



# NAC: International Space Station Program Status

April 2014  
Michael T. Suffredini  
Manager, ISS Program







# 38 Soyuz Launch/Expedition 39 March - September 2014



**38 Soyuz Crew**

**Alexander Skvortsov, Soyuz Commander**  
**Oleg Artemiev, Flight Engineer**  
**Steve Swanson, Flight Engineer**



**Vehicle:** 38 Soyuz

**Launch:** March 25, 2014; 4:14 pm CDT (with 4 orbit rendezvous)

**Docking:** March 25, 2014; 10:14 pm CDT

**Undock/Landing:** September 11, 2014



**38 Soyuz crew will join 37 Soyuz crew already on orbit**

**Mikhail Tyurin, Soyuz Commander**  
**Koichi Wakata, Flight Engineer**  
**Rick Mastracchio, Flight Engineer**

**Vehicle:** 37 Soyuz

**Launch/Docking:** November 6, 2013

**Undock/Landing:** May 14 2014



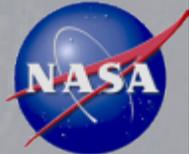
# Expedition 39 Objectives

## (March 2014 – May 2014)

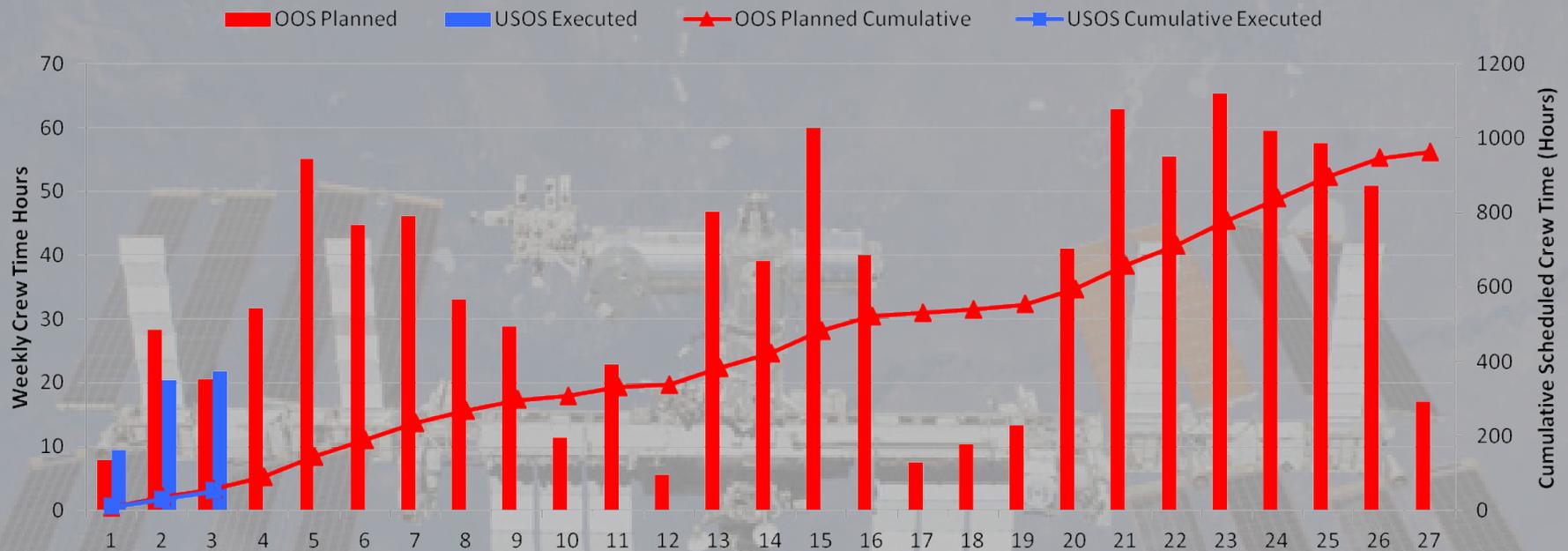


Perform an average of 39.4 hrs/week for payload investigations. New investigations include:

- **Hybrid Training** - *Will use electrodes on the arms to stimulate muscles to work against each other and load the bones while exercising to reduce muscle atrophy and bone loss during long space missions. The apparatus, similar to what chiropractors use on Earth, will be placed on one arm so doctors can compare regular exercise against exercise plus electrostimulation.*
  - **FASTER (Facility for Absorption and Surface Tension)** - *investigates how surfactants (surface acting agents that reduce the surface tension of water) will affect the physical chemistry properties and emulsion stability of droplet interfaces.*
  - **T-Cell Activation in Aging** - *Seeks the cause of a depression in the human immune system while in microgravity. T-cells, a type of white cell, are coated with chemical receptors that must trigger together to activate the body's immune system properly. T-cells from flight crews and ground volunteers in a range of ages are analyzed to determine changes in protein production and gene response on the ground and in microgravity.*
  - **Cell Mechanosensing** - *Will identify gravity sensors in skeletal muscle cells and help develop countermeasures to muscle atrophy, a key space health issue. Scientists believe that the lack of mechanical stress from gravity causes tension fluctuations in the plasma membrane of skeletal muscle cells, in turn changing the expression of key proteins and genes and allowing muscles to atrophy.*
  - **Gravi 2 (Threshold Acceleration for Gravisensing – 2)** - *Grows lentil seedling roots under various gravity conditions on board the International Space Station (ISS) to determine the amount of acceleration force sufficient to stimulate the direction of root growth.*
  - **OPALS (Optical Payload for Lasercomm Science)** - *will demonstrate and test optical communications technologies by transferring video data from the OPALS hardware on the ISS to a ground. Optical communication is an emerging technology where the data is modulated onto laser beams, which offers the promise of much higher data rates than what is achievable with radio-frequency (RF) transmissions.*
- Support planned visiting vehicle traffic:
    - 38S Launch, March 25
    - 38S Dock, March 25
    - 54P Unberth, April 7
    - 55P Launch & Dock, April 9
    - SpX-3 Launch, April 14
    - SpX-3 Berth, April 16
    - 53P Unberth for KURS-NA test, April 23
    - 53P Reberth, April 25
    - Orb-2 Launch, May 6
    - Orb-2 Berth, May 9
      - Note: Orb-2 launch/berth will move to June if SpX-3 launches in April
    - 37S Undock, May 13
  - Significant tasks:
    - National Geographic “Live from Space” event. (completed March)
    - X2R12.1 transition (completed March)
    - Install HDEV and OPALS (external payloads from SpaceX-3)
    - 53P KURS-NA test
    - SMILES relocate (JEM Exposed Pallet using JEM RMS)



# Inc 39 - 40 Utilization Crew Time



**Color Key:**  
 Completed (Blue)  
 Final OOS (Red)  
 FPIP Plan (Black)

3-Crew	6-Crew		3-Crew	6-Crew			
Increment 39			Increment 40				
Mar	Apr		May	June	July	Aug	Sep

Berth 03/18/14  
 Berth 04/12/14 \$&DEFG\$ Unberth TBD  
 Berth 05/04/14  
 Berth 05/09/14  
 Unberth 06/13/14  
 Unberth 06/15/14  
 Dock 07/03/14  
 Berth 07/27/14  
 Berth 08/10/14  
 Unberth 08/26/14  
 Unberth 09/07/14  
 Dock 08/12/14

OC/OZ reconciliation is completed as of Week 3

Executed through Increment Wk (WLP Week) 3 =	2.8	of 24.8 work weeks (11.29% through the Increment)
USOS IDR Allocation:	960.5	hours
OOS USOS Planned Total:	963.58	hours
USOS Actuals:	51.58	hours
	5.37%	through IDR Allocation
	5.35%	through OOS Planned Total
Total USOS Average Per Work Week:	18.42	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)

Pre-Decisional, For Internal Use Only



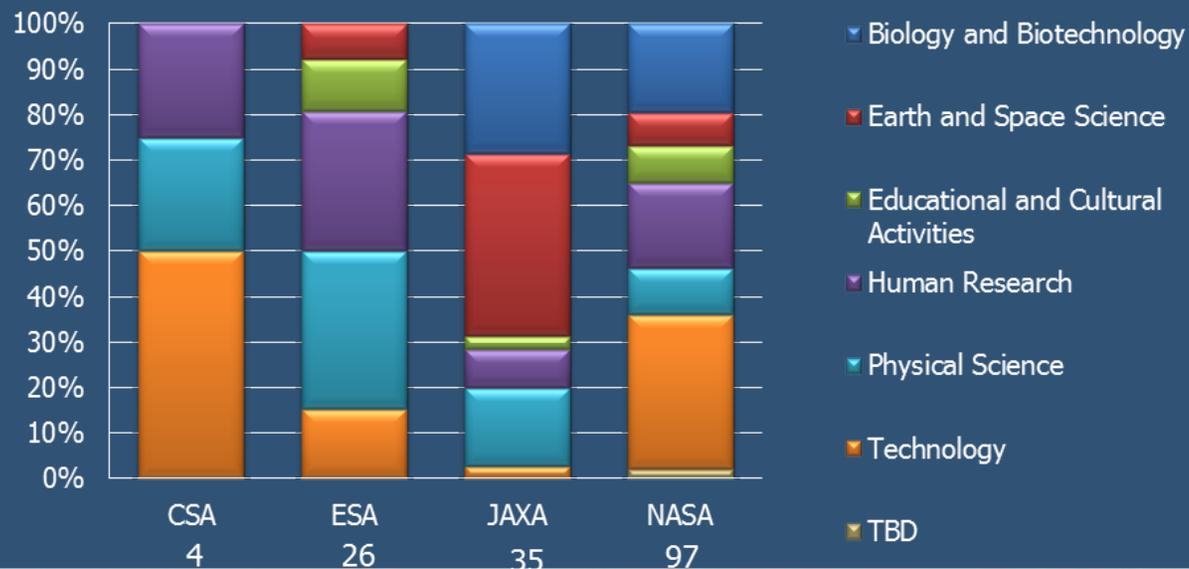
# ISS Research Statistics

## Working data as of January 31, 2014

**Number of ISS Investigations for 39/40 : 162**

- 97 NASA/U.S.-led investigations
  - 65 International-led investigations
  - 57 new investigations
    - 0 CSA
    - 14 ESA
    - 7 JAXA
    - 36 NASA/U.S.
- Roscosmos data in work*
- Over 600 Investigators represented
  - Over 700 scientific results publications (Exp 0 - present)

**Expeditions 39/40  
Research and Technology Investigations**

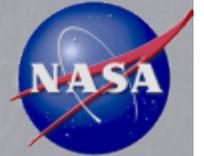


**Number of Investigations Expedition 0-34: 1502\***

*\*Expeditions 0-34 MCB approved  
Sept 2013*



# Total ISS Consumables Status



Consumable – based on current, ISS system status	T1: Current Capability		T2: Current Capability plus SpX3	
	Date to Reserve Level	Date to zero supplies	Date to Reserve Level	Date to zero supplies
Food – 100%	May 28, 2014	July 13, 2014	June 26, 2014	August 10, 2014
KTO	January 8, 2015	February 22, 2015	January 8, 2015	February 22, 2015
Filter Inserts	March 2, 2015	April 26, 2015	March 2, 2015	April 26, 2015
Toilet (ACY) Inserts	July 28, 2015	September 11, 2015	July 28, 2015	September 11, 2015
EDV (UPA Operable)	October 31, 2014	January 15, 2015	October 31, 2014	January 15, 2015
Consumable - based on system failure				
EDV (UPA Failed)	August 22, 2014	October 13, 2014	August 22, 2014	October 13, 2014
Water, if no WPA (Ag & Iodinated)	August 20, 2014	October 11, 2014	August 20, 2014	October 11, 2014
O <sub>2</sub> if Elektron supporting 3 crew & no OGA	June 14, 2014	October 23, 2014	June 14, 2014	October 23, 2014
O <sub>2</sub> if neither Elektron or OGA	April 3, 2014	June 9, 2014	April 3, 2014	June 9, 2014
LiOH (CDRAs and Vozdukh off)	#!%"&'("	#!%"&'("	#!%"&'("	#!%"&'("



# USOS Consumables Status



Consumable – based on current, ISS system status	U1: Current Capability		U2: Current Capability plus SpX3	
	Date to Reserve Level	Date to zero supplies	Date to Reserve Level	Date to zero supplies
Food – 100%	June 10, 2014	July 25, 2014	August 6, 2014	September 24, 2014
KTO	April 10, 2015	June 7, 2015	April 10, 2015	June 7, 2015
Filter Inserts	June 25, 2015	August 9, 2015	June 25, 2015	August 9, 2015
Toilet (ACY) Inserts	April 15, 2016	June 10, 2016	April 15, 2016	June 10, 2016
EDV (UPA Operable)	September 22, 2014	April 3, 2015	September 22, 2014	April 3, 2015
Utilization		August 14, 2014		October 3, 2014
Consumable - based on system failure				
EDV (UPA Failed)	April 8, 2014	June 2, 2014	April 8, 2014	June 2, 2014
Water, if no WPA (Ag & Iodinated)	September 23, 2014	December 28, 2014	September 23, 2014	December 28, 2014
O <sub>2</sub> if neither Elektron or OGA	April 6, 2014	June 27, 2014	April 6, 2014	June 27, 2014
LiOH (CDRAs and Vozdukh off)	~0 Days	~13.3 Days	~0 Days	~13.3 Days



# Pertinent ISS Vehicle Issues

Issue	Impact to Stage Ops	Rationale
Node 3 CDRA dP issue	Yes	High dP across bed 201 •Bed cleaned with new on orbit procedure •Amine Swingbed activated
RPCM LAD62B-A, RPC 12 Trip (Lab CDRA Valves)	No	Tripped on 4/1 due to overcurrent condition. •No moisture found during CDRA inspection on 4/4 •RPC closed on 4/4 and has remained closed •ABIT test conducted with good valve movement on all six valves and 2 half cycles successfully run. •Lab CDRA available as needed.
RPCM LAP51A4A-A, RPC 18 Trip (UOP-7: Lab RWS DCP and Lab PCS)	No	Tripped on 3/17, suspected FET Control Hybrid Issue. •Redundant RWS is launch commit criteria for SpX-3. •DCP and Lab PCS being powered from alternate locations for near term •RPCM pin “jumpers” being flown for long term RPCM fix. Ready for flight in April.



# Pertinent ISS Vehicle Issues (cont.)



Issue	Impact to Stage Ops	Rationale
RPCM LA2B-G, RPC 1 Trip (Lab MTL Regen TWMV)	No	Tripped on 4/1, suspected FET Control Hybrid Issue. •Lab ITCS was reconfigured to dual and the crew manually configured the Regen TWMV to full bypass to assist with ITCS temperature control •RPC was closed and has remained closed since 4/2. •Lab ITCS returned to single LT on 4/4.
RPCM LAS62B-A, RPC 7 Trip (Lab MTL NIA Vent Valve)	No	Tripped on 4/1, suspected FET Control Hybrid Issue. •Crew manipulation of the valve would be needed if a depress of the Lab MTL ITCS loop is required in response to an ITCS leak. •RPC was closed and has remained closed since 4/5.
Audio System PBIT Errors	No	Have received multiple PBITs on bus B of several audio ORUs as well as several IAC transitions since 2/12/14 •COL ATU-2 R&Red on 3/21. No IAC transitions have occurred since. PBITs have continued intermittently. •Audio testing on 4/5 show that Audio Bus B is non-functional with I/O enabled to COL ATU-2. •I/O to COL ATU-2 now being nominally inhibited •MART scheduled for 4/9.



# Pertinent ISS Vehicle Issues (cont.)



Issue	Impact to Stage Ops	Rationale
KU Fwd Link Dropouts	No	<p>KU Band has experienced intermittent drops of the forward link since May '13.</p> <ul style="list-style-type: none"><li>•Workaround procedure to disconnect/reconnect KU.</li><li>•Dropouts results in brief impact to S/G3 &amp; S/G4 audio and Orbital Communications Adapter (OCA) data.</li><li>•Forward link rate reduction testing during 3 crew period did not prevent drop outs.</li><li>•Next troubleshooting steps will be discussed at FIT on 4/8.</li></ul>
JEM ITCS Pump Shutdown	No	<p>JEM LTL had pump shutdown due to RPC trip from an overcurrent event. Suspected to be due to same condensation issue that failed the same pump in March 2012.</p> <ul style="list-style-type: none"><li>•No on-orbit spare. Earliest spare to launch summer 2014.</li><li>•LAB1PD1 RFCA configured to LT to support contingency relocation of MELFI from JEM to Lab if needed.</li></ul>



# EVA Suit Investigation Status

- Fan pump separator returned from 3011 in December 2013, clogged drums holes, cause of water in the suit issue (silica agglomeration)
- Ion exchange beds additionally returned, completely saturated, and had affinity to silica
  - All suits exposed via numerous ALCLR runs
- New exchange Ion beds developed to clean up water, to be launched on Orb-1
  - Post processing, significant corrosion encountered on ion bed cartridges (noticed during packing 6 days after being processed for flight)
  - JSC Bldg 7 water quality of Ion bed processing not up to Di quality water (post test constituents reflected basically Clear Lake City tap water)
- New processes put in place to produce clean Ion exchange beds (charcoal cleansing/rinse, water quality monitored continuously)
  - 2 New beds flown on 38S (late March), 2 more on SpaceX-3, 4 on Orb-2
- Based on water samples returned on 36S (mid March), determination made to flush (3 times) the EMU suits and the airlock water loops, concern is to reduce colloidal silica presently in the loop
  - This is in work, 12L of water to be returned on SpaceX-3 (along with several bad Ion Exchange beds), refill of EMU and Airlock loops using WPA water (significant compatibility testing)
  - Goal is to determine amount of colloidal silica in the water and check for any corrosive effects (low pH) to onboard systems due to contaminated Ion Exchange beds
- New Ion Exchange beds will be incorporated into the loops and then new fan pump separators will be put into suits 3010 and 3005 post water flush (3011 FPS R&R'd in December) – additional FPS to be flown on Orb-2
- New 3003 suit to be flown on SpaceX-3 and suit 3015 returned (sublimator issue)
- Return of hardware and water on SpaceX-3 is key in determining success of water cleanup activity and narrow probable cause to root cause of the initial suit failure
  - Will guide any follow on water cleanup activity
- ISS Program has aggressively been working this issue and close out of EVA MIB report actions prior to declaring readiness for planned EVA capability



# External MDM R&R Plans

- On Friday, during normal power up and loading of PPL's, EXT MDM-2 did not boot properly
  - Power draw was around 35W compared to normal 50 W
  - Numerous re-attempts to bring MDM online unsuccessful, declared failed
  - Spare MDM onboard
  - EXT MDM-1 is healthy and provides complete redundancy to Ext MDM-2 (i.e, no loss of functionality on ISS)
  - Next worst case failure team assessed impacts of losing functionality of EXT MDM-1
    - SARJ plan in place to support power loads, docking loads
    - E TCS will continue to operate nominally from lower tiered MDM, TRRJ's locked in position
    - Additional system configurations made to enhance redundancy (SSRMS hot backup, 2<sup>nd</sup> S-band string powered up, CMG MDM control switched
    - MT moved to provide access to EXT MDM -2 location on S0
    - Team has good understanding of next worst case failure and concurs with launch and berthing of SpaceX-3 in this configuration
    - Ext MDM was part of Big 13, significant pre-work completed to perform R&R
- Spare MDM to be configured to support R&R
  - Software loads, testing being performed on ground in preps for software load, application of cotherm to box for passive thermal control
- Plans for EVA in work to R&R the EXT-2 MDM
  - NET April 22<sup>nd</sup>
  - R&R FPS on 3005 (in work today), perform checkouts
  - Continue with flushes of loops and EMUs (to be finished tomorrow)
  - EVA to be conducted with EMUs 3005 and 3011 (Swanson, Mastracchio )



# Orbital-1 Mission



- Cygnus Status
  - All ascent cargo was successfully transferred to ISS (1462 kg)
  - Trash loading complete at 1477 kg
  
- Mission Status
  - Orb-1 successfully launched on 1/9/14 and berthed to ISS on 1/12/14
  - Unberth was successful on 2/18/14
  - The vehicle conducted four Detailed Test Objectives to further characterize spacecraft performance during free-flyer operations
  - Two burns occurred to put Cygnus into a “half racetrack” before setting the spacecraft up for destructive re-entry. The re-entry burn was successful on 2/19/14
  - Post Flight Review was conducted on 3/4/14
  - All mission objectives and mission success criteria were met; no anomalies
  
- Antares Status
  - Performance was nominal and injected Cygnus into orbit



Cygnus berthed to ISS on 1/12



Cygnus trash loading underway and preparing for unberth and destructive re-entry

Photo Credits: Orbital & NASA



# SpaceX-3 Mission Status



## ➤ Mission Planning

- Launch upmass total is 2025 kg
- Returning pressurized downmass is 1492 kg

## ➤ Pressurized cargo

- Launch: 1 GLACIER ; Micro-7 and Biotube Micro; 2 MERLINS, 5 Cold Bags, T-Cell experiment used to test the immune system and Short Extravehicular Mobility Unit (SEMU)
- Return: 2 GLACIERs ; Micro-7 and Biotube Micro Experiments, and 5 Cold Bags

## ➤ External Cargo

- High Definition Earth Viewing (HDEV) Camera on NASA Columbus External Payloads Adapter (CEPA)
- Optical PAYload for Lasercomm Science (OPALS) on SpX Express Payload Adapter (ExPA) (first use of SpX built ExPA)
- Poly-Picosatellite Orbital Deployer (P-POD) is secondary payload
- Potential contamination issue resolved for this flight, material modifications for follow on trunk development

## ➤ Dragon/F9v1.1 Status

- Stage Operations Readiness Review (SORR) conducted on 2/27
- Nominal pressurized cargo was received by SpX on 2/7 and loaded into the vehicle on 2/8
- SpX led Flight Readiness Review (FRR) was conducted on 3/5
- Dragon mate to Falcon was completed on 3/5
- Static fire was successfully completed on 3/8
- SpX led Launch Readiness Review (LRR) is planned for 4/11

## ➤ Completed SpX-3 milestones

- Authority To Proceed
- Vehicle Baseline Review
- External Cargo Baseline
- FRAM LON
- Mission Integration Review
- External Integration Review
- Cargo Integration Review



Falcon 9 v1.1 with landing legs installed

Photo Credits: SpaceX



# Road to SpaceX-3 Mission



- Mission
  - Final Safety Review Panel (SRP) Phase III completed on 2/11/14
  - Joint SW Stage Testing is complete; end-to-end test was conducted on 2/15/14
- Dragon Status
  - Nominal pressurized cargo load was completed on 2/7/14 with late load cargo completed at L-3 days (unpowered) and L-24 hours (powered)
  - Dragon was mated to F9 on 3/5/14
- Falcon 9v1.1 (F9-9) Status
  - Second Stage mate to First Stage was completed on 3/1/14
  - Static fire was completed on 3/8/14
  - Currently mated to Dragon and in horizontal configuration awaiting next launch attempt
- Launch Readiness Milestones
  - ISS SORR was completed on 2/27/14
  - SpaceX FRR was completed on 3/5/14 and SpaceX LRR is planned for 4/11/14 at the Cape
  - SpaceX launch NET readiness 4/14/14; berthing date to ISS is 4/16/14



High Definition Earth Viewing (HDEV) and Optical Payload for Lasercomm Science (OPALS) external payloads loaded into Dragon 5 trunk



# Orbital-2 Mission Status

- Pressurized Cargo complement 1,650 kg / 118 CTBE; 1240 kg for disposal
  - Four passive lockers (including two double cold bags)
- Mission Planning
  - Crew Equipment Interface Test (CEIT) completed on 2/10/14
  - Orb-2 Mission Readiness Review (MRR) completed on 3/19/14
  - Post Qualification Review (PQR) conducted on 3/21/14
  - Orb-2 Safety Review Panel (SRP) Phase III was completed on 3/28/14
  - Stage Operations Readiness Review (SORR) was conducted on 4/10/14
- Cygnus Status
  - Initial cargo loading was completed on 3/31/14
  - Service Module (SM) arrived at WFF on 3/31/14 and was mated to the Pressurized Cargo Module (PCM) on 4/4/14
  - Mate with Antares is scheduled for 4/29/14
  - Late and final cargo load is scheduled for 5/1/14 and 5/3/14
- Antares Status
  - Main Engine System (MES) is mated to Stage 1
  - Stage 1/ Stage 2 integration is completed
  - Fairing halves were delivered to WFF on 3/21/14 and 3/28/14

## ➤ Completed Orb-2 milestones

- Authority To Proceed
  - Long Lead Order Placement
  - Vehicle Baseline Review
  - Service Module Propulsion Sys Manufacturing Readiness Review
  - Mission Integration Review
  - Service Module Integration and Test
  - Receipt of Long Lead Items
  - Cargo Integration Review
- ## ➤ Upcoming Milestones
- Launch (May)



SM to PCM mate on  
4/4/14

Photo Credit: Orbital



# SpaceX-4 Mission Status

## ➤ Mission Planning

- Launch upmass total planned is 1790 kg
- Return downmass planned is 1580 kg

## ➤ Pressurized cargo

- Launch: GLACIER, Commercial Generic Bioprocessing Apparatus (CGBA), Animal Enclosure Module Transporter (AEM-T), and 7 Cold Bags
- Return: GLACIER, CGBA, 2 MERLINS and 7 Cold Bags

## ➤ External Cargo

- ISS RapidScat (RapidScat Nadir Adapter and RapidScat Instrument) for installation on Columbus Starboard Deck-X (SDX)
- Materials on ISS Experiment (MISSE) Flight Support Equipment (FSE) is planned for disposal

## ➤ Dragon Status

- Draco thruster installation was completed on 3/20
- AEM Safety Review Panel (SRP) was completed on 3/26
- Trunk avionics installation and checkouts were completed on 4/2
- Capsule to trunk stack is planned for late Apr
- Electromagnetic Interference/Compatibility (EMI/EMC) test is planned for early May
- Cargo Integration Review (CIR) is planned for May

## ➤ F9v1.1 Status

- First Stage Acceptance Test Procedure (ATP) and proof test is scheduled to begin in early Jun 2014
- Second Stage ATP is scheduled to begin in late May 2014
- Interstage, Second Stage, and First Stage receipt at the Cape is scheduled for Jun 2014

## ➤ Completed SpX-4 milestones

- Authority To Proceed
- Vehicle Baseline Review
- FRAM development
- FRAM Manufacturing Review
- Mission Integration Review
- External Integration Review

## ➤ Upcoming Milestones

- Cargo Integration Review (May)

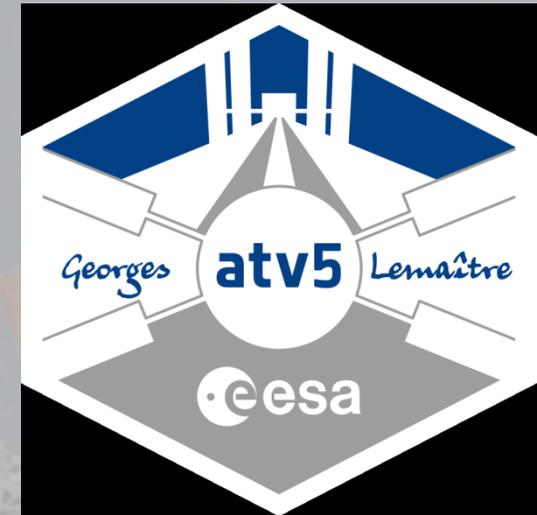


# ATV5 Mission Status



## ATV5: Georges Lemaître Mission Status

- Vehicle processing in Kourou is going well.
- Delta Phase III SRP held early Mar. to review minor Hazard Report updates. A new Hazard Report on the rendezvous experiment hardware (LIRIS) mounted on ATV5 front cone was also reviewed with no issues.
- **Cargo**
  - Nominal cargo load was received at the launch site early
  - Total cargo manifest > 6000 kgs.
- **On-orbit Status**
  - ISS is ready for ATV5 arrival. ATV5 will perform an ISS fly by a few days before docking to allow experimental rendezvous sensors to collect data.



ATV5 integration 17 Mar 2014

Georges Lemaître (ATV5)



Photo Credits: ESA



# ISS Top Program Risk Matrix Post January 23, 2014 PRAB



## Corrective/Preventative Actions

None

## Watch Items

No Watch Items Elevated

## Continual Improvement

None

L I K E L I H O O D

5				2	1
4			2	3	
3		1	3		5
2		1			
1					
	1	2	3	4	5
	C O N S E Q U E N C E				

Low		Medium		High	
C – Cost	S – Schedule	T – Technical	Sa – Safety		
▲ – Top Program Risk (TPR)					
Removed: 6347 - TUBSS, 6032 - On-orbit Stowage, and 6475 - ISS Budget & Schedule					
Rescored: 6439, 6039, and 5184					

## Risks (L x C)

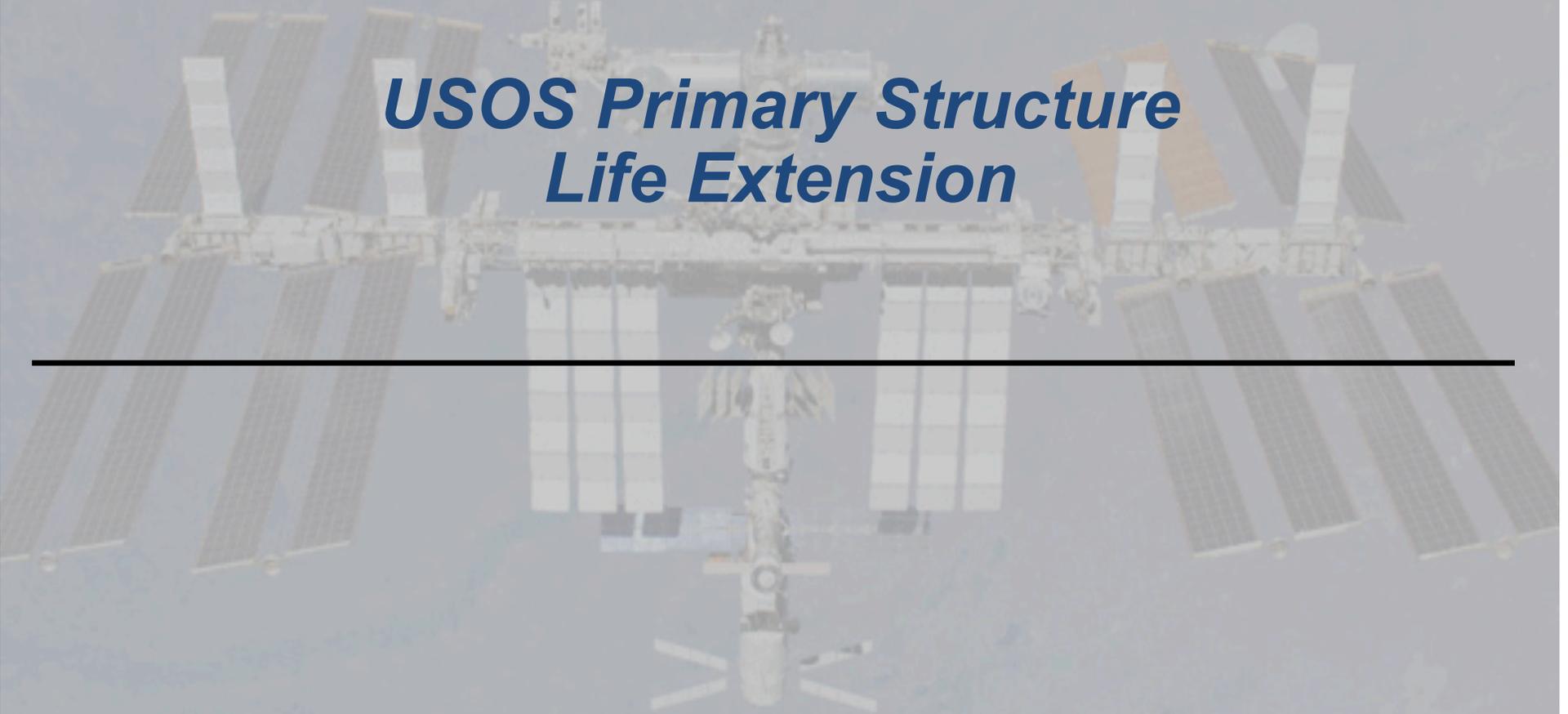
- Score: 5 x 5  
▲ 6352 - Lack of Assured Access to ISS - (OH) - (C,S,T,Sa)
- Score: 5 x 4  
▲ 6370 - ISS Pension Harmonization - (OH) - (C)  
▲ 6344 - ISS Operations Budget Reduction - (OH) - (C)
- Score: 4 x 4  
▲ 6372 - Full ISS Utilization at 3 Crew - Level 1 - (OZ) - (C,S)  
▲ 6169 - Visual Impairment / Intracranial Pressure - (SA) - (C,S,T,Sa)  
▲ 6439 - EPROM Memory Leakage - (OD) - (C,S,T,Sa)
- Score: 3 x 5  
▲ 2810 - Russian Segment (RS) capability to provide adequate MM/OD protection - (OM) - (C,S,T,Sa)  
▲ 5688 - ISS Solar Array Management Operations Controls and Constraints - (OM) - (C,S,T,Sa)  
▲ 6444 - ISS Cascading Power Failure - (OM) - (C,S,T,Sa)  
▲ 6450 - Potential Inability to Support ISS Critical Contingency (& other) EVA Tasks - (XA) - (C,S,T,Sa)  
▲ 6382 - Structural Integrity of Solar Array Wing (SAW) Masts due to MMOD Strikes - (OB) - (S,T,Sa)
- Score: 4 x 3  
▲ 5269 - The Big 13 Contingency EVA's - (OB) - (S,T,Sa)  
▲ 6438 - C2V2 Comm Unit Vendor Misinterpreting ISS Requirements - (OG) - (C,S,T)
- Score: 3 x 3  
▲ 6452 - Lack of Sufficient Sparring for the Ku-Band Space to Ground Transmitter Receiver Controller (SGTRC) to reach 2020 - (OD) - (C,S,T)  
▲ 6420 - NDS Qualification Schedule - (OG) - (C,S,T)  
▲ 6408 - FGB Sustaining Contract and FGB spares plan post 2016 undefined - (OB) - (C,S,T,Sa)
- Score: 3 x 2  
▲ 6039 - Carbon Dioxide Removal Assembly (CDRA) Function - (OB) - (C,T,Sa)
- Score: 2 x 2  
▲ 5184 - USOS Cargo Resupply Services (CRS) Upmass Shortfall - 2010 through 2016 - (ON) - (S,T)



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# ***USOS Primary Structure Life Extension***

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# Summary of Results

	Hardware	Design EOL	LE EOL	
← Phase I	FGB	20-Nov-13	31-Dec-28	
	Node-1	4-Dec-13	31-Dec-28	
	PMA-1/2	4-Dec-13	31-Dec-28	
	PMA-3	15-Oct-15	31-Dec-28	
	CBMs	various	31-Dec-28	
	Hatches	various	31-Dec-28	
	Z1 Truss	15-Oct-15	31-Dec-28	
	P6/Z1 RTAS	15-Oct-15	31-Dec-28	
	P6 LS	3-Dec-15	31-Dec-28	
	P6 IEA	3-Dec-15	31-Dec-20	
Phase I →	P6 IEA FP	3-Dec-15	31-Dec-28	
	P6 SAWs	3-Dec-15	31-Dec-28	
	P6 BGAs	3-Dec-15	31-Dec-28	
	P6 PVRs	3-Dec-15	31-Dec-28	
	US Lab	8-Feb-16	31-Dec-28	
	US Airlock	12-Jul-16	31-Dec-28	
	← Phase II	S0 Truss	8-Apr-17	31-Dec-28
		MTS Struts	8-Apr-17	31-Dec-28
		S1 Truss	7-Oct-17	31-Dec-28
		P1 Truss	26-Nov-17	31-Dec-28
0/1 SSASs		various	31-Dec-28	
S1 TRRJ		7-Oct-17	31-Dec-28	
P1 TRRJ		26-Nov-17	31-Dec-28	
S1 HRS		7-Oct-17	31-Dec-28	
P1 HRS		26-Nov-17	31-Dec-28	
MT		8-Apr-17	31-Dec-28	
ESP-1	8-Mar-16	31-Dec-28		
ESP-2*	26-Jul-20	31-Dec-28		

FGB primary structure is cleared through 2028.

All Phase I & II hardware is cleared for 2028, except the P6 IEA which is cleared for 2020.

Tasks are in-work to attempt to extend the P6 IEA life beyond 2020. Preliminary results are encouraging.

Remaining USOS hardware is cleared for 2020 based on launch date and 15-year design life.

### Key

LE = Life Extension  
 EOL = End Of Life  
 FP = Finplates  
 0/1 = P1/S0/S1

Boeing-sustained hardware only  
 (e.g. not all CBMs & Hatches)

■ = Cleared for 2028  
 ■ = Cleared for 2020

Forward Work	
Hardware	Design EOL
P3,P4	9-Sep-21
P5	3-Dec-21
S3,S4	8-Jun-22
S5	8-Aug-22
ESP-3	8-Aug-22
S6	15-Mar-24
ELC-1	16-Nov-24
ELC-2	16-Nov-24
ELC-4	24-Feb-26
ELC-3	16-May-26

\*ESP-2 UCP not included, Astrium analysis shows good to Dec 2020.



# Projected Event Peak Life Drivers by Hardware



Locations with 4 lives
  Locations with 5 or 6 lives
  Locations not cleared to 2028

Event	Node-1	PMA-1	PMA-2	PMA-3	CBMs	Hatches	Z1 Truss	P6/Z1 RTAS	P6 Long Spacer	P6 IEA	P6 IEA finplates	P6 SAWS	P6 BGAs	P6 PVRs	US Lab	US Airlock	S0 Truss	MTS Struts	S1 Truss	P1 Truss	SSASSs	TRRJJs	HRS Radiators	Mobile Transporter	ESP-1	ESP-2
Pressure Cycles																X										
Thermal Cycles		X	X				X	X	#	X	X	X				X	X		X	X	X	X	X			
Attitude Hold – RS MCS																									X	
Station Maneuver - RS MCS									X			X	X		X		X		X		X		X			
Station Maneuver - USTO					X							X	X		X		X	X	X	X	X		X			
Station Reboost					X							X	X		X		X	X	X	X						
Russian Vehicle / ATV Docking																							X			
EVA - APFR Layback																							X			
EVA - Other																							X			
IVA Pushoff / Landing												X														
Localized EVA / Tooth Crash																			X			X				