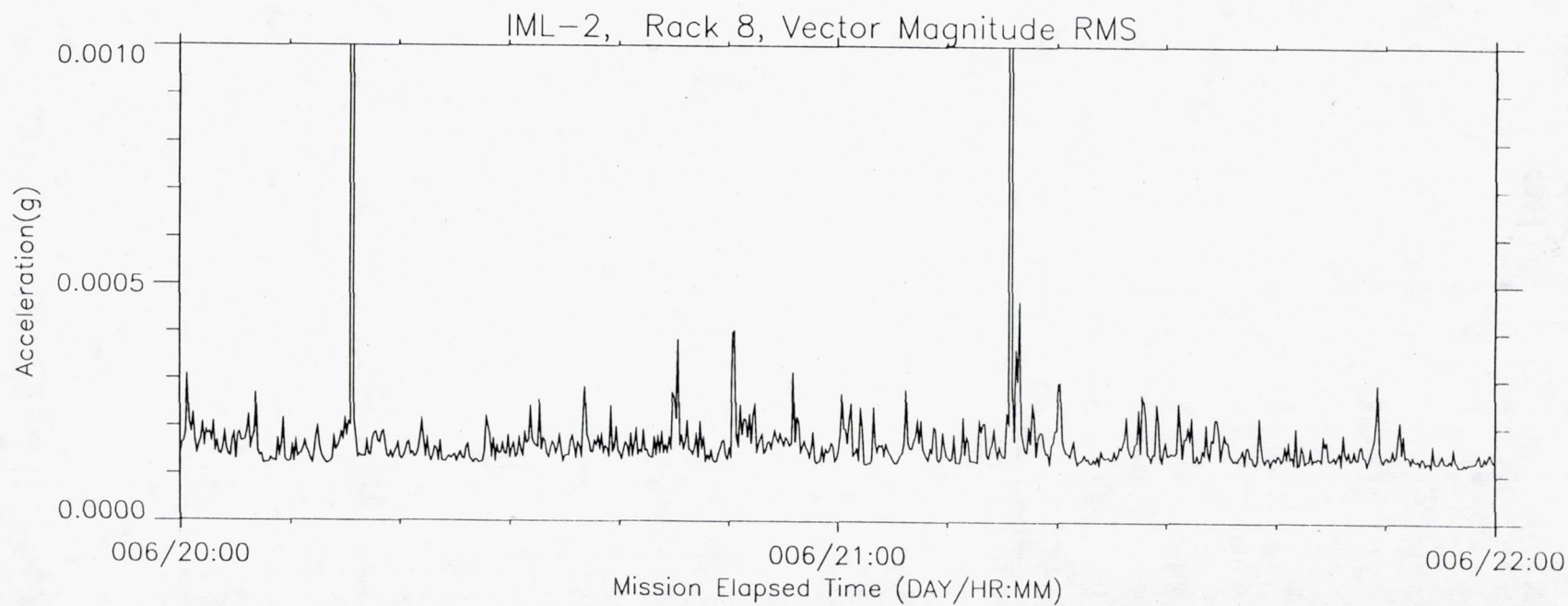
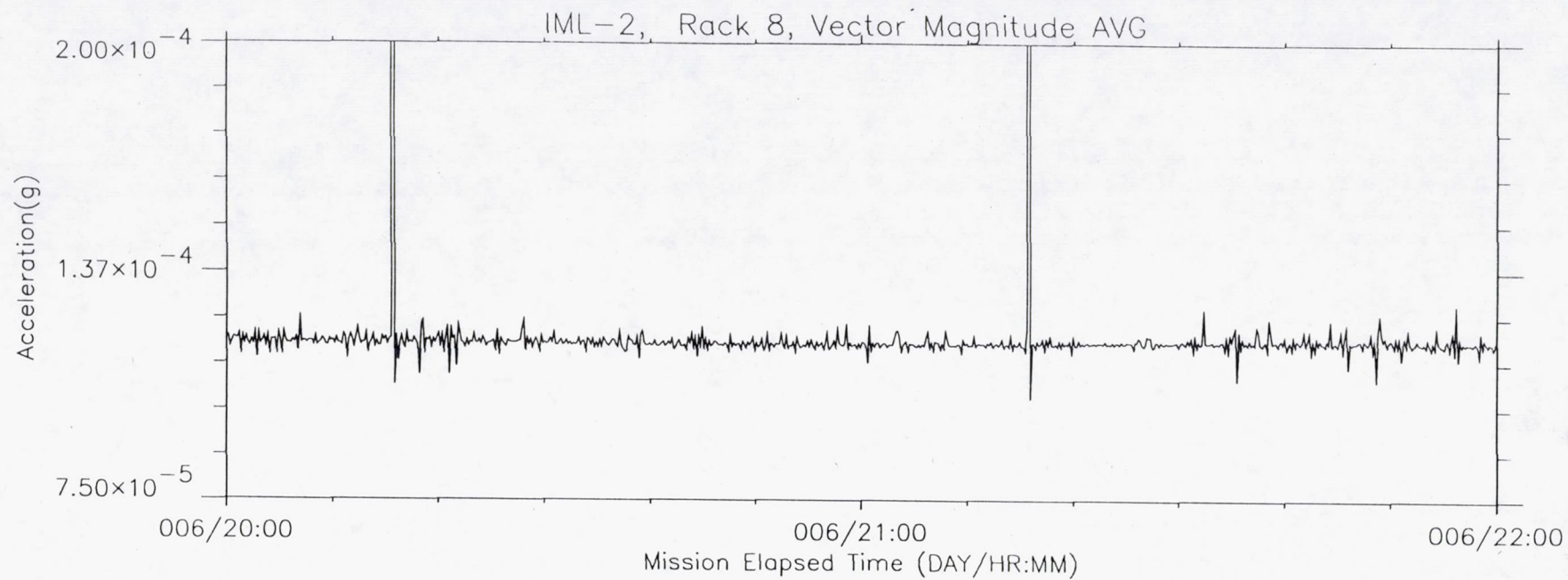


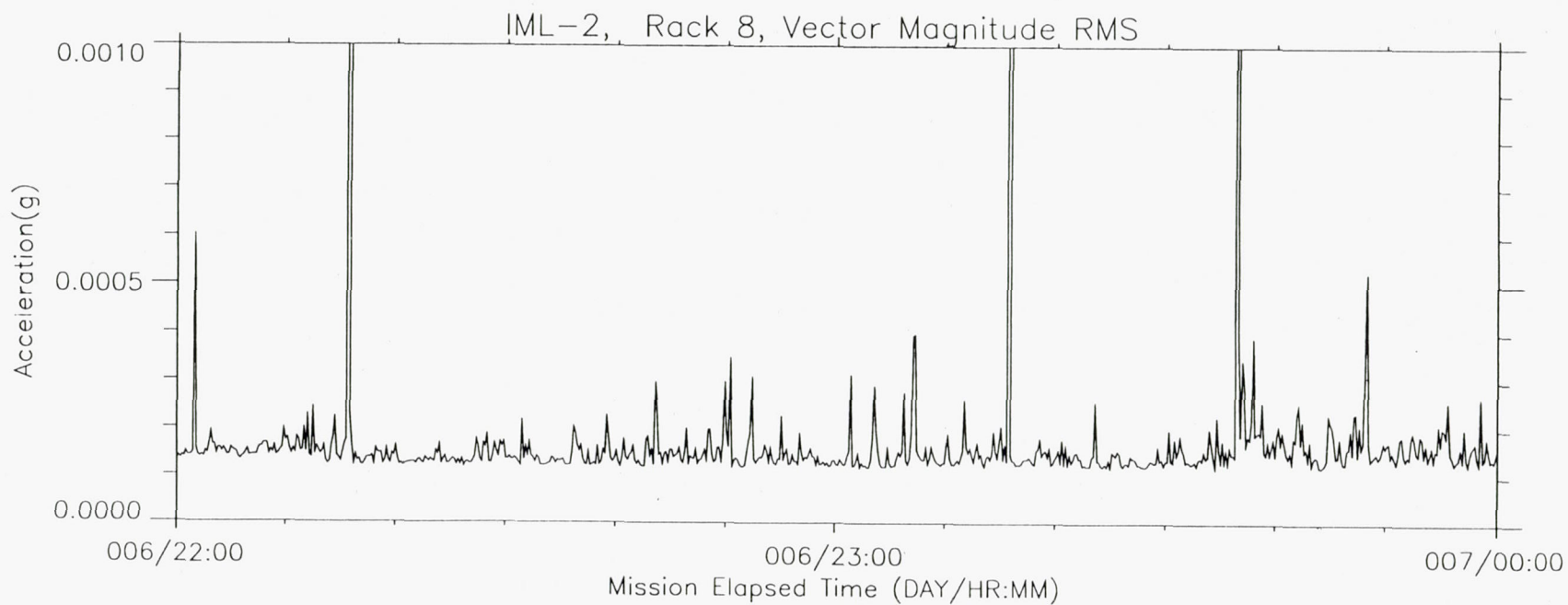
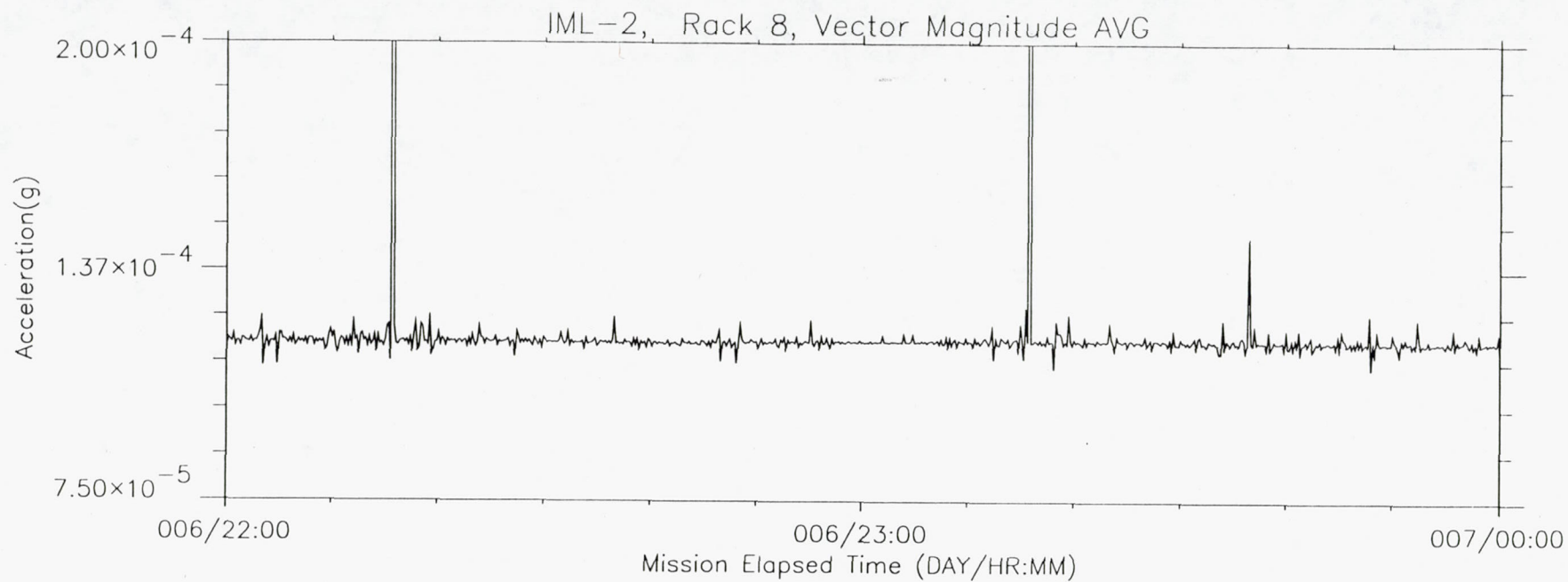


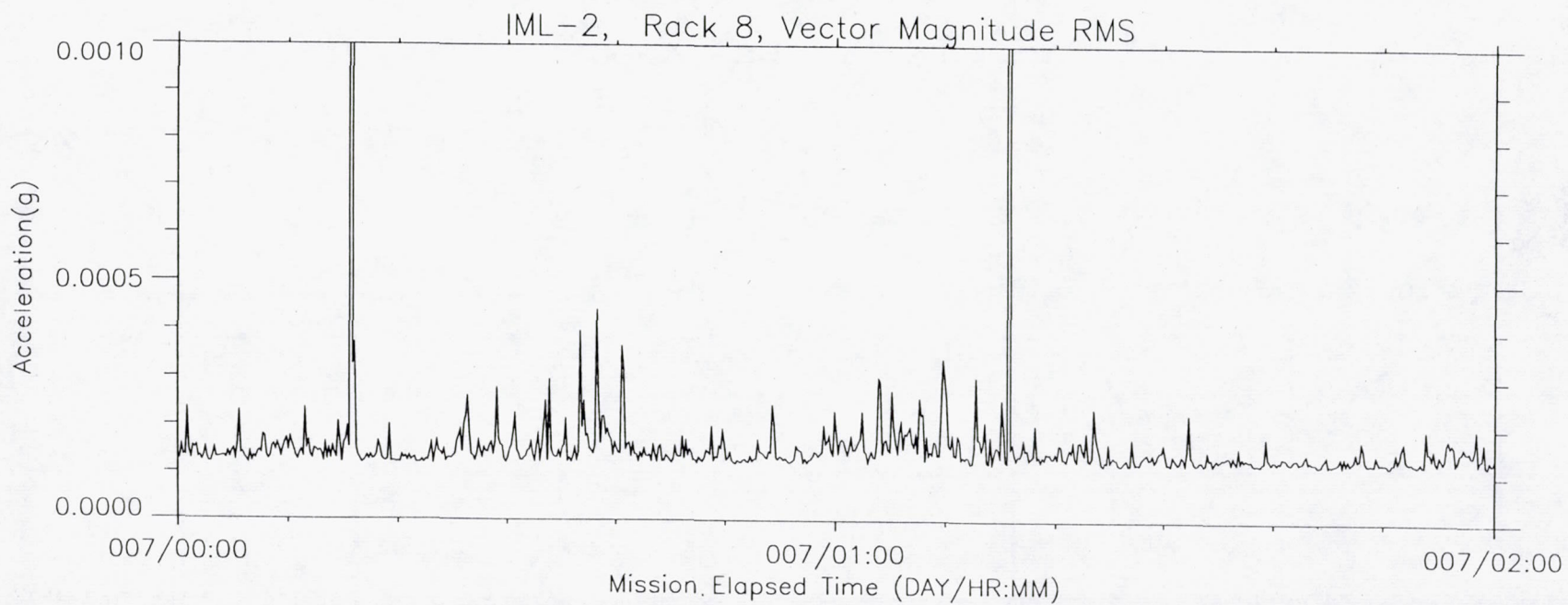
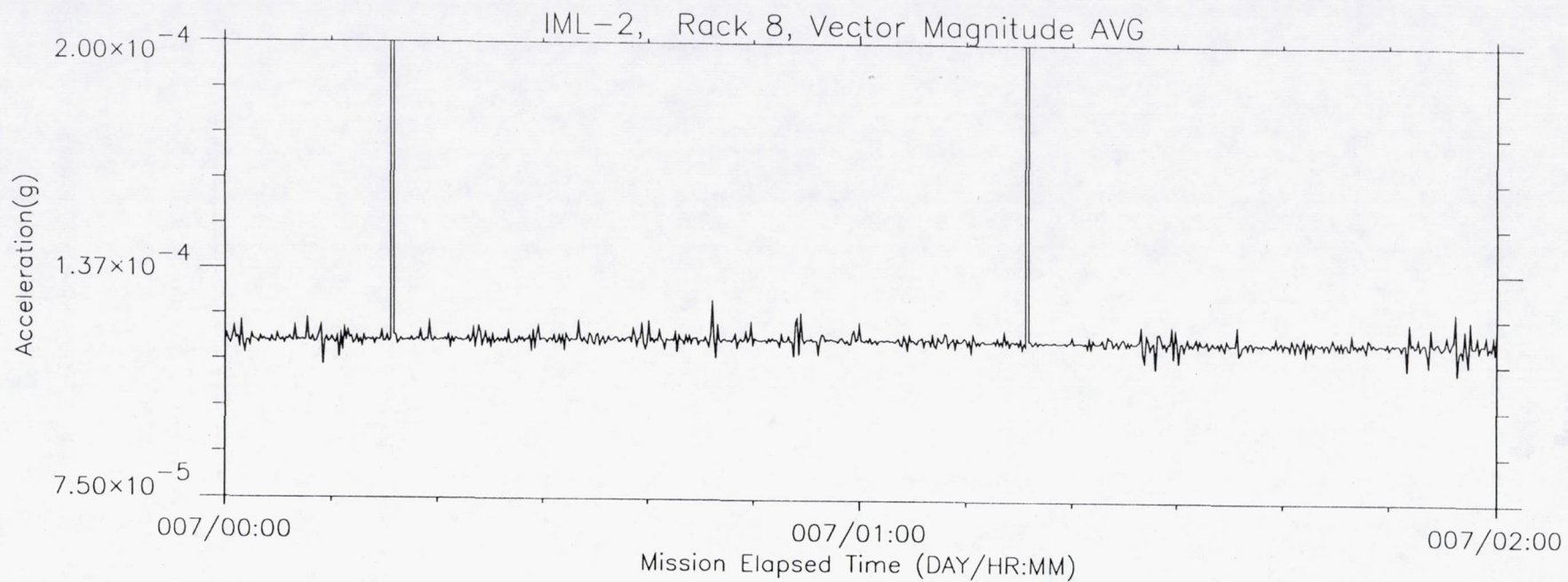


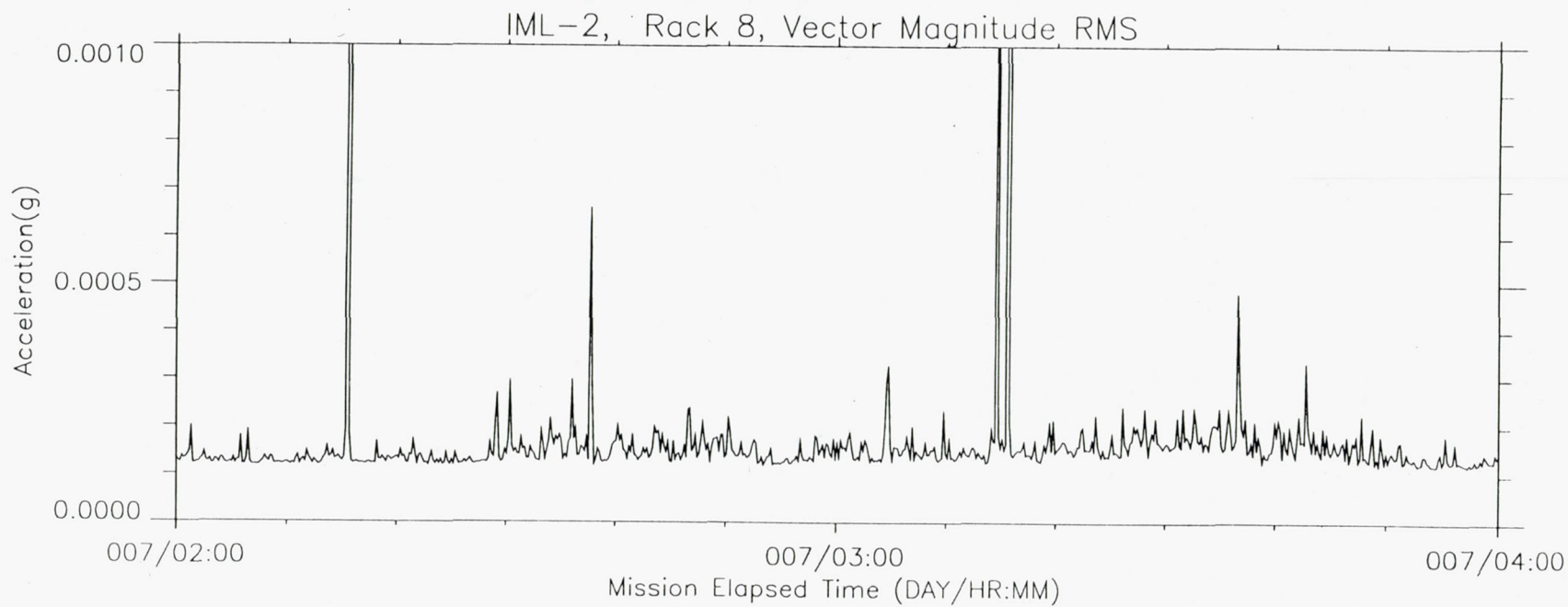
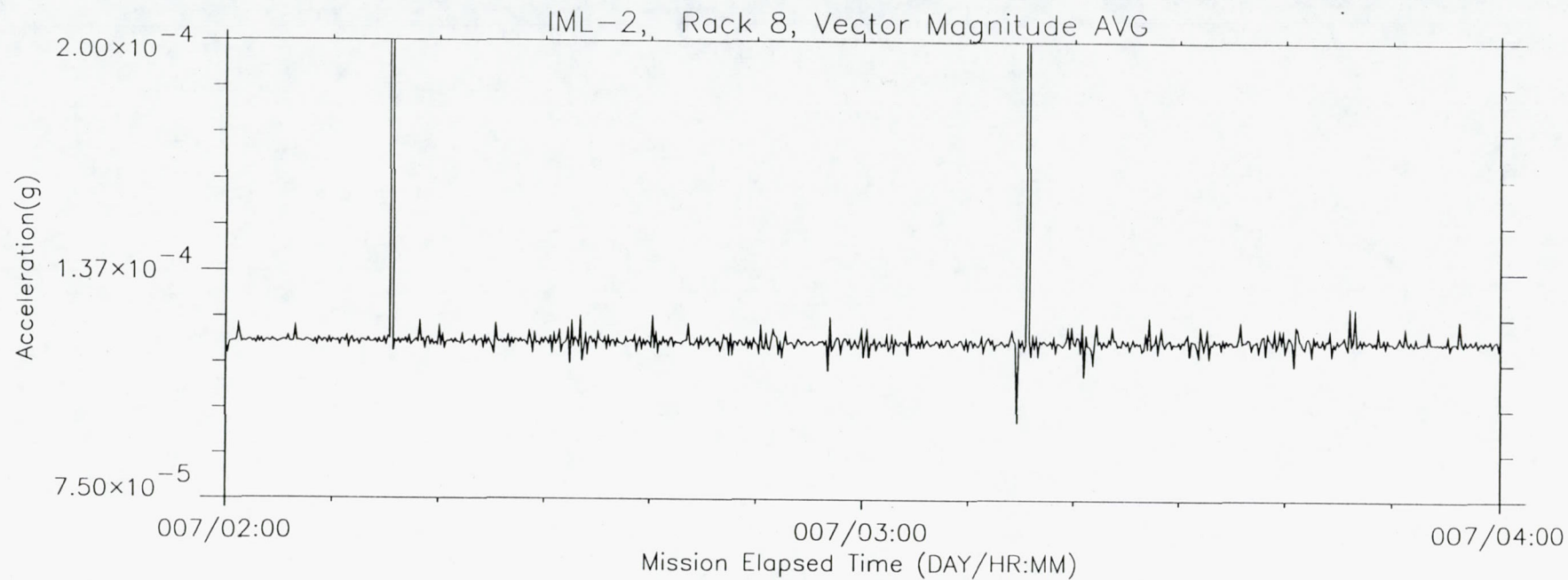


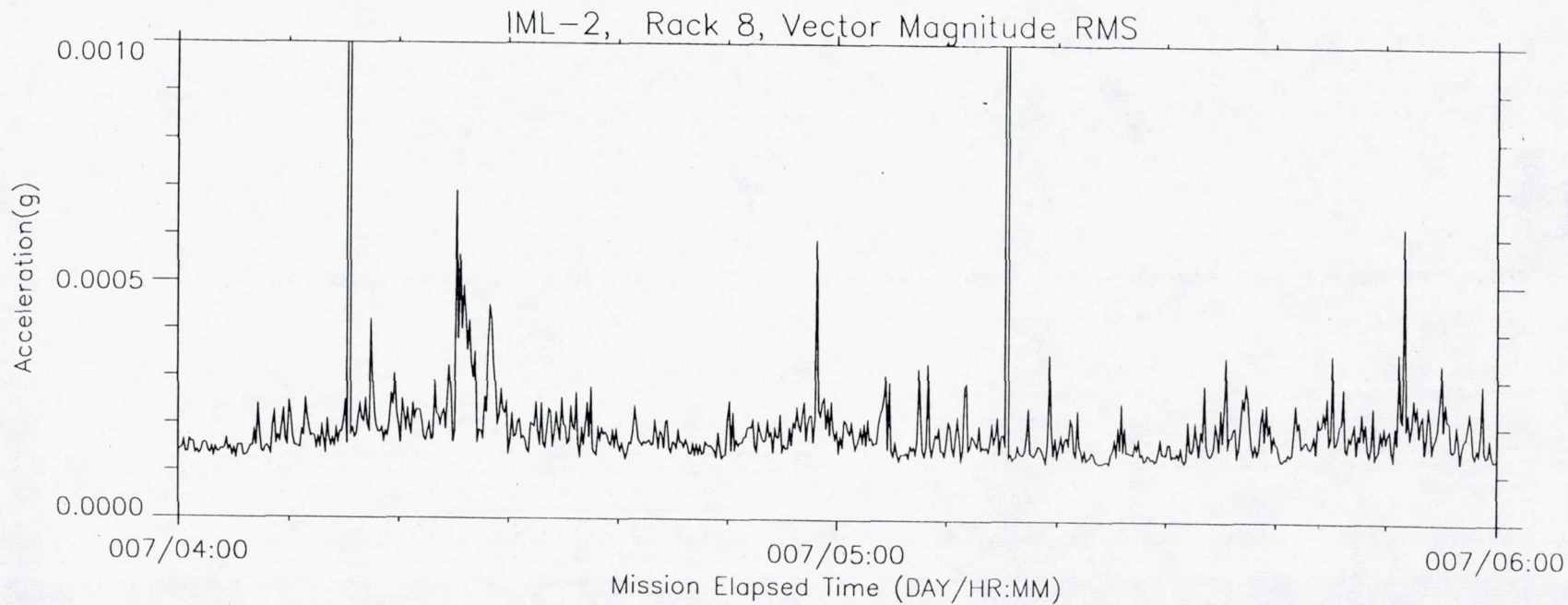
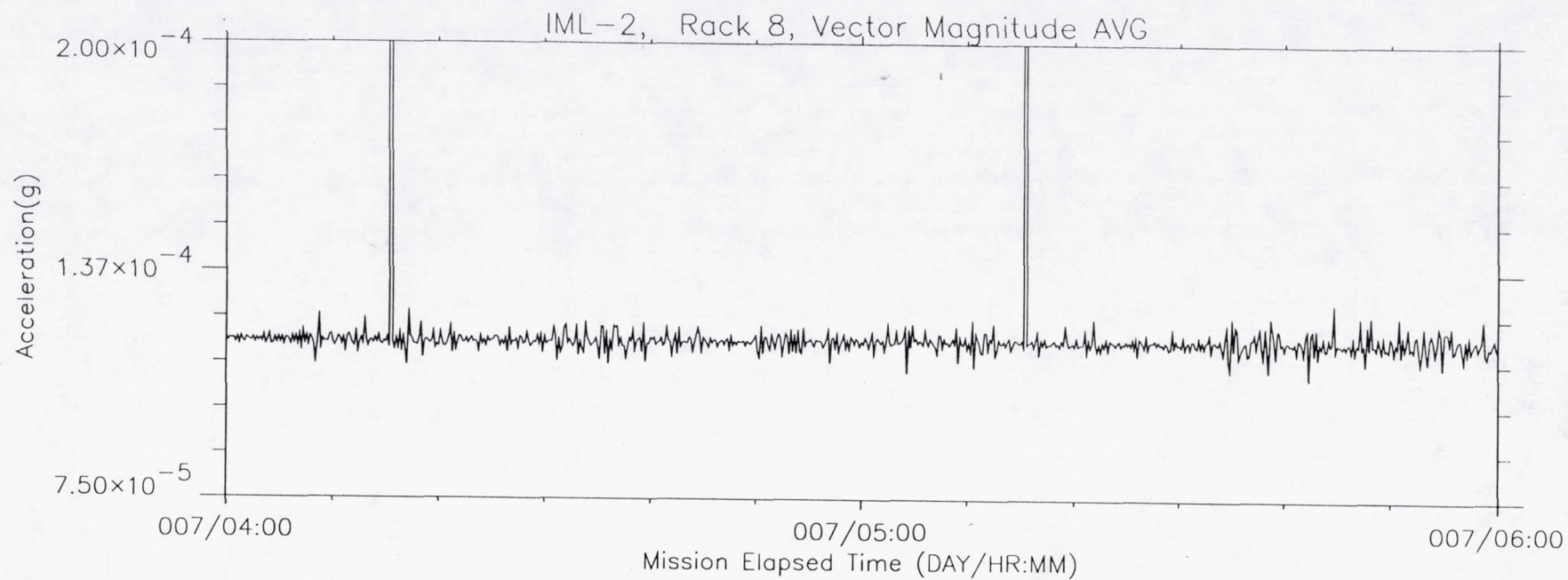


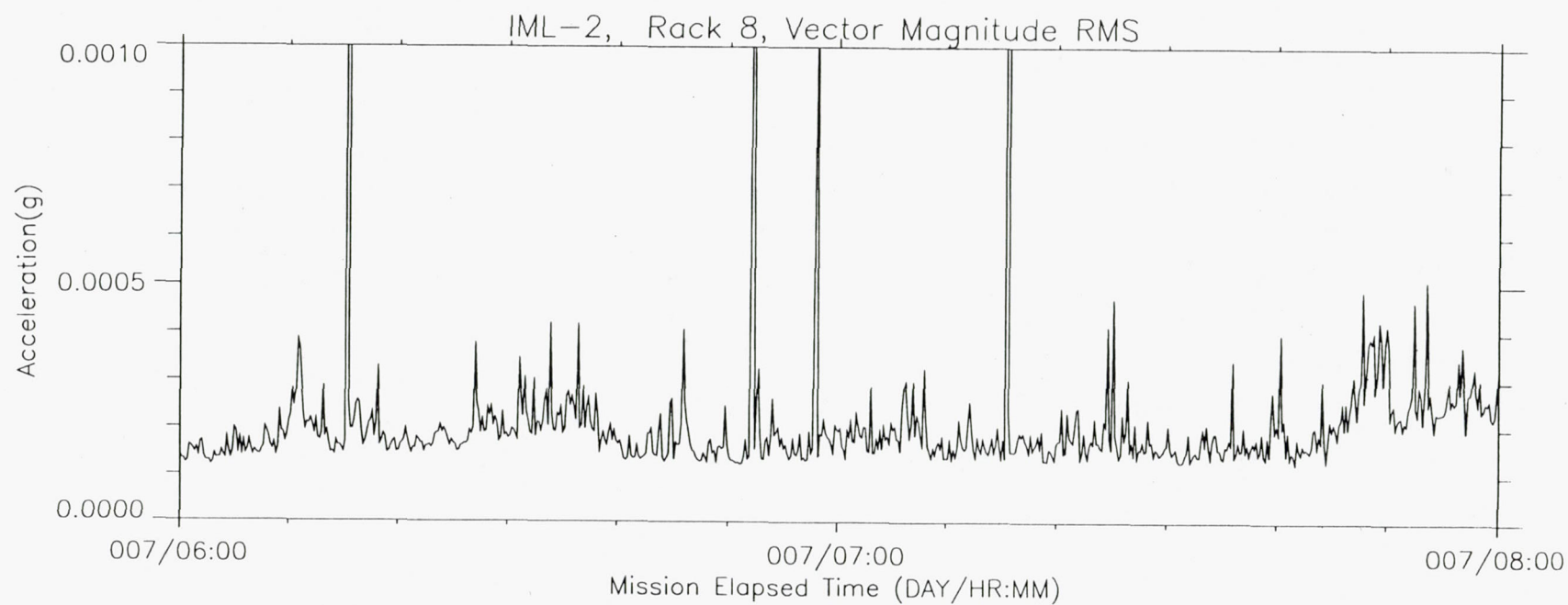
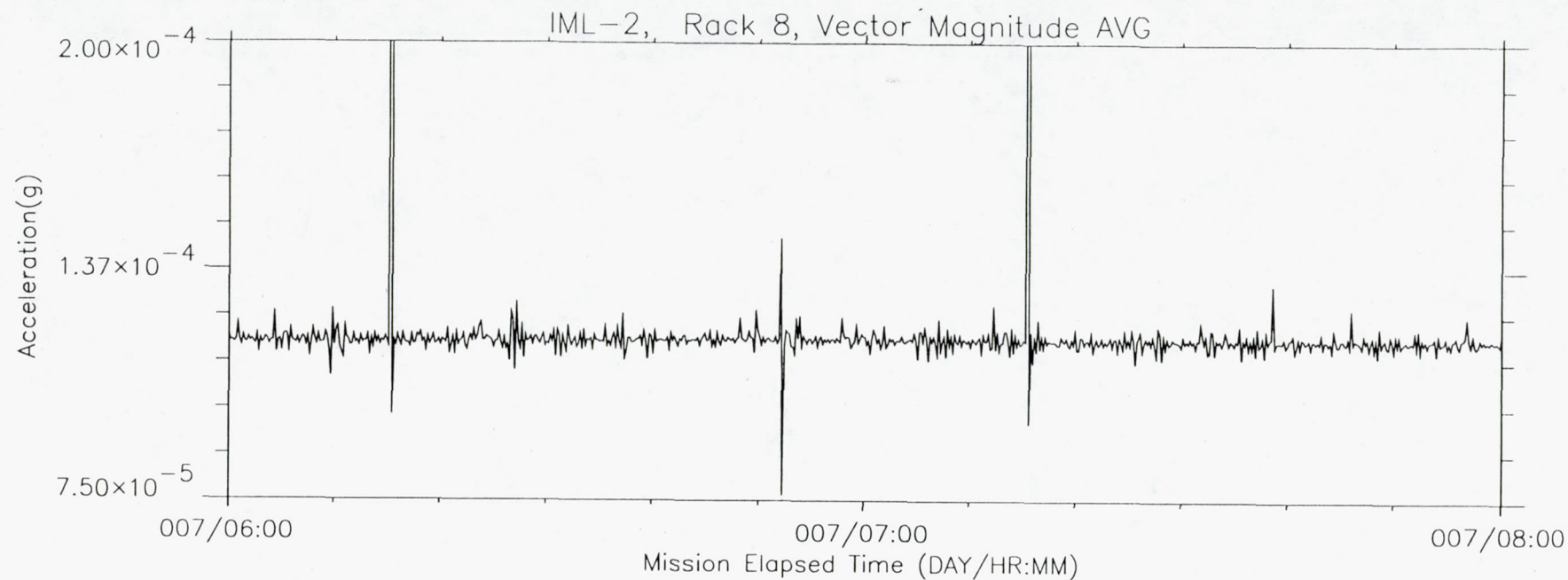


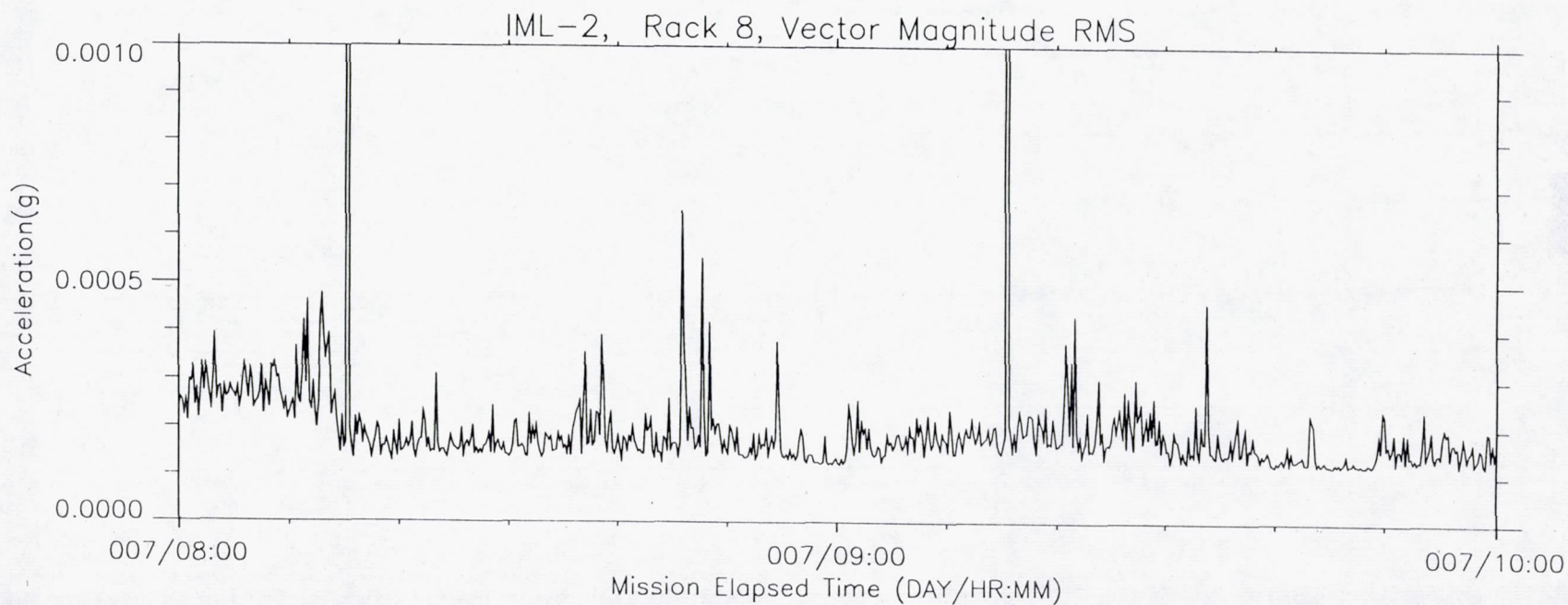
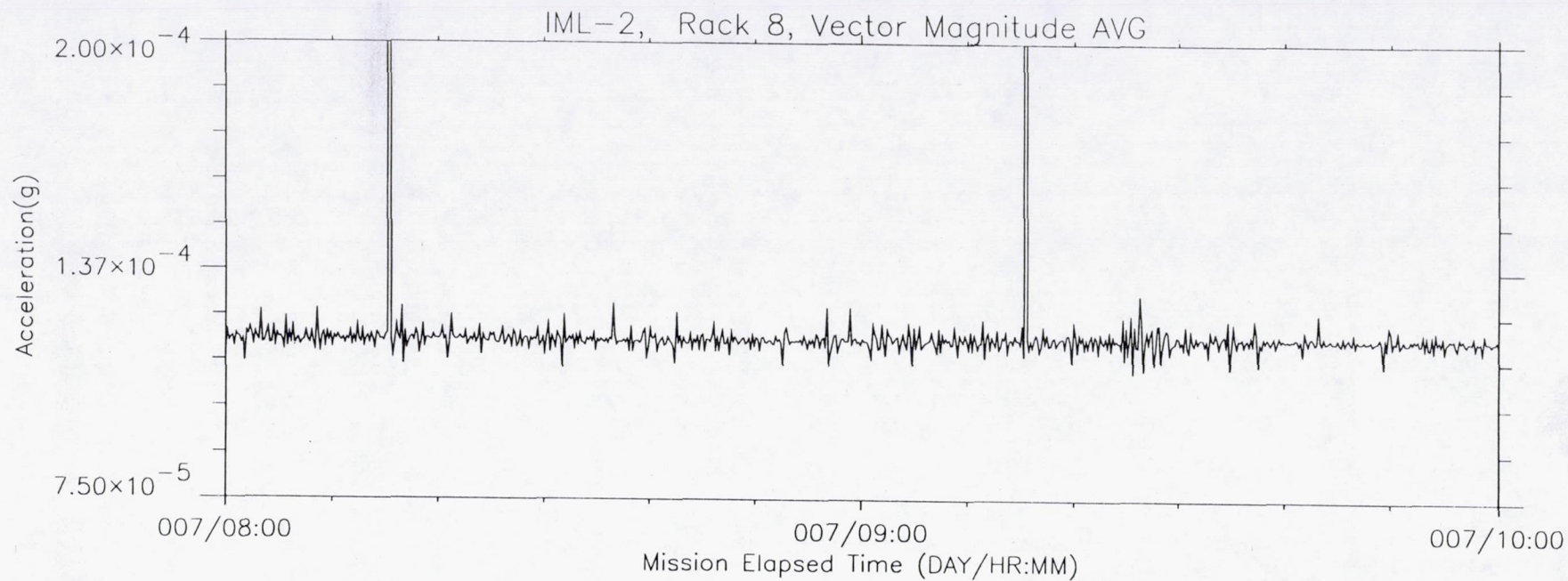


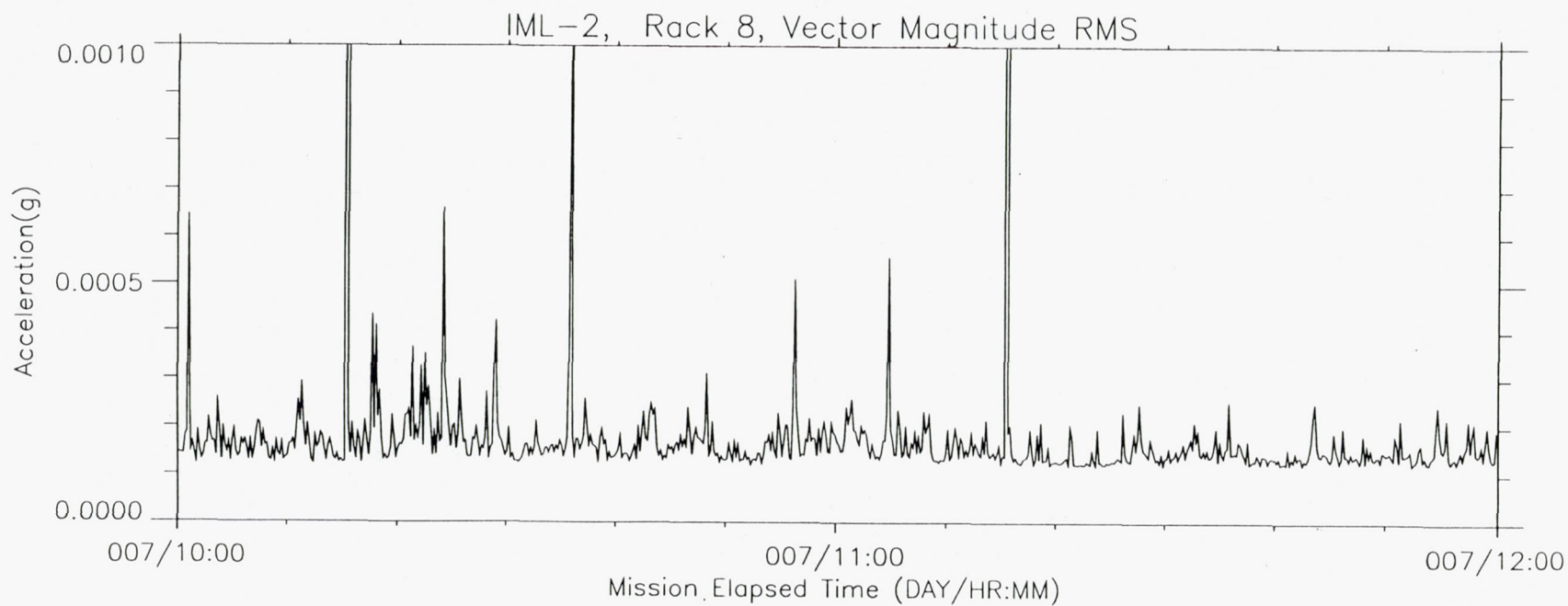
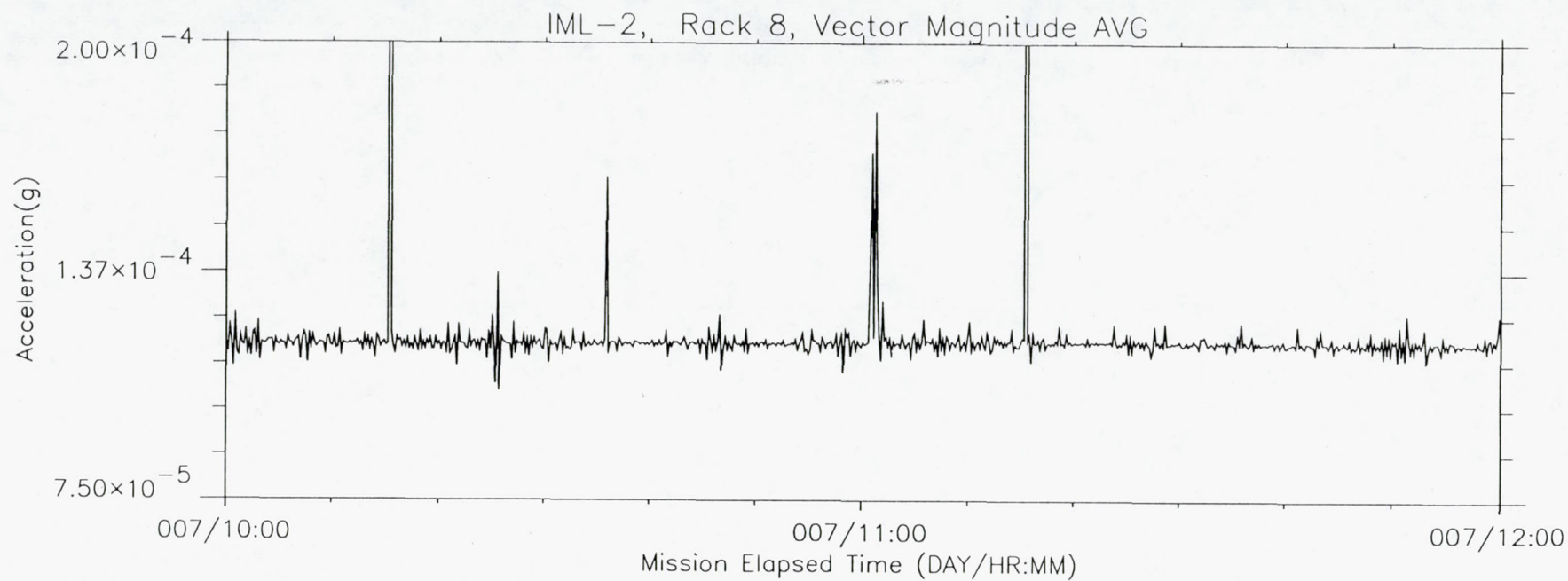


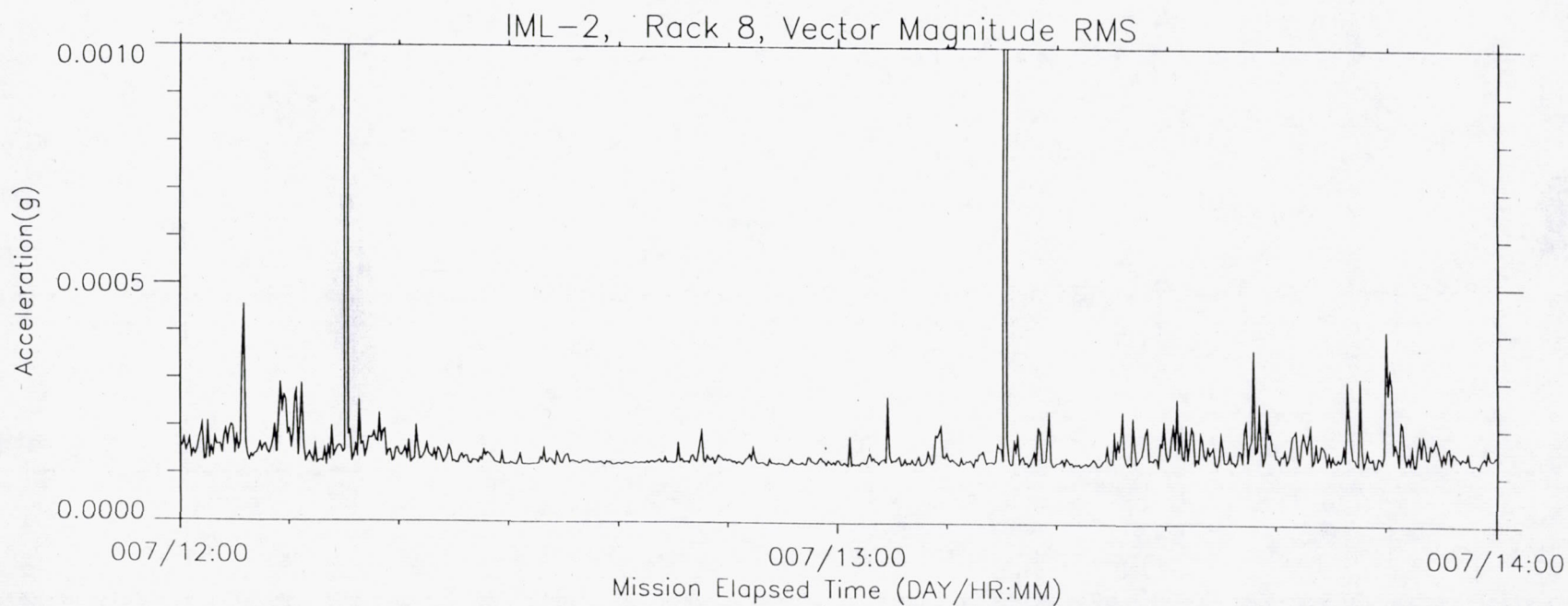
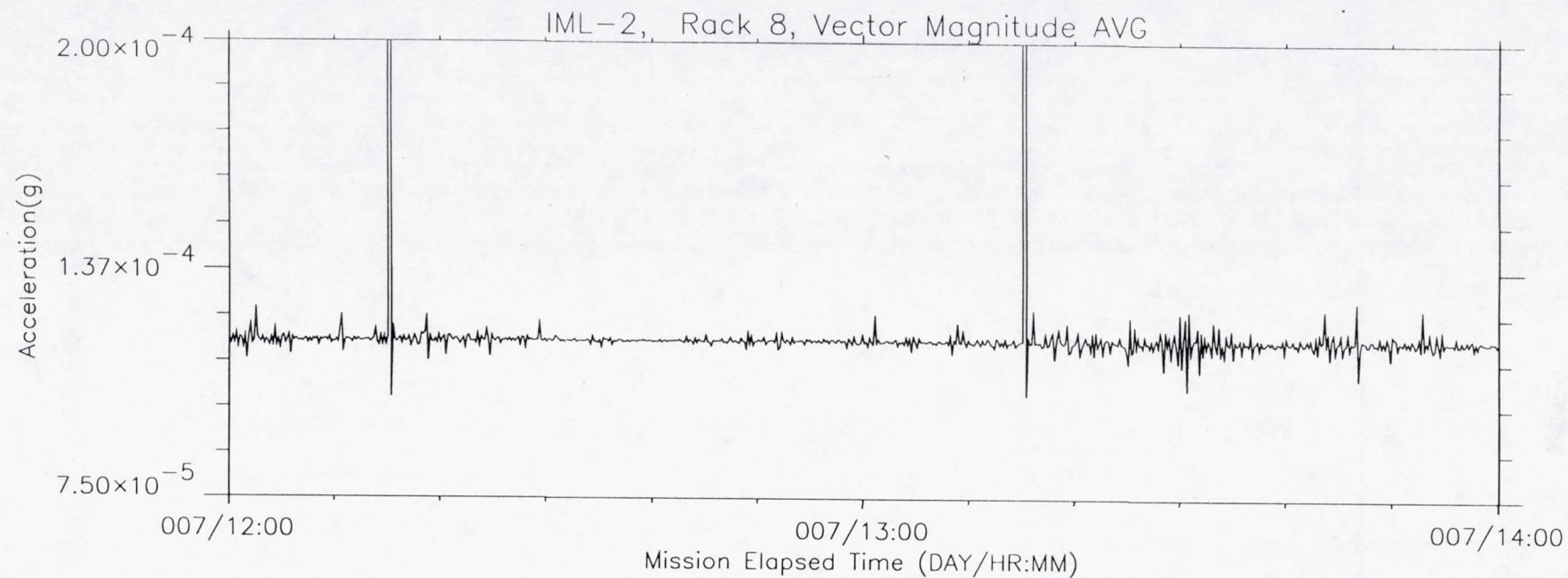


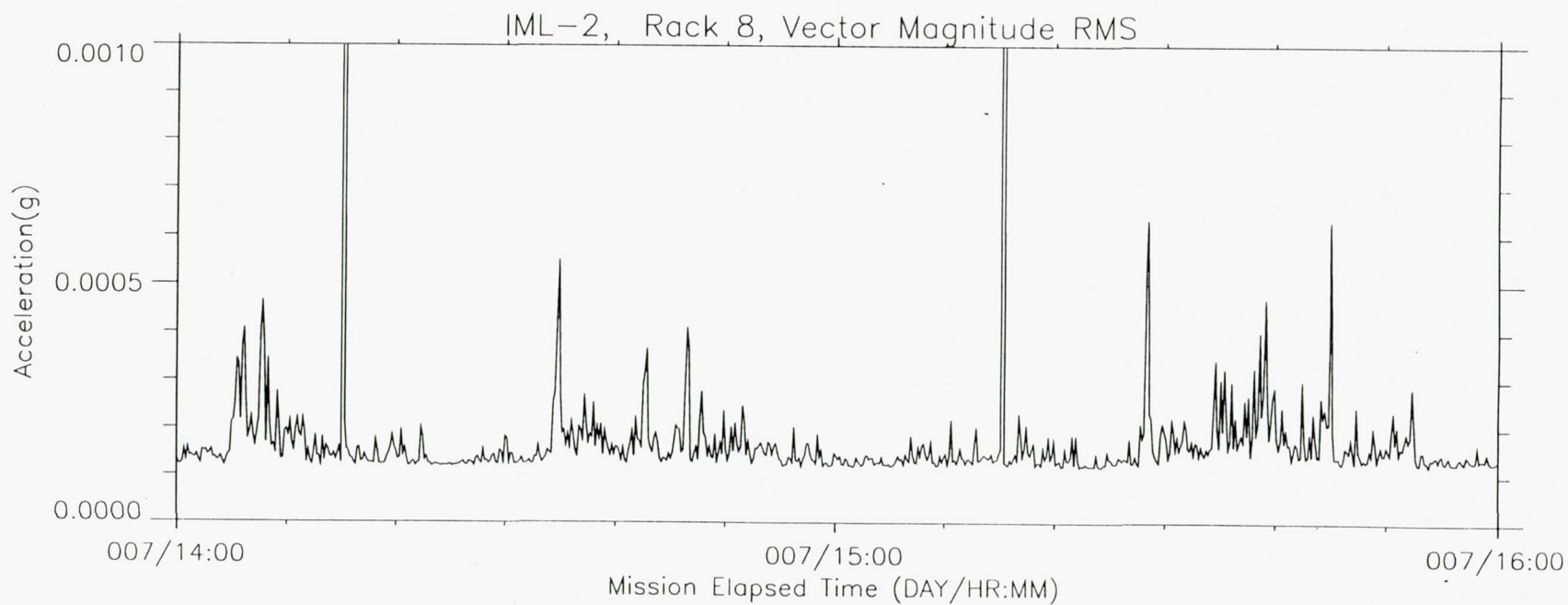
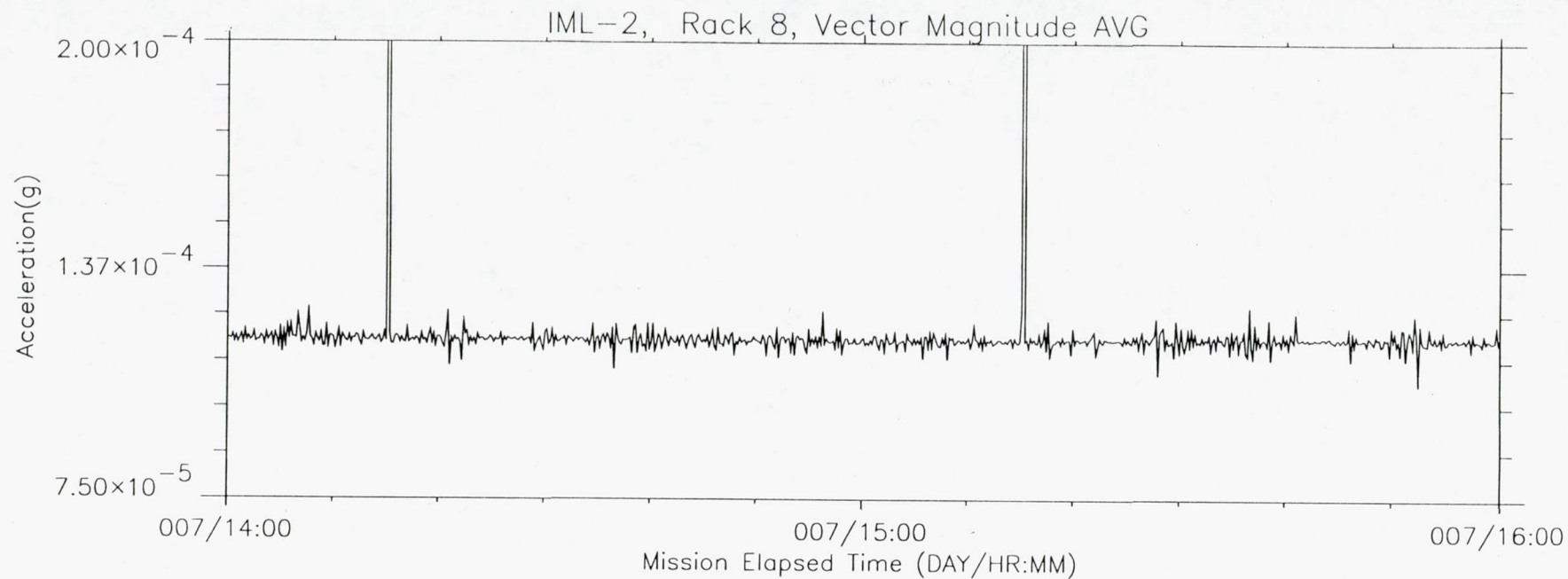


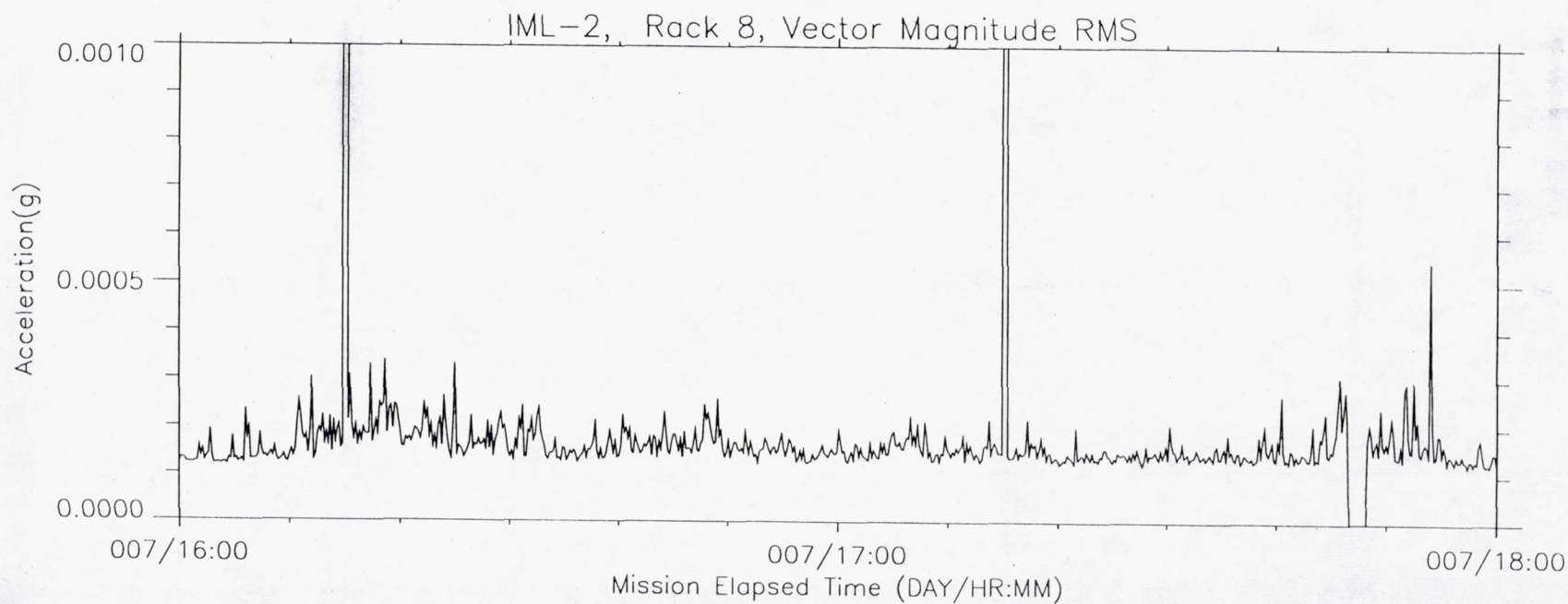
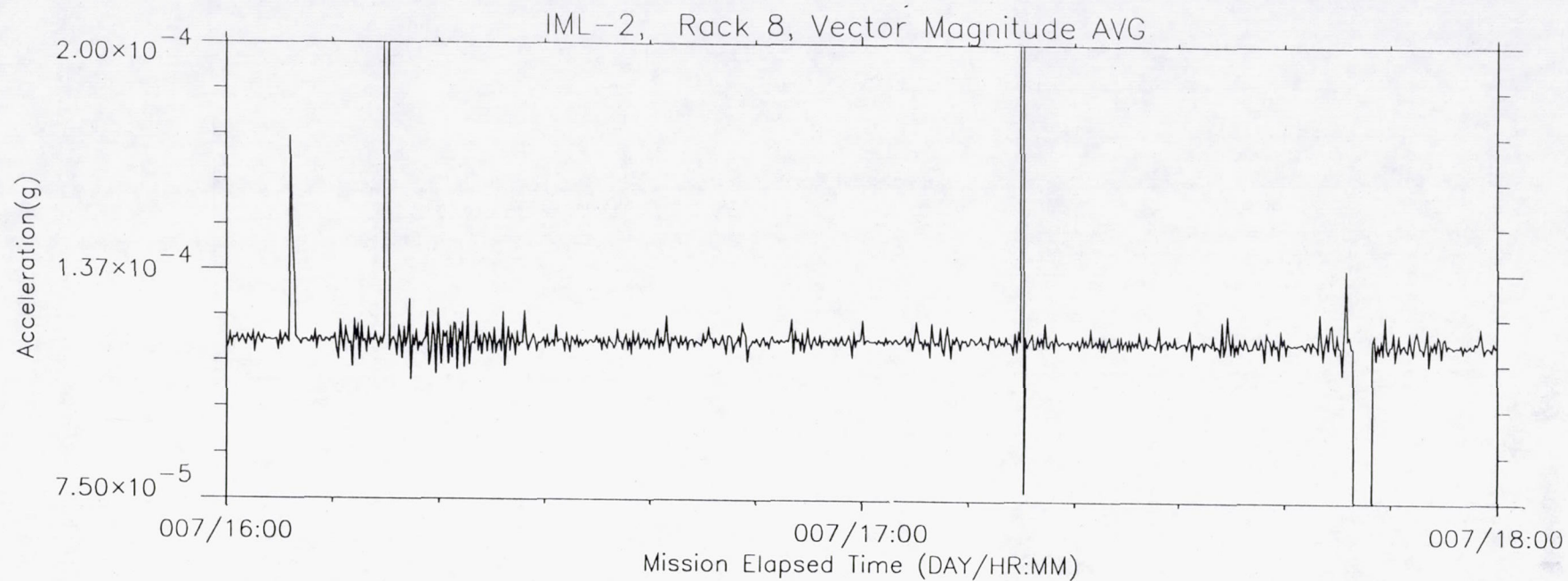


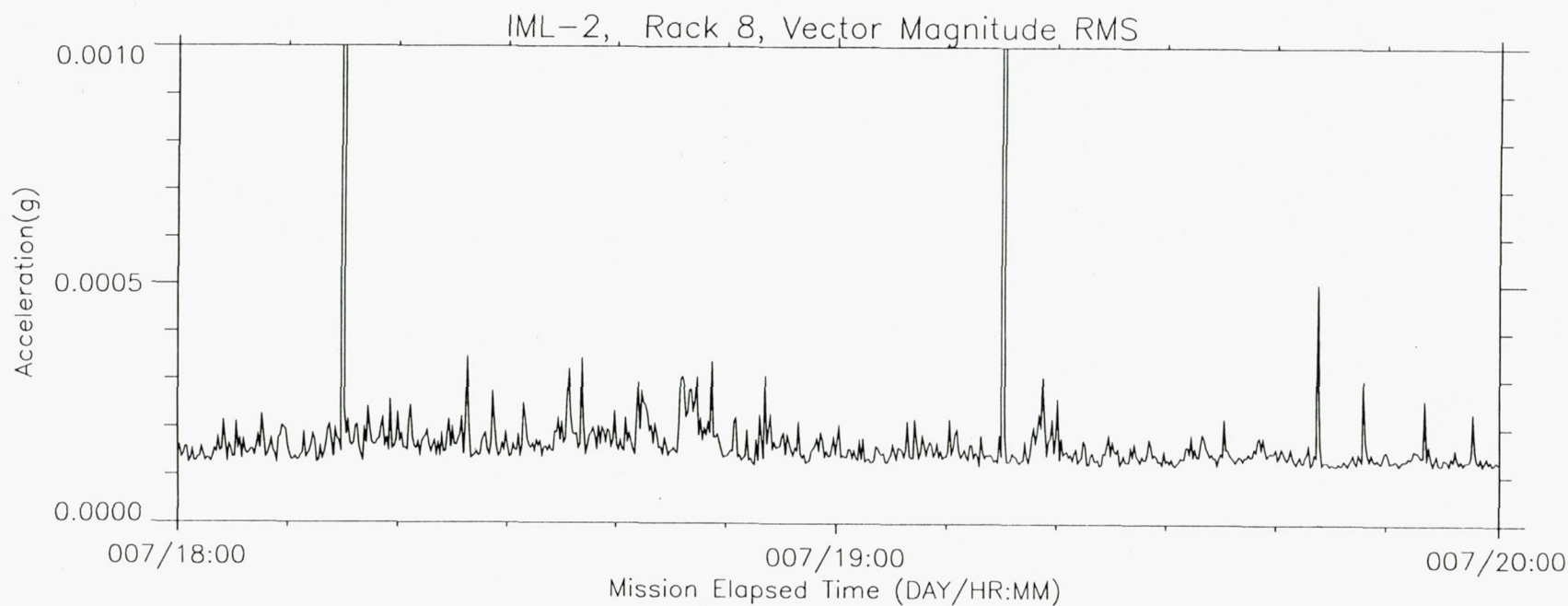
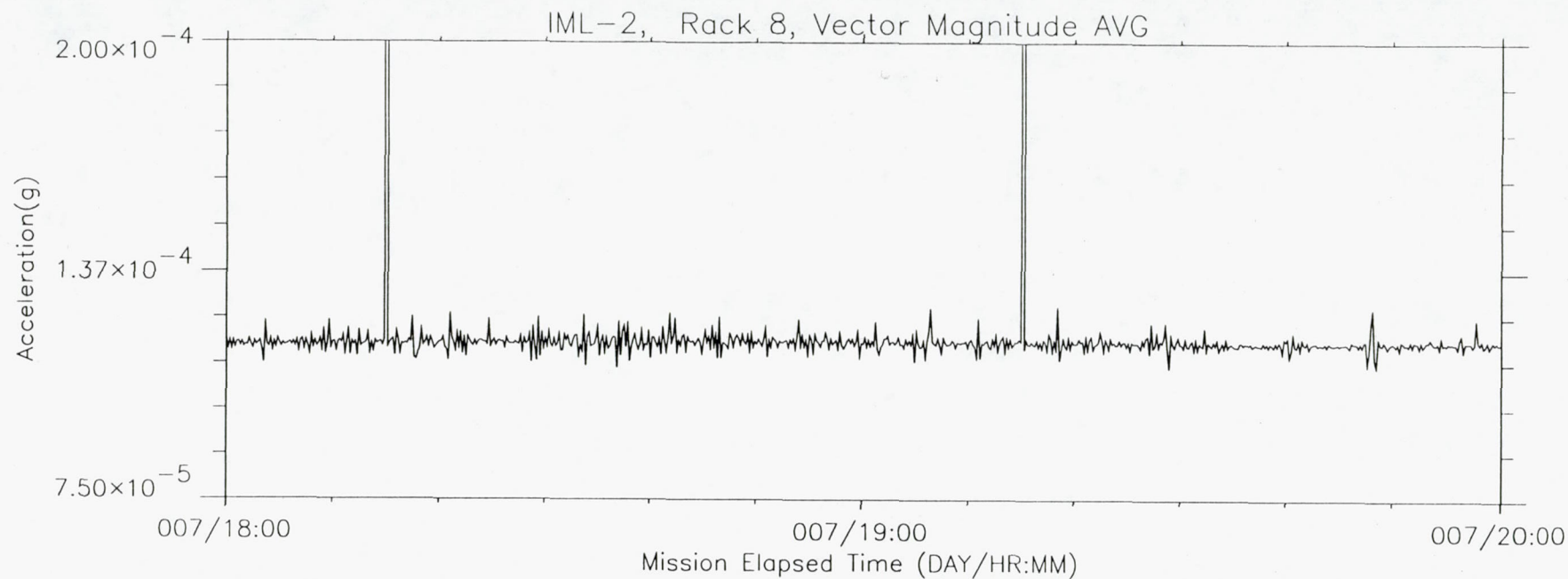


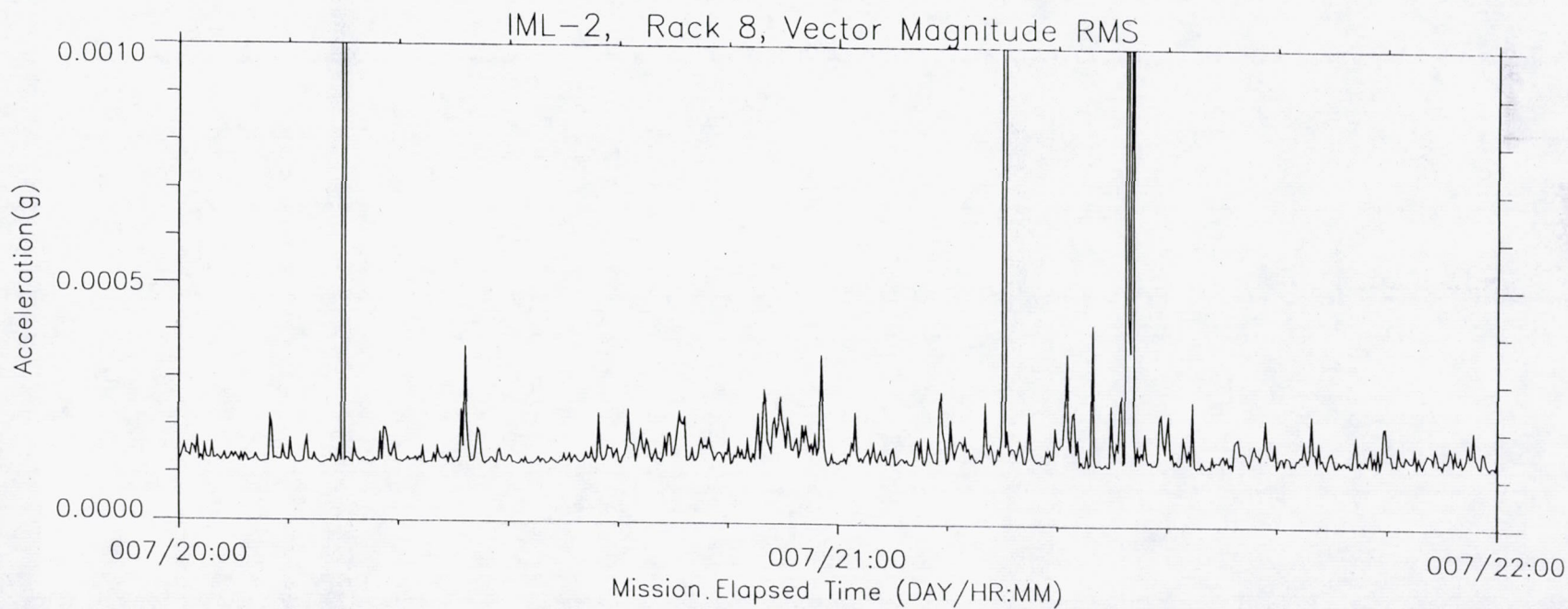
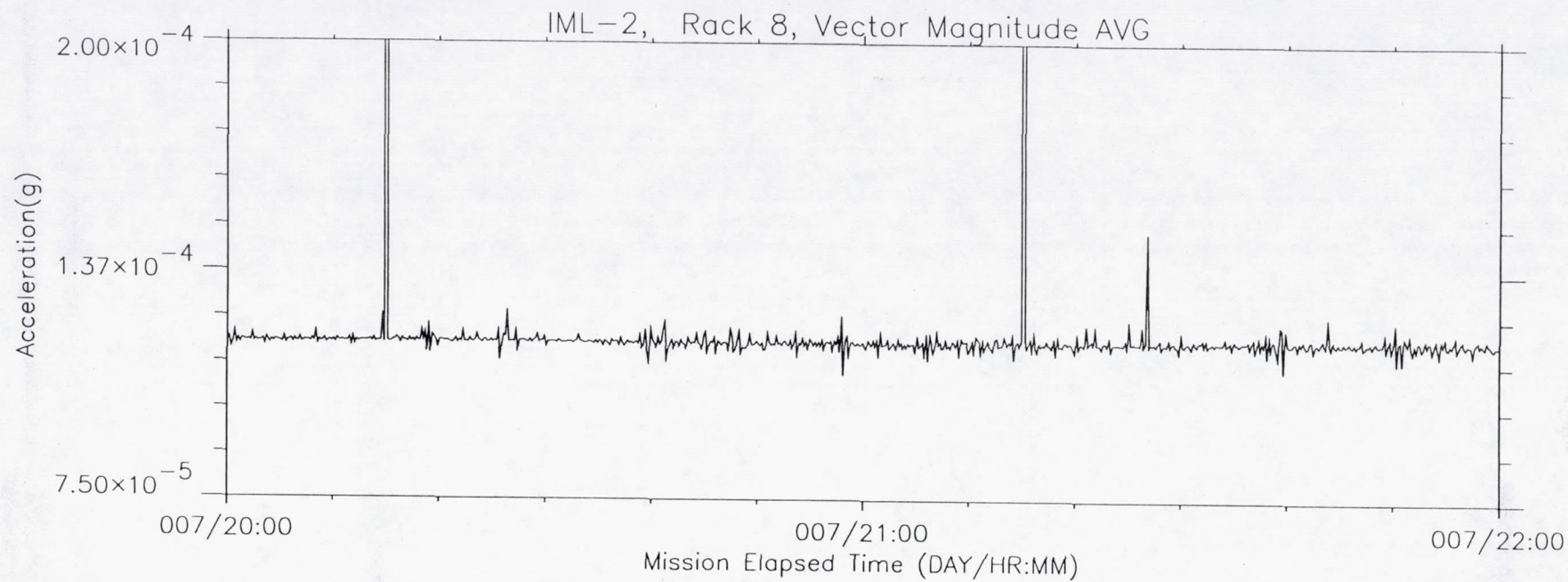


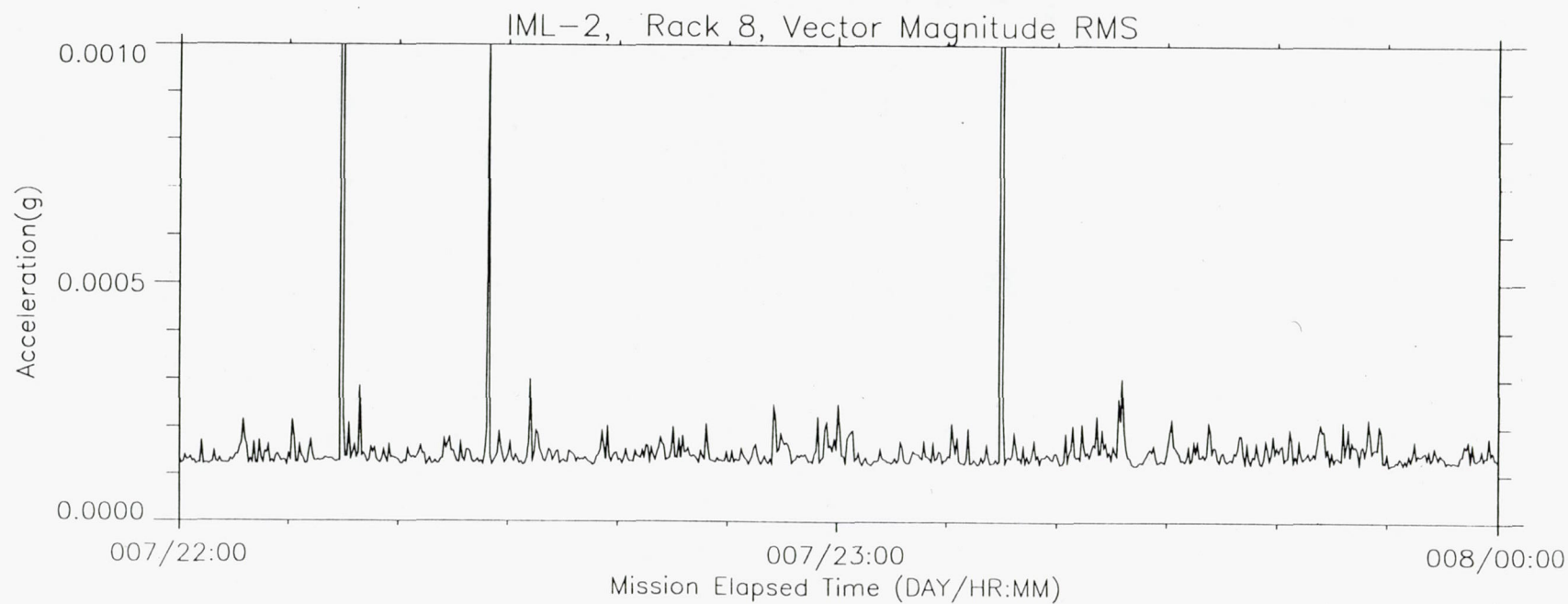
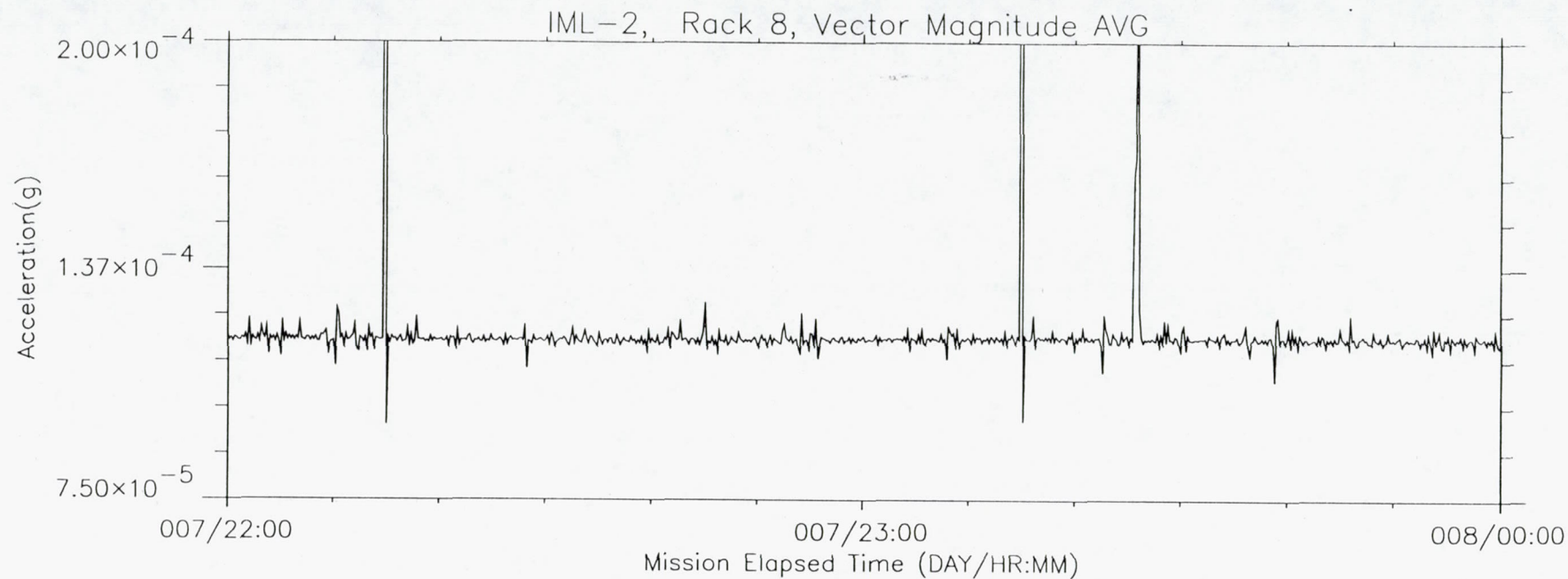


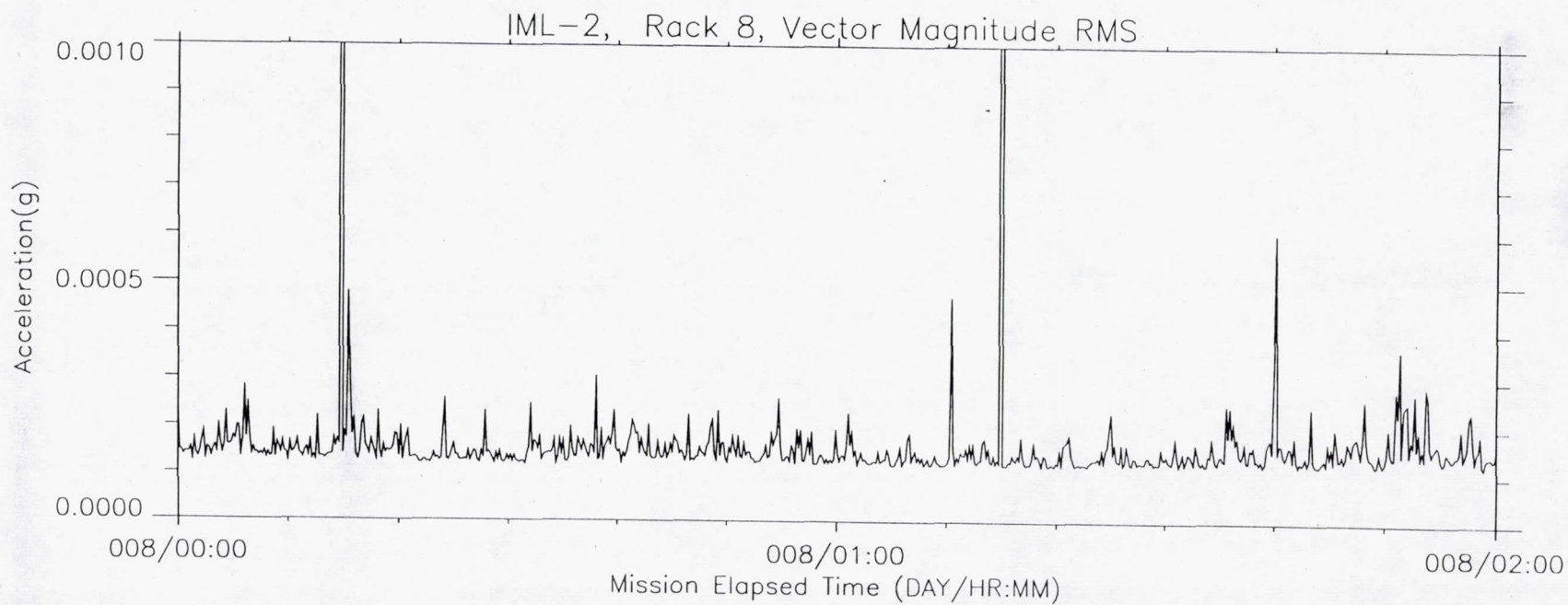
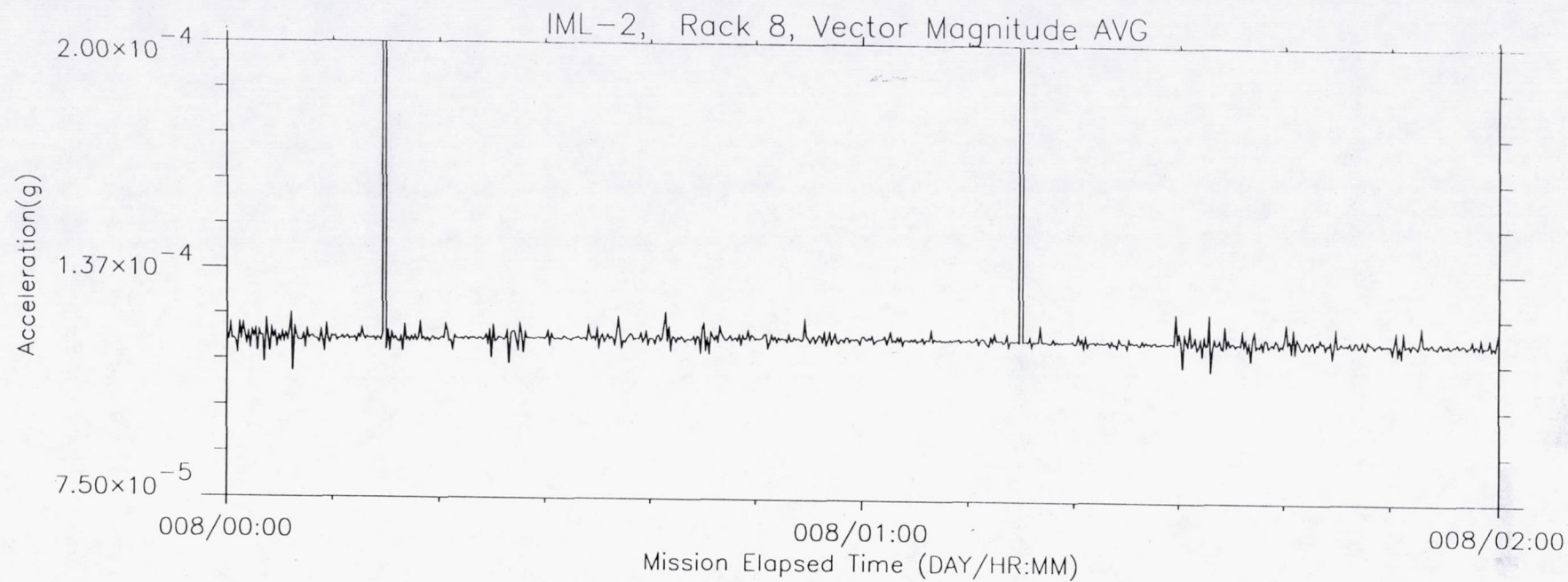


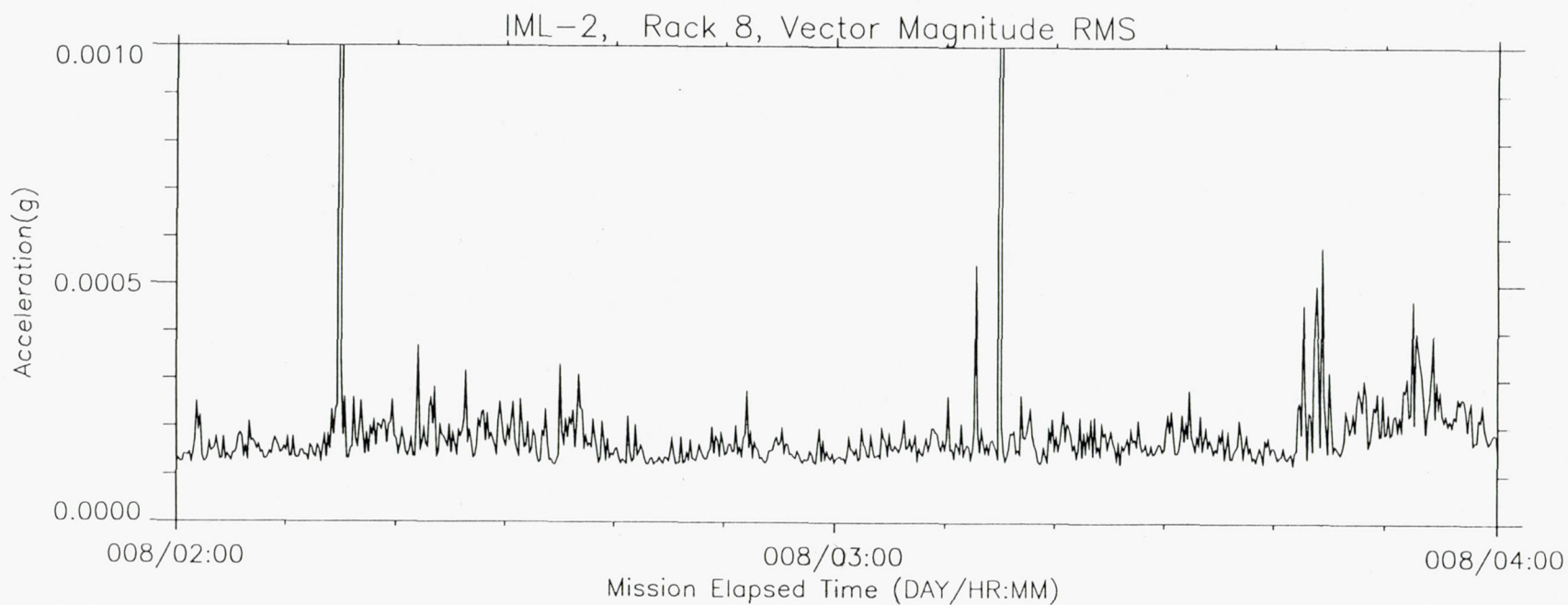
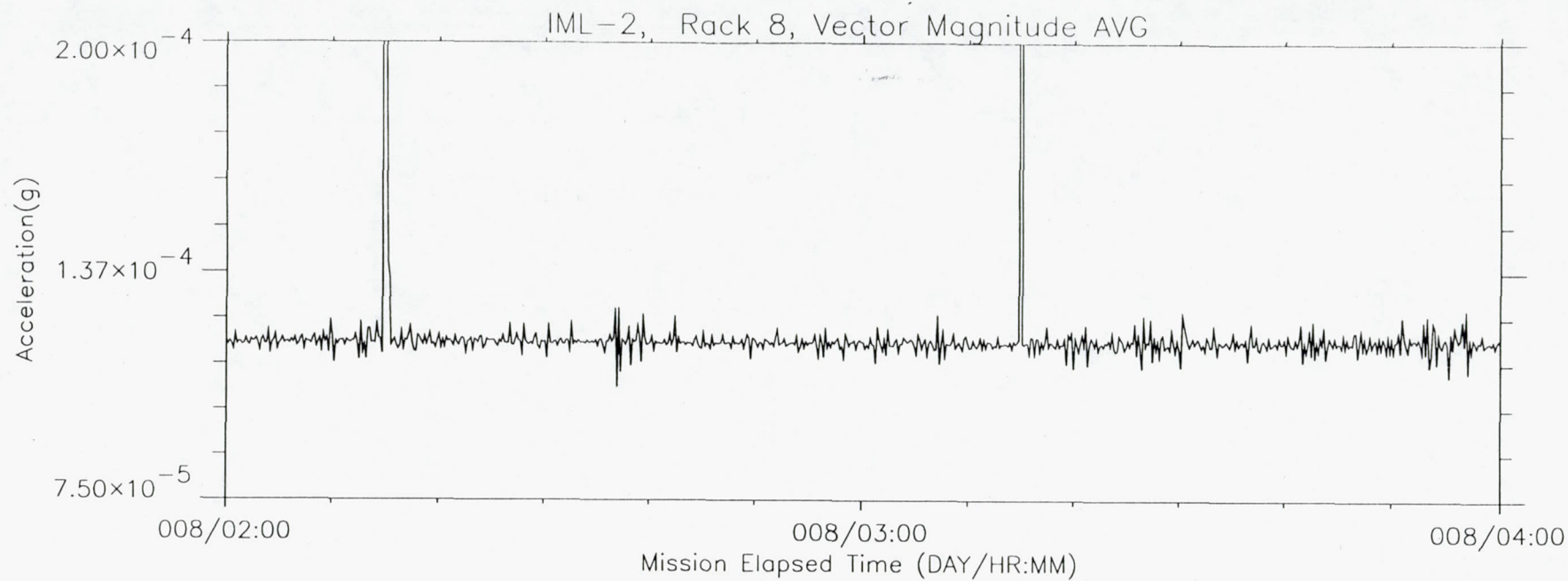


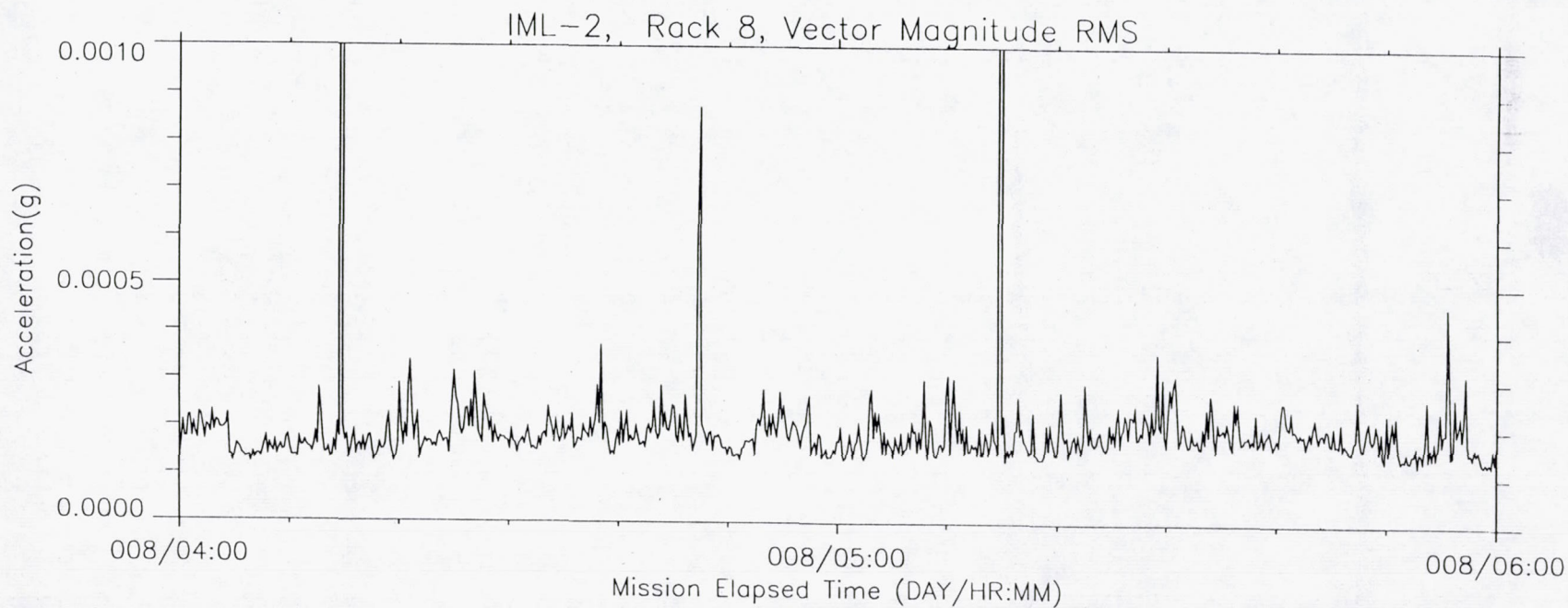
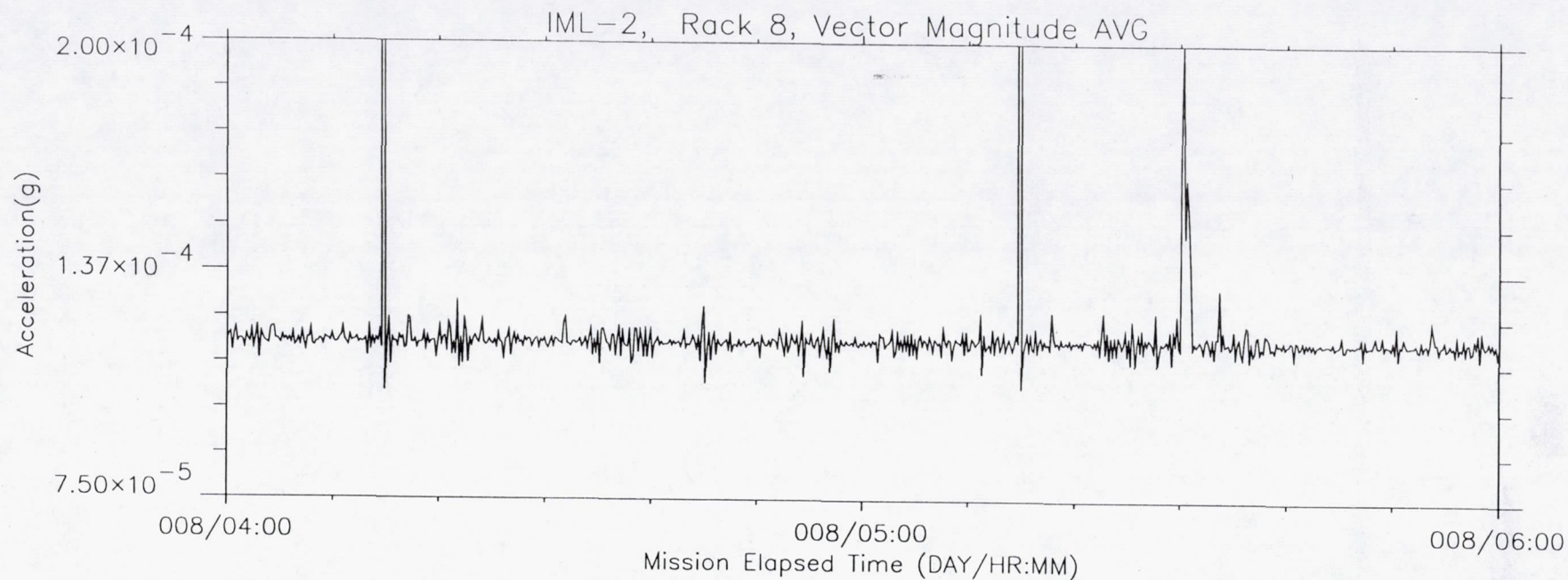


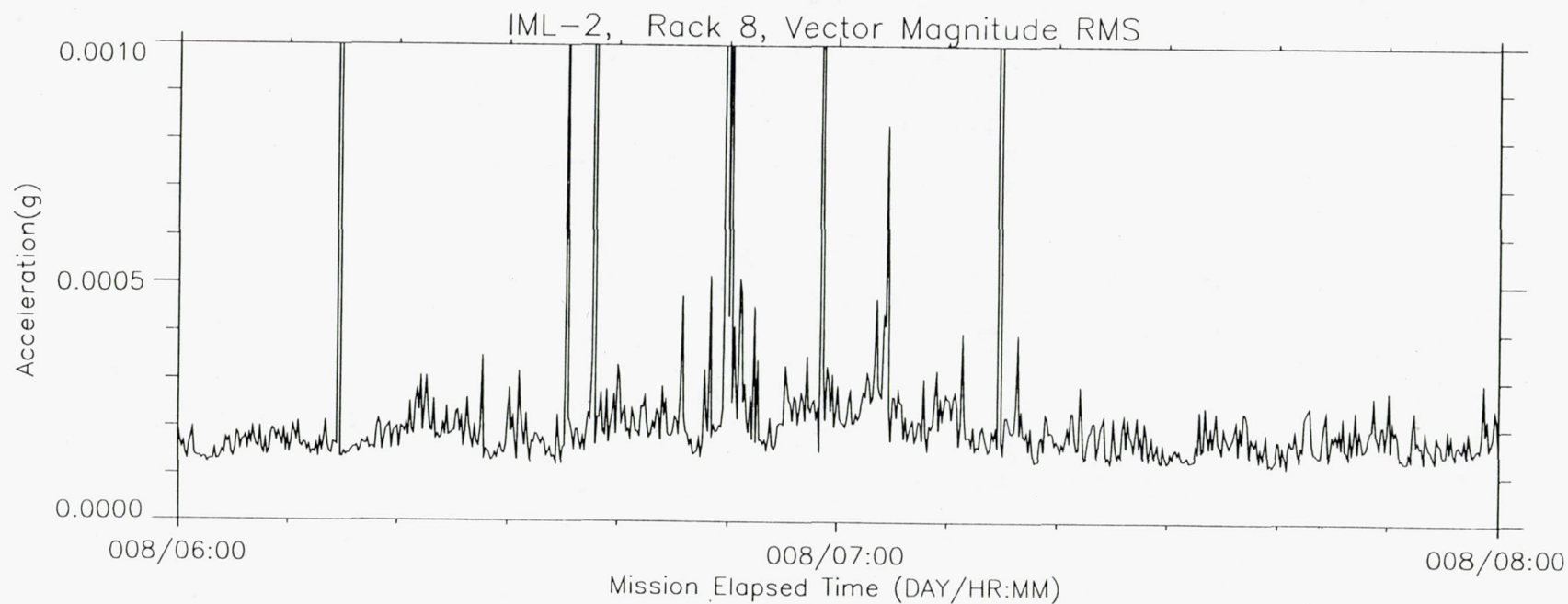
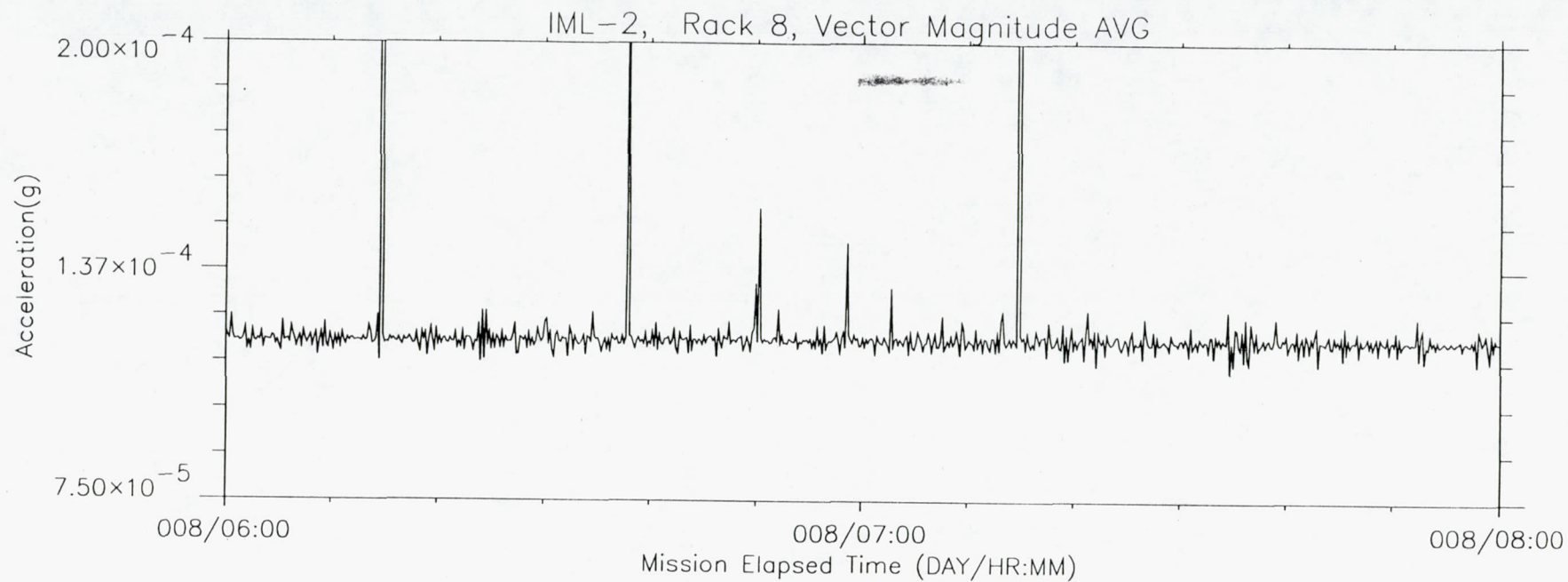


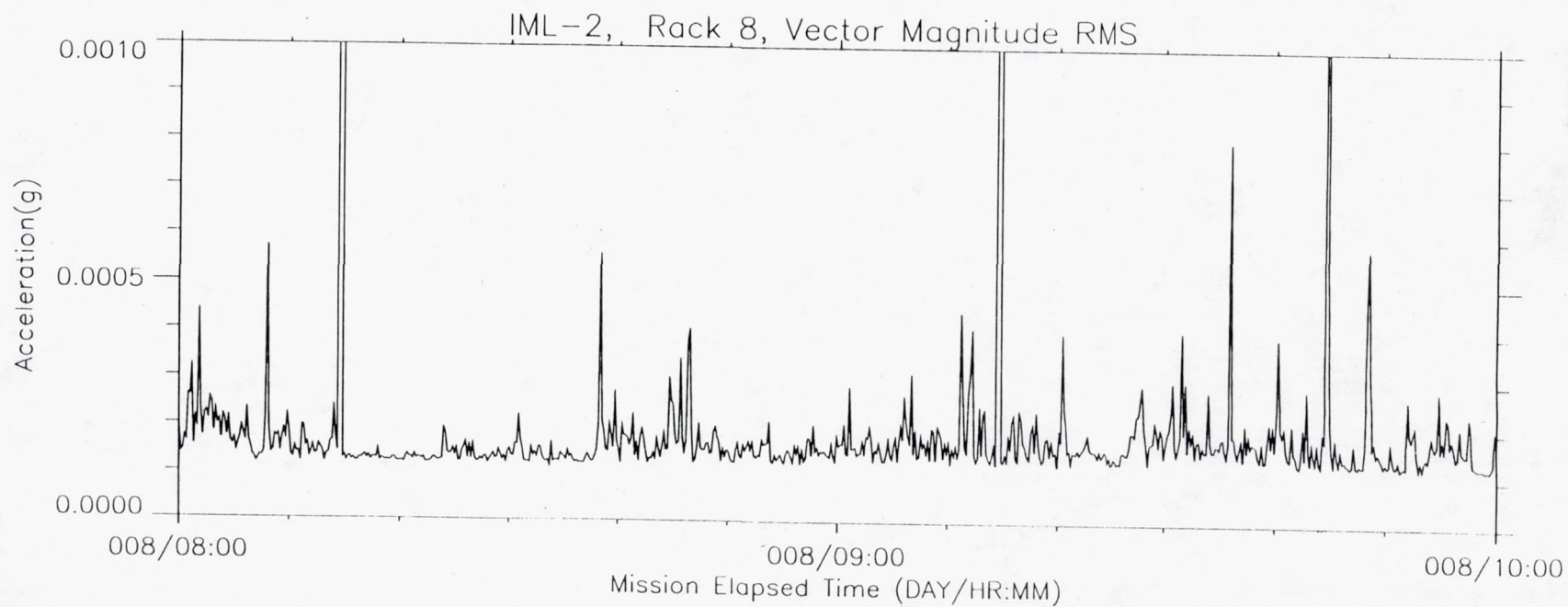
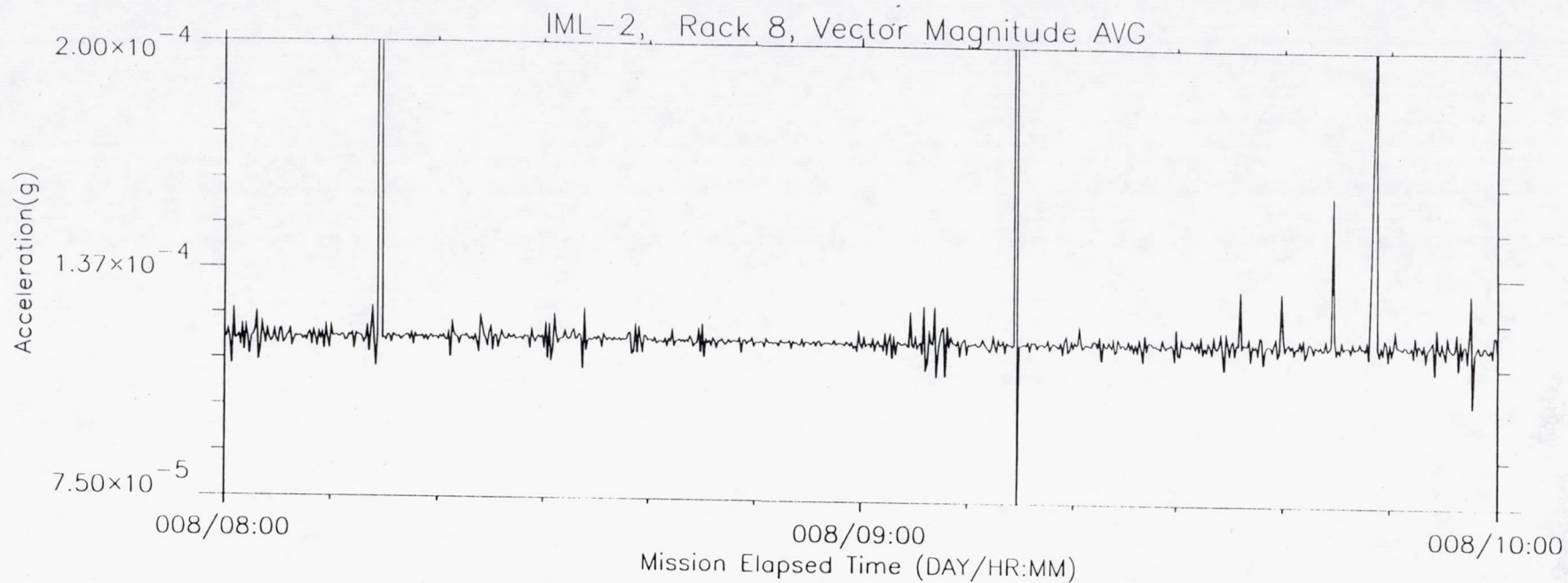


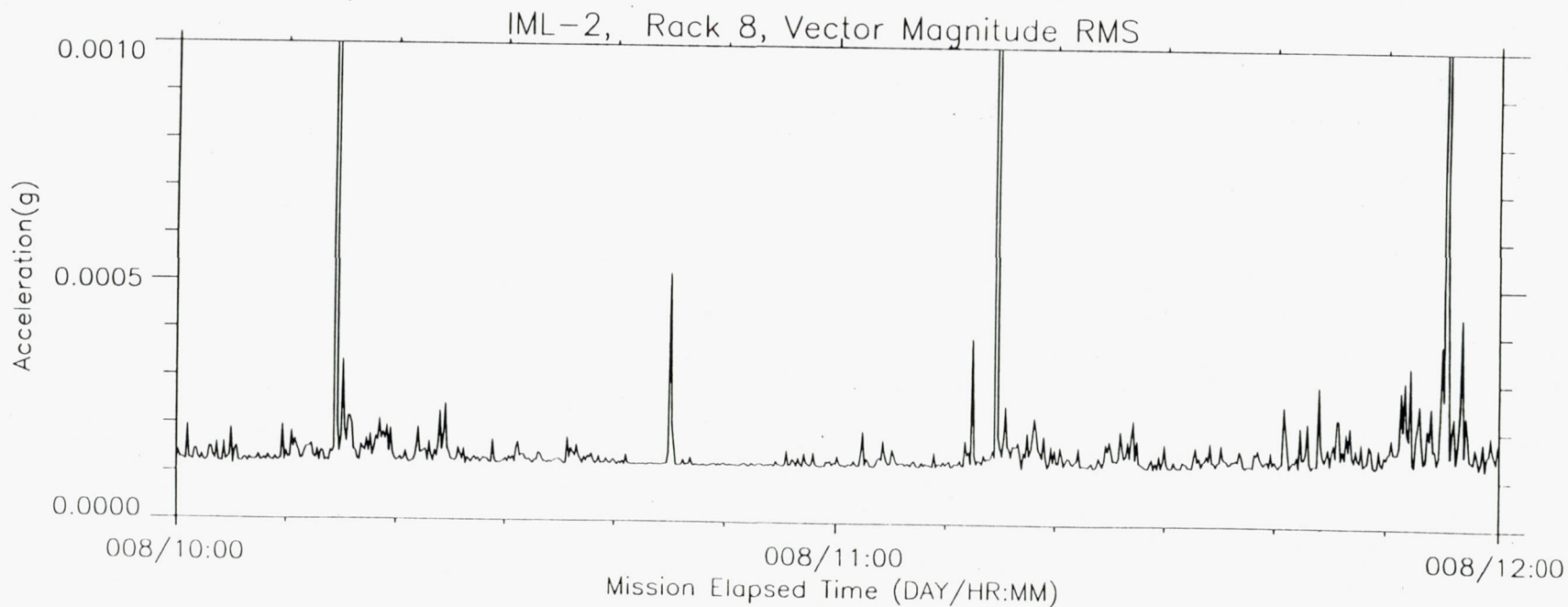
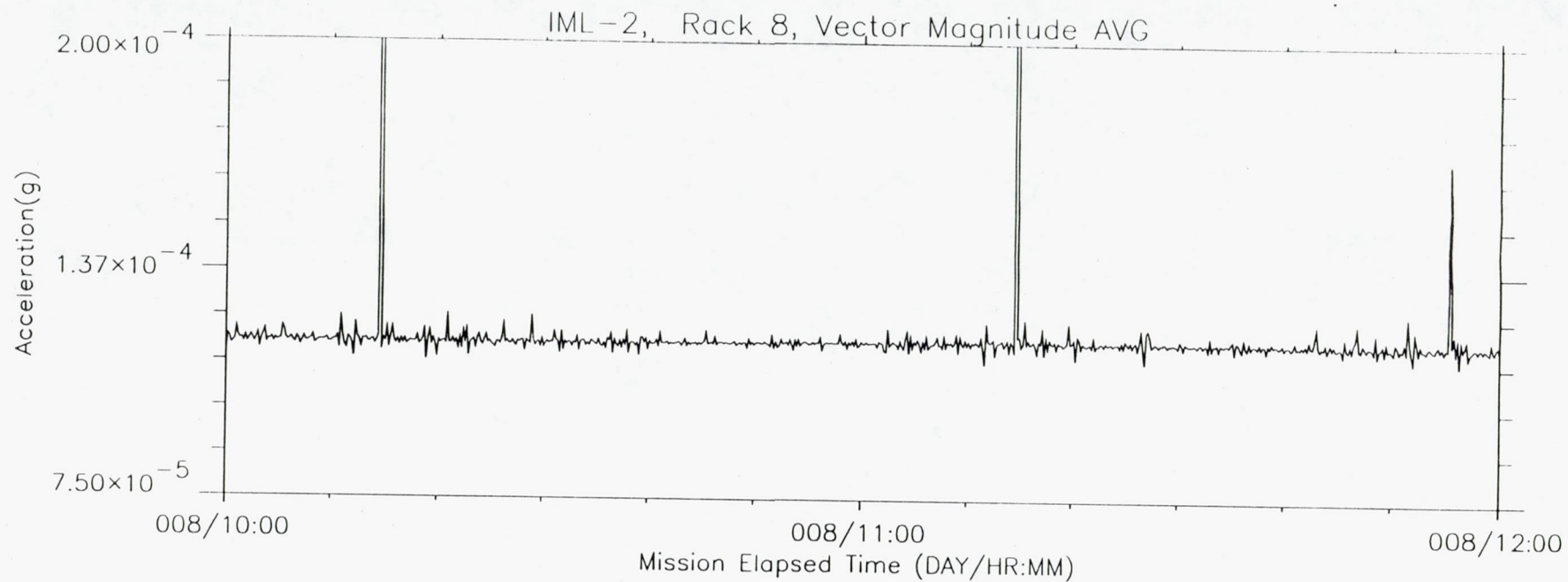


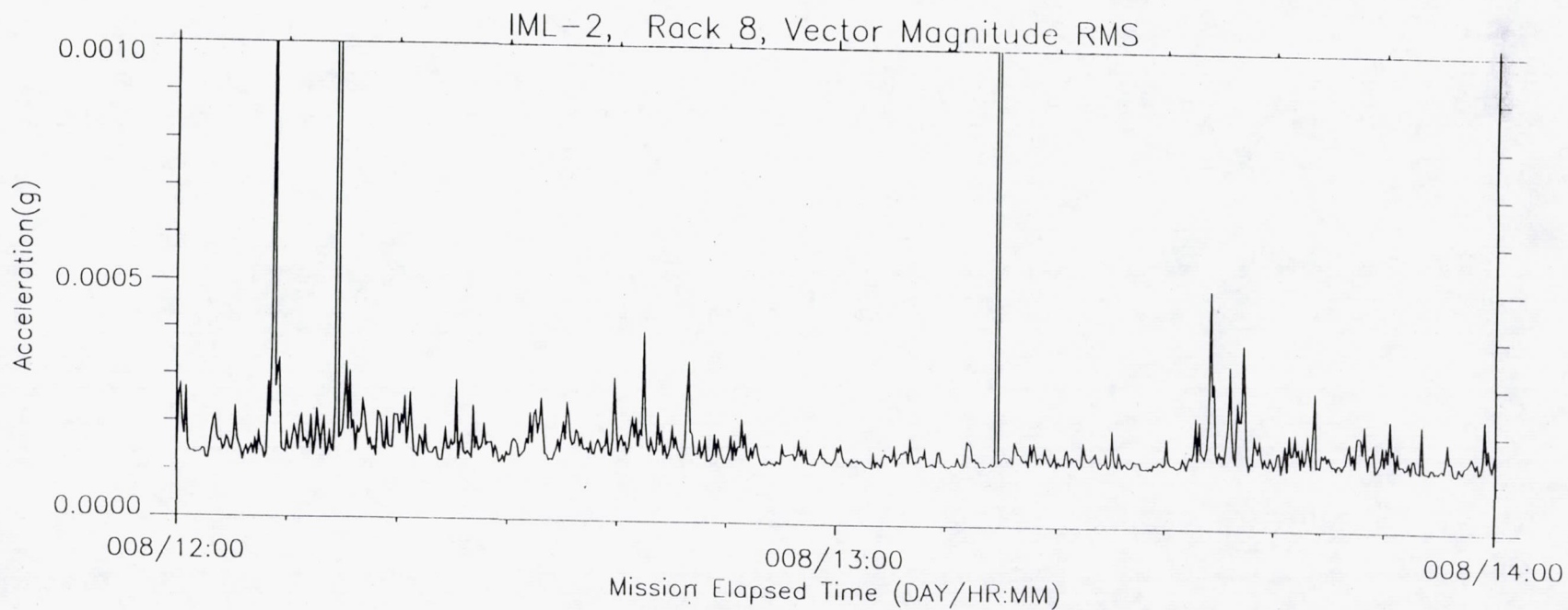
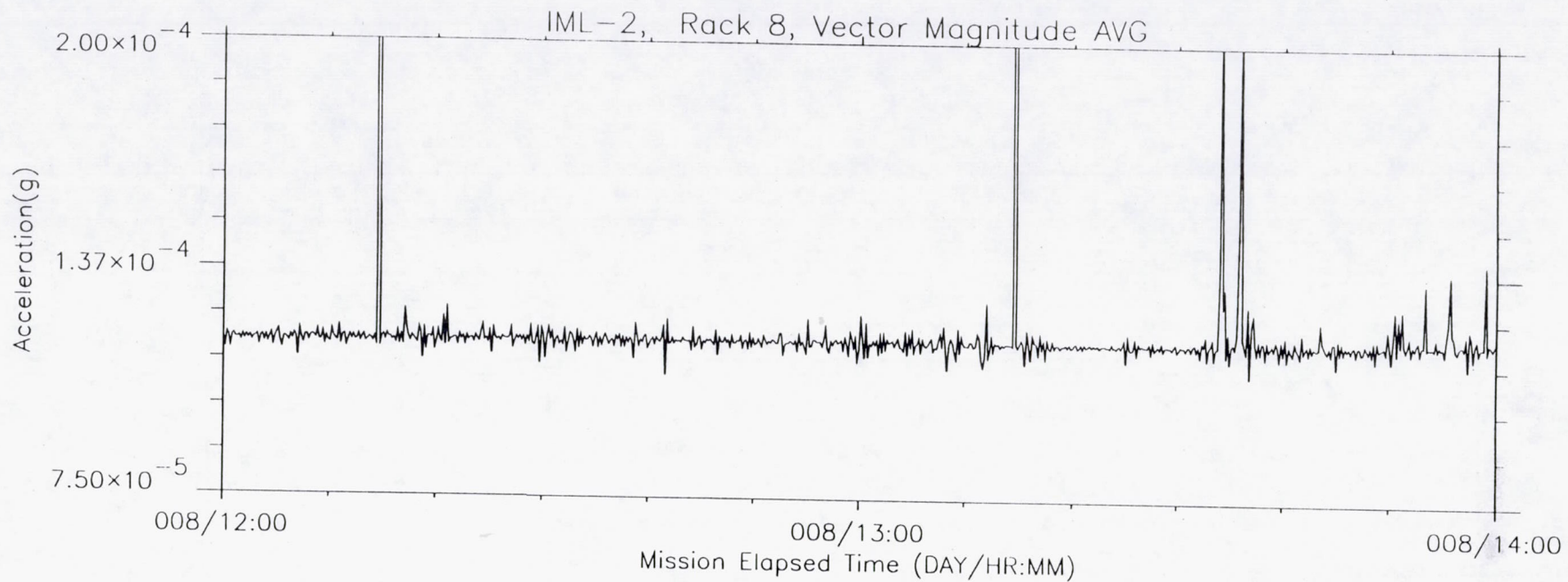


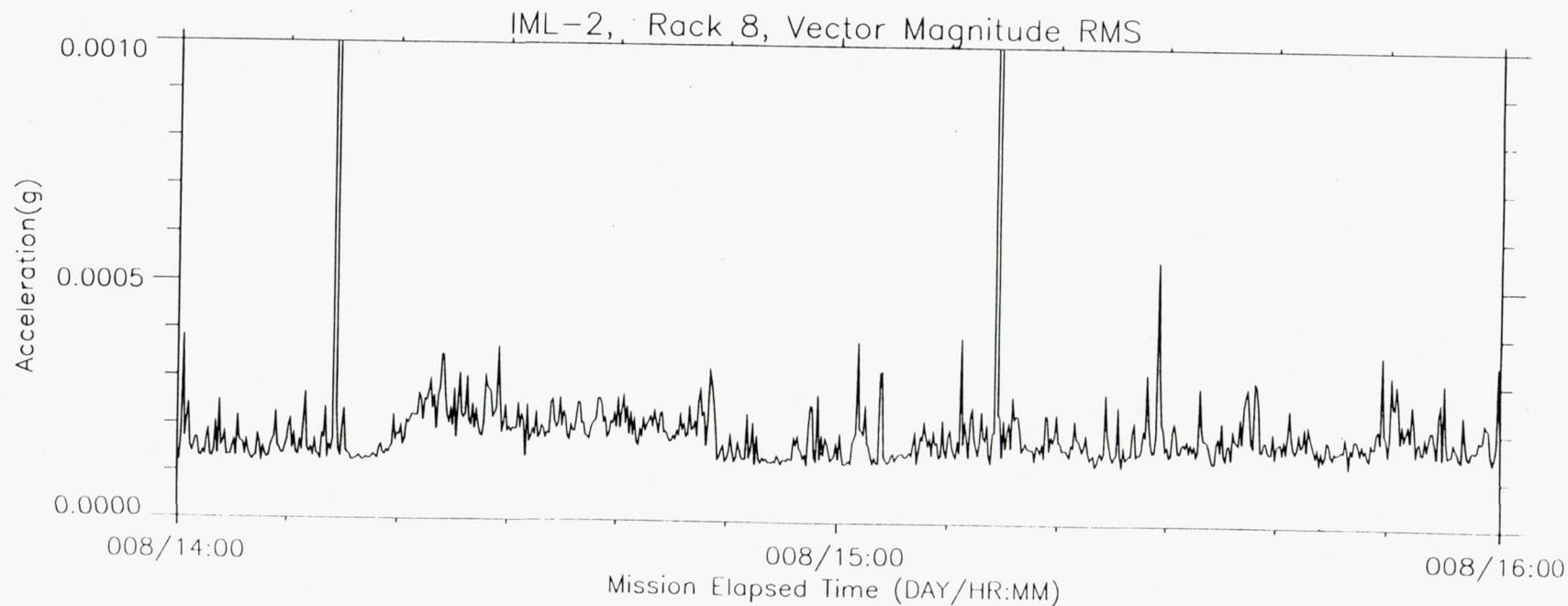
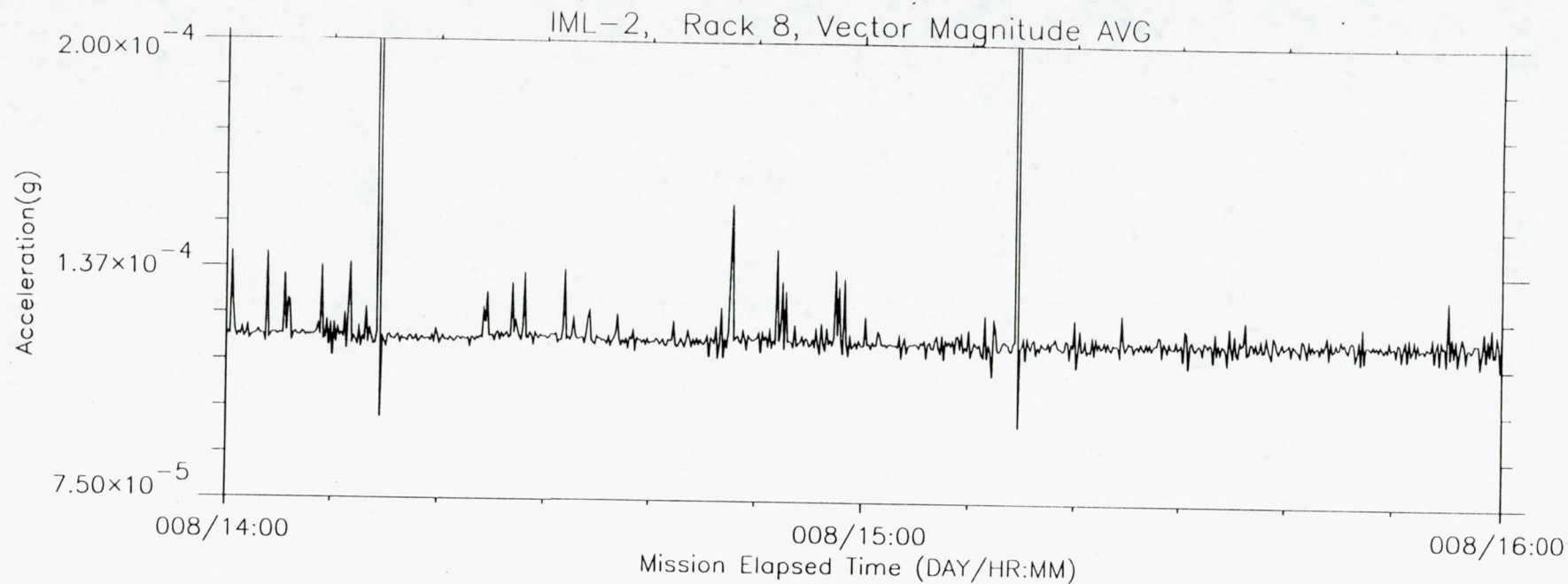


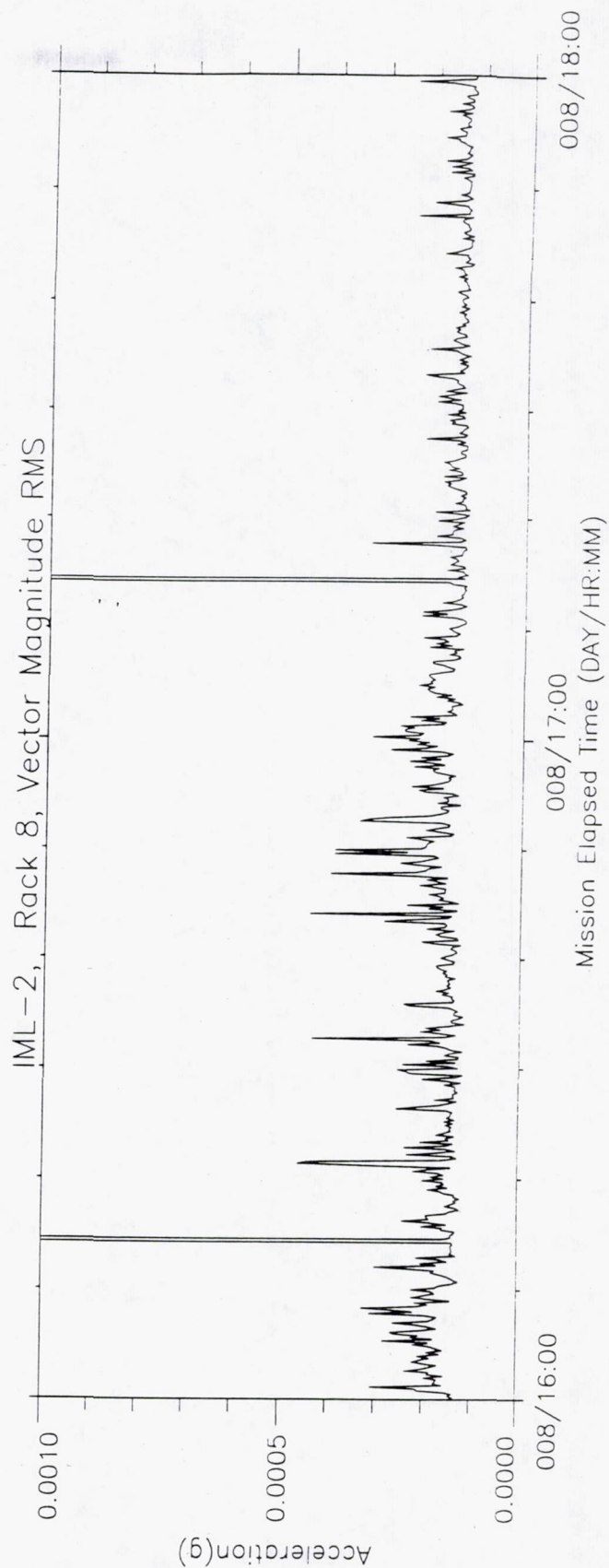
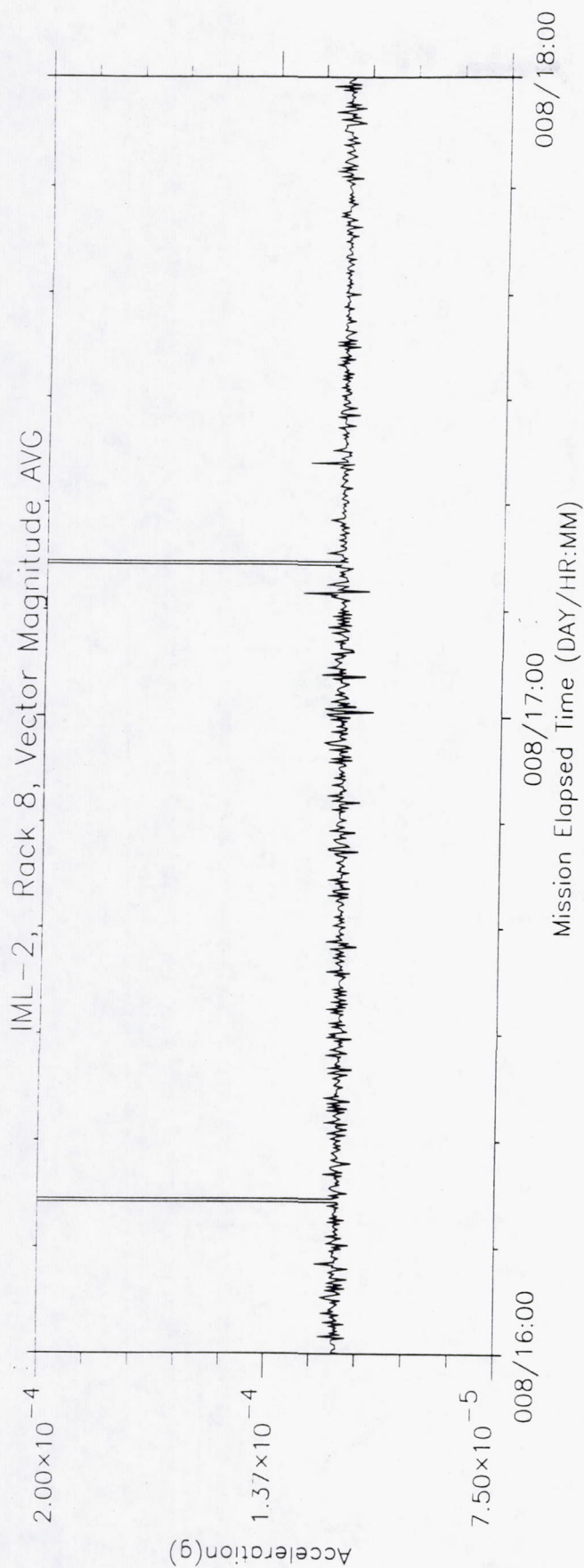


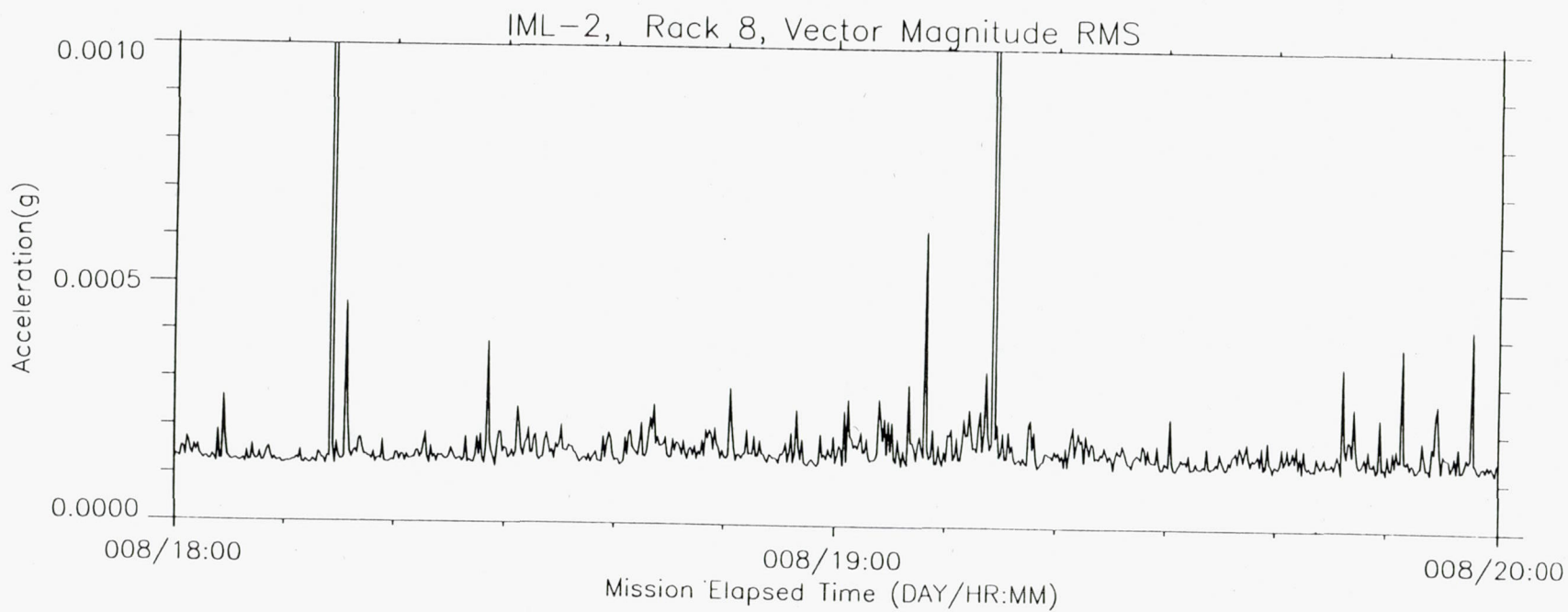
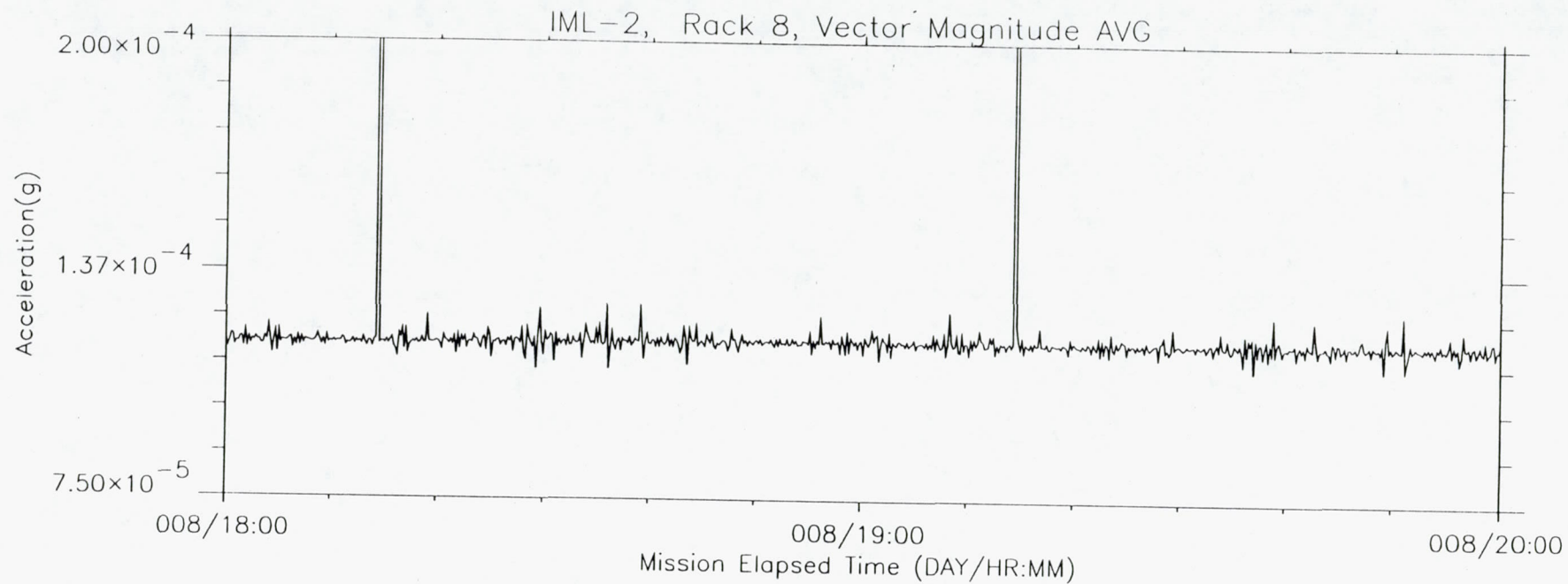


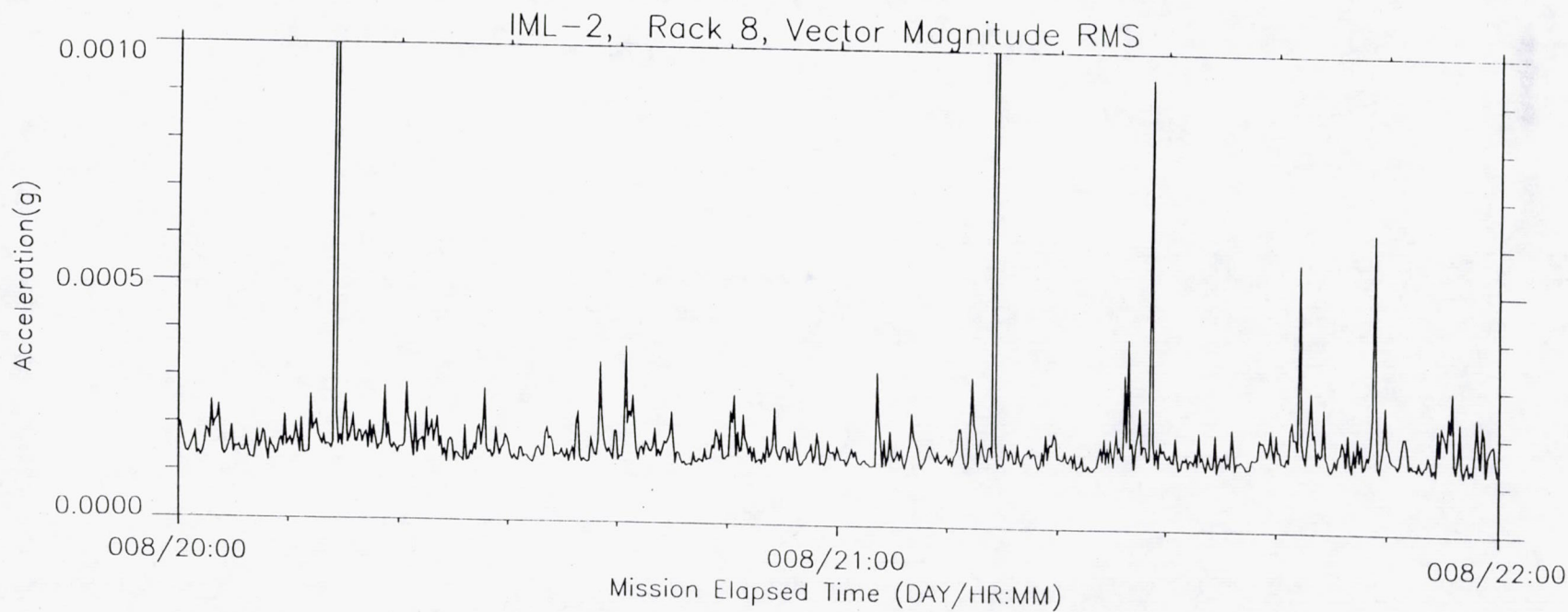
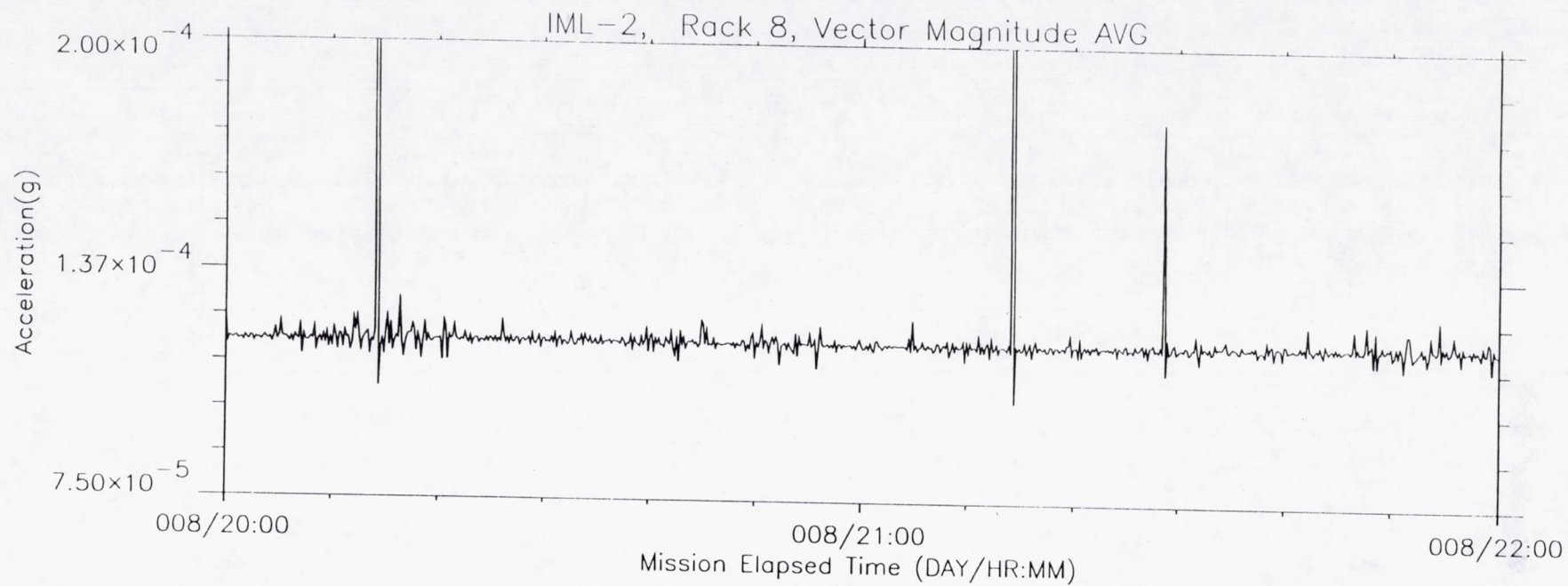


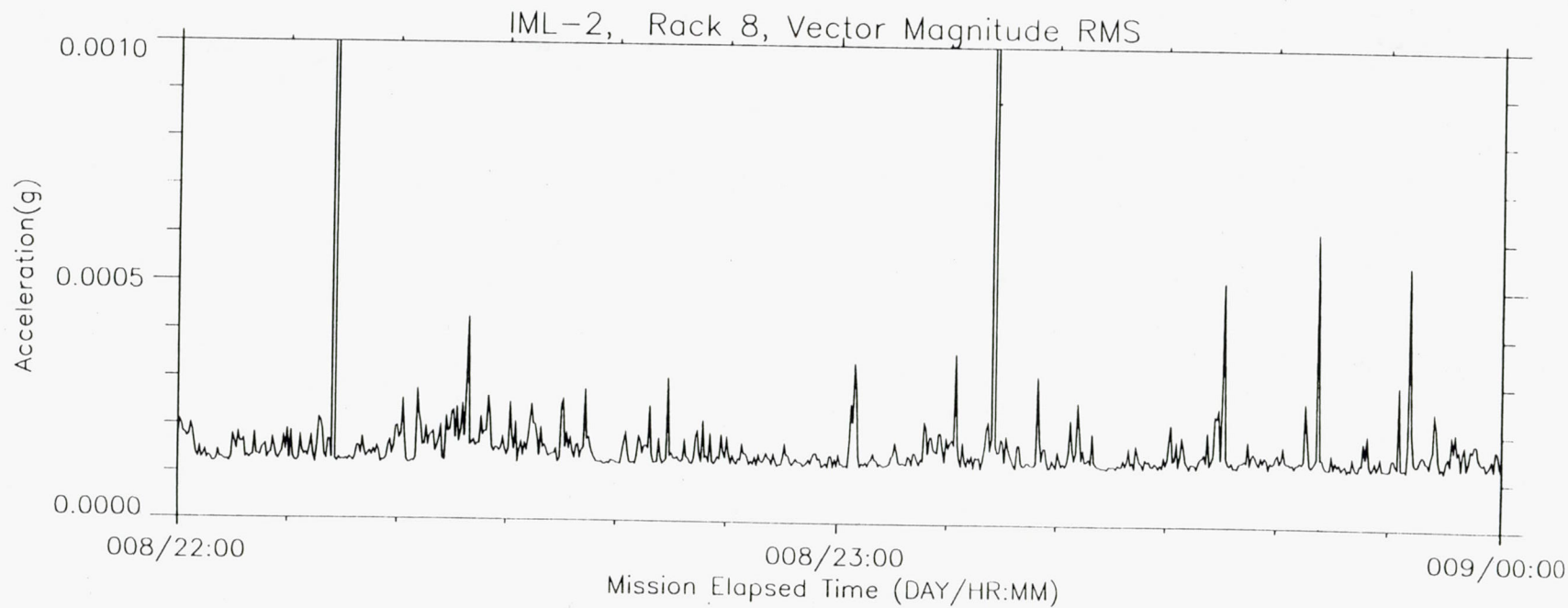
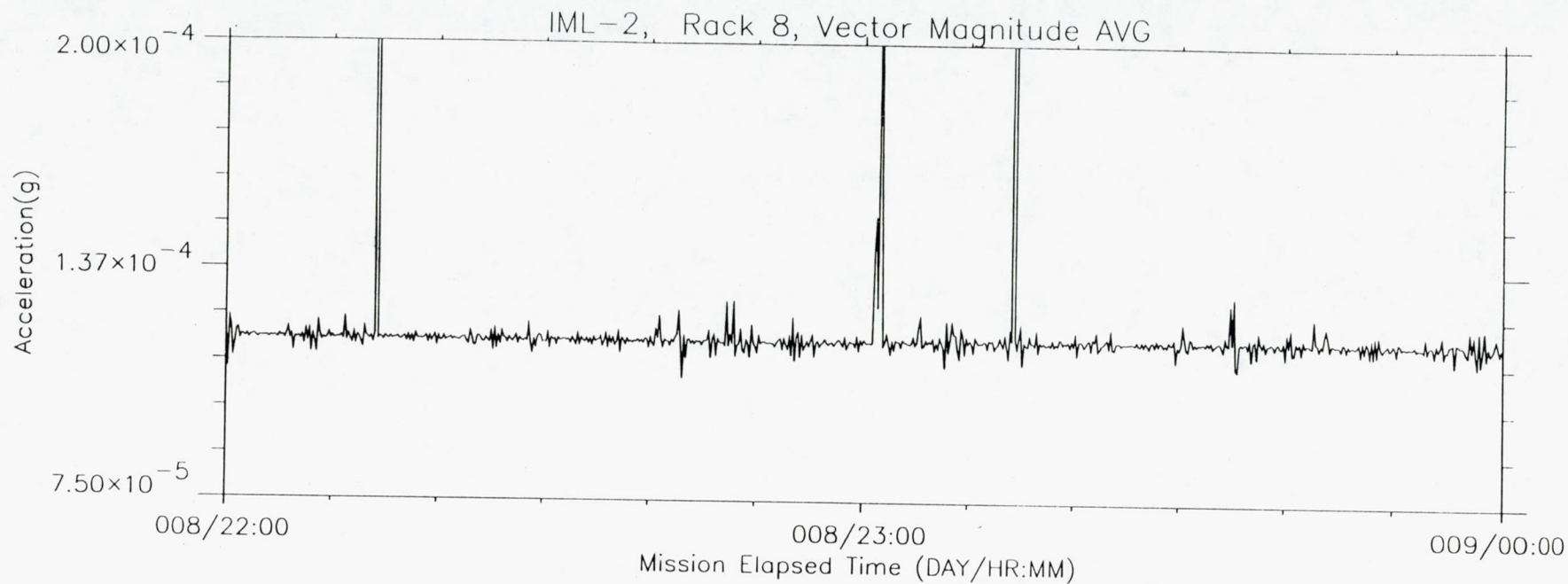


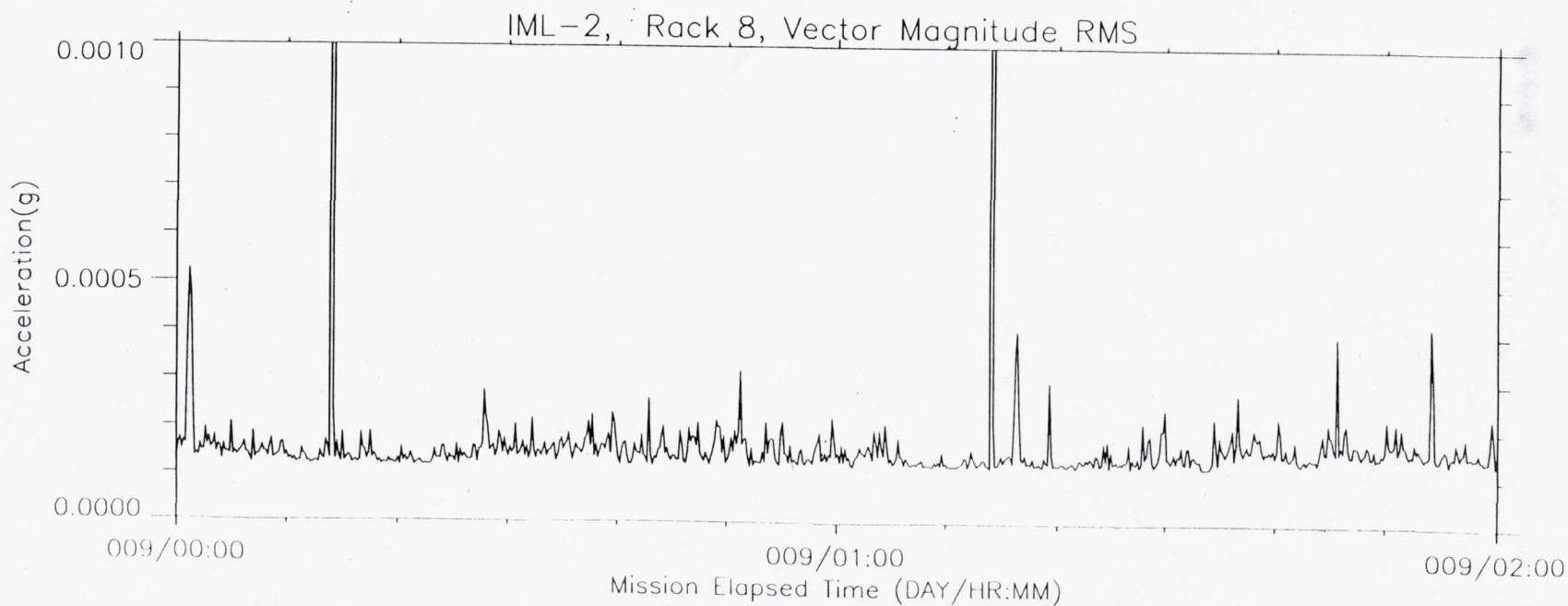
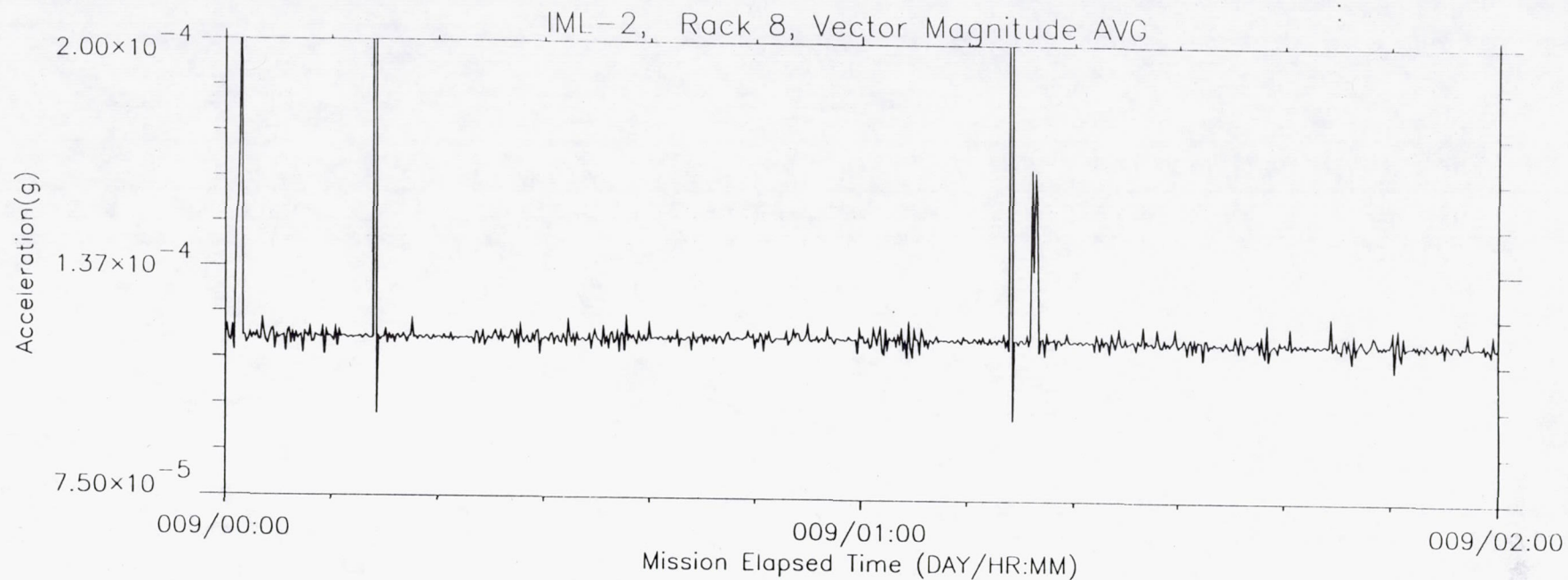


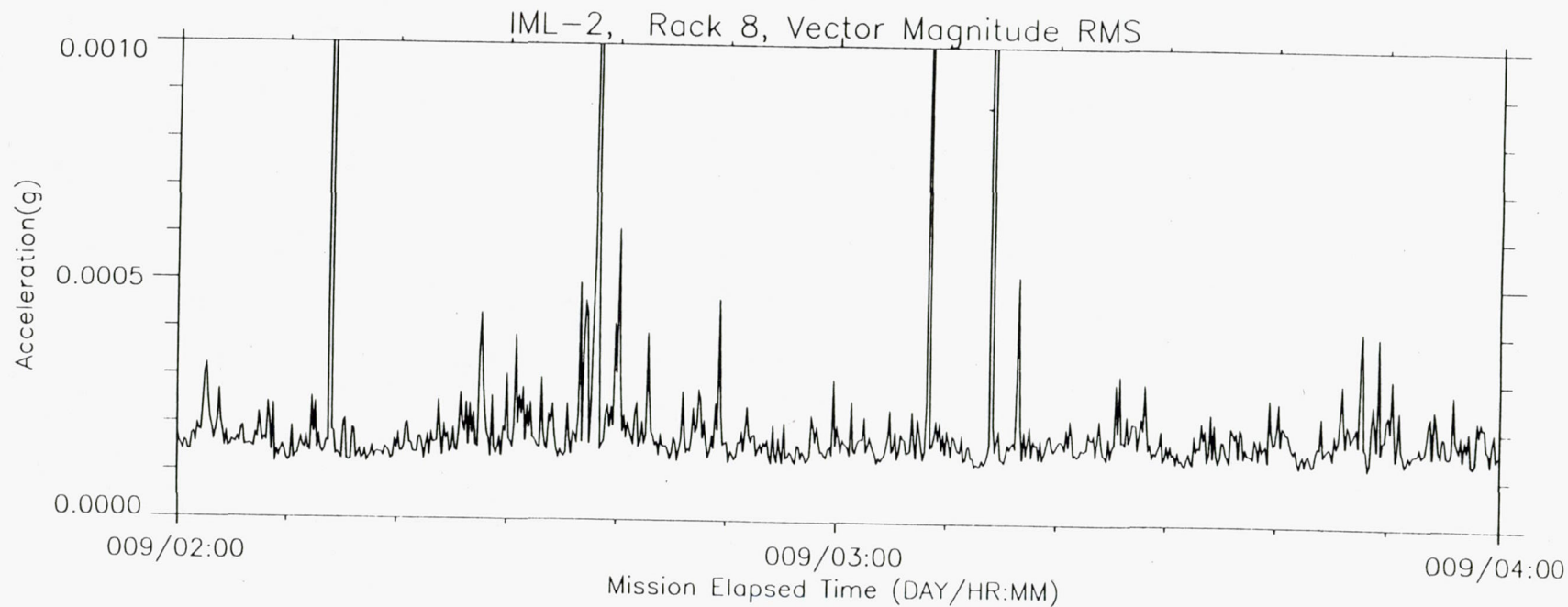
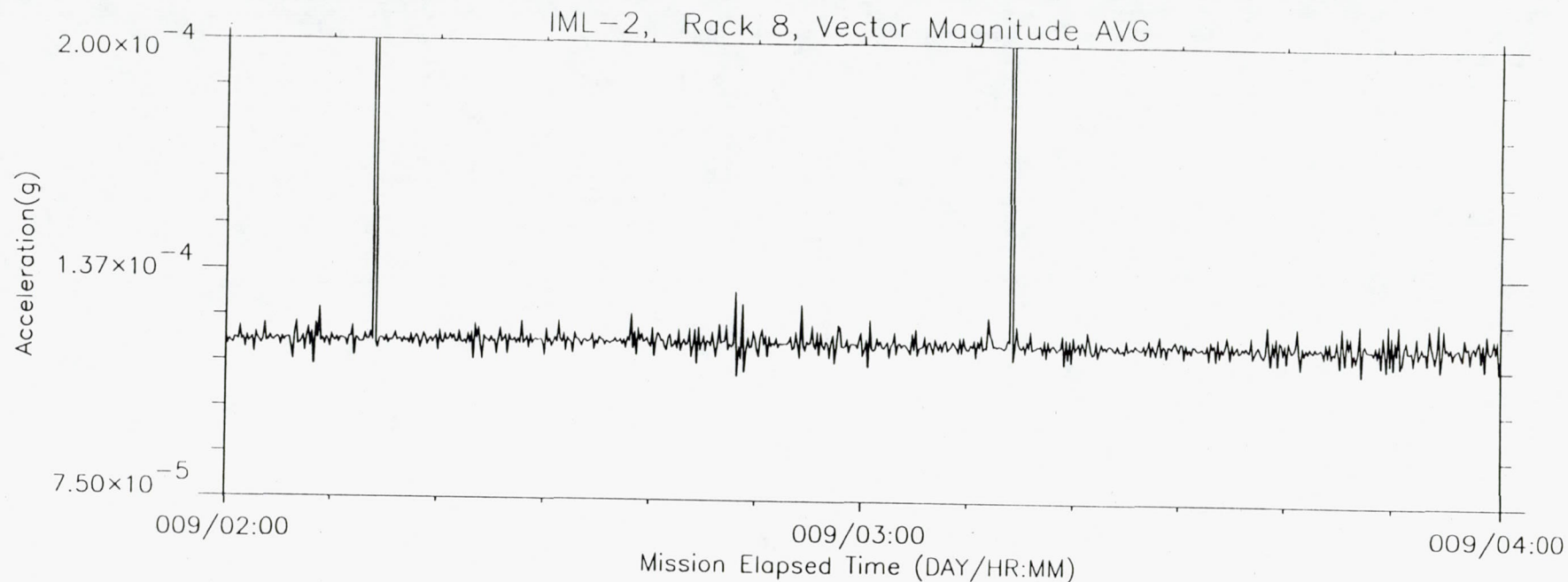


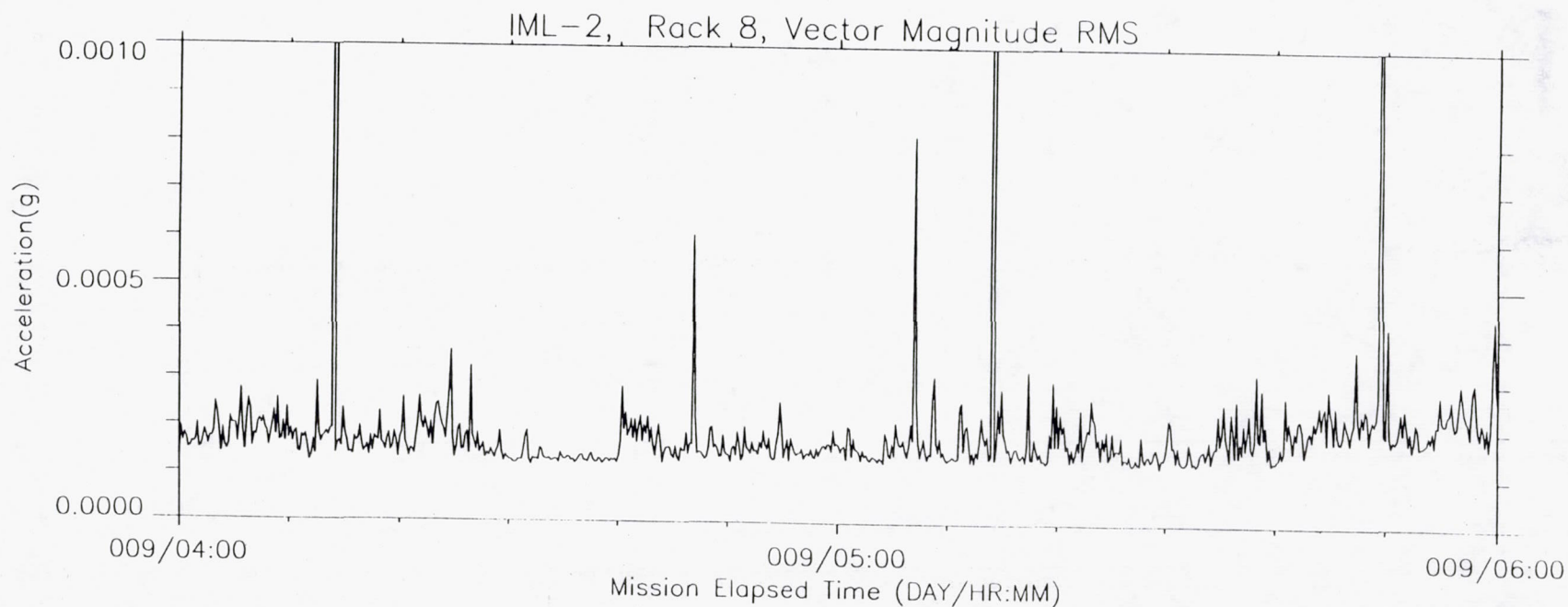
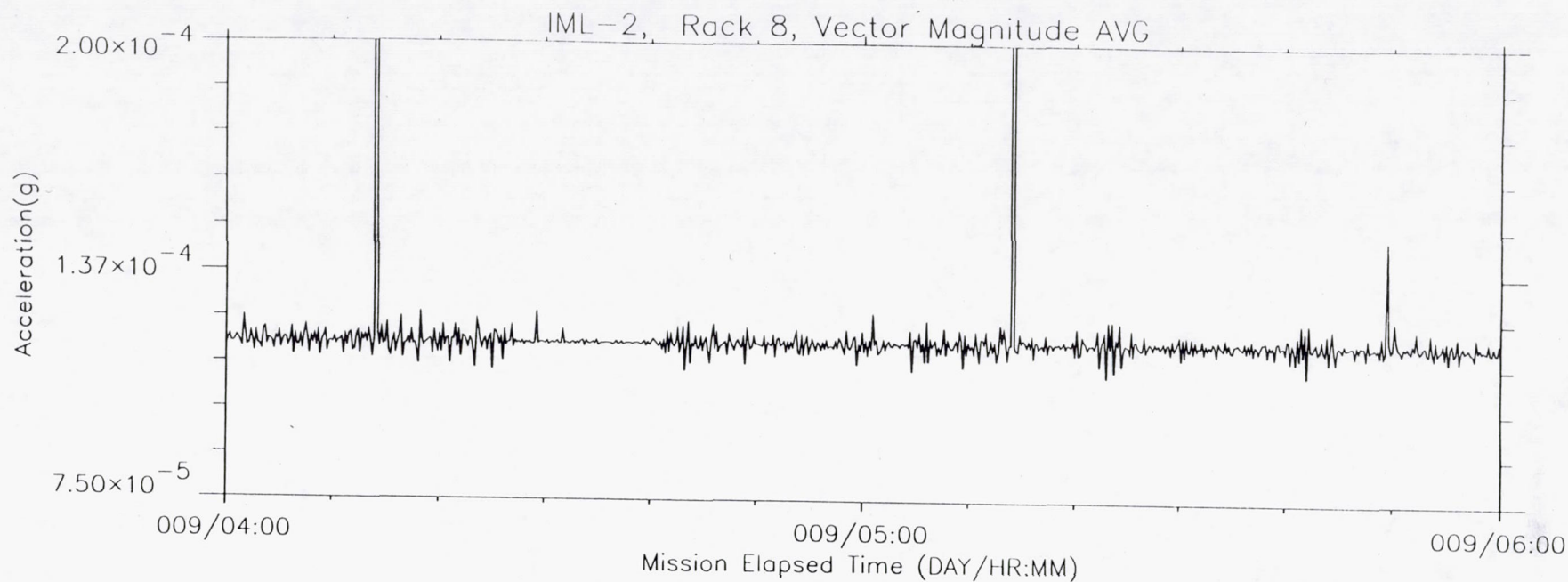


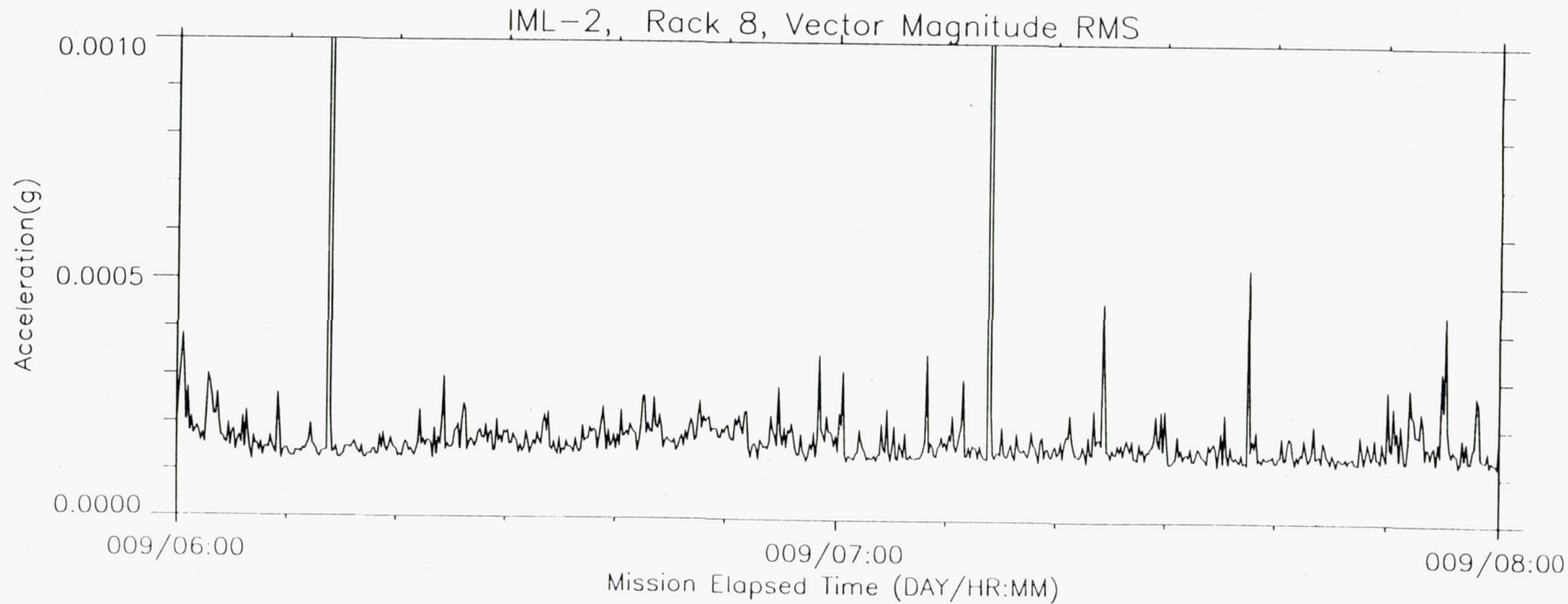
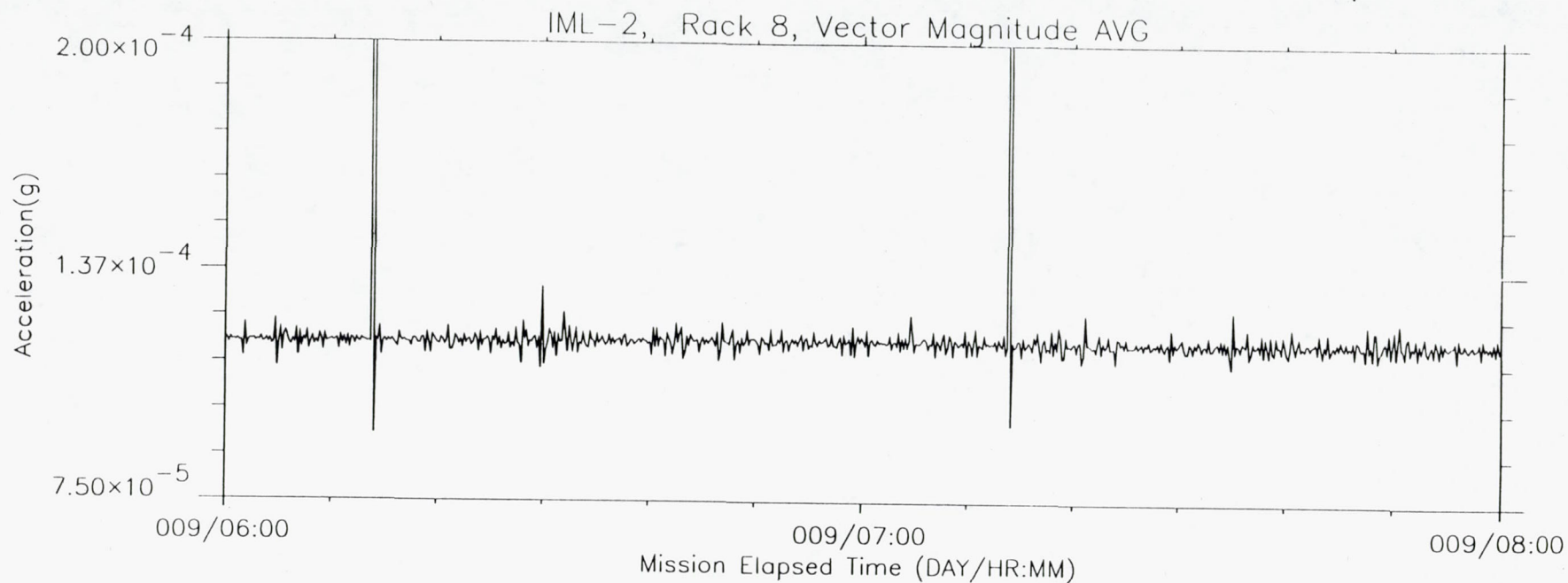


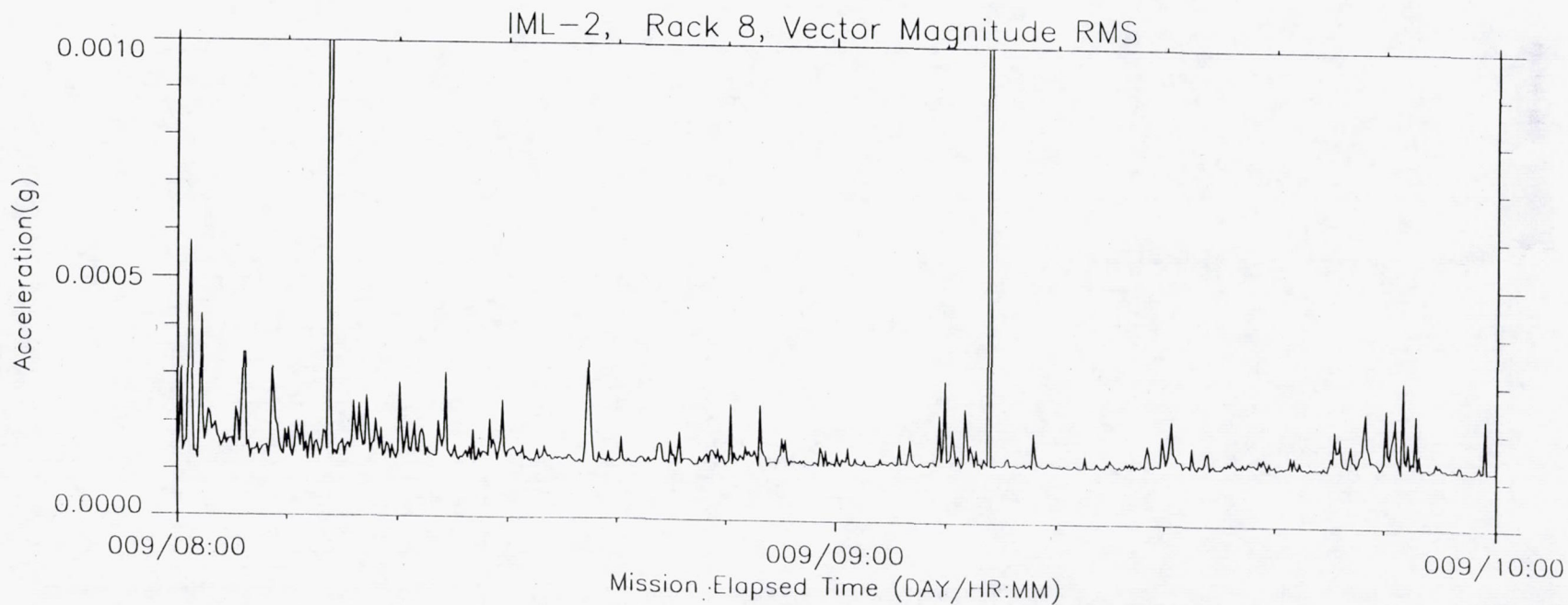
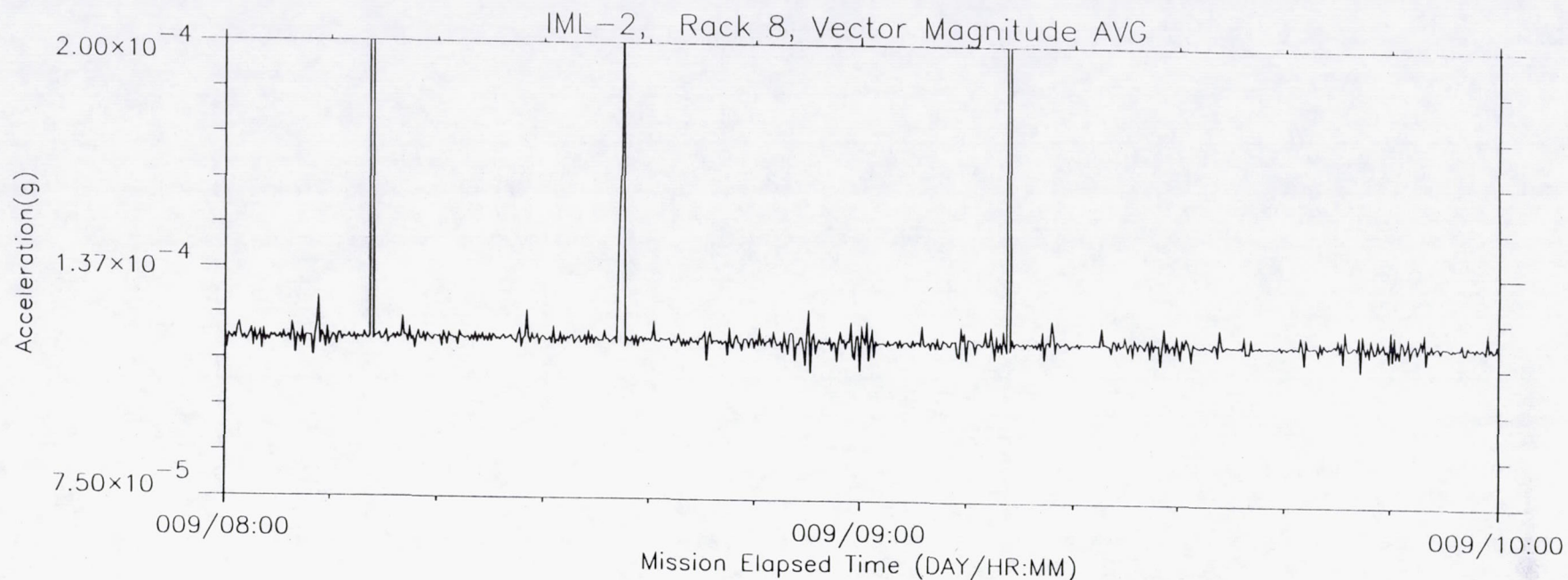


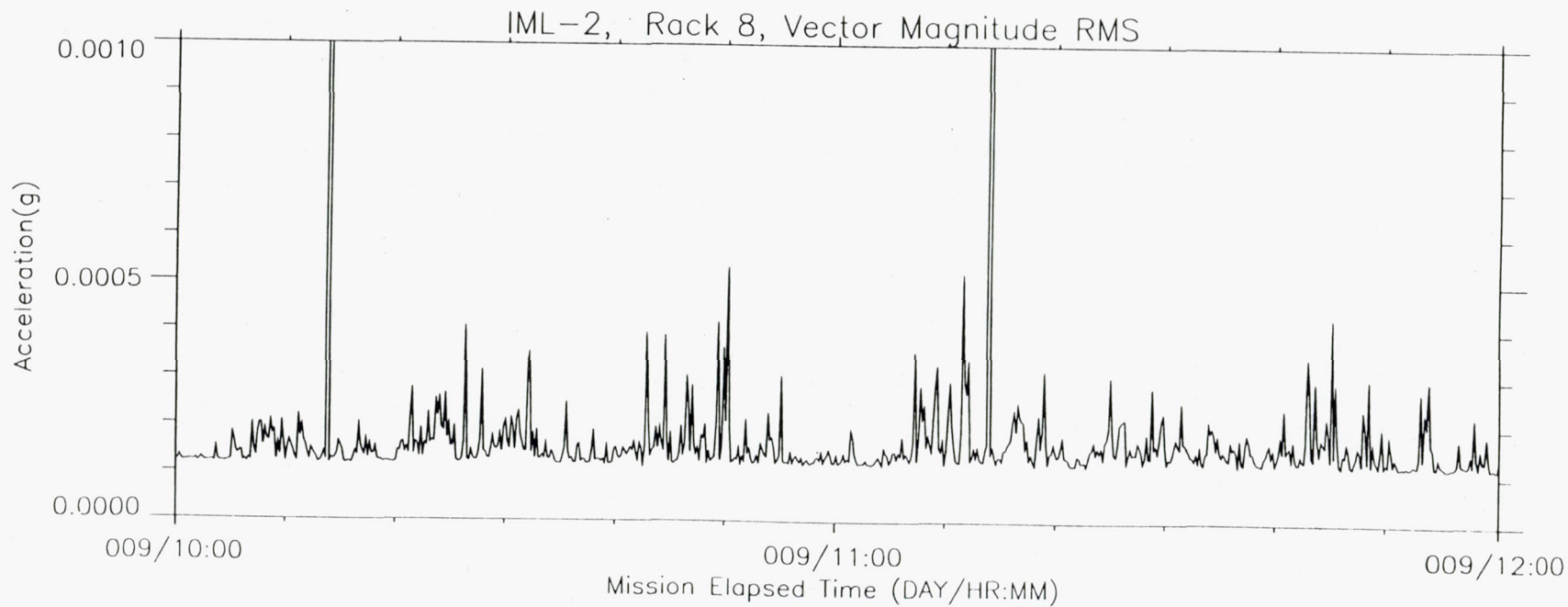
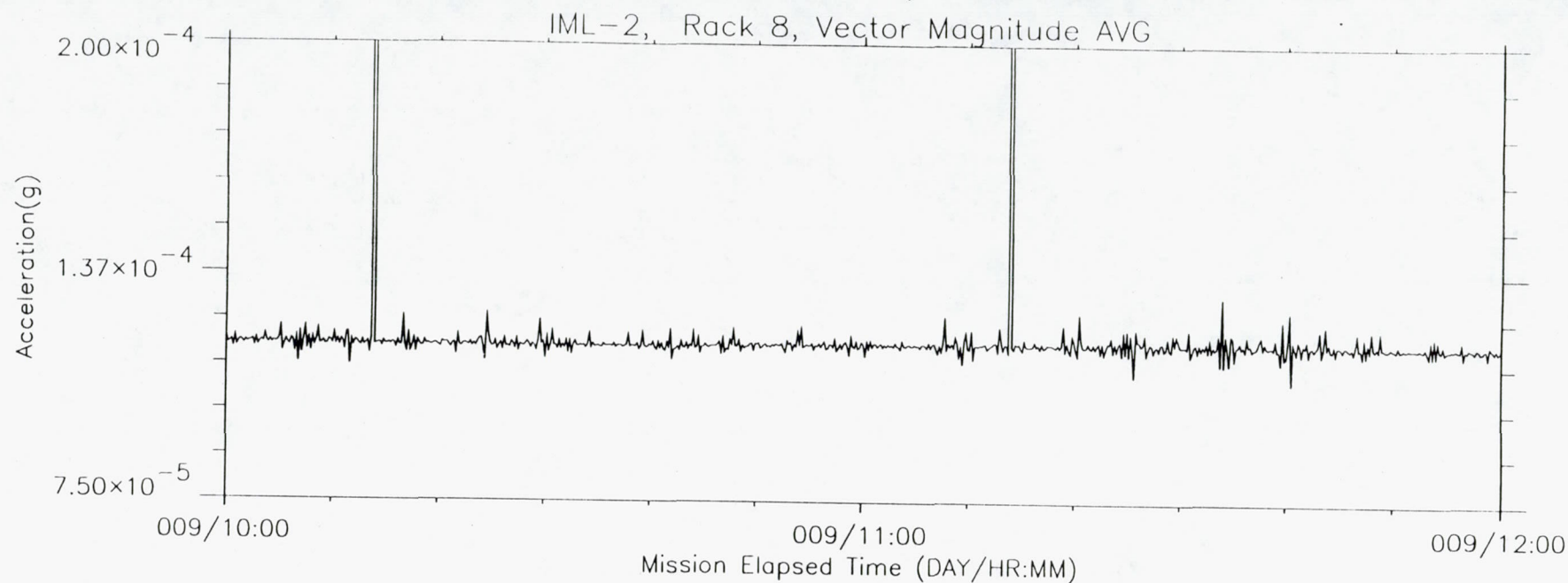


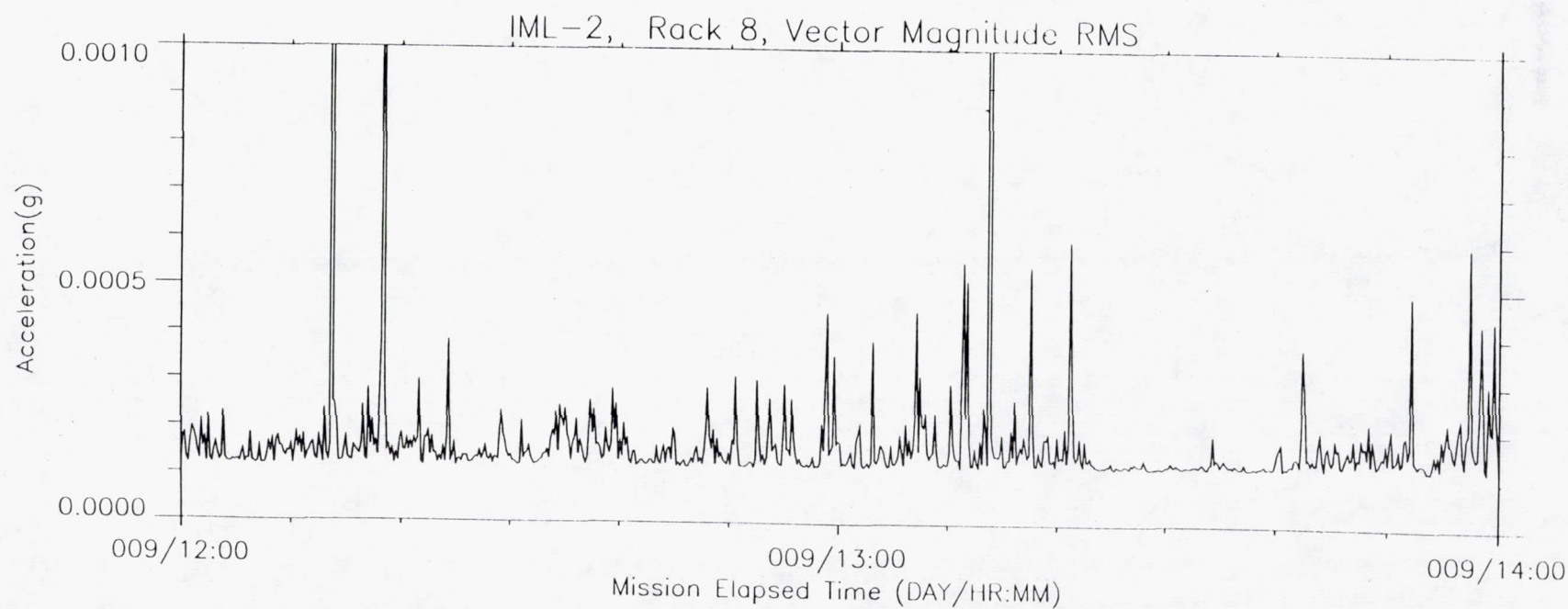
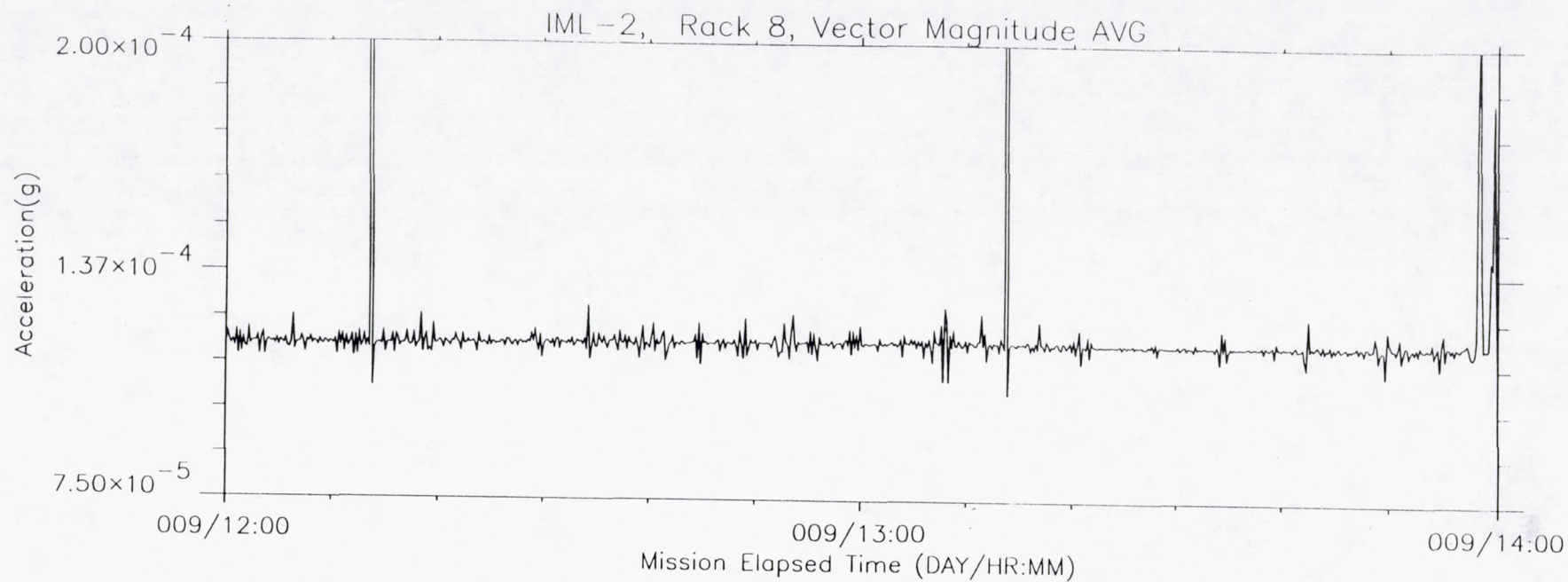


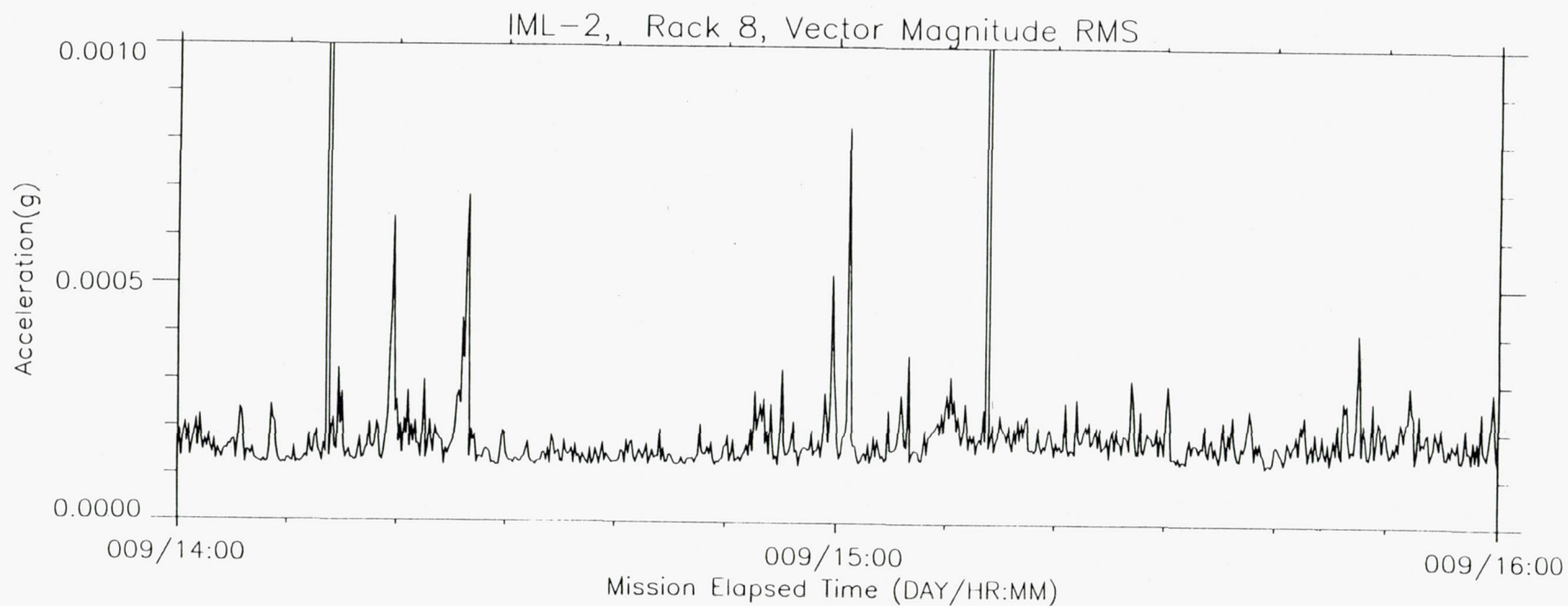
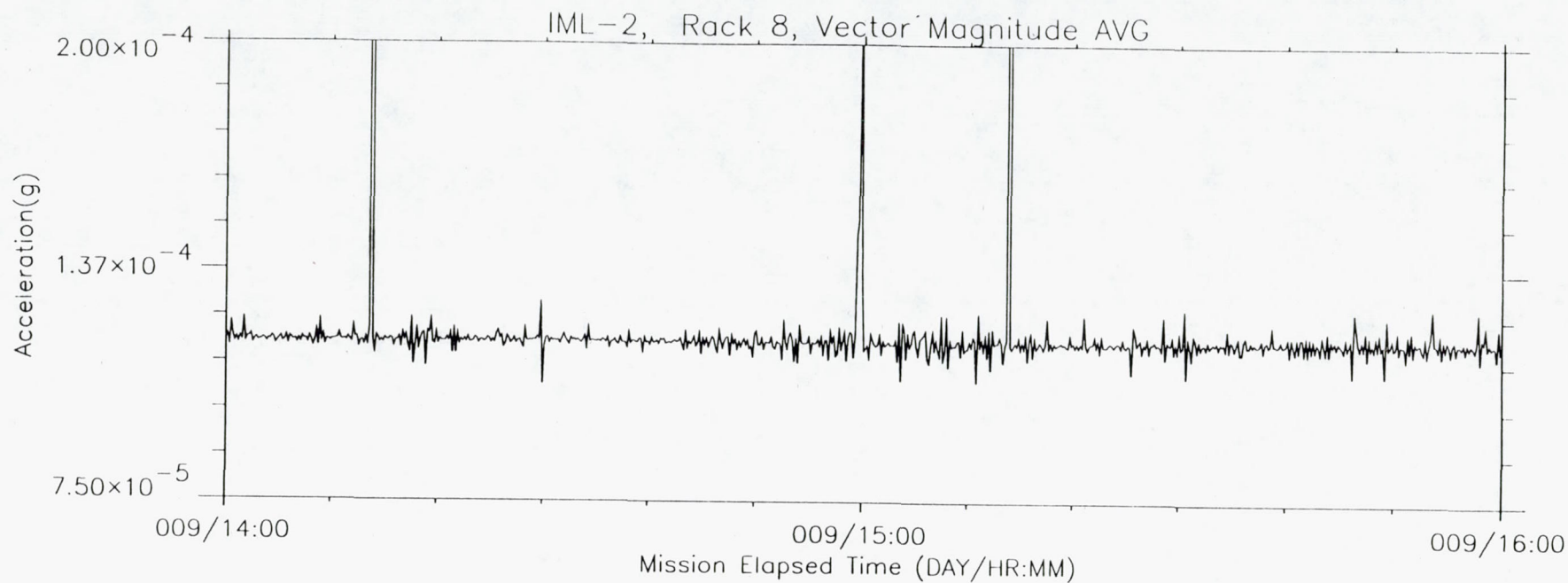


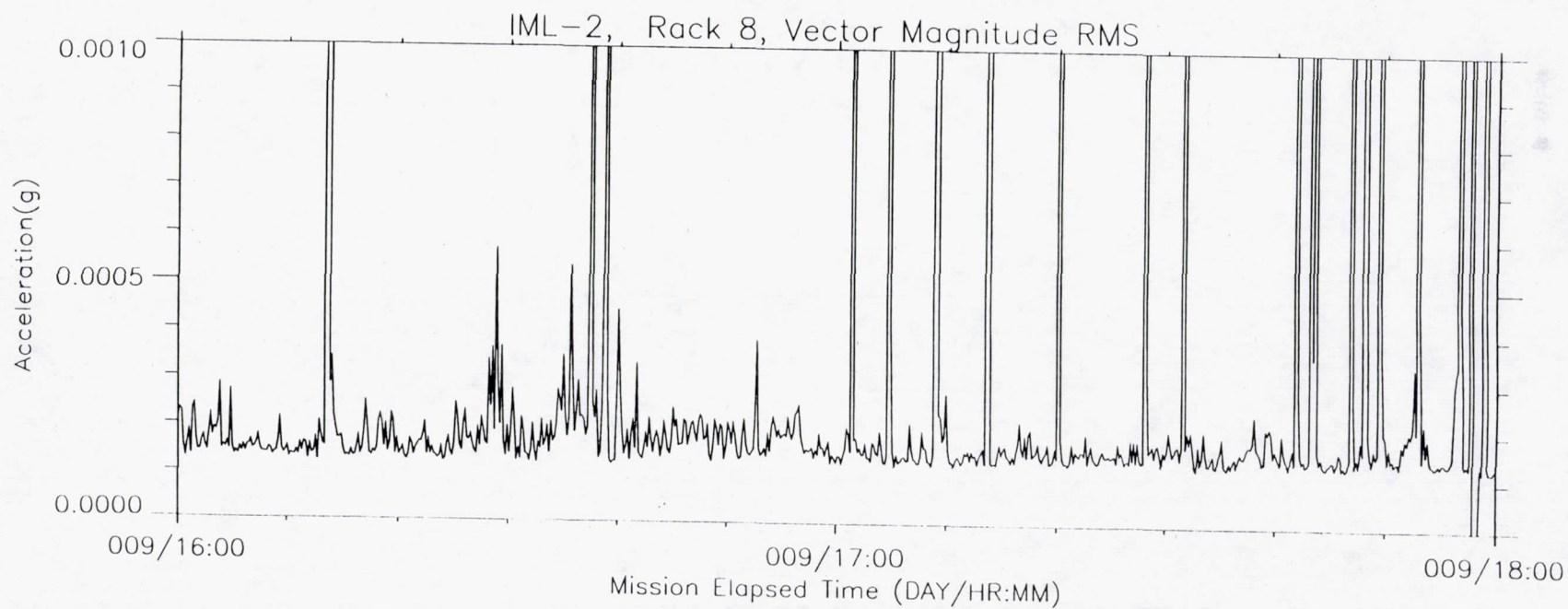
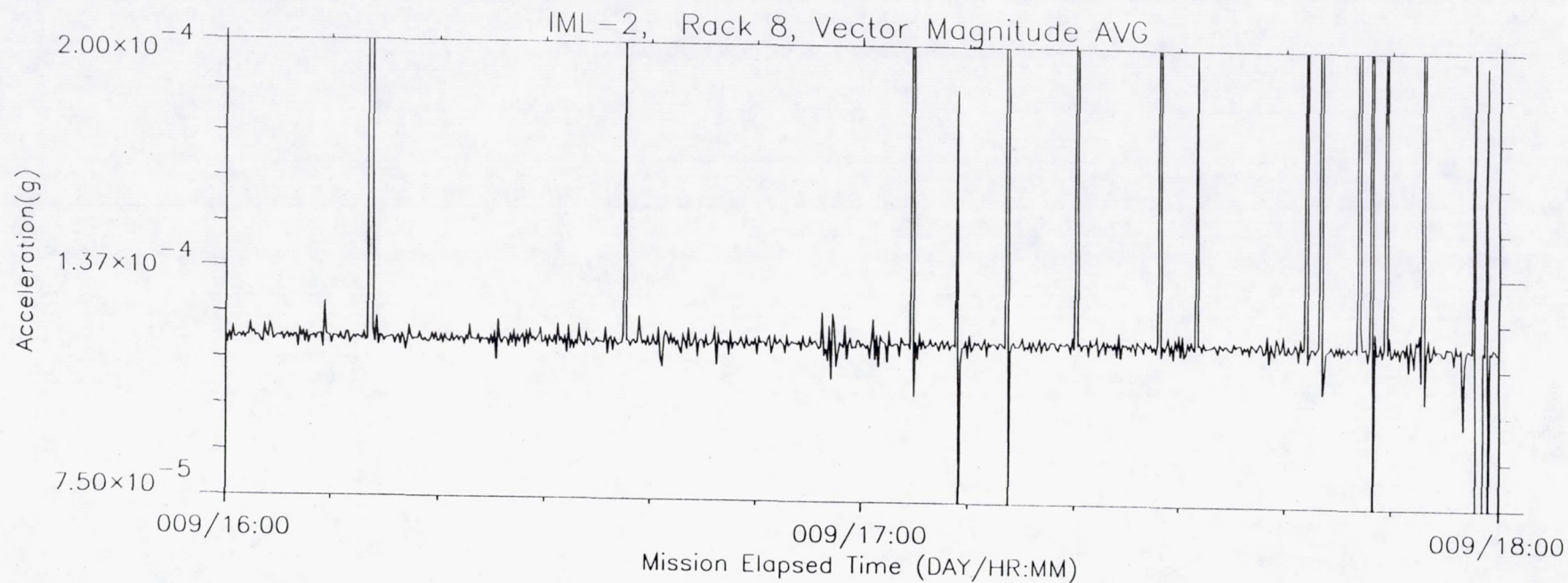


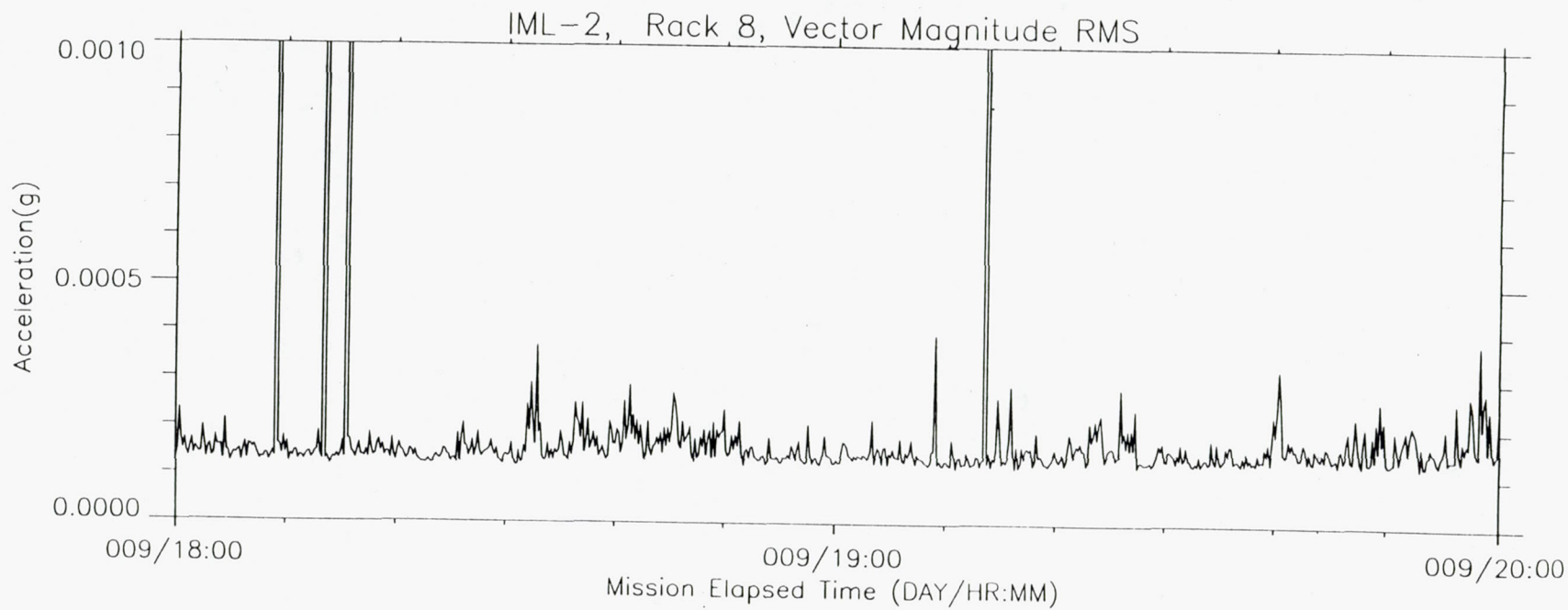
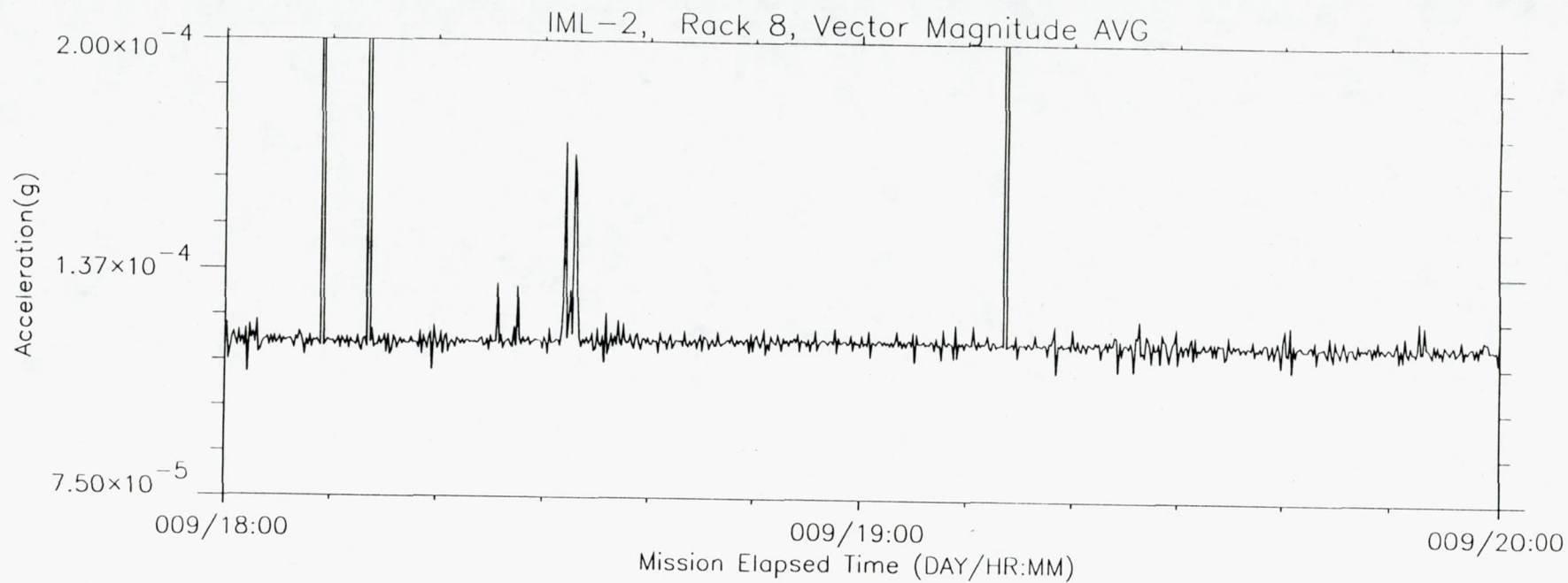


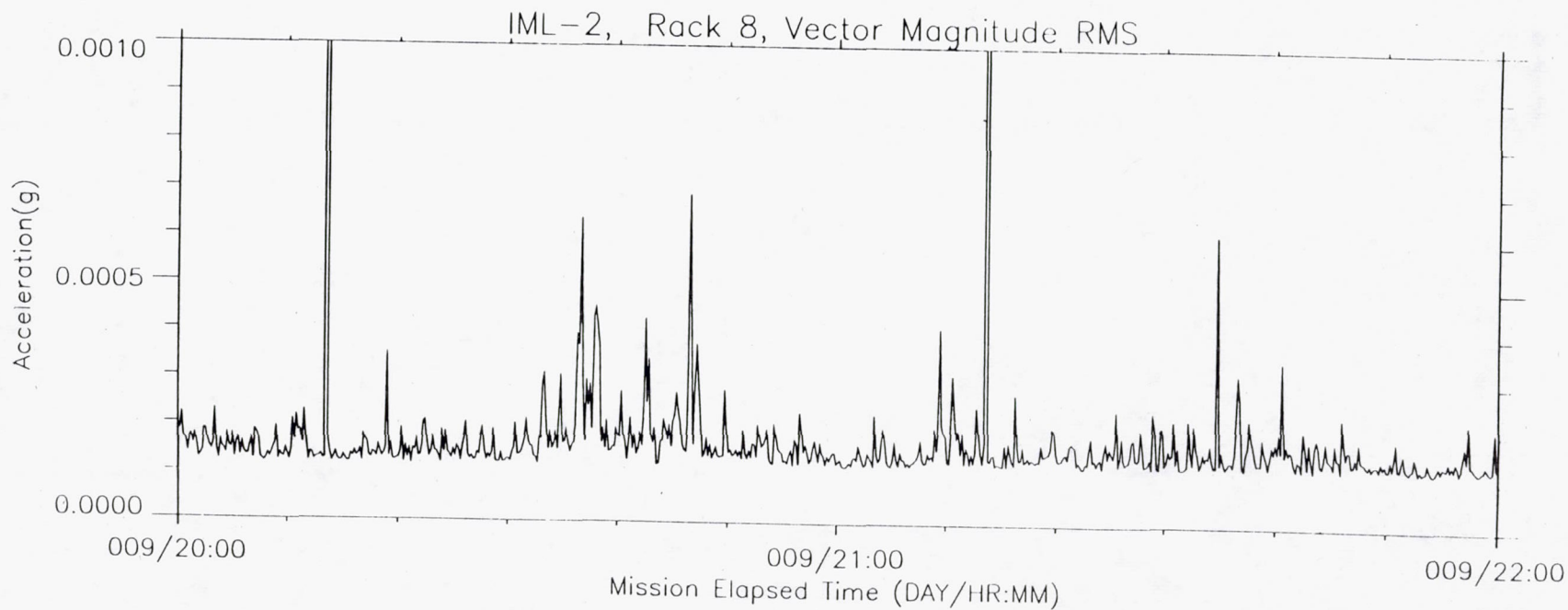
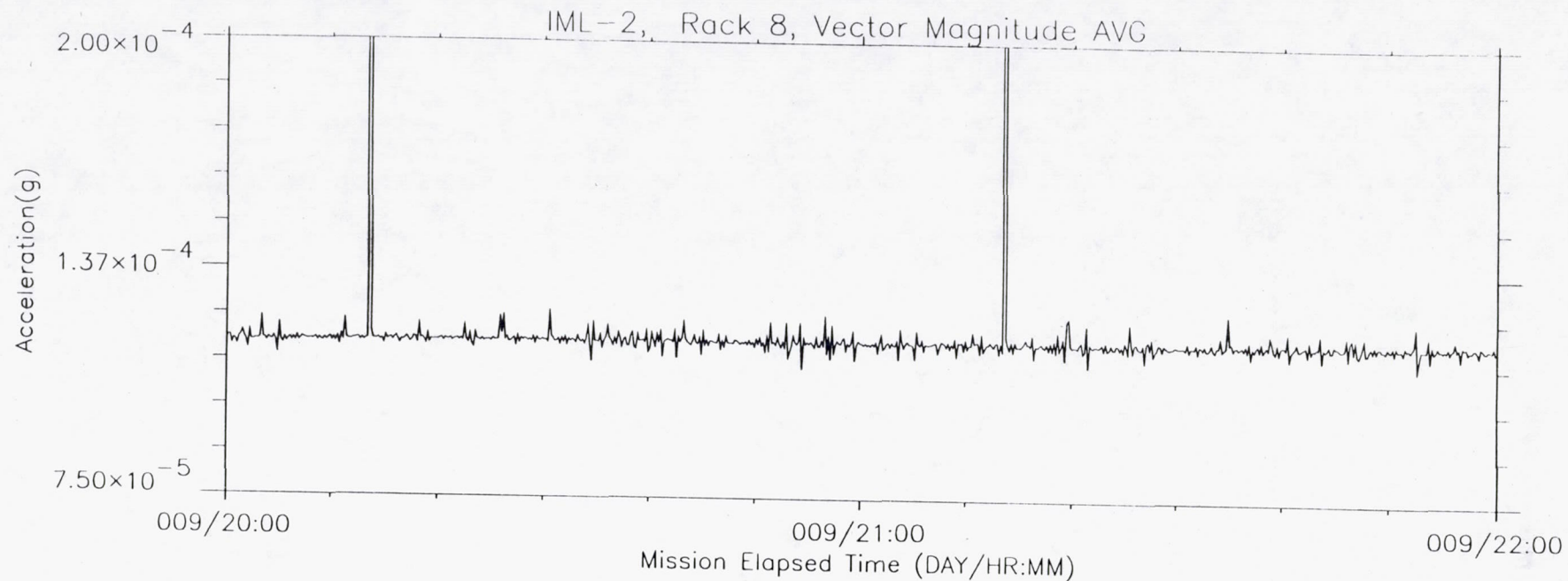


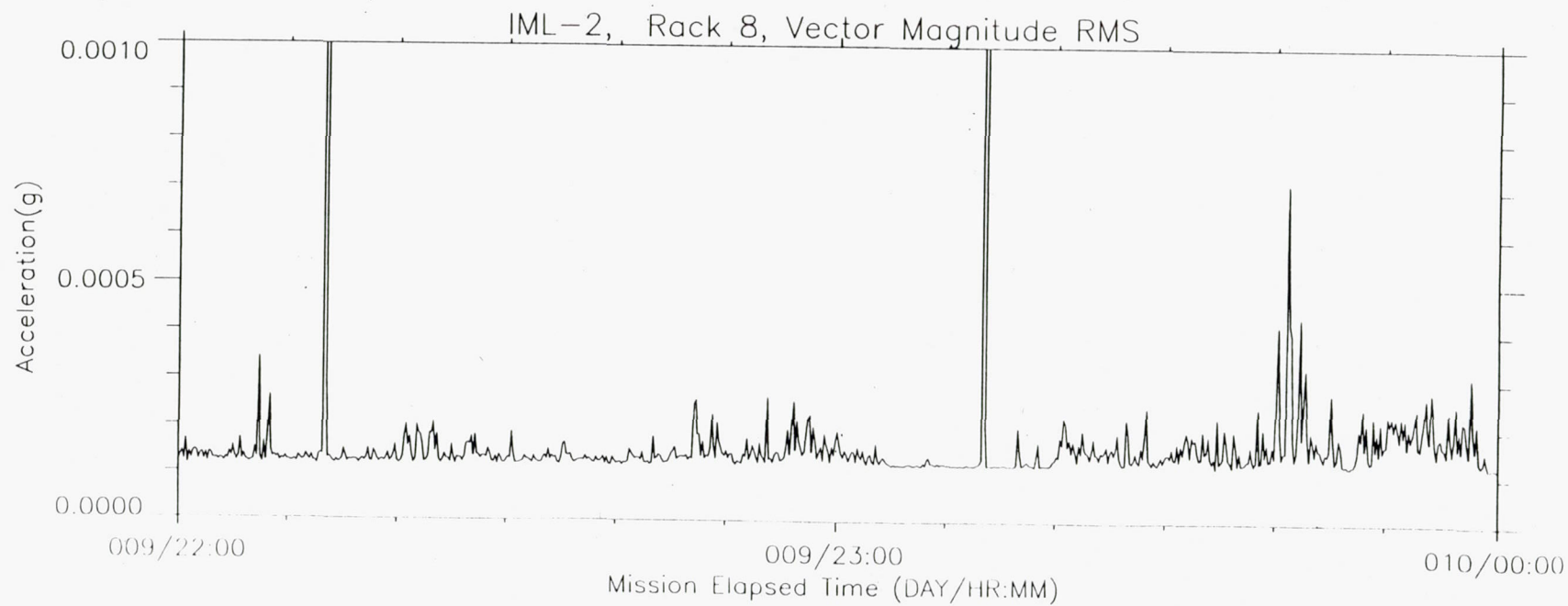
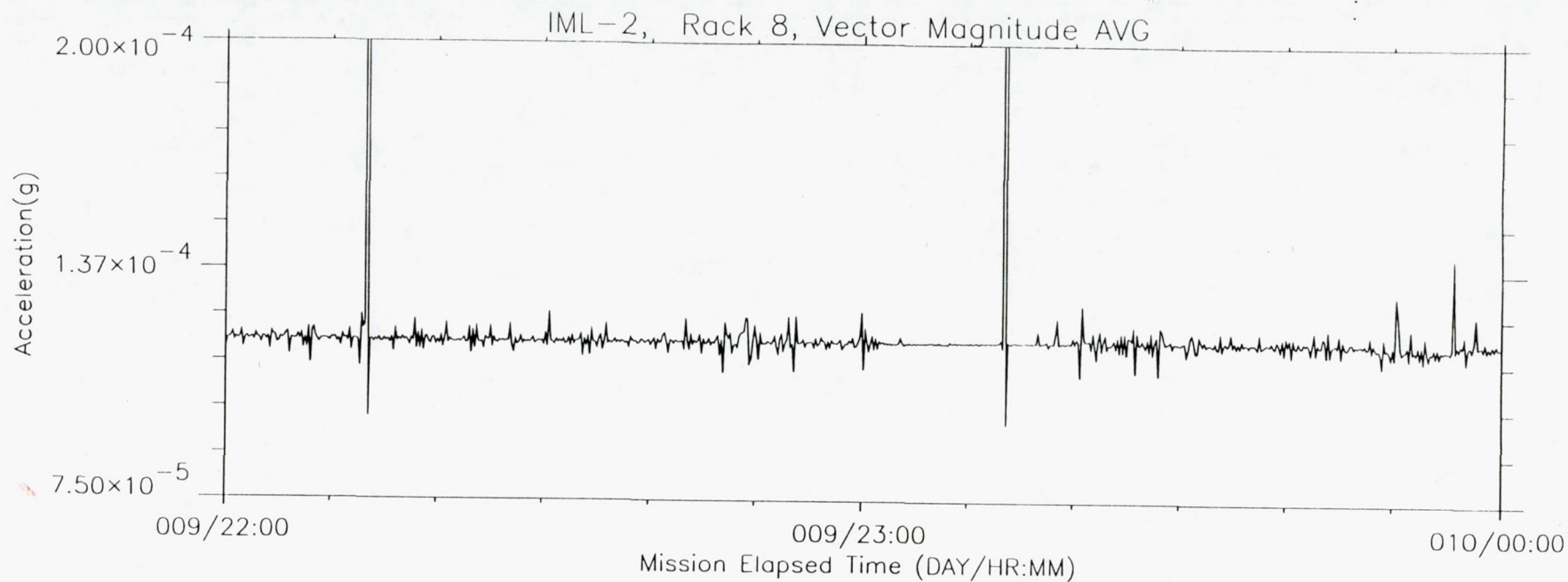


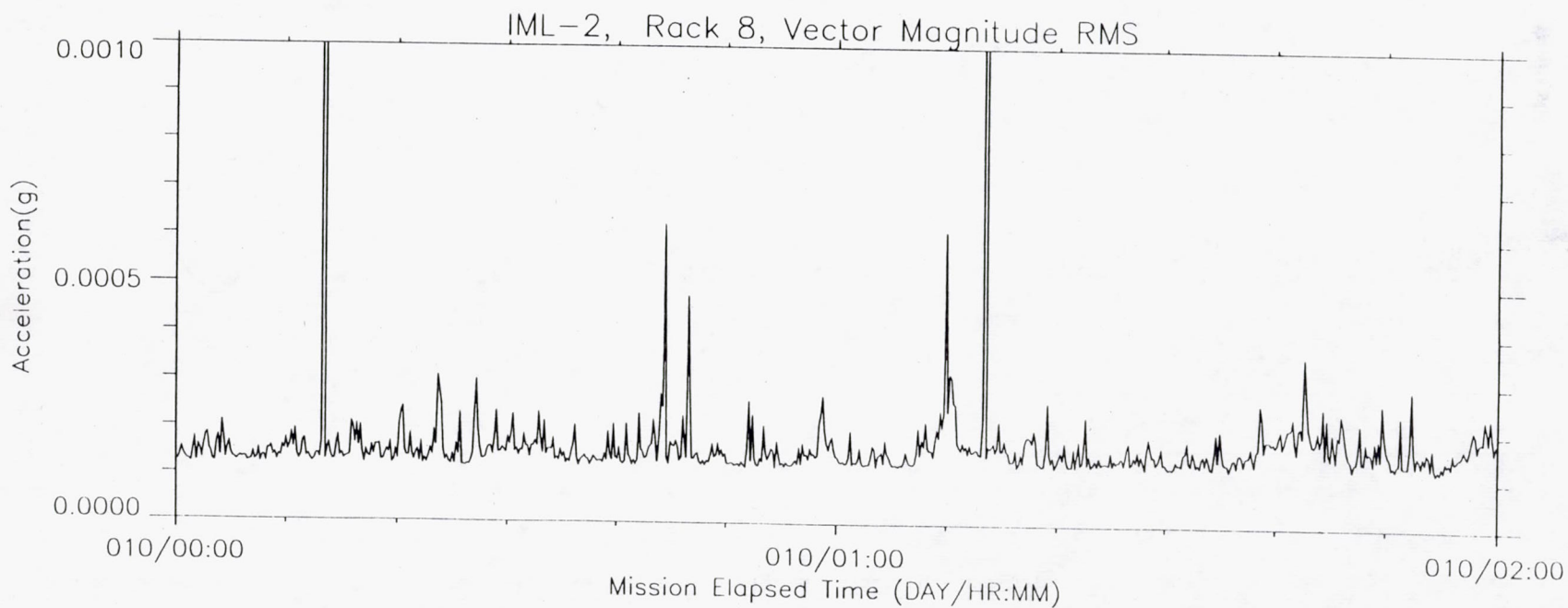
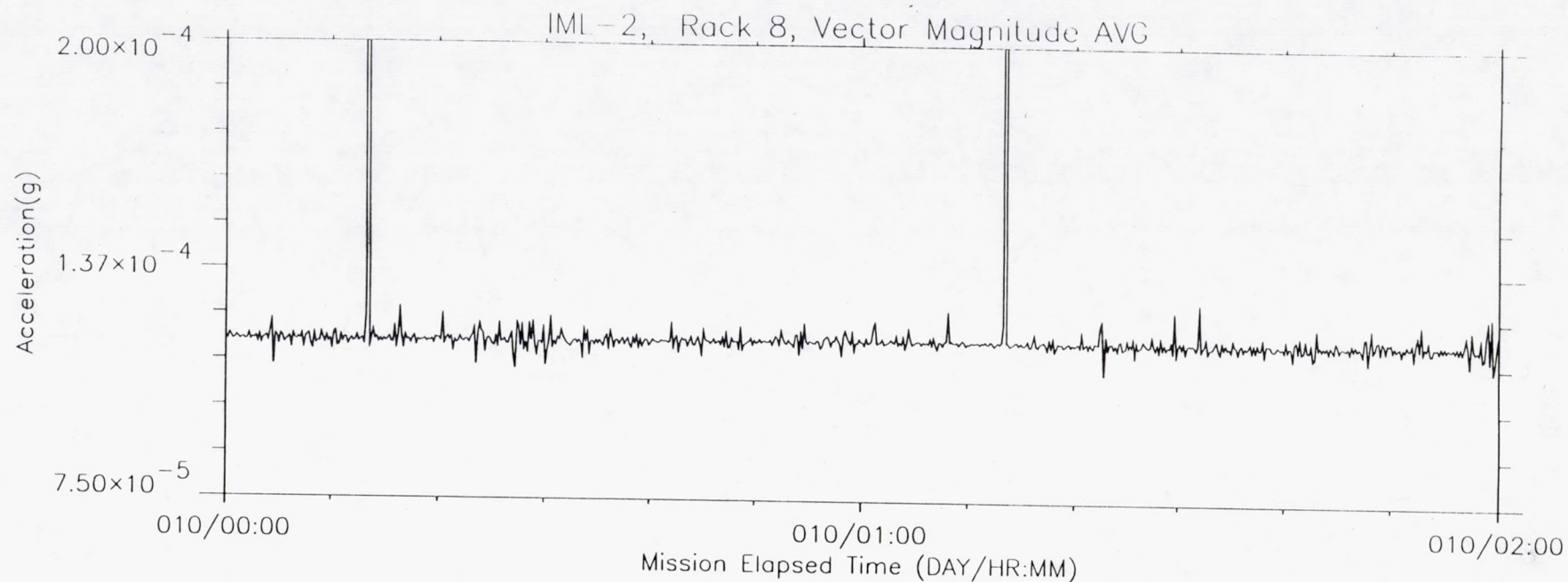


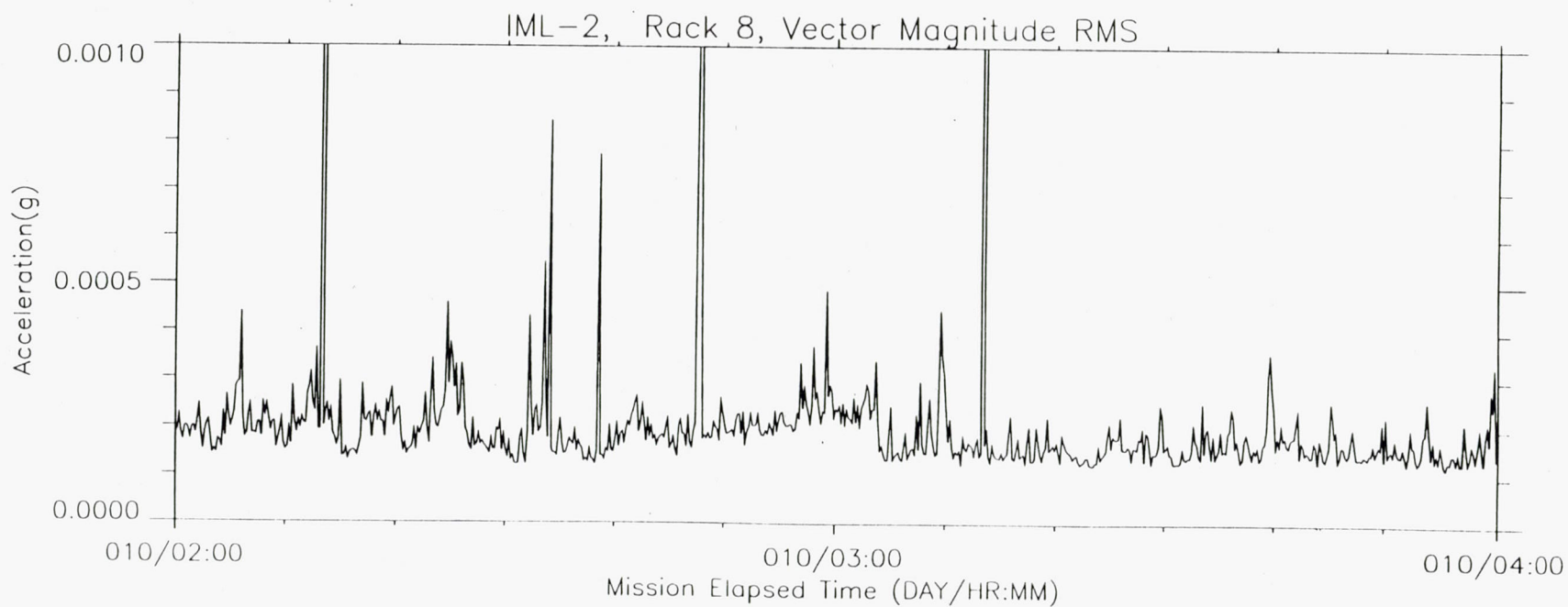
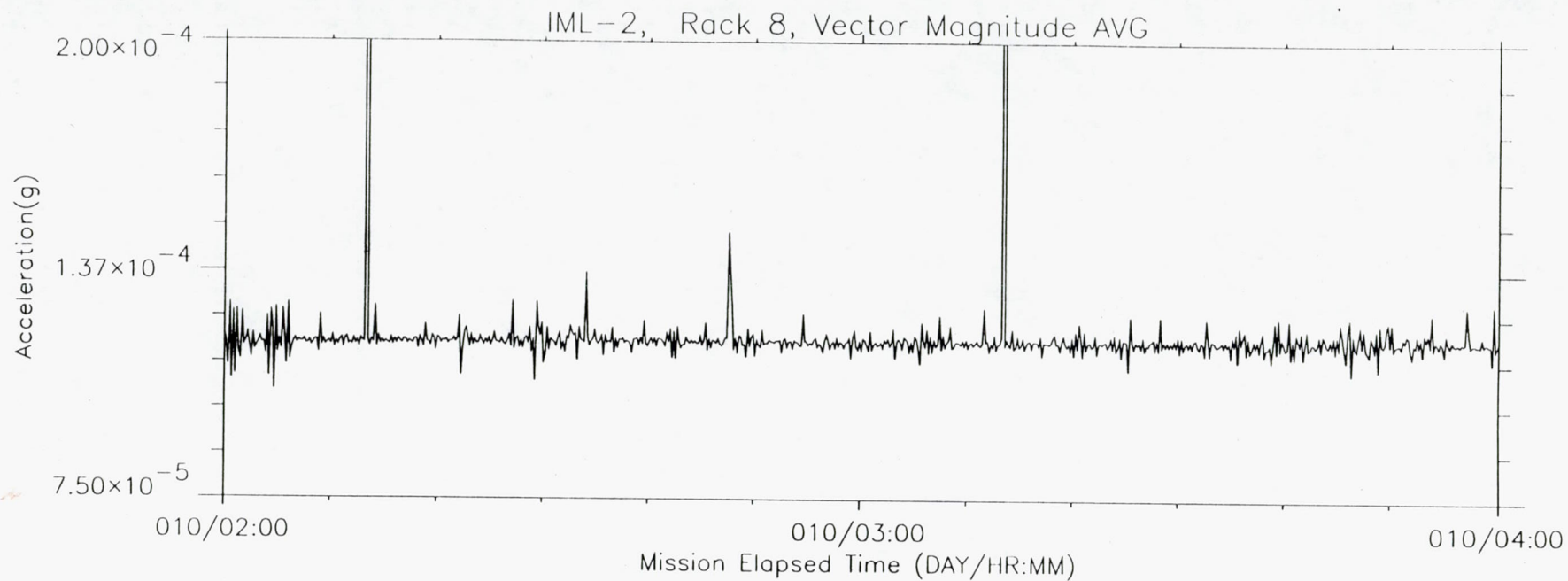


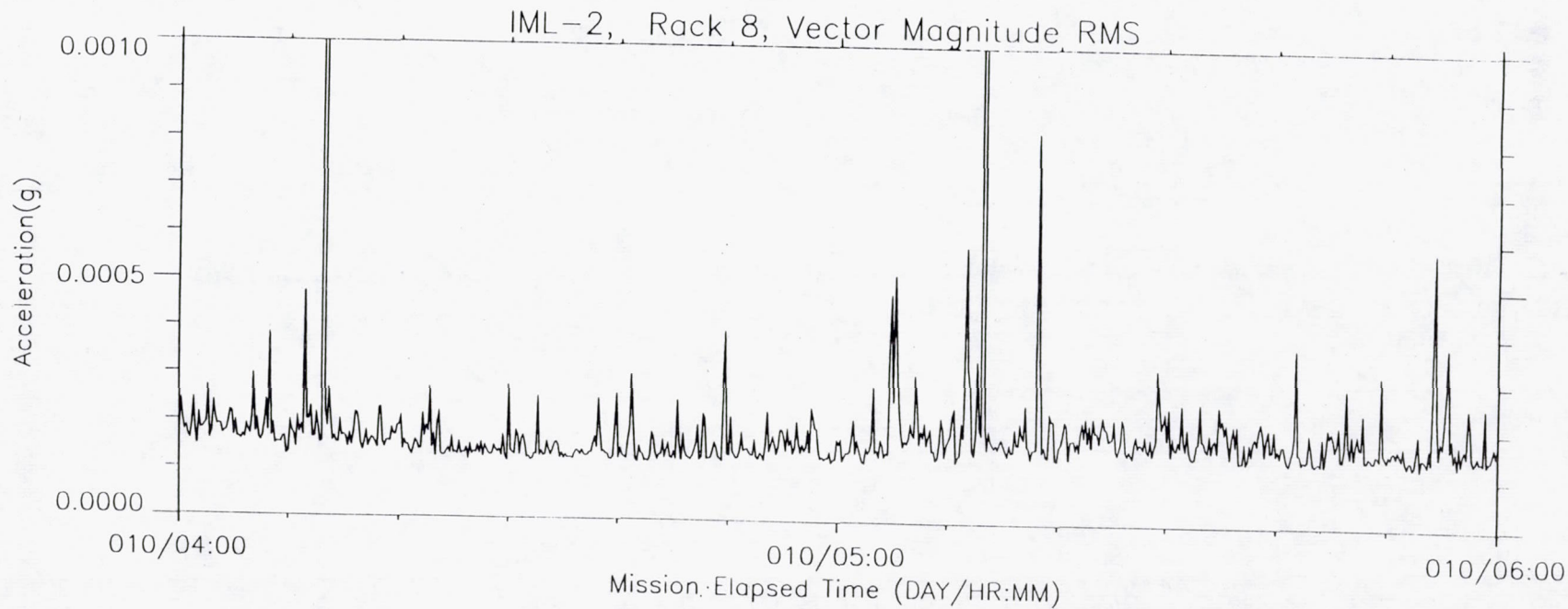
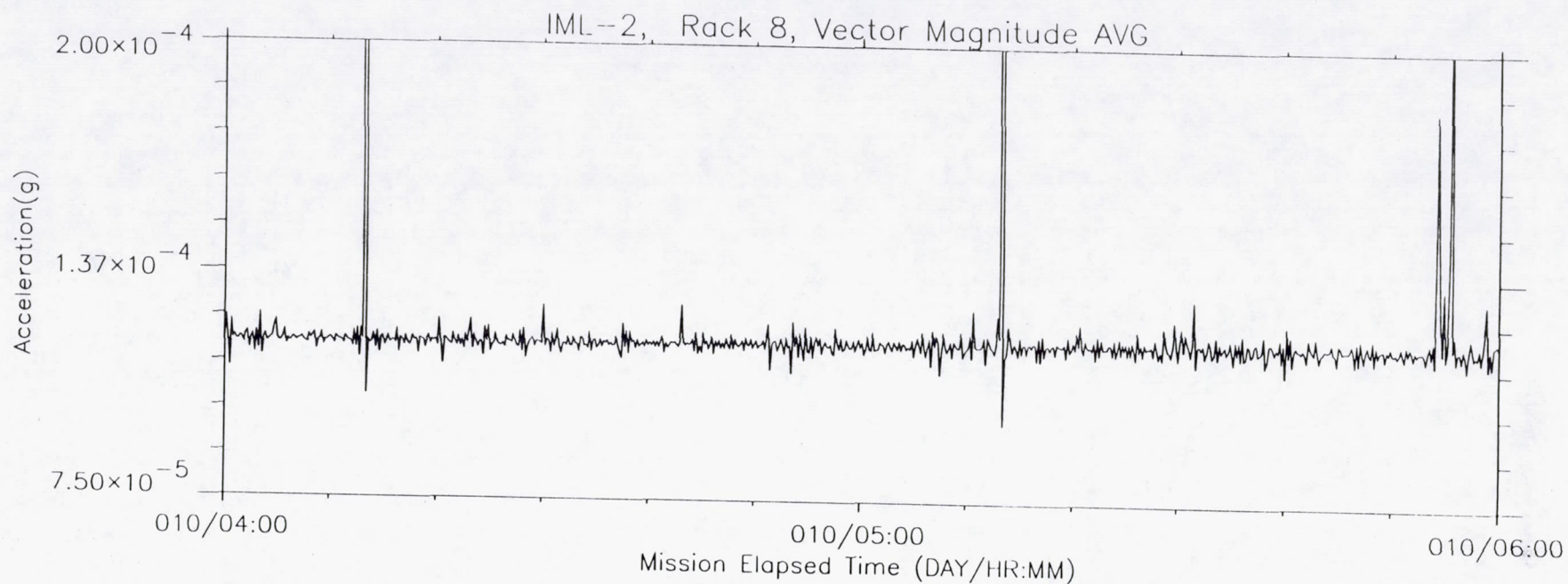


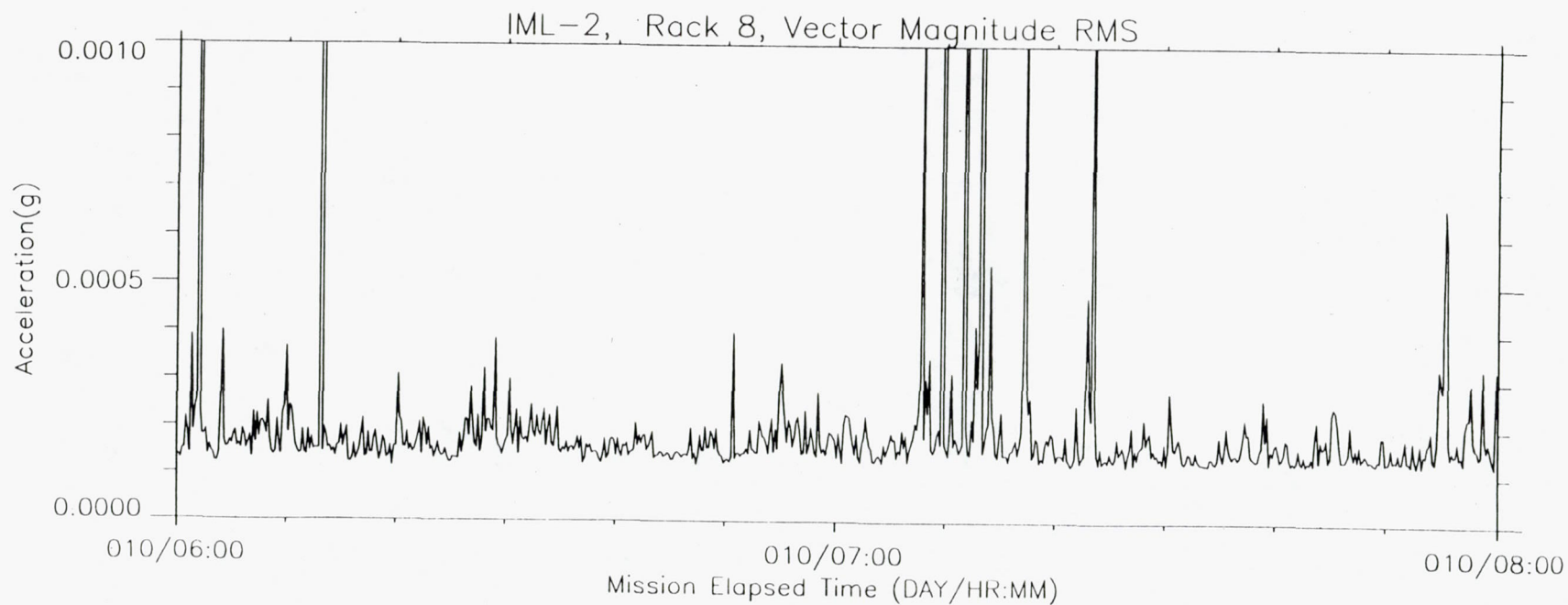
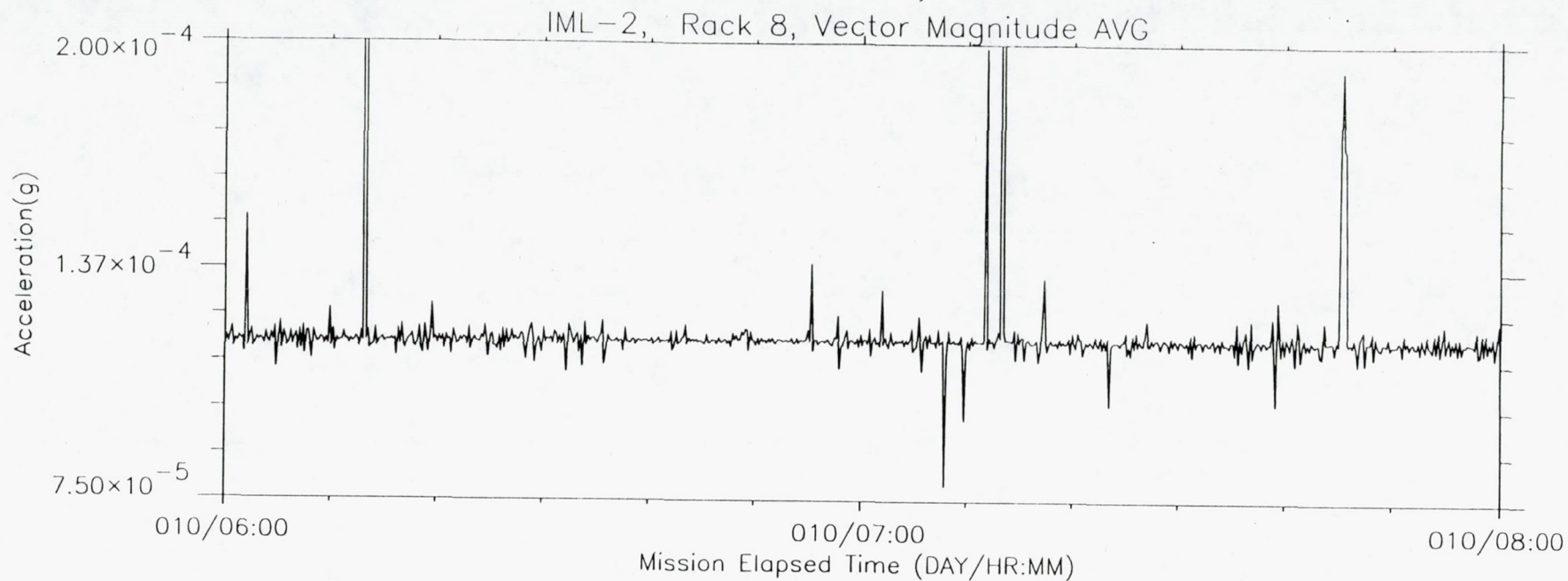


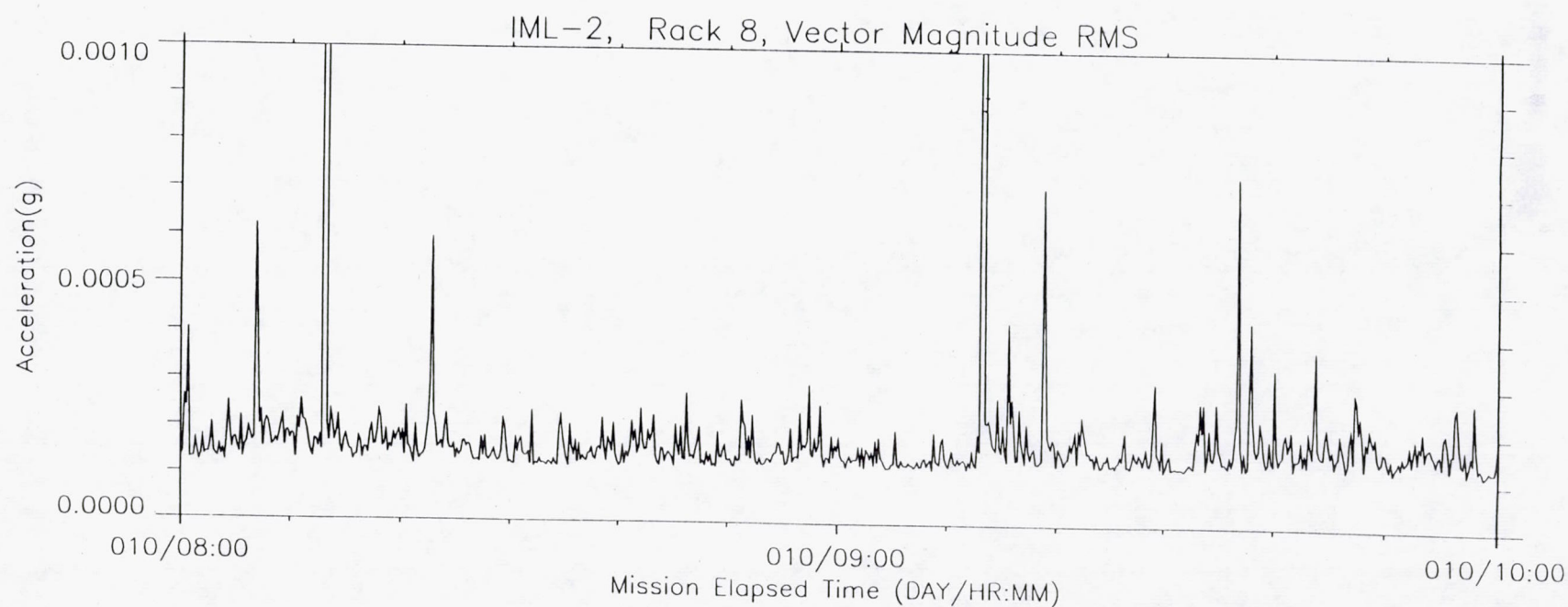
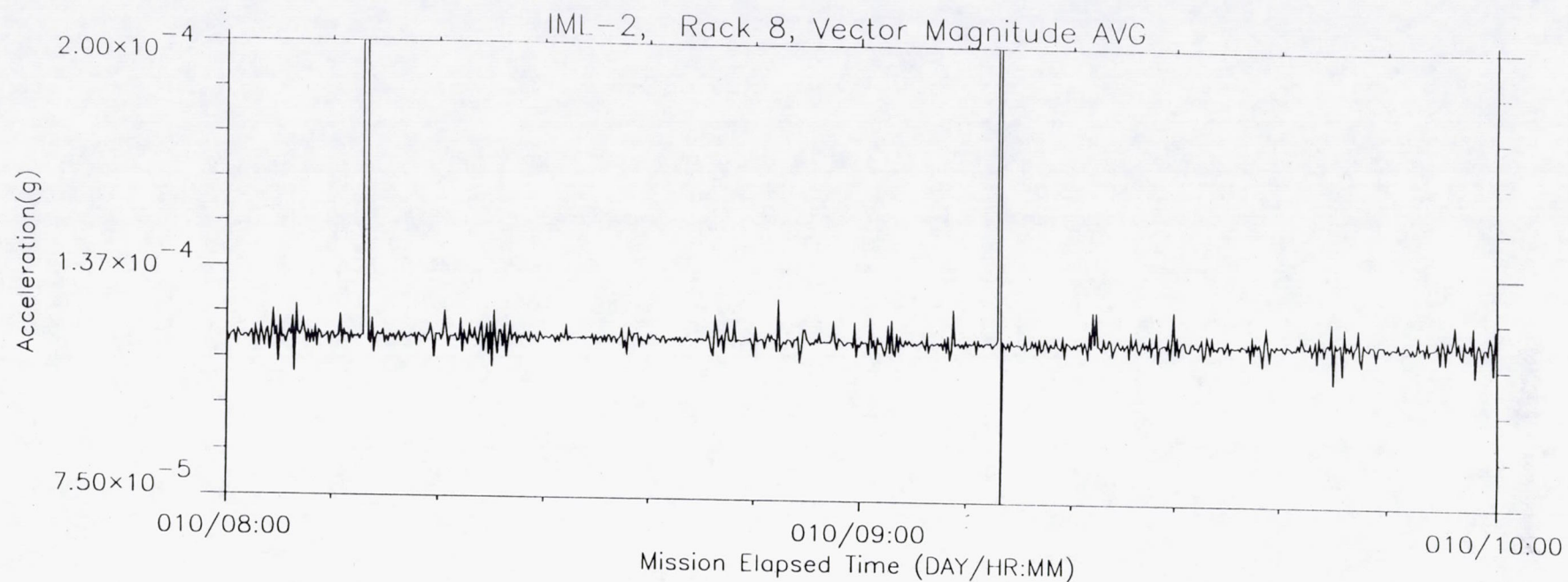


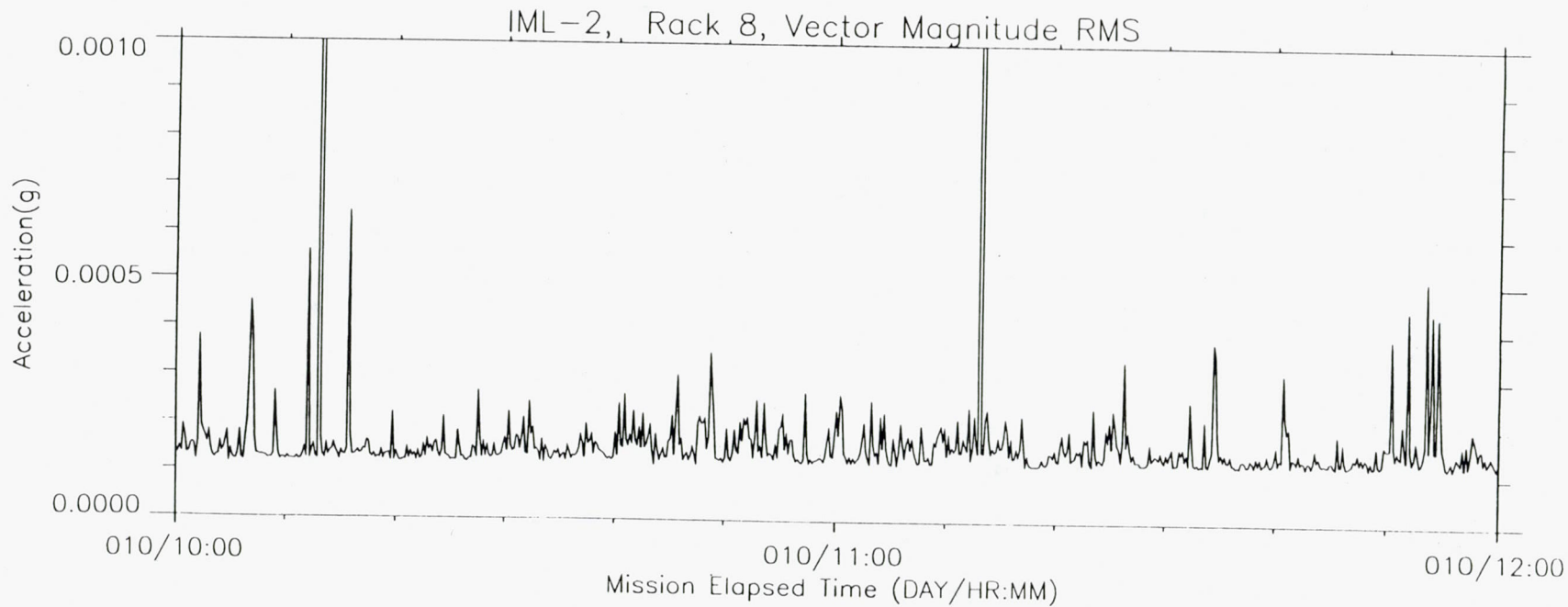
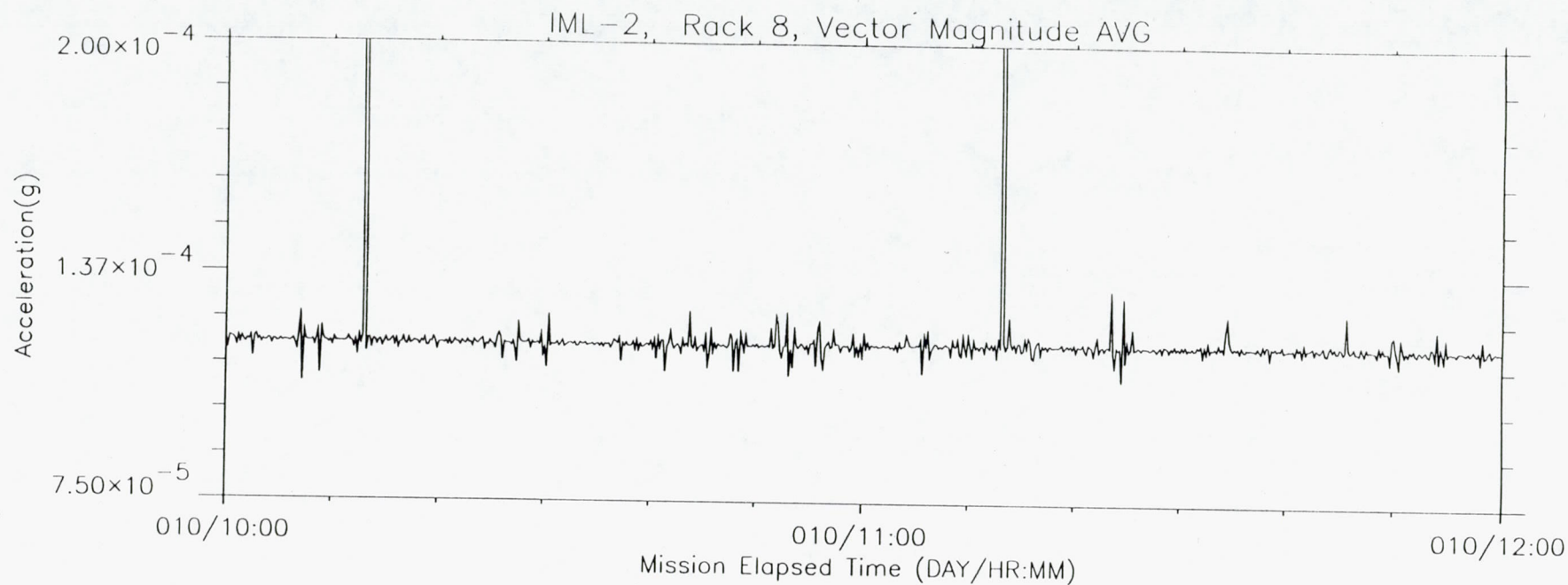


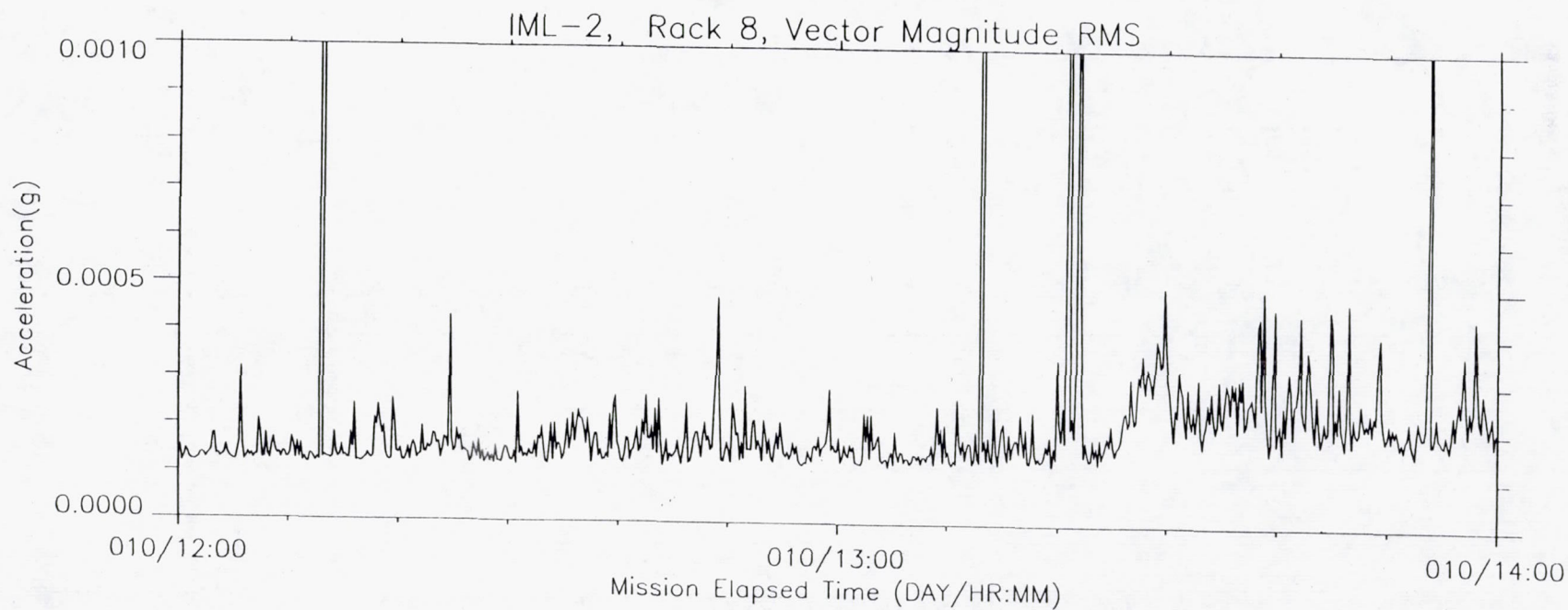
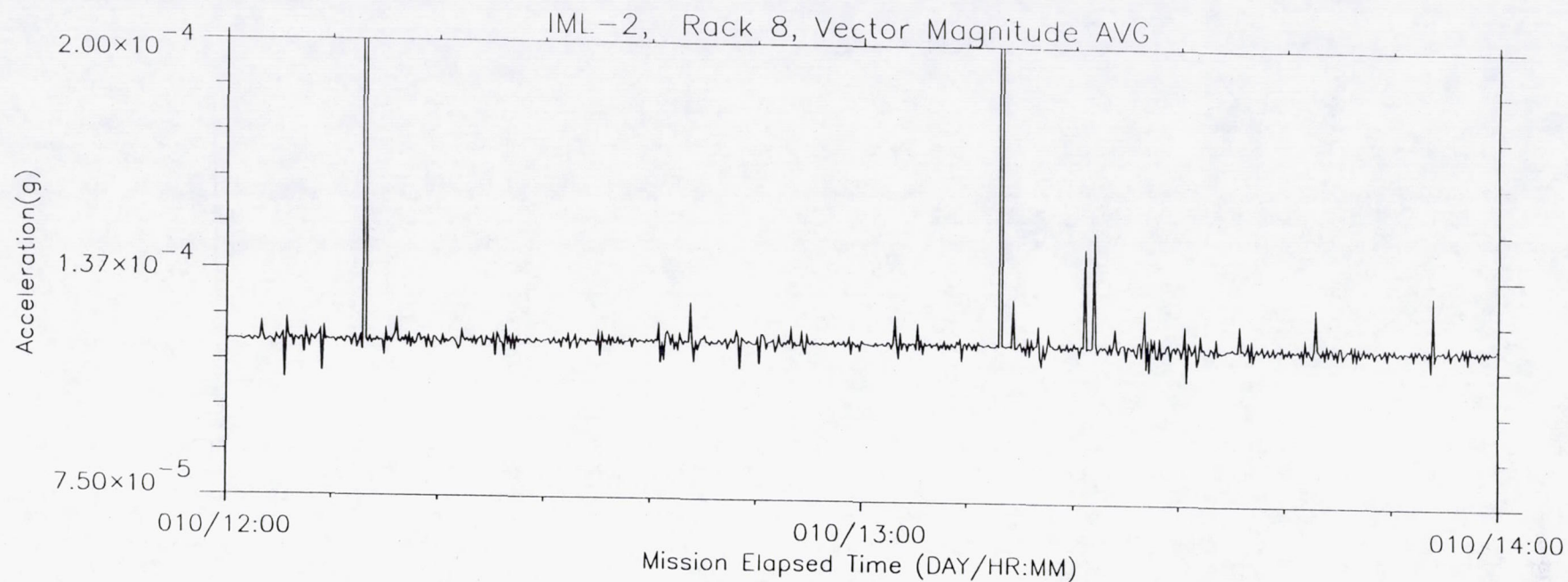


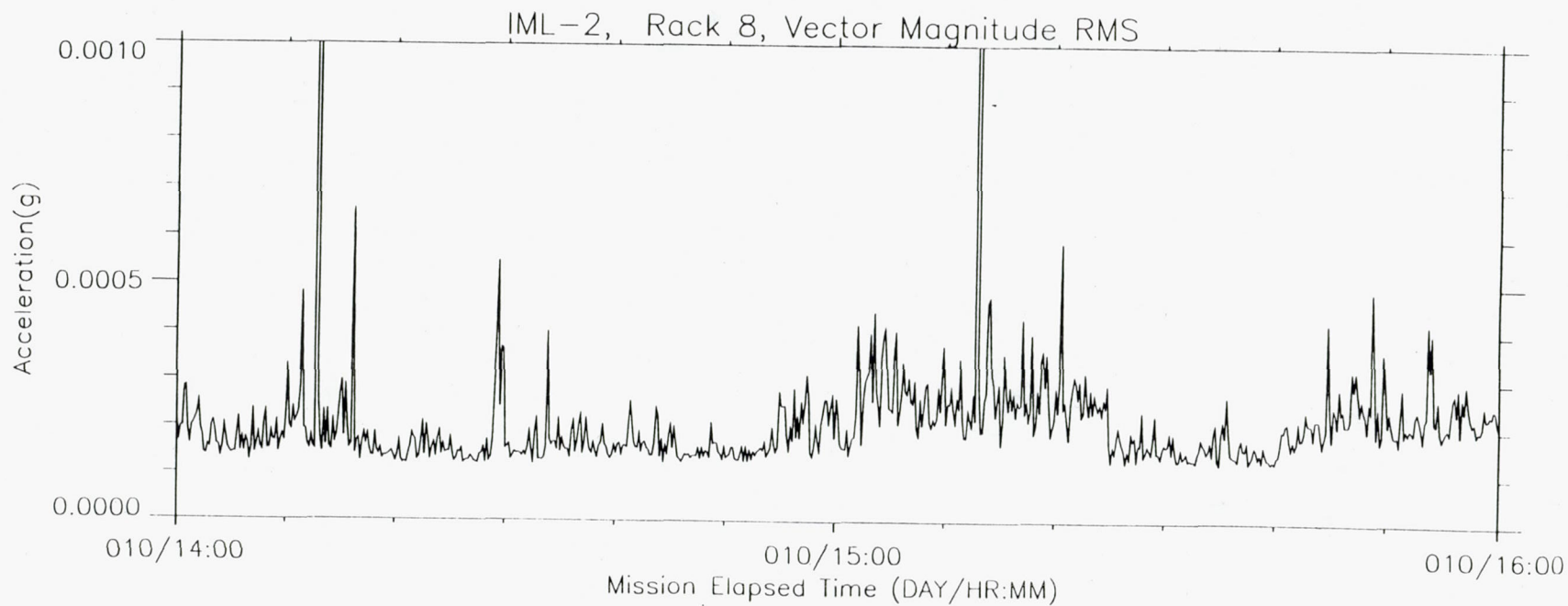
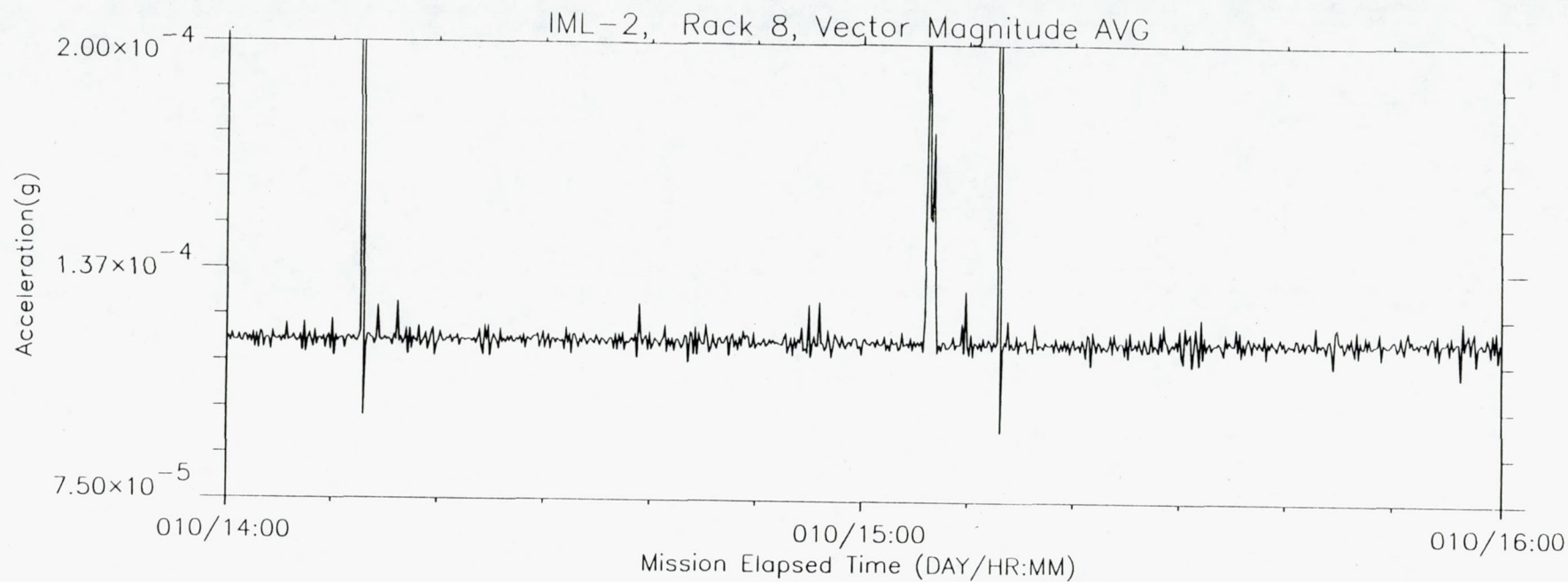


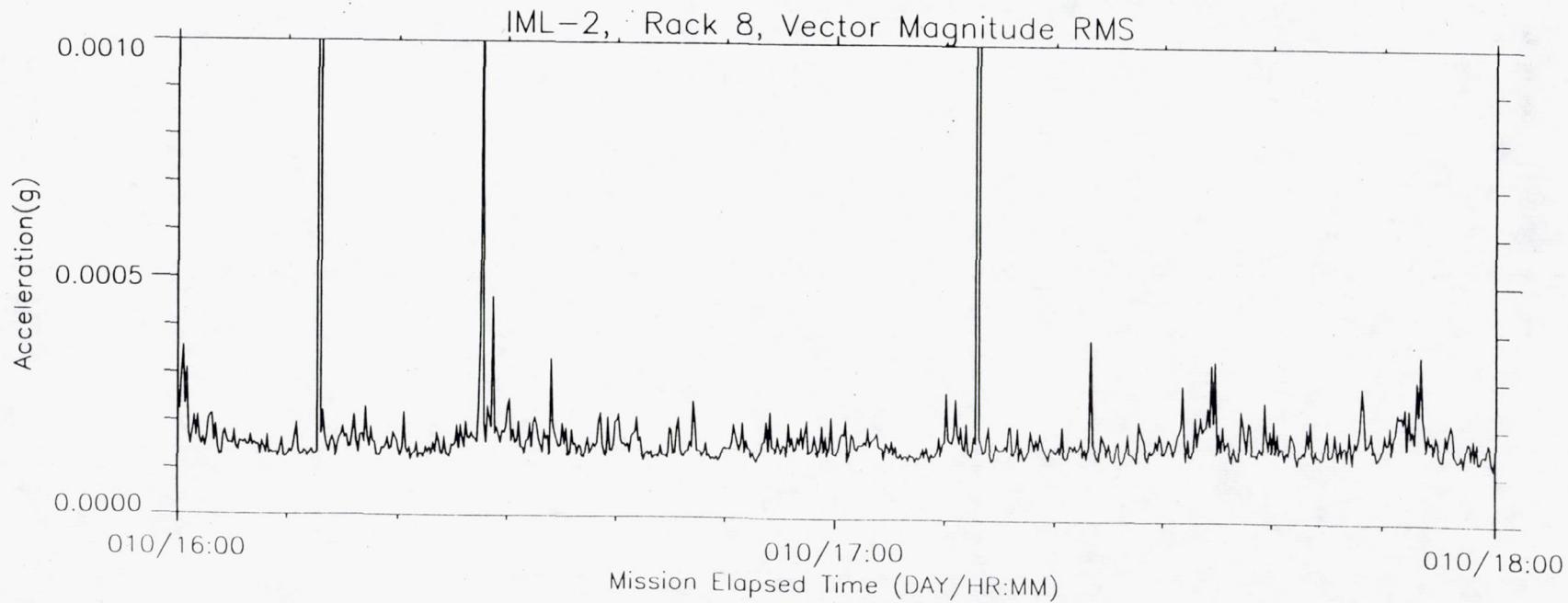
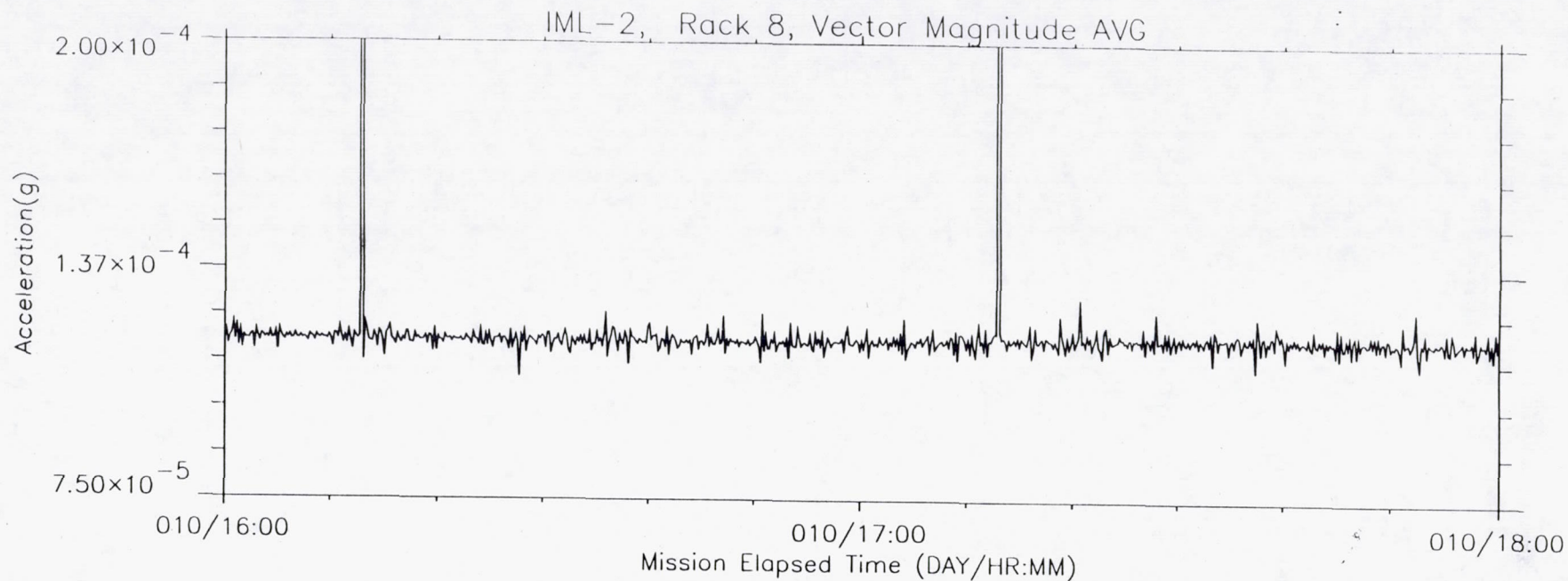


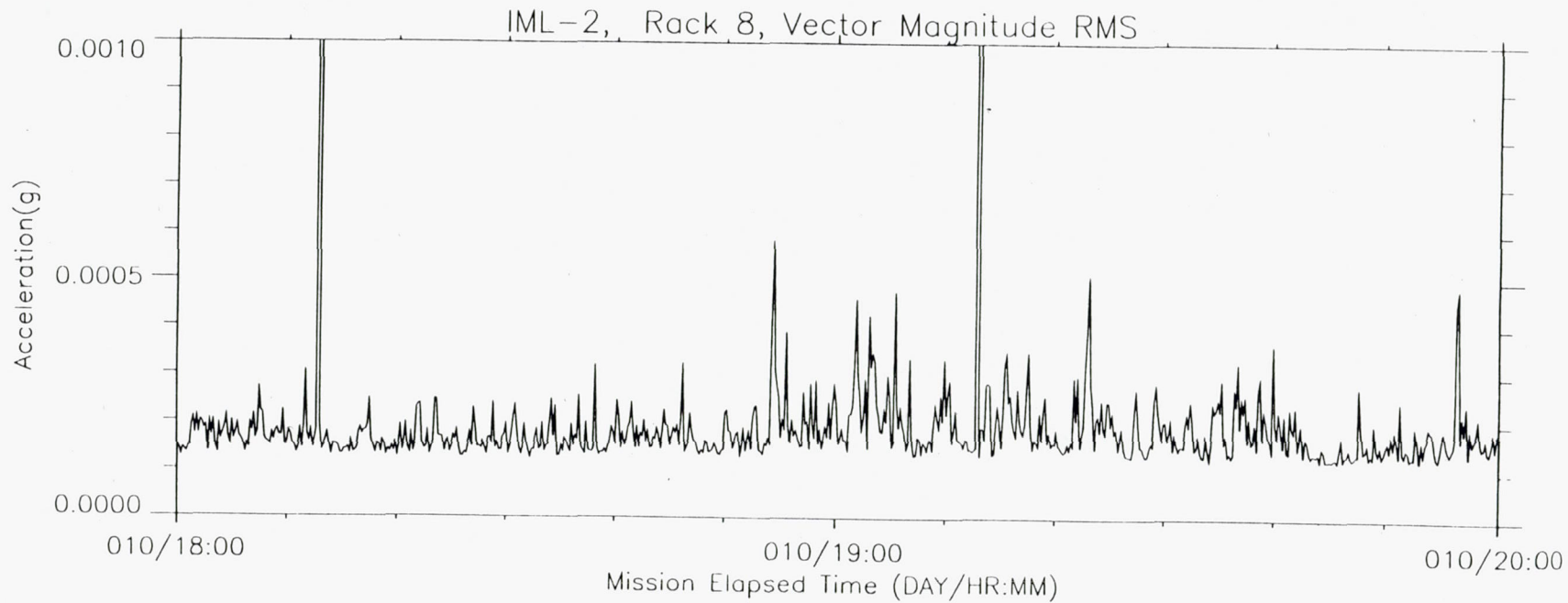
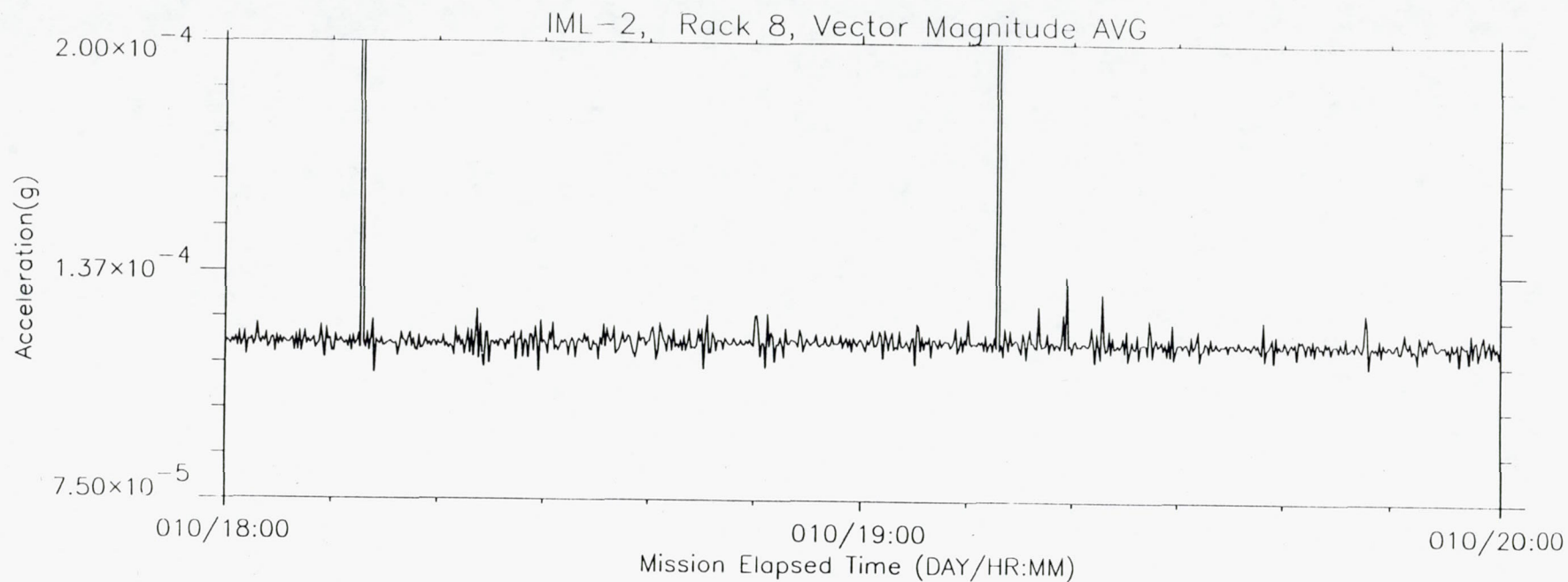


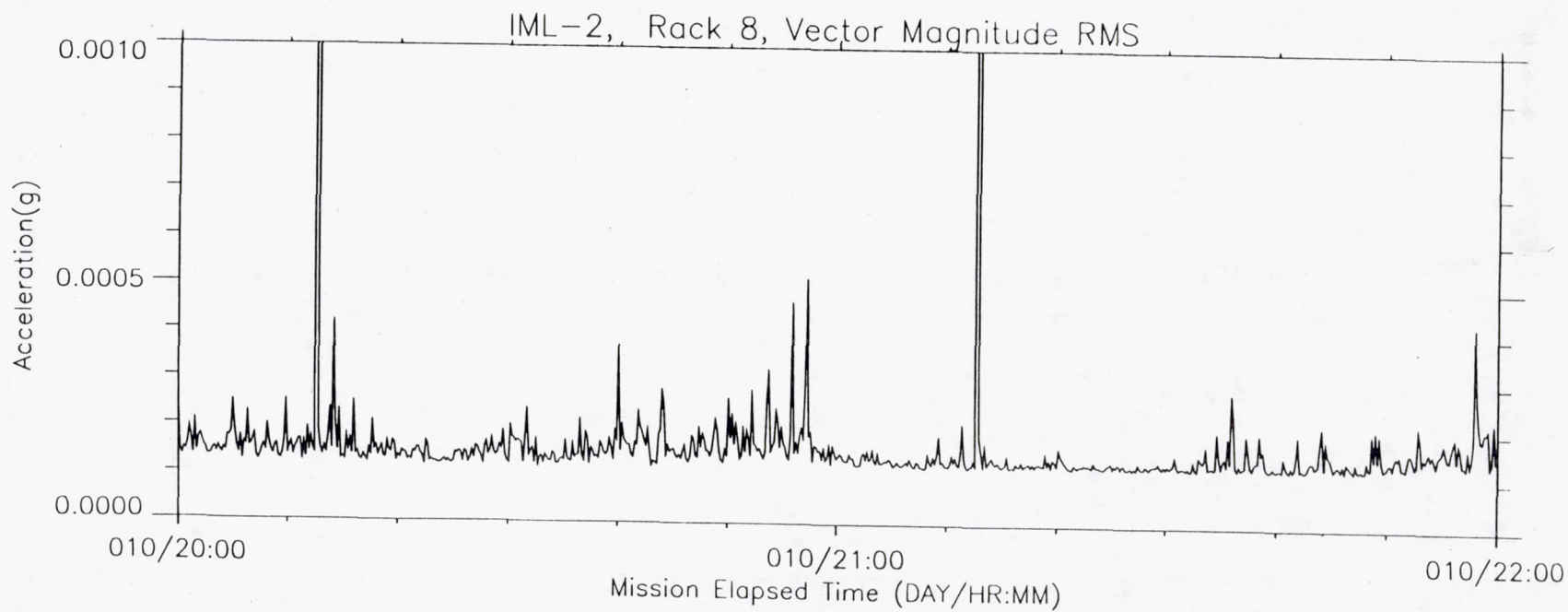
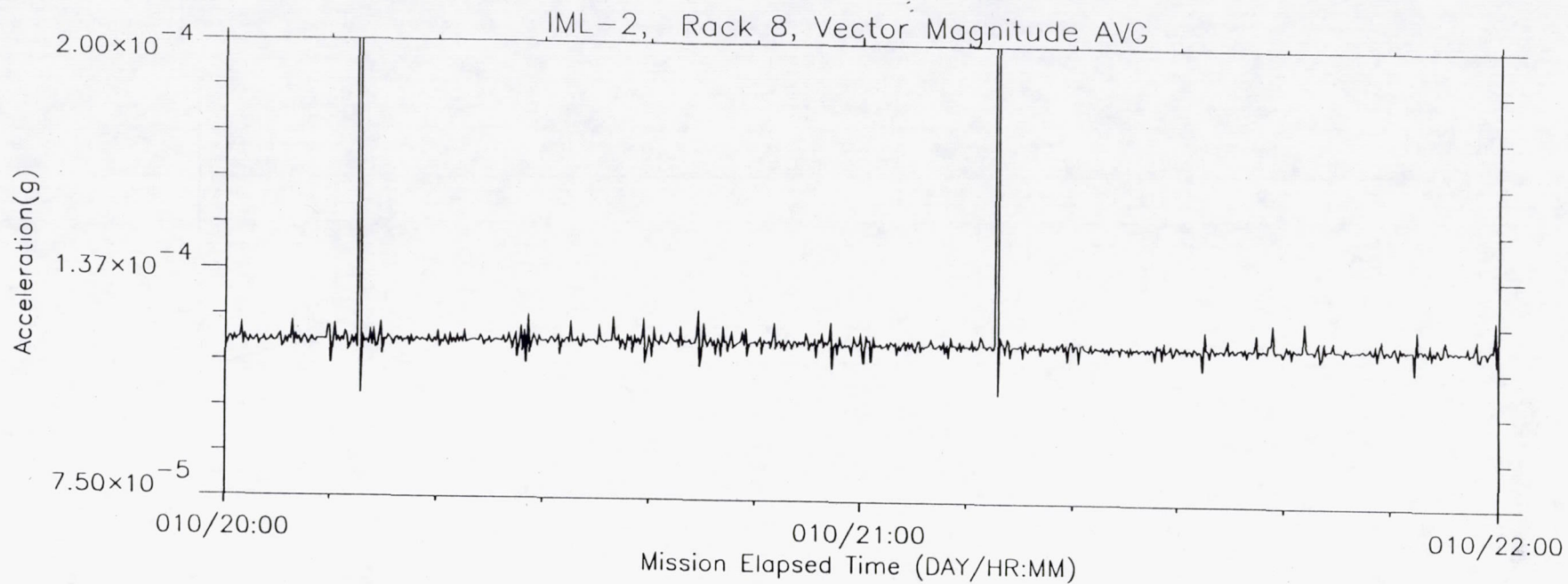


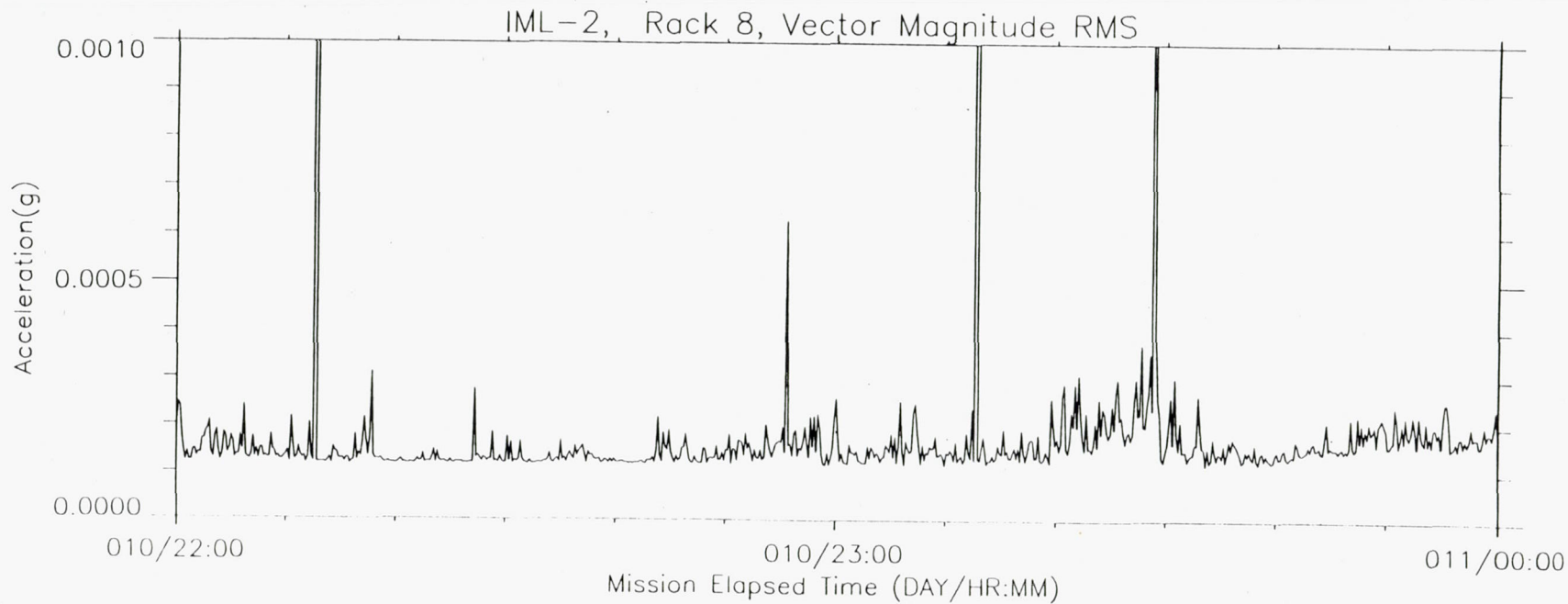
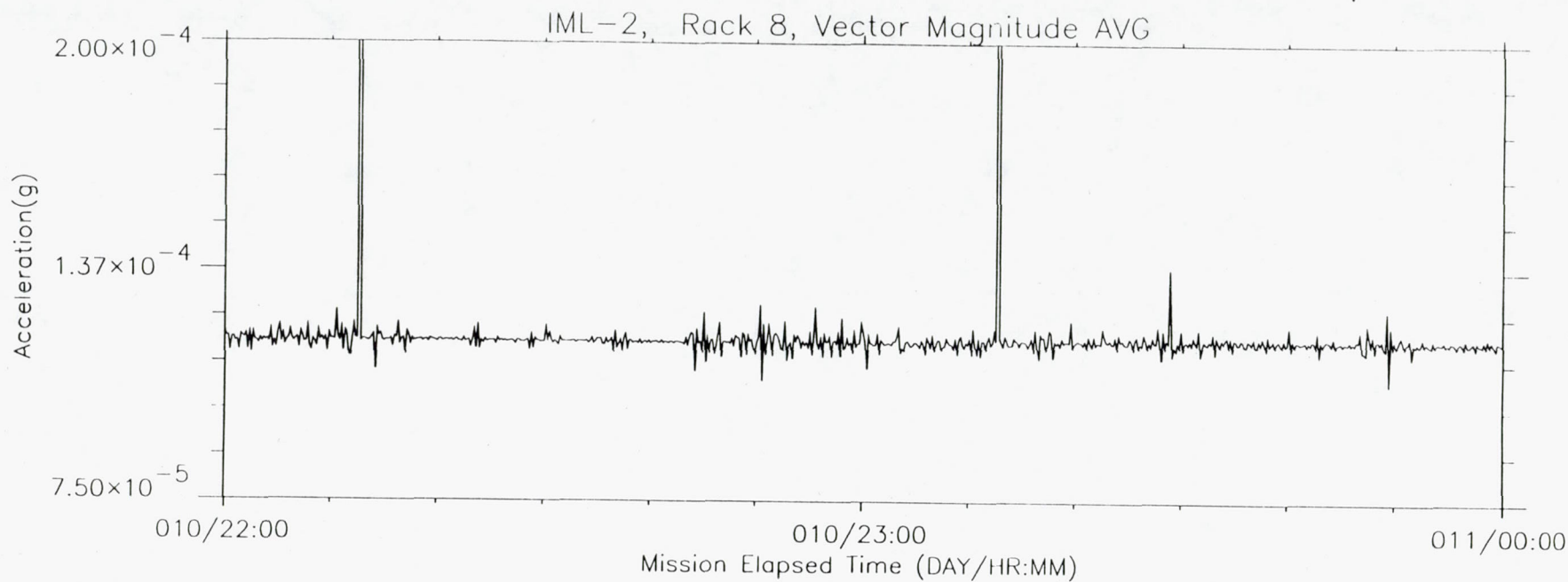


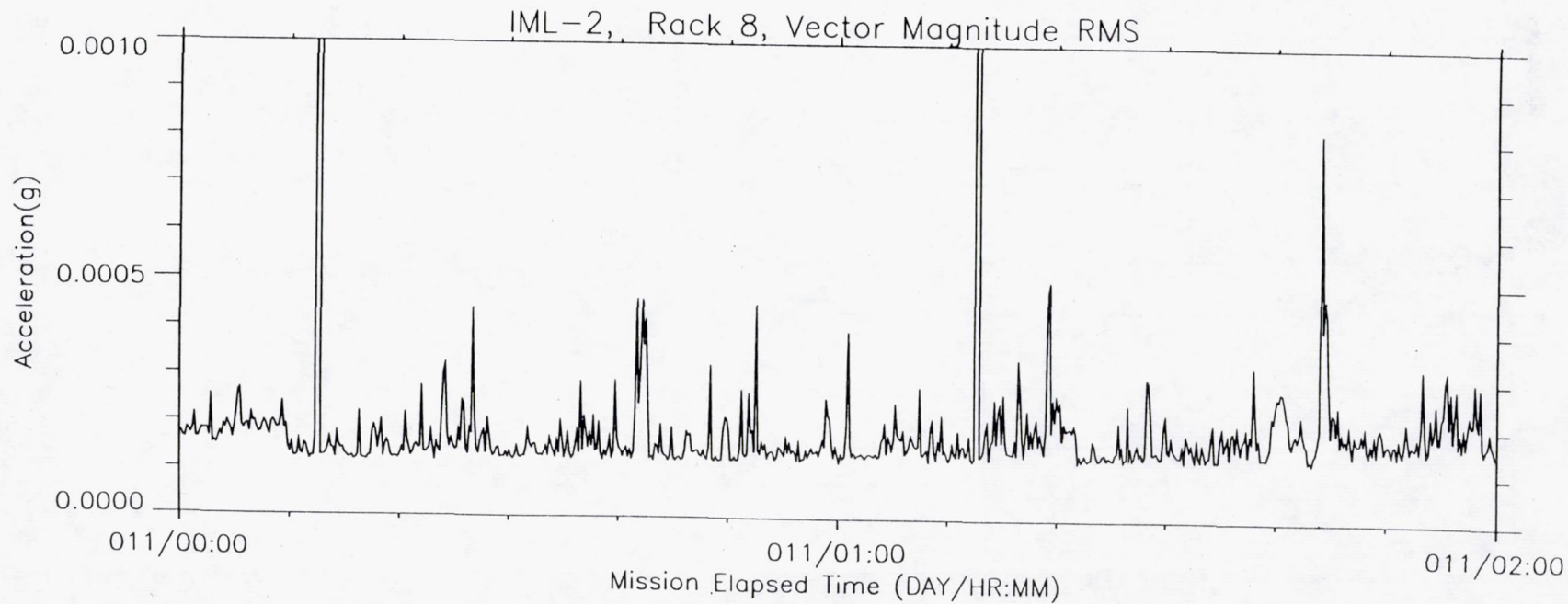
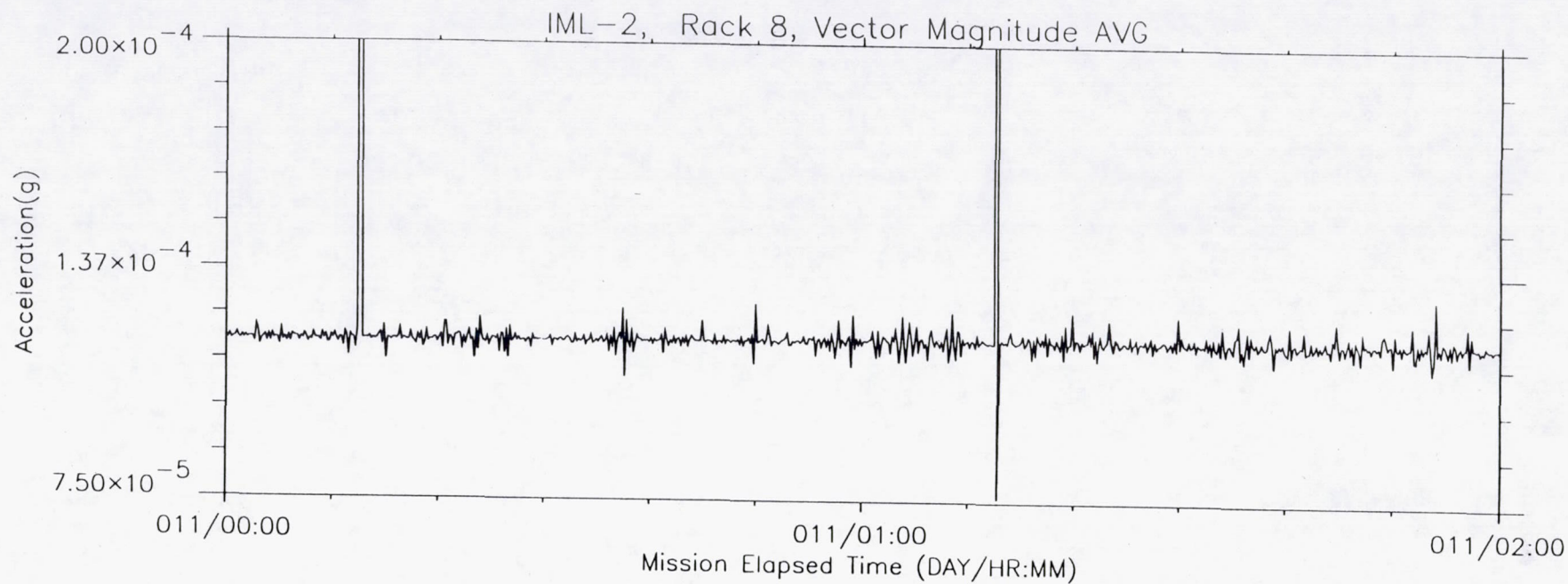


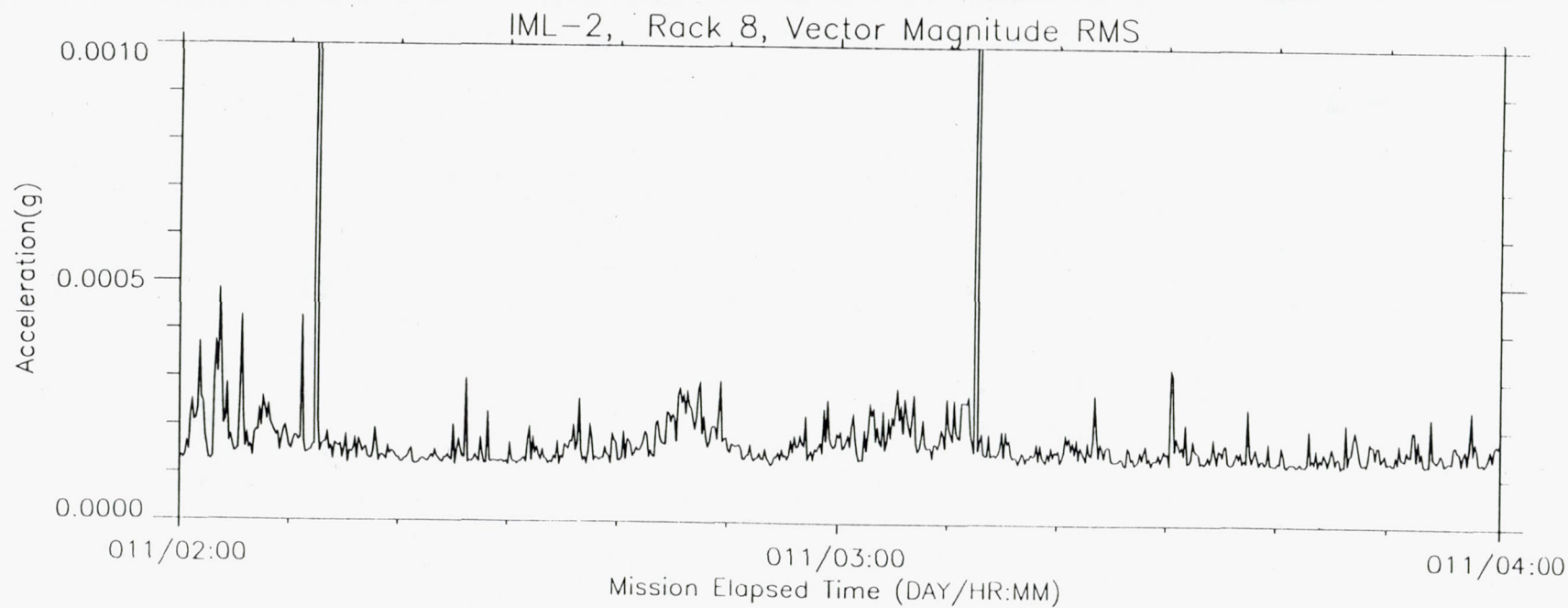
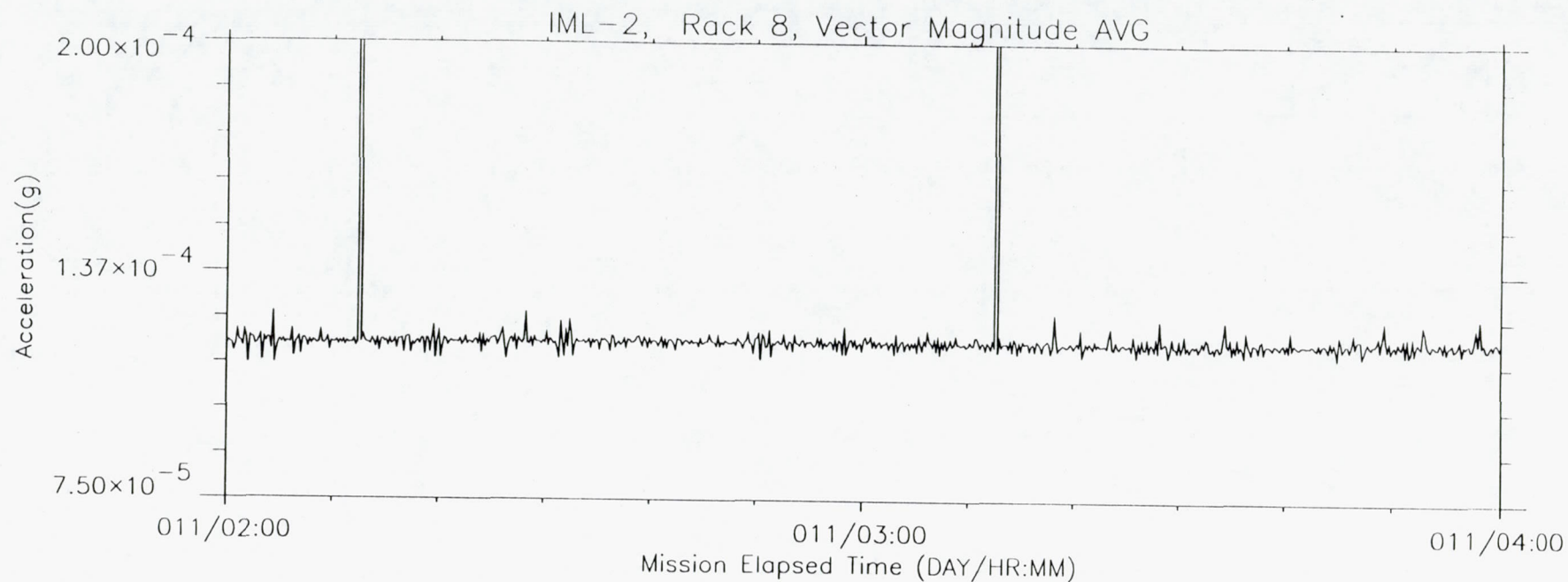


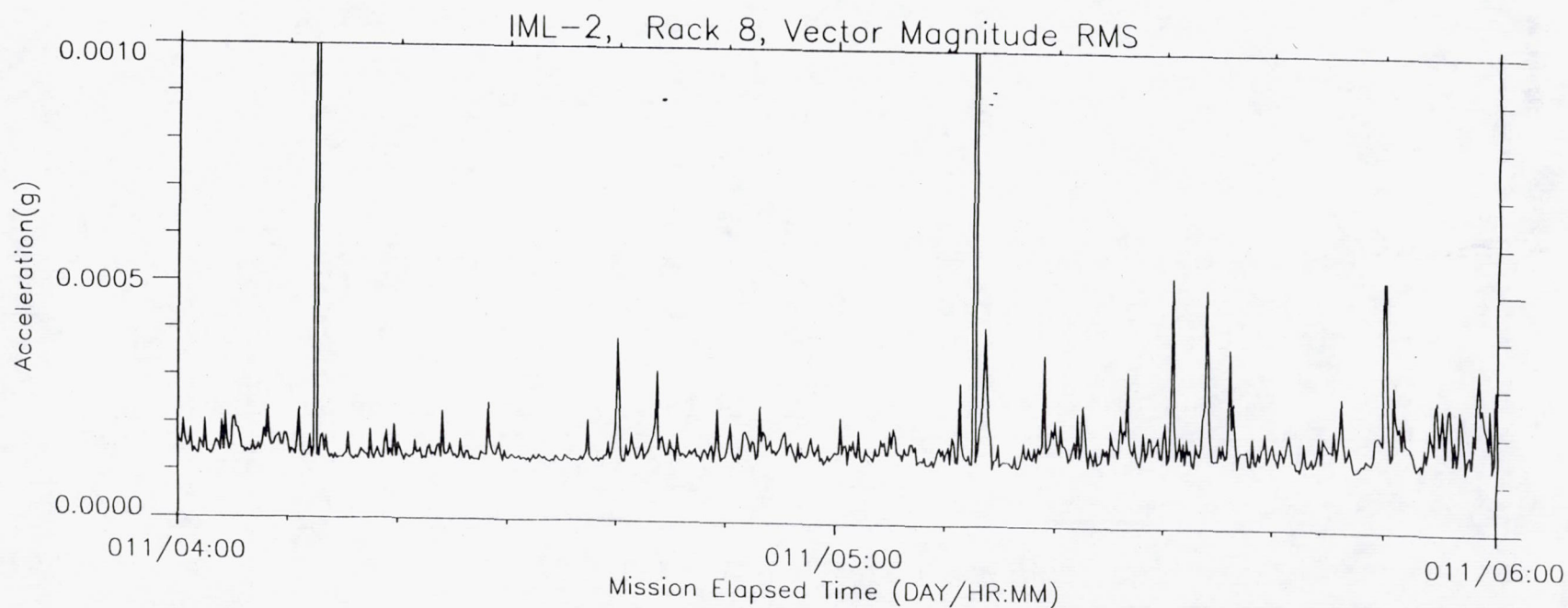
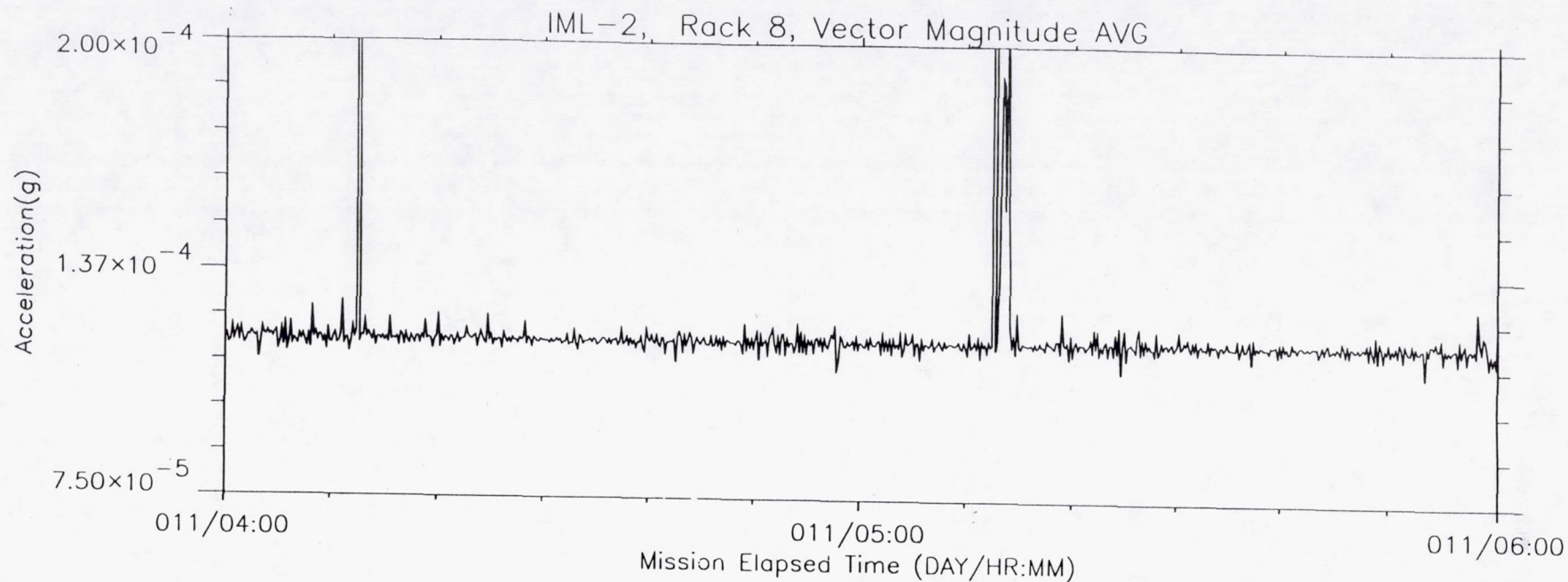


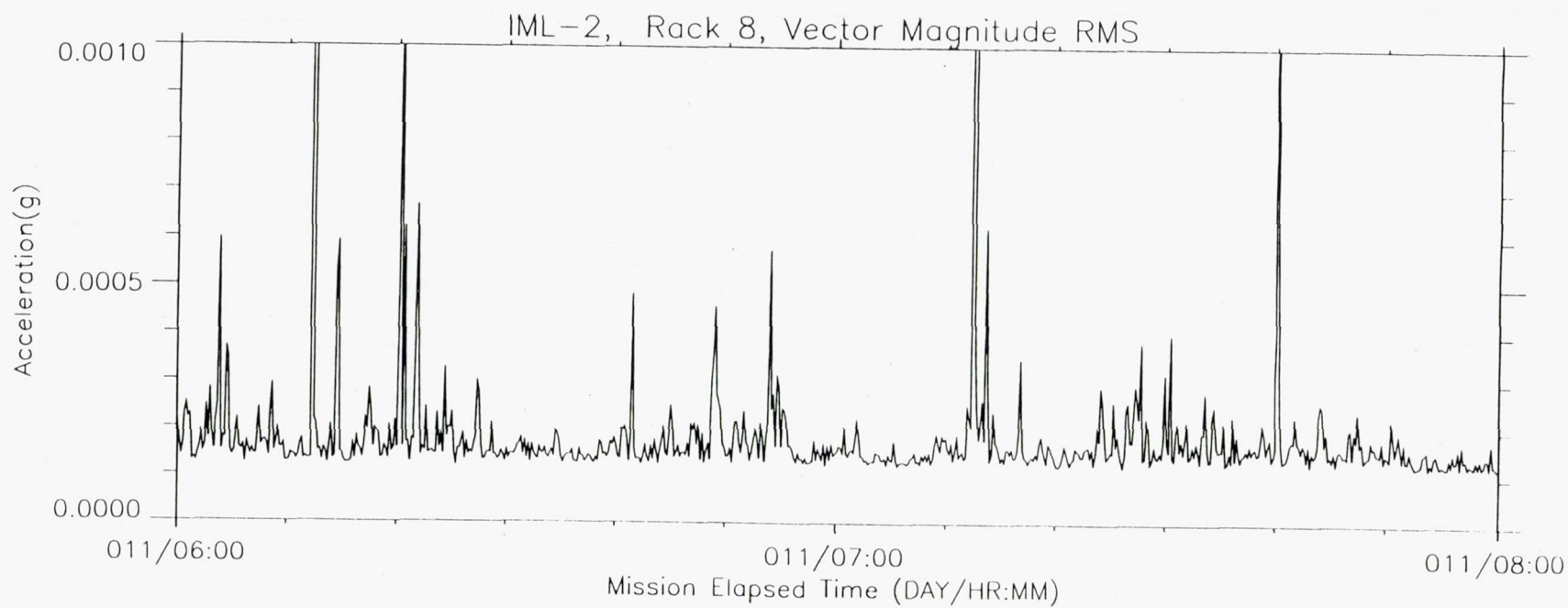
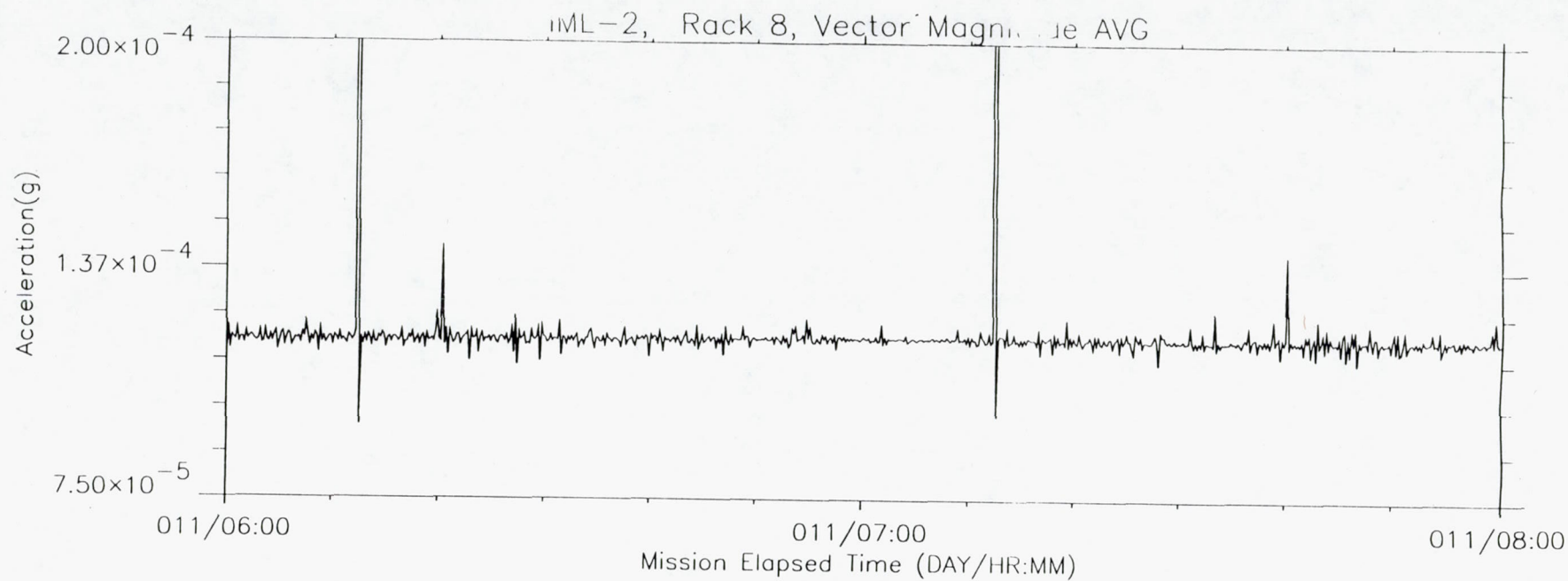


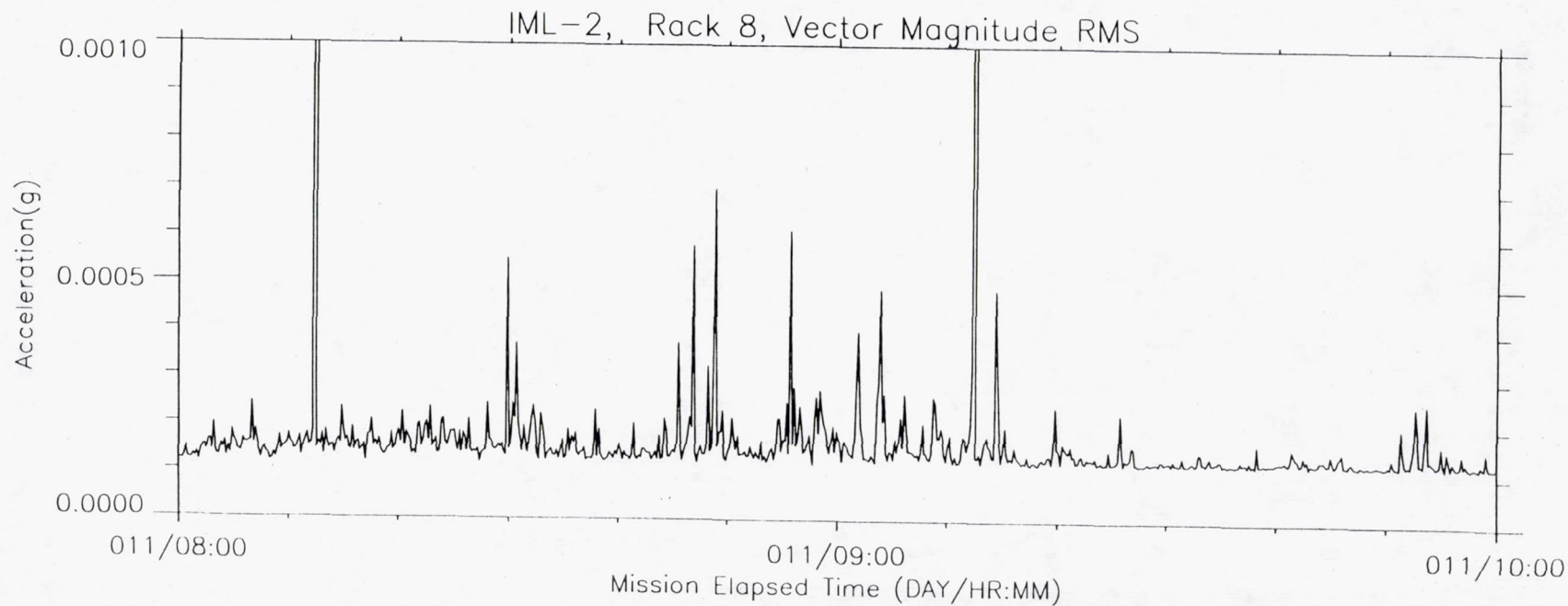
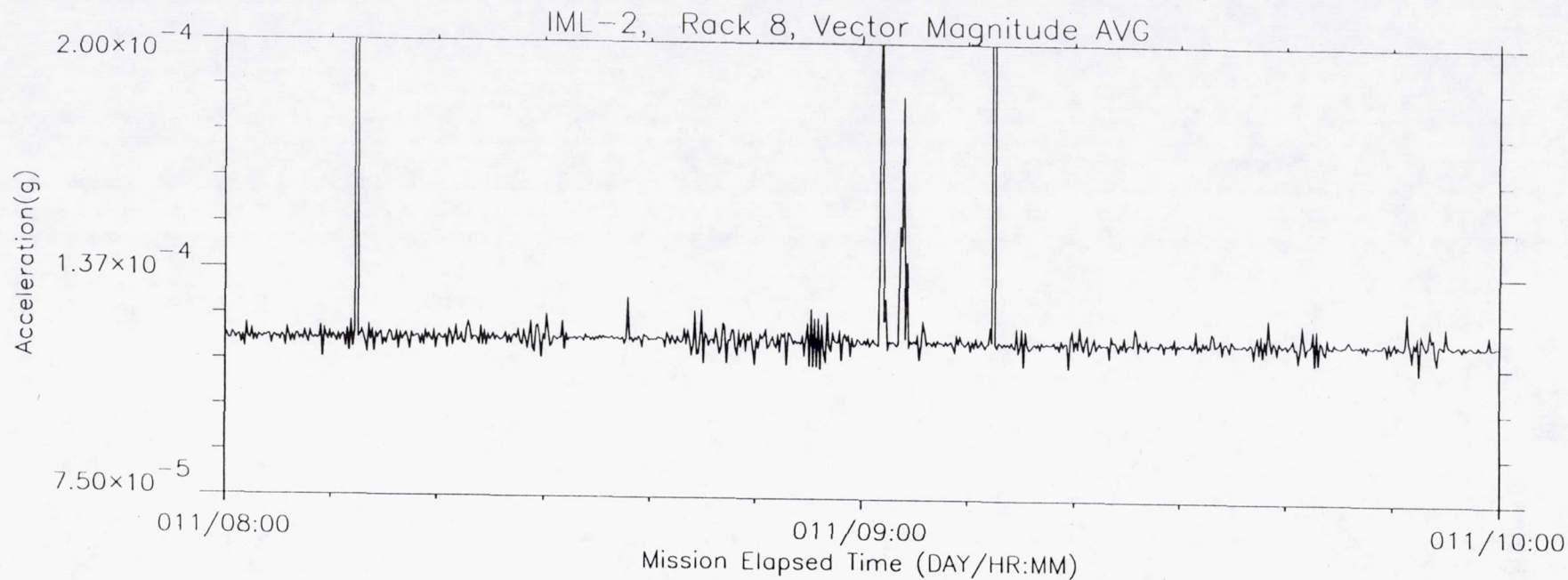


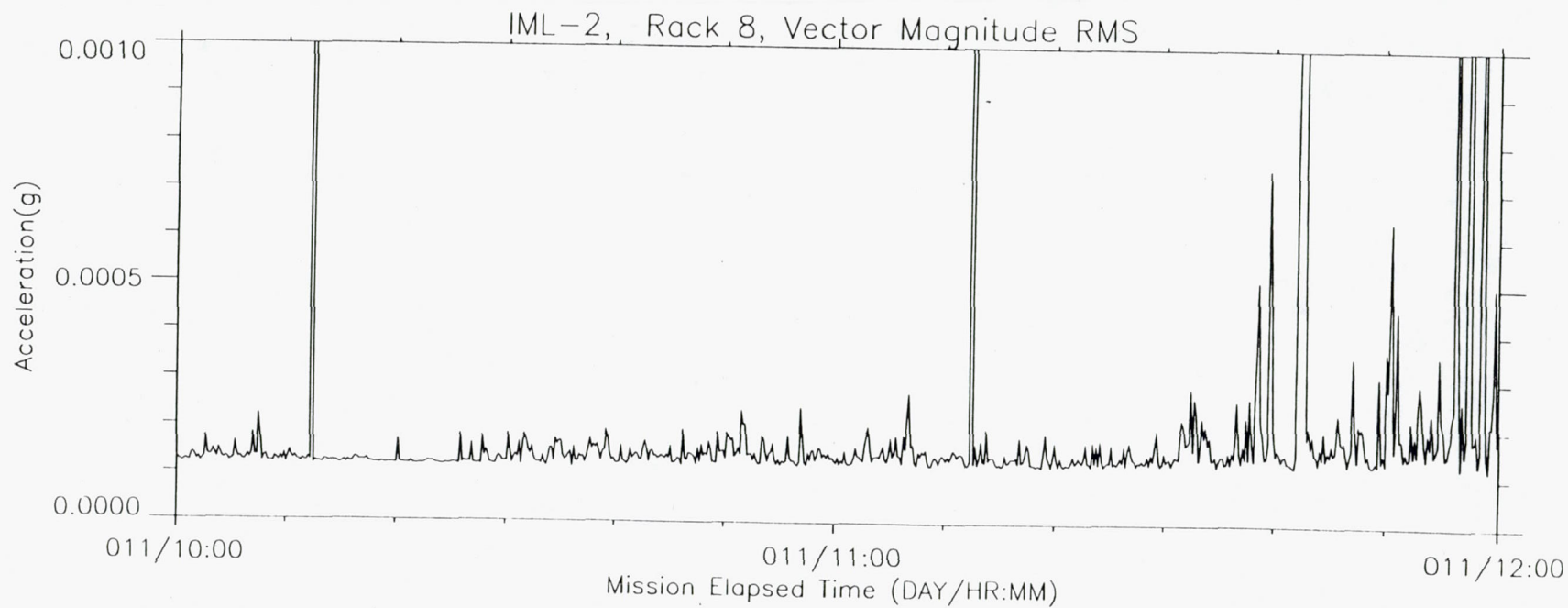
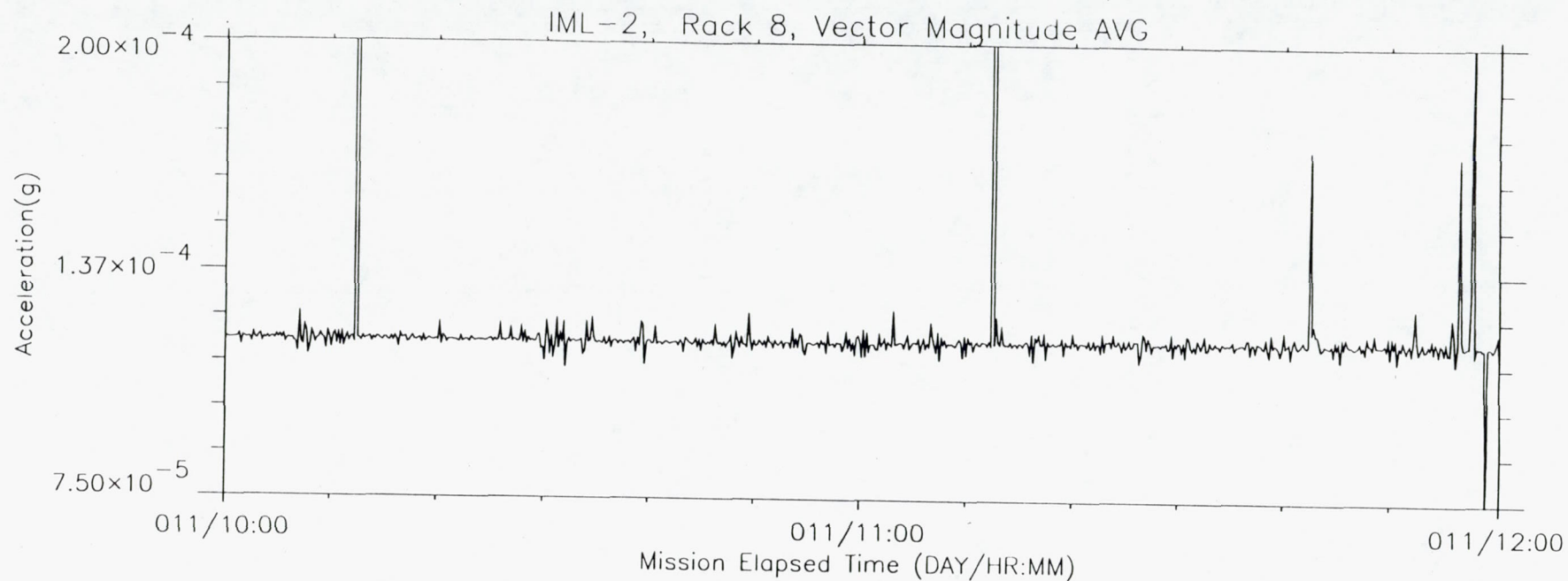


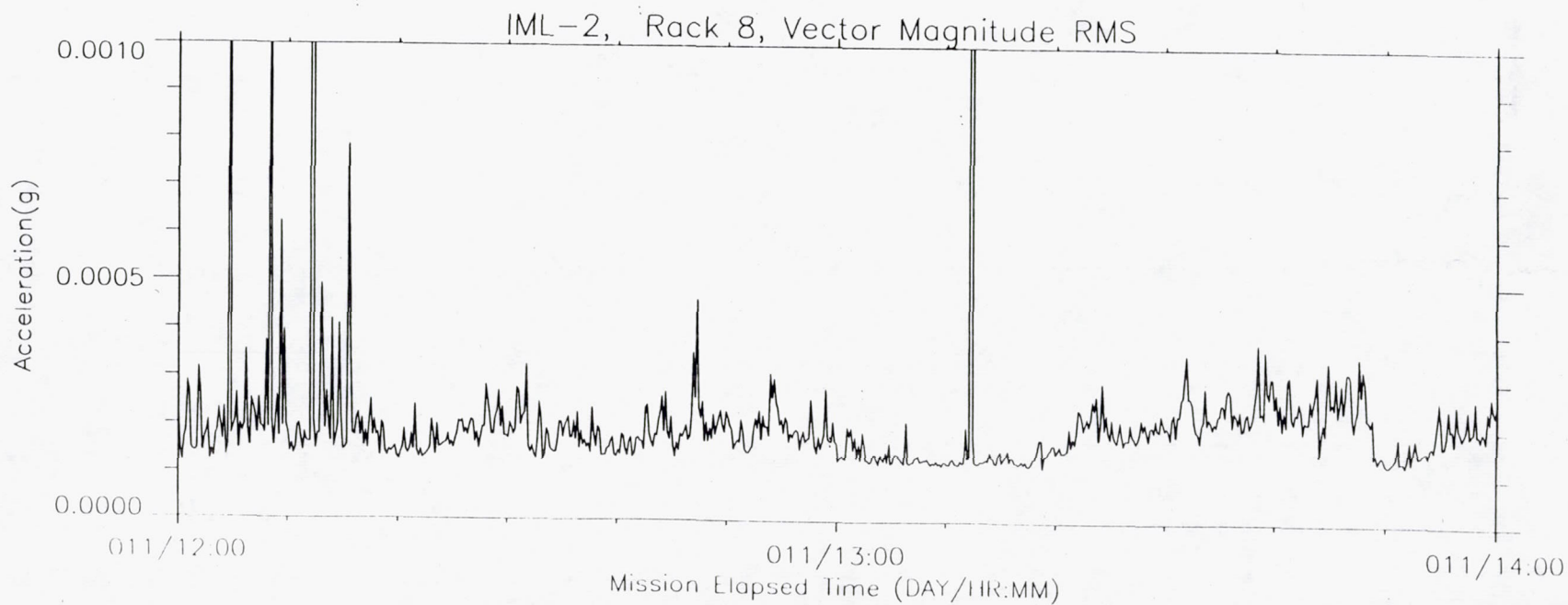
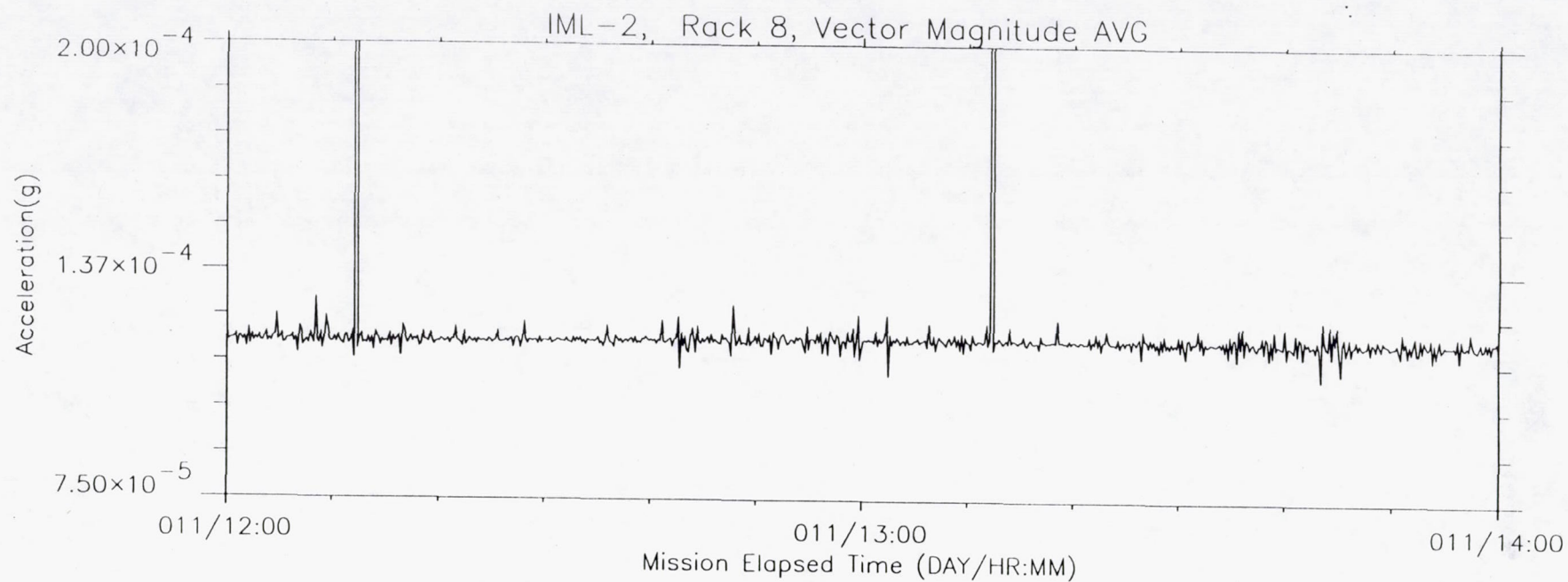


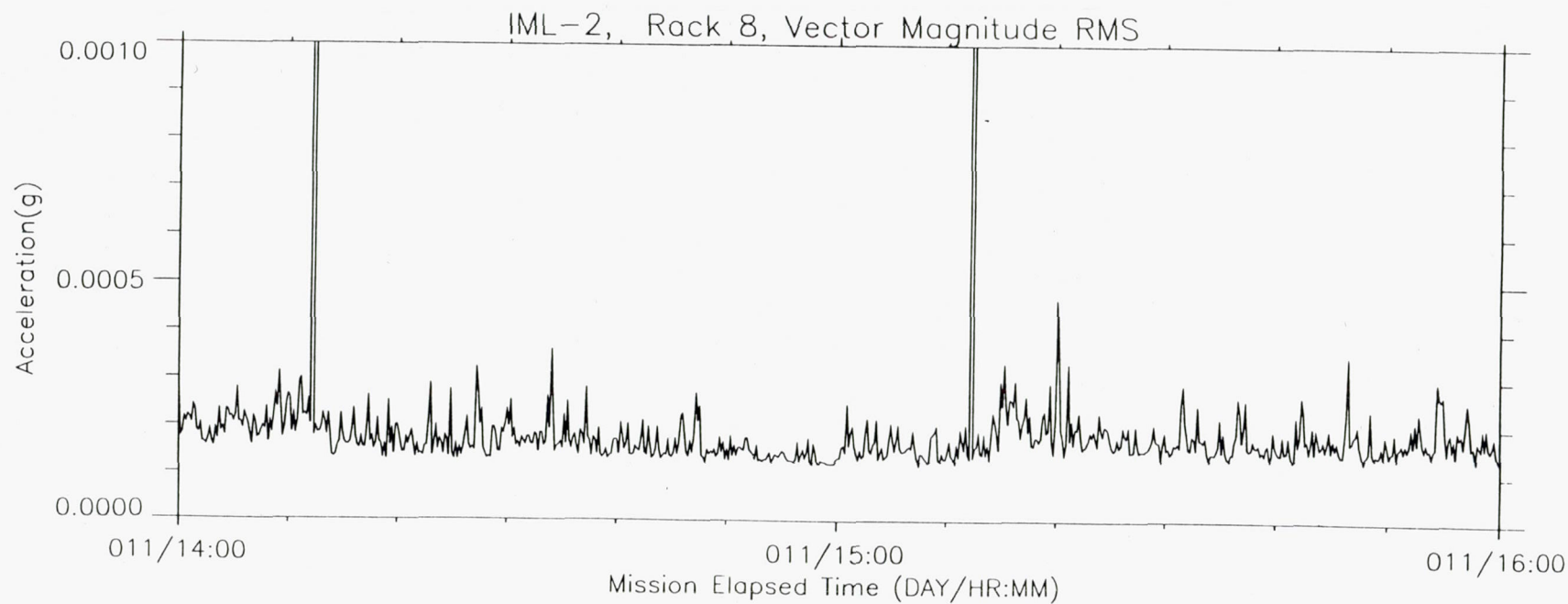
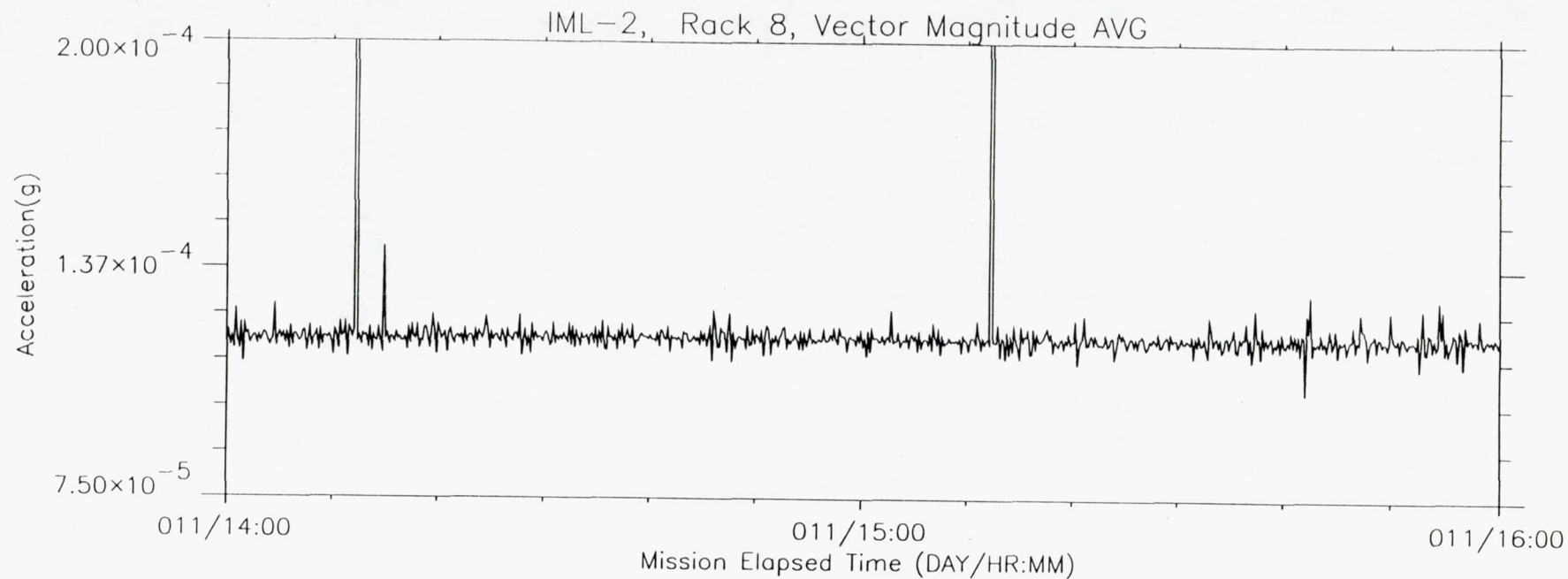


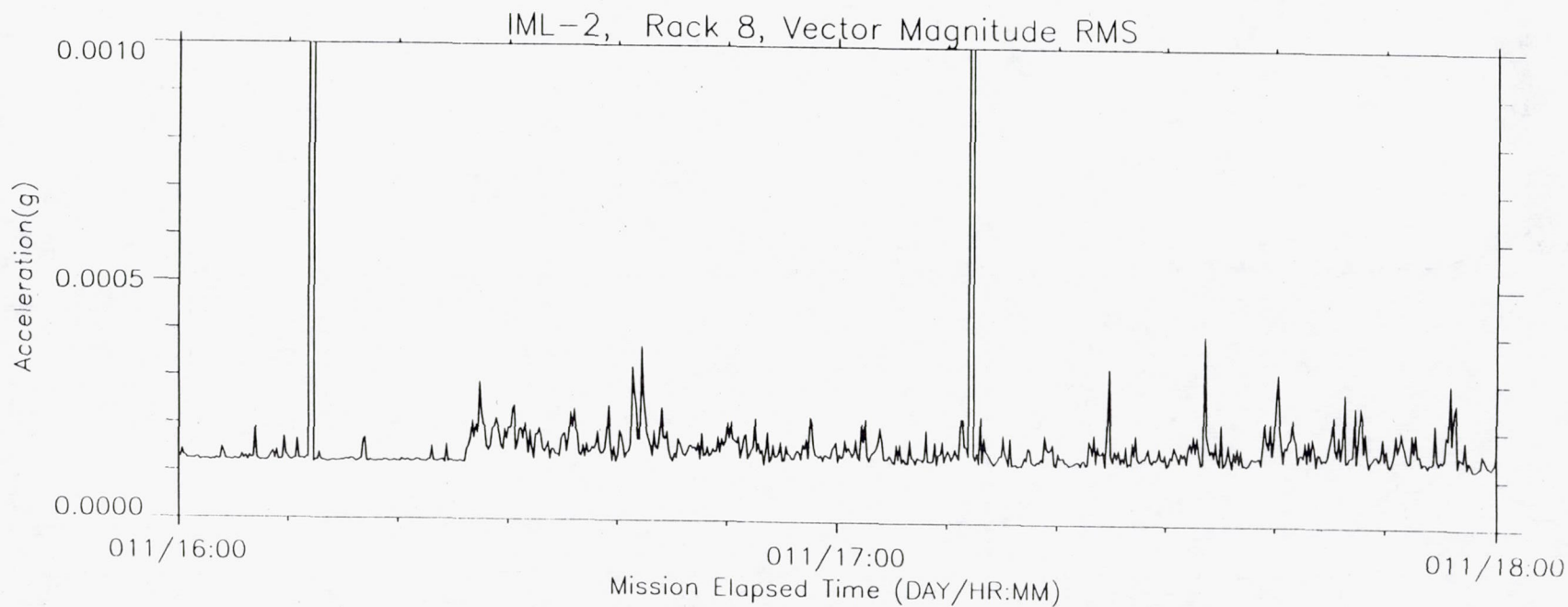
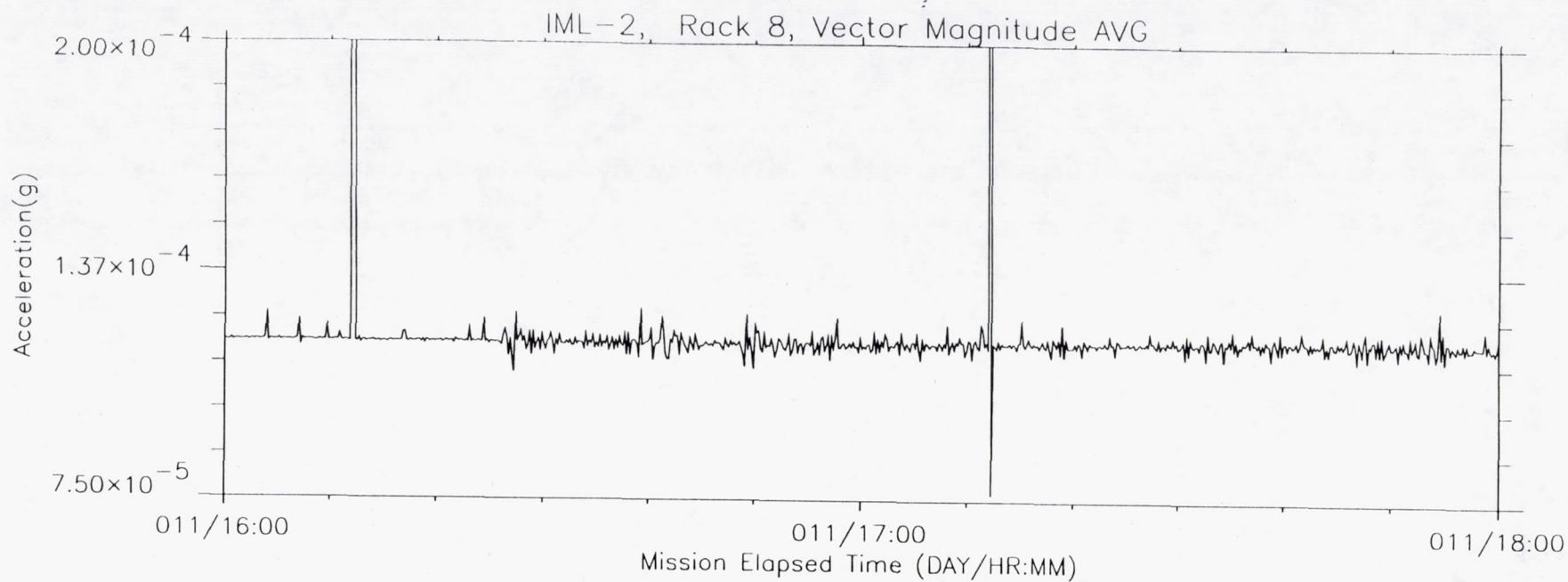


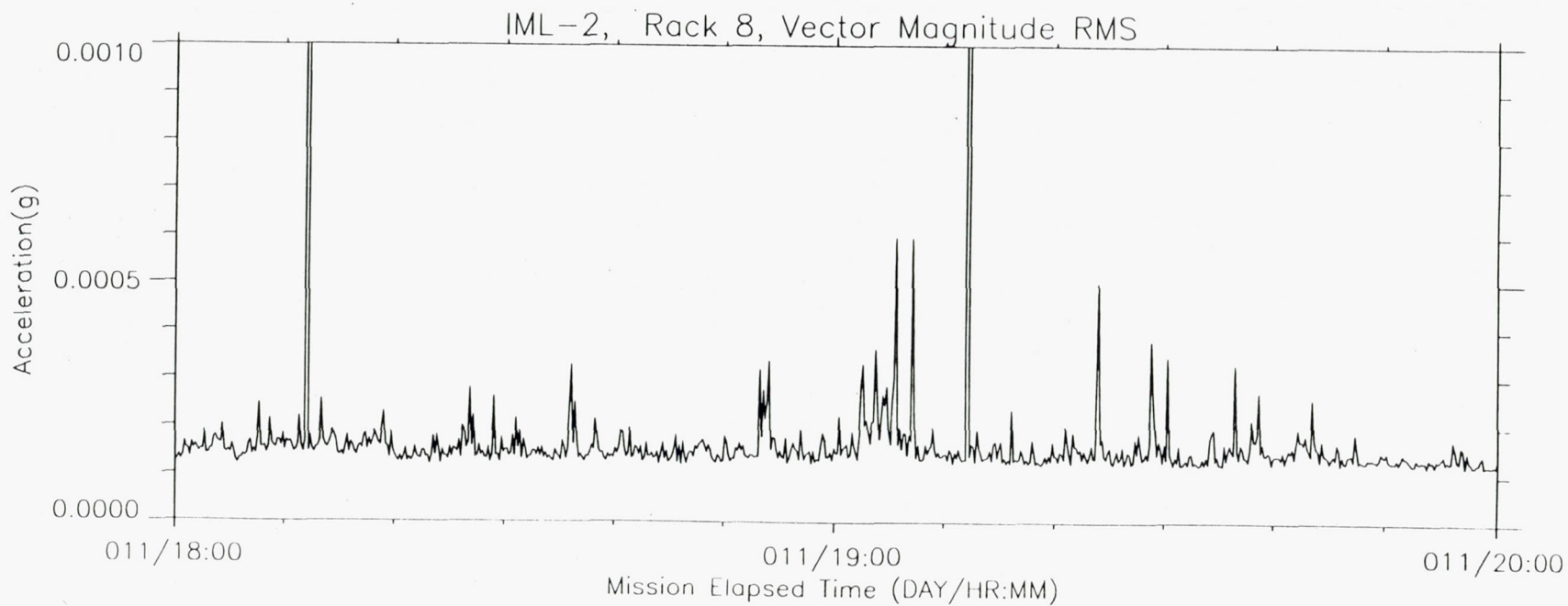
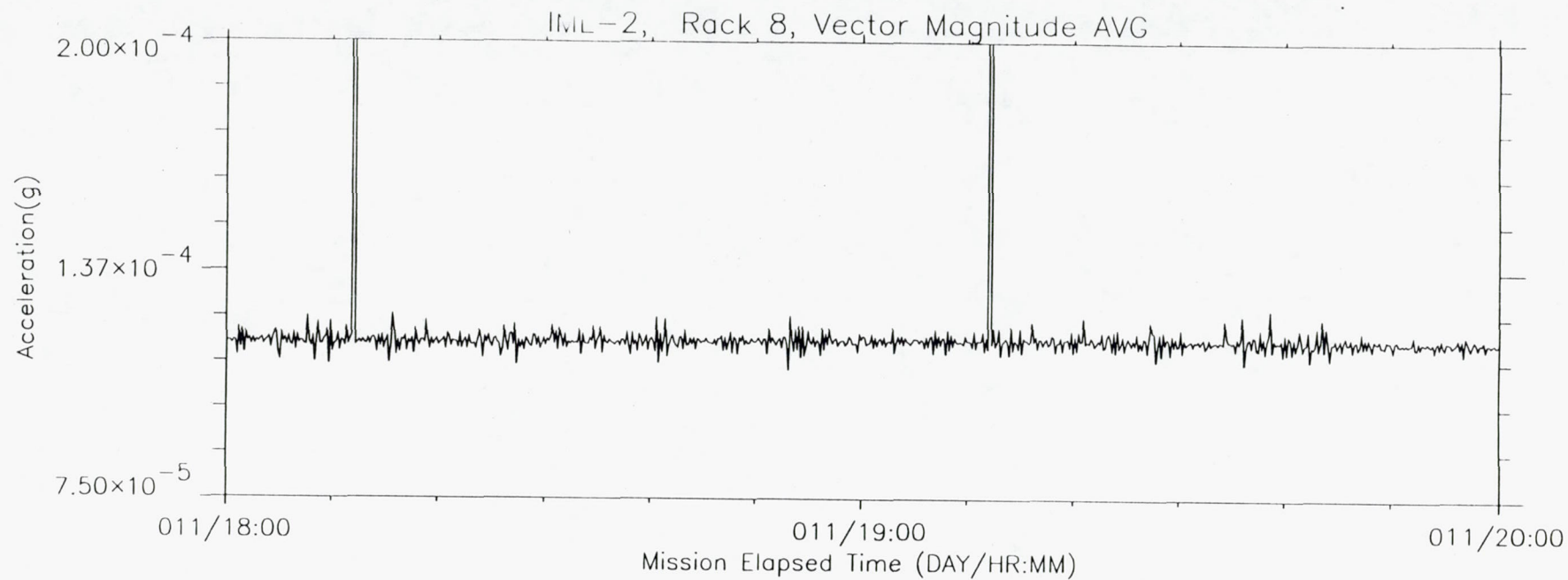


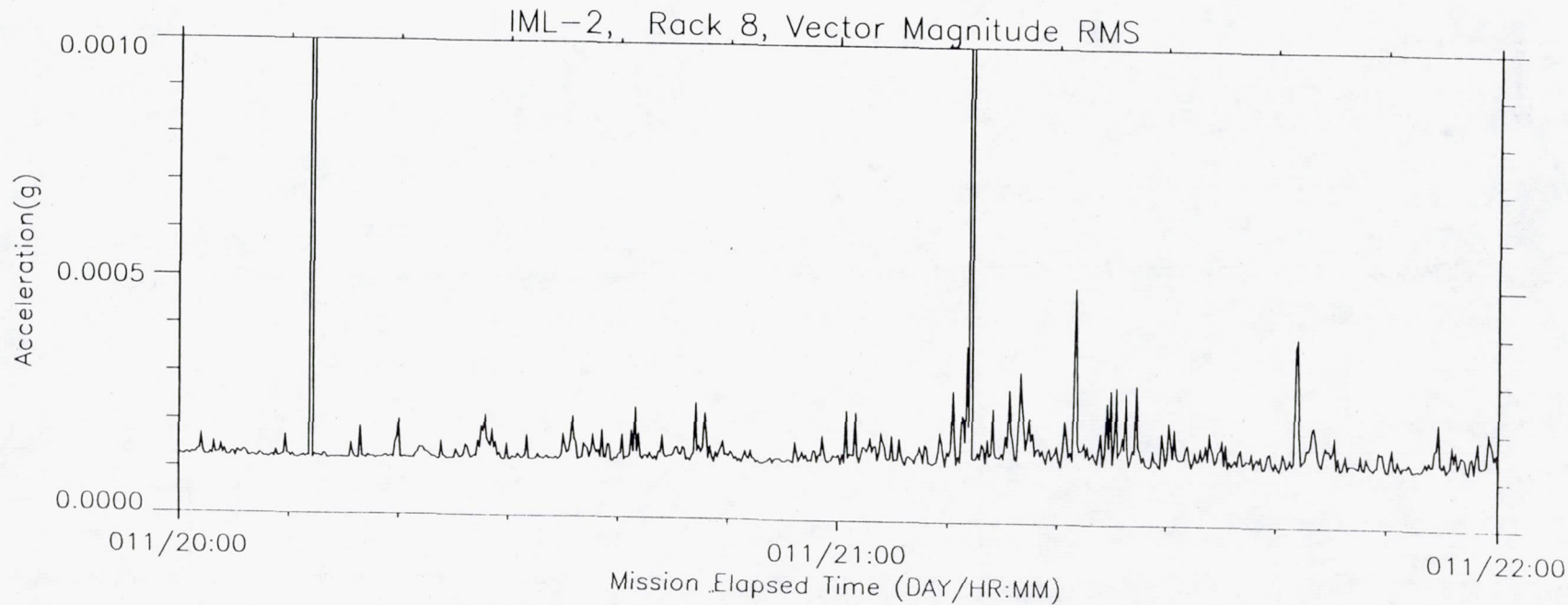
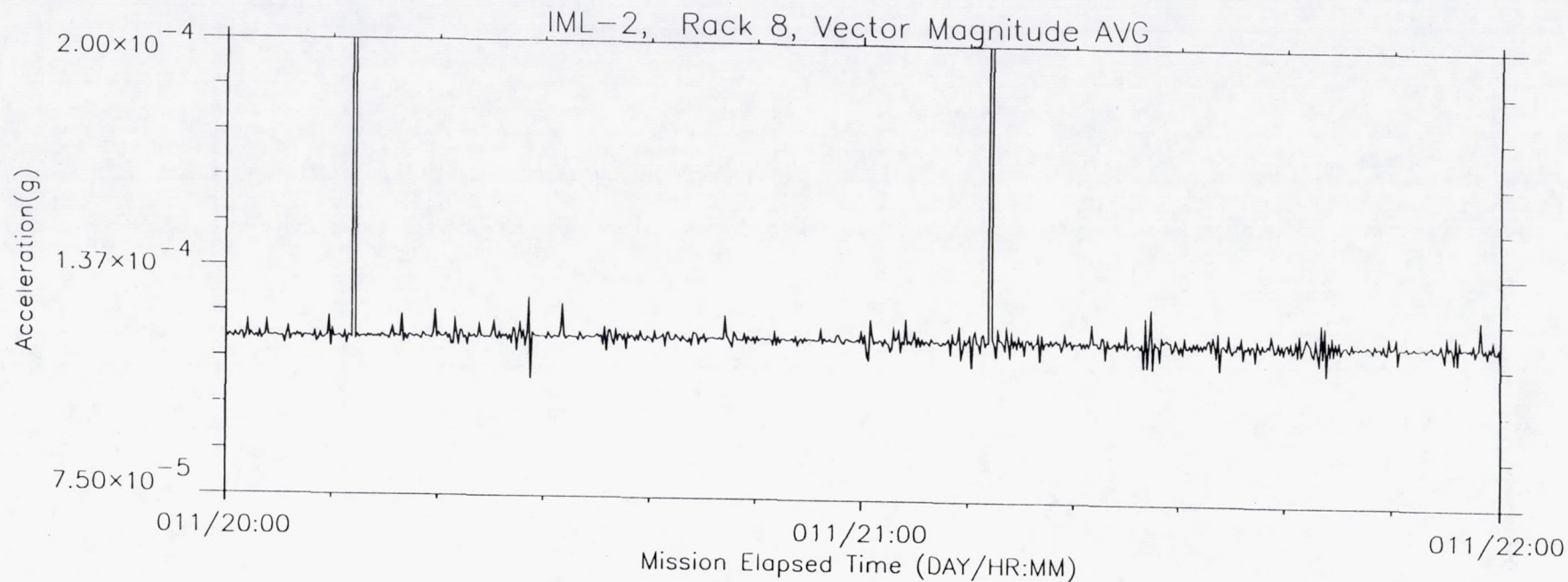


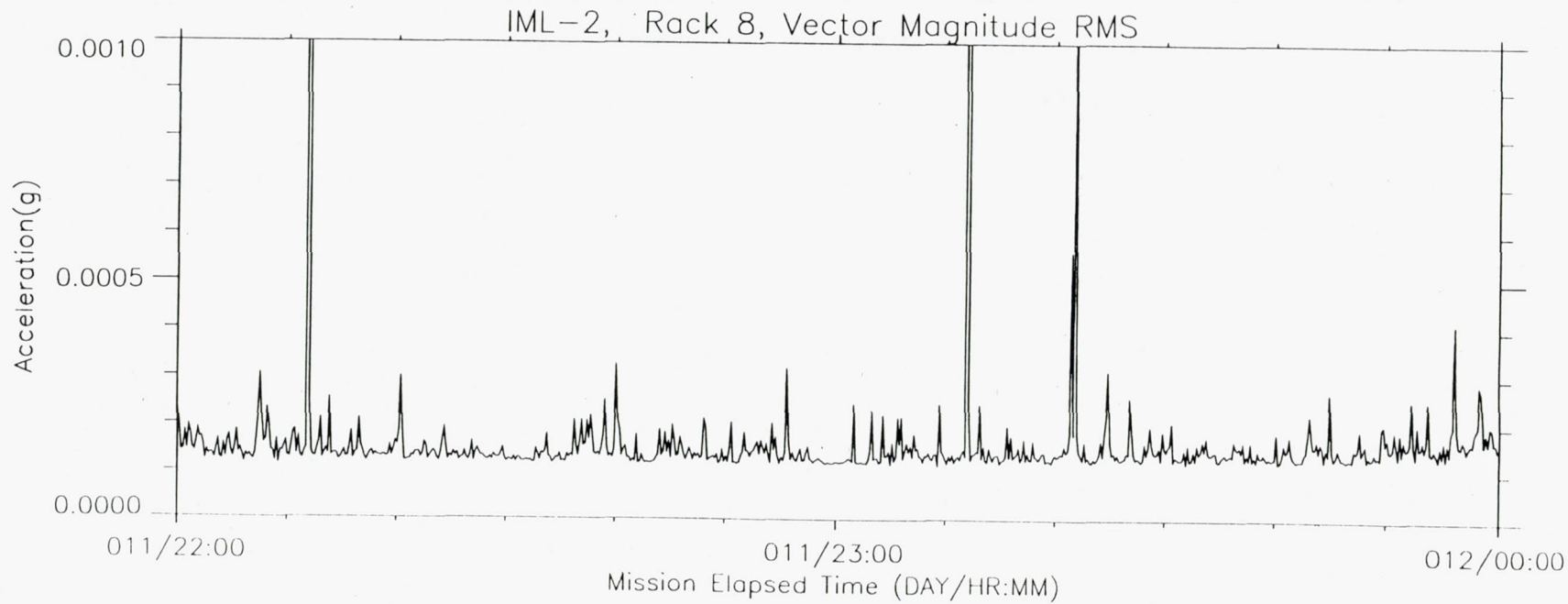
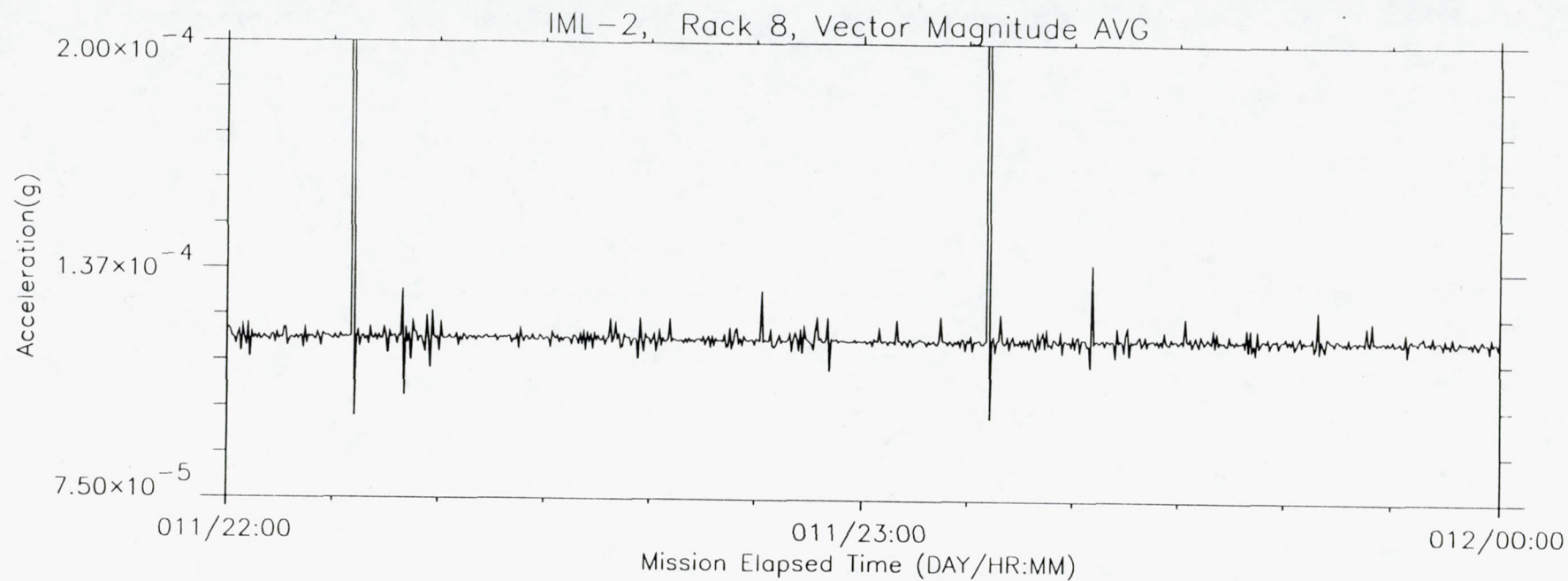


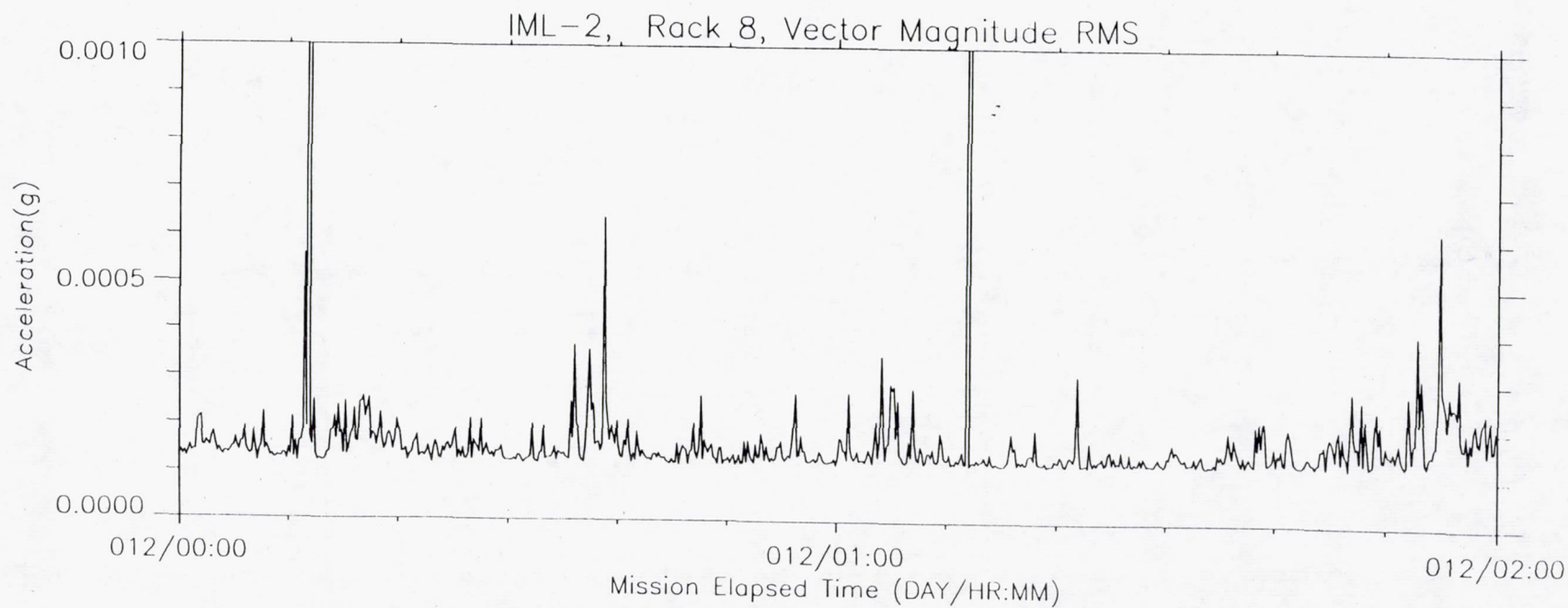
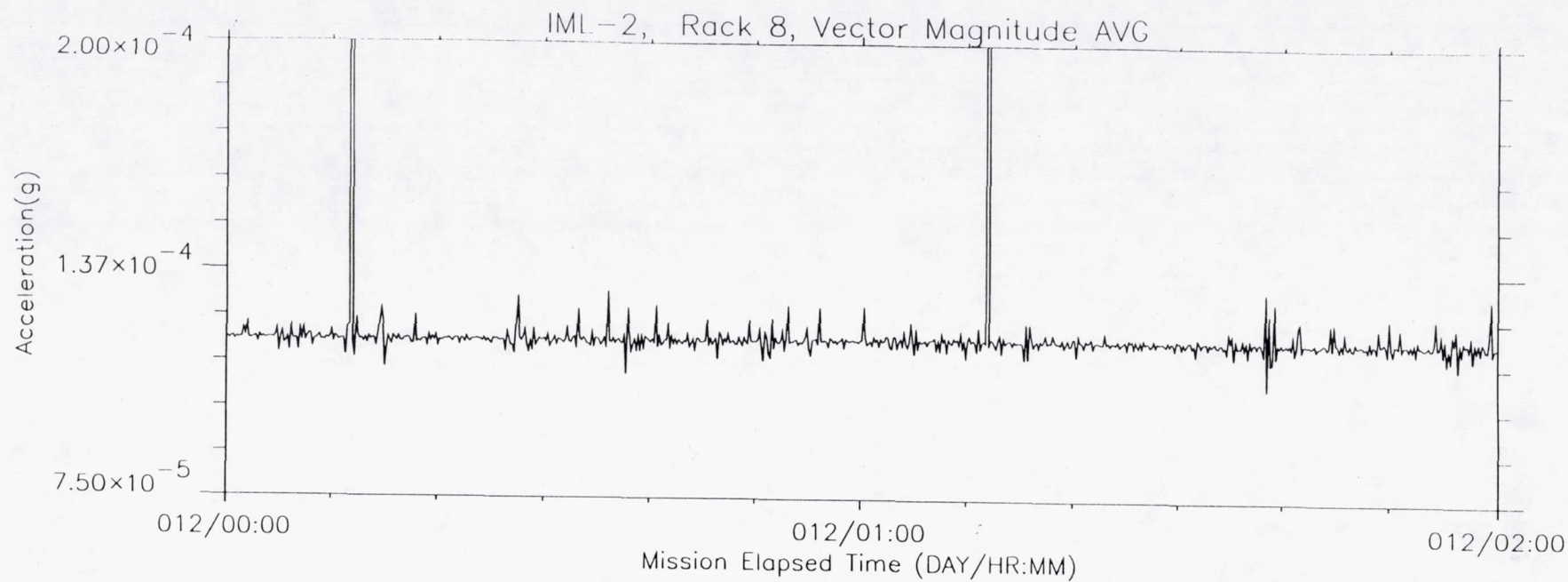


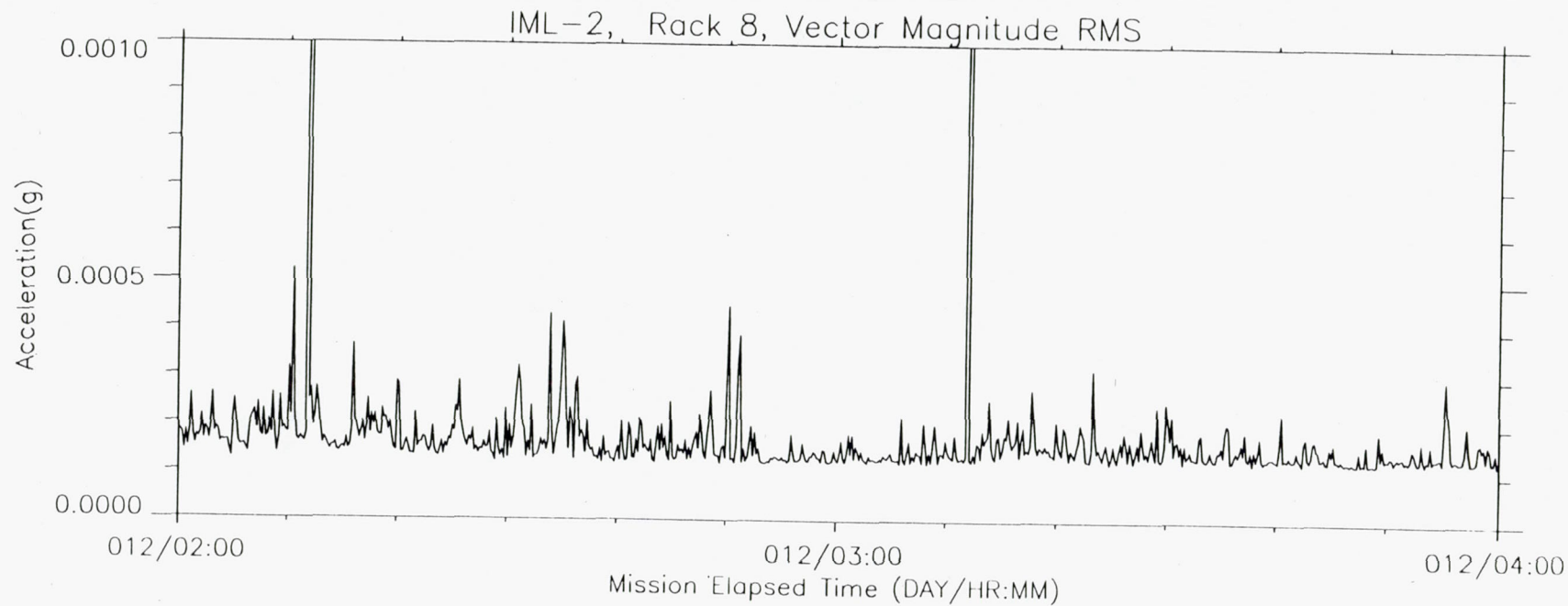
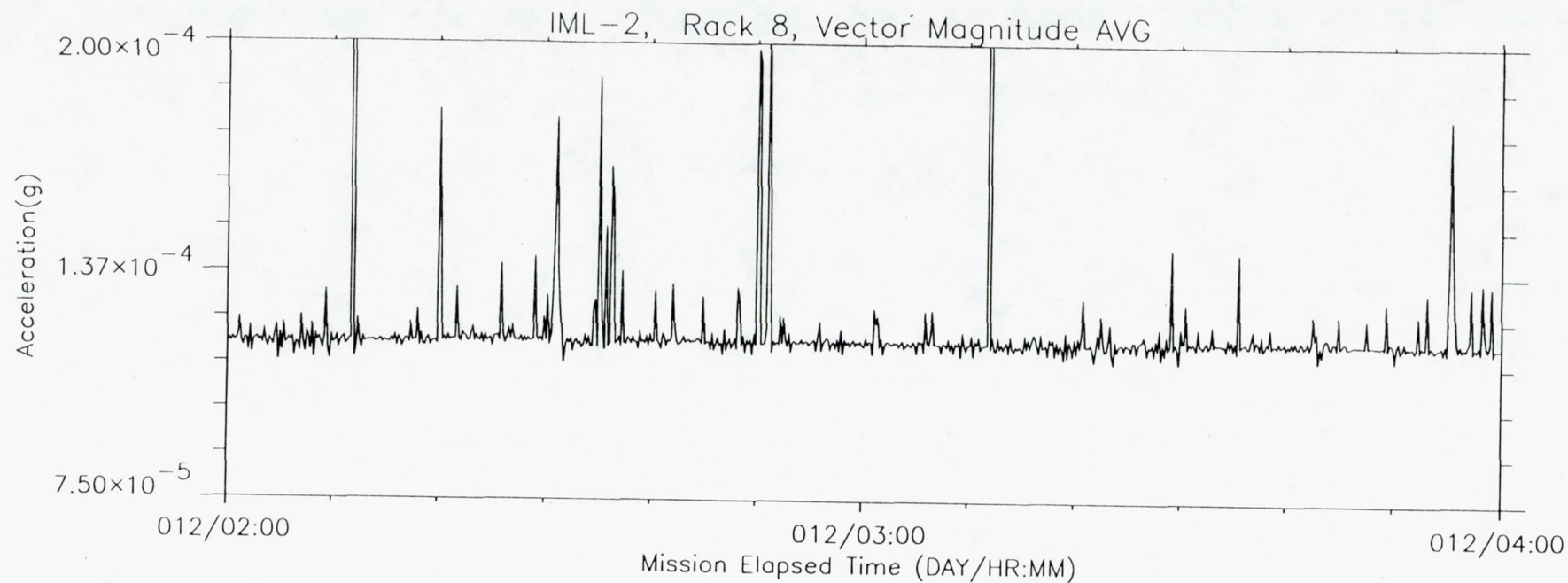


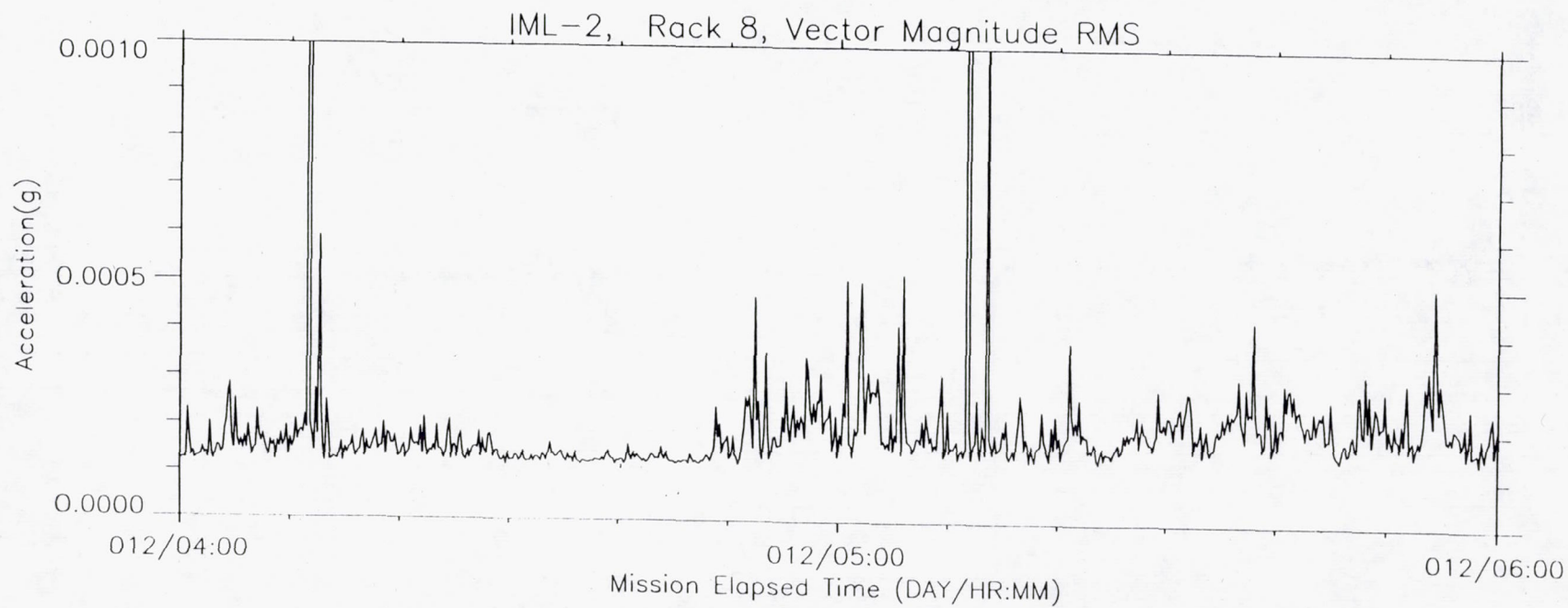
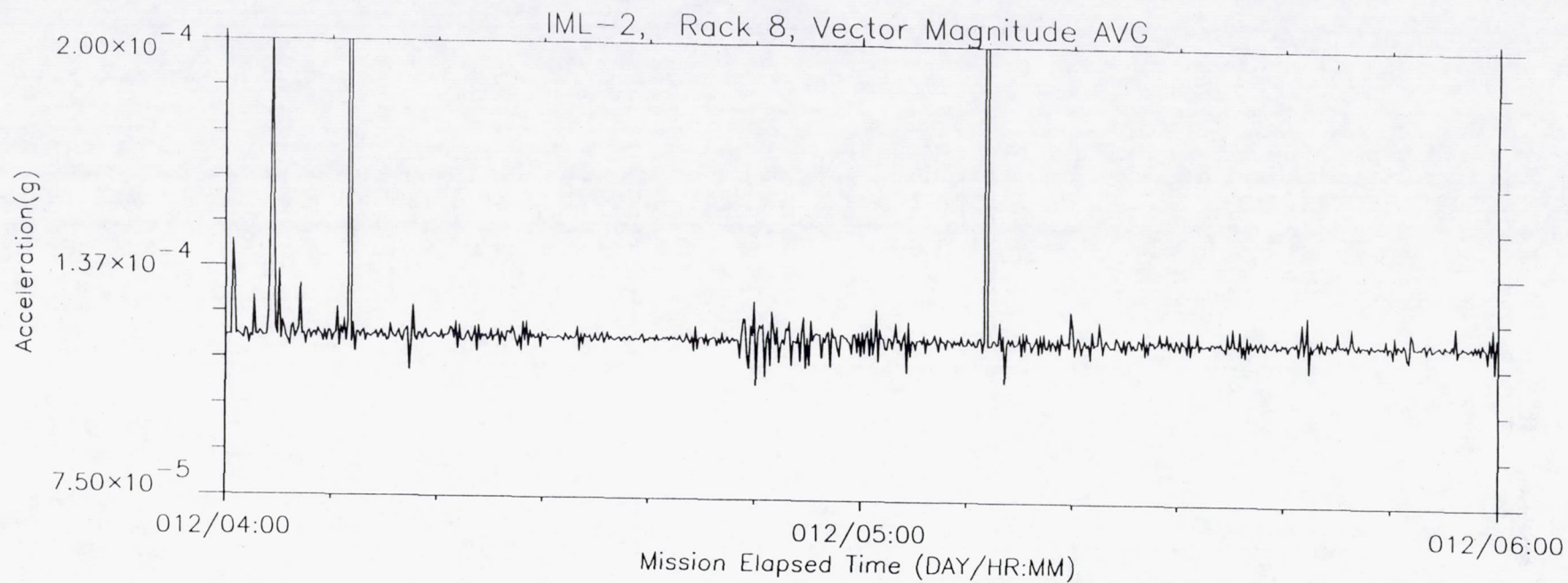


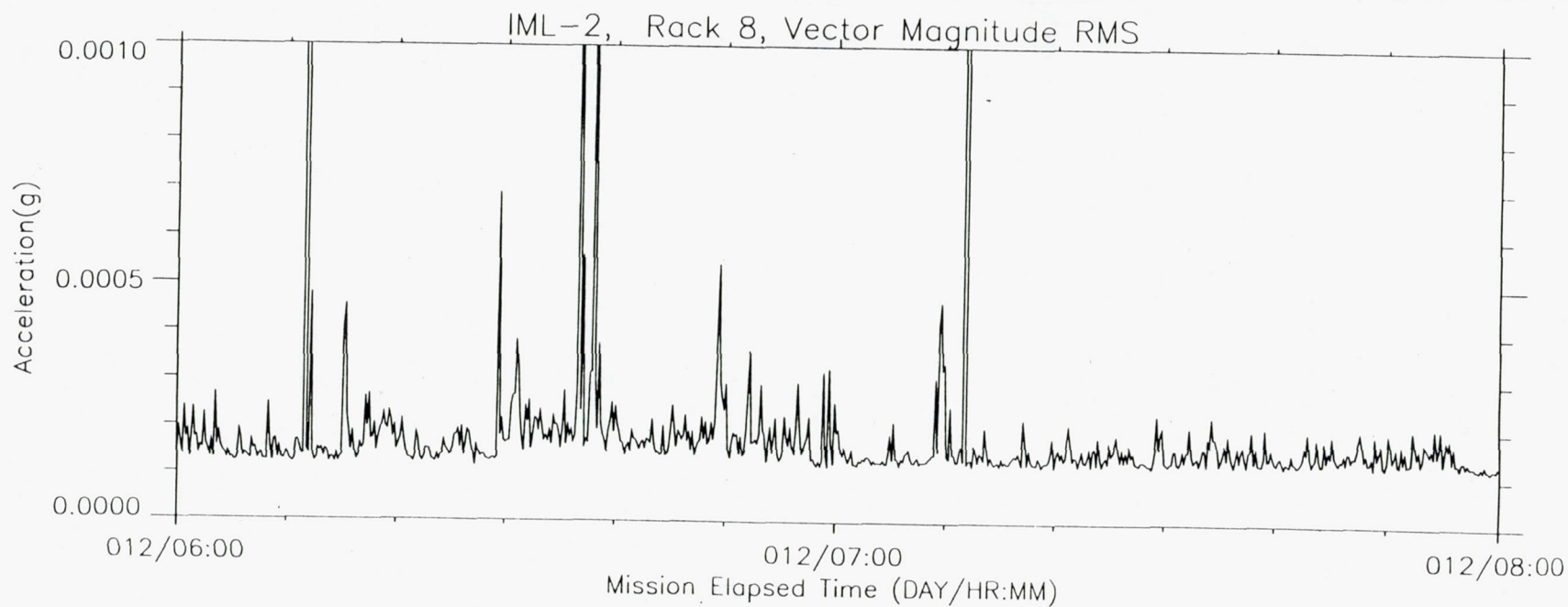
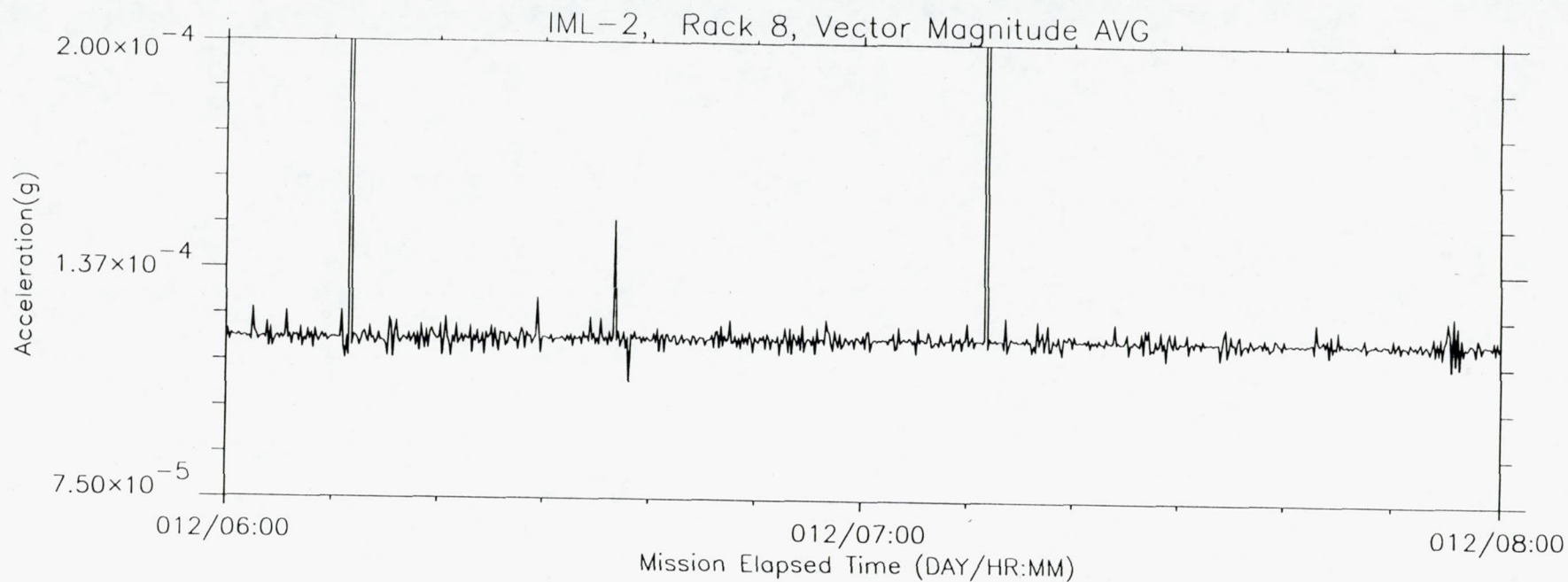


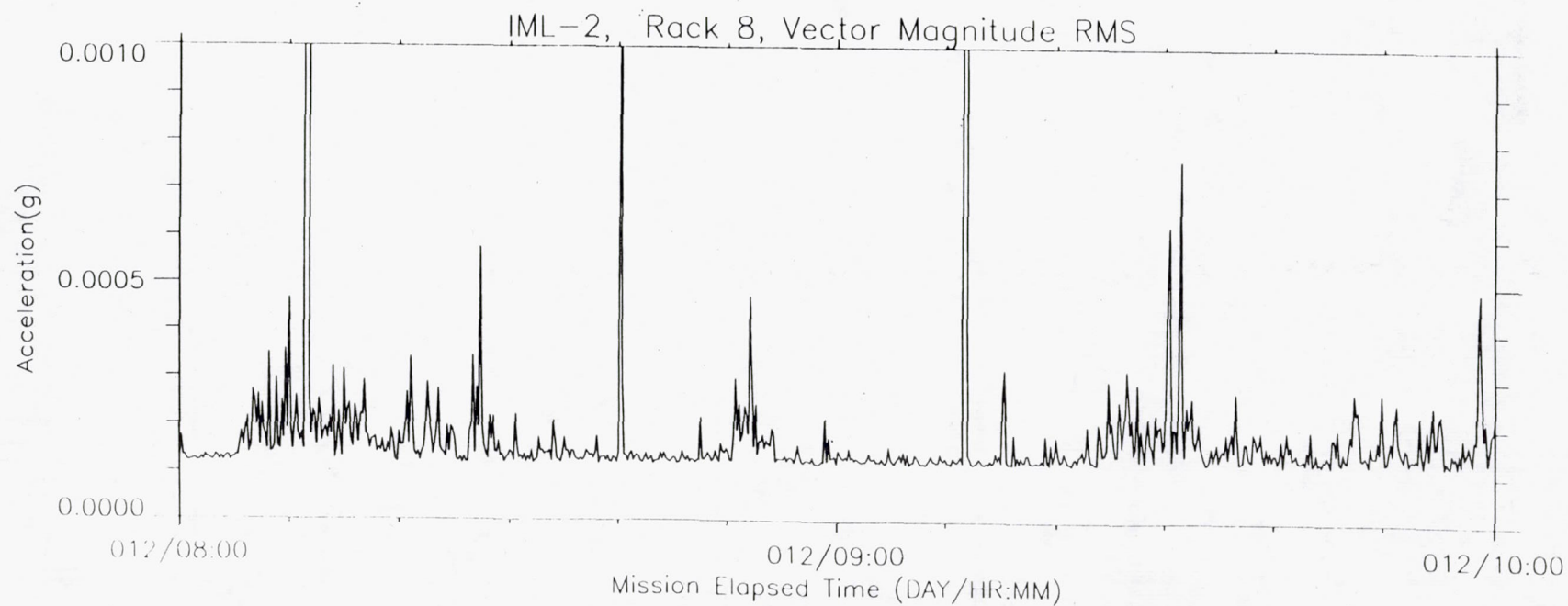
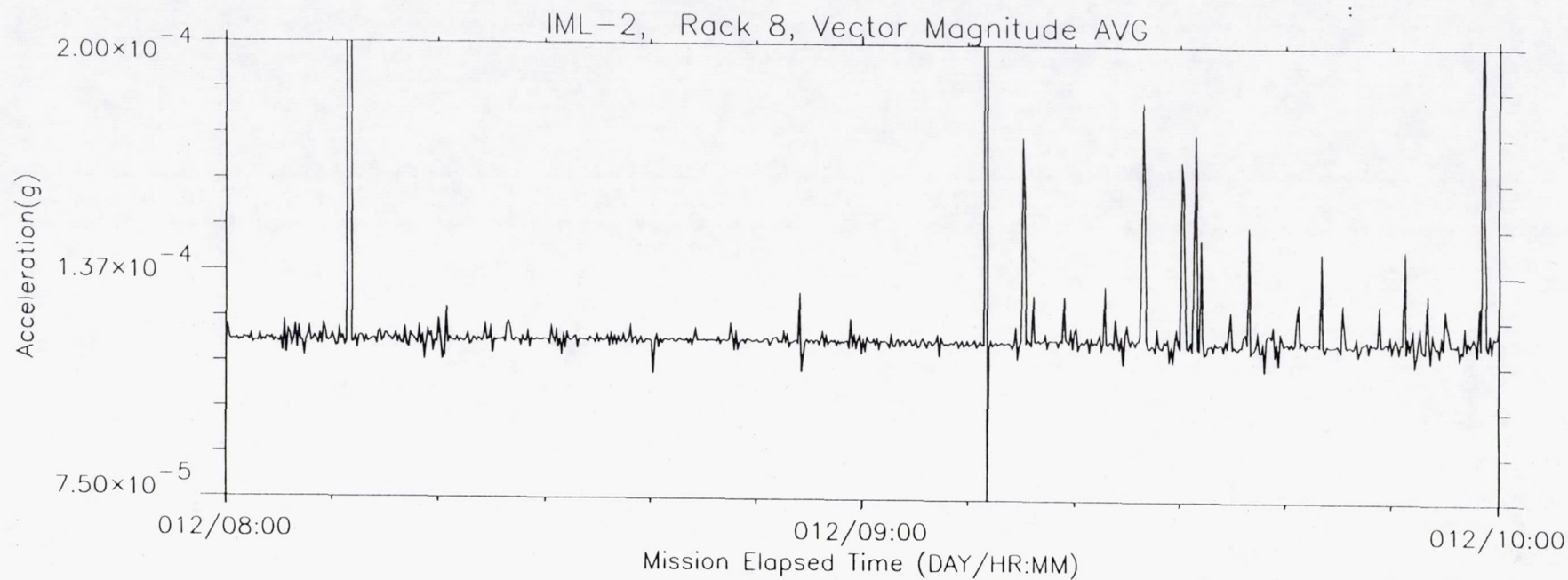


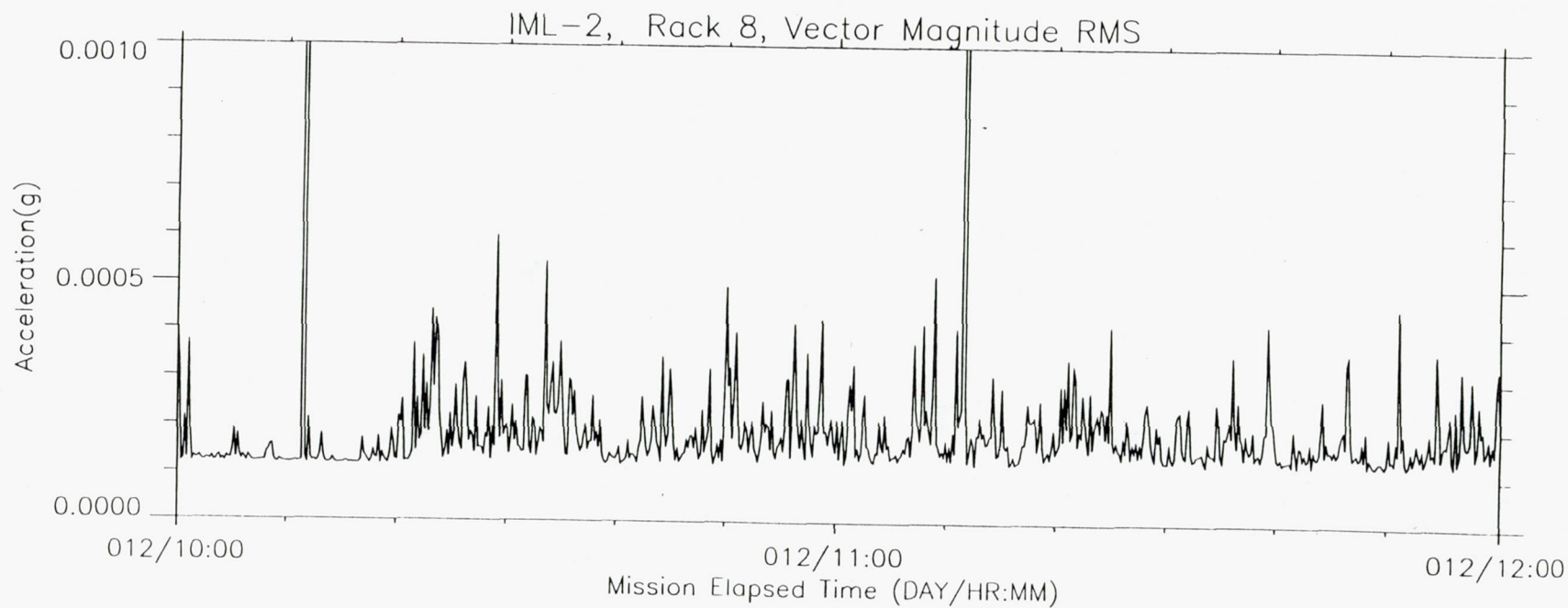
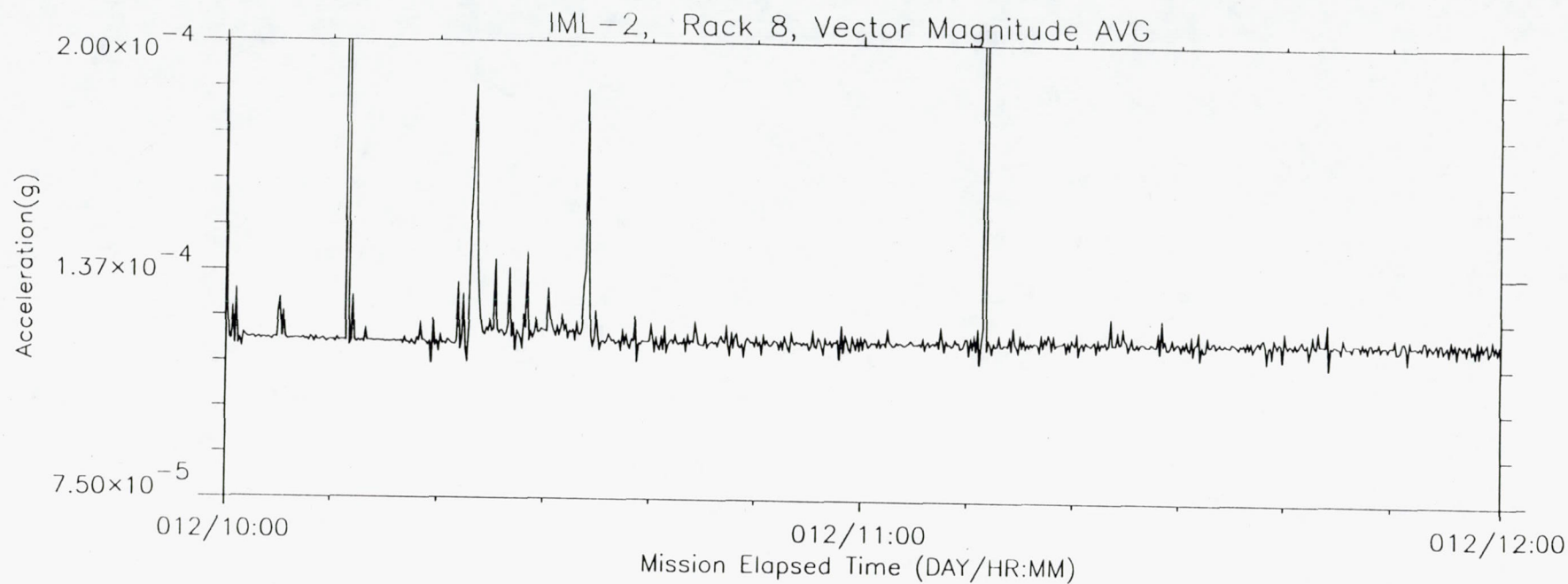


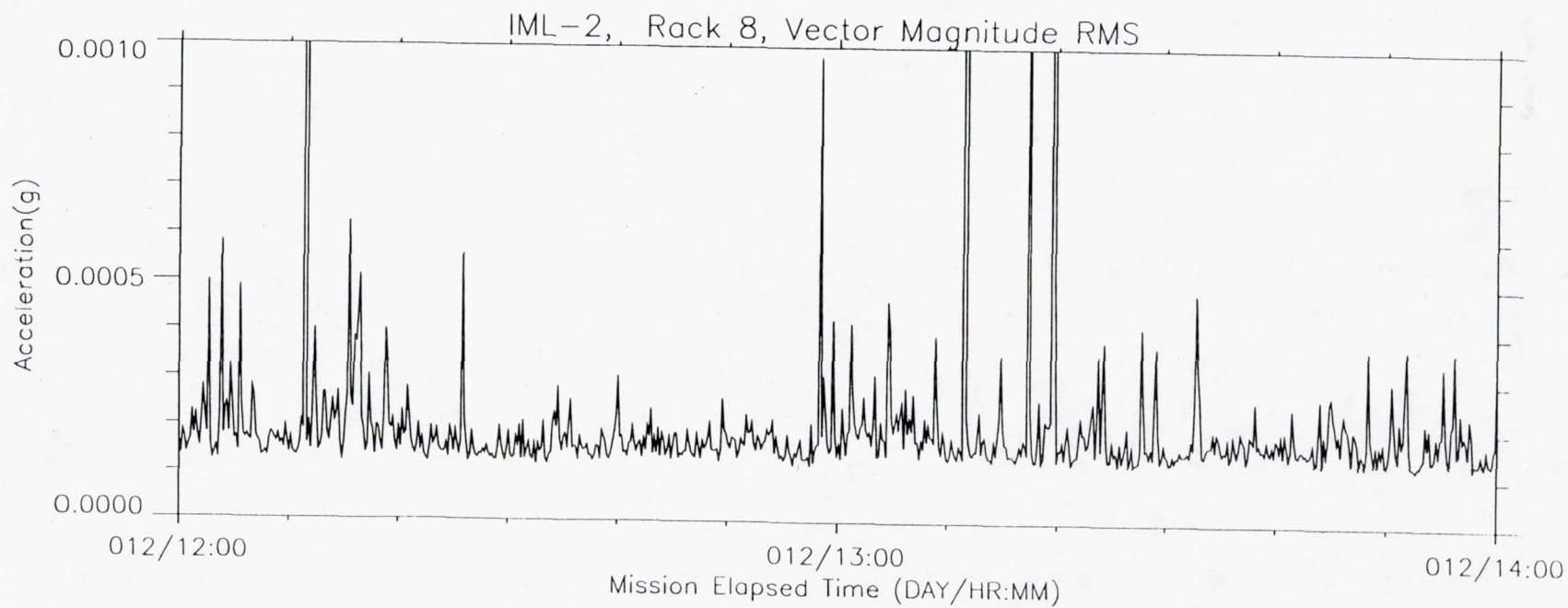
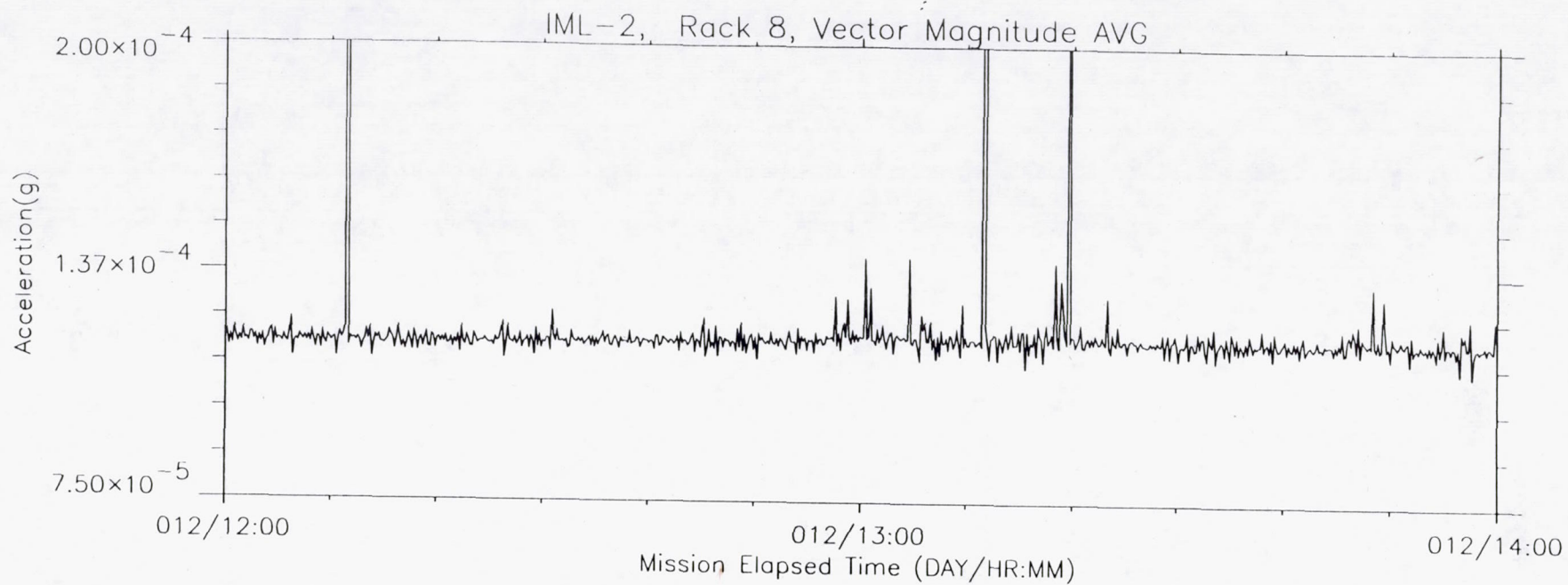


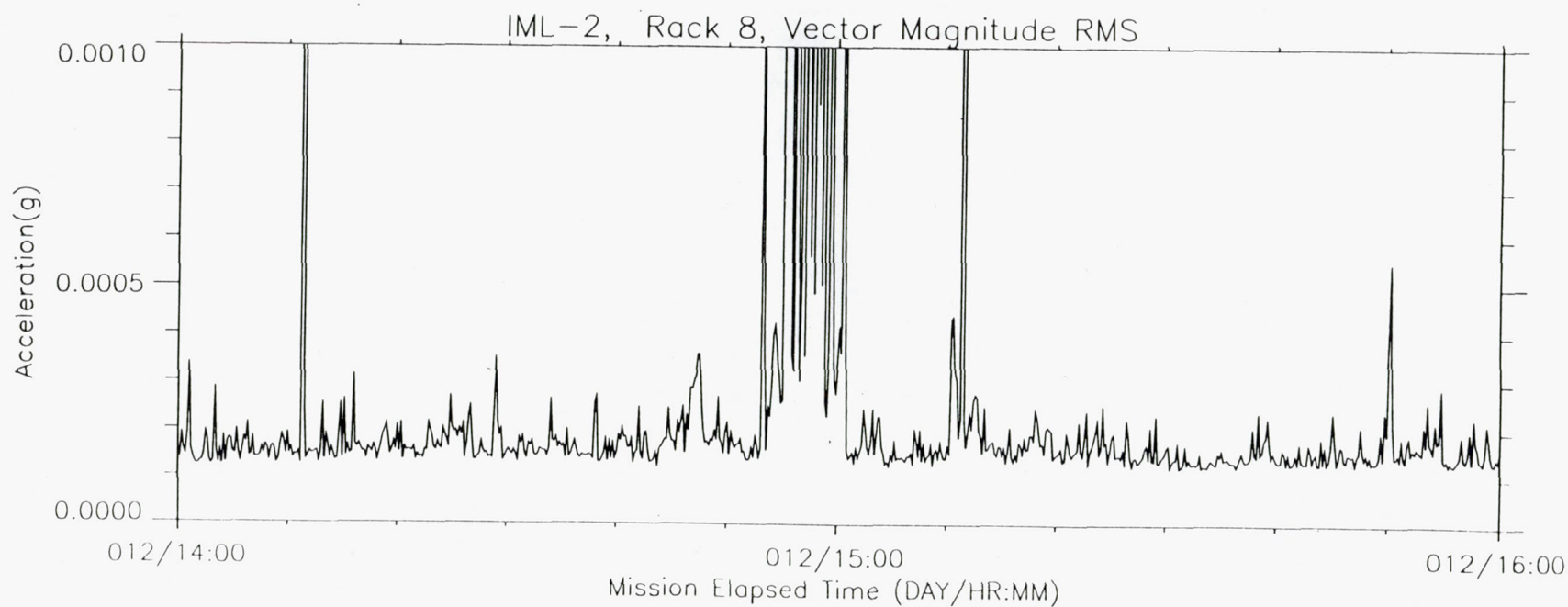
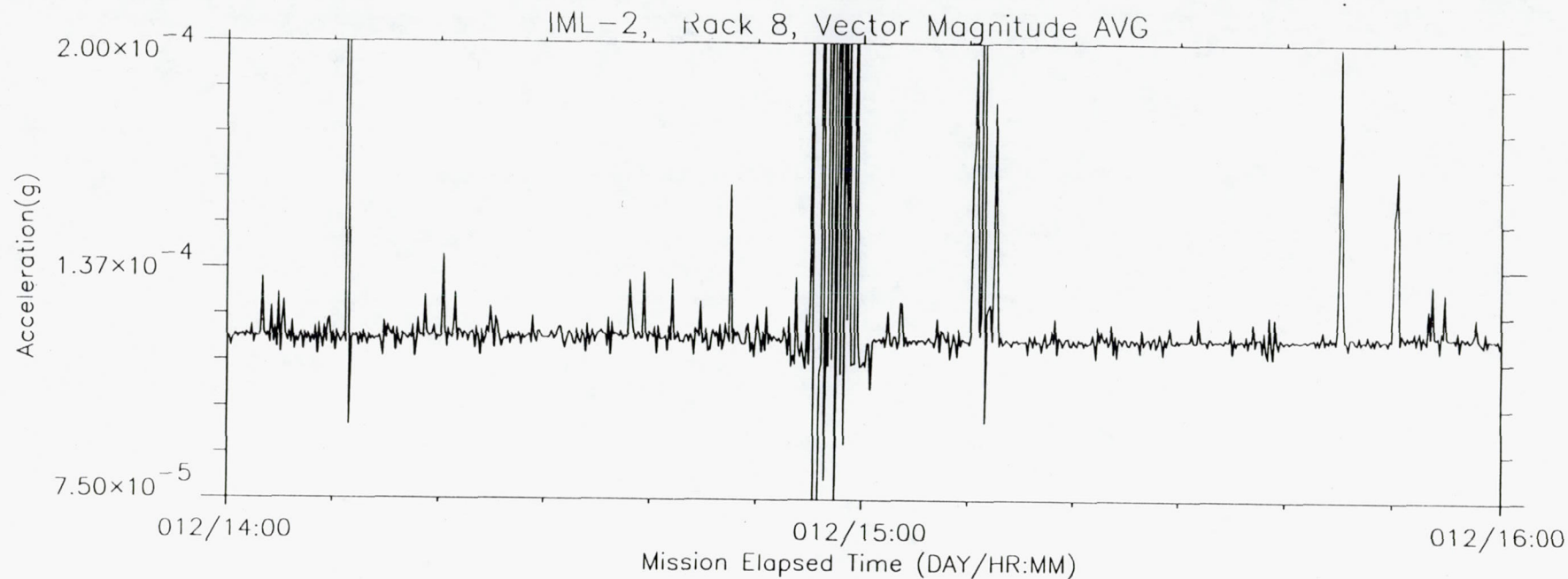


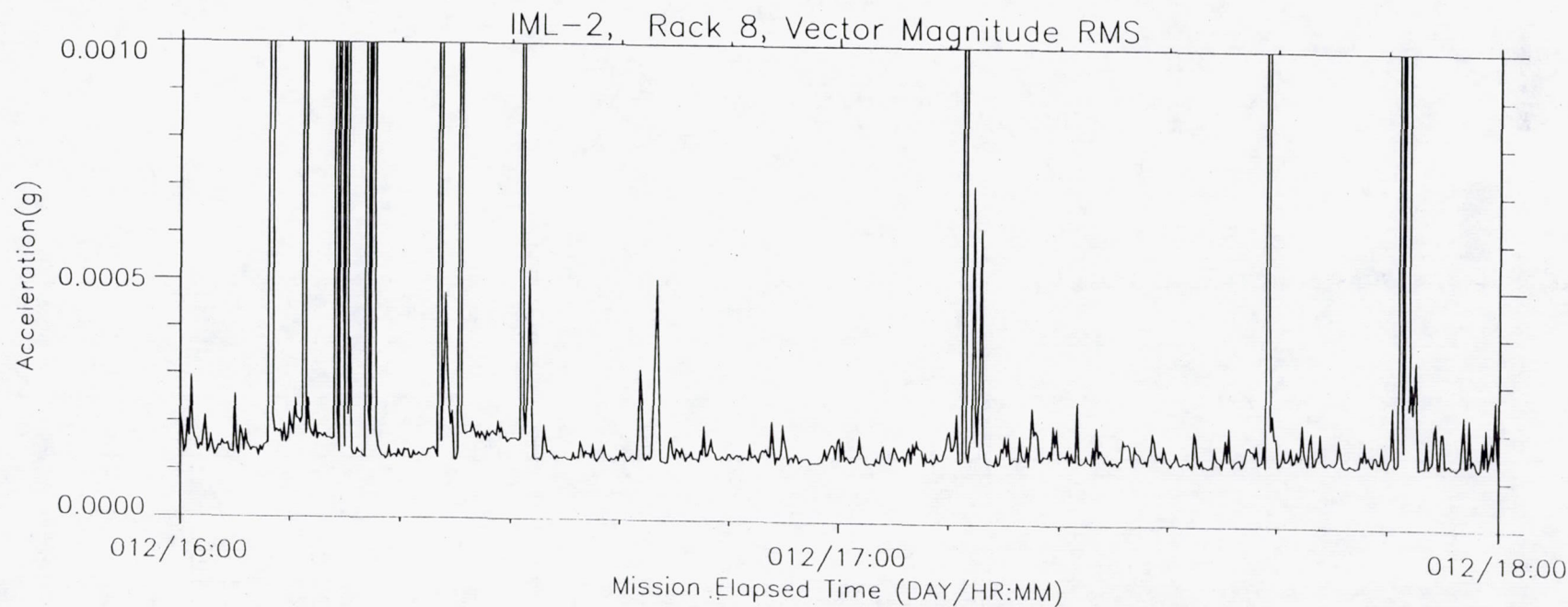
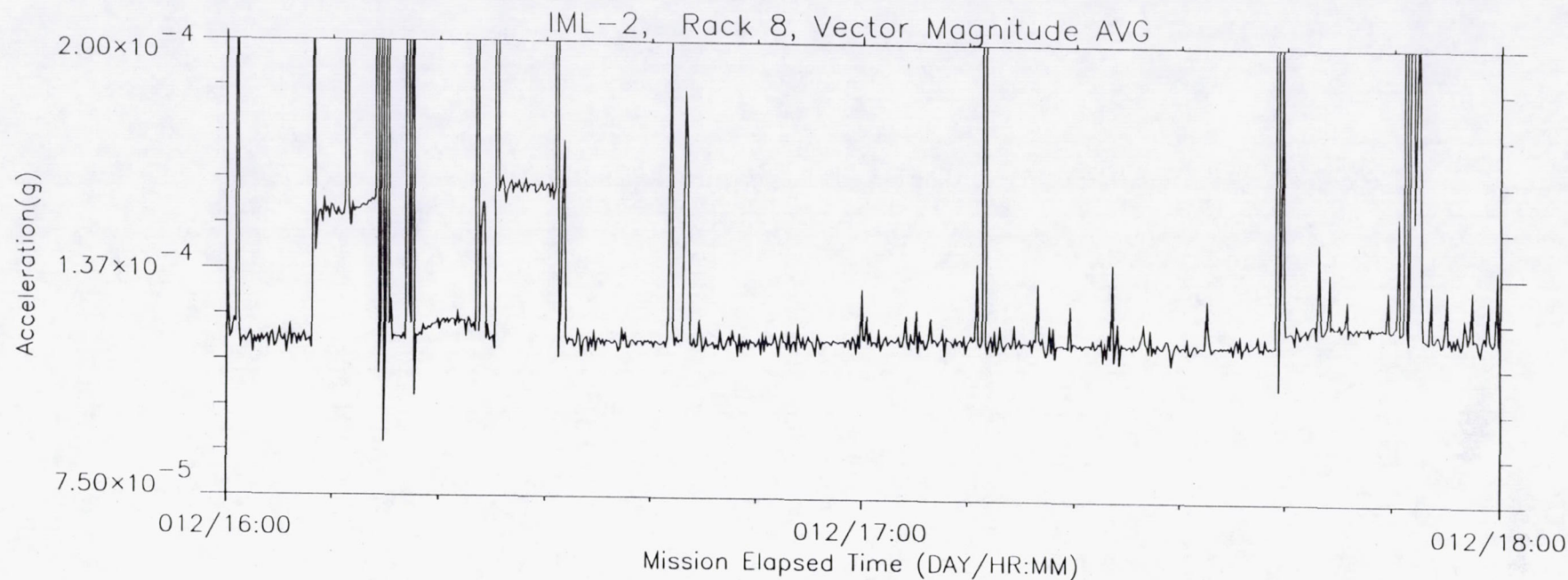


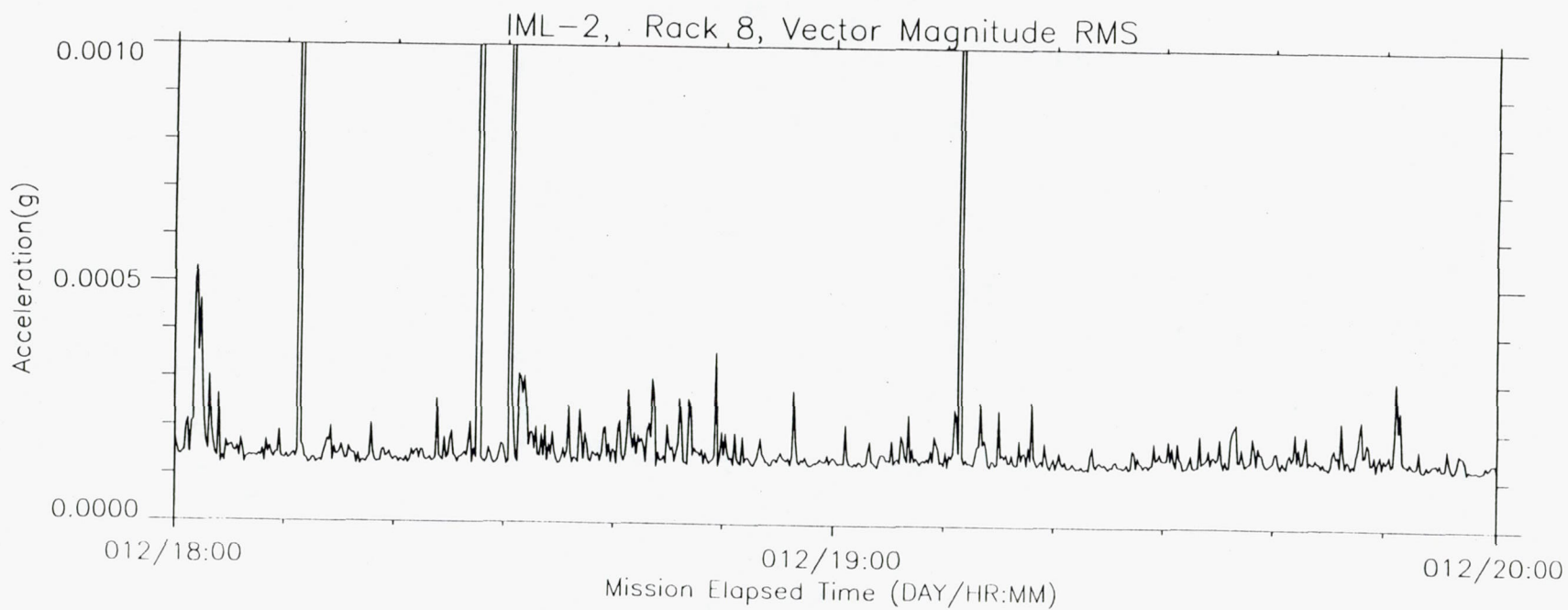
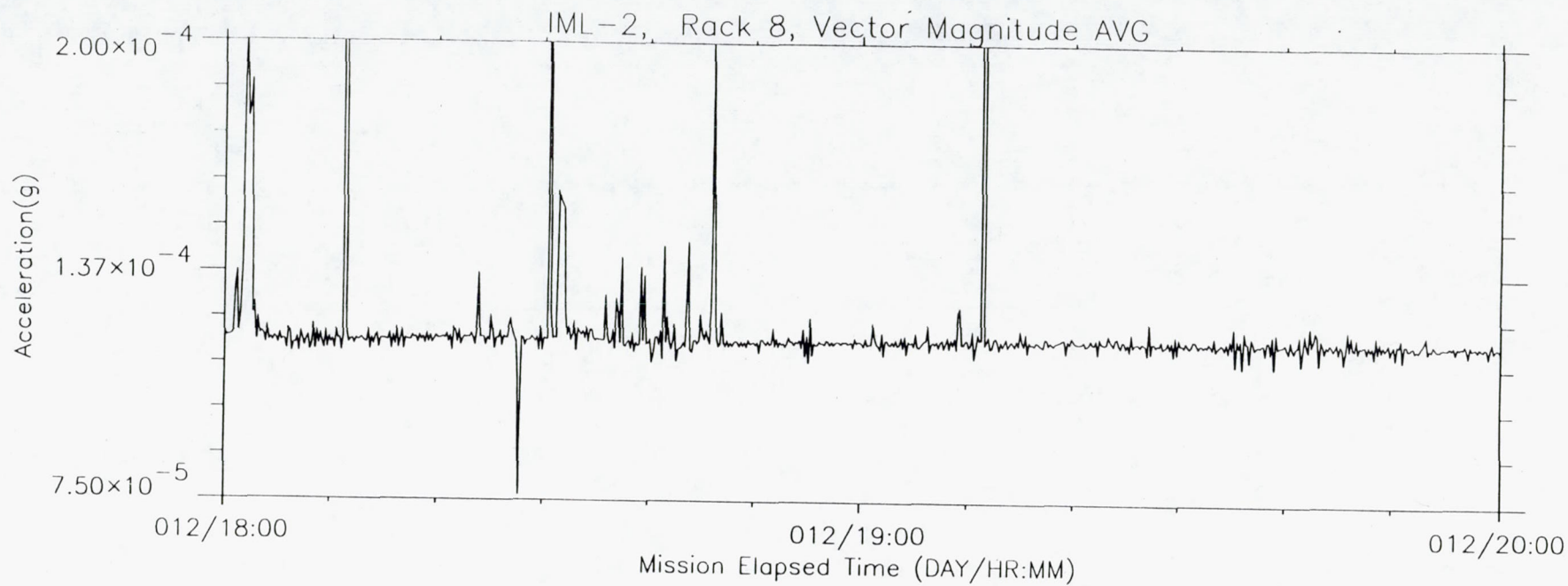


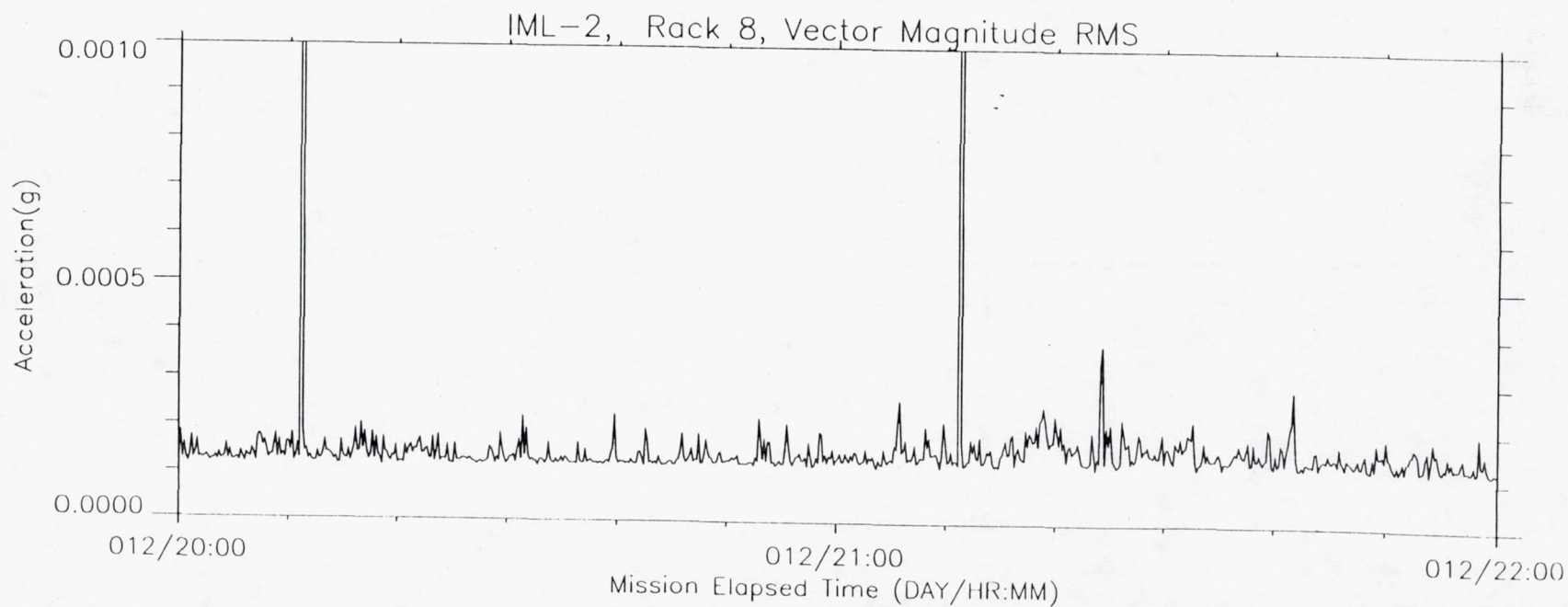
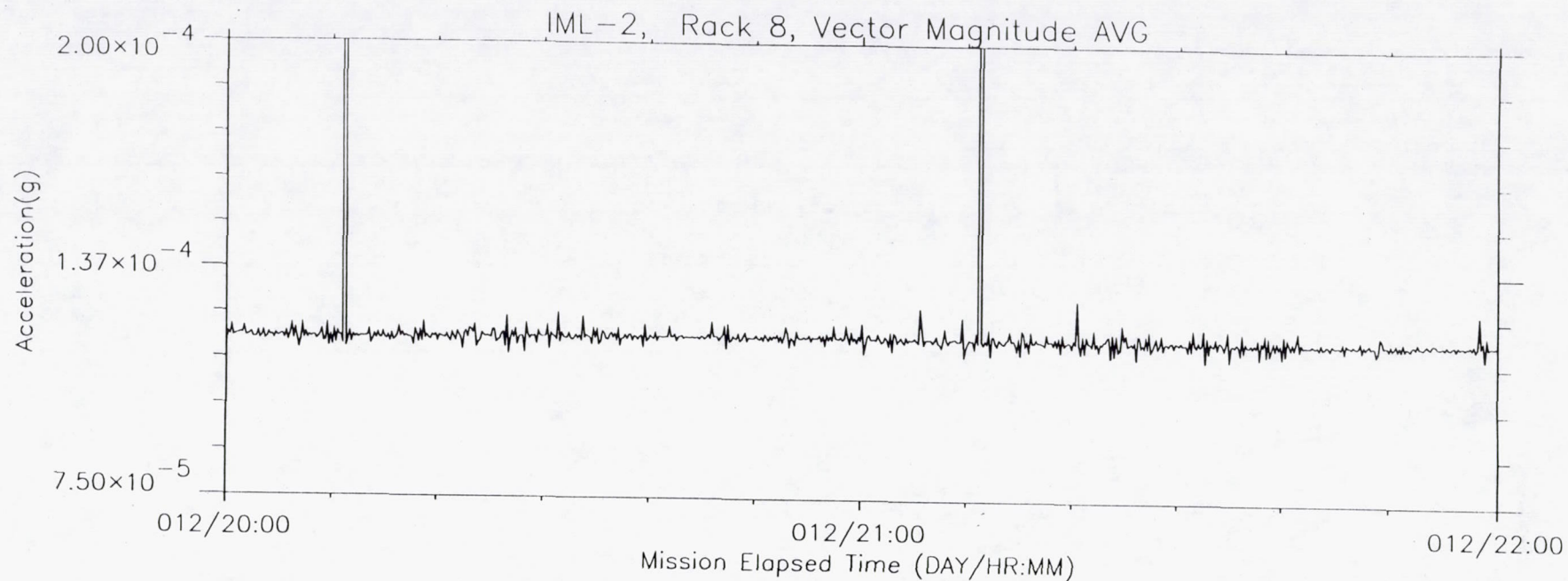


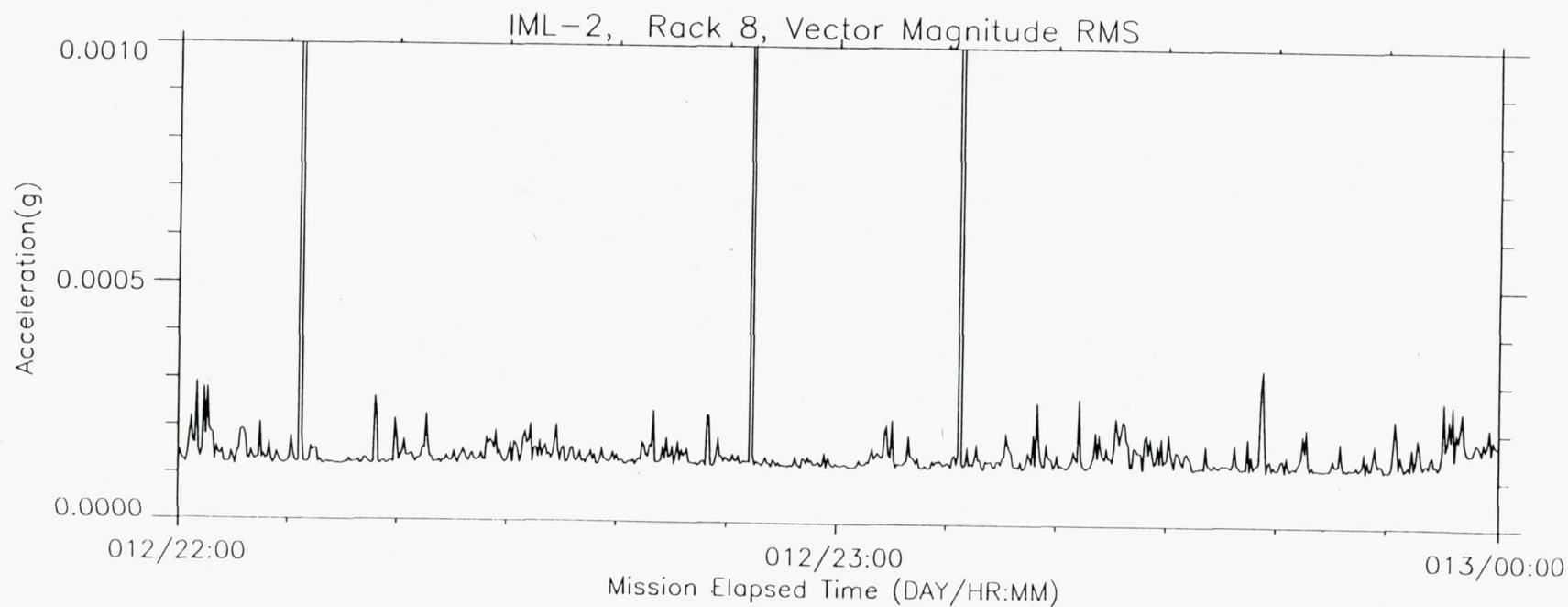
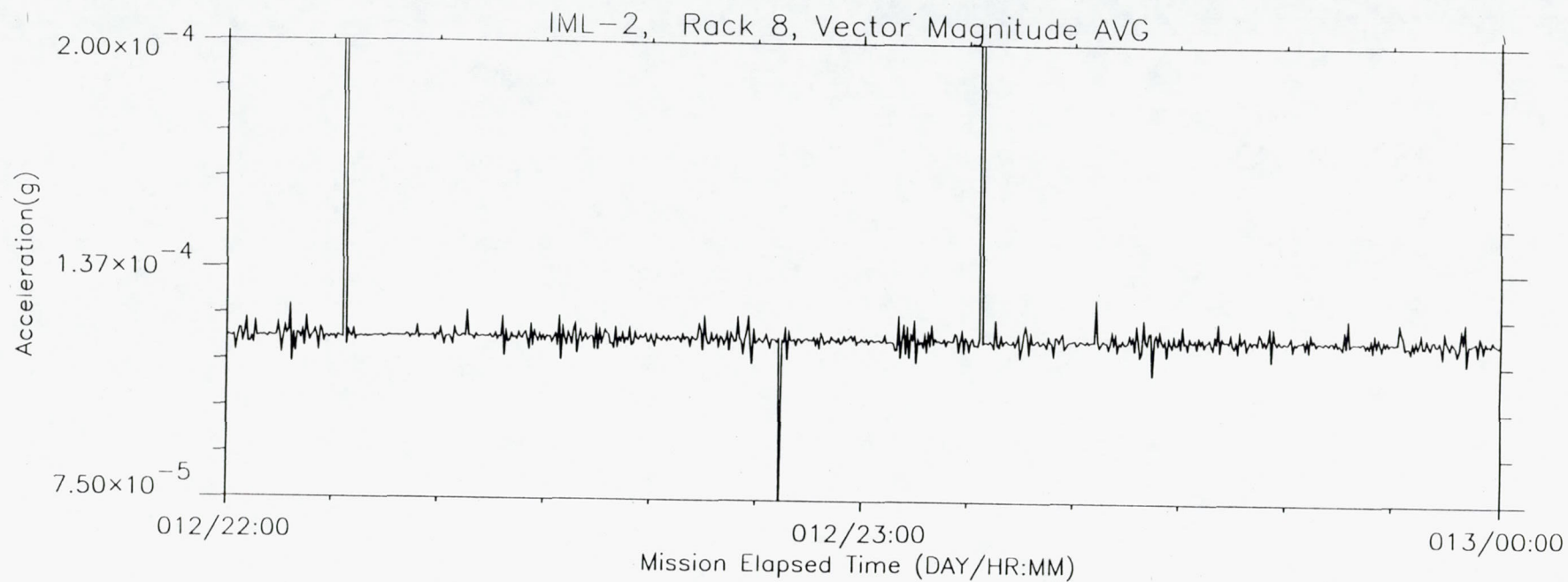


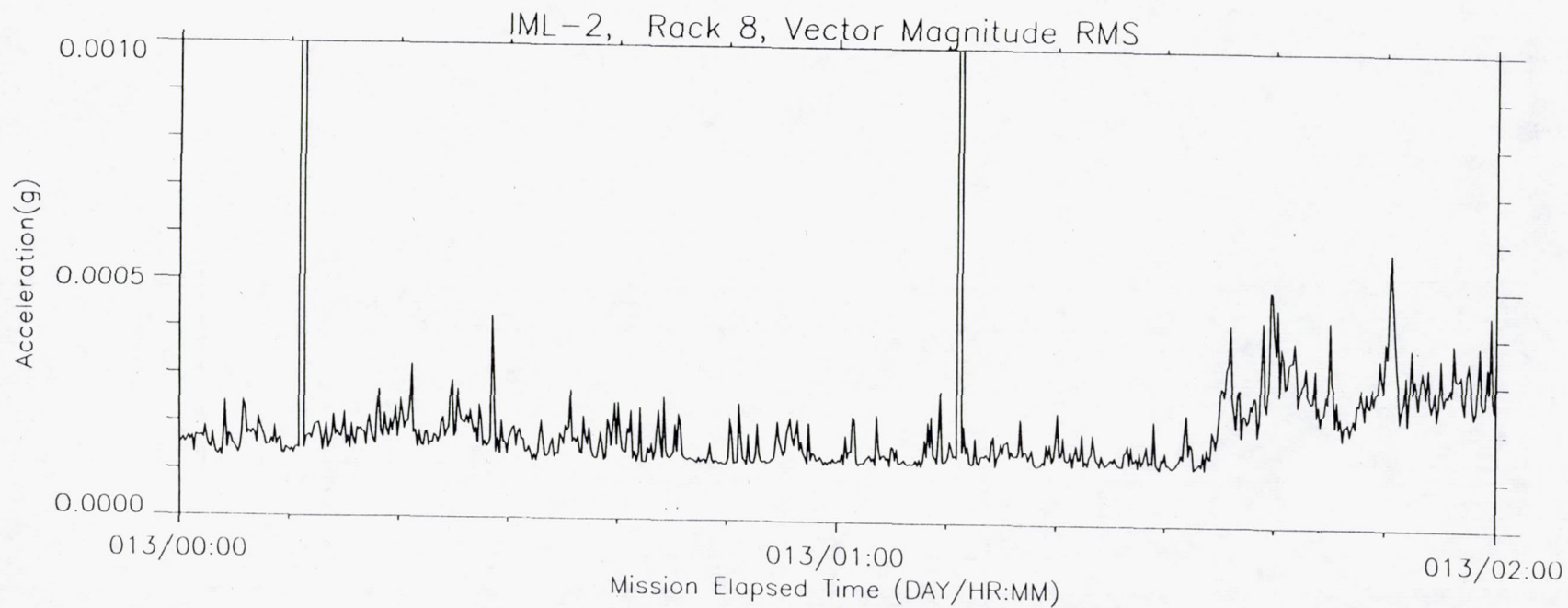
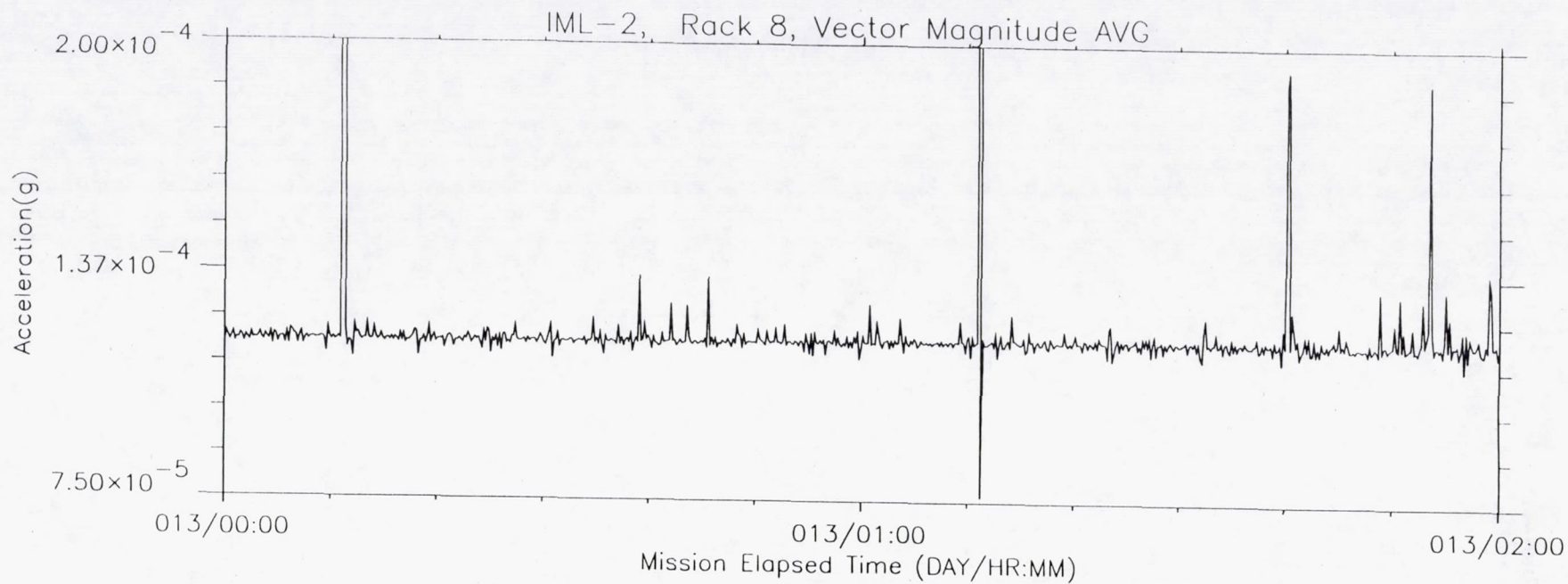


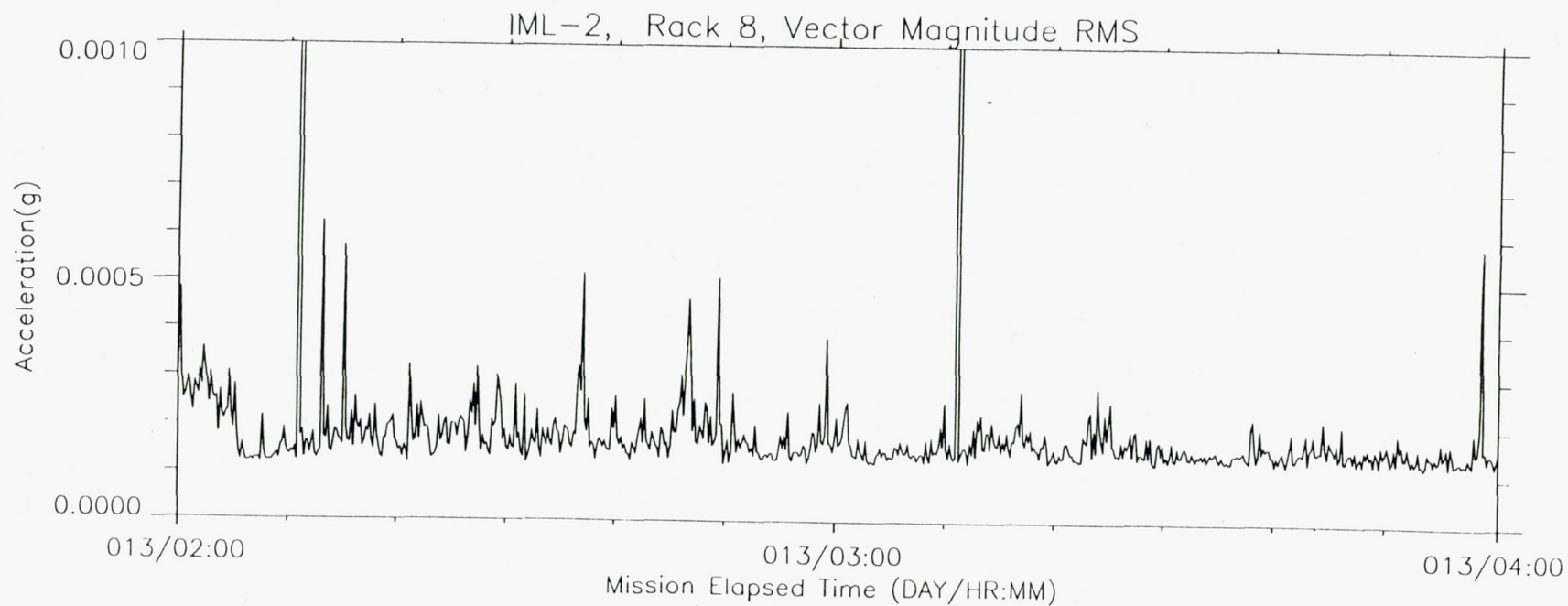
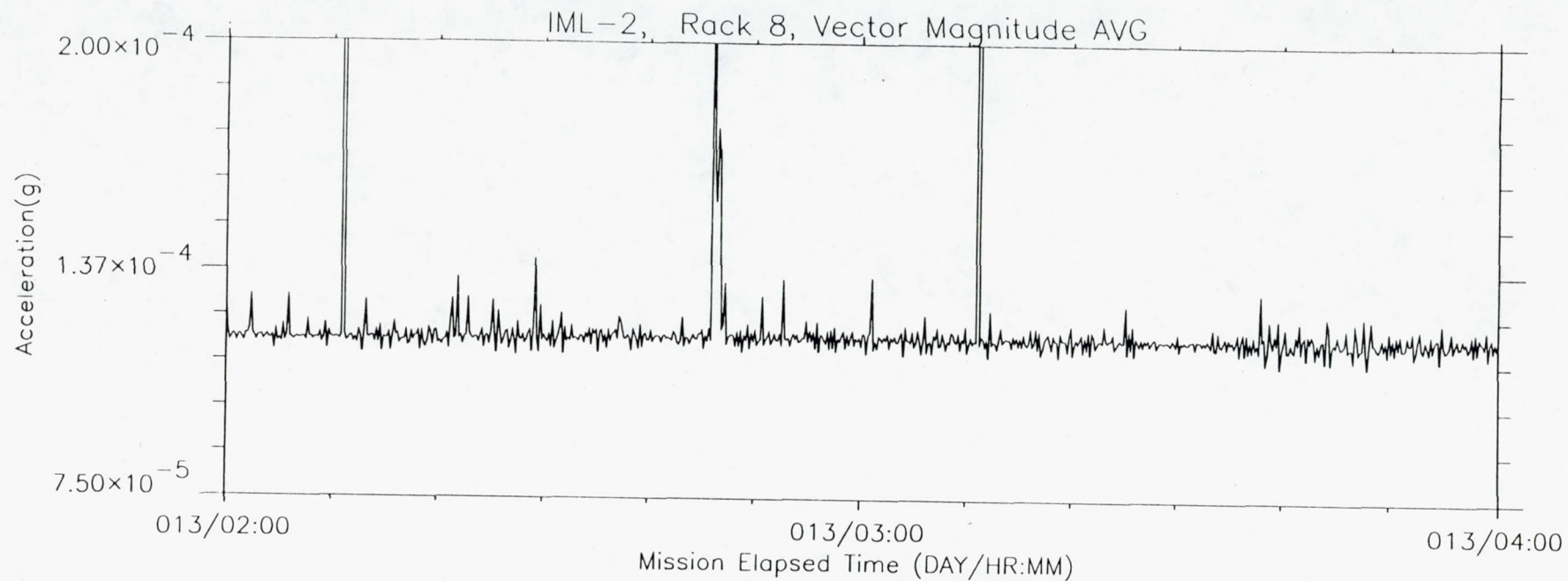


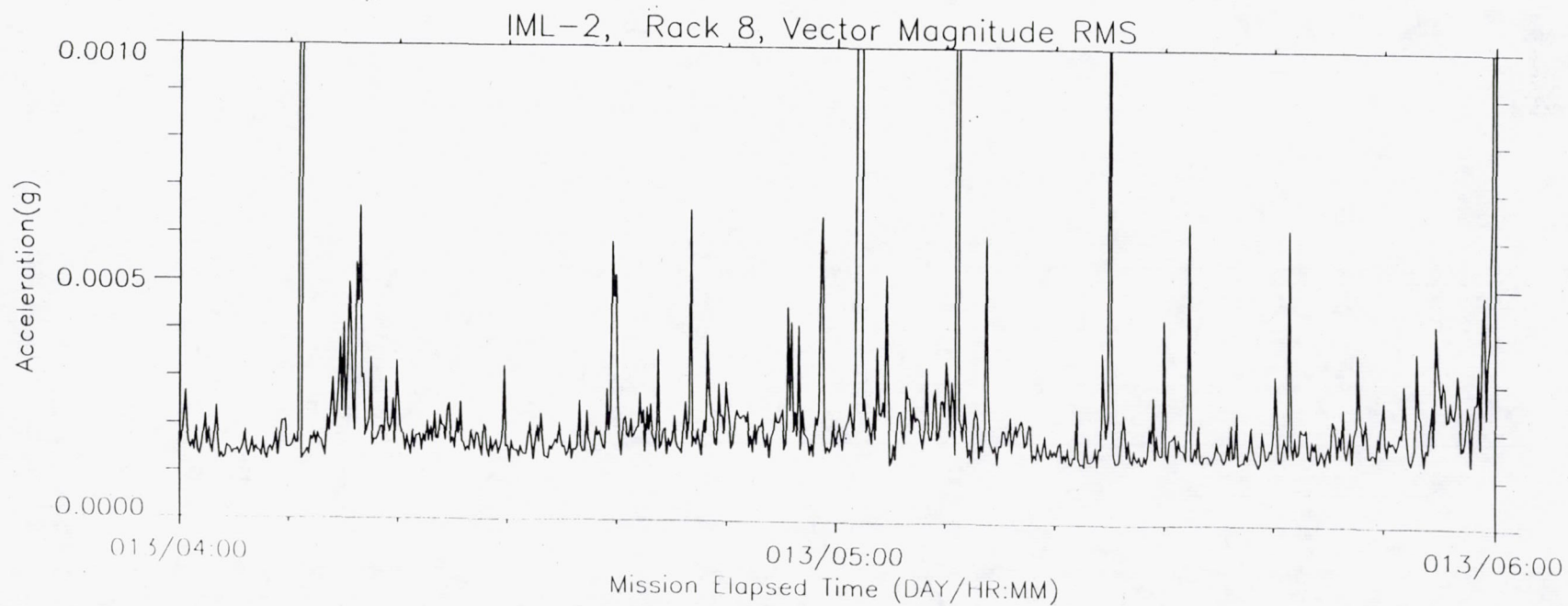
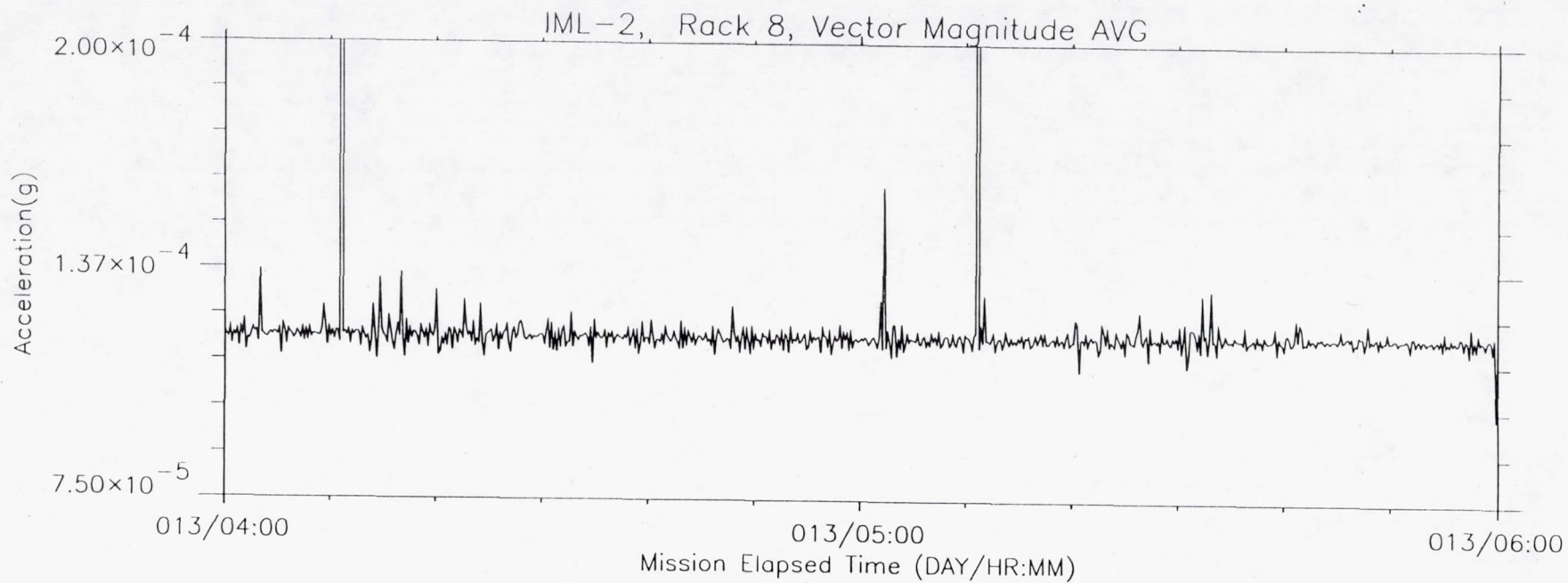


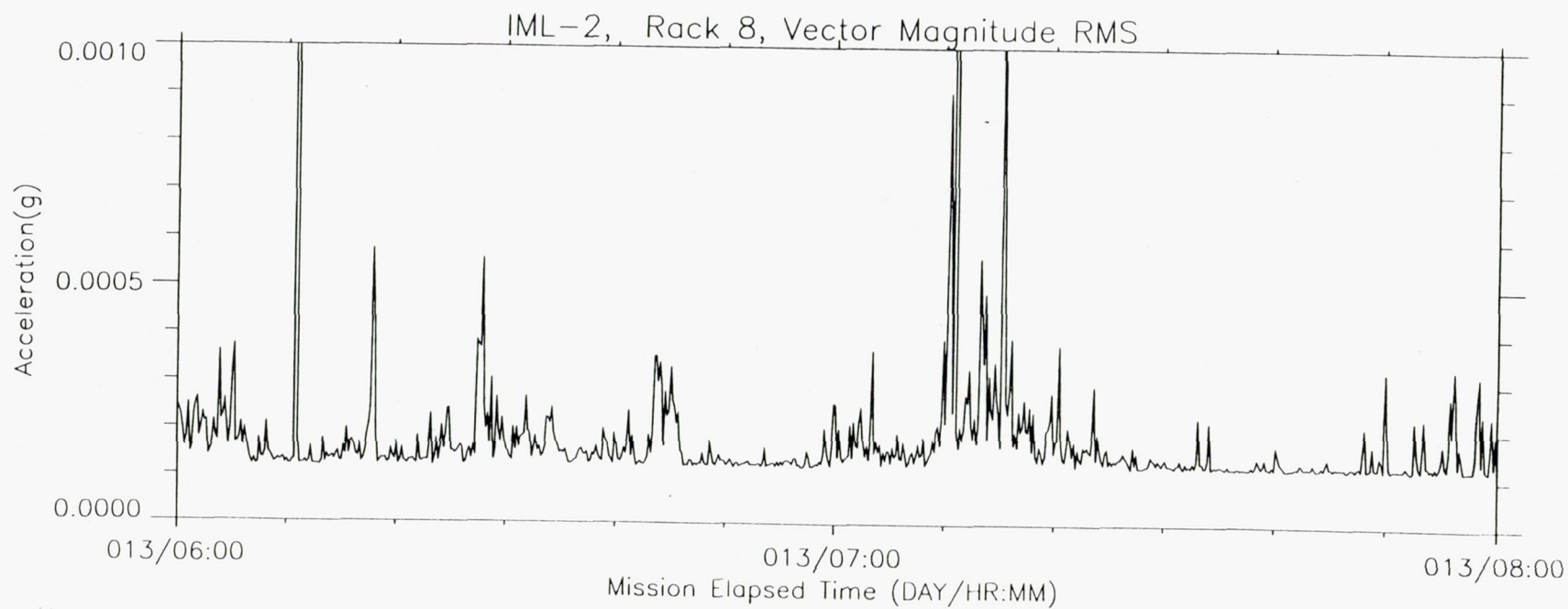
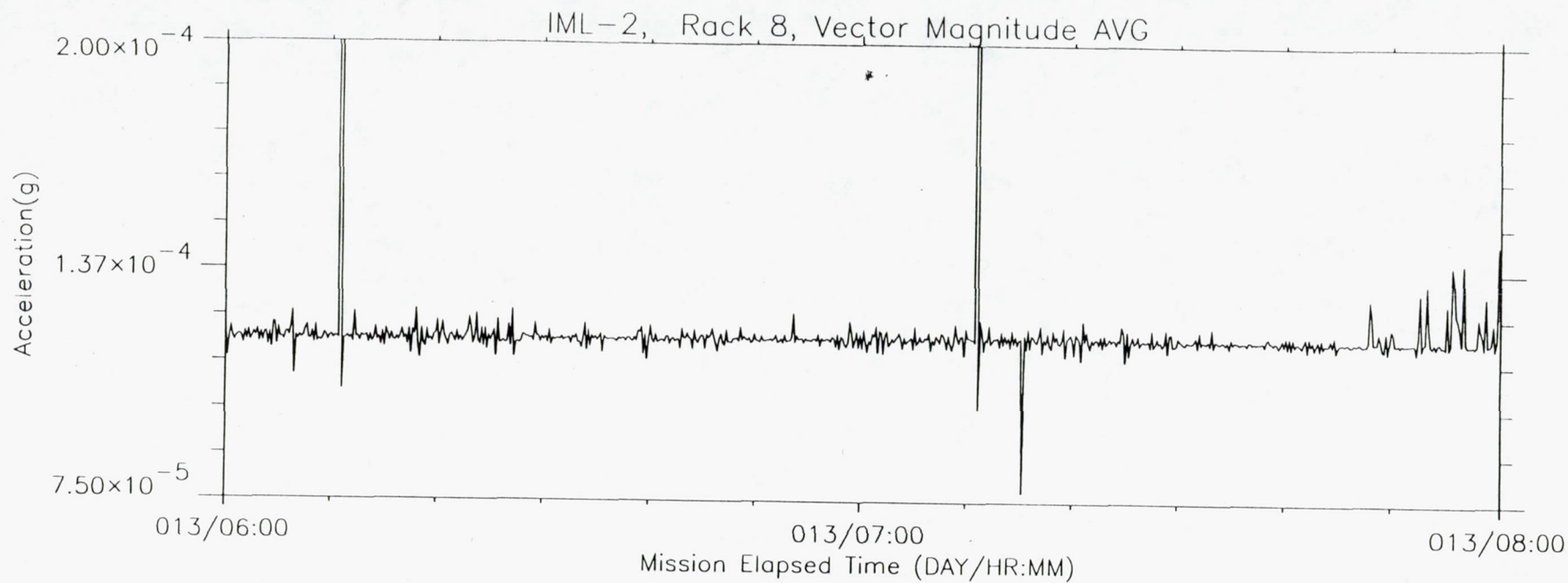












APPENDIX C SAMS COLOR SPECTROGRAMS

Accelerometer data collected on Orbiter missions are generally analyzed by the principal investigator or experiment team responsible for the system. The PI Microgravity Services (PIMS) project at the NASA Lewis Research Center was formed in part to support microgravity PI's in the evaluation of acceleration effects on their experiments and to characterize the vibrational environment of the Space Shuttle Orbiters. The primary continual source of accelerometer data from mission to mission is SAMS. Some of the SAMS data from STS-62 are presented in Appendices B and C to provide PI's with an overview of the environment during mission.

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 transformed to the shuttle structural coordinate system and formatted into files for distribution via CD-ROM and file server. See Appendix A for information on file server access to 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 the mission. Each spectrogram is a two-hour composite of amplitude spectra for consecutive ten second intervals. These plots should be used to identify times when the frequency character of the acceleration environment changes.

The color spectrograms were produced using STS-65 SAMS Head A data. The data were taken in two hour periods and an amplitude spectrum was calculated for consecutive ten second intervals. The frequency bandwidth for the spectra is 0.1 Hz.

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.

References

Thomas, J. E., R. B. Peters, B. D. Finley, Space Acceleration Measurement System triaxial head error budget. NASA Technical Memorandum 105300, January 1992.

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Figure C-1 IML-2 Rack 8, Vector Magnitude

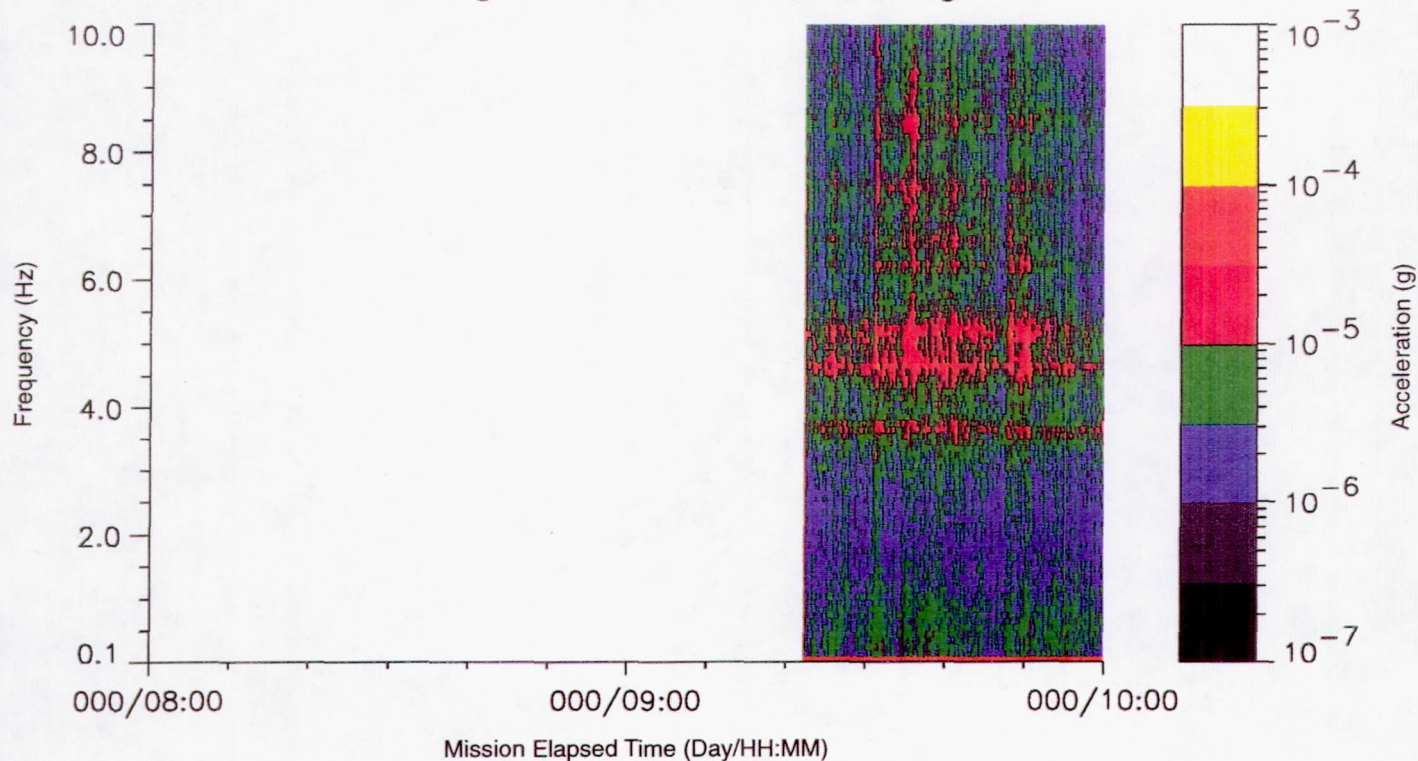


Figure C-2 IML-2 Rack 8, Vector Magnitude

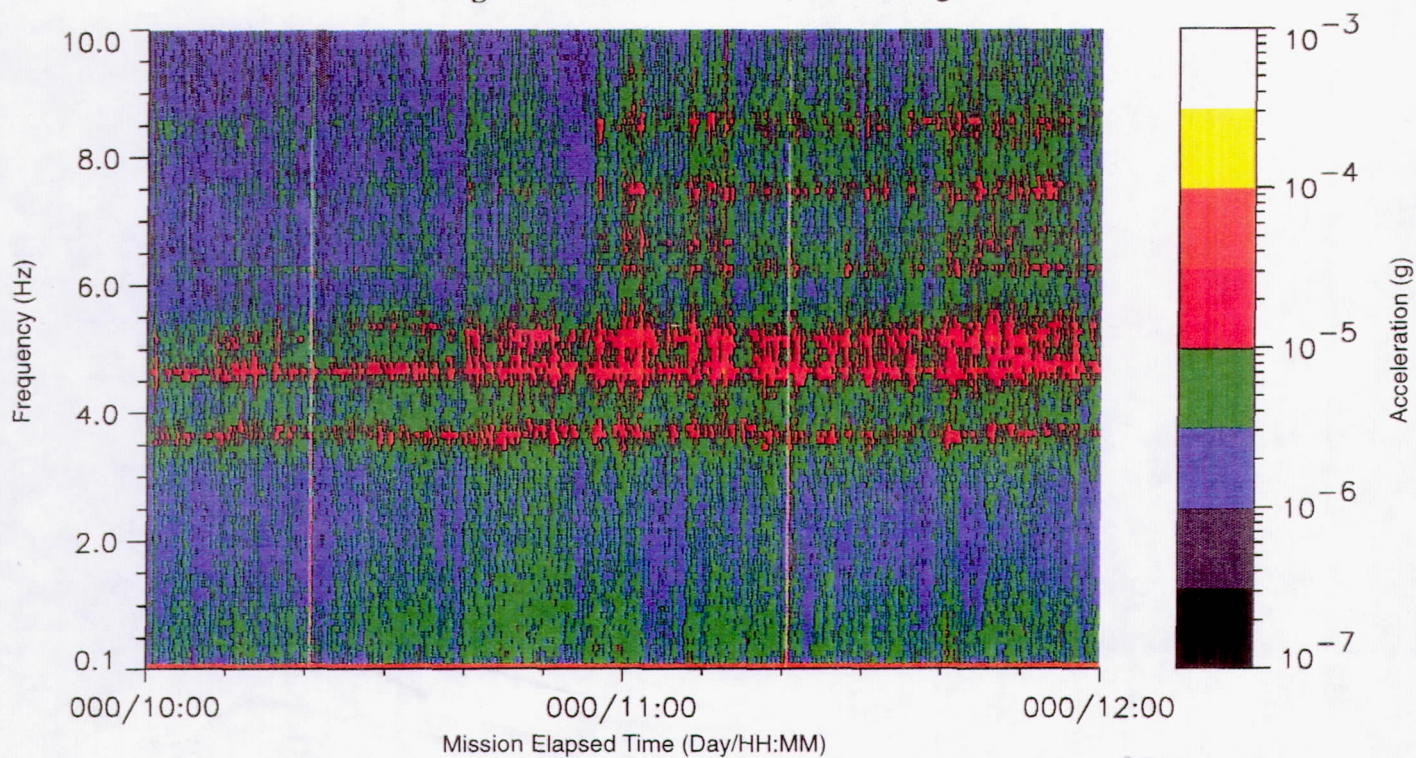


Figure C-3 IML-2 Rack 8, Vector Magnitude

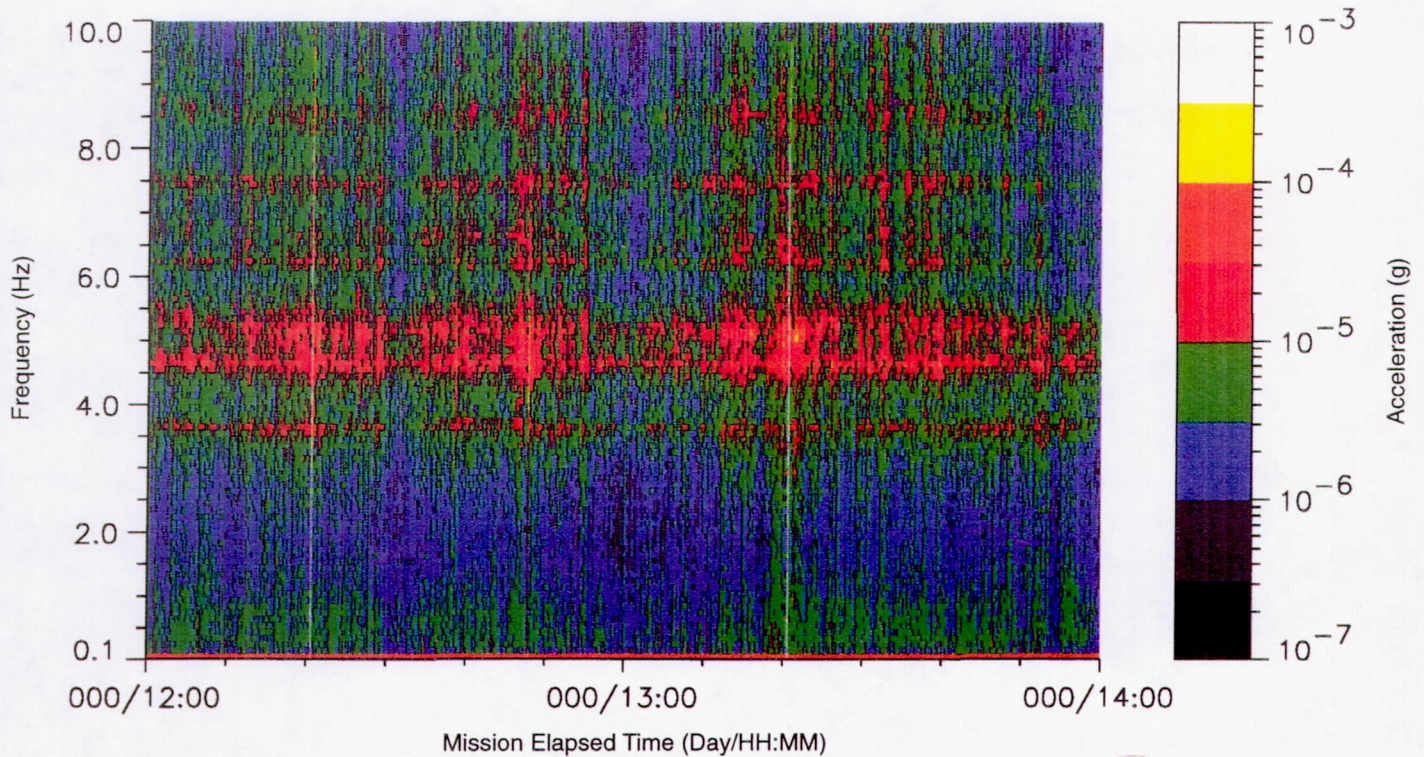


Figure C-4 IML-2 Rack 8, Vector Magnitude

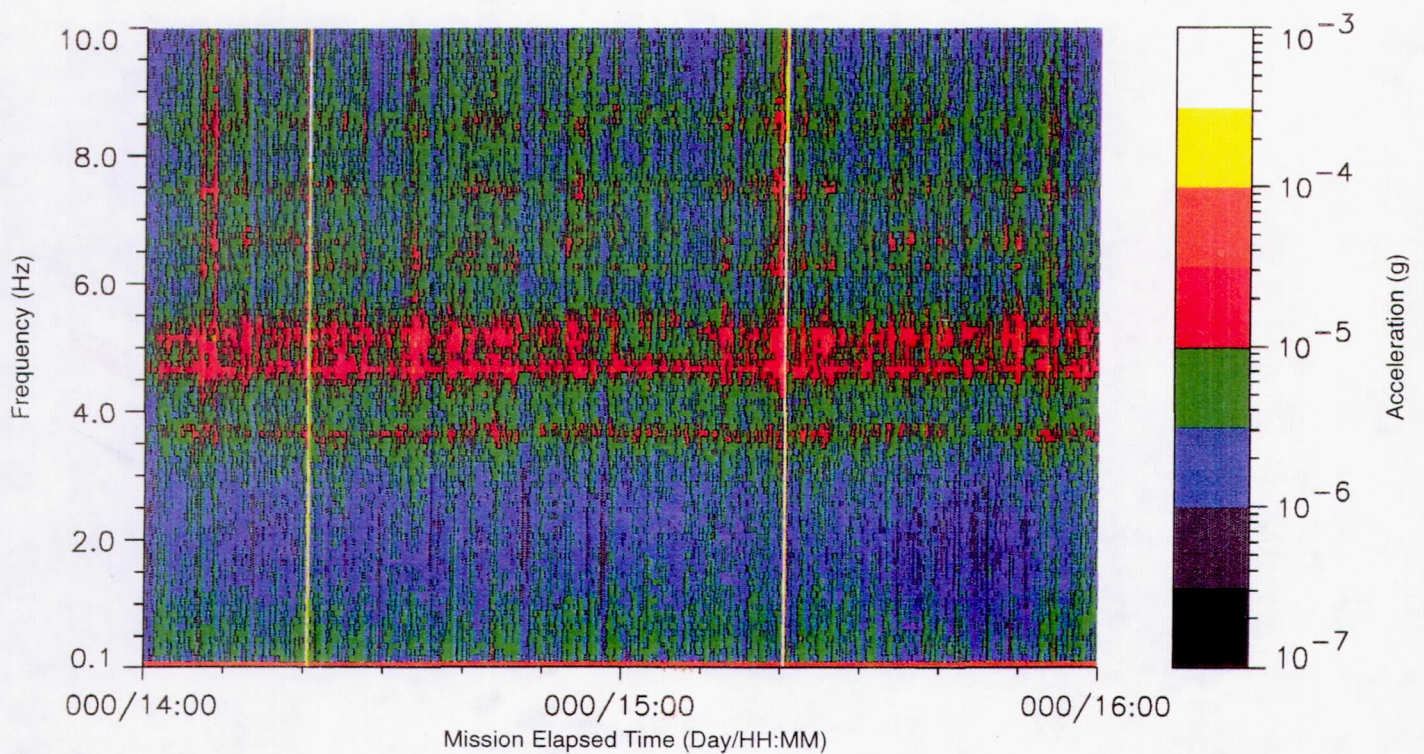


Figure C-5 IML-2 Rack 8, Vector Magnitude

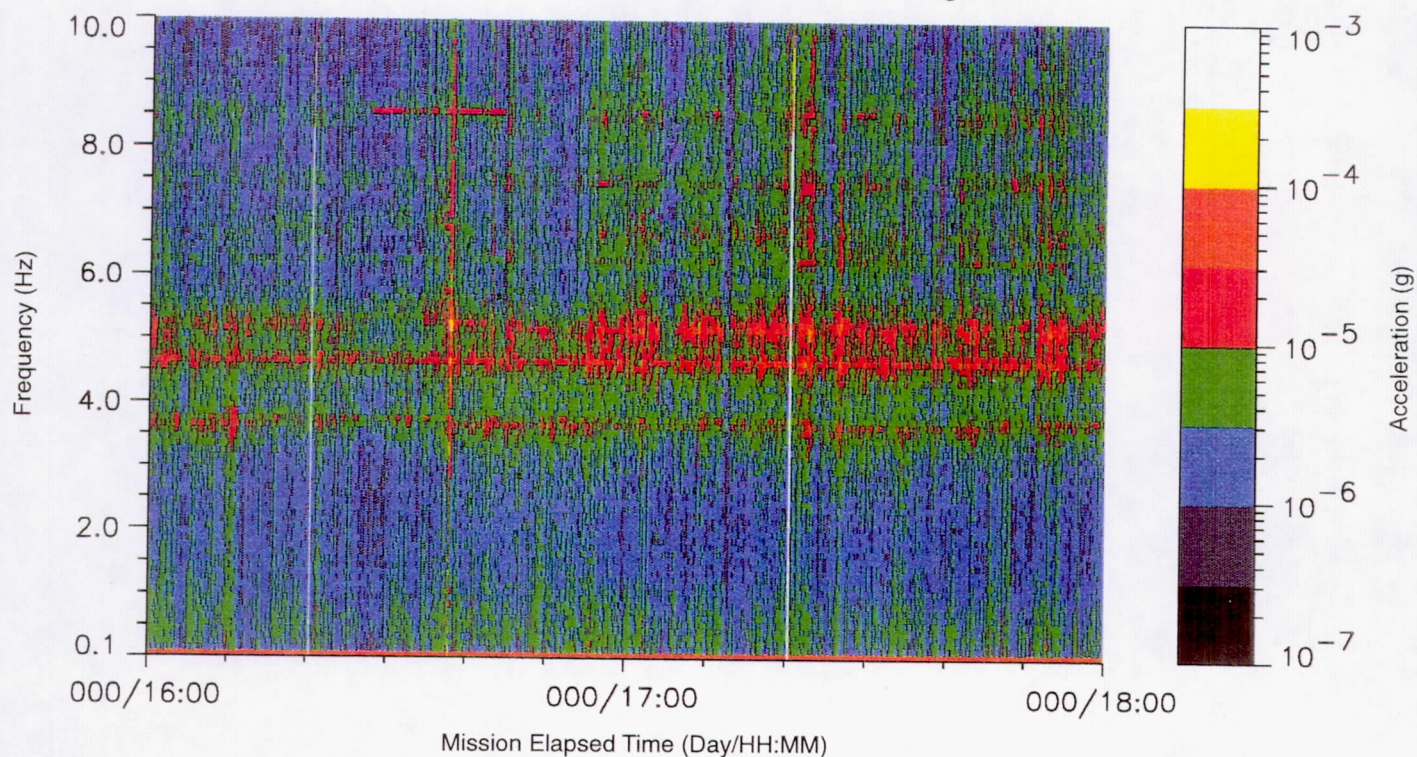


Figure C-6 IML-2 Rack 8, Vector Magnitude

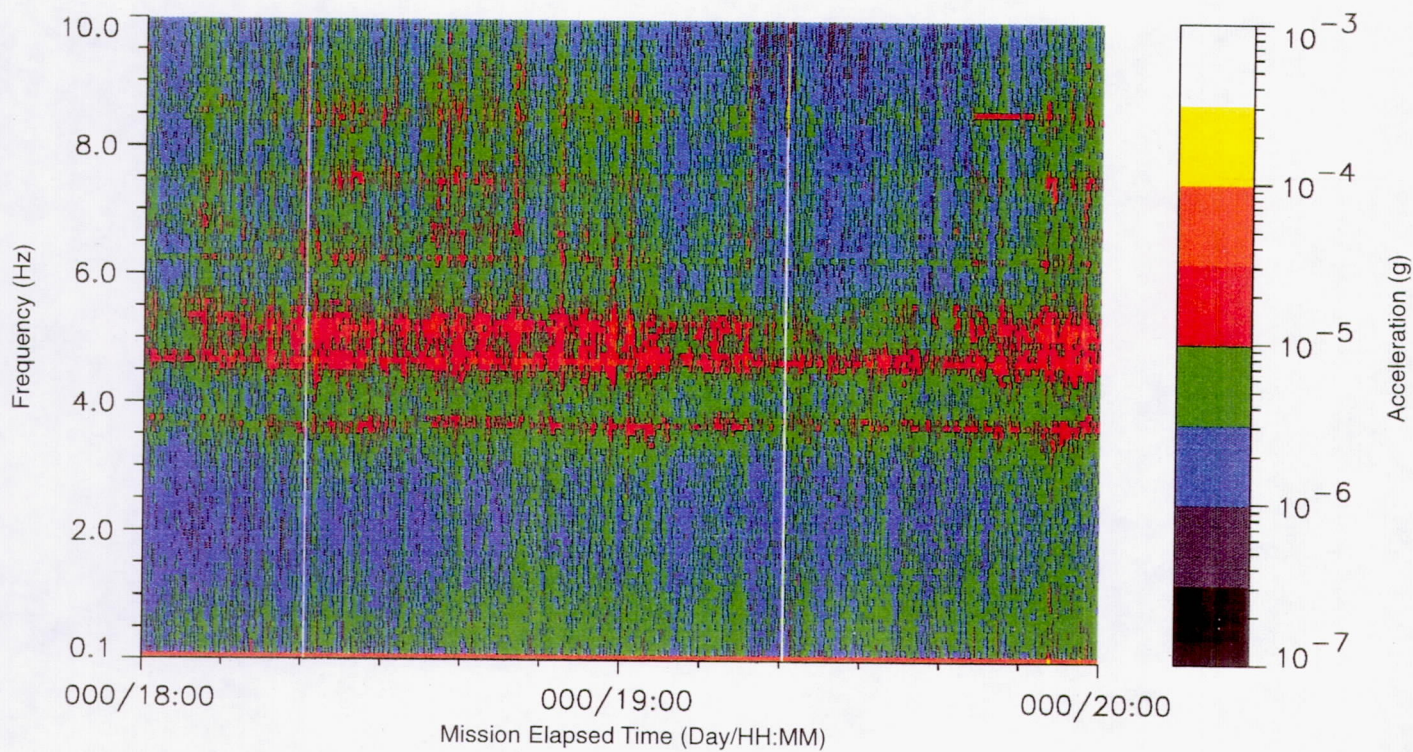


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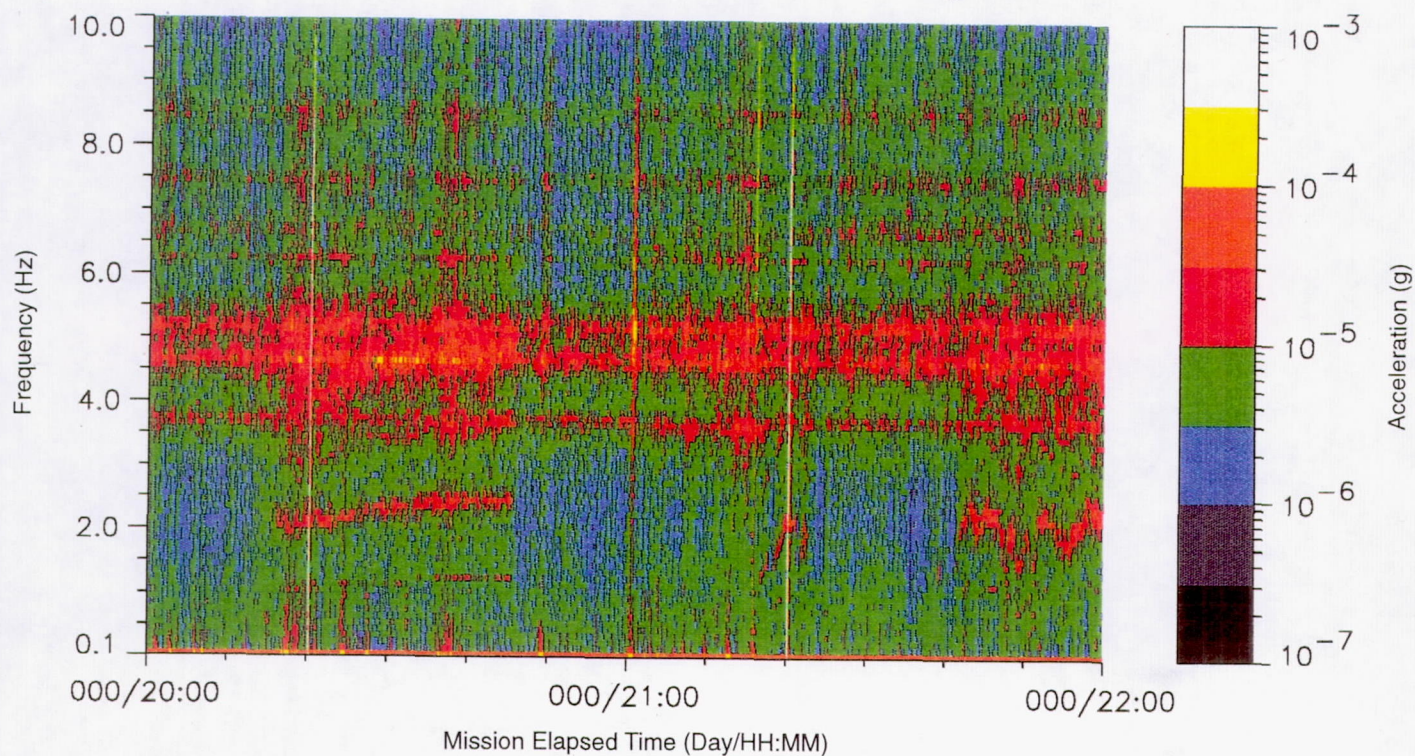


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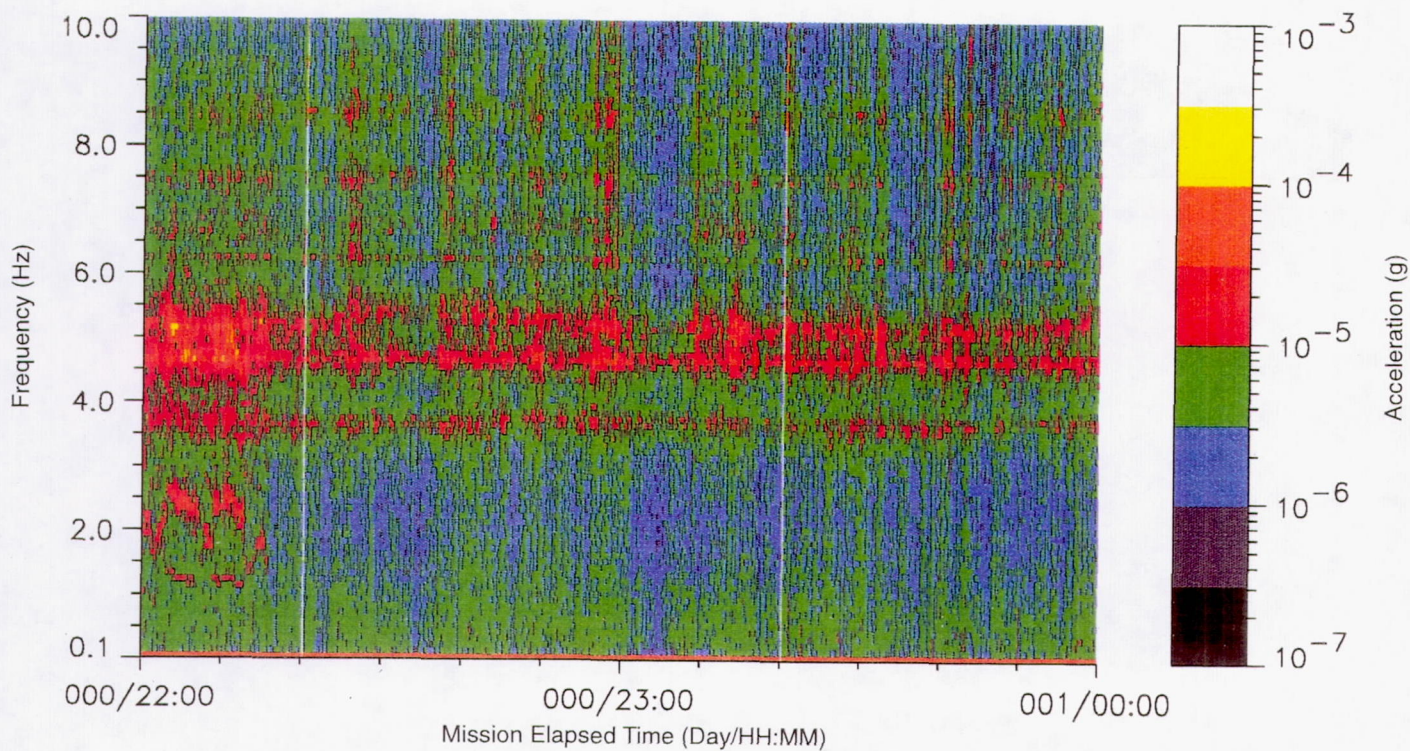


Figure C-9 IML-2 Rack 8, Vector Magnitude

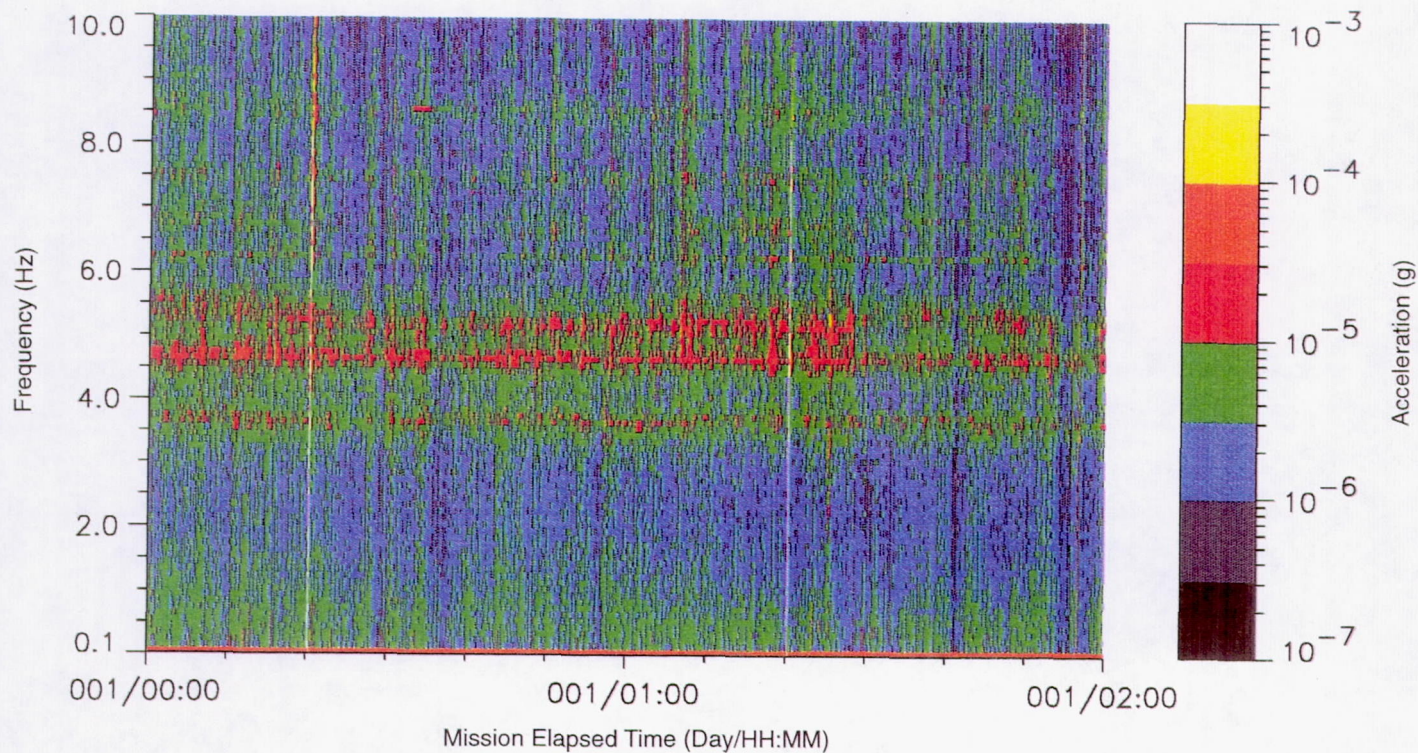


Figure C-10 IML-2 Rack 8, Vector Magnitude

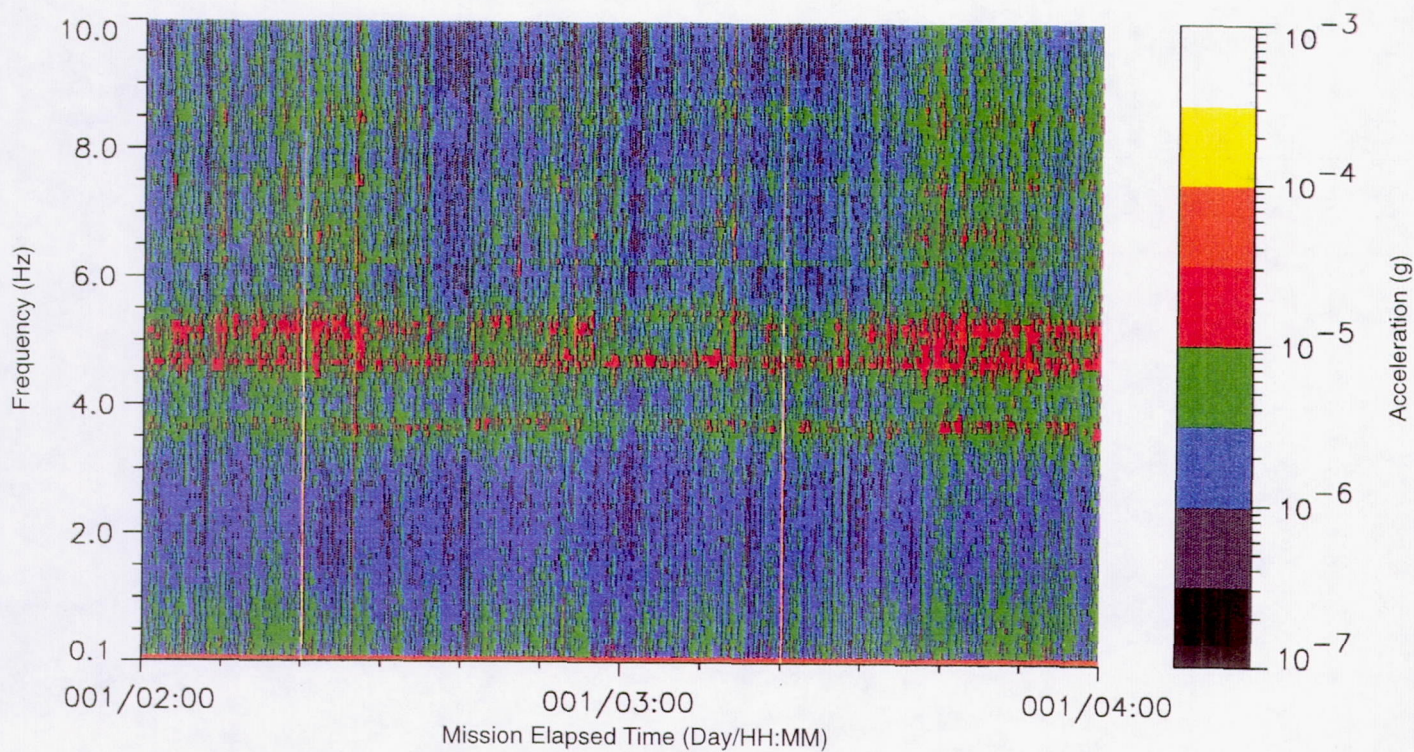


Figure C-11 IML-2 Rack 8, Vector Magnitude

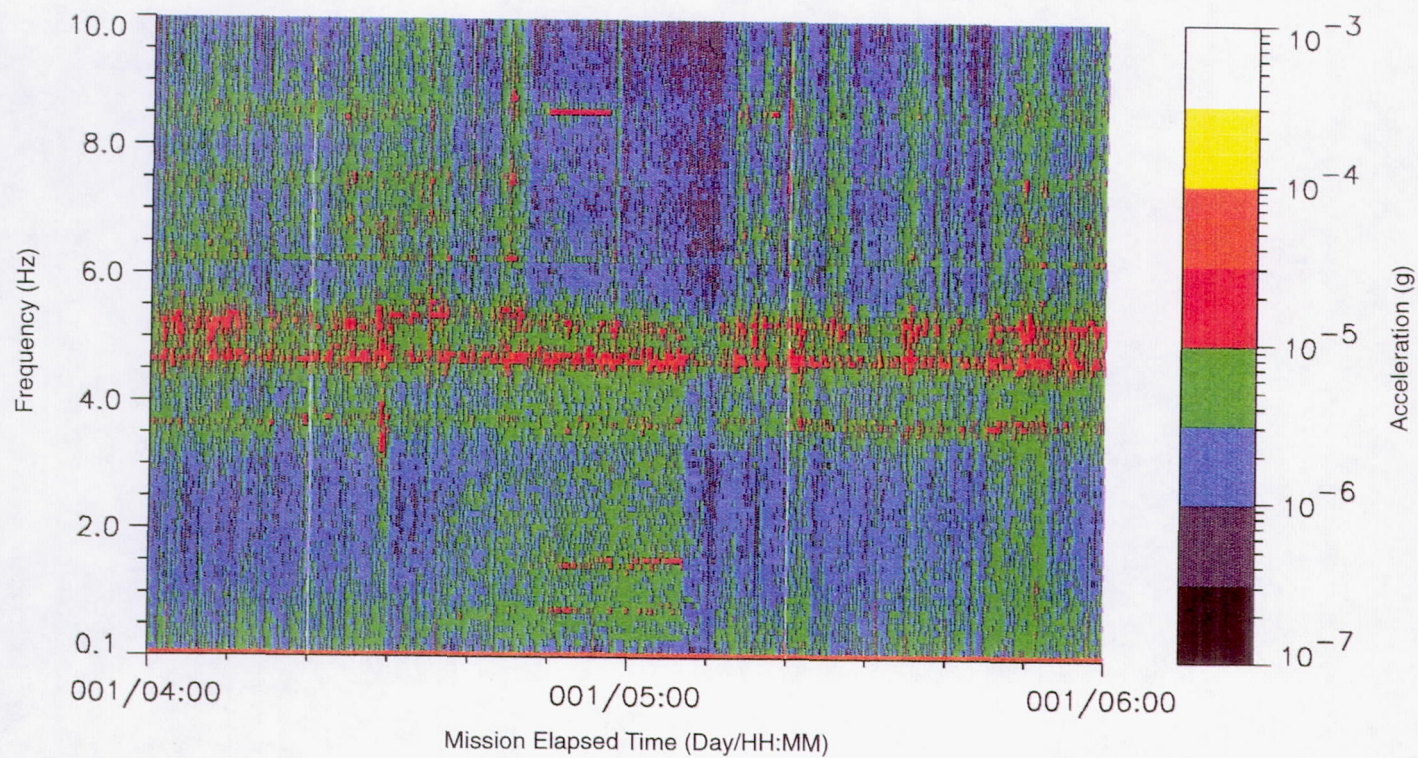


Figure C-12 IML-2 Rack 8, Vector Magnitude

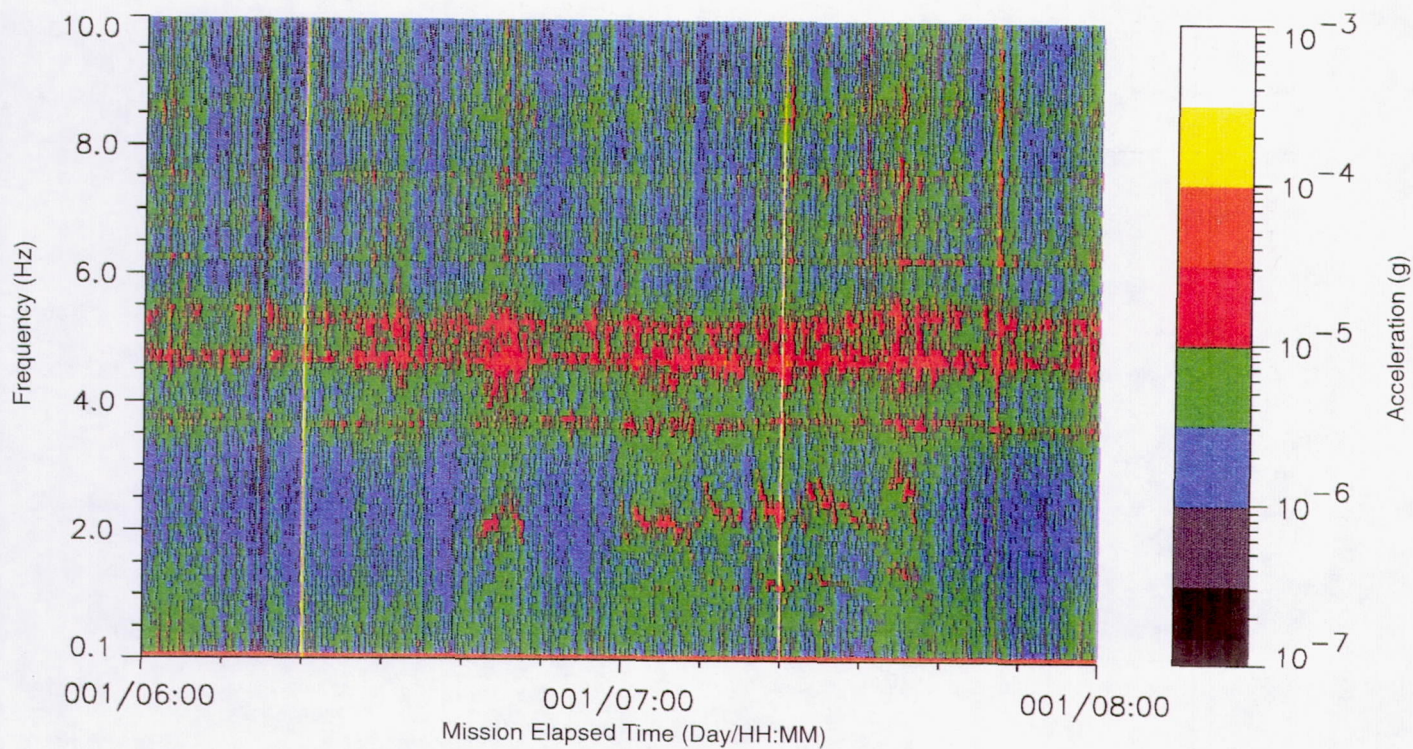


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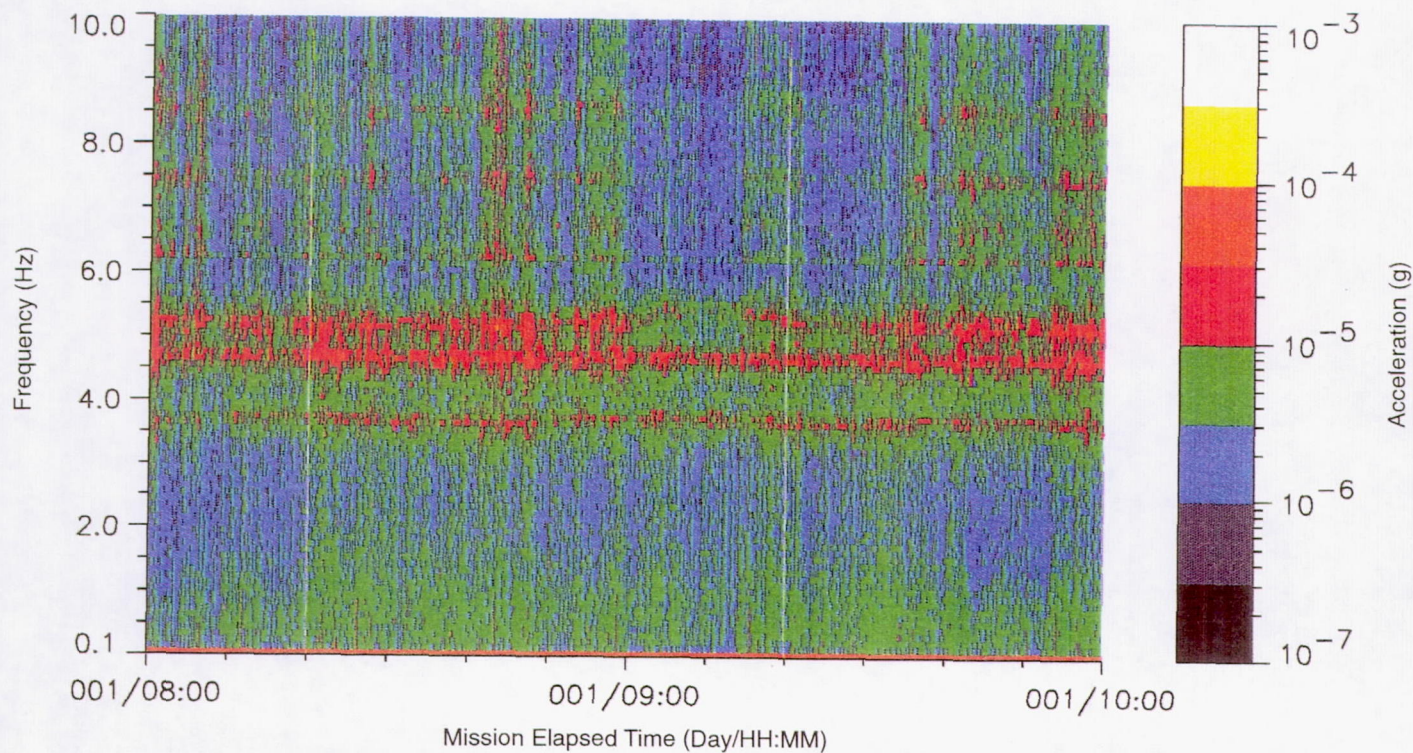


Figure C-14 IML-2 Rack 8, Vector Magnitude

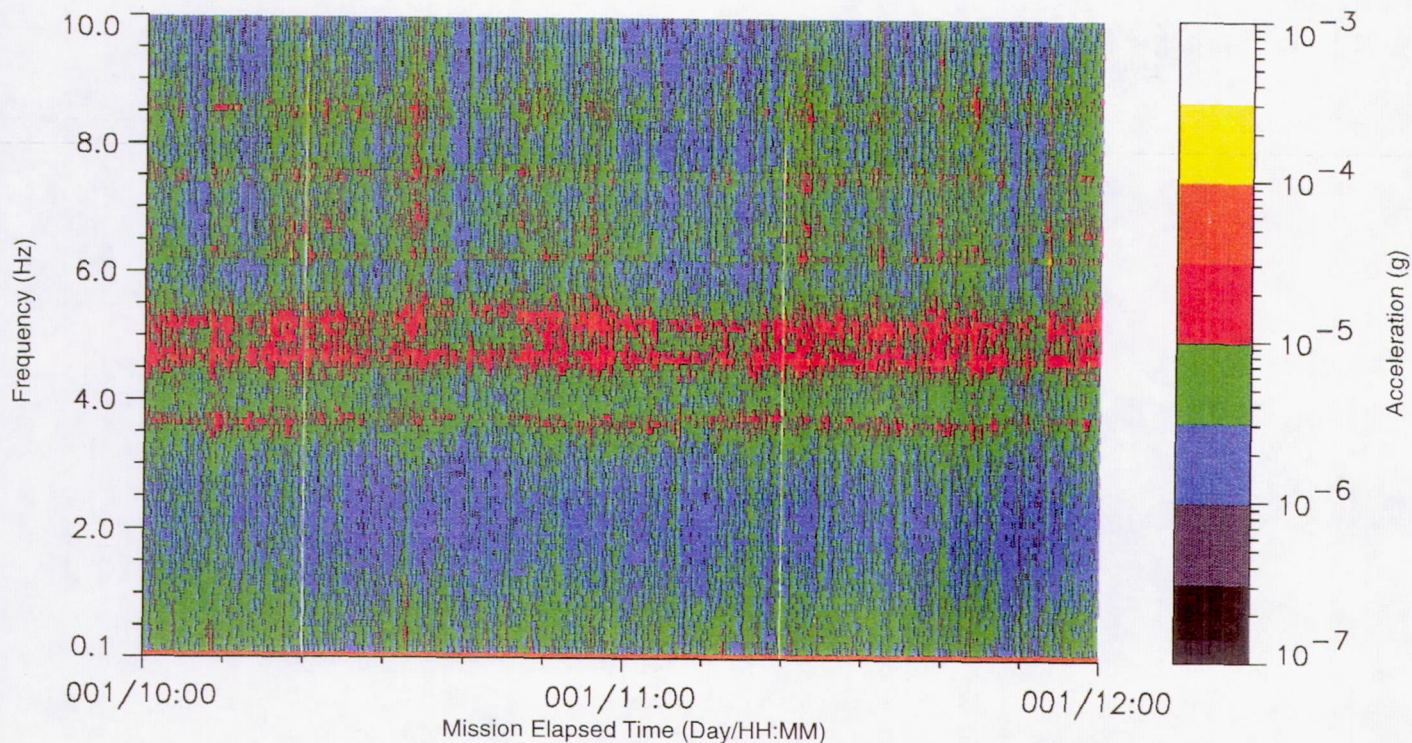


Figure C-15 IML-2 Rack 8, Vector Magnitude

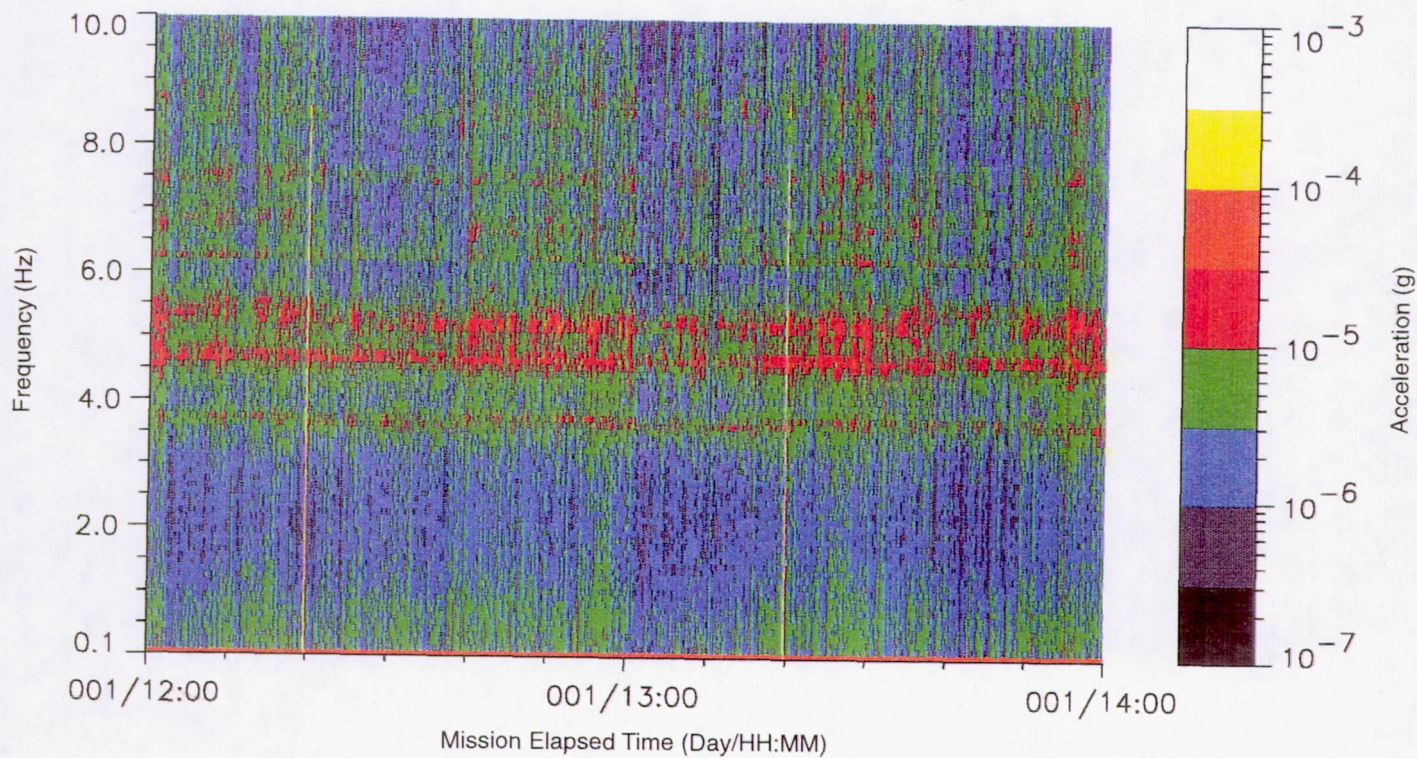


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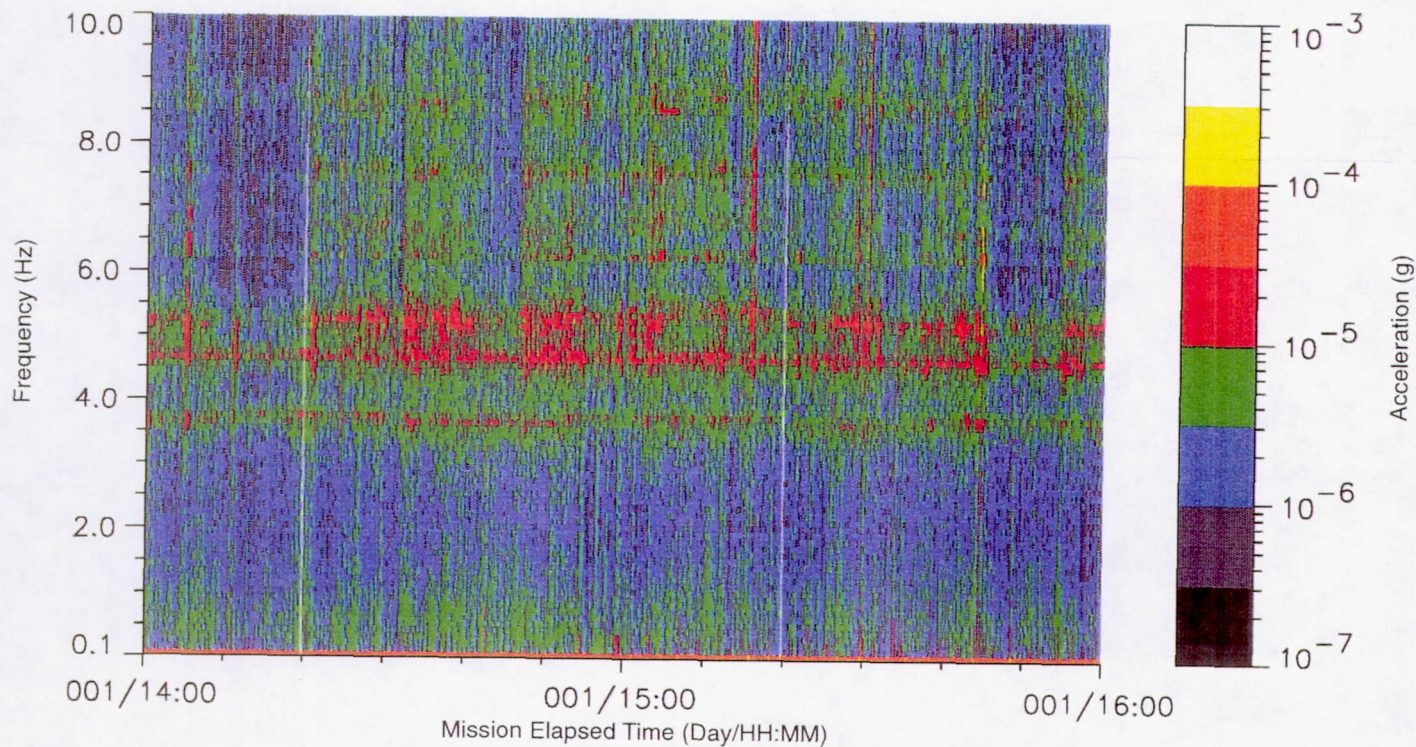


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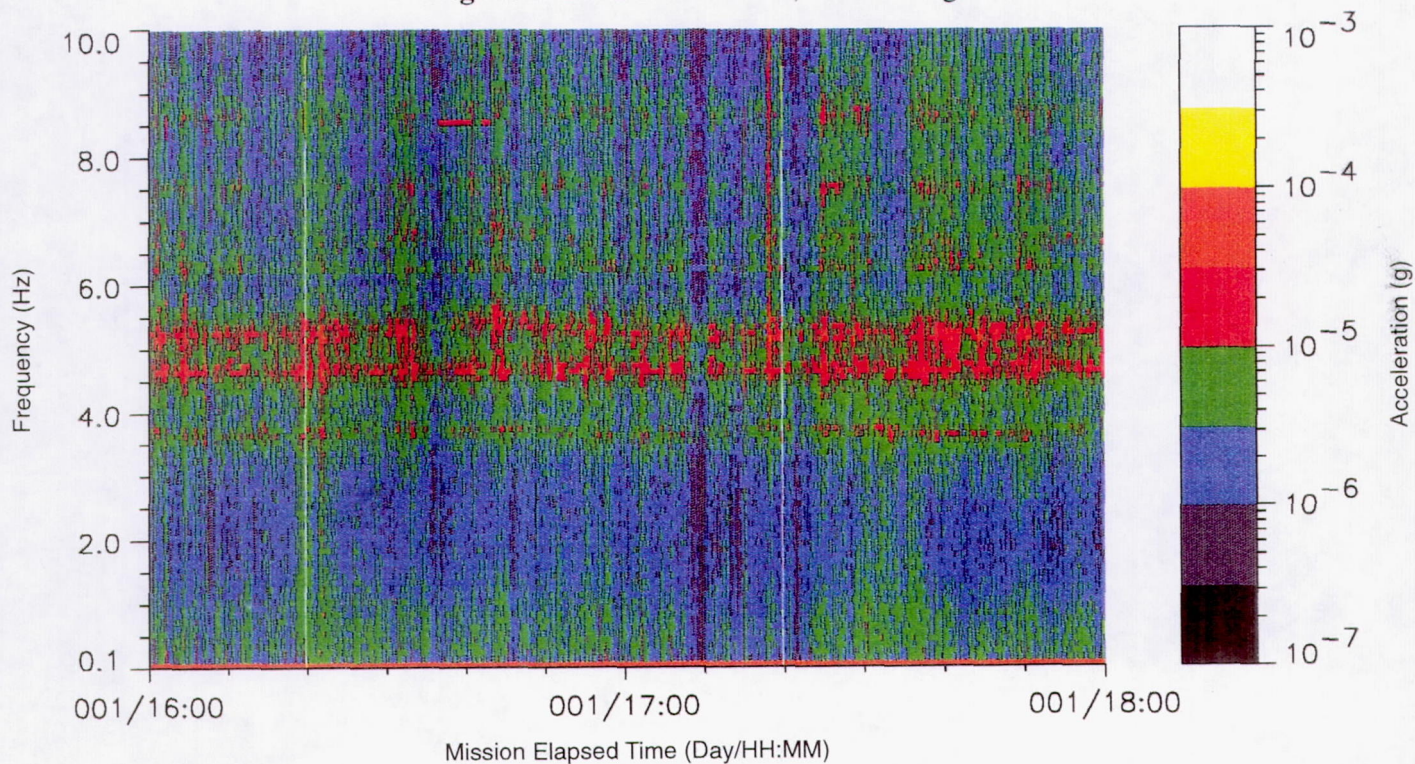


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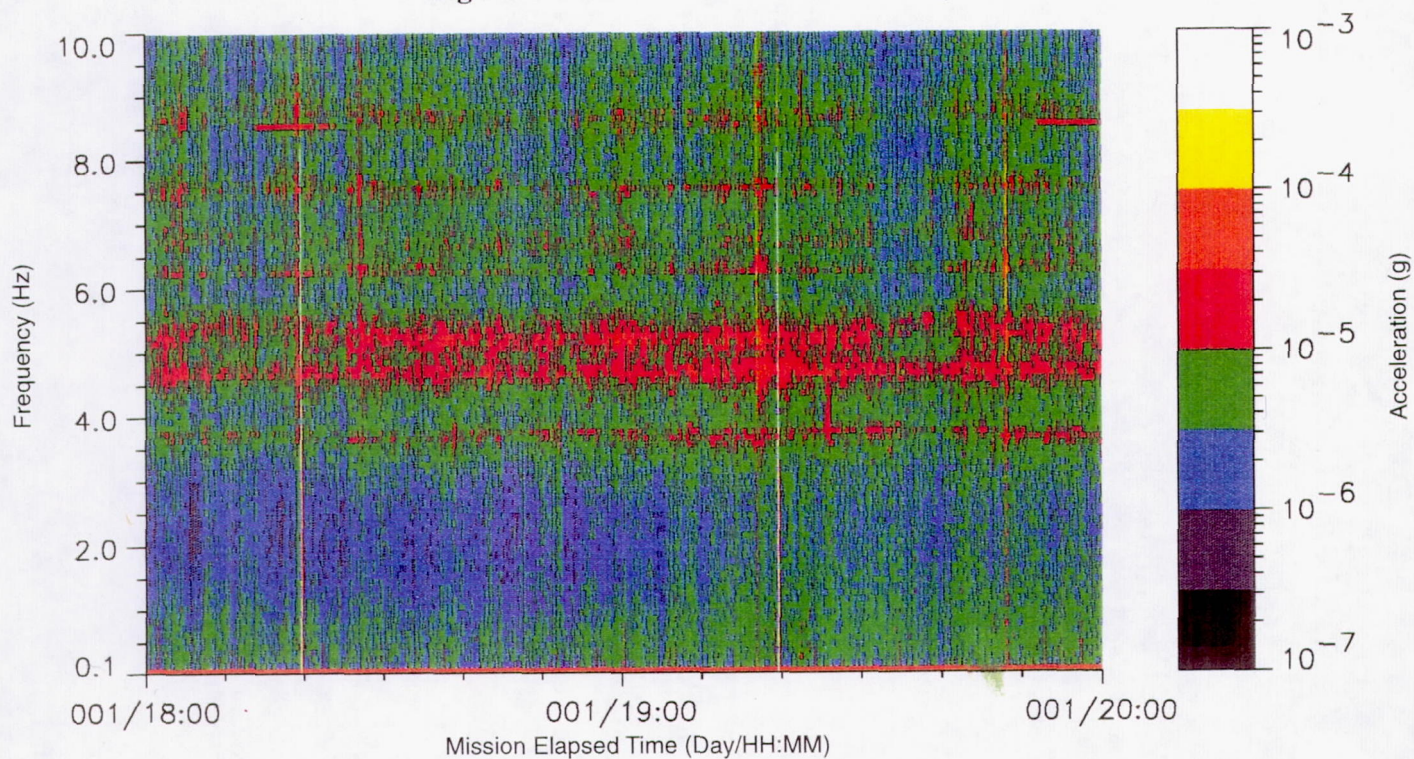


Figure C-19 IML-2 Rack 8, Vector Magnitude

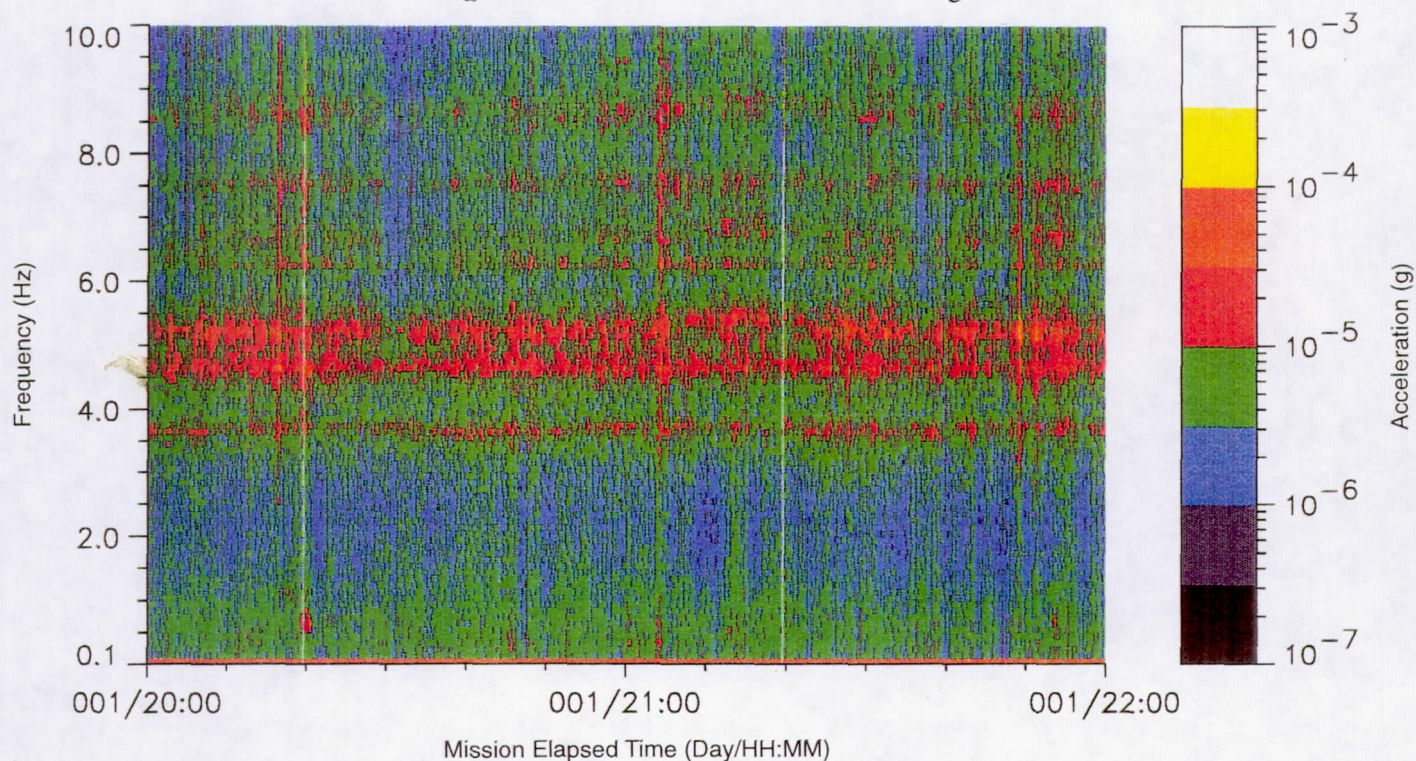


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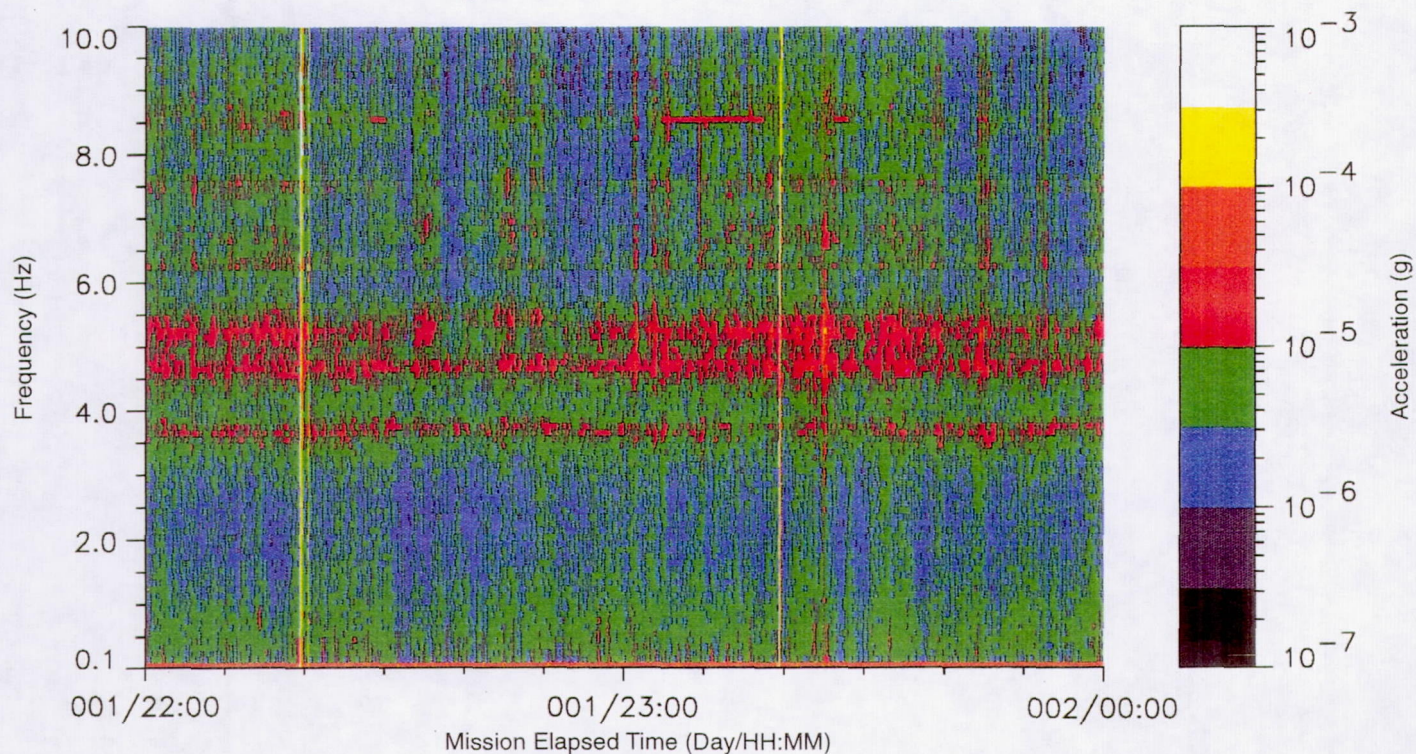
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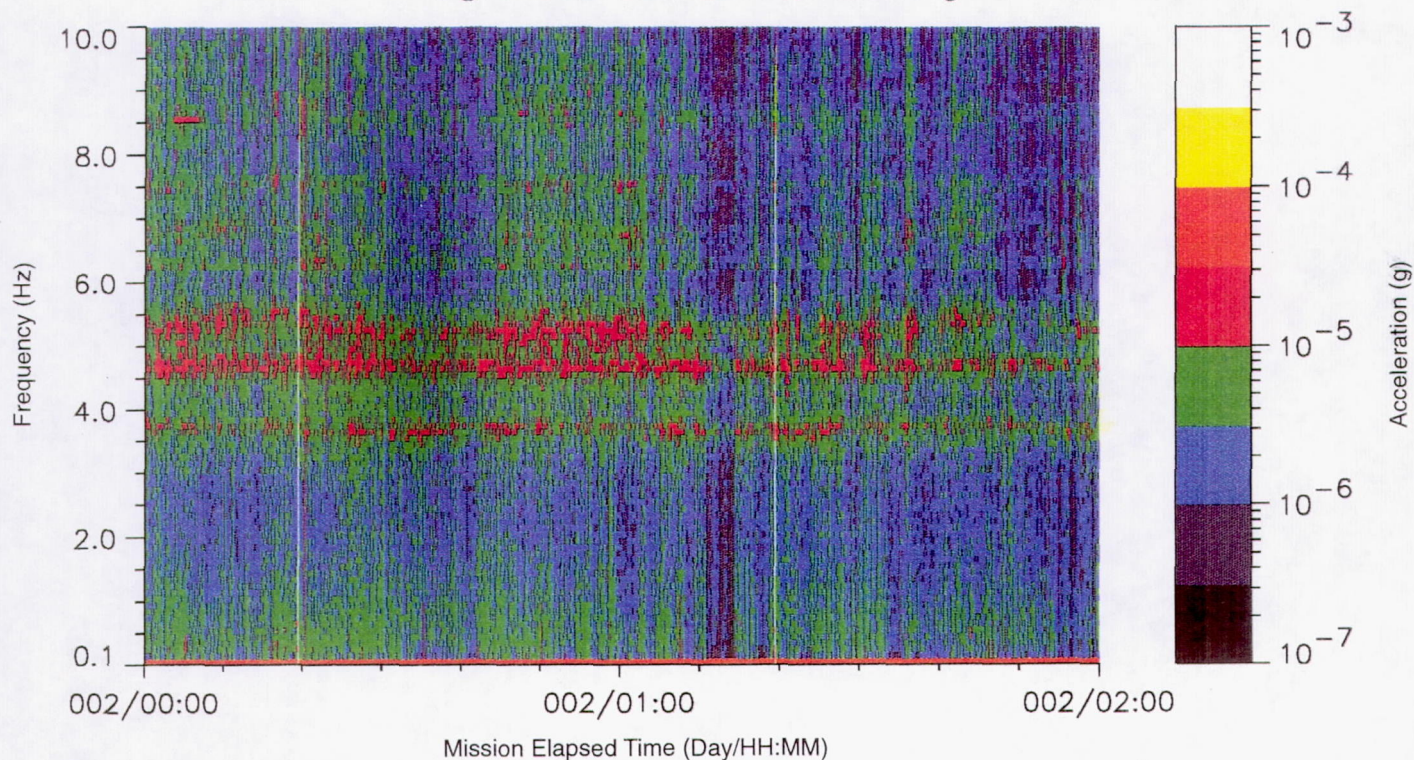


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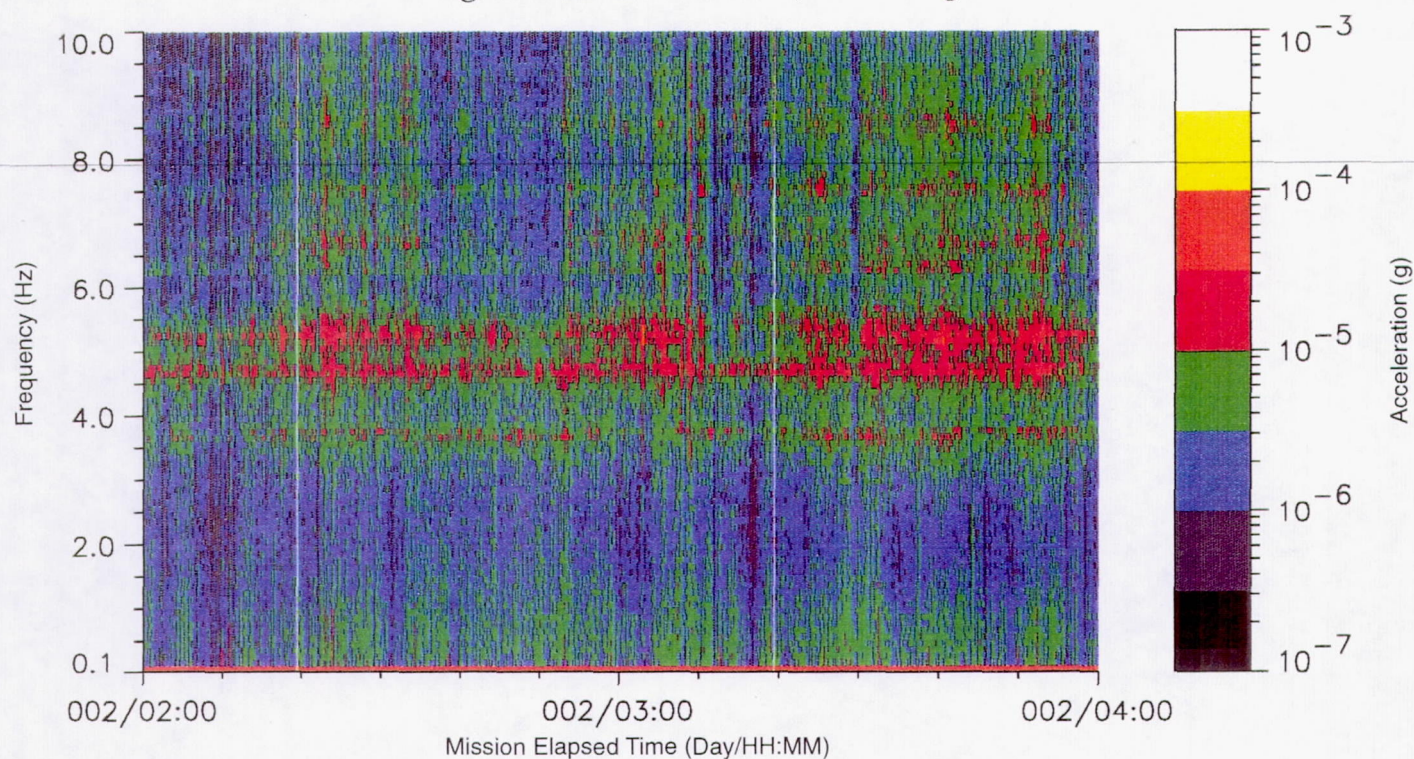


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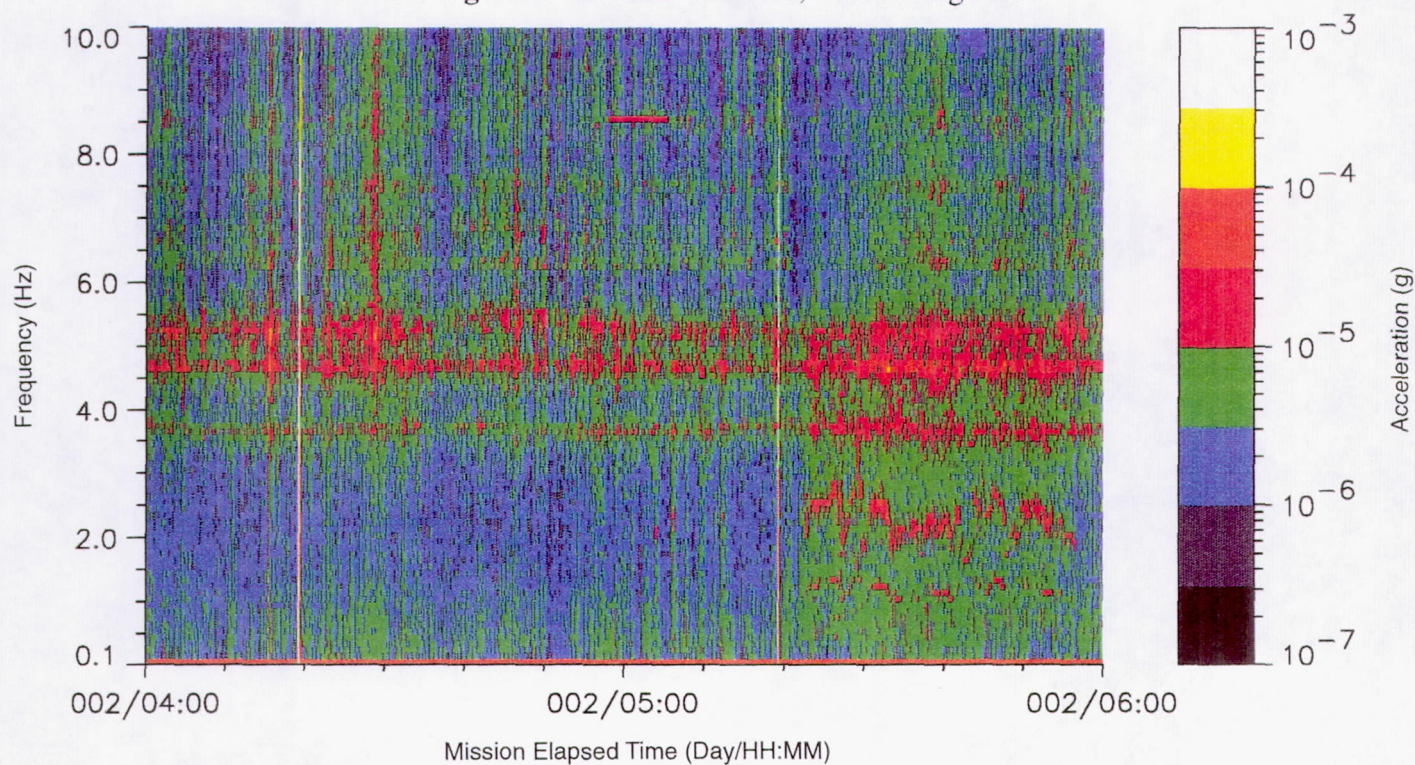


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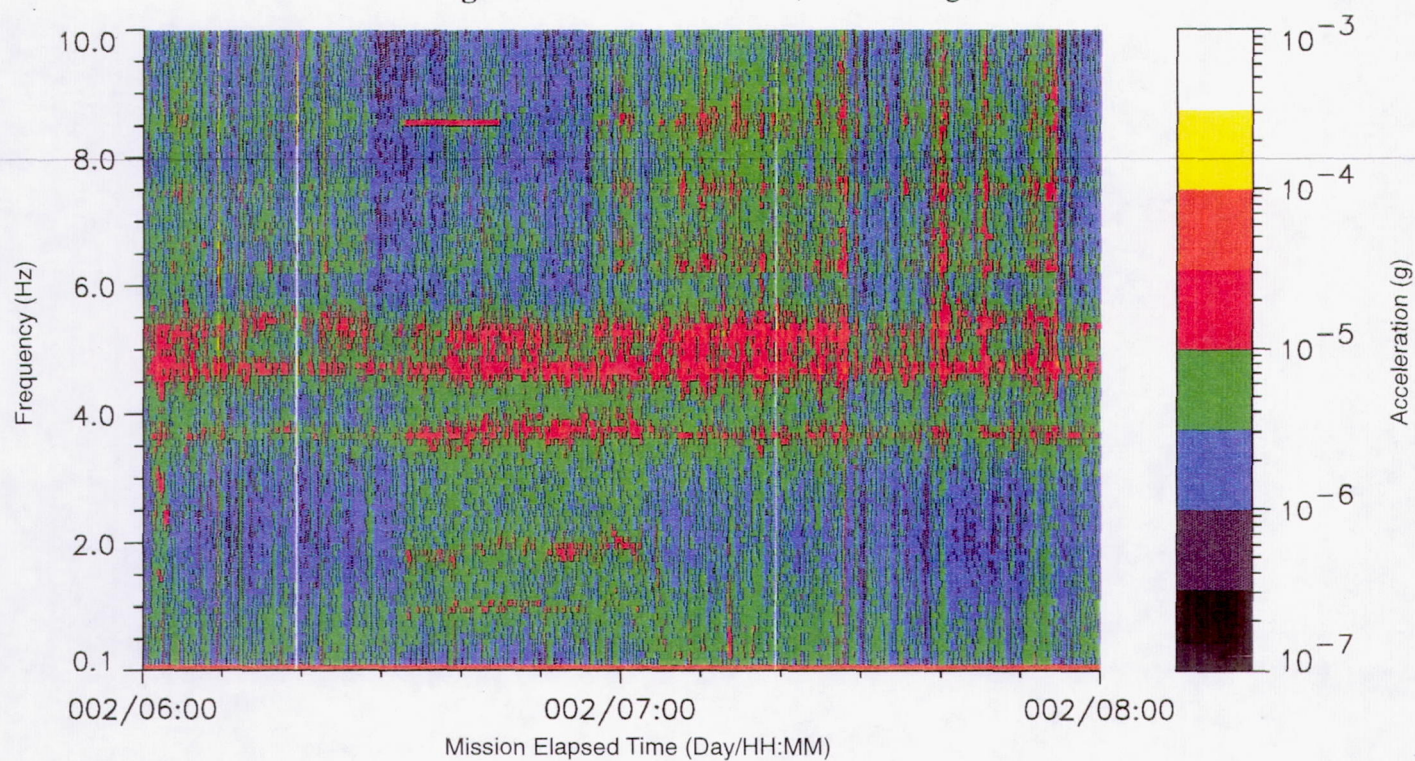


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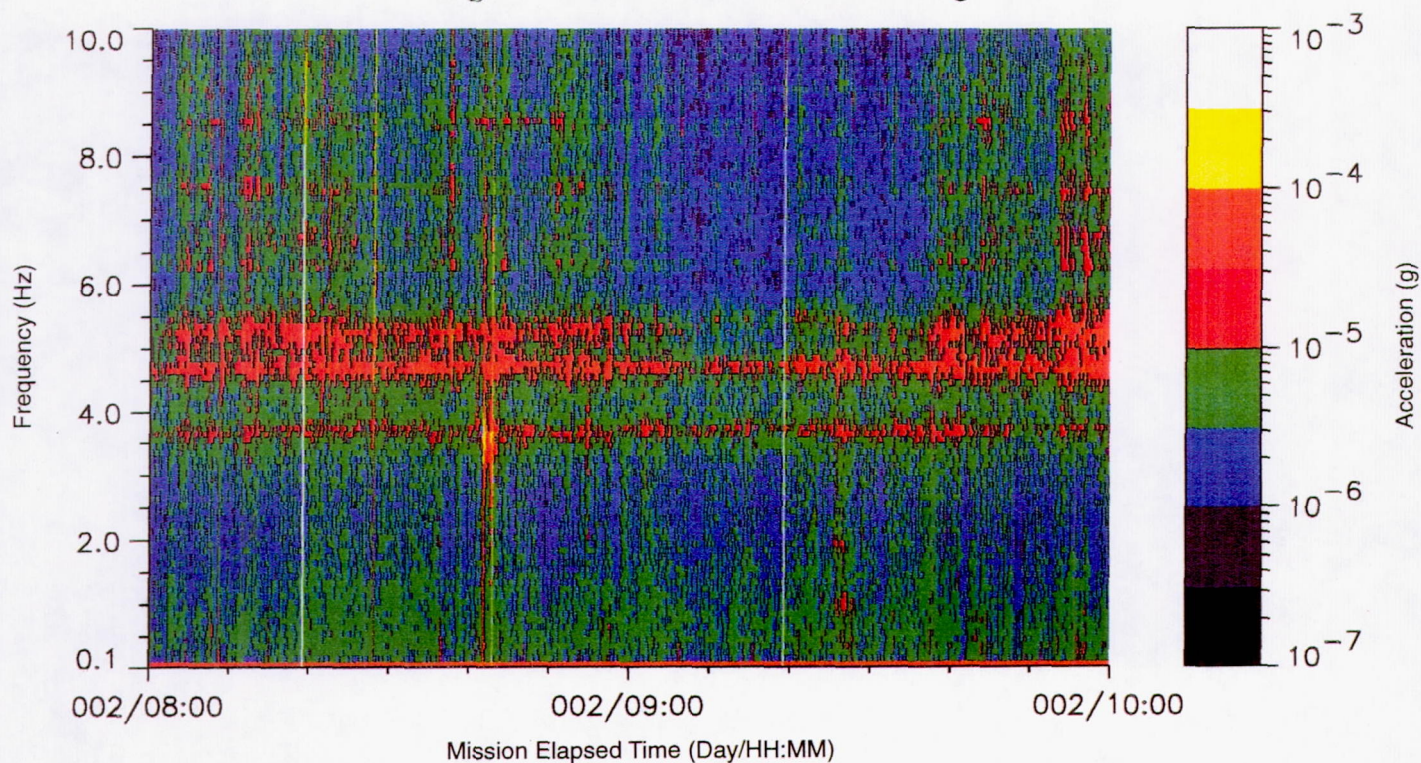
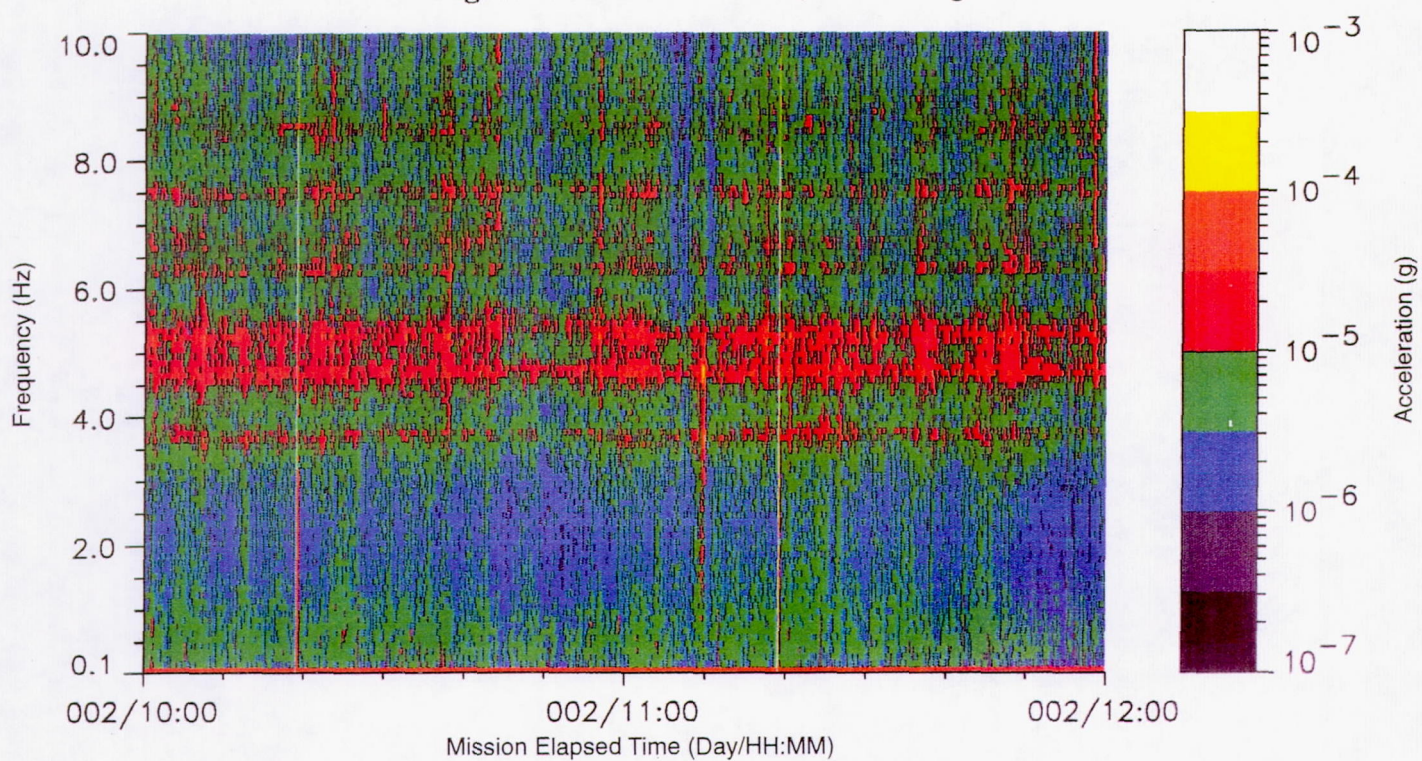


Figure C-26 IML-2 Rack 8, Vector Magnitude



SUMMARY REPORT OF MISSION ACCELERATION MEASUREMENTS FOR STS-65

Figure C-27 IML-2 Rack 8, Vector Magnitude

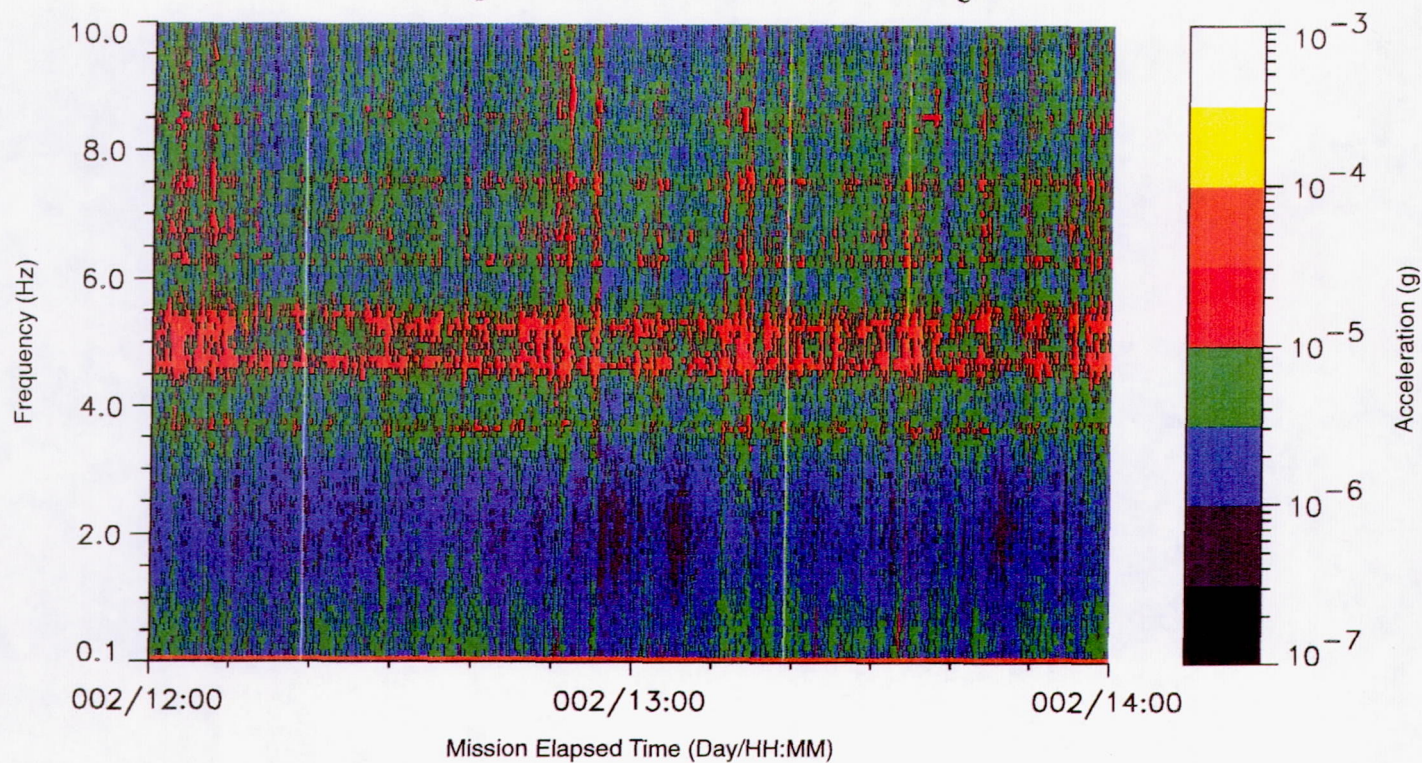
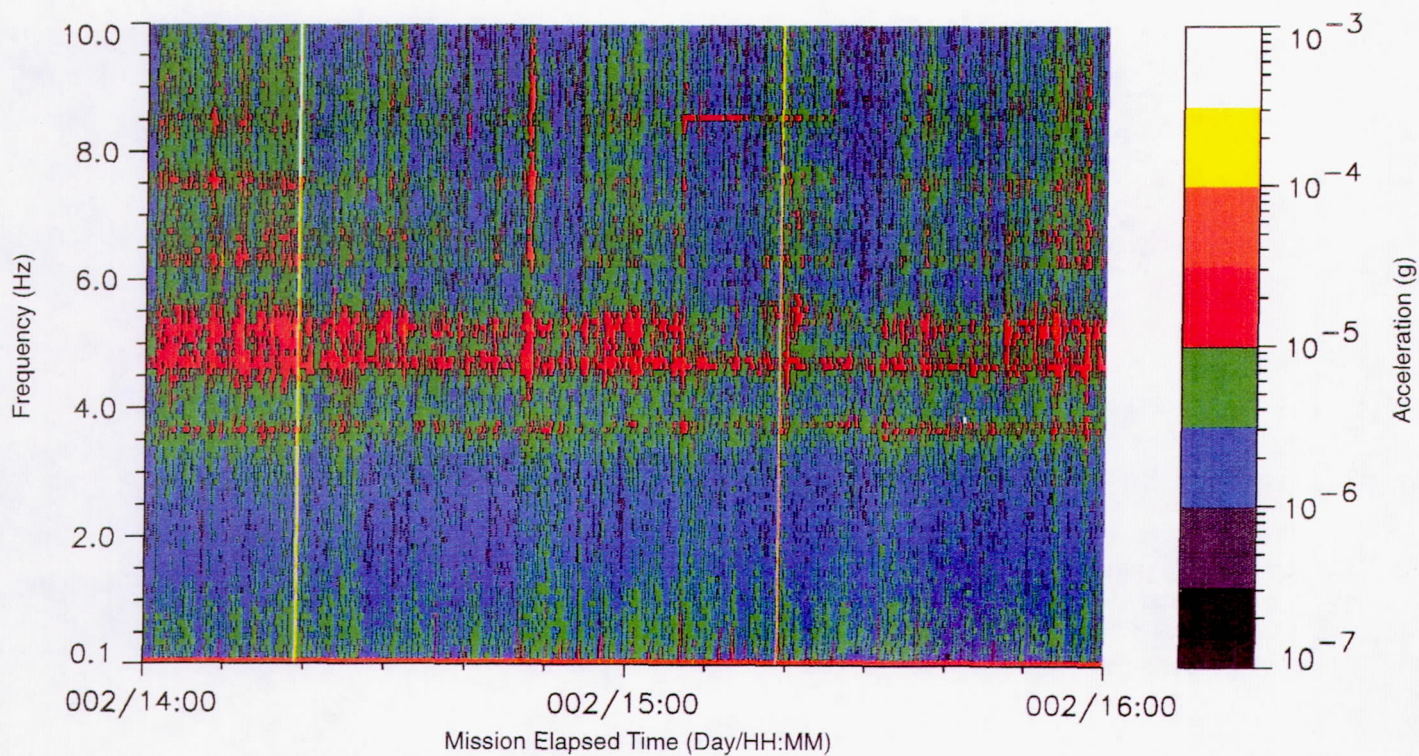


Figure C-28 IML-2 Rack 8, Vector Magnitude



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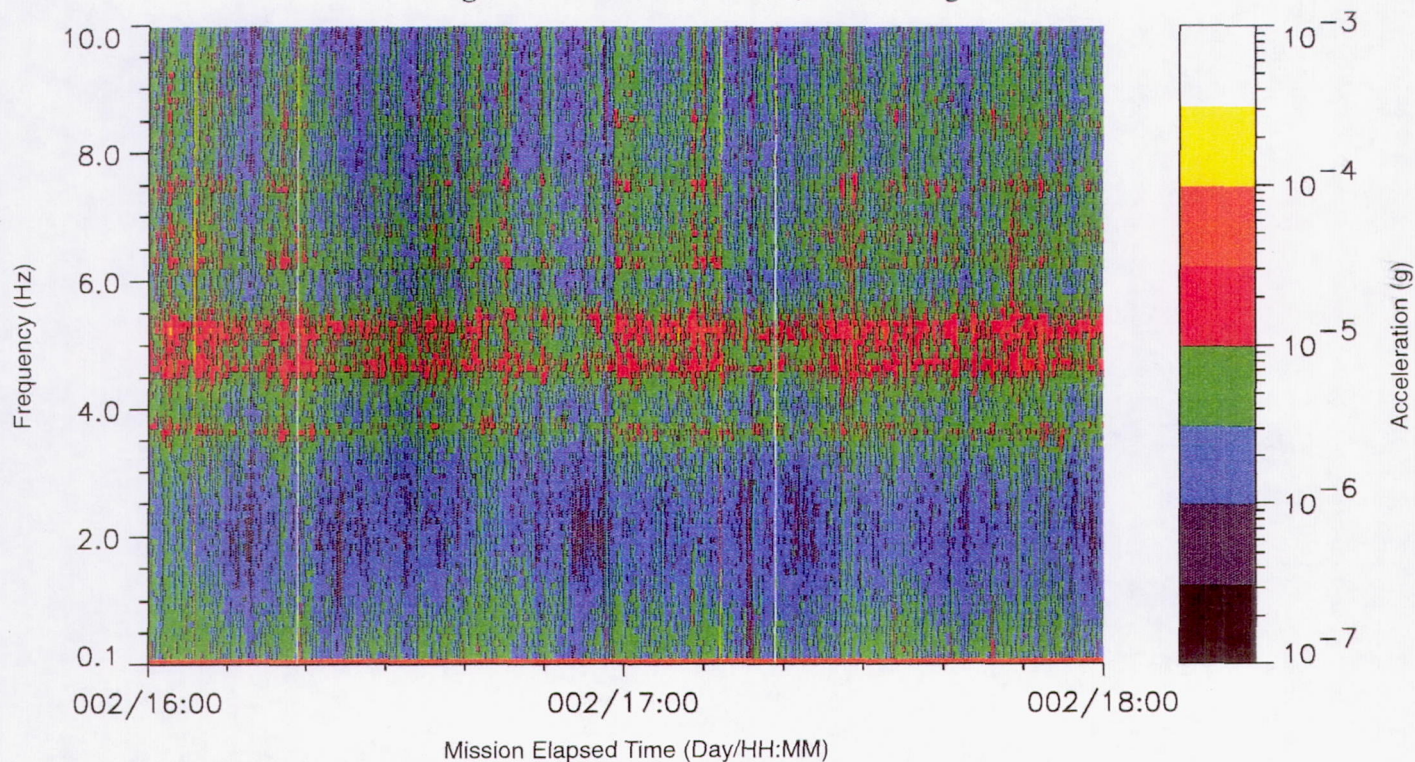


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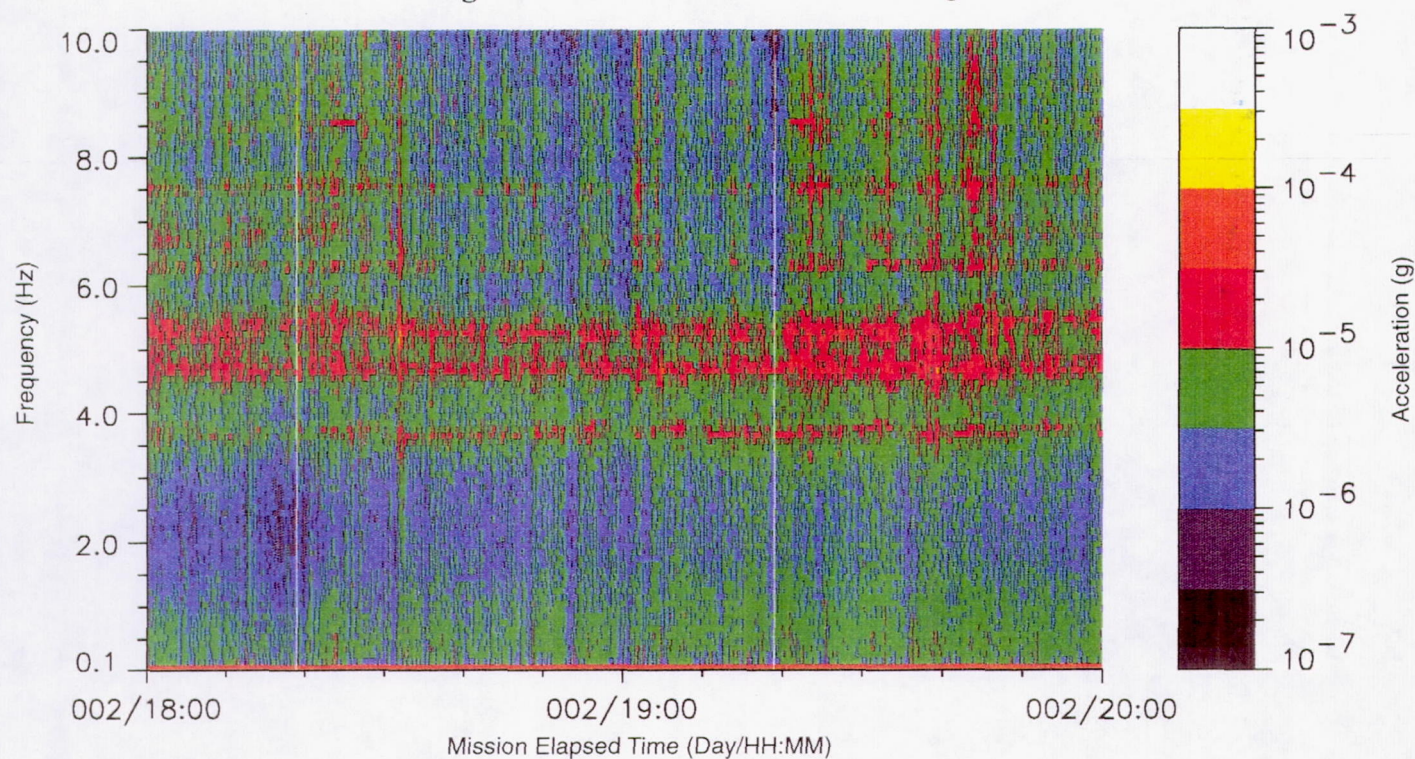


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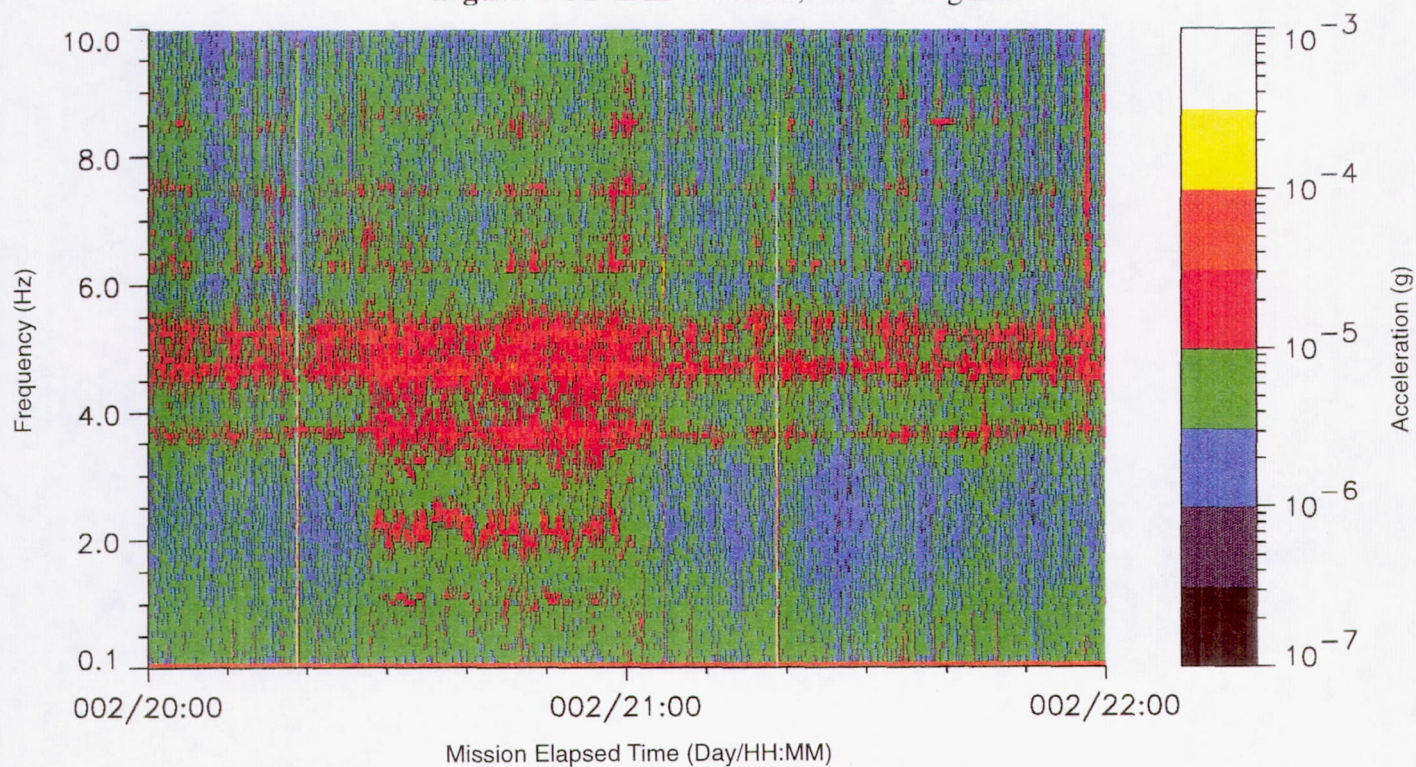


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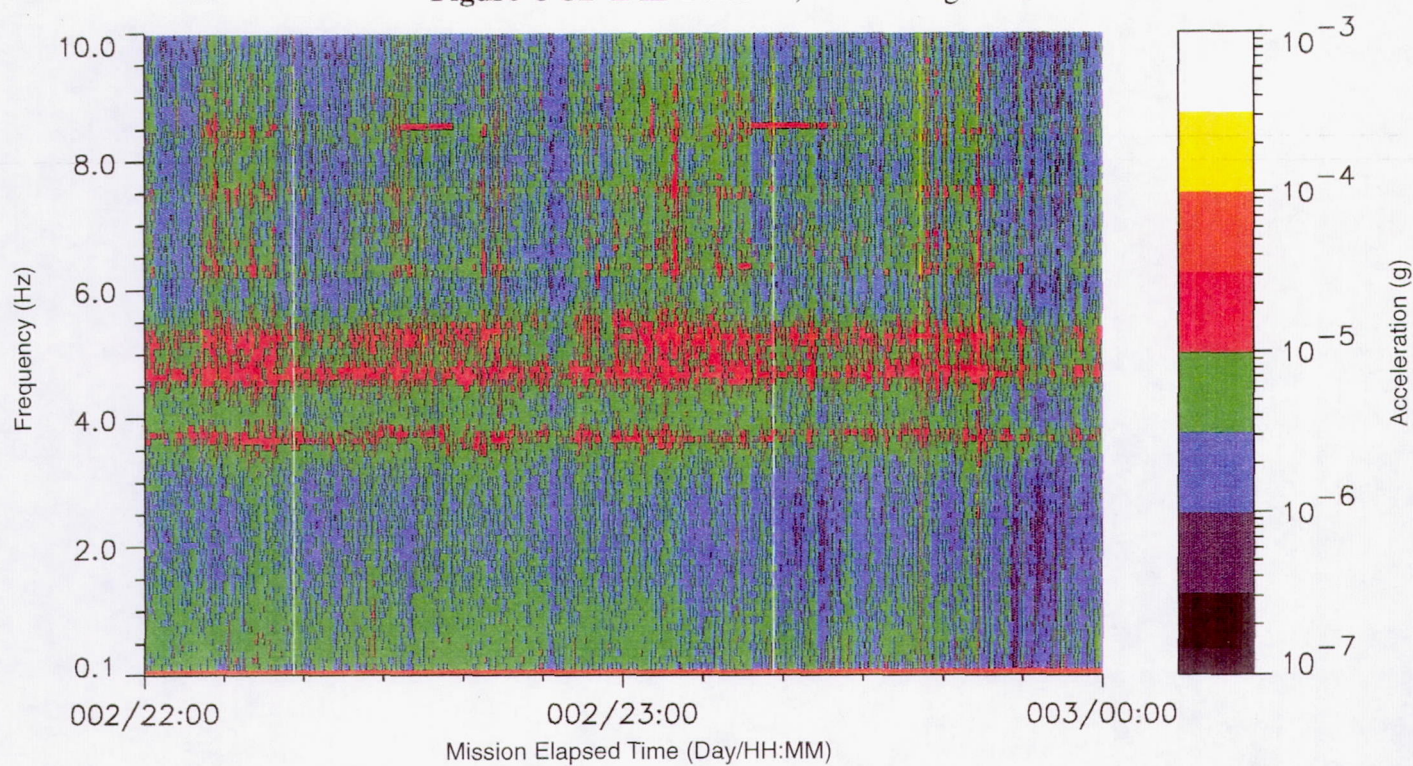


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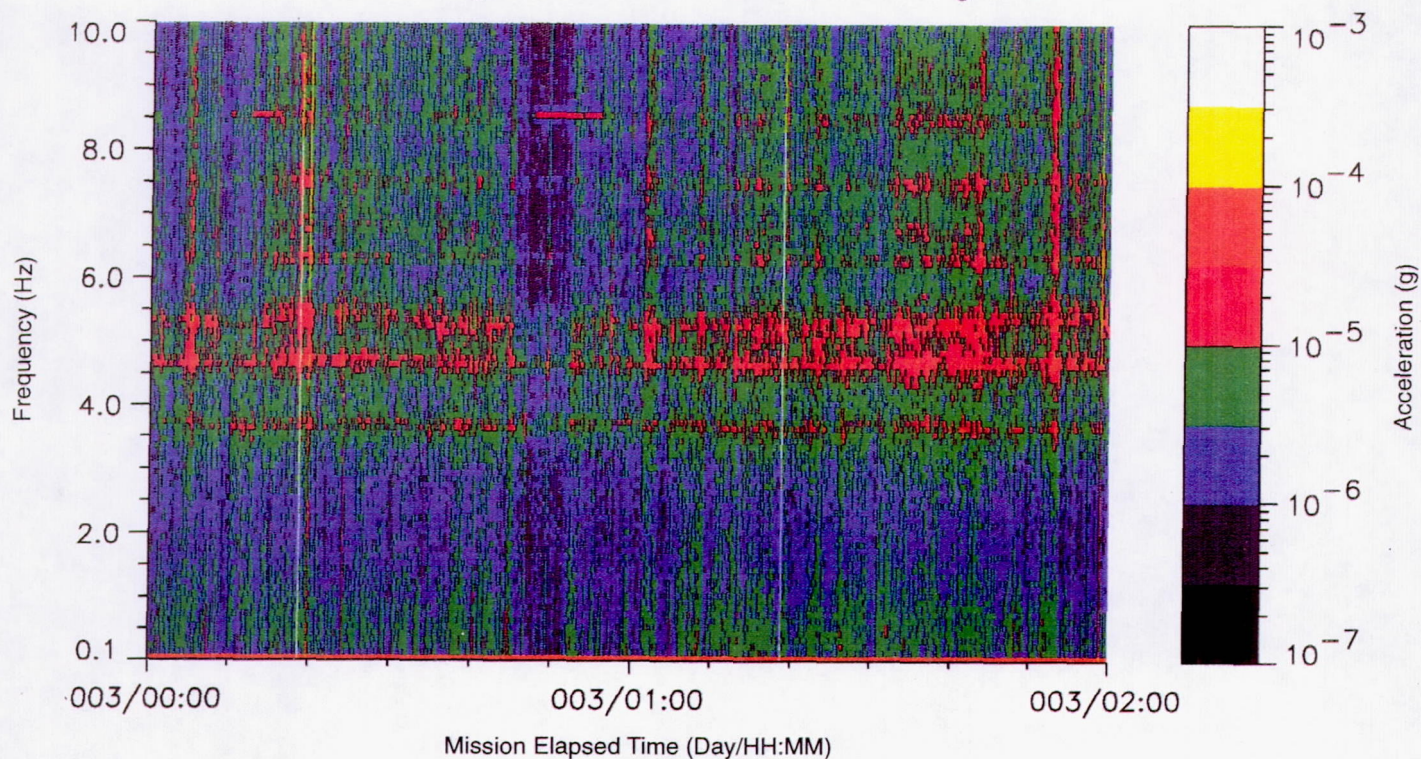


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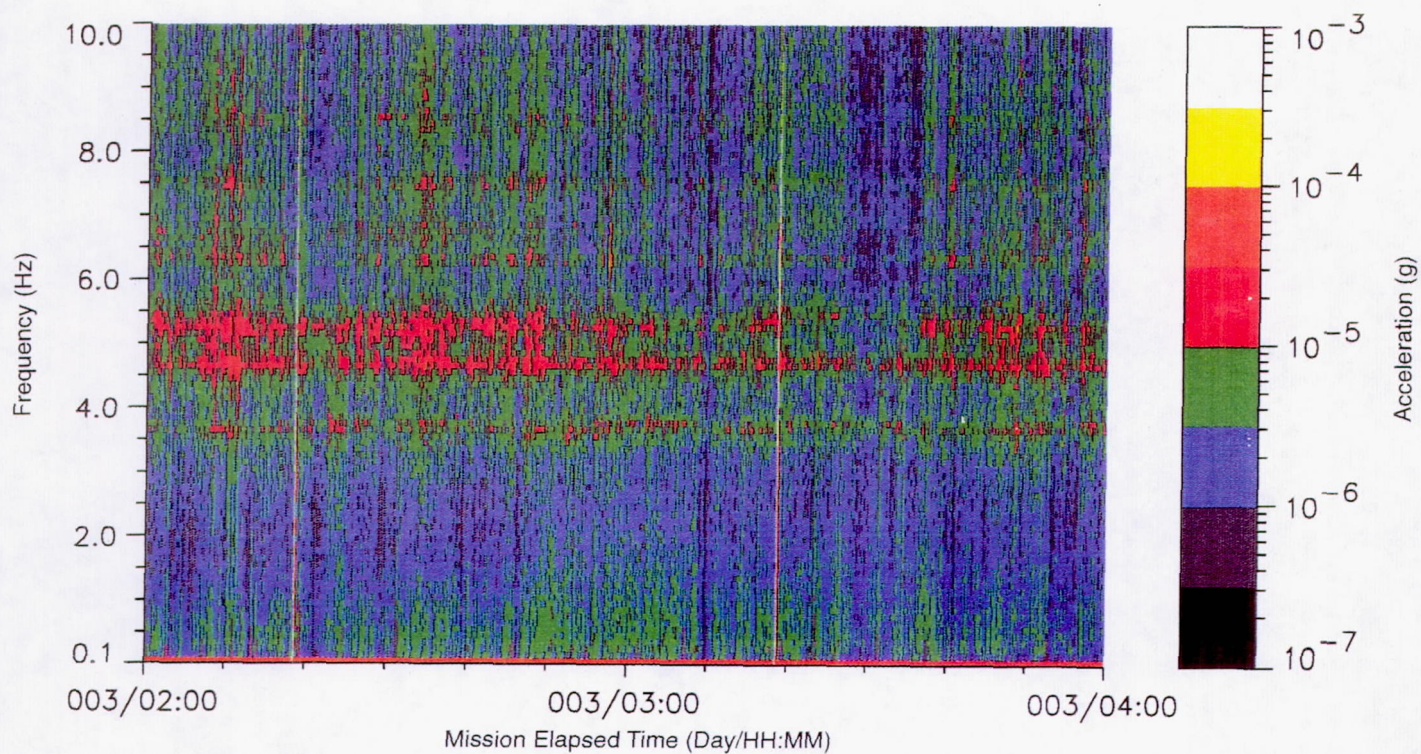


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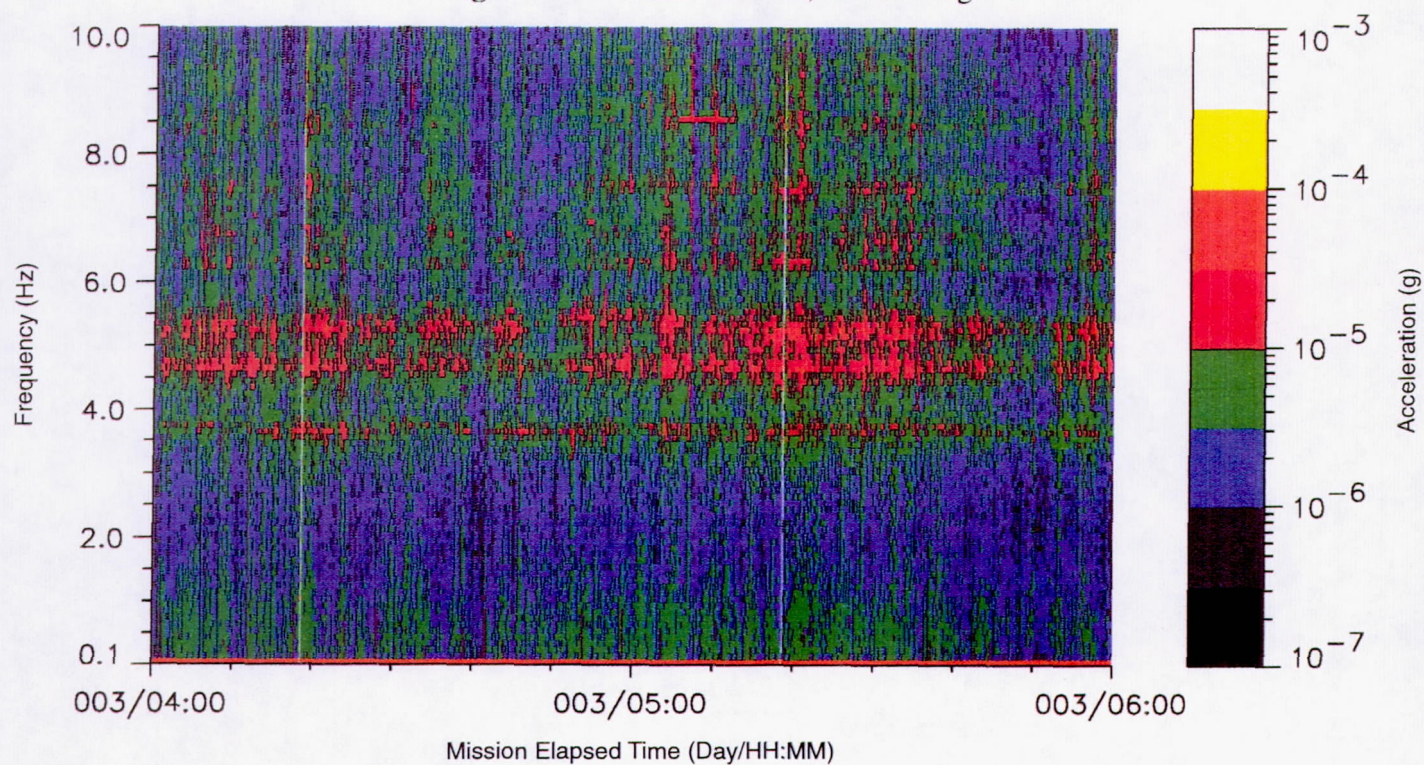


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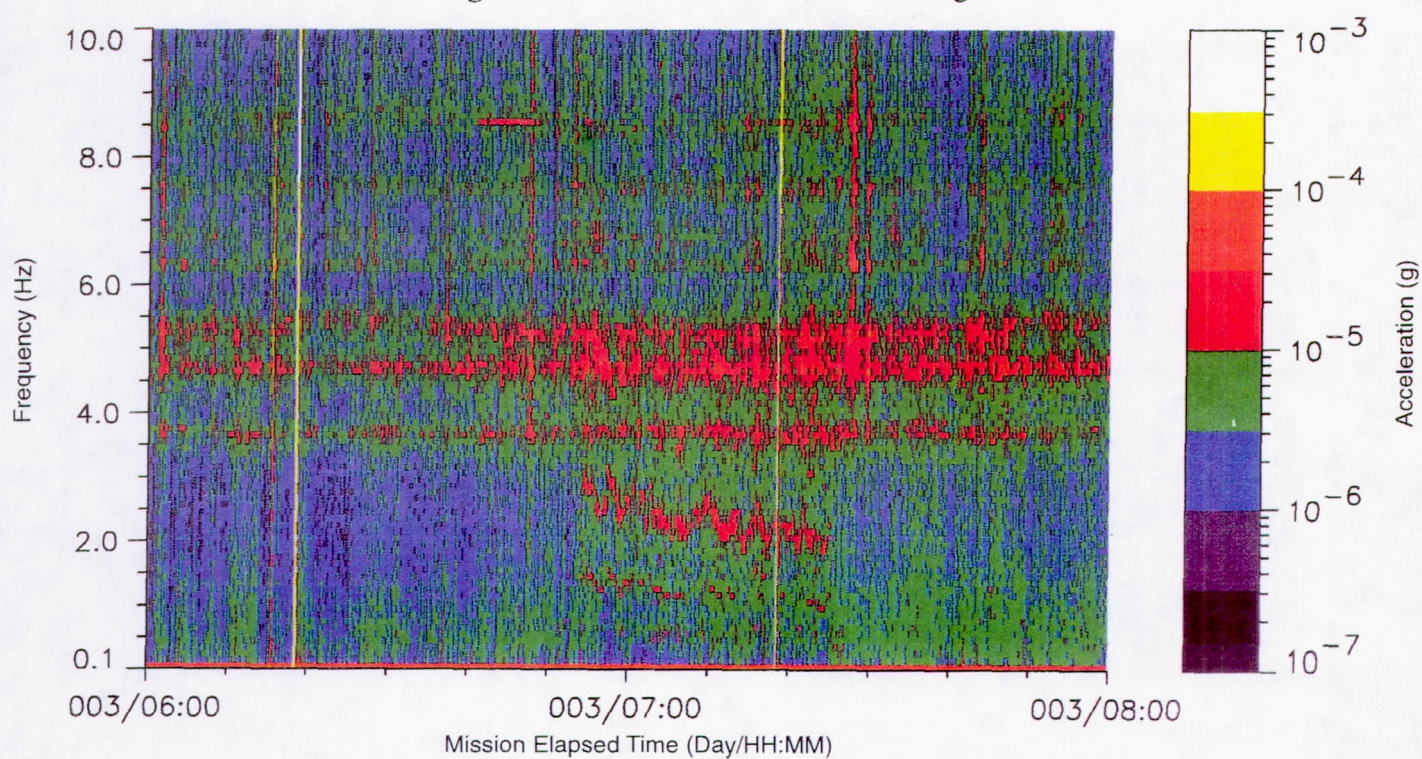


Figure C-37 IML-2 Rack 8, Vector Magnitude

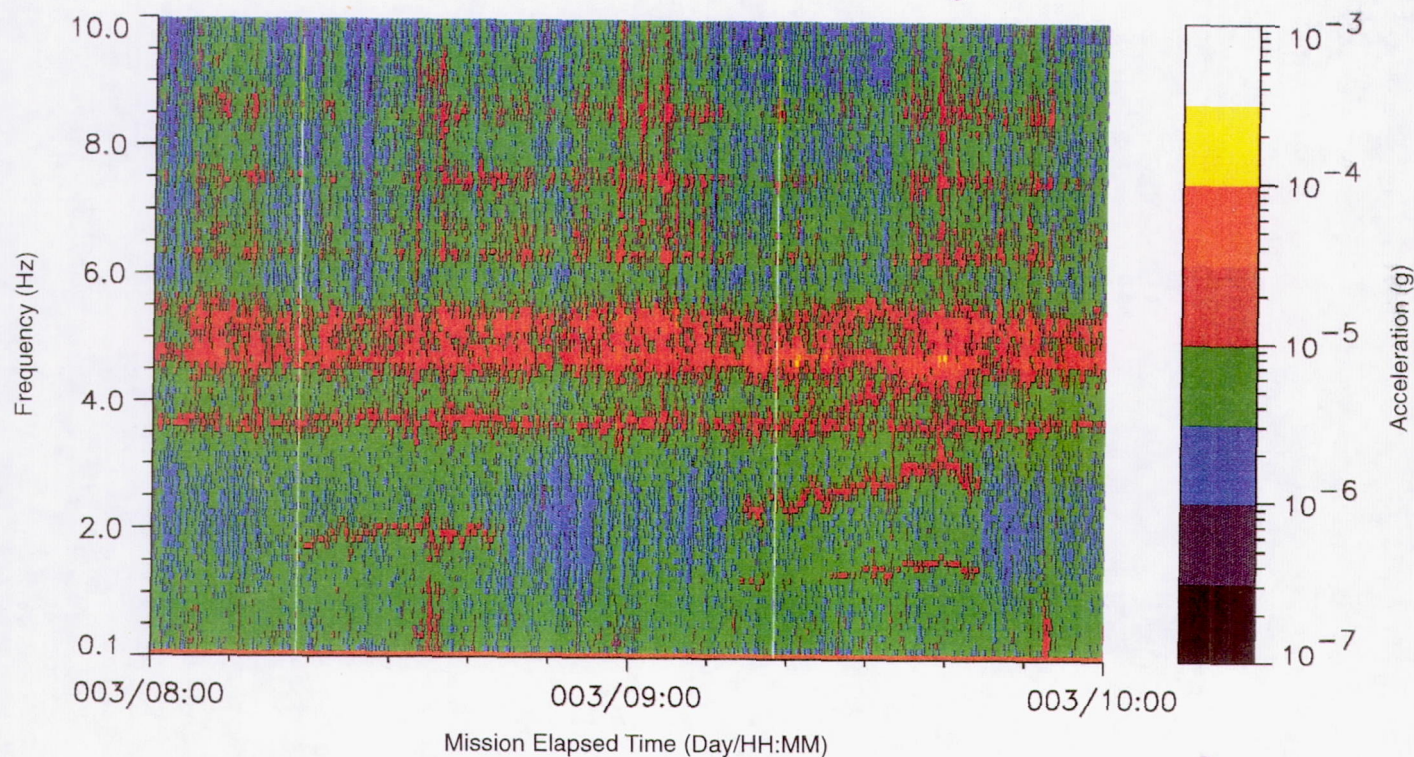


Figure C-38 IML-2 Rack 8, Vector Magnitude

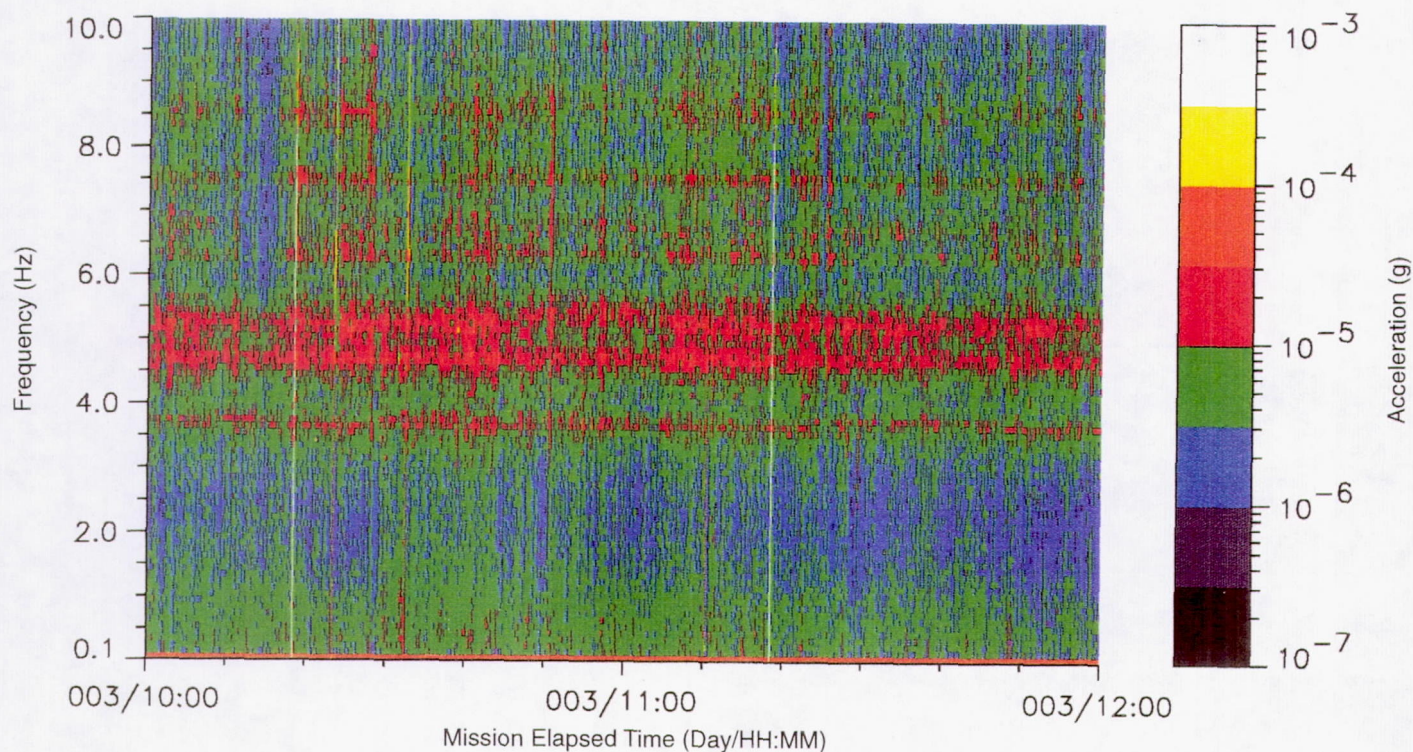


Figure C-39 IML-2 Rack 8, Vector Magnitude

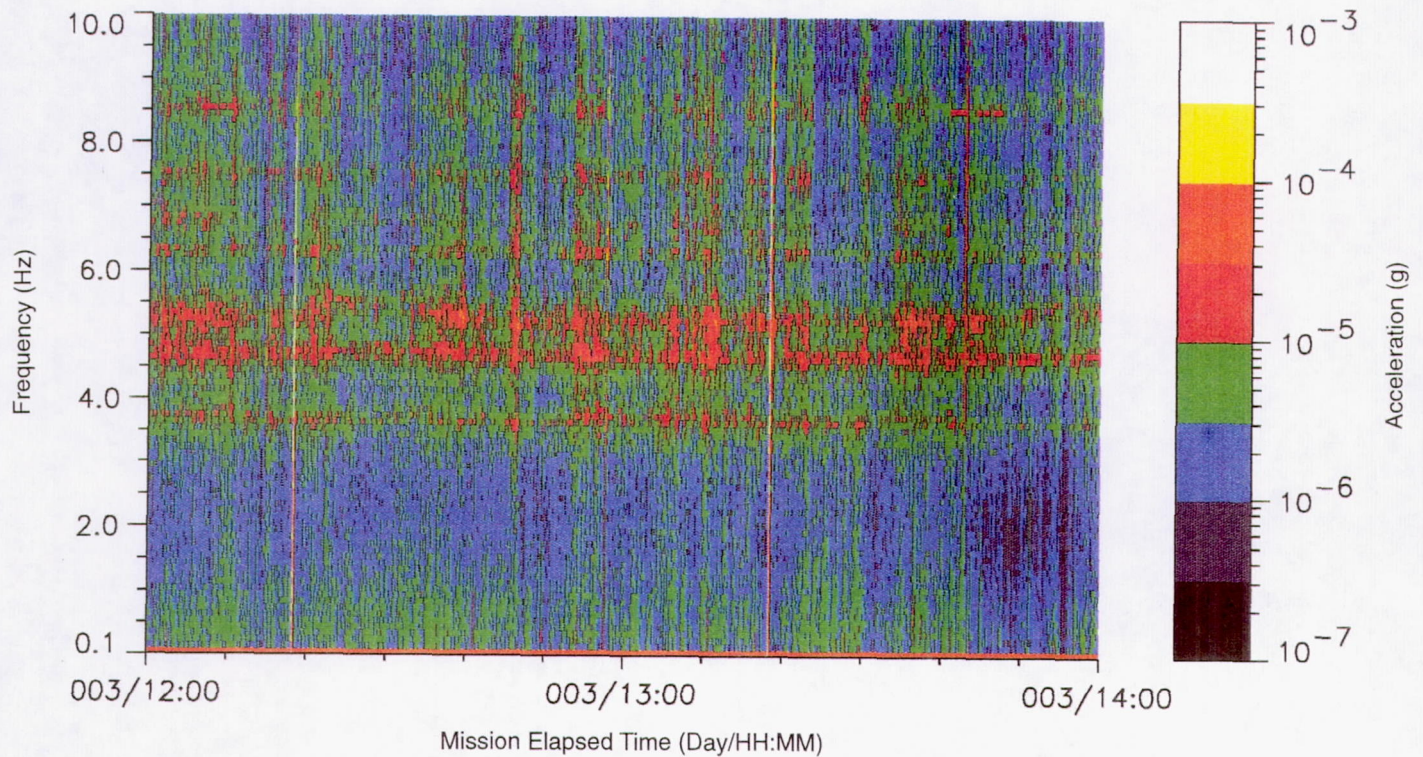


Figure C-40 IML-2 Rack 8, Vector Magnitude

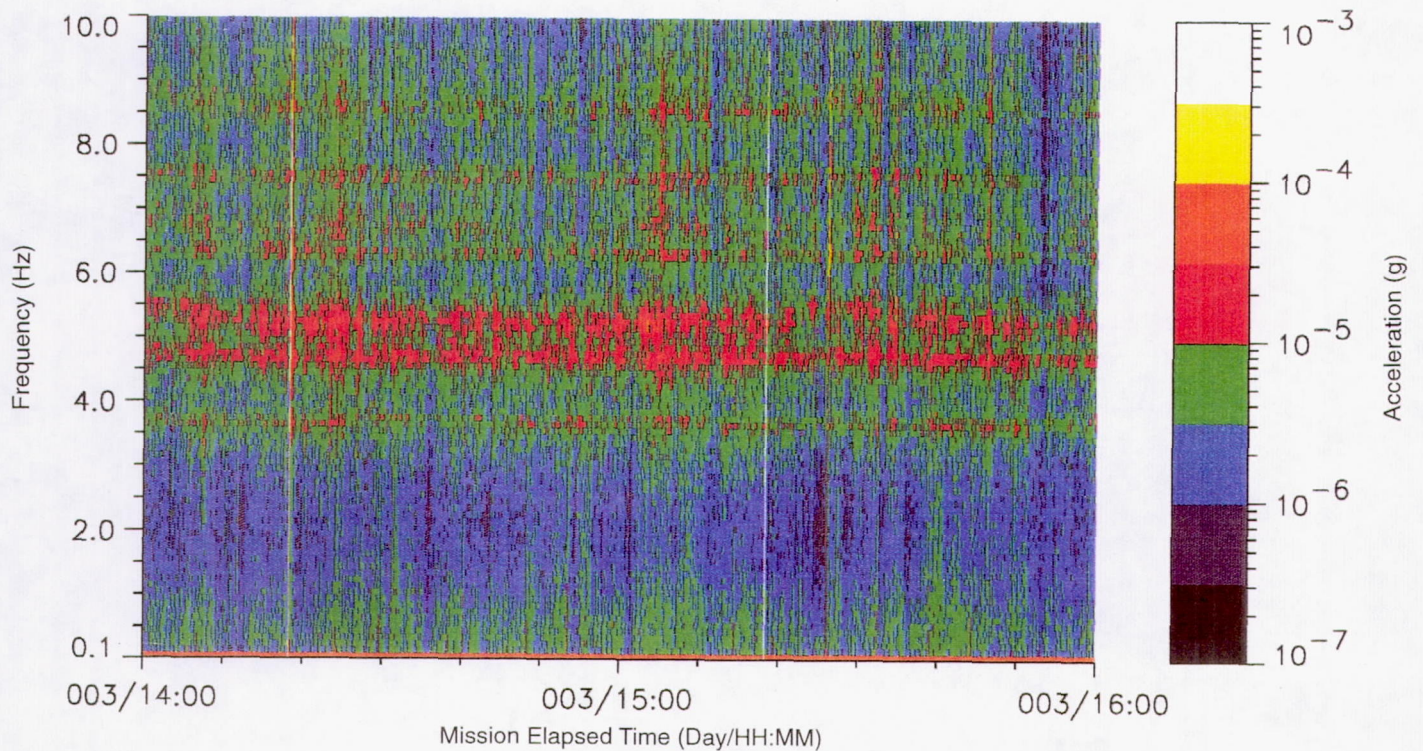


Figure C-41 IML-2 Rack 8, Vector Magnitude

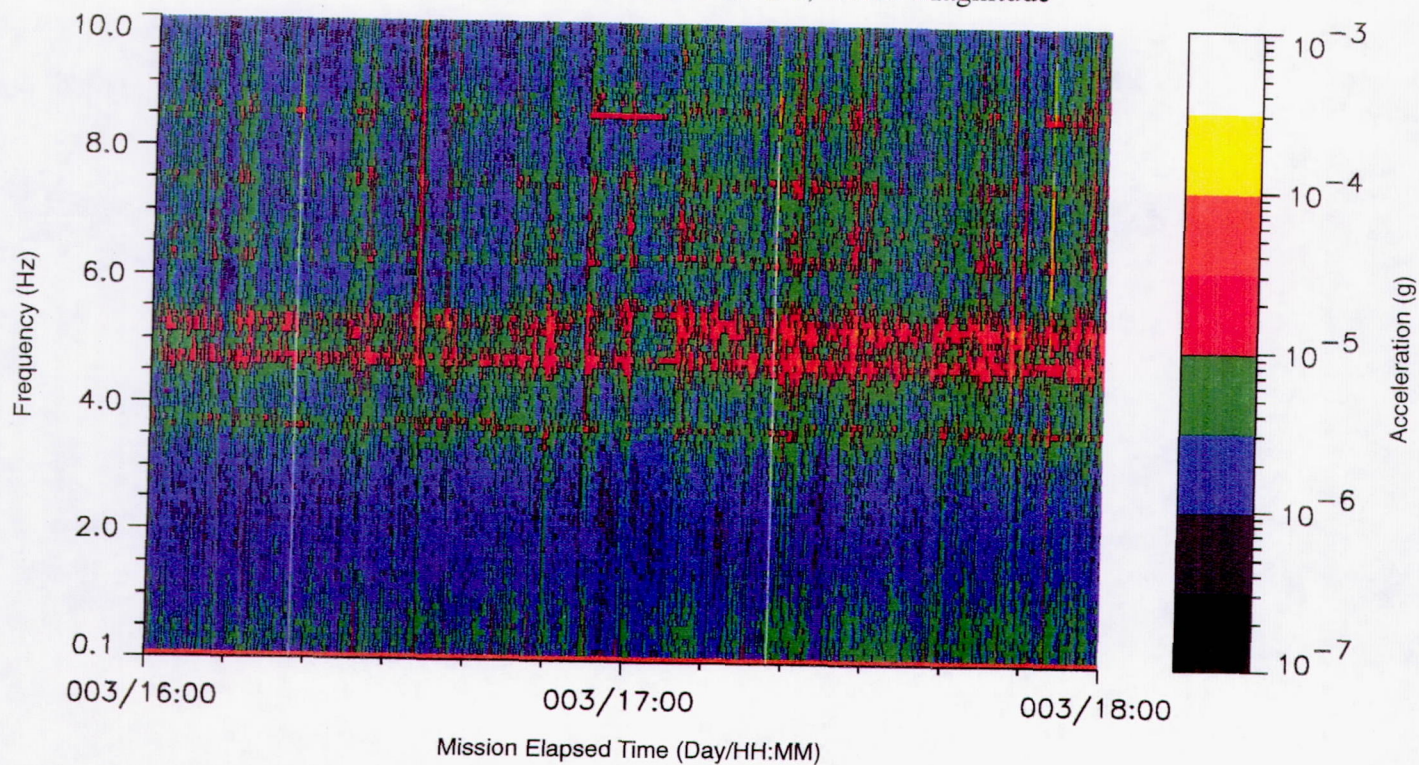


Figure C-42 IML-2 Rack 8, Vector Magnitude

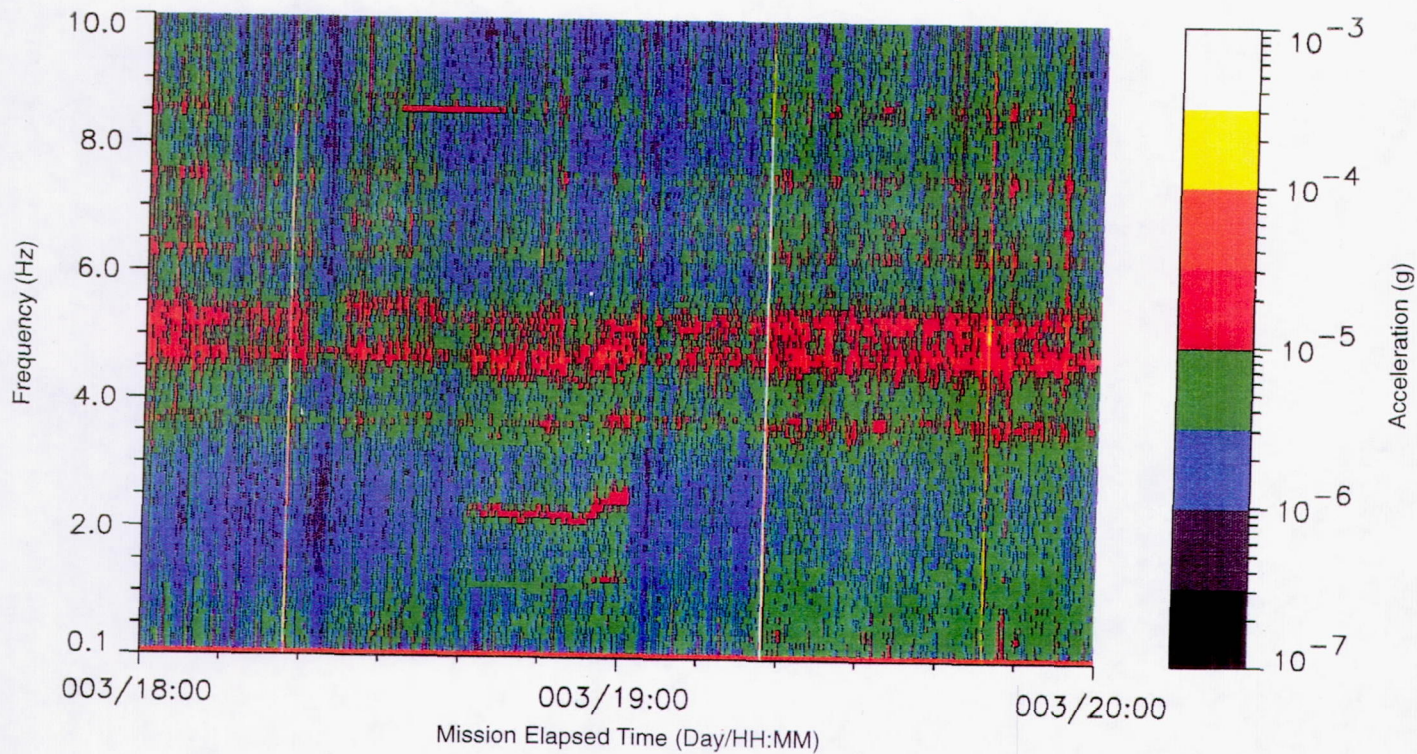


Figure C-43 IML-2 Rack 8, Vector Magnitude

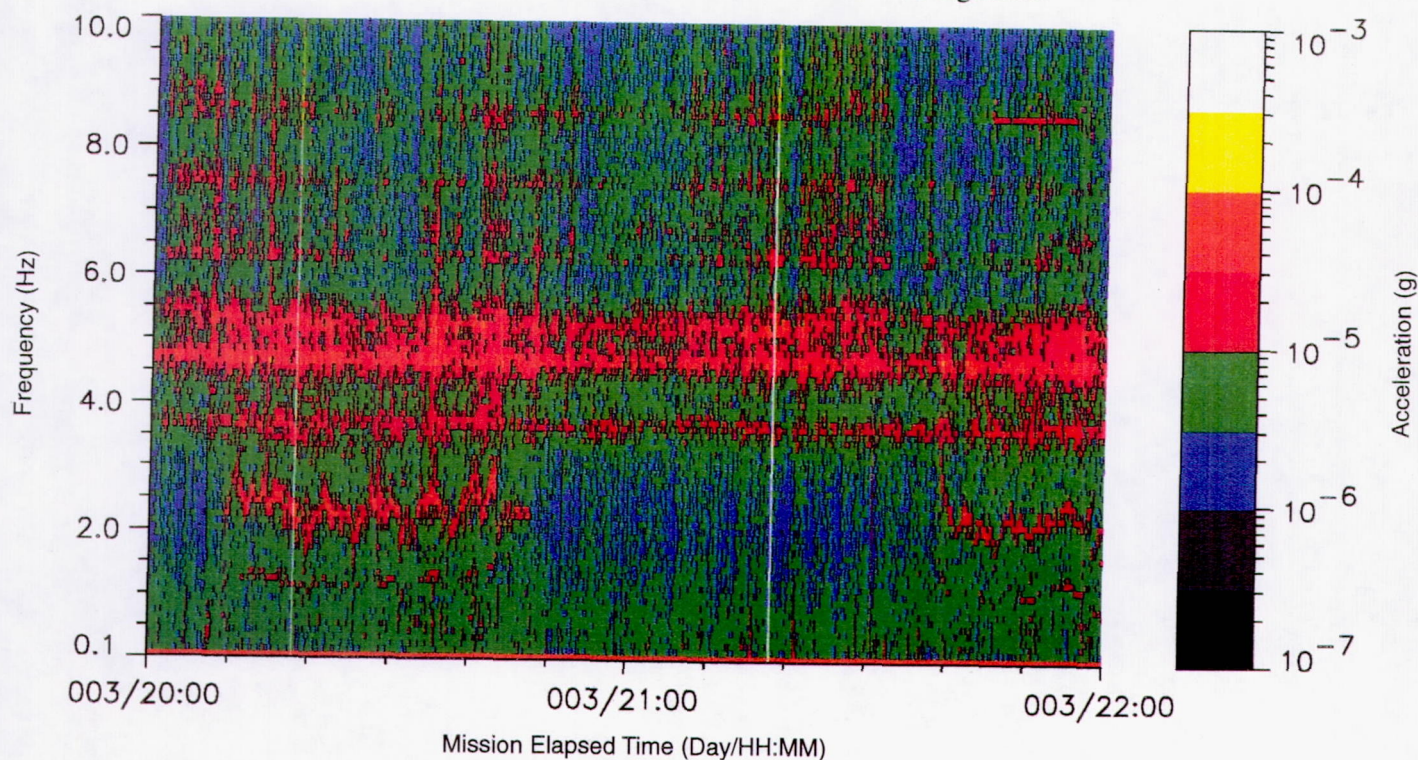


Figure C-44 IML-2 Rack 8, Vector Magnitude

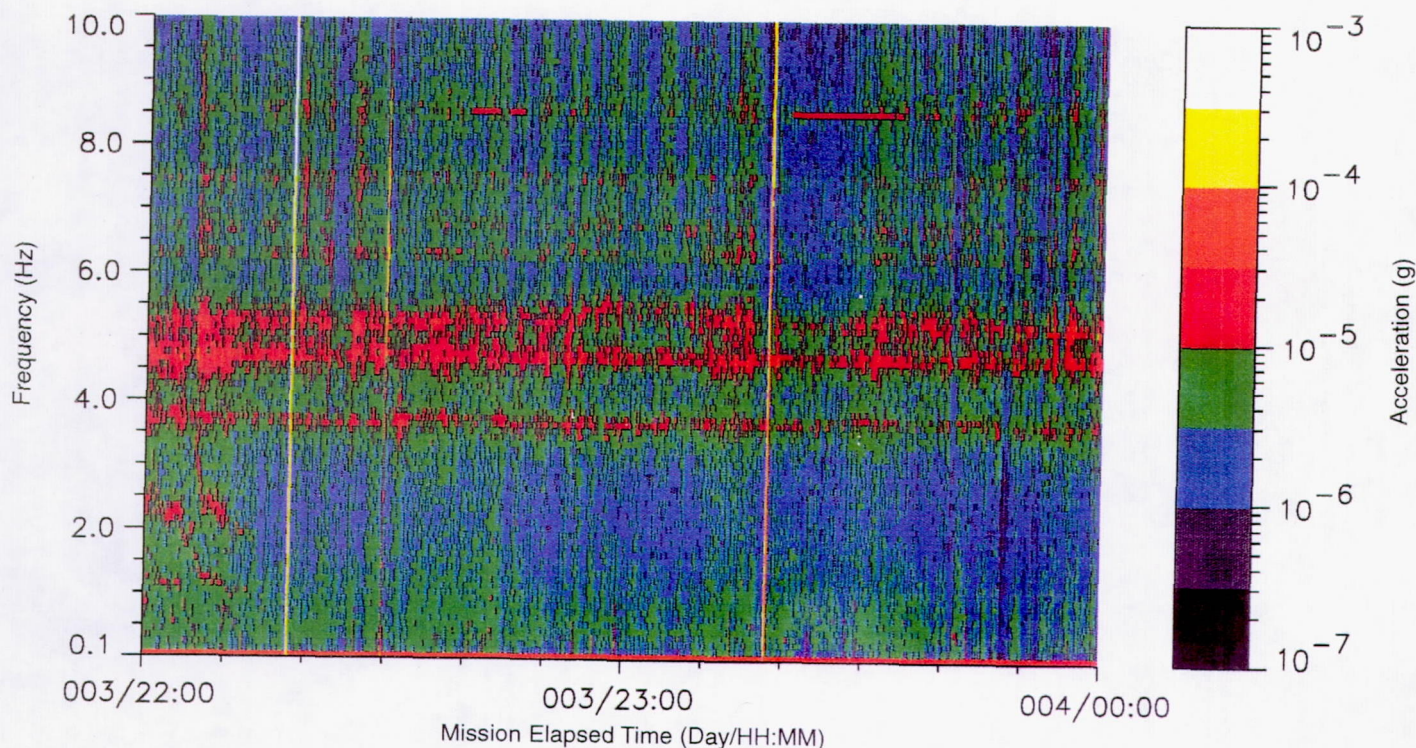


Figure C-45 IML-2 Rack 8, Vector Magnitude

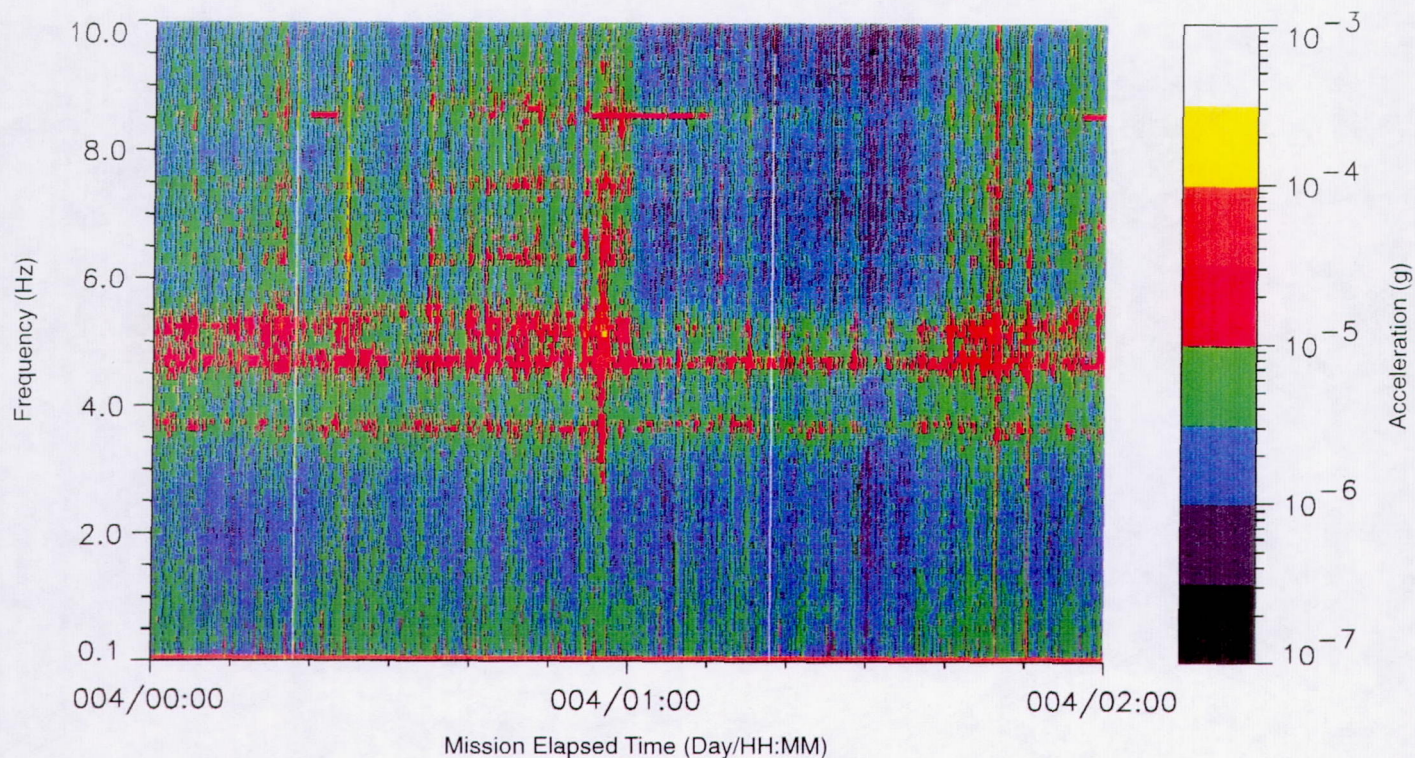


Figure C-46 IML-2 Rack 8, Vector Magnitude

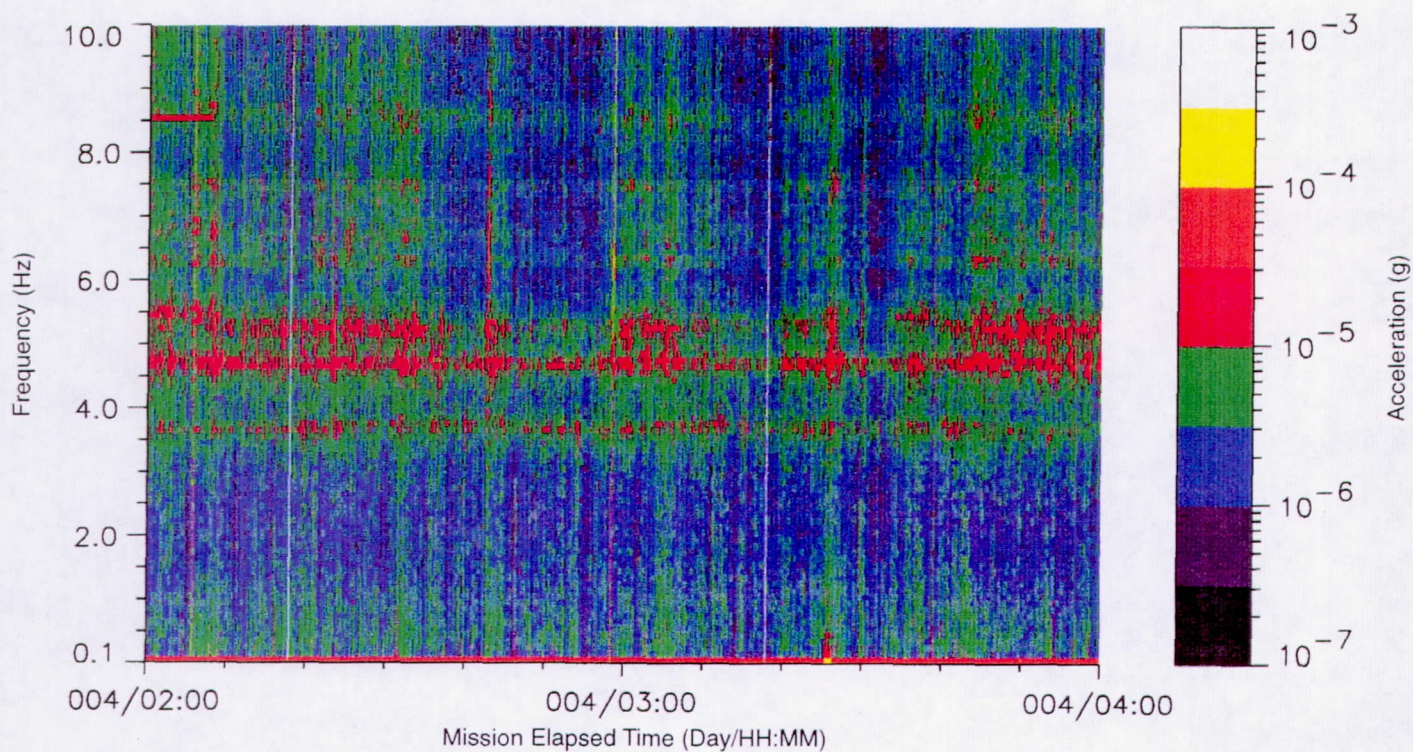


Figure C-47 IML-2 Rack 8, Vector Magnitude

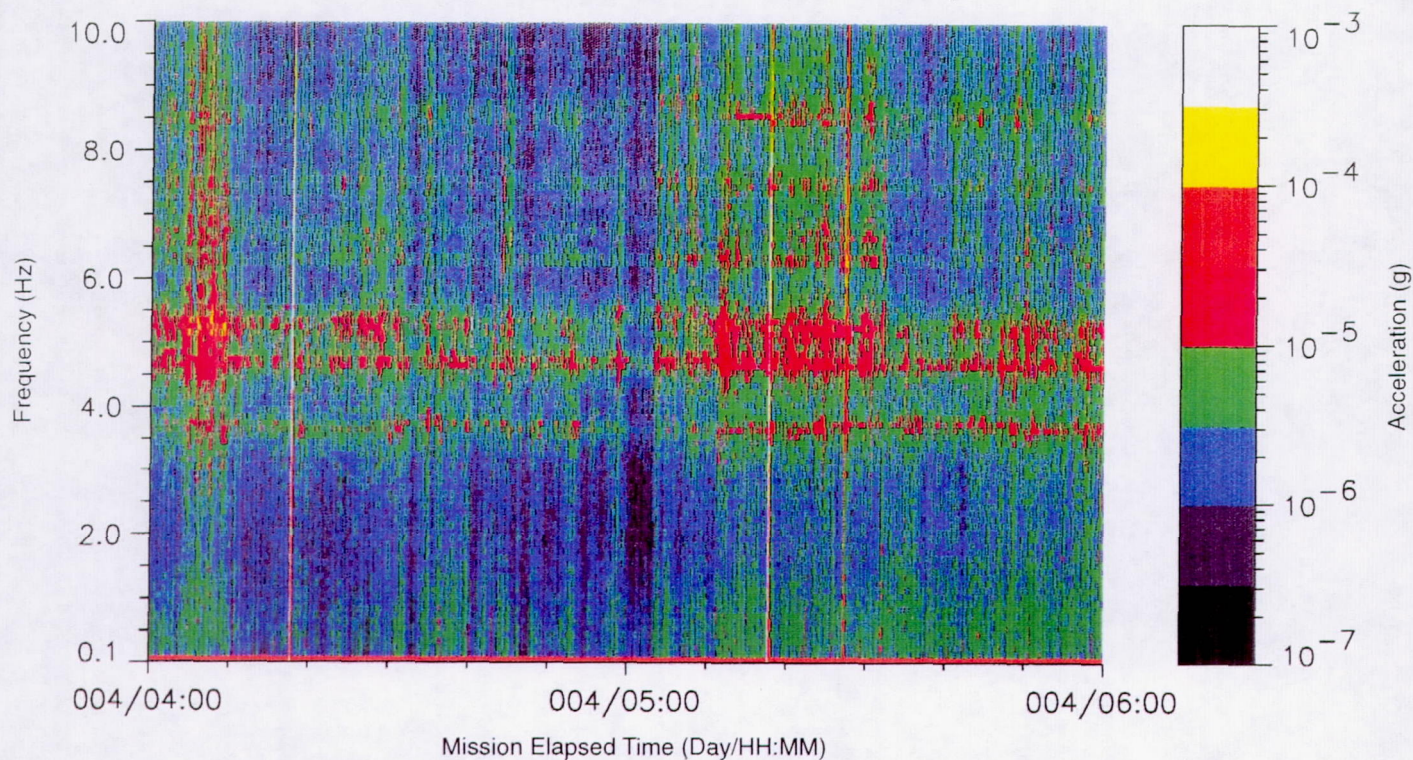


Figure C-48 IML-2 Rack 8, Vector Magnitude

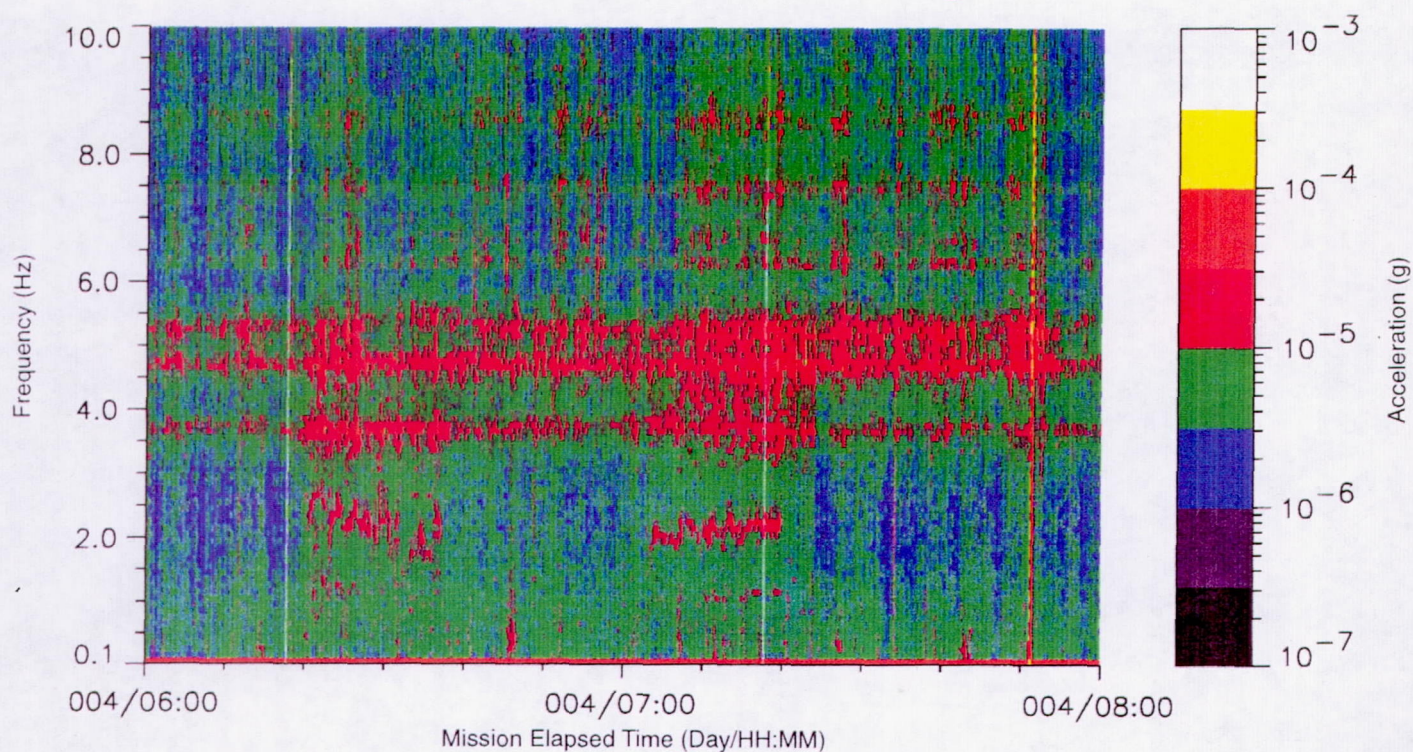


Figure C-49 IML-2 Rack 8, Vector Magnitude

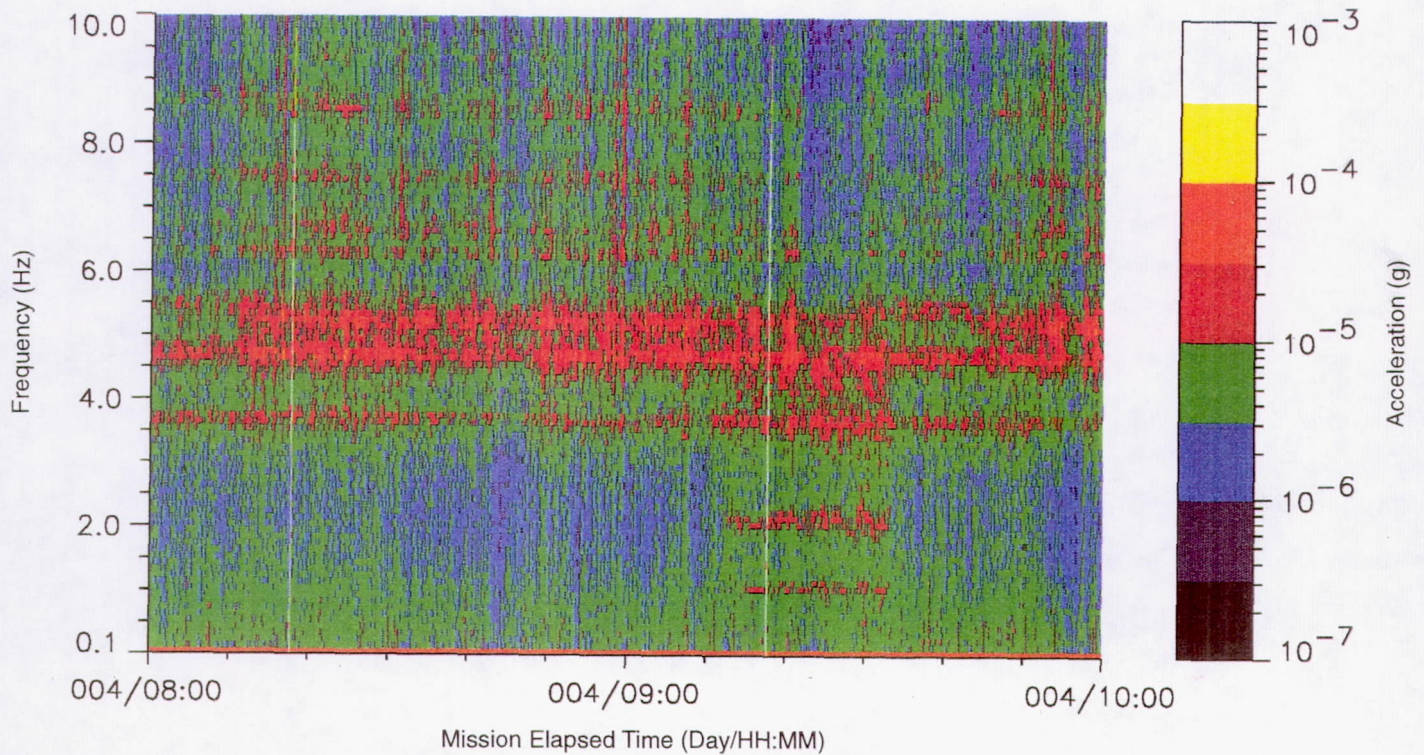


Figure C-50 IML-2 Rack 8, Vector Magnitude

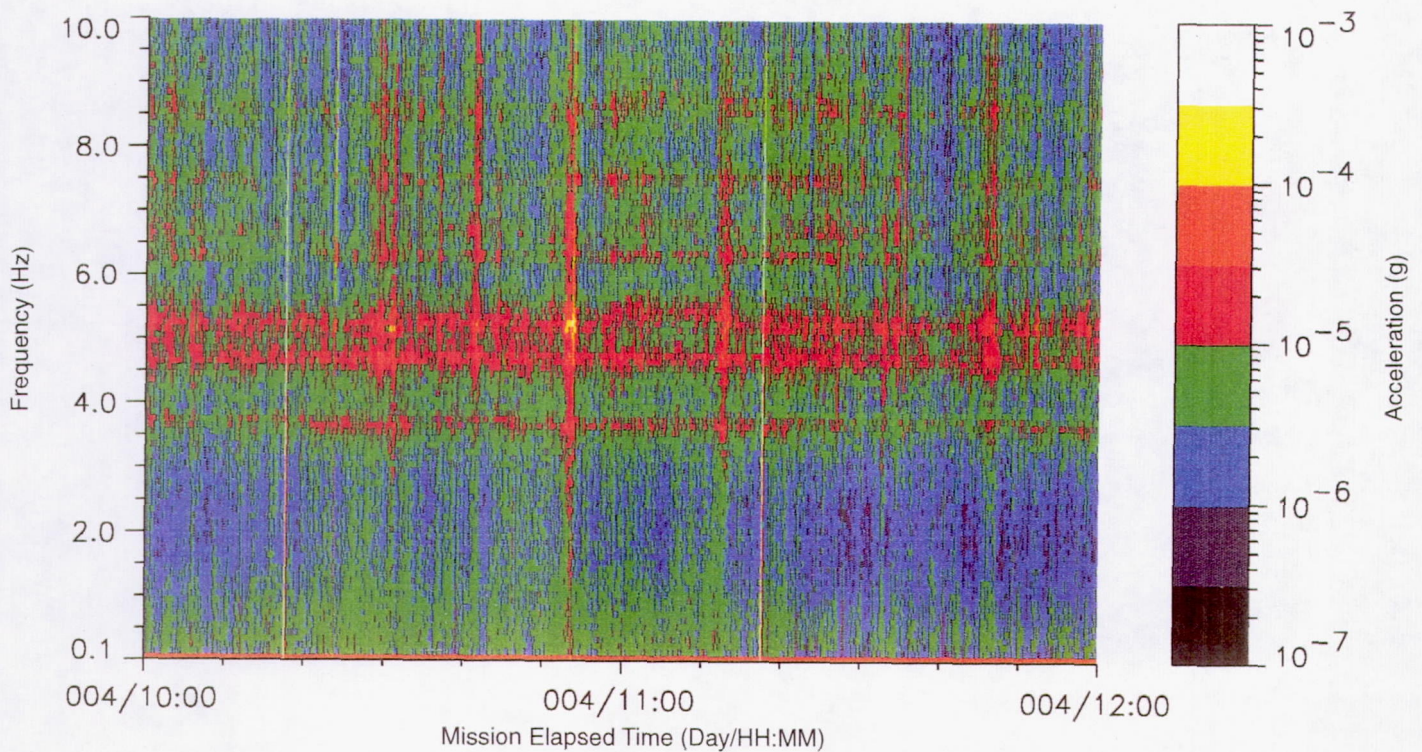


Figure C-51 IML-2 Rack 8, Vector Magnitude

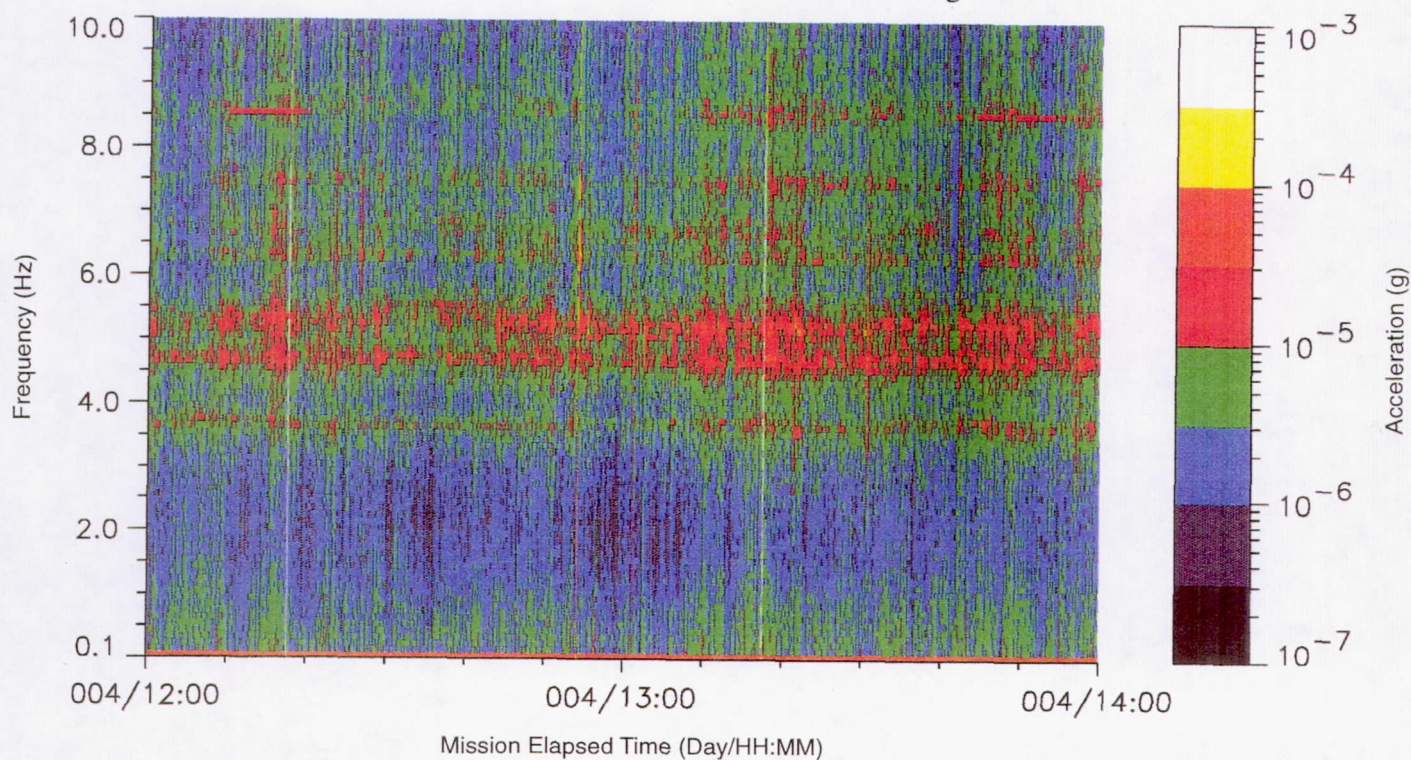


Figure C-52 IML-2 Rack 8, Vector Magnitude

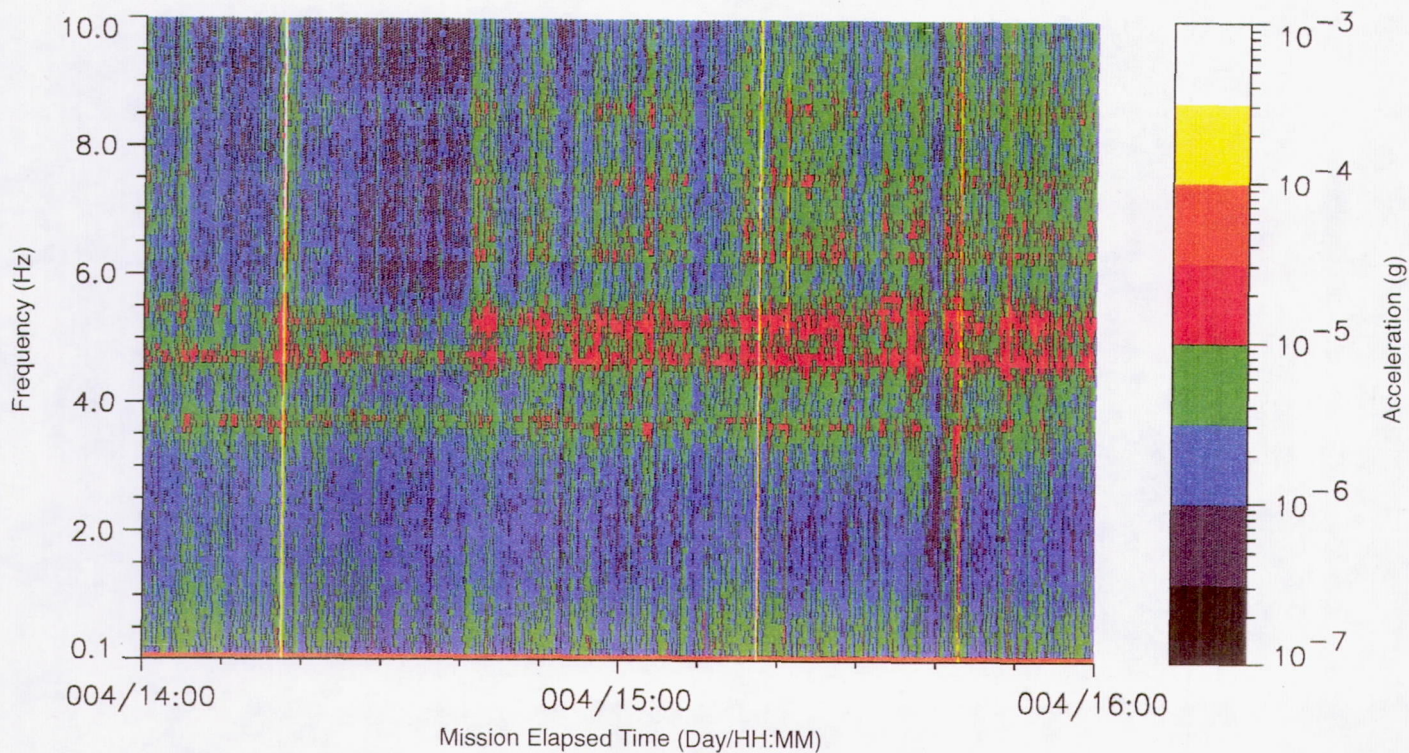


Figure C-53 IML-2 Rack 8, Vector Magnitude

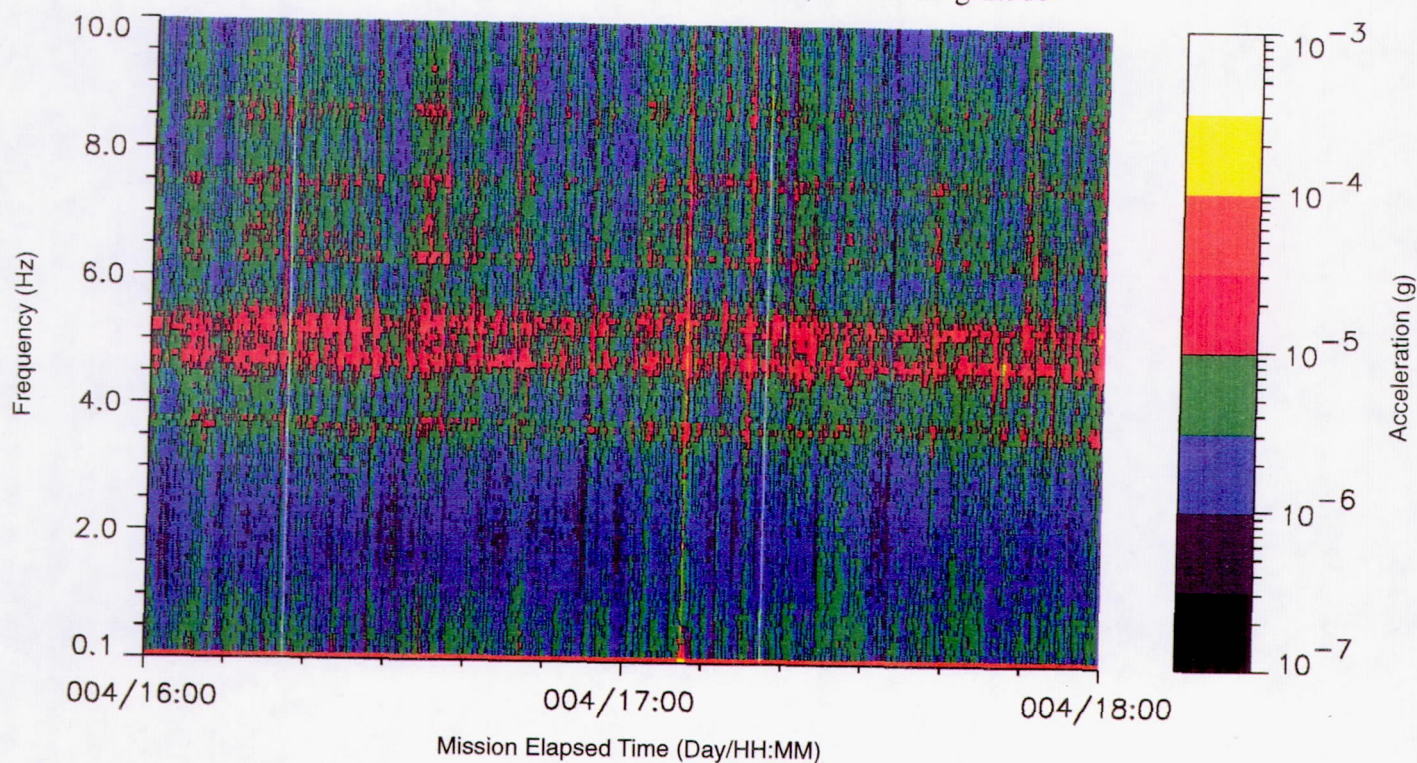
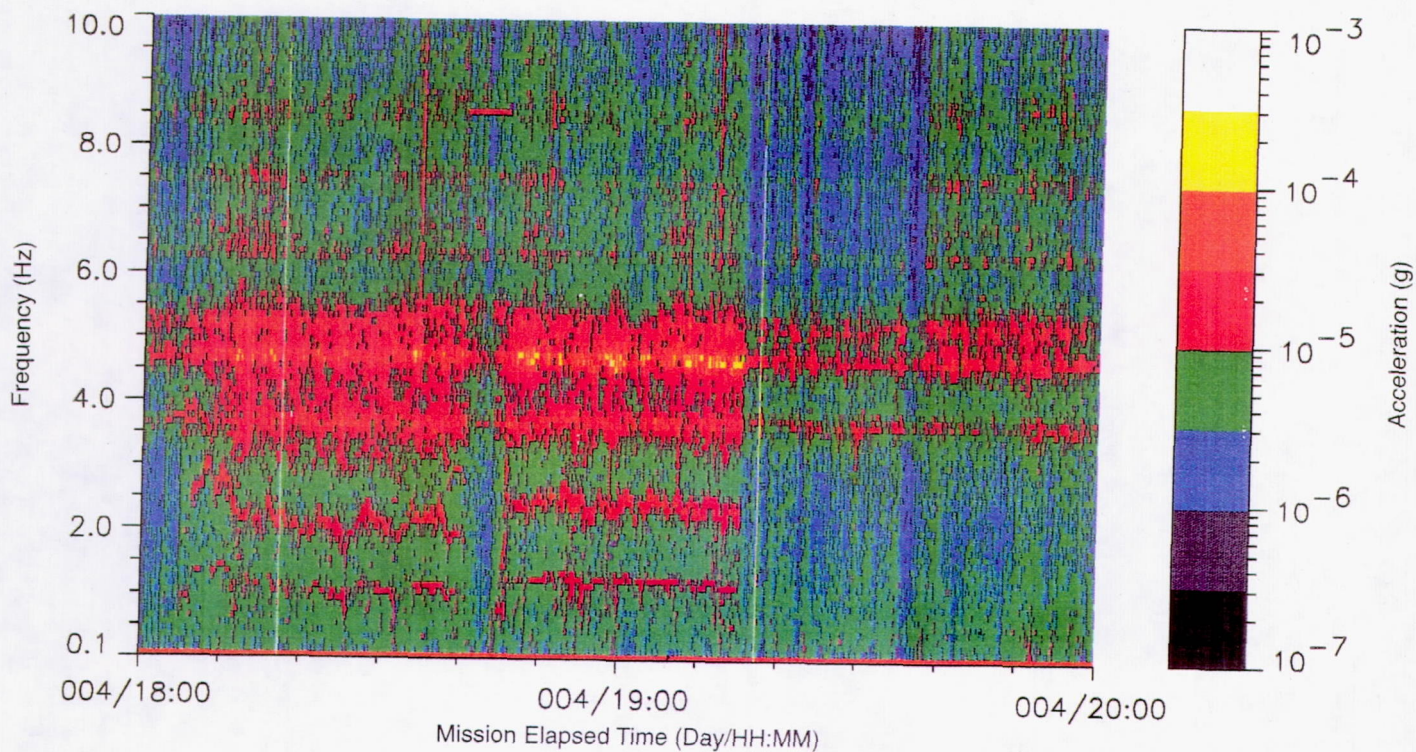


Figure C-54 IML-2 Rack 8, Vector Magnitude



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Figure C-55 IML-2 Rack 8, Vector Magnitude

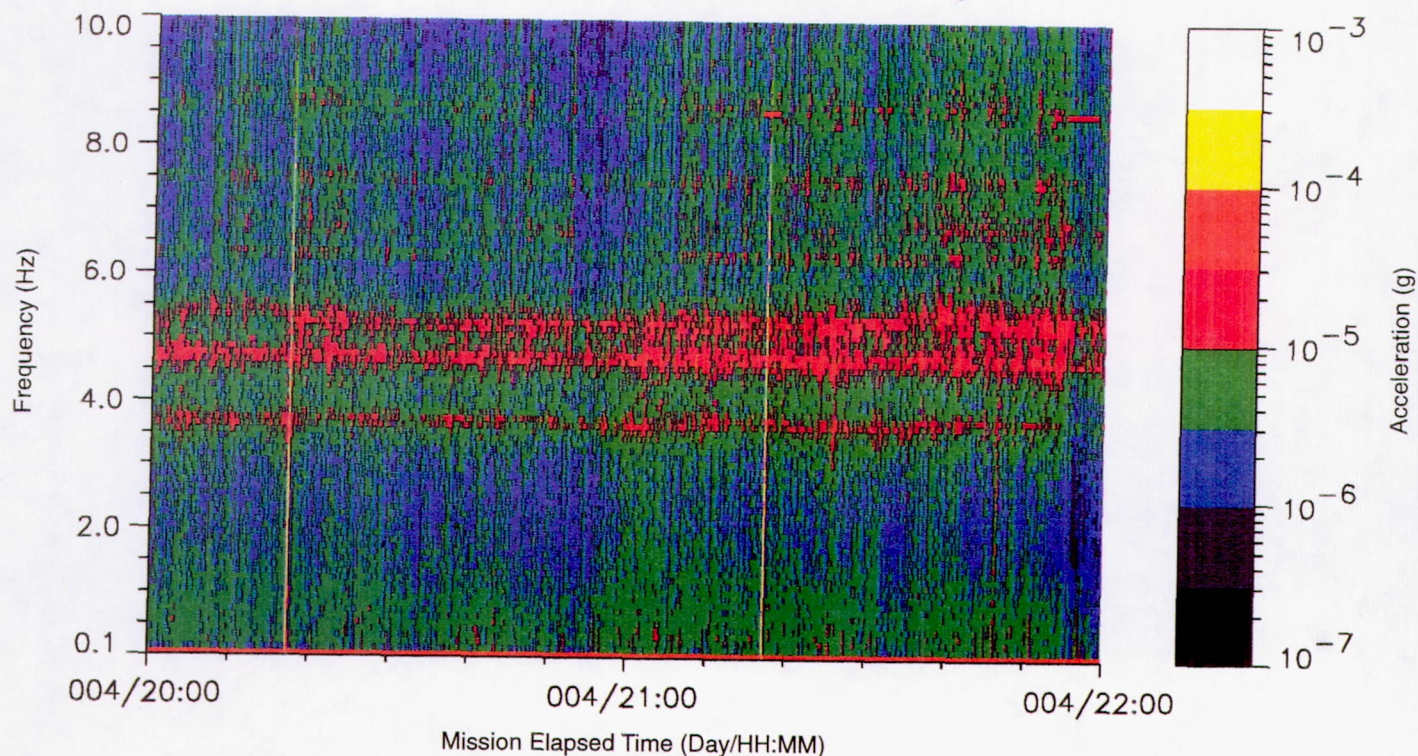


Figure C-56 IML-2 Rack 8, Vector Magnitude

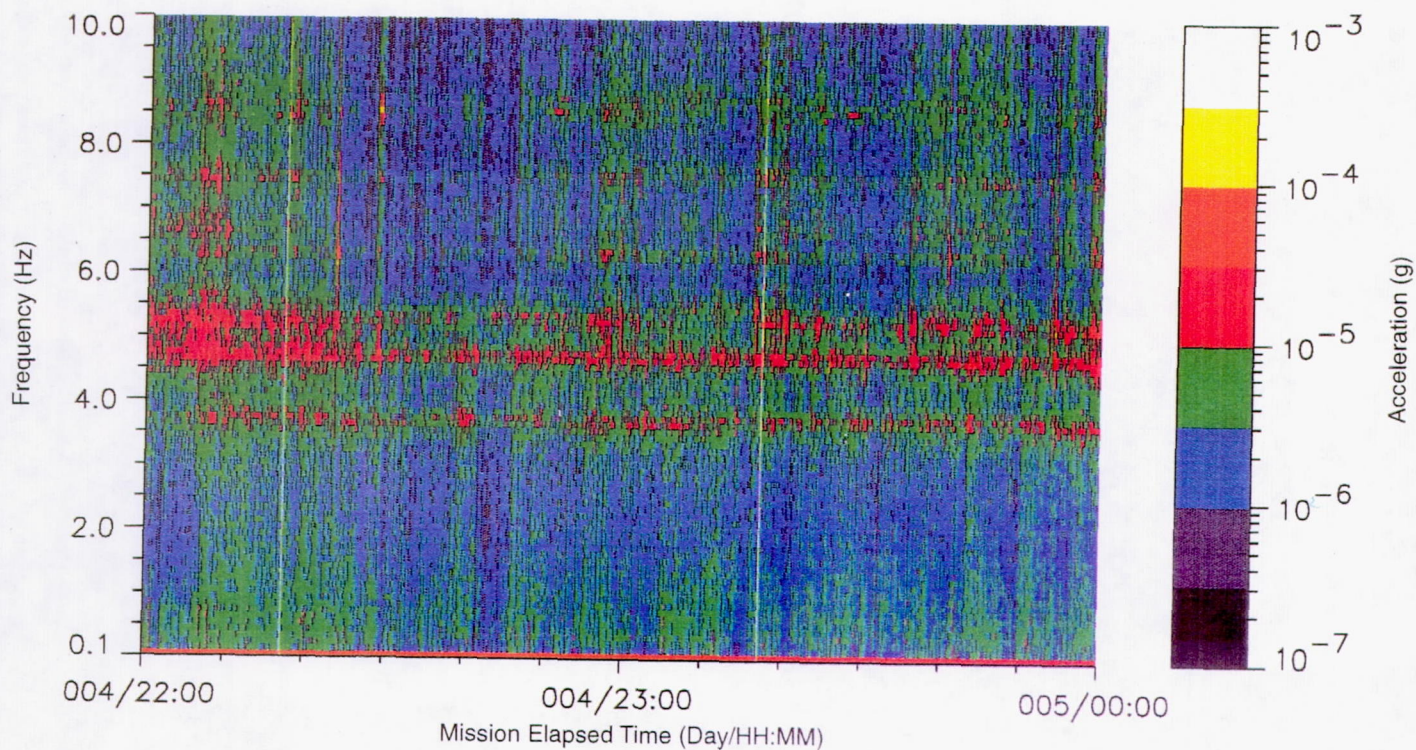


Figure C-57 IML-2 Rack 8, Vector Magnitude

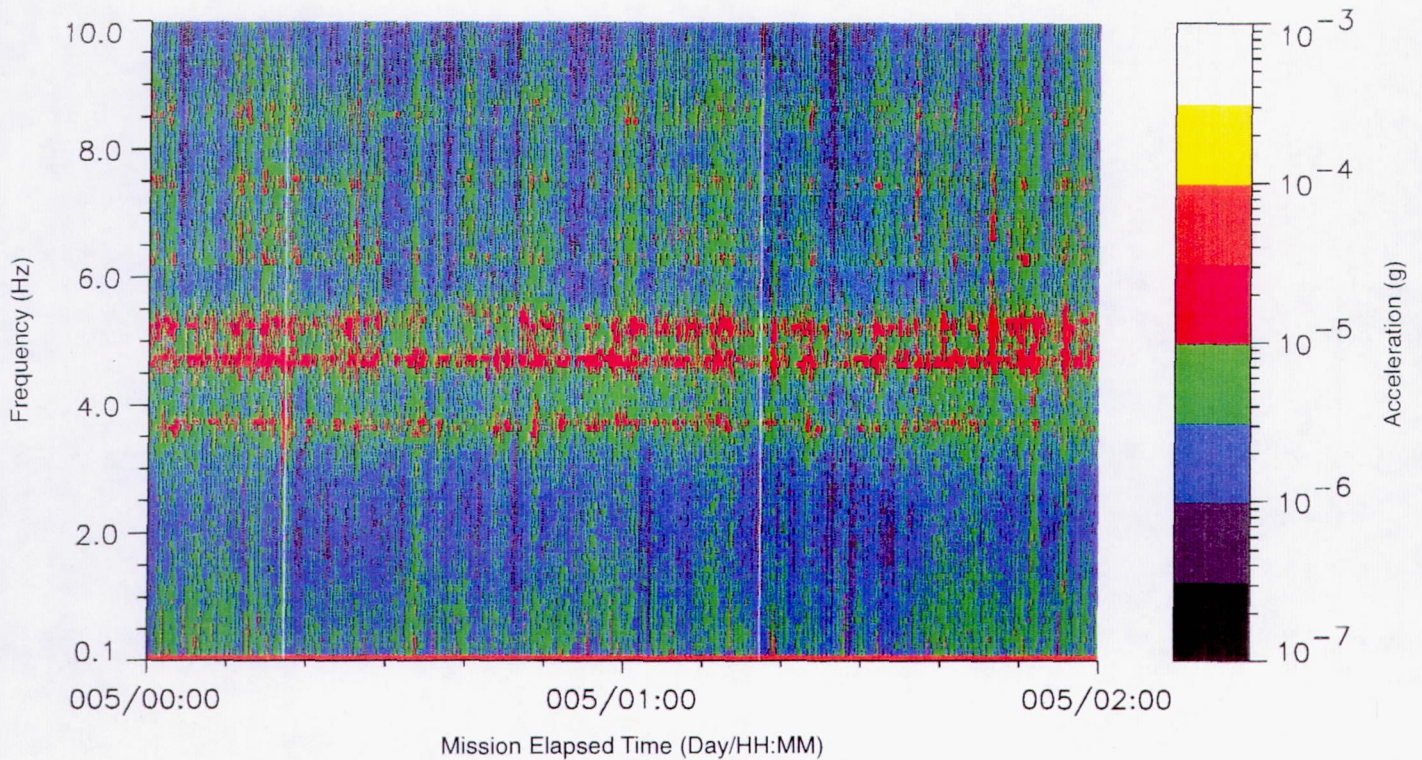


Figure C-58 IML-2 Rack 8, Vector Magnitude

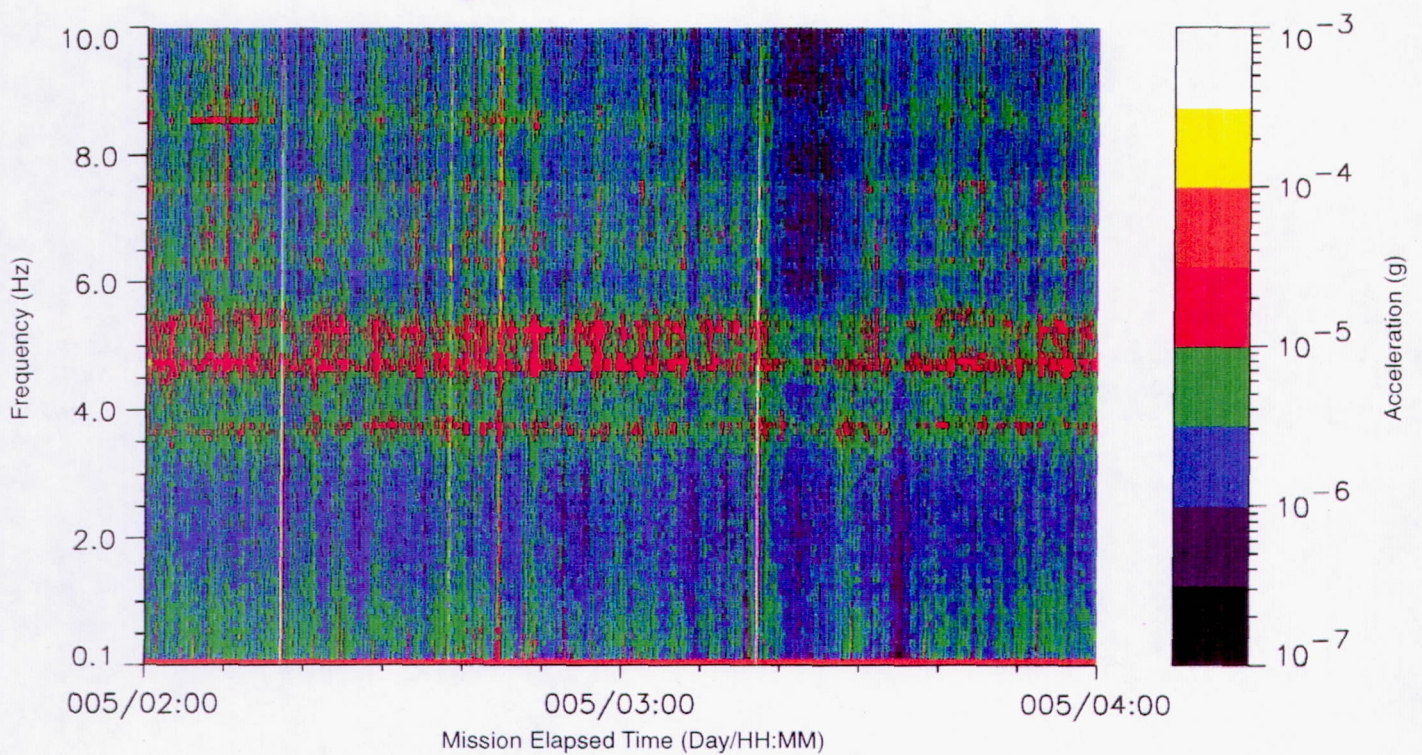


Figure C-59 IML-2 Rack 8, Vector Magnitude

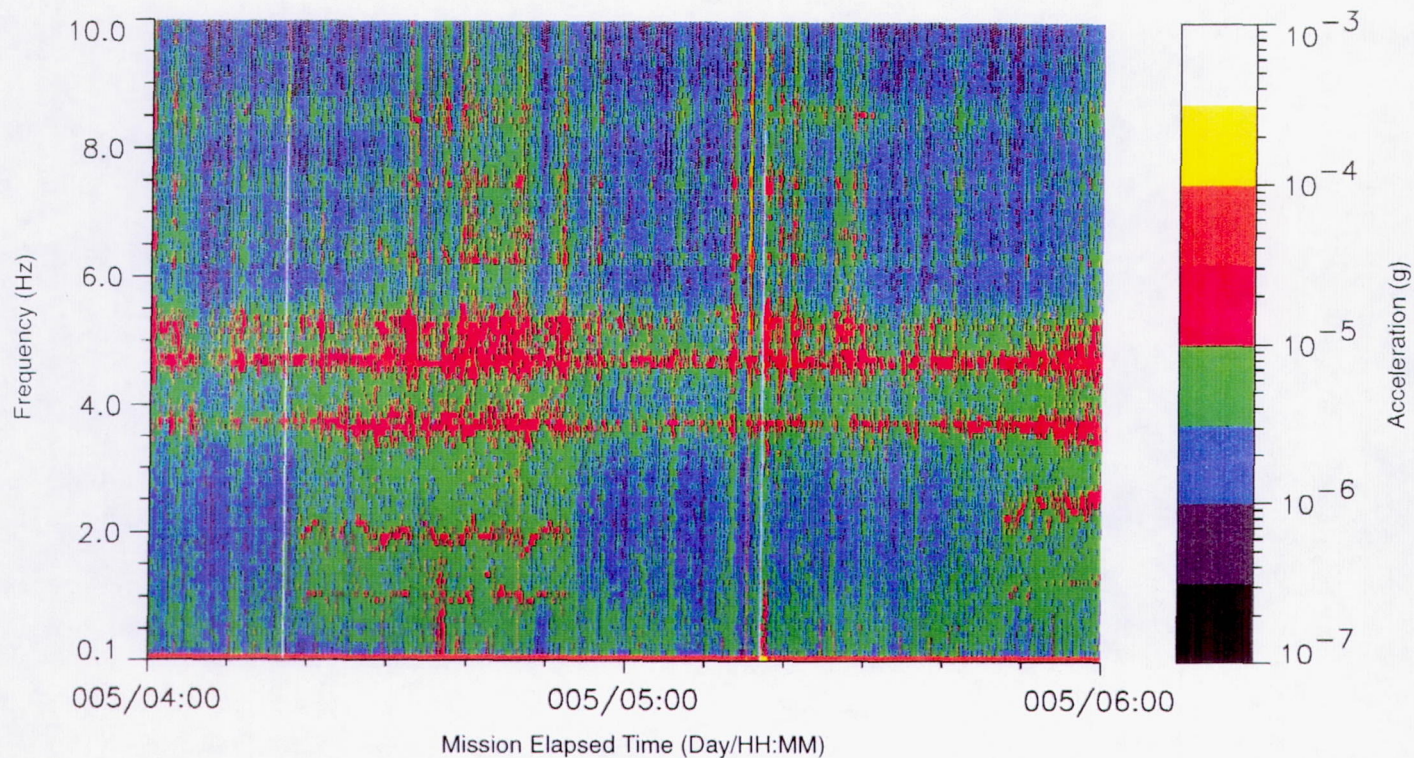


Figure C-60 IML-2 Rack 8, Vector Magnitude

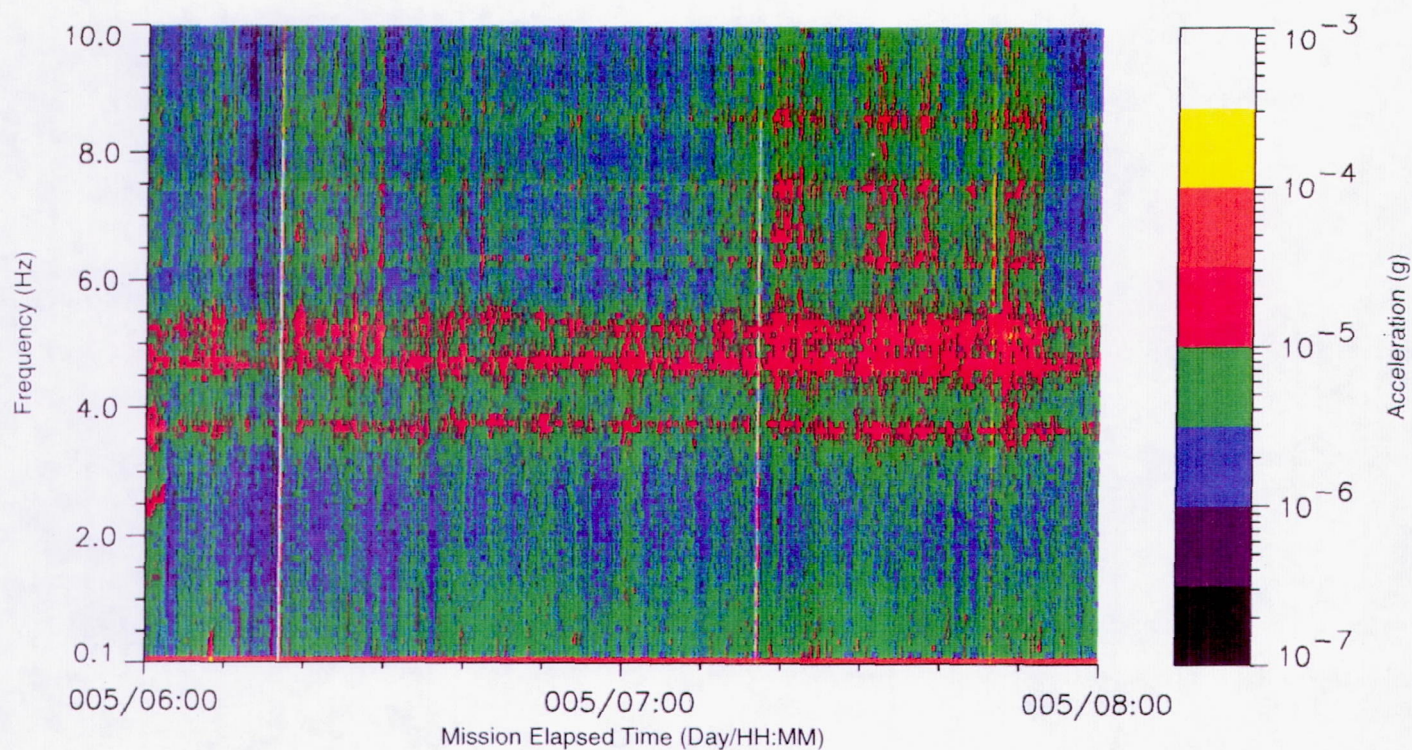


Figure C-61 IML-2 Rack 8, Vector Magnitude

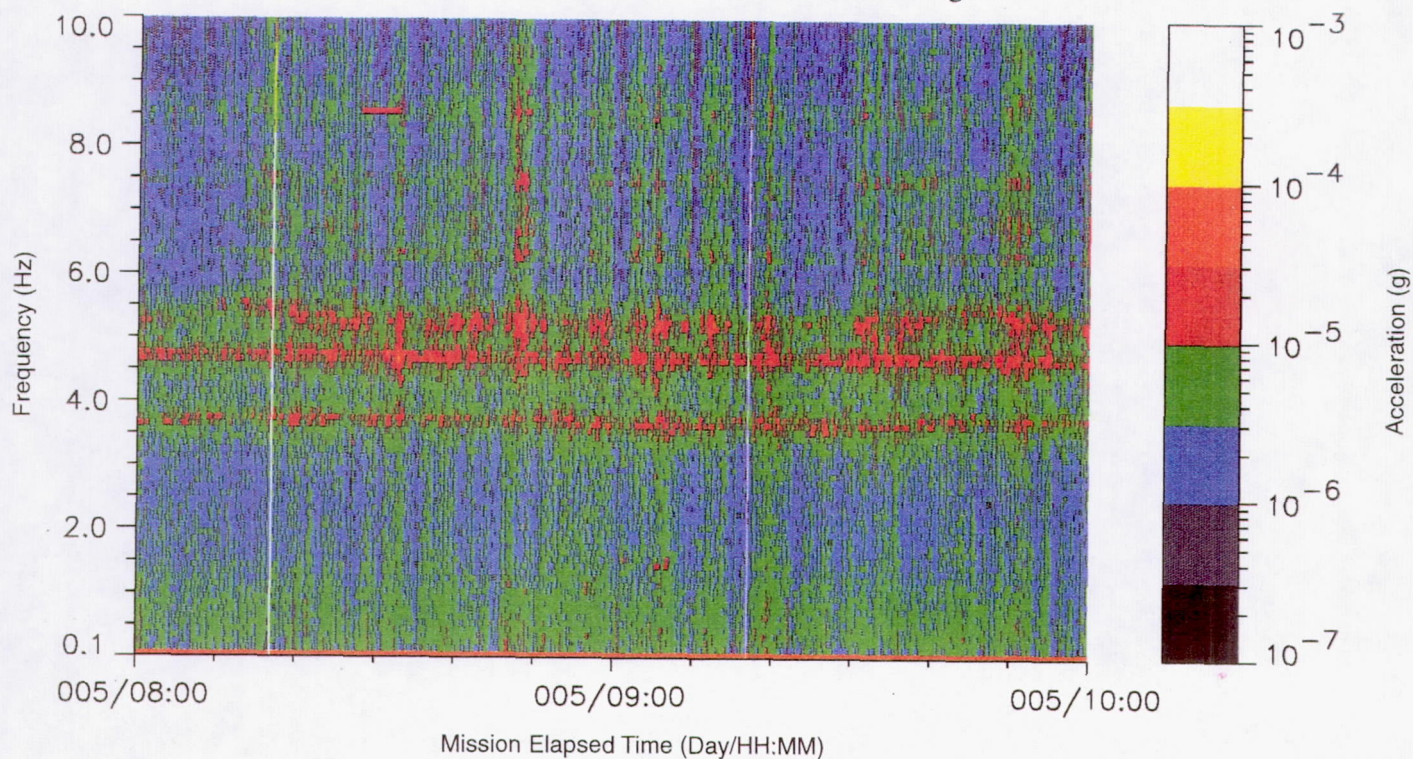


Figure C-62 IML-2 Rack 8, Vector Magnitude

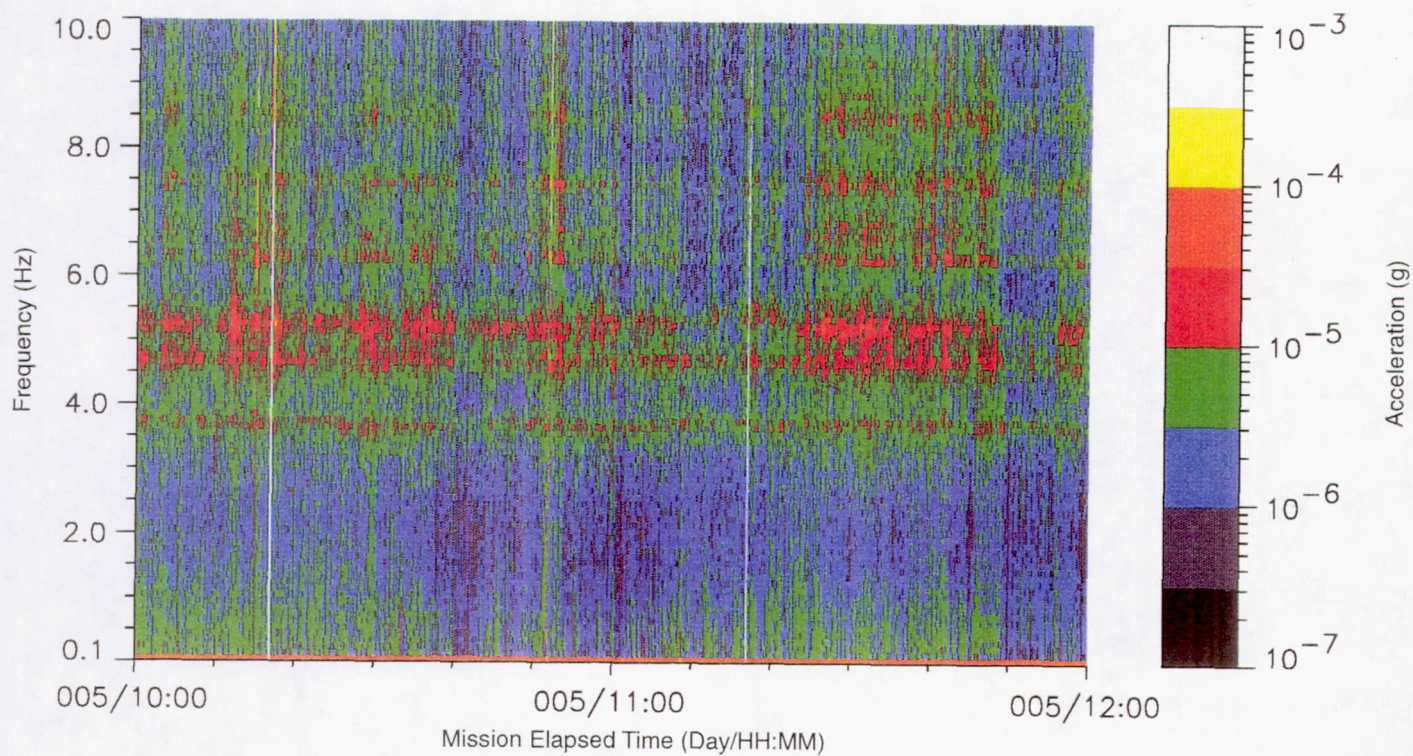


Figure C-63 IML-2 Rack 8, Vector Magnitude

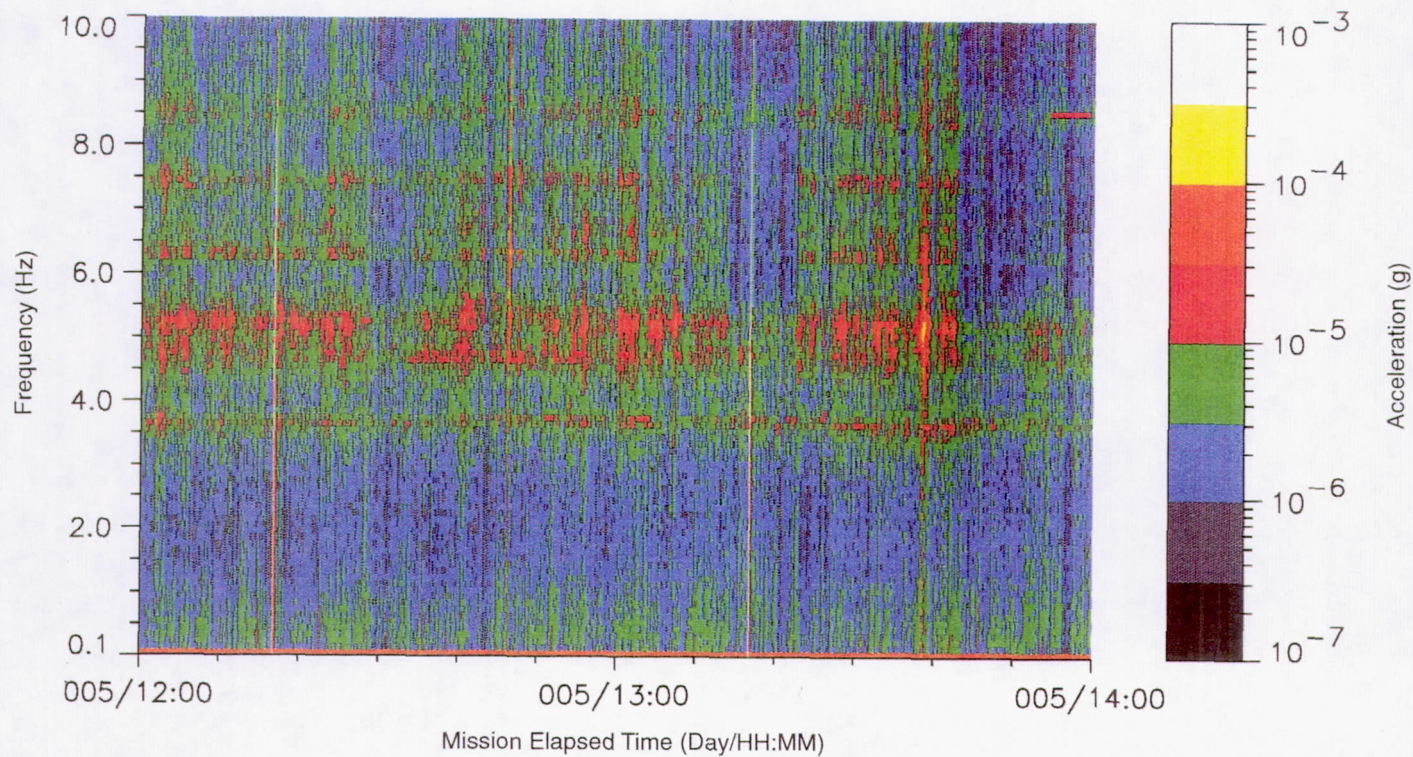
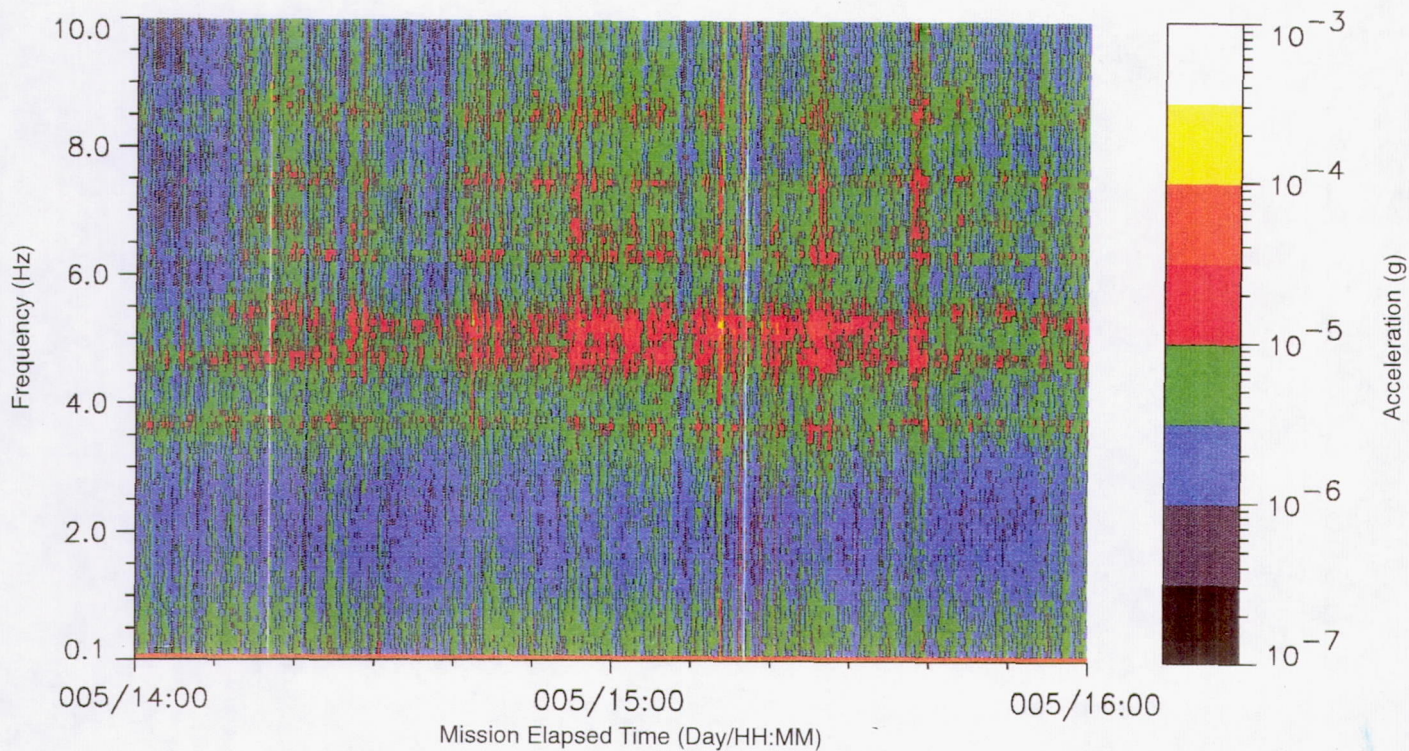


Figure C-64 IML-2 Rack 8, Vector Magnitude



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Figure C-65 IML-2 Rack 8, Vector Magnitude

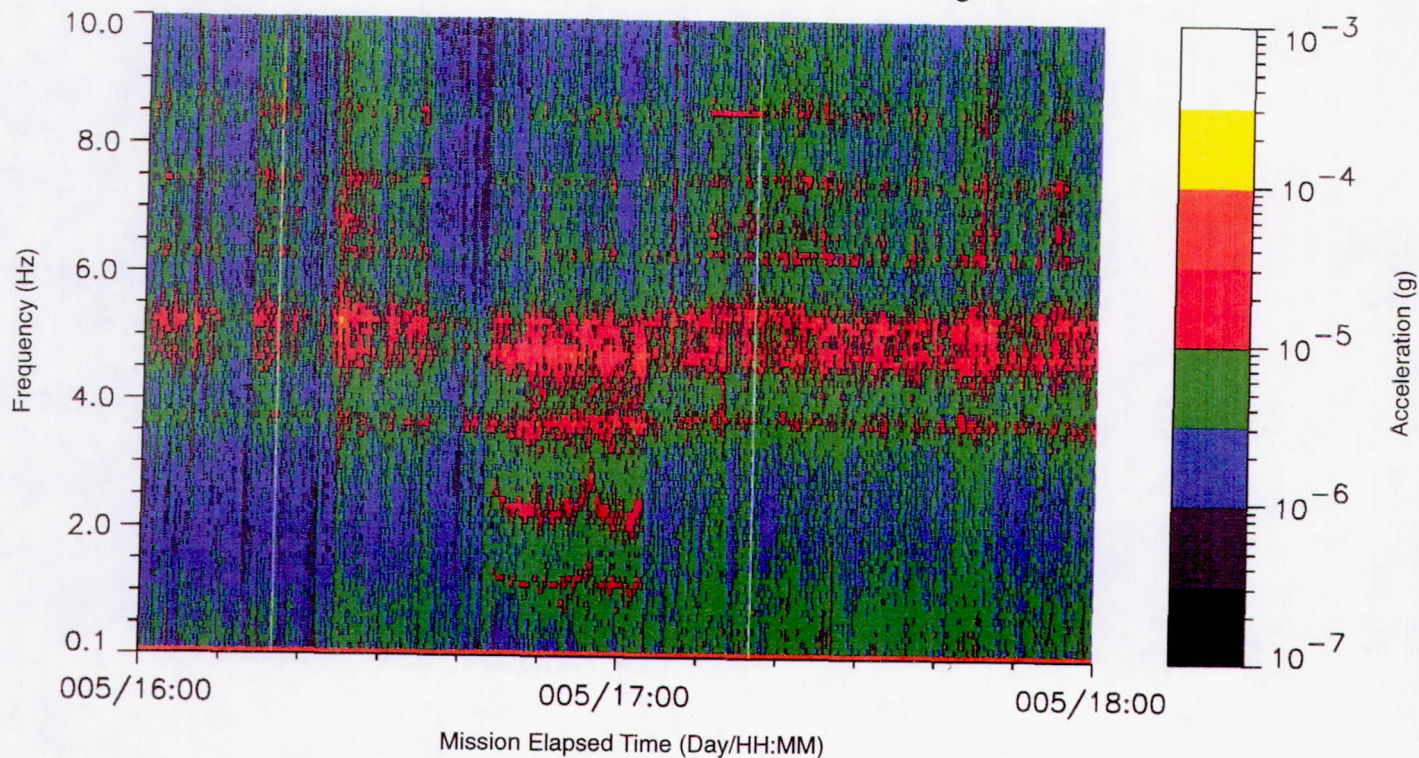


Figure C-66 IML-2 Rack 8, Vector Magnitude

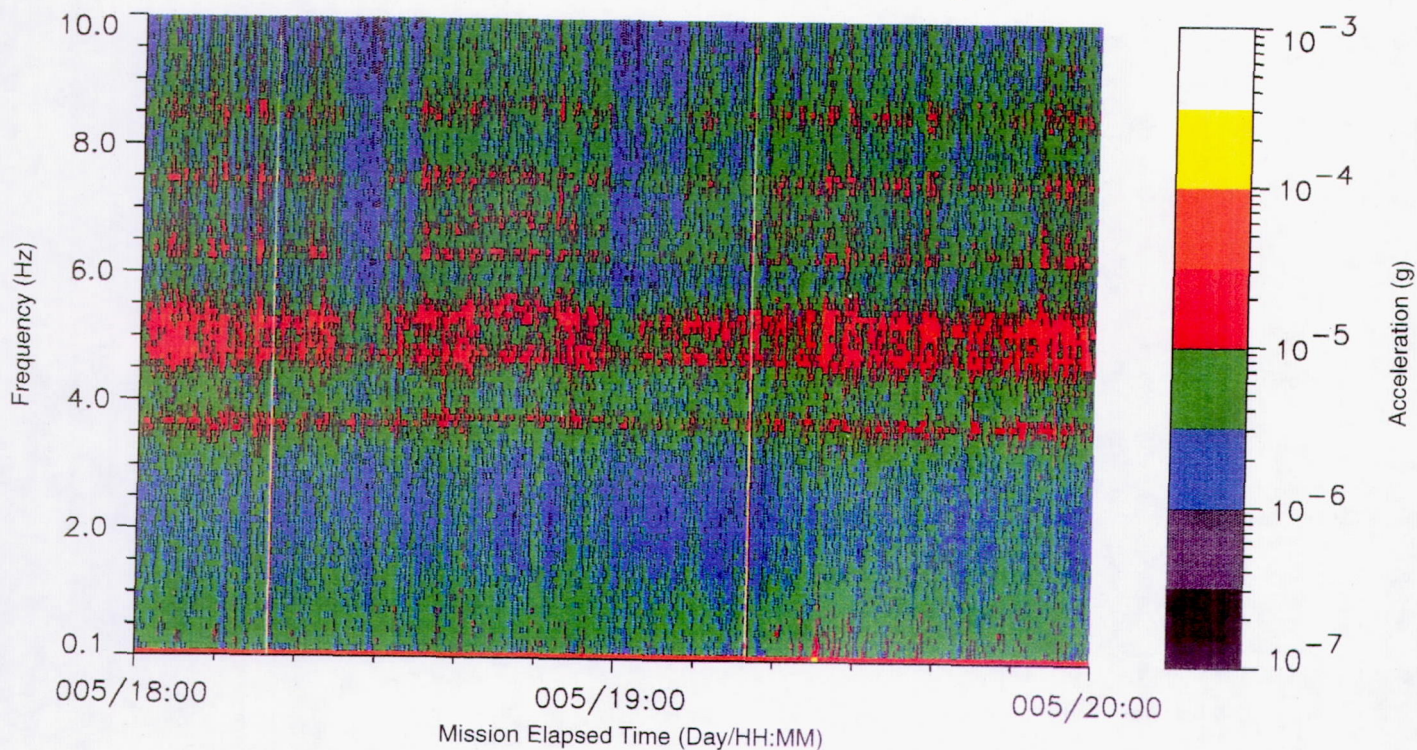


Figure C-67 IML-2 Rack 8, Vector Magnitude

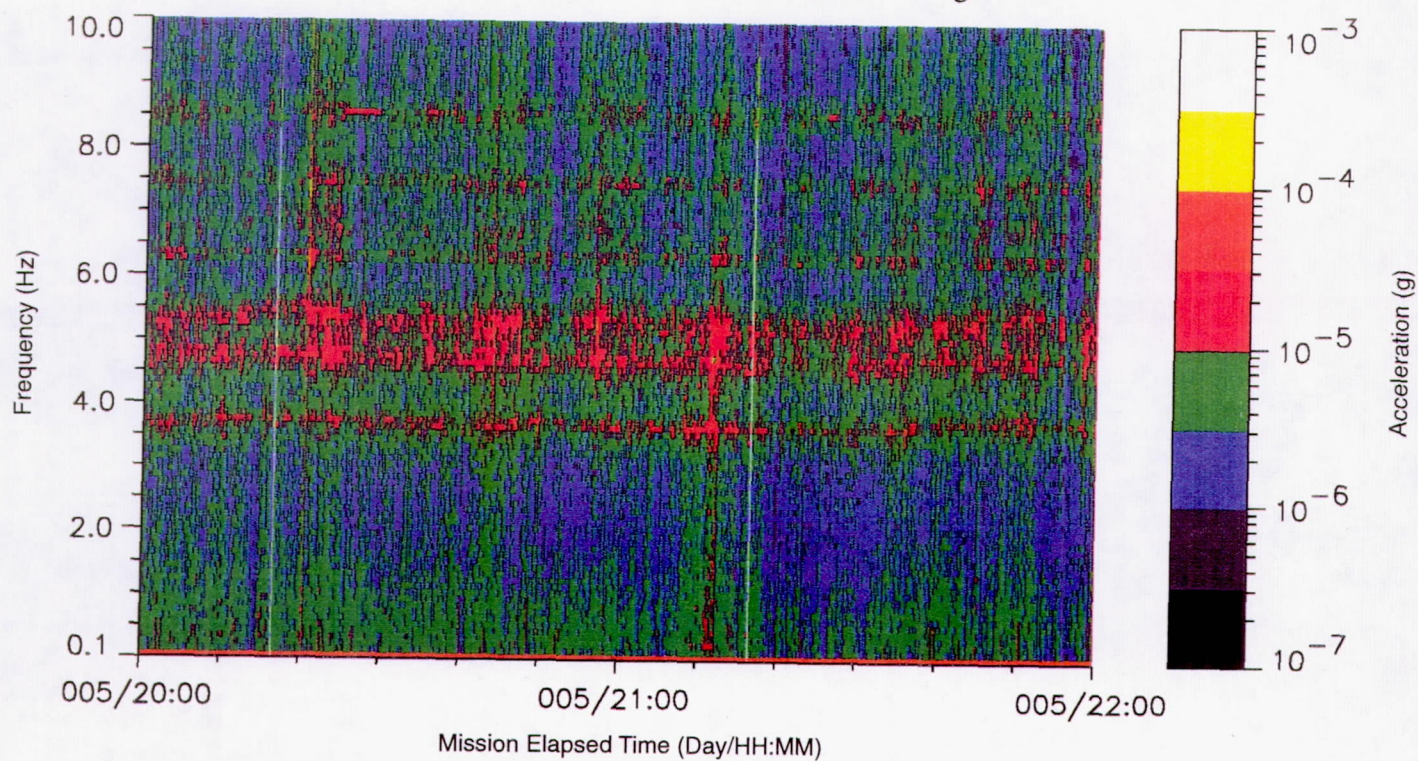


Figure C-68 IML-2 Rack 8, Vector Magnitude

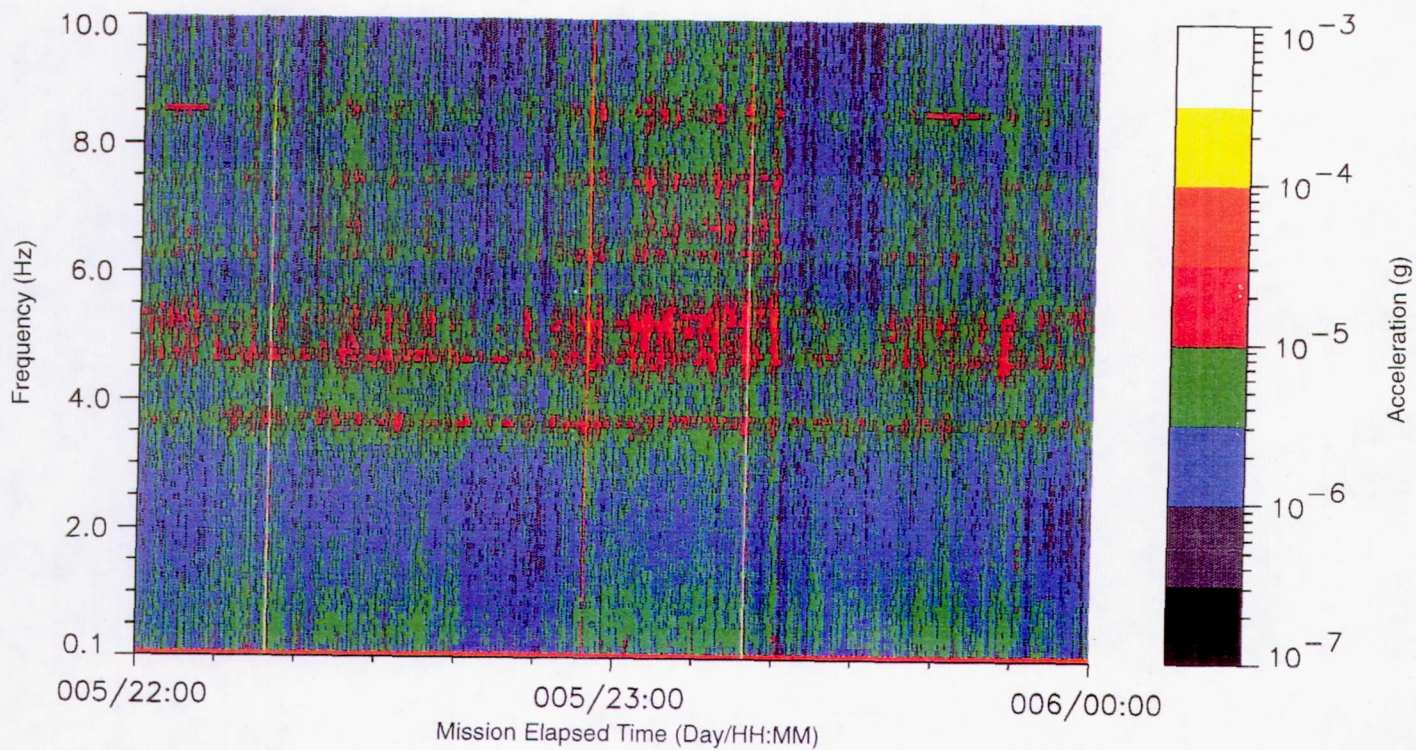


Figure C-69 IML-2 Rack 8, Vector Magnitude

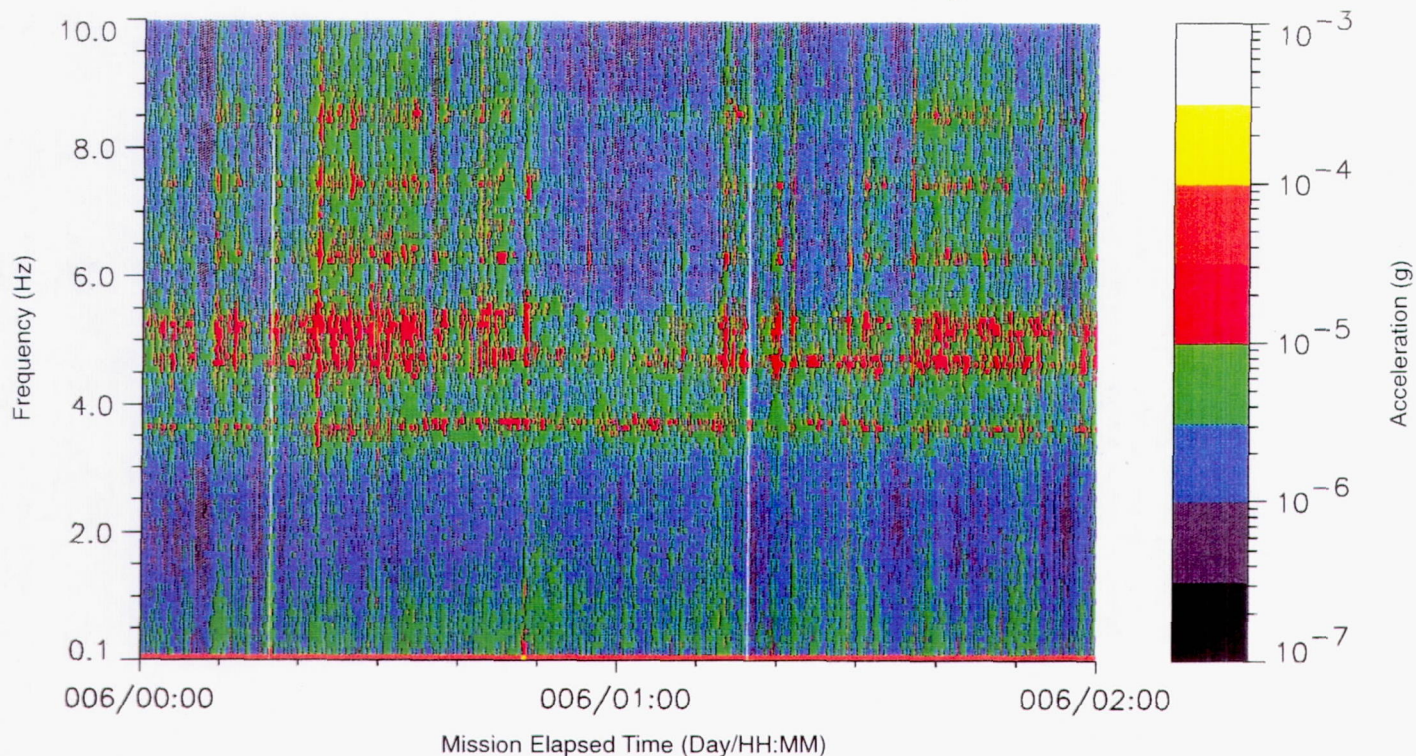


Figure C-70 IML-2 Rack 8, Vector Magnitude

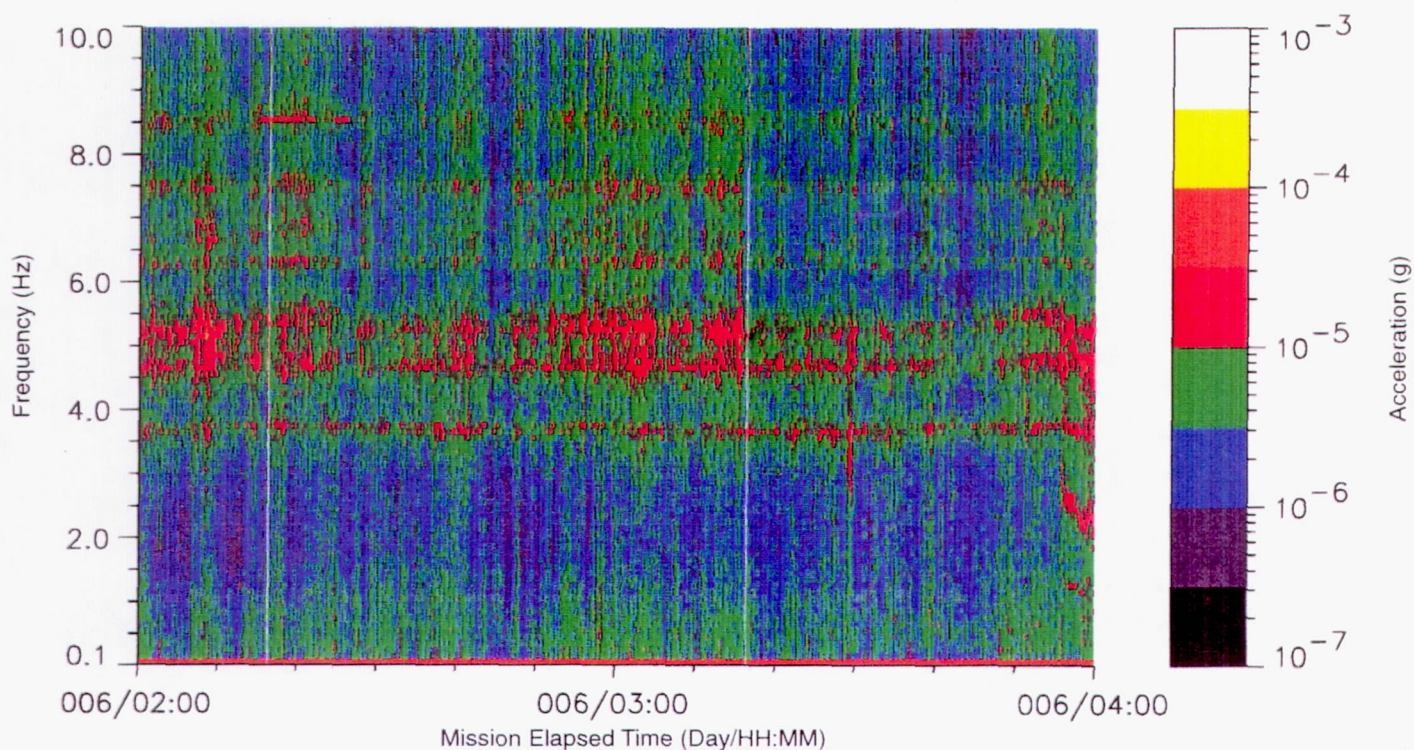


Figure C-71 IML-2 Rack 8, Vector Magnitude

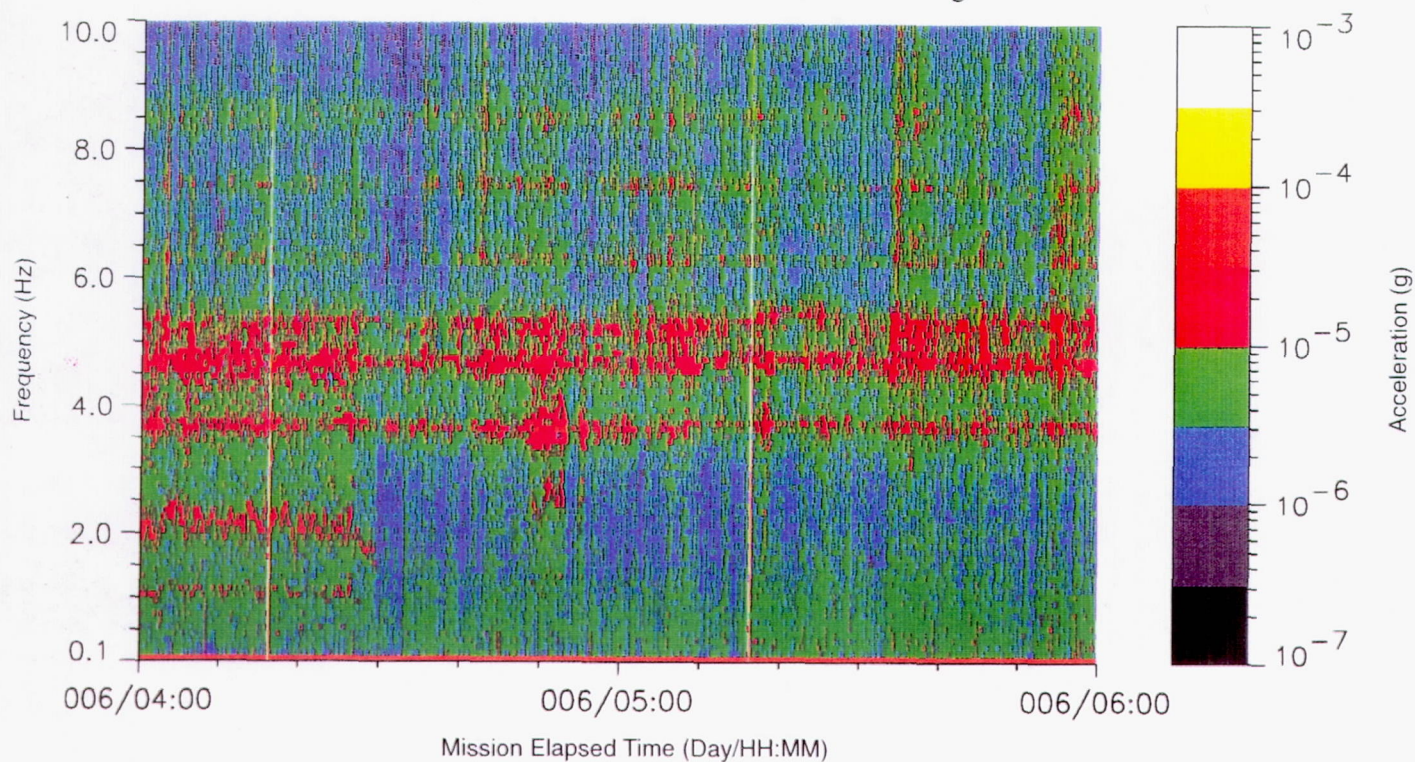


Figure C-72 IML-2 Rack 8, Vector Magnitude

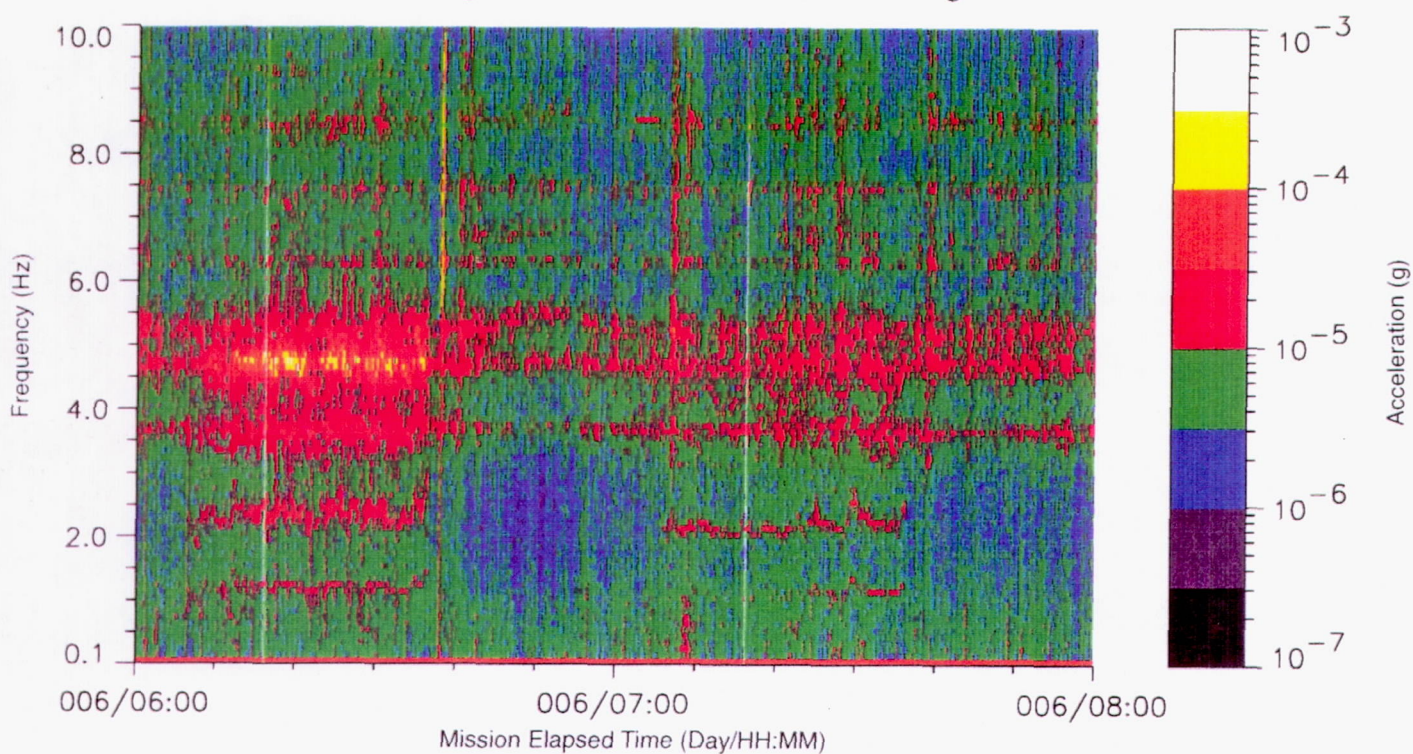


Figure C-73 IML-2 Rack 8, Vector Magnitude

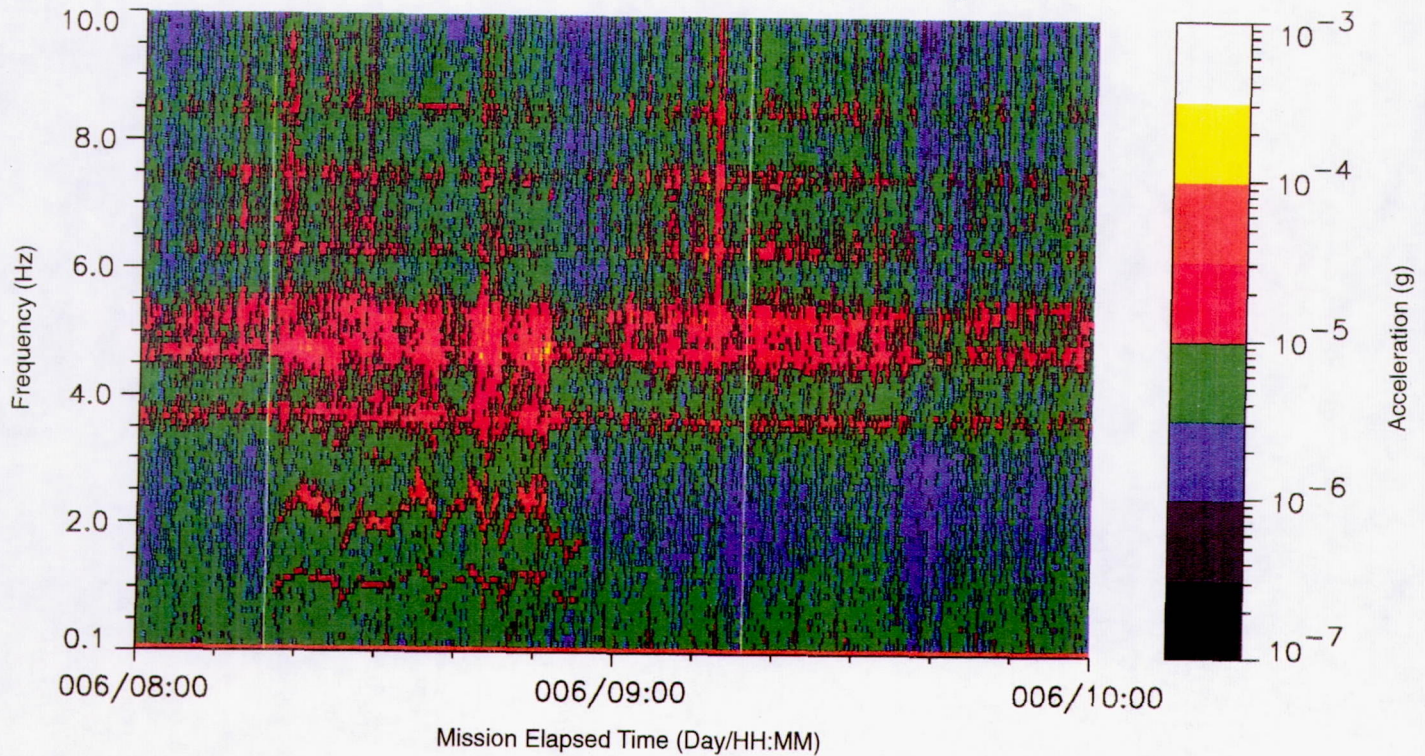
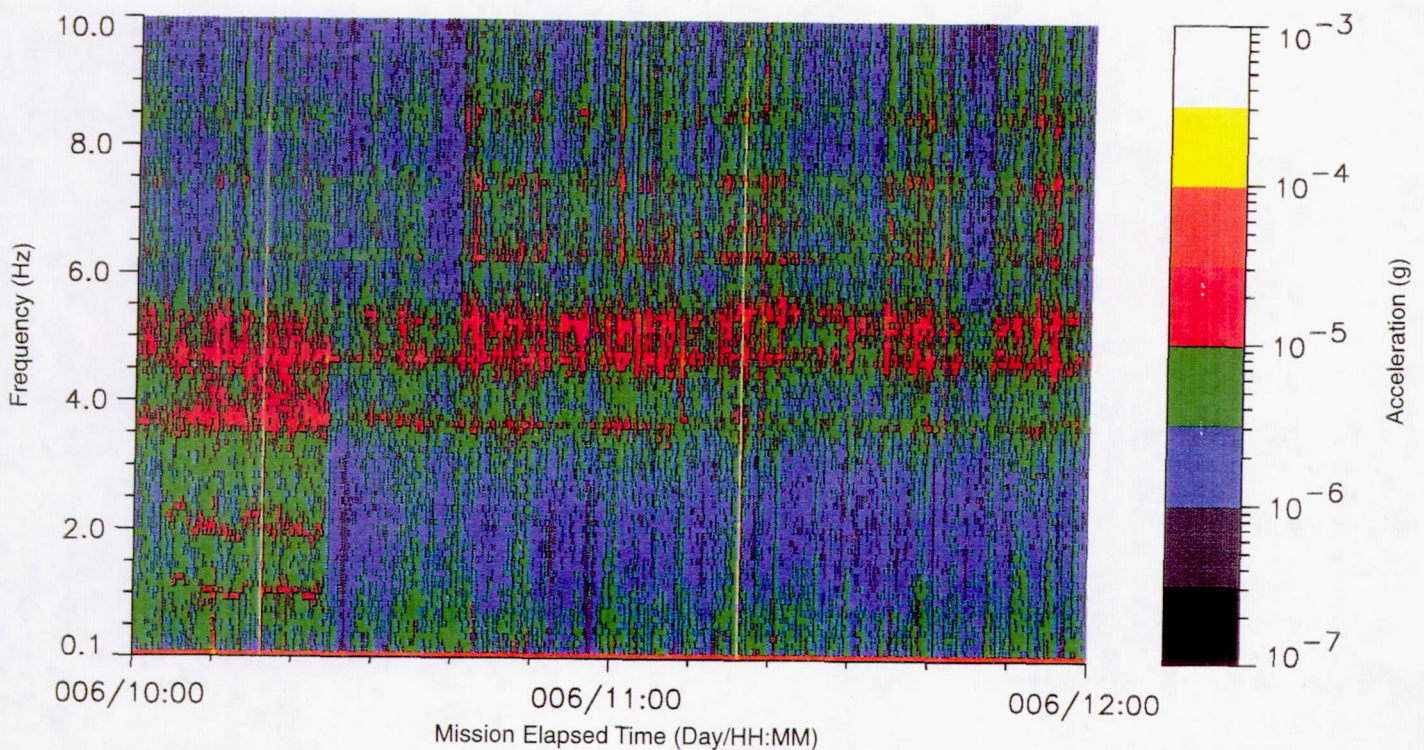


Figure C-74 IML-2 Rack 8, Vector Magnitude



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Figure C-75 IML-2 Rack 8, Vector Magnitude

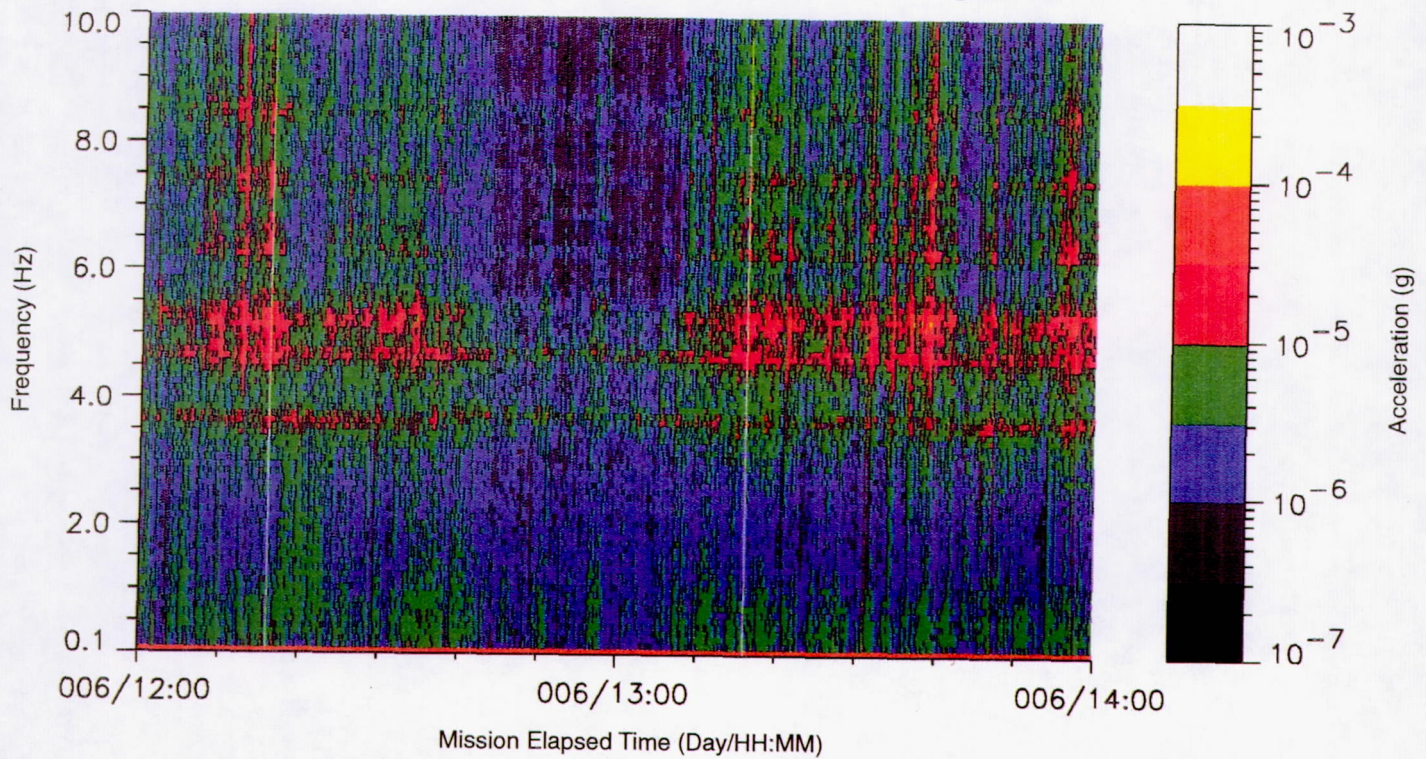


Figure C-76 IML-2 Rack 8, Vector Magnitude

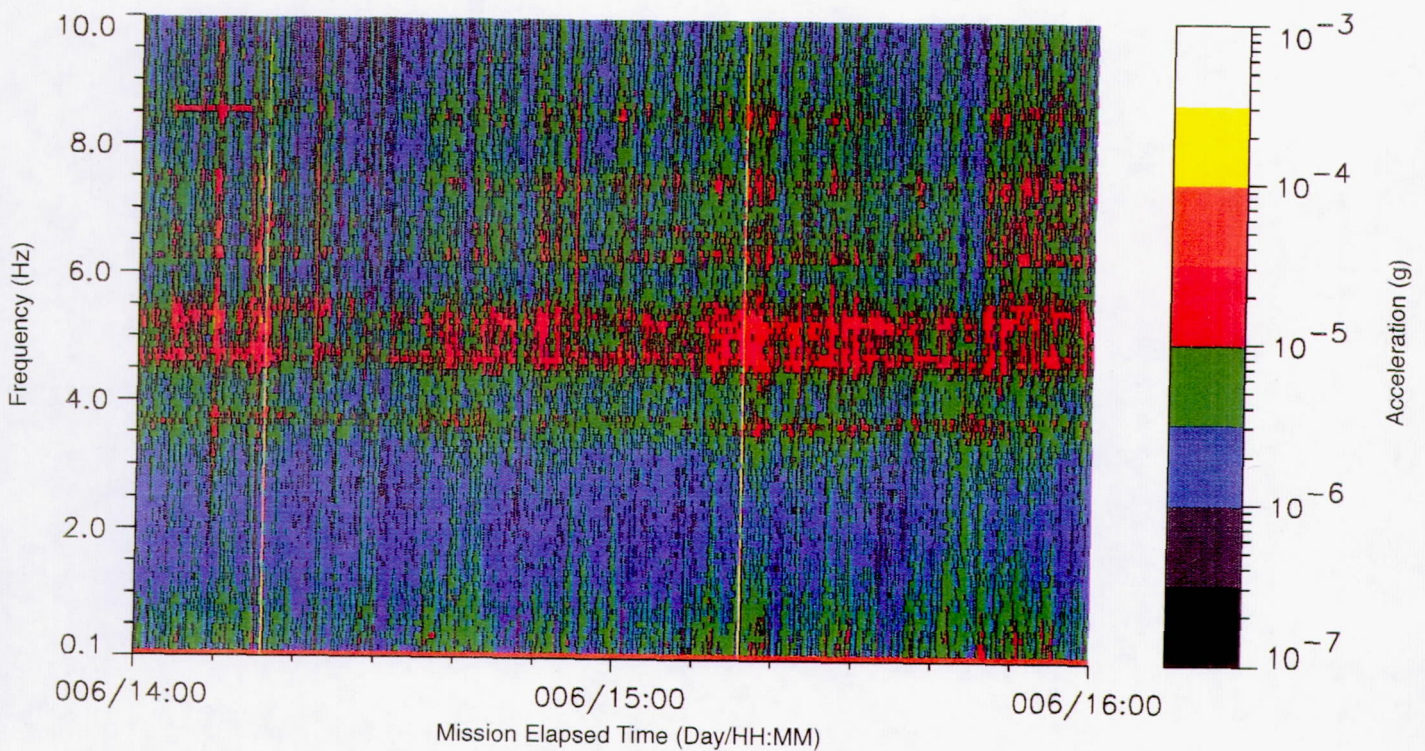


Figure C-77 IML-2 Rack 8, Vector Magnitude

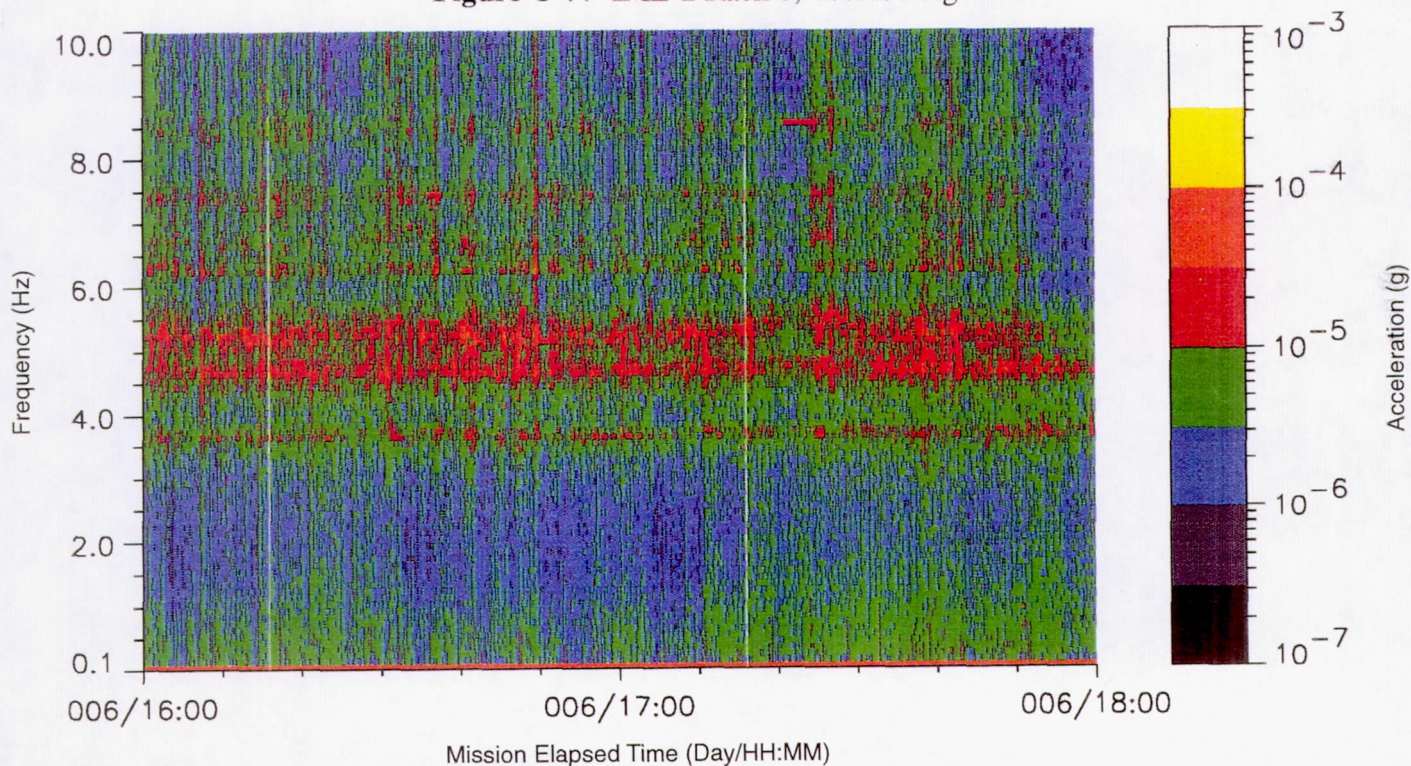


Figure C-78 IML-2 Rack 8, Vector Magnitude

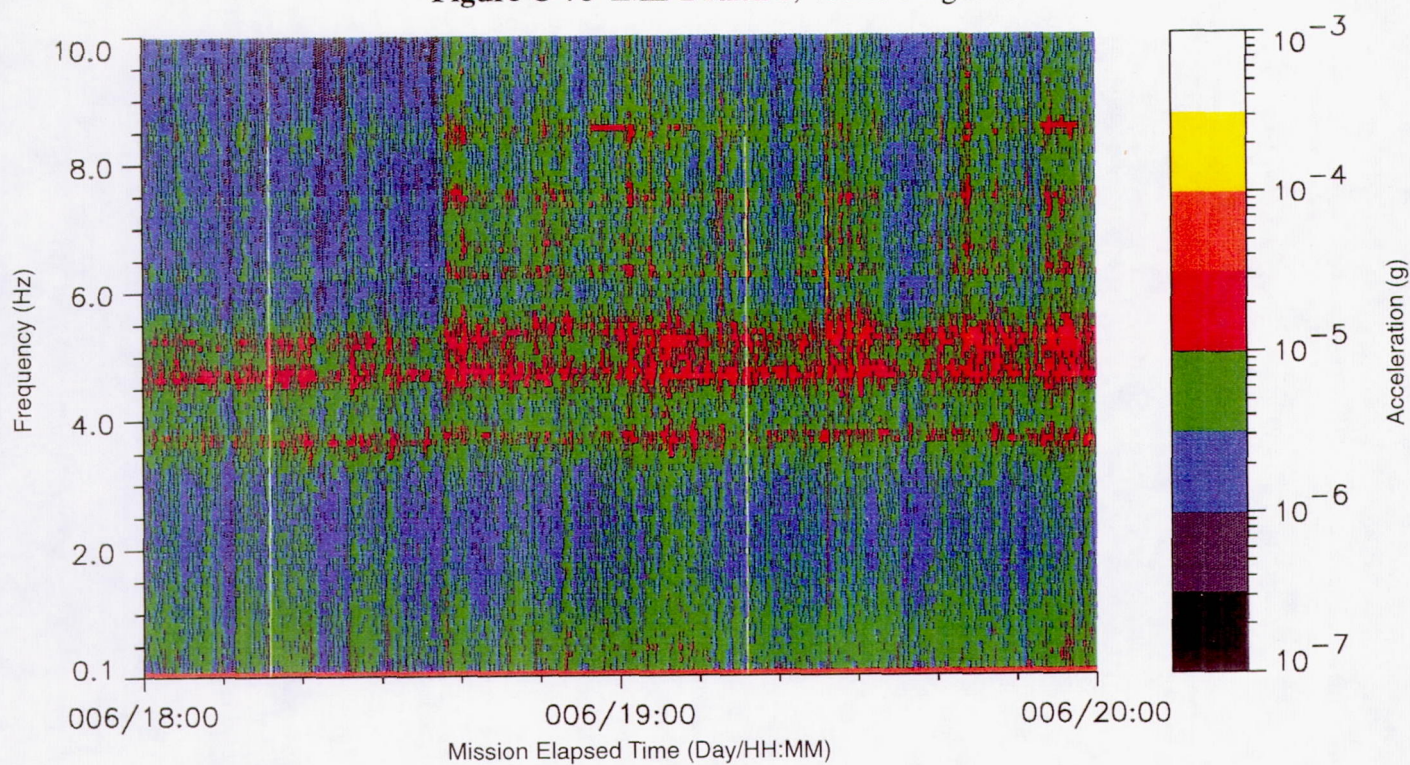


Figure C-79 IML-2 Rack 8, Vector Magnitude

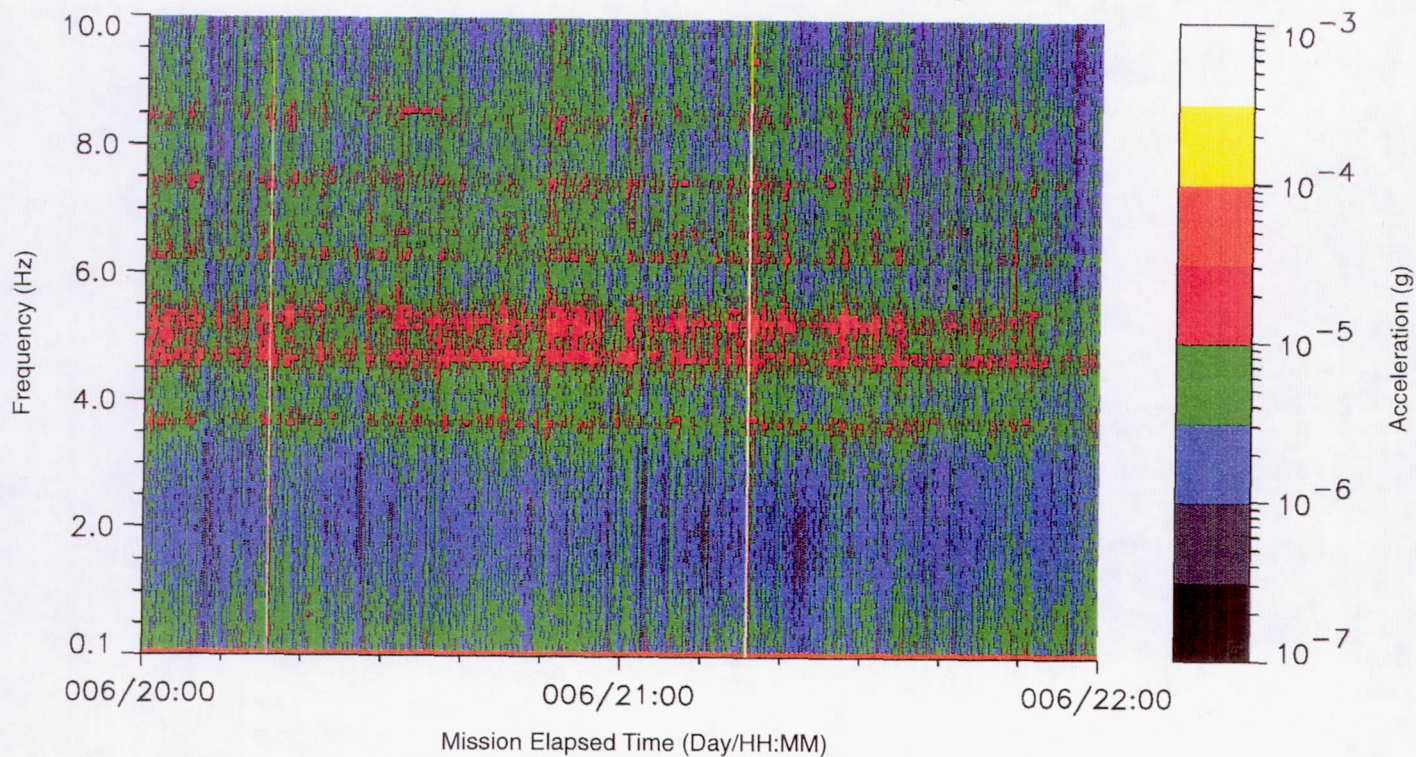


Figure C-80 IML-2 Rack 8, Vector Magnitude

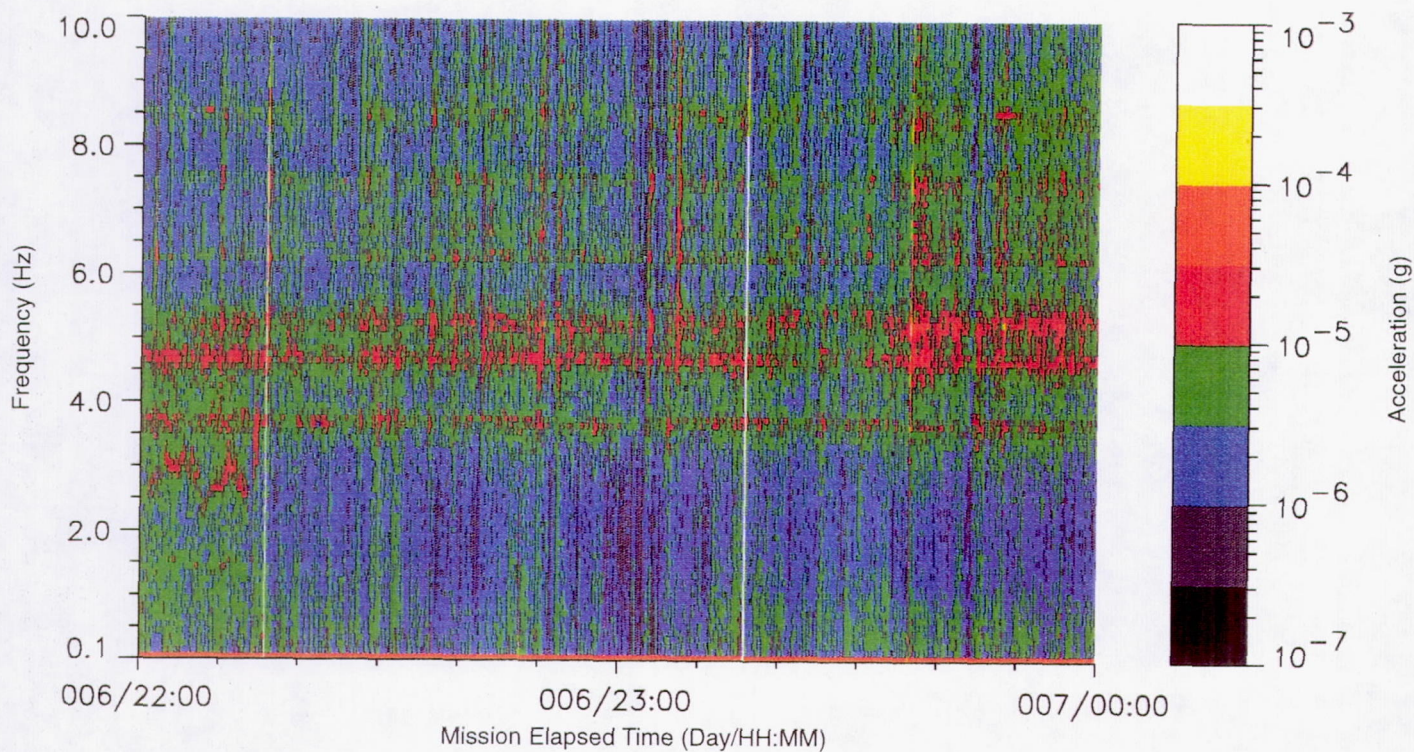


Figure C-81 IML-2 Rack 8, Vector Magnitude

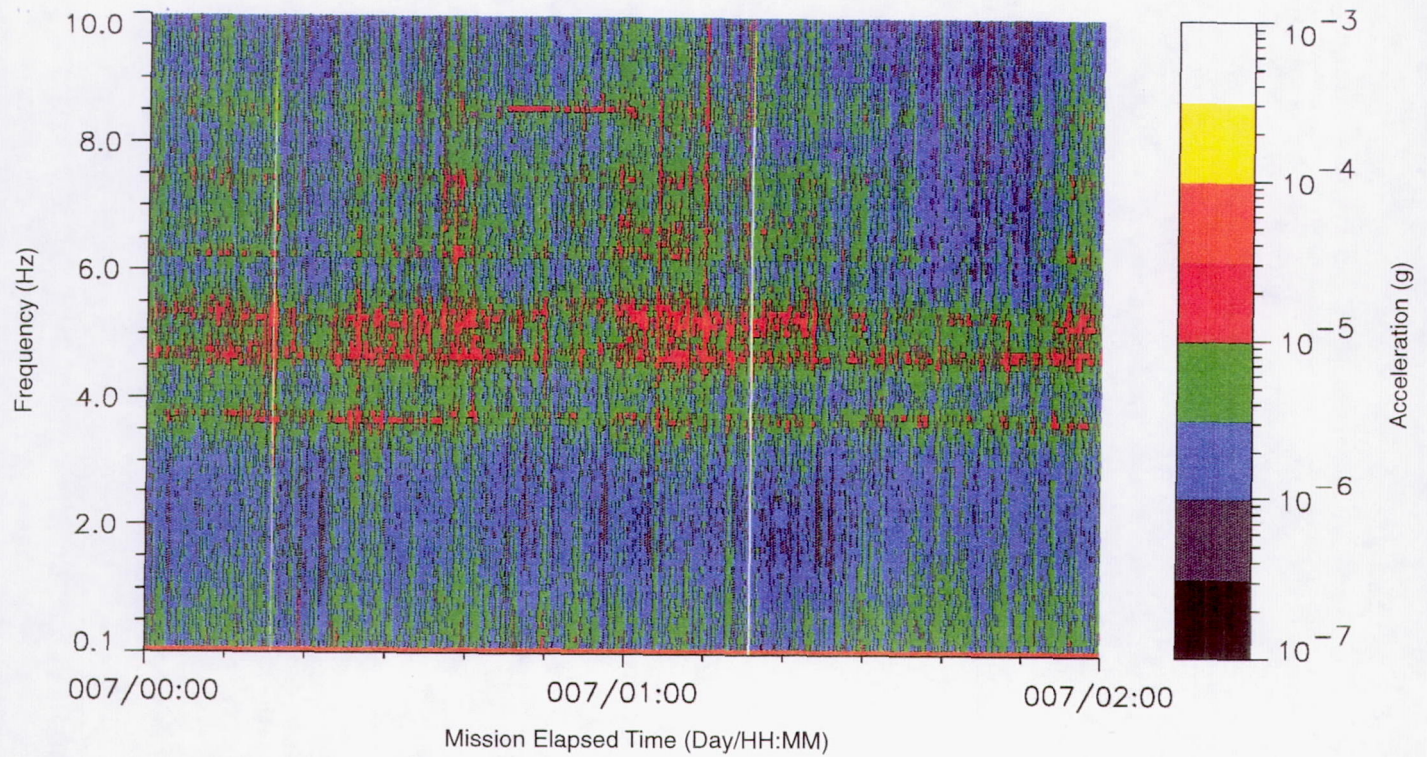


Figure C-82 IML-2 Rack 8, Vector Magnitude

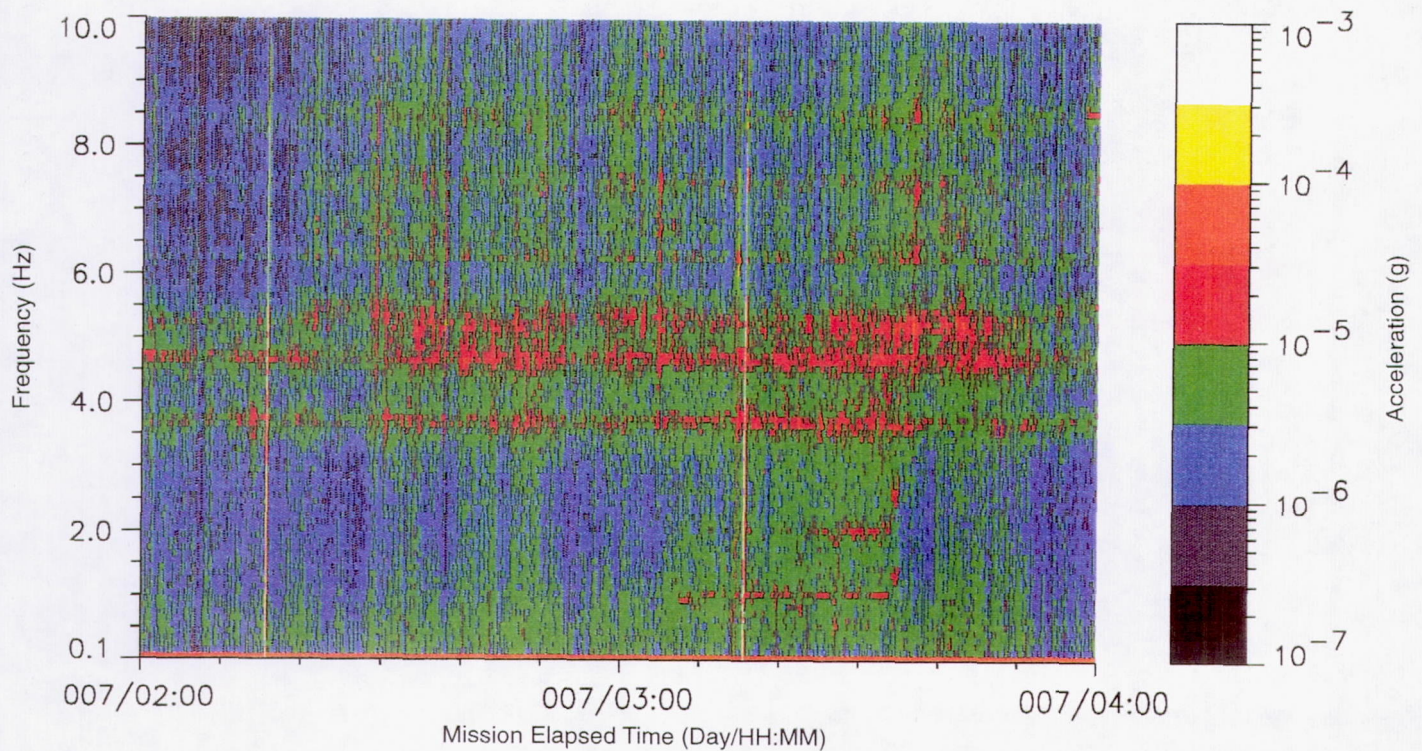


Figure C-83 IML-2 Rack 8, Vector Magnitude

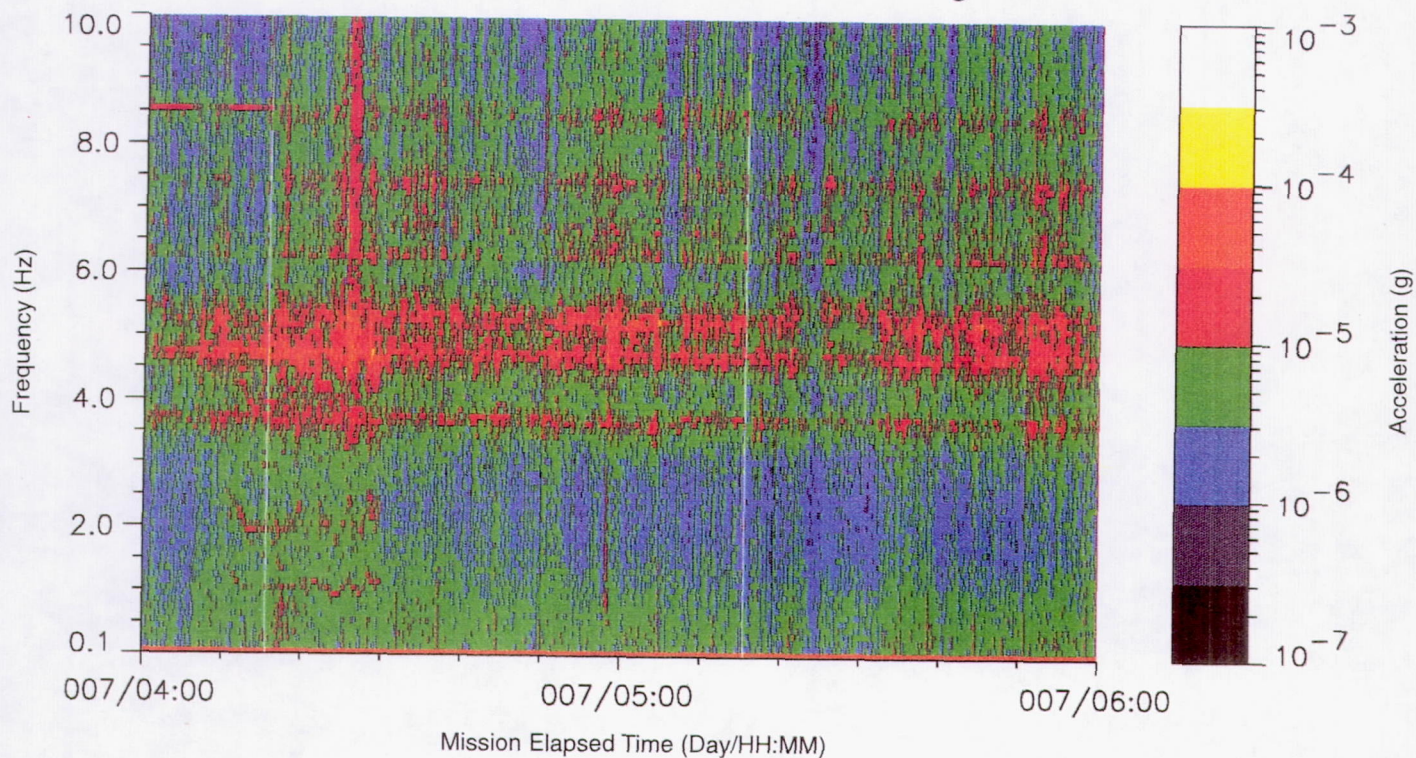


Figure C-84 IML-2 Rack 8, Vector Magnitude

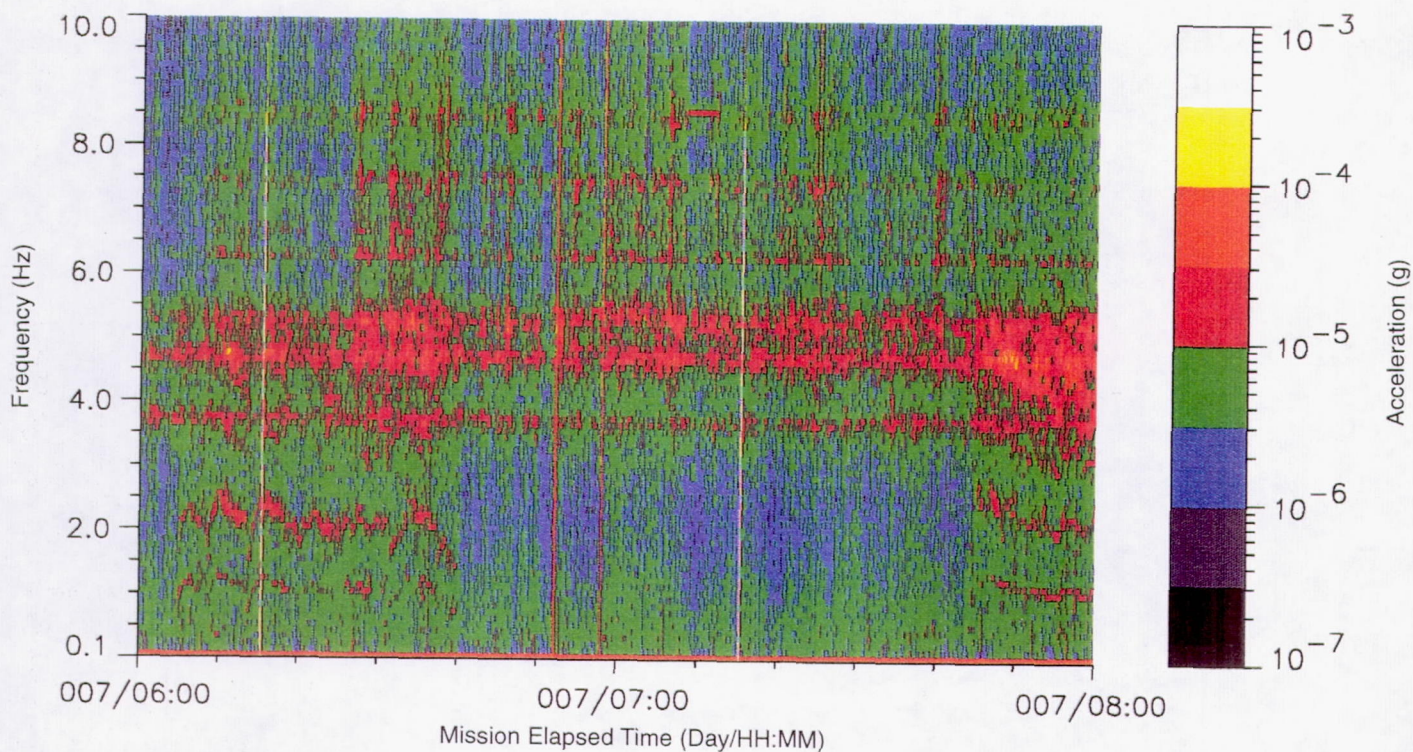


Figure C-85 IML-2 Rack 8, Vector Magnitude

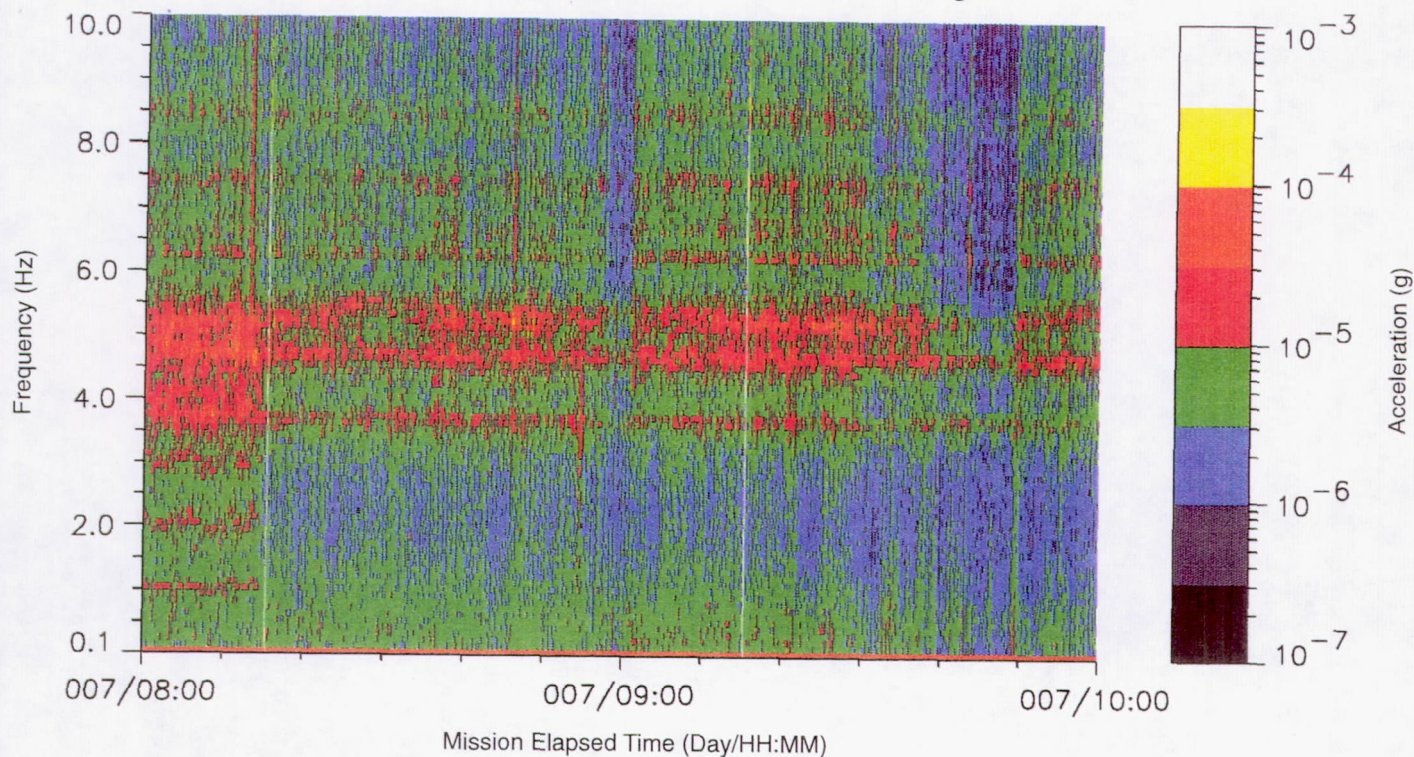


Figure C-86 IML-2 Rack 8, Vector Magnitude

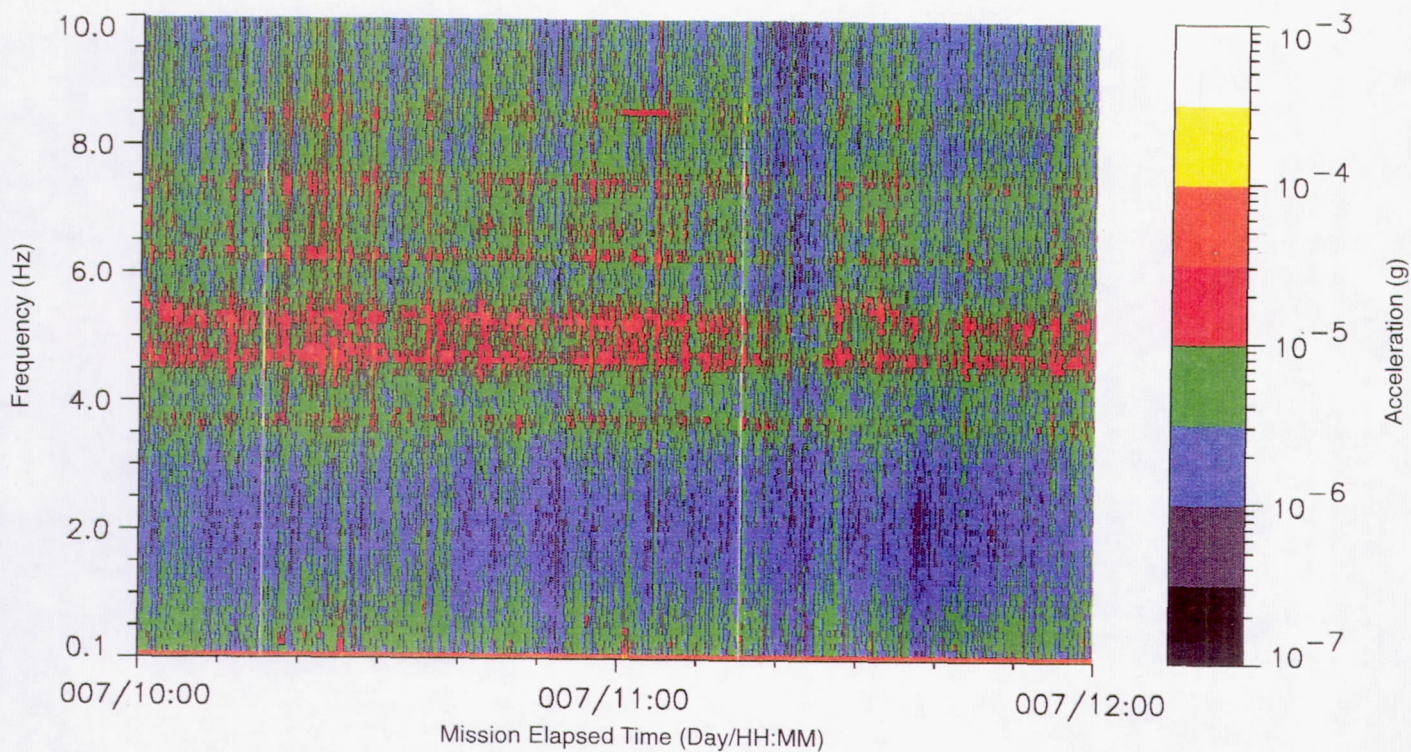


Figure C-87 IML-2 Rack 8, Vector Magnitude

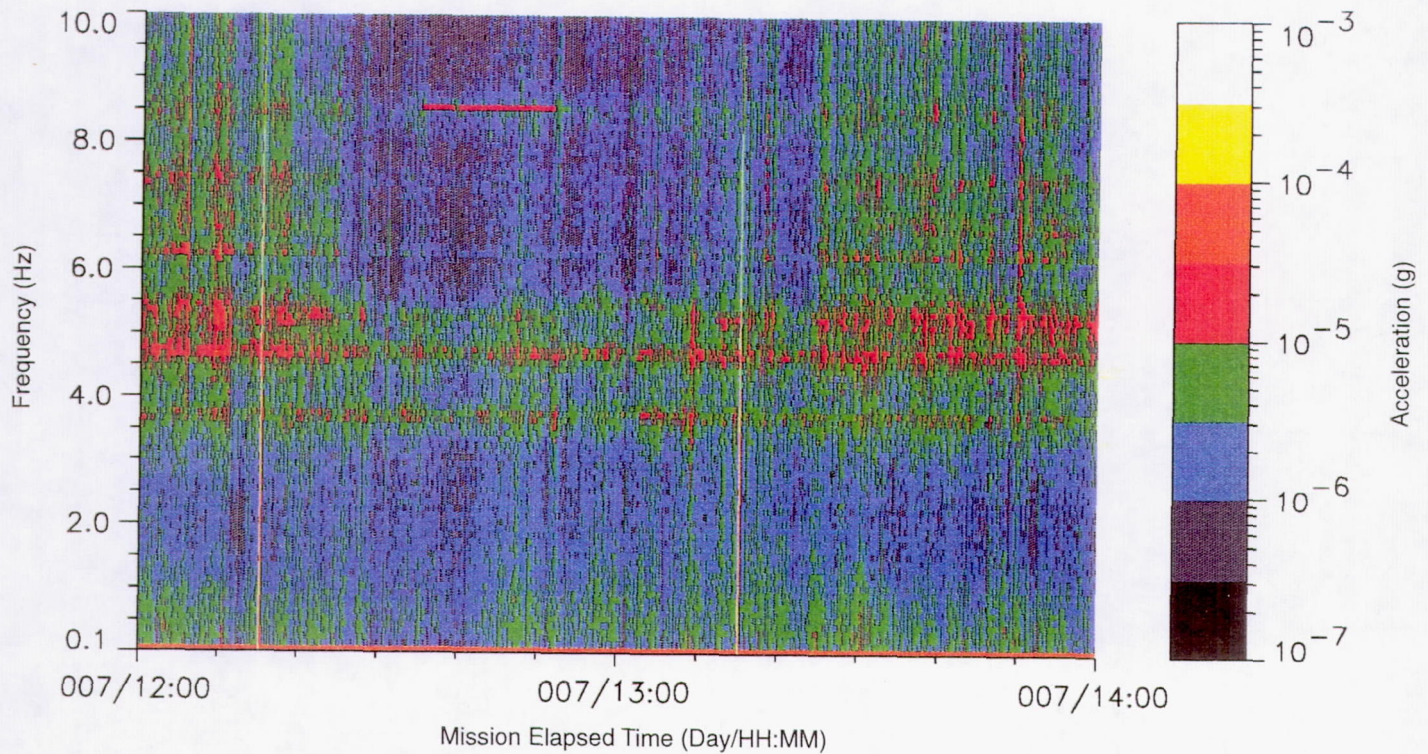


Figure C-88 IML-2 Rack 8, Vector Magnitude

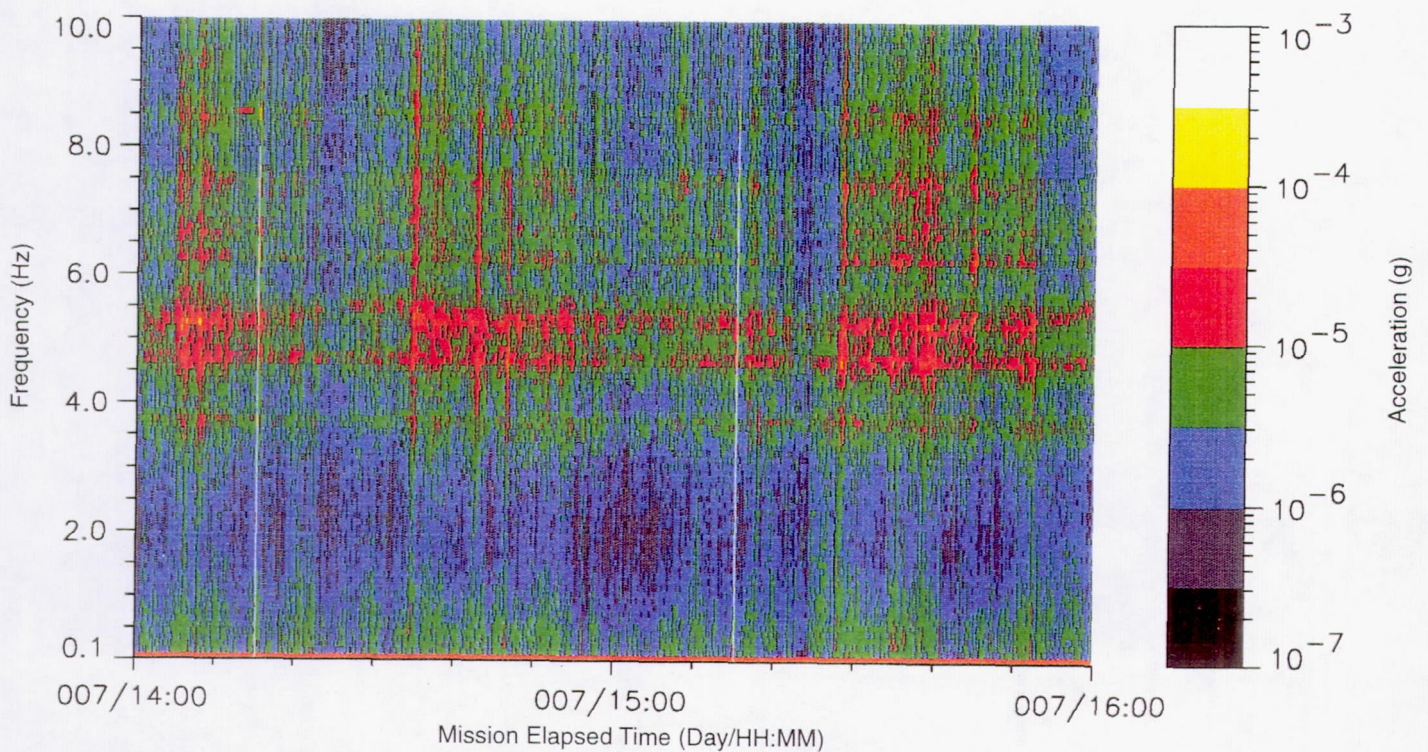


Figure C-89 IML-2 Rack 8, Vector Magnitude

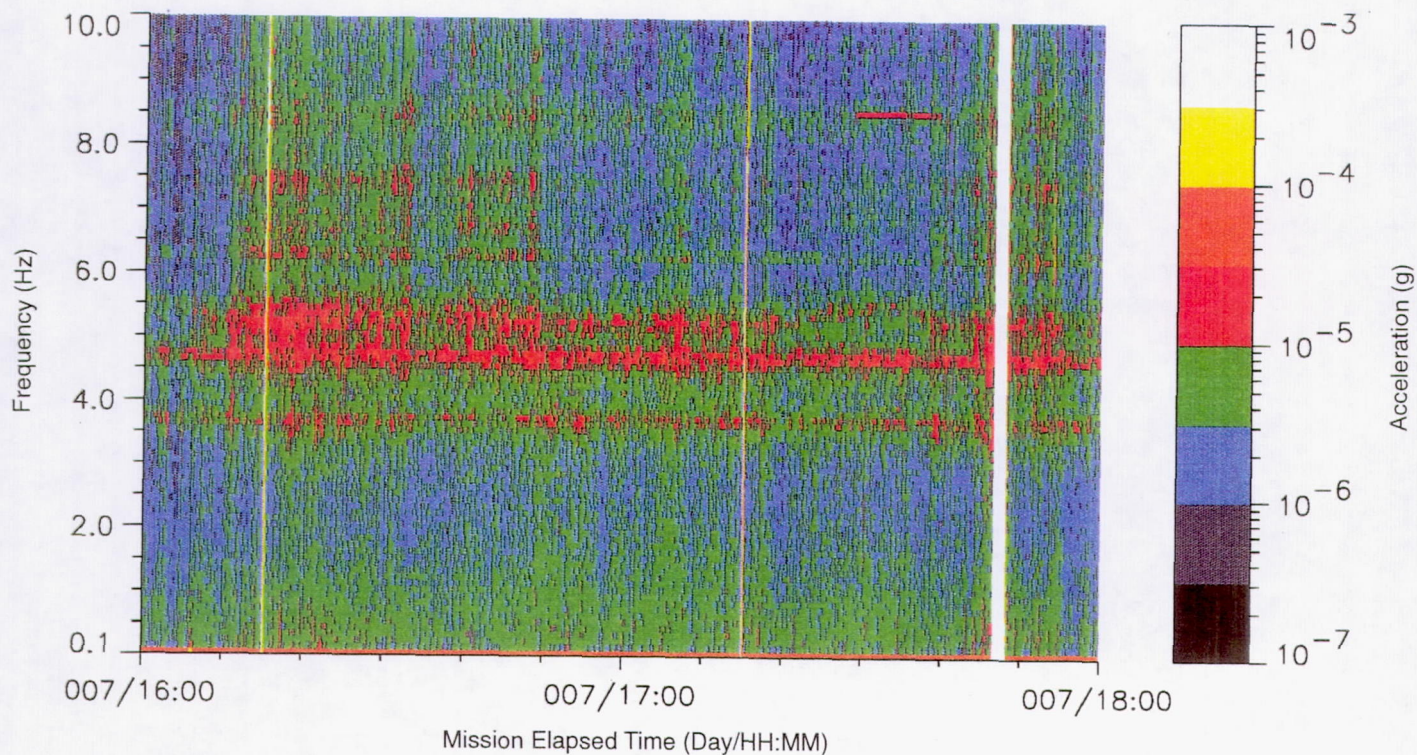


Figure C-90 IML-2 Rack 8, Vector Magnitude

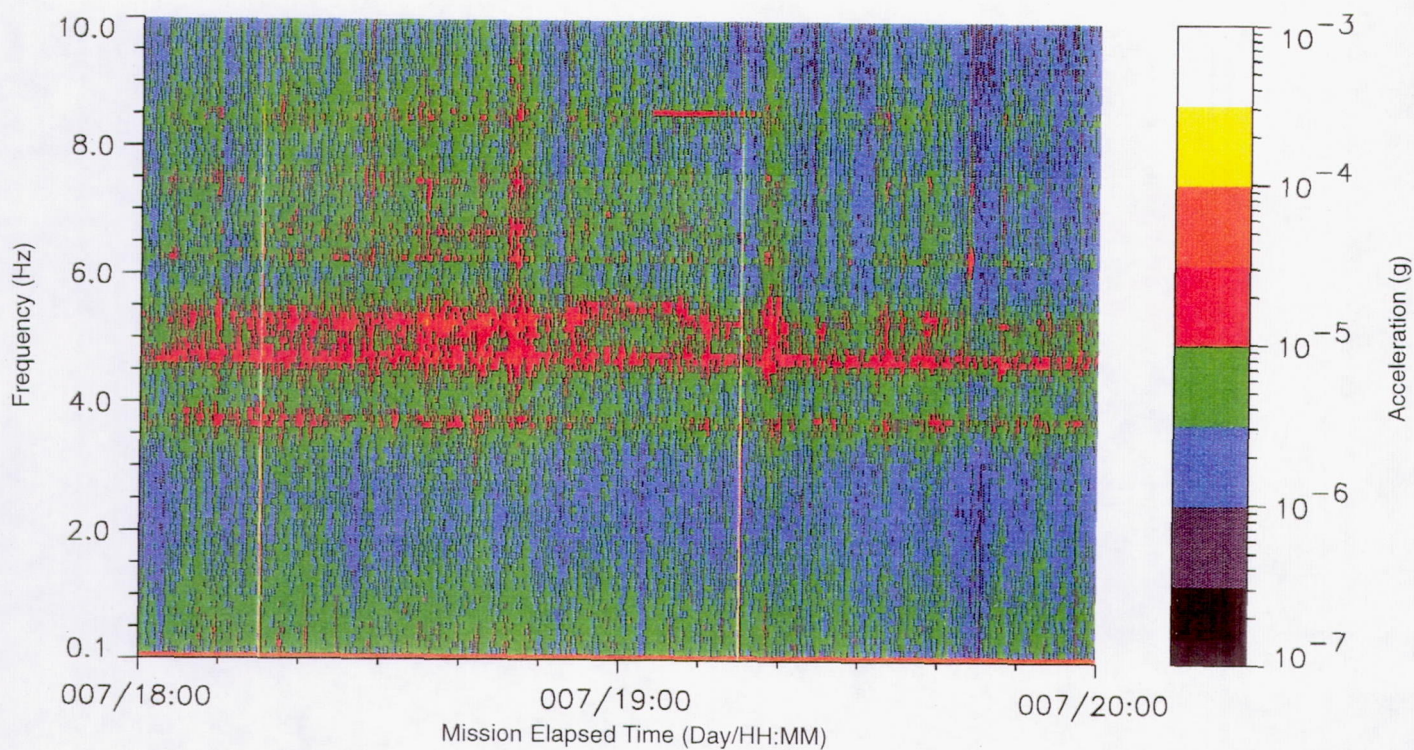


Figure C-91 IML-2 Rack 8, Vector Magnitude

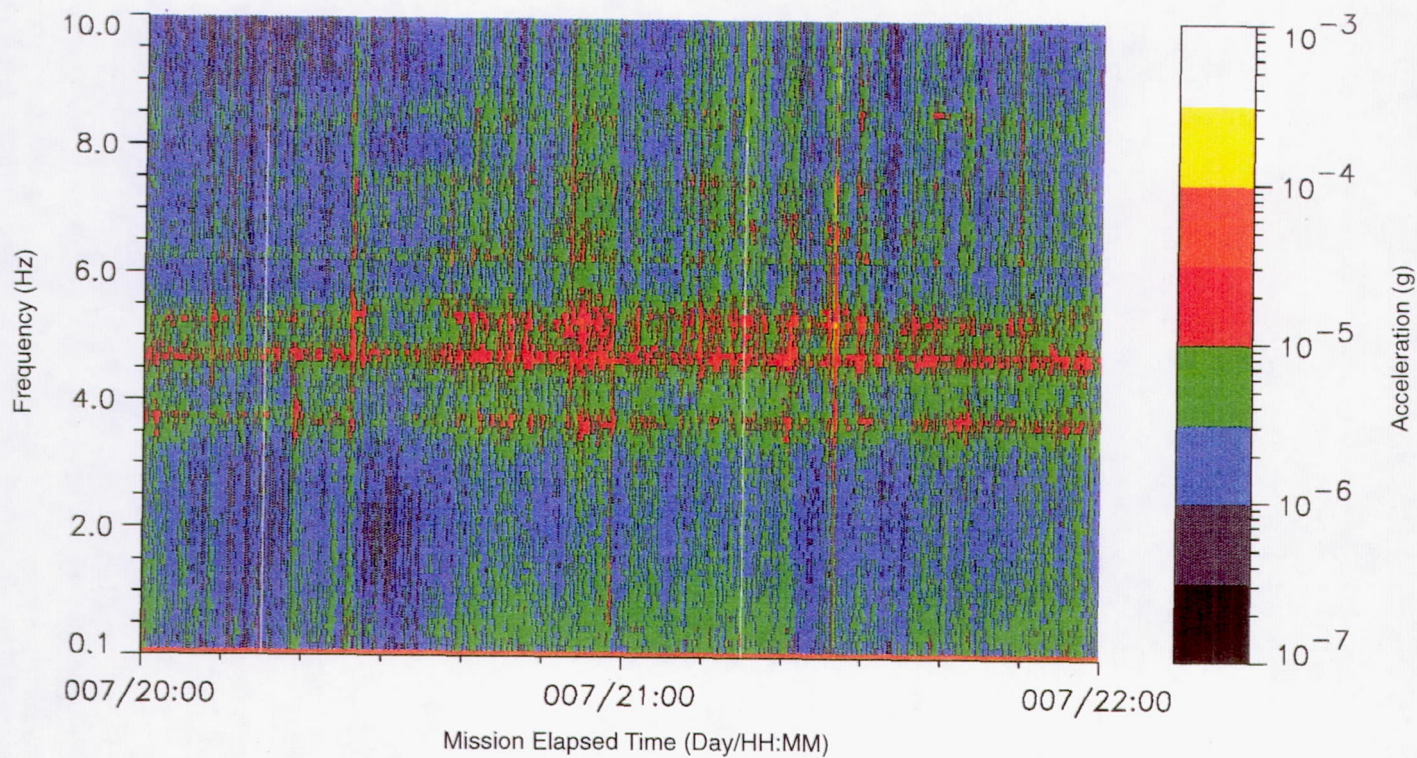


Figure C-92 IML-2 Rack 8, Vector Magnitude

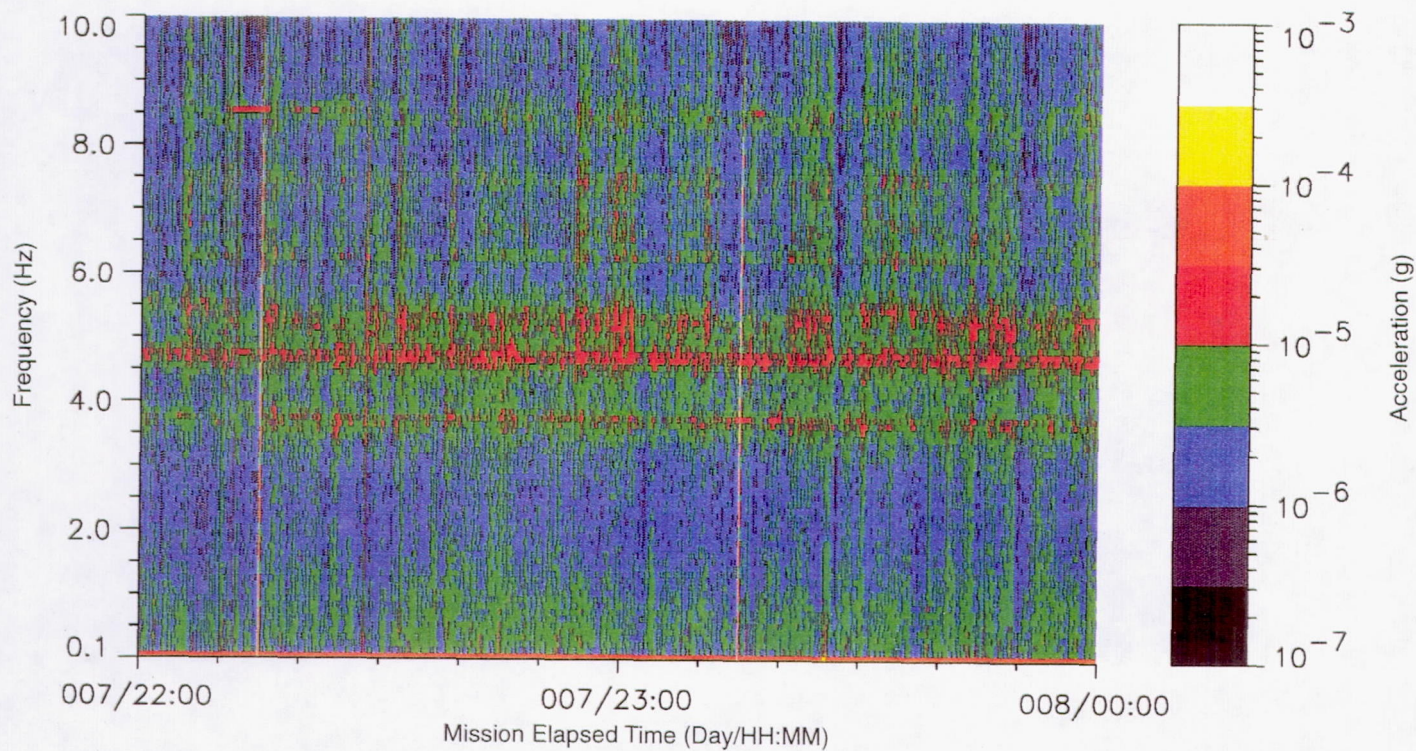


Figure C-93 IML-2 Rack 8, Vector Magnitude

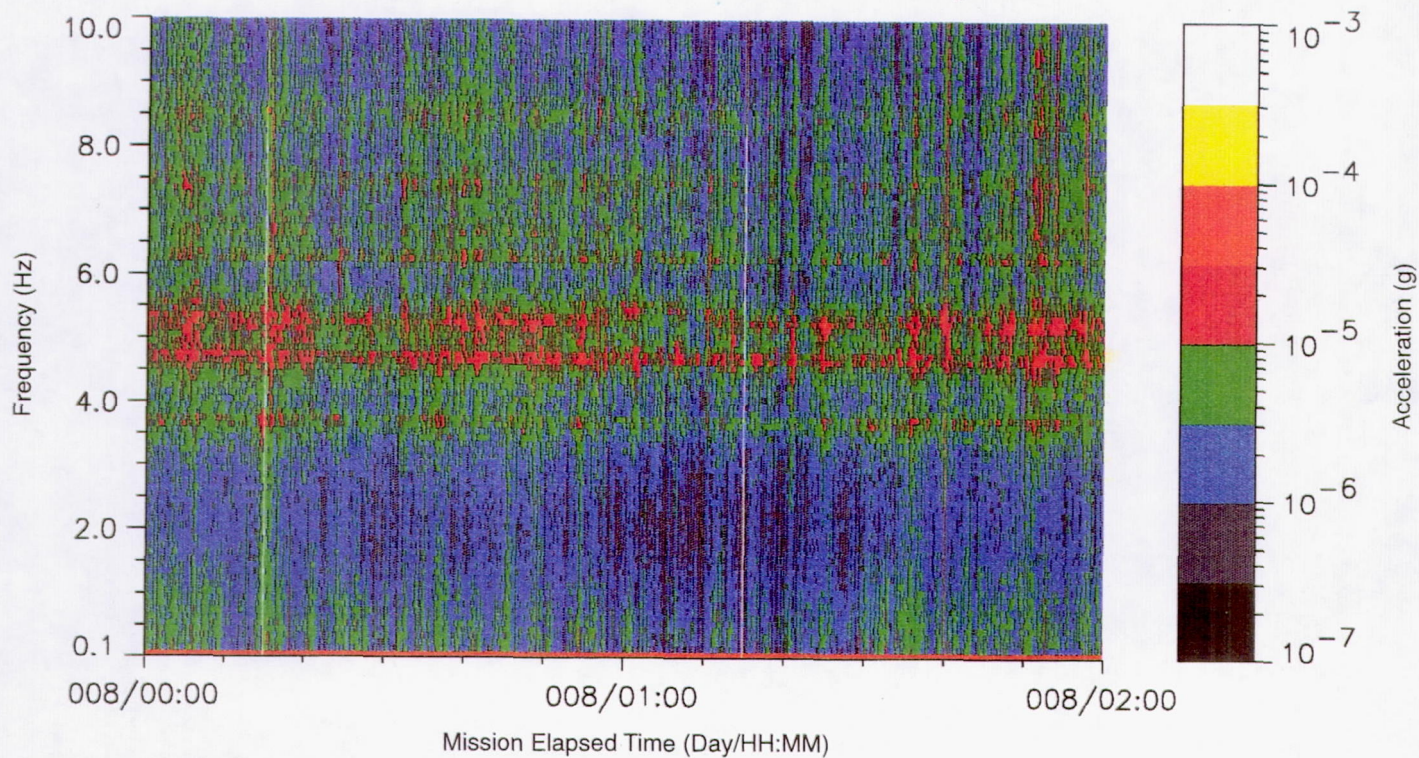


Figure C-94 IML-2 Rack 8, Vector Magnitude

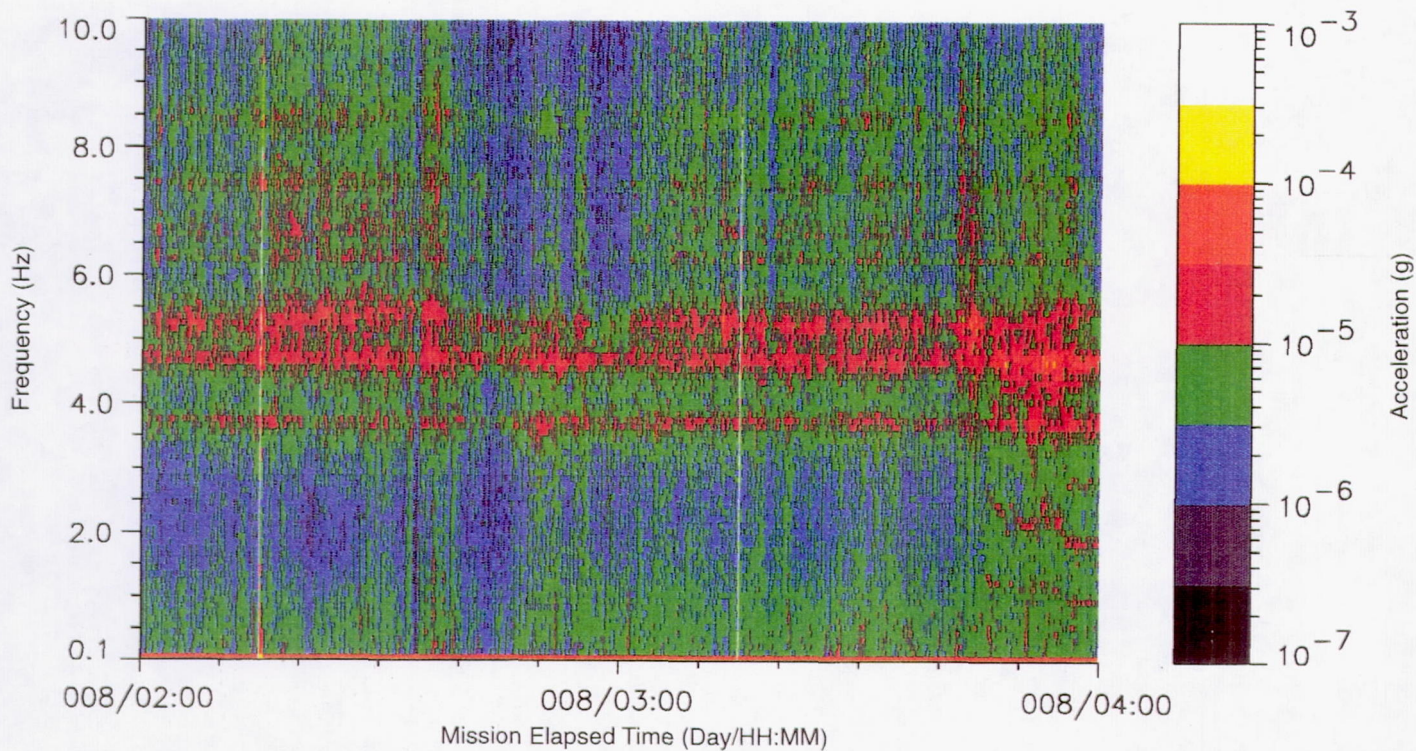


Figure C-95 IML-2 Rack 8, Vector Magnitude

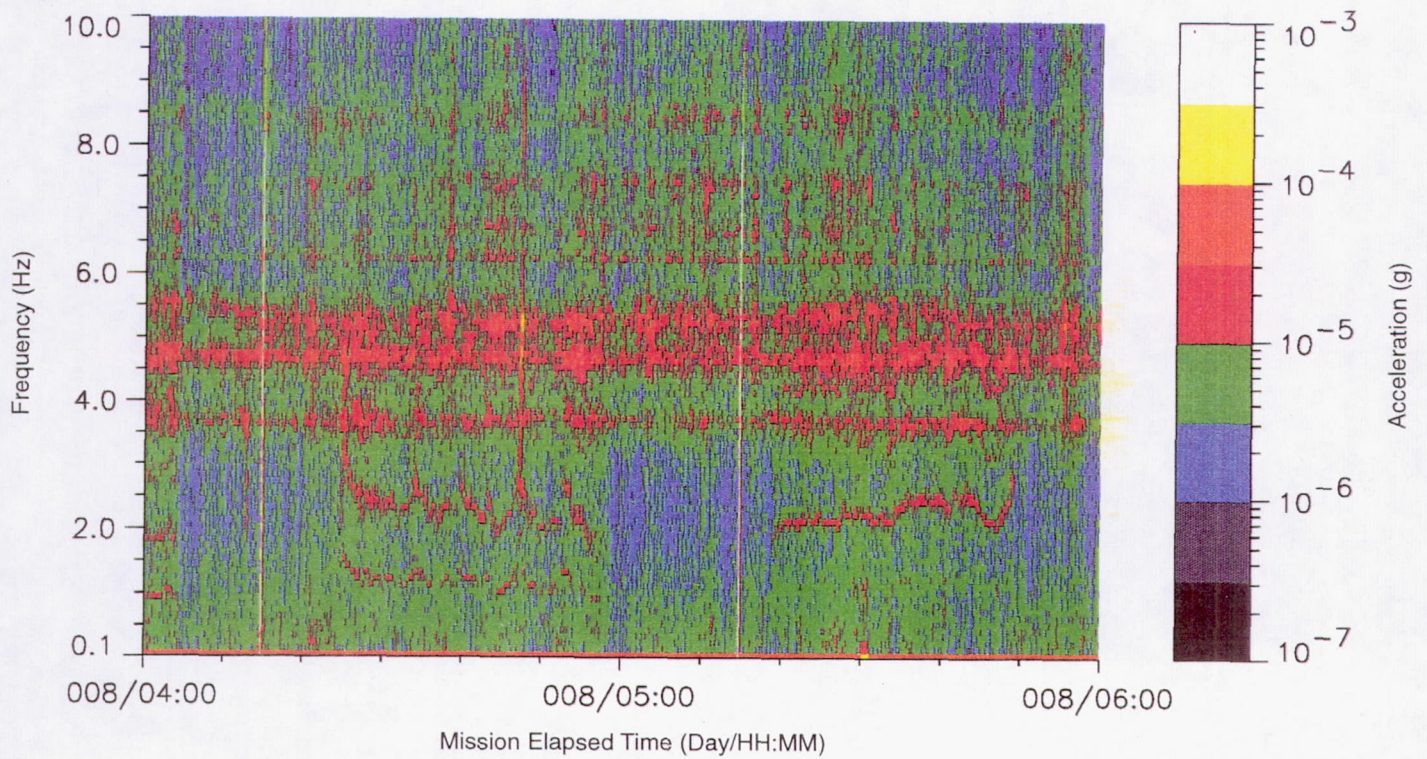


Figure C-96 IML-2 Rack 8, Vector Magnitude

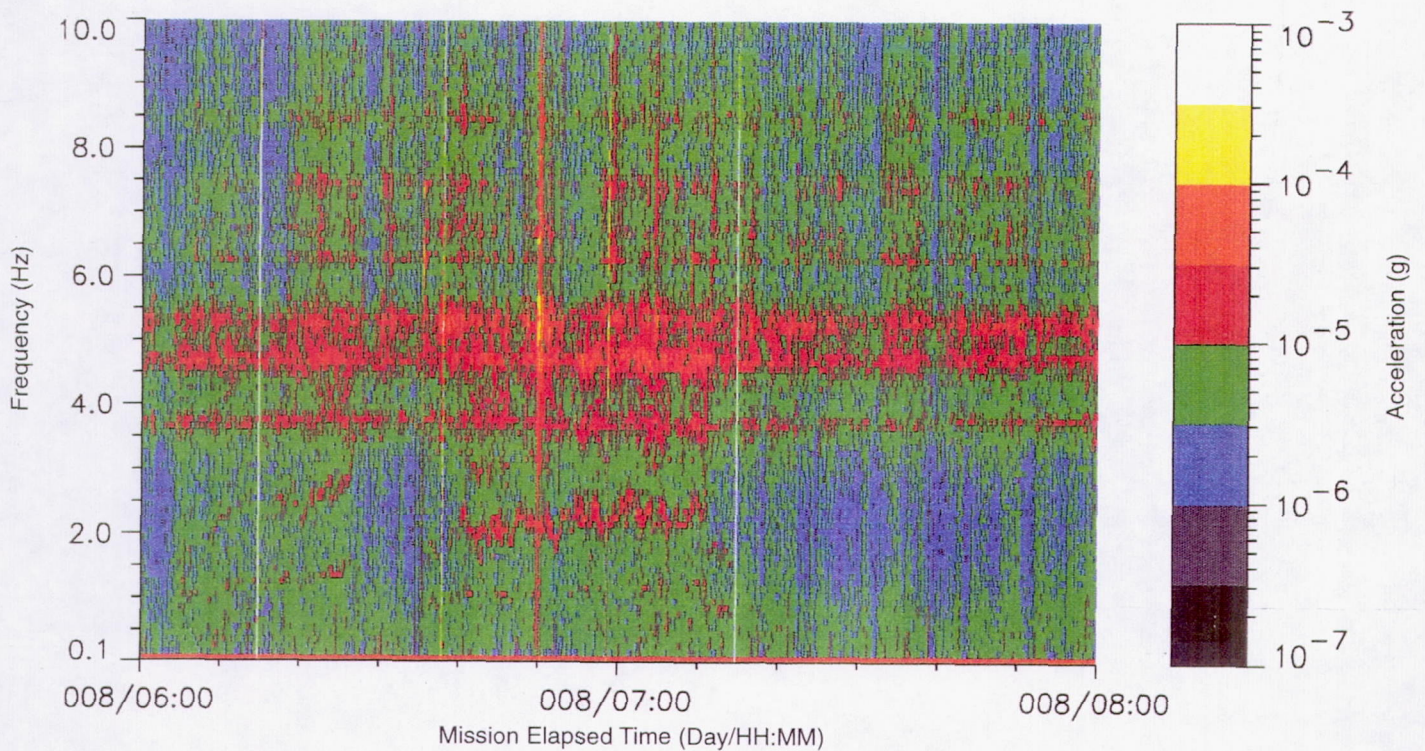


Figure C-97 IML-2 Rack 8, Vector Magnitude

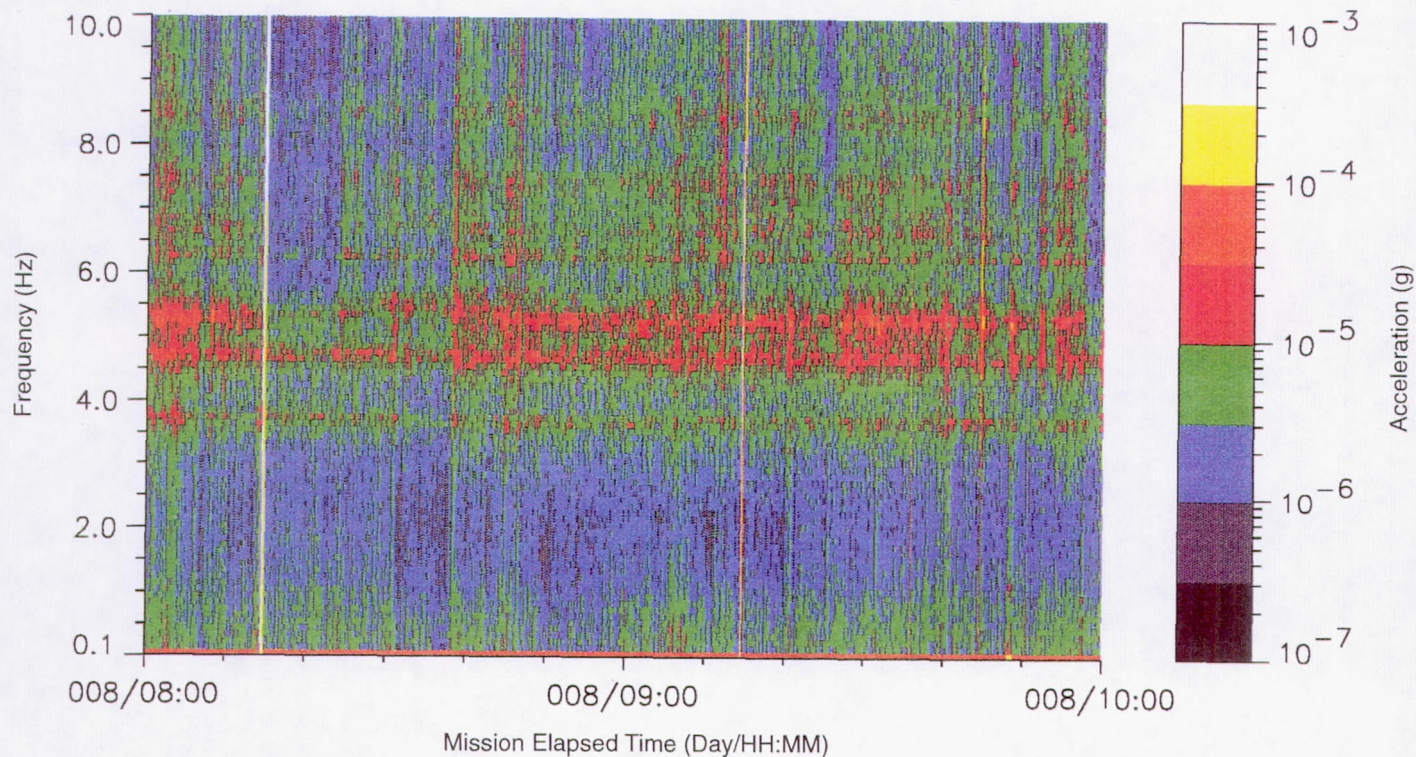


Figure C-98 IML-2 Rack 8, Vector Magnitude

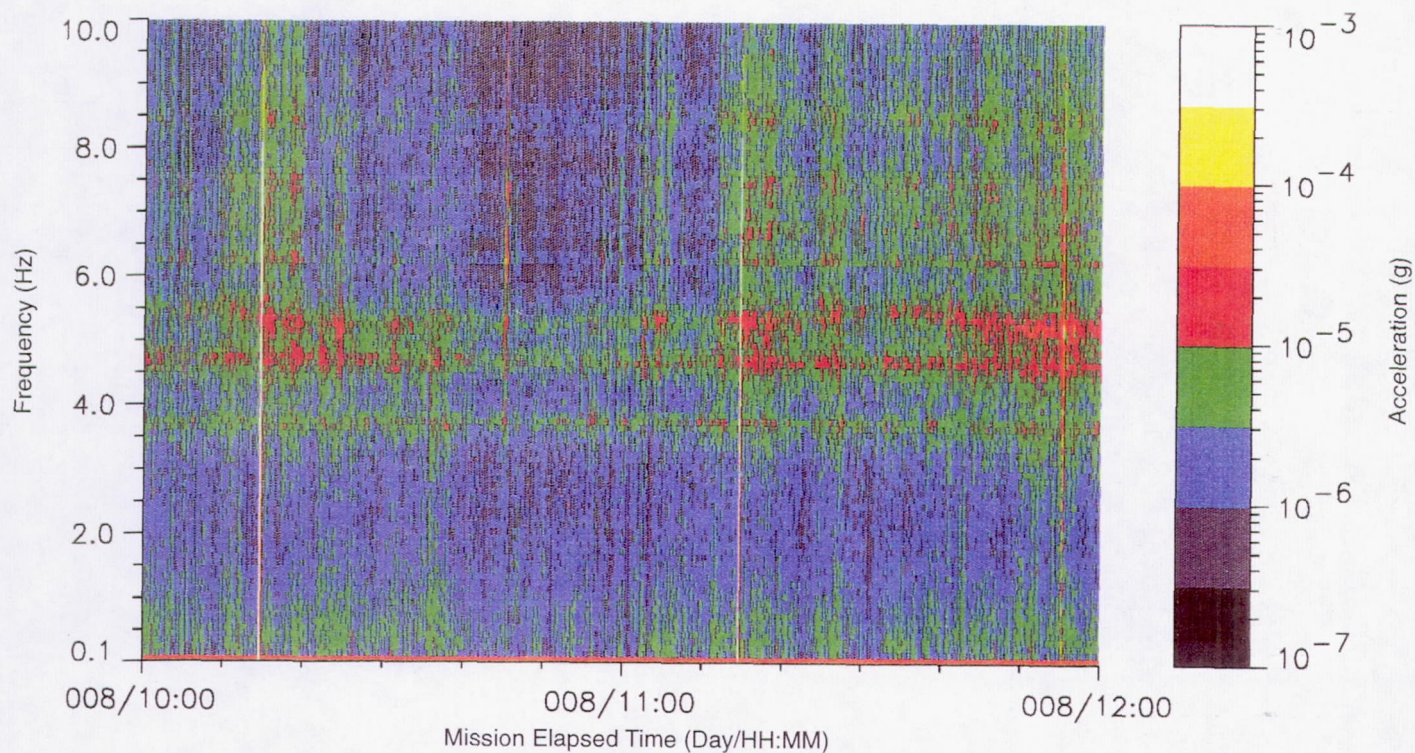


Figure C-99 IML-2 Rack 8, Vector Magnitude

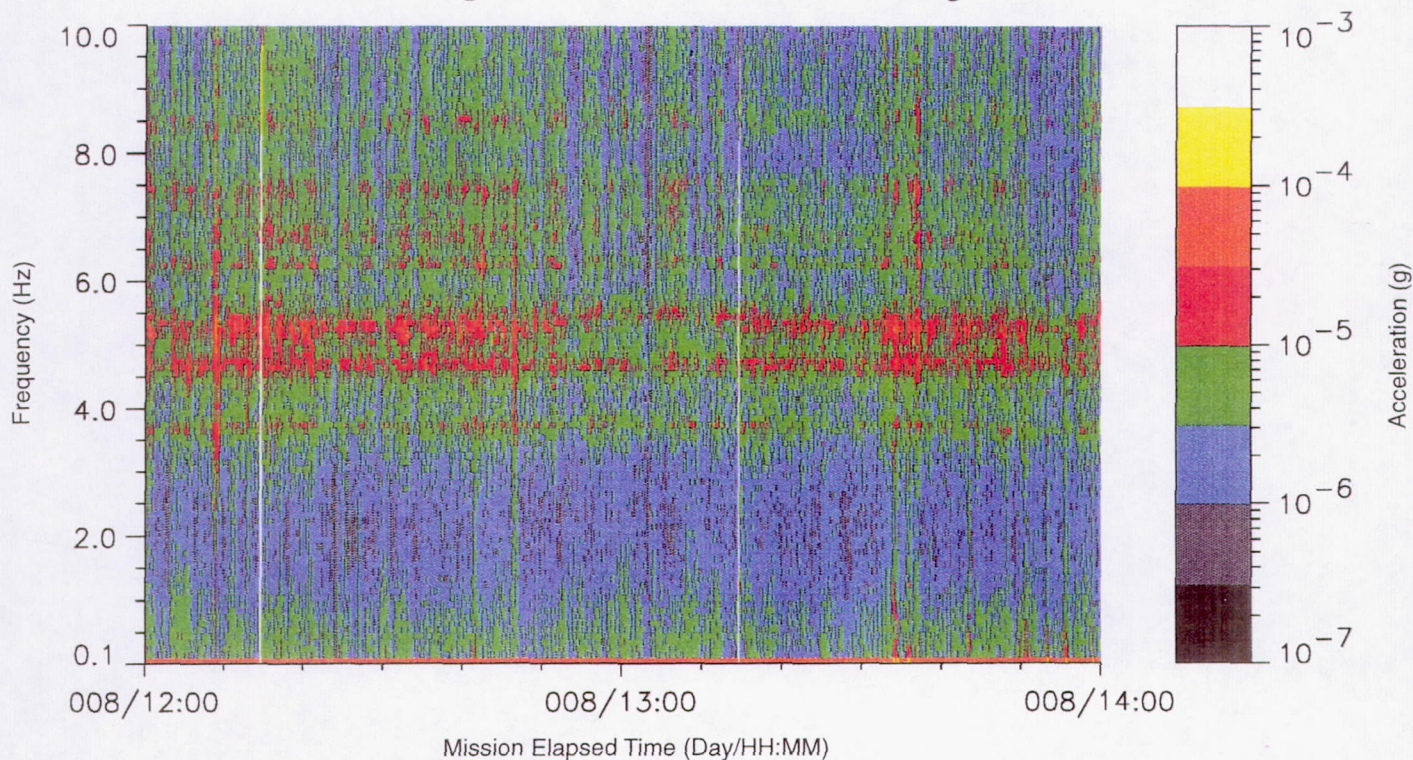


Figure C-100 IML-2 Rack 8, Vector Magnitude

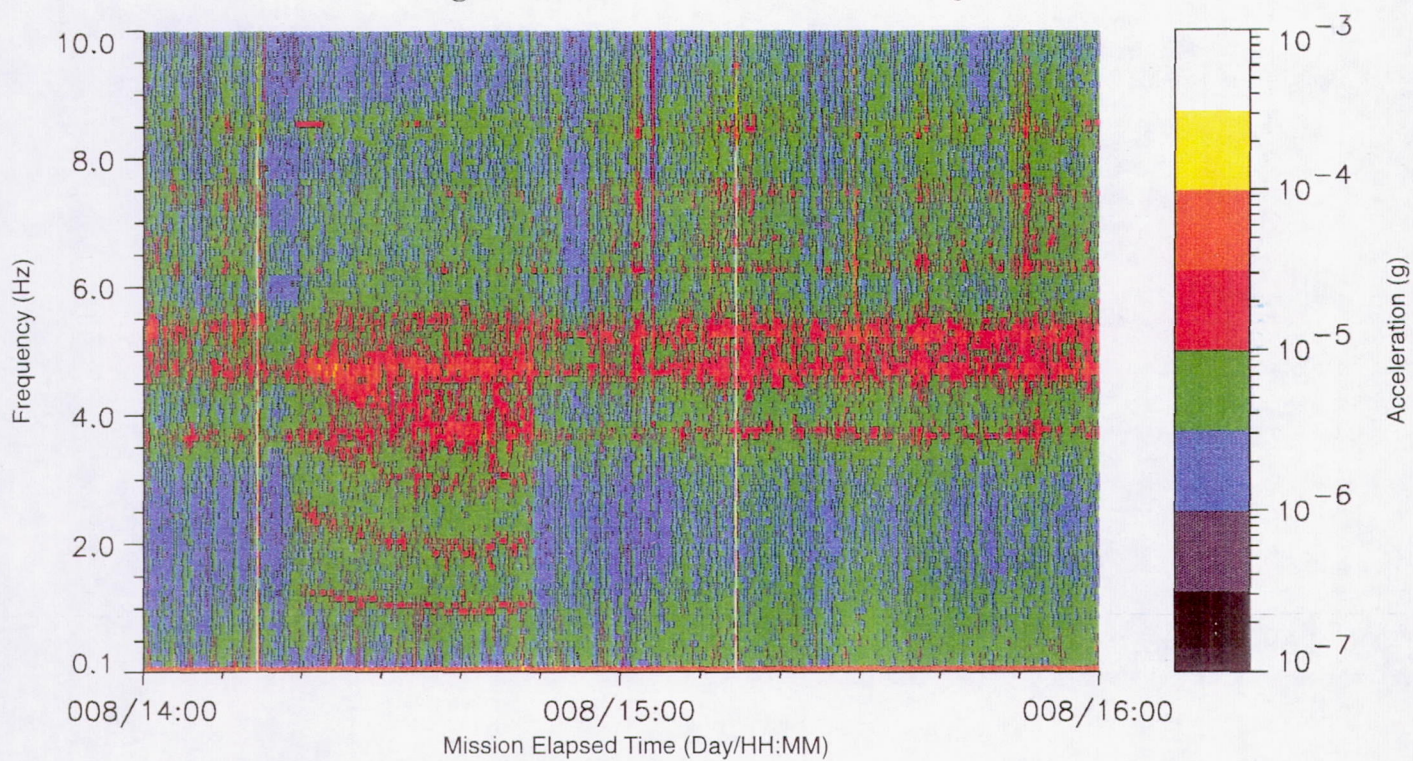


Figure C-101 IML-2 Rack 8, Vector Magnitude

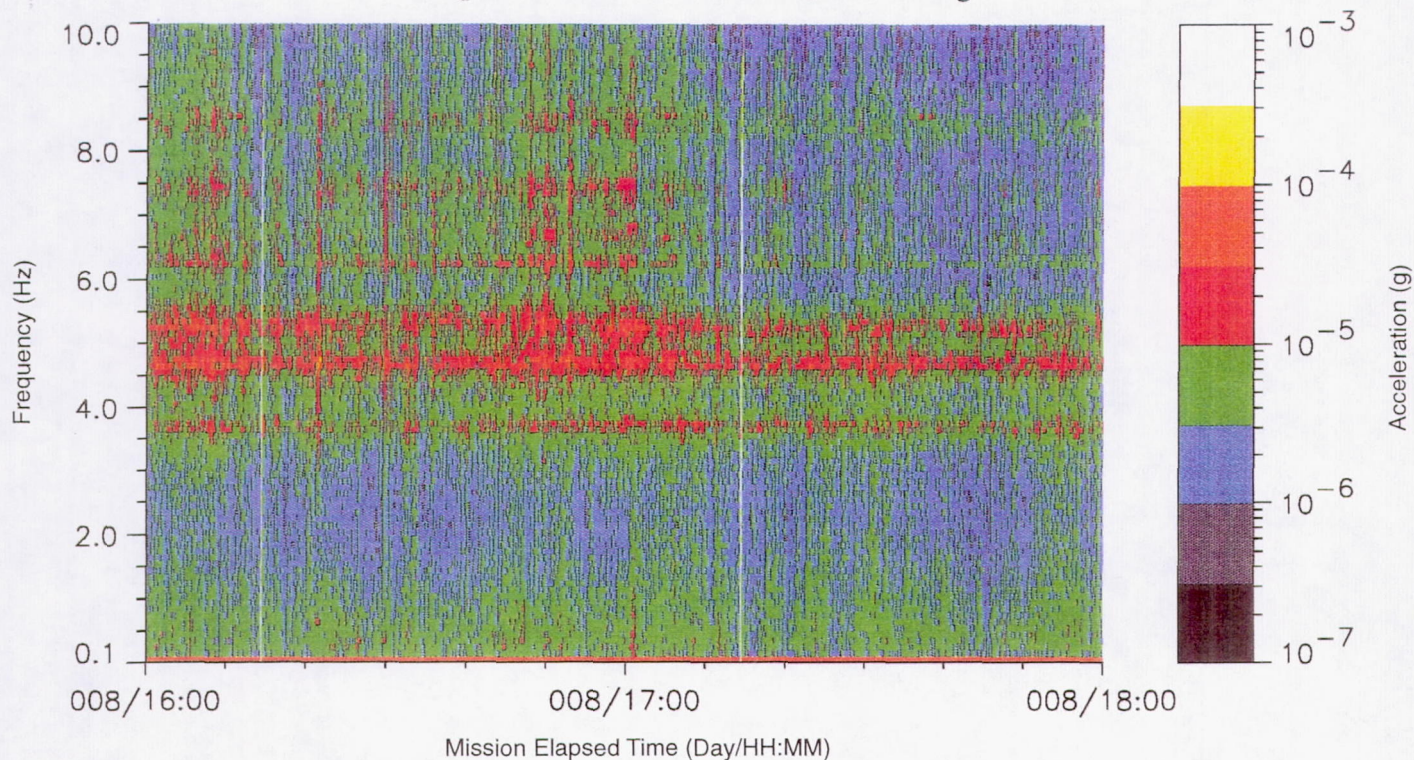


Figure C-102 IML-2 Rack 8, Vector Magnitude

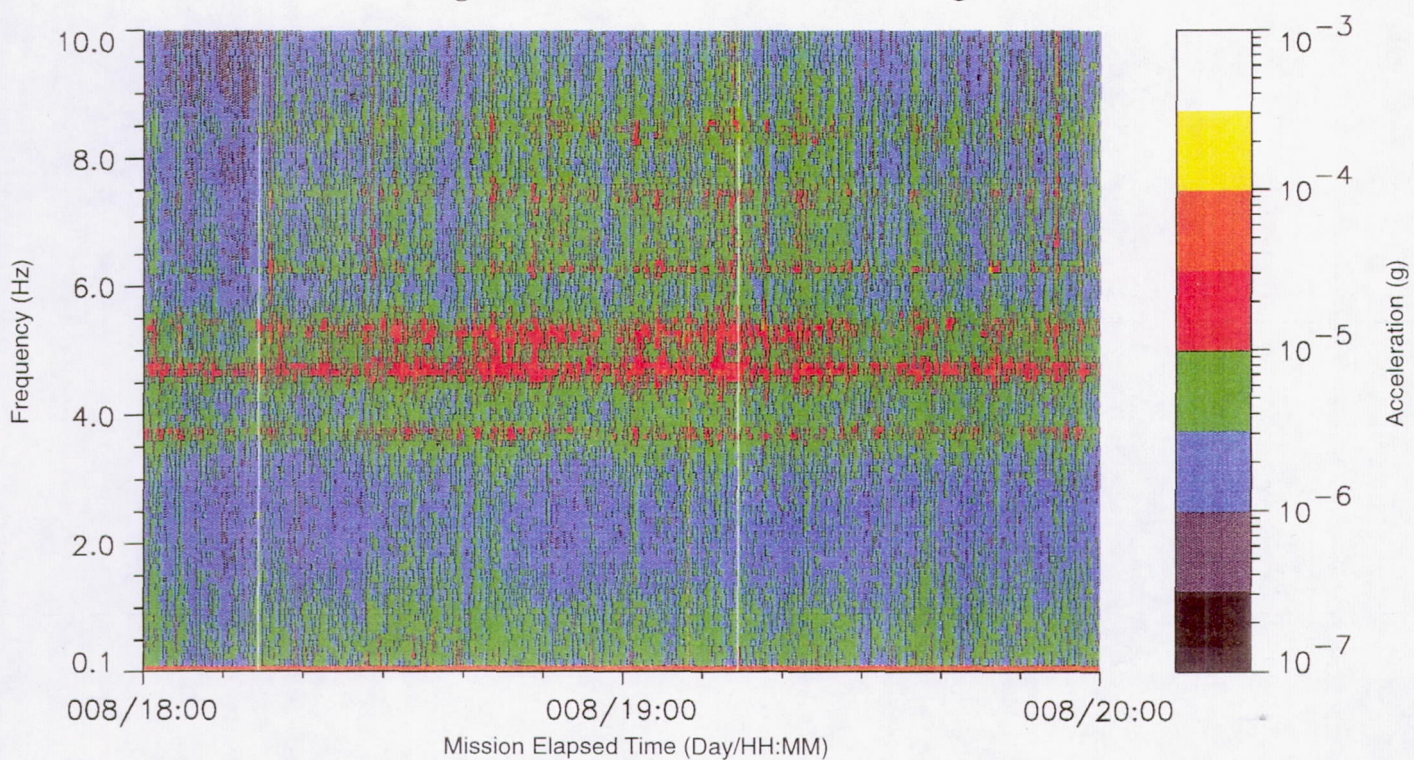


Figure C-103 IML-2 Rack 8, Vector Magnitude

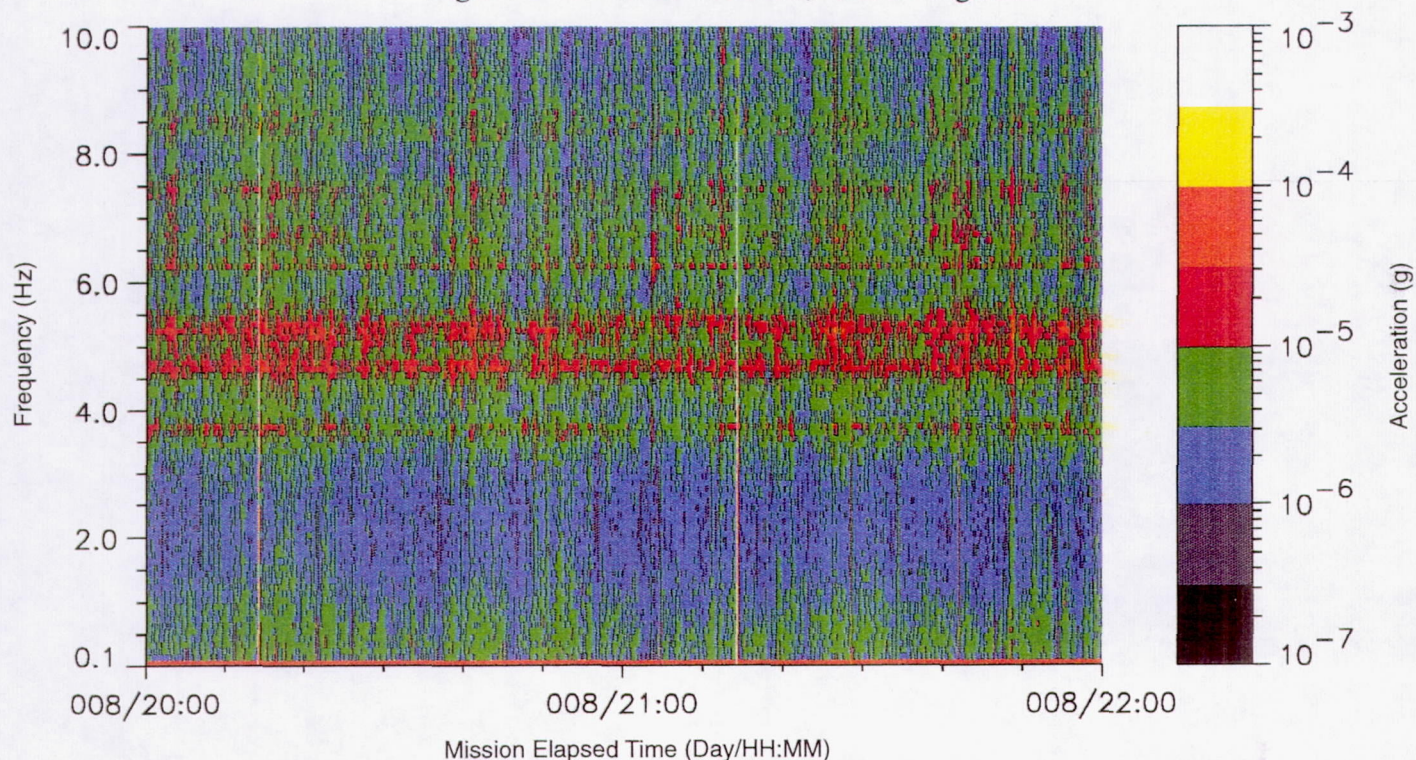
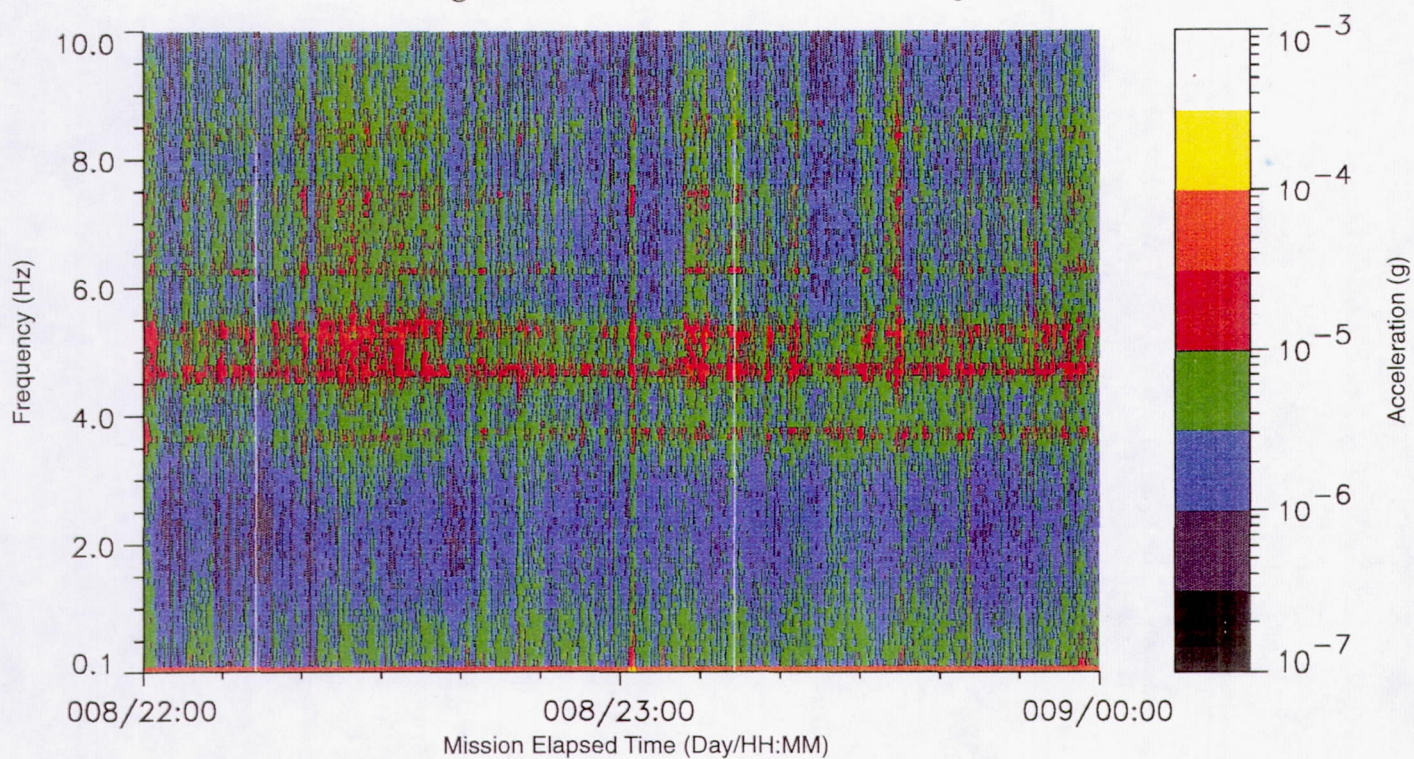


Figure C-104 IML-2 Rack 8, Vector Magnitude



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Figure C-105 IML-2 Rack 8, Vector Magnitude

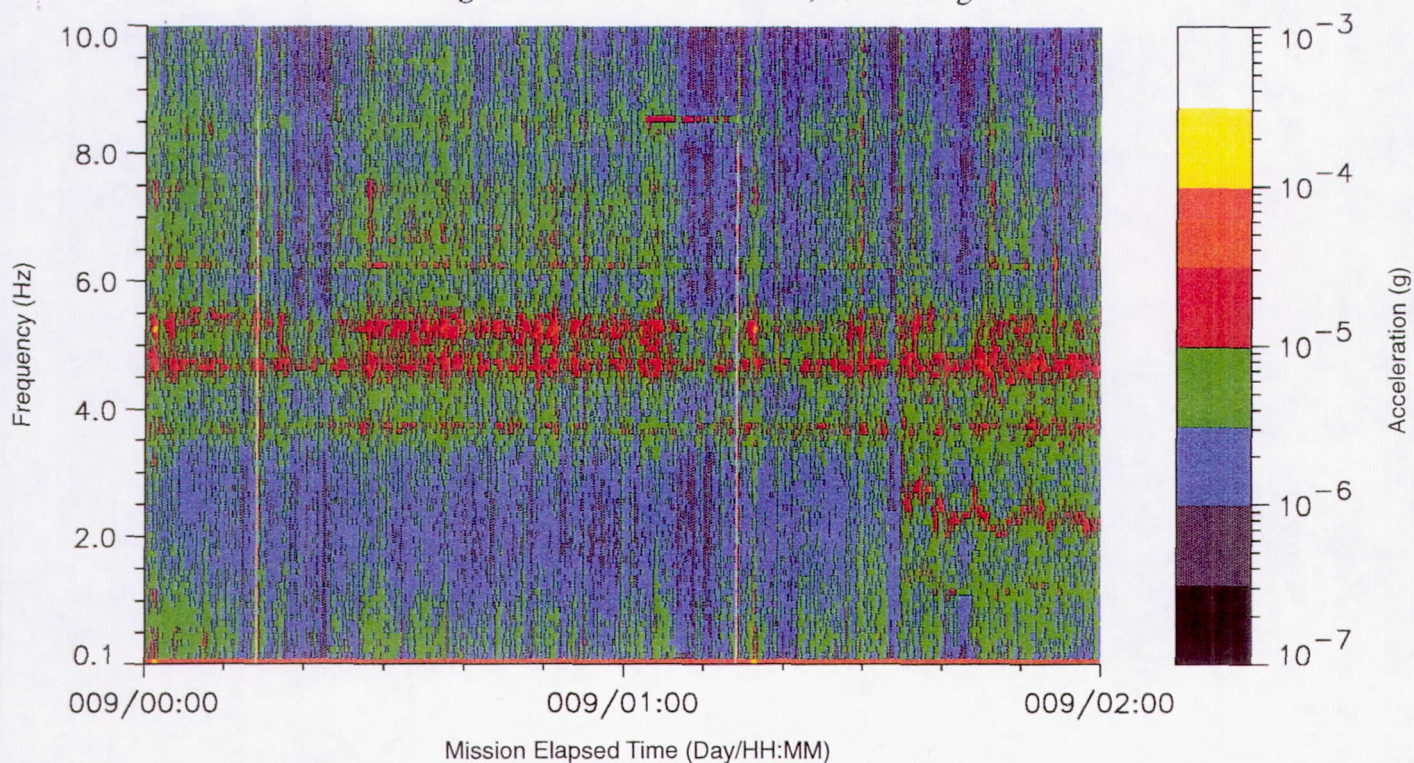


Figure C-106 IML-2 Rack 8, Vector Magnitude

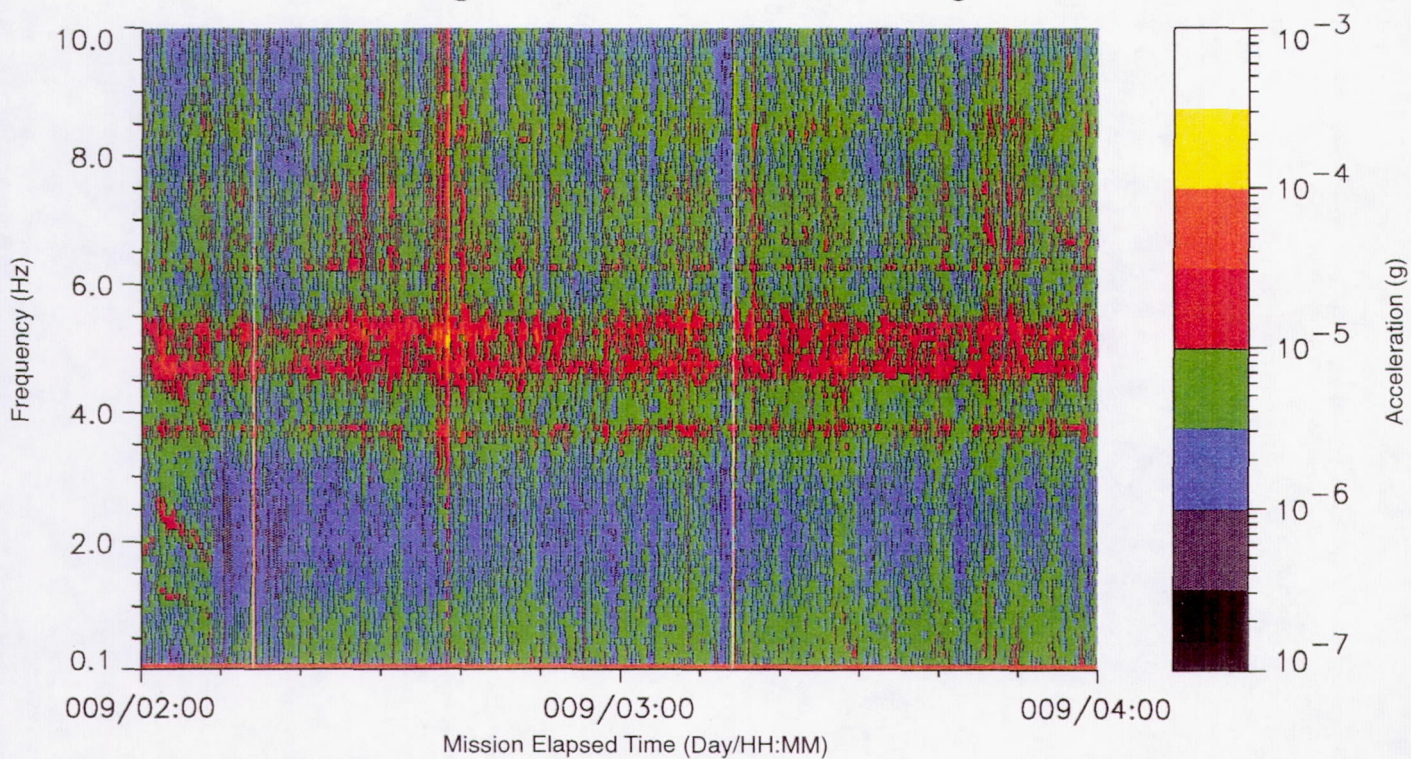


Figure C-107 IML-2 Rack 8, Vector Magnitude

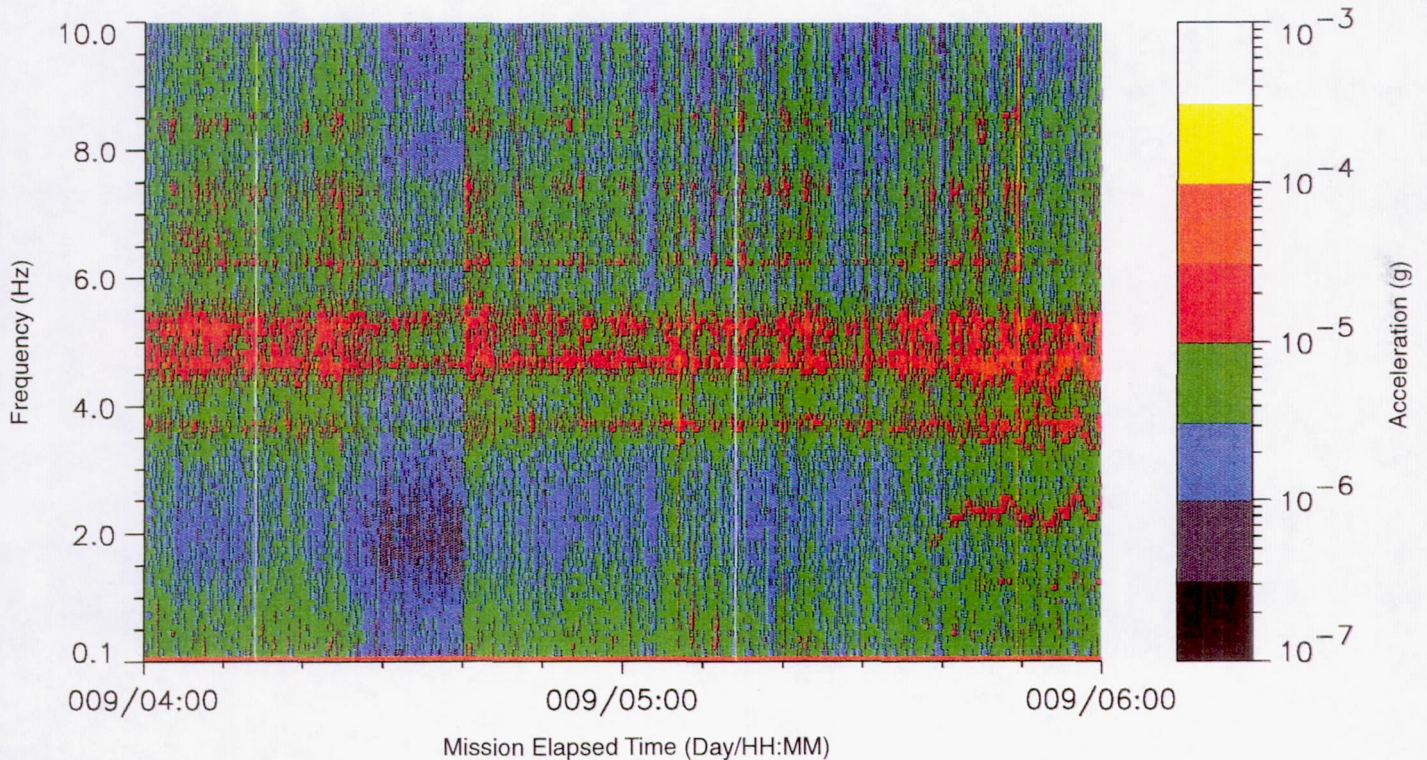


Figure C-108 IML-2 Rack 8, Vector Magnitude

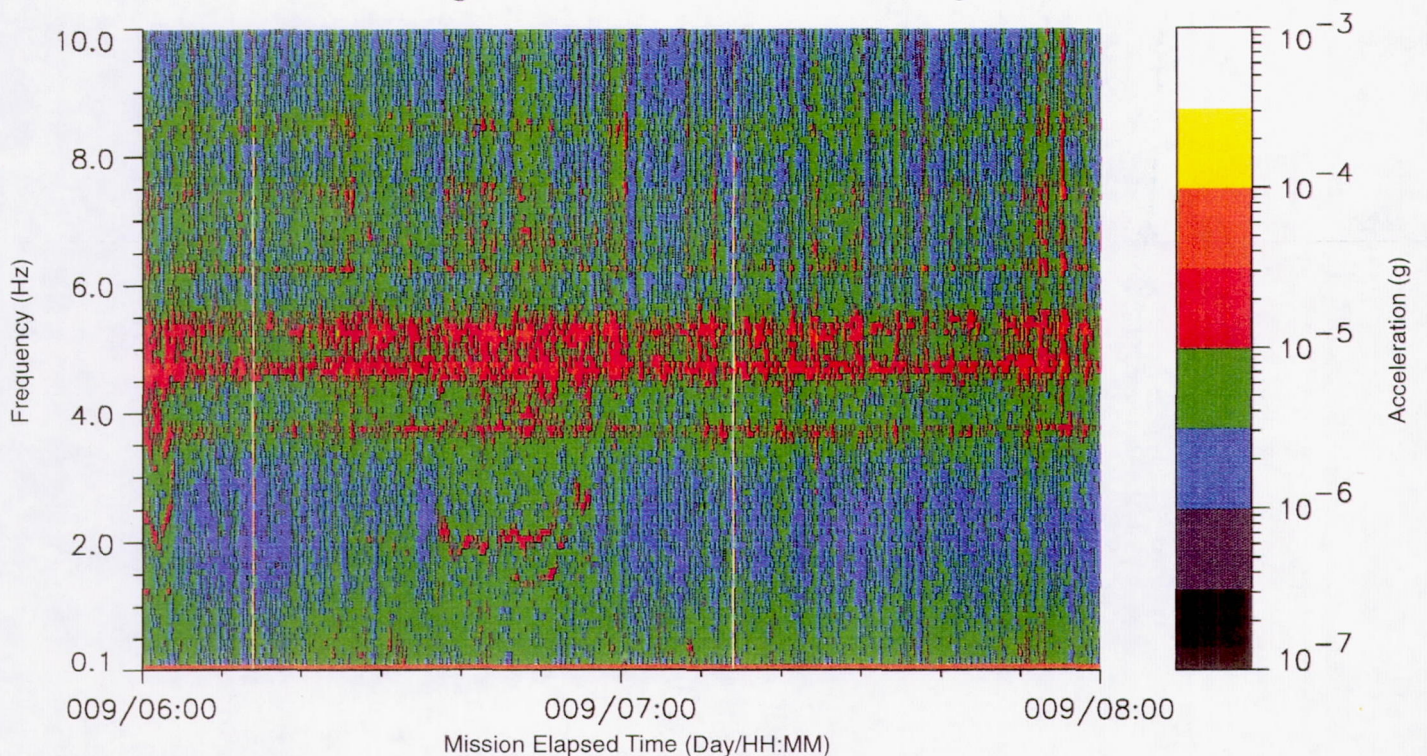


Figure C-109 IML-2 Rack 8, Vector Magnitude

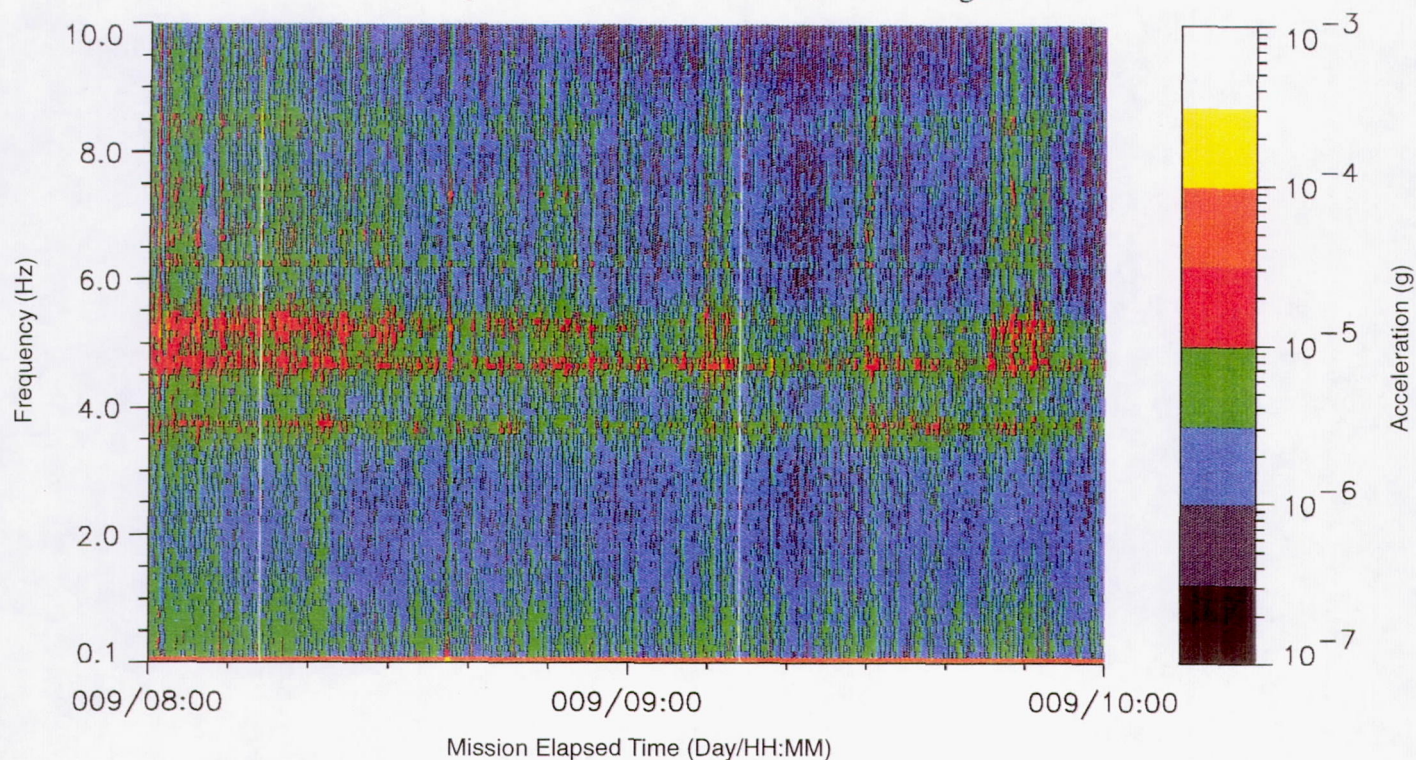


Figure C-110 IML-2 Rack 8, Vector Magnitude

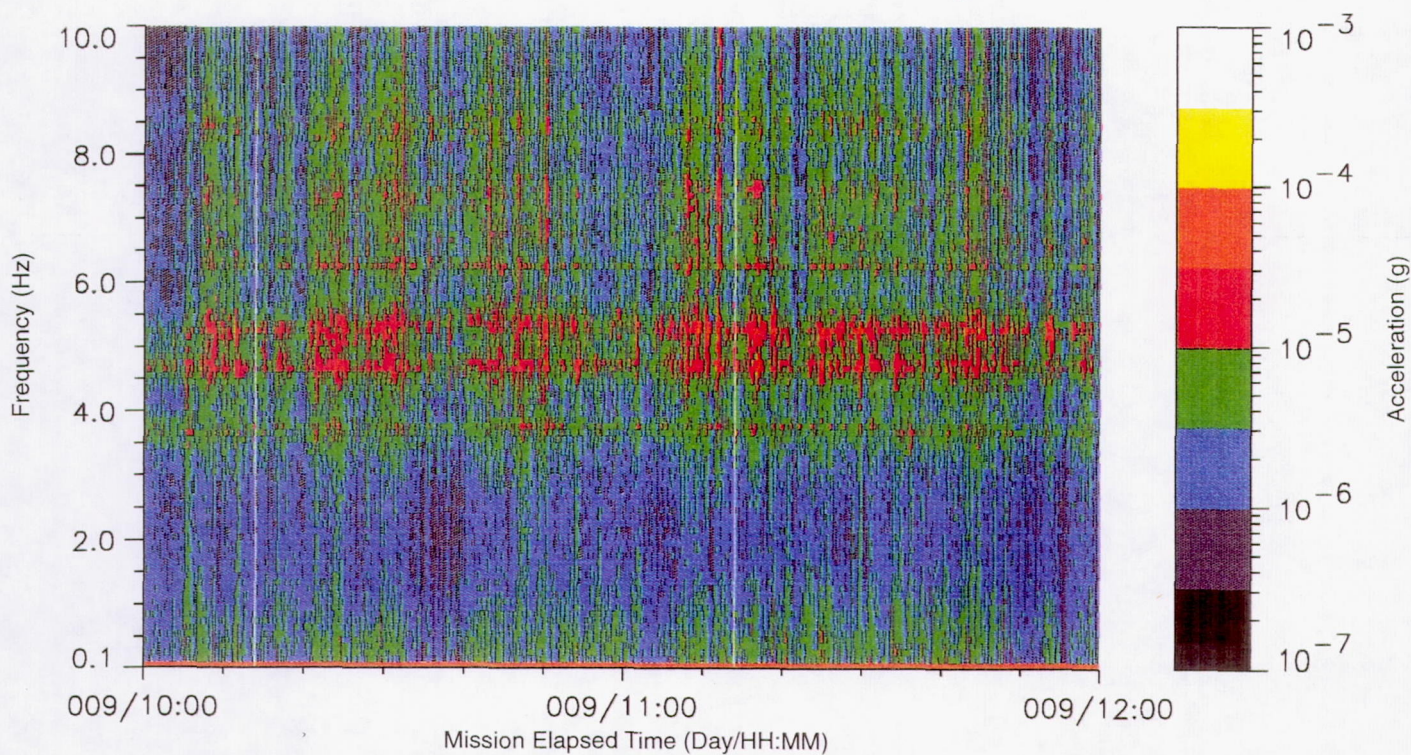


Figure C-111 IML-2 Rack 8, Vector Magnitude

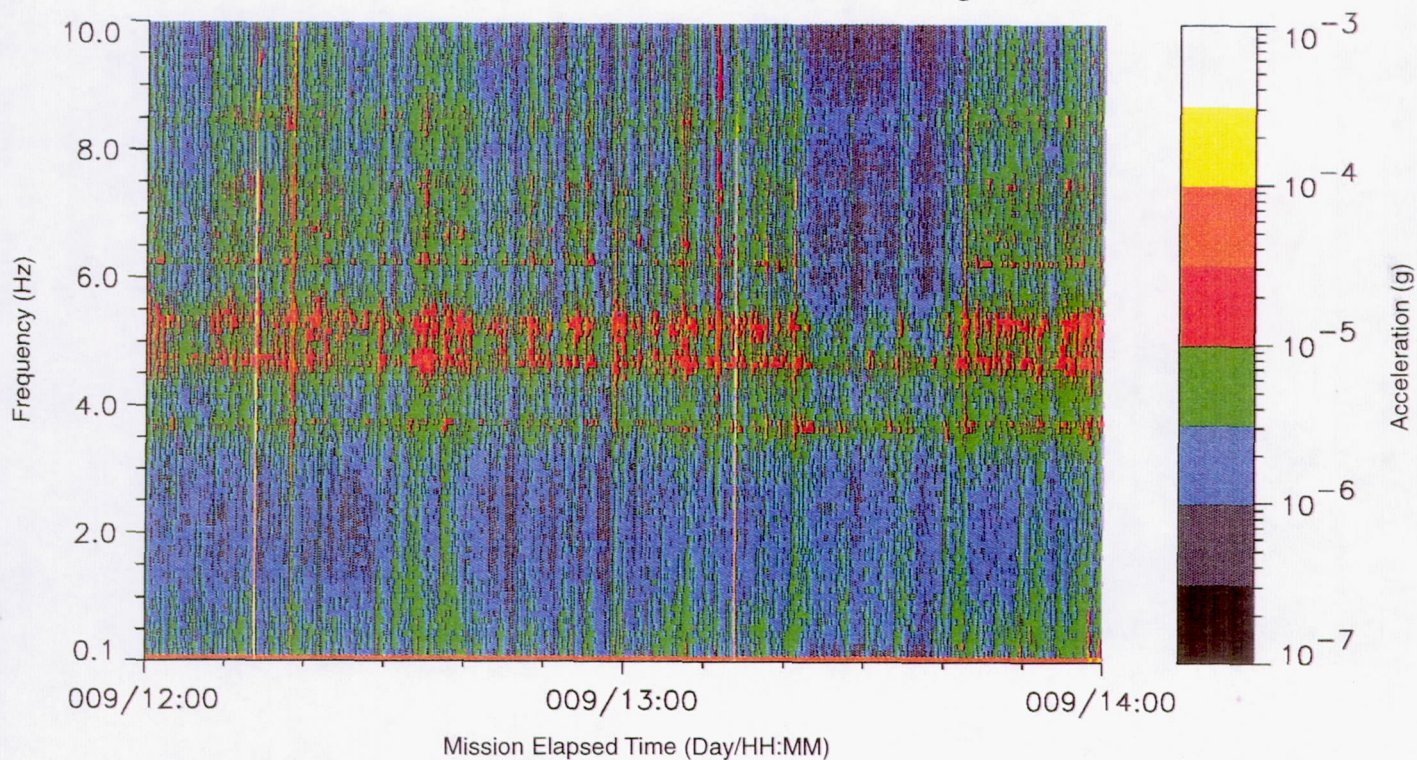


Figure C-112 IML-2 Rack 8, Vector Magnitude

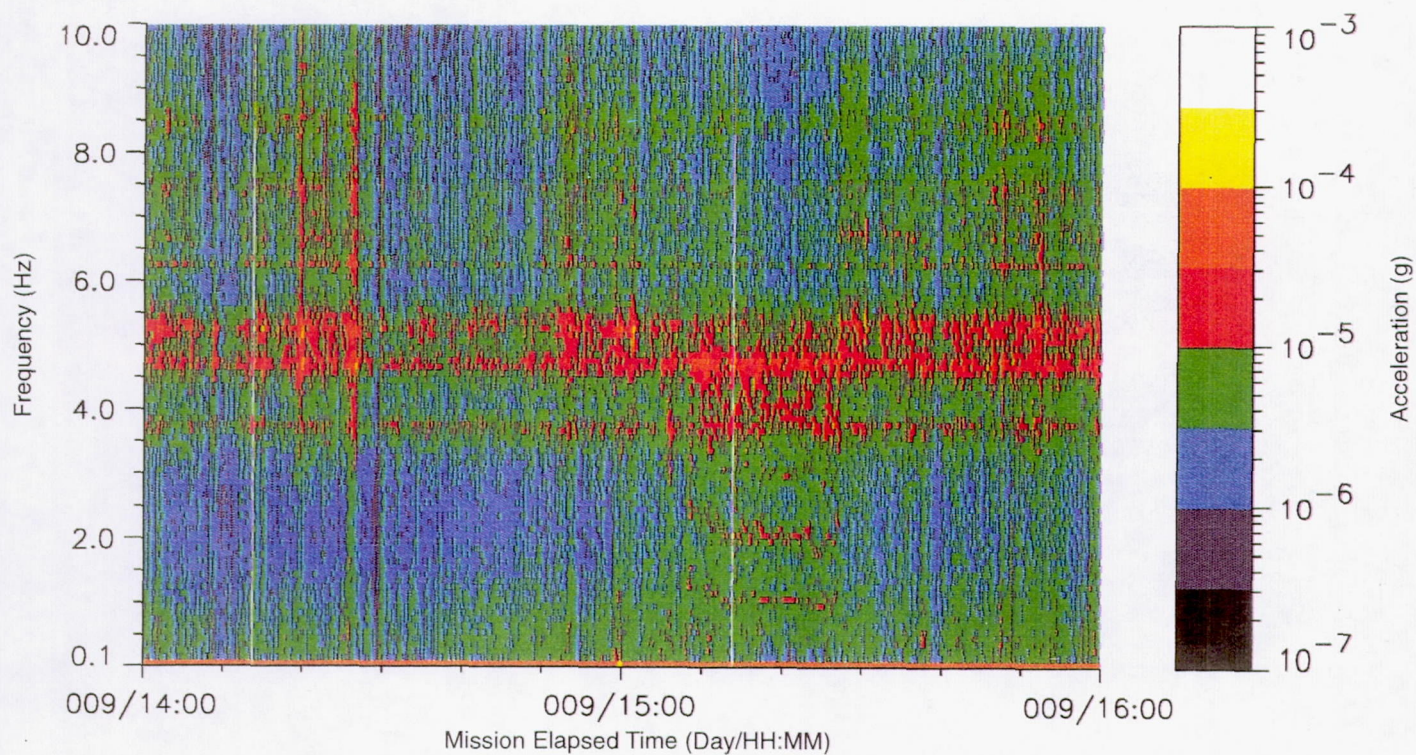


Figure C-113 IML-2 Rack 8, Vector Magnitude

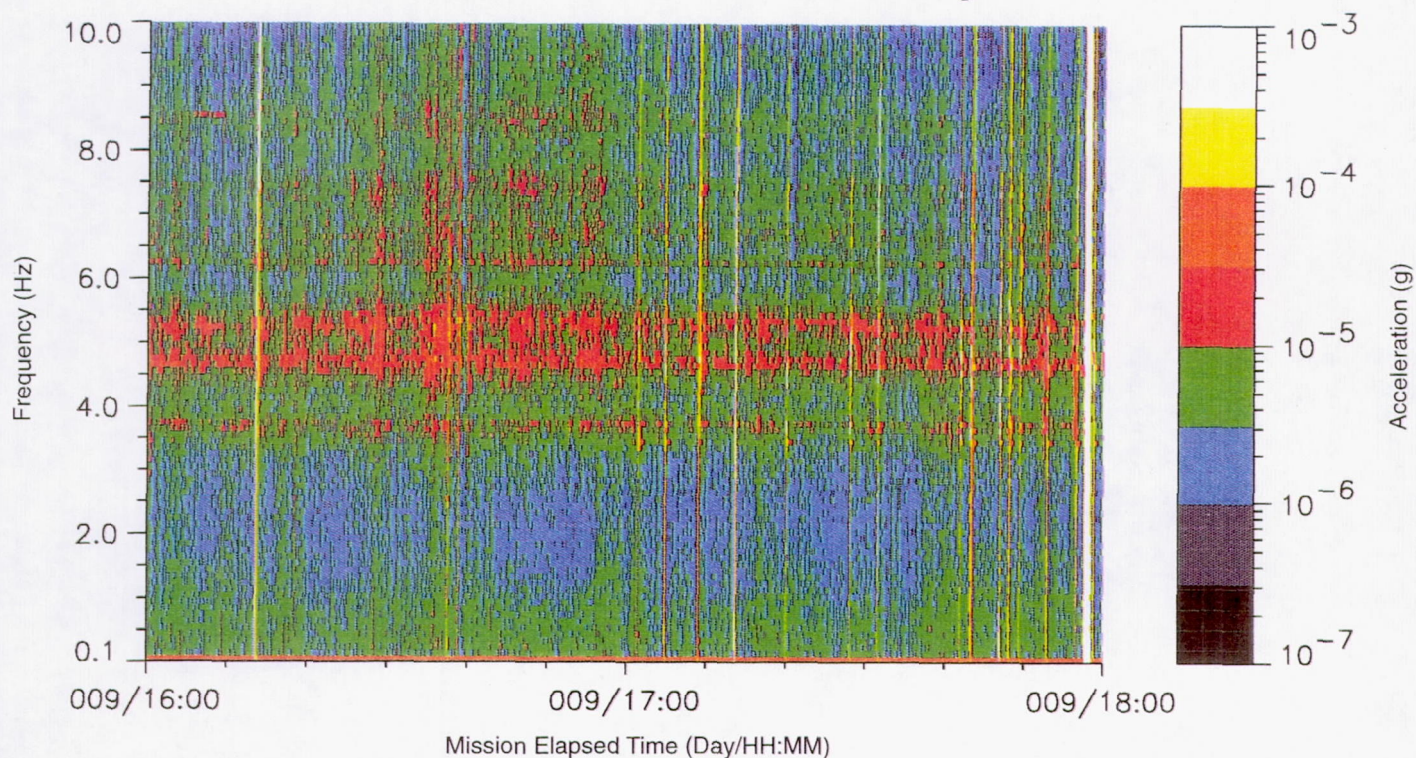


Figure C-114 IML-2 Rack 8, Vector Magnitude

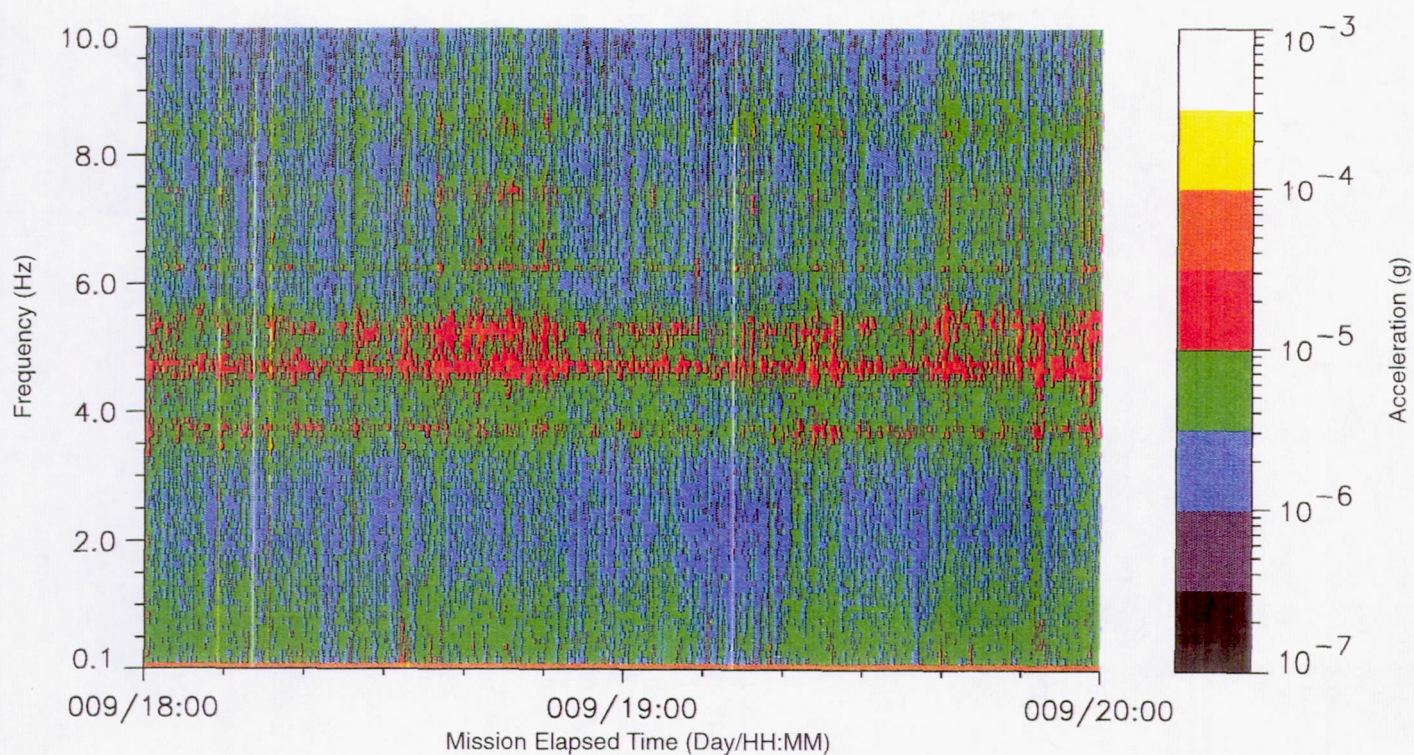


Figure C-115 IML-2 Rack 8, Vector Magnitude

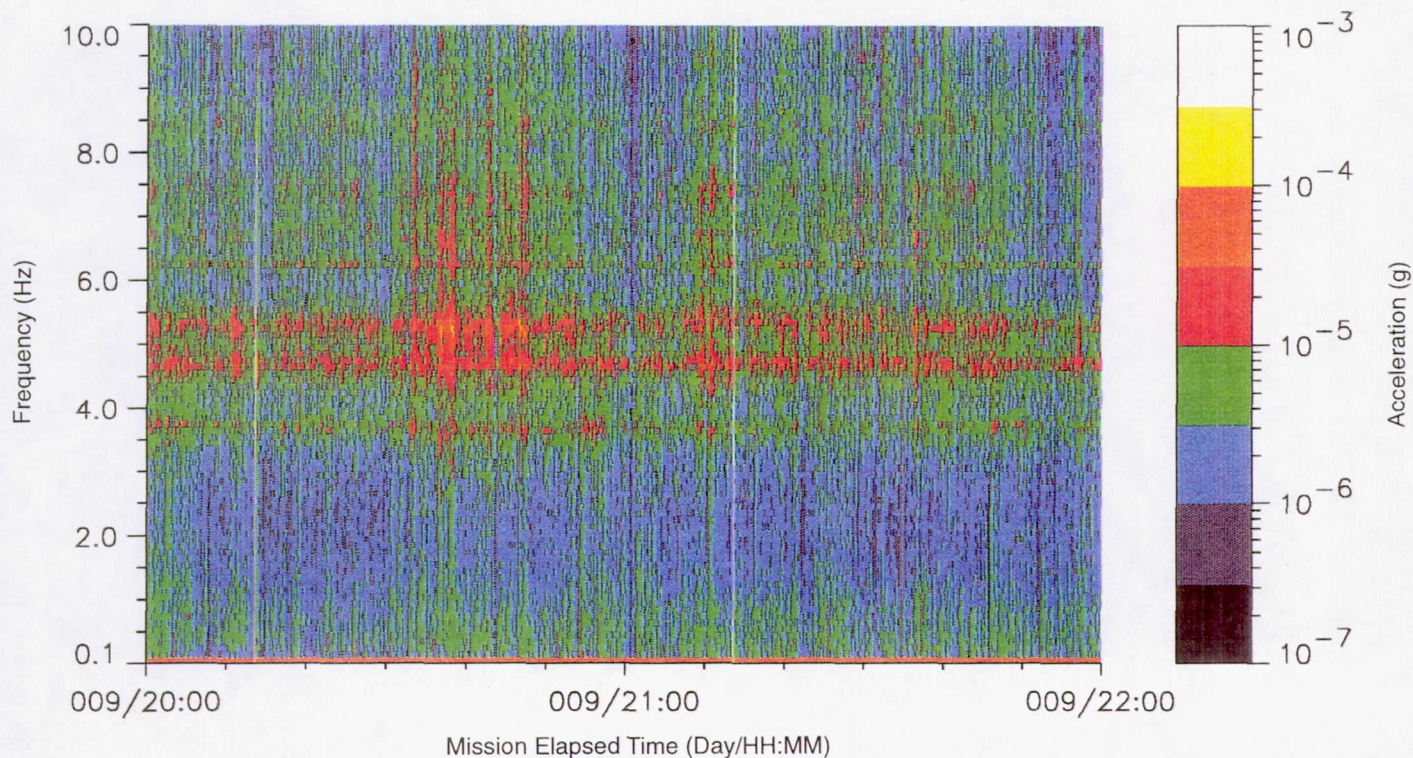


Figure C-116 IML-2 Rack 8, Vector Magnitude

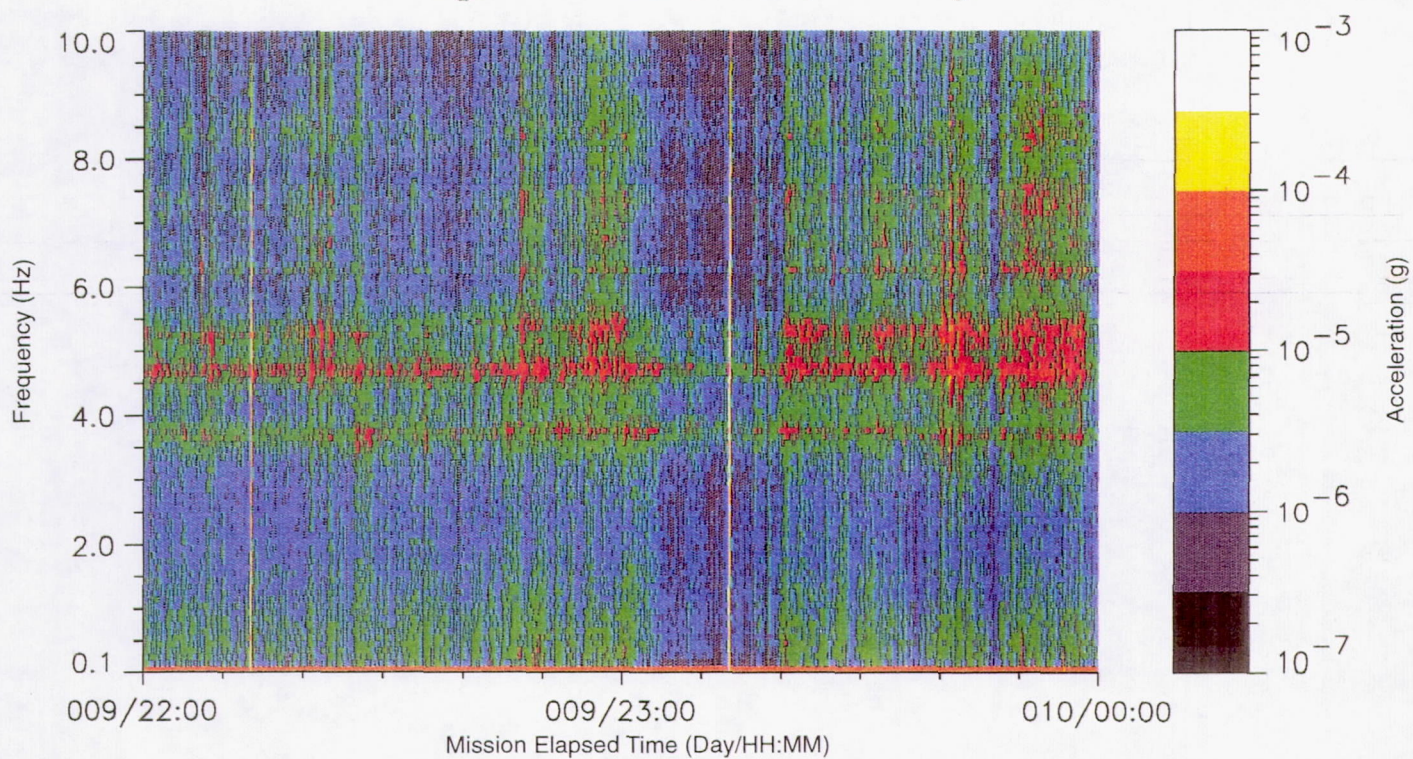


Figure C-117 IML-2 Rack 8, Vector Magnitude

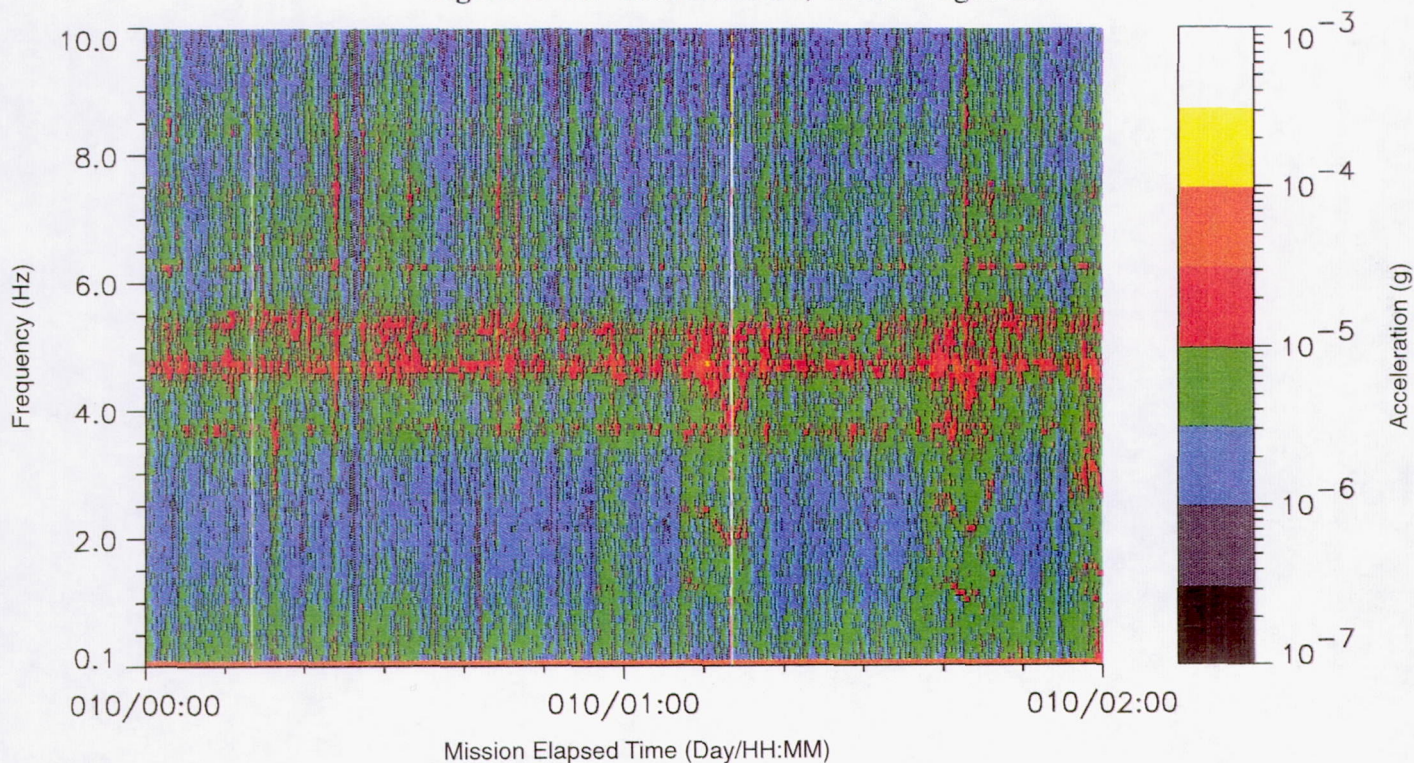


Figure C-118 IML-2 Rack 8, Vector Magnitude

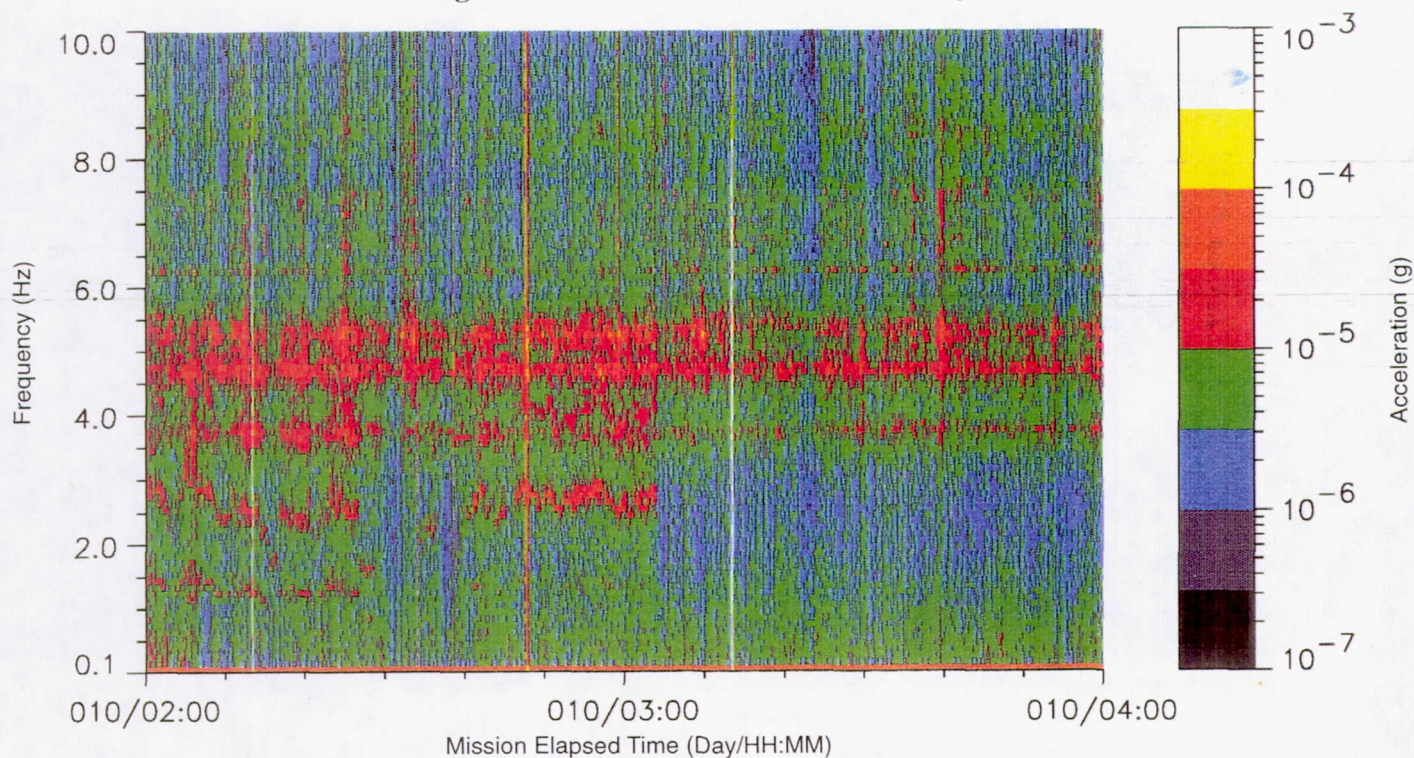


Figure C-119 IML-2 Rack 8, Vector Magnitude

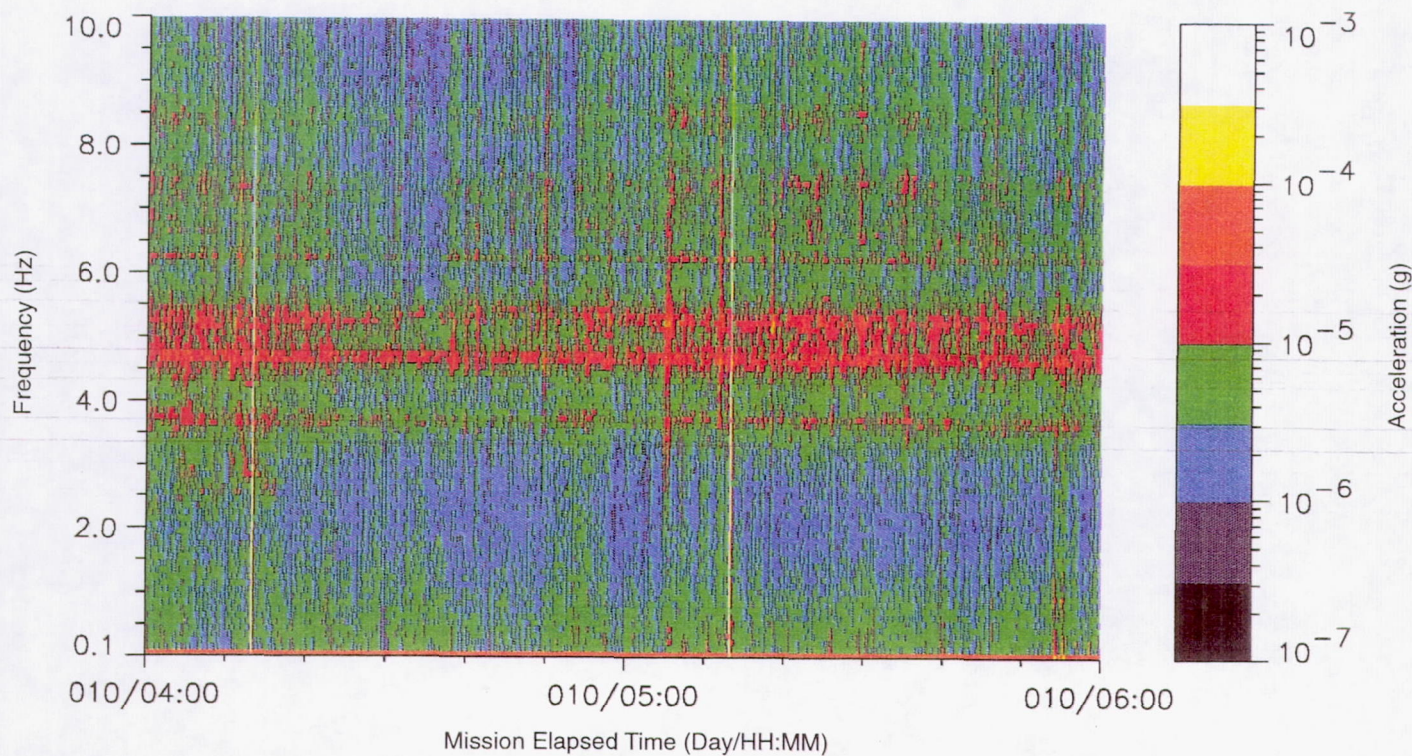


Figure C-120 IML-2 Rack 8, Vector Magnitude

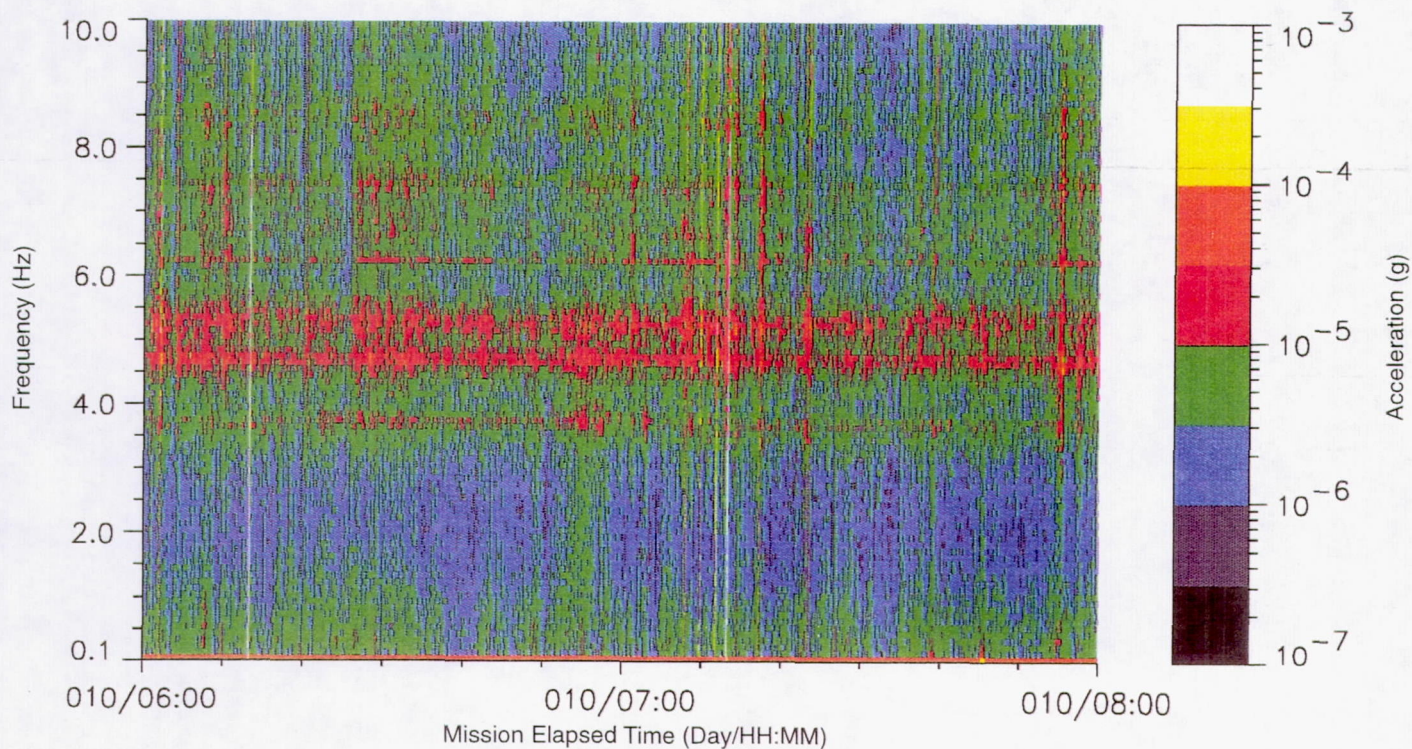


Figure C-121 IML-2 Rack 8, Vector Magnitude

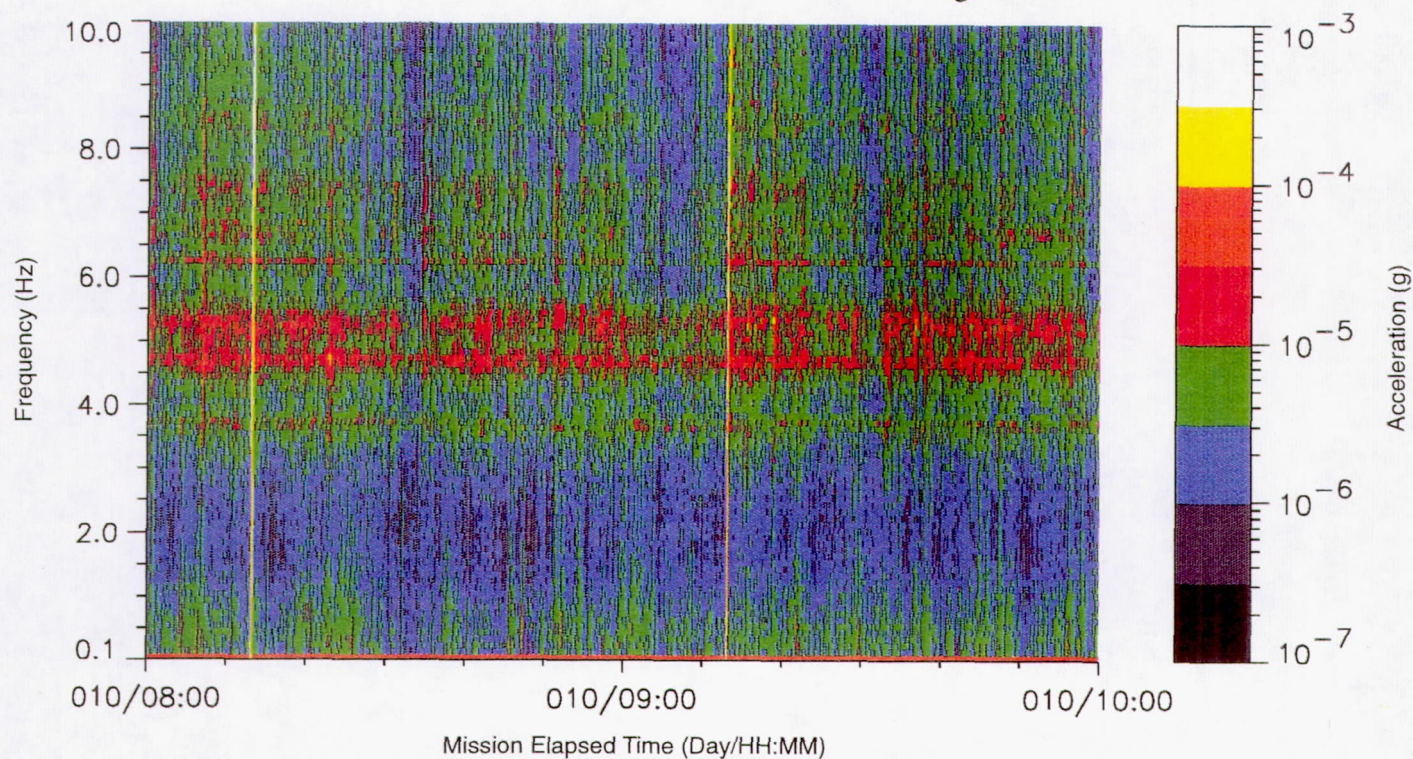


Figure C-122 IML-2 Rack 8, Vector Magnitude

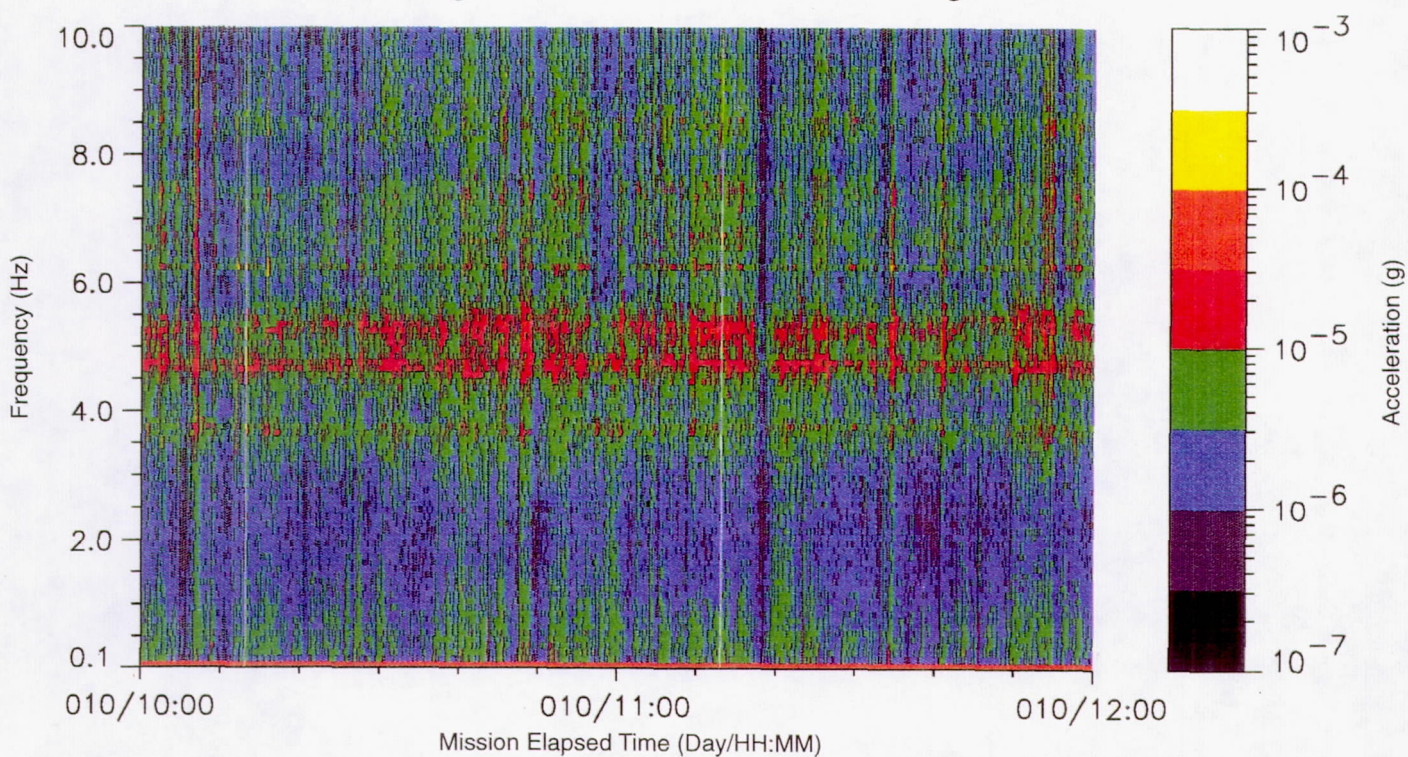


Figure C-123 IML-2 Rack 8, Vector Magnitude

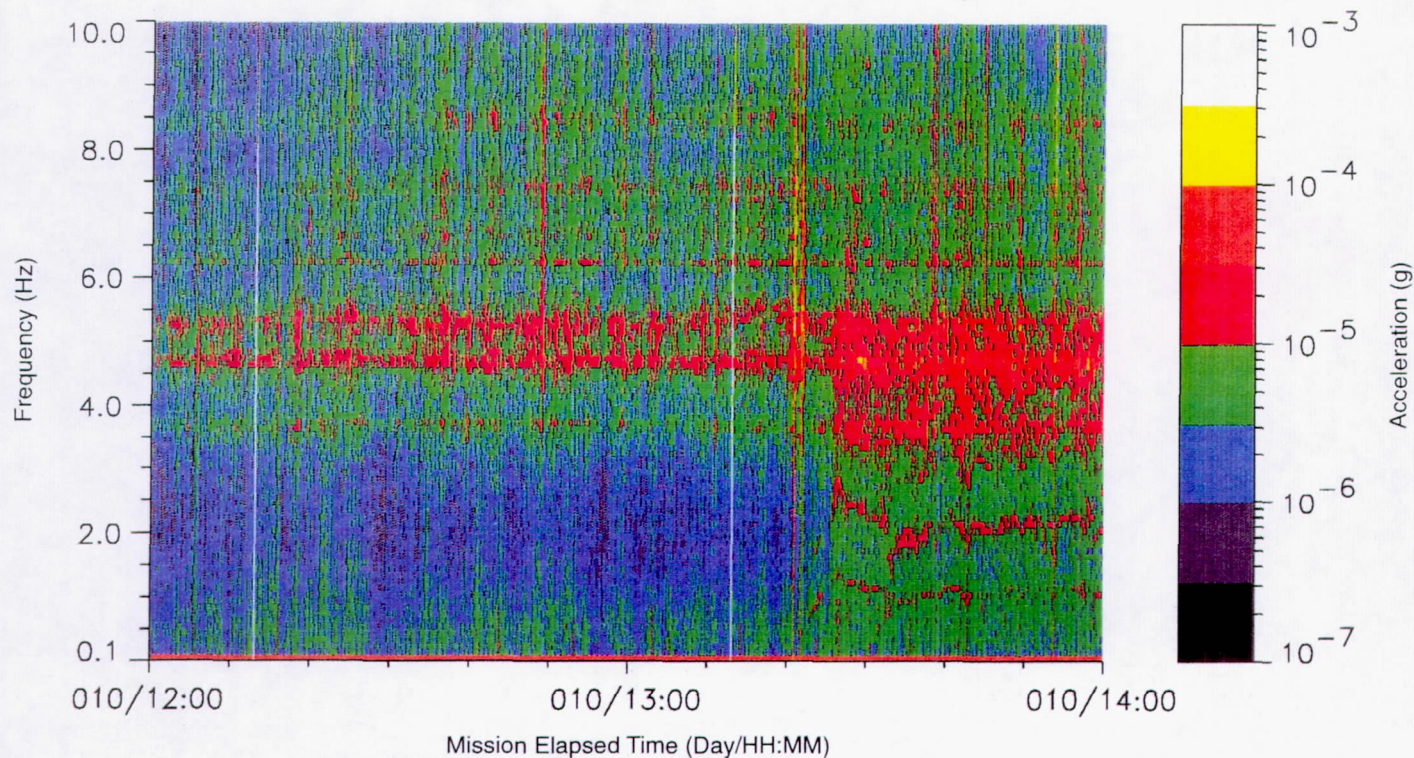


Figure C-124 IML-2 Rack 8, Vector Magnitude

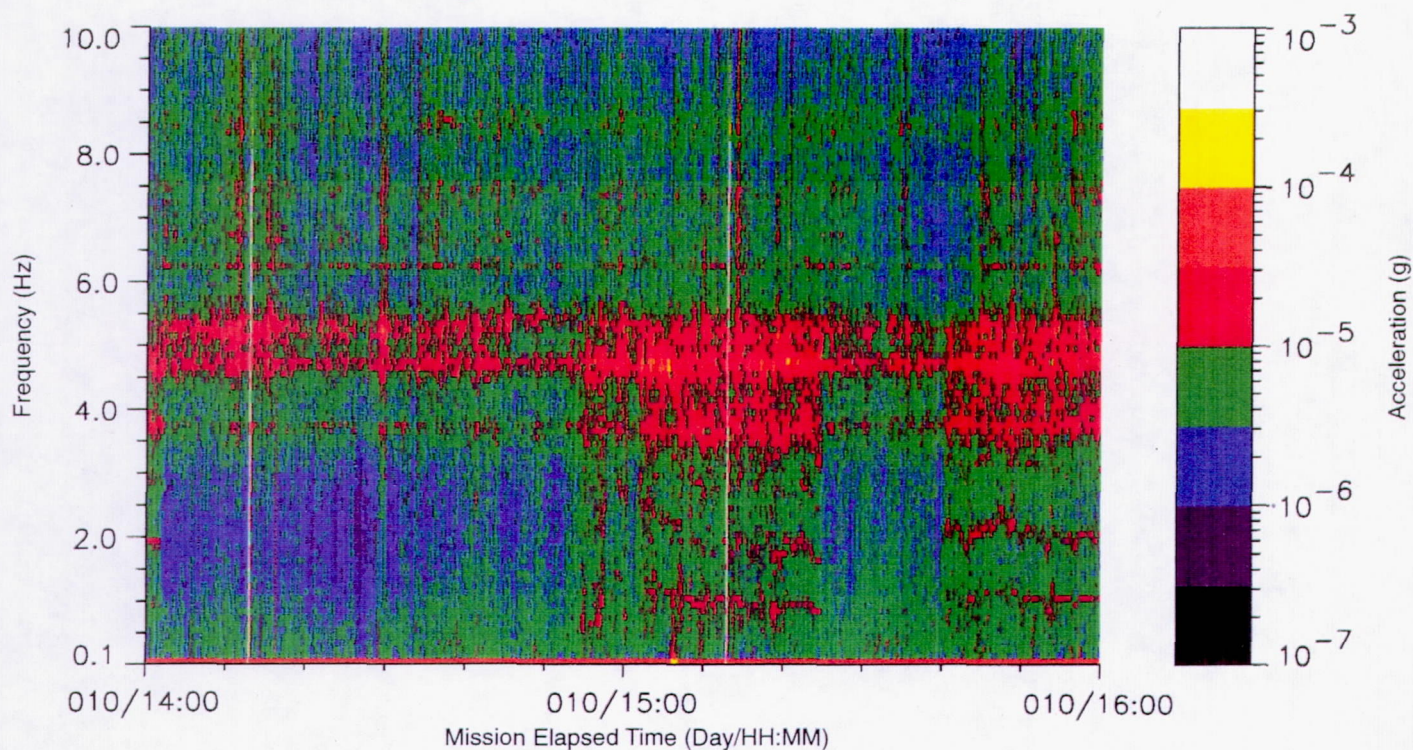


Figure C-125 IML-2 Rack 8, Vector Magnitude

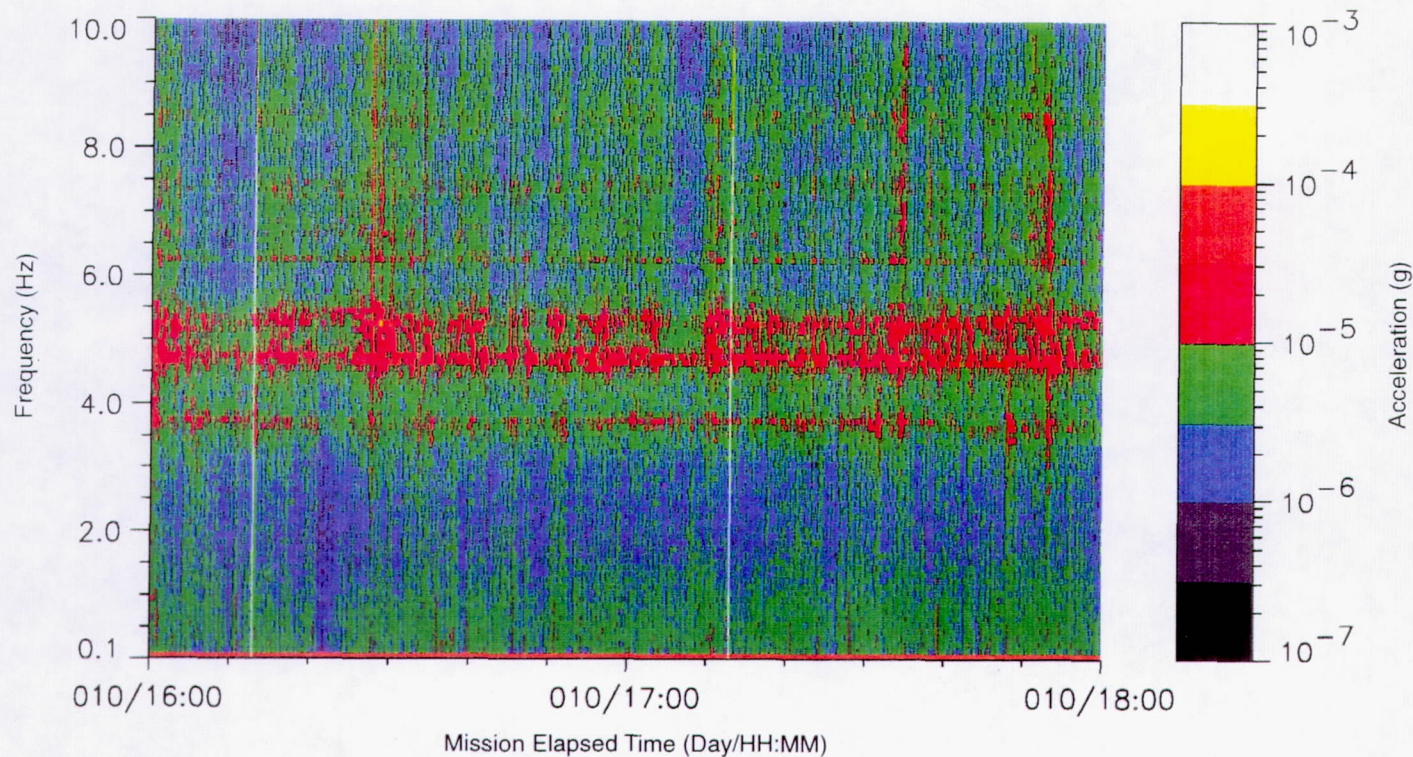


Figure C-126 IML-2 Rack 8, Vector Magnitude

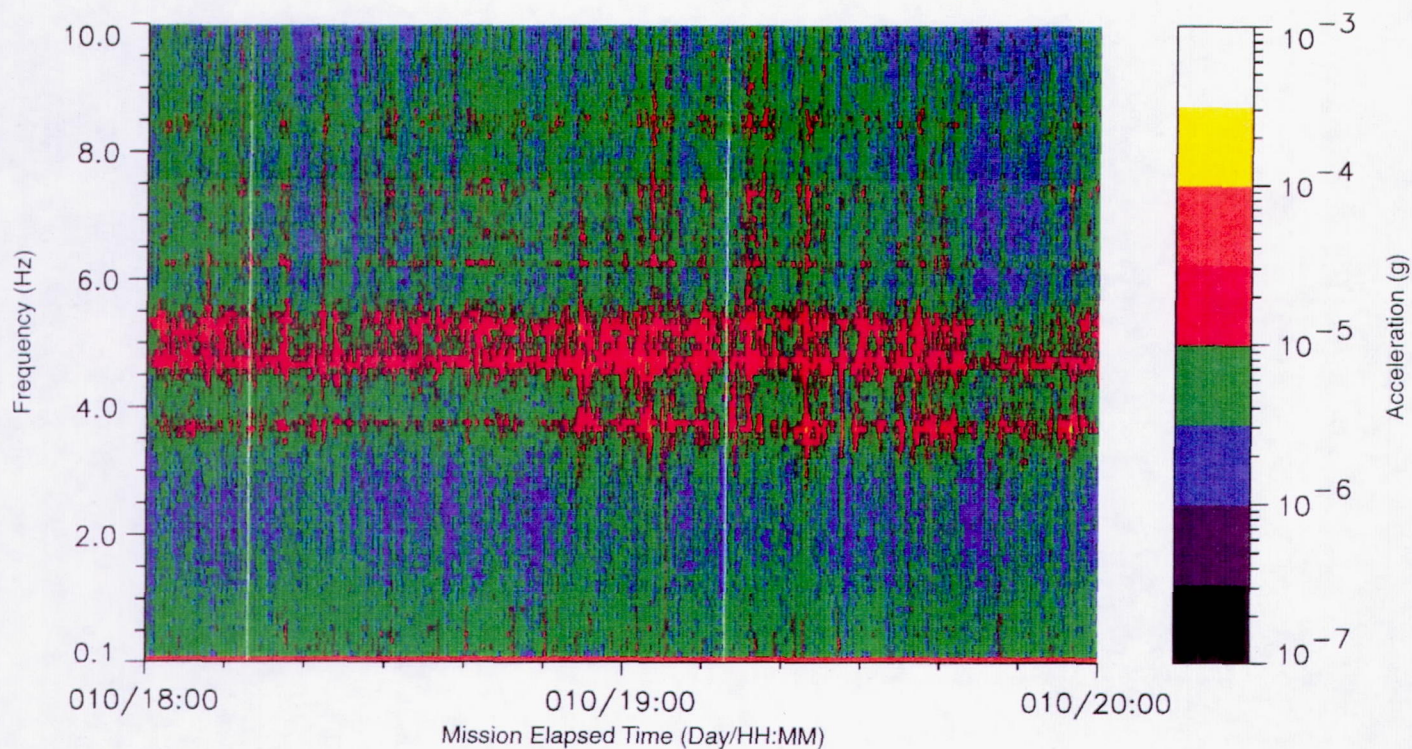


Figure C-127 IML-2 Rack 8, Vector Magnitude

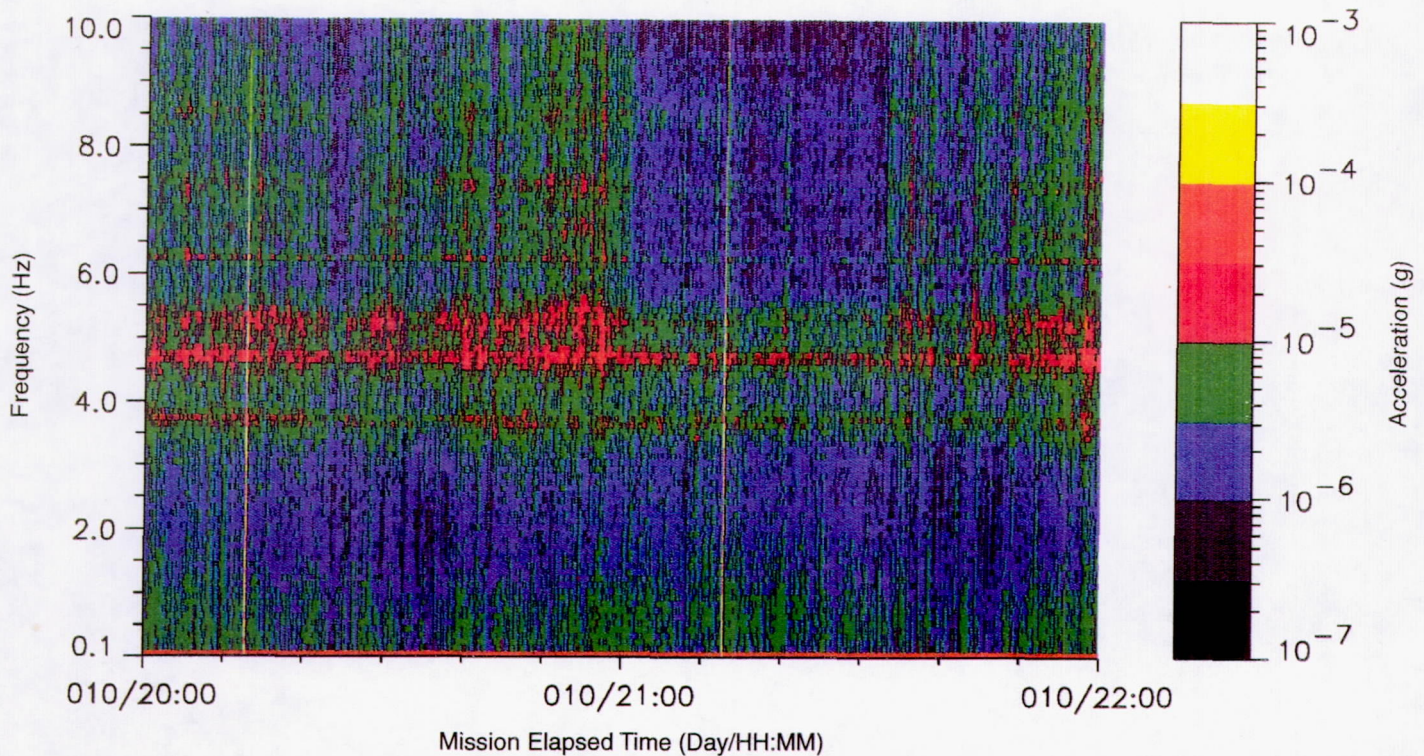


Figure C-128 IML-2 Rack 8, Vector Magnitude

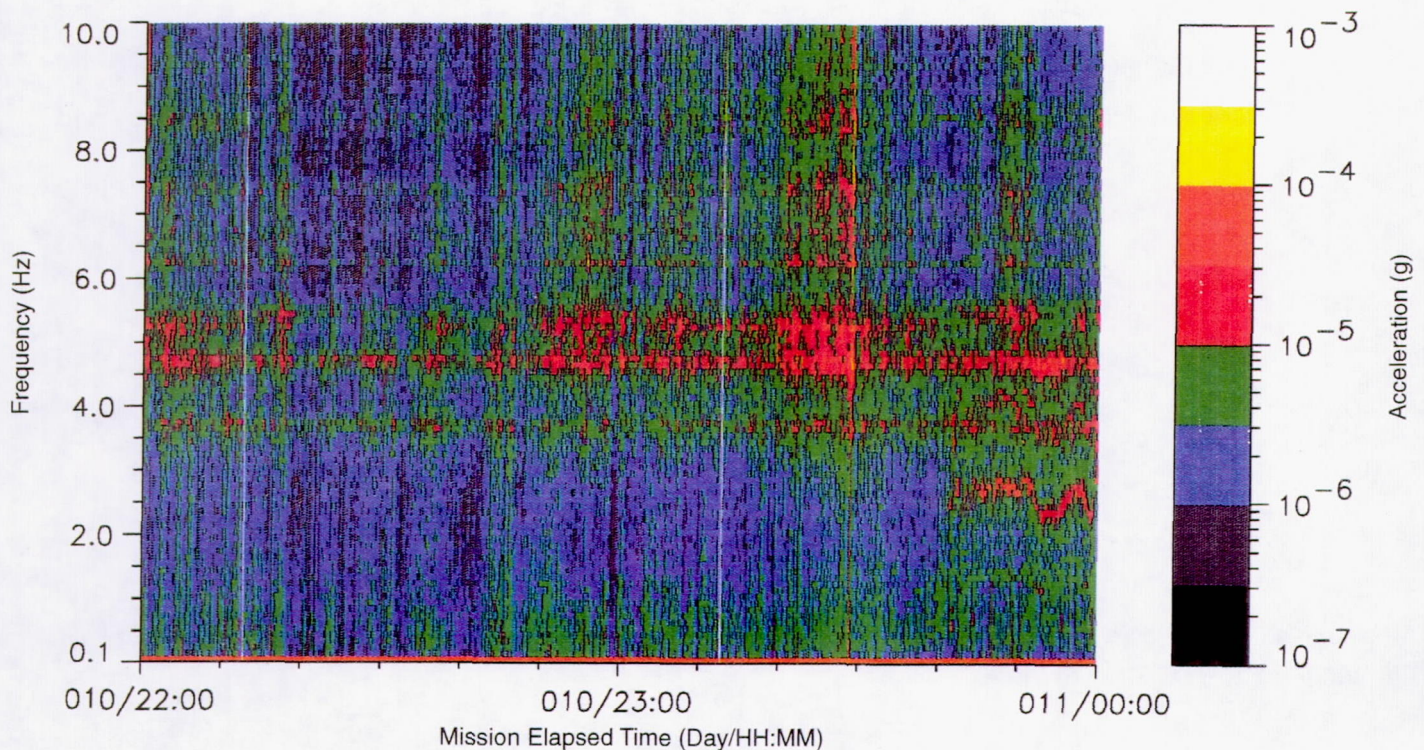


Figure C-129 IML-2 Rack 8, Vector Magnitude

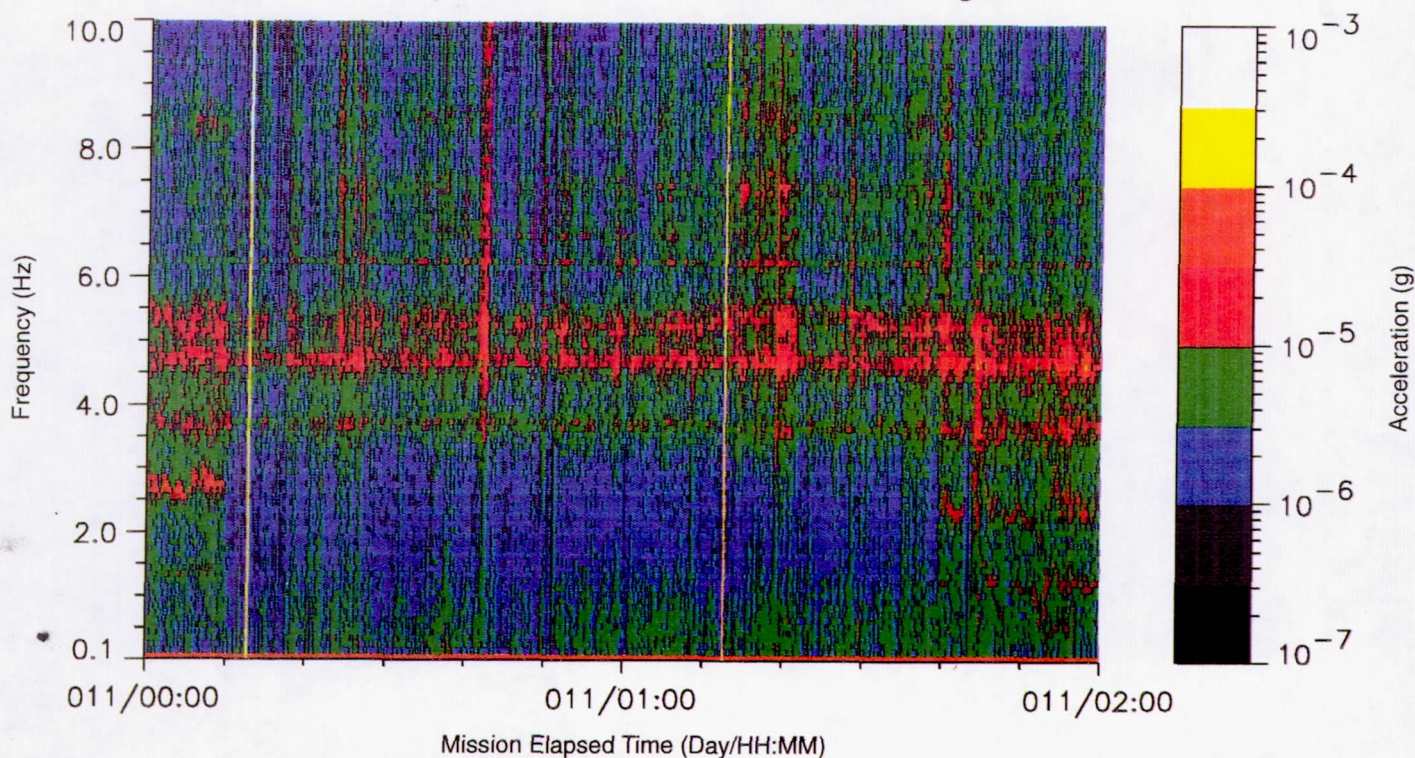


Figure C-130 IML-2 Rack 8, Vector Magnitude

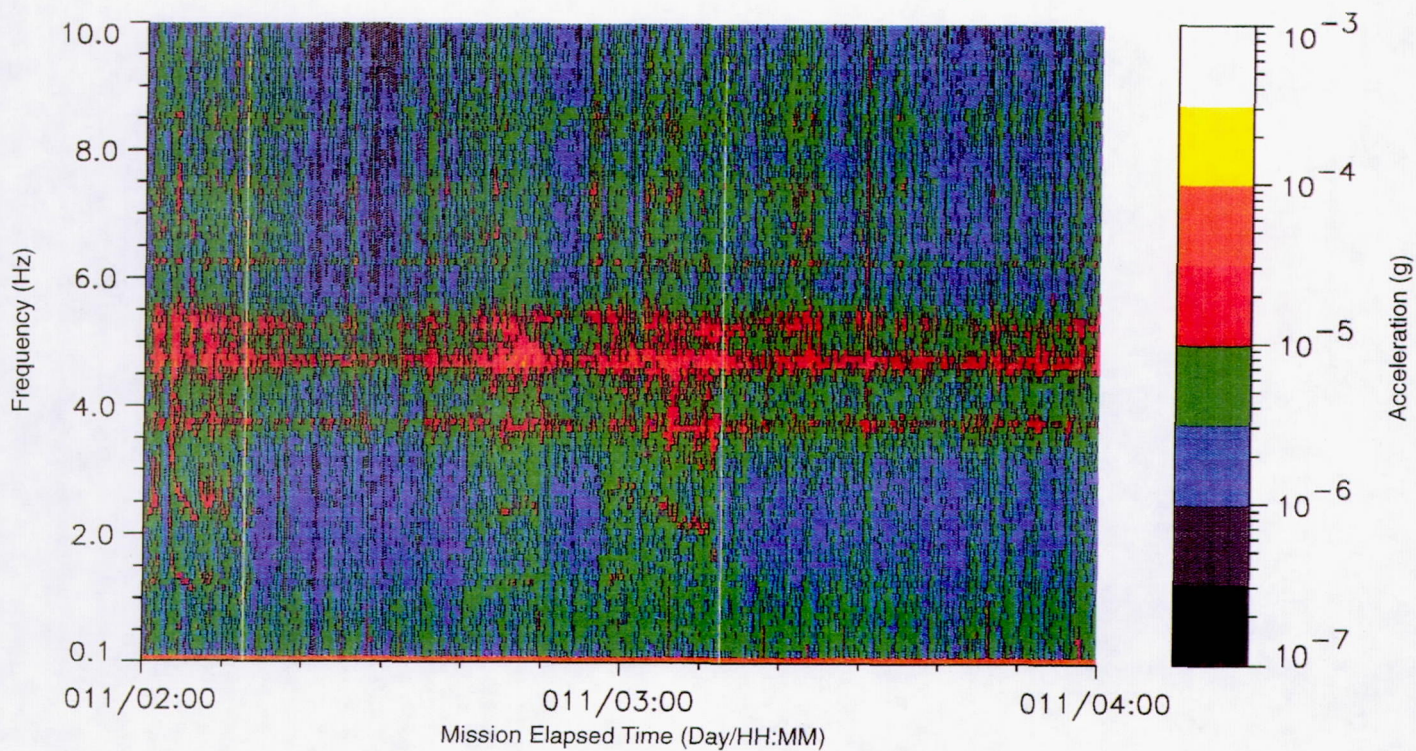


Figure C-131 IML-2 Rack 8, Vector Magnitude

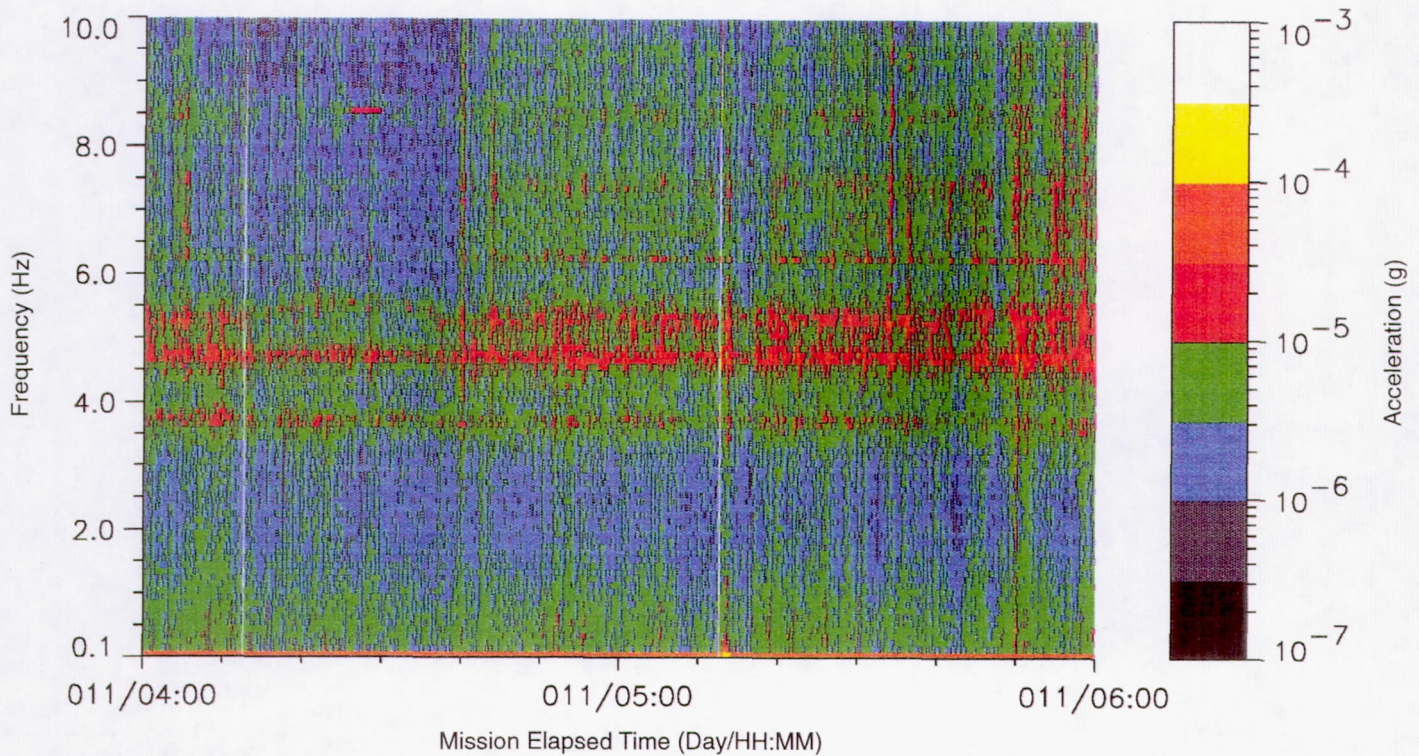


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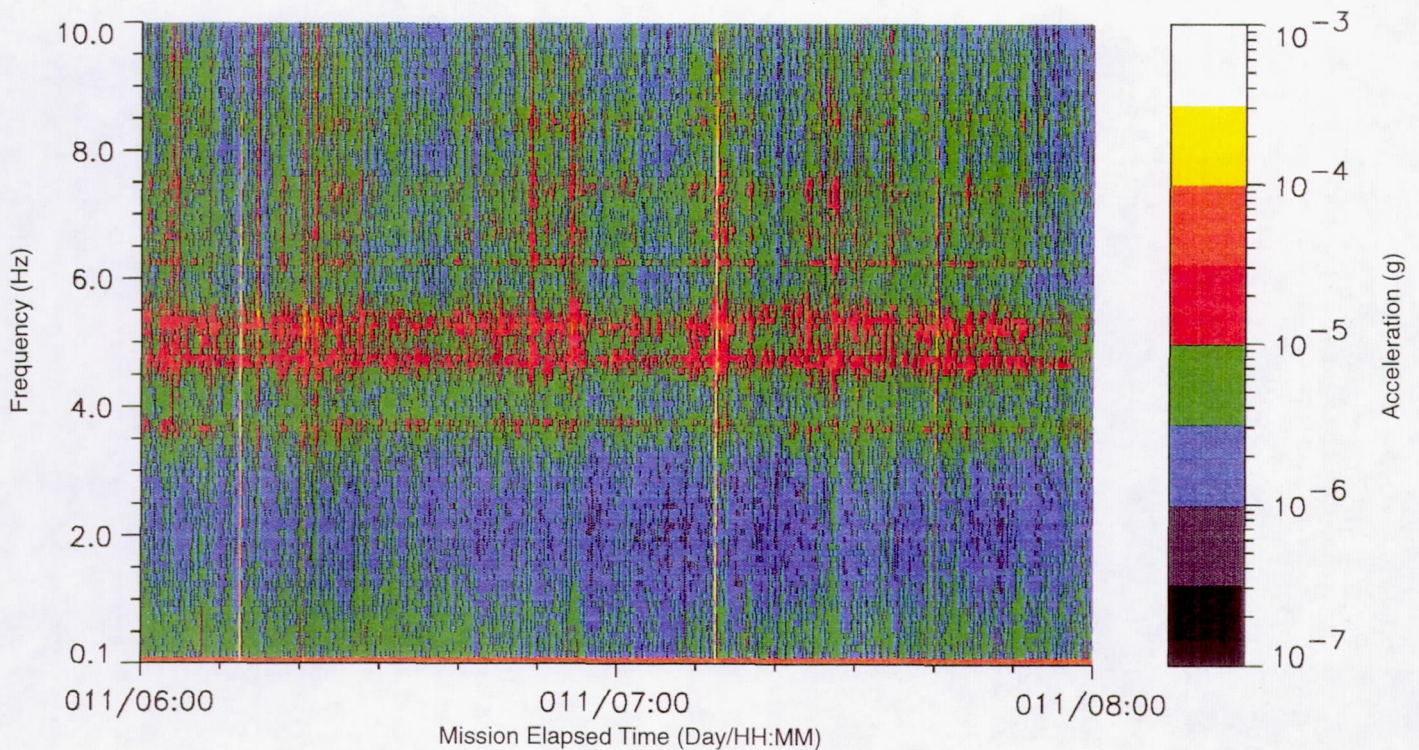


Figure C-133 IML-2 Rack 8, Vector Magnitude

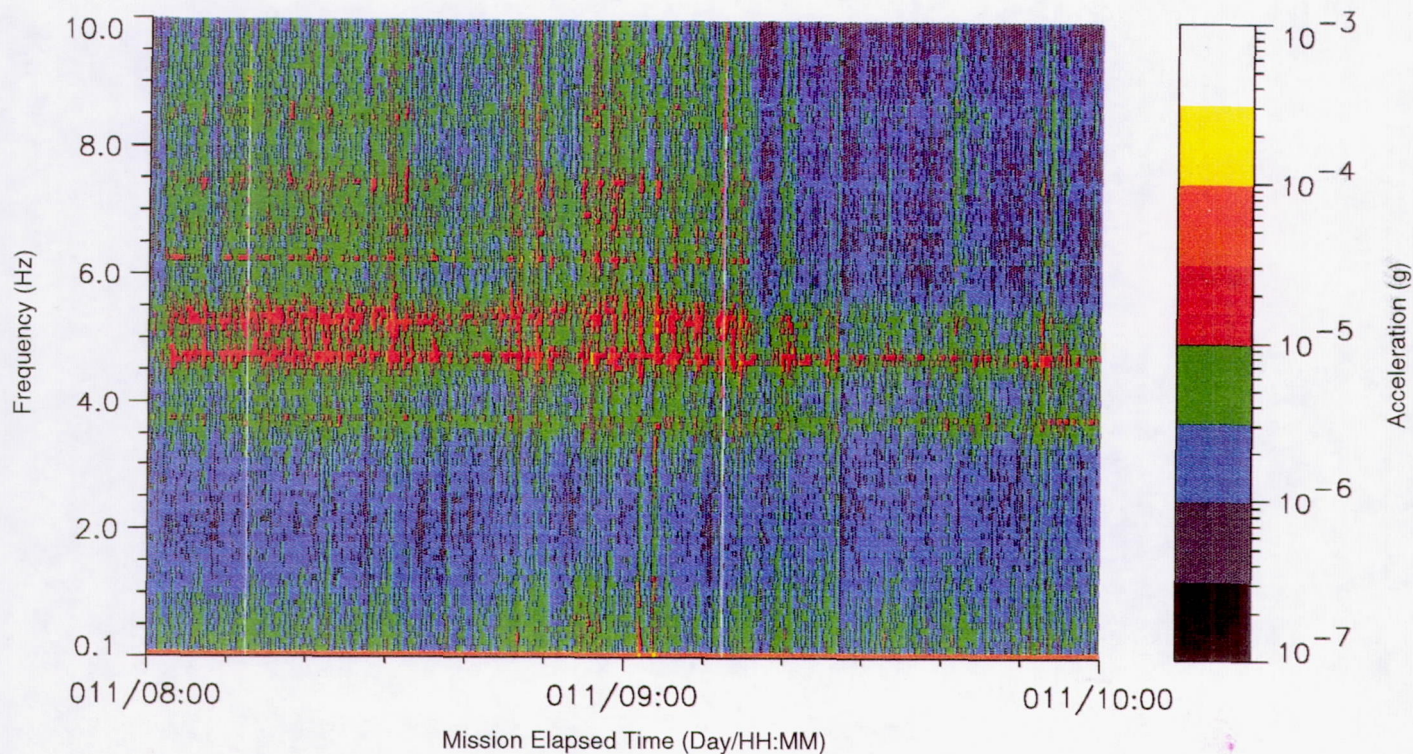


Figure C-134 IML-2 Rack 8, Vector Magnitude

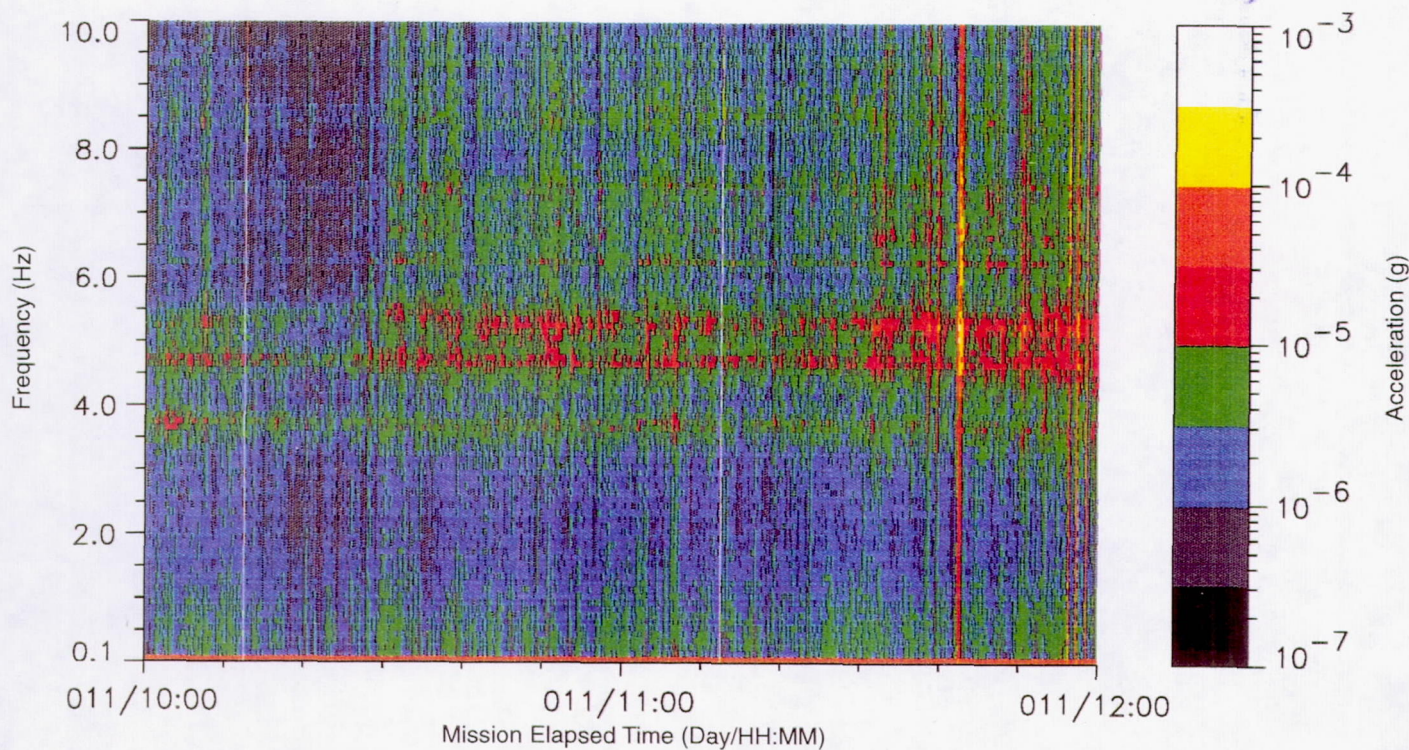


Figure C-135 IML-2 Rack 8, Vector Magnitude

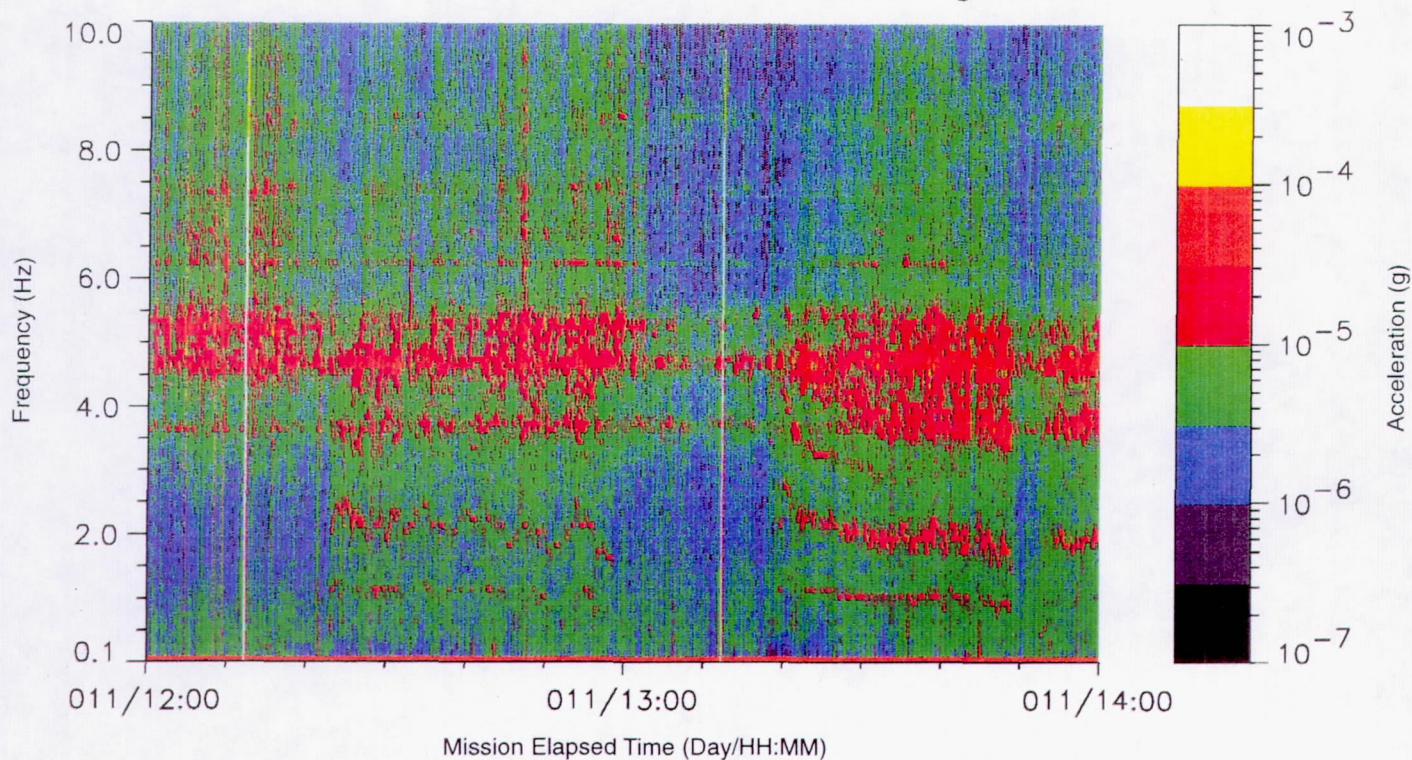


Figure C-136 IML-2 Rack 8, Vector Magnitude

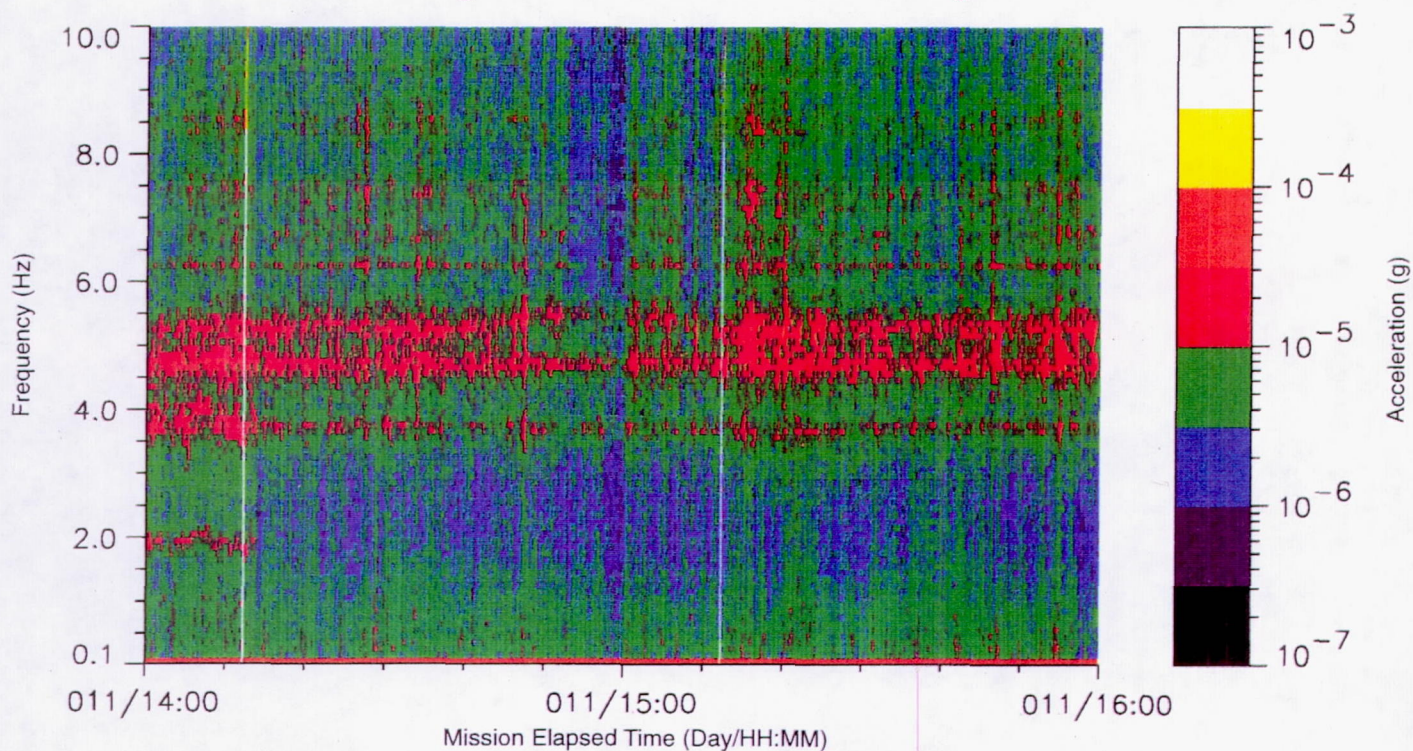


Figure C-137 IML-2 Rack 8, Vector Magnitude

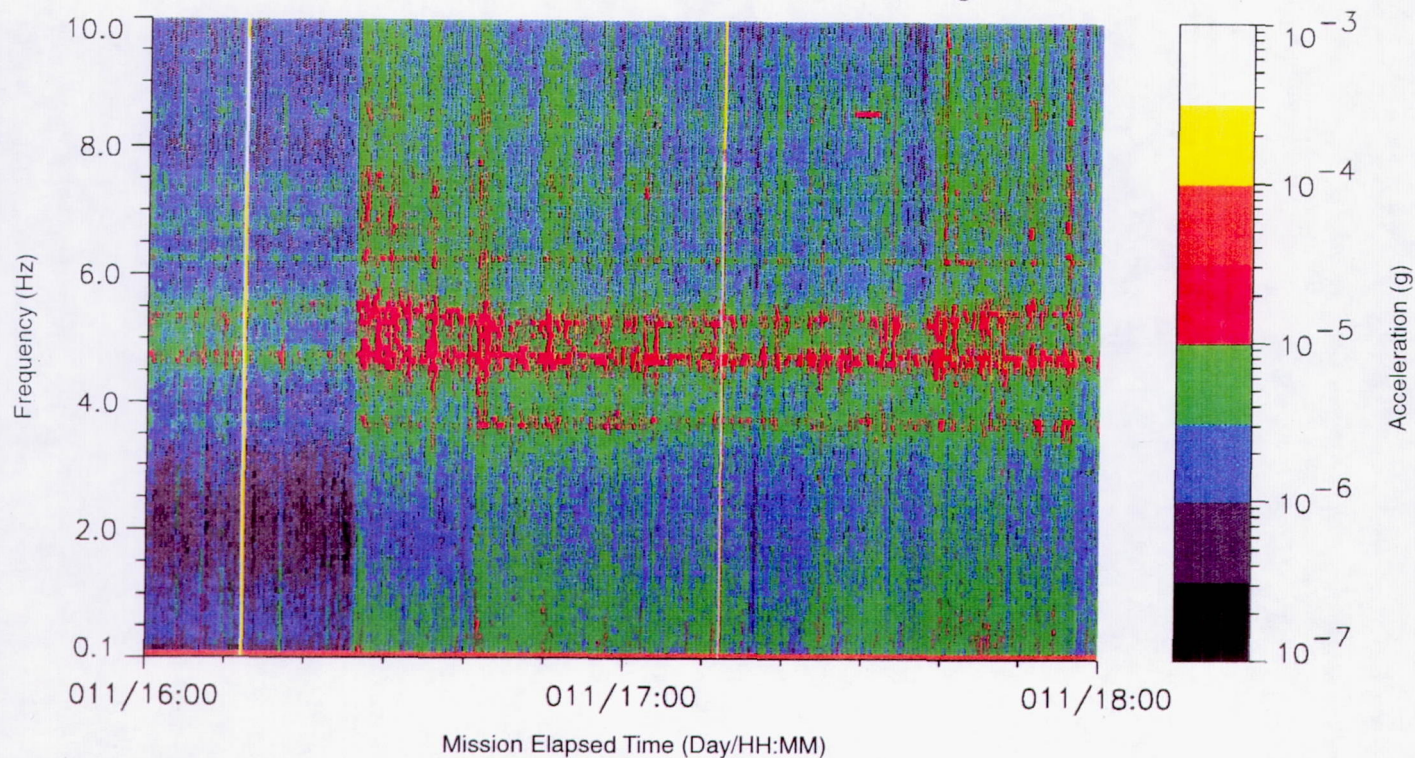


Figure C-138 IML-2 Rack 8, Vector Magnitude

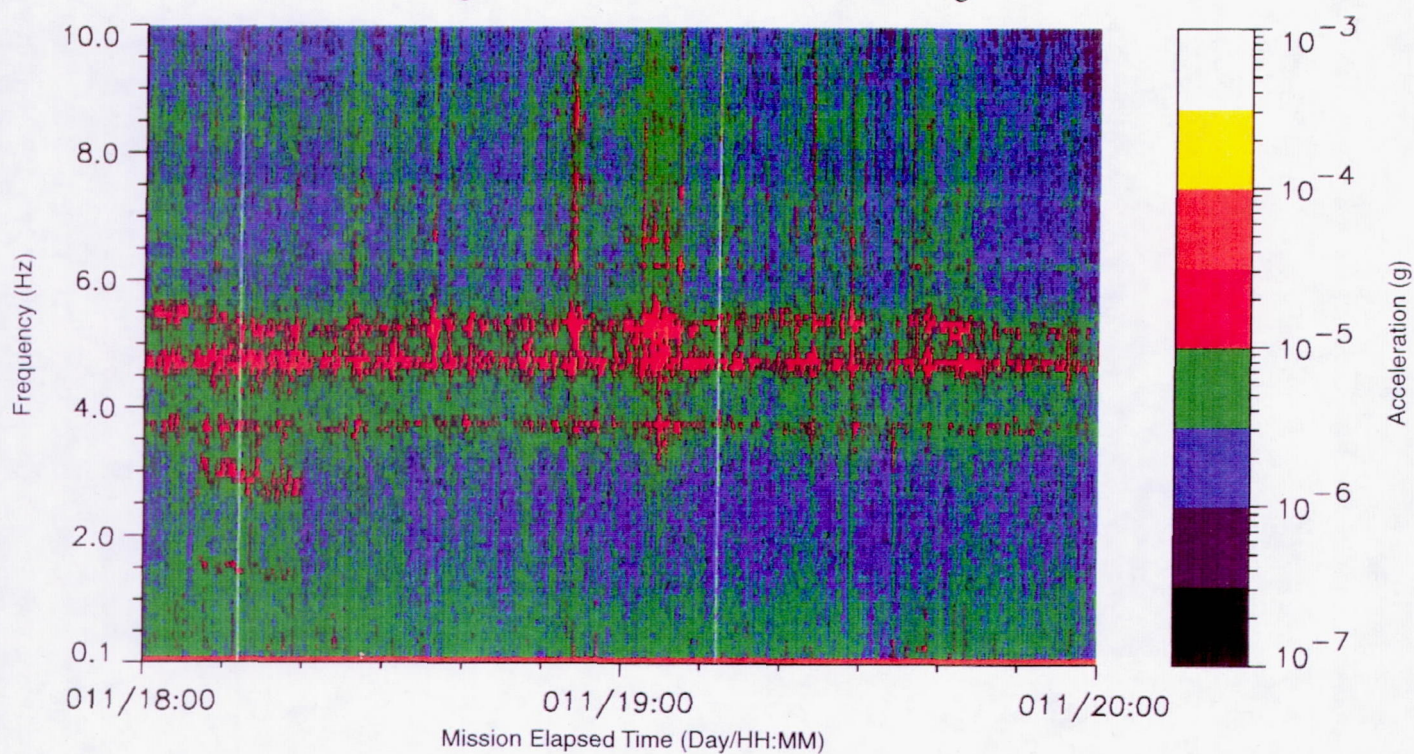


Figure C-139 IML-2 Rack 8, Vector Magnitude

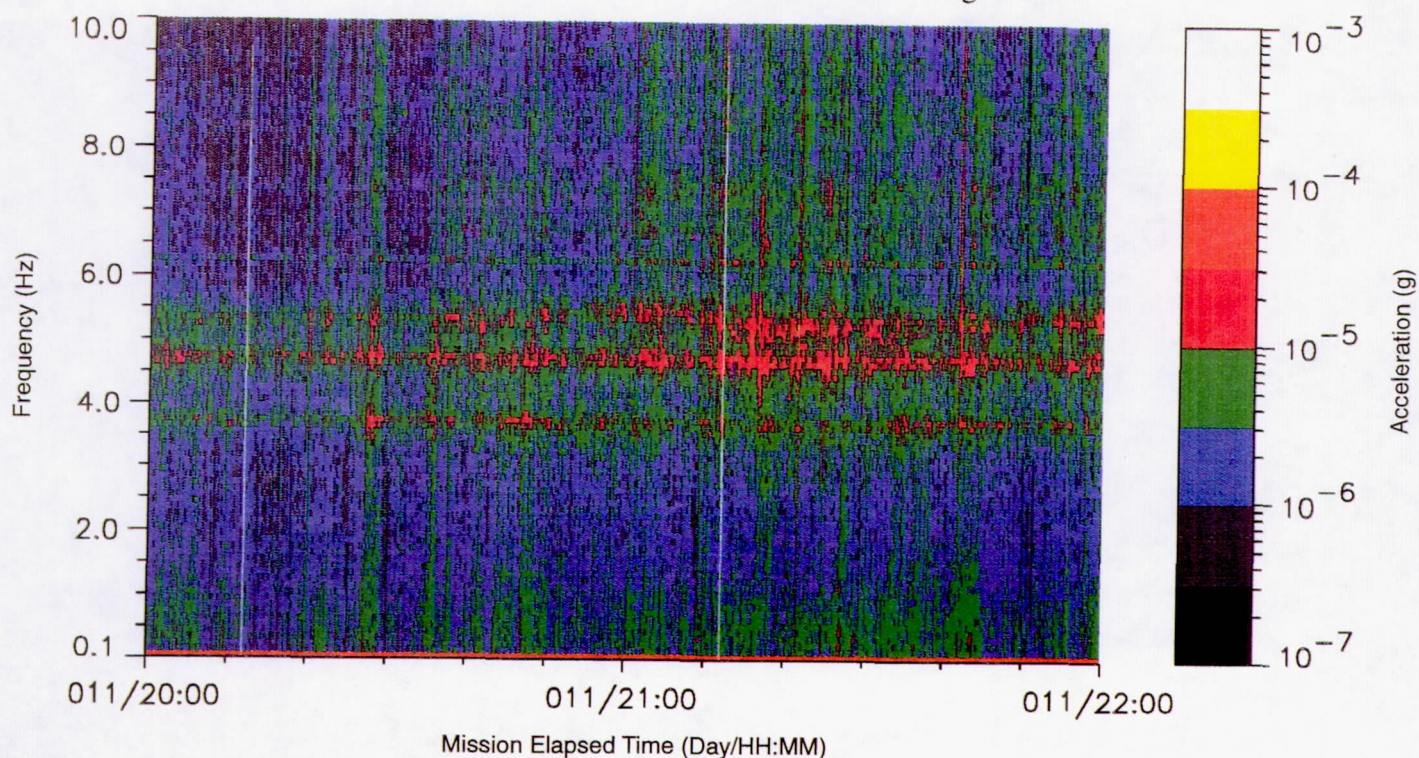


Figure C-140 IML-2 Rack 8, Vector Magnitude

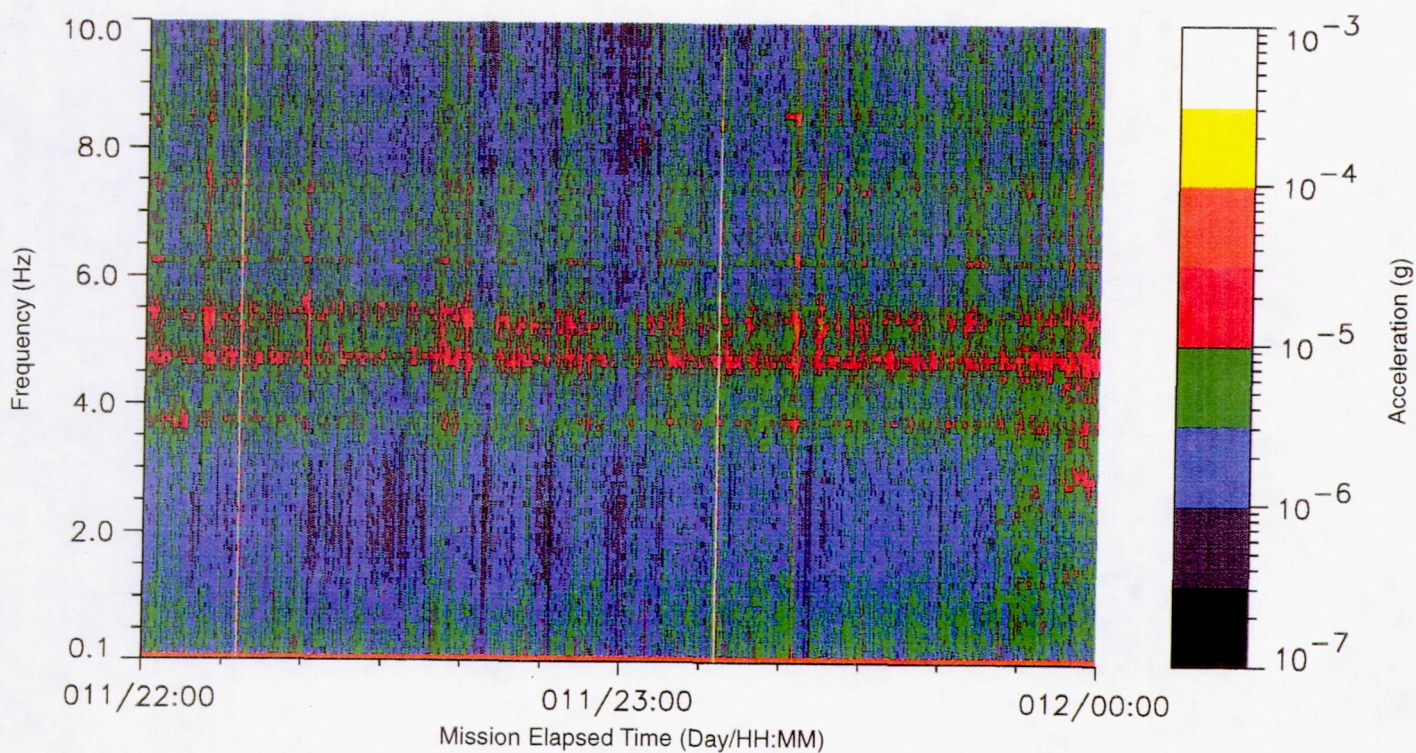


Figure C-141 IML-2 Rack 8, Vector Magnitude

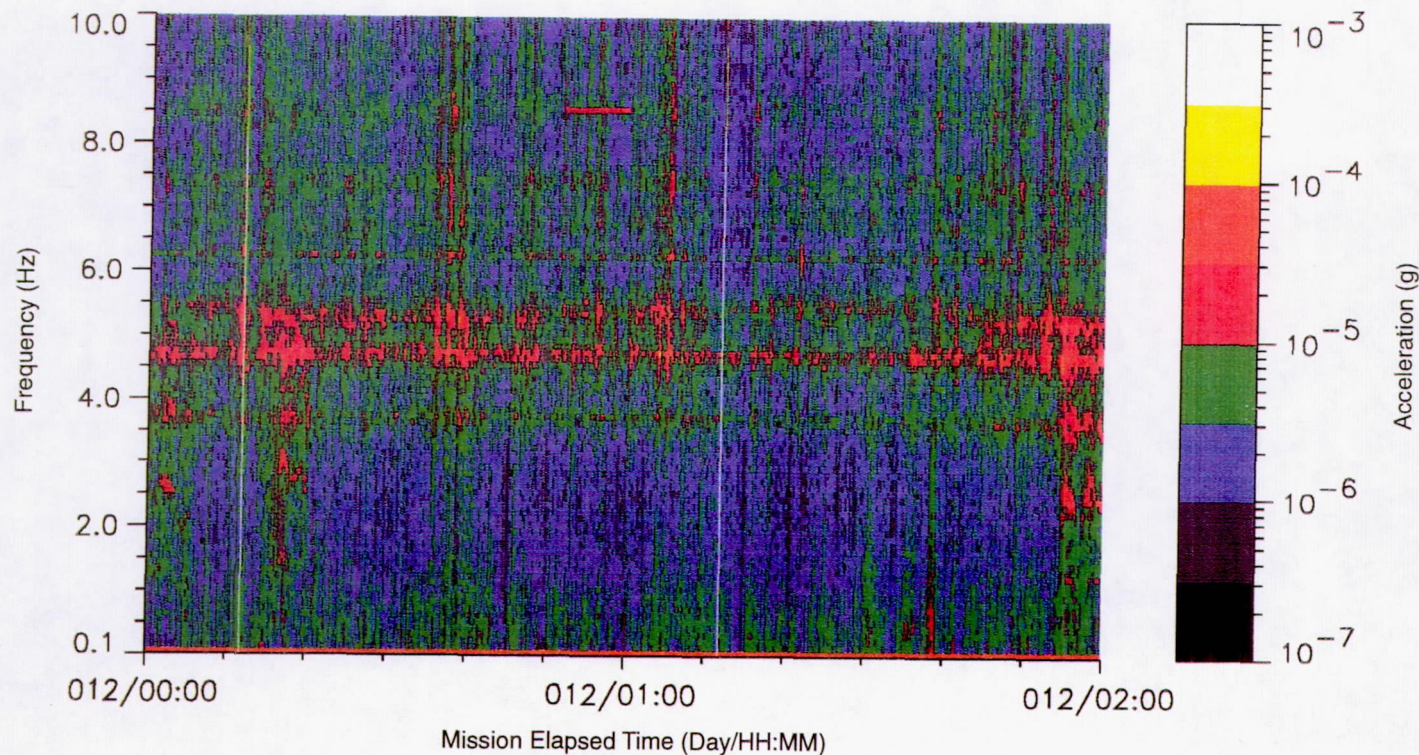


Figure C-142 IML-2 Rack 8, Vector Magnitude

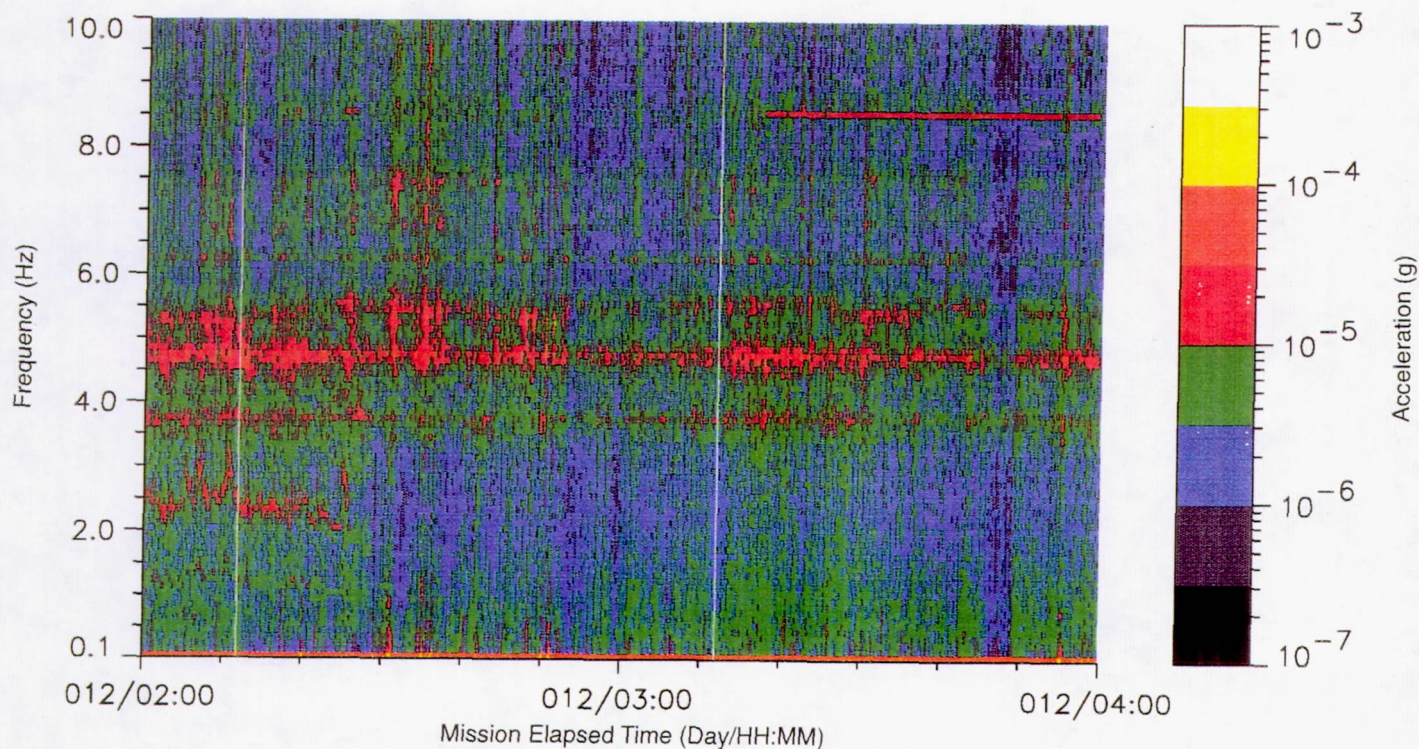


Figure C-143 IML-2 Rack 8, Vector Magnitude

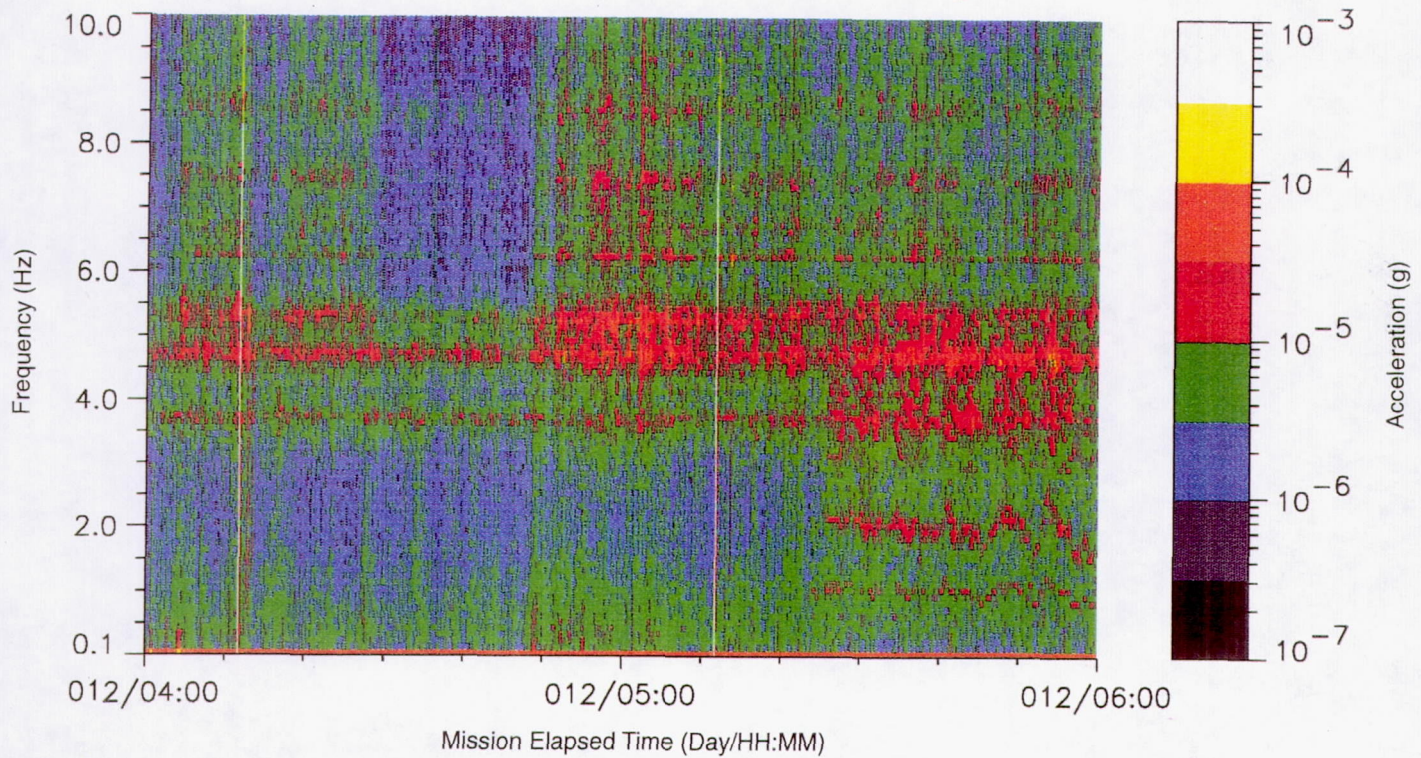


Figure C-144 IML-2 Rack 8, Vector Magnitude

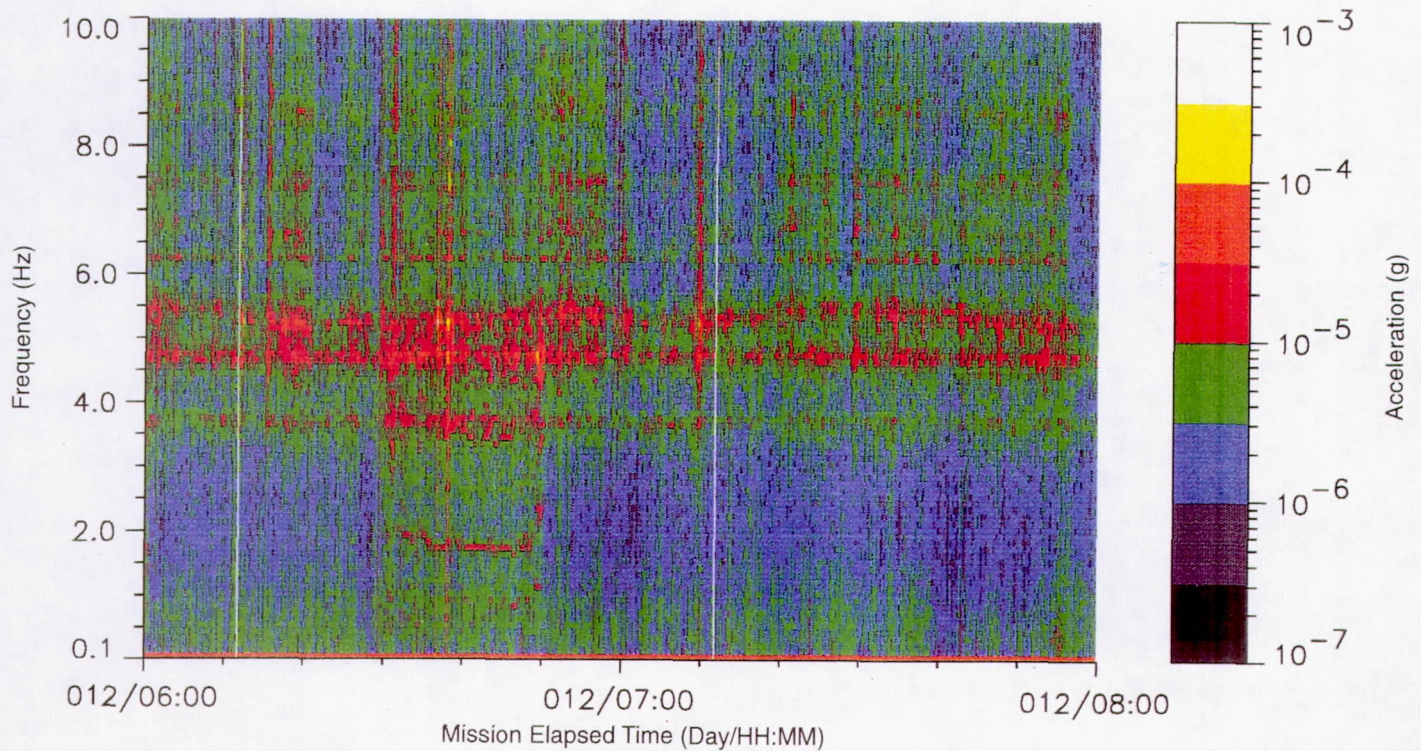


Figure C-145 IML-2 Rack 8, Vector Magnitude

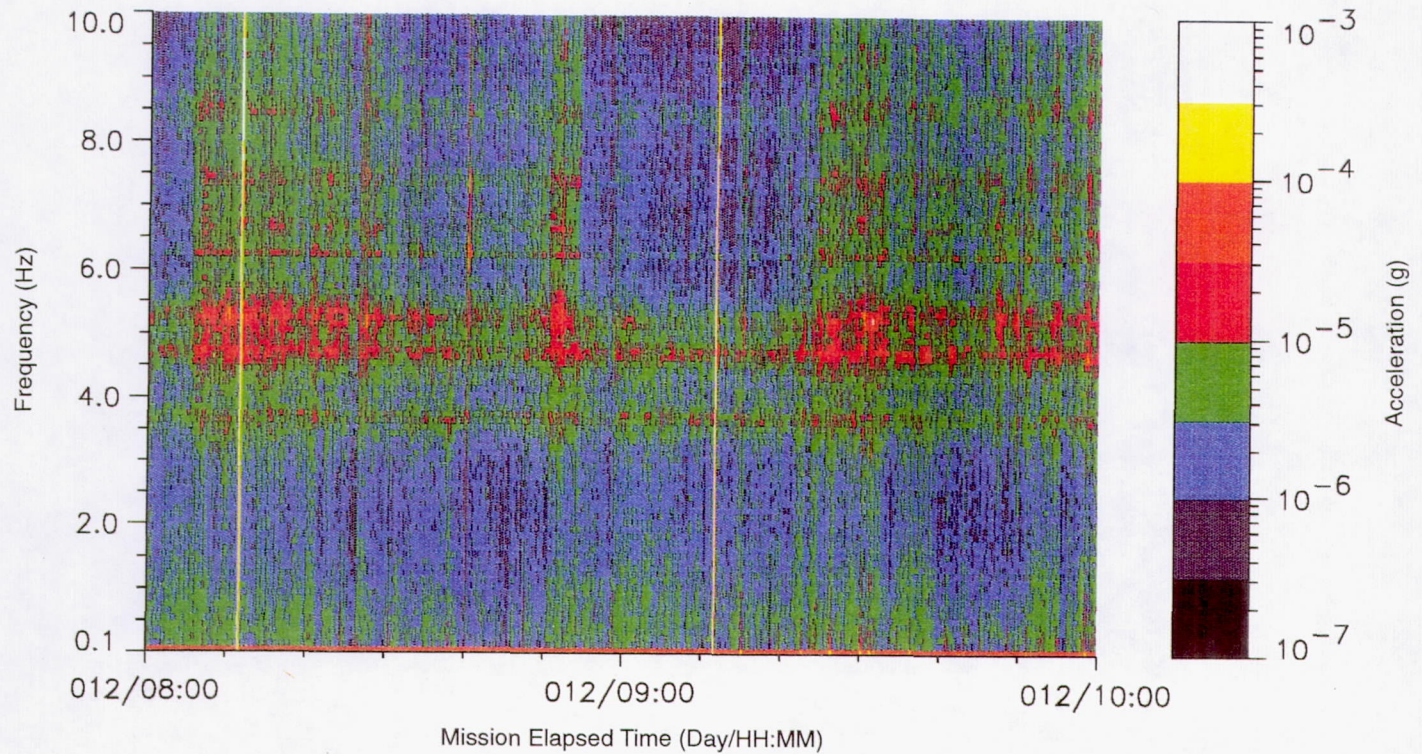


Figure C-146 IML-2 Rack 8, Vector Magnitude

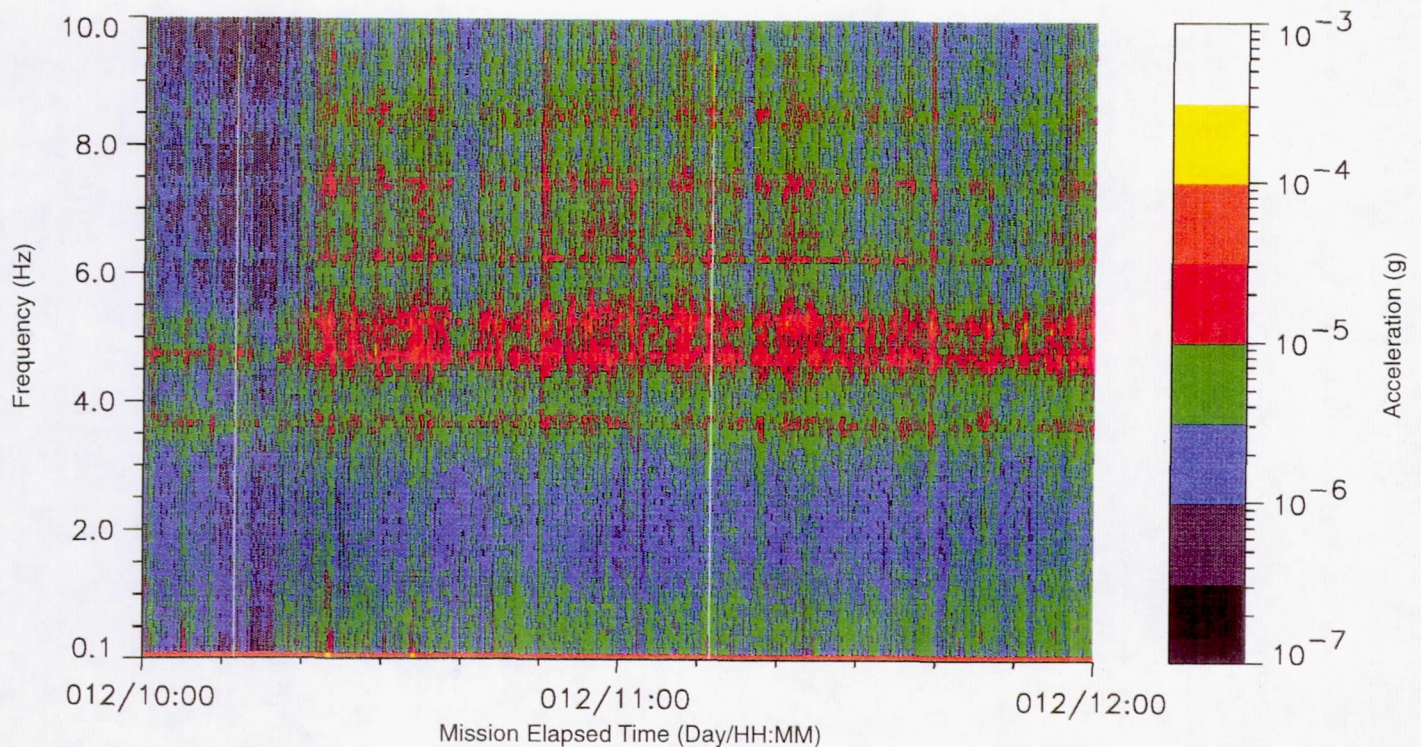


Figure C-147 IML-2 Rack 8, Vector Magnitude

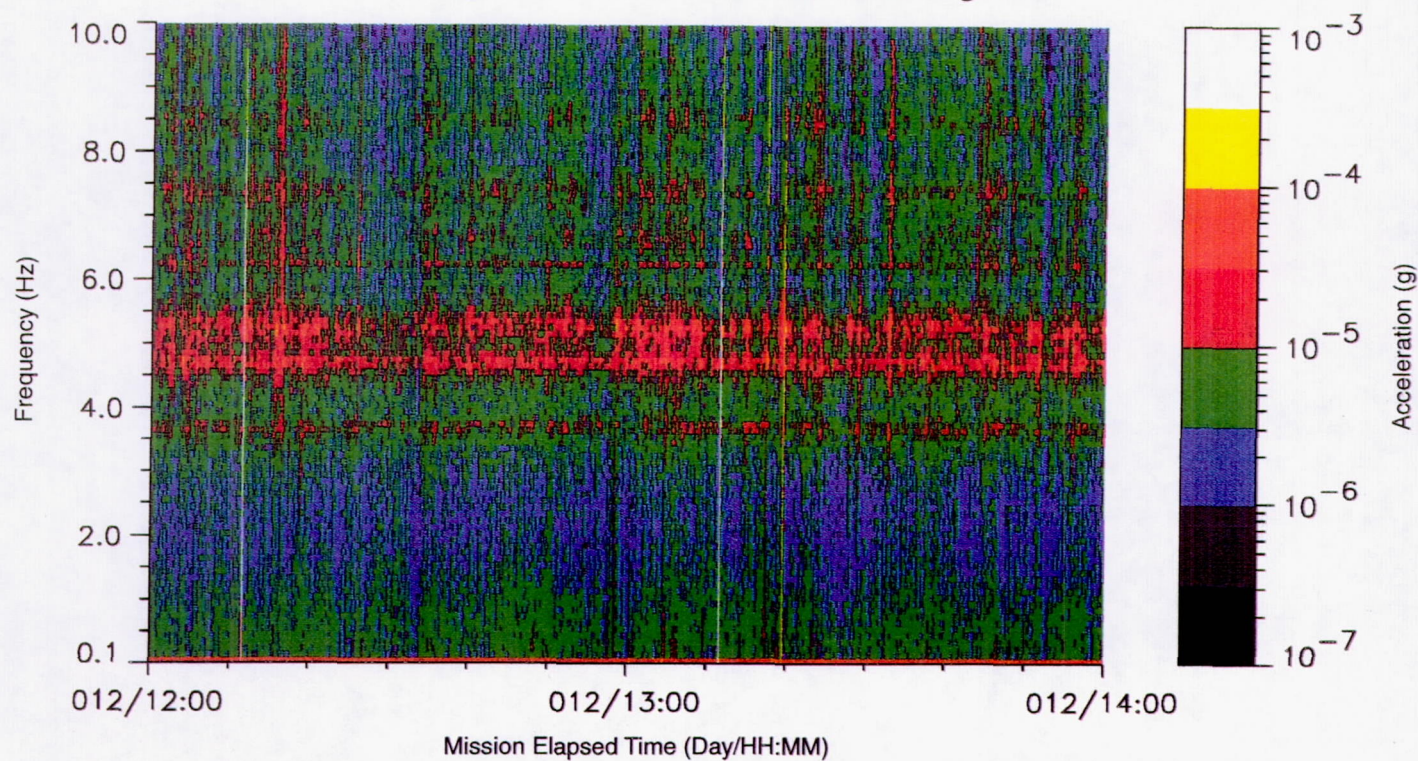


Figure C-148 IML-2 Rack 8, Vector Magnitude

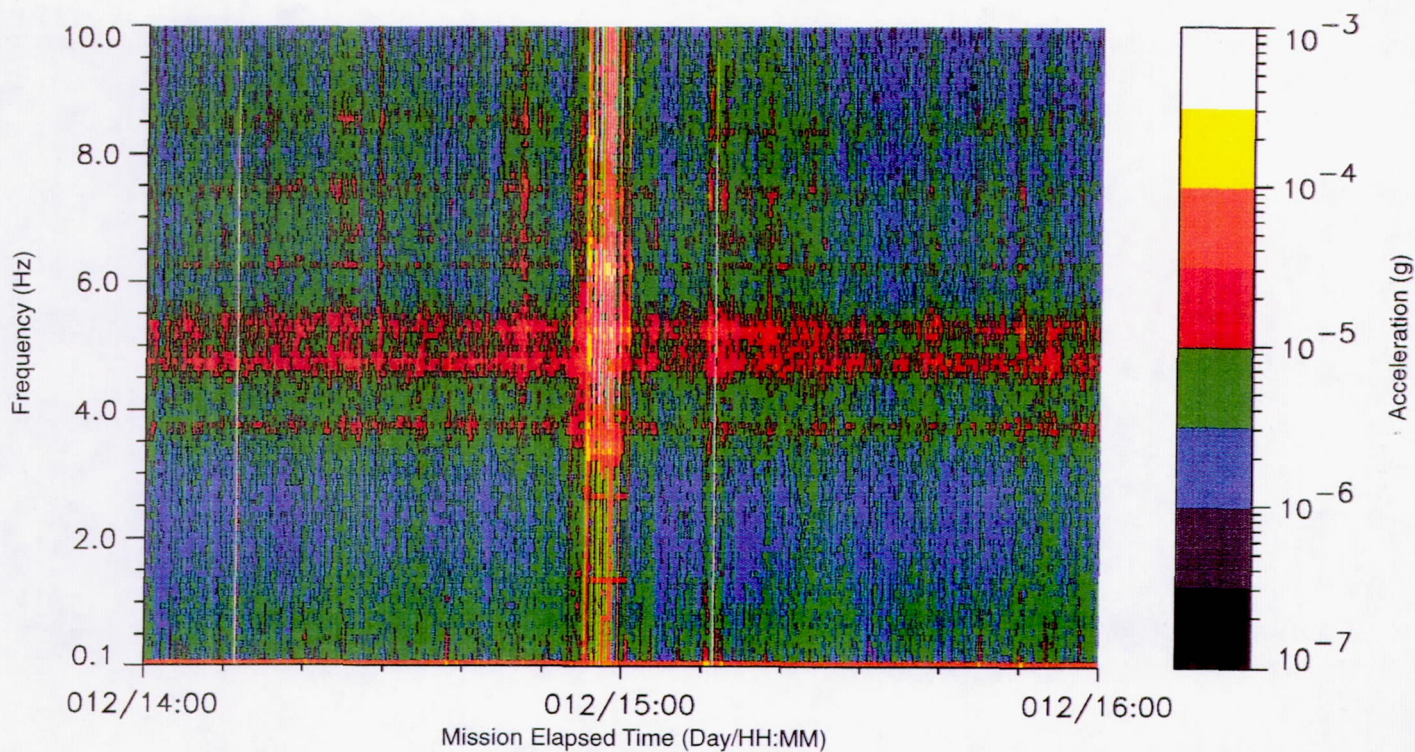


Figure C-149 IML-2 Rack 8, Vector Magnitude

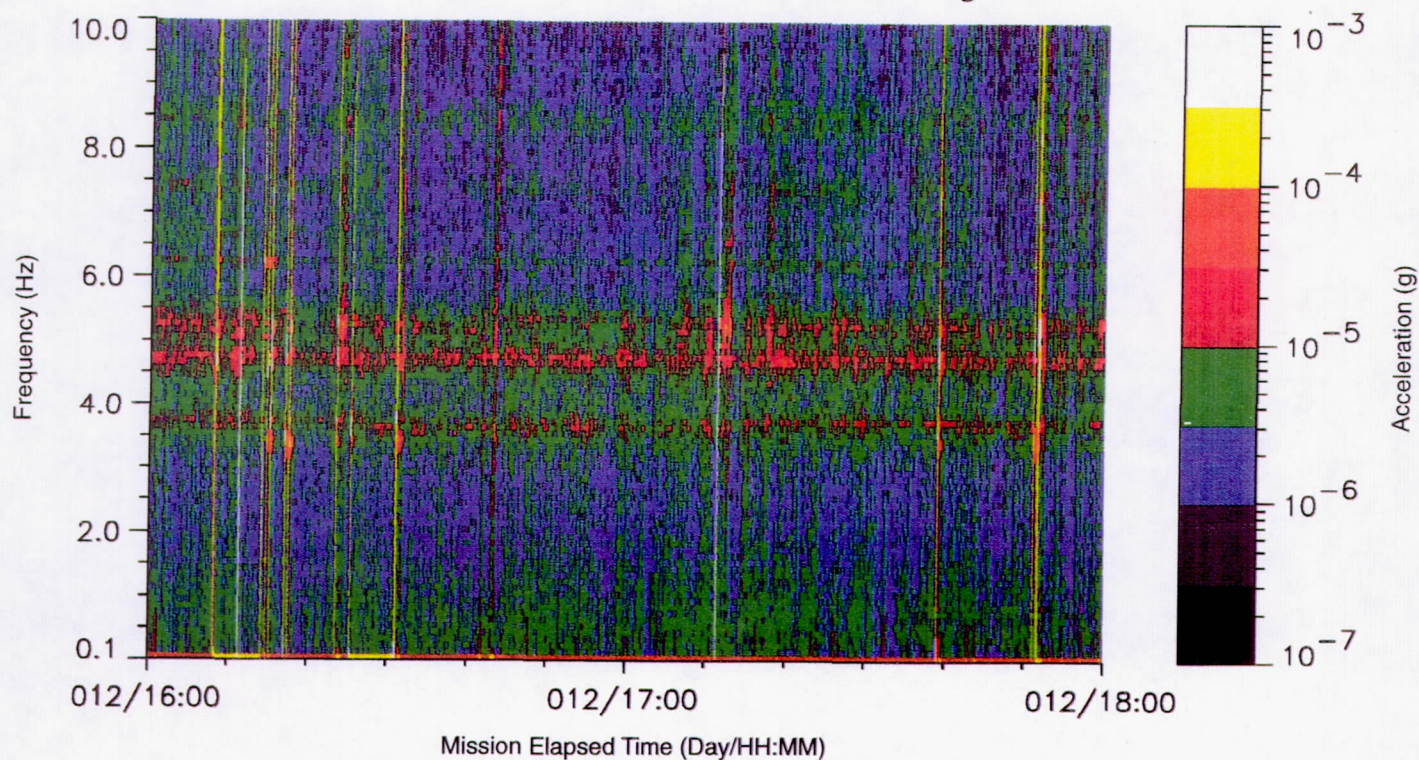


Figure C-150 IML-2 Rack 8, Vector Magnitude

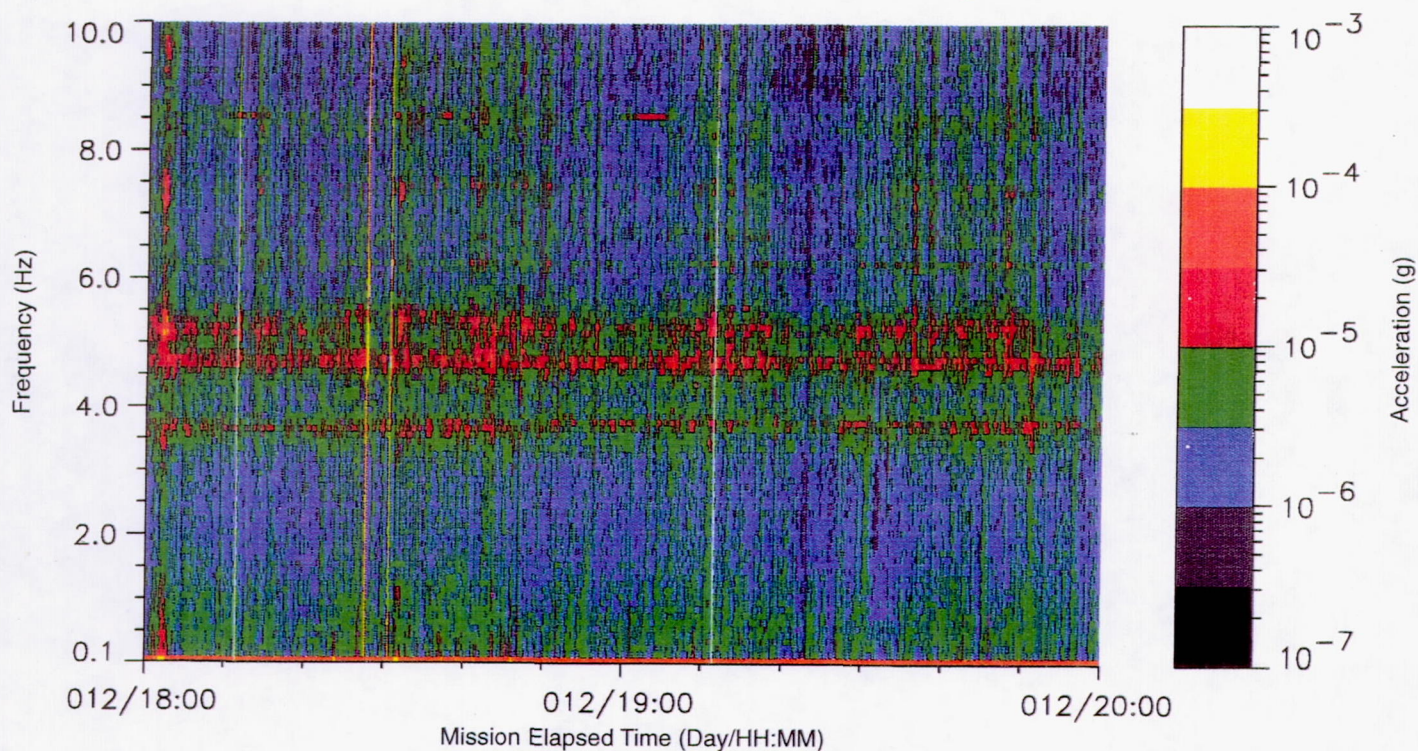


Figure C-151 IML-2 Rack 8, Vector Magnitude

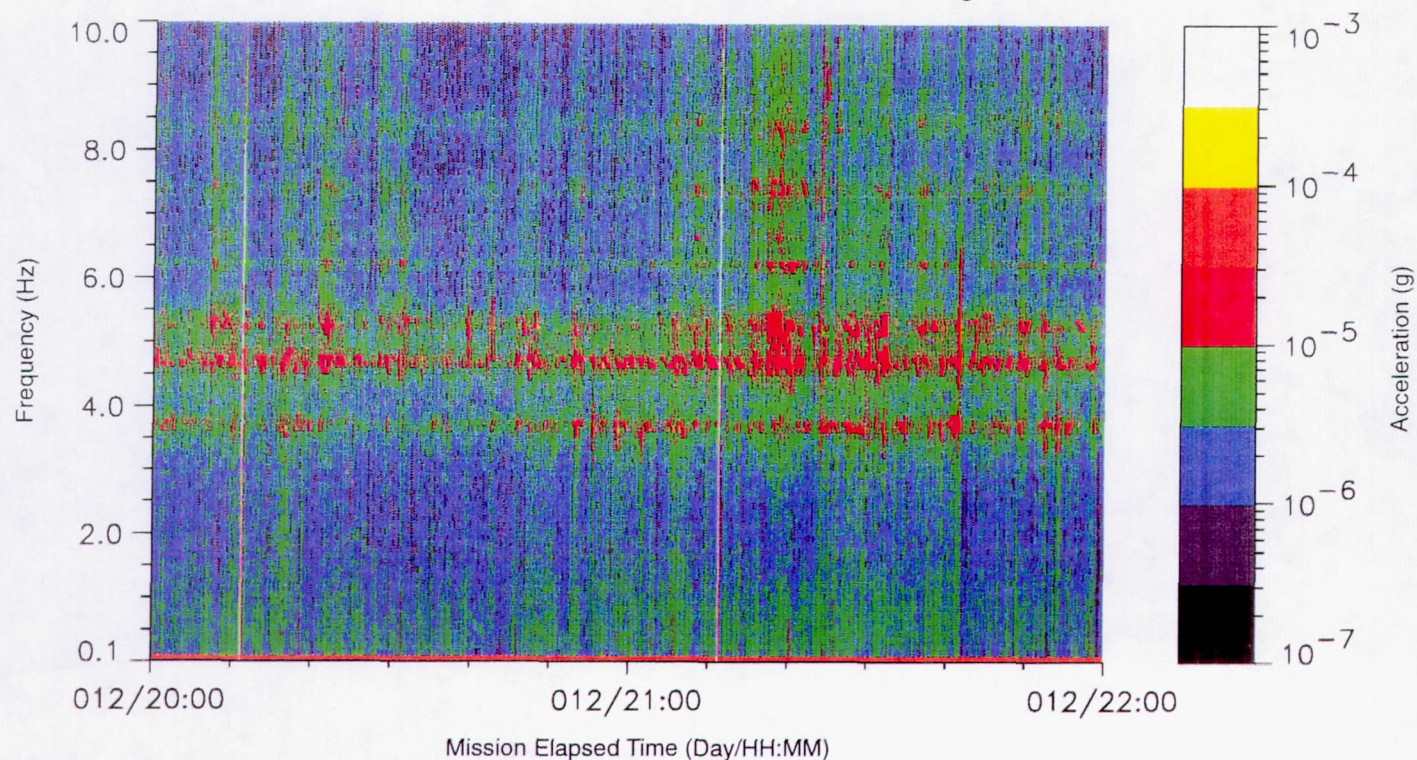


Figure C-152 IML-2 Rack 8, Vector Magnitude

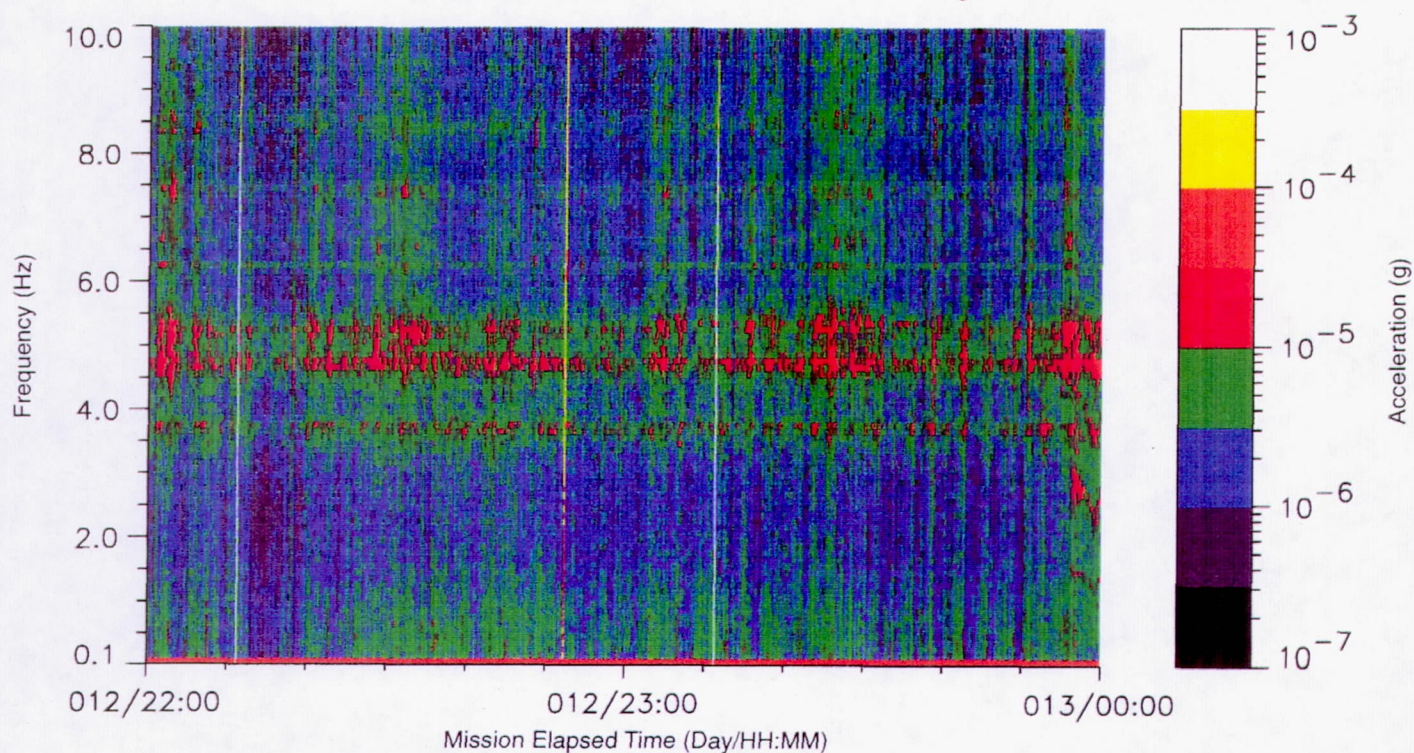


Figure C-153 IML-2 Rack 8, Vector Magnitude

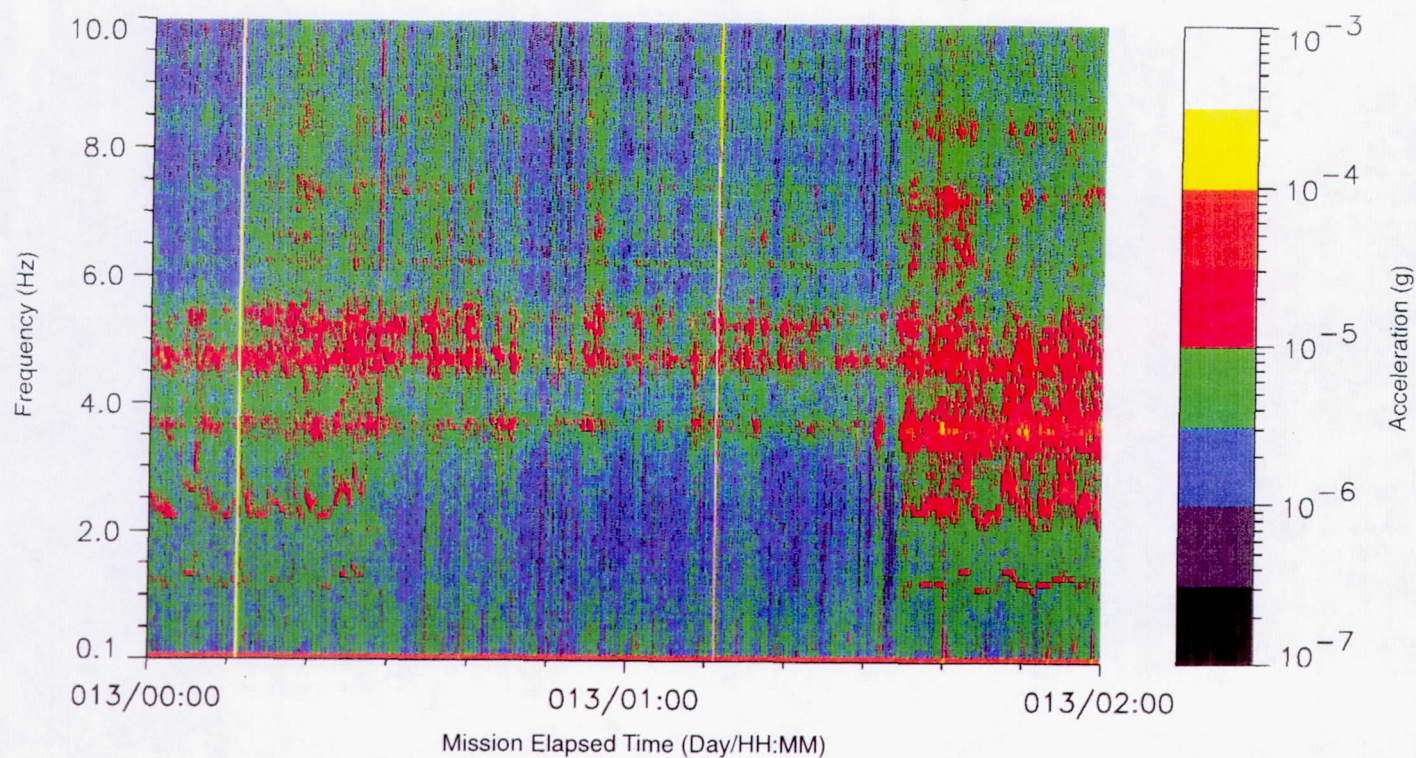
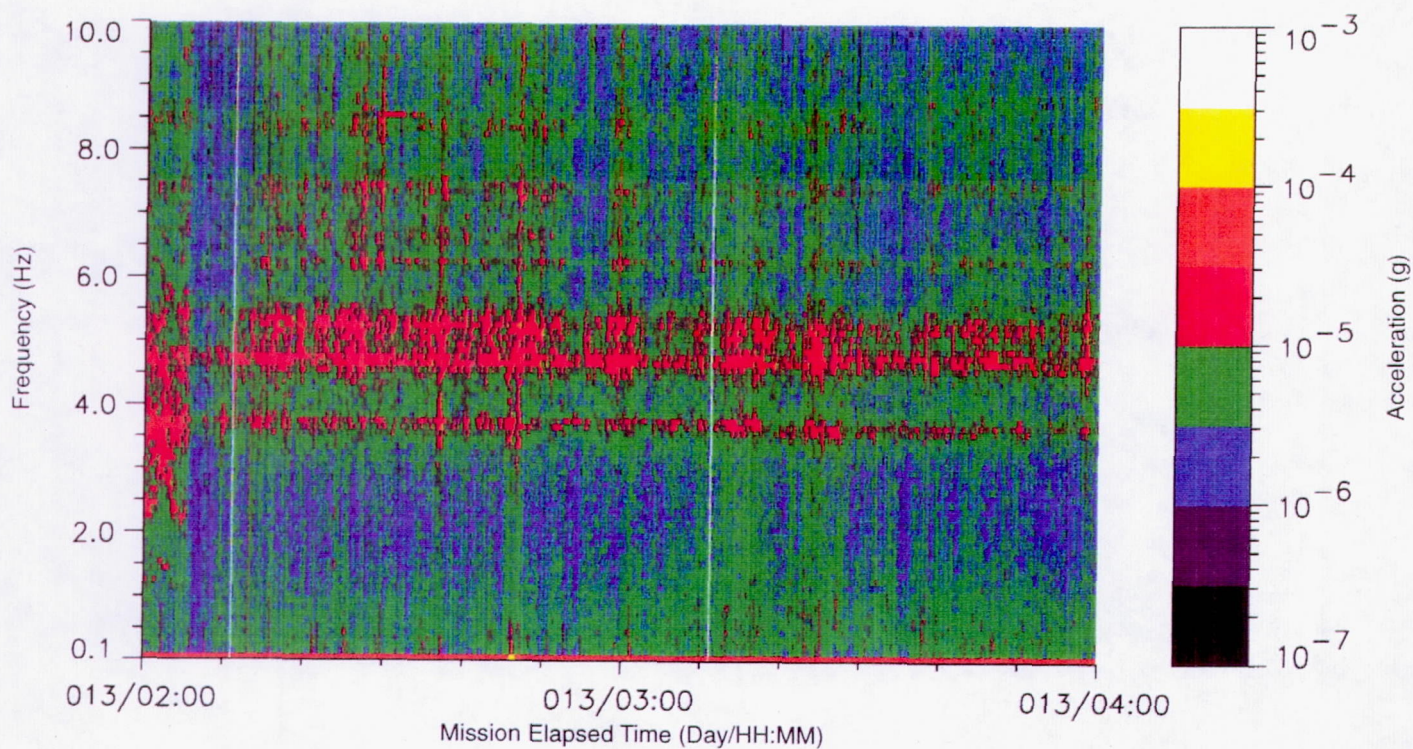


Figure C-154 IML-2 Rack 8, Vector Magnitude



SUMMARY REPORT OF MISSION ACCELERATION MEASUREMENTS FOR STS-65

Figure C-155 IML-2 Rack 8, Vector Magnitude

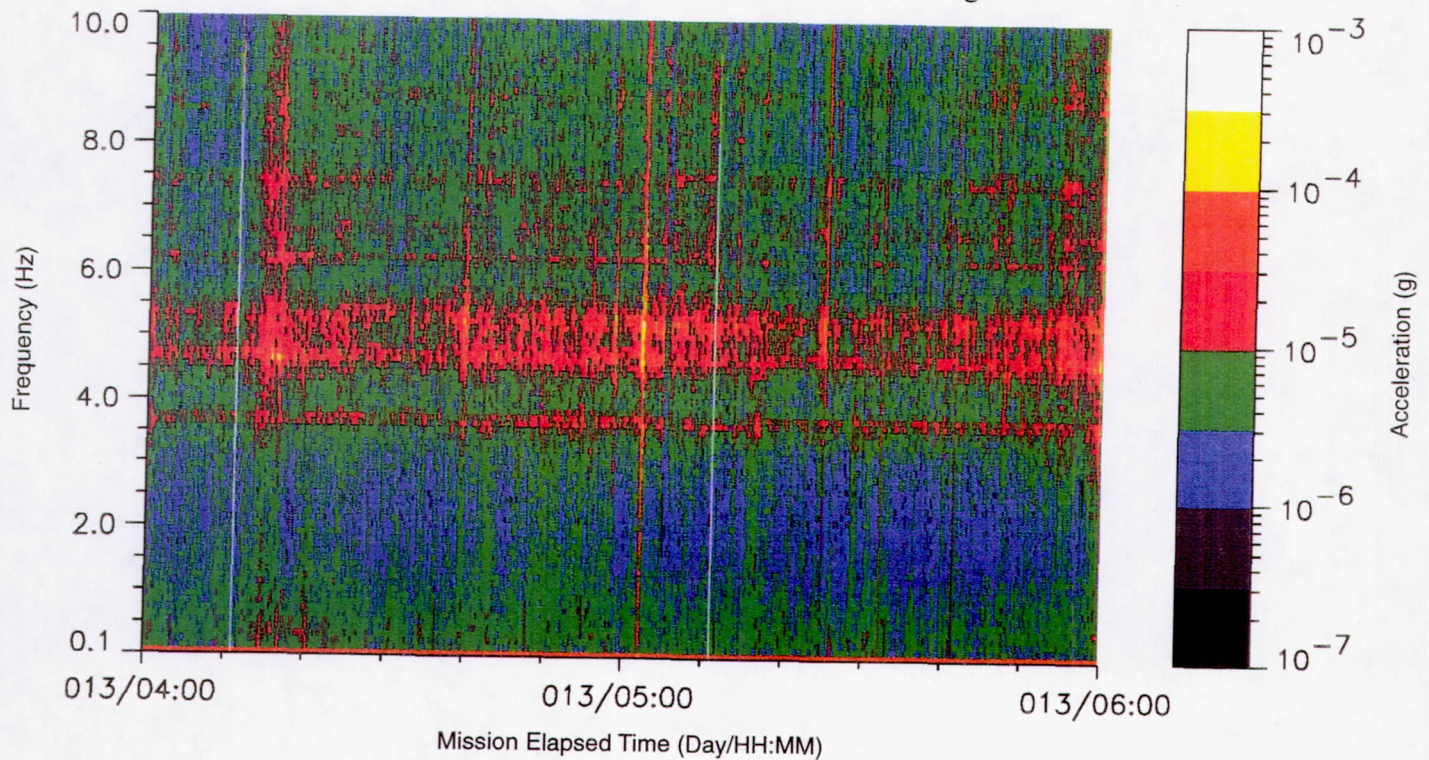
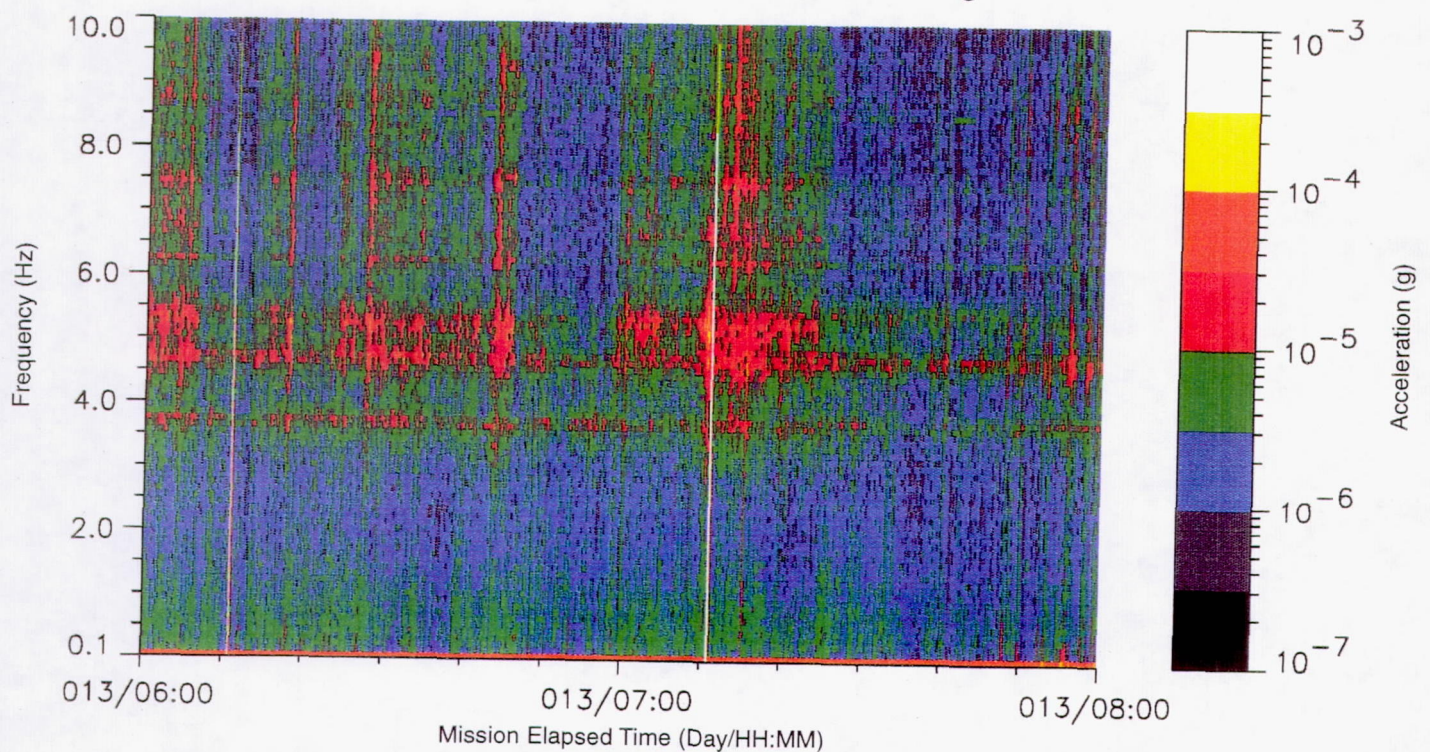


Figure C-156 IML-2 Rack 8, Vector Magnitude



APPENDIX D USER COMMENTS SHEET

We would like you to give us some feedback so that we may improve the Mission Summary Reports. Please answer the following questions and give us your comments.

1. Do the Mission Summary Reports fulfill your requirements for acceleration and mission information? _____ Yes _____ No If not why not?

Comments:

2. Is there additional information which you feel should be included in the Mission Summary Reports? _____ Yes _____ No If so what is it?

Comments:

3. Is there information in these reports which you feel is not necessary or useful?

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Comments:

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REPORT DOCUMENTATION PAGE

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13. ABSTRACT (Maximum 200 words) The second flight of the International Microgravity Laboratory payload on-board the STS-65 mission was supported by three accelerometer instruments: the Orbital Acceleration Research Experiment (OARE) located close to the Orbiter center of mass, the Quasi-Steady Acceleration Measurement experiment in the Spacelab module, and the Space Acceleration Measurement System (SAMS) in the Spacelab module. A fourth accelerometer flew on the mission; the Microgravity Measuring Device recorded data in the middeck in support of exercise isolation tests. OARE and SAMS are both managed by the NASA Lewis Research Center. Data collected by these systems during IML-2 are displayed in this report. The OARE data represent the microgravity environment below 1 Hz. The SAMS data represent the environment in the 0.01 Hz to 100 Hz range. Variations in the environment caused by unique activities are presented in the report. Specific events addressed are crew activity, crew exercise, experiment component mixing activities, experiment centrifuge operations, refrigerator/freezer operations and circulation pump operations. The analyses included in this report complement analyses presented in other mission summary reports.				
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