

LONG DURATION SPACE MATERIALS EXPOSURE (LDSE)

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ABSTRACT

The Center on Materials for Space Structures (CMSS) at Case Western Reserve University is one of seventeen Commercial Centers for the Development of Space. It was founded to: 1) Produce and evaluate materials for space structures, 2) Develop passive and active facilities for materials exposure and analysis in space, and 3) Develop improved material systems for space structures.

A major active facility for materials exposure is proposed to be mounted on the exterior truss of the Space Station Freedom (SSF). This Long Duration Space Materials Exposure (LDSE) experiment will be an approximately 6 1/2 ft x 4 ft panel facing into the velocity vector (RAM) to provide long term exposure (up to 30 years) to atomic oxygen, UV, micrometeorites, and other low earth orbit effects. It can expose large or small active (instrumented) or passive samples. These samples may be mounted in a removable Materials Flight Experiment (MFLEX) carrier which may be periodically brought into the SSF for examination by CMSS's other SSF facility, the Space Materials Evaluation Facility (SMEF) which will contain a Scanning Electron Microscope, a Variable Angle & Scanning Ellipsometer, a Fourier Transform Infrared Spectrometer, and other analysis equipment. These facilities will allow commercial firms to test their materials in space and promptly obtain information on their materials survivability in the LEO environment.

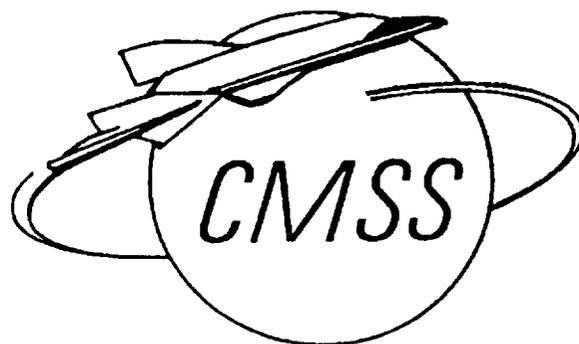
**LONG DURATION SPACE MATERIALS EXPOSURE
(LDSE)**

**CENTER ON MATERIALS FOR SPACE STRUCTURES
CASE WESTERN RESERVE UNIVERSITY**

AUGUST 5, 1992



**The Center on Materials for
Space Structures**



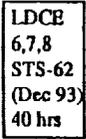
**A Center for the Commercial
Development of Space**

CMSS GOALS

- Produce and Evaluate Materials For Space Structures
- Develop Passive and Active Facilities For Materials Exposure and Analysis in Space
- To Develop Improved Materials Systems For Space Structures



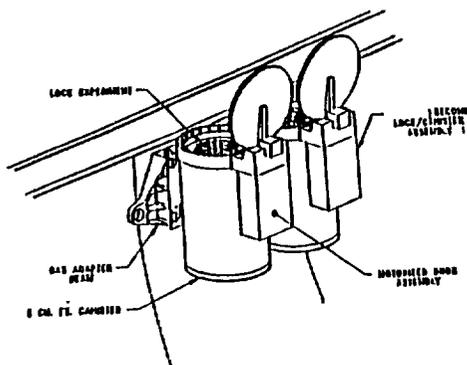
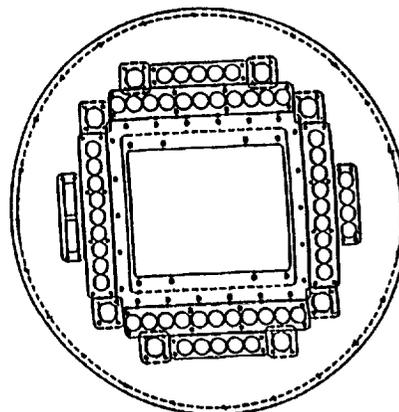
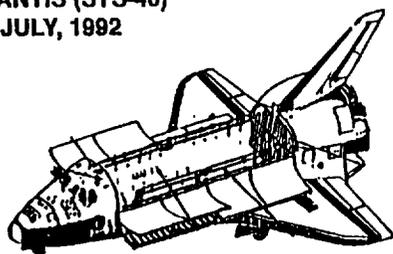
CMSS PROPOSED FLIGHT PROGRAM

	1992	1993	1994	1995	1996	1997	1998	1999	2000
PASSIVE SHUTTLE									
ACTIVE FREE FLYER FROM SHUTTLE			MatLab-1-2 WSF-02 STS-70 (Jan 95) 60 hrs	MatLab-1-3 WSF-03 STS-78 (Oct 95) 60 hrs	MatLab-1-4 WSF-04 STS-90 (Jul 96) 60 hrs				
ACTIVE FREE FLYER ELV			Matlab-2-1 COMET-02 (Aug 94) 130 days						
ACTIVE SHUTTLE			CMSE-1 STS-68 (Oct 94) 40-80 hrs	CMSE-2 STS-75 (Jul 95) 40-80 hrs	CMSE-3 STS-83 (Aug 96) 40-80 hrs	CMSE-4 (1997) 40-80 hrs			
SPACE STATION						LDSE-1 (1997) 30 yrs.	LDSE-2 (1998) 30 yrs	LDSE-3 (1999) 30 yrs	LDSE-4 (2000) 30 yrs
LUNAR							LSCE (1998) 2-30 yrs		
DEEPER SPACE						DSCE MEO (1997) 5 yrs			



Limited Duration Space Environment Candidate Materials Exposure (LDCE) Experiment LDCE-1,-2,-3

ATLANTIS (STS-46)
JULY, 1992



- 351 Experiment Samples (3/4" & 1")
- 3 LDCE Disks
- 40 Hours of Exposure
- 128 Nautical Miles Altitude



LDCE SPACEFLIGHT SAMPLE DISTRIBUTION

<u>SPONSER</u>	<u>LDCE-1</u>	<u>LDCE-2</u>	<u>LDCE-3</u>
Alcan	2	4	—
Battelle Pacific Northwest Labs	3	7	—
Case Western Reserve University	5	11	6
Dow Chemical	1	1	—
Dow Corning	5	2	2
Duralcan	—	2	—
Hexcel Corporation	11	—	—
Hoechst-Celanese	1	1	—
J.A. Wollam Company	—	9	11
Jet Propulsion Laboratory	—	—	10
Lawrence Livermore National Labs	—	—	40
McGhan Nusil Corporation	—	—	23
Monsanto	2	2	—
NASA Lewis	—	2	—
Premix	1	1	—
Science Applied International Corporation	1	1	1
Texas A&M University	1	1	—
3M Corporation	8	6	—
TRW	1	1	—
University of Toronto	20	—	—
University of Washington	1	1	—
Westinghouse-Hanford	—	6	10
U.S. Army-WPAFB	97	35	—
TOTAL SAMPLES	160	93	103
View Factor	1	4	—
Capacity (Total number of specimens: 351)	159	89	103

LDSE BENEFITS

- **New Materials for Space**
 - Lightweight, Oxygen Resistant Structural Materials
 - Corrosion Resistant Materials
 - Self-Healing Protective Coatings
 - High Vacuum Tribological Materials
 - Long-Life Optical Coatings
- **New Materials for Earth**
 - Lightweight Oxygen Tanks for Firefighters
 - High Strength, Corrosion Resistant Pipes and Vessels for Lower Cost Factories
 - Long-Life, Self-Healing Paints and Coatings
 - New Permanently Lubricated Motors and Machines
 - Solar Cells for Home Power Generation



LDSE OPERATIONAL SCENARIO

- **1st Launch in August, 1997 (LDSE-1)**
 - Launch of CMSE Type Panel Modified to Mount on Space Station Freedom Truss Pointed into Ram Direction.
- **Next Four Launches in FY 1998, 1999, 2000, and 2001 (LDSE -2, -3, -4, -5)**
 - Mount to Space Station Truss
 - Annual EVA's Required for LDSE-1 may Service LDSE-2 and LDSE-3
 - Two Additional EVA's required for LDSE-4, -5
- **Data Telemetered Through NASA-JSC to CWRU CMSS**

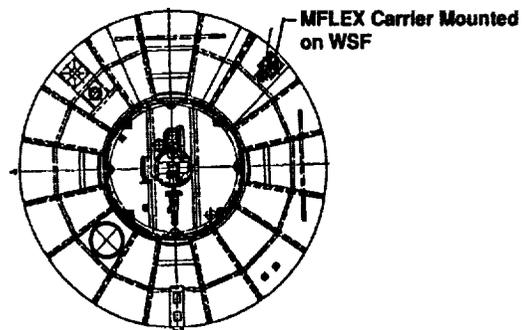
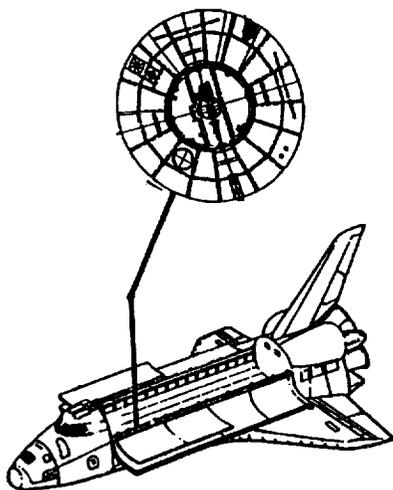


The General Purpose Materials Flight Experiment Carrier Concept

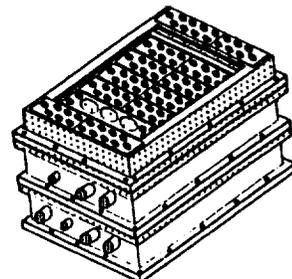
MFLEX



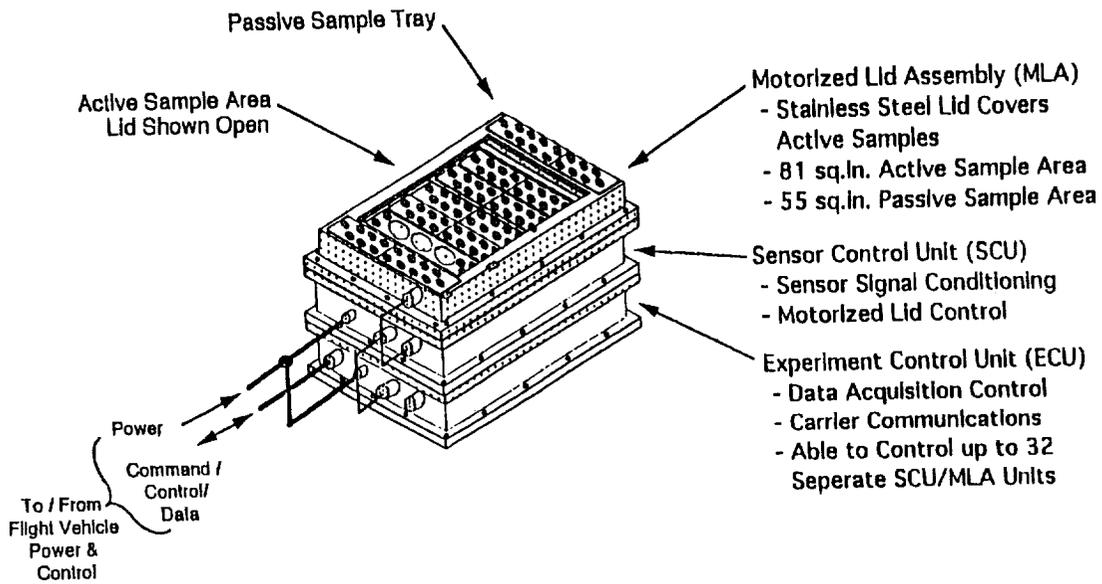
MatLab-1 Experiment on the WakeShield Facility (WSF)



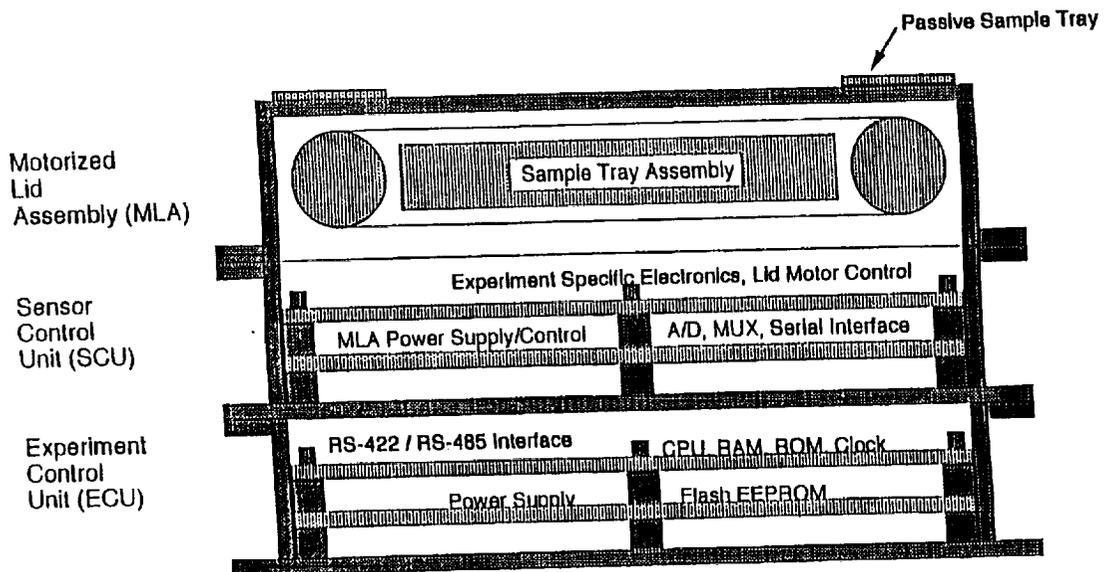
- Approximately 75 Instrumented Experiments
- Real Time Telemetry of Data
- Free Flyer Removes All Influence of Shuttle Environment
- 77 Hours of Exposure
- Flight on STS-60 Oct, 1993
- 190 Nautical Miles Altitude



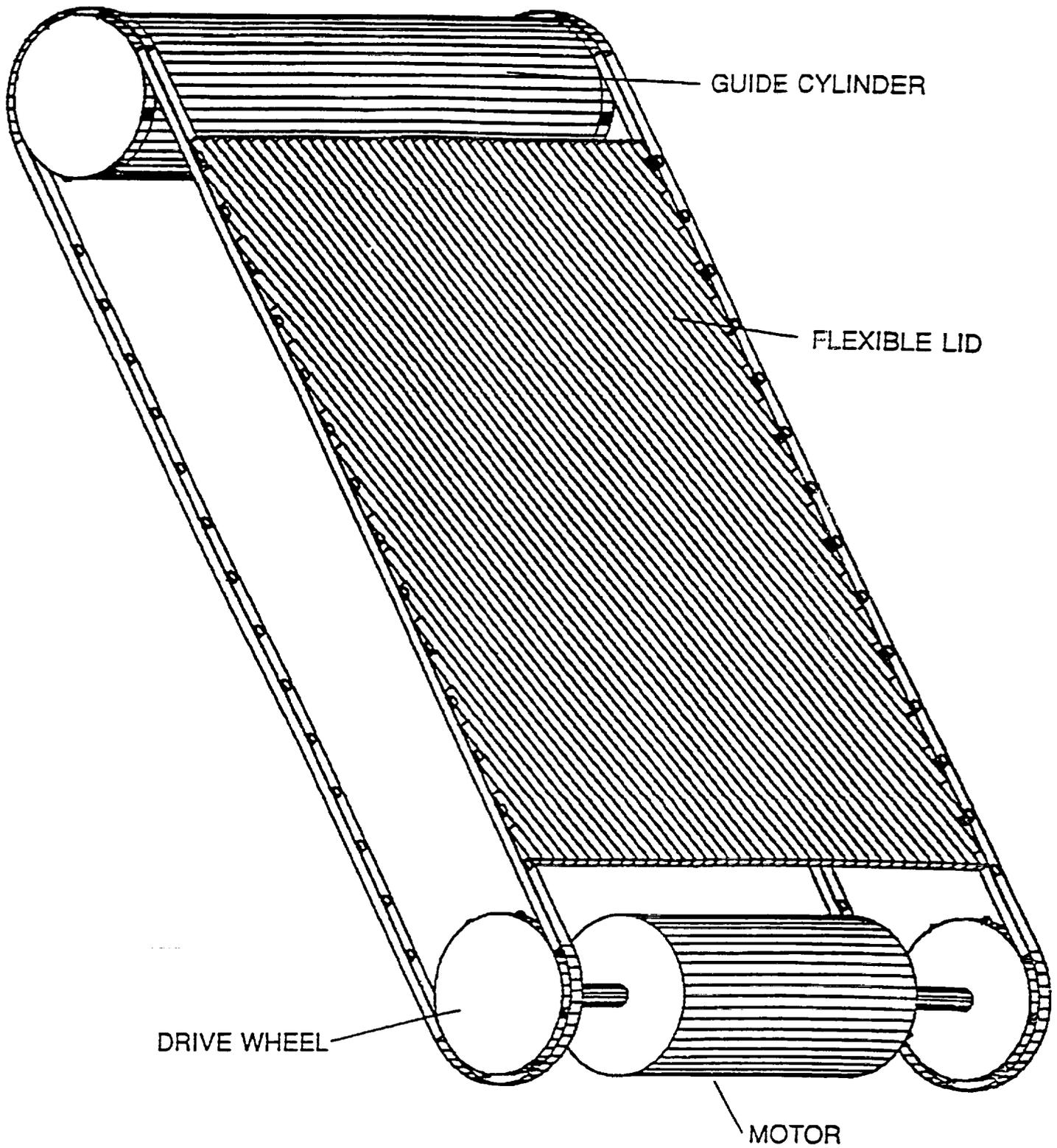
MFLEX Base Configuration with MLA



MFLEX Distributed Structural Concepts



MOTORIZED LID ASSEMBLY



MFLEX Supports These Active Experiments

- **68 Actinometers**
- **25 Strain Gauges**
- **5 Acoustic Emission Sensors**
- **72 Thermal Sensors**
- **24 Ultraviolet, Visible Light and Solar Diodes**

The MFLEX can provide up to 194 data channels per Sensor Control Unit and can accommodate up to 32 Sensor Control Units



MFLEX Flight Experiments:

- (11) MLA / SCA Test Assemblies
- (1) MLA / SCA / ECU Test Assembly
- (1) ECU controls all test assemblies
- 3 X 4 MFLEX packaging array

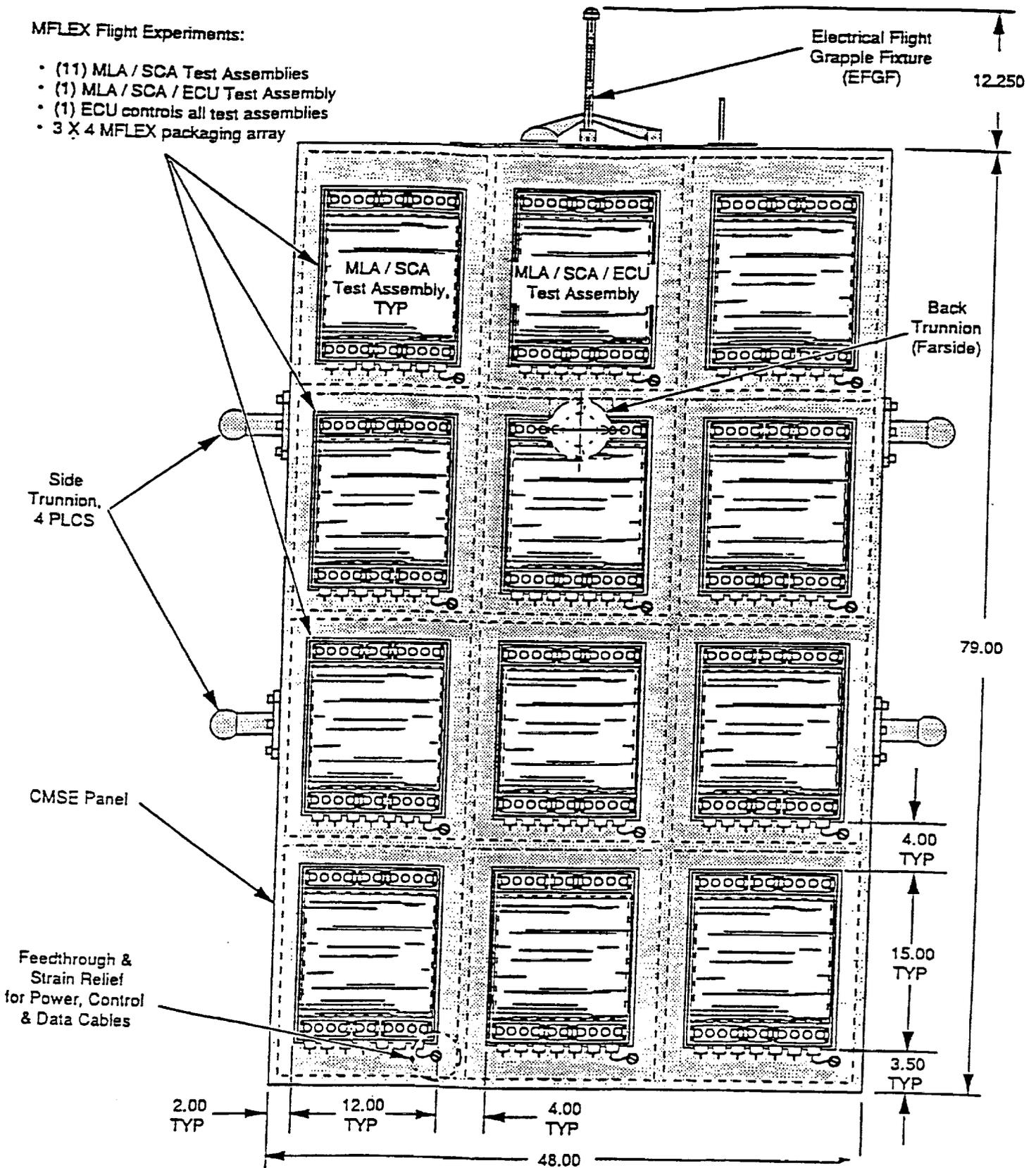
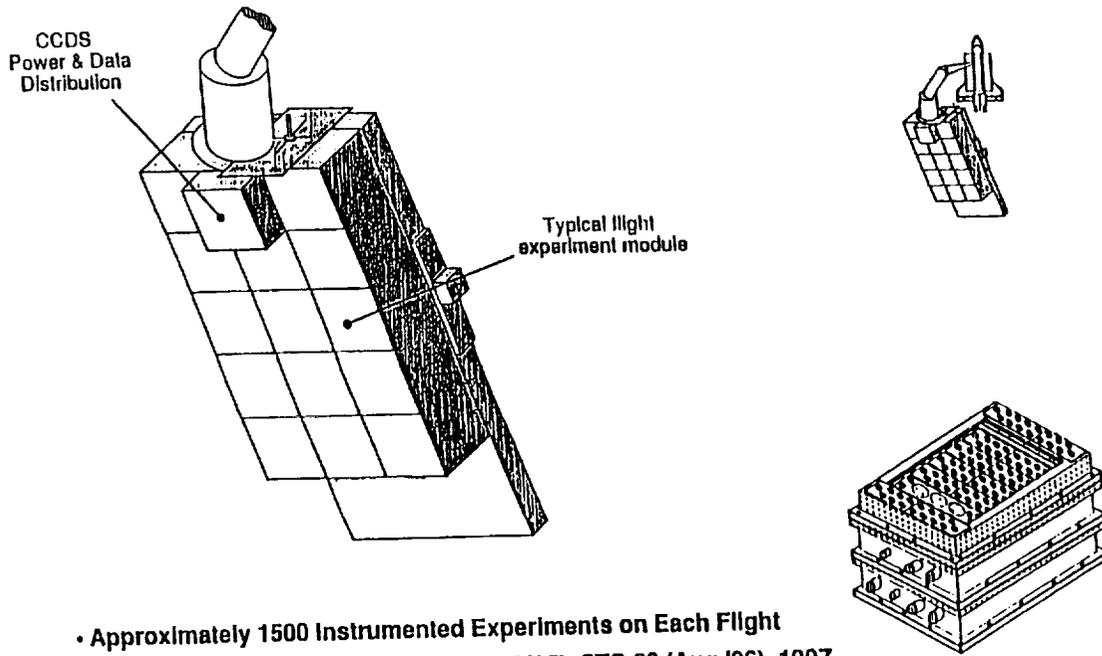


Figure 2 - CMSE Panel with Multiple MFLEX Experiments, Front View

FIGURE 1

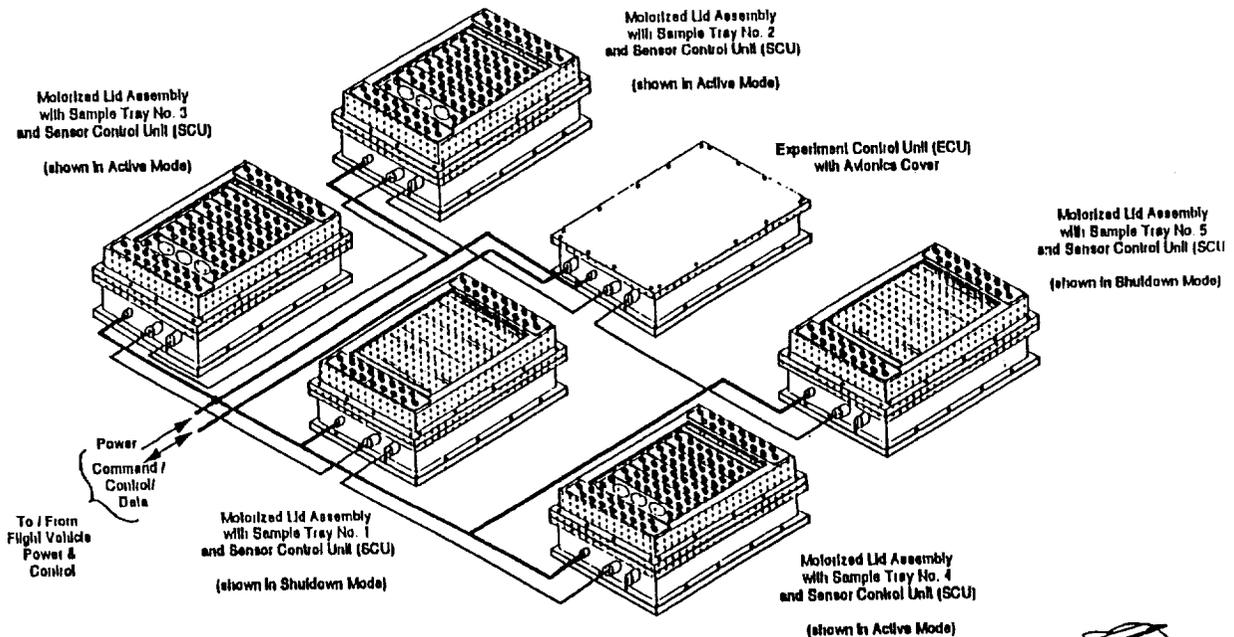
Candidate Materials Space Exposure Experiment (CMSE)



- Approximately 1500 Instrumented Experiments on Each Flight
- Flying on STS-68 (Oct '94), STS-75 (Jul,'95), STS-83 (Aug,'96), 1997
- 40-80 Hours of Exposure



MFLEX Flight Experiment Package Configured for Multiple Sample Trays



LDSE PAYLOAD READINESS

- **Conceptual Design:** FY 1994
- **OCP Space Station Funding:** FY 1995
- **Detail Design:** FY 1995
- **Fabrication:** FY 1996
- **Testing:** FY 1997
- **1st Launch:** 4th Quarter FY 1997
- **Subsequent Launches:** 4th Quarter FY 1998 FY 1999, FY 2000, FY 2001



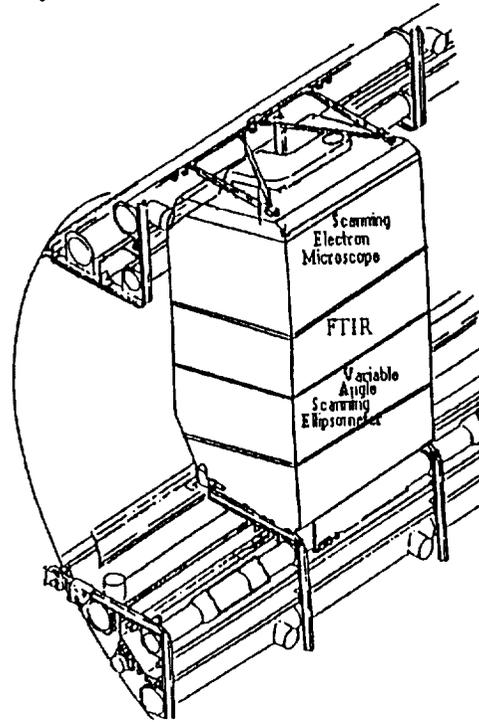
LDSE REQUIRED RESOURCES

Mass: 430 lbs each (5 required)
Volume: 79 in. tall x 48 in. wide x 12 in. deep
Power: 1.7 KW Peak .784 KW Average
Nitrogen: None
Liquid Heat Rejection: None
Avionics Heat Rejection: None
Water: None
Venting: None
Vacuum: None
Refrigerated Storage: None
Data Management: 30 K bytes/min. for each LDSE Panel
Video: Yes, 3x Camera Capability on Truss RMS
Uplink Command: Yes Open and Close Switches
Microgravity Level: N/A



Space Materials Evaluation Facility (SMEF)

- Standard Double Rack Aboard
Space Station Freedom
- Evaluation
 - Space Processed Materials
 - Space Exposed Materials
 - Other Experiment Support
- Equipment
 - Scanning Electron Microscope
 - Variable Angle Scanning Ellipsometer
 - Fourier Transform Infrared Spectrometer



For Further Information

on LDSE

or Other CMSS Experiments

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