



NASA Space Activities
presented to the
Wells Branch Community Library
Science Night

John W. Alred

NASA JSC Materials and Processes Branch

John.W.Alred@nasa.gov

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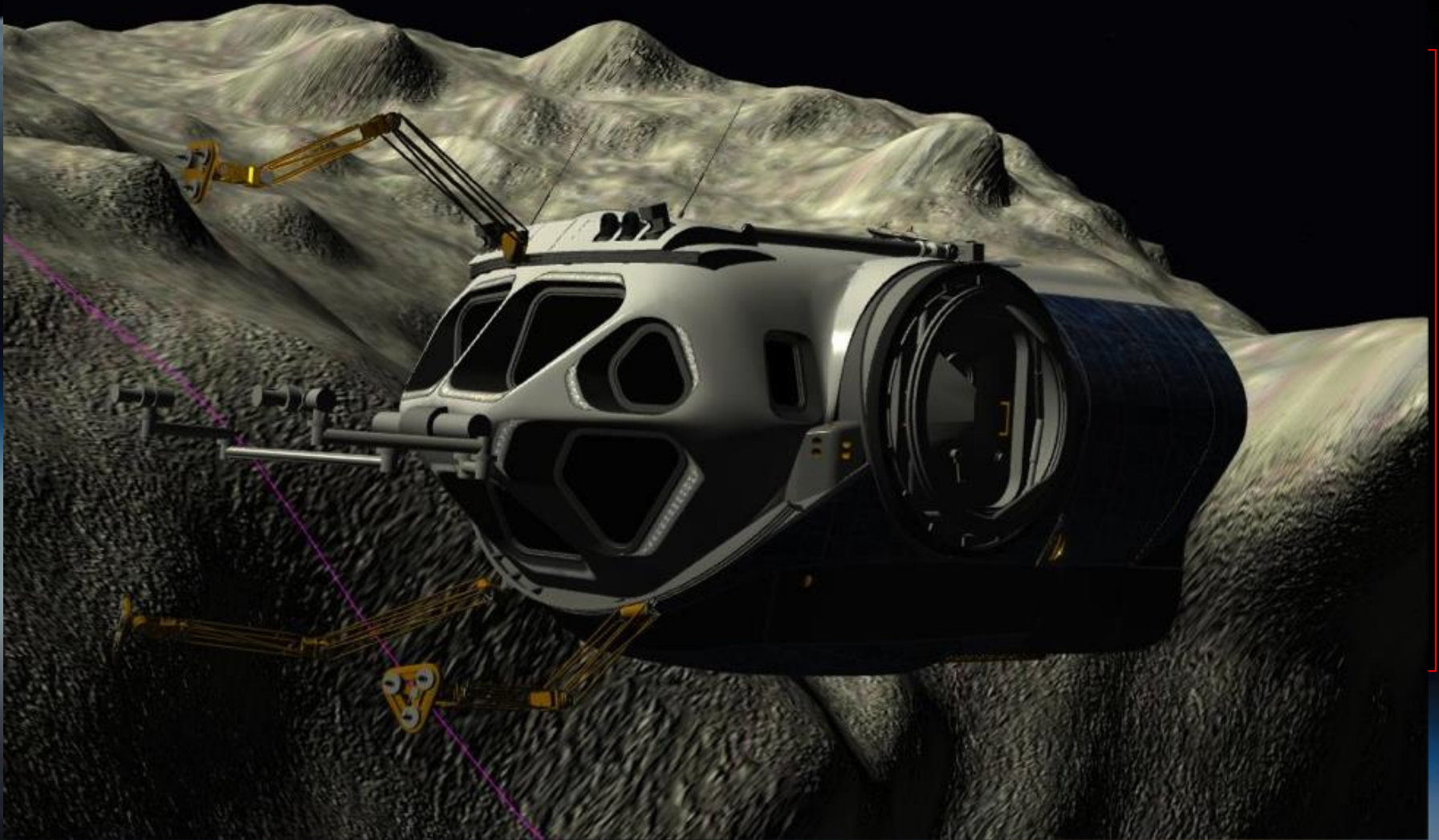


What's Hot?





Asteroid Roping?

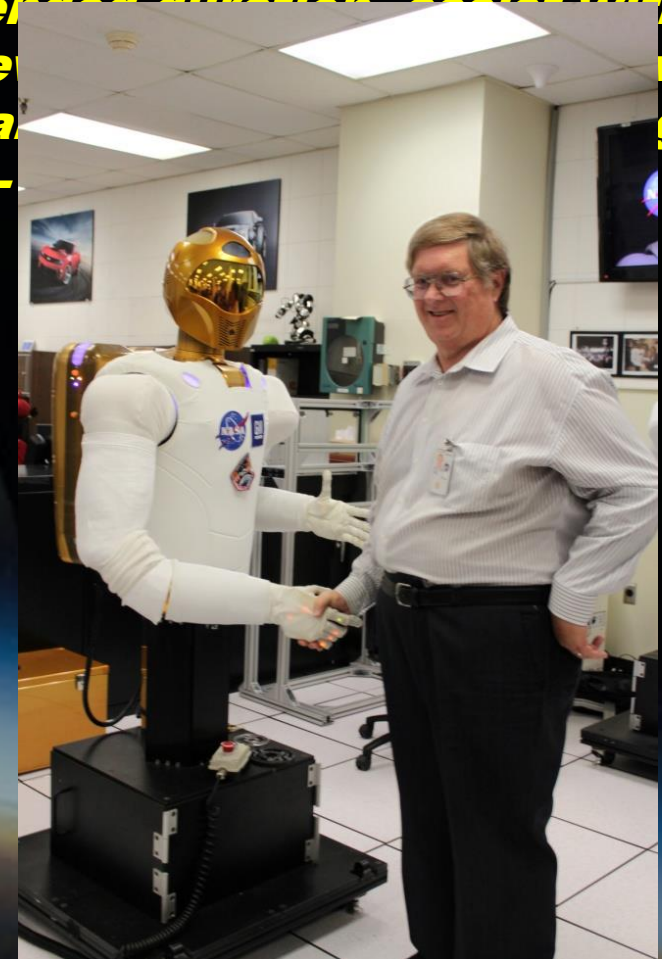




What's Hot 2?

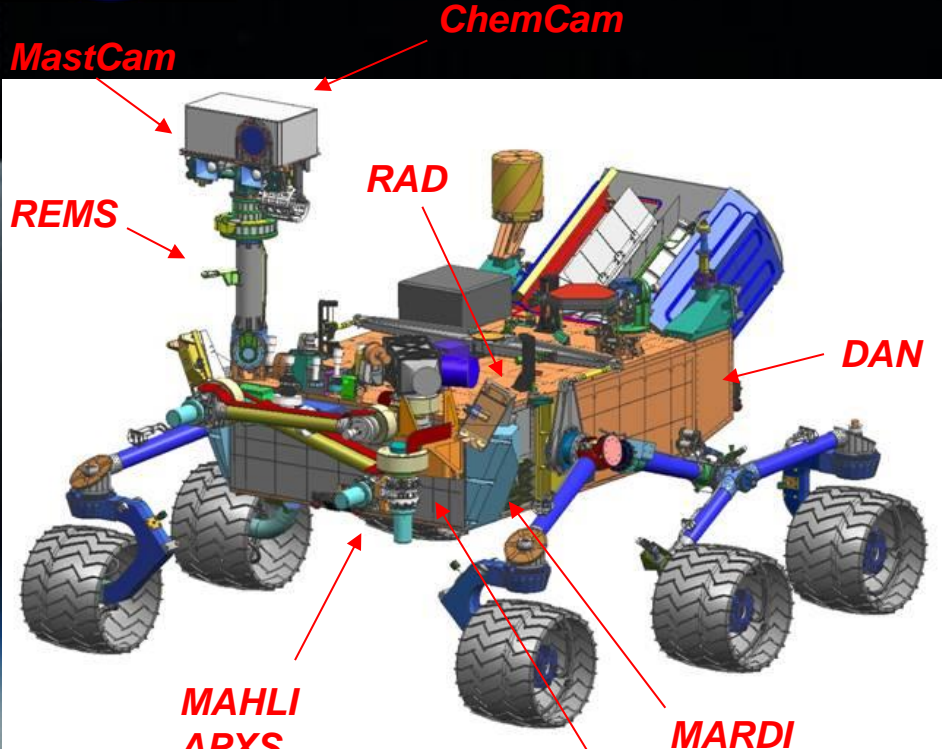


***Robonaut - spring board to evolve new robotic capabilities; operate for extended duration; assist with tasks, e...
“Legs” a...
in 2014-***





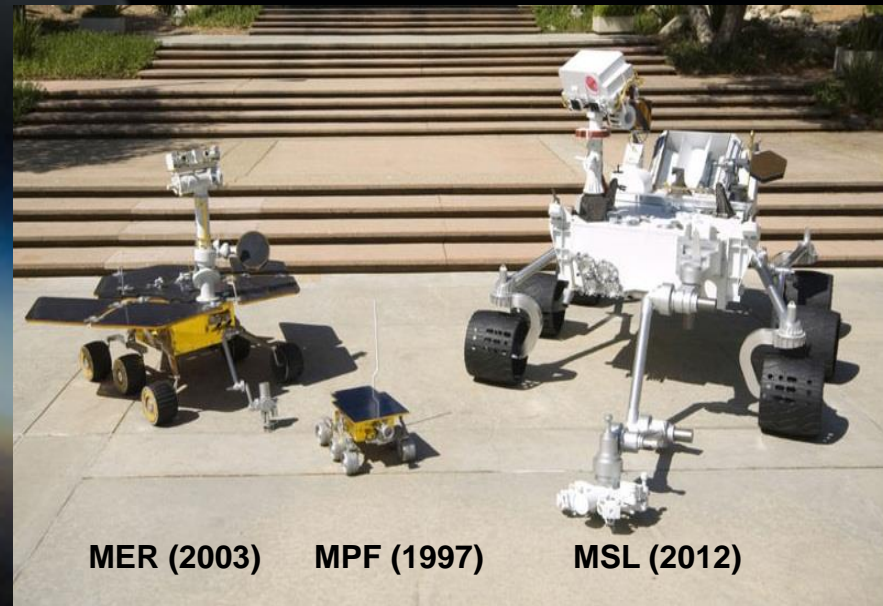
What's Hot 3?



**Brush / Abrader
Drill / Sieves
Scoop**

**SAM
CheMin**

**>130 co-investigators
in seven countries**



MER (2003)

MPF (1997)

MSL (2012)



The '7 Minutes of Terror'*



Guided Entry



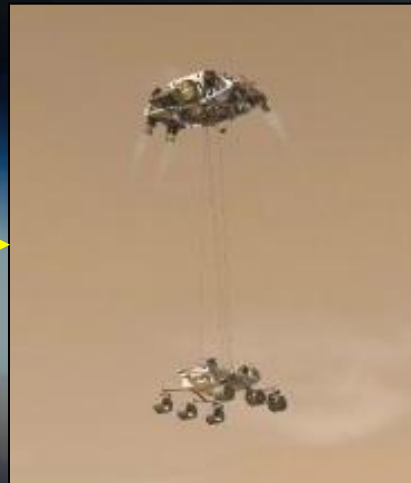
Parachute



Heatshield Jettison



Powered
Descent



Skycrane



Rover
Touchdown

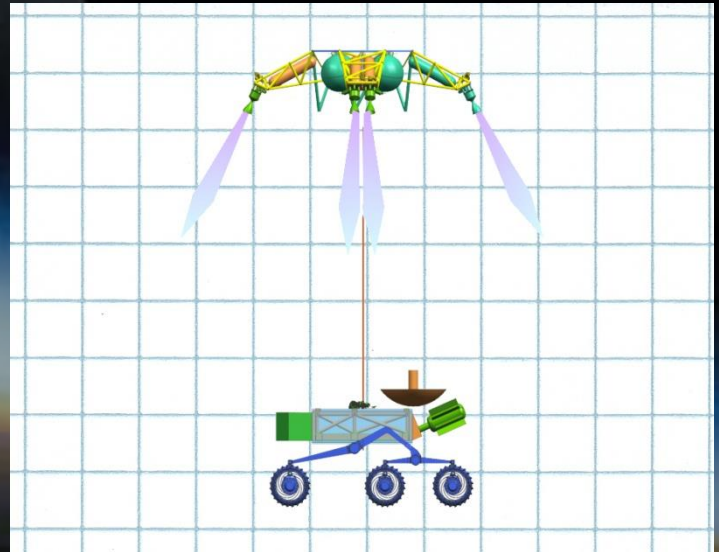
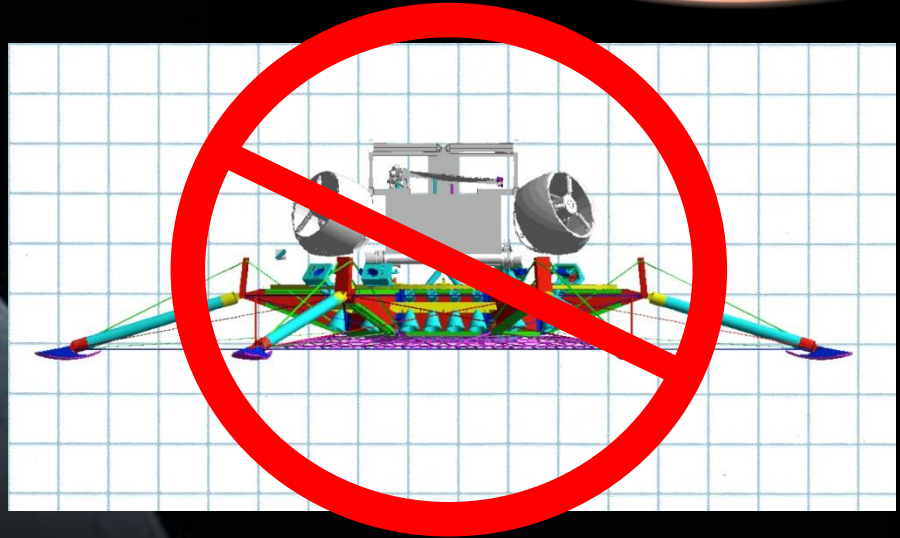
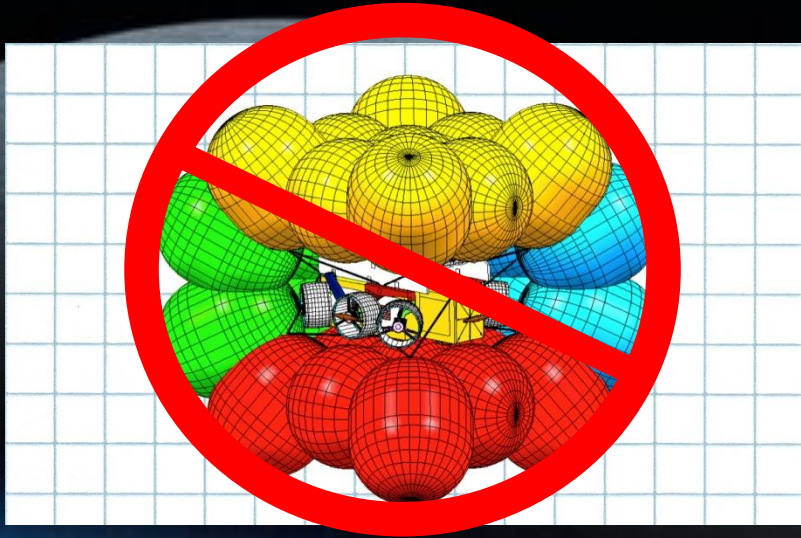


Descent
Flyaway

*If you have not seen the video, watch it!

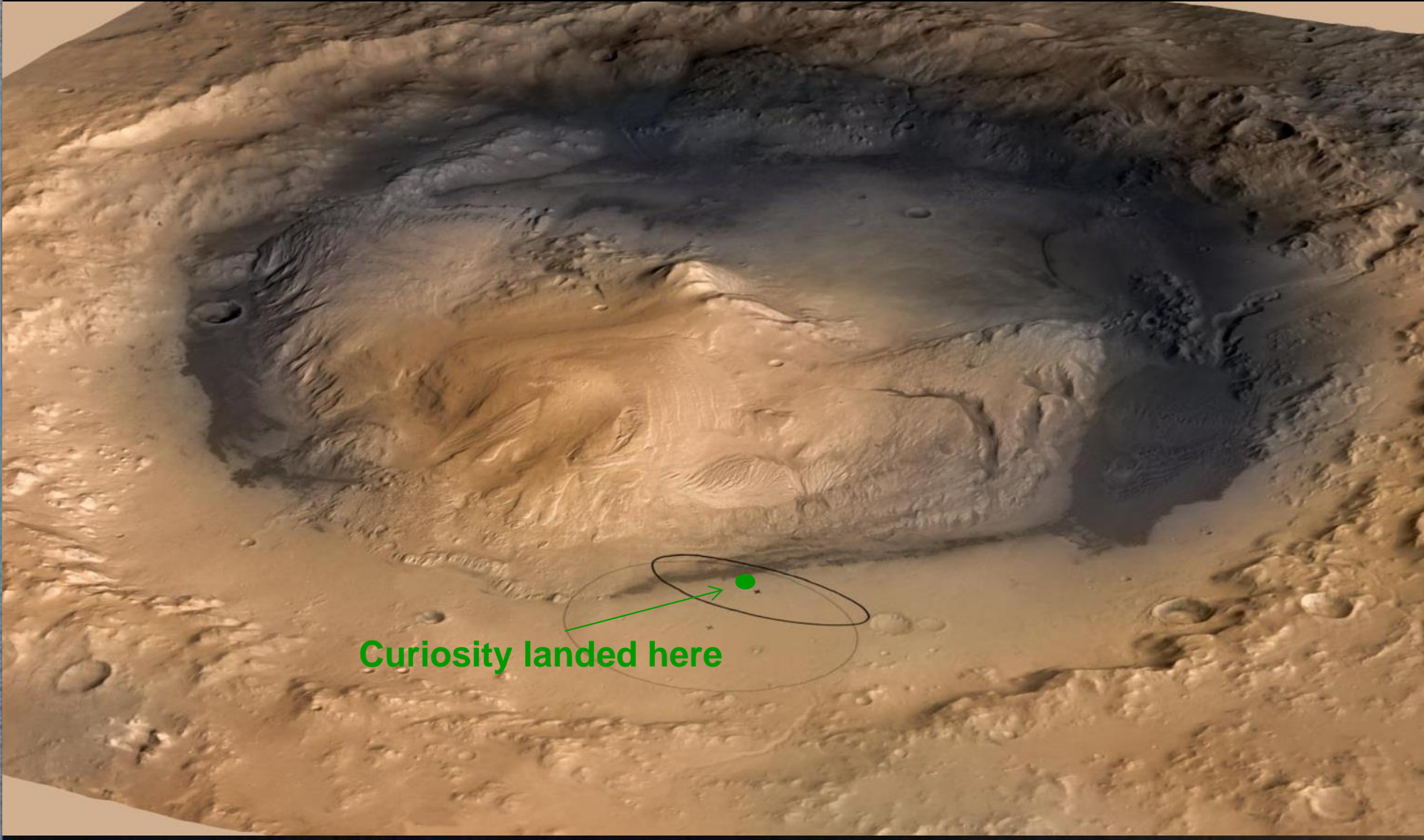


Why?



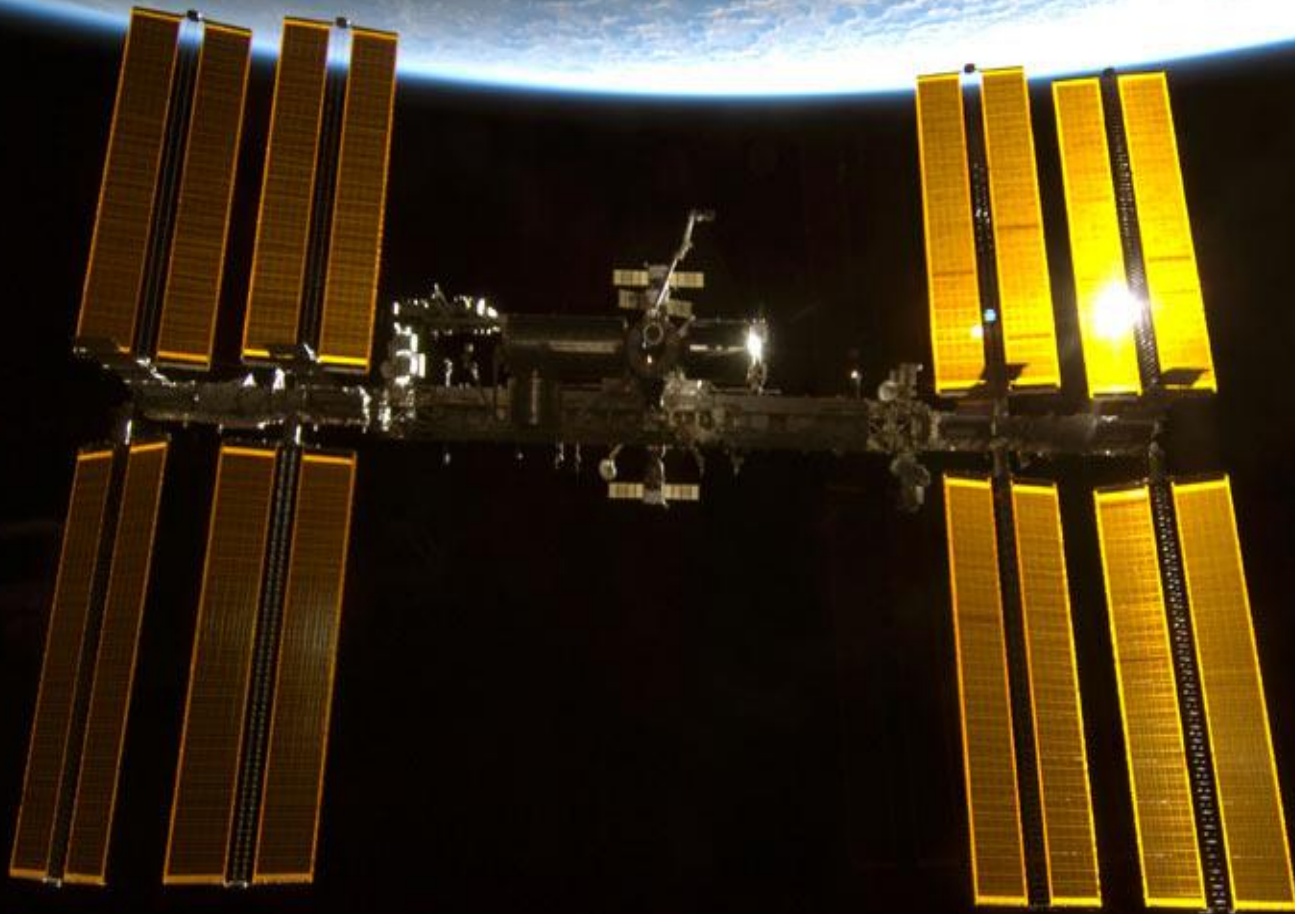


How Did We Do?



Curiosity landed here

International Space Station



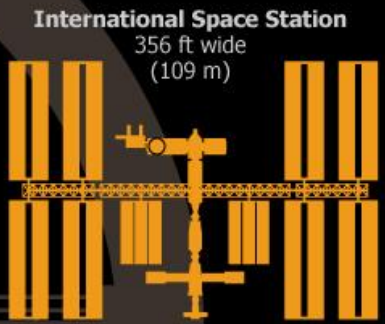


How Big is the International Space Station?

ISS is the largest man-made object in space. Here's how it compares to other notable objects both real and fictional, all drawn to scale.

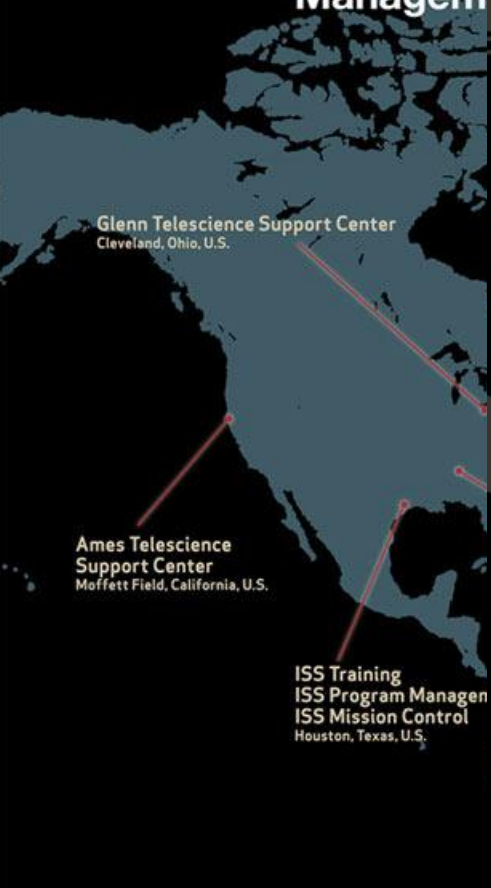


Boeing 747
232 ft long
(71 m)



International Space Station
356 ft wide
(109 m)

ISS Operations Management



Glenn Telescope Support Center
Cleveland, Ohio, U.S.

Ames Telescope Support Center
Moffett Field, California, U.S.

ISS Training
ISS Program Management
ISS Mission Control
Houston, Texas, U.S.

Space Station V
(2001: A Space Odyssey)
1000 ft wide
(305 m)



Statue of Liberty
305 ft tall
(93 m)



Saturn V Rocket with Launcher
400 ft tall
(122 m)



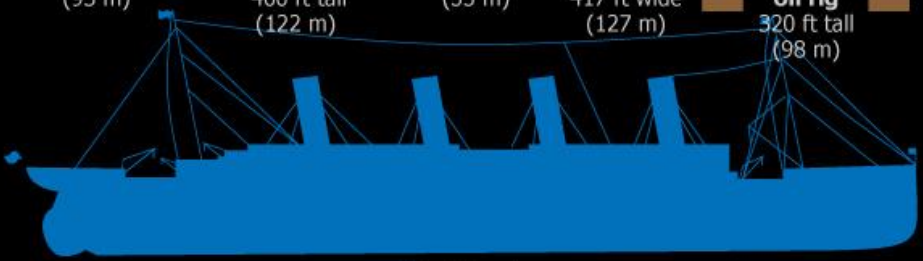
Space Shuttle Enterprise
181 ft tall
(55 m)
417 ft wide
(127 m)



Football Field
360 ft long
(110 m)



Deepwater Horizon oil rig
320 ft tall
(98 m)



RMS Titanic
882 ft long
(269 m)



Cosmonaut Center (GCTC)
Russia

Quarters

JAXA Headquarters
Tokyo, Japan

JEM/HTV Control Center and Crew Training
Tsukuba, Japan

Russian Launch Control
Baikonur Cosmodrome,
Baikonur, Kazakhstan

H-II Launch Control
Tanegashima, Japan



Graphic by Karl Tate



What do We Do for NASA?

① **Materials
and
Processes
(M&P)**



② **Space
Environments
and its Effects**



Basic Function of M&P



Materials Selection, Requirements and Certification

- ***Verification of Safe Use of Materials***
- **Materials Selection for Design**
- **Flammability**
- **Fracture Control**
- **Offgassing (Toxicity/Odor)**
- **Fluid Compatibility (Oxygen, Propellants)**
- **Corrosion/Stress Corrosion Resistance**
- **Outgassing (Thermal Vacuum Stability/Contamination)**
- **Material Analysis/Failure Analysis**
- **Materials Process Control/Review (Manufacturing Processes)**
- **Particulate Contamination Control during Ground Build/Processing (FOD)**
- **Fracture Control and Pressure Vessel Certification**



Flammability and Toxicity



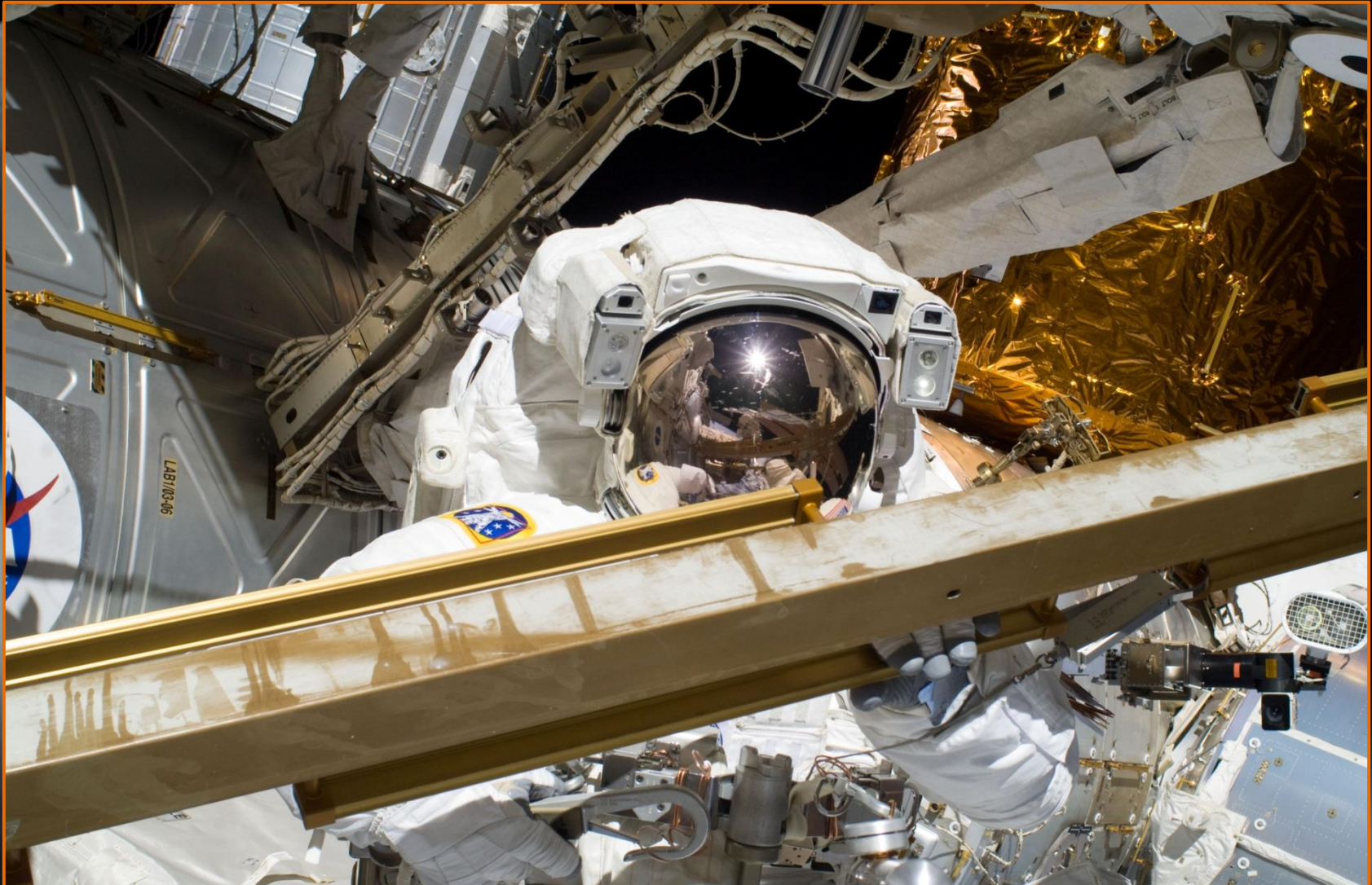
- 24.1% oxygen at 14.7 psia established by life support system throughout ISS.
- 30% oxygen at 10.2 psia conditions in the US Airlock.
- 34% oxygen baseline for the future.
- Enhanced oxygen testing for all new materials.
- Combustion products or offgassing testing for toxins at WSTF.





M&P Issue

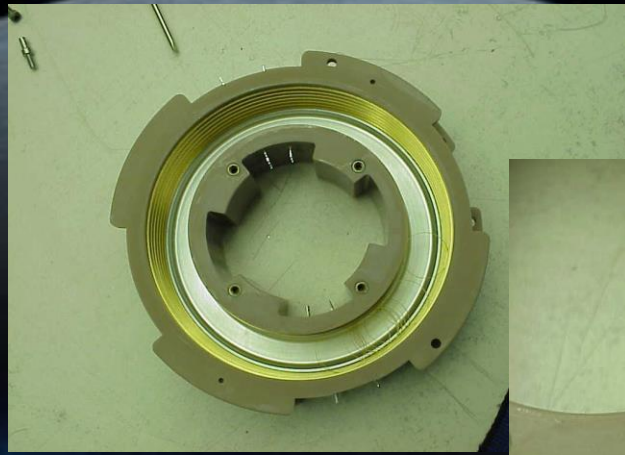
Ground Contamination



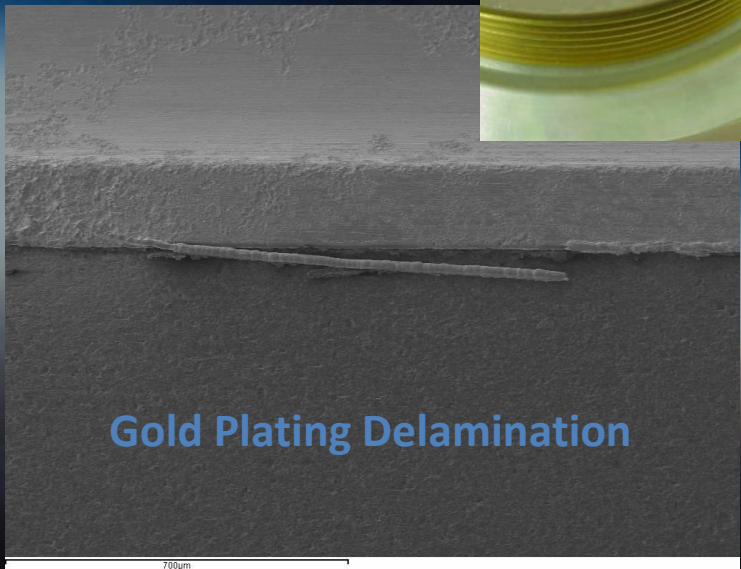
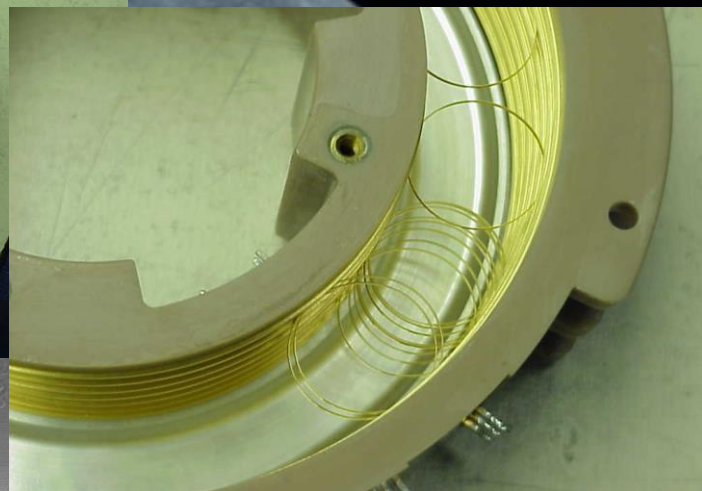


M&P Issue

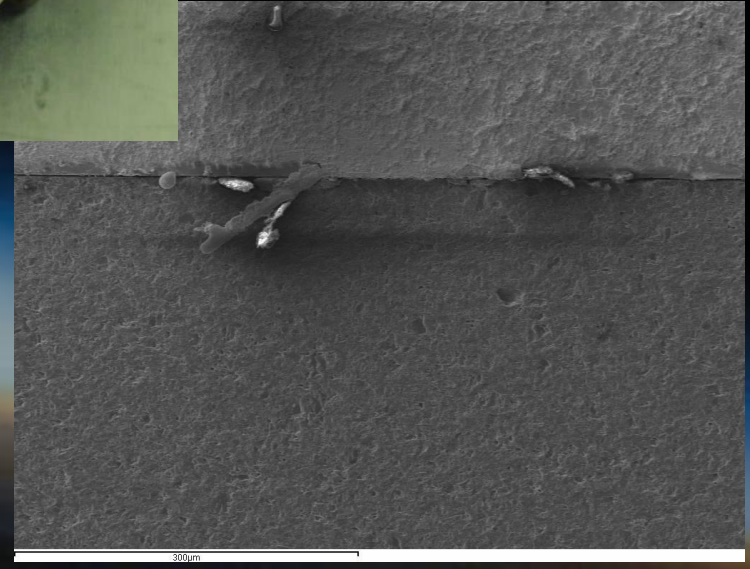
Flawed Process



Gold Plated Roll Rings



Gold Plating Delamination





M&P Issue

Process Refinement

Pre-flight Image Photofoil Label



On-orbit Image Photofoil Label



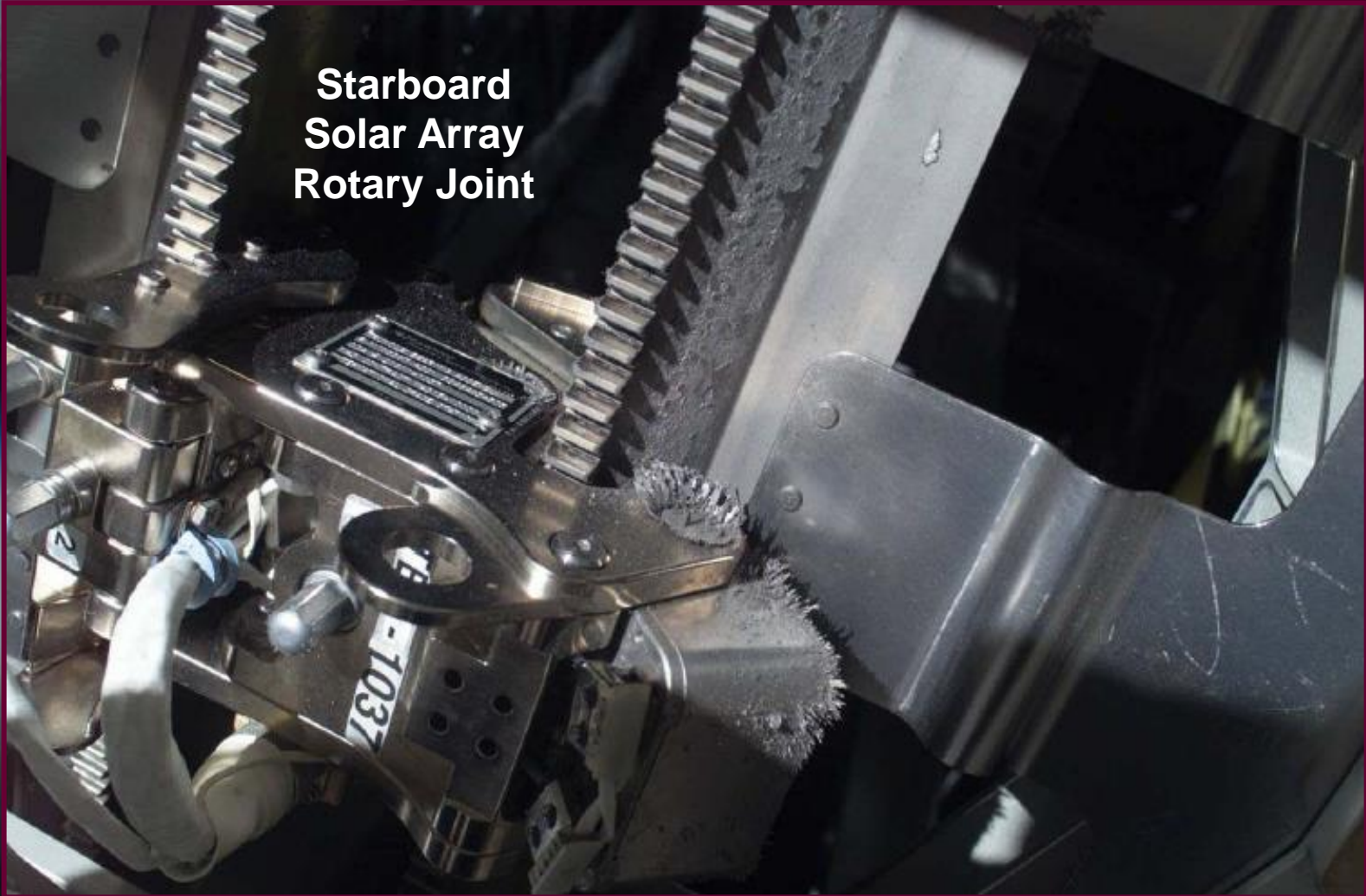


M&P Issue

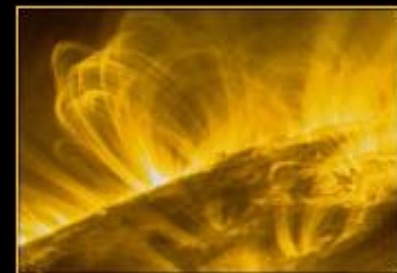
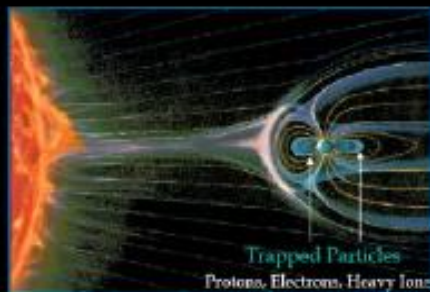
Lubrication Issue



Starboard
Solar Array
Rotary Joint



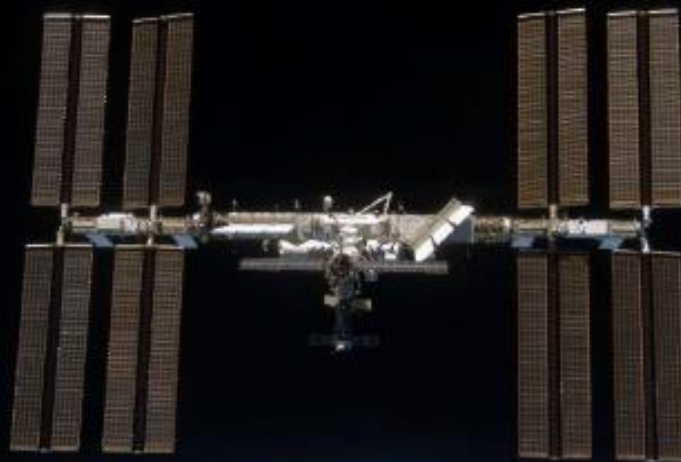
The Space Environment



Materials on the outside of spacecraft are exposed to many environmental threats that can be very harmful to the spacecraft & its operation

These threats include:

- Sun's radiation (ultraviolet (UV), x-rays)
- "Solar wind" particle radiation (electrons, protons)
- Thermal cycling (hot & cold cycles)
- Micrometeoroids & debris impacts (space particles)
- Atomic oxygen (single oxygen atom)





Space Environmental Effects :

Contamination





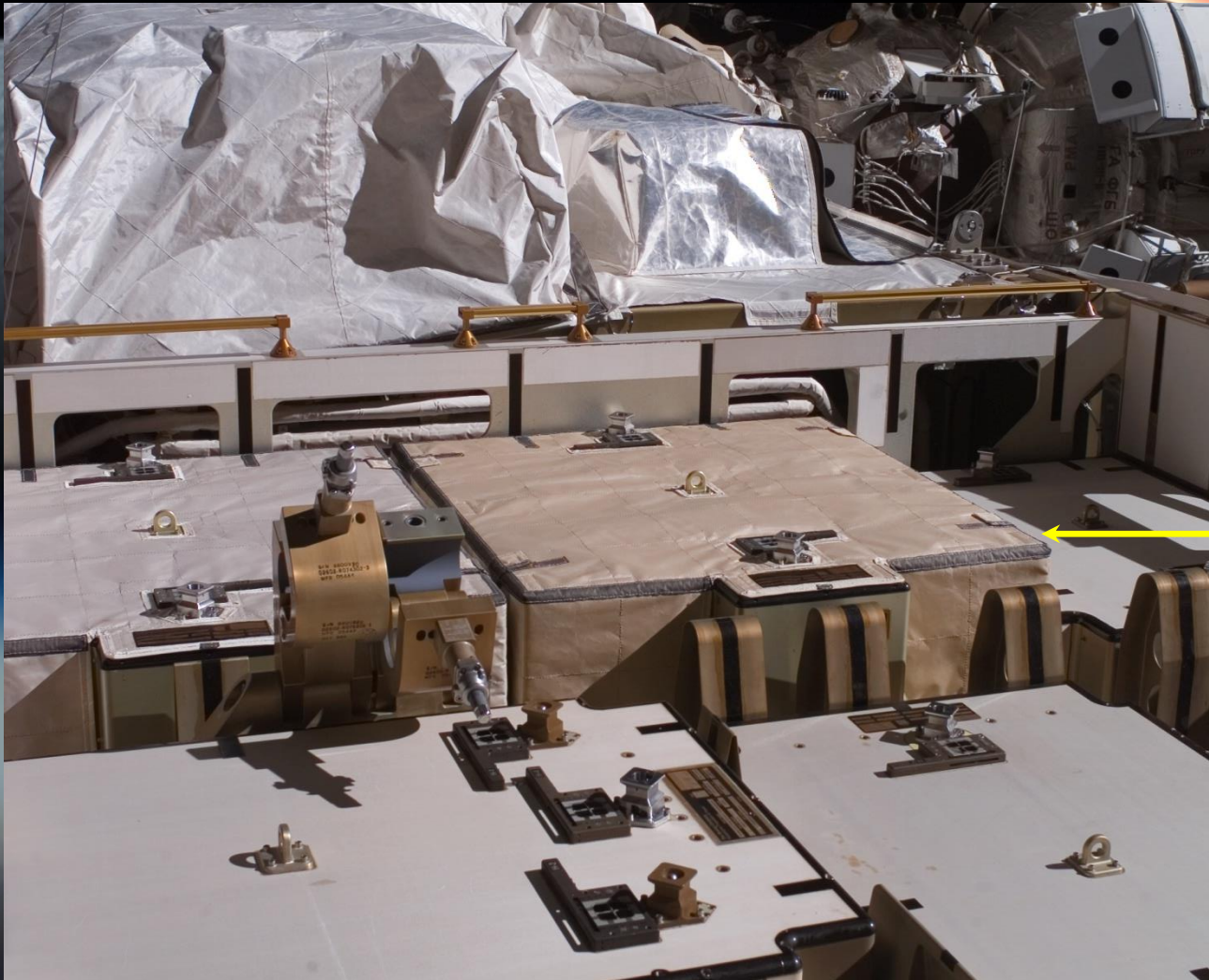
Space Environmental Effects :

Inadequate Venting





Space Environmental Effects : Inadvertent Materials Substitution

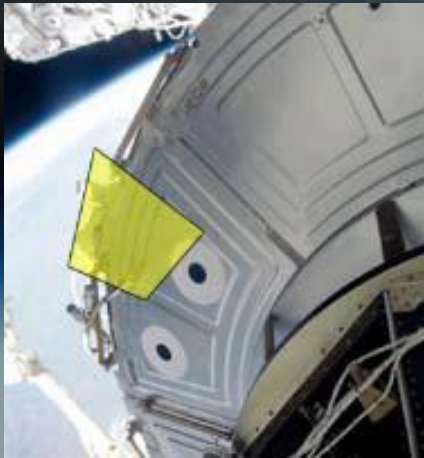
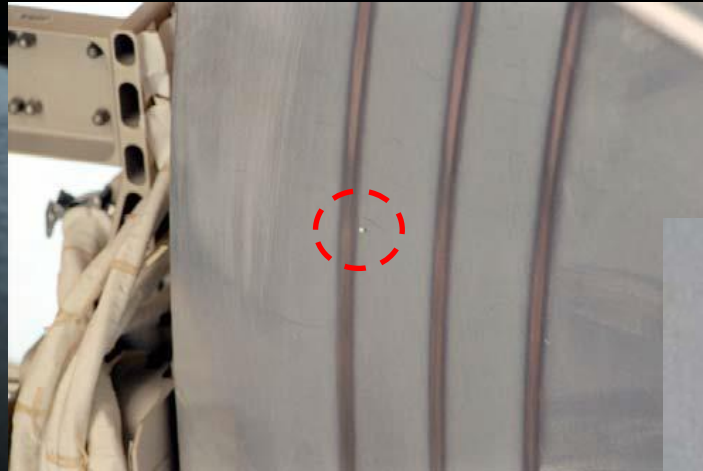


Battery Box used the 'wrong' grade of beta cloth



Space Environmental Effects :

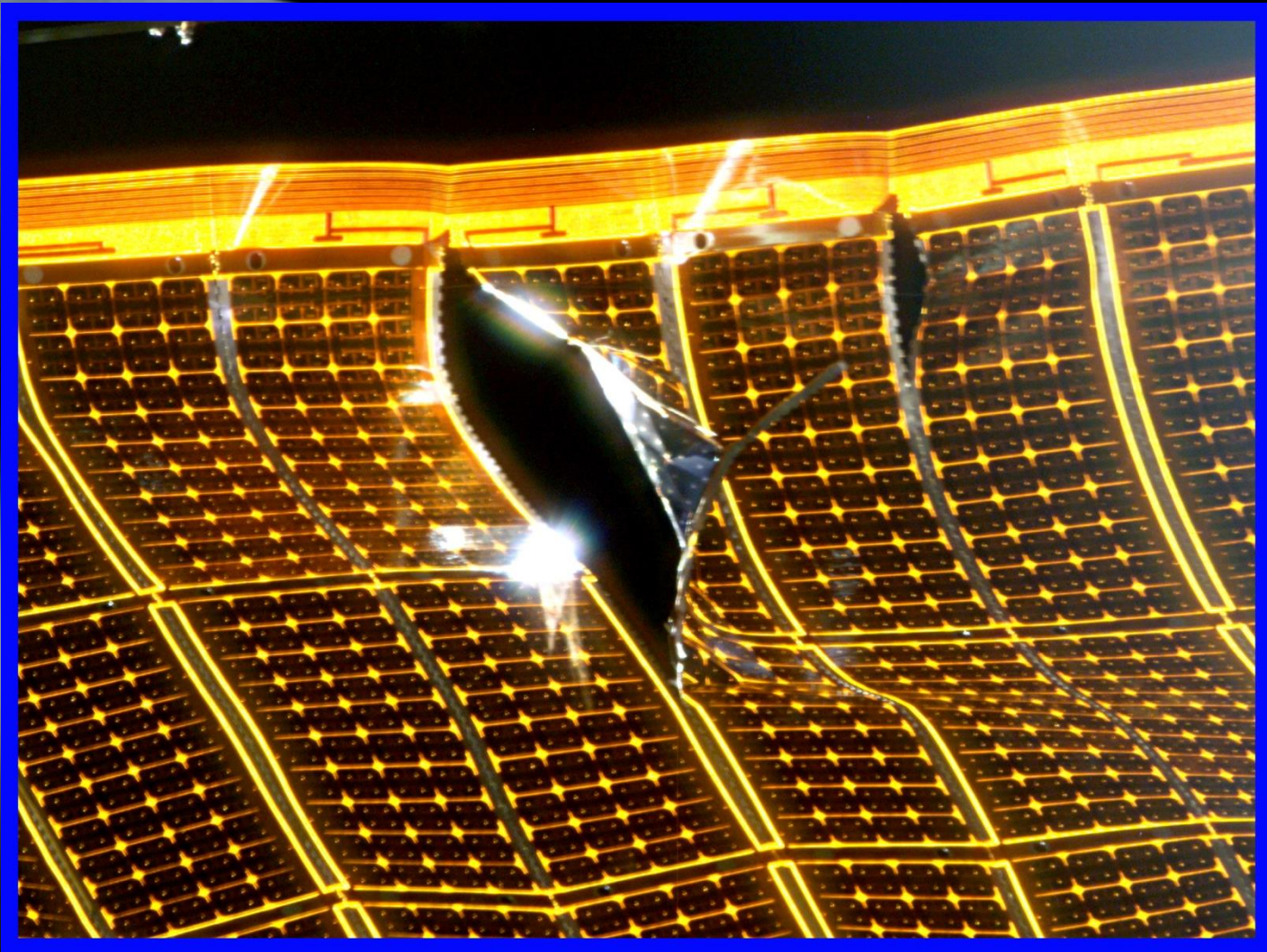
Debris Impact





Space Environmental Effects :

Operational Result of a
Probable Debris Impact



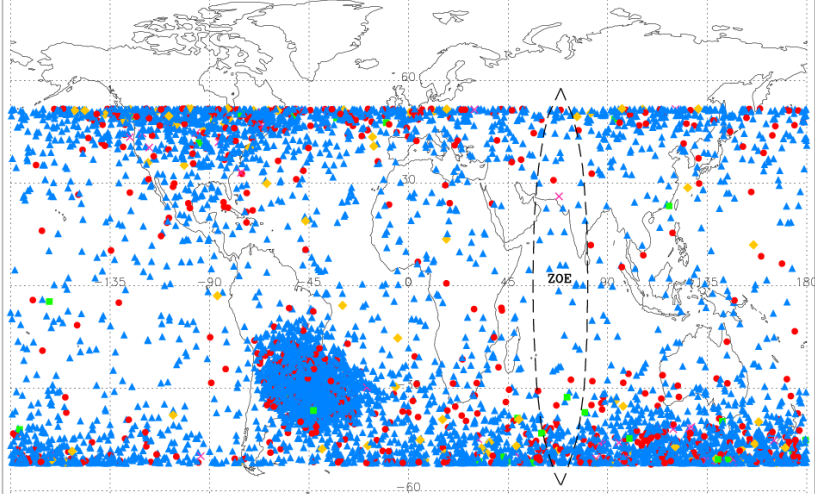


Ionizing Radiation on ISS



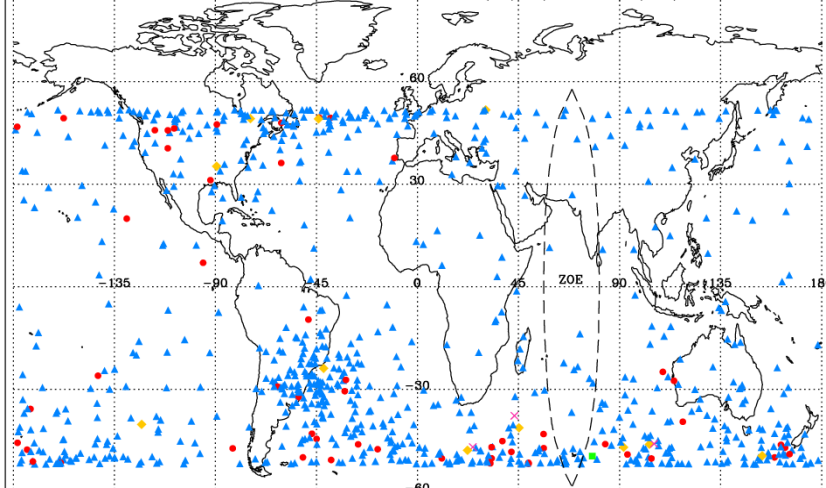
- The on-orbit Space Station must perform when exposed to the radiation dose environment.
- Class S parts used extensively in the electrical power system (EPS).
- Mil-883B parts used in the vast majority of ISS avionics hardware.
- High quality and reliability of Mil-883B parts in the late 80's and early 90's a direct result of the automotive industry demands on microelectronics producers – not military or aerospace space demands.
- Metrics for Measuring Performance:
 - ➡ Single Event Effects (SEE)
 - ➡ Total Ionizing Dose (TID)

P1-1 External MDM-4 1Mx4 DRAM SEU Events (1/12/05 - 7/8/11)



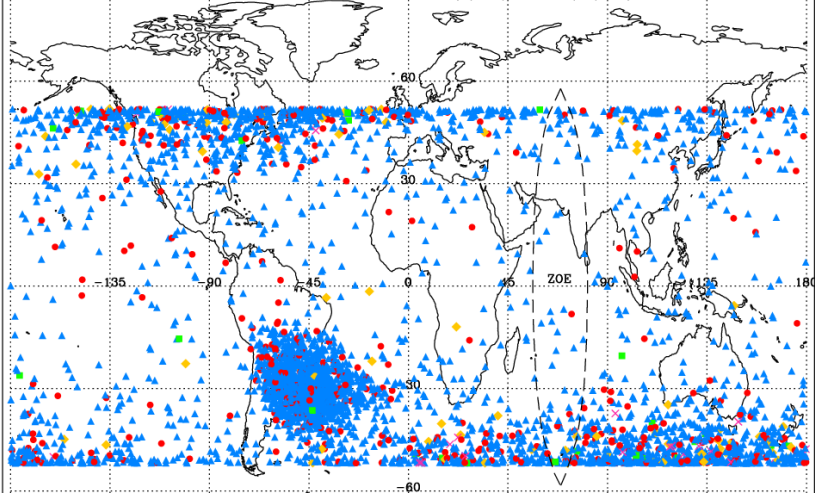
▲ Single Bit Upset = 5190 ● 2 Bit MBU = 690 ◆ 3 Bit MBU = 92 ■ 4 Bit MBU = 30 ✕ 5+ Bit MBU = 42

EXT1 External MDM-Enh 4Mx4 DRAM SEU Events (10/05/06 - 7/8/11)



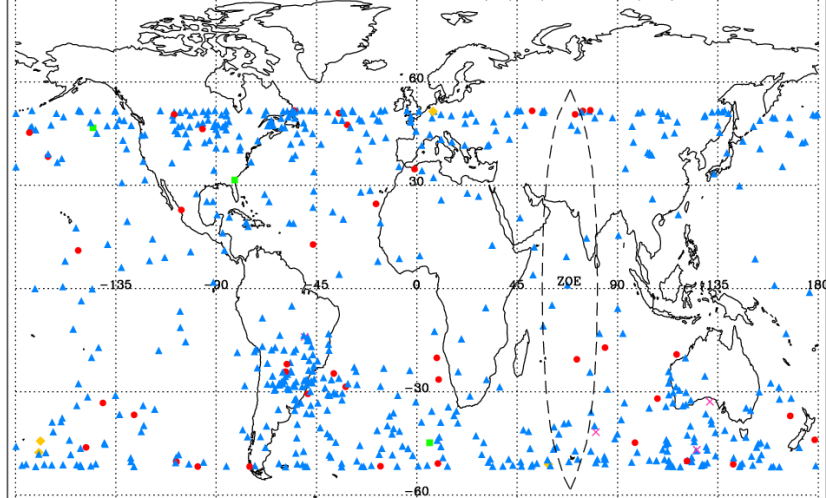
▲ Single Bit Upset = 765 ● 2 Bit MBU = 53 ◆ 3 Bit MBU = 11 ■ 4 Bit MBU = 1 ✕ 5+ Bit MBU = 3

S3-2 External MDM-4 1Mx4 DRAM SEU Events (6/12/07 - 7/8/11)



▲ Single Bit Upset = 3439 ● 2 Bit MBU = 461 ◆ 3 Bit MBU = 75 ■ 4 Bit MBU = 26 ✕ 5+ Bit MBU = 25

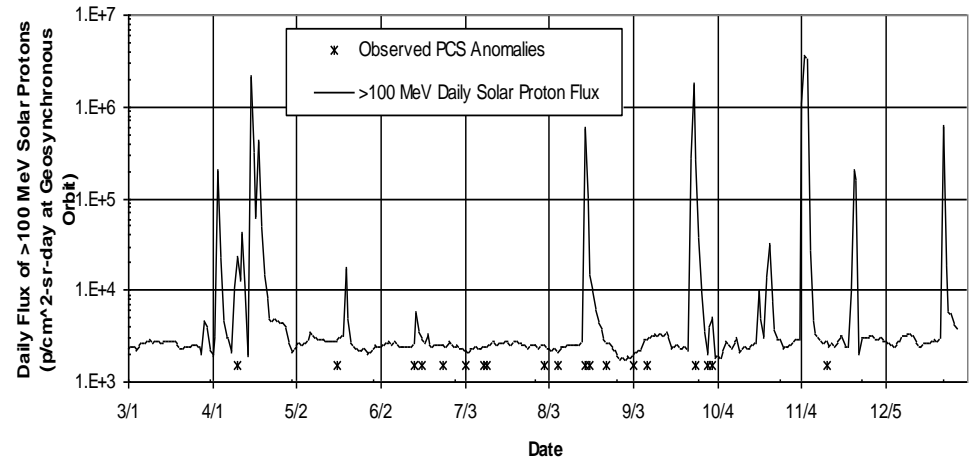
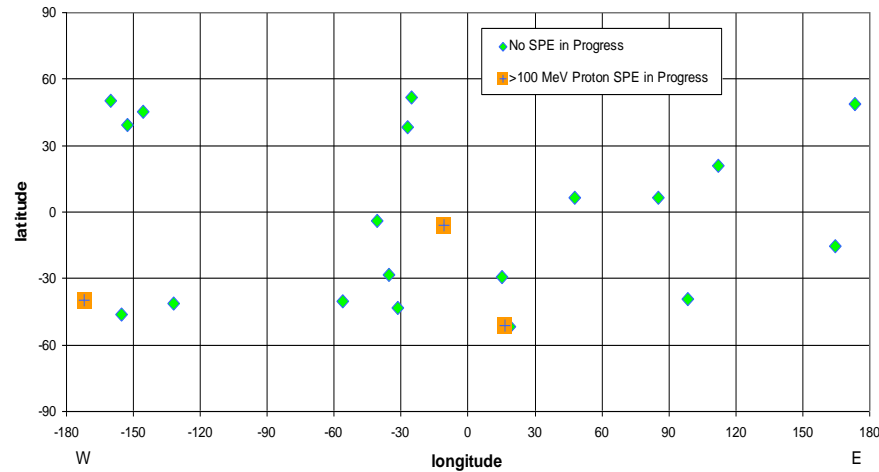
GNC1 Internal MDM-Enh 4Mx4 DRAM SEU Events (07/04/07 - 7/8/11)



▲ Single Bit Upset = 604 ● 2 Bit MBU = 40 ◆ 3 Bit MBU = 4 ■ 4 Bit MBU = 3 ✕ 5+ Bit MBU = 4



ISS IBM ThinkPad PCS Predictions and Results



Laptop	Predicted (200 MeV box level proton testing) Reboots/Day (radiation)	Observed Reboots/Day (radiation)
Service Module PCS	0.04	0.02
Lab Robotics Work Station PCS	0.04	0.01
Lab PCS	0.04	0.04
All	0.13	0.08

Predicted Radiation Induced Anomaly* Rate vs. In-Flight Anomaly Rate for Three IBM Thinkpad Laptop 760 XD Computers (PCS) on ISS

* Anomalies requiring reboot or power cycling for recovery and not attributable to causes other than SEE causes



ISS Functional Interrupts



Equipment acronyms

C&DH

APS – attached Payload Switch
 MDM – Multiplexer-De-Multiplexer
 C&T Audio
 AIU – Audio Interface Unit
 ATU – Audio Terminal Unit
 AUAI – ACS/UCS Audio Interface Unit
 IAC – Internal Audio Controller
 RAIU – Russian Audio Interface Unit

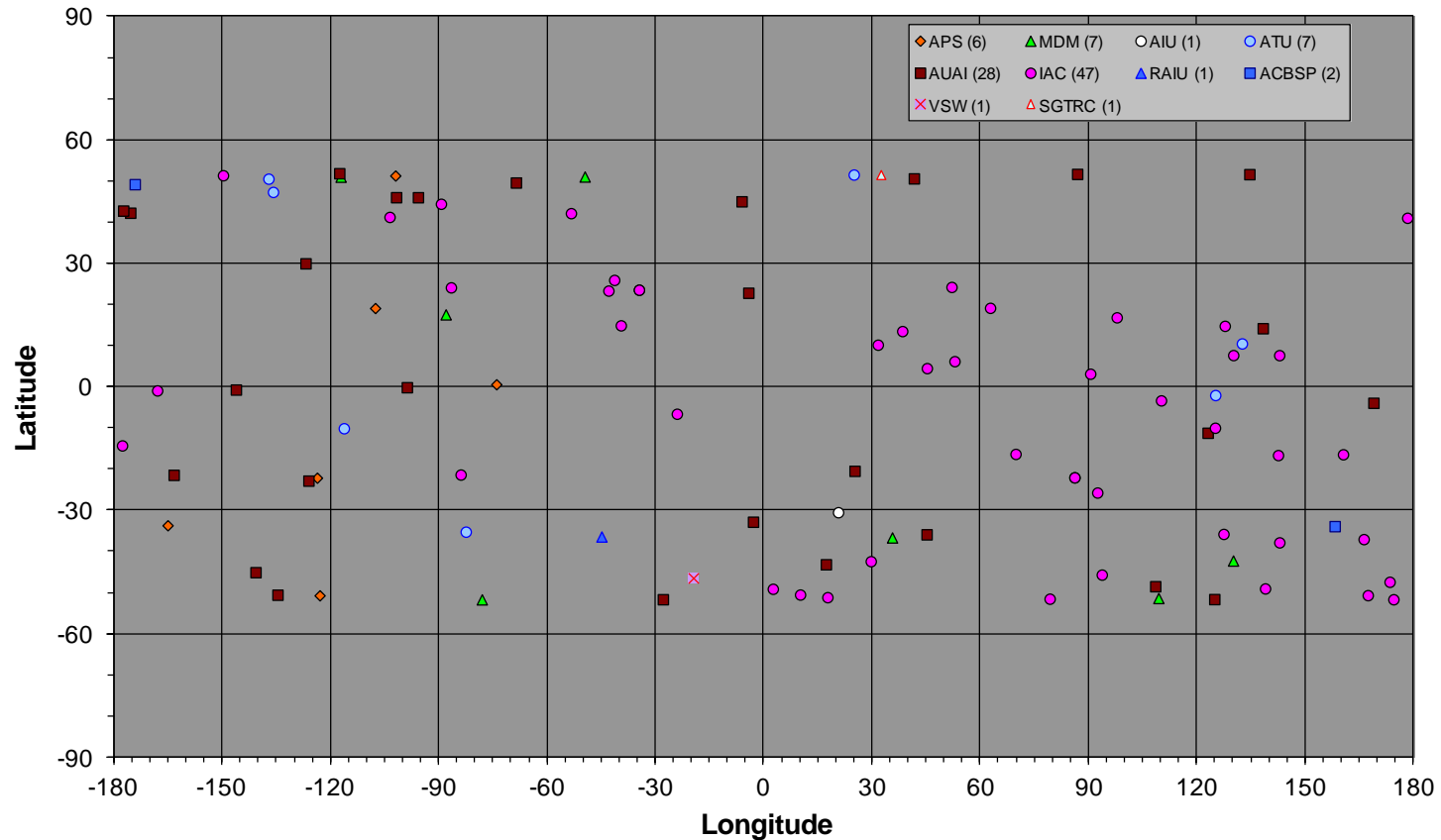
S-Band

ACBSP – Assembly and Contingency Baseband Signal Processor
 Video
 VSW – Video Switch

Ku-Band

SGTRC – Space-to-Ground Transmitter/Receiver Controller
 If you want, I can regroup by function (C&DH, Audio, Video, etc)

ISS Functional Interrupt Anomalies Potentially Caused by Radiation Induced SEE: 2001 - 2011



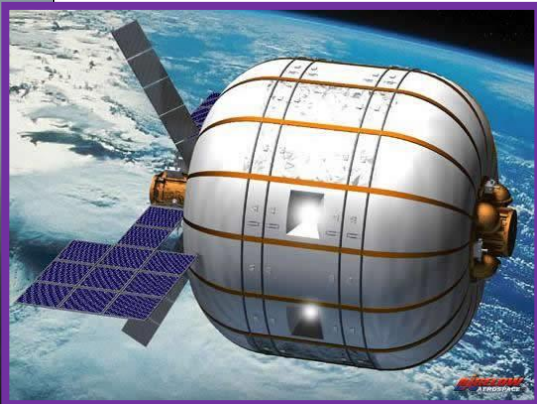
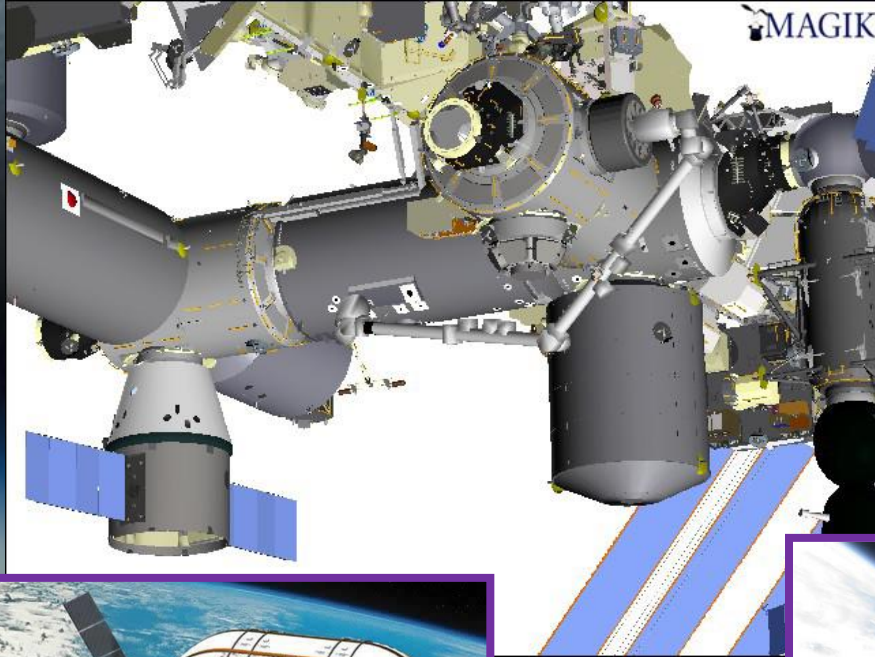
- No hard failures on ISS system hardware in 10 years of flight
- Unscreened or tested payload systems have occasionally suffered hard failures



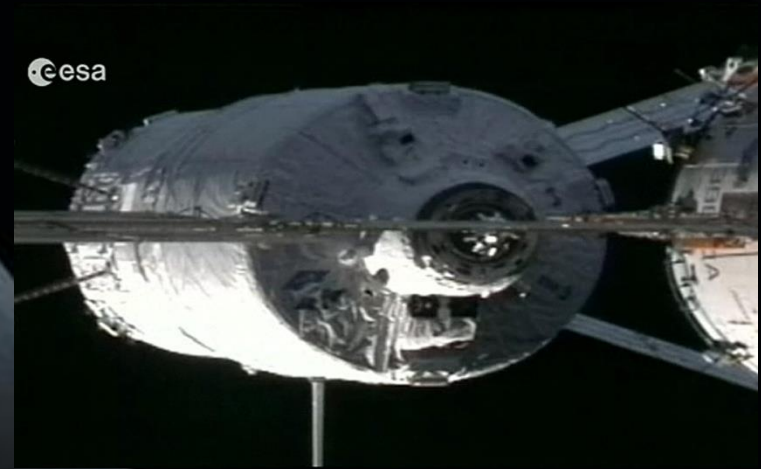
What's Next?



Inflatable Space Modules

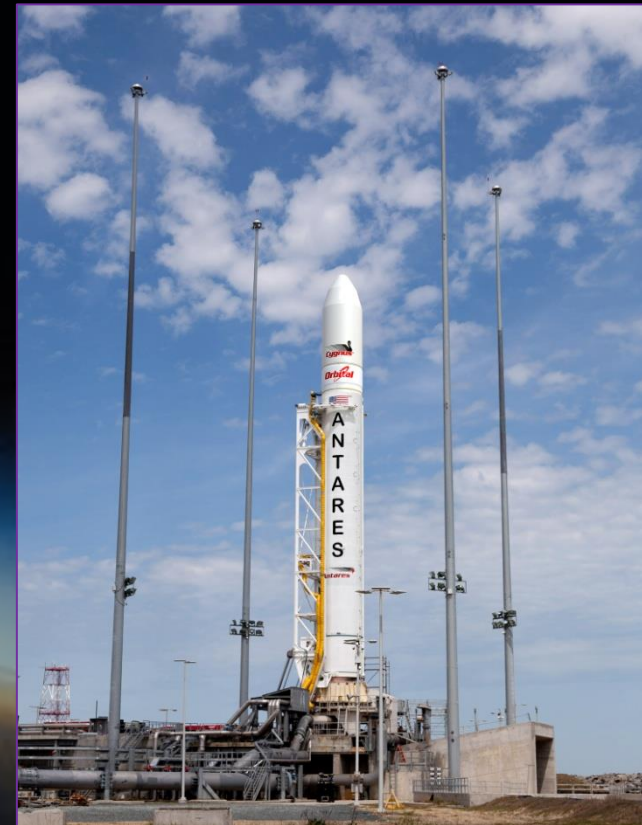


International Vehicles





Commercial Resupply





Orion

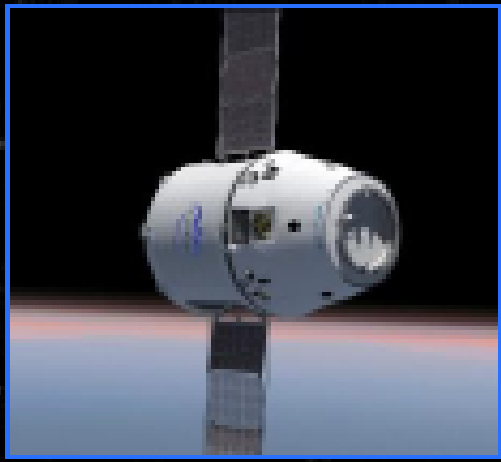




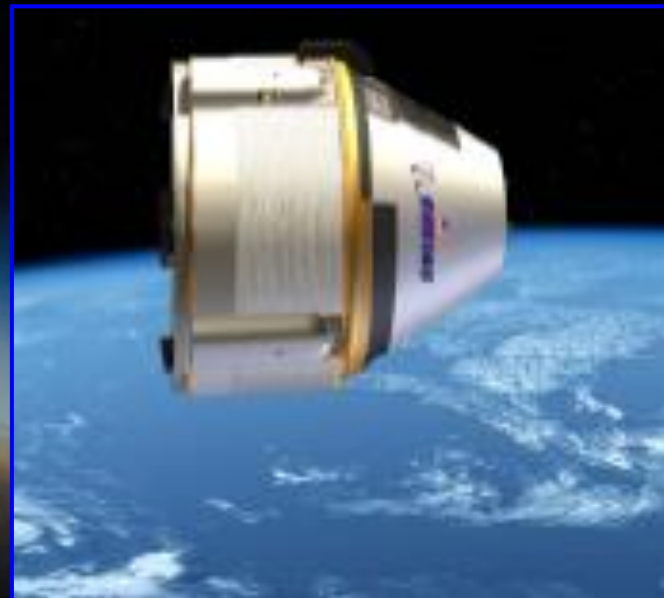
Commercial Crew



SPACEX



BOEING



SNC SIERRA NEVADA CORPORATION

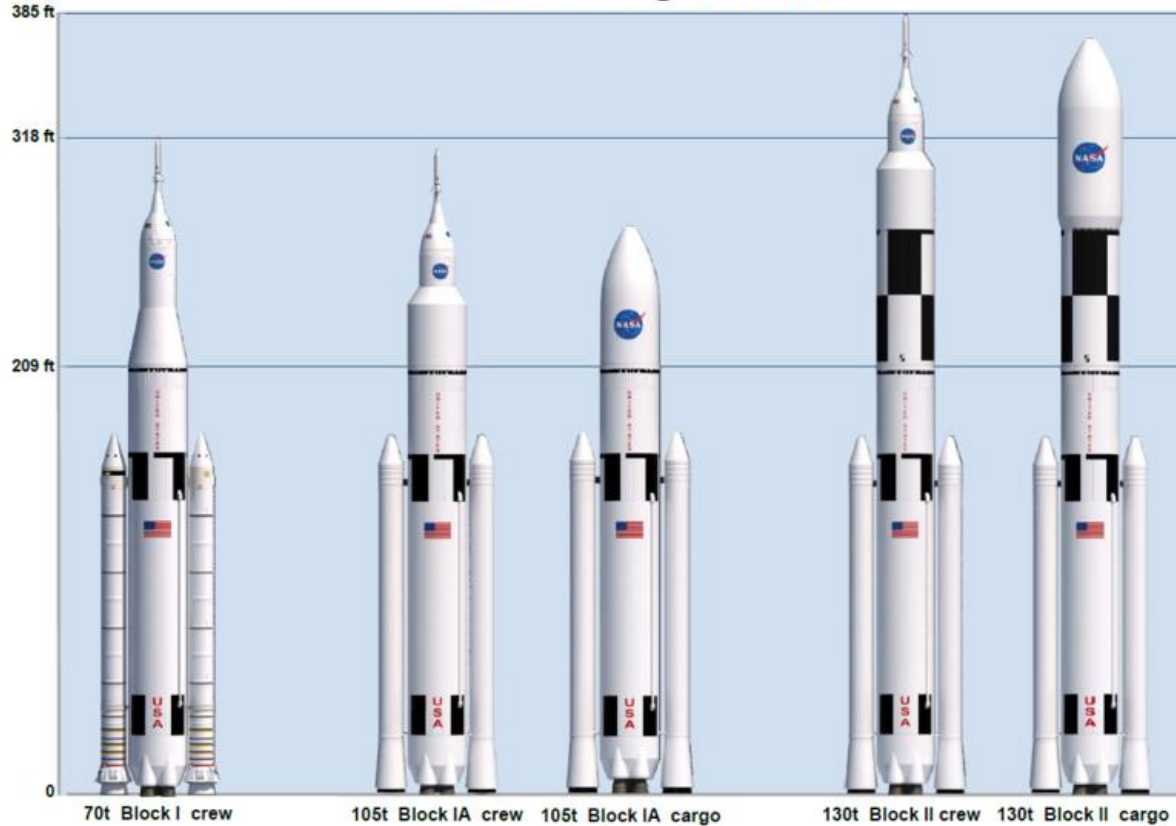




Space Launch System



SLS Vehicle Configurations





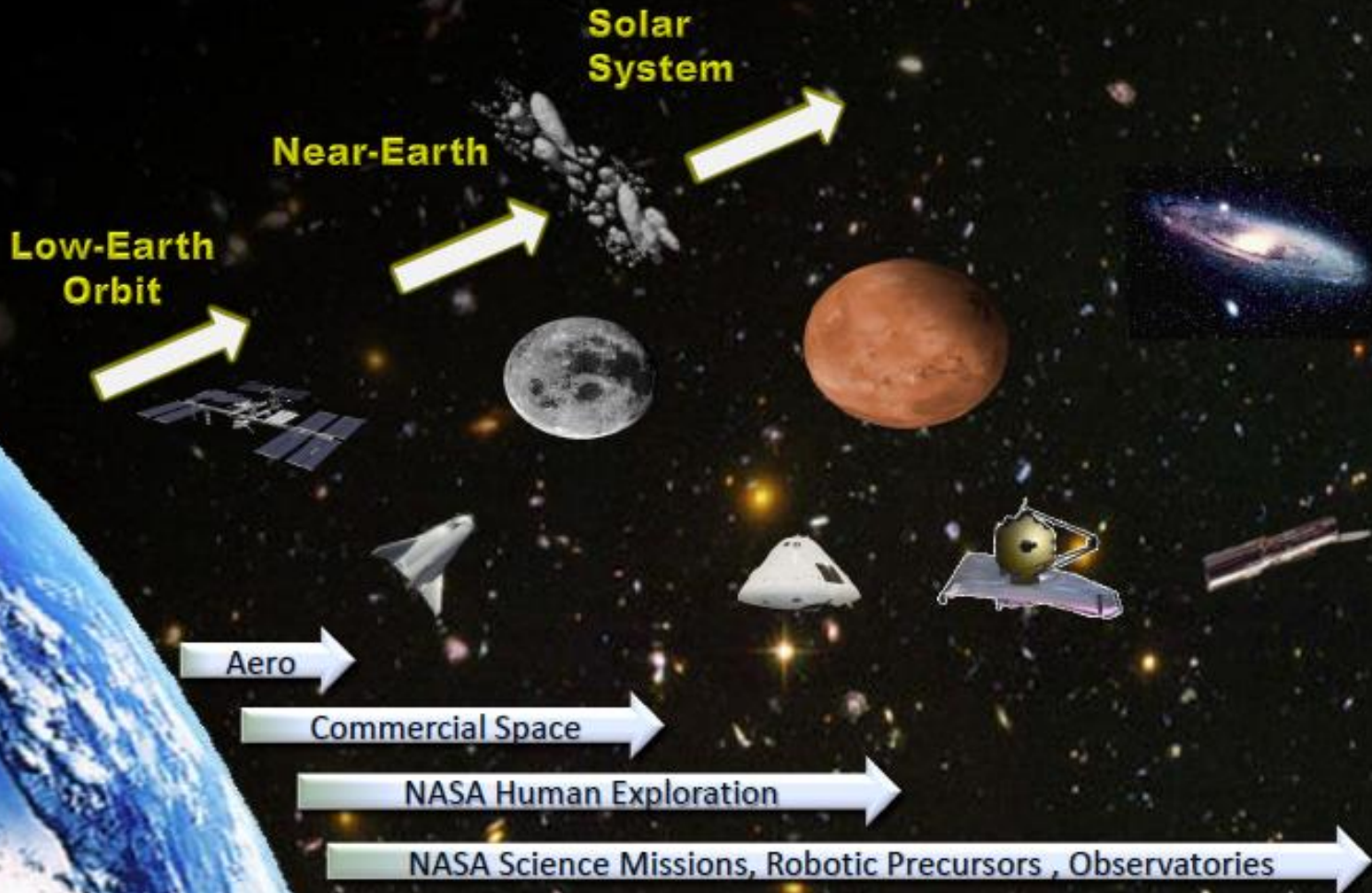
Moving Forward



Human Spaceflight Roadmap

Learn, Operate, Explore at Each Phase

Deep Space





Back-up



The Video



http://www.youtube.com/watch?v=Ki_Af_o9Q9s

The screenshot shows a web browser window with two tabs: "Mars Science Laborator" and "Challenges of Getting to". The address bar contains the URL www.youtube.com/watch?v=Ki_Af_o9Q9s. The YouTube interface includes the logo, a search bar, and navigation links for "Browse", "Movies", and "Upload". The user's name "Gavin Mendeck" and a notification count of "0" are visible. The video title is "Challenges of Getting to Mars: Curiosity's Seven Minutes of Terror". Below the title are buttons for "JPLnews", "Subscribe", and "308 videos". The video player shows a simulation of the Mars landing process, with a sky crane and the rover Curiosity descending over the red, cratered surface of Mars. The video progress bar is at 0:00 / 5:08. Below the player are interaction buttons: "Like", "Dislike", "Add to", "Share", "Print", and "Embed". The video has 381,454 views, 2,980 likes, and 28 dislikes. A suggested video titled "In Memoriam: Ray Bradbury 1920-2012" by JPLnews is shown with 35,262 views and a duration of 4:08. The video description at the bottom reads: "Published on Jun 22, 2012 by JPLnews. Team members at NASA's Jet Propulsion Laboratory share the challenges of".