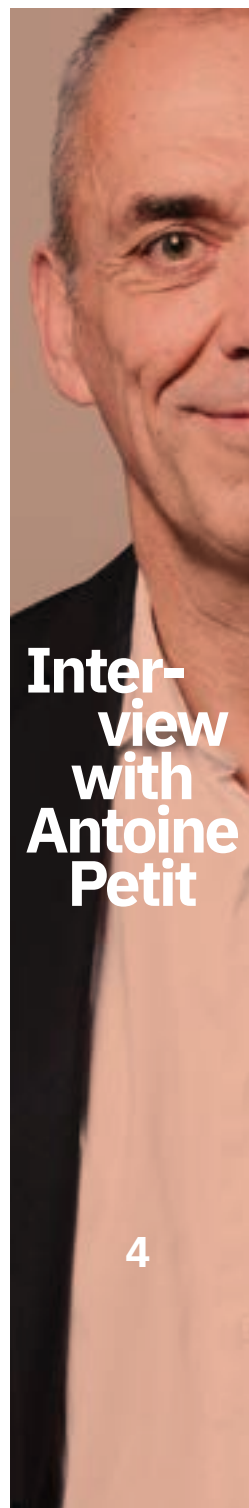


A woman with dark hair, wearing a dark blue t-shirt and jeans, is sitting on a wooden structure inside an anechoic chamber. She is holding a small, golden, bell-shaped object in her hands. The chamber's walls, floor, and ceiling are covered with blue and brown pyramidal-shaped acoustic absorbers. A bright light source is visible in the upper right corner, casting a strong glow. The overall atmosphere is scientific and focused.

A year at the CNRS

ACTIVITY
REPORT
2022



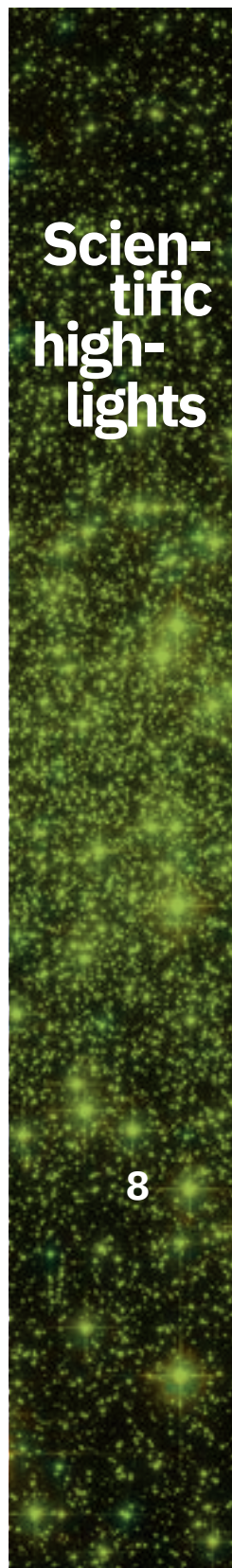
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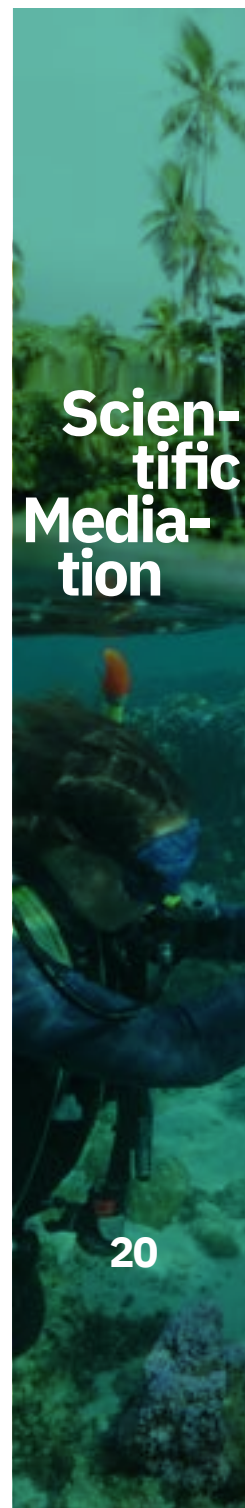
**Scien-
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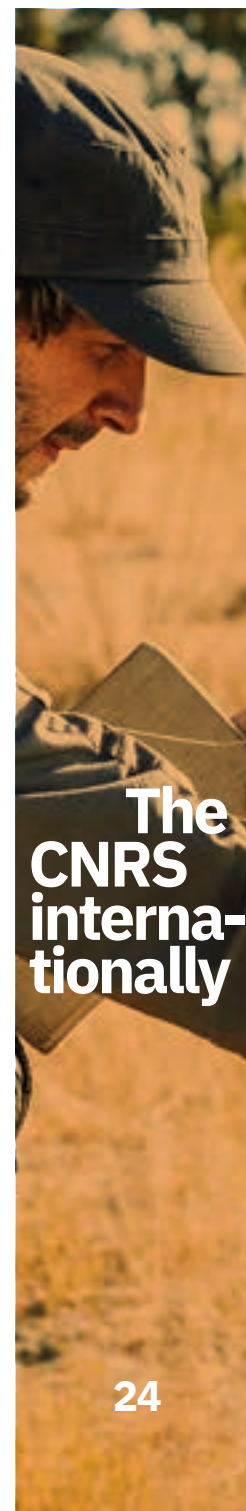
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Antoine Petit,
Chairman and CEO

“The CNRS contributes to positioning science at the heart of society”

You stress the importance of the role science can play in helping us understand and in supporting decision-making. For the first time, the CNRS was represented at the 27th United Nations Climate Change Conference (COP 27) held in Egypt - a major political decision-making forum for the future of the planet. What role should the CNRS play in the interface between science and the decision-making process?

All the crises we are going through in health, climate, energy or geopolitics demonstrate science's importance in providing the right elements to enhance understanding and support decision-making. These crises have also clearly shown basic research to be a necessity rather than a luxury. The CNRS's mission is to carry out basic research at the highest international level then use it to serve society and this has never been more important or even vital. In an era when France's influence on the international scene is undoubtedly less significant than in past centuries, the CNRS is helping to enhance the international standing of French science and the credibility of the scientific message.

The CNRS notably took part in the COP 27 pavilion in Egypt which was organised for the first time by research organisations from all over the world. The chosen theme was the Ocean which had never been dealt with in this context before despite its crucial importance for vital climate, biodiversity, geopolitical and economic issues. Now, the subject of the world's oceans is clearly on the negotiating table. And research is of course crucial to construct sustainable ways forward and support their implementation.

More generally, the CNRS is bolstering its commitment to contributing to public debate and supporting decision-making. We're achieving this through our scientific expertise missions and by responding to the increasing requests from European and national parliamentarians, local authorities and a growing number of stakeholders in the major societal challenges.

On January 1st 2022, France took over the Presidency of the Council of the European Union (FPEU) for a six-month period. How would you assess the actions taken in favour of the research world?

During this FPEU we aimed to put science in the spotlight. However, sadly the French Presidency was marked by the war in Ukraine right on the European Union's doorstep (the CNRS supported emergency aid to our Ukrainian colleagues through the *Collège de France's* PAUSE programme). The Presidency also took place in a context of significant geopolitical and economic tensions coupled with heightened climatic, digital and health challenges. The CNRS nonetheless organised nine events labelled as part of the 'FPEU' by the Ministry. These covered open science, gender equality, quantum ambitions, AI for industry and society, the European Research Council (ERC), Europe's attractiveness, Europe and its regions, collaborative research aimed at developing and reinforcing European research leadership and a new scientific partnership between Africa and Europe. The CNRS was also involved in four events on health, heritage, diplomacy and Europe's future. The organisation demonstrated its ability to organise and drive major events involving leading scientific and political figures alongside our high-level European counterparts.

For all these events, we extensively involved our European partners from the G6 network of the main European research organisations that represents a total of 135,000 staff members. This network constitutes a true force for collective thought and clearly affirms the values and bright future prospects of an ambitious European research sphere while also contributing to the construction of the European Research Area.

The CNRS's European strategy is also implemented through its partnership relations with its Brussels office and its 'Club Europe' involving our partners from industry. In this area the CNRS encourages meetings and joint initiatives and works to set up and run collaborative projects on the European scale. This dynamic was embodied by an event that brought academics and industrialists together in Brussels to debate, exchange ideas and identify the factors that can hinder or conversely accelerate European collaborative research. This work is an integral part of the CNRS's drive to intensify

its ambition for Europe as regards scientific excellence and career attractiveness, making a contribution to societal issues and innovation in a shared European research area.

What role do you see the Foundation playing in CNRS policy three years after it was created?

The Foundation was set up in 2019 to support the CNRS and help the organisation successfully fulfil its missions. Our aim is for our basic research to serve society and this clearly involves offering those who wish to contribute the opportunity to do so through the funding of research projects. More generally, the Foundation helps promote the CNRS and French scientific and technological research as a whole. It focuses on financing fundamental, exploratory, high-risk and even high-stakes research projects that need rapid support.

The Foundation has collected over €2.4 million in donations from individuals and companies in its three years of existence. This funding has been used to support a dozen research projects, notably working on the coronavirus, antiviral research to combat RNA viruses and climate change. Company patronage has meant the Foundation can sponsor scientific prizes, award grants and create chairs in fields that interest companies and CNRS laboratories alike. It also gives scientific communities and patrons from civil society the opportunity to create their own foundations under the CNRS Foundation's auspices, thus benefiting from its support and expertise. The Foundation already mentors several other foundations working on a wide range of projects like ocean exploration, protecting

the poles and 100-year forecasting. It also decided to support the CNRS's international image by funding our new 'Fellow-Ambassador' programme which annually invites around ten prestigious researchers from all over the world whose reputation and commitment to the CNRS help enhance our international influence. Finally, the Foundation has also chosen to associate with the CNRS in awarding the organisation's Gold Medal. This is considered by many to be France's most prestigious scientific distinction for an individual researcher or his or her laboratory.

JANUARY

The CNRS officially launches its Mission for Scientific Expertise (MPES) to support researchers working on publicly commissioned expertise missions.

The CNRS helps drive European research and innovation by organising a number of events during the French Presidency of the European Union (FPEU).

MARCH

The Intergovernmental Panel on Climate Change (IPCC) publishes its sixth summary report featuring contributions from CNRS researchers.

OCTOBER

The 2022 Nobel Prize for Physics is awarded to Alain Aspect in recognition of his work in the field of quantum physics.

NOVEMBER

The CNRS's National Institute for Mathematical Sciences (INSMI) organises a major conference, the 'Assises of Mathematics', to promote dialogue with the French public authorities and call for a nationwide rehabilitation strategy for French mathematics.

The CNRS adopts a low-carbon transition plan that aims to reduce the impact French research has on the environment while maintaining research excellence.

2022 in figures

HUMAN RESOURCES

Over
33,000
staff members
including
28,000
scientists

Over
200 different professions
providing direct
support for research

Among the researchers
recruited in 2022
42 % were women
and nearly
25 % were from other
countries

BUDGET

Nearly
€4 billion euros
(including payroll)
as the overall
budget
including nearly
€1 billion of CNRS
generated income

EUROPE

1st
ranked beneficiary institution of the
the European H2020 and Horizon
Europe framework programmes

50 %
of the winning French H2020
and Horizon Europe projects selected by
the European Research Council (ERC)

INTERNATIONAL

Nearly
80 International
laboratories
(including
4 created
in 2022
50 located in nearly
different countries

4 International
Research
Centres

10 Representative
Offices abroad

RESEARCH

10 thematic
Institutes

Over
1100
laboratories under CNRS supervisory
authority (research or support units)

PARTNERSHIPS

Over
120,000
staff members working in laboratories
under CNRS supervisory authority

2/3
of CNRS staff members work on
11
major university sites hosting
50 %
of our research or support units

PUBLICATIONS

Over
55,000
publications from laboratories under CNRS
supervisory authority including nearly
65 %
co-signed with a foreign laboratory

Nearly
95 % of publications by
CNRS researchers
in open access

INNOVATION

Nearly
100 start-ups deriving
from laboratories
under CNRS supervisory
authority created per year

Nearly
240 active CNRS/company joint
research structures

Over
9000 patent families
in the CNRS portfolio

1st
public co-filer of patents
with companies

JANUARY — THE UNIVERSE

Discovery of **the least metallic stellar structure in the Milky Way**. ©ESA/Hubble & NASA



FEBRUARY — MICROBIOLOGY

Bemnifosbuvir emerges as a promising treatment for Covid-19.

FEBRUARY — HEALTH

Scientists show that **exposure to a mixture of endocrine disruptors during pregnancy** affects the proper functioning of children's brains.

APRIL — BIOLOGY

5500 new species of RNA viruses are identified in the world's seas.

© Cyril FRESILLON / OOV / LOV / CNRS Images



FEBRUARY — LINGUISTICS

The book '**La Grande Grammaire du Français**' highlights the richness, variety and evolutions of spoken and written French on all five continents.



FEBRUARY — THE ENVIRONMENT

Massive methane emissions by the oil and gas industry are detected and analysed from space.

© Adobe Stock

APRIL — BIOENGINEERING

Spatial confinement is found to **reduce the production of proteins** in yeast.

APRIL — ELECTRICAL AND ELECTRONIC ENGINEERING

A simulation method is developed to enhance our understanding of the electro-chemical processes involved in **charging supercapacitors**.

Scientific highlights

MAI — PHOTONICS

Hydrogen is produced through the use of solar energy thanks to a new hybrid semiconductor/metal material. © Adobe Stock



JUNE — PHYSICS

The early history of the Earth: **The paradox of the missing xenon** is finally solved!

JULY — CRYPTOGRAPHICS

Several French laboratories take part in creating candidates for future **post-quantum cryptography** standards.



JULY — CLIMATE

The unprecedented **Paname 2022** measurement campaign provides its first observations on the climate and air quality in Paris.

© Cyril FRÉSILLON / CNRM / CNRS Images



JULY — THE ENVIRONMENT

The idotea, a small marine crustacean, is thought to act like a real 'bee' of the sea when in contact with gracilaria, a species of red algae.

© Wilfried THOMAS / Station biologique de Roscoff / SU / CNRS. Licence CC BY-NC-SA

MAI — CHEMISTRY

New **polymers** are developed that biodegrade in record time in water.

JUNE — CHEMISTRY

Scientists obtain promising results for the **capture and conversion of CO₂** which is now a major environmental issue.



JULY — CHEMISTRY

Rosetta Mission: a new analysis of data leads to the formal identification of twelve organic molecules in cometary material.

© ESA/ATG medialab; Comet image: ESA/Rosetta/Navcam



JULY — PLANT BIOLOGY

Scientists demonstrate that **plants and microbiota have communicated** through chemical signals for over 400 million years.

© Mélanie Rich

JULY — ARTIFICIAL INTELLIGENCE

Bloom, the world's biggest open science multilingual language model (capable of managing 46 languages from English to Basque) is unveiled.



AUGUST — ANTHROPOLOGY

Sahelanthropus tchadensis, believed to be the oldest representative of humankind at 7 million years old, is found to have been arboreal and quadrupedal as well as bipedal!

© Sabine RIFFAUT / Guillaume DAVER / Franck GUY / Paleovprim / CNRS Images

AUGUST — FLUID MECHANICS

Researchers find that the **airborne transmission of viruses** depends on the composition of the droplets that carry them.

SEPTEMBER — CHEMISTRY

Radioswitch, a new system activated by radiotherapy, paves the way for new therapeutic applications triggered in deep tissue.



AUGUST — ENGINEERING

Researchers develop **MiGriBot**, the world's fastest miniature pick-and-place robot.

© University of Franche-Comté

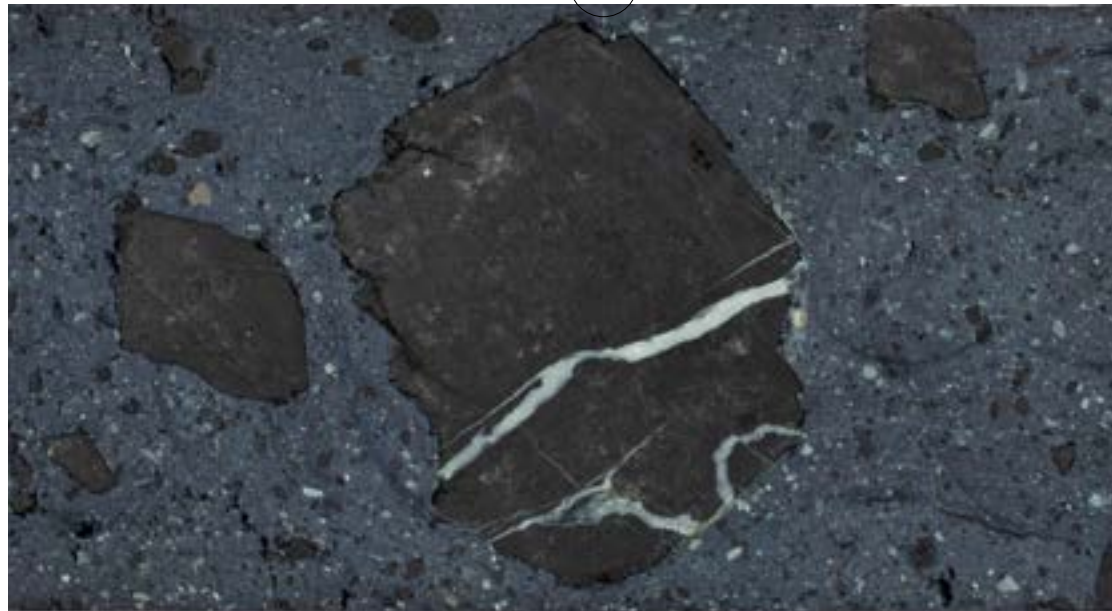
SEPTEMBER — MATHEMATICS

A study of the **economic impact of mathematics in France** confirms it makes a strong contribution to the national economy which has been in growth since 2015.

SEPTEMBER — THE EARTH

A major reservoir of **organic carbon** deep in the Earth is observed for the first time.

© Tim Fulton, IODP JRSO



SEPTEMBER — NUCLEAR PHYSICS

SPIRAL2's LINAC (LINear ACcelerator) successfully produces its first oxygen beam, accelerating to an energy level of 7 MeV per nucleon. © CEA / Philippe Stroppa



SEPTEMBER — PHYSICS

Researchers produce a macroscopic device capable of extracting energy from **disordered fluctuations**.

SEPTEMBER — PHYSICS

Scientists rediscover the signature of a universal physics that describes the **growth of interfaces** in classical physics.

SEPTEMBER — THE EARTH

A study reveals that **collisions that occurred during the Earth's formation** changed its composition.

© NASA/JPL-Caltech



OCTOBER — THE ENVIRONMENT

An analysis proves that the existence of **marine protected areas** counters the effects of climate change.

OCTOBER — NUCLEAR PHYSICS

Scientists observe a **giant mirror symmetry break** in an atomic nucleus.

NOVEMBER — PHYSICS

Quantum sensors make it possible for people to find their bearings without using a GPS which is useful for the navigation of airliners or making military vehicles safe.



SEPTEMBER — THE UNIVERSE

The **Noema radio telescope** reaches full capacity thus becoming the most powerful millimetre radio telescope in the northern hemisphere.

© Jérémie BOISSIER/IRAM/CNRS Images

OCTOBER — HEALTH

Chemotherapy: scientists combine **an active ingredient with a water-soluble polymer** so it can be administered to the skin without toxicity.

OCTOBER — HISTORY

Extracts from a **lost astronomical catalogue dating from the 2nd century BC** are discovered that shed new light on the history of astronomy in Antiquity.

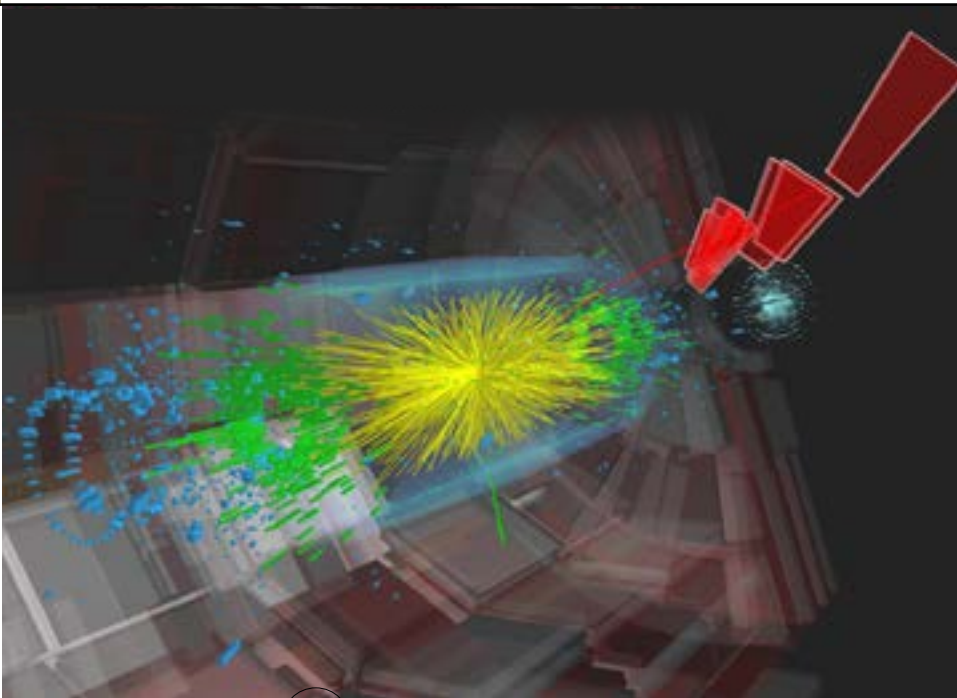
OCTOBER — CHEMISTRY

The potential of **bacteria** is exploited to construct functional artificial cells.



NOVEMBER — PARTICLE PHYSICS

In its Run3, the Large Hadron Collider reaches several luminosity records before its winter shutdown. © CMS Collaboration/CERN



Talents & awards



© Frederique PLAS/CNRS Images

Jean-Marie Tarascon

The CNRS Gold Medal was awarded to the chemist Jean-Marie Tarascon, professor at the Collège de France, director of the Solid State Chemistry-Energy Laboratory¹ and a member of the French Academy of Sciences. The award was in recognition of his work on electrochemical energy storage. He is a true pioneer in the development of the first extra-flat lithium batteries used in certain electric vehicles. In 2003 he initiated the creation of the Alistore-Eri European network of excellence and in 2011 did the same with the RS2E research federation which he directs. RS2E is France's very first energy network and developed the sodium-ion battery marketed by the Tiamat start-up.



From left to right: Jacques Marteau, Pierre Nassoy, Denis Spitzer and Céline Vallot
© Frederique PLAS/CNRS Images

Jacques Marteau

He is a particle physicist at Lyon's Institute of Physics of the 2 Infinities (IP2I)² and a pioneer in muon imaging. Muons are elementary particles that are produced naturally in the atmosphere and pass through matter over long distances without being absorbed. In 2021 Jacques Marteau and his team created the Muodim start-up which targets the very broad market for non-destructive testing which, for example, has applications in the steel industry, geophysical prospecting and civil engineering.

Pierre Nassoy

He is a physicist at the Digital Photonics and Nanosciences Laboratory (LP2N)³. His work focuses on the stem cell therapies of the future particularly for use in combating tumours or Parkinson's disease and has led to increasing numbers of patents being filed. The CNRS's prematuration programme has provided "support that has been crucial" and helped make his company TreeFrog Therapeutics one of the most noted French start-ups of recent times, winning national and international awards alike. This company produces reliable high quality stem cells in large quantities.

Denis Spitzer

He is a chemist with the Nanomaterials for Systems under Extreme Stress Laboratory (NS3E)⁴ in Strasbourg. His work has led to the creation of the first two processes capable of facilitating the study, formulation and production of sub-micron particles. He has also set up numerous partnerships and obtained over 18 patents, including six international patents, and markets his discoveries through the Spinofrin company.

Céline Vallot

She is a biologist with the Dynamics of Genetic Information: Fundamental Bases Foundations and Cancer⁵ laboratory and specialises in epigenetics. She has co-invented two families of patents and two software programmes that enable the rapid interactive analysis of cellular data by people with no specific computing skills like biologists or doctors searching for new therapeutic targets. She created the One Biosciences start-up which aims to become a world leader in precision medicine for complex diseases.



From left to right: Julien Bobroff, Étienne Ghys, Carolyn Scheurle, Jean Claude Ameisen, the cover of the 'Les décodeuses du numérique' graphic novel. © Cyril Fresillon/CNRS Images - © JohnPusceddu/CNRS Images - © CNRS Éditions

Julien Bobroff

He is a professor at Paris-Saclay University and a researcher at the Laboratory of Solid State Physics⁶. In 2013 he founded the 'Physics Reimagined' team in which he works on original collaborative projects with designers and creators of all genres. Julien Bobroff is unanimously recognised as one of the key figures in scientific mediation for physics and is also committed to a veritable research approach to these subjects. He also applies the results of his research to his own teaching and disseminates them to his research community.

Étienne Ghys

He is a CNRS emeritus research professor and the Perpetual Secretary of the French Academy of Sciences, a post he has held since 2019. As such he promotes mathematics and its usefulness in this position. In 2009, he created the online version of the 'Images des mathématiques' journal which showcases recent advances in mathematical research along with historical, cultural and sociological aspects of mathematics.

Carolyn Scheurle

She is the coordinator of the 'Culture Océan' Ocean Culture Unit at the Sea Institute in Villefranche⁷ and created the 'adopt a float' educational programme. This course has led to over 2000 young people around the world and their school classes adopting an underwater robot from the OneArgo scientific programme steered by the French Research Institute for Exploitation of the Sea (Ifremer) and co-directed by the CNRS. These young people follow their adopted robot in real time on its 'travels' through the ocean with the help of constantly enriched educational resources.

Jean Claude Ameisen

He is an immunologist, doctor and director of the 'Centre d'Études du Vivant' (Centre for Studies of the Living Sphere) at the Institute of Humanities, Paris-Diderot University. He is also the honorary president of the National Consultative Ethics Council (CCNE) and was awarded the CNRS's Special Prize for Scientific Mediation in 2022. His books include 'La sculpture du vivant', 'Le suicide cellulaire' and 'La mort créatrice'. For over ten years he hosted a Saturday morning programme 'Sur les épaules de Darwin' (On the Shoulders of Darwin) on the national France Inter radio station, questioning humanity's reaction in the face of global upheaval and attracting over 1.5 million listeners every week.

Les décodeuses du numérique

The 'Digital Decoders' project is managed by the parity and equality unit at the CNRS's Institute for Information Sciences and their Interactions (INS2I). This graphic novel aims to rectify gender imbalances in the digital sciences by spotlighting female researchers, academics and engineers in the digital field through 12 portraits drawn by the illustrator Léa Castor. The book also aims to make the digital sciences more accessible by portraying the full diversity of the subjects explored which have a clear resonance with major societal issues. It is published by CNRS Éditions with nearly 13,000 copies already sold or distributed.

67

CNRS researchers won ERC grants in 2022 (all types together)

2

winners of 'Étoiles de l'Europe' trophies came from CNRS laboratories namely Jean-François Doussin and Nicolas Mansard

Over 55 %

of women among the 22 Silver Medals, 44 Bronze Medals and 28 Crystal Medals awarded by the CNRS in 2022

Universe

In 2022 **Janne Blichert-Toft** was awarded the 2022 Harry H. Hess Medal by the American Geophysical Union. She is a geochemist and analyst specialising in radiogenic and stable isotopes and also a research professor at the CNRS's Laboratory of Geology¹ in Lyon. Her work has many applications in the Earth and Universe Sciences and also in anthropology, archaeology, ancient history and numismatics.

Mathematics

Francis Bach was awarded the 'Assises of Mathematics' medal in recognition of his major research work at the interface between mathematics and computer science. He is a research professor at the French National Institute for Research in Computer Science and Control (INRIA) and a member of the Computer Science Department at the *École Normale Supérieure* in Paris.

Computer Science

As well as her 2022 CNRS Bronze Medal, **Nina Amini**, a CNRS researcher at the Laboratory of Signals and Systems² was awarded the Irène Joliot-Curie 'young female scientist' prize for her work on the control of quantum systems. She uses mathematical, physical and automatic tools to help develop systems capable of solving problems that are currently unsolvable with conventional computers. These systems will revolutionise methods in other disciplines like artificial intelligence and medicine for instance.

Ecology

Céline Bellard, a CNRS researcher with the Ecology, Systematics and Evolution laboratory³, was awarded the Irène Joliot-Curie Prize's Special Prize of Commitment. She is a specialist on the impact of global change and more specifically biological invasions and the effects of global change on the biodiversity of island systems.

Chemistry

Raphaël Rodriguez is a CNRS research professor director of research and team leader at the Institut Curie. He was awarded the prestigious Klaus Grohe prize in 2022 in recognition of his pioneering work at the crossroads of chemistry and biology. His research provides new knowledge in chemistry and enhances the understanding of biological mechanisms at the molecular level. The overall aim of this work is to discover novel therapeutic approaches and new drug molecules.

Ecology

Claude Grison is a CNRS research professor, director of the Bio-inspired Chemistry and Ecological Innovations Laboratory (ChimEco)⁴ and the winner of the CNRS's Innovation Medal in 2014. In 2022 she won the 2022 European Inventor Award in the 'Research' category in recognition of the plant-based approach and methods she developed to extract metal elements from polluted soil and then use these 'ecocatalysts' to create new molecules for industry.

Biology

Gaëlle Legube is a CNRS research professor and head of the 'Chromatin and DNA repair' team at the Centre for Integrative Biology⁵ in Toulouse. In 2022 she was awarded the Raymond Rosen Prize which recognises and encourages scientists whose research focuses on cancer and finding a cure. She studies the mechanisms that enable genome integrity to be maintained and more specifically strives to understand how certain DNA breaks are repaired.

Gwyneth Ingram, a CNRS research professor with the Reproduction and Development of Plants laboratory⁶, was awarded the Foulon Prize by the French Academy of Sciences. Her research focuses on the inter-tissue communication that coordinates the development of plant reproductive organs.

Physics

Bérengère Dubrulle, a CNRS research professor with the Condensed Matter Physics Laboratory⁷, was named 'Female Scientist of the Year' by the Academy of Sciences and awarded the 2022 Irène Joliot-Curie prize.

Economics and management

Loïc Berger, a CNRS researcher at the Economics and Management laboratory⁸ in Lille, was awarded the ARIA Early Career Scholarly Achievement Award Certificate in 2022. This international prize is awarded by the American Risk & Insurance Association (ARIA) in recognition of the high-level achievements of risk management and insurance researchers who obtained their PhD in the ten years preceding the award.

Philosophy

Anca Vasiliu is a specialist in classical and late Greek philosophy and was awarded the *Académie Française*'s Philosophy Grand Prix for all of her work which explores the relationship between image, language and thought through new readings of ancient texts.

Mechanical and computer sciences

Samuel Forest, a CNRS research professor at the Centre of Materials⁹ was elected to the Mechanical and Computer Sciences Section of the French Academy of Sciences. He also received the CNRS Silver Medal in 2012.

20

PhD students linked to CNRS laboratories won L'Oréal-UNESCO 'Young Talents France' prizes

Over

50

scientists linked to CNRS laboratories won French Academy of Sciences prizes in 2022.

11

CNRS researchers were among the 18 new members of the French Academy of Sciences named in 2022

Scientific mediation



The 'Échappées Inattendues' (Unexpected Vistas) - a mix of science outreach and a cultural event

On November 18th and 19th the *Centquatre* cultural centre in Paris was the venue for the first edition of 'Échappées inattendues - la science racontée par le CNRS' (*Unexpected Vistas: Science Recounted by the CNRS*).

This new series of science outreach events for the general public gives scientists a platform and will be rolled out throughout France from 2023 onwards. Visitors to these accessible fun events will discover the world of researchers through stories, immersive experiences, workshops and live demonstrations.



Alain Riazuelo, an astrophysicist at the *Institut d'Astrophysique* in Paris, talks with the public after his micro-conference on 'The Invisible Universe' at the 'Échappées Inattendues' event. © CNRS



'Le côté bleu de la force' (*The Blue Side of the Force*) won the jury's Coup de Cœur (*Particular favourite*) prize in the 'La preuve par l'image' (*Proof through images*) competition for 2022. A scientist-diver removes a tentacle from anemones bleached by rising ocean temperatures in Moorea, French Polynesia © Anne HAGUENAUER / Frédéric ZUBERER / CRIOBE / CNRS Images



'Proof Through Images' – portraying another angle of science

The 'La Preuve par l'Image' photo competition is co-organised with Acfas and presents research through images. The beauty of the images first catches the eye of a spectator, bringing up questions even before the captions presenting and contextualising research provide more information. In 2022, twenty scientific images were selected for the exhibition and Rémi Coulon (*Bleu hyperbolique*) and Françoise Watteau (*Cyclope*) were awarded the Jury's Grand Prize. The jury's Coup de Cœur (*Particular favourite*) prize was awarded to François Boulogne for '*Forêt de bambous*' and Anne Haguenauer for '*Le côté bleu de la force*'. Finally, the public's prize rewarded Rémy Char and Roxane Fabre for '*La face cachée de la cellule*'.



Brain Awareness Week

The 24th edition took place from March 14th to 20th and featured conferences, workshops, film debates, science cafés and podcasts all over France.



Emerging from crises

The book 'Sortir des crises' (Emerging from crises) was published on May 19th by the Editions Quae publishing house and is intended for professionals and students interested in public health issues. It presents various initiatives that have implemented the 'One Health'¹ approach.

The Year of Biology – from the laboratory to the classroom

The CNRS and the French Ministry of Education, Youth and Sport organised a series of training days in scientific culture for life and Earth sciences teachers to mark the Year of Biology. These took place in around 20 different towns throughout the 2021-2022 school year. The training programme included conferences and talks on recent scientific themes and results, laboratory visits and opportunities to meet CNRS researchers. This thematic year also provided the opportunity to give biology a platform for a wide audience through sharing content, teaching resources and documentaries on important current issues.



For two months, the 'L'Océan, colosse aux pieds d'argile' (*The Ocean - a colossus with feet of clay*) fresco gave passengers on the Paris metro an opportunity to find out about the many important issues linked to research into this largely unexplored ecosystem that is now threatened by global warming. © CyrilFrésillon/CNRS Images



Understanding (almost) everything about the climate

The book 'Tout comprendre (ou presque) sur le climat' (*Understanding (almost) everything about the climate*) was published by CNRS Éditions and has been available in all good bookshops since March 2022. It uses illustrations to dissect and counter preconceptions about climate change.



A fresco of the ocean in the corridors of the Paris metro

The world's oceans are full of secrets and, though threatened by climate change, remain the very lifeblood of our planet. How do scientists explore this ecosystem? What can be done to preserve the richness of marine life? These are just two of the questions that the exhibition 'L'Océan, colosse aux pieds d'argile' (*The Ocean, a colossus with feet of clay*) aimed to answer. The fresco was co-designed by the CNRS and the Ifremer working in partnership with the Parisian public transport company the RATP and displayed from May 13th to July 11th in the corridors of the *Montparnasse-Bienvenue* tube station in Paris.

Unusual visits to celebrate science

The CNRS celebrated the 2022 'Fête de la Science' event organised by the Ministry of Higher Education and Research from October 7th to 17th by opening the doors of its laboratories, observatories, scientific platforms and research sites throughout France to the public. These 'Visites Insolites' gave over 1200 people the unusual opportunity to immerse themselves in the very heart of research - discovering exceptional facilities or experiments and coming face-to-face with scientists.

180 seconds to present your thesis

The 100th anniversary of Acfas, a French Canadian organisation that promotes the transmission of knowledge, was the occasion for the international final of 'Ma thèse en 180 secondes', held in Montreal on October 6th. The jury's 1st prize was awarded to Mané Seck, from Gaston Berger University in Senegal, for her work on the development and characterisation of nanomaterials based on arabic gum and almond. The 2nd and 3rd prizes were respectively awarded to Sophie Rivara from the École Polytechnique Fédérale de Lausanne (Switzerland) and Mamy Heninstoa Randrianjatovonarivo from the University of Antananarivo (Madagascar). The Public Prize was awarded to Jihane Kenfaoui from Sidi Mohamed Ben Abdellah University in Fes (Morocco). The event saw twenty international candidates take the stage during a total of over two hours.



'Sur les épaules des géants', a festival that looks further

From September 22nd to 24th the CNRS was involved as a partner in the scientific culture festival 'Sur les épaules des géants' (*On the Shoulders of Giants*), organised by the city of Le Havre. This first edition of the festival was made up of 61 events over a period of 3 days including round tables, lectures, workshops, opportunities to meet scientists, theatre performances and exhibitions. A variety of event formats enabled the public to get to know the 'giants' of science better, helped by forty modern-day scientists 'sitting on the giants' shoulders' to help present their work.



The French astronaut Thomas Pesquet meets the public at the 'Sur les épaules des géants' festival which gave him the opportunity to take a look back at the highlights of Alpha, his second mission aboard the International Space Station. © CNRS

The NIMS Forum — The 6th edition of the 'New Initiatives in Scientific Mediation' (NIMS) forum organised by the CNRS and *France Universités* took place on May 31st and focused debate on how important it is to make the scientific approach a core science outreach issue.

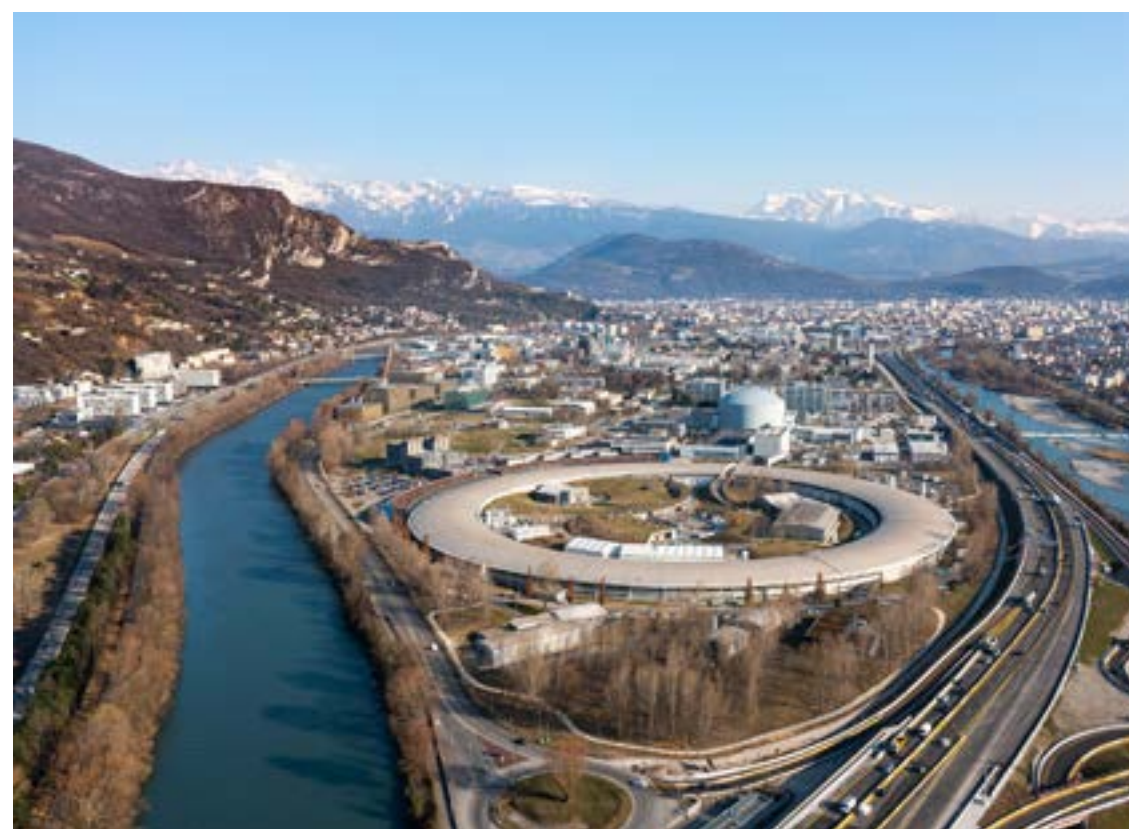
The CNRS inter- nationally

The CNRS, a major player in international research

The CNRS is a major player in world research and as such collaborates with the world's most prestigious scientific institutions, working hard to forge cooperation initiatives worldwide. In 2022, the CNRS consolidated its network of international partnerships and developed new collaborative initiatives with leading research institutions around the world. It now possesses a network of 10 Representative Offices in other countries along with nearly 80 international laboratories. It has also set up 4 International Research Centres with partners selected for their scientific excellence and multidisciplinary research. In 2022 two major international institutional strategies were also rolled out namely the 'Africa Plan' - a ten-year roadmap for the construction of equitable and sustainable scientific cooperation with the African continent - and the 'Europe Strategy' which aims to reinforce CNRS participation in the European Union's research and innovation programmes. Finally, the CNRS is a committed stakeholder as regards the crucial global interdisciplinary issue of the Ocean and has therefore taken an active part in major international political meetings ranging from the One Ocean Summit in France to the COP 27 in Egypt. Through this involvement, the CNRS has highlighted the importance of research and issues linked to the preservation and sustainability of the oceans, thus once again affirming its leading role in the scientific community and as the voice of science at the service of society.

The CNRS is reinventing its influence through its Strategy for Europe

In response to the major challenge of how to reinforce its influence within the European Union, the CNRS is rolling out an active strategy to defend its scientific and political priorities in the European context. Through its 'Roadmap for Europe' featuring around twenty action items, the organisation aims to optimise its participation in European research and innovation framework programmes. The Horizon Europe programme is the cornerstone of European research and innovation for the 2021-2027 period and participation is therefore an integral core element for the CNRS's European ambitions. The CNRS's European project engineers, the AMORCE initiative and its Representative Office in Brussels located in the *Maison Irène et Frédéric Joliot-Curie* all reflect the CNRS's aim to position itself as a key proactive stakeholder in the European Research Area.



The European Synchrotron Radiation Facility is a major research infrastructure located on the Grenoble peninsula © vuedici.org/ESRF

← Horizon Europe, a new impetus for European research

Horizon Europe (HE) was launched in February 2021 and has an overall budget of €95.5 billion. It follows on from the previous Horizon 2020 framework programme and is constructed around three main pillars. The first pillar, 'Excellent Science', is devoted to empowering basic research through European Research Council (ERC) grants, Marie Skłodowska-Curie Actions and support for very large-scale research infrastructures. Its overall budget is €25 billion. The aim of the second pillar, 'Global Challenges and European Industrial Competitiveness', is to support major collaborative projects. This pillar is made up of six 'clusters' linked to key societal themes like health, energy or the environment and is endowed with the largest share of Horizon Europe's budget at €52.3 billion. The final pillar, 'Innovative Europe' (EIC) focuses on the development of innovation and applications and has a €13.6 billion budget.



A water sample is taken in a mesocosm of the aquatic metatron at theoretical and Experimental Ecology Station (SETE)¹ in Ariège in the framework of the FRAGCLIM ERC project. © Cyril FRESILLON/SETE/CNRS Images



The ERC and excellence in European research

— The European Research Council (ERC) has been supporting fundamental science for 15 years now. Excellence is its only selection criterion for assigning funding to long-term exploratory and interdisciplinary research. ERC grants help give researchers international visibility at different stages of their careers. The CNRS is the leading beneficiary of all the different ERC grants with over 650 winning projects among the total of 10,000 funded since the start of the programme. These projects make a significant contribution to the top 1% of the world's most cited articles. The programme helps scientists set up international collaboration initiatives and indeed 60% of the scientific publications deriving from work funded by the ERC involve collaborations between several countries. Moreover, the ERC's priorities are both the future - two-thirds of the researchers it supports are under 40 – and also gender equality, with an identical success rate for men and women.



The Chiral Track start-up which specialises in measuring pharmaceutical molecules to enhance the evaluation of their impact on health has received support from the EIC. © CNRS



Jean-Luc Moullet, the CNRS's Deputy CEO for Innovation, at the event jointly organised by the CNRS and the Ayming Institute in the framework of the French Presidency of the European Union at the *Maison Irène et Frédéric Joliot-Curie* in Brussels. © Antoine Rassart / Twane.be

Opening of the *Maison Irène et Frédéric Joliot-Curie*

The CNRS's Representative Office in Brussels is now housed in the *Maison Irène et Frédéric Joliot-Curie* (MIFJC), a space designed to reinforce the presence and visibility of French science among EU institutions. The MIFJC was initiated by the CNRS and *France Universités* and aims to promote France's research positions within the European Research Area to political decision-makers at the European Commission, particularly by organising events in Brussels to showcase French higher education, research and innovation, such as the events held during the French Presidency of the European Union. It also provides office space and meeting facilities for researchers to meet with European Commission members and provides information, analysis, advice and support to help these researchers get involved in European projects.



The EIC – leading Europe towards the forefront in world technology

— The European Innovation Council (EIC) possesses a budget of €13.6 billion over seven years and its role is to identify, develop and intensify work on breakthrough technologies and innovations. The EIC is one of the major new features of the Horizon Europe framework programme and its aim is to make Europe a leader in world innovation. The EIC's work is based on a three-pillar structure that provides support for very early-stage technologies with the EIC Pathfinder scheme, emerging technologies with the EIC Transition scheme and breakthrough innovations that are close to maturity for industrialisation with the EIC Accelerator scheme. The CNRS is one of France's major deeptech stakeholders with nearly 100 start-ups founded each year on the basis of research results from laboratories under its supervisory authority. Indeed, start-ups derived from CNRS laboratories have benefited from over €458 million of EIC funding since 2019.

AMORCE: early support to enhance access to European grants for more projects

— Often the first step towards submitting a European project is the most complicated for researchers... Although the CNRS has a higher success rate (16%) for European projects than the European average (11%), there is clearly remains considerable room for improvement. To encourage researchers to embark on the

European adventure, the CNRS has offered to support them through its AMORCE ('*Support for setting up European Coordination Research Projects*') call for proposals. This scheme has a simple aim, namely to persuade and support researchers who have yet to work on a European project along with those who wish to reiterate this initiative. This support was launched in 2022 and is aimed at all staff in CNRS research units who would like to coordinate a collaborative project with partners from the European public and/or private sectors under the Horizon Europe framework programme. AMORCE provides financial support for researchers aiming to create a consortium to set up all types of European projects with the exception of individual ERC grants. Winners receive funding of up to €10,000 and a European Project Engineer (French acronym – IPE) is assigned to help them write and submit their project.

← A commitment to a Europe of research and innovation

— As mentioned earlier, France held the Presidency of the Council of the European Union (FPEU) from January 1st to June 30th 2022. During this six-month Presidency the CNRS was greatly involved in the European Research Area (ERA), organising and taking part in many events with the backing of the French Ministry of Higher Education and Research. These events enabled various aspects of the ERA to be presented and provided a space for strategic thought about the major issues and challenges involved like open science, the mobility of researchers, the links between science and society and scientific and technological sovereignty. They also demonstrated the CNRS's central federating position in the European and French higher education, research and innovation landscapes.

The European Parliament building in Brussels.
© Grecaud Paul / Stock.adobe.fr

The CNRS and Africa: a co-constructed sustainable strategy

Africa is expected to represent a quarter of the world's population by 2050 and is experiencing a significant increase in its scientific production despite its profile remaining low on the world stage. The CNRS elaborated its 'cooperation roadmap for Africa' in 2022 which is an ambitious plan to reinforce cooperation with this fast-growing continent. The organisation's aim is to consolidate existing collaboration projects and develop new synergies with less-involved regions to construct a relationship of excellence that is equitable and sustainable. The CNRS's commitment to promising African science is clearly visible in the creation of the Africa-CNRS Council, the launch of the AFRAMED network and the organisation of high-level conferences and workshops.

The CNRS launches its roadmap for cooperation with Africa

— The CNRS is continuing its commitment to the African continent with a co-constructed and sustainable scientific collaboration strategy launched in February 2022. Its aims are to support African research and to bolster Franco-African synergies. This multi-year plan's priorities are to consolidate existing collaborations, strengthen the mobility and training of researchers and increase joint scientific production. Alongside this overall reinforcement of relations with African research, a commitment has been made to remedy the relative lack of institutional cooperation initiatives with African regions that have been hitherto less involved with French scientific communities.



Spectrocolorimetric analysis of a painted wall fragment from previous excavations at the Pomongwe shelter in the Matobo Hills of Zimbabwe held at the Zimbabwe Museum of Humanities in Harare. © Nicolas BAKER/TRACES/ARSCAN/CNRS Images

An Africa-CNRS Advisory Board

— An Africa-CNRS Advisory Board has been set up to foster a mutually beneficial scientific and strategic dialogue. This Board is made up of African, French and European personalities and will work alongside the CNRS upper management. The Board's knowledge of African scientific issues in Africa and pan-African scientific networks will enable it to take part in the co-construction of the CNRS's long-term cooperation plan with Africa. It will also provide input for developing the right cooperation methods, put forward themes of mutual interest to the various stakeholders and pinpoint the nascent collaborations that need to be reinforced.



Co-constructing balanced research relations

— In the framework of the French Presidency of the European Union, on June 29th the CNRS and the Research Institute for Development (IRD) organised a high-level event in Brussels and online for representatives of French higher education, research and innovation and of public administrations from over 46 African and European countries. The aim of the event was to provide a forum for discussion and thought that would facilitate the development of a new, revitalised and more balanced scientific partnership between the two continents according to the guidelines set out in the roadmap for Africa.

Antoine Petit, the CNRS Chairman and CEO, speaking at the event co-organised in Brussels by the CNRS and the IRD to develop a new scientific partnership between Europe and Africa. © Sara Bouleis/CNRS



The X-ray diffractometer at the Crystallography, Magnetic Resonance and Modeling Laboratory (CRM2)
© Cyril FRESILLON / CRM2 / CNRS Images

An international workshop to strengthen scientific cooperation between the two continents

— The CNRS, the National Research Foundation (NRF) and the South African Department of Science and Innovation invited around 60 scientists from African and European countries to a week-long seminar with workshops held at the University of Pretoria from October 17th to 20th 2022. Discussions at this event defined common scientific priorities and focused on the various obstacles to be overcome to develop, fund and create a favourable environment for international collaboration. All these discussions and meetings have led to the planned launch of a series of calls for projects in 2023 to help set up Residential Research Schools, Visiting Fellowships and Joint Research Programmes.



The AFRAMED remote laboratory

— The AFRAMED International Research Network was launched on August 31st 2022 and enables scientists from African laboratories to remotely control an X-ray diffractometer located in France on a platform housed by the Crystallography, Magnetic Resonance and Modeling Laboratory (CRM2)¹. This network is supported by the CNRS in the framework of its multi-year cooperation plan with Africa. Its aim is to facilitate the intensive training of scientists in using this diffractometer.

Planet CNRS: forging global alliances to explore the frontiers of science

2022 was marked by the launch of many international projects, networks and laboratories while two new Representative Offices were inaugurated in Melbourne and Ottawa to develop and strengthen scientific collaboration. In addition, the creation of three new International Research Centres has bolstered the CNRS's strategic cooperation with its key partners.

These initiatives provide prime opportunities for dialogue, collaboration and developing new synergies. This network of partnerships of excellence means the CNRS can provide effective support for scientists in their research on the international level.



The NOEMA radio telescope, located on the Bure Plateau in the French Alps, is the most powerful millimetre radio telescope in the Northern Hemisphere and one of Europe's largest astronomical research facilities. © Jérémie BOISSIER/IRAM/CNRS Image

EUROPE



➤ The European radio telescope NOEMA reaches full power

Eight years after its first antenna was inaugurated in 2014, this major project is now complete. With its twelve 15-metre antennas, Noema is Europe's major new infrastructure for radio astronomy. It results from over 40 years of scientific collaboration between France, Germany and Spain and will enable scientists to study the physics of black holes and enhance our understanding of these.

➤ The CNRS and Imperial College London launch a new international research centre

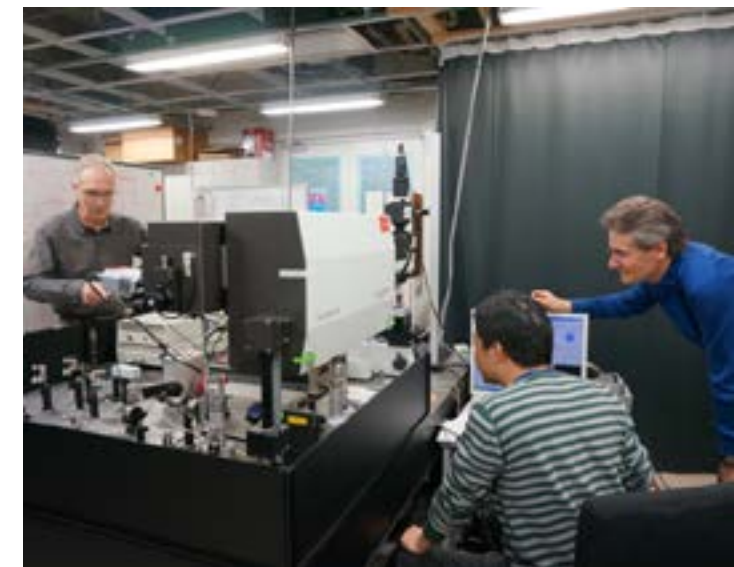
The International Research Centre jointly run by the CNRS and London's Imperial College focuses on digital transformation and global challenges and is the second international centre launched outside France by the CNRS. This centre was inaugurated on April 8th and facilitates an ambitious strategic dialogue between the two institutions to help define their mutual areas of interests and set up joint and co-financed collaborative projects.

The main entrance to Imperial College in London.
© Shadowsett/Wikicommons

ASIA

➤ An International Research Centre and two International Research Laboratories are launched in Japan

The CNRS established significant partnerships with Japan in 2022. On October 4th, the CNRS and the University of Tokyo inaugurated their third International Research Centre. The aim of this initiative is to foster excellence in research and training in varied areas like mathematical sciences, energy transition and gender equality. The CNRS also launched two new International Research Laboratories. One was the J-FAST laboratory set up in collaboration with Université Grenoble Alpes and the University of Tsukuba which will work on the physics of materials and microelectronics. These initiatives mark a major advance in Franco-Japanese scientific research collaboration.



Research at the new International Research Laboratory J-FAST in Japan.
© Université of Tsukuba

The CNRS strengthens its links with Singapore

Antoine Petit visited Singapore on January 25th and 26th 2022 to strengthen the links between CNRS and the city-state. There were three highlights to this official visit - the launch of the *DesCartes* artificial intelligence research programme, meetings with representatives of Singapore's higher education and research sector and with the French Chamber of Commerce in Singapore.

NORTH AMERICA



During the CNRS visit to the International Research Centre France-Arizona its delegation went to the Mirror Lab where researchers design mirrors for giant telescopes. © CNRS



In Arizona the first International Research Centre created by the CNRS is a success

— To mark the anniversary of the 2021 launch of the organisation's first International Research Centre, the France-Arizona Institute for Global Grand Challenges, the CNRS met with its partner in this initiative, the University of Arizona, to take stock of existing collaboration initiatives between the two institutions and lay the ground for future actions. These discussions led to three priority areas for collaboration being identified - water, carbon and future pandemics.



The CNRS and the University of Chicago strengthen their links

— On November 30th the CNRS inaugurated the International Research Centre for Fundamental Scientific Discovery which is its fourth facility of this kind in the world and is run in partnership with the University of Chicago. This Franco-American collaboration initiative will focus on scientific themes like quantum physics, the humanities and social sciences and marine biology.



The University of Chicago. © Vladislav Gajic/Stock.adobe.com



Inauguration at the French Embassy in Canada of the CNRS's ninth office abroad in the presence of Antoine Petit, CNRS Chairman and CEO of the CNRS, and Jan Matas, the director of the CNRS's office in Canada. © CNRS/Bureau du CNRS à Ottawa



The CNRS reinforces its presence in Canada

— The CNRS has increased its presence in Canada thus underlining the importance of bilateral partnerships for scientific research. The CNRS's ninth office outside France was inaugurated in Ottawa on February 14th. This was an important step forward in strengthening collaboration in strategic areas like AI, quantum sciences and ocean and polar sciences. The CNRS's presence in Canada was further consolidated by the opening of two new International Research Laboratories on April 25th namely the International Research Laboratory on Learning Systems and the Quantum Frontiers Lab. The former develops mathematical tools to enhance machine learning algorithms and make them safer to use while the latter works on quantum materials and circuits and their use in quantum technologies.

OCEANIA



Australia: the CNRS opens its tenth office abroad

— In April 2022, CNRS opened its Representative Office in Melbourne, Australia. In this part of the world the CNRS works on multiple scientific collaboration projects in computer science, physics, the environment and health, ecology, and the human and social sciences. Strong research themes feature such as the polar and coral spheres and radio astronomy.

An International Research Centre (IRC) is an institutional entity that aims to instil an ambitious strategic dialogue between the CNRS and its academic partner to define their common interests and the collaborations required to jointly respond to requirements in these areas. These can take the form of International Research Laboratories (IRL), International Research Projects (IRP), International Research Networks (IRN) or other existing or future structures.



The University of Melbourne which houses the CNRS's tenth office abroad. © Wikicommons/Gracchus250

The CNRS and the Ocean: global action in response to maritime challenges

The Ocean is at the heart of global interdisciplinary challenges and has become an issue of key importance for the international scientific and political community. Thanks to its expertise, the CNRS was asked to attend a number of major international events in 2022, confirming its role in driving ocean research and protection. At events like the One Ocean Summit in France, the United Nations Ocean Conference in Lisbon and the COP 27 in Egypt the CNRS continued to put across the views of science in the global debate on the future of our oceans.



The CNRS and its partners on the stand of the pavilion dedicated to the Ocean at the COP 27. © CNRS

← The CNRS attends the COP 27

For the first time, the CNRS attended the COP 27 held in Egypt alongside many international scientific partners and was particularly present as a partner organiser of the pavilion dedicated to the Ocean. This event was an opportunity for the CNRS to underline the importance of the ocean's role in future climate and biodiversity challenges and promote the creation of the International Panel for a Sustainable Ocean (IPOS) made up of a group of ocean experts. The pavilion featured a series of 'side events' organised by its partner institutions. Throughout the day, scientists, negotiators, decision-makers and sponsors met there to present actions linked to the COP's negotiating elements. This was an important opportunity to share scientific knowledge and was crucial for rethinking the ocean's future at the international level.

← Research has the wind in its sails at the One Ocean Summit

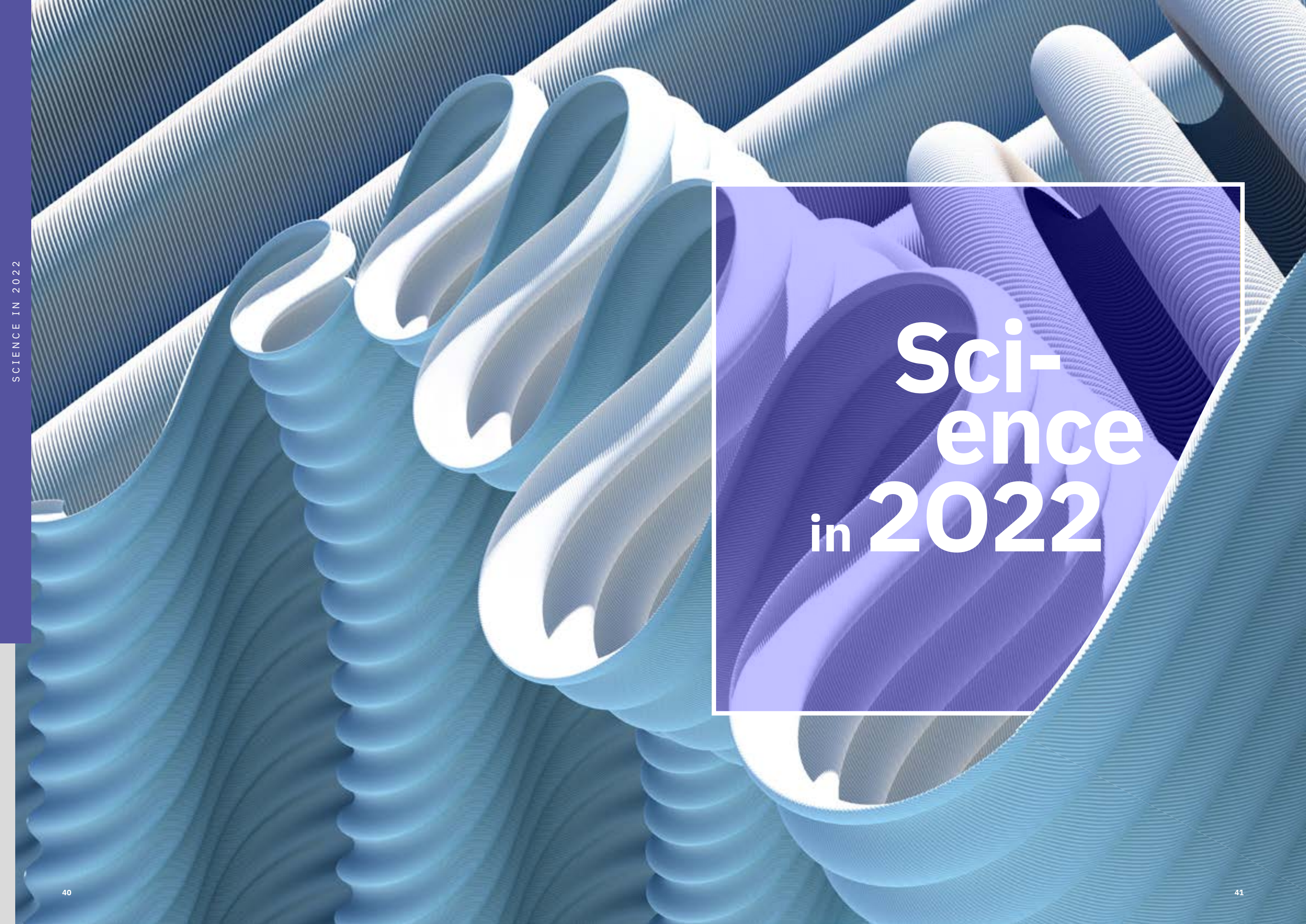
From February 9th to 11th 2022, France organised the first international summit dedicated to preserving the ocean in Brest with the support of the United Nations. The aim of this Summit was to drive and raise the ambitions of the international community as regards maritime issues and translate stakeholder nations' shared responsibility for the ocean into action. The summit provided an opportunity for the scientific community to highlight current research and the crucial issues surrounding this theme. It included over thirty workshops and meetings and was attended by more than 500 leading figures from 65 different countries alongside around twenty heads of state and government. Also over 100,000 people followed the Summit online.

The UN Ocean Conference: the CNRS response to the challenge of sustainable oceans

The United Nations Ocean Conference took place in Lisbon from June 27th to July 1st 2022. A large delegation from the CNRS was present and particularly took a leading role in the IPOS project. This new panel (see above) takes its inspiration from the successful achievements of the Intergovernmental Panel on Climate Change (IPCC) and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). The new panel's aim is to model ocean behaviour and define the actions required to achieve sustainable oceans.



A sound signature survey of a coral reef, Moorea lagoon, French Polynesia. © Yannick CHANCERELLE / CRILOBE / CNRS Images



Sci- ence in 2022

“The National Programmes Mission will give us an overall vision of our PEPRs and enable us to optimise their interactions”

Alain Schuhl,
Deputy CEO for Science

This year, the CNRS is steering or co-steering many Priority Research Programmes and Equipments (PEPRs) that are preparing for the future. How has the CNRS organised itself to respond to this challenge?

The aim of our Priority Research Programmes and Equipments is to build or consolidate French leadership in scientific areas that are linked to technological, economic, societal, health or environmental transformations. They are considered priorities at the national and European levels. We are gradually adapting to the growth and development of these programmes. Currently the CNRS steers or co-steers 31 PEPRs - 14 acceleration PEPRs and 17 exploratory PEPRs. In 2022, we set up a new structure called the National Programmes Mission (MiPN) to be operational as of January 2023. The MiPN's mission is to coordinate the work of the directors and dedicated staff of our PEPRs in terms of steering, communication and management for innovation. It will provide us with an effective overall vision of our PEPRs and enable us to optimise their interactions.

© FREDERIQUE PLAS/CNRS IMAGES

It's been three years since the launch of the CNRS Roadmap for Open Science. What steps forward have been taken this year?

Several pillars were identified in our Roadmap with the first concerning opening up publications. Significant progress has been made in this area with nearly 95% of publications by CNRS researchers now in open access. The second pillar concerns opening up research data. We are particularly active in this area at the CNRS - at the national level with the national data repository steered by the Ministry of Higher Education and Research and also at the European level within the European Open Science Cloud (EOSC) association. Our aim with this work on research data is to provide our communities with the means to make their data FAIR - Findable, Accessible, Interoperable and Reusable. The third pillar concerns the individual evaluation of researchers. We have changed our criteria to make sure all aspects of the research profession - teaching, dissemination of scientific knowledge, technology transfer to industry, administration and research - are given the value they deserve. Finally, we are promoting qualitative assessment including a significant narrative section for researchers to explain their choice of productions to be highlighted and their contributions to the advancement of knowledge.

The CNRS has adopted a low-carbon transition plan as part of its social responsibility policy. What does this plan consist of?

In 2022 we produced the CNRS's first greenhouse gas emissions report as our response to the very real concerns expressed by members of our laboratories, public stakeholders and society at large about the environmental impact of our activities. To avoid biases linked to Covid, the report covered 2019 and showed that 74% of our emissions derive from purchasing with 13% from professional travel. This enabled us to construct a low-carbon transition plan to reduce our carbon footprint with no negative effects on the efficiency and excellence of our research. The first action items like integrating environmental criteria into the CNRS's purchasing policy have already been implemented. We also launched an internal call for projects to financially support action projects that aim to reduce our carbon footprint and have received nearly 100 submissions which is a true success.

31

Priority research programmes and equipment (PEPR) steered or co-steered by the CNRS at the end of 2022

14

acceleration PEPRs and

17

exploratory PEPRs

Over

55,000

publications from laboratories under CNRS supervisory authority

Nearly

95%

of publications by CNRS researchers in open access

Environment and climate



A white paper on port research

— In the framework of France's national port strategy announced in 2021, a working group coordinated by the CNRS collaborated with the research community and stakeholders to analyse the organisation of port research in France. The result was the publication of a white paper in February 2022 that included an overall appraisal and recommendations.

The four main recommendations are aimed at research organisations and researchers as well as society as a whole. These are to structure the scattered port research community; to achieve this in a short timeframe; to reinforce links with computer and engineering sciences; and finally to set up forums for dialogue between scientists and socio-economic and institutional stakeholders.



A container ship belonging to the CMA-CGM company docked in the industrial port of Le Havre © MEDDTL – Arnaud Bouissou – TERRA



An artist's view of the SWOT mission satellite. © CNES / Mira Productions, 2022



A 4x5-inch view camera photograph of urban landscapes in the Armorique long-term socio-ecological research site in the 'Prairies Saint-Martin' park in Rennes where research is being carried out into the relationship between social and environmental dynamics. © Cyril FRESILLON/CNRS Images



Ecology, the environment and biodiversity: research is finding responses for tangible issues

— During the first National Week in Ecology, Environment and Biodiversity from May 30th to June 3rd 2022, researchers from France's Ecology and Environment Partnerships (DIPEE) organised outreach events all over the country that presented the scientific expertise of CNRS laboratories in this area to socio-economic stakeholders, local authorities and the general public.

21 million euros for Argo France

To support and develop the Argo France network's work on in situ ocean observation, €21 million is being invested in projects involving the CNRS.

Global warming - the IPCC's assessment cannot be ignored

— The 6th assessment report by the Intergovernmental Panel on Climate Change (IPCC) featured contributions from CNRS researchers and unequivocally takes stock of the situation, observing that unprecedented climate change is occurring in every region of the world. Climate change is progressing extremely rapidly compared to natural changes and is due to mankind, particularly the world's richest populations.



SWOT: a satellite to monitor land waters

— The Surface Water Ocean Topography (SWOT) mission was launched on December 16th 2022 for a period of three and a half years. This is a joint project run by the French (CNES) and American (NASA) space agencies which aims to use a brand new on-board instrument to measure the characteristics of two million lakes on Earth. The SWOT mission involves a number of CNRS laboratories.

A summer school devoted to the Great Green Wall of the Sahel

The Tèssékéré international human-environment observatory coordinated by the CNRS gathered researchers for its traditional summer school on the Great Green Wall.

The ANR CompAg programme — This programme involving the CNRS is coordinated by the National Research Institute for Agriculture, Food and Environment (INRAE). In January 2022 it published a report suggesting a number of ways to improve the agro-ecological transition.

← Paname 2022: studying air quality and the urban climate

— The aim of the Paname* 2022 initiative is to find out more about the causes and effects of climate change in urban environments. Intensive measurement campaigns began in the summer in the Paris region involving scientists and laboratories from the CNRS, Météo-France, Université Paris-Est Créteil, Sorbonne University, the Institut Polytechnique de Paris, the École des Ponts ParisTech, the Inrae, LigAir and Airparif. Ten different projects were brought together to pool resources and measurements while also developing synergies. This campaign also deals with the issues of air pollution and urban climate in a comprehensive and highly interdisciplinary manner combining physics, atmospheric chemistry, meteorological and climate sciences, ecology, medicine and the human and social sciences.

* Paname is a popular French nickname for Paris.

The CNRS's ambitious low-carbon transition plan

— Following on from the CNRS's initial assessment of greenhouse gas emissions based on data from 2019, the organisation has now committed to a low-carbon transition plan. The first action areas are purchasing, digital, mobility and energy. A lot of ideas have been proposed for each area with varying levels of investment, implementation schedules and impact. These are combined with transversal initiatives, particularly as regards employee awareness and training. A project led by the CNRS and the IRD was one of the ten winners in the government's call for 'eco-responsible innovation' challenges and is driving action in these areas. The CNRS's nationwide low-carbon transition plan is being steered by a Sustainable Development Committee working in collaboration with the network of reference people created within the organisation. In this way the CNRS aims to drive progress in this area in French higher education and research.

A sounding balloon being released into the atmosphere for a radiosonde on the banks of the Seine during the Paname 2022 campaign in Paris.
© Cyril FRÉSILLON / CNRM / CNRS Images

Mathematics and AI



The Jean Zay supercomputer - new uses for artificial intelligence

— Bloom, the largest trained open-science multilingual language model ever created, was released in 2022. It results from the BigScience project launched in 2021 with the support of Hugging Face, a French AI start-up involving many CNRS researchers that has developed one of the world's leading machine learning platforms. Bloom was supported by the French government in the framework of its national artificial intelligence strategy. Many partners have joined the Bloom adventure with a final total of a thousand participants from the academic and industry spheres in 72 countries. This makes the project a model of open and participatory science. Thanks to the CNRS, Bloom was trained on the Jean Zay supercomputer. This required five million hours of calculation which enabled the model to practise for four months on 46 languages at a time with varied sources ranging from literature to sports newsflashes.

The Jean Zay supercomputer. © Cyril FRÉSILLON / IDRIS / CNRS Images



There were several round tables involving scientists, decision-makers and industrialists at the 'Assises of Mathematics' event which resituated maths at the heart of societal issues. © CNRS - L'œil de votre événement



The field of mathematics formulates its future

— The CNRS's National Institute for Mathematical Sciences (INSMI) devoted 2022 to thought about the place of mathematics in society with seven working groups studying a range of themes linked to the discipline. The groups carried out around a hundred interviews to help take stock of the relations between mathematics and teaching or the worlds of research and of companies. The mathematics community was challenged to respond to calls for projects to disseminate mathematics or that are based on the role and relevance of mathematics as regards the challenges set out in the France 2030 plan. A major conference held at the UNESCO Headquarters in Paris from November 14th to 16th was attended by nearly 750 people and featured presentations by leading scientists and political and economic decision-makers. Four round tables enabled participants to discuss the working groups' recommendations and put forward tangible proposals.

Jean Zay takes up bridge

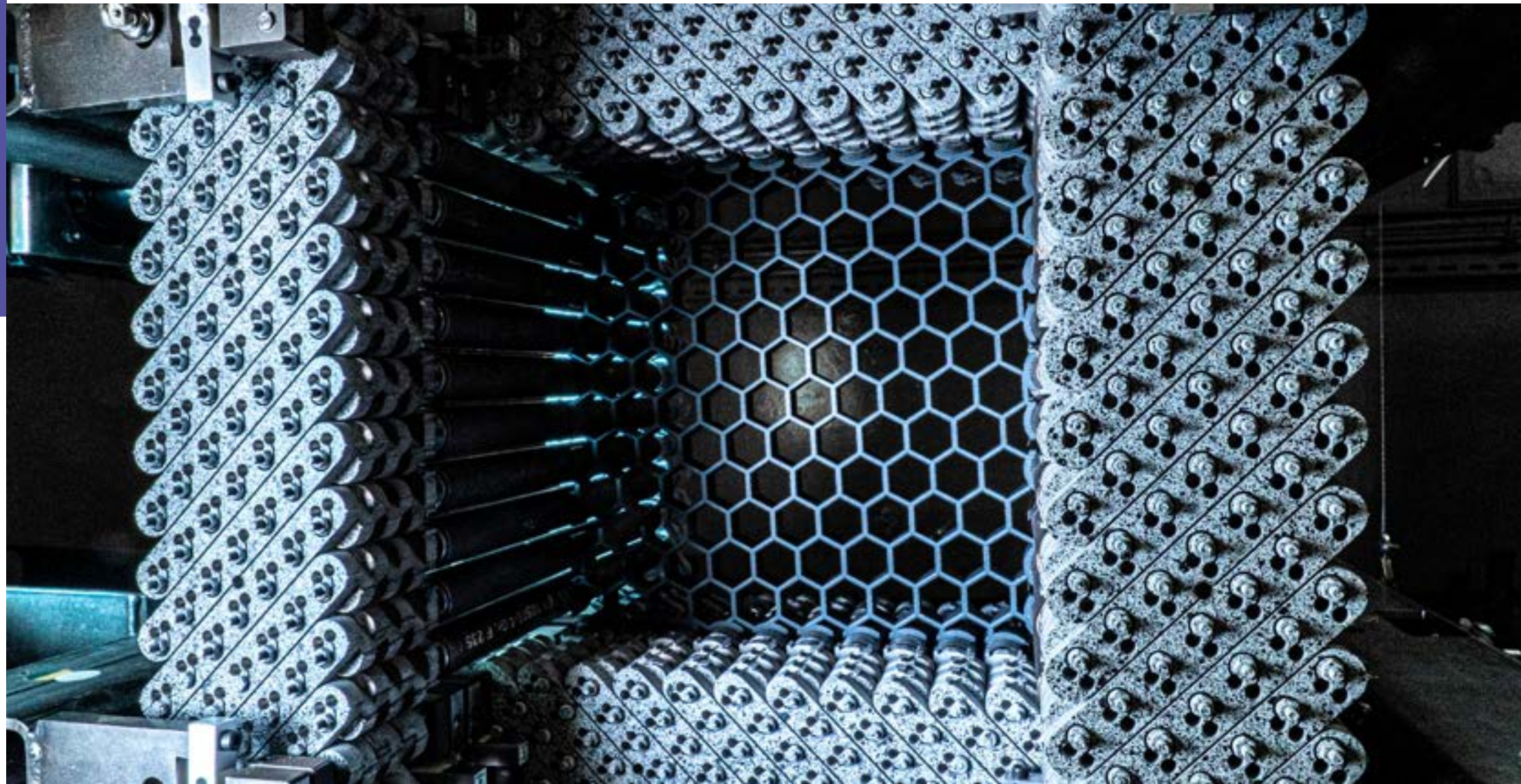
In March, an AI played humans in a game of bridge with the help of the Jean Zay supercomputer run by the CNRS. This was a world first.



Mechanics - a key to the future

— The CNRS, the French Academy of Sciences, the Association of Mechanics and the National Academy of Technologies of France organised the 'La mécanique, une clé du futur' (*Mechanics, a key to the future*) conference that took place on June 1st at the Institut de France. This event was part of the '2021-2022 - The Mechanics of the Future' year organised by the CNRS's Institute for Engineering and Systems Sciences (INSIS). A series of round tables at the conference gave participants the opportunity to take stock of the major advances and future challenges in mechanics. One particular focus was the modelling-simulation-experimentation triptych and its essential contribution to research and engineering in areas like health, energy, architecture and the smart cities of tomorrow. French mechanical engineering is an omnipresent driving force for our future and is ranked 6th in the world. It also represents the leading French sector in terms of jobs.

This futuristic-looking machine is used to measure the properties of innovative materials, known as 'architectures' because their structure gives them remarkable mechanical properties. © Maxence WANGERMEZ / Martin PONCELET / LMT / LMPS / CNRS Images



The 2022 Fields Medal

— Hugo Duminil-Copin, a professor at the University of Geneva and the *Institut des Hautes Études Scientifiques* (IHES) and a member of the Alexander Grothendieck Laboratory¹, was awarded the Fields Medal in 2022.

The Mathrice network's 20th anniversary

— Mathrice, the leading thematic network of CNRS computer scientists, celebrated twenty years of existence on October 19th. The network is made up of research support staff members working in mathematics laboratories.

Partnerships

The CNRS strengthens its academic partnerships

— In 2022, the CNRS both created and strengthened a number of partnerships. The organisation reaffirmed its joint scientific policy with the universities of Grenoble Alpes, Gustave Eiffel, Limoges, Pau and the Pays de l'Adour, and Saint-Quentin-en-Yvelines. It also reinforced its links with other research organisations by renewing its agreements with the IRD and the INRIA and by defining a joint roadmap with the Institute for Radiation Protection and Nuclear Safety (IRSN). In May, the CNRS also signed a cooperation agreement with the Provence-Alpes-Côte d'Azur region to strengthen the region's capacities in terms of research, training and innovation.

Physics



© Jérôme CHATIN/CNRS Images



Alain Aspect is awarded the 2022 Nobel Prize in Physics

— Alain Aspect, a CNRS research professor emeritus at the Charles Fabry Laboratory¹ (Institut d'Optique Graduate School/CNRS, Paris-Saclay University) and professor at the École Polytechnique, was awarded the 2022 Nobel Prize in Physics. He previously received the CNRS Gold Medal in 2005, the Wolf Prize in 2010, the Albert Einstein Medal in 2012, and the Balzan Prize and Niels Bohr Medal in 2013. He was awarded the Nobel Prize with two other researchers, John F. Clauser of the United States and Anton Zeilinger of Austria, for their experimental work on entanglement which has advanced our knowledge of quantum theory. His Nobel Prize also recognises a lifetime of revolutionary research in the field. Alain Aspect is the holder of the Augustin Fresnel chair at the Institut d'Optique Graduate School (IOGS) and is recognised for shedding light on the fundamental aspects of the quantum behaviour of single photons, photon pairs, and atoms, as well as for contributing to our understanding of the quantum world.



An artist's view of the Perseverance Rover. © NASA/JPL-Caltech

Space



Perseverance records the first Martian sounds

— In 2022, NASA's Perseverance rover recorded the Red Planet's 'soundscape' for the very first time. The international team includes scientists from the CNRS and reported back that the five hours of sound recordings obtained using the Franco-American SuperCam instrument reveal Mars to be quiet with natural sound sources rare apart from the wind. The team's analysis also found the speed of sound to be slower on Mars than on Earth with high- and low-pitched sounds not attenuated in the same way. In the future, other robots equipped with microphones could therefore improve our understanding of planetary atmospheres. In February, Perseverance also celebrated its first year on Mars and its millionth laser shot with the SuperCam!

Curiosity provides new geological observations

— The international scientific consortium working on the Curiosity mission to explore Mars includes members of the CNRS and delivered new observations of the geological history of the planet Mars. Measurements by the Franco-American ChemCam instrument when Curiosity crossed Glen Torridon provided a detailed characterisation of the geochemical and hydrological context for the formation of minerals on this Martian territory.

The Carina Nebula, a stellar nursery that is four times larger and more luminous than the Orion Nebula, as observed by the James Webb Space Telescope. © NASA/ESA/CSA and STScI



The Milky Way's black hole is revealed

— Scientists from the international Event Horizon Telescope (EHT) project have just unveiled the first image of Sagittarius A*, the giant black hole lurking 27,000 light-years from Earth at the centre of our Milky Way. This is the second direct image of this type of star, following the image of the central black hole of galaxy M87 the same instrument obtained in 2019. The CNRS is contributing to the EHT project through two observatories at the Institut de Radioastronomie Millimétrique (Iram, *Institute for Millimeter Radio Astronomy*). The first is a 30-metre telescope located on the slopes of Pico Veleta in southern Spain at an altitude of 2850 metres while the second is Noema (Northern Extended Millimeter Array), which went into use in 2018. This is a radio telescope whose twelfth antenna, measuring 15 metres in diameter, has just been put into service on the Bure plateau in the French Alps.



An image of the giant black hole Sagittarius A* located at the centre of the Milky Way. © EHT Collaboration



The James Webb telescope delivers its first images

— On July 12th 2022, the first images from the James Webb Space Telescope (JWST) were unveiled. The JWST was developed by the American (NASA), European (ESA) and Canadian (CSA) space agencies and enables scientists to observe very distant objects like primordial galaxies or closer objects that are very faint like stars or planets in formation. Several laboratories linked to the CNRS were involved in its development. One of the JWST's priority observation programmes was co-directed by a CNRS scientist and in September this delivered the most detailed and sharpest images ever taken of the inner region of the Orion Nebula. This is located in the constellation of the same name, 1350 light-years from Earth. It is an environment similar to the one in which our solar system was born over 4.5 billion years ago. Study of this Nebula will enhance our understanding of the conditions that prevailed at that time.

France on board an American lunar mission

— The French Space Agency (CNES) and the Institute of Earth Physics of Paris¹ (of which the CNRS is the first supervisory authority) were selected to integrate the first seismometer to land on the Moon since the Apollo missions (1972-1977) into NASA's next lunar mission in May 2025. This instrument will measure earthquakes on the Moon's surface and seismic attenuation in the deep lunar mantle while also determining the thickness and stratification of the Moon's crust along with lunar microseismic noise.

Health

The first assessment report from the *SHS Santé* platform

From October 24th to 26th 2022, the CNRS and its partners organised a conference entitled 'Risks, crises and the human and social sciences: towards inclusive occupational and environmental health observatories' which provided an opportunity to take stock of the research initiated by the Humanities and Social Sciences of Health research platform, *SHS Santé*. This platform was initially launched for a two-year period by the French Ministry of Higher Education and Research in 2020 and its aim is to help collaborative action develop in the human and social sciences of health. Two years later, the project's stakeholders wish to continue this activity and develop new research methods working in contact with the populations concerned. They also aim to develop long-term systems for study of the health effects of environmental problems on affected populations.

An image of the cerebral lobe of a *Drosophila* larva from Nikon Imaging Center microscopes @Institut Curie-CNRS. © Manon Budzyk / Cell biology and cancer (CNRS/Institut Curie) – Basto team



A work meeting during the Covid-19 health crisis.
© Christian MOREL / LISN / CNRS Images



Measuring the effects of the health crisis on science

The CovETHOS project was launched by GEMASS¹, the Sorbonne research group for the study of the methods of sociological analysis¹, and involves a questionnaire sent to CNRS staff respondents in April 2022. The aim of this project is to study the different effects of the Covid-19 crisis on scientific work - from publications to integrity and communication.

A large-scale programme on psychiatry research

The PROPSY (precision-psychiatry project) programme is led by the French National Institute of Health and Medical Research (INSERM) and the CNRS. It has a budget of 80 million euros over five years and aims to improve the coordination of all the French research forces in psychiatry while also increasing the continuum between research and care. This exploratory Priority Research Programme and Equipment (PEPR) focuses on four of the most debilitating disorders - bipolar disorder, major depressive disorder, schizophrenia and autism spectrum disorder. It will open up the field of precision medicine in psychiatry, revolutionising the diagnosis of these illnesses and patient care.



Nikon Imaging Center: a scientific imaging platform that is unique in France

In 2022 the Institut Curie, the CNRS and Nikon announced the renewal of their partnership. The Nikon Imaging Center @ Institut Curie-CNRS platform also celebrated 15 years of service to basic, biomedical and innovation research in the field of optical microscopy.



The CC-IN2P3 magnetic tape storage library.
© Cyril FRESILLON / CC IN2P3 / CNRS Images

Open science

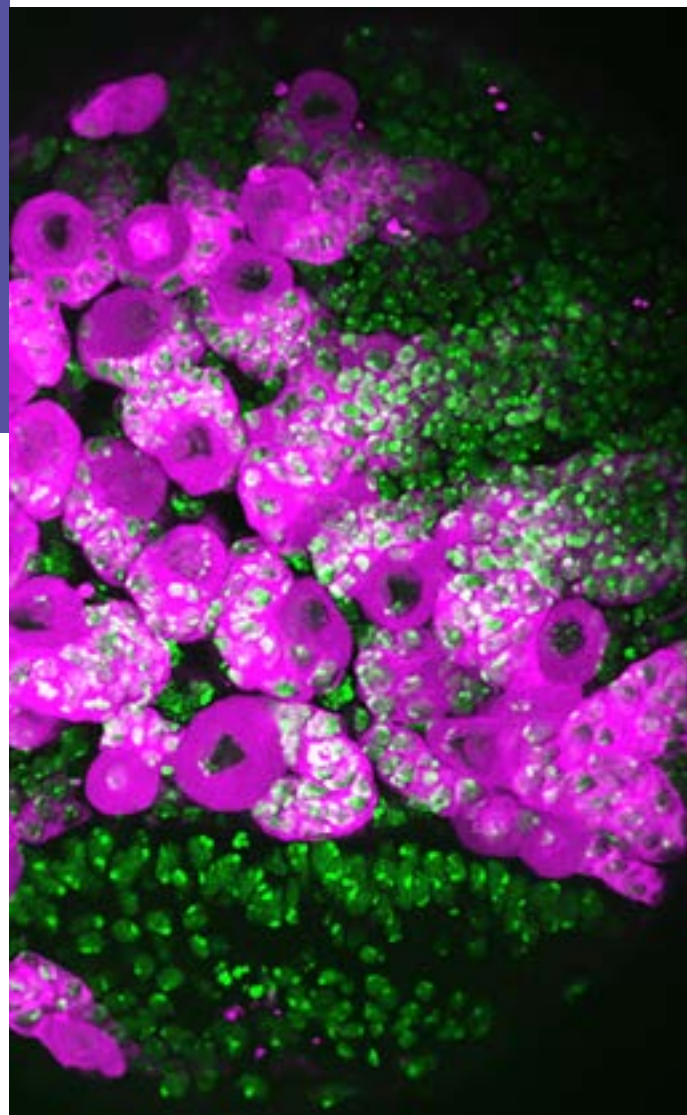
Data - a major open science issue

On November 30th 2022, the CNRS's Open Research Data Department (DDOR) organised the 4th Open Science Day in Paris. This event was devoted to issues linked to the management and sharing of research data. It also gave those present the opportunity to take stock of existing open science tools and services.



Open science: CNRS supports the 'Action Plan for Diamond Open Access'

On March 2nd 2022, the French National Research Agency (ANR), Science Europe, the Operas research infrastructure and the 'cOAlition S'¹ published the 'Action Plan for Diamond Open Access' of which the CNRS was one of the first signatories. The CNRS encourages its researchers to adopt free publication models (for both authors and readers) and deposit their accepted author manuscripts (AAM) in the HAL open archive as soon as the corresponding article is published. This action plan argues in favour of a virtuous economic publication model based on academic subsidies. This will make it possible for open access publication channels to be offered free of charge. This is different from open access platforms with compulsory publication fees as most of these involve cost and ethical problems.



Science & Decision-making

The CNRS sets up a new Mission for Scientific Expertise

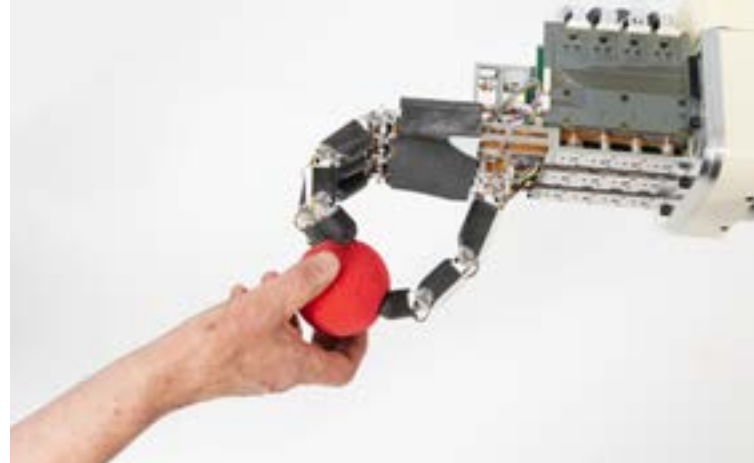
— At the start of 2022, the CNRS officialised the creation of its Mission for Scientific Expertise (MPES) to support researchers working on commissioned public expertise projects. The MPES has three founding objectives - to coordinate, promote and provide a framework for the CNRS's scientific expertise. Its work is based on four fundamental principles to ensure the quality of this expertise namely qualified competence, transparency, independence and plurality. The role of this Mission is to define and implement a working methodology, ensure experts are aware of the rules that need to be followed and support the scientific project leader in organising and carrying out an expert review.

Reforming scientific assessment: the CNRS among the first signatories

— On September 28th 2022, during the 4th European Research and Innovation Days, the European Commission put forward an agreement whose signatories would form a coalition to reform research assessment. The CNRS was one of the first of these signatories. This agreement is the culmination of a process that began in 2021 when the Commission published a report named 'Towards a reform of the research assessment system'. This followed on from the Declaration on Research Assessment (DORA) declaration signed by the CNRS in 2018 and deals with the assessment of research organisations and projects as well as individual researchers. Assessment is one of the four fundamental pillars set out in the CNRS Roadmap published in November 2019, the aim being to implement and use more qualitative and less quantitative criteria.

Scientists' public discourse - between freedom and regulation

The CNRS took part in a conference on scientific discourse organised on June 9th by the French Office for Research Integrity (OFIS).



The 'O2R' PEPR recommends a form of robotics that is socially adapted to respond to questions and issues linked to the integration of robots in our daily lives and in society. © Cyril FRESILLON / PPRIME / CNRS Images



The CNRS is co-steering Priority Research Programmes and Equipments (PEPRs)

— The results of the second wave of the call for exploratory PEPR projects were announced in July 2022. 13 new projects were selected to receive a total of €600 million in funding and the CNRS is steering or co-leading these PEPRs with its partners. The projects target emerging scientific or technological sectors for which the government wishes to identify and structure communities that are likely to be involved in possible national strategies in the future. The PEPRs operated by the ANR in the framework of the France 2030 investment plan come in two different forms. Firstly PEPRs for national acceleration strategies which support transformations that are already underway like low-carbon hydrogen and artificial intelligence (AI). Secondly there are the exploratory PEPRs designed to develop emerging sectors.

What kind of dialogue should science and public authorities have in times of crisis?

— The CNRS and the Cour des Comptes (*Court of Accounts*, France's supreme audit institution) organised their 2nd conference in partnership with the Inserm. The theme was research support for public action particularly as regards the recent Covid-19 health crisis. The conference was an opportunity to reiterate the importance of investing in cutting-edge basis research and taking a multidisciplinary approach to preparing for future crises. The Covid-19 crisis demonstrated the worldwide interdependence between science and industry. Three conference sessions respectively dealt with accessing and using databases for research in response to the Covid-19 crisis (using the Modcov19 platform as a particular example), the role of the humanities and social sciences in a time of crisis and the importance of innovation and technological risk-taking.

Research facilities and equipment



Research infrastructures: the CNRS's flagship

— 108 infrastructures were identified in the new French National Roadmap for Research Infrastructures (RIs) published in March 2022. The CNRS is involved in 91 of these with 86 already operational. All the RIs set out in the roadmap are co-led by the CNRS and its partners. Of these, the CNRS leads 6 out of 23 and is the sole leader of all the humanities and social sciences RIs. Significant human and financial resources are required because of the scale of the scientific and technological issues covered by these infrastructures and the work required to construct and operate them.

Outdoor tank for growing microalgae in sunlight on the site of the AlgoSolis1 research infrastructure in Saint-Nazaire. © Jean-Claude MOSCHETTI/AlgoSolis/CNRS Images.jpg

EquipEx+: high-quality research facilities to achieve a world-class level

— The Terra Forma EquipEx+ project was launched in January 2022 and is developing an observation platform based on a network of intelligent sensors distributed throughout France to monitor ecosystems. This launch provided an opportunity to take another look at these high-quality research facilities and equipment as defined in the framework of the Investments for the Future Programme (PIA3). The aim of EquipEx+ projects is to invest in strategic, cutting-edge scientific equipment to maintain the excellence and leadership of French research. In 2020, 52 projects were selected for a total of €422 million in funding in the framework of the 'Structuring equipment for research: EquipEx+' initiatives. The CNRS is greatly involved, collaborating on many projects and coordinating sixteen which target major scientific challenges in fields ranging from astronomy and biodiversity to digital technology.





Inno- vation in 2022

“The CNRS Entreprises Club launched in 2022 now brings together 500 decision-makers from start-ups, SMEs and major groups”

Jean-Luc Moullet,
Deputy CEO for Innovation

In the CNRS's Objectives and Performance Contract (COP), the target was set of creating 50 additional deeptech start-ups per year, over and above the average annual flow of 100 start-ups.

How can this dynamic be encouraged and how should the transfer of innovative technology to the market be supported?

The creation of start-ups means we can play a core role in increasing the impact of public sector research on the national economy. Creating one start-up represents the creation of around 20 jobs over the next ten years! Currently there are 1400 active start-ups deriving from research laboratories under the supervisory authority of the CNRS. These include Eurofins Scientific, which has actually become an international group and a CAC40 shareholder in 35 years of existence; Treefrog Therapeutics which was created in 2018, is part of FrenchTech120 2022 and is developing a new generation of cellular therapies based on stem cells;

or Quobly, created at the end of 2022 in Grenoble in the field of quantum technologies on semiconductors. These three start-ups put together represent more than 90,000 employees which is three times the size of the CNRS! A continuum of support was put in place to facilitate their creation process. This starts with the invention declaration leading to the patent, which is essential for the creation of start-ups, through to the prematurity programme. The latter supports 80 projects a year in 'technological de-risking' to develop a proof of concept of the innovation envisaged. Finally we have the RISE programme to support researchers in working towards entrepreneurship.

The CNRS has launched the CNRS Entreprises Club to further the dialogue with companies. What are this club's objectives and what other initiatives are underway?

The CNRS Entreprises Club launched in 2022 now brings together 500 decision-makers from start-ups, SMEs and major groups to discuss new scientific issues and the interaction between science and economic issues. In this context, we organise visits to laboratories and scientific explanatory sessions to report on the state of a given scientific subject of interest like quantum technology or DNA storage. Of course, the CNRS Entreprises Club also serves to facilitate contacts between laboratories and companies and develop new research collaboration projects. In 2022, we continued to reinforce our relations with the business world, particularly by continuing our growth trend as regards joint laboratories. There are nearly 240 operating joint laboratories which clearly demonstrates the attractiveness of this flexible and agile form of collaboration for companies.

In more structural terms, the CNRS also launched the recruitment of technology transfer engineers in 2022. What will their role be?

The issues that face companies are often extremely interesting subjects for scientists to work on. We need to reach out to companies to understand and identify their requirements more effectively. This is the spirit underpinning the recruitment programme for technology transfer engineers. Their main mission is to reach out to companies, particularly the smallest among them whose research we may know less about, but the input of which we need just as much. In 2022, we recruited around thirty technology transfer engineers and we will continue at this rate in 2023 and 2024 until we have recruited a network of around one hundred such engineers working in CNRS laboratories and our regional offices.

Over

1400

active companies from laboratories under CNRS supervisory authority since 1999 including nearly 100 new companies set up in 2022

107

start-up projects supported by RISE including 25 new RISE projects in 2022

314

projects supported by the prematuration programme including 58 in 2022

22

framework agreements with major companies including 2 new agreements in 2022

Nearly

240

active joint CNRS / company laboratories

including

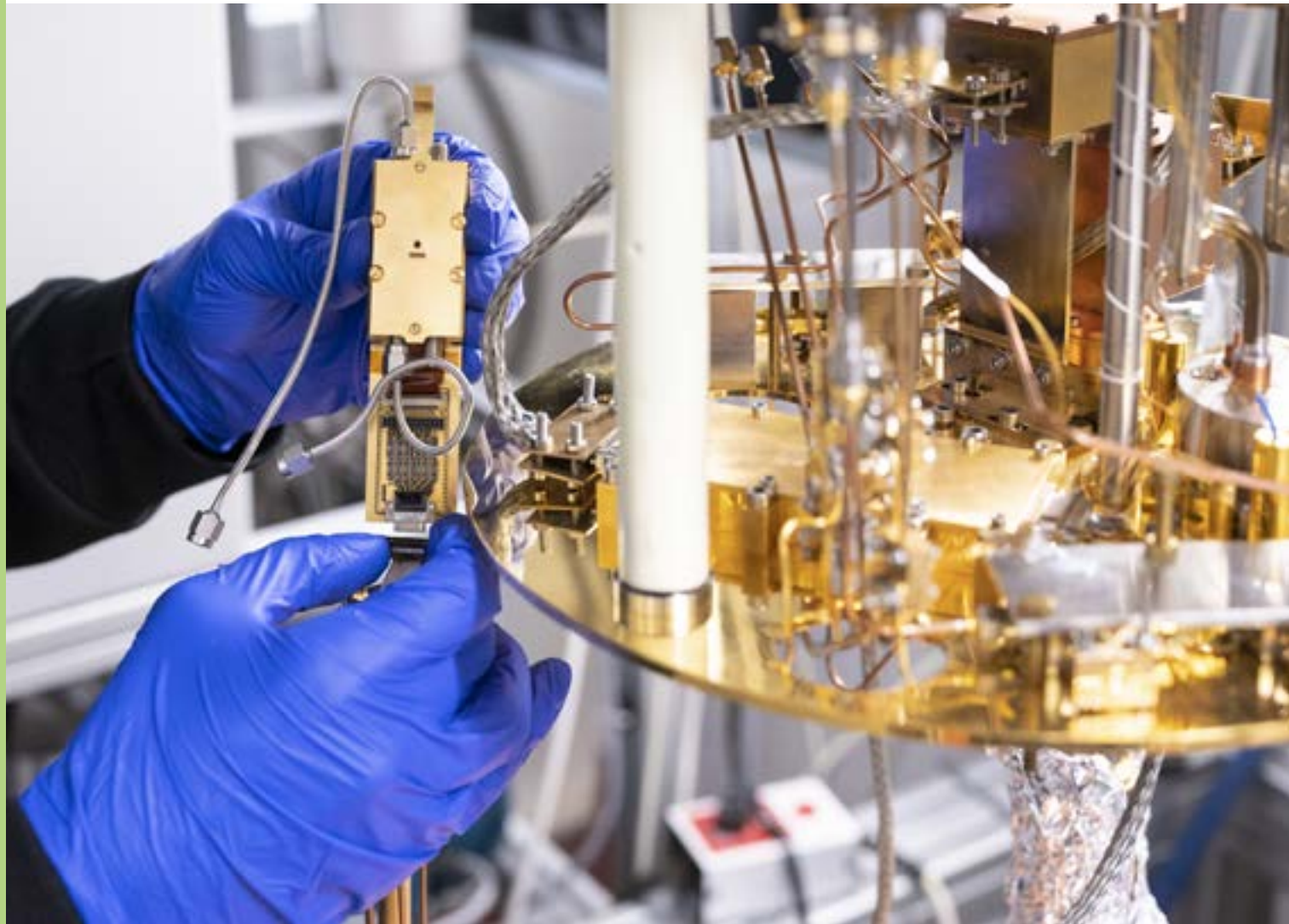
39

new laboratories created in 2022

Nearly

9 000

patent families in the CNRS portfolio including a third co-filed with industrial companies



The C12 Quantum Electronics start-up develops high-fidelity quantum processors using a basic material-carbon nanotubes. Quantum computers could revolutionise many industrial sectors. © Hubert RAGUET / C12 Quantum Electronics / LPENS / CNRS Images

Start-ups

RISE: nearly 30 new start-up projects supported by the CNRS

— The CNRS's RISE support programme is run by CNRS Innovation. Its aim is to support projects to create deeptech companies that will use and transfer the technologies developed in the 1100 laboratories under CNRS supervisory authority. Since the programme's launch in 2019, the CNRS has supported 107 start-up projects in health, new materials and processes, quantum, digital and human and social sciences. Nearly 30 new start-up projects from CNRS laboratories and their partners were supported in 2022.

CNRS at the forefront among projects selected in the framework of the France 2030 maturation-prematuration call for proposals

— The 'maturation-prematuration' call for proposals was launched as part of the France 2030 investment plan and is intended to support the innovation cycle in national acceleration strategies. The projects submitted in response to the call were reviewed in 2022 and four consortia coordinated by the CNRS were selected. These projects relate to programmes included in national acceleration strategies namely Batteries, Decarbonising industry, Recyclability, recycling and reincorporation of materials and Quantum technologies. The organisation is also a partner in six of the winning consortia.

Focus on start-ups

Kayrros: controlling industrial infrastructures using satellite imagery

The Kayrros start-up is a platform for observing and monitoring the impact of climate change and infrastructure in the energy, natural resources and industry sectors. It was presented at the 2022 Vivatech exhibition. Kayrros's technology is based on results from basic research and uses satellite imagery, geolocation data, textual information and multiple alternative data sources.

Quobly (formerly Siquance): a new player in the world of quantum computing

The creation of Quobly is an example of the CNRS's continuing strategic investment in quantum computing. This start-up was set up in November 2022 by the CEA and the CNRS to develop and eventually market a quantum computer based on microelectronics technologies and relying on the capacities of European semiconductor producers.



BioInspir: depollution using plants

The BioInspir start-up was co-founded by Claude Grison who won the 2022 European Inventor Award in the 'Research' category. It studies and develops innovative techniques for using plants to progressively depollute degraded terrestrial and aquatic ecosystems while exploiting the metallic elements concentrated by such plants.

Aqemia: using artificial intelligence and quantum physics to serve health

Aqemia is a digital drug research platform that works on the rapid development of innovative therapeutic molecules for dozens of diseases. Its aim is to use its own unique technology to massively accelerate its own research projects while also working in parallel on selected diseases with major pharmaceutical companies. This has been greatly facilitated by the recent injection of €30 million in funding.

Claude Grison and her colleague working on the ecocatalytic recycling of invasive Japanese knotweed in the ChimEco laboratory for the BioInspir company. © Cyril FRESILLON / ChimEco / CNRS Images





On the CNRS stand at the Vivatech Startup and Tech Event. © Yud Pourdieu Le Coz/CNRS



The CNRS once again present at Vivatech

From June 15th to 18th 2022 in Paris, the CNRS once again took part in Europe's largest deeptech event, Vivatech. This gave the organisation the opportunity to showcase its innovations in health, sustainable development and digital technology through a dozen start-ups deriving from CNRS laboratories and those of its partners. The CNRS stand featured presentations by researchers, PEPR coordinators and representatives of start-ups on the priority themes of the government's national acceleration strategies. It effectively reiterated the fact that the CNRS is one of the major players in French deeptech.

Partnerships

The launch of *CNRS Entreprises Club* to inform company directors about the science of tomorrow

In October 2022, the CNRS launched its *CNRS Entreprises Club* to help company directors understand more about important new scientific issues and how science could help the socio-economic sphere to evolve. To do so, this structure organises meetings with researchers, visits to laboratories, scientific explanatory sessions and thematic conferences. It also gives all stakeholders opportunities to discuss the challenges our society is facing and find out more about major French and European research projects.

Recruiting technology transfer engineers to develop research partnerships

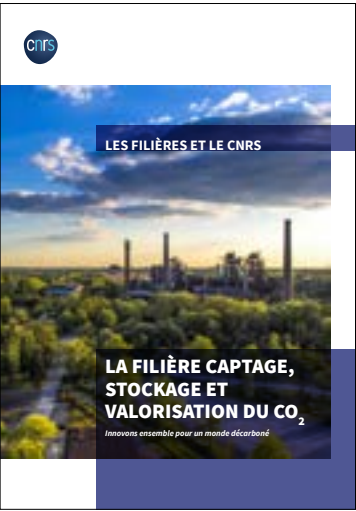
The CNRS has launched a programme to recruit one hundred technology transfer engineers between now and 2024 to accelerate the development of partnerships between the research units it supervises and companies. These engineers will be distributed among CNRS laboratories and regional offices and tasked with helping to increase the number of research agreements. One of the ways they will achieve this is by presenting to companies the range of research services the CNRS can offer them while identifying company R&D needs and the potential partnership opportunities resulting from these. This programme is set out in the CNRS's Objectives and Performance Contract (COP) for 2019-2023.

Two new framework agreements with Valeo and Berger-Levrault

The CNRS aims to facilitate and accelerate the implementation of joint research projects between laboratories and companies and create the right foundations for future scientific collaboration. One example of this being put into practice came with the two new framework agreements the organisation signed in 2022. The first was signed with Valeo and organises the company's cooperation with the CNRS in shared research programmes over a five-year period. The aim of this partnership is to accelerate the development of innovations to make the mobility of people and goods cleaner and safer. This involves work in areas like sustainable design, artificial intelligence, cybersecurity, data sciences, inclusive cities and new energies. The second was signed with Berger-Levrault, a company that publishes software for local authorities, and is the CNRS's first framework agreement with a French SME. Its objective is to accelerate the development of digital services that enhance the social, environmental and economic performance of French territorial areas in response to the challenges of sustainable cities.

Cybersecurity: the CNRS wishes to strengthen collaboration with companies

In 2022, the CNRS organised a series of cybersecurity round tables bringing together researchers and entrepreneurs to take stock of collaboration tools and drive thought about how to strengthen relations with companies working in this sector. The Cyber Campus was set up in February 2022 in the framework of the national strategy to accelerate cybersecurity. It is the prime space for cybersecurity in France and the CNRS works therein, collaborating with the CEA, the Inria, universities and *grandes écoles*.



The CNRS presents its CO₂ capture, storage and recovery sector

Faced with climate change the CNRS is working with its partners to innovate for a low-carbon world. The organisation is drawing on its scientific excellence to help speed up the maturation of technologies and to support businesses in their environmental transformation. CO₂ capture, storage and recovery are the three research areas being explored using multidisciplinary approaches to provide an overall response.

3rd most innovative research institution in the world in 2022
(Scimago Institutions Ranking)

6th place in the 2022 INPI ranking of patent applicants

92 start-ups from laboratories under the supervisory authority of the CNRS and of its partners identified by the ChemTech 2022 Mapping (Bpifrance Le Hub and France Chimie), 5 of which benefited from the RISE programme

Associated laboratories



Researchers working on the development, durability and dynamic properties of elastomers at the joint Elast-D3 laboratory, a partnership between the University of Rennes 1, the CNRS and Continental that was inaugurated in 2022. © Jean-Claude MOSCHETTI / Elast-D3 / CNRS Images



The CNRS gives top billing to its new associated laboratories

On average a new associated laboratory is set up every fortnight and the CNRS had nearly 240 such laboratories in activity at the end of 2022. This is a particularly structuring form of public-private sector collaboration which appeals to companies of all sizes. The organisation intends to give these laboratories long-term sustainability to respond to many environmental and societal challenges. In 2022, the CNRS brought together the academic and industrial heads of around twenty of these joint laboratories in Paris. These including long-standing CNRS partners like Michelin, Thales or Naval Group along with new companies such as Blue Solutions with whom the organisation signed agreements for two joint laboratories in 2022.

TOP 10 of industrial partners involved in joint laboratories with the CNRS (and the number of laboratories involved):

COMPANY	NUMBER OF ACTIVE ASSOCIATED LABORATORIES IN 2022
SAFRAN	18
TOTALENERGIES	11
STELLANTIS	11
THALES	11
EDF	8
MICHELIN	7
CETIM	6
ARKEMA	6
SAINT-GOBAIN	4
ORANO	4

New processes to create innovative sapphires

The Institute for Light and Matter¹ and RSA Le Rubis have created an associated laboratory named SaphirLab to develop sapphires that respond to the requirements of fast-growing sectors like microelectronics. Their joint aim is to develop and enhance the reliability of sapphire synthesis using innovative techniques that are more economical and productive than those used in conventional processes.

The CNRS and Arkema reinforce their collaboration

The CNRS and Arkema have been working together under a framework agreement since 2008 and in 2022 two new joint laboratories were set up to further strengthen this relationship of trust and fruitful collaboration. These are LAMPS (Light for Advanced Materials and Processes) which focuses on photopolymerization and iHub Poly-9 which works on developing new high-performance materials for the batteries of the future. The CNRS and Arkema jointly filed 56 patents between 2017 and 2021.

A production line at the Blue Solutions factory which manufactures all-solid batteries, the company's core product. © Erwanreud/BlueSolutions



Blue Solutions and the CNRS - working to develop innovative batteries

Blue Solutions and the CNRS have set up two associated laboratories - Li2 and IMNBlue Lab. These focus on the future of electric batteries and more specifically all-solid batteries, the French manufacturer's core product. The two laboratories will help drive innovation for a new generation of batteries that are safer, cheaper, with higher energy density and quicker to recharge.

Europe/ international



Computer-generated image of Singapore's Marina Bay illustrating a usage case from the DesCartes programme related to optimal flight trajectories for drones in the critical 'smart city' system. © Immersion for DesCartes Program, CNRS@Create

15 new companies supported by the European Leadership4SMEs programme

Leadership4SMEs provides a specific support programme steered and coordinated by CNRS Innovation for a selection of European SMEs and start-ups. In 2022, a second group of innovative companies were able to benefit from this programme. The programme's mission is to encourage such companies to optimise the use of their intellectual property in connection with their financing and development strategy.

The NIST, the CNRS and the University of Limoges sign a licence agreement

A licence agreement between the National Institute of Standards and Technology (NIST), the CNRS and the University of Limoges was signed in July 2022. This demonstrates the recognition of the excellence of French basic research on the world stage and illustrates the quality of the French school of mathematics and cryptography. The agreement means operators and users of NIST-selected post-quantum cryptographic standards will not need to obtain a separate licence for this family of CNRS patents which will in turn favour the rapid and widespread adoption of these cryptographic standards.



The CNRS launches the Descartes project in Singapore

The DesCartes programme led by CNRS@Create is one of the CNRS's largest collaborative projects. It involves 22 partners including 13 universities and grandes écoles working alongside 5 industrial companies including ESI Group, Thales and EDF Lab Singapore. The project focuses on hybrid artificial intelligence and is dedicated to decision-making in critical 'smart city' systems.

An event intended to strengthen collaborative research with companies in Europe

Given the strong competition on the international stage, the CNRS has committed to the collaborative excellence of the European Research Area and effectively contributes to this dynamic. In this context, the CNRS organised an event in Brussels on May 17th 2022 with the Ayming Institute in the framework of the French Presidency of the Council of the European Union. This event was an opportunity for around sixty major company representatives, European economic leaders and directors of research organisations and laboratories to debate, exchange ideas and identify the obstacles to collaborative research in Europe as well as the accelerating factors involved.

France's recovery plan



'France Relance' - the CNRS plays a leading role in preserving R&D jobs

The national 'France Relance' recovery plan was launched by the government in May 2021 in the wake of Covid-19. The plan's R&D job preservation measure was implemented by the CNRS. It enables the academic world to host staff from companies to work on research projects of common interest. Reciprocally companies can host researchers to work on technology transfer and developing the technological maturity of scientific results that interest the companies. When the programme closed at the end of 2022, the CNRS had signed 191 collaboration contracts and hosted 216 staff all over France. The programme has mainly benefited SMEs and VSBs which are involved in 69% of the collaboration contracts signed by the CNRS while large companies accounted for 19%.

13 start-ups
from the
laboratories of
the CNRS and its partners
were selected for support
in the French Tech Next
40/120 programme.

72

winners in innovation
competitions including
23 i-PhD, 32 i-Lab and 17
i-Inov winners



The manufacture of a steel part using the wire arc additive manufacturing process (WAAM) developed by the Mechanics and Civil Engineering Laboratory (LMGC)¹. © Christophe HARGOUES / LMGC / CNRS Images



Re- sources in 2022

“2022 laid several foundations for the future”

Christophe Coudroy,
Deputy CEO for Resources

2022 was a year of change particularly with the renewal of the Chairman and CEO's mandate and the arrival of a new government. How has this been reflected in the CNRS's management of resources? Several structural projects were completed in 2022. Here are some examples. First of all, a new multi-year employment path was defined with the supervisory authorities. This confirms the principle of replacing all retirements on a phased basis over the next few years which amounts to the recruitment of 270 researchers and 360 engineers and technicians from 2023 onwards (projections made before the national pension reform). 2022 was also marked by changes to the system of contributions to pooled expenditure based on research contracts and more specifically the eventual creation of a pooled scientific action fund. This was required because the CNRS business model is evolving, with an increase in CNRS-generated income over the long term. We should also cite the considerable amount of work carried out internally to adapt the regional office model to provide the best possible support for the greater differentiation of scientific policy. Our work on the management of joint research units is also worthy of mention.

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What progress has been made in terms of process simplification at the CNRS?

In 2022, several projects from the 'User first' programme came to fruition. In particular a module for the automatic generation of contracts was opened with *Webcontrat*. This enables our laboratories to make a detailed simulation of the costs associated with projects they wish to submit, for example to the ANR. The HR portal and the data portal are also noteworthy as they mean our laboratories and regional offices can access useful information more easily. The year was also marked by our roll-out of the 'Etamine Missions' tool and a substantial amount of work carried out to interface it with our travel and accommodation booking tools. This link will be effective in 2023 with the objective of simplifying this time-consuming activity for staff members in the field particularly if our academic partners accept to use integrated tools.

The issue of attractiveness is of increasing importance. What is the situation at the CNRS?

The CNRS is faced with the same difficulties as the whole research sphere and the French civil service in general. Salaries are a crucial factor. In 2022, the research programming law led to an increase in researchers' bonuses. A rise was also obtained for engineers and technicians in 2022. This is all a step in the right direction that we now need to build upon. Apart from salaries, a number of other short- and medium-term measures were structured in an 'attractiveness plan' adopted in the autumn to attract and then keep as many staff members as possible. Along the same lines, through social dialogue the CNRS developed a new plan to improve working conditions. For managers specifically, a managerial skills frame of reference was created to provide them with enhanced support. Finally, the establishment's social responsibility policy was formalised in 2022 and features a wide range of actions as regards sustainable development and energy efficiency. Clearly then, 2022 laid several foundations for the future and now this dynamic needs to be nurtured.

Over

33,000
staff members including over
9000
contractual employees

Nearly

45 %
women

Over

570
permanent staff
recruited in 2022

Over

55 %
of CNRS staff members
teleworked in 2022

Over

11,500
staff members received training in
2022, including over 2000 contract
employees.



Researchers and engineers from the 'Cidre' team at the Research Institute of Computer Science and Random Systems (IRISA)¹ work together to develop methods and tools capable of detecting when a computer system is compromised by an attacker, understanding the scope of the attack and putting it right. © Christian MOREL / IRISA / CNRS Images

Junior Professorships - a new recruitment opportunity

— In 2022, the CNRS opened 25 Junior Professorships (JPCs) covering 25 different themes around major scientific challenges. This new 'tenure-track' recruitment channel is intended to attract scientists from France and other countries to carry out cutting-edge research. These tenure track JPCs are recruited for a period of three to six years on a contract basis and then given tenure as research professors. They benefit from an entry package of €200,000 financed by the ANR that the CNRS adds to with funding for a doctoral contract.

The monthly 'Nominative Social Declaration'

— The Nominative Social Declaration (*Déclaration Sociale Nominative*, DSN) is a monthly file produced from payroll information. It is used to communicate the information required to manage employees' social protection to the organisations and administrations concerned. The DSN was implemented in January 2022 and will replace all periodic or event-based declarations and administrative formalities that employers previously sent to a variety of bodies that manage health and social security (CPAM or Urssaf), pensions, unemployment benefit, taxes, special schemes and so forth. The data transmitted in a monthly DSN covers an employee's situation at the time the monthly payroll was created. It also gives information on any events that may impact the payroll during a given month such as illness, maternity, changes to or termination of an employment contract and so on.

A new action plan to improve working conditions

— Following on from the initial action plan for a quality of working life (QWL) approach rolled out by the CNRS between 2017 and 2019, the organisation launched a new action plan in 2022 for the 2023-2027 period to improve working conditions through the prevention of psychosocial risks (PSR) and by developing quality of working life for its staff members. The plan aims to reinforce the CNRS's managerial culture to respond to existing requirements and anticipate those that may emerge in the future. Another objective of the plan is to strengthen the feeling of belonging to the organisation by improving communication and local exchanges between the CNRS and its employees. The overall goal is thus to improve the quality of life and working conditions at the CNRS.



2022 - the Year of Prevention Assistants

— In 2021 a questionnaire was sent out to the 2000 prevention assistants working at the CNRS. On the basis of their replies, the National Prevention and Safety Coordination (CNPS) worked with personnel representatives on the launch of the 'Year of Prevention Assistants' campaign for 2022. This campaign was inaugurated with a video message from the CNRS Chairman and CEO Antoine Petit and featured online documents, videos and podcasts posted throughout the year to raise awareness of prevention assistants' work and showcase their achievements. In the last quarter of 2022, over 1500 prevention assistants from all the 18 CNRS regions met at events to exchange ideas which CNRS partners were also invited to attend. In 2023, this operation will lead to new tools and innovative ideas from the field being pooled.

Meeting days in all the CNRS regional offices (Alsace here) enabled the organisation's prevention assistants to meet and exchange ideas. © CNRS





Bioengineering researchers discuss a sample at the Toulouse Biotechnology Institute, Bio & Chemical Engineering¹.
© David VILLA / SciencImage, CBI / TBI / CNRS Images

Two new networks for the equality action plan

Two new networks of laboratory equality officers were launched in 2022 to facilitate the implementation of the equality action plan (2021) and to help all CNRS staff members appropriate equality policies. The Brittany and Pays de la Loire and the Aquitaine regional offices have now joined the pioneering offices in Western Occitania, Hauts-de-France, Rhône Auvergne and Alsace. All these equality offices have been given training particularly in preventing and combating sexist and sexual violence. Other regional offices plan to set up their own networks of equality officers in the near future.

Cartopro'RH, a reference library of HR procedures

Cartopro'RH is a library of human resources procedures at the CNRS. This reference tool presents these procedures in graphic form. It covers all areas of HR activity such as recruitment, careers, professional development, health, working time, social action or support for structures. In 2022, 49 applicable procedures were published in Cartopro'RH while the publication of 36 more was initiated. Over 500 staff members working in HR can use this repository to self-train and manage procedures more easily. Certain procedures have been made clearer and others simplified. In 2022 there were over 3000 connections to Cartopro'RH which is now an accepted working tool for HR departments' staff members.

The HR Portal is the essential website for CNRS HR professionals

This portal was developed in the framework of the 'User First' project and was selected following the 2020 call for projects organised by the FTAP (Fund for the Transformation of Public Action). It opened in July 2022 to provide HR professionals with a single access interface for HR information and will be upgraded in 2023 to integrate new functionalities.

A new allowances scheme for researchers

In 2022, the CNRS introduced RIPEC, a new bonuses scheme for its teaching and research staff members. This is made up of two allowances and one bonus. The first allowance is linked to the staff member's grade and its annual amount is set at €2800 gross for 2022. The second allowance is linked to the performance of specific duties or responsibilities. The individual bonus is linked to the quality of staff members' work and professional commitment to all their tasks. This allowances scheme is subject to CNRS management guidelines.

The CNRS launches an attractiveness plan

In November 2022, the CNRS's upper management launched an action plan to enhance the organisation's attractiveness as an employer. The aims of the attractiveness measures set out in the plan were to simplify and professionalise recruitment processes and to enhance the organisation's visibility by developing new partnerships with *grandes écoles*, universities, apprenticeship training centres (CFAs) and companies. Alongside this, complementary attractiveness measures to integrate and retain staff members are intended to help the CNRS establish itself as a reference among employers.

A new call for projects to promote the quality of working life (QWL)

In 2022, following four consecutive annual calls for projects aimed at enhancing the quality of working life at work, the CNRS launched a complementary second call for projects called 'Groupements QVT' (*QWL Groupings*) to encourage larger-scale initiatives. 162 units joined forces to submit 69 applications in 2022 and 16 winning projects supported by 52 associated units were chosen for financial support by the selection juries.

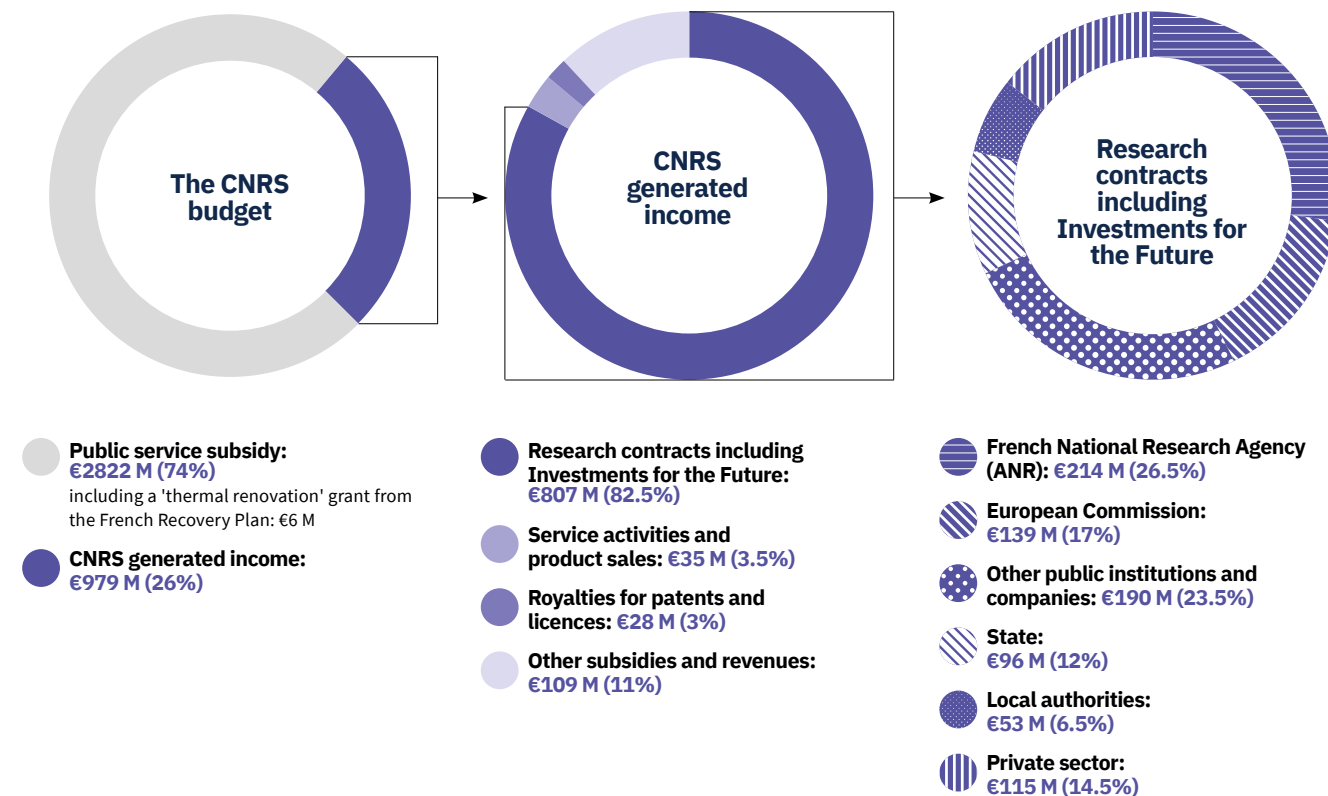
40.3 %
of researchers recruited in 2022 were female which is an exceptionally high rate given that the overall percentage of female researchers at the CNRS is 34.4%.

5.67 %
of disabled staff members at the CNRS in 2022 compared to 5.54% in 2021.

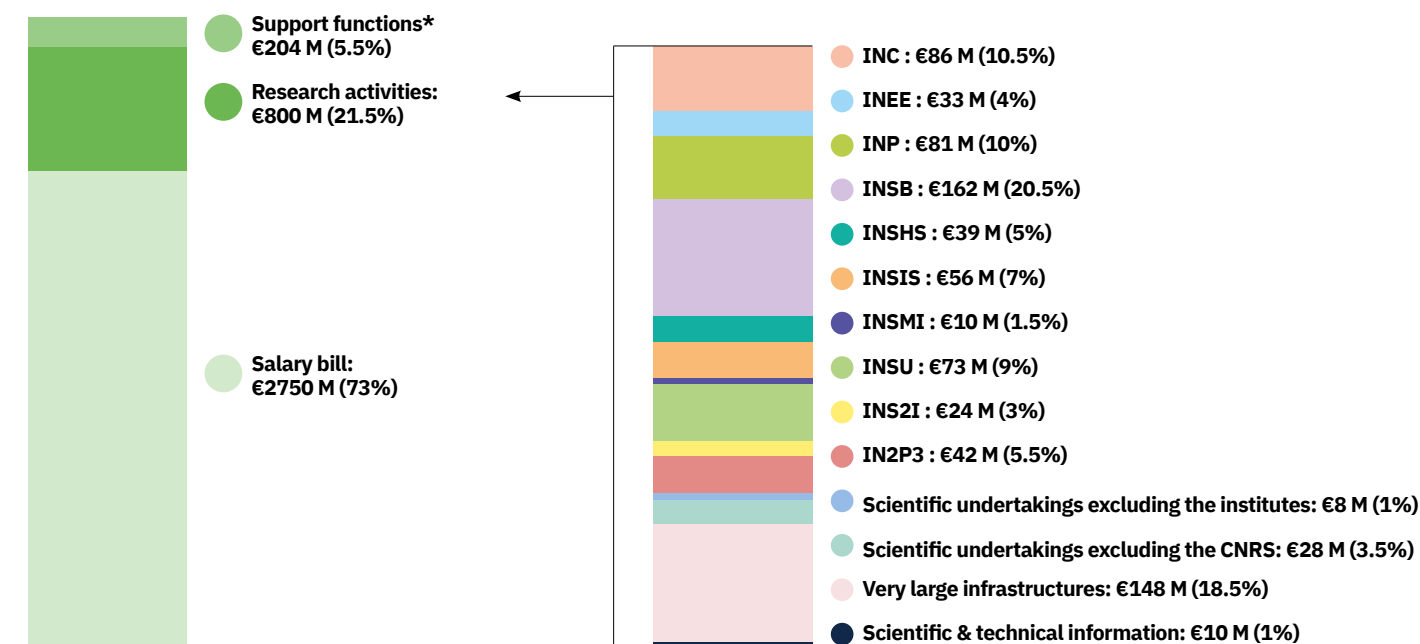
Statistics and indicators

THE CNRS BUDGET

Resources



Expenditure

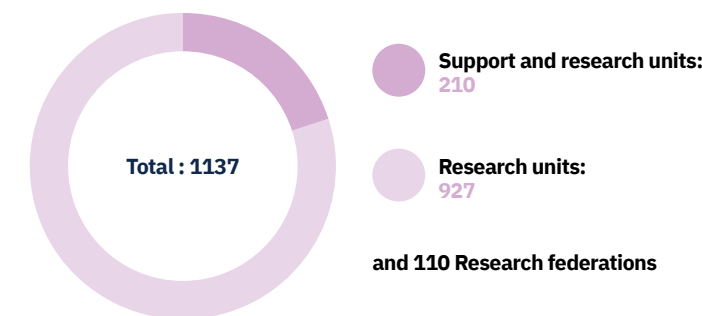


Source: BFC data – processing: CNRS/DCIF-DSFIM

* Operations, equipment and investments not related to research activities

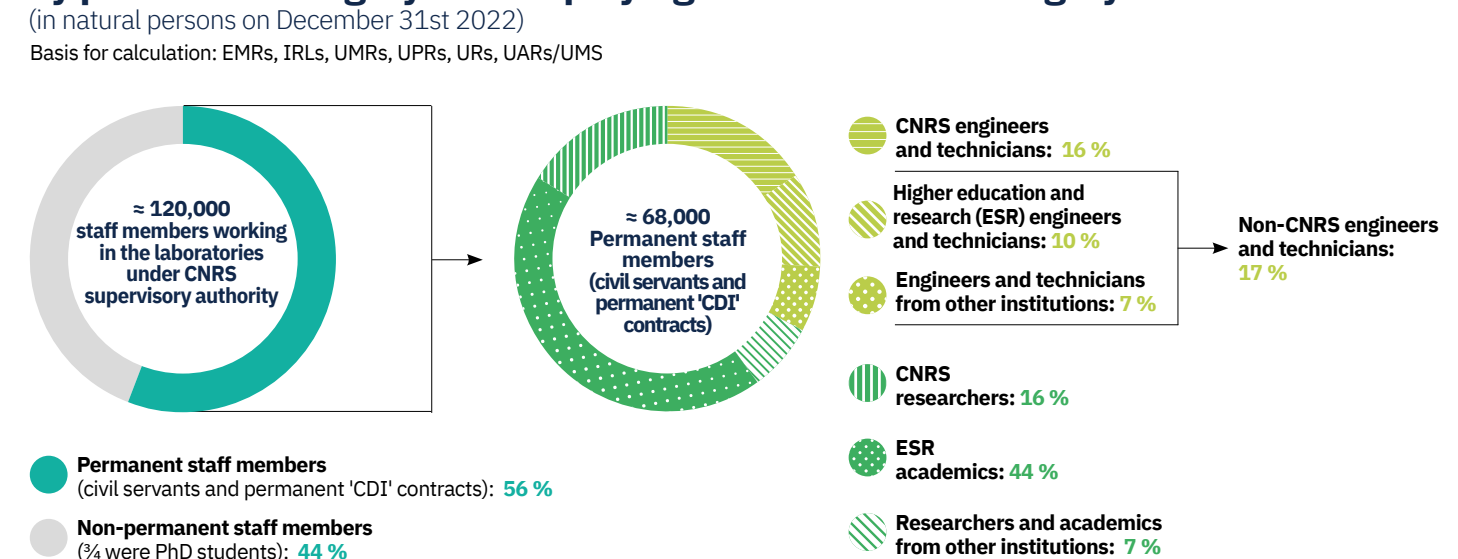
LABORATORIES LINKED TO THE CNRS AND TO ITS PARTNERS

Laboratories linked to the CNRS



Staff members in laboratories linked to the CNRS by personnel category and employing establishment category

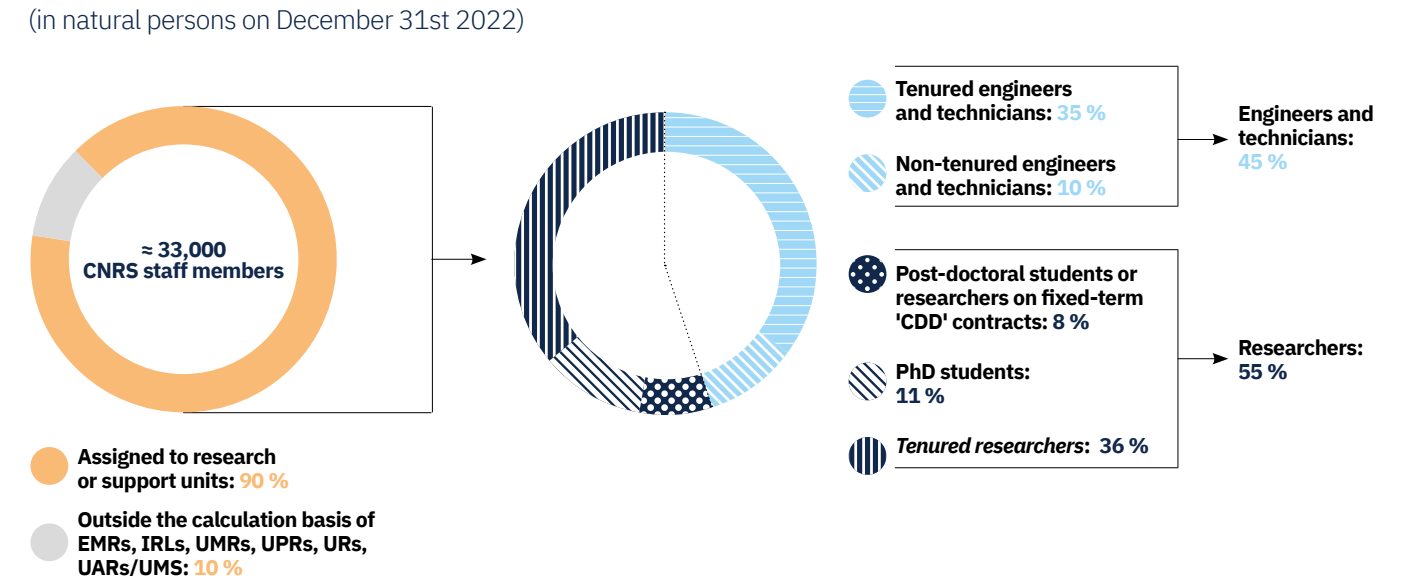
(in natural persons on December 31st 2022)
 Basis for calculation: EMRs, IRLs, UMRs, UPRs, URs, UARs/UMS



Source: Réséda data on December 31st 2022 – processing: CNRS/DAPP

CNRS staff members from laboratories linked to the CNRS

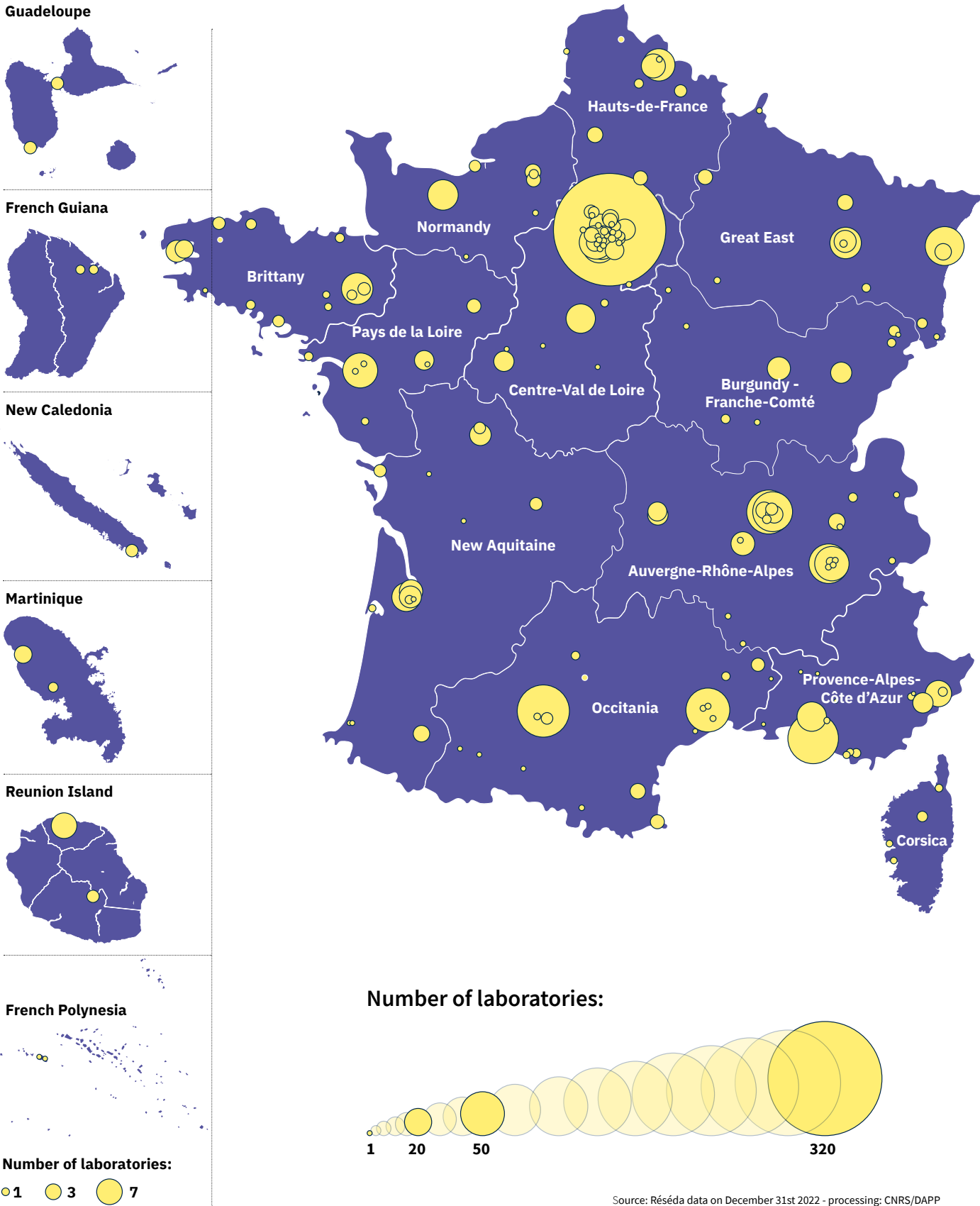
(in natural persons on December 31st 2022)



Source: Sirhus data on December 31st 2022; processing: DRH

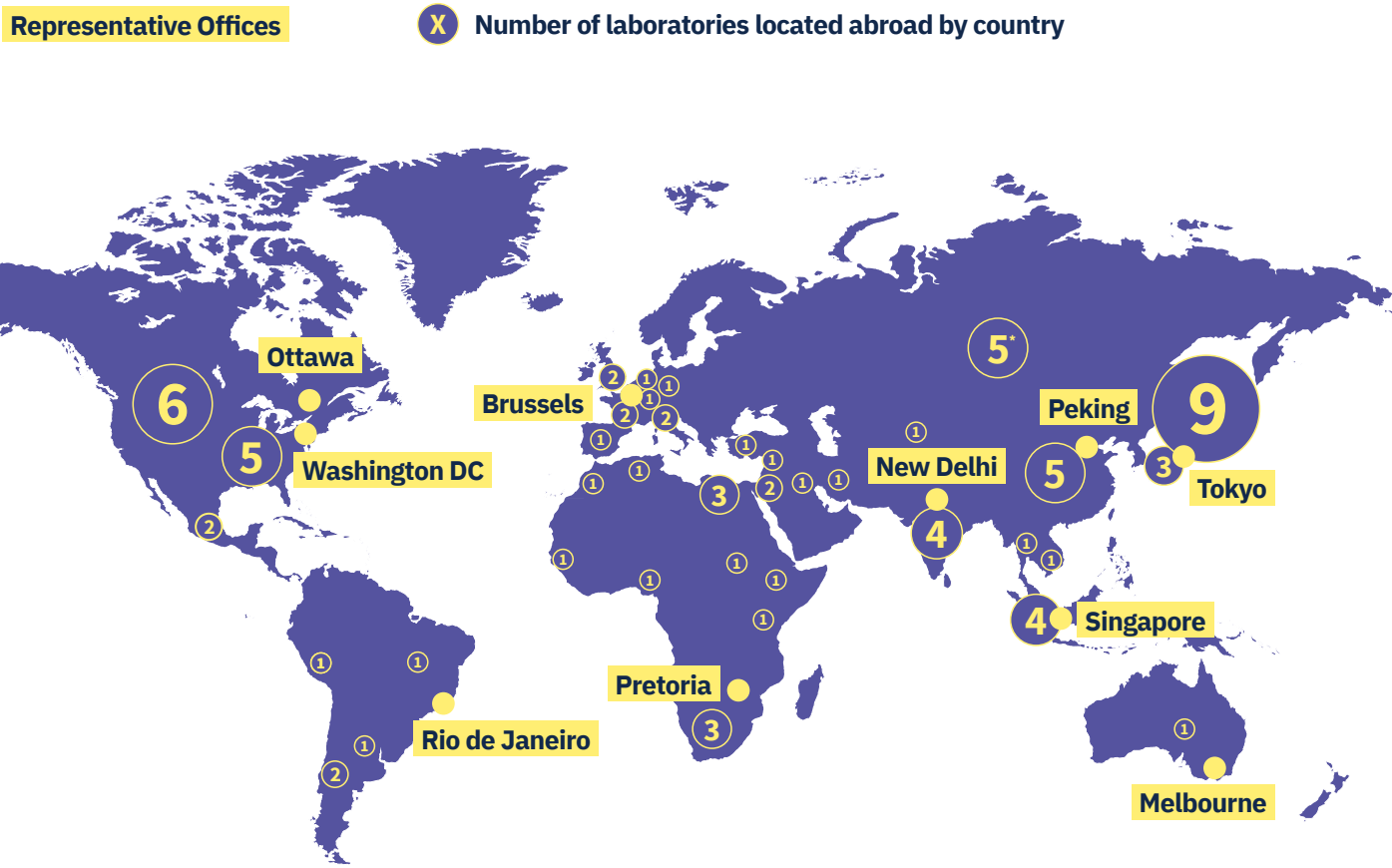
Locations in France and Internationally

Locations of laboratories linked to the CNRS in 2022



CNRS laboratories and Representative Offices throughout the world

The CNRS contributes to the influence of French research worldwide through over 80 International Laboratories and its 10 Representative Offices abroad.



Source: DEI on December 31st 2022. Since February 2022, the CNRS has suspended its scientific collaboration activities with Russia.

Addresses of the offices:

Washington DC USA & Mexico CNRS Washington Office French scientific mission 4101 Reservoir Road N.W. Washington DC 20007 - US dei-washington@cnrs.fr	Ottawa Canada University of Ottawa Pavillon Tabaret - Vice-Rectorat à la recherche 550, rue Cumberland (246) Ottawa, Ontario K1N 6N5 Canada dei-ottawa@cnrs.fr	Brussels European Union Maison Irène et Frédéric Joliot-Curie (MIFJC) 100 rue du Trône 1050 Bruxelles - Belgique dei-bruxelles@cnrs.fr	New Delhi India CNRS Office French Institute in India Embassy of France in India 2, Dr A.P.J. Abdul Kalam Road 110011 New Delhi - India dei-newdelhi@cnrs.fr	Peking China CNRS Office, French Embassy N° 60 Tianze lu, Liangmaqiao 3e quartier diplomatique Chaoyang District Beijing 100600-PRC - China dei-beijing@cnrs.fr
Rio de Janeiro South America Avenida Presidente Antônio Carlos, 58 Sala 415 20020-010 Rio de Janeiro - RJ - Brazil dei-rio@cnrs.fr	Pretoria Southern Africa IRD-CNRS-CIRAD Joint Office Postnet Glenfair Suite 485 Private Bag X025 Lynnwood Ridge 0040 Pretoria - South Africa dei-pretoria@cnrs.fr	Singapore ASEAN Office in ASEAN c/o CNRS@CREATE Create Tower #08-01 1 Create Way Singapore 138602 dei-singapour@cnrs.fr	Tokyo Japan, Korea, Taiwan C/o Embassy of France in Japan 4-11-44 Minami-Azabu, Minato-ku Tokyo 106-8514 - Japan dei-tokyo@cnrs.fr	Melbourne Oceania The University of Melbourne Parkville Campus Building 174, Block C, Room 314-315 Victoria 3010 - Australia dei-melbourne@cnrs.fr

Source: Réséda data on December 31st 2022 - processing: CNRS/DAPP

Notes and supervisory authorities

Pages 16-17:

- 1. CNRS/Collège de France/Sorbonne University
- 2. CNRS/Claude Bernard Lyon 1 University
- 3. CNRS/Institut d’Optique Graduate School/University of Bordeaux
- 4. CNRS/French-German Research Institute of Saint-Louis/University of Strasbourg
- 5. CNRS/Institut Curie/Sorbonne University
- 6. CNRS/Paris-Saclay University
- 7. CNRS/Sorbonne University

Pages 18-19:

- 1. CNRS/ENS Lyon/Claude Bernard Lyon 1 University
- 2. CNRS/Centrale Supélec/Paris-Saclay University
- 3. CNRS/AgroParisTech/Paris-Saclay University
- 4. CNRS
- 5. CNRS/Université Toulouse III-Paul Sabatier
- 6. CNRS/Inrae/ENS Lyon
- 7. CNRS/CEA/Paris-Saclay University
- 8. CNRS/IÉSEG School of Management/University of Lille
- 9. CNRS/Mines Paris-PSL

Page 21:

- 1. The objective of the One Health initiative is to encourage a global, multidisciplinary approach to health issues on the international scale. This includes public, animal and environmental health as well as environmental disturbances caused by human activity.

Pages 24-25: (opening photo)

A photograph being taken of the terrain on Nxaraga Island in the Okavango Delta, Botswana during a photographic and GPS survey campaign. © Cyril FRESILLON / Géosciences Rennes / CNRS Images

Page 28:

- 1. CNRS

Page 33:

- 1. CNRS/Université de Lorraine

Pages 40-41: (opening photo)

A close-up of a surface representing hyperbolic space and its edge at infinity. © V. Borrelli/R. Denis/F. Lazarus/B. Thibert/M. Theilliere/ICJ/G-SCOP /LJK/uni. Luxembourg, supported by the FNR/CNRS

Page 48:

- 1. CNRS/Institut des hautes études scientifiques (IHES)

Page 49:

- 1. CNRS/Institut d’optique Graduate School

Page 51:

- 1. CNRS/ Institute of Earth Physics of Paris (IPGP)

Page 52:

- 1. CNRS/Sorbonne University

Page 53:

- 1. 1. cOAlition S is a European consortium of research funding agencies and organisations that aims to speed up the transition to immediate open access to scientific research results.

Page 55:

- 1. CNRS/University of Nantes (Photo of the tank, AlgoSolis)

Pages 56-57: (opening photo)

An electronic circuit carrying out a person-machine interface function transferred onto a spherical object using 'hydroprinting' technology patented by the Institute of Electronics and Digital Technologies. (CNRS/CentraleSupélec/INSA Rennes/ University of Nantes/University of Rennes). © Jean-Claude MOSCHETTI/IETR/CNRS Images

Page 65:

- 1. CNRS/Claude Bernard Lyon 1 University

Page 67:

- 1. CNRS/University of Montpellier

Pages 68-69: (opening photo)

Four PhD students from the Institut de Recherche en Informatique Fondamentale (CNRS/Université Paris Cité) discuss their research subject. © Christian MOREL / IRIF / CNRS Images

Page 72:

- 1. CNRS/University of Rennes

Page 74:

- 1. INSA Toulouse/CNRS/INRAE

Cover photo:
An anechoic chamber on the CAMILL (Characterization of MILL and subMillimetric Band Antennas) Technical Platform. The antenna this scientist is holding can be moved in all directions to take 3D measurements of its electromagnetic radiation.

© Jean-Claude MOSCHETTI / IETR / CNRS Images

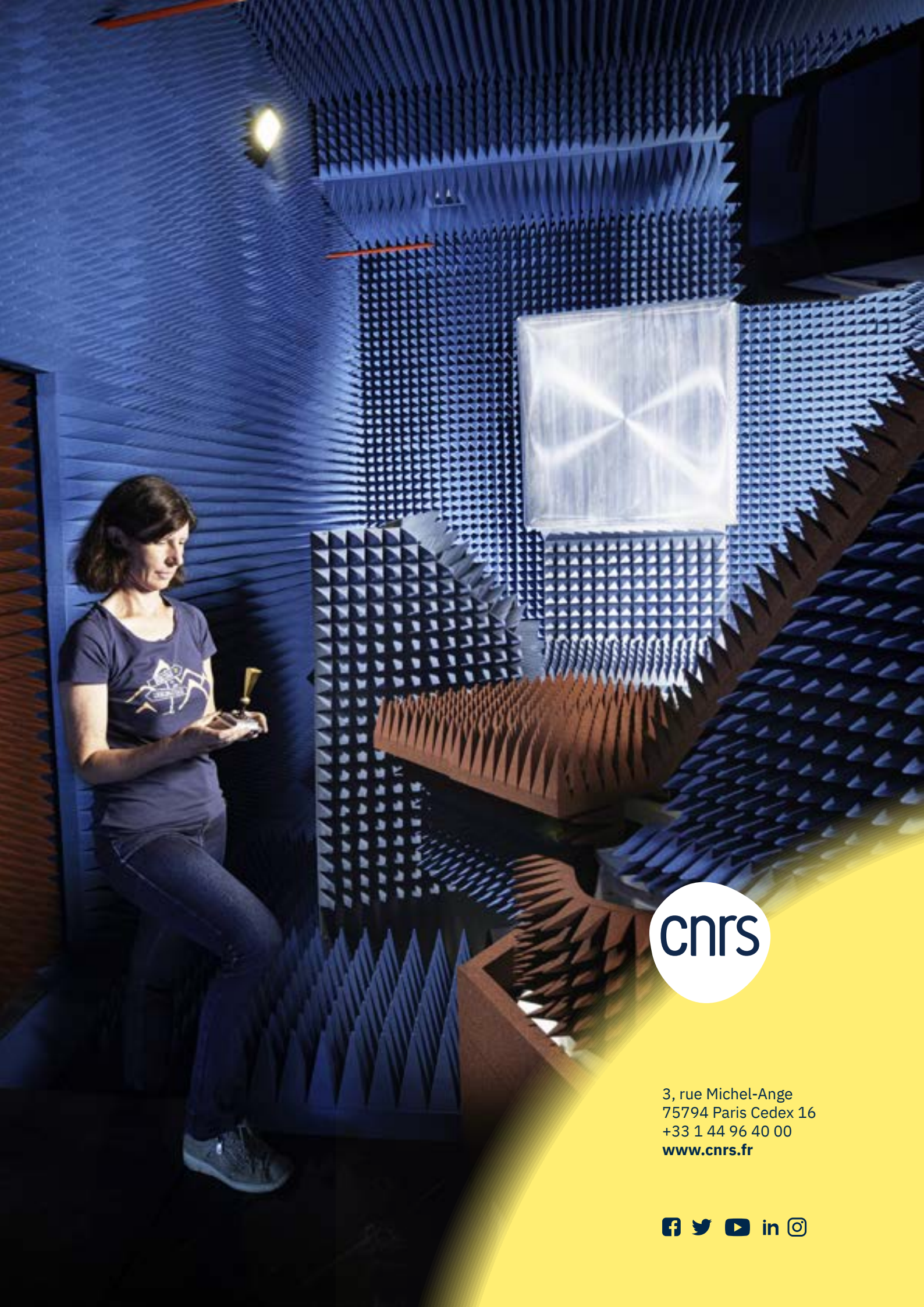


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3, rue Michel-Ange
75794 Paris Cedex 16
+33 1 44 96 40 00
www.cnrs.fr

