International Space Station Status

Sam Scimemi
Director, International Space Station

HEO NAC
July 2015

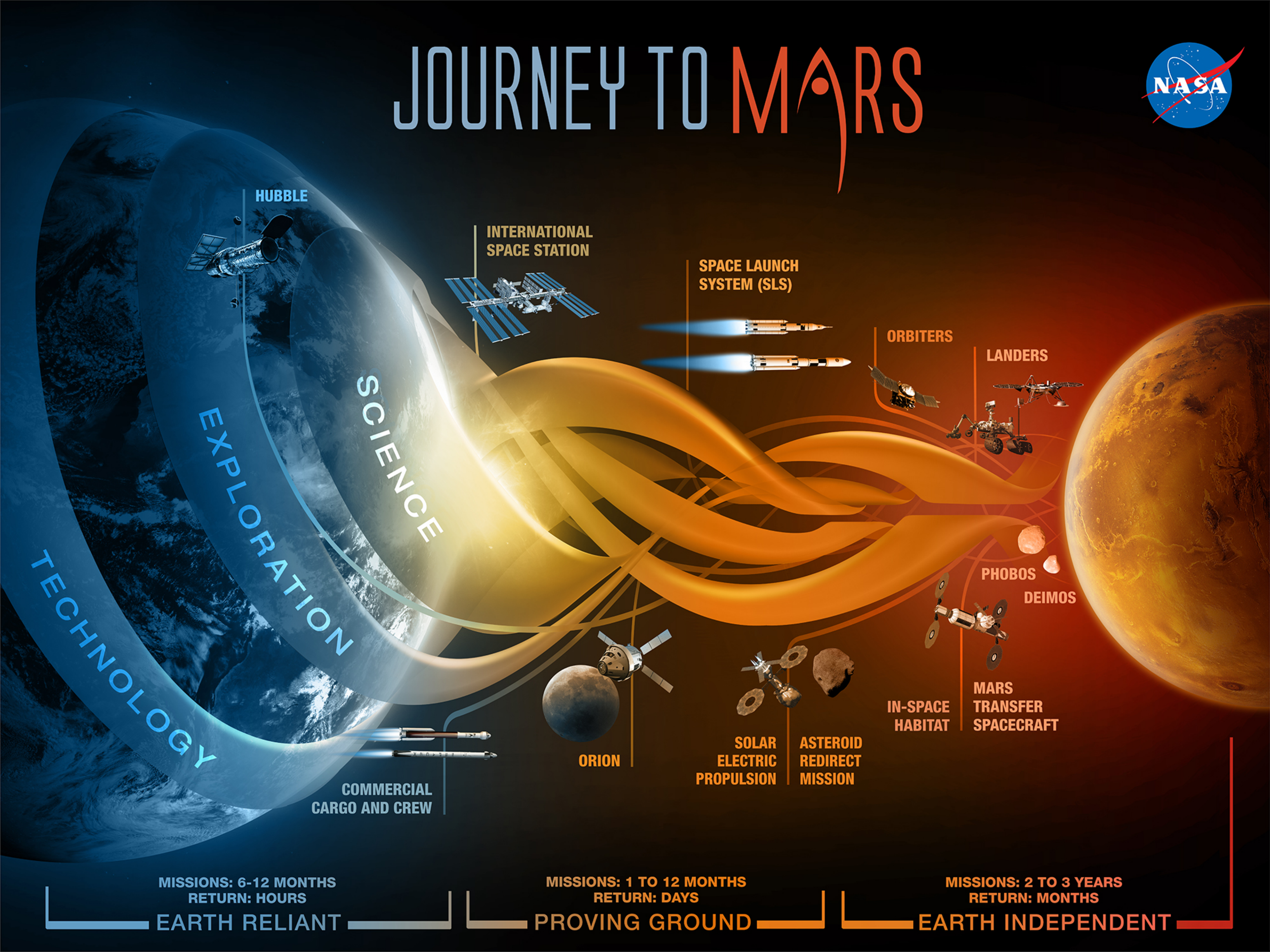
Agenda

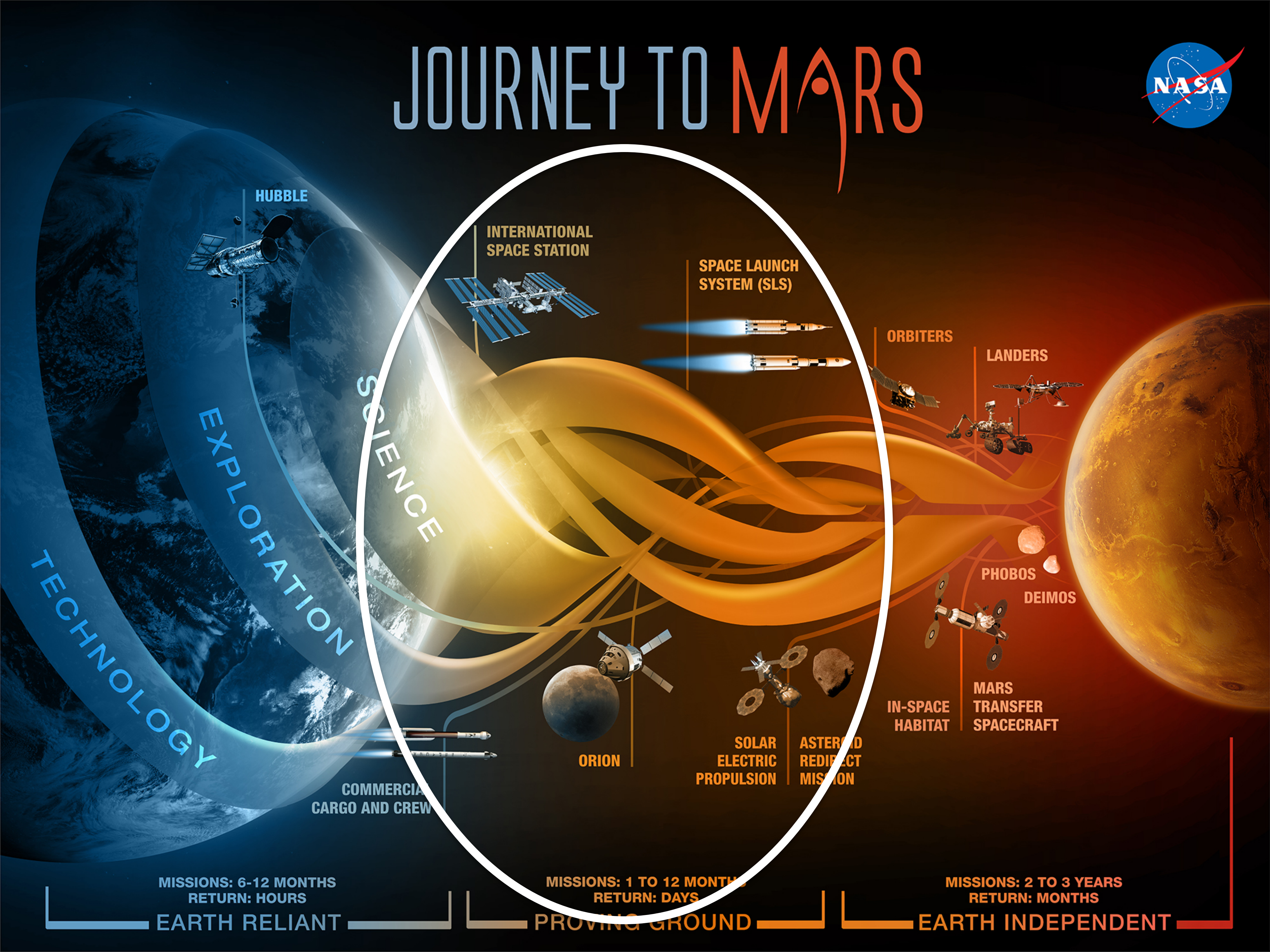
- Transitioning HSF from ISS to the Proving Ground and the Commercialization of LEO
- ISS Overview Status
- Visiting Vehicle Status
- Utilization Highlights

A proposed two pronged approach to ensuring that HSF transitions without a gap between ISS and cis-lunar space

and

research and technology development in LEO continues seamlessly between ISS end-of-life and commercially available capabilities


JOURNEY TO MARS
NASA
HUBBLE
INTERNATIONAL SPACE STATION
SPACE LAUNCH SYSTEM (SLS)
ORBITERS
LANDERS
SCIENCE
EXPLORATION
TECHNOLOGY
PHOBOS
DEIMOS
MARS TRANSFER SPACECRAFT
IN-SPACE HABITAT
ORION
SOLAR ELECTRIC PROPULSION
ASTEROID REDIRECT MISSION
COMMERCIAL CARGO AND CREW
MISSIONS: 6-12 MONTHS
RETURN: HOURS
EARTH RELIANT
MISSIONS: 1 TO 12 MONTHS
RETURN: DAYS
PROVING GROUND
MISSIONS: 2 TO 3 YEARS
RETURN: MONTHS
EARTH INDEPENDENT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EARTH INDEPENDENT

From Earth Dependent

~ 2 days transit time

Communications (near real-time)

Crew exchanges

Crew supplies and logistics

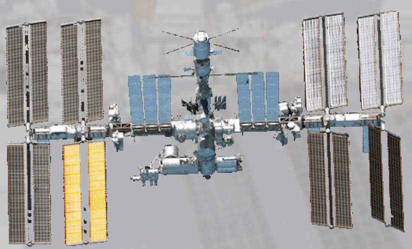
Crew and atmosphere samples

Modified hardware

Emergency Crew Return

Trash

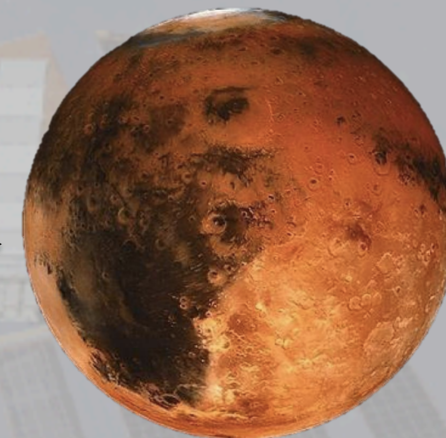
~400 kilometers



"car camping in space"

To Earth Independent

~228,000,000 kilometers



~2 - 3 years transit time

Communications (up to 42 minutes)

“ independent life”

So what do we want to accomplish Proving Ground by the end of the next decade from a HSF perspective?

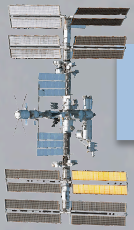
First Prong:
A Primary Goal for Human Spaceflight in the Proving Ground

Prepare all the crew related capabilities for long duration transit missions to Mars that culminates in one year crewed expeditions in cis-lunar space

“shake down cruise”

Transitioning HSF from LEO to Cis-Lunar Space (Earth Dependent to the Proving Ground)

Earth Dependent



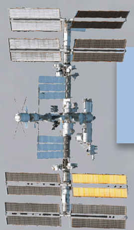
Long Duration Human Health & Habitation Research and Demonstrations

First half of the 2020's

Second half of the 2020's

Transitioning HSF from LEO to Cis-Lunar Space (Earth Dependent to the Proving Ground)

Earth Dependent



Long Duration Human Health & Habitation Research and Demonstrations

Goal:
One year crewed mission(s) in cis-lunar space

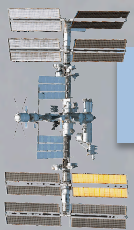
First half of the 2020's

Second half of the 2020's

Proving Ground

Transitioning HSF from LEO to Cis-Lunar Space (Earth Dependent to the Proving Ground)

Earth Dependent



Long Duration Human Health & Habitation Research and Demonstrations

Goal:
One year crewed mission(s) in cis-lunar space

First half of the 2020's

Second half of the 2020's

Proving Ground

Short Duration Habitation & Transportation system validation

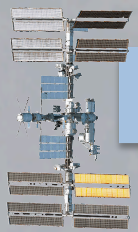
ARM

- SLS/Orion performance
- Deep space multi-body navigation with humans
- Integrated crewed/robotic vehicle operations in deep space staging orbits
- System and crew performance in deep space radiation environments
- Advanced autonomous proximity operations and rendezvous in deep space and with non-cooperative objects
- Astronaut EVA for sample selection, handling, and containment
- Validating Earth return trajectories and emergency return strategies

Transitioning HSF from LEO to Cis-Lunar Space (Earth Dependent to the Proving Ground)

Goal:
One year crewed mission(s) in cis-lunar space

Earth Dependent



Long Duration Human Health & Habitation Research and Demonstrations

First half of the 2020's

Second half of the 2020's

Proving Ground

Short Duration Habitation & Transportation system validation

Long duration human health & habitation Validation for Mars transit

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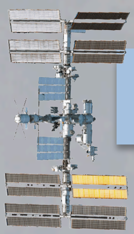
- Validate crew health and performance countermeasures developed on ISS
- Validate habitation system and crew performance in deep space radiation environment developed on ISS
- Simulate Mars transit crew operations –
  - Limited interaction with MCC based on path finders on ISS
  - Limited/No re-supply
  - No crew exchanges
- Develop and validate the operational habitation, life support and environmental monitoring systems that were validated on ISS integrated with other systems (e.g. thermal, power, etc.)

Transitioning HSF from LEO to Cis-Lunar Space (Earth Dependent to the Proving Ground)

Earth Dependent



Long Duration Human Health & Habitation Research and Demonstrations

Knowledge & Capabilities

Goal:
One year crewed mission(s) in cis-lunar space

First half of the 2020's

Second half of the 2020's

Proving Ground

Short Duration Habitation & Transportation system validation

Long duration human health & habitation Validation for Mars transit

Knowledge & Capabilities

ARM

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Implications for the next several years

- Having this goal of a "shake down cruise" (*or multiple cruises*) near the near the end of the 2020's provides an anchor for other HSF activities and possibly broader scientific objectives

<u>Human Spaceflight</u>

- – Drive SLS/Orion performance and EM mission objectives
- – Provide the basis for ISS-to-PG transition discussions with IP's
- – Provides the pull for shorter duration missions – particularly ARM
- – Provides focus for near-term policy and budgets
- – Help drive requirements for other areas such as logistics, propulsion, etc.

<u>Robotic/Science</u>

- – Lunar robotic exploration
- – Lunar surface in-situ demonstration
- – Cis-lunar space science objectives

Commercial and International Partnership

- There are many opportunities for public-private and international partnerships in achieving the goal of one year duration crewed missions in cis-lunar space

  – Habitation and habitation systems
  – Dissimilar redundancy
  – Logistical support
  – Communications
  – Navigation
  – Propulsion and re-fueling systems
  – Transportation
  – Other mission or scientific objectives

So What does this mean for ISS

- All the critical research and system demonstrations needed to validate long duration HSF must be completed on ISS…before they are applied in the Proving Ground…
  - Human research and performance
  - Habitation systems such as ECLSS, environmental monitoring, crew systems, etc.
  - All the other technologies and systems that need maturation
    - Docking, communication protocols, autonomous crew operations, etc.

- We are now in the process is determining specifically what transitional objectives we want to accomplish on ISS and what we expect to tranfer to cis-lunar space
  - Human research, system performance, operational considerations, etc.

We are beginning to plan for the transition of HSF out of LEO
and into the Proving Ground

Second Prong:
Expand the full breadth of the US economy into LEO

Vision: Sustained economic activity in LEO enabled by human spaceflight, driven by private and public investments creating value and benefitting Earth through commercial supply and public and private demand

Goals

1.0 LEO commercialization enabled by leveraging ISS

- User-friendly ISS process improvements
- Maximize throughput
- Demonstrate & communicate value proposition of ISS
- Foster "success stories"
- Utilize more commercial acquisition strategies

2.0 The policy and regulatory environment promotes commercialization of LEO

- Establish interagency working group to address policy and regulatory issues
- Investigate economic cluster potential
- Address barriers such as IP retention, liability, ITAR

3.0 A robust, self-sustaining, and cost effective supply of US commercial services to/in/from LEO accommodates public and private demands

- Leverage NASA NEXTSteps BAA studies and follow-on to enable commercial LEO capabilities
- Enable Earth-similar laboratory capabilities for ISS that can transition to commercial platforms
- Transition from NASA-supplied to commercially-supplied services and capabilities once available

4.0 Broad sectors of the economy using LEO for commercial purposes

- Establish consortia for potential high-payoff, market-enabling microgravity applications with public and private funds to support development (e.g. protein crystallization, exotic fibers, lightweight alloys, 3D tissues)
- Establish commercial LEO utilization university curriculum and programs

So What does this mean for NASA and ISS

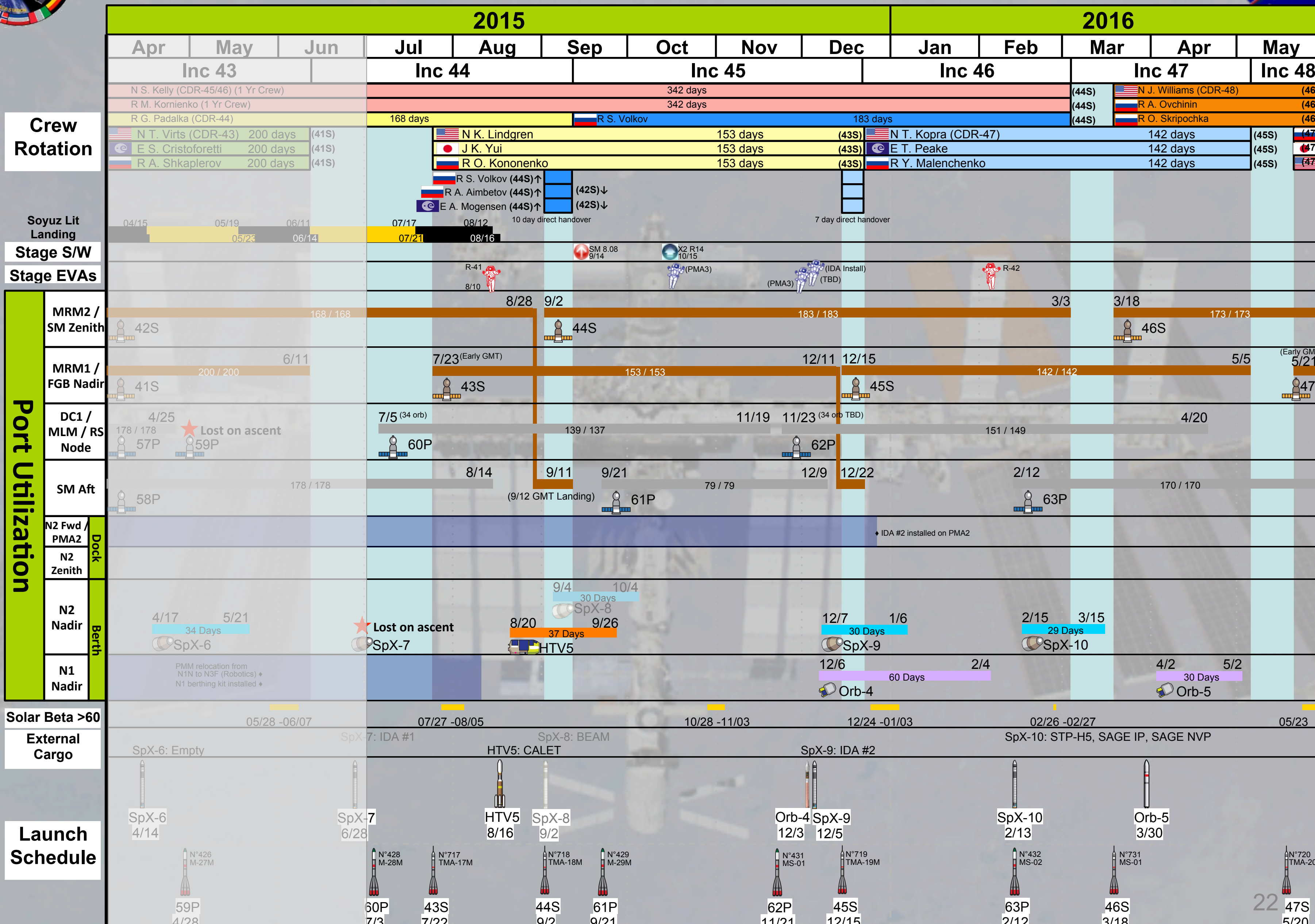
- Facilitate sustainable and growing demand for LEO research and applications across industry, academia and other government agencies through partnerships other means
- Today CASIS is already working with industry and OGA (NIH, NSF, NIST, etc.) to utilize the ISS…however, current activities are focused on individual project and not necessarily to establish long-term LEO investment and research
- To go beyond individual ISS projects, NASA is working with CASIS, industry and OGA's to augment existing relationships and activities with focused initiatives in potential high-payoff market-enabling areas (e.g. materials development & manufacturing, pharmaceutical, tissue engineering, model organism research)
- ISS, CASIS and private industry are working together to drive the utilization of ISS toward the benefit of non-NASA users
- Working toward partnering with OGA's (DOC, DOT, etc.) to establish long term policy and regulation that will span the life of ISS and commercially available capabilities

The next capabilities in LEO will be driven by national demand and interests – not only by NASA's

Next HEO NAC

We hope to present a top level draft of the HSF ISS to Proving Ground transition plan and progress towards building the commercial and OGA demand for LEO

ISS Overview Status


2015
2016
Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May
Inc 43
Inc 44
Inc 45
Inc 46
Inc 47
Inc 48
Crew Rotation
N S. Kelly (CDR-45/46) (1 Yr Crew) 342 days (44S)
R M. Kornienko (1 Yr Crew) 342 days (44S)
R G. Padalka (CDR-44) 168 days
R S. Volkov 183 days (44S)
N J. Williams (CDR-48) (46S)
R A. Ovchinin (46S)
R O. Skripochka (46S)
N T. Virts (CDR-43) 200 days (41S)
E S. Cristoforetti 200 days (41S)
R A. Shkaplerov 200 days (41S)
N K. Lindgren 153 days (43S)
J K. Yui 153 days (43S)
R O. Kononenko 153 days (43S)
N T. Kopra (CDR-47) 142 days (45S)
E T. Peake 142 days (45S)
R Y. Malenchenko 142 days (45S)
(47S)
R S. Volkov (44S)↑
R A. Aimbetov (44S)↑
E A. Mogensen (44S)↑
(42S)↓
(42S)↓
10 day direct handover
7 day direct handover
Soyuz Lit Landing
04/15 05/19 06/11 05/23 06/14 07/17 07/21 08/12 08/16
Stage S/W
SM 8.08 9/14
X2 R14 10/15
Stage EVAs
R-41 8/10
(PMA3)
(PMA3)
(IDA Install) (TBD)
R-42
Port Utilization
MRM2 / SM Zenith
168 / 168 42S
8/28 9/2 183 / 183 44S
3/3 3/18 173 / 173 46S
MRM1 / FGB Nadir
200 / 200 41S 6/11
7/23 (Early GMT) 153 / 153 43S 12/11
12/15 142 / 142 45S 5/5
(Early GMT) 5/21 47S
DC1 / MLM / RS Node
4/25 178 / 178 57P
Lost on ascent 59P
7/5 (34 orb) 139 / 137 60P 11/19
11/23 (34 orb TBD) 151 / 149 62P 4/20
SM Aft
178 / 178 58P
8/14 9/11 (9/12 GMT Landing)
9/21 79 / 79 61P 12/9
12/22 2/12 170 / 170 63P
N2 Fwd / PMA2
N2 Zenith
Dock
IDA #2 installed on PMA2
N2 Nadir
Berth
4/17 5/21 34 Days SpX-6
Lost on ascent SpX-7
8/20 37 Days 9/26 HTV5
9/4 10/4 30 Days SpX-8
12/7 1/6 30 Days SpX-9
2/15 3/15 29 Days SpX-10
N1 Nadir
PMM relocation from N1N to N3F (Robotics)
N1 berthing kit installed
12/6 60 Days 2/4 Orb-4
4/2 30 Days 5/2 Orb-5
Solar Beta >60
05/28 -06/07
07/27 -08/05
10/28 -11/03
12/24 -01/03
02/26 -02/27
05/23
External Cargo
SpX-6: Empty
SpX-7: IDA #1
HTV5: CALET
SpX-8: BEAM
SpX-9: IDA #2
SpX-10: STP-H5, SAGE IP, SAGE NVP
Launch Schedule
SpX-6 4/14
SpX-7 6/28
HTV5 8/16
SpX-8 9/2
Orb-4 12/3
SpX-9 12/5
SpX-10 2/13
Orb-5 3/30
N°426 M-27M 59P 4/28
N°428 M-28M 60P 7/3
N°717 TMA-17M 43S 7/22
N°718 TMA-18M 44S 9/2
N°429 M-29M 61P 9/21
N°431 MS-01 62P 11/21
N°719 TMA-19M 45S 12/15
N°432 MS-02 63P 2/12
N°731 MS-01 46S 3/18
N°720 TMA-20M 47S 5/20

43 Soyuz Launch/Increment 44
July – December 2015

Vehicle: 43 Soyuz

Launch: July 22, 2015 (planned 4 orbit rendezvous)

Docking: July 23, 2015

Undock/Landing: December 22, 2015

42 Soyuz crew

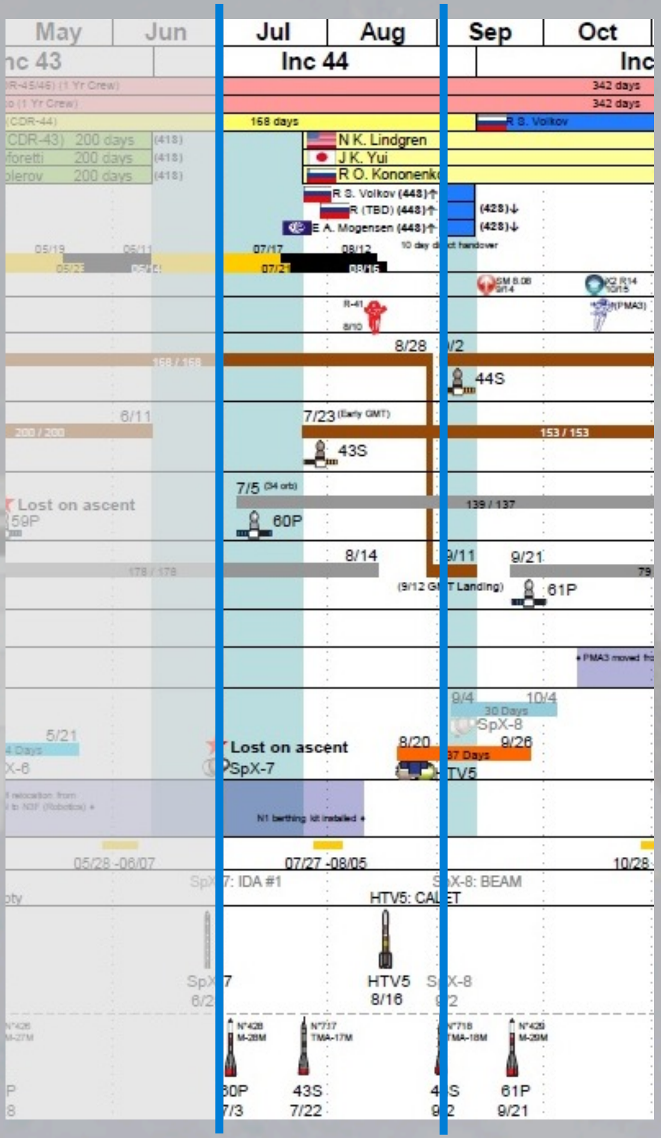
Genady Padalka, Soyuz and Increment 44 Commander
Scott Kelly, Increment 45/46 Commander
Mikhail Kornienko, Flight Engineer

43 Soyuz Crew

Oleg Kononenko , Soyuz Commander
Kjell Lindgren, Flight Engineer
Kimiya Yui, (JAXA) Flight Engineer

Increment 44 Overview
Major Stage Objectives

- Increment 44: 92 Days
  - Stage 44-3: 41S Undock to 43S Dock: 41 days
  - Stage 44-6: 43S Dock to 44S Dock: 41 days
  - Stage 44-9: 44S Dock to 42S Undock: 10 days
  - EVAs
    - RS EVA 41 (8/10)
  - Cargo vehicles:
    - 58P Undock from SM Aft (8/14)
    - HTV-5 Launch/Berthing (8/16, 8/20)
  - Science/Utilization:
    - Original Inc 43/44 Utilization Target: 35 hrs per week average (1045 hours)
    - Maximizing onboard utilization
  - Stowage Ops
    - Making room for Galley and MSPR racks launching on HTV-5
  - Maintenance/Outfitting
    - EMU 3011 Return-to-Service
    - NORS AIK Install
    - N1 Nadir Prep for USOS Cargo VV Berthing
    - C2V2 Outfitting



Total ISS Consumables Status

	T1: Current Capability		T2: Current Capability + HTV5	
Consumable – based on current, ISS system status	**Date to Reserve Level**	**Date to zero supplies**	**Date to Reserve Level**	**Date to zero supplies**
Food – 100%	October 22, 2015	December 06, 2015	November 20, 2015	December 31, 2015
KTO	October 13, 2015	November 27, 2015	December 04, 2015	January 15, 2016
Filter Inserts	June 05, 2016	July 20, 2016	November 10, 2016	> December 31, 2016
Toilet (ACY) Inserts	February 10, 2016	April 03, 2016	February 10, 2016	April 03, 2016
EDV + TUBSS (UPA Operable)	March 08, 2016	June 21, 2016	March 08, 2016	June 21, 2016
Pre-Treat Tank	December 11, 2015	January 22, 2016	December 11, 2015	January 22, 2016
Water (Nominal Usage)	December 06, 2015	March 17, 2016	January 30, 2016	May 21, 2016
Consumable - based on system failure				
EDV + TUBSS (UPA Failed)	November 26, 2015	January 09, 2016	November 26, 2015	January 09, 2016
Water, if no WPA (Ag & Iodinated)	October 15, 2015	December 17, 2015	November 22, 2015	January 22, 2016
O_2 if Elektron supporting 3 crew & no OGA	September 02, 2015	December 15, 2015	September 02, 2015	December 15, 2015
O_2 if neither Elektron or OGA	July 31, 2015	September 22, 2015	July 31, 2015	September 22, 2015
LiOH (CDRAs and Vozdukh off)	~0 Days	~14 Days	~0 Days	~14 Days

USOS Consumables Status

	U1: Current Capability		U2: Current Capability + HTV5	
Consumable – based on current, ISS system status	Date to Reserve Level	Date to zero supplies	Date to Reserve Level	Date to zero supplies
Food – 100%	November 13, 2015	December 23, 2015	January 05, 2016	February 19, 2016
KTO	October 14, 2015	November 28, 2015	January 22, 2016	March 10, 2016
Filter Inserts	February 09, 2016	March 30, 2016	> December 31, 2016	> December 31, 2016
Toilet (ACY) Inserts	June 14, 2016	July 29, 2016	June 14, 2016	July 29, 2016
EDV + TUBSS (UPA Operable)	July 26, 2015	January 18, 2016	July 26, 2015	January 18, 2016
Pre-Treat Tanks	December 31, 2015	February 14, 2016	December 31, 2015	February 14, 2016
Water (Nominal Usage)	December 04, 2015	May 24, 2016	April 24, 2016	October 17, 2016
Utilization		December 14, 2015		> January 2016
Consumable - based on system failure				
EDV + TUBSS (UPA Failed)	July 09, 2015	September 08, 2015	July 09, 2015	September 08, 2015
Water, if no WPA (Ag & Iodinated)	August 07, 2015	September 25, 2015	September 19, 2015	November 13, 2015
O_2 if neither Elektron or OGA	August 06, 2015	October 09, 2015	August 06, 2015	October 09, 2015
LiOH (CDRAs and Vozdukh off)	~0 Days	~13.3 Days	~0 Days	~13.3 Days

New Pertinent ISS Vehicle Issues

Issue	Impact to Stage Ops	Rationale
Inadvertent Soyuz Thruster Firing	No	Soyuz approach and attitude control thrusters fired inadvertently while conducting unique testing of the FGB KURS-P for 41S vehicle, saturating the USOS CMGs. Handover to RS attitude control was initiated for return to nominal TEA • event caused by an error in the testing procedure that prematurely removed the free drift flag the Soyuz once the KURS test was completed while Soyuz was attached to ISS − Actions taken: RSC-E is upgrading the Software Verification Facility to enable performing test runs related to Soyuz vehicles with the ISS configuration (scheduled for July 2015) − RSC-E plans to publish the guidelines for developing, coordinating and validating the procedures not included in the nominal operational documentation (scheduled for August 2015). • Ground validation testing is performed with the flight radiogram prior to any nominal usage of RS propulsion assets (maneuvers, DAMs, etc)

New Pertinent ISS Vehicle Issues

Issue	Impact to Stage Ops	Rationale
High TOC Levels	Yes	The Total Organic Carbon (TOC) readings of the WPA product water have been climbing for the last several weeks. • Indicates that the WPA MF Beds are saturated and require an R&R. • There are no spare MF Beds on-orbit, two are targeted for launch on HTV 5. • To keep TOC levels steady, teams are processing only distillate from the UPA. Condensate will not be processed as it likely contains DMSD. • A 24 hour reprocess will continue to occur after every process cycle. • The Flight Rule TOC limit of 3000 ppb is being investigated.

Visiting Vehicles Status

Progress 59P Anomaly

- Launch of 59P occurred on April 28th but failed to reach proper orbit
  - Most telemetry lost and attempts to activate and gain control of Progress unsuccessful
  - Reentered on May 8, 2015
- Russian commission formed to investigate failure, determine cause, provide recommendations – Alexander Ivanov, First Deputy Head Roscosmos as chair
  - 10 versions analyzed, reduced to 1 most probable cause
- NASA formed independent team to review the anomaly, partners participated – similar to 44P investigation, detailed fault tree analyses aligned with Russian findings
- Most probable cause findings
  - Commission Report : "Design feature of the Soyuz-2 .1a LV Stage 3-to-Progress M cargo vehicle stack, related to its structural response, which resulted in the LV oxidizer and fuel tank pressure integrity breach and damage to the Progress vehicle"
  - NASA Assessement : "Engine shutdown oscillations coincided with integrated vehicle longitudinal structural eigenmode as a dynamic interaction to cause structural failure
- One possible failure scenario
  - structural failure resulted in oxidizer integrity breach after engine shutdown (shutdown is rapid, significant propellant remaining in tanks, large accelerometer spike reflected in data due to "hammer" effect)
  - Resulting pressure loads on fuel tank calculated at 167MT of force, enough to result in mechanical separation of Progress with 3rd stage pyro bolt system

Progress 59P Anomaly

- After each flight, Rocket & Space Center Progress analyzes the actual loads, including a comparison and verification of the structural response during ascent with the pre-flight analysis and previous flights
  - dynamic interaction upon engine shutdown not seen on FG/U 3rd stage configurations
- No changes have been introduced into the Soyuz FG 43S launch vehicle systems configuration
- Successful 60P launch with Soyuz U 3rd stage on July 2nd (nominal performance)
- Russian teams recently completed modal testing of the 2.1a / Progress configuration, analyses in work
- Plan to utilize the 2.1A 3rd stage for 62P in November (modal survey results and subsequent mods dependent)
  - No restrictions in place for other missions utilizing the 2.1A 3rd stage
- No planned crew missions on the 2.1a configuration thru 2020

SpaceX-7 Mission Anomaly

- SpX-7 successfully launched on time at 9:21am CT on 6/28/15
- At 139 seconds, the Falcon launch vehicle experienced an anomaly that ended in loss of vehicle
- SpaceX is leading the investigation with FAA oversight
- NASA supporting with LSP, CCP, and ISS Program personnel
  - Team collocated in Hawthorne, daily status meetings, independent assessments being performed by LSP
  - Excellent sharing of information
- Detailed fault tree developed with emphasis on second stage operation and performance
- Detailed timeline (to the msec's) developed, taking into account video lag, sensor to computer latency, etc. to correlate timing of events
- Complete audit underway of as flown configuration, reviewing preflight approved issue tickets, component level acceptance packages, integrated stage testing results, etc.

SpX-7 Lost Cargo Summary

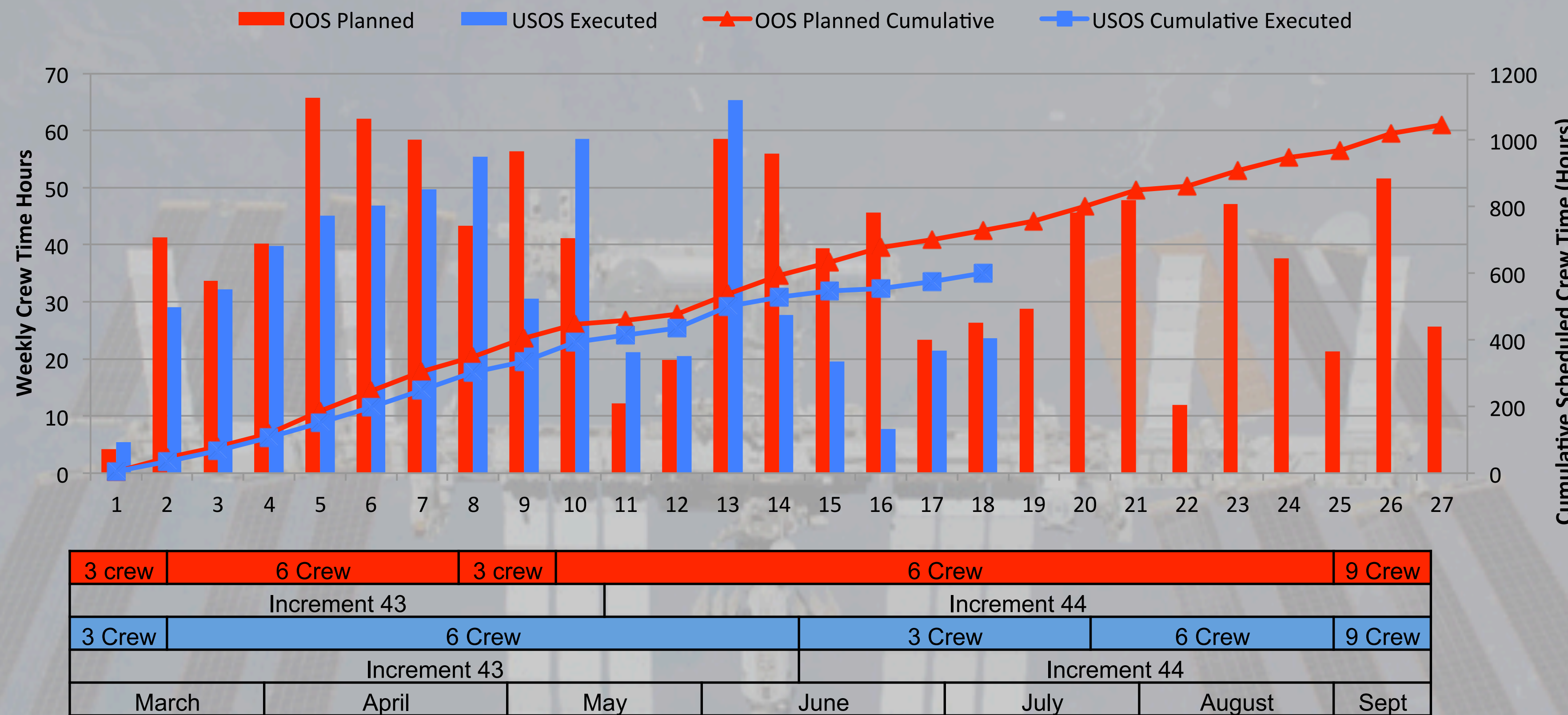
- **Crew Supplies** **690 kg**
  - 92 Food BOBs, 2 Bonus Food Kits, 2 Fresh Food Kits
  - Crew Provisions, Crew Care, ODF
- **Utilization** **573 kg**
  - CSA: Vascular Echo Exercise Band
  - ESA: Circadian Rhythms, KUBIK EBOXes, Interface Plate, EPO Peake, BioLab, Spheroids, EMCS RBLSS, Airway Mon. LiOH Cartridge
  - JAXA: Atomization, Biological Rhythms, Multi-omics, Cell Mechanosensing3, Plant Gravity Sensing3, SAIBO L&M, Space Pup, Stem Cells, MSPR LM, Group Combustion Camera
  - US: 2 Polars, 6 DCBs & Ice Bricks, 1 MERLIN, FCF/HRF Resupply, HRP Resupply [Kits, MCT, Microbiome, Twin Studies], IMAX Camera, Meteor, Micro-9, MSG resupply, Nanoracks Modules & 0.5 NRCSD #7, Universal Battery Charger, Veg-03, Microbial Observatory-1, Microchannel Diffusion Experiment, Wetlab RNA Smartcycler, SCK, Story Time, MELFI TDR Batteries
- **Computer Resources** **36 kg**
  - Proj. Screen, Sidekick, OCT Laptop & Pwr. Supply, 32GB MicroSD Cards, Generic USB Cables & Pwr Modules & Card Readers, Preloaded T61p Hard Drives, CD Stowage Container, Network Attached Storage Devices, XF305 Camcorders, RS-422 Adapter Cable
- **Vehicle Hardware** **462 kg**
  - CHECS CMS: HRM Watches, Bench Lock Studs, Glenn Harness for Kelly, Kopra, and Peake
  - CHECS EHS: CO2 Monitoring Assys, Filter Assys, CSA-CP/CDM Battery Assys, SIEVE Cartridge Assys, Water Kit, Petri Dish Packets
  - CHECS HMS: IMAKs, Oral Med Packs
  - C&T: C2V2 Comm unit (and HTV5 Unit Data Converter)
  - ECLSS: 3 Pretreat Tanks, Filter Inserts, 9 KTOs, UPA FCPA, CDRA ASV, IMV Valve, Wring Collector, Water Sampling Kits, OGS ACTEX Filter, ARFTA Brine Filter Assys, O2/N2 Pressure Sensor, NORS O2, 3 PBA Assys, 2 MF Beds, 2 Urine Receptacles, Toilet Paper Packages, H2 Sensor, Ammonia Cartridge Bag, PTU XFER Hose
  - EPS: 2 Avionics restart cables
  - Makita Drill, PWD Filter, N3 Bulkhead Connectors, Yellow/Red Adapters, IWIS Plates, 6.0 & 4.0 Waste Xfer Bags, BEAM Ground Straps, JEM Stowage Wire Kit
- **EVA** **167 kg**
  - SEMU, REBA, EMU Ion Filters (4), Equipment Tethers, Gas Grap, EMU Mirrors, Crewlock Bags, SEMU arms / legs
  - Lindgren / Yui ECOKs & CCAs, Lindgren LCVG
  - Kelly LCVG, Padalka EMU Gloves
- **RS Cargo – RS Torque Wrench**
- **Unpressurized Cargo: IDA #1 (OB)** **526 kg**

Orbital-4 Mission Status

- **Mission Planning**
  - Orbital has contracted with United Launch Alliance (ULA) for an Atlas V launch of Cygnus
  - First use of Atlas V401 with the Cygnus spacecraft
  - Integrated Mission Review (IMR) #1 was conducted on 4/9/15 with IMR #2 planned for 7/14/15
  - Integrated Ground Processing Technical Interchange Meeting (TIM) was completed on 5/20/15
  - Trilateral Joint Operations Panel (JOP) was conducted on 5/27/15; planning for a 60 day berthed capability
  - Cargo Integration Review (CIR) is planned for 7/29/15; upmass cargo capability is 3,513 kg
  - On track for late November/early December launch
- **Pressurized Cargo complement**
  - Final ISS cargo manifest will be due in Jul at Launch minus 5 (L-5) months
- **Unpressurized Cargo**
  - Cubesats manifested on this mission; scheduled post ISS departure for deployment operations
- **Cygnus Status**
  - First enhanced Cygnus with a longer Pressurized Cargo Module (PCM) and ultraflex solar arrays
  - Final Integrated Systems Test (FIST) began on 6/27/15
  - PCM was shipped to the Cape on 6/23/15 with arrival to the Cape on 8/7/15
  - Service Module planned to be completed in Aug with shipment to the Cape in Oct
- **Atlas V 401**
  - Serial Interface Test was completed on 4/22/15
- **Orb-3 Mishap Investigation Report provided by Orbital ATK to the FAA last week**

Utilization Update

Increment 43 / 44
Utilization Crew Time



Executed through Increment Wk (WLP Week) 18 =	16.4 of 25 work weeks 65.6% through the Increment
USOS IDRD Allocation:	1,045.00 hours
OOS USOS Planned Total:	1,045.10 hours
USOS Actuals:	599.67 hours
	57.38% through IDRD Allocation
	57.38% through OOS Planned Total
Total USOS Average Per Work Week:	36.57 hours/work week
Voluntary Science Totals to Date:	0 hours (Not included in the above totals or graph)
RSA/NASA Joint Utilization to Date:	48.25 Hours (not included in the above totals or graph)

Color Key:
Final OOS
FPIP Plan
Completed

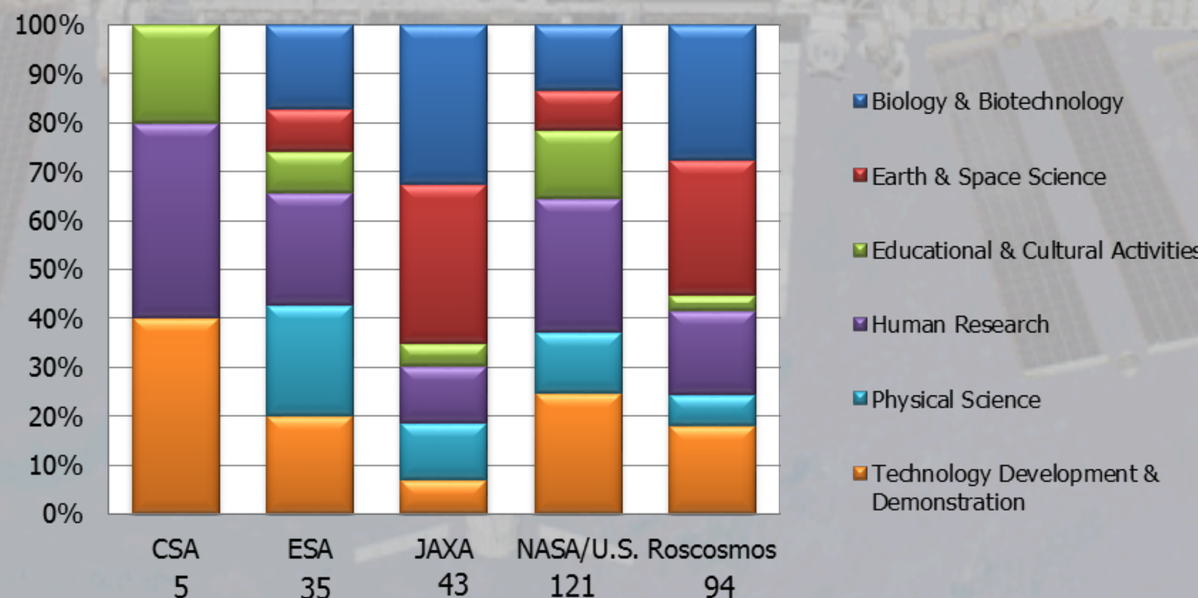
ISS Research Statistics

Number of Investigations for 43/44 : 298*

- 121 NASA/U.S.-led investigations
- 177 International-led investigations
- 84 New investigations
  - 1 CSA
  - 16 ESA
  - 12 JAXA
  - 47 NASA/U.S.
  - *8 Roscosmos*
- Over 500 Investigators represented
- Over 1000 scientific results publications (Exp 0 – present)

*Preliminary data, pending baselined CEFs for SpX-7 loss adjustments

Expeditions 43/44
Research and Technology Investigations



Estimated Number of Investigations Expedition 0-44: 1915**

**Pending Post Increment Adjustments

Working data as of June 30, 2015

Pre-decisional, For Internal Use Only

Increments 43 & 44 Research Plan - Investigation List

Human Research

Bone & Muscle Physiology
Bisphosphonates (Control), Check-Saliva (Bone/Muscle Check) (ASI), IVD (P), Force Shoes, Hip QCT (P), Sprint, Marrow C/O, Tbone (P), Brain-DTI (P), CARTILAGE (P), EDOS-2, IMMUNO-2

Cardiovascular & Respiratory Systems
Cardio Ox, Drain Brain (ASI), Orthostatic Tolerance (ASI), Wearable Monitoring (ASI), BP Reg, Vascular Echo C/O, IPVI

Crew Healthcare Systems
Skin-B

Habitability & Human Factors
Astro Palate, Body Measures, Fine Motor Skills, Habitability, Training Retention

Human Behavior & Performance
Cognition, Journals, Reaction Self Test, Sleep ISS-12, Space Headaches, Synergy (P)

Other
Content, Interactions-2, Pilot-T

Human Microbiome
Microbiome, Myco

Immune System
Salivary Markers, Multi-Omics (MAHM)↑

Integrated Physiology & Nutrition
Biochem Profile, Field Test (P), FTT (P), Repository, Telomeres, Twins Study, Circadian Rhythms, MARES Commissioning Part 1, Biological Rhythms 48hrs

Nervous & Vestibular Systems
Manual Control (P), NeuroMapping, Straight Ahead in Microgravity (P), V-C Reflex (P)

Radiation Impacts on Humans
SDM: ESA-Active-Dosimeters

Vision
Fluid Shifts, Ocular Health

Biology and Biotechnology

Animal Biology
Micro-10, Rodent Research-2, Rodent Research-3 Eli Lilly, Embryo Rad, JAXA Mouse Habitat Unit, Nematode Muscles, Space Aging, Space Pup

Macromolecular Crystal Growth
CASIS PCG 3, CASIS PCG-4, NanoRacks PCG↑, JAXA PCG-9, JAXA PCG Demo

Plant Biology
BRIC-21, Veg-01, Aniso Tubule, Plant Gravity Sensing-2, Plant Rotation

Microbiology / Cellular
CASIS Stem Cell-2, Cell Shape and Expression (ASI), Microbial Observatory-1, Nanoparticles and Osteoporosis (ASI), NanoRacks Module-28*, Osteo-4, RJR Microbial Sampling, VIABLE (ASI), CYTOSKELETON, ENDOTHELIAL CELLS, SPHEROIDS↑, Stem Cell Differentiation, TripleLux-A, TripleLux-B, Microbe-IV, Stem Cells, SDM: Melondau

Physical Sciences

Combustion Science
BASS-II, BASE-M ↑, FLEX-2, FLEX-2J, Group Combustion ↑

Complex Fluids
ACE-H-1, ACE-H-2, ACE-M-3, OASIS, PK-4

Fluid Physics
BCAT-KP-1, CFE-2, PBRE, Dynamic Surf-2, Dynamic Surf-3

Materials Science
CSLM-4, Synthetic Muscle, NanoRacks Module-40 ↑, EML Batch 1, SpaceDRUMS↓, Soret Facet

Earth & Space Science

Astrobiology/Astrophysics/Heliophysics
AMS-02 (E), NanoRacks Module-24, EXPOSE-R2 (E), Solar-SOLACES/SOLSPEC (E), CALET (E), ExHAM#1(E), MAXI (E), MCE (E)

Earth Remote Sensing
CATS (E), CEO, HICO-RAIDS (HREP) (E), IMAX, ISERV, ISS-RapidScat (E), NREP Inserts (E) ↑, Tropical Cyclone

Near-Earth Space Environment
SEDA-AP (E)

Technology Development and Demonstration

Air, Water, & Surface Monitoring
Multi-Gas Monitor, WISENET

Avionics & Software
SNFM

Characterizing Experiment Hardware
Capillary Beverage, MVIS Controller-1

Communications & Navigation
OPALS (E), SCAN Testbed (E), Vessel ID System

Food & Clothing Systems
ISSpresso (ASI)

Life Support Systems & Habitation
AMO-TOCA, , UPA (PCPA/FCPA), UBNT

Radiation Measurements & Shielding
REM, Radi-N2, DOSIS-3D, Area PADLES-14, -15, PS-TEPC , Free-Space PADLES

Repair & Fabrication Technologies
3D Printing in Zero-G

Other
SDM: 3D-VIT, Skin Suit, SUPVIS-E, MOBIPV, Mobile-HR

Robotics & Imaging
3DA1 Camcorder, HDEV (E), Moon Imagery, Robonaut, RRM-Phase 2 (E), Haptics-1, Haptics-2, INTERACT

Spacecraft and Orbital Environments
REBR-W

Space Structures
BEAM

Small Satellites & Control Technologies
NRCSD CubeSats, NanoRacks-MicroSat-SIMPL↑, SPHERES-Slosh, SPHERES Docking Port (UDP), SPHERES-VERTIGO, JSSOD CubeSat

Educational Activities

Classrooms Versions of ISS Investigations
Windows on Earth

Commercial Demo
JAXA Commercial

Educational Competitions
NanoRacks Module-9, SPHERES-Zero Robotics

Educational Demos
ISS Ham Radio, Tomatosphere-IV, JAXA Try Zero-G for Asia

Student-Developed Investigations
NanoRacks Module-53

Other
EPO CRISTOFORETTI, EPO IRISS (SDM), ESA-EPO-FLYING CLASSROOM, JAXA EPO

Key: NASA | National Lab | CSA | ESA | JAXA | ROSCOSMOS

(P) Pre/Post only, (E) External Payload,
*CEF approval pending, ↑/↓ Launch/Return only

Increments 43 & 44 Research Plan - Research Lost on SpX-7

Human Research

Bone & Muscle Physiology

Cardiovascular & Respiratory Systems
Airway Monitoring↑,
Vascular Echo C/O

Crew Healthcare Systems
Medical Consumables Tracking

Habitability & Human Factors

Human Behavior & Performance

Other

Human Microbiome

Immune System
Multi-Omics (MAHM)↑

Integrated Physiology & Nutrition

Nervous & Vestibular Systems

Radiation Impacts on Humans

Vision

Biology and Biotechnology

Animal Biology
Space Pup

Microbiology / Cellular
Micro-9,
Microbial Observatory-1,
Cell Mechanosensing-3, Stem Cells

Macromolecular Crystal Growth

Plant Biology
Veg-03,
Plant Gravity Sensing-3

Physical Sciences

Combustion Science
ATOMIZATION,
Group Combustion

Fluid Physics
Microchannel Diffusion

Complex Fluids

Materials Science

Earth & Space Science

Astrobiology/Astrophysics/Heliophysics
Meteor

Earth Remote Sensing

Near-Earth Space Environment

Technology Development and Demonstration

Air, Water, & Surface Monitoring

Avionics & Software

Characterizing Experiment Hardware

Communications & Navigation

Food & Clothing Systems

Life Support Systems & Habitation

Microgravity Environment in ISS
WetLab-2

Power Generation/Distribution Services
Universal Battery Charger

Radiation Measurements & Shielding

Repair & Fabrication Technologies

Other

Robotics & Imaging

Spacecraft and Orbital Environments

Space Structures

Small Satellites & Control Technologies
NRCSD CubeSats

Educational Activities

Classrooms Versions of ISS Investigations

Commercial Demo

Cultural Activities

Educational Competitions
NanoRacks Module-9

Educational Demos
ESA-EPO-PEAKE↑, Story Time from Space-3

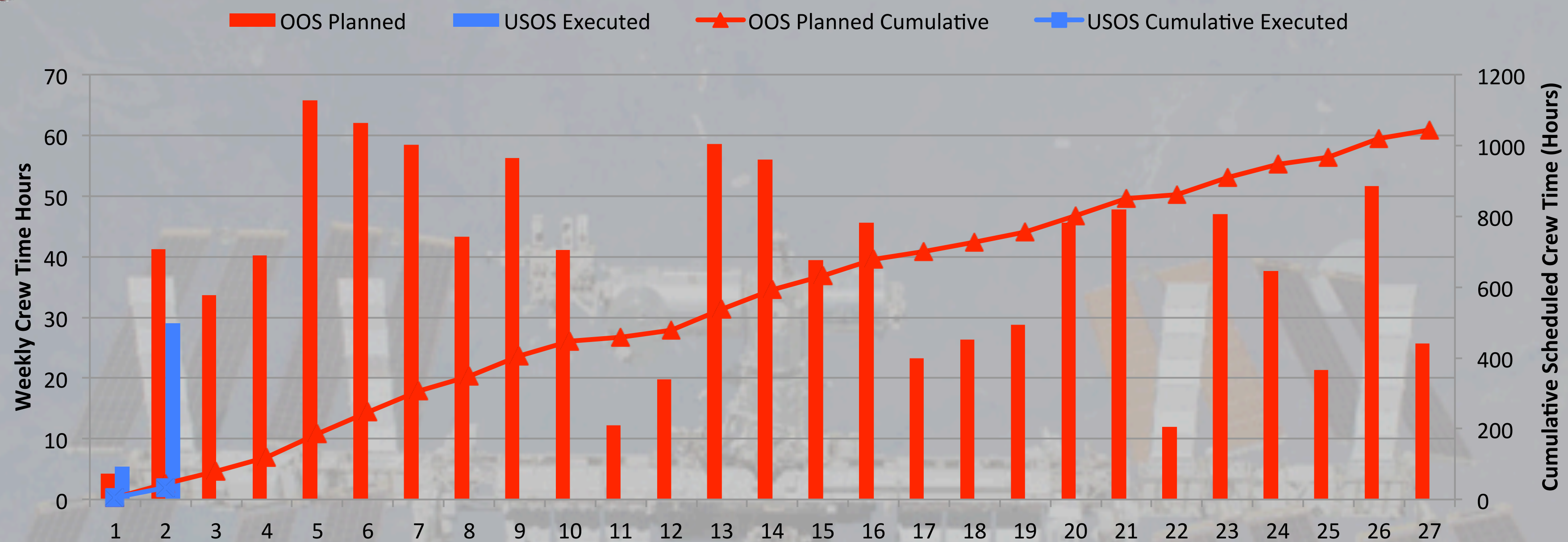
Student-Developed Investigations
NR Mod-33 (NR-AGAR), NR Modules-16, -18, -20, -21, -22; NR Modules-41, 44, 45, 46, NR Mod-54, NR Mod-55, NR Mod-56

Other

I43/44 Crew Time Impact (hours): Prime: 101.92, Reserve: 60.33 hours

Key: NASA | National Lab | CSA | ESA | JAXA | ROSCOSMOS | ↑ Launch only

Inc 43 - 44 Utilization Crew Time



3-Crew	6-Crew		3-Crew	6-Crew				9-Crew
Increment 43			Increment 44					
Mar	April	May		June	July	Aug	Sep	

Color Key:
Final OOS
FPIP Plan
Completed

40S Undock 03/11/15

SpX-6
Berth 4/10/15
Berth 4/12/15
Unberth 5/17/15
Unberth 5/21/15

RS EVA 41

SpX-7
Berth 6/15/15
Unberth 7/15/15

US EVA 7/7/15

HTV5
Berth 8/23/15 N2N
Relocate 8/24/15 N1N

Soyuz relo 8/28/15

SpX-8
Berth 9/4/15

Undock 09/11/15
Undock 09/11/15

OP/OZ reconciliation is complete through Week 2.

Executed through Increment Wk (WLP Week) 2 =	1	of 25.0 work weeks (4 % through the Increment)
USOS IDRD Allocation:	1045.1	hours (41.8 hrs/week)
OOS USOS Planned Total:	1045.1	hours
USOS Actuals:	34.42	hours
	3.29%	through IDRD Allocation
	3.29%	through OOS Planned Total
Total USOS Average Per Work Week:	34.42	hours/work week
Voluntary Science Totals to Date:	0	hours (Not included in the above totals or graph)
RSA/NASA Joint Utilization to Date:	0	Hours (not included in the above totals or graph)

"Benefits for Humanity" and ISS R&D Conference

- July 6 2015 Release Date
  - Human Health
  - Earth Observation & Disaster Response
  - Innovative Technology
  - Global Education
  - Economic Development of Space

http://www.nasa.gov/stationbenefits

ISS R&D Conference July 7-9, Boston, MA

http://www.issconference.org/

ISS R&D CONFERENCE 2015

ISS R&D Conference

- 703participants currently registered, expect to exceed 500 participants during the conference week.

- Plenary Sessions to include: the ISS a Catalyst for the Future; Leveraging ISS to Enable LEO Commercialization; and the Role of ISS in Support of Exploration

- Research Plenary Sessions to include: Biomedical Advancements on iSS; Stem Cell Research and Therapeutics; Precision Medicine on the ISS; Materials Science Research; STEM on the ISS; and Humans Survive 1,000 days in Space

- Technical Parallel Sessions to include: Biomedical Research; Earth Science Research; Advances in Communication; Sensors and Components; Drug Discoveries and Delivery Systems; Plants in Space; Developing Commercial Capabilities and Services; Crew Research and Performance; Technology Development on ISS; Space Biology Tools; Cell and Microbiology; Materials Manufacturing and Function in Space; STEM Programs and Processes; and Concepts for the Future

Center for the Advancement of Science in Space (CASIS) and National Laboratory

- NASA has a co-operative agreement with CASIS – not a contract
- To make the mission and goals of the ISS and the National Lab successful, NASA and CASIS have to work together
- CASIS remains funded at $15M/year
- CASIS has made considerable progress in finding users for their National Lab allocation
  - Breadth, but not necessarily depth

- NASA/CASIS relationship is transitioning to sustaining long-term relationships and investment with non-NASA users – private industry and other Government agencies
- NASA works closely with CASIS in Agency commercialization planning activities
- NASA/CASIS working together with National Science Foundation, National Institutes of Health, National Institute of Standards and Technology, U.S. Department of Agriculture
- Stepping up joint NASA/CASIS activities to find common research goals and data sharing

CASIS Commercial Utilization

Also in proposal development with Cargill, John Deere, ADM, Dow, and J&J 14

HISTORICAL ISS NATIONAL LAB USAGE

Increment	Upmass (kg)			Downmass (kg)			Crewtime (hrs)		
	Allocation	Actuals	Usage	Allocation	Actuals	Usage	Allocation	Request	Usage
Inc 37/38	287	334.7	117%	6	7.9	132%	427	95	22%
Inc 39/40	766	389.1	51%	244	197.8	81%	386	96.2	25%
Inc 41/42	539	716	133%	225	705.5	314%	346	178.9	52%
Inc 43/44 (projected)	1202	1215	101%	537	359	67%	229	224	98%

(Data through 3/31/15)

From CASIS Quarterly Report

CASIS Highlights

ISS NATIONAL LABORATORY PROGRESS

ISS National Laboratory Key Accomplishments

- **Commercial Engagement** – 60 percent of CASIS-sponsored research and development projects are from a wide range of commercial companies. ***Repeat customers include Eli Lilly, Merck and P&G***
- **Balanced Portfolio** - CASIS has evaluated 206 proposals, awarded approx. $20M in grants to 77 research projects with a diverse mix of life sciences/tech dev/remote sensing/phys sciences
- **Leverage** - 7:1 External contribution to project cost versus CASIS seed funding for unsolicited projects
- **Sponsored Program Model** – Mass Life Sciences Center contributed $550,000 to be first-of-its-kind CASIS RFP funded 100% by an outside organization
- **Building Networks** – Stimulating demand with support of 45 partnerships across 6 targeted geographic ecosystems

ISS National Laboratory 2015 Emphasis

- **Expand Sponsored Programs** – Increase outside funding and commercial engagement with repeatable, customer-focused model
- **Strong Alignment with NASA** – LEO Commercialization; Crew time; OGA process; GeneLab/Good Health
- Expect more than **12 peer-reviewed** publications across wide disciplines
- Approve several projects under strategic collaborative campaigns **Good Earth** & **Good Health**
- **ISS Research & Development Conference** – Transform annual conference into a dynamic ISS community platform to include strong attendance growth and increased industry investment