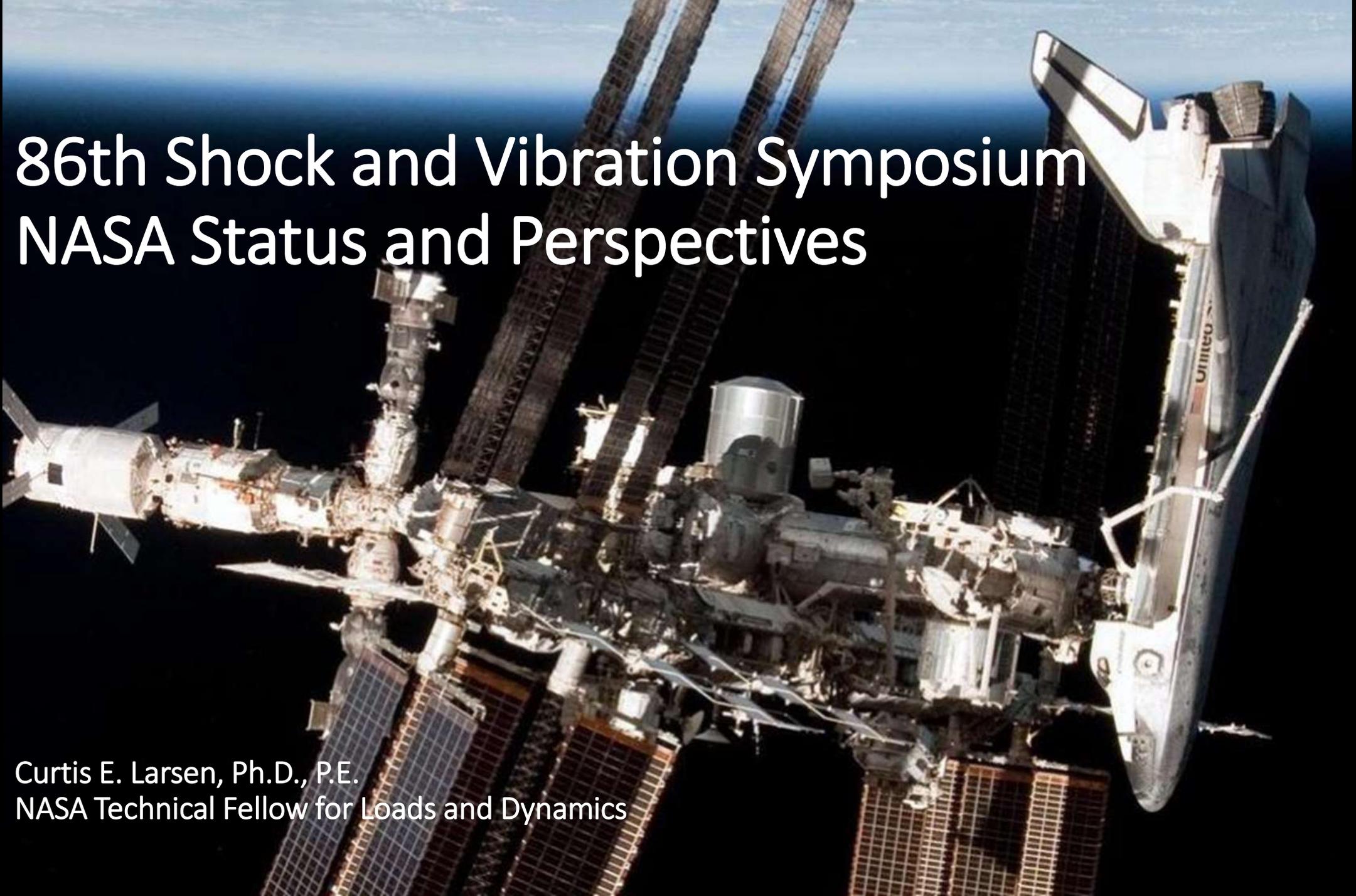


86th Shock and Vibration Symposium NASA Status and Perspectives

Curtis E. Larsen, Ph.D., P.E.
NASA Technical Fellow for Loads and Dynamics



















Progress Mission M-27M/59P

- <http://www.theguardian.com/science/video/2015/apr/29/progress-spacecraft-spinning-earth-space-video>
- <http://www.bbc.com/news/world-europe-32517447>



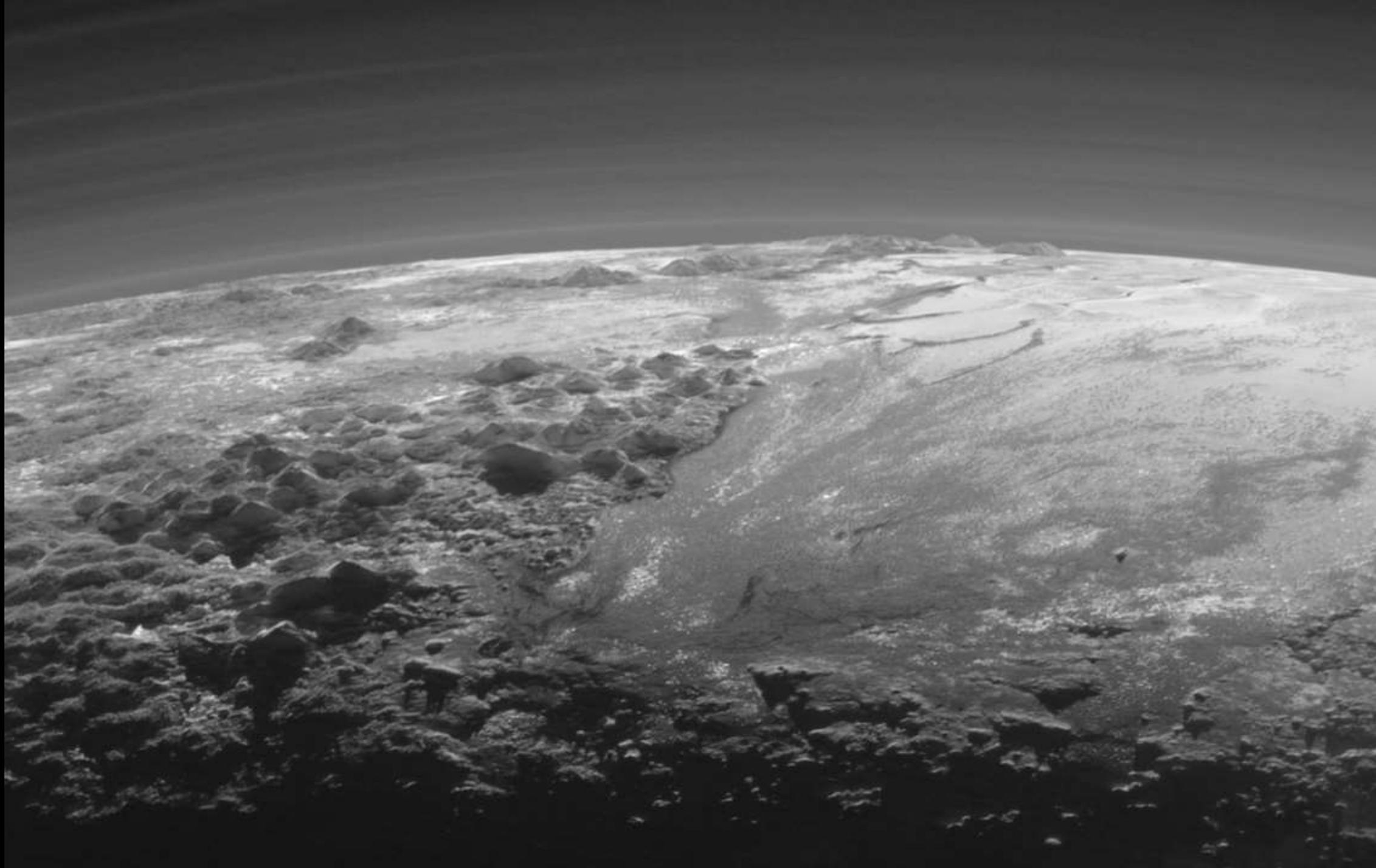




Earth From DSCOVR at 1×10^6 Miles







Kepler's Six Years In Science (and Counting)

By The Numbers*

2,258 DAYS
IN SPACE

2 MISSIONS
Kepler and K2

306,604
STARS OBSERVED

4,601
CANDIDATE
exoplanets

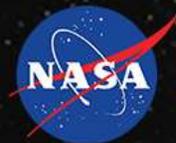
12.5 BILLION
brightness
measurements of stars

1,024
CONFIRMED
exoplanets

20.9
TERABYTES
publicly available data

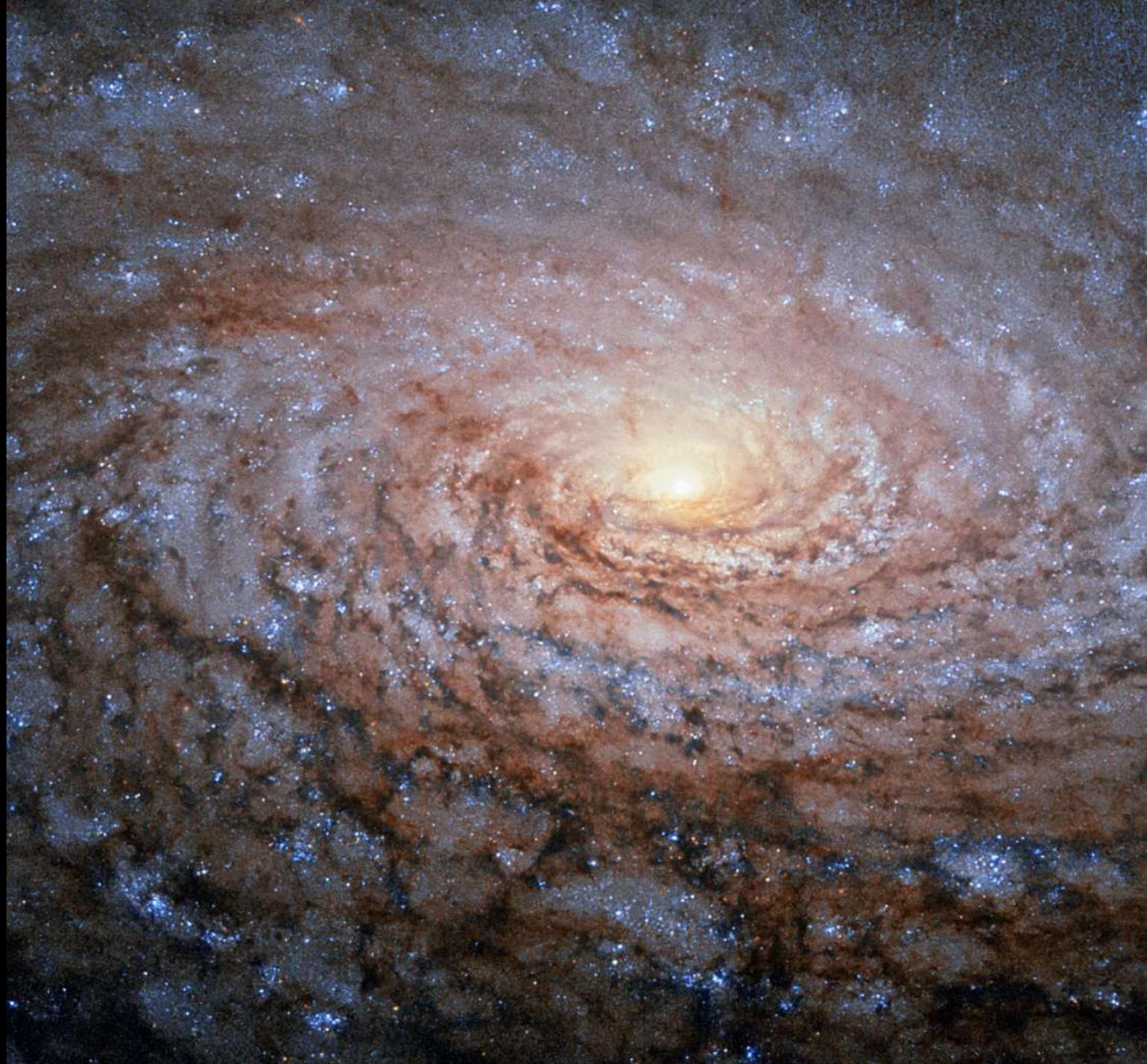
8 CONFIRMED
SMALL HABITABLE ZONE
EXOPLANETS

64 MILLION MILES AWAY
trailing Earth around the sun



www.nasa.gov/kepler

* As of May 12, 2015





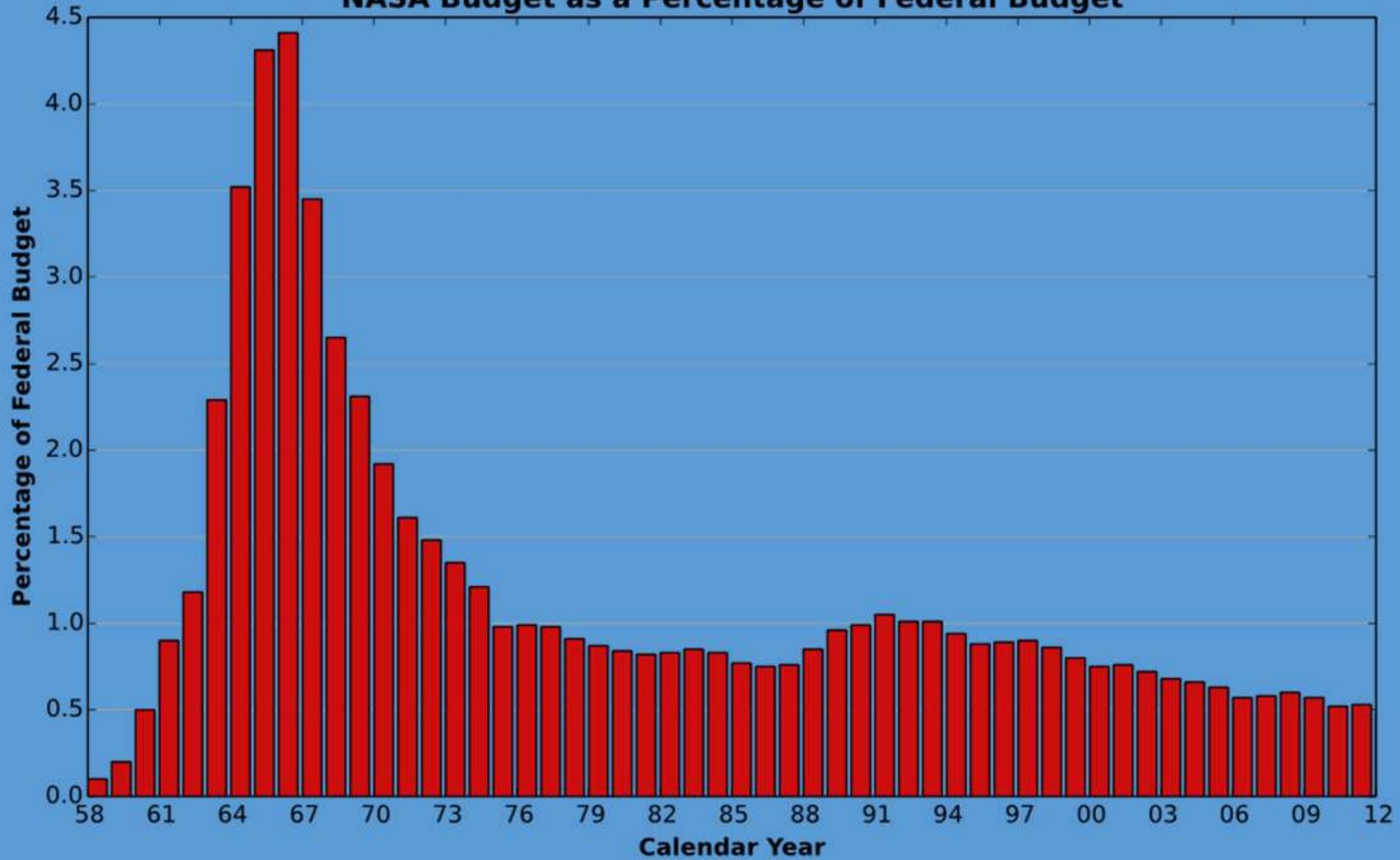


How much of our tax dollars is NASA using?

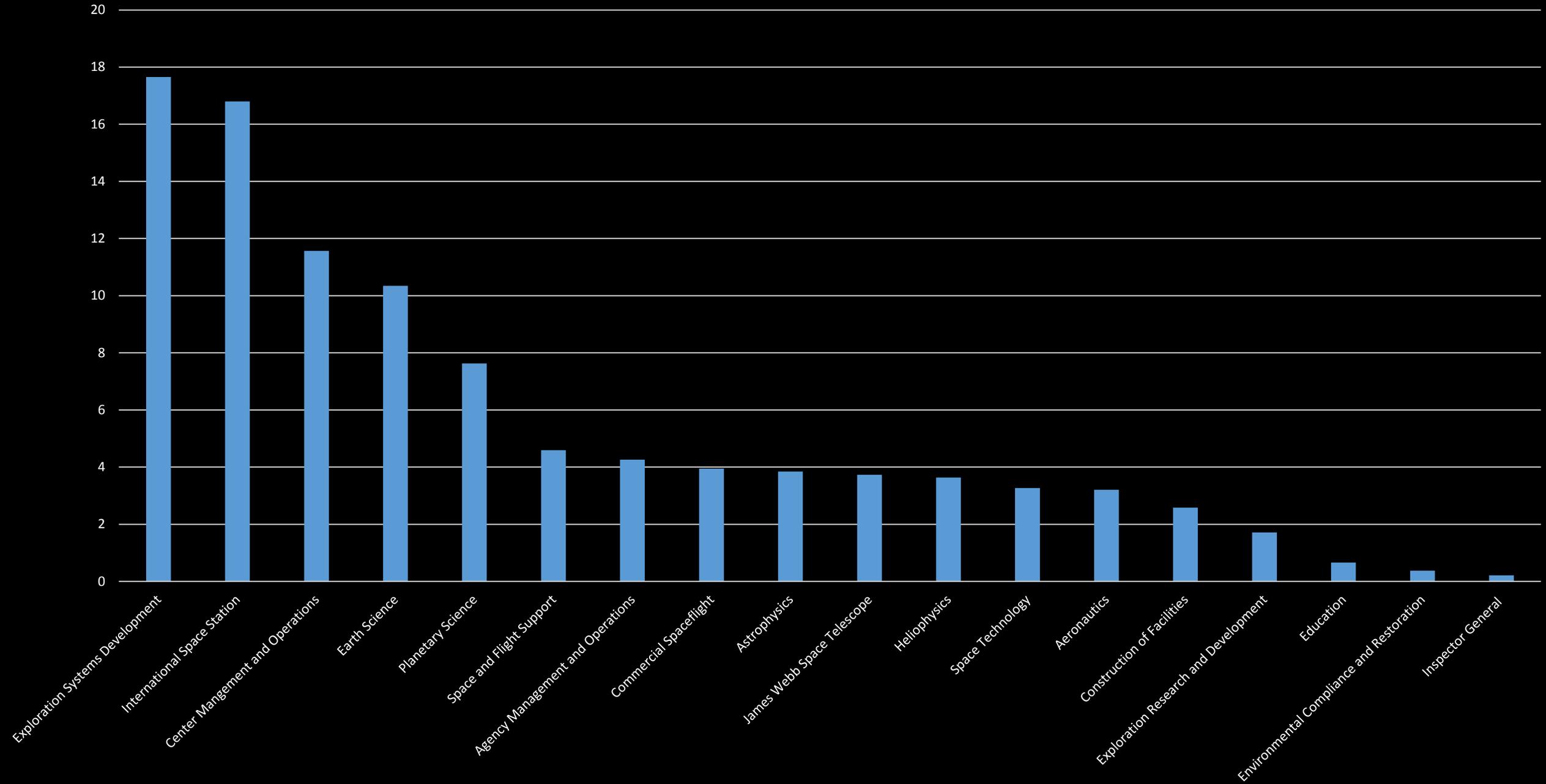
Comparison of spending in total Federal budget 2015

- <https://www.nationalpriorities.org/budget-basics/federal-budget-101/spending/>

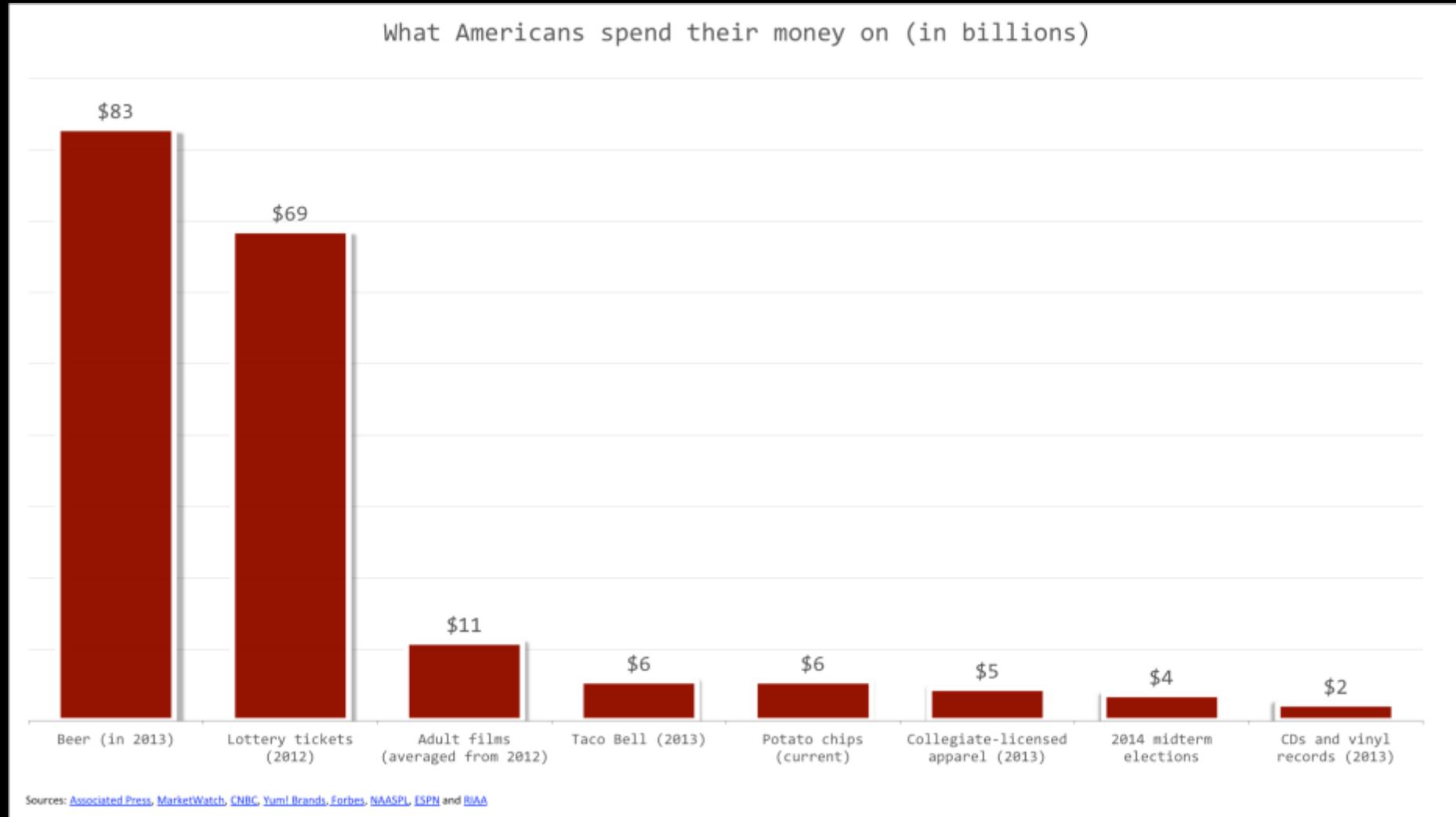
NASA Budget as a Percentage of Federal Budget



2014 Actual NASA Budget
Percentage of Total \$17.64650 Billion

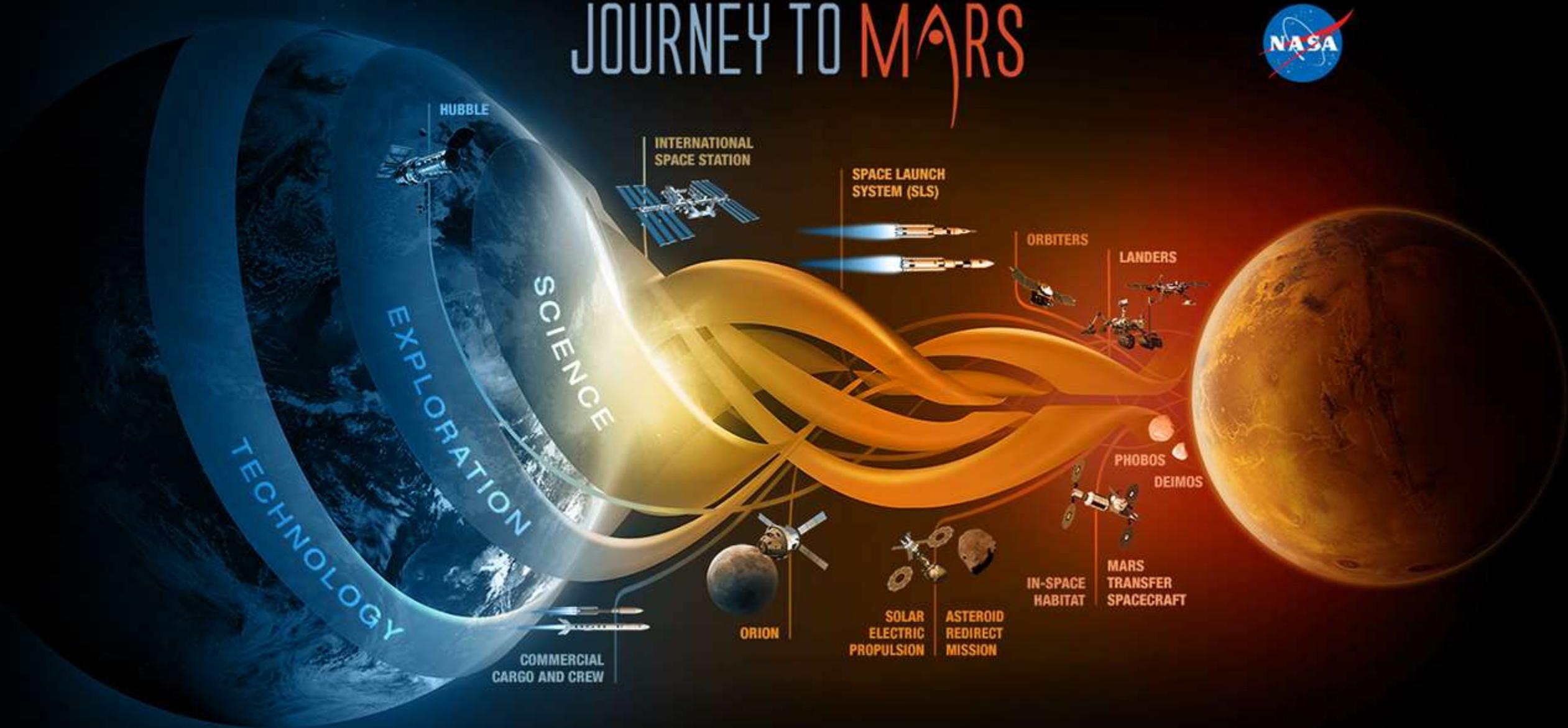


National Priorities?





JOURNEY TO MARS



HUBBLE

INTERNATIONAL SPACE STATION

SPACE LAUNCH SYSTEM (SLS)

ORBITERS

LANDERS

SCIENCE

EXPLORATION

TECHNOLOGY

COMMERCIAL CARGO AND CREW

ORION

SOLAR ELECTRIC PROPULSION

ASTEROID REDIRECT MISSION

PHOBOS

DEIMOS

IN-SPACE HABITAT

MARS TRANSFER SPACECRAFT





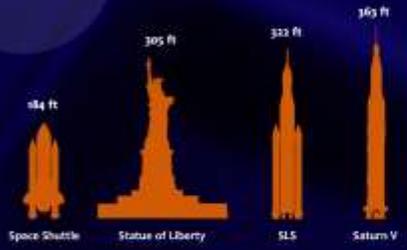
Being Exploration Mission-1, or EM-1, NASA's Space Launch System, or SLS, will carry an uncrewed Orion spacecraft into space on a mission that will take it 180,000 miles away from Earth.

While EM-1 is a test of SLS and Orion for human exploration, the power and flexibility of the rocket also enable future game-changing science missions that will expand our knowledge of our solar system and beyond.

This is only the beginning!

Meet the Rocket:

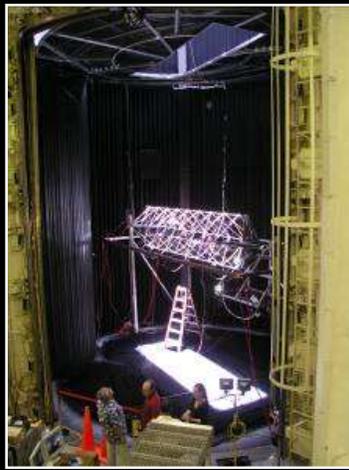
If you wonder how NASA's Space Launch System, or SLS, compares to earlier generations of NASA launch vehicles...



SLS will launch more than three times as much weight into space as the space shuttle.







NASA Engineering and Safety Center



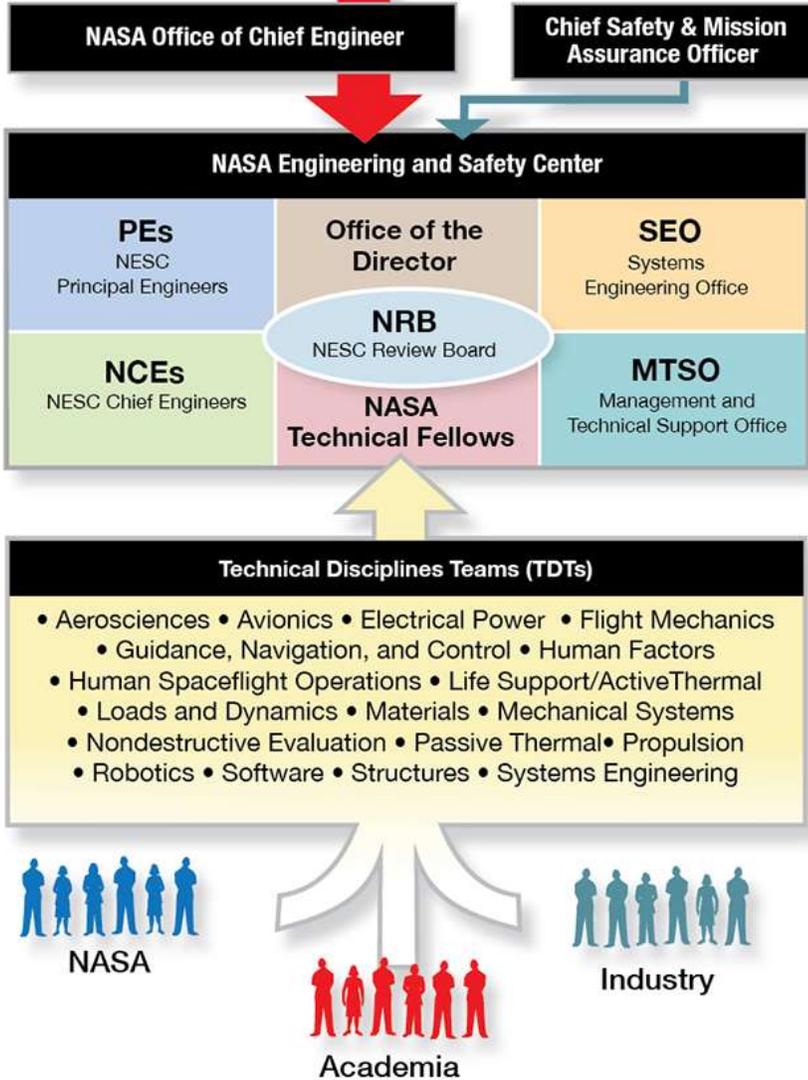
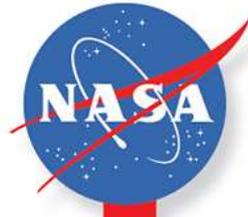
NASA Engineering and Safety Center (NESC)

- NESC was established in July 2003 in response to the Columbia accident
- Safety philosophy has 3 tenets:
 - Strong in-line checks and balances
 - Healthy tension
 - “Value added” independent assessment
- NESC provides independent assessment of technical issues for NASA programs and projects
- NESC is cultivating a Safety culture focused on **engineering and technical excellence**, while fostering an **open environment** and attacking challenges with **unequaled tenacity**

NESC Model

- Institutionalized “Tiger Team” approach to solving problems
- Agency-recognized NASA Technical Fellows lead Technical Discipline Teams (TDT)
 - TDTs include “ready” experts from across NASA, industry, academia and other government agencies
- Assemble diverse, expert technical teams that provide robust technical solutions to the Agency’s highest-risk and most complex issues

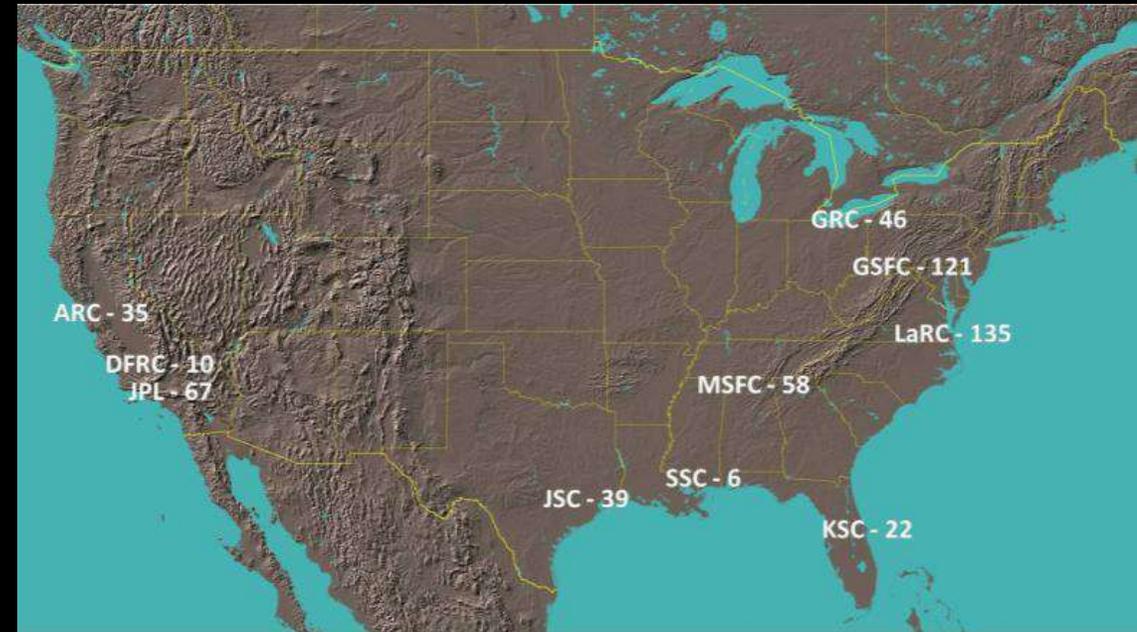




NESC Organization

Distributed NESC Team

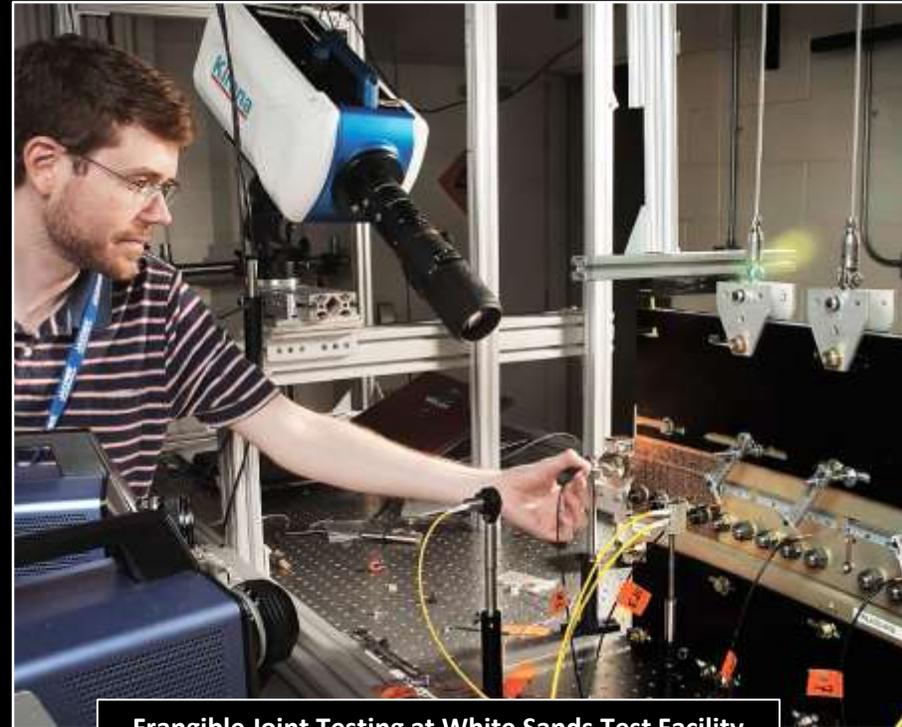
- NESC has 64 full-time employees selected from across the Agency and externally
- NESC Chief Engineers at each Center provide technical insight and liaison roles
- 18 NASA Technical Fellows are recognized experts in their respective engineering fields
- 21 Technical Discipline Teams (TDT) comprised of 19 engineering and 2 operations disciplines create a nationwide network of over 700 engineers available for matrix support
- More than 200 TDT members are drawn from industry, academia and other government agencies



NASA Personnel Providing Matrix Support to the NESC

NESC Technical Highlights

- ✓ Commercial Crew Program (CCP) Chief Engineer asked NESC to assess the risk of Frangible Joints (FJ) in CCP spacecraft designs
- ✓ Examined historical designs (Shuttle, Apollo, Atlas, Delta, other ELV), for usage history, failures and successes
- ✓ NESC has extensive FJ modeling and testing underway to characterize design sensitivities
- ✓ This work will advance our understanding of this hardware and facilitate its safe handling, installation, and operation in flight hardware



Frangible Joint Testing at White Sands Test Facility

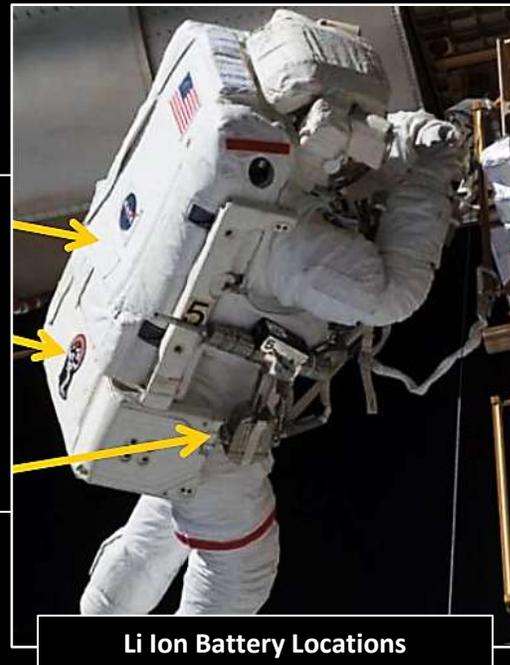
NESC Technical Highlights

- ✓ NESC participated in the ISS EVA Water Anomaly and EVA Recovery Team Failure Investigation



From US-EVA-23 MIB

- ✓ NESC is assessing the potential for ISS/EVA Lithium-Ion Battery thermal runaway and developing severity reduction measures



Life Support Power
- 80 Cells

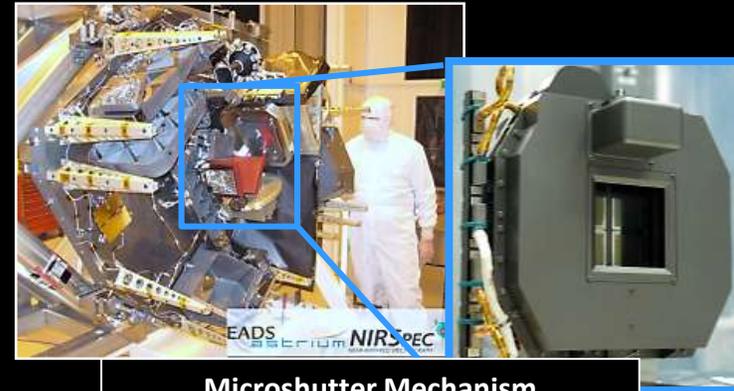
EVA Battery: Glove
Heaters, Lights,
etc. - 45 Cells

Pistol Grip Tool
- 10 Cells

Li Ion Battery Locations

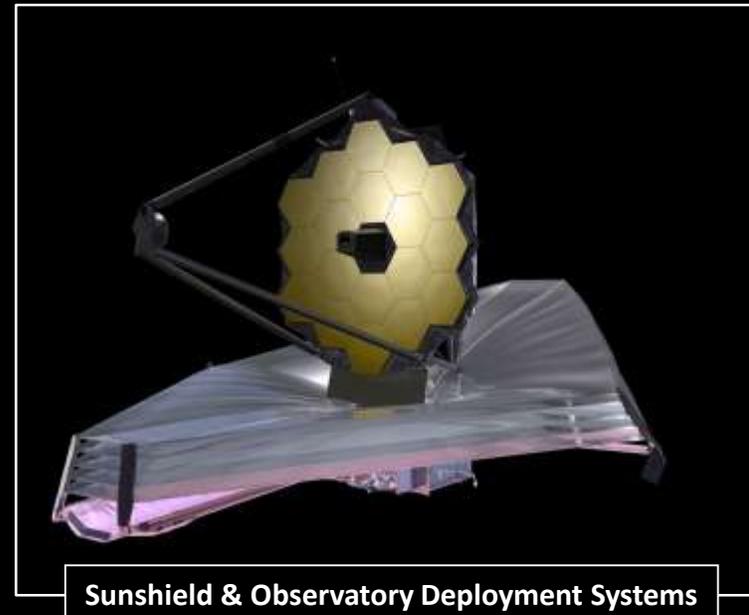
NESC Technical Highlights

- ✓ NESC conducted independent testing of the JWST micro-shutter mechanism to isolate the cause of unexpected wear. Determined there was debris from roller misalignment and insufficient lubrication.



Microshutter Mechanism

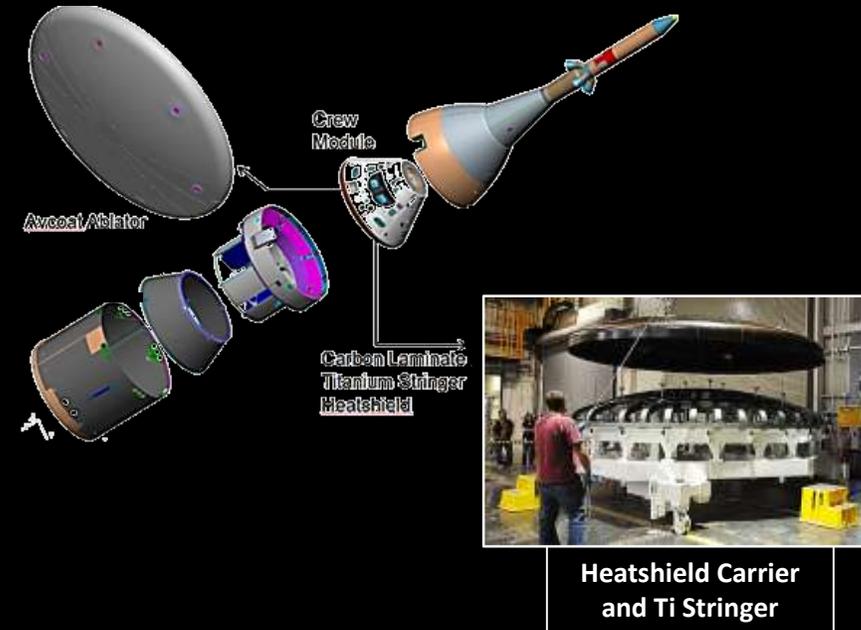
- ✓ NASA Technical Fellow for Mechanical Systems is providing peer review of critical Observatory deployment systems



Sunshield & Observatory Deployment Systems

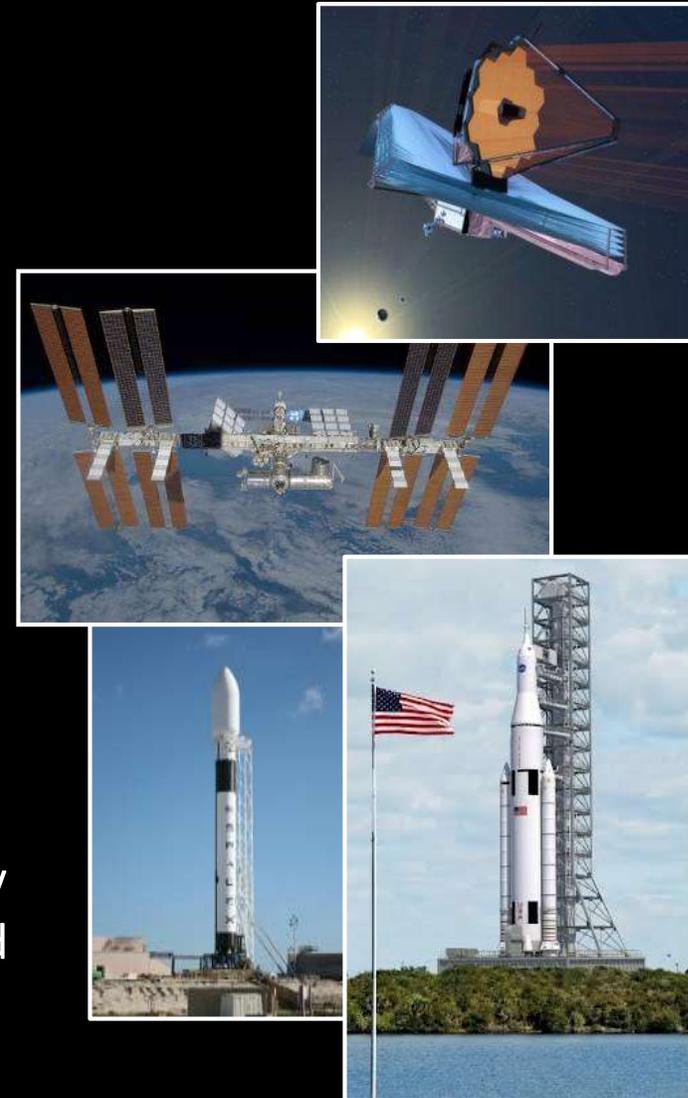
NESC Technical Highlights

- ✓ NESC conducted tests and analyses to isolate the cause of low material properties and cracking observed in the Avcoat used on the EFT-1 heat-shield
- ✓ NESC is assisting in development of bond verification techniques for Avcoat block

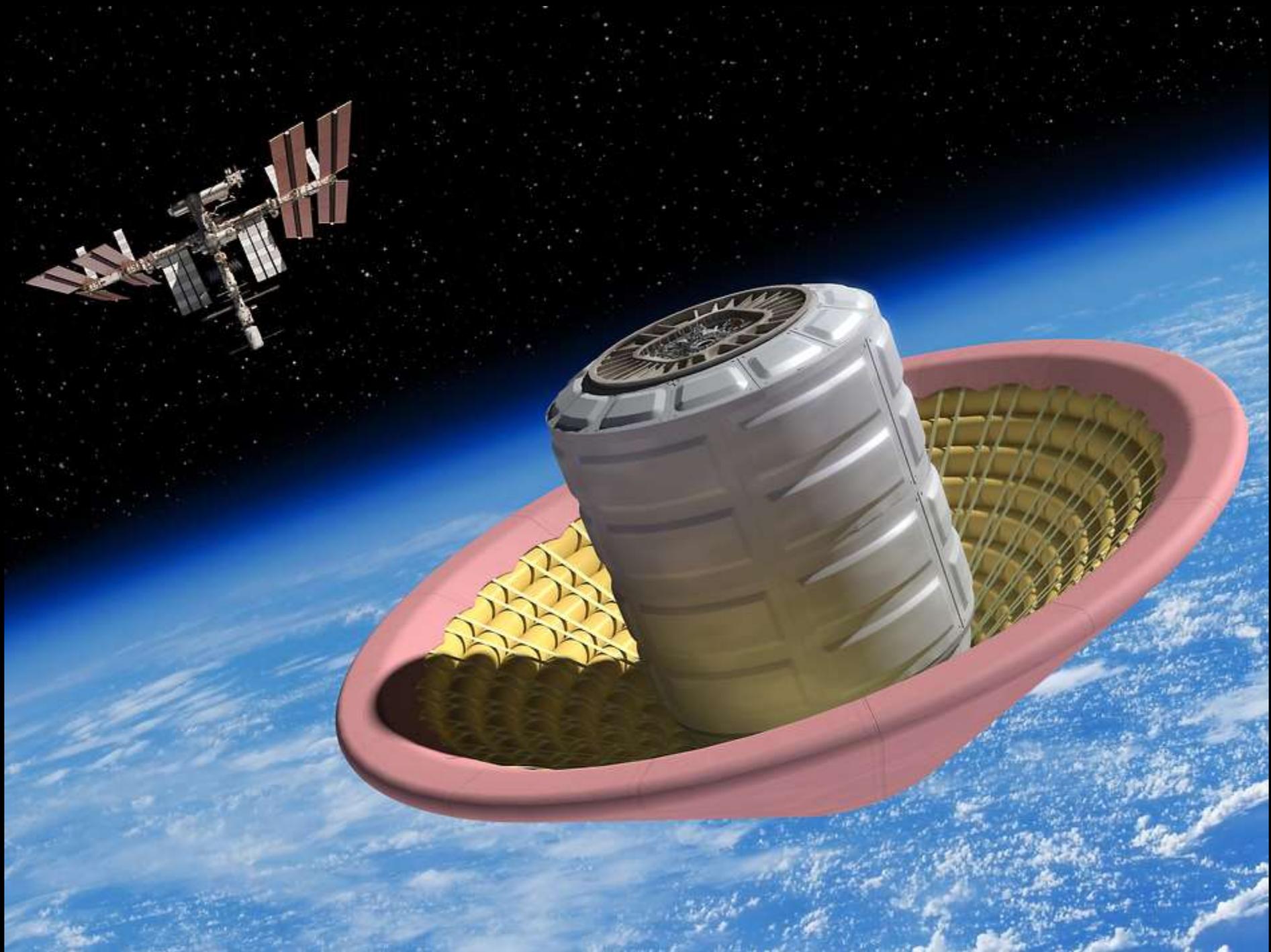


NESC Summary and Challenges

- ✓ NESC has established itself as the “value added” independent test and analysis organization for the Agency with over 600 Assessments in 11 years
- ✓ NESC continues to maintain and demonstrate a robust capability that includes outstanding support and participation in NESC assessments from the Centers
- ✓ NESC workload remains high and is distributed across all of NASA missions
- ✓ With three human space flight programs in development, one in operation, and multiple earth and planetary science programs in every lifecycle phase, continued Agency support and investment ensures NESC can continue to accomplish its mission









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Discipline Specific Challenges

- Particular areas for improvement include:
 - Quick turn-around coupled loads analysis (between major CLA cycles)
 - Efficient execution of integrated structural design cycle
 - Output Transformation Matrices with 10K's of recoveries!
 - Analysis of highly non-linear, complex systems with significant uncertainties:
 - Deployable or inflatable structures
 - Lander vehicles
 - Shock response prediction analyses and mitigation methods
 - Understanding and implementation of damping
 - Ascent loads and vibroacoustics Independent Verification & Validation
 - Interdisciplinary Monte Carlo ascent loads analysis
 - NASA in-house vibroacoustics tool





Loads and Dynamics

