

International Space Station Status

HEO NASA Advisory Council

14 November 2016

Sam Scimemi Director, ISS NASA Headquarters

Spot The Station



Increment 49 Overview: Crew



Anatoli Ivanishin FE (R) - 47S (CDR Inc. 49)



47S Dock 6/26/16 47S Undock 10/30/16

Takuya Onishi FE (J) - 47S

Kate Rubins FE (US) - 47S



48S Dock 10/21/16 48S Undock TBD



Andrey Borisenko FE (R) – 48S



Sergey Ryzhikov FE (R) – 48S CDR



Shane Kimbrough FE (US) – 48S *(CDR Inc. 50)*



Increment 49 Overview: Major Stage Objectives

- Increment 49: 54 Days
 - Stage 49-3: 46S Undock to 48S Dock: 45 days
 - Stage 49-6: 48S Dock to 47S Undock: 9 days
 - EVAs
 - » None scheduled
 - Cargo vehicles:
 - » OA-5 Capture/Berth (10/23)
 - » 63P Undock (10/14)
 - Science/Utilization:
 - » Airway Monitoring
 - » Fluid Shifts
 - » SODI-DC MIX
 - » Phase Change Hx
 - » JEM AL Cycle: NRCSD#9
 - Maintenance/Outfitting
 - » Lab Major Constituent Analyzer (MCA) Return to Operations
 - » SSLA Installation in Crew Quarters
 - Stowage Ops
 - » Unloading and packing of OA-5







Increment 50 Overview: Crew



Shane Kimbrough FE (US) - 48S (*CDR Inc 50*)



48S Dock 10/21/16 48S Undock TBD



Sergey Ryzhikov FE (R) – 48S CDR – 48S



49S Dock 11/19/16 49S Undock TBD



Peggy Whitson FE (US) – 49S (*CDR Inc 51*)



Thomas Pesquet FE (US) - 49S

Oleg Novitski FE (R) – 49S CDR



Andrey Borisenko FE (R) – 48S



Increment 50 Overview: Major Stage Objectives (through HTV6 post-unberth)

- Increment 50: 119 days
 - Stage 50-3: 47S undock to 49S dock: 17 days
 - Stage 50-6: 49S dock to 48S undock: 102 days
 - EVAs
 - 3A Battery R&R EVA (January)
 - 1A Battery R&R EVA (January)
 - 2-4 contingency Battery EVAs pending MSS performance
 - Cargo vehicles:
 - OA-5 Unberth (11/21)
 - 65P docking (12/3)
 - HTV-6 Berthing (NET 12/13)
 - HTV-6 Unberthing (NET 1/20/17)
 - Science/Utilization:
 - Fluid Shifts
 - SARCOLAB-3
 - Post OA5 unberth utilization (SAFFIRE, NR external CubeSat deploy above ISS)
 - JSSOD #5, 6 and NRCSD #9
 - Osteomics
 - Cool Flames
 - Maintenance/Outfitting/Robotics:
 - N1 galley rack activation and checkout
 - PMA3 relocation prep
 - X2R15 FSW transition and JSL v10 upgrades
 - Z-book deploys
 - RELL deploy and checkout
 - CDRA bed R&Rs





- US EVA #36 (IDA2 Install) completed Friday, August 19, 2016
- EV1: Jeff Williams, EV2: Kate Rubins
- PET: 5:58
- All planned tasks completed:
 - Perform final IDA2 cable routing.
 - Perform IDA2 MLI removal.
 - Perform IDA2 outfitting.
 - Install HEMI reflectors (2).
 - Install H-Fixture MLI.
 - Install PMA2 planar reflector cover.
 - Install PMA2 HEMI reflector cover.
 - Route White/Green Cable W2288 for IDA3.
 - Perform SSPTS cap removal.
 - Connect MDM Ethernet cable
 - EPIC MDM Ethernet Cable Route
- Comm Cap issues
 - Loss of audio in EV1 right ear cup (documented as a recurrence of AR 7055)
 - Suspected comm dropout from EV1 to MCC
 - Appeared some calls from the ground were not heard by EV1
 - and some calls from EV1 were not heard by the ground
 - (EV1 and EV2 never lost comm with each other)
 - Investigation proved there was no comm drop, Flight Control team sensitized to protocol

EV2 completing the IDA3 white/green cable routing



IDA EVA Operations









US EVA #37 – TTCR Restow EVA

- > TTCR Restow EVA completed Thursday, September 1, 2016
- > EV1: Jeff Williams, EV2: Kate Rubins
- PET : 6:48
- Performed Tasks:
 - Perform retraction of TTCR, cinch, and install shroud.
 - Perform tightening of Port AJIS struts 3, 2, and 1.
 - Perform installation of EHDC on CP09 ETVCG.
 - Perform CP09 luminaire R&R.
 - Perform imagery of port SARJ at cover #17 location
 - PFCS MLI fold and stow
- Get Ahead Tasks Completed:
 - Perform installation of EHDC on CP08
 - Port CETA Cart Brake Handle Tieback









Increment 50 EVA Plan

- > 2 planned EVAs
 - Up to 4 contingency
 - EVA 1
 - 3A battery replace
 - EVA 2
 - 1A battery replace



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olor key:	IEA	A Worksit	e EP Worksite									
PET	PET 0:00		1:00	2:00		3:00		4:00	5:00		6:00	
EV1	[1	1 Egress (0:15)	Worksite Prep (0:55)	Retrieve AP A / AP B (0:35)	Install AP A (0:45)	Relocate Battery 4 (0:35)	Install AP B (0:20)	Relocate Battery 2 (0:45)	Retrieve/Install AP C (1:00)	1A Battery Prep/Cleanup (0:40)	Ingress (0:30)	[12]
EV2	[1	1 Egress (0:15)	Worksite Prep (0:55)	Retrieve AP A / AP B (0:35)	Install AP A (0:45)	Relocate Battery 4 (0:35)	Install AP B (0:20)	Relocate Battery 2 (0:45)	Retrieve/Install AP C (1:00)	1A Battery Prep/Cleanup (0:40)	Ingress (0:30)	[12]
	E	V1:	EV2:		•				•			-
	[1] Post Depress (0:05) [1] Post Depress (0:05)											
	[1	2] Pre R	epress (0:05) [12] Pre Repr	ess (0:05)								

HTV6 S4 Battery R&R = FVA 1 (lanuary)

HTV6 S4 Battery R&R - EVA 2 (January)

olor key:	IEA Worksit	e EP Worksite									
PET	0:00	1:00		2:00	3:00		4:00	5:00		6:00	
EV1	[1 Egress (0:15)	Worksite Prep (0:55)	Retrieve AP E / AP F (0:35)	Install AP F (0:45)	Relocate Battery 4 (0:35)	Install AP E (0:20)	Retrieve/Install AP D (1:00)	Cleanup (0:40)	Get Ahead (0:45)	Ingress (0:30)	[12
EV2	[1 Egress (0:15)	Worksite Prep (0:55)	Retrieve AP E / AP F (0:35)	Install AP F (0:45)	Relocate Battery 4 (0:35)	Install AP E (0:20)	Retrieve/Install AP D (1:00)	Cleanup (0:40)	Get Ahead (0:45)	Ingress (0:30)	[12
	EV1:	EV2:									
	[1] Post Depress (0:05) [1] Post Depress (0:05)										
	[12] Pre R	epress (0:05) [12] Pre Repr	ress (0:05)								

EVA activities have been significantly supplemented by a tremendous amount of robotic activity to reduce the number of EVA's

Inc 49-50 Utilization Crew Time







ISS Research Statistics

Number of Investigations for 49/50: 304*

- Record 44.03 avg hours/week of utilization in Inc 47/48
- 120 NASA/U.S.-led investigations
- 184 International-led investigations
- 89 New investigations
 - 2 CSA
 - 11 ESA
 - 11 JAXA
 - 59 NASA/U.S.
 - 6 Roscosmos (Preliminary Data)
- Over 800 Investigators represented
- Over 1300 scientific results publications (Exp 0 – present)



Expeditions 49/50 Research and Technology Investigations

Estimated Number of Investigations Expedition 0-50: 2276**

*Working data as of Aug 31, 2016 **Pending Post Increment Adjustments



Featured Investigation

Functional Immune research

- HRP investigation planned for Expeditions 39 52 is a comprehensive examination of previously uninvestigated immune system areas such as the presence of inflammation, physiological stresses, latent viral reactivation as well as the immune system cellular responses and the response to a particular pathogen.
- Previous research has shown crew members experience alterations in their immune systems during spaceflight, but this investigation is the first to examine unique immune-related changes, such as the distribution of white blood cells, particular aspects of innate immunity and reactivation of latent viruses.
- Pre-flight, in-flight and post-flight blood, urine and saliva samples are collected from 10 crewmembers. Frozen blood, urine, and saliva samples are stored in the MELFI freezer for return to the PI. Health Questionnaires are completed using the Data Collection Tool (DCT) and downlinked to the ground.



Information obtained can be used to assess the need for immune countermeasures to maintain and protect crew health on deep space missions. And for Earth applications provides a unique view of the subtle changes in the immune system that may occur before symptoms present which may help scientists pinpoint the onset of illness, and suggest monitoring strategies, or treatments, that can boost the immune system and prevent full-blown infections and diseases



Oxygen Generation Assembly Status

- The installed OGA showed indications of a potential voltage degradation and as a precaution was shut down on 10/28
- The crew installed the onboard spare on 11/9 and the OGA was successfully activated
- Additional spare parts will be flown on the Progress launching Dec 1, and a full spare on the next Orbital/ATK launch.





Additional ISS Vehicle Issues

lssue	Impact to Stage Ops	Rationale
UPA Conductivity	No	 On 4/27/2016 UPA distillate conductivity began fluctuating during process runs. Elevated and erratic conductivity during process runs continue. Proximate cause is under investigation. Analysis of samples returned to ground have identified pretreated urine in Purge Distillate line. Pretreated urine can enter purge distillate from either the Distillation Assembly (DA) or the Fluids Pump (FCPA). On-orbit troubleshooting is ongoing to isolate source of contamination. Accomplished by isolating FCPA from purge line and evaluating effect on distillate conductivity During troubleshooting activity, the Purge Pump (PCPA) failed due to nominal end-of-life condition (ruptured peristaltic tubing). PCPA was replaced on GMT 302 (10/28) to support continued UPA troubleshooting
MERLIN-3 Failure	No	 On GMT 209 (7/27), MERLIN-3 Health and Status was lost with an associated power drop. MERLIN-3 was power cycled as well as Locker 6 on ER-1 with no recovery. Science was relocated to MERLIN-1 (allocated to the Galley at that time). Science was later moved out of MERLIN-1, and it has been returned to Galley use. Additional troubleshooting on GMT 218 (8/5) was unsuccessful. LEDs never illuminated. MERLIN-3 was returned on SpX-9 and the failure has been identified as a failed disk on chip. It has been replaced and the unit will under go functional testing next. Spare MERLIN unit is being prepared for launch on SpX-10.



OA-5 Antares Return to Flight Mission



OA-5 rollout on 10/13/16 and launch on 10/17/16





OA-5 Mission Status

- Mission Planning
 - Antares Flight Readiness Certification Review (FRCR) was conducted on 9/23/16
 - Launch Vehicle Assessment (LVA) Part 3 and Stage Operations Readiness Review (SORR) closeout was conducted on 9/30/16
 - NASA Flight Readiness Review (FRR) was conducted on 10/3/16
 - Cargo Delivery Milestone Part 1 conducted 10/27/16
 - Launch on 10/17/16, Berthed on 10/23/16, Un-berth planned for 11/21/16
- Pressurized Cargo 2342 kg planned; 1265 kg disposal estimated
 - Saffire #2 payload was integrated into Cygnus on 5/12/16; this is a post-unberth experiment
- Unpressurized Cargo 83 kg planned
 - NanoRacks CubeSat Deploy (NRCSD) for deploy above post unberth
- Cygnus Status (S.S. Alan Poindexter)
 - Cygnus Service Module (SM) and Pressurized Cargo Module (PCM) were mated on 6/2/16
 - Due to SpX launch slip, team completed a cargo priority swapout on 9/19/16
 - $^\circ~$ Mated to Antares on 10/10/16; berthed to ISS and ingress on 10/23/16
- Antares Status (0000.7 Core/E4A & E5A)
 - This was the first flight of the new Antares 230 Core and engines as well as the first successful flight of the upgraded Castor 30XL (Second Stage) engine (first use of Castor 30XL was during Orb-3 mission anomaly); initial reports indicate good performance on both stages
 - Rollout to pad occurred on 10/13/16 with successful launch on 10/17/16





SpaceX Falcon Anomaly Status

- During pre-launch static fire operations for Falcon-9 AMOS-6 (F9-29), an anomaly occurred around the second stage that resulted in loss of the vehicle and payload in an explosion on the pad at Space Launch Complex (SLC)-40
 - Initial indications are that the anomaly initiated around the upper stage liquid oxygen tank
 - Anomaly propagation time was about 35-55 milliseconds
- SpaceX began its investigation immediately after the loss, consistent with accident investigation plans prepared for such a contingency
 - An Accident Investigation Team (AIT) was assembled with oversight from the FAA and participation from NASA, the USAF, and NTSB
 - The anomaly investigation team is currently performing testing in Texas and working through the fault tree
 - Leading suspicion is an issue in the cryogenic helium system in the second stage liquid oxygen tank
- ► Damage to SLC-40 from the explosion is extensive
 - SpaceX is focusing on accelerating the readiness of pad 39A at KSC in order to resume F9 launches as early as November 2016





HTV6 Mission Status



6 Batteries loaded on the Exposed Pallet (EP) and the Pallet loaded into the Unpressurized Logistics Carrier (ULC)





HTV6 Mission Status

- Mission Planning
 - ISS Post Qualification Review (PQR) was completed on 10/7/16
 - Delta ISS End-to-End test using MCC 21 Av 1.2 was conducted
 - Final/Long Simulation is currently planned for 11/10/16
 - Stage Operations Readiness Review (SORR) is currently planned for
- Pressurized Cargo planned 2750 kg upmass and 2040 kg
 - Completed Pressurized Logistics Carrier (PLC) nominal cargo loading on the second secon
- External Cargo planned 1400 kg and 1000 kg disposal
 - Delta HTV/Exposed Pallet (EP) Phase III SRP, completed 6/1/16
 - All Li-Ion batteries were installed to the EP as of 6/3/16 and charged as of 6/10/16
 - EP installation to the Unpressurized Logistics Carrier (ULC) completed on 6/16/16
- HTV Vehicle
 - Re-mating of Avionics Module, Propulsion Module, and the Carrier Assembly (PLC and ULC) was completed on 9/11/16
 - Launch vehicle (H-IIB) handover is planned for 11/16/16 with fairing capsulation on 11/18/16



Commercial Resupply Services CRS-2 Status

- CRS-2 Contract award was announced on January 14, 2016
 - Awardees are Orbital-ATK Inc. (OA), Sierra Nevada Corporation (SNC) and SpaceX (SpX)
 - ISS Integration work has been ordered for each provider as of 6/3/16; there are seven integration milestones required to be completed prior to 1st vehicle launch
 - A minimum of six missions will be ordered from each provider
- ISS Integration Milestones #1 Kickoff and #2 System Requirements Review
 - OA, SNC, and SPX completed both Integration Review (IR) #1 and IR #2 milestones
- ISS Integration Milestone #3 Preliminary Design level review
 - OA IR #3 milestone is completed
 - SNC and SpX IR #3 milestones are both on schedule for completion





ISS National Laboratory / CASIS

> Increased sustained cooperation and multi-year funding with Other Government Agencies to do research:

- NSF selected 5 projects for the ISS-NL, providing \$1.5M grant funding for the projects. This will become an annual sponsored program valued over \$1M per year.
- NIH-National Center for Advancing Translational Sciences (NCATS) is providing grant funding focused on human physiology and disease onboard the ISS-NL. This is a four-year collaboration through which NCATS will provide up to \$12 million in funding to use tissue chip technology for translational research onboard the ISS National Laboratory for the benefit of human health on Earth.
- Corporate sponsorships also complement these partnerships, bringing the FY16 total for external funding of ISS-NL research competitions to more than \$6M.

Increased R&D in orbit—and success of ISS-NL projects

- As commercial vehicles resumed spaceflight in 2016, **58 ISS-NL payloads were delivered in FY16** to the International Space Station.
- CASIS consistently requested over 50% of the US allocation for ISS-NL projects in FY16.
- To date, CASIS-sponsored projects have led to 29 academic journal publications.

▶ ISS-NL CASIS project pipelines continues to attract and enable non-traditional space customers

- Of the 34 projects selected for ISS-NL during FY16, almost half are new to space customers.
- More than 50% of FY16-selected projects are from commercial users.
- The number of new commercial service providers for the ISS-NL continues to grow (up from 1 in 2012; 4 now on station; 8 expected by FY18)

New capabilities onboard the ISS-NL the past 12 months

- Commercially developed protein crystallization plate.
- Commercial additive manufacturing capability on ISS enables new pathways to on-orbit production.
- Multi-Lab, a general-purpose research platform for commercial, academic and government use.
- DNA sequencing technologies, which allow in-orbit gene expression analysis for the first time (allowing real-time experimental modifications).
- External platform, allowing small payload exposure to the external space environment without EVA.

ISS-NL/CASIS Investor network increased to 33 investors; CASIS facilitated over 70 introductions between start-up companies and the investor network



Kate Rubins; October 4 2016 Hurricane Matthew