THEON SENSORS
Advanced Optronics

Optimizing Thermal Performance and Structural Reliability of Electro-Optical Components with Ansys

THEON LISTED EURONEXT

FT FINANCIAL TIMES statista 1000 EUROPE'S FASTEST GROWING COMPANIES 2024

THEON SENSORS – Who We Are

THEON INTERNATIONAL is a highly flexible, medium-sized, European group of companies specializing in the development and manufacture of **Electro-Optic Night Vision Systems** and **Thermal Imaging Devices** for Defense and Security applications.

Indicative numbers

- Established in 1997
- Over 350 Employees, more than 30% engineers
- More than 200.000 systems delivered so far worldwide
- Users in more than 71 countries
- Certified for Defense Applications
- NATO secret security clearance

Night Vision

Thermal Imaging

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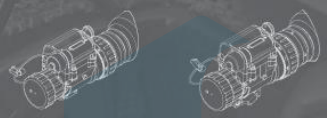
Product Line

Oculars | Weapon Sights | Vehicle Systems | Customized solutions

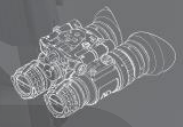
NIGHT I²

ARGUS
Multi-Purpose Night Vision Monoculars



ARGUS PANOPTES
Multi-Purpose Night Vision Monoculars

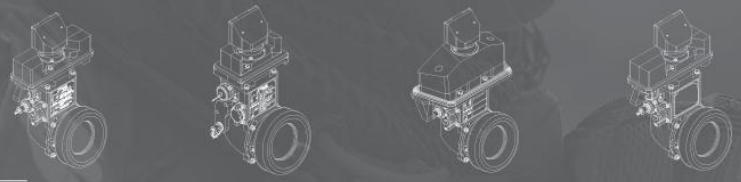
NYX
Dedicated Night Vision Binocular



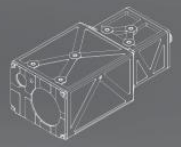
ARTEMIS
Night Vision Stand Alone Weapon Sights

DAMΩN
Family of Clip-On Night Vision Devices

TITANS
Night Driver's Viewers



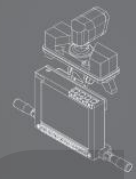
URANIA
Vehicle Mounted Day-Night Camera



THERMAL

THERMíS
Family of Thermal Clip-On Sights

THERMÓN
Thermal Periscope



Today, up to 90% of military and security operations are carried out by night!

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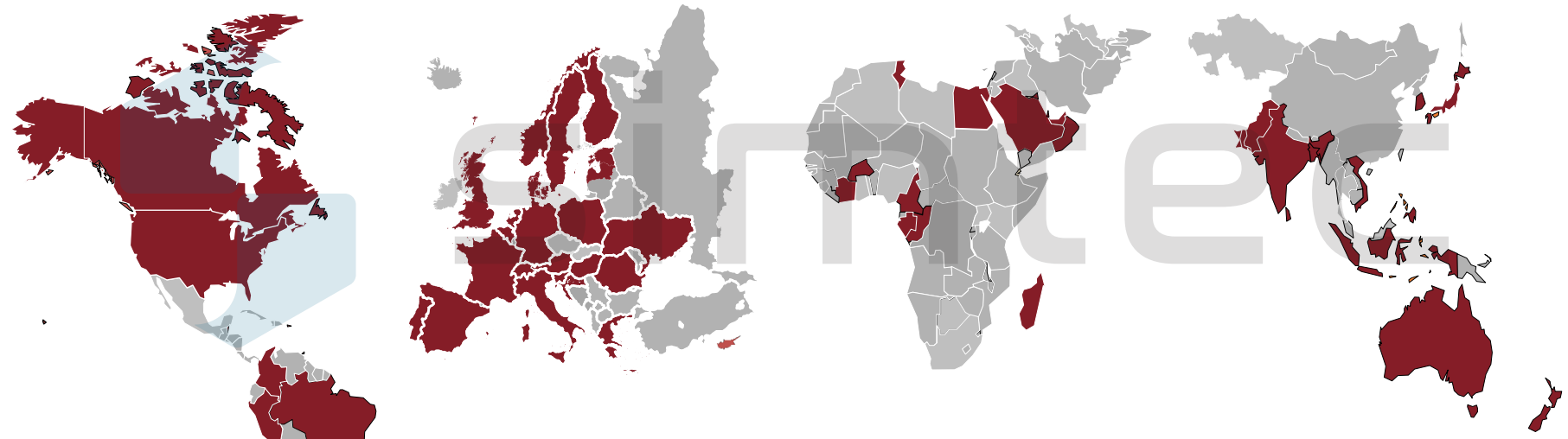
Global Customer Base

Theon has sold military grade products in 71 countries in Europe, S. America, Middle East, North Africa and Asia Pacific



Americas

- Canada
- USA
- Brazil
- Chile
- Peru
- Colombia

Europe

- Austria
- Belgium
- Croatia
- Cyprus
- Denmark
- Estonia
- Finland
- France
- Germany
- Greece
- Italy
- Latvia
- Netherlands
- Norway
- Poland
- Hungary
- United Kingdom
- Portugal
- Romania
- Slovenia
- Spain
- Sweden
- Switzerland
- Ukraine

Middle East & Africa

- Burkina Faso
- Cameroon
- Congo
- Egypt
- Gabon
- Tunisia
- KSA
- Kuwait
- Oman
- Qatar
- UAE
- Ivory Coast
- Madagascar

Far East

- Australia
- Bangladesh
- India
- Indonesia
- Japan
- New Zealand
- Pakistan
- Philippines
- S. Korea
- Singapore
- Sri Lanka
- Vietnam

Exports

THEON SENSORS
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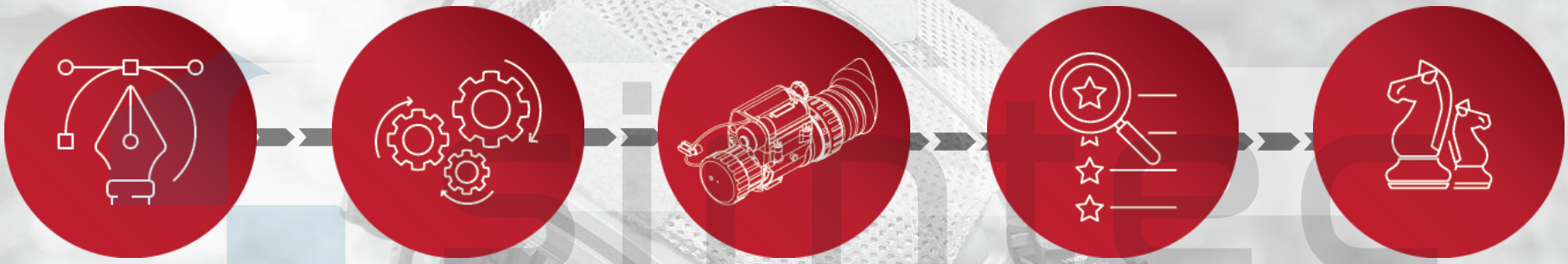
Process Analysis

All products are In-house designed by THEON
And reach the end user's expectations



DESIGN/D&D

The D&D department uses modern and state of the art computer-aided design tools

PRODUCTION

THEON's CNC workshop is equipped with multi-axis CNC machines, which can cut metal and plastics.

ASSEMBLY

The assembly of optical components is being done in class 100 (FED-STD-209E) flow-boxes which are located in a 10.000 class clean room

TESTING

THEON utilize Advanced testing facilities for electro-optical and thermal systems

MARKET

Global network of carefully selected agents
Flexibility and full customization

What we build

Design

- Housing
- Mounts
- Accessories (filters, lens covers)
- Test stations
- Special tools

Manufacturing

- Custom parts
- Machined
- 3D printed

Electronics

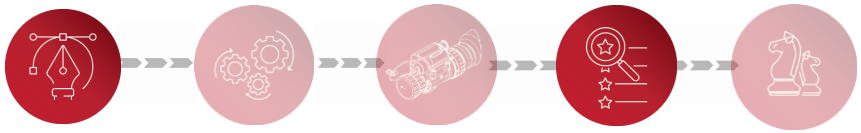
- PCBs
- Smart connected devices (wifi, bluetooth)
- Firmware/Software
- Theon designs its own Thermal Engine

Lens

- Design of all optical elements

Simulation

Simulation Involvement



Ansys tools

Simulation in Design and Testing Processes

- **Design Phase**
  - Analyze initial design concepts to identify weaknesses and potential improvements, providing valuable feedback to D&D Engineers for iterative development
  - Optimize thermal, structural performance to enhance durability and efficiency
  - Explore alternative materials and geometries for improved performance and cost-effectiveness
  - Conduct virtual prototyping to reduce physical prototyping cycles
- **Testing Phase**
  - Simulate real-world environmental conditions to validate device behavior
  - Support the development of accelerated life testing scenarios
  - Identify performance deviations before physical failure occurs

Ansys Discovery
Pre-processing and CAD preparation

AEDT / SIwave
DCIR, Specific electronics operations

AEDT / Icepak
Thermal analysis of electro-optical devices

LS-Dyna
Impact-Drop Test- Shock explicit simulations

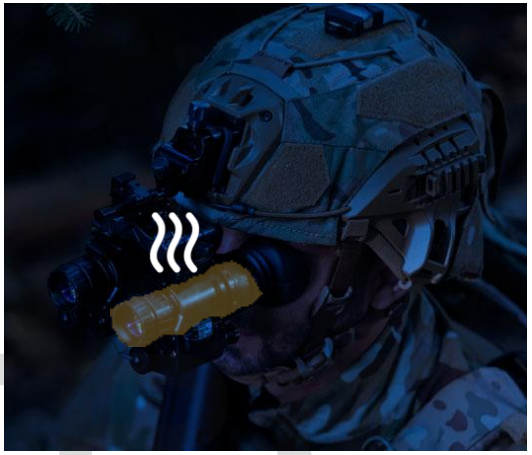
Material Designer
Complex material model calibration

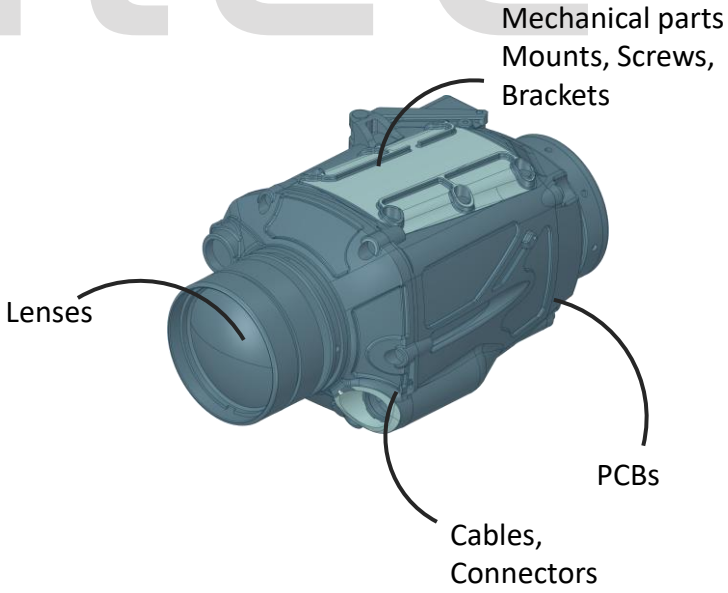
Thermal Transfer Analysis Workflow

AEDT / Icepak
Thermal analysis of electro-optical devices

- Thermal management is crucial for our devices
  - Integrate passive cooling techniques to maintain safe operating temperatures
  - Keep low temperature profile to avoid detection during military operations
- All electro-optical devices are made of **hundreds of different components**
- **Thermal Transfer Analysis Workflow**
  - Use HFSS 3D layout to pre-processing the ECAD file. Incorporate detailed PCB-stackups and material properties for accurate modeling
  - Use Icepak to build the PCB and add the mechanical parts to complete the model for simulation
  - Define the proper thermal BCs based on the real application
  - Create the necessary mesh regions to build an appropriate mesh
  - Solve and post-process in Icepak
- The workflow has been automated using PyAEDT which is part of PyAnsys products, a pythonic interface for accessing all the applications in AEDT.

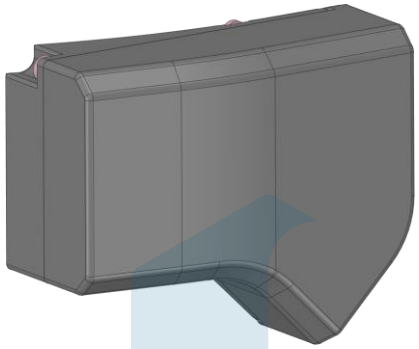
Electro-optical device





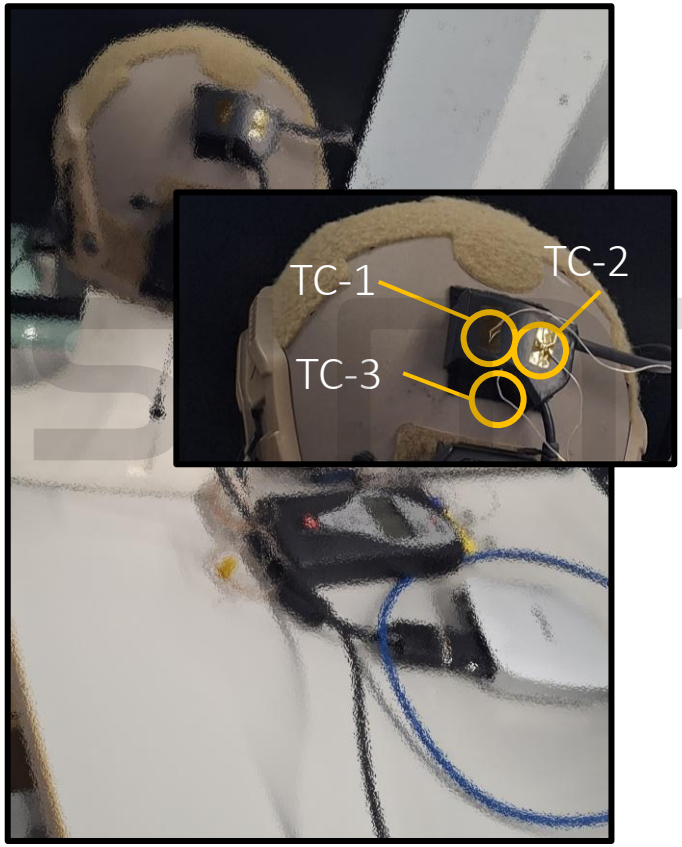
Electronic Device – Thermal Trasher Analysis

Electronic Device

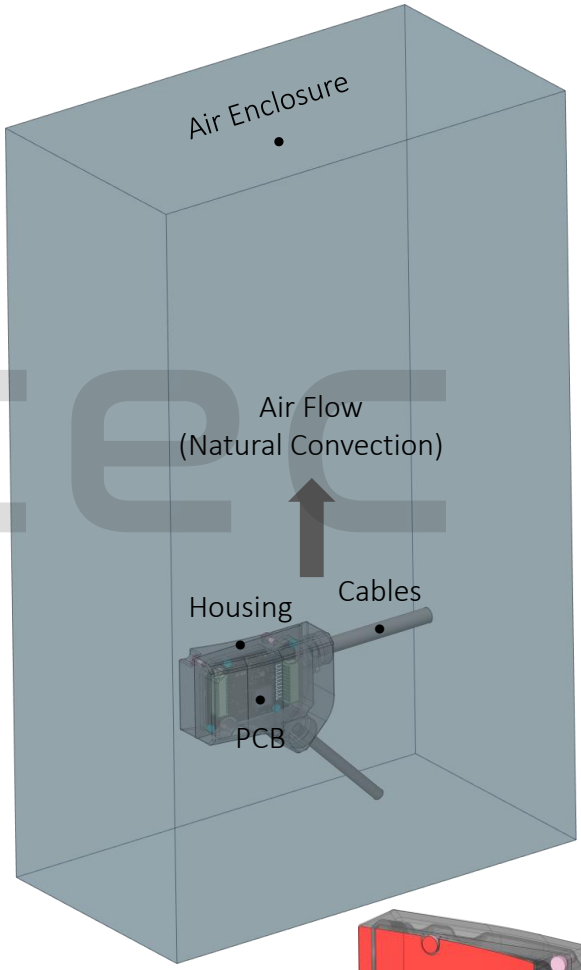


- PCB is the heat source
- High consumption in small volume
- Passive cooling to maintain safe operating temperatures

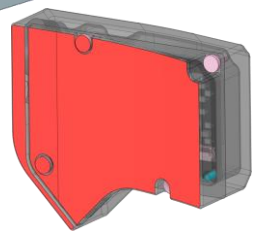
Real Measurement



Simulation



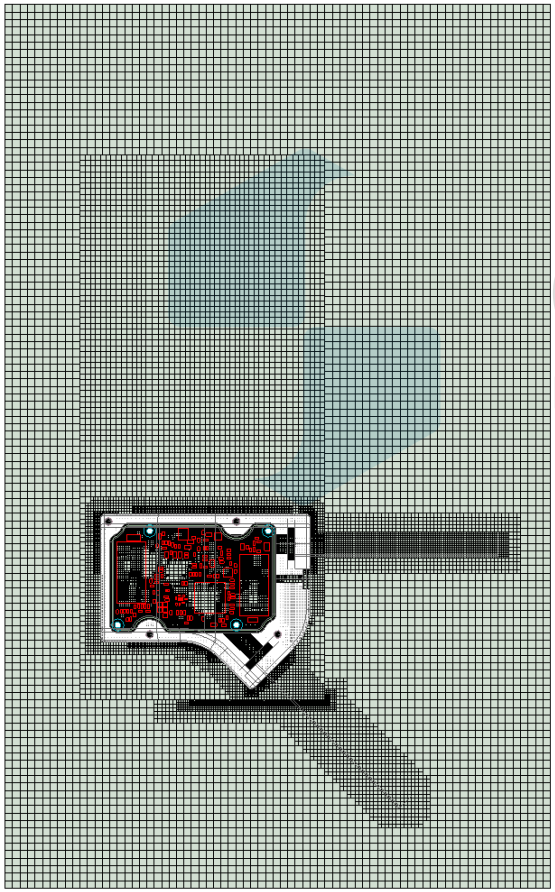
Account for Velcro at the back face



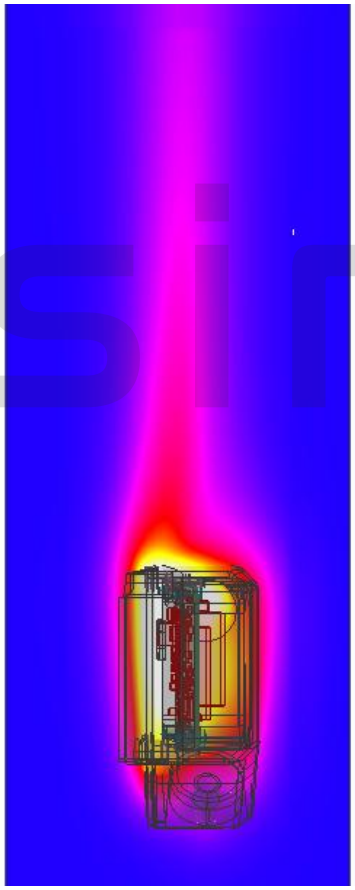
Electronic Device – Thermal Trasher Analysis

AEDT / Icepak
Thermal analysis of electro-optical devices

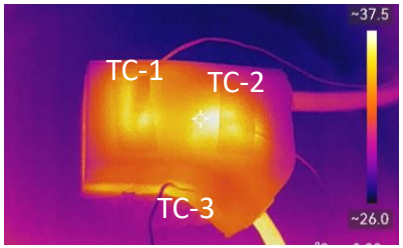
Mesh

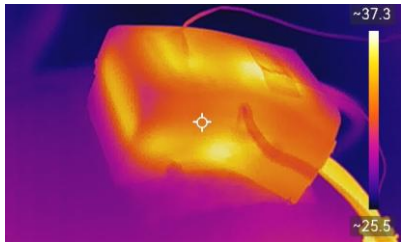


Temperature

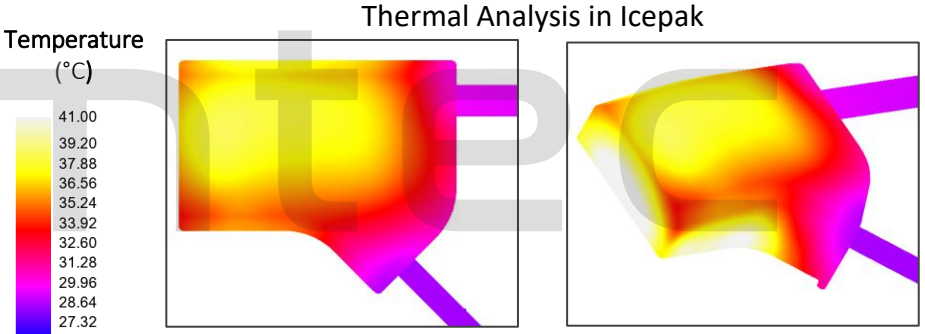


Thermal Camera Image (underestimated*)





Thermal Analysis in Icepak



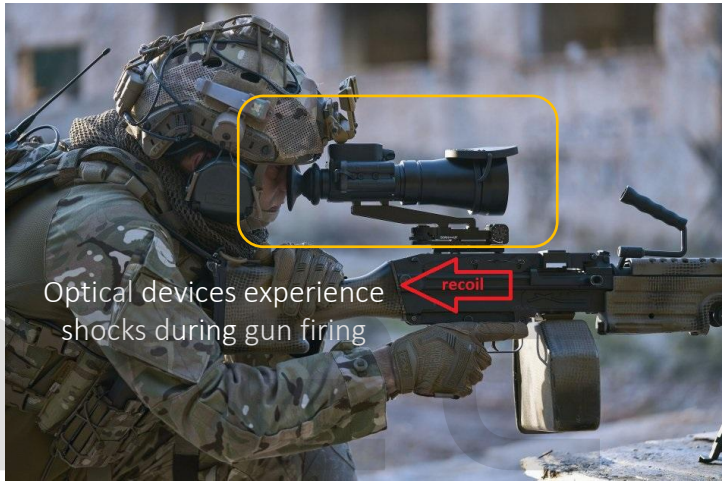
Electronic Device		
Position	Temperature (°C)	
	Experiment (thermocouples)	Simulation
TC-1	39.2	39.6
TC-2	39.8	40.1
TC-3	39	40

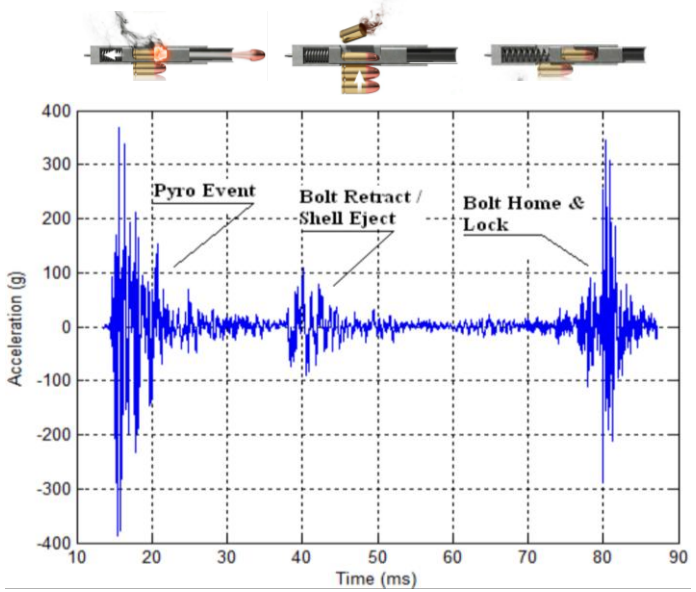
Weapon Shock Simulation

LS-Dyna

Impact-Drop Test- Shock explicit simulations

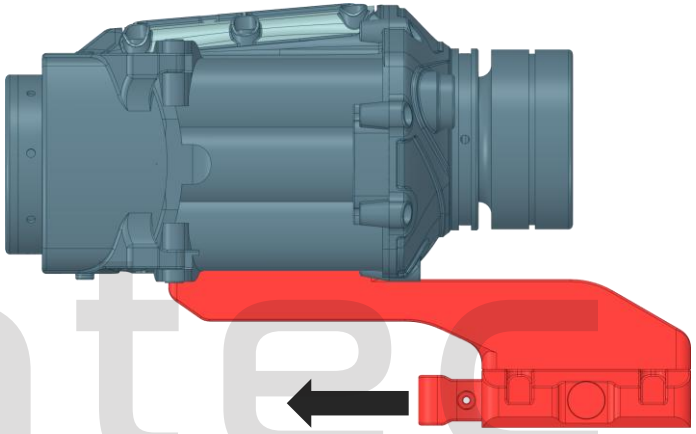
- Weapons produce shock due to **pyroshock** (when the bullet is fired), **bolt retract** and **bolt lock**.
- Pyroshock is the most severe shock phase of duration 0.5ms – 1ms
- Peak accelerations higher than 1000G
- Get acceleration data from real gun firing shocks using accelerometers
- **Explicit dynamics simulation workflow**
  - Base excitation problem
  - Pre-processing CAD making suitable for analysis
  - Build a proper mesh for explicit dynamics
  - Apply the proper BCs based on data got by accelerometers
  - Introduce proper material properties accounting for linear and non-linear behavior
    - Composites Materials
  - Post-process in Ansys LS-Dyna





Weapon Shock Simulation

- Explicit dynamics simulation workflow
  - Base excitation problem
  - CAD Pre-processing for cleaning and simplifying
  - Proper mesh for explicit dynamics
  - Apply the proper BCs based on data got by accelerometers
    - Apply 3-axial acceleration. Significant in all axes
  - Object modelling
    - No need to model the weapon or the mount
    - Simplify complex parts
    - Remove unnecessary parts
  - Introduce proper material properties
    - Composites Materials
    - Linear and non-linear behavior
  - Post-process in Ansys LS-Dyna



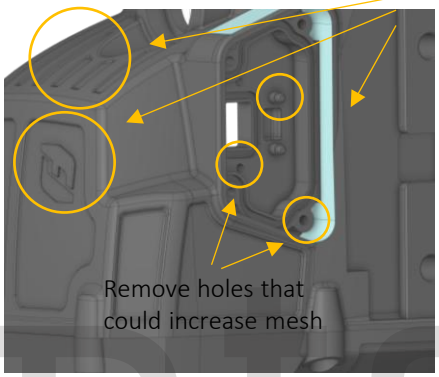
Weapon Shock Simulation

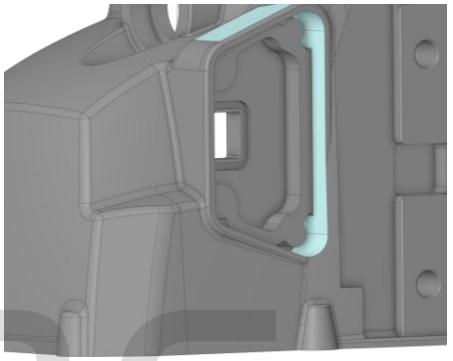
- **CAD-preprocessing**
  - Decrease complexity
  - Remove parts that do not contribute to solution
  - Smooth surfaces or remove unnecessary parts that could lead to extremely high mesh
  - Change areas that could lead to instabilities or unphysical stresses (sharp corners)
  - Remove extra edges to help meshing solver

Original CAD

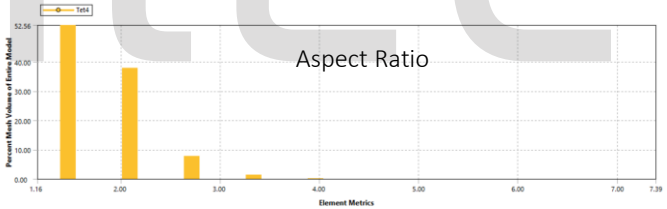
Remove unnecessary parts

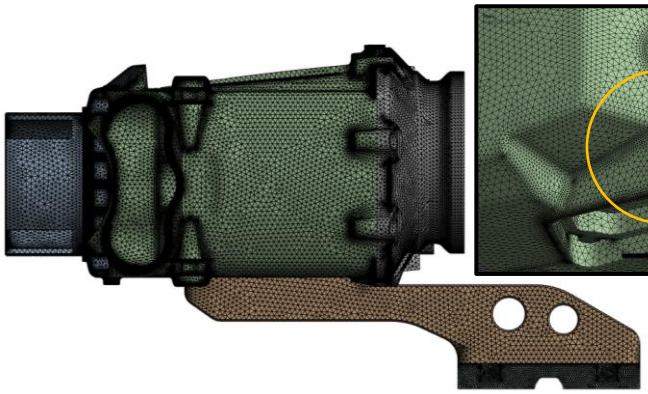
Simplified CAD

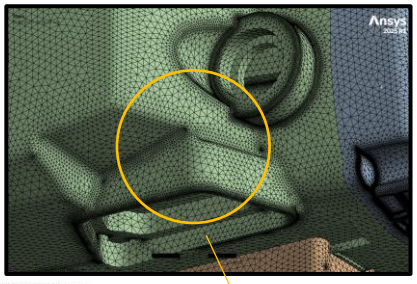




- **Mesh**
  - Total number of elements : 3.8 M
  - Uniform mesh size in the main body
    - Refined in locations where it is necessary, to avoid unphysical stresses
  - Target good aspect ratio
    - Aspect ratio is lower than 3.5 for all elements
    - 53% of the total elements have aspect ratio lower than 1.5



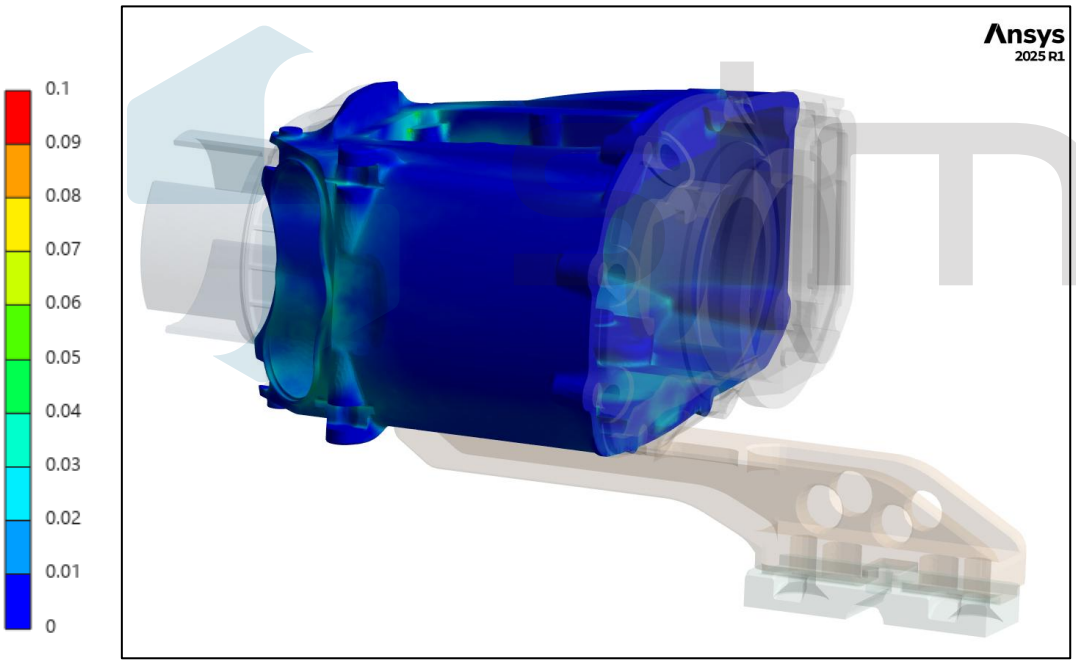


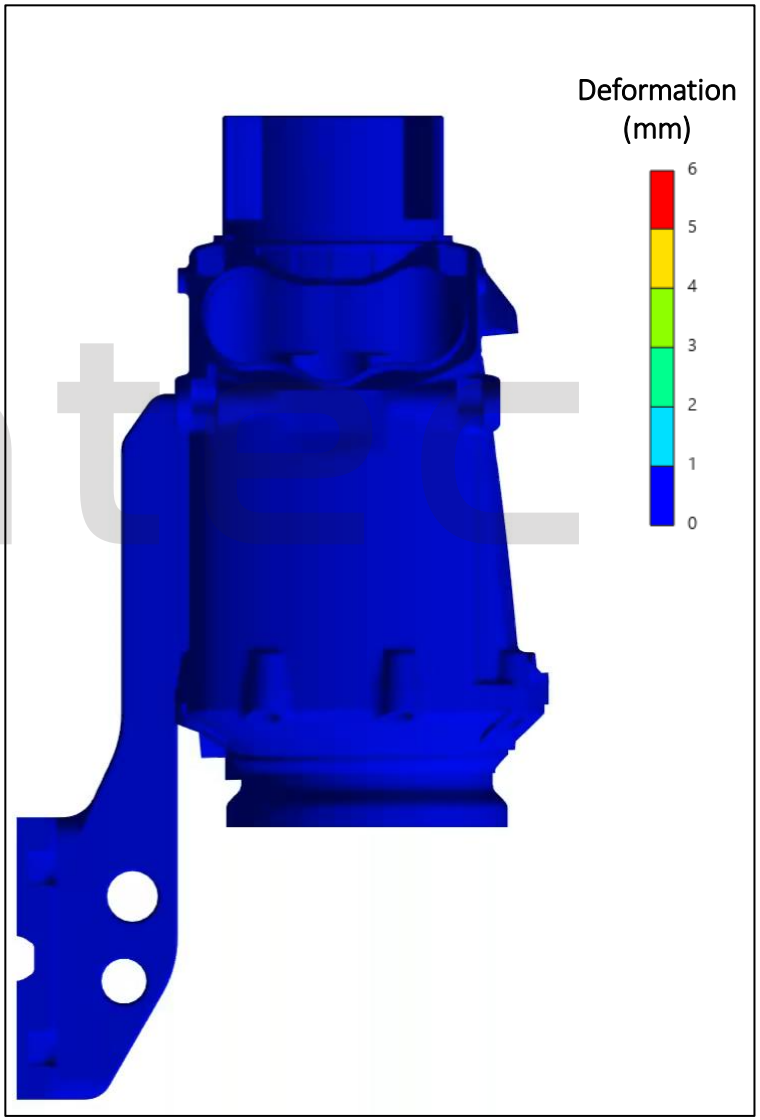


Capture corners properly

Weapon Shock Simulation

Maximum
Von Mises Stress over time
(GPa)

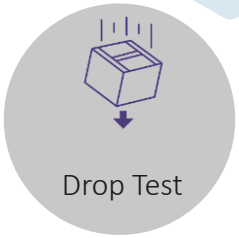




Other Applications using Ansys Tools

- Mechanical
- Modal analysis
- Harmonic Analysis
- Fatigue

- Mechanical/LS-Dyna
- Explicit or Implicit
- Test impacts including applying heavy loads or random impacts



- Mechanical/LS-Dyna
- Explicit or Implicit
- Test different scenarios of drops

- Material Designed
- Model calibration to find the properties of composites

Summary of Simulation

- Thermal Transfer Analysis
  - Analyze and gather feedback on the temperature distribution across the system
  - Optimize thermal management through iterative design modifications, including geometry, BCs and component placement
  - Evaluate and compare alternative materials for improved heat dissipation
  - Integrate passive cooling techniques to maintain safe operating temperatures
  - Meet technical specifications and customer requirements
- Explicit Shock-Drop-Impact Analysis
  - Model the dynamic response of the shock events on the electro-optical devices
  - Analyze stresses, deformation, and other mechanical responses.
  - Identify/predict failures caused by material limitations or resonant effects.
  - Develop techniques to replicate the shock signal impact without live firing

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