IMPETUS

driving precision

To users of IMPETUS and participants signed up for todays conference

Since we are not able to meet in Flekkefjord today, we choose to provide you with a small status summary of our main conference topic – distribution and protection of data for IMPETUS simulations. We hope you will enjoy it!

Many years of discussions and valuable input from our users has led to the development a framework for sharing and protecting data used for simulations. We refer to this framework as “objects”. There are several object types, of which the most mature and important one is the material object.

The material object concept is based on the idea of saving data from expert material calibrations, together with an appropriate documentation. For an engineer, the main focus should be on design and not on collecting data from various sources in order to be able to calibrate a material model, that often still has uncertainties linked to it. A successful use of these objects requires a distribution platform, specialist suppliers of good data and an accepted business model.

In the second half of 2020, IMPETUS will launch a web-based platform where suppliers can market their objects.
We refer to the data and objects as being "on-top" of the IMPETUS platform since the distribution of objects is separated from the IMPETUS Afea Solver software itself and potentially involves IPR and contribution from several parties.

Since the objects can protect data, such as the actual material calibration, it will be possible for suppliers to license the same material objects to several users. This paves the way for an attractive business for both suppliers and users, since the costs can be shared. During our conference, scheduled for today, we planned for users and suppliers to present their data and thoughts on this topic. Over the following pages, a few updates from the planned presentations are summarised.

Several of you also chose to send a summer greeting, which is much appreciated in these difficult times!

We hope that this short status summary also will inspire you to give us input of what kind of data you will need for the future. This will help us and our suppliers to prioritise and help the majority of users to be more efficient.

Have a good summer!

IMPETUS Team
Flekkefjord, 01 July 2020

NORDMETALL

MATERIALS AND IMPACT ENGINEERING

Nordmetall is a specialized company with the mission to assist customers in solving their specific challenges of material loading in sophisticated engineering applications. We help to understand, to evaluate, to apply materials.

During the last year, we have developed a database of more than 10 materials and material models which are currently transferred into licensable IMPETUS objects.
There, sophisticated experimental investigations for strength and failure modelling are the baseline for development of validated material objects. With a specific focus on blast and terminal ballistic applications, we can currently offer material objects of:

- MHA, HHA; UHA armour steel grades
- Structural steels
- THA
- FSP
- Armour-grade aluminum alloys

More will follow soon.

For more information, please contact:
Mr. Norman Herzig.
e-mail: Norman.Herzig@nordmetall.net
mobile: +49 176 325 874 82

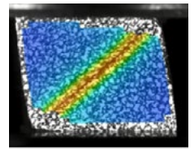
Material objects

Testing

- Low to high strength metallic and non-metallic materials
- Low and high temperatures
- Wide range of strain rates (up to >10+4 s-1)
- Complex stress states (-0.33 ≤ h ≤ 2, -1 ≤ L ≤ +1)

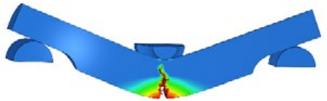
Modelling and Simulation

- Advanced strength and failure modelling
- Consideration of adiabatic shear failure and enhanced
- High temperature ductility
- Integration of ICME assisted approaches



Validation

- Impact testing
- Impact penetration
- Real blast and ballistic loading



Consulting

- Technical consulting on materials
- Active management of material objects
- Continuous increase of database
- Consideration of customer requirements

SYNERGIC SURVIVABILITY

Synergic Survivability AB is a consulting company specialized in survivability of military vehicles and their personnel.

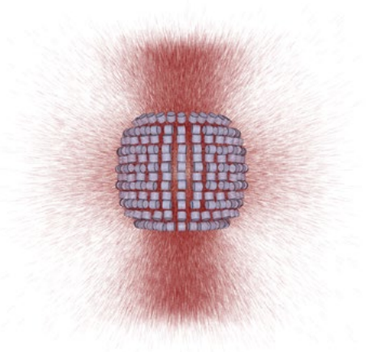
With our more than 15 years of experince we aid military industry and MODs to enhance the survivability for soldiers using an integrated and holistic approach. The services include survivability design work, ballistic protection development and protection system qualification. We use Impetus Afea for proof of concept work, risk mitigation and overmatch assessment.

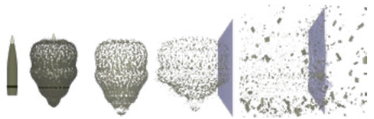
For existing Impetus Afea users, we offer several pre-defined and calibrated threat objects like

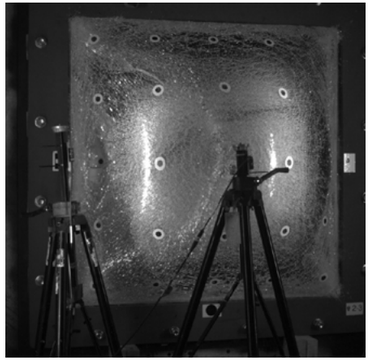
- DM-31
- MON 100 & 200 fragmenting mines
- 155 mm M107 artillery grenade
- TMRP-6 EFP mine
- 3"-10" EFP surrogates

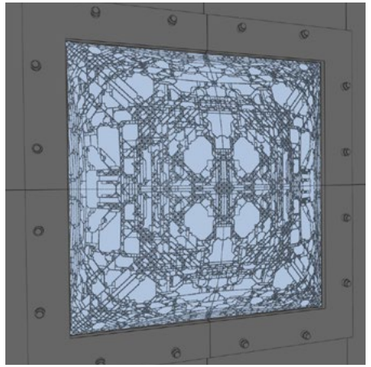
Please contact us for more information.

Karl-Petter Sjösvärd
Tel: +46 70-860 17 00
Mail: karl-petter.sjosvard@synergic.se
Web: www.synergic.se









FORSVARSBYGG

The Norwegian Defence Estates Agency (NDEA) is a government administrative agency under the Ministry of Defence. We develop, build, operate and divest real estate for the defence sector.

The National Centre for Protection of Buildings is a part of NDEA.

We combine experiments with numerical simulations to understand the behaviour of protective structures for blast and terminal ballistics. IMPETUS Afea is used for various simulations, such as blast loading of concrete buildings, behaviour of laminated glass and fragmentation behaviour of stacked ammunition casings.

We wish you all a good summer!

Contact person at NDEA
Svein Olav Christensen

SIMBLAST

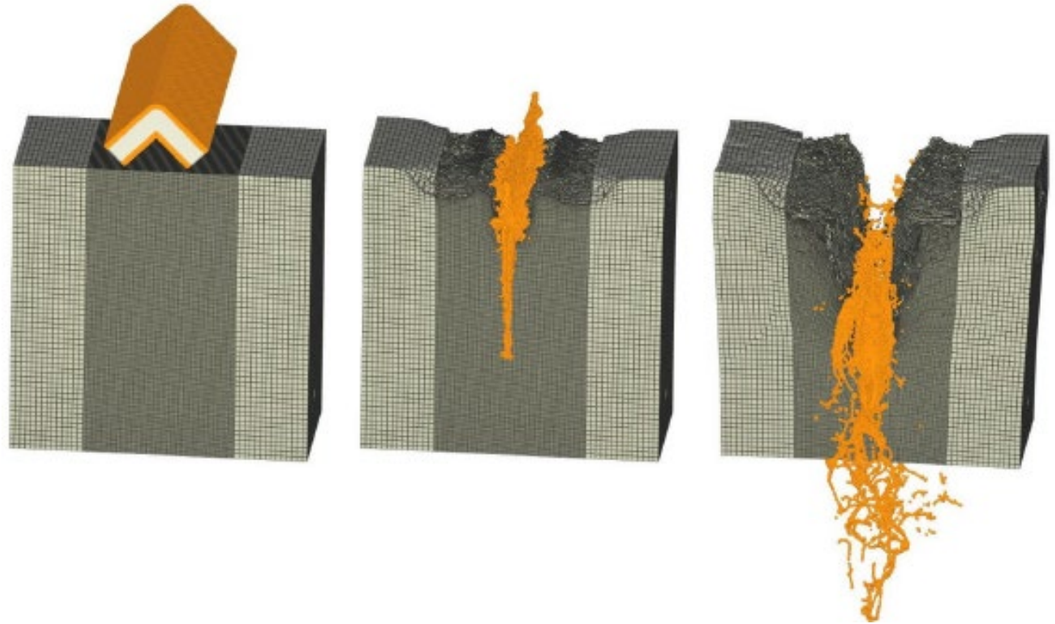
SIMBLAST provides numerical simulations in terminal ballistics and blast phenomena. Our core services cover the evaluation of protective structures, the design of protection concepts for armoured vehicles and the optimization of breaching tactics for the law enforcement sector.

Founded in 2018, SIMBLAST today represents one of the major providers of tactical simulations for SWAT teams within the German Police.

We exclusivly use state-of-the-art hardware and software for our simulations. Our customers value our detailed results, accuracy and promptness of delivery.

Please contact **Daniel Huber** for more information: daniel.huber@simblast.com

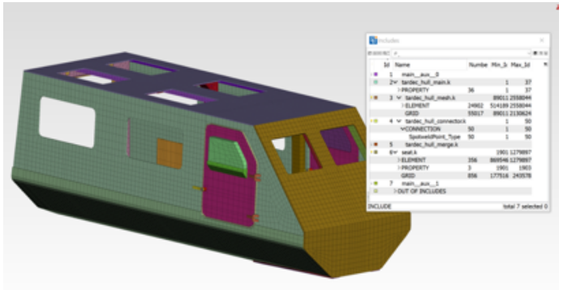
Find out more about SIMBLAST:
Follow us on our social media channels



BETA
SIMULATION SOLUTIONS

BETA CAE Systems transformed CAE by introducing revolutionary automation software tools and practices into Simulation and Analysis processes almost 30 years ago.

Committed to our mission to enable engineers to deliver results of high value, we continue to offer state-of-the-art, high-performance software and best-in-class services. Our simulation solutions liberate low risk and high Return-On-Investment innovation.



Streamlining analyses with IMPETUS

To support the numerous customers who use the IMPETUS solver, we decided to develop a process to prepare and evaluate an IMPETUS analysis using our products.

In cooperation with AUDI, we will present the build-up of a process for solving an IMPETUS file. First, we read a model in ANSA pre-processor, perform the appropriate modifications, and output an IMPETUS file. We then set up the boundary conditions and proceed to calculate the file in IMPETUS. Finally, we import the result file in META post-processor and evaluate the results.

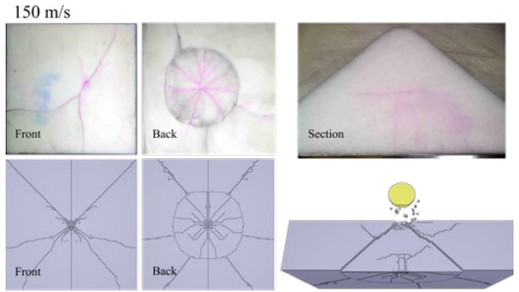
Contact at BETA CAE Systems: **Thanasis Fassas**
Contact at AUDI AG: **Peter Haffner**

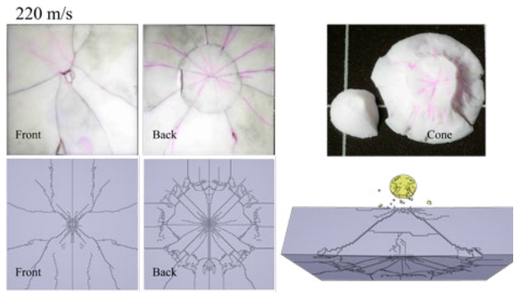
FOI researches for a safer, more secure world. This is the vision that we aim to achieve in everything we do. FOI, the Swedish Defence Research Agency, is one of Europe's leading research institutes in defence and security.

We create, evaluate and disseminate knowledge and techniques to handle threats and vulnerabilities for both the Swedish Armed Forces and the civilian society.

With several years of experience on studying ceramics as a ballistic protection material at high impact velocities, we have recently focused on studying the initiation and propagation of macro cracks using low velocity impact experiments. Macro cracks in ceramics is an important failure mechanism in ballistic applications and suppression of these cracks may greatly increase the ballistic performance of the ceramics. Adequate modelling of macro cracks is essential and to this end, we utilize the model developed by Impetus that incorporates different failure mechanisms in compression and tension.

Simulations using Impetus agree well with the low velocity impact experiments where steel or tungsten spheres impact freestanding ceramic tiles. The simulation especially captures the development of crack pattern and failure mode when tensile damage dominates the process.





Picture from the ACSV G5 on the test track

FFG Flensburger Fahrzeugbau Gesellschaft mbH (FFG) specialises in military equipment with a strong focus on vehicles, in particularly tracked ones.

Based on half a century of maintenance, repair and overhaul of all kind of military vehicles, FFG started comprehensive upgrade projects on the Armoured Personnel Carrier M113 and the Leopard 1 based Bergepanzer 2.
This experience formed the foundation for our own innovative development projects: FFG's WiSENT2 is the most modern Leopard2 based platform for ARV, AEV and Mine Clearing roles and is used by five nations today. FFG's Armoured Combat Support Vehicle ACSV G5 is a versatile vehicle platform with a Gross Vehicle Weight of 26 metric tonns – the verification of the Prototype is currently in process, and the Norwegian Army is looking forward to receiving the series vehicles from 2022 onwards. FFG uses Impetus Afea Solver software for the development and simulation of the integrated mine protection systems on its vehicles.

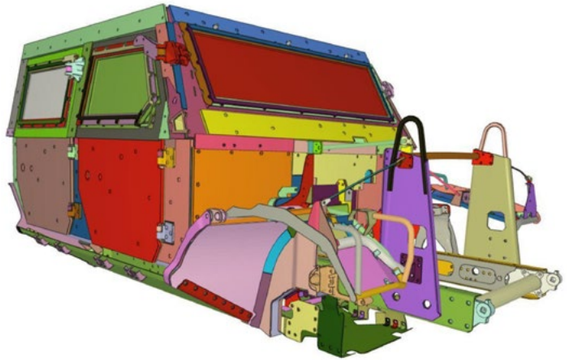
FLENSBURGER FAHRZEUGBAU FFG

IVECO
DEFENCE VEHICLES

Iveco Defence Vehicles is dedicated to delivering innovative mobility and protection solutions to meet the needs of military customers worldwide.

Our product range includes specialist military logistic multirole and armoured vehicles as well as Iveco's full commercial range, adapted as necessary to meet the demands of the military user.

The company boasts a dedicated organic research and development organization, whilst also benefiting from access to Iveco's corporate engineering resources.



EDAG

EDAG Engineering GmbH is one of the largest independent engineering partners to the worldwide automotive industry with the ability and speciality of complete vehicle development.

Our passion for detail and more than 50 “years” experience in mobility engineering help us to advise and support our customers from the initial idea to the finished prototype.

By validating products and product properties at an early stage, development periods are shortened, development costs reduced, and last but not least products improved. The key factors here are virtual simulation and testing.

Nearly 30 years of experience in the development of special protection vehicles have shown that a solution is only as good as the results it provides when put into practice.

Therefore we use IMPETUS Afea during the product development process of tailored ballistic and blast protection systems for risk mitigation, hedging of the certification process and overmatch assessments.

Calibration of explosive and ballistic threats

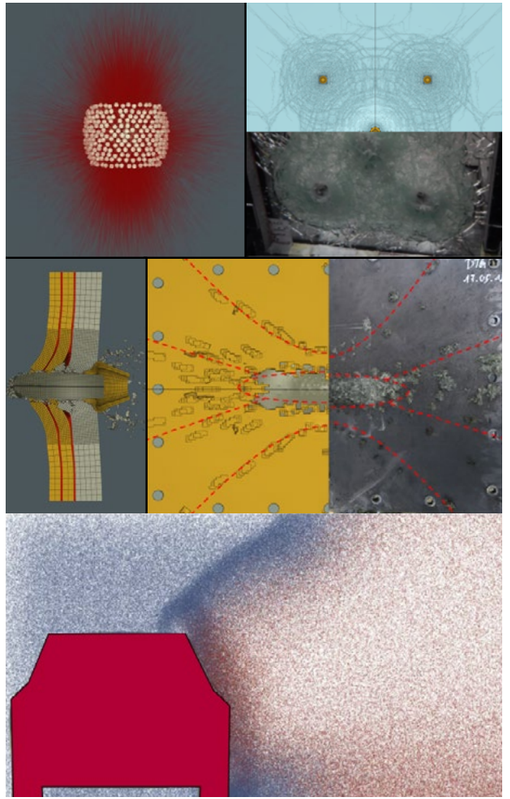
- DTG-5 [BSI PAS 300]
- 12,5kg PETN Charge [VPAM ERV 2010]
- 7,92 · 57mm Mauser S

Component wise investigations and weak spot analysis

- Multi Hit on LSG [DIN EN 1063 and VPAM PM 2007]
- Test series of armour configurations against hand grenades
- Impact simulation of test projectiles on structures

Integrated development of special protection vehicles

- Simulation of the ballistic resistance testing procedure
- Simulation of the blast resistance testing procedure
- Investigation of more severe threats for overmatch assessment



IMPETUS

Lamera

CAE at Lamera

Since 2014, Lamera AB has established an in-house CAE facility. Using a high precision solver has been an important decision for the company in order to:

- Give a better knowledge concerning product performance
- Improve product development
- Verify and improve the concept
- Fulfil the customer demand

For further information please contact:

Dr. Ramin Moshfegh
CTO at Lamera AB

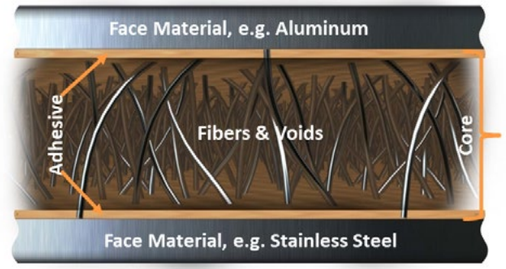
ramin.moshfegh@lamera.se
+46766404090

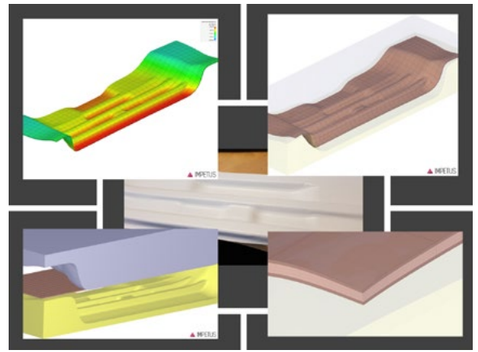
Lamera AB

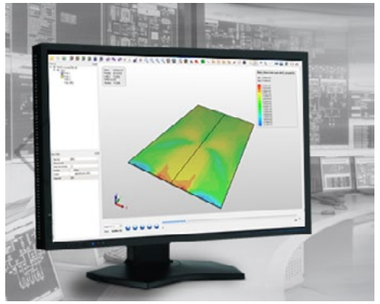
Hybrix™ is an umbrella trademark name for an advanced lightweight sandwich material which is produced by Lamera AB.

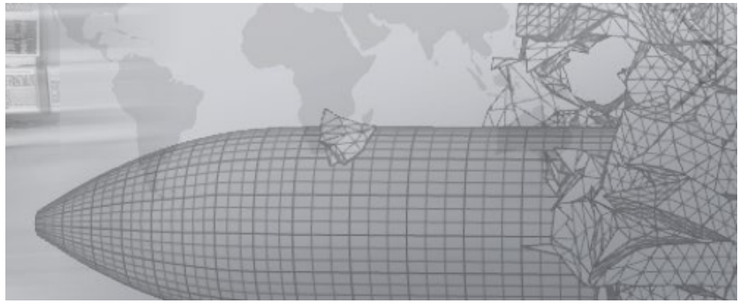
The sandwich material is a very thin (0.5 - 3.5mm) with a total weight of 1.0 to 8.5kg/m² (depending on the configuration) with an excellent stiffness properties in comparison with the corresponding monolithic sheet metal.

The unique interface between core configuration and face materials makes the Hybrix™ material formable unlike conventional lightweight sandwich material.









Dynaexpert company is an authorized distributor of Impetus Afea software in Poland.

We provide services in the field of implementing Impetus Afea software, training and technical support.
Our mission is the ability to offer our clients both specialized software and engineering knowledge.

Have a good summer!

Dynaexpert Team
Borek Szlachecki, Poland, 01 July 2020
www.dynaexpert.pl

dynaexpert

QINETIQ

QinetiQ is a global specialist R&D company with a mission to "Innovate for the Customers' Advantage"

Over the last 30 years QinetiQ have pioneered novel techniques based on low-rate interrupted tensile testing for the development of material and fracture models for use by hydrocodes. This development resulted in the modified Armstrong-Zerilli deformation model and the Goldthorpe Path Dependent Fracture model for metals.

High strain rate and ballistic testing is used to validate these models. Therefore, the testing required to generate constants for the models is minimised making it a very cost-effective method to characterise another metal.

Currently QinetiQ has constants for approximately 50 metals and alloys as follows:

- Pure and shocked iron and 30 steels (including RHA and armour steels)
- Titanium alloy—Ti6Vn4Al
- Four tungsten alloys
- Four aluminium alloys
- Pure tantalum
- Pure molybdenum

Phil Church

Richard Townsley

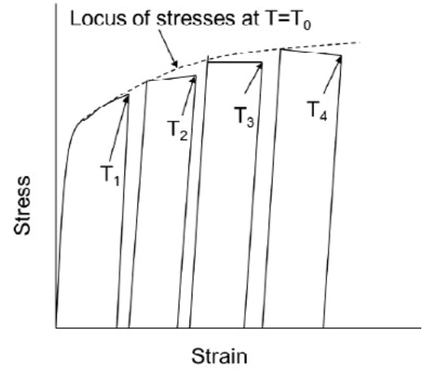
For more information contact:
Phil Church or **Richard Townsley**

pdchurch@qinetiq.com
rgtownsley@qinetiq.com

Material Model Validation

Derivation

- Material models derived using interrupted tensile testing and novel analysis of sharp neck.
- Interrupted tensile tests performed over a range of temperatures and strain rates.
- All constants for model are measured from material test data.

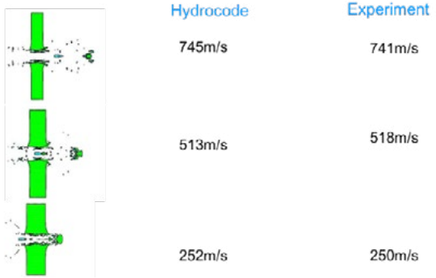


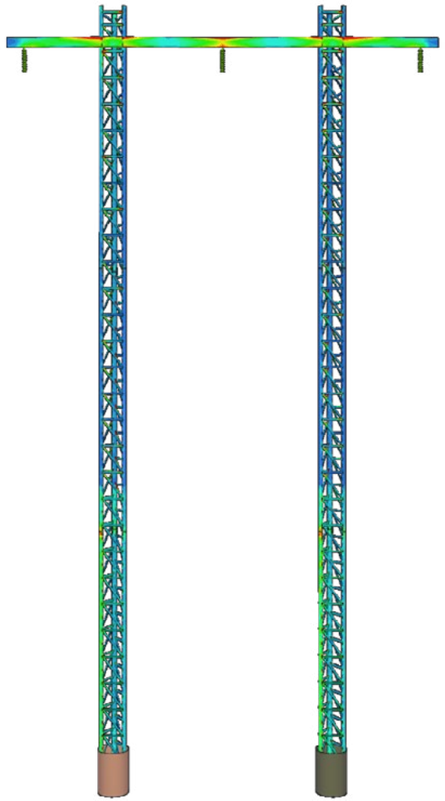
Hydrocode Implementation

- Material and fracture models currently implemented in GRIM and DYNA hydrocodes.
- Models can be implemented into IMPETUS objects for use by third parties.

Validation

- Achieved through high-rate and ballistic tests for selected materials, such as 'plugging' (see image, right).
- Models have been used to support applications such as EFPs, structural response and ballistics penetration.





Hyndla

Hyndla provides renewable energy solutions with a manufacturing-first perspective.

Our custom built digital twin* approach couples CAD and FEM data without the need for re-meshing of parts that are changed, moved, or re-used. The robust Impetus Solver and the object oriented graphical user interface helps make Hyndla the most agile and creative mechanical designer in the renewable sector.

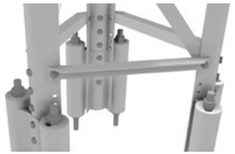
One application is our aluminium transmission tower for regional transmission lines. With linear elements we achieve realistic stiffness and distribution of forces, whereas a simple switch to third order elements allows for component stress analysis and prediction of buckling in key areas.
This approach has shown to reduce weight by more than 20% compared to Eurocode 9, due to Eurocode's crude handling of eccentric loading of closed profiles, which induces even greater reductions of carbon footprint and cost.

Don't hesitate to get in touch with, and kind regards from,

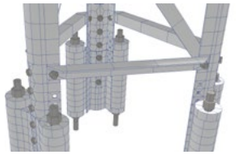
Magnus Kjepso Halvorsen
magnus@hyndla.com

**Recall Tore Tryland's presentation at the Impetus Conference in 2019 regarding digital twins with ambitions to improve the real product.*

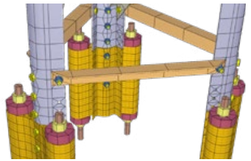
Production Detail



Engineering Detail



Discretized Geometry



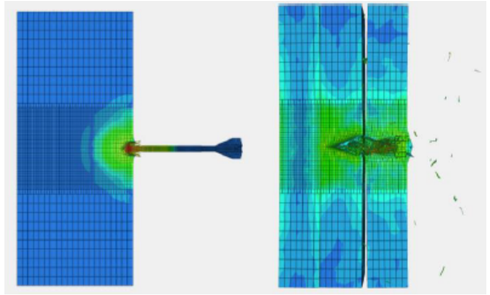
Impetus Model

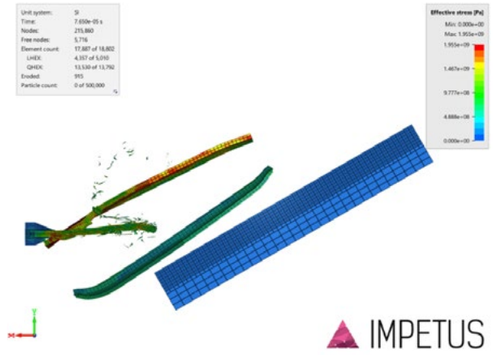
The French-German Research Institute of Saint-Louis is a bi-national institute operated jointly by the Federal Republic of Germany and the French Republic.

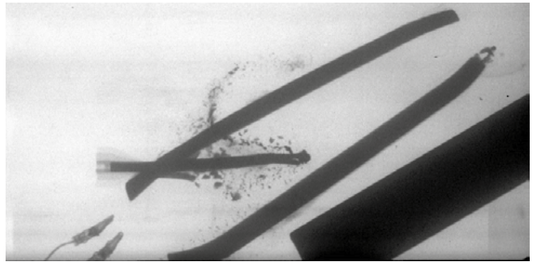
The mission of the ISL is to develop technical innovations in the fields of defence and security and conduct interdisciplinary research for the development of future equipment for the armed forces.

Research activities combine experimental and theoretical investigations with numerical simulations using IMPETUS Afea for protection against blast and kinetic energy threats.

The objectives are the understanding, description and modelling of the physics of Passive, Non-Energetic Reactive and Explosive Reactive Armor protection architectures.

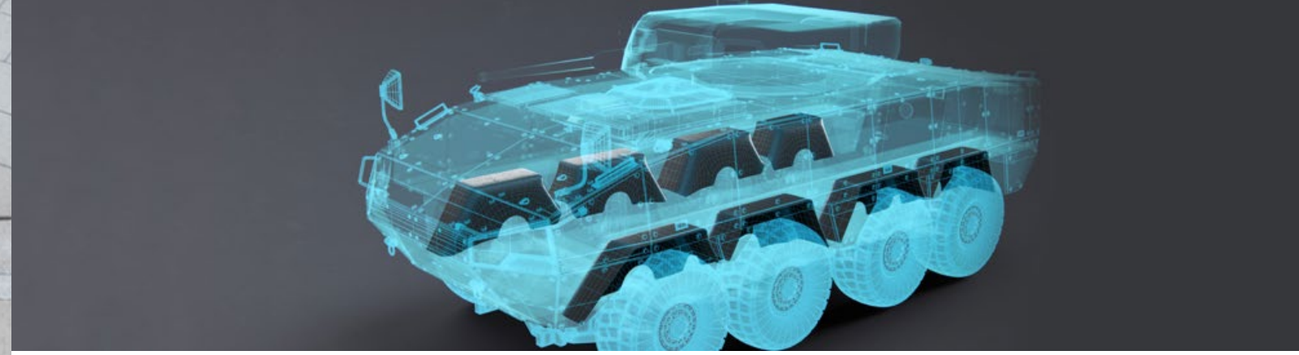






https://www.isl.eu/en/research/protection-technologies-security-situational-awareness

www.isl.eu



TENCATE
materials that make a difference

TenCate Advanced Armour is an experienced strategic supplier of lightweight survivability solutions for land, sea and air systems.

TenCate Advanced Armour is a global supplier with entities in France, Netherlands, Denmark, UK and the US. In lightweight armour TenCate Advanced Armour is one of the top 3 suppliers globally.

The main function of armour is protection of the entire system and\or vital components in the system against bullets, grenade fragments, mine blast and Improvised Explosive Devices. TenCate Advanced Armour has more than 25 years' experence in developing ballistic solutions based on a trial and error approach.

In 2019 our R&D team have started to use Impetus modelling and simulation software and this adds a new dimension to the development skills especially for protection against the larger calibre threats where testing is very expensive e.g. mine blast, RPG, EFP, Kinetic Energy threats Stanag 4569 L5 and higher. Experimental results of the past can be used for calibration of the models. Or final goal is to get a reliability of > 95% in the modelling and simulation and a final test is only needed for verification of the chosen setup.

We are looking forward to meet the Impetus user team again in order to create partnerships in developing the Modelling and Simulation tool.

ØGLÆND SYSTEM

In response to the industry's push for standardization and digitalization, Øglænd System has developed a simulation environment that reduces engineering hours and adds smartness to a mechanical product portfolio.

Powered by Impetus, P4D applies knowledge and techniques from automobile and defense industries to the innovative, light-weight, and modular Mekano® multidiscipline support system.

By following a mentality of mass production of standardized solutions, we have made it economically viable to use the most advanced technology to develop structural documentation with unrivalled accuracy.

Bjørn Stian Sjursen
Product Manager P4D

BjornStian.Sjursen@oglaend-system.com
www.oglaend-system.com

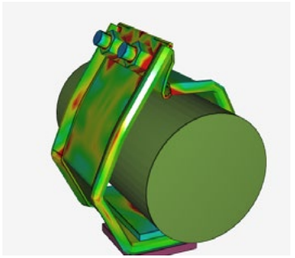
Pre-engineered Mekano® support
Mekano® multidiscipline supports with standardized configurations and modular design are pre-engineered, delivering maximum time and cost saving during design.

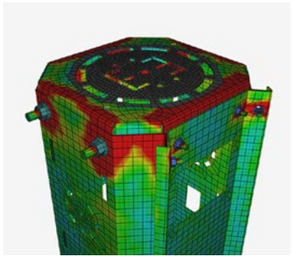
Precision for decision
Mekano® channels are exactly modelled allowing P4D to report exact capacity, thus allowing for weight and cost saving decisions to be made in the design process.

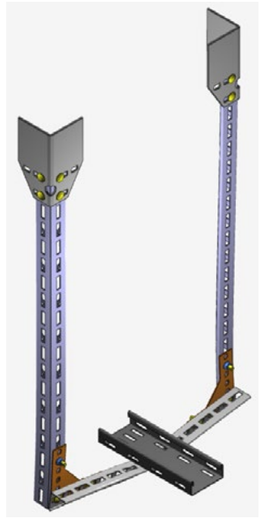
Multidiscipline analysis
Supports can be modelled with combination of disciplines and combinations of loadings representing exact consecutively loading conditions in order to optimize product selection and design.

Standardization with Flexibility
The combination of MultiGrid® design together with P4D pre-engineered Mekano® supports delivers optimal design flexibility. This is complemented with digital typical application details and comprehensive 3D model libraries.

Full documentation
P4D delivers a comprehensively detailed report for each load combination in a standardized and simple to read format.







P4D®

THIOT INGENIERIE

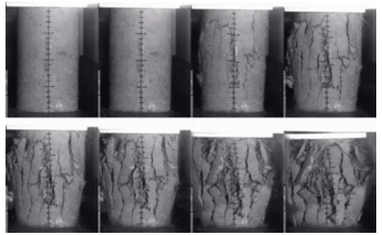
Thiot Ingénierie is a French company that provides a global expertise in shock physics.

For more than 30 years, we have been designing and manufacturing gas guns, Split-Hopkinson bars and other fast dynamics equipment for research centers and industrials worlwide.

Thiot Ingénierie is also a unique shock physics laboratory. We test the dynamic behavior of materials and structures subjected to shocks like impact, blast, fragmentation, acceleration... We help defence, security, space and aeronautics players to assess and improve the performance of their materials. Our philosophy: a permanent correlation between experiments and numerical simulation for the most reliable results.

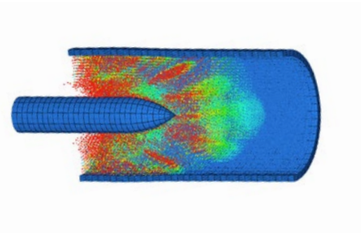
- Impact testing up to 10 km/s
- Acceleration tests up to 100 000 G
- Dynamic material characterization

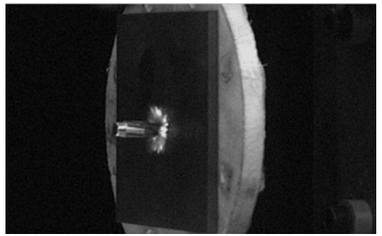
For more information, please contact us:
contact@thiot-ingenierie.com / + 33(0)5 65 38 36 07



Material characterization for modelling

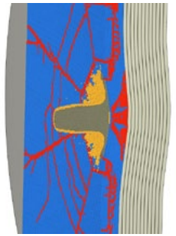
- Split-Hopkinson testing (compression, tension and torsion)
- From quasi-static to high strain rate
- Wide range of materials: geomaterials (concretes), composite, ceramics, polymers, metallic...

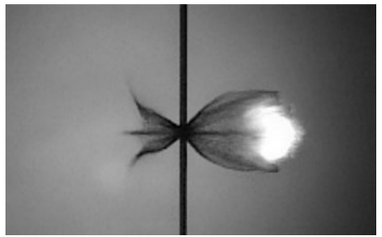




Impact testing and modelling for ballistic application and validation

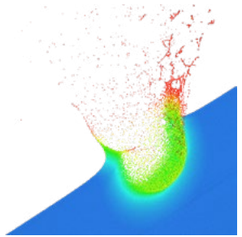
- Bullet impacts on light-weight armor
- FSP/Fragments impacts on armor steel
- Penetrator impacts on concrete





Hypervelocity impact tests and modelling

- Space debris impacts
- Velocity up to 10 km/s



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CertaSIM, LLC is located in the San Francisco Bay area and was founded in 2011 as the US and Canadian Distributor of the IMPETUS Afea Solver Suite.

In the last 9 years we have introduced the IMPETUS Afea Solver to many companies that were using “legacy solvers” and are now hardcore IMPETUS users. It is very satisfying when a customer says, “I will not go back to the old technology” once they have experienced IMPETUS. They appreciate that IMPETUS represents both “Next Generation” software and hardware.

We wish everyone a safe and healthy future and look forward to the next IMPETUS User's Conference.

- CertaSIM Team

CertaSIM Technical Journal.
Available for download on our website


Have a great summer and we look forward to seeing you in Flekkefjord in 2021!
IMPETUS
driving precision