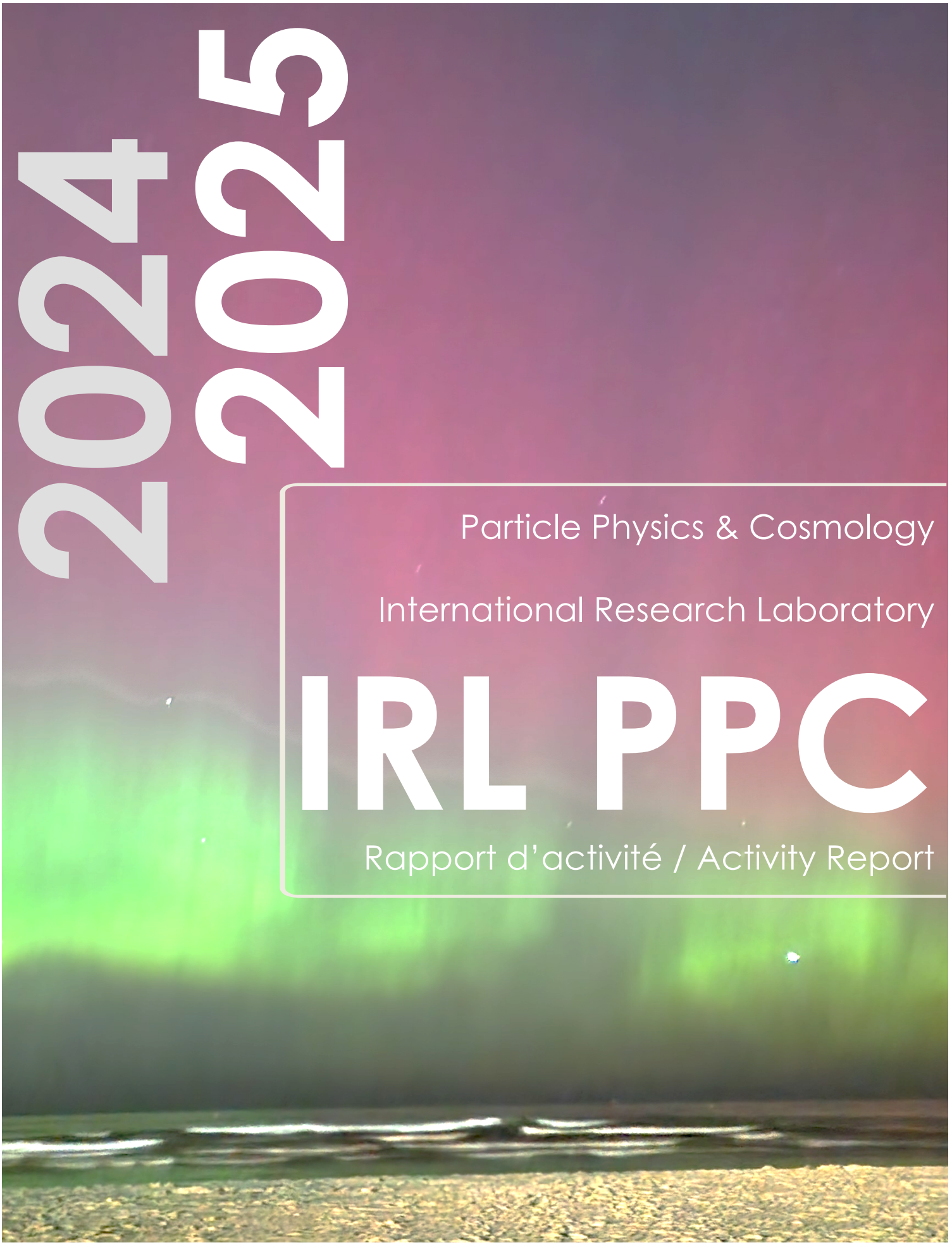
2024
2025

Particle Physics & Cosmology

International Research Laboratory

IRL PPC

Rapport d'activité / Activity Report



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Director's Foreword



It has already been a year since the launch of the IRL Particle Physics and Cosmology (IRL PPC) in August 2024. Its official signing between all partner institutions will take place in November 2025. This first year has been dedicated to understanding and shaping this powerful collaborative tool: learning how it works, exploring its possibilities, meeting the first partners and researchers, and facing several challenges. Above all, it has been a year of learning how to use this framework to do more—and to do better—within the long-standing partnership between the CNRS and the University of Chicago, together with Argonne National Laboratory (ANL) and Fermilab.

A central question remains: how can the IRL make a difference in long-standing collaborations—built over years or even decades—and already deeply structured around large international experiments and facilities such as those at the CERN collider in Geneva or the DUNE experiment now under construction? Beyond that, how can we foster, support, and promote new ideas, new collaborations, and new partnerships? How can we sustain the motivation and spark for international scientific cooperation in a world that continues to experience profound geopolitical change? The IRL PPC has begun addressing these challenges, acting as a catalyst for collaboration.

From a scientific perspective, the IRL has played a key role in identifying opportunities and building new bridges. Within DUNE, the Deep Underground Neutrino Experiment—one of the largest CNRS–UChicago joint endeavors, involving nearly 80 CNRS scientist and engineers in seven laboratories—the IRL helped connect French DUNE groups with the Chicago local expertise around the short baseline neutrino program at Fermilab, where France is not institutionally involved. A first joint workshop brought together young collaborators—PhD students and early-career researchers—allowing them to share their experiences and recognize how the technical challenges and methods developed in both experiments can benefit one another. It also broadened their perspectives in a context where most of the collaboration's focus today is on detector construction, reminding us how essential it is to train the next generation of physicists. This neutrino workshop is expected to become an annual event. It also led to several visit of students and academics at Fermilab and at the IRL PPC. These efforts have been supported through several complementary instruments, including the CRADA agreement between the CNRS and Fermilab, a FACCTS[1] grant, and the IRL PPC's internal resources.

[1] FACCTS: France and Chicago Collaborating in the Sciences

Discussions have begun to explore the possibility for the EFI neutrino team to join the CNRS International Research Network (IRN) on Neutrino Physics, thereby gaining access to France's extensive network connecting Europe, China, Japan, and the United States in this field of research.

Speaking of the FACCTS program—an invaluable instrument for fostering collaboration—the IRL PPC's on-campus presence has made it possible to engage France and US teams more actively in proposing projects eligible for support through the France Chicago Center. Many outstanding proposals were submitted, and five received FACCTS awards in 2025, tripling the average CNRS success rate in this field of physics.

The IRL PPC has also facilitated new initiatives at the frontier of instrumentation and quantum technologies. One particularly innovative collaboration has emerged on superconducting radio-frequency (SRF) resonant cavities, the building brick of particle accelerators and a technological key in quantum physics. This new collaboration brings together researchers from ANL, Fermilab, and the IJCLab[2] in Orsay. This project, supported by both a FACCTS grant and awarded by a CNRS–UChicago Joint PhD Grant in 2025, exemplifies how the IRL framework helps transform early scientific exchanges into structured, jointly supported research initiatives. More cutting edge technological studies have to be explored, particularly on quantum sensors and the use of artificial intelligence.

On the institutional side, the IRL has strengthened the dialogue between Université Paris Cité (UPCité) and the University of Chicago. The partnership between these two major universities has been consolidated around the two IRLs on campus and the IRC Discovery. UPCité will now act as a partner institution, contributing additional resources to support the operation of both IRLs on campus and, more broadly, their interactions with the IRC. This is a clear example of how the CNRS's international strategic instruments can help structure and strengthen collaborations among partner institutions.
In parallel, dialogue and networking have begun among the four IRLs established by CNRS Nuclei and Particles in North America, located at Michigan State University, UC Berkeley, TRIUMF (Vancouver), and the University of Chicago.

Several other scientific visits, collaboration meetings, and initiatives took place over the past year, and you will find details of all of them—along with key figures—in this annual report.
In just one year, the IRL PPC has demonstrated its ability to create new momentum and connect communities. The coming year will be decisive in further strengthening this shared scientific space among all contributing partners.

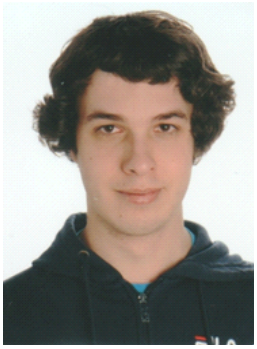
[2] IJCLab : Irène and Joliot Curie Laboratory

Awards & Recognition

CNRS–UChicago Joint PhD Grant awardee at the IRL PPC

Spotlight on Ultrahigh-Performance SRF Cavities

A new seed program has been jointly launched and supported by CNRS and the University of Chicago, marking one of the first initiatives to receive both a **CNRS–UChicago Joint PhD Grant** and a **FACCTS award (France and Chicago Collaborating in the Sciences)**.
The project, led by Achille Stocchi and Akira Miyazaki (IJCLab[3]) in collaboration with Orlando Quaranta and Tejas Guruswamy (Argonne National Laboratory & CASE, University of Chicago), focuses on ***fundamental research on ultrahigh-performance superconducting radio-frequency (SRF) resonant cavities***. This double recognition underscores the strength of the partnership and its potential to open new avenues in SRF technology for future accelerators.
The CNRS-UChicago Joint PhD Grant supports the recruitment of Carlos Redondo Herrero, whose expertise in Quantum Chromodynamics (QCD) will contribute to the theoretical and experimental aspects of the project. On the UChicago side, Hannah Hu, a PhD student at the Enrico Fermi Institute and Fermilab, will serve as a counterpart in the SRF studies, while Daniel Bafia (Fermilab – SQMS Center) also contributes to the effort. The grant provides dedicated travel funds for both teams, fostering sustained collaboration across the Atlantic. A kickoff workshop is planned for early December to initiate this long-term program.

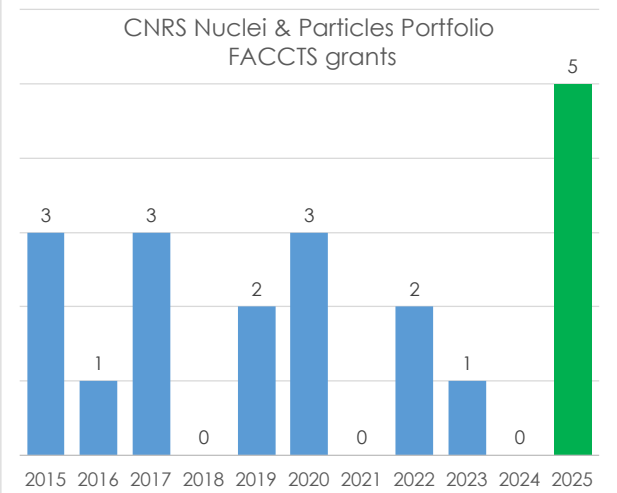


Carlos Redondo Herrero will be joining IJCLab as a new student in Fall 2025. He will work under the supervision of Akira Miyazaki and Achille Stocchi and will be supported by the CNRS-UChicago Joint PhD Grant.. His research focuses on the response of superconductors to electromagnetic waves in Superconducting Radiofrequency (SRF) cavities. He employs the Nambu-Gorkov Green's function formalism, a technique associated with Quantum Field Theory (QFT). This builds directly on his Master's thesis work at the Universidad de Salamanca, where he gained experience in QFT, specifically in Quantum Chromodynamics, Effective Field Theories, and Heavy Quark Effective Theory.

[3] IJCLab: The laboratoire de physique des deux infinis Irène Joliot-Curie is a joint research unit of the CNRS/IN2P3, Paris-Saclay University, and Paris-Cité University.

FACCTS Grants (France and Chicago Collaborating in the Sciences)

Five proposals submitted within the CNRS Nuclei and Particles science portfolio were awarded **FACCTS** funding this year — more than **three times the historical average** over the past decade. This remarkable increase illustrates the growing impact of the IRL PPC, whose permanent presence on campus has fostered direct and productive interactions between French and UChicago teams, encouraging them to seek support through existing collaborative programs.



The supported programs are:

- **Orlando Quaranta** (Argonne / UChicago PSME CASE) & **Achille Stocchi** (CNRS IJCLab – Université Paris-Saclay): *Fundamental Research on Ultrahigh-Performance Superconducting RF Resonant Cavities*
- **Edward Blucher** (UChicago EFI) & **Alessandra Tonazzo** (CNRS APC – Université Paris Cité): *Neutrino Energy Reconstruction in the Deep Underground Neutrino Experiment*
- **Paolo Privitera** (UChicago EFI & KICP) & **Cédric Cerna** (CNRS PPC - UChicago): *Building Bridges in Particle Physics and Cosmology: Supporting Exploratory Research through FACCTS and the IRL PPC*
- **Javier Tiffenberg** (Fermilab / UChicago) & **Xavier Bertou** (CNRS IJCLab – Université Paris-Saclay): *Probing Millicharged Particles with Skipper-CCDs: A Fermilab–CNRS Collaboration*
- **Chihway Chang** (UChicago KICP) & **Cyrille Doux** (CNRS LPSC – Université Grenoble Alpes): *Breaking Through Blending: A Multi-Survey Approach to Dark Energy with LSST, Euclid, and Roman*

Fermilab Neutrino Physics Center (NPC) Fellowship

The Neutrino Physics Center (NPC) at Fermilab hosts an international program dedicated to advancing research in neutrino oscillations, interaction studies, and detector development. Through its fellowship scheme, the NPC welcomes visiting scientists—both experimentalists and theorists—for short- to medium-term stays designed to strengthen collaborations and stimulate exchange within the global neutrino community.
In 2025, **Laura Zambelli** (CNRS/LAPP – Université Savoie Mont Blanc) was awarded a Fermilab NPC Fellowship for her project aimed at developing a charge–light matching algorithm for event reconstruction and refining the modeling of space-charge effects in DUNE. Her stay at Fermilab in spring 2026 will follow her visit to the IRL PPC in fall 2025, reinforcing the scientific continuity of her research.

Visits & Research Exchanges

Matteo Galli

Matteo Galli (CNRS APC - Université Paris Cité) visited Fermilab for two months (Feb–Mar 2025) in the context of **DUNE**. He worked on the Photon Detection System, specifically characterizing the electronics of the Signal-over-Fiber system. His stay was supported by CNRS and the **iCRADA** agreement CNRS owned with Fermilab. An opportunity to perfect his skill and connect better our communities.

Interview with Matteo Galli



"I am Matteo Galli, a Ph.D. student at the Astroparticule et Cosmologie laboratory in Paris. My doctoral thesis is within the field of particle physics. In particular, I am part of the Deep Underground Neutrino Experiment (DUNE) collaboration that wants to study important features of neutrino physics. I completed all my studies in my hometown, Milan (IT), before deciding to move away to continue my development in the world of experimental particle physics. During my experience in particle physics, I had the opportunity to cultivate and develop my interest in the field by visiting some of the most important particle physics laboratories.

During my time at Fermilab, I participated in the testing and development of the DAPHNE data acquisition system integrated with the Signal-over-Fiber (SoF) electronics developed at APC. The SoF electronic system converts the SiPM signals into light. This light is transmitted through optical fibers to the outside of the cryostat, where it is captured by the SoF warm analog optical receiver. The receiver then converts the optical signals back into electrical signals, which are later digitized by the DAPHNE. I performed the first test of a new 8-channels warm receiver designed at APC by experienced engineers. This new version of the board is very important to provide good conversion of the signal from optical to electronic. I characterized the behavior of each channel of the receiver studying the noise of the different components. The SoF technology will be installed on prototypes of the final detector at the CERN Neutrino Platform. In addition, thanks to David Chistian's supervision (Fermilab's senior scientist, and lead designer of the DAPHNE digitizer), I had the opportunity to conduct the first tests on a new version of DAPHNE called DAPHNE mezzanine. These preliminary tests will be useful in commissioning and debugging the system, optimizing its performance."

I Cheong Hong

I Cheong Hong (CNRS APC - Université Paris Cité), came at EFI during 3 weeks in May in the framework of his **CNRS-UChicago Joint PhD** on vertex reconstruction in **DUNE**.

I Cheong Hong's research focuses on developing advanced machine-learning methods for neutrino event reconstruction, with a particular emphasis on vertex finding. He has contributed to both software development and performance studies for DUNE's atmospheric neutrino.

Interview with I Cheong Hong



"During my visit to the Enrico Fermi Institute and the APA assembly factory, I participated in hands-on activities related to the construction of the Anode Plane Assemblies (APAs) for the DUNE Far Detector. In parallel, I collaborated with researchers at the University of Chicago to develop a Graph Neural Network (GNN) architecture for vertex reconstruction. I also shared my experience on preparing large-scale datasets for machine-learning training and conducted sessions to guide others in using the prototype GNN model for DUNE data analysis."

Olivier Deligny

Olivier Deligny (CNRS IJCLAB – Université Paris Saclay) will be at UChicago at the end of November 2025 in the framework of the Dark Matter experiment **DAMIC-M**. He is supported by supported by the **FACCTS** program, awarded by Pr. Paolo Privitera (EFI and KICP - UChicago).

Dr. Olivier Deligny is a senior researcher at CNRS/IN2P3 and member of the IJCLab (Laboratoire de Physique des 2 Infinis Irène Joliot-Curie). His research explores the origin and propagation of ultra–high-energy cosmic rays and the nature of dark matter beyond the WIMP paradigm. Member of the Pierre Auger Collaboration from the early days, he contributed to build the world's largest cosmic ray Observatory and developed several analyses leading to the measurements of anisotropies and energy spectra, revealing subtle features in the cosmic-ray arrival directions and flux at energies beyond about 10 EeV. His work has also advanced the understanding of air-shower characterization and resolved longstanding questions on GHz emission suppression in the atmosphere. On the phenomenological side, he has led innovative studies connecting cosmic-ray anisotropies to starburst galaxies and long gamma-ray bursts, and computed the

minimal fluxes of gamma rays and neutrinos expected from Galactic interactions. He also contributed analytical models of cosmic-ray transport in turbulent magnetic fields.

In the realm of beyond–Standard-Model physics, he investigates super-heavy dark matter at scales around 10^{13} GeV, proposing new mechanisms for metastability and testing them through Pierre Auger data, as well as hidden-sector extensions of the Standard Model at MeV scales that are testable with current generation of direct-detection experiments such as the DAMIC-M (Dark Matter in CCDs at Modane) one. In this experiment, he co-develops the data acquisition system and is interested in characterizing hidden-sector particles interacting with electrons, opening a window into early-Universe dark matter production via freeze-in or freeze-out processes.

Interview with Olivier Deligny



"First results of the DAMIC-M (Dark Matter in CCDs at Modane) experiment now make it possible to constrain the cross section for dark matter/electron interactions with sufficient sensitivity to explore realistic scenarios for dark matter production in a mass range between ~1 MeV and ~1 GeV. This is particularly interesting in the context of so-called hidden sector theories, in which one or more particles couple only very feebly to those of the Standard Model via an additional mediator. A prime example of these theories draws inspiration from electromagnetism to introduce an analogue of the photon into the hidden sector, a « dark photon », which, unlike the photon, could be massive. The next setup of the experiment is in preparation and will be installed this fall. My visit at UChicago will consist in finalising data acquisition utilities on the one hand, and to establish collaboration in studying parameter ranges for which hidden-sector particles could have been in thermal equilibrium in the early Universe on the other hand, helping to understand the future physics targets of the experiment."

Laura Zambelli

Laura Zambelli (CNRS LAPP – Université Savoie Mont Blanc) is coming for a month visit in the neutrino group of the Enrico Fermi Institute from Oct. 28th, 2025 to Nov. 20th, 2025. Her stay is supported by the IRL PPC.

Interview with Laura Zambelli



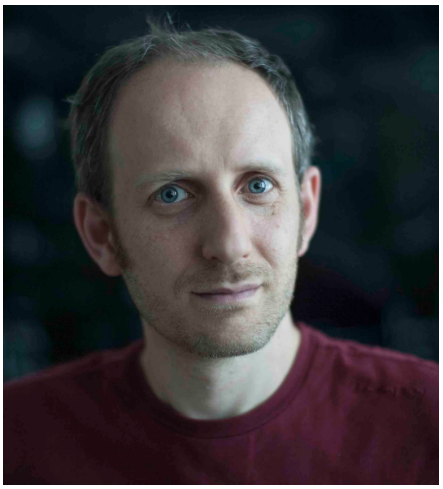
"I have always worked on long-baseline neutrino oscillation experiments. During my PhD at LPNHE (Paris), I focused on predicting the neutrino flux for the T2K experiment using hadroproduction data from the NA61/SHINE experiment at CERN. As a postdoc at KEK (Japan), I finalized this work while also contributing to the development and analysis of a small local LArTPC detector. After joining LAPP, first as a postdoc and later as a permanent CNRS researcher, I became involved in the WA105 and DUNE experiments, working on dual-phase LArTPC technology. In 2020, following the operation of the dual-phase prototype at CERN, the design was revised toward the vertical drift concept. Since then, I have been actively working on this technology, particularly on characterizing its performance, as it will be used in the first DUNE far detector module to be built in 2027."

Luca Scotto Lavina

Luca Scotto Lavina (CNRS LPNHE --Sorbonne Université & the Université Paris Cité) has come in July and August in the Chicago area and visited the Department of computing science in the framework of the Dark Matter project Xenon nT.

Luca Scotto Lavina is a CNRS Director of Research leading the Xenon group at the LPNHE Laboratory in Paris. He is currently working on XENONnT, the latest generation of the XENON project, which aims to directly detect dark matter using dual-phase xenon TPC technology. He leads the project's computing efforts and is also responsible for the two xenon storage and recovery systems. In addition, he is involved in R&D programs focused on developing advanced technologies for future dark matter detectors. Earlier in his career, he made major contributions to neutrino oscillations physics through experiments such as CHORUS and OPERA.

Interview with Luca Scotto Lavina



"I have led the XENON computing efforts for the past 15 years. I collaborate closely with Luca Grandi (University of Chicago) on the development and maintenance of the XENONnT cyber-infrastructure, as well as on data handling and analysis tools. Together, we serve as co-leading PIs of the computing working group. In July and August, I visited Chicago to work directly with computational scientists and system administrators — namely Paschalis Pascos and Judith Stephen — focusing in particular on data management using Rucio and discussing the evolution of GRID computing for next-generation astroparticle experiments. The LPNHE and the University of Chicago also collaborate on XENON data analysis, with a particular focus on understanding background processes in dark matter and neutrino searches".

Alain Mermet

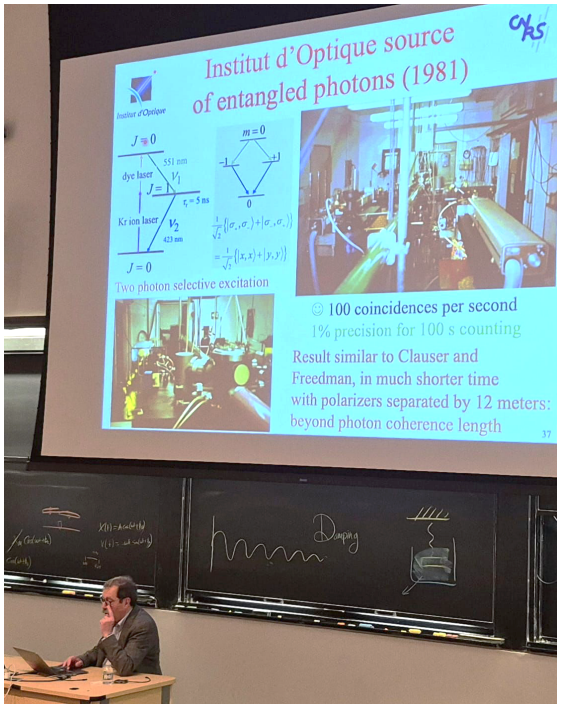


On October 25th, 2024, **Alain Mermet**, Director of the CNRS Europe & International (DEI), visited UChicago Global to support the early development of the IRL PPC. His visit was both an honor and an opportunity to gain deeper insight into the CNRS international strategy — particularly how the International Research Center Discovery (IRC Discovery) at the University of Chicago, one of only eight IRCs worldwide, serves as a powerful lever to access the best collaborative tools and foster new partnerships.

He was welcomed by Edward Blucher, Director of the Enrico Fermi Institute (EFI), which hosts the IRL PPC office, and had the privilege of touring the assembly hall for the giant wire chambers (Anode Plane Assemblies, or APAs) being prepared for the future DUNE (Deep Underground Neutrino Experiment) detector.

Alain Aspect

On April 7th, 2025, the University of Chicago had the honor of hosting Prof. **Alain Aspect**, Nobel Laureate in Physics 2022, for several days of inspiring discussions and academic exchange around quantum physics. Together with our colleague Prof. David Miller (UChicago), who is also one of the IRL's supporting PIs, we had the privilege of spending several hours discussing with Alain Aspect. A memorable time where we had the time and freedom to explore a wide range of topics from dark matter to quantum sensors. We also celebrated the upcoming publication of his book, Einstein and the Quantum Revolutions (The University of Chicago Press). A must-read for anyone curious about the foundations of quantum physics.



Christelle Roy

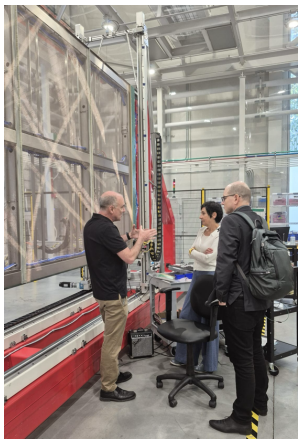
Over the past year, Christelle Roy, Director of CNRS Nuclei and Particles, visited Chicago twice, each time marking a key step in the development of CNRS–U.S. collaborations in high-energy physics and in the consolidation of the IRL PPC.



Her first visit, on November 21, 2024, took place at Fermilab, where she joined **Regina Rameika** (DOE Office of Science Associate Director for High Energy Physics) to sign a bilateral agreement between the U.S. Department of Energy (DOE) and the CNRS. This agreement supports two flagship projects hosted at Fermilab: DUNE, which will deepen our understanding of neutrinos, and PIP-II, which will upgrade the laboratory's accelerator complex.



Her second visit, on September 10, 2025, was centered on the IRL PPC at the University of Chicago. Accompanied by Jan Matas, Director of the CNRS Office for North America, she met with University leadership, faculty members affiliated with the IRL, representatives of the France Chicago Center, and Ms. Charlotte Montel, Consul General of France in Chicago. This very constructive visit provided an opportunity to assess the progress made after the IRL's first year of activity and to outline the next steps for its development.



Workshops & Seminars

Reconstruction in Liquid Argon Time Projection Chambers

On May 23rd, the IRL PPC held its first workshop on "Reconstruction in Liquid Argon Time Projection Chambers (LAr TPCs)", at the University of Chicago.

Supported by the CNRS, the IRL PPC and the Enrico Fermi Institute (EFI), the event brought together around 20 scientists and early-career researchers from both institutions. It was a real success, an intense and collaborative day that strengthened the ties of our community and fostered deep discussions around shared technical challenges and opportunities. This workshop is aimed to happened every year now, in coincidence with the DUNE collaboration meeting when it happens in the United States. It will be supported by the FACCTS grant awarded to Prof. Edward Blucher (Enrico Fermi Institute).



Ultrahigh-Performance Superconducting RF Cavities

On December 8th to 11th, 2025, three days **kickoff workshop** on *Ultrahigh-Performance Superconducting RF Cavities* will be held at the University of Chicago, the Argonne National Laboratory and Fermilab. It will be a unique opportunity for the team awarded by the 2025 UChicago-CNRS joint PhD and FACCTS Grant to meet with the new appointed PhD students and the senior scientist, visit the infrastructures and discuss the organization of the work.

Antoine Kouchner

Fishing for neutrinos in the Mediterranean Sea



On November 17th, 2025, **Antoine Kouchner** (CNRS APC - Université Paris Cité) will give a colloquium at the Enrico Fermi Institute titled*: Fishing for neutrinos in the Mediterranean Sea*.

Abstract: Neutrinos provide a unique window into the most extreme and energetic environments of the Universe, as they propagate virtually unperturbed across cosmological distances. Following more than a decade of successful operation, the **ANTARES** detector — the first undersea neutrino telescope — has been decommissioned after paving the way for the new-generation observatory KM3NeT, now under construction at two deep-sea sites in the Mediterranean. At the Toulon site (France), **KM3NeT/ORCA** is optimized for precision measurements of atmospheric neutrinos and the study of fundamental oscillation parameters, while off Sicily, KM3NeT/ARCA targets high-energy astrophysical neutrinos from cosmic accelerators.

This seminar will recall the scientific legacy of ANTARES, whose final results include stringent constraints on astrophysical neutrino fluxes, searches for point-like and extended sources, and contributions to multi-messenger campaigns. Recent KM3NeT/ARCA observations have already delivered a remarkable highlight: the detection of the ultra-high-energy neutrino candidate KM3-230213A, with a reconstructed muon energy of about 120 PeV, making it one of the most energetic neutrino-induced events ever recorded. Its extreme energy and geometry suggest a possible origin in a powerful cosmic accelerator, or even a first hint of a cosmogenic neutrino. Looking forward, KM3NeT promises unprecedented sensitivity to both oscillation physics and astrophysical neutrino sources, with the potential to address some of the most pressing questions at the interface of particle physics and high-energy astrophysics.

Akira Miyazaki

Detection of dark matter axions at high frequency: journey from classical microwaves to quantised photons



On December 8th 2025, Akira Miyazaki (CNRS IJCLab) will give a colloquium at the Enrico Fermi Institute titled : *Detection of dark matter axions at high frequency: journey from classical microwaves to quantised photons.*

Abstract : Axions were originally introduced as a byproduct in solving the strong CP problem in quantum chromodynamics (QCD) and are also excellent candidates for dark matter. Compared to Weakly Interacting Massive Particles (WIMPs), axions exhibit a distinct nature: they behave like classical waves owing to their long de Broglie wavelength and the high occupation number of axion particles. Through the inverse Primakoff effect, which converts axions into microwaves, typical axion searches involve challenges in classical microwave technology, such as the development of high-quality and tunable resonant cavities. In this seminar, we will review the fundamental properties of these conventional "classical" axions and briefly explore phenomena beyond this regime—namely, the "quantum" aspects of axions, particularly those associated with relatively heavy axions predicted in post-inflationary scenarios.

Physics highlights

DAMIC-M

DAMIC-M (Dark Matter in Charge-Coupled Devices at Modane) is an exceptional dark matter experiment built deep beneath the French Alps. It stands as a flagship collaboration between the University of Chicago and the CNRS.

Led by Prof. Paolo Privitera (UChicago) with contributions from numerous researchers at UChicago, the CNRS, and partner institutions, DAMIC-M employs a groundbreaking CCD-based detection technique of unprecedented sensitivity to search for dark matter particles. The detector is being installed at the **Laboratoire Souterrain de Modane** in France, nearly 1,500 meters underground.



A recently published article in Physical Review Letters [4] reported significant advances from the DAMIC-M experiment, opening new avenues in the exploration of dark matter interactions. The paper was co-authored by former **CNRS–UChicago Joint PhD** participants Paolo Privitera, Mariangela Settimo

[4] Probing Benchmark Models of Hidden-Sector Dark Matter with DAMIC-M; https://arxiv.org/abs/2503.14617
DAMIC-M Collaboration, K. Aggarwal et al.

(Subatech[5]), and Claudia De Dominicis (LPNHE[6]), as well as **FACCTS awardees** Paolo Privitera, Olivier Deligny (IJCLab[7]), and Antoine Letessier-Selvon (LPNHE). The experiment also gained public visibility this year, being featured in the French newspaper Le Monde—a recognition of both its scientific impact and the strength of the Franco-American partnership behind it.



PHYSICAL REVIEW LETTERS **135,** 071002 (2025)

Probing Benchmark Models of Hidden-Sector Dark Matter with DAMIC-M

K. Aggarwal,[1] I. Arnquist,[2] N. Avalos,[3] X. Bertou,[4,5] N. Castelló-Mor,[6] A. E. Chavarria,[1] J. Cuevas-Zepeda,[7] A. Dastgheibi-Fard,[8] C. De Dominicis,[5] O. Deligny,[4] J. Duarte-Campderros,[6] E. Estrada,[3] R. Gaïor,[5] E.-L. Gkougkousis,[9] T. Hossbach,[2] L. Iddir,[3] B. J. Kavanagh,[6] B. Kilminster,[9] A. Lantero-Barreda,[6] I. Lawson,[10] A. Letessier-Selvon,[5] H. Lin,[1] P. Loaiza,[4] A. Lopez-Virto,[6] R. Lou,[7] K. J. McGuire,[1] S. Munagavalasa,[7] J. Noonan,[7] D. Norcini,[11] S. Paul,[7] P. Privitera,[7,5,12] P. Robmann,[9] B. Roach,[7] M. Settimo,[13] R. Smida,[7] M. Traina,[6,1] R. Vilar,[6] R. Yajur,[7] D. Venegas-Vargas,[11] C. Zhu,[11] and Y. Zhu[5]

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(Received 22 March 2025; revised 2 June 2025; accepted 23 June 2025; published 13 August 2025)

We report on a search for sub-GeV dark matter (DM) particles interacting with electrons using the DAMIC-M prototype detector at the Modane Underground Laboratory. The data feature a significantly lower detector single e^- rate (factor 50) compared to our previous search, while also accumulating a 10 times larger exposure of ~1.3 kg-day. DM interactions in the skipper charge-coupled devices (CCDs) are searched for as groups of two or three adjacent pixels with a total charge between 2 and 4 e^-. We find 144 candidates of 2 e^- and 1 candidate of 4 e^-, where 141.5 and 0.071, respectively, are expected from background. With no evidence of a DM signal, we place stringent constraints on DM particles with masses between 1 and 1000 MeV/c^2 interacting with electrons through an ultralight or heavy mediator. For large ranges of DM masses below 1 GeV/c^2, we exclude theoretically motivated benchmark scenarios where hidden-sector particles are produced as a major component of DM in the Universe through the freeze-in or freeze-out mechanisms.

DOI: 10.1103/2tcc-bqck



Le Monde

SCIENCES • PHYSIQUE

Sous une montagne de Savoie, la chasse aux particules de « matière noire », ce monde parallèle qui structure l'Univers

Près de Modane, un laboratoire du CNRS enfoui au niveau du tunnel routier tente de capter les éléments d'un monde parallèle à notre Univers. D'ici à la fin de l'année 2025, la « fenêtre » d'observation des chercheurs franco-américains sera dotée de détecteurs plus performants.

Par David Larousserie

Publié le 27 juillet 2025 à 18h00, modifié le 29 juillet 2025 à 07h18 · Lecture 5 min.

[5] Subatech : A joint research laboratory of CNRS, IMT Atlantique, and the University of Nante
[6] LPNHE : Laboratoire de physique nucléaire et de hautes énergies, a joint research laboratory of CNRS , Sorbonne Université and et the Université Paris-Cité
[7] IJCLab : The laboratoire de physique des deux infinis Irène Joliot-Curie a joint research laboratory of CNRS , the Université Paris-Saclay and the Université Paris-Cité

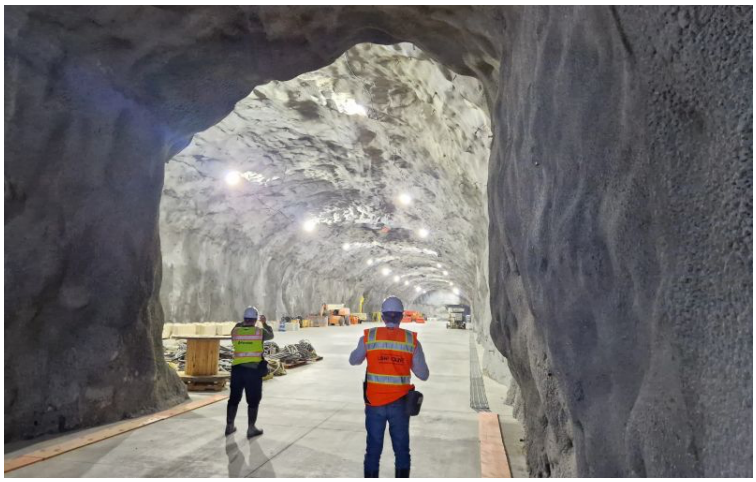
DUNE

The **Deep Underground Neutrino Experiment (DUNE)** stands as a cornerstone of the IRL Particle Physics and Cosmology, embodying the deep and dynamic partnership between the CNRS and the University of Chicago. As one of the largest joint endeavors in particle physics, DUNE brings together nearly 80 CNRS scientists and engineers across seven French laboratories with their US colleagues, making it a model for international collaboration in fundamental research.

The long-standing CNRS and UChicago collaboration has been instrumental in strengthening and expanding this partnership. The project is supported by a **CNRS–UChicago Joint PhD Grant**, awarded in 2022 to Edward Blucher (UChicago) and Camelia Mironov (APC, CNRS–Université Paris Cité), which now funds the doctoral research of I Cheong Hong (APC, CNRS–Université Paris Cité). I Cheong works in collaboration with Yirui Liu, a PhD student at UChicago, on vertex reconstruction in DUNE. In addition, Edward Blucher and Alessandra Tonazzo (APC, CNRS–Université Paris Cité) were awarded a 2025 **FACCTS grant** to facilitate closer integration between French and US teams.

The past year was marked by significant scientific exchange and technical preparation. **Long-term visits** by Matteo Galli (CNRS APC–Université Paris Cité), supported by the **CRADA Fermilab–CNRS** agreement, and Laura Zambelli, recipient of a **Fermilab Neutrino Physics Center Fellowship**, are crucial in advancing the project's scientific and technical objectives.

Among the year's key activities, the DUNE collaboration organized major events in the United States, including the **DUNE Collaboration Meeting at Fermilab** (September 8–12, 2025), a week-long international conference that brought together hundreds of researchers from around the world. The IRL PPC played a key role in facilitating French participation, through its **support for travel** and the organization of a one-day **satellite workshop** at the University of Chicago (see *Workshops and Seminars*). Additionally, the CNRS DUNE community actively prepared for the construction phase of DUNE by participating in a series of technical workshops dedicated to the installation of DUNE's far detector at the Sanford Underground Research Facility (SURF) (September 16–20, 2024, and March 24–28, 2025). These workshops are critical for addressing the complex



logistical and technical challenges of deploying the experiment's gigantic detector modules, ensuring that the collaboration remains on schedule and at the forefront of neutrino science.

JEM-EUSO

The **JEM-EUSO (Joint Exploratory Missions for Extreme Universe Space Observatory)** collaboration continues to advance its mission to observe high-energy cosmic rays from space. In December 2024, a delegation from CNRS Particles & Nuclei—Denis Allard, Etienne Parizot, Bruny Baret, Alexandre Creuzot, and Enzio M'sihid—attended the JEM-EUSO collaboration meeting at the **Kavli Institute for Cosmological Physics (KICP)** at the University of Chicago. This meeting was a crucial step in preparing for the next flight mission, which aims to detect the highest-energy cosmic rays as they interact with the Earth's atmosphere. While the IRL PPC has not yet been directly involved in JEM-EUSO activities, it is closely following these developments and exploring opportunities to strengthen collaboration between CNRS and the University of Chicago in this cutting-edge field.



Publications & Bibliometrics

Between 2020 and 2025, the number of joint publications involving the University of Chicago and at least one of the CNRS/IN2P3 laboratories increased by **about 40%** over the period. After a temporary dip in 2021, the steady rise that followed reflects the consolidation of transatlantic research links and the expansion of collaborative projects across several domains of particle physics and cosmology.

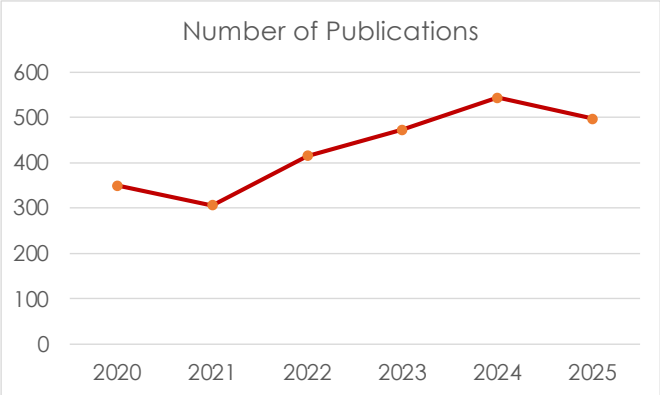


Figure 1: Evolution of the number of cross-publications involving academics from the University of Chicago and at least one of CNRS Nuclei and Particles laboratory.

Looking at the distribution by scientific field, **High-Energy Physics (HEP)** remains the dominant area of collaboration, mostly in connection with the LHC program at CERN, with an average share of **46%** over the past decade, though its relative weight has declined from **61% in 2020 to 35% in 2025**.

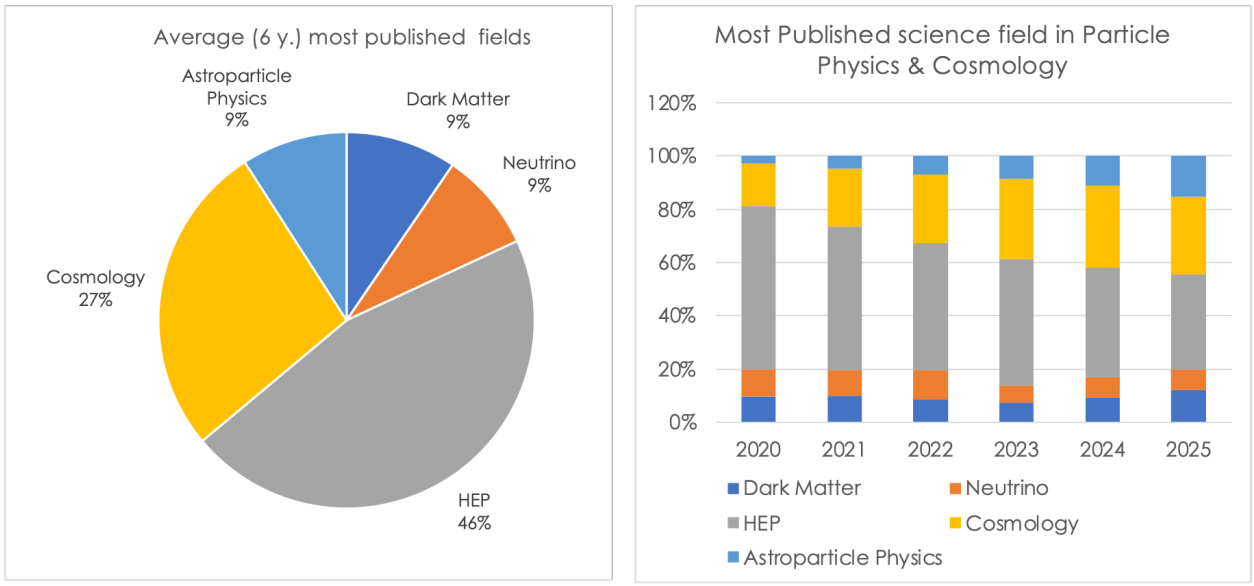


Figure 2: Average distribution and evolution of publications by research field (2020–2025)

Over the same period, **Cosmology** and **Astroparticle Physics** have seen remarkable growth. This diversification illustrates a clear shift toward broader scientific themes, including **Dark Matter** and **Neutrino Physics**.

Overall, the data reveal a progressive rebalancing of the collaborative landscape: while HEP remains a cornerstone, cross-disciplinary efforts in cosmology, dark matter, and astroparticle physics are increasingly shaping the shared scientific output between CNRS and the University of Chicago.

Picture of the Year

Superb Northern Lights over Lake Michigan on the night of October 8th 2024, seen from Montrose beach in Chicago. It's one of those marvelous natural phenomena in which the naked eye can see the traces of elementary particles (electrons) or combined particles (protons, ions).

Northern Lights over Lake Michigan



People and Leadership at the IRL PPC

Leadership



Cédric Cerna

Director, CNRS-UChicago Particle Physics and Cosmology IRL

Visiting Scholar at the Enrico Fermi Institute at UChicago Senior scientist at CNRS | CNRS Project Manager of the Deep Underground Neutrino Experiment (DUNE)



Bonnie T. Fleming

Deputy Director, CNRS-UChicago Particle Physics and Cosmology IRL

Professor at the University of Chicago | Fermilab's Deputy Director for Science and Technology and Chief Research Officer

Principal Investigators



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Dept. of Physics, Director of the Enrico Fermi Institute, and the College



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Scientist at CNRS

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Institute of Physics of the two Infinities Irène Joliot-Curie (IJCLab), CNRS & the Université Paris-Saclay



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Luca Scotto Lavina

Senior Scientist at CNRS

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Administrative staff



Séverine Boué

Administrative Manager, Particle Physics and Cosmology IRL and Humanities Plus IRL

She has been working at the National Centre for Scientifique Research (CNRS) since 2000.
She holds a PhD in history from Paris 1 Panthéon-Sorbonne University, specializing in Franco-American diplomatic relations. Since the beginning of her career, she has worked in several higher education and research institutions where she held positions in the field of international relations (Ministry of Foreign Affairs, Ifremer, Paris-Est University, National Research Agency, Embassy of France in China).

Communication & Outreach

Website : https://ppc.in2p3.fr

The IRL PPC website is hosted by CNRS. The layout was designed by **Fanny Cadou** (LP2I/CNRS-IN2P3 & Université de Bordeaux) and the website is maintained by **Séverine Boué** (IRL PPC)

Linkedin : https://www.linkedin.com/company/intl-research-laboratory-particle-physics-cosmology/

Annexe CNRS Nuclei and Particles (IN2P3)

The CNRS Nuclei and Particles (IN2P3) is the CNRS institute responsible for coordinating research in nuclear physics, particle physics and astroparticle physics in France. Since its creation in 1971, it has advanced knowledge at both ends of the scale of the Universe — from the infinitely small (elementary particles, strong/weak interactions) to the infinitely large (cosmology, astrophysics) — and developed critical infrastructures, detector technologies, large-scale data mining capabilities and major international partnerships. It stimulates innovation and supports the interplay between fundamental science, technological development and wider applications.

Key Figures



IN2P3 Laboratories in France

Acronym	Full Name	City
APC	Astroparticule et Cosmologie	Paris
CPPM	Centre de Physique des Particules de Marseille	Marseille
IJCLab	Laboratoire de Physique des 2 Infinis – Irène Joliot-Curie	Orsay
IP2I	Institut de Physique des 2 Infinis	Lyon
IPHC	Institut Pluridisciplinaire Hubert Curien	Strasbourg
L2IT	Laboratoire des 2 Infinis de Toulouse	Toulouse
LAPP	Laboratoire d'Annecy de Physique des Particules	Annecy
LLR	Laboratoire Leprince-Ringuet	Palaiseau
LP2IB	Laboratoire de Physique des 2 Infinis de Bordeaux	Bordeaux-Gradignan

LPC	Laboratoire de Physique de Clermont	Clermont-Ferrand
LPC Caen	Laboratoire de Physique Corpusculaire de Caen	Caen
LPNHE	Laboratoire de Physique Nucléaire et de Hautes Énergies	Paris
LPSC	Laboratoire de Physique Subatomique et de Cosmologie	Grenoble
LUPM	Laboratoire Univers et Particules de Montpellier	Montpellier
Subatech	Laboratoire de Physique Subatomique et des Technologies Associées	Nantes

IN2P3 International Research Laboratories in the World

Acronym	Full Name	City/Country	Direction
CPB	Centrer Pierre Binétruy	Berkeley, USA	Radek Stompor
DMLab	CNRS Helmholtz Dark Matter Lab	Hambourg, Germany	Dirk Zerwas
ILANCE	International Laboratory for Astrophysics, Neutrino and Cosmology Experiments	Tokyo, Japan	Michel Gonin
NPA	Nuclear Physics and Astrophysics	East Lansing, USA	Jérôme Margueron
TYL	Toshiko Yuasa Laboratory	Tsukuba, Japan	Karim Trabelsi
PPC	Particle Physics & Cosmology	Chicago, USA	Cédric Cerna
NPAT	Nuclear Physics, Nuclear Astrophysics and Accelerator Technologies	Vancouver, Canada	David Lunney

Annexe Physical Sciences Division at UChicago

"The Physical Sciences Division (PSD) at the University of Chicago has a rich history of defining and advancing new fields in the physical and mathematical sciences, and that tradition of innovation continues today. Our faculty and students lead research on the origins of life, the planet, and the universe; forge new paths towards a better future with applied sciences; and expand the impact of the physical and mathematical sciences through discoveries of the fundamental laws of nature and reason.

The division includes the academic departments of Astronomy & Astrophysics, Chemistry, Computer Science, Geophysical Sciences, Mathematics, Physics, and Statistics. In addition, PSD is home to a number of interdisciplinary research institutes and centers, including the Enrico Fermi Institute, the James Franck Institute, and the Kavli Center for Cosmological Physics. Many of our scientists have joint appointments at the Fermi National Accelerator Laboratory and Argonne National Laboratory as well as joint affiliations with other Chicago-based research institutions such as the Toyota Technological Institute of Chicago, the Adler Planetarium, the Museum of Science and Industry, and the Field Museum. Our students build connections with world-leading scientists, collaborate across disciplines, and enjoy the dynamic Chicago and University communities."

From the website of the Physical Sciences Division (https://physicalsciences.uchicago.edu)

Departments :

- Astronomy and Astrophysics
- Chemistry
- Computer Science
- Geophysical Sciences
- Mathematics
- Physics
- Statistics

Institutes :

- Data Science Institute
- Enrico Fermi Institute
- Institute for Biophysical Dynamics
- Institute for Mathematical and Statistical Innovation
- James Franck Institute
- Kavli Institute for Cosmological Physics
- National Institute for Theory and Mathematics in Biology (NITMB)
- The SkAI Institute

Director of publication: Cédric Cerna
Assistant: Séverine Boué

Particle Physics and Cosmology

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