PHILLIPS LABORATORY

DIRECTORATE OF SPACE AND MISSILES TECHNOLOGY

ADAPTIVE STRUCTURES FLIGHT EXPERIMENTS

CAPT MAURICE MARTIN

NASA/DOD Flight Experiments
Technical Interchange Meeting
Monterey, CA
October 5-9, 1992

ADAPTIVE STRUCTURES FLIGHT EXPERIMENTS

1. ADVANCED CONTROLS TECHNOLOGY EXPERIMENT (ACTEX)

2. ADVANCED CONTROLS TECHNOLOGY EXPERIMENT II (ACTEX-II)

3. STRV-1B CRYOCOOLER VIBRATION SUPPRESSION FLIGHT EXPERIMENT

4. PRECISION OPTICAL BENCH (PROBE)

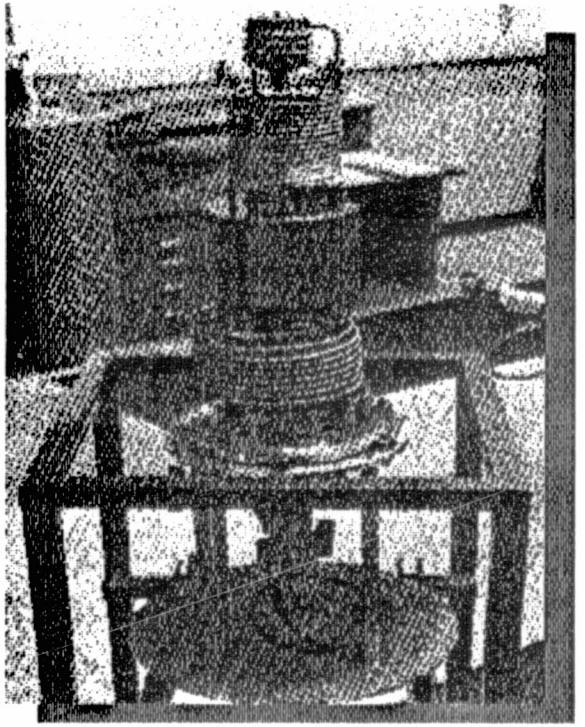
5. OTHER SDIO FLIGHT PROGRAMS
   - MODULAR CONTROL PATCH
   - ADVANCED COMPOSITE STRUCTURAL COMPONENTS FOR CLEMENTINE
   - TECHSAT ALL-COMPOSITE SPACECRAFT

6. INEXPENSIVE STRUCTURES AND MATERIALS FLIGHT EXPERIMENT (INFLEX)

A0802.02

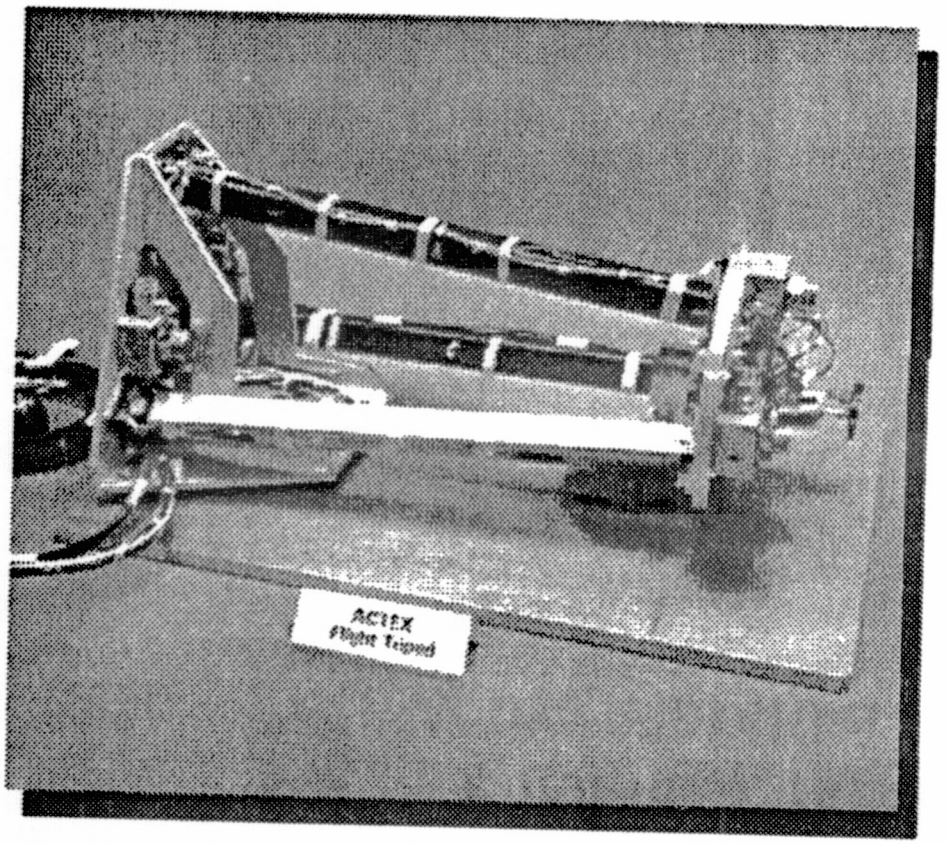
Enhanced Resolution Using Active Vibration Suppression....

PIXEL SMEARING DUE TO JITTER



ENHANCED IMAGE USING ACTIVE VIBRATION SUPPRESSION

Advanced Controls Technology Experiment (ACTEX)



OBJECTIVE

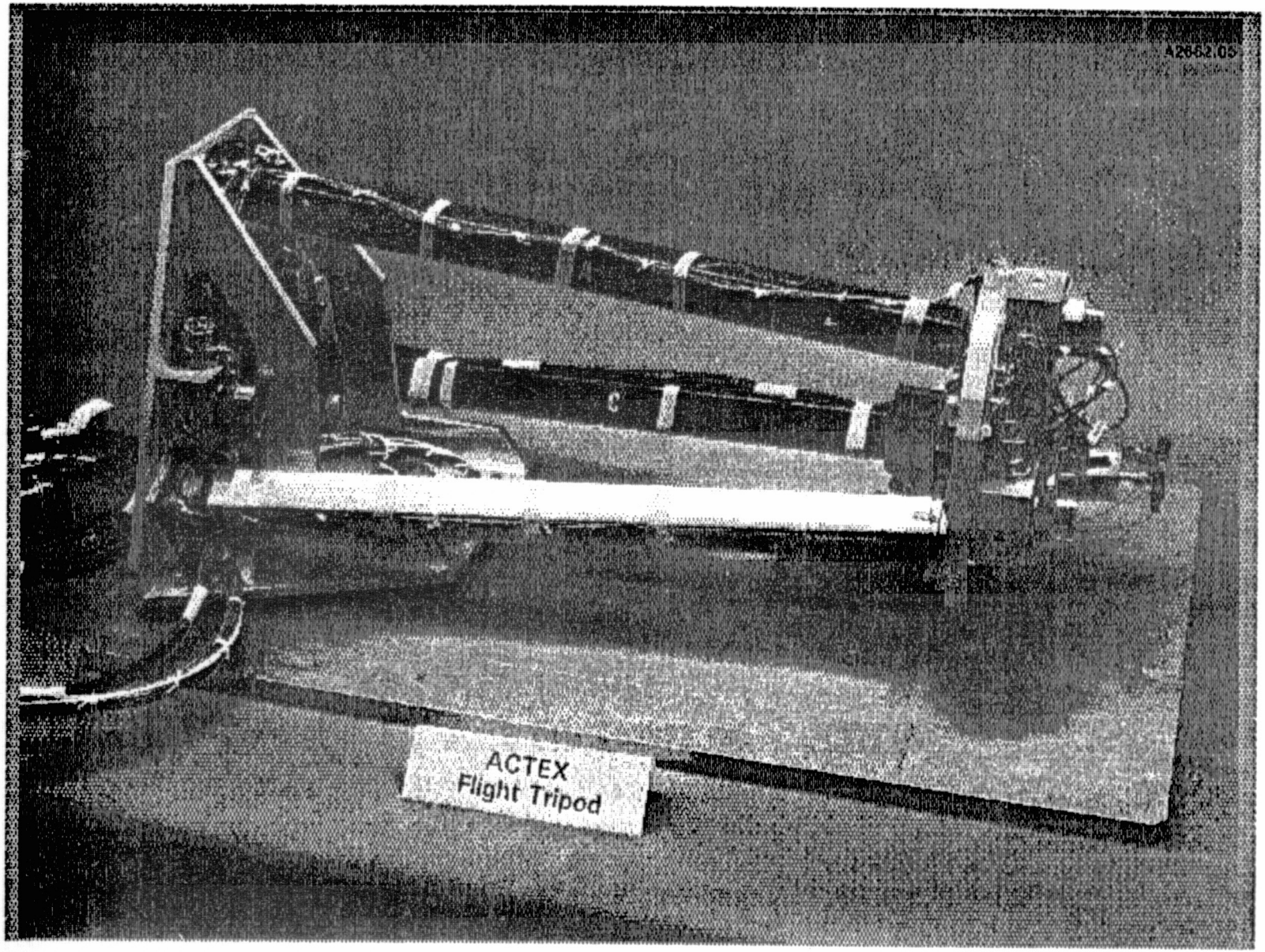
On-Orbit Demonstration of Embedded Piezoceramic Sensors and Actuators for Active/Passive Vibration Suppression

DESCRIPTION

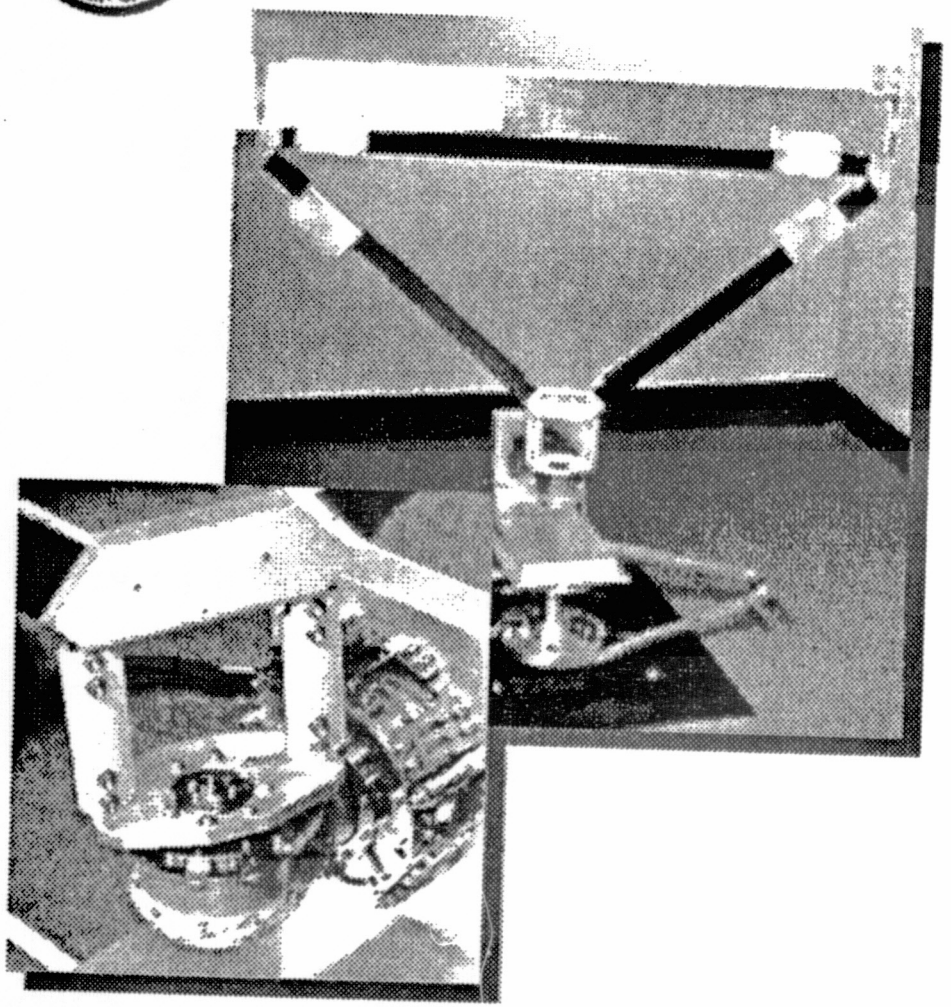
- 1 ft x 1 ft x 2 ft Tripod Structure
- Piezos for Active Control Layered in 1 inch Advanced Composite Tubes
- Passive Damping Using Piezos with Resistor Shunt
- On-Orbit System ID/Structural Characterization
- Dynamic Change Mechanism with On-Orbit Adaptive Control
- Launch Restraint Using Nitinol Non-Pyrotechnic Release Device

ACTEX PROGRAM STATUS

- PROGRAM FULLY FUNDED BY SDIO
- TRW HAS COMPLETED EXPERIMENT FABRICATION
- EXPERIMENT DELIVERED TO NAVAL RESEARCH LABORATORY IN AUGUST 1992 FOR SPACECRAFT INTEGRATION
- LAUNCH ANTICIPATED IN 1994


A2662.05
ACTEX
Flight Tripod

Advanced Controls Technology Experiment II (ACTEX-II)



OBJECTIVE

System Application of Piezoceramic Sensors and Actuators to Damp Solar Array Vibrations

DESCRIPTION

- Solar Array Yoke with Embedded Piezoceramic Sensors and Actuators
- 6 ft x 2.5 ft Simulated Solar
  - Deployable Aluminum Framework
  - Modal Frequencies of 0.5-10 Hz
- Vibration Suppression Using Digital Control Electronics
- Electronics Miniaturized Into Multichip Module Mounted on Yoke
- Advanced Solar Array Drive Motor with Viscoelastic Damped Interface
- On-Orbit System ID/Structural Characterization

ACTEX-II PROGRAM STATUS

- PROGRAM FULLY FUNDED BY SDIO
- TRW IS FINALIZING FLIGHT HARDWARE DESIGN
- EXPERIMENT TO BE DELIVERED IN EARLY 1994 FOR INTEGRATION ON STEP-3 SPACECRAFT
- LAUNCH ANTICIPATED IN EARLY 1995

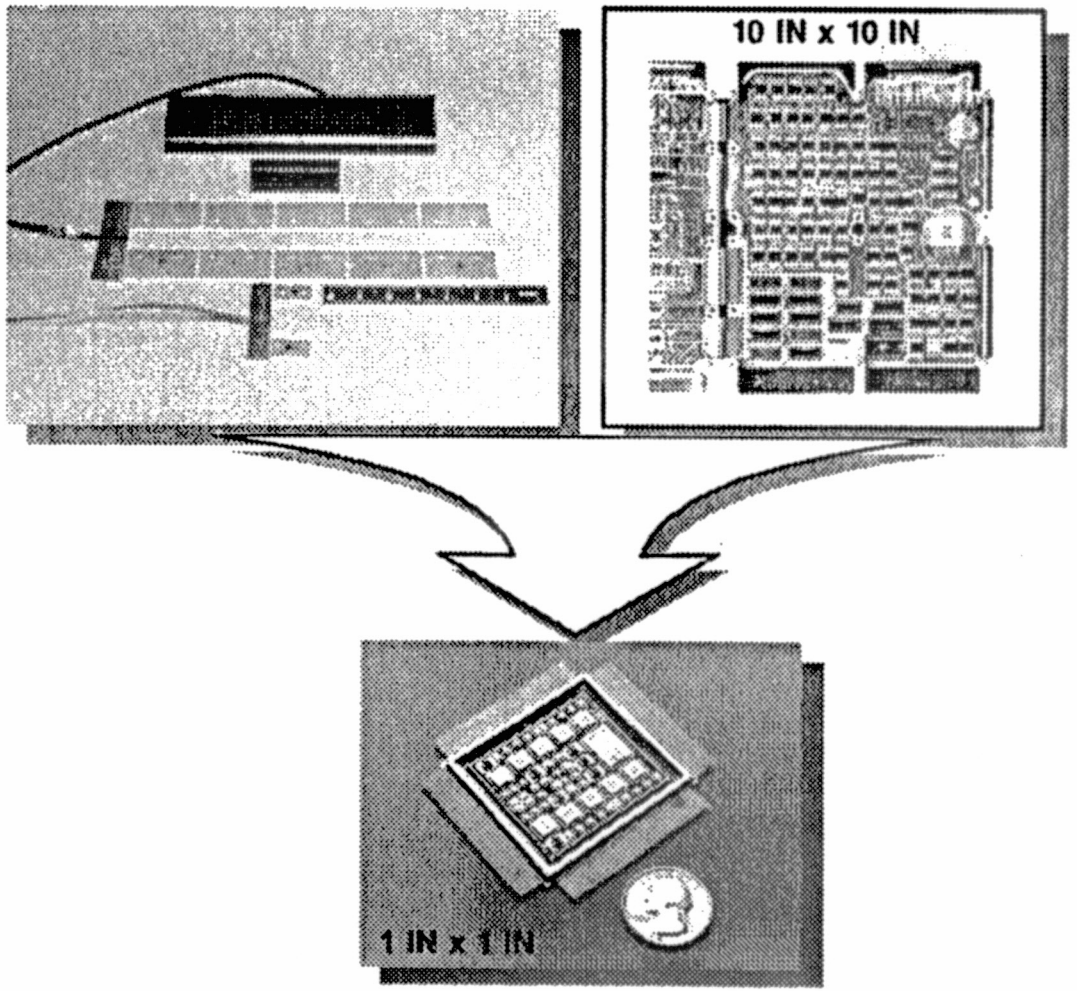
Modular Control Patch

OBJECTIVE

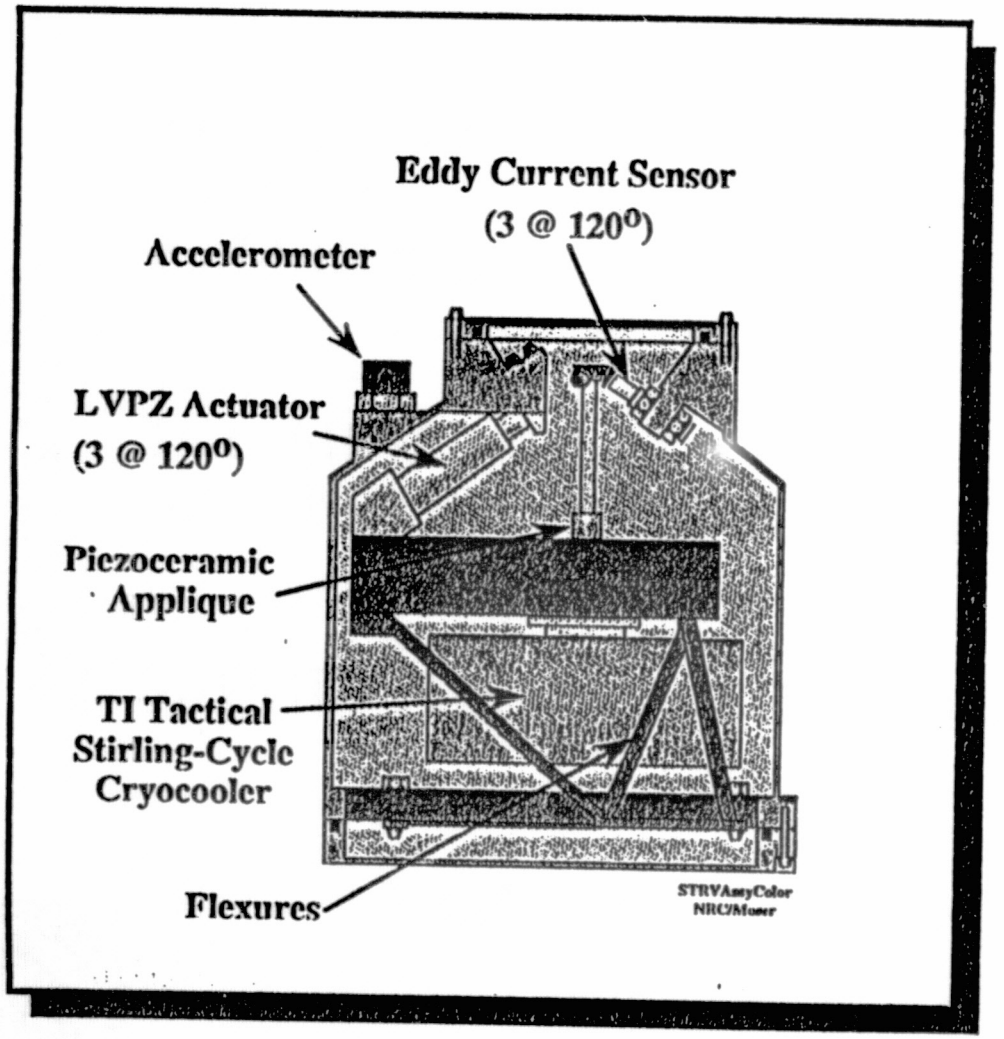
Develop a Miniaturized, Modular Vibration Suppression System Having Sensing, Actuation, and Control/Power Conditioning Components Integrated into a Self-Contained Package

PAYOFF

Miniaturized, Lightweight, Retrofitable Vibration Suppression System



STRV-1b Cryocooler
Vibration Suppression Experiment



OBJECTIVE

Vibration Suppression of Cryocooler Cold Finger Using Active Control Technologies

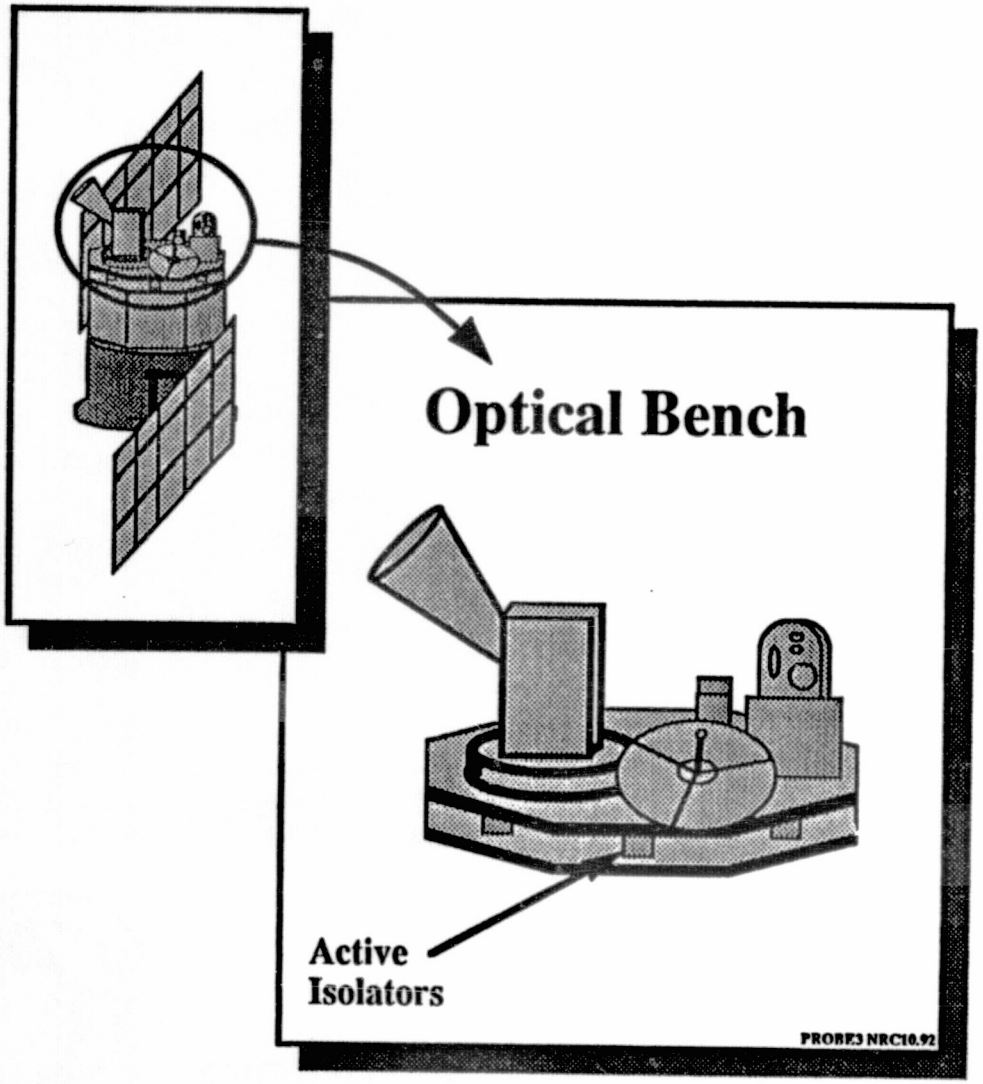
DESCRIPTION

- Stirling-Cycle Cryocooler Traceable to SDI Class Systems
- Piezo Stack Actuators for for 3-Dimensional Control of Cryocooler
- Actuation Using Piezo Applique Bonded to Base of Cold Finger
- Eddy Current Transducer to Measure Cold Finger Tip Motion
- Integrated Digital and Analog Control Electronics

STRV-1B PROGRAM STATUS

- PROGRAM FULLY FUNDED BY SDIO
- EXPERIMENT FABRICATION IN PROGRESS AT THE JET PROPULSION LABORATORY
- EXPERIMENT TO BE DELIVERED TO THE ROYAL AEROSPACE ESTABLISHMENT EARLY 1993 FOR SPACECRAFT INTEGRATION
- ARIANE LAUNCH ANTICIPATED IN MID 1994

PROBE
PRECISION OPTICAL BENCH EXPERIMENT



OBJECTIVE

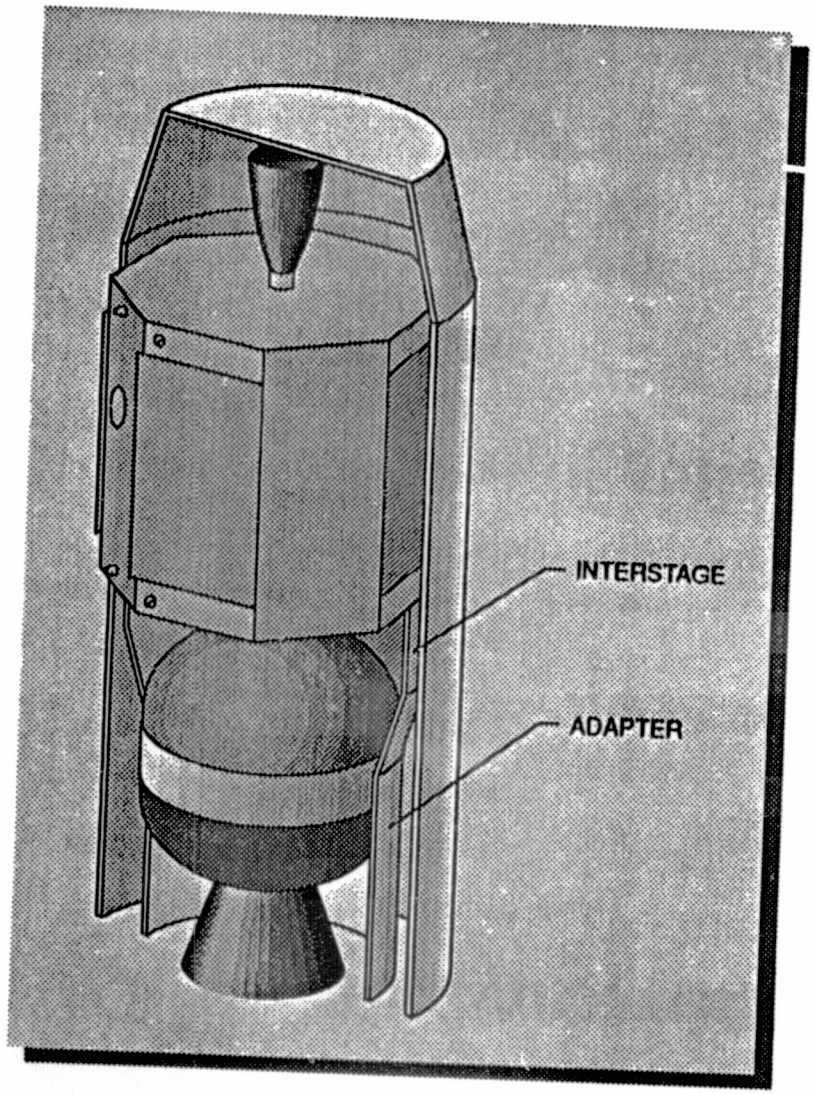
Integration of Active/Passive Control Technologies to Create a Vibration Isolated Optical Bench

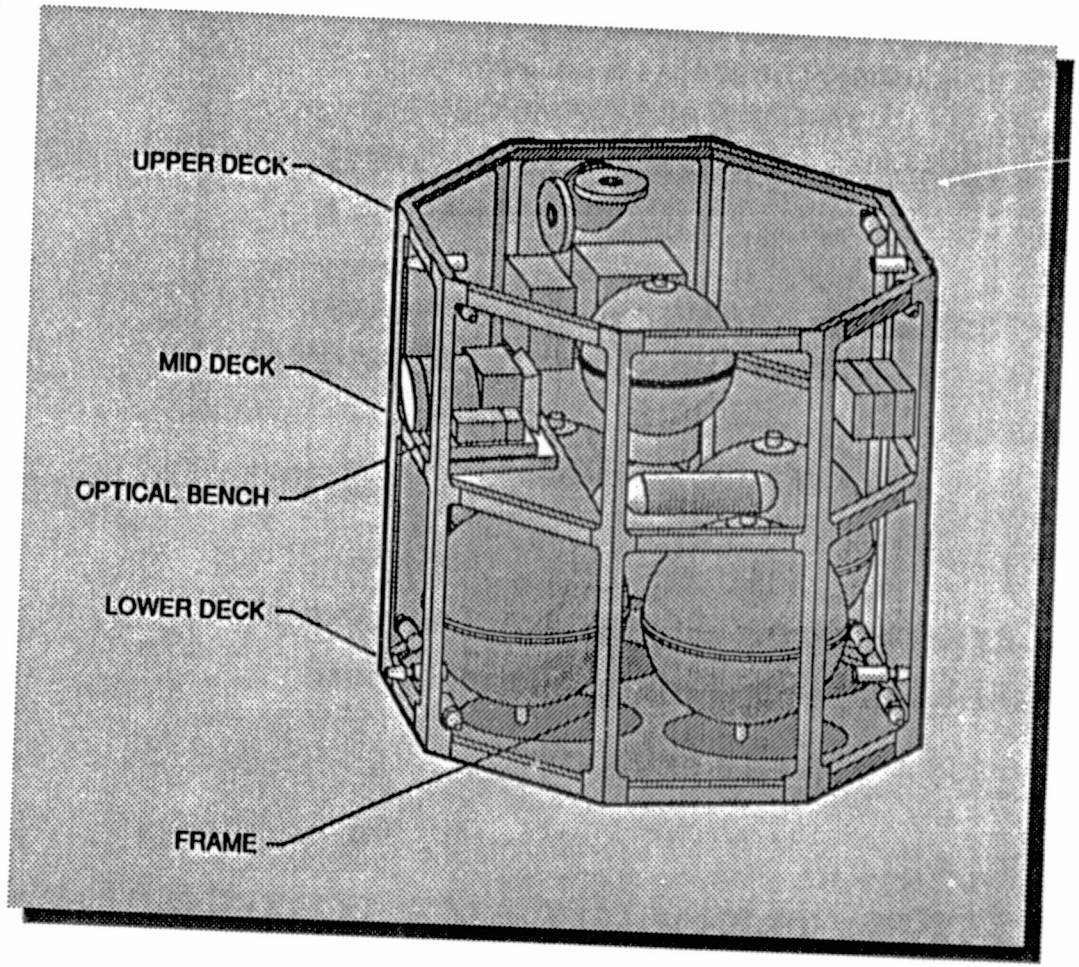
DESCRIPTION

- Advanced Composite Platform with Passive Damping Treatment
- Vibration Isolation of Platform Using Active Control Components
  - Vibration from Spacecraft Bus
  - Disturbances on Platform (Slewing Sensors, Cryocoolers, etc...)
- Active/Passive Vibration Suppression at Optical Sensors
- Correlation of Vibration Suppression to Sensor Performance

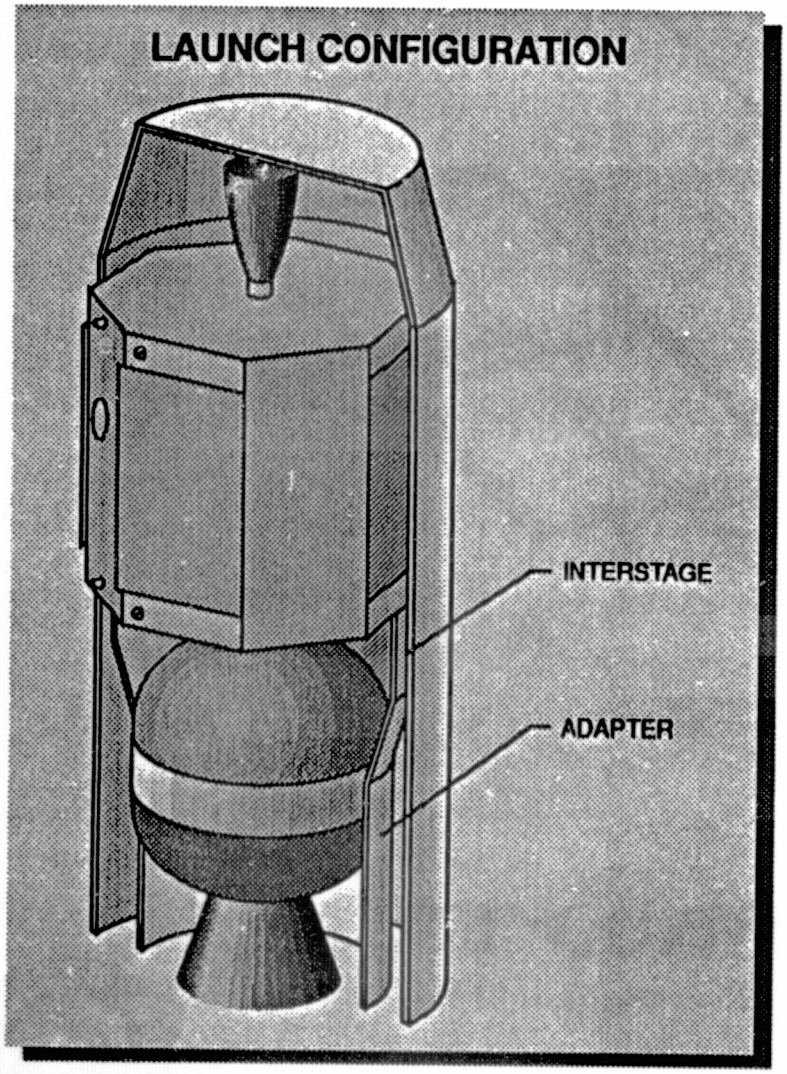
Clementine Candidate Structural Components

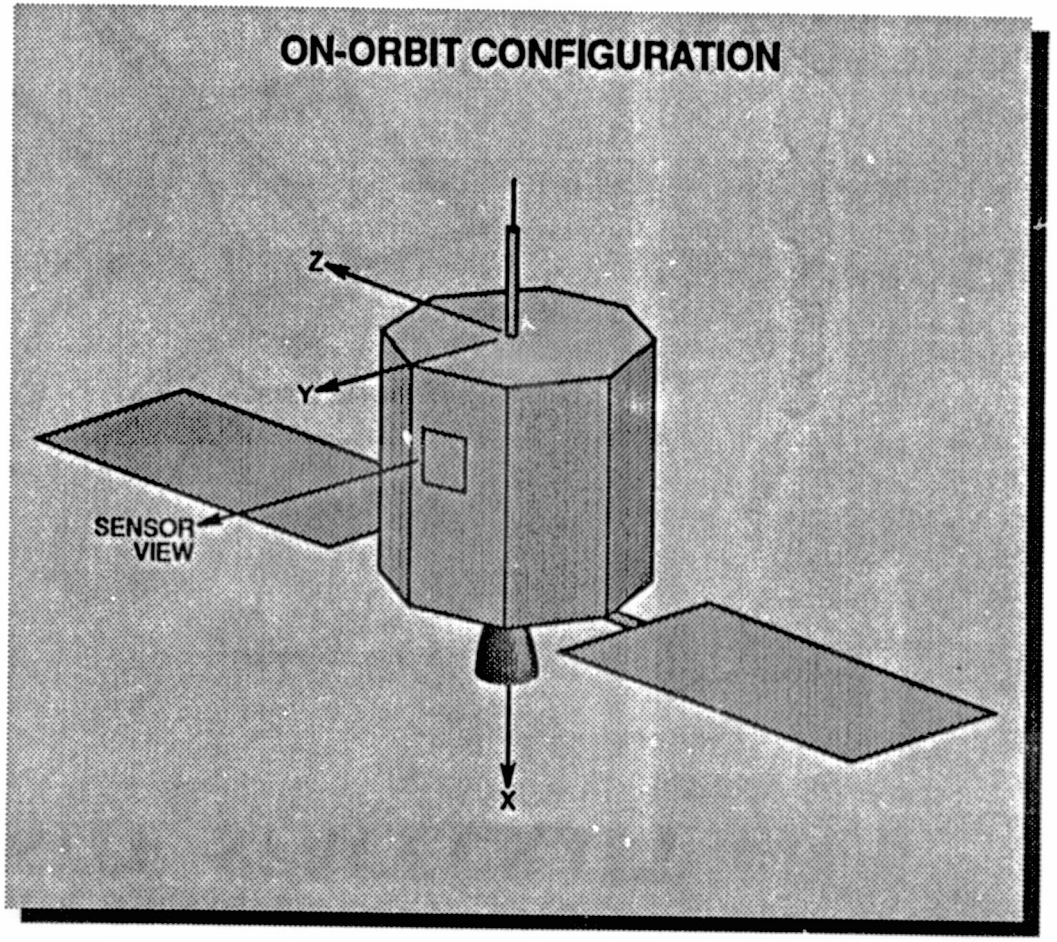
A1892.01



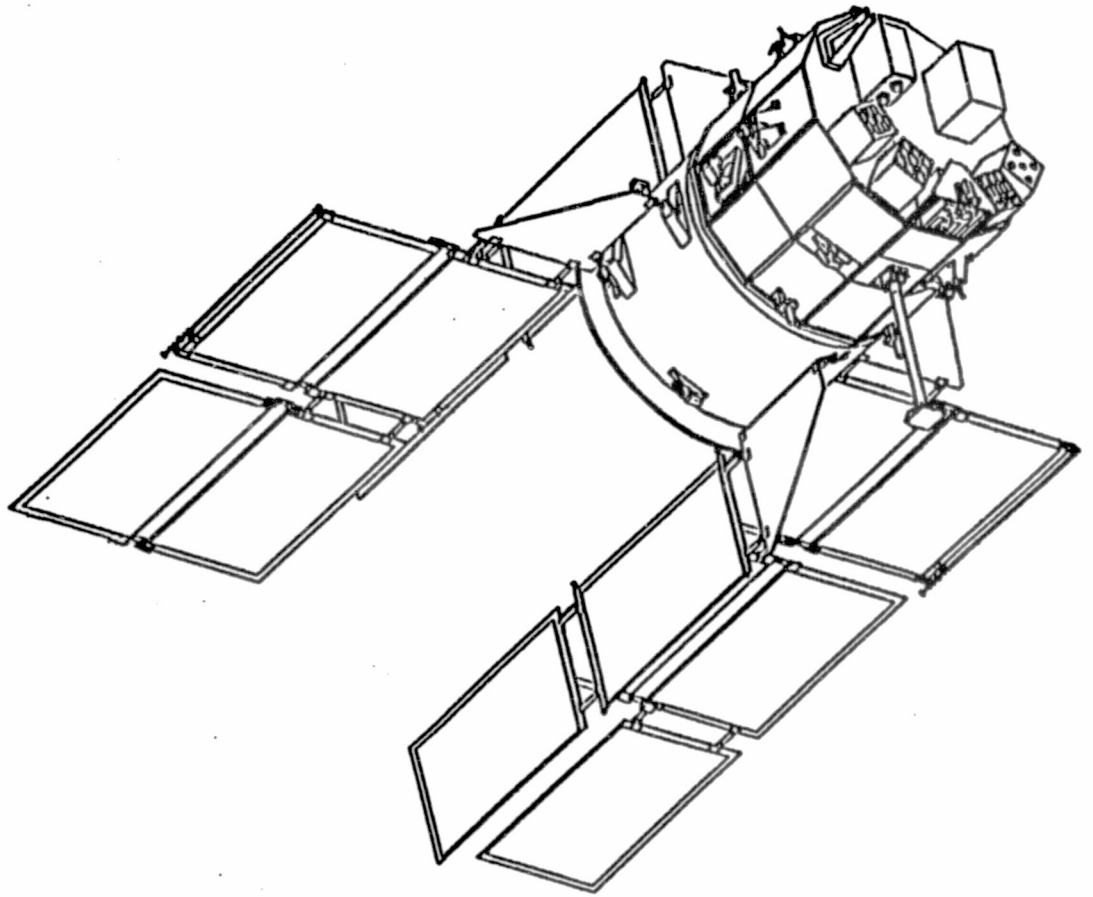


Clementine Spacecraft Configuration



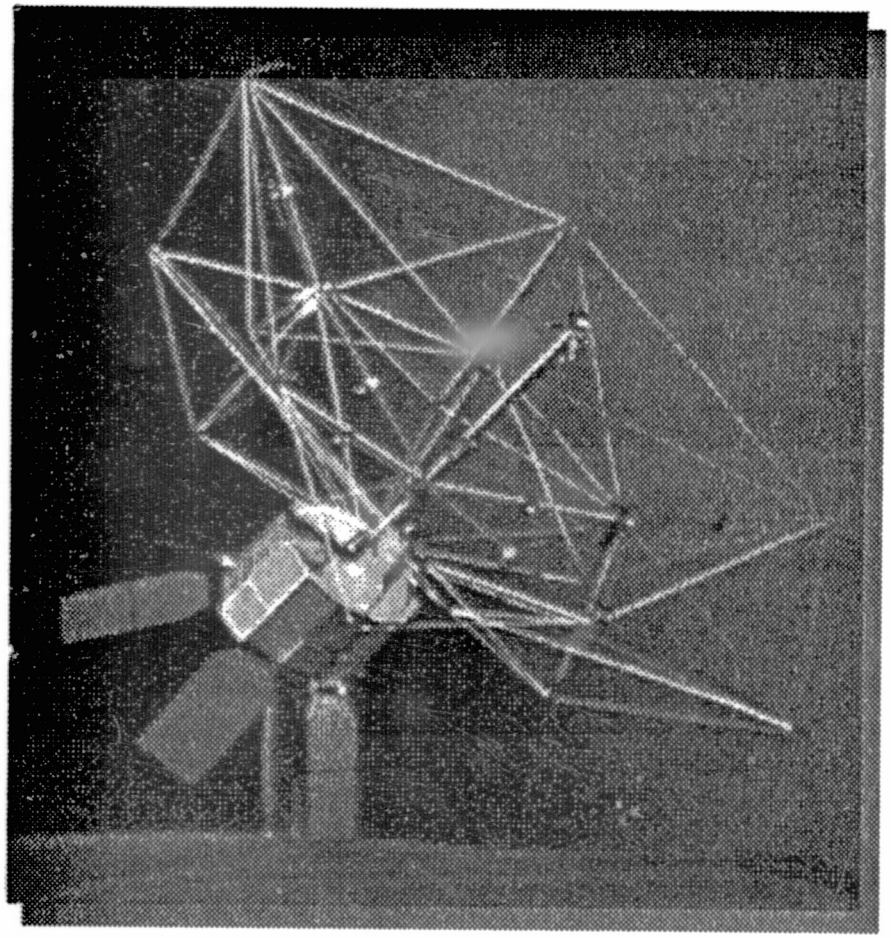


TECHSAT
ALL-COMPOSITE SPACECRAFT



B1182.02

Inexpensive Structures and Materials Flight Experiment (INFLEX)



OBJECTIVE

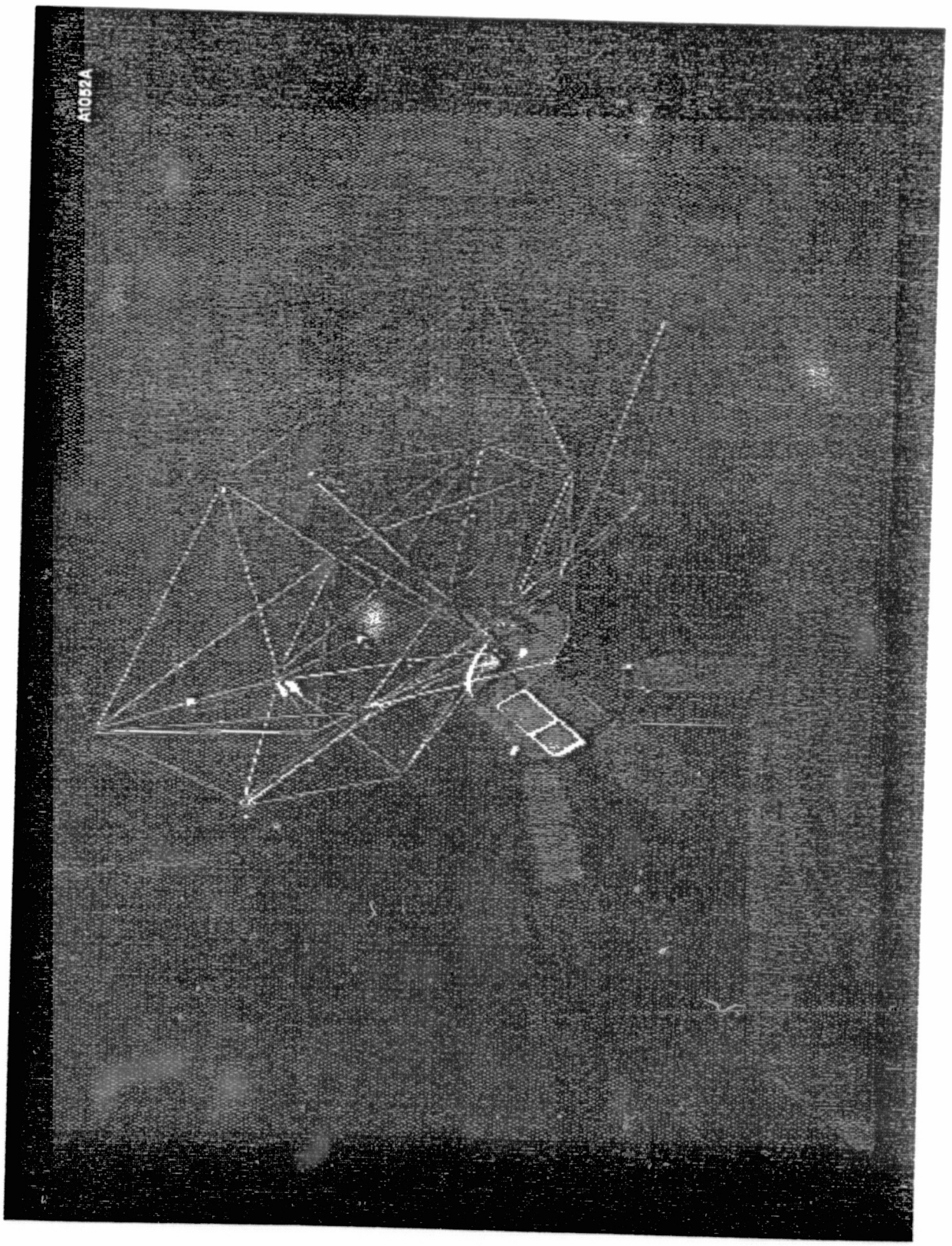
Integrated On-Orbit Demonstration of Advanced Structures, Materials, and Controls Technology for Precision Space Structures

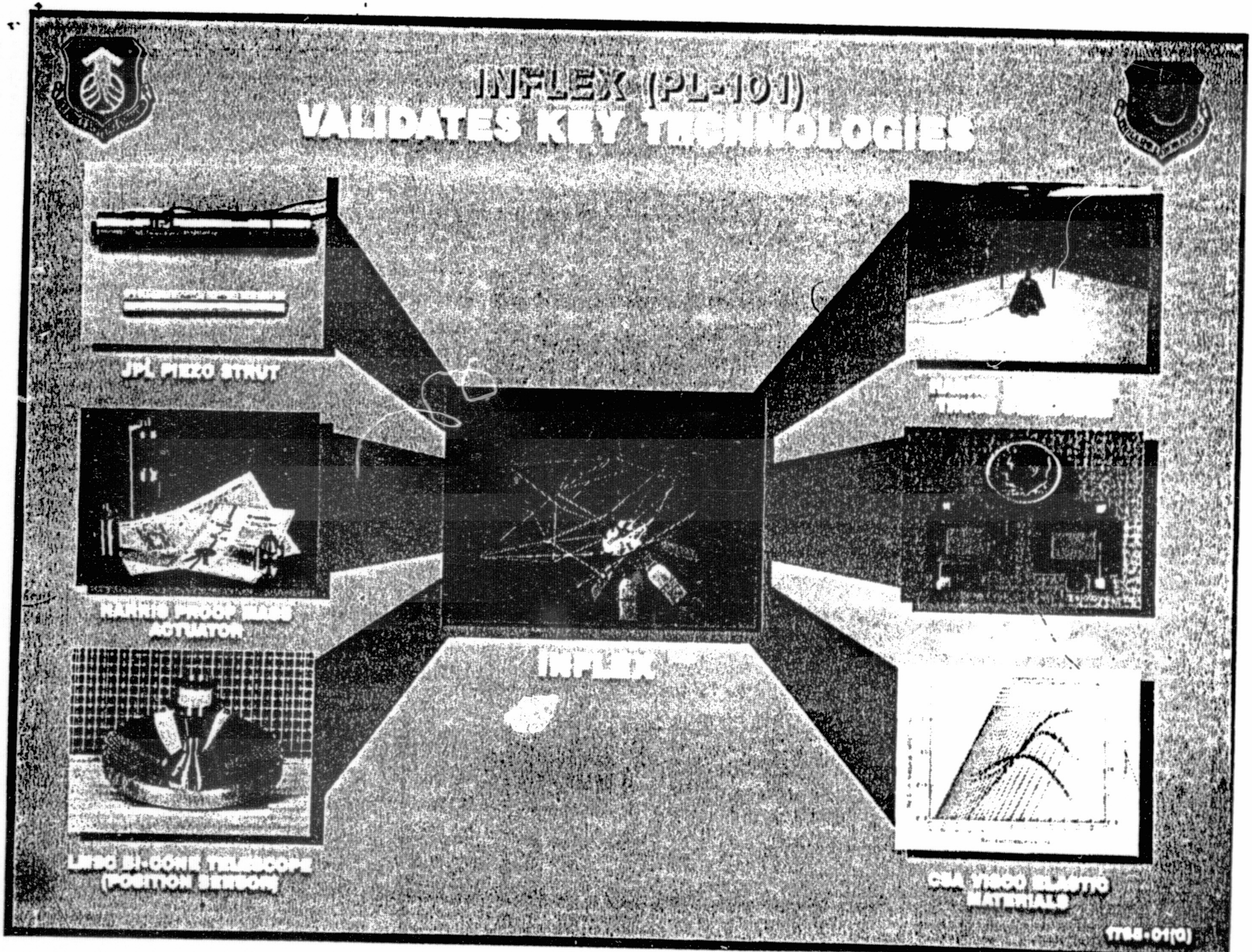
DESCRIPTION

- 16-Foot Advanced Composite Deployable Antenna, Sized for Pegasus Launch
- Optical Sensing System for Antenna Shape Control
- Piezo Strut for Coupled 2-Body Dynamics
- High-Capacity Processor for Advanced Control Algorithms
- Structural Change Capability for Controller Reconfiguration

INFLEX PROGRAM STATUS

- $1.1M AIR FORCE FUNDING THROUGH PHASE II
- HARRIS CORP HAS COMPLETED ENGINEERING DRAWINGS FOR PRELIMINARY FLT EXP DESIGN
- EXPERIMENT FABRICATION TO COST $12M AND REQUIRE 2 YEARS FROM START DATE
- EXPERIMENT FABRICATION IN PHASE III IS CURRENTLY UNFUNDED





CONCLUSIONS

- ON-ORBIT DEMONSTRATIONS ESSENTIAL TO TRANSITION ADVANCED TECHNOLOGY TO OPERATIONAL SPACE SYSTEMS
- SUCCESSFUL FLIGHT EXPERIMENTS ADDRESS SPECIFIC OPERATIONAL CONCERNS IN SMALL, NEAR-TERM TECHNOLOGY DEMONSTRATIONS
- JOINT EFFORTS GREATLY FACILITATE EFFORTS, E.G., SDIO FUNDING, AF TECHNOLOGY, NRL FLIGHT
- SDIO HAS PROVIDED STRONG SUPPORT FOR FLIGHT EXPERIMENTS IN AREA OF ADAPTIVE STRUCTURES