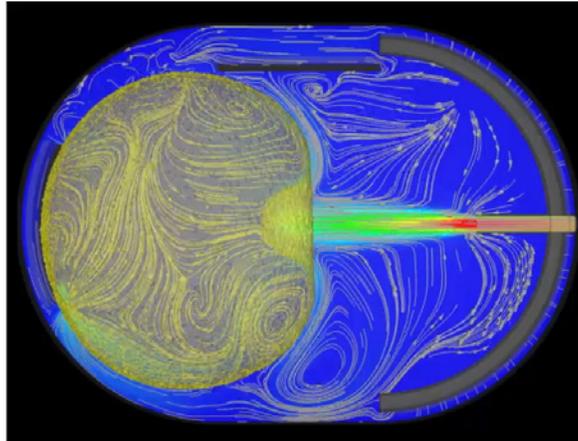
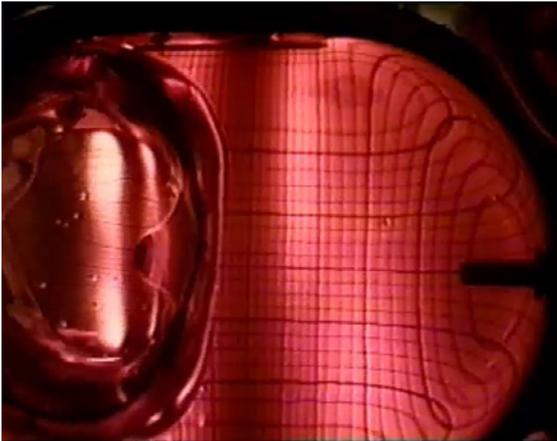


## Evolvable Cryogenics Project (eCryo)



**NASA's eCryo project is looking at validating computational fluid dynamic models through comparison to experimental data. The simulation above is from the space shuttle's Tank Pressure Control Experiment. (NASA/GRC)**

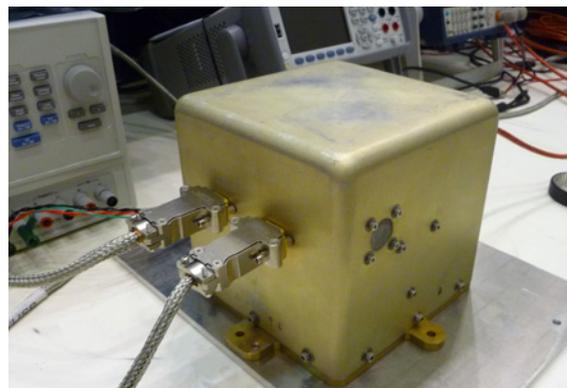
Cryogenic propellants are fluids such as liquid hydrogen, liquid oxygen and liquid methane which, when chilled to extremely cold temperatures, can be used to provide high-energy propulsion solutions critical to future human exploration missions into the solar system.

As NASA pursues new missions to Mars and other solar system destinations, long-duration storage and transfer of these cryogenic fluids — a technology research area collectively known as cryogenic fluid management, or CFM — is crucial. The challenge is to develop energy-efficient, mass-efficient and cost-efficient new solutions for in-space management of cryogenic propellants, benefiting a range of extended science and exploration missions beginning with Mars.

High specific impulse — the measure of efficient engine operation — is needed to provide sufficient thrust to deliver sizeable payloads into Martian transfer orbits, vehicle orbits or Earth-return orbits. Chemical rockets fueled by liquid oxygen and liquid methane could gain new potential if *in-situ* resource utilization is used to produce the propellants on the Lunar or Martian surface.

The [Evolvable Cryogenics](#) project or [eCryo](#), managed and led for the [Space Technology Mission Directorate](#) by [NASA's Glenn Research](#)

[Center](#) in Cleveland, Ohio, seeks to bridge the development gap in a number of key CFM technologies. The eCryo project builds upon and adapts a wealth of cryogenic fuel expertise from multiple NASA centers with access to an array of enhanced test facilities and new test rigs to further mature cryogenic propellant storage and transfer technologies that could support a variety of future space vehicles and space systems, including the [Space Launch System](#) rocket. Technologies developed under the eCryo project will play a critical role in enabling increasingly longer duration in-space missions beyond low-Earth orbit.



**The eCryo project is developing a Radio Frequency Mass Gauge for measuring fluid levels inside a tank. The system will be demonstrated on an experiment aboard the International Space Station. (NASA/GRC)**



The project is performing subscale characterization testing of multilayer insulation, as shown, and vapor-based heat intercept concepts. Test results will inform the design of the Structural Heat Intercept, Insulation and Vibration Evaluation Rig, or SHIIVER, a 4-meter liquid hydrogen tank at NASA's Plum Brook Station in Sandusky, Ohio. (NASA/GRC)

**2) Multi-layer insulation characterization:** Testing and analysis to quantify the thermal performance of thick MLI blankets at conditions and configurations representative of SLS upper-stage mission implementations.

**3) Vapor-based heat intercept:** Characterization of the potential benefit of using vapor vented from a propellant tank to intercept heat coming into the tank through structural elements.

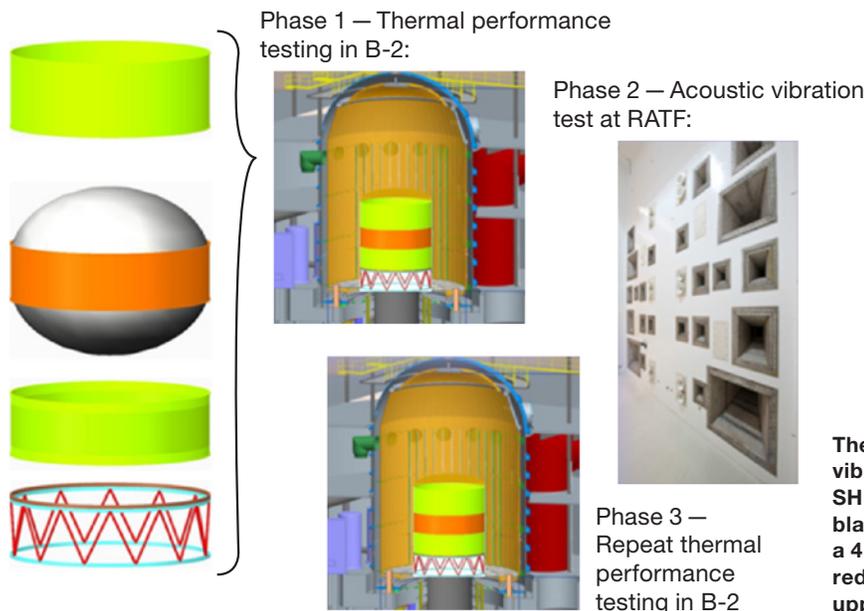
**4) Radio frequency mass gauging:** Quantifying the microgravity performance and accuracy of an RFMG system, an innovative propellant-quantity gauging technology to be implemented in a cryogenic tank flown on the [International Space Station](#) as a demonstration.

Engineers on the eCryo team also are evaluating the performance of the Integrated Vehicle Fluids system developed by United Launch Alliance of Centennial, Colorado, for potential incorporation into block upgrades of the SLS upper stage.

To ensure the maturation of CFM technologies that can enable the capabilities needed for NASA's near-term missions, eCryo is addressing four focus areas:

**1) Analysis tools:** Development and validation of computer codes capable of predicting boil-off, tank mixing, pressurization and chill-down phenomena for both settled and unsettled cryogenic fluid systems.

The eCryo project is part of NASA's [Technology Demonstration Missions Program](#), which is managed on behalf of STMD by NASA's [Marshall Space Flight Center](#) in Huntsville, Alabama. TDM projects seek to bridge the gap between scientific and engineering challenges and the technological innovations needed to overcome them, enabling robust, cost-effective new space missions.



The eCryo project will assess the thermal vacuum and vibro-acoustic performance of the large, cryogenic SHIIVER test tank. Demonstration of multilayer insulation blankets and vapor-based heat intercept concepts at a 4-meter scale will help characterize the benefits of reduced cryogenic boil-off when incorporated into an upper stage tank. (NASA/GRC)

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