NUMERICS

FI-BLAST

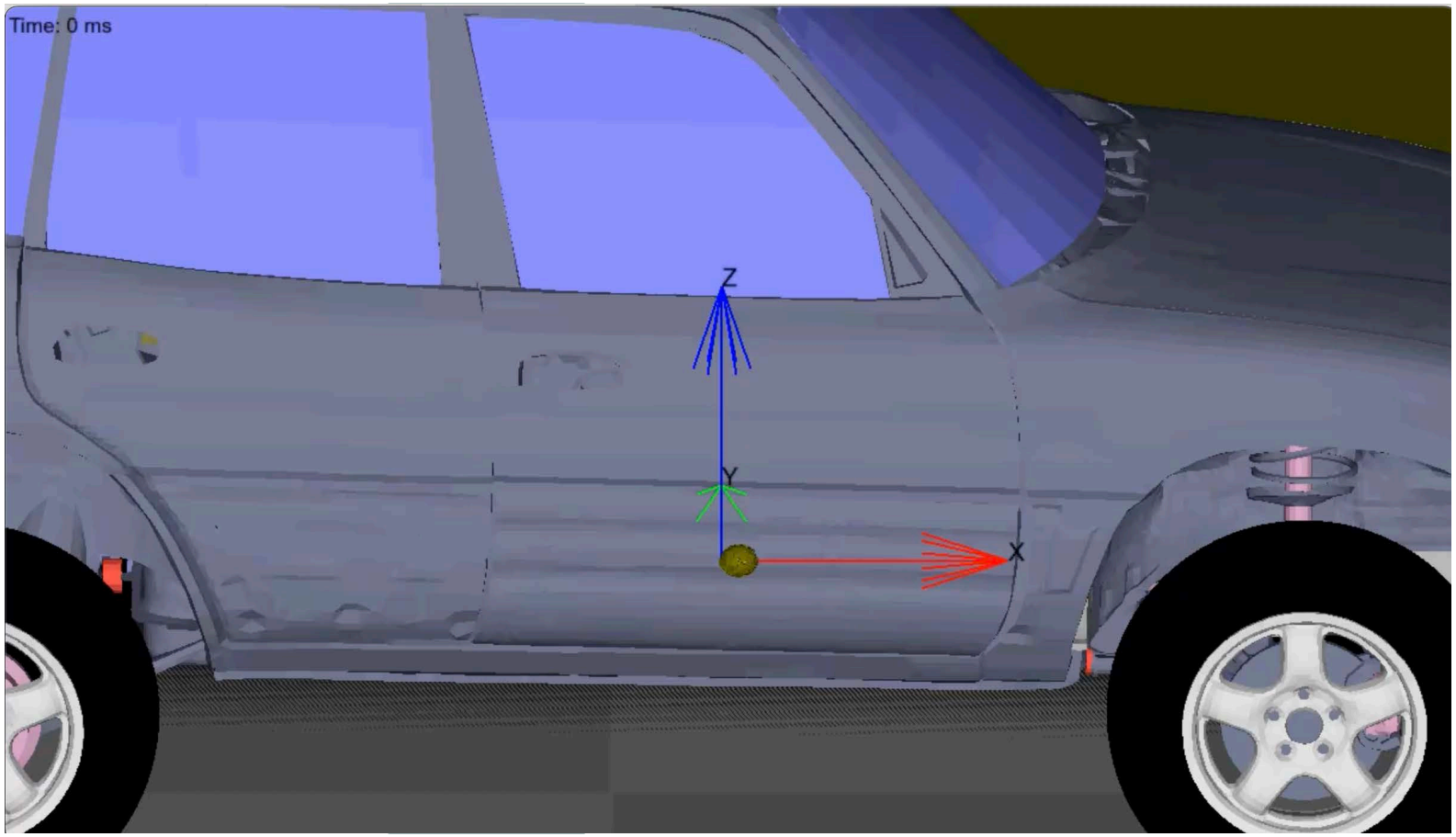
***F**ast **I**nterface for **B**last & Impact **L**oad **A**nalysis of **S**tructures*

Expert System to Assist the Fast Analysis of Blast and Fragment Loaded Structures

Product information

FI-BLAST Overview

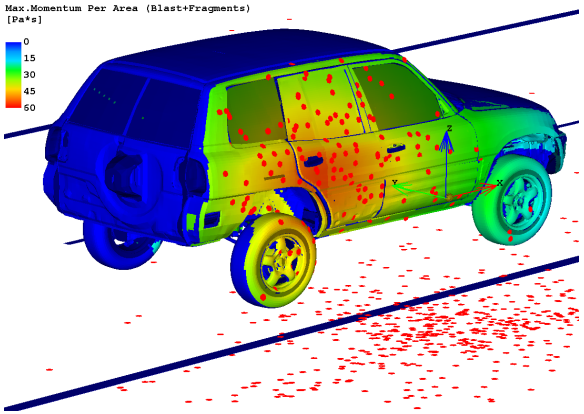
FI-BLAST is an expert system to assist the fast analysis of blast and fragment loaded structures like vehicles or buildings.

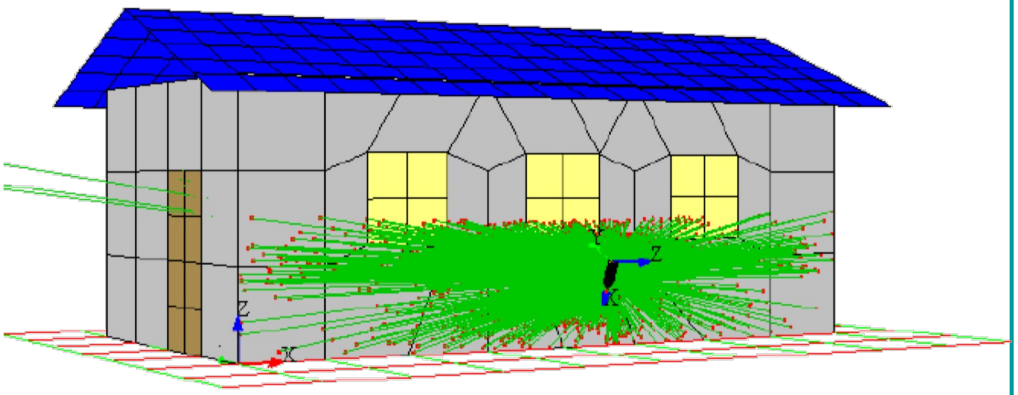


FI-BLAST Overview

Basic idea

Analysts often build detailed FE models of vehicles or buildings. Using these models to analyze the effects of explosive devices requires an adequate definition of loads. However, in most cases a fully coupled 3D hydrocode analysis including blast and fragment propagation is too expensive or not feasible at all.

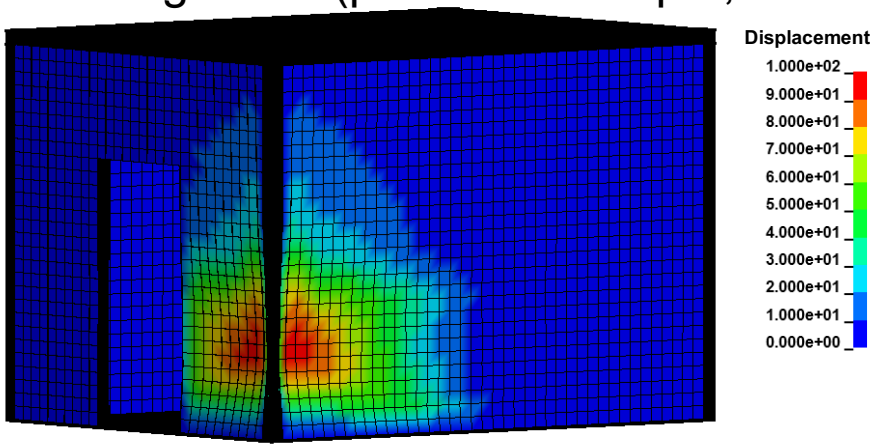




FI-BLAST Overview

Features

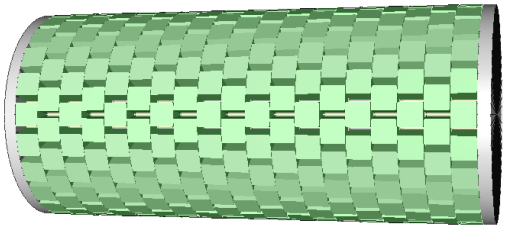
- Use existing FE models and calculate the blast/fragment loads based on a fast and validated engineering approach
- Incorporates blast functions and projectile momentum to create time histories on surfaces of FE models as stress boundary conditions
- Provides trajectories of fragments to analyze and define safety areas based on damage and injury criteria
- Evaluates terminal ballistic effects of fragments (penetration depth, residual velocity and mass) by using XWAM approach incl. Monte-Carlo analysis
- Parametric impact analysis with a user-defined fragment or projectile to identify vulnerable areas of a target.



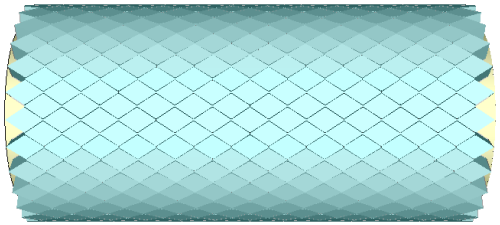
Structural Analysis of a protective container.

FI-BLAST Overview

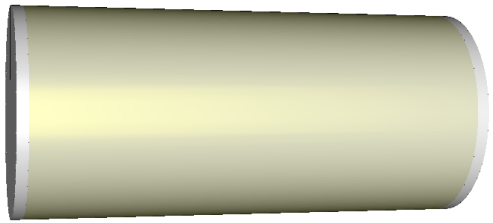
FI-BLAST covers all typical casing structures



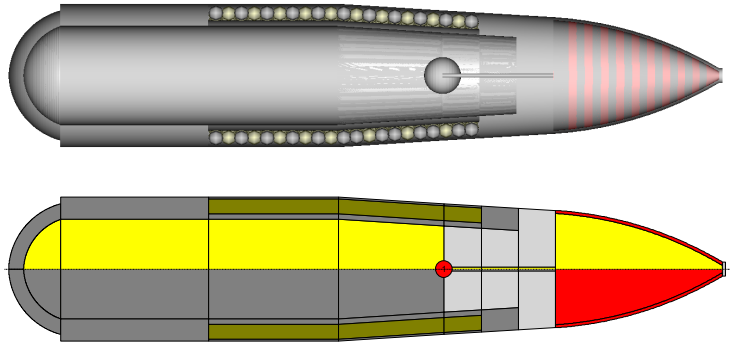
pre-formed



notched



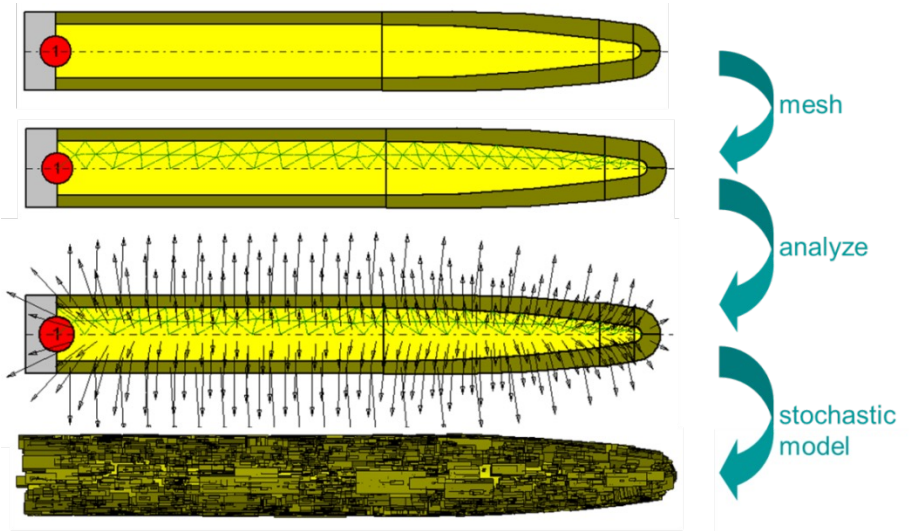
natural



multi-layer combinations

FI-BLAST Overview

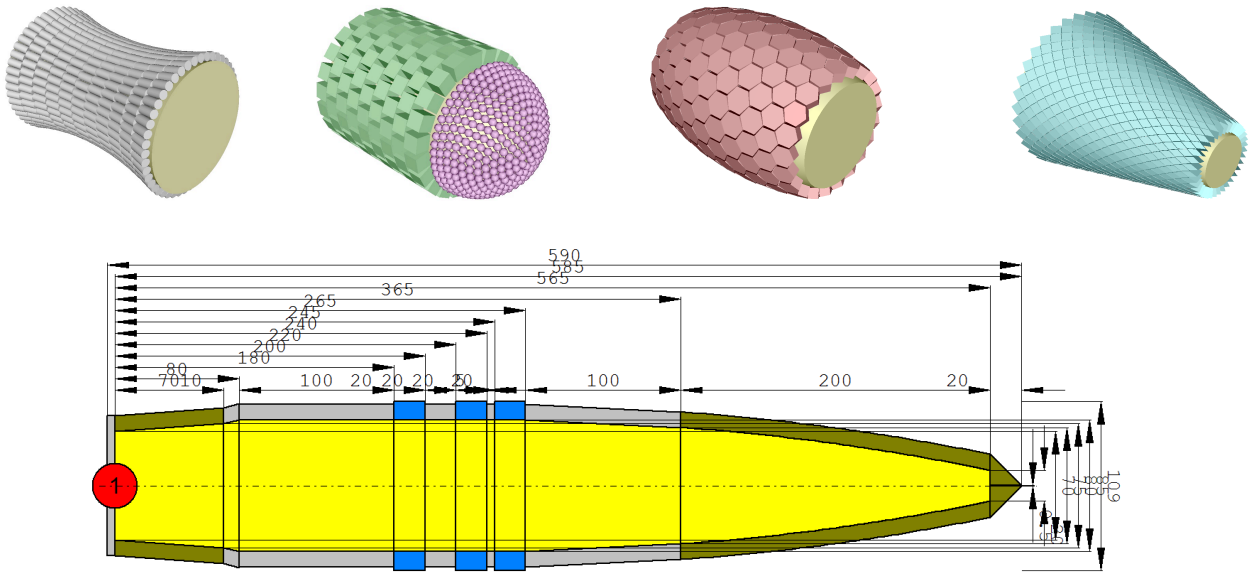
- Unique 3D Gurney-Method
    - for the calculation of fragment velocities
    - for the calculation of an initial blast field
- Models of multiple and/or asymmetric initiation
- XWAM (Extended Walker-Anderson Model) for (semi-)analytical penetration calculation
- Mass and shape models of natural fragments



FI-BLAST Overview

Effector Modeling

- series of axis-symmetric sections with (multi-layer) casing
- user-expandable material library with HE, casing & structural materials
- single or multiple symmetric or asymmetric initiation
- end plate and end cap modeling



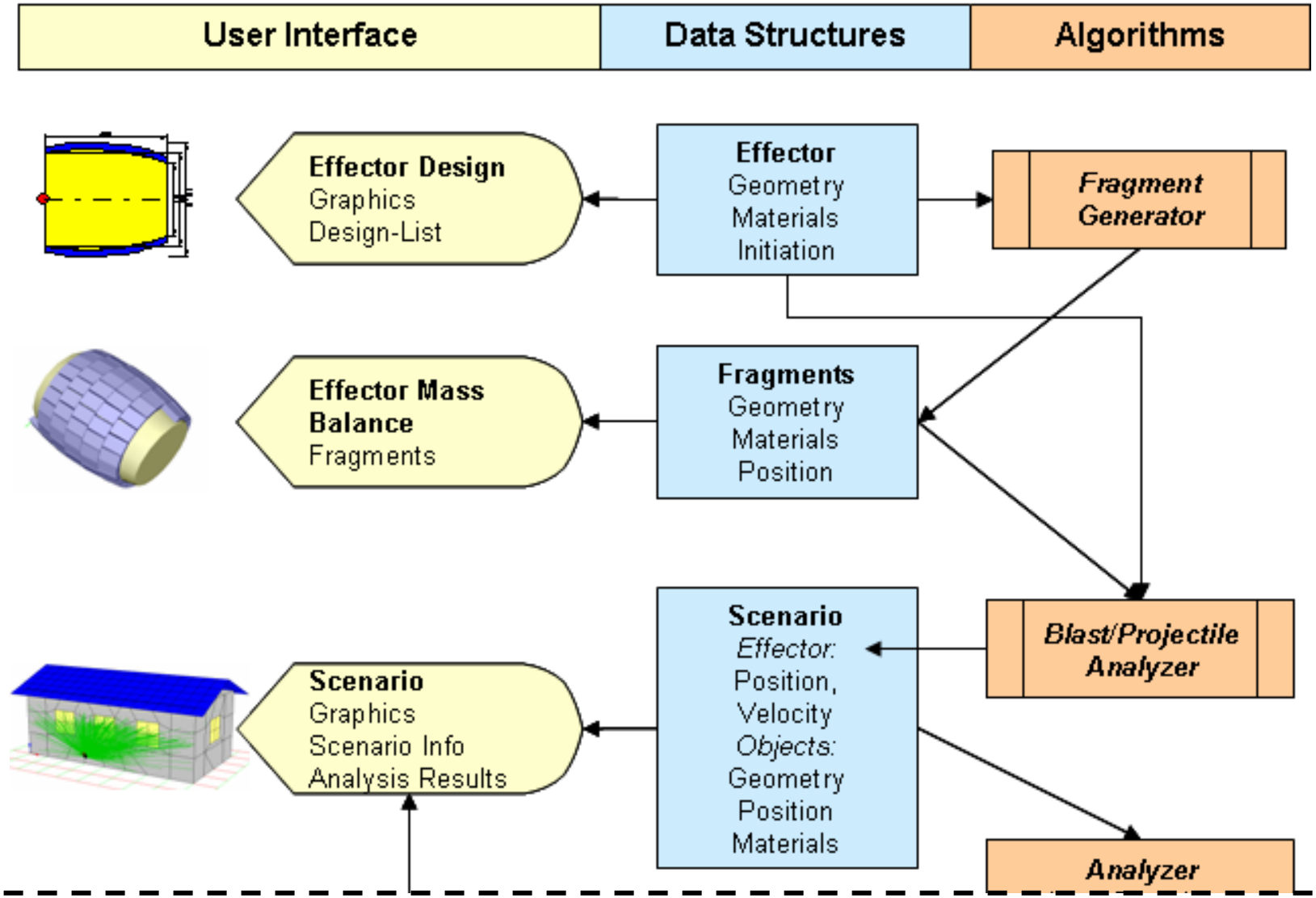
FI-BLAST Overview

Analysis and Post-Processing

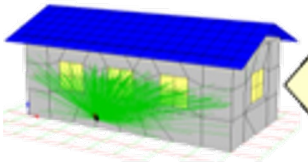
During the analysis of the warhead, a wealth of performance data is generated:

- Fragment characteristics (mass, velocity, ejection angle)
- Fragment trajectory including drag
- Penetration / perforation performance
- Initial blast field
- Blast loads on structures
- …

Principles of Modelling



Principles of Modelling



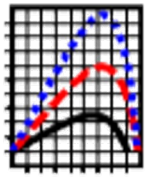
Scenario
Graphics
Scenario Info
Analysis Results

Scenario
Effector:
Position,
Velocity
Objects:
Geometry
Position
Materials

Blast/Projectile Analyzer

Analyzer
Load Functions
Fragments Effects
Projectile's Effects
Safety Ranges

Analysis Results
Loads on Surfaces
Fragments Effects
Vulnerability
Protection Level



Post Data
Graphics
Plots, Lists

Post-Data
Time History
Isocontour

Export-Data
P(t) Files

Principles of Modelling

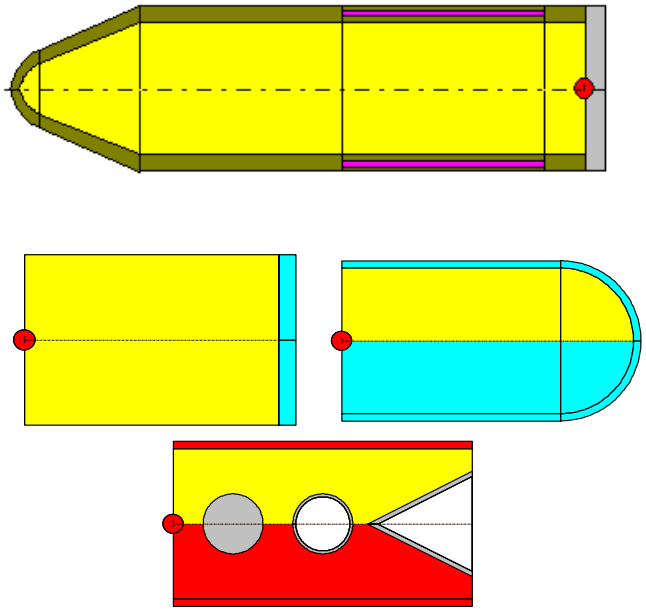
Each session, the user will perform the following steps:

1. Load or create an effector design
2. Create a scenario
    - Upload effector into the scenario
    - Create scene within the scenario.
        - Import FE-model(s) and/or adding witness boxes
3. Trigger the analysis for calculating
    a) Blast/Fragment loads on structure / vehicle (FE-model required)
    b) Fragments effects on the structure / vehicle,
    c) Projectile's effects on the structure / vehicle or
    d) Safety ranges
4. Postprocessing
5. *Export p(t) functions for LS-DYNA or SPEED*
6. *Use LS-DYNA or SPEED simulation for the structural analysis*

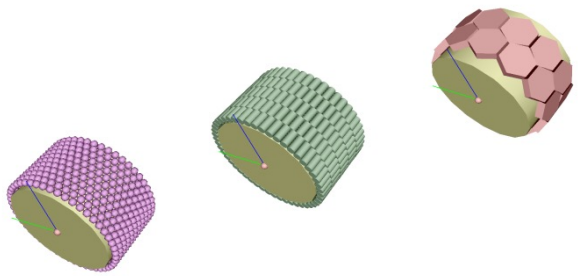
Principles of Modelling

Effector Designs

- **Model a variety of effectors**
  - Bare charges
  - Cased charges: controlled fragment, preformed fragments, natural fragmentation
  - Model various aspects of the effector
    - Endcaps
    - Bores
    - Individual fragments
  - Model various explosives



- **Model a variety of projectiles**
  - Rod, rectangle, sphere
  - FSP

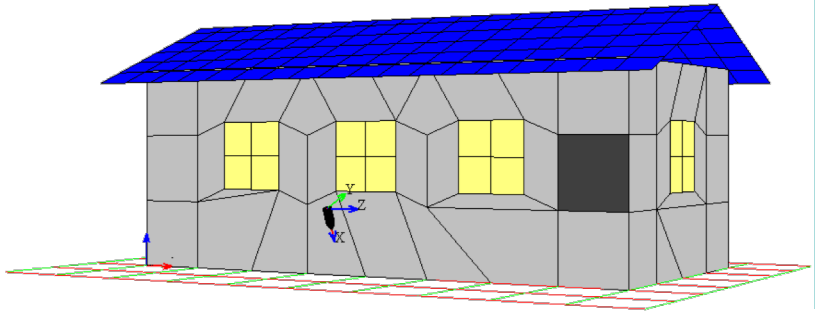


Principles of Modelling

Create a Scenario

- **Model various encounter situations including structures, buildings and vehicles**

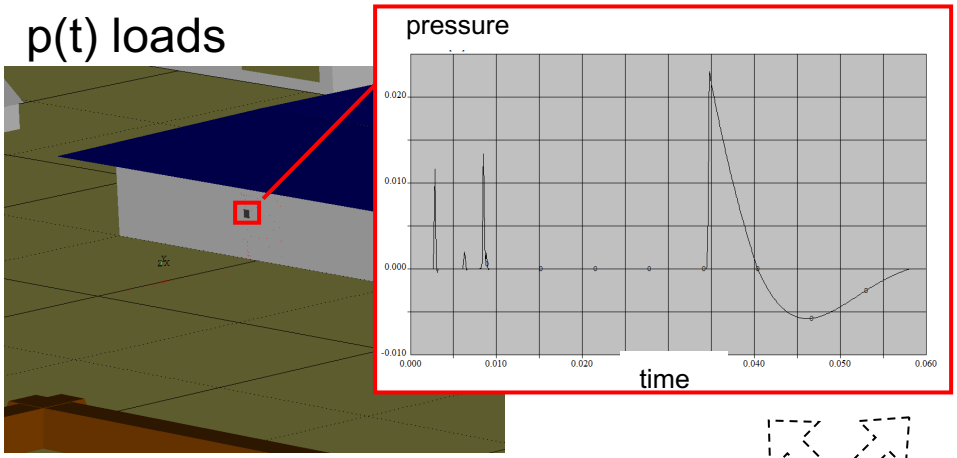
- **Create the scene**
  - Import FE-Models
    - LS-DYNA, SPEED
    - Other solvers on request
  - Use FI-BLAST Objects
    - Boxes
  - Load Effector
    - Position and kinematics



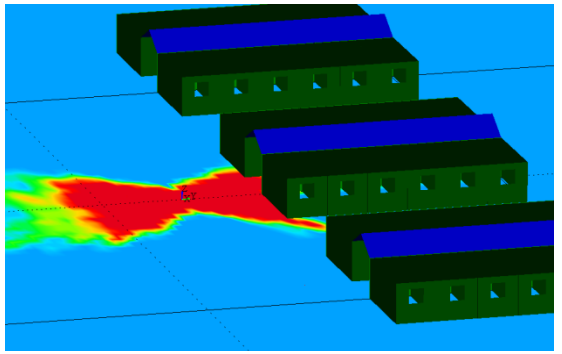
Principles of Modelling

Trigger an Analysis

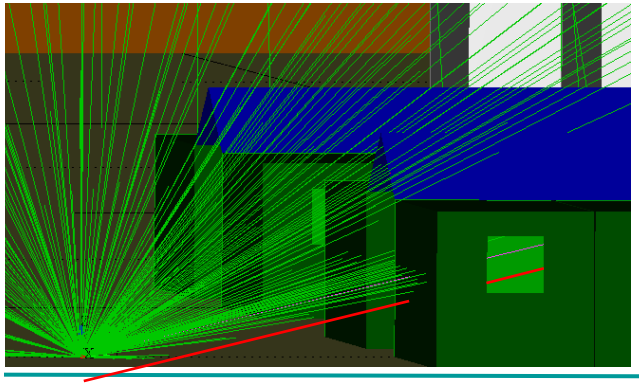
p(t) loads



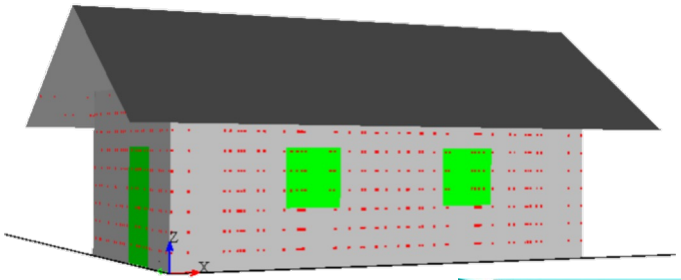
Analysis of Safety Areas



Analysis of fragment impact



Parametric Shot Analysis
(projectile effects)

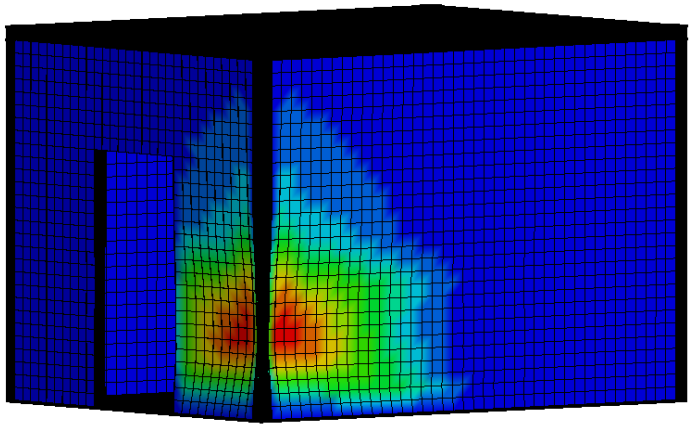


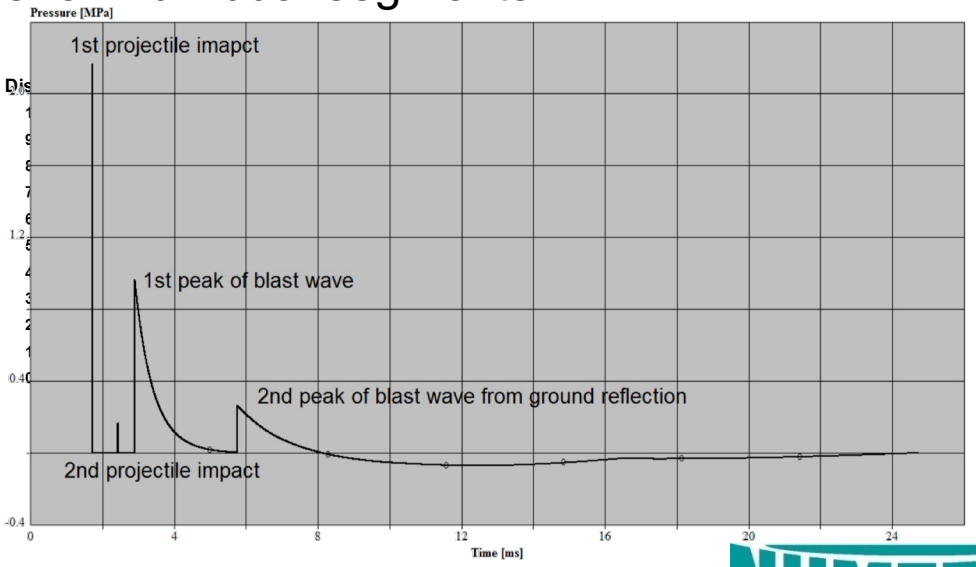
Principles of Modelling

1. Load Function Analysis

The objective of this code feature is to provide a fast way of creating load functions for a structural analysis.

- Calculate load functions from blast and fragments on each effected surface segment
- Export of the loads as pressure boundaries p(t) to FE analysis tools for structural assessment
- Visualize load functions for individual segments



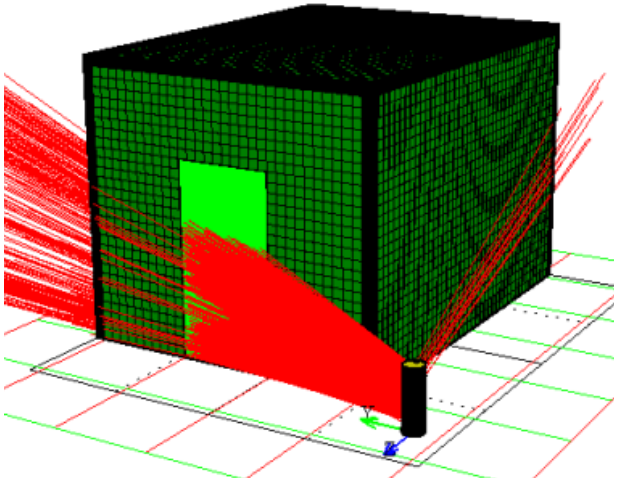


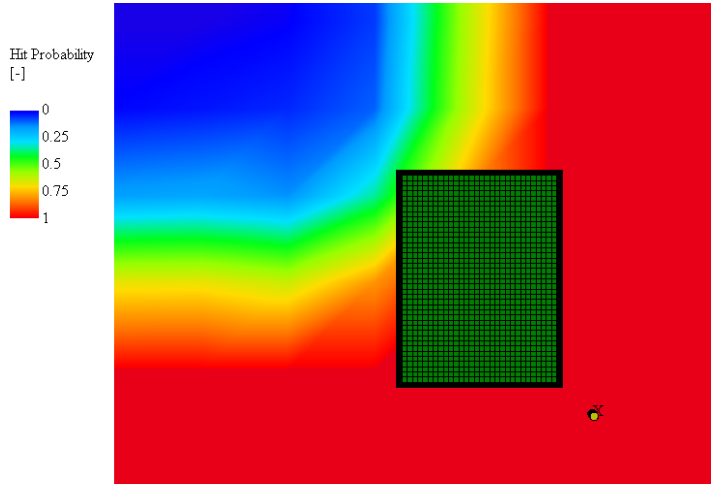
Principles of Modelling

2. Fragment Effects Analysis

This type of analysis enables the user to set up vulnerability or safety analyses based on an existing FE-model of a structure.

- Evaluate effects of a fragmenting effector within a scenario
- Visualize fragment trajectories
- Calculate and visualize fragment impacts, penetrations and perforations
- Determine vulnerability of a structure / vehicle



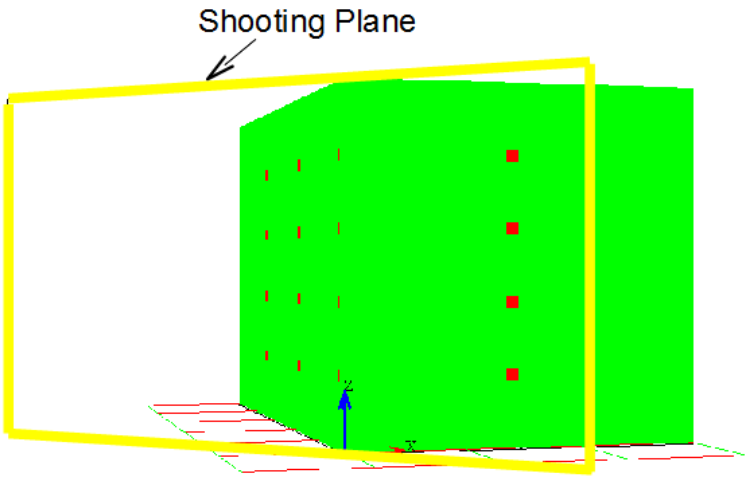


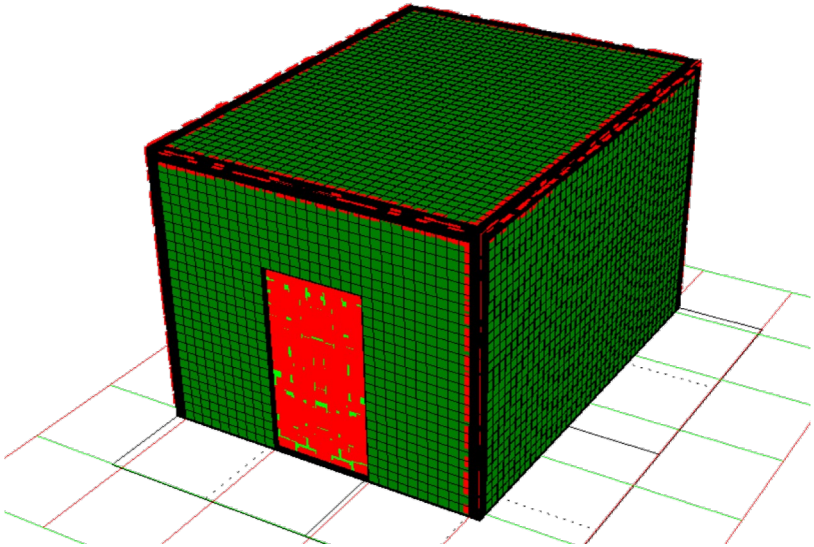
Principles of Modelling

3. Projectile Effect Analysis

The objective here is to analyze a specified projectile, e.g. a bullet or a standardized fragment, and to determine its effects on a structure.

- Evaluate Safety / Vulnerability of a vehicle or building given a specific projectile
- Vary impact locations and impact trajectory
- Easily identify vulnerable areas of a vehicle / structure



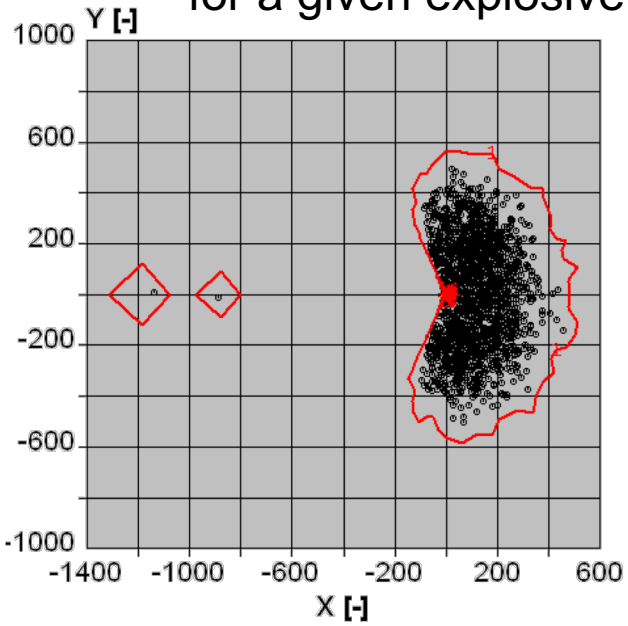


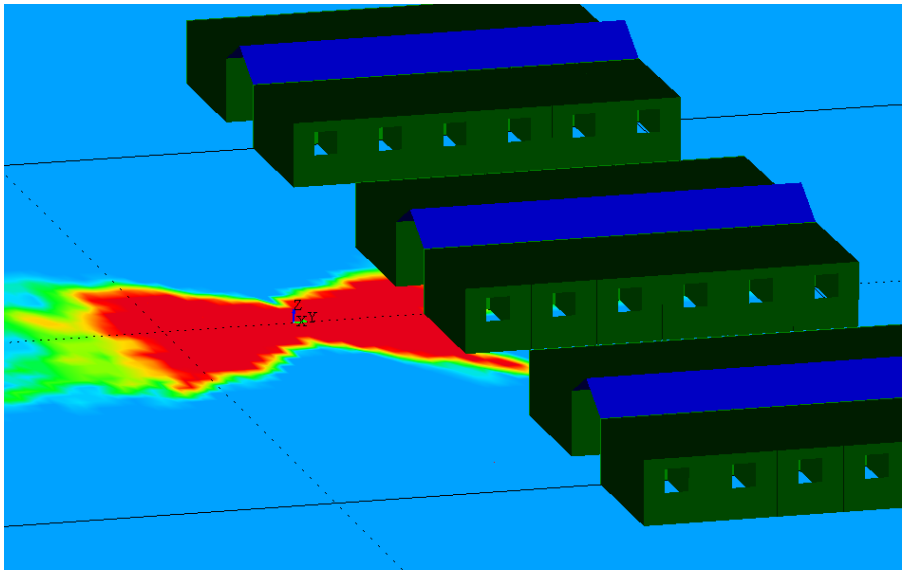
Principles of Modelling

4. Analysis of Safety Areas

Given an explosive device, this analysis option determines safety ranges with respect to blast and/or fragments:

- Define safety criterion, e.g. blast peak overpressure or fragment energy
- Calculate and visualize required safety ranges for a given explosive device





Applications

Example 1: Blast load of a 5 kg TNT bare charge

Example 2: Hand grenade HG85

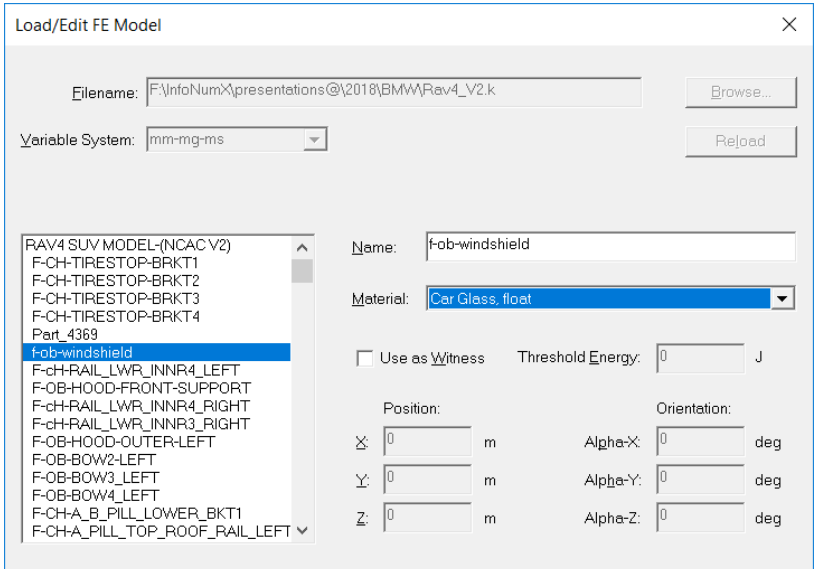
Example 3: Projectile's Effects

1. Blast load of a 5 kg TNT bare charge

Target Model

Upload FE-Model (k-file)

- Choose file
- Select unit system
- Assign material from FI-BLAST library

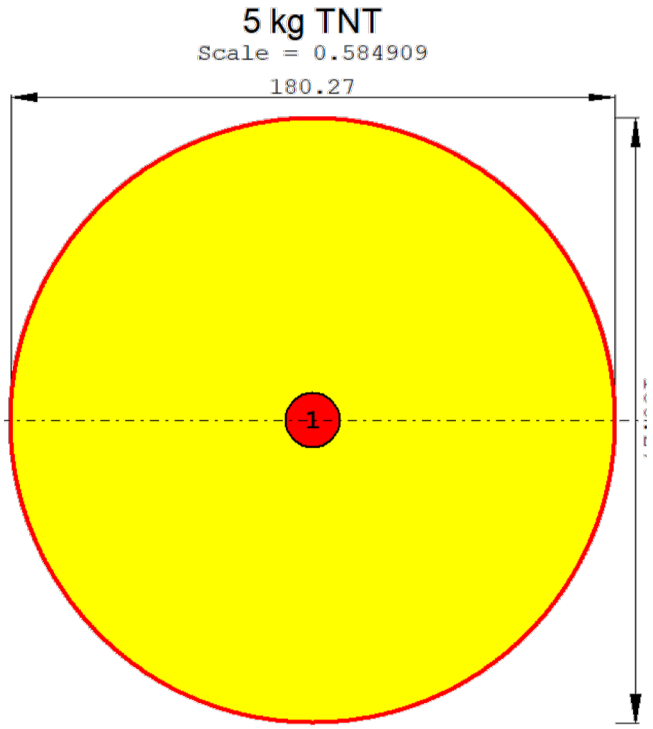


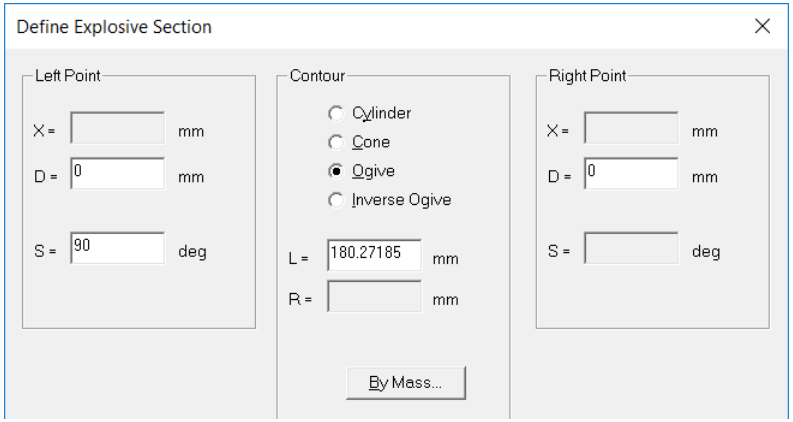
1. Blast load of a 5 kg TNT bare charge

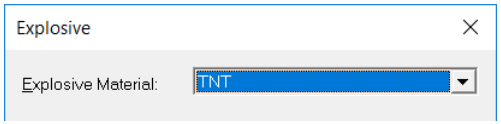
Effector Model

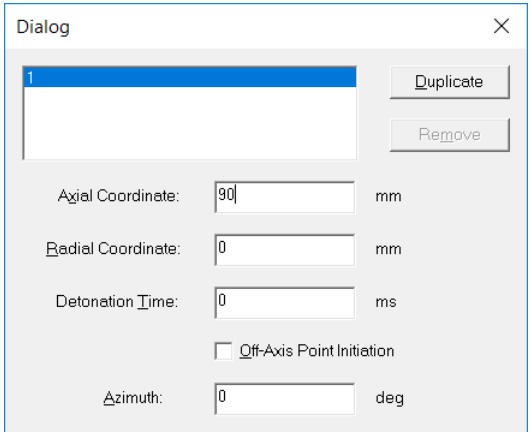
Design 5 kg TNT sphere

- Define explosive section by mass
- Choose explosive
- Set explosive initiation point







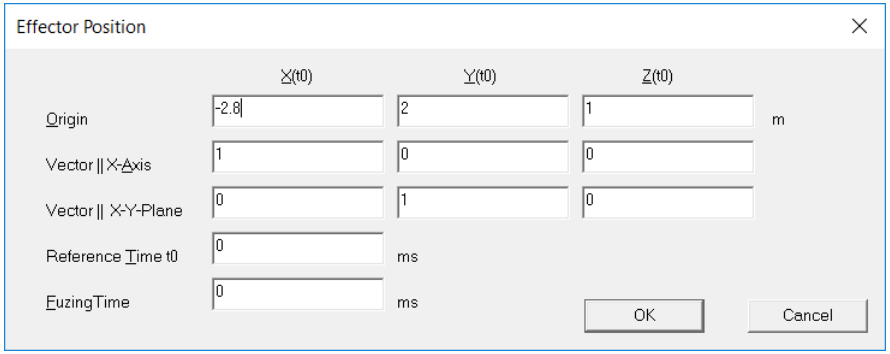


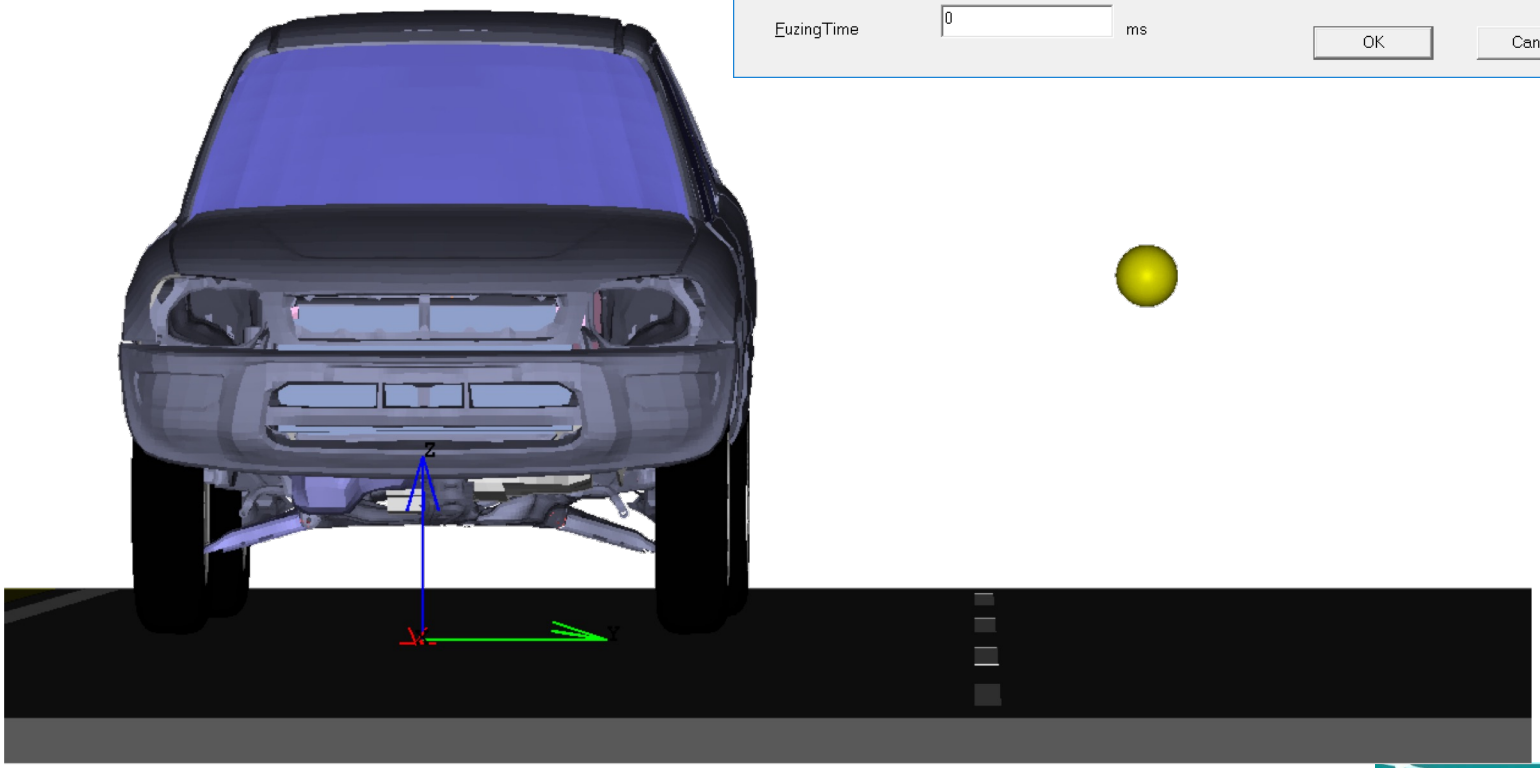
1. Blast load of a 5 kg TNT bare charge

Encounter Definition

Set Scenario

- Upload effector into scenario
- Set coordinates of effector



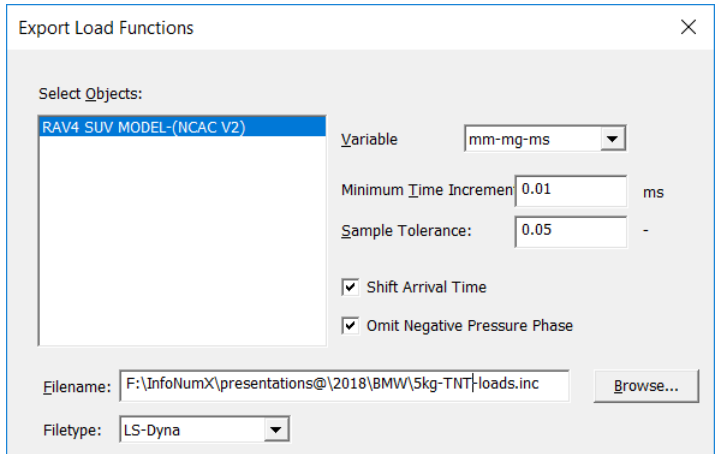


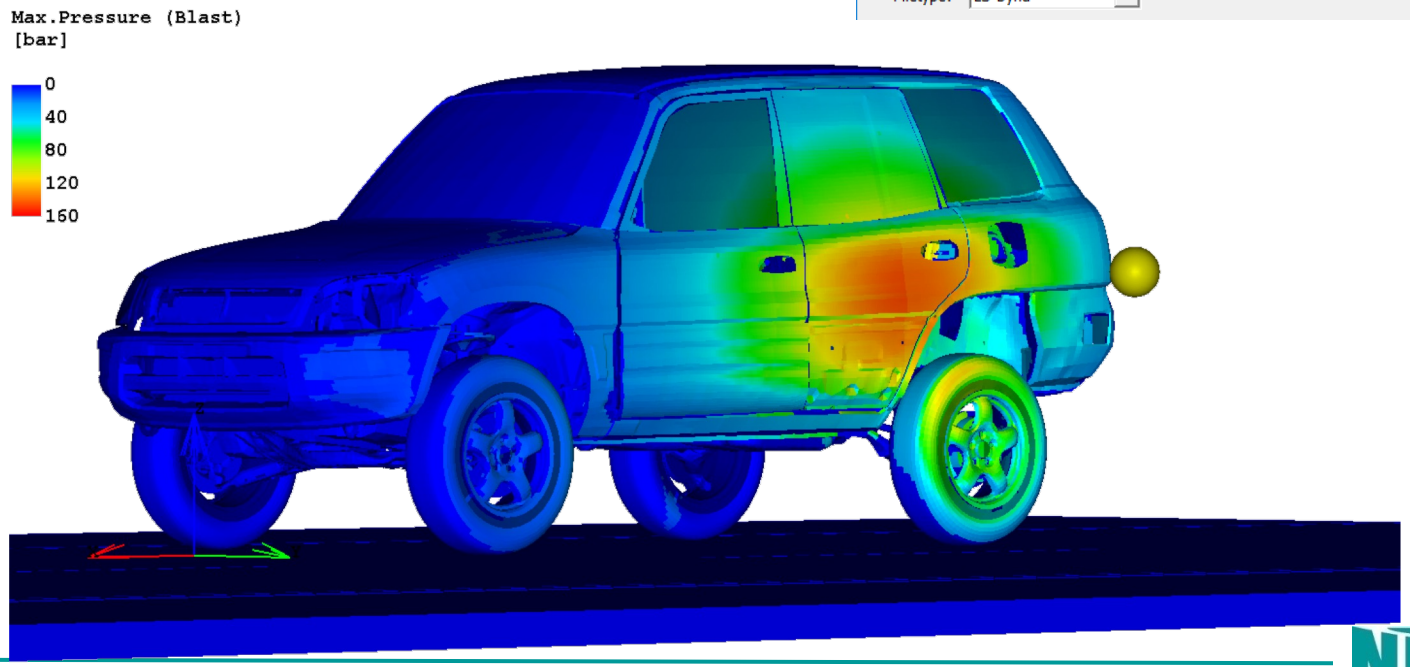
1. Blast load of a 5 kg TNT bare charge

Load Function Analysis

Export Loads

- Select unit system
- Define curve parameters
- Filename and filetype
- Show pressure plot





Applications

Example 1: Blast load of a 5 kg TNT bare charge

Example 2: Hand grenade HG85

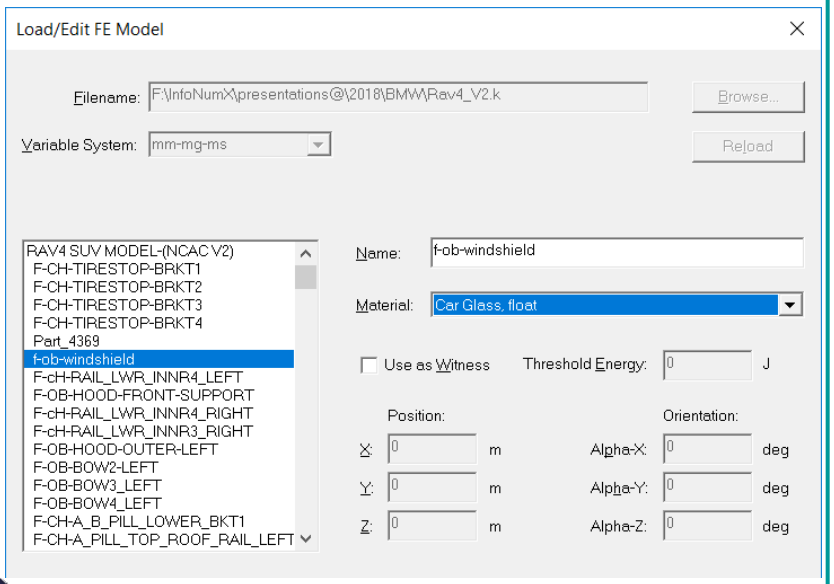
Example 3: Projectile's Effects

2. Hand grenade HG85

Target Model

Upload FE-Model (k-file)

- Choose file
- Select unit system
- Assign material from FI-BLAST library

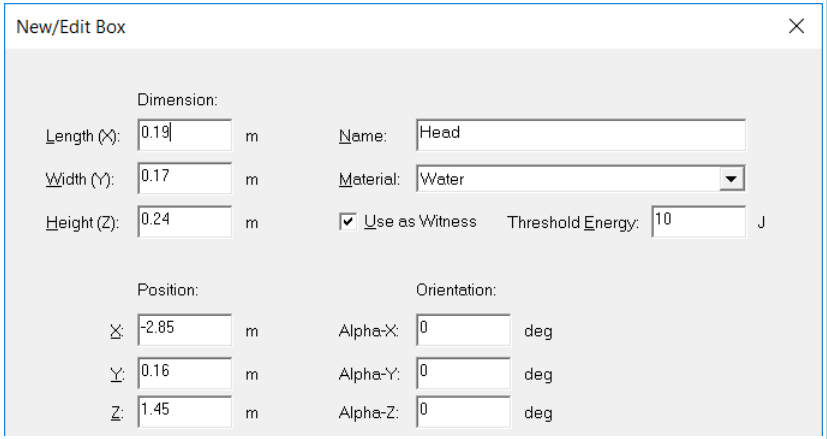


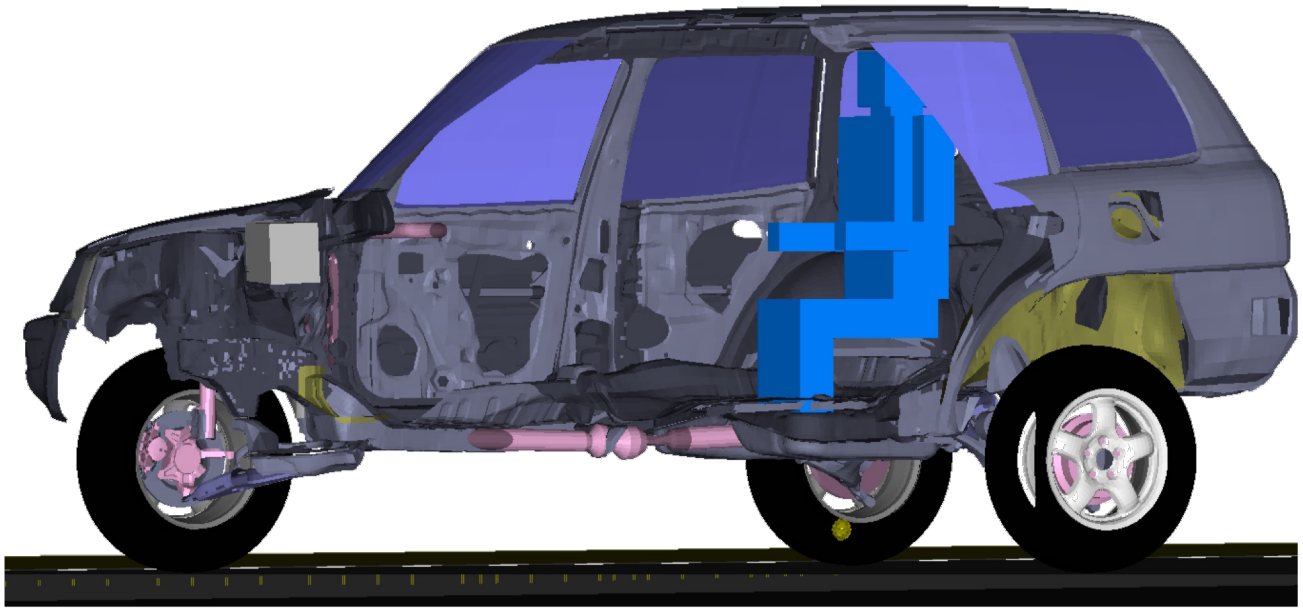
2. Hand grenade HG85

Target Model

Define passenger as witness

- Define dimensions of box
- Assign material from library
- Activate ‘Use as Witness’
- Define Threshold Energy
- Define position / orientation



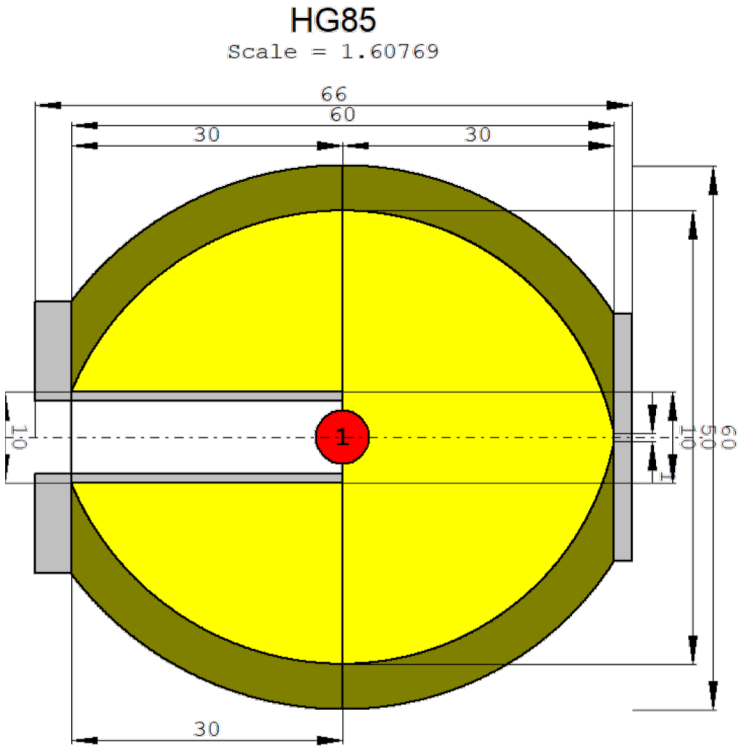


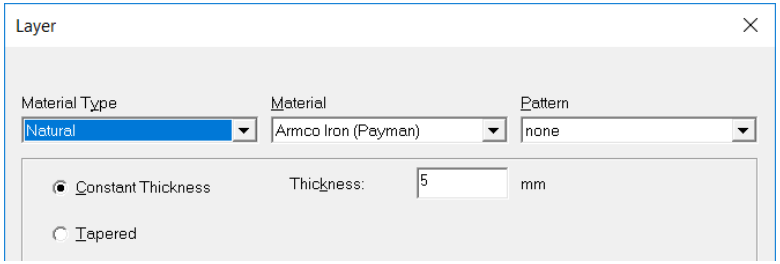
2. Hand grenade HG85

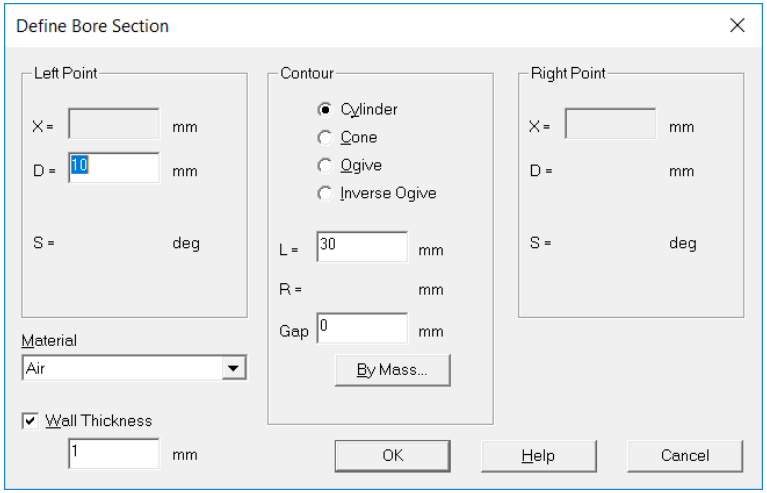
Effector Model

Design HG85 hand grenade

- Define explosive + layer geometry
- Define bore section
- Define left + right confinement





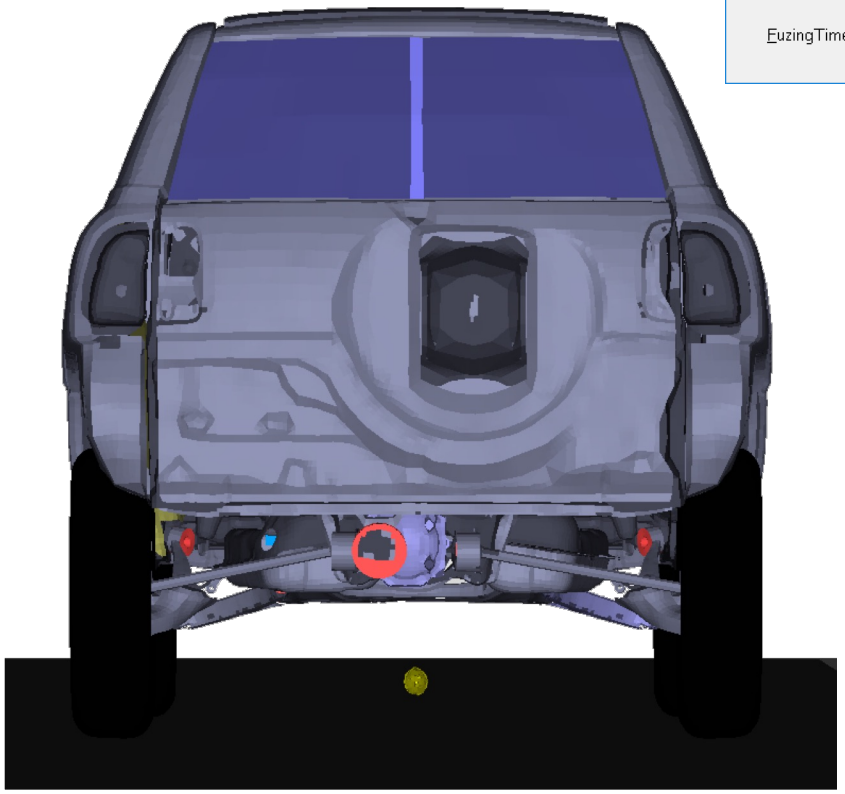


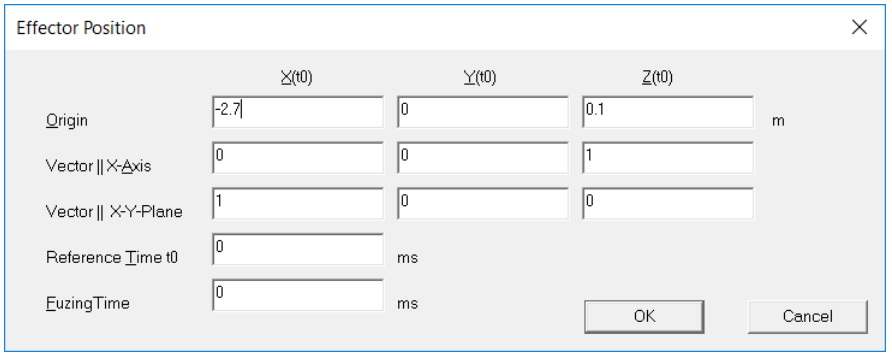
2. Hand grenade HG85

Encounter Definition

Set Scenario

- Upload effector into scenario
- Set coordinates of effector



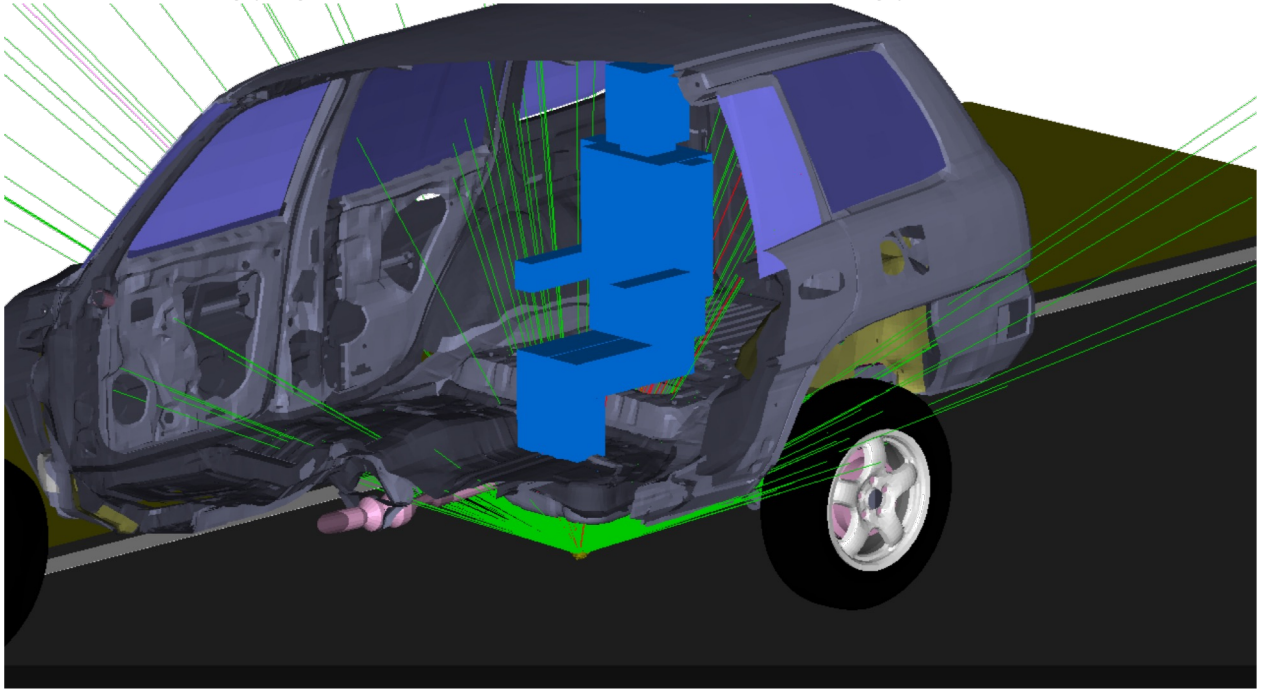


2. Hand grenade HG85

Fragments Effects Analysis (1)

Set Single Shot Analysis

- Evaluates the fragment impacts
- Green shotline: fragment trajectory
- Red shotline: fragment trajectory which hits the passenger with energy greater than threshold energy

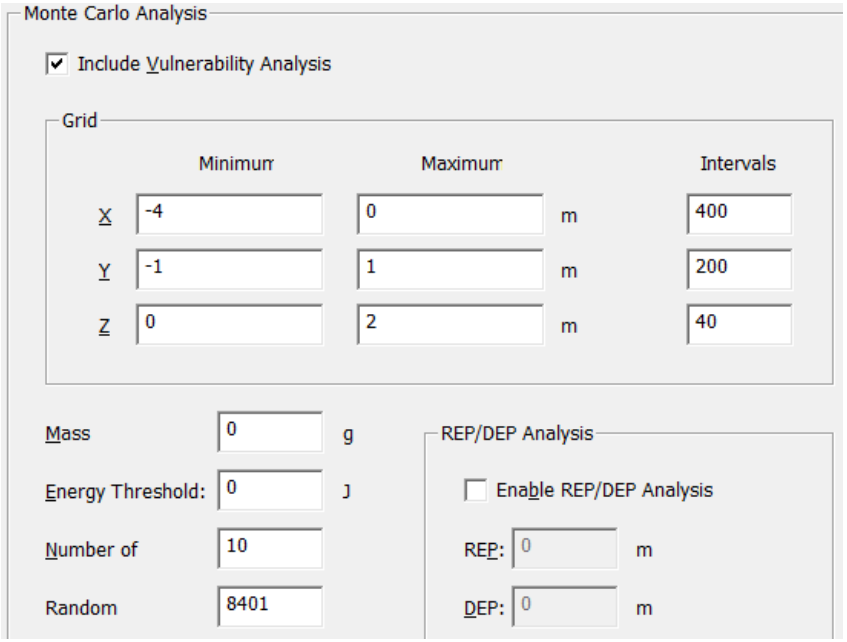


2. Hand grenade HG85

Fragments Effects Analysis (2)

Monte-Carlo Shot Analysis

- Use this analysis if effector has natural casing and orientation should be taken into account
- Define the evaluation grid
- Define threshold values
- Define number of trials

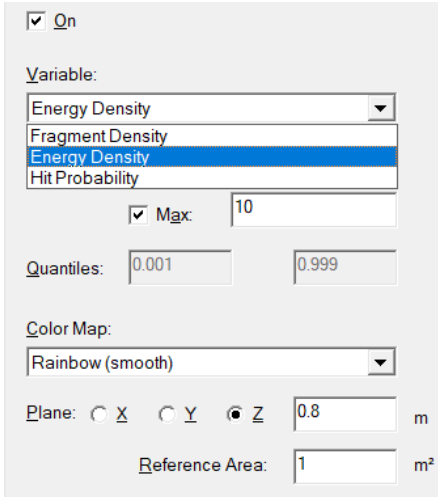


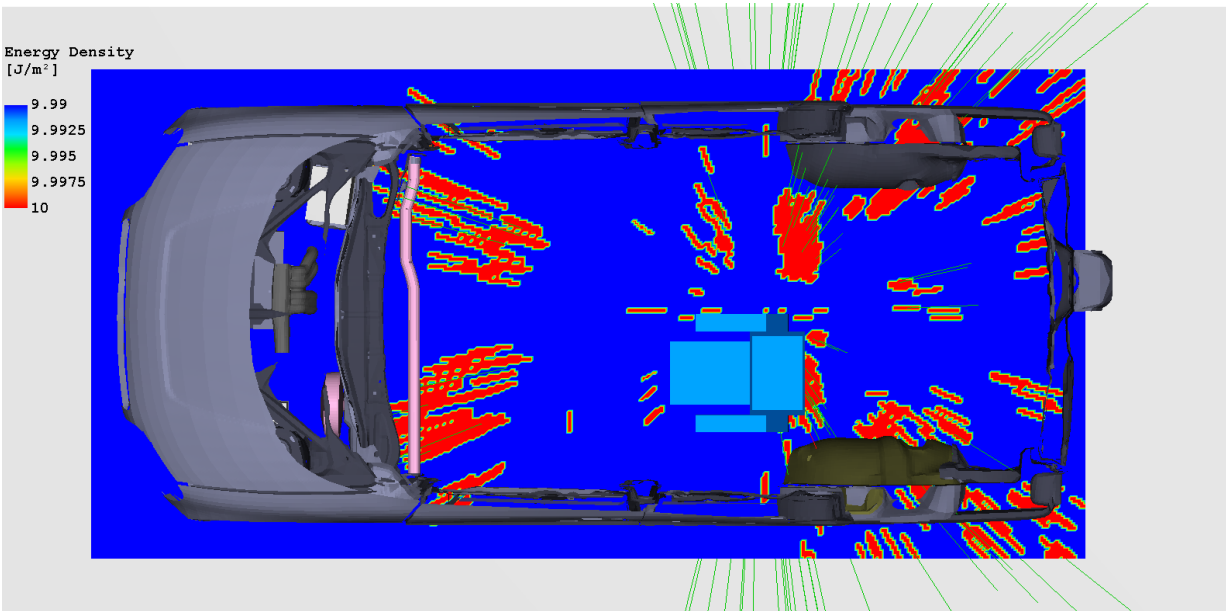
2. Hand grenade HG85

Fragments Effects Analysis (3)

Monte-Carlo Shot Analysis

- Choose variable to be evaluated
- Choose plane (X/Y/Z) and level
- Define reference area
- Result below: red area = fragments which cross the evaluation plane with energy density > 10 J/m²





Applications

Example 1: Blast load of a 5 kg TNT bare charge

Example 2: Hand grenade HG85

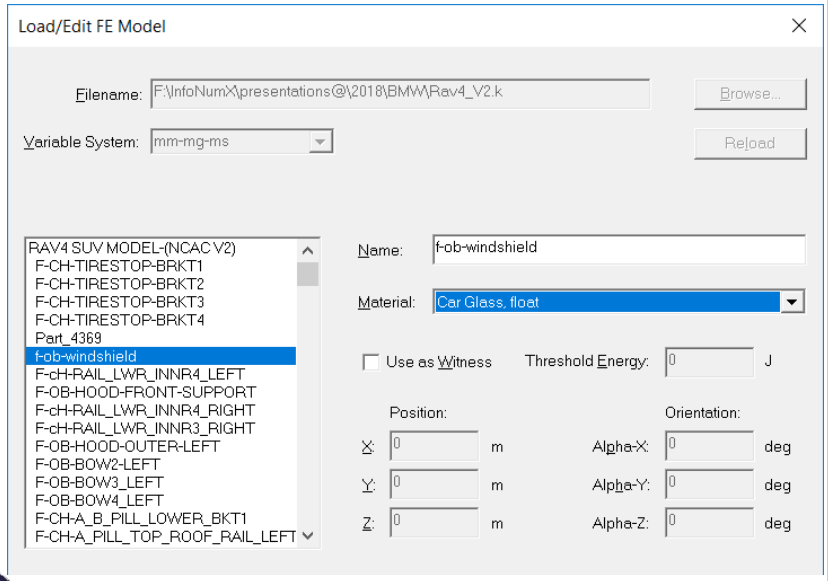
Example 3: Projectile's Effects

3. Projectile's Effects

Target Model

Upload FE-Model (k-file)

- Choose file
- Select unit system
- Assign material from FI-BLAST library

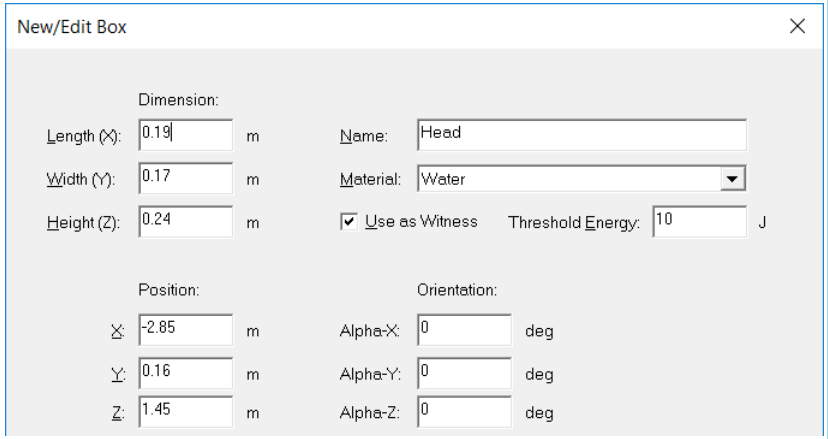


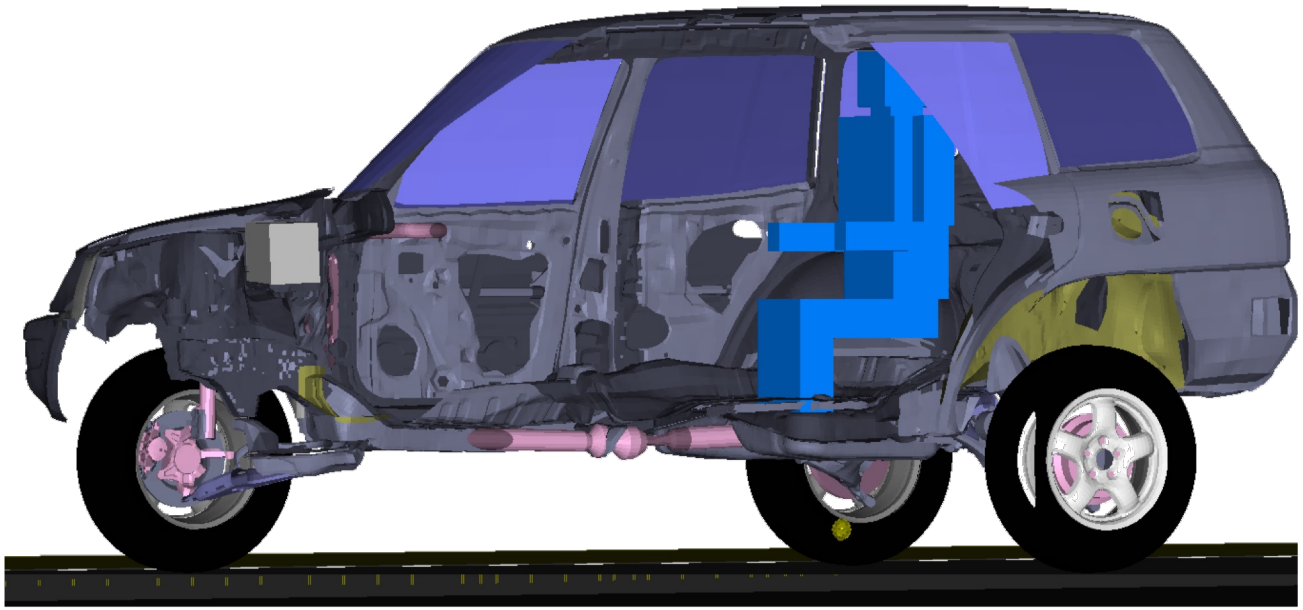
3. Projectile's Effects

Target Model

Define passenger as witness

- Define dimensions of box
- Assign material from library
- Activate 'Use as Witness'
- Define Threshold Energy
- Define position / orientation



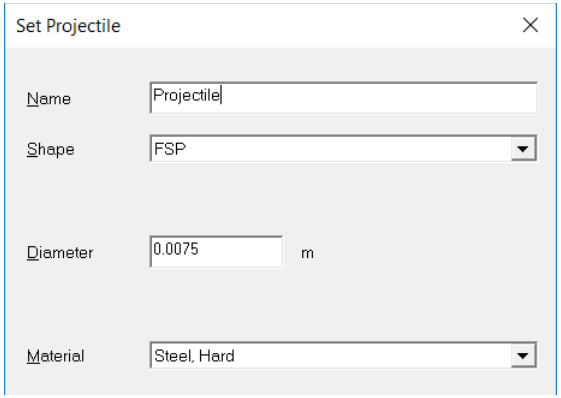


3. Projectile's Effects

Projectile Model and Analysis Options

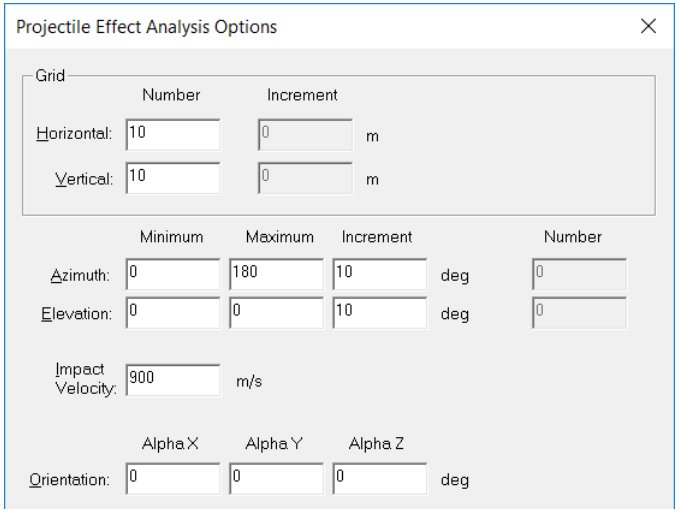
Design FSP[1)]

- Choose shape of the projectile
- Define diameter
- Assign material from FI-BAST library



Define parameters for analysis

- Define horizontal and vertical shot grid
- Define range of azimuth and elevation angles
- Set impact velocity of the projectile



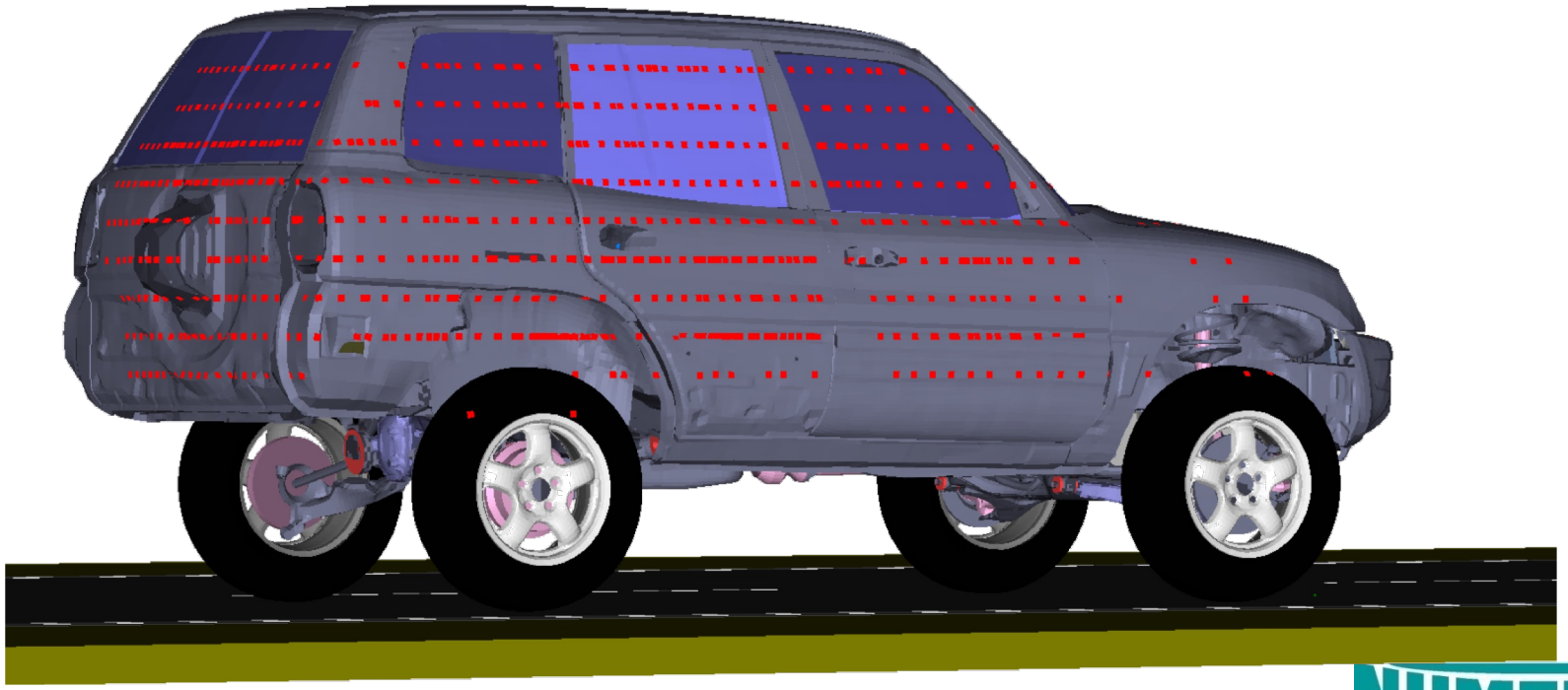
[1)] ***FSP = Fragment Simulating Projectile***

3. Projectile's Effects

Projectile Effects Analysis

Result

- Red dots show the impact location where the projectile is able to perforate the car **and** hit the passenger inside with a projectile energy greater than the energy threshold of the passenger



Summary

- FI-BLAST permits to generate reliable results while requiring only little calculation time → standard for structural analysis, fragments effects analysis, V/L analyses and estimation of safety ranges
- FI-BLAST is characterized by its outstanding performance and is unique on the commercial market
- FI-BLAST is fully validated by open literature experimental data
- NUMERICS engineering tools are used by industry and governmental agencies in more than 20 countries world-wide

→ FI-BLAST is offered either as stand-alone software or as a part of customized tailored solutions

Contact: info@numerics.de