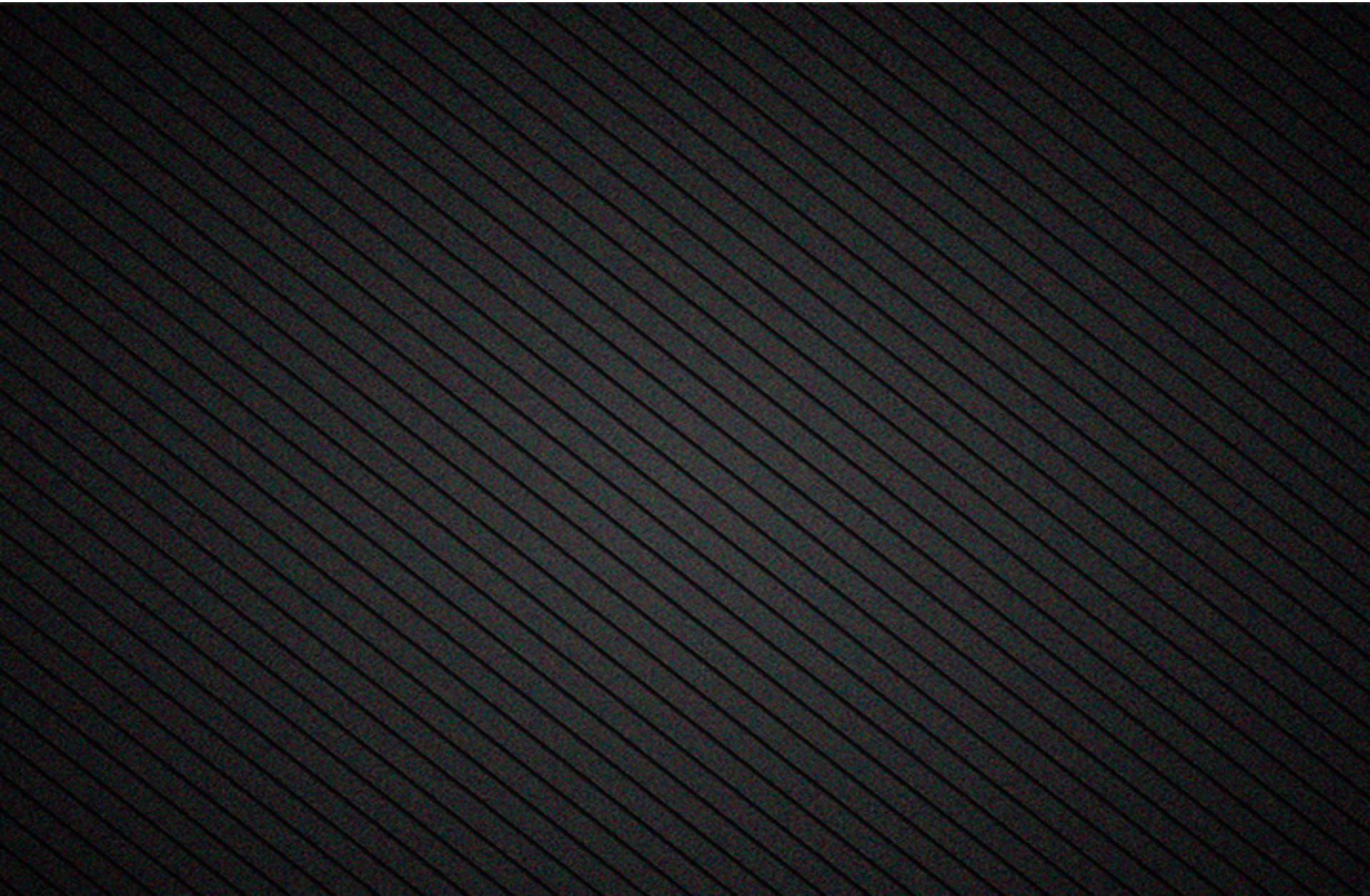
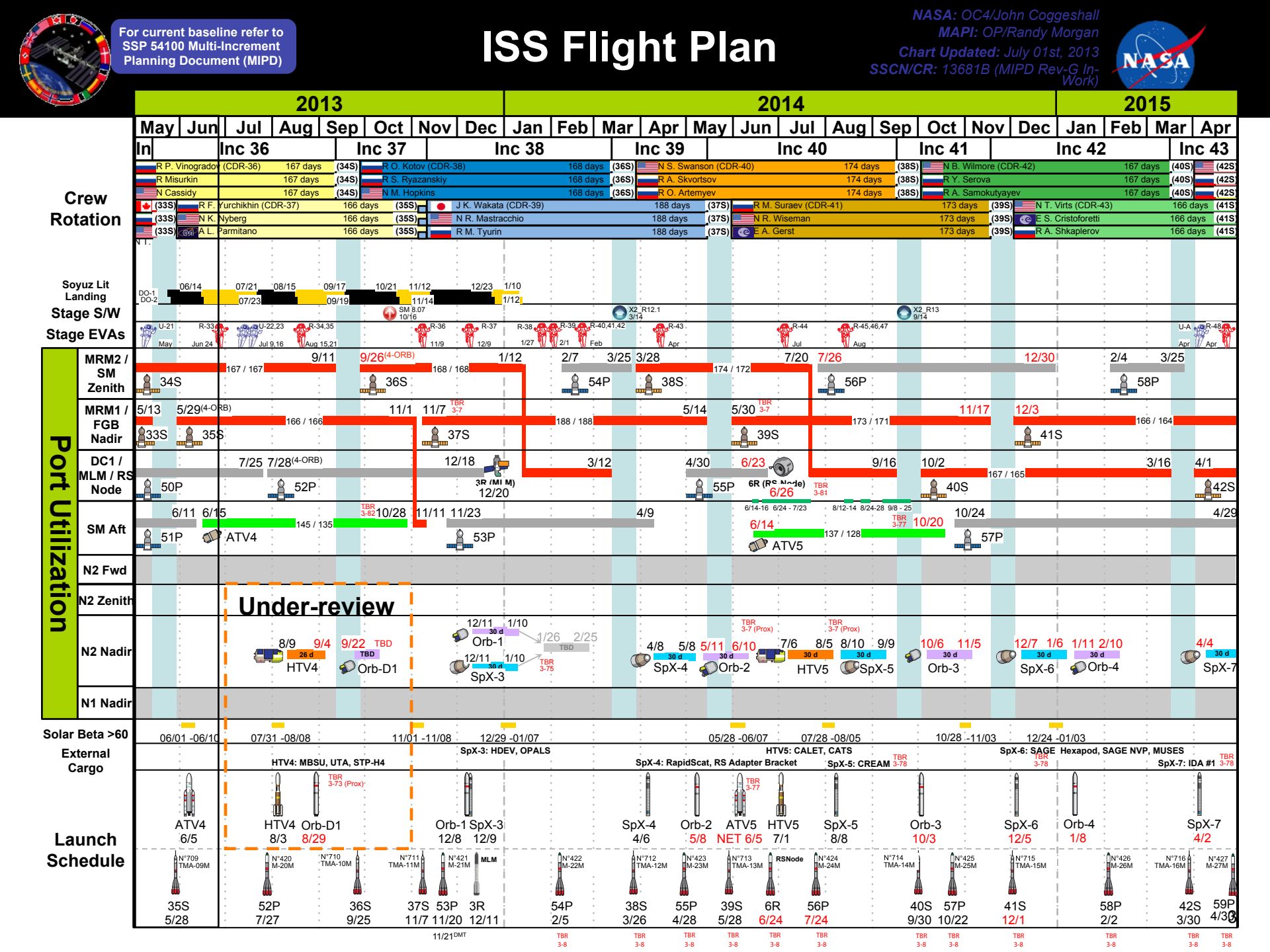
Status of Human Exploration and Operations Mission Directorate (HEO)

Bill Gerstenmaier | July 29, 2013

International Space Station




For current baseline refer to SSP 54100 Multi-Increment Planning Document (MIPD)
ISS Flight Plan
NASA: OC4/John Coggeshall
MAPI: OP/Randy Morgan
Chart Updated: July 01st, 2013
SSCN/CR: 13681B (MIPD Rev-G In-Work)
2013
2014
2015
May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr
In Inc 36 Inc 37 Inc 38 Inc 39 Inc 40 Inc 41 Inc 42 Inc 43
Crew Rotation
R P. Vinogradov (CDR-36) 167 days (34S)
R Misurkin 167 days (34S)
N Cassidy 167 days (34S)
R F. Yurchikhin (CDR-37) 166 days (35S)
N K. Nyberg 166 days (35S)
A L. Parmitano 166 days (35S)
R O. Kotov (CDR-38) 168 days (36S)
R S. Ryazanskiy 168 days (36S)
M. Hopkins 168 days (36S)
J K. Wakata (CDR-39) 188 days (37S)
N R. Mastracchio 188 days (37S)
R M. Tyurin 188 days (37S)
N S. Swanson (CDR-40) 174 days (38S)
R A. Skvortsov 174 days (38S)
R O. Artemyev 174 days (38S)
R M. Suraev (CDR-41) 173 days (39S)
N R. Wiseman 173 days (39S)
E A. Gerst 173 days (39S)
N B. Wilmore (CDR-42) 167 days (40S)
R Y. Serova 167 days (40S)
R A. Samokutyayev 167 days (40S)
N T. Virts (CDR-43) 166 days (41S)
E S. Cristoforetti 166 days (41S)
R A. Shkaplerov 166 days (41S)
(42S) (42S) (42S) (41S)
Soyuz Lit Landing
DO-1 DO-2 06/14 07/21 07/23 08/15 09/17 09/19 10/21 11/12 11/14 12/23 1/10 1/12
Stage S/W
SM 8.07 10/16
X2_R12.1 3/14
X2_R13 9/14
Stage EVAs
U-21 May
R-33 Jun 24
U-22,23 Jul 9,16
R-34,35 Aug 15,21
R-36 11/9
R-37 12/9
R-38 1/27
R-39 2/1
R-40,41,42 Feb
R-43 Apr
R-44 Jul
R-45,46,47 Aug
U-A Apr
R-48 Apr
Port Utilization
MRM2 / SM Zenith
167 / 167
9/11
34S
9/26(4-ORB)
168 / 168
36S
1/12
2/7
54P
3/25
3/28
174 / 172
38S
7/20
7/26
56P
12/30
2/4
58P
3/25
MRM1 / FGB Nadir
5/13
5/29(4-ORB)
166 / 166
33S
35S
11/1
11/7 TBR 3-7
188 / 188
37S
5/14
5/30 TBR 3-7
173 / 171
39S
11/17
12/3
41S
166 / 164
DC1 / MLM / RS Node
7/25
7/28(4-ORB)
50P
52P
12/18
3R (MLM)
12/20
3/12
4/30
55P
6/23
6R (RS Node)
6/26
TBR 3-81
9/16
10/2
40S
167 / 165
3/16
4/1
42S
SM Aft
6/11
6/15
145 / 135
51P
ATV4
TBR 3-82
10/28
11/11
11/23
53P
4/9
6/14
137 / 128
ATV5
TBR 3-77
10/20
10/24
57P
4/29
N2 Fwd
N2 Zenith
Under-review
N2 Nadir
8/9
9/4
26 d
HTV4
9/22
TBD
Orb-D1
12/11
1/10
30 d
Orb-1
1/26
2/25
TBD
12/11
1/10
30 d
SpX-3
TBR 3-75
4/8
5/8
30 d
SpX-4
5/11
6/10
30 d
Orb-2
TBR 3-7 (Prox)
7/6
8/5
30 d
HTV5
TBR 3-7 (Prox)
8/10
9/9
30 d
SpX-5
10/6
11/5
30 d
Orb-3
12/7
1/6
30 d
SpX-6
1/11
2/10
30 d
Orb-4
4/4
30 d
SpX-7
N1 Nadir
Solar Beta >60
06/01 -06/10
07/31 -08/08
11/01 -11/08
12/29 -01/07
05/28 -06/07
07/28 -08/05
10/28 -11/03
12/24 -01/03
External Cargo
HTV4: MBSU, UTA, STP-H4
SpX-3: HDEV, OPALS
SpX-4: RapidScat, RS Adapter Bracket
HTV5: CALET, CATS
SpX-5: CREAM TBR 3-78
SpX-6: SAGE Hexapod, SAGE NVP, MUSES TBR 3-78
SpX-7: IDA #1 TBR 3-78
Launch Schedule
ATV4 6/5
HTV4 8/3
Orb-D1 8/29
TBR 3-73 (Prox)
Orb-1 12/8
SpX-3 12/9
SpX-4 4/6
Orb-2 5/8
ATV5 NET 6/5
TBR 3-77
HTV5 7/1
SpX-5 8/8
Orb-3 10/3
SpX-6 12/5
Orb-4 1/8
SpX-7 4/2
N°709 TMA-09M
35S 5/28
N°420 M-20M
N°710 TMA-10M
52P 7/27
36S 9/25
N°711 TMA-11M
37S 11/7
N°421 M-21M
MLM
53P 11/20
3R 12/11
11/21DMT
N°422 M-22M
54P 2/5
TBR 3-8
N°712 TMA-12M
38S 3/26
N°423 M-23M
55P 4/28
N°713 TMA-13M
39S 5/28
RSNode
6R 6/24
N°424 M-24M
56P 7/24
N°714 TMA-14M
40S 9/30
N°425 M-25M
57P 10/22
N°715 TMA-15M
41S 12/1
N°426 M-26M
58P 2/2
N°716 TMA-16M
42S 3/30
N°427 M-27M
59P 4/30

35 Soyuz Launch/Expedition 36
May - November 2013

Vehicle: 35 Soyuz, TMA-09M

Launch: May 28, 2013

Docking: May 30, 2013

Undock/Landing: November 10, 2013

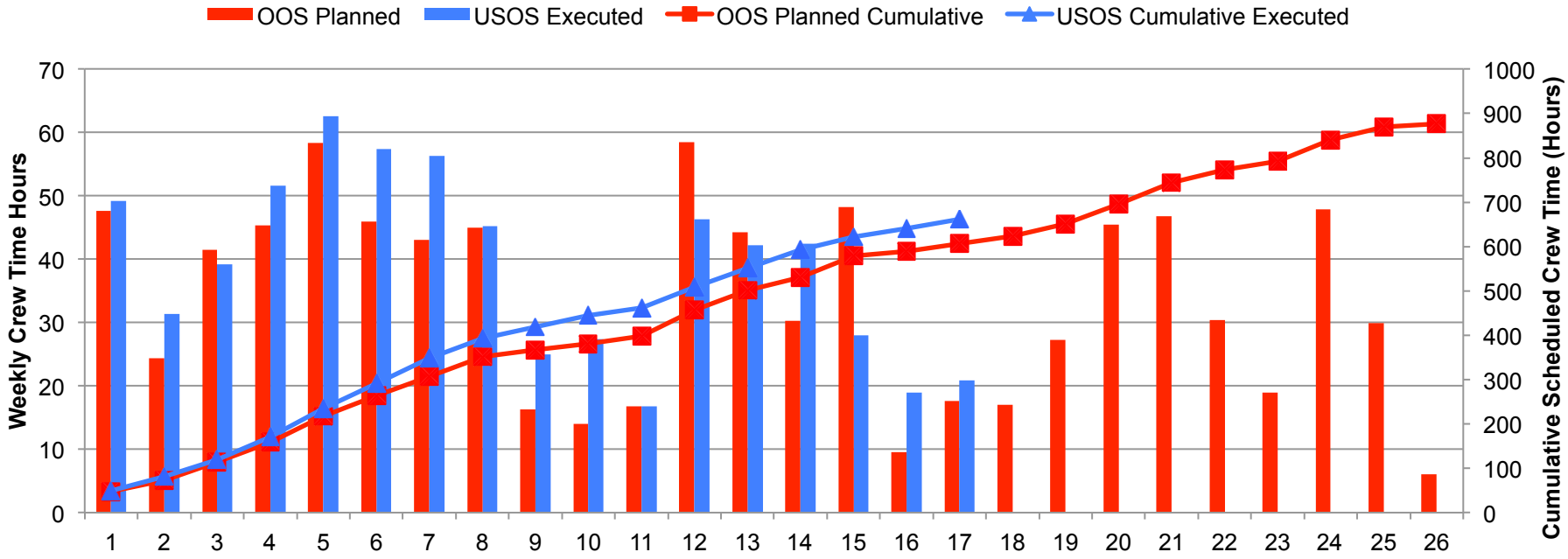
Soyuz 35 crew will join crew already on orbit

Pavel Vinogradov Exp 36 Commander
Alexander Misurkin ISS Flight Engineer
Chris Cassidy ISS Flight Engineer

35 Soyuz Crew Expedition 36

Fyodor Yurchikhin Soyuz Commander & Exp 37 Commander
Karen Nyberg ISS Flight Engineer
Luca Parmitano (ESA) ISS Flight Engineer

Inc 35-36 Utilization Crew Time



3-Crew	6- Crew	3-Crew	6-Crew
Increment 35		Increment 36	
March	April	May	June	July	August	Sept

Completed 35-36 Final OOS

SpX-2
(Unberth on 3/24/13)
(Unberth on 3/26/13)

(Dock on 5/1/13)

US EVA 21

(Berth on 5/8/13)
Below the line

(Dock on 6/15/13)

US EVA US EVA

(7/20/13 – 8/19/13)

(8/9/13 – 9/4/13)

(Berth on 9/22/13)

WLP 2 contains 35 minutes of ESA Utilization that has not been agreed upon.

OC/OZ reconciliation is not completed as of Week 17.

Executed through Increment Wk (WLP Week) 17 =	16.0	of 24.2 work weeks (66.12% though the Increment)
USOS IDRD Allocation:	875	hours
OOS USOS Planned Total:	876.49	hours
USOS Actuals:	661	hours
	75.54%	through IDRD Allocation
	75.41%	through OOS Planned Total
Total USOS Average Per Work Week:	41.31	hours/work week

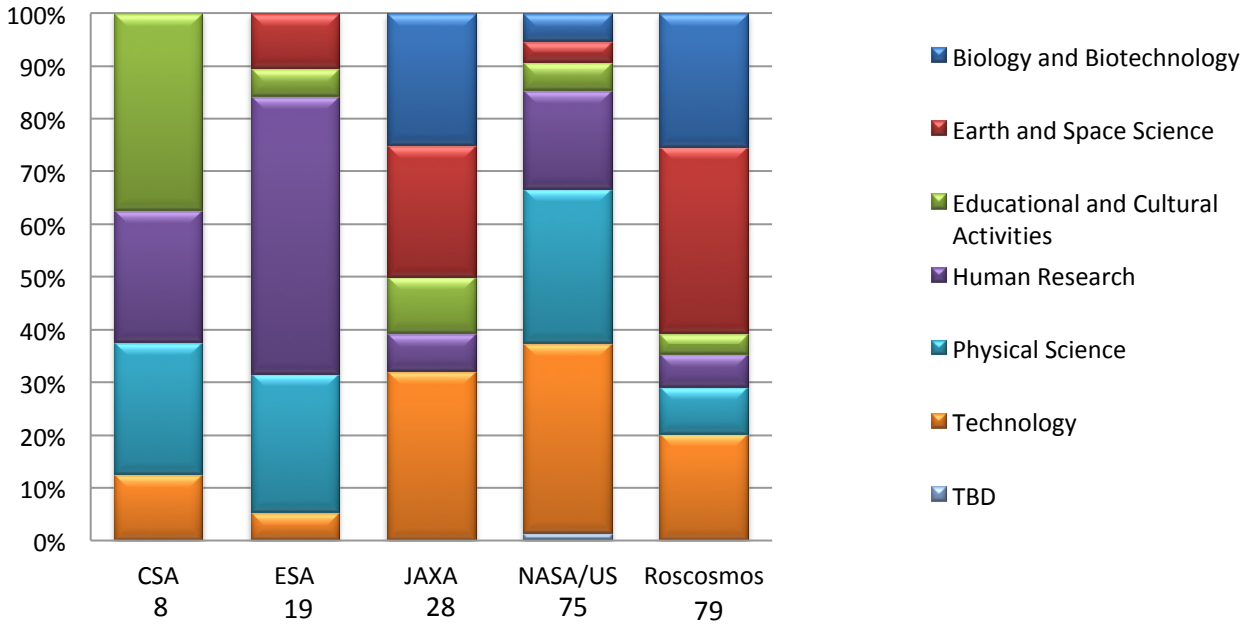
ISS Research Statistics
Working data as of March 31, 2013

Number of ISS Investigations for 35/36 : 209

- 75 NASA/U.S.-led investigations
- 134 International-led investigations
- 30 new investigations
  - 1 CSA
  - 4 ESA
  - 7 JAXA
  - 16 NASA/U.S.
  - 2 Roscosmos

- Over 400 Investigators represented
- Over 500 scientific results publications (Exp 0 – present)

Discipline by ISS Partner: Expedition 35/36



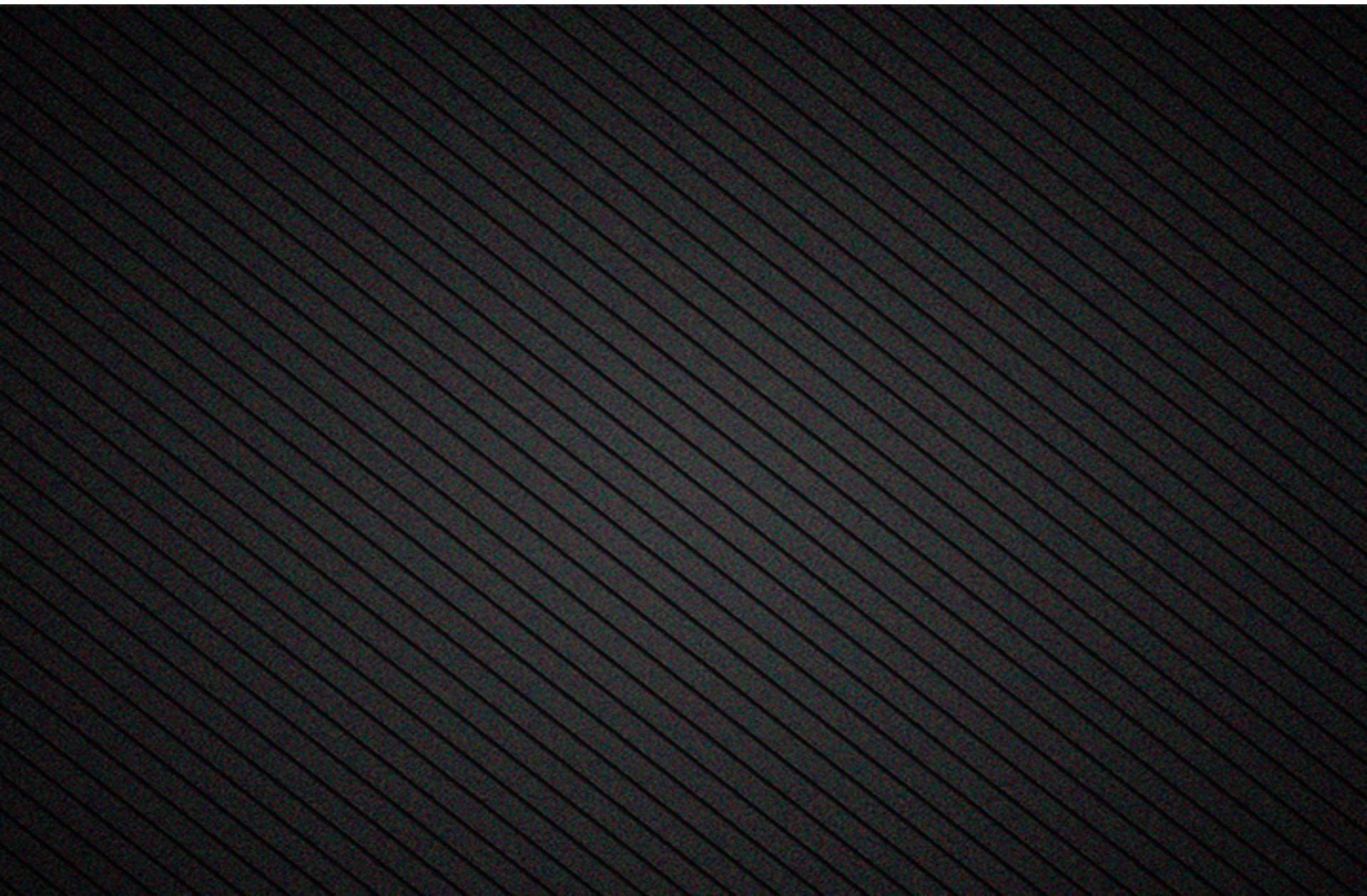
Number of Investigations Expedition 0-32: 1549

CASIS: A Paradigm Shift In How We Conduct Space Business

National lab utilization to date:

- $15M obligated for ISS National Lab research across 40 projects
- $2M non-NASA funds committed to targeted flight opportunities
- Commercial Partnerships with Boston Museum of Science, MD Anderson, Baylor College of Medicine, MIT, MassChallenge, Boeing, NSTA, The Broad Institute, etc.
- Flight Project Agreements with P&G, Merck, Cobra Puma, numerous universities
- MOAs in place and/or in development with NIH, NOAA, USDA, VA, DoD, NRL (Navy)

Advanced Exploration Systems

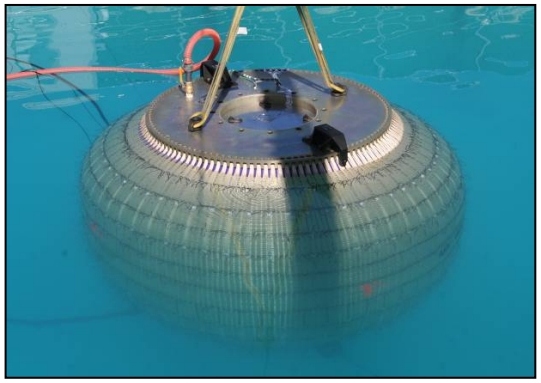


Advanced Exploration Systems

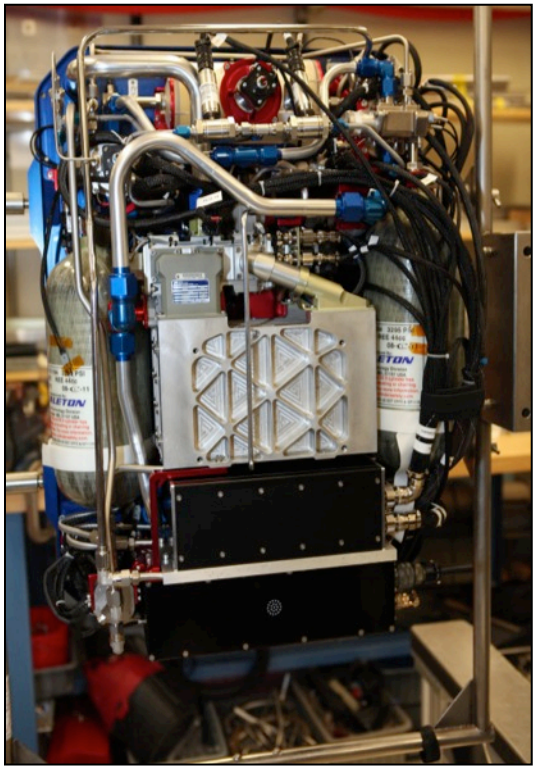
Rapid development and testing of prototype systems and validation of operational concepts to reduce risk and cost of future exploration missions:

- **Crew Mobility Systems**
  - Systems to enable the crew to conduct "hands-on" surface exploration and in-space operations, including crew excursion vehicles, advanced space suits, and crew egress
- **Deep Space Habitation Systems**
  - Systems to enable the crew to live and work safely in deep space, including deep space habitats, reliable life support, radiation protection, and fire safety
- **Vehicle Systems**
  - Systems for in-space propulsion stages and small robotic landers, including nuclear propulsion, modular power systems, lander technology test beds, and autonomous precision landing
- **Operations**
  - Systems to enable more efficient mission and ground operations, including integrated testing, autonomous mission ops, integrated ground ops, and logistics reduction
- **Robotic Precursor Activities**
  - Acquire strategic knowledge on potential destinations for human exploration to inform systems development, including prospecting for lunar ice, characterizing the Mars surface radiation environment, radar imaging of NEAs, instrument development, and research and analysis

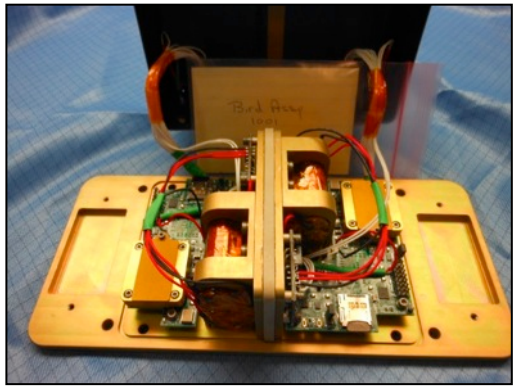
Recent Accomplishments
Advanced Exploration Systems Program



BEAM: Signed $17.8M contract with Bigelow Aerospace to develop inflatable module for demonstration on ISS in 2015. Completed burst test to 8x operating pressure.



EVA: Completed assembly of the Portable Life Support System (PLSS) 2.0. This is the first new PLSS to be developed since the Shuttle EMU was introduced in 1981. The PLSS 2.0 incorporates new technology components developed by STMD for CO2 removal, suit pressure regulation, thermal control, and energy storage.

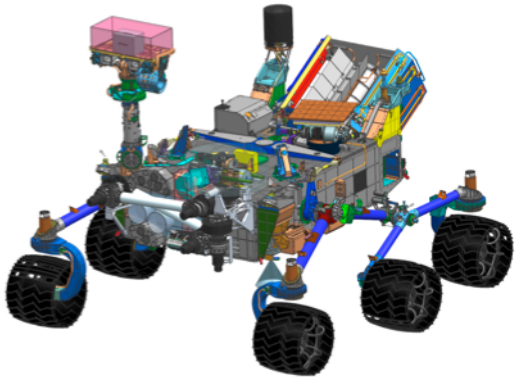


Radiation Protection: Completed assembly of Radiation Environment Monitor flight unit for EFT-1 mission.

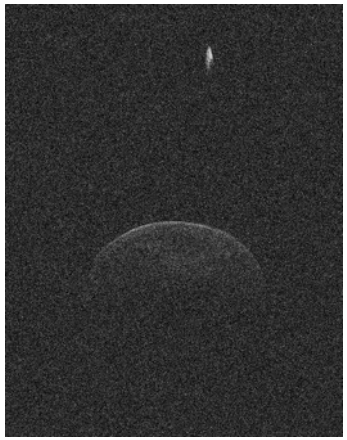
Life Support: Completed integrated chamber tests of ISS-derived Carbon Dioxide Removal Assembly, Trace Contaminant Control System, Sabatier reactor, and Oxygen Generation Assembly.

Recent Accomplishments
Advanced Exploration Systems Program

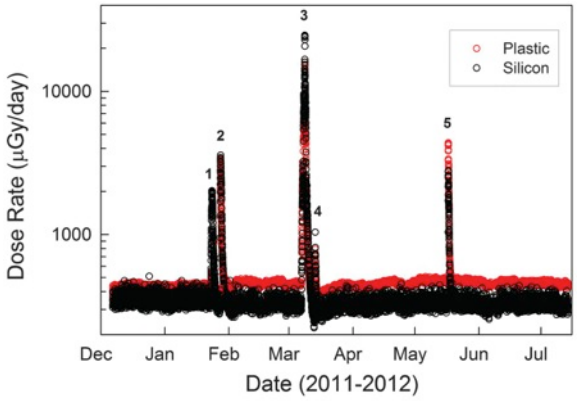
Morpheus: Completed first tether test of new 1.5B vehicle. Demonstrated stable hover and in-flight switching to backup IMU. ALHAT autonomous precision landing system will be demonstrated on Morpheus later this year.



Mars 2020: Partnering with SMD and STMD to develop an in-situ resource utilization payload to demonstrate oxygen production from the Martian atmosphere.



Goldstone Radar: Imaged over 10 candidate targets for human NEA missions. Discovered moon around asteroid 1998 QE2 during its closest approach (0.04 AU) on May 31.

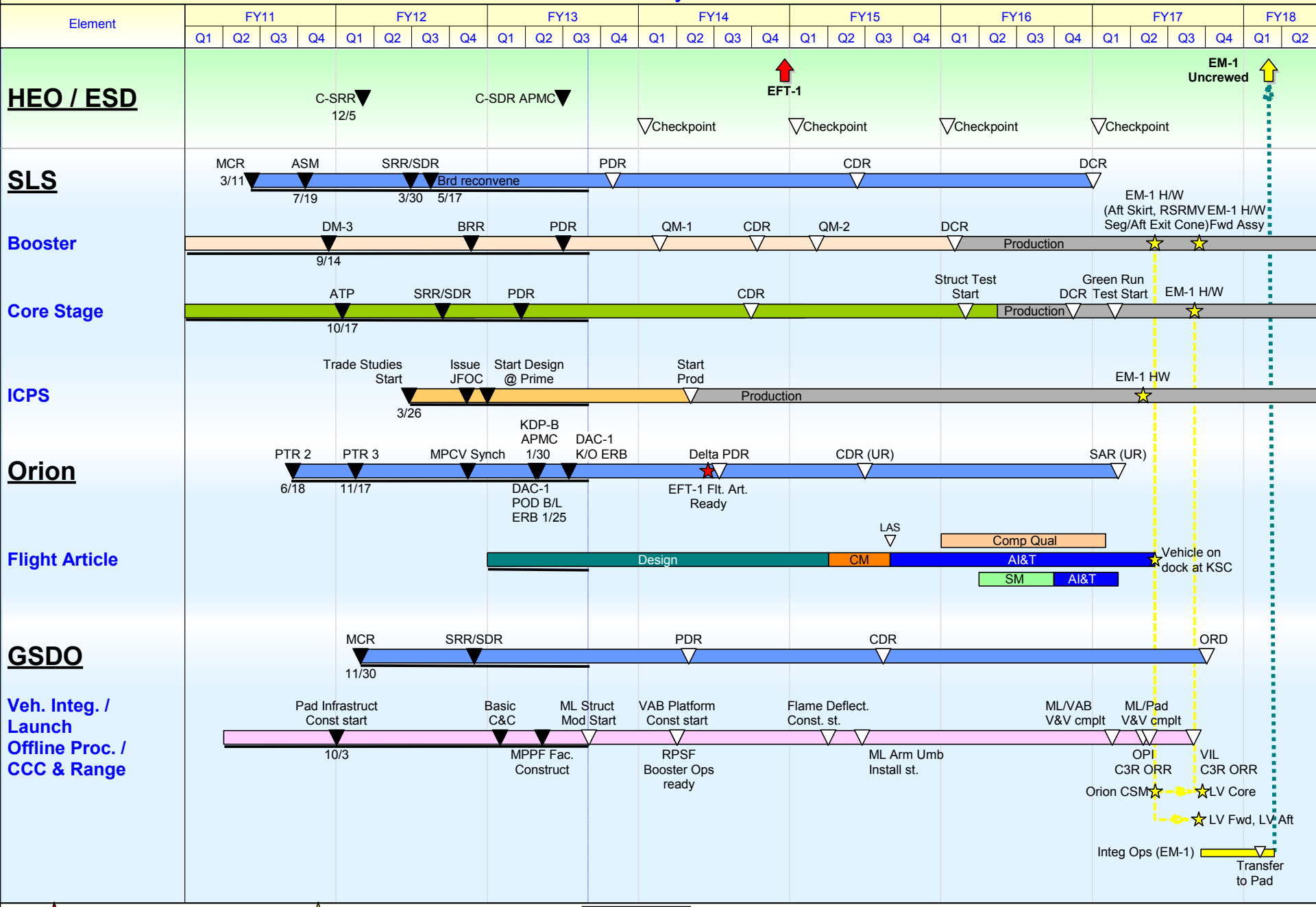


Radiation Assessment Detector: Operating for over 320 sols on Mars. Dose rate data acquired during trip to Mars were published in the May 31 issue of the journal *Science*.

Exploration Systems Development

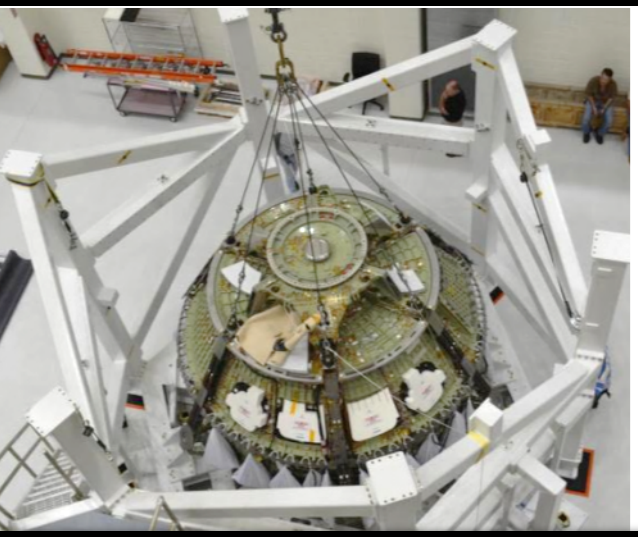
ESD Summary Schedule

Version: 2013-05-31



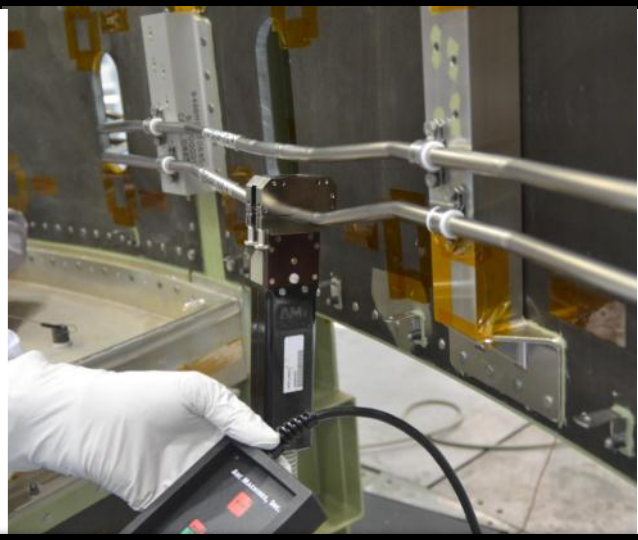
For comments contact david.l.webster@nasa.gov

Orion Accomplishments

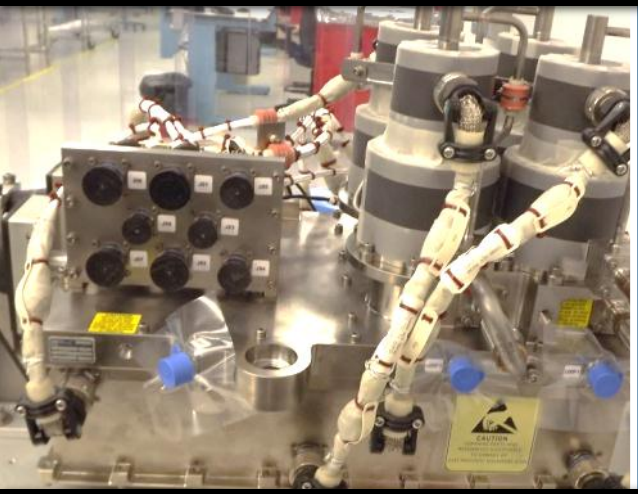


EFT-1 Crew Module being placed in the Static Loads Test Fixture at the Operations Checkout

Fairing separation test 1 at Lockheed Martin, Sunnyvale, CA

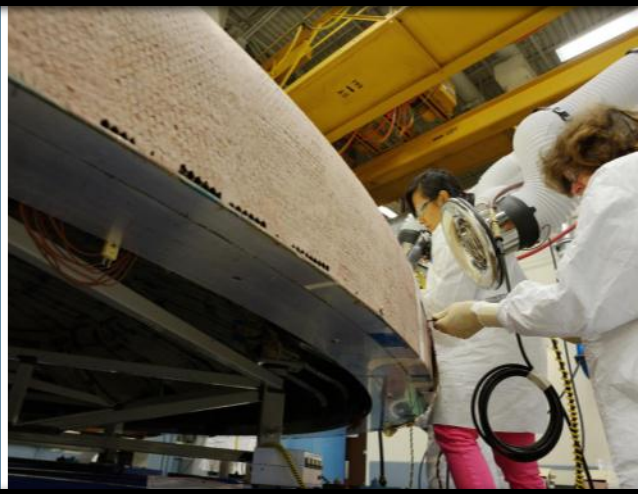


Service Module Environmental Control and Life Support System tube welding



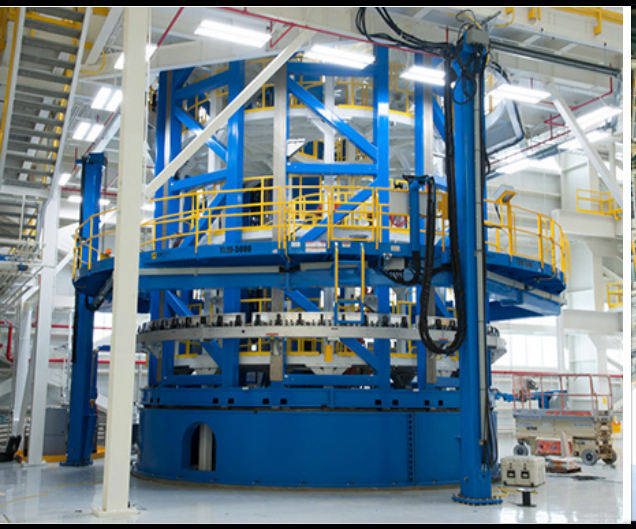
Environmental Control and Life Support System – Coolant Pump Package 1

Capsule Parachute Assembly System testing at Army Yuma proving ground in AZ



Applying the Avcoat material to Orion heat shield – Textron in MA.

SLS Accomplishments



Vertical Weld Tool Complete at Michoud Assembly Facility

Vertical Assembly Center Construction begins for the Core Stage production

First Trial Barrel Segment Completes Vertical Weld on Core Stage

Completed MSA Shell

Completed Flight Control Test #2,Booster Avionics

Center segment for QM-1 delivered to its test bay at ATK's facility in Utah

GSDO Accomplishments

Installation of flooring in the main firing room started – application of floor sealant

Landing and Recovery EIT participated in shipment of the Crew Module Recovery Cradle to Langley Research Center

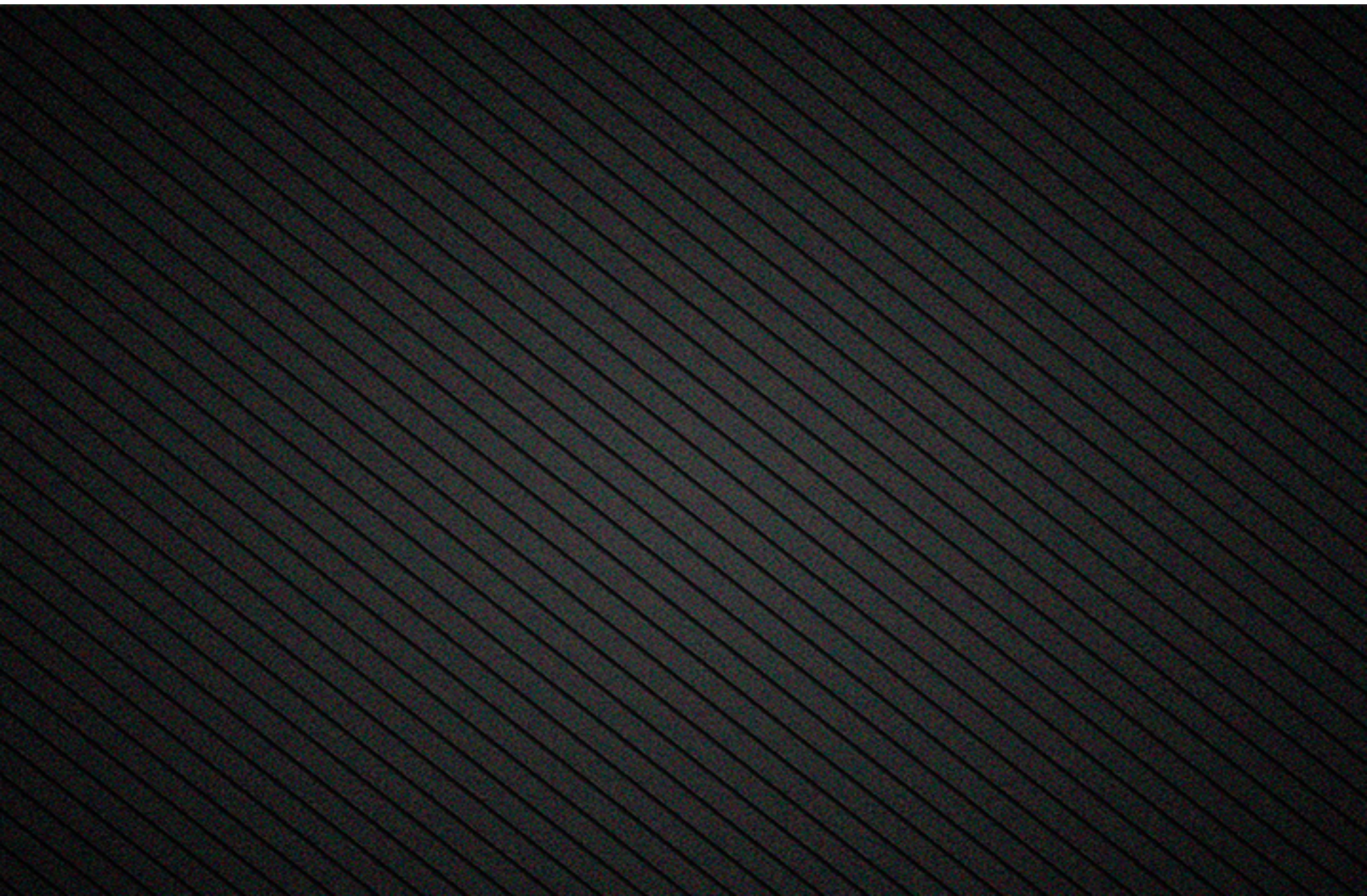
Facility modifications in the Multi-Payload Processing Facility

Fabrication of Liquid Oxygen (LO2) Vaporizer that will be installed at Pad B

Pad B Flame Trench and Flame Deflector demolition project

Completed Crew Module Recovery Cradle testing

Space Communications and Navigation



Network Services Accomplishments (Operations proficiency plus added needed capacity)

Deep Space Network (DSN): 99.6%

Near Earth Network (NEN): 99.79%

Space Network (SN): 99.96%

AS3 11 meter antenna

- Completed most, if not all, aging and obsolescence fixes for the SN at the White Sands Complex (WSC)
- Completed assembly of the first 34 meter antenna at the DSN site in Canberra. This is a HEO/SCaN effort to replace the 70 meter with an equivalent aperture array of smaller size antennas
- Completed the Factory Acceptance Testing for the new 11 meter antenna for the University of Alaska. Critical to meeting growing Earth Science requirements

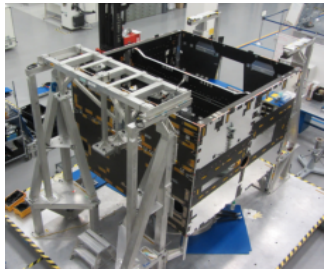
Network Services Accomplishments

Space Network Ground Segment Sustainment (SGSS)

- Successfully completed all element Critical Design Reviews (CDR), and System Technical CDR.
  - Cost and schedule to complete will be available by end of FY 2013.

TDRS-L

TDRS-K

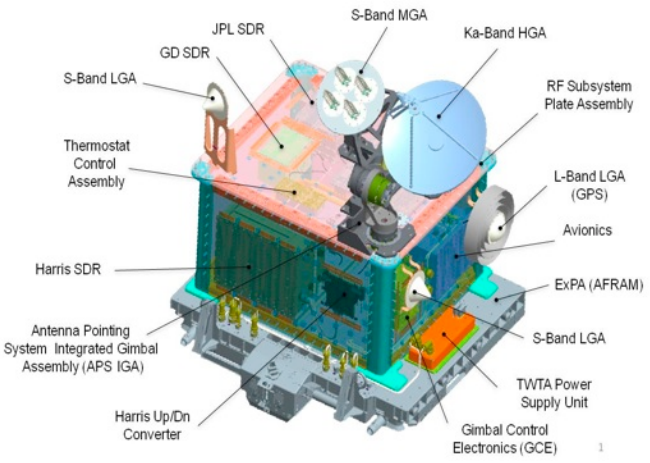


TDRS-M

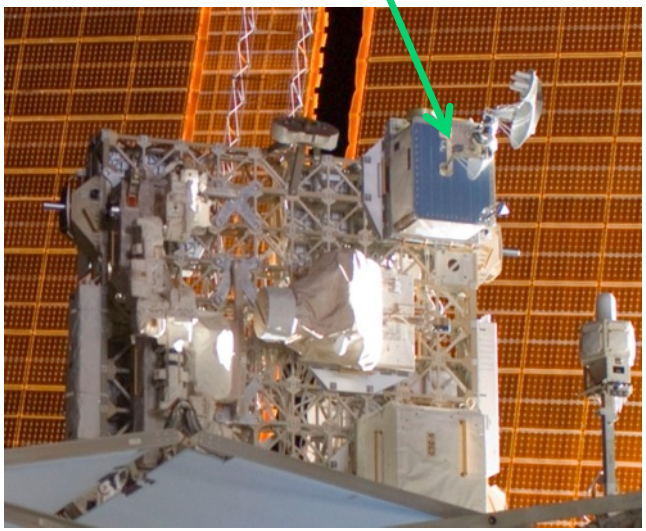
Tracking and Data Relay Satellite (TDRS)

- TDRS-K: Completed Vendor On-orbit Testing
- TDRS-L: Placed in storage at Boeing
  - Launch scheduled for late January 2014
- TDRS-M: Completed Production Readiness Review (PRR)
  - Ready for launch early FY 2016

SCAN Testbed (STB)
ISS Flight System Payload Overview



SCAN Testbed on ISS ELC-3



STB launched to ISS in August 2012
Commissioning completed with all ops nominal

- Experiment program is underway
- Forty experiments in the queue for FY13/14/15; SDR technology advancement, networking, DTN, modulation and coding, protocols; additional experiments under review
- User interest is high and diverse from government, industry, and academia
- First three standard compliant Software Defined Radios in space; First NASA Ka-band user successfully operating on orbit; First civilian reception of L5 GPS carrier signals in space; First SDR reconfigurations on-orbit

STB Experiments and Users

- SDR technology advancement; networking; DTN; GRC, JPL, GSFC, WSC

modulation and coding; GPS/navigation; data protocols

Non-NASA Users

• Scintillation-Hardened GPS (Solar Flare Study)	Comm Largo Inc.
• Single-Carrier FDMA Adaptive CPM	FIT & Harris Corporation
• Signal Classification and Interference Mitigation	Virginia Tech University
• GPS Jammer Detection and Geolocation	NAVSYS Corp
• Calibration of Satellite Antenna Arrays	Ohio State University
• Secure DTN Communications	Innoflight Incorporated
• Civil GPS Navigation Test (CNAV) (Phase I)	Air Force
• DTN International Interoperability	CNES and NASA

Technology and Standards Accomplishments

Backup Terminal
JPL Table Mountain

Primary Ground Terminal (White Sands)

Backup Terminal
ESA Tenerife

Lunar Laser Communications Demonstration (LLCD) onboard Lunar Atmosphere and Dust Environment Explorer (LADEE)) – scheduled for launch September 6

(Critical to validate optical Communications technology for future space communications)

- Spacecraft and LLCD space terminal at Wallops Flight Facility
- Final Space Terminal Test complete
- Primary Ground Terminal successfully transported to White Sands, reassembled and in testing
- JPL Table Mountain Auxiliary Ground Terminal data interchange compatibility test complete
- ESA Auxiliary Ground Terminal detectors demonstrated and preparing for compatibility testing

International Cross Support Collaboration

SCaN planned and attended Interoperability Plenary (IOP-3), held in Toulouse, France (June 25-26)

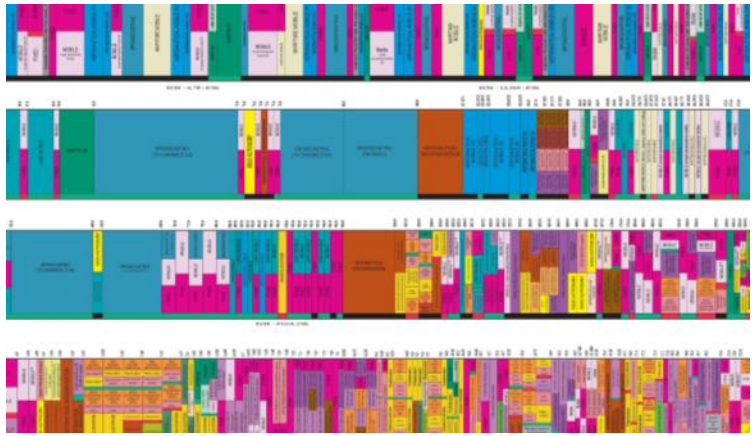
- IOP-3 set the agenda for subordinate groups to enable strategic interoperability and cross support among participating space agencies

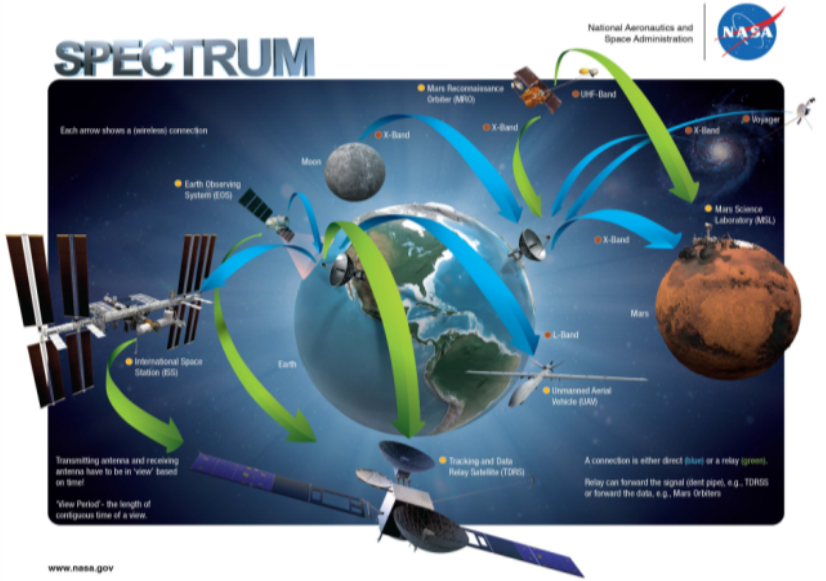
- Major conclusions included:
  - IOP endorsed strong liaisons with Space Frequency Coordination Group (SFCG), Consultative Committee for Space Data Systems (CCSDS), International Committee on Global Navigation Satellite Systems (ICG), and International Space Exploration Coordination Group (ISECG)
  - IOAG was directed to work with CCSDS, SFCG, ICG and member agencies to demonstrate and develop responsive standards and insertion opportunities for cross support. This includes GNSS Interoperability, Optical Communications, 26GHz in Low Earth Orbit, Solar System Internetworking, and Mission Operations Systems

Spectrum Management Accomplishments and Planning

Broadband Analyses

- NASA led a briefing to the FCC for removal of 2025-2110 MHz band, critical to NASA present and future operations, from domestic and international Mobile Broadband consideration
- WRC-15 preparations are well underway
- **National Broadband Initiatives –** Engaged in government/industry working groups established to address spectrum sharing (1755-1850 MHz)
- **Executive Branch –** Developing plans on how to address requirements contained in latest Presidential Memo
- **WRC-15 Planning –** Studies underway within responsible ITU-R working parties on agenda items of interest/concern. Critical international meetings in July and Sept
- **Space Launch System –**agreement for spectrum to support flights beyond EM1 and EM2

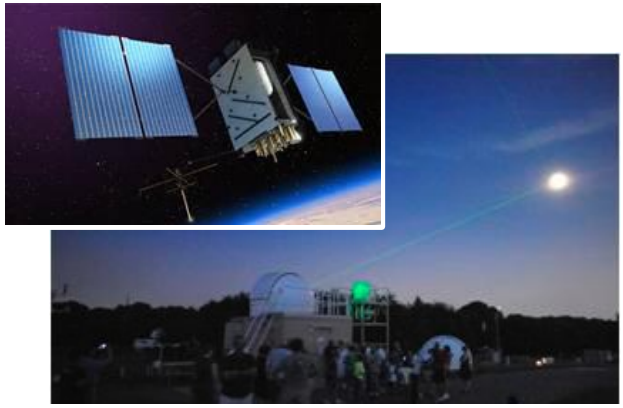




GPS/PNT Policy Implementation
Key Policy Progress

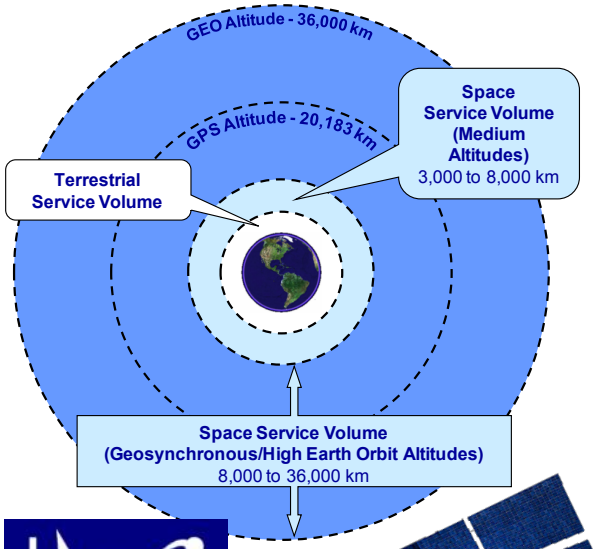
Implementation of Laser-Retro-reflectors on GPS III

- NASA signed an agreement with Air Force Space Command on June 3 to implement laser retro-reflectors onto GPS III
  - This completes a multiyear effort led by NASA with multiple Federal agencies to improve the performance of the GPS constellation and to get better accuracy for our Earth Science measurements.



Development of GNSS Space Service Volume (SSV)

- SCaN has secured adoption of the GNSS Space Service Volume concept as a United Nations International Committee on GNSS (ICG) work item, which the IOAG and IOP now also support.
- The GNSS SSV will extend GNSS-based navigation services for space users from 3,000 km to geosynchronous orbits while enhancing worldwide interoperability



NASA Participation in GPS Civil Navigation (CNAV) Testing for L2C and L5

- Testing with the USAF utilizing the SCaN Software Defined-Radio test-bed on the International Space Station (ISS), helped in discovering problems with of GPS modernized signals.

Space Life and Physical Sciences Research and Applications Division

SLPSRA Mission

- NASA's Space Life and Physical Sciences Research and Applications Division (SLPS) has been formulated to execute high quality, high value research and application activities in the areas of:
  - Fundamental Space Biology
  - Physical Sciences
  - Human Research
- These programs conduct fundamental and applied research to advance basic knowledge and to support human exploration in the environment of space.

SLPSRA Implementation Approach

- The top priority is to maximize ISS utilization by maintaining the present content on schedule and bringing in new content through annual NRA selections
- Socialize the Open Source concept within the Agency, other Government agencies and the research communities
- Future NRA selections will be driven towards the Open Source mode and away from single PI selection; single PI's are not ruled out, but will not be the focus of our selection process
- Develop and implement the GeneLAB and Microbial Observatory research platforms to maximize our research opportunities and dove tail with the Open Source concept
- Expand the GeneLAB concept to other as many of our research disciplines as feasible. Concepts in work for MaterialsLAB, FluidsLAB, CombustionLAB
- Continue to work with the ISSPO to ensure that our top priority requests to ISSPO (rodent research, databases, I&O funding) will be approved by the ISSPO. If they are not, our planned posture will have to be reduced
- Work with CASIS to develop the right synergy to maximize the return on research investment for both organization while ensuring maximum utilization of ISS.

Accomplishments

- Delivered over 20 experiments to ISS and completed operations for 13 investigations
- With new Division Director on–board re-structured organization to better align with present management responsibilities
- Selected twenty eight new investigations in Space Biology
- Planning to select at least six flight investigations out of the 2012 Complex Fluids NRA this summer
- Memorandum of Agreement signed between SLPS Director and ISS Program Manager; MOA has been directly responsible for re-vitalizing our efforts to maximize utilization of ISS
- Over 20 peer-reviewed publications in Fundamental Physics
- Pursuing open source collaborations with other government agencies.

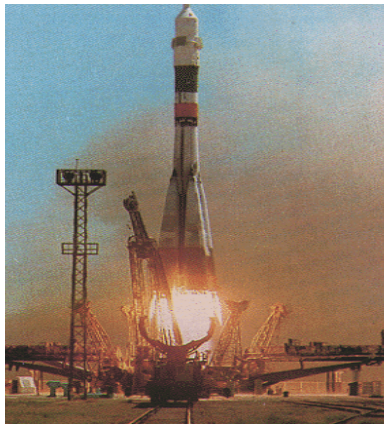
Accomplishments

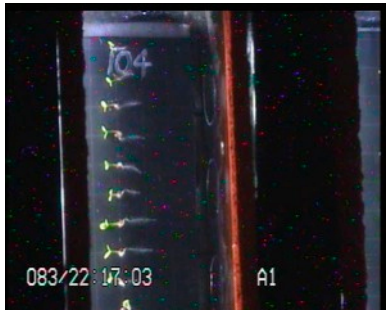
- Bion-M1 successfully launched; working all necessary arrangements for post-flight processing

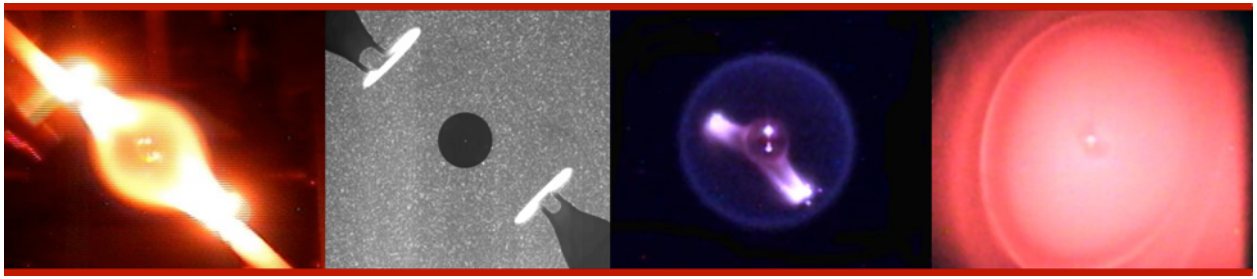
- Baselined ISS Implementation Plan for Rodent Research Payloads on SpaceX-4:
  - Successfully completed euthasol crystallization test – no procedures changes required
  - Held training meeting to get crew time for euthanasia procedures in the access unit
  - Received final approval for the Rodent Habitat ICD – uploaded to ISS EDMS
  - Completed Phases 1 and 2 of the transportation test – preliminary results look good, data analysis underway

- A new phenomenon was discovered conducting one of our ISS experiments, where a hot flame extinction leads to a low temperature, “cool-flame” burning was observed during the combustion of alkane fuels in microgravity for the first time.

- These experimental results from FLEX have now been verified using numerical simulations with detailed chemistry and theoretical calculations. This discovery has many potential applications on earth including the development of next generation low temperature internal combustion engines, such as the HCCI engine among others.

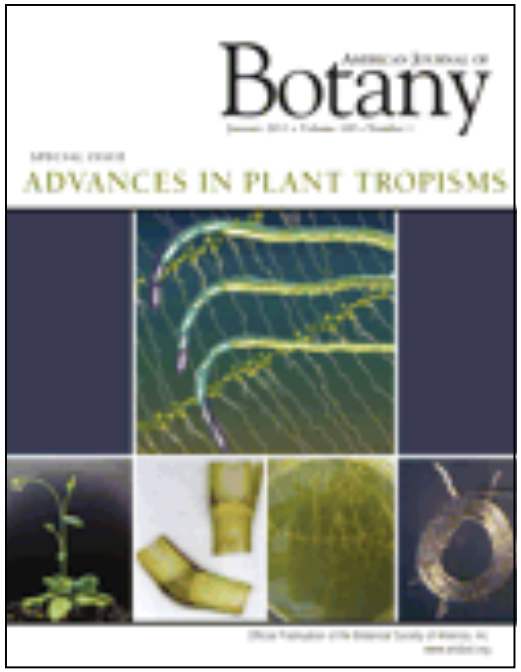






Accomplishments

The American Journal of Botany dedicated an entire issue to the topic of plant tropisms including results from ISS flights by NASA-funded plant researchers, including the following papers:

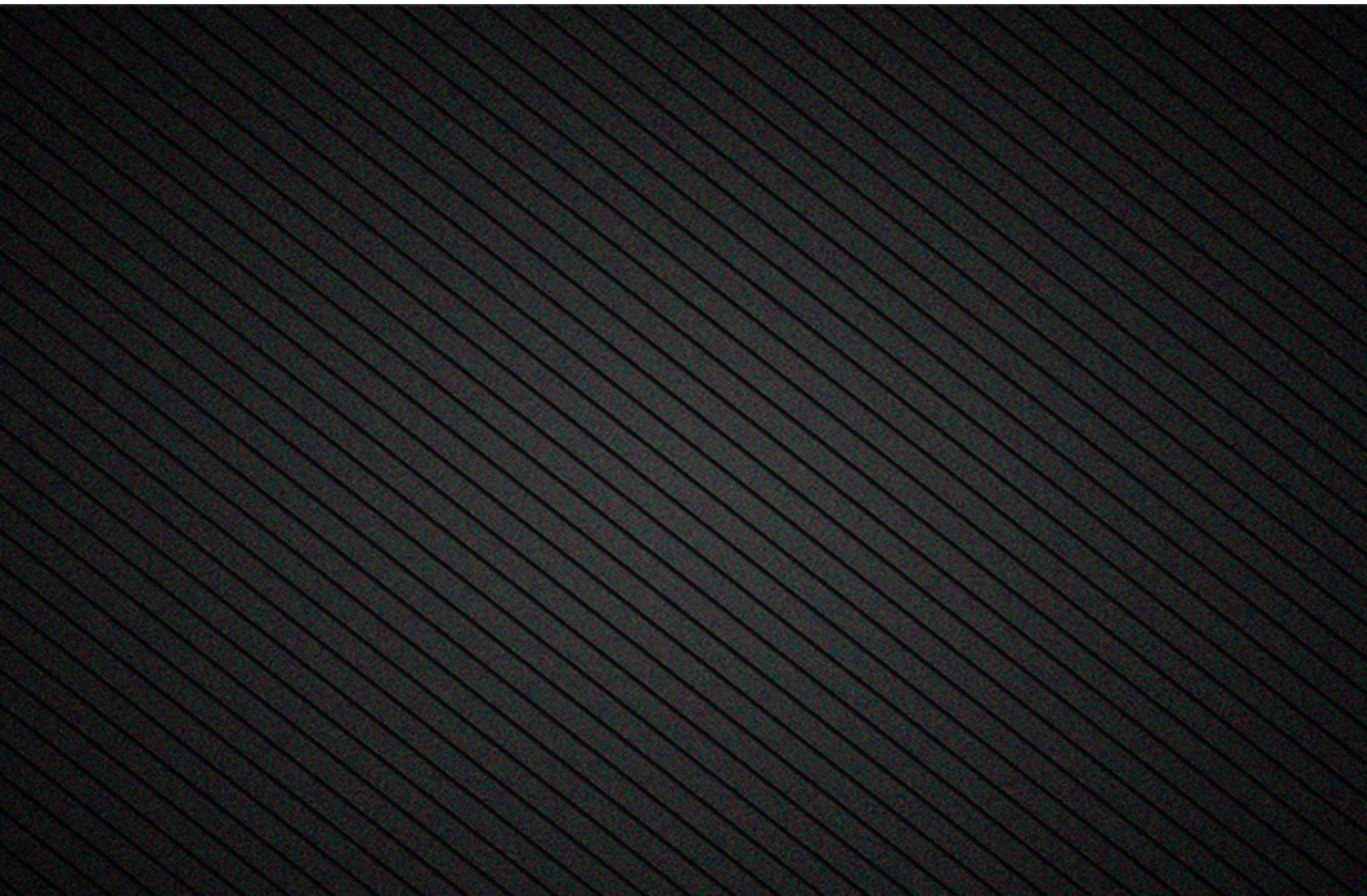


- Wyatt & Kiss *Plant tropisms: From Darwin to the International Space Station* Comprehensive introduction to the issue's research focus, including well studied plant tropisms - water, light, and gravity.
- Paul, Wheeler, Levine & Ferl *Fundamental Plant Biology Enabled by the Space Shuttle* Overview of Space Shuttle Plant Science showing how plant growth changes in microgravity.
- Millar & Kiss *Analyses of tropistic responses using metabolomics* Characterized movement of wild-type and mutated *Arabidopsis thaliana* to red & blue light and gravity. Results showed that gravity changes elicited large gene expression alterations in wild type.
- Zupanska, Denison, Ferl, Paul Spaceflight Engages Heat Shock Protein and other Molecular Chaperone Genes in Tissue Culture Cells of Arabidopsis thaliana Used space flight to document a previously unknown fact that plant tissue culture cells can sense gravity without specialized cell structures as had been thought previously.
- Hasenstein et al. Analysis of Magnetic Gradients to Study Gravitropism Magnetic gradients were shown to be able to move diamagnetic compounds in plant cell roots under weightless or microgravity conditions, serving as a directional signal for root growth in low gravity environments. Will be continued as subject of upcoming ISS experiment.

Human Research Program (HRP) Accomplishments

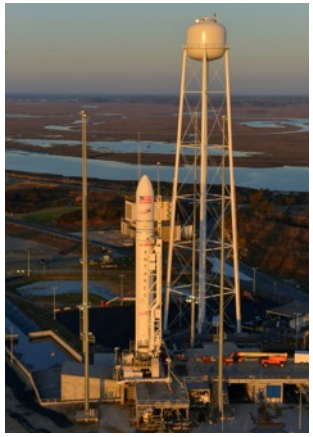
- ISS research results have demonstrated the effectiveness of exercise using the ISS ARED device and pharmaceuticals in significantly limiting bone loss in crewmembers. The use of the ARED exercise protocols will be tested further during the one-year mission to assess long-term effectiveness.
- ISS biomedical investigations on ocular surveillance were developed and implemented to address the visual impairment that occurs in Astronauts. These investigations will gather information on the visual changes that occur in crewmembers and determine its association with the fluid shifts that occur while in space.
- NASA space radiation cancer risk model was updated and put into operational use to ensure Astronaut health and safety. The radiobiology data updates incorporated into to this model significantly increased the number of mission days that Astronauts could be in space.
- Human Exploration Research Opportunities (HERO) Research Announcement to be released end July to address crew health and performance risks for long-duration exploration missions.

Commercial Crew and Cargo



Commercial Cargo Status

- SpaceX successfully completed all COTS milestones in May 2012. Regular CRS flights to the ISS have commenced.
- Orbital successfully completed a maiden test flight of its Antares rocket on April 21, 2013 from the Mid-Atlantic Regional Spaceport.



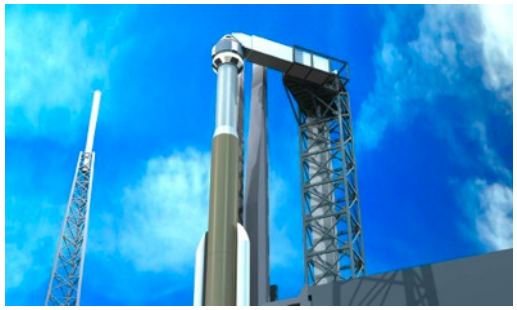
- Orbital successfully conducted the COTS Demo Mission Readiness Review on June 26, 2013. No outstanding actions.
- Tentative target date for the COTS Demo Mission to the ISS (i.e., the final Orbital COTS milestone) is August 29, 2013. Potential range conflicts with the LADEE mission may delay the launch date.

Commercial Crew Status

- All three Commercial Crew Program partners are completing their milestones on schedule, significantly maturing their designs.
- Early certification work has begun through the Certification Products Contracts. Over 400 deliverables have been submitted to NASA covering alternate standards, hazard reports, and variances.
- The draft RFP for the next phase of the program, Commercial Crew Transportation Capability (CCtCAP), was released for comment on July 19.
- The program is on track to deliver a certified capability by 2017, depending on budget and technical progress.

Artists' conception of astronauts in Dragon

Artists' conception of Dream Chaser



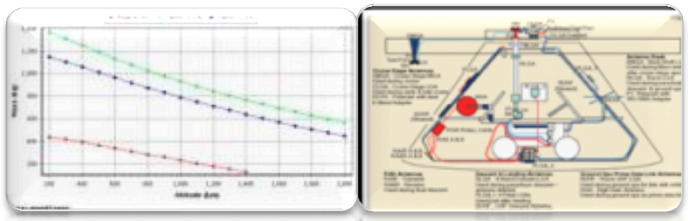
Artists' conception of CST-100/Atlas on Pad

Launch Services

Launch Services Program Overview

Acquire launch services

Verify and validate mission engineering and analysis



Insight and approval of production, integration, testing and processing

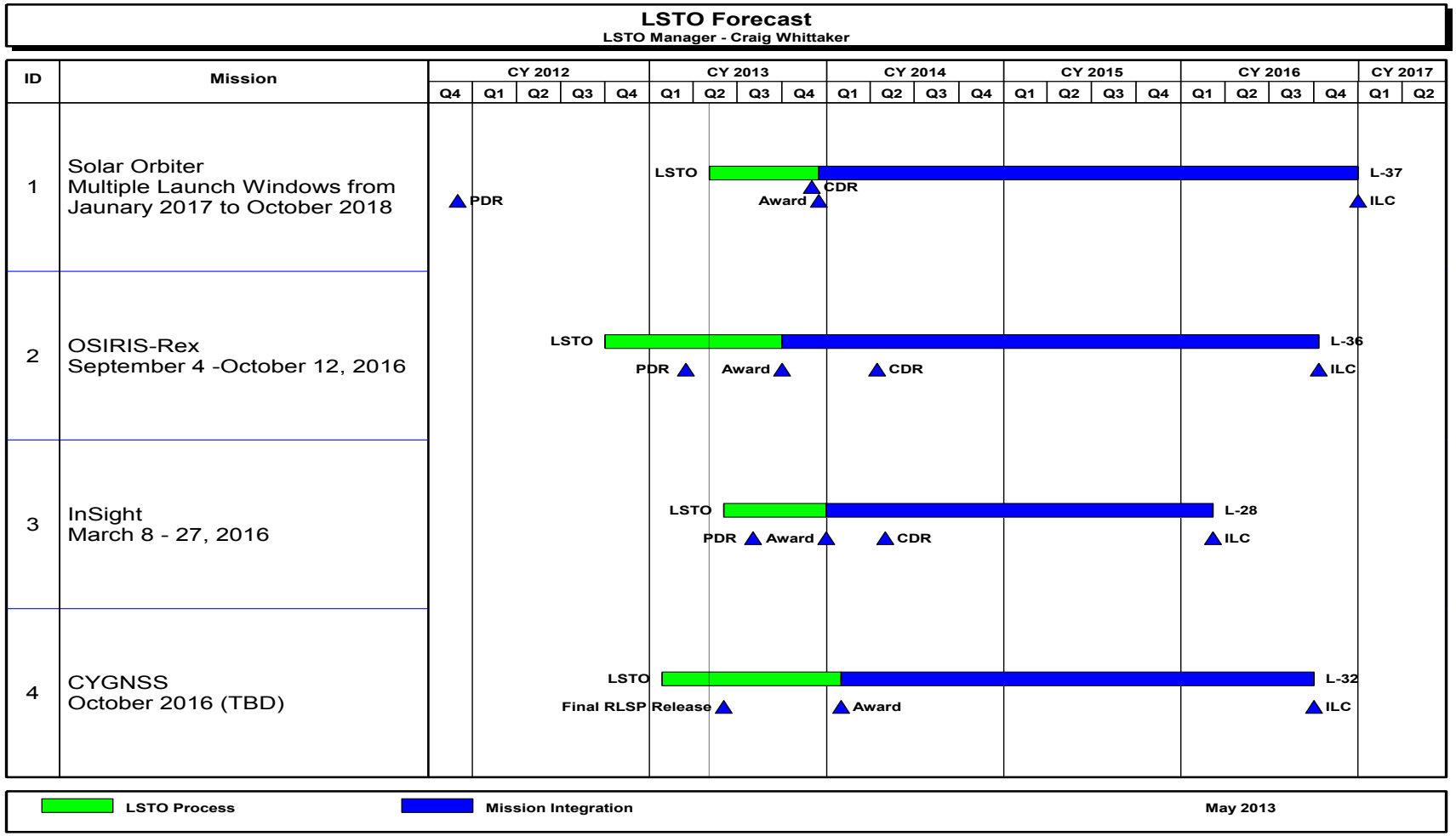
Provide technical, operational, contractual, budget and business knowledge and expertise to future missions

Certify launch systems for NASA use

Establish strategic partnerships and make investments to satisfy Agency launch service needs

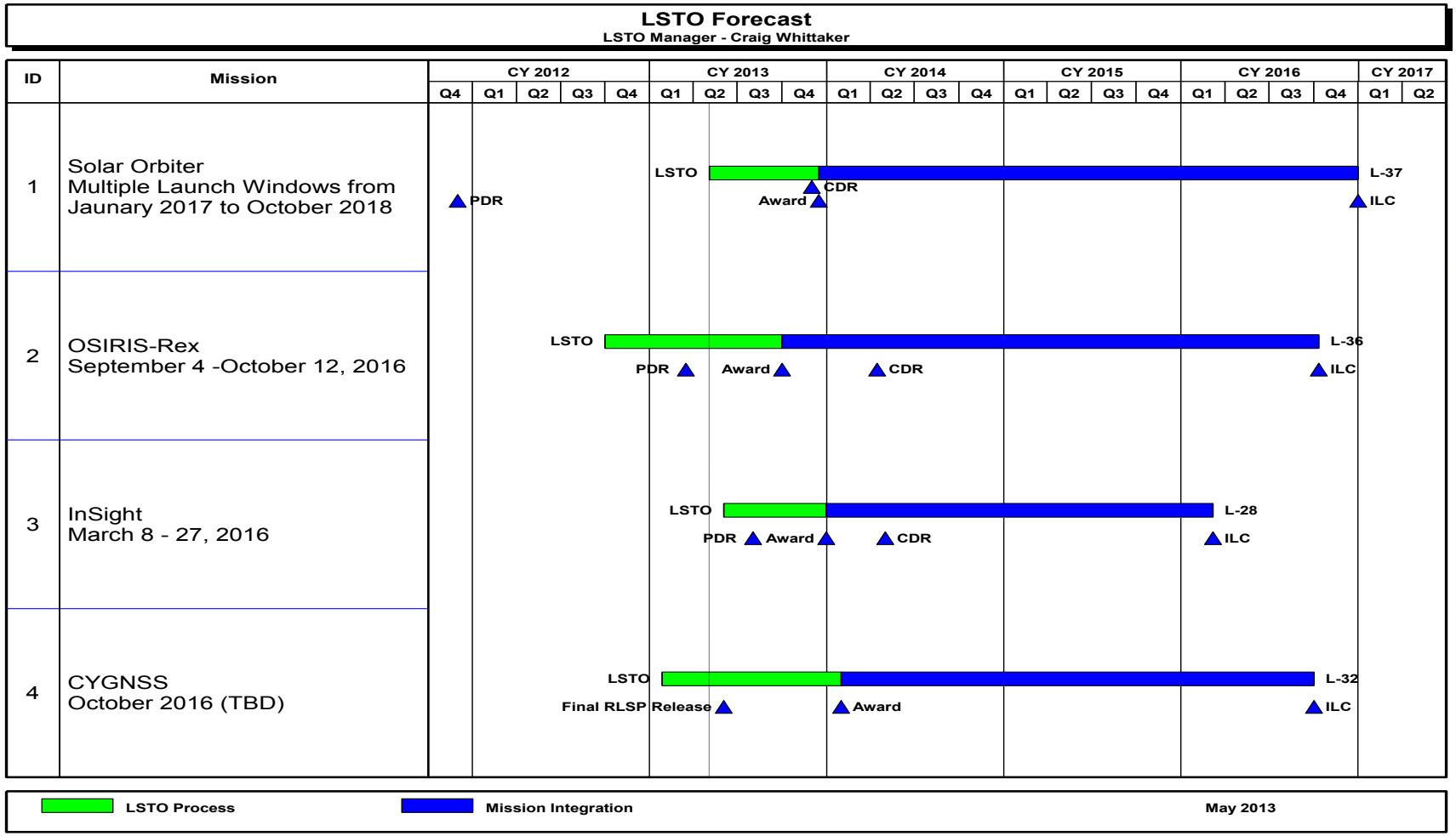
Manage launch vehicle to spacecraft integration

LSTO Forecast Schedule



4 Commercial Launch Service Proposal Activities Underway

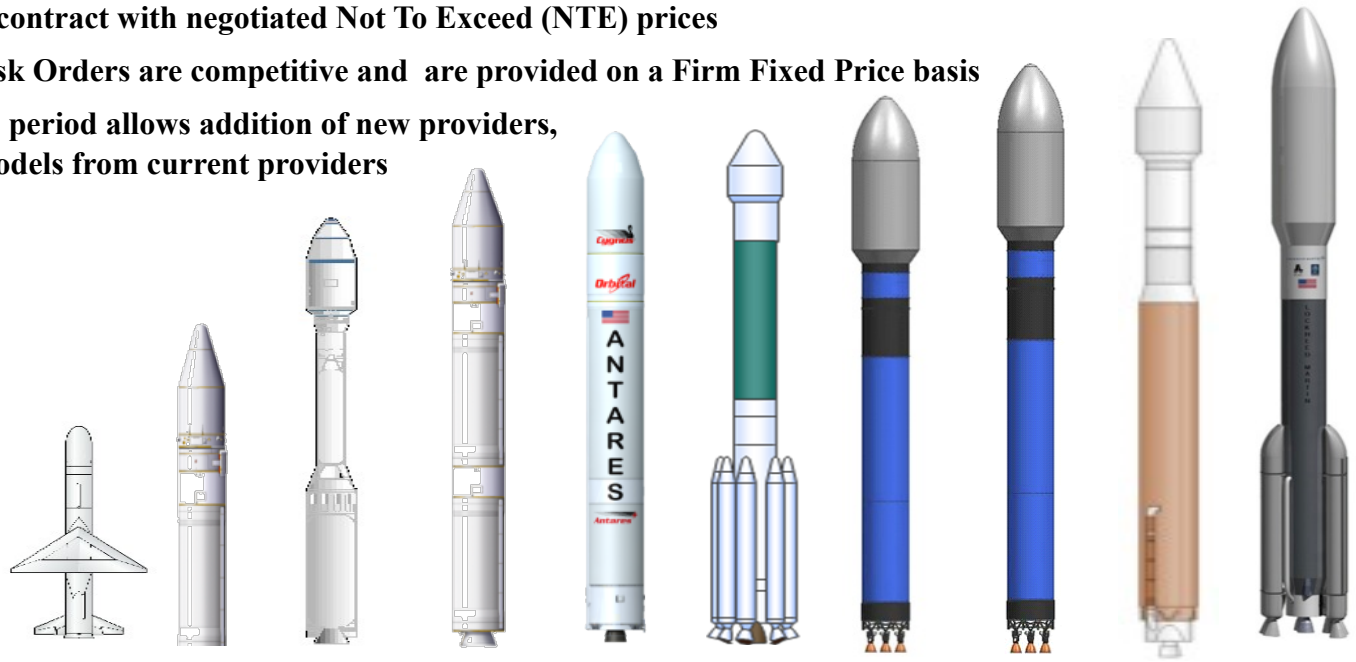
LSTO Forecast Schedule



4 Commercial Launch Service Proposal Activities Underway

Launch Vehicles on NLS II Contract

- **NLS II is an IDIQ contract with negotiated Not To Exceed (NTE) prices**
- **Launch Service Task Orders are competitive and are provided on a Firm Fixed Price basis**
- **Annual "on-ramp" period allows addition of new providers, or new vehicles or models from current providers**



Performance shown below rounded down to nearest 50kg in the Small class and nearest 100 kg in the Medium and Intermediate classes. For detailed performance data see http://elvperfor.ksc.nasa.gov

Vehicle Class	Small			Medium				Intermediate		
Launch Vehicle	Pegasus XL	Athena Ic	Taurus XL	Athena IIc	Antares 120/130	Delta II 7320/7920	Falcon 9 v1.0	Falcon 9 v1.1	Atlas V 4XX	Atlas V 5XX
Offeror	OSC	LMSSC	OSC	LMSSC	OSC	ULS	SpaceX	SpaceX	ULS	ULS
Perf @ 600 km Sun Synch	200 kg	300 kg	800 kg	1100 kg	1400/*2500kg	1500/2900 kg	6400 kg	12200 kg	6600kg	14200 kg
Perf @ C3 of 10	n/a	n/a	n/a	n/a	*600 kg/ n/a	n/a	1300 kg	2600 kg	2400kg	5000 kg
Certification Category	Cat 3	n/a	Cat 2	n/a	n/a	Cat 3	n/a	n/a	Cat 3	Cat 3
Launch Sites	CCAFS	CCAFS	CCAFS	CCAFS	WFF	VAFB	CCAFS	CCAFS	CCAFS	CCAFS
	WFF	KLC	WFF	KLC			VAFB	VAFB	VAFB	VAFB
	RTS	WFF	VAFB	WFF						
	VAFB									

* Not all Antares performance data is available for each vehicle configuration

NASA Launch Services (NLS) II Contract Fleet

Certified

Vehicles On NLS II Contract

Pegasus XL

Taurus XL

Delta II
VAFB only

Atlas V
4xx, 5xx

Not Yet Certified

Vehicles On NLS II Contract

Falcon 9
v1.0, v 1.1

Athena Ic

Athena IIc

Antares
12x, 13x

Potential/Emerging Vehicles

Delta IV
4m, 5m, H

Athena III

Falcon Heavy

Stratolauncher

Virgin Galactic Launcher One

Other

NASA Launch Services Office View of Current Situation

- **Intermediate-Class**
  - Currently 1 “certified” launch vehicle (Atlas V); but, expect 2-viable competitors for portion of mission portfolio after Falcon 9 v1.1 flies late summer 2013
  - Coverage for entire mission portfolio after Falcon Heavy flies (2013?)

- **Medium-Class**
  - All manifested NASA medium-class missions with ILCs between FY14-FY17 have been awarded competitively selected commercial launch services
  - FY18 & beyond, expect Falcon 9 & Antares to replace Delta II and compete
  - CRS flights will provide opportunity to demonstrate reliability

- **Small-Class**
  - 2 “certified” launch vehicles: Pegasus XL & Taurus XL
    - Falcon 1 & 1e no longer being offered
    - Athena Ic & IIc still need first flight
  - “New Providers” developing dedicated LVs for “nano-sat” market
    - When ready, will provide about “half” lift capability of Pegasus XL or Athena Ic

For more information about the HEO directorate visit:

www.nasa.gov/directorates/heo

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