

# Research

at Limoges University

# From basic research to applications in real-life socio-economic situations

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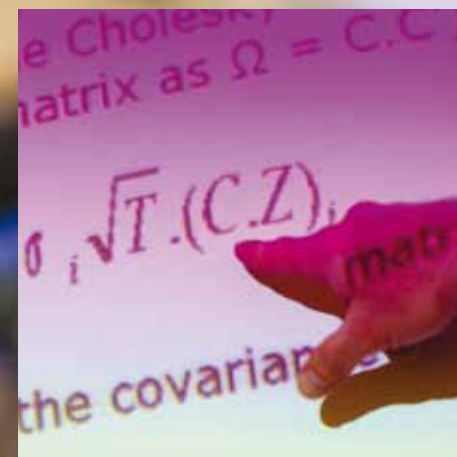
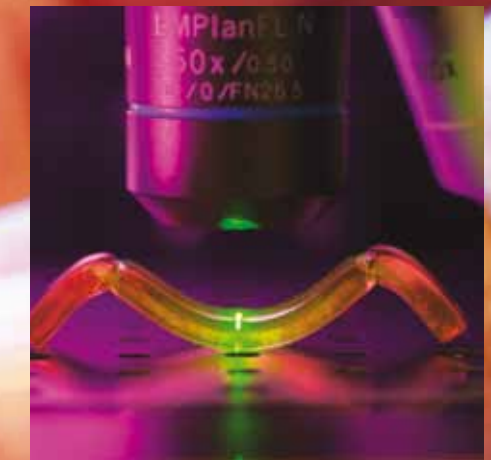
The University of Limoges acts as a gateway to the fields of science and other areas of knowledge with its focus on cutting-edge research.

It takes a modular, multi-disciplinary approach to research with its four research institutes, 20 laboratories - 8 of which are mixed units supported by large French research agencies (CNRS, Inserm, INRA, IRSTEA), a laboratory of excellence (Labex) and 9 joint laboratories run alongside large companies.

With its rich history in the area of ceramics, Limoges also offers the largest laboratory in France in the field of ceramic materials and processes. Electronics and photonics are also areas of specialism the university is known for and the healthcare, immunology, cancer research and care and neuroepidemiology departments are also recognised for their excellence. At the Department of Human and Social Sciences, crucial issues such as sport law, the environment, international conflict management, banking risk analysis, semiotics and French language studies are perfect examples of the diversity of the areas of research undertaken.

The University also maintains partnerships with academic institutions and socio-economic players at both the domestic and international level for the development of its basic research.

With its focus on innovation and coming up with new ideas and approaches, the research done in Limoges is shaping tomorrow's world.





# Our focus on research

## Highlighting several projects under way in University of Limoges laboratories

### Communicating objects and systems

The XLIM research centre has developed several innovative projects involving the use of communicating objects and systems for use in the civil, military and space sectors. One of the objectives here is increasing interactivity between objects and humans to improve our daily life whilst increasing security levels at the same time (sensor networks for monitoring conditions within a building, self-driving vehicles, e-health, etc.). Research projects are under way concerning the development of very high-speed networks (a new generation of microwave components over 50 GHz, considering how to commodify 5G communications) as well as reducing how much energy communications systems consume. New materials and new technologies - particularly 3D printing - are also being studied and optimisation methods are being developed for the manufacture of objects and then processing and providing adequate security measures for the data generated by these new communications systems.

XLIM > [www.xlim.fr/en](http://www.xlim.fr/en)

### Secure environments

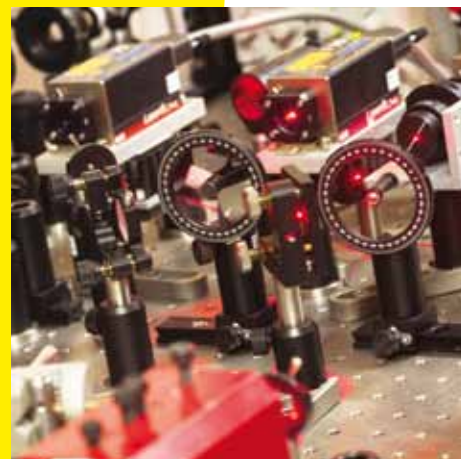
We are becoming more and more dependent on digital information, which can now be easily sent and received. The security of digital environment has likewise become a major issue for cutting edge technology for large industries such as those for lasers, drones, sat nav systems, aviation and space. In this area work has been carried out at XLIM to secure entire fleets of drones, improve how human/robot co-operation is perceived or develop new high-power laser sources. Research teams are also working on developing improved security measures for images and video, which could become a major source of misinformation if counterfeited, as well as the development of new systems for encrypting data. Research is also under way concerning the psychovisual filtering of content to improve the safety of assets and individuals which, given the current context of data massification, would provide access to reliable information in a very short amount of time, and then enable an appropriate response to be taken in the event of a crisis situation.

XLIM > [www.xlim.fr/en](http://www.xlim.fr/en)

### Technology for biological and healthcare application

Healthcare technology refers to the whole of technological developments which are crucial for biomedical progress, both at the most basic level (observing and understanding the mechanisms of living organisms) as well as at the clinical level (translating knowledge into therapeutic solutions). Work is being carried out in XLIM on fibre optic functional imaging, with one leading example being a new type of endoscope which operates in real time. The progress made in the field of imaging will likewise enable more detailed diagnoses to be made in the fields of biology and healthcare. Studies are also under way for the development of innovative therapeutic solutions. Experiments are therefore being conducted on treatments involving nanosecond pulsed electrical fields enabling systemic in situ treatment of certain types of incurable cancers. A new generation of labs-on-chips to neutralise cancer stem cells with electromagnetic waves is also under development under the framework of a major European project.

XLIM > [www.xlim.fr/en](http://www.xlim.fr/en)



### Innovation at the macromolecular level within the field of natural resources

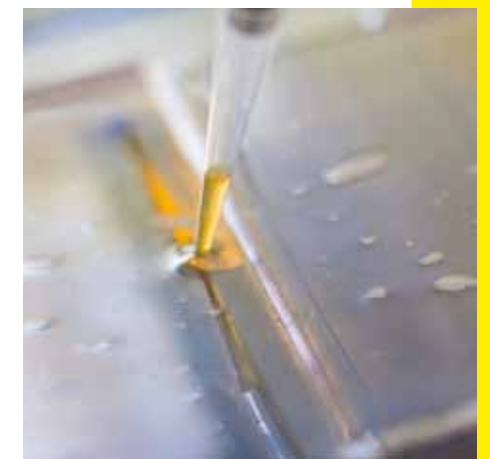
With the field of natural resources the University of Limoges has developed functionalised macromolecules for targeted use within the areas of healthcare and the environment; their environmental use currently meets all requirements in terms of measuring water quality. In contrast to the devices currently being used, these new macromolecules allow for more accurate calculations of mean concentrations of pollutants found in water and, when used in decontamination reactors, are also capable of capturing or breaking down environmental contaminants. When used as part of healthcare, these biopolymers are, after their activation, capable of specifically targeting tumours and destroying them via the drug they transport (such as photosensitisers, etc.).

GEIST > <http://unil.im/GEIST>

### Immunosuppression, immune system, infectiology, cancer and neuroscience (3ISCN): the core of our healthcare research

Within the area of 3ISCN bespoke medical tools have been developed such as biomarkers, mathematical models, clinical scores and therapeutic biomolecules for use in treating transplants and sepsis (severe general infection of organisms owing to pathogenic germs), immune diseases, cancer (lymphomas and solid tumours) as well as neuroscience. New physiopathological mechanisms and resistances to treatment have also been identified, whilst translational research programmes are currently in their validation phases for these new diagnostic and prognostic biomarkers as part of multiple European H2020 programmes. A number of patents and start-ups have come about as a result of this research in addition to the clinical applications (an international expert system on the personalisation of immunosuppressor treatment, an ex vivo model for testing new anti-infection active substances, crossover studies involving neuroscience and disabilities in older patients).

GEIST > <http://unil.im/GEIST>







**Future bone graft substitutes:  
a new generation of bioceramic implants for bone reconstruction**

The treatment of pathologies involving repairing lost bone material is one of the major challenges faced by public health. In order to optimise the properties of replacement implants and understand their scope of application in engineering new bone tissue, the IRCER is developing a new generation of bioceramics using calcium phosphates. The aim here is to enhance the implant's capacity for cell colonisation whilst controlling reabsorption, giving way in turn to neoformed tissue. This restoration of the patient's bone stock, which has been studied using both in vitro and in vivo biological models, is expected to occur via two processes: the first is natural, with the chemical makeup of the material adapting to its surroundings and a custom made design which is now possible via the use of additive manufacturing technology; the second is via stimulation, by loading the bioceramics with active substances, thereby inducing vascularisation and biomineralisation. The development of these innovative bioceramics began in the dedicated  $\Sigma$ -Lim laboratory, by combining the skills and facilities of the XLIM, CAPTuR, PEIRENE and Limoges University Hospital laboratories.

Institute of research for ceramics (IRCER) > [www.ircer.fr](http://www.ircer.fr)

**Ceramic film, coating and treatments:  
more options for plasma and laser procedures**

IRCER has also developed a complementary approach combining the design and development of new plasma and laser procedures with its expert knowledge of materials for the creation of new coatings and surface treatments. Numerical modelling and experimental investigations into plasma environments (in situ diagnoses, simulations, modelling) coupled with the results from testing carried out on materials' growth mechanisms has led to the manufacturing of innovative new materials. Their optimised properties and their multi-scale structures have made them prime candidates for use in devices and objects subjected to strict requirements in terms of performance and reliability. Thermal sprayed coatings are particularly valued as thermal barriers by the aviation industry and for tribological applications under demanding conditions. The thin films created via laser ablation have been incorporated into optoelectronic devices, helping to improve their functionality.

Institute of research for ceramics (IRCER) > [www.ircer.fr](http://www.ircer.fr)



**Additive technology: a new way of viewing design  
and the manufacture of ceramic parts**

Additive technology provides the means for the creation of specific structures which would otherwise not be possible by traditional methods, opening the door to the use of components offering new features within different fields such as electronics, healthcare, chemistry and catalysis.

These technologies make up what could be considered a new industrial revolution and will be key components in factories of the future. The IRCER is a pioneer in this branch of technology and has worldwide recognition in this field. Two innovative technologies created by two SMEs - 3DCeram and CERADROP - were developed at IRCER and have been used as part of ground-breaking applications: Stereolithography: the creation of hydroxyapatite brain implants using a scanned image file from patients (a world first for both Limoges University Hospital and 3DCeram) and the development of ICT components at the Labex  $\Sigma$ -lim alongside XLIM; ink-jet printing: printing multi-material components for microelectronic use in collaboration with the CERADROP company and the development of endoscope probes for the detection and treatment of cancers (Limoges University Hospital and Kamax).

Institute of research for ceramics (IRCER) > [www.ircer.fr](http://www.ircer.fr)



**LabEx  $\Sigma$ -lim :  
a laboratory  
of excellence  
supported by XLIM  
and IRCER**

Recipient of the French Government Future Investments award in 2011 for «Ceramic materials and components for specific use in integrated, secured and intelligent communications systems», the projects under way at the Labex  $\Sigma$ -lim are exploring new technology, hardware and software architecture types to build tomorrow's communications systems.

This project, which is shaping both Limoges University and its region as well as scientifically structuring the work done by the parent laboratories, has enabled the creation of three chair positions (one each overseeing Radio Frequency Systems, Optical and Microwave Metrology and Bioengineering) as part of the project. With its powerful modelling capacity, new technological solutions are being unlocked to produce secure features and systems using original circuits and components

based on new materials. Real-life applications are aimed at optimising communications systems' overall performance levels, the security of environments (assets, premises and individuals) and use in biology and healthcare technology. The Labex  $\Sigma$ -lim has created its own integrated research, training and high-level assessment policy for the purposes of strengthening its position at the international level as a point of reference in advanced ceramic design and innovative materials, the development of new electronic and photonic components as well as designing innovative secure communications systems. This makes the Labex  $\Sigma$ -lim the perfect example of the international scope of research happening at the University.





### Innovative areas of study concerning structural life span

GC2D has developed scientific areas of study on the life span of structures within their given environments, which translates to the development of mechanical behaviour based on the environment, as well as heat and humidity transfer laws. This set of tools now means specific issues can be approached in terms of studying the long-term behaviour of road, wooden and masonry structures for the purposes of providing advanced diagnostic tools for companies working within these sectors, site managers or local councils. Examples of work currently being undertaken in this area would analysing a roadway network using a decision aid, development, hydric monitoring for laminated or edge-glued wooden buildings and a probabilistic approach to masonry buildings, with the whole of these actions taking a cross-cutting approach to the simulation of combined thermal and water transfers.

Civil Engineering Laboratory, diagnosis and sustainability (GC2D) > <http://unilim.fr/GC2D>



### Closing the distribution gap in the food industry

GEOLAB has been heavily invested in food industry proximity distribution since 2009, a field focusing on making various sectors as open as possible, such as agriculture, artisanal crafts, the food industry, distribution and the restaurant industry. Additionally, whilst the agricultural sector has traditionally relied on national and supranational public policy, food industry proximity distribution has begun to take over at the regional and infra-regional level. GEOLAB, co-founder of the Observatory for Proximity Distribution in 2013 ([www.proximites-obs.fr](http://www.proximites-obs.fr)) has taken steps towards creating a knowledge base shared by all players involved and making access to the base easier for dissemination via university publications, professional journals and the public at large. At the university level GEOLAB truck a partnership with RURALITIES at Poitiers, prior to launching a multi-disciplinary initiative with CREOP at Limoges University as well as the Bordeaux National School of Agricultural Engineering and Bordeaux Montaigne University.

Physical and Environmental Geography Laboratory (GEOLAB) > [www.unilim.fr/geolab](http://www.unilim.fr/geolab)

### Sociology research

GRESKO is a team created around a common understanding of the role the sociologist should play, mobilising various methods of analysis based on the importance of empirical investigation. It offers four different lines of research: Education, socialisation, career paths; Cultures, lifestyles and social relationships; Work, employment and social classes; Healthcare, illness and disability. What makes GRESKO unique in this respect is therefore its ability to put into practise how these topics are interrelated within its programmes, lectures and national and international conferences.

Center West Sociological Research and Study Group (GRESKO)

> [www.unilim.fr/gresco](http://www.unilim.fr/gresco)

### The Training, Research and Intervention (FRI) project

This project brings together researchers from Limoges, São Paulo, Port-au-Prince and the RechercheAvec network (an international French-language interdisciplinary exchange programme and knowledge sharing network) which deals with production and circulation of knowledge with and concerning public services deemed «fragile» as well as the professionals supporting them.

By employing an epistemic, ethical and practical questioning system, new reflections on the training of practitioners and students are gleaned. This project involves the FrED laboratory which works on healthcare education, the relationship between the healthcare system and society at large, healthcare and the family and approaches related to social mediation techniques and ethical and civic issues. The relationship between educational and social issues within the context of training, informing and monitoring are investigated via the educational sciences to empower individuals and groups from very young ages. One of the key challenges faced in this area is strengthening ties socio-educational professionals are trained up to a very high level and are capable of acting on the ground, at the local level or at the international level amongst French language-speaking communities as well as in other languages.

Francophonie Education Diversity (FrED) > [www.unilim.fr/fred](http://www.unilim.fr/fred)



## Outstanding research

Below is a very brief summary of the numerous prizes, noted publications, international awards and recognised discoveries our university community has received as a whole.

**CRIBL** was recognised for making a vital discovery in genetics concerning a heretofore unknown phenomenon: suicide genes. This was a major event in understanding how immunity is regulated which generated two publications in «Sciences» and «Medecine Sciences», two scientific journals of international renown, in 2015.

**PEIRENE** has received international recognition for its use of photosensitisers and more specifically the use of dynamic phototherapy. In 2015, ChemPlusChem featured PEIRENE on its front cover as the feature story on the creation of nanoplatforms capable of transporting drugs that would be particularly useful in cancer treatment.

**Armelle Vardelle**, an IRCER researcher, was the first woman appointed to the American Society of Material's (ASM) Hall of Fame in 2016 in recognition of her work performed at the international level on plasma spraying.

**XLIM** was ranked 7th in the world for patent applications for light sources for healthcare applications by FIST SA - an expert in analysing and managing validation projects - in 2015.

**Amine Tarazi**, LAPE director, was named a senior member of the prestigious Institut Universitaire de France (IUF - French Institute of Universities) in 2017 for his research on banking and financial research which has been recognised internationally, confirming the excellence and creativeness of his scientific activities and their influence all over the world.





# A peek inside our researchers' heads

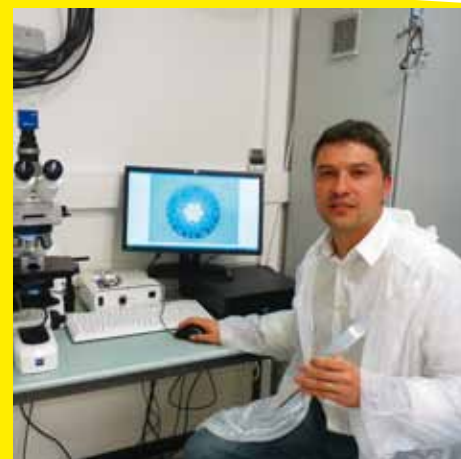
Some of Limoges University's heads of research talk to us about what's going on within their respective fields of research



## Using electromagnetic waves to treat cancer

Arnaud Pothier  
**XLIM research fellow**

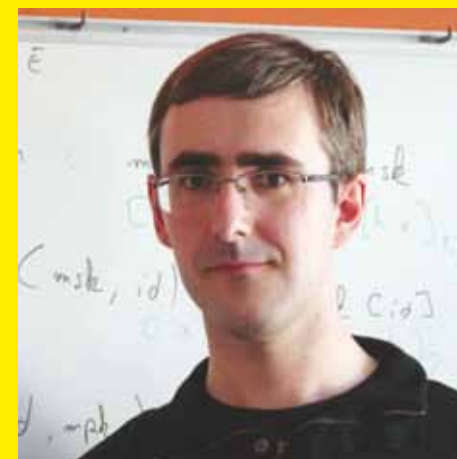
Arnaud Pothier is working on developing work which would act as an interface between multiple disciplines by taking full advantage of the rich, unique research environment in place at Limoges University. Dr Pothier is an ardent support of micro- and nanotechnology and has designed and run experiments on new microsystem designs using the lab-on-chip format. These chips possess tremendous potential for innovation and could be used for a broad range of applications - from synthesising materials to biomedical applications - and are one of the core components of the SUMCASTEC European project which Dr Pothier has headed up since its start in 2017 and which is tasked with neutralising cancer stem cells using electromagnetic waves.



## Extreme optical fibres

Frédéric Gérôme  
**XLIM research fellow**

Frédéric Gérôme's activities are based around the development of a new family of hollow optical fibres which would allow light and gases in all of their forms (molecular gas, atomic and ionised vapour) to coexist in the same space at micro- and nanometric scale and under extreme conditions for a tremendous scope of application. These world-firsts would ultimately have a huge impact on micromachining carried out by high speed lasers, provide the correct metrology for the development of fibre-based atomic clocks as well find a use in biomedical applications for innovating endoscopy solutions and/or compact laser sources for cytometry and medical imaging. Frédéric Gérôme was given the Jean Jerphagnon award in 2015 for this innovation, with technological development being carried out by the GLOphotonics start-up created by the XLIM GPPMM research team.



## Encryption every step of the way

Olivier Blazy  
**XLIM lecturer**

Olivier Blazy's work involves encryption protocols. Concerned with protecting the private life of users as well as the security of systems, Dr Blazy works on developing new schematics and proving their robustness for use. He has worked in a variety of areas including electronic voting and money, the confidentiality of biomedical data and drone applications. He has also been involved in multiple ANR (French National Research Agency) projects, such as the IDFIX project on identity encryption, which he has led since October 2016.



## The structure of tomorrow's materials

Maggy Colas  
**IRCER research fellow**

Maggy Colas's research focuses on the use of tellurium oxide-based materials for applications within the field of telecommunications (such as storage capacity optimisation or transmitting information). As a physical chemist her approach consists of correlating the structure of the material (at the atomic bonding level) to the optical properties of the materials. This synergy between the structure and properties is a crucial area in terms of optimising materials which will be used in the future.



## Ceramic/organic hybrids

Romain Lucas  
**IRCER lecturer**

Romain Lucas works on creating composite ceramics which are rust-resistant for use in high temperature environments, more specifically within the aviation, aerospace and nuclear sectors. One of the original areas of study developed by Dr Lucas is the manufacture of ceramic/organic hybrid objects, a domain in which he has co-operated with the University of Cambridge since 2011. He has largely been able to carry out his research owing to the complementary expertise offered at IRCER and by the experimental facilities available, particularly the cutting-edge equipment for very specific tasks.

## Publications by our researchers

To provide greater visibility both nationally and internationally to the research projects carried out at Limoges University and also for the purposes of maintaining a permanent archiving of scientific publications by our researchers, the University runs a multi-disciplinary free, open access archive containing collections based on each individual research unit.

Hal-Unilim  
[► hal-unilim.archives-ouvertes.fr](http://hal-unilim.archives-ouvertes.fr)

# RESEARCHERS



# RESEARCHERS



## Radio-immunotherapy testing

Stéphanie Durand-Panteix  
CRIBL project manager

Stéphanie Durand-Panteix has created a Technology Upgrade Unit for Immunology and Immunotherapy (CUTE-12), an emerging structure designed to promote work carried out by CRIBL via transfers of technology. The main project this unit is responsible for is CARAT (Consortium for the Application of Alpha Radition Therapy), a major R&D project financed by Bpifrance and led by Areva Med with the co-operation of Limoges University Hospital. The objective set for CARAT is the conduct of preclinical trials for new lead-212 radiation immunotherapy treatments to combat haematologic cancers.



## New cancer biomarkers

Fabrice Lalloué  
University lecturer at CAPTur

Fabrice Lalloué conducts research work in the field of oncology, having identified and characterised new diagnostic and prognostic biomarkers. His work is based on translational research in close co-operation with Limoges University Hospital's clinical teams and has led to the creation of the position of Chair of Experimental Pulmonology who is tasked with studying bronchial cancers and the underlying mechanisms which make them resistant to treatment. His work alongside IRCER and XLIM at the same time has led to the creation of innovative diagnostic tools.



## Using natural active substances to destroy cancer cells

Frédérique Brégier  
PEIRENE lecturer

Frédérique Brégier has developed an area of research around extracting and/or synthesising new composites for dynamic anti-cancer phototherapy treatments. The close co-operation between chemists and biologists at PEIRENE means the anti-cancer potential of composites synthesised can be quickly assessed. Certain natural active substances sourced from vegetables, are, in the presence of light, capable of destroying cancer cells and provide an alternative option or complementary treatment to current therapeutic strategies.



## Diversity in toxoplasma

Aurélien Mercier  
NET lecturer

Aurélien Mercier is co-director of neuroparasitology research at NET. Originally an ecologist who then received his doctorate in parasitology, he is a specialist in the ecology of health in tropical regions. His work involves identifying and understanding environmental, historical or contemporary factors of man-made or natural origin to study a parasite which feeds off neurological environments - toxoplasma gondii. His research has helped contribute to describing the diversity of toxoplasma alongside its epidemiology at a worldwide scale.



## Preventing financial instability

Céline Meslier  
LAPE lecturer

Céline Meslier is interested in the impact banking structures and behaviours have on economic activity and bank financing and financial instability phenomena and their prevention, all of which have been issues economic authorities have tried to tackle following the financial crisis of 2007-2009. Her research is conducted alongside universities and central banks both in France and abroad, taking in both industrialised and emerging countries and also considering the local and regional context for each individual phenomenon.



## The environment, law and society

Jessica Makowiak  
OMIJ university lecturer

Jessica Makowiak's research revolves around the core principles of environmental law (access to courts, the obligation of non-retrogression of law, etc.) by focusing on their societal context. More specifically she has worked on the environmental assessment of Nouvelle-Aquitaine urban planning documents for the Environmental Regional Authority Mission, the major world conference on the environment (the United Nations World Conference, COP 21, etc.) and regularly undertakes assessment work for European and international institutions.





# RESEARCHERS



## Reflections on the decolonisation of knowledge

Philippe Colin  
EHIC lecturer

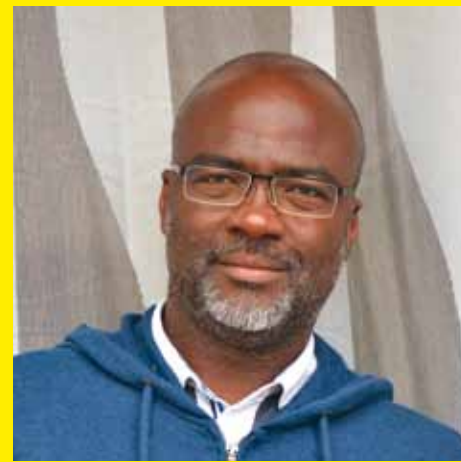
Philippe Colin's research lies at the intersection between the history of ideas and political philosophy, focusing on the discourse, practices and knowledge produced by the indigenous peoples subjected to Spanish rule in post-colonial Latin America. As part of the scope of this consideration of anti-hegemonic discourse, his contribution lies in raising awareness about and developing in France the decolonial theory developed by Latin American researchers from the Modernité/Colonialité (Modern Times/ Colonialism) Group, which is centred around an alternative means of criticising the dominant models used to produce knowledge.



## Ancient societies and climate-related crises

Gaëlle Tallet  
CRIHAM lecturer

Gaëlle Tallet has been a researcher of ancient history since 2007 and is the current director of the French Mission in El-Deir (Kharga Oasis, Egypt), combining her passion for archaeological sites with reflections on how ancient societies dealt with climate-related crises. Alongside the Poitiers site she co-ordinates CRIHAM's environmental history area and has received support from a number of experts to develop a major international research network (involving the USA, Italy and Egypt) as part of the ANR CRISIS programme, which she has directed since 2016. This project aims to explore the core concept of what a «crisis» meant throughout the history of the Southern fringes of the Roman Empire in the largest oasis of the Egyptian portion of the Libyan Desert.



## Semiotics in smart objects and devices

Didier Tsala Effa  
University lecturer at CERES

Didier Tsala Effa carries out research on semiotics as relates to objects as part of daily use. Having explored the process of generating meaning and interactions within the fields of marketing and communications, he has extended his research to objects designed to assist individuals (humanoid robots, smart objects, home automation devices) in response to reduced autonomy. He also the scientific director of the «Qualitative research» area of the «E-health, personal autonomy and ageing well» Excellence Chair.



## Doctoral training

Limoges University provides clear support for doctoral training and the recruitment of doctoral students. The University takes an open approach towards international doctoral studies as well as those focusing on socio-economics.

- Over 600 doctoral students enrolled to pursue thesis studies
- Over 130 theses successfully defended each year
- 8 Doctoral Schools (EDs) and their respective laboratories train students for research whilst at the same allowing them to conduct research:
  - ED 614 - Chemistry, Ecology, Geoscience and Agrosociences (CEGA)
  - ED 615 - Biological Sciences and Health (SBS)
  - ED 609 - Material science and engineering, applied mechanics and energetics (SIMME)
  - ED 610 - Systems engineering, Mathematics, Computer Science (SISMI)
  - ED 611 - Linguistics, Psychology, Cognition (SLPCE)
  - ED 612 - Humanities
  - ED 88 - Pierre Couvrat Law and Political Science (DSP)
  - ED 613 - Science of society, Territories, Economics, Management (SSTSEG)

The Doctoral College oversees the Doctoral Schools:

> [www.unilim.fr/collegedoctoral/](http://www.unilim.fr/collegedoctoral/)



## Drawing a direct line between Masters programmes and research

Developing a specialism within a given field of study, getting started on research, being able to lead a research project, choosing whether to aim for a Ph.D. and what further research projects can be done in the field: the Masters programme at Limoges offers all of these things, with all of the support in the world from our research laboratories and scientific studies being conducted by our lecturer researchers.

With 54 programmes on offer - a third of which involve international work and 12 of which are work-study Masters - Limoges University not only provides its students with an academic grounding but also qualifying courses providing inroads into sectors as cutting edge as electronics, photonics, genomics, cancerology, encryption, biotech, neuroepidemiology, immunology, water and the environment, the chemistry of natural substances, ceramic process and surface treatments, transitional justice, sport law, banking and finance, semiotics, etc.

Find out more about our Masters programmes at:

> [www.unilim.fr/formation/loffre-de-formation/](http://www.unilim.fr/formation/loffre-de-formation/)



# AT THE INTERNATIONAL LEVEL

## Attractive research at the international level

**Limoges University is committed to the development of its students at the international level and has seen its teams strike up collaborative efforts with foreign universities and create partnerships with specialist centres around the world**

### International partnerships

Our laboratories have developed academic research partnerships not just in Europe but around the world: America (such as the Universities of Illinois, Colorado, New York, Washington, etc.), South America (the Universities of São Paulo and Mato Grosso do Sul in Brazil, etc.), Asia (Xi'an Jiaotong University in China, Nagoya University in Japan, Nanyang Technological University in Singapore, etc.), Africa (the University of Mostaganem in Algeria, Sfax and Tunis Universities in Tunisia, the University of Ougadougou in Burkina Faso, etc.) and Australia (the University of Sydney, etc.).

### The figures

- International collaborative research, in numbers: 143 framework agreements
- 259 partnership agreements
- 33 international partnership degrees

### A closer look at the services offered by our International Centre

- A project support unit (CAP) is in place at the university which has been tasked with helping project leaders complete their work at both European and international levels.
- Movement is encouraged via the implementation of schemes suited to researchers and doctoral students.
- Welcoming events organised by foreign scientific researchers (for help with lodging, inductions, etc.)
- An observatory where you can find out more about our international partnerships International

International Centre e-mail > [ri@unilim.fr](mailto:ri@unilim.fr)

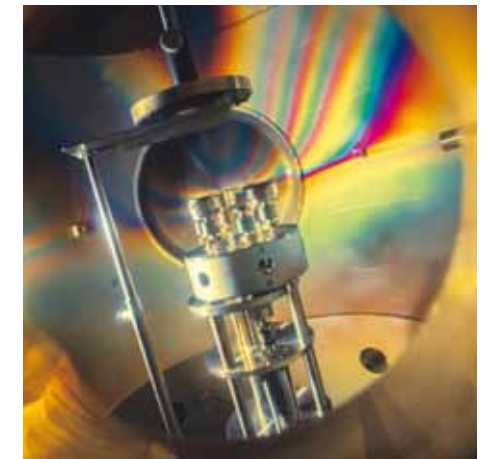
### A closer look at some of our projects

**SUMCASTEC** (Semiconductor-based Ultrawideband Micromanipulation of Cancer STem Cells): this innovative European H2020 project is headed up by XLIM in co-operation with CAPTuR and 5 European partners for the purposes of developing new designs for labs-on-chips using semiconductor technology to neutralise tumorous cancer stem cells using electromagnetic waves. The end result is being able to offer treatments which more effectively target tumours and are less harmful to patients.

**BIOMARGIN** (BIOMarkers of Renal Graft INjuries in kidney allograft recipients): a pan-European project co-ordinated by IPPRITT with the involvement of 12 different research teams from all over Europe focusing on devising non-invasive methods to prevent and diagnose kidney allograft lesions and improve treatment and monitoring of the graft over the long-term. This innovative approach aims to simultaneously study a large number of genes, proteins and metabolites for the large-scale identification of lesion biomarkers.

**AMITIE** (Additive Manufacturing Initiative for Transnational Innovation in Europe): this H2020 European staff exchange project is led by IRCER and involves 17 pan-European academic and industrial partners for the development of additive manufacturing technologies adapted to ceramic IT, communications, energy, transport and biomaterial products.

**ATHOR** (Advanced THermomechanical multiscale mOdelling of Refractory linings): this H2020/Marie Skłodowska-Curie actions/ITN (Innovative Training Network) project is co-ordinated by IRCER, with 6 pan-European academic partners and 8 industrial partners involved. The purpose of this excellence network is the development of new capabilities within the field of thermomechanical behaviour for ceramic materials subjected to harsh industrial environments by aligning interactive research projects (15 PhDs) with frequent interdisciplinary training sessions.



### Limoges University: a place for reflection on the protection of fundamental rights on a worldwide scale

The International Research Institute on Conflicts (IIRCO), backed by the OMIJ, has developed an international research programme in conjunction with international criminal courts, NGOs and various UN bodies. The focus of this Institute's work rests on how war crimes and crimes against humanity are punished, European human rights law per European Court of Human Rights jurisprudence, texts and expert opinions issued by the Council of Europe and UN law in post-conflict regions.



# High-tech platforms

## Limoges University technical platforms are open to both the university community and companies

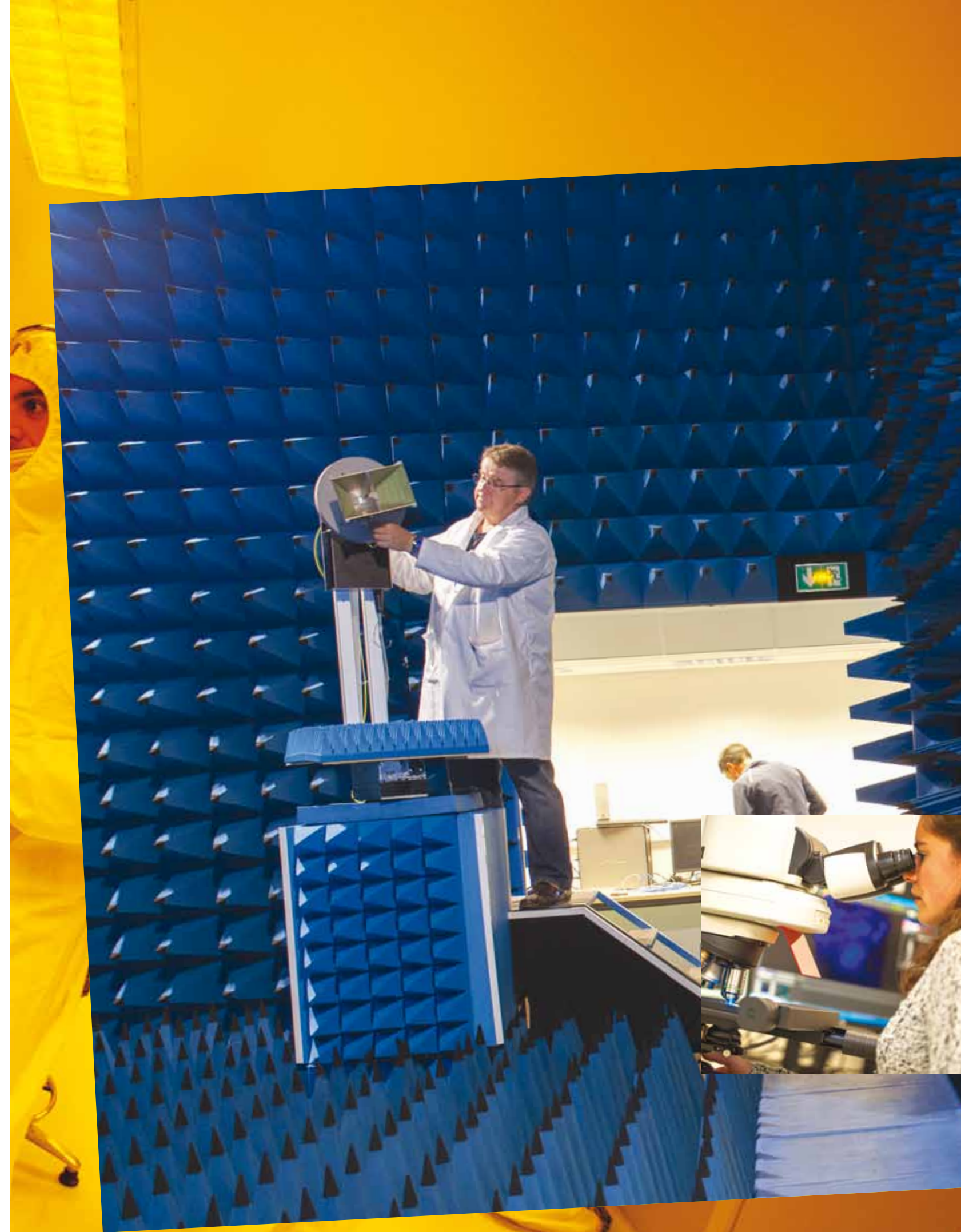
### **CARMALIM** - IRCER's materials characterisation platform

Located in the European Ceramics Centre, CARMALIM promotes the use of thermal treatment characterisation techniques for the materials under study as part of IRCER's research on ceramic materials and processing. CARMALIM itself is divided into six separate areas, each specialising in different fields of characterisation: Microscopy, X-ray Diffraction, Thermal, Chemical and Morphological Analysis, Spectroscopy and Optics, Thermal Treatment – Mechanical Properties and Suspensions. CARMALIM is on the cutting edge of innovation owing to the pool of characterisation instruments on hand - a pool which is constantly being added to and upgraded - and offers the latest equipment available on the market. The platform itself is also well-known for the expertise of its staff, who have fully mastered characterisation techniques and materials.

**PLATINOM** - XLIM's technology and instrumentation platform for optics and microwaves PLATINOM is the whole of the equipment used to characterise high frequency and optical fibre electronic components as well as the production of electronic and optical components accessible to manufacturers and research institutions. The instruments available are capable of characterising circuits and aerials transmitting from 50 MHz to 330 GHz by using the only techniques and equipment of their kind in France. This equipment is used in a variety of projects to conduct specific characterisation procedures on GaN material-based components, innovative aerials, lasers or microwave passive circuits as well as time-based characterisations of non-linear power devices. The technology centre possesses all measuring and manufacturing equipment for prototypes and small numbers of RF-MEMS components, integrated functional materials and organic electronic components. The optical fibre stretching units - drawing towers - mean micro-structured fibres can be developed for applications producing high powered optical sources as well as the transmission of data. This uniqueness contributes to the renown, influence and attractiveness the XLIM has garnered for itself.

### **BISCEm** - The GEIST Institute's technical and bio-IT platform

BISCEm (Integrative Biology - Healthcare - Chemistry - the Environment) provides know-how and both the equipment and software tools required for the analysis of composites, cells, tissues and animals. This platform relies on the expertise of the GEIST research teams - renowned nationally, at the European level and worldwide - within the fields of study of composites by using mass spectrometry and nuclear magnetic resonance, the analyses of nucleic acids, computer analysis of data obtained using high throughput technology, experimenting on rodents, histology, fluorescent microscopy and flow cytometry. BISCEm is financially supported by Limoges University, the Dupuytren University Hospital and the large national French research organisations (CNRS, Inserm and INRA).







## An unrivalled corpus

**An unparalleled archival data base for international and transitional criminal justice jurisprudence**

With backing by the Conflict and Post-conflict Management Excellence Chair and the Observatory for Institutional and Legal Changes (OMIJ), the International Research Institute on Conflicts (IIRCO) manages the only international data base on international and transitional criminal justice of its kind.

This data base consists of digitised files issued by various public and private institutions concerning the management of post-conflict areas such as the International Criminal Court, international criminal tribunals (such as those held concerning the former Yugoslavia, Rwanda, Cambodia, Sierra Leone, etc.), transitional justice processes, truth and reconciliation (various commissions, Gacaca, etc.) NGOs, international committees of inquiry, the public funds of the States affected, private files (from lawyers, preservation organisations, etc.), press articles and works of fiction. The data is digitised from the various materials (hand-written/printed texts, audio and video recordings, photographs) and then indexed for use by researchers from any number of disciplinary backgrounds.

> [www.unilim.fr/iirco/](http://www.unilim.fr/iirco/)

## Cutting-edge equipment

### **Cali: the supercalculator available for use by researchers**

CALI (Calculation in Limousin) is a supercalculator which provides the power required to properly conduct high performance digital simulations and calculations. Access to supercalculators within the European area is a crucial element for scientific research in the 21st century, and CALI is fitted with over 800 computing cores, 6 To of memory and is capable of performing billions of calculations per second. It is available for use in all university laboratories and their partners as well as innovation SMEs in the Region. Dozens of scientific publications and doctoral theses have benefited from the results provided by CALI.

### **Ion Proton : the latest in DNA sequencing equipment**

Located in the Biology and Healthcare Research Centre (CBRS), Ion Proton is the first of its kind installed in Europe, capable of multiplying of Limoges University's already powerful sequencing capacity by factors of 20-100. This unit is capable of sequencing incredibly long segments of DNA from bacteria, viruses, parasites and of course patients with genetic diseases. This sequencing means the impact DNA mutations have on certain chronic diseases (diabetes, high blood pressure, etc.) can be better analysed to better anticipate the reaction patients will have to drugs and develop a better understanding of cancer cell anomalies and enable more accurate studies on bacterial populations (metagenomic analysis) and minority viral strands (such as HIV) which are resistant to anti-viral treatment. A bio-IT analysis cell has been created and installed in the CALI supercalculator to simultaneously process a tremendous amount of data.

### **4 drawing towers and synthesis equipment - the only ones of their kind in France for specialty fibres**

The manufacture of optical fibres is one of the three areas of research XLIM's PLATINOM focuses on, with its optical fibre equipment and more specifically the four drawing towers being designed for the manufacture of both indexed doped silica fibres, air silica microstructured fibres, «low temperature» fibre glass or even metal and/or silica and/or glass hybrid fibres. This area of research also has specific equipment for the creation of preforms using powder (reinforcement and vitrification units), sol-gel (a dip-coating unit) or by assembly/drawing (stack and draw units). This pool is rounded out by characterisation equipment (for index profile measurement, chromatic dispersion, near-field measurements, optical microscopes, scanning electronic microscopes). These procedures mean original fibres - the only ones of their kind in France - can be manufactured for use in lasers, sensors, for medical applications or high-powered guidance systems.

### **IRCER's 3D-imaging Raman high resolution spectrometer**

The Renishaw in Via Reflex Raman spectrometer is one of the first spectrometers in the world to possess a high-resolution 3D Raman imaging module, meaning structural information at the atomic-bonding level or for transparent materials' operating wavelengths can be taken, with the Raman data being recorded by a series of shots inside of the material itself. These images are then reconstructed by volume based on the parameter the investigator wishes to view (stress fields, distribution of crystals, heterogeneity within phases, etc.). The power available in terms of statistical analysis methods, when combined with the Raman spectrometer's increased focus, means the volumetric distribution of the phenomenon being investigated can be determined with sub-micron resolution.







## The latest, most innovative research infrastructures

44% of university spaces for research have been rolled out since 2010

### European Ceramics Centre (CEC) – The only research centre of its kind for ceramic materials in Europe

Within a huge futuristic space measuring 14,000 m<sup>2</sup> wholly dedicated to new technologies, the CEC is where all of the leading research and higher education on ceramic materials takes place.

Located at the heart of a technological and institutional structure specialising in the most cutting-edge fields of ceramic materials, it is a beehive of activity with 450 researchers, lecturers, lecturer researchers, engineers, technicians and administrative staff, undergraduate students, doctoral students and post-doctoral students.

IRCER itself is located inside the CEC and has developed areas of study which are completely unique for their research done not just in France but worldwide for ceramic processing and surface treatments. This arrangement and the preferential conditions promote some of the most innovative convergence projects in the world within the field of ceramics.

### The Biology and Healthcare Research Centre (CBRS): Limoges University's springboard to global recognition in biological research

Located in the Limoges University Hospital, the CBRS combines hospital biological services under the hospital's biology/cancer division and the mixed research units (UMRs) for healthcare research at Limoges University. This closeness between research laboratories and hospital services has been implemented to promote translational research, i.e. examining the links between clinical care, clinical research and basic research within an environment of hygiene and safety in line with current requirements, with the end objective being the promotion of the rapid transfer of technology from basic research to clinical research for the benefit of patients.

Additionally, this unity between the site, services and various units means centralised technological platforms (such as flow cytometry, high throughput genomics, high resolution mass spectrometry, NMR etc.) can be shared meaning whoever needs access to these has access to cutting-edge equipment.

## Business and research

### Support structures for innovation

Limoges University is a dynamic university that has developed a close, on-going relationship with a number of companies and institutions, receiving «French Tech» accreditation in 2016 in recognition of its commitment to creating new areas of business

**AVRUL** (Limousin University Research Results Transfer Agency) acts as an interface between results and socio-economic players, supporting the creation of partnerships and ensuring these players benefit from the potential offered by the innovation developed in university laboratories and providing long-term transfer potential for researchers and their research. Additionally, with its business incubation department, AVRUL provides innovative projects the conditions needed to ensure their creation and due development.

> [www.avrul.fr](http://www.avrul.fr)



**The Partnership Foundation** contributes via innovative legal structures and actions for the development of synergy with socio-economic players.

> [www.fondation.unilim.fr](http://www.fondation.unilim.fr)

**The SATT Centre** (Business Acceleration and Technology Transfer) monitors the development of inventions discovered at the university which have been identified as having tremendous potential for economic development.

> [www.sattgc.com](http://www.sattgc.com)

**The Limousin-Poitou-Charentes PEPITE** (Student Division for Innovation, Technology Transfer and Entrepreneurship) raises awareness amongst students concerning entrepreneurship, providing training and follow-up and more generally promoting actions in this respect.

> [www.iae.unilim.fr](http://www.iae.unilim.fr)

## Key figures

**9 joint laboratories** shared with top-ranking companies and institutions (CEA, THALES, Air Liquide, CILAS, NXP Semiconductors, INOVEOS), an undeniable breeding ground for scientific production methods and technology innovation, with each partner providing major human resources to ensure optimum results.

**5 cutting-edge technology platforms** available for companies to use

**106 projects incubated**  
**61 companies created** between 2008 and 2016 via AVRUL's business incubation scheme.

**93 priority patents** managed  
**17 active licences** granted by AVRUL

**12 industrial research chair positions** created by the Partnership Foundation as part of the corporate framework sponsorship - a great tool enabling the development of research expertise for areas of study defined alongside partner companies.





# Start-up incubated at AVRUL

the gateway  
between research  
and industrial  
applications



## **Gooméo** Online and mobile solutions for events

Created in 2009 and backed by XLIM, Gooméo offers online and mobile Solutions for events enabling professionals to easily create informational and interactive mobile applications specifically for their events. Between 2011 and 2014 Gooméo experienced a 779% growth rate, quickly becoming the market leader for mobile applications for events, coming in 18th in Deloitte's In Extenso Technology Fast 50 ranking in 2015. Gooméo is now viewed as a point of reference at the national level in terms of growth dynamics for companies, promoting and encouraging development by combining innovation and growth within the cutting-edge technology sector.

> [www.goomeo.com](http://www.goomeo.com)



## **Luxeram** A pearl of innovation in ceramics

Luxeram has developed transparent ceramic materials which combine aesthetics with technicality and curiosity at the very top of the luxury, jewellery and clockwork sectors. Transparent ceramics possess the same qualities as gemstones such as hardness, lustre and colouring and could possibly overshadow sapphire and crystal. As an AVRUL business incubation project Luxeram benefited from R&D support from IRCER, who provided its technical and scientific expertise honed over ten years in the field of transparent ceramics to ensure the roll-out of an innovative ceramics manufacturing process for transparent objects with complex or original shapes.

> [www.luxeram.fr](http://www.luxeram.fr)



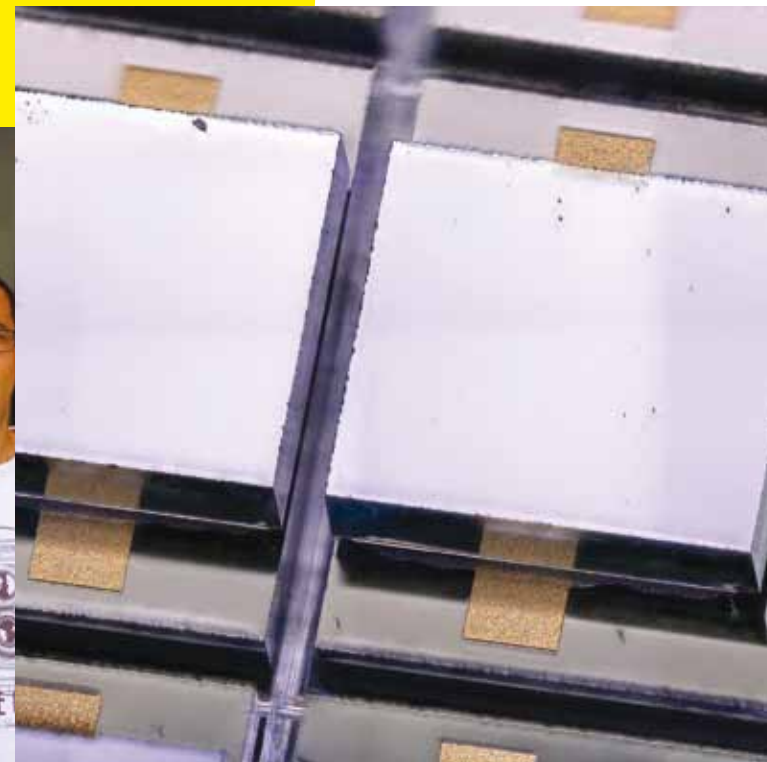
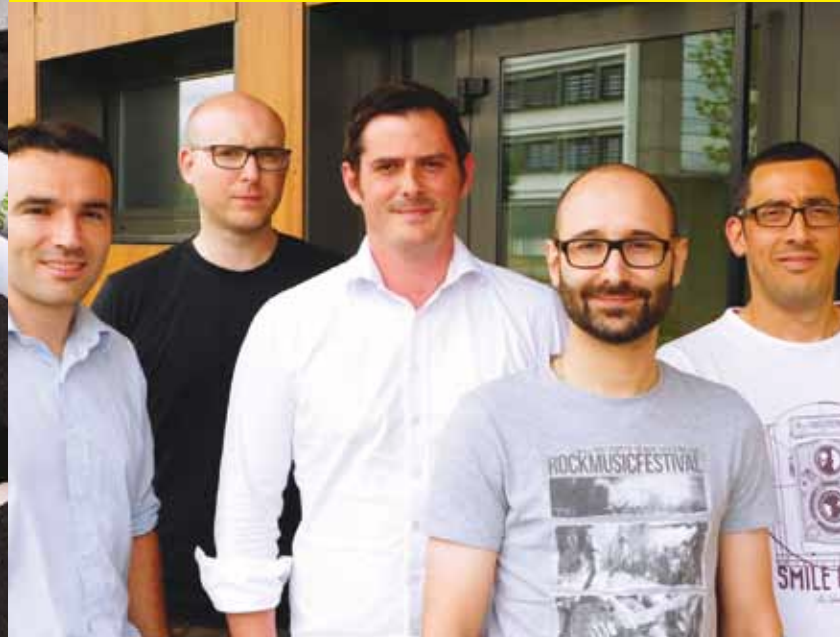
## **B cell design** Mucosal immunity technology

B Cell Design is a biotechnology company created in 2007 for the purposes of applying the innovation developed at CRIBL. The result of fundamental research conducted at Limoges University, B Cell Design designs and produces chimeric monoclonal antibodies. This focus has led to the development of two lead compounds: a candidate vaccine for infectiological applications (anti-HIV) which was patented in 2015, as well as a candidate drug for oncological use (an anti-colorectal cancer drug) which was patented in 2017. ArkAb, a subsidiary of B Cell Design focusing on the in vitro diagnosis market, provides a broad range of human chimeric antibodies as alternatives to the positive controls, standards and quality controls involved in using human biologicals. Both B Cell Design and ArkAb have continued to work with Limoges University laboratories, particularly CRIBL and RESINFIT.

> [www.b-cell-design.com](http://www.b-cell-design.com)



# Start-up



## Novassay

### i-LAB 2016 award winner

Novassay develops and markets analysis and field tools, equipment capable of quantifying and characterising organic matter and heavy metals (such as uranium, copper, gold, iron, etc.). These innovative metrology tools mean mine operators can run a terrain analysis in a matter of seconds. The founder of Novassay read his doctoral thesis at the LCSN laboratory, who provided support with the scientific and technical abilities required to break down the technological barriers faced at the time and produce new, innovative products. Novassay was one of the 2016 award winners as part of a French competition providing assistance for the creation of innovative companies.

> [www.novassay.fr](http://www.novassay.fr)

## AirMems

### A European leader in high-performance radiofrequency circuits

AirMems designs, manufactures and markets specific radiofrequency electronic circuits using RF-MEMS technology. Romain Stéfani, the founder of the start-up, is the holder of a Ph.D. from XLIM and is now the operator of the exclusive licence for the patent held by Limoges University, still working with the research laboratory on projects under a collaborative agreement. AirMems has already performed tests on components fitted on satellites with the assistance of XLIM, the French National Space Studies Centre (CNES) and Thales Alenia Space, with parts being used on board the Ariane V rocket used to transport the Athenia-Fidus satellite into orbit in 2014.

> [www.airmems.com](http://www.airmems.com)

## The AVRUL business incubation unit

### Speeding up innovation

Ranked in the top ten of European university business incubators by the UBI index in 2014, AVRUL was the only French university business incubator included. The role of the incubator is the provision of the conditions required for the creation and development of innovative projects, supporting project leaders every step of the way as they start their business up (from project viability assessments to lodging and logistics, support, advice, assistance, etc.). Each project receives the support of a research laboratory possessing both scientific and technical expertise in the area. To date 106 projects have been incubated, with 61 companies and 244 positions effectively created by doctoral degree holders and engineers.

> [www.avrul.fr](http://www.avrul.fr)

\*AVRUL: Limousin University Research Results Transfer Agency



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