

Micrometeoroid and Orbital Debris (MMOD) Protection

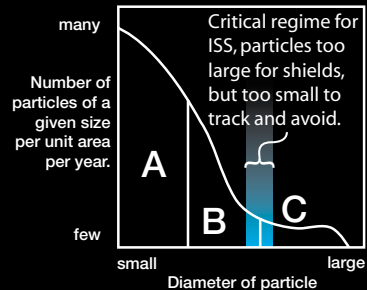
Spacecraft in low Earth orbit continually impact with meteoroids and with orbital debris. Most of the meteoroids and debris are small and cause little damage. A small fraction of the meteoroid and debris populations, however, are larger and can cause severe damage in a collision with a spacecraft.

The International Space Station (ISS) is the largest spacecraft ever built. When ISS assembly is complete, more than 11,000 m² (118,400 ft²) of surface area will be exposed to the space environment. Due to its large surface area, its long planned lifetime, and the potential for a catastrophic outcome of a collision, protecting the ISS from meteoroids and debris poses a unique challenge.

Many ISS elements are shielded from impacts. There are 3 primary shielding configurations:

- Whipple shield-is a two layer shield consisting of an outer bumper, usually aluminum, spaced some distance from the module pressure shell wall; the bumper plate is intended to break up, melt or vaporize a particle on impact.
- Stuffed Whipple shield-consists of an outer bumper, an underlying blanket of Nextel ceramic cloth and Kevlar fabric to further disrupt and disperse the impactor, spaced a distance from the module pressure shell.
- Multi-layer shields, consisting of multiple layers of either fabric and/or metallic panels protecting the critical item.

Other critical areas, such as electrical, data and fluid lines on the truss and radiator panels are toughened with additional protective layers to prevent loss from MMOD impacts.

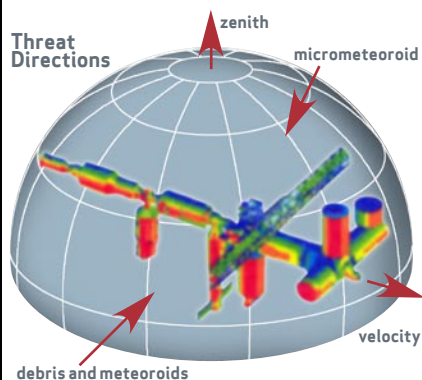


- A Pressure shell penetrations unlikely
B Possible penetrations that can be mitigated with shields
C Larger debris is tracked and ISS is maneuvered out of impact path

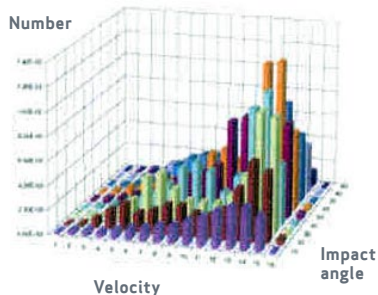


A 1.4mm diameter (inside) hole found March 2001 in an ISS mini-pressurized logistics module outer bumper panel (no damage reported to pressure shell). This 6cm (2.4in) x 3cm (1.2in) hole in the thermal blanket over the MMOD shield was found by crew in June 2007.

Micrometeorites may approach ISS from any direction, but are less likely from below where the Earth acts as a shield. Debris will typically approach ISS on a path roughly parallel with the Earth's surface, and from the side or front.



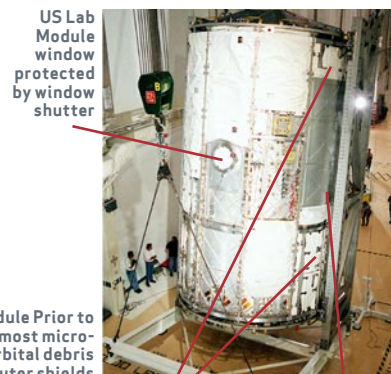
Risk computations based on exposure and shielding



US Lab in orbit, above Ken Bowersox uses camera at window with partially deployed shutter; to right window shutter fully deployed; outer debris shields are visible.



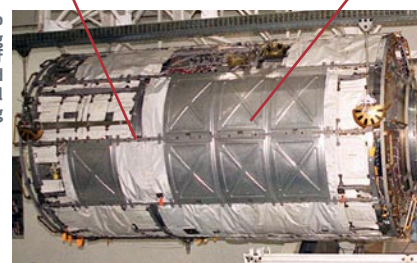
US Lab Module Prior to installation of most micrometeoroid and orbital debris outer shields



Intermediate Debris Shield, Nextel and Kevlar Blankets

Outer Debris Shield, Aluminum

US Lab Module during installation of micrometeoroid and orbital debris shielding



Deployed shutters for Cupola windows.

