



Astrobee Facility

***Sponsoring Org/Office Code: ISS Program, OZ3
Name of Forum: Astrobee Working Group
Date: April 21st, 2022***



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NASA Ames Research Center
Intelligent Systems Division (Code TI)
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Purpose



- **Purpose:** provide an Astrobe Facility overview and update
- **Select the appropriate box below:**
 - ☐ Request for Technical Concurrence
 - ☒ Information Only
 - ☐ Management Direction
 - ☐ Response to an Action Item
- **Agenda:**
 - Overview
 - Engineering
 - Operations



Overview



Project Description



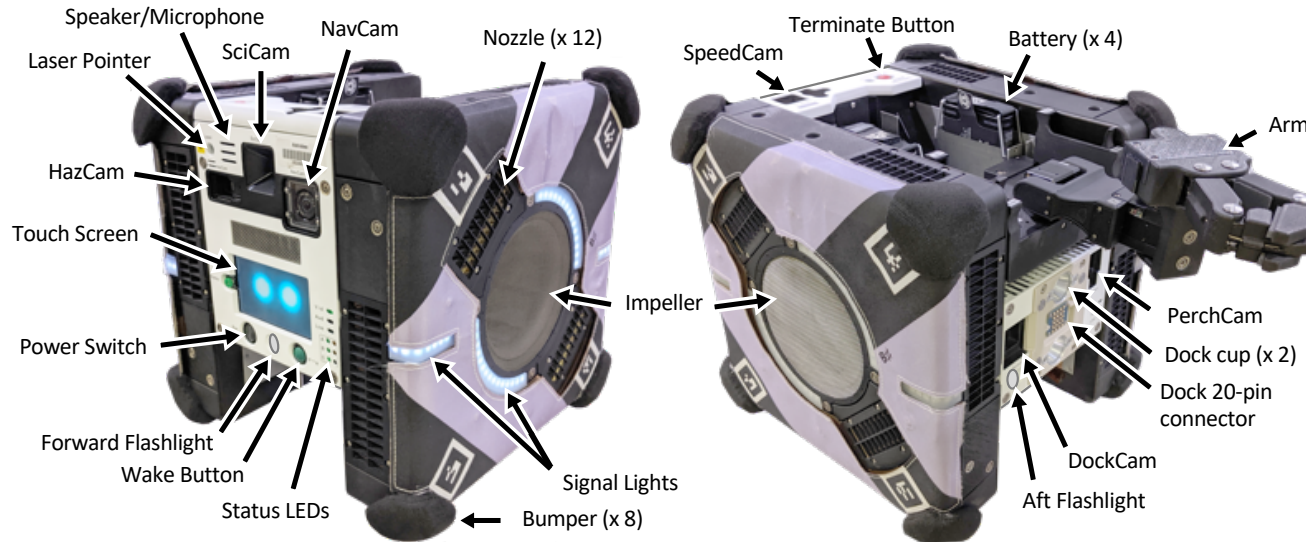
Based at Nasa Ames Research Center, the ISS Astrobee Facility provides a free-flying robotic system for ISS research and ISS STEM outreach. The Astrobee free-flying robotic system consists of three cubed-shaped robots, software, and a docking station used for recharging. The project provides sustaining engineering tasks for ensuring the facility operational readiness on ISS. The project provides payload support to users from academia, private industry, NASA, and other government agencies in the execution of ISS approved research and STEM objectives.



Chris Cassidy, GMT 248 2020



Astrobee HW Overview



- Free flying robot inside the ISS
- 32 cm wide, ~9.1kg (2 batt., no arm)
- All electric + fan-based propulsion
- Robot arm for “perching”, ~1kg
- Three smartphone computers
- Three payload bays for expansion
- Microphone not currently enabled
- More: www.nasa.gov/astrobee



Astrobee Users

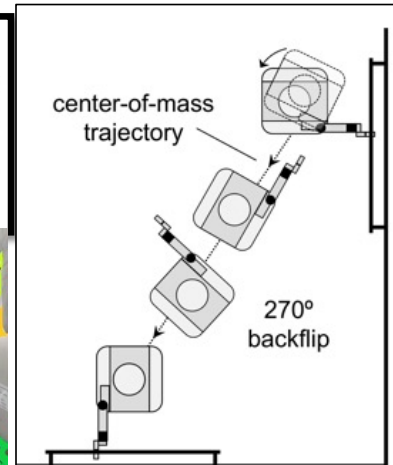
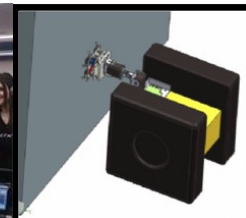
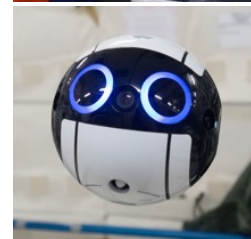


- 10 Projects actively working towards ISS payloads

- Astrobatix (Naval Postgraduate School)
- SoundSee (Astrobotic/Bosch)
- Gecko (Stanford)
- RFID Recon (NASA AES/REALM-2)
- JAXA Kibo-RPC (Third Annual)
- ISAAC (NASA STMD/GCD)
- SVGS (FIT)
- SOARS (Zero-g Horizons)
- Cubee/CLING
- Zero Robotics

- Complete:

- Astoportor (Tethers Unlimited)
- REGGAE (NanoRacks/Braunschweig)
- ROAM (MIT/DLR)
- ReSWARM (MIT)

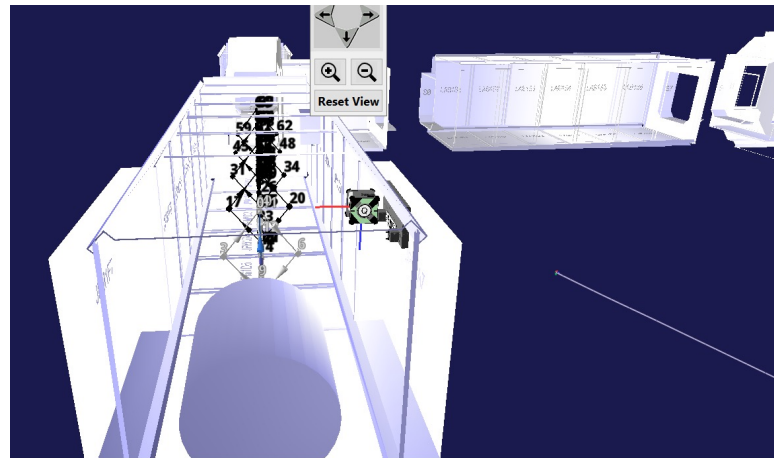




Highlights



- Maintained a high operating tempo
 - 13 Activities since the last AWG (10/28/2021)
- Dozens of successful research activities executed successfully and looking forward to dozens more in 2023 and beyond
- Celebrating 3 years of ISS Operations this month, April 2022



Bumble Shooting Star, Oct. 26, 2021



Astrobees Summary since last AWG



By Months

12/1/2021

4

- Start Date

- Number of Months

Legend

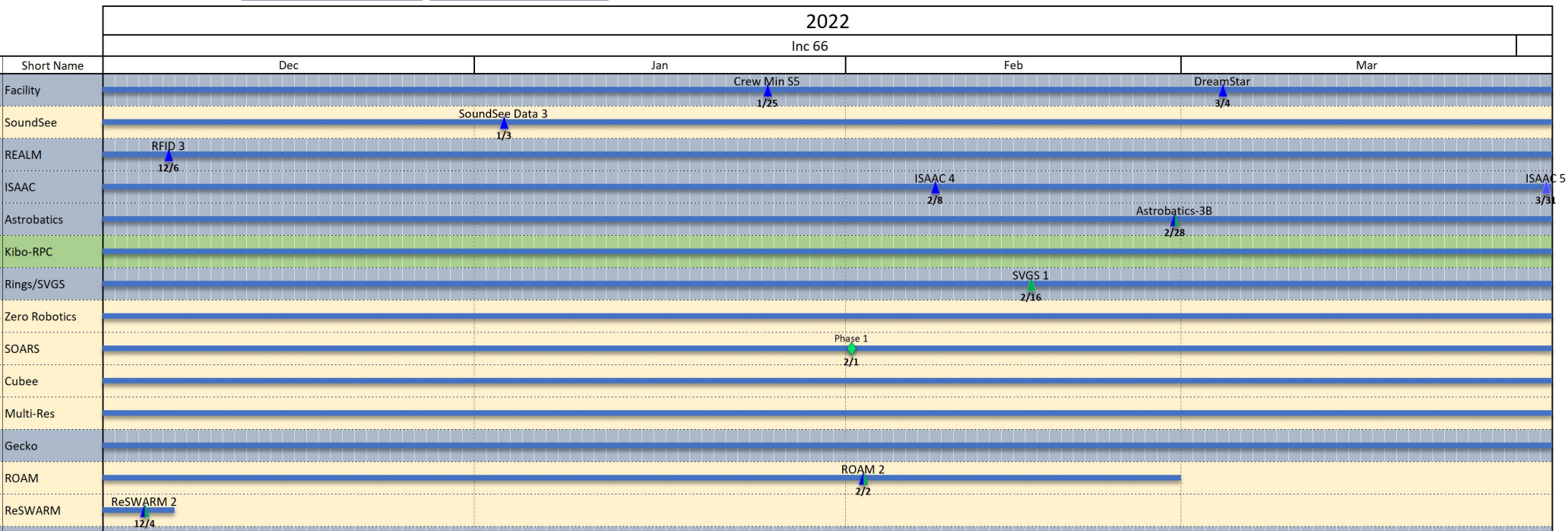


Astrobees



2022

Inc 66



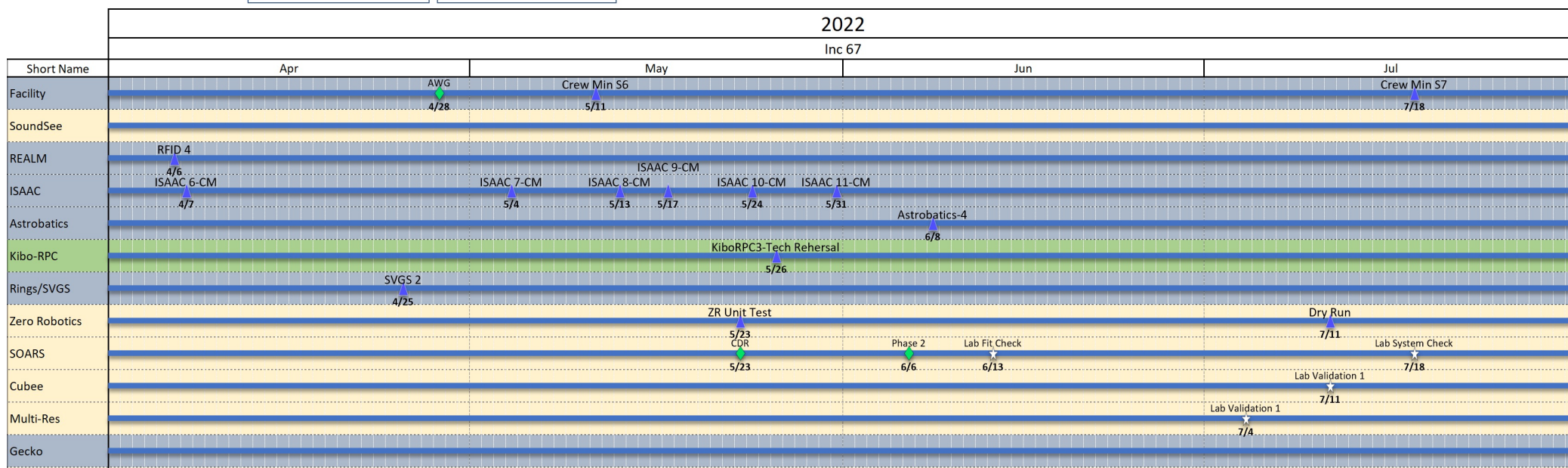
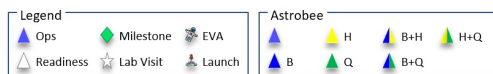


Astrobee Calendar



By Months
4/1/2022
4

- Start Date
- Number of Months

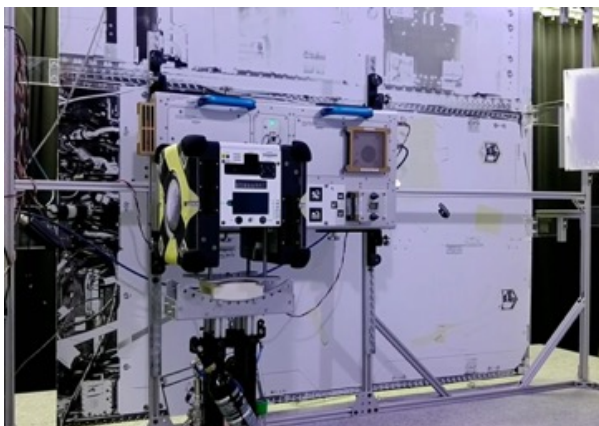




Hardware and Lab Status



- Granite Lab: Online



- Flight Lab: Online



- Engineering Evaluation Lab (EEL): Available upon request

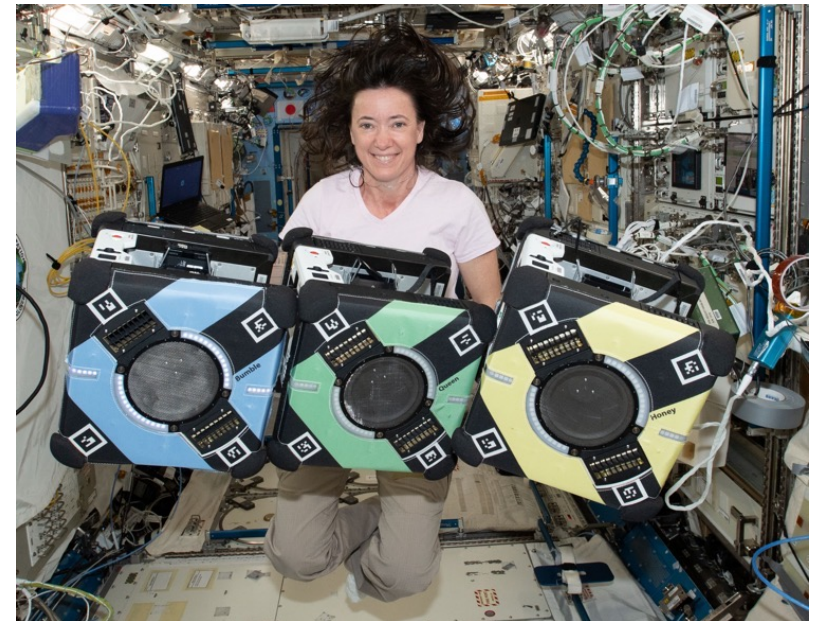
Name	Status
Flat Sat A	Operational
Flight 1,3	In Space, Operational
Flight 2	On Ground, In Repair
Flight Spare	Operational
Cert (B#)	Operational
Ground (Wannabee)	Operational



Honey Debug



- Honey at Ames for repair and testing
- SD Card failure confirmed
- Cleanliness evaluated
 - some maintenance for on-orbit units recommended
- Trade study conducted for SD card
- New cards are being procured





More Modules



- Node 2 mapping data gathered in ISAAC activity on 08 Feb
- Node 2 Map created on 18 Mar
- ISAAC activity on 31 Mar
 - US Lab mapping data gathered
 - Good results with Node 2 Map





2022-04-07 ISAAC-6



4 crew members working independently

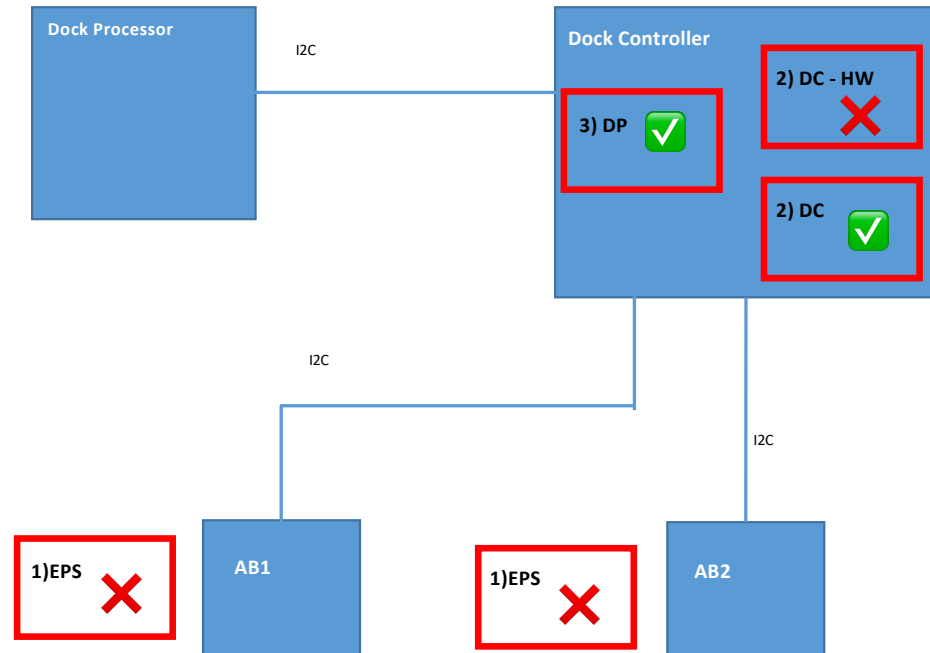




Dock Software Update - Status



- Recovery mode SSH and two watchdogs implemented
- Hardware watchdog requires further analysis
- EPS watchdog not yet implemented





User Integration Status

overall assessment



User Support: (by user, percent complete)

- User community support (Comm)
 - System documentation, working group meetings, conferences, public outreach
- Assessment and technology demonstration (Assess)
 - initial payload assessments,
 - ground-only/non-IPL technology demonstration support (e.g. NASA-STMD funded SBIR's and Grants)
- Integration, safety, and verification (Integration)
- Interface and user training (Interface)
- Lab testing (Lab)
 - Hardware/Software/Network interface testing
 - Operational Readiness Testing (ORT)
- Ops planning (Planning)
 - procedures, crew training, increment scheduling
- Ops activates (Ops)
- Data distribution

Finished Investigations

JAXA Kibo-RPC – Year 2

ROAM (MIT)

ReSWARM (MIT)

User	Percent Complete
Astrobatix (Naval Postgraduate School)	100
SoundSee (Astrobotic/Bosch)	100
Gecko (Stanford) – Phase 2	20
RFID Recon (NASA AES/REALM-2)	100
ISAAC (NASA AES)	100
SVGS (FIT)	60
SOARS	20
JAXA Kibo-RPC - Year 3	75
Cling/CUBEE	20
Multi-spectral	20
Zero-Robotics	20



Astrobee Family



Megan McArthur, All three Astrobee's, September 20th, 2021



Operations



Astrobee Utilization Stats Since last AWG



Utilization Stats to date	
Number of on orbit test sessions:	13
Unique Crew Members trained:	4
Number of on-console hours:	99
Crew hours	34



Operations: Functions



- Ensure Facility Readiness for ISS Test Sessions
 - All crew training is handled via Onboard Training (OBT).
 - Manage crew procedure and all planning products updates via OCR/ECR system
 - Coordinate crew time with ISS Lead Increment Scientist and POIC Cadre
 - Assist Astrobe team & PDs in acquiring proper access to ops systems as required for real-time ops support
 - Coordinate with investigators for product development and delivery
 - Help investigators set up remote communication capabilities as needed
- Real-Time ISS Test Session support
 - Coordinate with MSFC and POIS (POIC Specialist) all deltas to real-time ops and products
 - Support crew & POIC cadre with real-time ops – plan and conduct crew conferences as needed
 - Coordinate commanding and data download window requirements and planning
 - Test session data and video management
- Public Relations
 - Maintain website, work with ARC PAO office to publish material on site



Operations: Functions



- Increment Planning
 - 2-pager development and submittal, updates as needed throughout increment
 - Assist PIM (Payload Integration Manager) with CEF inputs as needed
 - Regular timeline planning with Lead PPM (Payload Planning Manager), PPM planning team and MSFC POIS/PARC team
- Safety and Verification Assessments
 - Integrated Safety & Verification Assessments as needed for Astrobees Facility and Guest Science Payload Developers (PDs)
 - Continued SPHERES Safety & Verification focuses on return of hardware.
 - Complete CoFR (Certification of Flight Readiness) for ground systems and on-orbit hardware and operations products
- Astrobees Ground Ops Development
 - Coordinate ground Engineering and Operations Readiness Tests (ERTs/ORTs) in preparation for real-time ops
 - Work with Astrobees team and PDs to develop flight procedures, coordinate reviews with MSFC for final delivery and formal ECR review

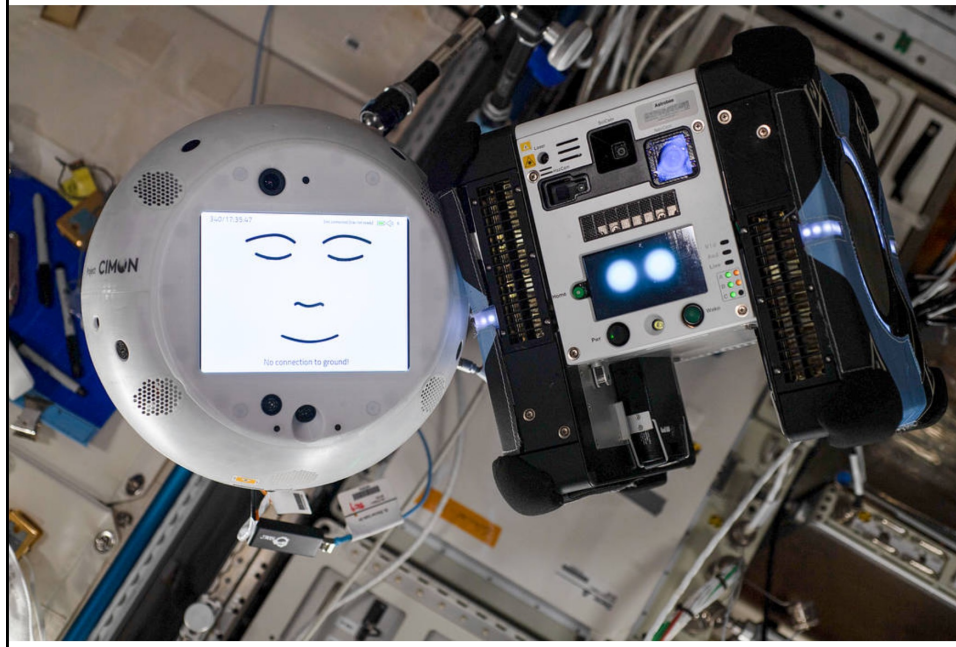


Astrobee Outreach



Mar 22, 2022

Robot Colleagues Meet Aboard the International Space Station



Website

<http://www.nasa.gov/spheres>

<http://www.nasa.gov/astrobee>



QUESTIONS?



Back-up Slides



Topic	Slide





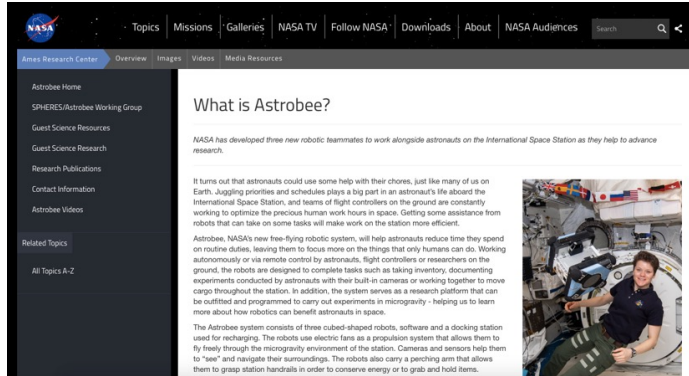
EPO Activities



- Summary of Education and Public Outreach
- Significant Media Coverage



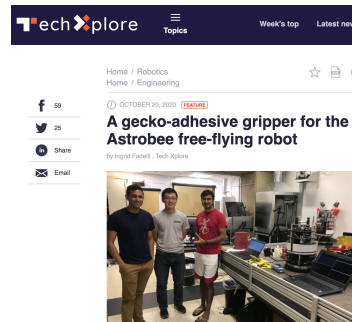
Web Features



www.nasa.gov/Astrobee

Hi Honey! NASA's Second Astrobee Wakes Up in Space

Hi Honey! NASA's Second Astrobee Wakes Up in Space



A gecko-adhesive gripper for the Astrobee free-flying robot



www.nasa.gov/astrobee





Stats



- **From the last AWG (7.8.21) to date**
 - 15 Test Sessions over 16 weeks (highlighted on slide 5 of the ops deck)
 - 4 unique crew
 - ~113 real-time console ops hours (not including data downloading)
 - 40 crew hours
- **Fiscal year (Oct 2020 through September 2021)**
 - 40 Test Sessions
 - 9 unique crew
 - ~330 real-time console ops hours (not including data downloading)
 - 101 crew hours
- **From 4/30/20 (our first remote ops Test Session) to date**
 - 55 total remote Test Sessions (1.4 weeks/session)
 - 10 unique crew (Chris Cassidy was our sole crew member for months.)
 - ~440 real-time console ops hours (not including data downloading)
 - 122 crew hours



On Break, back at 01:05pm PST