



Institut Clément Ader
3 Rue Caroline Aigle 31400 Toulouse FRANCE
Tel. +33 561 171 085

www.institut-clement-ader.fr

Contacts at ICA

Prof. Philippe Olivier

Director
Tel. : +33 562 258 836
E-mail: philippe.olivier@iut-tlse3.fr

Prof. Yves Gourinat

Deputy Director
Tel. : +33 561 338 117
E-mail: yves.gourinat@isae.fr

Prof. Jean-José Orteu

Metrology, Identification, Control and Monitoring Group
Tel. : +33 563 493 073
E-mail: jean-jose.orteu@mines-albi.fr

Prof. Farhad Rézai-Aria

Surface, Machining, Materials and Tools Group
Tel. : +33 563 493 082
E-mail: rezai@mines-albi.fr

Prof. Thierry Cutard

Deputy Director
Tel. : +33 563 493 161
E-mail: cutard@mines-albi.fr

Prof. Bruno Castanié

Composite Materials and Structures Group
Tel. : +33 561 338 116 / +33 561 559 265
E-mail: bruno.castanie@insa-toulouse.fr

Prof. Patrice Longère

Modelling of Mechanical Systems and Microsystems Group
Tel. : +33 561 338 115
E-mail: patrice.longere@isae.fr

Prof. Alain Daidié : Transverse Axis "Assemblies" - E-mail: alain.daidie@insa-toulouse.fr

Ass. Prof. Yann Landon : Transverse Axis "Machining of Multi-Materials Stacks" - E-mail: yann.landon@univ-tlse3.fr

Location



ICA Toulouse

3 rue Caroline Aigle
31400 Toulouse

ICA Albi

Ecole des Mines
Campus Jarlard
81013 Albi CEDEX 09

ICA Tarbes

IUT de Tarbes, Dépt. GMP
1 Rue Lautréamont
65000 Tarbes



Institut Clément Ader

Research Centre

Mechanics



www.institut-clement-ader.fr



Institut Clément Ader (ICA)



We are a research laboratory studying the mechanics of materials, manufacturing processes, structures and systems, with a particular attention paid toward aeronautics and space. Our work generally concerns process modelling, behaviour modelling, devising instrumentation and studying durability. We regularly combine experiment with modelling. Our laboratory is fully equipped for all computing and testing requirements, with in house softwares, laboratory test benches and also process pilots.

Institut Clément Ader groups together staff belonging to four major research and education institutions of the Midi-Pyrénées region : École des Mines d'Albi-Carmaux (Mines Albi), Institut National des Sciences Appliquées de Toulouse (INSAT), Institut Supérieur de l'Aéronautique et de l'Espace (ISAE), Université Paul Sabatier - Toulouse 3 (UPS).

The laboratory is structured into four research groups that are described below and also two transverse axes of research on Machining of Multi-Materials Stacks and on Assemblies. Since January 1st 2015, the laboratory is a CNRS unit (FRE CNRS 3687).

Composite Materials and Structures Group

The research activities of the Composite Materials and Structures Group can be split into two main axis:

SIMU: Structure, Impact, Modelling, Machining of composites

Under the main frame of both experimental and numerical approaches, SIMU axis (16 permanent people) addresses the following topics:

1/ Composite structures

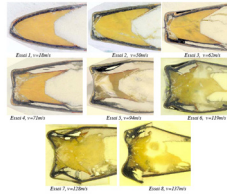
- Behaviour under static / dynamic loadings
- Study of structural details
- Assemblies strength and behaviour
- Structural testing
- Sandwich structures
- Durability of structures, ageing

2/ Impact / Crash

- Low / High energy impacts / Crash
- Residual strength
- Impact damages on monolithic and sandwich structures

3/ Machining of composite materials

- cutting tools geometry
- cutting parameters
- relationship between machining parameters and resulting damages and defects



MaPP: Materials Properties and Processes

MaPP axis (10 permanent people) addresses the following topics:

1/ Simulation of composite manufacturing

- Chemorheology modelling (TD), crystallisation of TP and inorganic matrices, Phase diagrams, multiphysics studies
- Study and simulation of composites manufacturing processes (RTM, Infusion, Filament Winding, Autocalve, ...),
- Emerging manufacturing technologies: I.R. heating, Induction heating systems
- Relationships between manufacturing parameters and induced material properties

2/ Tooling development

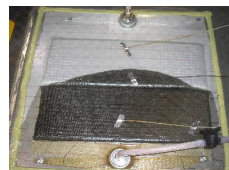
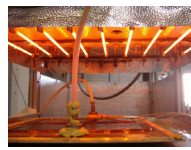
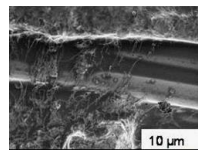
- Inorganic matrix composite moulds,
- Carbon/Polymeric moulds
- Tooling instrumentation,

3/ Innovative methods for multiscale study of composite materials in composite structures

- part instrumentation during manufacturing (FBG, MEMS Patches)
- composite repair: new methods, instrumented repair systems, water jet machining

4/ Functionalization of organic matrix composites

- Improvement of thermal and/or electrical behaviour of polymeric matrices and composites
- Simulation of physical and mechanical properties of nanofilled composites



A few indicators

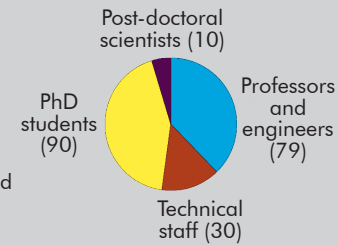
Scientific production:

20 PhD defended per year and 160 publications per year (journal and conference papers)

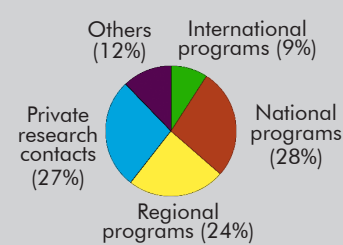
Scientific networks:

- GDR CNRS 2502 "Contrôle des décollements"
- GDR CNRS 2519 "Full-field Measurements and Identification in Solid Mechanics"
- GDR CNRS 3305 "Micro Nano Systèmes, Micro Nano Fluidique"
- GDR CNRS 3371 "Composites Manufacturing and Involved Properties"
- GDR CNRS 3437 "Dynamics of structures and non-linear dynamics approaches"

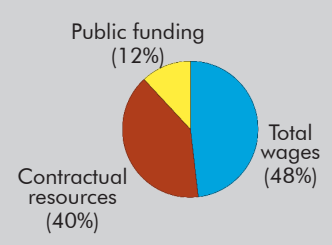
Human Resources (200 people)



Contractual Resources (3.3 M€/year)



Global Resources (8.3 M€/year)



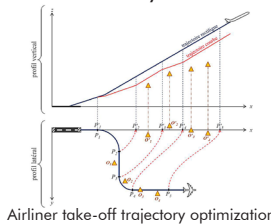
Modelling of Mechanical Systems and Microsystems Group

MS2M-group (65 people, PhD students inc.) research topics are turned towards the development of models and methodologies devoted to the multidisciplinary and multi-scale study of mechanical structures and systems, from the very beginning of the conceptual stage until the ultimate validation/prediction of the structure/system integrity in nominal service and/or when submitted to adventitious events. Scientific activities are grouped in two research axes:

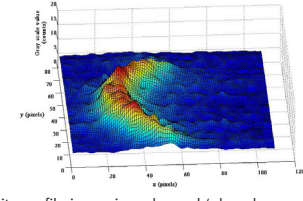
Systems and Microsystems Engineering

Research activities notably aim at developing methods of multidisciplinary optimal design, at the preliminary or project stage, in the presence or not of uncertainties. Theoretical and experimental studies are also conducted on the behavior of single phase or two-phase micro-flows encountered inside or generated by microsystems, focusing on specificities induced by high confinement. Design assisting-tools are also developed for dimensioning high technology systems and actuators.

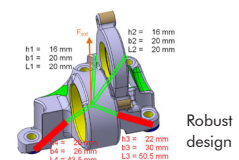
- Design optimization in multidisciplinary or uncertain environments
- Microfluidics and mechanical microsystems
- Onboard systems and actuators



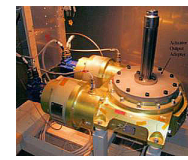
Airliner take-off trajectory optimization



Velocity profile in a micro channel (phosphorescence signal)



Robust design

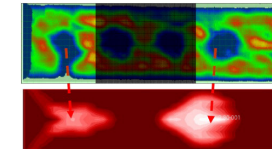


Redundant onboard actuator prototype

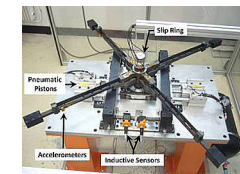
Structures and Systems Integrity

Research activities focus on structures and systems both in their nominal use and up to failure conditions. They especially address the nonlinear dynamic response of large structures and complex systems (e.g. rotors), as well as the analysis of structures submitted to accidental overloads (e.g. impact). Current emphases in research are put on structural health monitoring (SHM) and computational methods for strongly nonlinear, structure analysis.

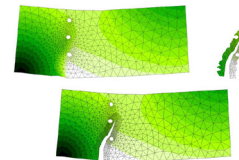
- Systems and structures dynamics
- Structures under severe conditions
- Computational Structural Mechanics



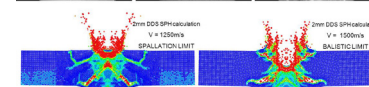
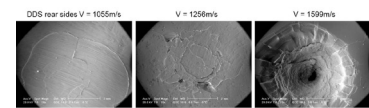
Topologic optimization for damage locating in composite structures (SHM)



Experimental study of an anisotropic rotor

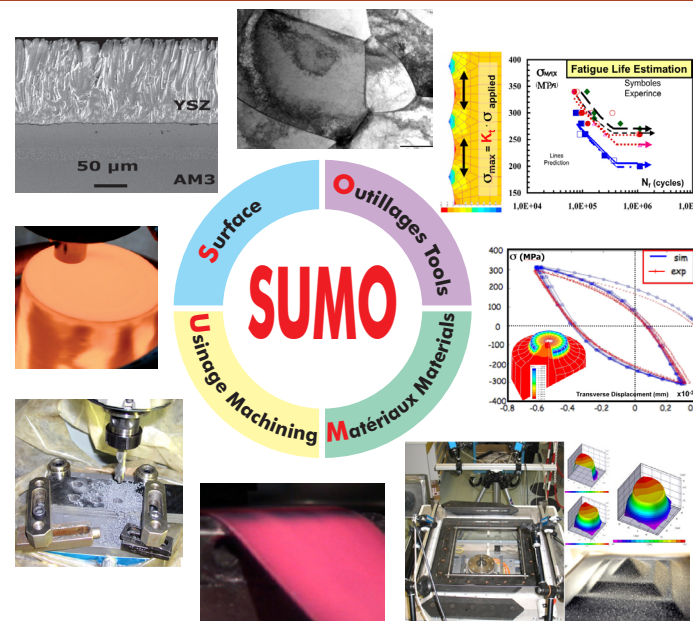


Non-intrusive, global FEM / local X-FEM coupling



Disposable Debris Shields spallation using SPH simulation

Surface, Machining, Materials and Tools Group



Research Fields:

- **Advanced Machining & Drilling**
3 & 5 Axis Machining, Strategy for Optimisation of Machining, Quality Enhancement, Optimisation of Tool Position on Plan Surfaces
- **Advanced Materials Processing (RT & HT)**
Hot & Cold Stamping, Titanium Hot Forming, SPF, Single Point Incremental Forming, FSW, Laser Forming, Forging, Rolling, Die Casting
- **Tools & Tooling in Materials Processing & Machining**
- **Metallic Materials & Multi-Materials, Heat Treatments & Aging**
Tool Steels, Titanium Alloys, Light Alloys, Superalloys, FGM, Anodising
- **Advanced Alloys Designing, Modelling & Simulation of Thermodynamic and Kinetics of Precipitation of Carbides & Intermetallics Phases**
- **Environmental (Oxidation & Corrosion) effects & TBC**
- **Tribology & Wear, Fatigue (Iso- & non- Isothermal) & Thermal Cycling, Static and Quasi Static Loadings & Spalling**
- **Damage Assesments, Cyclic Behaviour & Life Lifetime Modelling & Numerical Simulations under Thermomechanical Loadings**

Scientific Goals:

- Understanding of the Fundamental & Modelling of Behaviour & Damage
- Constitutive Behaviour Laws and Residual Residuals, Lifetime Modelling & Numerical Simulations
- Surfaces, Sub-Surfaces, Interfaces in Tools & Machined Parts
- Machining of Monolithic & Multi-Materials (Composite-Metallic)

TEAMS

FaMEU	: Fatigue, Wear, Damage, Modelling
PUMMA	: Functional Properties & Microstructural Relationships of Advanced Materials
USIMEF	: Machining & Metal Forming

Metrology, Identification, Control and Monitoring Group

The "Metrology, Identification, Control and Monitoring" group (25 people including PhD students) is dedicated to mechanical and thermal measurements for the characterization of materials and structures (photomechanics), and for process monitoring, and to identification from full-field measurements and NDT/NDE.

The main research topics dealt with by the group are:

- (3D) computer-vision for photomechanics, process control and monitoring, and NDT/NDE
- true temperature measurements by thermography and infrared radiometry
- modelling of materials/infrared radiation interaction and characterization of radiative properties
- instrumentation with Fiber Bragg Grating sensors for strain, temperature and pressure measurements
- materials and structures characterization and health monitoring using full-field or optical fibre measurements and NDT/NDE techniques
- identification of constitutive behavior from full-field measurements

