



Human Exploration and Operations Committee Status

Ken Bowersox
Committee Chair
July 31st, 2014



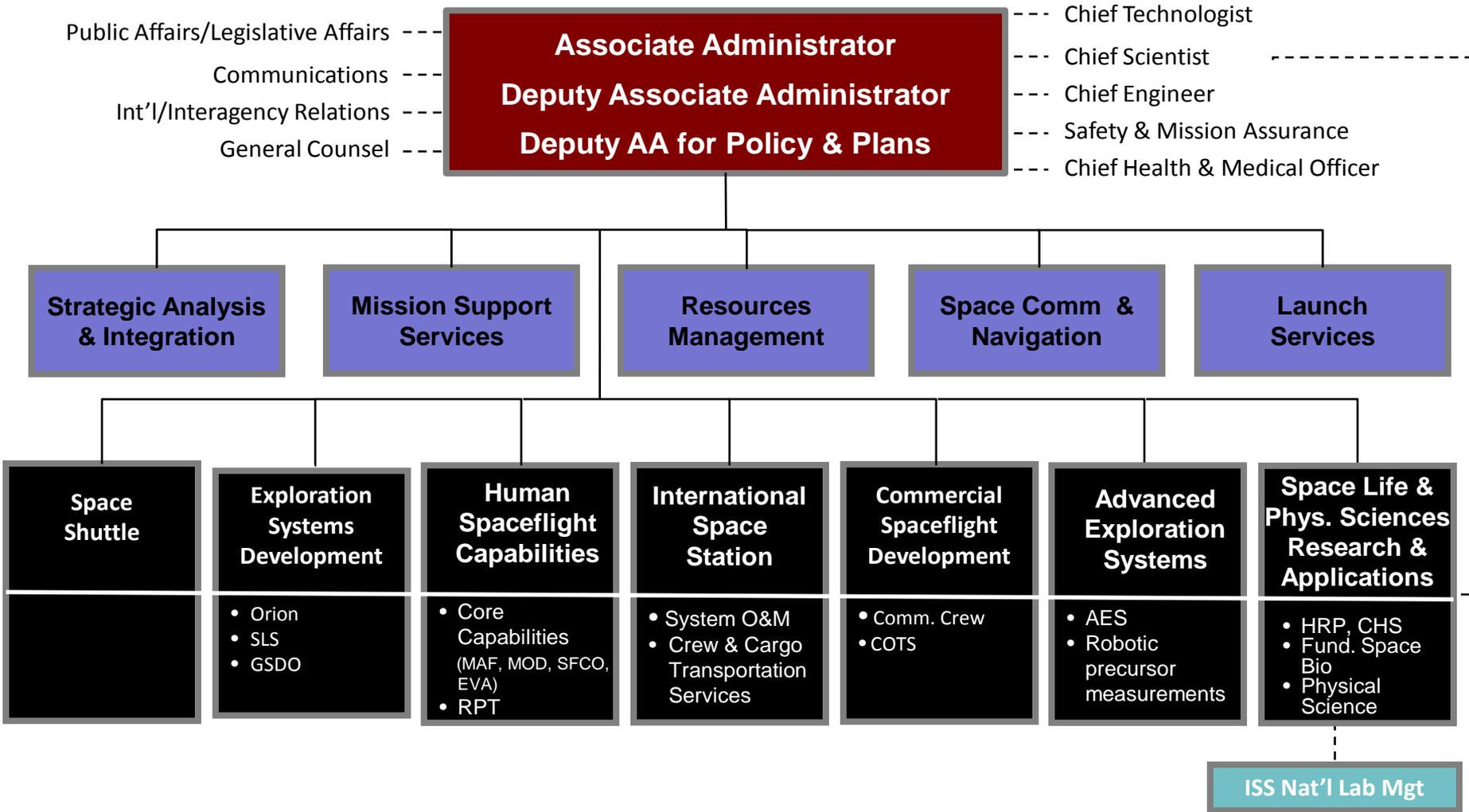
NAC HEO Committee Members



- Ms. Bartell, Shannon
- Mr. Bowersox, Ken, **Chair**
- Ms. Budden, Nancy Ann
- Dr. Chiao, Leroy
- Dr Condon, Stephen "Pat"
- Mr. Cuzzupoli, Joseph W.
- Mr. Holloway, Tom
- Mr. Lon Levin
- Dr. Longenecker, David E.
- Mr. Lopez-Alegria, Michael
- Mr. Malow, Richard N.
- Mr. Odom, Jim (James)
- Mr. Sieck, Robert
- Mr. Voss, James

Human Exploration & Operations Mission Directorate

Organizational Structure





NAC HEO Committee Meeting

Monday, June 23, 2014

Human Exploration Plans, Evolvable Mars Campaign Study

Monday July 28, 2014

Joint Meeting with the Science Committee

Human Exploration and Operations Joint Efforts with the Science Mission Directorate
SLS Capabilities

Program Status – Exploration Systems, Commercial Crew, ISS

Tuesday July 29, 2014

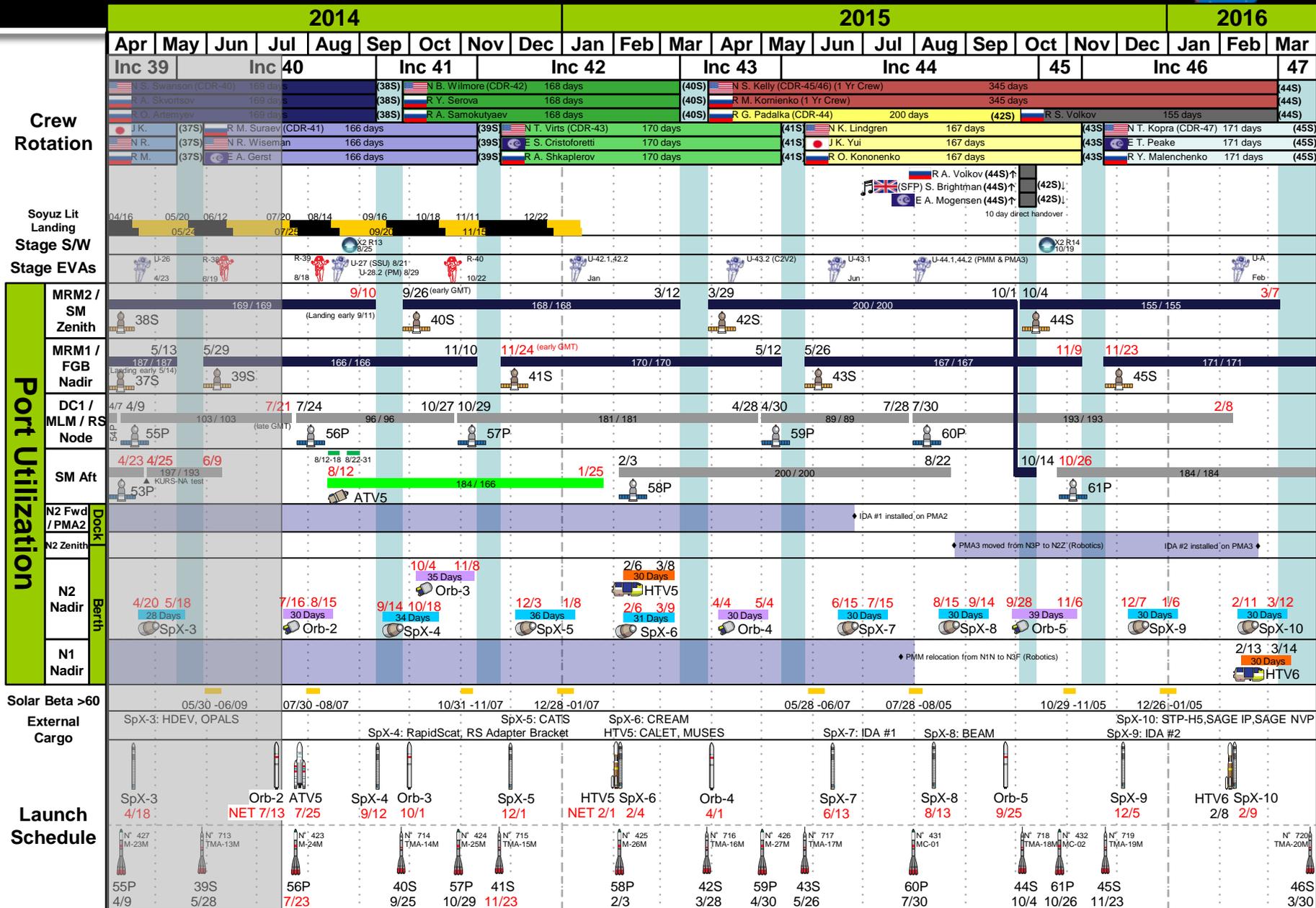
Committee Discussion and Deliberation

Status of the ISS USOS

NASA Advisory Council HEOMD Committee



Daniel W. Hartman
Deputy Manager, ISS Program
July 2014



Vehicle: 39 Soyuz

Launch: May 28, 2014; (with 4 orbit rendezvous)

Docking: May 29, 2014;

Undock/Landing: November 10, 2014

38 Soyuz crew

Alexander Skvortsov, Soyuz Commander

Oleg Artemiev, Flight Engineer

Steve Swanson, Flight Engineer



39 Soyuz Crew

Maxim Suraev, Soyuz Commander

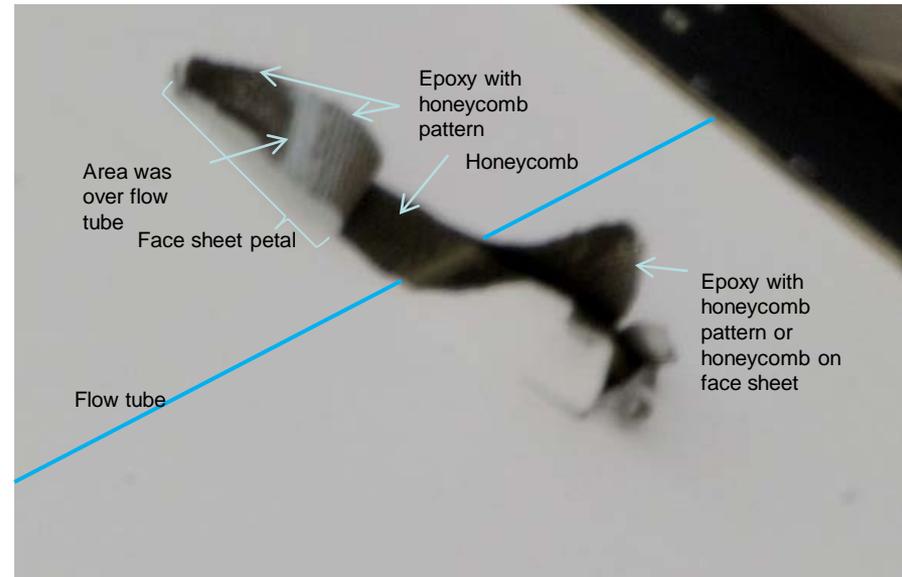
Reid Wiseman, Flight Engineer

Alexander Gerst (ESA), Flight Engineer



Pertinent ISS Vehicle Issues (cont.)

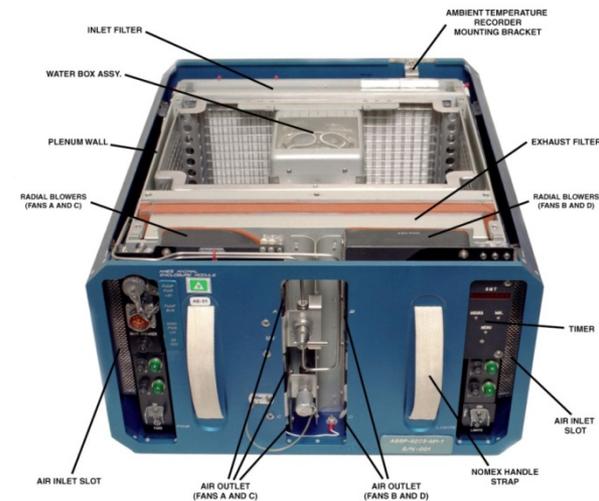
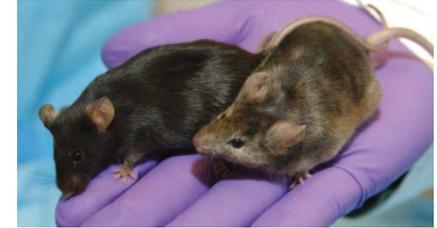
Issue	Impact to Stage Ops	Rationale
P4 PVR MMOD Strike	No	<p>Imagery review revealed a MMOD impact occurred between 5/12 and 6/20 on panel 3 of the P4 PVR.</p> <ul style="list-style-type: none"> S&M initial assessment shows no apparent structural damage Unclear if damage would impact ability to retract PVR radiator, but currently no plans to do so P4 ammonia mass trending shows no flow tube rupture (Small leaks will need to be trended long term)





Rodent Research-1: “The lack of an animal facility for rodents on the ISS suitable for long-duration studies on adult animals is a major research impediment that will hamper the ability to obtain information important for maintaining astronaut health and fitness for duty.” -*NRC Decadal Survey, 2011.*

- 10 NASA mice: Evaluation of hardware and on-orbit operations
- 10 CASIS mice: Pharmaceutical company evaluating muscle atrophy
- Based on existing AEM design
 - Flown 27 times on Shuttle
 - Modified to meet ISS needs (reduced acoustics, added cameras, improved airflow)
- Single MLE unit houses 10 mice or 3 – 6 rats (20 mice on SpaceX-4)
- Temperature and RH monitoring, no active thermal control
- Transfer animals to a clean Rodent Habitat with a full complement of food and water after 20 - 30 days to achieve longer duration missions
- Improved science and animal husbandry through video monitoring and in-flight access
- Animals housed in two groups of five on either side of the Habitat
- Animals loaded in the Transporter at L-25 hrs
 - Support up to 2 launch attempts before change out with a new Transporter



ISS Top Program Risk Matrix Post April 16, 2014 PRAB



Corrective/Preventative Actions

None

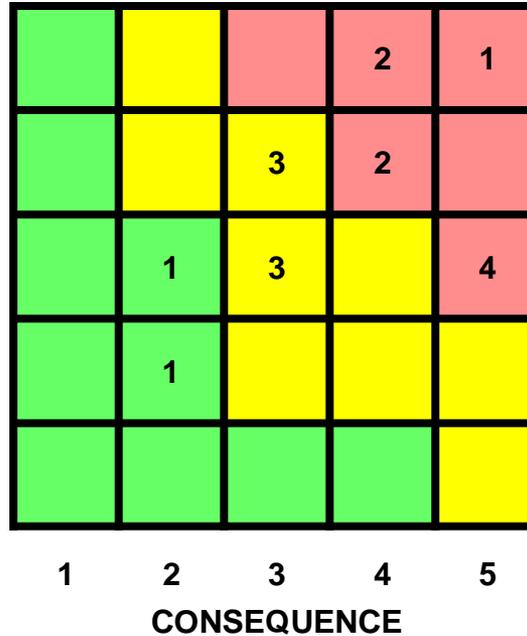
Watch Items

No Watch Items Elevated

Continual Improvement

None

L
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D



Low		Medium		High	
C - Cost	S - Schedule	T - Technical	Sa - Safety		
▲ - Top Program Risk (TPR)					
Added: 6484					
Removed: 2810 - RS MM/OD Shielding and 5688 - ISS Solar Array MGNT					
Rescored: 6169					

Risks (L x C)

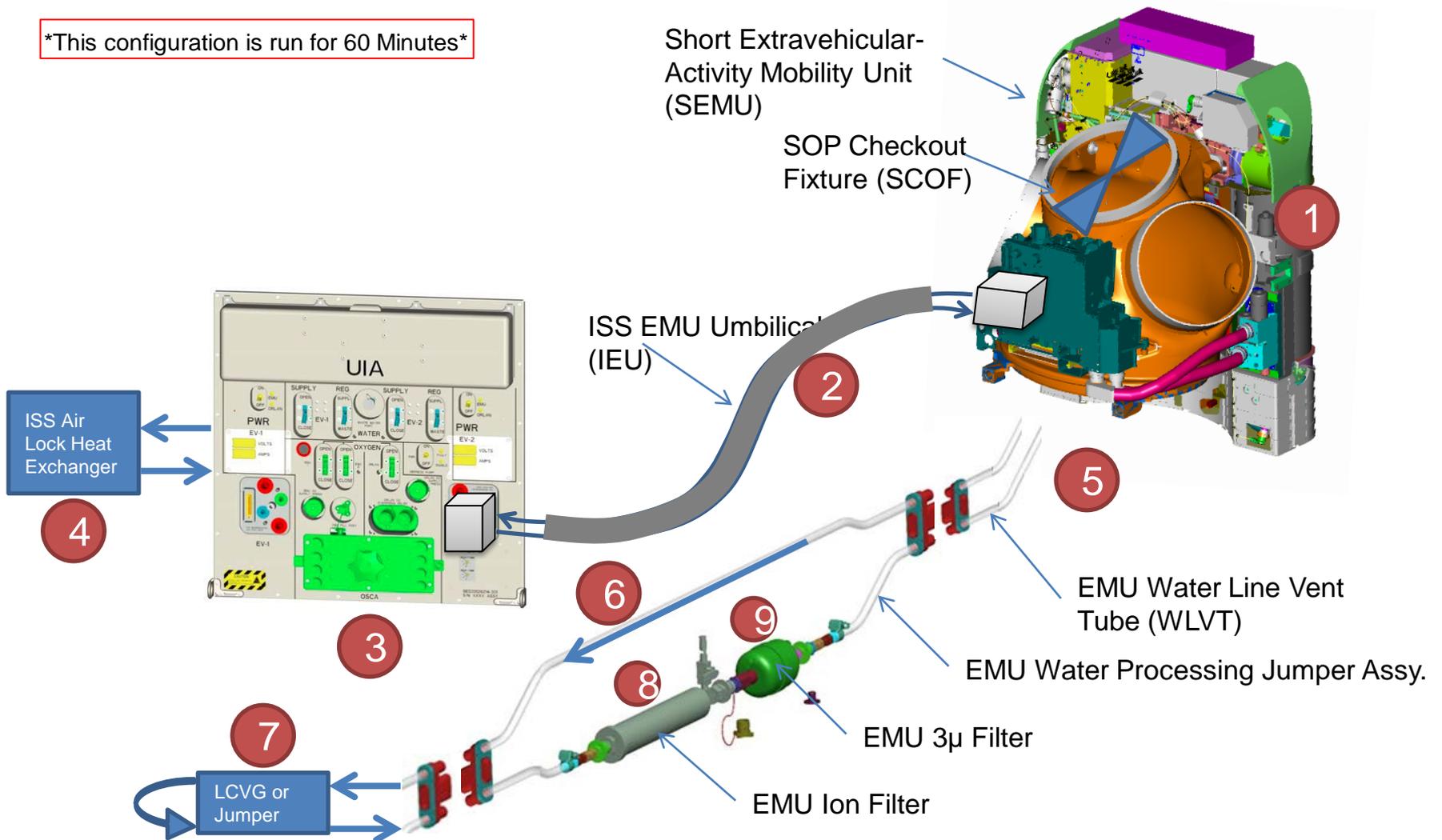
- Score: 5 x 5
▲ 6352 - Lack of Assured Access to ISS - (OH) - (C,S,T,Sa)
- Score: 5 x 4
▲ 6370 - ISS Pension Harmonization - (OH) - (C)
▲ 6344 - ISS Operations Budget Reduction - (OH) - (C)
- Score: 4 x 4
▲ 6372 - Full ISS Utilization at 3 Crew - Level 1 - (OZ) - (C,S)
▲ 6439 - EPROM Memory Leakage - (OD) - (C,S,T,Sa)
- Score: 3 x 5
▲ 6484 - ORDEM 3.0 Orbital Debris Model- CA, OB, OC, OD, OE, OK, OM, ON, OX - (S,T,Sa)
▲ 6444 - ISS Cascading Power Failure - (OM) - (C,S,T,Sa)
▲ 6450 - Potential Inability to Support ISS Critical Contingency (& other) EVA Tasks - (XA) - (C,S,T,Sa)
▲ 6382 - Structural Integrity of Solar Array Wing (SAW) Masts due to MMOD Strikes - (OB) - (S,T,Sa)
- Score: 4 x 3
▲ 5269 - The Big 13 Contingency EVA's - (OB) - (S,T,Sa)
▲ 6169 - Visual Impairment / Intracranial Pressure - (SA) - (C,S,T,Sa)
▲ 6438 - C2V2 Comm Unit Vendor Misinterpreting ISS Requirements - (OG) - (C,S,T)
- Score: 3 x 3
▲ 6452 - Lack of Sufficient Sparing for the Ku-Band Space to Ground Transmitter Receiver Controller (SGTRC) to reach 2020 - (OD) - (C,S,T)
▲ 6420 - NDS Qualification Schedule - (OG) - (C,S,T)
▲ 6408 - FGB Sustaining Contract and FGB spares plan post 2016 undefined - (OB) - (C,S,T,Sa)
- Score: 3 x 2
▲ 6039 - Carbon Dioxide Removal Assembly (CDRA) Function - (OB) - (C,T,Sa)
- Score: 2 x 2
▲ 5184 - USOS Cargo Resupply Services (CRS) Upmass Shortfall - 2010 through 2016 - (ON) - (S,T)



ALCLR Ion Bed Use



This configuration is run for 60 Minutes





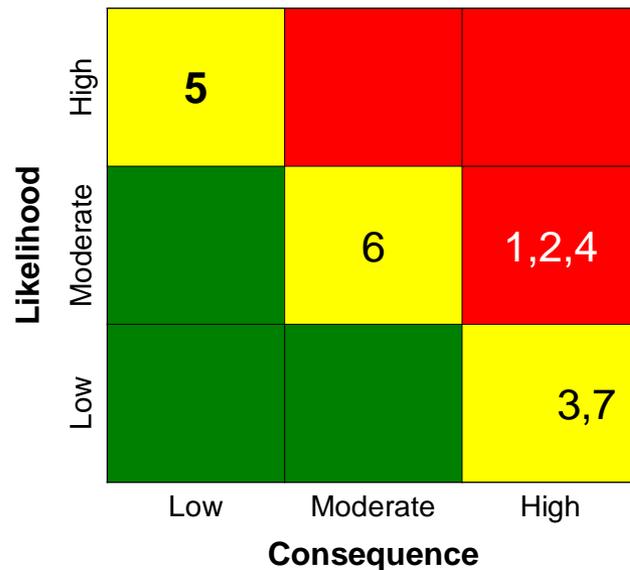
Commercial Spaceflight Development Update

July 2014
NAC HEO Committee Meeting
Philip McAlister



- COTS Cargo has been successfully completed and regular resupply missions to the ISS are in progress.
- Commercial Crew Program is concluding its final Space Act Agreement phase (CCiCap).
- The contract(s) for the final phase of Commercial Crew development (CCtCap) are planned to be awarded in August/September of this year.
- Next month, NASA will award multiple no-exchange-of-funds Space Act Agreements for the Collaborations for Commercial Space Capabilities initiative.

CCP Level I Risk Matrix



- 1. NASA costs may exceed NASA budget →
- 2. NASA-unique requirements may drive cost →
- 4. Lack of competition →

5. Technical/budget challenges may delay services →

6. CCtCap contract mechanism may lead to safety/cost risk →

- 3. NASA culture change may not be successful →
- 7. Partner(s) may not complete certification →

Trend

- ↓ Decreasing (Improving)
- ↑ Increasing (Worsening)
- Unchanged
- N New

Collaborations for Commercial Space Capabilities



Advancing private-sector integrated space capabilities

Emerging products or services have potential for commercial availability to government and non-government customers.

Spurring economic growth as new space markets are created

New capabilities may result in opportunities for industry to provide cost-effective commercial products and services to NASA.

Current Status

- Evaluating proposals
- Selection in August
- Execution beginning September

National Aeronautics and Space Administration 

Collaborations for Commercial Space Capabilities

Announcement Number NASA-CCSC-01

Release Date: March 31, 2014

Proposal Executive Summaries Due:
April 21, 2014

Commercial Space Capabilities Office
Lyndon B. Johnson Space Center
Human Exploration & Operations Mission Directorate

For Questions Regarding This Announcement:
<http://procurement.isc.nasa.gov/ccsc/>



HEO and SMD Joint Activities

James L. Green
Director, Planetary Science
July 28, 2014



For Human Exploration - What's Left to Know?

In the past 50 years, robotic missions have contributed data that reduces the risks of future human Mars exploration



No data,
Most "unknowns"

Complete data sets
Planet completely
characterized



**There's more
to know, but
we're well on
our way**

Radiation Measurements on Mars



RAD measurements show:

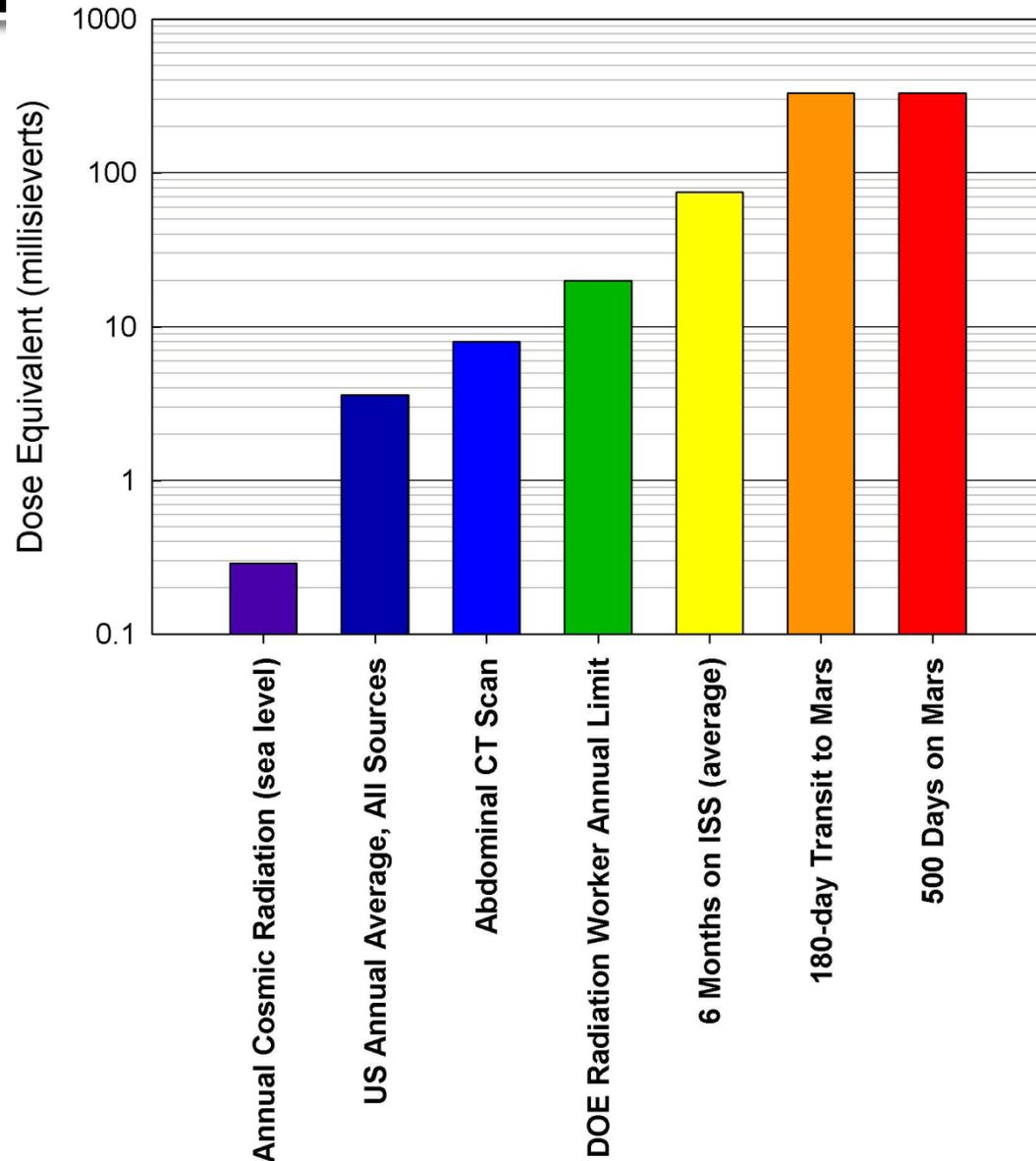
A return trip to Mars results
in an exposure of

Cruise: 662 +/- 108 mSv
On Mars: 320 +/- 50 mSv

In total ~ 1000 mSv

Compare to:

6 mos. on ISS: 75-90 mSv
Radiation worker: 20 mSv/y
Abdominal CT scan: 8 mSv



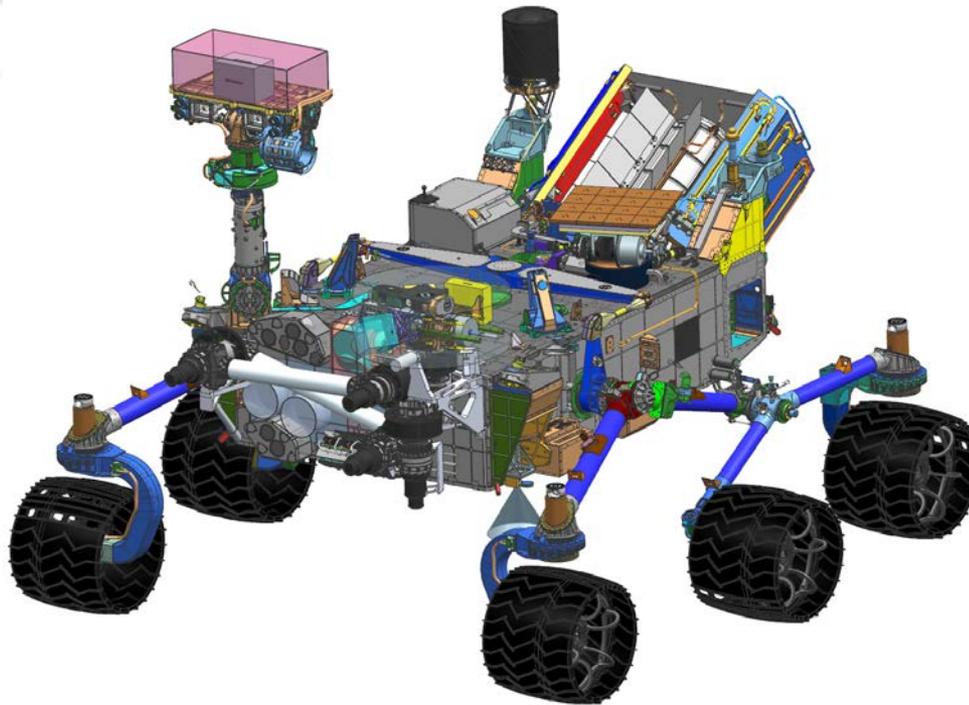
Seeking signs of life: Mars 2020 Rover



Conduct rigorous in situ science

Geologically
diverse site of
ancient
habitability

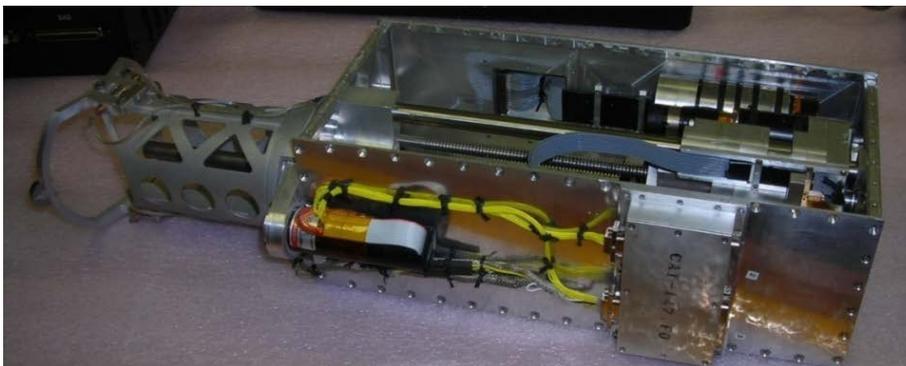
Coordinated,
nested context
and fine-scale
measurements



Enable the future

Critical ISRU and
technology
demonstrations
required for future
Mars exploration

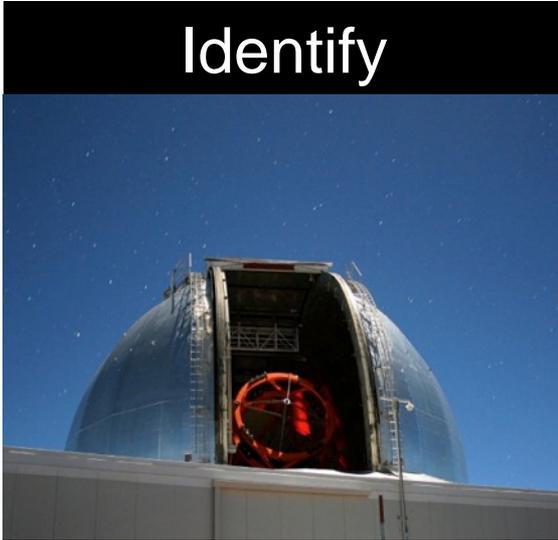
Returnable cache of samples



Asteroid Redirect Mission: 3 Segments



Identify



Asteroid Identification:

Ground and space based near Earth asteroid (NEA) target detection, characterization and selection

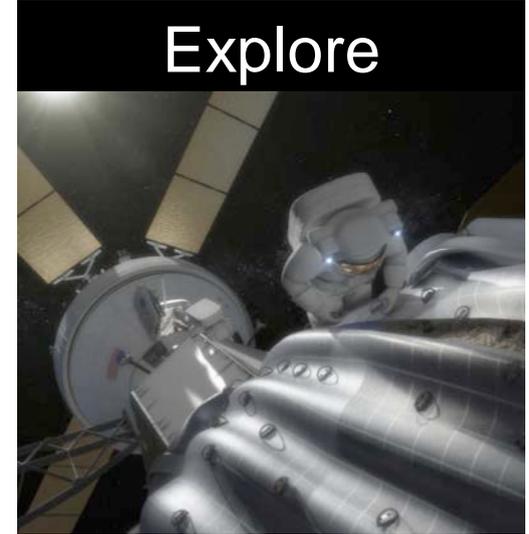
Redirect



Asteroid Redirect Robotic Mission:

High power solar electric propulsion (SEP) based robotic asteroid redirect to lunar distant retrograde orbit

Explore



Asteroid Redirect Crewed Mission:

Orion and Space Launch System based crewed rendezvous and sampling mission to the relocated asteroid



NASA's Space Launch System: A Revolutionary Capability for Science

Bill Hill

Deputy Associate Administrator

Exploration Systems Development Division

NASA Headquarters

Stephen Creech

Deputy Manager

SLS Spacecraft/Payload Integration and Evolution

July 2014

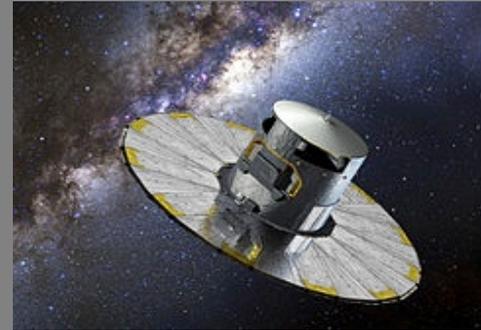
Space Launch System



SLS Benefits to Space Science



- ◆ **Greatest mass lift capability** of any launch vehicle in the world.

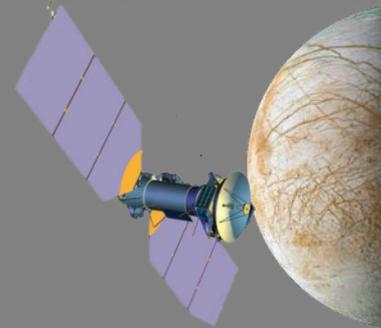


Deep Space Telescope

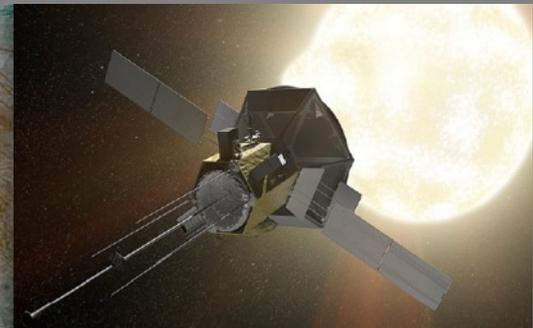


Mars Sample Return

- ◆ **Largest payload fairings** of any launch vehicle produce greatest available volume.



Europa Clipper



Solar Probe

- ◆ **High departure energy** availability for missions through the solar system and beyond.



Uranus Spacecraft

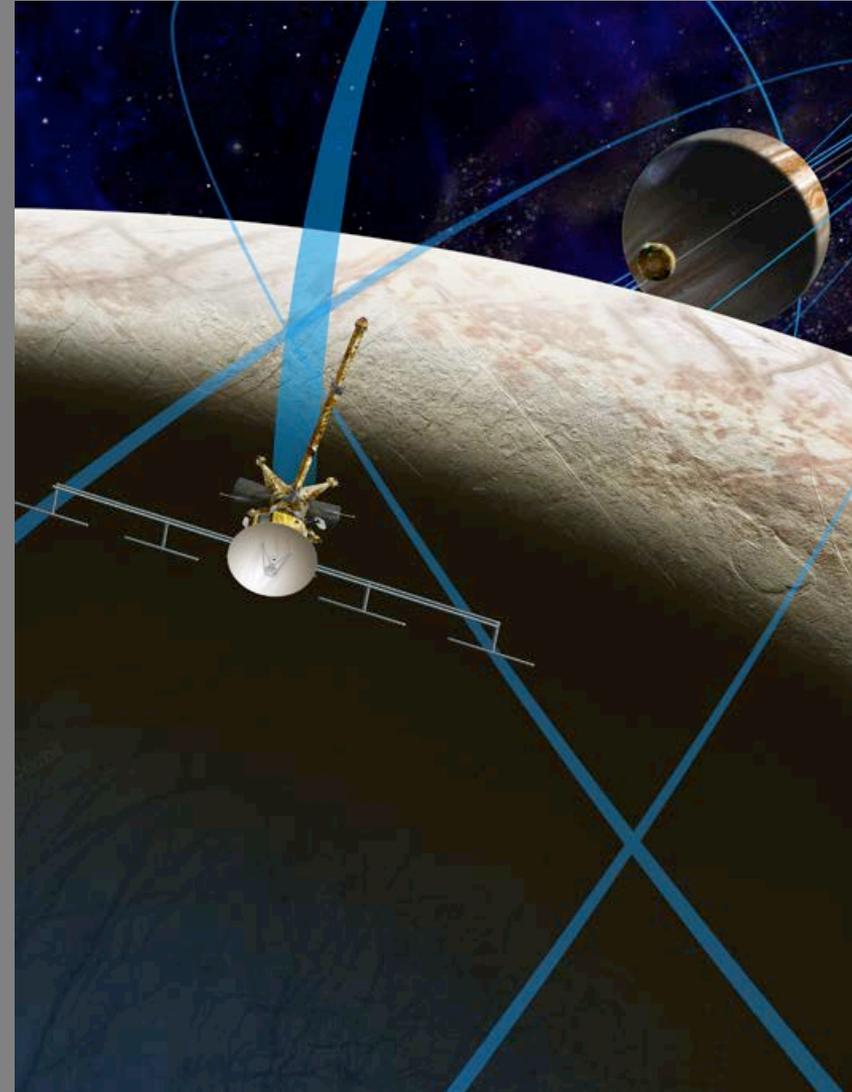


Interstellar

Case Study: Europa Clipper



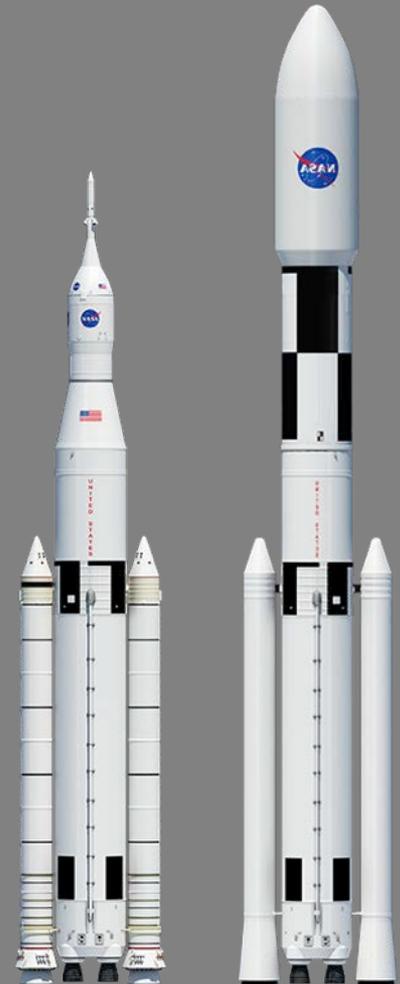
- ◆ **Europa exploration** was identified as a high priority in the “Visions and Voyages” planetary science decadal survey.
- ◆ **SLS can provide direct injection to Jupiter**, eliminating several years of planetary gravity assists to reduce flight time to Europa from 6.3 years to 2.7.
- ◆ **Additional benefits of SLS** for Europa Clipper include reduced operational costs, reduced mission risk, and greater mass margin.



Summary



- **SLS provides capability for human exploration missions.**
 - 70 t configuration enables EM-1 and EM-2 flight tests.
 - Evolved configurations enable missions including humans to Mars.
- **SLS offers unrivaled benefits for a variety of missions.**
 - 70 t provides greater mass lift than any contemporary launch vehicle; 130 t offers greater lift than any launch vehicle, ever.
 - With 8.4m and 10m fairings, SLS will offer greater volume lift capability than any other vehicle.
 - Initial ICPS configuration and future evolution will offer highest-ever C3.
- **SLS is currently on schedule for first launch in December 2017.**
 - Preliminary design completed in July 2013; SLS is now in implementation.
 - Manufacture and testing are currently underway.
 - Hardware now exists representing all SLS elements



NASA Advisory Council HEO Committee

July 28, 2014

Greg Williams

DAA for Policy and Plans

Human Exploration and Operations Mission Directorate



Evolvable Mars Campaign – Capability & Mission Extensibility



EARTH RELIANT

PROVING GROUND

EARTH INDEPENDENT

Capabilities

International Space Station



70+ MT SLS



Asteroid Redirect Vehicle

105+ MT SLS



Advanced Propulsion



EDL Pathfinder



Mars Surface

EDL/Lander



Transportation

130+ MT SLS

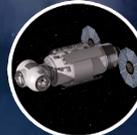


Long Duration Habitat

Long Duration Surface Systems



Working In Space



Exploration Augmentation Module



ISRU



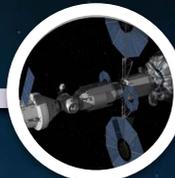
EM-X Crewed Missions in Cis-lunar space



Mars 2020



Asteroid Redirect Robotic Mission



Proving Ground Missions to Returned Asteroid & EAM for Mars risk reduction

All Paths Through Mars Orbit

ISS Deep Space & Mars Risk Reduction

Deep Space Mars Preparation



Mars Moon Missions



First Human Mission to Mars Surface



Long Duration Human Missions

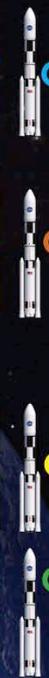
Missions

1: Mars Split Mission Concept



Getting to Mars

- DESTINATION SYSTEMS & CREW RETURN VEHICLE**
SEP pre-deploy to Mars orbit
- PHOBOS DESTINATION SYSTEMS**
SEP pre-deploy to Phobos
- TRANSIT HAB TO MARS**
Aggregate in Cis-lunar space
- CREW**
Launch to Cis-lunar space



Transit: 2-3 Years

Transit: 2-3 Years

CREW/TRANSIT HAB
Aggregation in HEO/DRO

6-9 Months
CREW/TRANSIT HAB
To Mars orbit via chemical propulsion

HABITATS return to staging point for refurbishment

6-9 Months
CREW/TRANSIT HAB
Return to Earth & DRO

CREW direct return to Earth

Surface Operations:
30-500 Days

Returning to Earth



- HEOMD and SMD Cooperative Efforts, SLS Capabilities
- Program affordability/sustainability
- Finding for the council endorsing aspects of NASA's human exploration plans
- Recommendation for the council on SLS minimum flight rate
- Topics for future Meetings



TITLE: Minimum SLS Flight Rate

Recommendation: The NAC recommends that NASA conduct a trade study to determine a minimum launch rate for the SLS with respect to cost, safety, mission success, and performance.

MAJOR REASONS FOR PROPOSING THE RECOMMENDATION:

Current agency plans for SLS show a flight rate of one mission every other year, while preliminary mission planning for future exploration missions shows that a much higher launch rate may be necessary for mission success. The experience of many members of the council would suggest that the currently planned launch rate is less than optimal for maintenance of the supplier base, and the ability of the engineering, production, launch and operations teams to make appropriate risk decisions in a timely fashion.

CONSEQUENCES OF NO ACTION ON THE PROPOSED RECOMMENDATION:

Increased likelihood of future SLS program cancellation due to an inability to meet mission objectives for exploration.

Finding – Endorsement of Human Exploration Strategy



Proposed NASA Advisory Council Finding NASA Human Exploration Strategy

Name of Committee:	Human Exploration and Operations Committee
Chair of Committee:	Mr. Ken Bowersox
Date of Public Deliberation:	April 14-15 2014 (HEO Advisory Committee)
Short Title of Finding:	NASA Human Exploration Strategy

The NAC endorses the following aspects of NASA's current approach to Human Exploration as presented by the HEOMD Deputy Associate Administrator at the July 30th, 2014 meeting of the Council:

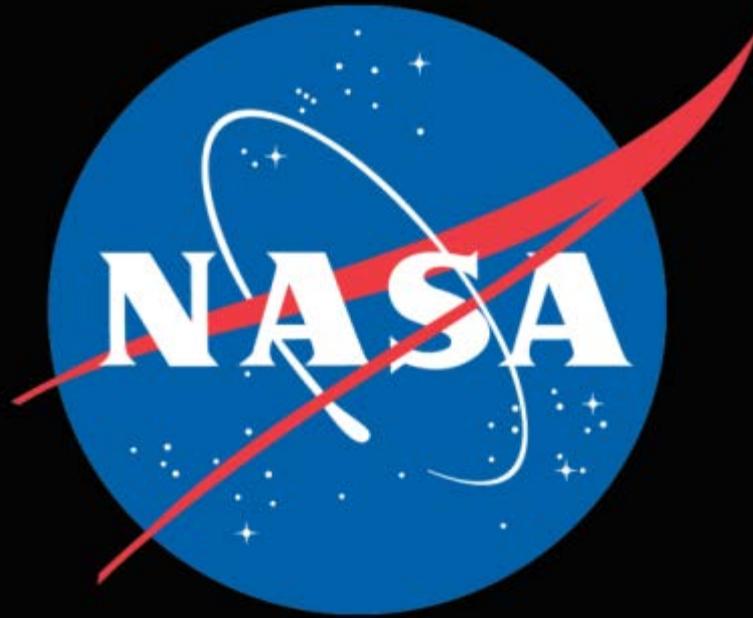
Mars as a horizon goal for human space exploration

An intermediate exploration goal which is affordable, and allows development of systems which can later be used for more distant exploration of the solar system.

An approach that emphasizes affordability and allows re-use of system components.

A flexible approach, which allows reassessment of goals and objectives as the US economy and technical capability develop with time.

Potential areas of involvement for commercial and international partners.



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