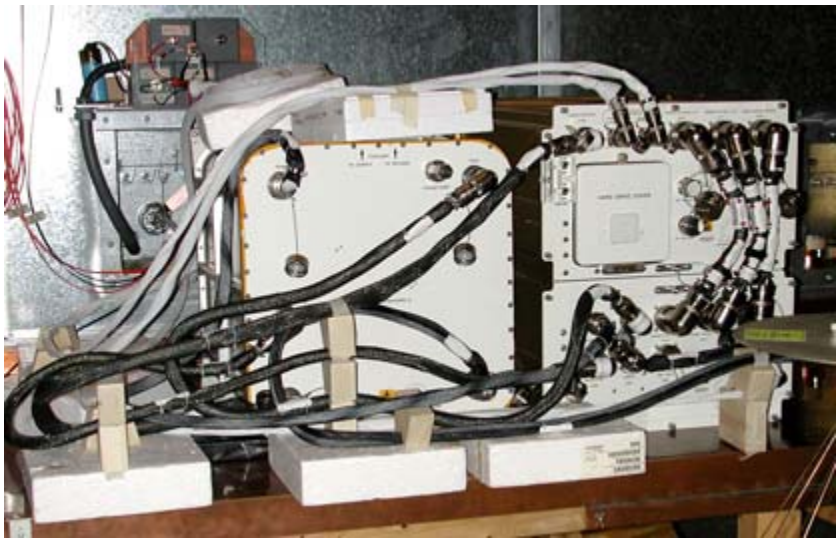
Physics of Colloids in Space--Plus (PCS+) Experiment Completed Flight Acceptance Testing



PCS+ hardware system (Test Section on left, Avionics Section on right) undergoing radiated emissions testing in Glenn's Electromagnetic Interference Laboratory.
Long description. PCS+ hardware system undergoing radiated electric field emissions, low-band, vertical polarity testing. This was just one of eight different types of emissions tests conducted on the PCS+ hardware.

The Physics of Colloids in Space--Plus (PCS+) experiment successfully completed system-level flight acceptance testing in the fall of 2003. This testing included electromagnetic interference (EMI) testing, vibration testing, and thermal testing. PCS+, an Expedite the Process of Experiments to Space Station (EXPRESS) Rack payload will deploy a second set of colloid samples within the PCS flight hardware system that flew on the International Space Station (ISS) from April 2001 to June 2002. PCS+ is slated to return to the ISS in late 2004 or early 2005.

EMI testing, vibration testing, and thermal testing were conducted, respectively, in NASA Glenn Research Center's Electromagnetic Interference Laboratory, Structural Dynamics Laboratory, and Thermal Test Facility--three laboratories that are critical for ensuring space flight payload hardware integrity. Because of unanticipated alterations to the original PCS flight hardware system to replace and upgrade some electronic diagnostic components for PCS+, the EMI emissions test regimen was included to determine if the new equipment would negatively influence overall emission profiles. EMI emissions on ISS are undesirable because they generate both electric and magnetic fields, which can propagate into the ISS environment, affecting onboard ISS systems or other payloads. Testing proved that EMI emissions were virtually unchanged and that the hardware was acceptable for use on the ISS. Vibration and thermal testing (performed in

both nonoperating and operating configurations) is required to ensure experiment integrity within prelaunch, launch, ISS operations, and deorbit environments as well as the quality of the reassembly workmanship. PCS+ also passed these tests.

PCS+ uses light-scattering techniques to extend the basic research in colloid physics that was begun under the Physics of Hard Spheres Experiment (PHASE) and the PCS experiment. Colloids are very small particles (about one hundredth of the thickness of a human hair) suspended in a liquid or a gas. Paint, ink, mayonnaise, milk, and even smoke are everyday examples of colloids. Colloids differ from other materials such as particles of sugar in water because they do not dissolve. Furthermore, the properties of these unique particle suspensions vary widely and often cannot be realized in other materials. Earth's gravity causes the heavier materials in a colloid to settle to the bottom (settling or sedimentation) and causes the lighter materials to go the top. Therefore, scientists cannot study many of the properties of these materials on Earth. On the ISS, where extended periods of microgravity exist, scientists can study the properties of colloids without any sedimentation or settling. The ordered colloids of PCS+ serve as a model for crystal growth, dendrite growth, and glass formation. These simplified model systems are furthering the fundamental knowledge of thermodynamic phase transitions, and this deeper knowledge could lead to novel drugs and materials. The principal investigator and coinvestigator for PCS+, respectively, are Prof. Paul M. Chaikin and Prof. William B. Russel (both of Princeton University).

The PCS flight hardware system is composed of a Test Section and an Avionics Section, which occupy four middeck locker spaces in ISS EXPRESS Rack 2. A third use of the PCS flight system has also been approved and is under development. This flight is called PCS-3. For PCS-3, the Avionics Section will be kept on-orbit after PCS+ operations are complete. A second Test Section will be fabricated for PCS-3 and will be populated with a third set of samples, which will be launched to the ISS approximately 10 months after the PCS+ launch. The principal investigators for PCS-3 are Prof. David Weitz, Prof. Michael Solomon (University of Michigan), and Prof. Eric Weeks (Emory University). The two Test Sections will be exchanged on-orbit. PCS-3 will initiate operations, whereas the PCS+ Test Section will be returned to Earth. The PCS+ experiment is being developed for launch by Zin Technologies under NASA contract NAS3-99154.

PHYSICS OF COLLOIDS IN SPACE: SERIES OF EXPERIMENTS ON THE ISS IN EXPRESS RACK 2

	PCS	**PCS+**	**PCS-3**
Launch date	April 2001	Fall 2004 (est.)	Summer 2005 (est.)
Landing date	June 2002	Summer 2005 (est.)	Spring 2006 (est.)
Principal investigator(s)	David A. Weitz (Harvard University	Paul M. Chaikin (Princeton Univ.)	David A. Weitz (Harvard Univ.) Michael J. Solomon (Univ. of Michigan), and Eric R. Weeks (Emory Univ.)

Highlights and thrust of experiment	• 2400 hr on-orbit operations • Over 80 percent of science achieved • Four classes of colloids • Validation of experiment facility hardware and operations	• Relaunch of refurbished Avionics Section; relaunch of Test Section with new samples • Fundamental studies of colloidal hard sphere disorder-order transition and the properties of the resulting ordered phase	• Launch of completely new Test Section, enabling continuous operations of PCS "facility" • Avionics Section may remain on orbit after PCS-3

Summary of table. The Physics of Colloids in Space series of experiments on the International Space Station in EXPRESS Rack 2 began with PCS, which flew on ISS from April 2001 to June 2002, conducting over 2400 hours of on-orbit operations, with over 80 percent of the science achieved, which validated the PCS experiment facility hardware and operations. PCS+, slated for launch no earlier than the fall of 2004 with landing in the summer of 2005, will be a relaunch of a refurbished Avionics Section and a Test Section with samples from a second principal investigator to conduct fundamental studies of colloidal hard sphere disorder-order transition. PCS-3, planned for launch no earlier than the summer of 2005 with landing 10 months later, will be a launch of a completely new Test Section with samples from a third set of principal investigators, extending continuous operations of the PCS "facility."

Find out more about this research:
Research description for Paul M. Chaikin, PCS+ principal investigator at http://pupgg.princeton.edu/www/jh/research/Chaikin_paul.htmlx
Glenn Research Center's Electromagnetic Interference Laboratory at http://facilities.grc.nasa.gov/emi/
Glenn's Structural Dynamics Laboratory at http://facilities.grc.nasa.gov/sdl/
Glenn's PCS research (includes data on a sample-by-sample basis) at http://microgravity.grc.nasa.gov/6712/pcs.htm
Glenn's microgravity research at http://microgravity.grc.nasa.gov/
Glenn's fluid physics research at http://exploration.grc.nasa.gov/life/

Glenn contact: Michael P. Doherty, 216-433-6641, Michael.P.Doherty@nasa.gov
Author: Michael P. Doherty
Headquarters program office: OBPR
Programs/Projects: Microgravity Science
Special recognition: The project team received a Space Act Award for their work on PCS.