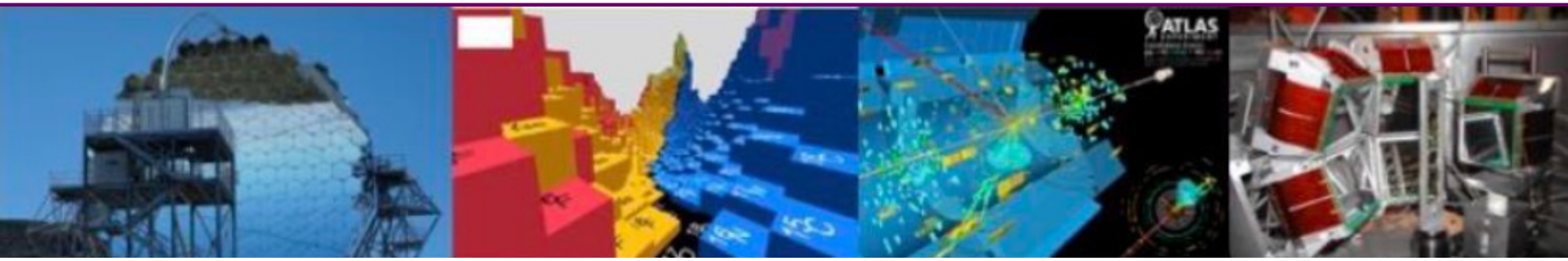
université PARIS-SACLAY
GRADUATE SCHOOL Physique

P2I Physique des deux Infinis



Physics of the 2 Infinities

Tiina Suomijärvi
P2I – GS Physics, Paris-Saclay University

1 December 2022

université PARIS-SACLAY
GRADUATE SCHOOL Physique

P2I Physique des deux Infinis

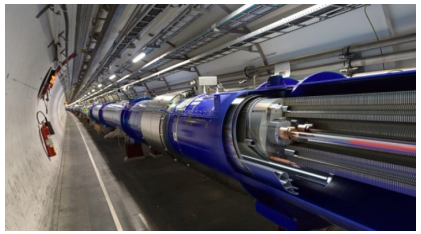
Physics of the 2 Infinities
Graduate School of Physics

Experimental and theoretical research on fondamental science

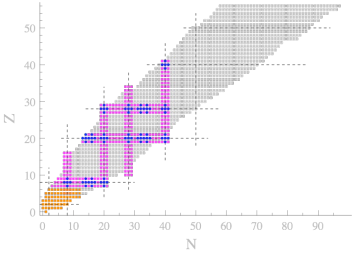
Uncover the ultimate, infinitely small components of matter and the fundamental laws that govern their interactions

Understanding complexity: strong interaction and the emergence of complexity

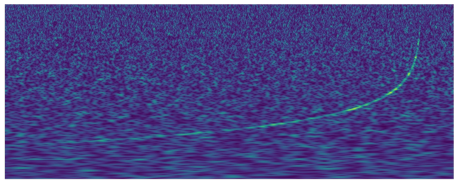
Elucidate the origin and evolution of the infinitely large components of the Universe



From the Standard Model to new physics



Modeling the nuclear chart: a many-body problem



Towards multi-messenger observations of the Universe

GW170817

Original interdisciplinary research on societal issues: health and energy

Unique know-how in advanced technologies

1400 people spread over 10 laboratories managed by 3 supervisory bodies: CEA, CNRS, UFR-Science
About 40% of the national community in our research area

université PARIS-SACLAY
GRADUATE SCHOOL Physique

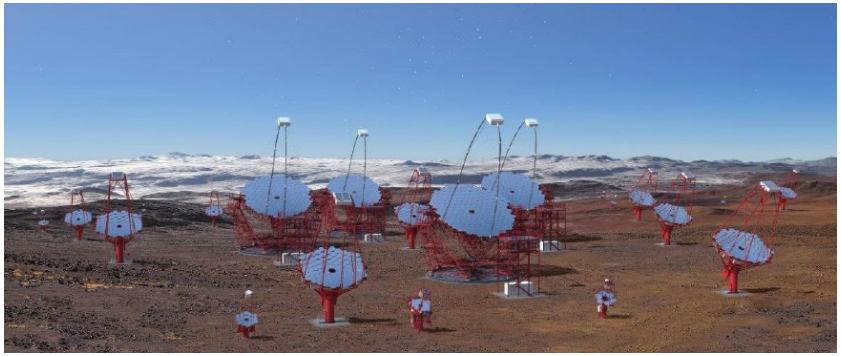
P2I Physique des deux Infinis

Astroparticles, Nuclear Astrophysics, and Cosmology

Astroparticles

Violent phenomena and the origin of cosmic rays

- CTA, flagship project with experience on H.E.S.S.
- Study of gravitational waves: Virgo, Einstein Telescope, LISA
- Importance of multi-messenger studies: charged particles (AugerPrime), gammas (CTA, SVOM)



Cherenkov Telescope Array

Cosmology

Dark energy and inflation

- Large structures: LSST
- Baryon Acoustic Oscillations: DESI
- Cosmic microwave background: LiteBIRD satellite, CMB-S4 observatory

Dark matter

- Upgrade of EDELWEISS, Xenon, Damic

LSST

Nuclear astrophysics

Nucleosynthesis

- Satellite projects and experiments with accelerators

- Rich and diversified program combined with a unique strong interface with astrophysics, particle and nuclear physics
- Research via multi-messenger and multi-wavelength approaches
- Development of space missions

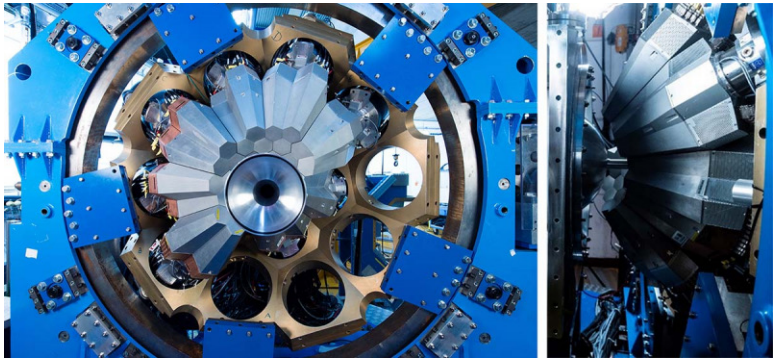
université PARIS-SACLAY
GRADUATE SCHOOL Physique
P2I Physique des deux Infinis

Nuclear and Hadronic Physics

Nuclear Physics

Measurements of nuclear properties in extreme conditions in temperature, isospin, and angular momentum

- Strong involvement in SPIRAL2 (GANIL)
- Experiences also with international accelerators
- ALTO as a local experimental platform



The AGATA (IR) detector seen from the front and in profile at GANIL.

Hadronic Physics

Understanding the Quark-Gluon Plasma

- Upgrade of the ALICE experiment at the LHC
- Nucleus-nucleus collision in LHCb and production of beauty/charm

Structure of hadrons

- Experiments at Jefferson Lab and FAIR
- Participation in the future electron-ion collider (EIC), structuring of the national effort

- Maintain and strengthen the preponderant place within French research on these themes
- Major role in future activities around GANIL
- Hadronic physics: questions on the future of quark and gluon plasma physics and on the future electron-ion collider (EIC)

université PARIS-SACLAY
GRADUATE SCHOOL Physique

P2I Physique des deux Infinis

Particle Physics

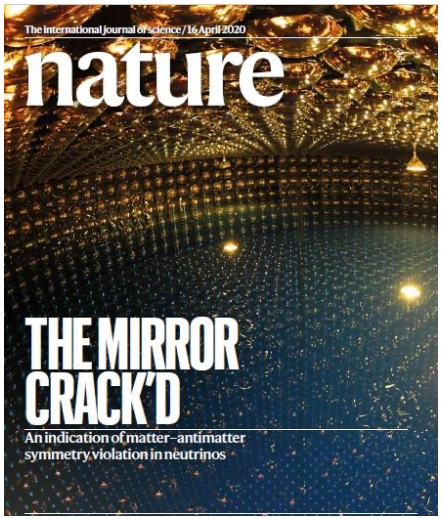
Particle physics

- Upgrades of LHC detectors (Atlas, CMS, LHCb) for the high-luminosity phase (measurements of couplings to the Higgs boson and its self-coupling)
- Flavor physics, anomalies in lepton universality (Belle II, LHCb)
- Prospects for future colliders

- Consolidate the major role in high-precision studies of the Standard Model, in the search for new physics, and in future projects by participating in the European strategy
- Technological developments at the frontier of current knowledge in detector and accelerator physics
- Major challenge: the success of the ongoing LHC detector improvement programs

Neutrino physics

- Precision measurements of oscillation parameters: CP violation and mass hierarchy (DUNE, T2HK)
- Nature Dirac/Majorana (SuperNEMO, CUPID)
- Constraints on sterile neutrinos (KATRIN, STEREO)
- Study of the coherent interactions of neutrinos (NUCLEUS, Ricochet)



The T2K experiment excluded for the first time, at three sigma, almost half of the possible values of the delta phase which governs CP violation in the lepton sector.

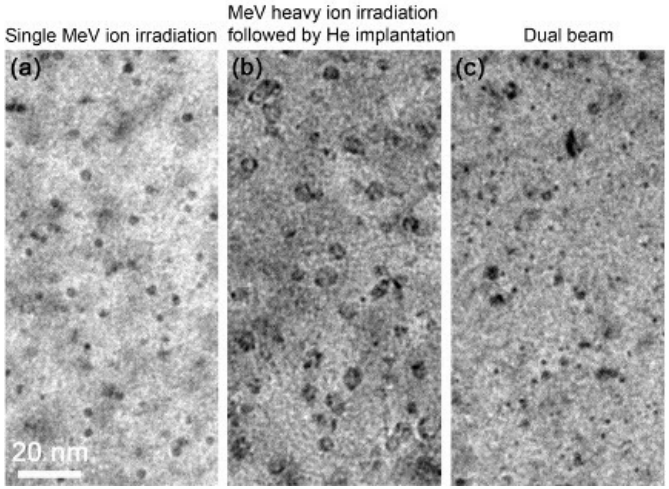
Research related to Energy and Health

Energy

- Nuclear energy (fusion, fission) and renewable energies (superconducting wind turbines)
- R&D on nuclear physics and innovative materials
- Multidisciplinary R&D on the interaction with the environment and the evolution of nuclear power plants

Health

- Research at the interface of physics, biology and medicine, complementary to other GS
- Preclinical and clinical imaging in oncology and neurosciences
- Development of probes for biological imaging
- New approaches in radiotherapy
- Modeling the evolution of cancerous brain tumors



Cavities induced by ion irradiation with heavy ions of a few MeV, simulating neutron damage, JANNuS-SCALP, IJCLab, Orsay.

- Based on skills and expertise in fundamental research, and on the implementation of cutting-edge technologies and innovation capabilities
- Strengthen interfaces to other domains

université PARIS-SACLAY
GRADUATE SCHOOL Physique

P2I Physique des deux Infinis

Accelerators and Superconducting Magnets

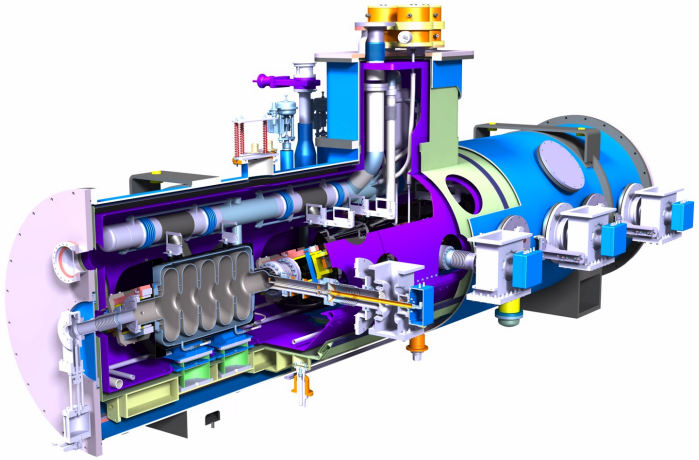
Research topics

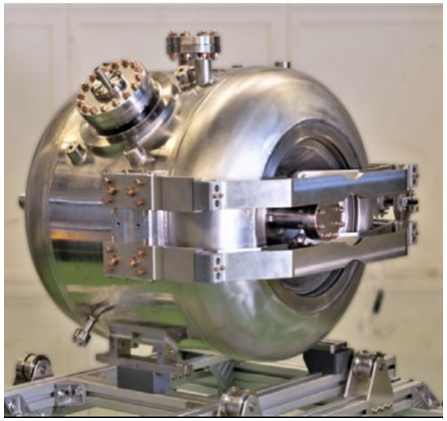
- New generations of cavities and superconducting magnets
- Very high gradient acceleration
- Mastery of extreme beams

P2I leader in France

- Contributions to the construction of national, European, and international research IRs
- Varied skills
- Ensure the operation of local installations (ALTO, JANNus, ThomX, IPHI, etc.)

- R&D for new conceptual and technological advances
- Integration of environmental themes and energy consumption
- Design and enrich local platforms





The Proton Improvement Plan-II (PIP-II) at Fermilab for DUNE: design of the cryomodule MB650 (irfu) and the first Spoke Resonator (IJCLab).

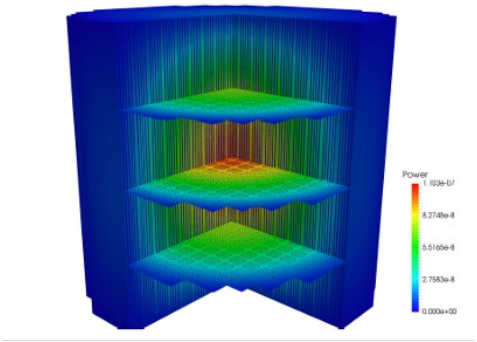
Detectors and Digital Research

Instruments at the border of the state-of-the-art

- Diversity of P2I domains ⇒ wide range of detection systems
- Ultimate performance: simultaneous development of detectors, their readout electronics, and their integration

Data processing and calculation

- Parallelism and new hardware architectures
- Data storage infrastructure
- Data science
- Rely on local or regional infrastructures

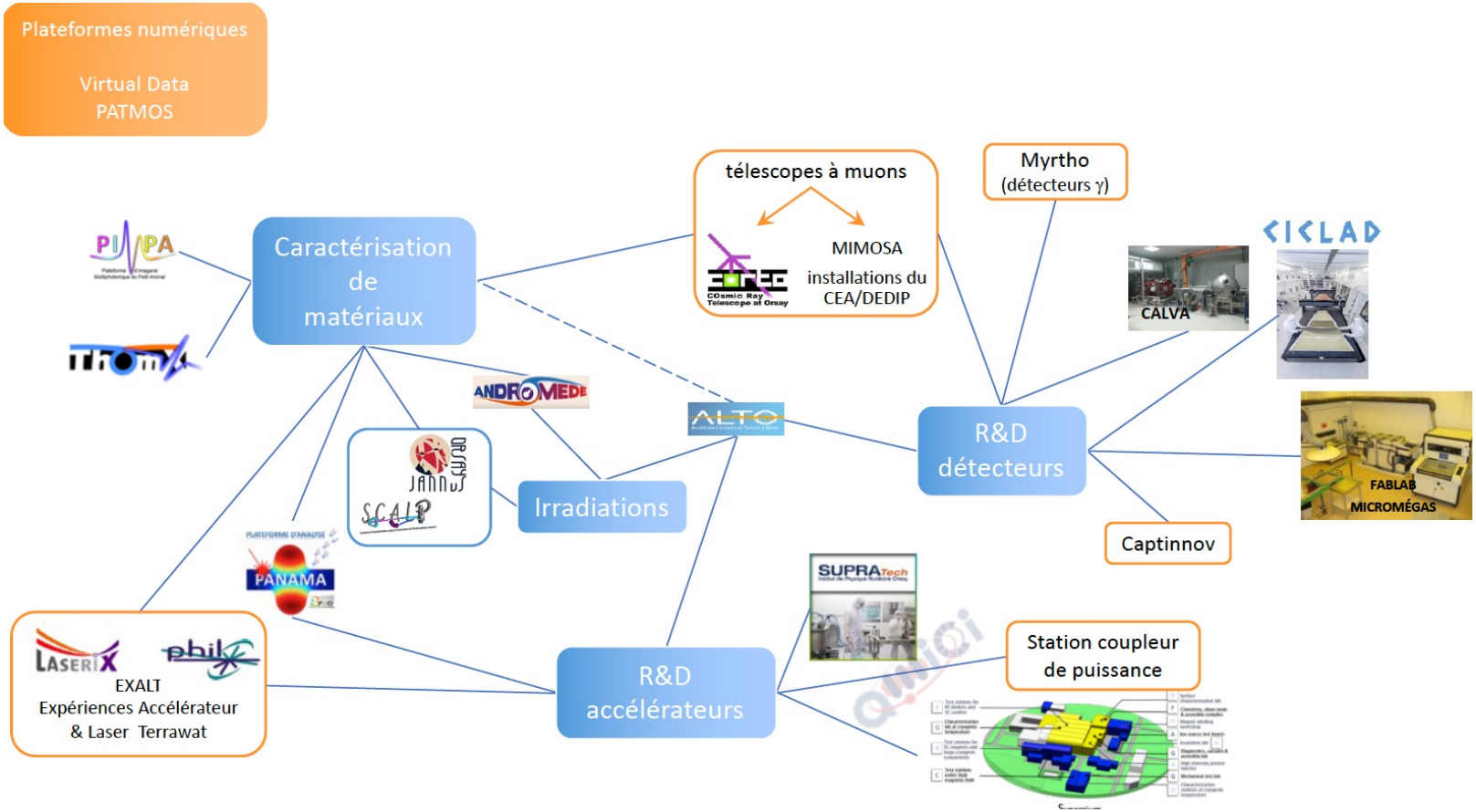


Simulation of the reactor core

- Sustainability of platforms and skills
- Promote experimental profiles and increase attractivity
- Increase R&D and synergies

Platforms

- Exploitation of ~ 20 technological or digital platforms
- Several supported by LabEx, SESAME, EQUIPEX
- Significant potential for training and links with manufacturers



Strengths, Opportunities, and Difficulties

Strengths
- Size of the P2I community (>40% of the national effort)
- National and international visibility
- Strong technical potential and a network of platforms
- Integrated teams: theoreticians - experimenters - engineers

Opportunities
- Numerous research projects on major fundamental questions
- Growing interactions between societal challenges and P2I research topics
- Better attractiveness of students and researchers
- Stronger local collaborations

Difficulties
- Funding is needed beyond major RI funding (planning and prototyping of RIs, data analysis and interpretation)
- The timescales of some projects are very long in comparison to the timescales of the funding time.
- P2I R&D topics are sometimes not much in phase with the priorities displayed by the funding desks (ANR or H2020).

université PARIS-SACLAY
GRADUATE SCHOOL Physique

P2I Physique des deux Infinis

Governance Structures of P2I

2017-20: P2I Research Department
Since 2021: P2I Research Axis of the Graduate School of Physics

The P2I Research axis includes the following bodies:

- Comité d'Axe (P2I Committee) with total 24 members
- Bureau (Office): currently of 4 members, will be extended to the current coordinator and deputy coordinator of the LabEx P2IO for a period going until the end of the projects undertaken by P2IO.
- Collège DU (Committee of the P2I laboratory directors)
- Collège des Tutelles (Supervisory Committee): CEA, CNRS, UFR-Science)
- Scientific Council (a total of 8-10 international researchers)

université PARIS-SACLAY
GRADUATE SCHOOL Physique
P2I Physique des deux Infinis

Responsibilities and Activities of P2I

- Participate in the development of the University's research and innovation strategy
- Participate in the definition of internal calls for projects at the University
- Propose a platform policy, consistent with that of the University
- Express its needs for human resources in training and research
- Competence to instruct and decide on
  - Calls for projects internal to P2I
  - Evaluations pour GS Physique/Paris-Saclay University (SESAME, Research Fellowships)
  - Animation, joint programming, and prospective research activities
  - The development or pursuit of research partnerships

Multiannual Research Program

Multiannual research program over 5 years (2023-27)

- Call for P2I projects
  - Emerging ideas and R&D projects
  - Support and develop platforms
  - Support for postdoc projects
- Call for “Flagships” projects (difficult)
- Support for the scientific animation and outreach activities (includes Emilie du Châtelet calls from P2IO and current calls from P2I)

Currently estimated budget:

2023	2024	2025	2026	2027
416 k€	416 k€	850 k€	850 k€	850 k€

Conclusions

- The size of the P2I community is about 1400 people corresponding to >40% of the national effort.
- P2I has strong technical potential and a network of platforms.
- P2I profits of integrated teams: theoreticians - experimenters – engineers.
- Funding is needed beyond major RI funding (planning and prototyping of RIs, data analysis and interpretation)
  -> Funding of the type P2IO + SESAME+ANR is crucial!
- P2I governance structures are prepared to evaluate and decide on a Multiannual Research Program.
- The Graduate School of Physics allows us to enhance interdisciplinary actions and student attractivity.

Many thanks to P2IO for the support of our research field!