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# Investigation of Shuttle Radiator Micro-Meteoroid & Orbital Debris Damage

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**This paper documents the data collected from two hypervelocity micro-meteoroid & orbital debris (MMOD) impact events where the shuttle payload bay door radiator sandwich panel was completely perforated; i.e., the MMOD impact created a hole in both the front and back facesheets of the radiator panel. The radiator damage occurred on Shuttle missions STS-115 (September 2006) and STS-118 (August 2007). Scanning Electron Microscope/Energy-Dispersive x-ray Spectroscopy (SEM/EDS) analysis of impact residue provided evidence to identify the source of each impact. Based on the SEM/EDS results, STS-115 damage was believed due to a piece of circuit board material (principally fiberglass); i.e., orbital debris. STS-118 damage was also believed due to orbital debris impact, composed of titanium, zinc and antimony. Impact site features that indicate projectile directionality are discussed, along with hypervelocity impact testing on representative samples conducted to simulate the impact event. The results of the ground-based impact tests indicate the likely size of the particles exceed 1mm in diameter to cause the observed damage. The paper provides results of predicted MMOD impact probabilities using Bumper code for the particle sizes thought to have caused the radiator damage.**

## Nomenclature

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|---|---|---|
| *EDS* | = | Energy-Dispersive x-ray Spectroscopy |
| *HITF* | = | Hypervelocity Impact Technology Facility |
| *LH* | = | Left Hand |
| *MMOD* | = | Micro-meteoroid/Orbital Debris |
| *NASA* | = | National Aeronautics and Space Administration |
| *RH* | = | Right Hand |
| *SEM* | = | Scanning Electron Microscope |
| *TCS* | = | Thermal Control System |
| *WSTF* | = | White Sands Test Facility |

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