External Surface Changes Observed on the International Space Station (ISS) Through 2010

J. L. Golden, Ph.D.
Boeing Technical Fellow
ICPMSE-10J Okinawa, Japan
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External Surface Changes on ISS

- **Acknowledgements**
  - **All Boeing and Boeing subcontractor activity conducted under NASA contract**
    - **NAS15-10000**
  - **All photography courtesy of NASA**
    - **Special thanks to the NASA Flight Image Science & Analysis Group (KX).**

Summary of Presentation

A sampling of ISS on-orbit and post-flight photography showing space environmental effects (SEE) in conjunction with:

- **Basic Materials Selection Issues**
- **Inadvertent Materials Substitution**
- **Materials Handling Issues (Ground Contamination)**
- **Contamination and MMOD**
- **Imaging Itself**

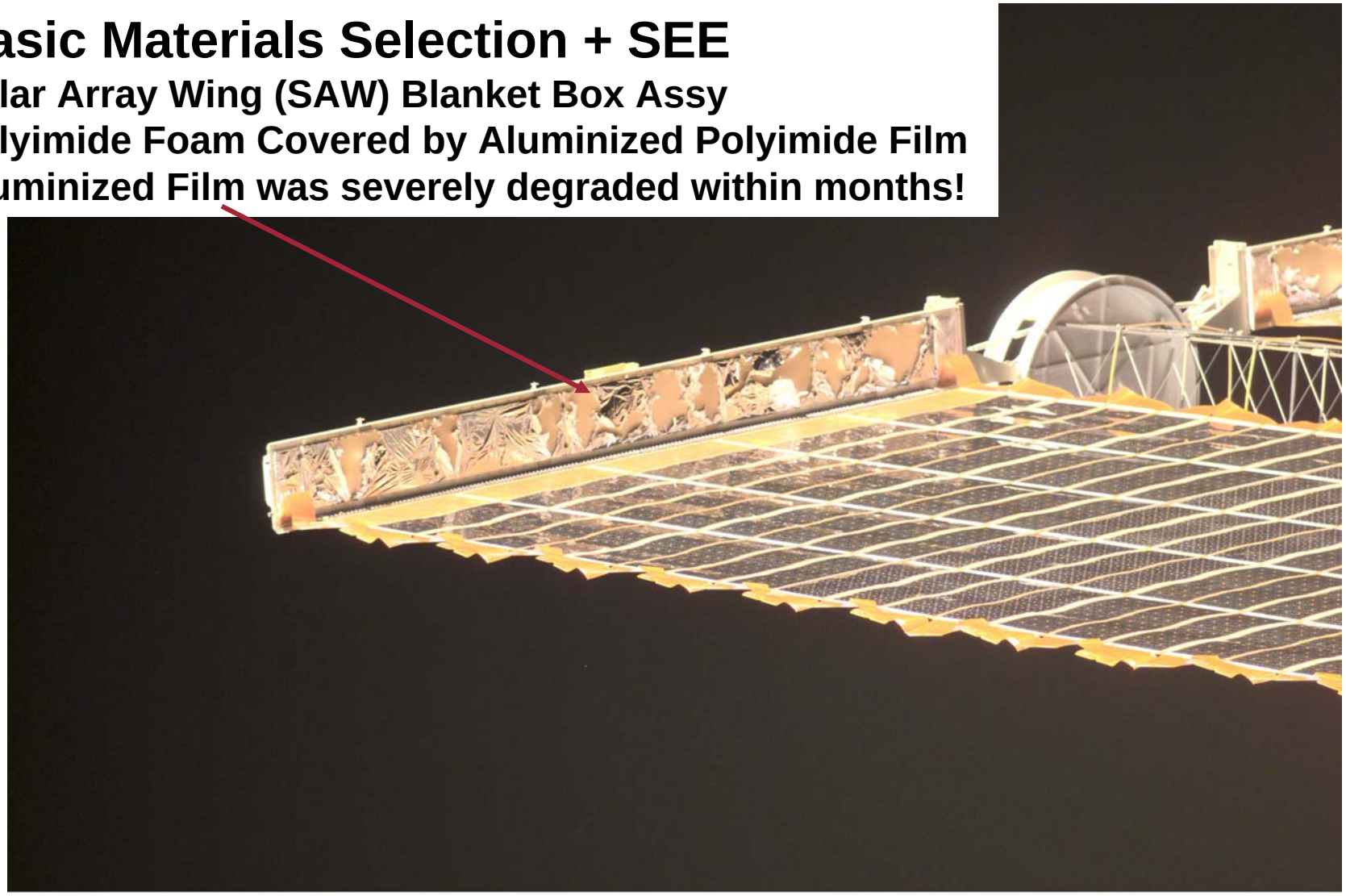
External Surface Changes on ISS

S129E009239

External Surface Changes on ISS

Basic Materials Selection + SEE

Solar Array Wing (SAW) Blanket Box Assy
Polyimide Foam Covered by Aluminized Polyimide Film
Aluminized Film was severely degraded within months!



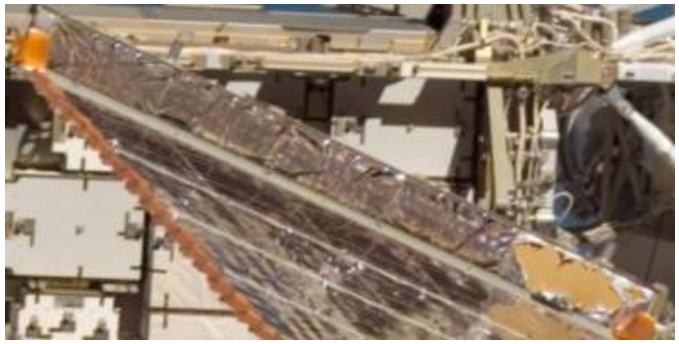
ISS003E5082 2001/08/04 03:40:57

External Surface Changes on ISS

Basic Materials Selection + SEE

Solar Array Wing (SAW) Blanket Box Assy

Not all SAWs were equally affected, plus the damaged occurred quickly and did not continue with time.



3 Months

38 Months

External Surface Changes on ISS

Basic Materials Selection + SEE

Trailing Umbilical System (TUS) Reel Grounding Strap (Tin-Plated)

External Surface Changes on ISS

Basic Materials Selection + SEE

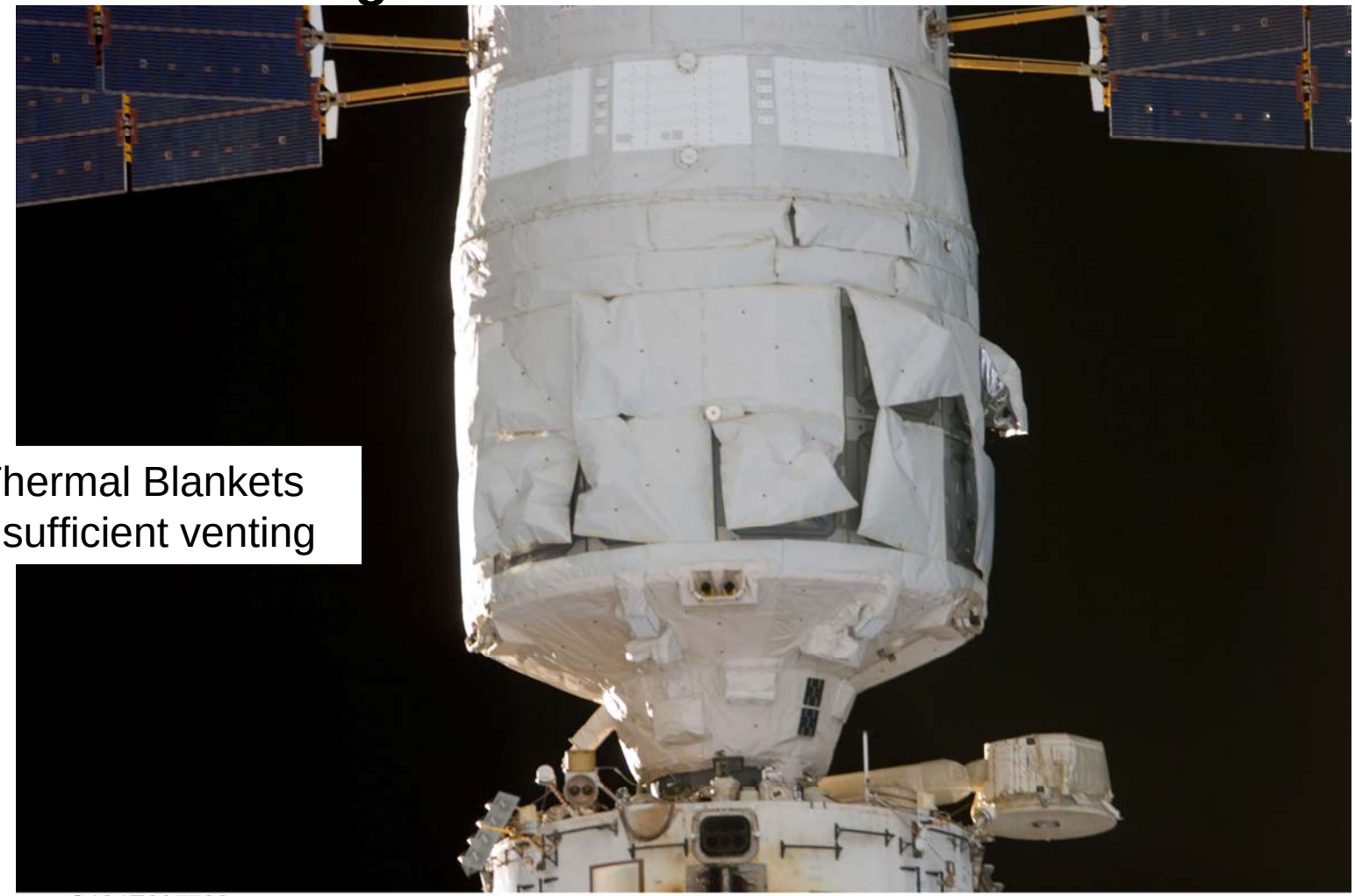
Detail of tin pest region

Ground strap removed from TUS

Scratches serving as initiation sites; low temperatures on-orbit accelerate phase transformation

External Surface Changes on ISS

Basic Materials Design + SEE

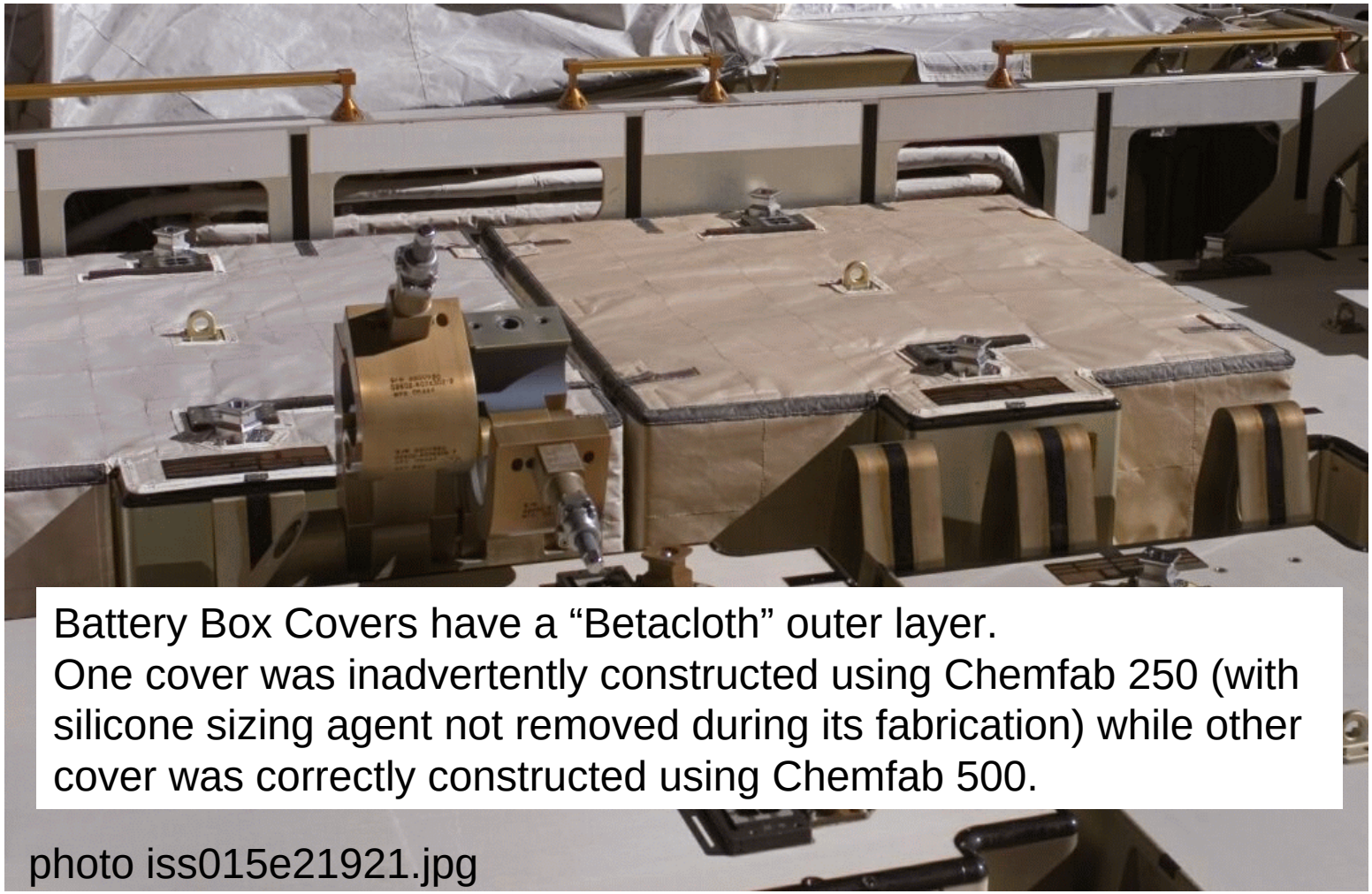


ATV1 Thermal Blankets show insufficient venting

S124E005722

External Surface Changes on ISS

Inadvertent Materials Substitution + SEE

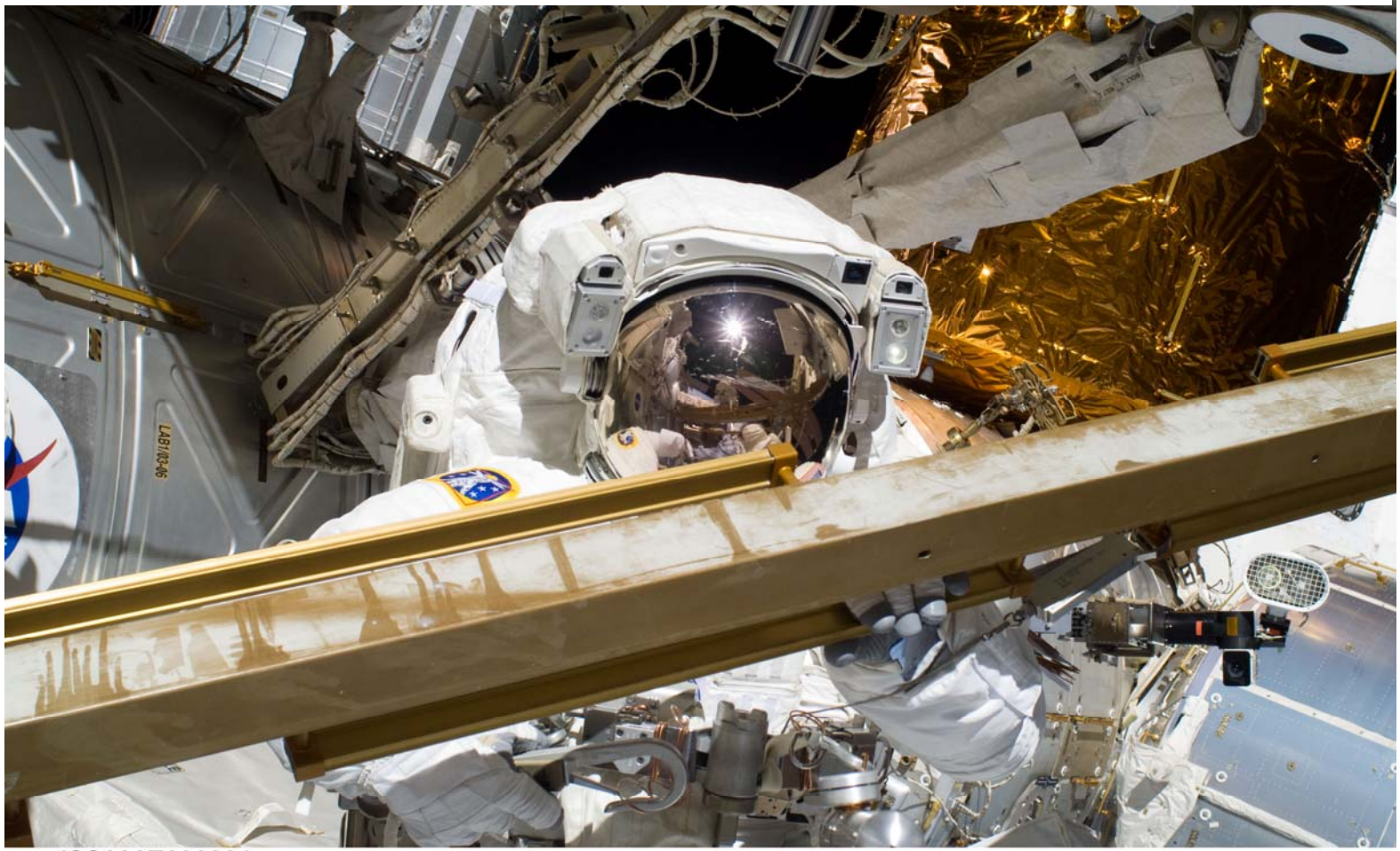


Battery Box Covers have a “Betacloth” outer layer.
One cover was inadvertently constructed using Chemfab 250 (with silicone sizing agent not removed during its fabrication) while other cover was correctly constructed using Chemfab 500.

photo iss015e21921.jpg

External Surface Changes on ISS

Materials Handling Issues (Ground Contamination)



ISS026E030931

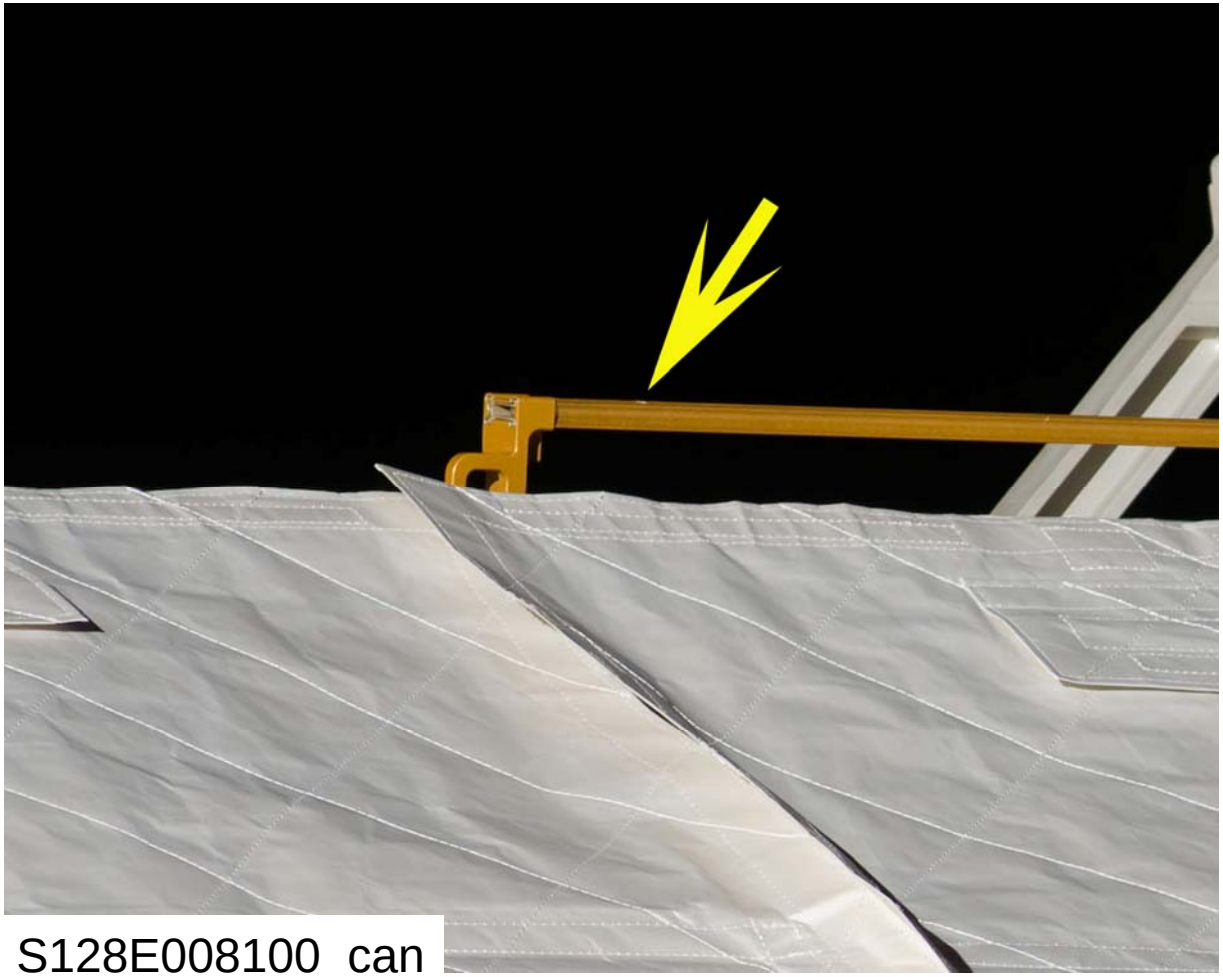
External Surface Changes on ISS

Materials Handling Issues (Ground Contamination)

S122e009382 - cropped

External Surface Changes on ISS

Space Environmental Effects



S128E008100_can

MMOD impacts on handrails are becoming increasingly troublesome, causing EVA glove damage

External Surface Changes on ISS

Space Environmental Effects

S128E008103

Anodized aluminum labels, which darkened quickly, have begun to recover their expected appearance with continued AO exposure!

External Surface Changes on ISS

Space Environmental Effects – Frequent and "New" Visiting Vehicles

Soyuz docked to FGB
Outgassing or Thruster Contamination

ISS022E067004

External Surface Changes on ISS

Space Environmental Effects – Frequent and "New" Visiting Vehicles

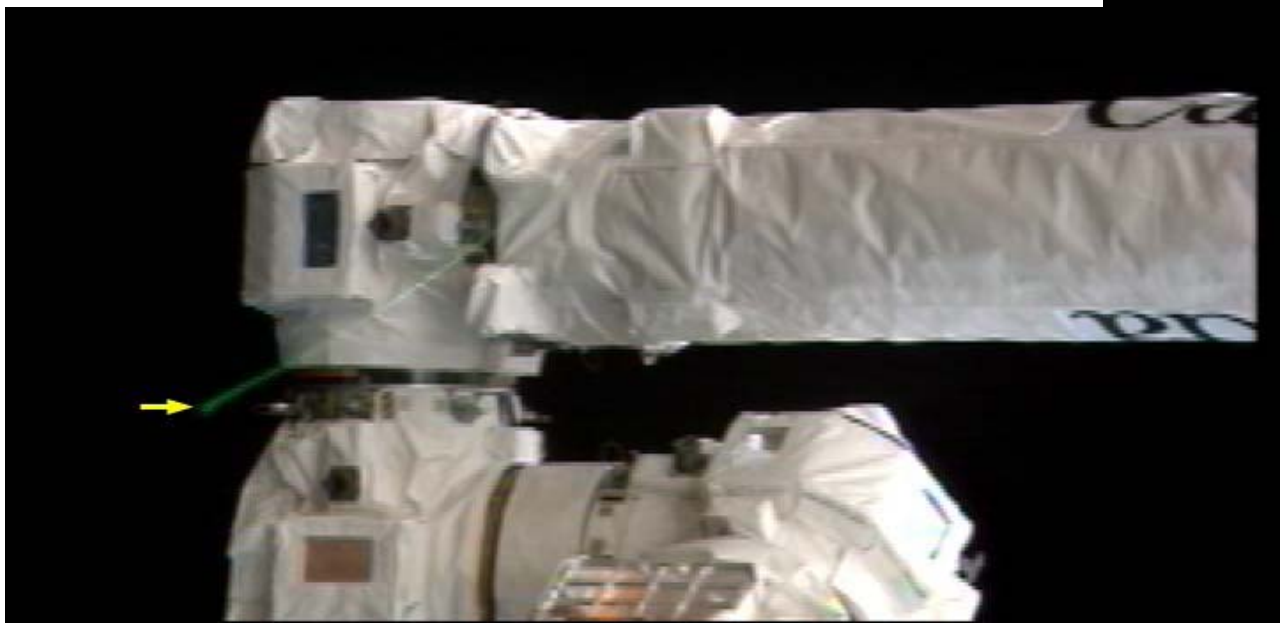
ISS021E031911

Opposite direction from previous photo

External Surface Changes on ISS

Issues with Imaging

Charged Particle affecting Digital Video Camera Imaging



External Surface Changes on ISS

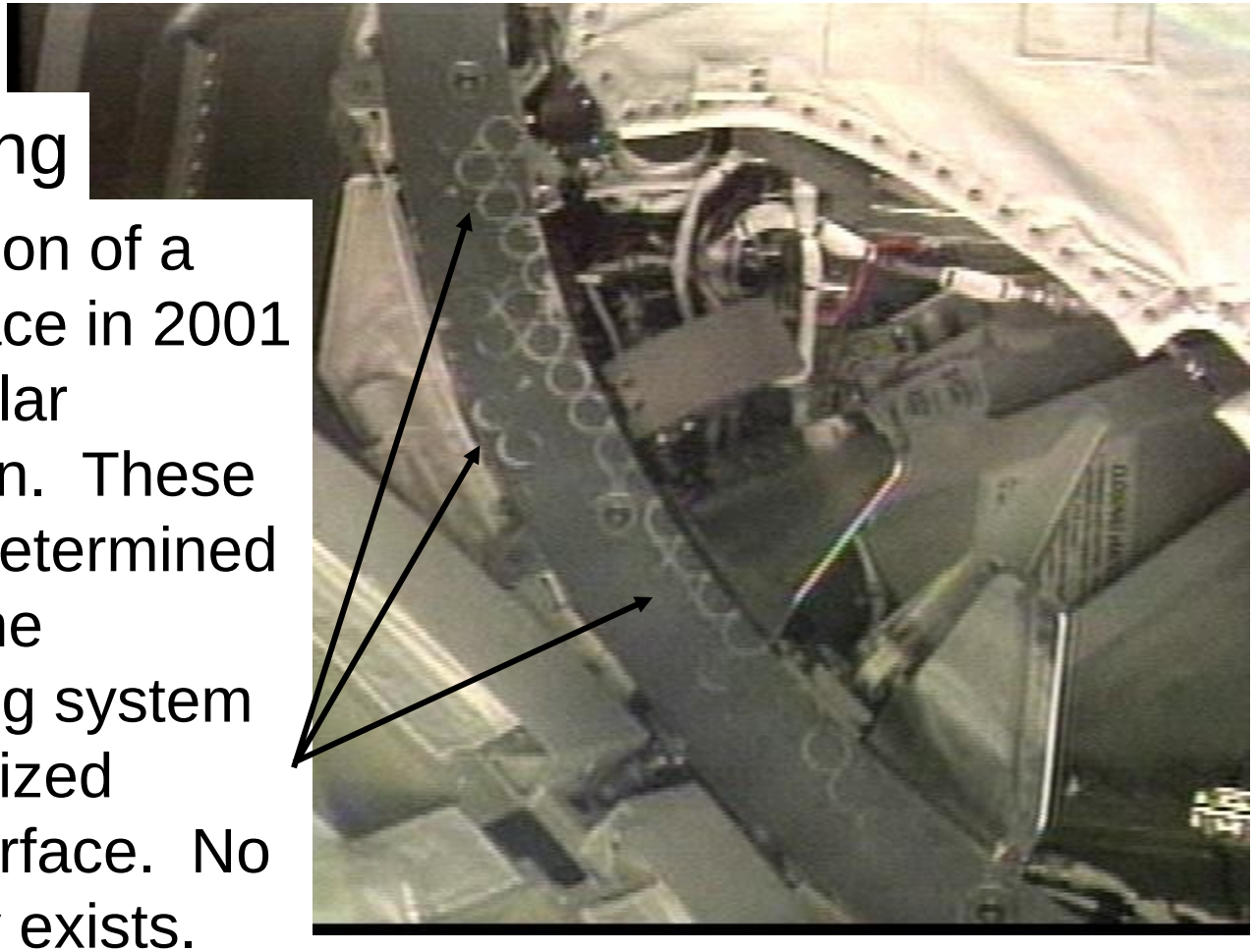
Issues with Imaging - Reflections

ISS023E021963

External Surface Changes on ISS

Issues with Imaging

Pre-berthing inspection of a Node 1 sealing surface in 2001 identified these circular features as a concern. These features were later determined to be reflections of the camera's LED lighting system on the smooth, anodized aluminum sealing surface. No such feature actually exists.



External Surface Changes on ISS

Summary

- **Some worse-than-expected materials degradation effects have been observed, but none have created any operational issues and some hardware (as with the anodized aluminum labels) appear to be recovering.**
- **Inadvertent materials substitutions have been observed, but none have created any operational issues.**
- **Hardware handling contamination effects have been observed, and although none have created operational issues, there is clearly room for improvement in this regard.**
- **Even with robust materials selections, space environmental effects will be observed.**
- **Be cautious when interpreting on-orbit photography, as lighting conditions and the space environment affect imaging.**