IJCLab Yearly Report 2024

Written by the Directorate

1. IJCLab Year 2024: introduction and organization of the document

After several iterations in the last two years between the laboratory and the "tutelles" a **Manifesto** defining the **missions of IJCLab** has been defined and can be summarized in five points:

- **To lead and play a major role on world-class flagship projects in high-energy physics, nuclear physics, astroparticles and cosmology by contributing at all levels, including theory**
- **To lead and play a major role in the conception, design and construction of current and future accelerators.**
- **To develop and exploit research infrastructures and technological platforms supporting these lines of research as well as, thanks to their irradiation performances, original research in health physics, material sciences and energy.**
- **To promote the development of new technologies for science and the valorisation of our research for the benefit of society, thereby supporting national and European industrial competitiveness.**
- **To welcome the students that the laboratory trains through and for research at the heart of a world-class university environment.**
- **The most relevant results for Year 2024 related to these five manifesto's points are discussed in Chapter 2. More extensively the Technical and scientific Highlights of the laboratory for Year 2024 are presented in Chapter 3.**

The possibility of fulfilling these missions depends on the laboratory's capability:

- **To set up an efficient and smooth organization of the laboratory, respectful of rules and aimed at enabling the optimal fulfilment of research and teaching missions … and ultimately, a laboratory where it is pleasant to live. (Chapter 8).**
- **To preserve and increase the technical and scientific staff and to offer them excellent opportunities for career evolution. (Chapter 5).**
- **To have the necessary fundings and in particular we have to be able to better position ourselves and succeed in different calls for tenders. (Chapter 6).**
- **To have a favourable working environment in the tertiary sector and the ability to have infrastructure capable of housing our instruments and our technological and research platforms (Chapter 7).**

And to be able to work in an efficient collaborative manner. For that it is crucial for the laboratory (**Chapter 4**)

- **To be an important partner in the network of the largest European laboratories. To also stimulate targeted collaborations with other European laboratories and worldwide.**

- **To increase the national collaborations with the other laboratory of IN2P3, and more largely to CNRS, RFU/CEA and the CNES.**

In the annual report we discuss the actions and the results connected to the missions of IJCLab expressed in the Manifesto in the Chapters indicated in the previous items.

To note that IJCLab will be examined in January 2025 by HCERES ("Haut Conseil de l'Evaluation et de la Recherche et de l'Enseignement Supérieur"). In preparation for that we have organizing IJCLab Perspectives in March 2024.

2. IJCLab Missions and success criteria

- **Leading world-class flagship projects in high-energy physics, nuclear physics, astroparticles and cosmology by contributing at all levels, including theory**

The projects and their evolution are monitored by a dedicated service (CEMAP) through a dedicated software (OSITAH-NSIP) allowing IJCLab members to declare their activity each semester.

The number of FTE implied on the high-energy physics, nuclear physics, astroparticles, astrophysics and cosmology and also in theory activities are summarized in Table 1.

	RESEARCHERS	TECHNICAL STAFF	TOTAL
HIGH ENERGY PHYSICS	84	34	118
ASTROPHYSICS & COSMOLOGY	50	18	68
NUCLEAR PHYSICS	52	18	70
THEORETICAL PHYSICS	76	0	76

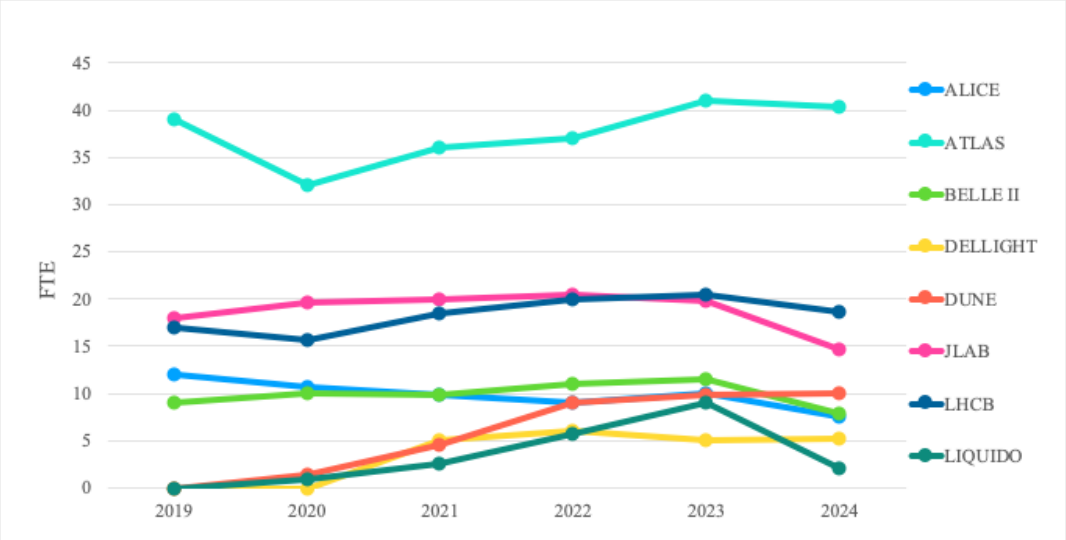
Table 1. FTE involved in the high-energy physics, nuclear physics, and A2C (for Astroparticles, Astrophysics and Cosmology) and Theory activities. In the number of researchers the PHD students are included. For PHE, notice that 67 FTE are involved in CERN-based experiments and for Nuclear Physics 13 FTE in GANIL experiments. –

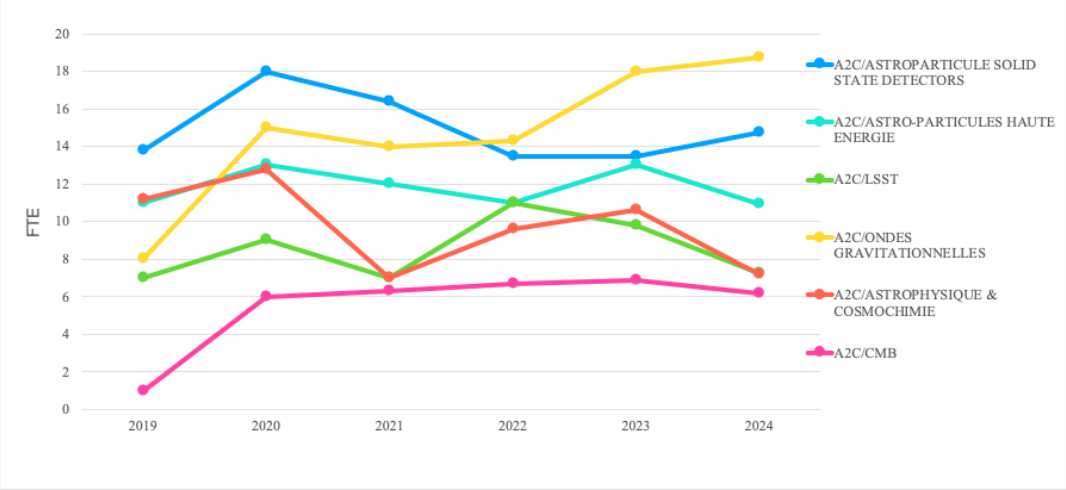
The Figure 1 shows that we have continued the projects which were initiated before the beginning of IJCLab and for most of the projects the implication has remained stable over the last years. We can notice globally a stability of the activities related to the CERN experiment

(ATLAS, LHCb and ALICE). The fluctuation are mainly due to non-permanent and mainly PHD students. At the same time, we managed to start contributing to new emerging projects, mostly to DUNE and an increase of the Gravitational waves related activities due to an increasing contribution to the Einstein Telescope project.

In 2024 IN2P3 got two important financial support in the “Projets à Risque” Call. both of 3M€ with a first financial support of 1M€ on the first year:

- ERL4ALL which provide most of the financial needs for the PERLE injector. This project is led by IJCLab/LPSC
- DM4ALL which provide money supporting the R&D needed for realizing TESSERACT project at LSM. IJCLab is an important partner of this project.





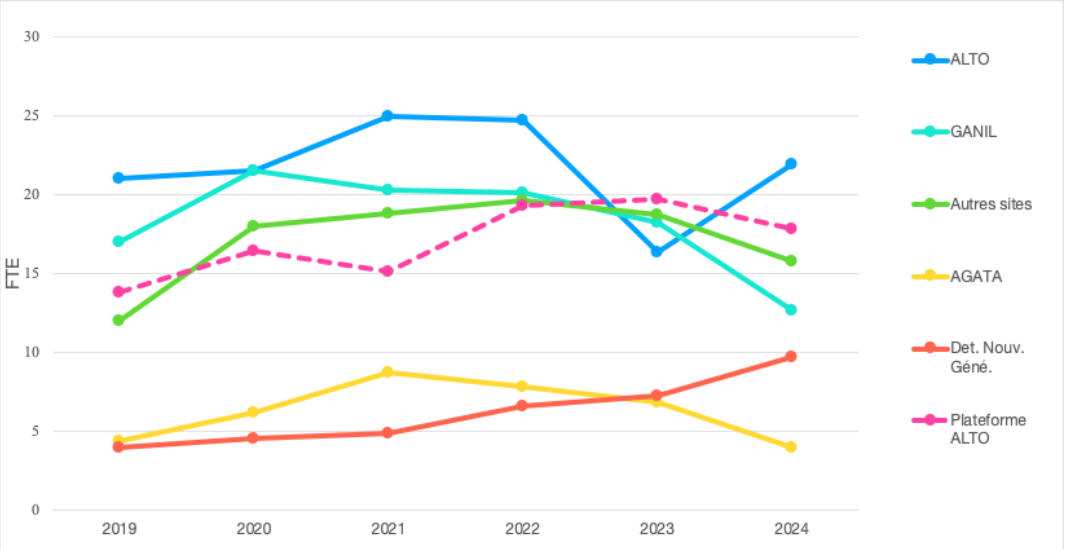


Figure 1. The Evolution of the FTE as a function of the years for PHE, A2C, Nuclear Physics projects.

One can make a few comments and observations:

- We are keeping a high level of involvement on the LHC projects ALICE, ATLAS and LHCb entering the upgrade phase
- Notice that the LIQUIDO activity (for future neutrino experiment but also with applications on Health physics) has been stopped in the laboratory and the technical staff working on this activity has been effectively reabsorbed in other laboratory projects.
- A newcomer is the project DUNE with an increased number of people involved. IJClab has put a strong priority on hiring new researchers and engineers to work on this project. Quantitatively the number of FTE increased from 1 to around 10 in the last 3 years.
- There is a constant and important participation in the GANIL and ALTO. Consider that the people working on ALTO are often in view of an experiment to GANIL. The oscillations over the years on these two facilities depend also mainly on the different experiment campaigns. To be also consider an important work done in order to upgrade the ALTO platform in the last two years with the aim of improving the capacity of ALTO to run in parallel stable and radioactive beams but also for the opening of ALTO to other applications thanks to the irradiation capabilities. We recall here that (as shown in the plot) 18 FTE have actually worked on the ALTO platform in 2024.
- We are also moving forward with a growing implication in Einstein Telescope in parallel with a continuation of the activities in VIRGO+. The AC team's activity also increased thanks to a balloon flight that took place last summer in order to increase the

TRL of an instrumental setup for a future constellation of nanosatellites dedicated to measuring the polarization of gamma-ray bursts.

In addition to the experimental projects a strong theoretical pole has been created at the beginning of IJCLab. The activities of this pole are summarized in Figure 2.

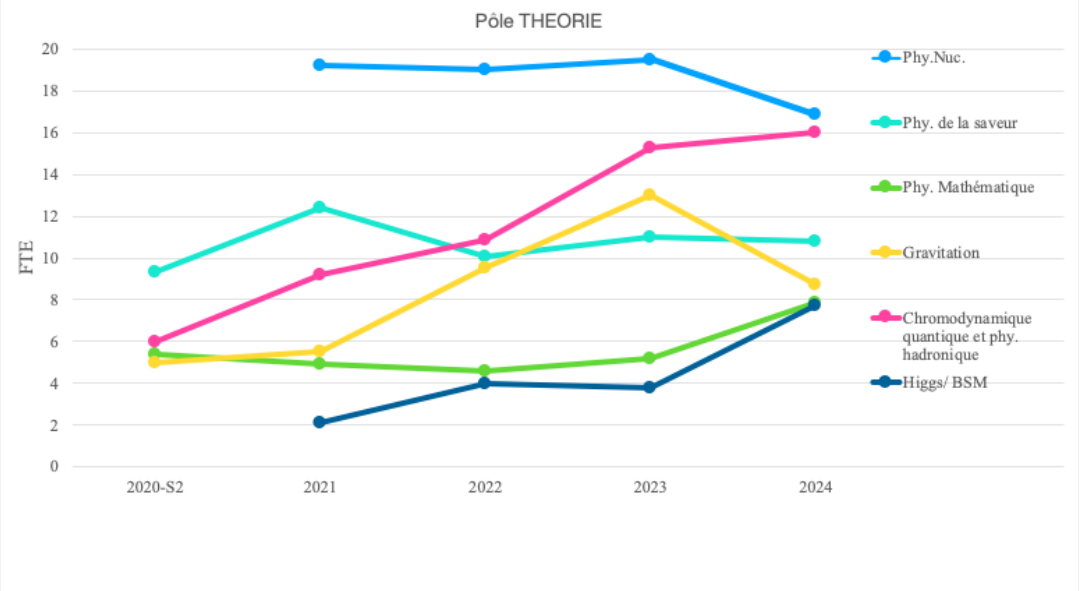


Figure 2. The Evolution of the FTE as a function of the years for Theoretical Physics.

As it can be noticed from this plot about 85% of the pole corresponding to about 60FTE is working on theoretical subjects on nuclear physics, Higgs, BSM, flavor physics, QCD and Cosmology/Gravitation. The research activities are often related to the experimental projects and activities of the laboratory (see Chapter 3**Erreur ! Source du renvoi introuvable.**). The theoretical pole is also very active in participating/leading the transverse's groups (see Chapter 3).

- **Play a major role in the conception, design and construction of current and future accelerators.**

We are running and contributing to several of the major accelerator programs in the world.

The main observations (see Figure 3) concerning very recent changes (mostly in the last year) are:

- A significant decrease of the forces needed for ThomX (end of the construction phase), but with a constant effort in order to complete the project and get the results from X-rays.
- The ESS (end of the production phase) contribution is reduced to less than 1FTE and we keep part of the facility in order to intervene in case of reparation.
- A still significant activity on MYRRHA
- A significant increase of the contribution to new project: PERLE, with today about 13 FTE
- A stabilization over the last 3 years of the needed forces on PALLAS.
- Contribution to international accelerator is increasing through the participation to PIP II a regain of activity under the umbrella of FCC-NPC.

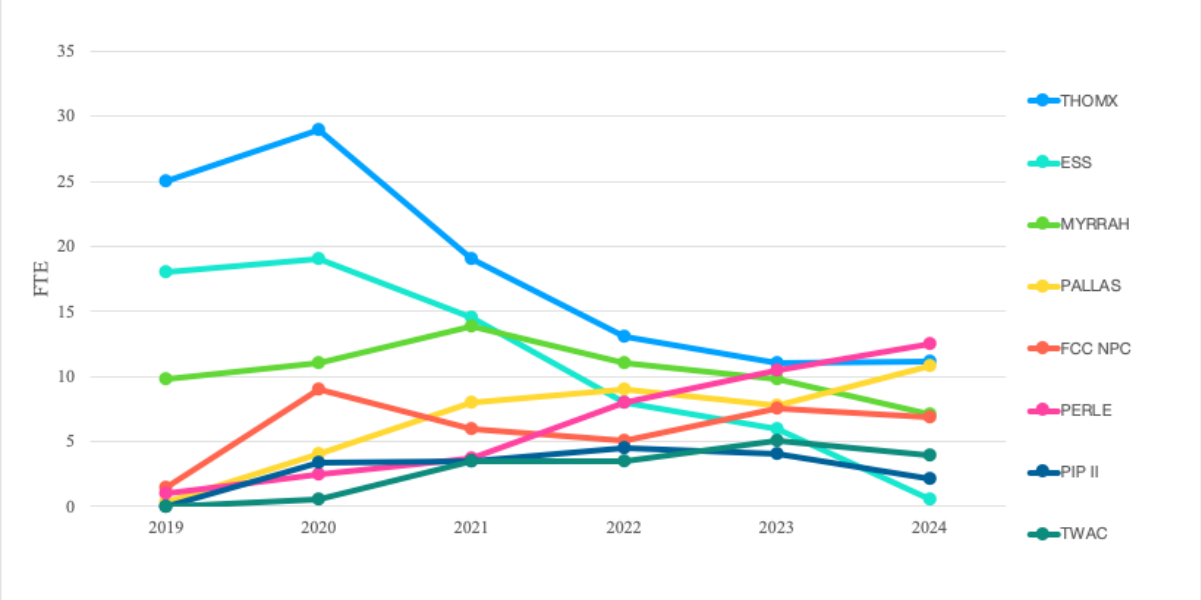


Figure 3. The Evolution of the FTE as a function of the years for Accelerator Physics projects

Besides that, we have several technological platforms which are essential for accelerators physics activities:

- We keep upgrading SUPRATECH with investments required for the realization of present and future experiments (ESS, Myrrha, PIP II, PERLE + SRF R&D)
- The LaseriX platform is hosting PALLAS project to build a compact laser plasma section accelerating electrons up to 200 MeV. LASERIX is participating in the TWAC project for electron acceleration in a dielectric waveguide. For the DELLIGHT project, LASERIX is used to demonstrate experimentally that the electromagnetic field carried by an ultra-intense laser pulse can modify the refractive index of a vacuum.

- Vacuum & Surfaces platform has been inaugurated in 2023 and is now fully operating. The aim of this platform is to maintain, acquire and adapt surface analysis resources to provide the best possible response to gas accelerator materials issues, with particular emphasis on dynamic vacuum and superconducting RF cavities. Installed in Halls D3 and D4 of Building 209C, this unique space houses a variety of equipment.

The number of FTE involved in these platforms is shown in Figure 4.

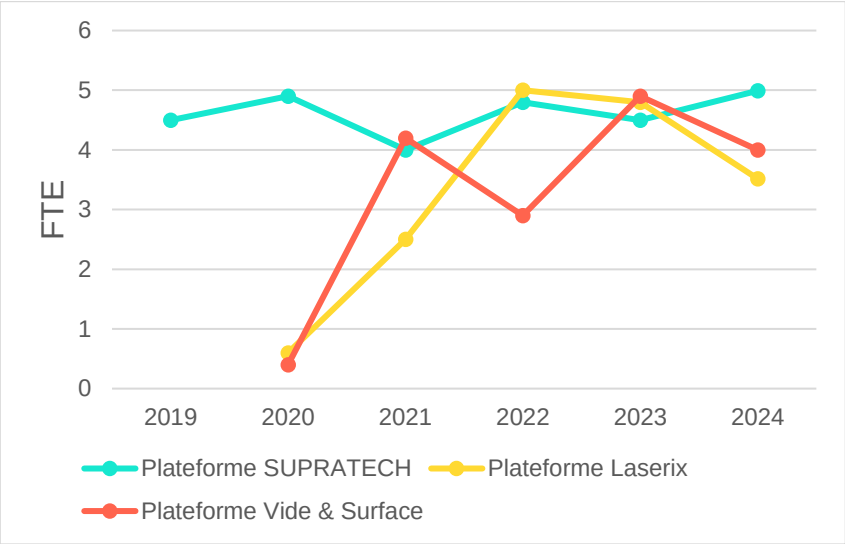


Figure 4. FTE as a function of the years for LaseriX, SupraTech, and Vide &Surface Platforms

- **To develop and exploit research infrastructures and technological platforms supporting these lines of research as well as original research in health physics, material sciences and energy, thanks to their irradiation performances.**

Some important progress has been achieved very recently, with quite significant investments, in particular:

- Significant investments are undergoing to upgrade the **detector platform of IJCLab** both from the infrastructure and the equipment viewpoints.
  - **PSI** (**Platforme SIlicium**) for the characterization, the preparation and the test of the silicon detectors, mainly for the ATLAS upgrade, but also for contributing to EIC.

- **DQC (Détecteurs Quantiques Cryogéniques**). A Platform for study and test of innovative cryogenic quantum detectors (mainly bolometers) for neutrino physics and the search for dark matter.
- **Myrtho.** In this platfrom we storage of the Antarctic micro-meteorite collection to perform analyses of the properties of micro-meteorite samples. We also develop the detectors for MeV gamma-ray astronomy

- **ALTO**
  - **ALTO-LEB:** Many upgrades have been made in the last two year: On-line commissioning of the new front-end, the stabilization system to track the position of the lasers in the source as well as the switch between both laser schemes (Ag and Ga), the robot which is starting to operate… New lines and experiments are installed as described in the Nuclear Physics highlight chapter.
  - **ALTO-HEB**: Many upgrades have been made in the last two years: the integration of Radiograff setup and the finalization of the BioALTO line; the installation of SPACE ALTO, the precision irradiation station for industrial clients, at beamline 320; the rejuvenation and upgrade of the magnetic spectrometer SPLIT-POLE…

- **JANNuS-SCALP and Andromede** platforms are now merged in a unique platform, named **MOSAIC**, of Ion beams for synthesis, modification and characterization of materials, and ion-matter interactions studies. 71 available elements, from protons to gold nanoparticles and in the energy range: from 50 eV to 32 MeV. This platform is a member of the EMIR&A French accelerator federation, Research Infrastructure. It is splitted in two sites. Building 108 hosts: 2 MV Tandem (ARAMIS), an ion implanter of 190 kV (IRMA), a 200 kV in situ TEM, a 40 kV mass spectrometer (SIDONIE) recently renovated and upgraded (see YR2022) and a SEM-EDX AFM. The Hall SuperACO hosts: 4 MV Tandem (Andromède), an accelerator of 30 kV for aggregates (Tancrède) and a new ion implanter which will be transported from Lyon of 400 kV (Némée).

ALTO and MOSAIC are efficiently functioning and the personnel employed is shown in Figure 5.

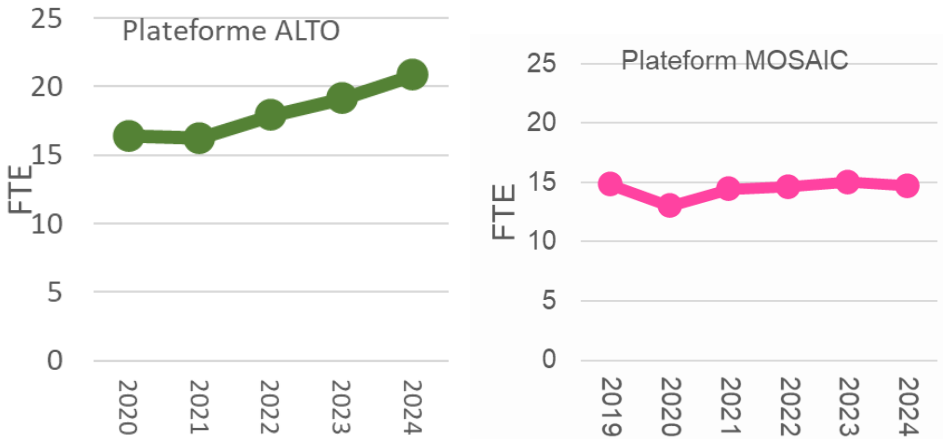


Figure 5. FTE as a function of the years for ALTO and MOSAIC Platforms

- **To promote the development of new technologies for science for the benefit of society, thereby supporting national and European industrial competitiveness.**

Several activities in laboratory are developed and/or transferred to Industrials. The industrial partnerships are summarized in the following chapters

- **To welcome the students that the laboratory trains through and for research at the heart of a world-class university environment.**

The number of PHD students has stayed constant over the last year with about 120 PHD students present at the same time at the laboratory. More than 30 PHD thesis are defended per year and more than 30 new PHD students are starting their thesis every year. The laboratory has also put a strong priority on welcoming internship students.

PhD Students.

In Figure 6 we show the number of new PHD entering IJCLab and PhD defenses over the years.

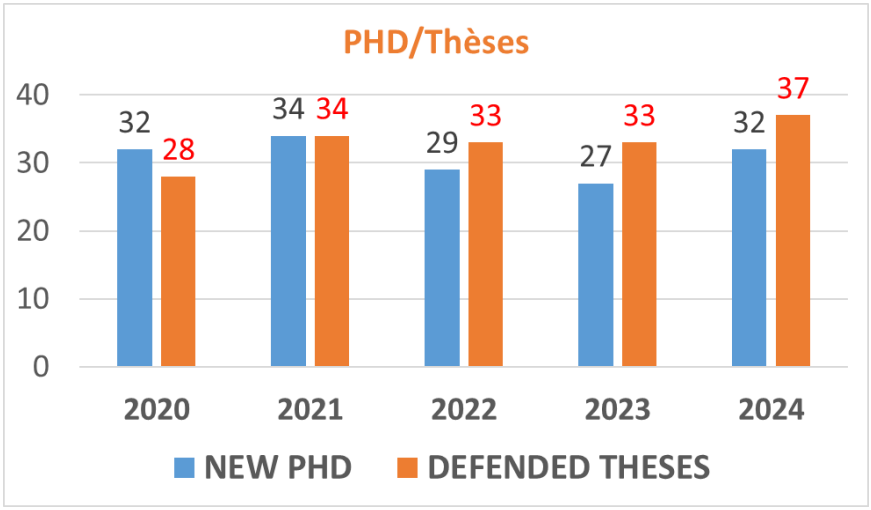


Figure 6. Number of PHD students and theses defended per year since 2020

Interesting to underline that the PHD students are from about 30 nationalities.

INTERNSHIPS

IJCLab has also a strong involvement in internships as a gateway to research for students. Table 2 indicates the number of internships from licence to Master

	2020	**2021***	**2022**	**2023**	**2024**
Number of internships	125	213	142	167	131
Number of months	375	641	483	397	357
Licence	24%	32%	34%	43%	35 %
Master1	28%	36%	32%	30%	37%
Master2	47%	32%	34%	27%	28%

Table 2. Quantitative data for internships: total number, number of month and percentage of internship student from Master 2, Master and Bachelor. In 2021 due to the Covid pandemic, all the French students could not travelled abroad and did their internships in France.

The full number of students from College up to Master visiting the laboratory is shown in Figure 7 . Beside the Licence and Master students we welcome more than 100 young students from College, Lycée…

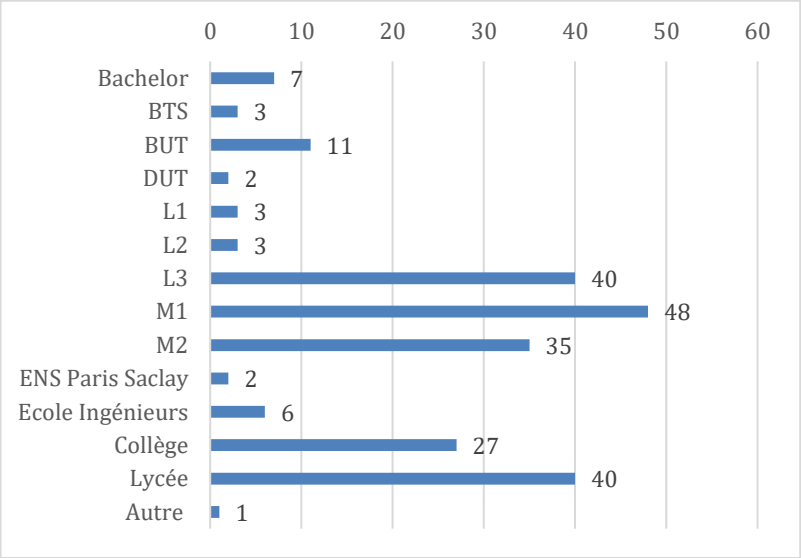


Figure 7 Number of visiting students at IJCLab in 2024

MASTER and DOCTORAL SCHOOLS

We have in particular important responsibilities in the following Master programs:

- M2 NPAC (Nuclei Particles Astroparticles and Cosmology) (around 35 students/year) directed by Fabien Cavalier
- M2 Grands Instruments/PLATO (around 15 students/year) directed by Sophie Kazamias
- M1 Nuclear Energy (around 25 students/year)
- M2 Nuclear Energy (around 50 students/year with 5 different majors)
- M1 General Physics (around 40 students/year)

One of the main Doctoral School in Physics of the Paris-Saclay University, ED PHENIICS, with more than 200 registered PhD students is directed by David Verney.

INTERNATIONAL PROGRAMS TO ATTRACT STUDENTS

Several international training activities are also led by IJCLab researchers/teachers. We mention here the largest ones and those who attract most the international students:

- **Trans-European School in HEP** (mostly East European countries), Winter School in HEP (**WISHEPP)** (Palestine), International **QCD school**.

- International student exchange networks: **Erasmus+ MIC Colombia, Georgia, Ukraine and Palestine** (globally more than 50 students/year)
- **Erasmus Mundus Lascala** (large-scale instruments) and **Quarmen** (quantum research)

3. Scientific and Technical highlights and events in 2024

3.1 The Scientific Poles and the Engineer Pole

NUCLEAR PHYSICS

NEXT Team

One of the researchers from the NEXT team has conducted an advanced comparison between conventional gamma-ray tracking algorithms and AI/ML approaches for **GRETA** and **AGATA**, with a particular focus on optimizing tracking using **Learning to Rank (LTR)** methods. These techniques enhance the resolving power of gamma-ray spectrometers by improving both detection efficiency and the Peak-to-Total (P/T) ratio.

Additionally, in the NEXT team, significant progress has been made in preparing for the **gSPEC project**, which aims to measure nuclear moments, initially around doubly-magic nuclei. In 2024, simulations and preparatory work were carried out at **IJCLab** and **GSI/FAIR**. A new magnetic setup was assembled and successfully commissioned offline with strong contributions from IJCLab's technical and engineering teams. The first prototype of ancillary detectors was developed at IJCLab and successfully tested with new electronics at GSI. Further offline and online tests are scheduled for **2025 and 2026**.

NESTAR Team

The NESTAR team achieved the **first experimental determination of α-spectroscopic factors and α widths** of ^{21}**Ne** states within the energy range relevant to **helium-core burning in massive stars**. This was accomplished using the **^{17}O(^{7}Li,t)^{21}Ne α-transfer reaction**. These measurements significantly reduced the uncertainties of the **^{17}O(α,n)^{20}Ne** and **^{17}O(α,γ)^{21}Ne** reaction rates by a factor of more than three, and their ratio was found to greatly exceed previous estimates. This has major astrophysical implications, as it enhances **neutron recycling**, boosting the weak **s-process** by over **30 times** in the **Zr-Nd** region and increasing **barium production by a factor of 100** in low-metallicity rotating massive stars. These findings align with observations in **the globular cluster NGC 6522** and carbon-enhanced metal-poor (CEMP) stars.

FIIRST Team

Several key projects were successfully carried out on the **ALTO** and **ANDROMEDE** experimental platforms, where the FIIRST team conducts its research.

At **ALTO**, a **helium recovery line** was installed in **room 110** for the **MLLTRAP** and **POLAREX** experiments, followed by testing and validation. Additionally, the **MONSTER detector** was installed on the **BEDO** beamline in preparation for an experiment on **Zn and Ga isotopes in 2025**. Meanwhile, the **TETRA setup** was relocated for offline measurements as part of the **FROZEN project**.
Regarding test benches, a **new bench was installed near ANDROMEDE** for the **HINA project**, while another was set up in **Building 102** for the **Nier-Bernas and IRENA projects**. For the **IDEAS³ project**, engineering plans were completed, and construction of the tape transport system for the **S3-LEB identification station** has begun.
Finally, the **frequency tripling process** for the production of **radioactive zinc ion beams via photo-ionization** was successfully achieved, along with the optimization of the laser scheme. Several scientific publications were also produced, including studies on **ECS, COeCO, and PARIS**.

SDF Team
The **SDF team** played a key role in the successful organization of the **nu-Ball2 workshop** in Milan, led by two of its reserachers, which brought together **40 participants from 16 institutions across 9 countries**. This workshop served as an important platform for discussing recent developments and future perspectives of the **nu-Ball2 campaign at ALTO**. The event was made possible thanks to the valuable support of **IN2P3, the University of Milan, and CAEN**. Additionally, a dedicated article on the **nu-Ball2 campaign** at ALTO, co-authored by two members of the SDF team, was published in *Nuclear Physics News*, highlighting key experimental results and advances in the field.
The **SDF team** celebrates the prestigious appointment of **Araceli Lopez-Martens** as the new **Chair of the Nuclear Physics Division (NPD) of the European Physical Society (EPS)**. Currently a **CNRS Research Director** at **IJCLab** and recipient of the **2023 CNRS Silver Medal**, she will serve as **President-Elect in 2025**, take on the **presidency in 2026-2027**, and then continue as **Vice-President in 2028**. Her election recognizes both her **outstanding scientific contributions** and **IJCLab's international influence** in nuclear physics.
Finally, the **SDF team** successfully organized the **INTRANS 2024 Workshop (Instrumentation and Training for Nuclear Spectroscopy and Reaction Dynamics)**, a key event within the **EURO-LABS Horizon EU program**. This workshop fostered coordination between European research infrastructures and nuclear physics groups, optimizing the use of valuable resources and strengthening collaborations across Europe. Inspired by the **NUSPIN workshops** from the ENSAR2 initiative, **INTRANS 2024** brought together leading experts to discuss the latest advancements in **gamma-ray spectroscopy**, recent theoretical developments, and future experimental challenges. The event featured **high-impact review talks** and **selected physics highlights**, with a strong emphasis on encouraging the participation of young researchers.

HEP (High Energy Physics)

The **LHCb** team has measured the photon polarisation in $B_s \to \phi e^+ e^-$ using this decay mode for the first time and the results are consistent with Standard Model predictions. They also have performed an amplitude analysis of the hadronic pK spectrum with $\Lambda_b \to pK\gamma$ decays and have studied charmonium production with di-hadron final states at 13 TeV. They have also measured lepton universality R(D**). The calorimeters are running smoothly, with calibrations being performed for the 2024 data-taking period. The plume detector is operating well, providing necessary information for luminosity measurements. Ongoing development is focused on an ASIC for the picocal, with plans to have the first prototypes ready in 2025.

After completing its first long shutdown (LS1), the SuperKEKB resumed operations in January 2024. It suffered from several problems, especially due to the Sudden Beam Loss, but it set a new world record for luminosity, $5.1 \times 10^{34}\ cm^{-2}\ s^{-1}$, breaking its own record. In coming years, the **Belle2** team will contribute to mitigate the SBL issue using the IDROGEN board developed by IJCLab. On the physics side, the team continued analyzing Belle II data collected in 2021 during energy scan between Upsilon(4S) and Upsilon(5S) resonances. The team confirmed the Upsilon(10753) resonances, a candidate for a 3D bottomonium state that contains a hadronic admixture. The team also observed a rapid increase of the e+e- -> B*B*bar cross section just above the threshold which indicates the presence of a molecular state near the threshold consisting of B*B*bar pair in a P-wave, indicating the first observation of P-wave molecular state.

The 2024 data-taking by **ATLAS** was an important milestone with a recorded luminosity of $117.6\ fb^{-1}$ at an energy in the center of mass of $13.6\ TeV$.
Although it contributed to a first analysis with Run 3 dataset on the Standard Model vector boson production, ATLAS-IJCLab team was mainly involved in Run 2 new results.

In addition to performance aspects, the team contributed to single Higgs production with measurements, tests of new physics and EFT interpretation, novel technique (so-called NSBI technique) to measure Higgs width at an unprecedented precision. On more rare signals, the team contributed to double Higgs production in a non resonant mode for two channels as well in combination, and for resonant search. The three ATLAS upgrade projects (HGTD, ITk, LAr) have made good progress with the preproduction.

For FCC-ee, detailed measurements of the ALLEGRO noble liquid calorimeter electrodes prototypes have been performed and a system for automated measurements has been built.
The GRAiNITA prototype was put in test beam at CERN. Results confirm the expected light yield and the non-uniformities are small enough to result in a small constant term.

For **DUNE**, after a participation to NP04 data taking at CERN on the Horizontal Drift prototype, the team is strongly involved in the analysis of these data, in particular on the identification of events coming from 42Ar decays, which can be used for calibration at low energy.

The NP02 cryostat, which contains the Vertical Drift prototype, has been filled with liquid Argon. In parallel, the long duration productions (chimney steel vessels, cathode frames) for the final detector have been started in the industry.

The **SuperNEMO** detector construction has been completed. The iron shielding and part of the neutron shielding of SuperNEMO have been installed at the Modane Underground Laboratory. The SuperNEMO collaboration will measure the background noise of the demonstrator, particularly Radon, and assess the influence of the different systems.

The sensitivity of the **DeLLight** project was mainly limited by poor spatial resolution due to the presence of interferometric phase noise induced by the mechanical vibrations of the DeLLight interferometer. The DeLLight team has developed a new method for measuring the phase noise at high frequency and subtracting it offline. In parallel, a new experimental dedicated room dedicated has been constructed near the LASERIX facility, with the goal of conducting the first in-vacuum measurements using intense laser pulses in 2026.

Open charm and beauty are studied within the **ALICE** team with the new Run 3 data and the non-prompt D meson fraction was obtained at midrapidity in pp collisions at sqrt_s = 13.6 TeV showing an increased precision compared to Run 2 results and an extended pT range down to 0 GeV/c, thanks to the ALICE upgrade during LS2.

Several analyses are on-going with data recorded by **HADES** at GSI. The focus was made recently on the production of phi meson and dileptons (e+e-) in a recent proton-proton experiment at 4.5 GeV, with emphasis on the role played by intermediate baryon resonances.

The **JLab** team recently published results on PRL for beam-spin asymmetry of DVCS on the neutron, obtained with CLAS12, which bring strong constraints on our understanding of the structure of nucleons. The data analysis of the recent Hall-C experiment using the NPS detector, built in the laboratory, is underway. The ALERT detector, partially built at IJCLab, was successfully installed in CLAS12, and the experiment will run during most of 2025. For **EIC**, R&D is ongoing for the electromagnetic calorimeter and the EIC-ROC ASIC.

A2C: ASTROPARTICLES, ASTROPHYSICS AND COSMOLOGY

In **CTAO**, most of the experimental work was focused on characterizing the first NectarCAM camera prior to its planned deployment in early 2026. This included developing test procedures and associated software for the Test Readiness Review, qualifying the calibration sources and defining their operating modes, as well as testing the sampling technologies required to integrate NectarCAM into the CTAO intensity interferometry network. The sensitivity of CTAO to heavy Galactic cosmic rays and the shape of the particle spectrum were studied through simulations. The results showed that CTAO will allow us to distinguish protons from heavy cosmic rays, to obtain information on the super-exponential cutoff index, and thus on different acceleration scenarios. Finally, the group made public the largest catalog of TeV γ-ray spectra from extragalactic sources, which allowed us to publish the best

measurement to date of the imprint of the cosmic optical and infrared backgrounds left in the TeV spectra.

For **Auger**, the exploitation of the Phase I data continues. The team has been particularly involved in several publications: constraints on super-heavy dark-matter production mechanisms, a search for photons above 10^{18} eV by simultaneously measuring the atmospheric depth and the muon content of air showers (from the PhD thesis of a former IJCLab student), and large-scale anisotropies with 19 years of data. Another study provides a model of transient sources to explain the main features observed in arrival directions of the highest-energy events. In **AugerPrime**, the upgrade of the Auger surface detectors is taking data in a stable mode since September 2024. The commissioning phase of the electronics, coordinated by the A2C/APHE team, was completed in November 2024. The data analysis is in progress and the first preliminary results will be presented at the upcoming conferences.

For **DAMIC**, following the commissioning of the prototype detector, the IJCLab team took part in the publication of binding limits on the effective cross-section between particles in the hidden sector and electrons by the exchange of so-called "heavy" photons taking advantage of the expected interaction of these particles in the Earth, producing a daily modulation in the expected signal. Even more constraining limits will be published from the latest science run, while the final detector is being installed at LSM, with the IJCLab team responsible for the DAQ.

Following ESA's call for ideas for Innovative Mission Concepts Enabled by Swarms of CubeSats, the **COMCUBE-S** mission, which is coordinated by the A2C/AC team, was selected from more than 70 proposals and was therefore offered a dedicated study at ESA's Concurrent Design Facility in preparation for a Phase A. A prototype of the proposed gamma-ray polarimeter was successfully tested during a stratospheric balloon flight between Swedish Lapland and the Canadian Far North, the first transatlantic flight operated by CNES.

With the support from CNES and ANR, and in collaboration with ICP and ISMO (Univ. Paris-Saclay), the A2C/AC team characterized the organic/mineral association of samples from the carbonaceous asteroid Ryugu brought back by the **Hayabusa2** Japanese space mission, at the sub-micron level using infrared nanospectroscopy (AFM-IR). The corresponding isotopic compositions were measured by nanoscale secondary ion mass spectrometry (NanoSIMS), in collaboration with the Carnegie Institution. The investigation by NanoSIMS of the N isotopic compositions of ultracarbonaceous Antarctic micrometeorites gave insights on the surface composition of cometary bodies, suggesting that they contain primordial N2 ices, together with N-rich organic-rich ices. In the frame of a MITI project, irradiations were performed at GSI (Germany) and IJCLab on mineral analogues, to simulate the pre-accretion exposure of cosmic dust minerals to Galactic cosmic rays, Solar wind and Solar energetic particles.

In 2024, the A2C/AC team tested a promising plasma system in the **NanoCR** experiment, making it possible to obtain unique collisions by crossing an ion beam produced by the

MOSAIC-Andromede accelerator and a nanoparticle beam delivered by an aerodynamic lens. This innovative experiment aims to study in the laboratory how interstellar grains are modified by irradiation of cosmic ray ions.

LiteBIRD has entered a reformation plan with the goal of reducing risk and cost to successfully pass the next reviews at CNES in 2025 and JAXA in 2026. The A2C/CMB team remains heavily involved in design studies and forecasting activities. In parallel, the team is leading the analysis of the latest data release (DR6) from the **Atacama Cosmology Telescope**, which will be published in March 2025. In 2024, the **Simons Observatory** achieved first light with the deployment of the three small-aperture telescopes, while the large-aperture telescope awaited its 6-meter-diameter mirror (installed in 2025). The team is working on a French proposal for an additional small-aperture telescope, which would join the existing ones in 2027. Additionally, the A2C/CMB team is working on a coherent analysis of CMB datasets to provide robust constraints on the sum of the neutrino masses (**ANR BATMAN**). The team led two major publications: one updating cosmological constraints using the latest CMB Planck PR4 data, and another on constraints on cosmological tensor perturbations from CMB and gravitational waves.

In 2024, the **LSST**Cam camera arrived at the Rubin-LSST observatory, marking the completion of the telescope installation. A reduced version of the camera for commissioning, LSSTComCam, was deployed in November for on-sky observations during one month of intensive testing and validation before the full installation in early 2025. the LSST team is heavily involved in these commissioning activities and the analysis of LSSTComCam images, including a key role in photometric calibration, covering both atmospheric and instrumental aspects. The LSST team has improved the modeling of the fast-forward model for the extraction of atmospheric parameters and can now finely analyze the atmosphere at the LSST site thanks to three years of accumulated observations with AuxTel in spectral mode (hologram disperser). The Collimating Beam Projector (CBP) activity emerged with the arrival of Enya van den Abeele on an ANR-2023 PostDoc to develop a Travelling CBP. Scientific activities in **DESC** cover various topics. One activity focuses on a Bayesian model "from pixel to theory," with the development of the JAX-Cosmo library, participation in the **JAX-Galsim** library and its related paper, and a study on generative models for galaxy images. As part of Joseph Chevalier's PhD a method for estimating photometric redshifts has been implemented, based on an original selection of SED templates obtained from stellar population synthesis on spectral data from Fors2, GoGreen, and DESI combined with photometric surveys. These scientific activities notably exploit the GPU resources of Jean Zay at IDRIS. Finally, we are closely engaged in the **StarDice** project, conducted at the Observatoire de Haute-Provence, with the aim of establishing an absolute calibration of white dwarf photometric standards with a per-mille precision, essential for cosmology with SN Ia. Repeated observations of star fields with an optical telescope and an infrared camera (funded by IJCLab) have demonstrated the possibility

of achieving the photometric precision required by surveys such as LSST. All these activities have led to 5 publications in peer-reviewed journals.

In terms of scientific contributions, the **Fink** team at IJCLab has participated in several new publications, including one that introduces a novel mathematical model to account for the variable geometry of solar system objects based on sparse observations. Another paper details the infrastructure tests and classification methods developed within the Fink broker, specifically in preparation for the **LSST**, and addresses the LSST-DESC classification challenge ELASTICC. Additionally, a technical paper on the multidatabase paradigm showcases the seamless integration of various database types—SQL, NoSQL, and Graph databases—for scientific applications. Finally, the engineering team has commenced Rubin LSST commissioning, successfully completing engineering runs and nearing the finalization of the migration of its production platform to CC-IN2P3.

Roman Le Montagner successfully defended his PhD in October 2024 (OG/IT), and he is continuing as a PostDoc in the SVOM team (ANR fundings). In the meantime, Julian Hamo started his PhD (AHE/IT). Fink also received support from EU via the **ACME** project (INFRA-SERV) to hire a new engineer in support for the start of Rubin (starting in 2025).

The **SVOM** satellite was successfully launched in June 2024. The IJCLab team has been involved in the commissioning of the X-ray on-board telescope (MXT). In particular, the on-board software, developed at IJCLab, has been characterized with known X-ray sources. In addition, a few gamma-ray bursts have been followed up with MXT and the on-board analyses localized the source with a very good accuracy. In January 2025, the SVOM science operations have begun.

In 2024, the **Virgo** detector joined the O4 observing run, along with the LIGO detectors. Having a third detector in the network improved considerably the localization of gravitational-wave events. These gravitational-wave events were detected within a few seconds and the IJCLab team has participated in implementing these low-latency searches. Offline searches are also being conducted by the group, the results of which will be published in 2025.

In 2024, the main activities of the A2C/OG team for **ET** focuses on one side on the design of the squeezing filter cavities and on the other side on weakly modeled search for compact binary coalescences and test in Mock Data Challenge.

The **GRANDMA** network has continued to follow-up on LIGO/Virgo alerts and on some Gamma Ray Bursts (especially those detected by the SVOM instruments). A bunch of papers have been published or about to be published.

In 2024, Fink celebrated its fifth anniversary, marking a significant milestone with over 200 million alerts received and processed, and an average of more than 100 unique users engaging

with the services hosted at VirtualData each day. Hundreds of transient events were redistributed, and follow-up by the scientific community. This year also saw the organization of two notable collaboration meetings: one at IJCLab in January, which brought together 30 participants, and another in Rio de Janeiro at CBPF, where Fink@Brazil attracted 50 participants from across South America. The team also actively participated to the Rencontres du Ciel et de l'Espace, that bring thousands of professional and amateur astronomers for 3 days in Paris.

In the field of neutrinoless double beta decay research, the A2C/ASSD group has been intensively preparing for the finalization of two large demonstrators of scintillating bolometer technology. One demonstrator is being developed at the Gran Sasso underground laboratory as part of the **CUPID** project, while the other is at the Canfranc underground laboratory within the **CROSS** framework. The group has placed strong emphasis on optimizing the performance of light detectors and studying their role in background reduction.

In 2024, **RICOCHET** observed its first signals of coherent elastic neutrino-nucleus scattering (CENNS) at the ILL research nuclear reactor site of Grenoble. The A2C/ASSD team realized the 18 Germanium CENNS detectors operating in a 10 mK dilution refrigerator on site.

The A2C/ASSD group has officially joined the **TESSERACT** direct dark matter research international collaboration and developed the first HP-Ge detector with a word-leading single-electron resolution.

The A2C/ASSD team studied superconducting niobium devices and reported the observation of a transverse voltage signal arising from electronic inhomogeneities. They also demonstrated a phenomenon of conductance jumps in voltage-biased superconductors which may be useful for designing switching devices with low power consumption.

ACCELERATOR PHYSICS

The **ThomX** machine is now producing X-ray regularly. However, ThomX is still in its commissioning phase to increase and guaranty the optimal performances achievable by this new X-ray source. During the 2024, a big technical stop was carried out to correct the ring length to allow synchronization between electrons beam and interaction laser pulse. In the meantime, the accelerating section was changed (to install the ThomX accelerating section) to permit to increase the electrons beam energy until 70MeV. The RF network was also renewed during this shutdown. Nowadays the optical cavity is synchronized with the electrons beam stored in the ring. The optical cavity ensures routinely a laser beam stored power of 90kW which is chosen to avoid damaging the cavity mirrors. Hence, the X-ray flux is daily about 10^10 ph/s. Three working point are set for different X-ray energies, one for 45keV (50MeV electrons beam), one for 70keV (61.5MeV electrons beam) and one for 90keV (70MeV

electrons beam). The first "user experiment" was held during the last week of February 2025. Promising results are expected from this first experiment. We expect to reach better performances by changing the photocathode (Copper to Magnesium) that will allows us to increase the stored charge in the ring. The optical cavity is also expected to be increase to its maximum at the end of ThomX as it is a risky procedure.

Two important events occurred in 2024 for **PERLE**, leading to a considerable impact on the project structuring, its phasing strategy and its overall planning. First, The Kick-off of the European **iSAS** project (April 24), in which a PERLE cryomodule will be manufactured and tested in the next 4 years. An important design optimization effort of the cryomodule and the related sub-systems is ongoing in order to reach an optimal operational efficiency later. Second, the approval in June 2024 of the "**ERL4ALL**" project within the CNRS "Risk and Impact Project-RI2" program. The allocated funds will allow the funding of the PERLE injection line over the next 4 years. In addition to the design work of the several injector systems, an important effort is made to install the DC gun and all related equipment (HV tanks, photocathode preparation facility, laser system, control-command, vacuum system, diagnostics, protection system…) in the igloo. First test on the electron source is foreseen fall 2025. In another hand, the lattice designs of 250 MeV and 500 MeV versions are now consolidated. A first paper "Beam dynamics driven design of PERLE" has been published in Physical Review Accelerators and Beams (PRAB) journal.

Prototyping phase of IJCLab contribution to **PIP-II** project has been finalized in June. Over the 6 prototypes cavities, 4 of them were tested in 2024 and then shipped to Fermilab. 3 cavities were successfully validated after reprocessing on Supratech platform. The 4th one couldn't be validated in time after reprocessing by the company. Preparation for production phase has been initiated. This consists in updating all documentation and starting the refurbishment/upgrade of the cryostat CV800.

For the **MYRRHA** project, IJCLab contribution was focuses on the dismantling of the prototype Cryomodule in order to transfer various systems to SCK in order to serve the preparation site of the series at Uppsala in Sweden. Our contribution on the R&D program of the MINERVA installation has been closed in October 2024 concerning the knowledge transfer of the beam optics of the accelerator, prototyping design and test of the Beam Position Monitor dedicated to the High Energy beam line at 100MeV of MINERVA and the expertise support to SCK CEN for the definition of the call for tender to various component in the expertise of Accelerator Pole at IJCLab. Finally, IJCLab continued the preparation of the experimental areas dedicated for the series validation of the MINERVA RF couplers to Spoke cavities and for the Cold Tuning Systems.

IJCLab's **HEP Collider R&D** is being implemented in both current colliders, such as SuperKEKB, and future colliders, specifically the Higgs factories, which can be circular, FCC-ee, or linear, ILC-CLIC through ATF3-KEK. The R&D program is conducted in close collaboration with CERN, other international laboratories in the USA and Japan, and other national labs. **Interaction Region (IR) optics design**, unique **monochromatization** operation

schemes, **polarimetry, dynamic vacuum, positron production,** and **material studies** for **SCRF** are the main areas of focus for the program. This year saw the signing of an MOU on FCC-ee activities, and in November 2024, a PhD thesis in cotutelle between Université Paris-Saclay and IHEP-CAS on monochromatization studies for FCC-ee was defended. Two more PhD students who study monocromatization and polarimetry have joined the team since October 2024. On October 16–18, 2024, a workshop on Advances in High Positron Sources Physics and Technologies (AHIPS2024) was held at IJCLab (https://indico.ijclab.in2p3.fr/event/10644/).

R&D efforts on modifying the surface properties of materials to enhance the performance of accelerator components (cavities and beamlines) have focused on several key aspects:
(i) reducing the multipacting effect through the deposition of thin layers on beam pipe walls; (ii) plasma processing for in-situ decontamination of superconducting accelerating cavities; (iii) investigating superconducting thin films for SRF cavities; (iv) dynamic vacuum studies, including experiments to measure electron and ion desorption yields.

For the first aspect, it was demonstrated in the PhD thesis of Yanis Pisi, defended in 2024 (in collaboration with SIMAP in Grenoble), that multilayers of alternating ultra-thin films (3 nm) of NbN and TiN significantly reduce the secondary electron yield of surfaces. A second ongoing PhD project (Camille Cheney) is addressing the second aspect, where it has been successfully shown that activating specific RF modes can effectively remove carbon contamination from the internal surfaces of cavities. To explore the third aspect, a postdoctoral researcher is currently studying the electrodeposition of FeSe superconducting thin films for cavity applications. In parallel, in collaboration with ICMMO, research is underway on depositing NbN superconductor material using CVD techniques. Finally, concerning the fourth aspect, experiments on electron-stimulated desorption with the PHIL photo-injector are planned before the end of 2025.

During 2024, the **PALLAS** project continued its installation in the EXALT bunker shared with PHIL, with the installation of the laser beam transport and optical characterization line, beam dump and spectrometer. 2 articles have been submitted to PRAB and Review of scientific instruments and the PACRI European project was accepted. A large amount of work was done on surrogate models and optimization of the cell design using PIC codes. The experimental campaign was postponed due to the climatic problems in autumn 2024 but the first electrons at IJClab should be demonstrated in spring 2025.

Within **TWAC** project, some of the concepts have been validated experimentally as independent subsystems which can be efficiently used on the final experimental prototype: THz generation process, table top characterization of the THz dielectric accelerating structure and its coupling system, validation of the passive streaking measurement at ARES linac at DESY, characterization campaign of the electron beam source. as well as dosimeter detector development. Next steps are the finalization of the design of each of the subsystems, before gathering them together as a first complete experimental prototype to effectively demonstrate the THz acceleration and measured the dose within the electron bunch.

Within the Equipex+ **PACIFICS** (2022-2027), equipment for Pallas project are installed and the one for R&D on materials for accelerators are now routinely used. Other acquisitions of specific test and measurement benches will follow in 2025.

ENERGY AND ENVIRONMENT

Research in *Radiochemistry of the Fuel Cycle and Environment* is currently being revitalized and strengthened at IJCLab with the creation of a *Laboratoire Commun de Recherche Jean-Frédéric Joliot* dedicated to Radiochemistry, in partnership with CEA-Saclay and CEA-DAM, and focused on the chemistry of radionuclides in the environment.

The chemistry of protactinium Pa (Z = 91) was revisited by quantum calculations and experiments. Located in between thorium and uranium in the periodic table, protactinium exhibits a very specific behaviour with oxygen, with the formation of so-called mono-oxo ligands. New calculations predict Pa mono-oxo ligand to be weaker than initially considered, with a chemical bond Pa-O slightly longer than 180 pm. The recent use of High Energy Resolution Fluorescence Detected-XANES (HERFD-XANES), used for the first time ever to study protactinium, allows to probe the electronic structure of Pa(V). Recently, the Pa-O distance in a chloro-complex has been observed at 183 pm, in agreement with theoretical calculations.

The *Material and Irradiation* activity focusses on the role played by radiation-induced defects and impurities in the matrix destabilization of nuclear ceramics. Recent investigations on aluminium nitride were performed on a solid that has a potential use in diagnostic systems of future nuclear reactors due to its radiation tolerance. Combining ion implantation of helium (He) at high temperatures at the MOSAIC facility and advanced microstructural characterisation (TEM, XRD) allowed to get detailed information on the fundamental mechanisms of point defect formation, He-vacancy complexes, up to the formation of He bubbles leading to a strong increase of the crystal disorder. The size and shape of He bubbles depends on the implantation temperature. The microstructural differences at high temperature in a narrow range points out the need to get a full picture of solids submitted to irradiation and gas injection, to better understand the growing mechanism of bubbles and predict their long-term radiation stability.

HEALTH PHYSICS

Regarding the radiotherapy axis, progress on the THIDOs project has resulted in the first clinical evaluation of the gamma camera dedicated to dosimetric monitoring of thyroid radiation therapy with the Institut Claudius Regaud in Toulouse. The evaluation, which will be completed in early 2025, shows promising initial results. In the framework of the PRISM/TTRIP project, pure 155Gd targets (155Gd/Gd > 99.9%) produced by the SIDONIE ion separator on the MOSAIC platform were used to measure the complete excitation

distribution of the 155Gd(p,n)155Tb reaction, with two new measurement campaigns performed at NPI/ReZ (Czech Republic) and SPIRAL2/NFS (Caen). The effect of the co-produced main contaminant 156Tb on the image quality obtained with 155Tb is currently being studied via SPECT measurments combined to Monte-Carlo simulations. In parallel, Tb(III) complexation studies were carried out by various methods with simple commercially available and newly synthesized ligands. The most promising ligands were bioconjugated with monoclonal antibodies and first experiments were performed to measure the biodistribution in mice. For the BioALTO project, 2024 saw the installation of the beam line on the final structure at the end of ALTO line 320 and the integration of various beam monitoring tools such as a diamond monitor (in collaboration with LPSC). As a result of the progress to date, the radiobiological irradiation line should be completed in 2025 and the BioALTO platform should be in commissioning by the end of 2025. The MODERATO project was implemented through the development of a new high-potential computer algorithm for tracking cells on videomicroscopy data from in vitro cell populations subjected to ionizing radiation. This software, now available in the Gitlab open source library, enables the identification and tagging of a single cell within a cell population, over time, and then makes possible lineage tree analysis for each cell, that should permit correlations between irradiation conditions and cell interactions to be detected on the large dataset currently being acquired.

On the imaging front, the IMIT team has gained momentum with the official arrival of Bertrand Devaux, the first physician to join the IJCLab staff. A longtime collaborator on the OPALIS project, Bertrand Devaux—neurosurgeon at Lariboisière Hospital—brings valuable expertise, particularly in brain tumor research. In partnership with Synchrotron SOLEIL, the team has expanded its study on brain metastases, revealing how their molecular composition varies depending on their origin and confirming the potential of autofluorescence analysis for differentiation. Additionally, in collaboration with CREATIS, the team has developed AI tools for processing biobank and clinical data. Building on its previous work on intracerebral probes for awake rodents, IMIT has launched a new project with Neuropsi to develop a bimodal optical probe capable of tracking acetylcholine release and its impact on prefrontal cortex activity during social interactions. At the same time, the team is analyzing clinical study results to strengthen its translational research efforts. Last but not least, the MAPSSIC project has successfully delivered its first functional probes, characterized using homogeneous 18F and 11C sources.

Finally, on the modeling front, The MOV team has published its results on modeling the temporal evolution of irradiated glioma cell populations. Gliomas are invasive brain tumors, with tumor cells migrating far from the tumor center into healthy tissues, contributing to poor prognosis. To improve treatment strategies, the team conducted in vitro time-lapse fluorescence microscopy, tracking glioma cells after a single high-dose irradiation (part of the Moderato project). Over six days, they analyzed cell density evolution under different radiation doses and initial densities. Their data revealed a non-linear effect: higher initial cell densities delayed population regrowth over time. A biophysical model was developed to explain this phenomenon, showing that senescent and dead cells inhibit the proliferation of repaired cells.

The model also predicted survival fractions, demonstrating their dependence on initial cell density. Since glioma cell density varies spatially—high at the tumor center and low at the periphery—accounting for this density-dependent regrowth delay could refine radiotherapy models. Additionally, these results help explain why gliomas often recur at the tumor's edges after treatment. Integrating these insights into treatment planning could enhance radiotherapy effectiveness and improve patient outcomes

THEORY

Mathematical Physics: New applications of the methods from Random Tensor theory to Stochastic analysis have been developed. The construction of the first consistent gauge theory on a recently discovered quantum 4-dimensional Minkowski space-time has been achieved with invariance under the corresponding quantum Poincaré group. Various geometrical methods have been designed to analytically compute complicated Feynman integrals and these methods are now implemented by a dedicated Mathematica package. A new class of braid groups has been defined and proven to act as internal symmetries of quantum groups involved in the dynamical symmetries of certain quantum integrable systems.

Cosmology and Gravitation: The search for black hole solutions and their perturbations, the cosmological bispectrum, domain walls and their phenomenology have been the main direction of research. The latter is most important for the phenomenology of compact objects and their gravitational wave imprint. One highlight has been the discovery of explicit and simple black holes with primary hair, one of the first examples found in the literature. Additionally, the solutions found have for the first time the feature of being regular compact objects for a specific relation between the black hole charges. Perturbations of these solutions, figuring out in particular their quasi-normal modes, have already been studied. We have also started the classification of alternative theories of gravity that couple gravity and the Maxwell field in a non-minimal way, opening the possibility to predict deviations in the trajectory of light rays. In parallel to all these works, phenomenology of melting walls in cosmology is also discussed, which seems to be in very good agreement with the recent data of NANOGrav GW recently released.

Physics Beyond the Standard Model: Collider searches for heavy neutral leptons were performed beyond simplified scenarios. Thermal effects in freeze-in neutrino dark matter production were carefully studied. Giovanni Piazza's PhD thesis (on dark matter and neutrino physics) received "Maiani" and "Orso Mario Corbino" prizes. Gravitational wave production during reheating with primordial black holes and inflaton condensates was explored, leading to a characteristic three-peak structure of the signal. Modern textbook "Particles in the dark universe" and several popular books including New Physics (Bourrienne prize 2024) were published by Yann Mambrini. Classical effects of scalar black hole hair in black holes collisions were studied using quantum amplitude methods.

Flavor Physics: The flavor physics team has continued its activity on the theory and phenomenology of flavor-changing processes in the Standard Model (SM) and beyond. Recent work comprises the reassessment of the SM predictions for $B \to K\nu\nu$ decays, which are currently under study at Belle-II, and the interpretation of its measurement in terms of a general Effective Field Theory (EFT) approach and concrete models of New Physics. The EFT approach has also been used to systematically study lepton flavor violating processes at low and high-energy scales, including the relevant renormalization group effects. The flavor physics team also remains active in lattice QCD simulations, particularly in studying the hadronic structure of quarkonia. Finally, we have continued our exploration of flavor physics opportunities at future experiments such as HL-LHC and FCC-ee, as well as the development of public tools for flavor-physics phenomenology, which are references in the field (https://highpt.github.io/ and https://eos.github.io/).

Nuclear Physics: Research on compact stars has been actively progressing, focusing on neutrino cross-sections in dense matter, the effects of three-body interactions in neutron matter, the superfluid fraction in the "pasta" phases of the crust, and the study of hybrid star models constrained by gravitational wave signals. Additionally, the team plays a key role in developing tools to address the many-body problem, such as few-body reactions, EFT approaches, or quantum computing

QCD: A review on the physics case for quarkonium studies at the US EIC was published, following the yearly series of the "Quarkonia as Tools" workshops. High-energy factorization matched to collinear factorisation was successfully employed for exclusive J/Ψ photoproduction, thereby solving a longstanding issue in the field since 2005 and paving the way for a better determination of gluon GPDs. The study of inclusive photoproduction studies in ultra-peripheral proton-lead collisions at the LHC has been shown to be feasible and capable of doubling the reach in pT of existing data from HERA. For exclusive diffractive meson production, a golden channel for investigating gluonic saturation inside nucleons and nuclei, the first systematic framework to deal with beyond leading power corrections was settled, allowing for a complete description of virtual photon to meson transitions with arbitrary polarizations. Following our discovery in 2023, through exclusive photoproduction of a $\pi^0\ \gamma$ pair, of the very first case, for an exclusive process, of collinear factorization violation at leading power, we have provided a complete description of the underlying mechanism for this violation. For top quark production and decay, linear power corrections were shown, in the narrow width approximation, to affect polarization effects, that manifest themselves in correlations of angular distributions of particles from top quark decays and final state jets in the production sub-process.

Statistical Physics: A Mean-field Game model for pedestrians allows for the first time to reproduce some high-density crowd experimental observations, with a single discount parameter allowing to span over 3 different experimental protocols.

RESEARCH and TECHNOLOGY (2024 Engineering Pole highlights)

ANR SENSE (Scintillating Elpasolite for Neutron Spectroscopy Enhancement, PI Clément Delafosse Detectors and instrumentation department) was approved in autumn 2024. The emergence of inorganic elpasolite crystals containing chlorine, which are sensitive to both neutrons and gamma radiation, could form the basis of the next generation of neutron and gamma spectrometers for applications in nuclear physics. The ability of these crystals to discriminate between neutrons and gamma rays by analysing the shape of the signal is well established, but little is known about their efficiency and energy resolution.
The SENSE (Scintillating Elpasolite for Neutron Spectroscopy Enhancement) project aims to study various elpasolite crystals containing chlorine in their crystal structure (CLYC, TLYC, CLLBC, etc.). The aim will be to evaluate their response to neutrons of different energies, through measurements with spontaneous neutron or gamma sources or with an accelerator (LiCORNe@ALTO), in order to build a demonstrator for a nuclear physics experiment.
The second part of the project aims to produce realistic simulations of the demonstrator using multi-physics libraries (Geant4) in order to establish a detector response function. These simulations will be compared with measurements in order to understand the operation and limitations of the detector.

The CRYOSEL project aims to extend efforts for direct Dark Matter detection to the sub-GeV domain. In order to achieve this, novel cryogenic detectors are being developed at IJCLab. One of the main limiting factors in detecting sub-keV signals is the Low Energy Excess, or "Heat-Only", events present in cryogenic detectors. The CRYOSEL R&D program is developing detectors based on semiconductor crystals capable of suppressing this background and lowering the detection threshold to an unprecedented low energy scale by employing custom fabricated superconducting devices.
The CRYOSEL technology has been selected for the TESSERACT High Voltage detectors. The first results with 40g Ge crystals showed word-ranking results. The detection threshold reached single-electron with a reduction in background to 1 electron (< 1 Hz) and detector stability in excess of 12 hours of data acquisition.

The SVOM satellite was successfully launched in June. The Computing Development team delivered the on-board software for the MXT instrument and continues to contribute actively to the commissioning phase.

The THIDOS gamma camera (Internal Dosimetry project) entered the clinical test phase at Oncopole in Toulouse in May. The acquisition software, including the graphic interface for clinicians, was developed entirely by the Computing Development team.

The FINK team organised two noteworthy collaborative meetings (at IJCLab and in Rio de Janeiro) and actively participated in the “Rencontres du Ciel et de l'Espace”, which brings thousands of professional and amateur astronomers to Paris for 3 days. Several new articles have been published. Fink has also received support from the EU through the ACME project (INFRA-SERV) to hire a new engineer to support Rubin's start-up.

The Computing Development team is involved in **the EVERSE project** (European Virtual Institute for Research Software Excellence) launched in 2024. In this context, funding was obtained for the recruitment of a fixed-term contract for 2 years. This has made it possible to launch a RAG-LLM activity (conversational robots) in the department and to set up a working group on this subject within RI3 (Réseau des Informaticiens de l'IN2P3 et de l'IRFU).

IJCLab developed and tested in 2024 a new version of the **IDROGEN board** in collaboration with the Paris Observatory and dedicated daughter boards in collaboration with mainly NANCAY observatory, KEK. Those devices achieve pulse timestamped for signal analysis or ultra-stable RF signals with an accuracy below 100 fs RMS, based on enhanced White-Rabbit hardware and firmware.
The modular design allowed the rapid integration of a commercial 2-channels, 250-MSPS to 1-GSPS digitizer boards (project New Comet, CTAO, Nenuphar, PAON IV). The containerization of the data acquisition software reduced the development time. The tests validated also the possibility of online and offline processing on distant virtual machines. The IJCLab teams validated the concept with the data acquisition of high-purity Germanium detector signals, and the stellar intensity interferometry for CTA.

The engineering pole teams were strongly involved in the second **balloon flight of the COMCUBES** project with simulations and mechanical integration, electronics design and software development. The 4 days flight from northern Europe to Canada was a full success.

The **DOSIMOEMS** project to monitor in real time the delivered dose during a radiotherapy entered in 2024 in its second phase with the delivery of the second version of a 50 channels prototype. The first publication on this subject is ongoing.

• PhD Thesis defences

Raphael Gazzini: “Neutrino Physics with the new LiquidO detection technology and its experimental demonstration". Supervisor: Giulia Hull Detectors and instrumentation department.
Roman Le Montagner: « The transient high-energy Universe in the era of large-scale optical sky surveys ». Projet FINK. Co-supervisor Julien Peloton IT Department
Roméo Molina : « Mixed precision for high-performance computing, application to measurements of low-energy gamma radiation»: Co-supervisor Vincent Lafage, IT Department, collaboration LIP6 lab.

• Teaching

Computing Development team members have been very active in the **Gray Scott Reloaded school** in Annecy and in **advanced C++ training courses**, including one at CERN.

3.2 The Transverse Groups

The Transverse Groups are a group of people working on projects/activities on a theme which, by its very nature, cuts across the divisions. They have a budget to run them. These groups may be more scientific in nature, in which case they are closer to the CNRS GDR (Research Group) concept, or they may have a strong technical connotation, significantly involving technical staff from the engineering, accelerator or platform divisions.

No much activity has been done in 2024 and we are discussing for proposing the revitalisation of these working groups with new mandates.

4. Collaborations@IJCLab

- **To be an important partner in the network of the largest European laboratories. To also stimulate targeted collaborations with other European laboratories and worldwide.**

We will not discuss extensively the existing and ongoing historical collaborations with most of the large research centers and laboratories in Europe, USA and Asia (mainly Japan).
IJCLab is part of the LDG group, which brings together the 10 major European laboratory and CERN and provides a forum to synchronize the laboratories respective strategies, projects and priorities, with the aim of maximizing cooperation in the planning, preparation and execution of future projects. In addition, LDG oversees the European accelerator roadmap activities, aimed at developing technologies and concepts for future particle collider infrastructures. A concentrated input is expected for the European Strategy in 2025.

An important partnership including the full laboratory has been started with a similar size laboratory, the IFJ PAN, in Krakow (Poland). A collaboration agreement was signed between the 2 parties in 2023 and is organized with regular meetings among the teams and an annual joint workshop. About ten joint projects were presented.

In the same spirit, a delegation from IJCLab visited Oslo from November 5 to 7 to discuss the basis for an equally rich and promising collaboration with the University of Oslo and the NNRC laboratory, focused on training. A collaboration agreement was also signed on this occasion.

- **To increase the national collaborations with the other laboratory of IN2P3, and more largely to CNRS, RFU/CEA and the CNES.**

With IRFU/CEA the links and the common activities are numerous and in general IN2P3/CNRS and CEA participate together to large Research infrastructures IR* such as: HL-

LHC (CERN), GANIL/SPIRAL 2 (Caen), CTA (Spain and Chile), FAIR (Germany), ESS (Sweden).
In 2024 no new important partnerships have been established with IRFU.

Several teams from the A2C division have been collaborating with CNES for over twenty years on COMCUBE, SVOM, LiteBIRD, and extraterrestrial sample return missions (Hayabusa2, Rosetta, Chang'E5). An official visit from CNES has been organised in January 2025.

5. Human ressources

5.1 Manpower: global picture and evolutions

The repartition of IJCLab staff by status is broadly summarized in Figure 8

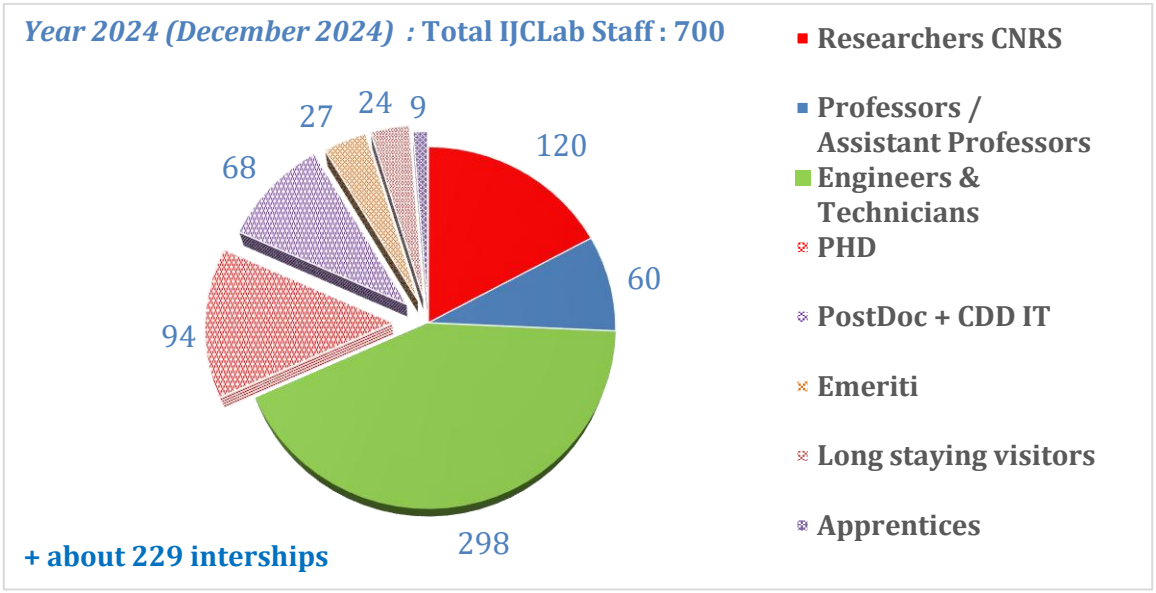


Figure 8. IJCLab staff status.

PERMANENT **STAFF**:

The yearly evolution of technical staff is shown in Figure 9 and of researchers in Figure 10.

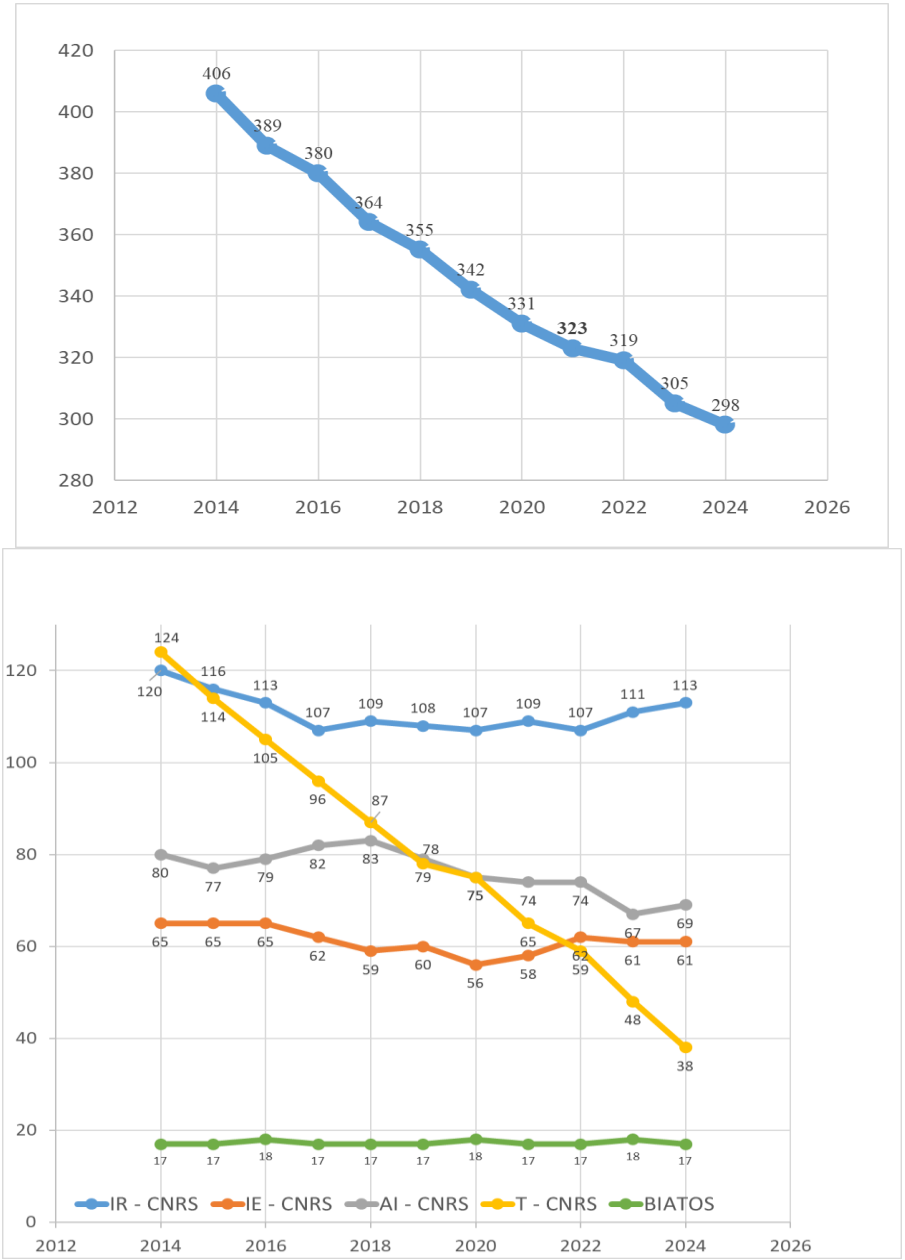


Figure 9. Yearly evolution of the technical staff. For CNRS staff : IR = Ingénieur de Recherche (Blue), IE = Ingénieur d'étude (orange), AI = Assistant Ingénieur (grey), T= Technicien (yellow). For University staff: BIATSS include all categories (green). The indicated numbers are given at the end of the year indicated in the x-axis.

For the permanent technical staff and for several years before the creation of IJCLab, there was a -13 balance on average between hiring and departures. This is mainly due to retirements

which are impossible to compensate with the current level of recruitment at CNRS and University (about 30 openings each year at the national level).

On average since the creation of IJCLab there is a loss of about 9 persons per year. Most of the lost are in the technical staff. In the last two years it is compensated hiring non permanents staff on own IJCLab resources.

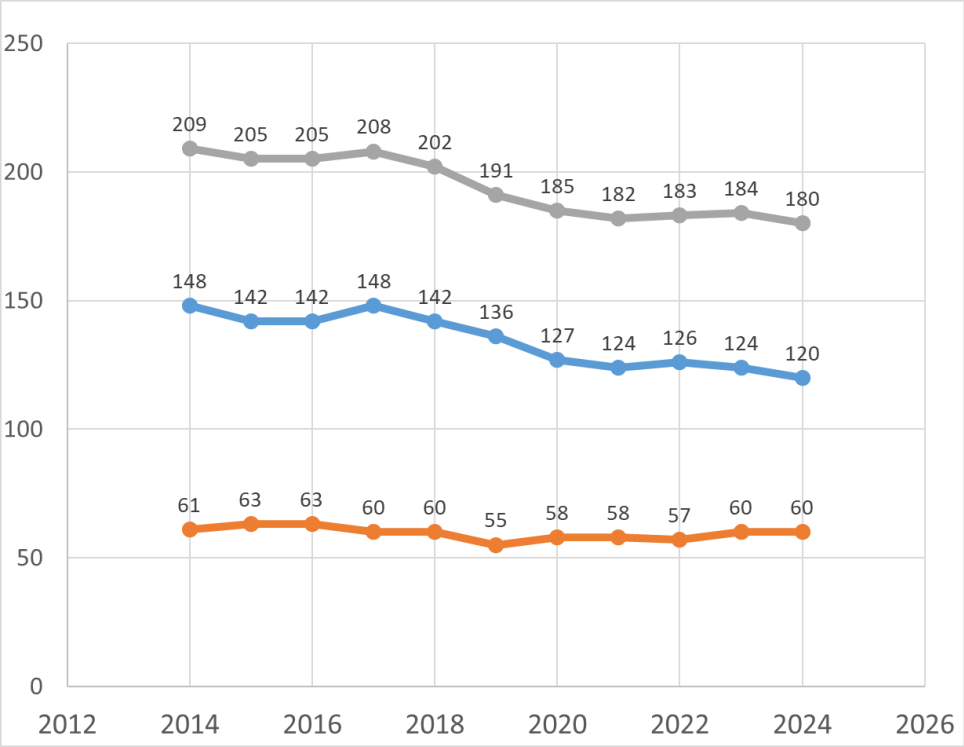


Figure 10. Yearly evolution of the research staff. In brown (blue) for CNRS researchers (University lecturers/professors), in green for the total. The decrease of the number of CNRS researcher from 2023 to 2024 is due to the fact that 3 researchers will be actually hired formally beginning of 2025.

As far as permanent researchers (CNRS and University) are concerned, prior to the creation of IJCLab, we had a period of stability (until 2017) in terms of HR, followed by a loss of about 6-7 researchers per year due to retirements and mobilities to other laboratories.

In the last years, since the creation of IJCLab we have again reached stability thanks to a quite important number of new recruitments and incoming mobilities.

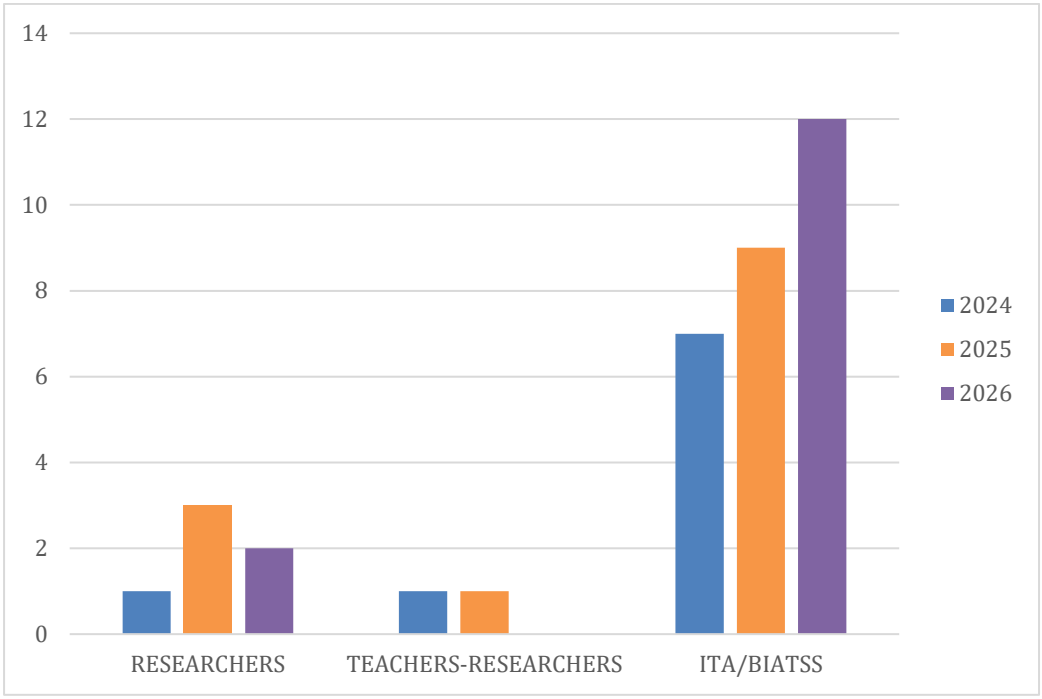


Figure 11. Number of people (researchers, teachers and technical staff) 65-year-old 67-year-old taken as a reference age for the technical staff (researchers) at the time given in abscissa.

We show in Figure 11 above the number of retirements in the last 5 years and the prevision for the next years. The situation of retirement in France is in evolution and it is difficult to precisely make a prediction. For that from year+1 we consider that the average age of retirement is 67 for researchers and 65 for technical staff.

NON-PERMANENT STAFF

The non-permanent members of the laboratory gather PhD students on three-year contracts, PostDoc (often with two-year contract), technical CDD (fixed-term contracts), emeriti, long-stay visitors and internships. PHD and internships are detailed in **Chapter** 2.

Post-Doctoral fellows, Temporary Technical staff contracts and apprentices. Figure 12 shows the number of post-Doctoral fellows; Temporary Technical staff contracts and apprentices present in the laboratory over the last 3 years given at the end of the year. For completeness, we also indicate the number of emeriti.

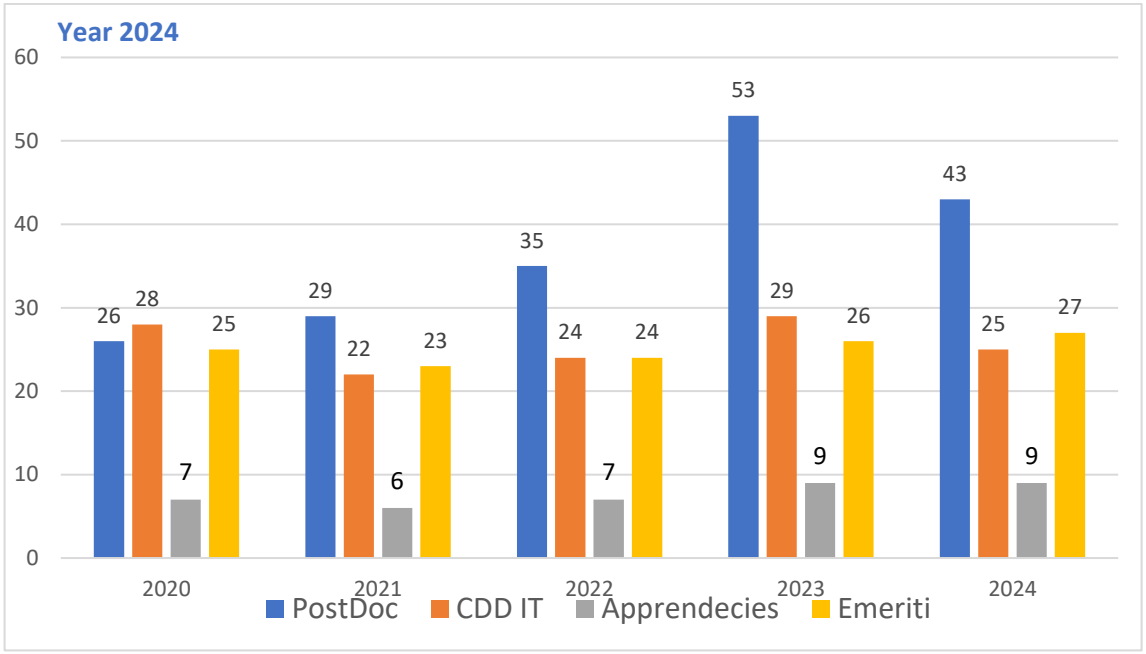


Figure 12. The number of new PostDoc, Technical CDD, Apprentices and Emeriti at IJCLab

Finally, the evolution of the IJCLab staff (permanents and non-permanents) is shown in Figure 13. As already comment this plot summarized what has been already shown before, namely a general reduction of the permanent technical staff a slight increase of the permanent researcher staffs and an increase of non-permanents position (mainly Postdoc).

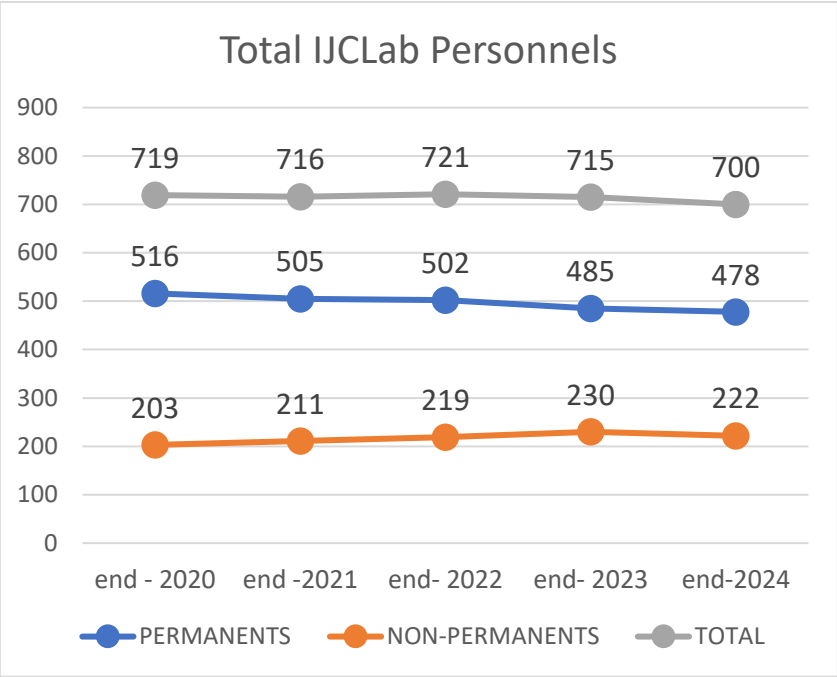


Figure 13. Evolution of the IJCLab staff

5.2 Distribution of manpower according to activities and projects

The evolution by semester of the FTE affected in the research activities of the different scientific departments of IJCLab is shown below **Erreur ! Source du renvoi introuvable.**.

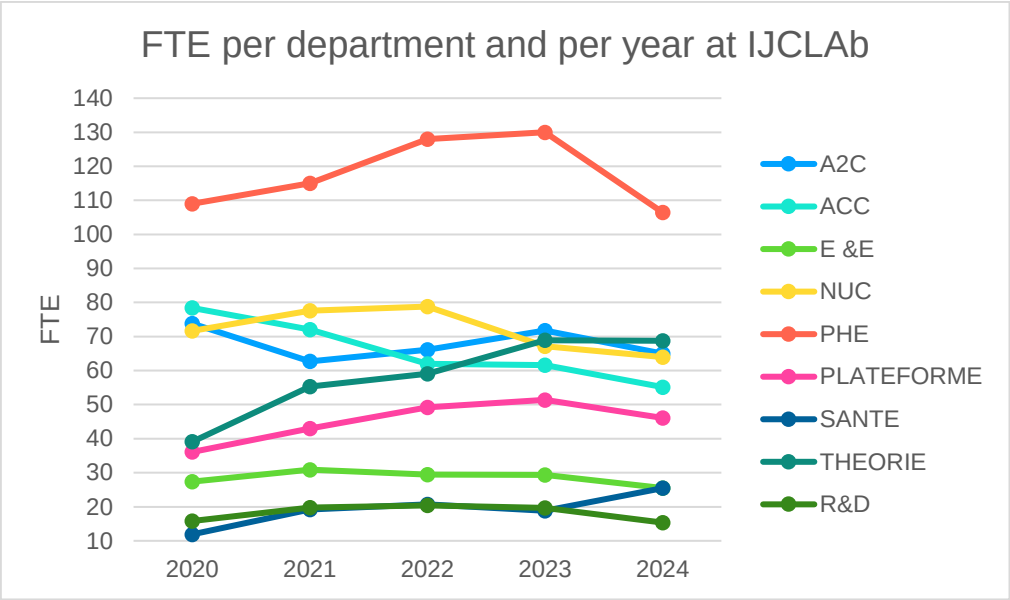


Figure 14. FTE evolution by semester over the activities in the IJCLab departments.

Figure 15 shows the distribution of FTE for the projects with the highest need for human resources at IJCLab

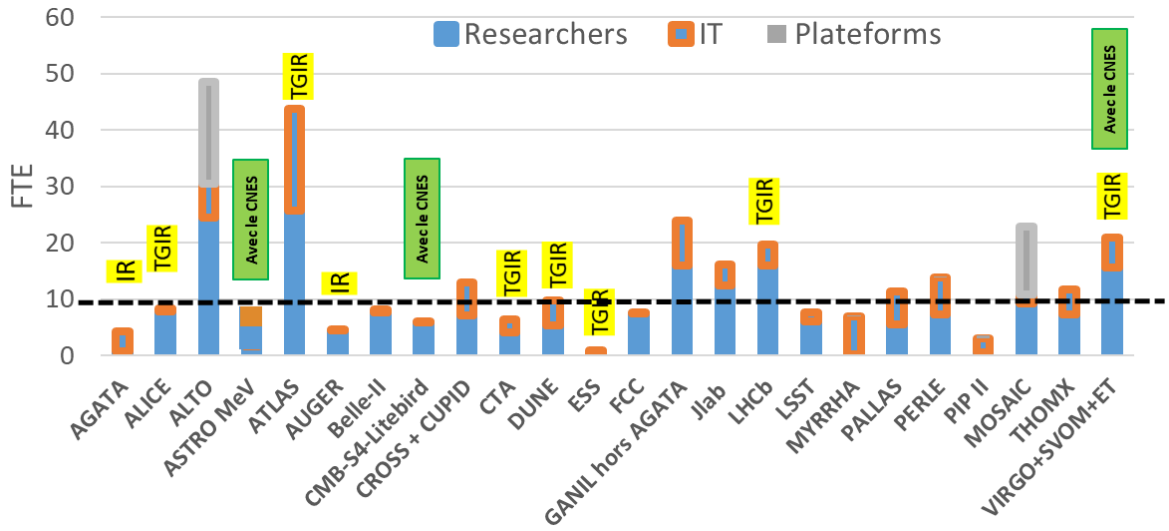


Figure 15: The distribution of FTE for the projects with the highest need for human resources at IJCLab.

5.3 Career of permanent technical staff

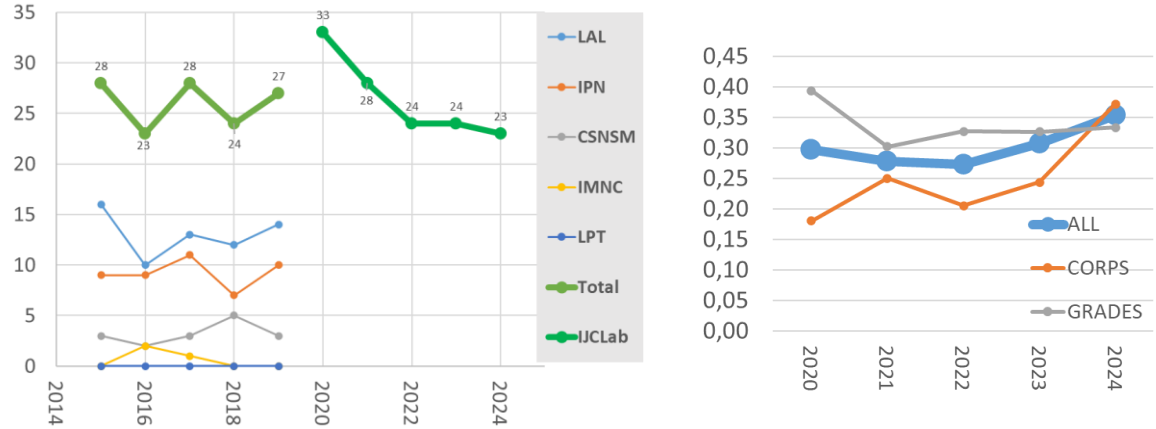


Figure 16: (left) Number of promotions as a function of the year summing up the two types of promotion: "changements de corps" (top) and "changements de grade" (bottom). (right) The ratio between the number of promotions and the number of proposed person for the promotions.

We have performed an analysis concerning the careers of the technical staff at IJCLab. At the creation of IJCLab a major concern was that the number of promotions of technical staff could decrease. The results of the last three years are shown in the plots showing that the situation is at least similar compared to those of the earlier laboratories (see
Figure 16)
A plot for the researcher and teachers since 2020 is also shown in Figure 17.

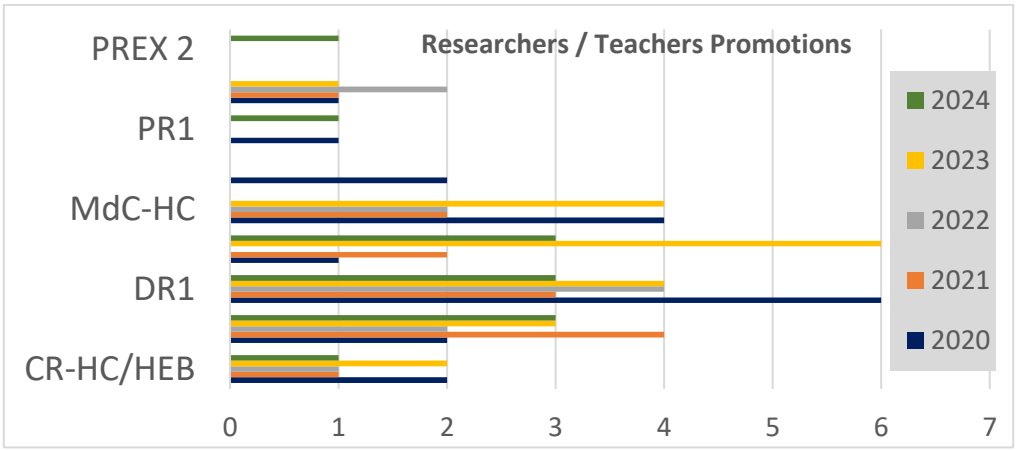


Figure 17: Number of promotions as a function of the year for researchers and teachers-researchers.

6. Budget

6.1 Global Budget

The budget is shown in

Table 3 and Figure 18 and compared with the budget for previous years (without the salaries). The first part of the budget is the one attributed by IJCLab Governing Bodies ("tutelles") every year. It is dedicated to the normal functioning of the laboratory (infrastructures, equipment and missions) and for the execution of the specific research/project activities.

Budget spent [M€] *(rounded to the nearest 2 digits)*		***Y2020***	***Y2021***	***Y2022***	***Y2023***	***Y2024***
Assigned by Governing Bodies	*Laboratory Operation*	*4.24*	*4.36*	*3.84*	*3.6*	*3.88*
	Specific Programs (TGIR, AP, ERM) : *Programmes Fléchés : AP/ERM/TGI/RPTGI (CTA)* **Projets Ministère** : IR*DUNE (RPTGI &SETGI) / IR*FAIR / IR*HL-LHC TES4DM / ERL4ALL /	*3.57*	*3.78*	*3.76*	*2.89*	*4.27*
	Europe *dont nouveaux contrats :* ACME / R2D2 / EVERSE / ISAS /ODISSEE	*0.52*	*1.26*	*1.87*	*2.03*	*2.50*
	ANR – EQUIPEX					

Contracts	*dont nouveaux contrats :* EDIM / COM&NIM / CRYOLUX / gDEGASgSPEC / ROAD_4_EIC / SENSE	*0.89*	*0.53*	*1.18*	*2.93*	*2.99*
	Industry, BPI IDEX, PIA, CNES, DIM, SESAME, LabEx *dont nouveaux contrats :* AAP P2I -AAP PHOM - AAP JOUVENCE PLATEFORMES / COMCUBE / LITEBIRD Lot 5 / MIAMI / NAAREA / IMS LAB /	*2.04*	*1.66*	*3.11*	*2.03*	*1.6*
Own Resources (overheads, services…)	*"Ressources propres banalisées" (obtained outside pre-assigned funding and contracts)*	*0.99*	*0.99*	*0.81*	*0.88*	*1.1*
	AGDg (Indirect costs from contracts, management fees)	*0.72*	*0.41*	*1.00*	*1.49*	*2.19*
TOTAL		*12.97*	*12.99*	*15.57*	*15.55*	*18.53*
"Frais Campus" payed by university (~1.4M€ in 2022)				*~1.4*	*~1.4*	*~ 1.4*
CPER 2015-2022		*4.16*	*4.78*	*1.88*	*2.77*	*0.5*

Table 3. IJCLab budget implemented in Year 2024 as compared to previous years.

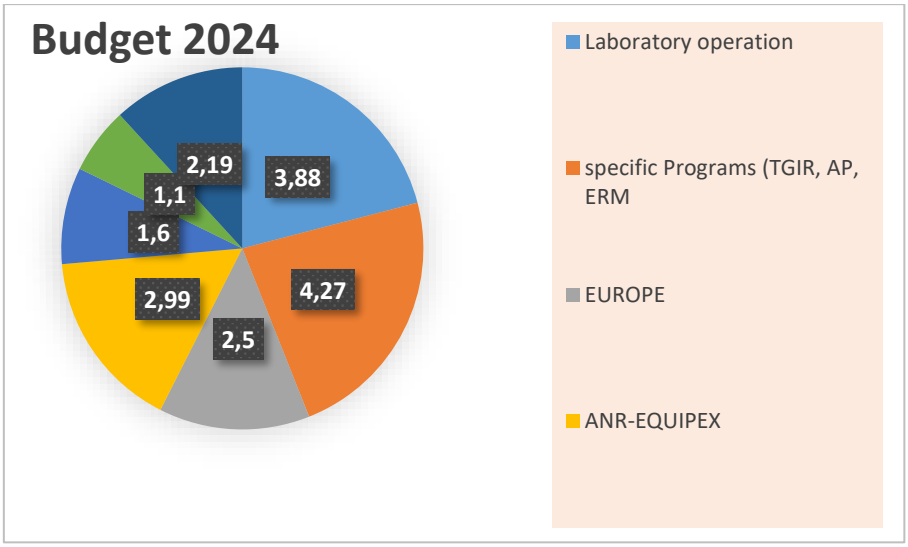


Figure 18. Budget implemented in 2024 as shown in the previous table.

This budget is complemented by funding coming from different contracts (ANR, Europe, Industry, Region...), which must be spent on pluriannual basis. The IJCLab budget is completed by what we call “own resources” ("Ressources propres"), which comes from the contract overheads and from the different services provided by the laboratory to external academic and industrial partners. This last part of the budget is mainly used for hiring personnel (technical and research, theses, internships), to impulse/help emerging projects punctually and to acquire new equipment outside of pre-assigned project funding. Finally IJCLab has received a budget from Region/State/Department “CPER 2015-2022 CD91, RIDF, ETAT)“ which can be used for the renewal of the IJCLab infrastructures.

6.2 Focus on the success to different external calls

We would like to focus on external contracts obtained thanks to the success of IJCLab teams to some important calls. presents a summary of the situation in Table 4 for 2023 and 2024.

Contracts	Year 2024	Budget [M€] YR 2024	Budget [M€] YR 2023
ANR	COM & Min, CRYOLUX, EDIM, gDEGASgSPEC, ROAD_4_EIC, SENSE	1,81	1,48
	PEPR : no contract in 2024	-	0,49
BPI	No projects in 2024	-	-
Europe	Infrastructures: iSAS, EVERSE, ACME	1,66	-
	Euratom: EURAD-2, APRENDE	0,07	-
	MSCA: R2D2	0,21	0,40
Ile-de-France Region	No SESAME project in 2024	-	0,38
TOTAL		**3,75**	**2,75**

Table 4 Contracts obtained in 2024. The budget is to be spent on a multiannual basis. As a comparison we give the budget obtained in 2023 for the same type of contracts.
***ANR**: COM & Min (Characterization of the Organic Matter and Minerals contained in cometary particles), CRYOLUX (Enhanced Low-Temperature Light Detectors for Neutrino Physics, coordination by IJCLab), EDIM (Exploitation of the DAMIC-M Instrument at Modane), gDEGASgSPEC (gDEGAS detectors for gSPEC at FAIR, coordination by IJCLab), ROAD_4_EIC (ReadOut of AC-LGAD sensors for EIC, coordination by IJCLab), SENSE (Scintillating Elpasolite for Neutron Spectroscopy Enhancement, coordination by IJCLab)*
***Europe Infrastructures:** iSAS (Innovate for Sustainable Accelerating Systems, coordination by IJCLab), EVERSE (European Virtual Institute for Research Software Excellence), ACME (Astrophysics Center for Multimessenger studies in Europe)*
***Europe EURATOM:** EURAD-2 (European Partnership on Radioactive Waste Management – 2), APRENDE (Addressing PRiorities of Evaluated Nuclear Data in Europe),*
***Europe MSCA**: R2D2 (Ab initio nucleaR Reactions in the Discovery perioD of exotic nuclei, coordination by IJCLab)*

The actions regarding industrial partnerships are summarized in Table 5

Interaction with socio-economic world / impacts on economy, society and culture					
Category	**Title**	**Partners**	**Date**	**Budget [k€] / Program**	
Platforms for industrial use					
	X-SPACE ALTO		**04/25 – 03/28**	**100+IT**	**CNRS/DGD-I**
Technology and know-how transfer	**MITA OPALIS - Multimodal Indicator for Tissue Analysis (for) Operating Autofluorescence Light for Surgery**		**12/22 -12/23 (extended to 03/24)**	**100**	**Proof of concept – SATT Paris-Saclay**
	Peroperative sensing head adapted to be coupled to an ablation tool	**Beams**	**2022 - 2032**	**-**	**Licenced patent**
	Cryomodule assembly	**CNIM**	**11/03/22 – 10/03/32**	**-**	

	DOSIMOEMS – Real-time dosimeter for radiotherapy		**04/21 - (10/25)**	**30 +5**	**DECLIC – IN2P3 - IJCLab**
Start up	**BEAMS**		**Created on march 21**	**-**	
Industrial Contracts					
NDA	**Radiation effects**	**Spin-Ion Technologies**	**28/06/22 (extended to 06/25)**	**-**	
	Development of vanaduim for fusion reactor	TOKAMAK	01/25 – 01/27		
	Energy recovery linacs and sustainable and energy efficient accelerator technologies	HBZ	12/23 – 12/24	-	
Research collaboration	**Optimization of DC photo injectors**	**Research Instruments**	**28/06/23 – 27/06/26**		
	Design and production of a plasma thruster demonstrator	**OsmosX**	**12/23 – 04/27**	**30**	
	études de sels fondus pour le développement du concept XSMR ®/XAMR ®.	**NAAREA**	**01/23 – 12/24**	**30**	
	SuperChooz Pathfinder	**EDF**	**9/22 – 08/26**	**-**	
	In-vivo properties of fluorescent magnetosomes	**NANOBACTERIE**	**04/22 - 03/23 (extended to 03/24)**	**60 + 57**	
	Medical imaging based on the use of nuclear detection technology	**Beams**	**02/22 - 02/24 (extended up to 08/25)**	**-**	
	Pyrochemical treatment	**ORANO SUPPORT**	**01/22 – 04/25**	**262**	
	MAEVA2- *concrete with depleted uranium*	**ORANO Chimie-Enrichissement**	**01/22 - 12/24**	**230**	

	Graphite chemistry	**ORANO CYCLE**	**10/21- 03/25**	**200**
	Modeling of interfaces for the resolution of the Boltzmann equation	**FRAMATOME**	**07/21 - 06/24**	**37**
	Development of (GHz) laser source	**AMPLITUDE SYSTEME**	**03/21 - 03/24**	**8**
	Hosting and collaboration agreement – MINERVA	**ACS**	**03/21 – 03/23**	**-**
	Optimization of the cryogenic distribution and control systems of the superconducting Linear Accelerator – MYRRHA	**ACS**	**11/20 - 10 /23**	**15**
Joint laboratory	**Accelerator technologies and photogun R&D**	**Research Instruments**	**09/23 – 08/26**	
	Innovative Molten Salt Laboratory (IMSLab)	**NAAREA**	**05/2024 – 04/2029**	**800**
Service contract	Disassembly and packing of equipment including amplifer and RF testing	**SCK-CEN**	**12/24**	**50**

Table 5. Industrial partnerships obtained in the last years.

7. CPER: Operations for the renovation of infrastructures

IJCLab is located in the Orsay Campus of Université Paris-Saclay in buildings that belong mainly to the University (a few are CNRS property), dating back to 1960-70. Financial support was obtained in 2015 in the framework of CPER (Contract Pluriannuel État Region) for the period 2015-2021 for a total amount of 20.6M€. This project was essentially oriented towards the extension/renovation of different buildings to host scientific equipment. Most of the operations are completed by now. The execution of this plan is almost completed. We suffer a delay for the movement of the “Theory” department which could be done on summer 2025. The list of the operations is given in the Table 6

Operation	Budget used [M€]	Budget available [M€]	End date	
IGLEX (D1-D2)	3.6		May-21	Completed
Renovation of Building 104	4.3		Sep-23	Completed
Virtual DATA (Bat 206)	2.2		Aug-20	Completed
Workshop Vacuum& Surface (D3-D4)	1.2		Apr-22	Completed
Mechanical Workshops (Bdg 100, 200)	2.4		Apr-22	Completed
Extension SCALP-JANNuS Platf. (Bdg108)	1.5		Apr-22	Completed
Construction of the PSI Platform (Bdg 200)	0.4		Jul-19	Completed
Renovation Bdg 100, 102, 103, 200, 208	1.6		Dec-21	Completed
Laser area and infrastructure work in Bdg 200 / 201	1.4		Feb-21	Completed
Renovation "Theory" Bdg 100	0.53	0.05	Jun_25	
Renovation Construction Hall Bdg 106	0.5		Mar-20	Completed
TOTAL	19.63	0.05		

Table 6. Implementation of the budget for the operation of CPER 2015-2022. We mention here that a 1.0M€ of this program was used for renovating a building for IAS laboratory.

In 2021 we have obtained an additional financial support of 9.1 M€ in the framework of the next CPER 2022-2027. This financial support has been confirmed. After a long delay due to Covid and the difficulty from the University to find the programmers, the project has recently received a green light and could effectively start in 2025. About 7M€ will be mainly oriented to the renovation/restructuring of different IJCLab buildings to improve their energetic performances and the quality of work; the other 2M€ will be used for the infrastructure work for the installation of the PERLE project in the IGLOO building.

8. Organizational aspects of the laboratory

At a global level, the IJCLab organization built during 2020/2021 has not significantly changed in 2024. We can give some significant information. In IJCLab there are about 70 positions of responsibility, with mandates and mission letters and in the last years we have a rotation rate of 25%?

We have created Working Groups on: Environment and QVCT and a "Equality, diversity and inclusion" Mission. Both they are work effectively. The QVCT group together with CL have formed group "Appui à la recherche" to work and advices the direction on the

Improvement of the organizations. For that we also hired a M2 student in “sociologie quantitative” and they have organised a survey. The results of the survey have been presented in an Assemblée Générale and a document has been published.

We have also presented during the CL council on November 18 November a response from the Direction to the needs expressed by the staff in the summary report of Working Group “Appui à la recherche”, which is available on the IJCLab intranet.

We have also introduced a Newcomers' Day, opened 3 café spaces, editing each year a welcome booklet, introduced the QVCT cafés and every year we organise a “Fête du Laboratoire”.

We have updated the « Direction » intranet by adding links to allow staff members to access various documents, such as past Yearly Report versions, documents presented during the different general assemblies, the 'HCERES Scientific Report' portfolio, as well as the report on the HCERES visit from January 9 to 11, 2025.

As introduced last year we would like to measure the rate of involvement of the engineers in the engineering division in projects that were not initially labeled as coming from their home laboratory. We define a 'mixing rate' corresponding, for each member of the engineering department, to the time spent working on projects originating from a laboratory other than their original laboratory divided by their total working time.

Figure 19 shows the distribution of this mixing rate for all members of the engineering department. Large values of the mixing rate indicate the evolution towards a more unified laboratory. It can be noticed that the number of persons with zero mixing rate decreased from 2022 and those with mixing rate of 1 increased. In general, the mean mixing rate increased from 0.20 (in 2022) to 0.32 (in 2024).

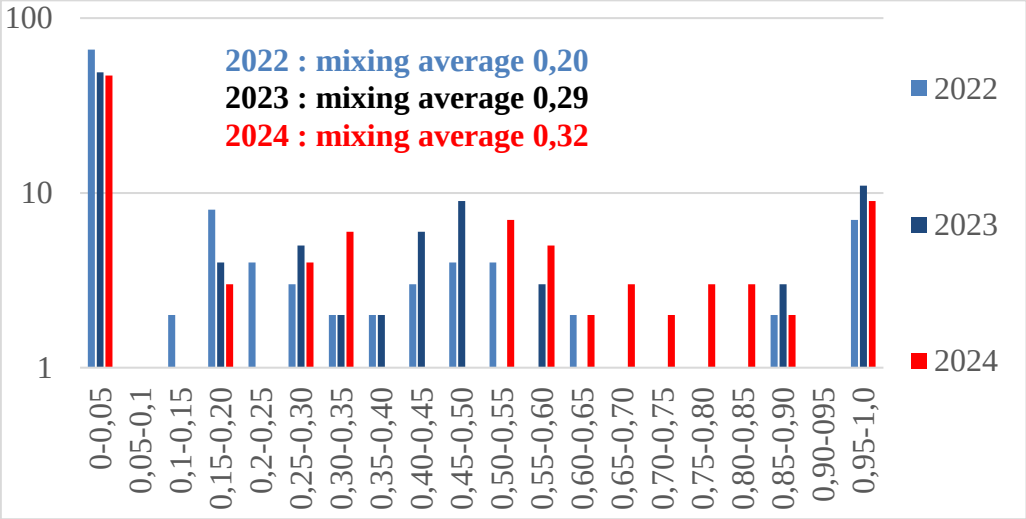


Figure 19. The 'mixing rate' or each member of the engineering division. The mixing rate is defined as the time spent working on projects originating from a laboratory other than their original laboratory divided by their total working time.

9. Appendix 1 – IJCLab organisational chart in 2024

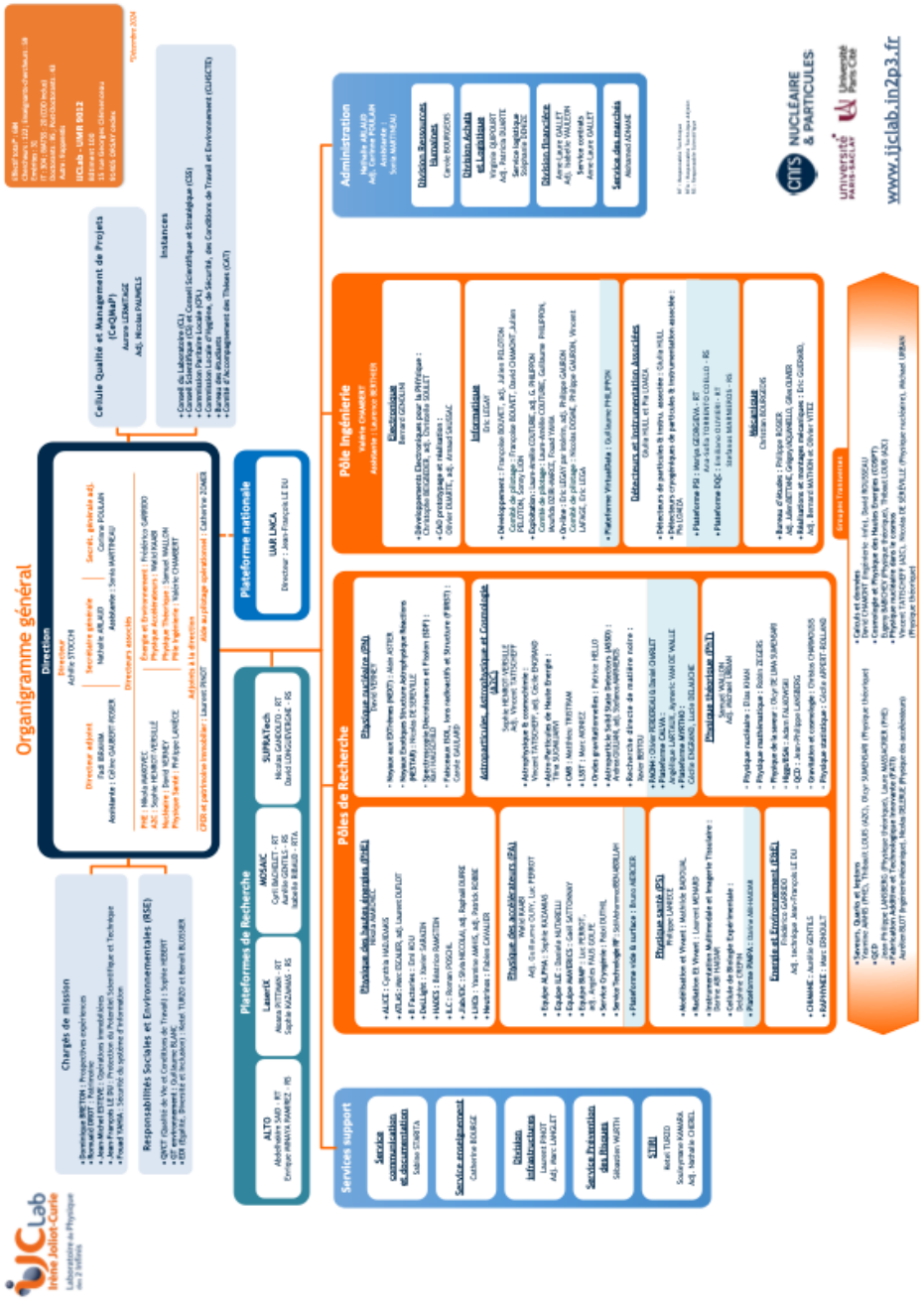


Figure 20. Organigramme of IJCLab

10. Appendix 2 – Subjects of IJCLab Scientific Councils (2020-2024)

Several project and activities have been examined by the Scientific Council:

- Scientific Council 19 November 2020
  - Participation to EIC (Electron Ion Collider) experiment
  - The activities in laser/plasma project PALLAS

- Scientific Council 12 Mars 2021
  - Participation to DUNE
  - GRIT and Direct Nuclear Reactions

- Scientific Council 13-14 October 2021
  - The activities on BAO-Radio
  - The project PARIS
  - The participation to MYRRHA

- Scientific Council 15-16 December 2021
  - The activities on Material under Irradiation for Energy
  - The activities on Material for Accelerators
  - R&D Bolometers and the CUPID project.

- Scientific Council 31March-1 April 2022
  - The Andromede Platform and Physics
  - The activity on Radionuclei on PRISM
  - The Super Heavy Elements

- Scientific Council 15-16 December 2022
  - The Calorimeter Upgrade of LHCb
- Scientific Council 16-17 March 2023
  - DELIGHT
  - PERLE

- Scientific Council 5-6 July 2023
  - Einstein Telescope
  - Physique des réacteurs et du cycle électronucléaire

- Scientific Council 16-17 October 2023
  - S3-LEB et physique ISOL basse énergie
  - Engineering Division @IJCLab Structure and Activities

- Scientific Council 10-11 June 2024
  - TESSERACT
  - Radiochimie au 107
  - SUPRATECH

- Scientific Council 12-13 November 2024
  - Radiochimie des sels fondus
  - COMCUBE-S
  - MadMax

11. Appendix 3 – Subjects of IJCLab Scientific and Strategic Councils (2021-2024)

- Scientific and Stragegic Council 21 May 2021
  - JCLab local and international landscape
  - An overview of the technical equipment and ressources
  - IJCLab : scientific and technical overview

- Scientific and Stragegic Council 18-19 October 2022
  - Return on 2021 CSS Recommendations and Scientific News – Yearly
  - Panorama of the Accelerator Activities at IJCLab: Panorama / Scientific activities / Large Project
  - Panorama of the Accelerator Activities at IJCLab: Skills and Competences for Accelerator activities
  - Activities and accelerator Projects within ESPP: Platforms supporting Accelerator R&D and construction
  - Activities and accelerator Projects within ESPP: Links with Industries and Technological Transfers
  - Visit of platforms (restricted to CSS members)
  - Activities and accelerator Projects within ESPP: ERL : PERLE@Orsay
  - Activities and accelerator Projects within ESPP: ERL : PALLAS@Orsay
  - Activities and accelerator Projects within ESPP: Contribution to future Large Accelerators (LHC, FCC, ILC, PIP II, muon colliders) (including also positron, polarimetry GF activities…)
  - Wrap up : Timeline and RH for the next 5 years and beyond

- Scientific and Stragegic Council 18-19 December 2023
  - Return on 2022 CSS Recommendations and Scientific News – Yearly Report 2023
  - The ALTO research platform
  - The MOSAIC facility
  - Visit of platforms (restricted to CSS members)
  - VirtualData
  - DQC (Détecteurs Quantiques Cryogéniques) installation for low temperature detectors
  - PSI

12. Appendix 3– Subjects of IJCLab CODEC (2020-2024)

This is a body made up of members of the Management Board, heads of departments and project leaders. The CODEC examines projects - for decisions on the allocation of resources/adequacy - following the Scientific Council, to analyze major changes or the launch of new phases, the launch of new projects, etc.

More than 70 CODEC, listed below, have been organized since the beginning of 2020.

2020

24 juin : CODEC des projets PLUME et FINK
15 juil. CODEC des projets SPACE-ALTO et PALLAS
02 sept. CODEC THIDOS
17 sept. CODEC des projets FASTIME, DARWIN et CHANGE
25 sept. CODEC CUPID
30 sept. CODEC PRISM
08 oct. CODEC ThomX
14 oct. CODEC PIP-II et LiquidO
05 nov. CODEC Myrrha
18 nov. CODEC GRIT
25 nov. CODEC TULIP
09 déc. CODEC IMOP et ATLAS-HGTD

2021

27 janv. CODEC ATLAS-ITK
10 févr. Reunion Préparation COPIL IN2P3 ALTO
10 mars REVUE SCALP & ANDROMEDE
24 mars CODEC SUPRATECH
31 mars CODEC DAMIC et EIC
13 avr. CODEC NuBall & AGATA
05 mai CODEC PERLE-TDR
12 mai CODEC CAPTINNOV
19 mai CODEC ComptomCAM
16 juin CODEC THOMX
01 juil. CODEC ILE
07 sept. CODEC ALICE et LHCB
22 sept. CODEC SIXPAC
30 sept. COPIL ThomX
08 oct. CODEC ANR STIRI
10 nov. CODEC FINK
23 nov. CODEC GRANDMA
08 déc. CODEC MINERVA (PA6)
15 déc. Revue de suivi de projet CV1250

2022

26 janv. Revue JUNO
26 janv. CODEC PARIS
09 févr. CODEC PACIFICS

09 févr. CODEC SpaceALTO
16 févr. Préparation COPIL ALTO ANNULE
07 mars Préparation ANR phase 2
07 mars Préparation COPIL JANNuS-SCALP
09 mars CODEC Liquido : Mini Gamma, TEP-Otech, AM-Otech
23 mars CODEC SQUEEZING
30 mars CODEC Revue PALLAS
30 mars CODEC TWAC
13 avr.CODEC DUNE
13 avr. Préparation Revue KDP2 PIP-II
20 avr. CODEC ANDROMEDE installation finale 201
20 avr. CODEC GRAINITA
11 mai CODEC PERLE
25 mai CODEC Fabrication Additive
25 mai CODEC Astro-Chimie
08 juin CODEC création d'une plateforme TP pour les L3 énergie
22 juin New COMET
22 juin ReX Projets : Direction / CeMaP
13 juil. CODEC INSPIRER
20 juil. CODEC - projets MOGLIH et MODERATO
14 sept. Présentation projets R&T
14 sept.Réunion de préparation KDP2 CALICE
21 sept. CODEC ThomX
30 nov. CODEC BIO-ALTO

2023

01 févr. CODEC préparation KDP2 DUNE
01 févr. CODEC LUXE
15 févr. CODEC EINSTEIN TELESCOPE
07 mars Préparation ANR phase 2
08 mars CODEC CUPID
08 mars Préparation COPIL ANDROMEDE/JANNuS-SCALP
22 mars CODEC FAIR
05 avr. Revue de Lancement production pour Atlas HGTD / ITK sur PSI
19 avr. CODEC FRIENDS3
19 avr. CODEC OPALIS - ex IMOP
10 mai CODEC TETRA/FROZEN
24 mai CODEC SPLIT-POLE
24 mai CODEC ATLAS à PSI
07 juin CODEC Dellight
14 juin CODEC BELLE2
14 juin CODEC SIXPAC
04 oct. Demandes R&T
18 oct. CODEC ThomX
18 oct. CODEC IRENA
15 nov.CODEC COMCUBE/Ballon
22 nov. CODEC PIONEER SIRIUS
22 nov. CODEC MONSTER

2024

10 janv. CODEC SUCO (COBOT)
10 janv. CODEC MYRRHA proto.
24 janv. CODEC IA/Artifact
14 mai CODEC IDEAS3
14 mai CODEC ASSD salle blanche
10 juil. CODEC LHCb
10 juil. CODEC PIP2, la phase test de cavités SSR1 et la série SSR2.
11 sept. EIC information ACCELERATEURS
11 sept. CODEC EPIC Roman Pots
11 sept. CODEC EPIC Calo
09 oct. CODEC Plateforme TP 102
02 oct. CODEC SIMONS OBSERVATORY (SO)
02 oct. CODEC TESSERACT
20 nov. CODEC COMCUBE-S
20 nov. CODEC Einstein Telescope
04 déc. CODEC DOSIMOENS
04 déc. CODEC GRIT
11 déc. CODEC PRISM/TTRIP
11 déc. CODEC PERLE-ISAS
18 déc. CODEC HINA
18 déc. CODEC Plateforme Vide et Surface (Validation du modèle économique)

13.Appendix 4 – Various IJCLab awards 2020-2024

2020

- Médaille de bronze du CNRS : Nicolas Morange
- Several Prix ED Pheniics Maira DUTRA (TH/LPT) "Origins for dark matter particles : from the "WIMP miracle" to the "FIMP wonder" ; Vitalii LISOVSKYI (PHE/LAL) "Study of rare b-baryon decays and test of lepton universality at LHCb¨; Carlotta TRIGILA (PS) "Development of a portable gamma imaging system for absorbed radiation dose control in molecular radiotherapy"; Ho san Ko (pôle PHE, équipe JLab/EIC) : prix jeune chercheur/se, Laboratoire Franco-Coréen de Physique des particules, pour ses travaux de thèse en co-tutelle SNU et UPSay.

2021

- Cristal du CNRS : Véronique Puill
- Prix SFP Joliot Curie 2020 : Marcella Grasso
- Prix fondé par l'Etat de l'Académie des Sciences : Marie-Hélène Schune
- Hélène Langevin-Joliot a été élevée à la dignité de Grand'Croix dans l'ordre national du mérite.

- Several Prix ED Pheniics 2021 : Christine AGAPOPOULOU (PHE) "Recherche de la supersymétrie avec le détecteur ATLAS et développement du High Granularity Timing Detector¨; Pierre CHATAGNON (PHE) "Etude de la structure du nucléon avec CLAS12 à Jefferson Lab"; Angélique VOLLARD (A2C) "Dépasser la Limite Quantique Standard pour le détecteur d'ondes gravitationnelles Advanced Virgo

2022

- Médaille d'argent du CNRS : Vincent Tatischeff
- Cristal du CNRS : Jihane Maalmi
- Prix Jean-Louis Laclare : David Longuevergne
- Prix Académie des Sciences - Madeleine Lecoq : Suheyla Bilgen
- Sylvain David, nommé au grade de chevalier de l'Ordre des Palmes académiques.
- ATLAS Awards : Prix « Outstanding achievement awards 2022 d'ATLAS » décernés à des personnels IN2P3, dont Stefan Simion, pour ses "contributions exceptionnelles au système électronique numérique de déclenchement du calorimètre à argon liquide"
- Prix collaboration LHCb à Valeriia Zhovkovska pour le prix remis aux scientifiques en début de carrière et à Guillaume Pietrzyk pour le prix de la meilleure thèse LHCb

2023

- Prix André Lagarrigue : Daniel Fournier
- Médaille d'argent du CNRS : Araceli Lopez-Martens
- Prix Jaffé - Institut de France : Zhiqing Zhang
- Prix Mid-Career Award 2023 de la conférence Radiation Effects in Insulators (Fukuoka, Japon) décerné à Aurélie Gentils
- La start-up Beams issue d'IJCLab est lauréate du concours d'innovation i-Lab 2023 dans la catégorie « Technologies Médicales».Fink a reçu le prix science ouverte du logiciel libre de la recherche 2023, espoir de la catégorie « Coup de cœur » du jury, décerné par le ministère de l'Enseignement supérieur et de la Recherche
- Prix Suzanne Bella Srodogora 2023 de la Fondation CNRS et la mission pour la place des femmes au CNRS : Véronique Puill
- FINK : prix science ouverte du logiciel libre de la recherche 2023, espoir de la catégorie « Coup de cœur » du jury, MESR

2024

- Cristal du CNRS : Nathalie Arlaud
- Médaille de Bronze du CNRS : Vladimir Manea
- Sylvain David nommé au grade de chevalier de l'Ordre des Palmes académiques
- Yann Mambrini, prix Bourrienne 2024 vulgarisation scientifique
- Marc Winter Prix Instrumentation ICFA 2024

14. Appendix 5 - Events and seminars at IJCLab

A dedicated service in laboratory organizes several conferences, workshops or collaboration meetings. These events last from one day to a week. In the last three years (2021, 2022, 2023) the laboratory has organized about 20 events/year with variable number of participants. The events organized in 2024 are shown in Table 7.

Janvier	Fink Collaboration Meeting	40 personnes	3 jours
Janvier	ARIEL Final Workshop	45 personnes	3 jours
Janvier	Workshop INTRANS	70 personnes	4 jours
Mars	Prospectives IJCLab	~ 130 personnes	3 jours
Avril	ISAS	45 personnes	2 jours
Mai	Workshop MesoNET	25 personnes	2 jours
Juin	Prix Srodogora	100 personnes	1/2 journée
Juin	AugerPrime SDEU2F Meeting	30 personnes	3 jours
Juin	Progress of Algorythms	30 pers	2 demi journées
Juin	GDR QCD Summer School	70 personnes	5 jours
Juin	AG GDR DI2I	70 personnes	3 jours
Juin	Fête des personnels IJCLab	Labo	1 journée
Juillet	Ecole des 2 Infinis	30 personnes	10 jours (4 à IJCLab)
Septembre	Journées/inauguration MOSAIC	60 personnes	2 jours
Septembre	Higgs Hunting	100 personnes	3 jours
Octobre	AHIPS	50 personnes	3 jours
Octobre	Atelier calcul SCIPAC	60 personnes	2 jours
Novembre	SSNET	100 personnes	5 jours
Novembre	Visites de la DR4	30 personnes	1/2 journée

Table 7. Large events organized in 2024.

Other events as collaborations meetings and small scientific workshops are also organized and are not yet reported in this plot.

In Figure 21 we report the seminars organized at IJCLab in 2024. There are different categories going from seminars in the scientific poles, between different poles, of general interest, the ERL series and the Colloquium.

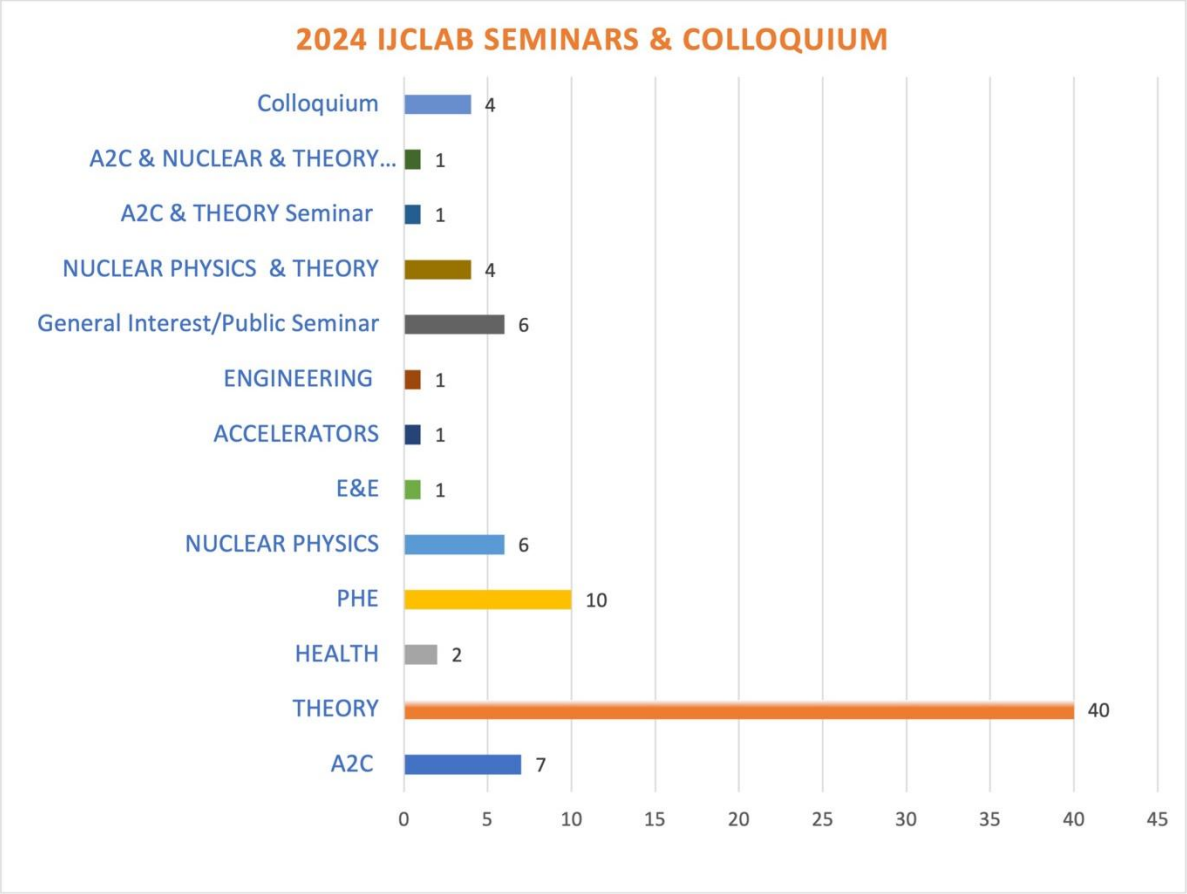


Figure 21. Number of Seminars & colloquium organized by IJCLab in 2024.