



NAC Human Exploration and Operations Committee

Mr. Richard Kohrs, Chair
November 28, 2012





Status of Orion, Space Launch System and Ground Systems Development & Operations and Integration

- Mr. Daniel Dumbacher

NASA Headquarters
Space Operations Center (SOC)
Room 7C61
Washington, DC 20546-0001
PUBLIC MEETING
WEDNESDAY, NOVEMBER 14, 2012

International Space Station Status

- Mr. Michael Suffredini

Final Report of Mars Program Planning Group – Joint Meeting with NAC Science Committee

- Dr. Jim Garvin

Outreach

- Ms. Alotta Taylor



Human Exploration and Operations Status

- Mr. William Gerstenmaier

Commercial Certification Process and Accomplishments

- Mr. Phil McAlister

NASA Headquarters
Space Operations Center (SOC)
Room 7C61
Washington, DC 20546-0001
PUBLIC MEETING
THURSDAY, NOVEMBER 15, 2012

NAC HEO Committee Members

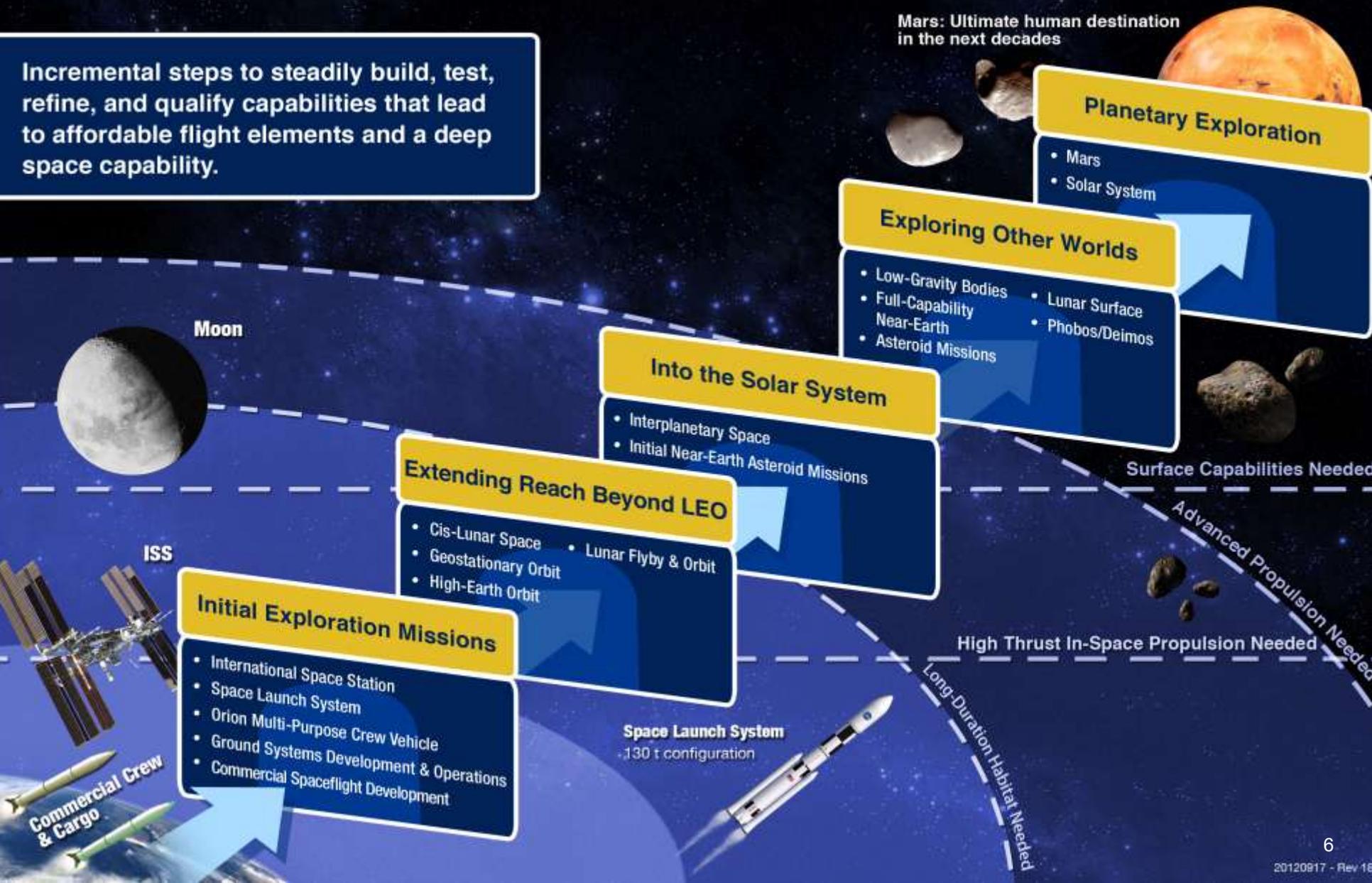


- **Present**
 - Mr. Richard “Dick” Kohrs, Chair
 - Mr. Bohdan “Bo” Bejmuk, Vice-Chair
 - Ms. Shannon Bartell
 - Dr. Leroy Chiao
 - Dr. Stephen “Pat” Condon
 - Mr. Joseph “Joe” W. Cuzzupoli
 - Mr. Tommy Holloway
 - Dr. David E. Longnecker
 - Mr. Richard “Dick” Malow
 - Mr. James “Jim” Odom
 - Mr. Robert “Bob” Sieck
- **Not Present**
 - Ms. Nancy Ann Budden

Capability Driven Exploration



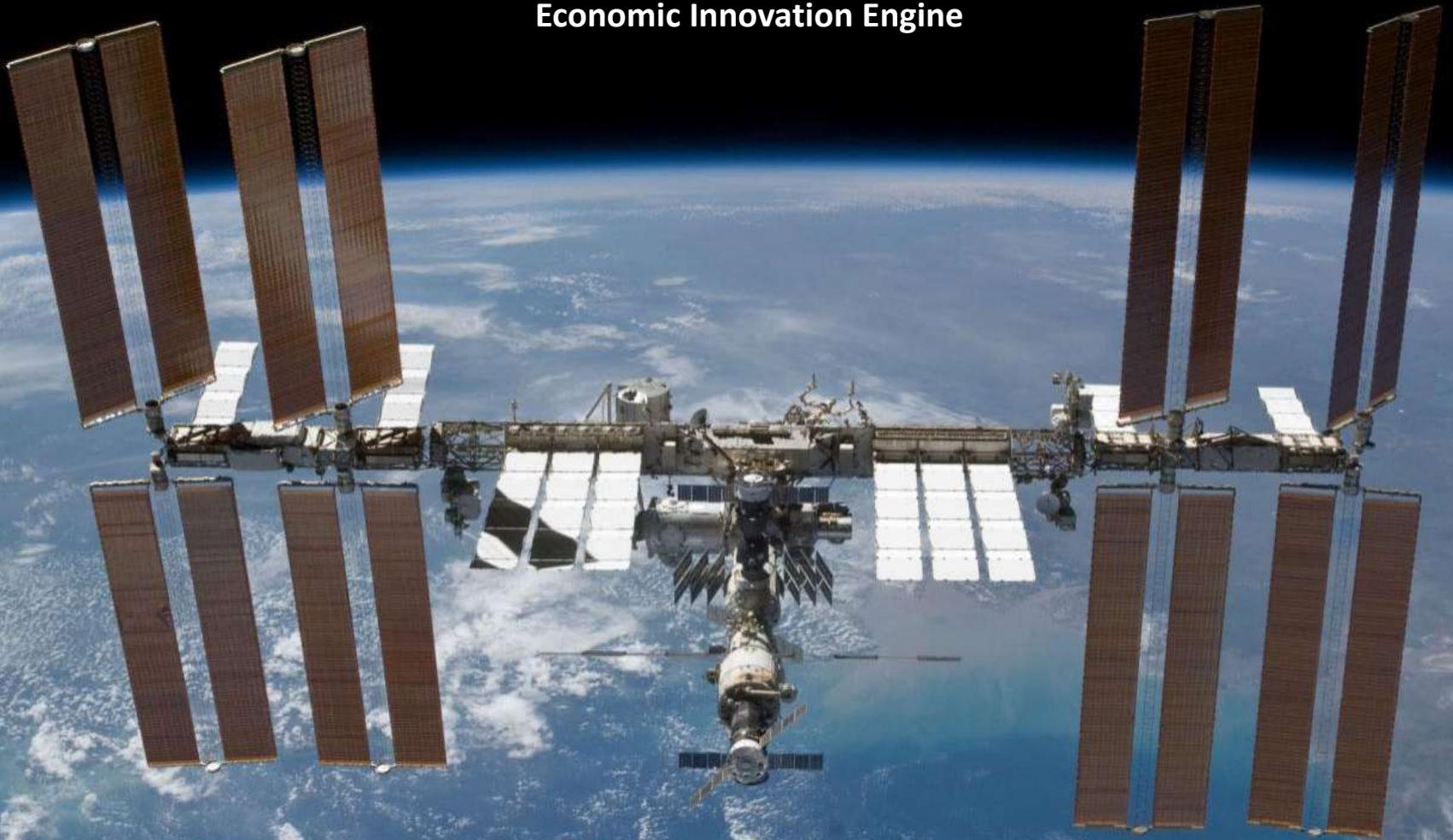
Incremental steps to steadily build, test, refine, and qualify capabilities that lead to affordable flight elements and a deep space capability.



Utilization



Scientific Laboratory
Technology Testbed
Orbiting Outpost
Galactic Observatory
Economic Innovation Engine



ISS Utilization for Exploration



- ISS activities to support future human exploration missions will build upon current activities and leverage the incremental development of exploration capabilities.
- Exploration preparation activities on the ISS fall into four main categories (details on following pages):
 - Exploration technology demonstrations
 - Demonstrating maturity and readiness of critical exploration systems
 - Human health management for long duration space travel
 - Operations simulations and techniques for missions beyond LEO
- A significant amount of exploration related research is planned in the near-term
 - Increment 31-32 (Summer 2012) - 52% (32 of ~71 payloads)
 - Increment 33-34 (Winter 2013) - 49% (37 of ~75 payloads)
 - Increment 35-36 (Summer 2013) - 56% (40 of ~71 payloads)
 - Increment 37-38 (Winter 2014) - 51% (37 of ~73 payloads)

October 5, 2012: NASA and its international partners have announced an agreement to send two crew members to the International Space Station on a one-year mission designed to collect valuable scientific data needed to send humans to new destinations in the solar system.

ISS Technology Demonstrations & Critical Exploration System Development



Technology Demonstrations

- Technology demonstrations are on-board or manifested on ISS, with plans in place to prepare additional technology demonstrations for future flights.
 - ISS partners are discussing ways to ensure that priority technology demonstrations are able to be flown to ISS.
 - Examples of technology demonstration activities onboard or planned for launch include demonstrating:
 - Use of RFID tags, smart enclosures, and portal readers for improved inventory management;
 - Autonomous vehicle fault management, power automation, disruption tolerant network (DTN) communications, and use of software controlled radios;
 - Demonstrating use of on-board and surface robots/assets for mission-enhancing IVA, EVA, and surface routine, emergency, ISRU, and scientific operations.

Systems Development

- To meet beyond LEO exploration requirements, the state of the art of critical systems sustaining the ISS crew must be advanced. Examples include:
 - ISS environmental control and life support system (ECLSS); initial focus for this effort
 - Advanced carbon dioxide removal systems,
 - Advanced oxygen generation systems,
 - Advanced atmospheric monitoring systems,
 - New trace contaminant control systems
 - Robotics, Comm and Nav, Power Generation, Thermal Control



Human Health Management for Long-Duration Space Travel

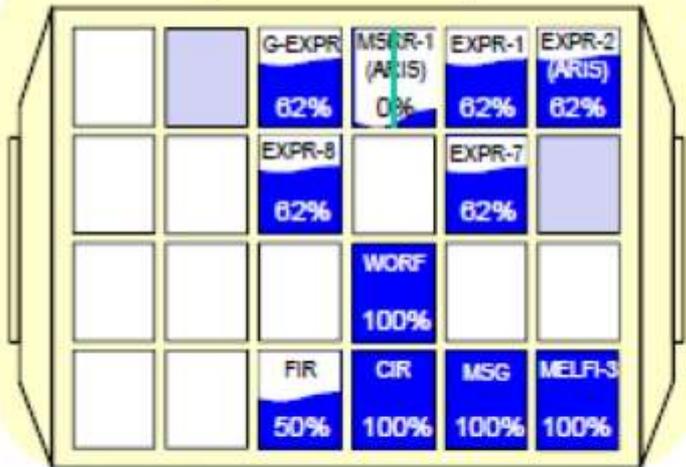
- NASA and its international partners are conducting over 160 studies and activities onboard the ISS to address Top human health and performance risk:
 - Immune system studies
 - Nutrition studies
 - Integrated cardiovascular system studies
 - Functional task studies
 - Vitamin studies
 - Exercise effectiveness studies
 - Crew performance studies
 - Ocular health studies
 - Medical operations and health management studies

Operational Techniques and Simulations

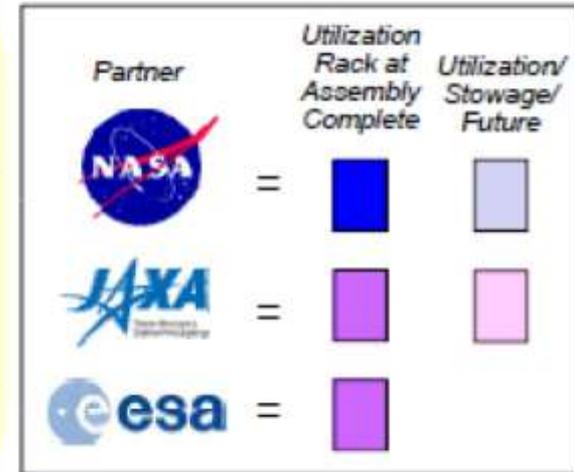
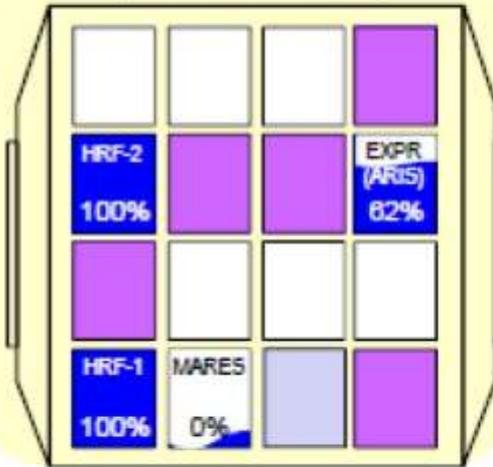
- ISSP plans to conduct a one year increment on-board ISS
 - This is to validate our current state of physical performance countermeasures; those which address:
 - Bone density and strength
 - Muscle mass and strength
 - Aerobic capacity and overall fitness.
- Other planned activities to demonstrate exploration operations concepts and techniques include:
 - Demonstrating just-in-time medical and other training
 - Evaluating a crew's ability to schedule their own activities
 - Increased crew autonomous procedure execution

Internal Rack Capacity

DESTINY



COLUMBUS



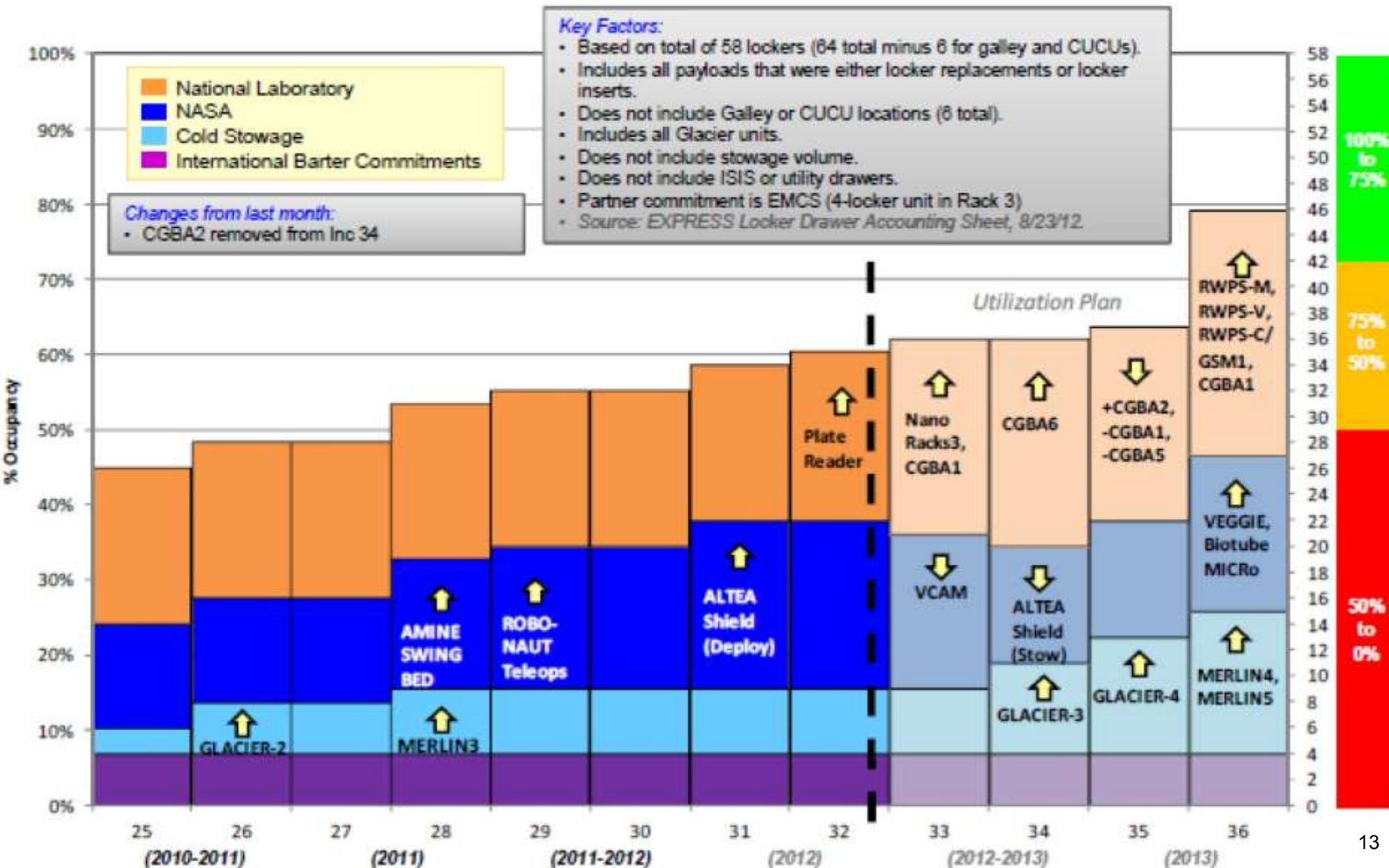
KIBO



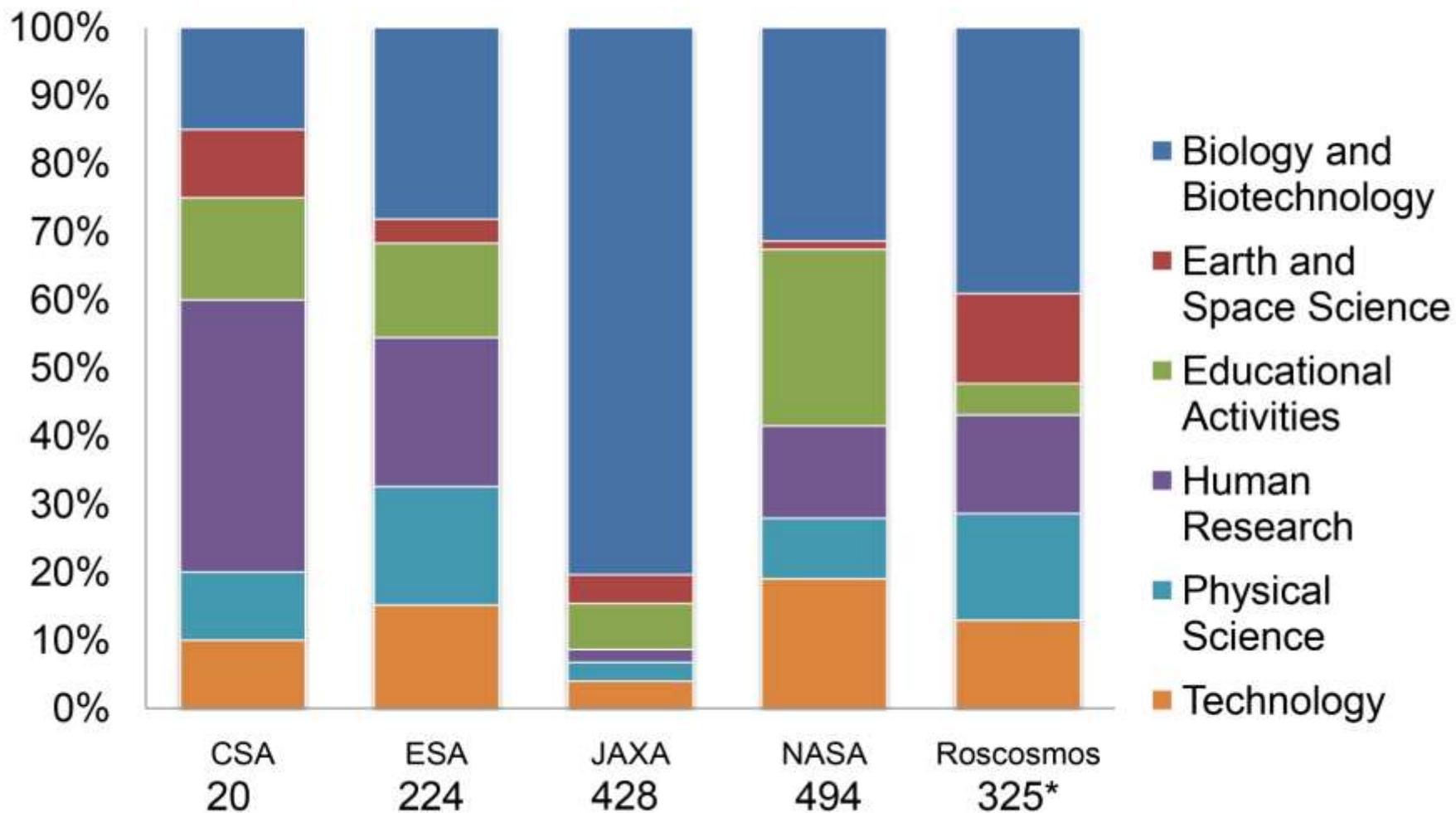
U.S. Facility Occupancy – Current To Date and Planned by End of FY 2012

Facility	Notes	To-Date Percentage	End of FY12 Percentage	Number of Racks (Weighting Factor)
EXPRESS	36 of 58 lockers	58.6%	62%	7.25 Racks (excluding Galley & CUCU)
HRF	Standby equipment	100%	100%	2
MARES	First use in FY13	0%	0%	1
MSG	SODI, SLICE, BASS, INSPACE 3	100%	100%	1
CIR	FLEX-2	100%	100%	1
FIR	CVB, PACE-2, ACE-1	60%	50%	1
MSRR/MSL	12 cartridges/yr @ 1 cartridge/wk	0%	0%	0.5
MSRR Open Bay	Currently used for payload stowage but scarred for payload	0%	0%	0.5
WORF	ISSAC, EarthKAM	100%	100%	1
MELF1	3 MELF1s full or standby	100%	100%	3
	Total	12.85	13.0	18.25
	Weighted Percentage	70.4%	71.2%	-

Facilities in Express Racks



ISS Utilization Number of Investigations (Expeditions 0-30)



* Estimated
 † Draft

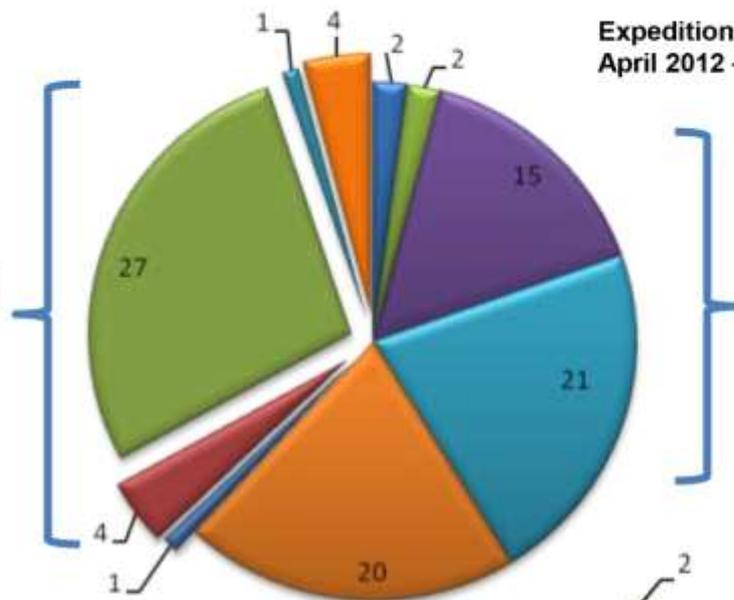
ISS National Laboratory as a portion of the US research portfolio



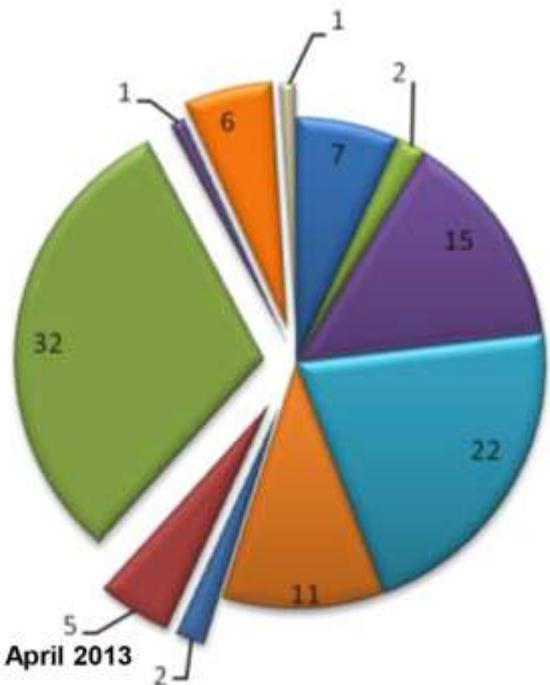
Expedition 31/32
April 2012 – September 2012

ISS National Laboratory

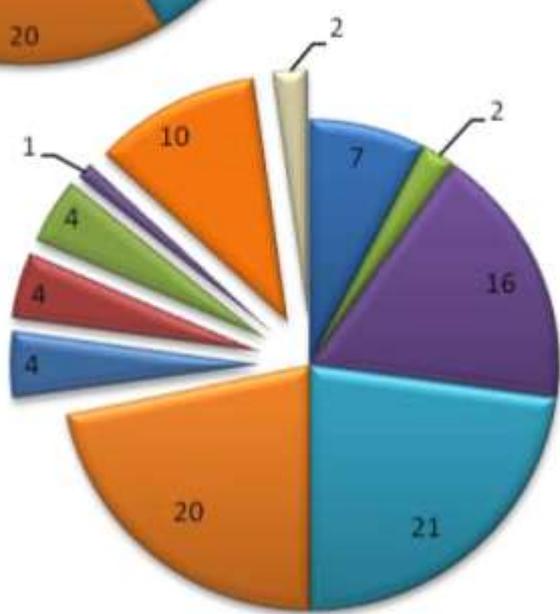
NASA-funded



Expedition 33/34
September 2012 – April 2013



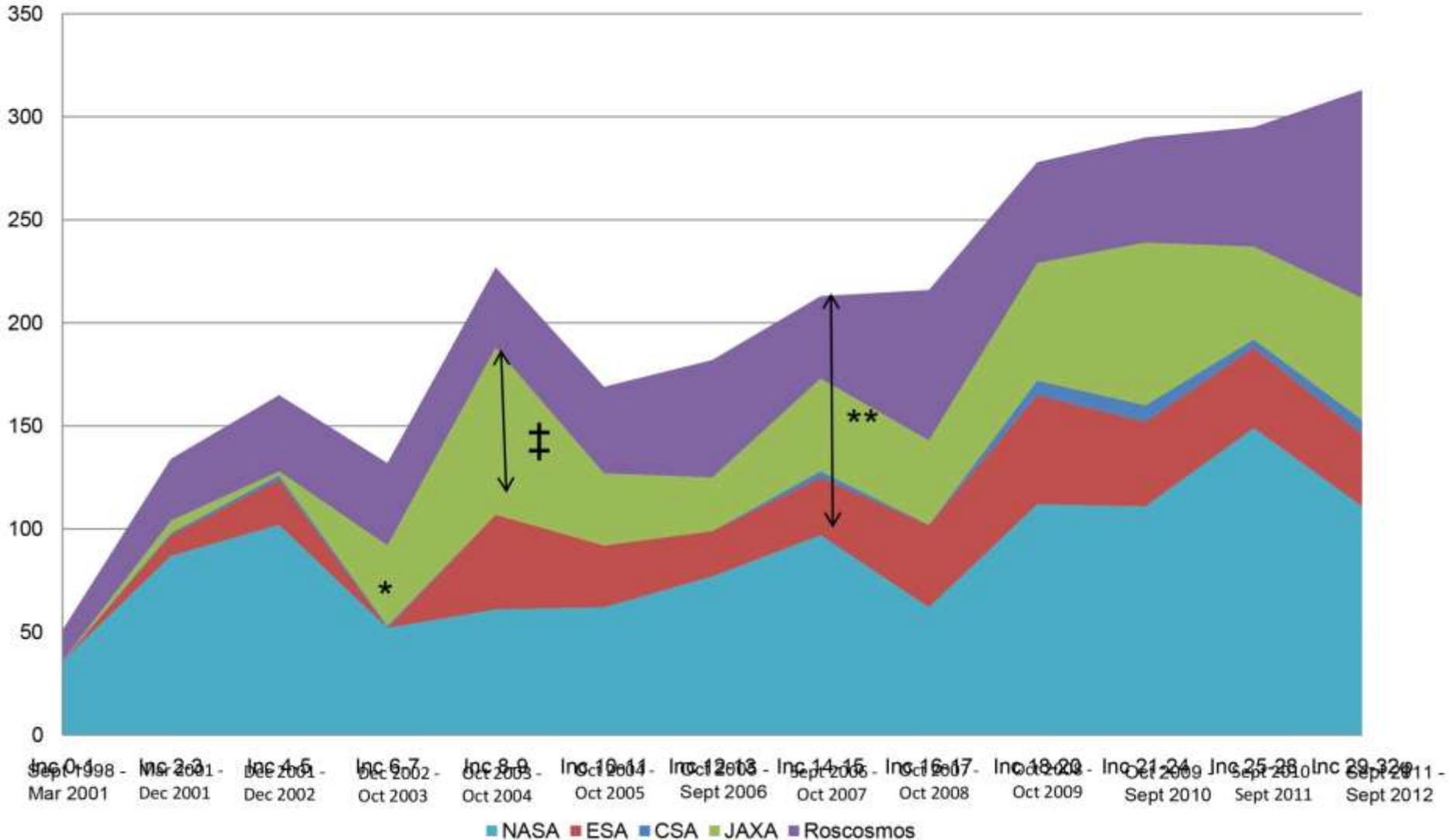
Expedition 35/36
April 2013 – September 2013



Growth of ISS National Lab

- **From 2005-2012 “National Lab Pathfinders”**
 - By 2011, Approximately 25% of ISS investigations were National Lab Pathfinders
- **2011-2013 Transition to CASIS management**
 - First research solicitations open now
 - First CASIS-selected experiments will fly in Expeditions 37/38 (about 1 year from now)
 - Some pathfinders will end, some will transition to CASIS management

Research and Technology Investigations December 1998 - September 2012



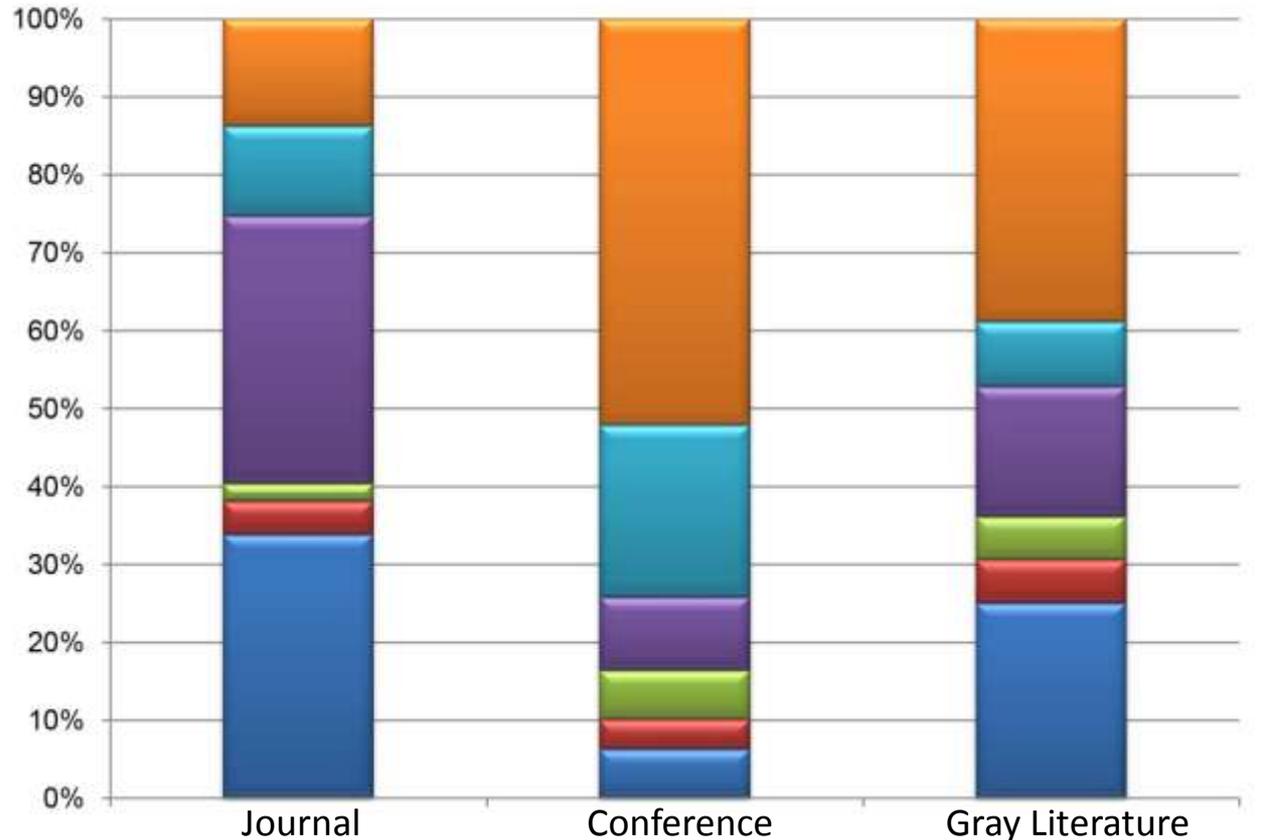
* Post- Columbia

‡ Japanese investigation surge in protein crystal growth

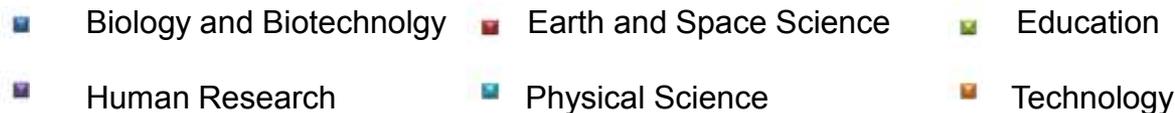
** Shuttle Return to Flight

φ Estimated Numbers

ISS Result Publications



- As of 10/5/12 a total of 783 results publications have been collected for ISS investigations for all of the partners.
- Of these:
 - 588 Journals
 - 159 Conferences
 - 36 Gray Literature (patent, book, magazine, technical paper, DVD)



Top Journals with ISS Results by Impact Factor/Eigenfactor

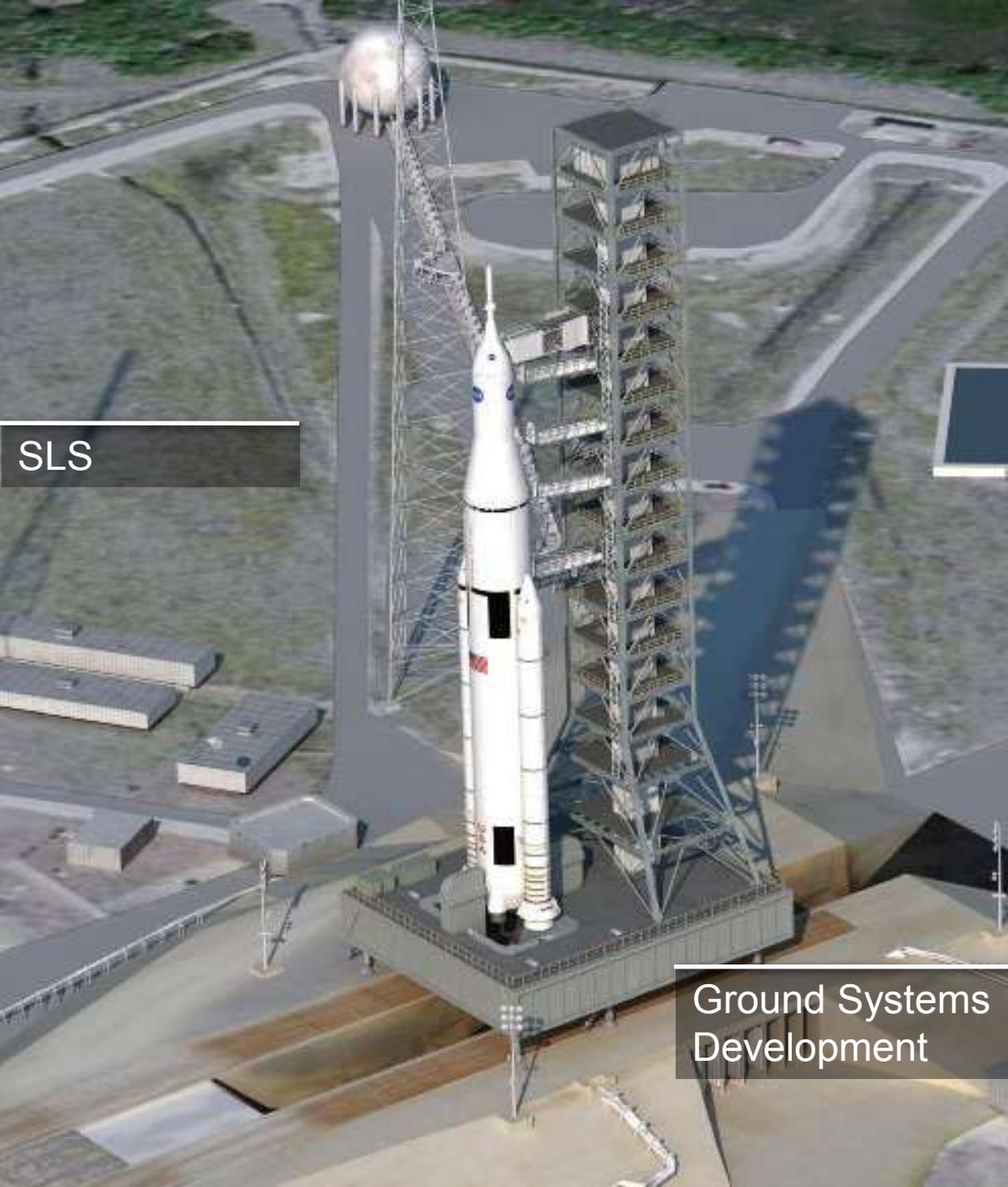
Journals	1Year Impact Factor	5 year Impact Factor	Eigenfactor
Nature	36.280	36.235	1.65524
Proceedings of the National Academy of Sciences of the United States of America	9.681	10.472	1.60168
Physical Review Letters	7.370	7.013	1.14457
Journal of Biological Chemistry	4.773	5.117	0.74213
PLoS ONE	4.092	4.537	0.50162
Journal of Neuroscience	7.115	7.915	0.44963
Journal of Geophysical Research	3.021	3.441	0.33245
Journal of Physical Chemistry B	3.696	4.061	0.24652
Geophysical Research Letters	3.792	3.759	0.23991
Langmuir	4.186	4.514	0.22322
NeuroImage	5.895	6.608	0.15356
Applied and Environmental Microbiology	3.829	4.453	0.12769
New Journal of Physics	4.177	3.773	0.11881
Brain Research	2.728	2.739	0.09356
FASEB Journal	5.712	6.340	0.08876
Journal of Urology	3.746	3.856	0.08303
Radiology	5.726	6.380	0.07346
American Journal of Physiology: Heart and Circulatory Physiology	3.708	3.878	0.06857
New Phytologist	6.645	6.693	0.06386
Ophthalmology	5.454	5.567	0.05634
Acta Crystallographica Section D: Biological Crystallography	12.619	7.038	0.05384

ISS Patents from Research*

Discipline	Investigation	Patent
Facility	CRIM-M	<p>Robyn Rouleau, Lawrence Delucas, Douglas Keith Hedden. Patent US6761861. High Density Protein Crystal Growth.</p> <p>Lawrence Delucas, Robyn Rouleau, Kenneth Banasiewicz. Patent US6623708. High Density Protein Crystal Growth.</p>
Biology and Biotechnology	MEPS	Dennis R. Morrison. Patent 7295309. Microparticle analysis system and method.
Biology and Biotechnology	NLP Vaccine	Timothy G. Hammonds, Patricia L. Allen. Patent US20090258037. Vaccine Development Strategy using Microgravity Conditions.
Technology Development	Amine Swingbed	Walter C. Dean II. Patent 7637988. Swing Bed Canister with Heat Transfer Features.
Physical Science	CFE	<p>Donald R. Pettit, Mark M. Wieslogel, Paul Concus, Robert Finn. Patent 8074827. Beverage cup for drinking use in spacecraft or weightless environments.</p> <p>Christopher M. Thomas, Yohghui Ma, Andrew North, Mark M. Weislogel. Patent 7913499. Microgravity condensing heat exchanger.</p> <p>Mark M. Wieslogel, Evan A. Thomas, John C. Graf. Patent 7905946. Systems and methods for separating a multiphase fluid.</p>

* Does not include the patents from ISS systems development

SLS, ORION and GSDO Status



SLS

Ground Systems Development



Orion

Orion will serve as the exploration vehicle that will carry the crew to space, provide emergency abort capability, sustain the crew during the space travel, and provide safe re-entry from deep space return velocities.

ESD Accomplishments (FY 12)



Space Launch Systems:

- SLS completed a major system design review in July 2012, only ten months after program start.
- This review also clears the way for manufacturing and testing of key hardware elements, including production of a large adaptor mechanism that will fly with the Orion Multi-Purpose Crew Vehicle (MPCV) test flight EFT-1 in 2014 and future flights of Orion on SLS.
- Continued rigorous testing of the J-2X engine at the Stennis Space Center in Mississippi, reaching full power milestones in only a fraction of the time of previous high-performance rocket engines development timelines.

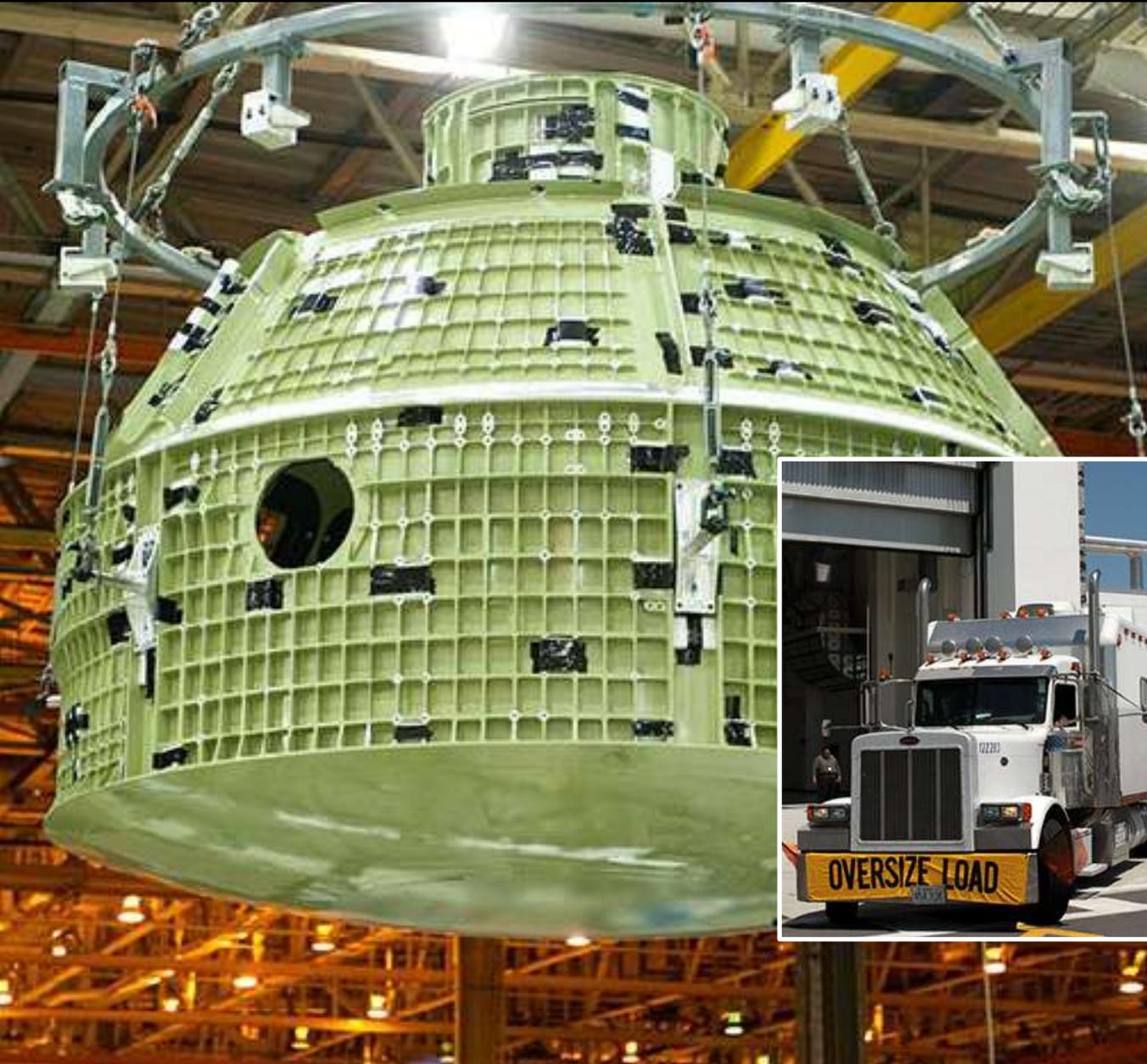
Orion MPCV:

- Delivered first flight test crew module structure of Orion MPCV for EFT-1 Test flight to Kennedy Space Center (KSC) for assembly and integration.
- Orion MPCV program completed
 - Significant acoustic and vibration testing in the Lockheed Martin Denver facilities
 - Water impact tests at Langley Research Center
 - Parachute tests in various configurations at the Yuma Proving Grounds

Ground Systems Development

- Continued extensive progress toward enhancing the launch infrastructure at KSC to support the EM-1 launch, the first planned flight for the integrated SLS and Orion MPCV in 2017.
- Awarded the mobile launcher structure and facility support system design contract was awarded, ensuring the ML is structurally sound and is outfitted to support SLS and Orion MPCV requirements enroute to and on the launch pad.
- Completed refurbishment of LC 39B systems, including Pad B instrumentation and Ground Support Equipment development
- Finalized Firing Room 1 command and control hardware installation, implementing initial voice, video, and data infrastructure.

Orion EFT-1 Updates

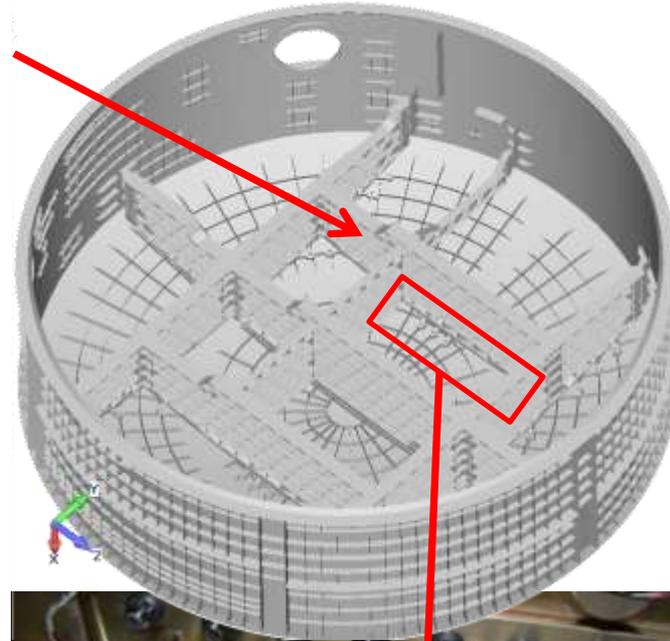


Orion EFT-1 in route to NASA's Kennedy Space Center

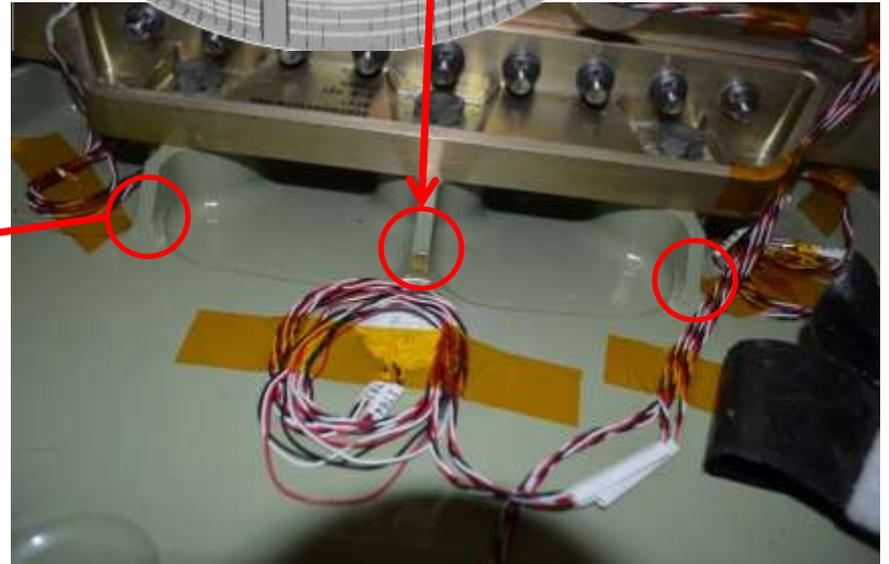
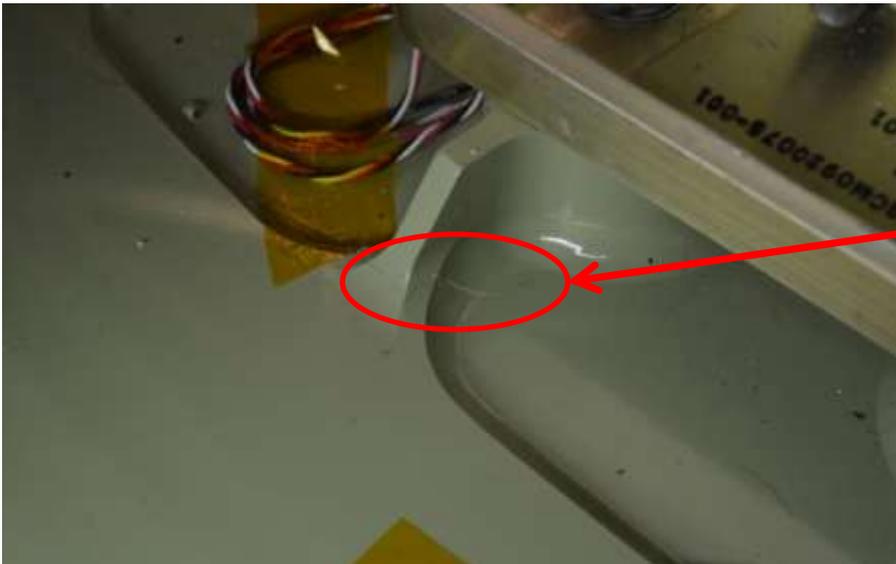
Cracked Occurrence During Proof Testing



Backbone panel 4



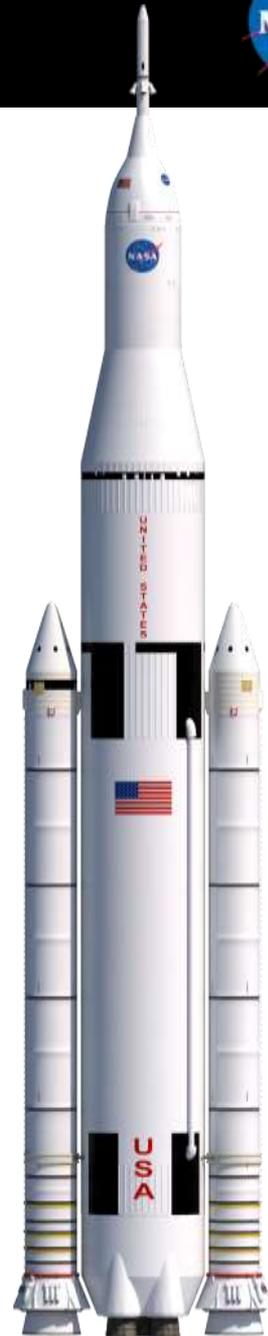
3 cracks at radius of rib run-out on far side of backbone panel 4



Exploration Flight Tests: Entering a New Era of Human Spaceflight



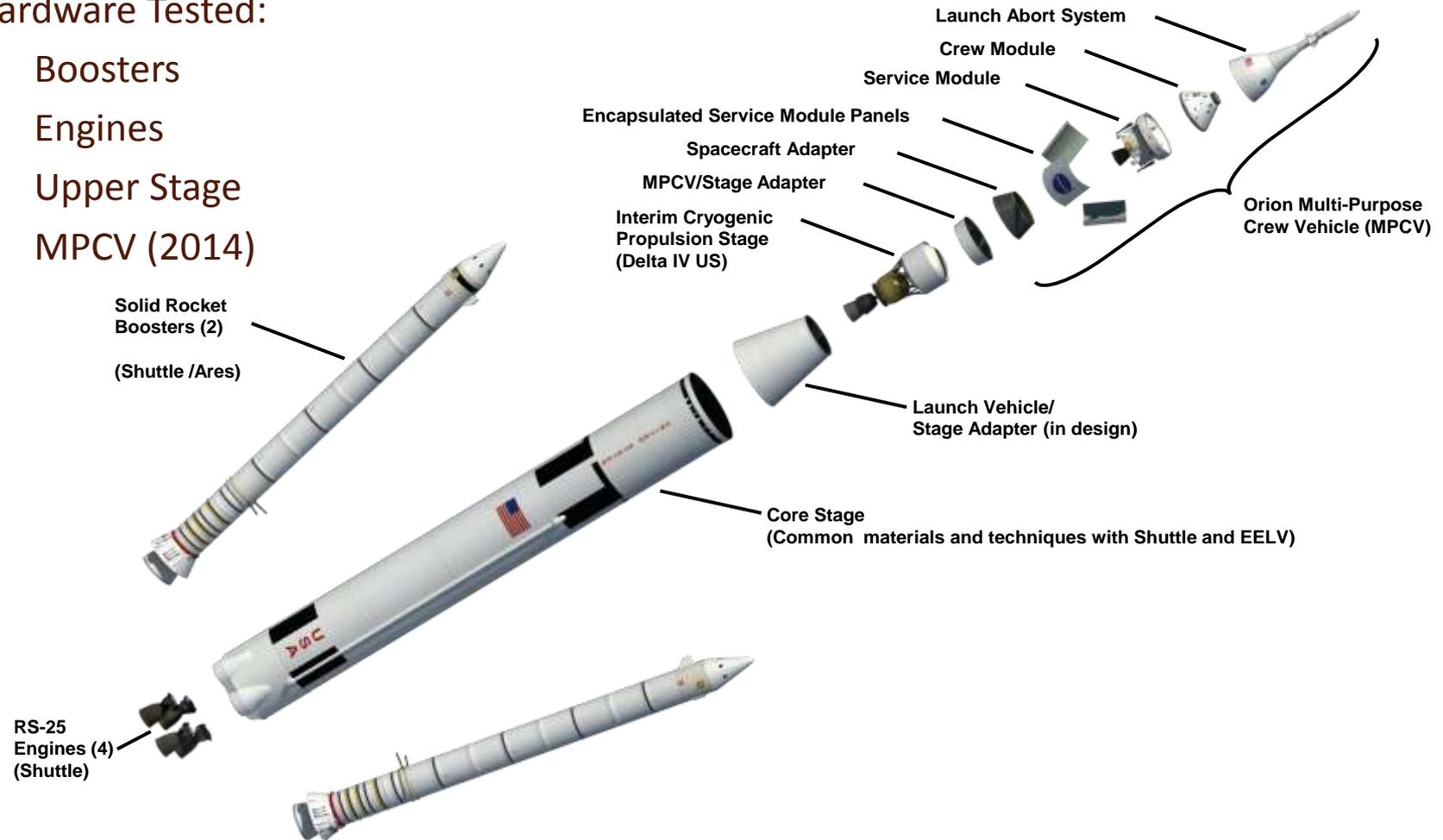
- The SLS and MPCV programs are actively working toward the goal of sending humans to explore deep space, with flight tests starting in 2014
- The Un-crewed Exploration Flight Test-1 (EFT-1) in 2014 and Exploration Mission 1 (EM-1) in 2017 will validate innovative approaches to space systems development to ensure the systems are safe for human travel, reduce cost, and demonstrate spacecraft post-landing recovery procedures
- The crewed Exploration Mission 2 (EM-2) will validate human risk mitigation techniques developed for the integrated SLS-MPCV system
- Current flight test plans take the integrated SLS-MPCV system to lunar fly-by and high lunar orbit. Current assessments are evaluating alternate destinations to address long-term exploration and science-based objectives.



Space Launch System

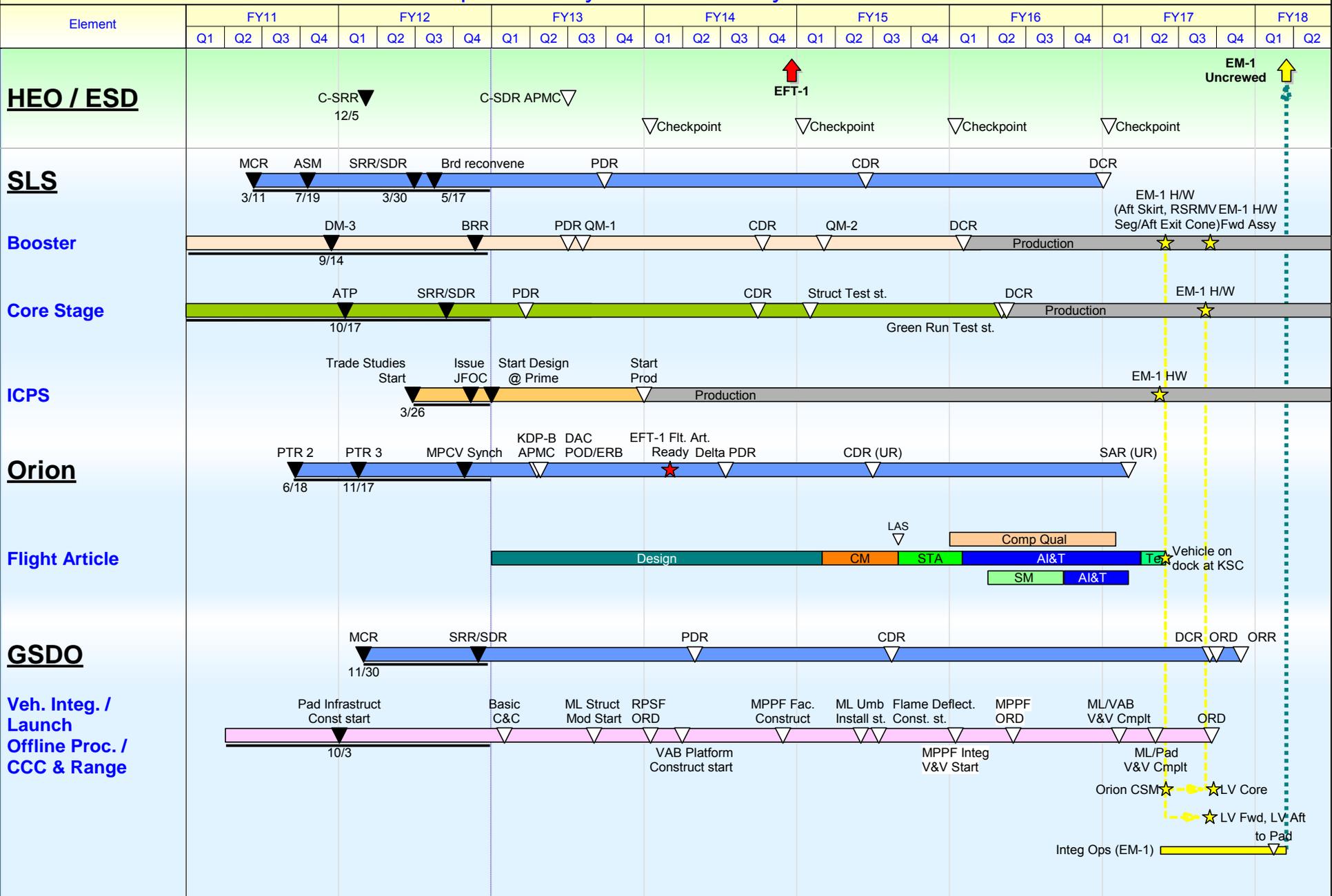
Hardware Tested:

- Boosters
- Engines
- Upper Stage
- MPCV (2014)



Exploration Systems Summary Schedule

version: 121107 R0



★ EFT-1 fit h/w

★ EM-1 fit h/w

Progress to date

Milestones are "complete" milestones unless noted

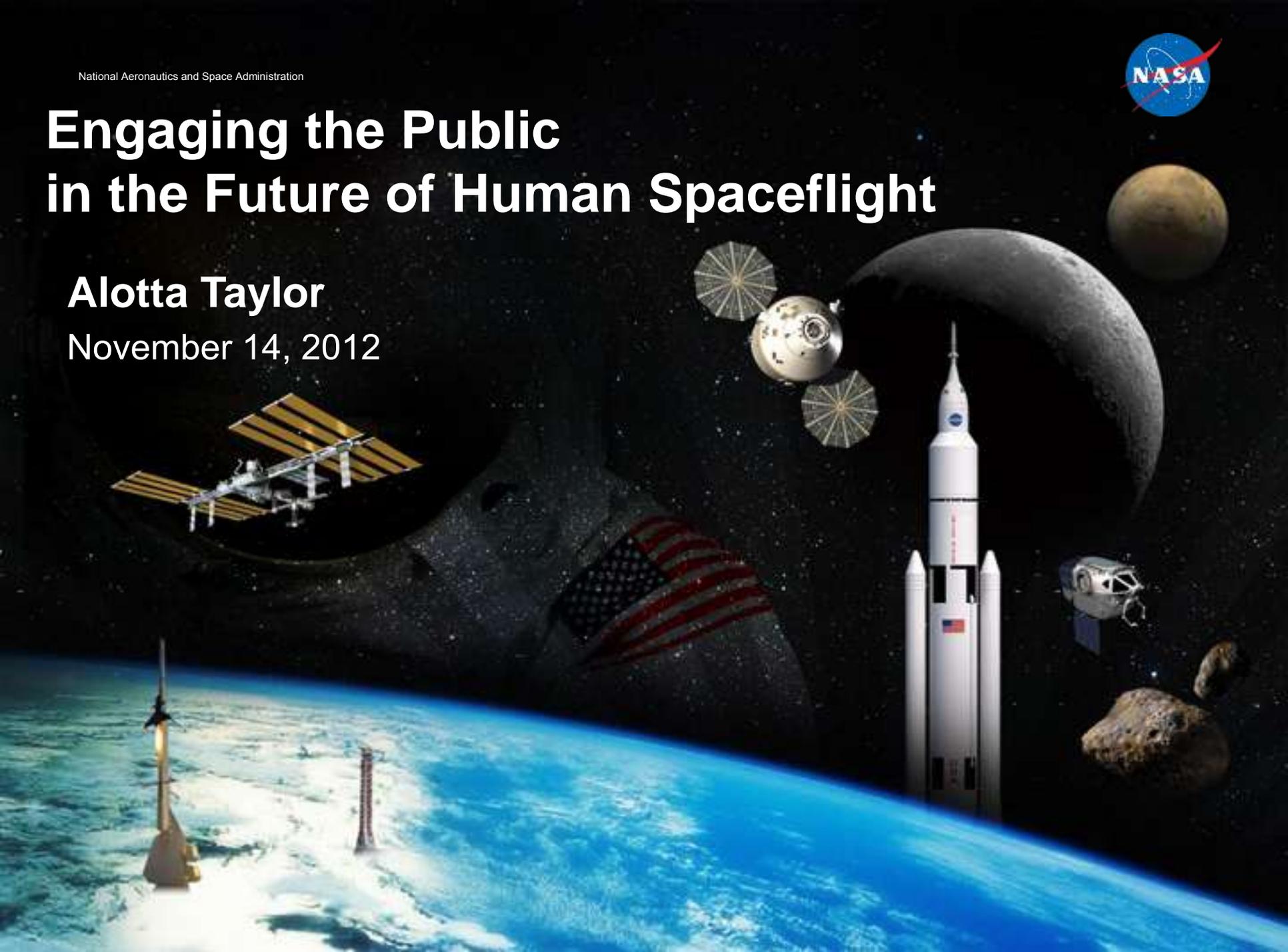
For comments contact david.l.webster@nasa.gov



Engaging the Public in the Future of Human Spaceflight

Alotta Taylor

November 14, 2012



Agency Aligned Communications and Education Goals



AGENCY GOAL #6:

To 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.



DIRECTORATE GOALS:

- Increase public awareness of the marvels associated with ISS, including world-class research/technology advancements and tangible daily benefits to humanity
- Articulate meaningful, exciting and viable missions and uses for SLS and Orion MPCV as part of a capability-driven approach to multi-destination human spaceflight exploration
- Engage the public and Congress in understanding the reasons for exploration in a way that is exciting to young people

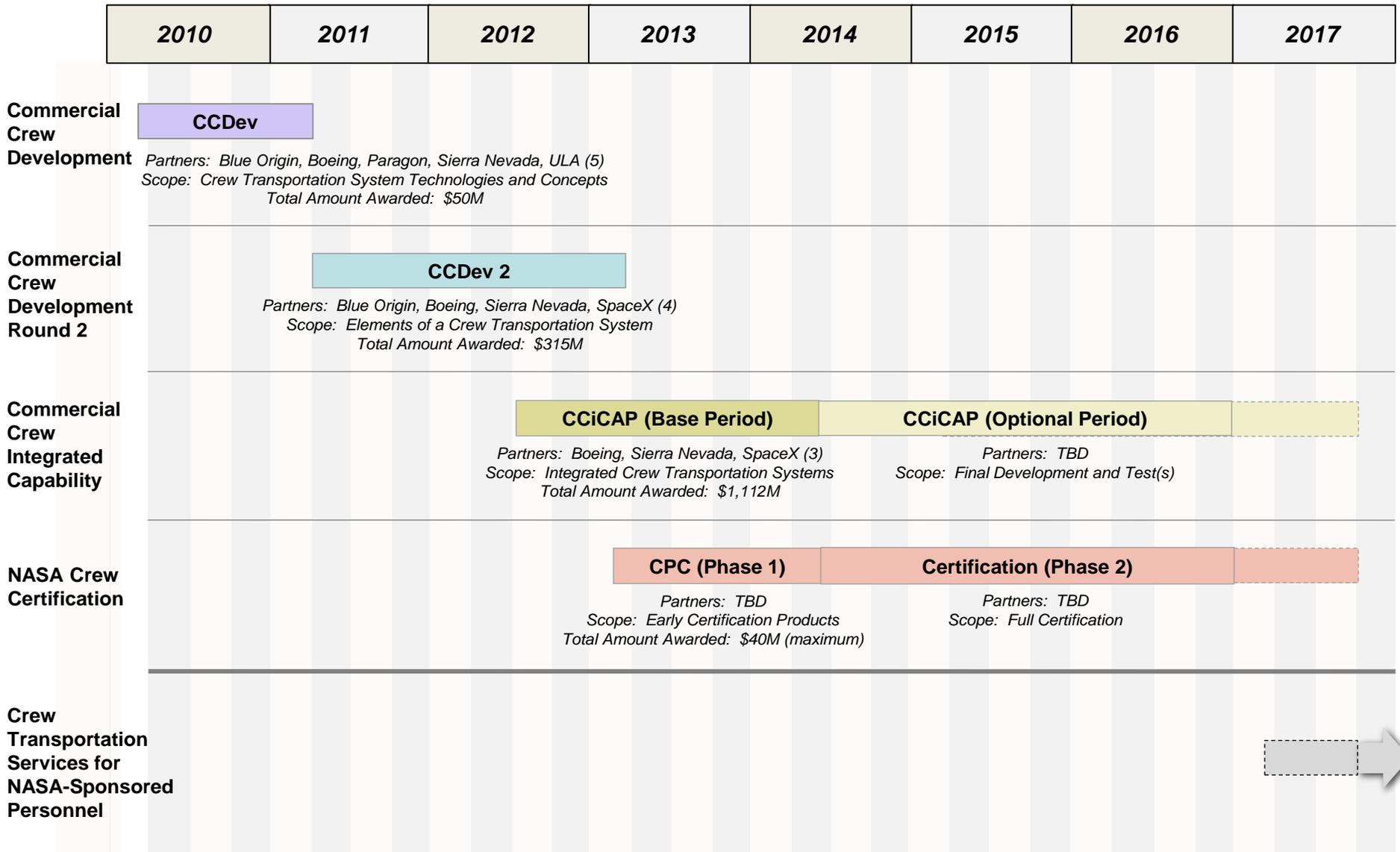


Commercial Certification Process and Accomplishments

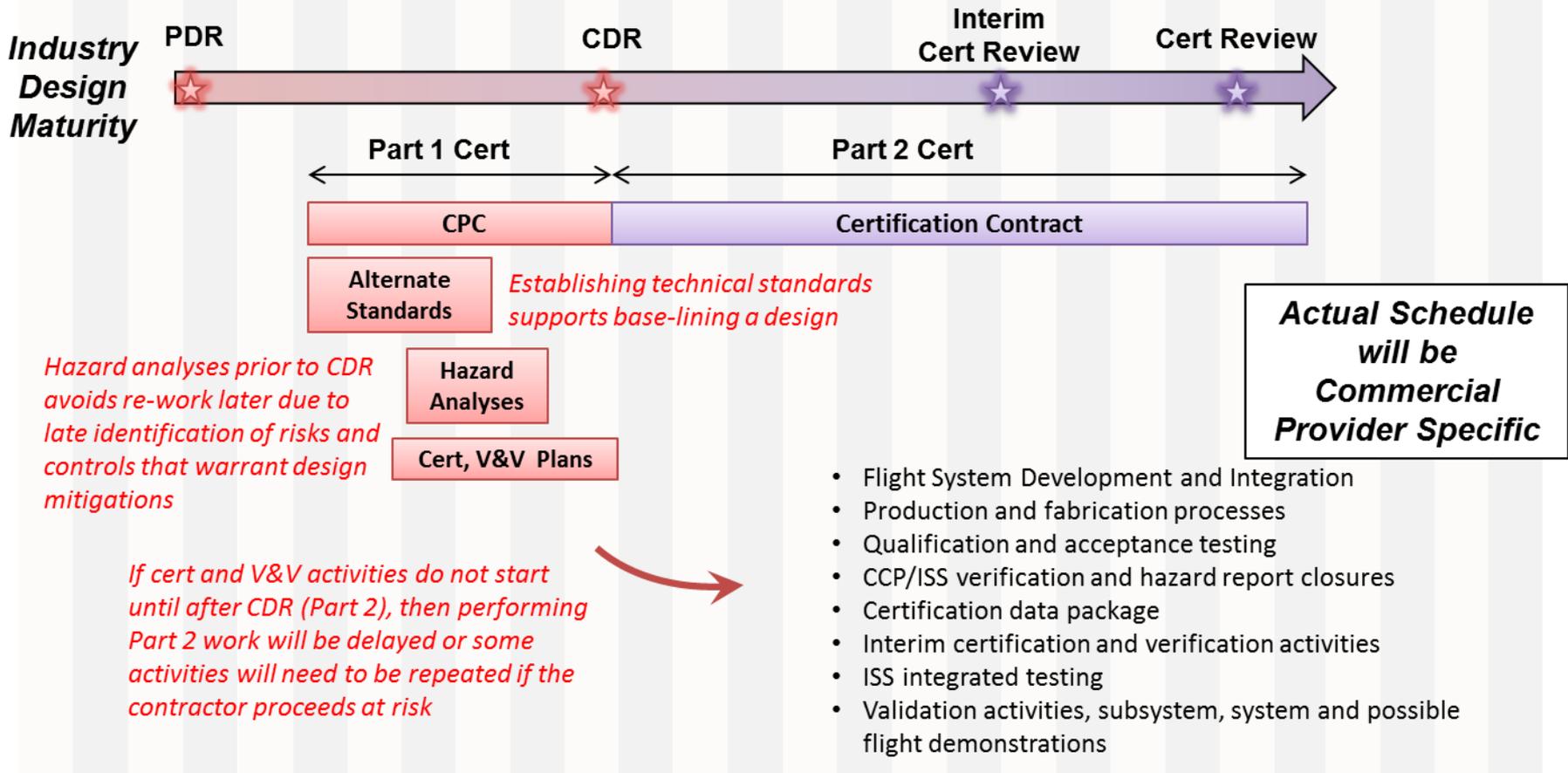
November 15, 2012
NAC Meeting



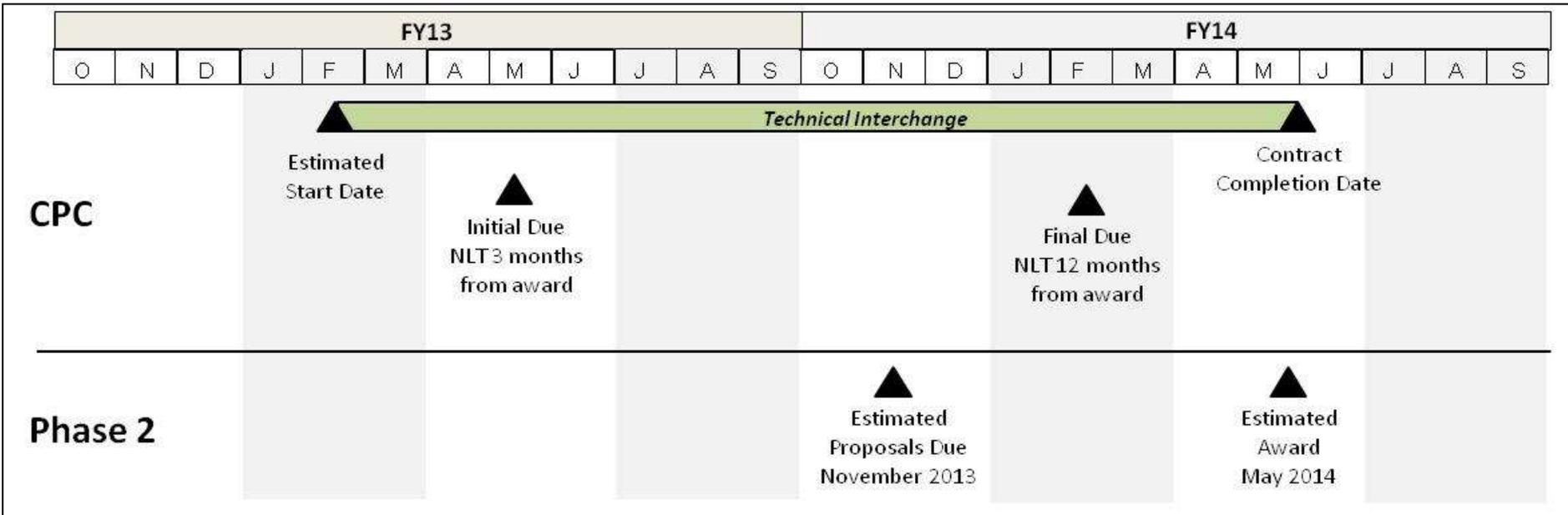
Commercial Crew Program Roadmap



NASA Certification Strategy



Planned Timing of Phase 1 and Phase 2





Proposed Recommendation to NASA Advisory Council

Short Title of Recommendation: Mars Program Planning Group (MPPG)

Recommendation: Provide the Human Exploration & Operations Committee and the Science Committee with a status update on the disposition of the MPPG report and its recommendations at the next meeting of the respective committees.

Major Reasons for the Recommendation: The Mars Program Planning Group (MPPG) has done an outstanding job in defining and analyzing several potential options for future Mars missions. Their report will soon be presented to NASA leadership for consideration.

Consequences of No Action on the Recommendation: The committee is concerned that an opportunity to define a well constructed Mars program may be lost or delayed.



Proposed Recommendation to NASA Advisory Council

Short Title of Recommendation: Outreach

Recommendation: NASA should leverage its contractors in developing its overall outreach strategy. Specifically, NASA should develop an integrated outreach plan that includes actions that the Agency and its contractors can perform. NASA should also include a requirement in solicitations for offerors to submit their outreach plans as part of their proposal. An offeror's outreach plan, including flow down of the outreach requirements to subcontractors, would be evaluated and factored into the overall proposal rating.

Major Reasons for the Recommendation: NASA has a multifaceted outreach program. It could be significantly enhanced by leveraging this program with a network of NASA's contractors and their numerous sub-contractors.

Consequences of No Action on the Recommendation: Many Americans are under the mistaken impression that the human spaceflight program has been cancelled. We risk losing support for our program if our stakeholders are not aware of the programs within the Human Exploration and Operations Mission Directorate.

Back-Up

NASA Advisory Council Recommendation

Systems Integration 2012-02-06 (HEOC-01)

[Page 1]

Recommendation:

Integration among the Space Launch System (SLS), Orion, and Ground Systems programs requires definition and implementation. The Council recommends that a small team of experienced integrators, led by an empowered, accountable and responsible leader, should be established to ensure adequate integration of the three programs.

Major Reasons for the Recommendation:

Integration at the NASA Headquarters level appears to be insufficient to ensure schedule, technical and cost performance of the system composed of the three separate programs.

Consequences of No Action on the Recommendation:

Due to lack of adequate integration of the three programs, design and configuration disconnects will be identified late resulting in cost overruns, schedule slips and risk to mission.

NASA Response:

NASA agrees that sufficient integration is needed to assure the technical, cost, and schedule integration of the SLS, Orion, and the Ground Systems. The Exploration Systems Development (ESD) Division within the Human Exploration and Operations Mission Directorate (HEOMD) has been established for this purpose. ESD is led by experienced people with human spaceflight development and operations experience, as well as other NASA program hardware development expertise. ESD also takes advantage of the human spaceflight development and operations expertise across the Agency. This expertise has been integrated into the program management processes with appropriate oversight and monitoring by the ESD.

NASA Advisory Council Recommendation

Systems Integration 2012-02-06 (HEOC-01)

[Page 2]

NASA is using the Standing Review Board (SRB) process to review the integration activities as well as the detailed SLS, Orion, and the Ground Systems technical, cost, and schedule performance. The SRB provided an assessment of the integration activities as part of the Cross Program Systems Requirements Review earlier this fiscal year, finding that the approach and processes were sound for the level of integration needed at this phase of the programs. The SRB also pointed out certain areas requiring strengthening, and each of those findings is being addressed.

This fall/winter, the SRB will review the approaches and processes via the Cross Program Systems Definition Review. In addition, integration activities are key aspects of the SRB assessments of the individual programs, with findings and recommendations specifically addressing integration in addition to program specific findings. As we proceed through the development of the initial exploration capabilities, the need to continually assess the approaches, processes, and results has led to the establishment of periodic review checkpoints (annually at a minimum) to objectively assess the integrated technical, cost, and schedule performance, as well as quarterly focus briefings at the Agency Baseline Program Review.

NASA recognizes that this model is being implemented in a constrained fiscal and schedule environment. This integration model has been established to fit within these constraints, assure timely decision making, and make efficient use of resources while assuring rigorous technical, cost, and schedule management. We welcome the NASA Advisory Council's (NAC) input as we continue to develop the next phase of human space exploration. We will provide a more detailed briefing of our approach and process at the next meeting of the NAC Human Exploration and Operations Committee in November 2012.