NASA Space Activities

presented to the Wells Branch Community Library Science Night

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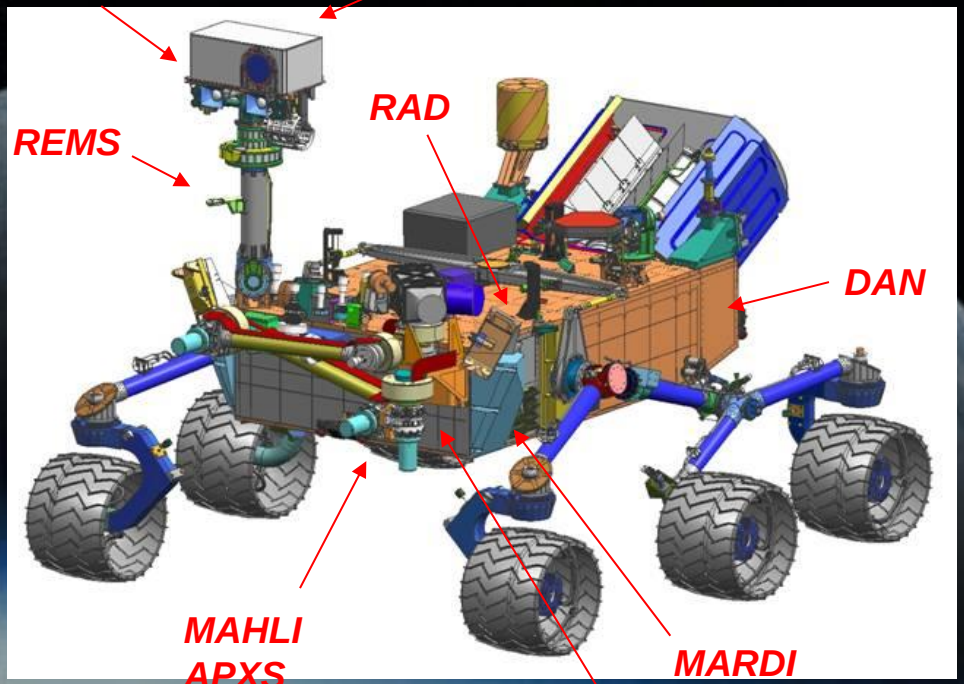
What's Hot?

Asteroid Roping?

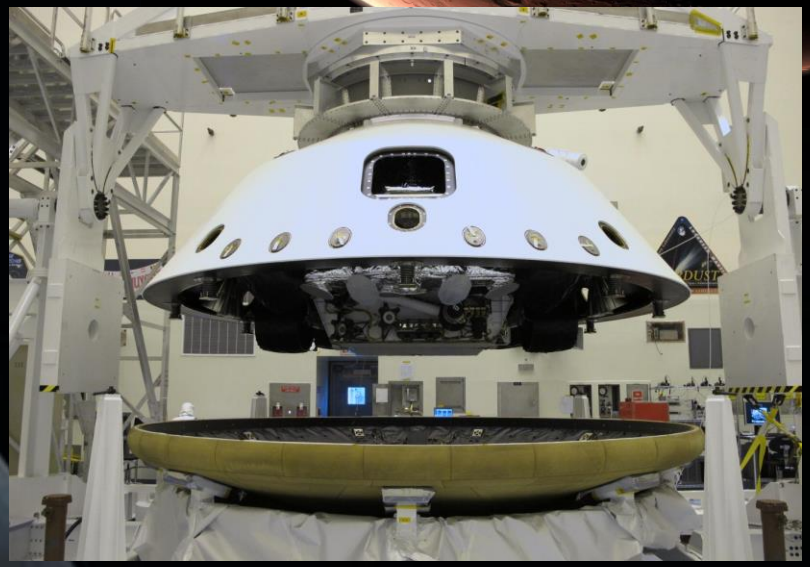
What's Hot 2?

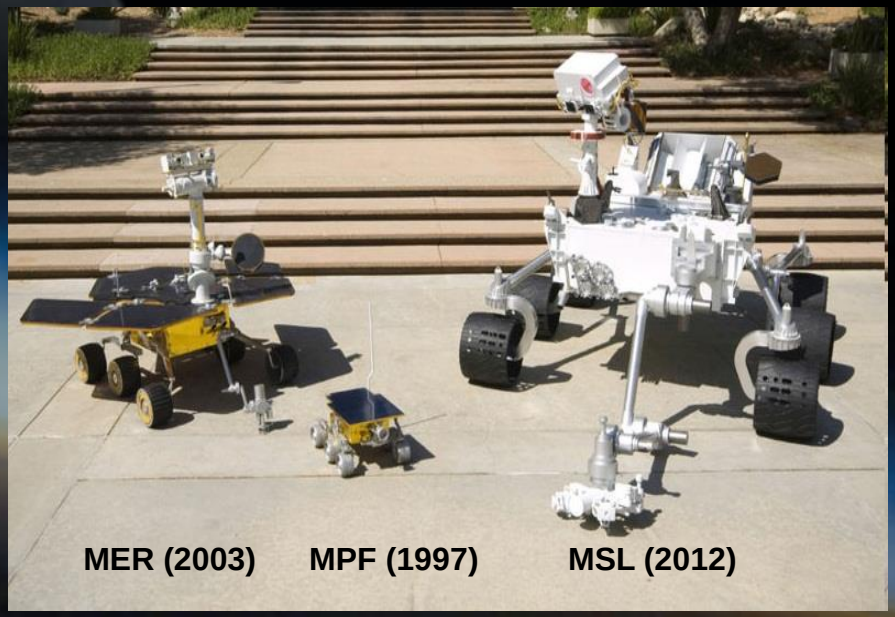
Robonaut - ***spring board to evolve new robotic capabilities; operate for exte tasks, e “Legs” a in 2014-***

What's Hot 3?



>130 co-investigators in seven countries





The ‘7 Minutes of Terror’*

Guided Entry

Parachute

Heatshield Jettison

Powered Descent

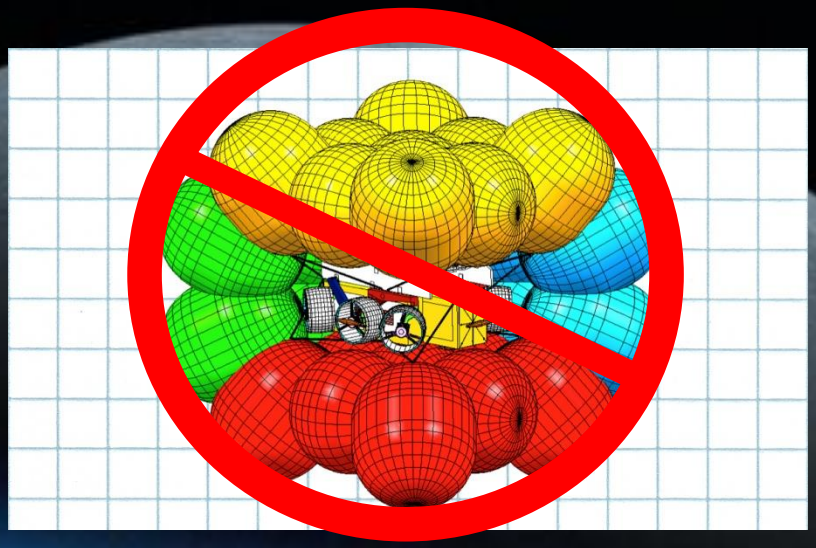
Skycrane

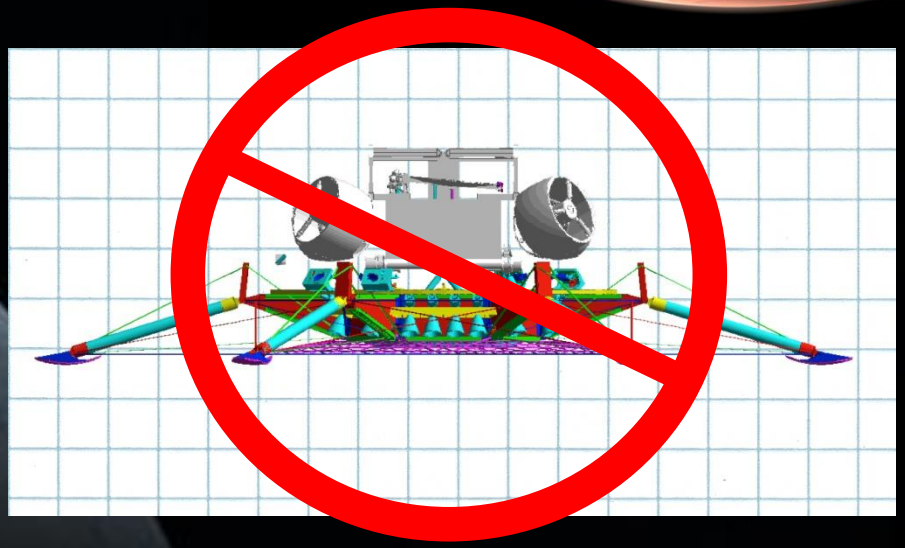
Rover Touchdown

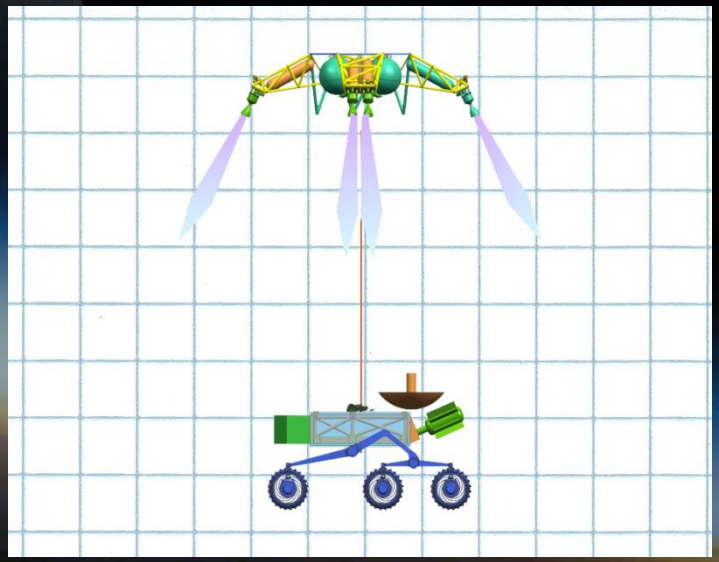
Descent Flyaway

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

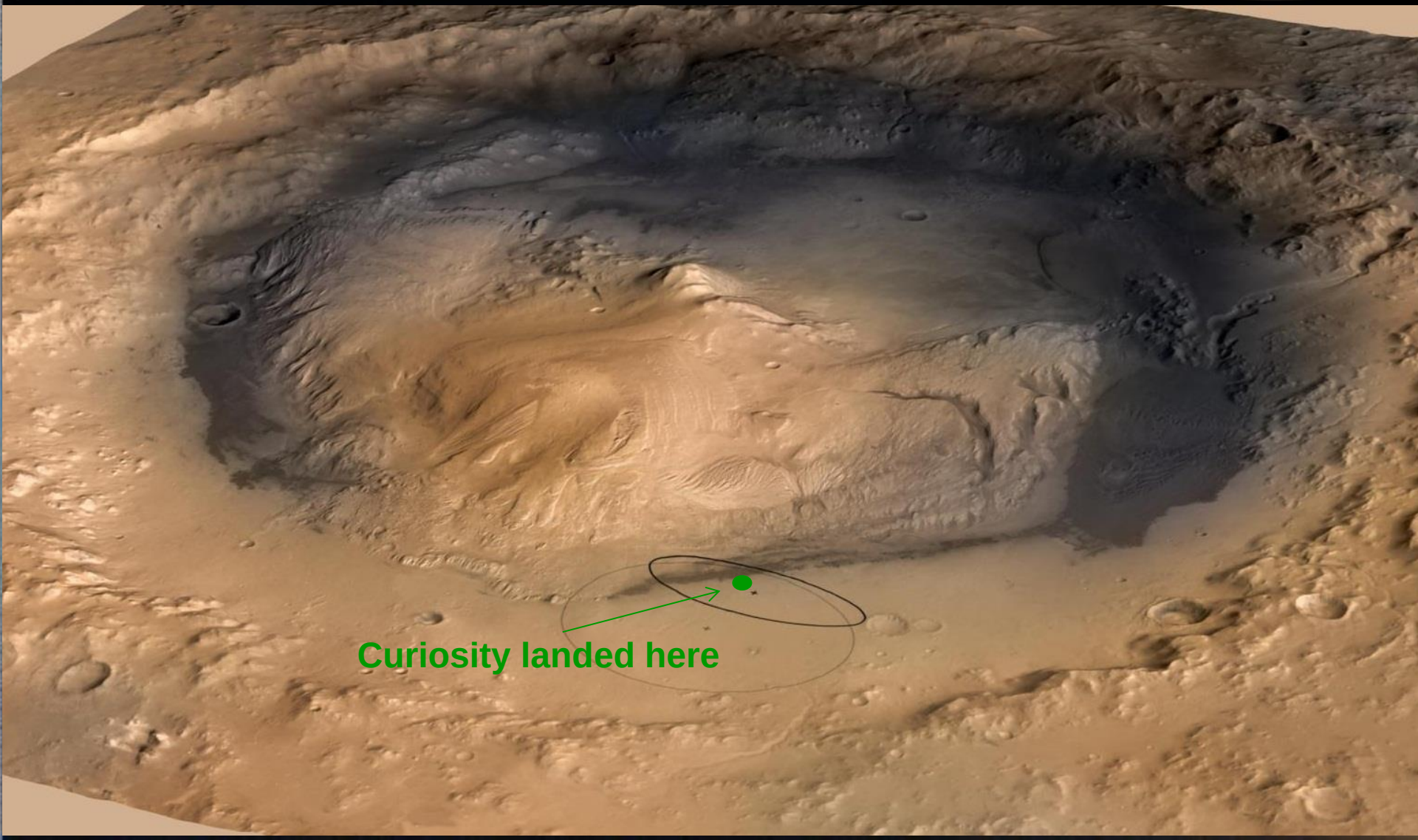
Why?







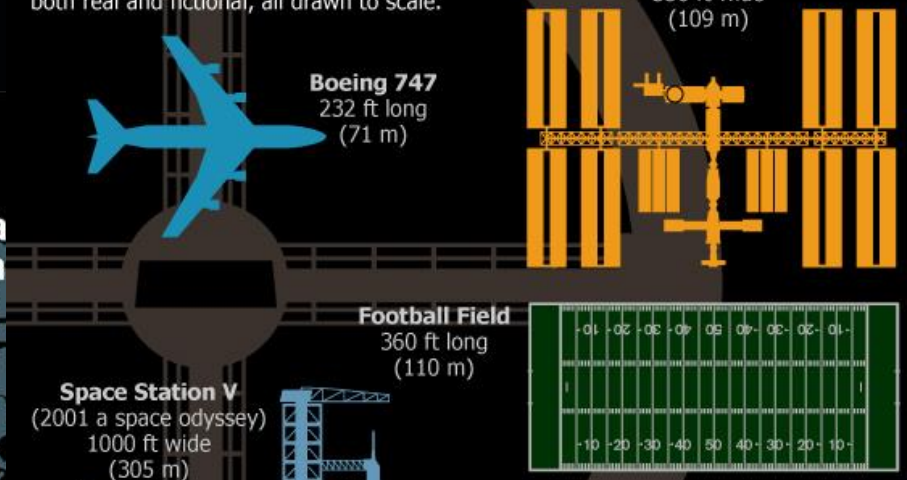
How Did We Do?



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.



ISS Opera
Managem

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

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

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

arch
TEC)

Cosmonaut Center (GCTC)

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

Life's Little Mysteries

What do We Do for NASA?

❶ Materials and Processes (M&P)

❷ Space Environments and its Effects

Basic Function of M&P

Materials Selection, Requirements and Certification

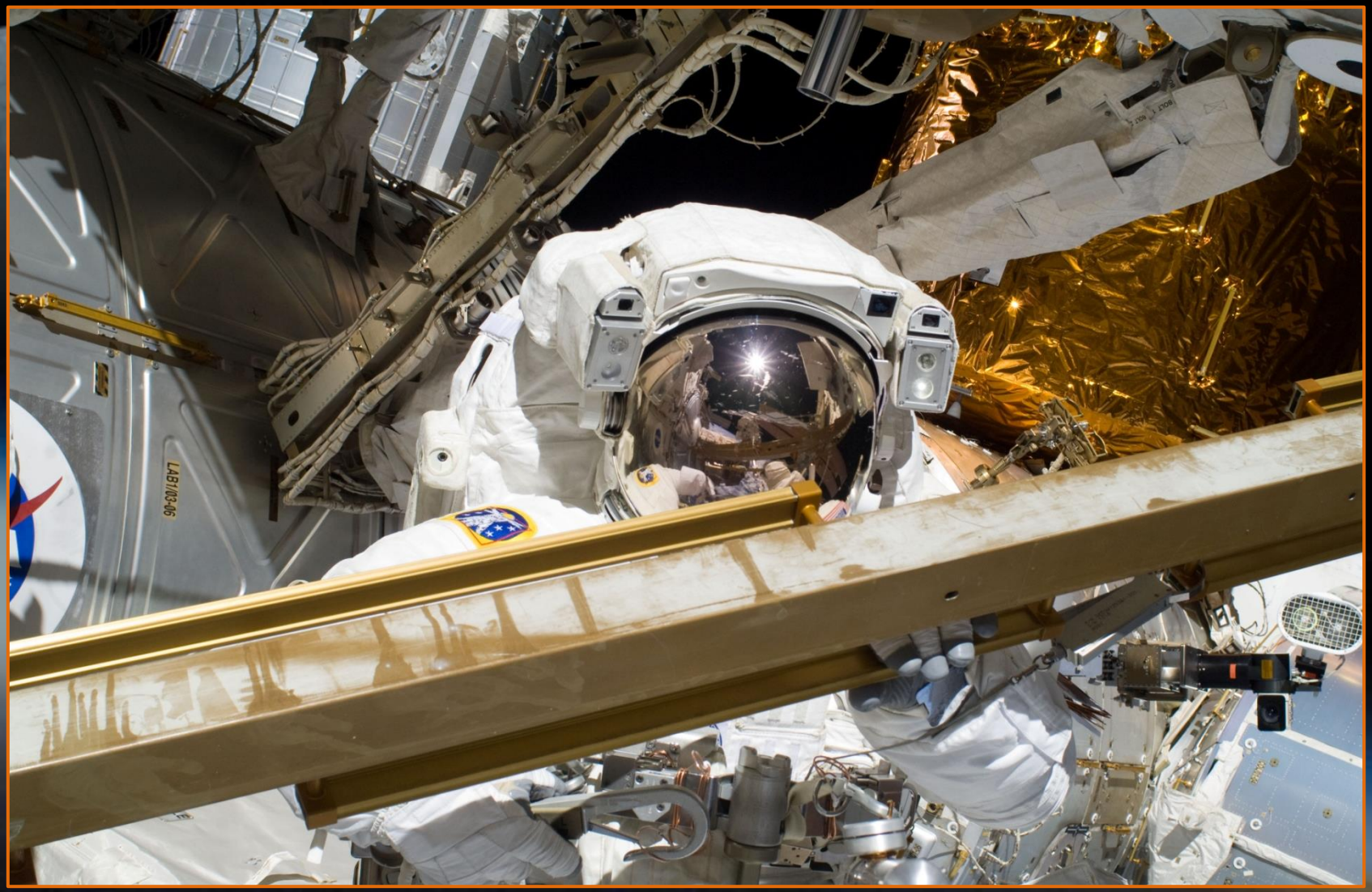
- *Verification of Safe Use of Materials*
- Materials Selection for Design
- Flammability
- Fracture Control
- Offgassing (Toxicity/Odor)
- Fluid Compatibility (Oxygen, Propellants)
- Corrosion/Stress Corrosion Resistance
- Outgassing (Thermal Vacuum Stability/Contamination)
- Material Analysis/Failure 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

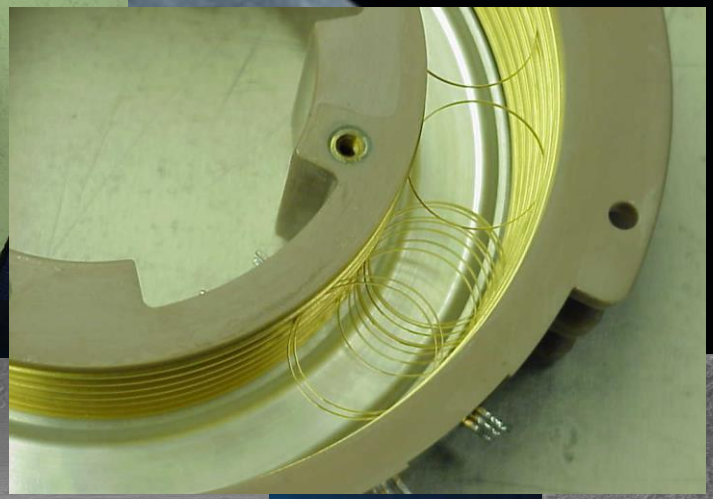
Ground Contamination



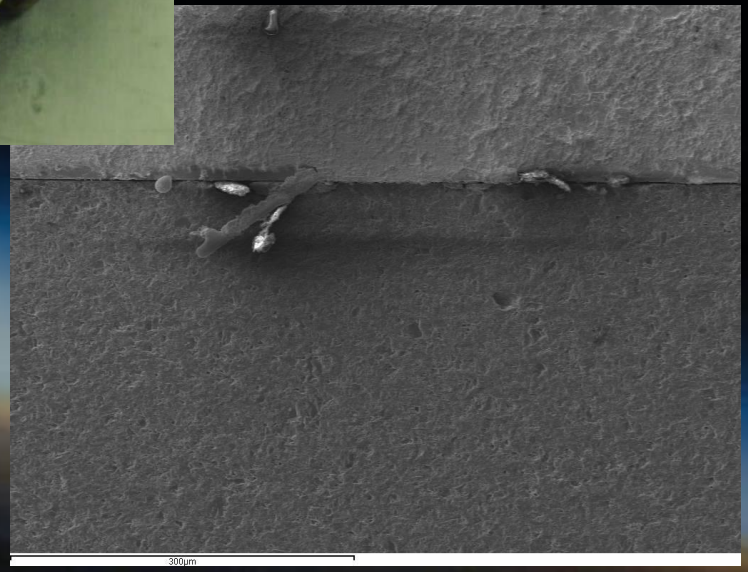
M&P Issue

Flawed Process

Gold Plated Roll Rings



Gold Plating Delamination



M&P Issue

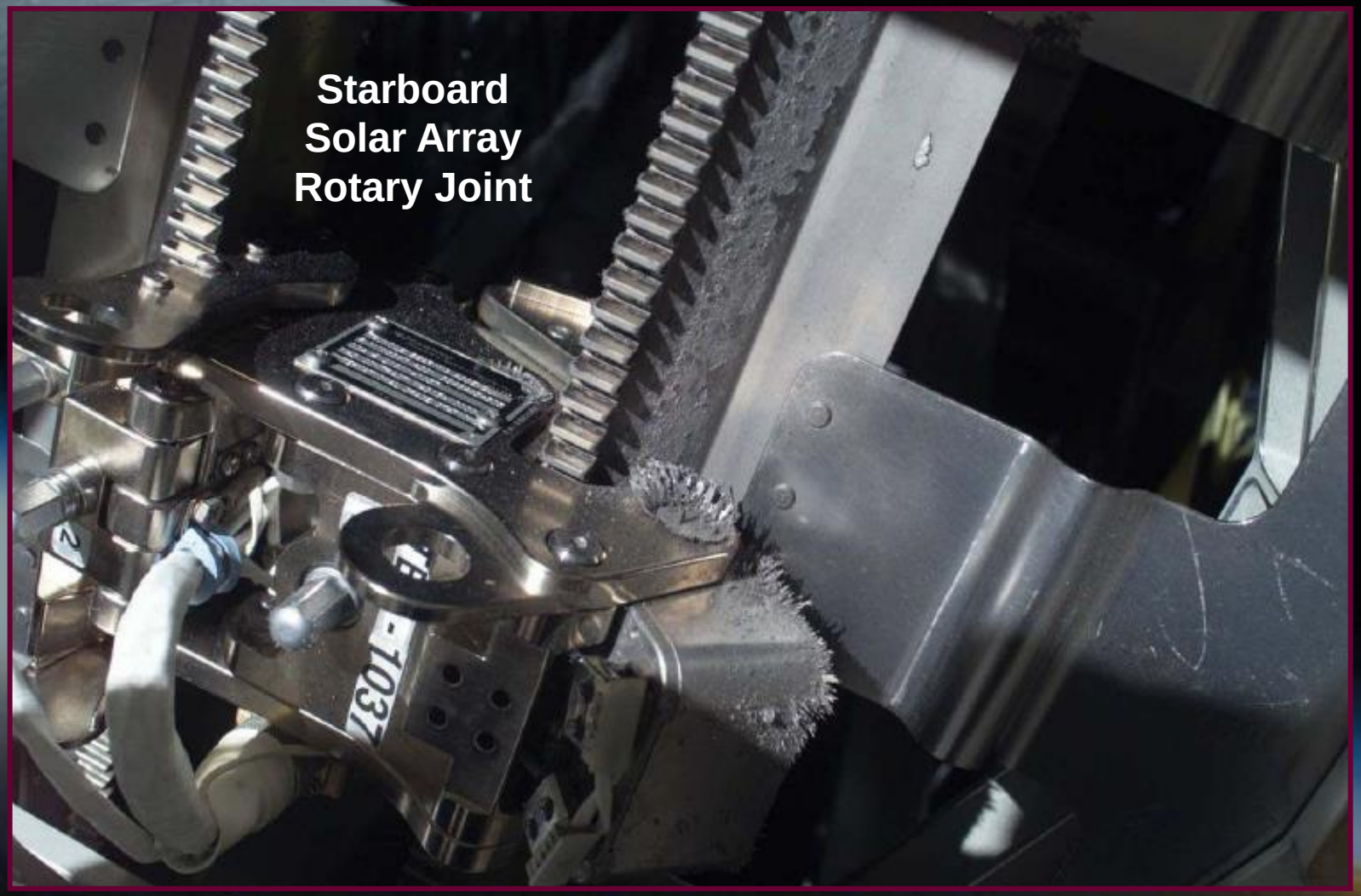
Process Refinement

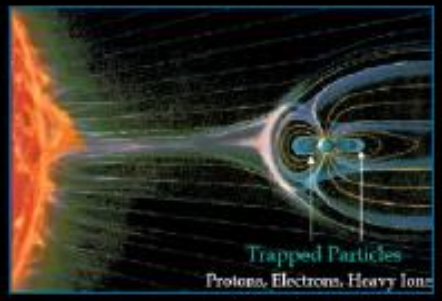
Pre-flight Image Photofoil Label

On-orbit Image Photofoil Label

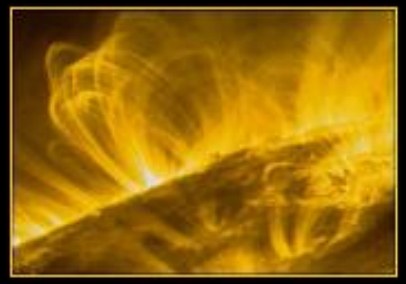
M&P Issue

Lubrication Issue





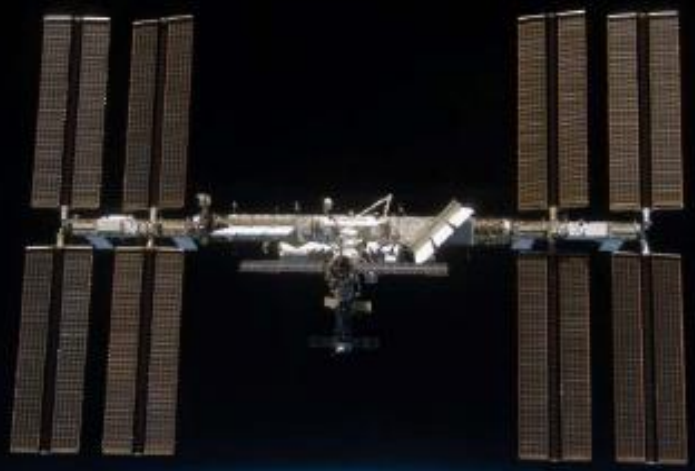
The Space Environment



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

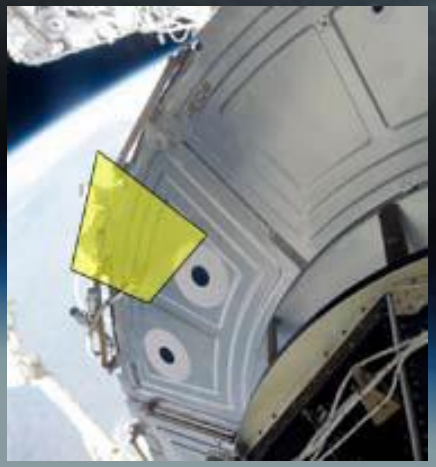
Space Environmental Effects :

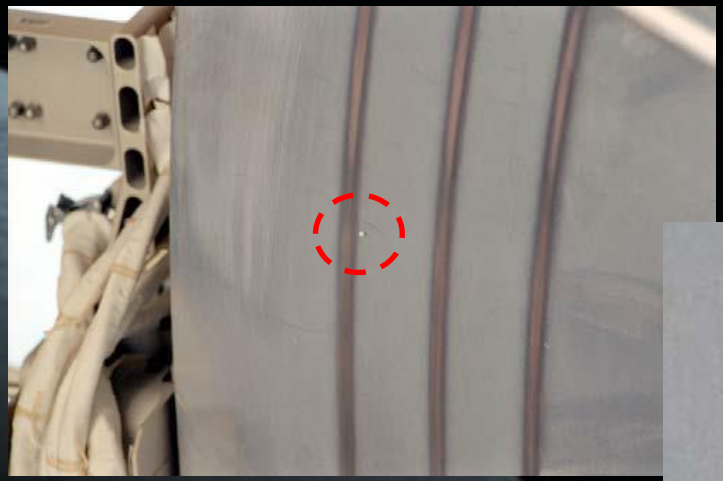
Inadvertent Materials Substitution

Battery Box used the ‘wrong’ grade of beta cloth

Space Environmental Effects :

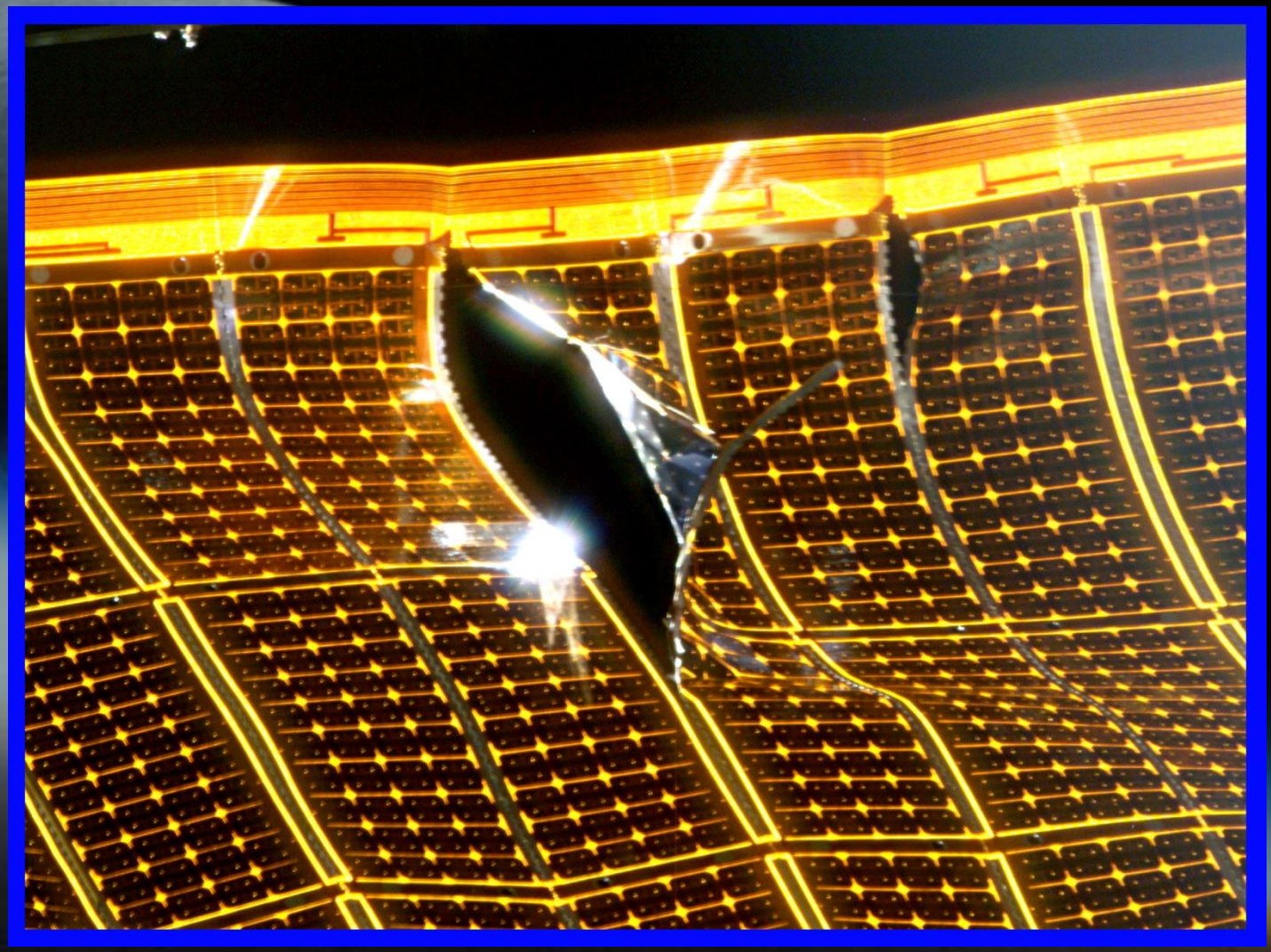
Debris Impact





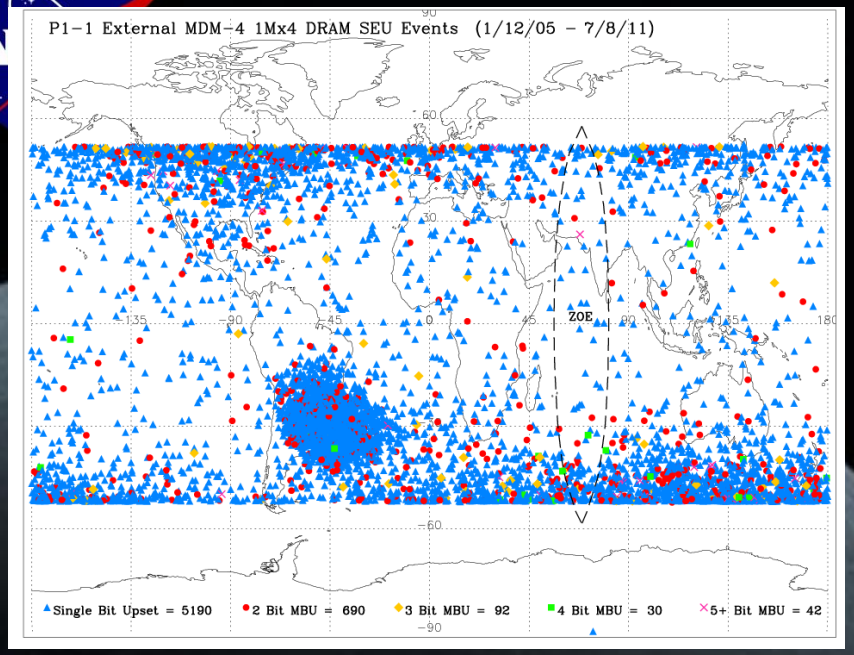
Space Environmental Effects :

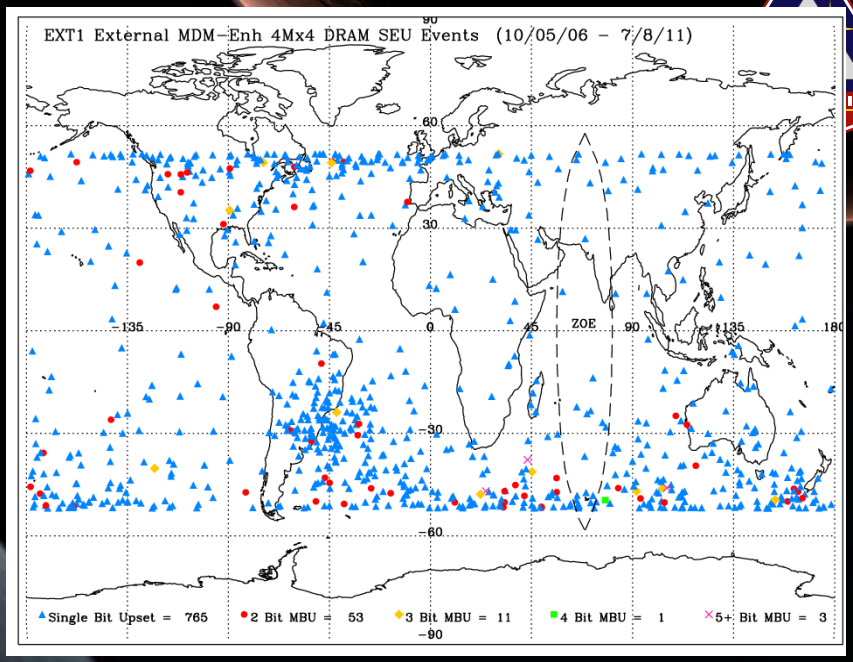
Operational Result of a Probable Debris Impact

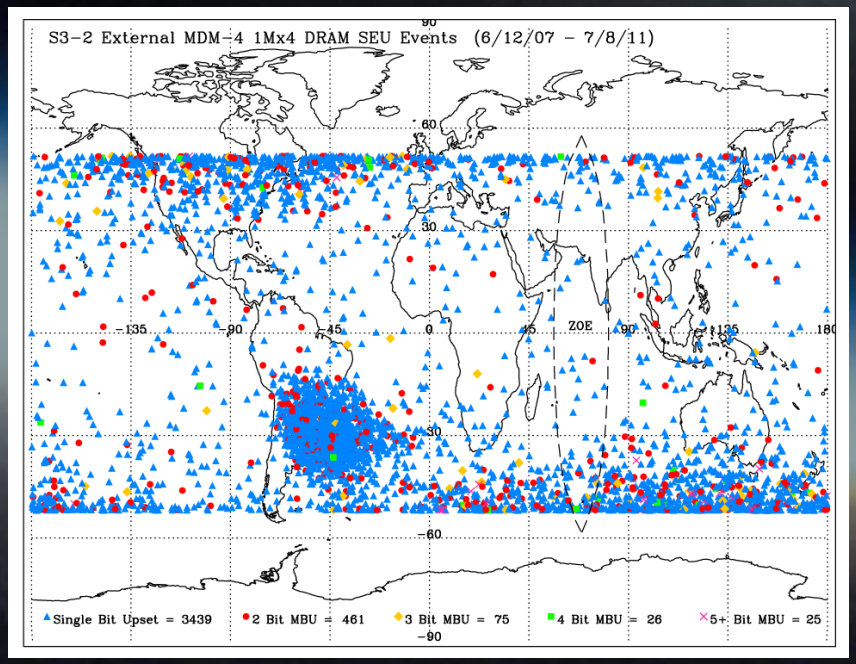


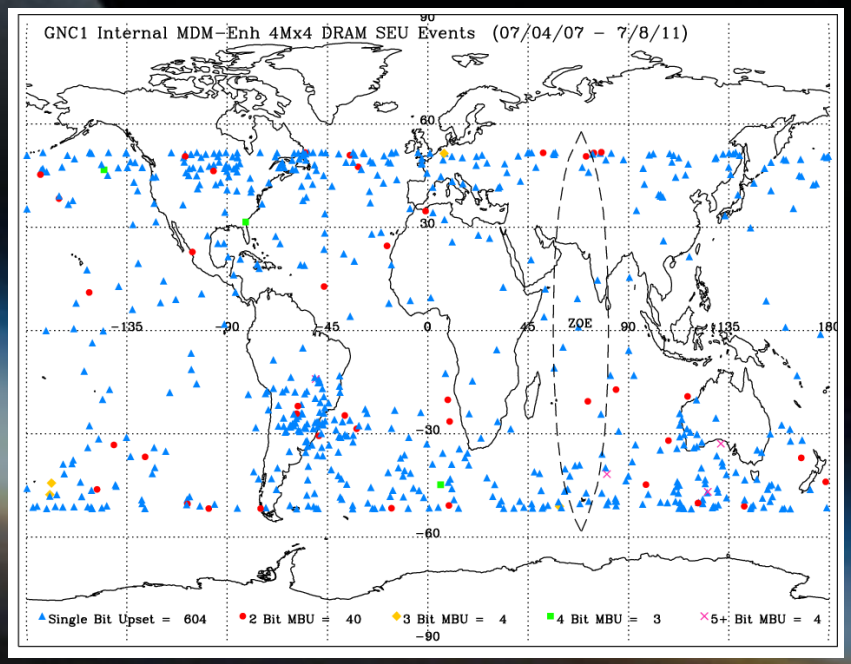
Ionizing Radiation on ISS

- 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)

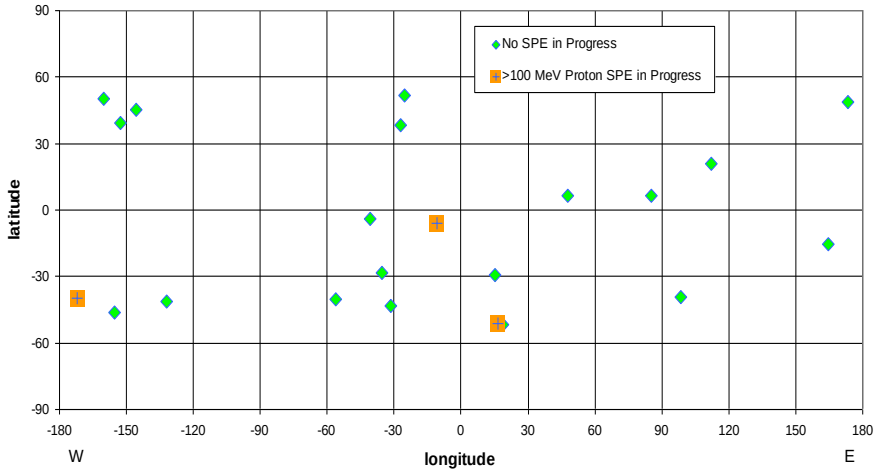

P1-1 External MDM-4 1Mx4 DRAM SEU Events (1/12/05 - 7/8/11)
ZOE
Single Bit Upset = 5190
2 Bit MBU = 690
3 Bit MBU = 92
4 Bit MBU = 30
5+ Bit MBU = 42

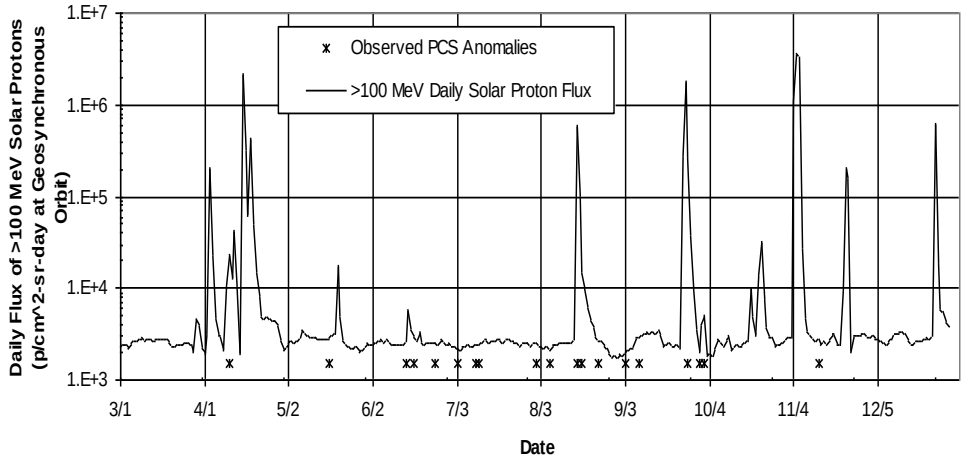

EXT1 External MDM-Enh 4Mx4 DRAM SEU Events (10/05/06 - 7/8/11)
ZOE
Single Bit Upset = 765
2 Bit MBU = 53
3 Bit MBU = 11
4 Bit MBU = 1
5+ Bit MBU = 3


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

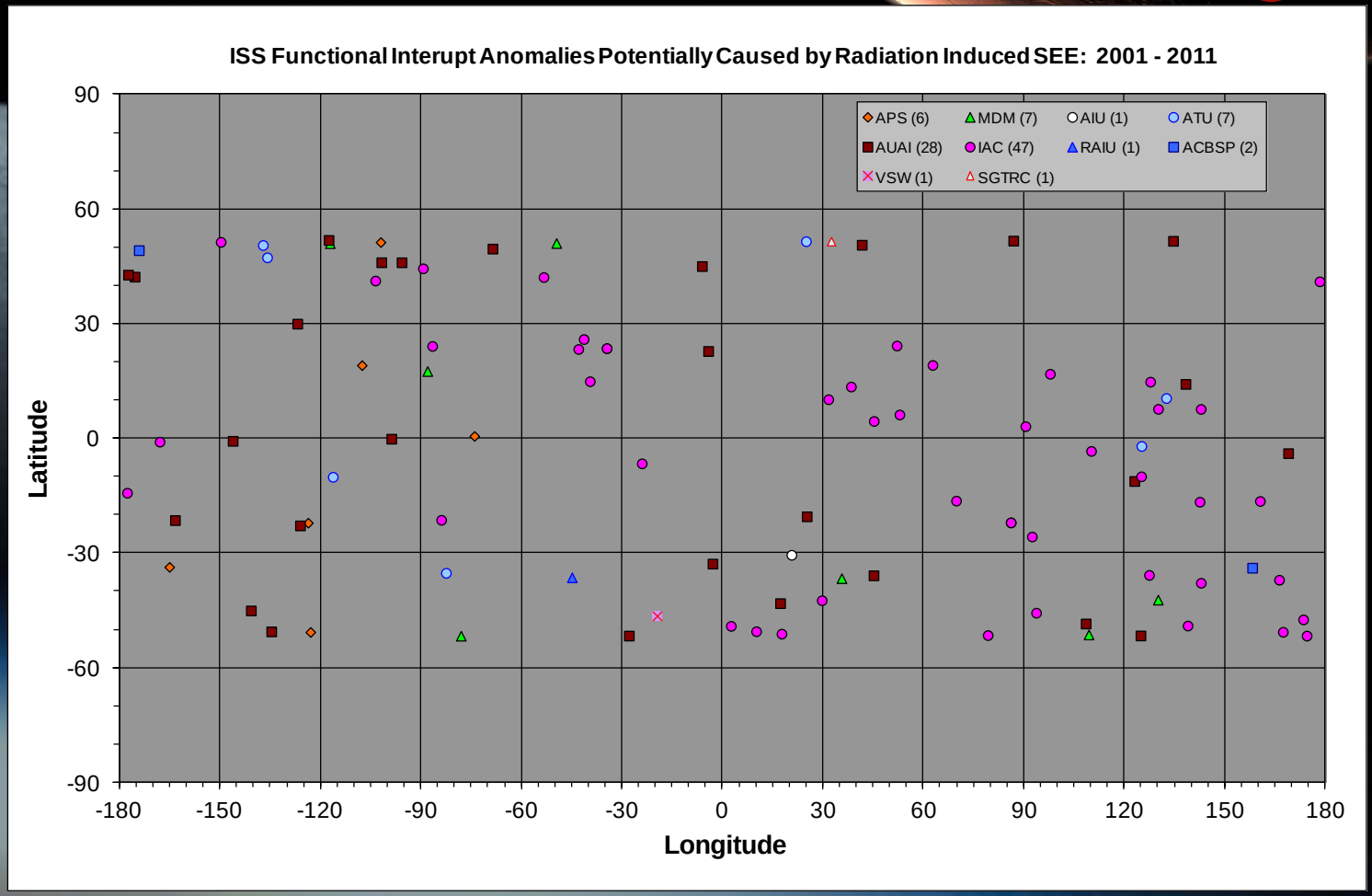
ISS Functional Interrupts

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

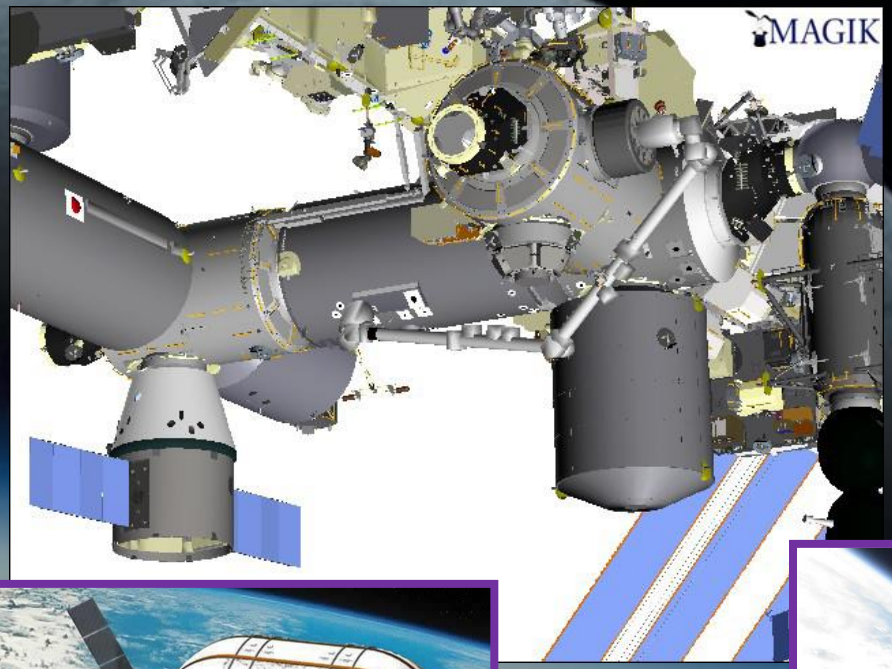
Ku-Band
SGTRC – Space-to-Ground Transmitter/Receiver Controller
If you want, I can regroup by function (C&DH, Audio, Video, etc

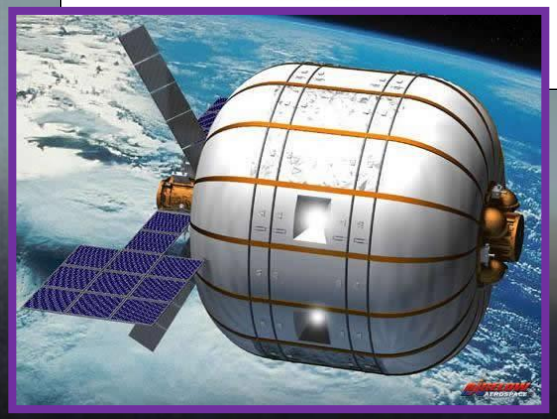


- No hard failures on ISS system hardware in 10 years of flight
- Unscreened or tested payload systems have occasionally suffered hard failures

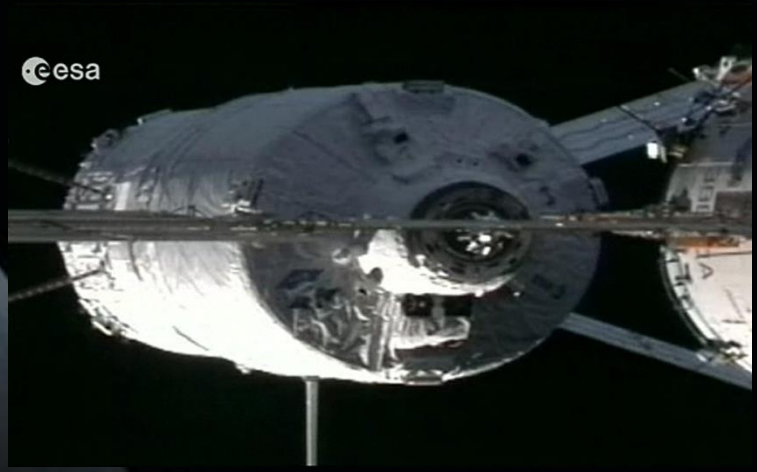
What's Next?

Inflatable Space Modules

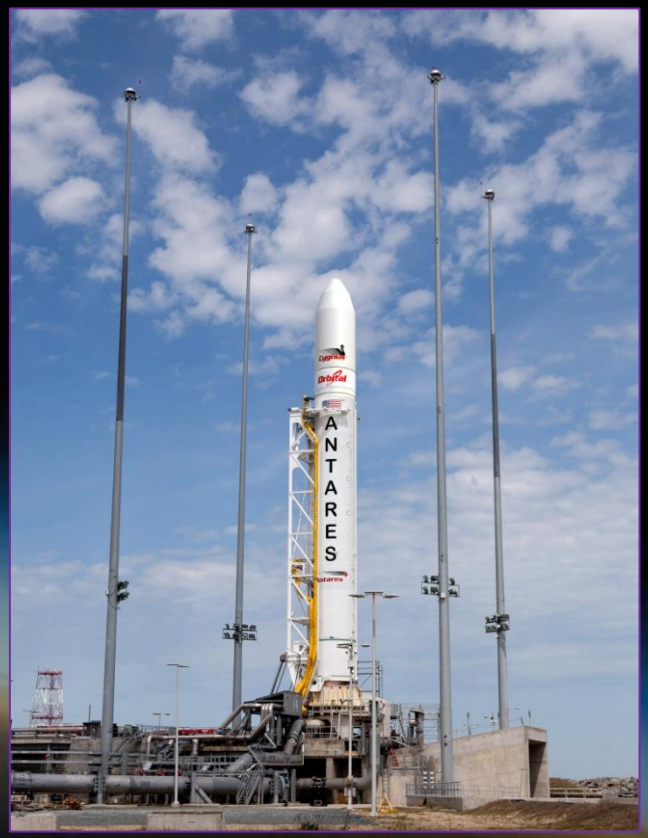




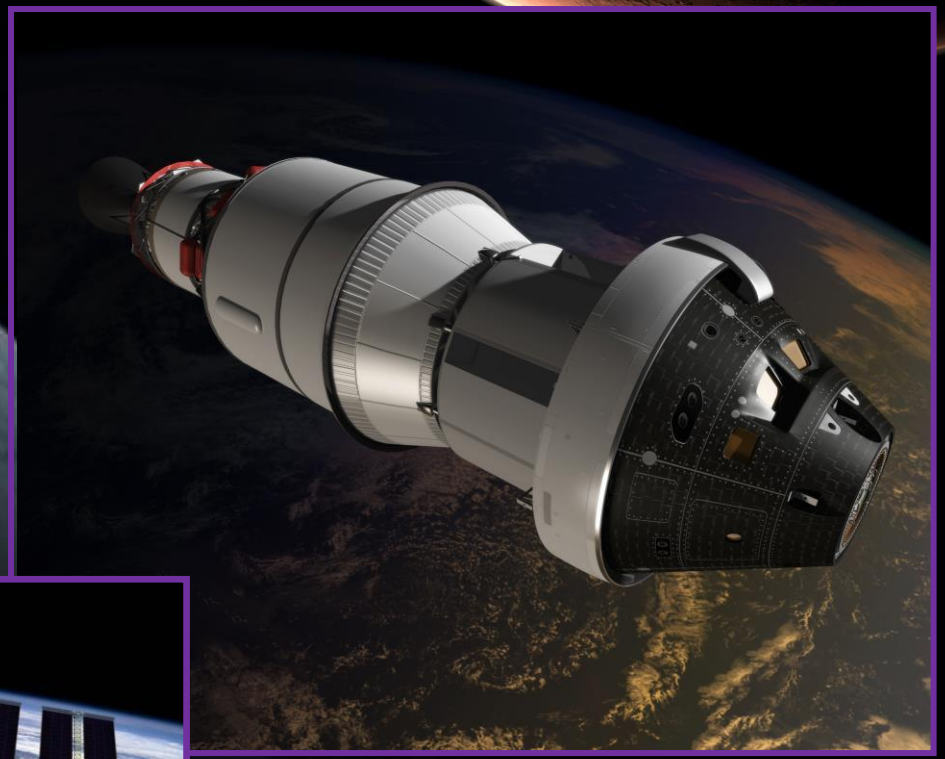
International Vehicles



Commercial Resupply

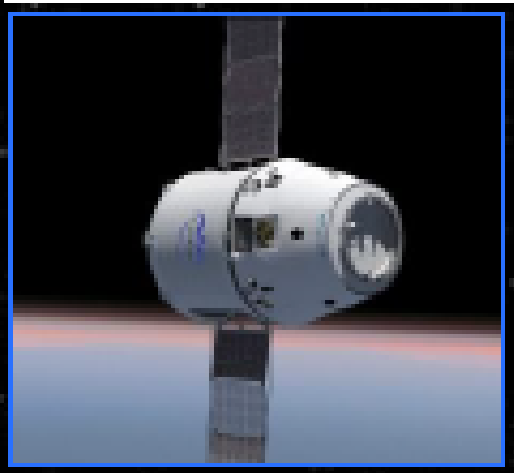


Orion



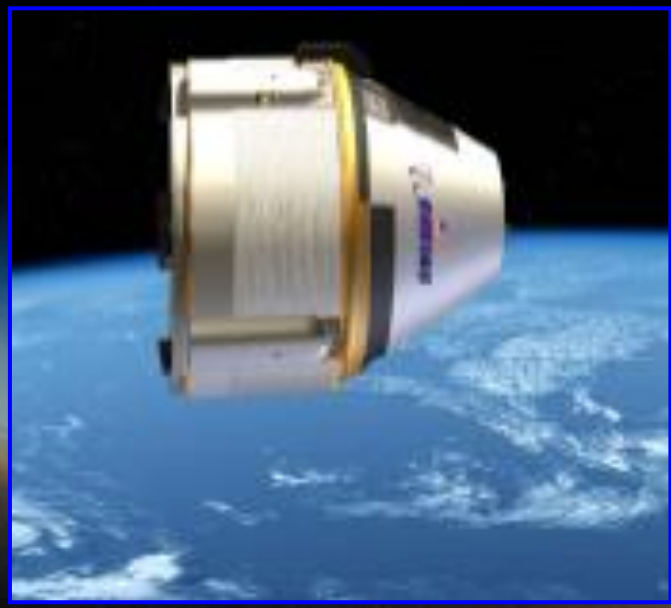
Commercial Crew

SPACEX

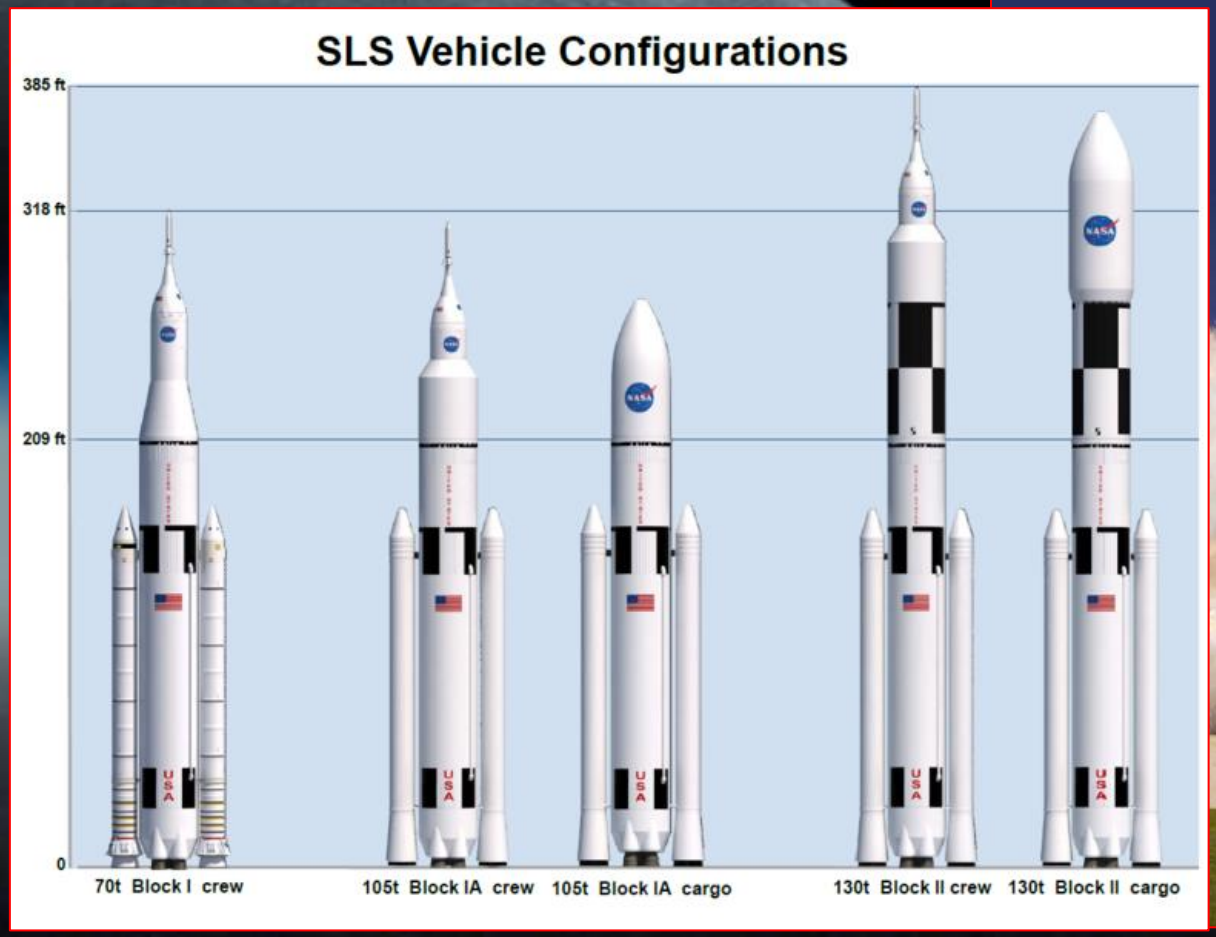


BOEING

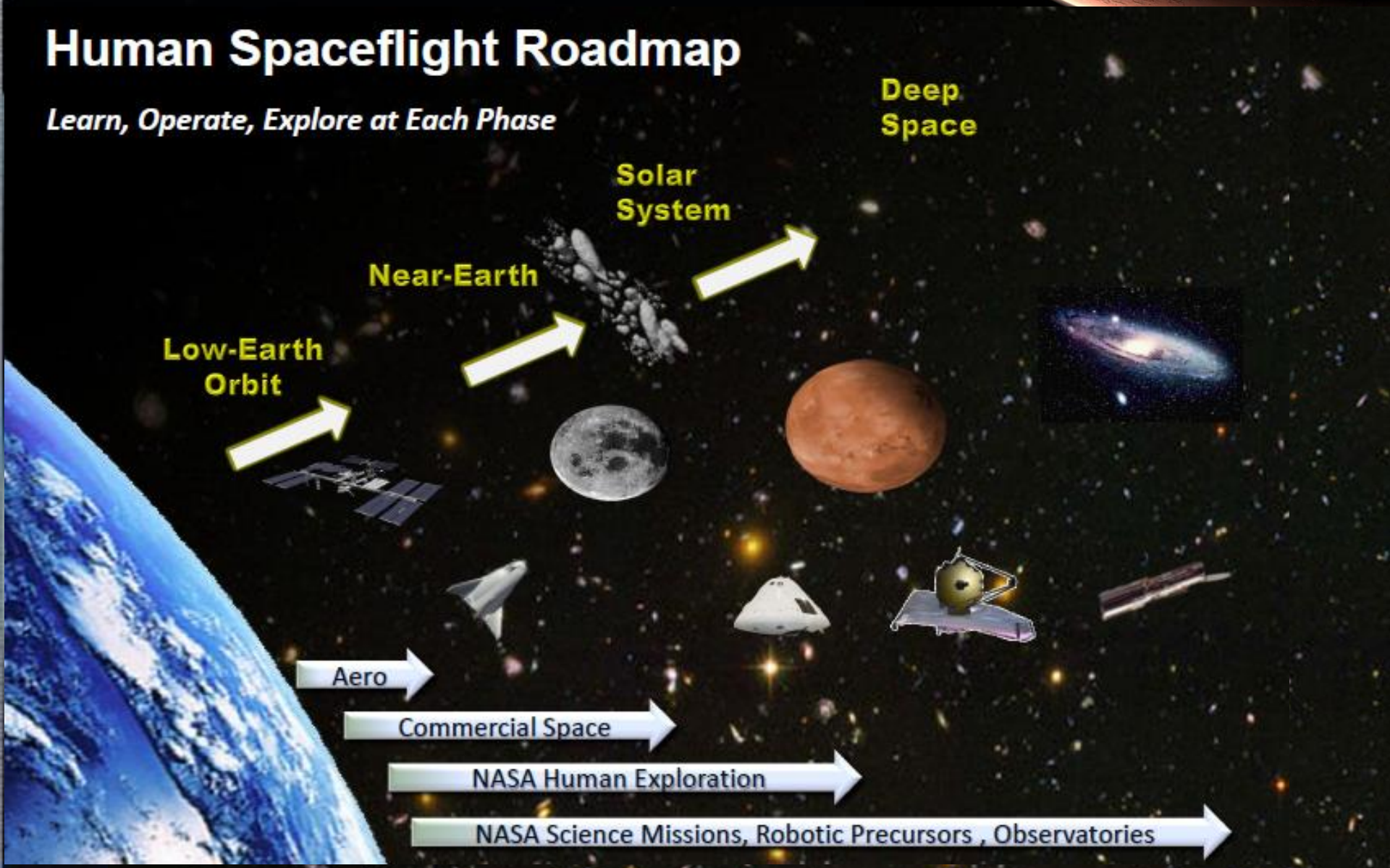
SIERRA NEVADA CORPORATION



Space Launch System



Moving Forward




Back-up

The Video

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