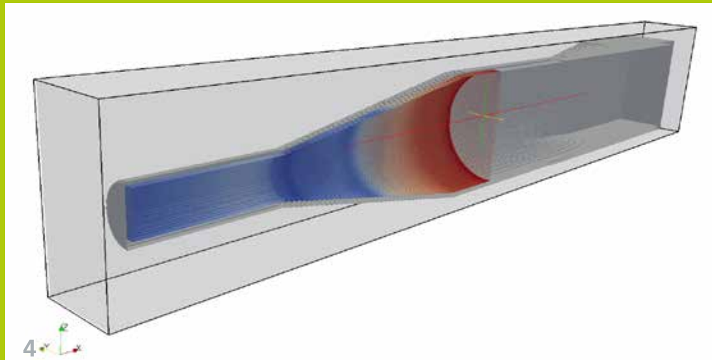
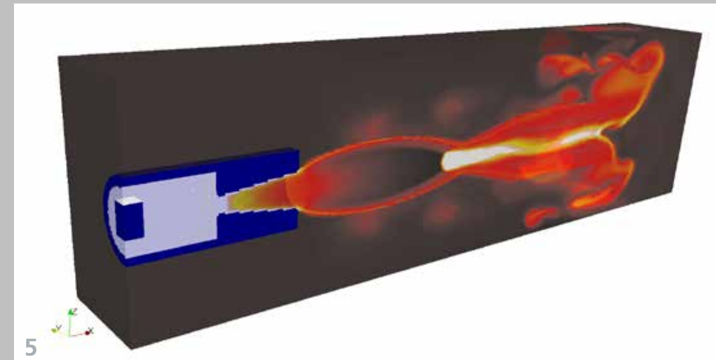




Computing Time vs. Accuracy

You can control the spatial resolution and thus the computing time and accuracy conveniently with a single input parameter. This makes it easy to start with a fast run which renders a quick estimate in a few minutes and to continue with a high resolution, high fidelity simulation.

Preprocessing

Preprocessing is provided by the GUI: the specification of the flow domain is achieved through combination of rectangular parts; embedded voxel models can be created by blending of simple hollow or filled objects such as boxes, planes, spheres or cylinders. Voxel models can also be imported from files.

Postprocessing

For the visualization of flow fields the VTK format is used, which can be processed by freely available tools, such as PARAVIEW. The further ASCII formatted output files comprise a broad variety of quantities relevant for engineering tasks. These output files can be graphically processed by the GUI or may be imported into GNUPLOT or EXCEL.

Damage and Hazard Analysis

Blast effects - i.e. hazards to persons and potential damage of structural elements such as windows or walls - are automatically estimated through the evaluation of damage models based on the computed peak overpressures and overpressure impulses.

Experimental Validation

A large number of model scale experiments have been conducted and evaluated at Fraunhofer EMI for the validation of the applied methods and models. The comparisons confirmed the predictions obtained with the APOLLO BLASTSIMULATOR for both internal and external detonations.

Required Resources

Due to its high computational efficiency, the APOLLO BLASTSIMULATOR can be run on standard PCs or Laptops. Versions for Windows and Linux are available. Memory requirements depend on the model sizes you wish to simulate. For typical applications, a memory of min. 1 GB is recommended.

Licenses and Contact

We offer annual licenses, project licenses (3 months) and training courses (1-2 days). For further information and acquisition of a license please contact: apollo@emi.fraunhofer.de

www.emi.fraunhofer.de

APOLLO BLASTSIMULATOR

4 *Pressure waves in a large shock tube.*

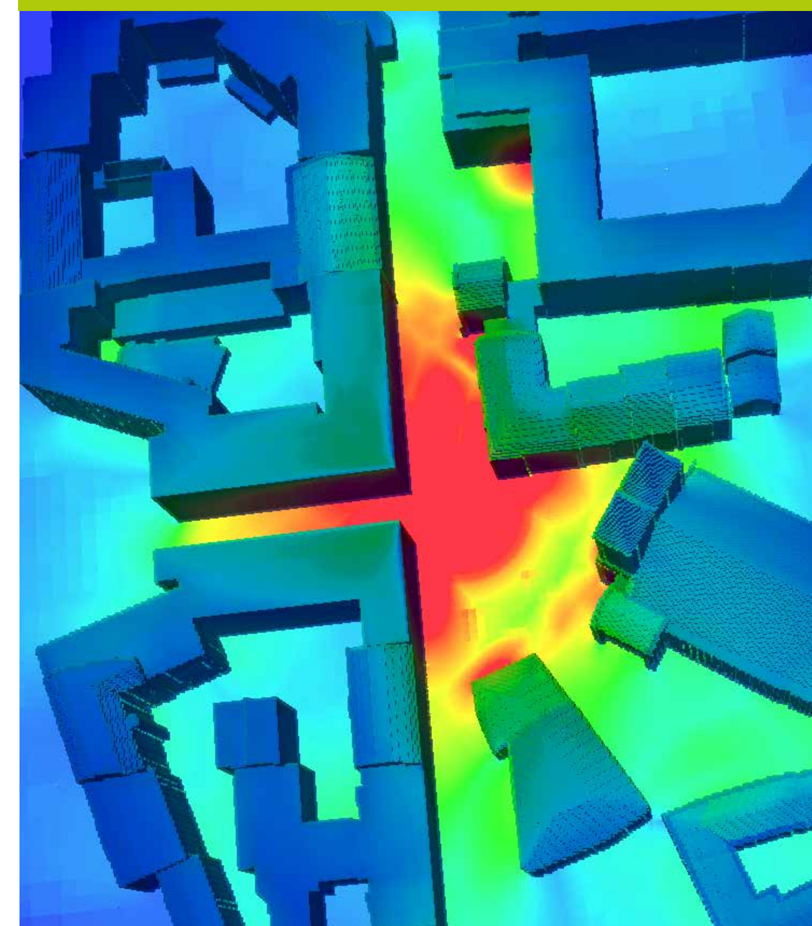
5 *Transient free jet exiting a nozzle.*

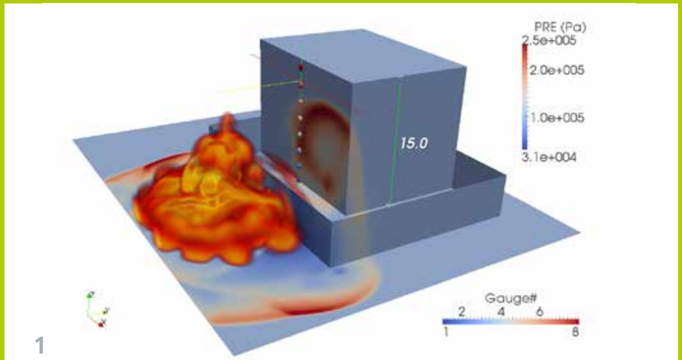
Fraunhofer EMI

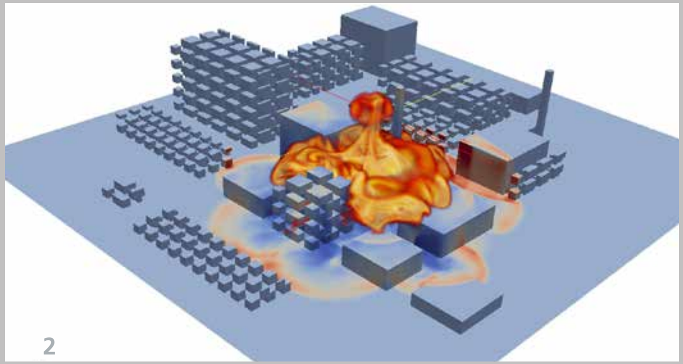
FRAUNHOFER INSTITUTE FOR HIGH-SPEED DYNAMICS, ERNST-MACH-INSTITUT, EMI

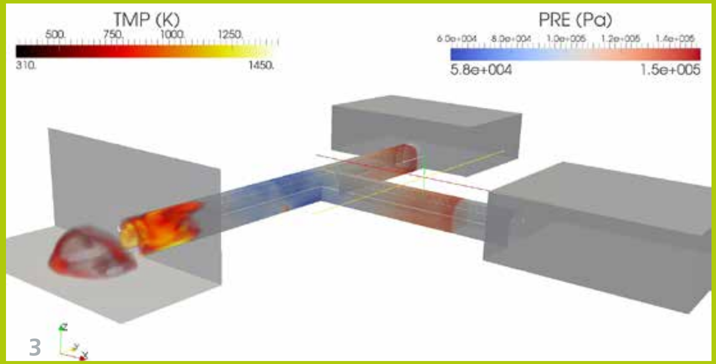
APOLLO BLASTSIMULATOR

THE CFD TOOL DEDICATED TO THE SIMULATION OF DETONATIONS, BLAST WAVES AND GAS DYNAMICS









Purpose

The APOLLO BLASTSIMULATOR is a specialized CFD-tool dedicated to the simulation of detonations, blast waves and gas dynamics. Distinct from general purpose CFD-tools, it offers a unique combination of

- simplicity of application
- sophistication and suitability of models
- short computing time and high accuracy.

Owing to its specialization, the APOLLO BLASTSIMULATOR delivers high quality results in less time with less effort and is equally suitable for experienced CFD users and non-specialists.

Features

- Finite-Volume method with explicit time integration.
- Dynamic Mesh Adaption (DMA): Cartesian grids with automatic global and local adaption.
- Versatile modeling capabilities and geometry import.
- Validated state-of-the-art models for high explosives and gas detonations.
- Comprehensible graphical user interface (GUI).
- **NEW:** Afterburn model for oxygen deficient explosives
- **NEW:** Direct evaluation of blast damage for various types of windows and walls.

Models

The APOLLO BLASTSIMULATOR solves the conservation equations for transient flows of inviscid, chemically reacting or inert gas mixtures. Detonations are modelled on the basis of the CJ theory. Geometric modelling is achieved through multi-block Cartesian domains and embedding of arbitrarily shaped voxel models.

Methods

A Finite-Volume method with explicit time integration is applied for the solution of the equations. A particular Riemann solver, which efficiently copes with the extreme conditions occurring in detonations and high speed flows, is used for the calculation of transport between finite volumes. Full second order accuracy is achieved with a novel scheme for the three dimensional reconstruction of the flow states in the mesh cells. This scheme ensures excellent isotropy and convergence behavior.

Modules

The APOLLO BLASTSIMULATOR comprises three modules: a 1D solver for the fast and accurate computation of spherical detonations, a 3D solver for the efficient computation of detonations of non-spherical high explosives charges, and a 3D solver which permits the simulation of blast wave propagation, gas detonation or other gas dynamic processes. These modules are integrated into a single processing chain, which requires no in-between user interaction.

DMA - Dynamic Mesh Adaption

Efficiency and accuracy of the APOLLO BLASTSIMULATOR rely on the Dynamic Mesh Adaption technique (DMA): the domain size is automatically adapted to the global extent of the flow; the mesh resolution is automatically adapted to local flow features such as shock fronts and material interfaces. Thereby, the computational effort is spent only on relevant regions of the flow field.

Graphical User Interface (GUI)

The GUI guides you through the steps required for the model set-up and the execution of the simulation. It is clearly structured and offers help pages for the relevant issues. The GUI is available for Windows and can be offered for Linux.

1 *Car bomb explosion in front of a blast protection wall.*

2 *Large scale explosion on a chemical production plant.*

3 *HE Charge detonation in a tunnel system.*