National Aeronautics and
Space Administration

HEO NAC May 2020

International Space Station Status

Kirk Shireman
International Space Station Program Manager

Agenda

- ISS Increment Overview
- Exploration Research and Technology
- Utilization Summary
- ISS National Lab Update
- ISS Operational Status
- ISS Future

ISS Increment Overview

Increment 63 Crew

Increment 63 began at Soyuz 61S undock on 4/17/20
and concludes upon Soyuz 62S undock on 10/21/20

Chris Cassidy
(NASA)

Anatoly Ivanishin
(Roscosmos)

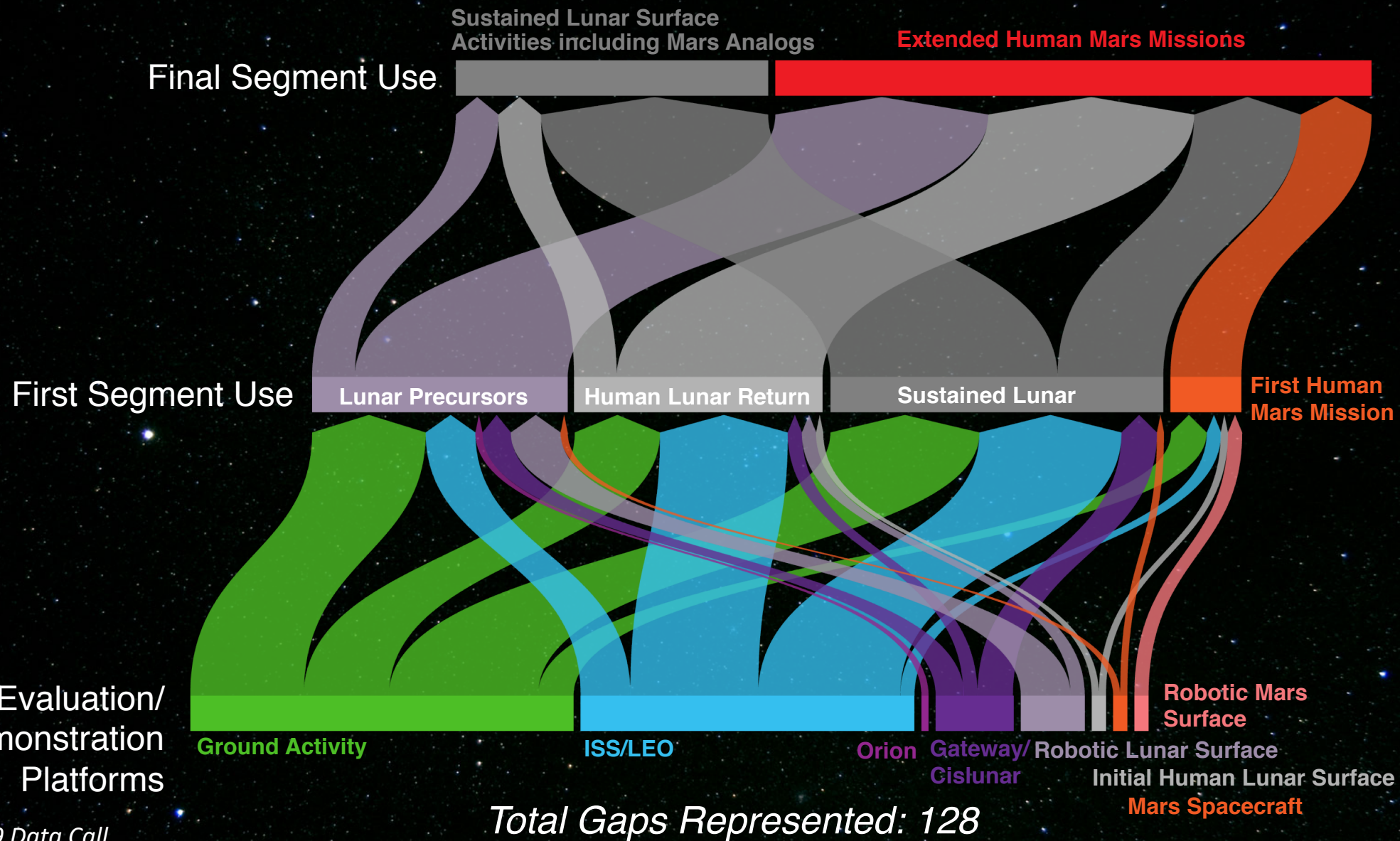
Ivan Vagner
(Roscosmos)

Flight Plan – Increment 63

- 04/17/20 – Inc 62 Ends/Inc 63 Begins/Soyuz 61S Undock and Landing (NASA/Morgan, NASA/Meir, Roscosmos/Skripochka)
- 04/25/20 – Progress 75P Launch and Dock
- 05/11/20 – Northrop Grumman CRS-13 Release
- 05/20/20 – JAXA HII Transfer Vehicle (HTV) 9 Launch (Capture/Berth on 05/25/20)
- 05/27/20 – SpaceX Demo-2 Launch and Dock (NASA/Behnken, NASA/Hurley)
- Jun 2020 – S6 Battery R&R EVAs
- Jun 2020 – Columbus Upgrades EVA
- 07/08/20 – Progress 74P Undock
- 07/20/20 – JAXA HTV9 Release
- 07/23/20 – Progress 76P Launch and Dock
- Sep 2020 – Northrop Grumman CRS-14 Launch and Berthing
- Sep 2020 – USOS EVAs
- NLT Sep 2020 – SpaceX Demo-2 Undock and Landing (NASA/Behnken, NASA/Hurley)
- 10/14/20 – Soyuz 63S Launch and Dock (Crew TBD)
- Oct 2020 – Russian EVA #48
- Fall 2020 – Boeing Orbital Flight Test 2 Launch, Dock, and Return
- Fall 2020 – SpaceX Crew-1 Launch and Dock (NASA/Glover, NASA/Hopkins, NASA/Walker, JAXA/Noguich)i
- 10/21/20 – Inc 63 Ends/Soyuz 62S Undock and Landing (Roscosmos/Ivanishin, Roscosmos/Vagner, NASA/Cassidy)


Exploration Research
and Technology

Technology and Development Capability Gaps



Total Gaps Represented: 128

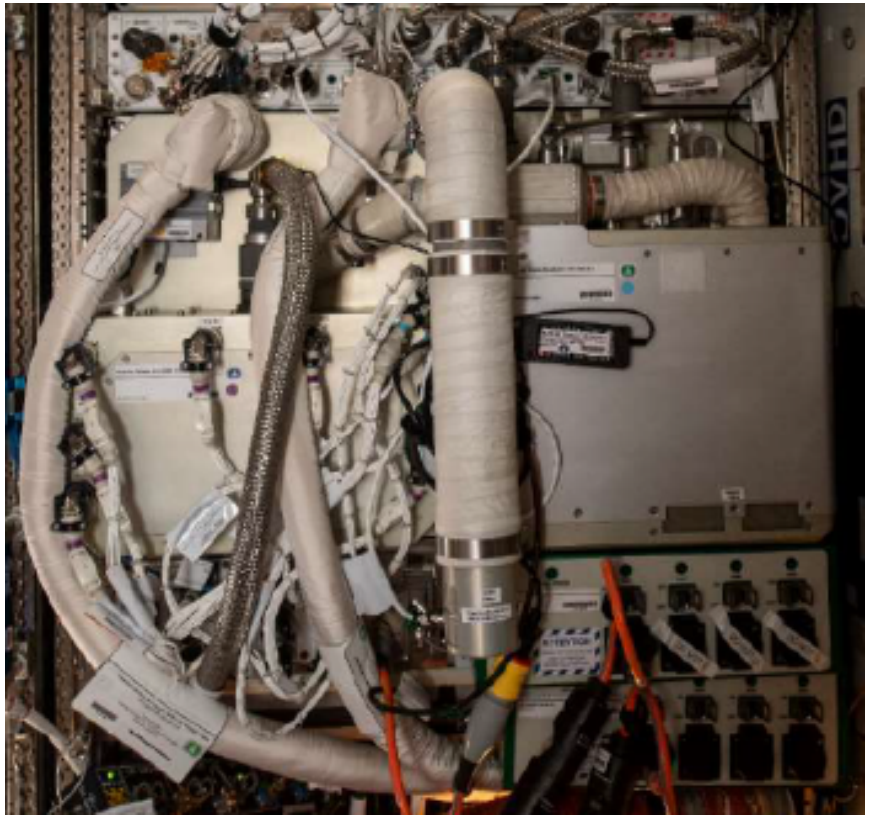
Data from 2019 Data Call
2020 Data Call Planning is Underway

Featured Technology: ECLSS on ISS

Environmental Control and Life Support Systems (ECLSS)

Capability Gap: Highly reliable Carbon Dioxide (CO_2) removal system with performance goal of 2 mmHg ppCO_2

- Thermal Amine Scrubber (TAS) is first of 4 candidate CO_2 removal technologies under development for long-duration exploration missions to be demonstrated on the space station, delivered on NG-11 in April 2019
- Blower failure/rework paused operation from July 2019 until Jan 2020
- Now operating on ISS with projected performance close to target



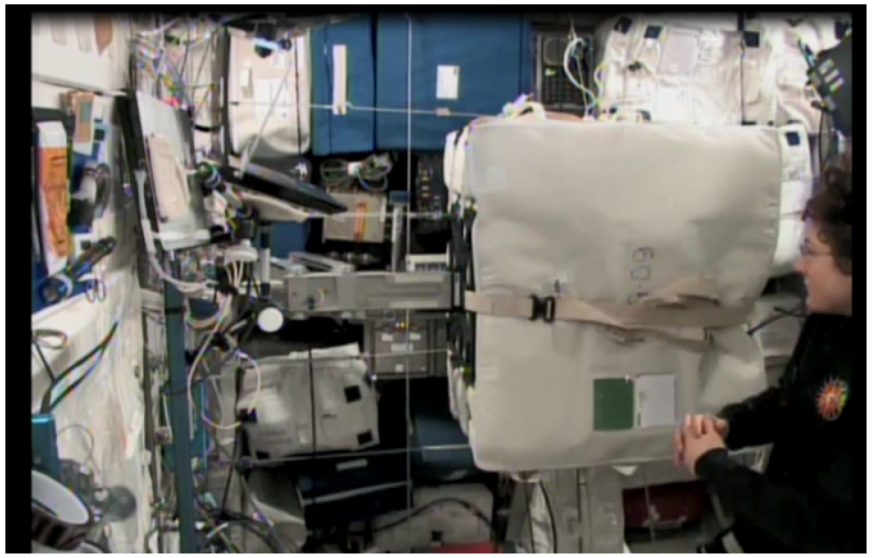
Thermal Amine Scrubber on ISS

Featured Research: HRP Status

Human Research Program (HRP)

HRP ISS Science Highlights:

- High priority science accomplished onboard ISS despite limited crew time due to multiple spacewalks
- Highlights include: Fluid Shifts, Ongoing Food Physiology ops (first subject), final Team Task Switching inflight ops, completion of Veg04B ops with final harvest, and ISSP/SpaceX DTO using HRP Space Linear Acceleration Mass Measurement Device (SLAMMD)



SpaceX SLAMMD Test Objective:

- SpaceX performed a series of tests using an adapter plate they built to weigh the mass of several cargo bags.
- Initial results were positive and discussions are ongoing about potential future operations.

ISS as a Deep Space Analog: We are ready to use higher levels of Mars mission relevance

- Durations
- Isolation and confinement
- Simulating autonomy and communications delay
- Simulating medical response
- Simulating surface operations after a long transit

Using ISS as a Mars Transit Analog

The microgravity environment of ISS is high fidelity for a Mars transit, depending on mission duration.

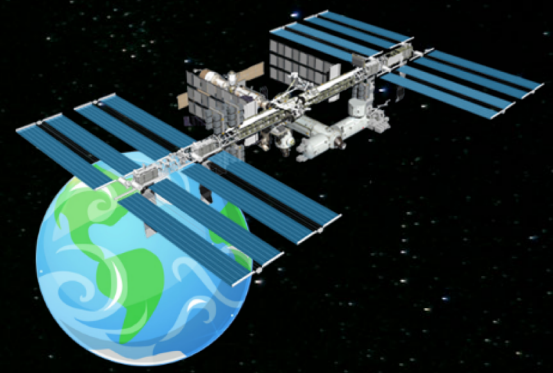
Gravity (or lack thereof)..... **MATCH**

Hostile/Closed Environment..... Atmosphere and environment, variable over time

Radiation..... Radiation differences

Isolation & Confinement.....Too large and active

Distance from Earth.....Too close and connected



Road to Mars

Time Course of Spaceflight Changes I Unknown Risks I Operations and Medical Paradigms

ISS / HRP Accepted Use Cases with Planning Underway

Microgravity Extended Duration:
More 1-year Missions

Distance from Earth / Autonomy:
Medical Event Simulations

Gravity Transitions and Operational Capabilities
for first 24 hours after Landing

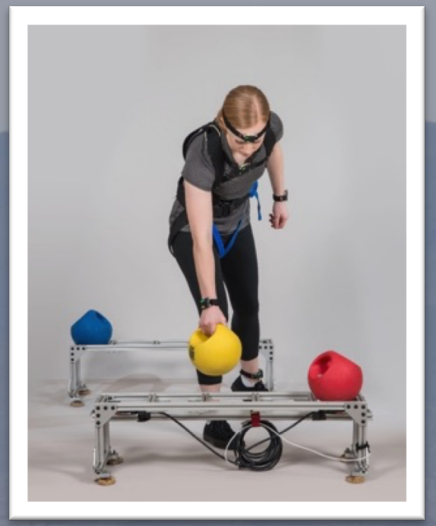
Distance from Earth: Communications
Delay/Blackout for 1 day to 2 weeks

Use Case: Why HRP and ISS are Doing more 1-Year Missions

- Same research on different platforms (ISS and ground analogs) over different time scales
- Duration as independent variable to extrapolate to multi-year missions
- Develop and validate protective countermeasures and safeguard crewmembers on exploration missions.
- Scientific and anecdotal comparisons from the crewmembers show differences between 6 and 12 month missions
  - Gene expression
  - Bone markers
  - Lower body pain, skin sensitivity, rashes, fogginess

6mo	6mo	6mo	6mo	6mo	6mo	6mo	6mo	6mo	6mo
1Y		1Y		1Y		1Y		1Y	
6wk		6wk		6wk		6wk		6wk	

Use Case: Deconditioned Crew carry out simulation tasks simulating the first 1-3 days of a Mars landing (phase-in starts 2022)



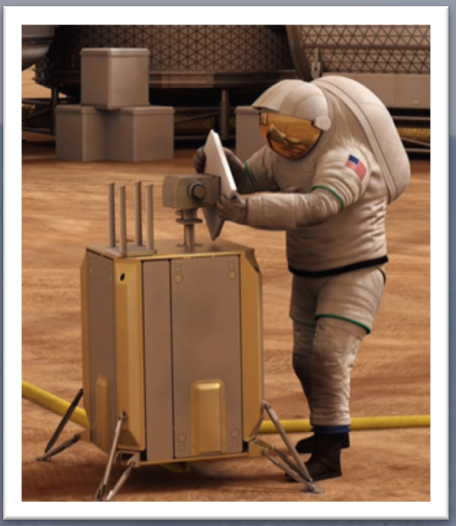


Image: Boeing

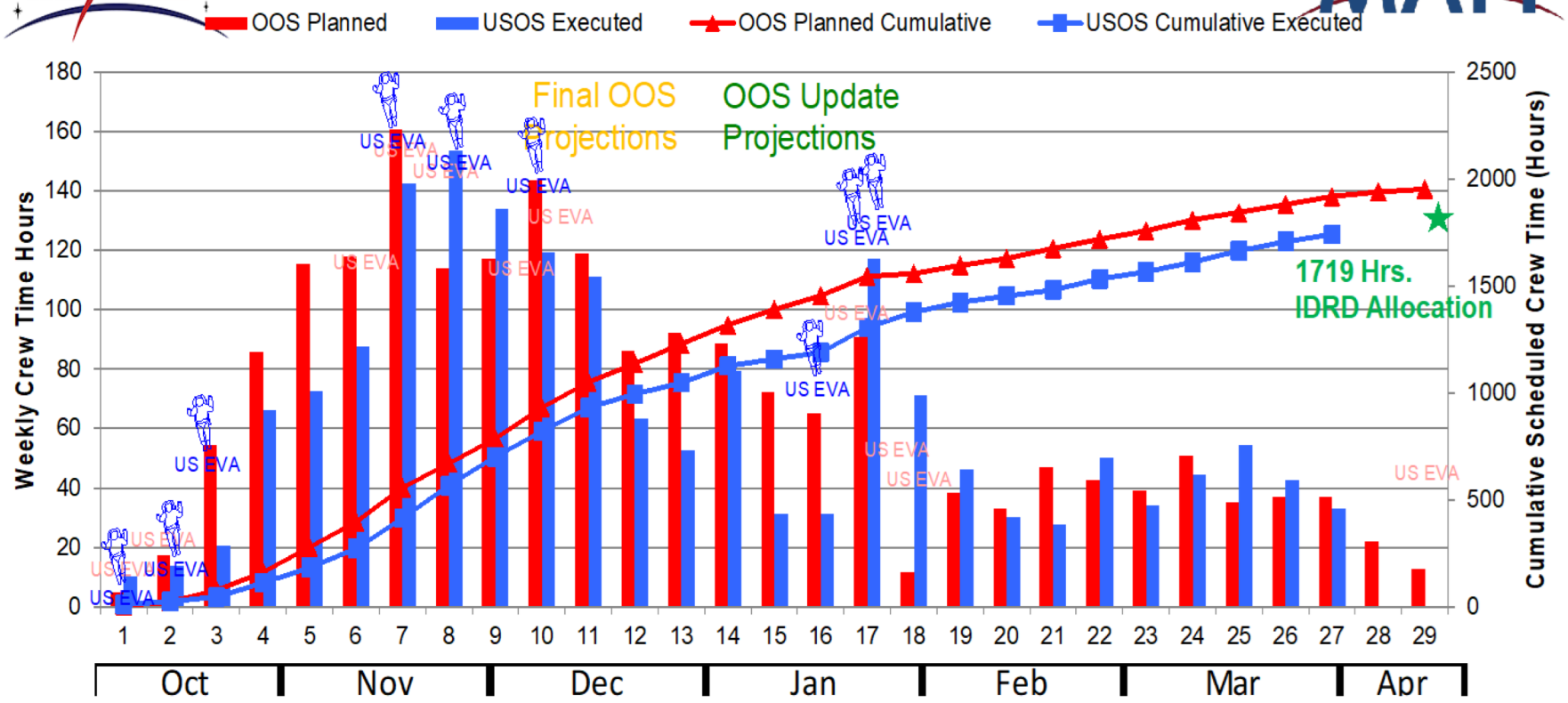
ISS as a Deep Space Analog:
ISS/Human Research Program Accepted Use Cases

Case	Concept Accepted, Planning Status	Not accepted, further work
1-Year Missions (Mars Transit Duration)	10 more starting in 2021, starting to show in flight plan, Russian coordination ongoing.	Once 1-Year series is complete, should revisit duration and risk compared to DRMs at that time.
On-orbit Medical Simulations	*Quick-start contingency operations without ground support (Spring 2020).* 1-2 day medical simulation on orbit (starting in 2021), 4x. Standard utilization.	
Operations Autonomy and/or Comm delay	Comm delay capability, available Fall 2019 Planning is extremely complex and a team with flight operations leadership being commissioned to start planning. Decision by late 2020.	30-day minimum and up to 1-year studies in smaller volumes desired but very operationally challenging for ISS with significant impacts on other users and partners; possible LEO Commercial module use
Isolation and Confinement		Reduced volumes not feasible unless enabled by future modules or operations changes

Additional use cases have been identified and are under additional discussion within NASA and internationally


Utilization Summary

Inc 61 - 62 Utilization Crew Time



Executed through Increment Wk (WLP Week) 27 :	25.4	of 27.4 work weeks	(92.7% Complete)
USOS Actuals:	1741.40	hours -> 68.56 hours/week	
USOS IDRD Allocation:	1,719.00	hours-> 62.74 hours/week	(101.3% Complete)
OOS USOS Planned Total:	1953.57	hours (Final OOS 1734.76)	(89.1% Complete)
AMS EVA Total to Date:	488.42	hours (included in the above totals and graph)	
RSA/NASA Joint Utilization to Date:	32.25	hours (not included in the above totals or graph)	

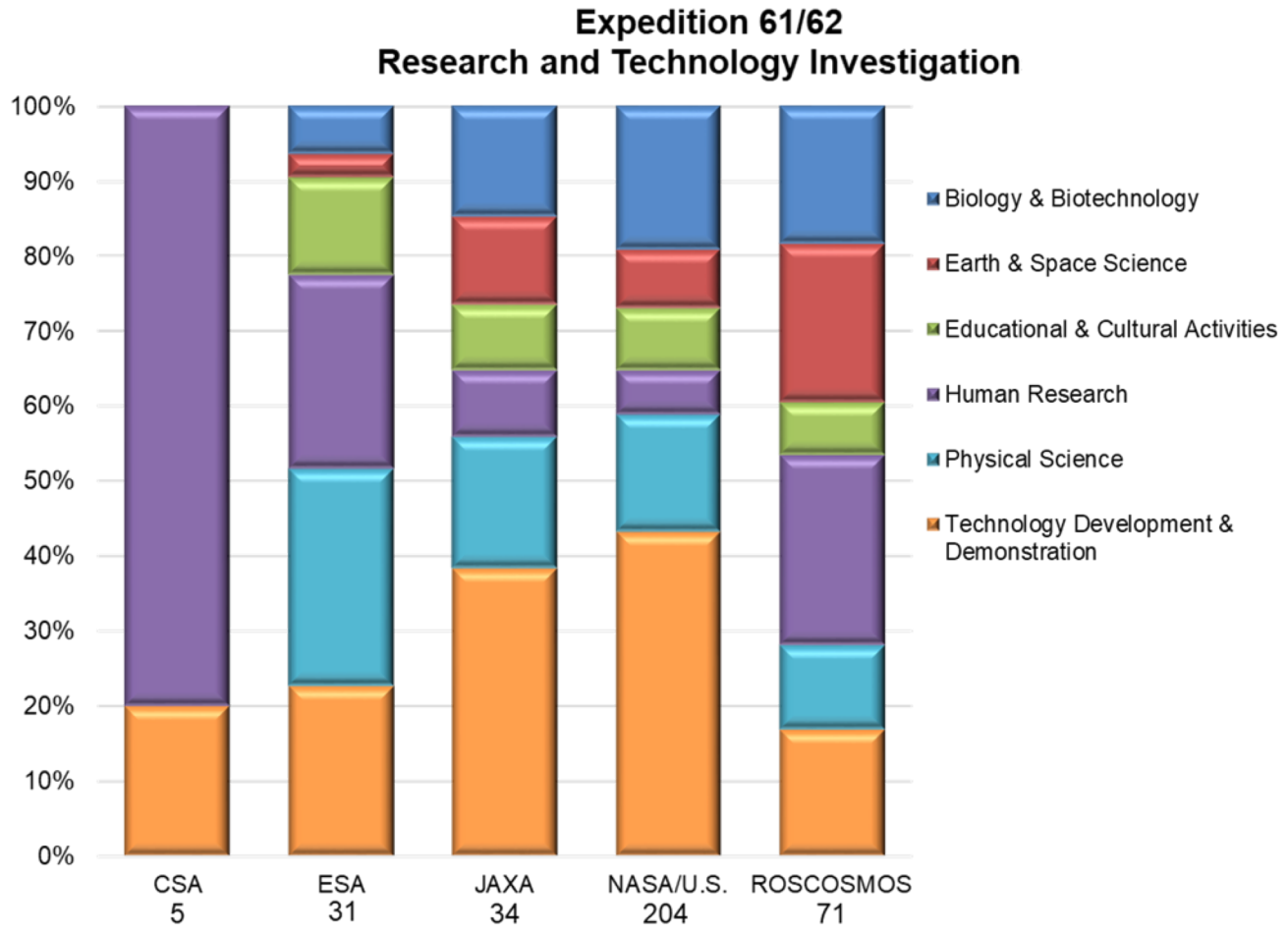
Inc 61/62 Research Statistics

Number of Investigations for 61/62: 345

- 204 NASA/U.S.-led investigations
- 141 International-led investigations
- 112 New investigations
  - 0 CSA
  - 7 ESA
  - 7 JAXA
  - 86 NASA/U.S.
  - 12 Roscosmos

ISS Lifetime

- Estimated Number of Investigations Expedition 0-63: 3099*
- Over 4022 Investigators represented (Exp 0 – Exp 58)
- Over 1905 scientific results publications (Exp 0 - Feb 2020)
- 108 Countries/Areas with ISS Research and Educational Investigations (Exp 0 - Exp 58)



*Working data as of Feb 29, 2020**
Pending Post Increment Adjustments

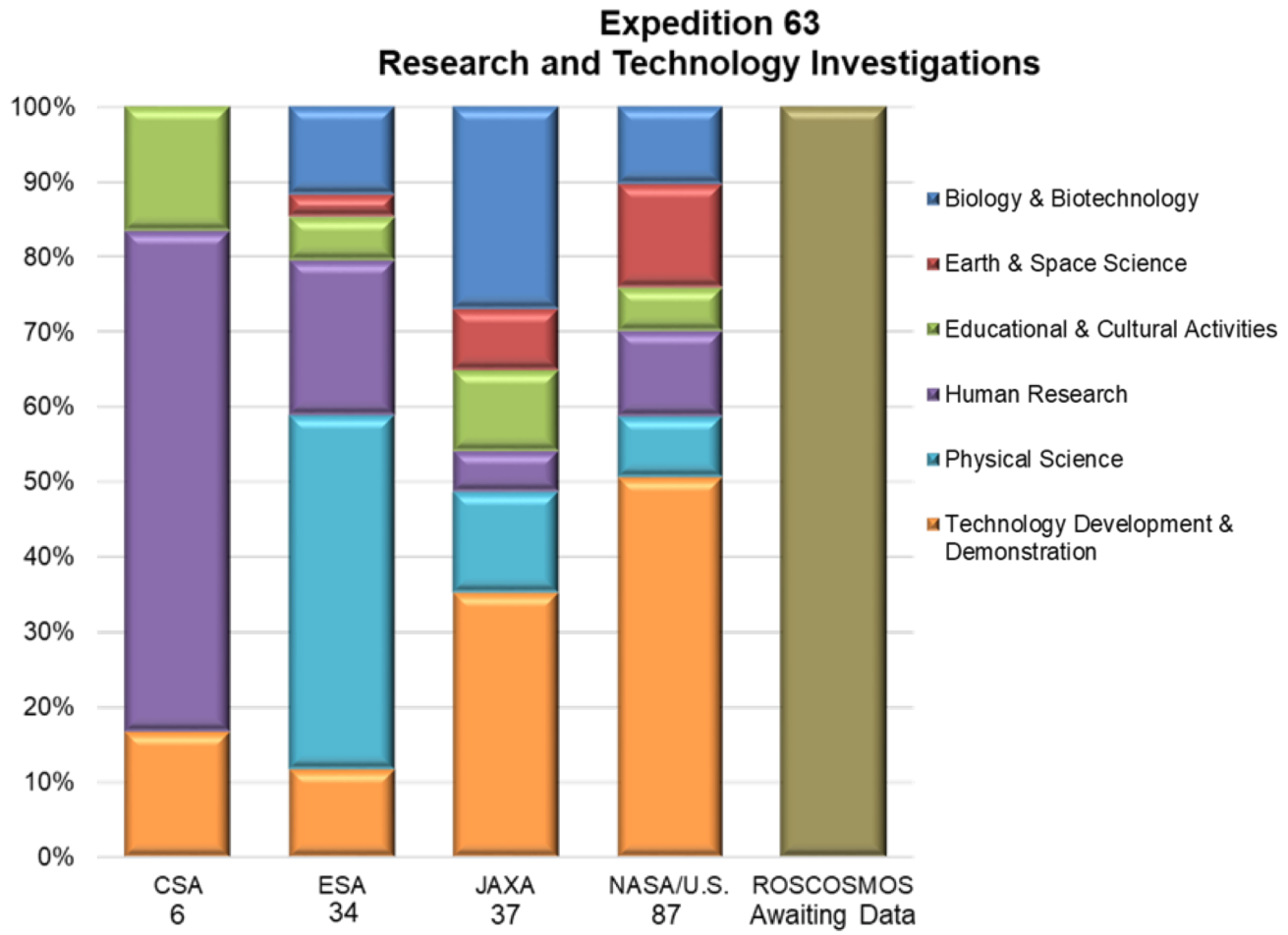
Inc 63 Research Statistics

Number of Investigations for 63: 164

- 87 NASA/U.S.-led investigations
- 77 International-led investigations
- 39 New investigations
  - 0 CSA
  - 3 ESA
  - 11 JAXA
  - 25 NASA/U.S.
  - TBD Roscosmos (awaiting data)

ISS Lifetime

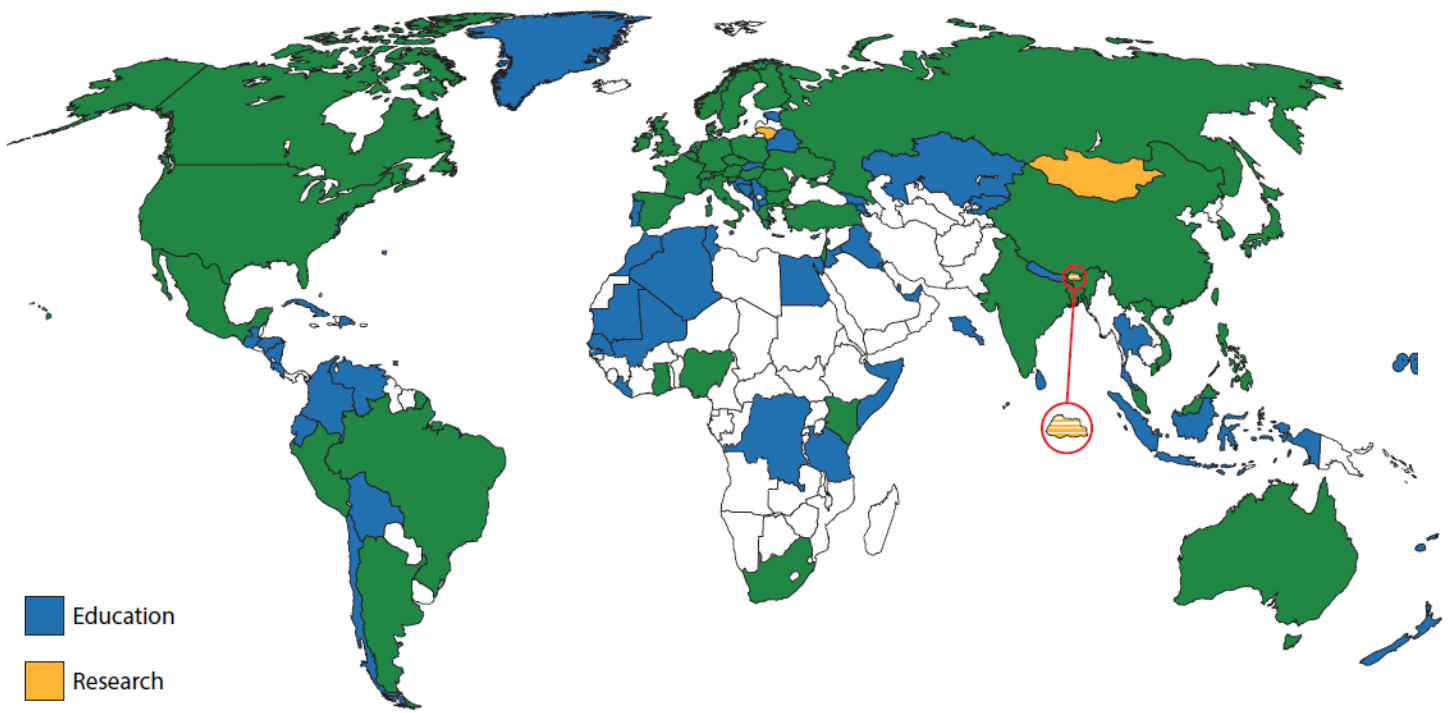
- Estimated Number of Investigations Expedition 0-62: 3060*
- Over 4022 Investigators represented (Exp 0 - Inc 58)
- Over 1905 scientific results publications (Exp 0 - present)
- 108 Countries/Areas with ISS Research and Educational Investigations (Exp 0 - present)



*Working data as of Feb 29, 2020**
Pending Post Increment Adjustments

Global Involvement in Utilization

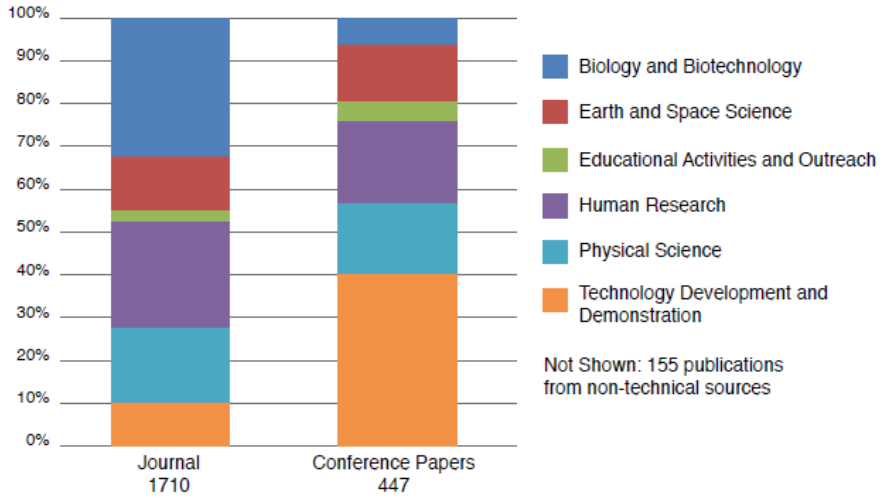
International Participation on ISS



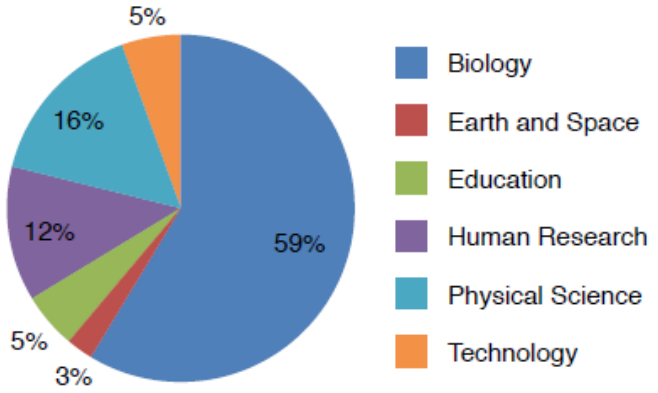
108 highlighted countries and areas have participated in ISS Research and Education Activities

Newly added countries: Bhutan (Research)

ISS Results Publications through March 2019



International Collaboration Percentage by Investigation Categories



Increments 63 Research Plan - Investigation List

Human Research

Bone & Muscle Physiology
EDOS-2
Myotones

Cardiovascular & Respiratory Systems
Vascular Aging
Vascular Echo

Crew Health Care Systems
AMOS Demonstration

Habitability and Human Factors
AstroRad Vest

Human Behavior & Performance
Time Perception in Microgravity

Immune System
Functional Immune
Immuno-2

Integrated Physiology & Nutrition
Food Acceptability
Food Physiology
Repository
Bio-Monitor

Nervous & Vestibular Systems
GRASP
GRIP
VECTION

Radiation Impacts on Humans
LIDAL (ASI)

Cross-Disciplinary/Other
Standard Measures

- NASA/ASI
- National Lab
- CSA
- ESA
- JAXA

Increments 63 Research Plan - Investigation List

Biology & Biotechnology

Animal Biology – Vertebrates
JAXA Mouse Mission

Cellular Biology
Cell Gravisensing
Confocal Space Microscopy
Ribosome Profiling
Space Organogenesis*

Macromolecular Crystal Growth
JAXA Low Temp PCG
JAXA Moderate Temp PCG
JAXA PCG

Microbiology
Veggie Monitoring
STaARS Bioscience-12
JEM Microbe
Micro Monitor

Plant Biology
BRIC-Light Emitting Diode (LED)
Plant Habitat-02
TICTOC
Canes

Physical Science

Combustion Science
FLARE

Complex Fluids
ACE-T-2
ACE-T-9
ACE-T Ellipsoids
Foam Coarsening
PK-4

Fluid Physics
FBCE
PBRE-2↓
PBRE-WR↓
Drop Vibration
Droplet Formation Study
FLUIDICS
Multiscale Boiling
Spirits Maturation

Fundamental Physics
Cold Atom Lab
DOSIS-3D
JAXA Colloidal Clusters

Materials Science
NanoRacks Module-79**
EML Batch 2
MSL SCA-Batch 2b-ESA
Advanced Nano Step
ELF Investigation
Round Robin

Other
TELLAS

- NASA/ASI
- National Lab
- CSA
- ESA
- JAXA

Increments 63 Research Plan - Investigation List

Earth & Space Science

Astrophysics
NICER (E)
ISS-CREAM (E)
AMS-02 (E)
CALET
MAXI

Earth Remote Sensing
CEO
ECOSTRESS (E)
GEDI (E)
OCO-3 (E)
SAGE III-ISS (E)
Total & Spectral Solar Irradiance (TSIS) (E)
NREP Inserts***
ASIM (E)
HISUI
iSIM (E)

Educational & Cultural Activities

Commercial Demonstrations
The ISS Experience
I-Space Essay ↑
Space Studio Kibo

Cultural Activities
NanoRacks Module-48
Communications and Outreach-C3-CSA

Educational Competitions
Robo-Pro Challenge

Educational Demonstrations
ISS Ham Radio
Sally Ride EarthKAM
AstroPi
ESA-EPO-TASK-LIST

Other
JAXA EPO

- NASA/ASI
- National Lab
- CSA
- ESA
- JAXA

Increments 63 Research Plan - Investigation List

Technology Development & Demonstration

Air, Water and Surface Monitoring
APM
Mini CO2 Scrubber
OGA H2 Sensor Demo
Spacecraft Atmosphere Monitor

Characterizing Experiment Hardware
ECHO

Commercial Demonstrations
Turbine CMM
Mobile Companion (Cimon)
Kibo Avatar-X
SOLISS

Communication & Navigation
HTV WLAN Demo

EVA Systems
SERFE

Fire Suppression and Detection
Saffire-IV

Food & Clothing Systems
EveryWear

Imaging Technology
HDEV↓
HDTV-EF2
JEM Internal Ball Camera-2
JEM IR Camera Demo

Life Support Systems & Habitation
Thermal Amine Scrubber
Universal Waste Management System (UWMS)
Water Capture Device
JEM Water Recovery System (JWRS)

Radiation Measurements & Shielding
RadMap Telescope
Radi-N2

Small Satellites and Control Tech
RED-EYE#3 (E)

Spacecraft & Orbital Environments
STP-H5 (E)
STP-H6 (E)

NASA/ASI
National Lab
CSA
ESA
JAXA

Increments 63 Research Plan - Investigation List

Facilities

Cryo Chiller	Manufacturing Device	EDR-2	KOBAIRO Rack
EXPRESS Rack 11B	MISSE-FF (E)	EPM	MSPR
GLACIER	MUSES (E)	FSL	Ryutai
Glovebox Freezer	NanoRacks Nanode	ICE Cubes/Experiment #7	Saibo
Hermes	NanoRacks Plate Reader	LSR	
HRF-1	NRCSD#18	Bio-Analyzer	
HRF-2	NRCSD#19	CBEF-L	
Iceberg	SlingShot-4 (WIDAR, ULTP-1,	EFU Adapter	
KERMIT	Gunsmoke)	ExHAM #1	
MELFI	SlingShot-5	ExHAM #2	
MERLIN	STaARS-1 EF	HDTV-EF2	
Spectrum	TangoLab-1	IPU2	
ADSEP	Bartolomeo	J-SSOD #13	
Bone Densitometer	BioLab	J-SSOD #14	

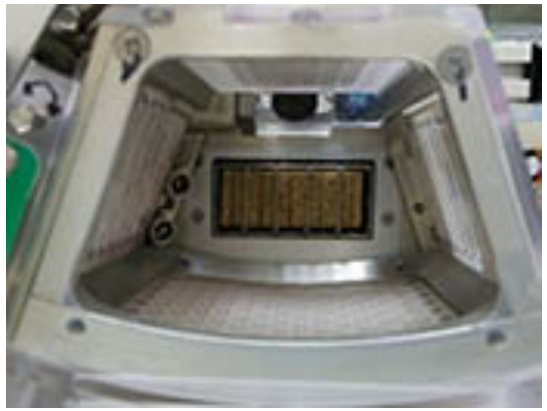
- NASA/ASI
- National Lab
- CSA
- ESA
- JAXA

Featured Investigation: Mouse Habitat Unit-5 (MHU-5)

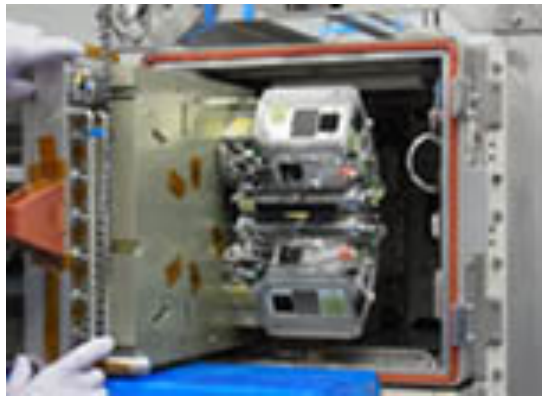
Sponsoring Agency: Japanese Aerospace and Exploration Agency (JAXA)

PI: Dai Shiba, PhD of JAXA

- The purpose of this space investigation is to analyze any alterations of the gene expression patterns in several organs, and the effects on the germ-cell development of mice exposed to long-term partial G conditions (e.g. more than 30 days)
- Under partial G conditions, various types of stress could induce unusual gene expression patterns in somatic cells - Diverse adaptive responses to environmental changes in cells are also supposed to be elicited in a systematic manner.
- This study could reveal the effects of long-duration spaceflight on mammals at the molecular level of gene expression and epigenetic modification.
- Data obtained from MHU-5 could contain fundamental information for the long-term exposure of humans to partial G during future exploration missions to the Moon, Mars, and beyond.



Mouse Habitat



The Cell Biology Experiment Facility (CBEF)

ISS National Lab Update

Alexander MacDonald
NASA Chief Economist

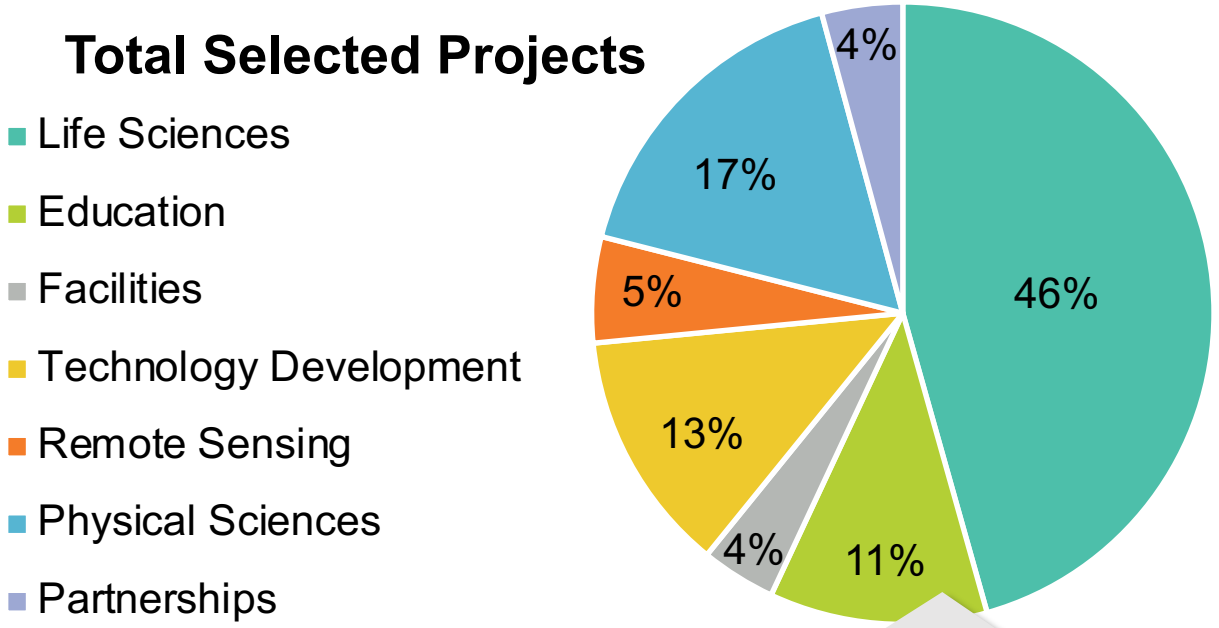
ISS National Laboratory Independent Review Team (IRT) Recommendations

- IRT final report delivered to NASA on February 4th, 2020
- NASA response along with the final report was posted on April 6th, 2020
- NASA's forward plan is based on the IRT's findings and recommendations, many of which validate changes for which NASA and CASIS had already planned before the initiation of the Independent Review:
  - Identify an ISS National Lab program executive at NASA Headquarters as the primary liaison to CASIS ✅ (April 15th, 2020)
  - Work with CASIS on the best roles and composition of the CASIS Board of Directors and leadership
  - Support CASIS' establishment of a User Advisory Committee to provide input to the organization about how best to manage resources
  - Create transparent project and program evaluation and prioritization processes
  - Update strategic priorities for the ISS National Lab on an annual basis
  - Work with CASIS to optimize the allocation of ISS National Lab resources to meet strategic priorities

ISS National Lab 2019 Annual Report

The ISS National Laboratory 2019 Annual Report is now available online at **issnationallab.org/ar2019**

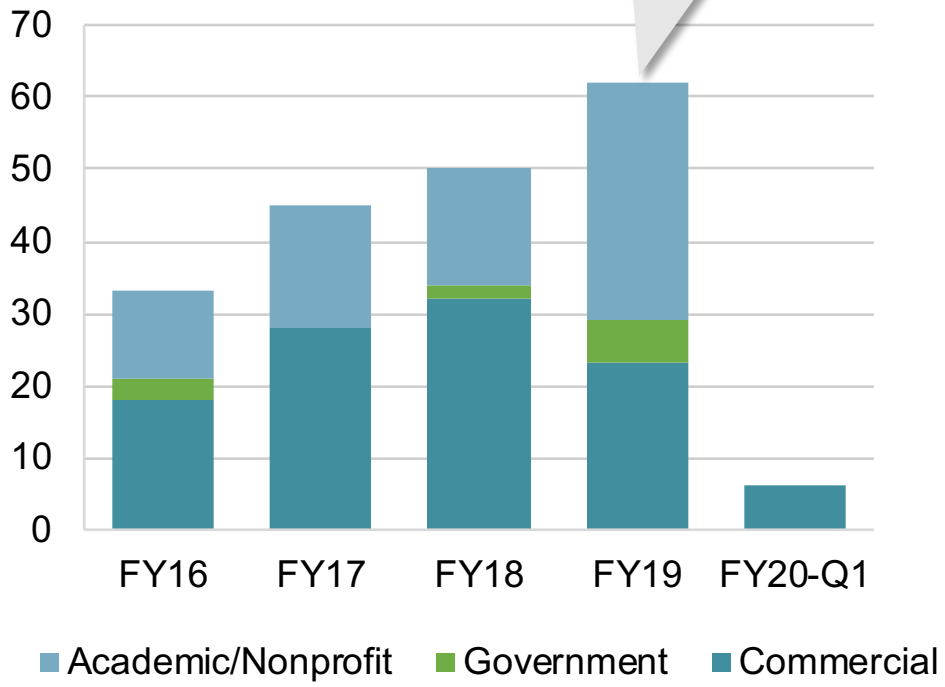
Total Selected Projects



- 64% of projects are by new-to-space investigators
- 2 new commercial facilities were delivered (Slingshot and BFF) and 1 new commercial transferred (SSIKLOPS)

62 projects selected in FY19, 24% increase from FY18

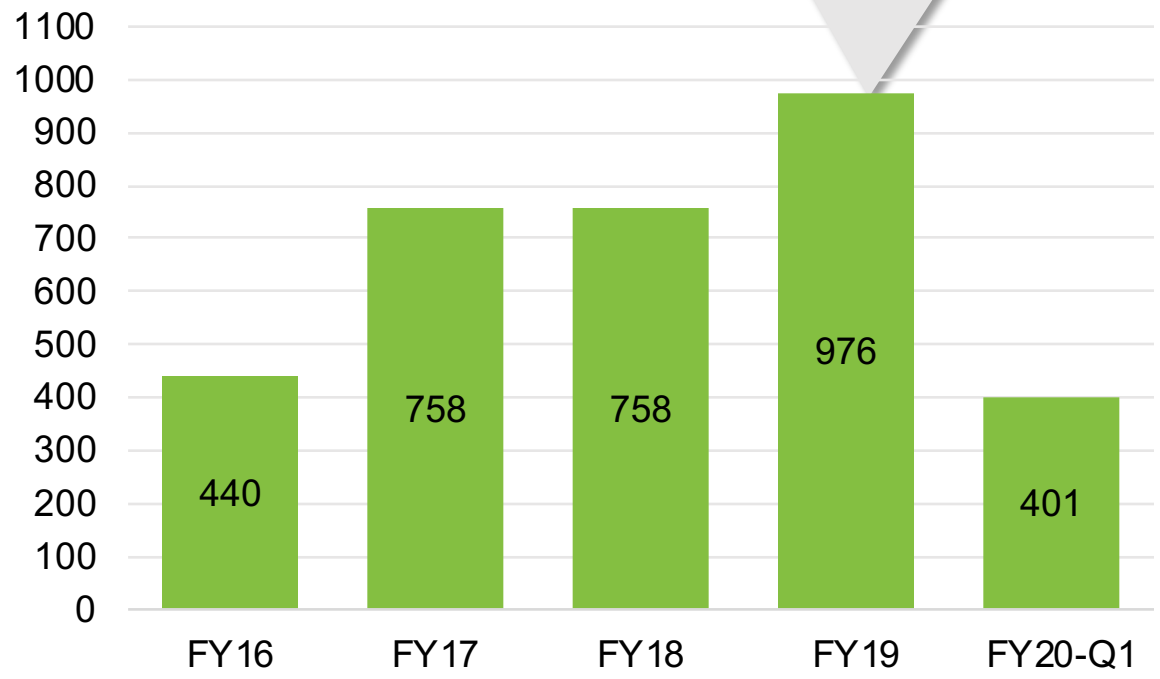
National Lab Customers



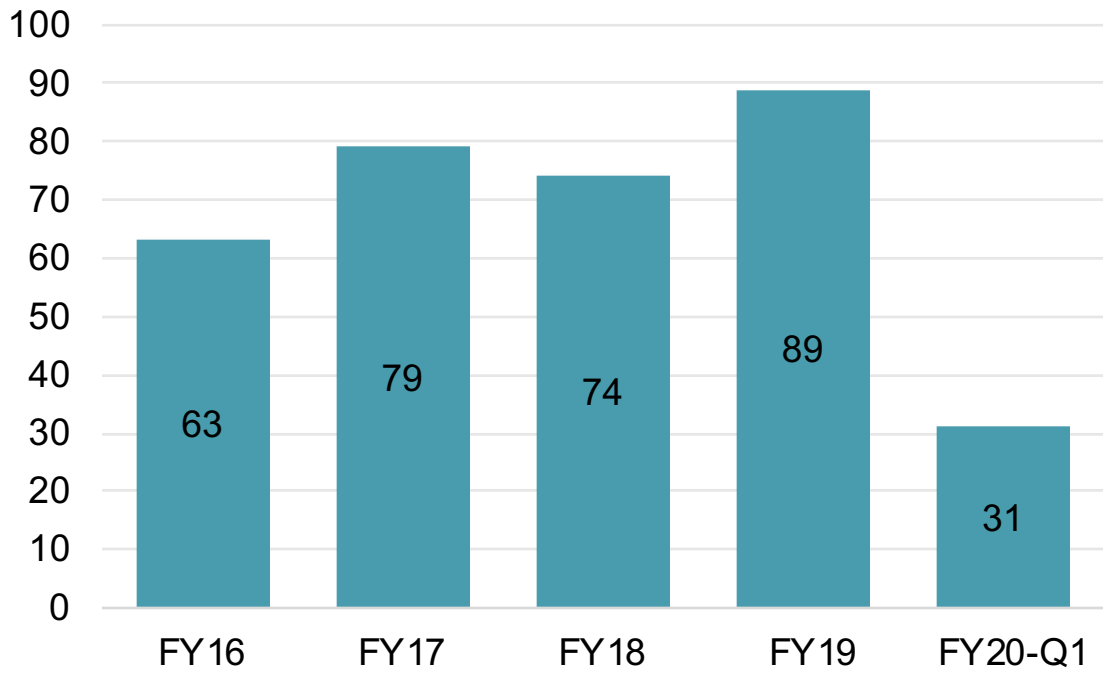
ISS National Lab Resource Utilization

- Record set for total number of crew time hours used over a year (967 hours)
- Record set for total number of crew time hours used in an increment (708 hours)

Crew Time Utilization (hours)

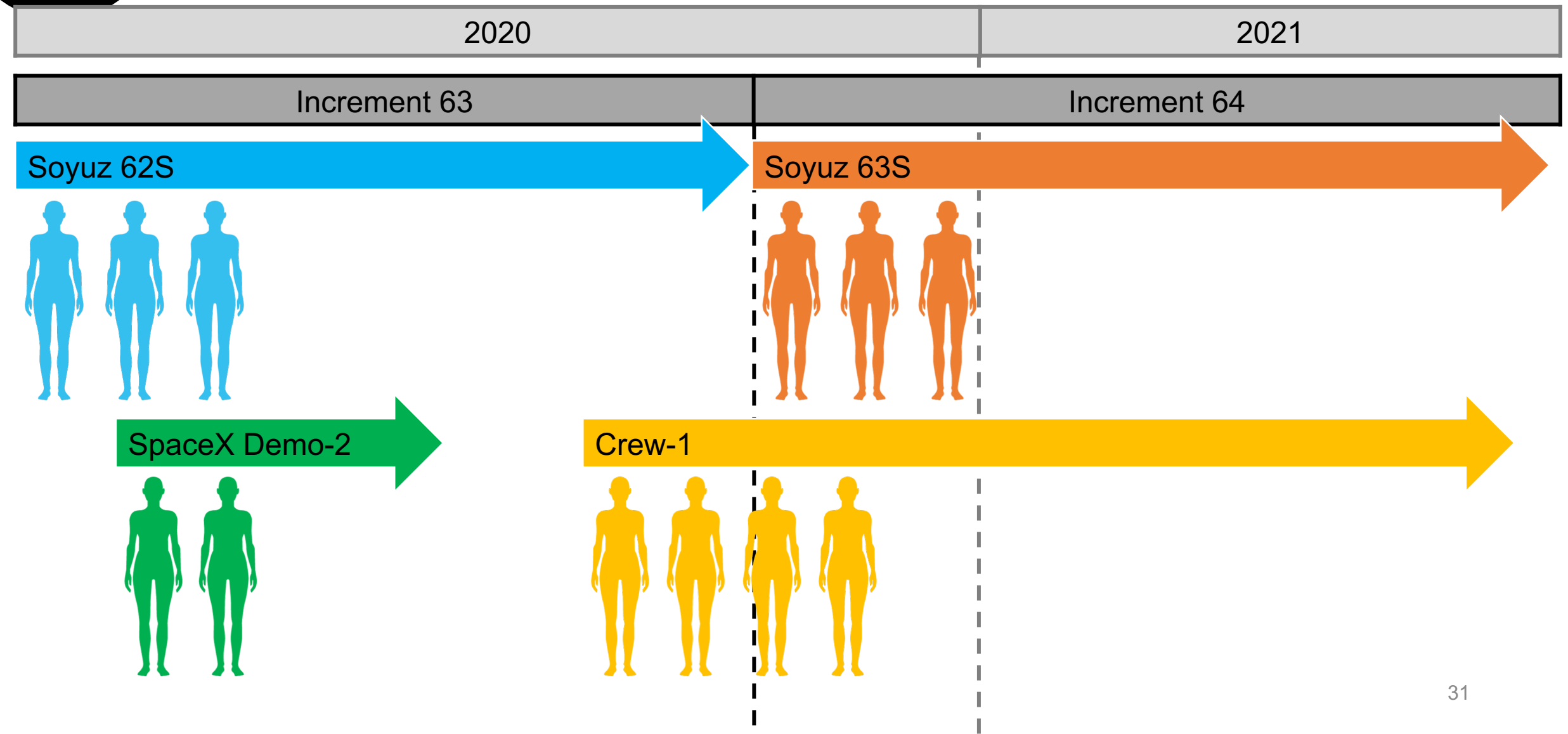


Payloads Delivered



89 payloads were delivered to the ISS, a record and a 20% increase from FY18

Crew Time Increase

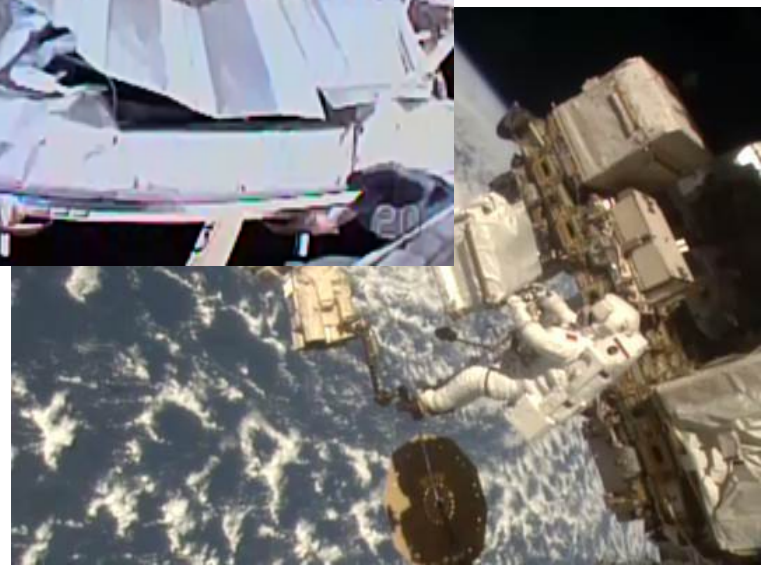


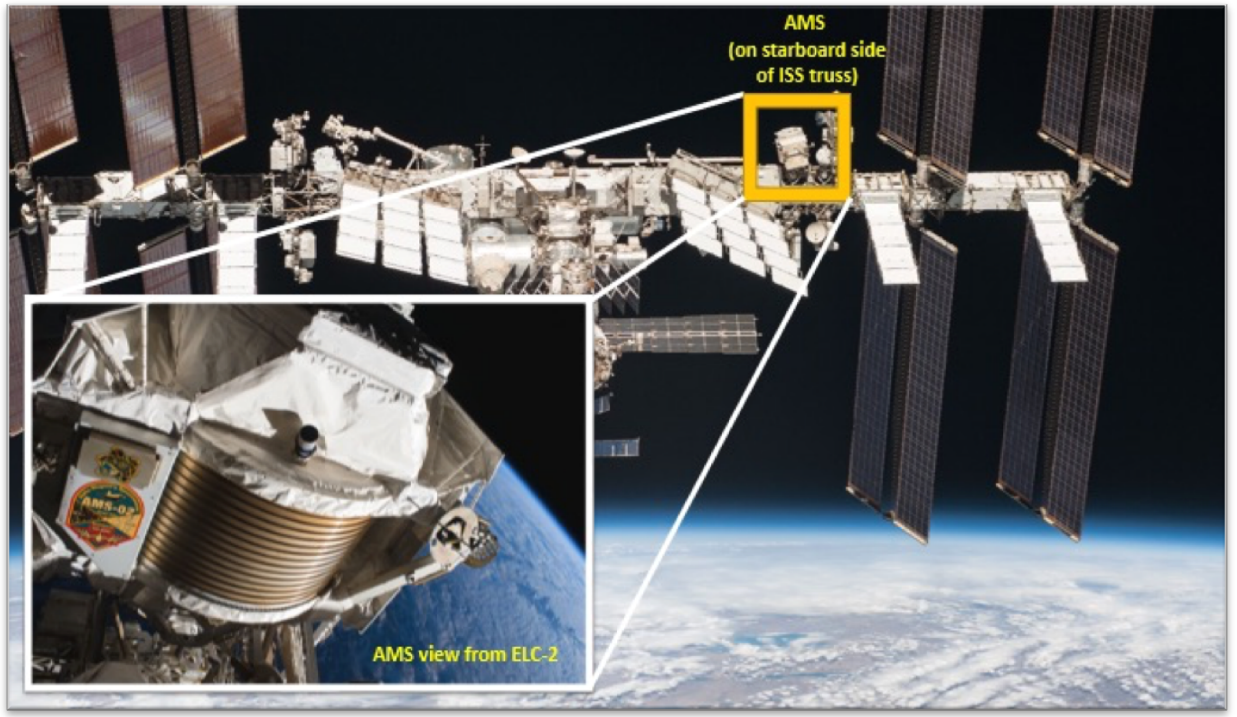
ISS Operational Status

Completed EVA Overview: AMS Repair

Alpha Magnetic Spectrometer (AMS)

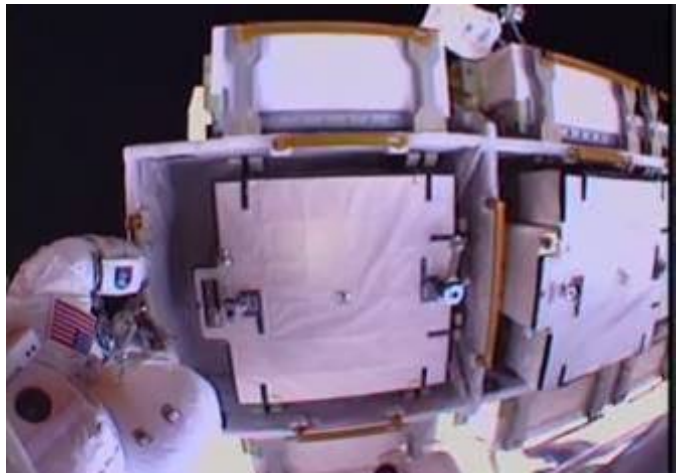
A set of four spacewalks successfully repaired the space station's Alpha Magnetic Spectrometer (AMS), a renowned scientific instrument that explores the fundamental nature of the universe. The AMS Tracker Thermal Control System (TTCS) was repaired due to degraded pumps and coolant leak.





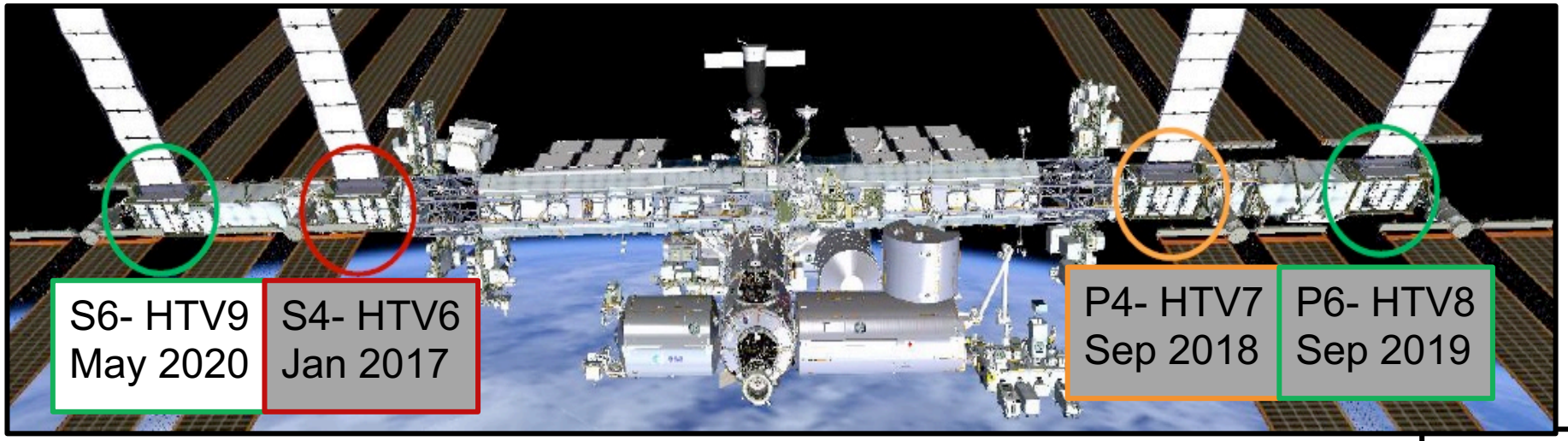
Completed EVA Overview –P6 Battery Upgrades

Two spacewalks in January completed the task to replace the current nickel-hydrogen (NiH2) batteries on power channel 4B of the P6 truss segment with lithium-ion (Li-Ion) batteries and battery adapter plates. These spacewalks were rescheduled from October to January in order to replace a Battery Charge/ Discharge Unit (BCDU) that failed to activate following successful installation of the first set of Li-Ion batteries. The new batteries are part of the overall upgrade of the station's power system that began with similar battery replacement during spacewalks in January 2017.

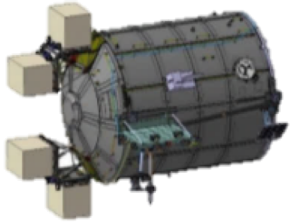


Upcoming EVAs: S6 Battery R&R and Columbus Upgrades

Four planned spacewalks in June to replace the current nickel-hydrogen (NiH2) batteries on the S6 truss segment with lithium-ion (Li-Ion) batteries and battery adapter plates. This is the last set batteries to be replaced.

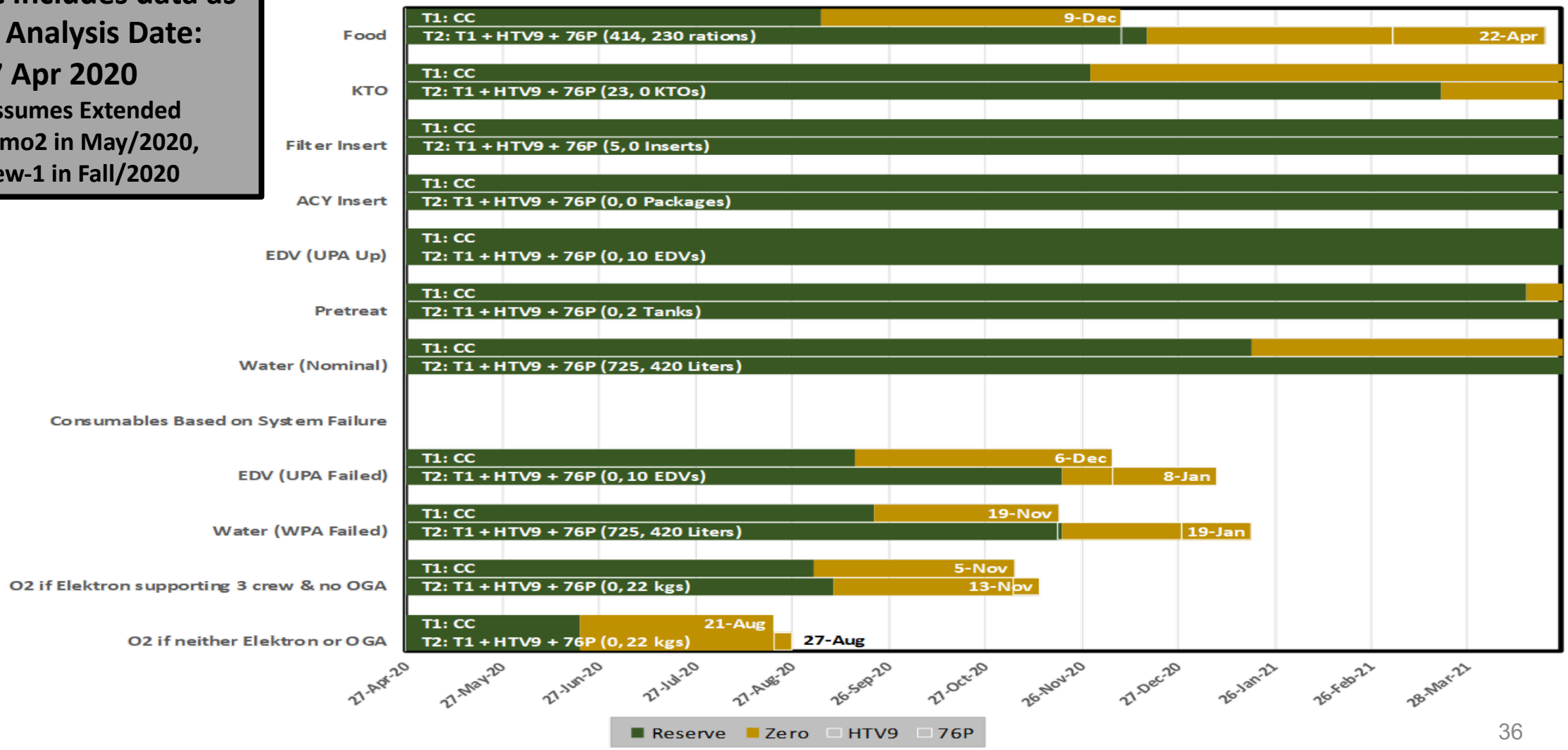


One planned spacewalk NET June to prepare Columbus module for Bartolomeo installation and install the Columbus Ka-Band Terminal (COL-Ka)



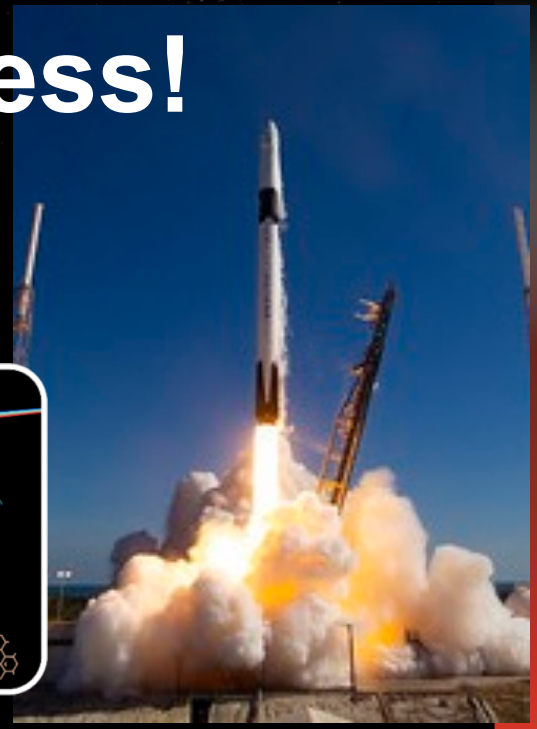
Total Consumables

CC Includes data as of Analysis Date: 27 Apr 2020
(Assumes Extended Demo2 in May/2020, Crew-1 in Fall/2020



SpaceX CRS-19 Mission Success!

- Mission Planning
  - Launched 12/5/19 with capture and berthing 12/8/19
  - Unberth/Splashdown occurred 1/7/20
- Upmass – 2617 kg manifested; Return - 1676 kg
- Pressurized Cargo
  - Ascent: 1 PAUL, 2 AEM-T, 2 Polar
  - Return: 1 Merlin, 2 AEM-T, 3 Polar
  - 1st time returning 10 Double Cold Bags (DCBs)
- Unpressurized Cargo
  - Ascent: Hyperspectral Imager Suite (HISUI) and 1 Lithium-Ion Battery
  - Disposal: BCDU FSE (Battery Charge/Discharge Unit - Flight Support Equipment) plus ascent restraint for HISUI and Li-Ion Battery



SpaceX CRS-19 Launch on 12/5/19

SpaceX CRS-19 berthing on 12/8/19

NG CRS-11 Mission Success!

- Mission Planning
  - Launched 4/17/19 with capture, berthing, and ingress on 4/19 /19
  - Unberth and release occurred 8/6/19
  - Re-entry complete 12/6/19
    - All secondary objectives completed post-unberth

- Upmass – 3,426 kg manifested; Disposal - 2750 kg Pressurized Cargo
  - Ascent: 2 AEM-T units, 1 AEM-E unit, and 1 POLAR
  - First flight items: rodent capability, L-24 hour final cargo load, and scrub turnaround with 48-hour refresh capability

- Unpressurized Cargo
  - Operations post ISS departure
    - Nanoracks External CubeSat Deployer (NRCSD-E including Aerocubes and Seeker payloads)
    - CMG Experiment
    - Slingshot Cubesat Deployer
    - Ubiquitilink payload

NG CRS-11 Launch on 4/17/19

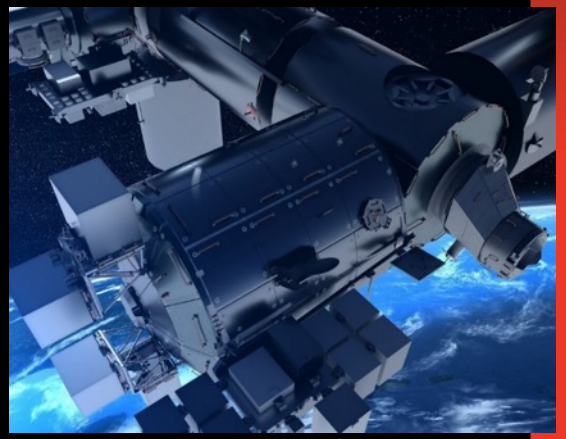
NG CRS-11 Departure on 8/6/19

SpaceX CRS-20 Mission Success!

- Mission Planning
  - Launched 3/7/20 with capture, berthing, and ingress on 3/9/20
  - Unberth/Splashdown occurred 4/7/20
- Upmass – 1891 kg manifested; Return - 1765 kg
- Pressurized Cargo
  - Ascent: 1 JAXA MHU (Mouse Habitat Unit), 1 MERLIN, 2 Polar, 1 PAUL
  - Return: 1 JAXA MHU, 1 MERLIN, 4 Polar
- Unpressurized Cargo
  - Ascent: Bartolomeo
  - Disposal: none
- Final CRS-1 mission

SpaceX CRS-20 Launch on 3/7/20

SpaceX CRS-20 berthed on 3/9/20



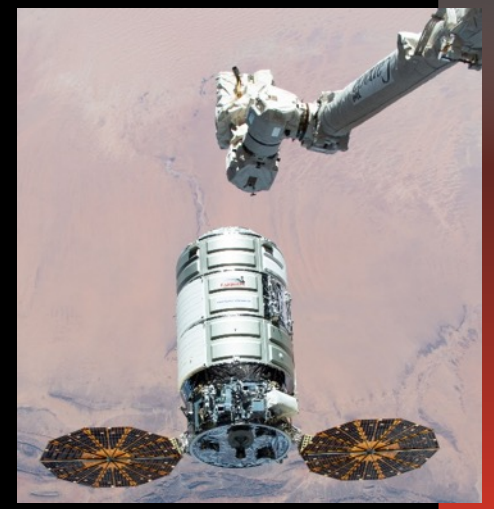
Bartolomeo payload platform on Columbus Module holds up to 11 external units (image credit: ESA)

SpaceX CRS-20 release on 4/7/20

NG CRS-12 Mission Success! (1st CRS-2 flight)

- Mission Planning – First CRS2 Mission
  - Launched 11/2/19 with capture and berthing 11/4/19
  - Unberth and release occurred 1/31/20
  - All secondary objectives completed post unberth
  - Re-entry complete 3/17/20
- Upmass – 3693 kg manifested; Disposal -2553 kg
- Pressurized Cargo
  - Ascent: 2 AEM-T units, 2 POLARs, 1 AEM-E Unit, 1 MERLIN
  - First Flight Items: Advanced Thermal Control Assembly (ATCA),
    Additional MDL (Mid-deck Locker) capability, MDL Command & Telemetry, Scrub turnaround with 24-hr refresh capability
- Unpressurized Cargo
  - First Flight Item: Unpressurized Disposal
  - Disposal: SOLAR, SDS (Space Debris Sensor)
  - Operations post-ISS departure: Nanoracks External CubeSat Deployer (NRCSD-E), SlingShot CubeSat Deployer (launched on SpX-19)
    - NRCSD-E and Slingshot deploys complete 2/1/20

NG CRS-12 Launch on 11/2/19



NG CRS-12 Capture on 11/4/19

NG CRS-12 release on 1/31/20

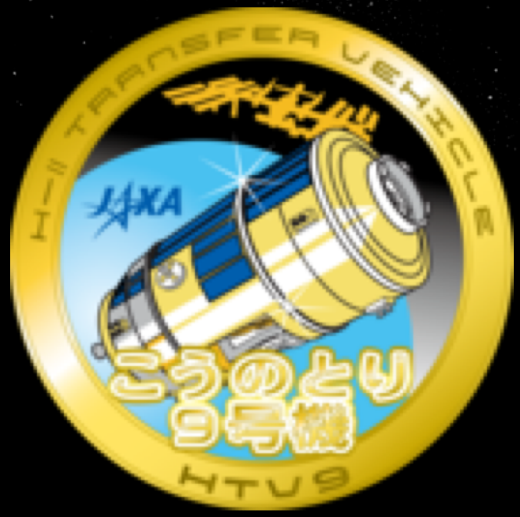
NG CRS-13 Mission Status

- Mission Planning
  - Launch occurred on 2/15/20 with capture and berthing 2/18/20
    - 1st launch attempt on 2/9/20 was scrubbed due to off-nominal readings in the pad ground equipment. Parts changed out and regression testing conducted.
  - Unberth and release occurred on 5/11/20
- Upmass – 3377 kg manifested; Disposal -2500 kg estimated
- Pressurized Cargo
  - Ascent: 1 Mobile Space Lab, 3 Polars, Saffire-IV, RED EYE II, ColKa, CEBAA, NORS Oxygen tank, OsteoOmics, Bio Fabrication Facility
  - "Extend the Lab" capabilities exercised during the mission (NG-13 powers 3 Polars until transferred to SpX-19 for return)
  - Operations post ISS Departure: Saffire-IV
- Unpressurized Cargo
  - Disposal: HDEV (High Definition Earth Viewing Camera)
  - Operations post-ISS departure: SlingShot CubeSat Deployer (launched on SpX-20), WIDAR hosted payload

NG CRS-13 Launch on 2/15/20

NG CRS-13 capture on 2/18/20

HTV9 Mission Status

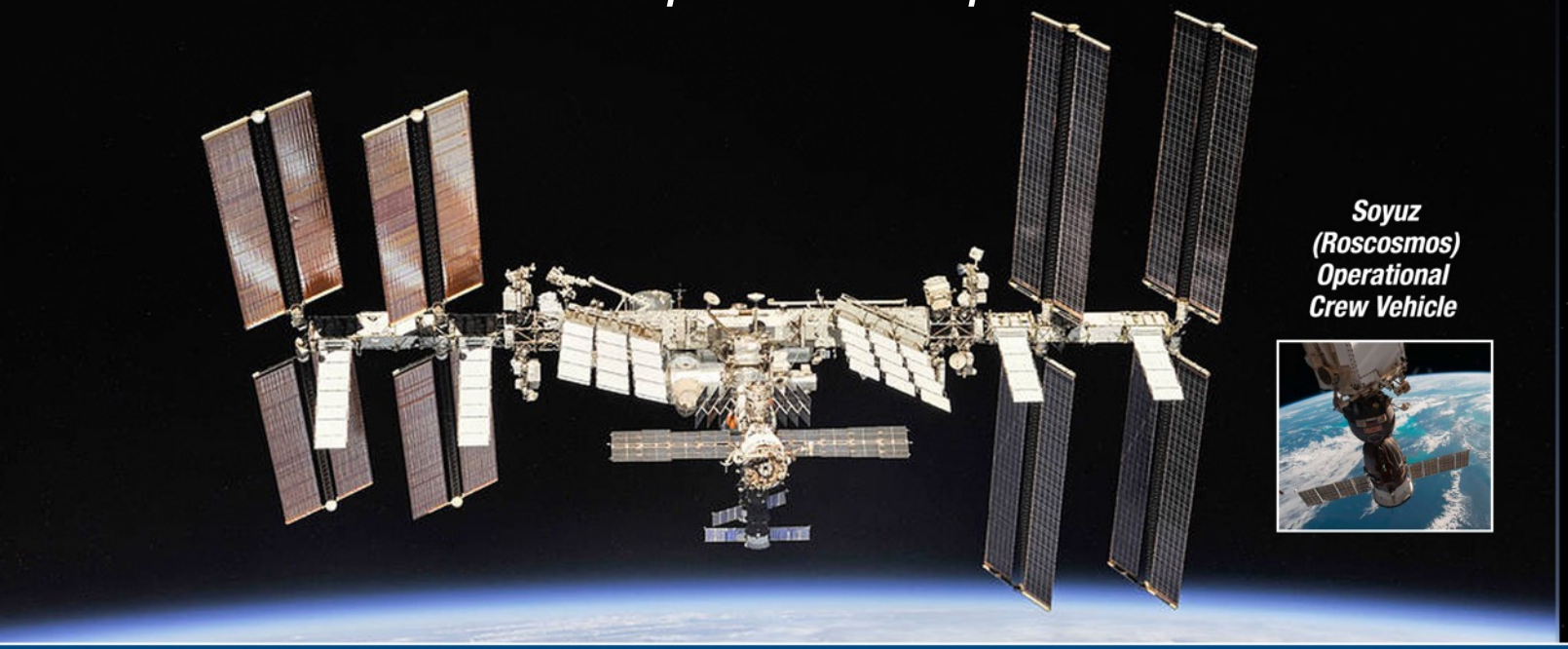


- Mission Planning
  - Launch planned for 5/20/20 with capture and berthing 5/25/20
  - Unberth and release planned for 7/20/20
- Upmass – 4700 kg manifested; Disposal -2600 kg estimated
- Pressurized Cargo
  - Ascent: BER3 (Basic Express Rack 3), EDR2 (European Drawer Rack 2), 1 NORS Nitrogen Tank, Crew Consumables
- Unpressurized Cargo
  - Ascent: 6 Lithium-Ion Batteries, all charged and installed on Exposed Pallet
  - Disposal: 8 Nickle-Hydrogen Batteries

ISS Future

The International Space Station

The centerpiece of exploration and model for a new future in space

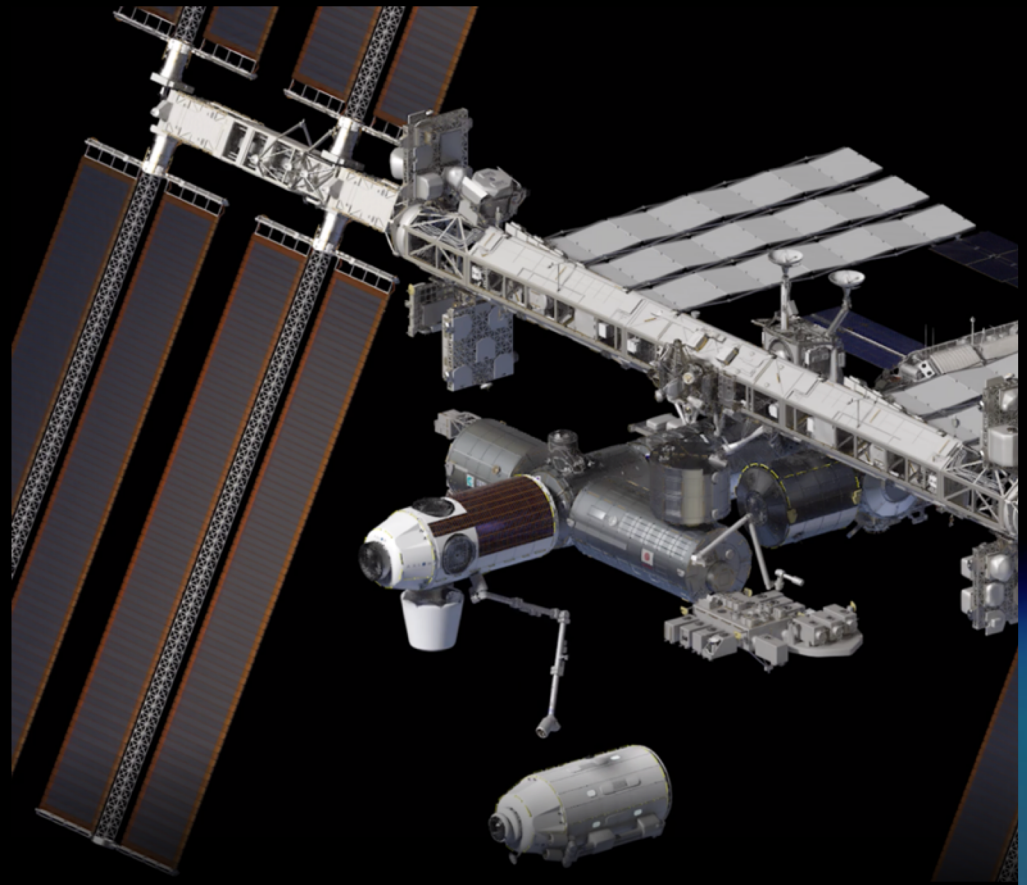


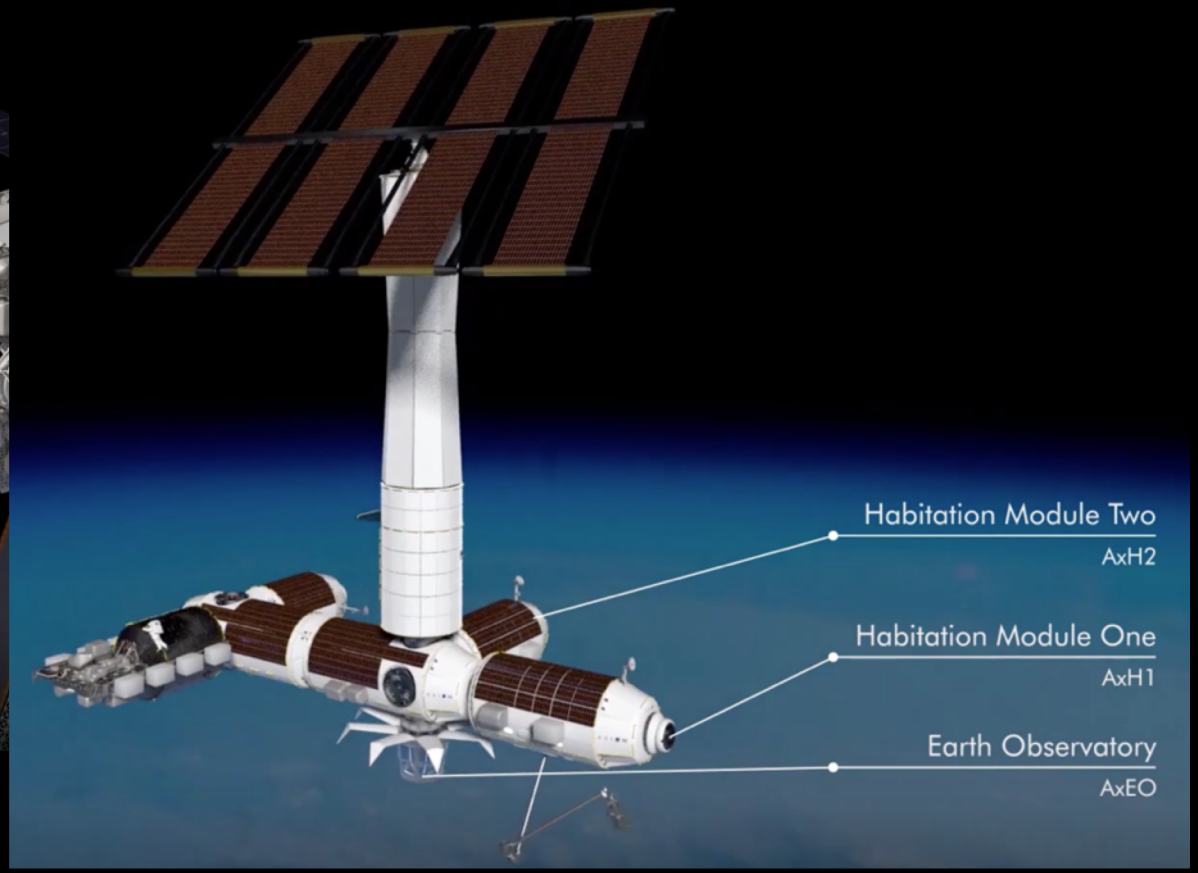
Continuous and ongoing cargo and crew operations aboard space station, along with commercial and international partnerships, allows human exploration to advance at a sustainable pace

CARGO

CREW

Axiom Space Selected for NextSTEP Appendix I:
Commercial Destination Development in Low-Earth Orbit Using ISS





Stimulating Sustainable Demand

NASA is providing seed money to enable selected companies to mature their concepts and stimulate demand to develop their future markets

Projects announced on April 7, 2020:

- **Apsidal:** Universal glass optics manufacturing module
- **DSTAR Communications:** Thin metal-coated optical fiber manufacturing
- **Made in Space:** Glass alloy manufacturing machine
- **Made in Space:** Semiconductor chip facility
- **Space Tango and Cedars Sinai:** Production of stem cells for personalized medicine applications
- **Space Tango and LambdaVision:** Protein-based retinal implant manufacturing
- **Space Tango and UC San Diego/Sanford Consortium:** Regenerative medicine laboratory
- **Bryce Space and Technology:** Action plan for barriers to entry to the low-earth orbit market

DSTAR Communications

FOMS

LUNAR RESOURCES

20 Years on the International Space Station

Counting Down to Nov. 2, 2020
Marking 20 Years of Continuous Human Presence on the
International Space Station

Deep Space Exploration | Commercial Space Market | Global Partnership | Space Laboratory

A truly global endeavor, the unique microgravity laboratory has hosted 239 people from 19 countries, more than 2,800 experiments from 4,000 researchers in 108 countries, and a variety of international and commercial spacecraft.

The International Space Station is the blueprint for American leadership in global cooperation, enabling a U.S.-led multinational partnership to advance shared goals in space exploration and remains the sole space-based proving ground and stepping stone for NASA's Artemis program.

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