

MICROGRAVITY ACCELERATION MEASUREMENT  
ENVIRONMENT CHARACTERIZATION

Richard DeLombard  
Lewis Research Center  
Cleveland, Ohio

Science

The Space Acceleration Measurement System (SAMS) is a general-purpose instrumentation system designed to measure the accelerations onboard the shuttle Orbiter and shuttle/Spacelab vehicles (see Figure 1). These measurements are used to support microgravity experiments and investigations into the microgravity environment of the vehicle. Acceleration measurements can be made at locations remote from the SAMS main instrumentation unit by the use of up to three remote triaxial sensor heads. The SAMS was developed by NASA's Lewis Research Center (LeRC) in support of NASA's microgravity science programs.

In the past, numerous acceleration measurement systems have flown on various space missions. These systems were tailored to measure accelerations for a narrow set of requirements and were limited in bandwidth, dynamic range, and recording capability. In addition, these systems were mission-peculiar and not easily modified for other applications or missions. The result has been an inability to accurately assess the expected microgravity environment prior to a mission for a particular experiment and/or location.

The prime science objective for SAMS on the SL-J mission will be to measure the accelerations experienced by a multitude of experiments in the two racks of the Japanese First Materials Processing Test (FMPT). The FMPT consists of a variety of materials science and life

science experiments contained in racks #7 and #10. The SAMS data will be made available to the FMPT principal investigators after the mission for their analysis with the FMPT data.

A secondary science objective for SAMS will be the characterization of the acceleration environment of the Spacelab module. This will include an analysis of the acceleration transfer function of the Spacelab module which will utilize the FMPT acceleration measurements along with measurements at the rack #9 structure. Another analytical effort to be undertaken is a general characterization of the acceleration environment of the Spacelab as an orbiting laboratory. These analysis efforts will be in conjunction with similar measurements and analyses on other SAMS Spacelab missions.

### Instrument

SAMS configurations are available for the Orbiter middeck locker area, Spacelab SMIDEX rack, and Spacelab center aisle. The configuration for the Orbiter cargo bay is presently under development. These configurations of the same instrument will enable microgravity measurements at nearly any desired payload location.

A SAMS unit consists of a main unit (shown in Figure 2) with one triaxial sensor head and up to three remote triaxial sensor heads. The main unit is comprised of the crew interface, optical disk data storage devices, and control and processing electronics. The remote triaxial sensor heads are comprised of three single-axis acceleration sensors, preamplifiers, and filters. Each head is connected to the main unit by an umbilical cable which has a maximum length of 20 feet.

The low-pass bandwidth for a triaxial sensor head is independent of the bandwidth of the other two heads and is chosen to match the requirements of the supported experiment. Standard choices for the low-pass bandwidth of a head are 0 to 2.5 Hz, 5 Hz, 10 Hz, 25 Hz, 50 Hz, and 100 Hz.

The standard SAMS triaxial sensor head employs the Sundstrand QA-2000 sensors, having a sensor resolution of 1 micro-g. Two triaxial sensor heads utilizing Bell XI-79 sensors are also available having a sensor resolution of 0.01 micro-g. The SAMS uses simultaneous sample and hold circuits to maintain phase coherence in the three axis measurements of a given triaxial sensor head. Similarly, the outputs of the three sensors of a given triaxial sensor head are digitized by the same 16-bit analog-to-digital converter. The signal processing for each triaxial sensor head has filtering characteristics matched to the data sampling rate for that triaxial sensor head. The preamplifier has four decade gain ranges and the capability for an electronic calibration mode.

The triaxial sensor head digitized data are formatted and transferred to optical disk for permanent storage. The optical disk drive enables crew-tended disk changes which allow essentially unlimited data storage during a mission. With 200 Mb of storage per optical disk side, typical times between disk change operations are from hours to days, depending on the triaxial sensor head sampling rates.

To support the FMPT life science experiments on SL-J, one SAMS head will be mounted in rack #7. This triaxial sensor head will utilize Sundstrand model QA2000 sensors and will be set for 50 Hz and 250 samples per second. This will result in measuring the acceleration environment experienced by the equipment mounted in rack #7.

To support the FMPT material science experiments on Spacelab-J, one SAMS head will be mounted in rack #10. This triaxial sensor head will also utilize Sundstrand model QA2000 sensors and will be set for 50 Hz and 250 samples per second. This will result in measuring the acceleration environment experienced by the equipment mounted in rack #10.

To measure the low-frequency accelerations experienced by the Spacelab, the third head will be mounted toward the bottom of rack #9 and will be set for 2.5 Hz and 12.5 samples per second. This triaxial sensor head will utilize one of the Bell model XI-79 sensor heads (if available) and will be set for 2.5 Hz and 12.5 samples per second. If a Bell sensor head is unavailable, a Sundstrand sensor head will be utilized.

The three separate sensor head locations will allow a continued characterization of the Spacelab module acceleration transfer function as well as contribute to a data base for characterizing the Spacelab acceleration environment.

SAMS units are currently manifested on the SLS-1, IML-1, SL-J, USML-1, USMP-1, and IML-2 Spacelab missions and STS-43 in the middeck. There will be eight flight units fabricated to support the expected flight rate of four microgravity science missions (e.g., IML-3, USML-2, USMP-2) per year.

#### Data Processing and Analysis

Post-mission processing of data by the SAMS project will be limited to data extraction, compensation, identification, format conversion, archival, and dissemination. The processed data

will be provided to the principal investigators involved with the particular mission and other interested organizations, as required.

In conjunction with the SAMS project, the Acceleration Characterization and Analysis Project will assist the PIs in the SAMS data conversion as well as performing analyses of the SAMS mission data. The SAMS acceleration data from the numerous missions will allow a better prediction of the acceleration environment for future microgravity missions.

**APPLICATIONS OF THE SAMS**

- MEASUREMENT OF LOW-G ACCELERATIONS
- MONITORING OF LOW-G ENVIRONMENT
- MONITORING OF EXPERIMENT-INDUCED VIBRATIONS
- VALIDATION OF VIBRATION ISOLATION TECHNIQUES

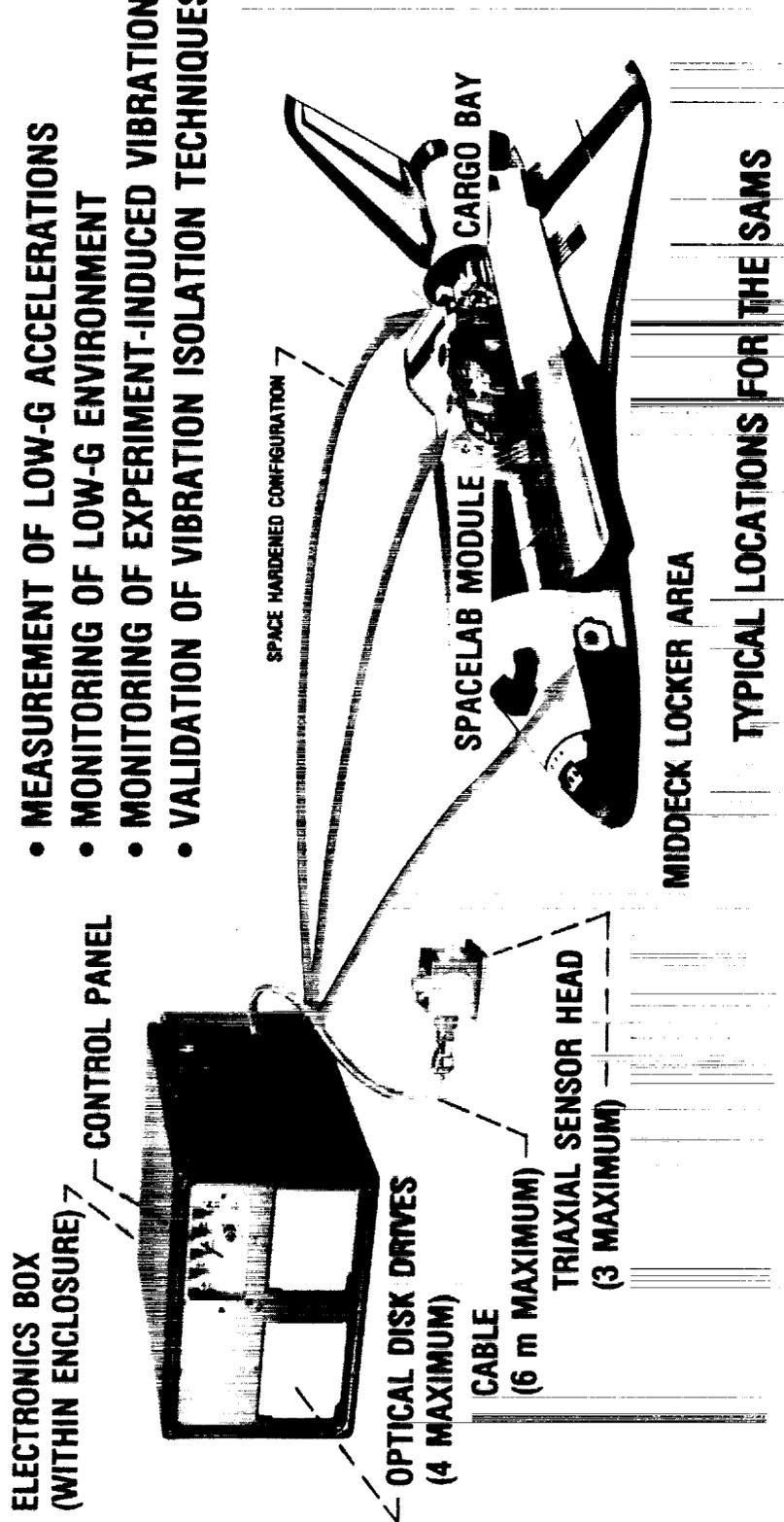


Figure 1. Space Acceleration Measurement System (SAMS).

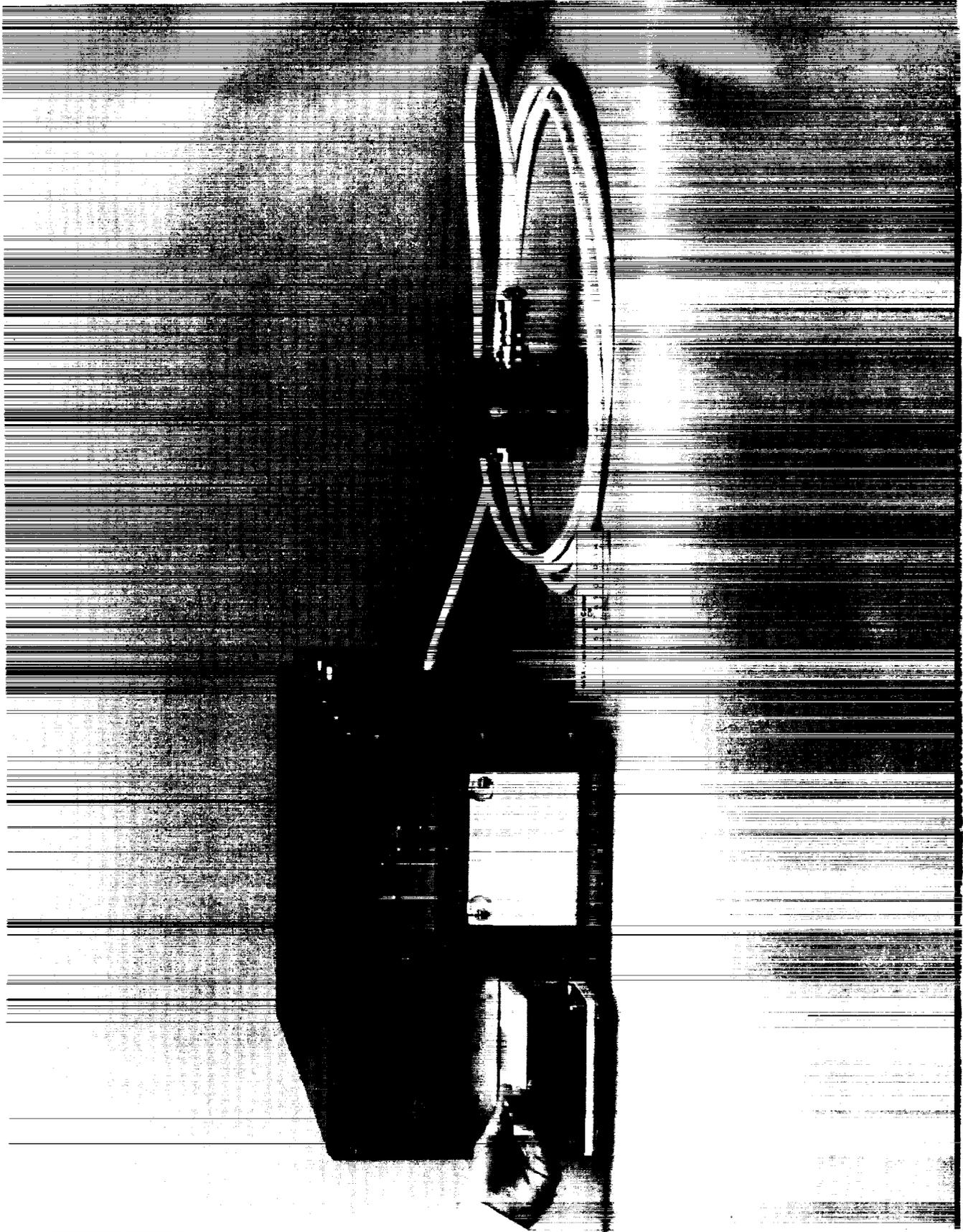


Figure 2. Space Acceleration Measurement System (SAMS).

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