Space Acceleration Measurement System for Free Flyers

Experimenters from the fluids, combustion, materials, and life science disciplines all use the microgravity environment of space to enhance their understanding of fundamental physical phenomena caused by disturbances from events such as spacecraft maneuvers, equipment operations, atmospheric drag, and (for manned flights) crew movement. Space conditions reduce gravity but do not eliminate it. To quantify the level of these disturbances, NASA developed the Space Acceleration Measurement System (SAMS) series to collect data characterizing the acceleration environment on the space shuttles. This information is provided to investigators so that they can evaluate how the microgravity environment affects their experiments. Knowledge of the microgravity environment also helps investigators to plan future experiments.

The original SAMS system flew 20 missions on the shuttle as well as on the Russian space station Mir. Presently, Lewis is developing SAMS-II for the International Space Station; it will be a distributed system using digital output sensor heads. The latest operational version of SAMS, SAMS-FF, was originally designed for free flyer spacecraft and unmanned areas. SAMS-FF is a flexible, modular system, housed in a lightweight package, and it uses advances in technology to improve performance. The hardware package consists of a control and data acquisition module, three different types of sensors, data storage devices, and ground support equipment interfaces.

Three different types of sensors are incorporated to measure both high- and low-frequency accelerations and the roll rate velocity. Small, low-power triaxial sensor heads (TSH's) offer high resolution and selectable bandwidth, and a special low-frequency accelerometer is available for high-resolution, low-frequency applications. A state-of-the-art, triaxial fiber-optic gyroscope that measures extremely low roll rates is housed in a compact package.

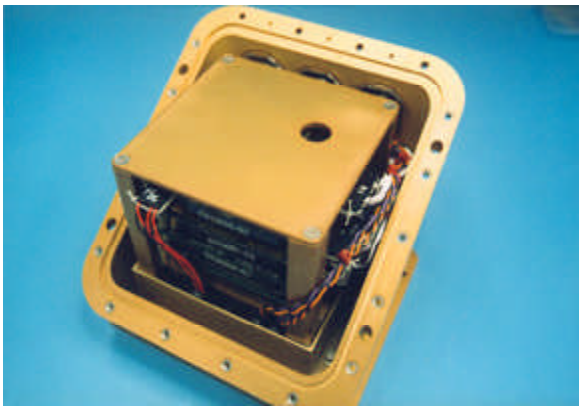
The versatility of the SAMS-FF system is shown in the three different types of missions SAMS-FF has supported. The first mission was on a sounding rocket supporting NASA Lewis Research Center's DARTFire combustion experiment on September 10, 1997. The results indicated that a sounding rocket is a very good platform to conduct short-duration research under high-quality microgravity conditions.

SAMS-FF-1: Implementation of TSH with laptop computer and battery.

SAMS-FF-2: TSH in hermetic enclosure.

A SAMS-FF TSH was used to support experiments flown on the NASA KC-135, flying parabolic arcs for low-gravity conditions. This TSH, which was utilized standalone connected to a laptop computer, served as a compact acceleration measurement system. Its small size and low power requirements allowed it to be mounted close to the area of interest.

SAMS-FF-3: Hermetically enclosed SAMS-FF system supporting HOST payload on STS-95.



SAMS-FF-4: SAMS-FF control and data acquisition unit in hermetic enclosure.

SAMS-FF was requested by the NASA Goddard Space Flight Center to support the Hubble Space Telescope program. On STS-95, a SAMS-FF system consisting of a control and data acquisition unit and two TSH's was mounted on the Hubble Space Telescope Orbital System Test (HOST) experiment that was launched October 29, 1998. HOST was a shuttle test flight of upgraded systems for the Hubble Space Telescope, including a cryocooler for the Near Infrared Camera and Multi-Object Spectrometer (NICMOS). SAMS-FF measured the vibrations produced by the cryocooler and the ability of the vibration isolation mounts for the cooler to conduct these vibrations to the telescope. The Hubble Space Telescope has very strict requirements for a low-vibration environment. SAMS-FF was chosen to perform this task since it has small volume and weight, but high measurement resolution. The acceleration data produced by SAMS-FF werenalyzed and documented by the SAMS-FF team, and the Hubble team usedthe report in quantifying he cryocooler vibration signature. The SAMS-FF system, which was designed and developed by Lewis and its contractors, is now manifested for support of microgravity measurement on several different platforms, including the KC-135, sounding rockets, the space shuttles, and the International Space Station (ISS).

Find out more about SAMS for free flyers
http://www.grc.nasa.gov/WWW/MMAP/SAMSFF/

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