

SPHERES

Synchronized, Position, Hold, Engage, Reorient,
Experimental Satellites



SPHERES/Astrobee Working Group (SAWG) Quarterly Meeting

October 3rd, 2018





Agenda

Agenda:

Please average less than 10 minutes each, I'm targeting a 1.5 hour meeting time, Thanks!

- 0 NASA Ames, Introductions
- 1 NASA Ames, SPHERES Facility Status (Jose B.)
- 2 NASA Ames Astrobees Status (Maria)
- 3 NASA JSC, Andrew Chu, REALM-2 (Verbal, No slides)
- 4 NPS, Dr. Josep Virgili-Llop, Astrobatics
- 5 Stanford, Abhishek Cauligi, Gecko Gripper
- 6 Astrobotic/Bosch, Fraser Kitchell, SoundSee
- 7 Tethers Unlimited, Brandon Smith, Astroporter
- 8 NK Labs, Rachel Chaney, EMAP
- 9 AltiUS Space, Jonathan Golf
- 10 NMSU, Dr. Hyeonjun Park, Astrobees MPC



SPHERES Community

□ SPHERES Working Group (SWG) Quarterly meeting

- Membership includes MIT, FIT, AFS, DARPA, CASIS, Airbus, and NASA (HQ, KSC, JSC, MSFC, and ARC)
- Face-to-Face, twice a year
- Next will be scheduled in May 2018, location TBD

□ Purpose:

- Information sharing across the SPHERES/Astrobee community
 - Astrobee Facility shares
 - ✓ National Lab Facility availability
 - ✓ Status of resources (batteries, CO2 tanks, etc.),
 - ✓ Overall Calendar (scheduled Test Sessions, upmass/return), and
 - ✓ Updates on “new” PD, Investigations, and ISS infrastructure.
 - Provide the SPHERES/Astrobee community (PD, investigators, etc.) with up-to-date information to determine opportunities to use the NL Facility
 - Discuss proposed changes/updates to Astrobee Nat Lab which may be required to support a specific activity or research.
 - Discuss specific support requests made to the ISS Office
-



Today's Goals

□ The SPHERES/Astrobee Facility success as a platform for technology development and fundamental research depends on the success of it's users

- What's your current goal with Astrobee? (Lab Demo? ISS Demo?)
- Plan for getting there
- Are there some make-sense partnerships with other groups here?





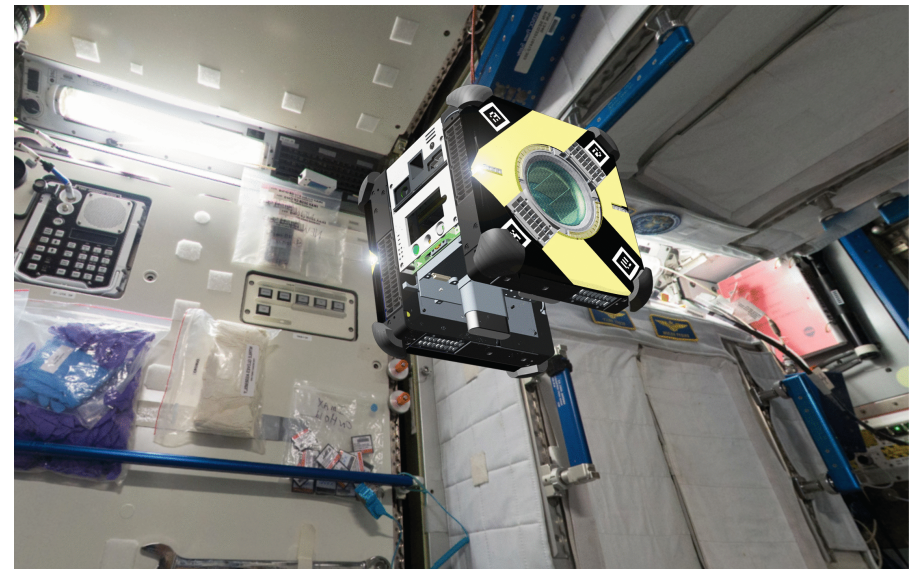
Guest Science Program (GSP)

- ❑ What's available from the Astrobee Facility?
 - ❑ Astrobee Robotics Software Simulation
 - ❑ Ground Hardware: Qty 3 & "Flat-Sats"
 - ❑ Labs: Granite & MGTF
 - ❑ Documentation and Training
 - ❑ Proposal Support
 - ❑ ISS Payload Partner
- ❑ How can I use Astrobee and what does it take?
 - ❑ **Guest Scientist Guide** & Mechanical Payload ICD
 - ❑ New Hardware or "just" Software?
 - ❑ Ground Demonstration or ISS Operation?
- ❑ We want to hear from you!
 - ❑ Approximate Scheduling
- ❑ Information found on website
<https://www.nasa.gov/astrobee>



What's next ...

- ❑ Next ZR competition is under way
- ❑ Continuing Vertigo Smooth Navigation research
- ❑ Continuing Tether-Slosh
- ❑ Continuing SPHERES-ReSWARM
- ❑ **Continue work transitioning to Astrobees**
 - ❑ Goal: Fully operational in 2019
- ❑ Astrobees and Int-Ball joint-activity discussions continuing
- ❑ Interns (Matt, Ruben, Cole, Vivek, Peter, Bryce)
 - ❑ Zero Robotics
 - ❑ GSP Software
 - ❑ Astrobees Build
 - ❑ Air Sampling on ISS



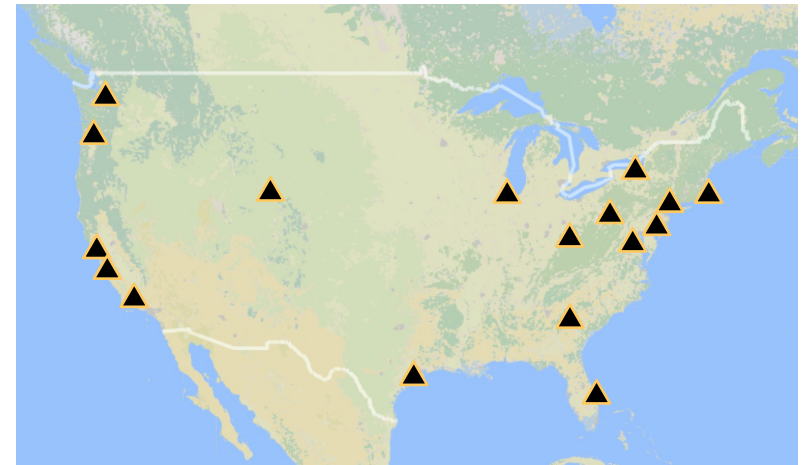


Guest Scientists

- ❑ Replacing SPHERES, it is anticipated that Astrobee will carry on as the **most highly utilized payload on the 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
 - Naval Postgraduate School
 - Astrobotic/Bosch
 - Stanford
 - REALM
 - JAXA joint activity
 - [Port Tester]

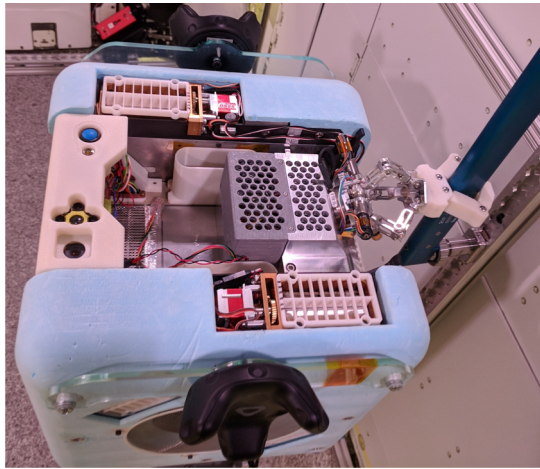


Astrobee guest scientist institutions in the US

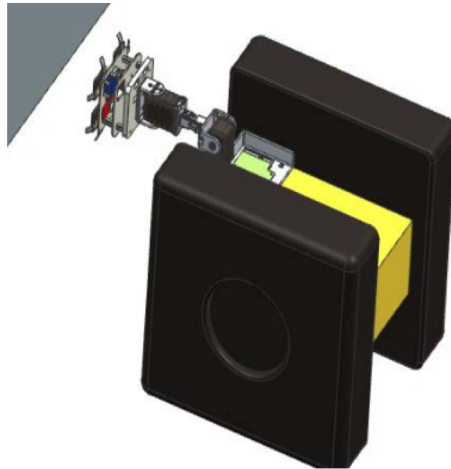
- ❑ **Ground Studies**
 - FIT/RINGS
 - Tethers Unlimited
 - NMSU



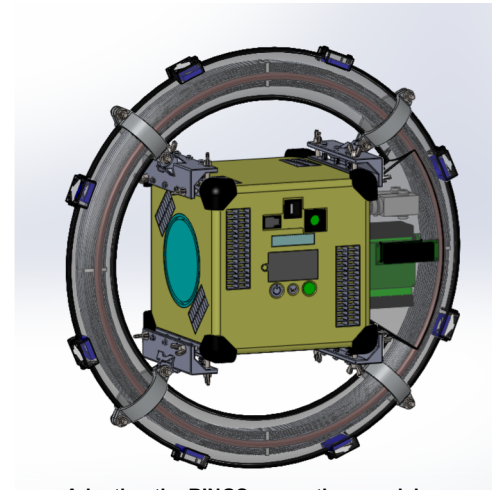
Guest Science Concepts



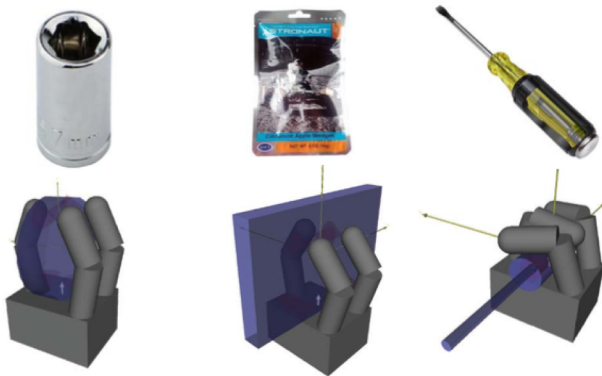
Prototype Astrobee arm based on Canfield joint, enabling new motions (Tethers)



Gripper concept based on gecko-like adhesives (Stanford)



Adapting the RINGS magnetic propulsion payload to Astrobee (FIT)



Improving gripper dexterity without increasing actuator count (Columbia)



Arm grasping controller developed using Astrobee open source simulator (NPS)

and many more...

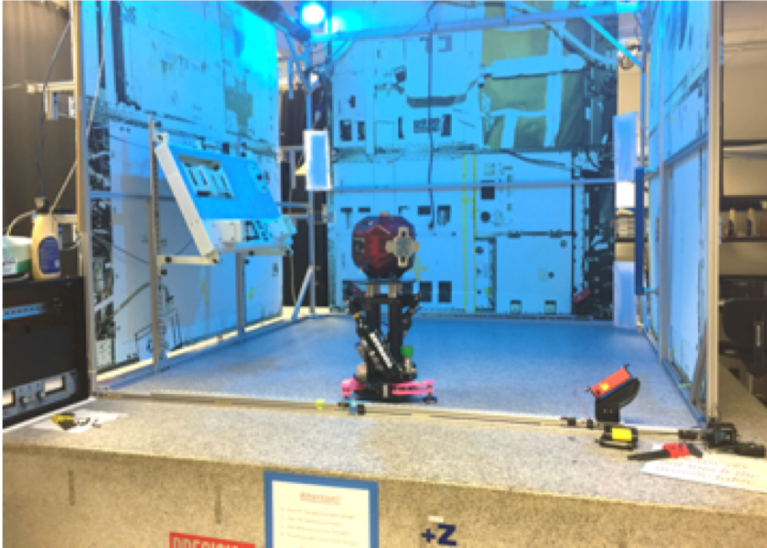


SPHERES Engineering



Ground Lab Status

- Granite Lab: Online



- Flight Lab: Online



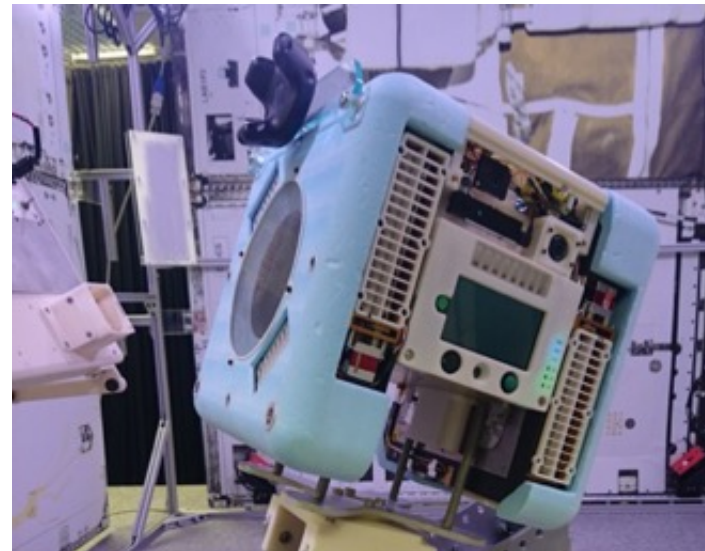
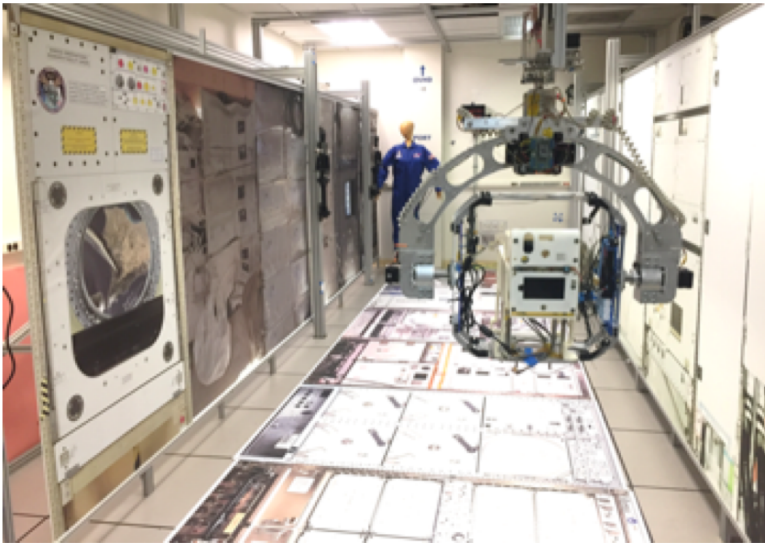
- Micro Gravity Test Facility (MGTF) Lab

- Engineering Evaluation Lab (EEL): Available upon request



Hardware Fidelity (Astrobee)

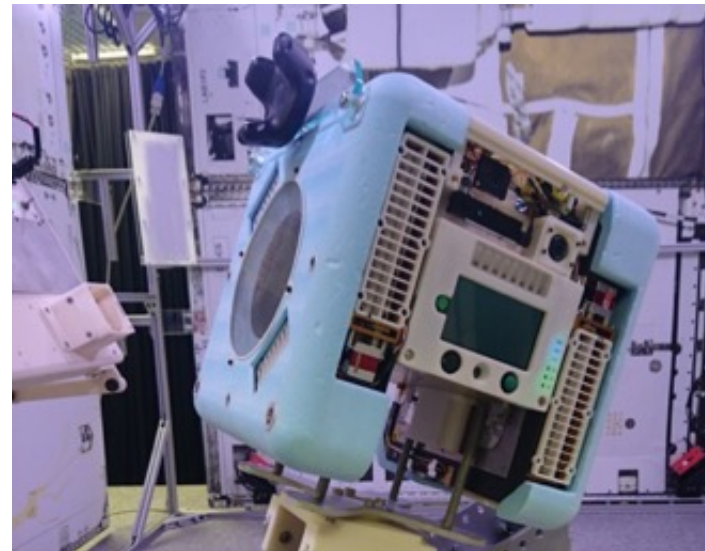
Name	Mechanical Fidelity	Electrical Fidelity	Software Fidelity	Sensor Fidelity
P4C	Low	Low	Low	High
P4E	Med	Med-High	High	High
Flat Sat A	Low	High	High	Low/None
Cert	High	High	High	High
Flight 1	High	High	High	High





Hardware Status (Astrobee)

Name	Status	Plans
P4C	End-Of-Life	Available in MGTF but unsupported
P4E	Operational	Dev. Testing in Granite until Cert, then MGTF
Flat Sat A	Operational	In use by FSW team
Cert	Complete	Debugging, then verification testing
Flight 1	In-Work	Complete by 08/17, then verification testing

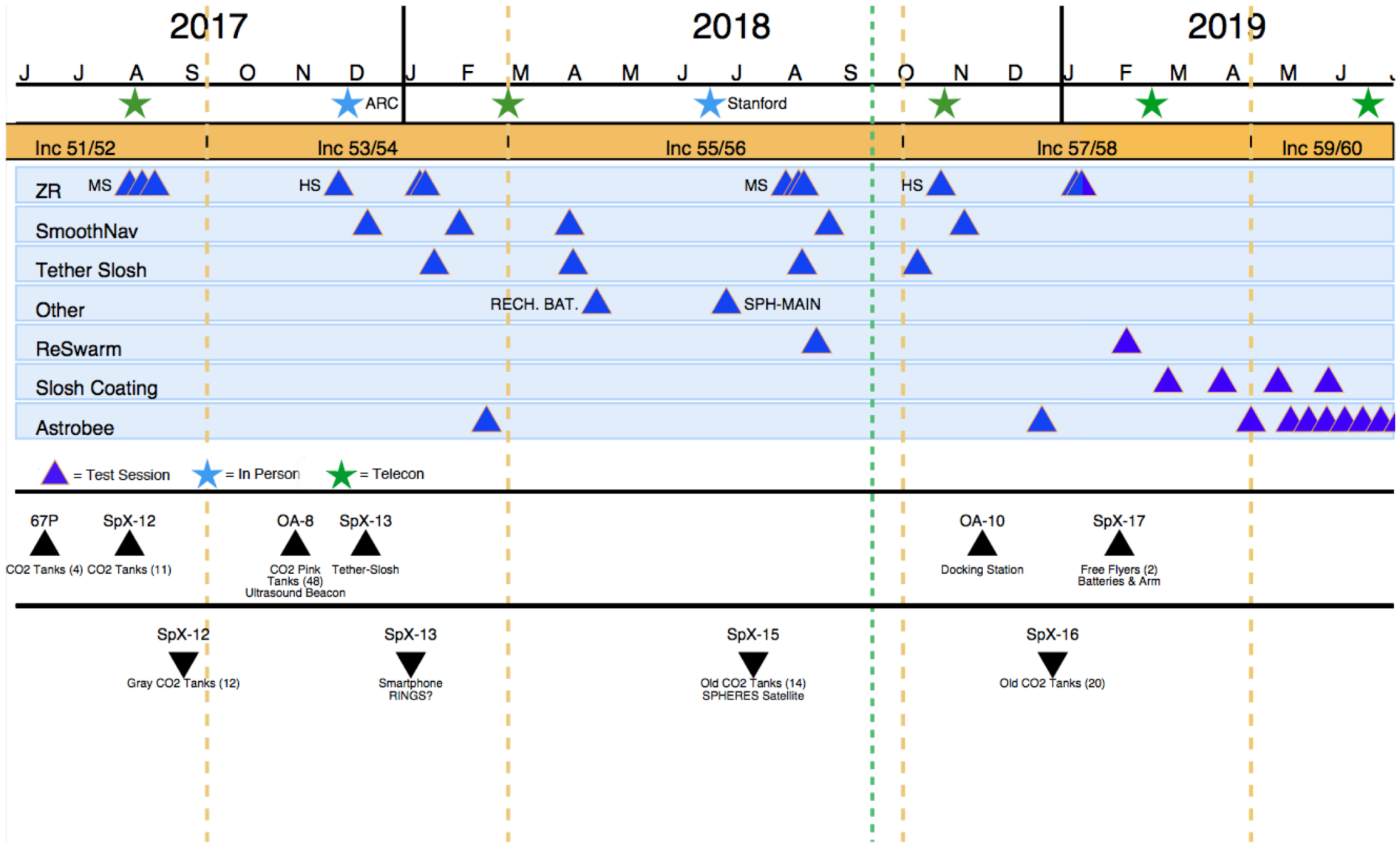




SPHERES & Astrobees Operations



SPHERES Calendar





SPHERES on Social Media

The screenshot shows the NASA SPHERES website. At the top, there is a navigation bar with links for Topics, Missions, Galleries, NASA TV, Follow NASA, Downloads, About, and NASA Audiences. A search bar is also present. Below the navigation bar is a large image of SPHERES satellites. The main content area is divided into several sections:

- Ames Research Center** (selected) | Overview | Images | Videos | Media Resources
- Follow** section with social media icons for Facebook, Twitter, Google+, YouTube, and Instagram.
- SPHERES Home** | Mission Overview | History | Satellites and Facilities | Partners and Affiliates | Guest Scientist Program | SPHERES Publications | FAQ | Archived Science | SPHERES Working Group
- Related Topics** | NASA Ames | Living in Space
- Tether Slosh**: Over a year after the first SPHERES Tether Demonstration Test Session was conducted on the International Space Station (ISS), researchers are aiming to expand their knowledge of tethering to captured objects and "space tug" chase vehicles in microgravity. In December 2017, a new investigation, called "Tether Slosh," launched new hardware to the ISS on SpaceX-13 that will integrate with existing SPHERES, Tether, and Slosh hardware on the ISS. Compared to the Tether Demonstration, the Tether Slosh Investigation has added new mechanical features that will be tested with new sophisticated algorithms and modeling techniques for liquid sloshing in space vehicles. Two SPHERES satellites will be used to represent the capturing vehicles pulling a liquid tank inside the ISS Japanese Experiment Module to study the sloshing effects and better understand its fluid dynamics in microgravity.
- SPHERES Shatters Own Record For Highest Operating Tempo in**: An astronaut is shown working with SPHERES hardware on the ISS.
- What is SPHERES?**: SPHERES consist of 3 free flying satellites on board the International Space Station that test a diverse range of hardware and software from scientist all over America. SPHERES has been active for 10 years and continues to be one of the most popular NASA projects and a favorite of many astronauts who are fortunate enough to work with the SPHERES project.
- SPHERES Zero Robotics High School 2016**: On Wednesday January 4, 2017, the SPHERES Zero Robotics (ZR) Units Test session was performed on the International Space Station (ISS). This is the first of three ZR sessions for this month. The third session, planned for January 27, is a finale event in which teams of students will see their code run live on the SPHERES satellites on the ISS.
- SPHERES Tether Demonstrates**: A small image showing an astronaut working with SPHERES hardware.
- Tweets by @NASA_SPHERES**: A small image showing a tweet.

Twitter

https://twitter.com/NASA_SPHERES

Website

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

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