



# Space Active Modular Materials Experiments (SAMMES)

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## Low Earth Orbital Mission aboard the Space Test Experiments Platform (STEP-3)

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# SAMMES/STEP-3 Overview

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## **SAMMES/STEP-3 Team**

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**Program Manager:** Lt. Col. Michael Obal, USAF (SDIO/TNI)

**Principal Investigator:** David Brinza (Jet Propulsion Laboratory)

**Experiment Support Group:** John Durrett, Leader (W.J. Schafer Associates)  
Graham Arnold (Aerospace Corp.)  
Michael Robyn (Aerospace Corp.)  
Robert Kraus (W.J. Schafer Associates)

**Prime Contractor:** Physical Sciences, Inc.  
**Program Manager:** Vic DiCristina  
**Project Engineer:** Prakash Joshi

**Major Sub-Contractors:**  
**Test Modules:** Research Support Instruments, Inc.  
**System Control Module:** Northeastern University  
**Environmental Test:** Fairchild Space Co.

**STEP-3 Mission Manager:** Lt. Janet Mayer, USAF (SMC/CUL)

**STEP-3 Experiment Integrator:** Douglas Wille (TRW)



# SAMMES System Architecture

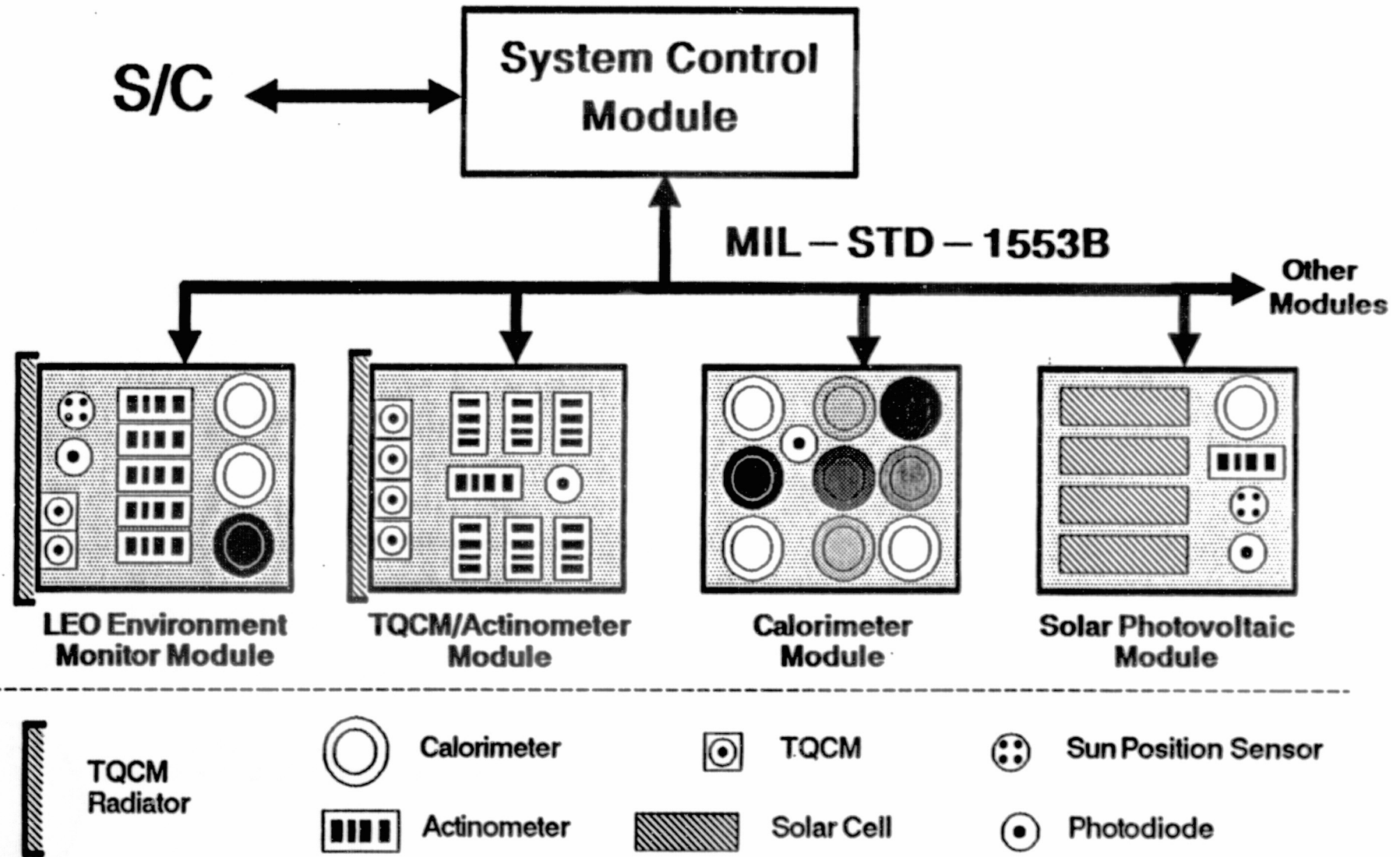
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- **Autonomous Modular System**
  - System Control Module
  - Distributed Test Modules
  - Internal MIL-STD-1553 Communications Bus
- **Spacecraft Interface Adaptability**
  - Host 1553, RS-232, RS-422 Standard Interfaces
  - TM Operations Controlled by SCM
  - Data Storage (8 Mbyte) Within SCM
- **Flight Experiment Flexibility**
  - Up to 8 Test Modules Controlled by SCM
  - Data Acquisition Asynchronous to Spacecraft Operations
  - On-board Data Processing Capability
  - Uplinkable Code for Operations and Data Processing
- **STEP-3 Configuration**
  - One System Control Module and Five Test Modules  
LEO Environment Monitor Module, Ram/Wake Calorimeter Modules,  
TQCM/Actinometer Module and Solar Photovoltaic Module





# SAMMES System Architecture





# SAMMES System Control Module

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- **Electronic Design**
  - **Host Microcontroller**  
S/C Commands, Data Transfer
  - **TM Microcontroller**  
TM Operations, Data Acquisition
  - **Program Memory**  
128 kByte + 16 kByte Dual Port
  - **Data Memory**  
1 MByte EEPROM, 7 Mbyte DRAM (battery back-up)
  - **Communications**  
SCM/TM: MIL-STD-1553B  
Host/SCM: MIL-STD-1553B, RS-232, RS-422
  - **Power Management**  
Auto-quiescent Mode, Conditioning, Heaters
  - **Health and Status**  
Temperatures, Microcontroller Status
  
- **Mechanical**
  - **Dimensions: 7.875" x 7.500" x 6.063"**
  - **Weight: 4.71 kg (Mg), 6.08 kg (Al)**



# SAMMES Test Module (Typical)

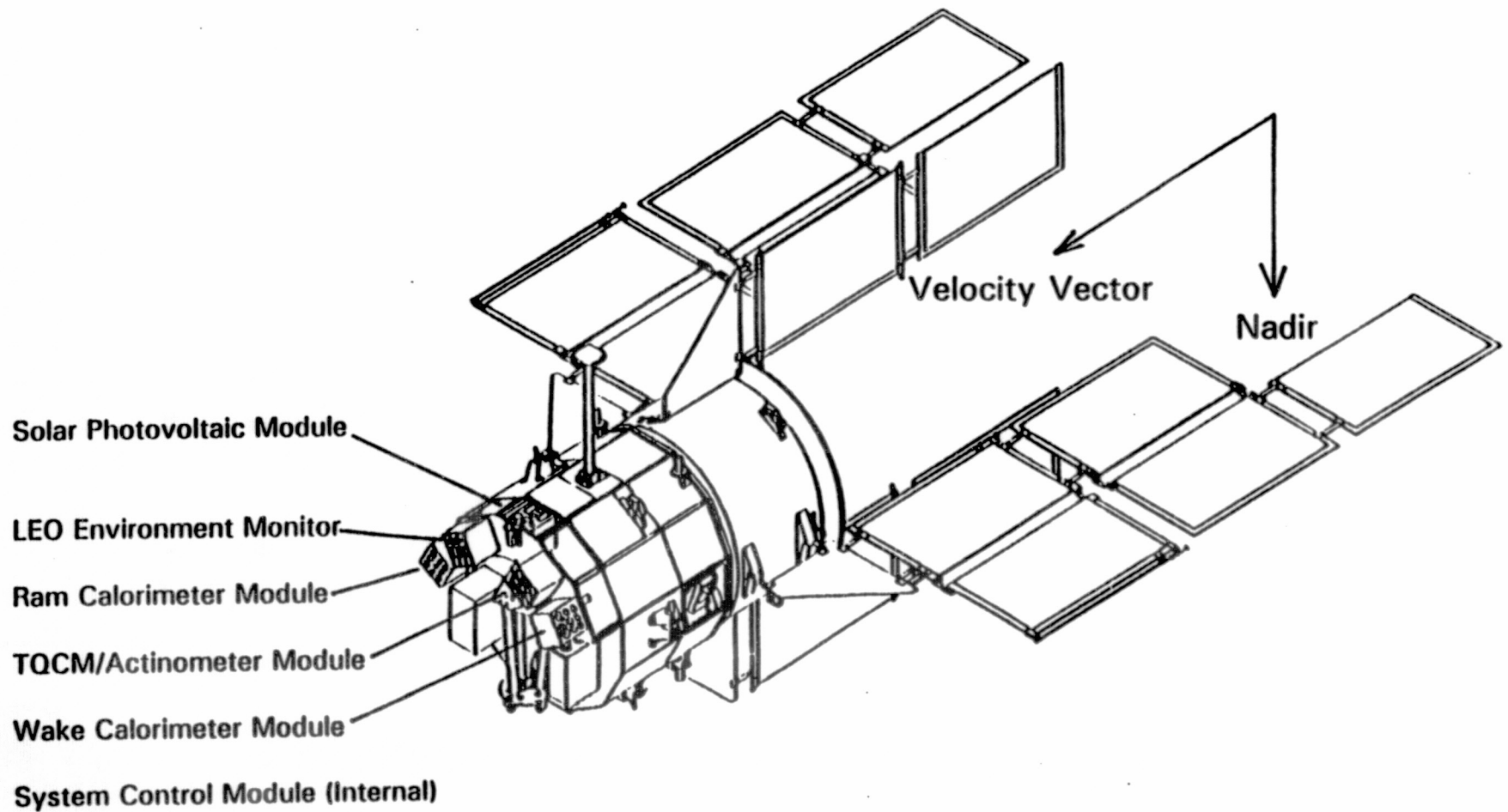
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- **Architecture**
  - **Microcontroller**
    - SCM Commands, Experiment Control, Data Transfer
  - **Analog Signal Conditioning & ADC**
  - **Sensor Temperature Measurement and Control**
  - **Sensors**
    - Temperature-Controlled Quartz Crystal Microbalances
    - Temperature-Controllable Reichard-Triolo Calorimeters
    - Temperature-Controlled Atomic Oxygen Actinometers
    - RADFET Total Radiation Dose Monitors
    - Sun Position Sensors, Photodiodes
    - Solar Photovoltaic I-V Diagnostics
    - Temperature Sensors (PRT & AD590)
  - **Operational Modes**
    - Quiescent Mode: Maintain Specimen Temperatures
    - Acquisition Mode: Sensor Sampling, Temperature Control
- **Mechanical**
  - **Dimensions: 6.500" x 6.000" x 5.500" (excluding radiators)**
  - **Weight: 2.5 - 3.2 kg**



## SAMMES on STEP-3

- Test Module Configuration on STEP-3 Vehicle





# **SAMMES/STEP-3 Mission Objectives**

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- **Assess LEO Space Environmental Effects on SDIO Materials**
  - Performance (a/e) of Thermal Control Materials (Ram/Wake)
  - Durability of Optical, Thermal Control, Protective Coatings
  - Performance of Advanced Solar Photovoltaics
  
- **Quantify Orbital and Local Environments**
  - Measure Atomic Oxygen Flux and Fluence
  - Assess Contaminant Accretion, Species ID, and Effects
  - Determine Sun Angle, Earth Albedo and Irradiance
  - Measure Total Radiation Dose
  
- **Demonstrate Modular Experiment Concept**
  - Autonomous Operations
  - Internal Power Management
  - Uplink Operational and Data Processing Code



# SAMMES/STEP-3 Mission Requirements

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- **Orbit Parameters, Mission Duration**
  - LEO Circular Orbit (~ 500km)
  - Ram and Wake Exposure Environments
  - 1-Year Minimum, 3-Year Goal
  
- **Data Integrity and Validation**
  - Material Pedigree
  - Contamination Control
  - Complete Environmental History (Early Mission Phase)
  - Test Material Temperature Control/Knowledge
  - Benchmark Material Performance
  
- **SAMMES/STEP-3 System Requirements**
  - System Mass: < 25 kg
  - System Power:
    - Peak (Operating): < 30 W
    - Average (Quiescent): < 20 W
  - Data (average) < 1 Mbyte/day



# SAMMES/STEP-3 Orbital Operations

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- **Early Operations (Insertion --> Post-Checkout)**
  - Power-up SAMMES, Early Operations Initiate Command
  - Verify SCM Status (if not operating, recycle power & initiate)
  - Activate Specimen Heaters
  - **Autonomous SAMMES Operation:**
    - Sample and Store Data from Selected Sensors (up to 8 Mbyte)
    - Power: ~28 W (Power-fault tolerant)
  - Downlink up to 8 Mbyte Data at end of Check-out Phase
  
- **Nominal Operations**
  - Initiate Normal Operations Command (once per day)
  - **Autonomous Operation:**
    - Deactivate Calorimeter Heaters, Stabilize (2 orbits @ ~15W)
    - Acquire Sensor Data ( 1.1 orbits @ ~28 W)
    - Transfer Data to S/C Onboard Storage
    - Re-activate Calorimeter Heaters
    - Return to Quiescent Mode (12 orbits @ ~18W)
    - Downlink ~1Mbyte Data
  
- **Special Operations**
  - Thermo-Gravometric Analysis (QCM's), Etc. (TBD)



# **SAMMES Data Analysis & Dissemination**

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- **Time-Variant Sensor Data**
  - **Full Orbital Temperature Profiles for Calorimeters**
  - **Frequency/Temperature Data for TQCMs**
  - **Resistance Measurements for Actinometers and Radiation Monitor**
  - **I-V and Temperature Data for Solar Photovoltaics**
  - **Current Measurements for Sun Sensors, Photodiodes**
  
- **Data Conversion and Analyses**
  - **Conversion to Engineering Units**
  - **Calibration Factors**
  - **Analysis Algorithms**
  - **Contamination Effects Assessment**
  
- **Data Dissemination**
  - **SDIO SEE Database**
  - **Interim and Final Reports**
  - **Workshops, Conferences and Publications**





# SAMMES Enhancements

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- **Test Module Autonomy**
  - Eliminate Need for System Control Module
  - Expanded TM Data and Program Memory
  - MIL-STD-1553 (Option for: RS-422, RS-232)
  
- **Test Module Miniaturization and Hardening**
  - ASIC, Hybrid Circuitry
  - Extensively Remoted Sensors
  - Radiation Hardening via Spot Shielding, Parts Selection
  
- **Expanded Sensor Suite**
  - Optical Properties Monitoring
  - Micrometeoroid and Debris Impact Sensing
  - Proton Spectrometer



# SAMMES Health Monitor Applications

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- **General Spacecraft Engineering Data**
  - Temperature Monitoring
  - Accelerations, Structural Deformations
  - Power System Monitoring
    - Solar Array Diagnosis
    - Battery Charge Rates
  
- **Orbital Environment Monitoring**
  - Atomic Oxygen Flux
  - Internal Radiation Dosage
  - Debris Cloud Detection
  
- **Payload and Mission Specific Monitoring**
  - Contamination Events and Effects
  - Optical System Diagnosis
  - Solar Exclusion Monitor (Safing)



# SAMMES Potential Flights

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- **SDIO TECHSAT**
  - Low Earth Orbital Mission
  - Mid-altitude Earth Orbital Mission
  
- **SDIO Testbed and Demonstration Vehicles**
  - Brilliant Pebbles Orbital Flight Test Vehicles
  - Brilliant Eyes Dem/Val Spacecraft
  
- **SDIO Operational Spacecraft**
  - Brilliant Eyes
  - Brilliant Pebbles
  
- **Other Satellites and Platforms**
  - Space Station Freedom and Free-Flyers
  - DoD Spacecraft
  - Civil Spacecraft (NASA, NOAA, Commercial)