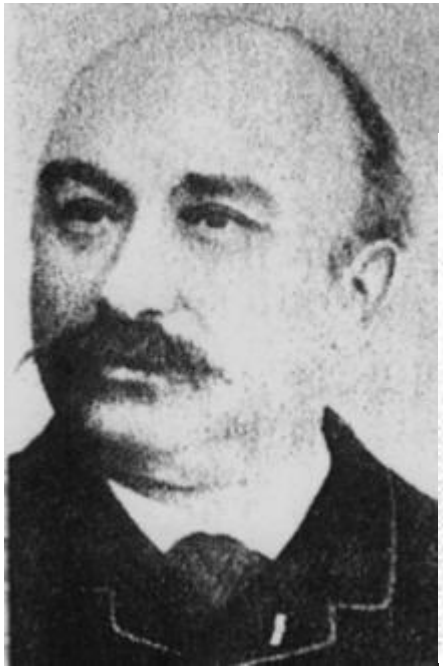
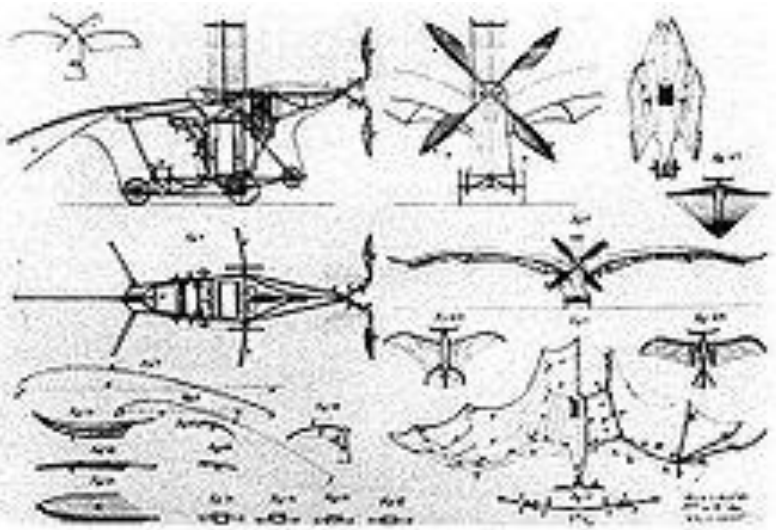
A brief overview of Institut Clément ADER research activities

Who was Clément ADER?





Clément ADER
Mechanical Engineer
Muret 1841 – Toulouse 1925

Paris, *Museum of Arts et Métiers*

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Dir. Ph. OLIVIER (Univ. Toulouse 3)
Deputy. Dir. Th. CUTARD (IMT-Mines Albi)
Deputy. Dir Y. GOURINAT (ISAE Supaéro)

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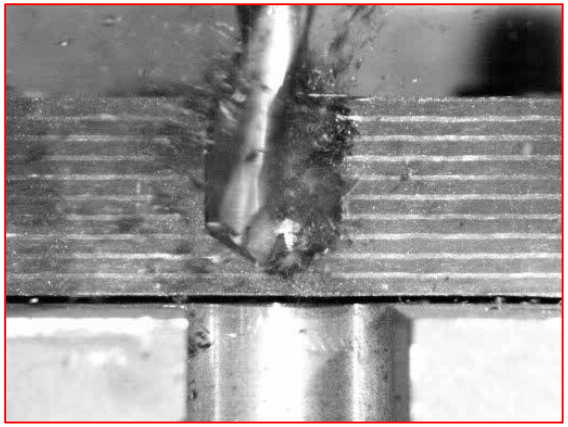
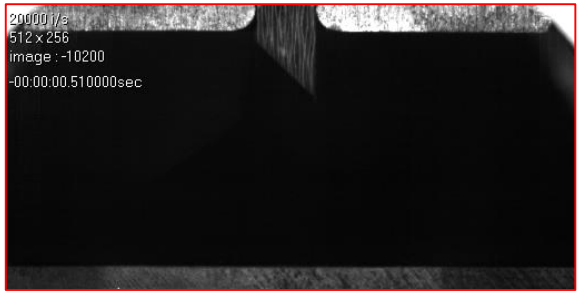
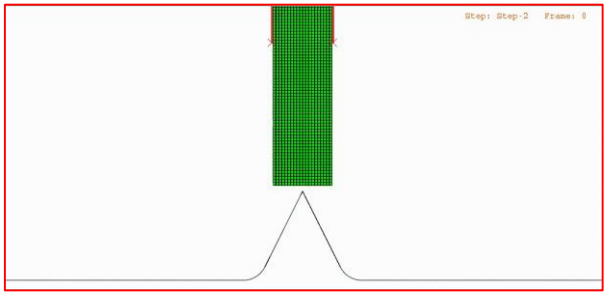
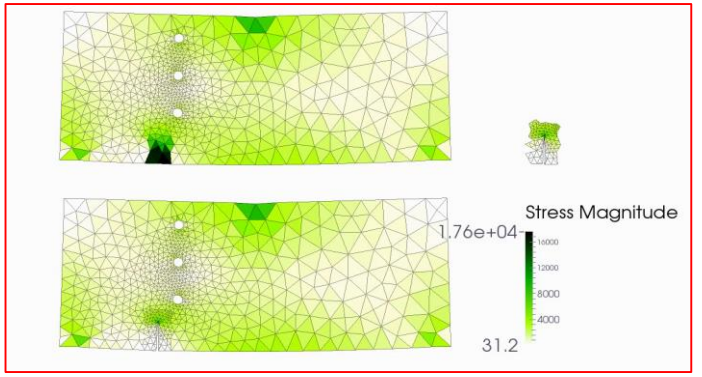
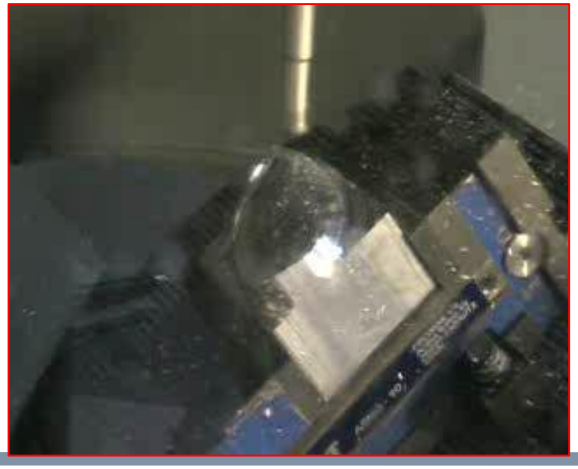
Activities at glance

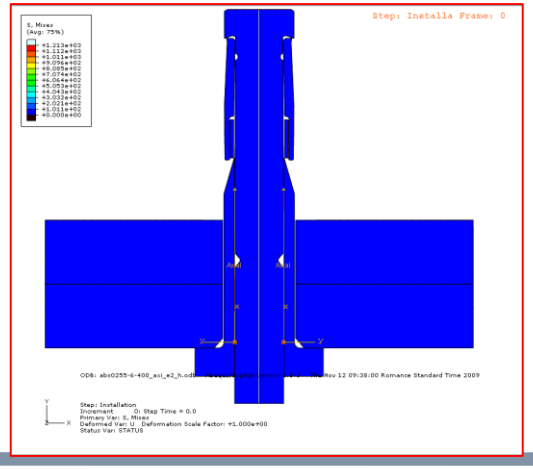


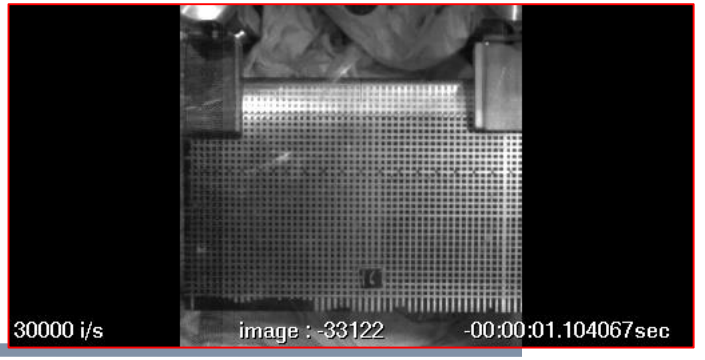












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A strong partnership with industry

FUI MACAO

AIRBUS

FUI-TiMaS (2013-2016)

FUI(s) INMAT 1 & 2

ANR ID4CS (2009-2013)

ANR VULCOMP2 (2013-2016)

FUI AIR-COBOT

ANR VULCOMP2 (2013-2016)

AIRBUS GROUP INNOVATIONS

ANR ICARE (2013-2017)

VERTEX (ANR)

FUI CARAIBE

LIEBHERR Aerospace

FUI AAP21 NOVA

THALES Systèmes Aéroportés

FUI THEOREM

FUI PLUME

FUI SAMBA

STELIA

AIRBUS DEFENCE & SPACE

RAPID DGA PRESID

Aerosat
- OSRARS
- ETC

FUI MACAO

FUI CARAIBE

SAFRAN Turbomeca

SAFRAN AEROSPACE · DEFENCE · SECURITY

RAPID DGA PRESID

FUI CARAIBE

ANR ID4CS (2009-2013)

SAFRAN AEROSPACE · DEFENCE · SECURITY

GROUPE LATECOERE

Projets EPICEA

GROUPE FIGEAC AERO

FUI-TiMaS (2013-2016)

A2015 FP7 CLEAN SKY

45 partners

Projets EPICEA

C|T ingenierie

FUI CARAIBE

SAFRAN Messier-Bugatti-Dowty

FUI MACAO

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A few figures

- **90** Permanent Researchers
- **110** Ph.D. Students
- **30** Administrative, Engineers and Technicians
- **4** Research Groups

stephane.colin@insa-toulouse.fr

MS2M, Modelling of Mechanical Systems & Microsystems

bruno.castanie@insa-toulouse.fr

MSC, Composite Materials & Structures

Luc.penazzi@mines-albi.fr

SUMO, Surfaces, Machining, Materials & Tooling

yannick.lemaoult@mines-albi.fr

MICS, Metrology, Identification, Control & Monitoring

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Around aircrafts

- Microfluidic systems for analysing cabin air quality
- Piezoelectric systems for de-icing
- Vibrations

- Composites: Damage tolerance, low and high speed impacts, multiaxial mechanical tests, dynamical couplings, manufacturing processes (fast cure cycles, ooa, low cost), initial damages, spring-in, repair of composites, short fibres structures (air).

- Design and optimisation of on-board equipment

- Mechanical assemblies

- High performances steels: ball screw wearing

- Ground robotic video systems

- NDT of thermal barriers

- Super Plastic Forming on Titanium alloys

- Actuators: Design process, simulation, optimisation

- Forming tools for Super alloys
- Thermomechanical behaviour of Engine disks

- High performance steels: thermomechanical behaviour, multiscale analyses

ICA keywords cloud

Extracted from keywords used in research papers published between 2014 and 2017

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❖ MS2M research group

Modelling of Mechanical Systems and Microsystems

- **Axis 1 – Dynamic behaviour of Structures ; Conception Preliminary design *(ISM)***
- **Axis 2 – Mechanical microsystems ; Modelling under Deterministic or uncertain environment *(ISS)***

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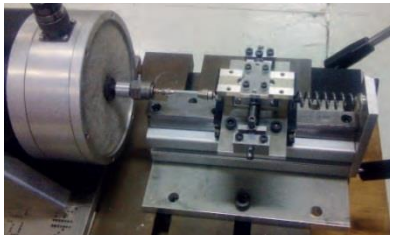
- **Modelling non linear dynamic systems**

Dynamic systems with a parametric excitation:

- Stay with shrouds structures,
- Rotors,

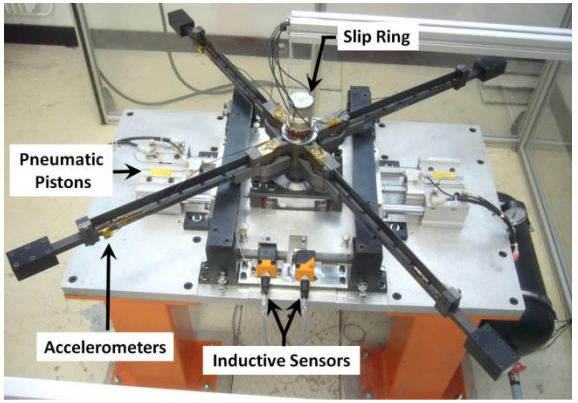
Passive vibration control:

- Localised non linearity,
- Structural damping,
- Energy pumping.



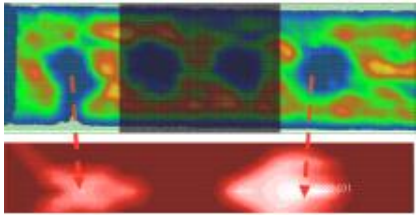
Non-linear passive damping

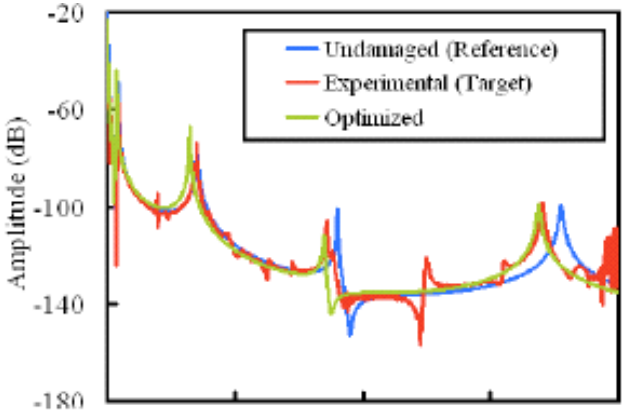
Helicopters: resonance at ground



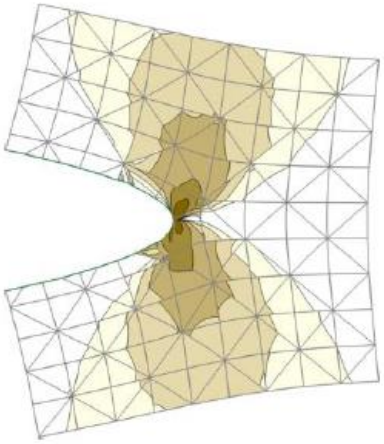
- **Energy dissipation and diagnostic**

- Damaging processes,
- Composite materials,
- Bio-inspired systems,
- Fatigue under vibrations.



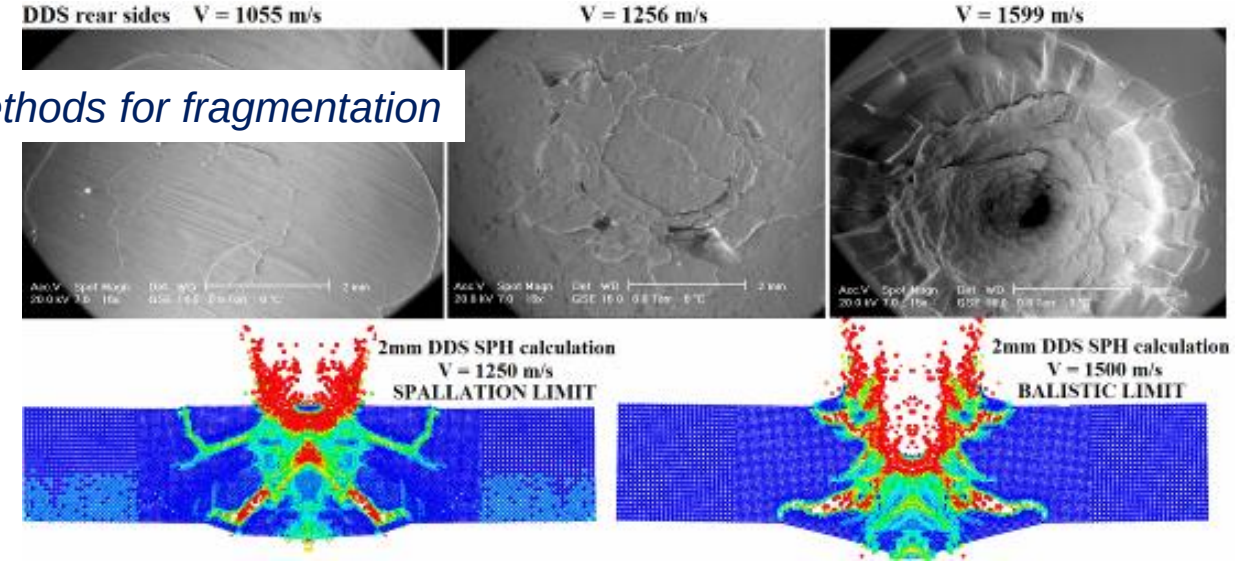


- **Numerical modelling of fracture materials and structure**
  - Non-linear transitory dynamics
  - Non-linear material and geometric modelling
  - Spatial discretisation (X-FEM, SPH, DEM,…)



X-FEM

SPH Methods for fragmentation



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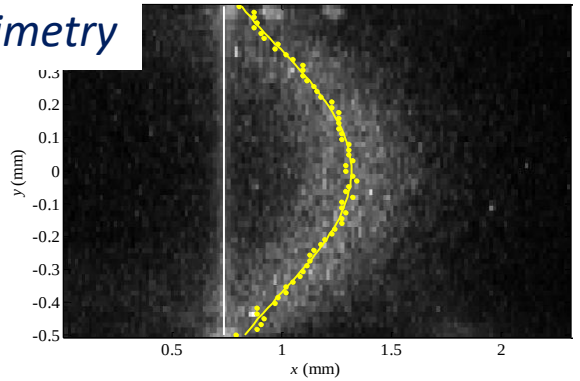
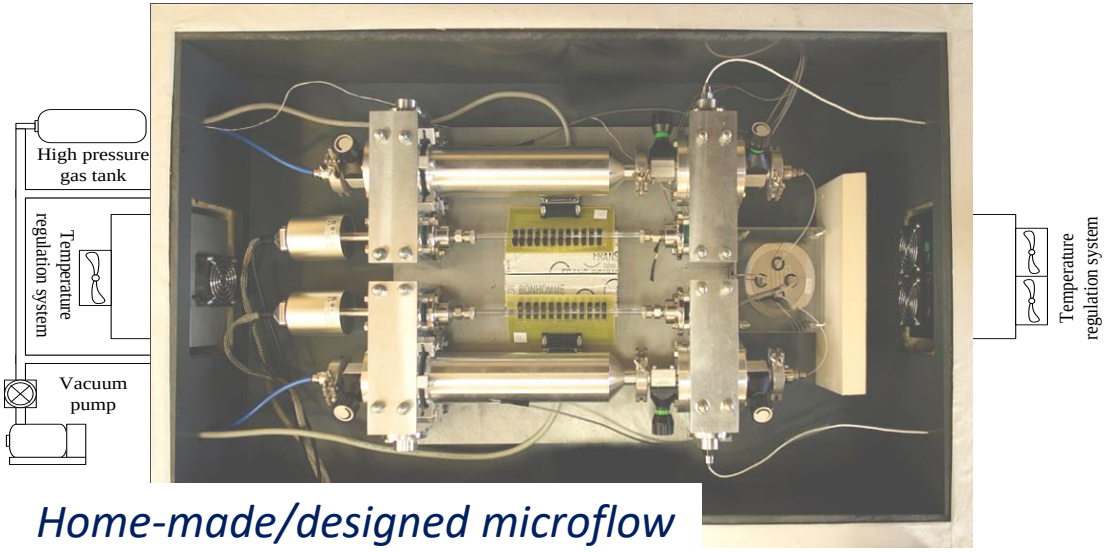
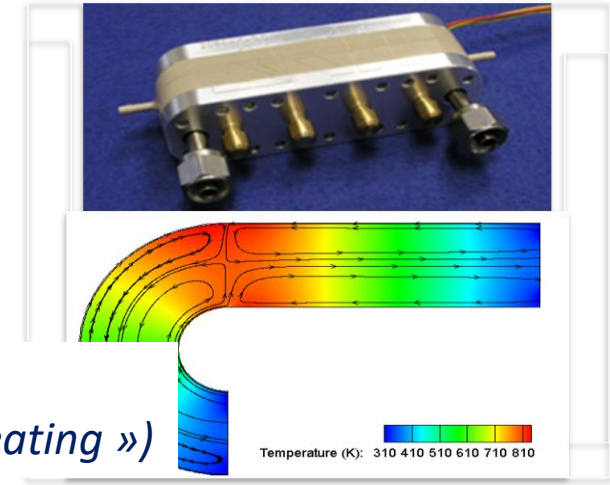
- **Microfluidics**
  - Gazeous microflows
  - Development of specific bench for microflows analysis
  - Continous and kinetics modelling of microflows

Molecular Tagging Velocimetry





Home-made/designed microflow measurement bench



Knudsen pump
(« thermal sweating »)

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❖ MSC research group

Composites Structures and Materials

- ❑ **Axis 1 – Structures Impact Modelling, Machining *(SIMU)***
- ❑ **Axis 2 - Materials, Processes, Properties *(MaPP)***

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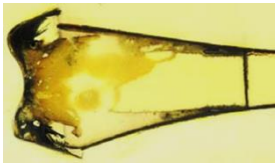
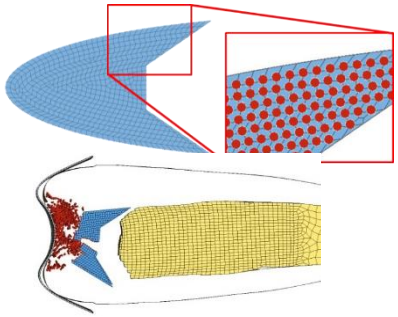
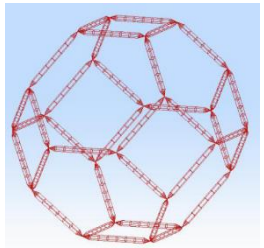
- **Modelling of composite structure damaging: helicopter blades example**

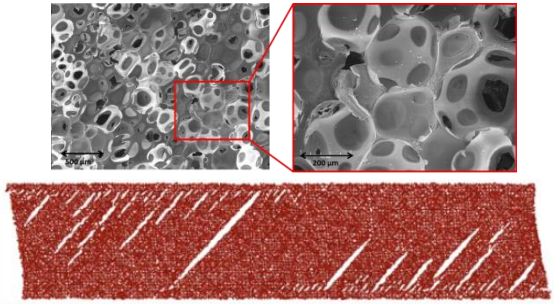
UD :

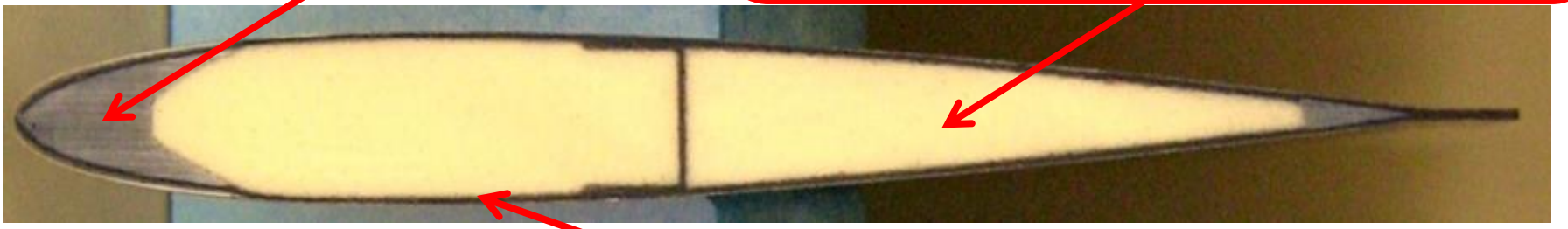




Foam core:

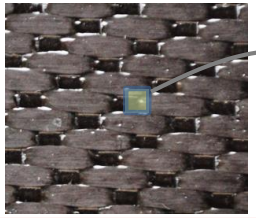


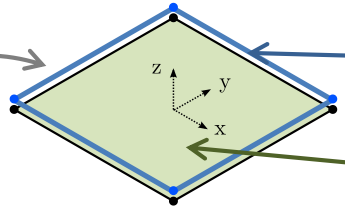




Woven composite skin :

(CIFRES Airbus Helicopters)

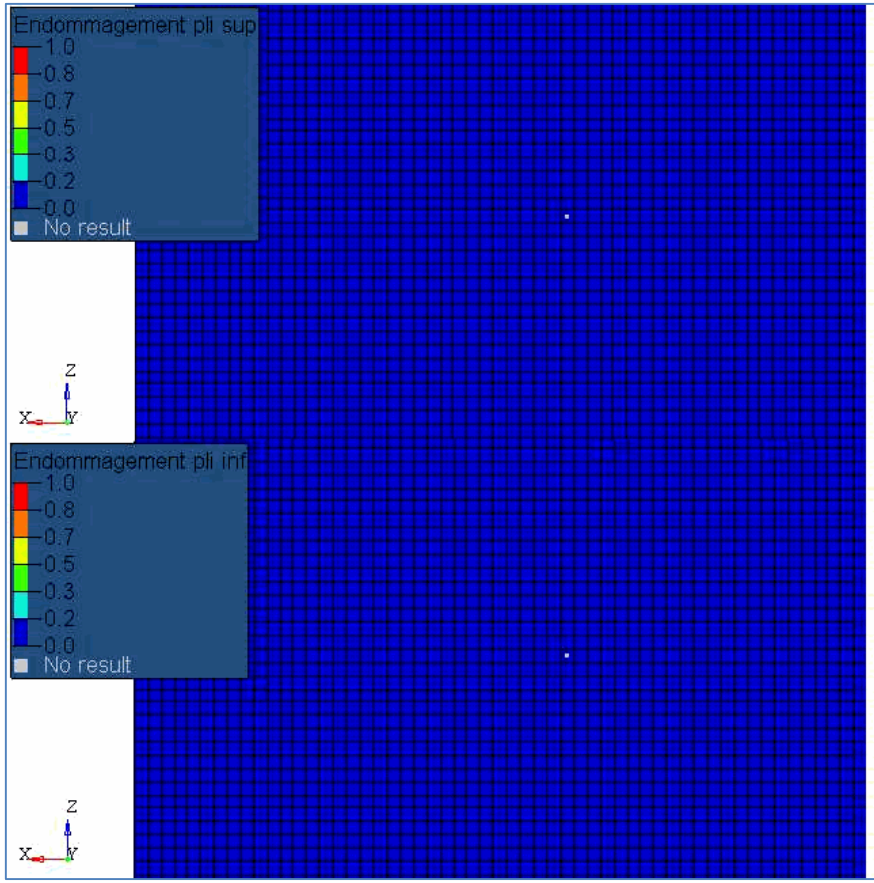


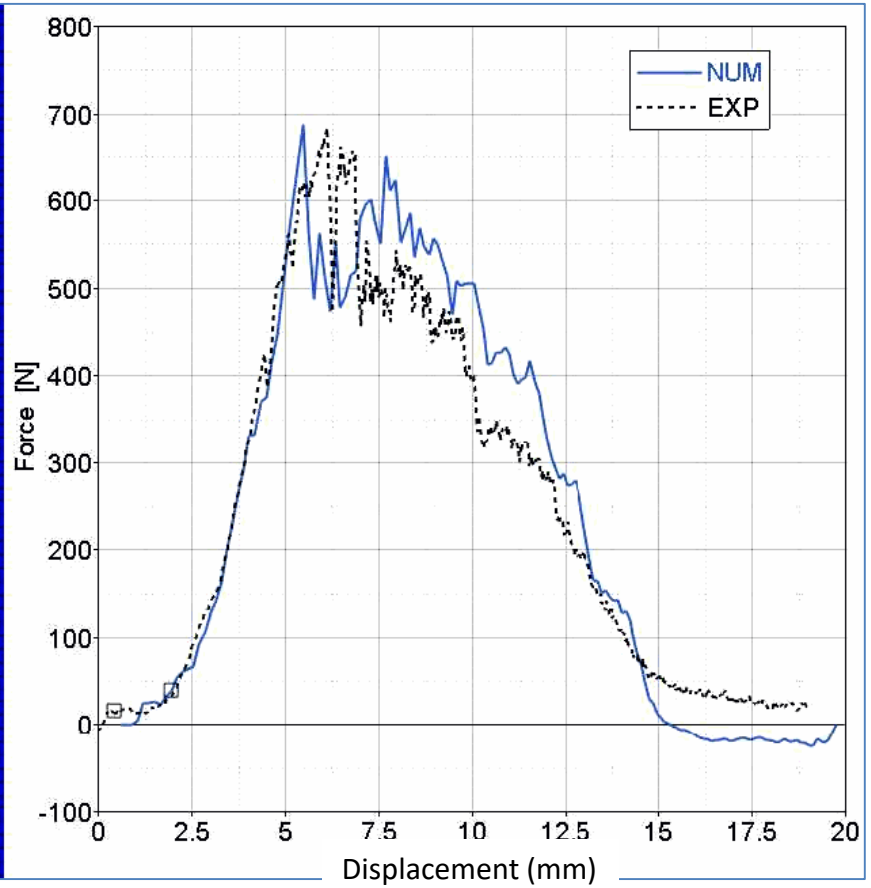


1D rods

2D shell element

- **Modelling low energy impact and damage simulation on composites**





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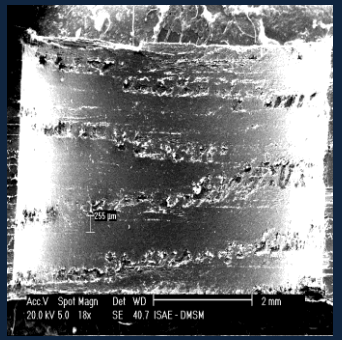
- **An overview of some of our manufacturing facilities**









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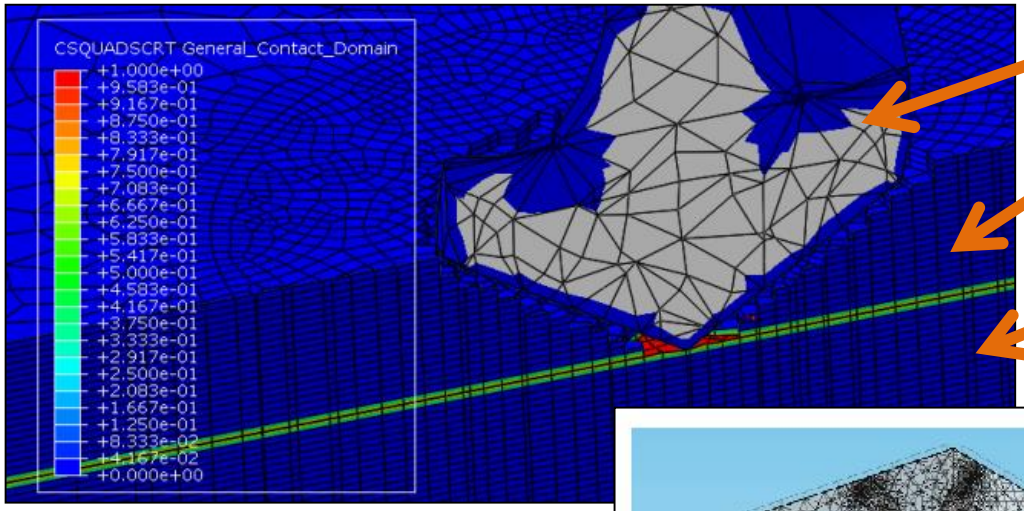
- **Machining / drilling of composites** **Damages prediction / cutting parameters**



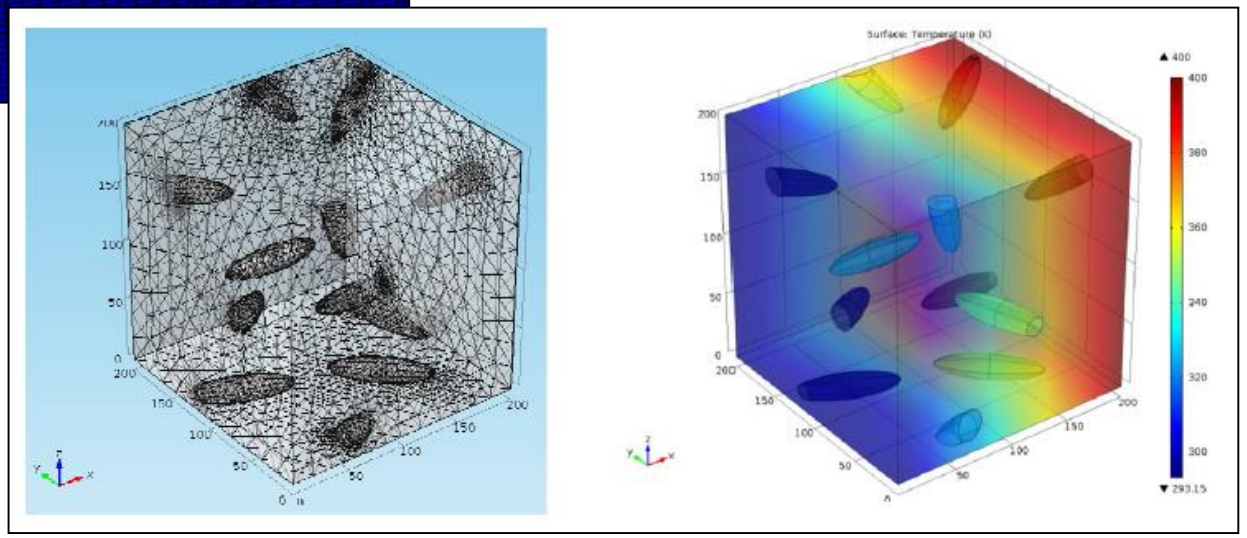
Drill

Carbon/Epoxy laminate

Aluminium layer

- **Virtual material / doped matrices**

Random dispersion of ellipsoïdal thermally conductive particules in a polymeric matrix



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❖ SUMO research group

Surfaces, Machining, Materials & Tooling

- ❑ **Axis 1 – Modelling of fatigue, damaging and wear *(FaMEU)***
- ❑ **Axis 2 – Properties and behaviour of metallic materials *(PUMMA)***
- ❑ **Axis 3 – Machining and metallic materials forming *(USIMEF)***

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- **Fatigue, Damaging, Wear**

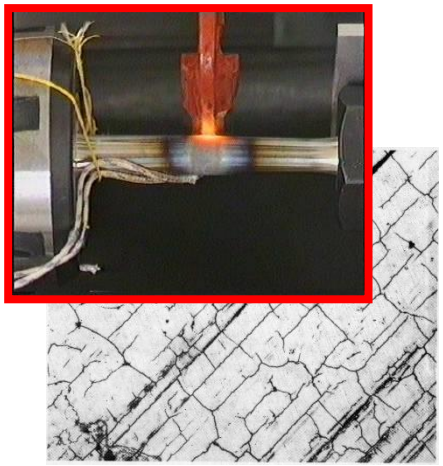
Thermo-Mechanical loading

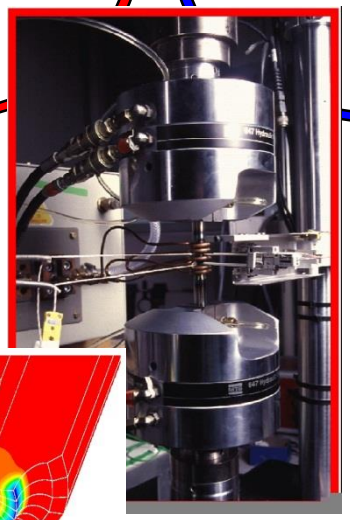
SURFACE of metallic materials

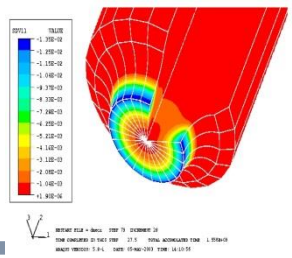
Environment effects

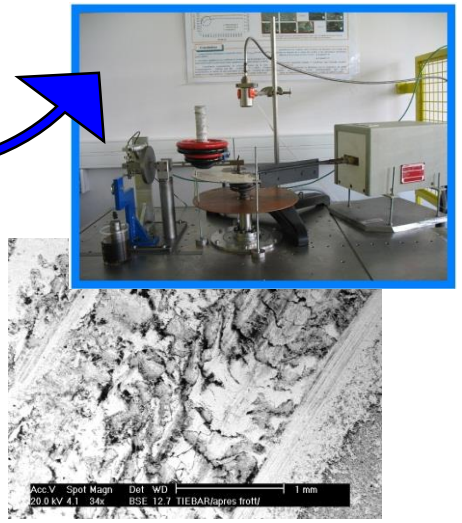
Isothermal fatigue + thermal - mechanical

Tribology









Damage stemming from thermal fatigue

Damage stemming from tribological laoding

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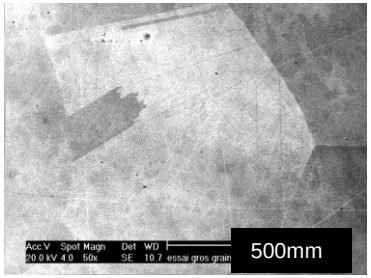
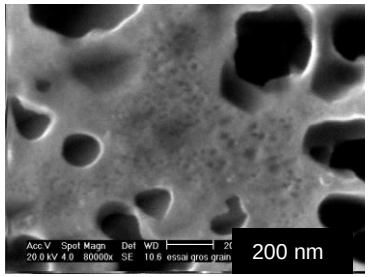
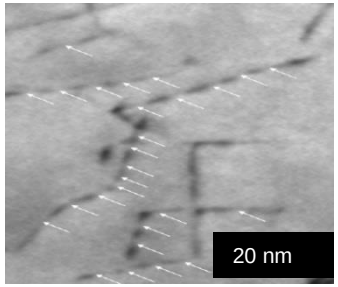
- **Properties and behaviour of metallic materials**

- **Various approaches**

  - nano-micro-macro investigations
  - surface / volume

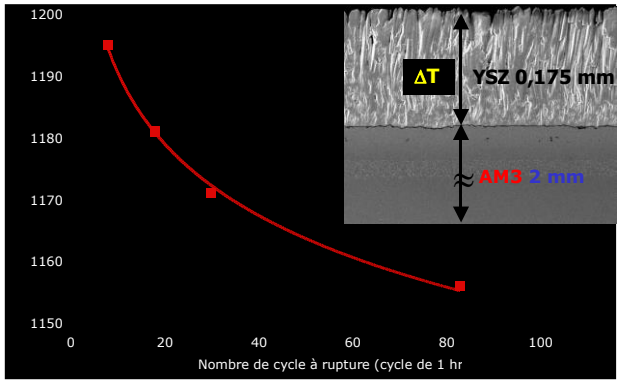






- **Various topics**

  - microstructure / properties relationship high performances steels, titanium alloys, super alloys
  - durability of coatings and functionally graded materials
  - oxidation & corrosion at high T°
  - thermal surface treatments
  - thermal fatigue
  - thermomechanical fatigue
  - fracture mechanics



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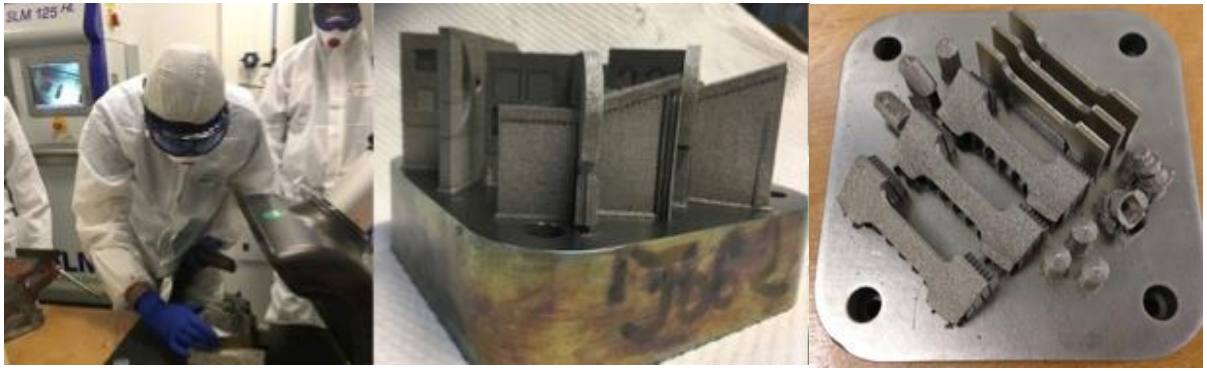
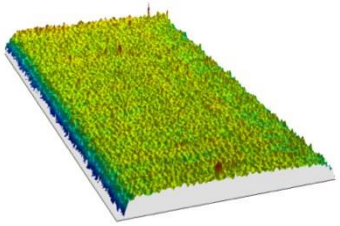
- **Manufacturing with metallic materials**

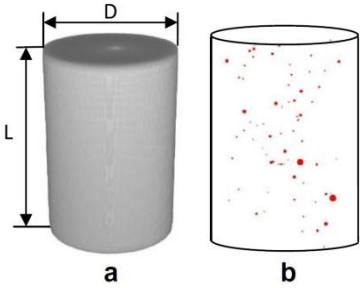
Additive manufacturing



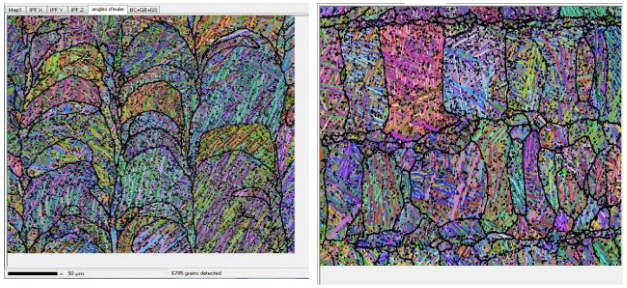
Experimental characterisation and simulation



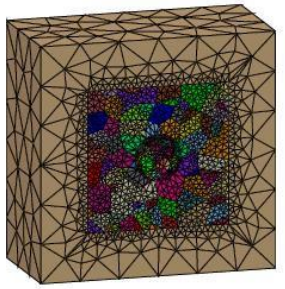
Surface analysis



Xrays Tomography



Anisotropy characterisation



Numerical simulation

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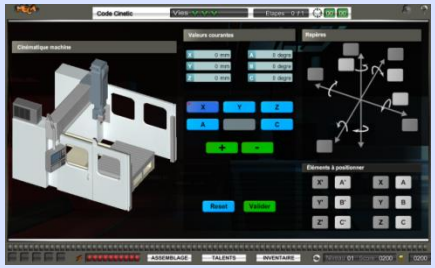
- **CAM (*Computer Aided Manufacturing*)**

An online Serious game to teach mechanical engineering

http://mecagenius.univ-jfc.fr/

216 activities to discover, to learn, to manufacture and to optimize machining processes



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❖ MICS research group

Metrology, Instrumentation, Control, Monitoring

- ❑ **Axis 1 – Innovative optical methods for dimensional and thermal metrology**
- ❑ **Axis 2 – Identification and Control of Thermal and Mechanical Properties**

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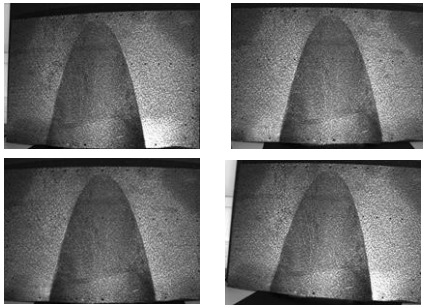
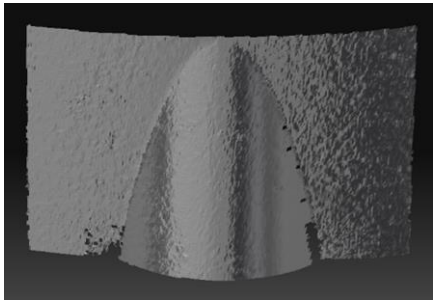
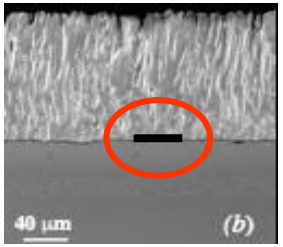
UMR CNRS 5312

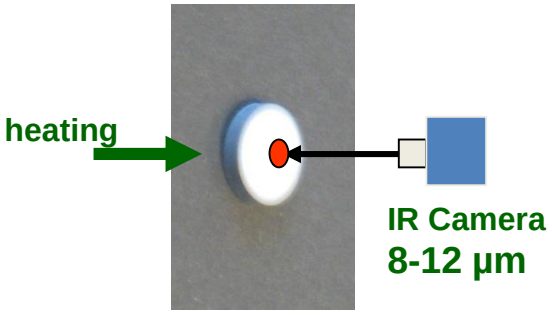
- **Innovative optical methods for dimensional and thermal metrology**

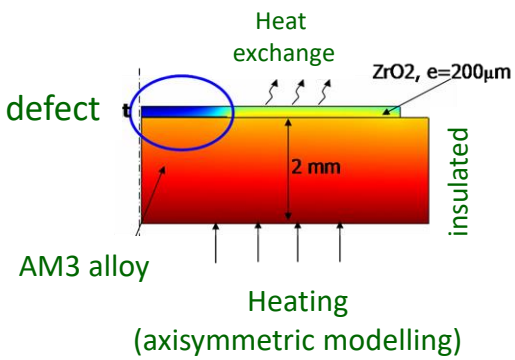
- Artificial vision for photomechancis and NDT
- Measurement of real temperature fields by infrared thermography and radiometry
- Modelling interaction between IR rays and materials. Radiative properties characterisation
- Optical fibre sensors instrumentation

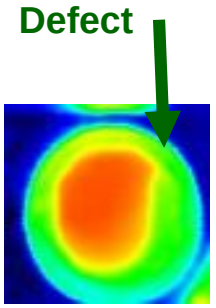












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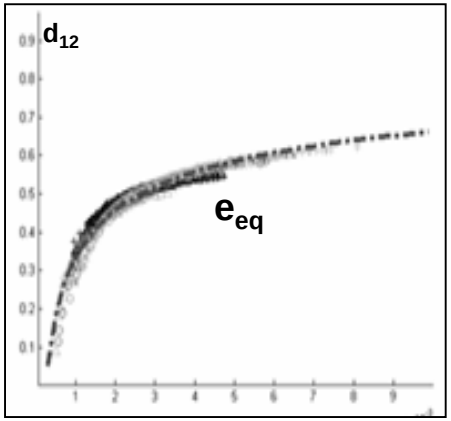
- **Identification and Control of Thermal and Mechanical Properties**

  - Health and behaviour of materials and structures: characterisation using digital image correlation (displacement fields) and NDE

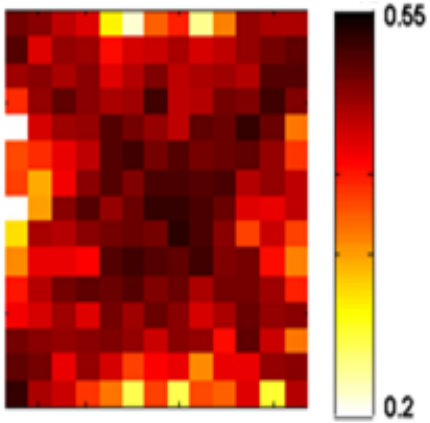
  - Design of instrumentation and sampling procedures for the study of heterogeneous materials and structures

  - Identification of behaviour laws from heterogeneous tests

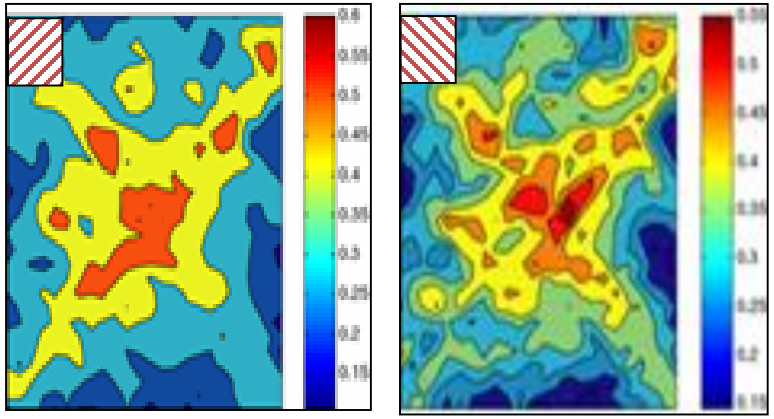
Damaging law



Identified charts



post treated charts



Thank You