



NASA Glenn Research Center (GRC) Acceleration Measurement and Analysis Projects

Over a Decade of Support for the International Space Station

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ACRONYM	Definition
ARED	Advanced Resistive Exercise Device
ATV	Automated Transfer Vehicle
BASS	Burning And Suppression of Solids
CASIS	Center for the Advancement of Science in Space
CEVIS	Cycle Ergometer with Vibration Isolation System
CIR	Combustion Integrated Rack
FIR	Fluids Integrated Rack
GRC	Glenn Research Center
HiRAP	High Resolution Accelerometer Package
ISS	International Space Station
JAXA	Japan Aerospace Exploration Agency
MAMS	Microgravity Acceleration Measurement System
MSG	Microgravity Science Glovebox
NASA	National Aeronautics and Space Administration
OARE	Orbital Acceleration Research Experiment
OSS	OARE Sensor Subsystem
PCSA	Principal Component Spectral Analysis
PIMS	Principal Investigator Microgravity Services
PSD	Power Spectral Density
RMS	Root Mean Square
RTS	Remote Triaxial Sensor
SAMS	Space Acceleration Measurement System
SE	Sensor Enclosure
T2	Treadmill 2
TB	Terabytes
TSH-ES	Triaxial Sensor Head Ethernet Standalone

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Outline

1. Capabilities and Services
2. Science Support and Customers
3. Timeline of Acceleration System Deployment
4. Current Sensor Locations
5. Basics of the Microgravity Environment
6. Roadmaps for the Microgravity Environment
7. When Should I Run My Experiment?
8. Brief Characterization of Some Disturbances

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Capabilities and Services

- **NASA GRC** - continued goal of providing timely and readily accessible acceleration data, along with archival and analysis services for scientific payloads, structural dynamics monitoring, and technology developers.
- **SAMS** - the Space Acceleration Measurement System has:
 - the ability to instrument and measure the vibratory regime in all 3 of the ISS labs, including throughout the USL ($0.01 \leq f \leq 300$ Hz).
 - VCB approval for upgrading the control unit, which provides a more robust, long-term solution for continued life-cycle support of the ISS.
- **MAMS** - the Microgravity Acceleration Measurement System:
 - measures the quasi-steady acceleration regime ($f < 0.01$ Hz).
 - data can be mapped to any location (rigid-body assumed).
- **PIMS** - the Principal Investigator Microgravity Services team maintains the acceleration data from the ISS and provides analysis and related services for investigators, sustaining engineering, and the microgravity community at-large.

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Capabilities and Services

24x7
SAMS & MAMS
stream acceleration
data from the ISS
to NASA GRC

8.2TB
Accel.
Archive

process & analyze

Start Date = 5/3/2001
Stop Date = 9/30/2012
Hours > 100,000

NASA GRC Sensor Hours = 354,451
SAMS Sensor Hours = 214,911
MAMS Sensor Hours = 139,540

Web access to: near real-time displays, acceleration archives, and tailored off-line requests
<http://pims.grc.nasa.gov>

pimsops@grc.nasa.gov

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Science Support and Customers

NASA's Physical Sciences Research Program conducts fundamental & applied research with experiments in:

- Fluid Physics**
- Combustion Science**
- Materials Science**
- Fundamental Physics**
- Complex Fluids**

SAMS/MAMS were designed to support these disciplines, and along with **PIMS** for analysis, these **NASA GRC** projects also fill an ongoing role in support of:

- Vehicle Loads and Dynamics Monitoring**
- Technology Developers**

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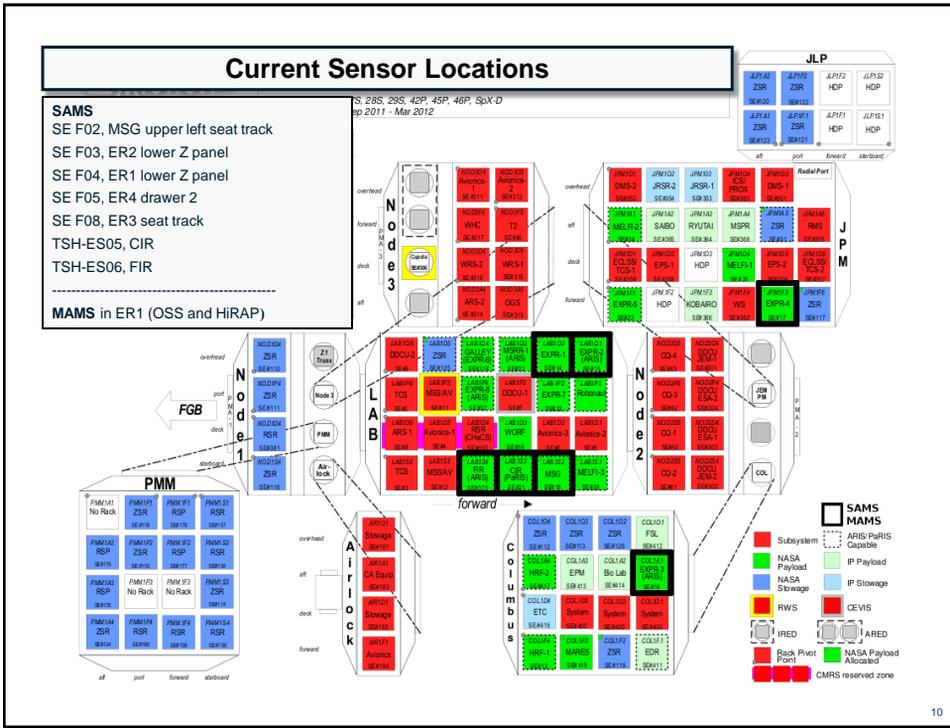
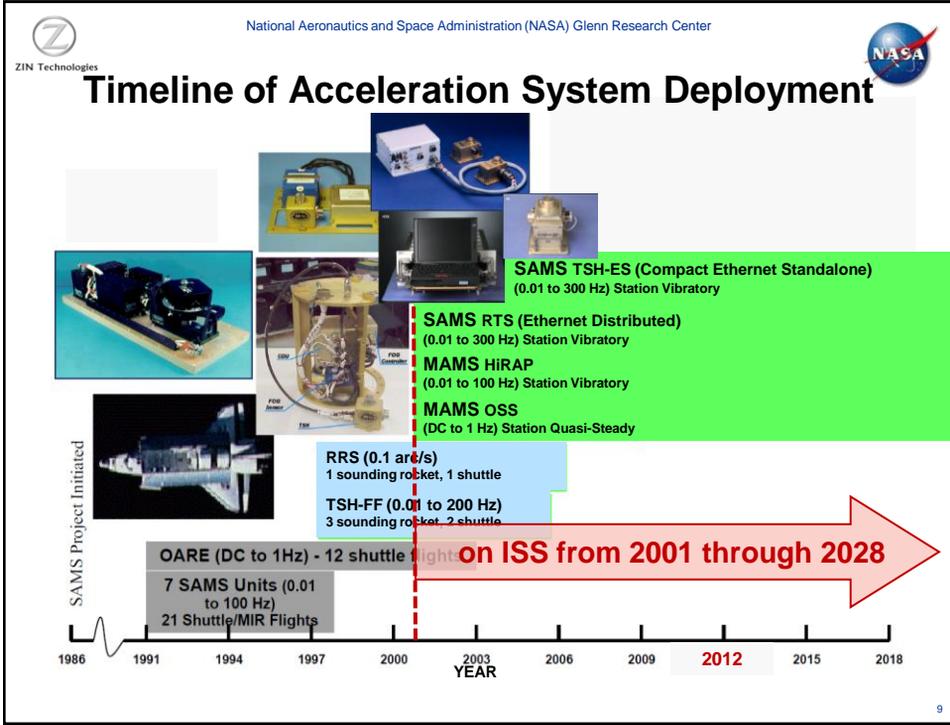
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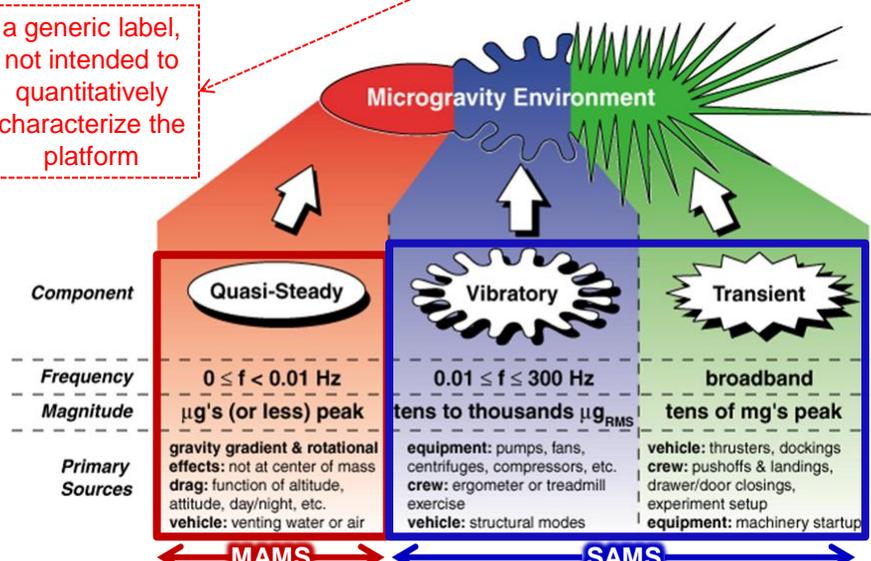


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Basics of the Microgravity Environment

a generic label, not intended to quantitatively characterize the platform

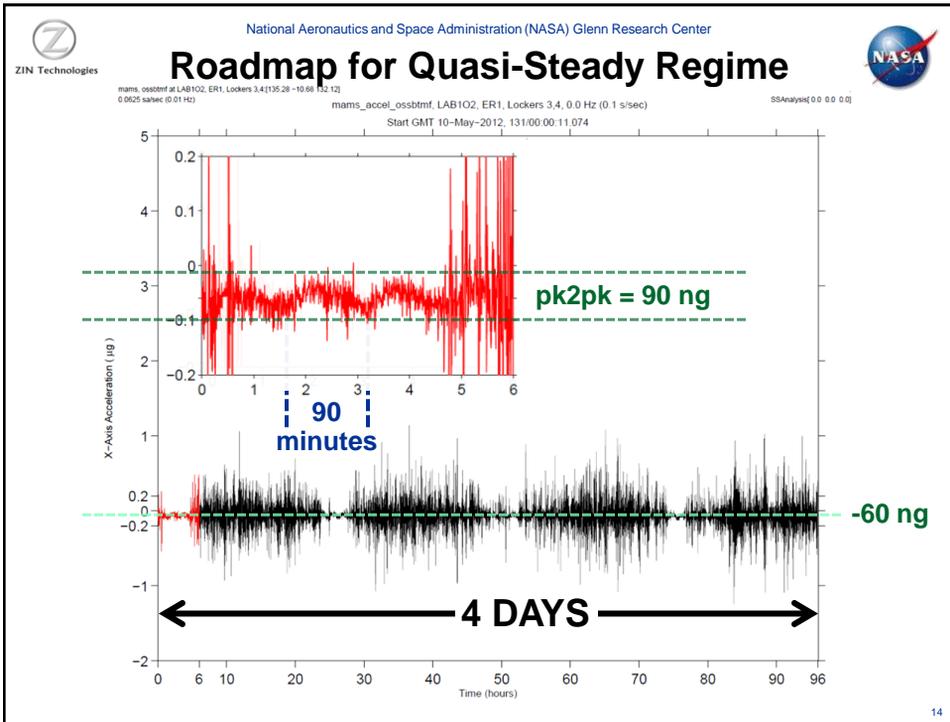
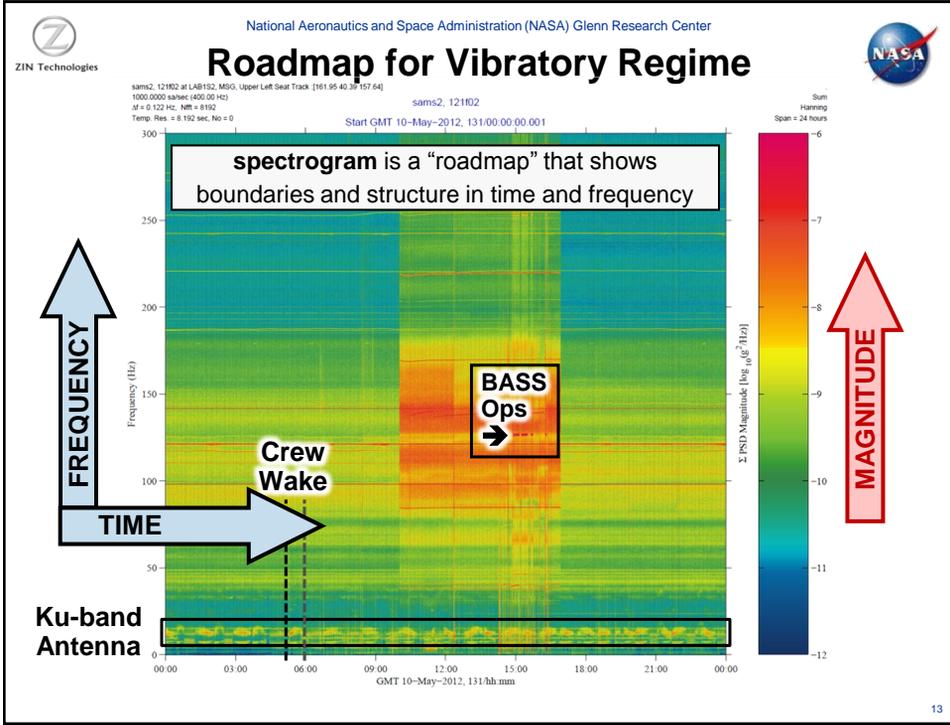


Component	Quasi-Steady	Vibratory	Transient
Frequency	$0 \leq f < 0.01 \text{ Hz}$	$0.01 \leq f \leq 300 \text{ Hz}$	broadband
Magnitude	μg 's (or less) peak	tens to thousands μg_{RMS}	tens of mg's peak
Primary Sources	gravity gradient & rotational effects: not at center of mass drag: function of altitude, altitude, day/night, etc. vehicle: venting water or air	equipment: pumps, fans, centrifuges, compressors, etc. crew: ergometer or treadmill exercise vehicle: structural modes	vehicle: thrusters, dockings crew: pushoffs & landings, drawer/door closings, experiment setup equipment: machinery startup

MAMS

SAMS

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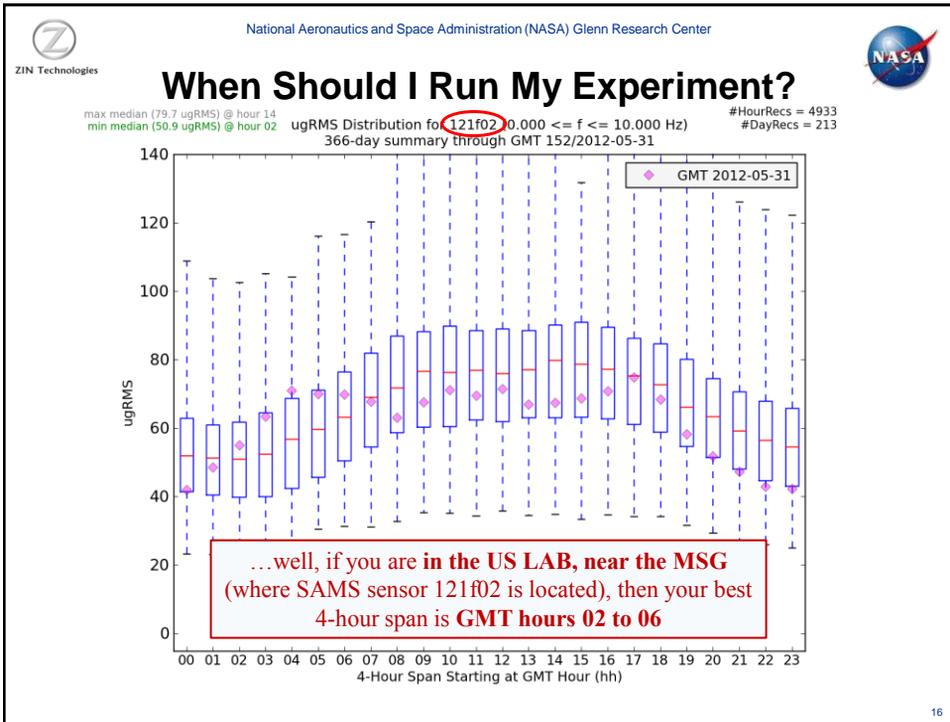
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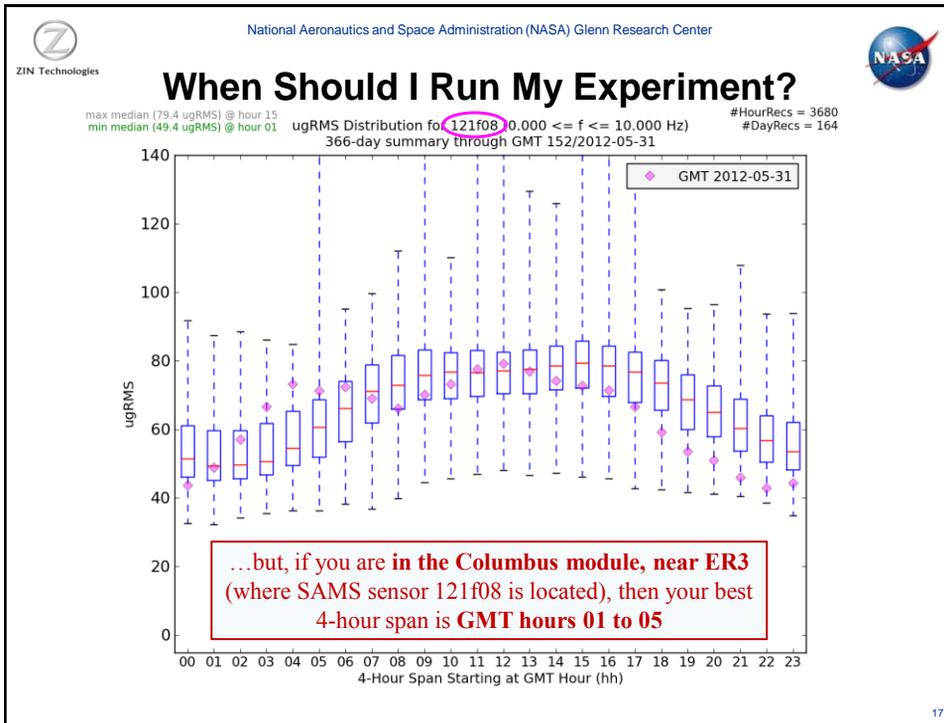


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Brief Characterization of Some Disturbances

Source	Brief Characterization Notes
Progress Reboost*	duration = 11.4 minutes, x-axis step = 0.4 mg * mean values based on 24 reboots
ATV3 Reboost	duration = 7.0 minutes, x-axis step = 0.3 mg
Mode One	~0.1 Hz, fund. mode of main truss monitored daily by loads and dynamics team USL < 2 ugRMS, COL & JEM < 3 ugRMS (Sept. 2012)
GLACIER Ops	two narrowband spectral peaks: (1) 162 ugRMS @ 60 Hz, (2) 112 ugRMS @ 120 Hz
Ku-Band Antenna	5 to 17 Hz, nom. < 500 ugRMS with orbital period variations
MSG Ops	broadband, step up 536 ugRMS for $f < 200$ Hz
Robonaut Ops	narrowband peak: 50 ugRMS @ ~47 Hz
ARIS Attenuation	0.01 to 20 Hz, step down from ~100 to ~10 ugRMS (FIR ops)
Crew Sleep/Wake	difference primarily below about 6 Hz
CCAA	fan: ~57 Hz or ~95 Hz, ~510 ugRMS water separator: ~98 Hz, ~234 ugRMS

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Backup Slides for Details on...

- Mode One
- Ku-band Antenna
- ATV3 Reboost
- ARIS Attenuation during FIR Ops
- Historical Look at Sensor Locations

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