



NASA/JAXA – Astrobee & IntBall Cooperation

Japan-U.S. Open Platform Partnership Program (JP-US OP3)

ISS Kibo Symposium, Tokyo, Japan

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Synchronized Position Hold Engage Reorient Experimental Satellites (SPHERES)



- A Facility of the ISS National Laboratory with three IVA nano-satellites designed and delivered by MIT to research estimation, control, and autonomy algorithms
- Installed on ISS in 2006
- Managed by NASA ARC since Fall 2010
- By working aboard ISS under crew supervision, it provides a risk tolerant Testbed Environment for Distributed Satellite & Free-flying Control Algorithms
 - ✓ Formation flight, Docking, Proximity Operations
- If anything goes wrong, reset and try again!
- The satellites can be reused
 - ✓ Replenishable consumables
 - ✓ Multiple test sessions assigned per year



NatGeo – “Live from Space”

If you can't bring the space environment to the laboratory, take the laboratory to space!

Over 154 Test Sessions (1,000+ hrs. of Facility Console activities involving crew)
One of the most used and popular ISS National Lab Facilities

Synchronized Position Hold Engage Reorient Experimental Satellites (SPHERES)



SPHERES welcomes scientists from around the world. GSP documentation, Simulator, and Support!



SPHERES team supporting Live ISS Test Session

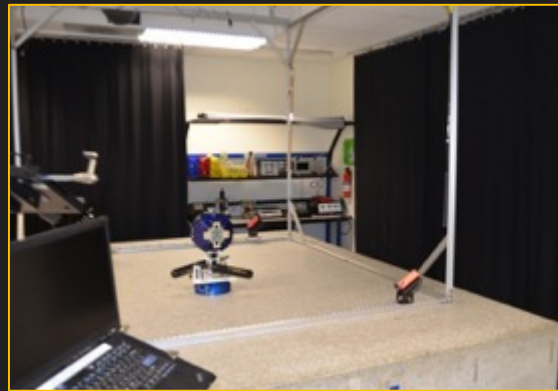


12+ years aboard ISS



Flight HW Lab

National Aeronautics and Space Administration



Granite Lab

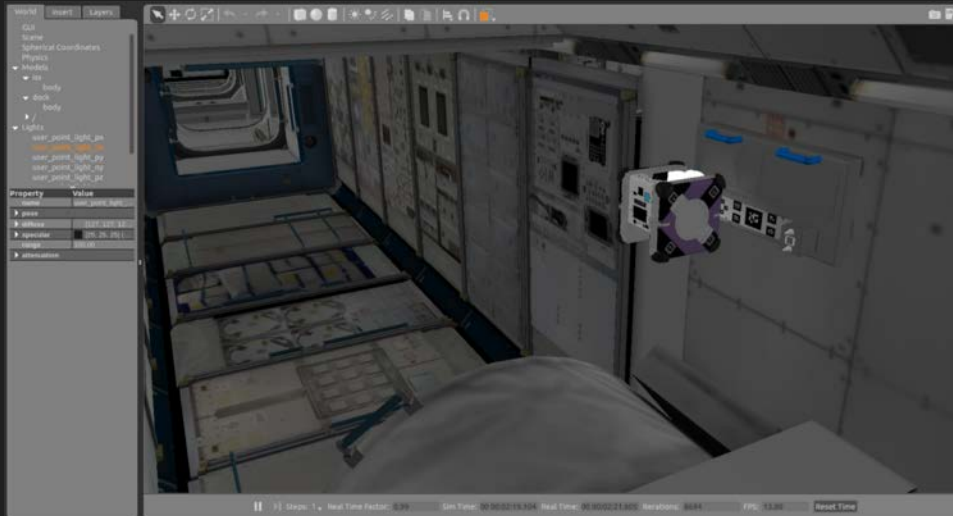


Microgravity Test Facility (MGTF)

Astrobee... Next Generation Free Flyer Robot



- six cameras
- touchscreen
- speaker
- microphone
- signal lights
- laser pointer

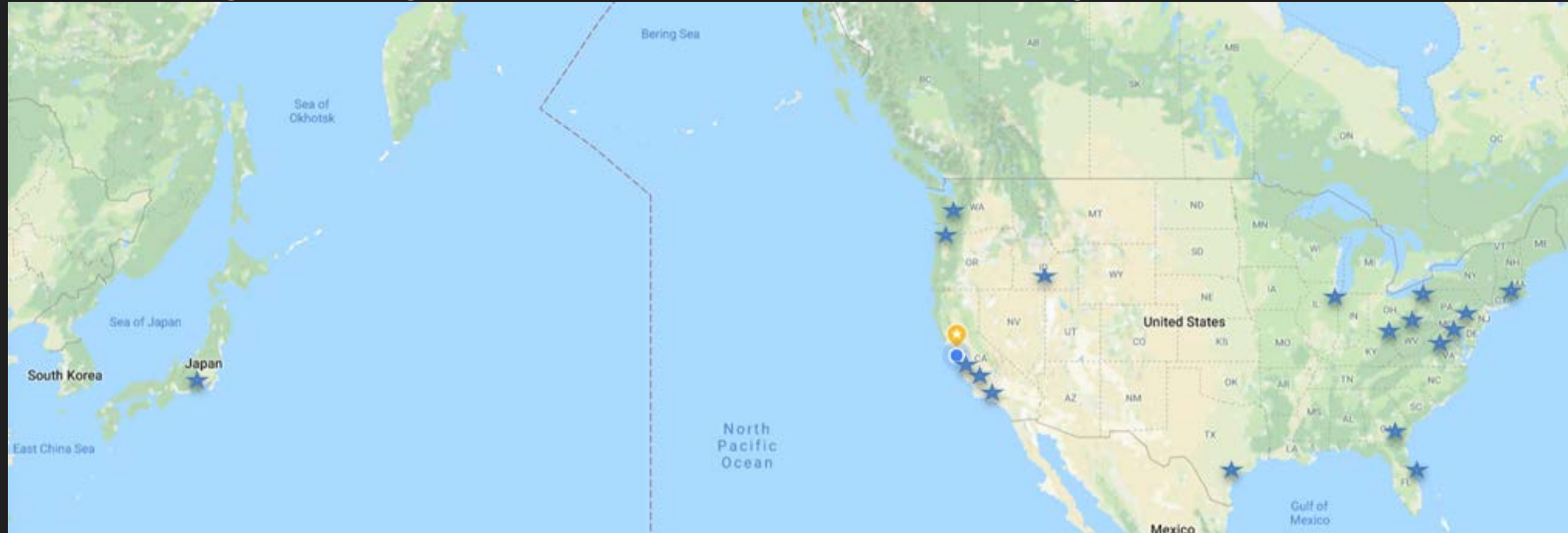


Astrobee Simulator Visualizer



2019 on ISS

- **40+ projects have expressed interest in using Astrobee**
 - ✓ Topics range from 0g fuel tank slosh to propellantless flight via acrobatic arm motion



- **7 Projects actively working towards ISS payloads**
 - ✓ MIT/Zero Robotics
 - ✓ US Naval Postgraduate School
 - ✓ Astrobotic/Bosch
 - ✓ Stanford Univ.
 - ✓ NASA JSC REALM
 - ✓ NASA ARC Port Tester
 - ✓ **NASA/JAXA joint activity**

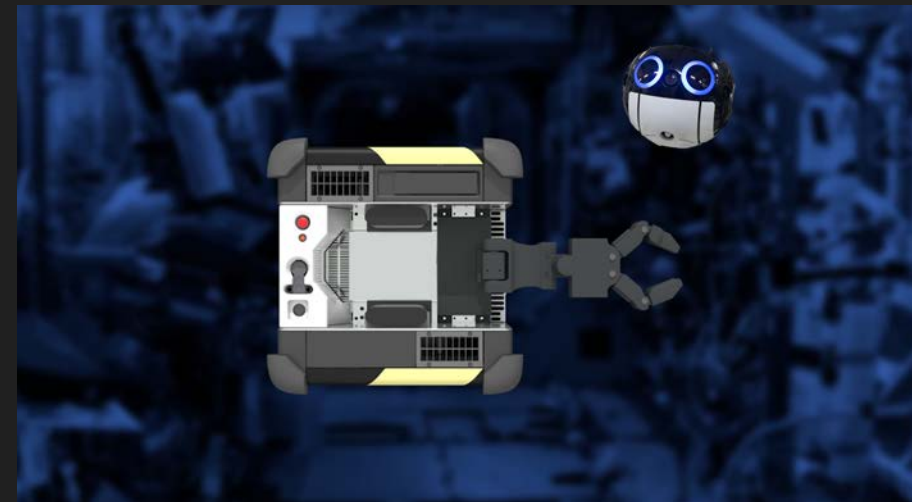


JP-US OP3

- Increased cooperation with developing spacefaring countries in the Asia-Pacific region, possibly through utilization of ISS resources.

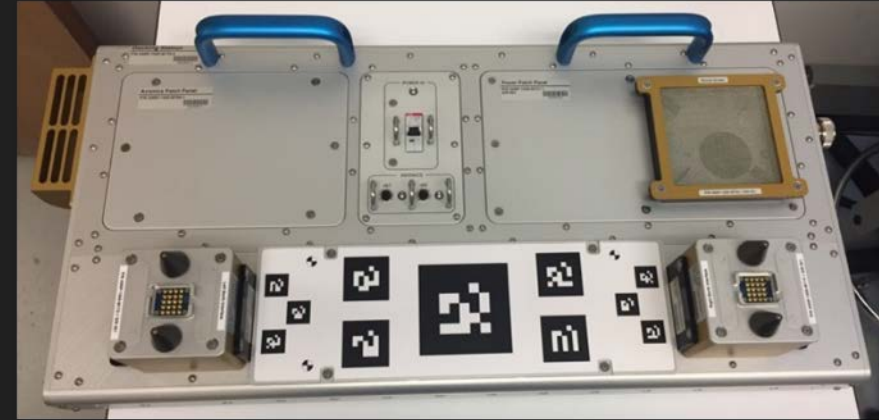
Status

- JAXA and NASA agreed to collaborate on developing spacefaring countries in the Asia-Pacific Region by holding a student competition utilizing NASA's Astrobees and JAXA's Int-Ball hardware.
- The detailed plan, including roles and responsibilities, has been coordinated by JAXA and NASA.
- Planning meetings and technical discussions in person at NASA Ames (July 2018) and Tsukuba (this week)





Astrobee Acoustic Testing at NASA JSC



Docking Station delivered to ISS on NG-10 NOV 2018

**Docking Station to be installed in the JEM this week
Astrobee Flight Units Delivered to JSC**

- 2 units manifested on NG-11 – April 2019
- 1 unit manifested on SpaceX-18 – June 2019



Astrobee Flight Units delivered to JSC

- NASA and its international partners have begun the initial formulation phase of the Gateway project. Gateway will not have crew on-board like we do in the ISS. Therefore, Intra-vehicular Robots will play a key role and will be required to conduct autonomous activities.

Status

- Formed the Gateway IV-R Working Group with international partner participation – (JAXA included)
- The IV-R working group is defining initial concept of operations, use cases, and requirements drafts.
- Free flyer Robots and other type of robotics will be considered.





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✓ JAXA/NASA joint activity

