Abstract project:

In the aid of understanding hypervelocity impacts (HVI) on space debris on protective shields around satellites (so called Whipple shields), a numerical model has been developed in LS-DYNA. A challenging aspect of HVI is to properly capture the debris cloud after impact so that damage caused by the debris cloud can be predicted accurately. Traditionally smooth particle hydrodynamics (SPH) has been used for HVI, the new model on the other hand uses a novel technique where FEM is combined with DEM to convert elements to particles upon reaching a certain damage threshold.

A parameters study has been performed in the original paper to investigate some important material and numerical parameters, i.e.

* Density (virtual materials only),
* Mesh size,
* Fracture parameter ,
* Friction coefficient.

In this project we will extend the parameter study by different materials in order to gain a better understanding of the hyper velocity impact mechanics and to identify important material parameters. We will use existing and well-known materials for the simulations. The three most used materials in space applications are light weight metals (aluminium), carbon fibre reinforced composites (CFRP) and additive manufactured (AM) metals, of which the first two will be considered in the analyses.

The project will consist out of two parts:

*Part I*  
Parameter study of metals. This includes a study on a variety of aluminium alloys (*list alloys*). For comparison steel alloys will also be considered mainly due to their higher density. Material cards are readily available, and implementation should pose little difficulties.

*Part II*  
Parameter study on composites. The existing model has been developed to account for isotropic materials and so requires modifications to be able to simulate orthotropic composites. In the second part of the project, we will try to implement composites with orthotropic behaviour. The implementation of among others multiple ply’s, orthotropy and intralaminar adhesion, can be challenging and therefore and so during the project we might choose to increase the emphasis of the project on Part I.

The different alloys and materials will be compared qualitatively by analysis of the debris cloud as well as quantitatively by means of the following simulations results:

* Residual velocity and debris cloud as a function of impact velocity,
* Debris cloud diameter as a function of impact velocity,
* Conversion of elements to particles due to temperature.