



# SHOCK PHYSICS ACADEMY

TRAINING COURSES IN  
SHOCK PHYSICS, IMPACT PHENOMENA  
& DYNAMIC BEHAVIOR OF MATERIALS

TRAINING  
COURSES  
PROGRAM

2020



## THE SHOCK PHYSICS ACADEMY

Created by the company THIOT INGENIERIE, the SHOCK PHYSICS ACADEMY offers training courses in shock physics, impact phenomena and dynamic behavior of materials. A complex field, at the heart of our expertise for more than 30 years, that we wish to share.

The unique feature of the Shock Physics Academy is that it offers both **theoretical and practical courses**:

- Benefit from the knowledge and experience of recognized professionals
- Walk through the doors of a laboratory equipped with outstanding test machines and handle our equipment

**READY TO LIVE A UNIQUE EXPERIENCE IN A HIGH-TECH TESTING LABORATORY?**



**TO MEET EXPERTS IN SHOCK PHYSICS AND NUMERICAL SIMULATION?**

## WHO ARE THESE TRAINING COURSES FOR?

(depending on the topic)



- Scientist
- Numerical simulation engineer
- Materials & Structures engineer
- Laboratory staff member

APRIL 21, 22 & 23, 2020



## BALLISTIC IMPACT ON METALLIC MATERIALS AND CALCULATIONS USING IMPETUS AFEA SOLVER®

2,500 €

	AM	PM
DAY 1	<ul style="list-style-type: none"> <li>- IMPETUS solver® general presentation</li> <li>- Introduction to calculations in dynamics, time integration, precision and stability conditions</li> <li>- Finite elements in dynamics (integration, hourglass, pseudo-viscosity, high level schemas, contacts)</li> <li>- Constitutive equations and equations of state</li> <li>- Plasticity behaviors:               <ul style="list-style-type: none"> <li>• V. MISES, TRESCA</li> <li>• HSS model, stress triaxiality</li> </ul> </li> <li>- Impact test on metallic materials with a gas gun TITAN</li> </ul>	<ul style="list-style-type: none"> <li>- HSS model and IMPETUS</li> <li>- HSS model advantages</li> <li>- Reference test</li> <li>- Single-stage gas gun:               <ul style="list-style-type: none"> <li>• Theory</li> <li>• Designs, performances</li> <li>• Internal ballistic software CESAR</li> </ul> </li> <li>- Digital Image Correlation               <ul style="list-style-type: none"> <li>• Theory</li> <li>• Applications</li> </ul> </li> </ul>
DAY 2	<ul style="list-style-type: none"> <li>- Post-mortem examination of target and projectile</li> <li>- Data test sheet</li> <li>- First conclusion, first analysis</li> </ul>	<ul style="list-style-type: none"> <li>- Split-Hopkinson Bars</li> <li>- Dynamic press JUPITER</li> <li>- Test analysis</li> <li>- Recorded Data: impact velocity, videos, Digital Image Correlation</li> <li>- Data consistency</li> <li>- Data quality</li> </ul>
DAY 3	<ul style="list-style-type: none"> <li>- Evaluation of model sensibility:               <ul style="list-style-type: none"> <li>• Standard models</li> <li>• Stress triaxiality models, high strength steel data</li> </ul> </li> <li>- Comparison between Experiments and calculation</li> <li>- Debriefing, course evaluation</li> </ul>	

**CANCELED**  
 due to health measures concerning COVID-19 outbreak  
 (this training course will be rescheduled later)



You are an engineer, project manager, technical manager, R&D manager or PhD student in the field of materials behavior



- Acquire knowledge in the field of perforation of metallic materials
- Put into practice knowledge in numerical simulation
- Conduct laboratory experiments with a gas launcher
- Be aware of the correlation experiments/calculation

**JUNE 16, 17 & 18, 2020**



**A SHORT INTRODUCTION TO SHOCK PHYSICS AND DYNAMIC BEHAVIOR OF MATERIALS**

**2,500 €**

AM

PM

DAY 1

- Presentation of the fields of application
- Basic knowledge of materials behavior:
  - Wave propagation in solids
  - Elastic waves, shock waves, characteristics
  - Waveform/behavioral relationship
- Dynamic behavior of metals:
  - Elasticity, plasticity
  - Microstructure/behavior relationship
  - Equations of state and constitutive equations
- Introduction to numerical simulation for fast dynamics by example with IMPETUS Solver®:
  - Integration in time, precision and conditions of stability

- Visit of Shock Physics Lab:
  - Single-stage launchers
  - Double-stage launchers
  - Dynamic press JUPITER
  - Split-Hopkinson bars
  - Acceleration generator CHRONOS
- Numerical simulation for fast dynamics by example with IMPETUS solver®
  - Finite elements in fast dynamics (integration, hourglass, pseudo-viscosity, high order schemas, contacts)
  - Equations of state and constitutive equations
- Numerical simulation: a tool for analyzing tests

DAY 2

- Metrology for dynamic applications:
  - Chronometry: displacement, material velocity, strain
  - Fast videos
- Measurement quality: reliability, accuracy, calibration
- Presentation of Split-Hopkinson bars, principle, purpose: compression bars, tension bars, torsion bars
- Configuration examples: preparation of the test at the lab

- Handling in the high-speed camera lab on low speed impact tests:
  - Performing tests & videos
  - Analysis of test results
- Handling in the lab on Hopkinson bars system:
  - Performing tests
  - Analysis of test results

DAY 3

- Data analysis:
  - Low speed impact tests
  - Hopkinson bars
- Comparison experiments/calculations
- Sensibility analysis of numerical parameters
- Debriefing, course evaluation



You are an engineer, project manager, technical manager, R&D manager, PhD student or technician in the field of materials behavior



- Acquire basic knowledge of shock physics
- Put into practice knowledge in numerical simulation
- Conduct laboratory experiments
- Be aware of the correlation experiments/calculation

**22, 23 & 24 SEPTEMBRE 2020**



Special France

**Training course restricted to people of French nationality working for a French company**

**RUPTURE ET FRAGMENTATION DES MATÉRIAUX SOUS IMPACTS HYPERVÉLOCES : APPROCHE EXPÉRIMENTALE (LANCEUR DOUBLE ÉTAGE) ET NUMÉRIQUE (IMPETUS AFEA®)**

**2,500 €**

AM

PM

DAY 1

- Rappel sur le fonctionnement général via IMPETUS Solver®
  - Introduction à la simulation en dynamique rapide
  - Eléments finis en dynamique rapide
- Modèles de comportement :
  - Plasticité : V. MISES, TRESCA
  - Modèles de rupture, de fragmentation
- Equations d'état :
  - Equation d'état de Mie-Grüneisen
  - Equations d'état multiphases

- Présentation des modèles multiphases dans IMPETUS
  - EOS de Tillotson
  - EOS Multiphases
- Modèles de fragmentation dans IMPETUS
- Lanceurs double étage :
  - Principe, fonctionnement, performances
  - Logiciel de calcul de balistique intérieure CESAR
- Métrologie :
  - Caméra rapide
  - Radiographie RX
  - Traitement et analyse des données

DAY 2

- Essais d'impact sur cibles métalliques avec un lanceur de laboratoire double étage :
  - Présentation de la configuration
  - Réglages de la métrologie Sensibilisation aux consignes de sécurité, aux éléments de qualité de l'essai
  - Réalisation de l'essai
- Bilan de l'essai :
  - Etat de la cible et du projectile
  - Complétude de la fiche de tir
  - Premier bilan, premières analyses

- Visite du laboratoire de Physique des Chocs :
  - Lanceurs simple étage
  - Lanceurs double étage
  - Générateur d'accélération
  - Barres d'Hopkinson
  - Presse dynamique
- Analyse de l'essai :
  - Analyse des mesures : vitesse d'impact, vidéos, RX
  - Cohérence des données
  - Qualité de la mesure

DAY 3

- Evaluation de la sensibilité du modèle de fragmentation :
  - Calculs avec des modèles standards
  - Calculs avec des modèles améliorés : EOS + fragmentation
- Comparaison entre l'essai et le calcul
- Discussion, débriefing, évaluation du stage



Vous êtes ingénieur, chef de projet, responsable technique, directeur R&D ou étudiant en thèse dans le domaine du comportement des matériaux



- Acquérir les connaissances de base en rupture et fragmentation
- Mettre en pratique ses connaissances en simulation numérique
- Réaliser des expériences avec un lanceur double étage
- Etre sensibilisé à la corrélation expérience/calcul

NOVEMBER 24 & 25, 2020



in English

## WORKSHOP

### BEHAVIOR OF MATERIALS AND COMPONENTS UNDER HIGH ACCELERATION PHENOMENA

450 €

free for speakers

Would you like to do a presentation? Please submit your abstract before July 31 to Pierre HÉREIL: hereil@thiot-ingenierie.com

#### The following topics should be addressed:

- Experimental investigations
- Acceleration generators and soft recovery techniques
- Material behavior, shock mitigation techniques including additive layer manufacturing
- Measurement techniques (accelerometers, embedded data recorders, telemetry...)
- Mechanical architecture, design and engineering
- Structural dynamics analysis, including shock and micro vibration
- Numerical simulation for high-G phenomena expertise



## ABOUT THIOT INGENIERIE

World leader in shock physics, this French company was founded in 1988. We are specialized in developing and manufacturing test equipment for laboratories and research centers studying dynamic material behavior: gas guns, powder guns, Split-Hopkinson bars, acceleration generators, detonation chambers...

With our own test laboratory correlated to a numerical simulation department, we also provide our partners with global expertise in dynamic behavior of materials and structures under shock.

- Impact tests (up to 10.5 km/s)
- Acceleration tests up to 100.000 G
- Dynamic material characterization



## PRE-REGISTRATION FORM

@ hereil@thiot-ingenierie.com

+ 33 (0)5 65 38 36 07

Thiot Ingenierie  
830 Route Nationale - 46130 PUYBRUN

Please send us this completed pre-registration form or contact Pierre HEREIL directly.

### I WOULD LIKE TO PARTICIPATE IN THE TRAINING COURSE:

April 21, 22 & 23: Ballistic impact on metallic materials and calculations using IMPETUS-AFEA solver®. *In English, 2,500 €\** **CANCELED DUE TO HEALTH MEASURES CONCERNING COVID-19 OUTBREAK.**

June 16, 17 & 18: A short introduction to Shock Physics and Dynamic Behavior of materials. *In English, 2,500 €\**

September 22, 23 & 24: Rupture et fragmentation des matériaux sous impacts hypervéloces : approche expérimentale (lanceur double étage) et numérique (IMPETUS AFEA®)- *In French, restricted to French nationals, 2,500 €\**

### I WOULD LIKE TO PARTICIPATE IN THE WORKSHOP:

November 24 & 25: Behavior of materials and components under high acceleration phenomena. *In English, 450 €\*.(free for speakers)* **Abstract to be submitted before July 31.**

\* The prices include lunches and an evening with a dinner to discover the surrounding area



## CONTACT INFORMATION

Ms.

Mr.

FIRST NAME

LAST NAME

COMPANY

OCCUPATION

STREET

CITY

COUNTRY

EMAIL ADDRESS

POSTAL CODE

PHONE N°

## HOW TO GET TO US

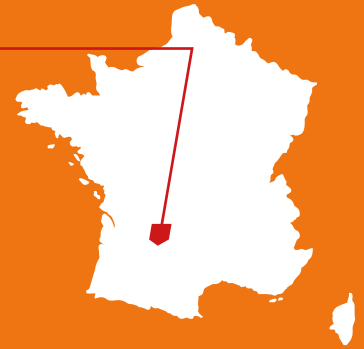
✈ Toulouse-Blagnac Airport  
2 hours away

✈ Brive-Vallée de la Dordogne Airport  
Brive-la-Gaillarde train station  
40-50 mn away



 SHOCK PHYSICS  
ACADEMY

THIOT INGENIERIE  
830 route Nationale  
46130 PUYBRUN (Lot)  
FRANCE



## FOR FURTHER INFORMATION

+33 (0)5 65 38 36 07  
contact@thiot-ingenierie.com

[www.thiot-ingenierie.com](http://www.thiot-ingenierie.com)

