



NUMERICS

SPLIT-X

Fragmentation Warhead Expert System

Product Information



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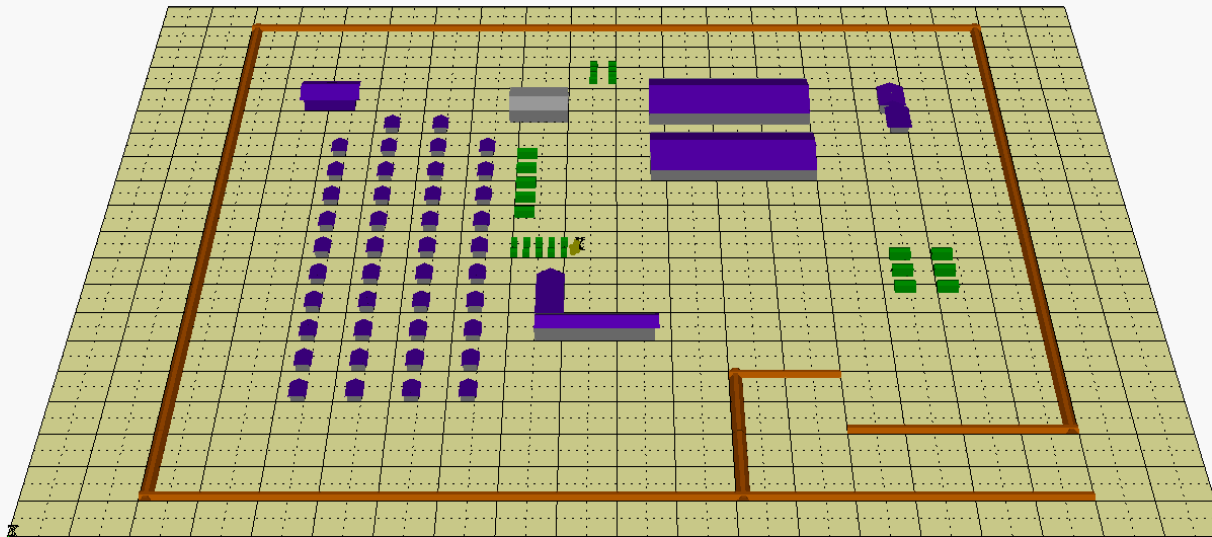
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SPLIT-X Overview

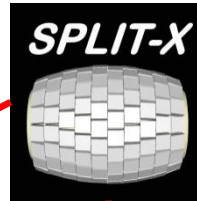
SPLIT-X is an expert system for the design and assessment of fragmenting warheads.

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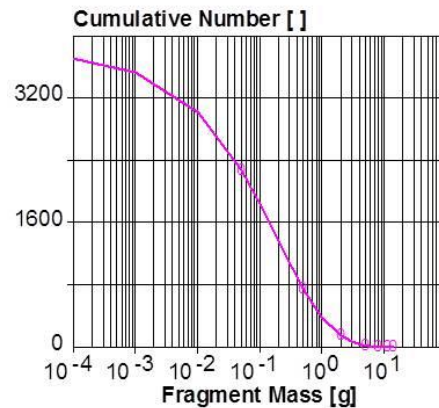
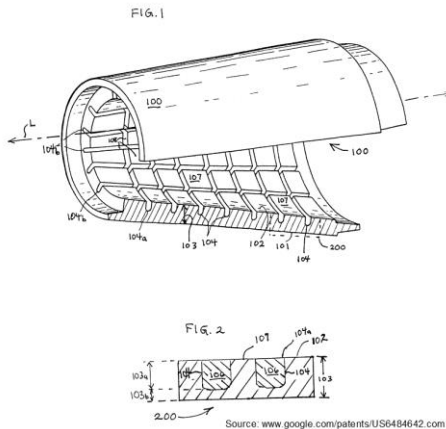
SPLIT-X Overview



Reliable warhead design and optimization

Fragment data as input for V/L analyses

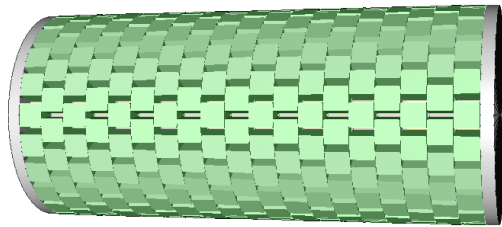
Design of protective structural elements



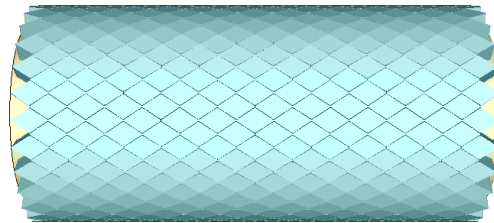


SPLIT-X Overview

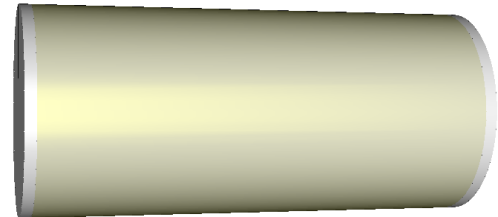
SPLIT-X covers all typical casing structures



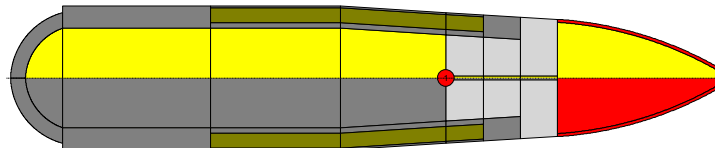
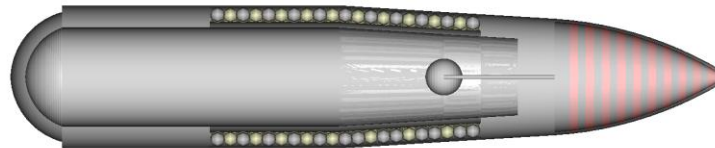
pre-formed



notched



natural

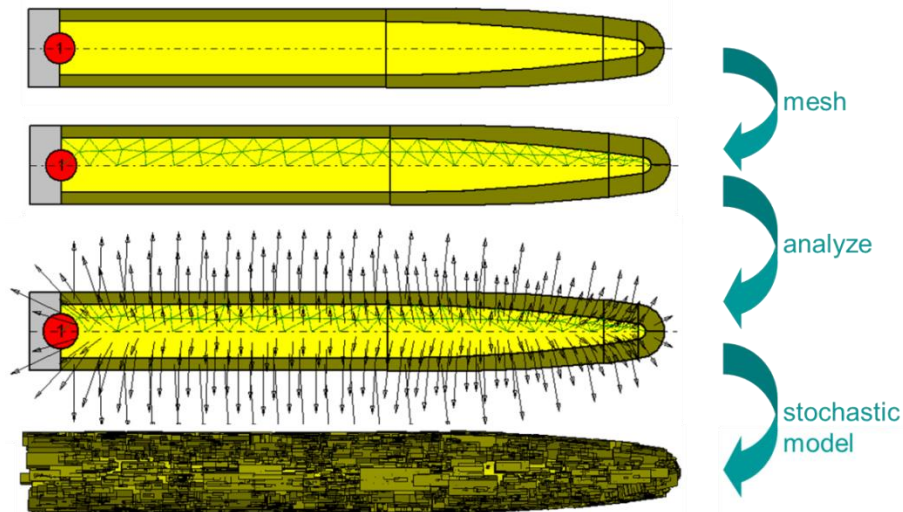


multi-layer combinations



SPLIT-X Overview

- Unique 3D Gurney-Method for the calculation of fragment velocities
- Models of multiple and/or asymmetric initiation
- XWAM (Extended Walker-Anderson Model) for (semi-)analytical penetration calculation
- Mass and shape models of natural fragments
- Optimization based on boundary conditions and performance requirements

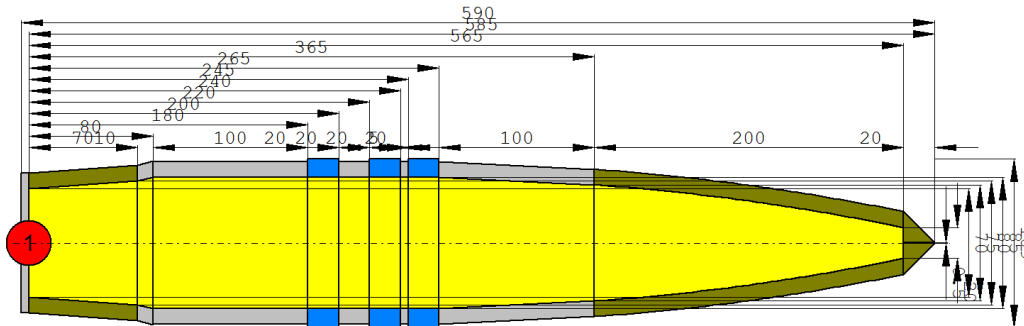
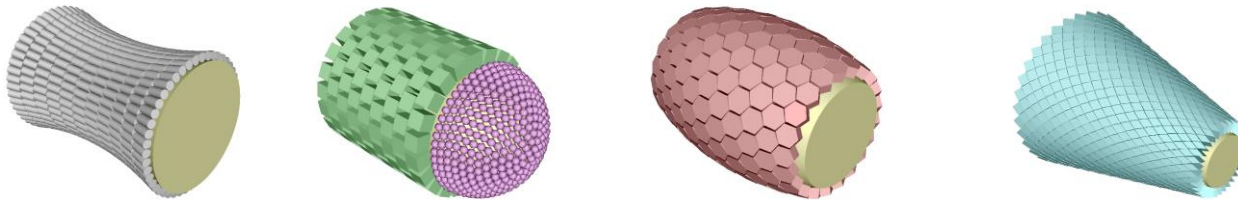




SPLIT-X Overview

Warhead 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



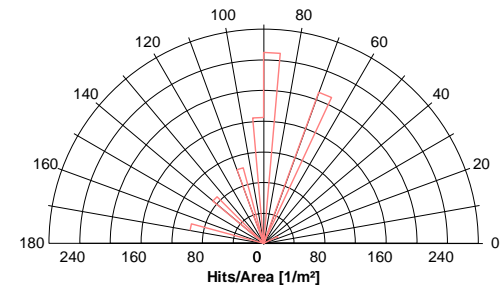
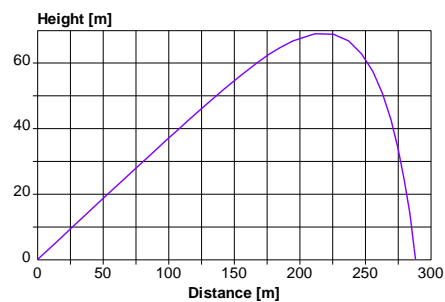
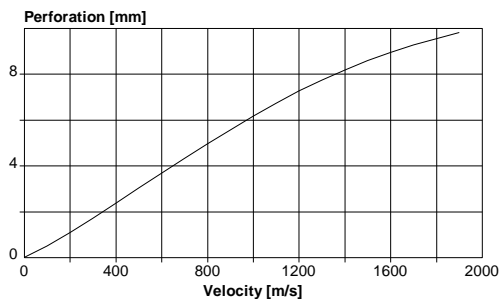


SPLIT-X Overview

Analysis and Post-Processing

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

- ejection angle, velocity, energy and perforation performance profiles
- angular fragment distribution and fragment trajectories
- perforation performance, velocity and energy vs. distance plots
- fragment mass distributions (natural fragmentation)
- fragment data in form of Z-data and explicit fragment data
- ...

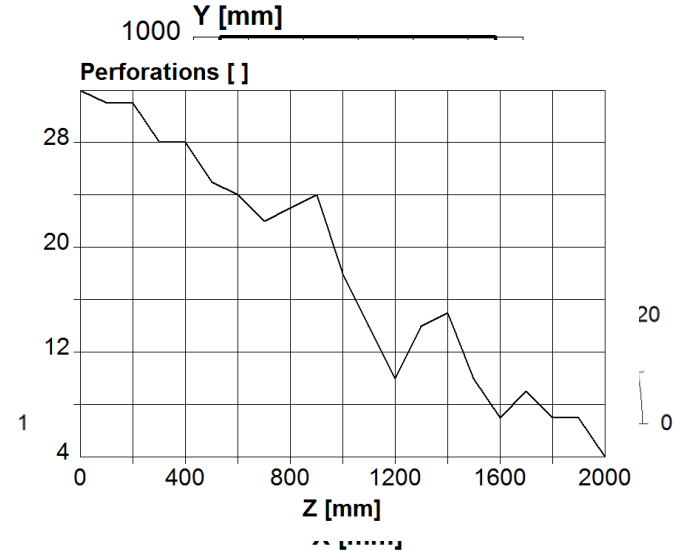




SPLIT-X Overview



Source: www.roketsan.com.tr



Arena Test

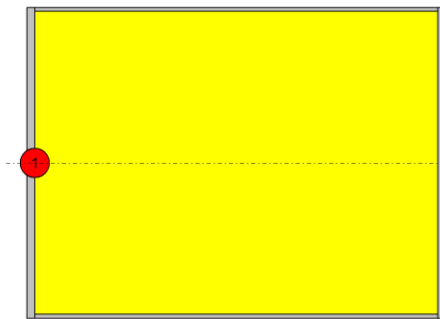
- semi-automatic arena test setup
- single shot fragment hit pattern
- stochastic (Monte Carlo) analysis function
- parametric analysis function



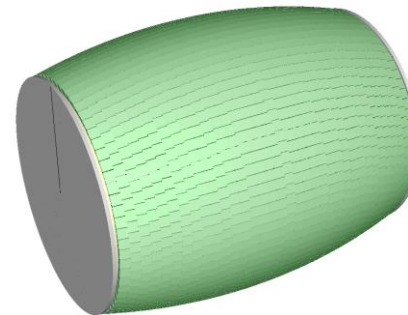
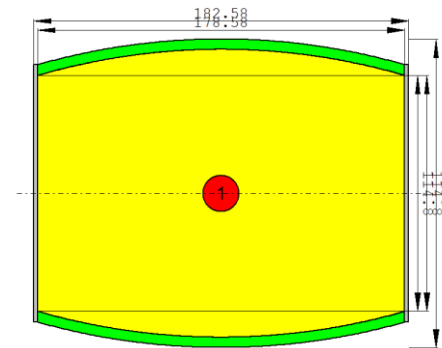
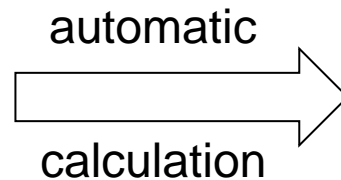
SPLIT-X Overview

Warhead Optimization

Based on structural constraints (e.g. mass, caliber, length, initiation) and performance requirements (fragment ejection angles, fragment number, target perforation capability), an optimized design is automatically determined.

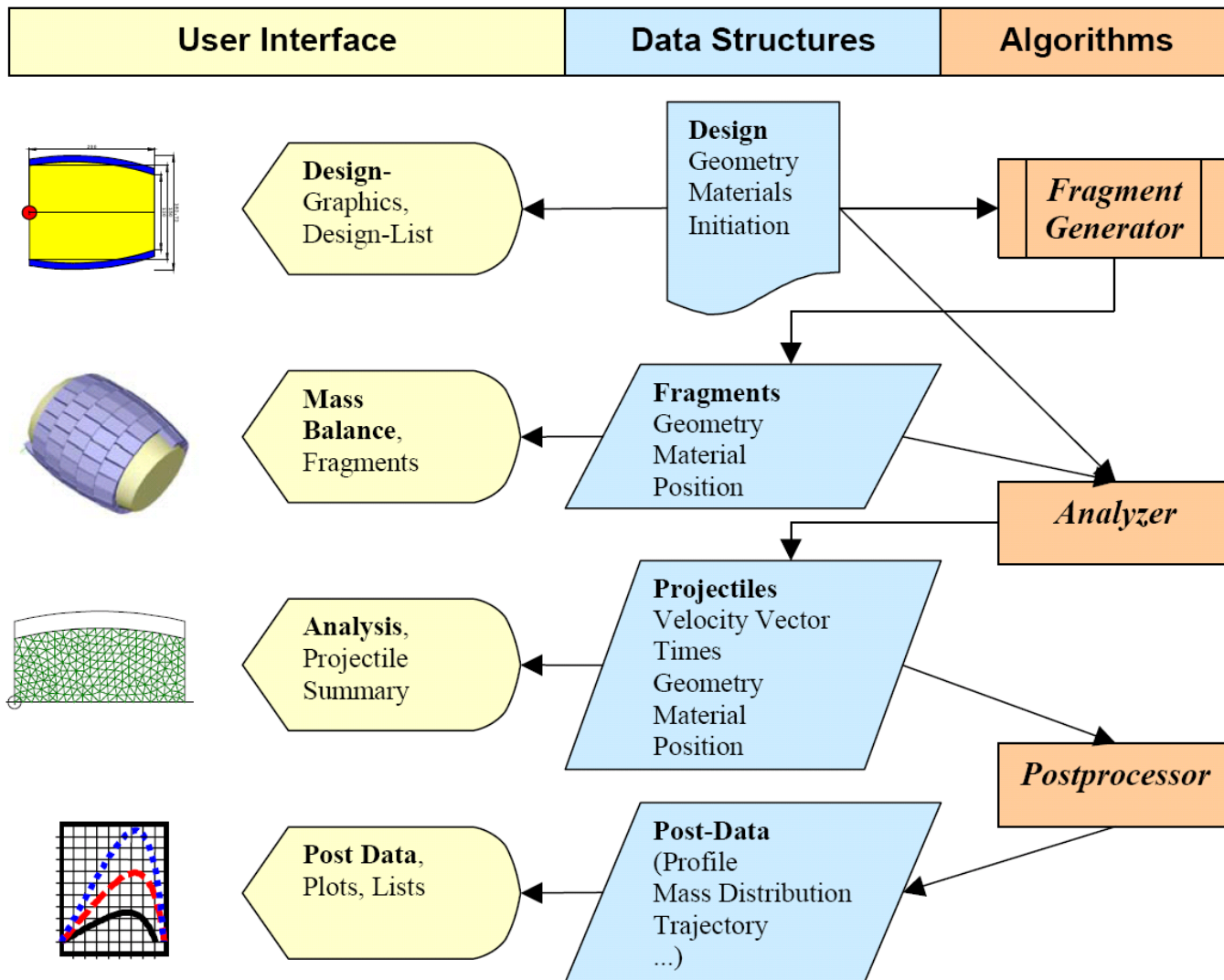


initial "design"





Principles of Modelling



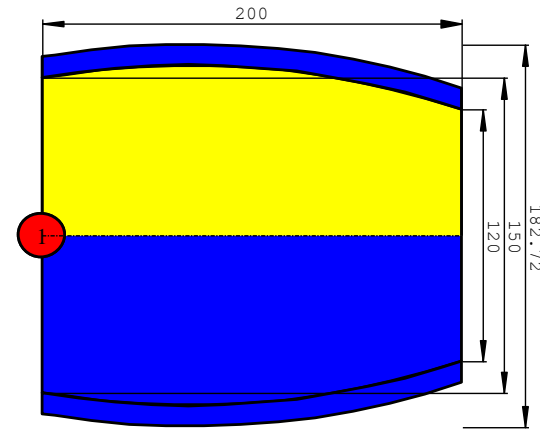


Principles of Modelling

Design

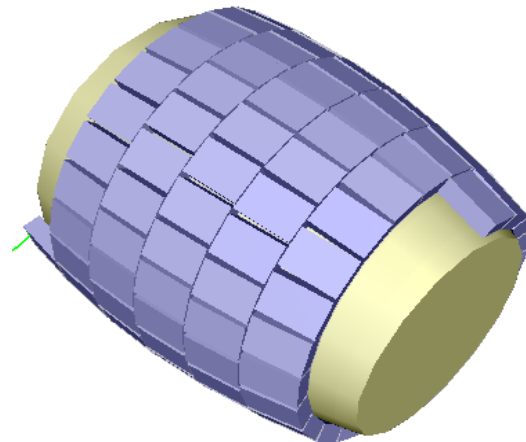
Design Parameters:

- Geometry
- Materials
- Initiation
- Fragments



Directly Coupled to the Design:

- Fragment positions
- Mass balance





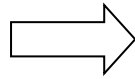
Principles of Modelling

Analysis

- calculates and stores projectile properties

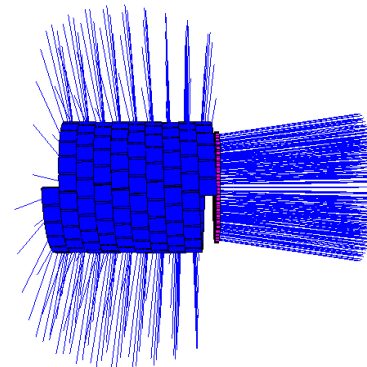
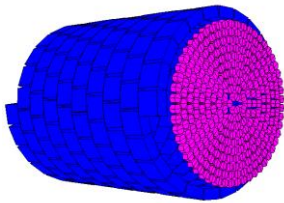
Design, Fragments:

- material
- size and shape
- position (pattern)



Analysis, Projectiles:

- material
- size (mass loss) and shape
- initial position
- begin/duration of acceleration
- velocity vector





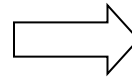
Principles of Modelling

Postprocessing

- collecting / displaying information

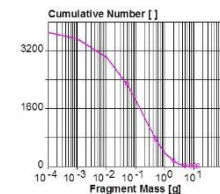
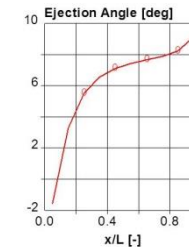
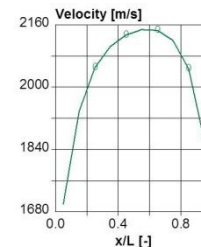
Analysis, Projectiles:

- material
- size (mass loss) and shape
- initial position
- begin/duration of acceleration
- velocity vector



Postprocessing Data Types

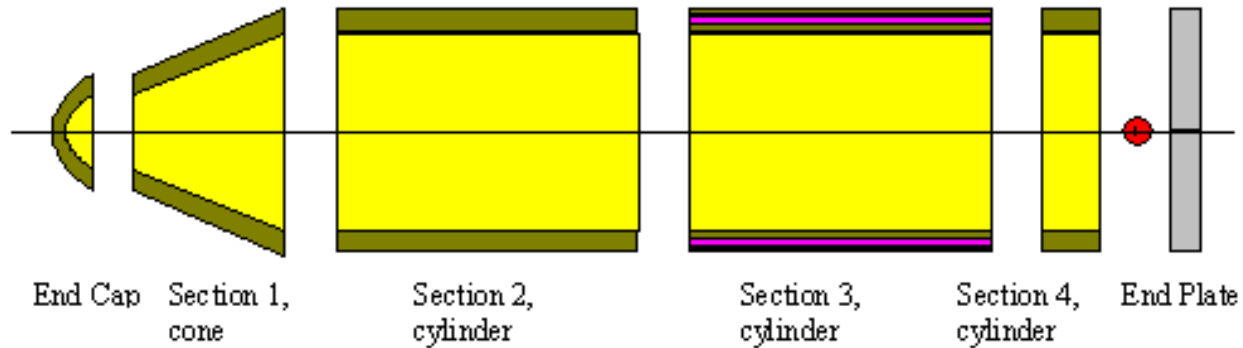
- profile plots
- range plots
- perforation pattern
- mass distribution
- angular distribution
- ...



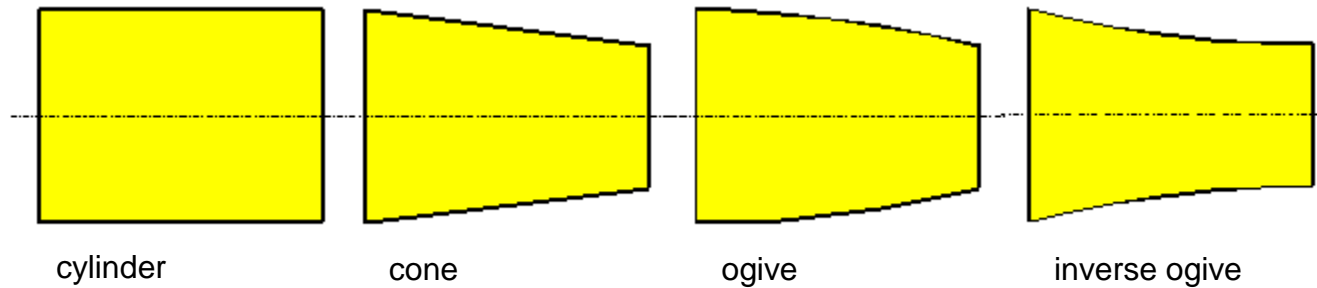


Principles of Modelling

Warhead designs are modelled as a series of rotationally symmetric sections



The following section geometries are possible

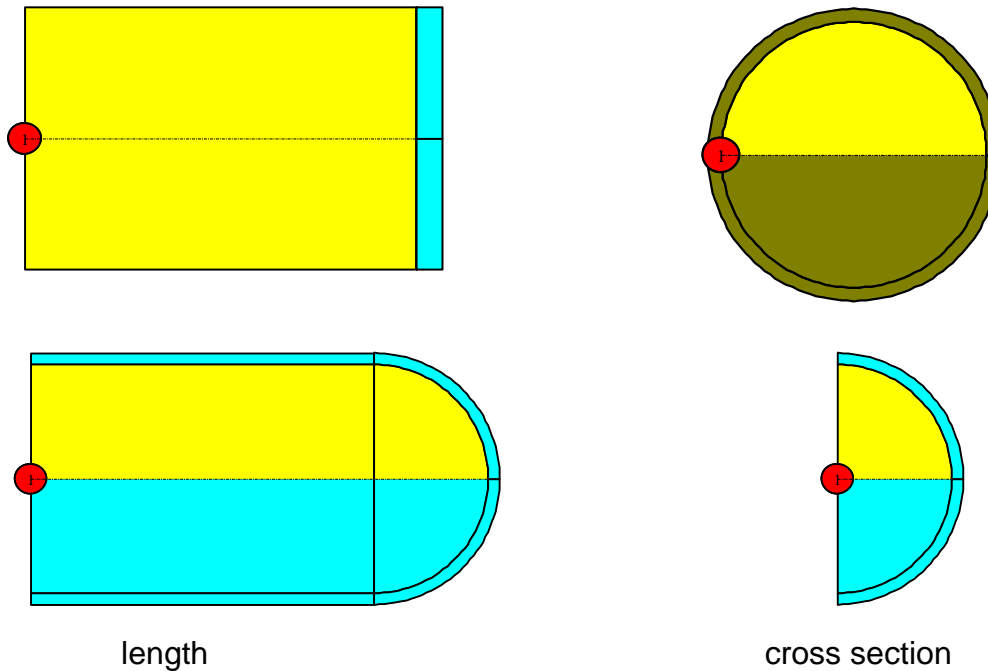




Principles of Modelling

End Cap Modeling

- Flat or curved end caps on both sides
- Uncovered charge, or fragment layers
- No restriction to number and kind of layers

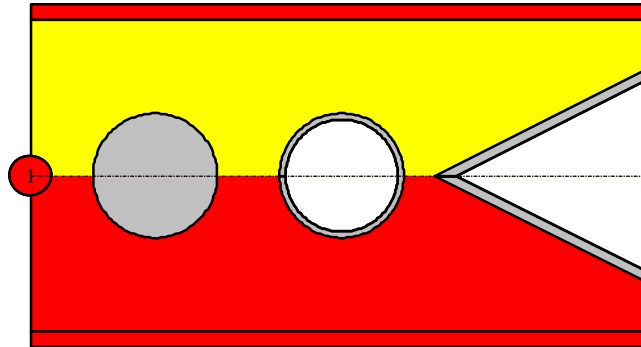




Principles of Modelling

Bores

- Arbitrary number of bore sections analogous to charge sections
- Shapes: cylindrical, conical, ogival ...
- Bores may be completely filled or have a wall thickness



Note:

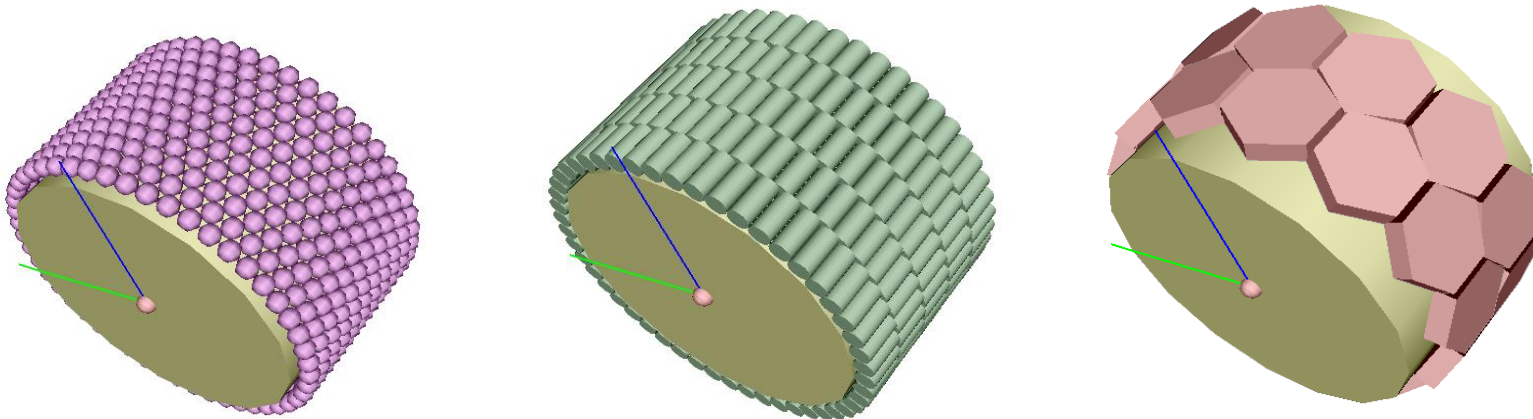
- Straight propagation of detonation ignores bores.
- No wave shaping effects included.
- SPLIT-X cannot distinguish between flow into bores and outward flow.
- Small bores should be filled with solid material to avoid unrealistic flow.



Principles of Modelling

Preformed Fragments

- 3D visualization
- 3D patterns possible (e.g. helix)
- Mass balance considers individual fragments.
- Gap between fragments can be modelled.
- Fragments creation requires sufficient space on the charge surface

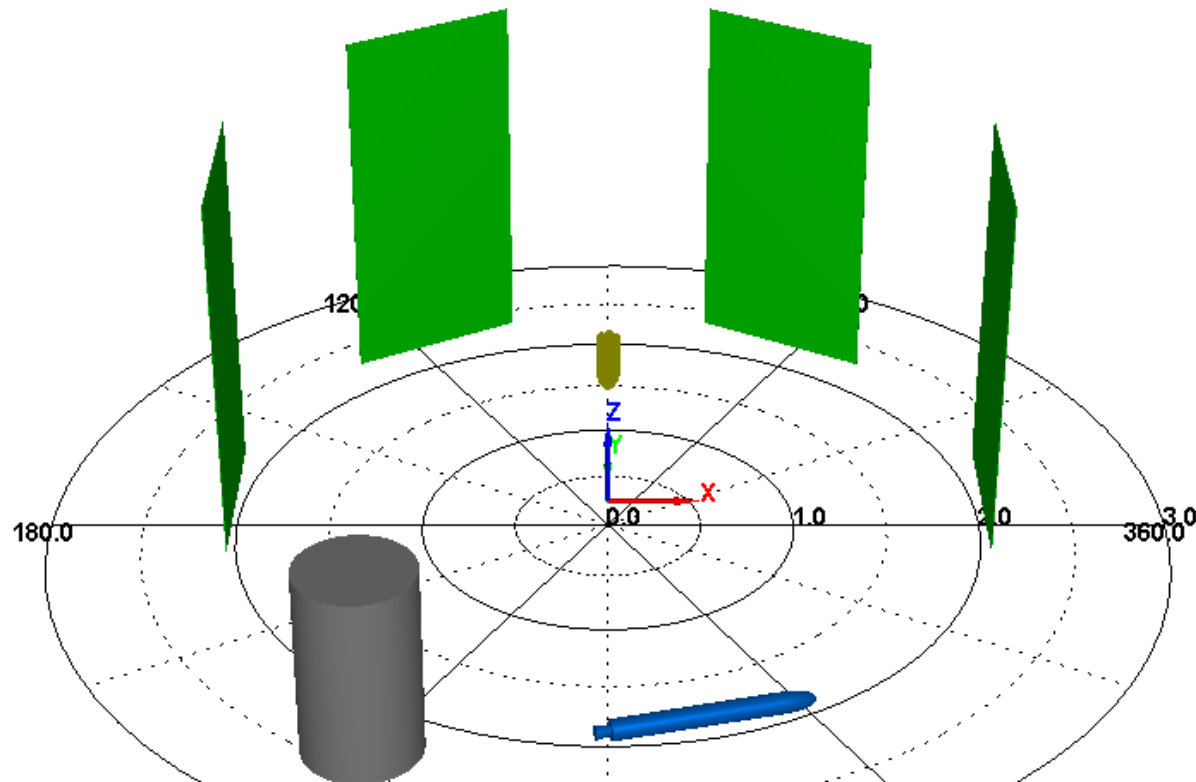




Principles of Modelling

Test Arena

- arbitrary number of target panels
- arbitrary material, size, position and orientation (6 DOF)
- arbitrary warhead position and orientation (6 DOF)



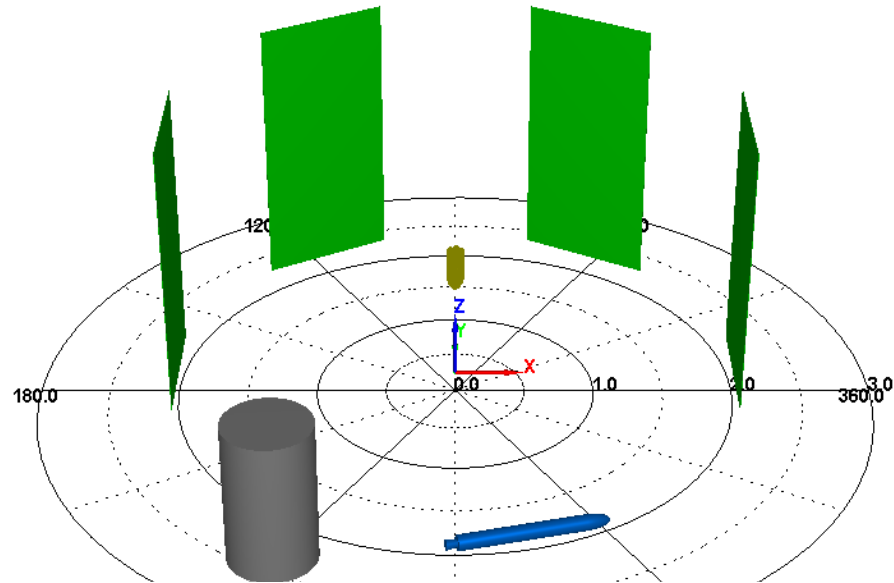


Test Arena

Test arena objects in SPLIT-X may be used to model static or dynamic warhead trials. Once a test arena is defined, it may be stored as a separate object (*.arn) or within a SPLIT-X session file (*.sxs).

A Test Arena contains:

- Set of Target Geometries
 - Boolean geometry
 - Various materials
 - Arbitrarily positioned
- Warhead kinematics
 - Position at reference time
 - Orientation
 - Velocity
 - Rotation Rate
- Groups of projectiles produced by warhead

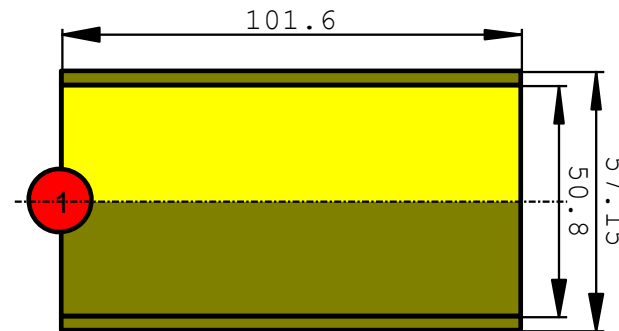
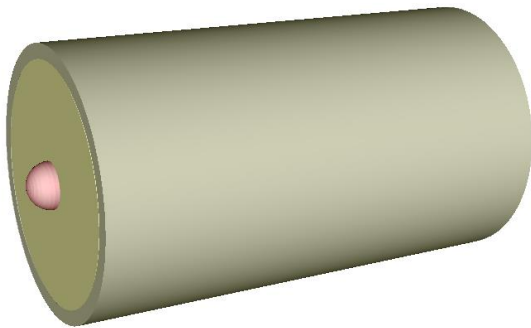




SPLIT-X – Application Example

Detonation of simple natural fragmentation charges¹⁾ filled with Octol 75/25

- series of three tests
- structural steel cylinders (L = 4.0", D = 2.0")
- 0.125" wall thickness
- side initiation

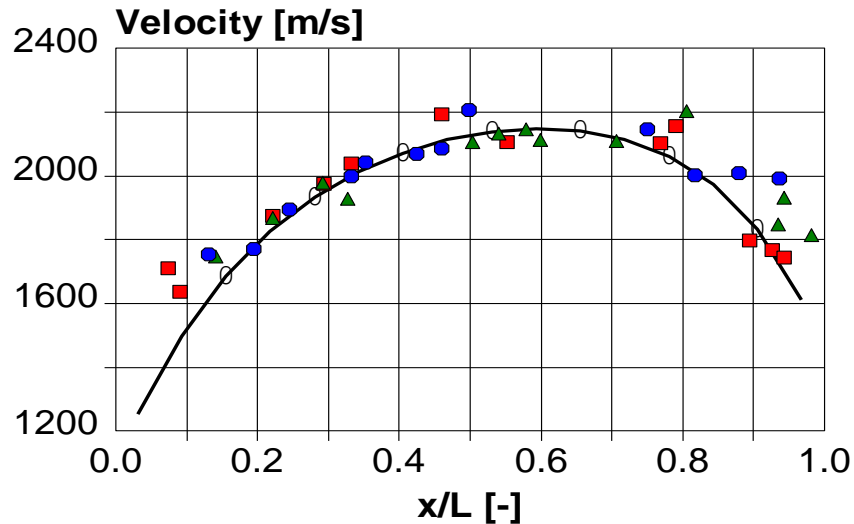


1) Anderson C.E., Predebon W.W., Karpp R.M. *Computational Modeling of Explosive Filled Cylinders*. Int. J. Eng. Sci., Vol. 23, pp. 1317-1330, (1985)

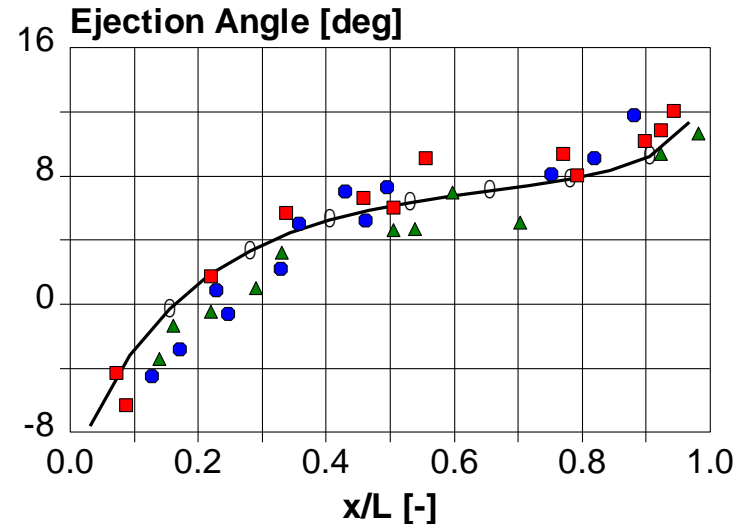


SPLIT-X – Application Example

Detonation of simple natural fragmentation charges¹⁾



○ = SPLIT-X prediction
● ▲ ■ = Experiments



○ = SPLIT-X prediction
● ▲ ■ = Experiments

Good agreement between simulation and experiment

(Calculation time: < 1 sec.)

1) Anderson C.E., Predebon W.W., Karpp R.M. *Computational Modeling of Explosive Filled Cylinders*. Int. J. Eng. Sci., Vol. 23, pp. 1317-1330, (1985)



Summary

- SPLIT-X permits to generate reliable results while requiring only little calculation time → standard for conceptual design, test layout, V/L analyses and mission planning for fragmenting charges
 - SPLIT-X is characterized by its outstanding performance and is unique on the commercial market
 - SPLIT-X 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
- SPLIT-X is offered either as stand-alone software or as a part of customized tailored solutions

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