

## **Tutorial : An overview of the orbital debris and meteoroid environments, their effects on spacecraft, and what can we do about it?**

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Because of the high speeds needed for orbital space flight, hypervelocity impacts with objects in space are a constant risk to spacecraft. This includes natural debris – meteoroids – and the debris remnants of our own activities in space.

A number of space surveillance assets are used to measure and track spacecraft, used upper stages, and breakup debris. However, much of the debris and meteoroids encountered by spacecraft in Earth orbit is not easily measured or tracked. For every man-made object that we can track, there are hundreds of small debris that are too small to be tracked but still large enough to damage spacecraft. In addition, even if we knew today's environment with perfect knowledge, the debris environment is dynamic and would change tomorrow.

This means that much of the risk from both meteoroids and anthropogenic debris is statistical in nature. NASA uses and maintains a number of instruments to statistically monitor the meteoroid and orbital debris environments, and uses this information to compute statistical models for use by spacecraft designers and operators.

Because orbital debris is a result of human activities, NASA has led the US government in formulating national and international strategies that space users can employ to limit the growth of debris in the future.

This talk will summarize the history and current state of meteoroid and space debris measurements and modeling, how the environment influences spacecraft design and operations, how we are designing the experiments of tomorrow to improve our knowledge, and how we are working internationally to preserve the space environment for the future.