



## **SECTION 2**

# **PIMS Interaction with Principal Investigator Teams**

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- **PIMS performs the project scientist role for the accelerometer instruments**
  - PIMS works with the science experiment principal investigators, project scientists, and other program participants to assist in the understanding and utilization of the acceleration data
  - PIMS **products** include general and specific analyses, vehicle characterization, and mission summary reports
  - PIMS **conducts** the Microgravity Measurements Group (MGMG) meetings to foster interchange of data and information within the microgravity environment community and to the microgravity science community
  - PIMS **conducts** the Microgravity Environment & Interpretation Tutorial (MEIT) to convey significant features of the reduced gravity environment to the microgravity Principal Investigator teams and other interested parties

## PIMS' Missions are:

- To **assist** PI teams in understanding different aspects of measuring and interpreting the reduced gravity environment of various platforms and ground-based facilities.
- To **provide** interpretation of the reduced gravity environment and perform detailed analyses for general and specialized characterization.
- To **educate** PIs, Project scientists and associates about the reduced gravity environment through the annual gatherings:
  - **Microgravity Environment Interpretation Tutorial (MEIT)**
  - **MicroGravity Measurements Group (MGMG)**

- **Microgravity Environment Interpretation Tutorial (MEIT)**

*A **yearly educational** opportunity for PI teams and other interested parties to understand the reduced gravity environment.*

- **Purpose**

**Present to PI teams information about the reduced gravity environment regarding the:**

- **effect of the reduced acceleration on experiments**
- **nature of the reduced gravity acceleration environment**
- **methods of measuring the accelerations**
- **methods of processing the acceleration data**
- **methods of presenting/displaying the acceleration data**
- **examples of the reduced gravity environment and experiment effects**

<http://www.grc.nasa.gov/WWW/MMAP/PIMS/MEIT/meitmain.html>

## •Microgravity Measurements Group Meeting (MGMG)

*Participation from investigators in all areas of microgravity research, including science experiment principal investigators and project scientist, numerical modelers, instrumentation developers, vibration isolation developers and acceleration data analysts*

### •Purpose

A forum for exchange of information and ideas about various aspects of microgravity acceleration research in the NASA Microgravity Research Program.

### •Topics (some past topics):

- Disturbances by microgravity science experiments
- Microgravity constraints on payloads
- Operational performance of SAMS and MAMS instruments
- Impact of crew exercise and other activities on environment
- ARIS-ICE and ARIS performance
- NASDA and Russian accelerometer systems discussion

<http://www.grc.nasa.gov/WWW/MMAP/PIMS/MGMG/mgmmain.html>

## Principal Investigator Microgravity Services (PIMS)

**Support NASA's Microgravity Research Program Principal Investigators (PIs) by providing acceleration data processing, analysis, and interpretation for a variety of reduced gravity carriers and ground-based facilities, such as:**

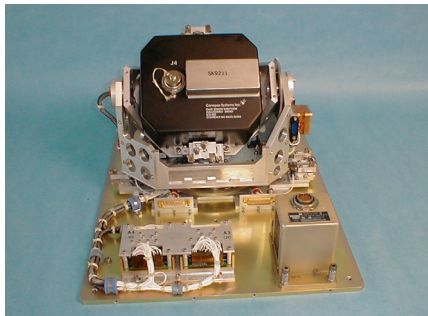
- **Space Shuttle**
- **ISS**
- **Sounding Rockets**
- **Parabolic Flight-Path Aircraft (KC-135)**
- **Drop Towers**
- **Ground Testing**
- **Microgravity Emission Lab (MEL)**

## Principal Investigator Microgravity Services (PIMS)

Analyze acceleration data from a number of acceleration measurement systems, such as:

- Space Acceleration Measurement System (SAMS): [0.01-400 Hz]
- Microgravity Acceleration Measurement System (MAMS):
  - MAMS-OSS: [ $\leq 0.01$  Hz]
  - MAMS-HiRAP: [up to 100 Hz]

MAMS-OSS/HiRAP



SAMS



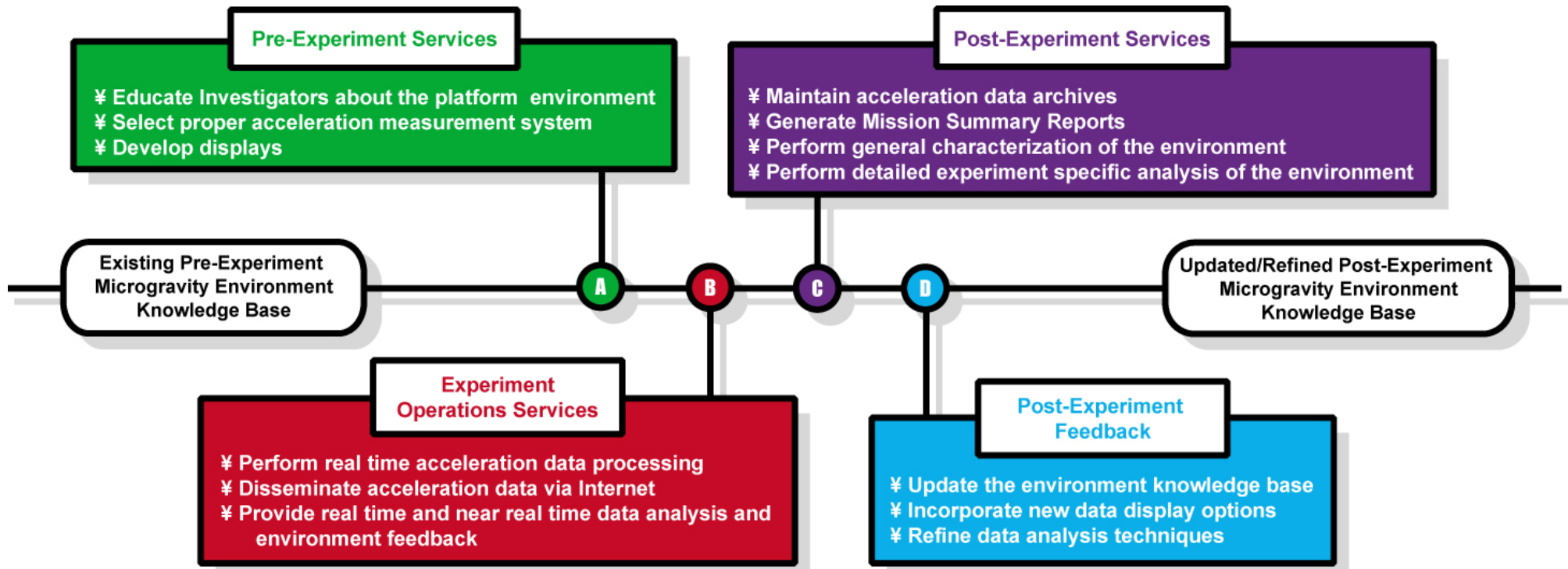
## Principal Investigator Microgravity Services (PIMS)

Support the following disciplines and Groups:

- **Biotechnology**
- **Combustion Science**
- **Fluid Physics**
- **Materials Science**
- **Fundamental Physics**
- **Astronaut Office**
- **International Partners**
- **Vehicle Dynamics**



## PIMS Functions During Experiment Life Cycle



## **PIMS' support to PIs includes the following:**

- **Receive, Process, Analyze, and Interpret Accelerometer Data to Characterize the Reduced Gravity Environment of Various Platforms for the Investigative Teams.**

### **ANALYSIS SUPPORT:**

- **Monitor the Reduced Gravity Environment in Real Time to Support PIs Operation (when needed)**
- **Provide Real Time Displays**
- **Provide Near Real Time Support**
- **Provide Post Mission Support**
- **Provide a Near Real Time ISS Reduced Gravity Environment Monitoring System (ISS MEMS) Via the PIMS' web site (Future Capability)**

## **PIMS' support to PIs includes the following:**

### **DATA SUPPORT:**

- **Provide easy access to plots of acceleration data from the PIMS' web site**
- **Provide easy access to archive acceleration data via the PIMS' ftp site**
- **Provide customized format plots to PI teams based on pre-mission inputs**
- **Publish Summary Report of Mission Acceleration Measurements (ISS and Space Shuttle)**

## Quasi-steady Plot Types

| Display Format                                 | Notes   |
|--|---|
| Acceleration versus Time                       | <ul style="list-style-type: none"> <li>• precise accounting of measured data with respect to time; best temporal resolution</li> </ul>  |
| Interval Min/Max Acceleration versus Time      | <ul style="list-style-type: none"> <li>• displays upper and lower bounds of peak-to-peak excursions of measured data</li> <li>• good display approximation for time histories on output devices with resolution insufficient to display all data in time frame of interest</li> </ul> |
| Interval Average Acceleration versus Time      | <ul style="list-style-type: none"> <li>• provides a measure of net acceleration of duration greater than or equal to interval parameter</li> </ul>  |
| Trimmed Mean Filtered Acceleration versus Time | <ul style="list-style-type: none"> <li>• removes infrequent, large amplitude outlier data</li> </ul>  |
| Quasi-Steady Mapped Acceleration versus Time   | <ul style="list-style-type: none"> <li>• use rigid body assumption and vehicle rates and angles to compute acceleration at any point in the vehicle</li> </ul>  |
| Quasi-Steady Three-Dimensional Histogram (QTH) | <ul style="list-style-type: none"> <li>• summarize acceleration magnitude and direction for a long period of time</li> <li>• indication of acceleration "center-of-time" via projections onto three orthogonal planes</li> </ul>  |

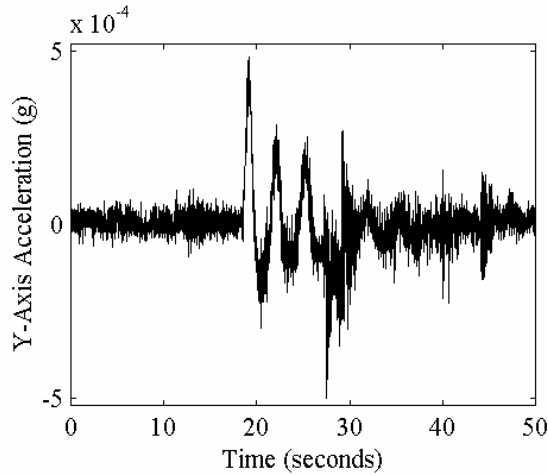
## Time Domain Summary Table

| DISPLAY   | NOTES   |
|---|---|
| Acceleration vs. Time                                 | <ul style="list-style-type: none"> <li>• most precise accounting of measured data with respect to time</li> <li>• display device constrains resolution for long time spans or high sample rates</li> </ul>  |
| Interval Minimum/Maximum Acceleration vs. Time        | <ul style="list-style-type: none"> <li>• displays upper and lower bounds of peak-to-peak excursions</li> <li>• good display approximation for time histories on output devices with resolution insufficient to display all data in time frame of interest (see notes below though)</li> </ul> |
| Interval Average Acceleration vs. Time                | <ul style="list-style-type: none"> <li>• descriptive statistics</li> <li>• not fully descriptive (“lossy compression”)</li> </ul>   |
| Interval Root-Mean-Square (RMS) Acceleration vs. Time |   |

## Frequency Domain Summary Table

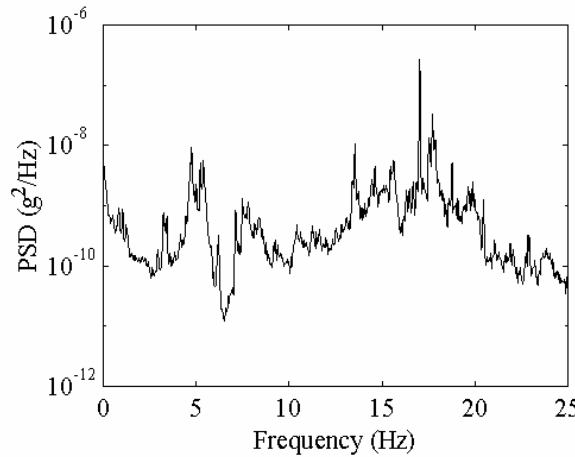
| DISPLAY  | NOTES   |
|--|---|
| Power Spectral Density (PSD)<br>vs. Frequency            | <ul style="list-style-type: none"> <li>• quantifies distribution of power with respect to frequency</li> <li>• windowing (tapering) to suppress spectral leakage</li> <li>• spectral averaging to reduce spectral variance (degraded <math>\Delta f</math>)</li> </ul>  |
| Cumulative RMS Acceleration<br>vs. Frequency             | <ul style="list-style-type: none"> <li>• quantifies RMS contribution at and below a given frequency</li> <li>• quantitatively highlights key spectral contributors</li> </ul>   |
| RMS Acceleration vs. One Third<br>Octave Frequency Bands | <ul style="list-style-type: none"> <li>• quantify RMS contribution over proportional frequency bands</li> <li>• compare measured data to ISS vibratory requirements</li> </ul>  |
| Spectrogram (PSD vs.<br>Frequency vs. Time)              | <ul style="list-style-type: none"> <li>• displays power spectral density variations with time</li> <li>• good <i>qualitative</i> tool for characterizing long periods</li> <li>• identify structure and boundaries in time and frequency</li> </ul>   |
| Principal Component Spectral<br>Analysis (PCSA)          | <ul style="list-style-type: none"> <li>• summarize magnitude and frequency excursions for key spectral contributors over a long period of time</li> <li>• results typically have finer frequency resolution and high PSD magnitude resolution relative to a spectrogram at the expense of terrible temporal resolution</li> </ul> |

**acceleration vs. time**

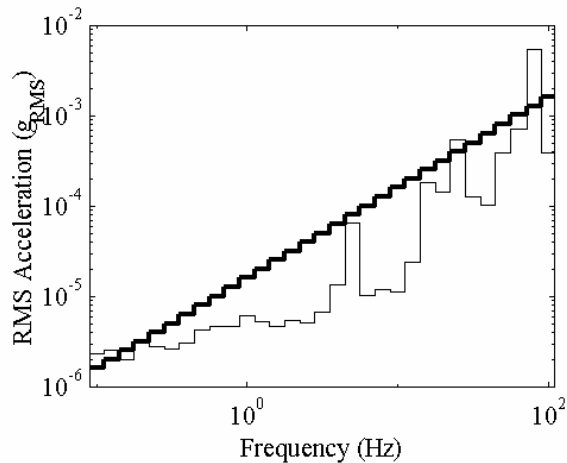
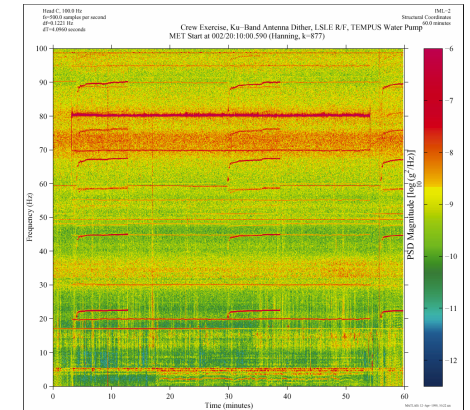


**power spectral density vs. frequency**

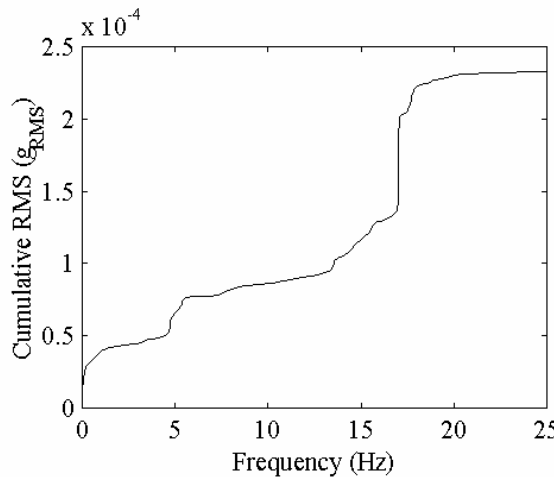
• displays distribution of power with respect to frequency



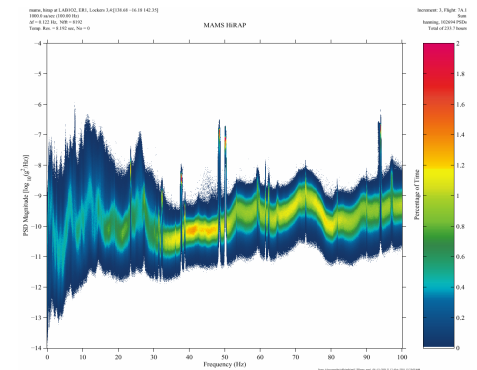
**spectrogram  
(power spectral density (3D)  
vs. frequency vs. time)**



**$g_{RMS}$  vs. 1/3 octave frequency bands**  
quantify RMS contribution over proportional frequency bands



**cumulative  $g_{RMS}$  vs. frequency**  
quantifies RMS contribution at and below a given frequency



**Principal Component Spectral Analysis (PCSA)**  
(% time (3D) vs. power spectral density vs. frequency)

## **PIMS' support to PIs includes the following:**

### **EDUCATIONAL:**

- **Annual Microgravity Environment Interpretation Tutorial (MEIT)**
- **Annual MicroGravity Measurements Group (MGMG)**
- **Astronaut Class Training (ASCAN)**
- **ISS Increment Specific Astronaut Training**
- **One on One seating with PI teams**





## How to Request Data and Science Support From PIMS:

- ❑ <http://pims.grc.nasa.gov/html/RequestDataPlots.html>

**Principal Investigator Microgravity Services International Space Station**

**Request Data Plots** (circled in red)

**Current Instrument Locations**

**Status Data Plots**

**View Interesting Data Plots**

**ISS µg Monitoring System**

**Current Real-Time Plots**

**PIMS Home Page**

**Acceleration Measurements Home Page**

**Access ISS Acceleration Data Archives**

Welcome to the Principal Investigator Microgravity Services (PIMS) International Space Station Website  
Click on the appropriate button to access the page you would like to view

**GMT Time**  
123 Days 20:41:55

**PIMS ISS Operations Links**

- 2002 Microgravity Environment Interpretation Tutorial (MEIT)
- PI Questionnaire
- STS-104 Docking Color Spectrogram
- NEW • PIMS ISS Increment Reports

Search the PIMS International Space Station Web Site

Search !

**PIMS on ISS**  
365 Days 04:41:55

**PIMS ISS Operations Ticker**

Launch from Kennedy Space Center, Fla., no earlier than May 30. Between now and launch, the shuttle will undergo final processing operations. The Leonardo Multi-Purpose Logistics Module will be installed into Endeavour's payload bay on Wednesday.

In addition to delivering Leonardo, STS-111 will ferry the Expedition Five crew to the station and

Click [here](#) to view all available sensors

GMT of the most recent status snap | name of the sensor | current sensor status  
Curr. GMT=123/20:40:21 GMT of Last packet=100/16:59:59 121F03@200HZ ON HOST:SEXSON IS NOT ACTIVE

Transferring data from pims.grc.nasa.gov

**Request Data Plots - Netscape**

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Location: <http://pims.grc.nasa.gov/html/RequestDataPlots.html>

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*Note: If you have filled this form within the last three months and your data needs and experiment are the same, except for different time periods, Please fill in your name and email address, then go to section 4*

*\* designates required fields*

FirstName:\*

LastName:\*

Title:

Microgravity Dicipline:   
(e.g., Biotech, Material Science, etc.)

OR Other:

Address:

Email:\*

Phone:\*

Experiment Name:

Ascent Flight/Descent Flight:

Affiliation (e.g. GRC, MSFC, ESA):   
OR Other:

Type:

Have you participated in:

MGMG

MEIT

INTERNATIONAL

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**1. Experiment Information**

1. Please briefly describe the scientific objective of your experiment (include specific scientific discipline, key principle under investigation, etc.):

2. Does your experiment or supporting equipment have any frequency sensitivities?

If yes, please elaborate.

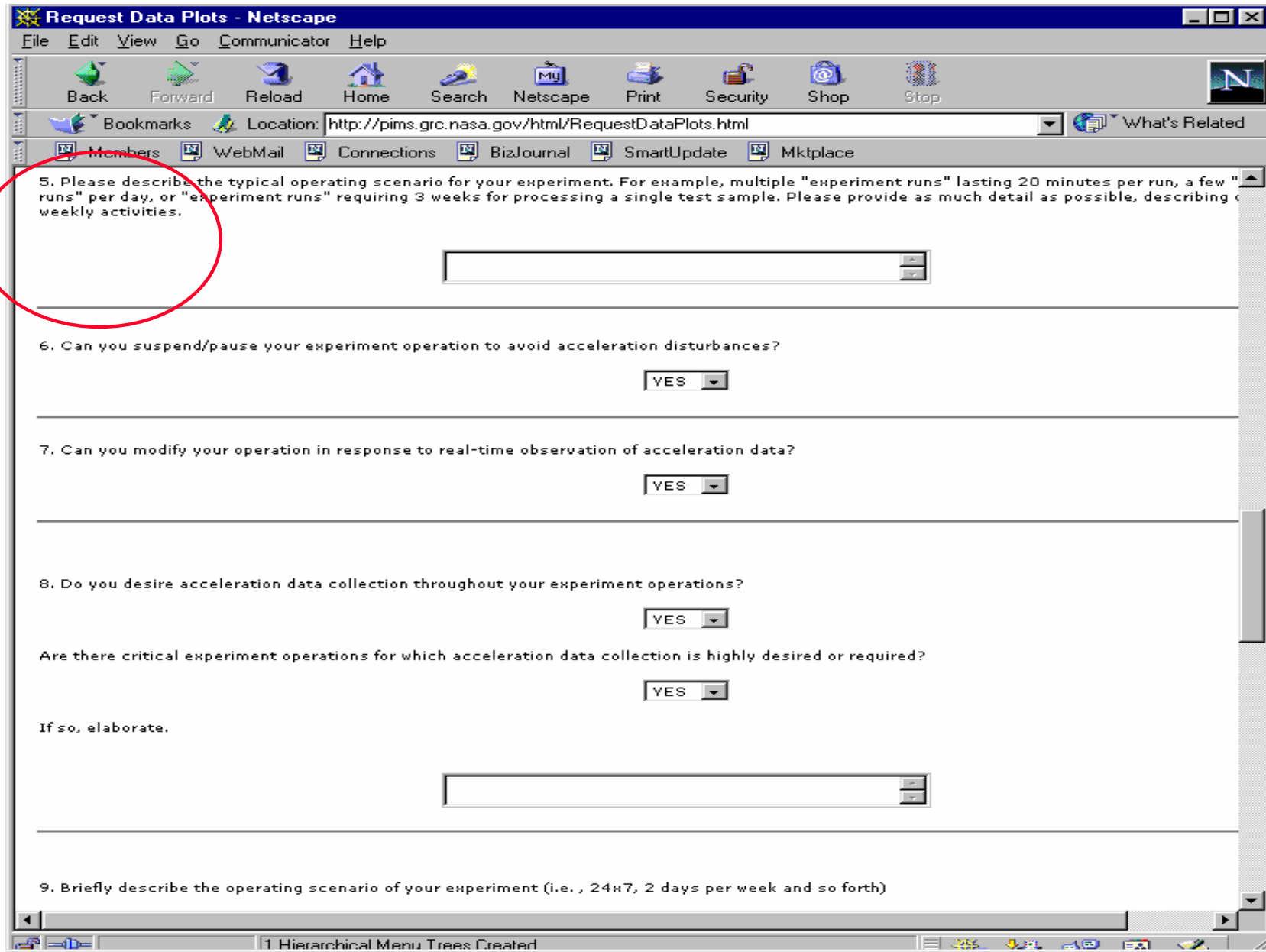
3. Does your experiment or supporting equipment have any directional sensitivity?

If yes, please elaborate.

4. Does your experiment or supporting equipment contain rotating equipment that may disturb the microgravity environment? (e.g., fans, centrifuges, etc.)

If so, please state them.

1 Hierarchical Menu Trees Created



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5. Please describe the typical operating scenario for your experiment. For example, multiple "experiment runs" lasting 20 minutes per run, a few "runs" per day, or "experiment runs" requiring 3 weeks for processing a single test sample. Please provide as much detail as possible, describing your weekly activities.

6. Can you suspend/pause your experiment operation to avoid acceleration disturbances?

7. Can you modify your operation in response to real-time observation of acceleration data?

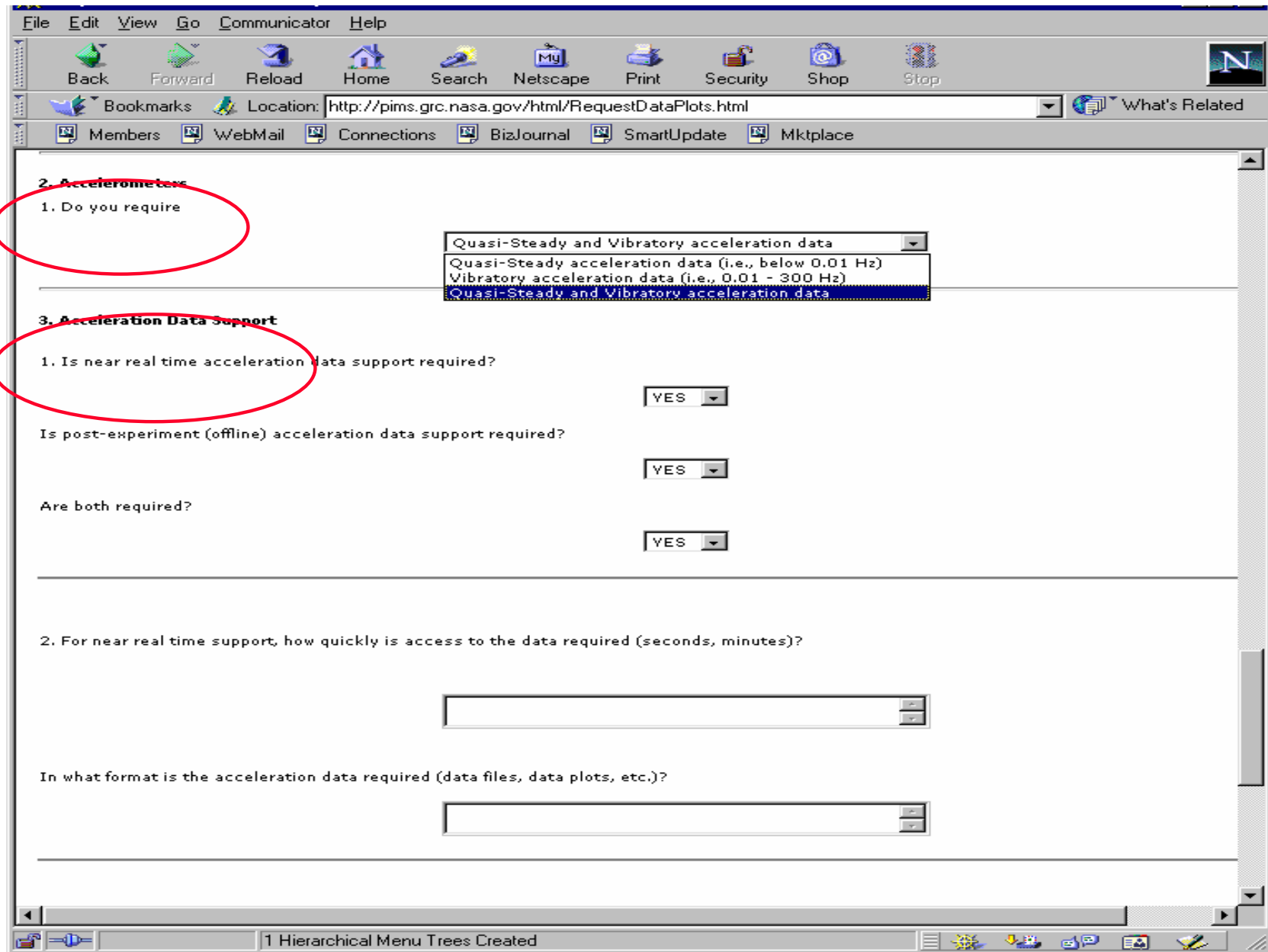
8. Do you desire acceleration data collection throughout your experiment operations?

Are there critical experiment operations for which acceleration data collection is highly desired or required?

If so, elaborate.

9. Briefly describe the operating scenario of your experiment (i.e., 24x7, 2 days per week and so forth)

1 Hierarchical Menu Trees Created



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**2. Accelerometers**

1. Do you require

Quasi-Steady and Vibratory acceleration data  
Quasi-Steady acceleration data (i.e., below 0.01 Hz)  
Vibratory acceleration data (i.e., 0.01 - 300 Hz)  
Quasi-Steady and Vibratory acceleration data

**3. Acceleration Data Support**

1. Is near real time acceleration data support required?

YES

Is post-experiment (offline) acceleration data support required?

YES

Are both required?

YES

2. For near real time support, how quickly is access to the data required (seconds, minutes)?

In what format is the acceleration data required (data files, data plots, etc.)?

1 Hierarchical Menu Trees Created

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Location: <http://pims.grc.nasa.gov/html/RequestDataPlots.html> What's Related

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In what format is the acceleration data required (data files, data plots, etc.)?

---

3. For offline support, how quickly is access to the data required (while still on orbit, post experiment operations, post increment operations)?

---

In what format is the acceleration data required (data files, data plots, etc.)?

---

**4. Data Requests**

Please provide below any additional information regarding your specific data needs, which may have not been captured above (e.g., type, plot format, time span for plots, data format, if actual values are needed and so on).

Submit Reset

*If you encounter any errors after submitting, please email the form to [kenol.jules@grc.nasa.gov](mailto:kenol.jules@grc.nasa.gov)*





## PIMS' Point of Contacts:

**Kenol Jules**

**PIMS Project Scientist**

**216-977-7016**

**[Kenol.jules@grc.nasa.gov](mailto:Kenol.jules@grc.nasa.gov)**

**Kevin McPherson**

**PIMS Project Manager**

**216-433-6182**

**[kevin.mcpherson@grc.nasa.gov](mailto:kevin.mcpherson@grc.nasa.gov)**

**OR:**

**[pimsops@grc.nasa.gov](mailto:pimsops@grc.nasa.gov)**



## Principal Investigator Microgravity Services

### Acceleration Measurement WWW links

- **Microgravity Science Division at NASA Glenn Research Center**
  - <http://microgravity.grc.nasa.gov>
- **NASA Glenn Acceleration Measurement Program**
  - [http://microgravity.grc.nasa.gov/MSD/MSD\\_htmls/acceleration.html](http://microgravity.grc.nasa.gov/MSD/MSD_htmls/acceleration.html)
- **Principal Investigator Microgravity Services Home Page**
  - [http://microgravity.grc.nasa.gov/MSD/MSD\\_htmls/PIMS.html](http://microgravity.grc.nasa.gov/MSD/MSD_htmls/PIMS.html)

### Microgravity Environment References

- **Microgravity Environment Description Handbook TM**
  - Compilation of major microgravity environment disturbances, their sources, and their effects as measured on the Shuttle Orbiters and the Mir Space Station
  - NASA TM-107486 July 1997
  - <http://www.grc.nasa.gov/WWW/MMAP/PIMS/HTMLS/Micro-descpt.html>
- **Acceleration Data Analysis and Presentation Techniques TM**
  - Detailed description of acceleration data analysis techniques
  - <http://www.grc.nasa.gov/WWW/MMAP/PIMS/HTMLS/adapt.html>
- **Mission Summary Reports**
  - Mission specific characterizations for various Shuttle and Mir missions
  - <http://www.grc.nasa.gov/WWW/MMAP/PIMS/HTMLS/reportlist.html>

## Principal Investigator Microgravity Services

### Acceleration Measurement WWW links

- **MAMS and SAMS**
  - <http://pims.grc.nasa.gov>
- **PIs on-line acceleration data request form for MAMS and SAMS**
  - <http://pims.grc.nasa.gov/html/RequestDataPlots.html>
- **Microgravity Environment Interpretation Tutorial (MEIT)**
  - <http://www.grc.nasa.gov/WWW/MMAP/PIMS/MEIT/meitmain.html>

- **Microgravity Meeting Group (MGMG)**
  - [http://www.grc.nasa.gov/WWW/MMAP/PIMS/MGMG/MGMG\\_main.html](http://www.grc.nasa.gov/WWW/MMAP/PIMS/MGMG/MGMG_main.html)
- **ISS Increment Mission Summary Reports**
  - [http://pims.grc.nasa.gov/html/ISS\\_Reports.html](http://pims.grc.nasa.gov/html/ISS_Reports.html)