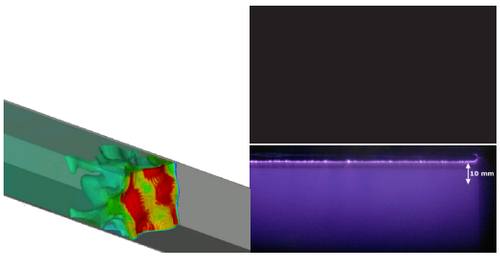

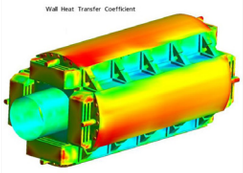

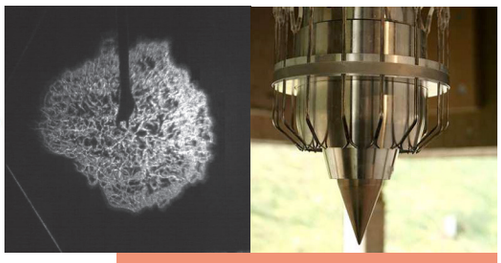

INSIS - Institute of **engineering sciences** and **systems**
INP - Institute of **Physics**

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PPRIME

Research Institute of Poitiers - **UPR3346**

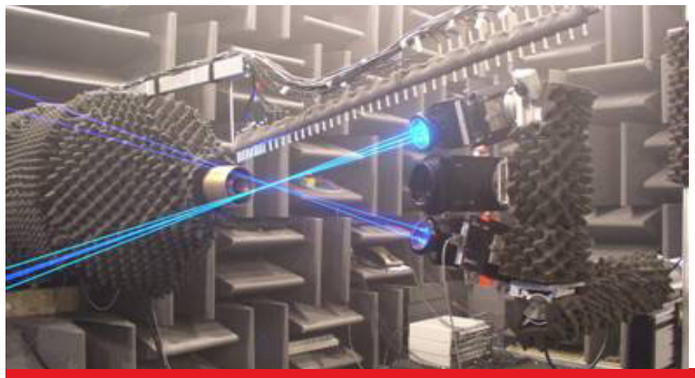
FLUIDS THERMAL COMBUSTION SCIENCE

Department Director: Karl JOULAIN
Department Deputy Director: Arnaud MURA

The department federates a broad spectrum of skills in the fields of fluid mechanics and aerodynamics, with or without compressibility effects ; heat transfer and associated systems ; combustion, premixed or not, possibly heterogeneous ; detonation and its applications ; physics of transfers and application of physics to electrical phenomena in fluids.

Our structure is reinforced by a continuum of methodologies associating theoretical approach, the development of a large spectrum of numerical approaches (from statistical modelling to direct numerical simulation), the use of dedicated and consequent experimental facilities associated with up-to-date measurement techniques and various sophisticated analysis techniques.

Research in the department has a fundamental orientation. The combination of this research and training at doctoral and master levels creates a scientific knowledge base enabling to address basic research issues using original and innovative approaches.



Anechoic Wind Tunnel « Bruit et Vent » © PPRIME

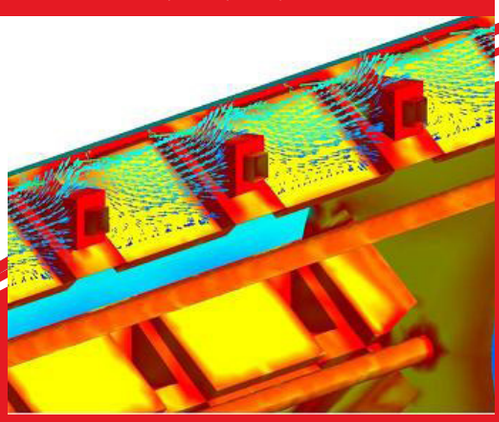
Staff

- **17** CNRS researchers
- **80** teacher-researchers
- **95** PhD students
- **9** Post-Doc
- **55** engineering, technician and administrative permanent staff

Keywords

Fluid mechanics, aerodynamics, subsonic, transonic, supersonic, hydrodynamics, environmental flows, compressibility, incompressibility, turbulence, acoustics, aeroacoustics, flow control, heat transfer, aerothermics, nanoscale heat transfer, convection, radiation, heat pipes, fuel cells, coherent sources, electro-hydrodynamics, cold plasma, heterogeneous combustion, thermal degradation, fire safety, porous media, turbulent combustion, detonation, deflagration, explosion, shock waves, flame structure, premixed flame, diffusion flame.

Aerothermics of a flow in an electric motor air-gap.
(coll. Leroy-Somer) © PPRIME



Research Training

- a Masters in **«Science for Engineers»** at the University of Poitiers, with specialisations in **«Energy management»**, **«aeronautical and terrestrial transport»** (faculty of Science) and **«Risk management»** (IRIAF),
- at ENSIP, ISEA/ENSMA including a number of international «Erasmus Mundus» degrees.

These courses, specific to the domains of fluid mechanics, aerodynamiques, combustion, thermal sciences and acoustics, also develop competence in experimental techniques, mathematical analysis and numerical modelling.

COLLABORATIONS: *ONERA, AIRBUS, MBDA, SAFRAN, SNECMA, Dassault-Aviation, Renault, Peugeot PCA, Air Liquide, EDF, GDF, CEMAGREF, CNES, ADEME, CEA, DGA,INERIS, ISL, PIC ICP Mocscou, TECHNICATOME, AREVA, IRSN, NRIFD, TOTAL, LOREAL, LCPP, SHEM, FRANCE HYDROELECTRICITE, Compagnie Nationale du Rhône, VNF, IFREMER, ONEMA, ANDRA, FNRAE, TURBOMECA LIEBHERR, SNPE, ALSTOM, VALEO, RATP, SNCF, Intertechnique et Zodiac, HENNESSY, MARTEL, OTHARD, Thalès, MAIF, SDIS.*

CNRS Regional Office Centre Limousin Poitou-Charentes

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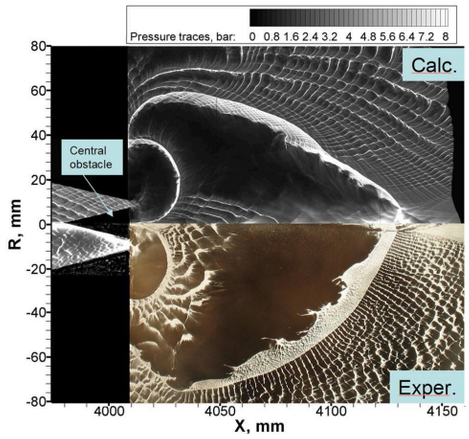
Research Institute of Poitiers - **UPR3346**

FLUIDS THERMAL COMBUSTION SCIENCE



Detonation diffraction from a tube to free space © PPRIME

Research Focus

The department contains nine scientific teams

HyDÉE - Hydrodynamics and Environmental Flows: the aim of HydEE is the study of hydrodynamic flows and their applications to environmental problems, environmental flows being considered as resulting of natural forces.

2AT - Acoustics, Aerodynamics & Turbulence: In the domains of compressible or incompressible flows and the induced acoustic effects, 2AT federates research works dedicated to turbulent or transitional shear flows, interacting or not with solid surfaces.

COST - Convection, Optimisation, Thermal Systems: phenomena studied in COST concern buoyant or forced heat transfer and compact two-phase heat exchangers including phase change. A third transverse activity develops optimisation and control tools applied to the situation mentioned above.

CT - Flame Structures and Turbulent Combustion: the research activities conducted in CT concern theoretical analysis, numerical modelling and experimental studies of laminar or turbulent flame structures and combustion in a very broad sense: subsonic or supersonic flows with either fully premixed reactants or non premixed injection of fuel and oxidizer, in gaseous phase or two-phase flows, under high pressure and possibly supercritical conditions.

CH - Heterogeneous Combustion and Porous Media: CH conducts numerical and experimental studies of heterogeneous combustion process, associated to ignition, propagation and extinction of fire.

There is also a strong interest in the study and upscaling of the properties of porous media and in life cycle analysis of combustion systems.

EFD - Electro-Hydro-Dynamics: EHD develops multidisciplinary activities at the interface between fluid mechanics, electrical engineering and physics. These are presently focused on 4 main themes: airflow control by plasmas actuators; liquid flow control by EHD forces; flow electrification and EHD of electrolytes; electrostatic hazards and applications.

Experimental facilities

MARTEL test bench (aeroacoustics), THALIE and ORACLES (aircraft engines), BALAFRE (tribology), VESTALES (axisymmetric turbulent flame), CERES (fire in confined areas), Large subsonic, transonic and supersonic wind tunnels, Anechoic wind tunnels, Fuel Cell test rig, Rheometers, Towing tanks, Laser velocimetry (LDV, PIV, PLIF), Cone calorimeter with FTIR, GCMS, TGA and DSC analyses, Granulometer, IR thermography, Multi-frequency visualisations, fast cameras, Clusters (8 Tflops, 55 Tflops),

Pergola test rig for ergol combustion (rocket engine applications), fire Safety Platform HESTIA, detonation tubes, explosion chambers, high-pressure and velocity instrumentation.

TNR - Nanoscale Heat Transfers and Radiation: TNR studies radiation in semi-transparent medium and heat transfer to submicron scales at ultrafast time, in conditions such that classical physical laws do not apply. This concerns both dense media with complex optical properties (curve medium, birefringence) and absorbing gas flows (coupling of convection and radiation).

DETO - Detonation: experimental, theoretical and numerical studies of detonations, deflagrations and explosions in various reactivemedia (gaseous or condensed, homogenous or heterogeneous)and initial conditions, as well as their effects on theenvironment. Studies are concerned with fondamental and applied issues (detonation cellular structure, chemical kinetics, rotative detonation engine).

TIC - Incompressible turbulent & control:
The main objective of TIC concerns the modeling and control of incompressible turbulent flows. The research of TIC are structured along four complementary activities: control methodologies, high performance computing, RANS modeling of laminar turbulent transition, wake formation and dynamics. TIC also aims at strengthening transversality around topics related to flow control and heat and mass transfer control.

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