

EUROPEAN SCIENCE EXPOSURE FACILITY (ESEF/ICA)
&
THE PARTICLE IMPACT EXPERIMENT (PIE)
- Results from MIR Space Science Payloads -

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ESEF/ICA

ESEF/ICA

- THE ESA MISSION, EUROMIR '95, BEGAN IN SEPTEMBER 1995, WHEN AN ESA ASTRONAUT (THOMAS REITER) WAS LAUNCHED TO MIR FOR A SIX MONTH STAY. DURING HIS EVA, REITER INSTALLED AN EXPERIMENTAL BOX CALLED INSTRUMENT COMRADE ACTIVE (ICA) TO THE PLATFORM.
- IN ADDITION TO THE ACTIVE ENUMERATION OF HYPERVELOCITY PARTICLE IMPACTS, THE ICA EXPERIMENT SENSORS WERE TO ACTIVELY MEASURE THE ATOMIC OXYGEN FLUX AND CONTAMINATION DEPOSITION/EFFECTS DURING THE MISSION.
- THE PRINCIPAL DETECTORS FOR MMOD FLUXES WERE MOMENTUM STAGE IMPACT DETECTORS. THE PRINCIPAL DETECTORS FOR THE MEASURE OF ATOMIC OXYGEN (AO) AND CONTAMINATION FLUXES WERE QUARTZ CRYSTAL MICROBALANCES AND CALORIMETERS.
- THREE QCMS WERE INCORPORATED INTO THE INSTRUMENT. TWO SENSORS WERE COATED WITH HDL CARBON TO MEASURE THE AO FLUX RATE. ONE SENSOR HAD NO DEPOSIT. THE INTENT WAS TO USE THE TWO AO FLUX SENSORS AS MASS DEPOSITION SENSORS AFTER THE CARBON WAS REMOVED.

PIE

SCIENTIFIC OBJECTIVES

PRINCIPAL OBJECTIVES:

- TO CAPTURE MICRON/SUBMICRON DUST GRAINS IN A MANNER THAT INSURES MINIMAL PARTICLE DEGRADATION.
- TO RETURN THE CAPTURED PARTICLES TO EARTH FOR COMPLETE AND DETAILED CHEMICAL, ISOTOPIC, SPECTRAL, MINERALOGICAL AND ORGANIC ANALYSIS THEREBY DETERMINING GRAIN COMPOSITION.
- TO IDENTIFY THE PARTICLE REMNANTS OF ANY MICRON SIZED EXTRATERRESTRIAL GRAINS HAVING IMPACTED ON PURPOSELY DESIGNED METALLIC COLLECTORS, FOR COMPLETE AND DETAILED CHEMICAL, ISOTOPIC AND ORGANIC ANALYSIS THEREBY DETERMINING GRAIN COMPOSITION AS WELL AS THE EXISTENCE OF ORGANIC AND INORGANIC MOLECULES, TO BE RELATED WITH THE POSSIBLE COMETARY ORIGIN OF THE GRAINS.

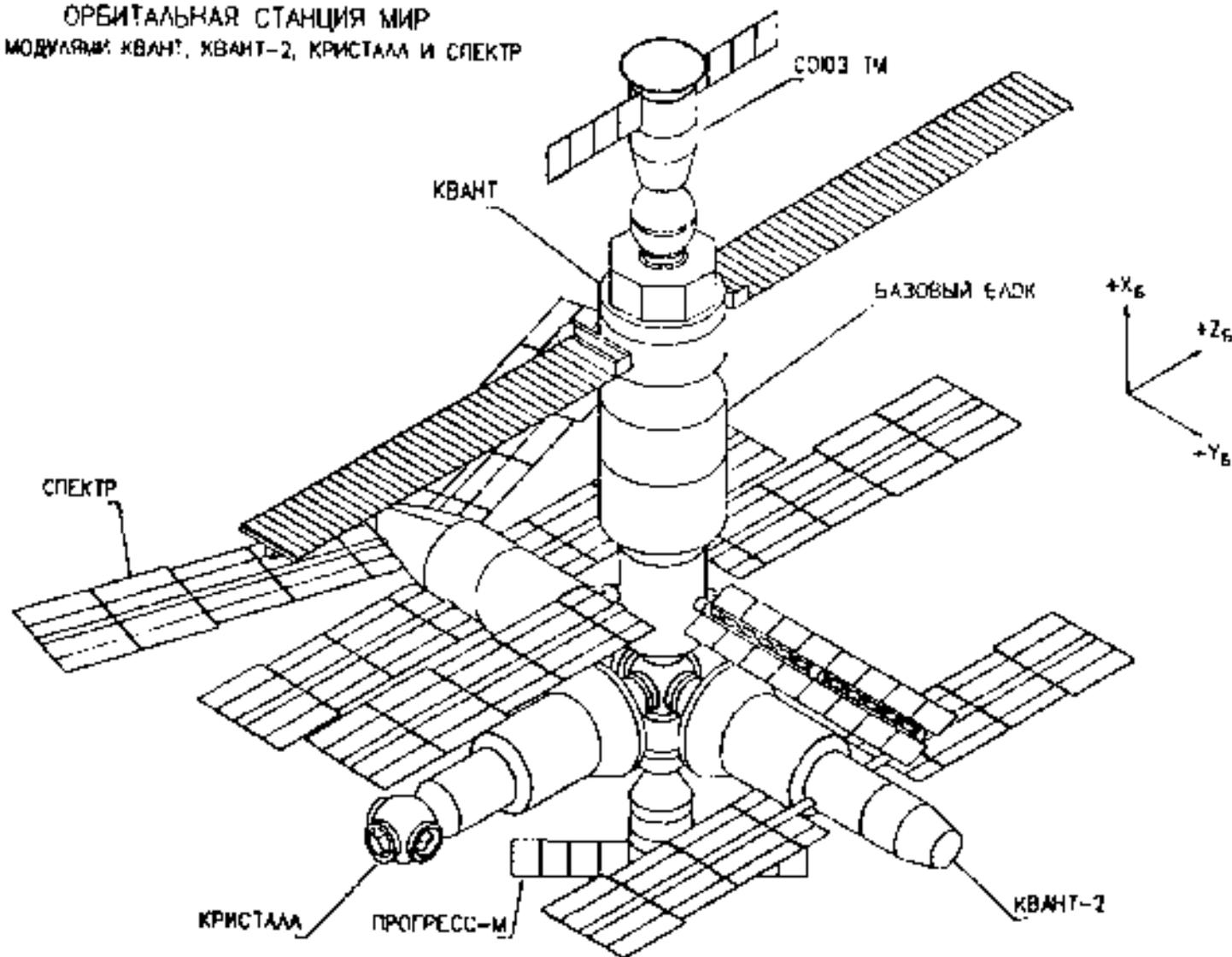
SECONDARY/TERTIARY OBJECTIVES:

- TO ASSESS THE LEVEL OF CONTAMINATION SEEN ON THE RETURNED HARDWARE.
- TO STUDY THE EFFECTS OF UV-RADIATION ON ORGANIC MOLECULES IN SPACE (POLYCYCLIC AROMATIC HYDROCARBONS AND KEROGENS).
- TO ASSESS HARD RADIATION ENVIRONMENT LEVELS, CONSTITUENTS AND EFFECTS.

LOCATION OF PARTICLE IMPACT EXPERIMENT

- PIE IS SITUATED ON KVANT-2 MODULE, + Z SIDE, \perp Y POINTING -

ОРБИТАЛЬНАЯ СТАНЦИЯ МИР
С МОДУЛЯМИ: КВАНТ, КВАНТ-2, КРИСТАЛЛ И СПЕКТР

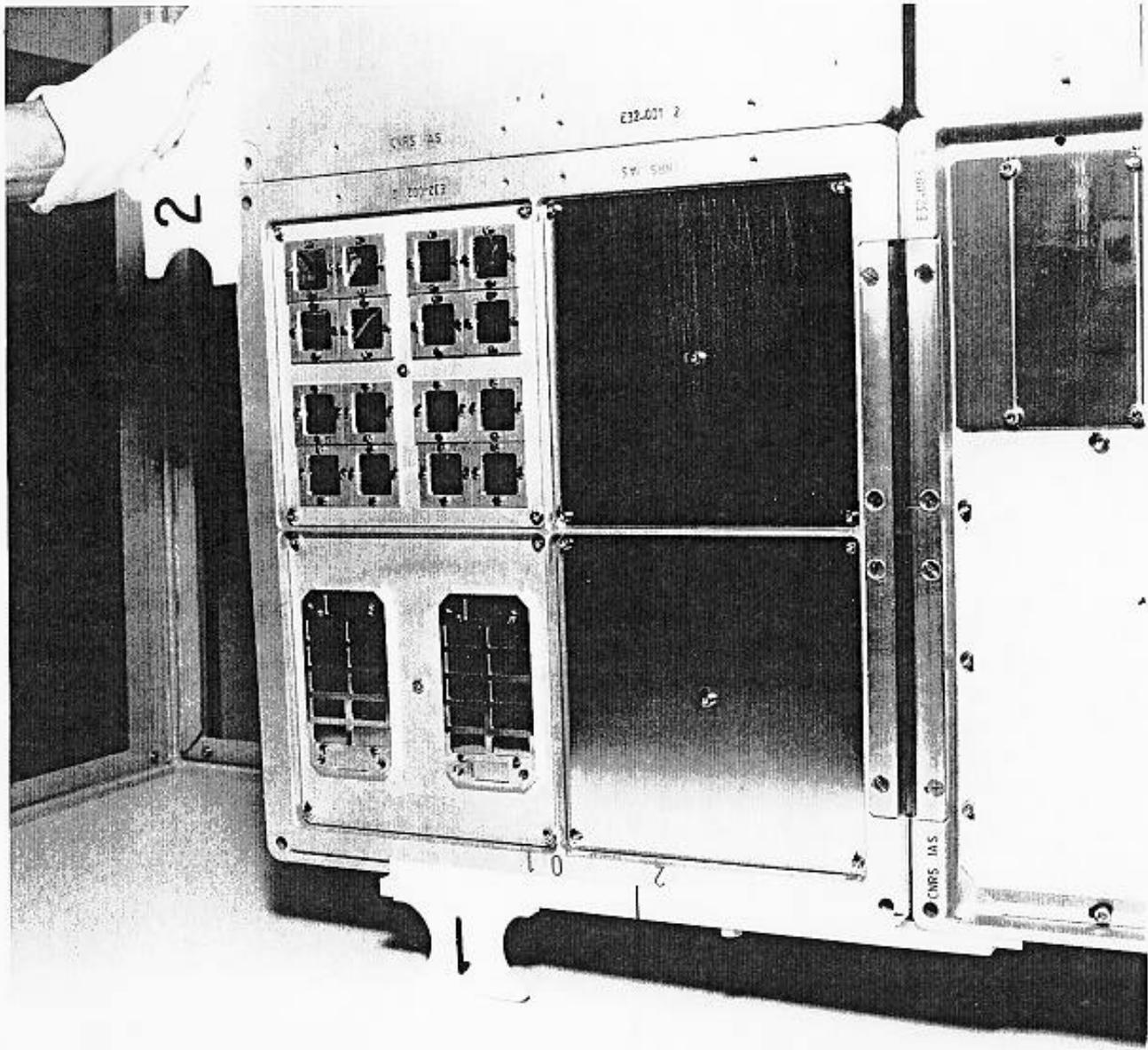




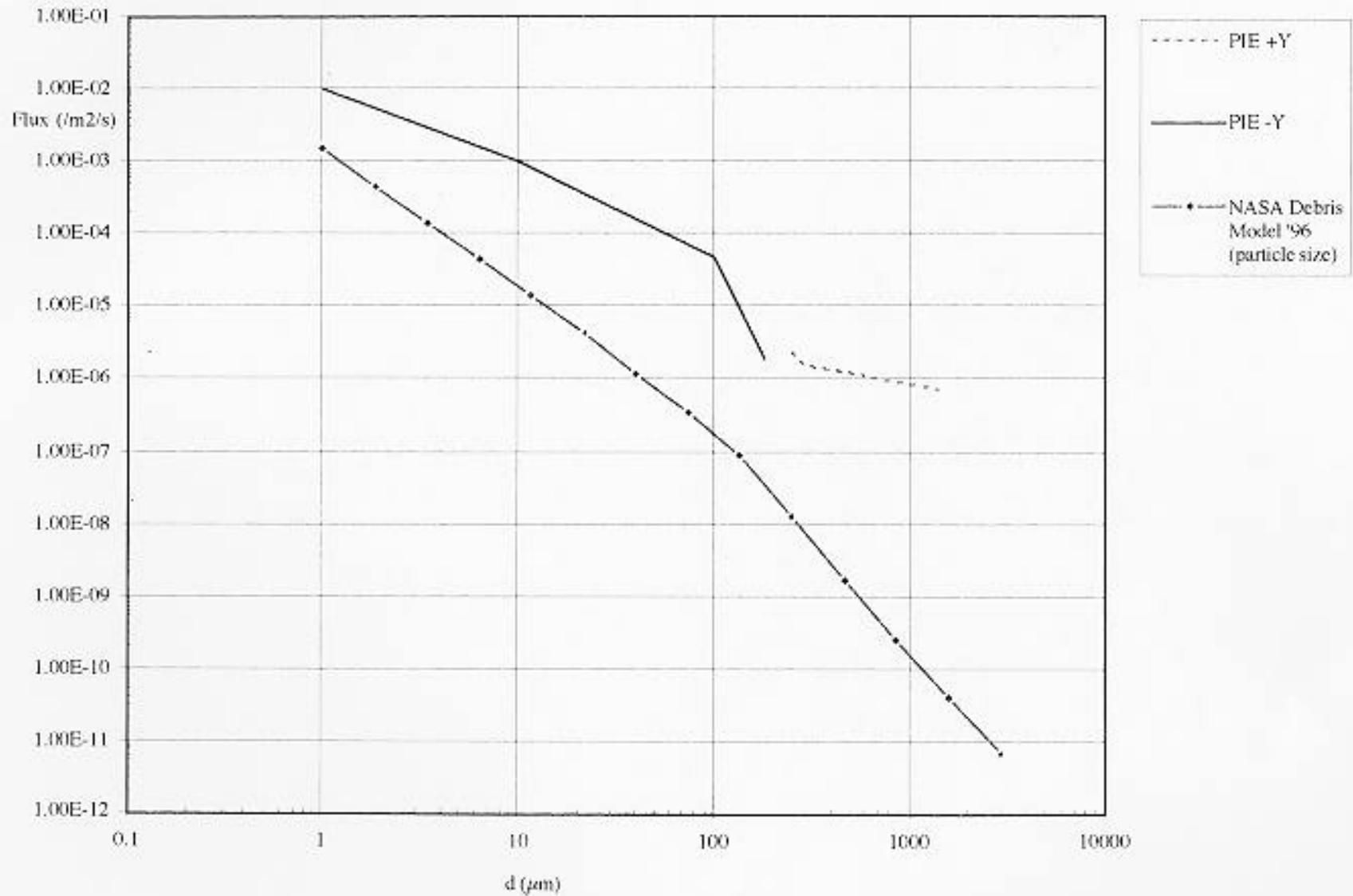
National Aeronautics and
Space Administration

596-20345

Lyndon B. Johnson Space Center
Houston, Texas 77058

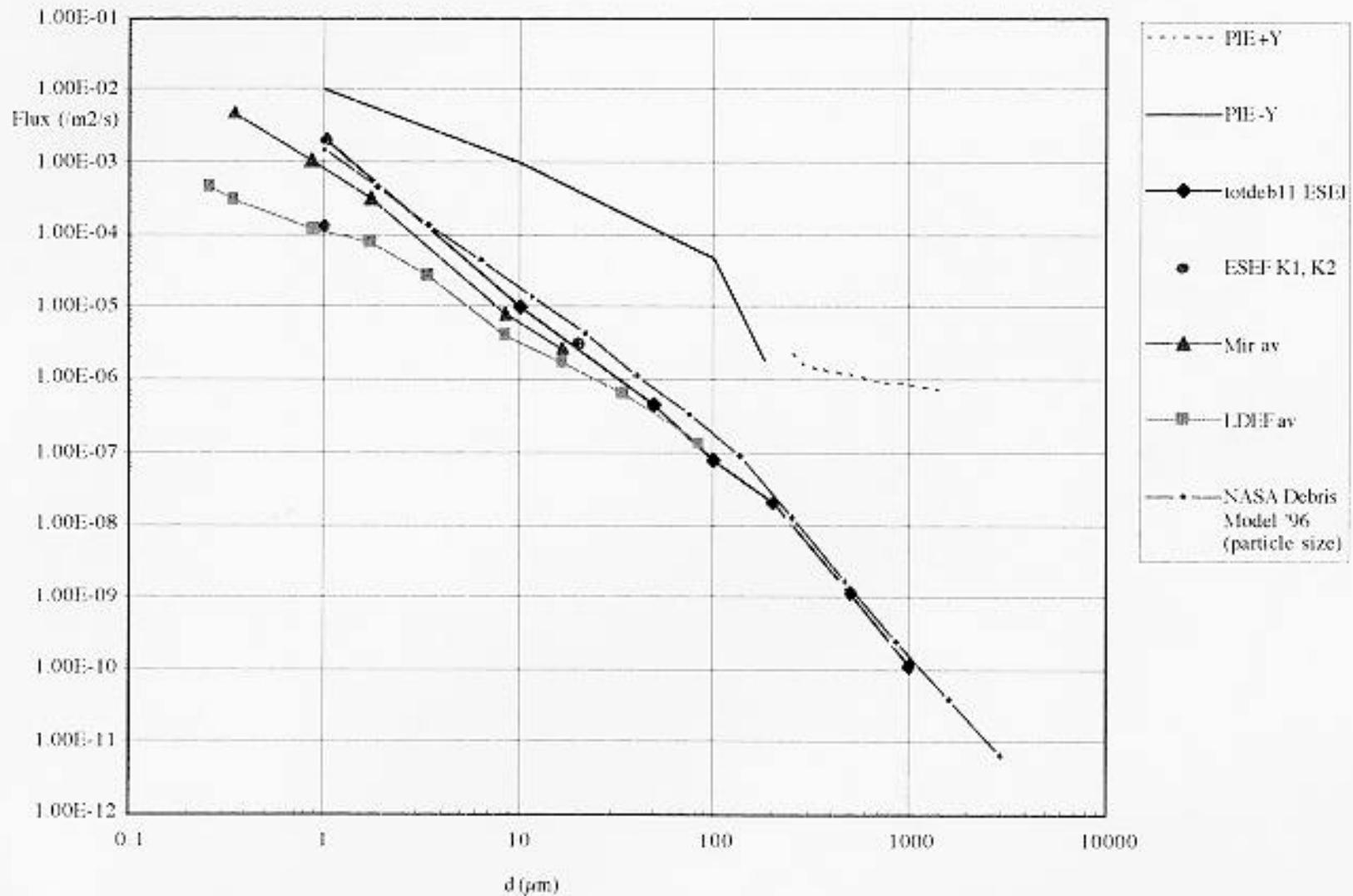


MEASURED CRATER FLUX FROM NASA/PIE



COMPARISON OF DATA

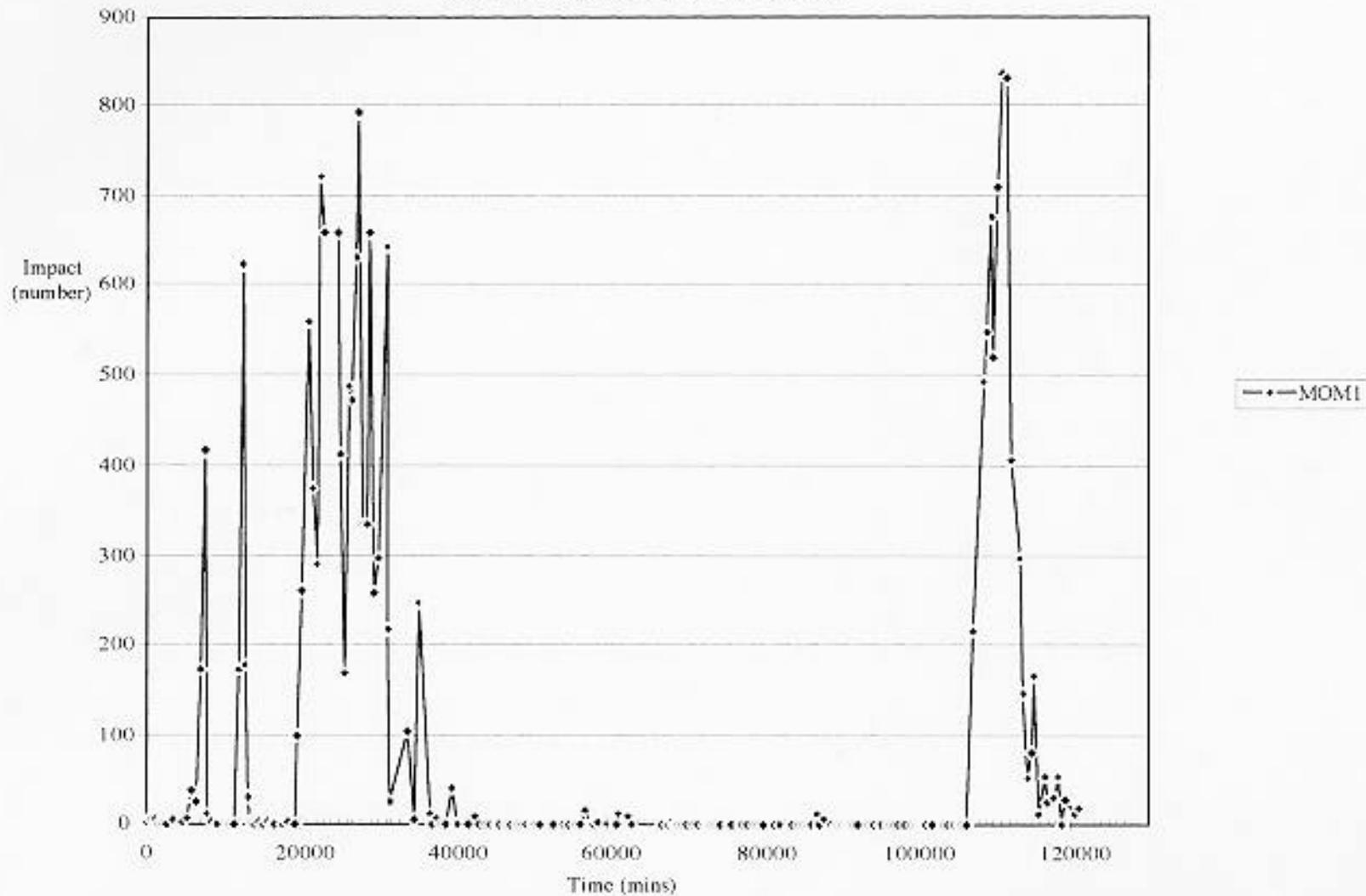
- LDEF, MIR ARAGATZ, EUROMIR '95 AND NASA/PIE -



EUROMIR '95/ICA OBSERVED CLOUD DATA

- MOMENTUM DETECTOR #1 -

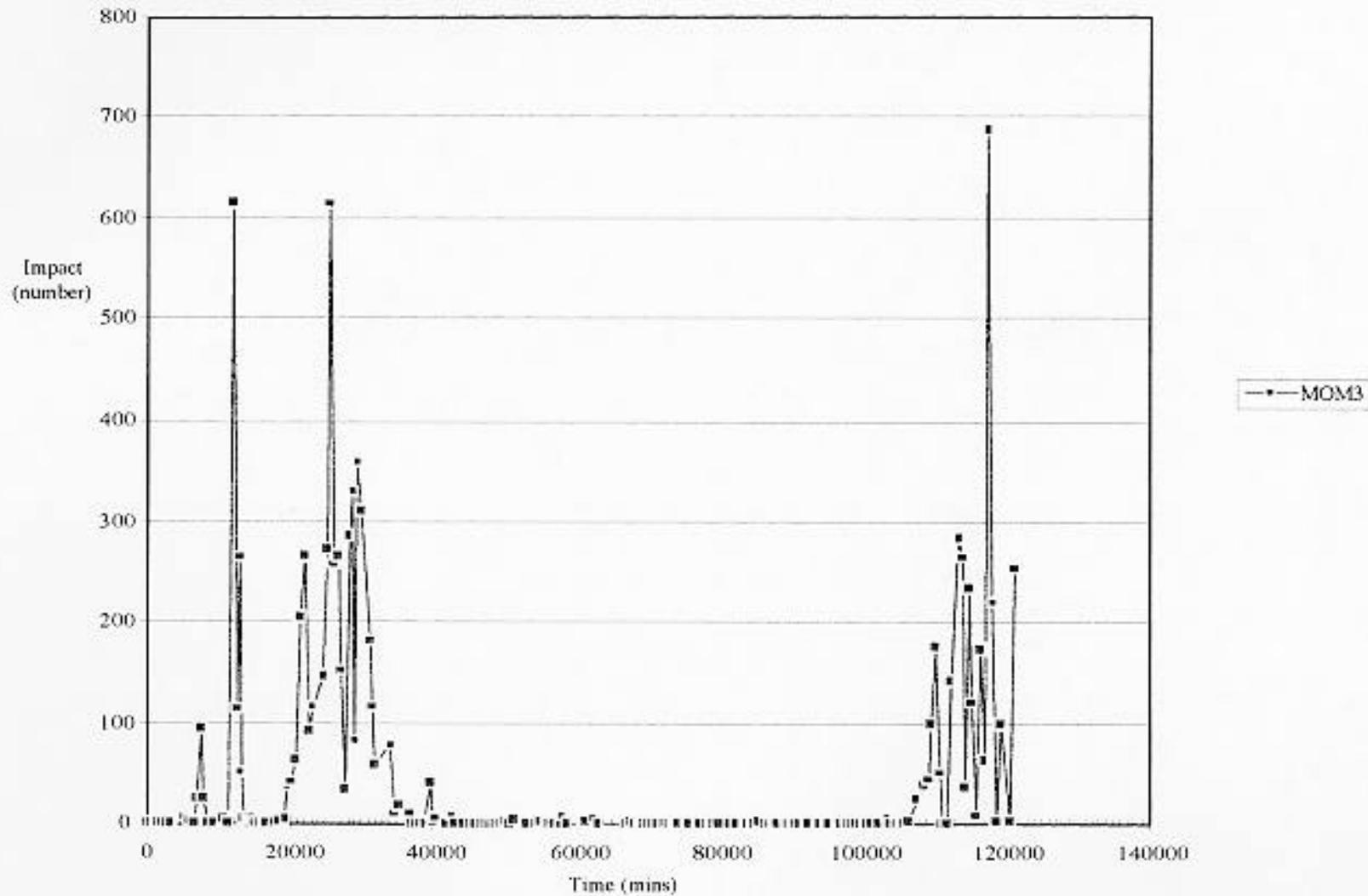
ICA Impacts for the period 24/10/95 to 16/01/97



EUROMIR '95/ICA OBSERVED CLOUD DATA

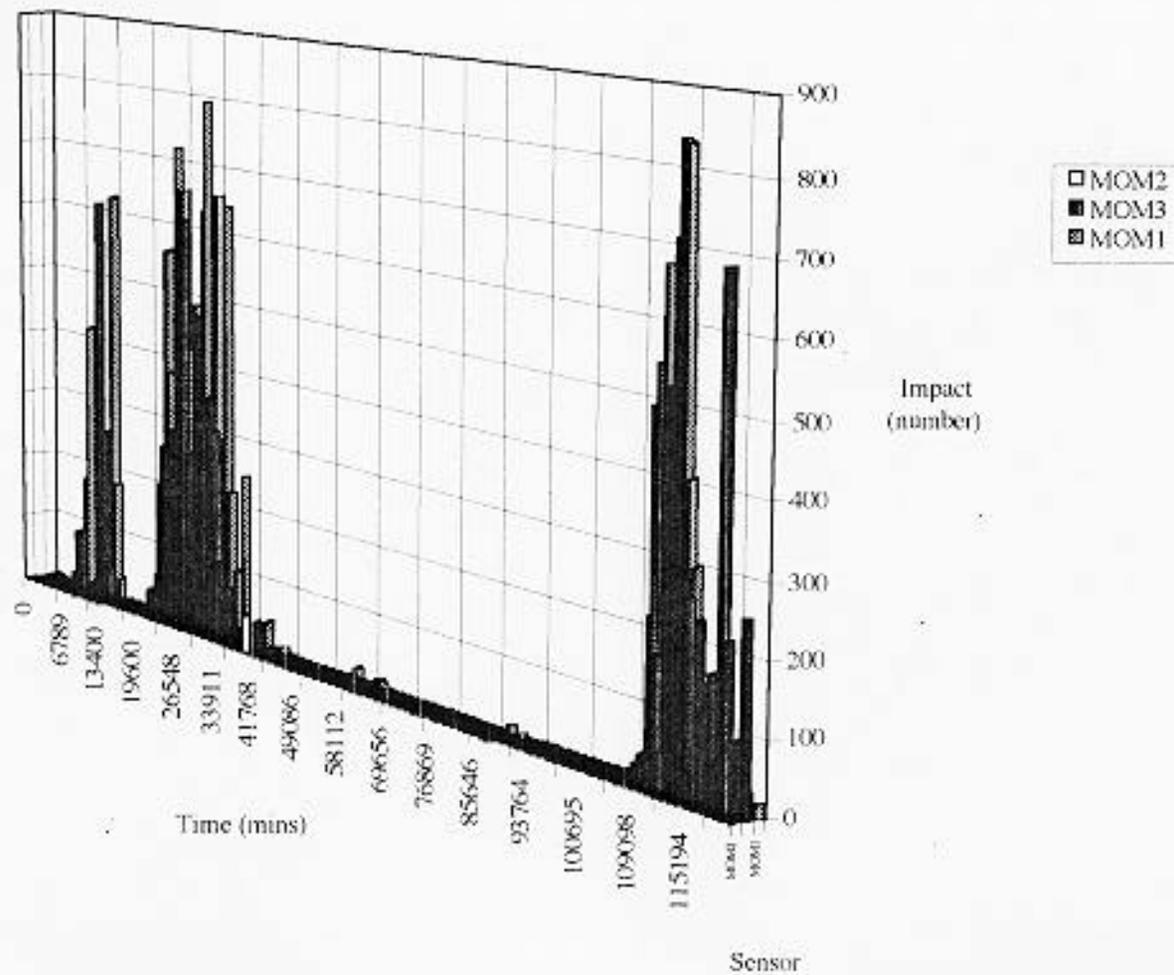
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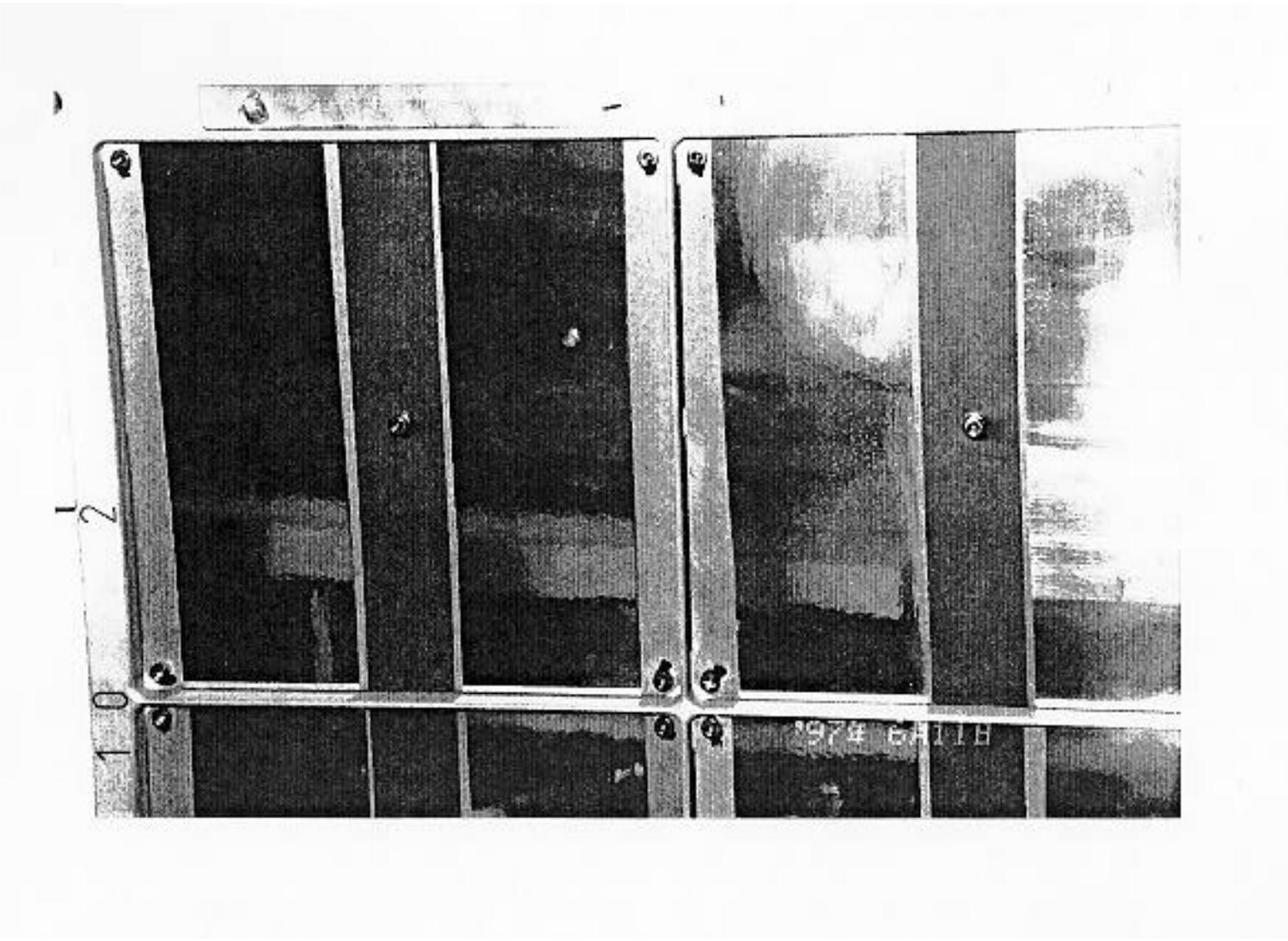
ICA Impacts for the period 24/10/95 to 16/01/96



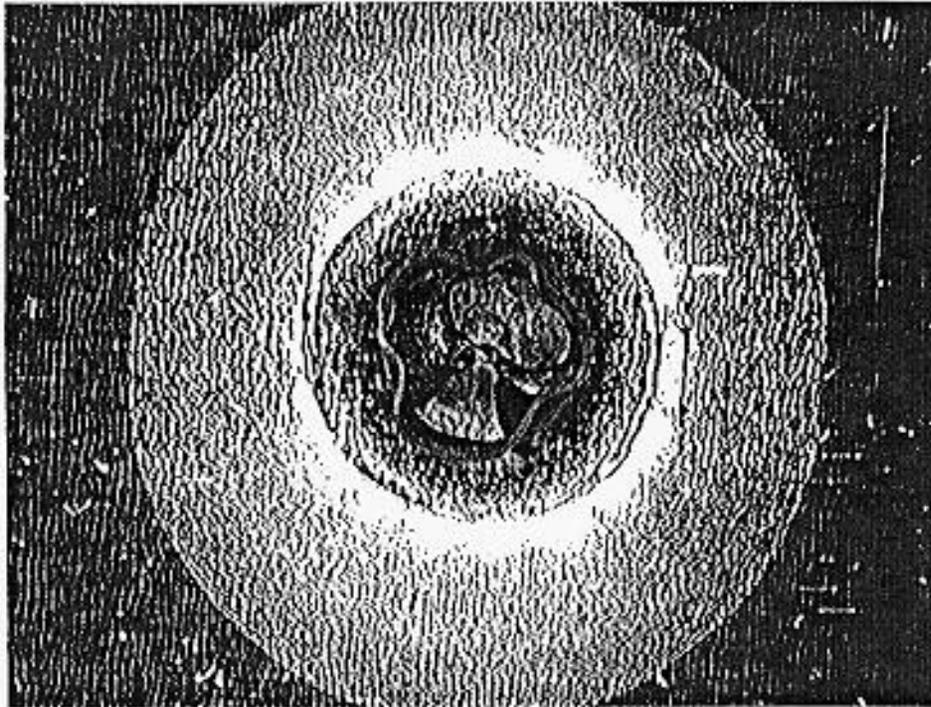
EUROMIR '95/ICA OBSERVED CLOUD DATA

ICA Impacts for the period 24/10/95 to 16/01/96

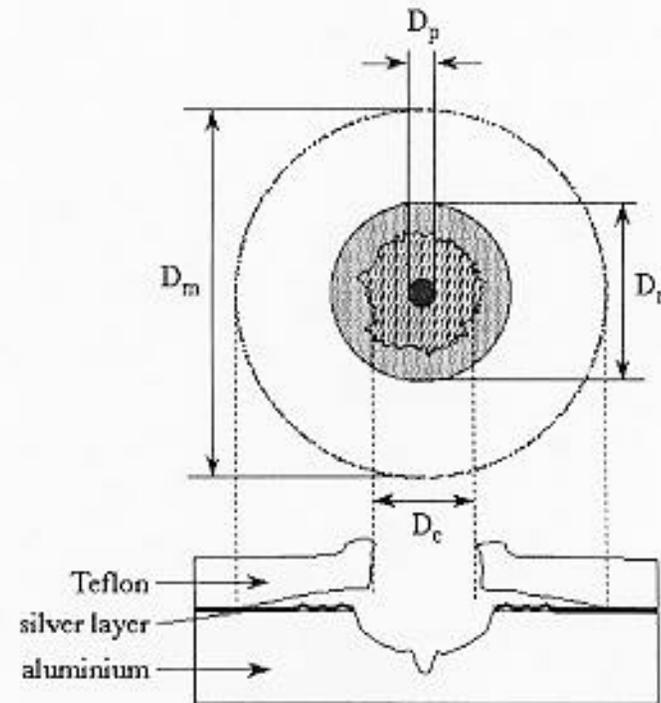




PIE IMPACT



CCD Camera at 50 X Magnification

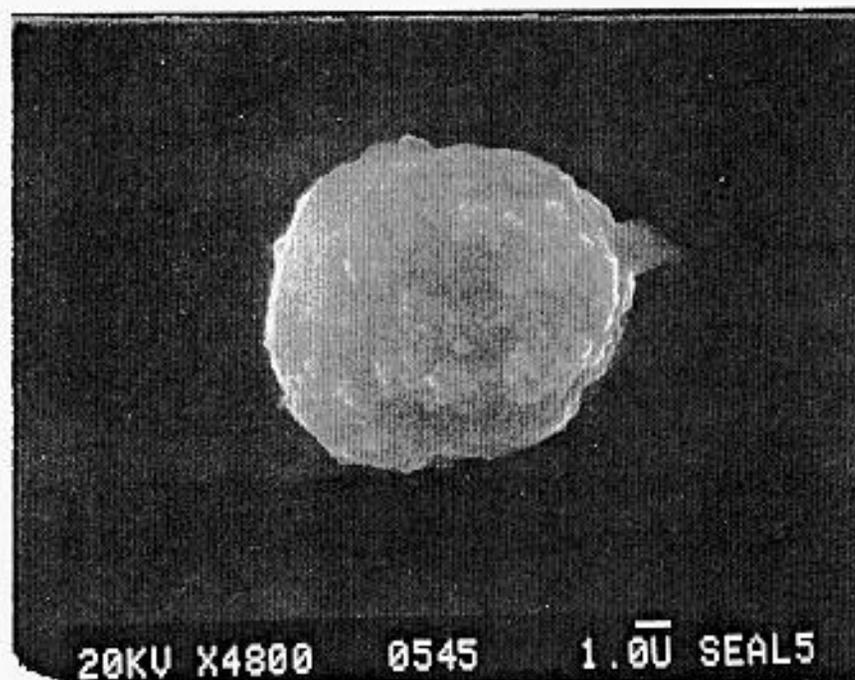


Impact Schematic

Measured Parameters:

D_m 4917 μm
 D_r 2505 μm
 D_c 1430 μm (also called D_{lip})
 D_p 471 μm

INTACT PARTICLE REMOVED FROM PIE

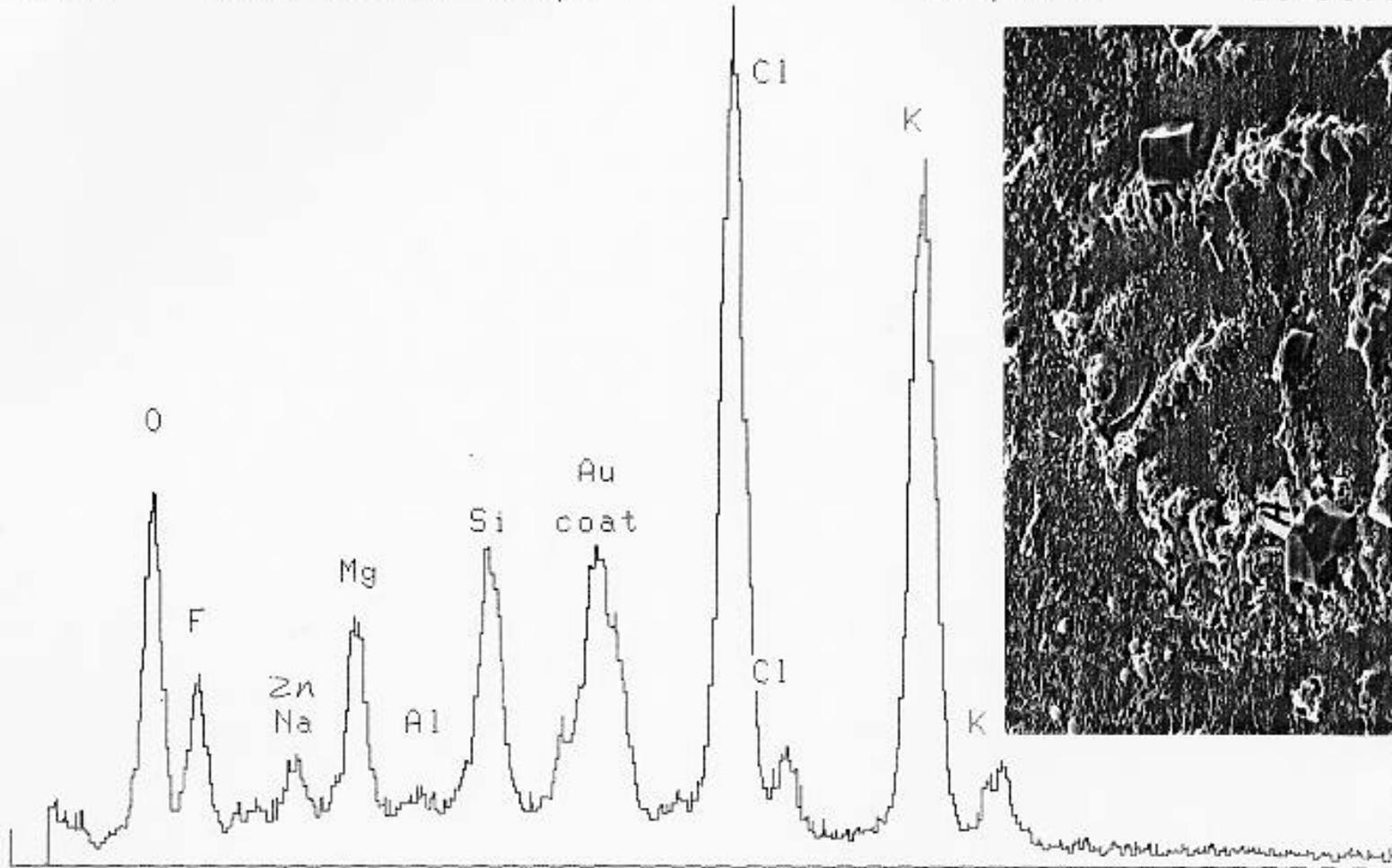


PIE SUMMARY

- THE FLUX-MASS DISTRIBUTION OF IMPACTING PARTICLES HAS BEEN DERIVED WITH REASONABLE ACCURACY DUE TO THE LARGE TIME-AREA EXPOSURE. SEVERAL INTACT CAPTURED PARTICLES HAVE BEEN LOCATED AND REMOVED.
- THE IMPACT DATA OBSERVED AT THE LARGER SIZES IS WELL ABOVE THE PREDICTED VALUES. THIS SUGGESTS ONE OF SEVERAL THINGS;
 - 1) THE POPULATION DENSITY OF LARGER SIZED PARTICLES IS GREATER THAN BELIEVED AT THESE HIGHER ALTITUDES (AND BY INFERENCE, THOSE IMMEDIATELY ABOVE THEM); AND/OR
 - 2) THE GROWTH RATE AT THE LARGER SIZES IS EQUIVALENT OR GREATER THAN THAT FOR THE SMALLER SIZED PARTICLES; AND/OR
 - 3) THAT IMPACTS CAUSED BY THE INTERSECTION OF THE STATION WITH ORBITING DEBRIS CLOUDS SKEW THE INTEGRATED FLUX TO AN ARTIFICIALLY HIGHER VALUE.
- FIVE (5) ISOTOPES (Co-57, Co-58, Co-60, Ta-182, Na-22) IDENTIFIED IN RETURNED HARDWARE.

2563A 10KV
Vert= 1361 counts Disp= 1

Preset= 60 secs
Elapsed= 60 secs



← 0.000 |1 Range= |2 10.230 keV

Integral 0 = 5.050 →
87017

PRINCIPAL RESULTS/CONTAMINATION

ICA

- THE TWO CARBON COATED QCMS NEVER LOST MASS, SUGGESTING THAT SIGNIFICANT MASS DEPOSITION OCCURRED FROM THE TIME OF PAYLOAD DEPLOY. OUTGASSING RATES, ON OCCASION, WERE NEARLY FOUR ORDERS-OF-MAGNITUDE GREATER THAN PLANNED FOR ISS.
- QCM DATA SUGGESTS, AS WITH EARLIER PASSIVE DATA THAT THE SOURCE/SOURCES ARE OUTGASSING (DIRECT OR RETURN FLUX) FROM SURFACES HEATED DURING SPECIAL STATION ATTITUDES. VENTING/LEAKAGE DO NOT APPEAR TO BE THE SOURCE OF ANY MASS DEPOSITION. PROPULSION SYSTEM EFFLUENTS HAVE NOT YET BEEN RULED OUT AS A SOURCE.
- THE RESULTS OF THIS EXPERIMENT HAVE HELPED DEFINE THE MATERIAL ISSUES AND REQUIREMENTS FOR THE INTERNATIONAL SPACE STATION.

PIE

- HYDROCARBONS AND SILICONES, ALONG WITH RESIDUE FROM WASTE DUMPS, WERE IDENTIFIED ON THE RETURNED HARDWARE.
- THE AO FLUENCE WAS MEASURED AS $6.9E-19$ ATOMS/CM².

SUMMARY OF MIR MOLECULAR CONTAMINATION DEPOSITION DATA

MIR CONTAMINATION OBSERVATIONS		
• ARAGATZ (CNES)	350 - 780 Å	(13 MONTHS/88-90)
• CAMERA BRACKET (NASA)	12,000 Å	(4 MONTHS/95-96)
• ICA - QCM #1 (ESA)	13,000 Å	(3 MONTHS/95-96)
• ICA - QCM #2 (ESA)	14,500 Å	(3 MONTHS/95-96)
• ICA - QCM #3 (ESA)	4,500 Å	(3 MONTHS/95-96)
• TREK BLANKET (NASA)	>20,000 Å	(4.2 YEARS/93-96)
• ASTRA-II (RSC/ENERGIA)	5,000 Å	(13 MONTHS/95-96)
• PIE (NASA)	3,500 Å	(10 MONTHS/96-97)

INTERNATIONAL SPACE STATION (ISS) REQUIREMENTS	
• TOTAL MASS DEPOSITION ON ANY SURFACE-	130 Å/YEAR
• DEPOSITION RATE SHOULD NOT EXCEED	1E-14 g/cm ² /s

SUMMARY

- ACTIVE DATA FROM THE MOM IMPACT DETECTORS RECONFIRM THE EXISTENCE OF ORBITAL DEBRIS CLOUDS. THIS INFORMATION IS CONSIDERED QUITE GERMANE DUE TO THE SIMILARITY IN ORBITAL ALTITUDE AND INCLINATION OF THE MIR AND ALPHA SPACE STATIONS.
- THE RESULTS OF THE ANALYSES SUGGEST THE EXISTENCE OF TWO REASONABLE SIZE CLOUD OF SMALL SIZE DEBRIS PARTICLES WITH MOMENTA IN THE RANGE OF $4E-11$ KG-M/S TO $5E-10$ KG-M/S.
- FLUXES AVERAGE $8.36E-05$ TO $1.79E-04$ IMPACTS/S DURING QUIESCENT PERIODS. DURING INTERSECTION OF THE MIR STATION WITH THE CLOUD, THE FLUX VARIES. MAXIMUM FLUX WAS $2.38E+01$ IMPACTS/S.
- DETERMINING THE PARENT SOURCE OF THE CLOUD HAS BEEN DIFFICULT. THE ANALYSIS IS STILL UNDER INVESTIGATION.
- MEASUREMENTS ALSO SUGGEST THAT THE IMPACTS OBSERVED ON 20/11/96 ARE FROM THE LEONID METEOR STREAM. FLUX AND MOMENTA ARE CONSISTENT WITH PUBLISHED DATA.