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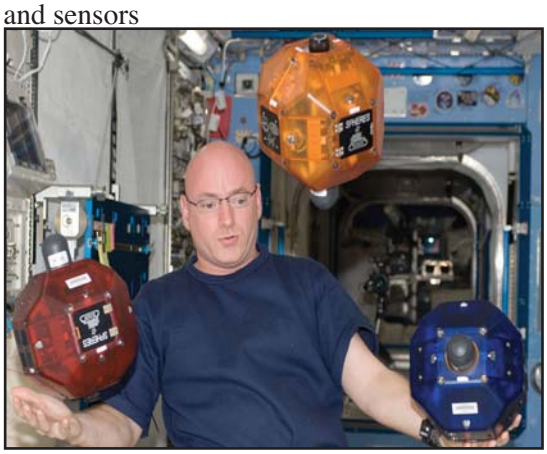
SPHERES Facility

Synchronized Position Hold, Engage, Reorient, Experimental Satellites

Synchronized Position Hold, Engage, Reorient, Experimental Satellites (SPHERES) are bowling-ball sized satellites that provide a test bed for development and research into multi-body formation flying, multi-spacecraft control algorithms, and free-flying physical and material science investigations. Up to three self-contained free-flying satellites can fly within the cabin of the International Space Station (ISS), performing flight formations, testing of control algorithms or as a platform for investigations requiring this unique free-flying test environment. Each satellite is a self-contained unit with power, propulsion, computers, navigation equipment, and provides physical and electrical connections (via standardized expansion ports) for Principal Investigator (PI) provided hardware and sensors



SPHERES Red, Blue and Orange during a Test Session

Basic Features of the SPHERES Facility

SPHERES consists of three self-contained satellites, which are 18-sided polyhedrons that are 0.2 meter in diameter and weigh 3.5 kilograms. Each satellite contains an internal propulsion system, power, avionics, software, communications, and metrology subsystems. The propulsion system uses carbon dioxide (CO2), which is expelled through the thrusters. SPHERES satellites are powered by AA batteries.

SPHERES Blue and Orange flying on ISS with Expansion Port

The metrology subsystem provides real-time position and attitude information. To simulate ground station-keeping, a laptop is used to transmit navigational data and formation flying algorithms. Once the algorithms are uploaded to the satellites from the laptop, the satellites perform autonomously and hold the formation until a new command is given.

SPHERES is an ongoing demonstration. Each session tests progressively more complex two and three-body maneuvers that include docking (to fixed, moving, tumbling targets), formation flying and searching for lost satellites.

SPHERES Red and Blue during a Test Session

Current Investigations

SmartPhone
Nexus S is the first commercial smartphone certified by NASA to fly on the space shuttle and to be cleared for use on the ISS. The smartphone includes a four inch touchscreen display, 1-GHz processor, digital camera, gyroscope, accelerometer, proximity and light sensors, Bluetooth and Wi-Fi networking, as well as 16 gigabytes of internal memory, and, as with an increasing number of smartphones, Nexus S uses the open-source Android platform. Investigations using the smartphone assess remote operation of advanced robots to increase productivity, reduce cost, and mitigate risk for deep-space human exploration missions.

Fluid Slosh
The SPHERES-Slosh investigation examines the way liquids move inside containers in a microgravity environment. Acquiring long-duration, low-gravity slosh data will be used for the calibration of detailed Computational Fluid Dynamics (CFD) models of coupled fluid-vehicle behavior. Predicting spacecraft and launch vehicle slosh dynamics is critical for the Launch Services program at Kennedy Space Center (KSC).

Resonant Inductive Near-Field Generation System (RINGS)
This investigation is designed to demonstrate and test, in a complex environment, enhanced technologies and techniques related to micro ElectroMagnetic Formation Flight (EMFF) and wireless inductive power transfer.

Visual Estimation and Relative Tracking for Inspection of Generic Objects (VERTIGO)
This investigation demonstrates and tests, enhanced technologies and techniques related to visual inspection and navigation. This effort incorporates hardware and software that enables multiple SPHERES to construct three-dimensional (3D) models of a target object. Additionally, this investigation explores how well the SPHERES free-flyers then perform relative navigation solely by reference to the 3D models.

Zero Robotics
This student competition inspires and encourages future generations in Science Technology Engineering and Mathematics (STEM) education. Student teams write software code with mentors to compete in simulation and ground testing. The ten final teams compete head-to-head on ISS, running their code on the SPHERES satellites.

For more information about SPHERES, visit:
http://www.nasa.gov/mission_pages/station/research/experiments/128.html

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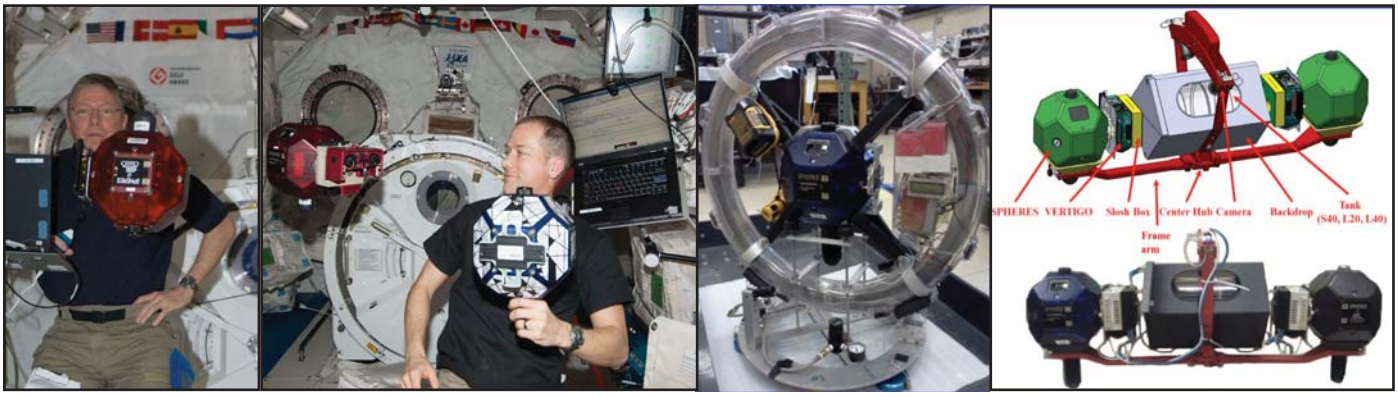

From right to left: SmartPhone Test Session, Vertigo Test Session, Rings hardware and Fluid Slosh display of hardware

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