Space Active Modular Materials ExperimentS (SAMMES)

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

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

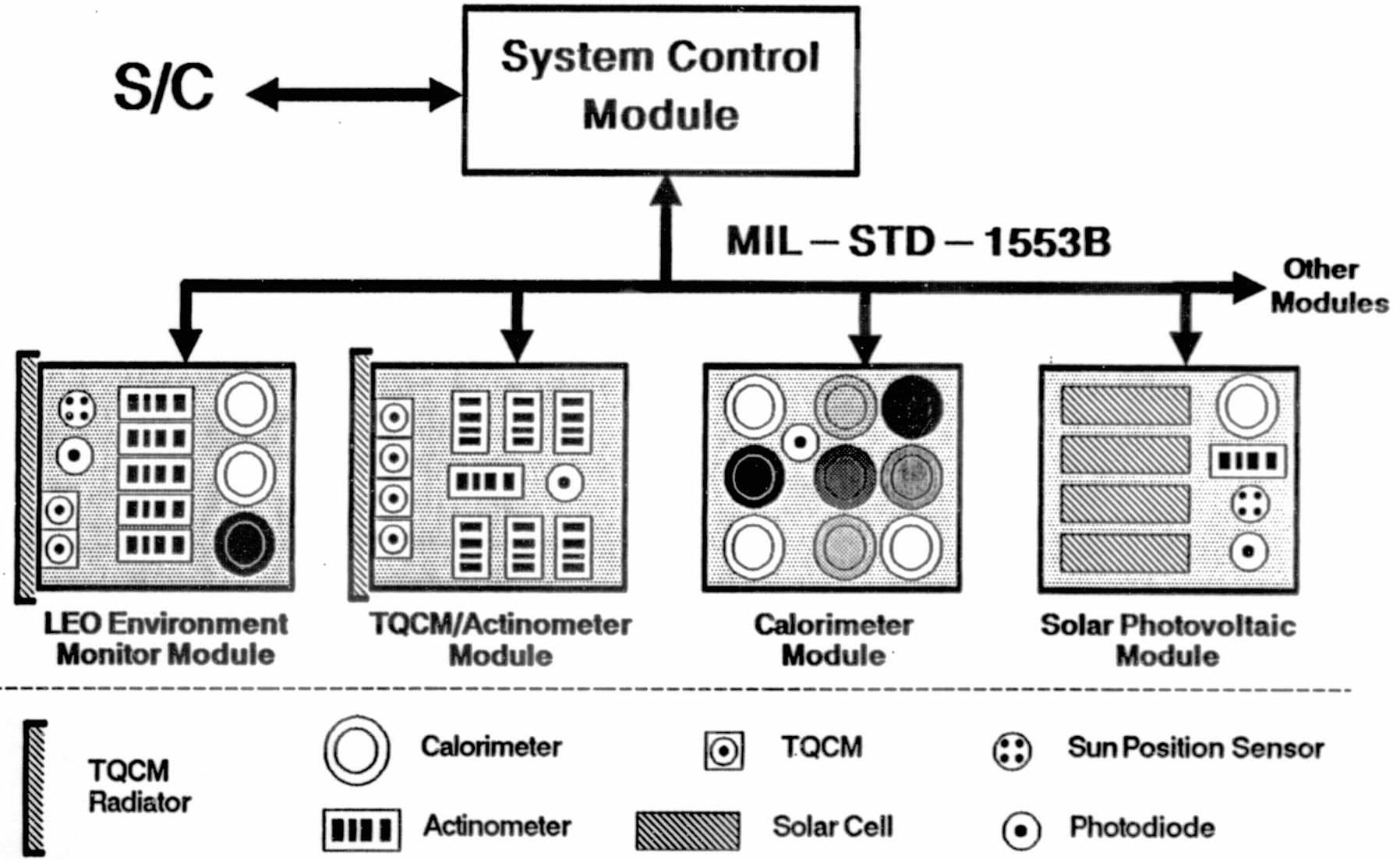
- Autonomous Modular System
  - System Control Module
  - Distributed Test Modules
  - Internal MIL-STD-1553 Communications Bus

- 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

- **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

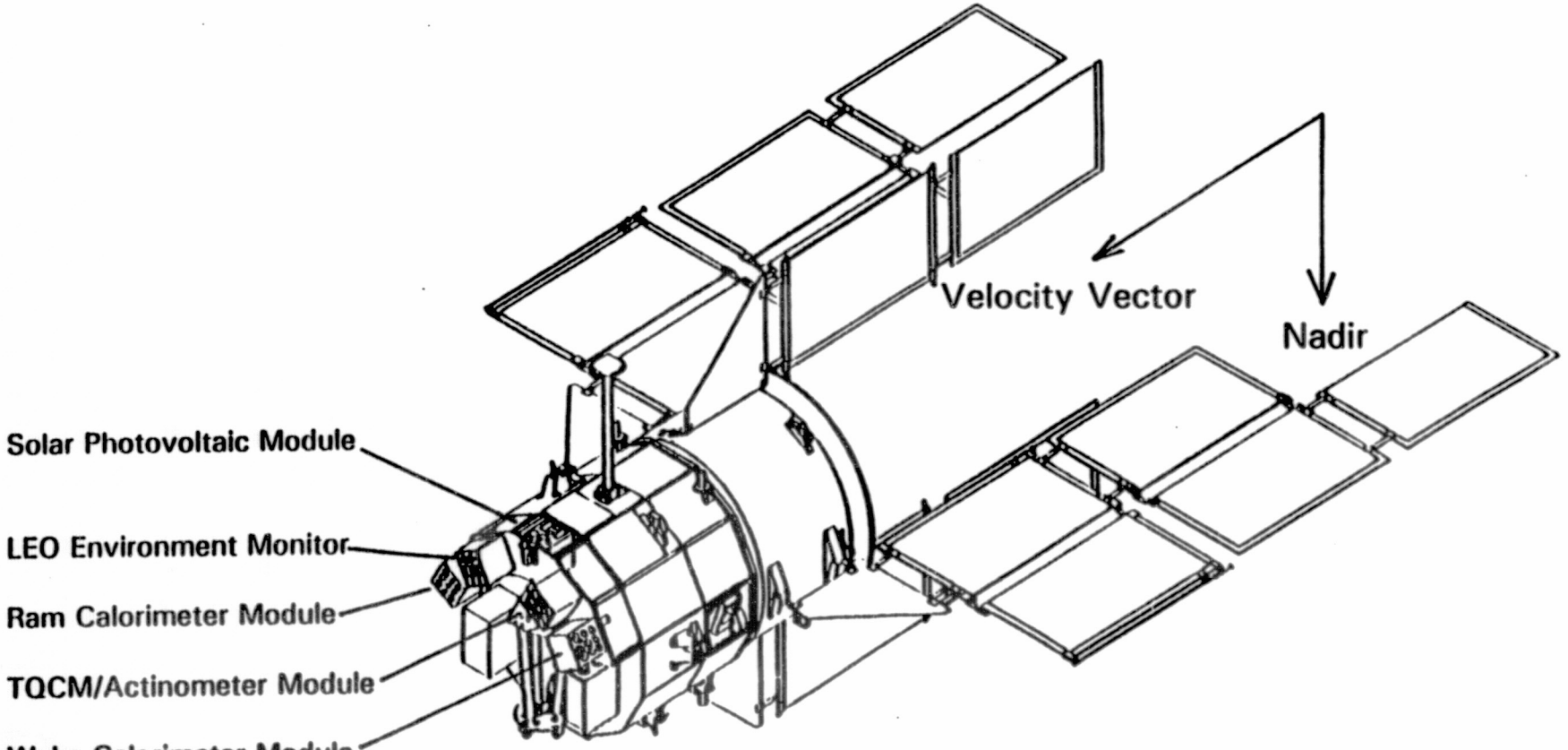
- **Mechanical**
  - **Dimensions: 7.875" x 7.500" x 6.063"**
  - **Weight: 4.71 kg (Mg), 6.08 kg (Al)**

SAMMES Test Module (Typical)

- **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

- **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

- **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

- **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

- **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

- **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

- 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

- 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)