Certa Sim

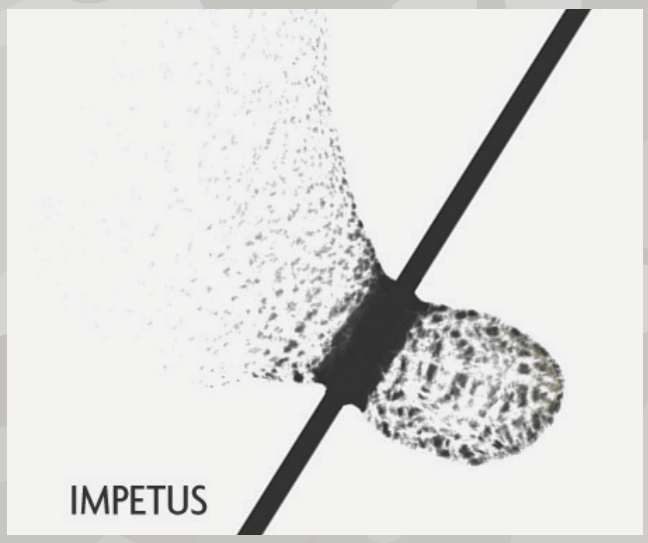
Providing Innovative Solutions

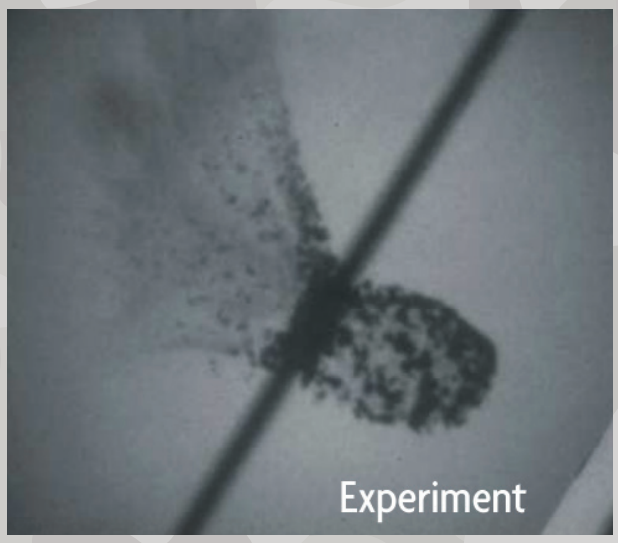
γSPH™ Solver

Hypervelocity Impact of a Sphere with a Plate

CASE STUDY

Hypervelocity events involve objects moving at very high velocities, greater than 2.5 m/s which leads to extreme deformation. There are many events that fall under this scenario, a few being: space debris impact on spacecraft, war head fragmentation, missile impact. Such extreme deformations result in nearly fluid like behavior for components made of metal. The physics cannot be captured with classic Lagrangian Finite Element solvers so the answer is to use a particle based method. The IMPETUS Afea γSPH™ Solver is the answer to accurate, robust and fast simulation of these scenarios. CertaSIM, LLC and IMPETUS Afea believe in verification of software through comparison with experimental results and many such studies have been carried out in order to demonstrate the accuracy of the software. One such study involved verification of a Hypervelocity Impact Experiment carried out at the Thiot Ingenierie Laboratory, Puybrun, France. In these experiments a 3 mm diameter aluminum sphere impacts a 2 mm thick aluminum target plate with a velocity on the order of 4000 m/s. Two different tests were performed, normal incidence at 4119 m/s and an oblique impact at an angle of 32° at 4050 m/s. By using ultra-high speed cameras it was possible to capture images of the debris cloud which can be used for comparison with numerical results.





Both experiments were modeled with the γSPH™ Solver using a linear elastic-plastic constitutive model and Mie-Gruneisen equations of state. The correlations with the experiments are excellent showing the accuracy of the γSPH™ Solver. This figure shows very good comparison of the resulting debris cloud.

The Solver was developed to take full advantage of GPU Technology which allows for massively parallel processing on a workstation or a single node of a cluster equipped with single or multiple GPUs. This particular scenario was run with model resolution of 800K, 6.5 million, 10 million and 33 million particles. The runtime for the 800K model was a mere 31 seconds and the 33 million particle model ran in 2.5 hours.

Key Features and Benefits:

- The γSPH™ Solver was used to model the Hypervelocity impact experiment performed by the Thiot Ingenierie Laboratory, Puybrun, France.
- The numerical results compare very well with the experiments.
- The Solver utilizes GPU technology for high performance computing on a single workstation or a single node of a cluster for very fast runtimes.
- Very high resolution models are critical to capturing the level of damage created by Hypervelocity impact and it requires a robust and accurate particle based method.

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