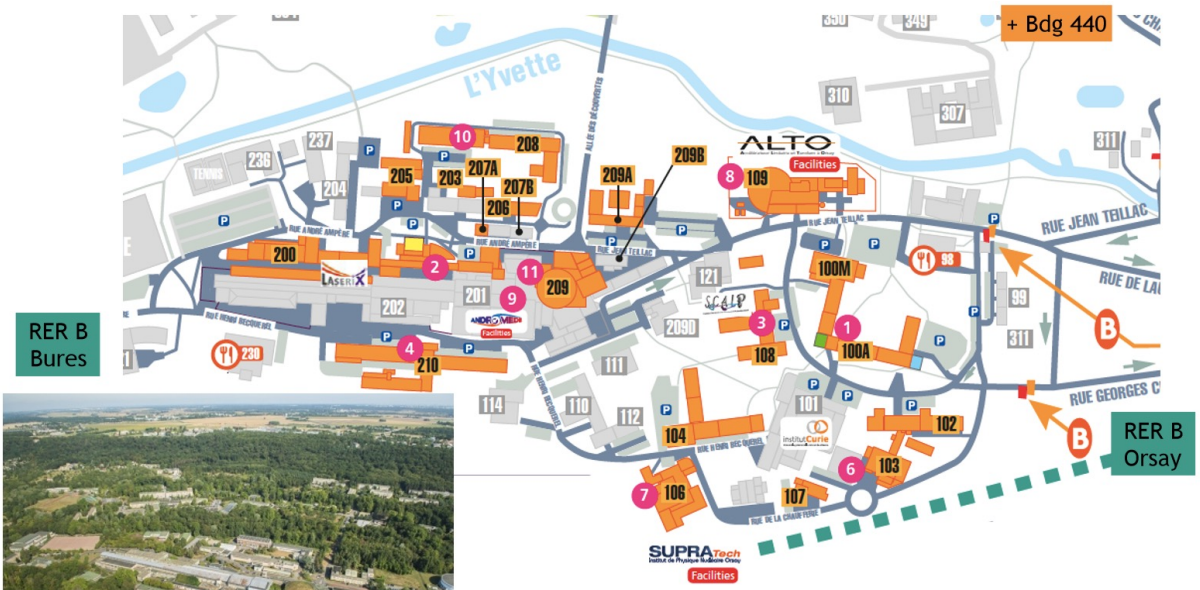
IJCLab

Laboratoire de physique des deux infinis Irène Joliot-Curie

New Laboratory born in 2020
from the merger of 5 Orsay laboratories



www.ijclab.in2p3.fr

730 Collaborators
- **260** Researchers & Professors
- **340** Engineers & Technicians

150 People accredited to supervise PhD

140 PhD and Post-docs
- **50** European and International Research Grants
- **150** National and Local Research Grants

600/y Articles in international peer-reviewed journals

7 Scientific Poles

1 Engineering Pole

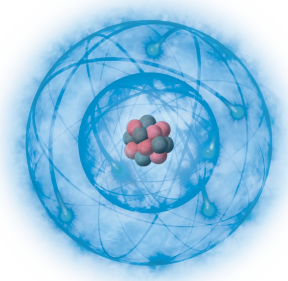
5 Research Platforms

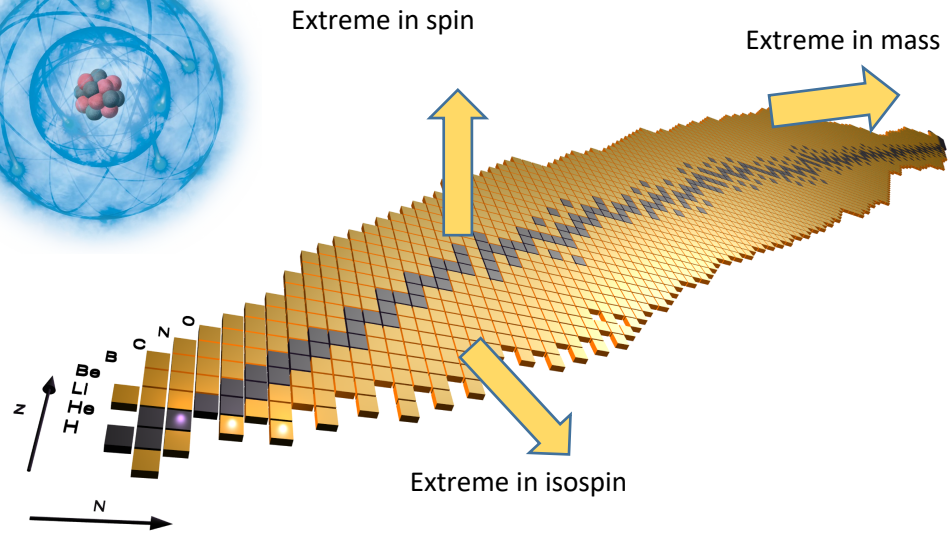
6 Technical Platforms

50000 m² of Buildings

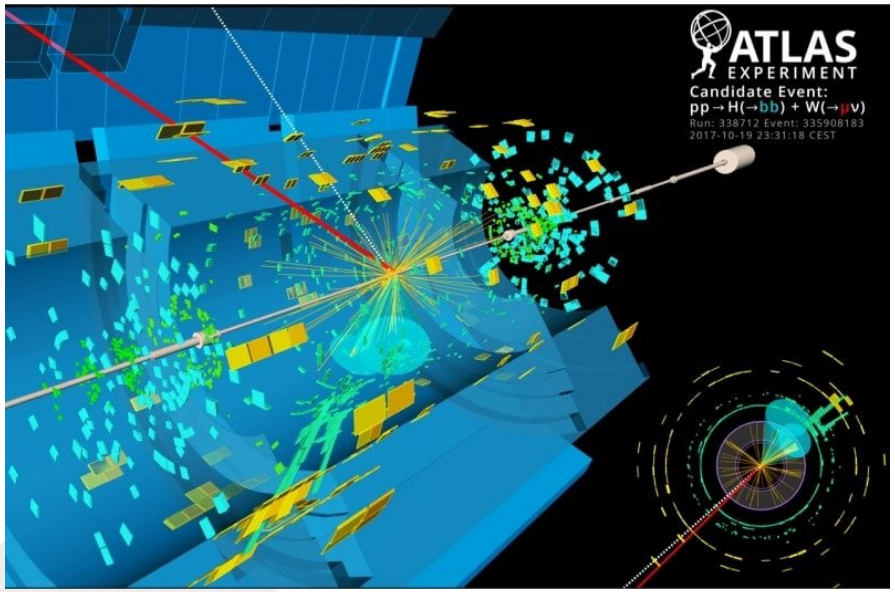
IJCLab in a nutshell (1)

Historically : Probing matter at small distances/high energies





Nuclear Physics



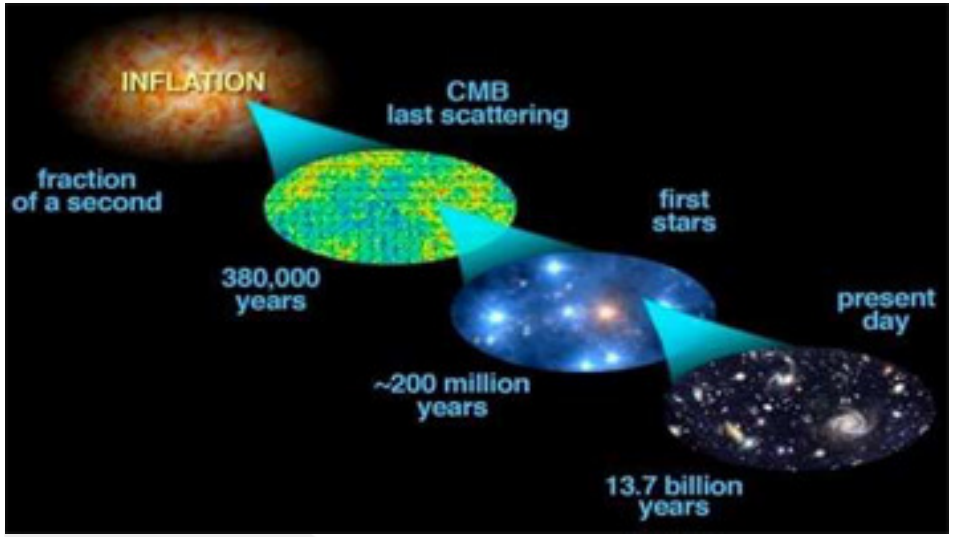
Particle Physics

Understanding the building blocks of matter, their interactions,
and how matter properties emerge from them

IJCLab in a nutshell (2)

High energies also involved in studying violent phenomena of the Universe with natural links with high-energy physics

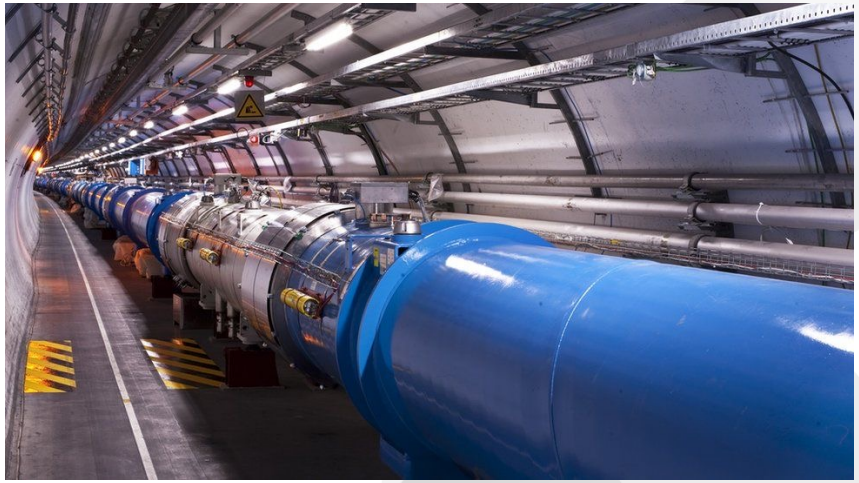
Astrophysical events
(high-energy cosmic rays,
black holes merger,
general relativity...)



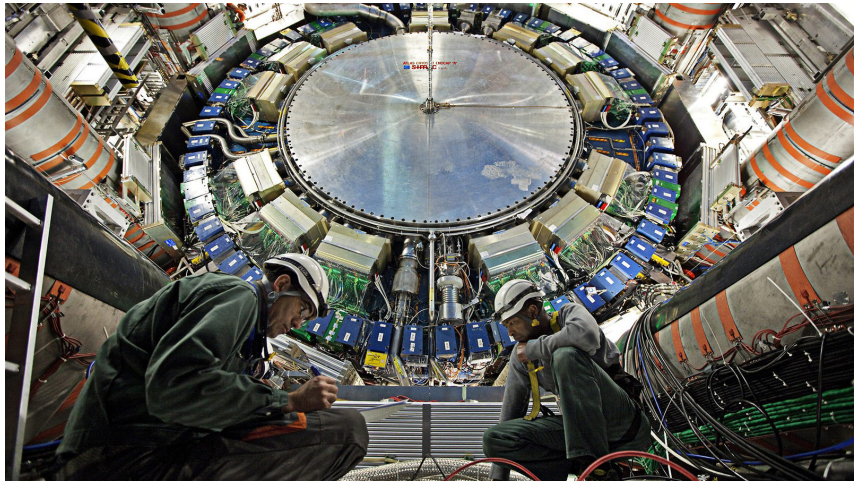
Cosmology
(evolution of the Universe,
inflation, large structures,
dark matter and energy)

IJCLab in a nutshell (3)

Building tools to perform these investigations

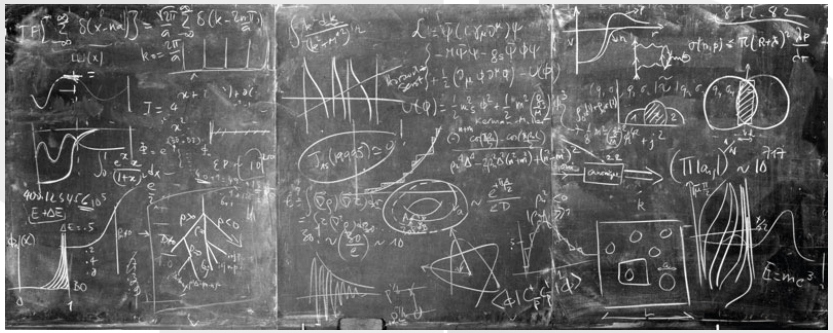


Accelerators



Detectors

Theory : interpreting and relating results

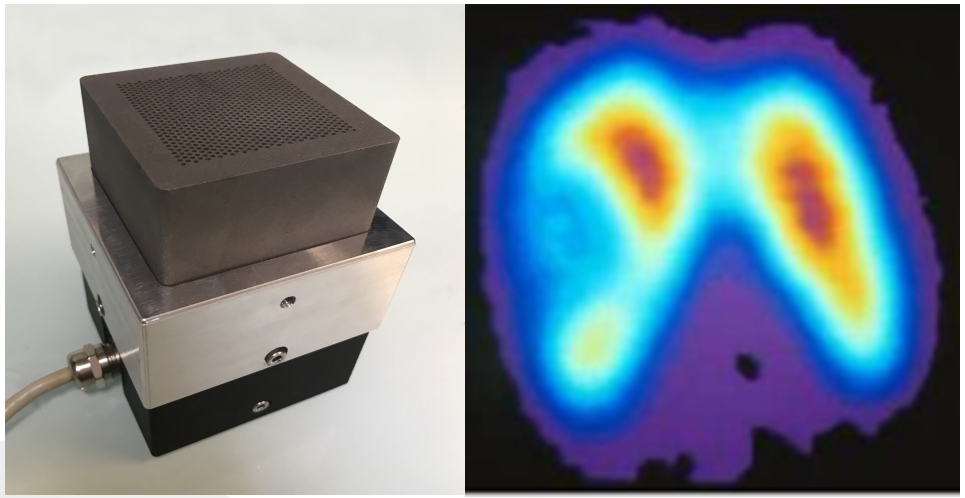


and suggesting new tests and ideas

IJCLab in a nutshell (4)

Tools and concepts applied in areas with impact on society

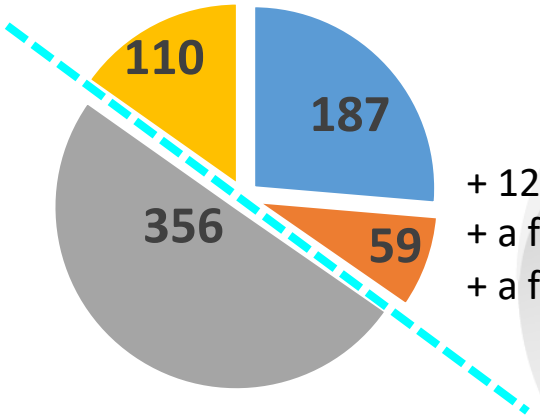
Energy and environment
(nuclear energy,
radiochemistry...)



Health physics
(imaging,
therapy by irradiation)

IJCLab staff and governing bodies

IJCLab
Staff Status
(including non permanent)



710 people
+ 120 Internships
+ a few trainees (« Apprentis")
+ a few Long term visitors

All in all ~ 800 people present at the laboratory

CNRS (Centre National de la Recherche Scientifique)

- ~17000 researchers + 16000 technical staff
- 10 institutes among them **IN2P3 (Institut national de physique nucléaire et de physique des particules)**
- IN2P3 composed by ~20 large-scale laboratories
- IJCLab mainly linked to IN2P3 ~1/4 of HR of the IN2P3

Université Paris-Saclay

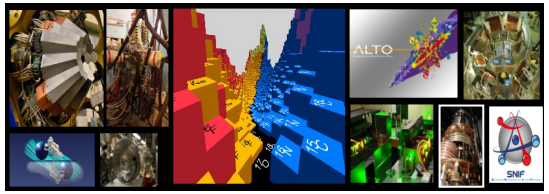
- 275 laboratories : 9000 researchers, 11000 IT *(University and research organism altogether, comprising CNRS and CEA)*
- 13th Shanghai ranking (Physics : 9th World, 1st Europe)
- 48000 students (with 9000 Master, 4000 PHD)

Université Paris Cité

- Specific links with IJCLab in Health Physics

7 Pôle Scientifiques

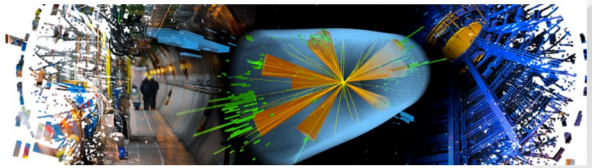
PHYSIQUE NUCLÉAIRE / NUCLEAR PHYSICS ~ 70



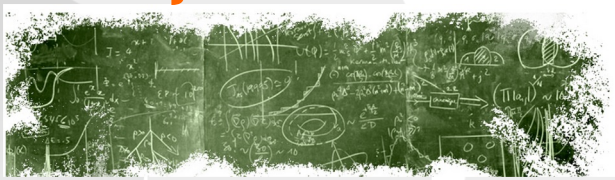
A2C Astroparticles, Astrophysics & Cosmology ~ 60

Accelerator Physics ~ 90

PHE Physique des Hautes Energies / High Energy Physics ~ 100



Theory ~ 80



Energy and Environment ~ 40

Health Physics ~ 25

710 members
530 staff
250 researchers
360 engineers and technicians

~ 110 PhD

~20 citizenships

~ 180 members
10 services in 4 tech depts

Mechanics

- Design office
- Mechanical realizations and assemblies

Workshops
- lathes
- milling machines
- 3D printer
- sheet metal work + control

IT and computing

- Development
- Operations
- On-line

Virtual Data datacenter
51 racks (2000 servers)
up to 600kW

Detectors and Instrumentation

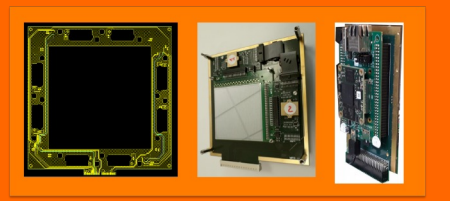
- Particle detectors
- Cryogenic detectors

and associated instrumentation

Captinov clean room for detector building and testing

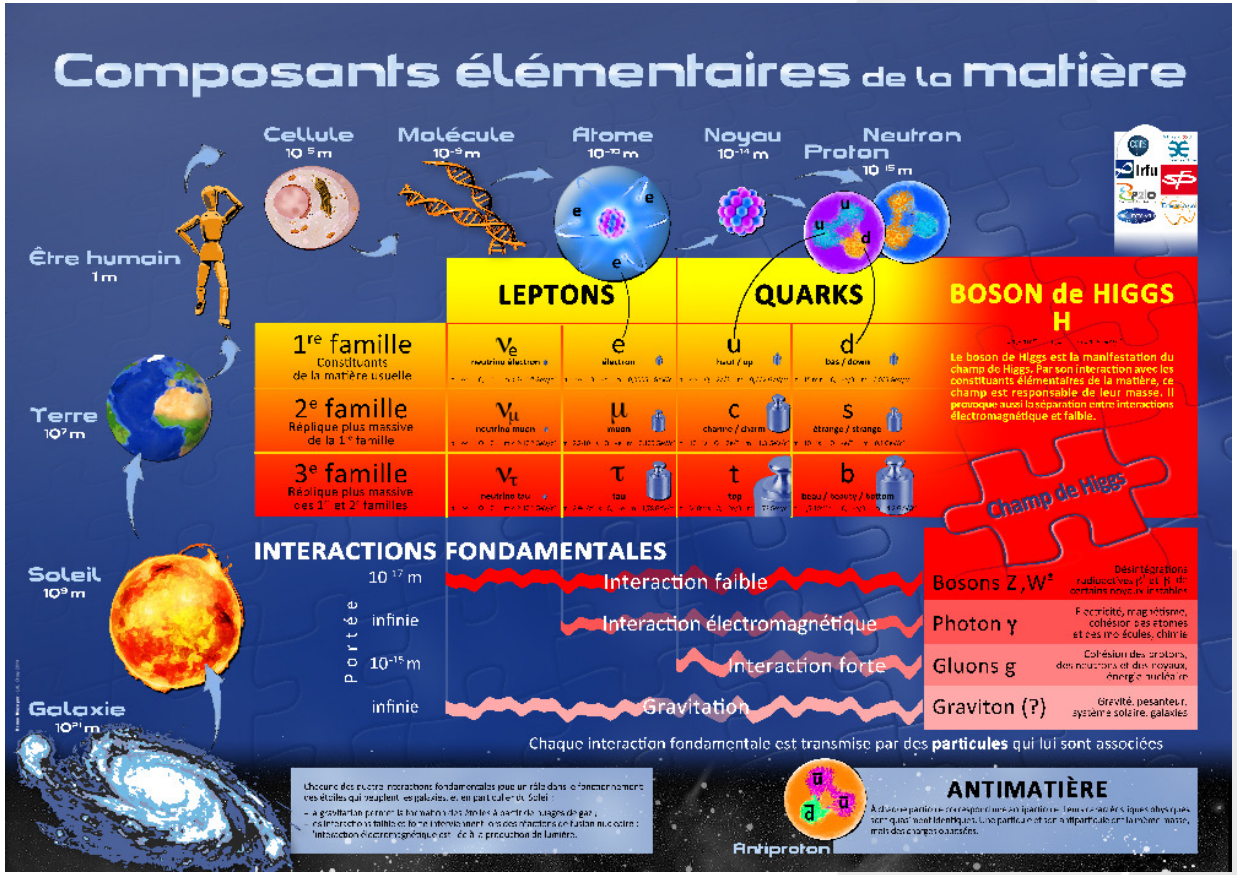
Electronics

- Analog dev. and microelectronics
- Digital systems and acquisition
- CAD prototyping and production



Low noise electronics for Si track sensors

High-energy physics



- Probing matter at the smallest scale
- Highest energies, creating new particles in collisions (eg LHC@CERN)
- Understanding their properties and interactions

Standard Model of Particle physics

- Tested and challenged for decades
- Latest addition : Higgs boson 2012

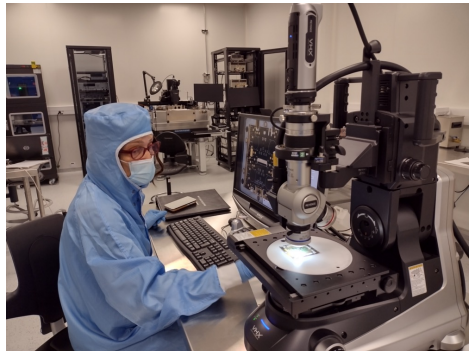
High-energy physics

Better understanding of the SM ⟷ **Challenging the SM**

Strong interaction

QGP & hadronic physics

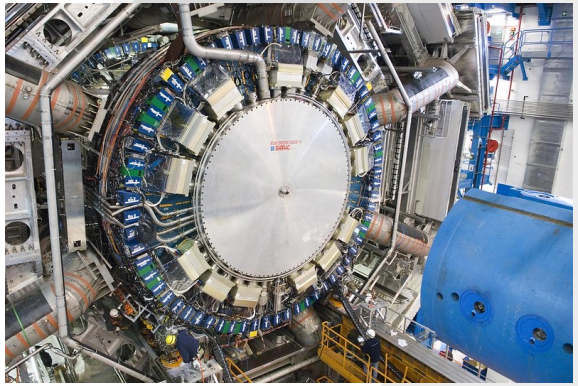
ALICE, HADES, Jlab, LHCb



Weak & electromagnetic interactions

(W,Z,H,t) physics

ATLAS, ILC



Flavour physics

Belle2, LHCb

Neutrinos physics

DOUBLE-CHOOZ
JUNO, DUNE

Beyond SM

ATLAS, Solid, (Super)NEMO

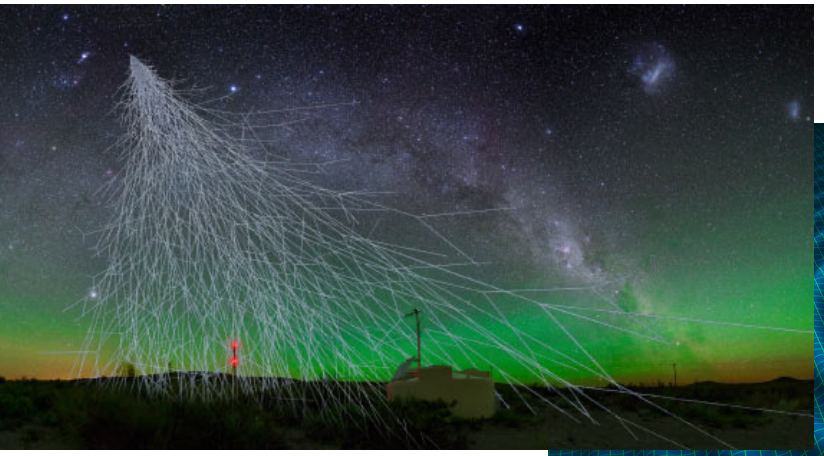
QED in intense em field

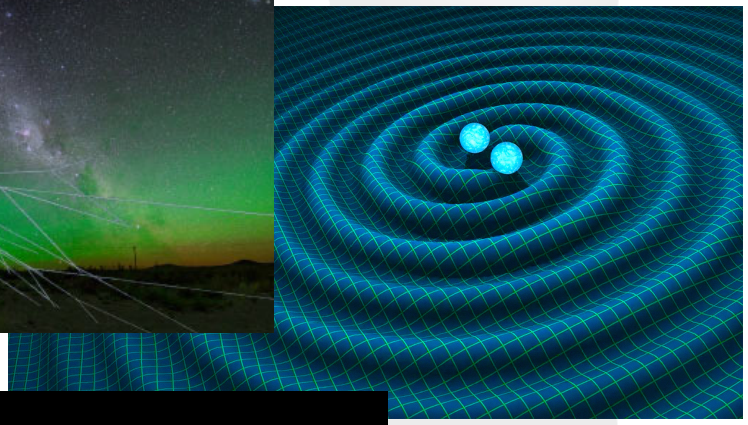
DeLLight

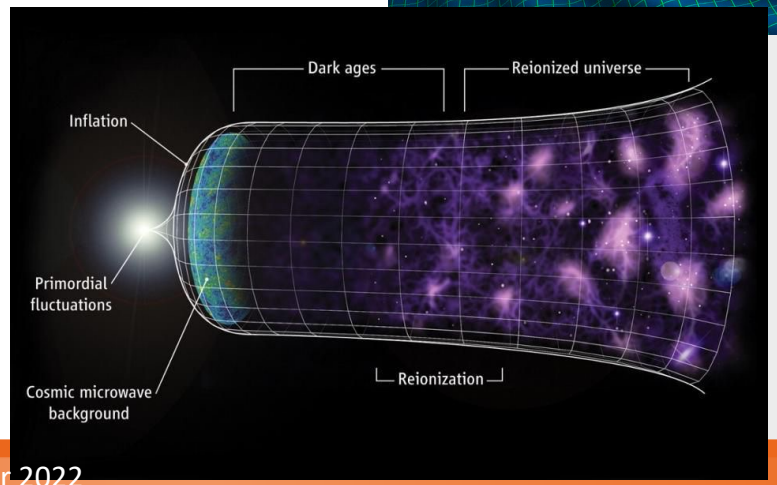
Challenging the SM → **direct searches**

Challenging the SM → **precise measurements**

Astroparticles, astrophysics and cosmology







- Violent phenomena in the universe (neutron stars, black holes, AGN...)
- High-energy cosmic rays
- Evolution of the universe (Big bang, large-scale structures)
- Role of dark matter, dark energy
- Multi-messenger astronomy (gravitational waves, astroparticles...)

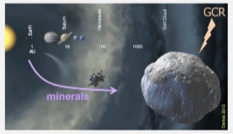
Connection with particle physics,
but also probing general relativity
and astrophysical questions

Astroparticles, astrophysics and cosmology

Astrophysique & Cosmochimie

e-ASTROGAM

micro-meteorites



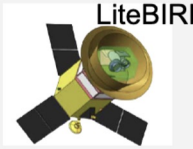
Astroparticules de Haute Énergie

Auger

CTA

CMB

LiteBIRD



Simons Observatory

Astroparticle solid state detectors

Cupid
Ricochet
Edelweiss

GREEN

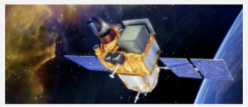
Vera Rubin (LSST)

BAO-Radio

Ondes gravitationnelles

LIGO/Virgo

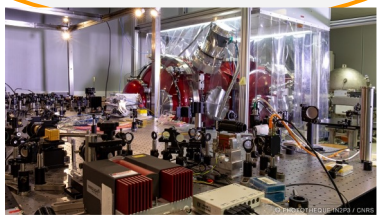
SVOM



DAMIC

and 2 platforms:

CALVA/Exsqueez



MYRTHO

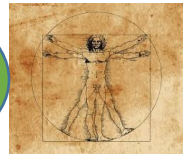
Nuclear Physics

reduction

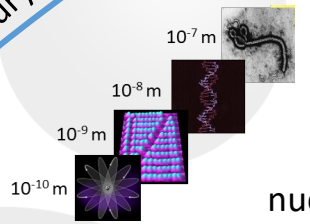
emergence

(the challenge of the XXIst century)

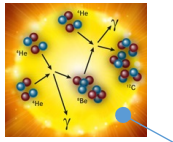
life & complexity



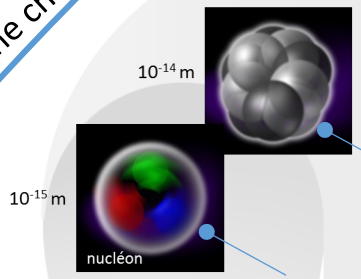
elemental diversity



nuclear processes and properties

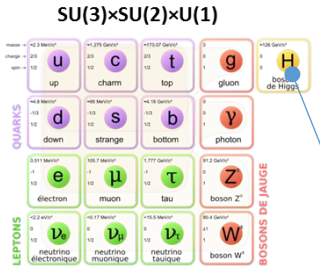


nuclear astrophysics



nucleons **in medium** binding energy ≈ **MeV/u**

quarks & gluons **medium** explains nucleon mass ≈ **1000 MeV**



Higgs process explains mass of quarks ≈ **5 MeV**

the origin of the mass of (≈90% of) visible universe:
due to **in-medium** (interacting) elementary particles

after the reduction to small set of constituents, emergence of nuclear properties ?

Nuclear Physics

a community of spectroscopists and builders

the discovery frontier (synthesis of new nuclei)

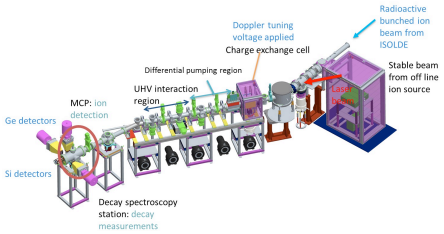
the precision frontier (network of observables)

with many experiments, locally (ALTO), nationally (GANIL) and internationally

Nuclear Spectroscopy : Orsay field of excellence

laser spectroscopy

- ISOLDE/CERN : CRIS, COLLAPS
- ALTO : LINO
- SPIRAL2/S3-LEB

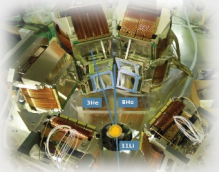


mass spectroscopy

- ISOLDE/CERN : ISOLTRAP
- TRIUMF/ISAC (Canada) : TITAN
- ALTO : MLL-Trap SPIRAL2/S3-LEB & DESIR

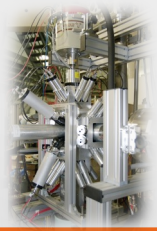
particle and missing/invariant-mass spectroscopy

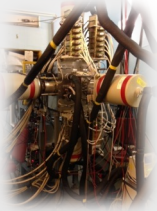
- GANIL : MUGAST, LISE, INDRA/FAZIA
- RIKEN (Japan)
- LNS (Italy): CHIMERA



delayed/recoil spectroscopy

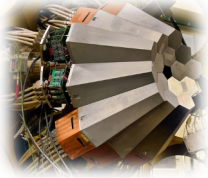
- ALTO : BEDO, TETRA, POLAREX
- GANIL : LISE
- JINR Dubna: GABRIELA
- SPIRAL2/S3: SIRIUS



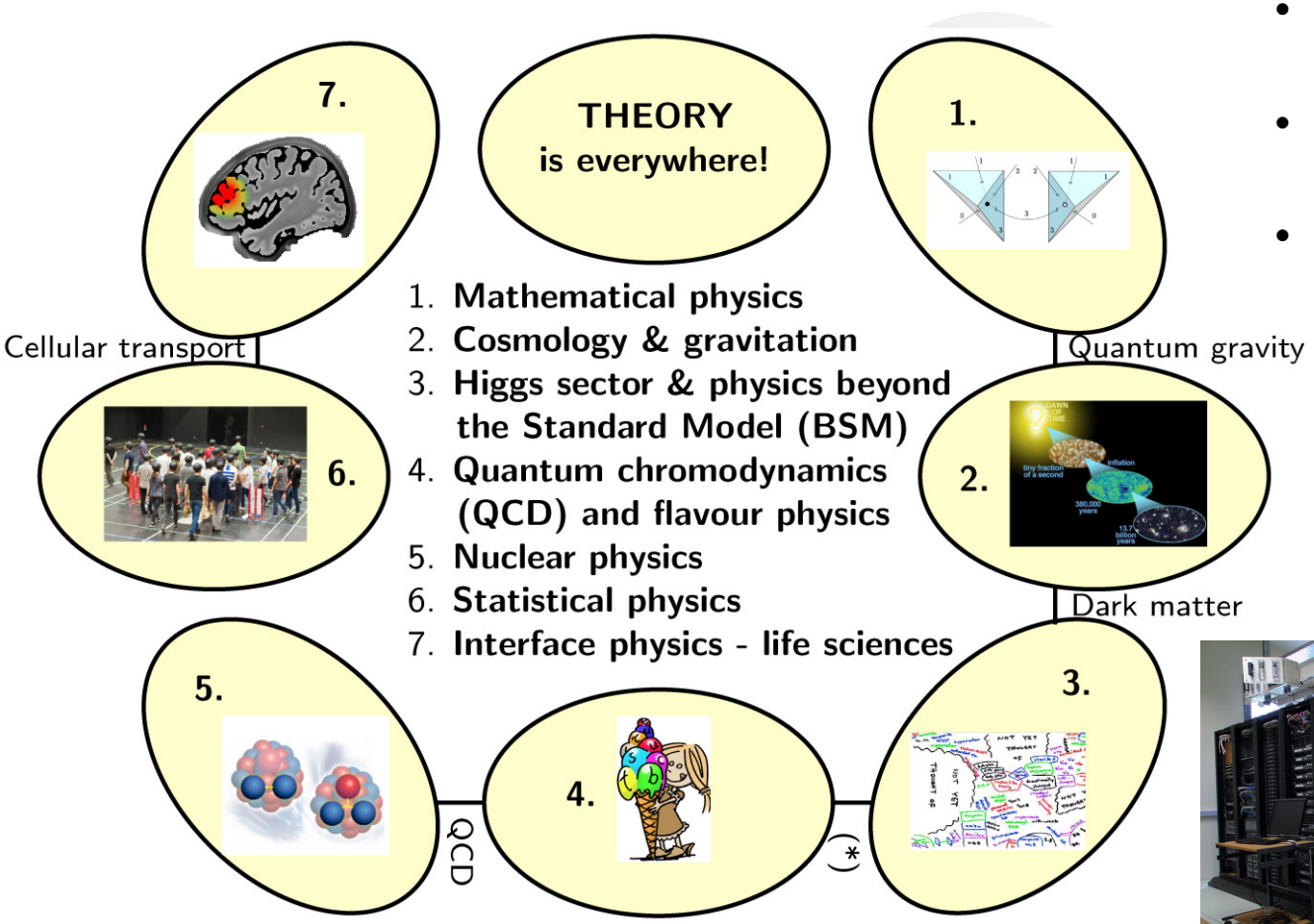


prompt γ-spectroscopy

- ALTO : MINORCA, Nu-Ball
- GANIL : AGATA
- OUPS: lifetime measurements
- JYFL (Finland) : JUROGAM2, RITU
- ANL (USA) : GAMMASPHERE
- ILL : EXILL, FIPPS

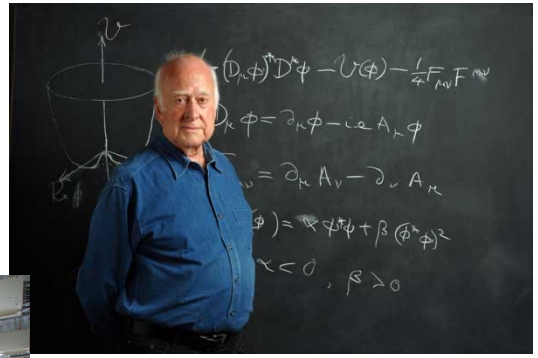


Theory



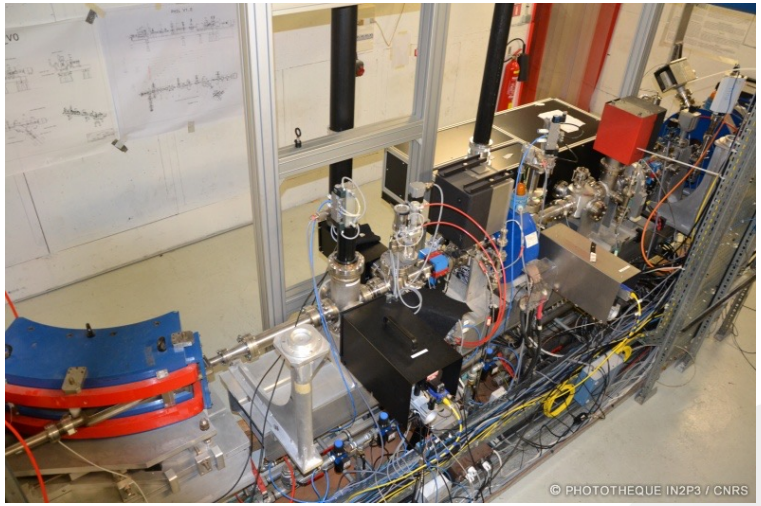
- Small teams (opposed to larger experimental collabs)
- Interaction with experimentalists from the other poles (phenomenology)
- Internal developments within pole and with external collaborators (global research)

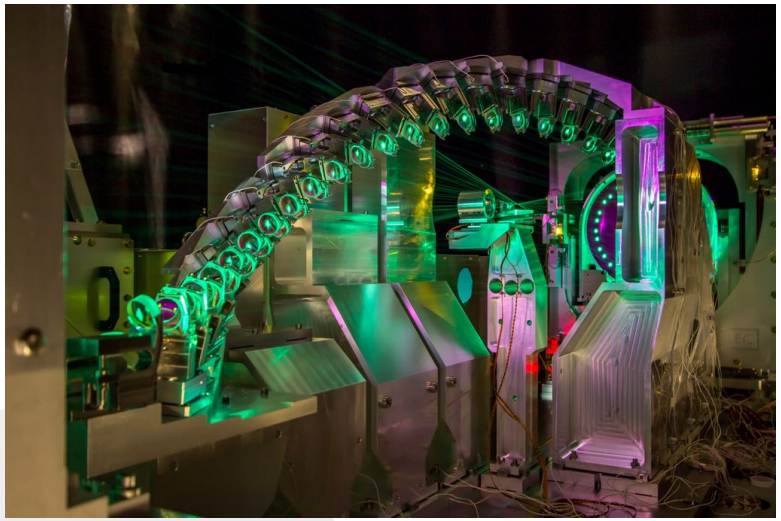
Pen, paper, blackboard ?
Yes but...

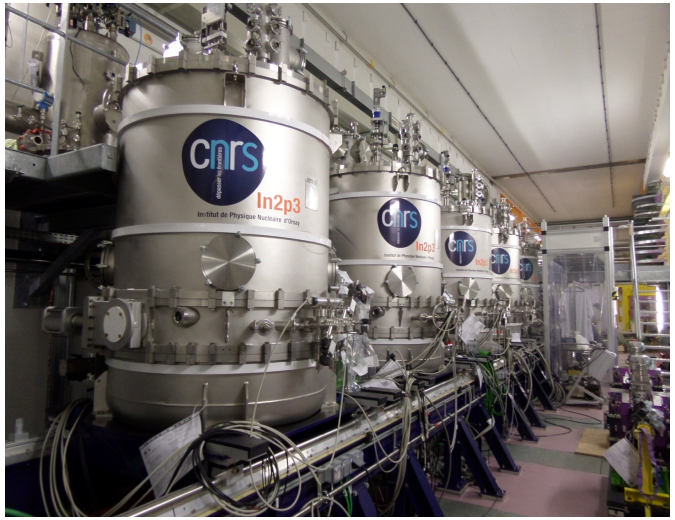


... more and more computers (analytic computation, simulations, data analysis...)

Accelerator Physics







Weighing in on a **European/global scale**
by making a major contribution to the design and construction of **large machines**
(LHC, GANIL, ESS, Myrrha, PipII...)

Research Themes

- New materials for accelerators
- Supraconducting RF
- Laser-plasma acceleration
- Beam Instrumentation

Health Physics

Develop an integrated project mainly in oncology (from biological foundations to therapy) at the heart of a laboratory with strong scientific and technical potential

Multimodal imaging
(preclinical and clinical)

Modeling
(statistical physics, animal models)

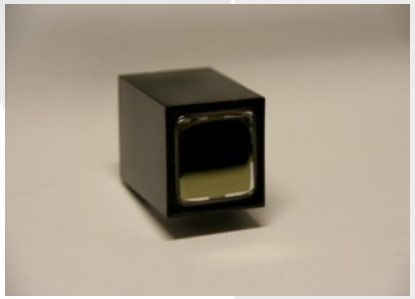
Radiotherapy
(radiobiology, radiotherapy, vector th.)

Biology
(from fundamental to experimental)

+ collaborations :

Upstream

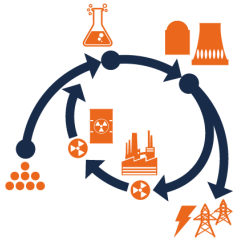
R&D IN2P3, IJCLab poles (engineering, nuclear, theory, accelerator), IRSN, Soleil, industry



Downstream

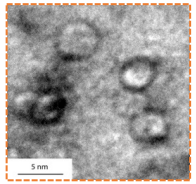
APHP, CPO, Inst. Curie, NeuroPSI

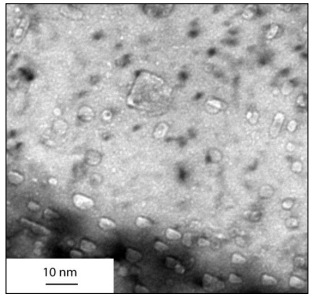
Energy & Environment



Major societal issues in relation to nuclear energy & environment with an emphasis put on an academic approach : understanding the physics and chemistry

- Analytical chemistry in complex environment for nuclear energy; Materials and irradiation; Radionuclides in the environment
- Chemistry of actinides; Nuclear Data; Nuclear Systems and scenarios





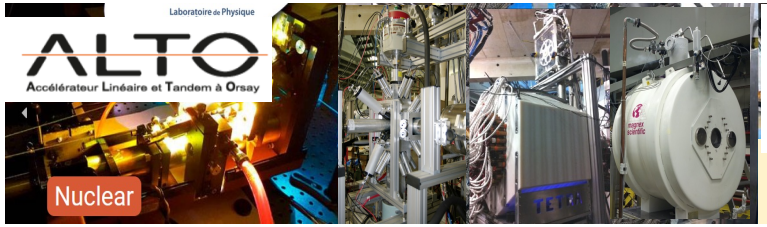
Scientific activities

- Actinide chemistry in aqueous and non-aqueous solvents
- Innovative nuclear systems and associated scenarios
- Nuclear data; actinide targets
- Fuels, molten salts, transmutation and immobilization matrices
- Materials and irradiation

Facilities within the Lab

- Analysis and characterization in radiochemistry (buildings 100 and 107)
- Ion implantation, irradiation, and analysis at JANNUS/SCALP platform
- *In situ* dual ion beam transmission electron microscope at JANNUS/SCALP

Platforms open to external users

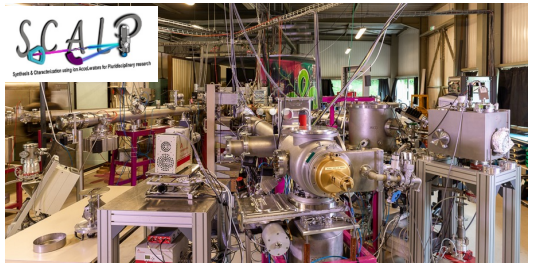


- **15 MV Tandem** (from proton to aggregates)
- **electron linac** -> radioactive beams by photofission

Nuclear, Health physics, Irradiation

Several MeV protons, multicharged atomic ions, gold molecules and nanoparticles

Nuclear/A2C, Health physics, Irradiation



Ion irradiation / implantation and *in situ* characterization techniques (TEM, IBA)

Energy, nuclear materials, Health physics, Irradiation physics and chemistry

Platforms for IJCLab projects

Semiconductor Platform :
Silicon Detector Characterisation/Production

VIRTUAL DATA
Advanced computing resources infrastructure
Grid / Cloud

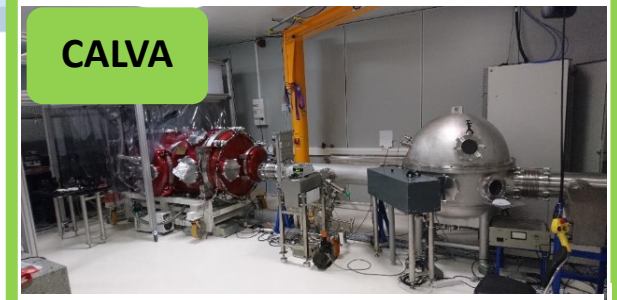
Health research themes

PIMPA
Plateforme d'imagerie Multiphotonique du Petit Animal

non linear optical biphotonique imaging

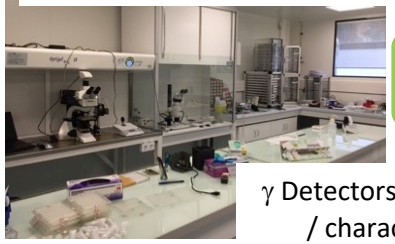
A2C Research themes

CALVA



Cavity locking/Squeezing for VIRGO and ET

Micrometeorite Preparation/analysis



Myrtho

γ Detectors development / characterization

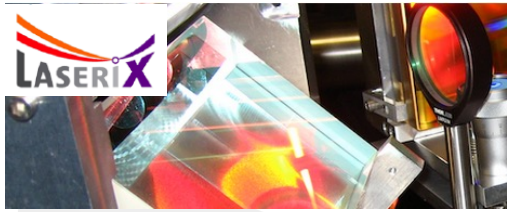
Radiochemistry laboratory
Actinides - Bat 107

Accelerators research themes/technologies

Opening to Materials, atomic physics, detectors

SUPRATECH

R&D on the superconducting cavities (prepare, package, assemble & testof the superconducting RF cavities).



LaseriX

coherent, intense, brief (50fs to 10 ps) **sources in near-infrared** (800nm) **and EUV** (30 to 90 eV)

Vide et Surfaces
under construction

International collaborations

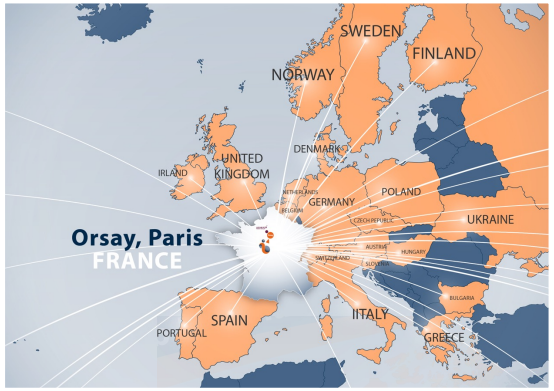
Some major laboratories with facilities or facilities in the world linked to IJCLab

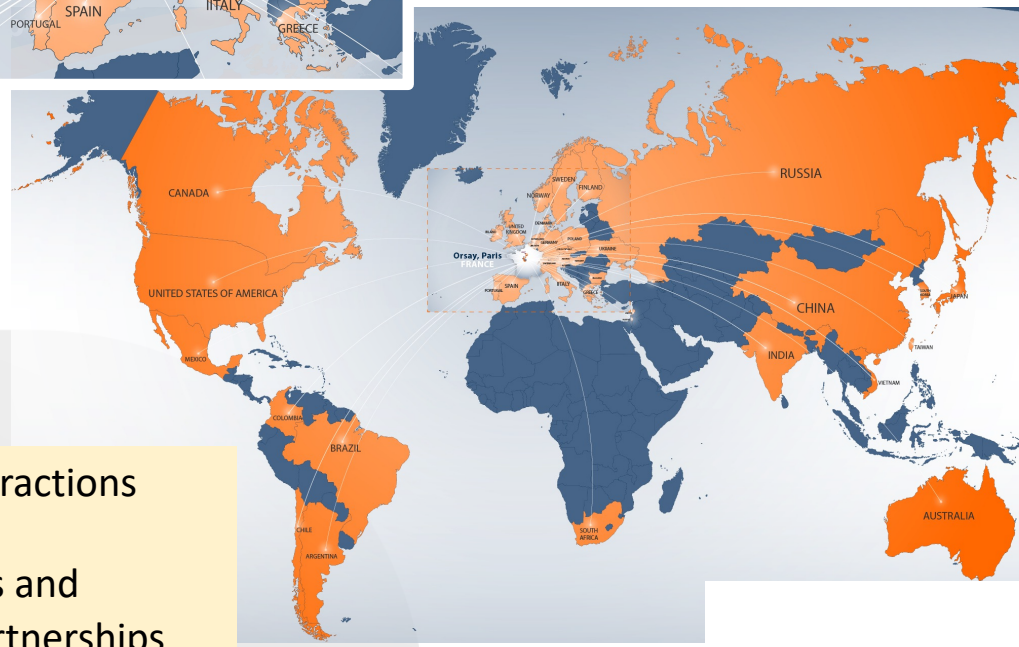
World

Auger-Argentina
LBNL/SLAC-US
Fermilab-US
JLab-US
KEK-Japan
LSST-Chile
Riken-Japan

Europe

SCK-CEN-Belgium
CERN
CTA-Spain
DESY-Germany
Dubna-Russia
EGO/VIRGO-Italy
ESS-Sweden
GANIL-France
GSI-Germany
Jyväskylä -Finland
LNCA-France
LNGS-Italy
LNL-Italy
LSM-France





+ many interactions with French laboratories and industry partnerships

Teaching and training

Teaching

Academic, Technical, Platforms

~60 Researchers-Teachers + ~30 Researches-CNRS *are involved in University teaching.*
~60 Technical staff *teach different skills and specialities (university / Schools..)*
Research Installations/ Platforms -> Educational platforms with dedicated lines

Internships for students

Internships: the gateway for students to discover research

Internships at different level (from L1 to M2 and international.) :
~110 internships in 2021 corresponding to approximatively ~600 months

Thesis

PhD Training by research and for research

~110 PhD students in the ensemble of the laboratories (from 30 different nationalities)
Number of technical theses rapidly increasing

International Schools

Participation and creation of international/national schools

Participation/creation of international/national schools
School : ***WISHEPP (Palestine), TESHEP (Ukraine…), QCD, School at*** *L3 level…*
IJCLab leads ***Erasmus+ MIC Colombia / Georgia / Ukraine / Palestine and Erasmus Mundus Lascala***

IJCLab Manifesto

Our ambition is to elucidate the mysteries of **matter, energy, space, time**, and to understand the constituents of matter, their **interactions** and the origin and the evolution of the **universe**.

We aim at **driving discoveries** on these questions by

- **Contributing to and lead projects at all stages in high-energy physics, nuclear physics, astroparticles and cosmology** (proposal, design, construction, operation, data analysis) with significant **theory** support
- **Playing a major role in the conception, design and construction of current and future accelerators**.
- **Developing and operating research infrastructures and technological platforms** supporting these research areas as well as **original research in health physics and energy**
- **Promoting the development of new technologies** for science for the benefit of society and thus supporting national and European industrial competitiveness
- **Welcoming students trained at IJCLab through and for research** at the heart of a world-class academic environment.

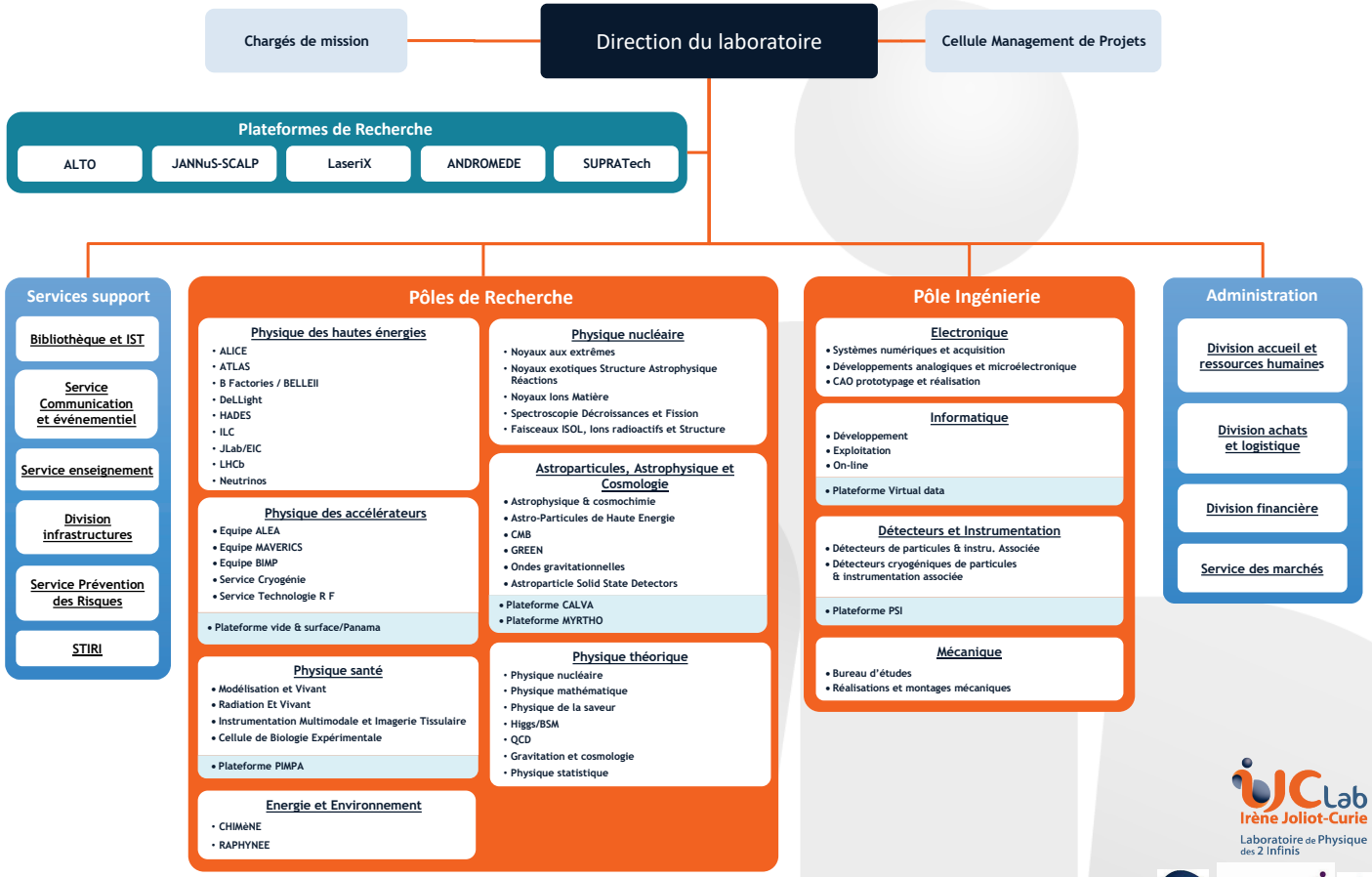
More information

www.ijclab.in2p3.fr

For internships/job opportunities

- Check the website
- Contact directly the poles and research teams

Laboratory organization



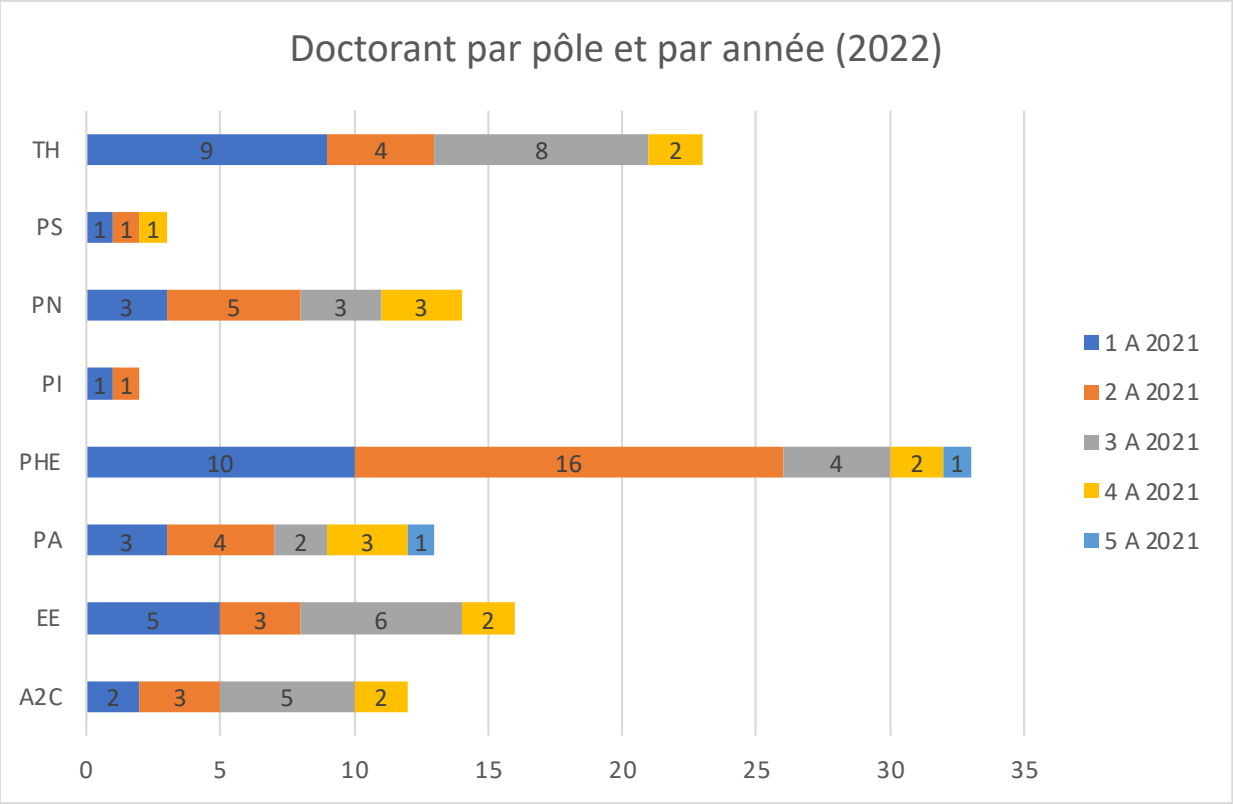
710 members
530 staff
250 researchers
360 engineers and technicians

7 Research poles
31 teams
1 Engineering pole
4 technical departements
11 services
1 administrative pole
3 Divisions
1 Service
8 support services
5 research platforms

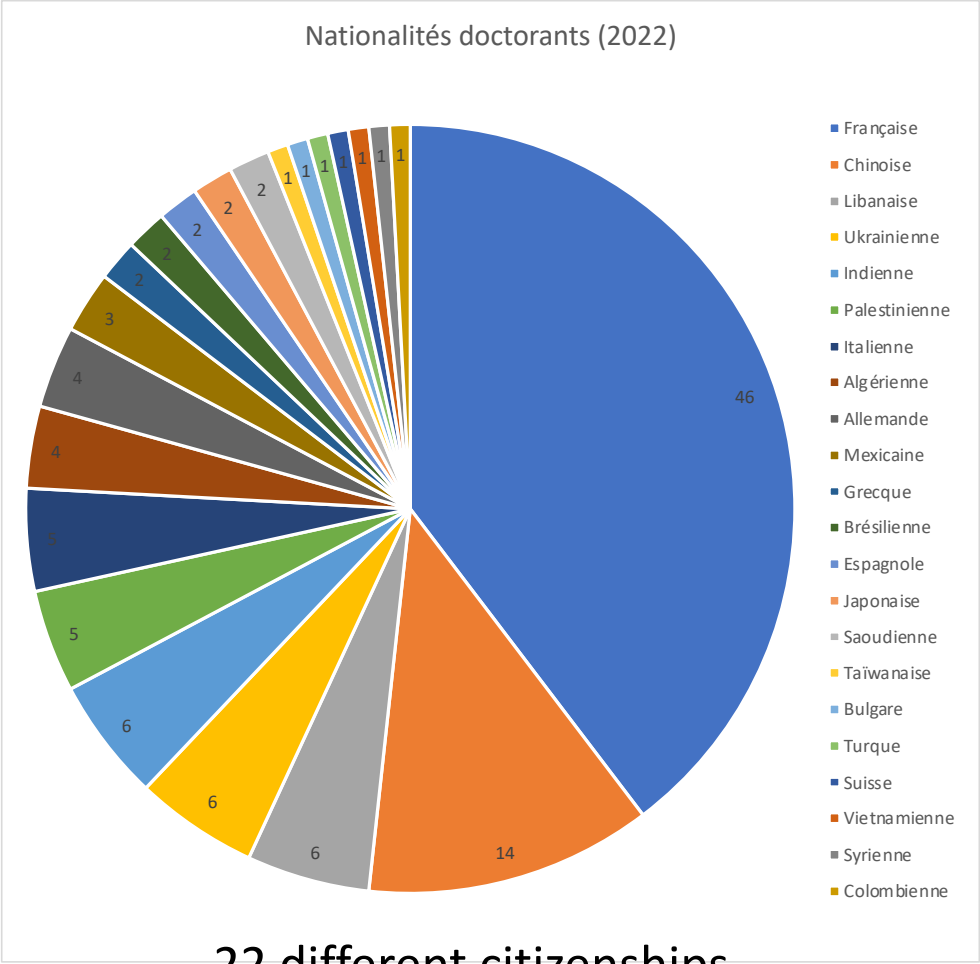
3 governing bodies

- CNRS (through IN2P3, Institut de Physique Nucléaire et de Physique des Particules)
- U. Paris-Saclay
- U. Paris Cité (Health Physics)

PhD students at the end of 2021



116 PhD @ IJCLab

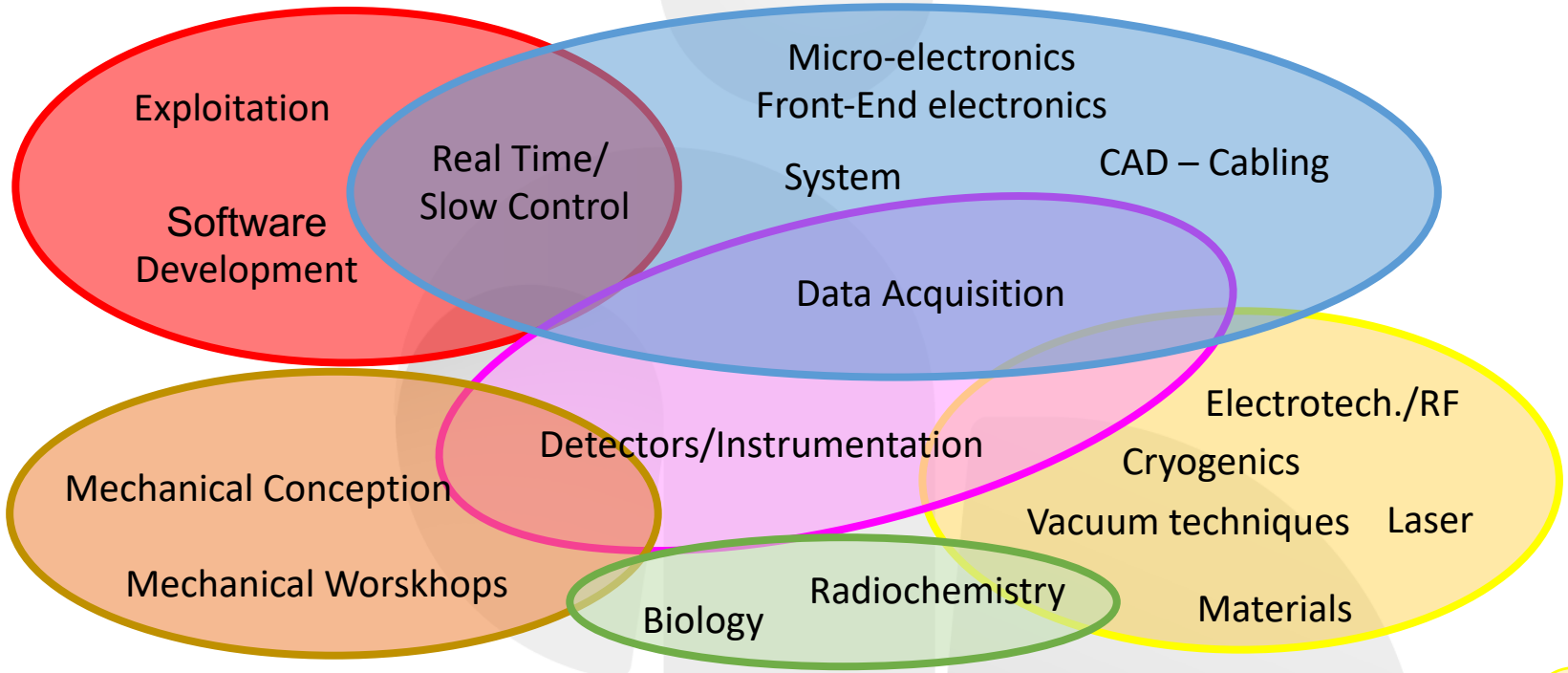


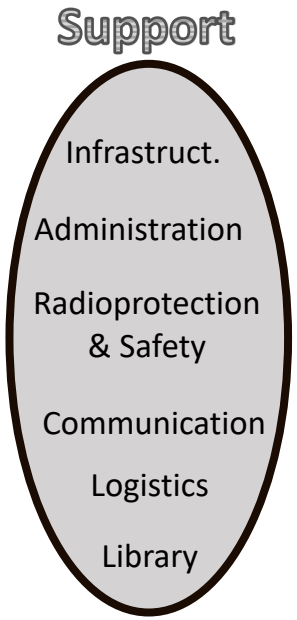
22 different citizenships

Technical activities

Technical staff with technical skills/expertise essential to design, draw and build instruments

- Engineering pole with 4 Technical Departments
- Accelerator Physics pole with RF and cryogenics services
- Competences in other scientific poles and platforms as well as in support services





Mechanics · Electronics · Computing · Bio, chemistry · Detectors · Accelerators and others specialties