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# L'Édition



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PARIS-SACLAY

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# Prizes & awards

## at Université Paris-Saclay



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## Anne L'Huillier & Pierre Agostini

### Nobel Prize in Physics 2023

On 3 October, Pierre Agostini and Anne L'Huillier, together with Ferenc Krausz, were awarded the Nobel Prize in Physics 2023. This prestigious award rewards work begun by the two French scientists at CEA Paris-Saclay over 40 years ago.

After completing his thesis at the Aix-Marseille Université in 1968, Pierre Agostini became a researcher at CEA Paris-Saclay, at what is now the Interactions, Dynamics and Lasers Laboratory (LIDYL - Univ. Paris-Saclay, CEA, CNRS).

He devoted his research to the study of the infrared (IR) laser ionisation processes of atomic gases, remaining there for 34 years. In 2005, the physicist became Professor Emeritus at Ohio State University (USA).

Eighteen years after her colleague, Anne L'Huillier also began her research career at CEA Paris-Saclay, after defending her thesis at the Université Pierre-et-Marie-Curie in 1986. In 1987, Anne L'Huillier discovered the generation of high-order harmonics at what is now the LIDYL.

This process, at the time entirely unknown and unforeseen by theory, makes it possible to produce flashes of light lasting close to an attosecond ( $10^{-18}$  seconds, i.e. one billionth of a billionth of a second) by focusing an intense infrared laser in an atomic gas. This time scale is that of electron movements in matter. The French-Swedish physicist has been a professor at Lund University since 1995. On 13 November 2023, she was awarded the title of Doctor Honoris causa by Université Paris-Saclay at an official ceremony.

In 2001, Anne L'Huillier's pioneering work paved the way for Pierre Agostini and his team to produce and observe series of consecutive light pulses 250 attoseconds apart. In the same year, Ferenc Krausz was able to isolate a 650-attosecond light pulse at the University of Vienna (Austria). This work means that it is now possible to observe and study electron-induced mechanisms on unprecedented time scales.

## Researchers

The French Academy of Sciences honoured eleven researchers from Université Paris-Saclay:

### Isabelle Bouchoule

director of Research at the Charles Fabry Laboratory (LCF - Univ. Paris-Saclay, CNRS, Institut d'Optique Graduate School), won the 2023 Alexandre Joannidès Prize.

### François-Didier Boyer

director of Research at the Institute of Chemistry of Natural Substances (ICSN - Univ. Paris-Saclay, CNRS), was awarded the 2023 Docteur Henri Labbé and Madame Henri Labbé prize.

### Kestutis Cesnavicius

researcher at the Mathematics Laboratory of Orsay (LMO - Univ. Paris-Saclay, CNRS), was awarded the 2023 Jacques Herbrand (mathematics) Prize.

### Francois David

director of Research Emeritus at the Institute of Theoretical Physics (IPhT - Univ. Paris-Saclay, CEA, CNRS), won the 2023 Physics Medal.

### Gilles Dowek

researcher at the Formal Methods Laboratory (LMF - Univ. Paris-Saclay, CNRS, ENS Paris-Saclay, CentraleSupélec, Inria), was awarded the 2023 Inria Grand Prix.

### Philippe Grangier

director of Research at the LCF, received the 2023 Ampère Electricity of France Grand Prix.

### François Ladieu

researcher and member of the Condensed State Physics Service (SPEC - Univ. Paris-Saclay, CNRS, CEA), was awarded the 2023 Anuita Wenter-Klein Prize.

### Erwan Poupon

researcher in the Biomolecules: design, isolation, synthesis Laboratory (BioCIS - Univ. Paris-Saclay, CY Cergy Paris Univ., CNRS), was awarded the 2023 Minafin Prize.

### Charis Quay

researcher at the Solid State Physics Laboratory (LPS - Univ. Paris-Saclay, CNRS), was awarded the Prix d'Aumale.

### Frédéric Taran

head of the Molecular labelling and bio-organic chemistry unit (SBCM - Univ. Paris-Saclay, CEA), received the 2023 Seqens Prize.

### Zhiqing Zhang

director of Research at the Laboratory of the Physics of the two Infinities - Irène Joliot-Curie (IJCLab - Univ. Paris-Saclay, CNRS, Univ. Paris Cité), won the 2023 Jaffé Prize.

## Students

Eight PhD candidates and post-doctoral fellows from Université Paris-Saclay have been awarded the 2023 Jeunes Talents Prize by the L'Oréal-UNESCO Foundation:

### Amandine Asselin

PhD candidate at the Laboratory of Mechanics Paris-Saclay (LMPS - Univ. Paris-Saclay, ENS Paris-Saclay, Centrale-Supélec, CNRS).

### Lucie Berkovitch

PhD candidate at the Cognitive Neuroimaging Laboratory (UNICOG - Univ. Paris-Saclay, Inserm, CEA, CNRS).

### Manon Cairat

post-doctoral fellow at the Centre for Epidemiology and Population Health (CESP - Univ. Paris-Saclay, Inserm, UVSQ).

### Fanny Chasseloup

post-doctoral fellow at the Endocrine Physiology and Physiopathology Laboratory (PHYSENDO - Univ. Paris-Saclay, Inserm).

### Archrène Dyrek

PhD candidate at the Department of astrophysics / Astrophysics, instrumentation and modelling at Paris-Saclay (DAP/AIM - Univ. Paris-Saclay, CEA, CNRS, Univ. Paris Cité).

### Clara Marino

PhD candidate at the Ecology, Systematics and Evolution Laboratory (ESE - Univ. Paris-Saclay, AgroParisTech, CNRS).

### Ophélie Mcintosh

PhD candidate at the Atmospheres, Environments, Space Observations Laboratory (LATMOS - Univ. Paris-Saclay, UVSQ, Sorbonne Univ., CNRS).

### Elise Verrier

post-doctoral fellow at the Evolution, Genomes, Behaviour and Ecology Laboratory (EGCE - Univ. Paris-Saclay, IRD, CNRS).

## Companies & Projects

### Sébastien Floquet

lecturer at the Versailles Lavoisier Institute (ILV - Univ. Paris-Saclay, UVSQ, CNRS), his associate Aneta Ozieranska and their colleagues from Moldova State University won the gold medal, the National Industrial Property Institute-France Prize and the prestigious Grand Prix of the International Exhibition of Inventions Geneva, for their Apimona project, which led to the launch of their start-up Oligofeed, currently in the maturation phase.

### Julien Nicolas

director of Research at the Paris-Saclay Galien Institute (IGPS - Univ. Paris-Saclay, CNRS) and founder of the start-up Imescia, received one of the three Innovators Prizes 2023, awarded by the Île-de-France Region.

I hope that you will enjoy reading this issue of *L'Édition*. I wish you a wonderful festive season!



## Editor's letter

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The end of the year is fast approaching, and with it comes the time to take stock of the past twelve months. It has been a busy year for *L'Édition* of Université Paris-Saclay, with a new format featuring four new pages to give you a better idea of the latest news at the University, and a new graphic design which we are proud to present to you today.

After eight years of existence, *L'Édition* has been redesigned to offer you a more modern, attractive and easy-to-read newspaper. It now has a dual layout: a central booklet presenting the Research and Business & Innovation sections, and a second booklet in a narrower format including the Prizes & Awards, Teaching and Learning, Science outreach, Seen from Abroad, Campus Life, Calendar and Reading highlights sections.

It is with great honour that we pay tribute in this issue to Pierre Agostini and Anne L'Huillier, both laureates of the 2023 Nobel Prize in Physics for their work in attosecond science, which they began at CEA Paris-Saclay. On 13 November, Anne L'Huillier was awarded the honorary title of Doctor Honoris Causa from Université Paris-Saclay.

In terms of research, this new issue looks more specifically at the University's sustainable research and development policy, and the associated action plan which is currently being deployed. The study of human history and heritage, both tangible and intangible, by the University's scientific community, also features in this issue. On the subject of health, you will learn about various studies based on a "One Health" approach carried out at the University, as well as three major new health initiatives - the PROMETHEUS and PRISM University Hospital Institutes (IHU), and the GenoTher Biocluster - aimed at identifying, studying and understanding present and future health challenges. Finally, you will also get a glimpse into what we know about cosmic rays, both in terms of their composition and their possible applications. And at the heart of the magazine, you can find out about the University's involvement in the development of innovation in 5G and future networks.

Doctoral programmes, the PhD Track and the University's unique apprentice training centre (CFA) are also among the University's recent educational news. Furthermore, we wanted to showcase the tremendous solidarity shown by the members of the Jacques Hadamard Mathematics Foundation (FMJH) in welcoming Ukrainian students to the University's mathematics laboratories.

I hope that you will enjoy reading this issue of *L'Édition*.  
I wish you a wonderful festive season!

**Estelle Iacona,**  
President of Université Paris-Saclay.

# Discovering doctoral education pathway

## Develop skills of futur doctors

**During the years spent writing their thesis, PhD candidates are invited to take part in group courses in addition to their laboratory research, in order to obtain their PhD. Regardless of whether such courses are mandatory subjects or are related to non-research activities, they contribute to the development of the skills expected of future doctors.**

There are many different objectives for the various doctoral education pathways that a university can offer. Such pathways can help to consolidate the scientific culture of PhD candidates, prepare them for their future careers or promote international openness. To achieve these objectives, Université Paris-Saclay offers a wide range of courses, particularly in the fields of artificial intelligence, the environment and sustainable development.

### A better understanding of artificial intelligence

While artificial intelligence is a research field in its own right, it can also accelerate discoveries in many fields, leading to new research practices. Understanding the basic concepts and being able to manipulate the tools is no longer optional for tomorrow's researchers. This is why, as part of the SaclAI School project, Université Paris-Saclay is offering a new doctoral education pathway, Artificial Intelligence, introduction to deep learning, open to all PhD candidates.

*"Our ambition is really to provide a fairly detailed technical education that is accessible to as wide an audience as possible,"* says Aurélien Plyer, a researcher at the Information Processing and Systems Laboratory (Univ. Paris-Saclay, the French Aerospace Lab ONERA) and a member of the teaching team. Very few prerequisites are required to join this pathway, which is structured around modules dedicated to becoming familiar with mathematical tools, deep learning, neural network architectures, etc. Just some of the courses that will enable future researchers to design and train their own neural network models to solve complex problems in a variety of fields.

*"And also to gain an insight into the business world, thanks to our associate professors who are not necessarily from academic laboratories,"* adds Aurélien Plyer.

### Understanding the challenges of the environmental crisis and the green transition

Doctoral schools must ensure that all PhD candidates are aware of and educated in the challenges of sustainable development. At Université Paris-Saclay, two online courses based on the content initially offered in the "Climate Action" institutional degree, set up as part of the

Alliance for climate, action now! (AICAN) interdisciplinary project, are now available to students.

The first, entitled Environmental crises: understanding the issues and solutions, explains these environmental crises through the prism of various disciplines such as economics, physics, ecology and environmental history. In practical terms, this course consists of videos of the seven opening lectures of the "Climate Action" institutional degree, accompanied by their presentation medium, which PhD candidates can view whenever they wish. Each lecture is followed by an assessment of their understanding using a MCQ. *"More than traditional courses, these videos provide a comprehensive, multi-disciplinary understanding of the issues and solutions associated with energy, climate and the green transition,"* explains Sophie Szopa, Vice-President of Sustainable Development at Université Paris-Saclay. For example, participants can watch a lecture by Valérie Masson-Delmotte on the physics of climate change, a talk by Paul Leadley on the impact of climate change on biodiversity, or a presentation by Yann Leroy on the circular economy.

*"Our ambition is really to provide a fairly detailed technical education that is accessible to as wide an audience as possible."* – Aurélien Plyer

Those wishing to refresh or increase their knowledge of certain topics, after or at the same time as viewing the aforementioned video lectures can find out more about the teaching units of the "Climate Action" institutional degree through the *Maison du doctorat*, with a view to selecting some in which to enrol.

These teaching units include:

- Climate change, Technology and society, Circular economy and eco-design
- Biodiversity and global health
- Governance and corporate social responsibility
- Environmental law and public policy
- Contemporary economic issues
- Energy transition
- City, planning and sustainable transport.

Each of these teaching units is organised around 10 to 20 hours of classes given at the end of the day and on Thursday afternoons. *"Following on from momentum of the AICAN interdisciplinary project, we really want to bring the interdisciplinary nature of our approach to life by making these courses accessible to an ever larger and more diverse audience,"* explains Jeanne Gherardi, a member of the Laboratory of Climate Sciences and the Environment (LSCE - Univ. Paris-Saclay, National Centre for Scientific Research CNRS, French Alternative Energies and Atomic Energy Commission CEA, Univ. Versailles Saint-Quentin-en-Yvelines UVSQ) and Co-Director of the "Climate Action" institutional degree. *"By bringing together as many profiles as possible, we hope to create a physical space for meeting and dialogue, where we can all work together to build a common language,"* adds Maxence Rojo, Project Manager for the AICAN interdisciplinary project.

### A legal approach to environmental issues

While major environmental issues raise important questions in the field of basic science, they are also an important area of work and research for lawyers.

*"From the personification of non-human beings to the question of animal welfare and the notion of sobriety, there are currently many major issues in environmental law, but they basically concern us all,"* explains Laurent Fonbaustier, Head of the Master's degree in Environmental Law at the Jean Monnet Faculty (Law - Economics - Management) and a member of the doctoral programme's teaching team.

In order to provide a few keys to understanding these major issues using the law as a tool, this year, the Law Graduate School at Université Paris-Saclay started to offer a five-hour course entitled *Entre écologie et droit: les grands enjeux environnementaux* (Between ecology and law: major environmental issues) to all PhD candidates who wish to take it.



© PICS/CentraleSupélec

After an initial hour putting the subject into perspective and considering how the question of ecological issues is formulated, the programme will offer four themes: the personification of non-human beings to address the issue of representations; waste in relation to the issue of wastefulness; climate and the problem of differences in temporality between law and politics; and biodiversity and the issue of the continuum of living beings.

*"From these highly interactive workshops, we hope that our students will come away with a heightened awareness of the extreme complexity of these subjects and the need to co-construct,"* concludes Laurent Fonbaustier.

A proposal that seems to have met with immediate success, as the eighteen participants in this first session testify.

# PhD Track

## A new programme for embarking on the path to a PhD

**The PhD Track programme is being launched in experimental form at Université Paris-Saclay in the 2023-2024 academic year. Some 15 students in all will follow the programme from the outset.**

The PhD Track is a veritable *"launch pad"* towards a PhD and is designed for students wanting to embark on a PhD project when they start the first year of their Master's degree. For the first session in 2023-2024, students will be required to submit a project on a "sustainable development" or "health sciences" theme.

degree and can also be awarded in the second year if approved by the PhD Track Committee. Once the student has obtained their Master's degree, and subject to the approval of the relevant doctoral school, they are awarded a three-year PhD contract to carry out their thesis within one of Université's research units. Lastly, the selected students undertake to act as ambassadors (in their field of study) for Université Paris-Saclay at different events promoting the education.

**To be admitted to the PhD Track, students must be enrolled in the first year of a Master's degree at Université Paris-Saclay.**

To be admitted to the PhD Track, students must be enrolled in the first year of a Master's degree at Université Paris-Saclay, have the goal of continuing their Master's degree with a thesis, and be selected by the programme jury. Applications for the PhD Track will be accepted from 20 November to 11 December 2023, with interviews for eligible candidates between 16 and 23 January 2024, and a final decision made by 26 January 2024.



### **Supervision and bursaries throughout the study path**

The PhD Track includes individual supervision for the winning student by a mentor, a member of a Université Paris-Saclay research unit. This mentoring programme complements the PhD Master's programme, a personalised support programme tailored to the focus of the work and the needs of each winner. A scholarship is awarded to students during their first year of the Master's

<https://www.universite-paris-saclay.fr/phd-track-programme-daccompagnement-vers-le-doctorat>

# Paris-Saclay Undergraduate School

## A positive first assessment



**As a cross-disciplinary component of Université Paris-Saclay, the Paris-Saclay Undergraduate School is responsible for coordinating initiatives based on student success at the undergraduate level.**

A mission structured around three main areas; to help students succeed in their studies, build their personal and professional projects, and enable them to become more open to the world. Having just published its first assessment for the 2020-2022 period, the Paris-Saclay Undergraduate School is reporting very positive initial results.

*"After just two years in existence, the Paris-Saclay Undergraduate School has really found its place at the heart of the Paris-Saclay system: it is now recognised by the academic and administrative communities*

*of all the constituent faculties and institutes with which we work, not only for its coordinating role, but also for its commitment to the success of our students through the many initiatives it has introduced,"* explains Pascal Aubert, Director of the Paris-Saclay Undergraduate School. In particular, this positive assessment can be credited to the increase in tutoring with the creation of a coordinator position, the deployment of the personal study and integration project in each undergraduate course, and the introduction of Small Private Online Courses (SPOC) on the issues of the green transition and critical thinking.

[https://ecole-universitaire-paris-saclay.fr/sites/default/files/2023-02/bilan\\_1er\\_cycle\\_ups2022\\_10.02\\_v11.pdf](https://ecole-universitaire-paris-saclay.fr/sites/default/files/2023-02/bilan_1er_cycle_ups2022_10.02_v11.pdf)

# Université Paris-Saclay creates a single Apprenticeship Centre (CFA)

## Towards harmonization

**At the start of the academic year in September 2023, and in order to standardise its apprenticeship course offer, Université Paris-Saclay launched its new Centre de formation des apprentis (CFA) or Apprenticeship Centre. This centre brings together all its apprenticeship students under a single banner.**

Université Paris-Saclay currently offers 26 apprenticeship programmes, giving students from undergraduate to master's degree levels the opportunity to acquire both theoretical skills at the university and practical skills by working directly in a company.

The Université Paris-Saclay CFA is the cornerstone of the apprenticeship programmes at the University, acting as the interface between prospective students, the teaching staff on the relevant courses and partner companies.

*"Until last year, we worked with 35 different CFAs, each offering their own services. It was difficult to manage such a large number of partners. The idea behind this single CFA*

*is to standardise and optimise apprenticeship schemes at the University. We want to support the supervisory teams in each course, the students looking for apprenticeship contracts, and our partner companies,"* explains Sylviane Liotenberg, Apprenticeship Programme Coordinator at the university and now Director of the Université Paris-Saclay CFA.

*1,200 apprentices at the start of the 2024 academic year." Due to the specific nature of its curriculum, the apprenticeship programme attracts new profiles to Université Paris-Saclay. "Apprenticeships, with their remuneration and more 'hands-on' approach, open the university's doors to a wide range of previously excluded students,"* adds Sylviane Liotenberg.

*"Apprenticeships, with their remuneration and more 'hands-on' approach, open the university's doors to a wide range of previously excluded students." – Sylviane Liotenberg*

In total, more than 450 apprentices are now members of the Université Paris-Saclay student community, within vocational undergraduate degrees or work-study programmes. A figure that Sylviane Liotenberg hopes to see rise at the start of the next academic year: *"We hope to be able to welcome around*

# Déclics Collège in Monthéry

## 3rd year pupils and scientists exchange ideas on regenerative medicine

In early June, as part of the Déclics Collège programme designed to introduce secondary-school students to the world of research, four classes of 14 years old students from the Paul Fort secondary school in Monthéry (Essonne) met a team of scientists from Université Paris-Saclay, who came to talk to them about the mechanisms of stem cell regeneration

"How many cells are there in our body? Are they all the same?" The presentation by the Stem cells and neurogenesis in the retina team from the Paris-Saclay Institute of neurosciences (NeuroPSI - Univ. Paris-Saclay, National Centre for Scientific Research CNRS), on Friday 9 June 2023, at the Paul Fort secondary school in Monthéry, began with some very general questions. In front of around thirty students, aged 14 and 15, the four scientists from the NeuroPSI laboratory used their educational skills, friendliness and patience to generate interest among their young audience. They encouraged their participation and awakened them to the cellular and genetic fundamentals of the human body.

The meeting was part of the *Déclics Collège* programme, run by *La Diagonale Paris-Saclay*, which aims to bring teams of scientists working on a wide range of research topics (astrophysics, bioacoustics, climate, neurology, etc.) into secondary schools. It aims to limit self-censorship in scientific fields among young people, especially girls, while introducing them to the world of higher education and research.

"This type of initiative is important for their scientific culture, as they only have an hour and a half of life and earth sciences lessons per week," explains Lambert Dubin, Life and Earth Sciences Teacher at the Paul Fort secondary school. "It also shows them the jobs available in the sciences and the courses they need to get there."

On this Friday in June, four classes at the Paul Fort secondary school benefited from the programme. Each presentation lasted almost two hours and took place in three stages; an introduction to the team and its research theme, followed by fifteen-minute speed-meeting workshops with pupils in small groups, during which each team member took the opportunity to describe their profession, background and research. Finally, an optional discussion with the academic staff closes the session.

**Discovering research, animal models and professions**

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The day's talk focused on stem cells and their benefits in regenerative medicine, particularly retinal medicine, and cell therapy. "That's the whole point of this event, because stem cells are on the curriculum in the third year," highlights the Life and Earth Sciences Teacher. The NeuroPSI team had the perfect partner for starting the discussion on this research topic: the axolotl, with its astonishing characteristics. "Pupils have asked a lot of questions about this animal in class," admits Lambert Dubin. This aquatic salamander, whose head is capped with external gills, is the regeneration champion of all species. It can regenerate a whole limb if it is cut or damaged. It's the perfect way to help secondary school children understand the value of research on amphibians, aimed at identifying differences between species and finding ways to regenerate the retina in patients suffering from eye diseases.

## Passionate individuals, the day's scientific mediators were fully committed to their mission of disseminating science, which they believe is part of their role as scientists.

During the speed-meeting workshops, Albert Chesneau, Research Engineer at NeuroPSI, introduced the pupils to the xenopus, the amphibian model studied in the laboratory, with a few live tadpoles on a table. They also learned about animal welfare. With Léa Jaulin, a PhD candidate in the first year of her thesis at NeuroPSI, they found out about further studies and university degrees - bachelor's, master's and PhDs - which are as yet unknown to them. With Caroline Borday and Patrick Pla, lecturers at Université Paris-Saclay, they found out about the job of lecturer, "two jobs in one!"



© Université Paris-Saclay

**Popularising science and imparting knowledge: a captivated audience**

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Passionate individuals, the day's scientific mediators were fully committed to their mission of disseminating science, which they believe is part of their role as scientists. "We obviously need to adapt to the pupils, to bring a high degree of popularisation. But I love getting them to say things that make sense to them, to make them reason. Today, on their own initiative, they have come up with concepts that we teach to first- and second-year undergraduates," comments Caroline Borday. "This type of event helps to raise the profile of research and shows that it is not inaccessible, and that scientists are people just like everyone else," agrees Léa Jaulin.

All in all, a day of discussions that left very good impressions on both sides. "The pupils leave with a wealth of knowledge they didn't have when they arrived. On the whole, the scientists' presentations were well adapted to the students' needs, and they were able to revisit concepts they'd seen in class," says the Life and Earth Sciences Teacher.

"I found the explanations clear and interesting, and learned things I didn't know," confirms schoolgirl Oihana. Her friend Nina comments: "It's interesting to find out about people's backgrounds. It takes a lot of years of study!" As for Arthur and Maxence, they're still amazed at the number of cells in the human body - 30,000 billion! - and the fact that many of them are continuously regenerating. "It made us want to take a greater interest in science. It would be nice to have more events like this!" conclude both school children together.

<http://www.sciencesociete.universite-paris-saclay.fr/participer/des-scientifiques-dans-les-colleges/>

# Artists' Residencies

## Université Paris-Saclay opens its doors to artistic creation



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**From the CEA to the University of Évry, many research establishments and institutions belonging to Université Paris-Saclay are opening their doors to artists. Looking back at the most recent artists' residencies at Université.**

An artists' residency, which involves institutions welcoming one or more artists for a given period, is often the precursor of new creations and offers a special spotlight on the work carried out in these institutions. As a result, many artists take up residencies in the research community.

"An artists' residency is first and foremost a time for experimentation," explains Serge de Laubier, composer and founder of Puce Muse, who is in residence at the Émulateur, the University of Évry's education centre.

During the 2022-2023 school year, Serge de Laubier and his fellow artists have been working with student volunteers on the *La tête dans le piano* (Head in the piano) project. This was an unusual residency in terms of both its collaboration and its intriguing nature. "We asked the students to play and create variations on the first prelude of Bach's The Well-Tempered Clavier, using game console controllers and the meta-instrument, a computer-assisted instrument of our own creation consisting of 92 sensors," explains the composer. Serge de Laubier and Puce Muse returned to the University of Évry to present their latest work in October 2023, during the Science Festival.

### ↓ *The ethnologist's position*

Hélène Launois completed a residency at CEA Paris-Saclay between 2017 and 2022. The visual artist is best known for her sculptures of objects and their staging in the light. "Before this residency, I had already created sculptures using oscilloscopes, alchemy cabinets with chemical glassware, etc. I have been drawn to the many materials that abound at the CEA for a long time," she says.

Hélène Launois' exhibition *Faire connaissance* (Get to know each other), which grew out of this residency, and in particular her works *Nuage transistor* and *Repas de béton*, showcase the objects and "materials" of CEA research.

"I have always worked with light, using electronic components that I initially hid. I made these components visible for aesthetic reasons," she explains. Hélène Launois' five-year residency at CEA Paris-Saclay gave her a thorough understanding of the research environment. "During this residency, I worked a lot with engineers and technicians on the design of my works. I also met and talked to a lot of researchers," says the artist. "I had no idea what works I was going to produce when I arrived in 2017! I would say I adopted the posture of an ethnologist in a new field, gradually becoming accustomed to my observation environment. This seems to have rubbed off on my work; the sculpture *Cérémonie*, for example, is presented as a purely ethnographic object," explains Hélène Launois.

<https://www.pucemuse.com/la-tete-dans-le-piano/>

<https://www.cea.fr/paris-saclay/Pages/Actualites/Institutionnel/2023/expo-helene-launois-2023-gif.aspx>

*"I have always worked with light, using electronic components that I initially hid. I made these components visible for aesthetic reasons."* – Hélène Launois

# Discover science

## The CEA's Cyclope conferences

**For over fifteen years, the French Alternative Energies and Atomic Energy Commission (CEA) Paris-Saclay and the French National Institute for Sciences and Nuclear Technologies (INSTN - Univ. Paris-Saclay, CEA) have organised science popularisation conferences for the general public.**

Known as Cyclope, these conferences give researchers from the CEA and other research organisations the opportunity to introduce their projects and present the latest scientific news on topics ranging from archaeology and nuclear energy, to health, climate and the Universe. Free of charge, Cyclope conferences are held

on weekday evenings at the INSTN lecture hall. They are also broadcast live on the CEA Paris-Saclay Facebook page and then stored on the CEA YouTube channel. The next Cyclope conference, *Proteins are everywhere!* will be presented by Marie-Hélène Le Du, a researcher at the Institute for Integrative Biology of the Cell (I2BC - Univ. Paris-Saclay, CEA, National Centre for Scientific Research CNRS).



<http://bit.ly/ConferencesCyclope>





## ● Research

**10** Sustainable development and research

**13** Deciphering history and heritage

**18** Environment, animals, humans: one health

**21** Low-energy cosmic rays

## ● Business & Innovation

**16** 5G and networks of the future



# Sustainable development and research

## Université Paris-Saclay: an action plan in progress

Sustainable development is one of the core concerns of Université Paris-Saclay and a key strategic element of its policy. The University is aware that it must strive to be exemplary and is therefore constantly working to minimise the demand for resources and the impact of its activities, particularly research.

### Keywords

- Ecology
- 
- Research
- 
- Action plan

The reports of the Intergovernmental Panel on Climate Change (IPCC) and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) leave no room for doubt: past and present development trajectories are causing serious, and in some cases irreversible, changes to the Earth's climate and biodiversity. Human and industrial activities are the causes of these profound changes.

These findings are a challenge for the world of research, and not just for specialists in these fields. Scientists are taking action to contribute to more sustainable trajectories.

### Taking transformative action

With its community of 48,000 students, 230 laboratories and 9,000 research staff, Université Paris-Saclay intends to make such a choice for itself. In 2021, it adopted a "Sustainable Development Charter" and in January 2023 set out the broad outlines of its strategy as part of the Energy Saving Plan.

*"We moved beyond the question of how to conduct research to that of its purpose and the conditions under which individual or collective bifurcations are possible." – Thierry Doré*

Making this kind of choice implies developing training for new professions, technological breakthroughs and research into environmental changes, new processes that emit less and consume fewer resources, processes for recycling critical materials, regulatory changes, societal changes, and more. And becoming aware of our own impact.

Today, Université Paris-Saclay's presidency, vice-presidencies and management teams are all set to meet these challenges. Thierry Doré, Vice-President of Research at Université Paris-Saclay, says, "We have launched reflection processes and gathered momentum to ensure we implement a strong strategy for the coming years across all the University's missions, especially research." This strategy is also in line with the mandatory deployment of a Sustainable Development and Social Responsibility Master Plan (S3DRS), as requested by the French Ministry of Higher Education and Research (MESR). As a reminder, to meet the European commitment to cut greenhouse gas (GHG) emissions by 55% by 2030 compared to 1990 levels, France must reduce its emissions by around 4.7% per year between now and 2030. Given the specific characteristics of the higher education and research sector, the MESR has set a target of a minimum annual reduction of 2%.

### Integrating sustainable development into research

At Université Paris-Saclay, the Research and Sustainable Development vice-presidencies are overseeing the implementation of a sustainable development policy applied to research and submitted to the boards for approval. The "Basic sciences and sustainable development: what should change in our research?" symposium organised in collaboration with the Centre d'Alembert on 31 May 2023, was the first visible milestone in this strategy.

As part of the International Year of Basic Sciences for Sustainable Development, Université Paris-Saclay wanted to address the ethical issues raised by environmental degradation and economic and social inequalities in research, from both a theoretical and a practical point of view. Nearly 300 people took part in the symposium, half of them PhD candidates. "This is striking, as it means that this is a focus of attention for young scientists," emphasises Thierry Doré. "The discussion was not confined to the fields of ecology or physics. We moved beyond the question of

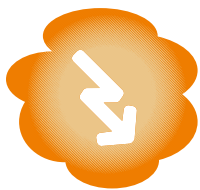
how to conduct research to that of its purpose and the conditions under which individual or collective bifurcations are possible." The challenge now is to ensure that all University's communities take up the subject, "in ways that are appropriate to them and with questions that depend on the nature of their disciplines," notes Thierry Doré.

### An action plan under discussion

A research and sustainable development policy containing an action plan has also been drawn up and put forward for discussion with the research community, all laboratory staff and senior management. This action plan was presented to laboratory directors across Université Paris-Saclay constituent faculties and institutes in July 2023. Its aim is to help them identify those practices that have the greatest impact on the environment. "The aim is to strengthen ties and ensure that this dynamic spreads to all University's laboratories," confides Thierry Doré.

While these actions concern the research laboratories, some must be applied more globally across Université Paris-Saclay. For its implementation, the action plan relies on the network of Sustainable Development Advisors appointed in the laboratories, who ensure the two-way relay of information. Part of the funding is provided by a portion of the management fees applied to the budget of research programmes managed by University. The action plan was also presented to Université Paris-Saclay's Management Committee and Governing Board during a webinar on 17 November.

As far as climate impacts are concerned, to raise research staff's awareness of the issue, Université Paris-Saclay's laboratories have the option of carrying out their own GHG emissions assessments, as some have already done, and using tools to help plan emission reductions (see focus below).



### Reduce energy consumption

- Regulation of temperature
- Thermic renovation
- Optimising the use of the premises



### Track indirect emissions

- Recruitment of a responsible purchasing specialist
- Better waste management
- Setting up central stores to limit the quantity of stored products



### More sober professional mobility

- 20% reduction in GHG emissions from business travel by 2025
- Definition of a maximum annual individualised carbon budget



### More global evaluation of research

- Examination of the positioning of projects in relation to the energy transition
- Increasing visibility of research in line with the objectives of sustainable development

## ACTION PLAN FOR A NEW RESEARCH AND SUSTAINABLE DEVELOPMENT POLICY OF UNIVERSITÉ PARIS-SACLAY

### Moving towards lower energy consumption

Energy consumption for heating and air-conditioning is a major factor in laboratories' GHG assessment. Today, this consumption is largely managed by Université Paris-Saclay, which controls the type of energy used, temperature regulation at source and the thermal renovation of buildings. The room for manoeuvre for laboratories therefore involves optimising the use of premises to reduce the occupied surface area and applying energy-saving recommendations in terms of temperatures in these premises, whenever possible.

However, electricity consumption in laboratories varies considerably depending on the specific equipment used for research activities. This is why the action plan proposes a discussion with each laboratory to identify ways of reducing their consumption. A self-diagnostic guide should be available by the end of 2023.

### Reasoned and more restrained professional mobility

Another strategic point concerns business travel linked to research activities. Whether for data acquisition or international scientific conferences, travel - and the mode of transport chosen - accounts for a significant proportion of the GHG footprint of certain laboratories.

In September 2022, the MESR informed higher education and research operators of a number of directives set out in a circular on energy saving. By 2025, this circular aims to reduce GHG emissions linked to business travel by research staff, which is primarily air travel.

As a result, Université Paris-Saclay is encouraging each laboratory, according to its own context, to take measures to limit air and road transport for its staff, for example by defining a maximum annual individualised carbon budget. At the same time, it is inviting them to start thinking about outside visitors who use these modes of transport, whether as individuals, for conferences or for other collective events.

### Combining purchasing policy, indirect GHG emissions and impact on the biosphere

At the same time, Université Paris-Saclay is tackling the issue of indirect emissions, i.e. those linked to purchases and to the carbon footprint of their manufacture and transport. It has begun to analyse the most critical purchases and the potential for progress. Setting up central warehouses would be one way of improving safety in laboratories, by limiting the quantity of products stored. *"The central warehouse in the Henri Moissan building was planned from the construction phase and could be used as a demonstrator. In any case, this will mean recruiting new staff to keep the warehouse running and make deliveries,"* explains Sophie Szopa, Vice-President of Sustainable Development at Université Paris-Saclay.

As far as equipment is concerned, Université Paris-Saclay recommends extending its lifespan and, if replacement is necessary, considering reuse by other communities, recycling or controlled destruction. Laboratories will be reminded of the existing equipment exchange platforms within University.

The disposal of hazardous and specific waste is regulated and Université Paris-Saclay applies these regulations. Waste sorting and collection, excluding special waste, will soon be assessed to identify areas for improvement.

For certain water-intensive processes, University will analyse, on a case-by-case basis, the possibilities of replacing open circuits with closed ones and the levers for reducing usage. Research requiring large areas of land (forestry, agriculture) will be the subject of a specific analysis with the laboratories concerned.

### Assessing the environmental impact of research

Université Paris-Saclay's commitment to raising awareness of sustainable development issues must also be reflected in the evaluation of research projects. Any University entity organising a call for proposals is therefore invited to include in its evaluation grid a dimension that examines the project's positioning with regard to the ecological transition. This evaluation will cover the research topic itself and its ability to advance the challenges of ecological transition, the mechanisms by which the acquisition of results will impact the environment and the measures taken to reduce these impacts.

University also intends to raise the profile of research aligned with sustainable development objectives. Its efforts to promote open science and interdisciplinarity are also in line with these aims.

However, the question of taking more general account of sustainable development challenges in all research decisions is an underlying one. Given the ecological emergency, should research focused on the challenges of sustainable development be promoted in order to identify ways forward? Should we abandon certain research projects whose supposed practical applications would go against sustainable trajectories? Is unfinished research likely to promote as much progress as completed research? Should we refuse to engage in research with non-academic partners whose activities are contrary to sustainable development trajectories, even though the object of the partnership is not?

*"We are well aware that the road ahead will be long, with setbacks and stumbling blocks, but this should not prevent us from proactively moving forward."*

– Thierry Doré

*"We are well aware that the road ahead will be long, with setbacks and stumbling blocks, particularly when it comes to GHG emissions, where the tendency is to minimise individual impact on the grounds that others are higher emitters, but this should not prevent us from proactively moving forward,"* points out Thierry Doré. *"For the moment, every part of the action plan is in the realm of the conditional. But we hope that at some point they will stop being so and become concrete,"* concludes Sophie Szopa.

### Publications

<https://www.universite-paris-saclay.fr/luniversite/nos-projets-identitaires/developpement-soutenable>

<https://www.centre-dalembert.universite-paris-saclay.fr/2023-sciences-fondamentales-et-developpement-soutenable-que-faudrait-il-changer-dans-nos-recherches/>

Plan Climat, biodiversité et transition écologique du MESR : [https://services.dgesip.fr/fichiers/Plan\\_climat\\_MESR\\_4.pdf](https://services.dgesip.fr/fichiers/Plan_climat_MESR_4.pdf)

# The path of a laboratory in transition

## The exemple of the MaIAGE laboratory

The Applied Mathematics and Informatics from Genome to the Environment (MaIAGE) laboratory has been committed to reducing its carbon footprint for several years now and is continuing its transition, marked by the completion of its first greenhouse gas emissions assessment in 2020 and the recent adoption of a voluntary reduction scenario, created with the endorsement of all laboratory members and the support of the Labos 1point5 collective.

While aspects of sustainable development had been under discussion since 2017, "some staff began to express the desire to adopt eco-friendly actions at work to be consistent with their personal actions," says Sophie Schbath, researcher and former Director of the MaIAGE Laboratory (Univ. Paris-Saclay, INRAE) and the laboratory's current Sustainable Development Advisor. It began with waste sorting, the installation of low-energy light bulbs, a move away from disposable crockery, etc. Regular meetings were set up and were open to all laboratory members.

(Yvelines) - is poorly served by public transport, forcing some staff to travel by car. "The gas heating in one of our two buildings accounted for the second highest emissions (24%)." Next came business travel and IT equipment (19% and 18% of emissions respectively), and electricity consumption (7%). When purchases were added, the laboratory's GHG footprint amounted to 158 tonnes of CO<sub>2</sub> equivalent, or 2.8 tonnes per staff member.

A number of proposals were put forward to reduce it, some of which have been implemented, such as buying less computer equipment and postponing computer replacement to five years. "Some colleagues started to change their practices on their own, without waiting for binding measures; for example, travelling less and flying less to attend conferences, instead attending by videoconference." Others decided to remote work an extra day or commute by bike.

### Creating ambitious, interlocking scenarios

The team then decided to draw up a list of actions and asked colleagues whether or not they were prepared to accept them. "We listed 28 actions, spread across just about every emission item in our GHG balance sheet. They ranged from very simple actions - such as putting a thermometer in the office - to more restrictive measures, such as having a quota for business air travel." An electronic vote was held, involving three-quarters of the laboratory's staff. Based on the results, the team devised increasingly ambitious action plans, which they integrated into five scenarios nested together like Russian dolls and numbered from zero to four. Scenario 0 was the status quo, and 1 was awareness-raising. Scenarios 2, 3 and 4 involved more restrictive actions. "The idea was to gradually accumulate these actions within the scenarios, adding the least accepted ones last."

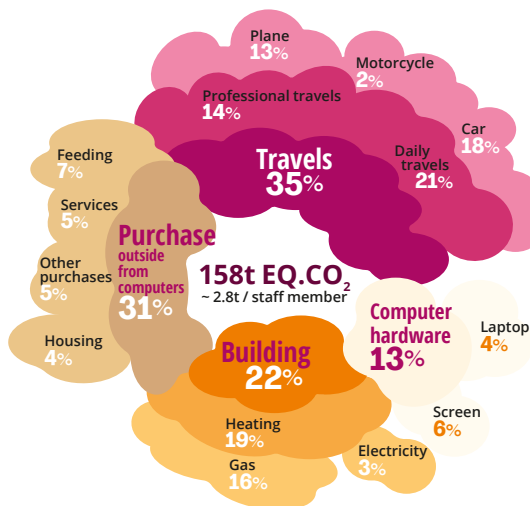
The team presented these scenarios at a laboratory general meeting and put them to a staff vote. The laboratory was committed to adopting the most ambitious scenario that gathered at least 50% support. In the end, scenario 3 was the winner and was adopted in March 2022. "It was a pleasant surprise! We estimated that it could amount to a 40% reduction in our emissions by 2030 compared with 2019." We are already seeing the first reductions, particularly those related to missions, travel and IT equipment. The introduction of a self-imposed carbon tax is also one of the key actions in the chosen scenario. It contributes to a fund dedicated to energy-saving investments. "As we are currently finding it difficult to reduce our emissions linked to the energy (gas, electricity) consumption of our buildings - it requires us to change heating and control systems and improve building insulation - we have decided to save part of the laboratory's operating budget over several years to cover these expenses." This amounted to 4,000 euros in 2022.

For any laboratory wanting to embark on similar initiatives, Sophie Schbath recommends three elements. "The first is to build up a small core of enthusiastic, motivated people who are willing to spend time on this issue. The second requirement is the support of laboratory management. The third is transparency and inclusion."

### References

<https://maiage.inrae.fr/fr/node/2551>  
<https://labos1point5.org>

### ASSESSMENT OF GREENHOUSE GAS EMISSIONS OF THE MAIAGE LABORATORY IN 2019



### The contribution of the Labos 1point5 collective

In 2019, Sophie Schbath discovered the Labos 1point5 collective, which brings together academic scientists from all disciplines on a national scale with the common goal of better understanding and reducing the impact of research activities on the environment, particularly the climate. The initiative appealed to the then director, who wanted to assess the laboratory's greenhouse gas (GHG) emissions. She took advantage of the lockdown in spring 2020 and the switch to remote working to free up time and apply the methodology just developed by Labos 1point5. She collected the necessary data and produced an initial GHG emission report for 2019. Four emission items stood out: commuting, business travel, gas consumption and IT equipment. "In first place was commuting (32% of emissions)." This was due to the fact that the laboratory's location - Jouy-en-Josas

### Further experimentation

Labos 1point5 launched its GHG 1point5 tool at the end of 2020. The MaIAGE laboratory then carried out a new GHG assessment, and the purchasing item, which had been developed by the collective in the meantime, finished in first place. To gain a better understanding of these purchasing-related emissions, Sophie Schbath created her own purchasing categories (accommodation, IT licenses, subscriptions, etc.), and discovered that "half of purchasing GHG emissions were linked to business travel and the reimbursement of expenses."

In 2021, Labos 1point5 launched the Expé 1point5 experiment to try out large-scale reduction measures and test their effectiveness. The MaIAGE laboratory joined the 20 or so other pilot laboratories following approval by the Service Board. Between May and October 2021, a small, motivated team studied the fun, collaborative workshops run by Climate Fresk, 2tonnes, Ma Terre en 180 minutes (My Earth in 180 minutes) and others. It also looked at the 1point5 Kit sheets on carbon tax, quotas, currency and carbon offsetting. During a general meeting of the laboratory, the team set up participative workshops to identify the advantages and obstacles of these systems and the levers for overcoming them. The team began work on GHG emission reduction scenarios for 2030. "We had to set an objective, quantify it and draw up an action plan, inviting people to take part in the process. But creating scenarios, i.e. projecting ourselves into the future, into a different world, is quite complicated."

# Deciphering history and heritage

## Perspectives

Heritage, the guardian of memories, always conceals a story to be deciphered. How can this object, at the crossroads of the past, present and future, be studied? This is an overview of the approaches taken by researchers at Université Paris-Saclay.

### Keywords

Heritage  
—  
Database  
—  
Buildings

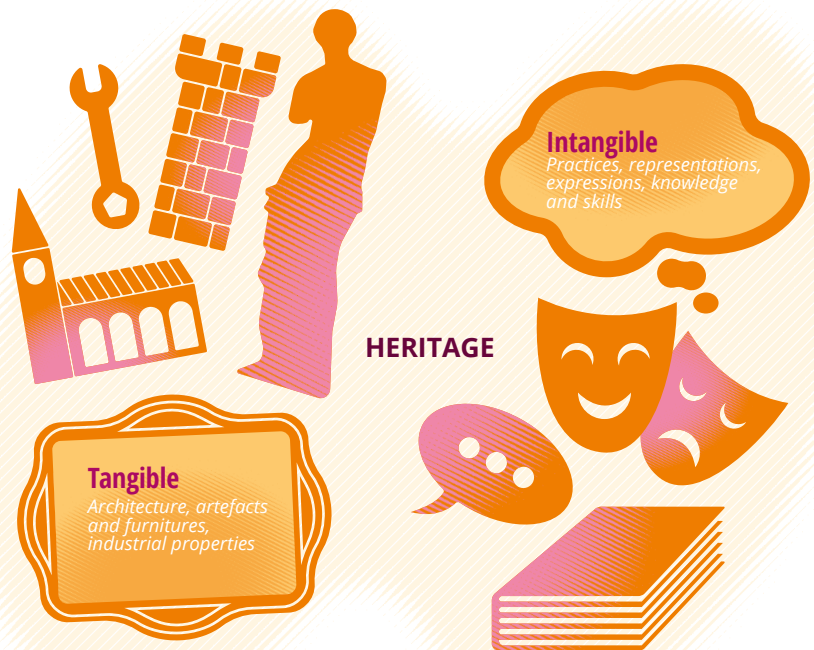
Heritage, a term often associated with historical legacy, is of considerable importance to society. Whether tangible or intangible, of cultural, historical, aesthetic or social value, heritage encompasses monuments, objects, traditions and practices that bear witness to the past and help to create a collective identity. However, the study and preservation of heritage face complex challenges that require a multi-dimensional and sometimes new approach. What are these approaches? What role does the scientific community play in heritage preservation?

### Ethical challenges of digital humanities in research

The creation of data sets, simulations and advanced analyses means that digital technology is at the heart of our historical research activities. Giovanni Pietro Vitali, lecturer at the Heritage and Cultural Dynamics Laboratory (DYPAC - Univ. Paris-Saclay, UVSQ), for example, uses a range of programming languages such as R, Python and JavaScript to analyse texts and various archives. Its *Last Letters from the World Wars* project focuses on the linguistic and thematic analysis of the last letters of people sentenced to death during the World Wars. Using digital tools, it examines corpora of letters collected in Italian archives, identifying significant elements in these correspondences.

Paolo Vannucci, professor at the Mathematics Laboratory of Versailles (LMV - Univ. Paris-Saclay, UVSQ, CNRS), focuses on the study of large monumental structures, in particular Gothic cathedrals such as Notre-Dame de Paris. It seeks to understand the impact of extreme actions on these monuments and studies the structural thinking of ancient builders. Using simulations and digital archaeology, it studies the impact of buttresses, wind resistance and climatic action on cathedrals.

Digital humanities, a discipline that uses digital technologies and computer science to study knowledge in humanities and social sciences, raises questions about the use of data and algorithms. For example, they can be influenced by the training data used to develop them. If this data is biased, the results produced by the algorithms will also be biased. Cultural or linguistic biases are also a cause for concern, for example when machine translation algorithms favour certain languages or regions, or perpetuate



cultural stereotypes. Privacy is another major concern, as these technologies often involve the collection, storage and analysis of vast amounts of personal data, raising questions about the confidentiality and privacy of individuals.

However, Giovanni Pietro Vitali points out that the transparency and accountability mechanisms offered by open science mitigate the biases and errors produced when using proprietary applications that do not guarantee full supervision of the internal processes of computational calculations, and guarantee results that benefit society as a whole. The researcher always raises the question of how to integrate open science technologies according to FAIR principles, which aim to promote the open access, reusability and interoperability of scientific data. The acronym FAIR stands for Findable - Accessible - Interoperable - Reusable. "I only work with programming languages such as R, to guarantee the complete autonomy of my product," adds the researcher.

He is also very active on GitHub, a cloud-based collaborative development platform used to host, manage and share source code projects. He shares all his projects, submissions and even tutorials there. In his study *A Theatre of Places: mapping 17th French Theatre*, the researcher uses text mapping to study the places mentioned in 17th-century French theatre literature. This text-mapping technique not only allows us to draw conclusions about literary influences and the strength of the genre over the course of the century, it is also easily reproducible and entirely *open source*, as all sources are transparent and accessible to all.

**Heritage vocabularies: an interdisciplinary issue**

Marie Cornu, specialist in cultural and heritage law at the Institute of Social Sciences in Politics (ISP - Univ. Paris-Saclay, ENS Paris-Saclay, CNRS, Univ. Paris-Nanterre), emphasises the importance of language and the normative dimension in relation to other disciplines in her legal research. She co-edited the *Dictionnaire de droit comparé du patrimoine culturel* (Dictionary of comparative law of cultural heritage) in 2012, which takes a comparative approach to the question of heritage vocabularies in ten European countries, and the *Dictionnaire des biens communs* (Dictionary of Common Property), published in 2017 and republished in 2021, a project that brought together several disciplines around the notions of the common and common property (economists, jurists, political scientists, sociologists, etc.). For several years, she has been working with researchers in heritage sciences to create an interdisciplinary *Dictionary of Heritage*. This project aims to go beyond a simple description of concepts and adopt a reflective approach to the notion of heritage.

Marie Cornu and her team have also studied the genesis of the texts that form the normative field of heritage. The *Mémoloi* project, for example, focuses on exploring and understanding the origins of laws, in conjunction with the French Ministry of Culture's History Committee. The researchers are also interested in how the law interacts with time and how it is applied in practice, *"We are interested in the law in action, taking into account the way it is reappropriated by the players involved,"* explains Marie Cornu. This dimension, which is crucial to understanding legal systems, is also a key research orientation at ISP.

*"We are interested in the law in action, taking into account the way it is reappropriated by the players involved."* – Marie Cornu

**Digital advances transforming heritage research**

Thanks to the use of simulations and advanced modelling techniques, the researchers are now able to examine ancient constructions from every angle, even though in some cases there is no written record of them. This approach challenges some of the assumptions made in the literature.

Paolo Vannucci and his team used the finite element method to assess the structural resistance of Notre-Dame Cathedral in Paris, determining the critical threshold at which the building becomes vulnerable to wind forces. The results were striking, as before the fire of 2019, the vault would have withstood wind gusts of up to 200 km/h. There is now danger as soon as the winds reach 90 km/h, exposing the cathedral to the risk of partial collapse. This 60% reduction in wind resistance highlights the urgent need to take measures to secure this architectural landmark.

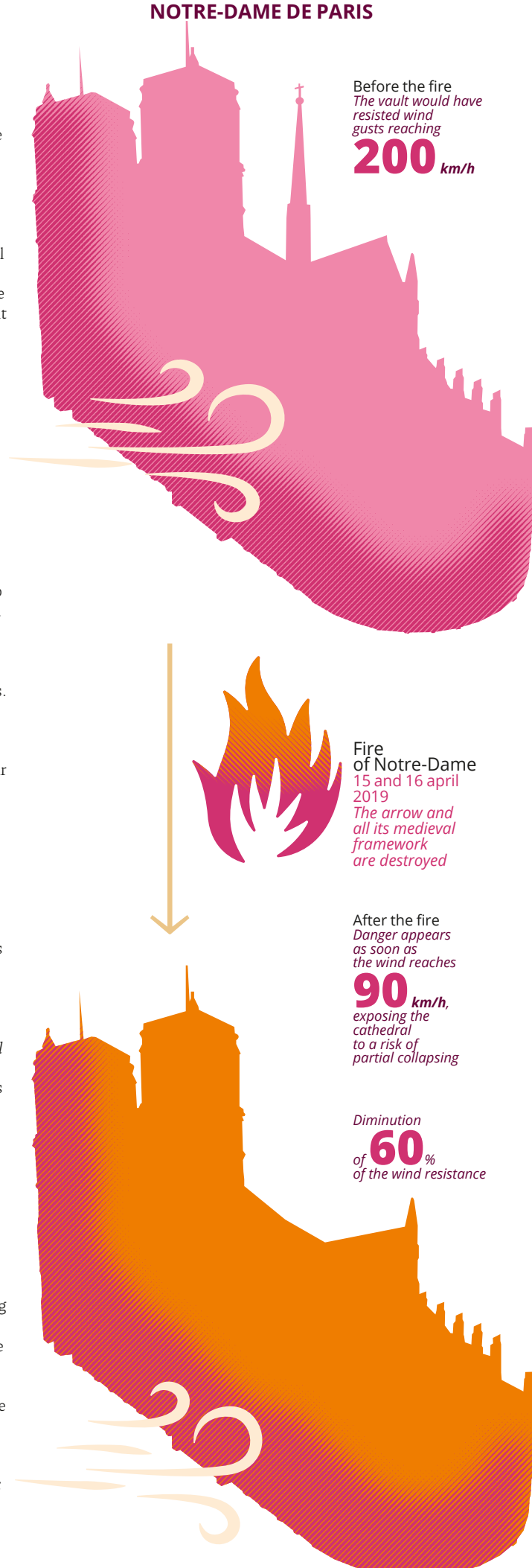
Other approaches, such as the discrete element method, which considers each particle individually, or the finite volume method, which divides the structure into small three-dimensional volumes, are also used to simulate granular movements and measure wind action on ancient monuments. Lastly, the limit analysis method aims to determine the maximum loads a structure can withstand before it collapses.

These advances provide a better understanding of the forces that shape ancient monuments and contribute to their preservation. *"Engineers have a variety of more or less interchangeable methods and tools at their disposal, with their own applications and levels of accuracy. The diversity of approaches gives engineers the tools to find the right solution for each challenge,"* explains Paolo Vannucci.

Giovanni Pietro Vitali considers that his role is not limited to writing, but extends to the development of all technological innovations likely to improve research. *"Advances in digital humanities offer new opportunities for revolutionising traditional approaches to humanities and social sciences,"* he explains. These opportunities include the analysis of vast data sets, which scientists can now use to identify trends, patterns and relationships that were once difficult to discern.

The *Prismatic Jane Eyre* project, in which the researcher is very involved, is a prime example. This study examines the linguistic transformations and variations that emerge in translations of Charlotte Brontë's famous novel *Jane Eyre*. By listing no fewer than 618 translations in 68 different languages, interactive maps have been created to highlight the global proliferation of this masterpiece and capture how it is understood across diverse contexts. *"This 19th-century English novel, which was ahead of its time in terms of its feminist scope, is of particular literary interest. Our aim is to analyse how this work was received in various countries and study the interactions it has generated within different cultures. The project looked at the most popular editions and found that*

**EVOLUTION OF THE STRUCTURAL RESISTANCE OF THE CATHEDRAL NOTRE-DAME DE PARIS**



Before the fire  
The vault would have resisted wind gusts reaching  
**200** km/h

Fire of Notre-Dame  
15 and 16 april  
2019  
The arrow and all its medieval framework are destroyed

After the fire  
Danger appears as soon as the wind reaches  
**90** km/h,  
exposing the cathedral to a risk of partial collapsing

Diminution  
of **60** %  
of the wind resistance

*the most interesting reactions came from the Arabic-speaking and Chinese worlds. We examined how this English novel was received in these two cultures, which were undergoing significant changes at the time. In particular, we analysed the evolution of book covers over time and space,"* explains the researcher.

The study of historic monuments often requires the involvement of research teams from different disciplines. And reconciling experts in history with other scientists specialising in mechanics, mathematics or other disciplines can be a challenge, as Paolo Vannucci points out, *"For example, when dealing with fracture mechanics in the analysis of monuments and their ultimate state, we may find ourselves talking to a colleague who is an expert in fracture mechanics and is considering problems on a millimetre scale. However, the problems encountered in cathedrals have dimensions that are measured in metres, which makes them totally different. Furthermore, the researcher points out that historical heritage issues are frequently raised in France, but their development is still limited."* The study of historical heritage faces considerable budgetary constraints, often resulting in a lack of funding for preservation, research and restoration activities. There may also be problems of coordination between the various entities and players involved in preserving and managing historical heritage.

Researchers at Université Paris-Saclay, such as Marie Cornu, have been actively involved in the development of an interdisciplinary heritage science community. It brings together specialists from a variety of fields, including history, art history, sociology, law and experimental science. One of the first concrete results of this collaboration was the Nomade seminar, which aimed to explore conceptualisation methods in the field of heritage, based on themes such as authenticity and notions of origin, trace, provenance and trajectory.

*"It was an experience that consolidated the heritage science community around a common reflection,"* adds Marie Cornu. These issues have been explored in depth in a number of fields, including scientific and technical heritage, archaeology, architecture, musicology, museology, conservation and restoration. A summer school organised by Ludwig Maximilian University in Munich and ISP, in close collaboration with the Graduate School Humanities - Heritage Sciences (GS HSP), Palabre interdisciplinary programme and the Franco-German University, also took place in September 2023 at Bibracte, a Gallic city dating from the first century BC and now preserved as an archaeological site in the heart of Burgundy-Franche-Comté. Workshops, lectures and seminars on topics such as the origin, illicit trafficking and collection of archaeological objects were all part of this summer school.

Mirroring this international collaboration, the Franco-Latvian Osmose project, conducted between 2014 and 2018, aimed to explore the diversity of normative systems related to intangible cultural heritage and examine the links between different branches of law. Marie Cornu, co-director of the ISP project in partnership with the Latvian Academy of Culture, explains, *"Heritage law is often the preserve of governments or regions, and is generally a matter of national sovereignty. But it is built and defined in different ways. It is therefore interesting to compare the legal recognition of heritage and the way in which this area of law is implemented. To do this, we have set up an international network of active researchers."*

### Prosopography, Constantine and Byzantium

Vincent Puech, a historian specialising in the Byzantine world and Roman Antiquity, and Director of the Institute of Cultural and International Studies (IECI - UVSQ), uses the prosopographical approach to study historical figures. This method involves compiling thematic files on specific individuals in order to understand the social, political and cultural dynamics of the period. His research is in line with social and political history, focusing on family networks, geographical origins and religious issues. His first book, *Constantin. Le premier empereur chrétien* (2011) (Constantine, the First Christian Emperor), illustrates this thematic approach and his interest in the Byzantine world and Late Roman Antiquity (4th-6th centuries). In particular, he discovered that the ancient statues imported by the Roman emperor to decorate Constantinople, the capital of his empire built on the site of Byzantium, followed a precise logic. They include objects paying homage to the ancient cults of Byzantium and its inhabitants, despite Constantine's conversion to Christianity.

This discovery led him to delve deeper into the question of ancient heritage in the Byzantine world.

Vincent Puech's approach to social history also opens up a methodological path to other disciplines. The historian explains that this approach is a form of history closely linked to sociology, focusing on the study of social groups and giving particular importance to their quantitative dimension. *"Although carrying out a quantitative study of these periods is complex, prosopography can nevertheless be used to group individuals into series. If we then see that phenomena are repeated, we can learn from them. Furthermore, there is a qualitative aspect that addresses another branch of sociology, one that focuses more on the individual and aims to understand individual behaviour in greater depth, without considering individuals in a deterministic way,"* he adds.

Monuments, artefacts and civilizations dating back hundreds or even thousands of years are fascinating subjects of study which today require new resources and increased collaboration to overcome the compartmentalisation of research.

### Publications

V. Puech. « Les statues des bains de Zeuxippe à Constantinople : collection et patrimoine dans l'Antiquité tardive ». *Anabases*. 2016.

P. Vannucci et al. "A study on the structural functioning of the ancient charpente of Notre-Dame, with a historical perspective". *Journal of cultural heritage*. 2021.

<https://github.com/digitalkoine>

Marie Cornu et al. - Carnet Hypotheses « Droit, patrimoine et culture » : <https://dpc.hypotheses.org/>

*"Furthermore, there is a qualitative aspect that addresses another branch of sociology, one that focuses more on the individual and aims to understand individual behaviour in greater depth, without considering individuals in a deterministic way."*

– Vincent Puech

# 5G and networks of the future

## National and European projects focusing on 5G and the networks of the future

There are many research projects aimed at improving 5G and developing the telecommunications networks of the future, with 6G at its spearhead. These include the 5G Priority Research Equipment and Programme (PEPR), in which several laboratories at Université Paris-Saclay are involved.

### Keywords

- 5G
- 6G
- Networks of telecommunication

As part of the France 2030 investment plan, the PEPR 5G and future telecommunications network technologies is a national acceleration strategy PEPR focusing on the development of advanced technologies for 5G and the networks of the future. Led by the French Atomic Energy Commission (CEA), the French National Centre for Scientific Research (CNRS) and the Institut Mines-Télécom (IMT), its aim is to help overcome the technological challenges that are currently preventing 5G from reaching its full potential, and to anticipate the technologies and architectures of future telecommunications networks in the medium and long term. These future high-performance networks will be based on intelligent devices capable of cooperating, making distributed decisions and dynamically reconfiguring themselves in response to the environment.

As well as developing technologies, the PEPR 5G and networks of the future focuses on the mathematical and methodological tools needed to analyse, model and optimise these technologies. It brings together around fifty national laboratories working in telecommunications, information and communication theory, signal processing (physical layer), statistics, machine learning, electromagnetism, hardware technologies (digital, analogue and radio frequency), etc. It includes nine targeted projects on network architectures, data throughput in the millimetre band, devices for high-speed links in the sub-terahertz band, the Internet of Things, security... and a tenth on platforms.

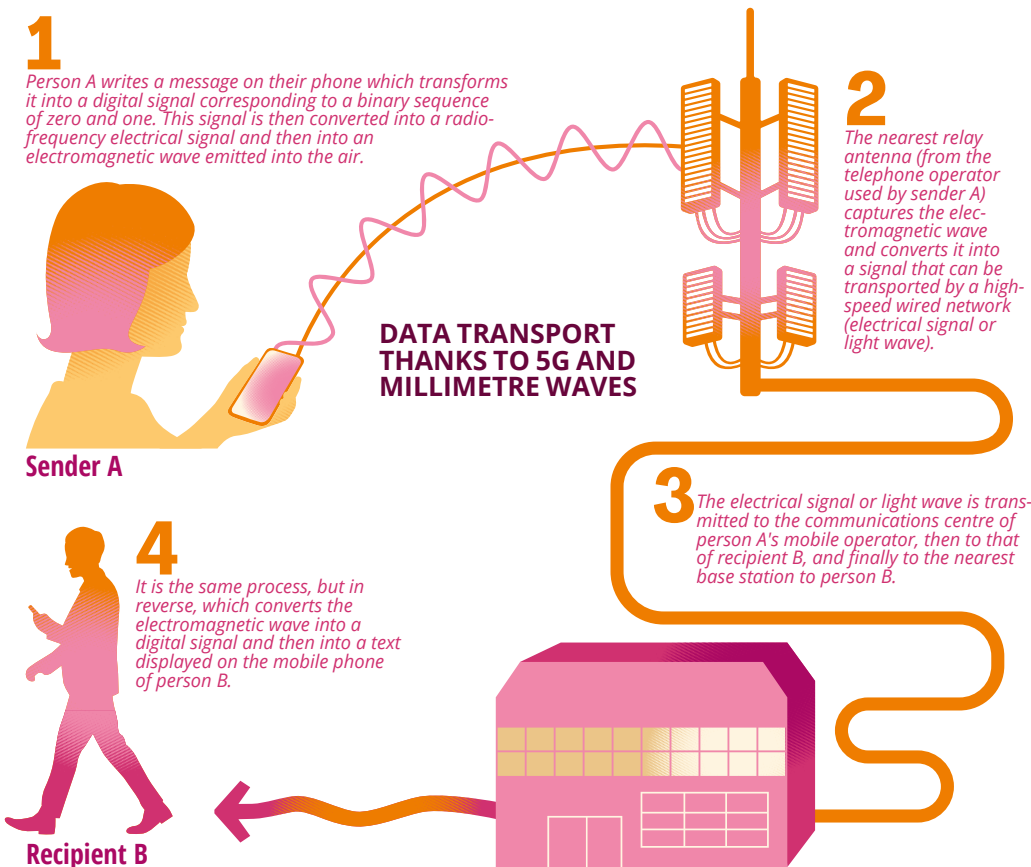
At Université Paris-Saclay, the Laboratory for the Integration of Systems and Technologies (List - Univ. Paris-Saclay,

CEA), the TRiBE (Internet beyond the usual) team at the Inria Centre in Saclay and the Signals and Systems Laboratory (L2S - Univ. Paris-Saclay, CNRS, Centrale-Supélec) are particularly involved. *"In view of the applications envisaged - such as the Internet of Things (IoT), virtual reality and vehicular networks, which require a great deal of information to be transmitted - it is necessary to use new waveforms rather than those on which current modulation systems are based. To drastically increase throughput, we want to use higher frequency bands, above 6 GHz - the millimetre waves of 5G - or even sub-terahertz or terahertz (THz), which go beyond 100 GHz,"* explains Marco Di Renzo, head of the L2S IPHYCOM team involved in some of the targeted PEPR projects.

However, the desire to transmit data using higher frequency bands raises a number of issues. Working with such frequencies implies higher power consumption. What's more, *"at such frequencies, it's difficult for signals to propagate over very long distances. The waves don't travel very far,"* adds Marco Di Renzo. And if there's an obstacle between the transmitting and receiving systems, the waves aren't always able to get around it, so you don't receive the message. Communication systems incorporating detection and localisation aspects are also being studied, in order to pinpoint the position of an object or a user in the environment. *"Currently, in autonomous vehicles for example, radar systems, which are used by cars to understand where they are, and communication systems constitute two separate hardware modules. We now want to bring these two systems together in a single optimised module,"* comments Marco Di Renzo.

### Exploring reconfigurable intelligent surfaces

With his team, the researcher is working on the design and optimisation of Reconfigurable Intelligent Surfaces (RIS). Three targeted PEPR 5G projects are focusing on them. *"RIS are a metamaterial developed by human beings with extraordinary electromagnetic and physical properties that are not found in any natural material,"* emphasises Marco Di Renzo. They represent a promising technology for improving the coverage and spectral efficiency of wireless systems, and for





## MOBILE NETWORKS EVOLUTION AND THEIR CHARACTERISTICS

| 1990's   | early 2000's   | early 2010  | 2020   | 2030  |
|--|--|---|--|---|
| <b>2G, 2.5G, 2.75G</b><br><b>Used frequencies</b> 900 et 1 800 MHz<br><b>Speed</b> 10 to 384 kbits/s<br><b>Applications</b> calls, text and image messages | <b>3G, 3G+, H+</b><br><b>Used frequencies</b> 900, 1,800 et 2,100 MHz<br><b>Speed</b> 2 to 42 Mbits/s<br><b>Applications</b> calls, text and image, messages, mobile internet, social networks, email sending, audio and video streaming | <b>4G, 4G+</b><br><b>Used frequencies</b> 700, 800, 1,800, 2,100, 2,600 MHz<br><b>Speed</b> 100 to 500 Mbits/s<br><b>Applications</b> high speed mobile internet, important data exchanges, e-trade, etc. | <b>5G</b><br><b>Used frequencies</b> 3.5 GHz, 26 GHz (millimetre waves)<br><b>Speed</b> 100 Mbits/s to 1 Gbit/s<br><b>Applications</b> connected objects, online games, 4.0 industry, smart cities, remote medicine... | <b>6G</b><br><b>Aimed frequencies</b> Beyond 100 GHz (not yet attributed)<br><b>Theoretical speed</b> 1 Tbit/s<br><b>Applications</b> immersive experiences, digital twin, eHealth, robotic and autonomous systems... |

controlling the wireless environment. "By analogy with a mirror reflecting the light of the environment in which it is placed, a RIS placed on a wall reflects the surrounding waves, but in a controlled way. If an object blocking signal transmission is present between the transmitting and receiving systems, and a wall is not far away, the RIS can operate as a low-complexity electromagnetic relay: the signal is sent to it, which is then reflected towards the receiving system."

*"RIS are a metamaterial developed by human beings with extraordinary electromagnetic and physical properties that are not found in any natural material."* – Marco Di Renzo

This technology has several advantages: it does not require a power amplifier and is relatively simple to deploy, it does not consume energy and does not require the creation of new electromagnetic waves or the deployment of new base stations. By using electromagnetic waves intelligently, it also reduces the electromagnetic impact on people.

As part of a collaboration with a major international company, Marco Di Renzo's team has simulated the deployment of such systems in cities and shown that with millimetre waves, a surface area of 70 cm x 70 cm improves network coverage quite significantly. The number of RIS and the distance needed between each one are currently being studied. "We have recently shown that installing between seven and eight RIS per base station gives almost perfect millimetre-band coverage."

In addition to PEPR 5G projects, Marco Di Renzo's team is involved in a number of other projects focusing on RIS, such as ARIADNE (Artificial Intelligence Aided D-band Network for 5G Long Term Evolution) and RISE-6G, in which Orange and SNCF are partners. "ARIADNE proposes the use of RIS for sub-terahertz band communications and machine learning techniques to optimize them," explains Marco Di Renzo. Recently, partners of RISE-6G have deployed this technology in Rennes station and the researchers have confirmed that RIS are useful for improving the quality of communications.

## A sustainable 6G chair Designing the networks of the future

Orange, Université Paris-Saclay, the French National Centre for Scientific Research (CNRS) and CentraleSupélec recently announced a five-year partnership to create a sustainable 6G research chair, headed by the Signals and Systems Laboratory (L2S). The aim of this industrial partnership is to design and manage low-energy 6G networks. The research work will provide a medium- and long-term overview of how future 6G networks will be built, and will address the need for energy-efficient networks. It will draw on the academic work and expertise of L2S in fundamental and applied mathematical aspects of control theory, information theory and communications.

While the 5G deployment is underway, with the aim of connecting human beings and objects, the vision of 6G is quite different, since it is intended to connect intelligent and autonomous entities. "In the first case, we are moving from a network transporting data between entities in a reliable way, to an intelligent network which, in the second case, must be adapted to the behaviour of intelligent entities and to the diversity of their needs," comments Salah Eddine El Ayoubi, researcher at L2S and holder of the Sustainable 6G Chair. However, it is now essential, in the light of climate emergency, to integrate the issue of energy sobriety into the development of these technologies.

### A better balance between performance and energy impact

That's why, "One of the main areas of work will aim to operate the network within strict energy consumption constraints. Instead of trying to achieve performance and throughput targets at a lower energy cost, we will concentrate on the challenge of low energy consumption, to which we will adapt the performance of the network," explains Salah Eddine El Ayoubi. There is also the question of how to integrate renewable energies natively into the networks of the future and use them as much as possible, and how to successfully adapt the networks to this varying energy profile.

While it will probably be necessary to deploy new equipment, attention will have to be paid to making the best possible reuse of the infrastructure already employed for 5G, and to relying on new equipment only where absolutely indispensable. It is therefore important to take full account of the life cycle of equipment when calculating the energy footprint of future networks, from the extraction of materials to their recycling. "As part of the Chair, we will incorporate this entire life cycle into our overall assessment of networks, so that we can propose one engineering rather than another. We will evaluate the most efficient

technologies, such as massive MIMO (for Multiple Input Multiple Output, designating a massive deployment of antennas already present in 5G) or intelligent reflective surfaces (RIS), and compare them with their energy impact in different contexts, in order to manage them strategically."

### Moving towards a more sustainable society

Another area of research explored by the Chair concerns the contribution of 6G to industry and society. "It's not just a question of reducing the carbon impact, but of helping society to achieve the sustainable development objectives set by the United Nations, particularly in terms of access to health, of a more innovative industry and a more sustainable city. One area of research, for example, will focus on connected robotics, with a view to the joint design of communication networks and control algorithms for robots in a factory, in order to increase the efficiency of industrial processes and reduce their environmental impact."

A final aspect will be society care and maintenance. "The idea is to take advantage of 6G to have a global approach to care, combining connected health (an already popular concept) and predictive maintenance, where we make sure that infrastructures, particularly those linked to energy, water, transport, etc., are in good shape and have an extended lifespan. By exploiting the gathering and processing of data through intelligently deployed sensors, 6G would make it possible to detect weak signals and predict possible breakdowns."

The Chair will involve academic theses, the results of which will be published under the banner of open science. More applied work is also planned as part of an industrial collaboration with Orange, in particular CIFRE theses on the management and optimisation of the 5G network and beyond, which will potentially lead to the filing of patents.

# Environment, animals, humans

## The one health approach

At Université Paris-Saclay, healthcare is ahead of its time, with research topics as varied as pollinator conservation or managing data with artificial intelligence. Human beings don't live in a goldfish bowl. The environment in which they are immersed is fraught with dangers (often resulting from human activity): air and water pollution, repeated global pandemics, exposure to carcinogens and long summer heat waves are all causes of mortality.

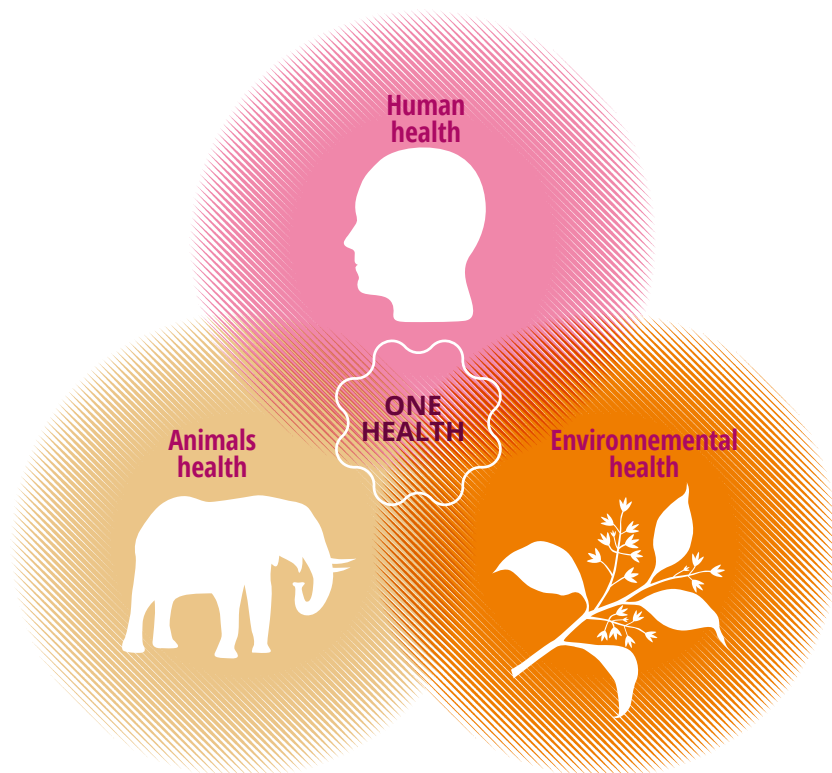
### Keywords

- One health
- Health data
- Future's medicine

The fact that our environment is full of dangers for human beings means rethinking medicine through the "one health" approach, which simultaneously study and preserve human, animal and plant health ecosystems and biodiversity. Scientists are promoting urgent action to keep the world liveable, including the fight against climate change, the detection of zoonoses, diseases carried by animals such as mosquitoes and transmitted to humans and the consideration of socio-economic aspects such as the cost of medicines.

### Bees under pressure

The "one health" approach also means protecting biodiversity, particularly that of pollinators, the animals that carry pollen grains from one flower to another and are involved in the sexual reproduction of many plant species. Over the past twenty years, bee colony collapse disorder has been decimating beehives worldwide. *"Bee mortality is reaching a worrying and widespread level,"* stresses Fabrice Requier, research fellow in agroecology at the Evolution, Genome, Behavior and Ecology Laboratory (EGCE - Univ. Paris-Saclay, CNRS, Research Institute for Development IRD). Pesticides, neonicotinoids, the disappearance of natural foraging areas, invasive pests... There are multiple causes of this collapse. *"It's a devastating cocktail effect for pollinators, especially honeybees, which we've selected over millennia for their productivity and non-aggressiveness, to the detriment of their resilience."* In the early part of his career, the ecologist worked on *Apis mellifera* bees, our domestic honey bees, which he studied from every angle. *"For example, we developed a field test that is now used for pesticide approval. Foraging bees are offered a mixture of sugar and pesticide. If they're not harmed, they're able to return to their hive without any problems,*



*otherwise it's proof that they've been poisoned."* He also assesses the influence of parasites, pathogens and viruses on bee health. The most studied, the varroa mite, is a virus-carrying parasitic mite that infiltrates the hive and causes premature mortality. The Asian hornet is also dangerous: *"After arriving in France in 2004, it attacks bees as they leave the hive, encouraging them to take refuge inside for days on end, to the detriment of food storage for the winter,"* notes the researcher.

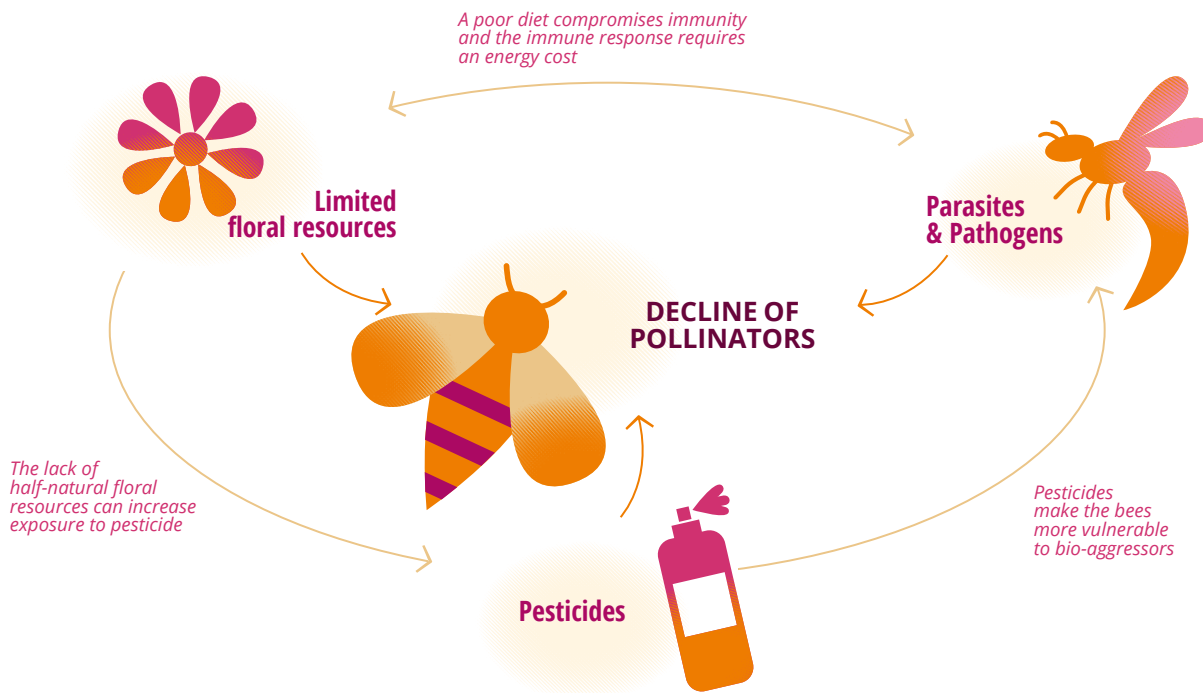
Even more worryingly, honeybee mortality is just the tip of the iceberg. Environmental pressures are also endangering the 20,000 other bee species, both domesticated and wild, as well as the 300,000 pollinating animal species.

According to Fabrice Requier, it would be a serious mistake to ignore this issue: *"Pollination is an ecosystem service, i.e. a benefit provided by nature. While the wind pollinates some staple crops, such as rice and wheat, other crops, like cocoa, are totally dependent on pollinators."* Many crops, such as apples, tomatoes, avocados and oilseeds also make more moderate use of pollinators. *"But that doesn't mean they can do without them,"* says the ecologist. Wind-pollinated strawberries are smaller and more irregular in shape. *"It is estimated that in a world without insects, the yield of these plants would halve, and the nutritional quality of the fruit would be lower."*

*"If the decline continues, essential vitamins and minerals may disappear from many people's diets."* The researcher and his team fear the emergence of iron and vitamin A deficiencies in developing countries, where dietary diversity is already fragile. *"We could be witnessing an increase in malnutrition and disease affecting nearly 71 million people,"* warns the researcher.

*"It's a devastating cocktail effect for pollinators, especially honeybees, which we've selected over millennia for their productivity and non-aggressiveness, to the detriment of their resilience."* – Fabrice Requier

In Kenya, where Fabrice Requier is about to work with a local university, there are some vast avocado monocultures. *"Farmers use high doses of insecticides, creating veritable deserts of biodiversity, with no pollinators,"*



laments the researcher. To give bees some respite, we need to curb the use of pesticides everywhere and increase the number of hedges and grassy strips, which act as refuges for wild pollinators. This would then protect chocolate, the nutritional quality of fruit and global health.

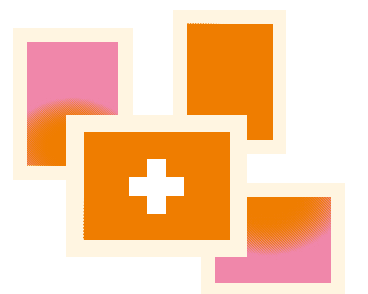
### How is health data analysed?

Medical research deals with huge quantities of data, a volume necessary for robust statistical analysis. This creates the challenge of analysing the information in the right way. In response, proponents of the "one health" approach are relying on multidisciplinary.

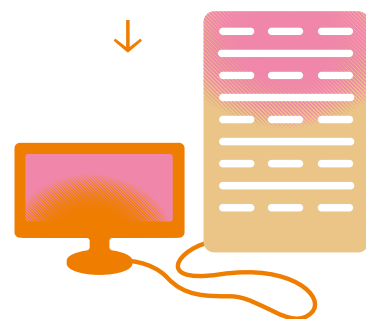
During the Covid-19 pandemic, the pooling of observations by hospitals and laboratories provided reliable data for monitoring the epidemic and guiding public policy. In order to repeat such achievements in other areas of health, Bertrand Thirion, Director of Research of the Inria-CEA Models and Inference for Neuroimaging Data (MIND) project team, is calling for a close working relationship between disciplines: "To develop sustainable health, we need to be proactive and call on specialists capable of managing, organising and analysing data, especially using artificial intelligence (AI)."

After contributing to the development of the Scikit-Learn general-purpose machine learning tool, the researcher is now focusing his research on the neurosciences. His team processes large datasets using predictive AI. "We create models capable of making a diagnosis from complex data, such as magnetic resonance imaging (MRI) scans. Some models can predict your age from a simple snapshot of your brain. Others diagnose cancers by analysing images of organs." The MIND project team is keen to make the process transparent: "To demonstrate precision, we need to build algorithms able to accompany their response with a confidence interval, and point to the area of the image on which their diagnosis is based," argues the researcher.

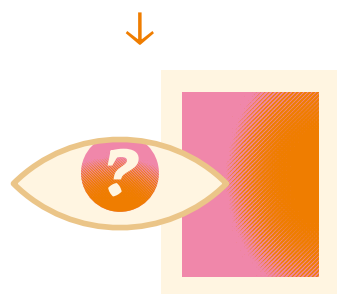
### DATA ANALYSED BY AI TO FACILITATE MEDICAL DIAGNOSIS



Large medical datasets are collected and pooled by hospitals



Datasets are analysed by predictive AI



AI produces diagnostic assistance for doctors

### Creating complete athletes

Bertrand Thirion also stresses the importance of dialogue with healthcare personnel to identify real needs: "The predictions we can make are only relevant if they are useful to doctors in improving their care." However, the researcher reminds us of the need for perspective in the face of the many promises heralded by the use of AI. "The current trend is to create models that are almost always right in the test phase." During this phase, data scientists calculate a prediction score by testing the model on one of the few large datasets available for research. "However, by using only a few datasets for training and evaluation, the risk is to create over-specialised algorithms, the performance of which is not guaranteed when faced with real data, especially if these are imprecise, sometimes incomplete hospital data." For example, an Olympic swimmer who dedicates all their training to swimming lengths will finish last if they have to take part in a pole-vaulting event. Instead, the challenge is to create versatile athletes who can perform in a wide variety of contexts. "Research data must be made free and public to create more databases and facilitate our work," concludes the researcher.

In order to predict the global health challenges of the 21st century, pollinators, biodiversity, agriculture, pollution, climate change and many other parameters need to be taken into account. Soon, you won't have to ask your doctor for a simple check-up, but rather how the bees and artificial intelligences in your area are doing.

### Publications

Requier F., et al., Bee and non-bee pollinator importance for local food security, *Trends in Ecology & Evolution*, Volume 38, Issue 2 (2023)

Mandonnet E., Thirion B., Tackling the Complexity of Lesion-Symptoms Mapping: How to Bridge the Gap Between Data Scientists and Clinicians? *Machine Learning in Clinical Neuroscience. Acta Neurochirurgica Supplement*, vol 134 (2022)

# New University Hospital Institutes (IHU) and bio cluster at Université Paris-Saclay

## Launchpads for the medicine of the future

On the front line in tackling health challenges, Université Paris-Saclay is involved in the France 2030 plan through the GenoTher bio cluster supported by Genethon, as well as the two PRISM and PROMETHEUS projects, winners of the national university hospital institutes (IHU) 3 call.

### ↓ Key informations

PROMETHEUS Project

#### Mission

To find new treatments against Sepsis

This disease mainly affects :  
· those under **1**  
· those over **75**

#### Funding

over **30** millions euros allocated during spring 2023

GenoTher Project

#### Mission

Ecosystem of innovation in genique therapy

+ than **6,000** genetic diseases recorded in the world

#### Label

Projet labeled "Biocluster" in spring 2023

PRISM Project

#### Mission

To model each cancer individually and ultra personalise treatment

#### Label

Project labeled "Institut hospitalo-universitaire" in **2023**

#### Funding

+ than **30** million euros allocated during spring 2023

## PROMETHEUS

### The right immune response

**The massive use of antibiotics in humans and animals has led to the development of bacterial resistance, reducing the usefulness of such drugs. Many experts paint the possibility of a future where antibiotics are ineffective.**

Yet many diseases are caused by pathogens. Among these, sepsis is the most serious form of infection, and particularly septicemia. Primarily affecting children aged under one or people aged over 75, this loss of control of the immune system causes disproportionate inflammation that can lead to organ dysfunction. This is followed by a period during which the immune system no longer responds, known as the immunosuppression phase.

### Focusing on the human body

To support the failing immune system, the treatment of sepsis relies in part on the immediate administration of broad-spectrum antibiotics, capable of annihilating most pathogens. But with antibiotics becoming less effective, it is imperative to find new ways of fighting them. Benoît Favier, immunology researcher at the Infectious Diseases Models for Innovative Therapies Department (IDMIT - Univ. Paris-Saclay, CEA), is interested in ways of guiding the immune response. He explains: *"Sepsis is due more to a defective response in the human body than to the pathogen itself. We need to develop means of action on the patient side."*

The researcher specialises in innate immunity, a defence mechanism that fights off threats from the very first contact with the organism. Benoît Favier is working on immune cells derived from bone marrow: *"These cells possess an arsenal of pro-inflammatory molecules which they release in the event of infection. We're looking for ways to boost their action in patients suffering from immunosuppression, or conversely, to reduce it if inflammation has become uncontrolled."* To understand the molecular mechanisms at work, his team at the IDMIT research centre reproduces sepsis in the laboratory using cell culture tools, animal models and patient blood and tissue extracts.

### Sepsis has become a national issue

Their research, along with that of other sepsis expert laboratories, will benefit from the national grant linked to the university hospital institute (IHU) label of over 30 million euros awarded to the PROMETHEUS project in spring 2023. Alongside the research orientation on host-pathogen interactions, in which Benoît Favier is involved, other teams will be working on the development of new

diagnostic tests and drugs. *"The creation of this IHU will encourage translational research, from fundamental work to hospital treatment. Partner scientists will be able to develop large-scale research: a cohort of patients followed for several months, a rapid testing platform, a digital twin of organs and investigations into the role of microbiota,"* declares the researcher.

### Publication

Abdallah F., [...], Lambotte O. and Favier B., Leukocyte Immunoglobulin-Like Receptors in Regulating the Immune Response in Infectious Diseases: A Window of Opportunity to Pathogen Persistence and a Sound Target in Therapeutics. *Front. Immunol.* 12:717998 (2021)

## PRISM

### Virtual cancer for real treatment

**Breast, colon or pancreatic cancer... Defining cancer according to the organ it affects is an outdated concept. According to Fabrice André, Professor at Université Paris-Saclay and Director of Research at Gustave Roussy Hospital: "It's the wrong definition, because it doesn't take into account the specific nature of each patient. We prefer to study the biological mechanism at work rather than the source of the cancer."**

Born in 2011 from the desire to model each cancer individually, the PRISM project brings together Gustave Roussy, CentraleSupélec, Inserm, the national federation of cancer centres (Unicancer) and Université Paris-Saclay. Doctors, biologists and mathematicians join forces to predict the aggressiveness of cancer and the best associated treatment as early as possible.

### Ultra-personalised treatment

Within PRISM, each diagnosis follows a rigorous, well-marked itinerary. Once tumour tissue has been biopsied, the first step is to create a biological avatar of the tumour, or organoid. This cluster of the patient's own cancer cells, grown in the laboratory, is subjected to a battery of tests to assess which treatment has the greatest impact in vitro. At the same time, general data on the patient are collected: genome, microbiota, spatial organisation of the tumour and cancerous material circulating in the blood. Biologists then hand over to mathematicians. This second stage sees the creation of a digital avatar using artificial intelligence, kinetics and mathematical modelling tools. This virtual cancer predicts disease progression. The personalised advice provided by the biologists and mathematicians is quickly returned to the doctors to inform their diagnosis.

### Ahead of its time

In 2023, the PRISM consortium was awarded the IHU label, accompanied by funding of over 30 million euros. Fabrice André welcomes this step forward: *"Our approach is part of a long-term dialogue between disciplines. We're creating new professions, straddling the dividing line between mathematics and medicine. The project is now mature, and our innovative approach will revolutionise the field. These funds will enable us to continue our investment in the education and recruitment of new talent, as well as purchase state-of-the-art equipment, such as servers and computing space for data science, and analysis machines for experimental biology."*

The development of these discoveries will be incorporated into the new Paris-Saclay Cancer Cluster. Four start-ups have already emerged, including Orakl, which creates the tumour avatars and Resilience, which has developed a mobile application for remote patient monitoring.

## GenoTher: The gene therapy market

**A genetic disease is caused by one or more abnormalities on one or more of the patient's chromosomes. More than 6,000 genetic diseases have now been identified worldwide, and the search for treatments to combat them is well underway.**

In spring 2023, the GenoTher innovation ecosystem, which includes the Genethon association, Genopole, Public Assistance – Hospital of Paris (AP-HP), the French National Institute of Health and Medical Research (Inserm) and the University of Evry, was awarded the "Bio cluster" label as part of the 2030 Health Innovation plan. This label acts as a catalyst for the development and marketing of new gene therapies, treatments based on the introduction of genetic material into the body. The research department studies several rare diseases, such as spinal muscular atrophy type 1, for which a drug from Genethon's laboratories received marketing authorisation in 2019, or Duchenne muscular dystrophy, the subject of an ongoing clinical trial.

### Publication

Bayle, A., et al., Clinical utility of circulating tumor DNA sequencing with a large panel: a National Center for Precision Medicine (PRISM) study. *Annals of oncology: official journal of the European Society for Medical Oncology* vol. 34.4 (2023): 389-396.

# Low-energy cosmic rays

## Between mysteries and applications

Cosmic rays, produced by extraordinary events such as supernovae, pass through the Universe, and thus through the Solar System and the Earth. What are these particles, which can have very high or very low energies, and what observations and applications are possible using these cosmic rays?

### Keywords

Cosmic rays

— Supernova

— Gravity

Cosmic radiation defines the flow of subatomic particles and atomic nuclei circulating in the Universe. The vast majority of these cosmic rays are composed of protons (89%) and helium nuclei (around 9%). The hypothesis of cosmic rays was first put forward by German physicist Albert Gockel in 1909, and confirmed by Victor Hess three years later. While aboard a hot-air balloon, the Austrian physicist discovered that the level of ionisation in the atmosphere at an altitude of 5,000 metres was three times higher than at sea level. His deductions were breathtaking for the time, as they meant that radiation from outer space was colliding with the Earth. These rays travel at close to the speed of light, penetrating the different layers of the Earth's atmosphere, which repel the majority of them. Even today, the scientific community still ponders the origin of the radiation that passes through the Universe. What is even more fascinating is that the detection and observation of these particles have given rise to a host of applications that many researchers at Université Paris-Saclay and elsewhere have seized on.

### Cosmic rays or cosmic particles?

"Cosmic radiation is actually a misnomer," explains Vincent Tatischeff, Director of Research at the Laboratory of the Physics of the two Infinities - Irène Joliot-Curie (IJCLab - Univ. Paris-Saclay, Univ. Paris Cité, CNRS). "Cosmic rays or radiation are historical terms, used for a long time (and still used today, incorrectly) before the term cosmic particle flux, which corresponds more to what we can observe. These cosmic particles represent a non-negligible component of the galaxy, in the sense that their energy density - the amount of their energy calculated per unit volume - is quite comparable to the amount of gas thermal energy or to the energy of the galactic magnetic field. This balance is due to the exchange of energy between cosmic particles and other constituents of the interstellar medium."

So what about the composition of these cosmic particles? "We are dealing with a whole spectrum," says the astrophysicist. While protons account for about 89% of the cosmic particle population, many atomic nuclei have also been observed. "Helium atoms, known as alpha particles, account for around 9% of cosmic particles. We also find heavier nuclei, such as carbon, nitrogen and oxygen, which make up approximately 1% of cosmic particles. Lastly, electrons typically make up 1% of this composition," explains Vincent Tatischeff.

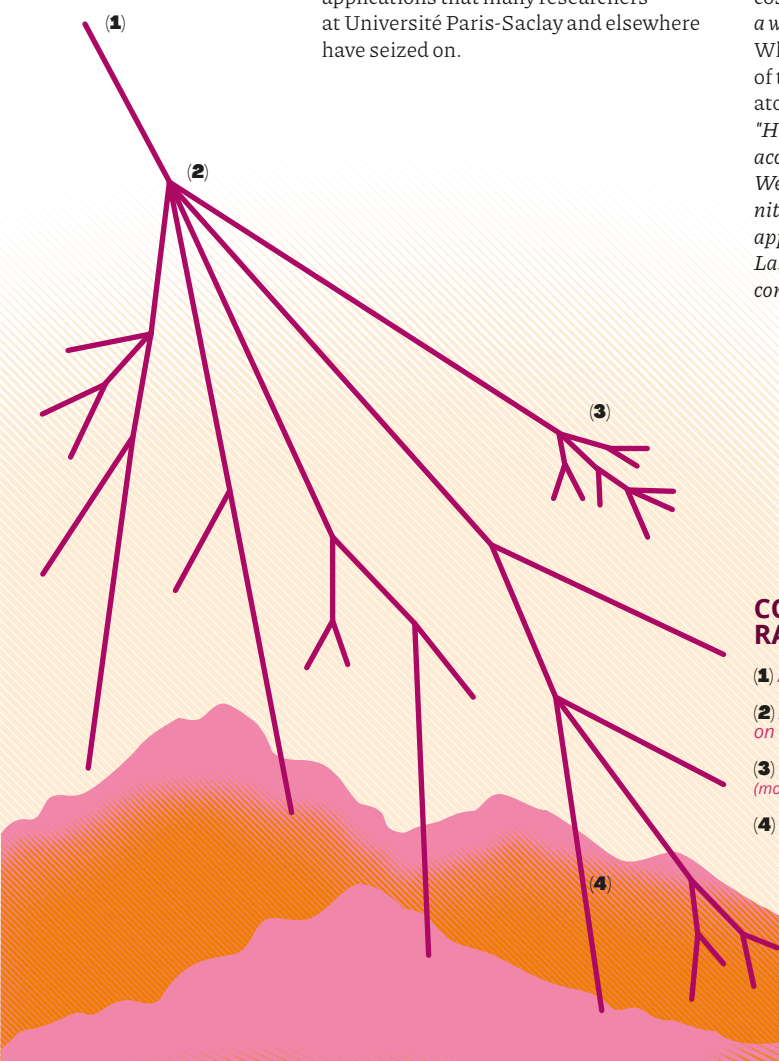
### "A true wonder of nature"

"We are still trying to understand where these particles come from," says the Director of Research. "The current hypothesis of the scientific community is that these particles are accelerated during events such as supernovae. It is possible that they come from other sources, but the shock waves generated by these events contain a particle acceleration mechanism, which was more or less predicted by Enrico Fermi in the 20th century". Once accelerated, cosmic particles interact with the gases and photons that make up their environment, producing gamma rays that can be observed from Earth using gamma-ray telescopes. The presence of cosmic particles accelerated by exploding stars can be established by the "gamma signatures" they produce. "There are other possible sources of cosmic radiation, such as winds from massive stars, but the current consensus is that most of this radiation comes from supernova star explosions," concludes the astrophysicist.

The energy distribution of the cosmic particles studied by astrophysicists is vast. "The energy spectrum of these particles spans around 14 orders of magnitude from the mega-electronvolt (MeV,  $10^6$  eV) up to  $10^{20}$  eV," says Vincent Tatischeff. "In terms of particle flux (the number of particles observed per square centimetre, per second and per unit of energy), our observations span 30 orders of magnitude from low energies to extreme energies. This colossal gap is, for example, that which separates the picosecond ( $10^{-12}$  seconds) from the age of the Universe!"

### COSMIC RAYS

- 1 Arrival of a cosmic ray
- 2 Appearance of the first sprays on contact with the atmosphere
- 3 Creation of new particles (most of them are stopped or disintegrated)
- 4 Some particles reach the ground



**The mystery of low-energy cosmic particles**

Ranging from the mega-electronvolt to the giga-electronvolt (GeV,  $10^9$  eV), low-energy cosmic rays play a key role in the formation of new stars in the galaxy. "Low-energy cosmic particles are responsible for the ionisation of gas in the galaxy. There are clouds of weakly ionised gas in the galaxy, which collapse in on themselves, creating new stars," explains Vincent Tatischeff. "But the ionization of these clouds by low-energy cosmic rays slows or even prevents the gravitational collapse at the origin of star formation. The presence of this cosmic radiation regulates the collapse of gas clouds, ultimately leading to the creation of new stars."

*"For the first time, we have obtained a direct measurement of low-energy cosmic rays in the local interstellar medium around the Solar System."*

– Vincent Tatischeff

The existence of these low-energy cosmic particles remained a mystery to the scientific community for a very long time. The reason was solar modulation, a phenomenon that describes the particle winds emitted by the Sun into the Solar System, of which the Earth is a part. These winds fill a cavity formed around the planetary system, repelling low-energy cosmic rays: the heliosphere. "Solar winds exert a pressure that stops the propagation of low-energy cosmic particles within the Solar System. Since these particles have never reached the Earth, they were unknown to us," explains Vincent Tatischeff. It was not until the Voyager 1 probe left the heliosphere that low-energy cosmic rays

were finally measured. In August 2012, 35 years after its launch, the probe reached the farthest reaches of the Sun's influence, at a distance of around 18 billion kilometres. Initial measurements indicate radiation energies close to 3 MeV. "We don't really know what is going on below this energy level. But overall, there is no reason to think that there are suddenly no more lower-energy particles," comments Vincent Tatischeff.

While Voyager 1 is still subject to the star's gravitational pull when it leaves the heliosphere, it is no longer subject to the solar wind. "It is an incredible feat," confesses Vincent Tatischeff. "For the first time, we have obtained a direct measurement of low-energy cosmic rays in the local interstellar medium around the Solar System." This discovery now raises new questions for scientists, particularly concerning the ionisation rates for which low-energy cosmic rays are responsible. "Overall, our observations lead us to believe that there are, on average, more low-energy cosmic rays in the galaxy than locally, where we have been able to measure them," explains the astrophysicist. "This means that the density of cosmic radiation varies from region to region, due to the density of events (such as the explosion of stars into supernovae) creating this radiation." The heliosphere, which encloses the Solar System, is itself enclosed in a local bubble of hot gas which some theories believe also protects its internal regions from low-energy cosmic rays. "This would explain the low local density of low-energy cosmic rays measured by the Voyager probes," says Vincent Tatischeff.

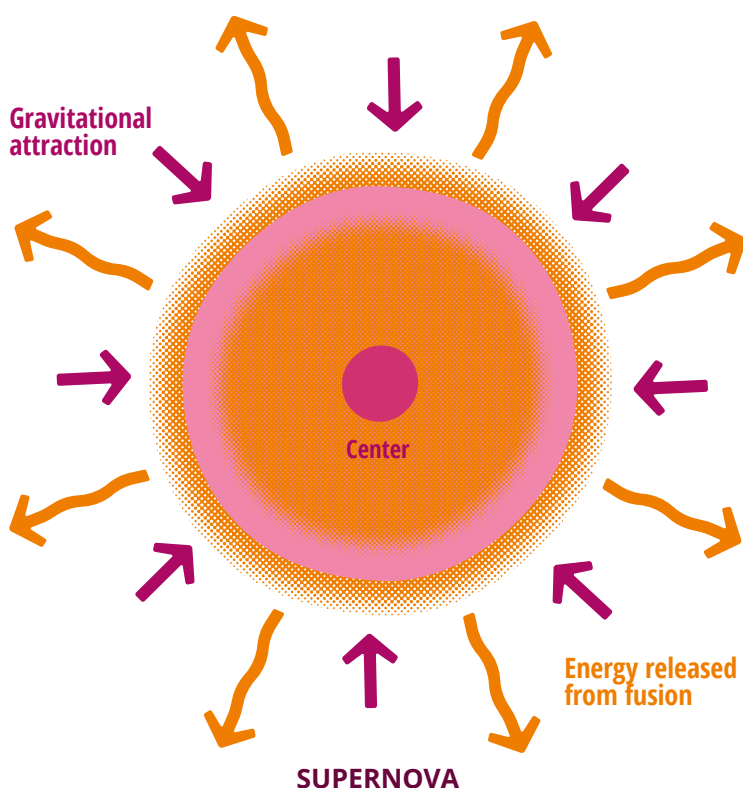
**Cosmic particles and pyramids**

David Attié studies muons in the Division of Electronics, Detectors and Computing for Physics (Dedip - Univ. Paris-Saclay, CEA) of the Institute of Research into the Fundamental Laws of the Universe (Irfu). Muons are part of the

Standard Model of particle physics and are produced by the encounter between cosmic rays and the Earth's upper atmosphere. The interaction between a cosmic particle and an atmospheric nucleus gives rise to a shower of new particles, notably pi mesons. Positive and negative muons are then produced by the decay of pi mesons, and pass through the different layers of the atmosphere to reach the Earth's surface. These particles are bombarding the Earth at every moment: the flow of muons reaching sea level is around 170 per square metre per second. Although harmless to humans, it is the penetrating nature of this particle that makes it so special. "For example, a 100-metre-thick rock will absorb almost all the muons that pass through it, but not all of them. And it is this tiny percentage that is particularly interesting," explains David Attié.

In 2012, the physicist began designing a cosmic bench to detect the passage of cosmic particles, including muons, and measure their trajectories. The instrument consists of a hodoscope to detect particle position and trajectories, glittering plastic plates to trigger the device when a particle passes through it, and electronic components so that the collected data can be read. "Lastly, a cosmic bench allows us to study and use natural cosmic radiation, with its low but permanent flux, and avoids the sometimes restrictive use of particle accelerators," explains David Attié.

Following the design of this instrument, David Attié and his colleagues turned to muon tomography, an imaging technique that uses muons and their penetrative properties to study the interior of targeted structures. In 2015, using the cosmic bench and muon telescopes, Irfu physicists recorded the muon fluxes that passed through the famous water tower at CEA Paris-Saclay. The muographic "snapshots" produced by this experiment showed the castle's internal water level at different times of the year. "We carried out



**What is a supernova?**

A supernova is the spectacular end-of-life process for a star. A star burns up hydrogen – among other – atoms over the course of its existence, which is generally between several million or several billion years. This combustion then triggers nuclear fusion reactions in the star's core, leading to the formation of ever heavier nuclei (from hydrogen to helium, then carbon, oxygen, silicon and iron).

At the centre of the star, where the heaviest elements reside, the pressure is so great that it rivals the forces of gravity and the star begins to collapse. This "iron core" drastically reduces in size in record time, taking with it the star's different internal strata. This collapse causes the star to implode, generating a light of incomparable intensity in the Universe.

two measurement campaigns, the first when the water tower was full and the second when the tank was being cleaned. For the first time using muon tomography, it is perfectly possible to see the design of the castle's structure and even its container on the images we obtained. We found differences between the two images when the water tower is emptied for cleaning and when it is full," says the researcher.

In parallel with these initial studies, the ScanPyramids project, led by Cairo University in Egypt and the French Heritage Innovation Preservation (HIP) Institute, was launched. Its aim was to study the great Egyptian pyramids and their cavities without drilling new holes. This challenge was seemingly destined for the muon tomography of David Attié and his colleagues. In collaboration with Japanese physicists from Nagoya University, researchers from CEA Paris-Saclay went to Egypt and its seventh wonder of the world, the Great Pyramid of Giza, following their first conclusive observations at the water tower. What was supposed to be a test phase for their new instruments turned into a major discovery.

*"On the northeast face of the pyramid is a small chamber, a cavity just a few cubic metres in size already accessible and known to specialists. Our idea was therefore to test our technology on this face, pointing our telescopes at this cavity, to demonstrate that we are able to observe this chamber located a few metres of rock from the outside. Not only were we able to observe this small chamber, we also detected the presence of another, previously unknown cavity,"* says David Attié. Above the Grand Gallery, on the pyramid's northeast face, CEA scientists confirmed in 2017 the presence of a previously unknown "big void", and then using muon tomography directly inside the pyramid two years later. The Japanese researchers confirmed the discovery with measurements from inside the pyramid; muon tomography had indeed discovered a new chamber, located above the Grand Gallery and close to the small chamber.

This momentous discovery is just one example of the possible applications of muon tomography and the observation of cosmic rays passing through the Universe and the Earth at every moment.

## Publications

Vieu T., et al., Cosmic ray production in superbubbles, *Monthly Notices of the Royal Astronomical Society*, vol. 512. DOI: 10.1093/mnras/stac543

Elkarmoty, M., et al., Discovery and validation of the North Face Corridor in the Great Pyramid of Giza using non-destructive techniques. *Papers of the ECNDT 2023. Research and Review Journal of Nondestructive Testing* Vol. 1(1). <https://doi.org/10.58286/28180>

# The satellite whisperers

## Portrait of instrument scientists

**In the large family of astrophysicists, there is a special profession at the frontier between research and engineering. We take a look at instrument scientists, a position that involves working very closely with satellites.**

Arnaud Claret is Director of the Science and Space Instrument Interface Laboratory (LISIS - Univ. Paris-Saclay, CEA) within the Institute of Research into the Fundamental Laws of the Universe (Irfu) of CEA Paris-Saclay. He also occupies a singular role at CEA Paris-Saclay, that of instrument scientist. *"I am an astrophysicist but I have an instrument scientist's profile. In other words, roughly speaking, I have one foot in science and the other in technology,"* says Arnaud Claret. *"An instrument scientist's job is to ensure that an instrument's performance is maintained to guarantee the success of a mission. This requires both scientific and technical knowledge. More specifically, I am interested in the effects of space radiation, such as cosmic rays, on onboard satellite instrumentation."*

*will regularly cross the South Atlantic Anomaly.* This anomaly is due to the tilt and offset of the Earth's magnetic field in relation to the poles.

The result is that the magnetic field enveloping the Earth is 500 kilometres closer to the ground in the South Atlantic than anywhere else on the planet. This magnetic field acts as a shield, repelling most cosmic rays, particles and solar winds. However, some of these particles remain "trapped" in the magnetic field and spiral in orbit around the planet. *"We end up with a magnetic field around the Earth structured like an 'onion' and in concentric shells,"* describes Arnaud Claret. And trapped particles sometimes remain between these field lines for a very long time. So, a satellite orbiting the Earth at a constant altitude like SVOM will experience this South Atlantic Anomaly at times and, for a certain period, find itself in a "magnetic shell" teeming with particles.

Therein lies the complexity of the SVOM mission for instrument scientists, i.e. how to design instruments whose shielding can cope with this anomaly. And how to manage the "background noise" generated by the regular passage through this area filled with particles of all kinds. *"This is all new to me, and pretty exciting. I was able to carry out simulation work using data from different observatories and different satellites that have already made this kind of orbit, to try and predict SVOM's behaviour. In the end, the job is quite similar to that of astrophysicists, who seek to predict their future observations; we have a similar scientific approach. This simulation work gives us the feeling that we are making the instrument our own and developing a certain intimacy with it as we try to predict its operation as accurately as possible,"* describes Arnaud Claret.

*This simulation work gives us the feeling that we are making the instrument our own and developing a certain intimacy with it as we try to predict its operation as accurately as possible."*

– Arnaud Claret

Arnaud Claret is a radiation expert for Irfu's space projects, including the Franco-Chinese low-Earth orbit mission Space-based Multi-band Variable astronomical Objects Monitor (SVOM). *"This mission is very interesting for me, not least because it will be located at an exceptionally low orbit of 600 kilometres in altitude. This implies that the satellite*





# Zaineb Amor

Portrait of a globe-trotting student, now a PhD candidate at CEA Paris-Saclay

After her studies, during which she travelled from Tunisia to Sweden, via Grenoble and Versailles, Zaineb Amor chose CEA Paris-Saclay to start her thesis on functional magnetic resonance imaging (fMRI) in 2020, not least due to the institute's excellent infrastructure in this field.

Originally from Tunisia, Zaineb Amor completed a two-year preparatory course for a competitive exam in physics and chemistry at La Marsa before moving to France to study signal processing at

the Grenoble Institute of Technology. She also studied in Sweden, where she completed a year's double degree at the Royal Institute of Technology in Stockholm. Lastly, Zaineb Amor completed her study path with two research internships, one on microscopic data in a Grenoble laboratory and a final year project as part of a research and development (R&D) team at General Electrics in Versailles, before starting her PhD in 2020 at NeuroSpin (Univ. Paris-Saclay, CEA), the research centre for brain imaging innovation at CEA Paris-Saclay.

As her thesis, entitled *Sparkling Non-Cartesian Encoding for High Spatiotemporal Resolution Functional Magnetic Resonance Imaging at 7 Tesla and Beyond* draws to a close, Zaineb Amor looks back on her decision to carry out her work at CEA Paris-Saclay rather than elsewhere.

"I was selected to start a thesis on medical imaging topics at three different institutions. But CEA, and more specifically NeuroSpin, was the most interesting for me, firstly because the proposed subject was more comprehensive and more interesting, and secondly because the working conditions (infrastructure, supervision and equipment) seemed ideal for the successful completion of my thesis," says the PhD candidate, who is already planning to continue in either academic or industrial research beyond her PhD contract.

*"The working conditions (infrastructure, supervision and equipment) seemed ideal for the successful completion of my thesis."*

– Zaineb Amor

## International press

### ABC

**Hallan una 'burbuja de galaxias' de mil millones de años luz, posible 'resto fósil' del Big Bang**

La gigantesca estructura, llamada Ho'oleilana, dobla en tamaño a Laniakea, nuestro continente galáctico, y se formó tras el crecimiento exponencial de una Oscilación Acústica Bariónica (BAO), poco después del comienzo del Universo.

<https://www.abc.es/ciencia/hallan-burbuja-galaxias-mil-millones-anos-luz-20230907165222-nt.html>

### Forbes

**ESA's ExoMars Rover Will Explore Untouched Corner Of Red Planet**

The equator in the Martian Northern hemisphere is an area of Mars that has not really been studied by landers on the surface, John Carter, a planetary scientist at France's Paris-Saclay University, told me at the conference.

<https://www.forbes.com/sites/brucedorminey/2023/05/16/esas-exomars-rover-will-explore-untouched-corner-of-red-planet/?sh=2d7d1281ced6>

### Daily Mail

**Meet Mauricio Pochettino's son Sebastiano who joins Chelsea support staff in critical role**

The 28-year-old has previously worked with the Argentine coach at Paris Saint-Germain. He earned a master's degree in Integrative Biology of the Adaptations to Exercise for Health and Performance from the Paris-Saclay University.

<https://www.dailymail.co.uk/sport/football/article-12010851/Meet-backroom-staff-Mauricio-Pochettino-bring-Chelsea.html>

### BUSINESS INSIDER

**The James Webb Space Telescope found a molecular building block of life hiding in the Orion Nebulae**

"This detection not only validates the incredible sensitivity of Webb but also confirms the postulated central importance of CH<sub>3</sub><sup>+</sup> in interstellar chemistry" Marie-Aline Martin-Drumel, a researcher at the University of Paris-Saclay and another co-author on the paper, said in a NASA press release.

<https://www.businessinsider.com/webb-space-telescope-found-molecular-building-block-life-orion-nebula-2023-6?r=US&IR=T>

# The University in support of Ukrainian mathematics students

**February 2022: as Russia invaded their country, Ukrainian civilians tried to flee the conflict. In France and at Université Paris-Saclay, the Ukrainian mathematical community would notably be welcomed by a lecturer from the University of Évry.**

On 24 February 2022, war broke out between Russia and Ukraine, almost eight years after Russia's annexation of Crimea and the start of a major crisis between the two countries. Everywhere, the international community was rallying to help the Ukrainian people.

Initially spearheaded by Vincent Runge, Associate Professor at the University of Evry and Head of the 2nd year Master's degree in Data science: health, insurance and finance at Université Paris-Saclay, and then by the Jacques Hadamard Mathematics Foundation (Fondation Mathématique Jacques Hadamard - FMJH), an initiative to welcome Ukrainian students to the mathematics laboratories at Université Paris-Saclay was quickly set up.

↓ **"A moral obligation to act"**  
*"When the war started, I felt a moral obligation to act. Few of my colleagues are as familiar as me with the political and cultural context of the former USSR. In a way, I felt it was 'me or nothing',"* says Vincent Runge. During his studies, the mathematician completed a master's degree in Russia, followed by a PhD in joint supervision with Moscow.

*"In practical terms, I contacted a Ukrainian colleague to offer to host students in France. A few days passed before a student contacted me from the town of Zaporizhzhia, which at the time was under threat from a nuclear accident. She immediately joined me in Paris, where she stayed first with friends and then with colleagues. The Evry Mathematics and Modelling Laboratory (LaMME - Univ. Paris-Saclay, CNRS, Univ. Evry, ENSIIE Engineering School, INRAE) to which I belong, agreed to let me take on this mathematics student from Shevchenko University in Kiev. By postponing the various administrative barriers, the University of Evry provided decisive support: rapid, free enrolment in an equivalent course for the student, financial support in the form of a CROUS grant, etc.,"* continues Vincent Runge.

Following this first victory for the mathematician, he saw that his colleagues also wanted to support these young mathematicians in danger. *"I then acted as an intermediary. Students would contact me via Telegram using a protocol I had established: assessment of the security urgency, discussion about their professional project, correction of CV and cover letter elements. In an extremely short space of time (often less than two days), I had to find someone who could offer a paid internship in the student's field, as well as free accommodation for a few weeks with friends,"* recounts the mathematician. *"All this was only possible*

*thanks to the generous commitment of some thirty people, who selflessly gave their time and energy to help these young people, often deeply scarred by the tragedy of war. By May 2022, we had welcomed a total of nineteen students, spread across some ten universities in the Ile-de-France region,"* smiles Vincent Runge. However, the internships on offer were only for a few months, and as the conflict in Ukraine has dragged on, the question of the future of the nineteen refugees has arisen.

*"This initial commitment was mainly focused on the emergency: internships began in May and finished at the end of the summer. With a prolonged conflict, we had to find more permanent solutions,"* says the mathematician.

**"By May 2022, we had welcomed a total of nineteen students, spread across some ten universities in the Ile-de-France region."**  
 – Vincent Runge

↓ **The Jacques Hadamard Mathematical Foundation: support on a larger scale**  
 Created in 2011 by various mathematics laboratories, including the Borelli Centre (CB - Univ. Paris-Saclay, CNRS, ENS Paris-Saclay, Univ. Paris-Cité, SSA), the Orsay Mathematics Laboratory (LMO - Univ. Paris-Saclay, CNRS) and the Alexander Grothendieck Laboratory (LAG - Univ. Paris-Saclay, IHES, CNRS), the Jacques Hadamard Mathematics Foundation (FMJH) aims to develop and structure mathematics education and research policies for all its member laboratories. Today, all the University's mathematics laboratories (as well as those of the Polytechnic Institute of Paris (Institut Polytechnique de Paris) are affiliated to the Foundation. The FMJH recently launched the FMJHCare programme, aimed at French and foreign master's and PhD students with an excellent level of mathematics, but whose financial resources prevent them from accessing higher education.

*"For the past ten years, we have been distributing around 60 scholarships to foreign students throughout Université Paris-Saclay on excellence criteria,"* explains Pascal Massart, Director of the FMJH.

*"The new idea behind the FMJHCare programme is to increase the social diversity of Université Paris-Saclay by also taking this social criterion into account when awarding scholarships. We are also taking advantage of the University's worldwide reputation, particularly in mathematics, to attract more and more new profiles. And this new visibility is now attracting applications at undergraduate level."*

In the summer of 2022, the FMJH decided to support Vincent Runge. *"Until then, Vincent's work had been painstaking. With him, we've been able to give more structure to our hosting offer and obtain new funding, enabling us to extend the stay of existing interns and welcome additional students,"* explains Pascal Massart.

Today, more than a year after war broke out, a total of around 25 students are enrolled in various fields of study in mathematics, including a dozen new arrivals in 2023. *"Our aim is to maintain this support (the end of the war is unfortunately not going to happen soon) for as long as is needed."* On their arrival in France, FMJH students are supported by a mentor and a tutor, and can benefit from the psychological support offered by the University Health Service (SSU).

In 2022, Ukrainian researcher Maryna Viazovska was awarded the Fields Medal for her work on sphere packing. The Ukrainian students came up with an event and *"took it upon themselves"* to contact the researcher, stresses Pascal Massart. A few months later, on 11 January 2023, Maryna Viazovska gave a lecture entitled Sphere packing at the Orsay Mathematics Laboratory, to an audience of mainly Master's students in mathematics. Proof if it were needed of the unflinching motivation of these young Ukrainians to pursue their education in mathematical research despite the war ravaging their country.

# Curiositas Festival

## A campus in celebration!

The seventh Curiositas Festival took place at Université Paris-Saclay from 16 October to 16 November. For the first time since its creation, the Festival took place on almost all Université's campuses, illustrating the scale of the territory. Ahead of the Curiositas Festival, the traditional Science Festival had already kicked off the festivities on all Université campuses from 6 to 16 October.

The Curiositas Festival has been merging arts and sciences since 2013 to generate curiosity and discovery in as wide an audience as possible. No prior knowledge of either arts or sciences is required to enjoy the festival. From 16 October to 16 November 2023, the seventh Curiositas Festival, focusing on the theme of wonder, offered a wide range of activities that allowed people to discover science and art from an angle of amazement and fascination.

### "Reaching out to the public"

While previous editions of the festival were usually concentrated in a single venue, this new formula has extended Curiositas to every department in which Université Paris-Saclay is located, as a reminder of University's heterogeneous nature. From the UVSQ's Guyancourt and Versailles campuses to the University of Evry, the Orsay Faculty of Sciences and ENS Paris-Saclay, a total of 15 venues hosted the festival's 20 or so activities, ten of which were affiliated to Université Paris-Saclay. "This time, we wanted to reach out directly to the public," say Marjorie Tarjon and Audrey Perez, in charge of arts-sciences-society projects and an apprentice at Diagonale Paris-Saclay

respectively. Using a range of venues also opened the festival up to audiences far removed from the world of research, as well as to local residents who are perhaps less aware of the existence of such an event.



© Angélique Gilson

### Soap bubbles, "bridal" juggling and quantum physics

With exhibitions, dance and folding workshops, quantum physics discovery trails, olfactory tours, films and concerts, a fun conference on soap bubbles and more, the Curiositas festival offered a wide range of activities, each one an opportunity to combine science, discovery and the arts. "The challenge of the festival is to bring a scientific dimension to a work of art, by providing knowledge related to the work presented, thus arousing interest and curiosity," explains Olivier Kahn, Director of Diagonale Paris-Saclay. On 17 October,

juggler Fabrizio Solinas put on a juggling show at the University of Evry, focusing on love and seduction. Following the show, Hélène Courvoisier, a lecturer at Université Paris-Saclay specialising in animal acoustic communications and a member of the Paris-Saclay Institute of Neuroscience (NeuroPSI - Univ. Paris-Saclay, CNRS) joined the juggler in a performance about animal behaviour. "It is important to us to always keep scientific research close to a subject proposed by artists. Following the presentation of a work of art, we wanted to highlight the emotion generated by scientific research and the understanding of the complexity of the world, living beings and what surrounds us. It is a virtuous circle of fascination, curiosity and so on for the public," explains Olivier Kahn.

To attract new audiences to the Curiositas Festival, the Diagonale Paris-Saclay team has "consciously forged partnerships with different popular science venues," notes Olivier Kahn. These venues included Youth and Culture Centres (MJCs) in Palaiseau and Orsay (Essonne), media libraries in Essonne and Yvelines, and the Explo-radôme museum in Vitry-sur-Seine (Val-de-Marne).

<https://www.curiositas.fr/>



© Christophe Peus

## Science Festival 2023

Université Paris-Saclay celebrated sport

Université Paris-Saclay hosted the Science Festival on its many campuses from 6 to 16 October. As in previous years, the programme featured a wide range of activities, including laboratory visits, lectures, performances and workshops, over a ten-day period devoted primarily to sports science.

Université's Science Village featured a scientific game focusing on the economics of attention in sport, set up by the S[cube] association, and a quiz on women and the Olympics.

# Open Science

## Services for everyone

**By supporting the creation of new tools, education and communications around open science, Université Paris-Saclay is involved in the rise of this crucial change taking place in the academic world.**

According to the Second National Plan for Open Science published in 2021 by the French Ministry of Higher Education and Research, open science is defined as the unhindered dissemination of results, methods and products from scientific research. This means unrestricted sharing of publications and, wherever possible, research data. Université Paris-Saclay aims to be an active player in the movement to open up science and, to this end, has published a unique open science document for 2022, which acts as the real pillar of the University's strategy.

A number of tools, in the form of events, courses and news networks, are now being used to give all the University's researchers the opportunity to practice open science.

In October, to coincide with International Open Access Week, the University hosted the Open Science Month, a series of webinars covering the full range of open science services and projects, broadcast to the entire University research community.

*"International open access week is a key event for open science worldwide,"* enthuses Luc Bellier, Deputy Director of the Digital, Research and Open Science Office of the Libraries, Information and Open Science Department (DIBISO). In addition, since September 2023, the FILSO newsletter has been reporting on open science news on a monthly basis.

The University's institutional website also features new pages dedicated to open science. As part of a redesign of the previous pages, this new platform will be restructured *"around the eight pillars of open science established by the University's unique document,"* notes Luc Bellier, and will enable everyone to find out more about open science. A one-stop shop, in the form of a single e-mail address for the entire research community within the scope of Université Paris-Saclay, has also been set up.

*"This one-stop shop will centralise requests from the University's entire academic community to a single address, thereby making all services in the field of open science equal,"* explains Julien Sempéré, the University's Deputy Director General of Services.



## Toolbox

### Open science month

<https://www.universite-paris-saclay.fr/open-science-month-2023>

### FILSO Newsletter

<https://forms.mailing.universite-paris-saclay.fr/5bae-2086b85b536066d96355/mYm607G-RkeMaZ7kAg-vuUg/form.html>

### Institutional website open science page

<https://www.universite-paris-saclay.fr/recherche/science-ouverte>

### One-stop-shop email address

[Science.ouverte@universite-paris-saclay.fr](mailto:Science.ouverte@universite-paris-saclay.fr)



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# On the plateau

## Lumen opened

**Lumen, located at the heart of the Plateau de Moulon campus, opened its doors on 18 September 2023. Both a university library and a living space, the new building is designed to bring together the local community of Université Paris-Saclay.**

A new building has stood opposite the Henri Moissan site on the Moulon plateau since September 2023: Lumen. Recognisable by its original exterior and its design that follows the curve of the future aerial metro, this new venue is the perfect cross between a university library, a collaborative workspace, a living space and a venue for events of all kinds.

*"Lumen is shared by CentraleSupélec, ENS Paris-Saclay and Université Paris-Saclay. It also integrates two other Université departments: the Diagonale and the Design Spot, with which we will be developing joint projects," explains Martine Coppet, Deputy Director and Head of Lumen within the Department of Libraries, Information and Open Science (DiBISO) at Université Paris-Saclay. "The building brings together the collections of the two Grandes Ecoles and those of the library of the former Chatenay-Malabry Faculty of Pharmacy, now on the Moissan site, as well as part of the chemistry, biology and physics collections of Orsay University library. The aim was to assemble a collection covering all areas of the Plateau's activity."*

Designed with its future users in mind, Lumen is open not only to the entire Plateau community (students, researchers, staff, etc.) but also to local residents.

Covering an area of around 7,000 m<sup>2</sup>, Lumen has a total capacity of 1,100 places (all types), around 30 group study rooms (4 to 8 places), educational innovation rooms, a recording studio, an auditorium, an exhibition hall, a press and literature area, a relaxation area and a ground-floor restaurant, due to open in 2024. Lumen gives us the opportunity to develop new services for our users," adds Martine Coppet, "for example, the loan of board games, carbon dioxide sensors and, soon, a range of tools and equipment for students."

<https://www.lumen.universite-paris-saclay.fr/>



# Calendar

Autumn/Winter 2023

## We were there

All campuses  
La Diagonale  
16 oct → 16 nov



### Festival Curiositas

For its seventh edition, the Curiositas festival took place across the whole of the Université Paris-Saclay. Around the theme of wonder, a larger and more diverse public than ever was able to attend workshops, shows, exhibitions and tours combining the arts and sciences.

<https://www.curiositas.fr/>

AgroParisTech  
AgroParisTech, Graduate School Biosphera, Île-de-France Federation for Research on the environment

20 nov

Conference

### « Détrivore »

La voie manquante entre décomposition et formation de la matière organique des sols (Detrivore: the missing link between decomposition and the formation of soil organic matter)

Hosted by François-Xavier Joly, a specialist in soil ecology, this free lecture introduced important topics such as detrivores before the launch of the *Traits écologiques et biologiques des organismes des sols* (Ecological and biological features of soil organisms) days, from 20 to 22 November.

<https://www.agroparistech.fr/agenda/journees-tebis-trait-ecologiques-biologiques-organismes-sols>

Place

Host

## Do not miss

Atrium of the Eiffel building  
CentraleSupélec

CentraleSupélec  
18 oct → 15 dec



Exhibition

### Gustave Eiffel, centralien du siècle (centralian of the century)

To mark the centenary of Gustave Eiffel's death, CentraleSupélec is honouring the memory of its most famous alumnus with a fun exhibition retracing the engineer's career and life.

<https://www.centralesupelec.fr/fr/eiffel>

University of Evry, Pelvoux building  
University of Evry, Helmo studio

18 oct → 8 déc



Exhibition

### Stratigraphie

The *Stratigraphie* exhibition, curated by graphic designers Thomas Couderc and Clément Vauchez, founders of the Helmo studio, will be on show in the Technology Hall of the Pelvoux building at the University of Evry for almost two months. The exhibition combines screen printing and mechanical image reproduction processes.

<https://www.univ-evry.fr/evenements/agenda-des-evenements-vie-etudiante/evenements-culture/exposition-stratigraphie-studio-helmo>

Lumen  
Pascale Laborier and Pierre-Jérôme Adjedj

10 nov → 22 dec

Exhibition

### « Poser pour la liberté »

Portraits de scientifiques en exil  
(Posing for freedom -  
Portraits of scientists in exile)

The exhibition, presented by researcher Pascale Laborier and photographer Pierre-Jérôme Adjedj, features portraits of some fifty researchers in exile around the world.

<https://www.universite-paris-saclay.fr/actualites/poser-pour-la-liberte-portraits-de-scientifiques-en-exil>

Pascal Institute  
Université Paris-Saclay  
12 dec at 6.30 p.m



Conference

### « Nos belles histoires »

with Bertrand Serlet  
and Michel Safars

In December, Université Paris-Saclay will launch a new series of alumni conferences. "Nos belles histoires" (Our inspiring stories), will give centre stage to inspiring figures and give them the chance to share the story behind their success.

The series' inaugural conference will welcome the renowned software engineer, Bertrand Serlet, who will be interviewed by Michel Safars, an entrepreneur and a professor in strategy and entrepreneurship at HEC Paris.

<https://www.universite-paris-saclay.fr/en/news/alumni-conference-bertrand-serlet>

ENS Paris-Saclay  
La Scène de recherche and the students' office of ENS Paris-Saclay

16 jan

Tuesday lunchtime feast

### « Des os à l'oral » (From bones to speech)

In September 2023, La Scène de recherche launched its Tuesday lunchtime feasts. One Tuesday a month, a show is organised and followed by a feast proposed by members of the ENS Paris-Saclay Student Offices. Registration is free but mandatory.

<https://ens-paris-saclay.fr/scene-de-recherche/des-os-loral>

# Reading Highlights

Autumn 2023

## The Conversation

### Risks of extreme temperatures in Western Europe underestimated

Researcher and PhD candidate respectively at the Laboratory of Climate and Environmental Sciences (LSE - Univ. Paris-Saclay, CNRS, CEA, UVSQ), Davide Faranda and Robin Noyelle look at the origins of extreme, rising heat in Western Europe in the wake of a scorching summer. The scientists are categorical that it is not impossible that Paris will one day reach 50° Celsius.

<https://theconversation.com/les-risques-de-temperatures-extremes-en-europe-de-louest-sont-sous-estimes-213015>

### Equal pay for men and women: where do things stand in football?

While women's football is growing rapidly in France, the pay gap between male and female professional players is still at record levels. On average, as shown by Yann Imine and Michel Desbordes, professors at the Faculty of Sports Science of Université Paris-Saclay, a French professional female footballer earns 26 times less per month than a professional male footballer.

<https://theconversation.com/egalite-des-salaires-hommes-femmes-ou-en-est-on-dans-le-football-208900>

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# Accessibility policies

at Université Paris-Saclay

Université Paris-Saclay aims to offer teaching and working conditions equal and open to all individuals, and is therefore committed to a policy of accessibility for all.

+15%



increase in the number of students with a disability at Université Paris-Saclay



A digital accessibility master plan currently being drawn up

+900

students declared as having a disability

+5%

increase in the number of staff declared as having a disability compared with 2022



A series of webinars for staff, scheduled for late November

## Key-numbers

3%

of Université staff recognised as having a disability in 2023



A master plan for Université Paris-Saclay, reflecting its desire to be an example of inclusion  
<https://www.universite-paris-saclay.fr/sites/default/files/media/2020-06/sdh.pdf>

Advisors in each of Université's constituent faculties and institutes

2 types of advisors

teaching advisors  
administrative advisors



A Disability and Studies Department (part of the Disability Diversity Centre of the Student Life and Equal Opportunities Department)



A Disability Department for University staff

## Partnerships

### Atypie-Friendly

Université Paris-Saclay is a committed and active participant in Atypie-Friendly, a partnership of national universities dedicated to making higher education inclusive.

### H-Lab

Founded in 2012, H-Lab is a non-profit organisation promoting the social participation of people with disabilities through universal design.

## Contacts

A page containing all student contacts, for all constituent faculties and institutes:

<https://www.universite-paris-saclay.fr/vie-de-campus/handicap/contacts-handicap>

### General email (students)

[handicap.etudiant@universite-paris-saclay.fr](mailto:handicap.etudiant@universite-paris-saclay.fr)

A page dedicated to resources and contacts for staff with disabilities:

<https://www.universite-paris-saclay.fr/vie-de-campus/handicap/personnel-en-situation-de-handicap>

### General email (staff)

[personnel.handicap@universite-paris-saclay.fr](mailto:personnel.handicap@universite-paris-saclay.fr)