Earth & Space Science on the ISS

A primer for new researchers

The International Space Station

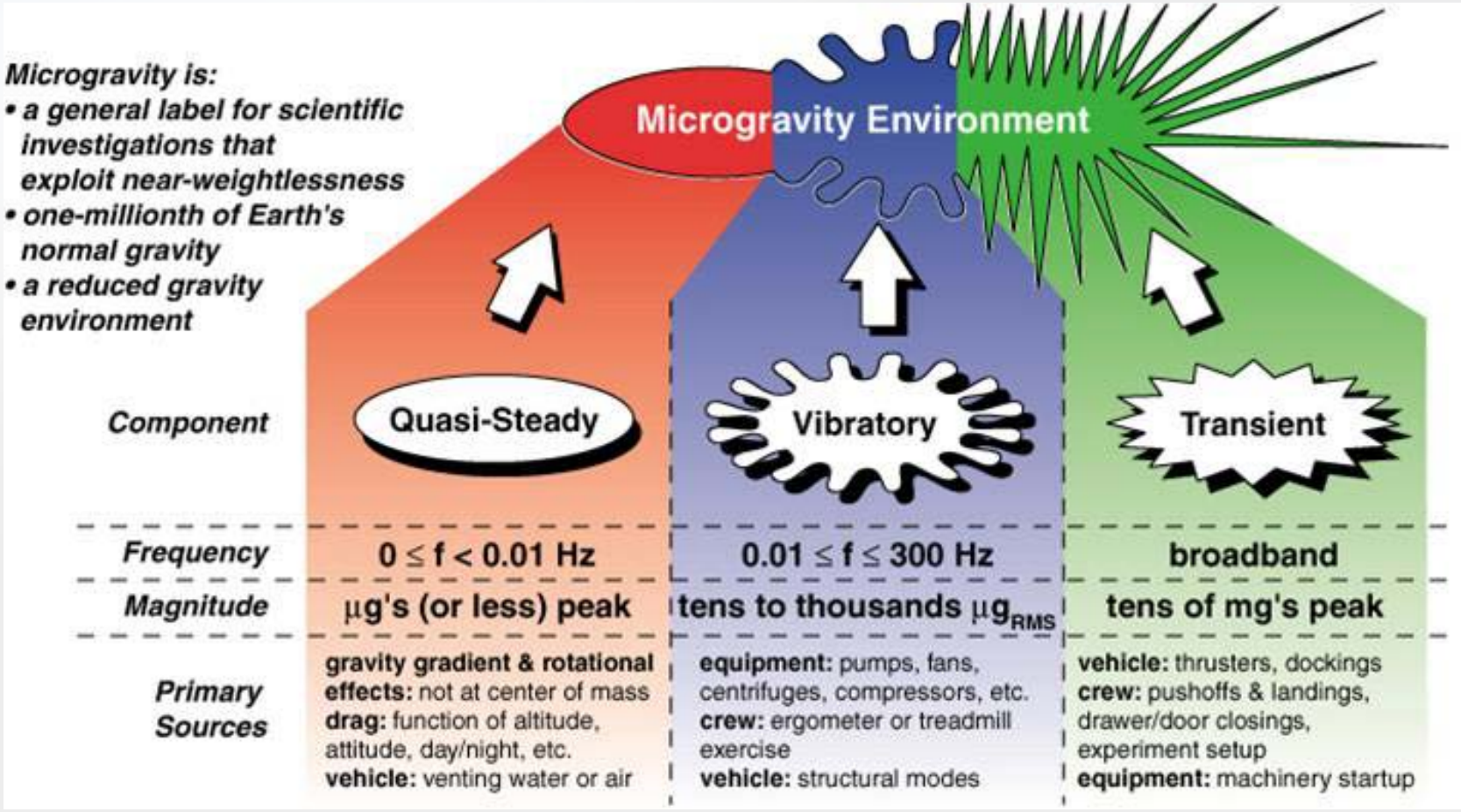
A Unique Platform for Science

- Crew tended
- Suitable for long-term studies

Critical Capabilities

- Microgravity
- Exposure to the thermosphere
- Observations at high altitude and velocity

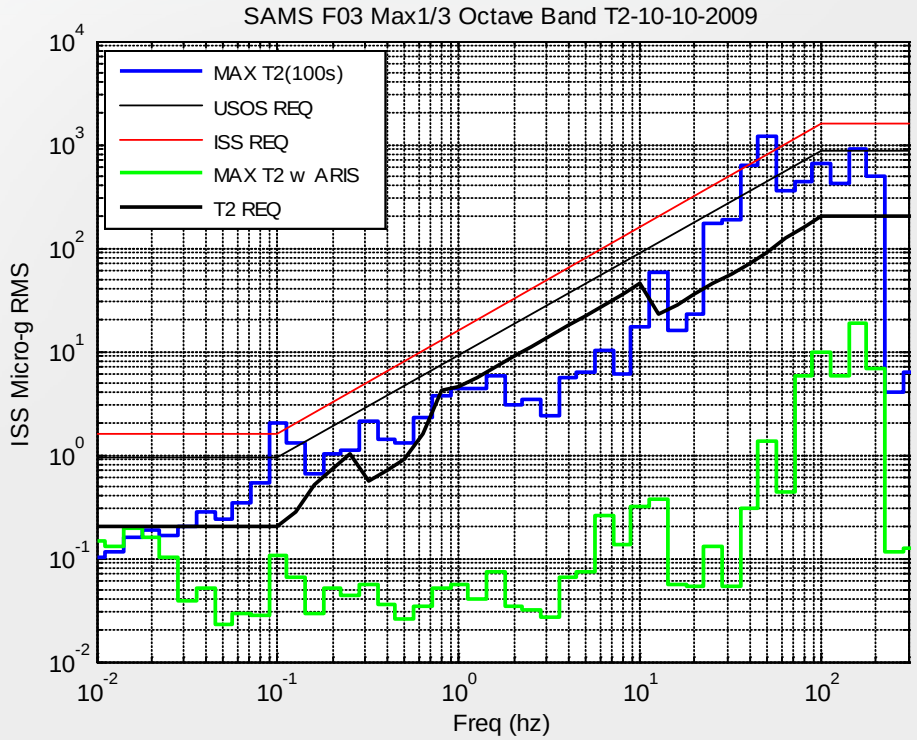
The Microgravity Environment

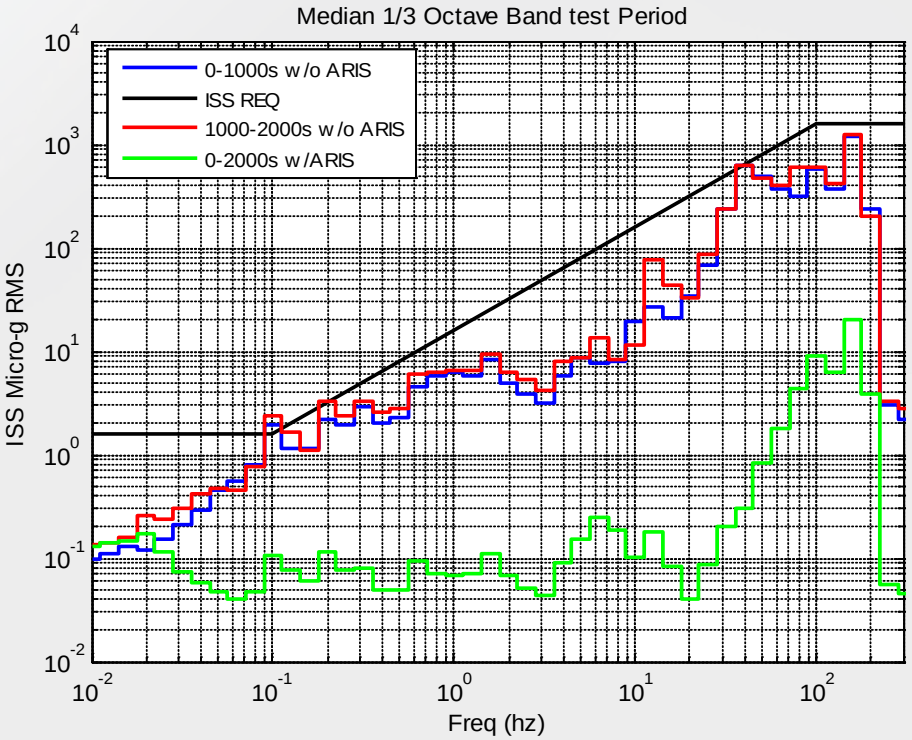


The Microgravity Environment

On-board sensors monitor perturbations to the microgravity state on the ISS.

Even without the Active Rack Isolation System, vibrations are typically within ISS requirements.



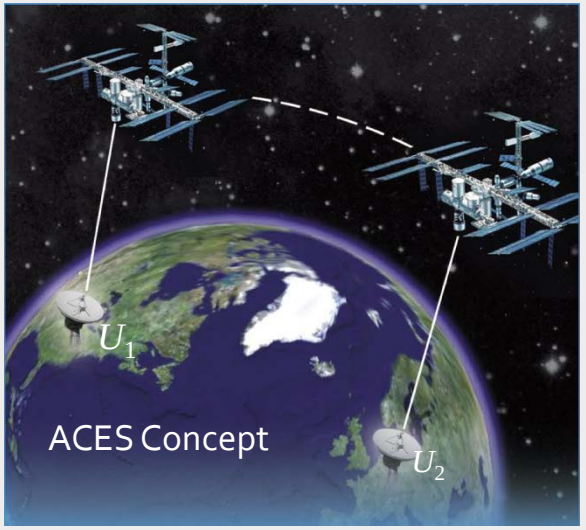


While the Station is at its most "quiet" during the eight hours of crew sleep, the Active Rack Isolation System can be effective even during crew exercise.

Fundamental Physics

Benefits on the ISS:

- Access to significant variations of gravitational potential and acceleration
- Greatly reduced non-gravitational sources of noise
- Access to large distances, velocities, and separations
- Access to vacuum conditions of space
- Conduct laboratory studies of space, matter, and time



Fundamental Physics

Opportunities on the ISS:

- Test the inverse-square law of gravity at varying scales to search for violations
- Test Einstein's equivalence principle at high precision
- Test General Relativity at high precision
- Determine the edm of the electron
- Local position invariance tests of special relativity
- Clock experiments of physical constants
- Search for dark matter properties via discovery of Newton's force law and equivalence principle violations

Earth Science

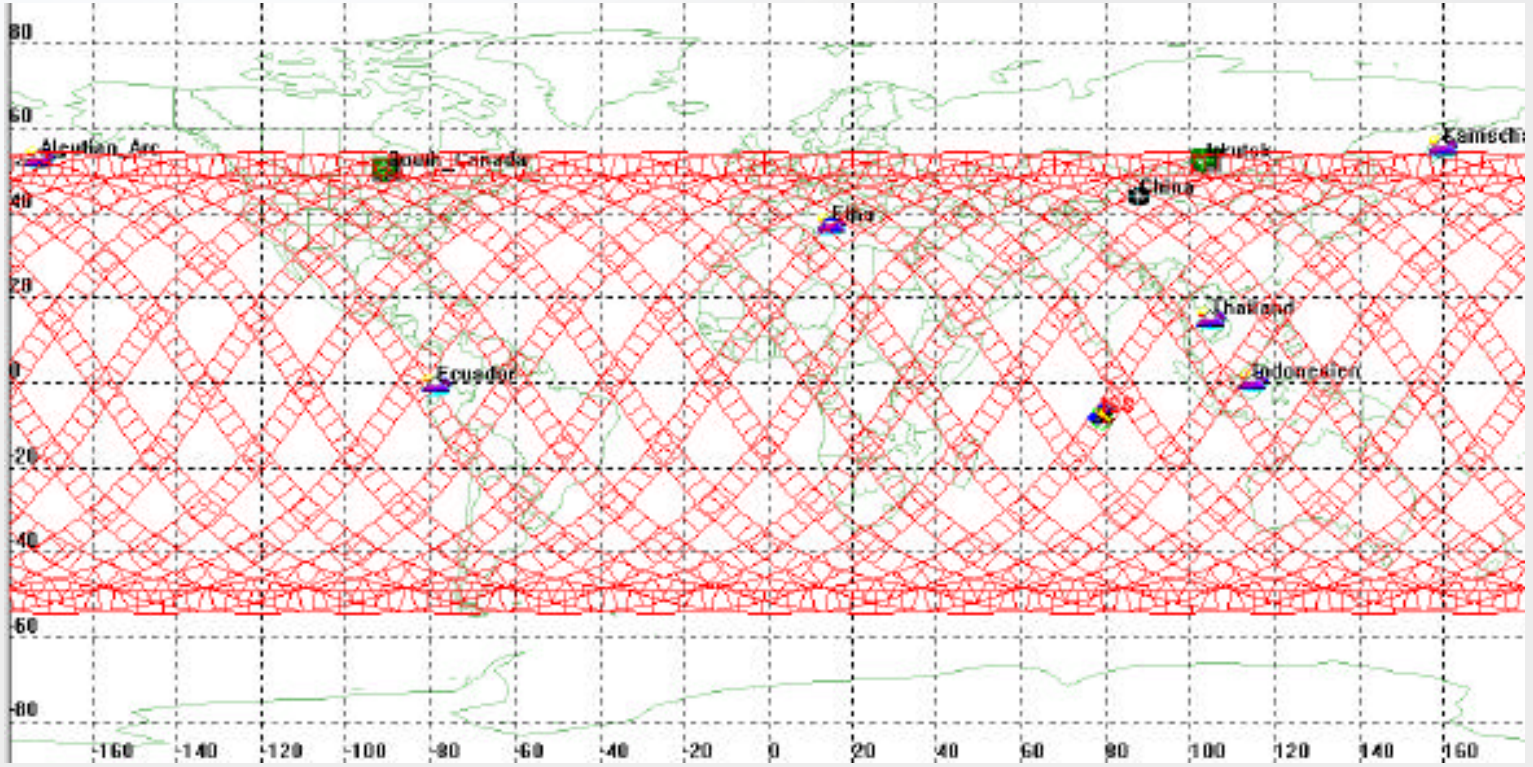
All geographical locations between 51.6° N and S latitude can be observed from ISS in nadir pointing

- 95% of inhabited land area
- 85% of Earth's surface

Using handheld motion compensation, station crewmembers have achieved a spatial resolution of less than 6 meters in photographs of Earth

Change trends and magnitude can be directly observed

Earth Science

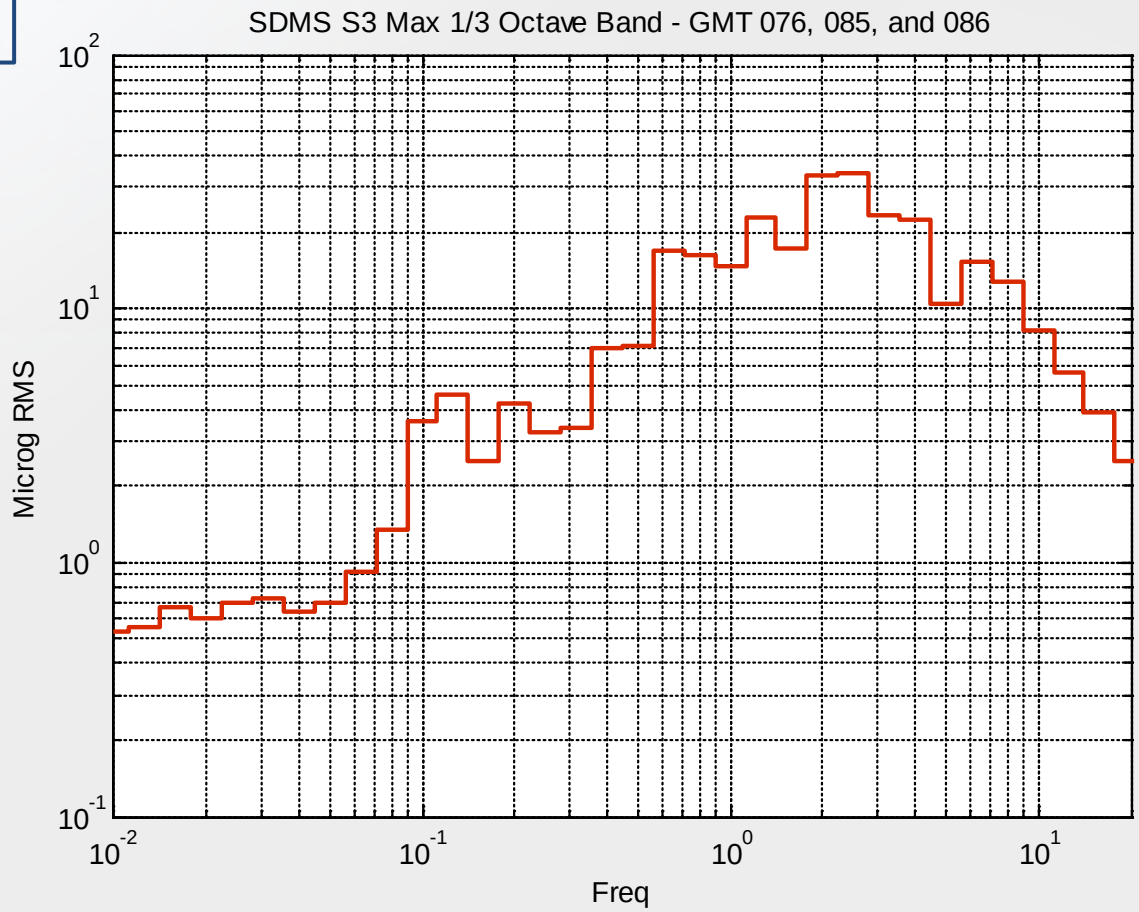


ISS coverage in 24 hrs for a 70°-swath optical payload. (Courtesy of ESA)

ISS Truss Vibratory Environment For External Payload Pointing Instrument

Data measured on ISS S3 truss

- ISS quiescent mode = No thruster firings, dockings, EVA, or robotics operations
- Typical response, not worst case
- Maximum per octave band
- Snapshot of 3 10-minute data takes
- All data taken on March 16, 26, and 27, Stbd SARJ Rotating, exercise, 3 crew.

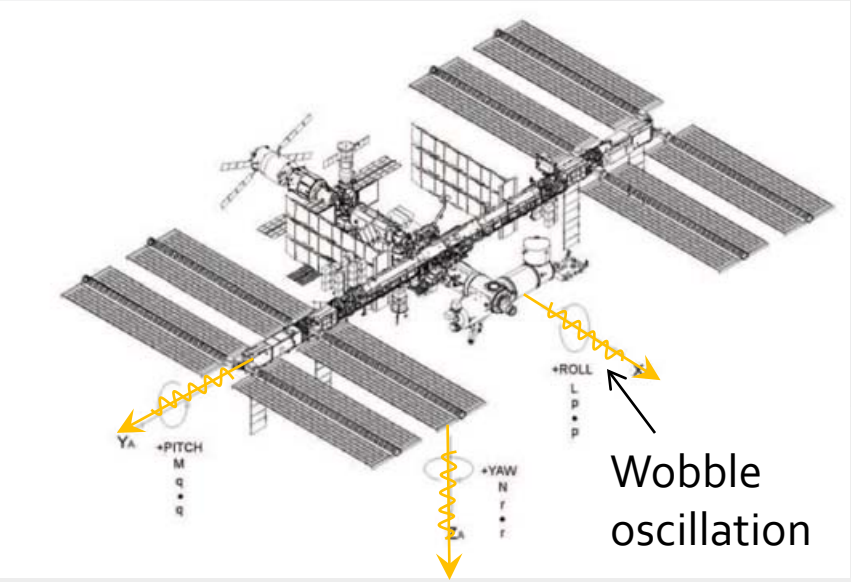


ULF-4 analysis concluded peak ELC rotations on the order of 0.03 degrees (quiescent mode)

Data provided by Boeing, June 2010

ISS Attitude Torque Equilibrium Attitude (TEA) & Wobble Oscillation Description

For Stage configurations (i.e.; no Orbiter or Orbiter sized vehicle docked on the ISS) in the foreseeable future, the predicted TEA ranges are:
Roll: -1.0 ~ +3.0 deg
Pitch: -7.0 ~ +2.0 deg
Yaw: -15 ~ +15 deg.



Momentum Manager Controller Peak to Peak Attitude Wobble Oscillation

Performance Descriptions	Peak to Peak Attitude Oscillations Per Orbit			Peak Attitude Variation from Steady-State Orbit-Average Attitude		
	Roll (X) (deg)	Pitch (Y) (deg)	Yaw (Z) (deg)	Roll (X) (deg)	Pitch (Y) (deg)	Yaw (Z) (deg)
Non-Micro-Gravity (Assembly Stages) Non-Propulsive (Momentum Manager) Attitude Control Performance Requirement	10.0	10.0	10.0	+/- 5	+/- 5	+/- 5
Micro-Gravity (Assembly Complete) Non-Propulsive (Momentum Manager) Attitude Control Performance Requirement	7.0	7.0	7.0	+/- 3.5	+/- 3.5	+/- 3.5
Typical Steady-State Performance of **Minimum** *CMG momentum oscillation* Momentum Manager Controller	1.6	1.6	2.0	+/- 0.8	+/- 0.8	+/- 1
Typical Steady-State Performance of **Minimum** *Attitude oscillation* Momentum Manager Controller	1.6	0.4	0.2	+/- 0.8	+/- 0.2	+/- 0.1
Typical Steady-State Performance of **Minimum** *CMG momentum & Attitude oscillation* **Blended** Momentum Manager Controller	1.6	0.7	1.2	+/- 0.8	+/- 0.35	+/- 0.6

Earth Science

Opportunities on the ISS:

- Hyperspectral imaging of land and sea
- Observation of transient atmospheric and geologic phenomena
- Land use studies (example: agriculture, urban growth)
- Planetary science sensor testbeds
- Automated or crew-tended studies with the Window Observational Research Facility in the Destiny module