International Space Station Status

National Aeronautics and Space Administration

HEO NAC January 2021

Robyn Gatens

Acting International Space Station Director

Agenda

- ISS Increment Overview
- ISS Operational Status
- Utilization Highlights
- ISS Future

ISS Increment Overview

Increment 64 Crew Overview

Increment Highlights:

- 76P Undock
- 75P Undock
- SpX-21 Mission (NR's Airlock)
- 77P Mission
- NG-14 Release
- Boe-OFT2 Mission
- EVA's
- NG-15 Mission
- Crew-2 Launch

63S Dock 10/14/20 - 63S Undock 4/17/21

Kate Rubins
Flight Engineer

Sergey Ryzhikov
CDR Exp 64

Sergey Kud-Sverchkov
Flight Engineer

Crew-1 Dock 11/16/20 – Crew-1 Undock May

Shannon Walker
Mission Specialist

Victor Glover
SpX PLT

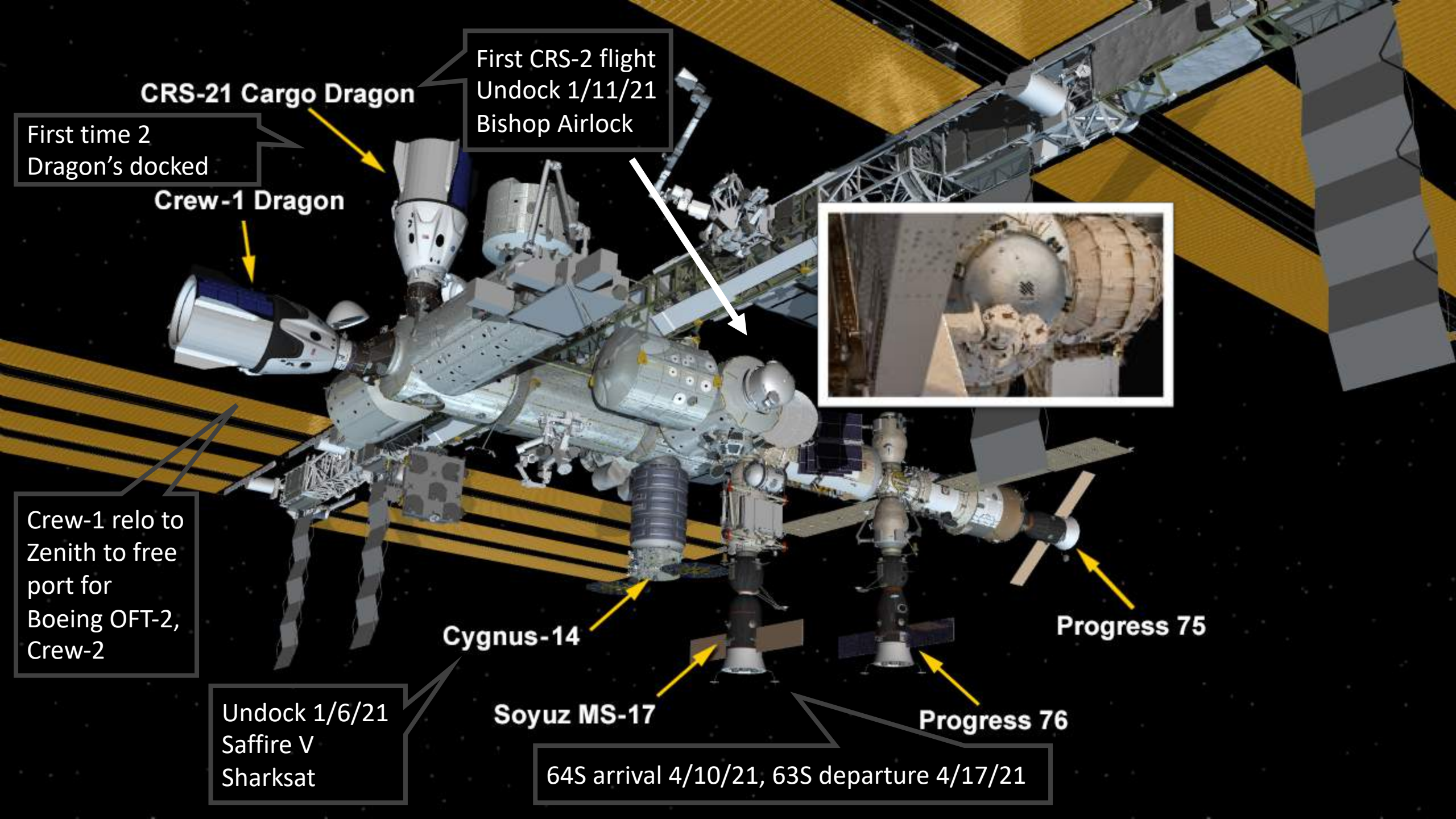
Michael Hopkins
SpX CDR

Soichi Noguichi
Mission Specialist

Additional Crew on ISS (5 USOS)

- With the arrival of SpaceX Crew-1, ISS occupancy is up to 7 total and 5 USOS.
- Significantly increased time dedicated to utilization and research.
- Astronaut Mike Hopkins will be utilizing Dragon as a sleeping location for duration of Crew-1 stay or until additional sleeping equipment arrives.

ISS Operational Status

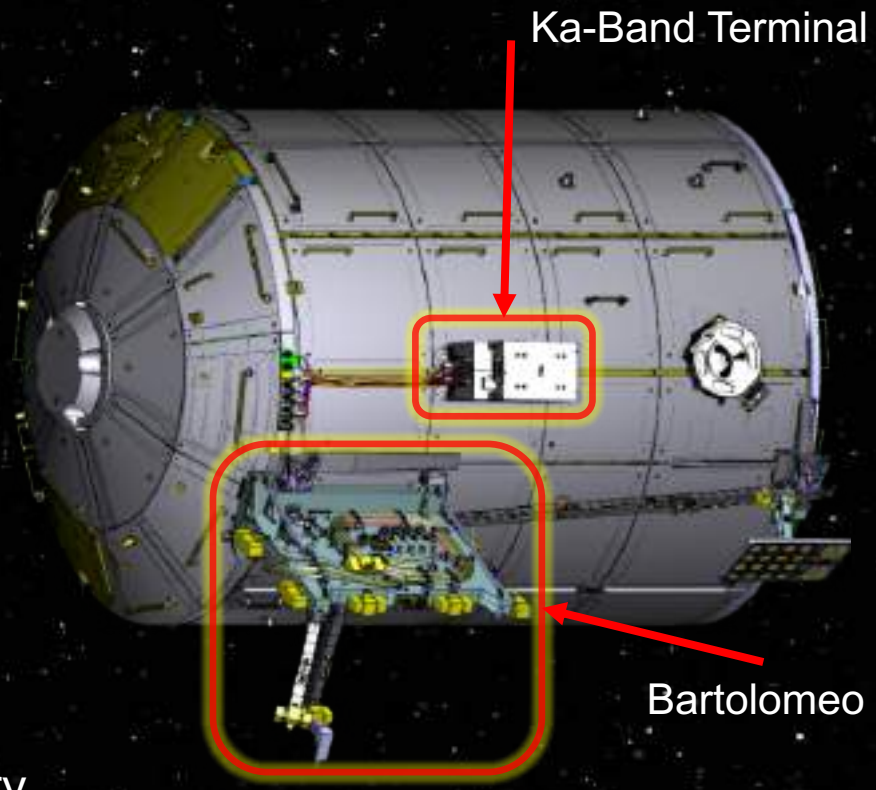

CRS-21 Cargo Dragon
First CRS-2 flight
Undock 1/11/21
Bishop Airlock
First time 2
Dragon's docked
Crew-1 Dragon
Crew-1 relo to
Zenith to free
port for
Boeing OFT-2,
Crew-2
Cygnus-14
Undock 1/6/21
Saffire V
Sharksat
Soyuz MS-17
Progress 76
Progress 75
64S arrival 4/10/21, 63S departure 4/17/21

Upcoming Spacewalks (EVA)

- Astronauts Michael Hopkins & Victor Glover will conduct the first pair of spacewalks in January, the 233rd and 234th in support of ISS assembly, maintenance and upgrades.

- **Columbus Upgrades**
  - Cable and antenna setup for the “Bartolomeo” science payloads platform.
  - Configure Ka-band terminal to enable an independent, high-bandwidth communication link to European ground stations.
  - Grapple fixture bracket removal in prep for future power system upgrades.

- **ISS Upgrades II**
  - Installation of a final lithium-ion battery adapter plate (finalizes battery upgrade initiative)
  - Replace an external camera on the starboard truss
  - Install new high-definition camera on the Destiny laboratory
  - Replace components for the Japanese robotic arm’s camera system outside the Kibo module.



Upcoming Spacewalks (EVA)

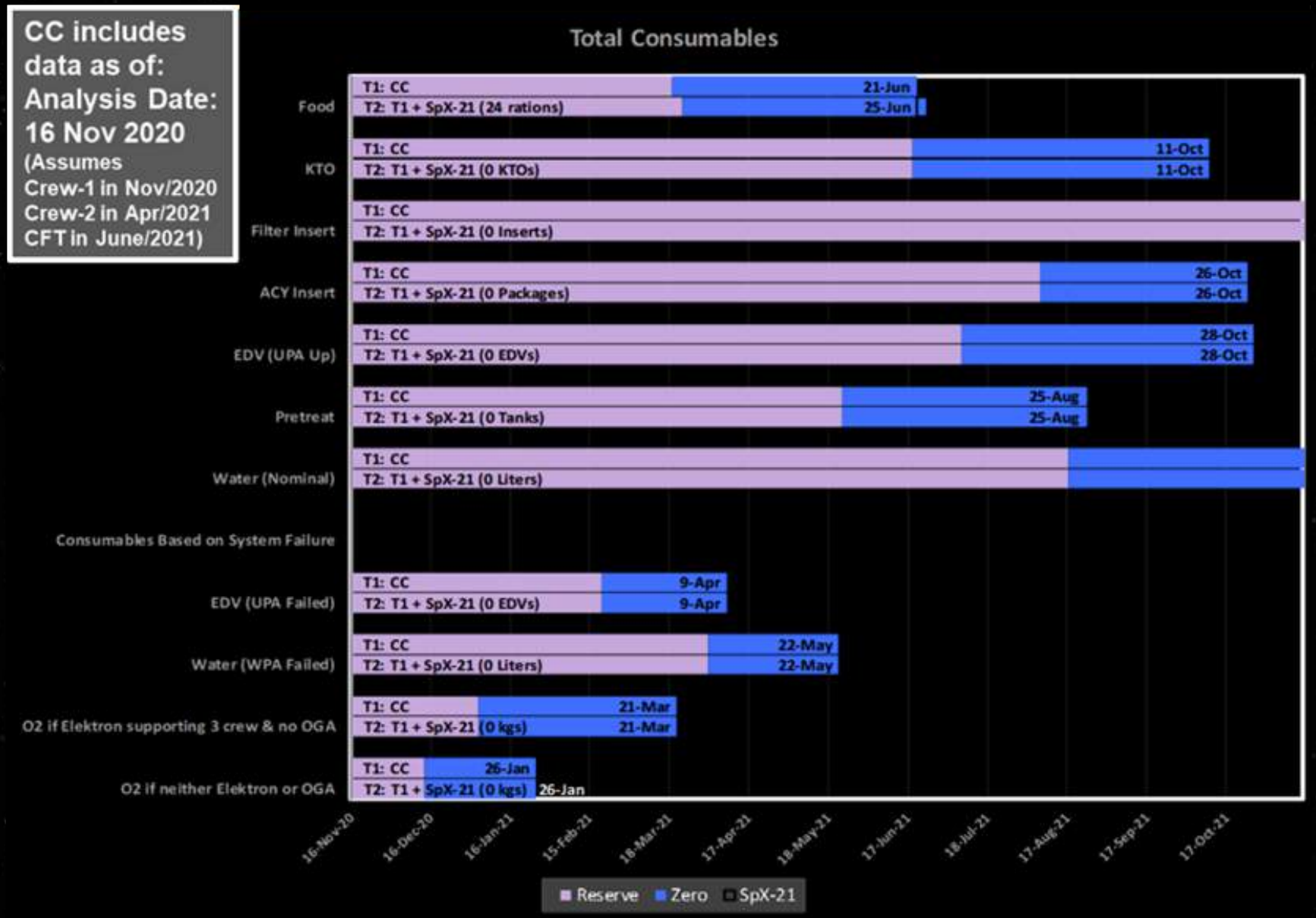
- **IROSA Prep**
  - Though functioning well, the current solar arrays are showing signs of degradation, as expected.
  - To ensure sufficient power is maintained for exploration technology demonstrations for Artemis and beyond as well as utilization and commercialization, six of eight existing power channels will be updated.
  - The new ISS Roll Out Solar Array (IROSA) wings will be delivered in pairs on the SpaceX Dragon cargo spacecraft during three resupply missions starting in 2021.
  - Each array installation will require two spacewalks: one to prep, another to install. This EVA is the first to begin preparing the worksite.
- **ISS Upgrades III**
  - Early Ammonia Servicer (EAS) Jumper Venting
  - Mod Kit Completion
  - Equipment Removal & Replacement (Airlock Magnet, PIP Pin, WETA)
  - Camera Port Cable Routing

Atmosphere Leak

- Since September 2019, ISS has been tracking a slight increase above the previous sustained cabin air leak rate.
- The leak presents no immediate danger to the crew or the space station at its current state.
- A small crack was found in the aft segment of the Russian Service Module (SM). The crew applied a patch kit, slightly reducing the leak. In the near term, that part of SM has been isolated to minimize consumable loss.
- Teams across the partnership have been working together to identify additional leak source(s) and provide further leak mitigation / resolution.
- There is sufficient gas currently on-orbit, and planned to be launched, to sustain appropriate levels of atmospheric pressure until the issue is resolved.

Total Consumables

CC includes data as of:
Analysis Date: 16 Nov 2020
(Assumes Crew-1 in Nov/2020
Crew-2 in Apr/2021
CFT in June/2021)




Utilization Summary

Exploration Capabilities Development Technology Demonstrations: Recently Arrived on the Space Station

Atmosphere

Left: Thermal Amine scrubber system installation in Destiny module

Right: Spacecraft Atmosphere Monitor (S.A.M.) TD-1

Waste Management and Water Recovery

Left: Installation of the Urine Processor Assembly (UPA) Upgraded Distillation Assembly

Bottom: Double Toilet Stall

Above: Universal Waste Management System (UWMS)

Right: upgraded WPA catalytic reactor flew on SpX-21

Featured Technology: UWMS

Universal Waste Management System

Closing capability gaps—advantages of UWMS:

- “Universal” Fit
  - Regenerative systems (ISS, Gateway)
  - Orion (Artemis II vehicle install upcoming)
- 65% mass reduction and 40% volume reduction
- Through pretreatment, contributes to reaching exploration goal of 98% water recovery (current recovery on the space station ~90%)
- Lower maintenance time required due to simplified systems, corrosion resistant parts
- Improved cleanliness and crew comfort

Exploration Capabilities Development Technology Demonstrations: Recently Arrived on the Space Station

Monitoring and Logistics Management

Left: RFID Enabled Autonomous Logistics Management (REALM) installed

Right: Airborne Particle Monitor

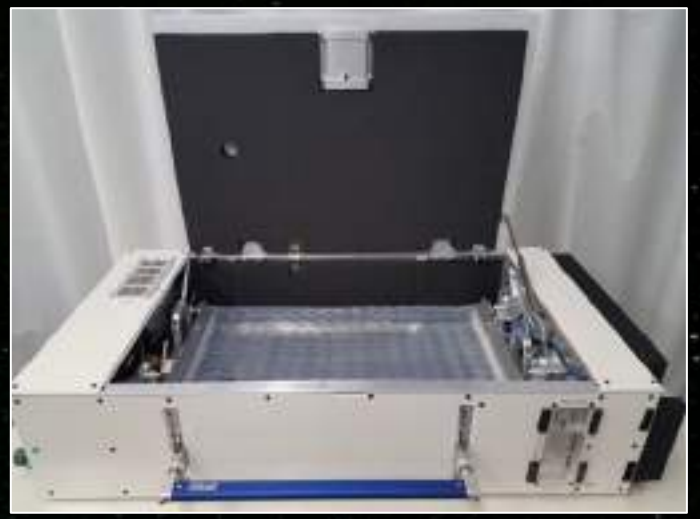
Bottom: MinION DNA Sequencer

Fire Safety

The fifth Spacecraft Fire Safety Experiments (Saffire-V) will be deployed when Cygnus leaves ISS

Coming Soon: - 2021

4-Bed CO_2 Scrubber



Brine Processor Assembly (BPA)

Metrics – Agency Priority Goal (APG)

Initiate at least five technology demonstrations on the International Space Station to advance deep space exploration.
Status: GREEN

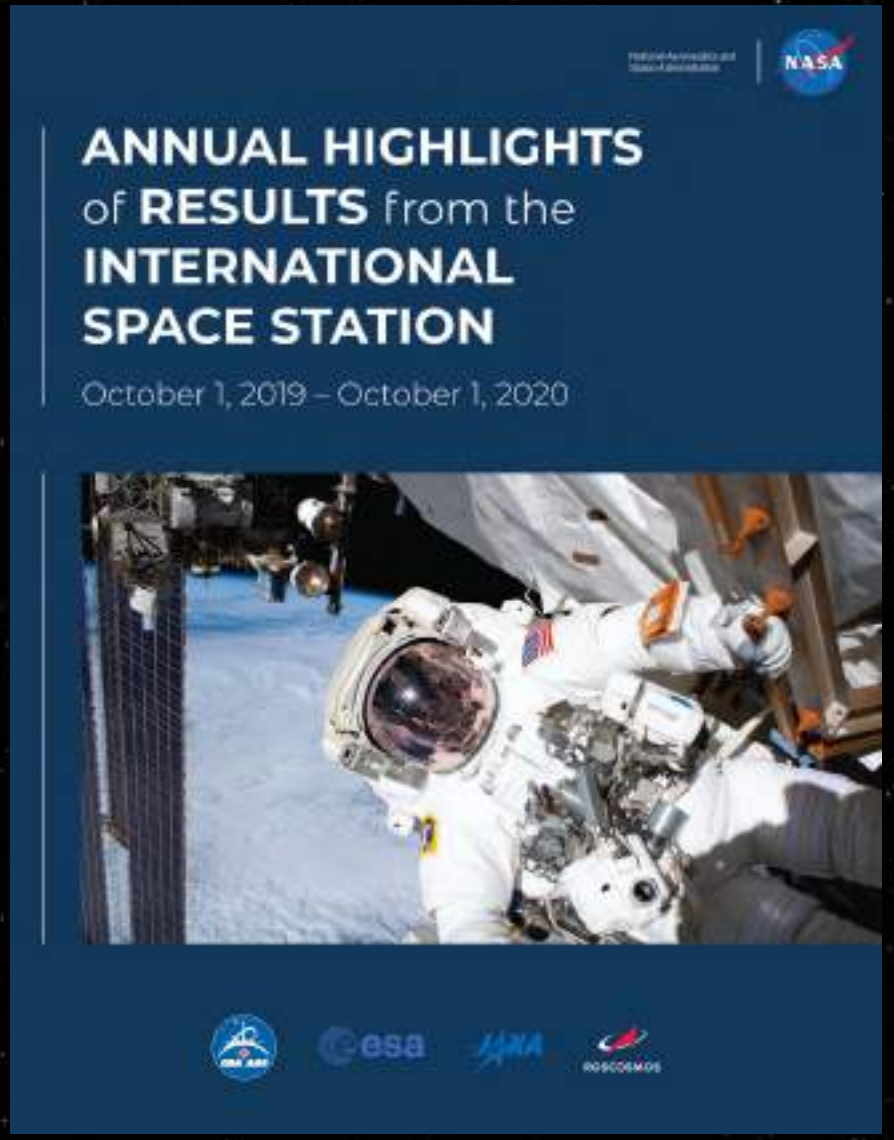
FY20 Initiated (final)	FY21 Delivered	FY21 To Be Delivered
Spacecraft Fire Safety (Saffire) IV	Spacesuit Evaporation Rejection Flight Experiment (SERFE) (Initiation began FY21, Q1)	Brine Processor Assembly (BPA)
Advanced air filters – finished initialization in U.S. modules	Universal Waste Management System (UWMS) (Installation in progress)	4-Bed CO2 Scrubber
Urine Transfer System	RFID-Enabled Autonomous Logistics Management-2 (REALM-2) (awaiting initiation)	Spacecraft Atmosphere Monitor (SAM) Unit 2
Biomole / Microbial Monitoring	Spacecraft Fire Safety (Saffire) V, initiation following NG-14 departure from ISS	Urine Processor Assembly (UPA) Upgraded Purge Pump & Separator
Water Processor Assembly (WPA) Multi-Filter (MF) Single Bed Operation	Water Processor (WPA) Upgraded Catalytic Reactor	Exposed Root On-Orbit Test System (XROOTS)
Urine Processor Assembly (UPA) Upgraded Distillation Assembly	Airborne Particulate Monitor (Initiation began FY21)	

Annual Highlights of Results from the ISS

- Latest highlights of research results from October 1st, 2019 to October 1st, 2020 have been published at:

https://www.nasa.gov/mission_pages/station/research/results_category

- Results are a collaborative effort of the ISS partnership and represent the research of scientists around the world for investigations sponsored by NASA, the ROSCOSMOS State Corporation for Space Activities, the Japanese Aerospace Exploration Agency (JAXA), the European Space Agency (ESA), and the Canadian Space Agency (CSA)



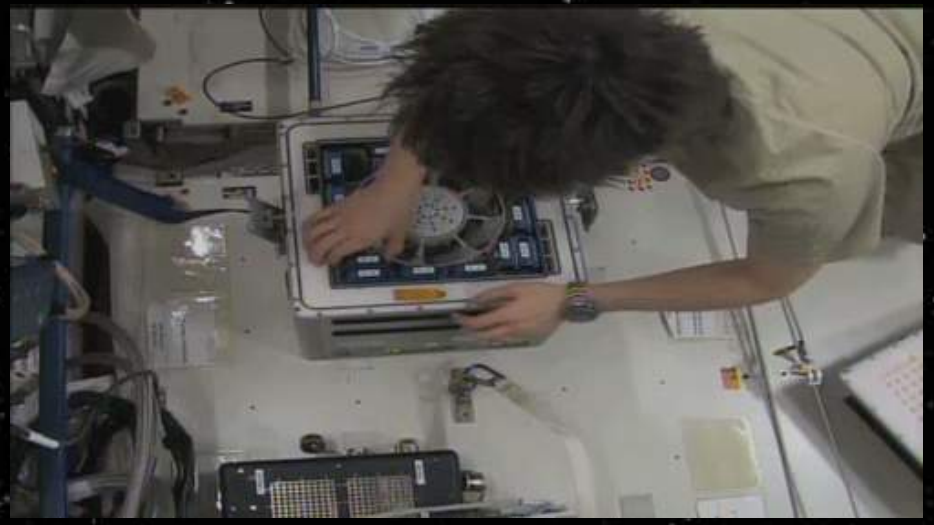
2020 Utilization Highlights

Enabling Exploration

MARROW Study (Bone Marrow Adipose Reaction: Red or White?)

- Anemia is a known issue when astronauts return from space, investigation sought to characterize problem and find cause
- Used more than 5 decades of astronaut data to determine that space anemia occurs after landing back on earth and the red blood cell loss is proportional to spending time in space, recovery taking 1-3 months depending on mission duration

Nanoparticles-based Countermeasures for Treatment of Microgravity-induced Osteoporosis (NATO)



- Project studied a type of nanoparticle that could help counteract bone density loss, a significant problem for long term spaceflight missions
- Results from the experiment conducted in 2015 showed that the new drug delivery system has beneficial effects on cells responsible for bone formation
- Research results can be used to develop treatments for both astronauts and osteoporosis patients on Earth

2020 Utilization Highlights

Science

Cold Atom Lab (CAL)

- Microgravity allowed observation of Bose-Einstein condensate (BEC) using ultracold atoms that are normally prevented by Earth's Gravity
- Can use BEC to perform tests of underlying principles of General Relativity

Organs-On-Chips

- Platform for studying effects of microgravity on human physiology and how cellular changes occur on a chip that models human organs and tissue
- Offers solutions for modeling human physiology and disease

2020 Utilization Highlights

Science

Arcsecond Space Telescope Enabling Research in Astrophysics (ASTERIA)

- Small Satellite deployed from ISS in 2017 designed to demonstrate new technologies for astrophysical observations
- ASTERIA is responsible for the first detection of an exoplanet transit by a small satellite
- Named 55 Cancri, the exoplanet is a known transiting super-Earth orbiting a Sun like star

Biomolecule Sequencer

- Investigation tests the functionality of a permanent molecular biology capability that allows scientists to sequence DNA in space real time making crew members more independent in their decision making and problem-solving strategies
- Sequencer could identify microbes, diagnose diseases, and understand crew member health

2020 Utilization Highlights

Commercial Economy

Fiber Optics Manufacturing

ZBLAN optical fibers exhibit reduced attenuation by more than an order of magnitude when fabricated in zero gravity due to suppression of sedimentation processes

STEM

EarthKAM

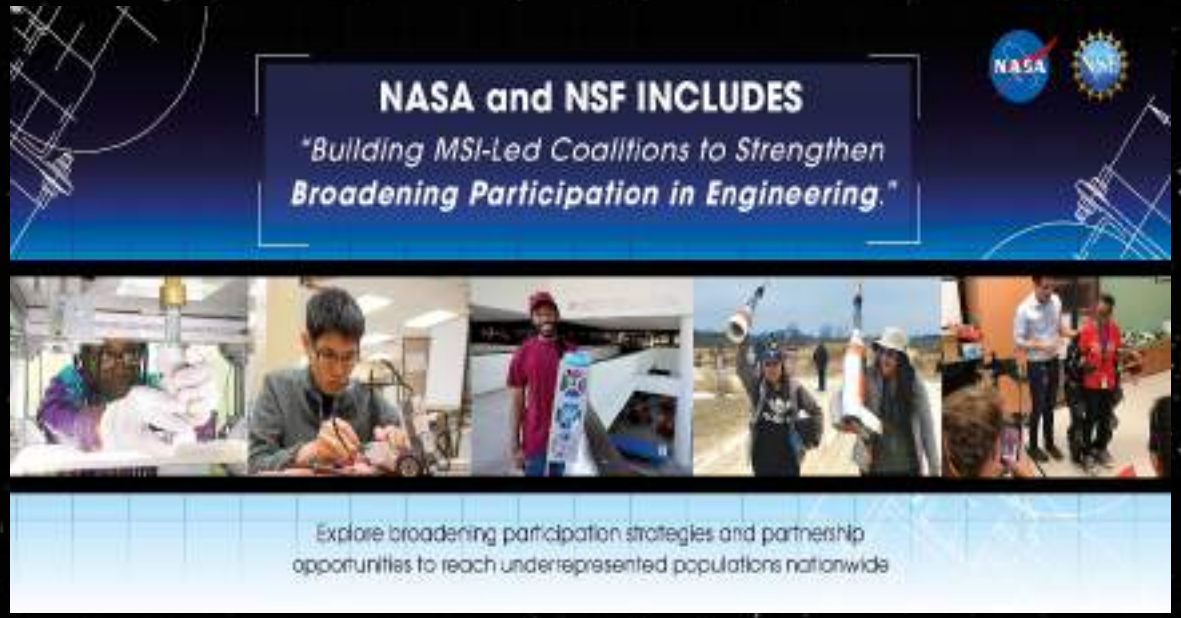
Thousands of students can remotely control a digital camera mounted on the ISS to take pictures of Earth .

2020 Utilization Highlights

Interagency Partnerships

NASA signs Memorandum of Understanding with the USDA and the NSF to continue collaboration.

NASA and NSF



NASA and NSF will continue to engage in research aboard the International Space Station ("ISS") addressing biological and physical research in microgravity, plasma physics and joint solicitations in transport phenomena, tissue engineering, and mechanobiology through ISS National Laboratory ("ISSNL")'s manager, Center for the Advancement of Science in Space.

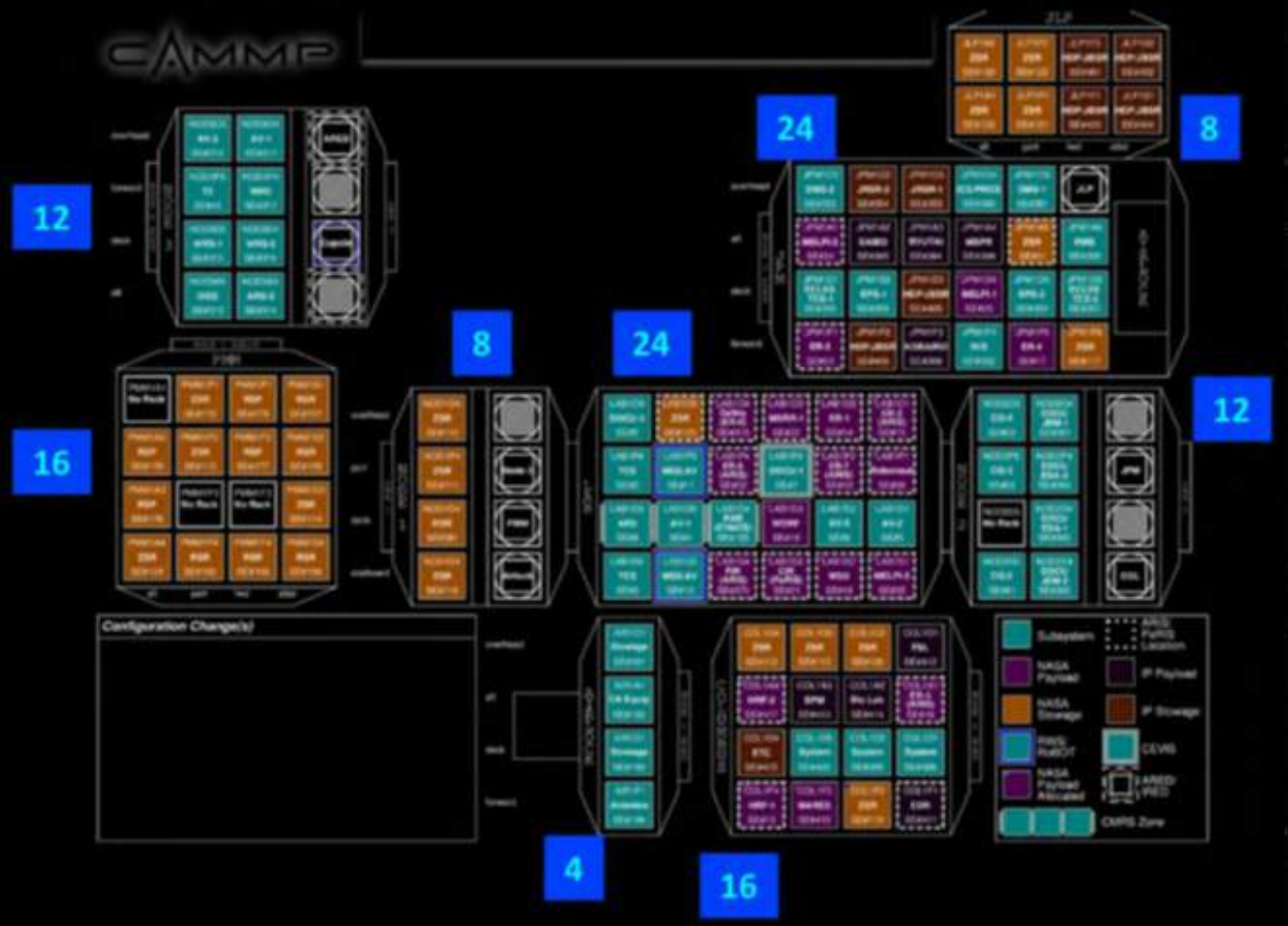
NASA and USDA

NASA and USDA will explore research gaps of importance to the agricultural community that could be addressed through innovative Earth observation systems and technologies developed over the next decade. The collaboration also will address recommendations made in the 2017 National Academies' Earth Science Decadal Survey.

Increment 64 Research Highlights

Three-dimensional Microbial Monitoring (3DMM) of ISS Environment

- Investigation uses DNA sequencing and other analyses to construct a 3D map of bacteria and bacterial products throughout the station
- 3DMM addresses specific questions by characterizing the microbial species and their natural products expressed under multiple stimuli encountered in spaceflight environments (altered gravity, atmosphere composition)
- The main objective is to determine how alterations in gravity affect microbial growth, geno- and phenotype, and natural product characteristics

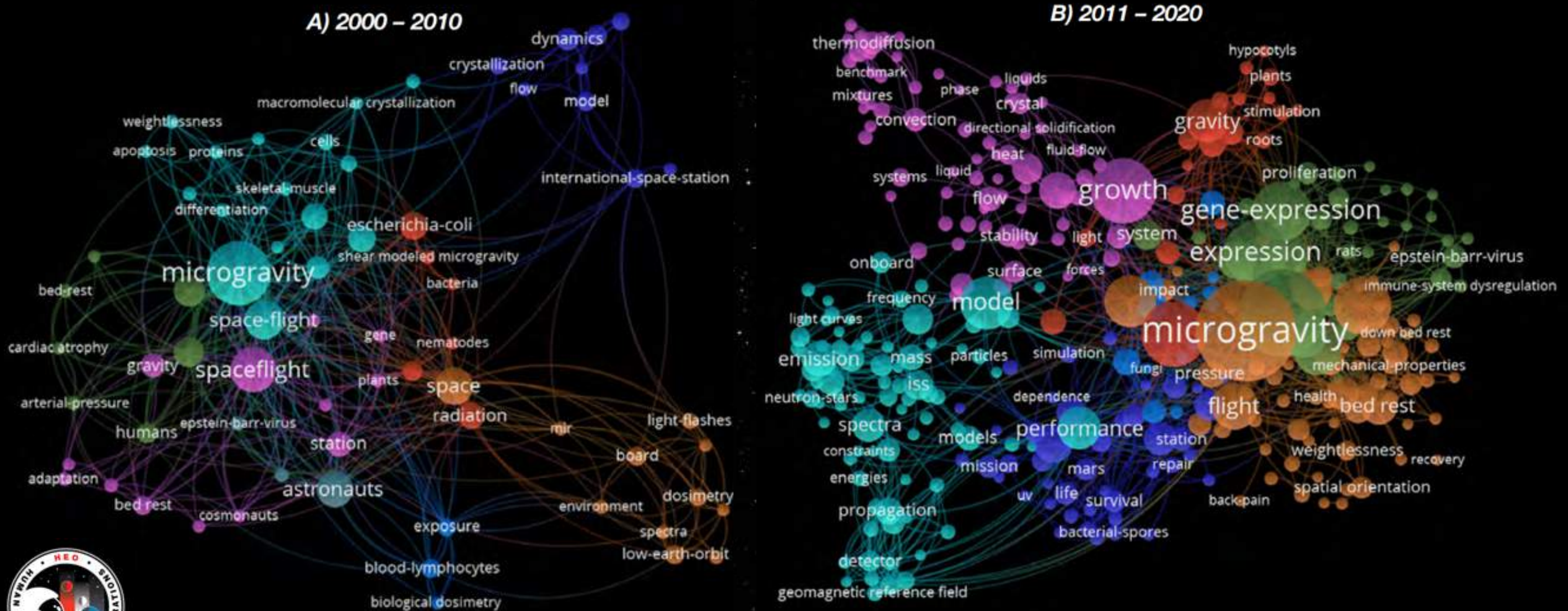


Increment 64 Research Highlights

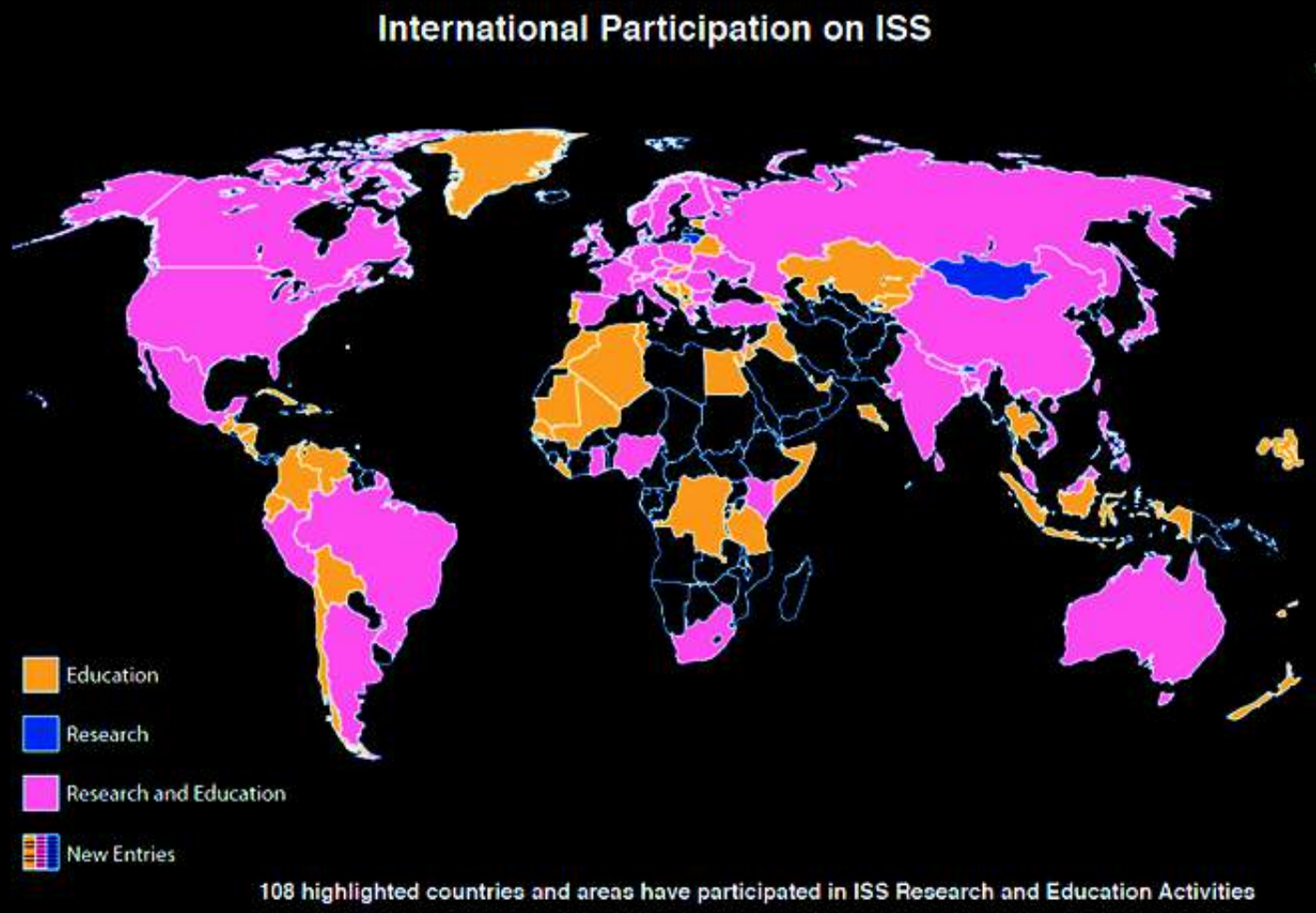
Assessment of Nutritional Value and Growth Parameters of Space-grown Plants (Plant Habitat-02)

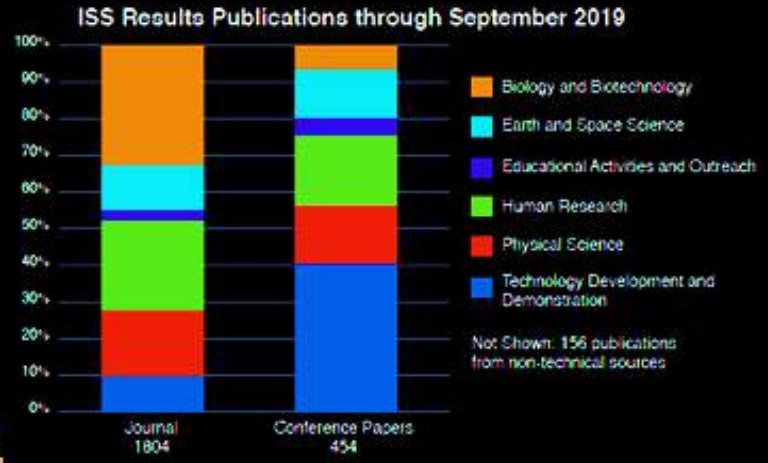
- Investigation grows radishes which is considered a model plant that is nutritious and edible, has a short cultivation time, and is genetically similar to *Arabidopsis*, a plant frequently studied in microgravity
- Developing the capability for food production in space requires understanding cultivation conditions such as intensity and spectral composition of light and the effects of the culture medium or soil
- This research could help optimize plant growth in the unique environment of space, as well as evaluation of nutrition and taste of the plants

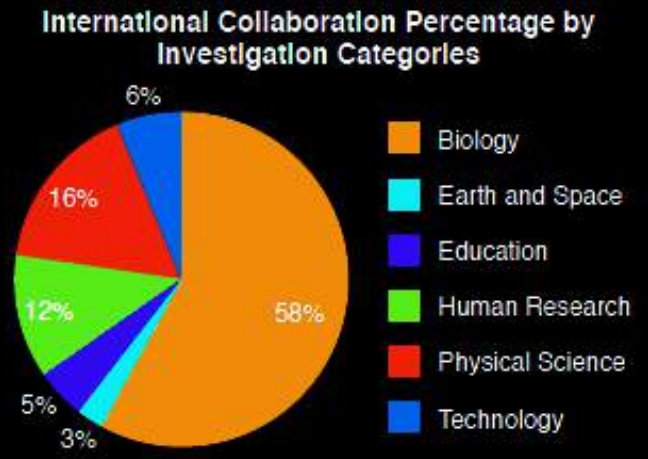
20 Years of Research Growth



Figures from: https://www.nasa.gov/sites/default/files/atoms/files/np-2020-11-021-jsc_iss_annual_results_highlights_2020-121720_c.pdf

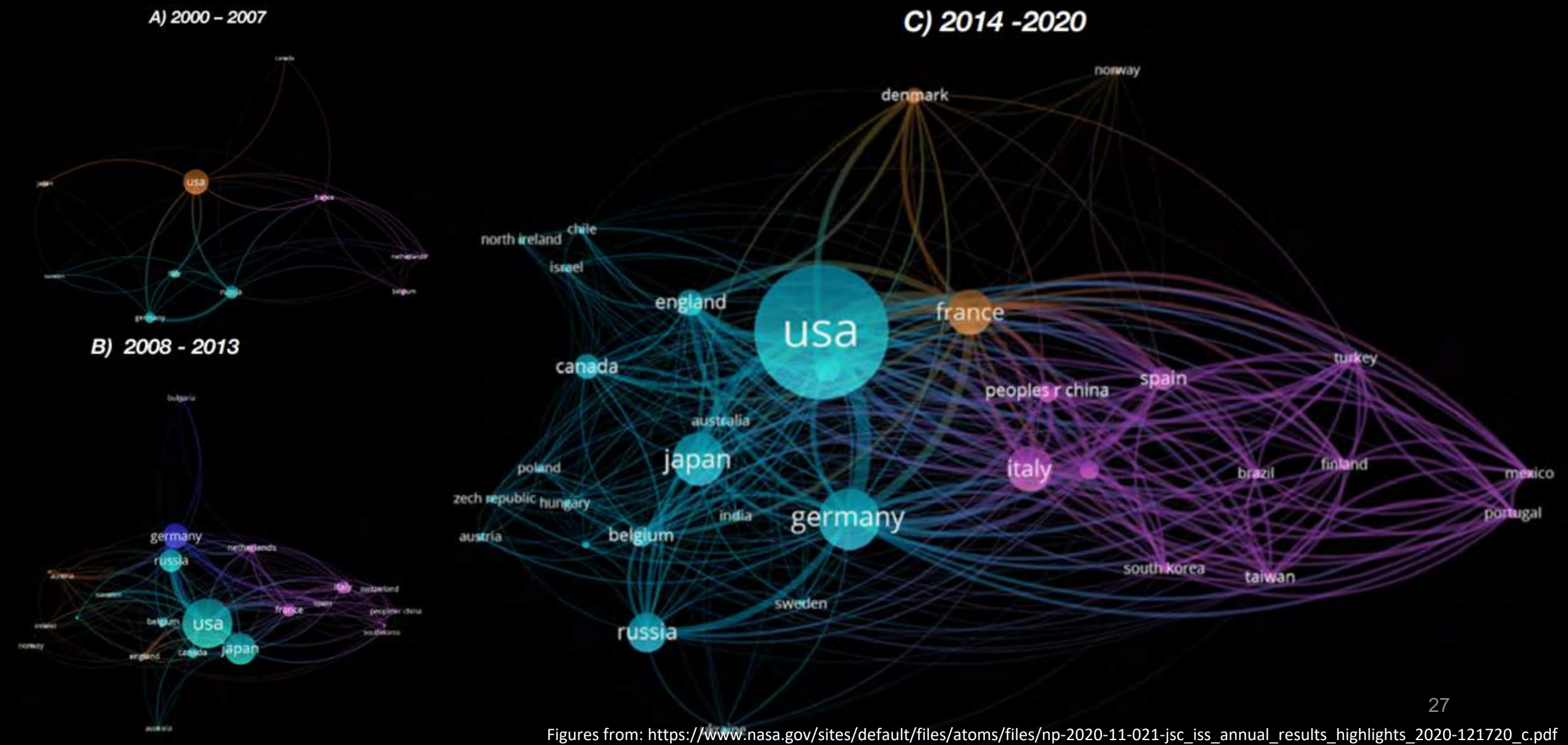






Global Involvement in Utilization

20 Years of Collaboration



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ISS Research Statistics

Current Investigations for 64: 228 †

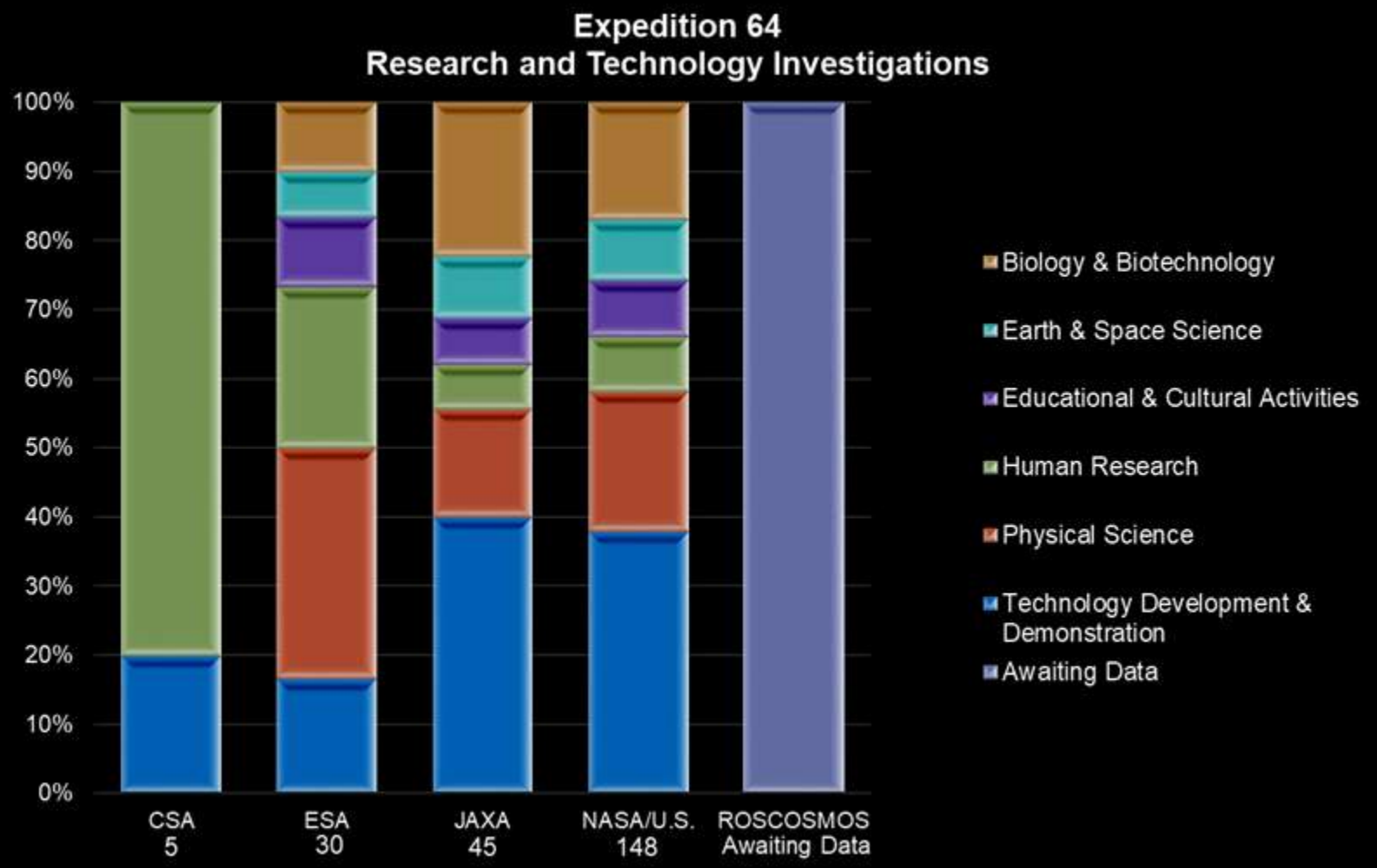
- 148 NASA/U.S.-led investigations
- 80 International-led investigations
- 45 New Investigations
  - 0 CSA
  - 7 ESA
  - 3 JAXA
  - 35 NASA/US

†*ROSCOSMOS Awaiting Data*

MCB Approved Statistics Exp. 0-60

- 2948 Investigations
- 4269 Investigators Represented
- 108 Countries/Areas with ISS Research and Education Participation
- Over 2162 Scientific Results Publications (Dec 1998 – Sept 2020)

Estimated Number of Investigations Expedition 0-64: 3156*

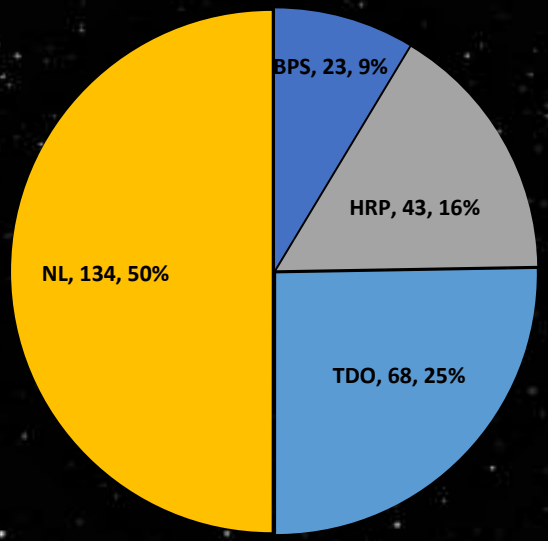


*Pending Post Increment Adjustments

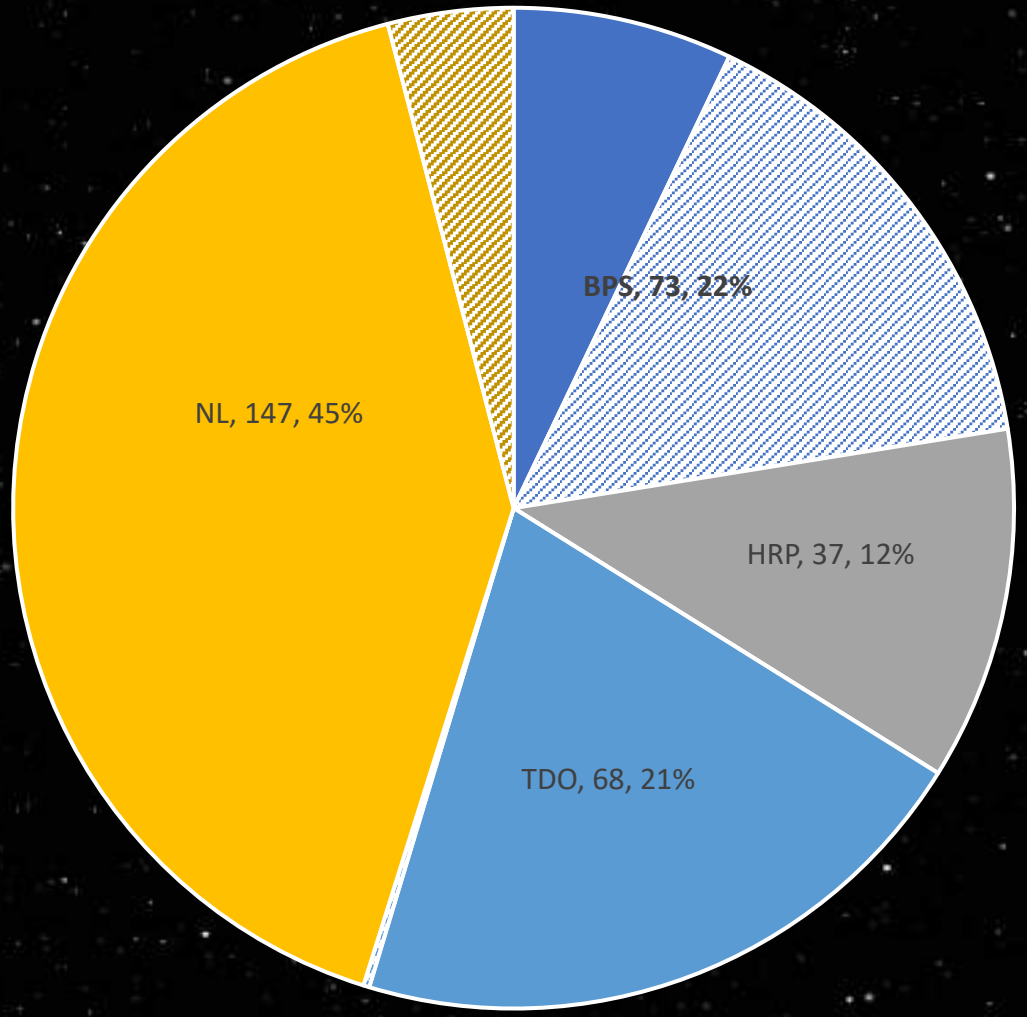
Increment 63 (April ’20 – Oct ‘20)
Crew Time by Sponsor

- **Enablers**
  - Additional capability and crew time by extending Demo 2 duration
  - Operationally ready reserve complement
- **Challenges**
  - Extended period with 1 USOS crew until Crew-1 arrival
  - Loss of research requirements from Increment due to slip of NG-14 flight
  - COVID-19 impacts to payload readiness

Planned Hours - 268



Actual Hours - 325



*Hatched wedges indicate increase from plan

ISS Future

ISS 20 Years of Human Presence

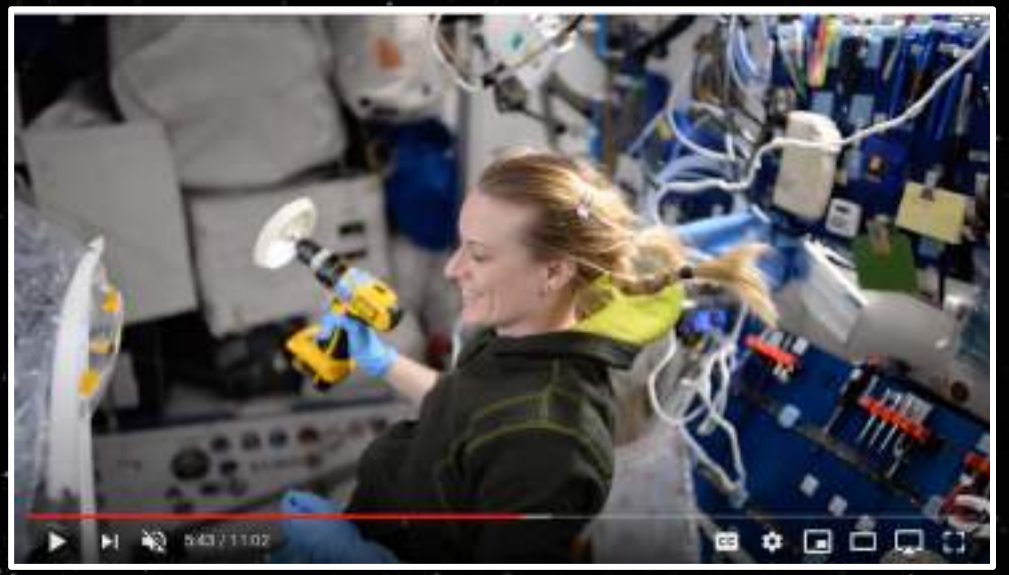
- Nov. 2, 2020 marked 20 years of continuous human presence on the International Space Station.
- A 20-day countdown celebration (October 22 – November 2) featured various online activities like:

Videos

[EZ Science episode with Drs. Ellen Stofan and Thomas Zurbuchen about the 20th anniversary]

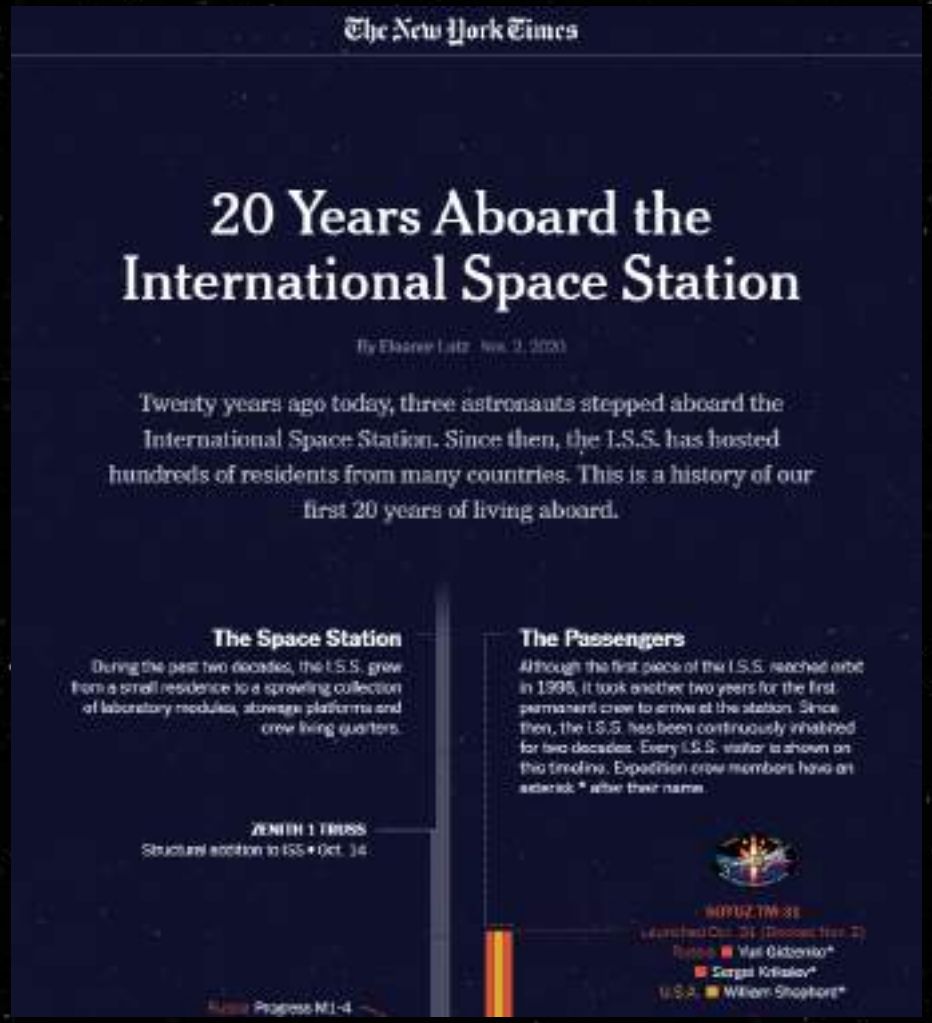
Documentary Release

[20 Years of Science: NASA Explorers S4 Bonus Video on the @NASA YouTube Channel]



ISS 20 Years of Human Presence

Web Features



Social Media Engagement

Kerbal Space Program Reddit AMA

Podcast Interview

nasa.gov/station | #SpaceStation20th

ISS Future and Transition Planning

2020 National Space Policy: "Continue the operation of the International Space Station in cooperation with international partners for scientific, technological, commercial, diplomatic, and educational purposes while developing separate commercial platforms to sustain continuous US presence in and utilization of low Earth orbit and to transition beyond ISS operations"

- **Key ISS Mission Goals:**
  - Enabling Exploration - close all technology capability gaps and human research risk reduction activities requiring ISS as a testbed
  - Research to Benefit Humanity - continue groundbreaking basic and applied government, academic, and commercial research requiring unique environment of space, with goal of sustained demand to support future platforms
  - International Partnership - continue to lead partnership and expand opportunities for global participation
  - Enable Commercial LEO Economy - work closely with Commercial LEO Office to enable new commercial initiatives and ensure no gap in LEO after ISS transition

Learn more about the space station at

NASA.GOV/STATION