HSF Transition from ISS to cis-lunar space
and
ISS Status

Sam Scimemi

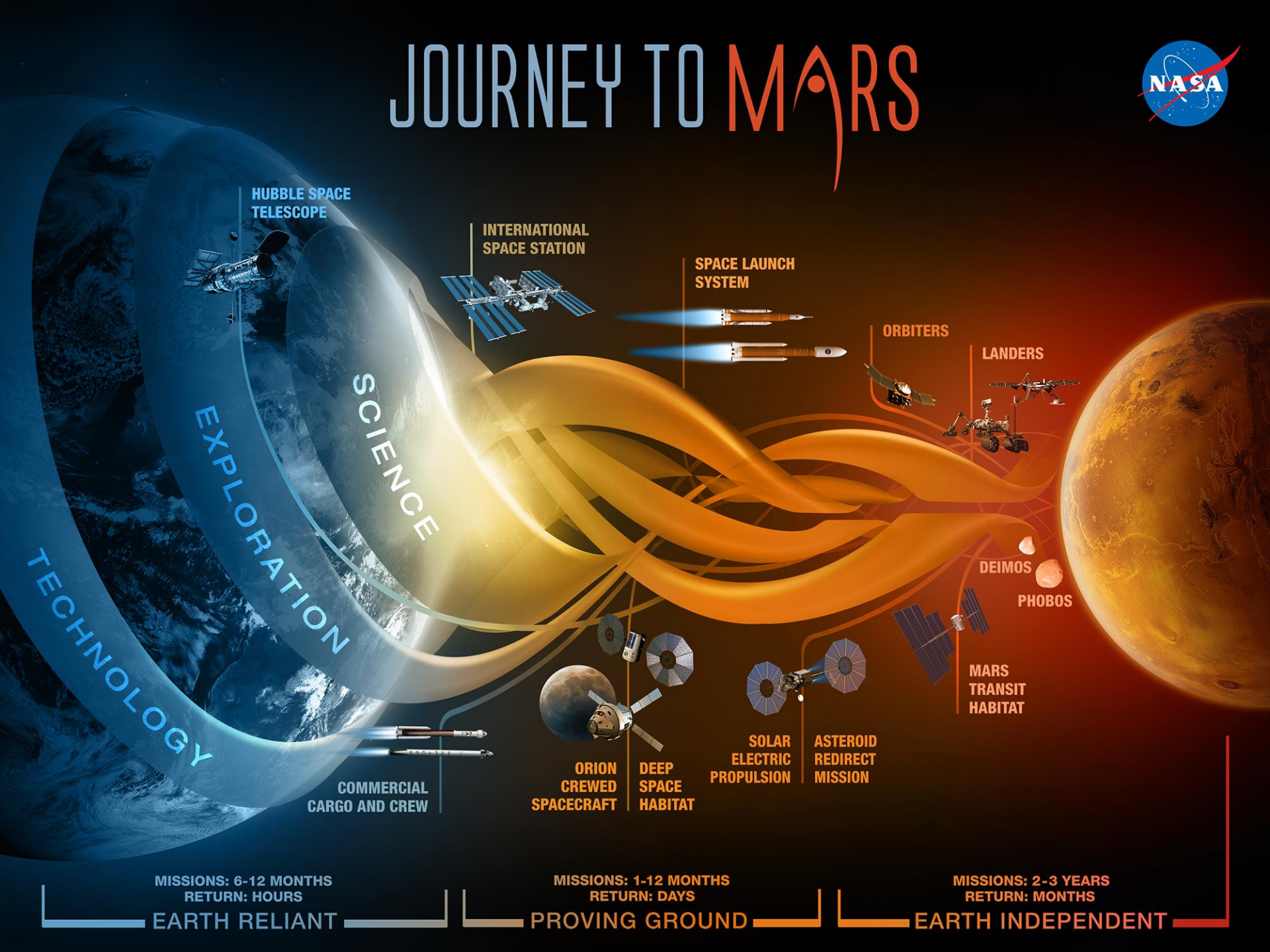
Director, International Space Station
NASA Headquarters

HEOMD NAC
November 4, 2015

Agenda

- **HSF transition from ISS to cis-lunar space**
  - Goals, objectives and research perspective
- **ISS Overview Status**
- **Utilization Status**
- **Visiting Vehicle Status**

JOURNEY TO MARS



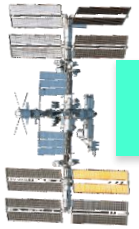
MISSIONS: 6-12 MONTHS
RETURN: HOURS
EARTH RELIANT

MISSIONS: 1-12 MONTHS
RETURN: DAYS
PROVING GROUND

MISSIONS: 2-3 YEARS
RETURN: MONTHS
EARTH INDEPENDENT

Transitioning HSF from ISS to Cis-Lunar Space (Earth Reliant to the Proving Ground)

Earth Reliant



Long Duration Human Health & Habitation Research and Demonstrations

* Currently building a plan to demonstration on ISS the Mars habitation systems.

Knowledge & Capabilities

Goal at the end of the 2020s: Mars ready - One year crewed mission(s) in cis-lunar space

Proving Ground

Short Duration Habitation & Transportation system validation

Long duration human health & habitation Validation for Mars transit

Knowledge & Capabilities

Learning how to be Earth Independent

- SLS/Orion performance validation
- Crew health and performance research and validation
- Habitation systems performance validation including EVA
- Radiation shielding characterization and validation
- Guidance and navigation in deep space
- Prox ops and docking in deep space
- Breaking the logistics chain
- Reduced reliance on the ground control
- Validating other spacecraft system validation (power, propulsion, communications, etc.)

Habitation Systems Objectives

System	Includes	Today	Cis-Lunar Goal
Life Support	Air revitalization, water recovery, waste collection and processing	42% recovery of O2 from CO2; 90% recovery of H2O; <6 mo MTBF for some components	>75% recovery of O2 from CO2; >98% recovery of H2O; >2 yr MTBF
Environmental Monitoring	atmosphere, water, microbial, particulate, and acoustic monitors	Limited, crew-intensive on-board capability; rely on sample return to Earth	On-board analysis capability with no sample return; identify and quantify species and organisms in air & water
Crew Health	exercise equipment, medical treatment and diagnostic equipment, long-duration food storage	Large, cumbersome exercise equipment, limited on-orbit medical capability, food system based on frequent resupply	Small, effective exercise equipment, on-board medical capabilities, long-duration food system
EVA	Exploration suit	ISS EMU's based on Shuttle heritage technology; not extensible to surface ops	Next generation spacesuit with greater mobility, reliability, enhanced life support, operational flexibility
Fire	Non-toxic portable fire extinguisher, emergency mask, combustion products monitor, fire cleanup device	Large CO2 suppressant tanks, 2-cartridge mask, obsolete fire products. No fire cleanup other than depress/repress	Unified fire safety approach that works across small and large architecture elements
Radiation Protection	Low atomic number materials including polyethylene, water, or any hydrogen-containing materials	Node 2 CQ's augmented with polyethylene to reduce the impacts of trapped proton irradiation for ISS crew members	Solar particle event storm shelter based on optimized position of on-board materials and CQ's with minimized upmass to eliminate major impact of solar particle event on total mission dose

Human Health and Performance Research
Transition from ISS to cis-lunar space

ISS Goals for Space Exploration

- Fully utilize ISS to understand human health risks and verify capabilities to mitigate these risks
- Develop and test exploration biomedical technologies and tools
- Extend mission durations to one-year to validate six-month research and countermeasures
- Understand visual impairment/intracranial pressure risk and assess countermeasures
- Develop space radiation human protection & monitoring systems
- Investigate long-term spaceflight stressors and changes to the immune system and microbiome
- Develop and test exploration food system
- Develop, test, and verify crew habitation systems and models

Cis-Lunar Space Goals

- Validate advanced countermeasures against deconditioning for transit vehicle (bone, muscle, cardiovascular capacity)
- Validate crew performance, psychological well-being, and intervention toolkit under long-duration flight operations
- Validate integrated exploration medical capabilities (autonomous medical capability for diagnosis and treatment)
- Validate human health, performance, and environmental health in a closed spacecraft environment (immune system, microbiome)
- Validate exploration food system
- Validate space radiation human protection and monitoring systems for exploration
- Validate crew habitation systems for exploration
- Validate robustness and reliability of crew exploration exercise systems

What could we accomplish along the way with humans in cis-lunar space

- **Research objectives - origins of the universe**
  - Asteroid Redirect Mission – *currently in formulation*
  - Human/robotic Lunar exploration of far side and Shackleton crater
  - Some of the techniques and technologies/systems have been demonstrated on ISS already – more could be done
  - Human assisted Lunar sample return
  - Point of departure for human missions to asteroids in their native orbit
- **Research objectives - search for life**
  - Human/robotic construction of large diameter telescope at L2 (*18-20m, ATLAS, Space Telescope Science Institute*)
  - Some of the techniques and technologies/systems have been demonstrated on ISS already – more could be done
- **Earth/sun/moon environs monitoring**
- **Basic research for exploration**
  - Deep space radiation exposure characterization of materials and biological samples – extension of current ISS research
  - Long term zero boil off technology
- **Other basic research**
  - Astrophysics – *follow on to CREAM and AMS-02?*

Would require further study


NASA

International Space Station Status

Sam Scimemi
Director, ISS
NASA HQ
HEO NAC
November 2015

ISS Flight Plan

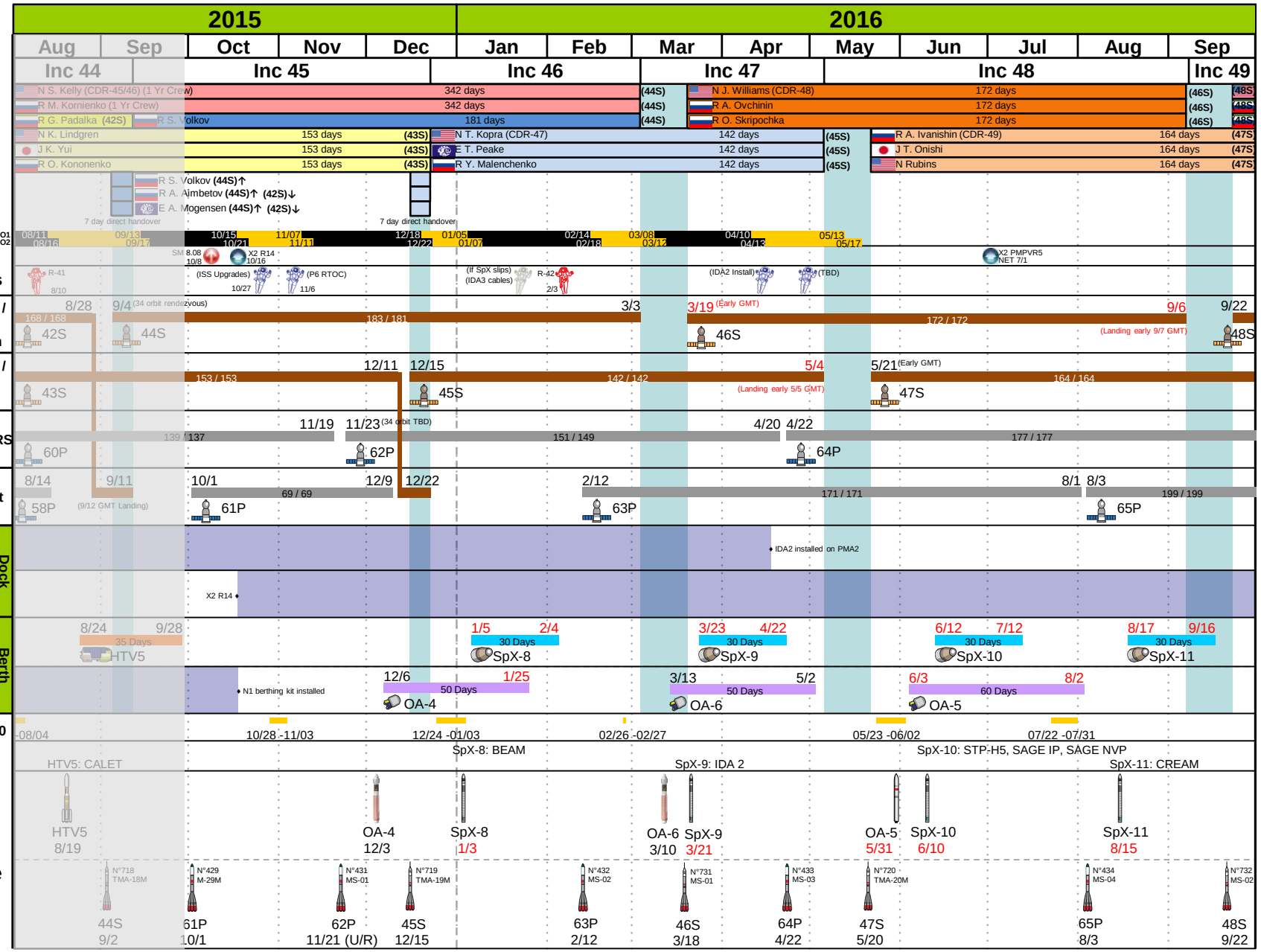
Flight Planning Integration Panel (FPIP)

(Pre-decisional, For Internal Use, For Reference Only)

For current baseline refer to SSP 54100 Multi-Increment Planning Document (MIPD)

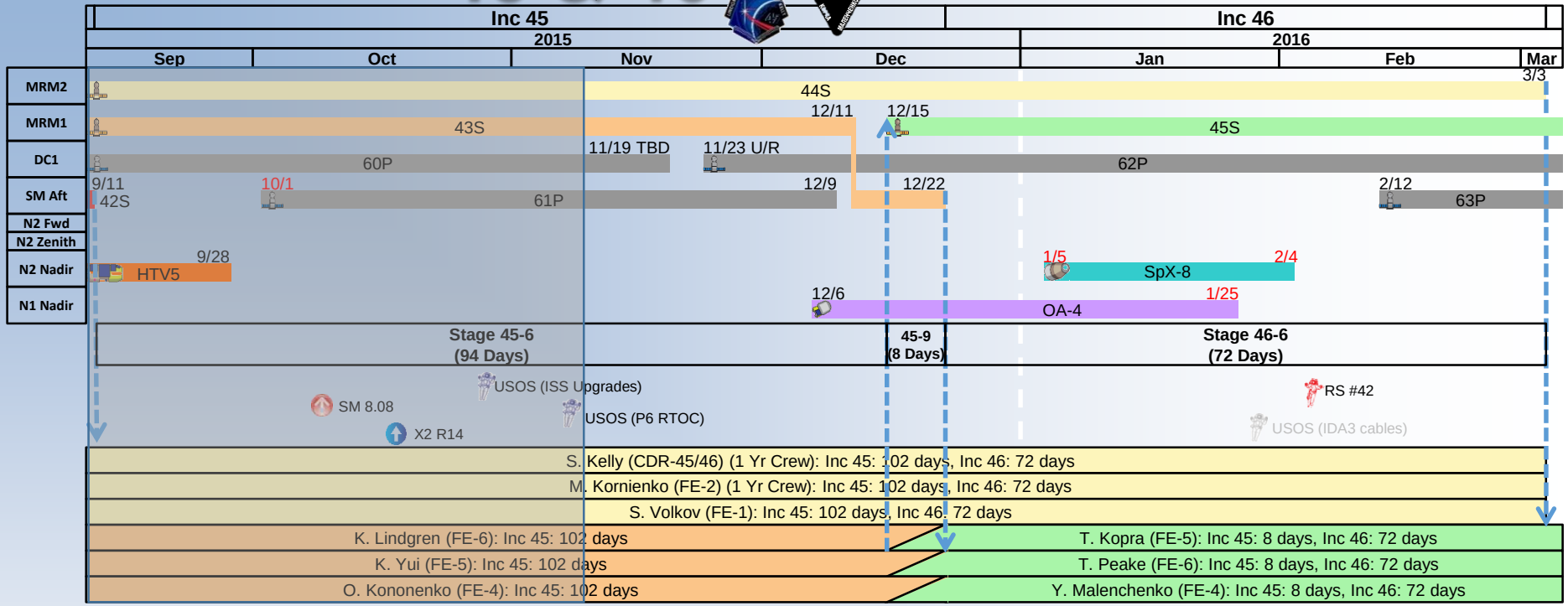
NASA: OC4/John Coggeshall
MAPI: OP/Randy Morgan

Chart Updated: October 26, 2015



INCREMENTS 45 & 46

Updated 10/29/2015: All Dates GMT
SSCN/CR: 15088A, 15191 (in work)

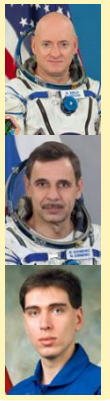


	Increment 45	Increment 46
Utilization	✓ STP-H4, SMILES, MCE disposal (HTV5) ✓ JEM A/L: J-SSOD #4, NRCSD #6, ExHAM #2 ✓ RRM Phase 2 Science	• Complete 1 year crew science • Rodent Research-3 (SpX-8) • BEAM berth (SpX-8) • Airway Monitoring • JEM A/L: SIMPL, NRCSD #7
EVA, Robotics, Systems, Software	✓ SM 8.08 ✓ X2R14 Software Transition ✓ USOS ISS Upgrades EVA ✓ USOS P6 RTOC EVA ✓ USOS Reconfig: N1 Nadir prep for VV • NORS AIK installation ✓ Galley Rack transfer (HTV5) • RPCM P12B_A replacement	• USOS IDA3 Cables EVA (Below the line) • RS EVA #42 • USOS Reconfig: Install C2V2 rack, comm units, perform C2V2 checkout • USOS Reconfig: Install IMVs, VAPs

43Soyuz Crew

O. Kononenko, K. Yui, K. Lindgren

44Soyuz Crew



S. Volkov, M. Kornienko, S. Kelly

45Soyuz Crew

Y. Malenchenko, T. Peake, T. Kopra

IM - Ryan Lien (x47284)
IDM - Gaurang Patel (x30023)
IE - Karen Engelauf (x40860), Jorge Salazar (x39663)
IPE - David Cook (x46387)

https://iss-www.jsc.nasa.gov/nwo/mio/riit/inc_45/web/

Pre-decisional, Internal Use Only

Increment 45 Overview: Crew

42S Dock 3/28/15
44S Dock 9/2/15
44S Undock 3/3/16

Scott Kelly
CDR (U) – 42S↑ / 44S↓

Mikhail Kornienko
FE (R) – 42S↑ / 44S↓

Oleg Kononenko
FE (R) – 43S

43S Dock 7/23/15
43S Undock 12/22/15

Kimiya Yui
FE (J) – 43S

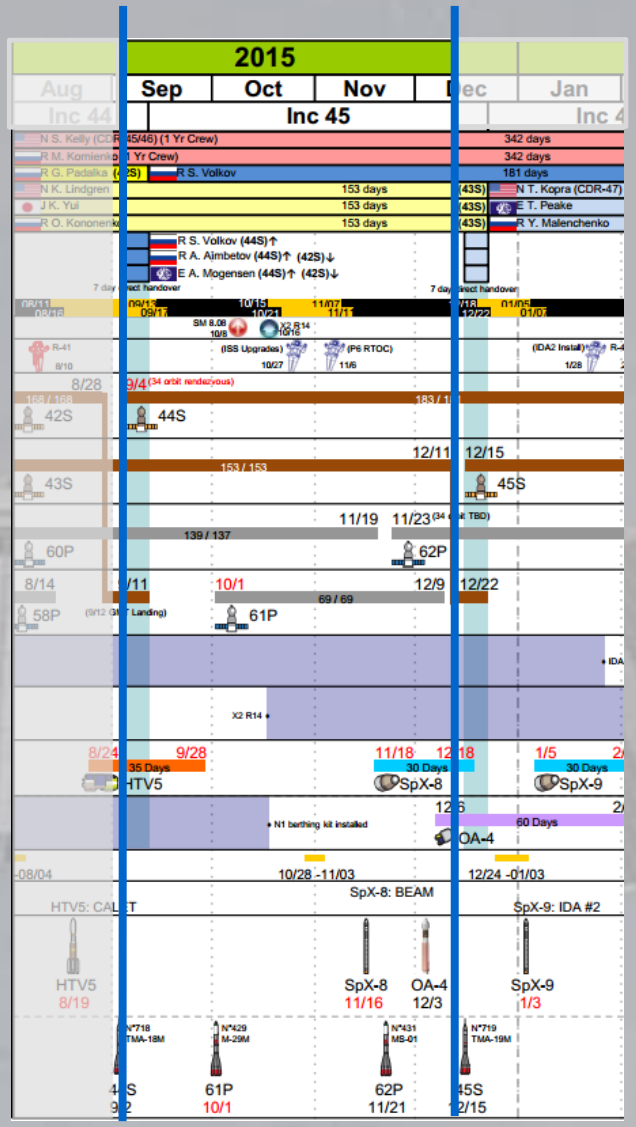
Sergei Volkov
FE (R) – 44S

44S Undock 3/3/16

Kjell Lindgren
FE (U) – 43S

Increment 45 Overview: Major Stage Objectives (Based on Final OOS Assumptions)

- Increment 45:
  - Stage 45-6: 42S Undock to 45S Dock: 94 days
  - Stage 45-9: 45S Dock to 43S Undock: 8 days
  - EVAs
    - ISS Upgrades – October 28
    - P6 Return to Original Config – Nov 6
  - Cargo vehicles:
    - 61P Dock to SM Aft (10/1)
    - HTV-5 Unberth/Release (9/28)
    - SpX-8 (1/3 – U/R)
    - 60P Undock from DC1 (11/19)
    - 62P Dock to DC1 (11/21 U/R)
    - OA-4 Capture/Berth (12/6)
  - Science/Utilization:
    - Fluid Shifts FD150
    - RRM Phase II
  - Software
    - SM 8.08 (10/8) – successfully completed
    - X2R14 (10/16-10/21) – successfully completed
  - Stowage Ops
    - HTV left completely full
  - Maintenance/Outfitting
    - N1 Nadir Prep for USOS Cargo VV Berthing
    - NORS AIK Install in airlock

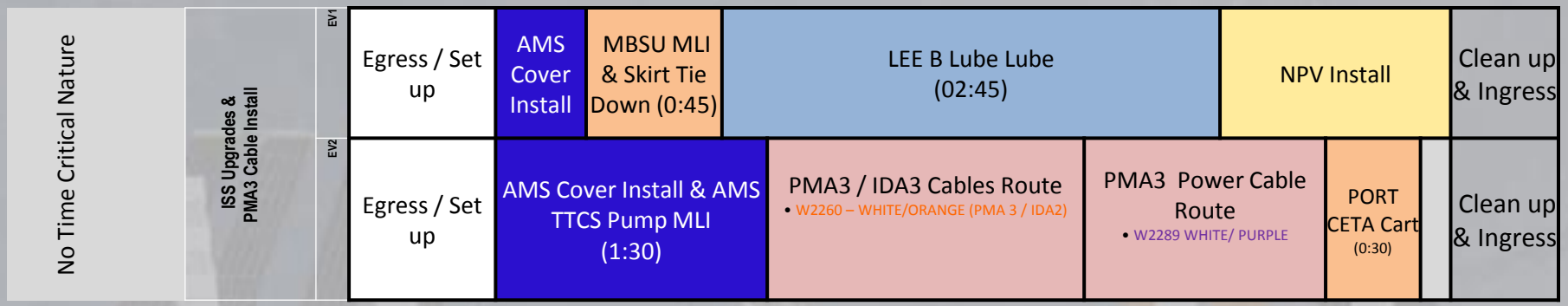


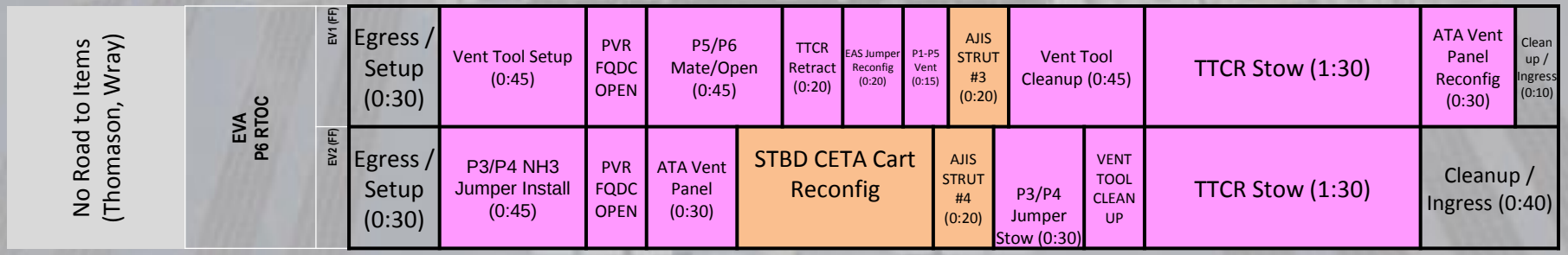
ISS Reconfiguration Status

- Goal : Establish 2 docking ports and 2 berthing ports on ISS USOS to support crew and cargo vehicles
- Initial configuration : Berthing ports at Node 2 nadir, Node 2 zenith
  PMA 2 on Node 2 forward, PMA 3 on Node 3 port
- Final configuration : Berthing ports at Node 2 nadir, Node 1 nadir
  Docking ports at Node 2 forward (PMA 2 / IDA 2), Node 2 Zenith (PMA 3 / IDA 3)
- Move PMM from Node 1 nadir to Node 3 forward *(completed)*
- Configure Node 1 nadir to support berthing *(completed)*
- Move PMA-3 from Node 3 port to Node 2 zenith *(required EVA deferred with loss of IDA 1)*
- ~~Install IDA 1 on PMA 2 (Node 2 forward) – SpaceX-7~~ *(IDA 1 lost)*
- Install IDA 2 on PMA 2 (Node 2 forward) – SpaceX-9
- Install IDA 3 on PMA 3 (Node 2 zenith) – SpaceX-14 *(new IDA 3)*
- Install C2V2 antenna system on truss elements P3 and S3 *(completed)*
- Configure Node 3 aft to support BEAM *(completed)*
- Move ARED configuration in Node 3 *(completed)*

ISS ready to receive IDA 2, EVA Oct 28 to route cables in support of PMA-3 relocate Node 1 nadir and Node 2 nadir ready to receive CRS vehicles

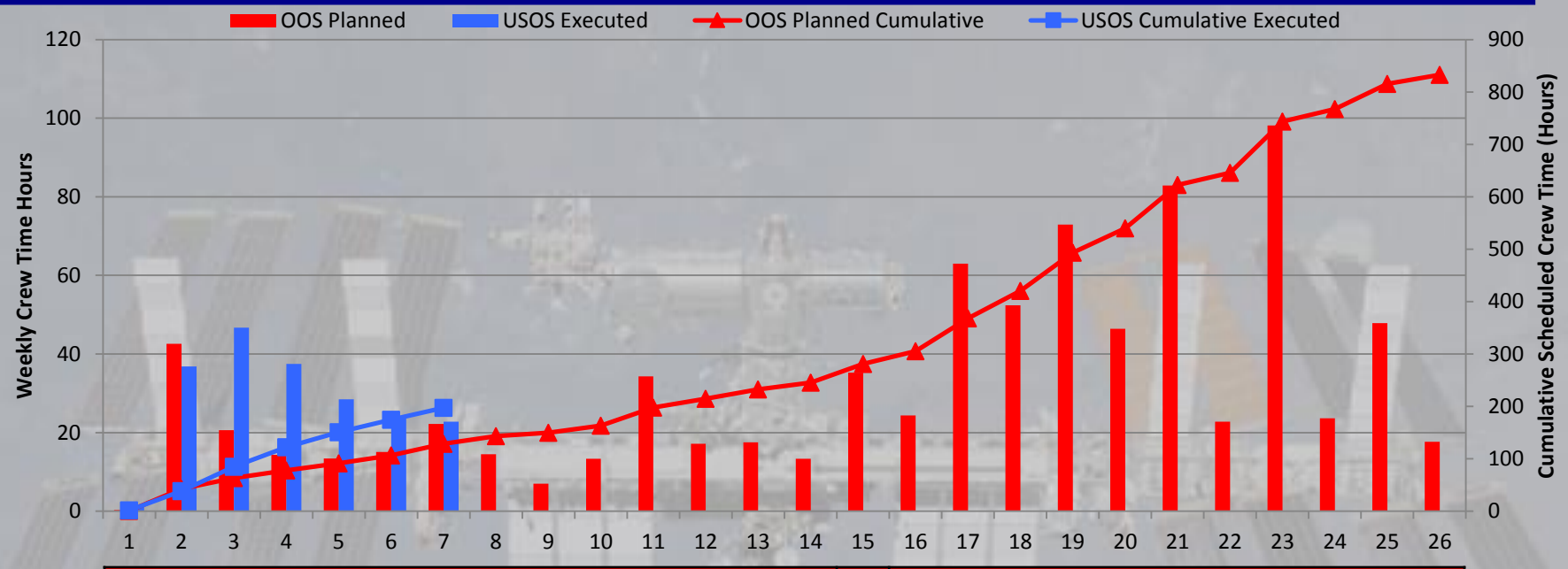
Increment 44/45 Overview: EVAs





Needed for IDA2
Needed for PMM Relocate
Needed for IDA3
Needed for PMA3 Relocate
ROBO MNVRs
Get Aheads
ISS Upgrades
P6 Reconfig/ TTCR Stow
LEE Lube
AMS MLI

Inc 45 - 46 Utilization Crew Time



Color Key:
Completed
Final OOS
FPIP Plan

HTV5
Unberth 9/28/15

US EVA
US EVA
(ISS Upgrades)
10/28/15

OA-4
Berth 12/6/15
Unberth 2/4/16
Unberth 1/25/16

Soyuz relo
12/11/15

SpX-8
Berth 01/3/16
Berth 1/5/16
Unberth 02/1/16
Unberth 02/4/16

USOS (IDA3 cables)

SpX-9 and SpX-10 were not planned in the Final OOS.

Executed through Increment Wk (WLP Week) 7 =	5.6	of 23.6 work weeks (23.73% through the Increment)
USOS IDRD Allocation:	826.0	hours (35 hrs/wk)
OOS USOS Planned Total:	832.91	hours
USOS Actuals:	197.42	hours
	23.90%	through IDRD Allocation
	23.70%	through OOS Planned Total
Total USOS Average Per Work Week:	35.25	hours/work week
Voluntary Science Totals to Date:	0.00	hours (Not included in the above totals or graph)
RSA/NASA Joint Utilization to Date:	4.50	Hours (not included in the above totals or graph)

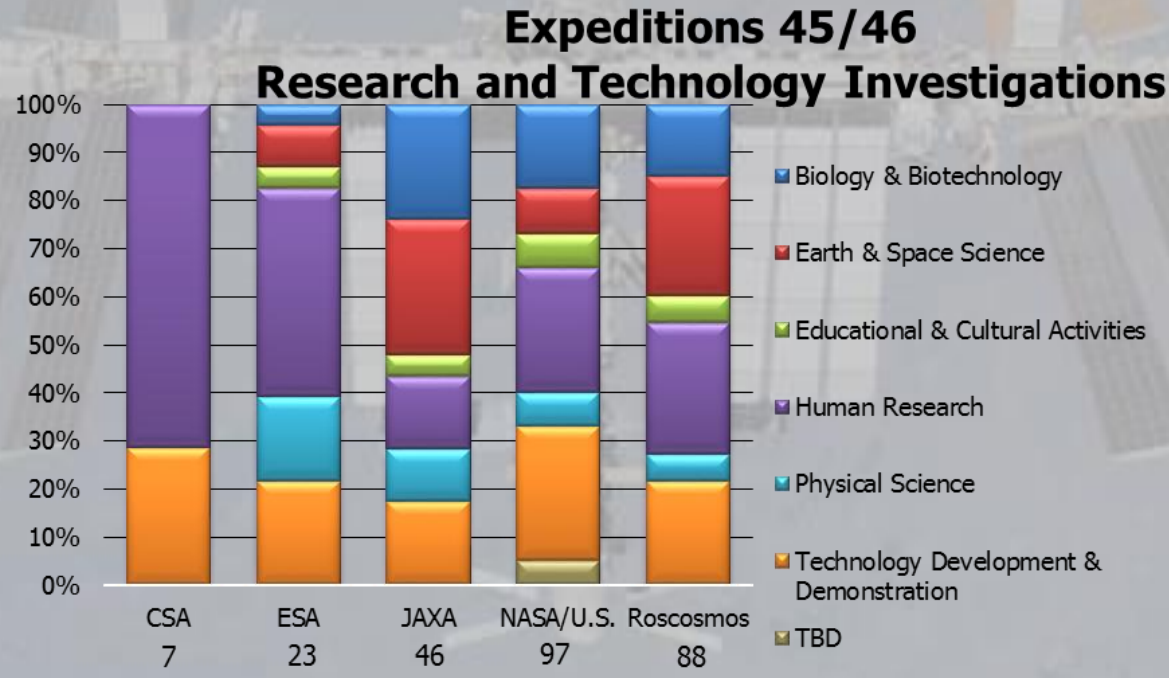
ISS Research Statistics

Number of Investigations for ISS Increments 45 & 46: 261

- 97 NASA/U.S.-led investigations
- 164 International-led investigations
- 49 New investigations
  - 3 CSA
  - 2 ESA
  - 7 JAXA
  - 35 NASA/U.S.
  - *2 Roscosmos (prelim)*

- Over 800 Investigators represented
- Over 1200 scientific results publications (Exp 0 – present)

Estimated Number of Investigations Expedition 0-46: 2053*



Increments 45 & 46 Research Complement Snapshot

Biology & Biotechnology

Animal Biology
- Rodent Research-3-Eli Lilly — SpX-8 (↑↓), SpX-9 (↓)
- Micro-10 — SpX-8 (↑↓)
- Embryo Rad — SpX-8 (↓)
- Mouse Epigenetics — HTV5, SpX-9 (↑↓)
- Space Pup — SpX-10

Cellular Biology
- Cell Science-01 — SpX-9 (↑↓)
- Heart Cells — SpX-9 (↑↓)
- OsteoOmics — SpX-9 (↑↓)
- NanoRacks SyNRGE — SpX-8 (↑↓)
- Stem Cells — SpX-9 (↑↓)
- SPHEROIDS — SpX-8 (↑↓)

Macromolecular Crystal Growth
- CASIS PCG 4 — SpX-8 (↑↓)
- CASIS PCG 5 — SpX-10
- NanoRacks PCG — SpX-9, SpX-10
- PCG Crystal Hotel Validation
- JAXA PCG
- JAXA PCG Demo — SpX-8 (↑↓)

Microbiology
- (RJR) Microbial Sampling — SpX-8 (↑↓)
- Microbial Observatory-1 — SpX-9 (↑↓)
- Microbial Observatory-2 — SpX-9 (↑↓), SpX-10
- BRIC-NP — SpX-9 (↑↓)
- Microbe-IV — SpX-8 (↓), SpX-9 (↑)
- Myco (for 1YM)

Plant Biology
- APEX-04 — SpX-10 (↑)
- Auxin Transport — SpX-9, SpX-10
- Plant Rotation

Technology Development

Air, Water & Surface Monitoring
- Personal CO2 Monitor — SpX-10

Avionics & Software
- SNFM
- Telescience Resource Kit

Characterizing Expt Hardware
- POP 3D — Orb-4
- ESA-Haptics-1
- MVIS Controller-1

Communication & Navigation
- Maritime Awareness — SpX-9
- OPALS (Ext)
- SCAN Testbed (Ext)
- Vessel ID System (Ext)
- 3D VIT

Food & Clothing Systems
- Skinsuit

Imaging Technology
- 3DA1 Camcorder
- HDEV (Ext)
- ExHAM-Array Mark (Ext) — SpX-9 (↓)

Life Support Systems
- UBNT (RJR)
- UPA — SpX-9 (↑)
- LDST — SpX-10 (↑)

TBD
- NanoRacks MicroSat - K — SpX-9 (↑)
- NanoRacks-Gumstix — SpX-8

Repair/Fabrication Technologies
- 3D Printing In Zero-G

Robotics
- Robonaut (RJR)
- RRM-P2 (Ext)
- SUPVIS-E

Small Satellites Technologies
- NanoRacks MicroSat Deployer — Orb-4
- NanoRacks-MicroSat-SIMPL — Orb-4
- NRCSD#6 — HTV5
- NRCSD#7 — Orb-4

Space Structures
- BEAM (Ext) — SpX-8

Spacecraft & Orbital Environmts
- ISS External Leak Locator — Orb-4
- STP-H4 (Ext) — HTV5 (↓)
- STP-H5 APS (Ext) — SpX-10

Spacecraft Materials
- MISSE-8 FSE — SpX-10 (↓)
- ExHAM-CFRP Mirror (Ext) — SpX-9 (↓)
- ExHAM-MDM2 (Ext) — SpX-9 (↓)
- ExHAM-PEEK (Ext) — SpX-9 (↓)
- ExHAM-Solar Sail (Ext) — SpX-9 (↓)

Radiation & Shielding
- Radiation Environment Monitor
- Area PADLES
- PS-TEPC
- Radi-N2

Human Research

Bone & Muscle Physiology
- Bisphosphonates
- Hip QCT (P)
- Intervertebral Disc Damage (P)
- Sprint
- CARTILAGE (P)
- EDOS-2
- MUSCLE BIOPSY (P)
- Marrow
- Tbone (P)

Cardiovascular & Respiratory Systems
- Cardio Ox
- IPVI
- IPVI for 1YM (P)
- AIRWAY MONITORING
- BP Reg
- Vascular Echo — 61P, SpX-8

Crew Healthcare Systems
- Skin-B

Habitability and Human Factors
- Body Measures
- Fine Motor Skills
- Habitability

Human Behavior & Performance
- Cognition
- Journals
- Reaction Self Test
- Sleep ISS-12
- Synergy (P)
- Circadian Rhythms

Human Microbiome
- Microbiome

Immune System
- Salivary Markers
- Multi-Omics — HTV5, SpX-9
- IMMUNO-2

Integrated Physiology & Nutrition
- Biochem Profile
- Dose Tracker
- Field Test (P)
- Functional Task Test (P)
- Repository
- Telomeres
- Twins Study
- Biological Rhythms 48hrs
- Biological Rhythms 48hrs for 1YM
- Energy

Nervous & Vestibular Systems
- NeuroMapping
- V-C REFLEX (P)
- Straight Ahead in Microgravity (P)
- Space Headaches

Vision
- Fluid Shifts
- Ocular Health

TBD
- Interactions-2
- Pilot-T

Physical Science

Combustion Science
- FLEX-2J
- BASS-M — SpX-8
- ACME — SpX-9 (↑), SpX-10 (↑)
- ATOMIZATION
- Group Combustion — HTV5, Orb-4

Complex Fluids
- ACE-H2 — SpX-8
- ACE-T1 — SpX-9
- LMM Biophysics 1 — SpX-10 (↑)
- LMM Biophysics 3 — SpX-10 (↑)
- (RJR) OASIS — SpX-8 (↓)
- PK-4

Fluid Physics
- ARTE (Thermal Exchange) — SpX-9
- PBRE — SpX-8
- ZBOT — SpX-10
- Microchannel Diffusion — SpX-8 (↓)
- Dynamic Surf
- Marangoni-UVP
- Two-Phase Flow — SpX-9 (↑)

Fundamental Physics
- DOSIS-3D — 45S

Materials Science
- MSL 2b - NASA SCA — SpX-9 (↑↓)
- NanoRacks-LECN Maquette — SpX-8
- Interfacial Energy 1 — Orb-4
- JAXA ELF — HTV5, Orb-4
- EML Batch 1
- MSL Batch 2b — SpX-10

Earth & Space Science

Astrobiology & Astrophysics
- AMS-02 (Ext)
- Meteor — Orb-4
- CALET (Ext) — HTV5 (↑)
- MAXI (Ext)
- MCE (Ext) — HTV5 (↓)

Earth Remote Sensing
- CATS (Ext)
- HREP-RAIDS (Ext)
- ISS RapidScat
- SAGE III-ISS (Ext) — SpX-10 (↑)
- SMILES (Ext) — HTV5 (↓)

Heliophysics
- Solar-SOLACES
- Solar-SOLSPEC

Near-Earth Space Environment
- SEDA-AP (Ext)

Education & Outreach

Commercial Demonstrations
- JAXA-Commercial — HTV5

Cultural Activities
- NanoRacks Module-48 — SpX-9 (↑↓)

Educational Competitions
- SPHERES-Zero-Robotics (RJR)
- NanoRacks Module-9 — SpX-9 (↑↓), SpX-10 (↑↓)

Educational Demonstrations
- (RJR) Sally Ride EarthKAM
- ISS Ham Radio
- Story Time From Space — Orb-4
- JAXA EPO — HTV5
- Try Zero-G for Asia
- ESA-EPO-Peake — 44S

Student-Developed Investigations
- Genes in Space-1 — SpX-9 (↑↓)

TBD Category

- CASIS Dev 11 — SpX-10
- NanoRacks-SMiLE — SpX-9
- Payload Card Multilab-X — SpX-9
- Payload Card-X — SpX-10
- Content

Key

NASA	(P) = Pre/Post BDC only
National Lab	(Ext) = External
JAXA	(RJR) = Russian Joint Research
ESA	(↑) = Launch only
CSA	(↓) = Return only
RSA	(↑↓) = Crossover

Total ISS Consumables Status

	T1: Current Capability		T2: Current Capability + 62P + OA-4	
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%	February 09, 2016	April 02, 2016	May 28, 2016	July 15, 2016
KTO	February 07, 2016	March 31, 2016	June 26, 2016	August 10, 2016
Filter Inserts	October 28, 2016	December 19, 2016	December 19, 2016	> December 31, 2016
Toilet (ACY) Inserts	May 28, 2016	July 12, 2016	June 22, 2016	August 06, 2016
EDV + TUBSS (UPA Operable)	June 28, 2016	October 07, 2016	September 30, 2016	> December 31, 2016
Pre-Treat Tank	March 23, 2016	May 11, 2016	August 14, 2016	October 06, 2016
Water (Nominal Usage)	June 02, 2016	September 11, 2016	July 20, 2016	November 07, 2016
Consumable - based on system failure				
EDV + TUBSS (UPA Failed)	March 13, 2016	May 02, 2016	May 04, 2016	June 27, 2016
Water, if no WPA (Ag & Iodinated)	March 05, 2016	May 23, 2016	April 12, 2016	June 24, 2016
O_2 if Elektron supporting 3 crew & no OGA	November 28, 2015	March 31, 2016	December 26, 2015	May 21, 2016
O_2 if neither Elektron or OGA	November 09, 2015	January 02, 2016	November 09, 2015	January 20, 2016
LiOH (CDRAs and Vozdukh off)	~0 Days	~14 Days	~0 Days	~14 Days

USOS Consumables Status

	U1: Current Capability		U2: Current Capability + 62P + OA-4	
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%	February 23, 2016	April 13, 2016	June 16, 2016	August 06, 2016
KTO	March 09, 2016	April 26, 2016	August 28, 2016	October 17, 2016
Filter Inserts	> December 31, 2016	> December 31, 2016	> December 31, 2016	> December 31, 2016
Toilet (ACY) Inserts	November 30, 2016	> December 31, 2016	November 30, 2016	> December 31, 2016
EDV + TUBSS (UPA Operable)	December 13, 2015	June 29, 2016	February 16, 2016	September 08, 2016
Pre-Treat Tanks	April 19, 2016	June 14, 2016	November 05, 2016	December 26, 2016
Water (Nominal Usage)	November 08, 2016	> December 31, 2016	November 08, 2016	> December 31, 2016
Consumable - based on system failure				
EDV + TUBSS (UPA Failed)	November 06, 2015	December 28, 2015	November 06, 2015	January 18, 2016
Water, if no WPA (Ag & Iodinated)	December 23, 2015	February 16, 2016	December 23, 2015	February 16, 2016
O_2 if neither Elektron or OGA	November 11, 2015	January 15, 2016	November 11, 2015	January 30, 2016
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
SSRMS LEE B Safing Event	No	During HTV-5 release on GMT 271 (9/28/2015) the SSRMS LEE B experienced a safing event at the beginning of the Auto Release (start of derigidization). This resulted in a 1 orbit delay to HTV departure • Second attempt was successful. • Following HTV release, LEE-B completed a nominal grapple at MBS PDGF-1 • High Speed Data of the safing event was gathered and is currently under review by CSA • Leading theory is that the LEE carriage experienced an over speed condition while trying to overcome initial tension • LEE-B will be lubed in upcoming US EVAs
MELFI-2	No	On GMT 250 (9/7/15), MEFLI-2 (JEM) lost health and status with corresponding decrease in power draw and decrease in LTL out temp (in family with loss of Brayton motor) • Science samples were relocated to MELFI-1 (Lab) • Troubleshooting isolated failed ORU to the Rack Interface Unit (RIU) • 1 RIU was replaces. Nominal ops returned

Pertinent ISS Vehicle Issues

TOC Status	Yes	The Total Organic Carbon (TOC) Status: • High TOC indicates that the WPA MF Beds are saturated • The R&R of Ion Exchange Bed, Multifiltration Beds, and External Filter Assembly completed on Oct 2 • TOC readings now under detectable limits TOC Readings • July 15 – 2379 µg/L • Aug 19 – 446 µg/L • Sep 15 – 1943 µg/L

Pertinent ISS Vehicle Issues (cont)

Issue	Impact to Stage Ops	Rationale
Node 3 CDRA Status	No	Node 3 CDRA blower air leak • Post the N3 CDRA blower R&R (5/14/15) a leak was identified through troubleshooting at the V-Band Clamp (blower connection) • The leak does impact to CO_2 removal or Sabatier Operations • N3 CDRA has no constraints to operate and is currently operational
Lab CDRA RPC Trip (LAD62B-A, RPC 12)	Yes	RPCM LAD62B-A, RPC 12, provides power to the Lab CDRA selector valves, continued true overcurrent trips affects power to valves • RPCM replaced on GMT 205 (7/24/15) • First RPC trip occurrence on new RPCM on GMT 235 (8/23/15) • Second RPC trip event on GMT 273 (9/30/15) • Good ABIT following trip and re-closure of RPC • Troubleshooting cable to be developed and flown

Pertinent ISS Vehicle Issues (cont)

Issue	Impact to Stage Ops	Rationale
SPDM Arm 2 joint position issue	Yes	On GMT 281 (10/8/15), during Special Purpose Dexterous Manipulator (SPDM) Arm 2 power up, the shoulder yaw measured 0.0 degrees when the last known position was +3.9 degrees. • Robotics Refueling Mission (RRM) operations were completed with Arm 1, Multi-Function Tool was stowed with joint unpowered and brakes applied. • A quick turnaround diagnostic patch was uplinked on Wed 10/14/15 to gather additional data on SPDM Arm 2. Preliminary investigation indicated issue with Joint Electronics Unit ability to read motor/joint resolver data. • SPDM Arm 2 ok for unloaded operations using Degraded Joint Ops. • Contact ops require analysis to verify no break slippage or joint loads violations. • Next MART scheduled for 11/5/2015. • Next potential SPDM Operation is the RPCM P12B_A R&R in early December.

HTV5 Mission Status

Mission Planning

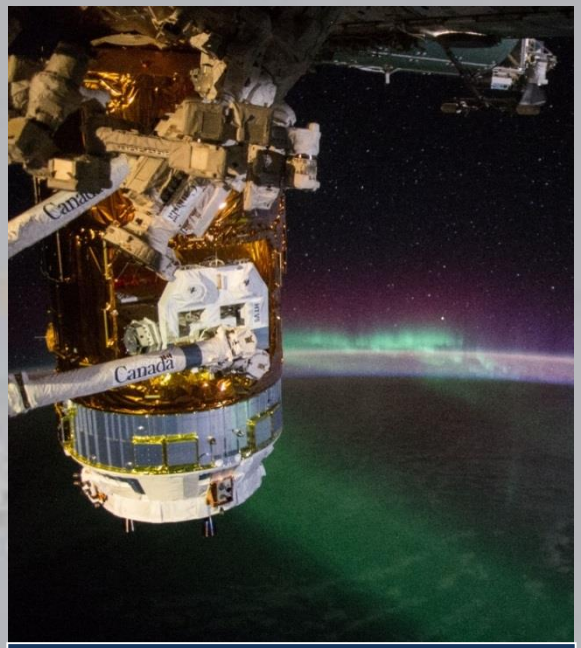
- Stage Operations Readiness Review (SORR) completed on 7/27/15
- Successful launch on 8/19/15 and berthing on 8/24/15
- No major issues tracked during mission
- Successful departure on 9/28/15

Cargo

- Pressurized cargo included Node 1 galley rack, MSPR-2 (JAXA rack), 30 Contingency Water Container – Iodine (CWC-I), and additional soft-stow cargo
- MPSR 2 was removed from HTV and installed in JEM in Aug
- Late load shipments #1 and #2 arrives at TNSC on 7/27/15 and 7/30/15 (NASA 992)
- Outstanding coordination post SpaceX-7 failure to adjust and add capability (MPSR front rack)
- Late load #1 and #2 completed on 8/13/15
- Vehicle launched ~ 8000 lbs pressurized, 1450 lbs external
- Trash Removed : 4,350 pounds

External Cargo

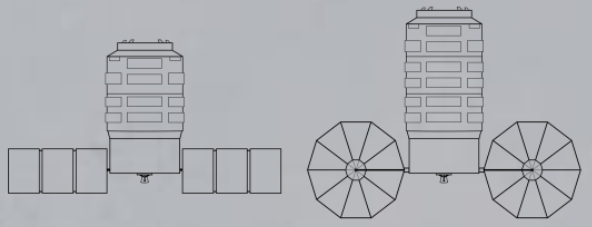
- CALorimetric Electron Telescope (CALET) which will investigate the high energy universe was removed from the HTV5 Exposed Pallet (EP) and installed to ISS
- MCE, SMILES and STP-H4 experiments were installed on EP for disposal; EP was returned to HTV5 on 9/15/15



HTV5 berthed on 8/24/15

OA-4 (Orb-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
  - Cargo Integration Review (CIR) was conducted on 7/29/15
  - Safety Review Panel (SRP) TIMs on 8/5/15 and 9/15/15
  - Chief Engineer Readiness Review was completed on 9/1/15
  - SRP Phase 3 is planned for completion on 10/13/15
- **Pressurized Cargo complement**
  - NASA delivered ISS cargo manifest in June
  - Planned Upmass : 7,730 pounds
- **Cygnus Status**
  - First enhanced Cygnus with a longer Pressurized Cargo Module (PCM) and lightweight solar arrays
  - Service Module (SM) will accommodate changes to the TriDAR/LIDAR configuration
  - PCM completed FE1410 testing at the Cape on 8/20/15
  - SM completed Final Integrated Systems Test (FIST) and scheduled to arrive at the Cape on 10/15/15
  - Initial cargo arrival is planned for 10/16/15
- **Atlas V 401**
  - Payload Adapter has been manufactured and is ready for integration
  - Booster ship to CCAFS is planned for 10/30/15



OA-6 (Orb-5) Mission Status

- **Mission Planning**
  - ULA/Orbital ATK customer kickoff meeting was held on 8/21/15
  - Ground Operations Readiness Review (GORR) is planned for mid Oct
  - Cargo Integration Review (CIR) is planned for Nov
- **Pressurized Cargo complement**
  - Final ISS cargo manifest planned for delivery in Oct to support CIR
  - Spacecraft Fire Experiment (Saffire) #1 payload will be integrated into Cygnus
  - Planned Upmass : 7,730 pounds
- **Cygnus Status**
  - Schedule rework is in progress to support an Service Module (SM) flight on an Atlas launch vehicle
  - SM has been in storage and will undergo Return to Flight (RTF) regression testing in Dec after TAS-E radio delivery
  - Pressurized Cargo Module (PCM) is planned for delivery to KSC in Jan 2016
- **Atlas V 401**
  - Payload Adapter planned for manufacturing

OA-5 (Orb-6) Mission Status

- **Mission Planning**
  - First enhanced Cygnus on the upgraded Antares Launch Vehicle launched from WFF Pad 0A
- **Pressurized Cargo complement**
  - ISS cargo manifest planned in support of Cargo Integration Review (CIR)
  - Spacecraft Fire Experiment (Saffire) #2 payload will be integrated into Cygnus
  - Planned Upmass : 7,050 Pounds
- **Cygnus Status**
  - Service Module (SM) in storage having completed integrated testing
  - SM plan for post-storage testing is approximately 3 months before launch
- **Antares Status**
  - Hardware Acceptance Review (HAR) for the RD-181 engines was conducted from 7/7/15 – 7/9/15 with delivery to WFF on 7/20/15
  - Antares 230 Stage 1 Core delta Critical Design Review (CDR) was conducted from 7/15/15 – 7/17/15
  - WFF range/FAA Antares 230 status briefing was conducted on 7/23/15
  - Engines 2A and 3A were attached to the Stage Test Article (STA) for fit check
  - RD-181 Certification Test Review was conducted from 9/2/15 – 9/4/15
  - Core is at WFF; modifications to support Antares 230 configuration are nearly complete
  - Engines are being prepared for hot fire test
- **Launch Pad Status**
  - Pad 0A rebuild completion and re-certification planed for Oct.

SpaceX-8 Mission Status

- **Mission Planning**
  - Cargo Integration Review (CIR) Part 1 completed on 5/28/15 with Part 2 planned for Oct
  - Safety Review Panel (SRP) Phase 3 review is planned to be complete by 10/7/15
  - Post Qualification Review (PQR) is planned for Nov
  - Stage Operations Readiness Review (SORR) is planned for Dec
- **Pressurized Cargo**
  - 1 Animal Enclosure Module-Transporter (AEM-T), 3 Polars (2 powered), and a NORS O2 Tank
  - Planned Upmass : 3,810 pounds. Planned Return : 4,100 pounds
- **External Cargo**
  - Bigelow Expandable Activity Module (BEAM) arrived at KSC on 7/23/15 and is dwelling in the SSPF until SpX is ready to integrate
- **Dragon Status**
  - Capsule and trunk stacking for integrated checkouts at Hawthorne was completed on 7/27/15
  - Final hatch blowdown and Acceptance Test Procedure (ATP) was completed on 8/25/15
  - Vehicle in the Loop (VITL) and polarity testing was completed on 8/31/15
  - Trunk and capsule are planned to be shipped by 10/9/15
- **Falcon 9 Status**
  - SpX-8 will be first CRS Falcon flight with full thrust capability (2nd or 3rd Falcon flight with full thrust)
  - Interstage in final assembly preparing for Stage 1 mate
  - M1D qualification completion is planned for Oct with MVac qualification planned for Nov
  - Stage 1 and 2 are planned to ship to TX by Nov for ATP

SpaceX-9 Mission Status

- **Mission Planning**
  - Cargo Integration Review (CIR) is planned for L-4 mo., Dec. 2015
- **Pressurized Cargo**
  - 1 JAXA Rodent Module (first flight – including live mice return), 1 Bioculture, 3 Polar, Short Extravehicular Mobility Unit (SEMU), and 2 NORS Tanks
  - Planned Upmass : 4,620 pounds Planned Return : 4,100 pounds
- **External Cargo**
  - International Docking Adapter (IDA) #2
- **Dragon Status**
  - Capsule pressure and service section integration mate was completed on 7/15/15
  - All tank welds were completed in Sep
  - Prop tank installation is currently underway
  - Capsule and trunk stacking at Hawthorne for integrated checkouts is planned for 11/3/15
- **Falcon 9 Status**
  - Engine Octaweb currently in final assembly
  - Production for other elements is planned to begin in Oct; engines to begin production and ATP in Oct

62P Progress-MS

- 62P is the first Progress MS vehicle
  - A number of updates to the Progress included in this version of the vehicle
    - MMOD shielding modified on the Orbital compartment (matches Soyuz vehicle updates)
    - Utilizes Kurs-NA rendezvous system instead of Kurs-A
    - GLONASS/GPS satellite navigation system added and previous orbital navigation hardware
    - Kvant radio replaced with S-band satellite communication system

- First Progress flight on Soyuz 2.1A booster since 59P accident
  - Russian specialists conducted coupled loads analysis with the Progress updates and the Soyuz 2.1A Booster
  - NASA has requested Russian specialist to present special topic from this analysis at upcoming reviews
  - NASA has requested a special topic on this at the Vehicle Assessment Review, SORR and FRR.

- Next Steps
  - 62P Vehicle Assessment Review – 10-15-15
  - 62P SORR – under review
  - 62P FRR – under review