

# ORBITAL DEBRIS ENVIRONMENT MONITOR ODEM

**Dr. John P. Oliver**  
**Institute for Space Science and Technology,**  
**Gainesville, Florida**

**Presented at the Flight Experiments**  
**Technical Interchange Meeting, Monterey, California**  
**5-9 October, 1992**

Institute for Space Science and Technology © 1992



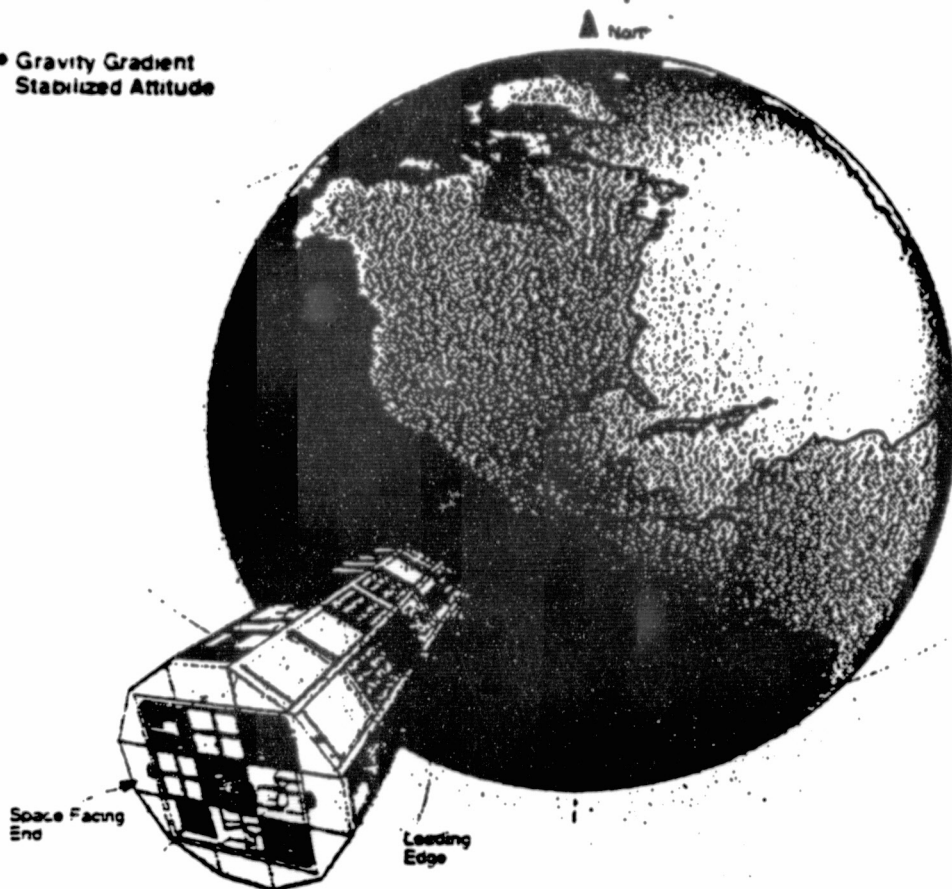
N93-28735

*2*  
*p. 16*  
*30/159241*

Institute for Space Science and Technology, 1810 NW 6th Street, Gainesville, Florida 32609 © 1992

# LDEF Orbital Flight Orientation

• Gravity Gradient Stabilized Attitude



NSA

L-00-10710

## LDEF Long Duration Exposure Facility

Orbital Attitude: Gravity Gradient Stabilized  
(Schematic)

Deployed: April 7, 1984, at 250 nmi (463 km)

Retrieved: January 12, 1990, at 178 nmi (330 km)

Total Duration in Orbit: 70 months (5.8 yr)

Atomic Oxygen Fluence (atoms/sq cm):  $\approx 10^{22}$

Orbital Ram Velocity:  $\approx 8$  km/s

LDEF Structure:

Material: 6061-T6, Aluminum

Coating: (Interior) Chemglaze Z306 (Flat Black)

Size: (12-Sided Cylinder)

Length: 30 ft ( $\approx 9$  m)

Diameter: 14 ft ( $\approx 4$  m)

Weight: (With Experiments) 21,393 lb (9,704 kg)

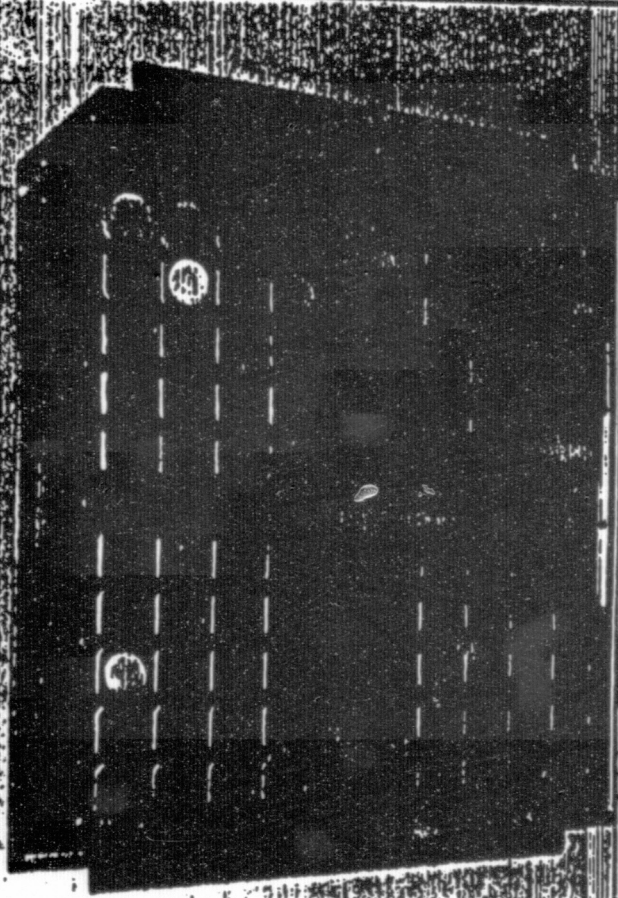
Number of Experiments: 57

Number of Investigators: >200

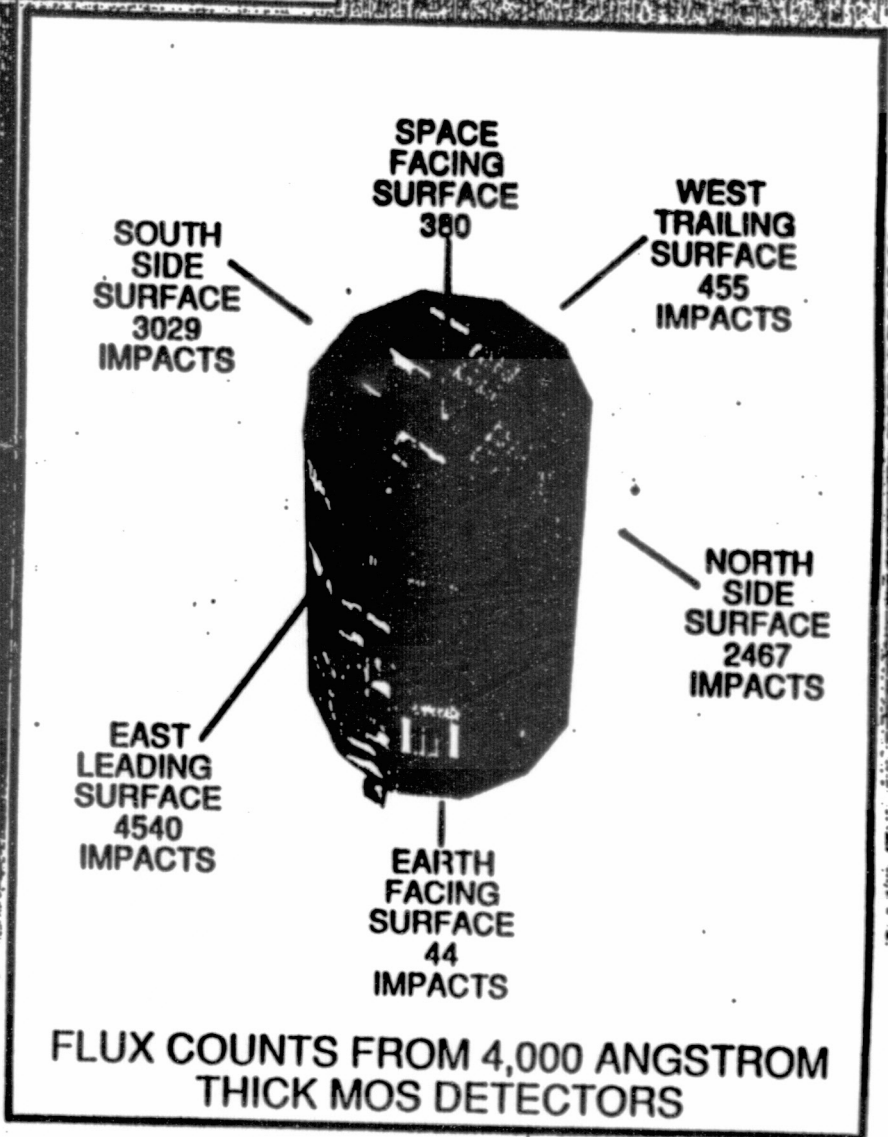
6.10

# INTERPLANETARY DUST EXPERIMENT

• Detector Arrays Mounted on 6 Sides of LDEF



DETECTOR ARRAY MOUNTED ON EARTH SIDE OF LDEF



Institute for Space Science and Technology © 1992

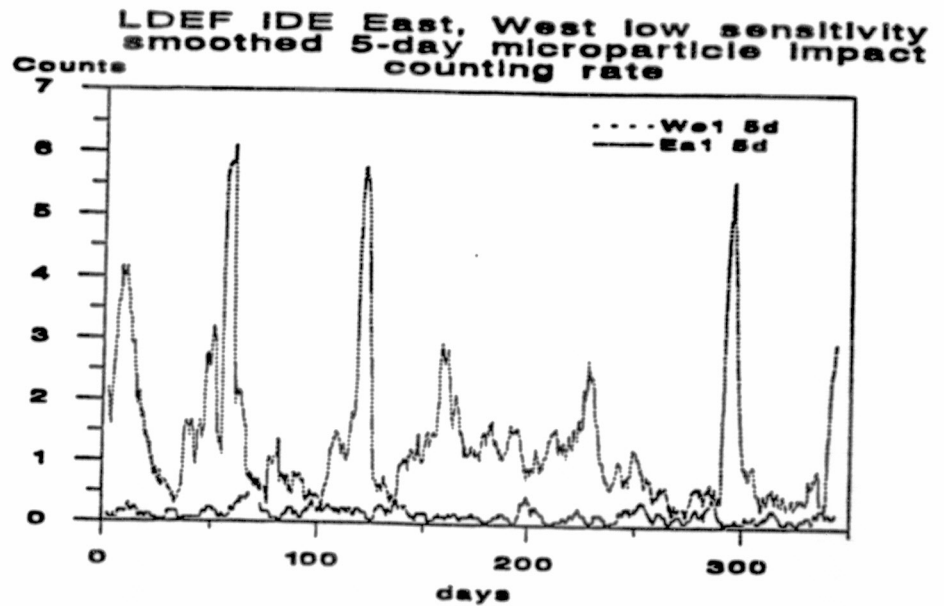


Figure 2a. Five day smoothed flux on the East and West low sensitivity IDE sensors as a function of time.

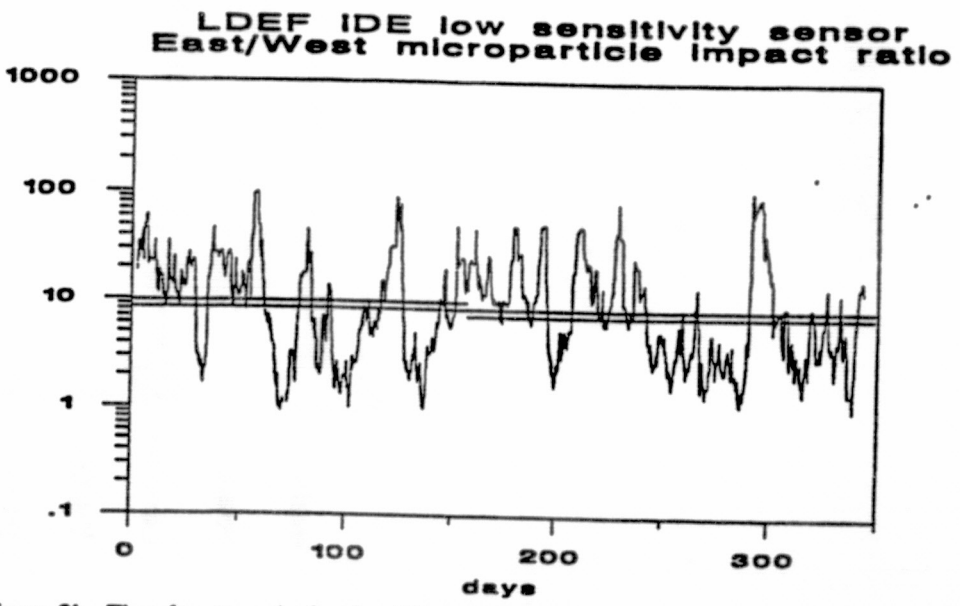
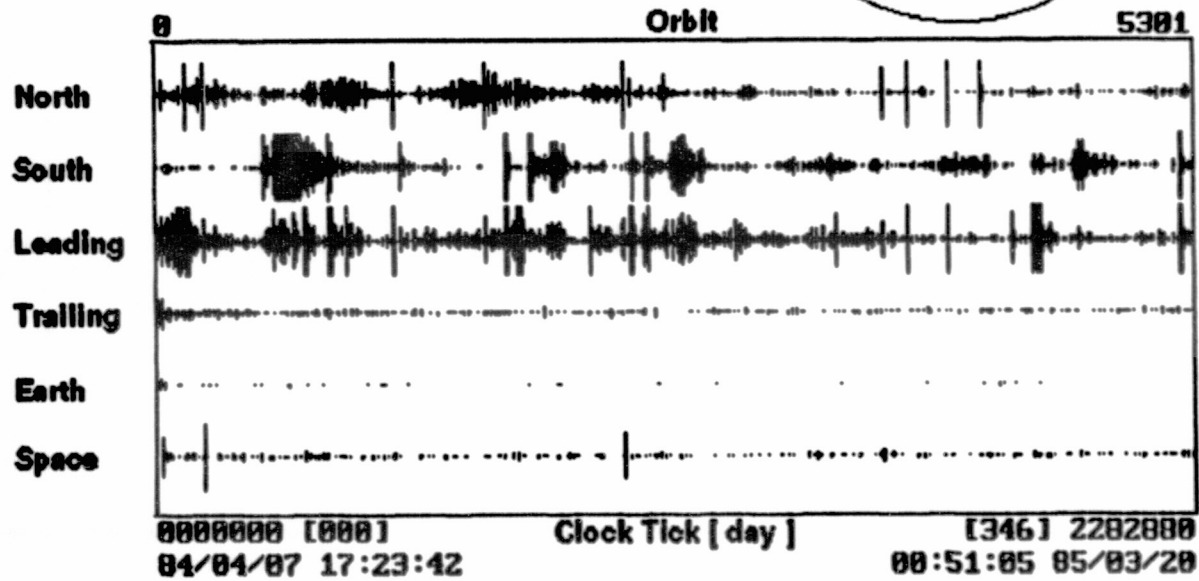
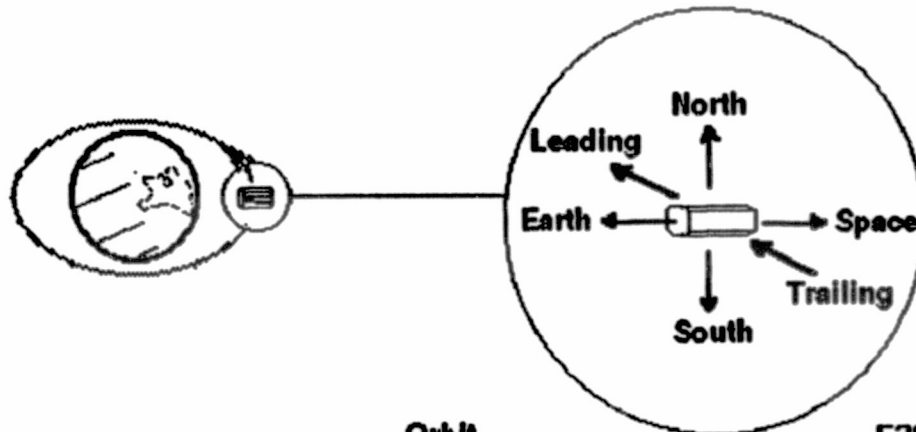


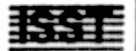
Figure 2b. Five day smoothed ratio of East and West low sensitivity sensor microparticle impact fluxes as a function of time. Horizontal lines mark mean values of full data set and the first and second halves of the data set..



# "Seismograph" Plot



Institute for Space Science and Technology © 1992



IDE active mission = 346 days

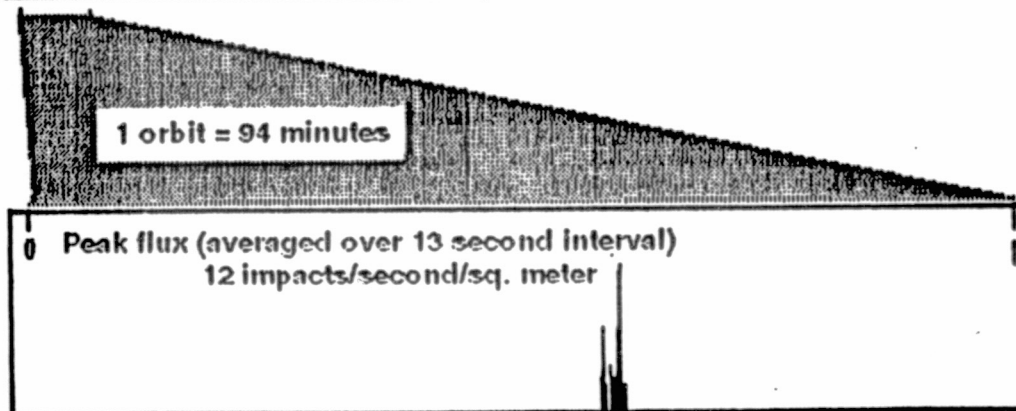
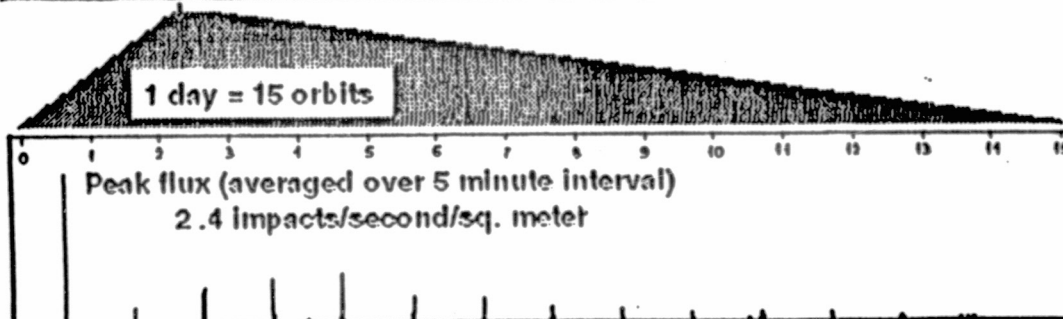
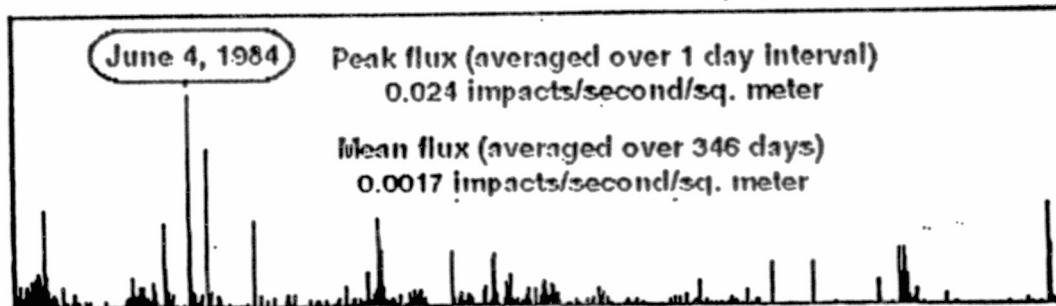
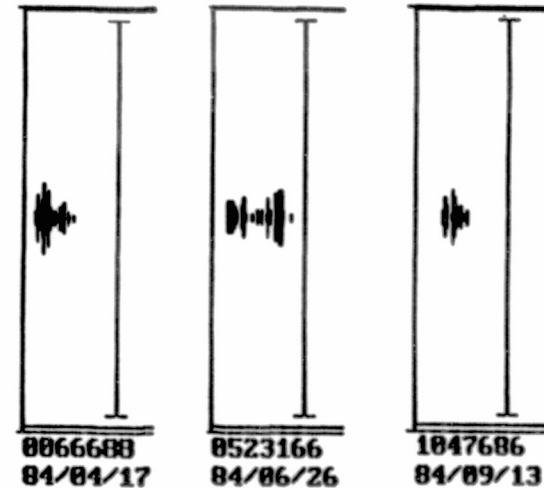
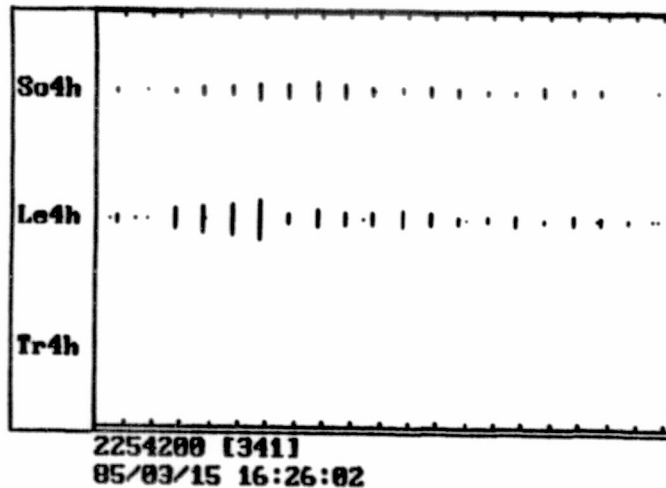
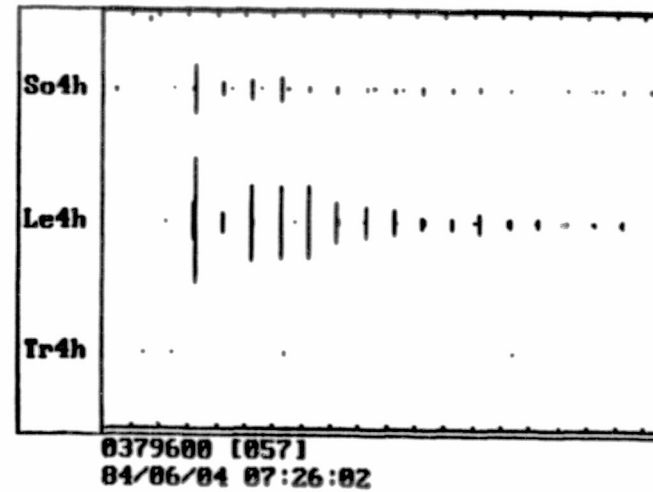
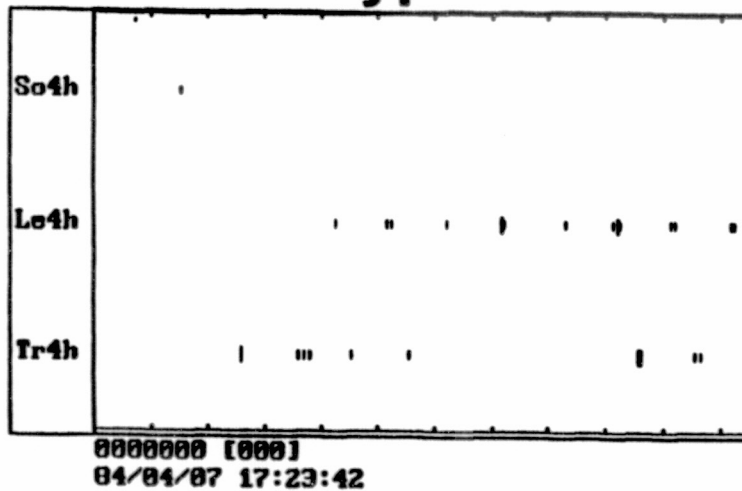


Figure 2. Observed activity on the leading (ram) edge of LDEF as recorded by the 0.4  $\mu\text{m}$  thickness detectors of IDE.

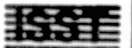
ISST

# Typical "MOEs" and "Spikes"



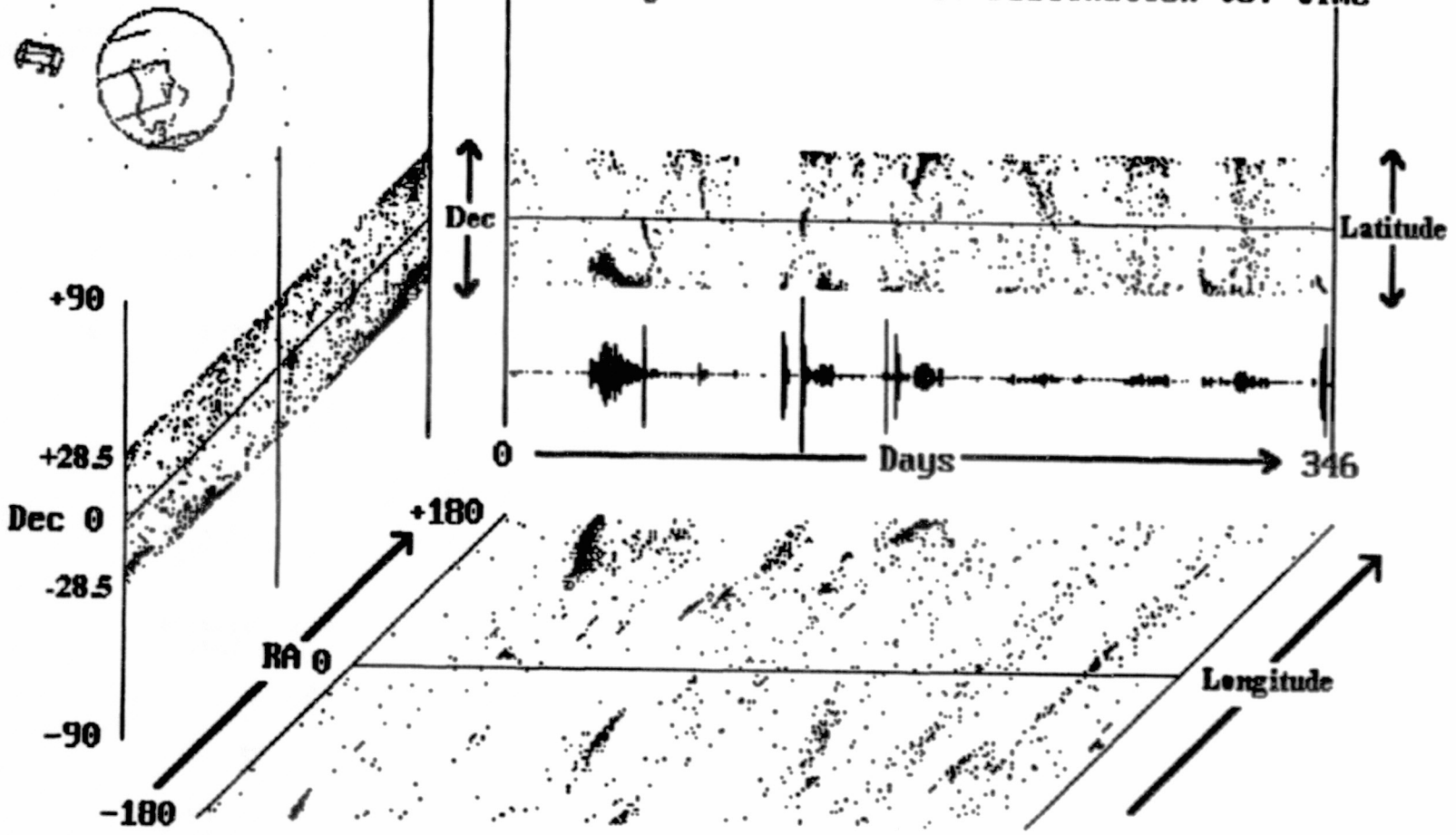
**Time Full Scale:MOE  $\approx$  1 day; Spike  $\approx$  10 minutes**

Institute for Space Science and Technology © 1992



ORIGINAL PAGE IS  
OF POOR QUALITY

LDEF IDE Data: South 0.4 I data  
LDEF Right Ascension vs. Declination vs. time



Institute for Space Science and Technology © 1992





## **Orbital Debris Clouds**

- **Greatly Increased Impact Rates Localized In Time and Space**
  - Events Occur Every 94.1 Minutes**
  - Typical Event Duration; 3 to 5 Minutes ( 1500 to 2500 Km )**
- **Events Occur in Same Place Each Orbit**  
**Relative Activity on Differing Surfaces**  
**May Yield Apparent Source Direction**
- **Precession Allows Mapping In Space**
- **May 13th Swarm . . .  $\approx 30^\circ$  Orbital Inclination**
- **June 4th B Event . . .  $\approx 65^\circ$  Orbital Inclination**



**ISST**

**institute for  
Space  
Science and  
Technology**

**1810 NW 6th Street  
Gainesville, FL  
32609**



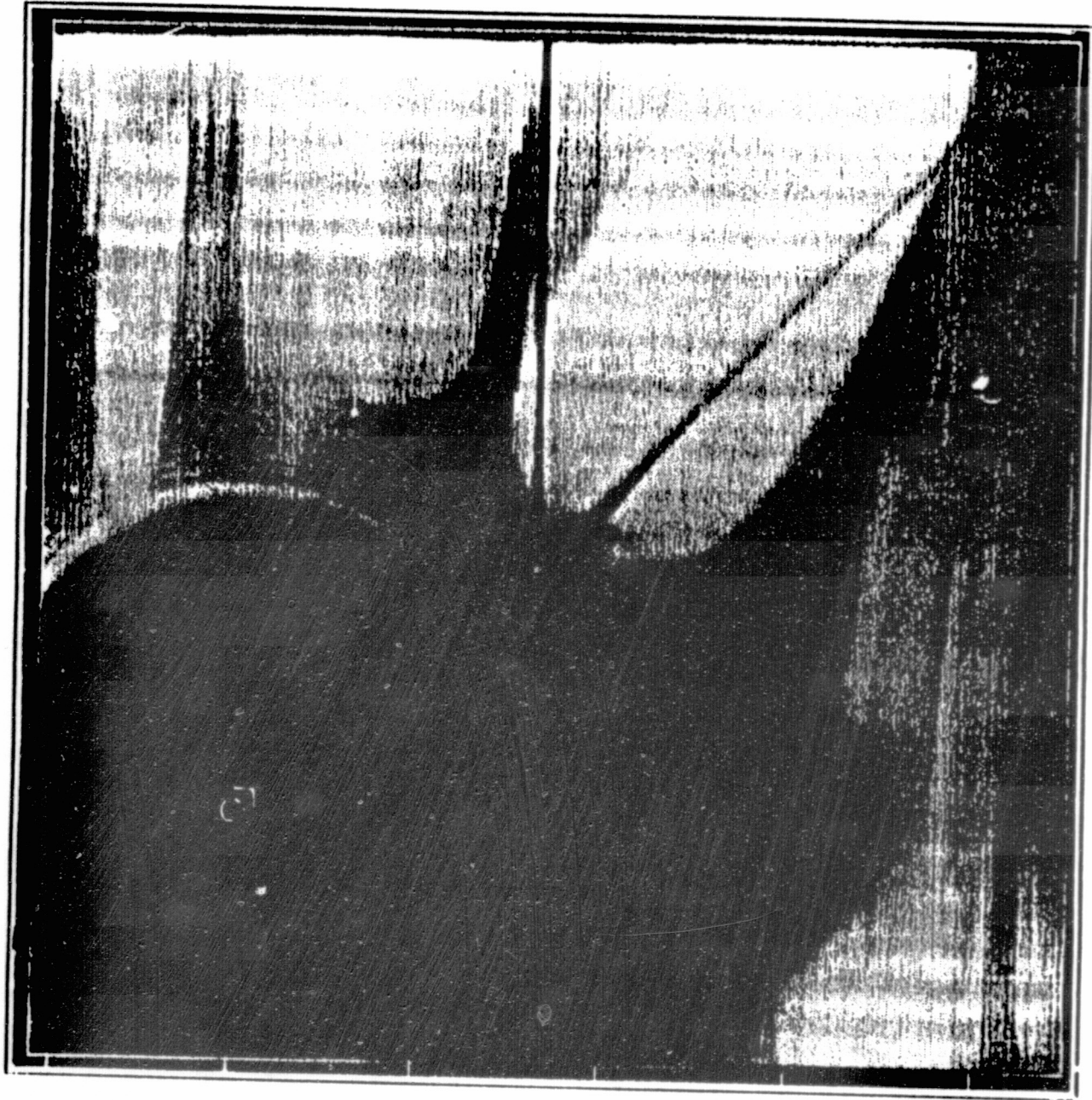
## **Mapping and Modeling of Orbital Debris Clouds**

- **Exploit the Unique IDE Spatio-Temporal Dataset**
- **Identify and Categorize Cloud Events**
- **Relate Cloud Events to Sources**
  - Launches to LEO**
  - LEO to GEO Insertion**
  - Accidental Disruption**
  - Deliberate Disruption**
- **Analyze Cloud Evolution and Dispersion**
- **Predictive Modeling of Clouds - Space Weather Prediction**
- **Statistical Prediction of Total LEO Debris Environment**



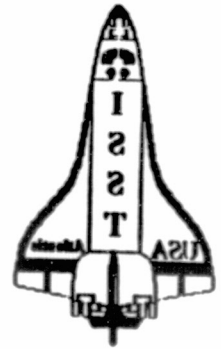
## **Solar Maximum Mission Spacecraft**

- **In same orbital plane, 15 km "above" LDEF at LDEF release**
- **HAO Coronagraph images showed near-field particles and particle clouds**
- **Although originally attributed to local contamination, statistical analysis suggests some were orbital debris particles**
- **Correlation of LDEF IDE data with SMM Coronagraph data taken during 1984-1985 can confirm orbital debris origin**
- **SMM Coronagraph data available for period from 1980 through 1989; allowing assessment of changes in**



IST

Institute for  
Space  
Science and  
Technology  
1810 NW 6th Street  
Gainesville, FL  
32609



## **SynMOD (precursor to ODEM)**

- **Synoptic Monitoring of Orbital Debris**
- **High time-resolution monitoring of near-Earth small particle impacts**
- **Uses proven MTS/Explorer 46/IDE sensors**
- **Selected for Eureka-2**

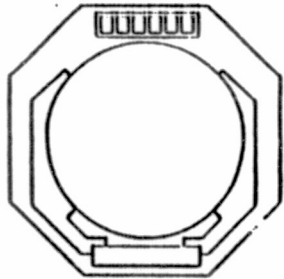
## **ODEM**

- **Orbital Debris Environment Monitor**
- **Adds impact energy/size/mass discrimination to SynMOD**
- **Standardized, Modular system**
- **Can easily mount on any Bus**

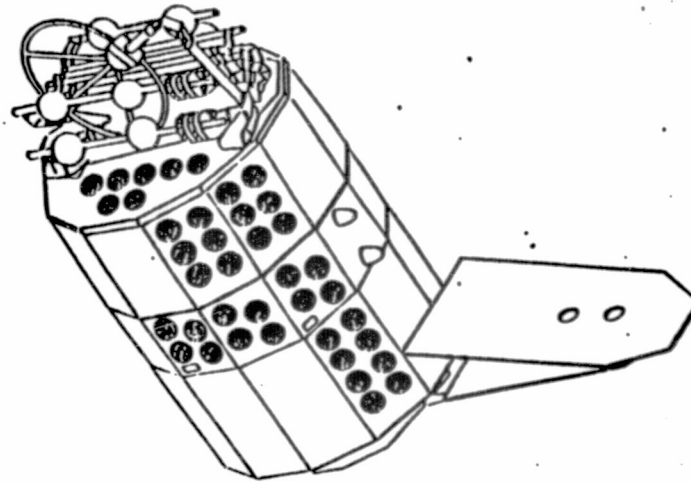
Institute for Space Science and Technology © 1992



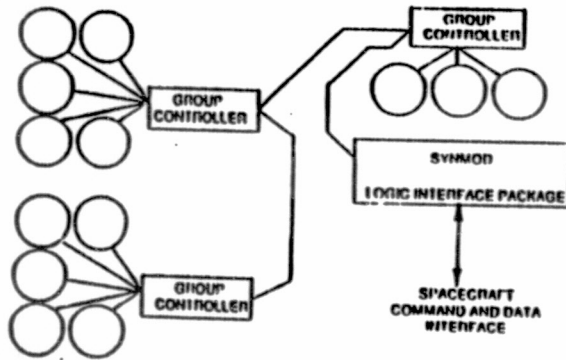
22. PICTORIAL



Individual Detector Element



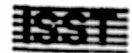
Possible Configuration Options



System Architecture

DD FORM 1721 AUGUST 1990  
PREVIOUS EDITIONS ARE OBSOLETE

Security Classification (When data entered)



## RESOURCE REQUIREMENTS

	SynMOD	ODEM
<b>Command and Data Uplink:</b>	none	none
<b>Telemetry Downlink:</b>	< 250 Kbits/day	same
<b>Power:</b>	nominal 2 watts	same
<b>Mass (per module):</b>	< 0.75 kg	same
<b>Mass (electronics):</b>	< 1.0 kg	same
<b>Volume (per module):</b>	.3 x .3 x .003 m	same
<b>Stabilization Required:</b>	none	none
<b>Desired Configuration:</b>	12 modules	same

Institute for Space Science and Technology © 1992

