Goddard Memorial Symposium

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for Human Exploration and Operations
ISS One-Year Mission

• 2015 marks the launch of astronaut Scott Kelly and cosmonaut Mikhail Kornienko to the ISS for 12 months – the longest mission ever assigned to a US astronaut
  – Joint US/Russian ISS research includes studies on: ocular health, immune and cardiovascular systems, cognitive performance testing, and effectiveness of countermeasure against bone and muscle loss

• HRP study of identical twins astronaut Scott Kelly, and retired astronaut, Mark Kelly
  – Provides unprecedented opportunity to research effects of spaceflight on twin genetic makeup, and better understand the impacts of spaceflight on the human body

http://www.nasa.gov/exploration/humanresearch/index.html
Beginning human exploration beyond LEO as soon as practicable helps secure our future in space.
Orion Accomplishments

- Ogive panels installed, Orion moved to launch pad
- Orion / Delta ready on pad ready for launch
- Service Module Panel Jettison
- Parachutes deploy after EFT-1 flight
- EM-1 Pathfinder Barrel machining
- EM-1 Tunnel Machining
Booster installed at ATK for Qualification Motor-1 test in March

RS-25 testing for SLS begins at Stennis Space Center

Delivery of new engine controller unit for RS-25 engines

SLS Stage Adapter flies successfully on Orion’s EFT-1 launch

First flight barrel section produced at Michoud Assembly Facility

Construction begins on core stage test stands at Marshall Space Flight Center
GSDO Accomplishments

The Orion crew module recovered Dec. 5 after splashdown in the Pacific Ocean.

Upgrades and modifications continue on the 175-ton crane inside the VAB.

Modifications continue on the Mobile Launcher at Kennedy Space Center Florida.
VALIDATE

- Advanced Solar Electric Propulsion (SEP) systems to move large masses in interplanetary space
- LDRO as a staging point for large cargo masses en route to Mars
- SLS and Orion in deep space
- Long duration, deep space habitation systems
- Crew health and performance in a deep space environment
- In-Situ Resource Utilization in micro-g
- Operations with reduced logistics capability
- Structures and mechanisms

CONDUCT

- EVAs in deep space with sample handling in micro-g
- Integrated human and robotic mission operations
- Capability Pathfinder and SKG missions
Cis-Lunar Space:
How the Earth and the Moon Interact

The contours on the plot depict energy states in the Earth-Moon System and the relative difficulty of moving from one place to another. A spacecraft at L2 is actually orbiting Earth at a distance just past the Moon, however if you look at it from the Moon, the orbit will look like an ellipse around a point in space giving them the name “halo orbits”.

The interaction of the Earth and Moon creates bends in the energy contours that can be used to lower the energy needed to move around the Earth-Moon system and beyond, such as this example of a low energy transfer between L1 and L2.

The Lunar Distant Retrograde Orbit leverages these equilibrium and low energy contours to enable a stable orbit with respect to the Earth and Moon, that is accessible with about the same energy as L1 or L2.
ARM is a Stepping Stone to Higher Power SEP Needed to Support Human Missions to Mars

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<th>Mars Moons</th>
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Solar Array Power (kW)

- Deep Space 1: 1 kW
- Dawn: 10 kW
- ARM: 100 kW
- SEP Mars Cargo: 1000 kW
- Chem/SEP Mars Crew: 300-700 kW
Using SEP for pre-emplacement of cargo and destination systems enables sustainable Mars campaign

- Minimizes the cargo needed to be transported with the crew on future launches
- Enables a more sustainable launch cadence
- Pre-positions assets for crew missions, allowing for system checkout in the Mars vicinity prior to committing to crew portion of mission
DRO as an aggregation point for Mars habitation systems
  • Provides a stable environment and ease of access for testing Proving Ground capabilities
  • Allows for Mars transit vehicle build-up and checkout in the deep-space environment prior to crew departure
  • Able to transfer Mars Transit Vehicle from DRO to High Earth Orbit with small amount of propellant to rendezvous with crew in Orion – HEO is more efficient location to leave Earth-moon system for Mars vicinity
Returning from Mars, the crew will return to Earth in Orion and the Mars Transit Habitat will return to the staging point in cis-lunar space for refurbishment in support of future missions.
Expand human presence into the solar system and to the surface of Mars to advance exploration, science, innovation, benefits to humanity, and international collaboration.