Annual report 2023

GENCI
Le calcul intensif au service de la connaissance

www.genci.fr/en

GENCI

In charge of **PROVIDING** high-performance computing and massive data processing resources, **GENCI**'s mission, at national and European level, is to promote the use of HPC combined with Artificial Intelligence and prototype quantum computing devices, for the benefit of scientific, academic and industrial **RESEARCH COMMUNITIES**.

More than 134 PFlop/s **IN 3 COMPUTING CENTERS**

- **CINES ADASTRA** Supercomputer 77.9 PFlop/s
  IDRIS JEAN ZAY Supercomputer 36.2 PFlop/s
  TGCC JOLIOT-CURIE Supercomputer 22 PFlop/s
- For the entire IR*, 1733 resource request files processed during the year, **with more than 3.1 billion core hours requested in CPU and 95 million GPU hours.**
- **4,206** users from academic and industrial research
- **11 Thematic Committees**

** Research infrastructure (IR)*

FIVE shareholders

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SYLVIE RETAILLEAU,
MINISTER OF HIGHER EDUCATION AND RESEARCH

MINISTÈRE
DE L'ENSEIGNEMENT
SUPÉRIEUR
ET DE LA RECHERCHE
Liberté
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For GENCI, the year 2023 was filled with events across all components of high-performance computing, with increasingly precise and numerous numerical simulations, the first applications of quantum technologies, and the extraordinary growth of artificial intelligence.

The past year is first and foremost highlighted by the successful deployment of the Adastra supercomputer at CINES, a system as powerful as it is energy-efficient, ranking 3rd in the world on the renowned Green500 list. This achievement underscores our commitment to environmentally responsible scientific development. However, 2023 is also the year of the selection of the Jules Verne consortium by EuroHPC. France will host, at the heart of the very large computing center (TGCC) of CEA, the second Exascale system of the European joint undertaking EuroHPC. This remarkable tool will likely be one of the most powerful machines in the world when it opens to the first French and European users. I would like to thank the teams of GENCI and CEA for their work in successfully leading this application, as well as all the national scientific actors who mobilized throughout the procedure.

The field of quantum technologies is also being highlighted at TGCC with the preparation for the installation of a quantum system from the French company Pasqal, which will be operational in 2024, and the finalization of the launch of a call for tenders with EuroHPC to host another photonic quantum computer.

The government has managed to mobilize substantial resources and is remaining attentive to digital sovereignty, which is a major challenge for the decades to come.

All of these projects have received significant budgetary support from the Ministry of Higher Education and Research, strengthened by the Research Programming Law, as well as the France2030 investment plan. The government has managed to mobilize substantial resources and leverage them in an ever-competitive European context, while remaining attentive to digital sovereignty, which is a major challenge for the decades to come.

Finally, 2023 was also the year of the advent of artificial intelligence. In this domain as well, we are not lagging behind, since it has been decided to extend the HPC-AI Jean Zay converged supercomputer at the CNRS/IDRIS for the last time, which will enable us to achieve performance levels worthy of the ambitions we have for this field. We are also mobilizing unprecedented resources to enable researchers, large companies and startups to benefit from large-scale computing capacity. As a significant proportion of these resources will be provided by French companies and startups, this project illustrates how GENCI's actions are emblematic of the efforts that the State is making through and for the research and innovation ecosystem.I look forward to seeing you throughout the year to follow the progress of these equally promising projects.

PHILIPPE LAVOCAT,
CEO OF GENCI

Interview

GENCI
Le calcul intensif au service de la connaissance

HOW WOULD YOU SUMMARIZE THE LAST YEAR FOR GENCI?

PHILIPPE LAVOCAT: 2023 was a decisive year for high-performance computing, artificial intelligence and quantum computing in the service of knowledge, science and innovation. Three highlights illustrate this point:

- The Jules Verne consortium - led by France via GENCI and the CEA - was selected in February by EuroHPC to host the second Exascale machine in Europe.
- The inauguration and commissioning of Adastra at CINES, a supercomputer initially ranked 10th in the Top 500 and still 3rd in the Green 500.
- The announcements from the President of the Republic during Vivatech event, concerning in particular the developments of the Jean Zay supercomputer, hosted and operated by CNRS-IDRIS.

HOW HAS GENCI'S SCOPE OF ACTIVITIES CHANGED?

P.L.: If the operations led by GENCI are carried out in the three French computing centers (CINES, IDRIS, TGCC), GENCI's activity takes place also more broadly within a European framework. As such, 2023 will have marked the end of our contribution to the great scientific adventure Prace and we will now dedicate ourselves 100% to our commitment to the European initiative EuroHPC.This Franco-European dynamic is particularly illustrated by the very promising achievements initiated within the framework of the French HQI initiative, like now the European EuroQCS project in the field of photonic quantum technologies. Finally, the excellence requirement which governs GENCI's activity and requested by our 5 Associates finds expression in the fact that more than 1,500 high-level scientific projects have mobilized our national resources in the 3 national computing centers in 2023.

IN THE UPCOMING OLYMPIC YEAR, HOW WOULD YOU DEFINE THE MAIN CHALLENGES FOR GENCI?

P.L.: In 2024, it will be faster, higher, stronger. GENCI will put HPC, AI and quantum computing increasingly at the service of the development of knowledge, future scientific discoveries, shared progress, and of the women and men who carry them.
Excellence rhymes with performance. While the Olympic Games will take place on French territory, major steps to meet cutting-edge challenges will be taken: launch of the call for tenders to acquire the second European Exascale class machine, realization of the first projects mobilizing the machines quantum technologies at TGCC, development of the use of Adastra at CINES and strengthening of national capacities in Artificial Intelligence at IDRIS.

GENCI puts high performance computing in the service of the development of knowledge, future scientific discoveries and innovation.

GUILLAUME AVRIN,
NATIONAL
COORDINATOR
FOR ARTIFICIAL
INTELLIGENCE

GOUVERNEMENT
Liberté
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Fraternité

National strategy for artificial intelligence

The National Strategy for Artificial Intelligence (SNIA), launched in 2018, aims to make France a leader in artificial intelligence (AI). After an initial phase focused on structuring the national AI ecosystem and strengthening research capacities in the field, the second phase of the strategy, launched in 2022, aims to disseminate AI throughout our economy, notably by translating research advances into industrial successes.

To achieve this objective, actors in the research and innovation sector require access to competitive, responsive, and sovereign computing infrastructures. In this perspective, the Jean Zay supercomputer installed at IDRIS (CNRS) and boasting a power of 32 PetaFlops/s is one of the most visible deliverables of the first phase of the SNAI.

To further enhance access to these supercomputers for training gigamodels, especially generative ones, the President of the French Republic announced at Vivatech a new expansion of Jean Zay's capacity, as well as the establishment of an exascale-class supercomputer at TGCC (CEA) as part of the European initiative EuroHPC. In this dynamic of evolving computing capabilities, as well as evolving usage needs expressed by Jean Zay users, our dedicated action plan for the adaptation and extension of existing public supercomputing infrastructures includes the following initial points:

1. Increase in computing power: An investment program (€40 million) led by GENCI for a new expansion of Jean Zay's computing capabilities, particularly for training gigamodels, through the acquisition and integration of new state-of-the-art GPUs.

2. Facilitating access to supercomputers: This reinforced computing power should be subject to improved accessibility for research, innovation, and training projects carried out by both public and private entities. This openness requires certain technical and organizational evolutions: tailored allocation processes for computing capacities adapted to different types of actors (academic laboratories, CIFRE theses, industrial groups, startups) and project types (including for pre-training and adaptation of gigamodels), management of access modalities, adapted software stack, economic model, etc.

3. Sustainability and strengthening of the support network for Jean Zay: The experience gained from the first phase of the SNAI shows that it is essential to ensure the sustainability of the CNRS teams providing support for Jean Zay, as endorsed by both public and private actors in our ecosystem.

On each of these points, GENCI has taken the necessary actions in 2023 to ensure that the SNAI achieves these objectives on time. We are delighted with the commitment of its teams and the quality of their work, which has been recognised by the entire ecosystem.

> **GENCI is at the heart of the AI national strategy.**

FOREWORD by CNRS

The continued growth in resource demands confirms the success of Jean Zay's GPU partition for artificial intelligence, a success highlighted by the French Cour des Comptes. An additional budget of €40 million, announced by the President of the Republic at the VivaTech show, will allow a very significant expansion of computing capacities and the arrival of new users.

However, the past year has given rise to some concerns. The very sharp increase in electricity prices could have forced us to reduce the availability of the machine. Such an unfortunate situation was avoided, thanks to the effective joint action of GENCI, CNRS and French Ministry of Higher Education and Research. Finally, the migration of high-performance computing codes to GPU architectures, the only way to increase the available computing power at a controlled energy cost, announces a challenge that we will tackle together.

Denis VEYNANTE,
Deputy director with responsibility for digital infrastructures within the research open data department, CNRS

FOREWORD by France Universités

The rapid growth in the use of artificial intelligence and the acceleration of quantum technologies require us to adapt our computing resources to serve our researchers and their partners, and generate a significant growth of training courses for which our universities are in the front line.

This year, 2023, has been marked by an exceptional mobilization of computing resources and staff at CINES and GENCI, which I would like to salute on behalf of France Universités. The mobilisation of our research units on the PEPRs, our HPC-centers and their support for industrial partnerships through MESONET and the deployment of the HPC-HPDA-IA skills centers are examples of the strong commitment of our scientific community, which we need to support as best we can. We are fully mobilized alongside GENCI and its associates to achieve this.

Guillaume GELLÉ,
President of France Universities

FOREWORD by Inria

2023 saw the launch of the NumPEx PEPR program, co-directed by CEA, CNRS and Inria. The aim of this program is to design and develop the software building blocks that will equip the future exascale machine. Teams from GENCI and the 3 data centers were instrumental in preparing the program and launching its implementation.

Numerous joint actions have been initiated, including participation in the drafting of the specifications for the future exascale computer, the production of benchmarks, and the launch of a working group on the subject of the Digital Continuum, bringing together CINES, IDRIS, TGCC and NumPEx partners.

GENCI's support is also highly appreciated in the European field, particularly in relation to EuroHPC, and internationally.

Finally, Inria project teams continue to make extensive use of the dynamic access procedure set up for Machine Learning.

Jean-Frédéric GERBEAU,
Deputy CEO
for science at Inria

FOREWORD by CEA

The year 2023 was marked by the success of France's application to host and operate the second European exascale machine through EuroHPC. The project, led by GENCI, was crowned with success thanks to the involvement of all stakeholders, with a decisive contribution from CEA as the Hosting Site, as well as remarkable mobilization from the application community.

From a scientific standpoint, CEA can celebrate notable projects that benefited from GENCI's computing resources in 2023. These projects also demonstrate the expansion of the use of computing resources into various scientific fields. For example, a team from NeuroSpin conducted a comprehensive evaluation of candidate biomarkers for the diagnosis and prognosis of neurodevelopmental disorders or neurodegenerative diseases using the world's largest open-access genetics imaging cohort (UK Biobank).

Maria FAURY,
Director for international and large scale infrastructures research CEA/DRF

WHAT THEY SAY ABOUT US

IN THE PRESS / ON THE WEB

news tank éducation & recherche

SiecleDigital

11/16/2023

AI, HPC, quantum: 1st French cloud portal for public & private training and research

Ten public and private players are launching the first cloud portal initiative dedicated to public and private research and training in the fields of HPC (High Performance Computing), artificial intelligence and, in the near future, quantum computing. The project, dubbed "Clusster" for "Unified Cloud, sovereign of services, technologies and infrastructures", brings together a consortium including GENCI (Large National Equipment for Intensive Computing), CEA (Atomic Energy and Energy Commission alternatives), CNRS (National Center for Scientific Research) and Inria (National Institute for Research in Computer Science and Automation) on the academic side; Eviden (Atos group), OVHcloud, CS Group, ActiveEon, Hublo and Qarnot.

aef info

05/05/2023

High performance computing: CINES inaugurates a supercomputer acquired by GENCI, among the most powerful ones in Europe

With 74 petaflops/s of computing power, twenty times more than the previous Occigen supercomputer, the new Adastra equipment inaugurated on May 4, 2023 by CINES and GENCI is among the most powerful in Europe, and thus "a major technological asset for French research". The supercomputer, acquired by GENCI in 2022 and commissioned at CINES in Montpellier, is available to academic and industrial researchers as part of an "open research" approach.

Les Echos

06/21/2023

France will soon welcome "Jules Verne", a new giant supercomputer

France has been chosen to host a machine of rare power: a latest-generation supercomputer. Named after a French writer, Jules Verne, it will be installed in the Paris region, at the CEA's Très Grand Centre de Calcul in Bruyères-le-Châtel, Essonne (...) "The European Commission has set up a policy, in conjunction with the Member States, through a joint undertaking called 'EuroHPC'. In a way, it is Europe's armed wing to equip it with high-performance computing resources", explains a spokesperson for GENCI, the French national High-Performance Computing organization, which was behind the French proposal, in collaboration with the French Atomic Energy and Alternative Energies Commission (CEA) and the Netherlands.

EVENTS

• 2023 was an eventful year. In particular, GENCI was present at the ISC trade show in Hamburg, the Teratec forum in Paris, and the Supercomputing 2023 event.

• As part of its participation in the HQI program, GENCI organized the presence of this initiative at Vivatech, through the Quantum village HQI @Vivatech.

↑ The Quantum village in the presence of Sylvie Retailleau, Minister of Higher Education and Research (center), and representatives of the GENCI ecosystem.

ON SOCIAL MEDIA

DISCOVER MORE GENCI'S NEWS

THE COMPUTING CENTERS IN 2023

TGCC

PREPARE FOR THE FUTURE WITH GENCI

NICOLAS LARDJANE,
TGCC'S MANAGER
(CENTER HOSTING
THE JOLIOT-CURIE
SUPERCOMPUTER)

2023 has been a particularly rich year for the TGCC and its team.

Rich in terms of computation, with a record use of the Joliot-Curie machine Rome partition, notably via the hosting of twelve grand challenges for nearly 350 million core hours. Rich in new projects as well, with the completion of work in the room dedicated to quantum computers and the launch of the adaptation of the TGCC for the installation of an exascale supercomputer by the end of 2025. Finally, rich on the human level, with the retirement of Christine Ménaché, whom I have the honor of replacing.

In 2024, a first quantum system from the Pasqal company will be installed at the TGCC, then coupled to the Joliot-Curie machine as part of the HPCQS project. Other QPU technologies will follow, including a photonic model co-funded by EuroHPC and HQI through the EuroQCS-FR project. Also in 2024, EuroHPC will launch the call for tender for the acquisition of the exascale machine of the Jules Verne consortium (GENCI, CEA, Surf). This massively accelerated supercomputer will replace the Joliot-Curie machine, offering new horizons in AI and HPC for France and Europe. This change in scale will be accompanied by increased user support from the three national computing centers, and will benefit as well from the outcomes of the NumPEx PEPR.

If 2023 was a rich year, the projects to come promise to be just as exciting, with a continued and ever increasing commitment of the TGCC teams to meet the needs of our communities.

JEAN ZAY

ECO-RESPONSIBILITY AND PERFORMANCE

PIERRE-FRANÇOIS LAVALLÉE,
DIRECTOR OF IDRIS
(CENTER HOSTING
THE JEAN ZAY
SUPERCOMPUTER)

In 2023, the energy crisis and the soaring cost of kWh, which was multiplied by 3 compared to the previous year, mobilized the IDRIS teams in charge of the Jean Zay national infrastructure, whose annual consumption reached 17 GWh. In collaboration with the CNRS and GENCI, several action plans were drawn up to provide a precise assessment of the center's energy consumption and its technical infrastructures, to validate procedures for possible load shedding requests, and to find an additional budget for electricity. Thanks to this proactive approach, the scientific communities were able to continue their research work throughout the year without any interruption in service.

In this context, optimizing Jean Zay's eco-responsibility makes perfect sense. While IDRIS has been reusing the heat generated by its calculators since 2011 to heat its building, the completion of work to interconnect Jean Zay with the EPAPS heating network at the end of 2023 will enable us to reach a new milestone, with the ambition of recovering around 4,000 MWh/year, the equivalent of heating 1,000 new homes.

The other major event of 2023 was the announcement by the French President at VivaTech23, to meet the growing needs of training large foundation AI models, to extend the computing power of Jean Zay for a budget of €40m. A tightly-knit IDRIS-GENCI team worked on implementing this extension, via a call for tenders published in October 2023. Within a tight schedule, the various stages of the procedure followed one another (drafting of the DCE, dialogue sessions) until the end of 2023. We look forward to seeing you in mid-2024, when this new partition incorporating the latest GPU technologies, will be operational.

← Element of waste heat recovery infrastructure at IDRIS: hot water circulation pump

MICHEL ROBERT,
HEAD OF CINES
(CENTER HOSTING
THE ADASTRA
SUPERCOMPUTER)

CINES

ADASTRA, THE SUPERCALCULATOR IS OPERATIONAL

CINES Montpellier, november 2023, CINES agents displaying the Green 500 certificate awarded to a delegation from the CINES DCI team during SC23 in Denver (USA).

Since May 2023, and the inauguration of Adastra, the supercomputer at CINES has been fully operational, offering 70 PFlop/s, which is 20 times more computing power than Occigen with comparable energy consumption. Ranked 11th in the Top500 in June 2022 and still 3rd in the Green500 in November 2023. With feedback and support from the scientific community, AMD, and HPE, CINES can provide researchers with a high-performance and energy-efficient computing environment.

In 2024, efforts will focus on continuously improving the services offered to the community, integrating various tools such as high-quality documentation and hackathon sessions, a true hub of scientific exchange. Maintaining performance and security of the platform will, of course, also be at the forefront of our concerns.

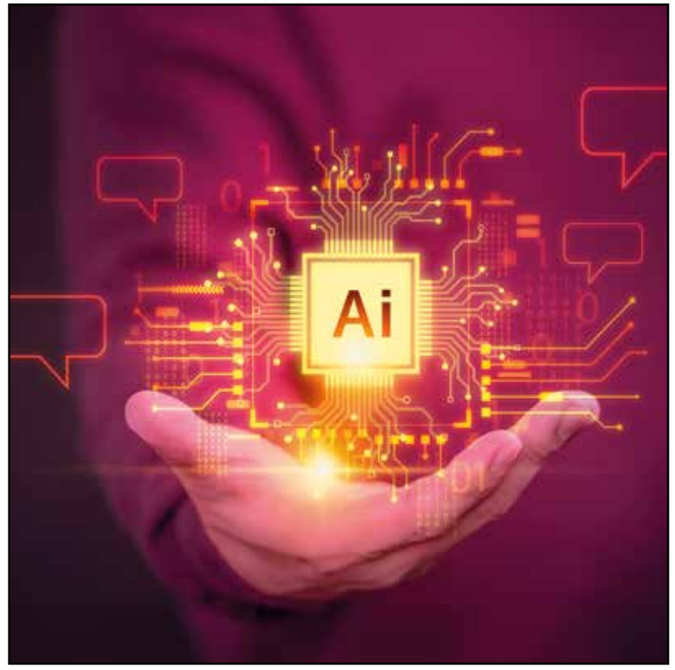
Finally, 2024 will be marked by the expansion of Adastra and the introduction of the MI300A partition, which will undoubtedly address major societal challenges related to AI, particularly in healthcare and Earth system studies.

Proud of the achievements of 2023, and ready to tackle the challenges of 2024, CINES will continue to make Adastra a major player in helping research to soar, as promised, "towards the stars".

ADASTRA Machine Outlook in the CINES room

A YEAR'S DIARY

CONTENTS



THE JULES VERNE CONSORTIUM

EXASCALE, FRANCE IS POSITIONING ITSELF IN EUROPEAN COMPUTING LANDSCAPE

The Jules Verne consortium has been selected by the EuroHPC Joint Undertaking to host and operate a new European Exascale supercomputer in France. The Jules Verne consortium brings together France, represented by GENCI as hosting entity, in collaboration with CEA as hosting site, and the Netherlands, represented by SURF.

The GENCI research infrastructure has been mandated by the French government to lead the French response to the call for expressions of interest (AMI) published in December 2022 by EuroHPC for the acquisition, hosting and operation of an Exascale-class supercomputer at the CEA's computing center (TGCC). The Netherlands has joined us in this consortium, named Jules Verne in tribute of one of the most widely translated French writers, who prominently featured futuristic scientific advancements in his novels. Our application was submitted to EuroHPC in February 2023 and was officially selected after an evaluation by independent experts, a hearing by these same experts on the EuroHPC premises and a vote by the EuroHPC Governing Board.

A CONTRACTUALIZED PROJECT

The main objective of the Jules Verne consortium is to deploy a world-class Exascale supercomputer, based on European hardware and software technologies, responding to major societal and scientific challenges through the convergence at scale of numerical simulation, massive data analysis and artificial intelligence. This computer will also be designed to interface and couple with quantum devices acting as accelerators currently being installed at TGCC.

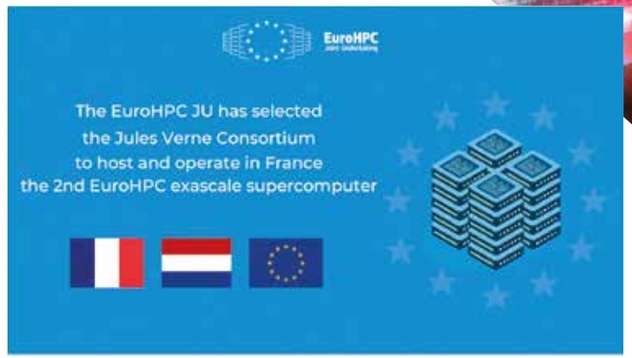
> **To deploy a world-class Exascale computer, based on European hardware and software technologies.**
>
> PHILIPPE LAVOCAT, CHAIRMAN AND CHIEF EXECUTIVE OFFICER, GENCI

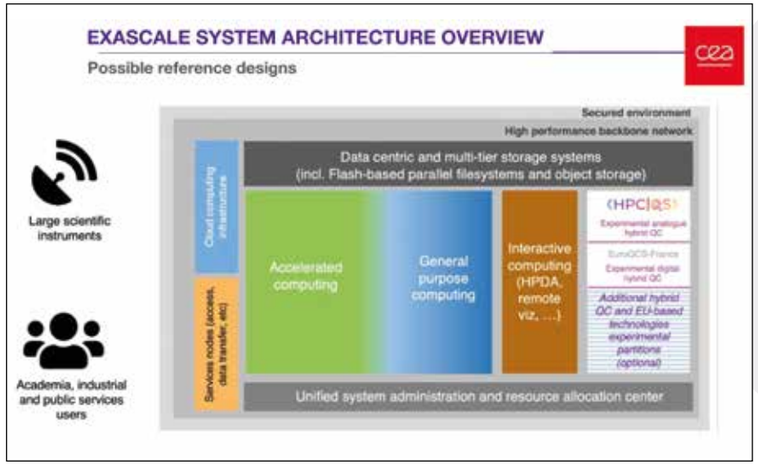
The official notification of selection of the Jules Verne consortium was published on 20 June 2023. Subsequently, EuroHPC, GENCI and its partners in the consortium then began discussions to contractualize the project by signing a Hosting Agreement.

In parallel, GENCI conducted outreach efforts with representatives from EuroHPC member countries, French public research organizations, and French industrial entities to invite them to join the Jules Verne consortium. Two research organizations expressed their intention to join the Jules Verne consortium.

AVAILABLE FROM THE END OF 2025

The procedure for acquiring the exascale-class supercomputer will be carried out by EuroHPC with the technical support of the consortium members, in particular GENCI and CEA, during 2024. This supercomputer will be based on a modular, energy-efficient architecture offering several computing, pre/post-processing and service partitions federated by a high-speed internal interconnection. It will be made available to European researchers for open research and to researchers from consortium members from the end of 2025 for a period of 5 years.





DISCOVER NEWS ON THE EUROHPC WEB

EPICURE
Unlocking European-level HPC support

CREATION OF AN APPLICATION TEAM SUPPORT

TO PORT AND OPTIMIZE APPLICATIONS

Beyond the machine itself, the Jules Verne consortium will provide support to European researchers for the porting and optimization of their applications on the supercomputer, as well as for training.

AN INTERNATIONAL VISION

In this perspective, the Jules Verne consortium has already established relationships with national Exascale R&D projects (such as the France 2030 NumPEx program, see page 20).

TOWARDS FEDERATED SUPPORT

GENCI is also a partner in the project financed by *EuroHPC, EPICURE,* aimed at bringing together application support teams from the different consortia hosting calculators financed by *EuroHPC*.

NUMPEX

A UNIQUE PROJECT TO PREPARE FOR *EXASCALE*

Launched in 2023 for a duration of 6 years, the NumPEx PEPR aims to contribute to the design and development of numerical methods and software components that will equip future European Exascale and post-Exascale machines. NumPEx also aims to support scientific and industrial applications in fully harnessing their potential.

With a budget of €40.8 million the NumPEx program brings together over 500 researchers and engineers on a national scale. One of the main drivers of the NumPEx program is the current paradigm shift in HPC system architectures with the rapid emergence of new technologies and applications (such as the digital continuum and AI), which requires the development and adaptation of the HPC software stack for future Exascale supercomputers. It is also essential for scientific and industrial applications to prepare for post-Exascale systems and their applications. The use of such supercomputers by academic and industrial researchers, with its potential for innovation and competitiveness, requires significant efforts in code adaptation and porting, both for simulation and data analysis.

A DIGITAL CONTINUUM

Adapting applications to these new architectures is a major scientific and technological challenge that requires substantial research efforts, made possible by the support of France 2030. NumPEx aims to rethink:

- algorithms and associated numerical methods,
- how to express and execute parallelism,
- and even the modeling of the physical phenomena being studied,
- while taking into account the evolution of data-driven usage and the implementation of AI approaches.

The approach is holistic: the supercomputer becomes an integrated component in a digital continuum formed by a chain of processes guided by data flow. NumPEx also engages in a comprehensive reflection aimed at identifying and designing the future corpus of Exascale and post-Exascale training, in close collaboration with our European and international colleagues.

FOCUS

THE CHALLENGE
In the era of Exascale computing, mastering the software stack of supercomputers is a scientific, technological, and national and European sovereignty issue.

OUTLOOK
To this end, NumPEx will contribute to the construction of a software stack that promotes the full utilization of the capabilities of the future Exascale machine in the Jules Verne project.

MORE ABOUT NUMPEX

A super motivated NumPEx team! Here at the mid-2023 kick-off meeting.

CLUSSTER

SOVEREIGN CLOUD OF PUBLIC AND PRIVATE PARTNERS FOR AI

The CLUSSTER project (Sovereign Unified Cloud of Services, Technologies and Infrastructures), started on February 1, 2023. Through a unique public-private partnership, it aims to develop and strengthen a French and European sovereign cloud sector, aligning with the acceleration strategy of the CLOUD initiative led by the Directorate General of Enterprises (PIA4). The project establishes a single entry point for the entire academic and industrial community to access a range of sovereign infrastructures and services.

With a total budget of €18.4 million over 3 years and bringing together private actors (ATOS as the project leader, OVHCloud, CS Group, Hubblo, Quarnot, and Activeeon) and public entities (GENCI as co-leader, CEA/LSCE, CNRS/IDRIS, and Inria), CLUSSTER will establish, for the first time in France, a sovereign cloud of infrastructures and services. Unique, open, and scalable, it will initially address Artificial Intelligence (AI) needs, then expand to cover High-Performance Computing (HPC) and quantum computing domains (as part of the national HQI project), while connecting to European initiatives such as EOSC (European Open Science Cloud) and Gaia-X.

WORK ALREADY LAUNCHED

In 2023, efforts were focused on drafting the technical architecture document, defining security constraints to be applied among the various partners, establishing the business model, and implementing internal pilot services. GENCI initiated a procurement process for a machine named DALIA located in a different network zone than Jean Zay at IDRIS, enabling the deployment of new services such as student training. Concurrently, work began with various user communities (climate, finance, CFD, Machine Learning, Earth Sciences, etc.) that will publish application services in CLUSSTER, with operational startup expected around mid-2024.

All the organization involved in the Clusster Project.

MORE ABOUT CLUSSTER

ADASTRA

A NEW SUPERCOMPUTER AT CINES

Acquired in 2022, the supercomputer Adastra represents a significant milestone in French research and is now operational at CINES in Montpellier. Adastra boasts a computing power of 77.9 PFlop/s, positioning it among the most powerful supercomputers in Europe (ranking in the top 10 of the Top500 in 2022).

↑ Scientific conference at the inauguration of the new machine in July 2023

Supercomputer Adastra also maintains its 3rd place in the Green 500 in 2023, underscoring the emphasis on energy efficiency in the acquisition process. Shared to meet the diverse needs of scientific research, this supercomputer provides massive computing capabilities, contributing to strengthening the position of French research.

Thanks to its innovative architecture, based on memory coherence between the scalar processor and accelerators, Adastra complements existing GENCI systems, offering a converged, balanced, and modular solution. These contributions benefit scientific and industrial communities in France and Europe, supporting various fields such as climate change, health, clean transportation, biodiversity, among others.

A TOOL DEDICATED TO SCIENCE

Academic and industrial researchers can access Adastra via the "DARI" as part of open research.
Adastra was inaugurated on May 4, 2023, marking the success of the close collaboration between CINES, HPE, and GENCI in deploying this exceptional tool dedicated to science. The event also provided an opportunity to present the first results from major simulations during the accompanying scientific symposium. Topics included offshore wind fields (by Gabriel Staffelbach from CERFACS), plasma turbulence in tokamaks for nuclear fusion (by Virginie Grandgirard from CEA-DRF-IRFU), and extreme meteorological phenomena (presented by Florian Pantillon from the Laboratory of Aerology in Toulouse).

The Grand Challenges are now concluded, with results to be presented in a dedicated publication. Restitution days are planned throughout the year 2024, offering an opportunity to explore and discuss the findings from these significant scientific endeavors.

« In 2024, efforts will focus on the continuous improvement of services offered to the community: high-quality documentation, hackathon sessions, etc. »

MICHEL ROBERT, HEAD OF CINES

MORE ABOUT THE PROJECT

FIRST EXTENSION FOR ADASTRA IN 2024

AMD MI300A
Deployment of the MI300A Next-Generation AMD Accelerator Extension: "A" for APU. The deployment features an extension based on the latest-generation AMD MI300A accelerators, where "A" stands for Accelerated Processing Unit (APU). The scalar processor and the accelerator share the same chip, maximizing data locality for increased efficiency in intensive computing and AI applications.

A PEAK PERFORMANCE OF 13.9 PFLOP/S
112 MI300A GPUs will be deployed, providing a peak performance of 13.9 PFlop/s.

CONSUMING 20 TIMES LESS ENERGY
Testimony to Technological Progress Over 10 Years: MI300A Extension of Adastra will be quite 3 times more powerful than the OCCIGEN machine while consuming approximately 20 times less energy.

← View of an open rack of *ADASTRA*'s machine

QUANTUM

A YEAR UNDER THE SIGN OF EUROPE

The year 2023 marks a confirmation of the role of hybrid quantum computing within GENCI's activities, with preparations underway for hosting the first quantum systems and the establishment of a user ecosystem. GENCI has become an essential player on the international stage.

Starting in January, the first emulation services of the HQI platform, the national platform for hybrid HPC/quantum computing, were made available to users. The quantum room at TGCC was prepared to receive the first systems. Initial equipment related to the Pasqal's Fresnel system was delivered. A first use case, led by Pasqal and Qubits Pharmaceuticals, aims to utilize hybrid quantum computing to better understand the protein hydration phenomenon.

THE FIRST BUILDING BLOCKS OF THE HQI PLATFORM

GENCI and CEA developed specifications for the EuroHPC Joint Undertaking's acquisition of a photonic quantum computer, with the Hosting Agreement signed in June.
To harmonize HPC-QC integration strategies at the European level, the EuroQHPC-Integration project was submitted, coordinated by GENCI, with 30 partners from 17 countries. It was presented to EuroHPC computing users during the User Day in December 2023.

DISTRIBUTION AND SUPPORT FOR USER COMMUNITIES

The "Quantum Village by HQI" was a highlight of the year for GENCI at the Vivatech international fair. Numerous stakeholders from the quantum ecosystem took part, allowing us to offer a dense and attractive program. The Parisian Quantum House was launched in October at "Station F" premises, led by Le Lab Quantique. This project foreshadows the launch of the national network of Quantum Houses. Three new projects supported by the Quantum Pack of the Ile-de-France Region have been initiated, thanks in part to GENCI's support.
At the request of the Region, we are working on organizing a seminar in early 2024 to present the outcomes of the Quantum Packs.
In March, GENCI sponsored the Big QC-AI-HPC Hackathon organized by PRACE and QuantX. GENCI also assisted in organizing the event through its European partners such as CINECA and PSNC. Additionally, GENCI sponsored the Blaise Pascal [re]generative quantum challenge and the LOQCathon, organized respectively by Pasqal and Quandela. The former resulted in the publication of a white paper titled "Towards Regenerative Quantum Computing," co-authored by Stéphane Requena.
Olivier Ezratty published a podcast featuring Stéphane Requena and Sabine Mehr, in which they explained GENCI's missions and the genesis of the HQI program. An interview with Sabine Mehr during the EuroHPC Summit in Gothenburg was used by EuroHPC to promote its activities related to hybrid quantum computing.

Ceremony for the Signing of Quantum Hosting Agreements between EuroHPC and its Hosting Entities

STRONG INTERNATIONAL ACTIVITY

Events such as the EQS3 seminars in Bavaria, the Érasme-Descartes conference in Delft, and the HPCQC event at CINECA helped establish a common roadmap for HPC-QC integration. GENCI is engaged in discussions to propose a European Center of Excellence for hybrid quantum computing to EuroHPC in 2024. Finally, the SuperComputing (SC23) conference in Denver enabled GENCI and CEA to exchange ideas and strengthen ties with international partners.

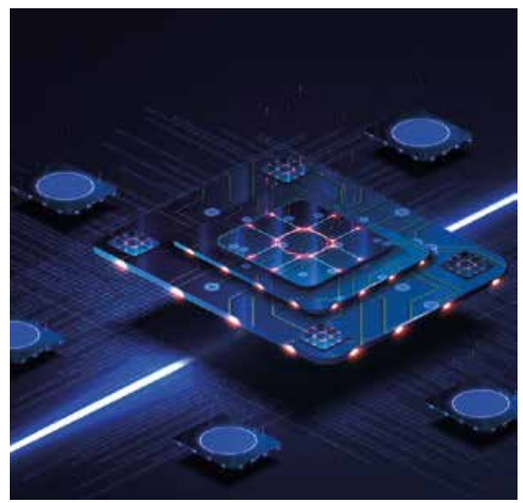
> **The challenge: establishing a common roadmap For HPC-QC integration.**
>
> PHILIPPE LAVOCAT, CHAIRMAN AND CHIEF EXECUTIVE OFFICER, GENCI

MORE ABOUT HQI

MORE ABOUT HPCQS

OUTLOOK FOR 2024

- The arrival of Félix Givois, a quantum computing project engineer, in September is expected to further boost this area within GENCI for 2024.
- Pasqal's delivery of the first quantum system is scheduled for February and should be accessible by the end of the first semester.
- The EuroHPC JU is expected to publish the EuroQCS-France tender in the first quarter. Following this, work related to the EuroQHPC-Integration project will be initiated to prepare for the integration of various systems.



ARTIFICIAL INTELLIGENCE

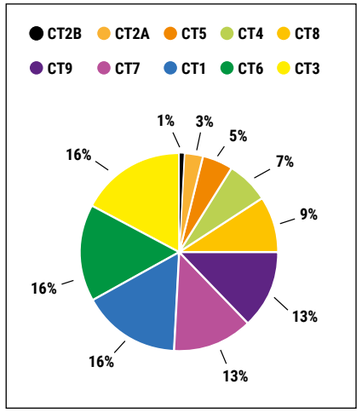
DYNAMIC ACCESS, ACCELERATING THE USE OF JEAN ZAY AND ADASTRA IN AI AND HPC

In addition to providing access to Jean Zay at IDRIS and Adastra at CINES, GENCI, along with the national centers, has implemented a new access mode allowing researchers to quickly access its computing resources: the dynamic access.

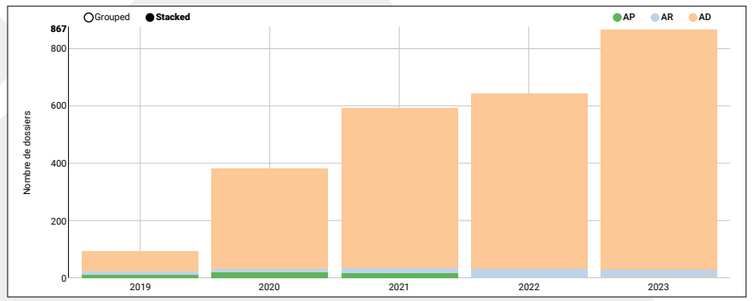
This has enabled the support of solutions based on Jupyter notebooks for increased interactivity, as well as containers to facilitate the porting of software environments from the client workstation to the supercomputers. Through dynamic access, it is now possible, with just a few clicks and within a few days, to obtain an annual allocation of up to 50,000 GPU hours or 500,000 CPU hours. Furthermore, to assist users in using the supercomputers, optimizing and scaling their models, or providing training, the support teams at IDRIS have 13 AI dedicated experts in addition to HPC experts.

SYNERGIES BETWEEN NUMERICAL SIMULATION AND AI

The year 2023 has demonstrated the strong momentum built around AI projects since 2019, with a total of 867 projects supported within the CT10 (Artificial Intelligence) framework, more than 90% of which were through dynamic access. This is evidence of the interest among communities in this type of access.



Split of AI projects (out of CT10) in 2023



Evolution of the number of projects per year and per type of access for the CT10

Panoram'IF

AND SPECIFIC ACTIONS OF RAISING AWARENESS AND TRAINING

In addition to the hackathons organized by IDRIS with NVIDIA and CINES with AMD, it's worth noting the continuation of the Fiddle initiative in 2023 (https://gricad-gitlab.univ-grenoble-alpes.fr/talks/fidle/-/wikis/home) and the establishment of a dedicated YouTube channel for AI by IDRIS called Panoram'IA (http://www.idris.fr/panoramia.html).

In addition to these 867 projects from the CT10, there are also 240 projects (169 projects with dynamic access and 71 with regular access) from other thematic committees, showing the synergies between numerical simulation and artificial intelligence. Thus, the projects running on Jean Zay encompass the rapid development of learning or specialization (fine tuning) of generative AIs in the fields of language processing, vision, multimodality, explainable AI, robotics, and also in "AI For Science" approaches in biology, health, new energies and materials, astrophysics and geosciences, fundamental physics, instrumental data processing, and the hybridization of numerical simulation/AI.

TOWER, A SUITE OF WIDE MULTILINGUAL LANGUAGE MODELS (LLMS)

Among the thousands of projects supported in 2023 by GENCI is Tower, a model based on LLaMA2 and available in two sizes - 7B and 13B parameters - supporting 10 languages: English, German, French, Spanish, Chinese, Portuguese, Italian, Russian, Korean, and Dutch.
The result of collaboration between academic and industrial partners, the main authors come from CentraleSupélec (Université Paris Saclay) and Instituto Superior Técnico de Lisboa on the academic side, and Unbabel (Lisboa) and Equall (New York, Lisboa, Paris) on the industrial side.

THE MOST PERFORMANT MODEL

Trained at the end of 2023 on Jean Zay and Adastra, Tower relies on techniques of continuous pre-training (on a set of 20 billion text tokens evenly distributed across languages) and fine-tuning of instructions (using a diverse and high-quality dataset specific to each task, as well as conversational data and code instructions) to boost the performance of LLaMA2. The resulting model named TowerInstruct is the most efficient open-weight model for translation, surpassing dedicated models and larger-scale LLMs such as NLLB-54B, ALMA-R, and LLaMA-2 70B. Moreover, it successfully competes with closed models such as GPT-3.5 and GPT-4 in certain language pairs.

SUSTAINABLE HPC

MAKING COMPUTATION USE AND CARBON FOOTPRINT RHYME

To comply with the 2015 Paris Agreement, we need to reduce the carbon emissions of all our activities. This also applies to research activities, as stated in the MESR's climate-biodiversity plan. As such, taking into account the carbon footprint of computing hours is based on efficient cooperation with GENCI.

As part of this reduction objective, quantifying impacts can help inform the debates, choices and actions to be implemented. A cooperative effort between GENCI, the computing centers, the GDS Ecoinfo [https://ecoinfo.cnrs.fr/] and the GDR Labos 1point5 [https://labos1point5.org/], supported by the Ministry, has resulted in an initial quantification of the carbon footprint of GENCI computing hours.

To do this, we first estimated the annual carbon footprint of national computing centers, and then established a method for allocating this footprint to users that avoids introducing false competition between centers; competition that could accelerate obsolescence and therefore be counter-productive from an environmental point of view. The method adopted considers all GENCI computing services as a unified service, but distinguishes between two types of hardware architecture (CPU and GPU). This quantification of GENCI computing hours is already available, directly via the eDARI portal, to project managers when they submit their request for hours or during the course of their project, and to unit managers for all their projects. At the request of GENCI associates, this initial work will be continued on a permanent basis within GENCI's operational framework.

GENCI has been commissioned to maintain a register of annual greenhouse gas emissions from its 3 supercomputers.

PHILIPPE LAVOCAT, CHAIRMAN AND CHIEF EXECUTIVE OFFICER, GENCI

Taking into account, quantifying and reducing the impact of calculating hours is a real objective.

ZOOM

Adastra
Machine operated at CINES, inaugurated on May 4, 2023. Ranked 3rd in the Green500. Technical criteria were based on an assessment of the total cost of ownership (TCO), based on sustained performance and energy efficiency. In concrete terms, 97% of the heat generated by the machine is cooled directly at the heart of the components by a hot-water circuit associated with a PUE (Power Usage Effectiveness) of 1.1, with a maximum sustained consumption of the machine of 1.59 MW, around 1 MW in regular production.

SUSTAINABLE DIGITAL SIMULATION

Minimizing the environmental impact of supercomputers is a concern embedded in the investment choices of public stakeholders in high-performance computing: the State, GENCI, Organizations, and Universities, as well as the EU. GENCI has been addressing these issues since its inception, focusing on two main areas: optimizing the energy consumption of supercomputers and rationalizing the use of supercomputers in the service of science.

> Regarding the rationalization of resources and the sharing of equipment, notable initiatives include the establishment of GENCI in 2007, EuroHPC in 2018, and projects such as equip@meso and Mesonet involving regional mesocenters.

> Concerning acquisition choices, key points include:
- Tender criteria: consideration of the energy envelope metrics for simulations in the selection of computers; requirements related to eco-responsibility and frugality in design, limitation of plastics and rare metals, and standards for dismantling.
- Machine architectures: adoption of converged scalar and GPU solutions with coherent memories.
- Machine lifespan (extended from 5 to 7 years).
- Improved Power Usage Effectiveness (PUE) through the widespread use of "warm" water cooling on all components and the recovery of waste heat.
- Attention to future technologies promising a much better energy efficiency ratio, such as Quantum computing or DNA storage (prototyping and evaluation actions in progress), or in the longer term, DNA coding and neuromorphic computing.

AT THE SERVICE OF SCIENTIFIC RESEARCH.

CONTENTS

HOW DOES GENCI WORK?

ACCESS TERMS AND CONDITIONS TO NATIONAL RESOURCES

ACCESS TERMS

National computing resources currently composed of scalar and accelerated partitions will soon accommodate a quantum computer. They are accessible to academic research and industrialists as well as startups.

National computing and storage resources are made available free of charge for one year for scientific projects in High-Performance Computing and Artificial Intelligence (AI), from academia with an RNSR number and industry with a SIRET number. To be eligible, open research projects must lead to publication at the end of the allocation period.
Two steps are necessary: make a request for resources on a or more calculators and get it, then make an account request on the calculators you got resources on. These two requests must be made on the portal *www.edari.fr*, common to the three national computing centers (CINES, IDRIS and TGCC).

2 CALLS FOR PROJECTS PER YEAR, 2 TYPES OF ACCESS

In 2023, two types of resource requests were available bases on user needs:
Regular Access and Dynamic Access. The first are open, twice a year, to project leaders who need significant computing resources: more than 50 million CPU core hours or 50 thousand GPU hours. They require a technical evaluation before being granted. The second, dynamic access, which is easier to obtain, is available all year round and is dedicated to projects that require less computing hours. This type of access was chosen by 76% of project leaders, all scientific fields combined.
3/4 of these ADs are projects in AI research or using AI. They are also accessible to doctoral students and to Master2 students then that ARs are strictly reserved for permanent staff of research structures. These resource request files will be enriched with your publications. The entire resource allocation process by GENCI is always IS9001 certified. All access combined, 15% of files are linked to manufacturers, including 61% carried directly by a private establisment such as startups.

AVAILABLE **INFORMATION**

- All information on the opening dates of Regular Access campaigns is available on the portal *www.edari.fr*. Also available are access conditions, "user" guides and current news.
- For public researchers, you can now connect via Renater's identity federation to access your user space and benefit from dematerialization of request validation procedures in most cases.
- For everyone, you will also find all the essentiel actions for your project (monitoring all of your requests: additional hours, consumption, account, addition of collaborators, etc.). Information on the financial cost in euros and the CO2 equivalent carbon footprint, represented by the resources requested and allocated in the project is provided for information purposes on the eDARI site, still in your user space.

COMPUTING INFRASTRUCTURE AVAILABLE RESOURCES IN 2023

DISCOVER DETAILS OF CALCULATORS

80% of GENCI calculation capacities (in PFlop/s) are provided by GPU accelerators. All GENCI calculators are accompanied by partitions for pre/post processing and visualization freely accessible to supercomputer users.

SUPERCOMPUTER CRAY EX4000

ADASTRA

CINES hosts a calculator from the manufacturer HPE with a power of 78 PFlop/s, with a scalar partition of 544 nodes composed of AMD EPYC Genoa representing 102 912 cores and a converged partition of 356 nodes composed of 1,424 AMD GPUs MI250x.

SUPERCOMPUTER SEQUANA X1000/XH2000

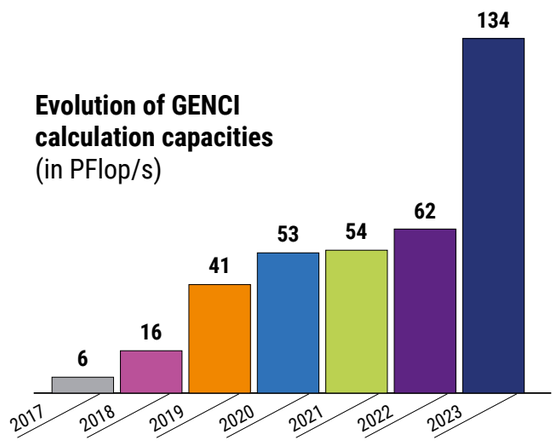
JOLIOT-CURIE

The TGCC hosts a calculator from the manufacturer Atos with a peak of power of 20 PFlop/s, composed of 3 production partitions including 2 scalar partitions. A first scalar partition of 2,292 AMD Rome nodes for 12.2 PFlop/s and 293,376 cores. A second scalar partition of 1,656 Intel Skylake-based nodes for 6.9 PFlop/s and 79,488 cores.
A third accelerated partition of 32 Nvidia nodes based on V100 for 1.2 PFlop/s and 128 GPUs. Added 2 prototype partitions: The 1st composed of 80 nodes equiped with an ARM v8.2A processor of 40 cores, for a total of 3,648 cores and 0.3 PFlop/s, aimed at preparing the codes for the transition to the European Exascale machine.
The 2nd, an Atos QLM for environments and quantum emulator and front-end for the future simulator and quantum machine.

SUPERCOMPUTER SGI 8600

JEAN ZAY

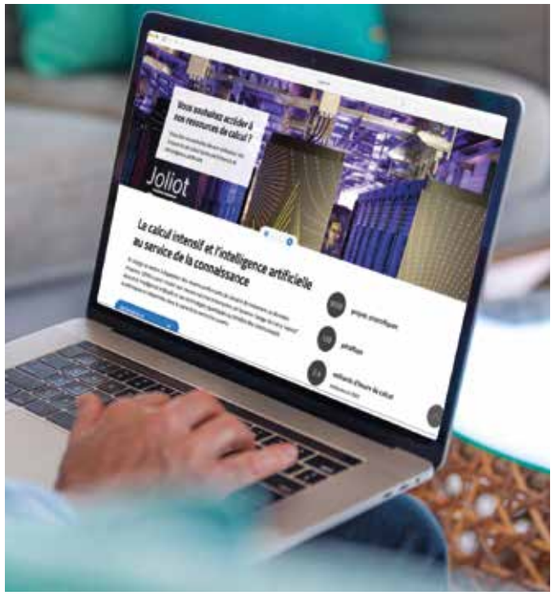
The IDRIS hosts a calculator from the manufacturer HPE with a peak power of 36.2 PFlop/s composed of a scalar partition and 2 converged partitions. A first scalar partition of 1,528 Intel Cascade Lake nodes for 4.9 PFlop/s and 61,120 cores. A 23.2 PFlop/s accelerated partition composed of 647 accelerated nodes based on 16/32 GB Nvidia V100 GPUs totaling 2,712 GPUs. And a final acceleration of 8.1 PFlop/s made up of 52 accelerated nodes on Nvidia A100 80 GB GPUs totaling 416 GPUs.



HOW DOES GENCI WORK?

GENCI'S WEBSITE GETS A MAKEOVER

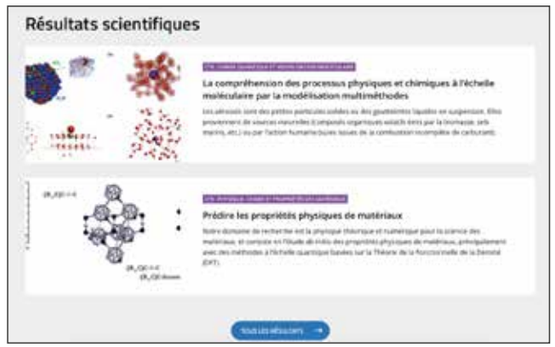
DISCOVER NEW GENCI'S WEBSITE



After selecting the PLUME agency as its public service provider, GENCI initiated the redesign of its website. The aim? Redesign this tool to improve the visibility and accessibility of the research infrastructure and national computing resources to the scientific community, as well as to a wider public.

THIS WORK WAS GUIDED BY FOUR PRIORITIES:

> Enhancing GENCI's visibility: promoting diversity of audiences by focusing on users and future users.
> Improved user experience: clearer segmentation; responsive design; homepage zoning in particular.
> Enhanced relations with visitors and web users: improved experience; regular information via newsletter; improved accessibility of social networks
> Re-edited content: hierarchy and presentation of information; greater emphasis on calculation resources and results in particular; access by audience.



Scientific results emphasized

Clarified segmentation

GRAND CHALLENGES, WHAT IS IT?

The Grand Challenges are a qualification period during which the stability of a new computing machine is tested when it is put into production. This period also allows the teams in charge in the center and GENCI to demonstrate their involvement by helping the scientific teams as much as possible.

The selected users then have the unique opportunity to access computing resources that can go up to the entire supercomputer, to carry out exceptional simulations or processing, often leading to scientific breakthroughs. The mobilization of the computing center's teams and the computer manufacturer's experts during this period makes it possible to resolve any start-up difficulties of the machine and to optimize the fine-tuning of the simulation software thanks to close collaboration with the researchers' teams. These numerical simulations push to the limits the capabilities of the machine, the simulation software and the computing environment, and are therefore essential for the scaling up of scientific simulations made possible by technological advances in the field of intensive computing.
In 2023 two sessions of grand challenges took place, linked to the deployment phases of the HPE Adastra machine at CINES:

- On the "accelerated" partition based on AMD MI250X GPUs from October 2022 to April 2023
- On the "scalar" partition based on AMD Genoa CPUs from May 2023 to October 2023

OUTLOOK FOR 2024

For the scalar part, the number of requests for very high-level science, largely exceeding the resources available on the Genoa partition of Adastra, led us to mobilize the scalar resources of the Joliot-Curie machine at TGCC (AMD Rome and Intel Skylake).

These works and their results will be presented during the year 2024:

> In June with the publication of two "Grand Challenges" notebooks: accelerated and scalar.
> By September with the organization of two days of restitution, with the participation of the project leaders.

SOME FIGURES*

> 3 million MI250X hours
were used by 12 accelerated grand challenges;

> 663 million core hours
(344 on Genoa, 259 on Rome, 60 on Skylake) were used by 20 scalar grand challenges (9 on AdAstra and 11 on Joliot-Curie)

** For each of the campaigns, (almost) all the major scientific fields (the environment, combustion, astrophysics, autonomous driving, generative AI, plasma physics, biology ...) were represented.*

Forword by

MARJORIE BERTOLUS
CHAIR OF GENCI'S ASSESSMENT COMMITTEE

2023 was my first full year as chair of the GENCI Assessment Committee. Working closely with the center directors and the GENCI team, this committee evaluated requests for computing resources and proposed allocations for two periods: from May 2023 to April 2024 and from November 2023 to October 2024. The vast majority of requests from users in the various communities benefiting from GENCI resources were met (see following pages), despite significant pressure, particularly on the Jean Zay supercomputer.

An important event this year was the start of production and the opening to users of the scalar partition of the Adastra machine at the CINES center, which enabled a significant increase in the computing power available to GENCI users. The inauguration of this machine in May 2023 was coupled with the organisation of a symposium on the challenges of high-performance computing in the exascale era. Results and prospects of calculations carried out on GENCI machines in several fields were presented during this symposium.

An important event this year was a significant increase in the computing power available to GENCI users.

Finally, after the user forum organized in December 2022, the dialogue between GENCI and users continues with the start of the "GENCI tour", in which the GENCI team goes to meet users in their laboratories all over France. Three meetings were organized in the Paris suburbs and Grenoble in 2023, and further meetings are planned in 2024.

RESEARCH COMMUNITY

Forewords by the chairs of the thematic committees (CT)

CT1
ENVIRONMENT

Jean-Louis DUFRESNE
Chair of CT1

The projects submitted to CT1 are very diverse in terms of themes, volume and approaches. The new modalities of access to GENCI resources have led to a reduction in the number of "small projects" and give us more time to better evaluate the larger applications. The number of applications had decreased significantly during the A12 call, but not much for A13. Climate modeling dominates in terms of the number of projects and resources requested. In call A13, the demand for four projects represented 60% of the total hours requested. The largest projects are related to climate simulations over very long periods (several thousand years), with a few simulations running for very long periods. The use of GPUs is still marginal.

CT2a
NON REACTIVE AND MULTIPHASE FLOWS

Guillaume BALARAC
Chair of CT2a

Supercomputing is now an essential tool for the study of fluid mechanics. Flow simulation contributes to a wide spectrum of research ranging from the analysis of fundamental processes to technology transfers. The projects supported this year testify to this diversity, by deepening our understanding of flow dynamic, as well as their consequences on transfers, mixing, acoustics or even interactions. fluid-structure. The applications targeted by this research are at the heart of current issues such as the renewable energies, the environment, process engineering, transport, health, etc.

CT2b
REACTIVE AND MULTIPHASE FLOWS

Pascale DOMINGO
Chair of CT2b

In 2023, 35 projects submitted to CT2b have received CPU time on the supercomputers from GENCI, among these projects 8 were new projects and 4 did benefit from dynamic access. The research topics covered by CT2b are extremely varied since all aspect of reactive and/or multiphase fluids mechanics are covered. Transition towards decarbonated energy is present through projects covering hydrogen use, nuclear related problem or solar energy. A large proportion of the project have received the support from ANR. Overall, an equilibrium between upstream research and applied research is present.
The great majority of the softwares used and developed in this community presents very good performances on the panel of computers proposed by GENCI, which facilitates the attribution process.

RESEARCH COMMUNITY

CT3
BIOLOGY AND HEALTH

Yolanda PREZADO
Chair of CT3

In 2023, CT3 (Biology and Health) evaluated 9 files in A14 and 10 files in A15.
The number of hours allocated in A14 was distributed as follows: 500 kh GPU on CINES Adastra Genoa, 6050 kh GPU on IDRIS Jean Zay CSL, 20,500 kh CPU on TGCC Joliot Curie/Irene Rome and 4000 kh CPU on TGCC Joliot Curie SKL. In A15, the allocation was as follows: 100 kh on CINES Adastra Genoa, 50 kh on IDRIS Jean Zay A100, 2000 kh on IDRIS Jean Zay CSL, 402 kh on IDRIS Jean Zay V100, 23,600 kh on CCGT Joliot Curie/Irene Rome, 10,670 kh on Joliot Curie SKL and 120 kh on Joliot Curie V100.
The projects cover the usual themes in the field: genetics, molecular dynamics, fluid dynamics, biomechanics, medical imaging, radiotherapy, etc.

CT4
GEOPHYSICS AND ASTROPHYSICS

Geoffroy LESUR
Chair of CT4

In 2023, the CT4 (Astrophysics and Geophysics) has evaluated a total of 44 applications for 300 million hours requested on CPUs and 1.9 million hours requested on GPUs. The trend observed last year is confirmed, with a number of multi-year projects exploiting GPU machines at IDRIS and CINES. However, demand remains strong on CPUs, with codes either in the process of being ported or non-portable for efficiency reasons. As a result, the CT4 community has begun to migrate to the CINES Genoa machine (74 million hours requested), which is likely to become the machine most favored by our community for massively parallel codes in the years to come.

CT5
THEORETICAL PHYSICS AND PLASMA PHYSICS

Virginie GRANDGIRARD
Chair of CT5

In 2023, the number of projects remained the same as in 2022, with a total of 30 projects, including 5 new ones. The overall volume of committee hours increased by 13.5% on the previous year. With a total allocation of 738 million hours for 2023, CT5 is once again the biggest consumer of computing time on the CPU partitions. The Irene-Rome partition remains its preferred partition, accounting for 75% of CPU computing hours. Demand for GPU hours, even though it has increased by 200%, remains marginal. It represents just 5 million hours. The teams are stepping up their efforts, and we can expect a marked increase in this trend once the most demanding codes, such as those for QCD, have completed their porting. However, the challenge between optimizing a few computing kernels on GPUs and creating a fully operational application on these architectures is colossal. Porting such complex codes to GPUs requires human resources and HPC skills that few teams are able to mobilise.

CT6
COMPUTING, ALGORITHMS AND MATHEMATICS

Hélène BARUCQ
Chair of CT6

2023 was not a busy year for TC6: only seven applications were submitted and assessed, five of which were renewals. Some projects, applied to physical medicine and neuroscience, are connected to AI through the use of learning techniques, which explains the intensive use of supercomputers. A new project aims to set a world computing record to demonstrate the progress of algorithms and their implementation for security applications of new "post-quantum" signature mechanisms. Only one application concerned quantum computing, with the aim of developing an emulator.
Requests for computing hours for structuring projects in the field of HPC are still topical, aimed at very large-scale simulations of complex physical phenomena. Regrettably, these requests are few in number, but the emergence of hybrid numerical methods combining AI and numerical schemes should rapidly restore a good dynamic in TC6.

CT7
MOLECULAR MODELLING APPLIED TO BIOLOGY

Patrick FUCHS
Chair of CT7

CT7 evaluated 49 applications in 2023, a fairly constant number compared to 2022 (48 applications). The amount of CPU hours allocated was also fairly stable and amounted to 160 million. Significantly, the number of GPU hours allocated has continued to increase and this year amounts to more than 9 million. The codes used by the CT7 are now, for the most part, ported to the GPU partitions of the 3 GENCI centers, including the recent Adastra supercomputer and its AMD GPUs.
The vast majority of projects concern molecular dynamics applied to biology. Membrane proteins play an important role, but also protein/small molecule or protein/nucleic acid interactions. GENCI's resources are essential to our researchers and have been decisive for the publication of their work.

CT8
QUANTUM CHEMISTRY AND MOLECULAR MODELLING

David LOFFREDA
Chair of CT8

In a context where artificial intelligence (machine learning) is on the rise in fundamental research, including in theoretical chemistry, it remains more essential than ever to continue to progress in the understanding of chemical properties and in the production of precise data. This is the whole purpose of the majority of efforts made by CT8 researchers during the year 2023, who are continuing their developments aimed at ever better prediction and understanding chemical bonding at the atomic scale in numerous fields of research. As the new generation of exascale machines arrives at our doors, it is in fact the theoretical chemists developing quantum codes who will be the first in our discipline to transfer their developments on these machines in order to achieve an unprecedented description for chemical systems and therefore new knowledge.

RESEARCH COMMUNITY

CT9
PHYSICS, CHEMISTRY AND MATERIALS PROPERTIES

Thierry DEUTSCH
Chair of CT9

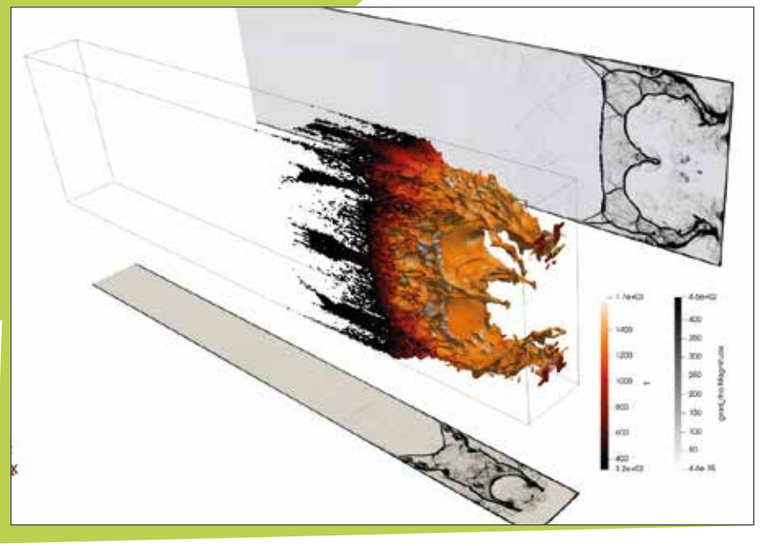
The number of files per session stabilizes at around 45 for an average of 5.3 million hours. Ab initio methods are mainly used in connection with interatomic potentials of the Machine Learning type. Other methods emerge at a higher scale of description. The year 2023 was marked by great successes in artificial intelligence, notably DeepMind's GNoMe project and large model languages. The analysis of experimental data increasingly uses these techniques and should also require HPC resources. The French PEPR Diademe project, started this year, is part of this perspective and will accellerate the discovery of materials by combining simulation, synthesis and characterization assisted by AI.

CT10
NEW APPS AND MULTIDISCIPLINARY APPLICATIONS OF HPC

Michaël KRAJECKI
Chair of CT10

In 2023, beyond LLMs, the issues of generative AI and foundation models will further increase the need for computing resources. Given this context, Jean Zay's success continued to grow.
The challenge today is undoubtedly to be able to access open models, as pioneered by BLOOM, so that they can be specialized for a particular field. From this point of view, the rise of Adastra and the arrival of the 4th extension of Jean Zay will be salutary. I would like to conclude by thanking the new members of CT10 who joined us in 2023: Rachel Bawden, Victoria Dolean and Laétitia Jourdan have not only strengthened CT10's capacity for expertise, but also its feminization. Welcome to all three!

TWO EXAMPLES OF SIMULATION

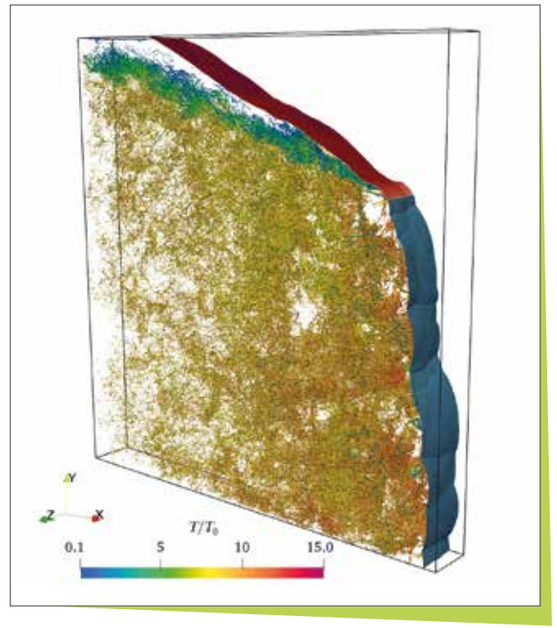


CORIA UMR 6614

anr agence nationale de la recherche

High-fidelity simulation of the interaction between a hydrogen/air flame and a shock. Application: control of the risk of explosion linked to the use of hydrogen as a carbon-free energy vector.

Credits: Émilie YHUEL, Guillaume RIBERT and Pascale DOMINGO



Iso-surface: front detonation. Turbulent structures colored by temperature. Detonations are encountered in process safety configurations, linked for example to hydrogen issues, or in the field of aerospace propulsion, in rotating detonation engine prototypes.

Credits: PPRIME Laboratory (Ashwin CHINNAYYA, Josue MELGUIZO-GAVILANES, Vincent ROBIN, Hiroaki WATANABE) and SAFRAN (Said TAILEB). Funding: Ministry of Research.

CT1
ENVIRONMENT

LMD
Postdoctoral researchers
Siteng FAN
Alexandre GAUVAIN
Antoine BIERJON
Alexandre BOISSINOT
Peng HAN
Lucas LANGE
Jiandong LIU
Yangcheng LUO
Maxime MAURICE
Enore MOISAN
Joseph NAAR
Thomas PIERRON
Romain VANDEMEULEBROUCK
Arthur LE SAUX
Aymeric SPIGA
Eran VOS

CNRS, LMD
Postdoctoral researchers
François FORGET
Sandrine GUERLET
Sébastien LEBONNOIS
Ehouarn MILLOUR
Martin TURBET

CNRS, LATMOS
Postdoctoral researchers
Audrey CHATAIN
Franck LEFÈVRE
Anni MÄÄTTÄNEN

LATMOS
Lola FALLETTI
Research engineer
Maxence Lefèvre
Postdoctoral
Emmanuel MARCQ
Lecturer (UVSQ)
Nicolas STREEL
PhD student

GSMA-LMD
Bruno DE BATZ
PhD student
Jérémy BURGALAT
Research engineer
(Univ. Reims)
Pascal RANNOU
Professor (Univ. Reims)

CNRS, LAB
Jérémy LECONTE
Researcher

CNRS, LESIA
Benjamin CHARNAY
Researcher
Tanguy BERTRAND
Assistant Astronomer

LESIA, LMD
Lucas TEINTURIER
PhD student

LISA
Deborah BARDET
Postdoctoral

IAP-LMD
Alice MAUREL
PhD student

RESEARCH RESULTS

Supercomputer Joliot Curie/ROME : **1.45 million hours CPU** | ADASTRA : **5.81 millions hours**

Modeling planetary atmospheres

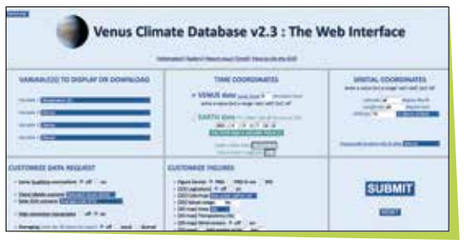
Announcement text: Using numerical models of the atmosphere similar to those used to determine weather and analyze climate evolution on Earth, we study the atmospheres of other planets in the solar system as well as those of exoplanets in other systems.

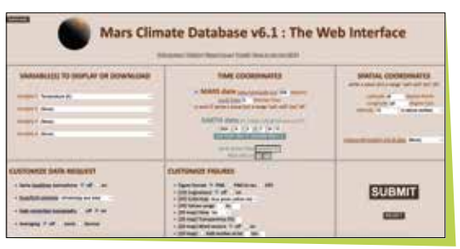
The "Planetary Atmospheres" project brings together work carried out mainly at the Laboratoire de Météorologie Dynamique (LMD) and the Laboratoire Atmosphères, Milieux, Observations Spatiales (LATMOS) in close collaboration within the Institut Pierre Simon Laplace (IPSL), in partnership with members of the GSMA (Molecular and Atmospheric Spectrometry Group), LESIA (Laboratory for Space Studies and Instrumentation in Astrophysics) and LAB (Bordeaux Astrophysics Laboratory).

UNDERSTANDING PLANETARY CLIMATES

For decades, we have been developing the community codes that make up our climate models of planetary atmospheres. These codes have in common a "dynamic" part (a module for solving the equations governing the flow of an atmosphere around a rotating planet) and more specific "physics" modules adapted to each of the atmospheres studied: These include the atmospheres of the telluric planets (Venus, Mars and Saturn's satellite Titan), giant planets (Jupiter, Saturn, Uranus and Neptune) and trans-Neptunian objects (Pluto and Neptune's satellite Triton) of the solar system, as well as a robust and versatile "generic" physics module for extrasolar planets and paleo-climates.

Our tools enable numerous analyses and interpretations of the abundant space mission data collected over the last few decades, providing a better understanding of the mechanisms controlling planetary climates.
The outputs of our models are compiled and shared with the international community in the form of climate databases (cited in over 650 articles; source NASA ADS) within the "Planetary Climates Database", a tool labeled since 2019 as a National Observations Service by INSU.





Illustrative examples of the web interfaces of the Venus (version 2.3) and Mars (version 6.1) climate databases produced by the project and made available to the community as part of the National Observations Service "Planetary Climates Database" (http://www-planets.lmd.jussieu.fr).

CT4
THEORETICAL PHYSICS AND PLASMA PHYSICS

CEA/AIM
Frédéric BOURNAUD
Searcher
Romain PAVIOT
Searcher

CNRS/AIM

Sandrine CODIS
Researcher

CNRS/IAP
Yohan DUBOIS
Researcher

LMU
Alexandre BARTHELEMY
Searcher

RESEARCH RESULTS

Supercomputer Joliot Curie/ROME : **20 millions hours**

Precision cosmology with multi-zoom simulations

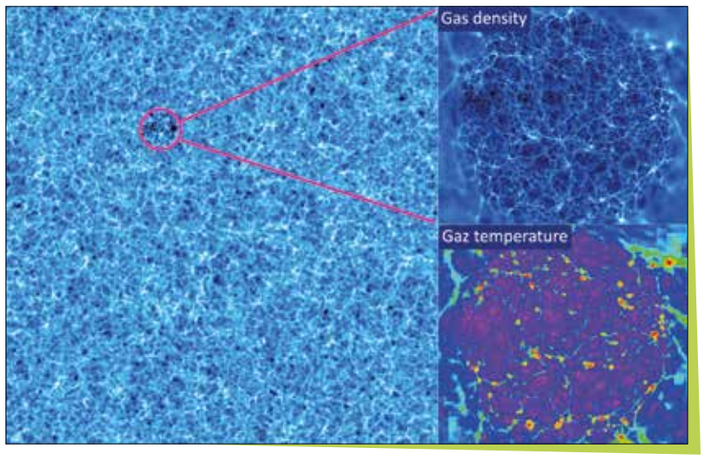
Understanding galaxy formation is essential to interpret current and upcoming cosmological surveys and eventually constrain the nature of dark energy.

Cosmology is living through a rich era, with numerous observational projects aiming at constraining the dark energy and dark matter, such as the European Euclid satellite that has been launched in summer 2023. But observables are always related to "visible" matter (often called baryons), which is not a direct tracer of dark matter, but also feedbacks onto it. If these effects are not accurately taken into account, they induce biases and potentially apparent tensions, some of which already exist, between the various cosmological surveys and probes.

A GREAT FIRST

Taking these so-called baryonic effects into account typically relies on hydrodynamical simulations. A major difficulty is that baryon physics is expressed at the scale of galaxies, or even stars, from which it retroacts to the larger scales of the Universe, which are the focus of cosmological observations. However, currently we do not have the necessary resources to produce such simulations covering very large volumes with sufficient resolution at the heart of galaxies.

Our GENCI project consists in robustly constraining the effect of baryons at the scales and in the environments relevant to cosmological surveys, by producing for the first time zoomed-in hydrodynamical simulations inside large cosmological volumes. Ultimately, this new set of simulations will enable the community to carry out a more accurate analysis of large cosmological observations, and eventually provide a better understanding of whether apparent tensions can be explained by baryonic physics, or call into question the current cosmological model, or even the underlying physics.



Multi-scale cosmological simulation: gas density and temperature

RESEARCH RESULTS

Supercomputer **ADASTRA** | Genoa : **20 M hours**

CT2a
NON REACTIVE AND MULTIPHASE FLOWS

LABORATOIRE LISM UMR 9015

Anne SERGENT
Lecturer Sorbonne's University

Yann FRAIGNEAU
Research engineer CNRS

Turbulence and thermal convection

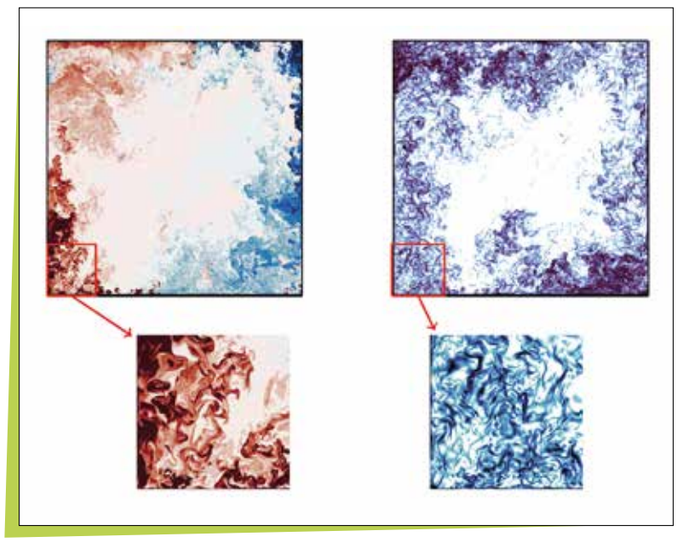
Spontaneous natural convection flows result from density inhomogeneities. In highly turbulent conditions, the existence of a specific optimal heat transfer regime, known as the inertial regime, has been demonstrated theoretically. We aim to characterize it numerically.

Natural convection flows occur both in geophysics (ocean, atmosphere) and in industrial applications (e.g. passive nuclear cooling, ventilation). Turbulent Rayleigh-Bénard convection is a canonical flow for studying this multi-scale, multi-structure phenomenon, combining small-scale turbulence, thermal plumes and large-scale circulation. It has been theoretically demonstrated that an optimal heat transfer regime exists (called the inertial regime), but only experimental indications of this regime have been observed to date. However, a wide range of behaviours can be observed after the inertial crisis. In some cases, heat transfer can vary by as much as a factor of two, raising questions about the safety of industrial plants, since a poor estimate of heat transfer capacity can be destructive.

TOWARDS NUMERICAL MODELING OF THE INERTIAL REGIME

We have carried out direct numerical simulations of thermal convection at very turbulent regime, seeking to describe all the scales of the flow in order to identify the inertial crisis. Figure 1 shows the first results obtained on a mesh of over 17 billion points. These three-dimensional results will serve as a reference for the analysis of thermal and kinetic mechanisms on the route to the inertial regime.

This numerical work has been carried out using the SUNFLUIDH calculation code, developed at LISN and constantly evolving to adapt to new needs and supercomputers. As numerical modeling of the inertial regime is extremely costly, we are considering accelerating calculations (GPU) for greater sobriety, or using machine learning at different phases of the calculation.



Rayleigh-Bénard convection at very high turbulence regime. 2D section at mid-depth of the temperature field (left: the hot fluid in red rises, the cold fluide in blue falls) and viscous dissipation (right).

The figure illustrates the multi-scale structuring of the flow.

RESEARCH RESULTS

Supercomputer Joliot-Curie/SKL : **2 M hours** | ROME : **2 M hours** | Jean Zay : **800,000 hours**

CT2b
REACTIVE AND MULTIPHASE FLOWS

MSME

Stéphane VINCENT
Teacher

Simon EL OUAFA
Postdoctoral

Benoît TROUETTE
Lecturer

IMFT

Jean-Luc ESTIVALEZES
Associate Professor (DR Onera)

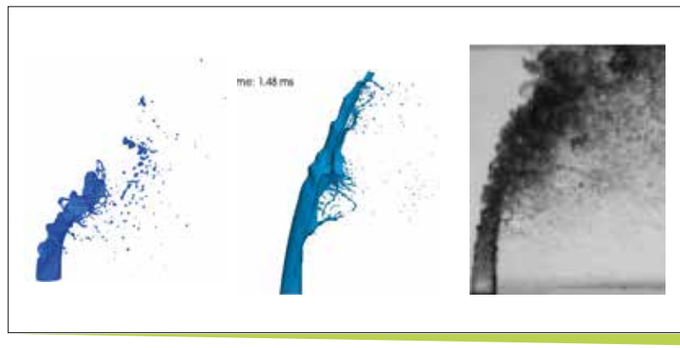
Multi-scale modeling and intensive numerical simulation of turbulent two-phase flows

The characterization of turbulent incompressible flows interacting with interfaces occurs in many fields (particle flows, fluidized beds, fragmentation and atomization of jets, air quality in work enclosures, coating and lubrication processes by impact of drops, plasma projection, dam and wave breaking, pneumatic spinning by turbulent jet, injection processes in composite materials, air quality, etc.).

Resolving the multitude of spatio-temporal scales requires the detailed resolution of the Navier-Stokes equations in three-space dimensions and in a two-phase formulation. Billions of mesh cells must be considered over several To of RAM, which requires the use of massively parallel computers with distributed memory, like those of the present GENCI project, started 10 years ago with the Fugu code which is dedicated to high-fidelity simulation using fully coupled solvers, VOF methods and front tracking of two-phase flows in the presence of an interface. We also use the DyJeat code, developed at ONERA with level set approaches, in order to validate and compare the results of the 2 simulation codes. The Fugu solver showed excellent scalability on GENCI computers to simulate problems containing 8 billion cells on 16,000 processors.

LARGER-SCALE ATOMIZATION MODELS

One of the objectives of our project is to carry out highly resolved simulations of unsteady and turbulent two-phase flows in order to provide databases for the formulation of original LES turbulence models but also to enable the analysis of the details of the physics of these complex flows. We show in the figure the example of the atomization of a water jet by a lateral air flow. We can observe the first interesting results of atomization (formation of ligaments, fragmentation, tearing of droplets). This work serves as a working basis for designing larger-scale atomization models capable of simulating combustion in engines or combustion chambers.



Simulation of water jet atomization by an air cross flow. Results from Fugu (left at t=1.5 ms for a 512 x 256 x 256 mesh), DyJeat [2] (middle at t=1.48 ms for a 1024 x 512 x 512 grid) and ONERA experiment [2] (right for long times).

RESEARCH RESULTS

Supercomputer Joliot Curie/ROME : **114.580 M hours** | Jean Zay V100 : **477,000 hours GPU***

CT5
THEORETICAL PHYSICS AND PLASMA PHYSICS

CNRS

Laurent LELLOUCH
Research Director

Supercomputers take on the standard model

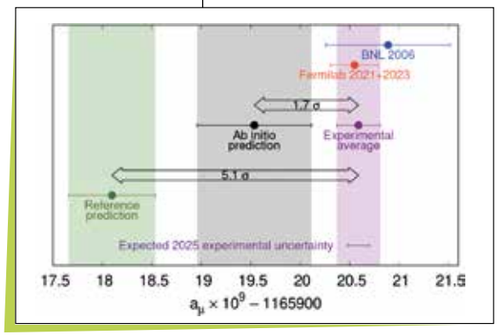
The recent measurement of a property of the muon would seem to call into question the standard model of particle physics, but massively parallel simulations do not validate this conclusion. New, even more precise calculations will help resolve this puzzle.

The standard model is the mathematical framework that describes the subatomic world. Although it has been confirmed by increasingly precise experiments over the past 50 years, it does not solve important mysteries that scientists face. Indeed, these researchers consider this model as an approximation of a more fundamental theory that remains to be formulated.
To envision what this theory could be, physicists are focusing on a particularly intriguing property of the muon, short-lived cousin of the electron. This elementary particle acts like a tiny magnet, characterized by a property called the magnetic moment.

SUPPORT FROM GENCI SUPERCOMPUTERS

In 2021, an international team based at Fermilab in Chicago presented its first measurement of this magnetic moment. The results revealed a discrepancy of more than 4 standard deviations with the standard model's reference prediction, which is partly based on the exploitation of experimental data. Such a discrepancy should have suggested the existence of previously unknown particles or forces.
However, simultaneously, a new prediction was published in the journal Nature. To achieve this result, we substituted the use of experimental data with massively parallel simulations of the standard model, performed thanks to the supercomputers of GENCI and other organizations in Europe. Unlike previous predictions, our result does not indicate the need for a new theory to explain the measurement of the muon's magnetic moment.
Since then, other teams have been able to confirm part of our calculations. Furthermore, our results have prompted a reassessment of the data used in the reference calculation. Additionally, Fermilab plans to present the final result of its measurement in 2025. To fully capitalize on this result and to test the standard model, it is imperative to reduce the uncertainties of our calculations by a factor of 4. With the support of GENCI and EuroHPC supercomputers, we are actively working to meet this challenge.

** A Budapest-Marseille-Wuppertal collaboration - CNRS, Aix-Marseille U., U. of Toulon, CPT, Marseille, France; Bergische Universität Wuppertal, Germany; Forschungszentrum Jülich, Germany; Université Eötvös, Budapest, Hungary.*



Comparison of two theoretical predictions ("ab initio", "reference") for the muon's magnetic moment with the results of its experimental measurement ("BNL 2006", "Fermilab 2021+2023" [including an update in 2023], and the average of these two values ["Experimental average"]). The numerical values of these results are given by the points with horizontal error bars, in units specific to particle physics, indicated on the x-axis. The error bars correspond to one standard deviation, and the double horizontal arrows indicate the difference between the predictions and the average of the experimental measurements, in units of the combined standard deviation (ÿ). For reference, the expected measurement uncertainty in 2025 is shown at the bottom of the figure.

RESEARCH RESULTS

Supercomputer IDRIS Jean Zay : **1.6 M hours CPU** | TGCC Joliot Curie/SKL : **600,000 hours CPU** | TGCC Joliot Curie/ROME : **3.6 M hours CPU**

CT9
PHYSICS, CHEMISTRY AND MATERIALS PROPERTIES

CNRS

Michele CASULA
Research Director

Mastering nuclear quantum effects using quantum Monte Carlo

Hydrogen is the simplest element in the periodic table, consisting of a single electron and a single proton. However, when it forms condensed phases, either in a pristine state or in compounds such as hydrides and water, its presence gives rise to a variety of structures that are often difficult to predict.

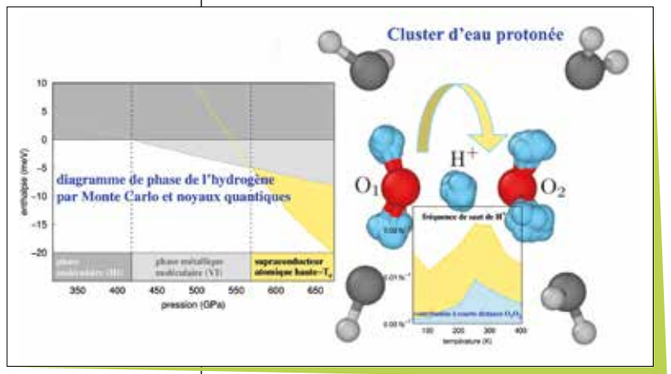


Figure on the left: **Phase diagram of hydrogne**, in yellow the stability region of the superconducting phase at high critical temperature, which becomes favorable only above 570 GPa.

Figure on the right: **Protonated water cluster**, one of the possible configurations with the graph which indicates the proton transfer frequency, in yellow, whose peak is located close to ambient temperature.

The reason for this richness lies in the deeply quantum nature of the hydrogen nucleus, associated with electronic correlation effects producing complex potential energy surfaces. The challenge is then to develop a predictive numerical approach that can take into account nuclear quantum effects as well as those arising from electronic correlations. We could thus describe phenomena such as superconductivity, which displays highest the critical temperatures for certain hydrides, and proton transfer, which plays a fundamental role in determining the thermodynamic properties of water.

We met these challenges using the so-called quantum Monte Carlo (QMC) methods, which have the advantage of being very precise for the resolution of the electronic part and, at the same time, adapted to include nuclear quantum effects.

In addition, these methods have excellent scalability with the number of processors, a property that makes them ideal in high-performance computing (HPC) environments, such as those offered by the GENCI centers. Through the use of QMC methods in an HPC environment, we were able to address two major problems, which are governed by nuclear quantum effects: the determination of the transition pressure to a superconducting atomic phase at room temperature in solid hydrogen [Nature Physics 19.845 (2023)] and the temperature dependence of the proton transfer rate in a protonated water cluster [Nature Communications 14.6930 (2023)].

This work was carried out within the framework of the European center of excellence TREX and the theoretical team of IMPMC, Sorbonne University.

** Contributors to the two articles: F. Mauri (La Sapienza, Rome), L. Monacelli (La Sapienza, Rome), T. Morresi (ECT*-Fondazione Bruno Kessler*, Trento), F. Mouhat (Saint Gobain Research Paris, Aubervilliers), K. Nakano (NIMS, Tsukuba), M. Peria (Sorbonne University, Paris), A.M. Saitta (Sorbonne University, Paris), S. Sorella (SISSA, Trieste), R. Vuilleumier (ENS Chimie, Paris).*

RESEARCH RESULTS

Supercomputer Joliot Curie/Rome : **2.7 M hours**

CT8
QUANTUM CHEMISTRY AND MOLECULAR MODELLING

CNRS

Hazar GUESMI
Researcher at ICGM

SCALMS at the frontier between heterogeneous and homogenous catalysis

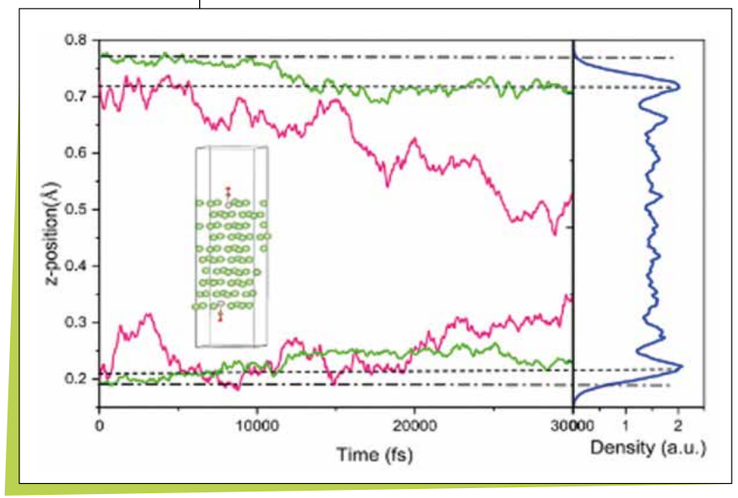
Dispersing isolated noble metal atoms on the surface of metallic nanoparticles (NPs), whose state becomes liquid at the reaction temperature, gives rise to a new generation of efficient catalysts, named SCALMS (supported catalytically active liquid metal solution), with little explored properties.

Here, we focus on catalysts formed by Pt monomers dispersed in Ga NPs supported on aluminum. These NPs transform into liquid droplets at temperatures below 30°C. Deprived of the ensemble effect and with strong electronic effects that significantly affect the adsorption of reactants, these catalysts have shown great performance for the propane dehydrogenation reaction and a unique resistance to coke formation.

MOST STABLE CONFIGURATIONS

Our project consists of studying the catalytically-active sites of Pt at the atomic scale, and determining how the noble metal is affected by the presence of a liquid Ga matrix, and how it evolves in the presence of adsorbed molecules (H2, H, CO, propanes, etc.). The theoretical study is carried out by combining density functional theory (DFT) calculations and ab-initio molecular dynamic (AIMD) simulations on semi-infinite Pt/Ga surfaces (see figure) and small Ga/Al2O3, Pt/Al2O3 and Ga12Pt/Al2O3 aggregates evolving in the presence of gas. More specifically, we apply the so-called simulated annealing method, which enables us to find the most stable configurations of a given system by analyzing a vast space of structural configurations. Simulations are carried out in the NVT ensemble, followed by DFT quenching at 0 K. Trajectories evolve with times of up to 30 ps and a step time of 10 fs. Several simulation temperatures are explored (between 200 and 1000 K), as well as several starting geometries.

The results show the decisive role played by adsorbed molecules in retaining Pt on the Ga surface, and highlight significant charge transfer between Pt and adsorbates, which explains the unique properties of these catalysts compared with pure NPs.



AIMD simulation (30 ps) showing the evolution over time of the position of two isolated Pt atoms placed on either side of a Ga slab. In pink, the Pt initially on the surface segregates toward the volume. In green, the presence of adsorbed CO induces stabilization of Pt in the sub-surface.

RESEARCH RESULTS

Supercomputer Joliot Curie/ROME : **31.8 M hours**

CT7
MOLECULAR MODELLING APPLIED TO BIOLOGY

CNRS

Philippe LORY
Research Director

Xiaojing CONG
In charge of research, Institute of Functional Genomics, UMR5203 - U1191 - University of Montpellier

Amaël DAVAKAN
Doctoral student, Institute of Functional Genomics, UMR5203 - U1191 - University of Montpellier

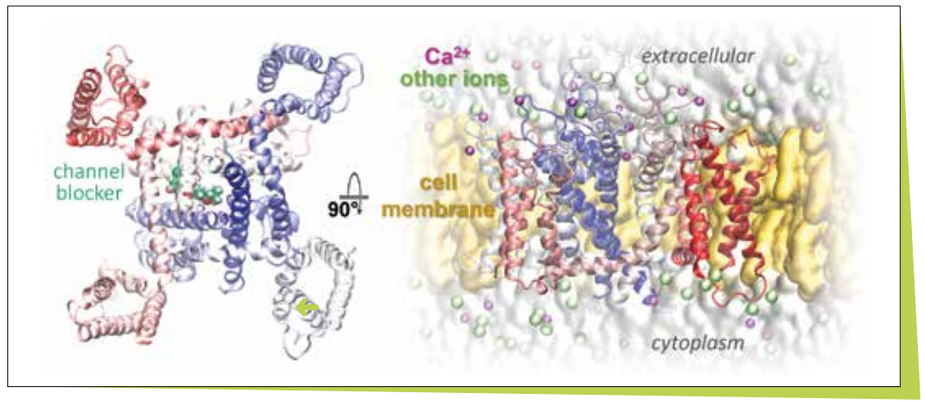
Molecular dynamics of Cav3.1 calcium channels

The voltage-gated Cav3.1 channels are crucial for regulating neuronal excitability. In silico simulations and in vitro pharmacology allow us to decipher the structure-function relationship of Cav3.1. This will aid in the design of therapeutics targeting Cav3.1 for neurological disorders.

Cav3.1 are voltage-gated T-type calcium channels in the cell membrane that regulate the influx of calcium ions into cells in response to changes in membrane potential. Various mutations in Cav3.1 have been identified and linked to severe neurodevelopmental or cerebellar ataxia disorders. Our goal is to unravel the impacts of recurrent pathogenic mutations on Cav3.1 structure and function.

FOR RELATED NEUROLOGICAL DISEASES

We used patch-clamp experiments combined with in vitro pharmacology to study abnormal activities of these Cav3.1 mutations, as well as their differential responses to T-type channel blockers. In the meantime, we performed molecular dynamics simulations of Cav3.1 in a transmembrane environment, applying different membrane potentials, to study how the mutations affect their conformational dynamics and response to channel blockers. Cav3.1 channels contain multiple transmembrane domains that form a pore through the membrane. They exhibit multiple diverse functional states and numerous microstates of conformations that may be altered by a single point mutation. Using molecular dynamics simulations and enhanced-sampling techniques, we obtained atomic-level descriptions of these microstates, connecting molecular details to experimentally observed macroscopic properties. The outcome will serve the design of Cav3.1-specific blockers as therapeutic agents and research tools for Cav3.1-related neurological diseases. It also enhances our understanding of the T-type voltage-dependent calcium channels in general.



Left Figure: X-ray crystal structure of Cav3.1 bound to a channel blocker (green).

Right Figure: All-atom molecular dynamics simulations of Cav3.1 (without blocker) in a transmembrane environment of explicit lipids and solvent.

RESEARCH RESULTS

Supercomputer Joliot Curie : **1.2 M hours**

CT3
BIOLOGY AND HEALTH

Simulating the microstructure of the human brain

CNRS / CEA

Cyril POUPON
Research Director

Alexis BRULLE
Doctoral student, BAOBAB Unit, UMR9027, *Neurospin* - Paris-Saclay University

Anas BACHIRI
Doctoral student, BAOBAB Unit, UMR9027, *Neurospin* - Paris-Saclay Universit

Understanding how the human brain works requires an understanding of its cellular organization in vivo, a challenge that NeuroSpin aims to meet by leveraging digital simulation and AI to create digital twins of brain tissue and their diffusion MRI signature.

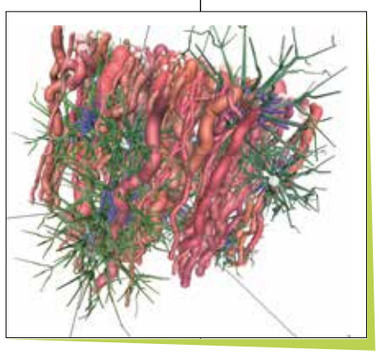
With almost 100 billion interconnected neurons, the human brain is a highly complex organ whose modeling requires coverage of all scales, from cell to organ. Cerebral pathologies are sometimes associated with cellular damage that does not necessarily induce visible changes in MRI scans acquired in hospital. It is therefore important to have the means for in vivo imaging of this cellular organization (also known as microstructure). Although the use of very high magnetic fields (>7 tesla) in MRI can increase spatial resolution, it remains an order of magnitude smaller than the size of neural cells.

As part of the Franco-German AIDAS institute (https://aidas-lab.eu), NeuroSpin's Ginkgo team has developed a comprehensive digital simulation environment capable of synthesizing true digital twins of brain tissue microarchitecture from a reduced set of key cell population geometry parameters, simulating the Brownian motion of water within these virtual samples, and finally simulating the expected diffusion MRI response of these samples.

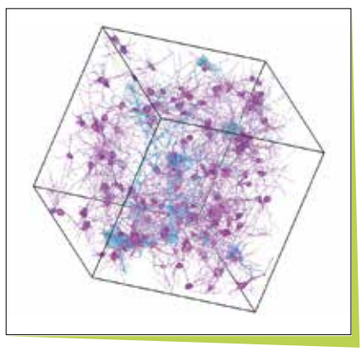
PROMISING INITIAL RESULT

A large-scale simulation campaign carried out on the Joliot-Curie supercomputer has made it possible to collect a large collection of representative samples of cerebral white matter and their diffusion MRI signatures. This Big Data was then used to train a deep neural network that is helping to transform MRI into a virtual biopsy tool of great utility for diagnosing and monitoring cerebral white matter pathologies.

Following this promising initial result, the team will shortly be launching a new simulation campaign to establish a second model dedicated to decoding the cytoarchitecture of the cerebral cortex in vivo.



The illustration shows the result of simulating a sample of cerebral white matter obtained with the Medusa simulator, including axonal fibers (in red), astrocytes (in green) and oligodendrocytes (in blue).



The illustration shows the result of simulating a sample of cerebral cortex obtained with the Medusa simulator, including a population of pyramidal neurons (in blue) and a population of multipolar neurons (in violet).

RESEARCH RESULTS

Supercomputer Joliot Curie/Rome : **2.7 M hours**

CT6
COMPUTING, ALGORITHMS AND MATHEMATICS

Large-scale modeling of time-harmonic waves with Hybridizable Discontinuous Galerkin method.

INRIA

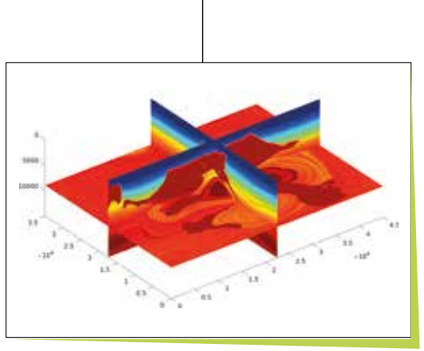
Florian FAUCHER
Research Director

This grand challenge concerns the simulation of the wave propagation for large-scale domains in the frequency domain. Our objective to simulate for many wavelengths propagating in complex media is critical for multiple applications in imaging.

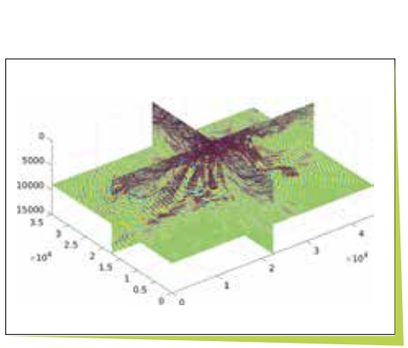
This grand challenge focuses on two cases: the Earth and the Sun. For the propagation of seismic waves in the Earth, one works with media with attenuation, possibly anisotropic, that are difficult to treat due to the complexity of the sub-surface and the size of the domain. For propagation in the Sun, we consider acoustic waves, and we have to handle drastic variation in the physical parameters near-surface, requiring high accuracy.

45 MILLION COMPUTATION HOURS

To reach our objectives, the time-harmonic wave equations are discretized, resulting in a large linear system to solve. For the discretization, we use the hybridizable discontinuous Galerkin method. Its advantage is to easily handle complex geometries, and to allow for a massively parallel implementation. Moreover, for high-order polynomials, the method allows to reduce the number of unknowns (hence of the size of the subsequent matrix) compared to more standard approaches. This grand challenge has used the Adastra CPU partition GENOA, with 45 million computation hours. Simulations have run using open-source code Hawen and linear solver MUMPS. These works have allowed for the simulation of configurations that were not accessible up until now, for instance with the consideration of more than 150 wavelengths propagating in geophysical domain. They also have allowed the simulation of acoustic waves in the entire Sun, opening the perspective of studying 3D phenomena in helioseismology. This grand challenge will be used for future applications in the European ERC-StG project Incorwave.



The illustration shows Geophysical model SEAM size 35x45x15 km^3



Simulation at 6Hz frequency

RESEARCH RESULTS

Supercomputer Jean Zay : **6,000 hours**

CT10
NEW APPS AND MULTIDISCIPLINARY APPLICATIONS OF HPC

AIM

François LANUSSE
CNRS researcher

AI in Service of Understanding the Universe

We have developed methods using Artificial Intelligence combined with numerical simulations of the Universe in order to constrain cosmological models with greater precision.

The new generation of large-scale galaxy surveys, such as those conducted by the European Euclid satellite or by the Vera C. Rubin Observatory in Chile, will provide us with an image of the Universe of unmatched size and precision. However, traditional analysis methods, based on analytical theoretical models, only allow us to exploit a part of the cosmological information present in these data.

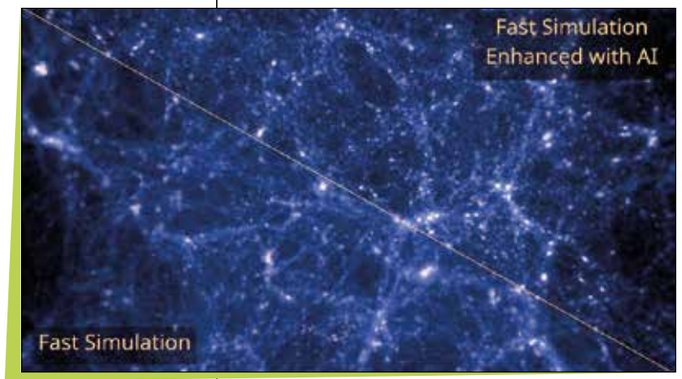
The use of numerical simulation as a model of the Universe would allow us to overcome these limitations of theoretical models, but presents numerical challenges. This project aims to tackle this problem from two angles:

1 - the establishment of fast cosmological simulations that can be easily interfaced with AI components to improve resolution and reduce computation time.

2 - the development of AI-based statistics methods to infer cosmological parameters from the data and simulation sets.

TWO STUDIES AND RESULTS

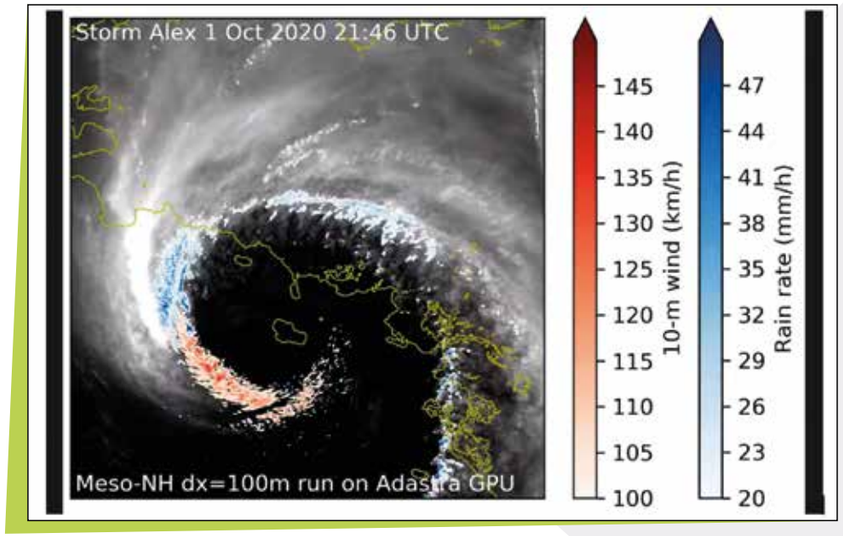
We have developed and tested a hybrid N-body simulation tool, based on a physical simulation but integrating a neural network that allows us to simulate at a low cost a higher resolution. We have thoroughly evaluated the contribution of this type of simulation for the analysis of the Vera C. Rubin Observatory's cosmological survey. In a second study, we compared different statistical inference methods using AI and these simulation tools and demonstrated an approach that optimally extracts cosmological information from the data. The simulation and statistical analysis tools we have developed contribute to the development of a new paradigm for the study of the Universe.



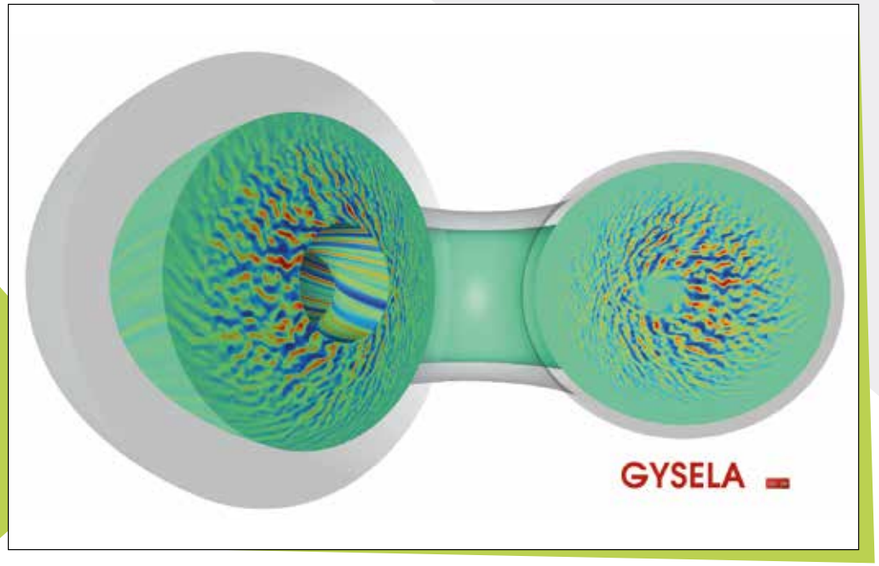
This image represents a numerical simulation of the dark matter structures on cosmological scales. We employ an AI technique to enhance the resolution and quality of fast simulations of the Universe, allowing us to simulate large volumes over cosmological times at low computational cost.

Credits: Denise LANZIERI & François LANUSSE, AIM Laboratory, CEA Paris-Saclay, CNRS, Paris Cité University, Paris-Saclay University

TWO EXAMPLES OF SIMULATION



"Large Eddy Simulation" performed by "LAERO Laboratoire d'Aerologie" of extreme wind gusts over Brittany using Meso-NH using AMD MI250X accelerators on Adastra supercomputer.



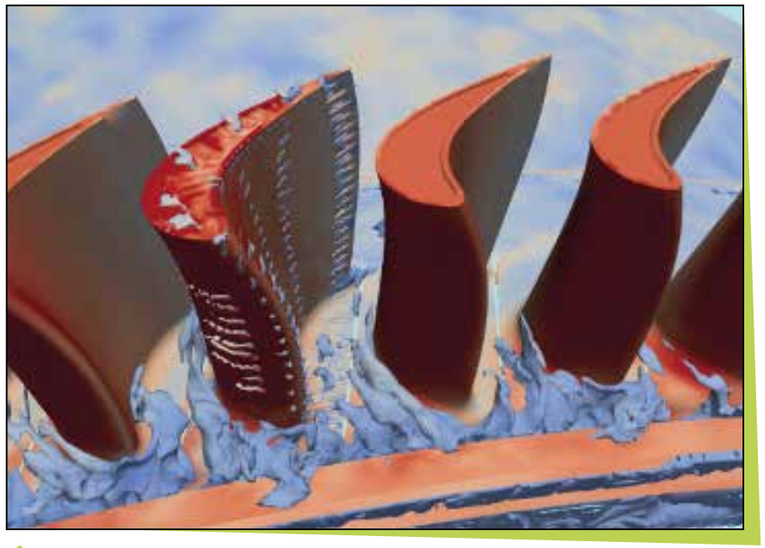
Nonlinear global gyrokinetic simulation of ion temperature gradient driven turbulence using the GYSELA code in a Tokamak for controlled nuclear fusion.

COMMUNITY OF LARGE INDUSTRIAL GROUPS

LABS/PROLB, A SUCCESS STORY

It all began in 2009 when CS Group, Renault and Airbus decided to launch a collaborative research project, supported by the Systematic competitiveness cluster, with the aim of developing fluid mechanics software based on the Boltzmann Network Method (LBM).

In collaboration with the Ecole Centrale de Lyon (LMFA) and the University of Aix-Marseille (M2P2), small team succeeded in setting up a working prototype: the LaBS software, which would later take the commercial name ProLB. One thing led to another, and the development consortium expanded with the addition of work from ONERA and Cerfacs, before Safran joined the adventure in 2023. Today, ProLB/LaBS (prolb-cfd.com) is capable of performing aerodynamic, aeroacoustic and aerothermal calculations on industrial cases, and multi-species flow and combustion models are under development.



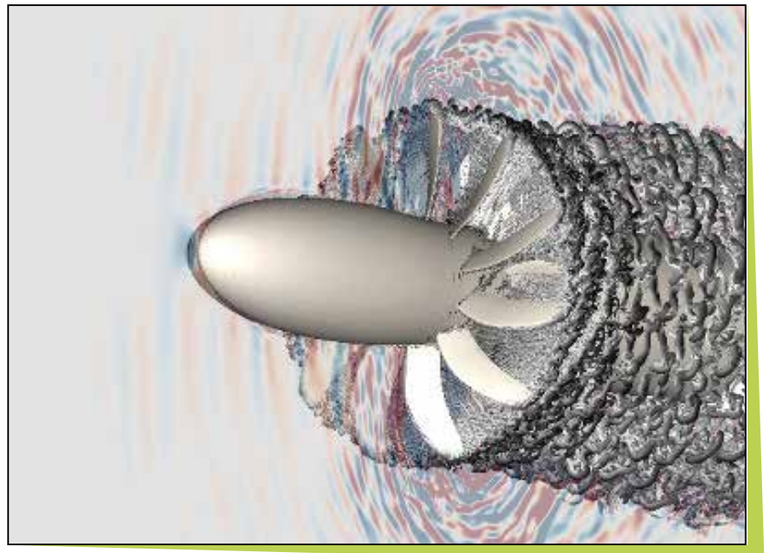
Aerothermal simulation of a turbine blade - Safran.

AN ANALYSIS PHASE

From 2020, we are extending our collaborative development of LaBS to the European level with the launch of the SCALABLE project: "SCAlable LAttice Boltzmann Leaps to Exascale" (scalable-hpc.eu), supported by the EuroHPC program. The project is coordinated by CS Group (France), with partners including the University of Erlangen (Germany), the Cerfacs (France) and Jülich (Germany) research centers, the IT4I HPC center (Czech Republic), Neovia Innovation (France), Airbus (Germany) and Renault (France).The first objective of this project was to identify the best assets and ingredients of two LBM codes: Walberla on the one hand, developed by our partner at the University of Erlangen, which is a high-performance open source LBM software but limited in terms of industrial functionalities, and LaBS/ProLB on the other, which had broad functionalities but performed poorly on real industrial cases when scaled up in terms of processor numbers (typically > 5000). After this benchmark and bottleneck analysis phase, we were able to jointly improve both software packages on various technical aspects: memory footprint reduction, energy consumption reduction, GPU porting strategies, scalability improvement for target runs on 50,000 CPU processors.

For our work, we were able to draw on HPC resources managed by Genci, Prace and EuroHPC JU. For example, our partners were able to launch industrial LaBS/ProLB runs on 30,000 processors on Karolina (IT4I) and Lumi-C (EuroHPC JU). CS Group relied on Irene (TGCC) for its CPU scalability work and Jean Zay (Idris) for GPU testing.

Among the challenges tackled, LaBS/ProLB has been improved in terms of the scalability of its pre-processing phase: LaBS/ProLB integrates a parallel volumetric mesher that processes facetized surfaces as input, which, in complete industrial cases, can be very large. These surfaces have to be processed and corrected (closing, local remeshing, etc.) during this parallelized pre-processing phase: several bottlenecks were overcome during the project.



Aeroacoustic simulation of a CROR (Contra-Rotating Open Rotor) engine. CROR design AIP7X by Airbus.

A 22% REDUCTION IN RUN ENERGY CONSUMPTION

Another interesting result is the implementation by IT4I of a library for optimizing the energy consumed by computation, by dynamically managing CPU frequencies: on an industrial case, we were able to achieve a 22% reduction in run energy consumption, with only a loss of less than 10% of computation time.

Finally, based on various GPU prototypes and taking into account feedback from the experts involved in the project, we have defined our GPU porting strategy, and developments are now underway. We are of course looking for maximum GPU performance, but our challenge is to be able to offer this GPU performance to our industrial users without limiting functionality and physical models compared with the pure CPU version. Of course, toy cases and academic configurations are used to test our developments, but our organization of the LaBS consortium enables our industrial partners Airbus, Renault and Safran to test prototype versions of LaBS/ProLB on their industrial cases on an ongoing basis, to check that results and performance are in line with their expectations. Examples of simulations carried out by Airbus and Safran are shown in figures XXX and YYY.

GENCI AND ITS ENVIRONMENT

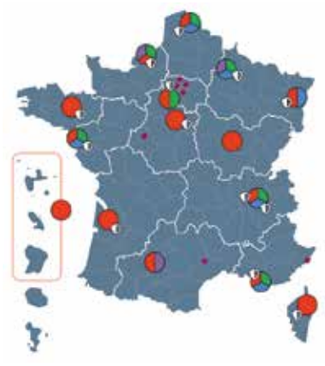
CONTENTS

GENCI IN REGIONS

MESONET, A FEDERATION OF 21 REGIONAL MESOCENTERS UNDER GENCI COORDINATION

The objective of Mesonet project (2021-2027) is strengthen the structuring of national and regional offers in digital simulation, the high performance computing (HPC) , associated with artificial intelligence (AI) methods, also providing access to a QLM and to training on quantum computing to facilitate access to resources by academic and industrial researchers and by teachers and students. All while relying on the specificities of mesocenters: local support.

GEOGRAPHICAL DISTRIBUTION OF ACTIONS

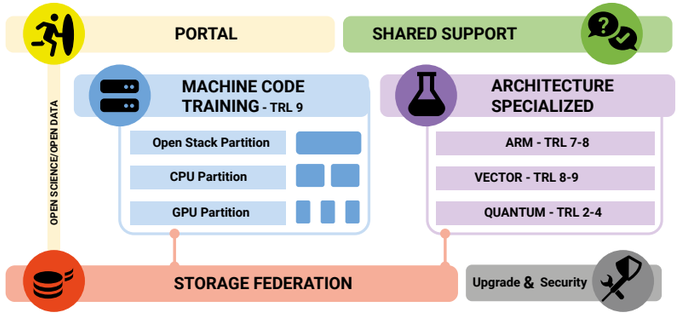


SHARED INVESTMENTS

Due to the international situation, and the delay in the delivery of components, services to user researchers were delayed and actually began at the beginning of 2023.
Machine known as “training codes”: national shared equipment distributed across 6 sites to meet 2 needs: offering cutting-edge research equipment for the development of scientific applications and calculation codes and opening the equipment to educational training for higher education and companies.

The chosen hardware and software infrastructure has 3 partitions:

- A CPU machine with 2 configurations based on the 2 main processor manufacturers (Intel and AMD),
- A 3-slice GPU machine equipped with servers accelerated by specific graphics units to meet all current HPC and AI uses.
- An OPENSTACK machine with a cloud-type software environment for different and complementary uses, based on a cluster-type environment.



SPECIALIZED ARCHITECTURES

VECTOR COMPUTING NODES

2 x Intel Icelake 16 cores 256Go DDR4

8 x VE NEC SX Aurora Tsubasa 20B
By VE: 8 cores 1.6 GHz – 48 Go HBM2
By heart: 64 vector registers
x 256 DP elements (16384 bits)
960 Go NVMe

TOTAL 176.9 TFLOP/S PEAK VECTOR
4.4. TB of HBM2 memory

Fast 200 Gbps network
Nvidia Mellanox Infiniband

Useful 510 TB storage
NEC GxFS 3.5GB/s

A connection front
A visualization node

Rocky Linux – Slurm

A NEC vector machine operated by CRIANN

An ARM ATOS machine operated by CALMIP

Turpan: Computing cluster + 630 TF/s Peak (CPU+GPU)

15 interconnected Nvidia ARM nodes in infiniband

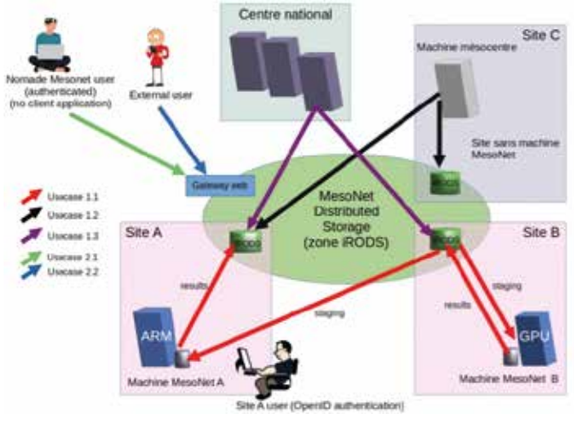
- ARM 80-core 3 GHz processor
- Nvidia A100-80 GPU (80 GB HBM2)

Storage+cluster admin (400 TB)
Front ends (#2) for connection to the ARM Cluster
Pre- and post-processing servers (#2)

Environment: GNU, ARM and Nvidia-hpc compiler
Support: 100 days Expert Engineers
Hosting: Occitanie West Data Center
Operator: UAR 3667 CALMIP (CNRS/UT3/INPT/ISAE/INSA)

QUANTUM COMPUTING

Access to the QLM simulator at the University of Reims Champagne-Ardenne for the entire community began at the beginning of 2023.
A call for tender has been set up to support the community, with 3 axes: Plenary dissemination conference aimed at a broad scientific audience, training program (12 days of training per year), project support (animation, events and promotion of architecture).



Storage federation: choice of investments made in 2023, acquisition during 2023/2024

USER SUPPORT

The Mesonet project has planned two types of recruitment in addition to the human resources provided by the project partners: personnel dedicated to investment management (system engineers and portal engineer) and those who provide decentralized and long-term shared user support. 7 recruitments have already been made.

LINK WITH INDUSTRIES

Mesonet partners have agreed to participate in the French Competence Center. The CRIANN (Normandy) and ROMEO (Reims) mesocenters carry out missions in EuroCC on behalf of the 21 mesocenters of the Mesonet project.

GENCI IN EUROPE

PRACE EVOLVES TOWARDS A USER FORUM FORMAT

With PRACE 3, the PRACE research infrastructure is now moving its scope to supporting European researchers, with the creation of a user forum.

Over the last 17 years (if we take into account the PRACE-PP project, which has already started providing its first services) PRACE aisbl, with the support of the various implementation projects (funded by the European Commission) and its members will have, since 2010, structured a unique HPC ecosystem in Europe, bringing together 25 countries and providing high added-value services based on access to computing resources (provided by 4 then 5 hosting members), training, support for SMEs, technology watch, joint development of tools and procedures and international collaboration.
Thanks to access based on scientific excellence for open research, PRACE will have given access to more than 35 billion computing hours to 947 academic and industrial projects, trained more than 29,000 people in 14 PTCs (PRACE Training Centres), supported 74 European start-ups and SMEs in the use of HPC, set up the SummerOfHPC mobility program for students and developed international collaborations, notably with the USA, Japan, Australia, South Africa, CERN and SKA.

A NEW PHASE

Fostering the advent in 2018 of the EuroHPC joint undertaking (bringing together 33 countries and the European Commission to date), PRACE aisbl will enter a new phase on January 1st, 2024 (named PRACE3) focused on the needs of the communities and the establishment of a user forum, around a new governance structure involving researchers and computing centers.
France (represented by GENCI), a co-founding and hosting member of PRACE (with Curie and Joliot Curie at the TGCC), has decided to withdraw from PRACE aisbl in order to refocus its activities on the programs proposed by EuroHPC.
We would like to thank Alain Lichnewsky (who was instrumental in the creation of PRACE), Catherine Riviere (who chaired the Board), and all the French partners (CNRS, CEA, Inria, CINES and GENCI) who were involved in this adventure.

GENCI IS PARTICIPATING IN EPI-SGA2 AND EUPEX

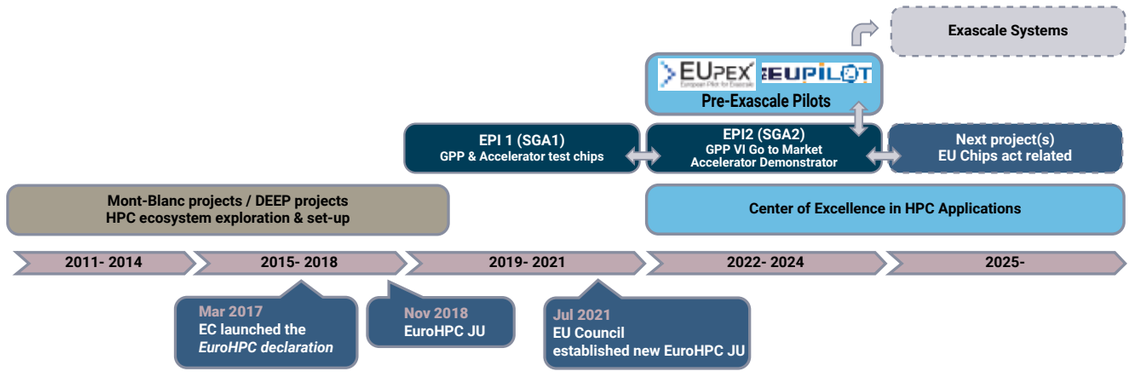
In continuation of the first part of the EPI (European Processor Initiative) project, called SGA1, Europe is continuing its support for the definition of the second generation of the European processor and its accelerator by committing funding of €70 million to the EPI SGA2 project, which started in February 2022 for a duration of 3 years.

EPI-SGA2 is part of the vision of the European "Chip Act" in response to a need for sovereignty in the supply of processors by bringing back to Europe the systematic value chain and know-how to equip future European systems, including notably the Exascale project led by France with the Jules Verne consortium. The review of the second period took place in March 2023, the delay in the SiPearl roadmap has been integrated into that of the project. Despite these delays, a very encouraging fact for sovereignty: More than 4,000 SiPearl RHEA1 processors will be installed in the first quarter of 2025 on "Jupiter" the first European Exascale machine, which will be hosted at JSC in Germany.

https://ec.europa.eu/commission/presscorner/detail/fr/STATEMENT_22_891
https://www.fz-juelich.de/en/ias/jsc/jupiter

EUPEX, WHAT IS IT ?

The EUPEX project, **EU**ropean **P**ilot for **EX**ascale, started in early 2022 and is part of the vision for developing sovereign technologies that can equip future European Exascale architectures. Co-financed by the EuroHPC Joint Undertaking and France (via Bpifrance), Germany, Italy, Greece, the Czech Republic, and Croatia, it has a budget of €40.8 million over 4 years and brings together industrial and academic partners (including Atos, CEA, Inria, GENCI and SME CybeleTech in France). EUPEX aims to deploy and validate the first pilot systems for HPC integrating European technologies, particularly the processor from the EPI project and software layers. It is in this perspective that the RHEA processor designed by the European company SiPearl is expected to be integrated. Two project meetings were organized in 2023 (on February 14 at the University of Zagreb and on November 6 at E4 in Reggio Emilia).



GENCI, A CIVIL COMPANY

AGILITY AND ENGAGEMENT IN A RAPIDLY EVOLVING CONTEXT

Since 2020, GENCI has continued its efforts towards the dematerialization of internal processes and their continuous improvement.

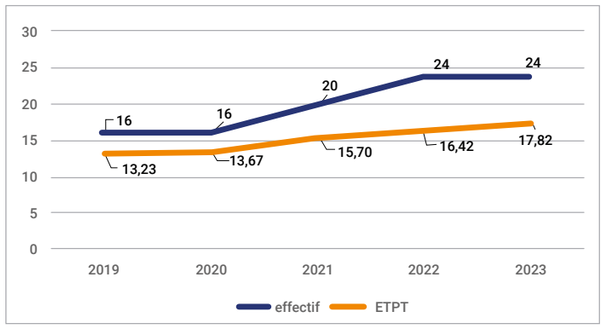
As part of this ongoing process improvement, GENCI has set up a dematerialized system for declaring timesheets for GENCI employees via the "Timmi Temps" HR tool, enabling a more detailed analysis of the participation of employees involved in the various projects. After a full year of use, this tool has enabled us to optimize the individual timesheets. The travel policy has also been amended to improve processes and raise the maximum amounts for travel expenses. This travel process has been entirely dematerialized on Resana system. In the same spirit, electronic signature tools have been installed to make it easier to sign GENCI's various commitments.

MULTIPLE AND MULTIPLIED PROJECTS

As part of this commitment to improving internal processes, GENCI has launched various tendering procedures for its civil society activities, making it possible to select new providers or renew existing ones. All of GENCI's communications activities (website redesign, graphic design, editorial design, audiovisual and photographic creation and production, public relations, promotional items, printing) were included in this improvement process, providing a structuring legal framework for communications activities.

The accountancy services contract was also renewed for a period of 48 months. In addition, GENCI signed a subsequent contract to be attached to the MATINFO procurement contract for the supply of IT hardware, thereby benefiting from a substantial reduction in IT hardware costs.

In terms of human resources, this year has been marked by three departures and three new recruits, for a total workforce of 24.The activities related to the CLUSSTER, EUPEX, HPCQS, Euro-QCS-France and HQI projects in 2023 involved the GENCI teams very heavily at technical and support level (administrative, legal and financial) and it will continue in 2024. GENCI teams were also heavily involved in the Exascale project, with technical, legal, tax and financial negotiations on the contractual documents with EuroHPC



The following table presents the evolution of GENCI's workforce since 2019.

(Hosting Agreement, Administrative Agreement, Grant Agreement, Consortium Agreement, Tendering Package). All of the technical and legal activities described above are in addition to GENCI's ongoing activities, which was particularly sustained in 2023. GENCI has increased the number of legal projects with the different centers, which has led to an increase in legal and financial activity: agreements with the centers, amendments, purchase orders and associated revenue phases as part of the renewal of the centers' computing resources or the purchase of quantum solutions and any associated delays and malfunctions (Adastra computer).

A REFLECTION ON THE EVOLUTION OF ACCESS TO GENCI'S COMPUTING

On the technical side, the workload will be just as heavy; in particular, the implementation of one of the conclusions of a reflection with the centers on the evolution of access to GENCI's computing and storage resources and the assessment of the greenhouse gas emissions of the national computing centers.

These varied and intense activities underline the ever-increasing workload to which GENCI teams are subjected and highlight GENCI's fragile balance, particularly in the event of a significant departure and the associated recruitment time (approximately more than six months).

In 2023, GENCI has hired three new members of staff for the positions of:

- Office Manager at the General Secretariat as a follow-up to the departure of the current employee;
- DARI Project Manager in the Operations division as a follow-up to the departure of the current employee;
- Quantum computing project engineer as part of the development of the national quantum plan activities entrusted to GENCI.

The position in the Operations division has not been filled in 2023 and remains open.

FOCUS ON THE NATIONAL HQI QUANTUM PROGRAM

This year has been particularly productive, with:

> the formalization of partnership agreements with the different participants in the quantum platform program,

> the signature of the Hosting Agreement for the European EuroQCS project with EuroHPC preparing the stage for the launch of a competitive tendering procedure for the acquisition of a second quantum system,

> and the signature of the framework agreement with the CEA for the hosting of quantum systems at the TGCC.

GENCI, A CIVIL COMPANY SUPPORT TO A RESEARCH INFRASTRUCTURE

INTERNAL ORGANIZATION

MANAGEMENT COMMITTEE

Philippe LAVOCAT
CEO

Édouard BRUNEL
General Secretary

Jean-Philippe PROUX
Operations
and Security Officer

Stéphane REQUENA
CTO and Innovation Manager

Marie-Hélène VOUETTE
Partnership Manager
Institutional Relationship Advisor

ADMINISTRATIVE & FINANCE DEPARTMENT

Maïté CAMPEAS
Executive Assistant

Christèle COCHARD
Office manager
(since 09/11/2023)

Imène LITIM
Administrative Assistant
(until 04/21/2023)

Jason LAFRENIÈRE
Administration
& Finance Manager

Marieke PODEVIN
Senior Legal Officer
Data Protection Officer

Célia LAGIÈRE
Legal Officer
(since 08/23/2022)

Rasa VAICIEKAUSKAITE FALLAHZADEH
Administrative
project manager

COMMUNICATION

Nicolas BELOT
Communication Manager
and European relations

Annabel TRUONG
Communication
Officer

TECHNICAL & OPERATIONS DEPT.

Éric BOYER
Project Officer HPC/HPDA/IA

Sabine MEHR
Chief Quantum Project Officer

Félix GIVOIS
Quantum computing project engineer
(since 09/01/2023)

Philippe SEGERS
European Projects Manager

Corinne BEAL
Exascale Project Manager

Loubna SALLAK
Project Operations
Manager
(until 04/14/2023)

Ana RIVET
Project Operations
Manager
(since 09/18/2023)

COMMITEES MEMBERS AND OFFICIAL BODIES (at 12/31/2023)

MEMBERSHIP OF THE GENCI COUNCIL

State and MESRI representative: Mr Laurent CROUZET – Mrs Karen AMRAM
CEA representative: Mrs Maria FAURY – Mr Hervé DESVAUX
CNRS representative: Mrs Adeline NAZARENKO – Mr Denis VEYNANTE
Universities' representative: Mr Guillaume GELLÉ – Mr Olivier SIMONIN
Inria representative: Mr Jean-Frédéric GERBEAU

MEMBERSHIP OF THE ADMINISTRATIVE AND FINANCIAL COMMITTEE (CCAF)

State and MESRI representative: Mr Antoine PERRANG, Chairman of CCAF
CNRS representative: Mrs Anne-Françoise DUVAL
CEA representative: Mrs Louise JULIEN-TAMISIER
Inria representative: Mrs Catherine GALLET-RYBAK
Universities' representative: Mr Michel DELLACASAGRANDE

MEMBERSHIP OF THE COMMITEE AUDIT CONTRACTS (CM)

State representative:
Mr Philippe AJUELOS, *Ministerial Administrator of Data, Algorithms and Source Codes – digital education department of the Ministry of National Education and Youth, President of the Markets Commission*
Mrs Lara MONTANTIN, *Legal Officer performance, financing and contractualization with research Department of organization management support and regulation*
CEA representative:
Mr Éric STEHLE, *Head of Commercial Service and Strategic Partnership of Paris-Saclay (CEA)*
MR THIBAULT PELLETIER, *Head of Reference Service and the Markets Commission at the Commercial and Strategic Partnership Department (CEA)*
CNRS representative:
Mr Sébastien TURCI, *Deputy Director for Purchasing and Innovation of the CNRS*
Mrs Marie-Laure COLIN, *Head of Public Economic Law and Regulations at CNRS*

TECHNICAL ADVISORY COMMITEE (CT)

State and MESRI representative:
Mr Guillaume AULANIER, *High-Performance Computing Officer, Digital Services and Infrastructures Department*
CEA representative:
Mrs Valérie BRENNER, *Fundamental Research Department*
Mr Émeric BRUN, *Directorate for Nuclear Energy*
Mrs Christine MENACHÉ (then Mr Nicolas LARDJANE), *Head of TGCC*
CNRS representative:
Mr Michel DAYDÉ (then Mr Michael KRAJECKI), *Scientific Delegate*
Mr Pierre-François LAVALLÉE, *Director of IDRIS*
Universities' representative:
Mr François BODIN, *Professor at University Rennes 1*
Mr Michel ROBERT, *Director of CINES*
Inria representative:
Mr Lucas NUSSBAUM, *Head of experimentation platforms program at the Executive Committee for Innovation*
Mr Frédéric DESPREZ, *deputy of the scientific director, in charge of the "Networks, Systems and Services" area.*

COMMITTEE FOR STRATEGIC GUIDANCE ON INVESTMENTS (COSI)

Committee with responsibility for advising and providing assistance to GENCI in its investment strategy covering in particular the compilation of a multi-year investment plan based on the indications given by the MESRI scientific committee and guiding the work of the CT and CCAF.
State and MESRI representative:
Mr Laurent CROUZET, *Head of Numerical Services and Infrastructures Department*
CEA representative:
Mr Christophe CALVIN, *Fundamental Research Department*
CNRS representative:
Mr Denis VEYNANTE, *Chairman fo the Steering Committee of the Compute & Data Mission*
Universities'representative:
Mr Olivier SIMONIN, *Chairman of National Polytechnique Institute (Toulouse)*
Inria representative:
Mr Jean ROMAN, *Deputy Scientific Director – Research Directorate for Applied Mathematics, Computing & Simulation.*

GENCI IN 2024

In 2024, GENCI's business will be bookmarked by many challenges

Infrastructures, users and projects

- Acquisition and installation of the Jean Zay supercomputer extension (IDRIS)
- Inauguration and commissioning of Pasqal's quantum machine (TGCC)
- Call for tender for the 2nd European Exascale machine
- Expansion of Adastra supercomputer resources
- Call for projects "Maisons du Quantique"
- Acquisition within the framework of EuroQCS-France
- First bricks of the Clusster project
- Call for projects on DARI resources A16 and A17
- Adastra Grands Challenges Day
- Scientific results

Events

EuroHPC summit Week 2024

Vivatech Teratec **ISC**

France Quantum

ORAP Forum

Supercomputing

And so much more...

A huge thank you goes to the authors and contributors for your time and the energy you have dedicated to this Annual Report outlining all the work of GENCI during 2023.

It is only thanks to the people in this report, as well as many others, that GENCI is able to achieve its objectives and be part of the emergence of new possibilities every year.

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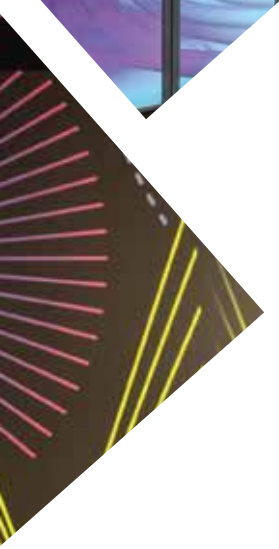

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