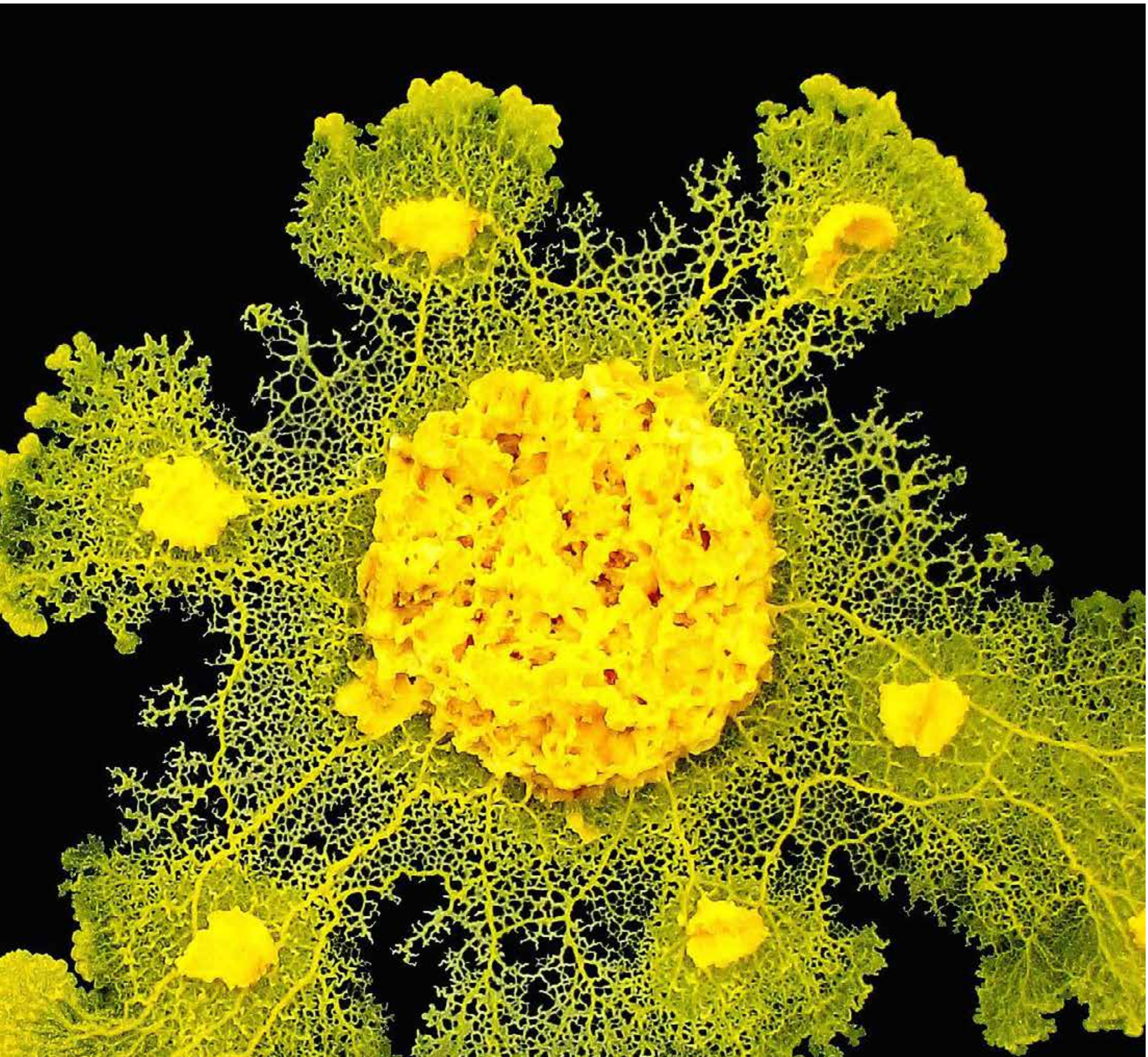


THE 2019-2023 OBJECTIVES AND PERFORMANCE CONTRACT

BETWEEN THE STATE AND THE FRENCH NATIONAL CENTRE FOR SCIENTIFIC RESEARCH

THE 2019-2023 OBJECTIVES AND PERFORMANCE CONTRACT BETWEEN THE STATE AND THE FRENCH NATIONAL CENTRE FOR SCIENTIFIC RESEARCH

Signed on January 27th 2020

Frédérique Vidal,
Minister of Higher Education, Research and Innovation:

Antoine Petit,
CNRS Chairman and CEO:

CONTENTS

INTRODUCTION

In 2019, the French National Centre for Scientific Research (CNRS) celebrated its 80th anniversary by organising many events in France and other countries to recall both its history and the importance of science. These celebrations underline that today, more than ever, basic research is fundamentally indispensable. This is firstly important because France has always been a great nation of culture and science and because advances in knowledge have always been one of the driving forces of our country's development and influence. Secondly, it is important because the only effective response to many of society's industrial and economic challenges is to rely on scientific excellence which exists at the frontiers of knowledge. This is why breakthrough innovations are essential to conquer or simply preserve new markets and to create or maintain jobs in France while creating value for society. Finally, the contribution of science is vital to achieving sustainable development objectives particularly those involving global warming, the erosion of biodiversity or renewable energies and health. However, it is also crucial if we are to respond effectively to other major challenges facing our societies such as security, artificial intelligence (AI) or migration. These are only some of the areas in which both France and Europe as a whole need research and a top international level scientific community. The relative unpredictability of scientific breakthroughs means it is essential for the development of the knowledge base to be sufficiently broad. It is quite simply a question of our sovereignty and our future.

The CNRS has a **unique position in the national system of higher education, research and innovation** (ESRI). It is the leading French research organisation in terms of size and even the largest such organisation in Europe which gives it a **particular responsibility** for developing an overall vision of global science. It carries out large-scale projects and actions at national, European or international level and explores new fields of research. It is fully involved in major developments such as open science. The CNRS is a major player conducting basic research in all fields of science aimed at developing new knowledge representing a public and a common good. The CNRS's research units are almost all jointly managed with other institutions and therefore the organisation is an integral part of a **very rich network of partnerships** with universities, schools and other national bodies. The organisation and its partners play **a specific role in how the national ESRI system evolves.**

France is fortunate to be able to rely on the CNRS. Thanks to all the research units it shares with its partners, the CNRS has helped enhance the renown of French science worldwide and acquired an internationally recognised reputation for excellence over the years. The CNRS is thus a flagship for France as a whole and not just for French research.

However, despite all of this, the CNRS still needs to continually evolve and in fact does so regularly to the extent that today's CNRS is very different from the organisation of 20 or 30 years ago. In a context of ever-intensifying international competition in terms of research and innovation with the national ESRI system continually evolving, the CNRS **also needs to continue to evolve** while still exploiting its known and recognised strengths.

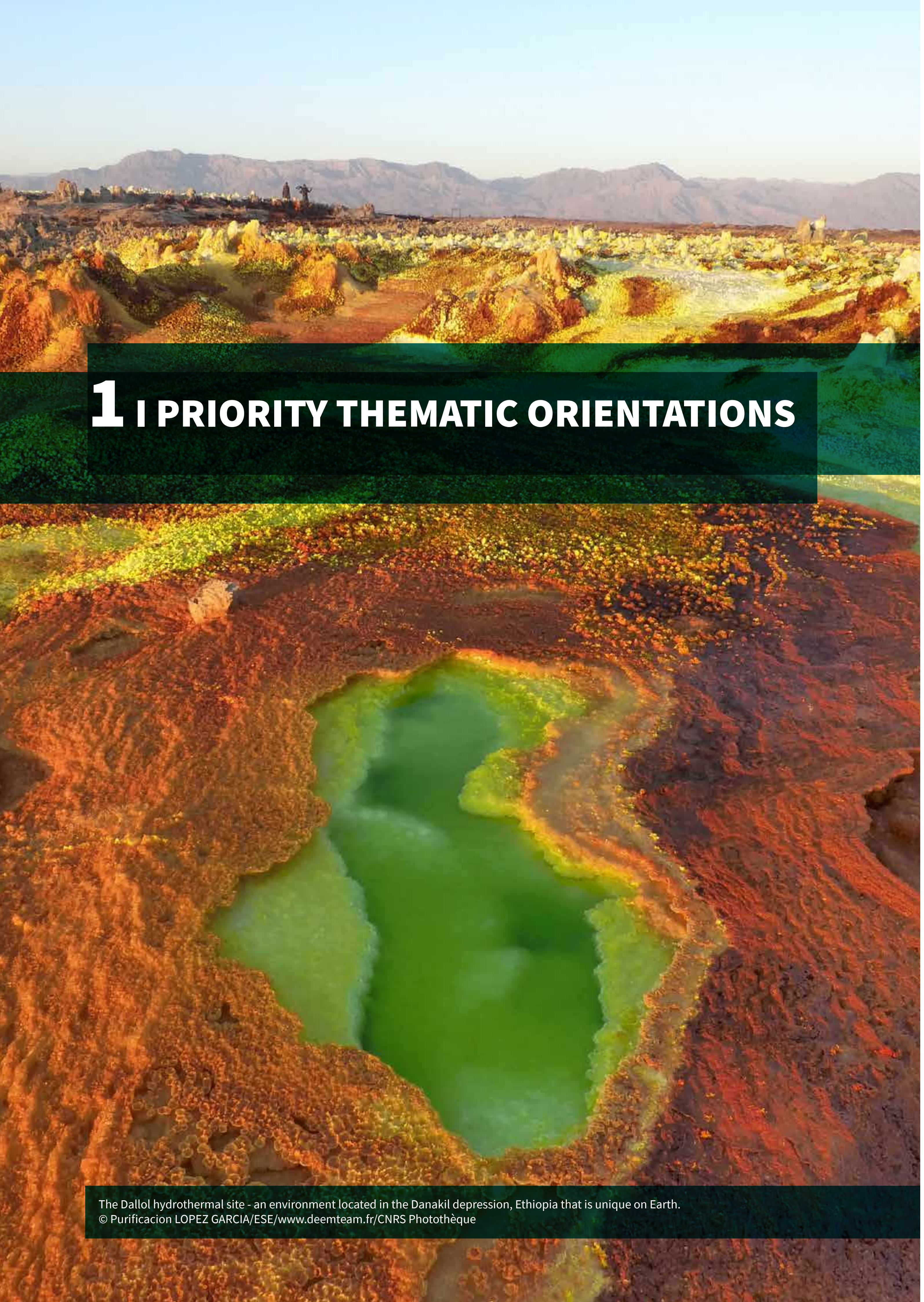
The first of these strengths is undoubtedly the **quality of its personnel,** both scientists and research support staff. This is an essential strength which we constantly need to work on because of today's fierce international competition. There is also intense national competition with many public and private actors, particularly as regards support functions. **The attractiveness of the CNRS and the competitiveness of its recruitment** of all permanent or non-permanent scientific or research support personnel **must be preserved and even reinforced.**

Another of the CNRS's strong points is that it **covers the entire spectrum of scientific fields.** Encouraging specialists from different disciplines to work together often still requires incentives in the same way as the increasingly widespread ambition of scientists to take an interest in social-economic problems facilitates interdisciplinarity. Indeed, the questions brought up by important industrial issues or, for example, the drive to respond to sustainable development objectives are never disciplinary in nature. On the contrary, they require **cross-disciplinary approaches and cooperation between disciplines.**

The third strength of the CNRS lies in its **incomparable network of partners** - its national academic partners, as already mentioned, and also its European and international scientific partners, its partners in the industrial and economic sphere, its partner associations and the French local authorities and administrative bodies. This is a unique network that still needs to be further strengthened. It gives the CNRS an exceptional multidisciplinary vision, both nationally and internationally, which must serve all French stakeholders even more than it currently does. Within the national ESRI system, one of the aims of this Objectives and Performance Contract (COP) is to further increase the CNRS's work on supporting and **promoting the emergence of major research universities at the highest world level.**

Finally, it is important to highlight once again the fact that **the CNRS offers** its personnel a fundamental advantage for carrying out quality research - the possibility to work over **a long timescale.** This also paves the way for serendipity, the importance of which should not be underestimated. There are many examples of very tangible applications or start-up companies that have resulted from research begun several years - and even sometimes several decades - ago without a precise idea of the possible future benefits in socio-economic terms. However, in all such cases, the basic research that led to these applications was at the **highest international level.** Carrying out research of this kind must therefore remain the CNRS's constant objective in all fields.

The present five-year contract will rely on these strengths to **accentuate the dynamics at work at the CNRS.** This contract aims to be **in touch with society** and **puts forward choices and priorities** that are of course scientific but also cover human resources and organisation. This is a highly pragmatic contract based on tangible actions and objectives, certain of which are associated with indicators and sometimes with a target value at the end of the COP period. Some of these objectives would require resources and room for manoeuvre that the CNRS does not currently possess. We will therefore need to work with the evolution of the resources the State allocates to the organisation in the framework of the perspectives opened up by the long-awaited multi-year Research Programming Law and the evolution of its other resources. The CNRS hopes the State budget will provide some of the resources required to achieve the ambitious objectives this COP sets out. The organisation will continue its efforts to increase its own resources and counts on the development of the CNRS Foundation set up in 2019 making it easier to obtain additional funding.



1 I PRIORITY THEMATIC ORIENTATIONS

The Dallol hydrothermal site - an environment located in the Danakil depression, Ethiopia that is unique on Earth.

Each of the ten CNRS Institutes conducts basic research in its field mainly driven by curiosity and the vocation of pushing back the limits of knowledge. The relative unpredictability of breakthrough innovations means it is essential that the development of the knowledge base is sufficiently broad. However, the CNRS needs to identify the thematic priorities.
These forty or so thematic priorities reflect the organisation's vision of scientific developments over the next five years. They take into account the numerous exchanges between the CNRS and its academic partners in 2019 and the CNRS will invite its partners to implement the priorities together. These priorities obviously do not cover all the research activities of CNRS teams and laboratories but will benefit from a significant assignment of the Institutes' resources over the next five years.

Some of these priorities reflect changes or even breaks in how science is evolving while conversely others correspond to themes which exist in the continuity of research which is already well developed but remains a current priority. Over the next five years, the CNRS aims to make a significant contribution to each of these fields at the highest international level.

These thematic priorities are grouped below within the following six major fields - Engineering; Matter, Waves and Particles; the Digital sphere; the Planet and the Universe; Societies; life and living organisms. To complement these mainly disciplinary priority themes, the CNRS, in its role as a national multidisciplinary organisation, has identified six major societal challenges which it aims to make a significant contribution to. These are climate change, educational inequalities, artificial intelligence, health and the environment, territories of the future, energy transition and these subjects will be described in the following section.

ACTION 1
In 2023, make a summary report for each of the thematic priorities of the main scientific contributions made by the units for which the CNRS is the supervisory authority.

INDICATEUR 1
The percentage of competitive scientific support dedicated to the thematic priorities.
(target value: 66% every year)

1.1 ENGINEERING

1. Multi-scale characterisation of matter

To simplify chemical synthesis, design new materials, implement innovative processes and detect ultra-trace species in complex domains (the environment, life and living organisms, etc.), matter needs to be observed in its environment, from the macroscopic scale to its elusive intermediate counterpart during the time of reaction up to around the transition state. This requires pushing the performance of analytical and spectroscopic techniques beyond their current limits, coupling sensors and instruments and possessing reactors which reproduce industrial conditions identically. These experimental advances must be accompanied by new developments in theoretical chemistry and numerical simulation. They also need to be coupled with data mining tools to represent, understand and predict phenomena at the molecular scale. These new tools are major issues of importance for chemistry as it strives to serve health, the environment and the energy transition.

The objective over the next five years is to set up a series of in situ or in operando facilities with at least 25% of them on open platforms.

2. Bioinspiration/Biomimetics

Bioinspiration represents a true opportunity for the future, observing and deciphering living organisms' mechanisms to take advantage of the solutions and inventions produced by nature. When applied at a higher level of integration, namely within ecological systems, it drives ecological engineering approaches and makes it possible to design innovative methodologies for environmental restoration, ecological compensation and the sustainable and efficient management of ecosystem services. Bioinspiration is thus a true challenge for a large and varied scientific community. It has multiple definitions and uses which vary from one country to another. Its contributions are beginning to be integrated by companies and SMEs which are building their approach to innovation on the basis of knowledge accumulated through multidisciplinary basic research into nature's properties to optimise products and applications.

The objective over the next five years is to set up at least one large-scale national operation based on a bio-inspired concept.

3. “Materials by design”

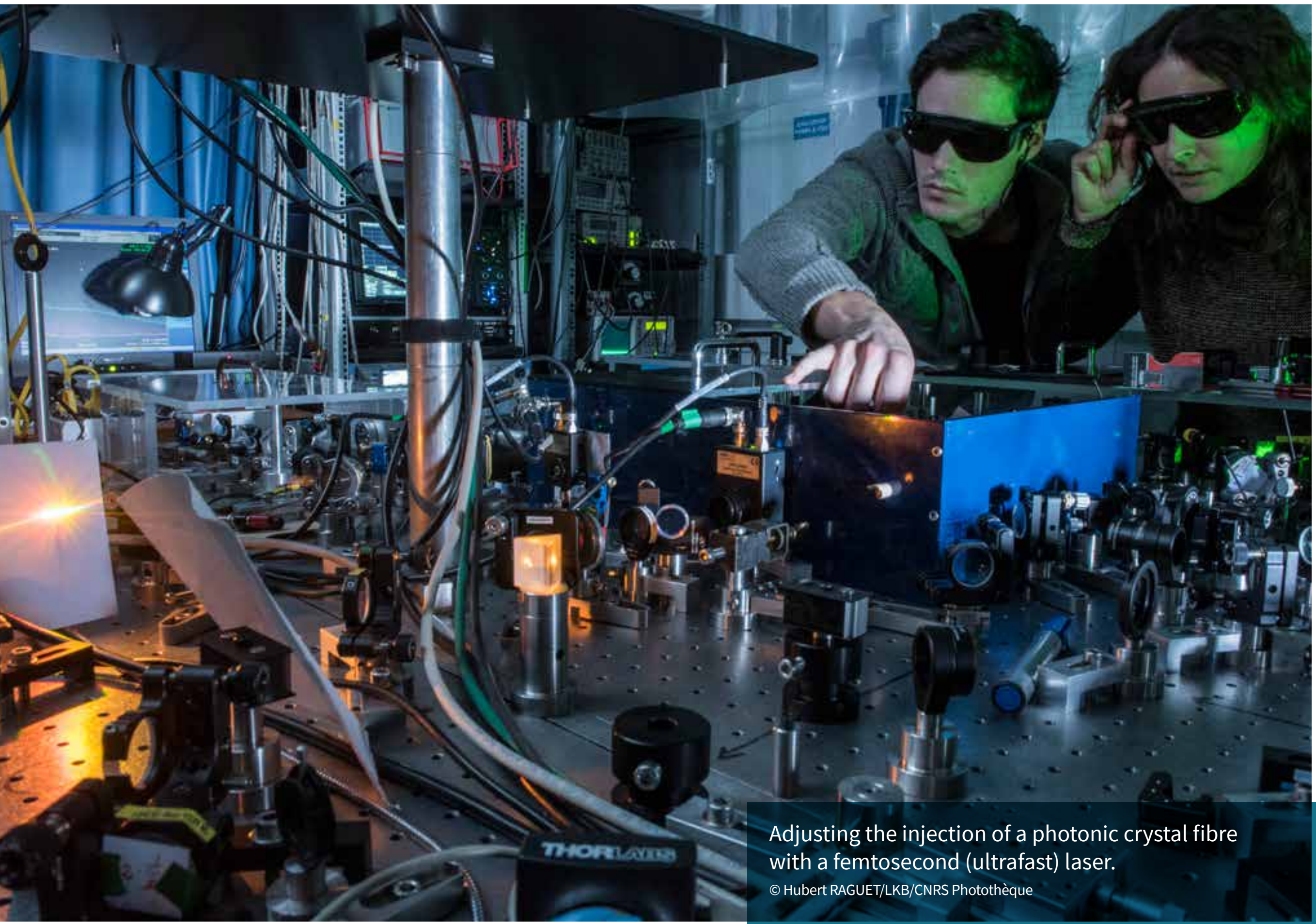
The classic *materials by design* approach involving only modulation of the chemistry and nanostructural refinement of materials or of their macroscopic shape may reach its limits now we are faced with a growing demand for multifunctional materials with optimised, combined or even extraordinary properties (metamaterials). To go beyond these limits, researchers need to work on an intermediate scale, the "mesostructure", in which the architecture of materials can be controlled by geometrical optimisation (topology and morphology) of heterogeneities and/or hybridisation. These include cellular, composite or fibrous materials, sandwich structures and structured surfaces, interlocking materials, materials with an active mesostructure or programmable materials. The use of concepts derived from database mining and artificial intelligence coupled with robotic or automated systems is an approach which merits in-depth study. This new materials by design approach must be combined with the optimisation of elaboration and shaping processes for these materials such as the shaping of composite materials, 3D and 4D printing, etc. This means mechanics specialists in these materials and structures have a central role to play.

The objective over the next five years is to design new architectural (meta)materials which represent a break with existing solutions by making substantial progress on (i) optimisation algorithms for mesostructures to better understand and integrate their instabilities and their strong material non-linearities and (ii) these new materials' elaboration processes.

4. Active fluids and interfaces

The original fluidic systems recently studied in the field of engineering require analysis of multiphysical coupling phenomena which open up new lines of research and possible future applications. It is thus possible to control a flow at selected scales by introducing active particles or mobile interfaces. Examples include electro-rheological fluids such as suspensions of conductive micro-particles; biofilms where the colony of bacteria induces forms of collective behaviour and interacts with the carrier fluid; interactions at plasma/solid interfaces for surface treatment and functionalisation; control of the macroscopic behaviour of a wet granular medium through its mass fraction, etc. There are major issues at stake with this research in hydrology, bio-ecology, effluent reprocessing, decontamination, food processing, chemical microreactors and industrial processes.

The objective over the next five years is to develop new strategies to control fluid volume alterations by using collective or interfacial particulate effects as applied to: (a) decontamination and treatment processes for multiphase effluents; (b) the optimisation of fluidic systems in chemistry, biological screening or energy science; (c) new concepts for the targeted delivery of therapeutic molecules.



Adjusting the injection of a photonic crystal fibre with a femtosecond (ultrafast) laser.

5. Micro-energy

The internet of Things is developing ever more massive dimensions and this raises the question of how to supply energy to connected and nomadic devices. These are capable of carrying out calculations, receiving and/or transmitting information and also need to be made energy self-sufficient. The miniaturisation of renewable energy sources by recovering ambient energy in solar, thermal, vibratory or chemical etc. forms the miniaturisation of electrical energy storage devices (micro-batteries, micro-supercapacitors). Furthermore, the design and manufacture of bio-inspired computing architectures which use the brain's known functional principles to create much less energy-intensive processing / pre-processing of information have all become major issues.

The objective over the next five years is to design new energy recovery microsystems integrating an ambient energy recovery device, a microstorage device, an energy-efficient information processing unit and a transmission device on the same chip. Particular attention needs to be paid to compactness, integration, energy efficiency and eco-compatibility as well as system aspects such as variability, optimisation and so forth.

6. Energy-efficiency in chemistry

Sustainable development requires the reduction of the human carbon footprint on the environment (CO_2 and CH_4 emissions) and rolling out technologies for the production and storage of renewable energy. Rapid global warming means these objectives need to be attained as quickly as possible and that chemistry must design and produce tomorrow's industrial intermediate materials and finished products efficiently in terms of resources and energy. The first urgent requirement is to replace elements which are already rare (in low supply on Earth or due to conflicts and strategic imbalances) like those used by alternative energy sources or to replace compounds which present risks for the health of humans all over the world and for the environment. It is also essential to identify new reactions which will make it possible to transform complex, abundant and highly oxidised molecules (biomass, CO_2) into useful and high value-added molecules in an energy-efficient manner.

The objectives over the next five years are to make it possible to replace rare elements (in low supply on Earth or because of conflicts and strategic imbalances) such as those used by alternative energy sources or to replace compounds presenting risks for the global health of humans and their environment and also to identify new reactions which will make it possible to transform complex, abundant and highly oxidised molecules (biomass, CO_2) into useful and high value-added molecules in an energy-efficient manner.

7. Mass recovery and recycling of CO_2

Controlling the production ("negative emissions") and use of carbon dioxide (CO_2) is a major challenge in our drive to limit climate change. CO_2 can be considered to be a very basic raw material and several methods for recovering it have already been implemented by industry. However, the quantity of CO_2 used in this way (for the synthesis of fertilisers, certain plastics, foams and rubbers) remains very low (about 0.5% of global emissions, i.e. less than 200 MT per year). New lines of research that involve mineralisation and carbonation processes are emerging, particularly for hardening concrete but the ultimate target is undoubtedly the production of energy carriers (methanol, formic acid, methane or synthetic fuels). A wide range of reduction reactions and processes are already used to access these molecules but to date they remain at the laboratory scale. Transforming massive quantities of CO_2 is an immense and urgent challenge which co-exists alongside the equally difficult challenge of producing enough "decarbonated" hydrogen to carry out this transformation.

The objective over the next five years is to set up an interdisciplinary unit to coordinate research projects involving industrialists and research teams in the sector.

8. Quantum matter, information and technologies

Quantum physics focuses on the investigation of open, fundamental questions that concern: quantum gases to study out-of-equilibrium N-body systems and their dynamics; the development of hybrid systems combining atoms with photonic or superconducting nanostructures; quantum electrodynamics in the presence of intense light sources and the production of matter in the vacuum; new states of matter and new kinds of quantum excitations. The field's main applications are computing, communications, simulation, quantum sensors, as well as the engineering of new quantum materials.

The objectives over the next five years concern all of these aspects with the aim of contributing significantly to the maturation of quantum technologies. This includes: experimentally observing exotic states and understanding how these should be manipulated with topological quantum computing to make the latter intrinsically robust to errors; demonstrating quantum acceleration on a computer with input at the level of silicon qubit design and architecture, including error correction; developing new quantum software in parallel with hardware architectures; and establishing secure quantum communication links between several sites on French territory.

1.2 MATTER, WAVES AND PARTICLES

1. The origins of the mass of particles

The next few years will see a sharp increase in the performance of the LHC and of its major experiments and their ability to measure the intrinsic properties of the Higgs boson which is responsible for the mass of elementary particles. Increased precision of the measurements will enable researchers to test many aspects of the standard model of particle physics and put strong constraints on new physics or even possibly shed light on that physics. Alongside this, the design, development and prototyping of new state-of-the-art particle accelerators are more necessary than ever to achieve the highest possible energy and luminosity needed to produce new particles.

The objective over the next five years is to continuously enhance the precision in measuring the Higgs boson to find possible deviations from the standard model and to intensify the development of new technologies required to build the accelerators of the future.

2. Exploring the limits of atomic nucleus stability

Superheavy elements represent a natural limit to the cohesion of atomic nuclei and the question of their formation beyond Fermium in stellar explosions remains to be answered. These elements will now be produced in the laboratory environment thanks to GANIL's new SPIRAL2 accelerator. This means they can be studied with unprecedented sensitivity and that researchers can further test for the presence of an island of stability in the chart of nuclei.

The objective over the next five years is to put into operation a new generation of experiments with the SPIRAL2 accelerator at GANIL.

3. Understanding the matter-antimatter asymmetry problem

Neutrinos currently remain the elementary particles about which the least is known even though they are thought to greatly affect the Universe's major structures. The last two decades have seen major results in this field, such as the discoveries that these neutrinos have mass and change flavour, which shed new light on the understanding of matter-antimatter asymmetry. Other major advances are expected with several upcoming major experiments involving CNRS teams getting underway.

The objective over the next five years is to put the JUNO experiment in China into operation to measure neutrinos in reactors and obtain the first results thereof, to finalise the construction of the KM3NET/ORCA detector for atmospheric neutrinos located off the coast of Toulon and to begin the DUNE experiment in the United States to measure neutrinos produced in accelerators.

The Cherenkov light sensor from the KM3NeT/ORCA neutrino telescope being installed on the new MEUST underwater infrastructure at a depth of 2,500 metres in the Mediterranean Sea off the coast of Toulon.

4. Understanding the fundamental laws of the Universe

The principal objectives of this endeavour are: to study the theory of fundamental interactions in the standard model and its extensions, to unify gravity with quantum mechanics; to study cosmology and astroparticle physics with the aim of simultaneously explaining the origins of the acceleration of the Universe's expansion and the rotation curves of galaxies. The development of instruments such as optical clocks and high-precision spectroscopy experiments is critical for testing our understanding of fundamental interactions and for understanding the Universe. These instruments have direct spin-off potential for applications in the fields of geophysics, satellite positioning or quantum technologies. The recent discovery of gravitational waves has opened a new window onto the Universe. Experiments in Europe and the United States are now joining forces to greatly increase the number of detected events, with Japan soon joining this initiative.

The objectives over the next five years are to measure fundamental constants through the development of cutting-edge instruments and to further develop gravitational wave observations in a multi-messenger approach to enhance our understanding of the Universe.

5. Phenomena which are out-of-equilibrium and are under extreme conditions

The challenge here is to improve our understanding of complex classical or quantum systems, which are out of thermodynamic equilibrium and to control and predict their behaviour. This includes for example: the ageing of matter; transient or glassy phenomena; the irreversibility or instability of various systems; the emergence of new materials, field-matter interaction; and ultra-short timescale physics in diluted and condensed matter systems. Two important aspects of this research are 1) the observation of matter under extreme conditions to understand and model its properties under high-pressure or high-temperature regimes, or in intense electromagnetic fields; 2) the study of intense electromagnetic fields, guided by observation on femto- and atto-second time scales, which paves the way for the study of the electronic coherence of matter.

One objective for the next five years is to begin operating world-class, extreme light facilities in France and to use their increased capabilities to opening up new avenues in the physics of laser-matter interactions at the intensity frontiers.

6. Multi-scale interactions, complex systems and topological matter

Multi-scale interactions are studied by combining experiments and theory (in particular statistical physics). This requires major contributions from studies carried out at Very Large Research Infrastructures and in the field of mostly non-linear optics. The study of confined fluids leads to a new form of physics at a scale where the laws of conventional hydrodynamics no longer apply. In operando characterisation allows the real-time monitoring of growth and synthesis phenomena, and paves the way for the discovery of new materials. The study of complex systems, at the frontier between classical and quantum physics, reveals emerging research directions such as gas-surface interactions or radionuclides in solution. The continuously evolving study of topological matter concerns insulating or phase-transition materials as well as low-dimensional or soft-matter-based systems. Finally, the development of materials is a major research field that includes for example granular materials, such as smart cement and metamaterials, characterised by self-organised activation in soft matter.

The objectives over the next five years include: the development of new material functionalities for information storage and processing, and for energy; an improved understanding of the mechanisms which underlie the development of living tissues, thanks to growth phenomena involving biological fibres.

1.3 THE DIGITAL SPHERE

1. The foundations of artificial intelligence — models, data and algorithms

The last decade has seen the world undergo a "transformation into data". Data is now at the core of a majority of decision-making processes. This revolution was made possible by research work in data management, random modelling to take uncertainties into account as well as high-performance computing, multidimensional data analysis and visualisation algorithms. However, today's most powerful algorithms lack theoretical foundations, are difficult to interpret and vulnerable to attacks. Their use in critical decision-making processes (medical diagnosis, autonomous driving, etc.) raises questions of relevance, trust, explainability, interpretability, bias, stability and robustness which are all major scientific challenges that need to be addressed by researchers in mathematics and computer science.

The objectives over the next five years are to help unlock the mysteries of deep learning and develop robust and explainable artificial intelligence algorithms.

2. The future of computing

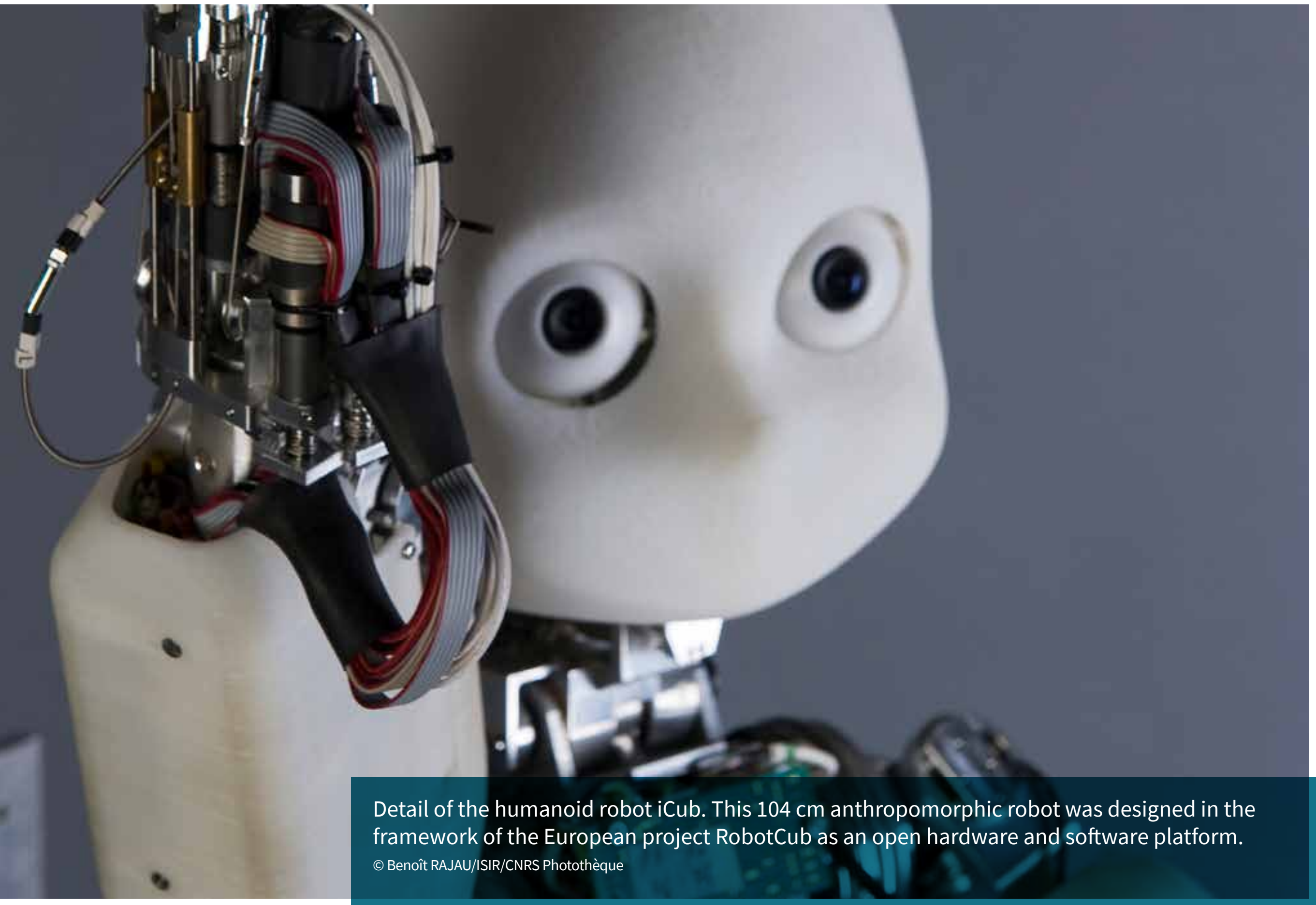
Nowadays, distributed computing and the Internet of Things with intelligent sensors are almost everywhere. Computer and more generally information sciences are at the origin of remarkable advances in these fields and are already preparing new concepts and methods for tomorrow. Quantum computing is one of these and this requires challenges to be solved in hardware design, communication and software. The convergence of distributed computing and the Internet of Things will result in an explosion of data flows which need specific analysis in an online and distributed processing approach. This requires the classical computing paradigms to be adapted, the development of new languages as well as pushing further the state of the art in semantics, verification, proof, etc. In the field of high-performance computing, the challenges for researchers are linked to energy efficiency and software design (code scaling, heterogeneity, parallelism, fault tolerance, etc.). Artificial intelligence and data management are also major consumers of intensive processing particularly in the fields of deep, symbolic, neuro-inspired learning and so forth which makes controlling energy costs a major issue.

The objectives over the next five years are to contribute to the national strategy of working towards Exascale computing particularly on algorithmic aspects, the robustness of carrying out computing and energy efficiency.

3. Autonomous and interactive systems

Autonomous and interactive systems must be able to adapt and make automatic decisions which result in actions in the physical world but also evolve in an environment of which humans are increasingly an integral part. This is the case with robotics (whether it be service, medical or collaborative robotics), autonomous vehicles and transport, new human-machine interfaces, brain-machine interfaces or even machine-to-machine interfaces and interaction with virtual agents. The associated scientific challenges concern the design, modelling, control, safety, operation and evolution of these interactive systems, shared decision-making with humans or sharing knowledge and preferences. As these systems are human-centred, it is crucial to take the perceptual and cognitive components of behavioural factors into account. These issues are at the core of the digital sciences but also concern the human and social sciences as well as life sciences.

The objective over the next five years involves the development of new approaches which more closely integrate autonomous systems with humans, ranging from physical or cognitive interaction and shared co-decision to the study and integration of behavioural factors.



Detail of the humanoid robot iCub. This 104 cm anthropomorphic robot was designed in the framework of the European project RobotCub as an open hardware and software platform.

© Benoît RAJAU/ISIR/CNRS Photothèque

4. A safe digital world

The digital transformation currently taking place in society brings with it very high expectations in terms of risk control. This involves combating malicious activity or protecting users from design and operating faults. Cybersecurity is an important area of research, particularly in the context of government services. Researchers in the field have to face up to constantly evolving threats, technologies and challenges. It is particularly necessary to ensure protocols (for voting, encryption, communication, etc.) function correctly and simultaneously to prevent malicious activity. More secure critical software also needs to be produced continuously through the development of dedicated programming languages. Finally, the accumulation and widespread usage of large masses of data means that the protection of personal data and processing transparency are major issues which need to be effectively resolved to preserve society's trust in the digital sphere.

The objective over the next five years is to make significant progress in the development of tools for the security of applications with high societal stakes (secure payment, voting, medical data, communication, etc.).

1.4 THE PLANET AND THE UNIVERSE

1. Observing the Universe

The Universe as a whole is a field of scientific study ranging from Earth itself to the first moments of the Cosmos which involves a highly interdisciplinary approach based on a combination of the trio of observation-modelling-simulation backed up by theory and laboratory physics. This research uses all possible messengers – electromagnetic and gravitational waves, particles - from space missions and is carried out in the best Very Large Research Infrastructures in the world. Their high productivity levels make astronomy a major producer of research data which require the best tools and algorithms for analysis. The major questions in the field have philosophical implications for humanity and range from the origins of the cosmos to those of life and its existence elsewhere in the Universe.

The objective over the next five years is to use the wealth of data from multi-messenger astronomy particularly to develop very high angular resolution to obtain a view of the Universe with unprecedented clarity.

2. Discovering the nature of dark matter and dark energy

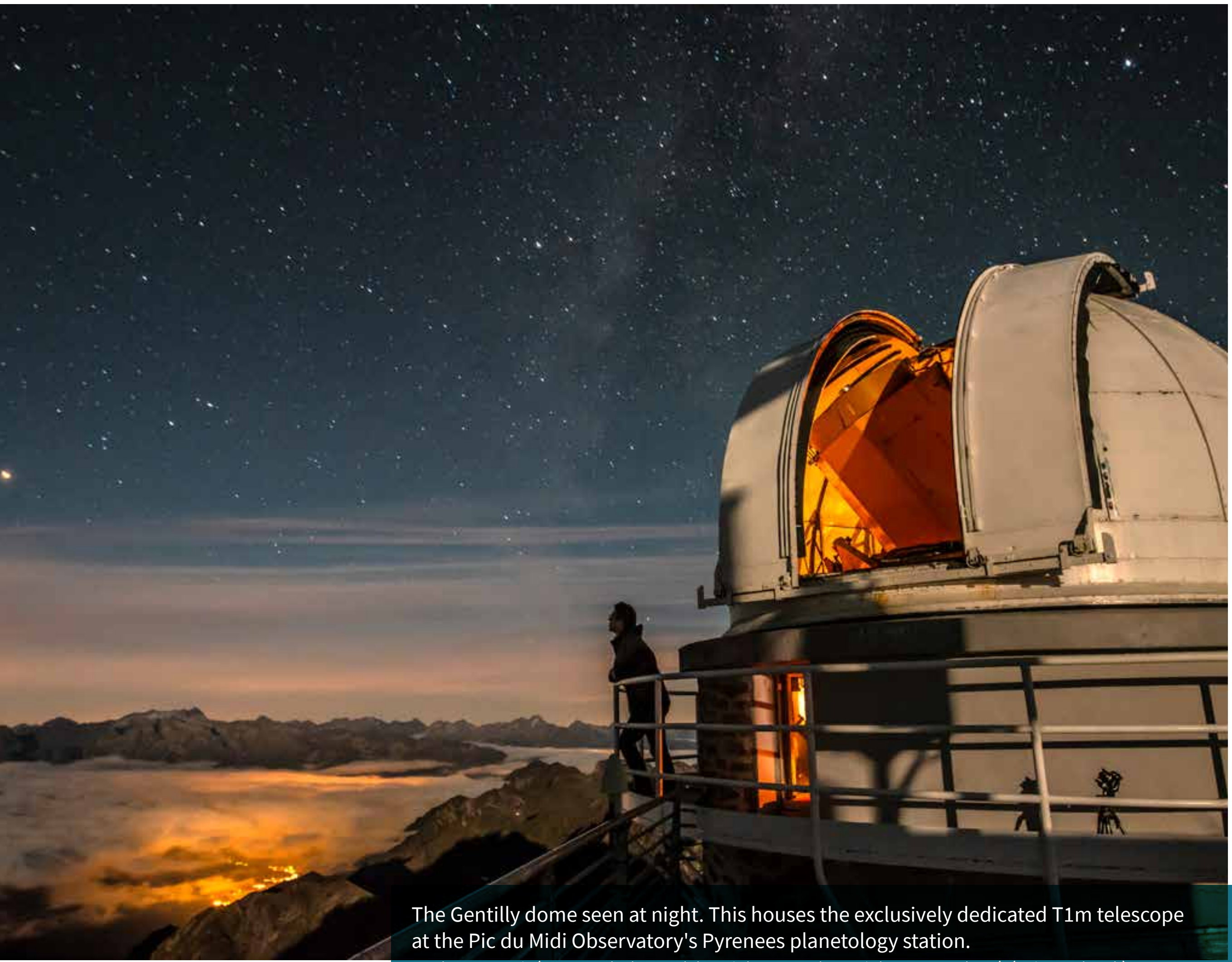
"Ordinary" matter currently makes up only about 15% of the mass in the Universe. The so-called "non-baryonic" matter that makes up the rest is called dark because it has little or no interaction with ordinary matter. Over the last decades, direct searches for this new matter have been unsuccessful but the range of possibilities has been greatly reduced and a discovery is within reach. If this is not the case, our understanding of matter will have to change drastically. Dark energy on the other hand is thought to account for 70% of the energy content of the Universe and is even more elusive. It will be studied in depth by three major projects starting between 2020 and 2022, which will systematically probe deep space from Earth (DESI and LSST) and from space (EUCLID). These promise significant advances in the understanding of dark energy which is presumed to be responsible for the recent acceleration in the expansion of the Universe and now represents 70% of its energy content.

With the analysis of the first data from the LSST, DESI and EUCLID projects, the objective over the next five years is to push back the limits of detection and possibly discover the nature of dark matter and dark energy.

3. Understanding the dynamics of the Earth's fluid envelopes

To ensure the development of our societies, we need to know about the dynamic and biogeochemical processes in the ocean, continental hydrosphere, cryosphere and atmosphere on a broad range of spatial and temporal scales. Researchers' aims are to understand how geochemical elements and pollutants are dispersed in the ocean via eddies of even just a few kilometres in size, to describe the mechanisms of extreme meteorological phenomena which develop over distances of less than 100 km and to integrate the dynamics of glaciers and the formation of soil and water resources to ensure their sustainability. Successful responses to all these challenges, and more particularly those related to mitigation and adaptation to global changes, require the role of living organisms to be integrated into these issues by studying ecosystems in an overall way using exa-scale calculations and AI to overcome the complexity of the formulations involved.

As the resolution of the models improves, their realism will enable more reliable projections of future climates to be made within five years as low as the scale of territories where their impact will be felt by us all.



The Gentilly dome seen at night. This houses the exclusively dedicated T1m telescope at the Pic du Midi Observatory's Pyrenees planetology station.
© Hubert RAGUET / Département de Physique de l'ENS / Observatoire de Paris / Observatoire Midi-Pyrénées / CNRS Photothèque

4. The formation of planets and the appearance of life

How does a planet form and develop until it becomes habitable and what signs of life should we look for on exoplanets? The analysis of extraterrestrial matter will provide unique information about the solar system's first millions of years of existence which can be combined with observations of young stars, accretion disks and exoplanets and also with simulations. Experiments at very high pressure and temperature will provide 3D chemical and physical mapping of the Earth's interior and of planets to help researchers understand primitive convection, plate tectonics and the origins of magnetic fields. Studies of the origins of life will require combining the (R)evolutions of living organisms, the deep microbial biosphere and life-mineral interactions, the impact of living organisms on biogeochemical cycles and taphonomy. These themes are helping to shape a true interface discipline whose ultimate aim is to assess the impact and feedback of geological events on the biosphere.

Understanding the origins of life and the role of the formation and dynamics of the planets in how life appeared and exploded is the main challenge for the next five years.

5. The cycle of resources for sustainable societies

Our current societal model overexploits critical resources and is therefore making the transition to an economy that takes account of their finiteness as an obligation. This requires a coherent model based on solid scientific foundations as stated in the introduction to the "2018 Resources Plan for France" drawn up as part of the "circular economy" roadmap which itself is linked to the law on energy transition for green growth. Some research, study and experimental systems and approaches will make it possible to understand the mechanisms underlying the formation of resources and the uses that societies make of them. It will also involve modelling the processes and trajectories of socio-ecosystems in response to climate and anthropogenic forcing.

The objective over the next five years is to provide the scientific community with a corpus of quality data for integrated modelling of resource dynamics while also providing informed support for public policies to help develop operational resource management solutions.

6. Mathematics for humans and their interaction with planet Earth

Climate change, impacts on ecosystems linked to human activities, genetic evolution and sustainable development are all major challenges that research needs to respond to using an approach which is necessarily multidisciplinary but difficult to implement. Mathematics has an important role to play in this research through the theoretical and/or numerical insight it can provide through modelling, analysis and simulation. A national structure focusing on mathematical themes for humans and their interaction with the Earth's ecosystem will be set up to encourage mathematicians to collaborate with researchers from other disciplines and promote the transfer of knowledge and methods.

The objective over the next five years is to make significant contributions to important issues for the environment and humans through the development of mathematical models integrating climate, ecological, health-based and socio-economic aspects.

1.5 SOCIETIES

1. Quantification, formalisation, modelling and simulation

One of the main priorities in the humanities and social sciences is the development of approaches based on the quantification and formalisation of data and modelling and simulation methods. Appropriate quantification of the phenomena studied is thus a major challenge particularly in economics, sociology and political science. Researchers are currently turning their attention to individual data collected in such a way as to be scientifically usable including in controlled experiments. The formalisation of data and the construction of mathematical models make it possible to empirically test the relevance and validity of the rules governing a community or a society or to make predictions about their behaviour which can be useful for public decision-making among other end usages. The use of models at the interface of climate sciences and territorial and economic sciences or in the analysis of sustainable bio-economic systems and their territorial aspects are excellent examples of this development in computational humanities and social sciences.

The objectives over the next five years are to increase the emphasis social science research puts on approaches which enable the replicability of analyses based on statistical data processing and the use of mathematical models.

2. Digital humanities

Digital humanities are changing research practices across humanities and social sciences (HSS) disciplines going far beyond simply providing access to digitised corpora and databases. Innovative methods for the analysis of data and metadata such as digitally enriched editions and reconstructions (digital philology, hypertext and hypermedia documentation, etc.) must be developed in close interaction with computer science by building on excellence skills such as the automatic recognition of documentary content and structures, mastering archiving and text standards, textometrics or 3D modelling. Particular focus will be given to the dissemination of digital humanities culture, technology and specific values such as sustainable management and reuse of data, open-access culture and crowdsourcing. Another priority will be to train SHS researchers in digital methods through thematic master classes or training workshops run in partnership with heritage institutions.

The objective over the next five years is to promote the development of new analytical methods in the digital humanities and to generalise their use throughout all HSS fields. A research centre in digital humanities, modelled after the Convergence Labs (Instituts Convergence) and based on the Condorcet Campus, will be created. It will spearhead an international and national network .

3. Health and the humanities and social sciences

Health is a multifaceted concept. It can be understood as an ultimate goal, a state of life, an object of scientific study, or the goal of political action. The HSS approach health from angles that are complementary to other disciplines such as health and care practices, studying for example health and care practices, medical thinking, health professions and institutions, patient movements and public reactions regarding health issues, health economics, health-related ethical and legal values or issues as well as epistemological knowledge models in the field of health. This kind of research also serves the objective of disseminating knowledge to civil society, health professionals and public decision-making bodies in a context where there are major issues in terms of literacy and democracy.

The objective over the next five years is to create a Health humanities and social sciences centre modelled after the Convergence Labs (Instituts Convergence) based on the Condorcet Campus which will act as a network leader nationally and internationally.

4. Area Studies

France is one of the few countries whose researchers are capable of advancing global knowledge of Africa, Asia, the Americas, the Pacific and Europe. To achieve this, research combines familiarity with field studies, learning of the languages spoken in the field and mastery of one or more HSS disciplines at the highest international level. The aims in this discipline are to continue developing the network made up of CNRS HSS units abroad, to encourage partners from other countries to come and work in France and to develop an area studies approach to research in Europe. Finally, area specialists are developing an expertise, which responds to the requirements of both the public and the State.

The objective over the next five years is to deepen our understanding of how "global knowledge" can be used to enhance our comprehension of so-called "multicultural" societies as well as the major transitions of the contemporary world particularly those linked to environmental issues.

5. Behaviour

This research aims to understand the determinants and mechanisms underlying individual and collective behaviours. The goal is to develop an integrated approach to the study of human behaviour combining the HSS, cognitive and computer sciences, and based on solid empirical and experimental data. This interdisciplinary field is rich in potential applications: health (eating behaviour, addictions), safety (crowd behaviour, taking action), climate transition (energy and resource consumption), economics (spending and saving behaviours), social life (collective decision-making, cooperation), etc.

The objective over the next five years is to integrate the contribution of behavioural sciences into the interdisciplinary approach to societal challenges, in particular those presented in section 3, with a particular focus on the interaction between science and public decision-making.

6. Gender

The question of "gendered" constructions and gender relations concerns all social and symbolic practices, whether they are public or private, collective or individual. The political and social issues related to this question, which include in particular the problem of parity and professional equality, continue to require strong and structured research. Although ethics, anthropology, political science and educational sciences are particularly concerned, gender scientific issues affect and transform all the humanities and social sciences. Beyond the question of power and inequalities, gender approaches question our individual and collective behaviour, our lifestyles and our cultural and technological relationships towards nature in the broadest sense. Beyond the HSS, they mobilise fields of research as varied as genetics, ecology and artificial intelligence. The CNRS, which has been supporting the emergence of gender studies in France, now intends to accompany the final phases of the consolidation of this field, in close collaboration with universities.

The objective over the next five years is to make a substantial contribution to the ex-ante and ex-post evaluation of public policies in this field.

A visitor using the Ikonikat application (Ikonik Analysis Toolkit) to analyse Louis Le Nain's painting "Famille de paysans" (ca. 1642) at the Louvre-Lens Museum.

1.6 LIFE AND LIVING ORGANISMS

1. Genome knowledge, genetic innovation, epigenetics and environment

Access to full-genome sequencing has generated a science that did not exist 30 years ago: genomics. This covers the study of all aspects of DNA, from sequence to three-dimensional structure and expression at the level of a cell, an individual or a species. In addition, it has been found that virtually all non-coding DNA is in fact transcribed into RNA. This gives non-coding RNA that appears now to be a key factor in the regulation of genome expression in all living organisms. Understanding the participation of non-genetic components in the heritability of phenotypic traits and in the process of adaptation is another major challenge. Non-genetic heritability plays an important role in diverse biological processes with extremely varied consequences (developmental, phenotypic, ecological or evolutionary). The non-genetic information, especially epigenetic information, takes prior individual histories into account to understand the present and anticipate the future. It confronts us with societal issues, in terms of the environment, personalised medicine, public and ecosystem health and socio-economic impacts. Finally, clearly a firm integrative and interdisciplinary approach to this emerging field of research is required.

The objectives over the next five years are to map the 4D organisation of the genomes of model species, along with the epigenetic markers related to the environment and to initiate a predictive model of gene expression in humans.

2. Working towards a multi-scale vision of the functioning of life

Living organisms occupy multiple spatial scales, from the metre to the nanometre, via three-dimensional structures: living macroscopic organisms (animals, plants, etc.); organs, cells, intracellular compartments, messengers acting between compartments or cells; macromolecular complexes, etc. Integrating these scales to obtain mechanistic models of biological and physiological functions from molecules to organisms and their behaviour is an ambitious challenge. The rapid development of tools for the analysis, modelling, design and synthesis of living molecules, or for their assemblies, has led to "omics" and single cell imaging analyses, machine learning and artificial intelligence approaches, analytical methods using sophisticated spectroscopy or microscopy equipment. These will contribute to the multi-scale analysis and advances will lead to innovative solutions for the early diagnosis and personalised treatment of disease.

The objectives over the next five years are to model life in prototypical species and to integrate the impact of molecular or subcellular changes into the behaviour of normal or pathological cells and tissues.

3. Exploring the diversity of life

Viruses, bacteria, archaea and eukaryotic unicellular organisms account for 90% of living species but only about 5% are known. Their study will have profound consequences in the field of biology. New technologies and approaches allow access to these vast ecosystems whose existence, diversity and originality of functioning were previously unsuspected. Their exploration is still in its infancy, with three main types of discovery so far: (i) extremophiles; (ii) little-known branches of life: the discovery of archaea and then of giant viruses - giant in terms of their physical and genome size; (iii) the immensity of the microbial world: the discovery of a large and unsuspected number of microbial species. Finally, many eukaryotes remain unknown and their study will provide information about the evolution of life and many new biological mechanisms. The understanding of microbial interactions in the environment also remains to be established, along with the molecular basis of symbiosis. This may help to understand major evolutionary transitions such as the origin of the eukaryotic cell.

The objective over the next five years is to achieve a more complete description of life forms. For example, to identify, describe and classify at least 40% of the viral, prokaryotic and eukaryotic species present in the oceans.

4. The human brain and cognitive functions

The objective is to address questions as to how the brain functions and of the emergence of self-awareness. The latter allows individuals to understand their own existence in relation to their environment. Researchers need to understand how this organ functions and also to identify the way in which consciousness emerges from this functioning which is much more complicated. How can neural networks lead to immaterial mental projections? What is the as yet unknown neural code that enables the molecular and cellular biology of the brain to generate functions that are specific not only to the brain (memory, recognition of objects, etc.) but also to the individual in his/her social dimension (body and self-consciousness, thought, language, symbols, relations with others, etc.)?

The objectives over the next five years are to make significant contributions to understanding the construction of the brain, its functioning and its role in establishing elaborate behavioural patterns, from model systems to the human being.

5. Health ecology

The world is currently facing disturbances of unprecedented scale and speed. One consequence of this is the emergence or re-emergence of pathogens and the intensification of vector-borne diseases. Therefore, the study of close and complex links between the environment, ecosystems and the etiological agents responsible for diseases in human, animal and plant populations is an important research area. Modern societies have built ecological niches in which sedentary lifestyles associated with inadequate dietary intake have become widespread. Whilst life expectancy has increased and the comfort of living conditions has improved, a gap has been created between the evolutionary history of human beings and their environment. Beyond the necessary juncture between the sciences of ecology, environment and evolution, human and animal medicine and agronomic sciences, pushing the integrative benefits expected from the "One Health" concept as far as possible also requires a new interface with the humanities and social or legal sciences.

The objective over the next five years is to break down the intersectoral barriers to the application of the "One Health" concept.

6.Autonomy and heteronomy of life

It is becoming increasingly clear that the autonomy of life can only be achieved in a context of heteronomy. This latter is understood as an extremely useful, if not obligatory, symbiotic interaction with one or more other living organisms. Studies on microbiota show that microorganisms can play an important role in host physiology. Where then does the location of self lie? Even within cells of the same genetic make-up of an individual, the boundary between self and non-self is often crossed. Recent findings are revolutionising our conception of self and non-self. They have opened up new avenues of research, both in terms of the perpetual dialogue between our biological frontiers and the biological systems that monitor them, notably the immune system and in terms of the ways in which organisms co-construct and co-evolve. Symbiosis and horizontal transfers of genetic material appear to be a powerful evolutionary driving force.

The objectives over the next five years are to understand the influence of the microbiota and how the homeostasis of a complex system of interactions between an individual and his or her microbiota is regulated.

7. Mathematics for life sciences and medicine

Modelling in the life sciences is booming and many aspects of mathematics are involved. The most visible at the moment are statistics with considerable increases in data, probability, dynamical systems, differential equations and deterministic or stochastic partial differential equations, optimisation in a broad sense, imaging, etc. Optimisation is carried out in the broad sense, with imaging and signal processing but also high-performance scientific computing, geometry, discrete mathematics, optimal control, etc. This concerns many areas of life sciences such as medical treatment, agriculture, genetics and epidemiology.

The objectives over the next five years are to make significant contributions to modelling in the life sciences through the development of mathematical models, by promoting interactions between mathematicians and life science specialists.

8. Ecological dynamics and mobility

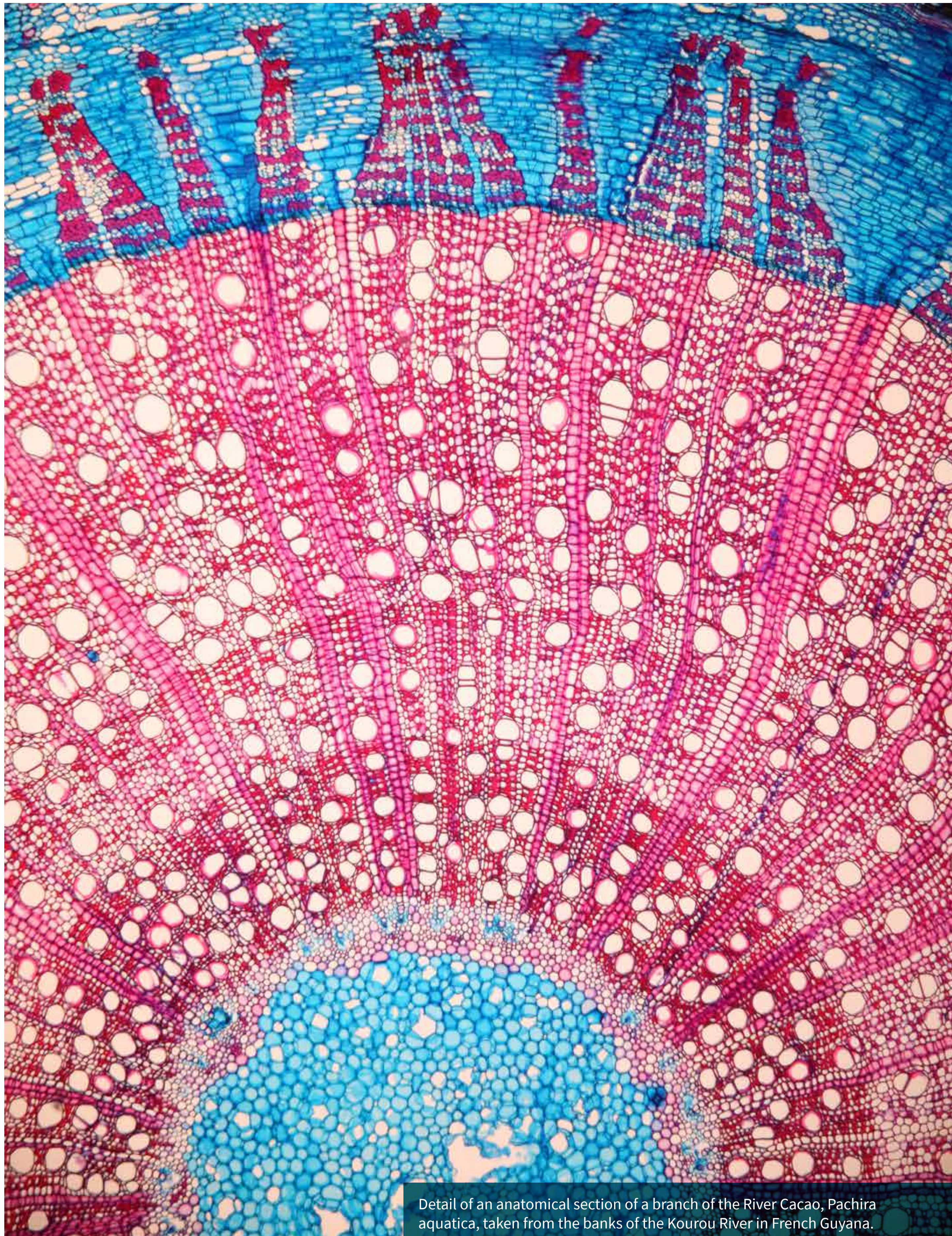
The characterisation and understanding of socio-ecological processes related to the active or passive past, present or future mobility of living organisms (plants and animals) is a rapidly growing field of study. It includes long time scales (as high as several millennia). The objective is to better understand the dynamics of the overall processes, their origins, their consequences on the re-composition of communities and ecosystems and their continuities in time and space, whether this is terrestrial or marine. The aim is to conduct retrospective studies to understand the geographical mobility of populations in the context of global changes, to experiment and to include ecological, health and socio-economic consequences.

The objective over the next five years is to model, anticipate and characterise invasive processes to gain a better understanding of the ecological and evolutionary dynamics of exogenous populations.

9. Adaptation

Adaptation is one of the central processes of biological evolution. The major issues and debates in the study of adaptation are still conceptual. Many questions, some of which are old ones and simply formulated, are proving complex to resolve. In most cases, the questions revolve around the genotype-phenotype relationship. They also arise in all aspects of the study of life, both in the present and throughout history. This includes many questions raised in the field of biological anthropology; the adaptation of societies to past and present environmental changes, the consequences of epidemiological crises, cultural and physiological adaptation, etc. This research will contribute to reflections on societal issues and expectations, highlighting the role of evolutionary sciences in their predictive dimensions and in the fields of health and the environment.

The objective over the next five years is to improve understanding of how organisms adapt to environmental change.



Detail of an anatomical section of a branch of the River Cacao, Pachira aquatica, taken from the banks of the Kourou River in French Guyana.

2 I INTERDISCIPLINARITY AND TRANSVERSAL ACTIONS

A statuette of a dog from the Bavay bronze treasure being analysed with the AGLAE (Accélérateur Grand Louvre d'Analyses Élémentaires) system in the basement of the Palais du Louvre in Paris.

Interdisciplinarity can often prove a highly fruitful source of enhanced understanding of science's objects of study and is important for those working on social or industrial issues. It is **one of the CNRS's strengths but which must nonetheless be consolidated.** It is present at all levels - at the level of national plans and Priority Research Programmes (PPRs) which the State asks the CNRS to steer for the entire national scientific community, within and between Institutes and finally within large interdisciplinary laboratories.

The CNRS must do even better in this area by strengthening its interdisciplinary scientific policy at all levels between and within the Institutes, particularly by steering cross-disciplinary projects like the "Poles" mission, the "Energy" unit, the ODD and Oceans task forces, the NEEDS programme, certain professional networks, etc. **Cross-disciplinary actions on societal subjects will be encouraged** by creating more links with socio-economic ecosystems throughout France, through partnerships with other actors and by promoting and enhancing the contribution of the HSS.

The recent name change from the Mission for Interdisciplinarity (MI) to the Mission for Transversal and Interdisciplinary Initiatives (MITI) reflects the CNRS's desire to broaden its field of action to include programmes which provide multidisciplinary responses like the "Make our planet great again" programme (MOPGA), the Sport PPR, the Notre-Dame project and so forth.

The development of interdisciplinarity is discussed below, first with reference to our actions in support of interdisciplinarity, then through our involvement in transversal initiatives and finally by presenting the six major societal challenges the CNRS has identified as priorities for this COP.

2.1 ACTIONS IN SUPPORT OF INTERDISCIPLINARITY

The development of interdisciplinarity is particularly favoured by the **recruitment of permanent researchers to support inter-Institute multidisciplinary projects.** This ambition concerns posts that are the subject of entrance competitions run by interdisciplinary commissions, Institute-specific posts with entrance competitions run by a disciplinary section that is part of another Institute and successful candidates in CR (researcher) entrance competitions selected by a section managed by one Institute who are then assigned to a laboratory under the authority of another Institute.

In 2019, the CNRS launched the PRIME programme of interdisciplinary multi-team research projects. The 80 projects selected received funding for a doctoral student as part of a top-down approach under the responsibility of the Institute managements and the management committee. The CNRS wishes to make **PRIME a long-term programme** which means it can concentrate on innovative high-risk projects. The organisation aims to take the programme further by funding around a hundred such projects each year.

The recently created Migrations Convergence Lab has been an undeniable success which is encouraging as regards **creating other interfaces between the HSS and other sciences** in partnership with universities and in connection with the Ministry of Higher Education, Research and Innovation (MESRI). The HSS/Health interface working on human health or global health is an excellent candidate as is the field of the digital humanities. The theme of educational inequalities is one of the six major societal challenges identified in section 2.3 below and also effectively testifies to the CNRS's involvement in multidisciplinary actions integrating the HSS.

Interdisciplinarity also means laboratories can be under the supervisory authorities of more than one Institute. Currently 1% of the units under CNRS supervisory authority belong to two main Institutes. More than 40% of laboratories have at least one secondary Institute affiliation which is probably too many laboratories and does not always correspond to scientific reality. Most of these laboratories regret a lack of investment and attention from their secondary Institutes. The CNRS is thus proposing to limit such secondary supervisory assignments **to laboratories whose scientific scope is significantly linked to the disciplinary fields of several Institutes** by strengthening the joint steering by the various Institutes involved. To achieve this, the Deputy Scientific Directors (DAS) of the secondary Institutes need to be more involved in monitoring laboratory activity.

ACTION 2
Reinforce the co-management of laboratories under the supervisory authority of more than one institute.

OBJECTIVE 1
Create one or two Convergence Lab-type structures at the interfaces between the HSS and other sciences.

INDICATOR 2 : The percentage of annual recruitments of permanent researchers working in support of multidisciplinary inter-Institute projects (target value: 20% each year).

INDICATOR 3 : The number of projects funded each year under the PRIME programme.

2.2 TRANSVERSAL ACTIONS

In conjunction with the CNRS's academic partners, the organisation wishes to nationally federate scientific communities working in established fields to make sure French research remains at the highest international level. The CNRS also aims to bring together disciplines that may sometimes be distant from each other to help provide responses to the major challenges now facing the planet and humanity.

The CNRS will further reinforce its capacity to lead or contribute to major transdisciplinary projects by using the skills present in laboratories attached to several of our Institutes. One of the major transversal issues which the CNRS particularly aims to **contribute to along with its partners is the United Nations' 2030 agenda through achieving sustainable development objectives** involves transforming our societies to make them more just, peaceful and frugal in full respect of our planet.

The research carried out by the units under the supervisory authority of the CNRS covers all scientific fields and will make it possible to address the issues specific to each of the sustainable development objectives and other issues at the intersection of several such objectives namely climate-ocean-water-health and water-energy-food-biodiversity-education. The CNRS is also part of national and international initiatives aiming to respond to sustainable development challenges. It is a member of France's National Observatory on the Effects of Climate Change and the French Foundation for Biodiversity Research and also hosts the Global Hub of Future Earth and the European hub of the Urban Climate Change Research Network. The organisation will continue working with its academic partners to promote the expertise of French laboratories in the United Nations climate and biodiversity panels IPCC and IPBES.

ACTION 3
Maintain a significant number of calls co-led with other research organisations and other partners, particularly major industrial corporations.

ACTION 4
Strengthen the MITI's capacity for rapid intervention in terms of steering and funding regarding transversal societal issues such as the government's "Grand Débat", the Notre-Dame project and so forth.

An engineer from the SCALab laboratory testing the Pupil Labs eye-tracking system on Mathieu Le Nain's painting "The Denial of Saint Peter" (circa 1655).
© Claire-Lise HAVET/Musée du Louvre-Lens/IKONIKAT/CNRS Photothèque

In addition, the MITI is now working on major transversal subjects through the Challenges initiative with its 13 calls for projects in 2019 targeting emerging themes like biomimicry, plastics in the aquatic environment, the origins of life or modelling life and living organisms. These projects may involve teams from other public scientific and technological institutions (EPSTs), public industrial and commercial institutions (EPICs), universities or schools. In 2019, three such calls for projects were set up and co-led with another EPST - the National Institute for Agricultural Research (INRA) for food mutations, the Research Institute for Development (IRD) on natural risks and the French National Institute of Health and Medical Research (INSERM) for digital health. Funding has been assigned to a total of 50 projects involving at least one team from each of the partner organisations. The MITI is responsible for managing the MOPGA PPR for all French research institutions and jointly leading it with our German partners. It will be also be in charge of scientific steering for the "Very High Performance Sport" PPR supported by the MESRI and the Ministry of Sports.

2.3 SIX GRANDS DÉFIS SOCIÉTAUX

In addition, the CNRS has identified six major societal challenges to which it aims **to make a substantial contribution in the forthcoming years,** in collaboration with its partners and through the coordinated mobilisation of the ten Institutes.

1. **Climate change**
2. **Educational inequalities**
3. **Artificial intelligence**
4. **Health and environment**
5. **Territories of the future**
6. **Energy transition**

These six challenges neither cover all the research carried out in the laboratories nor replace the "bottom-up" process which remains essential to driving the emergence of knowledge. They are priorities set out in this COP to which the CNRS will devote a significant part of its available human and financial resources.

ACTION 5
Launch MITI calls for projects on themes directly related to these major challenges with a minimum of one call every two years for each of the six challenges.

ACTION 6
Make a bi-annual summary report in 2021 and 2023 for each of the thematic priorities of the main scientific contributions made by units for which the CNRS is the supervisory authority.

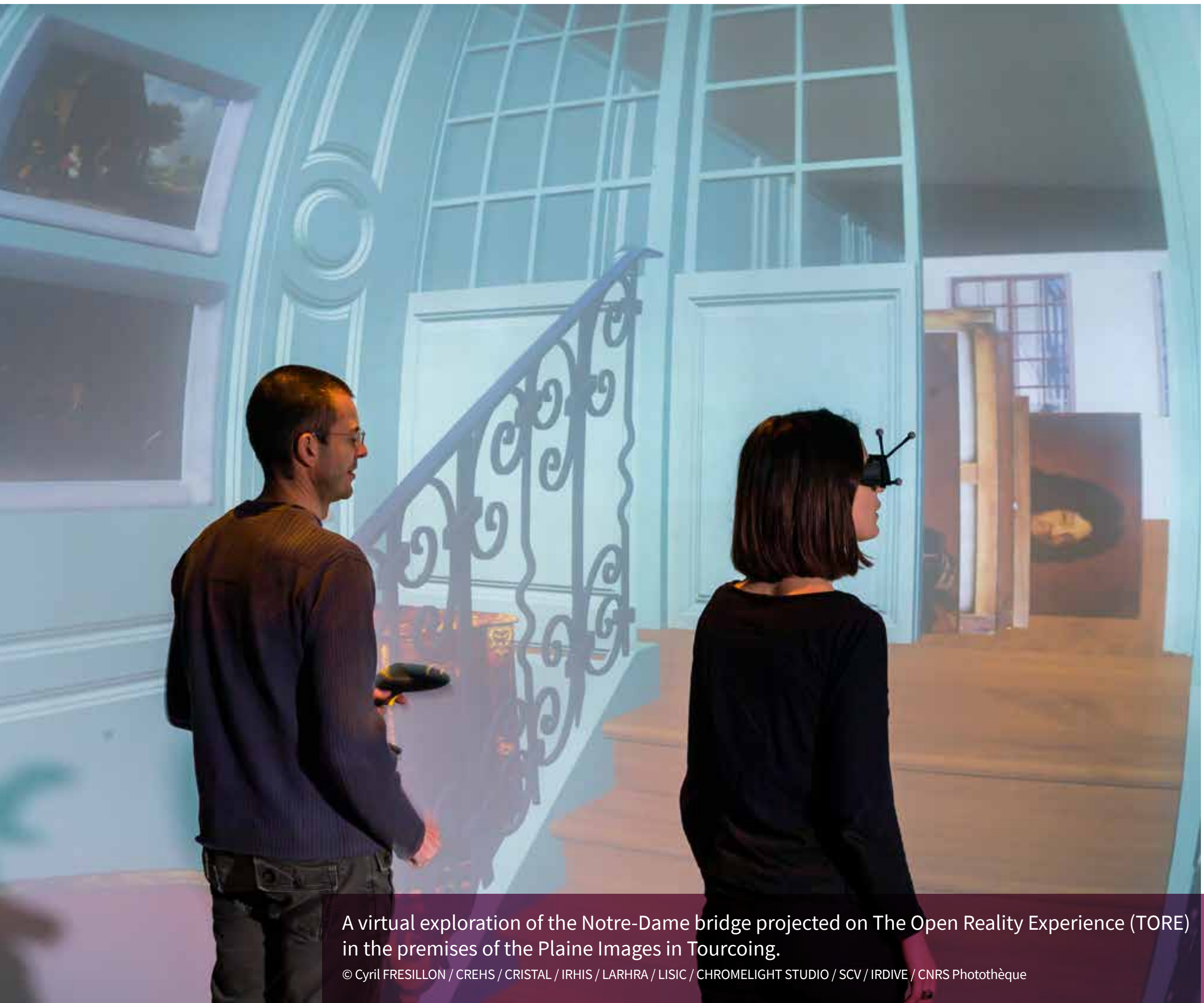
INDICATOR 4
The percentage of permanent researchers recruited to work on themes directly related to these major societal challenges. (target value: +10% each year)

1. Climate change

Limiting the impact of human societies on climate change, fighting global warming, mitigating and adapting to its effects all require an excellent understanding of the "climate machine" but also an accurate and holistic assessment of the various impacts of climate change and associated uncertainties. The main levers are observation and data acquisition, along with conceptualisation and modelling from natural or in silico data. A special effort will be made to combine the implementation of observation and modelling services and their operational application (climate services) with the challenge of "near" real time assessment, but also the issue of using huge volumes of heterogeneous data. The latter requires new computing architectures that are as close as possible to the data sources and a new organisation of computing, analysis and storage resources. The transition from normal models to small-scale models that are better suited to studying the impacts of climate change on territories is a challenge which researchers need to respond to. These developments must be based on new exchange platforms dedicated to an integrated approach, to the facilitation of closer links between data and method suppliers and to a wide range of end users (scientists, professionals, public policies, etc.).

These approaches must be implemented in a decisively systemic and therefore transdisciplinary dynamic, ranging from climate sciences to ecology and social and political sciences. It is essential to bring together global climate change scenarios and economic or sociological systems of specific interest. These are naturally vulnerable to climate change and its consequences. An operational scientific decompartmentalisation of communities is essential: Short-Time/Long-Time, Observation and Experimentation/Modelling, Biodiversity/Climate Science/Human and Social Sciences etc. Only a better structuring of the community to bring together the essential interdisciplinary resources on these scientific and societal issues will make it possible to provide a new vision of the necessary -geo-ecological climate trajectories and the conditions for their implementation and acceptance.

Controlling and reducing the impact of climate change means moving forwards with the proposal of trajectories that combine mitigation and adaptation and take into account the development of truly operational solutions to establish the necessary transitions, particularly those of an ecological, social, energy or agro-ecological nature. The efficient production of totally decarbonated energies and their storage, the creation of intelligent distribution networks or



A virtual exploration of the Notre-Dame bridge projected on The Open Reality Experience (TORE) in the premises of the Plaine Images in Tourcoing.

the development of eco-responsible solutions for use with a high carbon footprint are important subjects (see also the "energy transition" challenge described below). The work carried out must clearly raise the question of transitions and their articulation and support. Both conceptual and operational (innovation) points of view must be considered. Recent crises show that the social, financial and political acceptability of solutions must be a priority area for both research and the evaluation of public policies. Indeed, a question of instrumenting transformations can go as far as the analysis of disruptive scenarios as well as considering them using a global approach.

Beyond the scientific understanding of the dynamics of socio-ecosystems and the Earth system, these scientific questions cannot be separated from major societal issues, particularly those guided by the Sustainable Development Goals. These require the integration and management of the politico-socio-economic component of climate change mitigation and adaptation.

2. Educational inequalities

Democratic societies promote equality of opportunity, which is strongly linked to educational issues. Inequalities in education can be of various kinds: differential access to education, throughout the national territory, depending on the age and the population considered. This includes disabled students, particularly those with difficulties linked to the ability to learn content presented in a given pedagogical format and difficulties linked to abilities to exploit such a content to construct oneself as an individual and as a member of a community. In turn, educational inequalities have an impact on the development of our country, generating or aggravating other forms of inequality: economic, social, geographical sciences, etc. Some of these are being addressed by work responding to other challenges, such as inequalities in the face of climate change or health/environmental issues.

Currently, education is a priority research topic that is approached by specific research communities. The educational sciences or the Physical and Sports Activities Science and Techniques (STAPS) are examples but these are poorly represented in the CNRS. The programme carried out at the CNRS to respond to this challenge will seek to make a different contribution by developing interdisciplinary research dimensions. It will investigate educational mechanisms and learning processes, along with public policies, from three main standpoints:

- Knowledge of the causes of educational inequalities at individual and collective levels.
  The history and sociology of education make it possible to understand the interactions between the educational system and inequalities of all kinds. Economics and political science develop methods to evaluate public policies and teachers' practices across various contexts though some of these methods may unintentionally maintain educational inequalities. At the interface with the HSS, advances in brain and neurosciences highlight the positive or negative effects of different pedagogical choices on learning.

- The development of learning tools and methods, from the fundamental to the translational level.
  The development of digital tools has made it possible to offer new forms of learning (distance learning platforms, serious games, programmable robots, conversational agents, etc.) and new approaches to the diagnosis and remediation of learning disabilities. Multilingual language development and learning is a core issue that is increasingly important in an ever-growing globalised world. Working with the methods of both cognitive (experimental) and social sciences, linguistics sheds light on the nature and acquisition of multilingual knowledge and skills. Since such tools, like any tool, can contribute to aggravating inequalities rather than helping to reduce them, research must include a study of practices to avoid this pitfall.

- An informed and thoughtful approach to contemporary educational issues.
  Contemporary research in the human and social sciences concerning popular and/or alternative forms of education, both in and outside school, maps social innovations in pedagogical models. Furthermore, it analyses the diversity of ways of learning and socio-cultural contexts. It also leads to questioning of the fundamental contents of education, with a view to equipping the learner with the necessary critical eye and relational skills indispensable to human life, in a context of increased human/machine interactions.

The CNRS is the only organisation that brings together the full range of research needed to understand the phenomenon of educational inequality in all its complexity. Through the expertise of its research units, the CNRS can contribute to the development of sustainable solutions to phenomena that undermine the foundations of our social contract and for which there is currently no obvious solution. The implementation of this interdisciplinary research agenda will allow us to:

- organise access for all laboratories to data (social, schooling, health) so that they can develop statistically representative approaches and propose innovative indicators for educational quality;
- develop comparative approaches, thanks to a network of international scientific collaborations;
- encourage an experimental and translational approaches to education, through a network of collaborative initiatives with local education authorities and teacher training courses, which already exists in part. Observation of the behaviour of the different actors involved in the educational process will make it possible to support proposals for public action, including via randomised experiments;
- promote research across all population groups, and not just in schools;
- give special consideration to populations with disabilities, for example by facilitating the identification of signs of slight sensory (visual and auditory) and cognitive deficits throughout schooling;
- link research on education to research on technological innovations, particularly in the field of Artificial Intelligence. This would make it possible to test new methods of learning and predictive analyses. This field is also particularly conducive to the emergence of start-up companies that make use of the research developed.

3. Artificial intelligence

The development of digital technology and important artificial intelligence (AI) issues are current challenges for science and society. Data science, the development of highly efficient learning algorithms and platforms and rolling out robotics and new modes of interaction between humans or with virtual agents are revolutionising the world. Essentially, knowledge, human behaviour and social ties are affected. This new science also raises interdisciplinary questions. These concern the appropriation of digital methods and tools, intelligibility and responsibility for decisions made using algorithms or from data. Moreover, the reproducibility of experiments, critical analysis of their possible biases, scientific interpretation and associated ethical issues are addressed. AI can also contribute to approaching other major challenges, including those of climate change and educational inequalities.

Methodical comparison with facts and observations has long been at the heart of much research but data science provides tools for working on a large scale. Knowledge can be collected and structured from a set of data using probabilistic and logical models, machine learning methods and visualisation tools. This perspective renews questions about replication and scientific proofs that cut across the entire scientific field, from physics to climate science, from life sciences to social sciences. There are also developments in scientific practice. With the arrival of participatory science, citizens contribute to the production of scientific knowledge. The culture of open science is fostered by digital technology and facilitates the sharing, accessibility and exchange of data, software and results. The large-scale exploration of scientific literature and its cross-referencing with data from sensors, open bases, experiments, participatory science, etc. is based on the use of digital technology and the development of the "open science" approach. New methods of numerical experimentation are being developed, such as simulation or reinforcement of learning. These data mining processes are complex and often interdisciplinary. They rely on advanced methods of analysis along with large, computational resources and decision systems but they are powerful research accelerators. Moreover, the intensive analysis of masses of data leads researchers to think about necessary upstream control mechanisms and uses as well as the ethics associated with that usage.

Beyond science, the whole fabric of society, from individual practices to democratic life, is being transformed by digital technology. Electricity or transport networks and defence systems cannot function today without computers, signal processing or robots. The internet, online services, multimedia information and smartphones make up the landscape of what is now called the digital society. And in the near future, this list will include connected objects and cyber-physical systems. Digitisation is accompanied by social changes that lead to the transformation or emergence of many professions, the development of distance working, e-health, citizen mobilisation via social networks and political debate and communication via the blogosphere. The appropriation and analysis of private data by major digital players and their use as an alternative means of payment brings into play questions of control and ethics. This raises many queries about new consumption models, privacy, security, democracy, influence phenomena, etc. These are all societal issues need to be reformulated as lines of research based on digital models and social sciences.

The commitment of the CNRS - which is already involved in the national artificial intelligence plan alongside the National Institute for Research in Computer Science and Control (INRIA) and many other actors - will focus on four main areas:

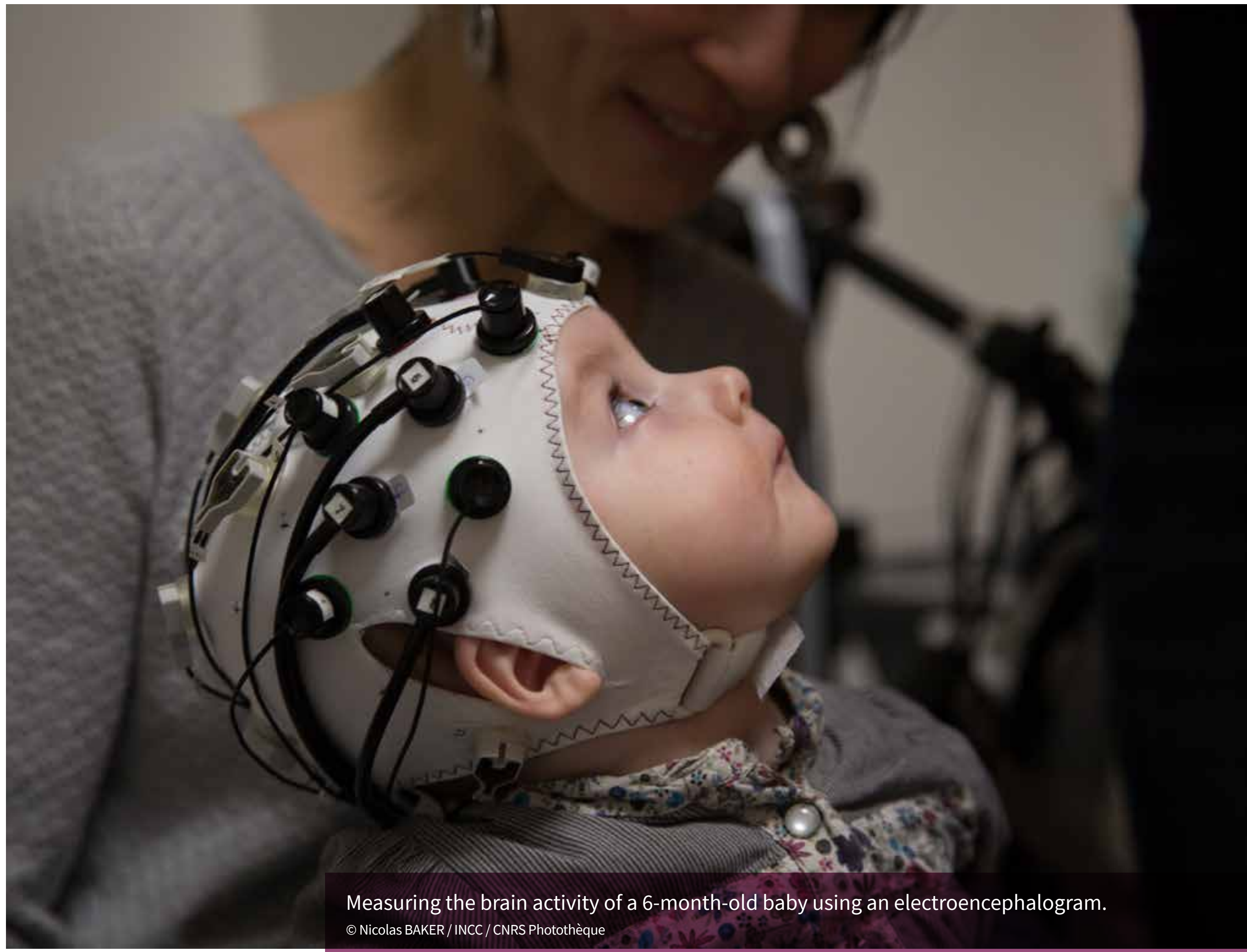
- fostering research at the highest international level concerning the foundations of artificial intelligence and digital sciences. This should be in the broadest sense, by promoting research on responsible, safe and more energy-efficient artificial intelligence;
- intensifying interdisciplinary research on the impact of artificial intelligence and digital technology, drawing on the multidisciplinary dimension of the CNRS;
- facilitating the flow of exchanges between the world of digital humanities and that of artificial intelligence (AI) and involving HSS researchers in digital and AI regulatory bodies and institutions;
- making the best use of the results of research carried out in conjunction with companies to intensify bilateral relations between Institutes. This puts AI and data science at the service of their major scientific sectors and initiates interdisciplinary projects on societal issues (security, transport, etc.) to measure, support and control their transformation by digital means as best possible.

4. Health and environment

Globalisation highlights the world-wide spread of health risks, as well as the importance of interactions between ecosystems and humans in the evolution and emergence of pathogens and vector-borne diseases and the determinism of chronic diseases. Changes in living conditions (diet, reduced physical activity, longer life expectancy, travel, etc.) and in the environment (pollution, climate change, infections, etc.) are leading to an increase in chronic diseases and to the emergence of communicable diseases. These pathologies are constantly increasing and have extremely serious human and societal consequences. The aim of the response to this challenge is to mobilise scientific communities to analyse these pathologies, their causes and consequences through a multidisciplinary approach involving biological sciences (physiology and physiopathology, infectiology and immunology, neurobiology), human and social sciences, environmental sciences, mathematics, physics and computer science. This multidisciplinary approach is intended to adopt a holistic, transdisciplinary and multisectoral approach to human, animal and ecosystem health ("One Health"). The objective is to increase the understanding of the exact links between the state of health of the environment and that of populations, to act more effectively on pathologies, to propose preventative solutions and to mitigate early and late effects. This will make it possible to improve the living conditions of a large part of the population and thus reduce the human and financial costs to society. This integrative and ambitious programme aims to take into account the interrelationships between humans and their environment and the consequences, as illustrated by the following examples:

- Environment and Epigenetics: Biological mechanisms imprint epigenetic marks after stress, exposure and aggression (famine, obesity, endocrine disruption etc.) suffered by previous generations.
- Diet, physical activity and diabetes: There is a strong correlation between modern diets that are high in sugars and fats, a lack of physical activity promoted by sedentary living conditions and the development of type 2 diabetes. This observation also applies to African countries where more than 40 million patients are expected to be affected by diabetes by the 2020s.
- Pollution and different pathologies: The many substances released into the environment (plastics and endocrine disruptors, pesticides and insecticides, medicines, heavy metals, etc.) are the cause of numerous pathologies (cancers, allergies and respiratory pathologies).
- Climate change, travel, infections and antibiotic resistance: Economic flows, climate change and bad practices result in the emergence or re-emergence of pathologies, the spread of pathogens and the development of resistance to treatments.
- Digital environment, complexity and neuroses: The complexity of the technological environment, information and multiple solicitations seems to favour the appearance of neuroses and mental pathologies. These are the prime cause of pathologies in France (10% of declared pathologies).
- Increased length of life and Neurodegeneration: Apart from other conditions (genetic, stress etc.), for most individuals increased life expectancy now also leads to a great increase in neurodegeneration. This leads to worse living conditions and requires the people close to sufferers to adapt with many negative consequences being observed.

The CNRS is in a position to put all of these themes into synergy. This enables researchers to strike a balance between the interpretation of changes between causes and consequences of human activities in ecosystems and assistance in decision-making. Although it is initially a regional matter, health security must be understood on a national scale and in a global and cross-cutting perspective. Human health, animal health, plant health and the health of ecosystems and biodiversity must all be integrated.



Measuring the brain activity of a 6-month-old baby using an electroencephalogram.

5. Territories of the future

According to the United Nations, by the year 2050 two out of three people will be living in cities. In France, over the last twenty years, population growth has been mainly concentrated in large urban areas, particularly in peri-urban zones, with a continuing decline in the rural population. This national evolution is part of a world-wide trend that is particularly noticeable in the least economically developed countries. The consequences vary from country to country and are of fundamental importance for cities and rural areas. They must be clear for both these territories.

It is essential to understand the economic, demographic and social changes in these territories, the socio-economic inequalities that affect them and the impact of this distribution on the environment. Only then can we imagine tomorrow's solutions for sober and efficient infrastructures, rethink modes of distribution and production, transport, etc. and take the impact of these changes on the environment into account.

The energy model used in tomorrow's society must take this inhomogeneous distribution of the population into account. Diversified production systems should be distributed from as close as possible to the user, which requires the optimisation of networks and storage. New modes of mobility must also be developed, based on new technologies that respect the environment (reduced emissions, low energy consumption) and new modes of social organisation. Remotely-managed health initiatives must be perfected, efficient while inexpensive water treatment systems have to be designed, etc.

Furthermore, the development of interconnected, contributory and collaborative territories which are also more inclusive is based on the availability of resilient and secure digital infrastructures in all territories. This makes it possible to increase their connectivity and to establish a real territorial data policy. In the transition of territories, these technical levers condition the distribution of new uses and services (e-service platforms for work, trade, health, disability, transport, etc.).

The CNRS will contribute to several aspects of this challenge for the future, ranging from a detailed understanding of this complex system to the construction of optimal solutions.
It is crucial to fully know the history of our territories and our domains and to understand the impact of the redistribution of land use on societies. This is also true of people's rights and public policies, analysing economic, social and environmental aspects, taking the proposals made by local population groups (associations, mobilisation groups, alternative social organisations) into account. Thence, we can invent other ways of living in the territories and predicting the impact of possible evolutions. These are fundamental and founding elements for imagining the future. How the solutions of the future should be built with the actors and in the interdisciplinary nature of scientific contributions will become clear, as will the optimal levers of action (public policies, incentives, laws, etc.) on each of the subjects and ways of measuring their impact?

The units under the authorities of the CNRS are already contributing to this challenge on a large number of aspects and will continue to do so. These aspects concern the technologies to be developed, the identification and management of risks related to urbanisation and the measurement of the impacts of the challenge on biodiversity. This challenge is of a particularly multidisciplinary nature and will require the setting up of a cross-disciplinary coordination. Without doubt, the identification of specific tools will jointly mobilise the many communities that can provide mutual enlightenment: information sciences, engineering sciences, ecology, physics, chemistry, mathematics, history, geography, demography, economics, law, political sciences and sociology. Moreover, there will be collective studies of the research priorities which need to be supported.

6. Energy transition

The urgency of France’s energy transition is underlined by the IPCC 2018 report. To ensure this transition, France relies on mature industrial sectors such as hydroelectric and nuclear power. Little research at the CNRS is directly concerned with hydropower. However, significant work is being carried out into the production of energy of nuclear origin, by fission - with the aim of operating under efficient and safe conditions, particularly the safe treatment and storage of waste - and by fusion. Research at the highest international level is organised in the field of production efficiency: high-performance reactors, inertial and magnetic confinement, etc. The aim is to understand the mechanisms at the core of reactors and the safety of installations (reliability of materials under irradiation, behaviour of waste or radionuclides in the environment, reprocessing). In addition, a subject for future studies is the impact of the decommissioning of current PWR plants on human beings and territories via man-environment observatories.

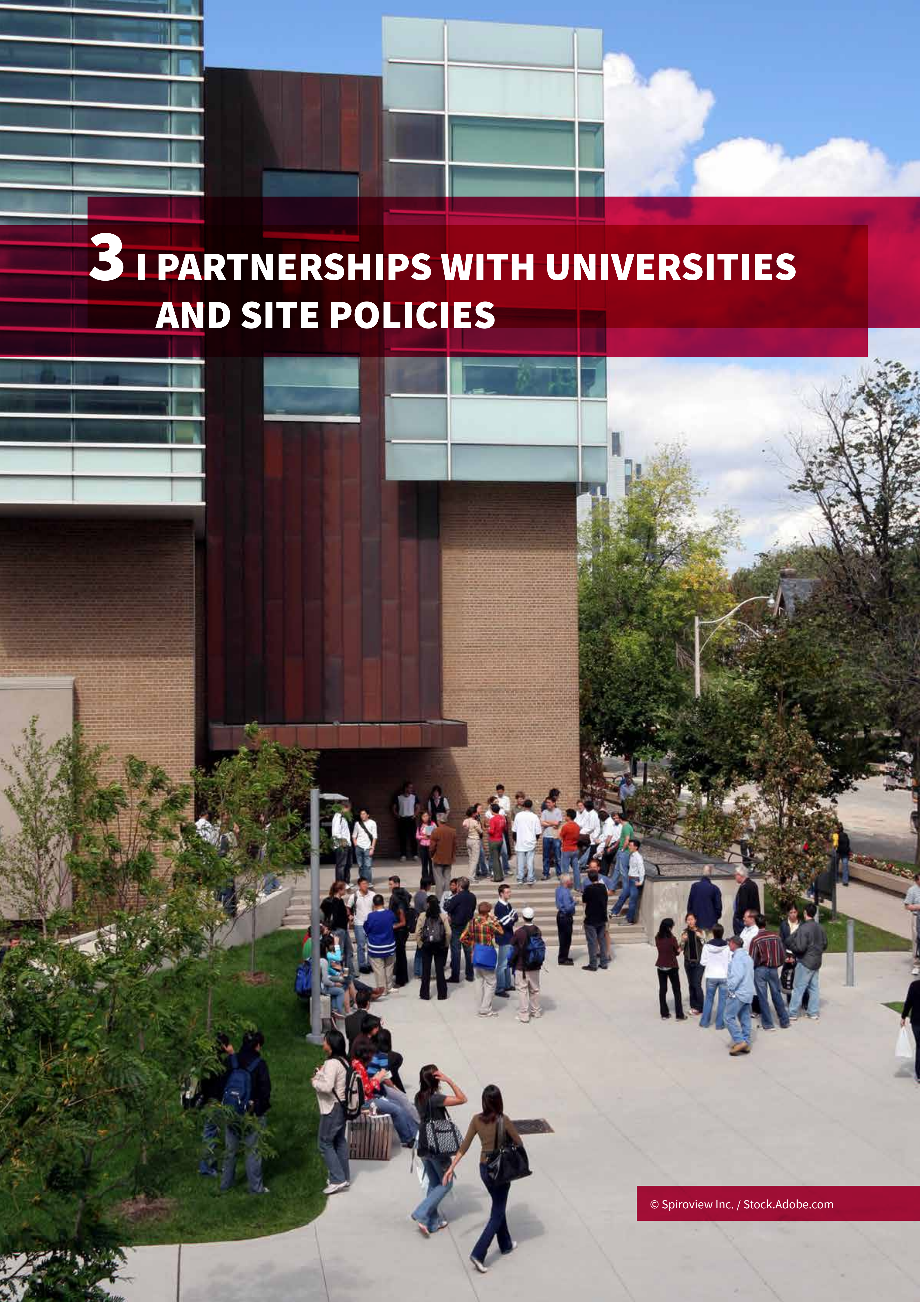
Also, strong political commitments have been made in favour of renewable energies. The CNRS contributes to these commitments by mobilising its laboratories working on these themes and by encouraging the emergence of new avenues at border-based research. Thus, the efficient and carbon-free production of solar, wind or marine energy is being studied, as well as the efficient and sustainable storage capacities needed to cover the intermittent nature of supply which is specific to these sources. Electrochemical storage seems a particularly effective way of meeting the high demand for transport. The CNRS is already an international leader in electrochemical storage through the research and technology network on electrochemical energy storage (RS2E). Other solutions are based on the efficient conversion of solar energy, the establishment of a hydrogen industry to produce electricity and heat using fuel cells and also on the development of CO_2 by transforming it into molecules that could become fuels and the conversion of biomass into biofuels. In this context, research concerning the decarbonated production of hydrogen will have to be intensified. This energy strategy should make it possible to minimise the use of fossil hydrocarbons as fuels, conserving them as a resource for transformations by fundamental chemistry.

Energy efficiency in buildings and industry is another important aspect of the energy transition. This includes the lightening of metal structures, thermal insulation, selective filtering of solar and infrared radiation and the sobriety of industrial techniques and processes. Lightening vehicle and building structures (frames), making engines more efficient and insulating buildings more effectively will all require "designing" the ideal materials. Constant attention must be paid to the sustainable management of strategic raw materials, especially metals. The design of novel functional materials is an area in which the CNRS will continue its efforts, sometimes in synergy with major industrial groups such as EDF, Total and Air Liquide within the Energy Transition Institute (IPVF), Solvay for the conversion of biomass into biofuels through electrochemistry or the action of new catalysts, Arkema on the development of organic photovoltaics.

Concerning distribution, the challenge is to develop solutions based on uses, for example by using the energy stored in private homes e.g. batteries in electric vehicles and by controlling energy-consuming domestic equipment on a local or centralised scale, etc. Efforts should also focus on adaptive intelligent electric networks - smart grids.

The study of interactions between energy transition and economies of fossil fuel exportation and the consideration of the energy ecosystem are the subject of research that focuses on the description of the entire life cycle. This aims to avoid falsely virtuous solutions such as hidden energy or CO2 costs. CO2 capture solutions at the world's 8000 major production sites will also be considered, along with its underground storage. Finally, the CNRS is original in that it aims to reinforce the effectiveness of these solutions by integrating tools and contributions from the humanities and social sciences in particular from the anthropological, sociological, political, economic and behavioural sciences. Thus, CNRS laboratories will work on all production chains right up to the installation sites of the devices. Only this form of integration is capable of ensuring sustainability is adopted as a concept with full public commitment from the very beginning of the research.

Heliostats of the THEMIS solar power plant in Targassonne in the Pyrénées-Orientales region.



© Spiroview Inc. / Stock.Adobe.com

3 I PARTNERSHIPS WITH UNIVERSITIES AND SITE POLICIES

The CNRS's history means it now has a presence throughout France as a research organisation with almost all of its research units run jointly with one university or more1 and sometimes with other research establishments. **For that reason our strategy needs to be adapted to the sites involved in a logic of close partnerships with the universities and all those involved in the local ESRI ecosystem.**

3.1 CONTRIBUTING TO THE EMERGENCE OF MAJOR UNIVERSITIES AT THE HIGHEST INTERNATIONAL LEVEL

Driving and enhancing the dynamic of emergence of major research universities of the highest international standard is one of the major objectives of French national higher education, research and innovation policies. As the leading national research organisation within the national ESRI system in terms of size and research diversity and with a significant presence on major university sites2, the CNRS will commit to increasing its contribution to this dynamic.

This requires the definition of strengthened and integrated site policies that are jointly developed and implemented by each site's stakeholders in the framework of "site governance". Such governance needs to be constructed with the reference university - when there is one - and other main organisations on the site so that it is well adapted in each case. These site policies will be applied to a wide range of shared subjects:

- joint research priorities with a shared vision of the site's strengths and the evolutions required in all the major research fields present on the site and that promote interdisciplinarity;
- shared elements in terms of recruitment policy and researchers from the organisations involved taking part in teaching work;
- shared elements in terms of partnership research, innovation and technology transfer policy particularly as regards setting up and developing relations with companies;
- concerted actions aimed at improving the site's teams' involvement in European research and innovation programmes;
- joint actions aimed at enhancing the site's attractiveness, strengthening training through research and the professional integration of PhDs, reinforcing relations between research and society and disseminating scientific culture;
- joint actions to reinforce European and international cooperation projects, particularly those that are part of the site's strategic partnerships;
- joint investment projects as regards scientific equipment and research infrastructures; etc.

For all the volunteer sites, the development and implementation of these integrated site policies will be based on **reinforced dialogues with all the site stakeholders,** following on from the "university-organisation workshops" the MESRI ran in the first half of 2019. To achieve this, the CNRS will rely on the organisation it set up to increase its presence and responsiveness on these sites. This organisation relies on the referent scientific director, his or her deputy directors and the CNRS regional office involved and thus paves the way for regular interaction with the site's stakeholders. It is also supported at the national level by the CNRS's Public Partnership Support Department (DAPP).

It is normal for each institution to first define the broad outlines of its strategy after prior consultation with its partners as the CNRS is doing with this COP. Dialogues with the stakeholders on each site should serve to share these institutional strategies and develop the best level of synergy possible by identifying common priorities and projects at the crossroads of the strategies of several stakeholders that can be worked on jointly. This intensive dialogue is essential for building and strengthening trust and a site's stakeholders' capacity for joint action. The CNRS and the State are both aware that a shared desire for such dialogue is required which is not always a simple matter. As a national organisation, the CNRS's role is to inform each site of its national and international vision of the research landscape and important research issues. Matching local strategies with this vision and choices that need to be made at national level can bring up legitimate difficulties. However, the organisation is firmly committed to this process of strengthening site policies with all the major university sites that volunteer to be involved and will work alongside the MESRI to continue the commitment to the process of renewing the five-year contract with these sites. The MESRI will work at the central level and at the decentralised level with the "rectorats" (local education authorities) and regional research and technology offices (DRRTs) to support stakeholders in constructing these reinforced site policies. Whenever relevant, the policy construction will involve other stakeholders, local authorities and socio-economic actors whose missions and roles will of course be taken into account.

1. In this and the following sections, the generic term "university" refers to "écoles" and institutions that are established or being established under the December 2018 Order.
2. More than 80% of CNRS permanent staff are assigned to 13 university sites and over 90% are assigned to 19 sites.

Implementing reinforced and integrated site policies will lead to a review of some of the indicators set out in the institutions' contracts. This review will define a site's stakeholders' shared indicators that are linked to the main objectives of the site policy they implement together. In other words, indicators need to be defined that will reflect a site's successes and the progress of joint actions rather than stakeholders' separate achievements. The CNRS will set up a study of this subject with its main partner universities and organisations in conjunction with the MESRI.

ACTION 7
Work alongside volunteer sites to construct site policies to enhance the dynamics for the emergence of major research universities at the highest international level.

ACTION 8
Work with partner universities and organisations and in connection with the MESRI in 2020 to develop a proposal for site indicators to monitor the activities of a university site's stakeholders.

3.2 A CNRS THAT IS WELL-GROUNDED IN FRENCH TERRITORIES

The CNRS is fully behind the priority accorded to the emergence of major research universities at the highest international level but also aims to continue working **alongside all universities** on the basis of its range of research themes, its geographical presence and its long history of cooperation with universities. These partnerships cannot be developed in the same way as with very large universities that are well-placed in the international rankings. The CNRS will however aim to ensure that partnerships with universities with more targeted ambitions are also part of a genuine strategic synergy. This kind of partnership should correspond to a form of "excellence niche" that will provide a site with prestige in a given field at the highest international level.

The CNRS intends to work with all universities to **help provide effective grounding for ESRI in the French territories.** Many of the ideas and actions set out in this COP can be implemented with the universities on a site-by-site basis in a spirit of partnership and voluntarism that takes full account of local specificities. This is particularly the case for initiatives involving developing relations with the economic fabric (particularly SMEs) and with society.

The CNRS is convinced that it must further **strengthen its links with local authorities** - particularly in France's regions and major cities - by making sure partner universities are kept as well informed and involved as possible. In dialogues with the local authorities the CNRS can as always offer its national and international perspective combined with an informed view of the authorities' assets and strengths. It will offer to develop partnerships with the local authorities through a certain number of actions like co-financing theses, joint scientific culture initiatives, pre-maturation projects or support for start-up companies that bring together partner universities and research units.

3.3 IN PRACTICE

The joint research unit (UMR) model is now widely acclaimed despite remaining atypical internationally. However it is commonly agreed that solutions need to be found to make it lighter in terms of administrative structure and to **simplify life for the management and staff of such units.**

More specifically, the work requested by the MESRI on these units' **primary and secondary supervisory authorities needs to be taken further.** The governance of UMRs must be made more fluid by making clearer distinctions between establishments with a strong and broadly transversal involvement in the unit - the main supervisory authorities - and those with a lesser or more targeted presence - the secondary supervisory authorities. Work also needs to be done on the idea that the CNRS could become the secondary supervisory authority of a UMR rather than the main authority if there is a minimal quantitative presence of CNRS staff within the unit. If this latter presence is non-existent or insignificant, then the CNRS should leave the universities concerned to manage their unit alone.

The CNRS's regional offices and partners already work together on many joint actions at the local level that act as an essential and pragmatic complement to the strategic cooperation mentioned above. This is particularly the case for local support functions in areas like communication, occupational medicine, health and safety and information systems. Such areas are jointly managed to varying degrees in terms of coordination, secondment and pooling and this is intended to develop.

The CNRS wishes to **create deeper relations with its academic partners in terms of providing more in-depth support for research units.** The organisation will continue to be part of initiatives aimed at harmonising and simplifying research units' processes and tools. The context of there being multiple ESRI stakeholders means there is a great need to simplify UMRs' processes for the units' management, administrators, laboratory staff and also for the institutions themselves. The CNRS will offer to set up **joint support units with volunteer universities to simplify and improve the administrative management of UMRs** and enable all such units to benefit from research support services. It will also continue to be involved in the projects of the "SI Labo programme" and its follow-up initiatives in the framework of guidelines set by the MESRI and in conjunction with the Shared Services Agency for Universities and other Higher Education Institutions (AMUE) and all the partners involved.

The CNRS will also work in combination with volunteer universities to **enable UMR directors to take on a real scientific leadership role** while liberating them from too many management tasks. There are numerous tangible paths for joint action - setting up joint management dialogue between all the supervisory institutions and unit directors as often as possible (at a frequency to be determined); training courses for unit directors put in place jointly by the supervisory institutions of the laboratories on a site; implementing a communication policy towards the laboratories as defined with the supervisory authorities; proposals for a secondment to the CNRS - or being freed from teaching work - for academics who are directors of units for the duration of their mandate (on a full- or part-time basis according to the size of the unit); etc.

Ways can and must be found at the scale of university sites (particularly larger sites) to make innovation support and technology transfer mechanisms simpler, better shared and more effective. This subject will be dealt with in section 4 below.

On another level, the CNRS will continue to work with the MESRI and the conferences of institutions on defining the best ways of pooling joint actions among ESRI players at the national level. In view of this, the organisation is ready to examine the possibility of joining the AMUE as it is currently the only main EPST that is not a member.

Along with the AMUE and Renater, the CNRS will contribute to enriching IT support services for laboratories.

Finally, when the CNRS became a "central purchasing unit" in 2015 this provided the organisation with an effective system to make it easier to provide its partners who so desire with products or services acquired under contracts awarded by the CNRS without the need for grouped orders. The CNRS is ready to suggest to its partners that the use of this system should be extended when appropriate and in consultation with the AMUE

ACTION 9
Continue work on reducing the number of supervisory authorities for UMRs and making a distinction between primary and secondary supervisory authorities.

ACTION 10
Actively continue its involvement in the SI Labo programme's follow-up initiatives in the framework of the guidelines set by the MESRI and in conjunction with the AMUE and all the partners concerned.

INDICATOR 5
The number of joint support units set up to simplify and improve the administrative management of UMRs.

4 I INNOVATION

Vance Bergeron, CNRS physicist and winner of the 2019 Innovation Medal with the "Carbon Trike". This carbon fibre recumbent tricycle was developed with a team from ENS Lyon who took part in the electrically powered bicycle event at the 2016 Cybathlon (Olympics for augmented athletes).

One of the major developments over the last twenty or thirty years at the CNRS has been the increasing importance accorded to relations with the economic world and the goal of transferring and exploiting research results wherever possible and relevant. Results in this area for all units under the supervisory authority of the CNRS are far from negligible:

- **a significant level of production of patented inventions, with a portfolio of more than 6800 patent families**
- **a total of over 1500 start-up companies created to work on inventions deriving from joint research units, with nearly 100 start-up companies created annually;**
- **nearly 150 joint CNRS-business structures including 17 joint research units run with industrial concern and over 130 joint laboratory agreements.**

The CNRS wishes to go even further in this direction as reflected by the creation of the CNRS Innovation Office in 2019 to coordinate all sectors of the organisation involved in the technology transfer process for its research results. It endorses the three urgent requirements identified in the September 2019 report by the "Partnership Research and Innovation" working group set up in the framework of the multiannual Research Programming Law:

- **the urgent need to create new leaders based on public research discoveries that will lead to the market breakthroughs of tomorrow;**
- **the urgent need to significantly increase the amount, depth and continuity of public-private, public-public and public-civil society interactions:**
- **the urgent need to significantly enhance the simplicity, agility and speed of the process to effectively and fully reveal the potential for partnership research and innovation in public laboratories and empower innovation process stakeholders.**

Three strategic orientations directly linked to these three urgent requirements will be implemented to consolidate ongoing research technology transfer initiatives, further increase the transfer of knowledge to companies and, more generally, to society as a whole, and increase the economic impact of such technology transfers.

4.1 SUPPORT THE ANNUAL CREATION OF AN EXTRA 50 START-UP COMPANIES WITH STRONG GROWTH POTENTIAL

The overall objective in this area is to set up more start-up companies with strong economic development working on inventions by our joint research units and also to increase transfers to companies. This is primarily a qualitative objective. The idea is more to support the creation of technological start-up companies likely to develop strong long-term economic growth than just to increase the absolute number of start-up companies created. Of course, this means creating more than the 100 start-up companies that currently emerge each year from laboratories for which the CNRS is the supervisory authority. However it is also and above all a question of identifying, supporting and monitoring **at least 50 start-up companies each year** that are natively Deep-Tech and **have proven potential for economic growth.**

The set of steps leading from the laboratory to the market form a value chain in which each of these steps depends on the quality of the work accomplished in the previous step. **More projects need to be identified upstream in laboratories** to reinforce the impact of this chain of actions. This requires the definition and implementation of a plan to systematically visit all the 1,000+ joint research units over a two-year period. This plan should focus on targeting research units thought to have unexploited potential while taking into account a unit's research themes and history in terms of technology transfer. It is intended to function in a framework of coordination on each site with the universities and organisations with joint supervisory authority over the laboratories concerned and also with other stakeholders involved in raising awareness and project detection such as SATTs (technology transfer companies) or Bpifrance.

The most promising projects identified will then be supported in the framework of a proactive pre-maturation policy. The CNRS wishes to **double the current number of projects receiving support for pre-maturation** (i.e. bringing projects to a level of technological maturity equivalent to TRL 3) to reach a target of around 100 such projects per year. This objective will be achieved while maintaining the current demanding level of project selection and in conjunction with sites and regions that have pre-maturation funding. As a complement to the current generalist policy, the CNRS wishes to define research fields with high innovation potential which requires a paradigm shift in project analysis methodologies. This innovative approach appears more suitable for the transfer of subjects in the fields of the humanities and social sciences, the ecology and the environment and science of the Universe.

A portable biological analysis device developed by the MagIA Diagnostics start-up company.

At the end of the pre-maturation phase, the best projects are preferentially directed towards maturation initiatives run by the SATTs which will ensure their growth from TRL 3 to higher technological maturity levels (typically 5 to 6). To achieve this, the CNRS will develop more balanced operational relations with the SATTs working in close collaboration with its university partners. The CNRS will also strengthen its role as a shareholder for the SATTs and participate to a greater degree in their governance and management.

Finally, the end-to-end action initiated as soon as a project is detected in a laboratory characterised by a high level of selectivity is concluded by reinforcing the current RISE programme (particularly its support component focused on strengthening the relevance of the business plans and teams of the supported projects). Three levers will need to be worked on:

- the proposal of a financial support system for the first round of funding for new start-up companies that is adapted to the CNRS's specificities (strong thematic diversity and broad territorial presence), complementary to existing national initiatives (the French Tech Seed fund) and in synergy with existing initiatives run on university research sites;
- the creation of a management support system for very early-stage projects;
- the implementation of a complementary service offer to lead the network of 1500 start-up companies originating from the CNRS while making sure such services function in good synergy with existing mechanisms.

ACTION 11
Work with partner universities to affirm the role of SATTs as the prime partners in the maturation of projects from laboratories under the CNRS's supervisory authority.

ACTION 12
Strengthen the RISE programme that supports the structuring of start-up companies with high development potential in terms of financing, support and network management.

INDICATOR 6
The number of start-up companies set up on the basis of technology or know-how transfers from units under the supervisory authority of the CNRS and including the number that have high development potential (target values: 150 and 50 for the latter).

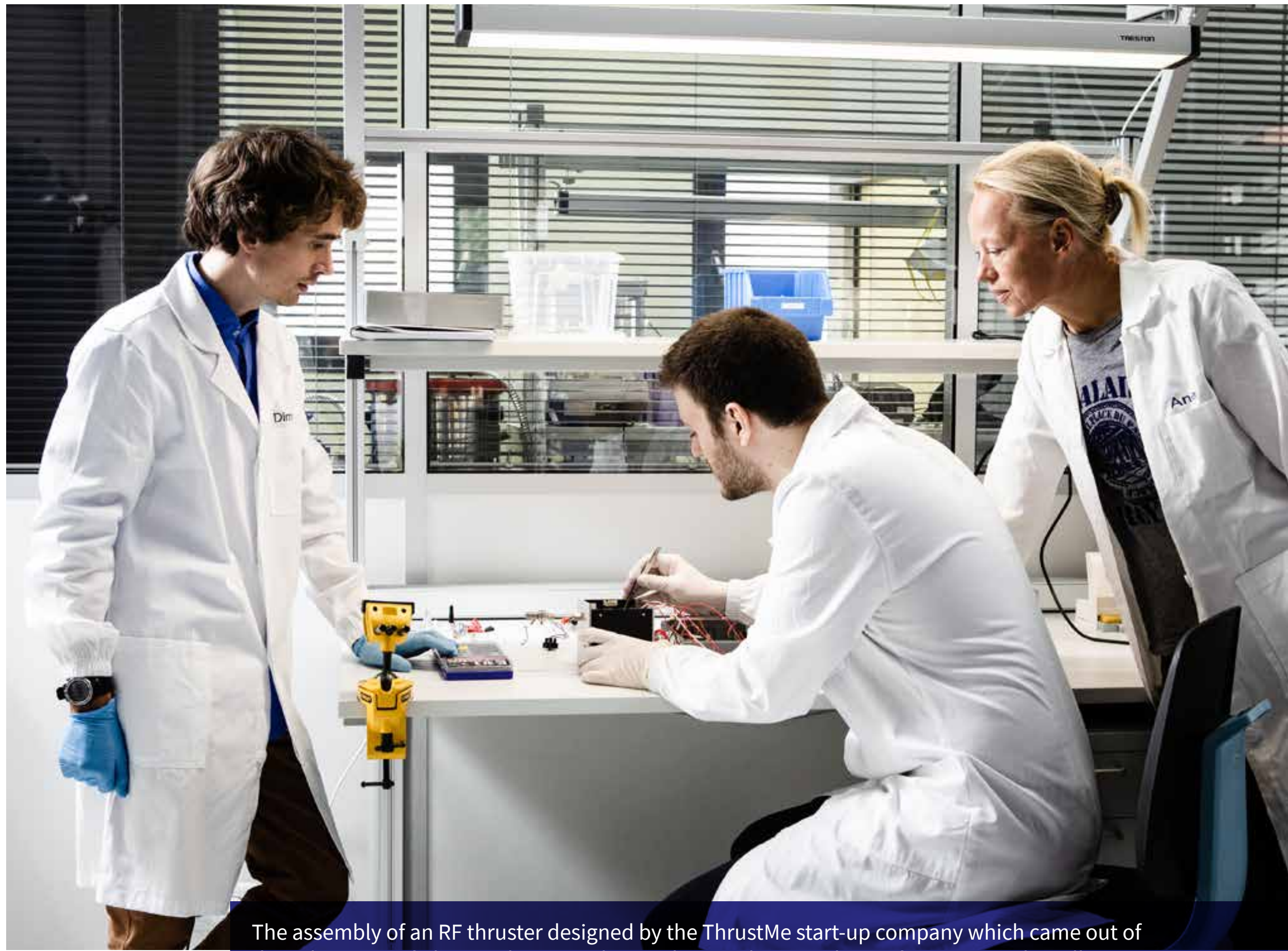
INDICATOR 7
The number of new projects supported for pre-maturation.

4.2 DEEPENING RELATIONS WITH COMPANIES

Increased investment in research and development is required to maintain French companies' competitiveness. The CNRS's world-class capacity for multidisciplinary research means **it can contribute to strengthening companies' scientific potential in the framework of a renewed relationship involving listening, dialogue and partnership.** To achieve this, the CNRS is setting up a joint team made up of both scientists from its Institutes and business development officers (initially half a dozen such officers). This joint team will lead and coordinate actions at several levels.

For each major industrial sector, it will be necessary to work in liaison with the strategic industry committee (CSF) to map the skills and capacities of the laboratories under the CNRS's supervisory authority taking pointers from the model created for the "Microelectronics initiative". The CNRS will be able to identify, put forward and run pre-competitive projects in relation to the different sectors by basing its work on the CSFs' cross technology/market roadmaps. Such work will also be closely linked to the joint MESRI - Ministry of Economics and Finance initiative involving a high-level representative of the academic world being part of each CSF.

Deepening relations with companies in this manner should make it possible to understand more about the issues they face, their requirements in terms of scientific resources and the technological obstacles they come up against. Closer collaboration of this kind should lead to shared roadmaps and joint actions aimed at defining and monitoring of a growing number of joint research projects (particularly via joint structures). This in turn should help increase the number of collaborative projects that apply for European funding.



The assembly of an RF thruster designed by the ThrustMe start-up company which came out of the Laboratory of Plasma Physics and specialises in the propulsion of miniaturised satellites.

It is also crucial for the sustainable development of a local economic fabric to increase relations with SMEs on research and development issues. This serves to counter the dual pitfall of SMEs being spread out throughout France and a cultural distance from SMEs that can often be significant. To develop proposals for this economic sector, the CNRS and its university partners aim to define a pragmatic methodology for working more closely with SMEs particularly via regional innovation intermediaries like the CRTs (technological resource centres) and Carnot Institutes by **providing a "service offer" adapted to the size and needs of SMEs.** This service offer should make it easier for SMEs to access the skills of the laboratories under the CNRS's joint supervisory authority and lead to an increase in the number of joint laboratories run with SMEs by developing creation and monitoring methods that are adapted to smaller companies.

When necessary the CNRS will also analyse opportunities to develop activities that help increase the TRL of discoveries made by research units working in relation with companies. To achieve this, **the CNRS wishes to set up a network of 100 transfer engineers in charge of supporting joint laboratories,** particularly those constructed with SMEs.

Bringing laboratories and companies closer together also means **encouraging the mobility of people in both directions,** particularly through part-time secondments. Special attention also needs to be paid to PhD students in conjunction with the universities, particularly by encouraging the use of CIFREs (Industrial Conventions for Training through Research) and providing these students with the right support.

ACTION 13
Develop a specific "service offer" for SMEs.

OBJECTIVE 2
Set up a network of 100 transfer engineers in charge of supporting increasing the TRL of discoveries made within the framework of CNRS relations with companies, particularly in joint laboratories.

INDICATOR 8
The annual amount represented by research contracts with companies.

INDICATOR 9
The number of joint CNRS-company units (target value: + 20%)

INDICATOR 10
The mobility of CNRS researchers and engineers towards companies.

Sodium-ion (Na-ion) battery cells developed by the Tiamat start-up company. These convert electrical energy from current into chemical energy and vice versa.

4.3 DEVELOPING PRAGMATIC AND AGILE INTELLECTUAL PROPERTY MANAGEMENT IN THE CONTEXT OF INTEGRATED SITE POLICIES

Intellectual property management issues underpin the two strategic axes presented above. Intellectual property is the vector of choice for development towards the industrial sector but conversely too often represents an obstacle to fluid exchanges with companies. The objective in this area is to **simplify the conditions of access to the intellectual property managed by the CNRS** without giving up on reasonable prospects for creating economic value.

To achieve this objective, the CNRS needs a coordinated implementation of actions to simplify how it organises its intellectual property management internally and to clarify its expectations in this area. This action is part of the quest for greater overall efficiency in public intellectual property management.

More generally, the CNRS's work on technology transfer cannot be isolated from the actions of the national innovation ecosystem. **In the framework of the reinforced site policies** set out in the previous section, the CNRS's objective is to encourage the construction of collective action with universities and other innovation stakeholders **to make local partnership research and innovation systems more agile and efficient.** In the spirit of the "university innovation poles" evoked in the September 2019 report mentioned earlier, the aim will be to work with volunteer sites:

- to organise relations with the economic sphere and local stakeholders in a unified way along with shared governance that closely associates the CNRS, academic stakeholders and the main technology transfer and partnership research tools (SATTs, incubators, etc.);
- to set up operational mechanisms that simplify the technology transfer process (a single agent with an extended mandate, an agreement on the distribution of intellectual property shares, etc.);
- to effectively steer the unified system with collective indicators on the impact for the economic fabric and efficiency indicators on technology transfer systems (including, for example, an indicator for measuring "transaction times" for technology transfer operations).

In this context, the CNRS will aim to develop its relations with the Technological Research Institutes (IRTs) and French Institutes for Energy Transition (ITEs) while also working more closely with the competitiveness poles, notably for relations with SMEs, and relying particularly on the DRRTs. Finally, close attention will be paid to work that needs to be carried out with local authorities to link regional logics and national strategies for the development of platforms and demonstrators or constructing collaborative projects.

ACTION 14
Simplify the conditions for access to the intellectual property managed by the CNRS.

OBJECTIVE 3
In the framework of site policies, construct a collective approach to public research technology transfer with willing universities.

INDICATOR 11
Nombre de licences d'exploitation issues des inventions des unités dont le CNRS est tutelle.

5 I EUROPE AND INTERNATIONALLY

The Espace Léopold at the European Parliament in Brussels. © Sergey Kelin / Stock.Adobe.com

The CNRS is well-known, recognised and respected on the international scene. **The CNRS's international dimension is essential and needs to be strengthened further.**

The international influence of the CNRS is also reflected in its strong presence among the winning scientists, teams and consortia in the various calls for projects organised within the Framework Programme (FP). And in fact, for years now, the CNRS has even been **the leading beneficiary of the FP** which is a remarkable result, even for an organisation of our size. However, **progress still needs to be made,** especially in certain disciplines like the HSS where our results do not match our ambitions and concerning the quality of the research carried out in units for which the CNRS is the supervisory authority.

The CNRS also stands out because of its high number of research structures, projects, networks, research infrastructures, co-funded doctoral student programmes and regular exchanges of scientists with foreign institutions, universities or research institutes. These cooperation initiatives contribute to France's influence beyond science and provide a real return on investment, particularly in the case of research infrastructures. The CNRS's view is that that effort on structuring with a few major partners will be useful and the organisation intends to pay particular attention to Africa and developing countries.

Finally, the CNRS recruits a significant number of non-French scientists to its permanent staff and even more non-permanent staff - mainly PhD and post-doctoral students. Like all major research institutions, it is essential to preserve these levels of recruitment and this issue will be dealt with in section 7.

5.1 HORIZON 2020, HORIZON EUROPE AND EUROPEAN PROGRAMMES

The main objective is to **enhance the performance of the CNRS and the entire French ESRI system in the various calls for projects organised in the framework of the FPs and certain other European programmes.** This objective is a full part of the action plan aimed at improving the level of French participation in European research and innovation programmes led by the MESRI and the other ministries concerned.

The CNRS has suggested installing its Brussels office within a "House of French Science (or Research) and Innovation" bringing together all the French ESRI stakeholders who are interested and willing to take part. This kind of structure would enhance its members' visibility, promote synergies and facilitate pooled actions in certain areas. Scientific conferences and seminars would be run to ensure the presence of French research in Brussels.

In fact **the CNRS will continue and develop its influence strategy with its partners in Brussels, in conjunction with the MESRI and its French partners** whether this house is set up or not. Some of the actions in the framework of this strategy will be jointly implemented with the other members of the "European G6" - the Max Planck, Helmholtz, Leibniz (Germany), CNR (Italy) and CSiC (Spain). These are all organisations which the CNRS maintains regular relations with. The CNRS will also make sure to maintain regular contact with CNRS or ex-CNRS experts posted in Brussels and will encourage French scientists to take part in thematic discussions, ad-hoc committees and evaluation panels in Brussels.

Increasing and enhancing the level of French performance in the different European calls for projects requires **awareness-raising and supporting scientists and laboratories.** Information on the various calls for proposals needs to be improved and training should be increased. These types of actions often need to be thought out at site level and the universities will be invited to carry out this work jointly with the CNRS. It is also important to encourage French scientists to take part in networks of experts and as members of various panels.

The CNRS will make a special effort to encourage projects that are submitted in the framework of the "Industrial Leadership" and "Societal Challenges" pillars of Horizon 2020 while also aiming to maintain a top-level presence in the "Excellent Science" pillar, particularly at the ERC.

Support in setting up European projects must also be provided. The CNRS wishes to do this on two complementary levels - by reinforcing the Institutes' involvement in scientific support and by **recruiting 100 engineers to help set up European academic research, collaborative research or innovation projects** funded from its own resources (the overheads of the selected projects). Once a project has been selected, better support to the grant winners in managing their projects must also be provided. The awareness of the CNRS regional offices' Partnership and Technology Transfer Departments (SPV) will be enhanced as regards the importance of providing this support. Finally, the CNRS wishes to offer **to finance the equivalent of 50 full-time posts in the regional offices each year in conjunction with partner universities. This staff would work on facilitating the submission of European projects** by academics, particularly ERC applications. The CNRS would also like **to increase the bonuses awarded to ERC winners and leaders of collaborative projects.** There is a dual objective to this increase in bonuses - to achieve standardisation between French public institutions and to enhance attractiveness to major European institutions.

ACTION 15
Continue and develop the influence strategy as regards the European Commission working in collaboration with the MESRI and our French partners.

ACTION 16
Support and more effectively inform scientists and units in submitting to European calls for projects, particularly those run by the ERC and EIC.

OBJECTIVE 4
Recruit 100 engineers to provide support for setting up all kinds of European projects.

OBJECTIVE 5
Finance the equivalent of 50 full-time posts in the regional offices each year to work on facilitating the submission of European projects by academics.

INDICATOR 12
The number of European projects submitted by units for which CNRS is the supervisory authority and the number of projects selected (with a breakdown by pillar).

INDICATOR 13
The number of ERC projects in units for which CNRS is the supervisory authority.

INDICATOR 14
The number of European multi-partner projects including the number of such projects run with companies and the number of projects for which CNRS is the sole coordinator.

INDICATOR 15
The total European Commission revenue (target value: a 25% increase compared to the 2014-2018 period).

5.2 STRATEGIC PARTNERSHIPS IN EUROPE AND INTERNATIONALLY

International cooperation is an inherent and integral part of CNRS scientific policy. Of course, it is important to cooperate with the best international institutions and research teams to strengthen scientific excellence, share knowledge, attract talent and stimulate innovation. Beyond this though, the work of certain disciplinary areas depends on access to fields or objects of observation outside France and also on using and developing international-level infrastructures. The interconnection of these different objectives (thematic excellence, attractiveness, geographical priorities, institutional visibility issues) and cooperation tools (the CNRS and its partners' mechanisms, infrastructures, European and international prospects and programmes) is at the core of the CNRS's international strategy.

The CNRS cooperates a great deal with a limited number of institutions throughout the world and this involves different Institutes and various themes. The CNRS will propose to the main institutions involved that **these strategic partnerships be reinforced and made durable** through "structures without walls" bringing together, namely the **International Research Centres** (IRCs). Each IRC will be monitored by regular meetings of a bilateral committee at the highest level of the two institutions involved. This committee will identify certain strategic areas linked to research fields in which both institutions have teams at the highest international level and a concerted joint effort will be made on the identified axes. Several universities in other countries have already expressed strong interest in this proposal.

The **International Research Centres** will bring together all the work the CNRS currently carries out with a partner institution - International Research Laboratories (IRLs) and Projects (IRP), International Research Networks (IRNs) and also, when appropriate, co-funding programmes for PhD students or exchanges of scientists. A certain number of joint laboratories run with universities abroad have been set up in association with French universities (a mechanism that is likely to develop). Similarly, the IRCs may involve French universities that have a stated international priority to develop permanent relations with a foreign partner institution. How this form of association for all or part of the IRC spectrum is implemented can be defined on a case-by-case basis.

Currently, the CNRS's relations with its partners in other countries are almost exclusively situated outside France except the joint laboratory in Metz run with Georgia Tech (USA). The CNRS will work with its foreign partners to look into setting up this kind of international laboratory in France, particularly in the framework of the IRCs presented above. Of course, such laboratories will be constructed in partnership with universities in France.

To develop its international partnerships further, the CNRS also aims to go further with the 2019 programme aimed at providing **funding for PhD students each year on a reciprocal "one for one" basis** with a partner institution abroad. It seems reasonable to aim for around one hundred new contracts per year - i.e. the equivalent of around fifty to be funded by the CNRS. The CNRS would also like to once again **finance hosted posts** for scientists who already have a post in an institution abroad to enable them to make one or more long-term stays in France. These kinds of exchanges are particularly useful for developing and maintaining scientific collaboration initiatives and also for jointly constructing European or international projects. The objective here is to finance the equivalent of 100 full-time posts per year. Some of these "international chairs" could be granted on a multi-year basis with the scientists appointed committing to several long-term working stays in France over a period of several years.

Finally, the CNRS will work with its major industrial partners to study together the possibility of setting up joint laboratories **outside France** in priority countries for these partners. This would follow on from existing laboratories run with Saint-Gobain in Japan and the United States, with Solvay in China, with Thalès in Singapore and the laboratory currently being set up in Australia with Naval Group.

Another ambition for the CNRS is to **enhance and increase our collaboration with African countries** as Africa is a fast-growing continent with strong scientific potential. Even though such forms of cooperation already exist, particularly through the UMIFREs (joint units with a French institute abroad), considerable room remains for improvement and the same is true for a certain number of high-development countries. For example, the CNRS has only one joint laboratory with a university in sub-Saharan Africa, the laboratory in Senegal. It is quite rare for these countries to have scientific institutions with high visibility in terms of international collaboration with their scientists. The CNRS will therefore initiate a study aimed at developing a **multi-year cooperation plan** involving all its Institutes that takes the specificities and expectations of the countries concerned into account. This study will involve the Ministry of European and Foreign Affairs (MEAE) and will thus include an exchange on the role and missions of the UMIFREs. It will also involve the MESRI, the IRD and the Agricultural Research Centre for International Development (CIRAD) to make sure our approaches and actions are complementary. Finally the study will naturally integrate French universities that have defined Africa and/or certain high-development countries as a priority for their international strategy.

ACTION 17
Construct strategic partnerships in the form of International Research Centres (IRC) with some of our main partners outside France.

ACTION 18
Establish a multi-year cooperation plan with Africa in 2021 by involving the relevant stakeholders in France and other countries.

OBJECTIVE 6
Fund 100 full-time hosted posts for scientists from other countries.

6 I SCIENCE IN SOCIETY AND OPEN SCIENCE

A magnetic tape storage library at the National Institute of Nuclear and Particle Physics's Computing Centre (CC-IN2P3). This research infrastructure designs and operates a system for the mass storage and processing of large amounts of data.
© Cyril FRESILLON / CC IN2P3 / CNRS Photothèque

The image of researchers working in isolation or in a kind of ivory tower is increasingly a thing of the past and indeed should be relegated to this status for good. **Scientists must continue to take their full place in society** and for once and for all abandon the top-down model of an academic authority that imposes its ideas on relatively uninformed citizens. We need to **explain, dialogue and sometimes debate more** to overcome mistrust and support public decision-making with modesty, high standards and ambition. This professionalisation of scientific mediation will be taken into account and applied at all levels of the CNRS - from laboratories to the general management and including our regional offices and Institutes.
In a context in which our fellow citizens' trust in science is sometimes unsettled, the scientific community **must aim for exemplarity in terms of ethics and scientific integrity.** The CNRS has a responsibility to pay the utmost attention to such subjects by relying on the mechanisms we put in place in 2018 (Scientific Integrity Officer, Ethics Officer and Whistleblower) and by developing awareness-raising and training initiatives for laboratory staff and the organisation as a whole.
One of the levers involved in rethinking the place of researchers and the CNRS in society in this way is the paradigm of open science. This makes full use of all the opportunities offered by digital technology to share research publications and data with all and thus make the circulation of knowledge more fluid, faster and freer.

6.1 SCIENCE IN SOCIETY

The view that laboratories live in a form of "splendid isolation" from the world around them is very far from the truth. Instead their work is influenced by and resonates with the challenges facing our societies such as climate change, the erosion of biodiversity, digital intrusion into all spheres of our lives, ageing populations or radicalisation. We currently live in a context of continual questioning of science's achievements and the CNRS intends to deal with such issues by providing scientific discourse for the media and the public at large and scientific insight to support public policy-making. The societal challenges set out in section 2 above will be the subject of original participatory scientific experiments involving citizens, decision-makers and scientists alike.

It is more crucial than ever **to provide access for all to the work and results of researchers.** In addition to "classic" initiatives like the Fête de la Science, conferences, exhibitions and other events for the often-well-informed general public, the CNRS will reorientate its communication and knowledge dissemination policy to reach new audiences. In this context, special efforts will be made to reach out to teachers and a partnership policy with the major cultural establishments and CCSTIs (scientific, technical and industrial culture centres) will be pursued along with deepened working in conjunction with our university partners in the regions of France.

Another ambition for the CNRS is to reinforce its actions aimed at providing **scientific expertise to support public policy-making.** Interactions with major State administrations will be amplified particularly through supervised and enhanced collective expertise and based on the model of existing "research-action" partnerships with the Ministries of Justice and the Interior, the Directorate of Military Intelligence (DRM) and the Gendarmerie. The CNRS's multidisciplinary dimension and specific contributions from the HSS will facilitate and enrich this policy of support for public decision-making. This type of collective expertise work will be encouraged and supervised to facilitate access to sensitive data.

In parallel, the **CNRS Foundation** will play an important role in research outreach and will enhance the visibility of the organisation throughout society. The themes of the societal challenges identified in section 2 will be included in programming the first targeted actions.

ACTION 19
Create new training and awareness-raising courses for teachers in the French national education system.

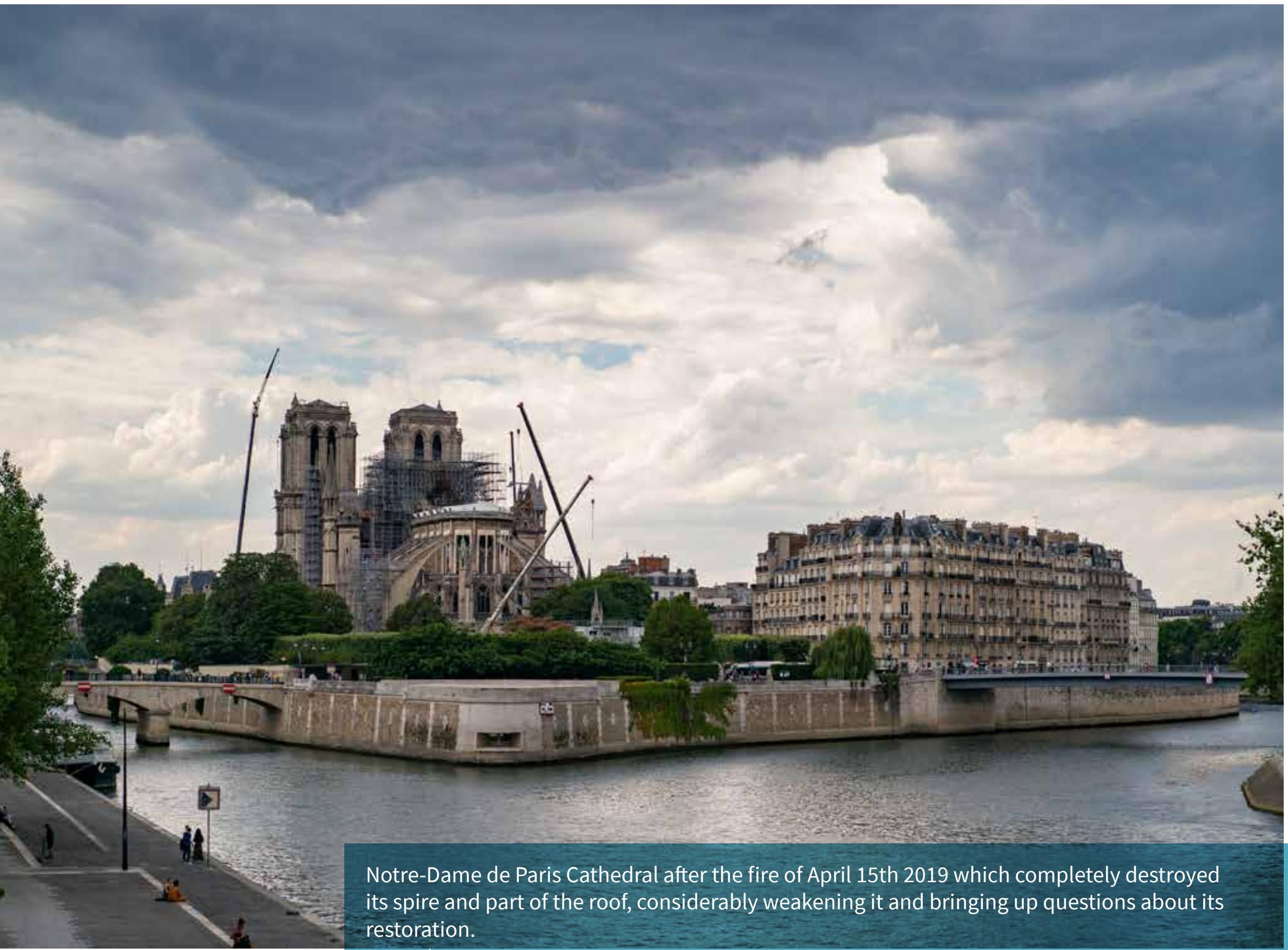
ACTION 20
Increase and enhance partnerships with the major cultural institutions and with scientific culture stakeholders throughout France while including these actions in the framework of relations with the regions.

ACTION 21
Develop new participatory science initiatives particularly in the fields of the six societal challenges set out in section 2.

ACTION 22
Promote and manage the CNRS's capacity for collective expertise and involve the scientific communities to provide scientific expertise for the State and public authorities.

INDICATOR 16
The production and dissemination of information on the CNRS website and on social media.

INDICATOR 17
The number of subscribers to the CNRS social media pages.



Notre-Dame de Paris Cathedral after the fire of April 15th 2019 which completely destroyed its spire and part of the roof, considerably weakening it and bringing up questions about its restoration.

6.2 OPEN SCIENCE

Open science reinforces the link between science and society by freely disseminating publications and, as far as possible, research data. This gives all sectors of society (citizens, students, associations, companies, etc.) access to knowledge deriving from research. Oalso enhances the quality of research because it gives researchers the means to go beyond community- or discipline-specific silos. Open science strengthens knowledge by giving access to the data underpinning publications which had previously been buried in laboratory archives. Data is now potentially available to all so that the findings of existing publications can be confirmed, discussed or refined. This can also often lead to new knowledge being produced.

The international open science movement began over 30 years ago but it is now going through unprecedented development because the web has made global open science possible at reasonable dissemination costs. The CNRS will work at the European level, particularly with its counterparts in the "European G6" (see section 5.1), to lead a coherent, proactive and ambitious policy to promote open science. In France, open science will be developed within the framework of the national plan led by the MESRI with all research stakeholders and particularly with university partners and other research organisations.

The CNRS will implement **a proactive policy for the development of open science** with tangible objectives to speed up this development in the following four main areas:

- scientific production - with the ambition of achieving 100% of CNRS joint research units' publications in open access by the end of this COP period; this will involve developing the Centre for Direct Scientific Communication (CCSD) - the joint service unit that pilots HAL - by giving it the means to achieve a new level of ambition and by supporting scientific open access publishing;
- research data - with the development of a data management and sharing culture based on implementing the FAIR principles (Findable, Accessible, Interoperable and Reusable) among all stakeholders in the data life cycle and the widespread use of data management plans;
- the analysis of scientific results - with the development of infrastructures, tools and skillsets to enable scientific content to be analysed in complete independence;
- the individual evaluation of researchers which firstly needs to be compatible with open science objectives and secondly needs to take the contribution of scientists to open science into account. In this context, each evaluation body should include the four principles listed below in its evaluation criteria:

  Principle 1: The results themselves should be evaluated rather than the fact that they may have been published in a prestigious journal or other reputable media.
  Principle 2: Researchers should explain the scope and impact of each of the productions cited in their evaluation files and specify their own personal contributions to these.
  Principle 3: It should be possible to include all types of research production in the evaluation.
  Principle 4: All the production cited in the evaluation files must be accessible in HAL or another open archive.
  Also, discussions will be pursued with the evaluation bodies (who have already been reminded that it is not useful to ask for exhaustive publication lists) with a view to limiting the publications examined for the recruitment and promotion of researchers to a small number of the most significant among them as is already the case in other countries.

Open science policy must be placed at the core of the Institutes' policies as they manage many data-producing research infrastructures. Some of these are thematic data management and sharing infrastructures listed in the National Roadmap for Research Infrastructures. These play an important role in the national, European and international landscape and include the Strasbourg Astronomical Data Centre, the Huma-Num platform for the digital humanities or the Data Terra (ex-Earth System) research infrastructure. The Institutes have also developed initiatives for publications, particularly the Open Edition platform for open access journals, the Mersenne centre developed for the open access publication of mathematical journals and so forth.

ACTION 23
Continue the transformation of the CCSD with our partners.

ACTION 24
Develop bibliodiversity, set up new open access journals or convert existing journals to open access publishing in partnership with French and European institutions and in a way that is adapted to each discipline.

ACTION 25
Develop a data management and sharing culture among all stakeholders in the data lifecycle based on the implementation of the FAIR principles (Findable, Accessible, Interoperable and Reusable).

INDICATOR 18
The percentage of publications from units under the supervisory authority of the CNRS published in open access (target value: 100%)

7 I HUMAN RESOURCES

Marking a *Nicotiana benthamiana* tobacco leaf following infiltration by the *Agrobacterium tumefaciens* bacterium.

As was reiterated in the introduction, **the CNRS's first strength is the quality of its scientific and research support staff.** CNRS researchers are recognised at the highest international level and the quality of the organisation's support services is often lauded by our partners. We need to ensure the CNRS's attractiveness is maintained, enhanced and reinforced in an increasingly competitive national and international context.

On the daily basis, the CNRS continually aims to **strengthen its employees' sense of belonging and pride and to invest in the quality of life in the workplace.** The organisation's social policy helps support our personnel in reconciling their professional, personal and family lives. It also strives to support staff members who are victims of life accidents. In this aspect, the CNRS will pay particular attention to the disabled in a context of decreasing FIPHFP (French fund for supporting the disabled in the public sector) funding. The CNRS has also taken the introduction of working from home in 2019 into account. The dematerialisation of simple HR processes on the Ariane platform means HR departments can develop advice and support activities at the individual and collective levels in laboratories and regional offices. The CNRS has also made parity one of its HR priorities and more generally is particularly vigilant as regards all forms of discrimination.

In 2017, the European Commission awarded the "HR Excellence in research" label to the CNRS for its commitment to the European Human Resources Strategy for Researchers (HRS4R). The European Commission's first evaluation of the CNRS in February 2019 was very positive and the high level of attention paid to these issues will be maintained.

The initiatives presented in this document require **a quality social dialogue** which the CNRS will strive to maintain in the context of the reforms announced for the whole French civil service.

7.1 PERMANENT STAFF

Clearly we can but note the reduced number of jobs at the CNRS financed by the organisation's public service subsidy (SCSP) which comes to over 3000 jobs in 10 years or nearly 11% of its workforce. Obviously this kind of trend cannot be allowed to go on in this way. **After the vote on the Multiannual Research Programming Law, the CNRS will prepare a multiannual plan for the evolution of its workforce** (see section 10). This plan will cover the recruitment of permanent and non-permanent researchers and engineers/technicians (ITs). It will also take into account how professions and the skills expected have evolved, particularly in the case of research support functions.

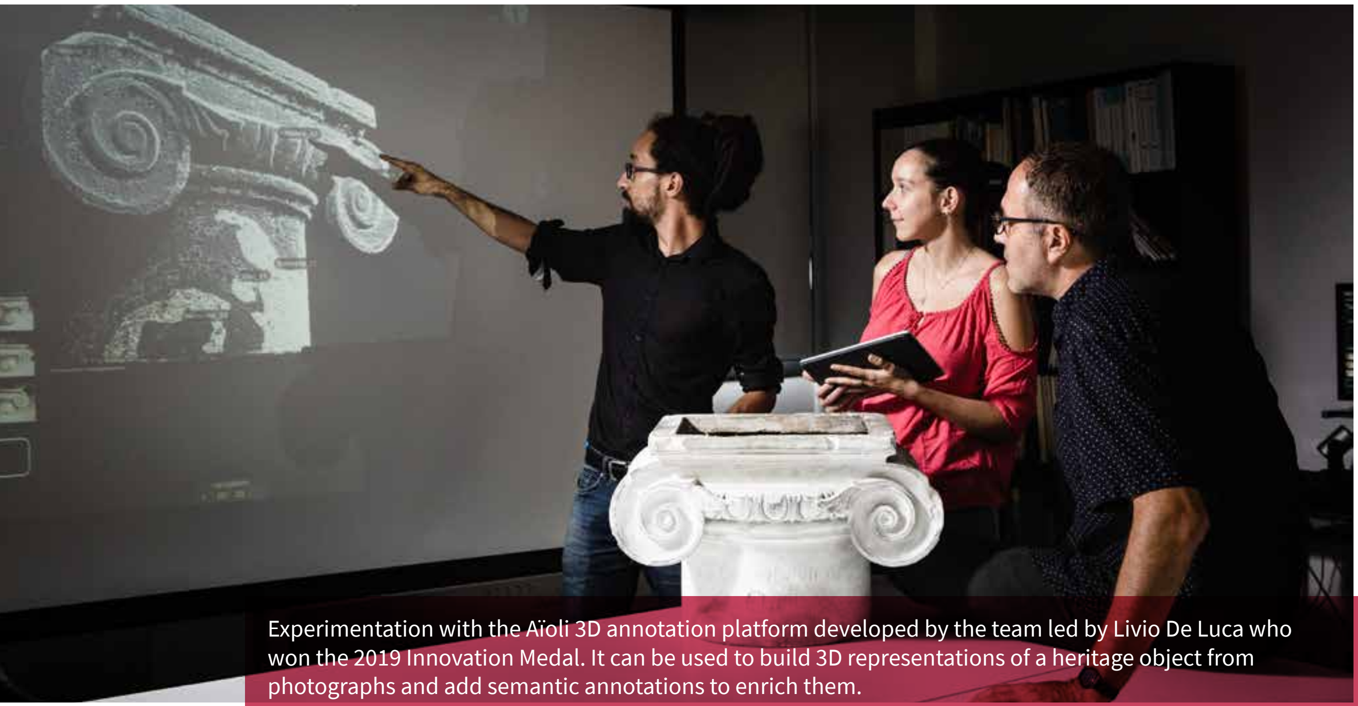
In the meantime the CNRS confirms the recruitment scheme initiated in 2019 will continue for the next few years. This provides for 560 annual recruitments of permanent staff with 250 researchers and 310 IT staff (as compared to 300 and 300 in the previous scheme). This modification to the balance of permanent recruitments demonstrates the **priority given to employing IT personnel.** We should recall at this point that around half of the permanent IT and BI-ATOSS (librarians, engineers, administrative, technical, service and health workers) employees working in units under CNRS supervisory authority are CNRS personnel while the proportion of CNRS staff is close to a quarter for our permanent scientific staff. For historical reasons, the proportion of A-level management personnel in the IT category is much higher than in the BI-ATOSS category. This all serves to show the importance of research support staff for the quality and attractiveness of the CNRS.

The CNRS wishes to have **open discussions with all the relevant stakeholders about its employees' salary and allowances schemes.** This is a particularly important subject given the ongoing pension reforms in France. The CNRS would like to see a study of how to change the allowances system for researchers (currently the lowest in the A+ category of the French civil service) possibly through membership of the RIFSEEP indemnity scheme (covering French public sector staff's functions, hardship, expertise and professional commitment) and with certain adjustments, if necessary. IT category staff have benefited from the RIFSEEP scheme since 2017 and the CNRS's aim is to continue in this direction to achieve parity with comparable ranks in other parts of the civil service.

Professional training has an important role to play in constructing career paths. The CNRS will therefore finalise a new training plan and specify how the personal activity account (CPA) and personal training account (CPF) will be implemented which will include a gradual increase in career development advisors. Finally, the CNRS will invite the main EPSTs, the Conference of University Presidents (CPU) and the Coordination of French Research-Intensive Universities (CURIF) to look into the creation of an executive school open to the whole of the ESRI in conjunction with the MESRI.

ACTION 26
In 2020 finalise a new training plan and implement the personal activity account (CPA) and the personal training account (CPF).

OBJECTIVE 7
Discuss the question of salary and allowances schemes with all the stakeholders concerned, in conjunction with the other EPSTs and under the supervision of the MESRI.



Experimentation with the Aïoli 3D annotation platform developed by the team led by Livio De Luca who won the 2019 Innovation Medal. It can be used to build 3D representations of a heritage object from photographs and add semantic annotations to enrich them.

7.2 THE RECRUITMENT, PROMOTION AND MOBILITY OF PERMANENT RESEARCHERS

The CNRS will continue its policy of diversifying the profiles of the researchers it recruits while making sure the organisation remains attractive at the international level. In 2019, the CNRS granted an average welcome package of €10,000 to new researchers. The organisation's aim is to increase this package as part of the drive to enhance the attractiveness of the French ESRI. This would be awarded on the basis of projects proposed during the competitive recruitment process but could be adjusted to take into account a researcher's insertion in his or her assigned unit and also the main orientations set out in this COP.

The CNRS and the National Committee for Scientific Research (CoNRS) will work on a study of the profiles of researchers who change rank or grade and will make sure it recruits and promotes researchers with varied profiles and skills that fully cover all the missions linked to their jobs. The aim of this is to **make sure the evaluation of researchers takes into account and enhances all aspects of the CNRS's work** which of course involves basic research and the advancement of knowledge but also investment in interdisciplinarity and research related to societal challenges; participation in European projects or strategic international partnerships; innovation, developing technologies and technology transfer, creating start-up companies or cooperation with companies; scientific mediation and the dissemination of scientific and technical information and culture to the public (particularly young people); providing expertise to support public policy-making and open science; and involvement in collective or managerial functions. To achieve this, the evaluation file of each researcher applying for promotion will include a declarative introduction setting out the dimensions of his or her main contributions to various research missions to make sure these are all taken into account.

The CNRS also aims to recruit more research professors (DRs) or employees on permanent contracts (CDIs) from outside the organisation to include more people without a current permanent post in the French academic sphere. These would be given a significant welcome package. This kind of scheme will notably make it possible to welcome ERC grant winners who would like to settle in France or help MOPGA programme winners work in France on a long-term basis. The organisation will aim to recruit candidates who offer added value to enhance the existing strengths of units under the supervisory authority of the CNRS, with all ten Institutes included.

The CNRS also aims to **encourage internal mobility** by offering packages linked to a specific innovative scientific project. The organisation **will also develop the possibilities of "double posts"** that enable researchers to retain that status while also contributing to scientific projects outside the CNRS, particularly in the socio-economic sphere. Finally, the CNRS is ready to generalise use of the "attached professors" system in collaboration with volunteer universities for example within the framework of Graduate Schools of Research (EUR). This system enables CNRS researchers to take a more active part in the partner institutions' teaching activities.

ACTION 27
Ensure that the evaluation of researchers takes into account and correctly values all dimensions of the CNRS's activities.

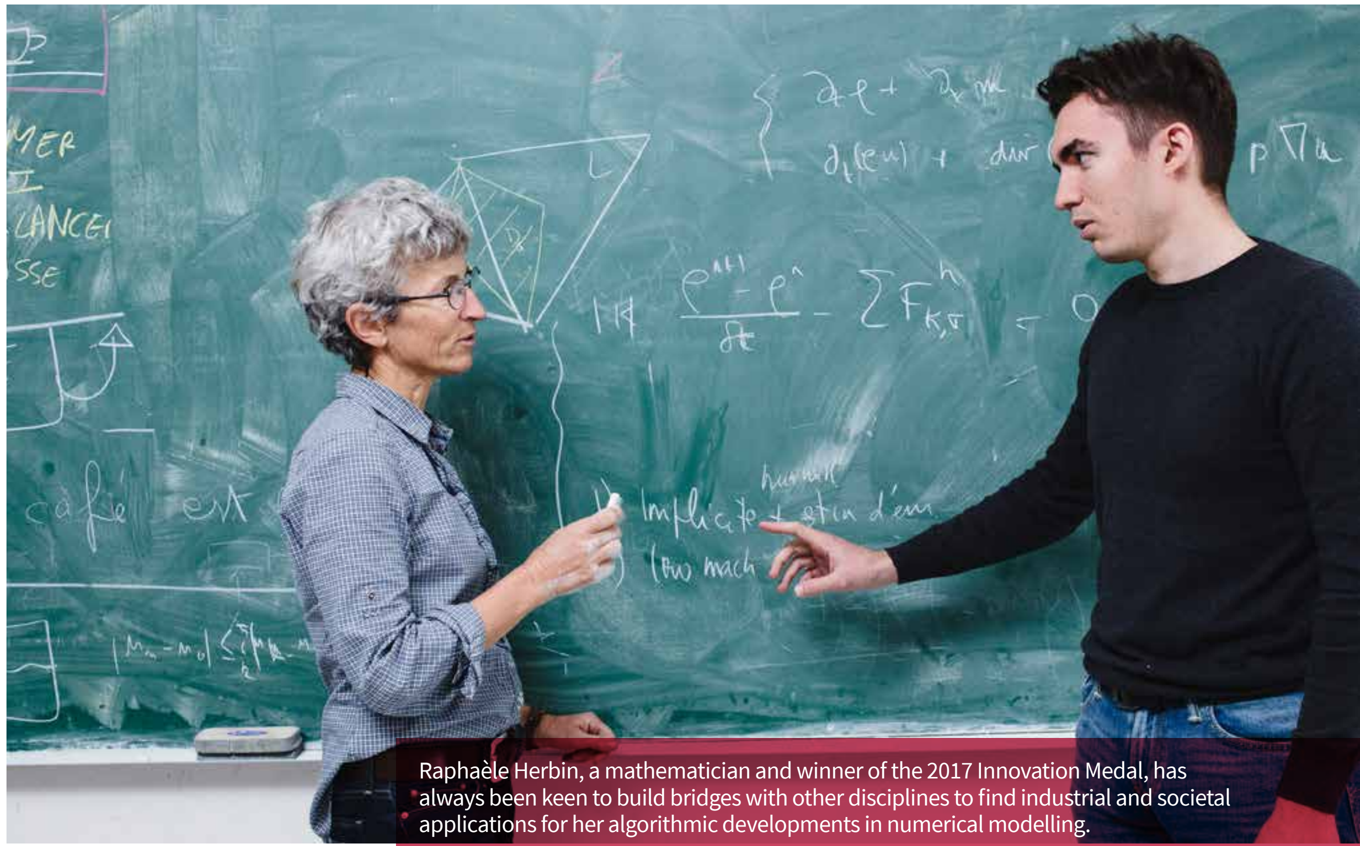
OBJECTIVE 8
Offer a significant welcome package to every new researcher recruited.

OBJECTIVE 9
Develop the possibilities of "double posts" with the socio-economic sphere.

OBJECTIVE 10
Generalise the "attached professors" system along with volunteer universities.

INDICATOR 19
The proportion of researchers from outside France recruited each year (target value: maintain current value).

INDICATOR 20
The number of scientists who do not already have a permanent academic post in France recruited to research professor posts.



Raphaèle Herbin, a mathematician and winner of the 2017 Innovation Medal, has always been keen to build bridges with other disciplines to find industrial and societal applications for her algorithmic developments in numerical modelling.

7.3 THE RECRUITMENT OF NON-PERMANENT STAFF

In 2019 the CNRS launched a recruitment plan for PhD students with three defined priorities - interdisciplinarity, problems deriving from social issues (such as. preparation for the 2024 Olympic Games, the reconstruction of Notre-Dame Cathedral, the phenomenon of radicalisation, etc.) and international cooperation. This plan was enthusiastically received by both the scientific community and our partners, particularly internationally. The CNRS considers this recruitment capacity to be an essential element of its scientific policy and therefore wishes to **progressively increase this to 500 new annual funding grants for doctoral students.**

INDICATOR 21
The number of new funding grants for PhD students.

7.4 ACADEMICS

The CNRS will **pursue its proactive policy of hosting academics on secondment posts,** cooperating closely with our university partners. As already mentioned in section 5.1, the organisation will reserve some of these secondment posts for those working on the submission of European projects and some to attract academics to work in the International Research Labs.

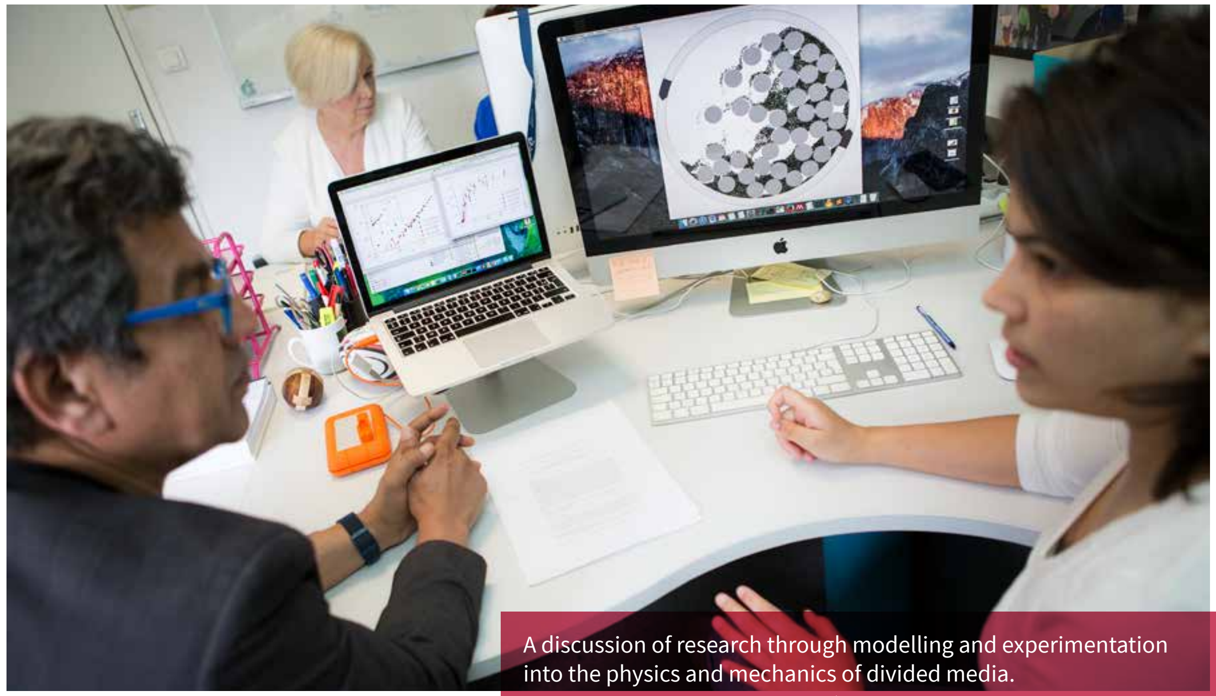
The CNRS will work with universities to make the principle of **unit directors** being freed from teaching duties or having seconded posts (the quota could depend on the size of the unit) systematic and granted for the duration of their mandate.

As a complement to permanent research positions which will remain the main recruitment system, the CNRS wishes to **implement a "tenure track" system, with volunteer universities.** This will enable young scientists to start their career at the CNRS before joining a university as professor or equivalent.

ACTION 28
Continue the proactive policy of hosting seconded professors, particularly in the case of unit directors, in close interaction with their employers.

OBJECTIVE 11
Implement a "tenure track" system with volunteer universities.

INDICATOR 22
The number of academics hosted on secondment posts each year including the number of academics hosted to work on European projects.



A discussion of research through modelling and experimentation into the physics and mechanics of divided media.
© Christophe HARGOUES / LMGC / CNRS Photothèque

7.5 GENDER PARITY

The CNRS has made gender mainstreaming a priority in its human resources policy for all permanent and contract staff. In support of the Mission for Women's Integration, a Parity-Equality committee has been set up to make tangible proposals in response to these two central issues:

- the fact that too few female researchers are recruited,
- the career management of female personnel as the proportion of female staff decreases further up grades and ranks.

Gender bias awareness training is regularly provided for members of the national committee sections and admission juries for our recruitment competitions.

In 2019 the CNRS set itself the objective of promoting a proportion of female researchers at least equal to that of the pool (and not that of female candidates, as female self-censorship is more common). This objective was achieved thanks to the raised awareness and involvement of the CoNRS sections and the management board and will be repeated annually. The objective of promoting a proportion of women that is at least equal to that of the pool will also apply to ITs, taking into account the specific features of each branch of professional activity (BAP).

The CNRS also wishes **to increase the proportion of female unit directors.** The organisation and the other supervisory authorities of laboratories - first and foremost the universities - will pay particular attention to this subject particularly through a review of the appointment process for unit directors.

To help cover the costs of childcare or travel for young children during parents' working trips, the CNRS will study all measures necessary and any regulatory changes these may require. The organisation will also remain vigilant in only officially supporting scientific events that take the gender dimension into account and also in particular by working to ensure gender parity (which may depend on the disciplinary field involved) as regards conference programme committees, invited speakers, members of round tables and so forth.

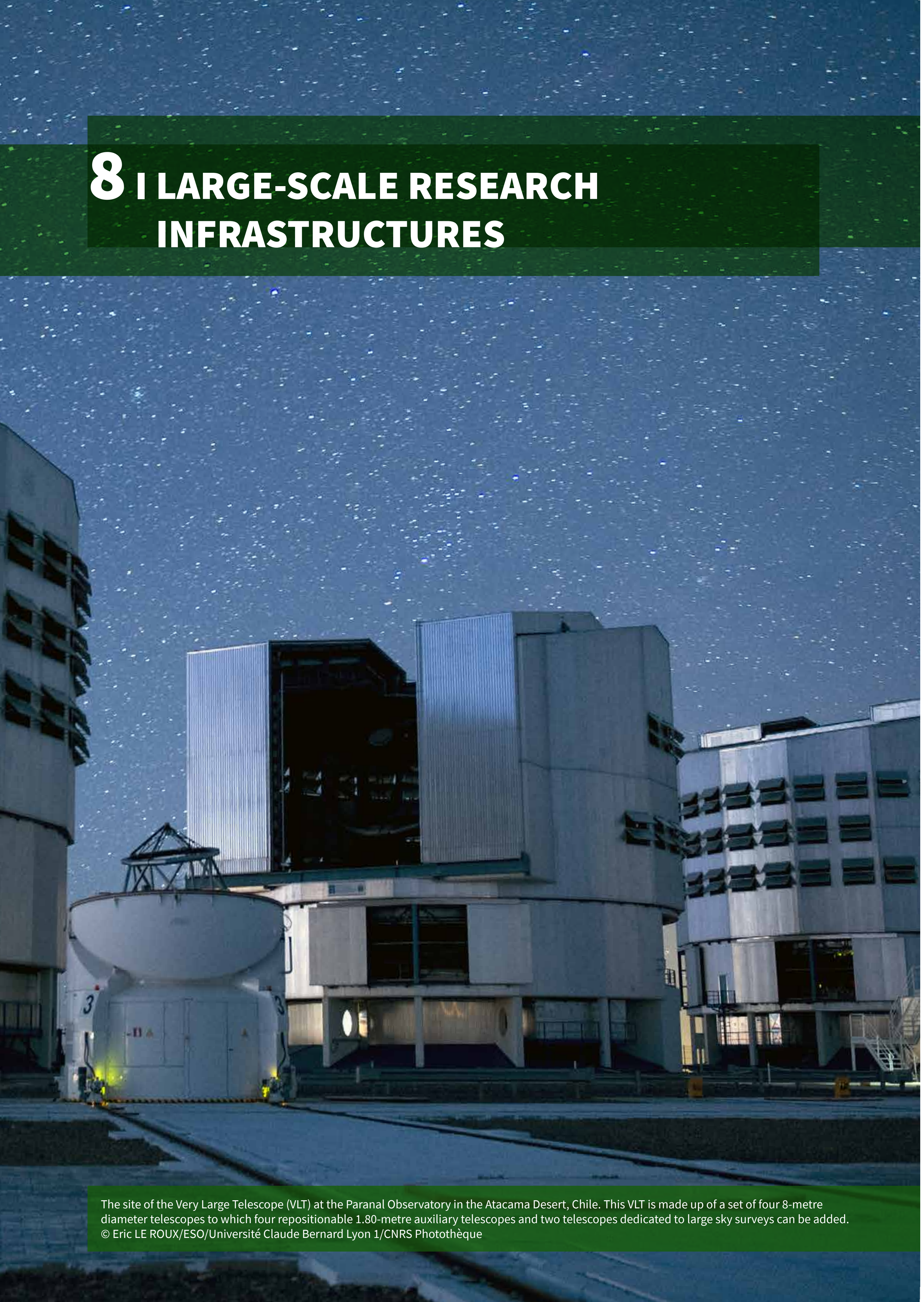
OBJECTIVE 12
Increase the proportion of women in the different ranks and grades of researchers.
Aim for similar proportions of women in the different grades of a given rank for scientists and engineers/technicians.

INDICATOR 23
The proportion of women recruited.

INDICATOR 24
The proportion of women promoted (target value: at least the same proportion as in the grade of origin).

INDICATOR 25
The proportion of women who win CNRS medals (target value: 50% every year).

INDICATOR 26
The number of female unit directors (target value: + 5% every year)



8 I LARGE-SCALE RESEARCH INFRASTRUCTURES

The site of the Very Large Telescope (VLT) at the Paranal Observatory in the Atacama Desert, Chile. This VLT is made up of a set of four 8-metre diameter telescopes to which four repositionable 1.80-metre auxiliary telescopes and two telescopes dedicated to large sky surveys can be added.

The CNRS manages numerous infrastructures[1] and very large research infrastructures in collaboration with its French, European and international partners. These essential infrastructures provide scientists with access to the most efficient equipment so they can carry out large-scale research in cutting-edge fields. They are important in terms of attractiveness and make a major contribution to enhancing France's international standing and to the construction of European collaborative research.

The scale of the scientific and technological issues involved combined with the construction and operating costs of these infrastructures means collaboration projects and significant human and financial resources are required, often on an international scale. Most of these infrastructures are located in France and Europe but some are further afield - in North and South America, Africa and even as far away as Antarctica. Support for these essential infrastructures is indispensable along with effective cost and impact control management.

The CNRS proposes to work with the MESRI alongside the other relevant stakeholders and more specifically the French Alternative Energies and Atomic Energy Commission (CEA) to examine **the changes that need to be made to how research infrastructures are steered** following the report by the French Cour des Comptes (Court of Auditors). The organisation also wishes to work with the MESRI and the other stakeholders concerned on a study for each main scientific field aimed at formulating a multi-year plan of requirements, possible pooling and new projects and the usages and closures of such infrastructures.

The CNRS aims to **create an overall "Data" plan** covering the specificities, requirements and expectations of the different major scientific fields that dovetails with ongoing national and European initiatives and is based on a specific form of data-dedicated governance.

In addition and in synergy with these initiatives, the organisation will continue with its "Computing" policy which is particularly based on the MiCaDo structure. This policy is implemented in conjunction with the French Very Large-Scale Computing Centre (GENCI) and involves the IN2P3's computing centre. Its aim is to provide a pooled response involving all the Institutes to the requirements of the scientific communities.

ACTION 29
Work with the MESRI and the other relevant stakeholders on a study of research infrastructures for each main scientific field aimed at formulating a multi-year plan of requirements, possible pooling and new projects and usages and closures.

ACTION 30
Create an overall "Data" plan in 2020 based on a specific form of data-dedicated governance.

1. The term "research infrastructure" as used here includes facilities sometimes referred to as "medium-heavy".

9 I SUPPORT FOR RESEARCH

Jean-Marie Tarascon, a solid-state chemistry specialist and winner of the 2017 CNRS Innovation Medal, with some of his team from the Solid-State Chemistry and Energy Laboratory he directs. © Frédérique PLAS / UMR8260 / CNRS Photothèque

Over the last 80 years the CNRS has constructed **high-quality research support services that are an essential component for achieving the organisation's overall performance level.** These support services have already been discussed in the human resources section. This section discusses transversal issues which the CNRS intends to particularly focus on during the COP period.

INDICATOR 27
The percentage of the organisation's support functions (target value: maintain current value)

9.1 EVALUATING AND SUPPORTING UNITS

The CNRS's joint research units (UMRs) are regularly evaluated by the High Council for Evaluation of Research and Higher Education (Hcéres) in conjunction with their other supervisory authorities. The National Committee for Scientific Research (CoNRS) generally sends a representative to the visiting committees set up by the Hcéres and uses the evaluation of the unit as a general framework for the evaluation of CNRS staff it is responsible for. The evaluation situation is less satisfactory when another EPST is the unit's co-supervisory authority. This can lead to duplications and redundancy in the different evaluations which creates extra work for the unit's managers and staff. The CNRS's proposition to all the supervisory authorities of a given unit is that they should jointly define the evaluation criteria and subsequently make sure all evaluations have the highest possible level of complementarity.

This form of evaluation is essential if it is of international level. It is an important factor in the allocation of basic funding support to units which came to over €160 million in 2019. This basic support is completed by another €80 million in funding which can be broken down to €40 million for research infrastructures and €40 million for competitive funding of more targeted actions. The allocation of the latter sum takes into account the quality of the projects presented and the Institutes' priorities. For both basic support and support for targeted actions, the resources allocated by the academic partners within the framework of a joint management dialogue are taken into account when possible and relevant.

The CNRS considers the overall sum of €240 million allocated each year to our units and their projects to be notoriously insufficient. The organisation hopes the next multi-year Research Programming Law will give it the opportunity to increase this overall sum considerably as the international attractiveness of our research units is at stake.

9.2 SIMPLIFICATION

For a long time now, the CNRS has relied on initiatives in the field and encouraged the sharing of best practices in the area of process simplification. The organisation will extend and increase the continuous improvement approach, particularly to benefit the Institutes at the national level and laboratories in the field.

The CNRS will also pursue its ongoing dematerialisation strategy. The organisation will stabilise the Ariane application and extend it to new HR processes while the project for the complete dematerialisation of staff members' administrative files will be implemented. It will revise and rationalise signature approval circuits partly by developing and encouraging the use of electronic signatures.

The CNRS will implement a project to **simplify the management of travel for work purposes** to reduce the workload in the field. It will provide the laboratories with a multi-supervisory authority monitoring and administration system by preparing a common market with the AMUE and rolling out the Etamine management tool for travel for work purposes.

ACTION 31
Pursue the ongoing dematerialisation approach, particularly aiming for the complete dematerialisation of staff members' administrative files.

ACTION 32
Simplify the management of travel for work purposes.

9.3 INFORMATION SYSTEMS

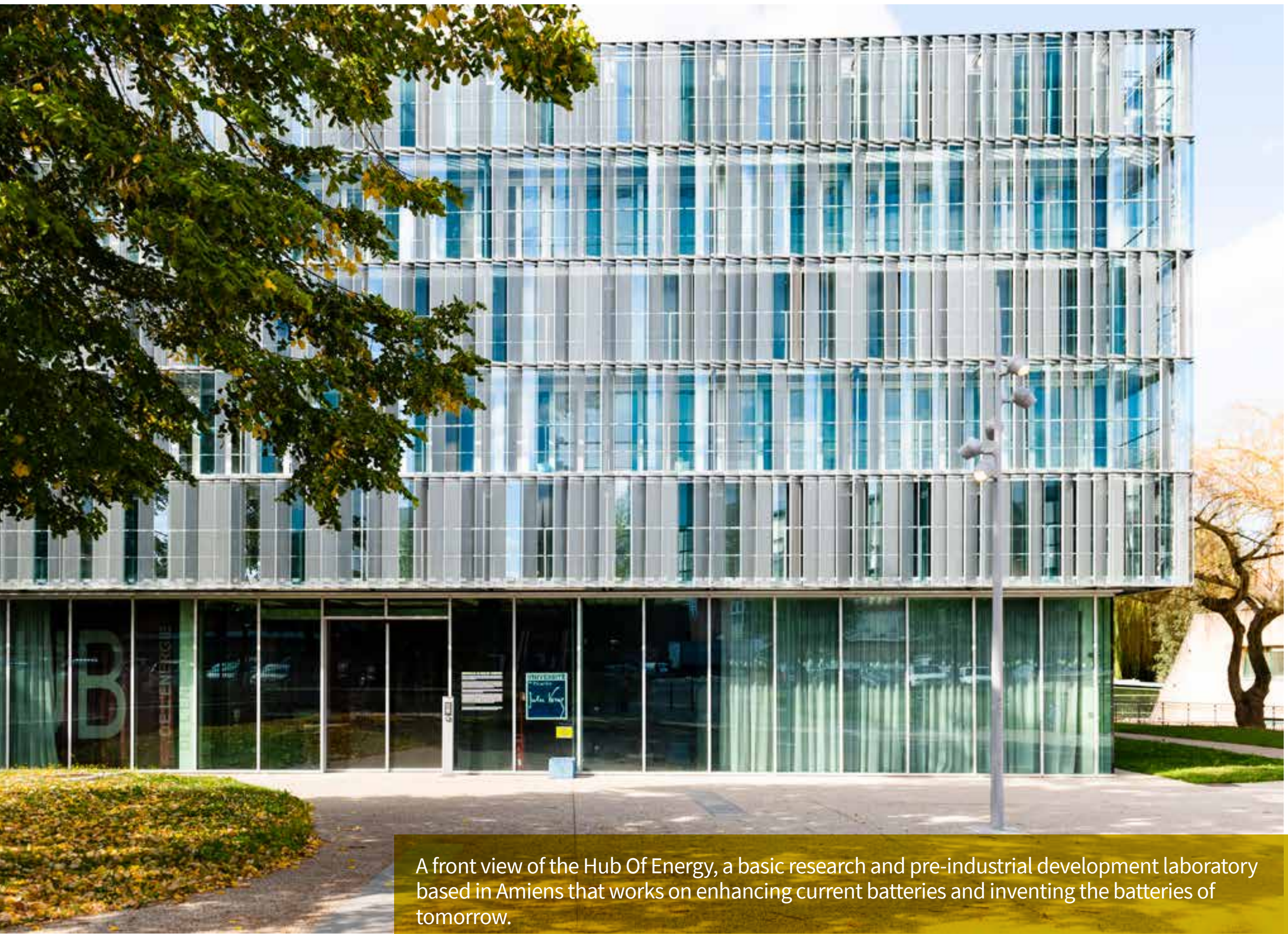
The CNRS's involvement in the "SI Labo programme's" projects in the framework of the MESRI's guidelines and working in conjunction with the AMUE and all the relevant stakeholders was discussed in section 3.

In addition, the CNRS's information systems were the subject of an external audit and the organisation will implement the resulting action plan. The ensuing main objectives are:

- to strengthen the staff of the Information Systems Department (DSI) and enhance the attractiveness of job offers;
- to better control outsourcing and make various adjustments to the regional office's IT departments;
- to continue reducing the "technical debt";
- to invest in certain technologies to facilitate the urbanisation and security of information systems.

9.4 REAL ESTATE

In 2015-2016, the CNRS prepared a multi-annual plan which marked a shift from preceding periods. It aimed to reduce the total surface area of property and made upgrading to comply with safety standards and economic and energy rationalisation the priorities. In 2020, the CNRS will work in conjunction with the MESRI and the French State's real estate department to prepare a new multi-year real estate strategy plan.



A front view of the Hub Of Energy, a basic research and pre-industrial development laboratory based in Amiens that works on enhancing current batteries and inventing the batteries of tomorrow.

9.5 THE REGIONAL OFFICES

In the preceding period, the scopes of the regional offices in the Île-de-France region were modified involving major transfers of units. This means that each group of institutions, IDEXes (excellence initiatives) and I-Sites now has just one regional office as its contact for all its units although there are some exceptions to this. The advantages and disadvantages of a possible change to the scopes of the Bordeaux and Orléans regional offices still need to be assessed.

9.6 SUSTAINABLE DEVELOPMENT

Research linked to the Sustainable Development Goals (SDGs) has been defined as a major priority scientific issue by the CNRS as was discussed in section 2.2. The organisation also wishes to take proactive action to respond "in practical terms" to the challenges of the SDGs. To achieve this, the CNRS has already set up a working group made up of researchers, engineers, technicians and purchasing and real estate managers. This group's work takes its inspiration from best practices, particularly those recommended by the "Labos 1.5 Collective"[1].

The CNRS will propose an action plan and a form of internal organisation to make its activities compatible with limiting its collective carbon footprint, by associating its French university partners and partner universities from other countries that are active in this field. Particular thought will be given to travel for work purposes along with the restoration and energy consumption of buildings or infrastructures and also the use of digital technologies.

This approach will also be integrated into training personnel straight after they are recruited. It will be applied at all levels of decision-making within the CNRS - from laboratories to the general management - and an evaluation of the results in this area will be made at the end of the COP period.

ACTION 33
Implement an action plan and a form of internal organisation to make its activities compatible with sustainable development goals.

ACTION 34
Carry out the first assessment of the implementation of this action plan in 2023.

1. Cf. https://labos1point5.org/texte-fondateur/

10 I IMPLEMENTING AND REVIEWING THIS CONTRACT

Model masonry structures in the form of arches made of silicone bricks. The aim is to carry out experiments to validate the computing codes developed by the Mechanics and Civil Engineering Laboratory (LMGC) for the deformation and displacement fields of masonry structures.
© Christophe HARGOUES / LMGC / CNRS Photothèque

This contract provides the essential basis for the relationship between the French State and CNRS for the 2019-2023 period. It derives from a shared vision:

- **in which the CNRS as an autonomous State operator is responsible for implementing its institutional strategy in the framework of the State's public higher education, research and innovation policies while paying particular attention to the quality of its relations with the other organisations within the national ESRI system;**
- **in which the State, represented by the Ministry of Higher Education, Research and Innovation, a signatory of the present contract and the CNRS's supervisory authority, is responsible for supporting the CNRS in implementing the orientations and actions set out above.**

An annual meeting will enable the implementation of this contract to be reviewed. This annual review will be based particularly on monitoring the COP indicators which are all set out in the table in the Appendix. Also, the CNRS will present a bi-annual qualitative report on all the actions, objectives and indicators set out in the COP.

The signatories of the present contract agree to organise a special meeting in the months after the promulgation of the multi-annual Research Programming Law to examine the possibility of amending the present contract to enable the CNRS to react to the opportunities opened up by this Law.

The CNRS would like this meeting to enable a multi-year personnel development plan to be adopted that includes a multi-year recruitment plan based on the public service subsidy and also takes the development of professions and skills within the organisation into account. The CNRS's objective is for this meeting to make it possible to define a "target trajectory" for the development of its resources. The implementation of this development will ultimately depend on the budgetary choices the government proposes to Parliament. The CNRS would like this "target trajectory" to be defined to enable it to begin correcting changes observed in recent years to the relative weight of the three main expenditure items - the salary bill, research infrastructures, and laboratory operations and equipment.

ACTION 35
Carry out a bi-annual review (2021 and 2023) of the actions, objectives and indicators set out in the COP.

SUMMARY OF INDICATORS AND MILESTONES

Indicateurs	2018	2019	2020	2021	2022	2023	Valeur-cible
Priorités thématiques et actions transverses							
1. The percentage of competitive scientific support dedicated to the thematic priorities.		~ 45%					66% each year
2. The percentage of annual recruitments of permanent researchers working in support of multidisciplinary in-ter-Institute projects.		22%					20% each year
3. The number of projects funded each year under the PRIME programme.		80					
4. The percentage of permanent researchers recruited to work on themes directly related to these major societal challenges.		35%					+10% each year
Partnerships with universities and site policies							
5. The number of joint support units set up to simplify and improve the administrative management of UMRs.		0					
Innovation							
6. The number of start-up companies set up on the basis of technology or know-how transfers from units under the supervisory authority of the CNRS and including the number that have high development potential.	90						150 and 50
7. The number of new projects supported for pre-maturation.	5						
8. The annual amount represented by research contracts with companies.	€35 M						€44 M (+ 25%)
9. The number of joint CNRS-company units.	145						175 (+ 20%)
10. The mobility of CNRS researchers and engineers towards companies.	47						
11. The number of exploitation licenses for inventions from units for which the CNRS is the supervisory authority.	110						
European programmes							
12. The number of European projects submitted by units for which the CNRS is the supervisory authority:	1,323						
• Pillar 1:	1,073						
• Pillar 2:	75						
• Pillar 3:	168						
The number of European projects selected (units for which the CNRS is the supervisory authority):	230						
• Pillar 1:	169						
• Pillar 2:	18						
• Pillar 3:	39						
13. The number of ERC projects in units for which the CNRS is the supervisory authority.	64						
14. The number of European multi-partner projects including:							
• the number of such projects run with companies,	89						
• number of projects for which the CNRS is the sole coordinator.	11						
15. The total European Commission revenue.	€132 M						+ 25%

Indicators	2018	2019	2020	2021	2022	2023	Valeur-cible
Science in society and open science							
16. The production and dissemination of information items on the CNRS website and on social media.							
• cnrs.fr:	1,400,000						
• Journal:	3,000,000						
17. The number of subscribers to the CNRS social media pages.	420,000						
18. The percentage of publications from units under the su-pervisory authority of the CNRS published in open access.	48%						100%
Human resources							
19. The proportion of researchers from outside France recruited each year.	25%						*Maintain current value*
20. The number of scientists who do not already have a permanent academic post in France recruited to research professor posts.	28%						
21. The number of new funding grants for PhD students.		200					
22. The number of academics hosted on secondment posts each year,		728					
including the number of academics hosted to work on European projects.		38					
23. The proportion of women recruited.	*See below*						
24. The proportion of women promoted.	*See below*						
25. The proportion of women who win CNRS medals.	50%						*50% each year*
26. The number of female unit directors.	264						*+ 5% each year*
Support for research							
27. The percentage of the organisation's support functions.	12.8%						*Maintain current value*

Indicators	2018	2019	2020	2021	2022	2023	Target value
23. The proportion of women recruited.	DR2*: 34.3% CRCN: 37.8% IR2: 35.8% IECN: 52.4% AI: 62.4% TRN: 62.7% ATP: 66.7 %						
24. The proportion of women promoted.	DRCE2: 18.0% (for 21.1% of those eligible for promotion) DRCE1: 36.2% (for 25.8%) DR1: 33.5% (for 30.3%) CRHC: 44.4% (for 37.9%) IRHC: 26.5% (for 31.6%) IR1: 35.5% (for 33.5%) IEHC: 52.6% (for 46.5%) TCE: 66.2% (for 65.9%) TCS: 72.5% (for 67.0%) ATP1: 61.5% (for 57.3%) ATP2: 100% (for 80.0%)						*At least the proportion of those eligible for promotion in the original grade*

*DR2 = research professor, 2nd grade; CRCN = researcher, normal grade; IR2 = research engineer, 2nd grade; IECN = engineer, normal grade; AI = assistant engineer; TCN = research technician; ATP = assistant research technician; DRCE2 = research professor, exceptional grade 2; DRCE1 = research professor, exceptional grade 1; DR1 = research professor, 1st grade; CRHC = researcher, exceptional grade; IRHC = research engineer, exceptional grade; IR1 = research engineer, 1st grade; IEHC = engineer, exceptional grade; TCE = research technician, exceptional grade; TCS = research technician, superior grade; ATP1 = assistant research technician, 1st grade; ATP2 = assistant research technician, 2nd grade.

Milestones	2020	2021	2022	2023
1. Make a summary report for each of the thematic priorities of the main scientific contributions made by the units for which the CNRS is the supervisory authority.				
2. Make a bi-annual summary report for each of the thematic priorities of the contributions made by units for which the CNRS is the supervisory authority.				
3. Work with partner universities and organisations and in connection with the MESRI to develop a proposal for site indicators to monitor the activities of a university site's stakeholders.				
4. Establish a multi-year cooperation plan with Africa in 2021 by involving the relevant stakeholders in France and other countries.				
5. Finalise a new training plan and implement the personal activity account (CPA) and the personal training account (CPF).				
6. Create an overall "Data" plan based on a specific form of data-dedicated governance.				
7. Implement an action plan and a form of internal organisation to make its activities compatible with sustainable development goals.				
8. Carry out a first assessment of the implementation of this action plan.				
9. Carry out a bi-annual review (2021 and 2023) of the actions, objectives and indicators set out in the COP.				

RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité

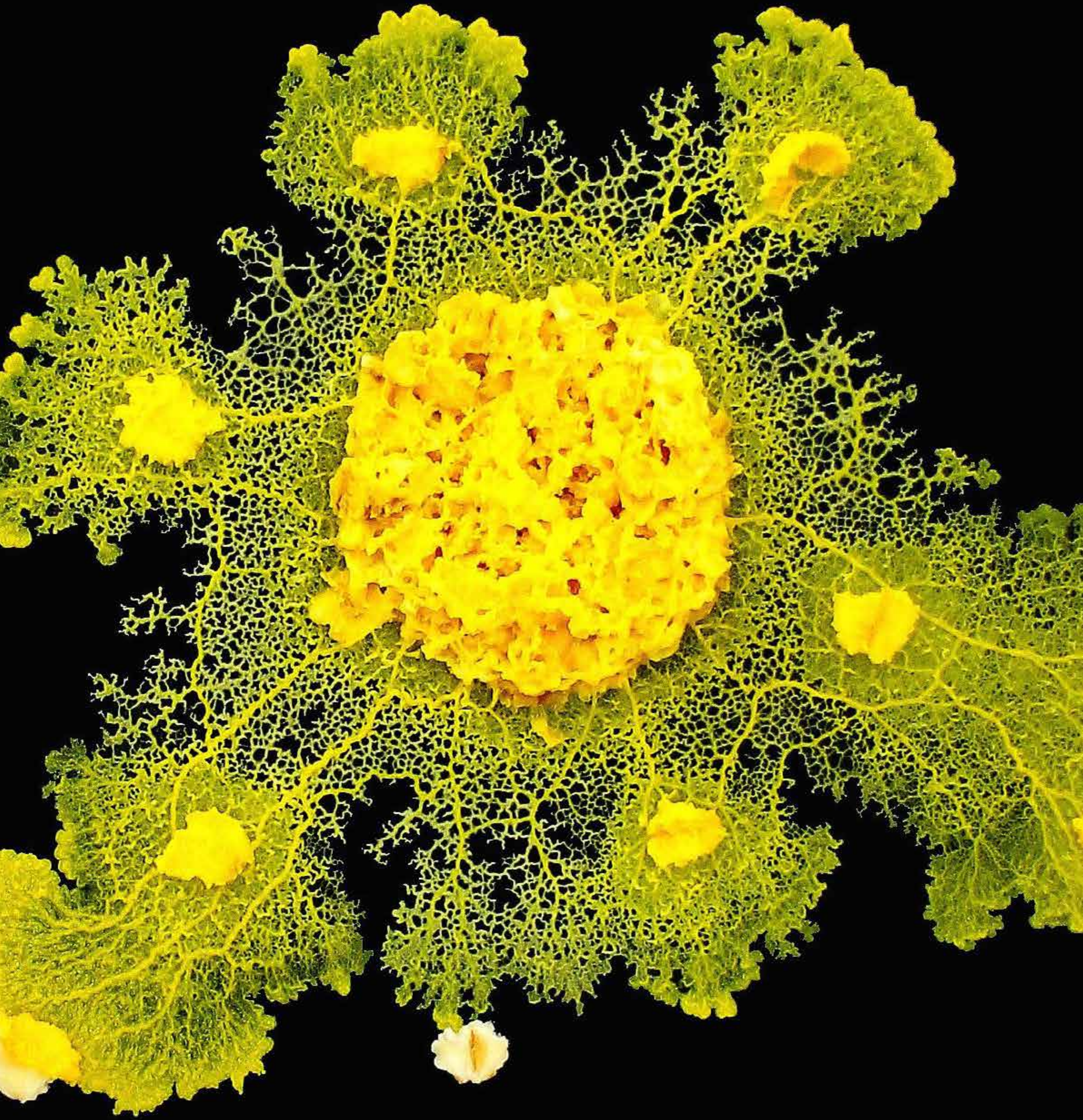
cnrs

Publisher
Antoine Petit, CNRS Chairman and CEO

Brochure published by the CNRS Communications Department
Translator: Richard Dickinson (Inist-CNRS)
Sub-editor (English version): Katherine Kean

Cover photo:
Development of the social amoeba, Physarum polycephalum, commonly known as the 'blob'.

Printed by IFSeM
January 2020



CNRS
3, rue Michel-Ange 75016 Paris
www.cnrs.fr