RÉPUBLIQUE
FRANÇAISE
Liberté
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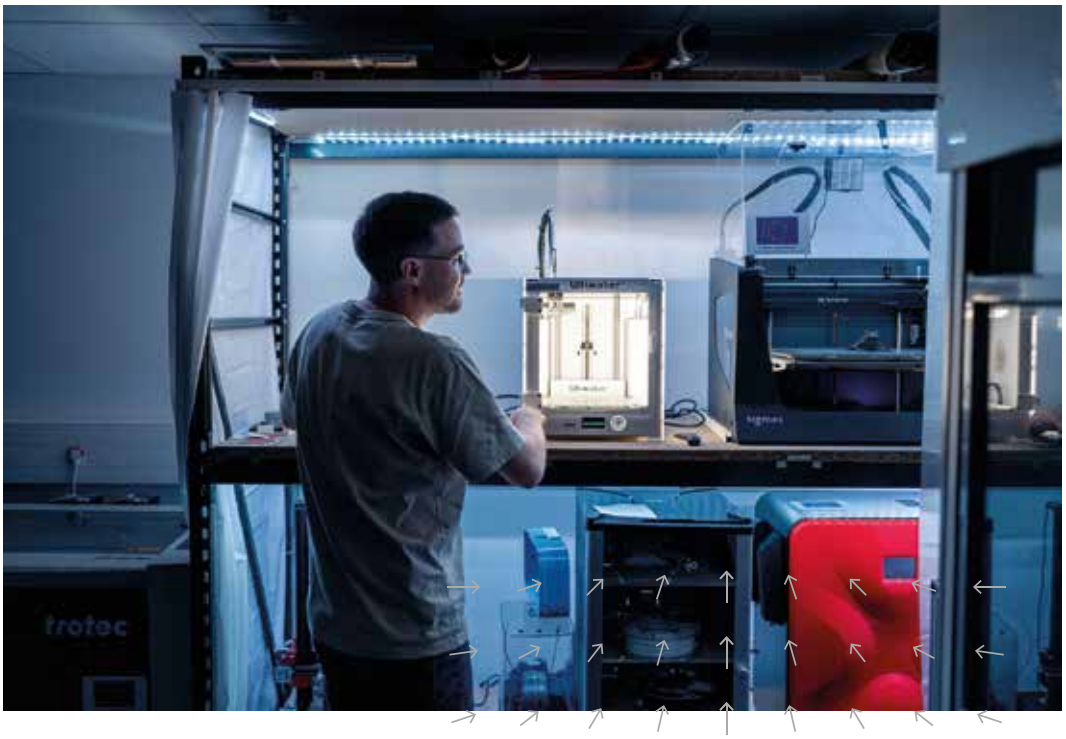
Inria

ANNUAL REPORT
2023



JUNE 2023

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Editorial:

Bruno Sportisse

2023 was the final year of our Objectives and Performance Contract with the government for the period 2019-2023: the growth trajectory that we have been on since 2019 shows the durability of our strategy, which successfully anticipated and adapted to changes in our environment. An evaluation carried out by the French High Council for the Evaluation of Research and Higher Education (HCERES) confirmed the impact our actions have had, outlining ten recommendations that are highly relevant for Inria and which will help us to prepare for the future.

Our institute has shown that it was up to the challenges facing it, promoting within an ecosystem a clear and integrated vision for digital with the capacity to strengthen France's strategic autonomy through research and innovation.

Digital continues to have an ever greater impact in all fields, from public policy (in health and education, for example) and the competitiveness of our economy to the very functioning of democracy itself, at a time of growing geopolitical tensions. This places new responsibilities on the shoulders of public research in the digital sphere: it must now contribute to the development of a long-term vision, commit to strategies that are in keeping with modern technology planning, and be able to build bridges that will strengthen the collective dynamic within our ecosystem, which goes far beyond the world of academia. Now more than ever we must consider the impact we have in all its dimensions, from science - on which we have built our reputation - to innovation and supporting public policy.

It is by promoting this integrated vision for digital, as part of an ecosystem comprising universities, startups and French tech companies - overseen by *Numeum*'s strategic committee on "Trusted Digital", in lockstep with public policy vis-a-vis the major challenges facing our society - that Inria can have the greatest impact. *Meditwin,* a project promoted by France 2030, is a good example of this: in partnership with *Dassault Systèmes*, university hospital institutes and startups, it will enable the development of a network within France for digital twins in health, the goal being to accelerate the development of new drugs and improve preparations for surgical procedures.

Inria must show flexibility in terms of its positioning if it is to adapt to a changing world, contributing towards collective dynamics, which are also central to regional ecosystems. Understanding the specificities and diverse strategies of these ecosystems will be essential, while ensuring they are rooted in national strategies. This is the goal of the Inria University Centres, a long-term strategy aimed at building a relationship of trust with universities, which play such a pivotal role in higher education and research across the country: in 2023 the addition of the University of Lorraine Inria Centre and the Inria satellite at the University of Montpellier built on what we started back in 2021.

At a national level, the launch of the Digital Programmes Agency - headed up by Inria and in keeping with the foundations we had been building since 2019 - is testament to the government's faith in our capacity to spearhead collective dynamics, to promote an integrated vision for digital and to inform public policy, in addition to breaking down barriers as we seek to boost the impact of public research both within and through digital.

Our next Objectives and Performance Contract for 2024-2028 will be centred around a coherent strategy for both the University Inria Centres initiative and the development of the Digital Programmes Agency, building on Inria's reputation as an internationally recognised national institute for research into digital.

2023 highlights

JANUARY

- Launch of the PEPR Agroecology and Digital with Inrae

FEBRUARY

- Launch of the PEPR NumPEx with the CNRS and the CEA

MARCH

- Creation of the Cyber Campus Transfer Programme

APRIL

- Inria and CWI sign agreement
- Inria and the University of Waterloo launch a platform for scientific cooperation between France and Canada

MAY

Grid'5000 celebrates its 20th birthday

JUNE

- The Inria satellite at the University of Montpellier opens
- Launch of the PEPR Digital Health with Inserm
- France's Ministry of National Education and Youth, France Universités and Inria commit to the deployment of the programme *"A scientistin every classroom"* across the country

JULY

13 startups from our ecosystem win awards in the *i-PhD* and *i-Lab* competitions

AUGUST

- Bruno Sportisse has his contract renewed as CEO of Inria
- The *Inria Science Days* event celebrates its tenth birthday

SEPTEMBER

- The University of Lorraine Inria Centre is launched
- The Côte d'Azur University Inria Centre celebrates its 40th birthday

OCTOBER

- Inria is assessed by a panel of experts from HCERES
- Launch of the PEPR eNSEMBLE with Grenoble Alpes University, Paris-Saclay University and the CNRS

NOVEMBER

Inria's head office hosts the first edition of the European AI, Data and Robotics Forum (ADRF)

DECEMBER

- *Inria Chile Science Days*
- The consortium *Meditwin* is created
- Speech given by French President Emmanuel Macron on the future of research (Digital Programmes Agency awarded to Inria)

Key figures for the year

19 new project teams

274 **SOFTWARE PROGRAMS** created

23 new Exploratory Actions

3 new Challenges

MORE THAN **150** **PRIZES** and awards

7 **PEPRS** in conjunction with our partners

1577 **people trained** over **33 sessions** of Inria Academy

€330m Annual budget

800 **scientific outreach** initiatives

122 **STARTUPS** supported by Inria Startup Studio since 2019

19 NEW PROJECT TEAMS to tackle current digital challenges

BERGER-LEVRAULT AND INRIA LAUNCH A DEDICATED SOFTWARE ENGINEERING TEAM

Can computer programs live forever? This is the goal of a new joint project team involving the University of Lille Inria Centre and the Research and Development Department of *Berger-Levrault*, a French company specialising in the creation of software and digital services, mainly for the public sector. The name of this project team is **EVREF** (an acronym for *Évolution réflexive des systèmes logiciels éternels*, which translates as "Reflexive Evolution of Ever-Running Software Systems"). They specialise in software engineering, specifically software modernisation through the platform Moose, next-gen development tools and virtual machines employing the use of *Pharo*.

QURIOSITY: QUANTUM-ENHANCED DATA

The new Inria project team Quriosity has set itself an ambitious and exciting target: to explore and harness the properties of complex quantum systems by combining the quantum theory of information with digital technology, the aim being to improve our capacity to process and protect data. A joint undertaking with Télécom Paris and the Institut Polytechnique de Paris, the mentality of this new project team is very much about keeping an open mind and pursuing innovation,

A FASTER AND MORE SECURE CLOUD

How can the performance and safety levels of distributed systems be improved? The project team Benagil targets distributed systems used in large-scale computing where performance and security are very much the order of the day. Examples include datastores, machine learning frameworks, data analysis platforms and high performance computing applications. This new project team involving the Inria Saclay Centre, the Institut Polytechnique de Paris and Télécom SudParis focuses on the key components of cloud infrastructure: operating systems, programming languages and storage systems, as well as the runtime systems for cloud infrastructure. They aim to develop new ways of evaluating these components and to then use these evaluations to develop new mechanisms for improving performance levels.

PHYSICS-INFORMED MACHINE LEARNING

Malice is the name of a new project team created within the Hubert Curien laboratory at the Inria Lyon Centre, in partnership with the CNRS and Jean Monnet University. The aim is to develop new machine learning methodologies for tackling the scientific and technological challenges of laser-matter interaction, drawing on theoretical and algorithmic expertise in computer science, applied mathematics and optimisation. With contributions from some of the laboratory's physicists, Malice is seeking to develop innovative solutions in fields such as health, security and energy.

Here are the 15 other project teams created in 2023: AIstroSight, Argo, Camus, Canari, Capsule, Epimethee, GammaO, Macbes, Merge, Nerv, Ockham, Olas, Sairpico, Splits, Topal.

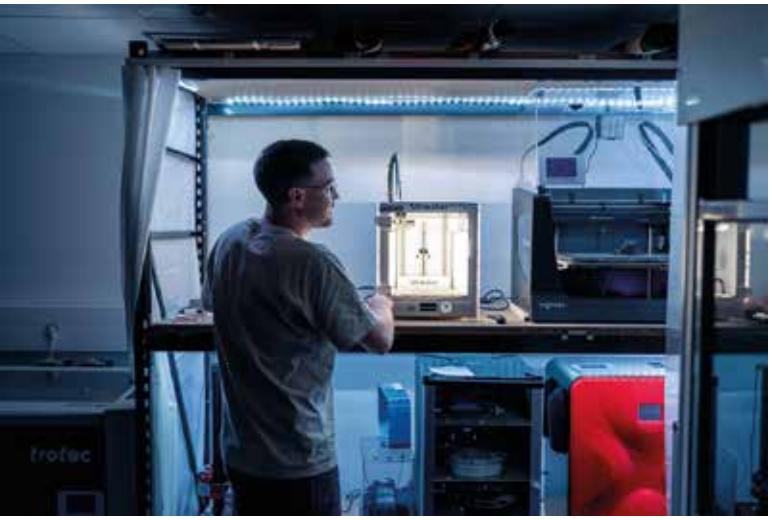
MEETING THE CHALLENGES of the future

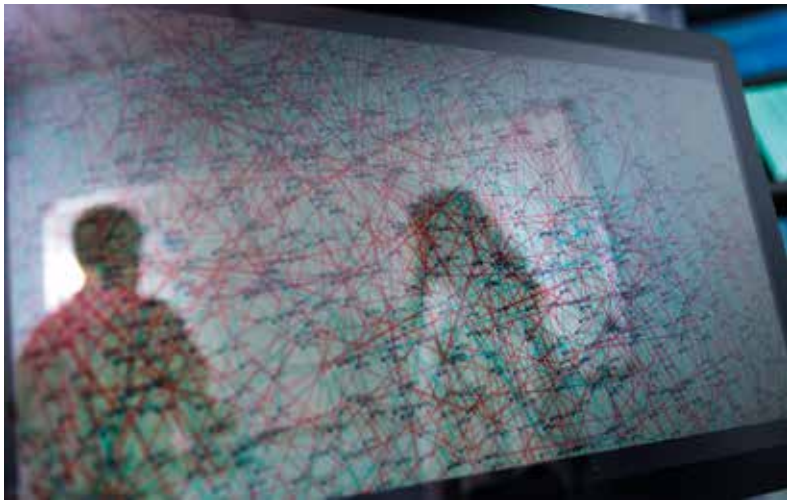
Alvearium

From photos and videos to confidential documents, *cloud* storage has been part and parcel of our daily lives for more than a decade now. Most user data is stored by major service suppliers, which possess the capacity to build data centres and process large quantities of information. Aiming to solve problems linked to data replication, security and traceability, *Hive* and Inria have joined forces on Alvearium, a four-year challenge aimed at developing a sovereign *cloud* capable of handling both the processing and storage of data through a peer-to-peer network, as opposed to a centralised network of data centres.

Dornell

Capable of being clipped to a walking frame, wheelchair or white cane, *Dornell* is a smart handle which stimulates the sense of touch in the hands of visually-impaired individuals, helping them to get about by showing them the direction to take or pointing out obstacles. Having emerged from previous research in assistive robotics geared towards promoting inclusion, the aim of the Dornell challenge will be to develop new haptic technology in order to provide innovative scientific and technological solutions for multisensory perception.





Protecting health data with FLAMED

By launching the exploratory action FLAMED, Aurélien Bellet, a researcher with the Magnet project team, is seeking to explore a decentralised approach to artificial intelligence applied to health. In collaboration with the project team INclude (Lille University Hospital, University of Lille), FLAMED carries out machine learning data analysis tasks involving multiple hospitals while enabling each site to keep a hold of data internally, thus ensuring confidentiality.

Optimising 3D printing

3D printing can be used to make a wide range of things, but production is still very slow. Optimising the code interpreted by the machines could be a means of boosting performance levels. *Ofast3D* is an exploratory action that was launched with the aim of cutting printing times without impacting print quality by optimising the code interpreted by 3D printers during the generation process and factoring in the geometry of 3D shapes. The teams involved in this exploratory action are looking to overhaul the software chain, from 3D models to low-level programming language.

Research excellence IN UNIVERSITIES

THE LEONARDO DA VINCI PROJECT

Immerse users in a virtual reality environment, get them to take on an avatar of Leonardo da Vinci and then ask them to carry out creativity exercises, and you'll see a notable improvement in results compared to a control group. This was the surprising conclusion to an experiment carried out by the University of Rennes Inria Centre and the Laval Institute (a school of engineering in Laval, France). The Hybrid project team and its partner designed this curious experiment consisting of an avatar of Leonardo da Vinci, his workshop, a set of objects needed for the exercises (a globe, a blackboard and a parasol) and an original "virtual embodiment" protocol. Dubbed the "Proteus effect" by researchers, the impact which embodying a character - in this case Leonardo da Vinci - has on people's behaviour and performance levels represents an enormous opportunity in fields such as training, health (rehabilitation, disabilities, etc.) and design.

HELPING THE BRAIN TO AGE WELL

How can we tackle the most common neurological diseases - strokes and dementia - and promote good brain health as people get older? The Vascular Brain Health Institute (VBHI), a university hospital institute coordinated by the University of Bordeaux and supported by Bordeaux University Hospital, Inserm, Inria and the Nouvelle-Aquitaine region, has come up with a new paradigm incorporating public health and therapeutic innovation. Bringing together researchers, clinicians and manufacturers, the VBHI is aiming to develop new methodologies with the capacity to shed light on the mechanisms involved in cerebrovascular disease, in addition to identifying effective prevention and treatment strategies. This is a major project operating on a local, national and global scale.

AI IN THE STARS

Conceived as a centre of excellence on high-performance computing and artificial intelligence for use in astronomy, ECLAT brings together fourteen laboratories and teams to work on a shared roadmap. The aim is to promote the R&D partnerships that will be needed for the design and development of cyber-physical systems for use in astronomy with the capacity to integrate, process and reduce vast quantities of data. ECLAT is centred around SKA, an ambitious international project aimed at building the world's largest radio observatory.

20 YEARS OF GRID'5000

Since its launch in 2003 Grid'5000 has become France's number one instrument for experimental research in distributed computing. This infrastructure is used for the reproducible analysis of IT objects such as software programs and large distributed systems in near-real-time conditions. Spread out across across nine sites (eight in France and one in Luxembourg) linked through a special network developed by Renater, Grid'5000 was funded by the major players in computer science research in France (Inria, the CNRS, universities, France's *grandes écoles*, regional authorities, etc.). Grid'5000 is now working on the infrastructure of the future in the form of SLICES, a new European platform which brings together wider communities (including IoT and networks) at a European level.

Tackling CHALLENGES FACING THE PUBLIC through research

Inria join forces with ADEME and the CNRS to raise awareness of digital sobriety in France

Seeking to support the deployment of digital sobriety in France, ADEME, the CNRS and Inria launched ALT-Impact. This programme, which has been given funding to the tune of around €15m, targets both the personal and the professional sphere, from ordinary citizens to organisations and local authority bodies. Its aim is to reduce the environmental impact of digital technology across the country, through three main areas of focus:

- accelerating awareness-raising and both initial and ongoing training with regard to digital sobriety by introducing a competency dictionary and associated validation mechanisms, by identifying and indexing relevant training and awareness-raising materials and by supporting the deployment of operational actions
- contributing to the development of a methodological framework for measuring and coordinating digital sobriety by identifying, building and sharing the data and methodologies needed to quantify the environmental impact of digital services This science and technology component also incorporates the development of new product category rules (PCRs)
- supporting actions for implementing digital sobriety within organisations, including by developing and experimenting with the adoption of a code of conduct and sharing best practice guides.

Inria and Cerema join forces to help look after our roads

The public road network is one of the most important assets within the public domain. The French government is responsible for around 21,000 km of roads, including maintenance, planning, replacement and preservation. Failure to look after roads properly can result in a reduction in both their asset value and their use value, with serious economic consequences. In response to these problems Cerema and Inria took the decision to pool their respective skillsets, bringing together Cerema's trade expertise and Inria's scientific expertise in digital technology. The aim is to assist road owners by improving the maintenance of this infrastructure, overcoming the scientific and technical obstacles currently faced by research centres.

Launched in 2021, the ROAD-IA challenge has four objectives:

↗ **To build a dynamic "digital twin" of the road network** through the instrumentation of roads and road structures, making inspections easier and more accurate through the use of wireless sensor networks and drones

↗ **To develop a better understanding of the behaviour and deformation of roads** and road structures through the use of surface inspection data, on-site visits, sensors and environmental data via accurate modelling and 3D representations

↗ **To invent the concept of "connected" bridges and tunnels** at a system level

↗ **To determine methods for the strategic planning** of investment and maintenance (predictive, prescriptive and automated)

Inria committed to France 2030

The priority research programmes and equipment (PEPR - *programmes et équipement prioritaires de recherche*) launched as part of the France 2030 investment plan are a set of initiatives aimed at establishing France as a leader in scientific fields judged as a priority at either a national or European level. Inria is playing a significant role in several of them.

Digital health: moving closer to realistic, multi-scale digital twins

The growing availability of data in health is paving the way for the development of diagnostic and prediction tools, in addition to tools for personalising treatments and care pathways, using multi-scale (spatial and temporal) and multimodal modelling.

With this in mind, the French government entrusted Inserm and Inria with the scientific coordination of the Digital Health research programme (PEPR SantéNum or *Santé Numérique*), which was allocated a budget of €60M over seven years. The French National Research Agency (ANR) is the operator on behalf of the state. Part of France's national strategy for the acceleration of digital health (SASN - *Stratégie nationale d'accélération en santé numérique*) launched by the French government within the framework of the France 2030 investment plan, this major research initiative was launched in June 2023. The objective is to produce the models, tools and methods required for the development of accurate descriptive and prescriptive digital twins for use in the healthcare system. Coordinating this research - which is divided up into 17 different areas of focus spanning more than 20 campuses and research sites across the country, with teams from more than 20 universities and engineering schools and 4 national research institutes, with support from a range of different hospitals and national clinics - is no mean feat.

NumPEx, a programme aimed at boosting the capacities of exascale computing

Launched on 24 February, with the CEA, the CNRS and Inria responsible for joint scientific coordination, NumPEx (*Numérique pour l'exascale* - Digital for Exascale) is a research programme aimed at developing software solutions for the exascale computers of the future in both France and Europe, in addition to helping major areas of application in science and industry to fully benefit from the capacities of these machines.

Allocated a budget of €40.8M over six years, NumPEx will contribute to the development of a sovereign set of tools, software programs, applications and training courses. The aim is to ensure that France remains a leader in the field through the development of a national exascale ecosystem in line with EU strategy, while ensuring Europe remains at the forefront of international competition and boosting its sovereignty.

Agroecology and Digital: supporting the agricultural sector by accelerating the agroecological transition

Allocated €65m over eight years, the aim of the PEPR Agroecology and Digital is to harness the power of digital in order to accelerate the ecological transition within agriculture while facing up to challenges relating to the climate, the environment and food security.

With Inrae and Inria responsible for scientific coordination, this programme has four main areas of focus: supporting changes to practices by studying the place, role, design and impact of technology; characterising the genetic resources of animals and plants in order to evaluate their agricultural potential and promote their deployment; developing next-generation agricultural equipment through the use of digital technology, including robotics; and developing digital tools for modelling and decision-support, with a particular focus on artificial intelligence for the collection and analysis of data in agriculture, the goal being to improve efficiency.

PTCC: an accelerator for knowledge and technology transfer projects in cybersecurity

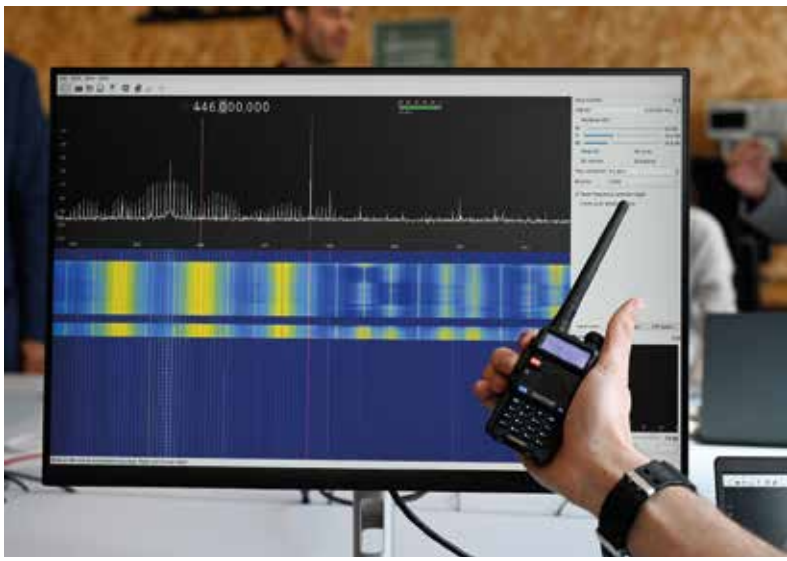
Allocated €40m worth of funding over five years as part of France's National Cybersecurity Strategy, the aim of the PTCC (*Programme de Transfert au Campus Cyber* - Cyber Campus Transfer Programme) is to improve research and technology and skills transfer from public research over to wider regional cybersecurity ecosystems.

Headed up by Inria on behalf of the wider academic community, this programme has four main areas of focus: partnership-based research, transfer, ongoing training and entrepreneurship. Its aim will be to promote joint projects involving multiple stakeholders (from the worlds of academia, industry and government), drawing on the Cyber Campus collective dynamic and its regional network.

eNSEMBLE: an exploratory PEPR to chart the future of digital collaboration

With Grenoble Alpes University, Paris-Saclay University, the CNRS and Inria responsible for scientific coordination, the aim of the exploratory PEPR eNSEMBLE *Futur de la collaboration numérique* (The Future of Digital Collaboration) is to conduct an extensive overhaul of digital tools for collaboration between individuals. The goal being to boost collaboration at unprecedented speed and on an unprecedented scale in order to meet the challenges of our age - from cutting down on travelling and improving national coverage to preparing for major changes over the coming decades - this programme will seek to design collaborative platforms, factoring in concerns relating to engineering, design, usage, organisation, education and regulations.

Over and above the scientific and technological challenges it will aim to address, eNSEMBLE also has a sovereignty component as well as a social component involving around a hundred or so multidisciplinary teams from fields including computer science, ergonomics, cognitive psychology, sociology, design, law and economics. The goal is to encourage new stakeholders to come up with solutions tailored to specific needs and use contexts.



i-PhD and *i-Lab*: a closer look at FOUR INRIA projects that won awards in these competitions

As part of France's Deeptech Plan, Bpifrance launched two competitions on behalf of the government: *i-PhD* and *i-Lab*. These competitions were set up to identify young researchers with entrepreneurial projects involving the use of disruptive innovations. Here are four projects from within our ecosystem which won awards in these competitions.

ALPHABRAIN: HELPING ANAESTHETISTS TO PREVENT POST-OPERATIVE COMPLICATIONS

AlphaBrain has developed a real-time, non-invasive augmented brain monitoring solution for use with general anaesthetic. This AI tool conducts real-time analysis of EEG (electroencephalogram) brain activity in operating theatres, combined with physiological signals. It provides doctors with suggestions on the correct dose of anaesthetic to be administered in order to ensure optimal depth of anaesthesia, as well as on the right blood pressure to maintain in order to ensure the right level of cerebral perfusion, thus preventing any post-op complications.

CELLEMAX: IMPROVING THE EFFICACY AND TARGETING OF CANCER TREATMENTS

Combining imagery of living cells with machine learning, CellEmax has developed a technological platform to assist with the identification of therapeutic targets. Used to resensitise cancer cells to the body's immune system and immunotherapy, these targets are crucial to designing dozens of new primary treatments and rational therapeutic combinations, ensuring that immunotherapies currently in development will be a success.

COMPLIANCE ROBOTICS: A NEW GENERATION OF SOFT ROBOTS FOR INDUSTRIAL USE

Compliance Robotics is aiming to develop the next generation of robots for industrial use, harnessing the innovative principles of soft robotics. Drawing on the PhD research carried out by Eulalie Coevoet on inverse modelling for soft robots, this project is centred around a flexible, versatile and less resource-intensive solution for manufacturing and controlling robots. This will make it possible to target sectors such as agri-food where robotisation has proved difficult, in addition to promoting sustainability in industrial robotics.

NIJTA: A SOLUTION TO PROTECT THE PRIVACY OF USERS OF VOICE APPLICATIONS

Nijta has developed unique speech anonymisation technology involving the use of artificial intelligence that is designed to protect against emerging threats to privacy and confidentiality, while preserving the value of speech data. This solution is targeted primarily at call centres and public services.

Congratulations to all our startups!

Nine other projects presented by Inria won awards in the *I-PhD* and *I-Lab* competitions in 2023:

↗ ***I-PhD* winners:** *DareWin Evolution, NeuroPin, DecorAR, Poucet, Vidibio, Voyance*

↗ ***I-LaB* winners:** *Pulse Audition, Malizen, DeepHawk.*

18% of *I-PhD* winners received support from *Inria Startup Studio*.

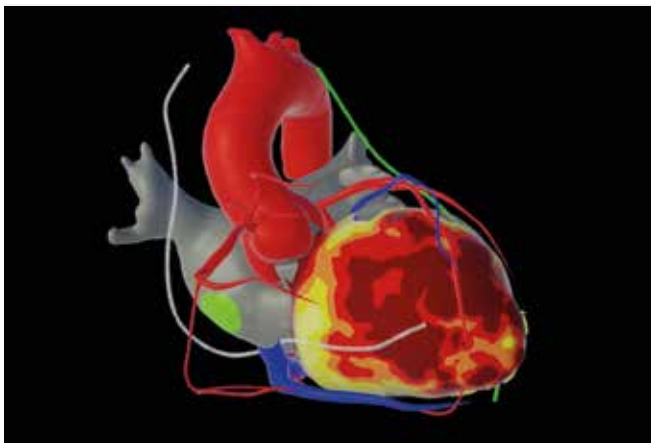
RETHINKING COLLABORATION in order to promote the emergence of new solutions, products and services

Inria is developing ambitious research partnerships with both major manufacturers and smaller companies, the majority of which are based either in France or elsewhere in Europe. These partnerships are helping to revitalise the industrial base in the digital sector, while preparing for the future.

MEDITWIN: VIRTUAL TWINS FOR IMPROVING DIAGNOSES AND CARE

Launched on 11 December 2023, MEDITWIN has its sights set on major breakthroughs in personalised healthcare. Through the creation of digital twins of organs, the metabolism and cancerous tumours, this consortium is seeking to improve the quality of healthcare while making it safer and accessible for all. Healthcare professionals will be able to use MEDITWIN to simulate treatment scenarios and evaluate results in advance, making it easier for them to choose and administer the right treatment for each individual patient.
Seven new medical practices will be modelled in fields ranging from neurology and cardiology to oncology, with seven digital health products to be launched by the end of the five-year project. These products will be marketed and hosted on a sovereign industrial cloud platform by *Dassault Systèmes*.

MEDITWIN harnesses the expertise of internationally-renowned partners, bringing together manufacturers (*Dassault Systèmes* and the startups *inHEART*, *Codoc*, *Qairnel* and *Neurometers*), medical research teams (seven university hospital institutes plus Nantes University Hospital) and Inria through eleven project teams as part of this consortium.



EDF AND INRIA RENEW THEIR **PARTNERSHIP ON ENERGY TRANSITION** THROUGH DIGITAL TECHNOLOGY

After signing a first agreement in 2016 which saw them work together on around 30 or so projects, EDF's R&D department and Inria have renewed their science and technology partnership. This gives EDF access to Inria's expertise in fields ranging from optimisation, AI and data science to cybersecurity, quantum computing, the IoT and telecommunications, as they seek to overcome key challenges linked to energy production and distribution.

This strategic partnership between EDF and Inria - which has already led to the creation of the joint project team IDEFIX in 2021 and the project HIPOTHEC in 2023 - has also recently seen the launch of a new Challenge relating to the management of the electricity systems of the future. The aim of this challenge - for which Luce Brotcorne has been tasked with scientific coordination on behalf of Inria - is to develop new tools (methods, regulatory design, algorithms and software) and new sources of information to assist with strategic and operational decision-making in the context of the energy transition. Nine Inria project teams from five different research centres will be taking part in the challenge.

Collaborations at a European and international level

One of our international highlights in 2023 was the strengthening of Inria's collaboration with the CWI and the University of Waterloo.

France and the Netherlands join forces to promote European sovereignty

Inria and the *Centrum Wiskunde & Informatica* (CWI), the Dutch national research centre for mathematics and computer science, have extended their cooperation in the fields of quantum computing, human-machine interaction, energy, cryptography, digital health, machine learning and software engineering. As part of this enhanced collaboration there is to be a joint research and innovation programme aimed at boosting networking, external partnership opportunities and financing, in addition to the creation of joint teams geared towards creating a powerful scientific alliance within Europe to tackle the complex issue of sovereignty.

Establishing a collaborative research network with America

Inria and the University of Waterloo (Canada) are seeking to build bridges between the French and Canadian ecosystems in science, technology and innovation. The aim is to strengthen existing collaborations and create new ones, including in key sectors such as quantum, AI, cybersecurity and digital health, opening up possibilities in terms of mobility, joint projects and the sharing of best practices between researchers in France and Canada.

Inria has also established closer ties with the LNCC (*Laboratório Nacional de Computação Científica* - the National Laboratory for Scientific Computing) and a network of universities in Brazil, the goal being to make collaboration between researchers as easy as possible. Inria-Brazil, which has twenty or so collaborative projects involving around twenty Inria project teams and the same number of teams from Brazil (around 200 researchers and PhD students in France and Brazil), is now exploring the possibility of further collaborations on subjects specific to Brazil alongside French companies with significant research and development activity in Brazil and who have signed framework agreements with Inria.

European research: the importance OF EXCHANGE

Bringing the AI, data and robotics communities together

As Europe continues to place ever greater emphasis on the issue of sovereignty, the aim of *Adra-e* - a project launched in July 2022 - is to develop a sustainable European ecosystem made up of three communities: AI, data and robotics. This EU project seeks to build bridges between communities while raising awareness and protecting the interests of EU citizens. The goal is to contribute to the development of a trusted, sustainable and competitive ecosystem with the capacity to attract private investment.
Inria is responsible for coordinating a consortium made up of major players from the worlds of industry and academia, pooling expertise in the fields of AI, data science and robotics. This consortium has helped to ensure that both industry and academia and these three deep tech disciplines are all equally represented. 8 and 9 November 2023 saw the first edition of the AI, Data and Robotics Forum held in Rocquencourt. Focusing on generative AI for European industry and society, it was attended by 200 participants. The first day was given over to keynote speeches and round table discussions, while the second day featured ten workshops on a range of different topics. The next edition of the ADRF is set to be held this autumn in the Netherlands.

SLICES: AN EU PLATFORM FOR DIGITAL SCIENCE

SLICES is an initiative that was set up to develop the very first technological platform for experimenting with solutions for the collection, processing and sharing of data in next-generation networks and systems. Coordinated by Inria alongside Sorbonne University and with sixteen partners from France (Inria, Sorbonne University, the CNRS, IMT, Eurecom, the CEA, the University of Strasbourg, the University of Toulouse, Grenoble Alpes University, the University of Lorraine, the University of Rennes, the University of Lille, the University of Nantes, INSA Lyon, ENS de Lyon and RENATER), this project looks set to attract significant interest from Europe's scientific community.
The technology involved in networks, processing and distributed computing is developing rapidly and has a range of constraints it must contend with. For the Internet of Things, for example, the name of the game is very much about identifying where to calculate efficiently, using as little computational resources as possible while optimising energy use and processing time frames. These technologies employ a wide range of different solutions developed within a substantial ecosystem, encompassing issues linked to communication, networking, processing, data intelligence and knowledge extraction.
When it comes to tackling such challenges, scientists are heavily reliant on experimentation in order to test new systems or architectures. The aim of SLICES is to provide them with the resources they need in order to design, test, prototype, operate and permanently automate the management of the entire life cycle of infrastructure, data, applications and digital services, in addition to ensuring that the results of their experiments are both reliable and reproducible across the entire data chain, from collection and transport using heterogeneous technology to processing.

Our ERC prizewinners

ERC grants are awarded to European scientists looking to develop particularly innovative exploratory research. Here's an overview of our seven winners from 2023.

(1)

(2)

(3)

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Florian Faucher (1)
Some environments, such as the internal structure of Earth or the Sun, are difficult to study owing to scientists being unable to gain direct access to them. As a result, non-intrusive methods are required in order to recreate these environments. This is what Florian Faucher, a research fellow with the Makutu project team at the University of Bordeaux Inria Centre, is looking to do with his project INCORWAVE. Focusing on passive seismic, it has been awarded an ERC Starting Grant.

Elena Gaburro (2)
Astrophysical phenomena are often complex and difficult to model from a mathematical point of view. The equations used to describe them are laborious, while the solutions to them can be limited in terms of accuracy and reliability. But breakthroughs in digital methods could see more accurate simulations become a reality, making it possible to analyse all of the variables of a given system. This is the focus of Elena Gaburro's project ALcHyMiA, which has received support in the form of an ERC Starting Grant.

Florence Marcotte (3)
Plasma flows in astrophysical objects are the source of complex instabilities which can have a significant impact on their development, resulting in phenomena such as turbulence or persistent magnetic fields. But the highly nonlinear nature of the equations governing these flows presents an obstacle when it comes to analysing their stability. CIRCE is the name of an ERC Starting Grant project developed by Florence Marcotte, a researcher in fluid mechanics at the Côte d'Azur University Inria Centre, that is seeking to use optimal control methods to model the conditions under which magnetohydrodynamic transitions can be triggered in a nonlinear fashion in astrophysical objects.

Maria Naya-Plasencia (4)
After receiving an ERC Starting Grant in 2016, María Naya-Plasencia, a member of the Cosmiq project team at the Inria Paris Centre, secured further support from the EU in the form of an ERC Consolidator Grant for her project SoBaSyC. Her research into symmetric cryptography and cryptanalysis will make it possible to conduct in-depth analysis of potential attacks as well as vulnerabilities which could be exploited by hackers.

Fabien Lotte (5)
Fabien Lotte won an ERC Proof of Concept Grant in 2023 for SPEARS, a project aimed at developing an algorithm that will use cardiac signals to evaluate the performance of athletes in order to personalise their training. Over time, SPEARS could eventually be used to make predictions as to cognitive performance, with possible applications in education for personalised learning.

Adrien Bousseau (6)
A researcher with the GraphDeco project team at the Côte d'Azur University Inria Centre, Adrien Bousseau was awarded an ERC Proof of Concept Grant for his project DLift (Lifting Design Drawings to 3D). The goal of this project is to provide industrial designers with software that will enable them to convert sketches into 3D shapes.

One more winner was announced at the last minute: **Georges Drettakis**, director of research with the project team GraphDeco, has just been awarded an ERC Advanced Grant.

Our prizewinning **scientists**

2023 was a particularly successful year for Inria researchers. This level of recognition highlights the quality of the research carried out by the institute's project teams across a wide range of research fields.

Benoit Sagot
Chair at the Collège de France

Benoît Sagot, who was awarded a prestigious chair in Computing and Digital Science at the Collège de France for the 2023-2024 academic year, took up the challenge of helping people to understand artificial intelligence (AI) systems, uses of which include automatically generating text based on written instructions. Sagot is head of ALMAnaCH, a project team at the Inria Paris Centre which specialises in natural language processing and digital humanities. He is also the holder of a chair at the 3IA institute PRAIRIE.

Gilles Dowek
The Inria-French Academy of Sciences Grand Prize

Gilles Dowek, head of the Deducteam project team at the Inria Saclay Centre and guest professor at ENS Paris-Saclay, is seeking to create an Esperanto for proof verification systems (also known as proof assistants) which, like the Coq assistant developed by Inria (and which Dowek made a brief contribution to early on in his career), are used to verify mathematical proofs. Now 56, Gilles Dowek has spent a large chunk of his career on these formal methods. A devotee of philosophy, this graduate of the École Polytechnique was previously awarded the Philosophy Grand Prize by the Académie Française in 2007 for his book *Les métamorphoses du calcul, une étonnante histoire des mathématiques* (published by Le Pommier).
In recognition of his career, Gilles Dowek was awarded *the Inria - French Academy of Sciences Grand Prize.*

Hervé Delingette, Maxime Sermesant, Pierre Jaïs, Hubert Cochet, Jean-Marc Peyrat
The Inria - French Academy of Sciences - Dassault Systèmes Innovation Prize

The Cardiologie Numérique Personnalisée team (Personalised Digital Cardiology) has developed a clinical decision-support system for cardiologists involving the use of digital twins combined with medical imaging, a major breakthrough which has increased the success rate of procedures aimed at preventing different types of cardiac arrhythmia by 50%. The startup inHEART, launched in 2017 to produce and market this technology, now has no fewer than 50 partner hospitals across Europe and the USA. In recognition of this achievement, building on more than 25 years of research, the team was awarded the *Inria - French Academy of Sciences - Dassault Systèmes Innovation Prize*.

Julien Mairal

The Inria - French Academy of Sciences Young Researcher Prize

Julien Mairal, has long been a pioneer in machine learning and computer vision. His work is chiefly centred around finding ways of making machine learning algorithms less energy- and data-intensive, while delivering the levels of robustness and interpretability required for scientific applications. Since starting out back in 2007 he has co-authored more than 100 papers, some of which have gone on to international acclaim. He has twice been awarded an ERC grant, a stipend from the European Research Council for leading scientists. At the Grenoble Alpes University Inria centre he is in charge of Thoth, a project team made up of around thirty or so individuals. The Inria - French Academy of Sciences Young Researcher Prize is recognition for Julien Mairal's remarkable career to date.

Stéphane Gaubert

The Inria-French Academy of Sciences Monpetit Prize

Stéphane Gaubert is an Inria director of research and head of Tropical, a project team that is a joint undertaking involving the Inria Saclay Centre and the CMAP centre for applied mathematics, a CNRS joint research unit involving Inria, the École Polytechnique and the Institut Polytechnique de Paris. His research concerns the way in which tropical geometry, optimisation, control and discrete event dynamic systems interact with each other. Gaubert's achievements include developing methods in algebra and tropical convexity, as well as in nonlinear Perron-Frobenius theory, linking these fields to game theory. He has applied these methods to fundamental complexity questions (including linear programming and Smale's 9th problem), as well as to practical problems relating to energy optimisation, biological modelling, verification and logistics for emergency call centres. In 2023 he was awarded the Inria-Michel Monpetit Prize, which recognises researchers and engineers for their work in the fields of applied mathematics and computer science.

Oana Goga

The French Academy of Sciences-SIF Lovelace-Babbage Prize

Oana Goga is a CNRS researcher and member of the project team Cedar whose research focuses on investigating the risks posed to humans and society as a whole by online platforms, AI and targeting technology. Her work is interdisciplinary, seeing her collaborate with economists, researchers in social sciences and legal practitioners to analyse risks linked to misinformation, security and privacy and child protection. Her research has had an impact on EU law, and she is also an external expert for the European Commission on issues linked to data access and the regulation of platforms. In 2022 she scored a prestigious ERC Starting Grant for her work in measuring and mitigating the impact of the use of algorithms to target information. She has also won a number of prizes for her research, including the Honorable Mention prize at The Web Conference in 2020 and the CNIL-Inria Prize for privacy protection. In 2023 she scooped The Lovelace-Babbage Prize, which is awarded to scientists who have contributed to the development of new technology through their research, from the most theoretical to the most applied.

Fabien Lotte

The French Academy of Sciences Lovelace-Babbage Prize

Fabien Lotte designs brain-computer interfaces (BCIs) which enable users to interact with computers using brain activity alone, developing algorithms to decipher brain signals while optimising human training in controlling BCIs. He has coordinated a wide range of research projects on BCIs, including the French National Research Agency (ANR) projects REBEL and PROTEUS and the ERC project *BrainConquest*. A member of the Potioc project team at the University of Bordeaux Inria Centre, he was awarded an ERC Starting Grant in 2016 and a Proof of Concept Grant in 2023. In 2023 he was awarded the Lovelace-Babbage Prize by the French Academy of Sciences, in partnership with the SIF (*Société informatique de France* - the French Computer Science Society).

Virginie Ehrlacher

The Irène Joliot-Curie "Young Female Scientist" Prize

Virginie Ehrlacher is a researcher at l'École des Ponts ParisTech and a member of the project team MATHERIALS. Her research focuses on the development

and mathematical analysis of high-performance digital methods used for function approximation, particularly on a large-scale, with applications in materials science. Having made important breakthroughs on tensor methods and model reduction, she leads the ERC Starting Grant project HighLEAP, which concerns the simulation of systems of large-scale agents and particles, making her an international authority on these subjects. In 2023 she was awarded the *Irène Joliot-Curie "Young Female Scientist" Prize*.

Anne Canteaut

Irène Joliot-Curie "Young Female Scientist of the Year" Prize

Anne Canteaut, director of research with the project team COSMIQ, is a specialist in cryptography, with a particular focus on encryption systems. Her research concerns both the design of new cryptographic algorithms - for protecting data confidentiality, for example - and analysing the security of existing systems, at the interface between cryptography, algorithms and discrete mathematics. She was the chair of Inria's Evaluation Committee from 2019 to 2023. In 2023 she was awarded the prestigious Joliot Curie "Young Female Scientist of the Year" Prize by the French Academy of Sciences and the French Academy of Technology for her work on encryption.

Nataliia Bielova

Privacy Award winner 2023

Nataliia Bielova is a researcher in computer science with the project team Privatics. From September 2021 to December 2022 she was on secondment to the CNIL (*Commission Nationale de l'Informatique et des Libertés* - the French Data Protection Authority). Her research concerns online privacy protection and the protection of personal data, taking an interdisciplinary approach that sees her collaborate with researchers in law and design. Arguably her main motivating factor is the impact her research could have on society. Providing original research results based on in-depth legal analysis of the GDPR and technical evaluation of websites' GDPR compliance, her work has influenced changes made to data protection legislation and decisions taken by data protection regulators. Bielova was awarded the "Rising Star" prize by W@Privacy, which supports women working in privacy and the protection of personal data.

George Drettakis

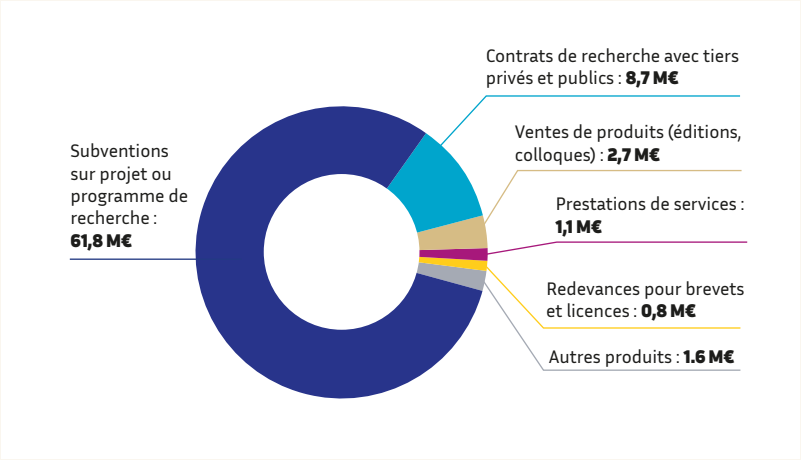
Best Paper Award SIGGRAPH

Combining cutting-edge computer graphics and machine learning, 3D Gaussian splatting is a process developed by the project team GraphDeco which can be used for the real-time rendering of photorealistic scenes trained using only a small number of images. Using an innovative method that is both quicker and more accurate, this represents a major breakthrough in a field previously dominated by Google's NeRF and Nvidia's InstantNGP, and saw the researchers behind the process win a Best Paper Award at the SIGGRAPH conference in 2023. In addition to its significant scientific impact, the process has also attracted a lot of attention from the graphic design community and companies in the audiovisual and computer games sectors, many of whom have tested and developed solutions based on this innovative technology through the software licence marketed by Inria. More than 100 commercial software licence requests have been received, and more than ten licences have already been signed.

Annual budget report for the 2023 financial year

Inria's initial budget for 2023, which was voted on in December 2022, was €307.1 million for resources and €334.1 million for expenses.
Regarding execution of the 2023 budget in terms of revenue, the Subsidy for Public Service Expenses (SCSP) stands at €191.6m compared to €189.7m in 2021 and €186m in 2022. It represents 71% of the revenues received for the 2023 financial year.

Own resources amounted to about €76.7m, representing an execution rate of 79% compared to the amounts posted in the last amending budget.
They accounted for 29% of all of the institute's resources in 2023.
Own resources come from:



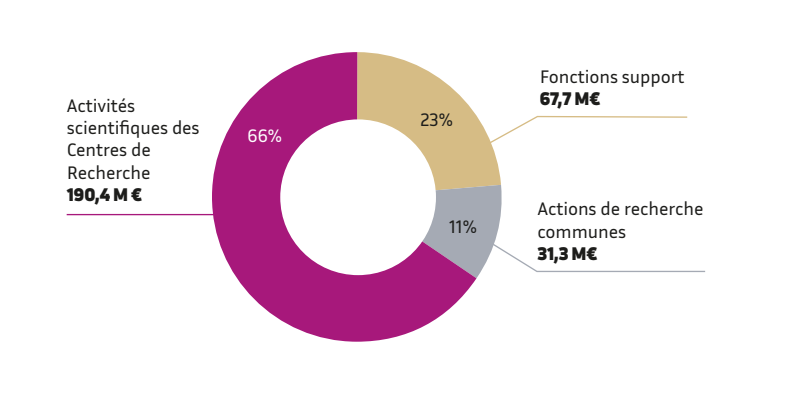
Total revenue was €268.3m in 2023, representing an execution rate of 93% compared to the amending budget.
By nature, expenditure breaks down as follows: €217.8m on payroll costs (75% of total expenditure), including €164.4m for the Restrictive Wage Bill and €53.4m for the Non-Restrictive Wage Bill.

The number of "under the ceiling" staff (i.e. those whose pay is based on the SCSP) reached 1686.0 full-time equivalent hours worked (FTEHW) compared to 1516.6 in 2021 and 1554.1 in 2022 and for 1725 forecast in the 2023 initial budget.

The number of "non-ceiling" staff (i.e. those whose pay is based on own resources) was 1134.0 FTEHW compared to 1091.8 in 2021 and 1090.1 in 2022.
€61.6m for non-scheduled investment and operating costs (FCI)
€10.0m in expenditure related to scheduled investment transactions (OIP)

Total expenses for 2023 were €289.4m, representing an execution rate of 94% in relation to the amending budget.

By purpose, expenditure in 2023 included:



The table below shows the scientific themes corresponding to the institute's main objectives, taking all expenses into account, regardless of funding source and all items combined.

Team expenses by sector *(in millions of euros)*	**119.15**
Applied Mathematics, Computing and Simulation	22.41
Algorithms, Programming, Software and Architectures	26.56
Networks, Systems and Services, Distributed Computing	15.34
Perception, Cognition, Interaction	29.84
Healthcare, Biology and Digital Planet	24.99

As has been the case since 2010, the 2023 accounts have been certified by two statutory auditors, Ernst & Young an Deloitte. The 2023 accounts were certified with two reservations.

The 2023 financial account shows a loss of €35.6 million (after a loss of €17.6m the previous year).

Points of note regarding this increase in losses are as follows:

➔ an increase in subsidies and similar income (+ €16.9m), which is explained, firstly, by the growth in the subsidy for public service expenses (+ €5.5m), and secondly, by that in other operating subsidies (+ €11.4m)

➔ a reduction in direct income from activity (- €7.1m), which can partly be explained by a reduction in income from contracts with private partners (- €12.1m), which has been partially offset by an increase in other management income (+€3.9m)

➔ a significant increase in payroll costs (+ €19.1m), to which can be added an increase in other operating costs (+ €5.6m), in addition to allowances for depreciation, amortisation and provisions (+ €4.1m).

The balance sheet total (assets and liabilities) stood at €329.7m in 2023 compared to €332.6m in 2022.

PROFIT AND LOSS STATEMENT

In thousands of euros	2023	2022	Variation 2023/2022
Subsidy for public service expenses	191,541	186,053	3%
Operating subsidies granted by the State and other public bodies	51,052	39,600	29%
Subsidies allocated to fund maintenance costs	-	-	-
Donations and bequests	329	399	-18%
Allocated tax income	-	-	-
SUBSIDIES AND SIMILAR INCOME	**242,922**	**226,052**	**7%**
Sales of goods or services	12,196	23,284	-48%
Income from the sale of assets	36	5	620%
Other management income	6,653	2,722	144%
Inventory and self-constructed assets	-	-	-
Income earned for provision of a public service	-	-	-
DIRECT INCOME FROM ACTIVITY	**18,885**	**26,011**	**-27%**
Write-backs on amortisation, depreciation and provisions	18,343	17,985	2%
Write-backs of asset-related funds	5,308	4,814	10%
OTHER INCOME	23,651	22,799	4%
OPERATING INCOME	**285,458**	**274,862**	**4%**
Use of goods and supplies, works and services	53,810	53,825	-
Payroll costs	207,028	187,963	10%
Other operating costs (incl. losses/write-offs)	25,714	20,129	28%
Allowances for amortisation, depreciation and provisions, Net accounting value of assets disposed of	34,554	30,497	13%
OPERATING COSTS	**321,106**	**292,414**	**10%**
NET INCOME (OR LOSS) FROM ACTIVITY	**-35,648**	**-17,552**	**103%**
Write-backs on depreciation and provisions	_	20	-100%
FINANCIAL INCOME	**-**	**20**	**-100%**
Other financial costs	-	20	-100%
FINANCIAL CHARGES	**-**	**20**	**-100%**
NET FINANCIAL INCOME (OR LOSS)	-	-	-
Corporate tax	-	-	-
FISCAL YEAR PROFIT OR LOSS	**35,648**	**17,552**	**103%**

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Inria is France's national institute for research in digital science and technology and since January 2024 has been responsible for the Digital Programmes Agency, the aim of which is to strengthen collective dynamics within higher education and research. World-class research, technological innovation and entrepreneurial risk-taking are an integral part of its DNA. Within 220 project-teams, the majority of which work jointly with major research universities, more than 3,800 researchers and engineers explore new paths, often through an interdisciplinary approach and in association with business partners to meet ambitious challenges. In its role as a technology institute, Inria supports diversity in innovation, from open-source software publishing to the creation of technology start-ups (deep tech). Inria has been awarded Carnot Institute status, confirming its desire to build bridges between the worlds of research and industry.

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