NEW PROTECTION CONCEPTS FOR METEOROID / DEBRIS SHIELDS

K. Thoma, M. Wicklein, E. Schneider

Fraunhofer-Institute for High-Speed Dynamics - Ernst-Mach-Institut, Freiburg, Germany
(thoma@emi.fhg.de)

Increasingly stringent safety requirements concerning protection against space debris and meteoroid impacts particularly for manned space missions, lead to heavy shielding structures. In order to decrease the weight of shield systems without compromising the protection performance, or in order to increase protection levels at constant weight, modern shield concepts have been evaluated by means of experimental and numerical impact simulations. New configurations have been compared with existing “Stuffed Whipple Shield“ protection systems, such as those used on the US modules of the International Space Station (ISS), and on the European ISS module (COLUMBUS). These systems consist of an Al-bumper and a so-called "stuffing layer" consisting of a combination of ceramic (Nextel) and aramid (Kevlar) fabrics. In the new concepts constant areal weight has been maintained allowing direct comparison with existing systems. Results are presented for Al-foam sandwich bumpers (multi-shock concept!) and bumpers of TiAl super alloys. A number of materials have been implemented as stuffing layers: Kevlar fabrics, Nextel fabrics combined with Kevlar fabrics, and Kevlar fabrics combined with polyurethane foam. Protection effectiveness of the individual configurations will be discussed. In addition to the experimental studies numerical simulations are carried out for the Al-foam shields. The calculations are conducted mesomechanically, i.e. the cell walls of the foam are modelled explicitly with a finite element mesh. The aim of the simulations is to study the influence of the foam on the distribution of momentum of the debris cloud.