# SPLIT-X
**Fragmentation Warhead Expert System**

## Introduction

SPLIT-X, developed by NUMERICS GmbH is an expert system for the rapid design of fragmenting warheads. In contrast to complex finite element codes it is based on analytical procedures and engineering approximations calibrated using experimental results and therefore requires relatively little computing time (typically in the range of seconds).

Running under Windows, SPLIT-X has an easy to use interactive graphical interface. The code can be utilised for parametric studies, for design optimisation, or for pre-proposal warhead performance estimation. Interfaces provide data for vulnerability assessment codes or blast and fragmentation characteristics for the layout of protective structures.

Uniquely, using built-in rules and an experimental database, the expert system SPLIT-X can also provide optimised design solutions based on user specified constraints such as warhead mass or dimensions (e.g. outer diameter) and for a requested performance. Typically, the code rapidly creates, calculates and analyses around 100 – 500 different designs until it suggests a solution.

## Features

The graphical user interface allows for an interactive definition of a broad variety of warhead types. The warhead geometry must have rotational symmetry, but a warhead can be composed of an arbitrary number of sections having various shapes. End projectors are possible, too.
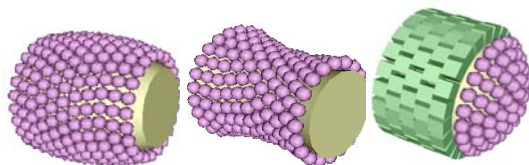
**Available shapes for warhead sections**

The casing may consist of structural layers and fragment generators. These can be one of the following types:

- Preformed fragments (spheres, cubes, rectangular, rods, cylinders)
- Controlled fragments (quadrilateral or hexagonal)
- Natural fragments

In addition, a materials database is included which can be updated and maintained by the user.
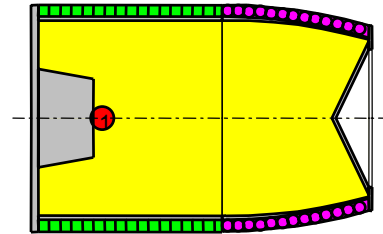
**Example of a complex warhead**

Given a sketch of the warhead the code allows calculation of all essential parameters such as:

- Mass of components and total mass of warhead
- Number of fragments, ejection angles and velocities
- Trajectory of fragments with retardation in air
- Impact points and velocities at the target
- Target perforation and fragment density distribution
- Warhead optimisation by mass and key dimension

For each analysis option a number of parameters may be defined, like altitude, distance to the warhead, impact angle, plate material etc.
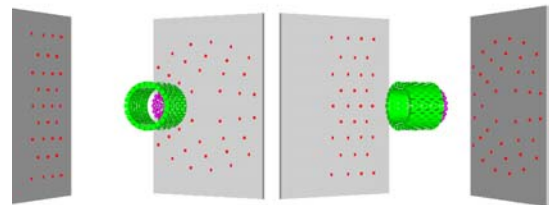
**Two different views of simulated perforation patterns in a test arena**

## Analytical Background

To determine initial velocities of the fragments the code uses a 3D-Gurney approach and empirical momentum transfer equations. Corrections are incorporated to account for end effects, gas leakage and multiple initiation points. Exterior ballistics uses tabulated drag coefficients and can include gravitation for calculating fragment ranges. Perforation of plates is estimated by various equations including the frequently used Thor equations.
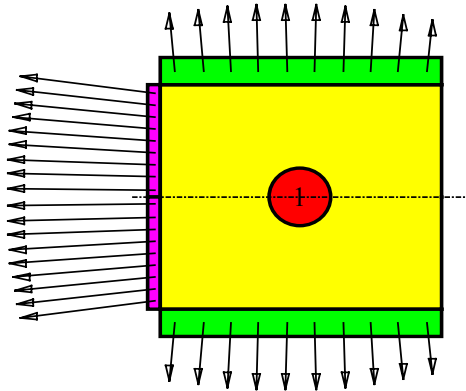
**Warhead geometry and initial velocities**

## Velocity Profile
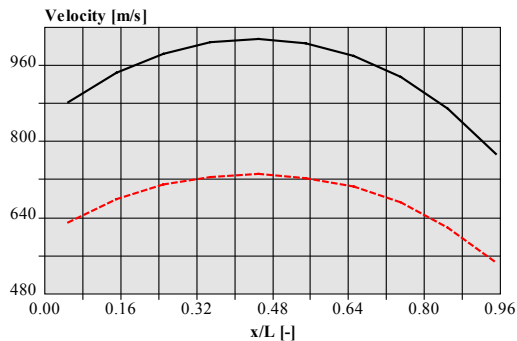


**Velocity profiles at different distances**

## Advanced Features

- **User Control:** The user has access to most parts of the analysis by defining parameters like leakage, drag or Thor-coefficients. In addition he may provide user routines via a DLL interface.

- **Natural Fragmentation:** SPLIT-X handles two modes of natural fragmentation: shear failure and brittle failure.

- **Off-Axis Initiation:** The effects of off-axis initiation are estimated by an empirical approach.
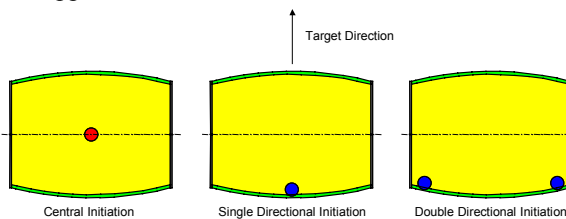


**Off-axis initiation of directional warheads**

## Benefits

The following are the benefits of using the SPLIT-X software:

- **Cost Savings:** The program can be used to rapidly assess a warhead design. The design can then be easily modified to optimise performance for a specific requirement.

- **High Productivity:** The program can be used to define, analyse and then modify a warhead in a short space of time, allowing rapid assessment of new or existing designs.

- **Continuous Development:** SPLIT-X will continue to be developed to maintain and enhance its capabilities and to incorporate the suggestions of its users.

## Hardware/Software

SPLIT-X is available for use on PC systems running under Windows.

The following items are delivered with the software:
- Executable code
- Full user documentation and example analysis files.

## Licences

SPLIT-X may be purchased as a paid-up license for perpetual use, or as an annual license.

In addition, a demonstration version is available during an exploration period of a few months.

## Services

NUMERICS has a wealth of experience in the development and application of this and other analytical and numerical methods. We offer a broad range of supporting consultancy services designed to meet the clients needs, including technical training and support, specialist software development, turnkey analyses and research and development.