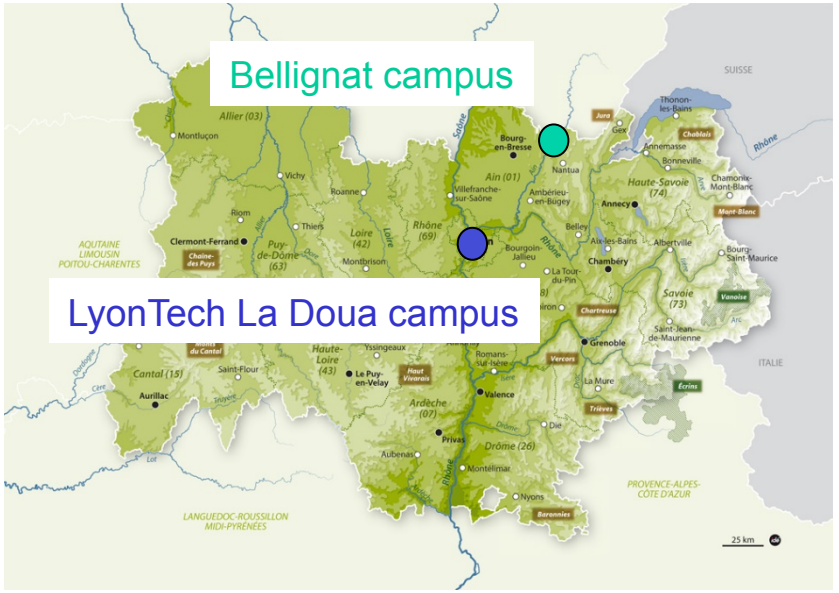
LaMCoS

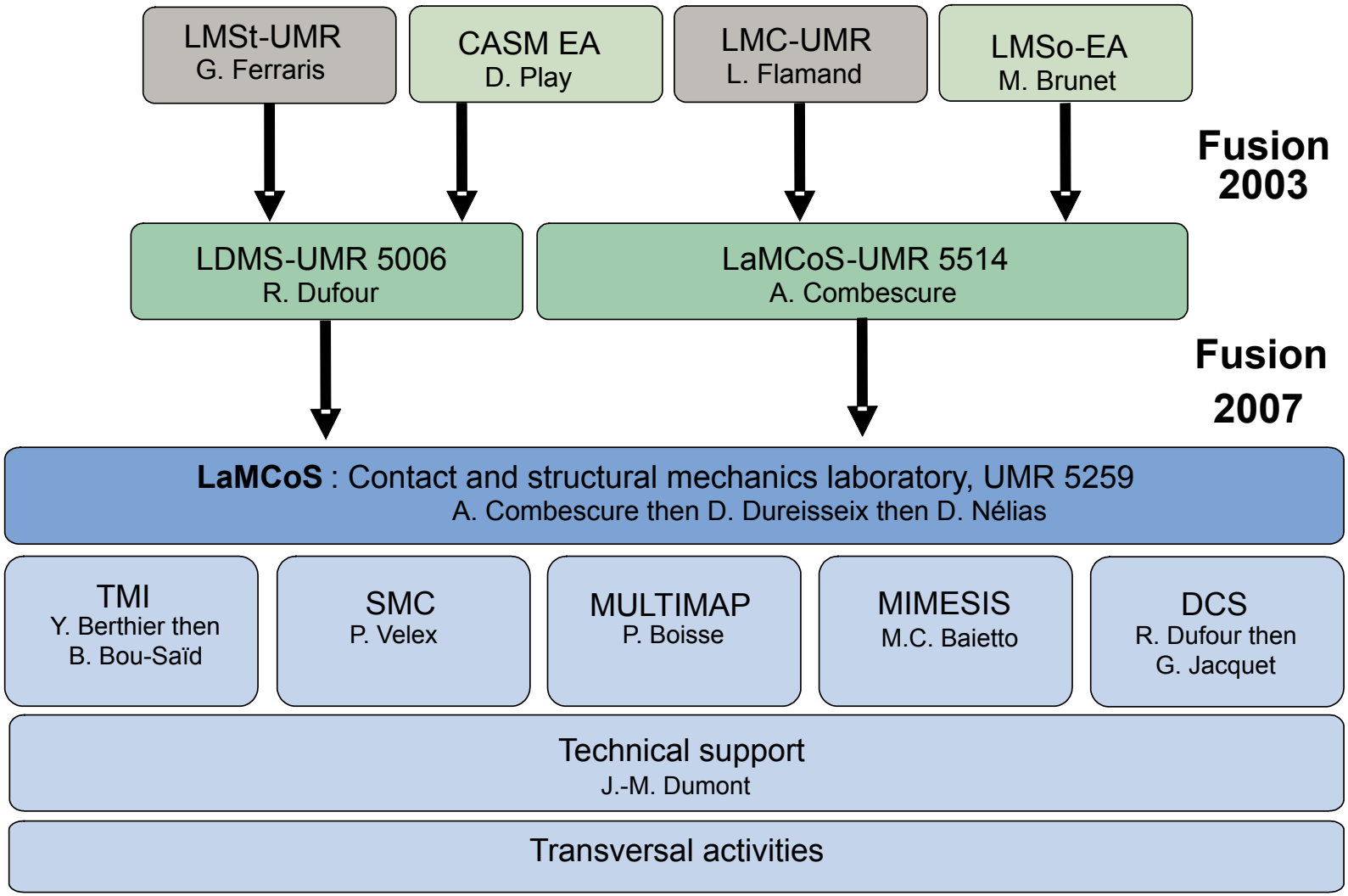
Contact and Structural Mechanics Laboratory

UMR CNRS5259 / INSA Lyon
27 bis avenue Jean Capelle
Bâtiment Sophie Germain
69 621 Villeurbanne, France
lamcos@insa-lyon.fr
http://lamcos.insa-lyon.fr

General presentation of LaMCoS - where

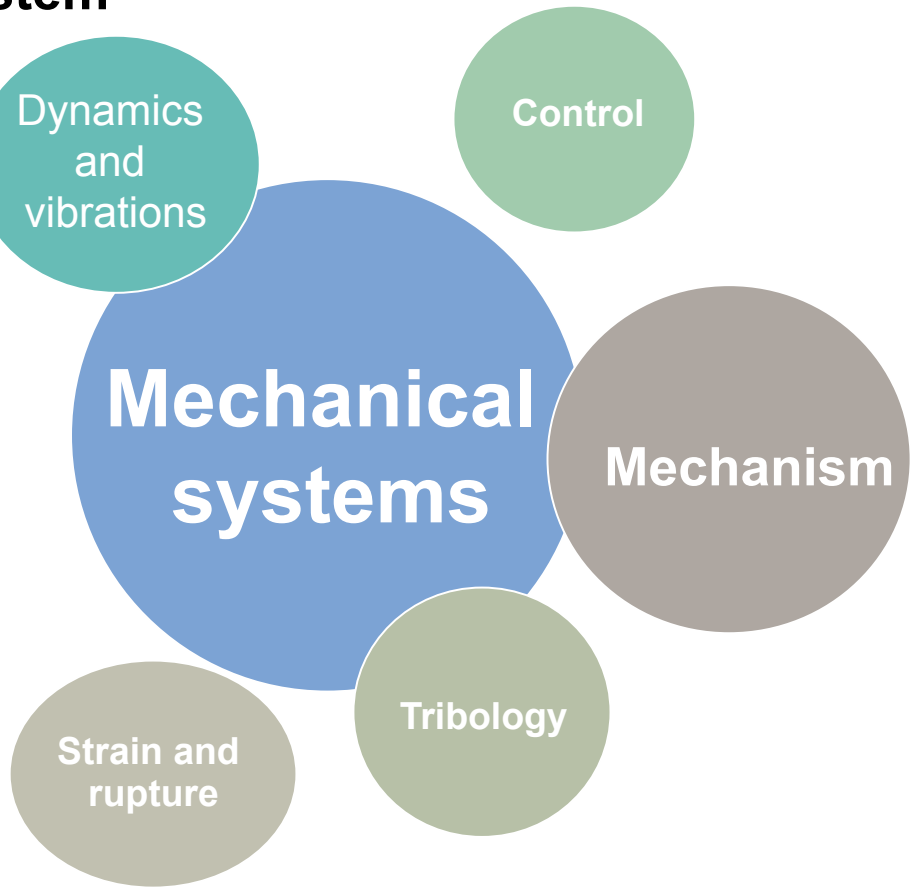


General presentation of LaMCoS – history



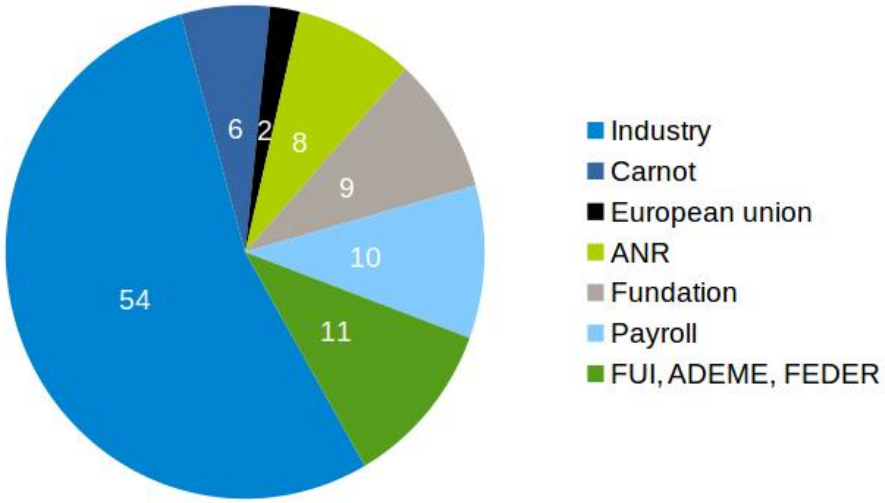
General presentation of LaMCoS – domains of expertise

Predict and control the performance and integrity of static and dynamic mechanical systems from the component to the whole system



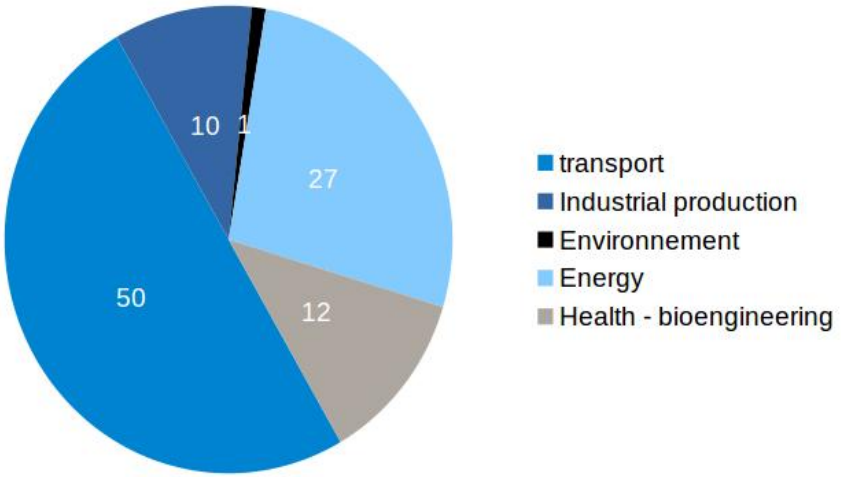
- Predict the performance and integrity of mechanical systems (living and industrial systems)
- Systematically confront experiments and numerical simulations or quasi-analytic models (pluridisciplinary teams, cutting-edge measurement techniques)
- Making relevant research topics arise from industrial barriers

General presentation of LaMCoS – facts and figures

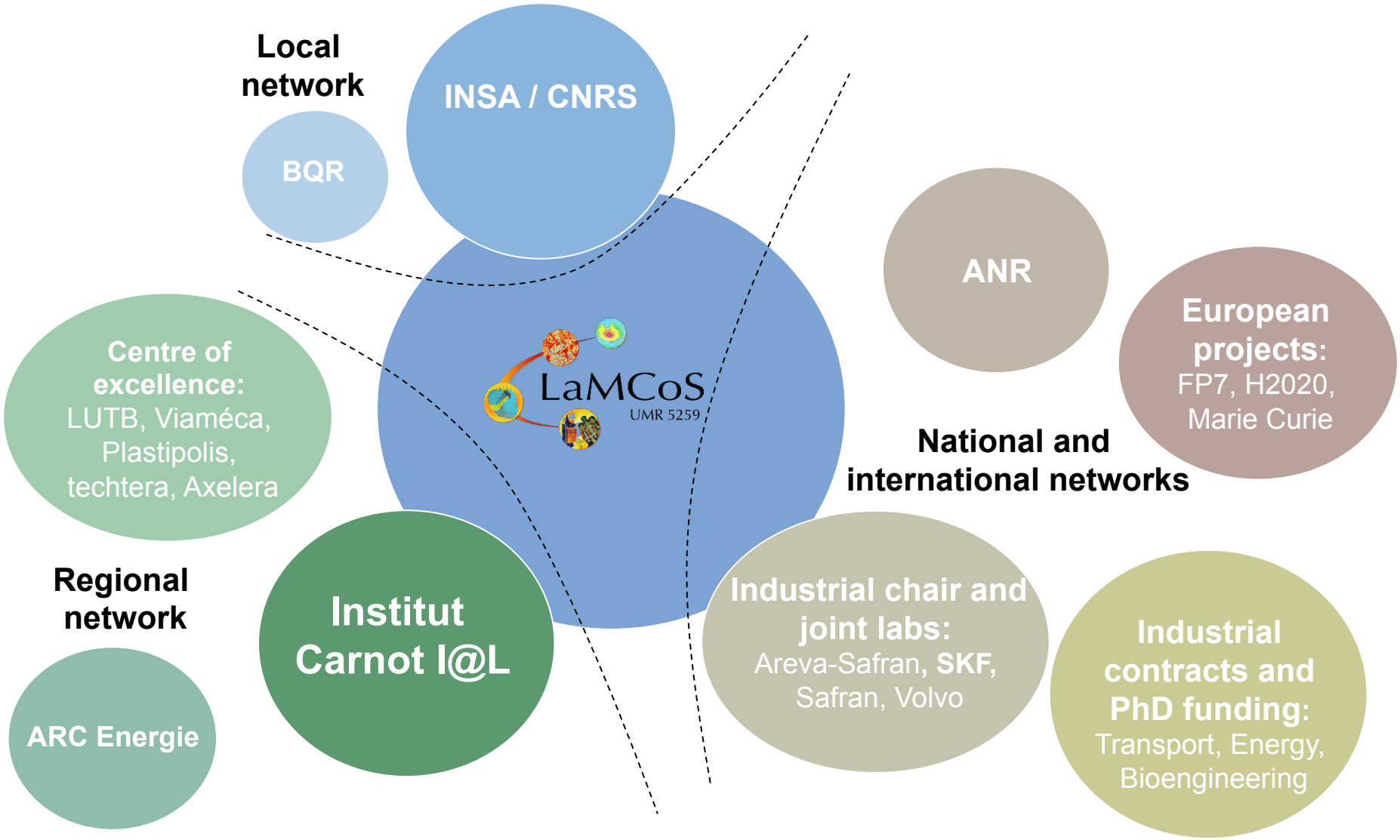


200 people; 3 papers/person/year
4.2M€ de CA*
53 teachers-researchers ; 21 technicians
104 post-graduate students ; 16 Post-docs**

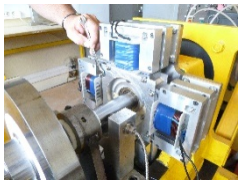
* Average 2011-2015
** Data at 30 June 2014



General presentation of LaMCoS – research network

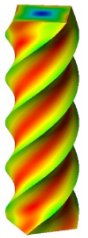


Research units



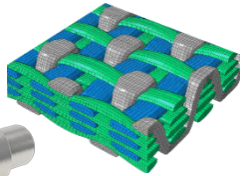
- DCS : Dynamics and Control of Structures, G.Jacquet-Richardet

Prediction and control of the dynamic behavior of machines and structures



- MIMESIS: Multiscale Mechanics for Solids, M.C. Baietto

Heterogeneous media damage and failure, non-linearities, change of scale, tangled media

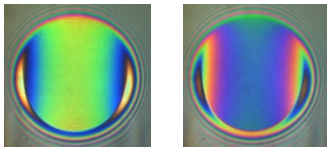


- MULTIMAP: Multiphysics Mechanics for materials and processes, P. Boisse

Numerical simulation of processes for composite, polymers and metallic materials, multiphase materials, dynamic behaviour of materials

- SMC: Mechanical Systems and Contacts, P. Velex

Quasi-static and dynamic functional analysis of lubricated systems



- TMI: Tribology and Interface Mechanics, B. Bou-Saïd

Understanding of the tribological behaviour of the contact interface.

Predictive friction, wear and fluid or solid lubrication models

- DCS : Dynamics and Control of Structures, G.Jacquet-Richardet

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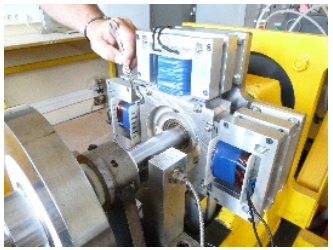
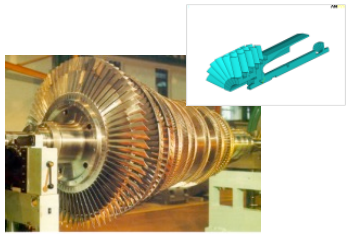


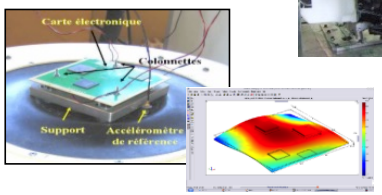
DCS Team: research topic

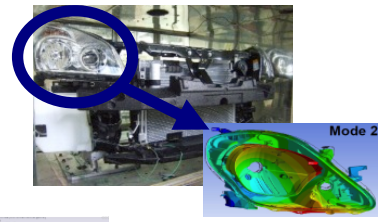
Societal issues

- UNDERSTAND and MASTER
- OPTIMISE performances
- REDUCE nuisances, limit risks
- MONITOR, ACT, CONTROL
- MAKE it energetically autonomous (smart structures)



Dynamics of Structures and Machines





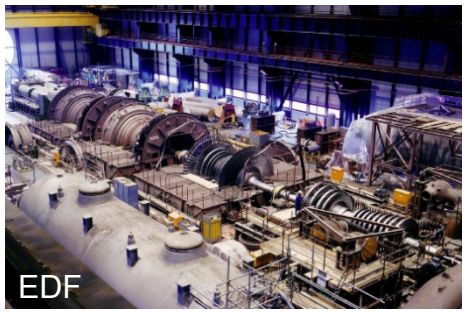
Scientific issues

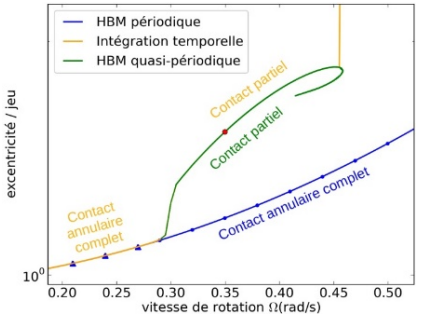
- MASTER non-linear behavior, uncertain environments and evolutive behaviors
- MIX numeric and experimental apoaches
- INCORPORATE multi-physical and multi-scale modeling of phenoma
- DESIGN smart materials and smart structures
- DEVELOP numerical dedicated method

Equipe DCS – Some achievements

Rotating Dynamic – Rotor/Stator contact

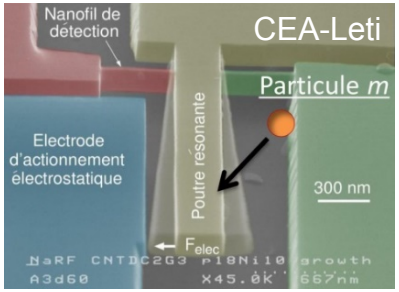
ANR IRINA (EDF) - Collaboration Turbomeca

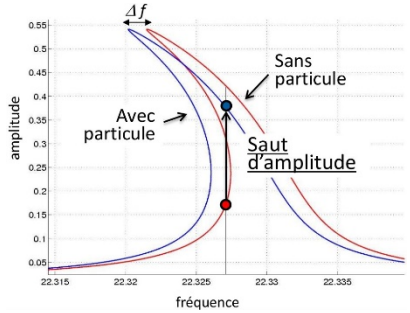




Non-linear Dynamic - MEMS/NEMS Sensors

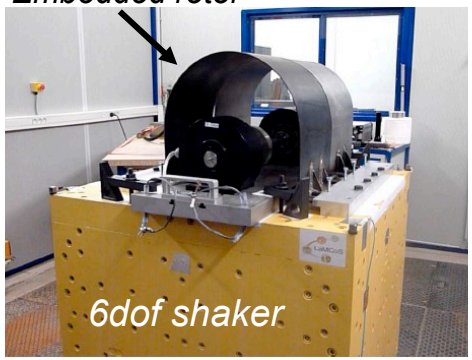
Collaboration CEA-Leti / LTDS – 2 patents





Equipex PHARE

Embedded rotor



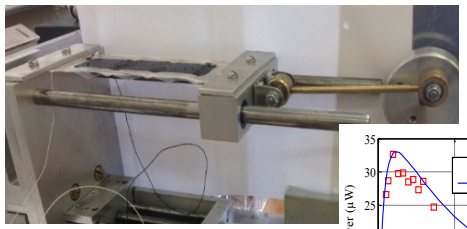
Characteristics : 62000N, 10g max, +/- 50mm, 5°rotation.

Vibration Control of new class of helicopter

Collaboration Airbus Helicopter

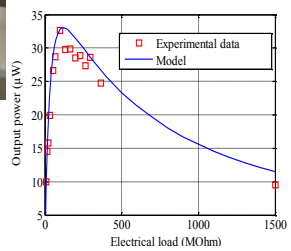
Soft hybrid Generator – Energy Scavenging

ANR SEASEA (SBM Offshore), Collaboration G2Elab, IMP, MSSMAT



Strain of 50% at 1Hz

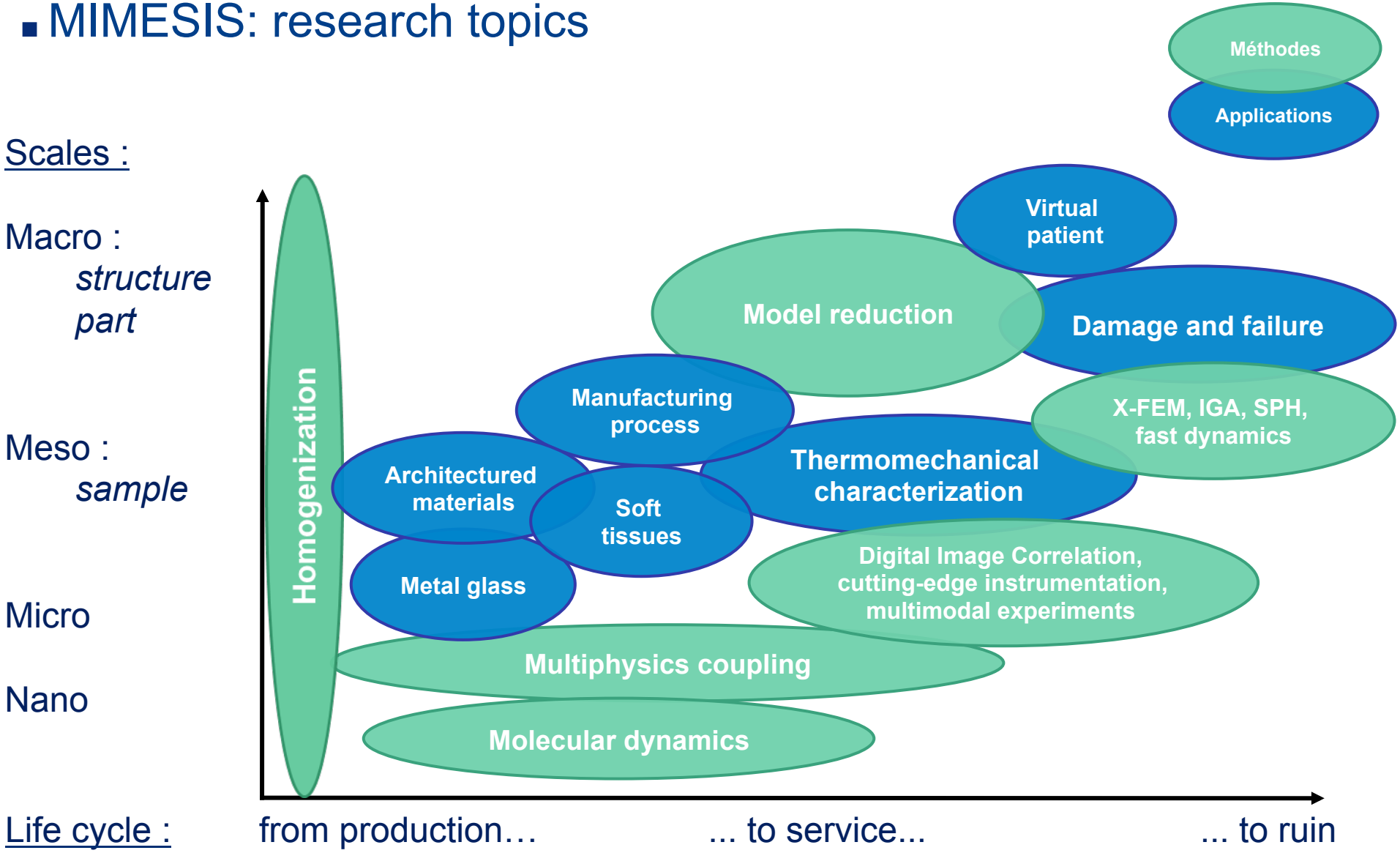
0,55mJ.g^{-1}



MIMESIS : Multiscale Mechanics for Solids, M.C. Baietto

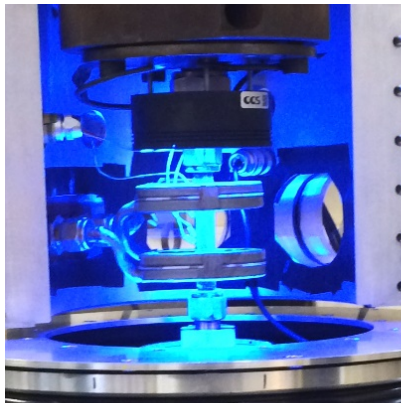
Heterogeneous media damage and failure, non-linearities, change of scale, tangled media

MIMESIS: research topics

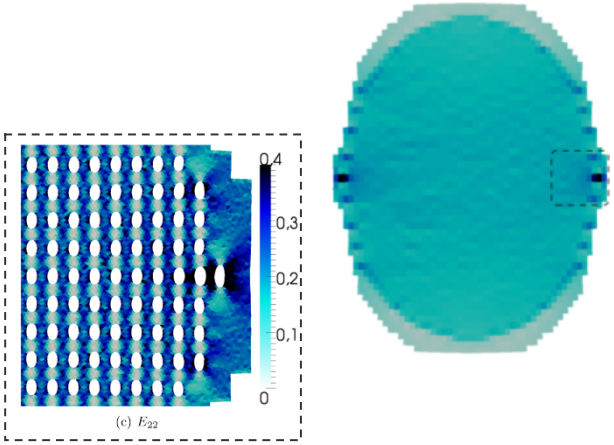


MIMESIS: some achievements

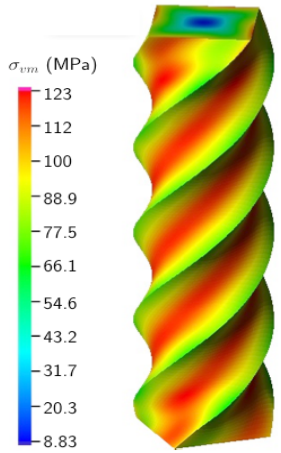
Multimodal experiments
Sheath rupture under pressure



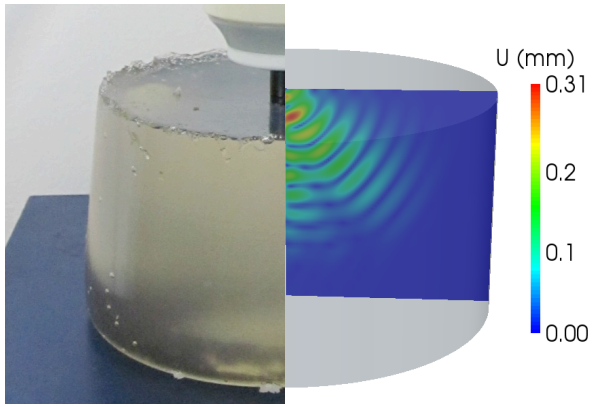
Scale transition in large strain and rupture



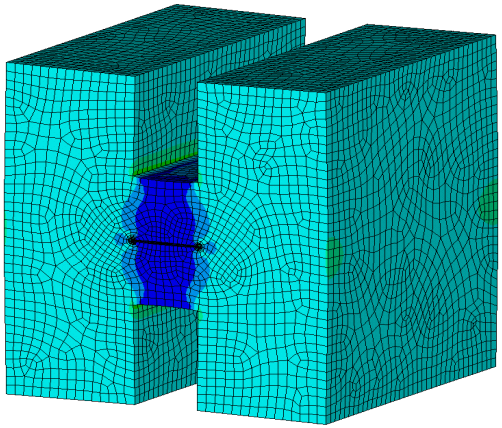
Isogeometric analysis



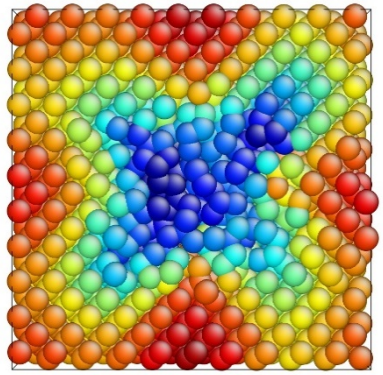
Numerical methods for soft tissues characterization



Propagation of 3D cracks using reduced-order modeling

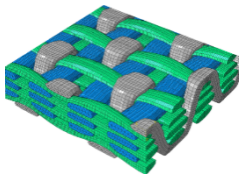


Molecular dynamics
Amorph material with an inclusion

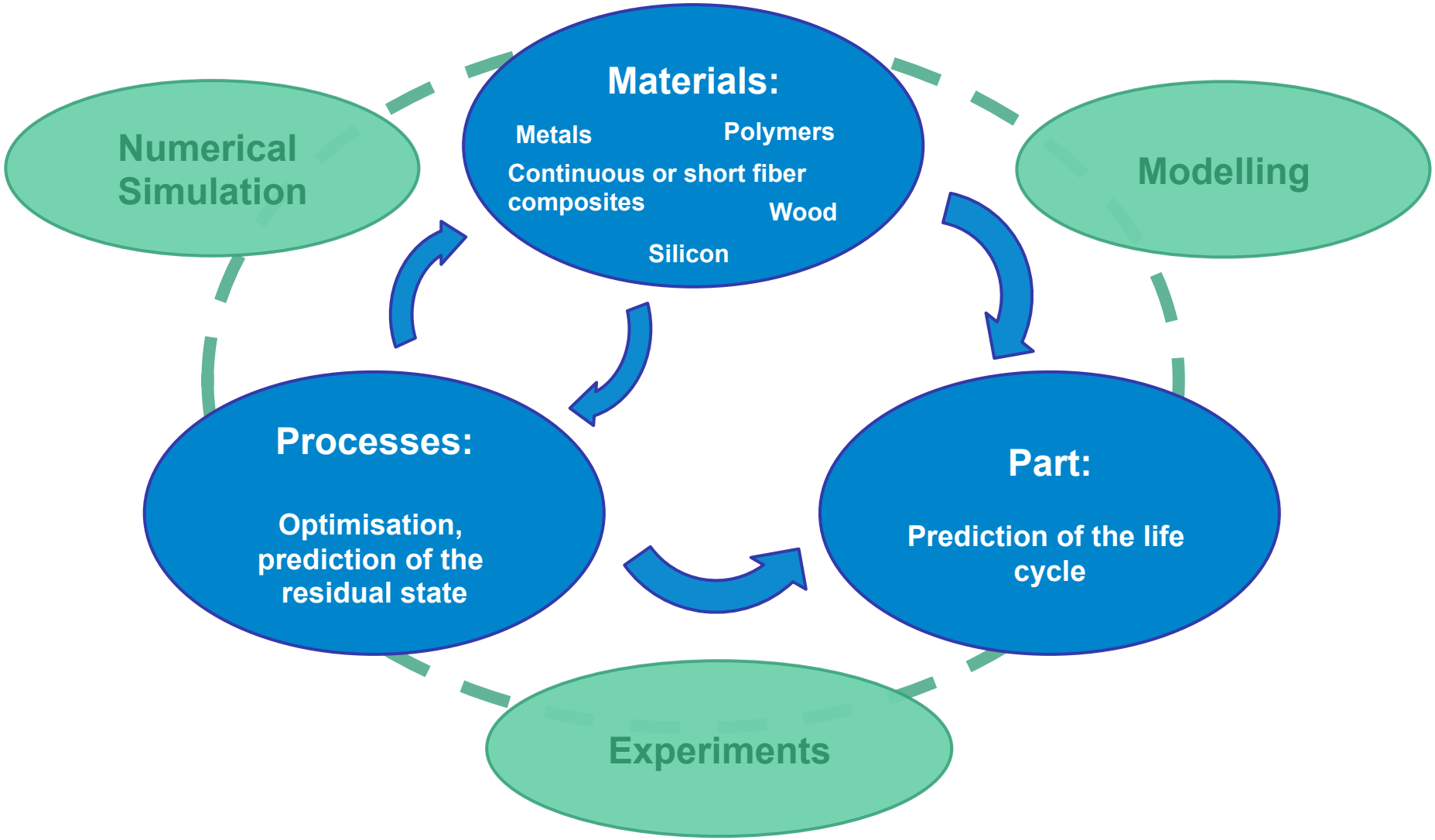


MULTIMAP : Multiphysics Mechanics for materials and processes, P. Boisse

Numerical simulation of processes for composite, polymers and metallic materials, multiphase materials, dynamic behaviour of materials



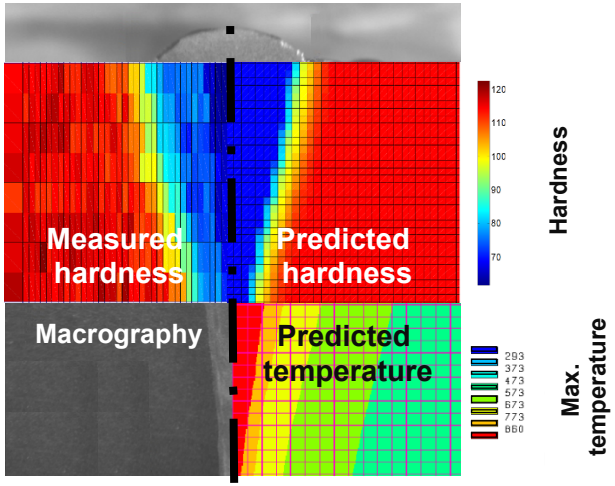
MULTIMAP: research topics



MULTIMAP: some achievements

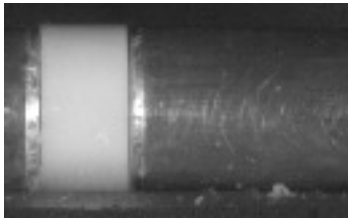
Processes for metallic materials (welding, peening…)

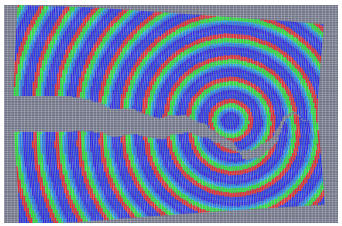
Ex.: prediction of the mechanical properties of a welded part

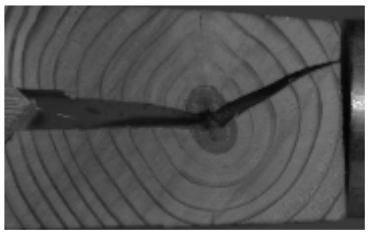


Dynamic behaviour of materials under conditions of shock

Ex.: dynamic rupture of wood and ice

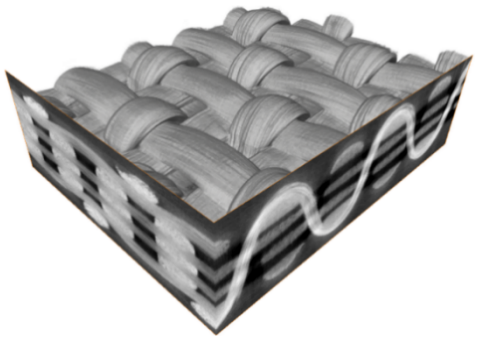


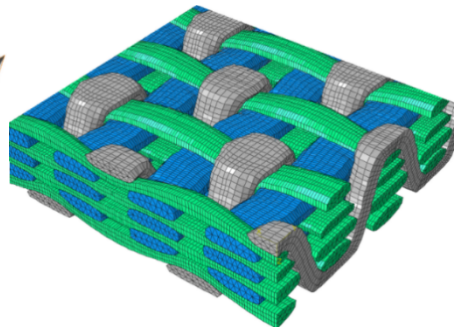




Composites forming process

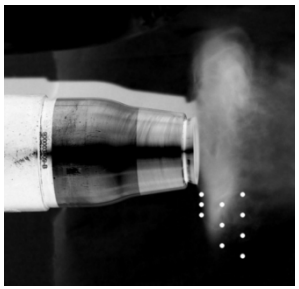
Ex: mesh generation from X-ray tomography

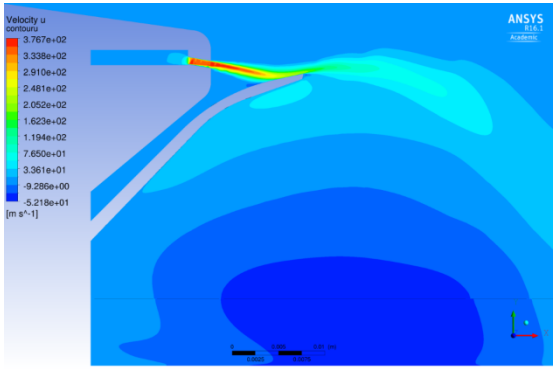




Polymer processing

Ex.: simulation of paint projection





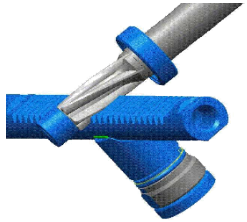
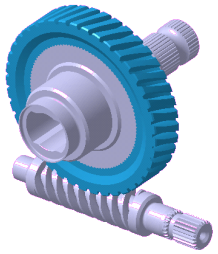
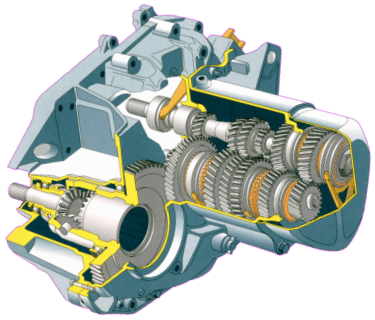
SMC : Mechanical Systems and Contacts, P. Velex

Quasi-static and dynamic functional analysis of lubricated systems

SMC Team

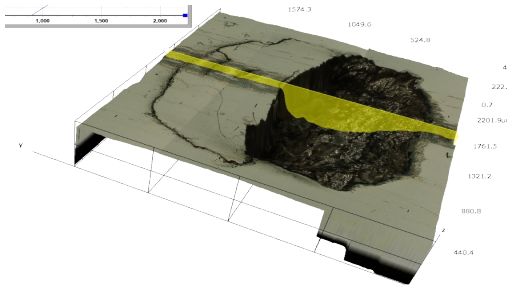
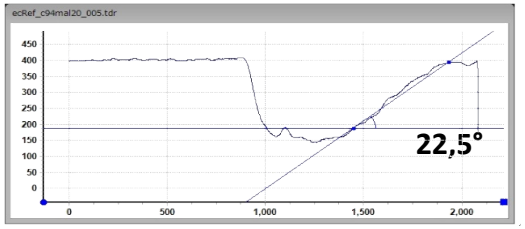
Static and **dynamic** study of **mechanisms** (gears, bearings...)

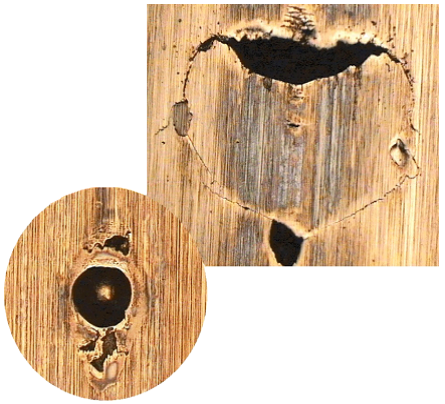
Multi-scale couplings between mechanical systems – contacts

Power losses in mechanical **transmissions**

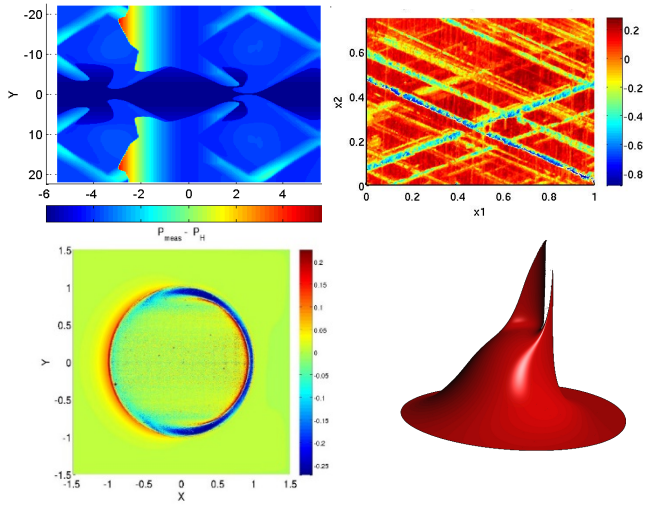
Contact failure analysis

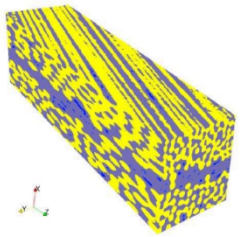


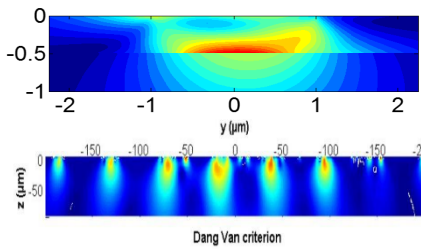
SMC Team

Optimisation of engine lubrication (texturing,...)

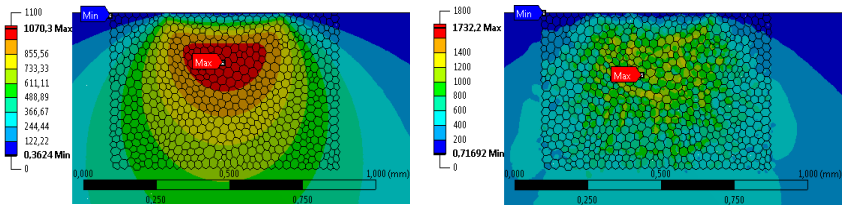


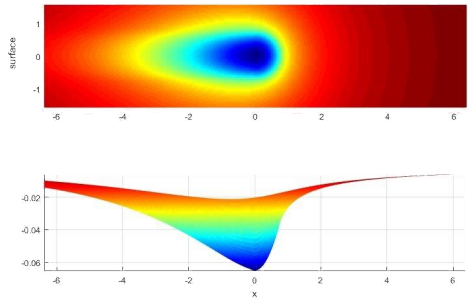
Numerical simulations of **engine part performance** (cam, piston rings,...)





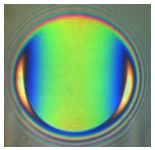
Numerical and **experimental** studies of **complex contact performance** (heterogeneous materials , adhesion, visco-elasticity, rugosity)

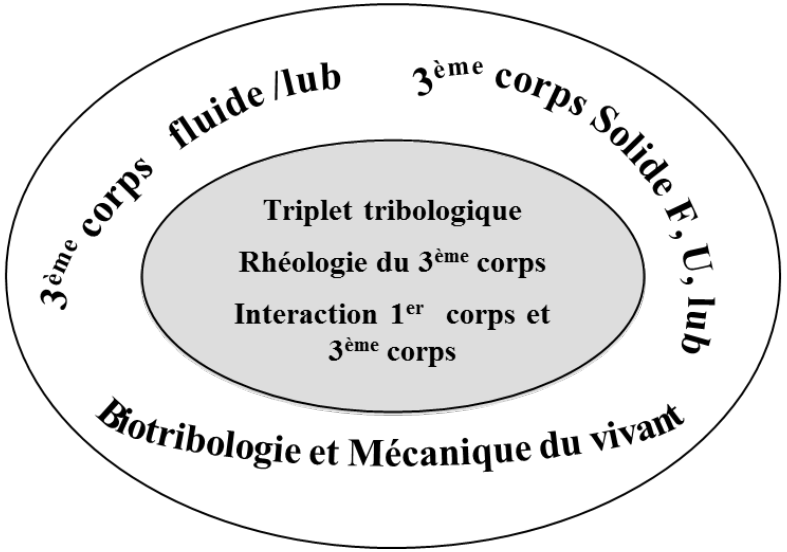


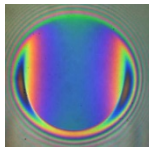


TMI : Tribology and Interface Mechanics, B. Bou-Saïd

Understanding of the tribological behaviour of the contact interface.
Predictive friction, wear and fluid or solid lubrication models
Biotribology and biomechanics





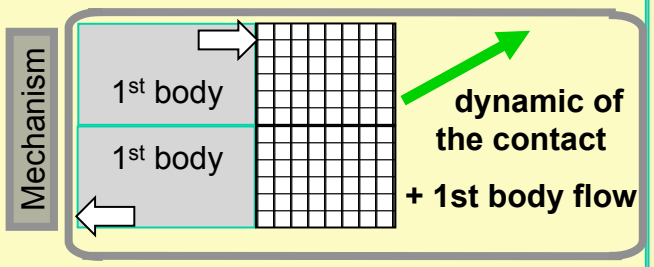


TMI Team

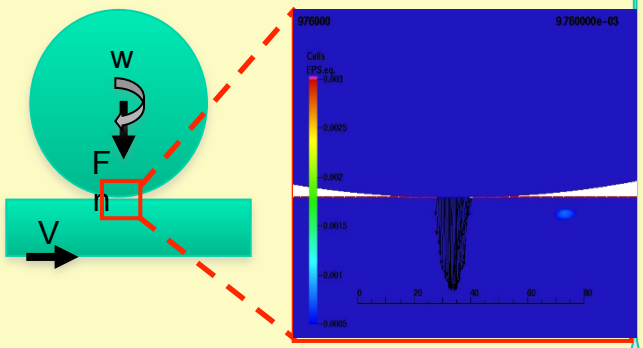
Tribology : **dual experimental-numerical approach**
1rd body, 3rd body, mechanism

1st body

Finite element modelling (EF)

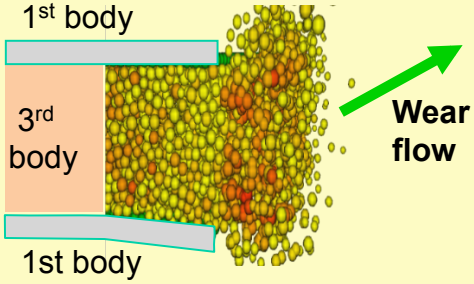


- Wheel-rail contact

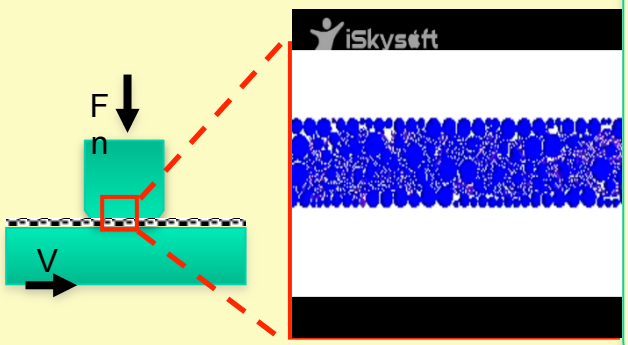


solid 3rd body

Discrete element modelling (ED)

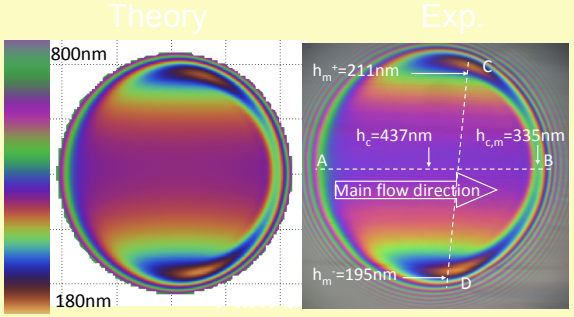


- Energetic materials-

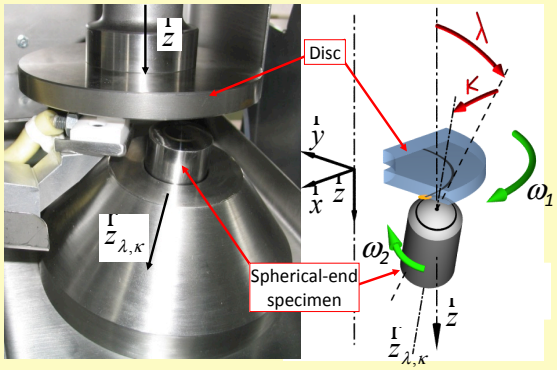


fluid 3rd body

Finite element modelling (EF)



- Flange-roller end contact

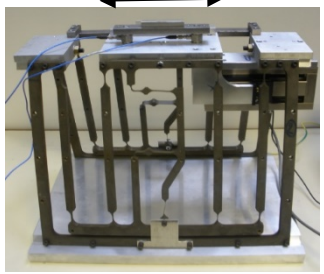


Tribogyr specimen and contact geometry

TMI Team

Some experimental devices

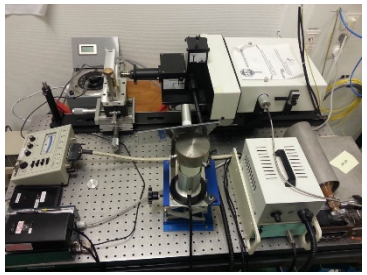
Tribotouch
100 mm



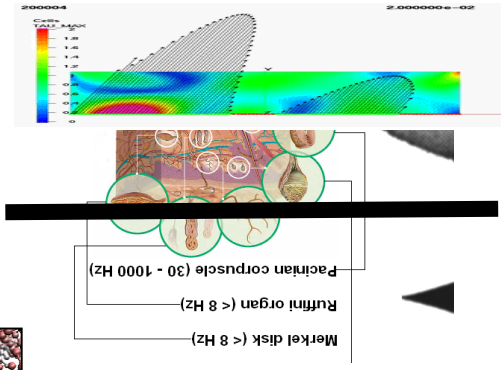
Instrumented railway train

Continuum macro

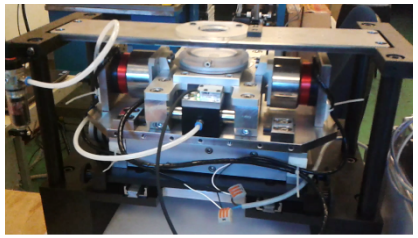
NanoFluo



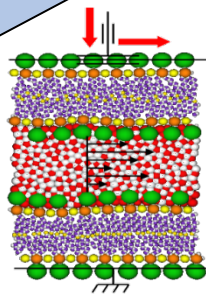
Continuum micro



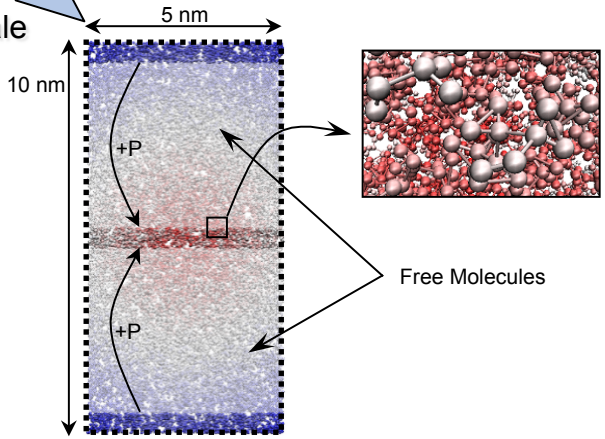
Tribometer + fluorescence confocal microscope



Nano-scale



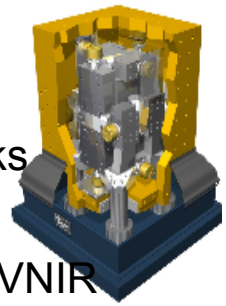
Nano-scale



Simulations

Keys projects

- **Industrial chairs**
  - Areva-Safran : Life extension and manufacturing processes
  - SKF : Lubricated Interfaces for the Future
  - Safran : Innovative mechanical transmissions for aeronautics
  - Volvo : Solutions for the Future of Urban Transport
  - Michelin : Multi-scale approach and new materials for tire performance



- **Equipex**
  - Durasol : Durability of solar materials and systems
  - Phare : Rotating machines platform to investigate and control environmental risks
- **LabCom**
  - Drillab (DrillScan) : Geothermal or oil drilling simulation laboratory AD VITAM : AVNIR Engineering, Advanced vibrations tests for the analysis of rotating machines
  - AD VITAM : AVNIR Engineering, Advanced vibrations tests for the analysis of rotating machines
  - Openlab PSA
  - TRANSMECA for mechanical transmissions (CETIM)
  - CIRTRANS (Renaults trucks, Safran HE, Alstom Transport, GIMA, Texelis, Reel, ECAM, INSA, ECL)

Industrial partners and research centers

- **Academic partners**
  - Local : U. Lyon 1, Centrale Lyon/LTDS, INSA/LGEF Ampère Mateis INL, INPG, U. J. Fourier Grenoble, Centre de Plasturgie…
  - France : CEA, Onera, CETIM, Femto-ST, nombreuses universités (Paris, Le Mans, Compiègne, Strasbourg, Montpellier, Marseille, Toulouse…)
  - Europe : EPFL, U. Bruxelles, Politechnico Milano, Fraunhofer, DTU Danemark, Imperial College, Trinity College Dublin, U. de Roma la Sapenzia…
  - Worldwide : Georgia Tech, LIGO (MIT), USC Los Ageles, U. Sherbrooke, U. Uberlândia, Tokyo Inst. Of Technology, …

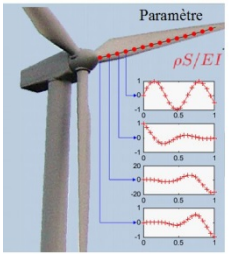
- **Industrial partners**
  - Groups : Airbus, Airbus Helicopter, Alstom, ArcelorMittal, Areva, CNES, CEA, DCNS, EADS, EDF, Faurecia, GE Global Research, GE Oil& Gas, Herakles, Hutchinson, Maïa-Eolis, Messier-Bugatti-Dowty, NTN-SNR, Decathlon, PSA-Citroen, RATP, Renault, Rhodia Solvay, Robert Bosh Gmbh, Rollex, Safran group, SKF, SNCF, Thalès, Total, Valéo, Volvo,…
  - SME : Cornilleau, Cornis, Microdb Solystic, Petzl, Vibratec, Tornier, Redex,…
  - Very small entreprises : Vibrateam...

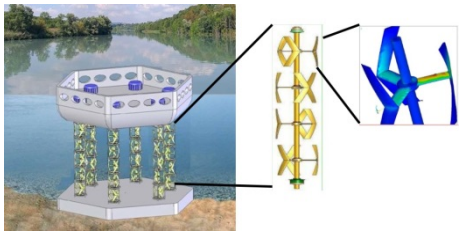
Involvement in the scientific community

- **Editor – Scientific committees – Convention organisation**
  - Experts in the tribology group of the ASME
  - ASME/IGTI, IFToMM Rotordynamics, IFToMM Terminology ISCORMA…
  - Conferences ASME IDETC
  - International Gear Conference 2014/2018
  - Leeds-Lyon Symposium on Tribology
  - ESAFORM 2008, JFT 2008, IUTAM 2007, JTM 2007/11/15...
  - Review panels : Wear, IJT, IJNME, IJFP,JVC, MI, JMD, JSV

- **Administrative committes**
  - Several research groups related to impacts, biomechanics, measures, fluid-structure interactions, non_linear dynamics…
  - FEDERAMS
  - Scientific evaluation committees (SNCF, CEA, SNECMA,etc.)
  - National Council of Universities
  - French Mechanics Association
  - Research and Safety National Institute
  - Mechanical Engineering teaching department

Future trends in research





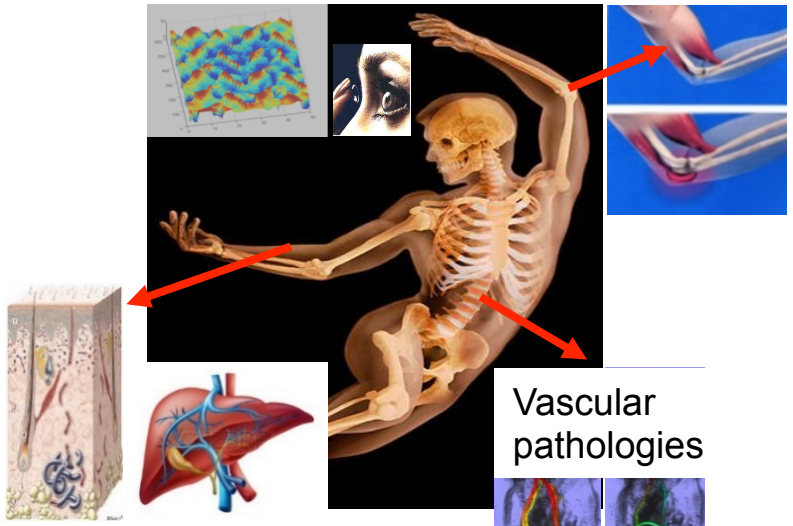
Sustainable development

Structure weight reduction – Prediction of damage –

Wear control – Non polluting lubricants – Identification of tribological sources of noise - Energy efficiency

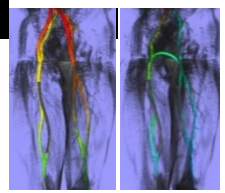
Biomechanics

Development of technologies for health



Soft tissue behaviour

Vascular pathologies



Multiphysic modeling

Micro- and nano- Technologies