POSA I and II, and ESEM Flight Experiment Results

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Several Colleagues Deserve Special Recognition

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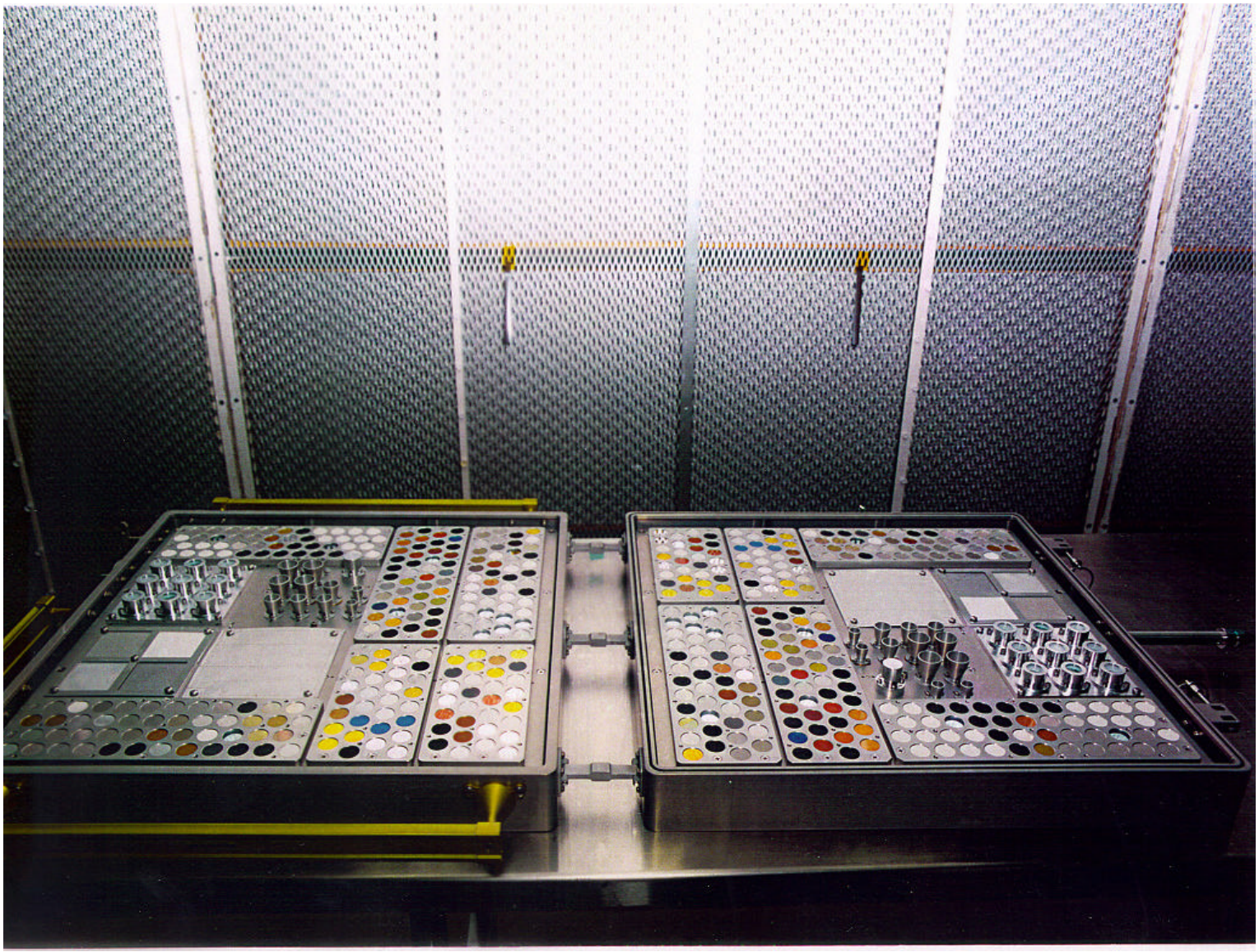
Introduction

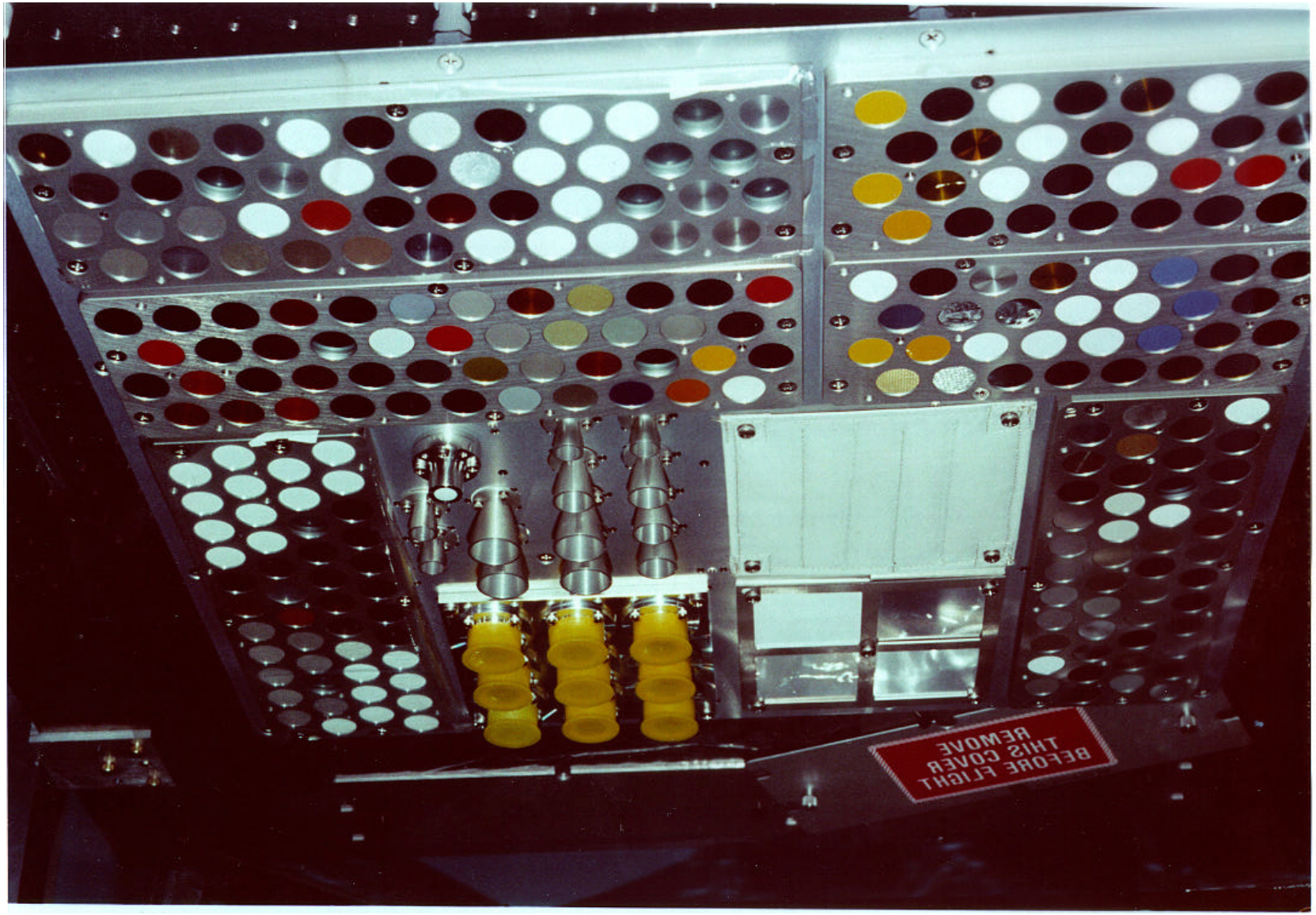
POSA (Passive Optical Sample Assembly) Experiments are part of an ISS Contamination Risk Mitigation Experiment

Flew March 1996 – September 1997

Significant on-orbit exposure
18 months in ambient space environment plus induced environment from MIR, docking module, and intermittent presence of Space Shuttles
(5 times during experiment deployment period)

ESEM (Effects of Space Environment on Materials) Experiment part of Japanese Flight Demonstration Experiment on STS-085, August 1997




REMOVE
THIS COVER
BEFORE FLIGHT

pre-flight photo of POSA II experiment

POSA Exposure Conditions

~52^{o} inclination
Deployed at Solar Min

Atomic oxygen levels determined from Kapton recession estimates

Solar UV Estimates from electrochemical measurements

Thermal Cycling

Contamination
- **Outgassing from nearby structure**
- **Discrete contamination events – waste dumps**

Significantly higher ionizing radiation dose than received by the LDEF

Kapton Recession Estimates

Used to Estimate fluence of atomic oxygen on each side of POSA II

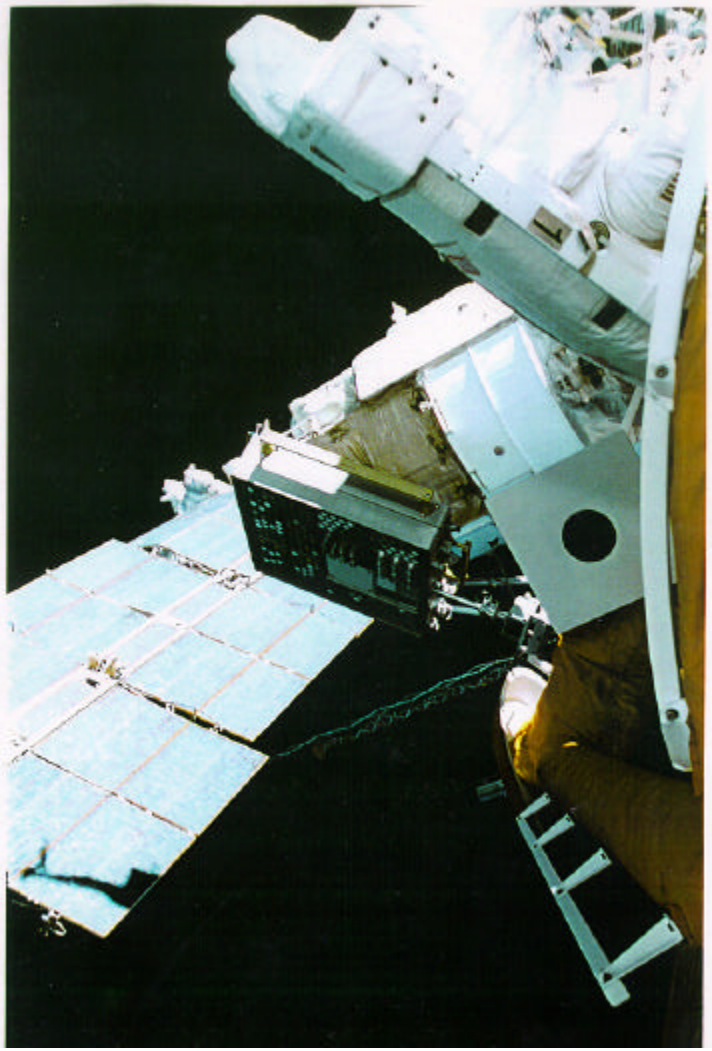
Based on weight loss, needs to be verified by independent technique

	Fluence (atoms/cm^2)
MIR facing side	1.7×10^{20}
Space facing side	2.9×10^{20}

National Aeronautics and
Space Administration

S76-37-002

Lyndon B. Johnson Space Center
Houston, Texas 77058

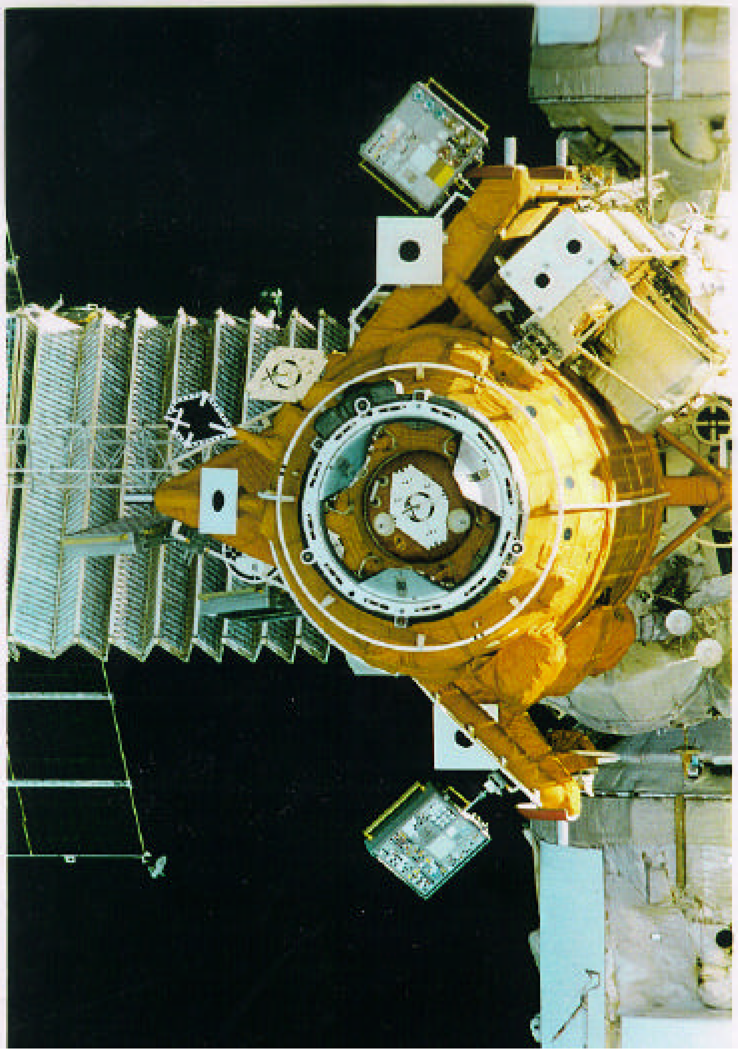


Nasa On-orbit photo of POSA II experiment about 5 months into exposure period

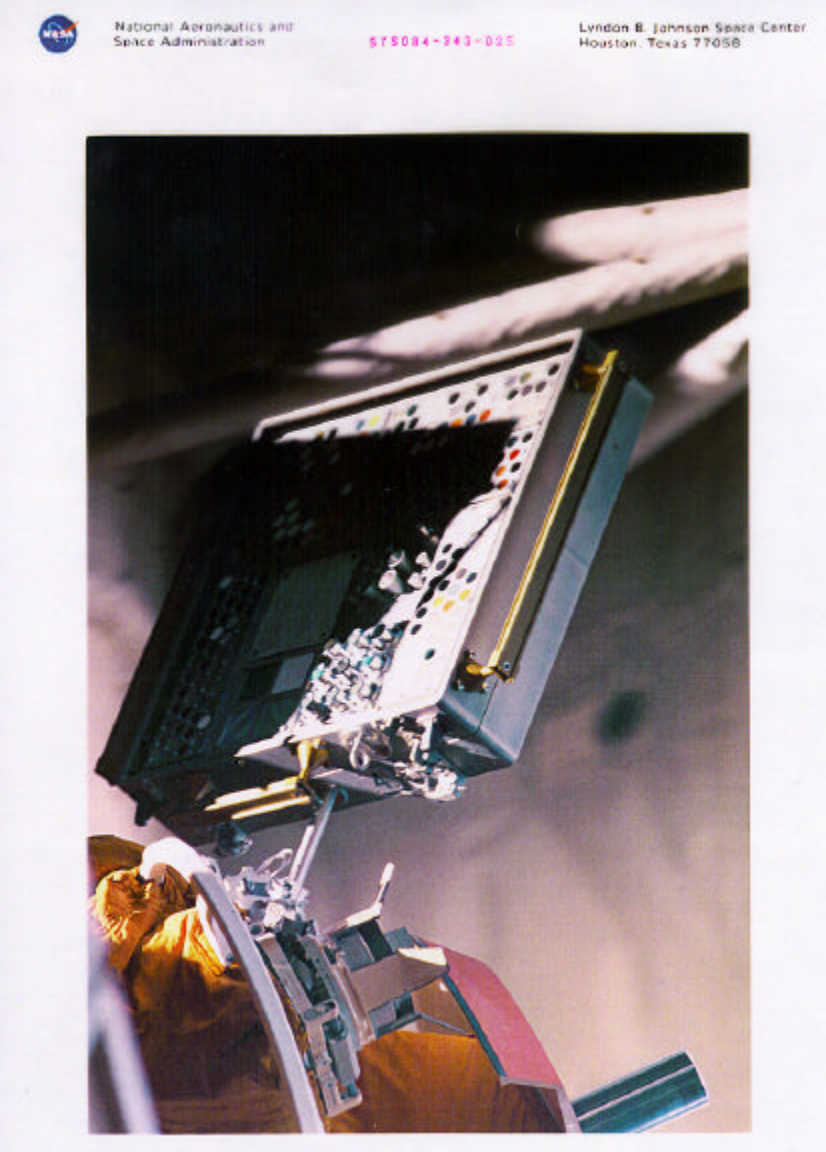
National Aeronautics and
Space Administration

STS079-321-035

Lyndon B. Johnson Space Center
Houston, Texas 77058



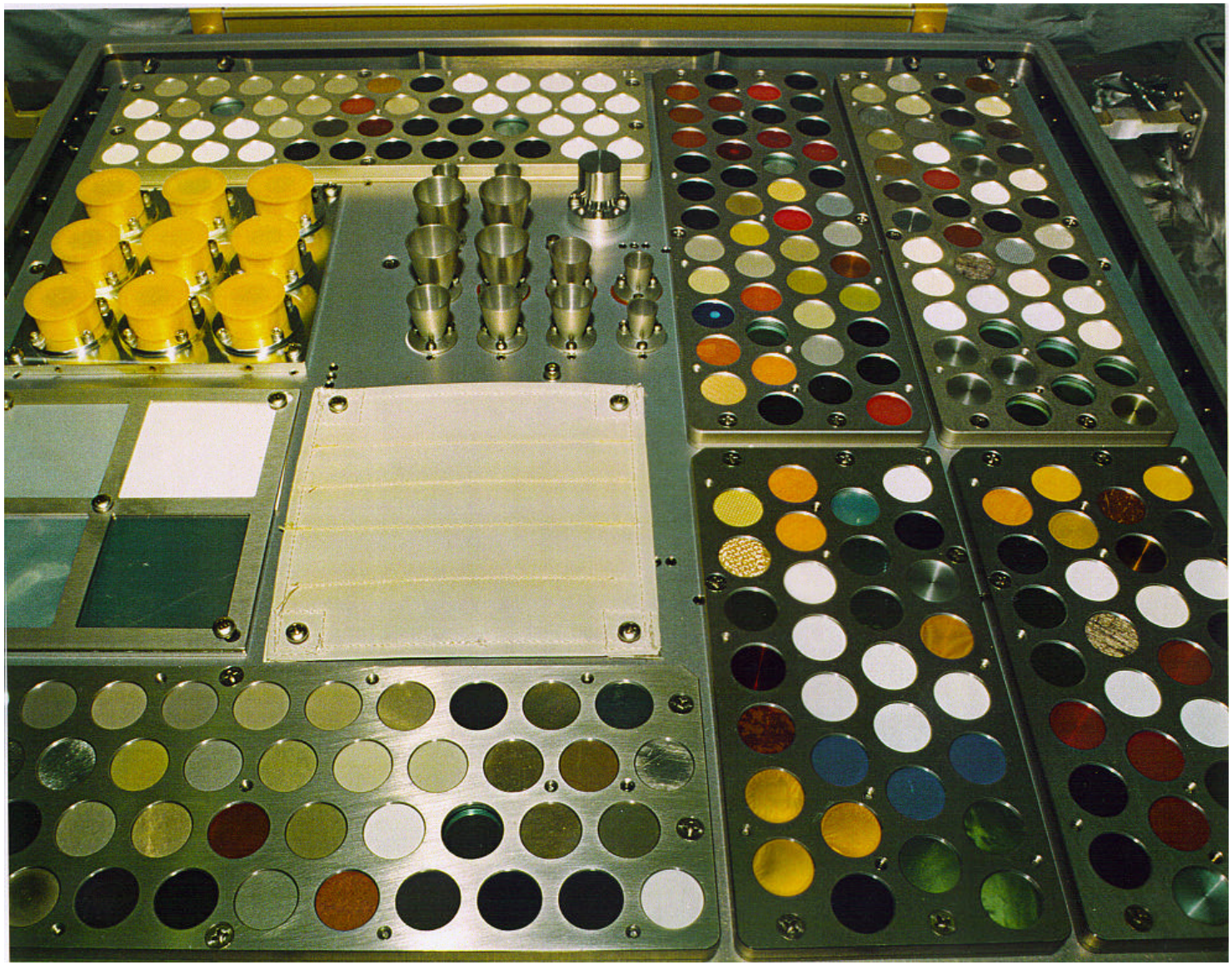
NASA On-orbit photo of POSA I and POSA II showing attachment locations on MIR/Space Shuttle docking module



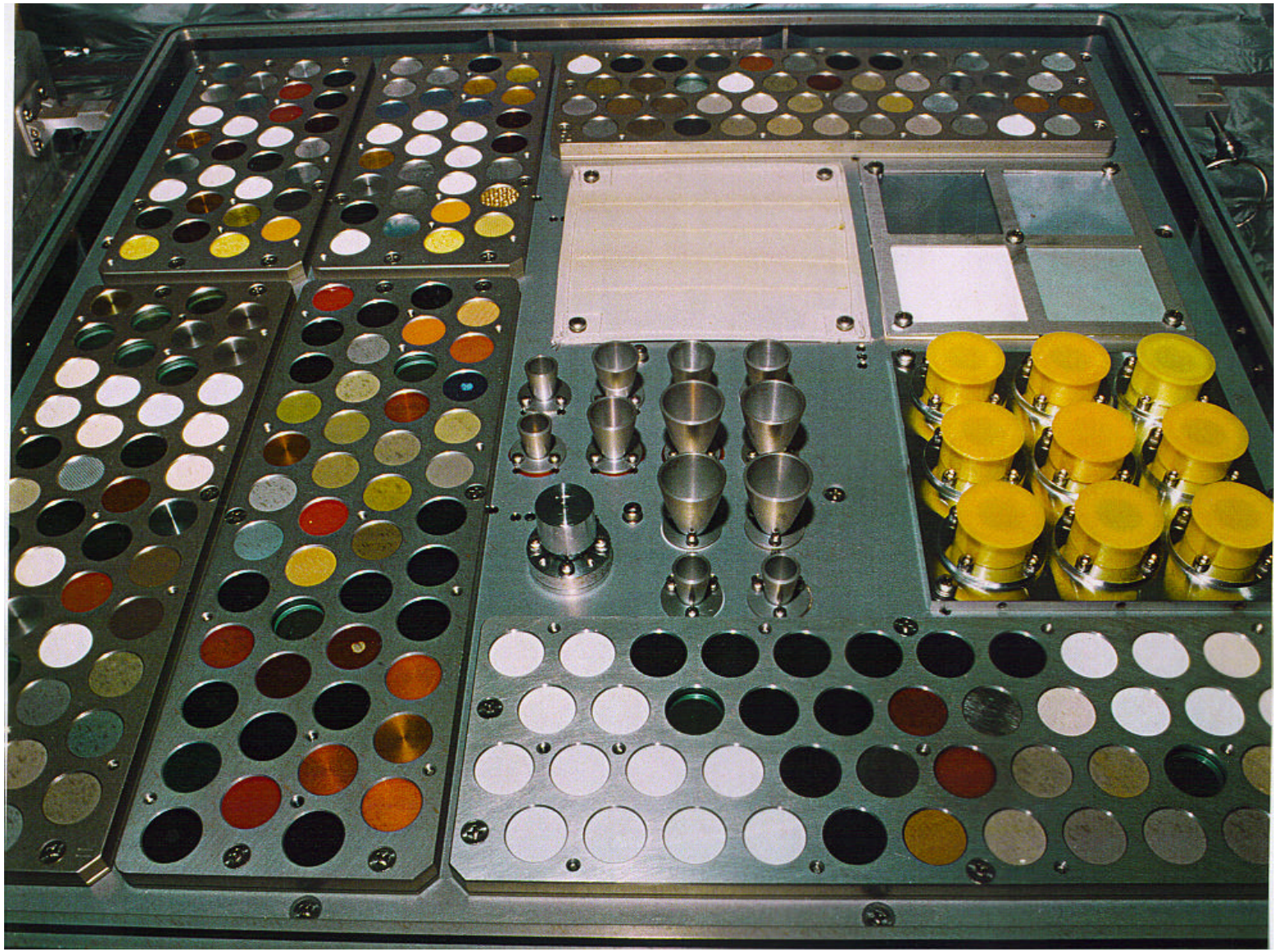
NASA On-orbit photo showing MIR facing side of POSA II

NASA On-Orbit photo of POSA II during retrieval

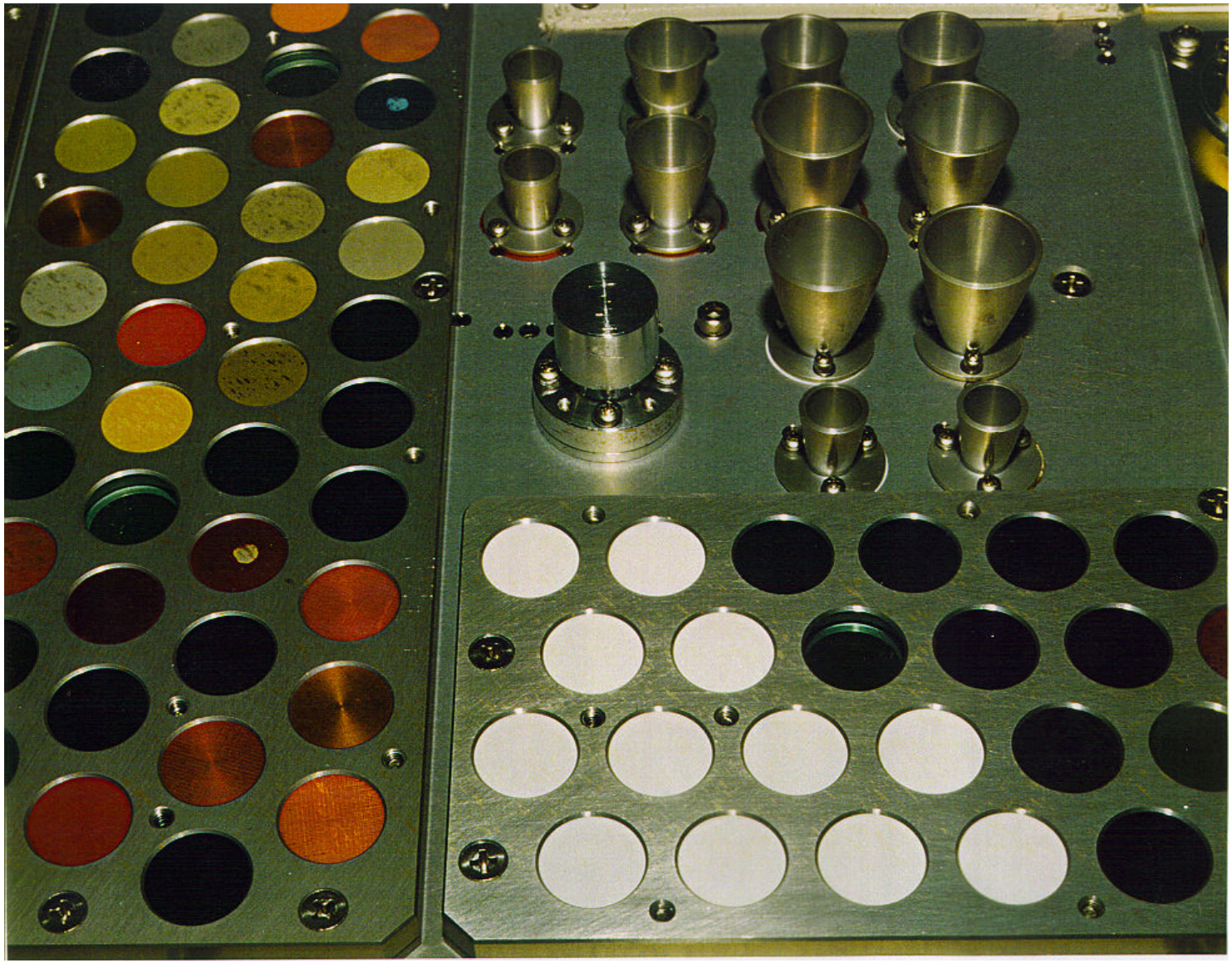
NASA On-oribt photo showing POSA II being closed during retireval



Post-flight photo of POSA II MIR facing side

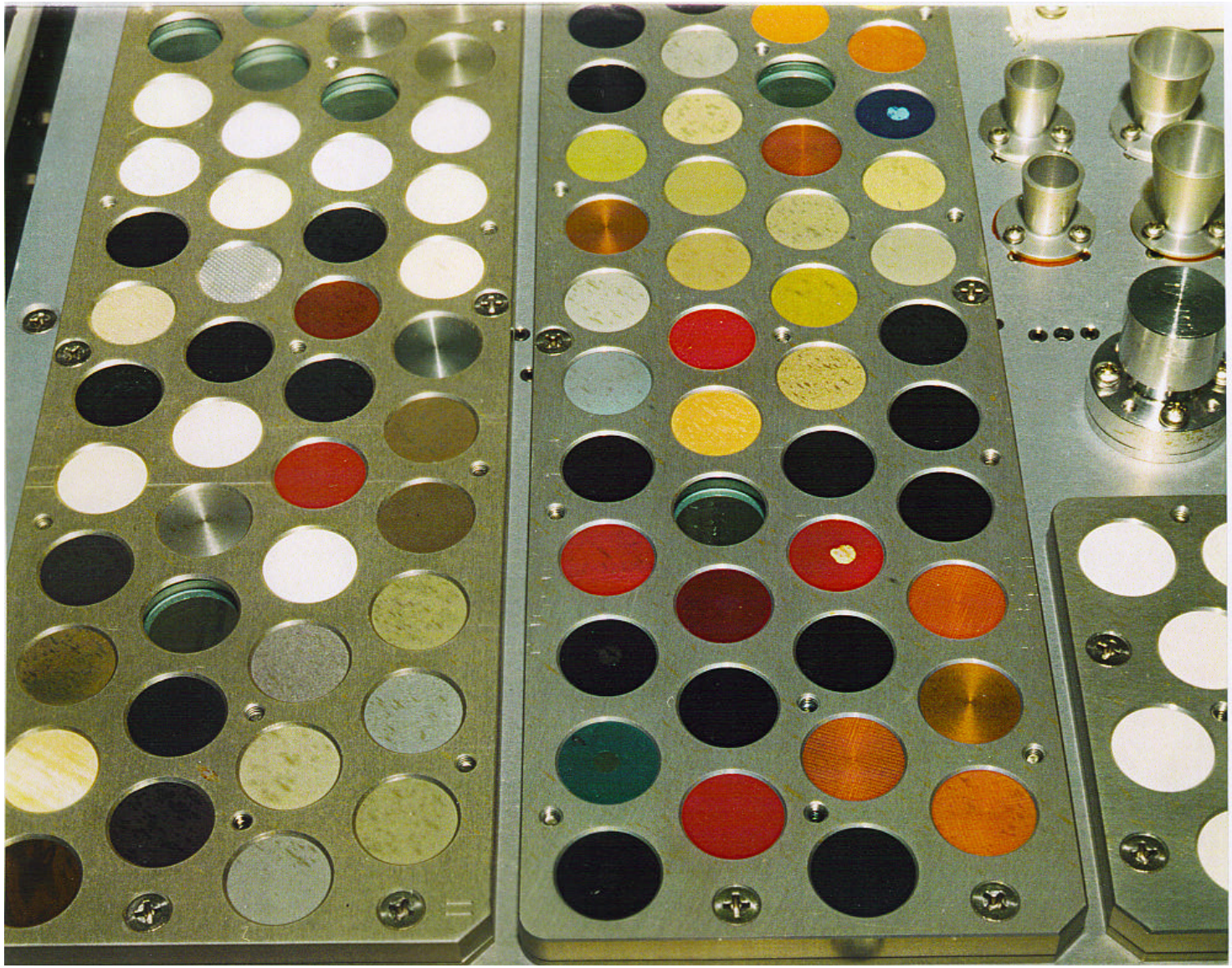


Post-flight photo of POSA II Space/Shuttle facing side

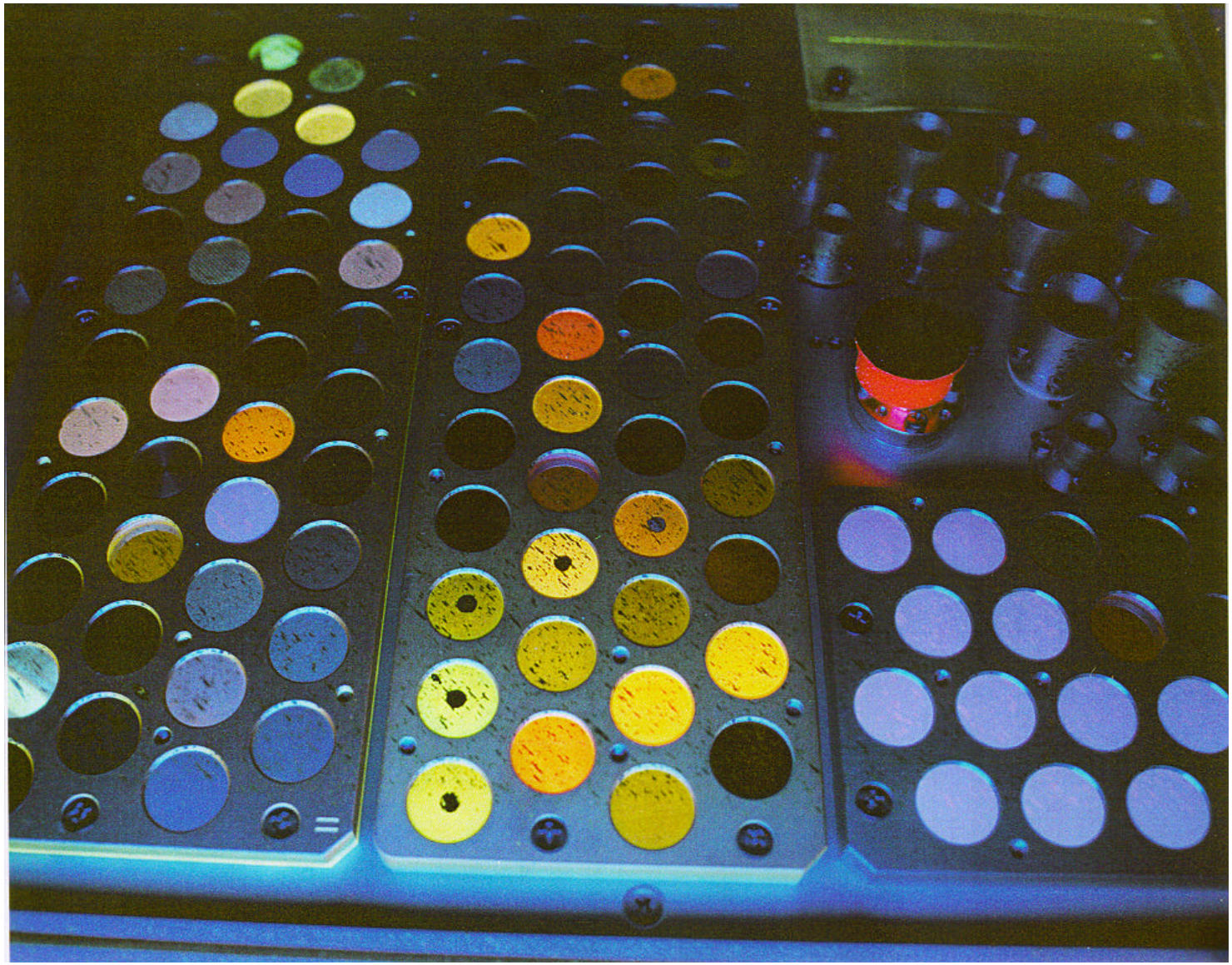


Post-flight close-up of POSA II Mir facing side

Black light post-flight photo of part of POSA II tray-MIR facing side



Post-flight photo of part of POSA II experiment with visible contamination streaks-space/space shuttle facing side



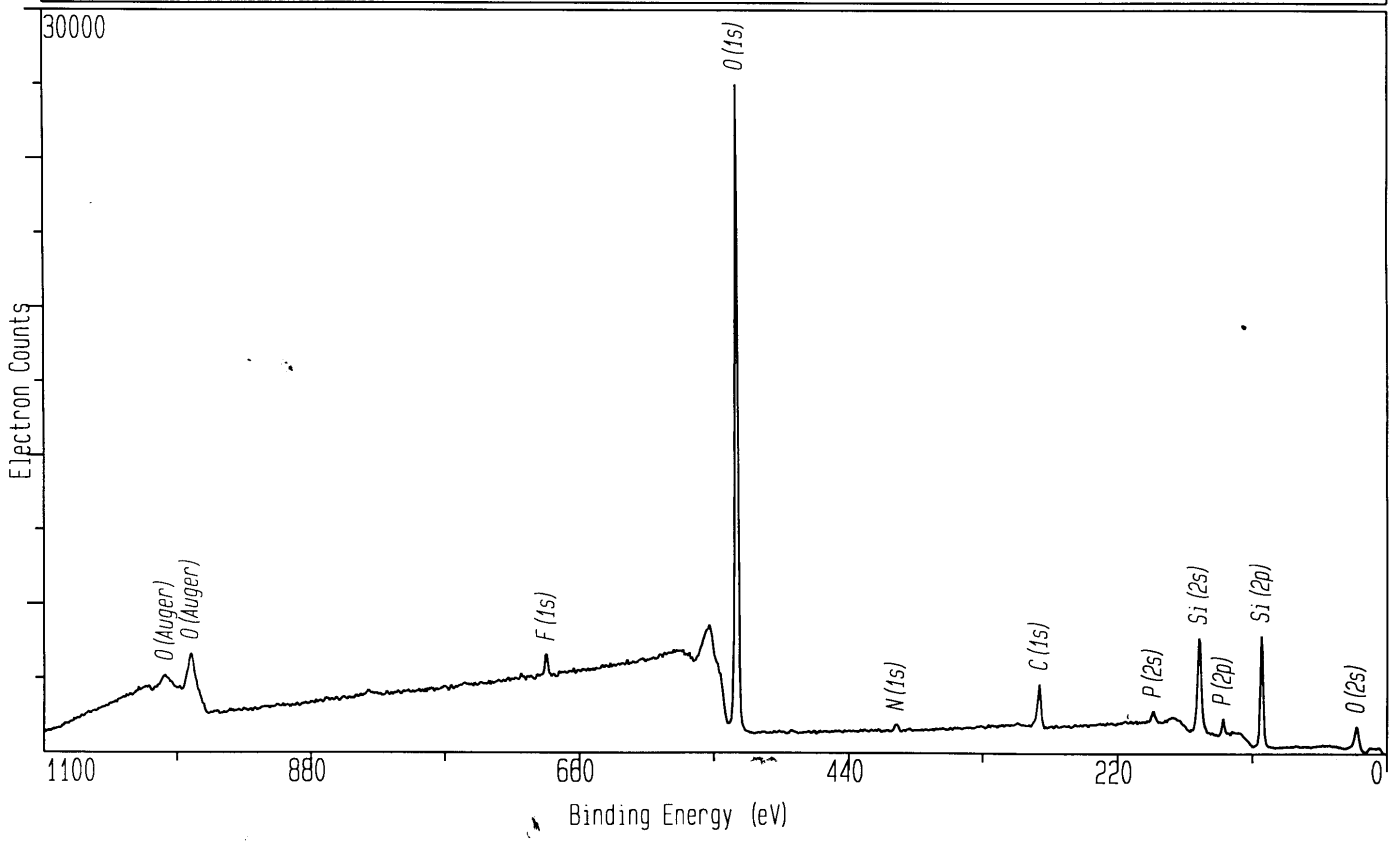
Black light post-flight photo of part of POSA II tray-space/space shuttle facing side

Black light post-flight photo of optical samples (foreground) on POSA II tray-MIR facing side

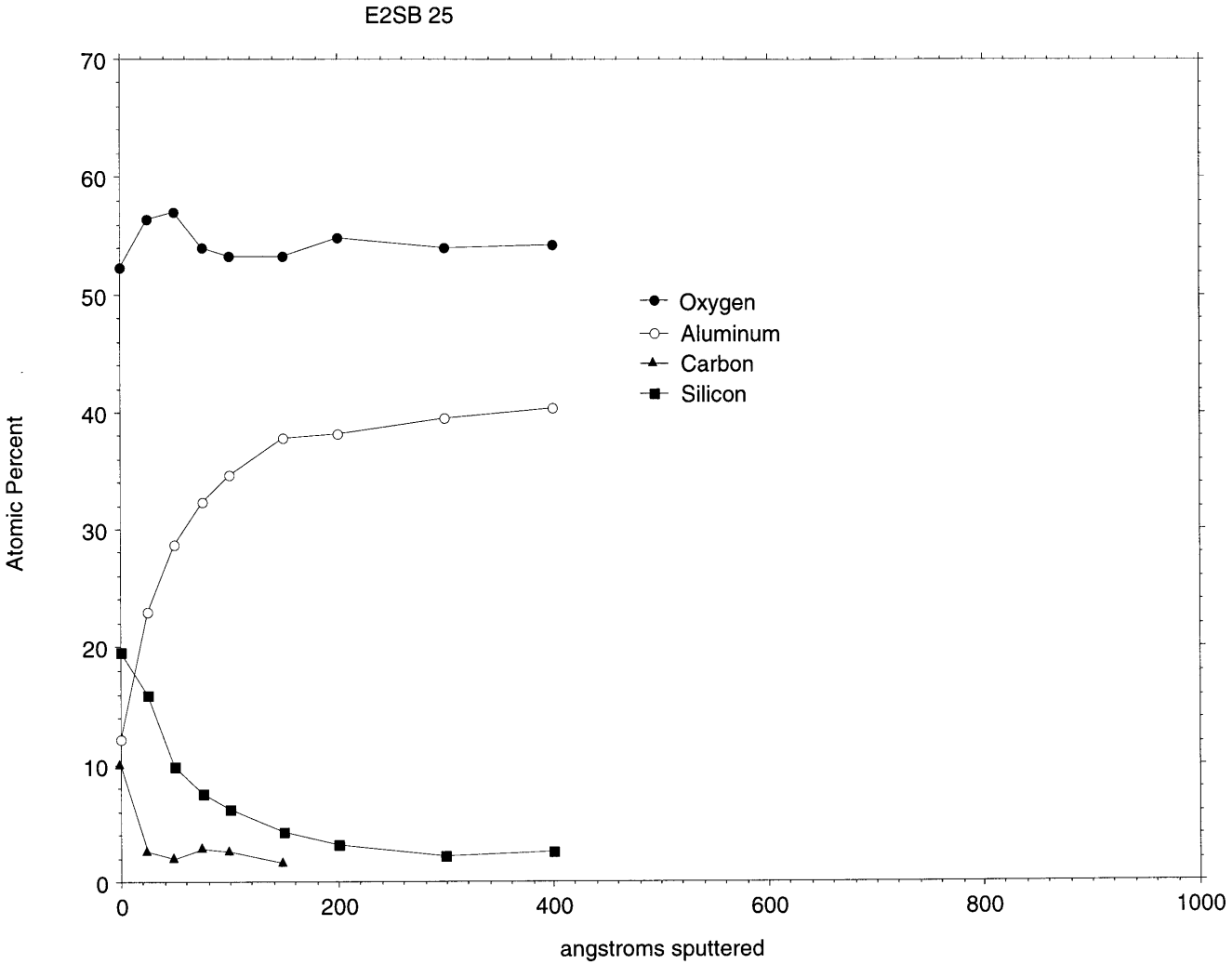
Results of Analysis to Indicate Source of Contaminant Material

- The procedure used involves the detection of urea by enzymatic hydrolysis to ammonia.
- Positive results indicated by yellow color to red-brown precipitate depending on the concentration of urea in the sample.
- Serial dilutions of a concentrated urea solution gave a detection limit of 1.5 µg.
- Negative and positive controls were run for comparison.
- Test was performed twice, the first time gave inconclusive results due to insufficient sample. The second time the test was run, results were conclusive and the reaction was equivalent to approximately 2 µg urea. Results were qualitative.

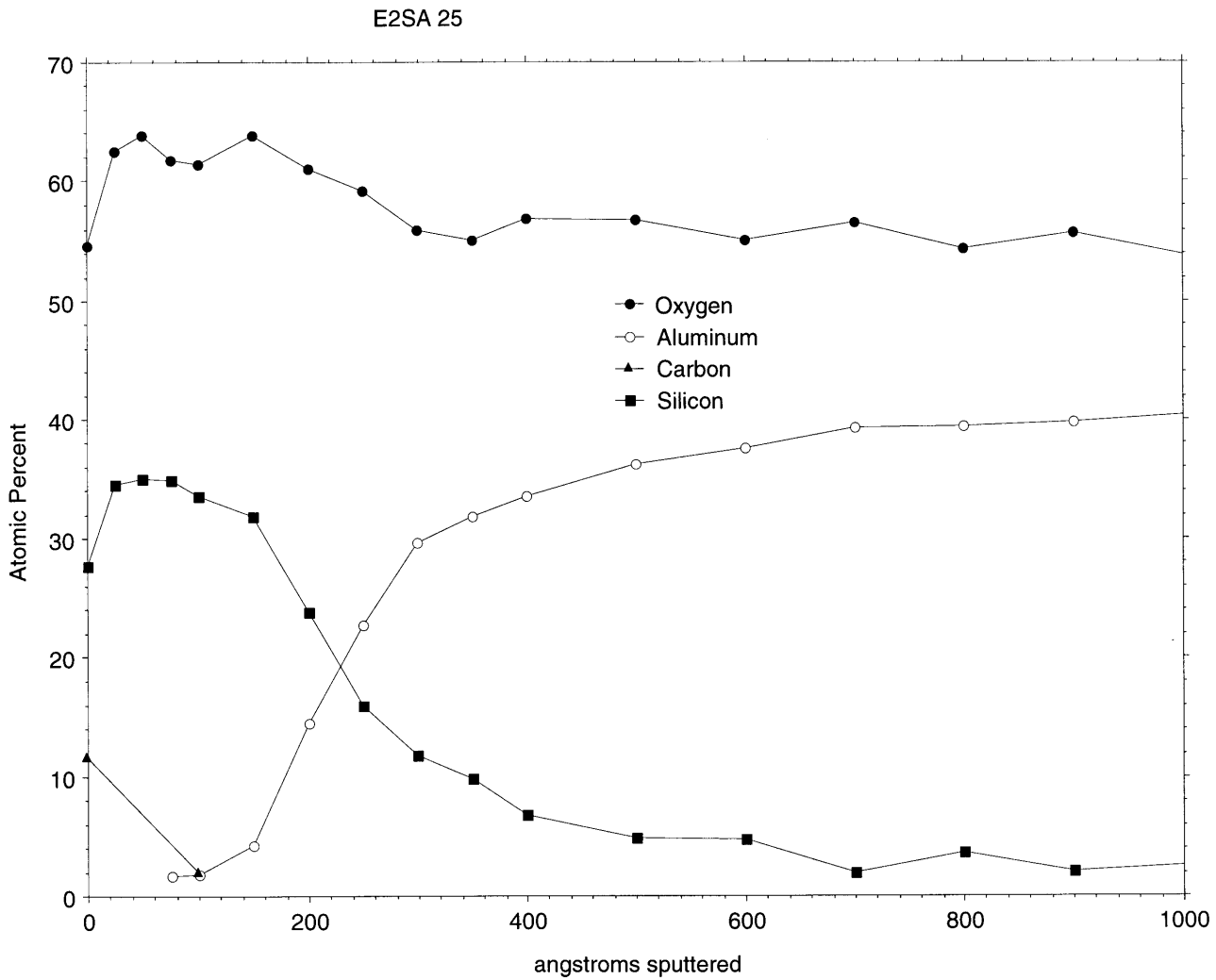
File: 98JUN12E Region: 1	Spot: 800 Resolution: 4	Flood Gun: 1.0 Scans, Time: 3	Data Points: 1101 Time/Point: 150	Date: Jun 12 1998 Operator: 98-045
Description:	surface E2SA 25			



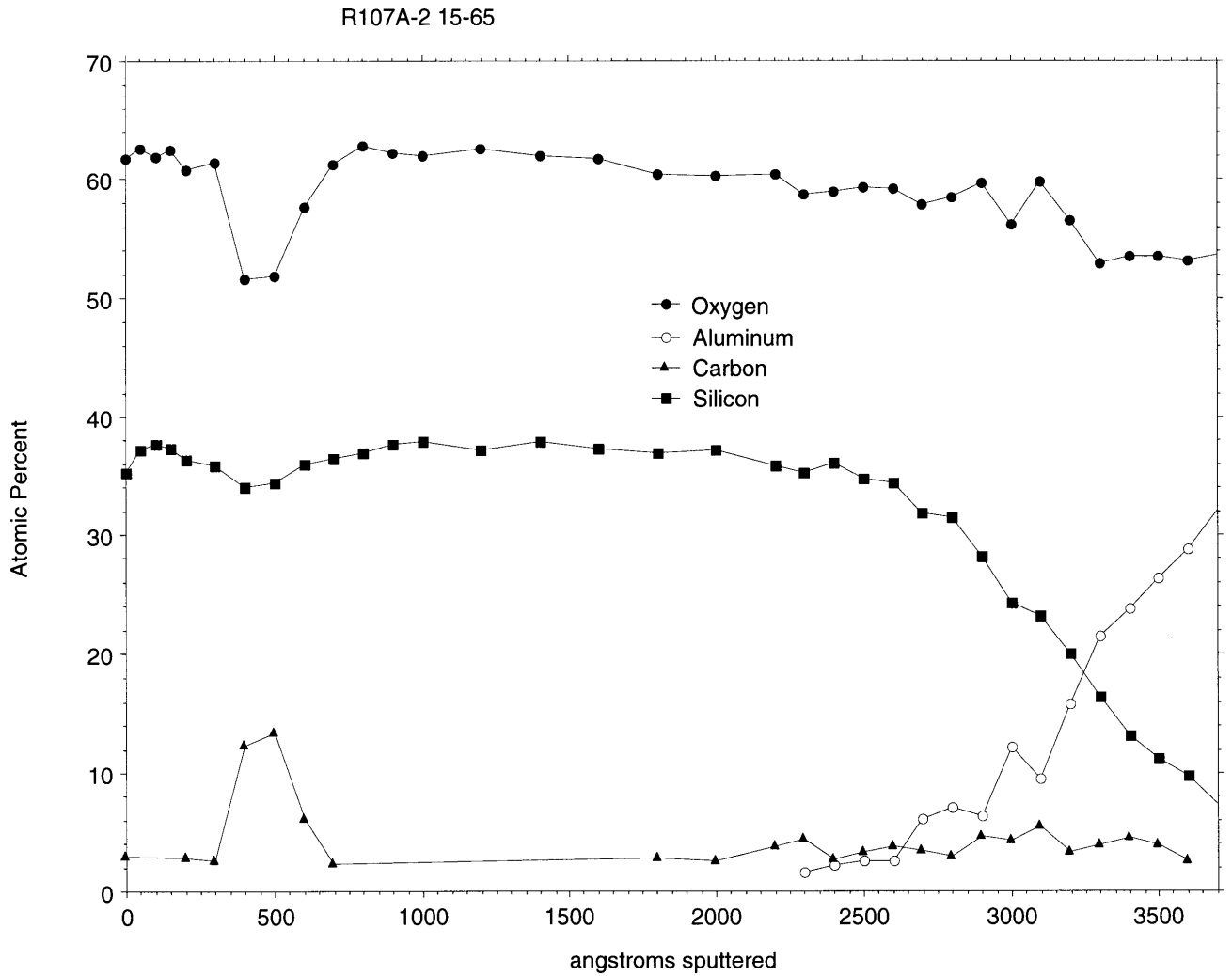
Boeing Phantom Works


E2SB 25
70
60
50
40
30
20
10
0
Atomic Percent
0
200
400
600
800
1000
angstroms sputtered
Oxygen
Aluminum
Carbon
Silicon

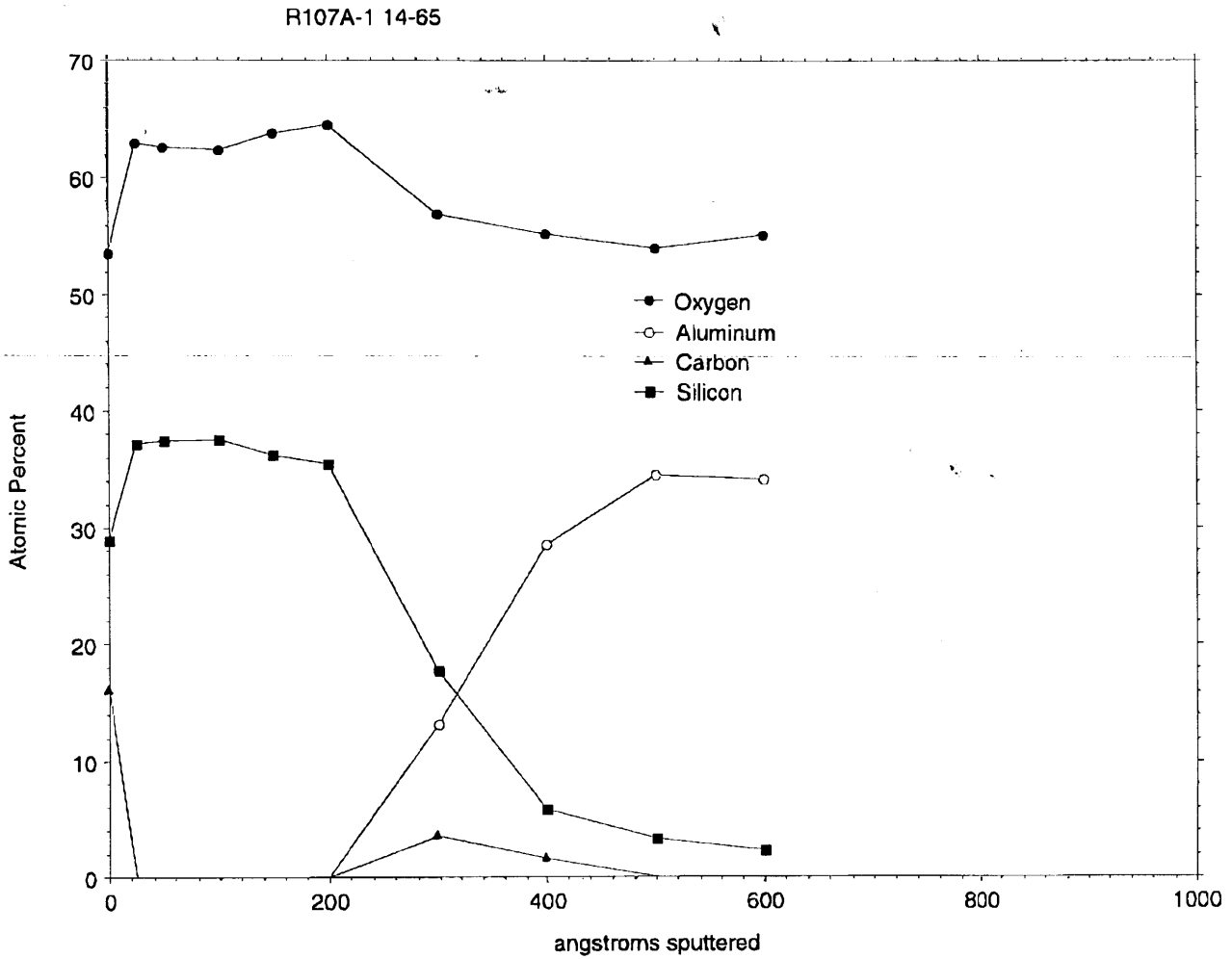
Depth profile, POSA II sample space/space shuttle facing side


E2SA 25
70
60
50
40
30
20
10
0
Atomic Percent
0
200
400
600
800
1000
angstroms sputtered
Oxygen
Aluminum
Carbon
Silicon

Depth profile, POSA II sample MIR facing side


R107A-2 15-65
Atomic Percent
angstroms sputtered
Oxygen
Aluminum
Carbon
Silicon
0
10
20
30
40
50
60
70
0
500
1000
1500
2000
2500
3000
3500

Depth profile, POSA I sample space/space shuttle facing side


R107A-1 14-65
70
60
50
40
30
20
10
0
Atomic Percent
Oxygen
Aluminum
Carbon
Silicon
0
200
400
600
800
1000
angstroms sputtered

Depth profile, POSA I sample MIR facing side

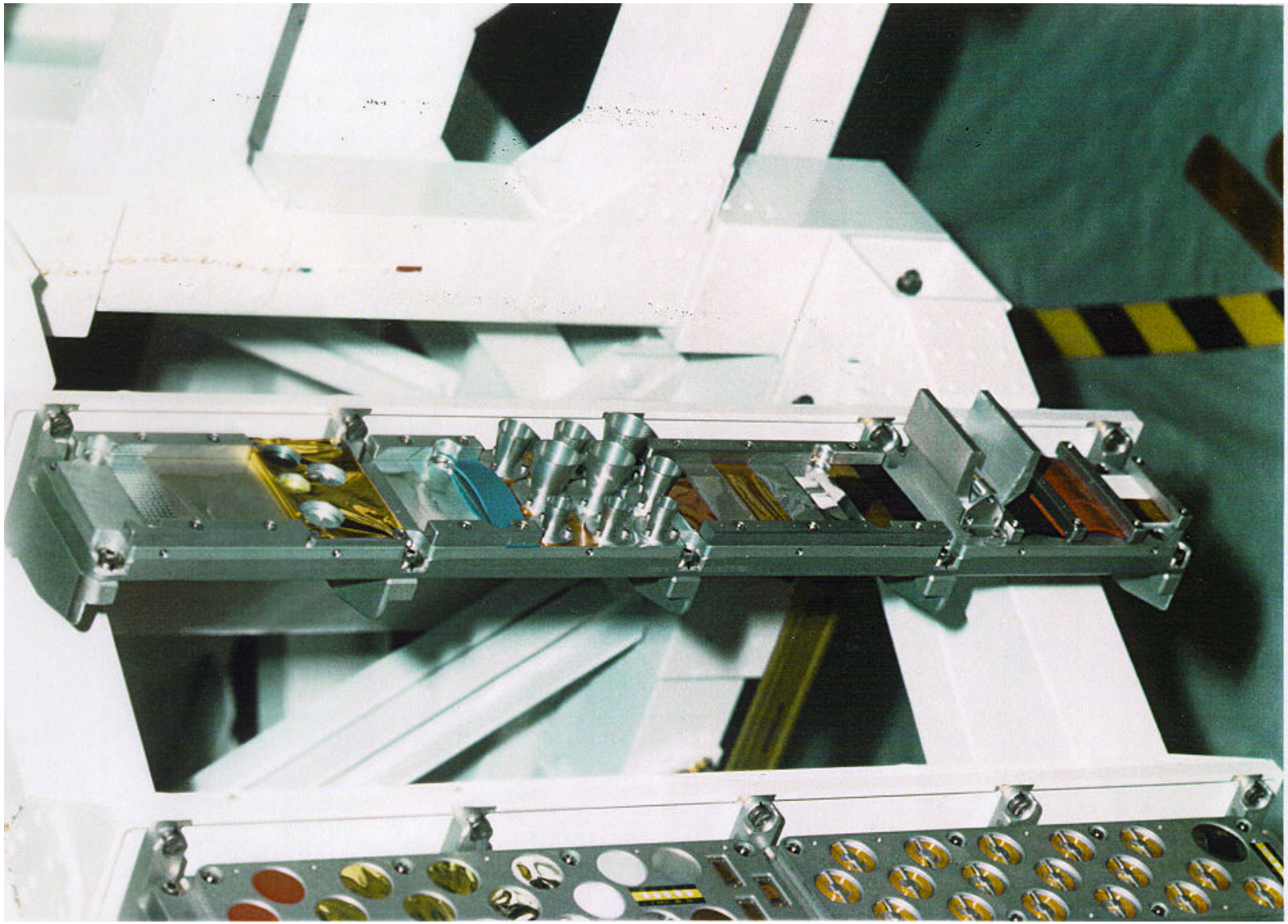
ESEM Exposure Conditions

~1-9 x 10^{19} atoms/cm^2 oxygen – estimated from Kapton recession rates
~42 hours in ram

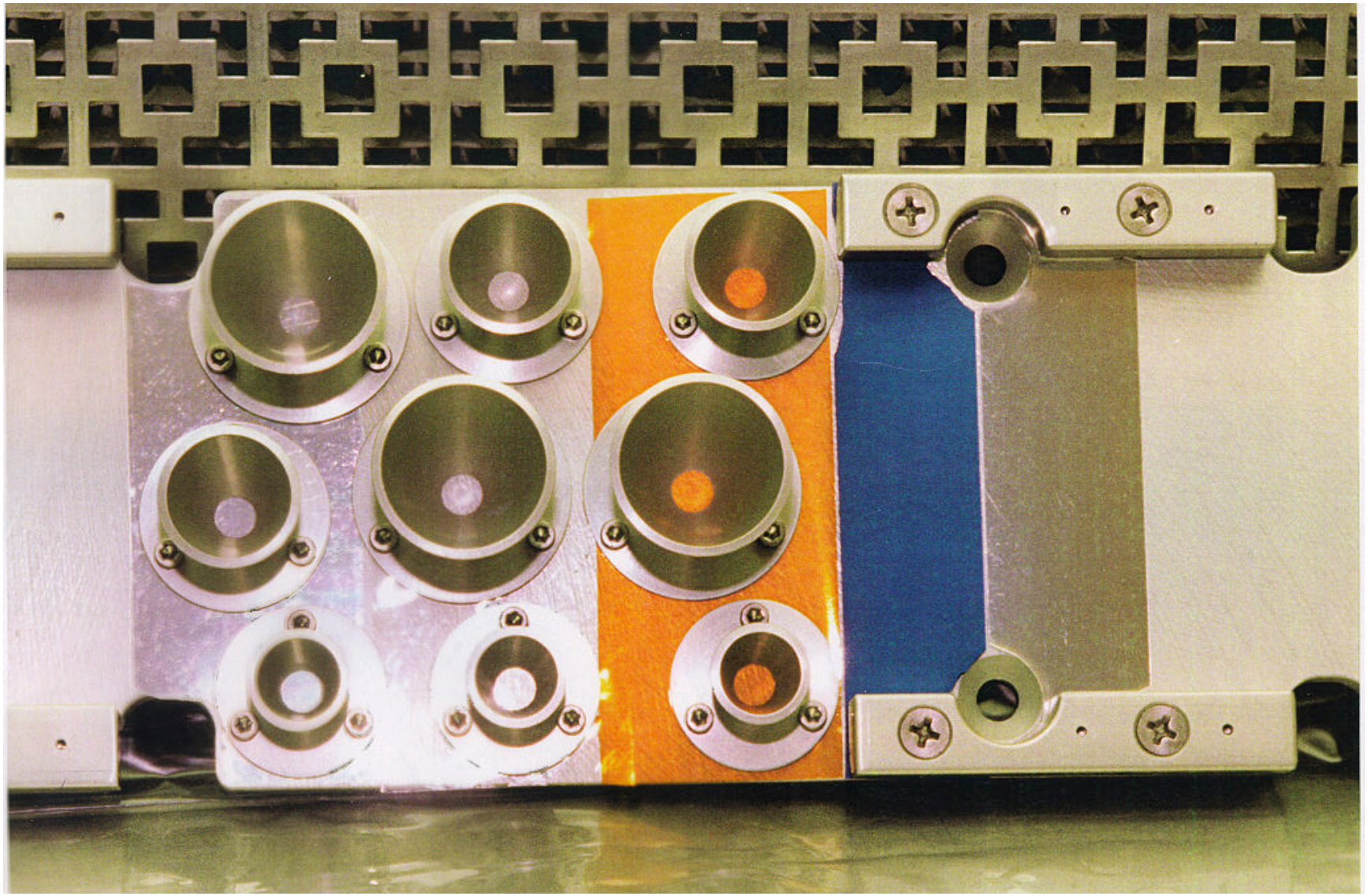
Few hours of solar UV

Thermal Cycling

Space Shuttle payload bay

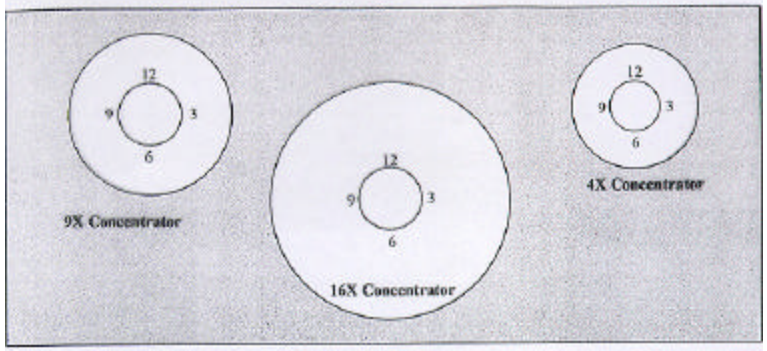


NASA Pre-flight photo showing the Materials Sample Holder and specimens



Poat-flight photo showing close-up of specimens and atomic oxygen concentrators on ESEM

Attachment 1 Kapton Erosion Measurements



16X Concentrator Erosion Measurements

Clock Position	Measurement µm
12:00	30µm
2:00	20µm
3:00	28µm
4:00	30µm
6:00	17µm
8:00	32µm
9:00	40µm
10:00	33µm

9X Concentrator Erosion Measurements

Clock Position	Measurement µm
12:00	26µm
2:00	28µm
3:00	33µm
4:00	20µm
6:00	20µm
8:00	28µm
9:00	25µm
10:00	25µm

4X Concentrator Erosion Measurements

Clock Position	Measurement µm
12:00	10µm
2:00	14µm
3:00	16µm
4:00	16µm
6:00	14µm
8:00	14µm
9:00	16µm
10:00	17µm

RECESSION MEASUREMENTS

LASER Profilometer
Resolution 0.00003" This means recessions of ~0.76 um can be detected

Kapton ambient exposure ~0.2 um recession

COR ambient exposure ~0.3 um recession

Acceleration factor	**X4**	**X9**	**X16**
Kapton	**9 um**	**18 um**	**15 um**
COR	**16 um**	**15 um**	**19 um**

Quantitative values do not mean much
Possible pressure build-up in focussing concentrators, opportunity for multiple reactions

It is clear that reaction rates were increased over ambient rates

Strategic Purpose for Spacecraft Environmental Effects Studies

Why should such studies be done?

- **Specific program support**
- **Technology Development**

Ask ourselves, is this enough?

What should we be providing?

- **Think of this type of work as a step in an information processing and distribution exercise.**

- **Strategic Purpose**
  - **Develop capability to conduct a virtual mission:**
    - **A Space Flight Simulator**
      - **Lifetime predictions**
      - **System reliability**
      - **Maintenance options**
      - **Environmental effects**