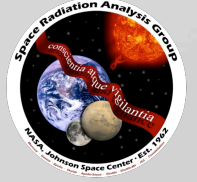
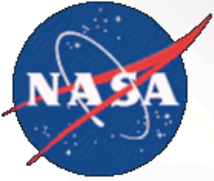


# NASA OPERATIONAL SPACE WEATHER NEEDS

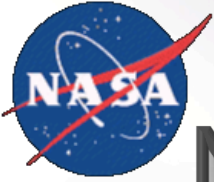
John R. Allen, NASA/HEOMD

CCMC Workshop  
Key Largo, FL  
January 16-20, 2011



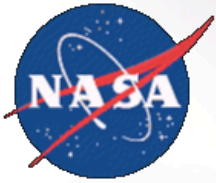
# Overview

- ▣ Introduction
- ▣ NASA Space Weather Needs
- ▣ Changes Within NASA
- ▣ Operational Space Weather Concerns
- ▣ Collaborative Activities
- ▣ Looking Toward the Future
- ▣ Summary



# NASA Space Weather Needs

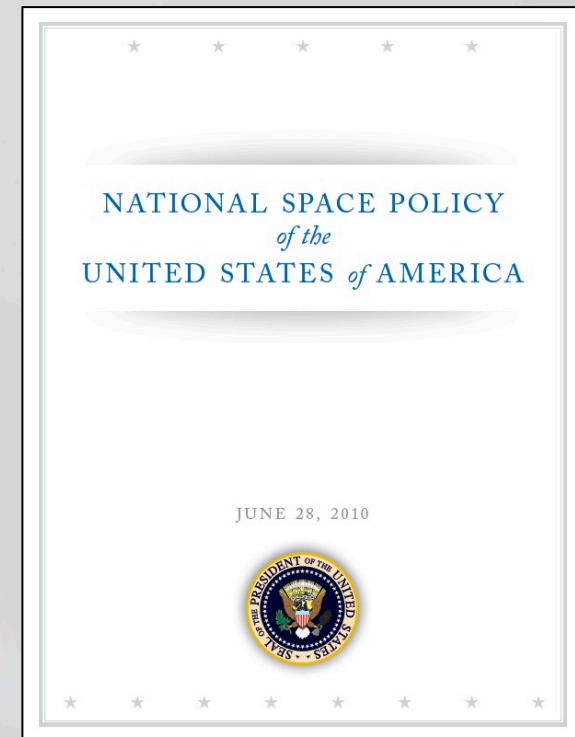
- ▣ Forecasting
  - For current human operational activities
- ▣ Forecasting
  - For current robotic missions
- ▣ Forecasting
  - For future exploration activities



# U.S. National Space Policy Goals

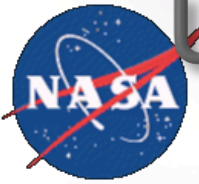


- Energize competitive domestic industries
- Expand international cooperation
- Strengthen stability in space
- Increase assurance and resilience of mission-essential functions
- Pursue human and robotic initiatives
- Improve space-based Earth and solar observation



"NASA has a key role in achieving the goals defined in the new policy. We are committed to working with other agencies, industry, and international partners to achieve national goals in exploration - human and robotic - and technology development that will ensure a robust future for the U.S. and our friends around the world." – NASA Administrator Charles Bolden, June 28, 2010

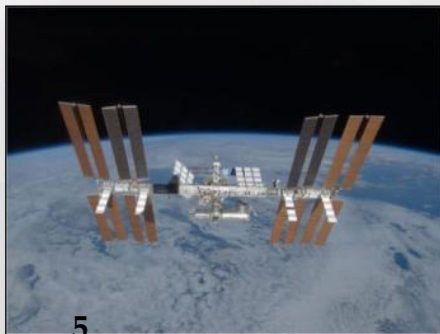




# U.S. Law: NASA Authorization Act of 2010

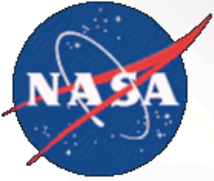


- ▣ The U.S. Congress approved and President Obama signed the National Aeronautics and Space Administration Authorization Act of 2010
  - Bipartisan support for human exploration beyond low Earth orbit
- ▣ The law authorizes:
  - Extension of the International Space Station until at least 2020
  - Support for a commercial space transportation industry
  - Development of a Multi-purpose Crew Vehicle and heavy lift launch capabilities
  - A “flexible path” approach to space exploration opening up vast opportunities including near-Earth asteroids (NEA), moon, and Mars
  - New space technology investments to increase the capabilities beyond low Earth orbit



5



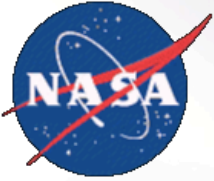


# The NASA Vision

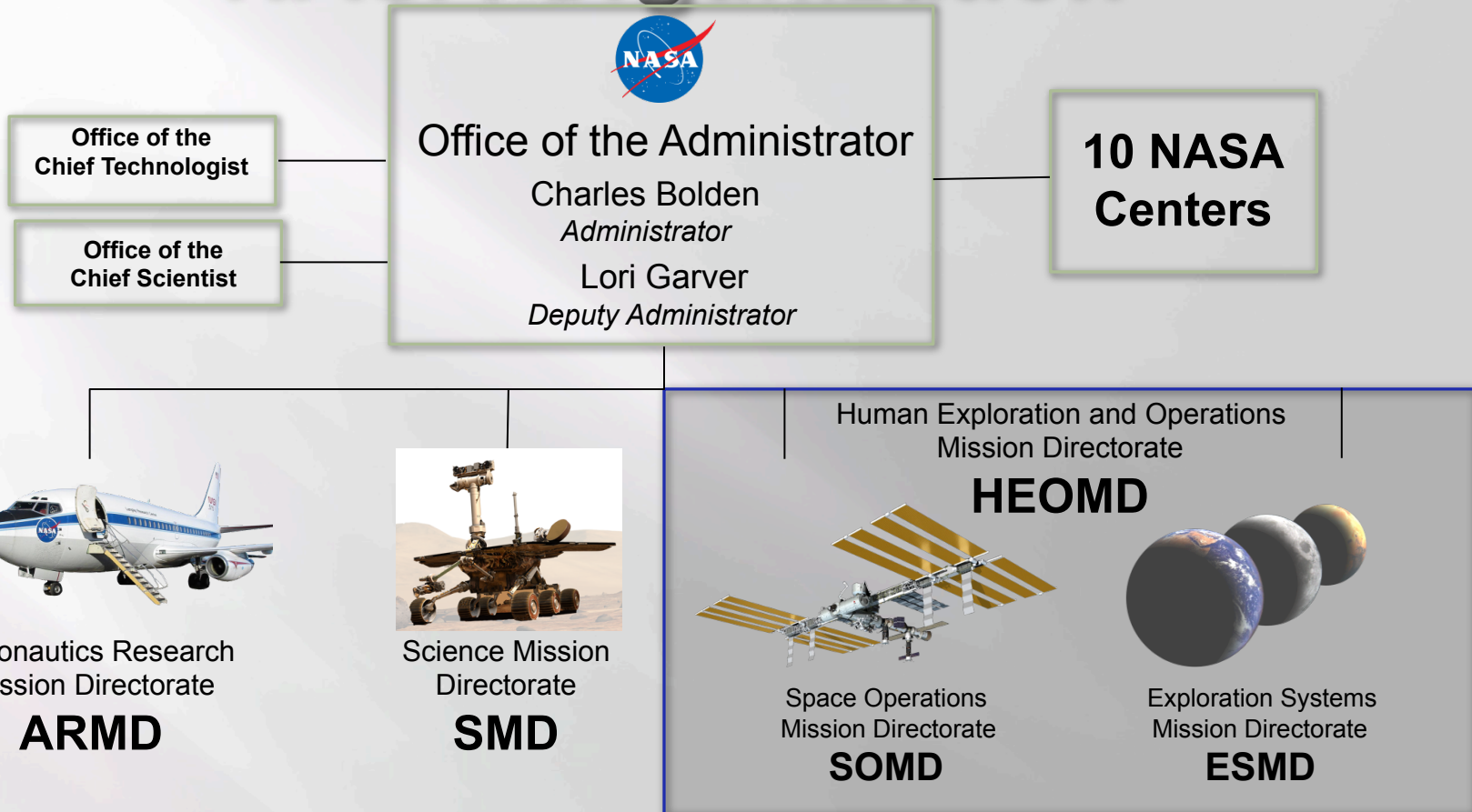
To reach for new heights and reveal the unknown, so that what we do and learn will benefit all humankind.

## NASA Strategic Goals

1. **Extend and sustain human activities across the solar system.**
2. **Expand scientific understanding of the Earth and the universe in which we live.**
3. **Create the innovative new space technologies for our exploration, science, and economic future.**
4. **Advance aeronautics research for societal benefit.**
5. **Enable program and institutional capabilities to conduct NASA's aeronautics and space activities.**
6. **Share NASA with the public, educators, and students to provide opportunities to participate in our mission, foster innovation, and contribute to a strong national economy.**



# NASA Organization

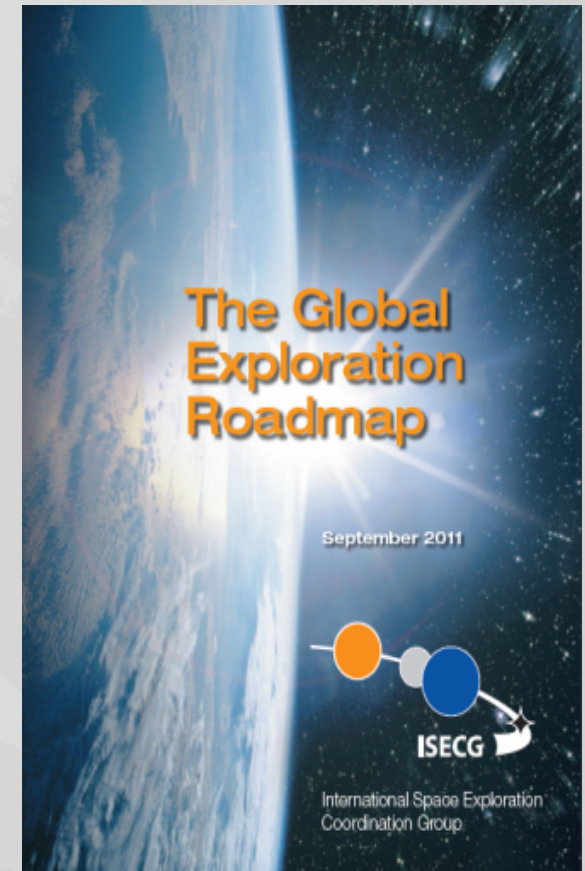




# The ISECG Global Exploration Roadmap



- The first iteration of the Global Exploration Roadmap was released by [International Space Exploration Coordination Group](#) in September 2011
- Reflects the international effort to collaboratively define technically feasible and programmatically implementable exploration mission scenarios with the common goal of humans on the surface of:
  - Asteroid, Moon, Mars
- A non-binding reference informing decisions related to exploration preparatory activities







# International Cooperation: Vital







# Capability Driven Human Space



Incremental steps to steadily build, test, refine, and qualify capabilities that lead to affordable flight elements and a deep space capability.

Mars: 33,900,000 mi  
54,556,000 km

## Planetary Exploration

- Mars
- Solar System

## Exploring Other Worlds

- Low-Gravity Bodies
- Full-Capability Near-Earth Asteroid Missions

- Phobos/Deimos

## Into the Solar System

- Interplanetary Space
- Initial Near-Earth Asteroid Missions

- Lunar Surface

## Extending Reach Beyond LEO

- Cis-Lunar Space
- Geostationary Orbit
- High-Earth Orbit

- Lunar Flyby & Orbit

## Initial Exploration Missions

- International Space Station
- Space Launch System
- Orion Multi-Purpose Crew Vehicle
- 21st Century Ground Systems
- Commercial Spaceflight Development

Moon: 237K mi / 381K km

ISS: 237 mi / 381 km

Surface Capabilities Needed

Advanced Propulsion Needed

High Thrust In-Space Propulsion Needed

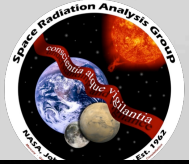
Long Duration Habitat Needed







# The International Space Station

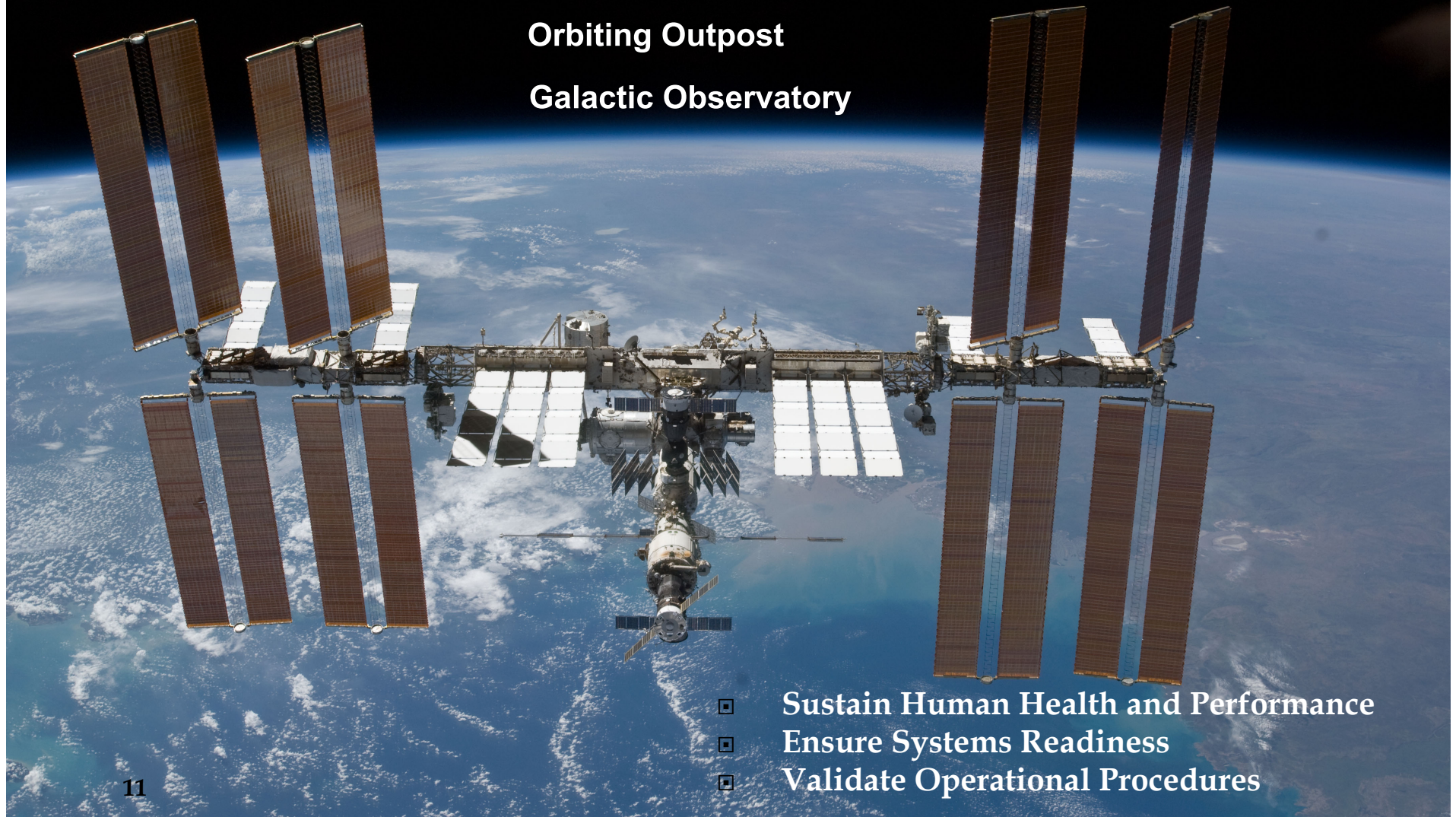


**Scientific Laboratory**

**Technology Testbed**

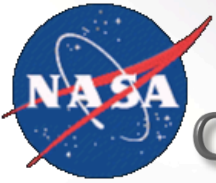
**Orbiting Outpost**

**Galactic Observatory**



- ❑ Sustain Human Health and Performance
- ❑ Ensure Systems Readiness
- ❑ Validate Operational Procedures



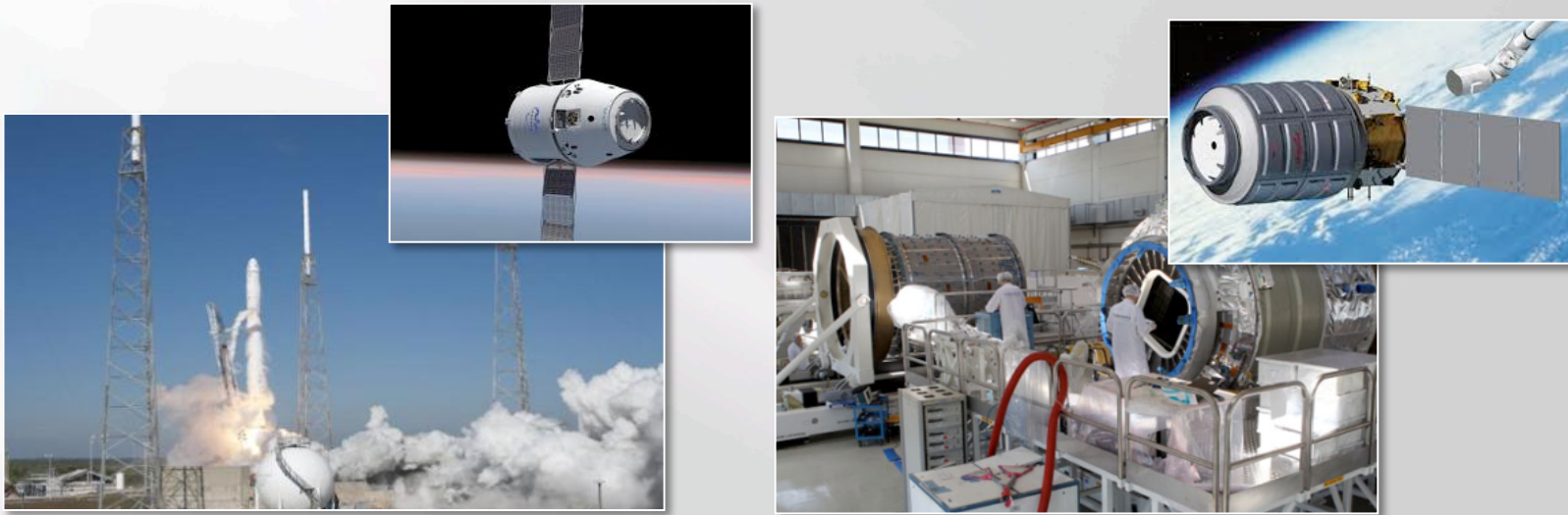


# Commercial Spaceflight Development Partners



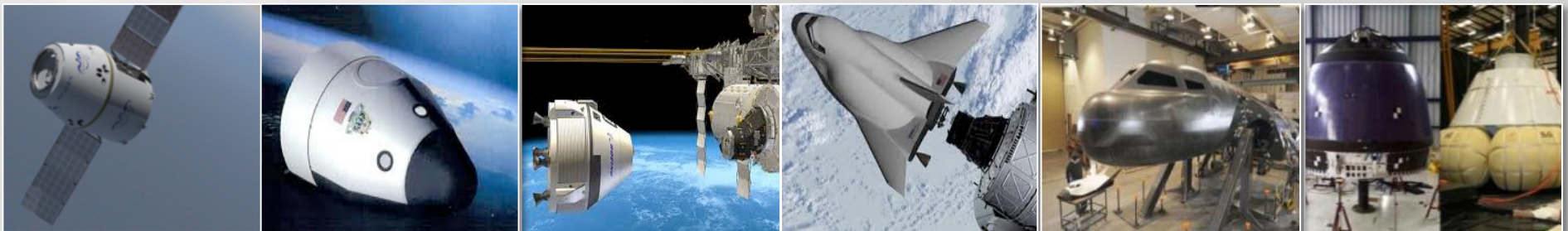
## Cargo Transportation

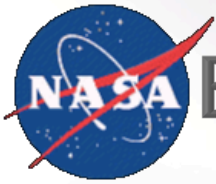
Space Exploration Technologies (SpaceX), Orbital Sciences



## Future Crew Transportation

Blue Origin, Sierra Nevada Corporation, SpaceX, The Boeing Company



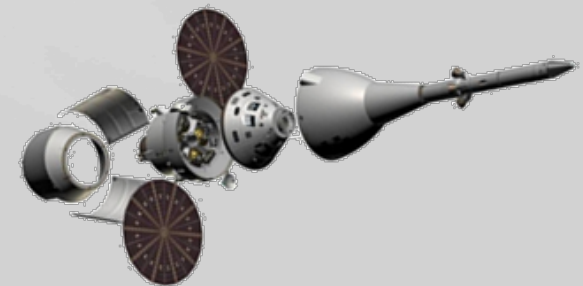


# Exploration Systems Development

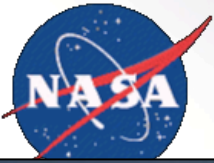


**These programs will develop the launch and spaceflight vehicles that will provide the initial capability for crewed exploration missions beyond LEO.**

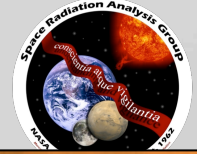
- The **Space Launch System (SLS)** program will develop the heavy lift vehicle that will launch the crew vehicle, other modules, and cargo for these missions
- The **Orion** program develops the vehicle that will carry the crew to orbit, provide emergency abort capability, sustain the crew while in space, and provide safe re-entry from deep space return velocities
- SLS and Orion will support **Ground Operations and Mission Operations**



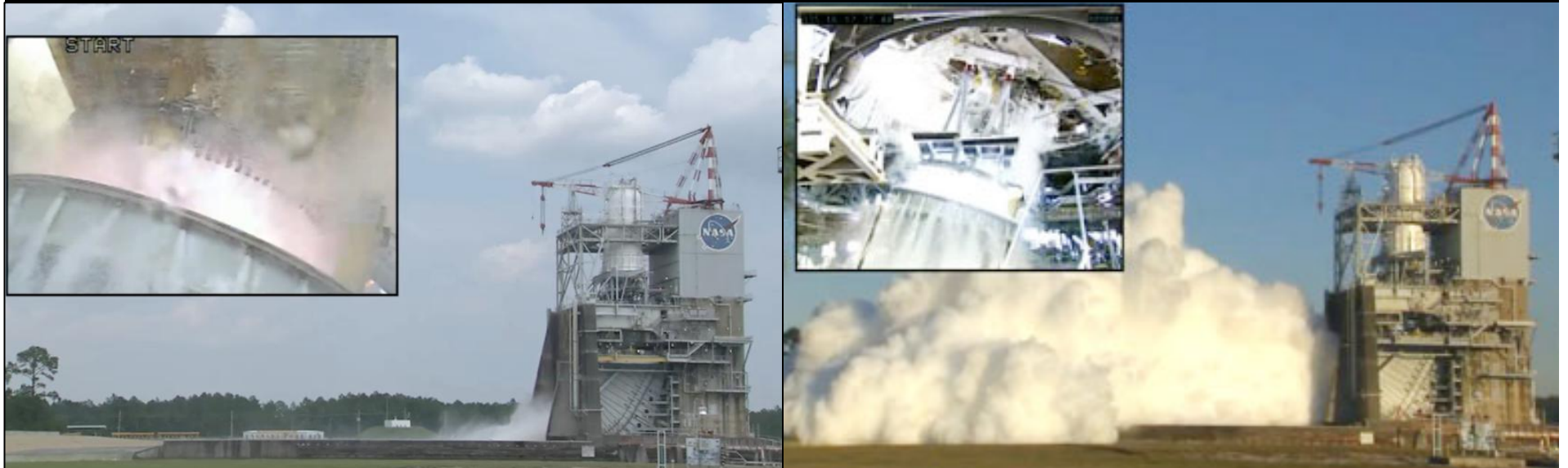




# SLS Progress



**DM-3 Static Test, Sept. 2011**



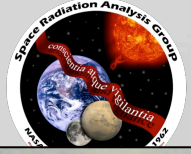
**J-2X 500-Second Engine Test, Nov. 2011**

**J-2X Combustion Stability Test, Dec. 2011**





# Orion MPCV Progress



**Water Landing Tests**



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**Acoustic Chamber Testing**

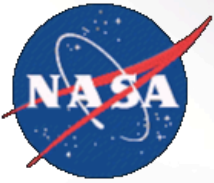


**Parachute Testing**



**Pad Abort 1 Flight Test**

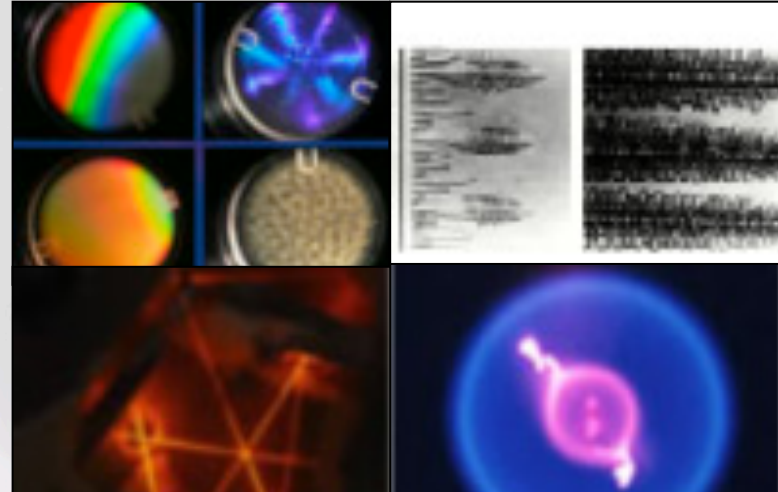




# Space Life and Physical Sciences Research and Applications



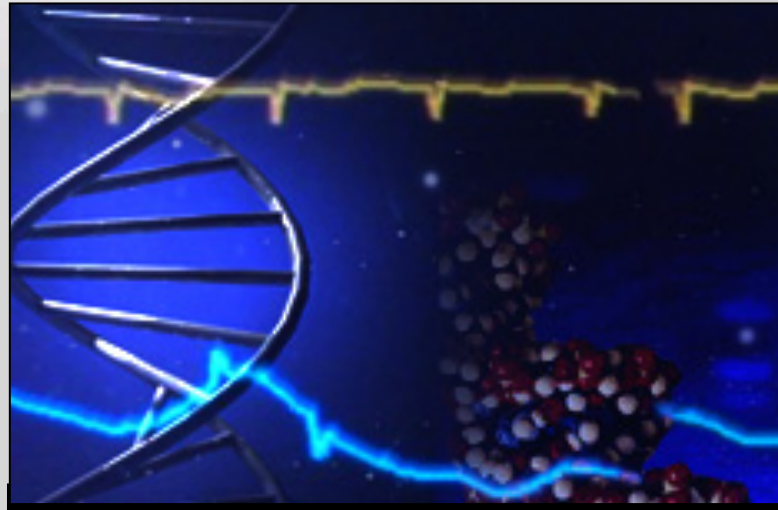
**Physical Sciences**



**Physical Sciences**



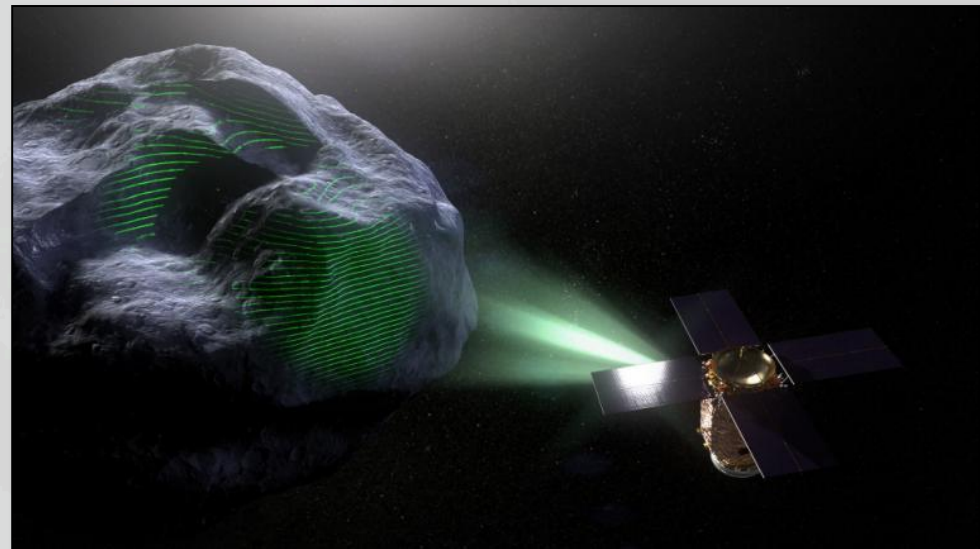
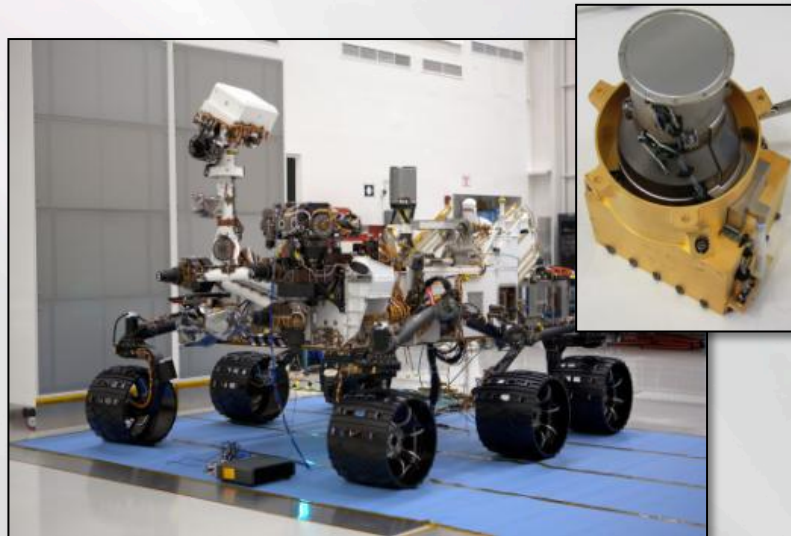
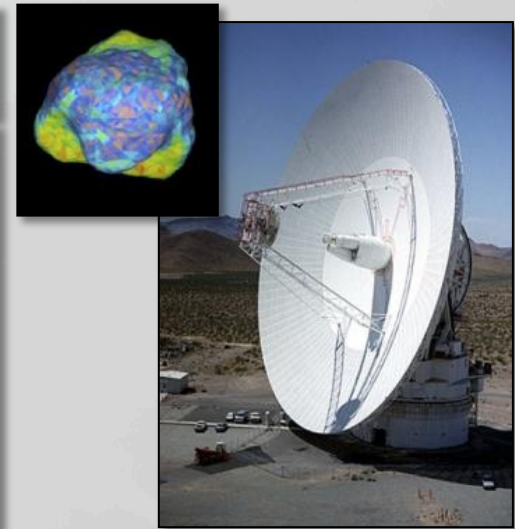
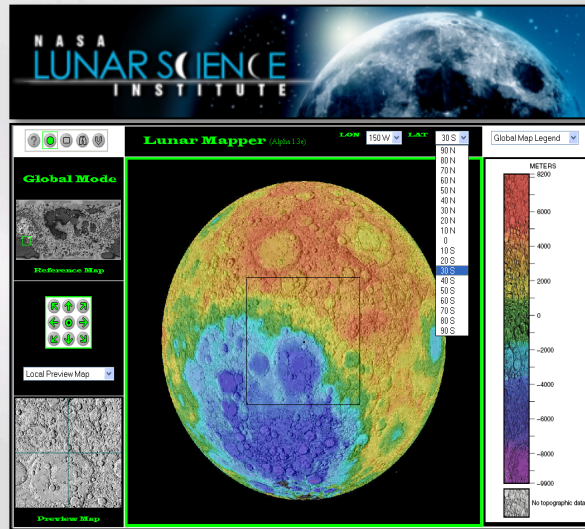
**Human Research**



**Crew Health and Safety**



# Robotic Precursor Missions Pave the Way for Future Human Exploration Missions





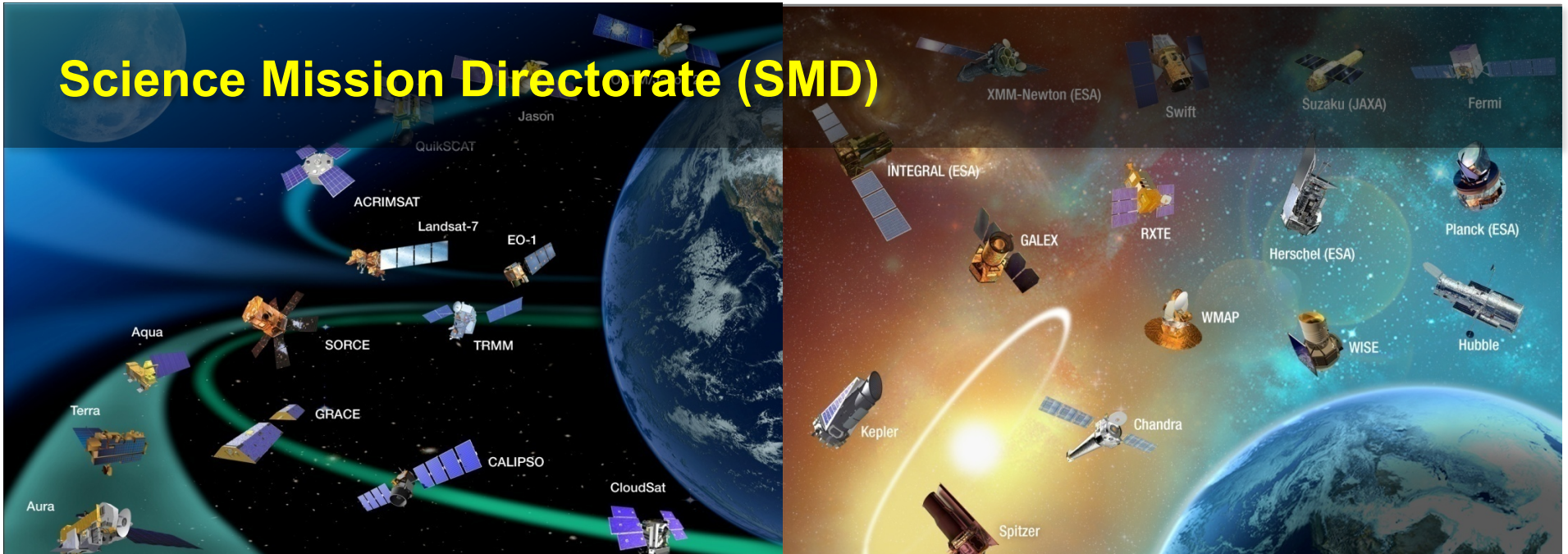


# Interoperability Allows Flexibility and Collaboration

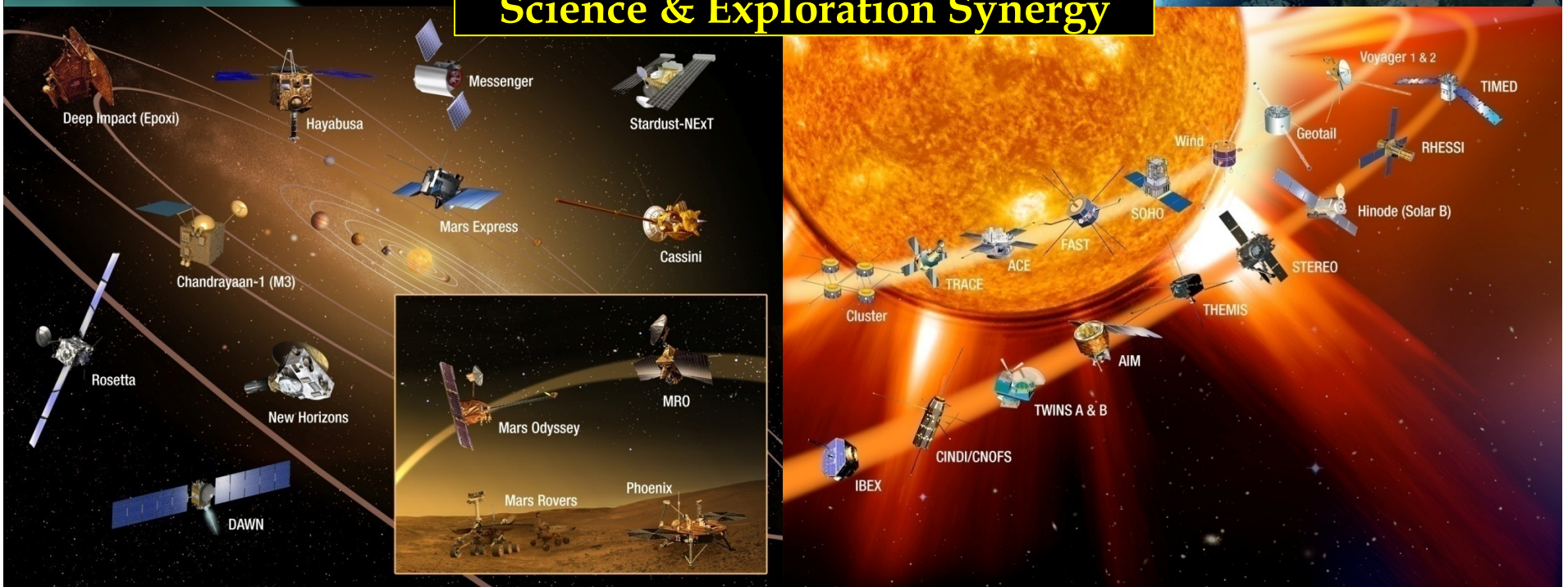




# Science Mission Directorate (SMD)



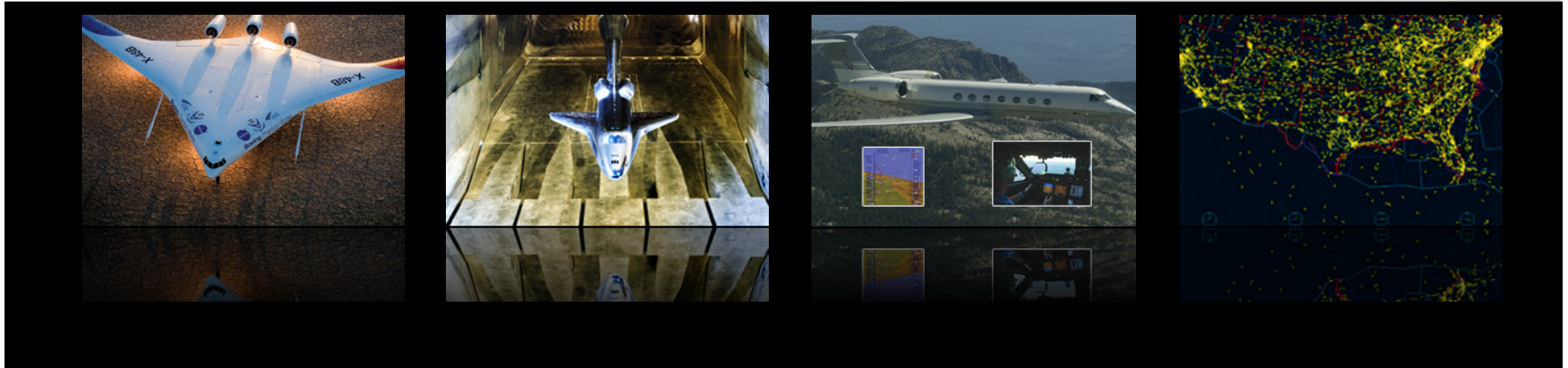
## Science & Exploration Synergy



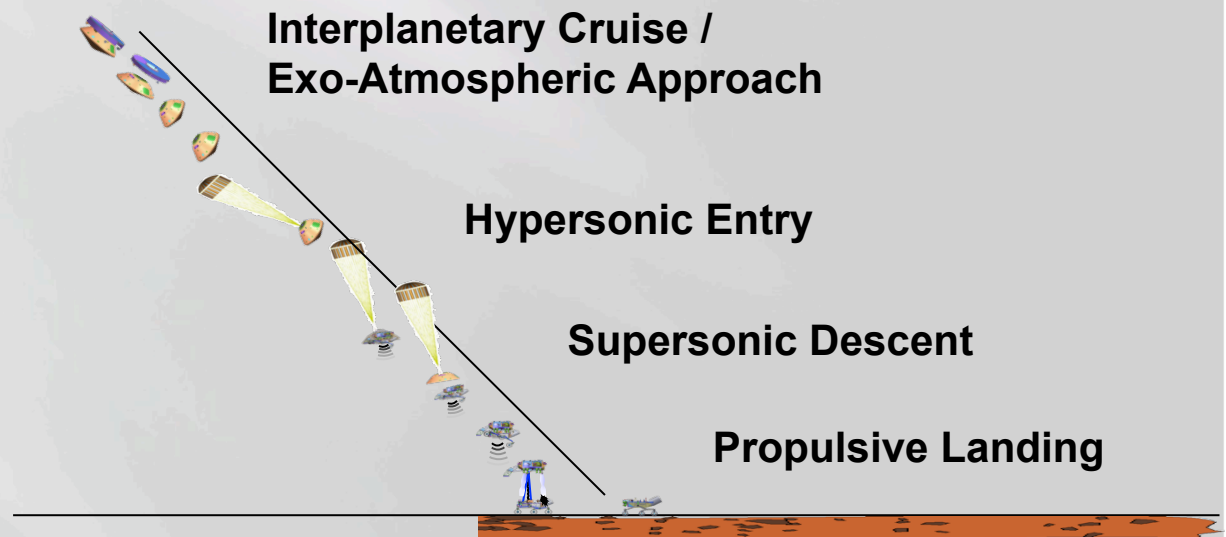


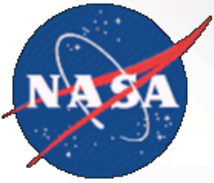


# Aeronautics Research Mission Directorate (ARMD)



- Aeronautics research and space exploration have always been linked.
- Advances in understanding aerodynamics, aerothermodynamics, flight dynamics and control, materials, structures, and human interface technologies helped make spaceflight possible.
- NASA continues to rely on its aeronautics expertise to solve challenges of flying vehicles into space and other planetary atmospheres.





# Operational Concerns

## Launch

- Communication loss (Solar Proton Event, geomagnetic storming, solar flaring)
- Launch into higher radiation environment

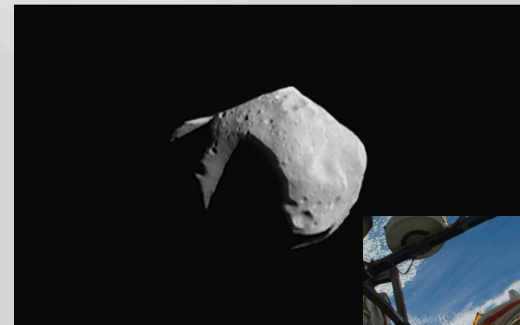
## Nominal IVA Mission Ops

- Crew Health: minimize exposure risk
- Damage to orbital/transit vehicles
- Extended mission lengths (Lunar, Cis-Lunar, NEO, Mars)

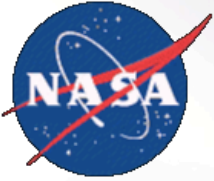


## EVA

- Increased crew exposure
- Hardware damage
- Up to ~7 hour duration
- Possibly longer lead time to shelter (Lunar)



ISS02E025742



# Space Wx Collaboration

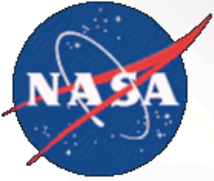
- ▣ Operations and Science Collaboration
  - NASA Space Weather Work Group
- ▣ SRAG receiving Space Weather Alerts
  - Weekly reports from the NASA GSFC Space Weather Center
- ▣ SRAG inputs have helped in designing some of the iSWA features
  - Magnetic connectivity product for SEP
- ▣ Collaborative project: Integrated Solar Energetic Proton (ISEP)
  - Alert warning system
  - Collaboration between JSC, GSFC, MSFC and LaRC
  - Largely an exercise in the transition of research to ops
  - Will hit probabilistic models for mission planning, all-clear forecasting, and real-time dose projection once an event kicks off
  - Being supported by OCT Game Changing program



# Looking Towards the Future



- ISS - centerpiece of human spaceflight activities until at least 2020
- Research/technology breakthroughs aboard ISS will facilitate travel to destinations beyond low Earth orbit
- Destinations for human exploration remain ambitious: moon, asteroids and Mars
- Continue to undertake world-class science missions to
  - observe our planet,
  - reach destinations throughout the solar system and
  - peer even deeper into the universe
- Advance aeronautics research to create a safer, more environmentally friendly and efficient air travel network for the Next Generation Air Transportation System
- Continue to inspire the next generation of scientists, engineers and astronauts by focusing on STEM education initiatives
- <sup>23</sup> Flexible path: for human and robotic missions to...



# Summary

- ▣ Cooperation between human space ops (SRAG) and CCMC is excellent and continues
- ▣ Challenges of working within a constantly changing and constrained environment
- ▣ Change is focused on the future
- ▣ Operations and Science
  - Research to Operations
- ▣ Promising collaborations