

IJCLab : Laboratoire de Physique des deux infinis Irène Joliot Curie

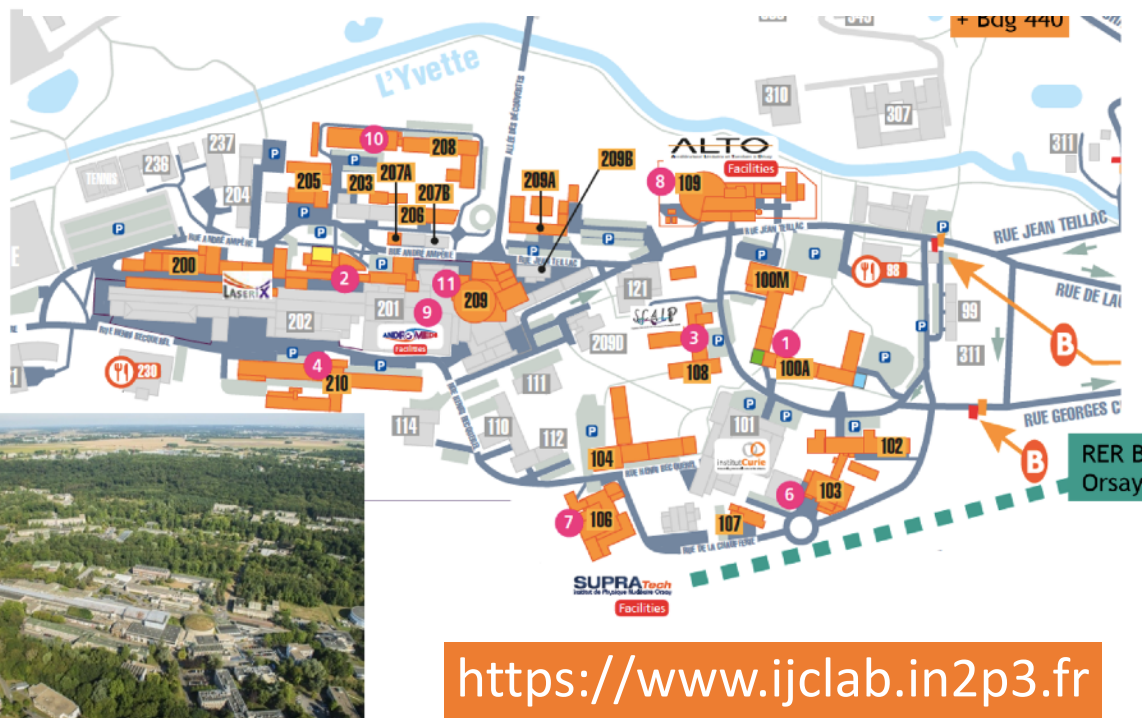
- Institutional presentation
- Some historical milestones

Réza Ansari

Univ. Paris Saclay & IJCLab CNRS/IN2P3

- General presentation of IJCLab
- Presentation of the scientific poles at IJCLab

IJCLab: New Laboratory born in 2020 from the merger of CSNSM, IMNC, IPNO, LAL, LPT



740 Membres

220 Chercheurs & Enseignants Chercheurs

370 Ingénieurs & Techniciens

4 Divisions Administratives **8** Services support

140 Doctorants & Postdoctorants

50 Bourses de Recherche Européennes & Internationales

150 Bourses de Recherche Nationales & Locales

150 Titulaires de HDR

600 Articles dans des revues internationales

7 Pôle Scientifiques

1 Pôle Ingénierie **4** Départements

5 Plateformes de Recherche

3 Plateformes Techniques

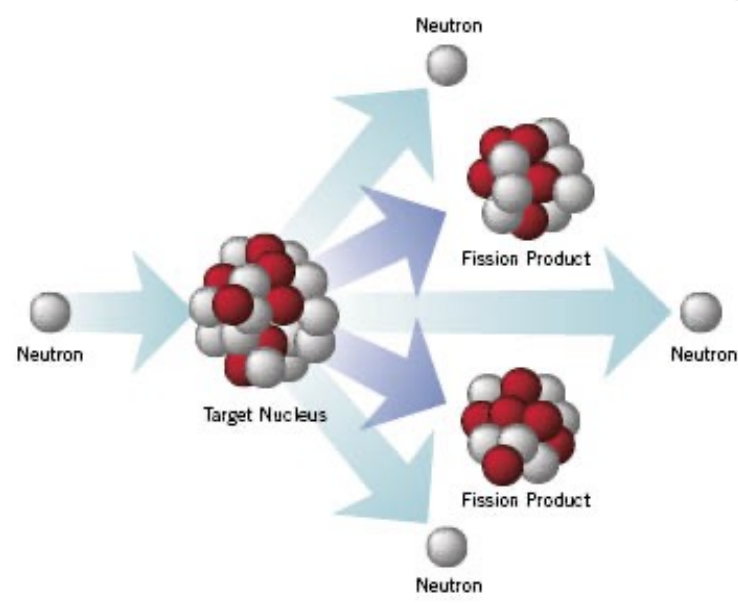
50000 m² de bâtiments

dont **20000** m² Ateliers & Infrastructures de Recherche

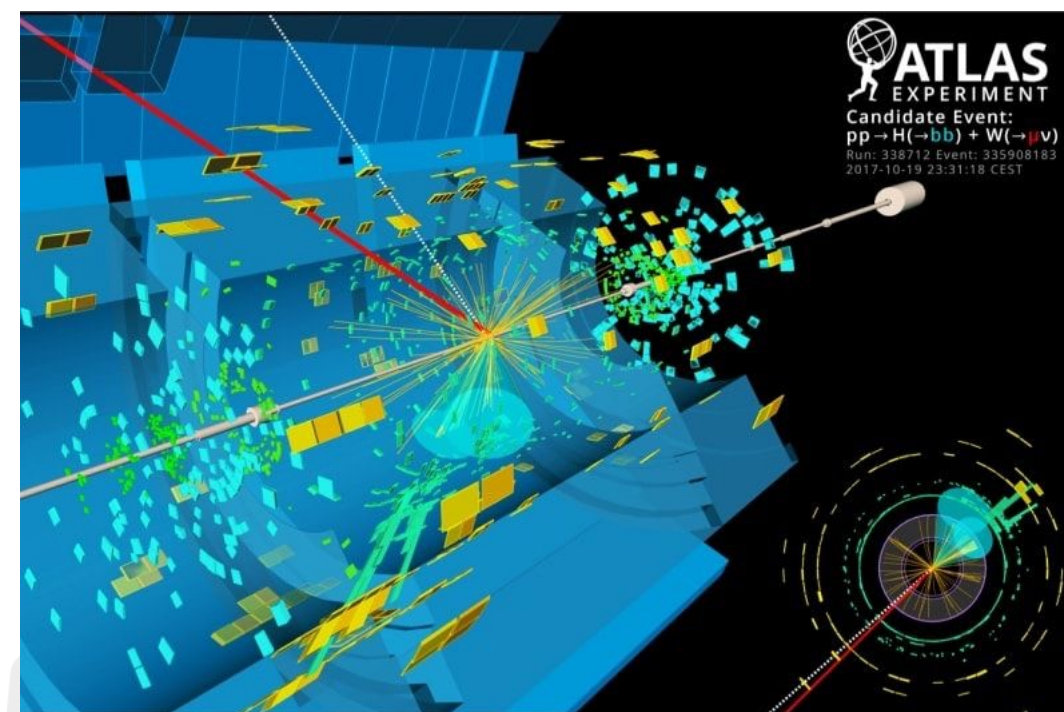


IJCLab in a nutshell (1)

Historically : Probing matter at small distances/high energies due to $E=hc/\lambda$



Nuclear Physics



Particle Physics

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

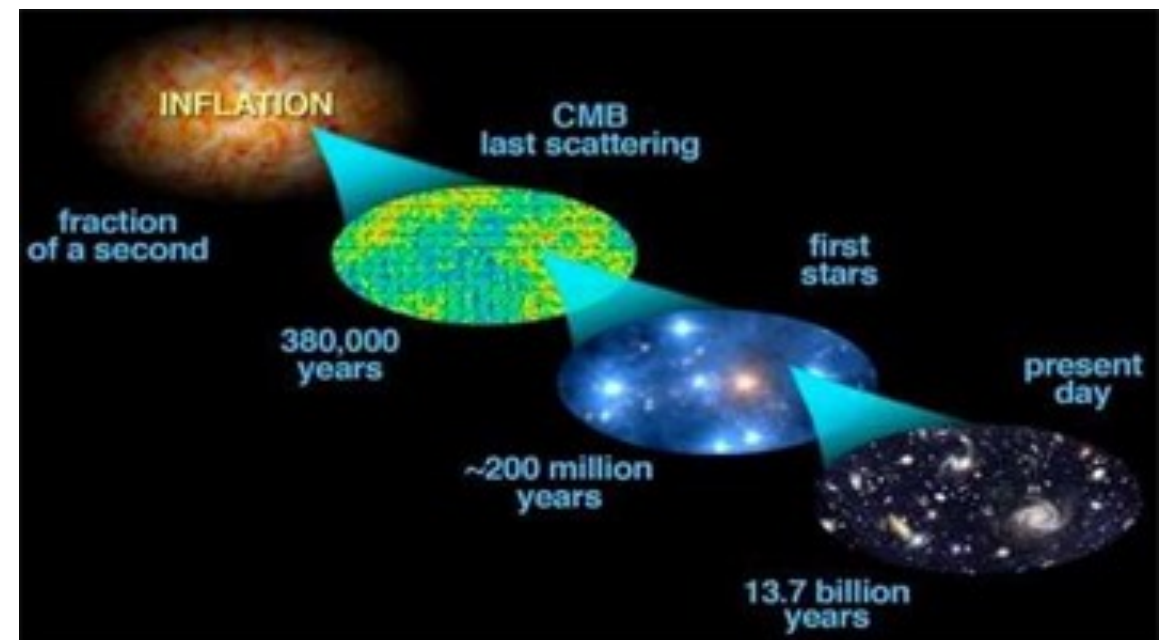


IJCLab in a nutshell (2)

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...)

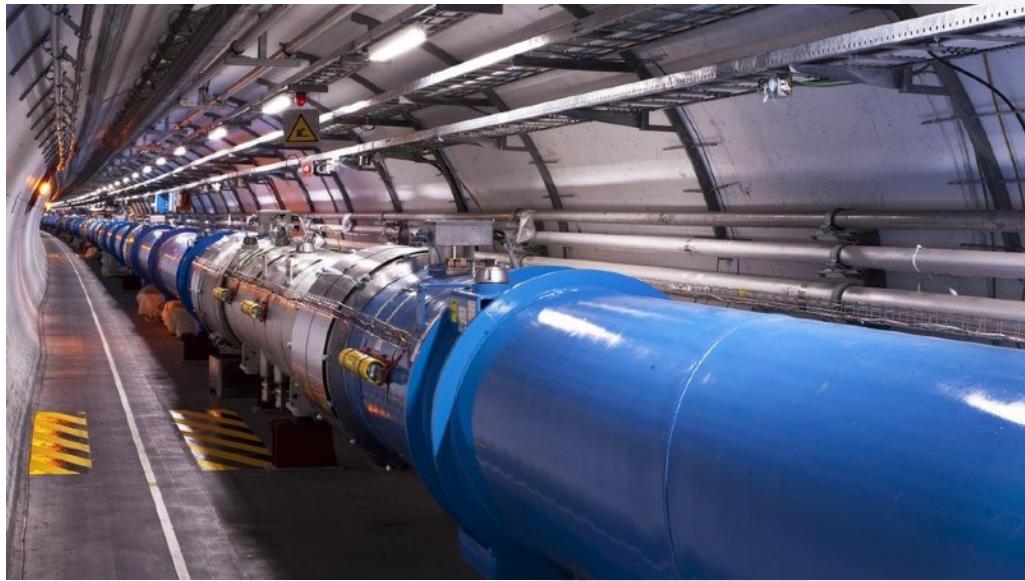


Early Universe
(cosmology, inflation,
large structures,
dark matter and energy)



IJCLab in a nutshell (3)

Building tools to perform these investigations

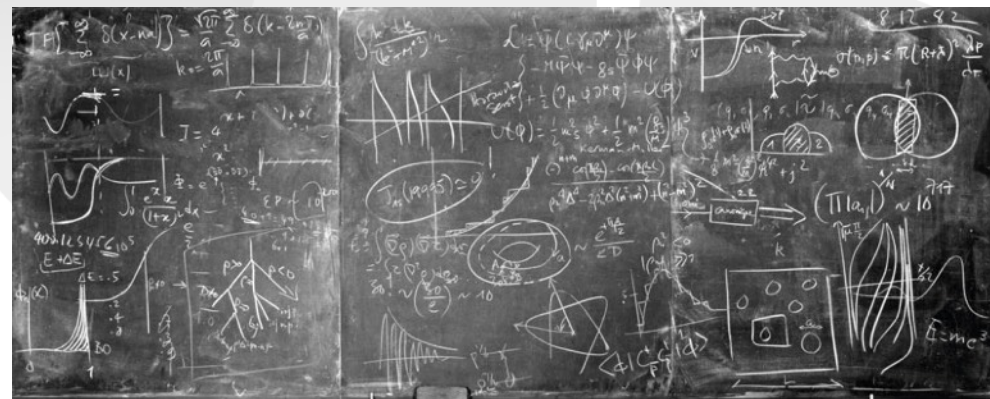


Accelerators



Detectors

Theory :
interpreting and
relating results



and suggesting new
tests and ideas

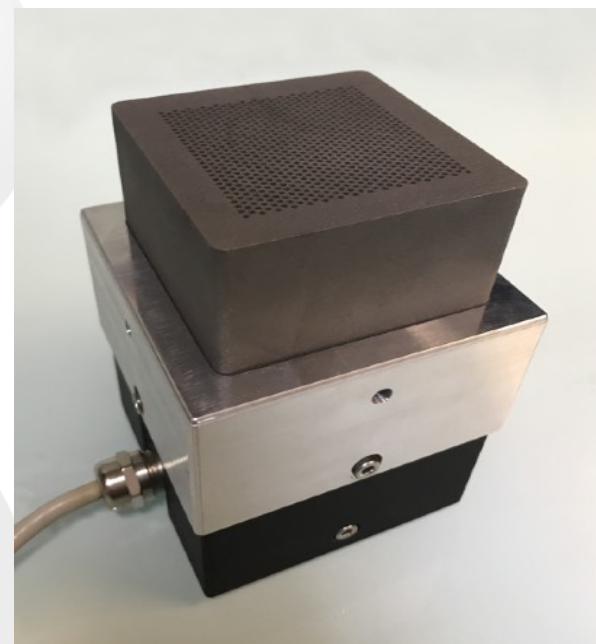


IJCLab in a nutshell (4)

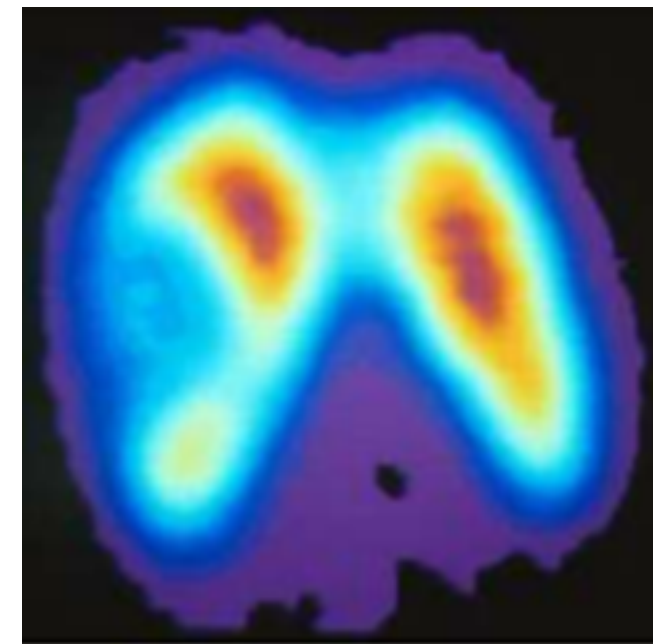
Tools and concepts applied in areas with impact on society



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



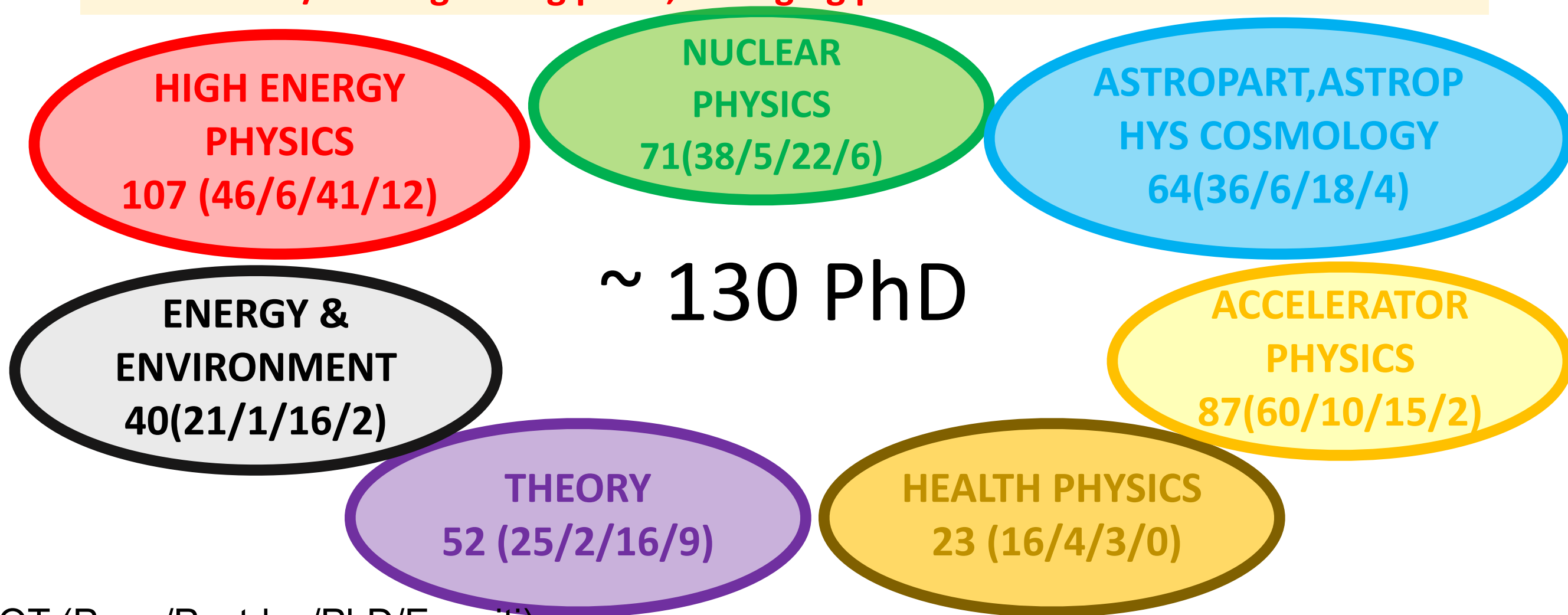
health physics
(imaging,
therapy by irradiation)





7 Research poles

all the themes of "the physics of the two infinities" with the presence of historical/existing strong poles, emerging poles and activities at the interfaces

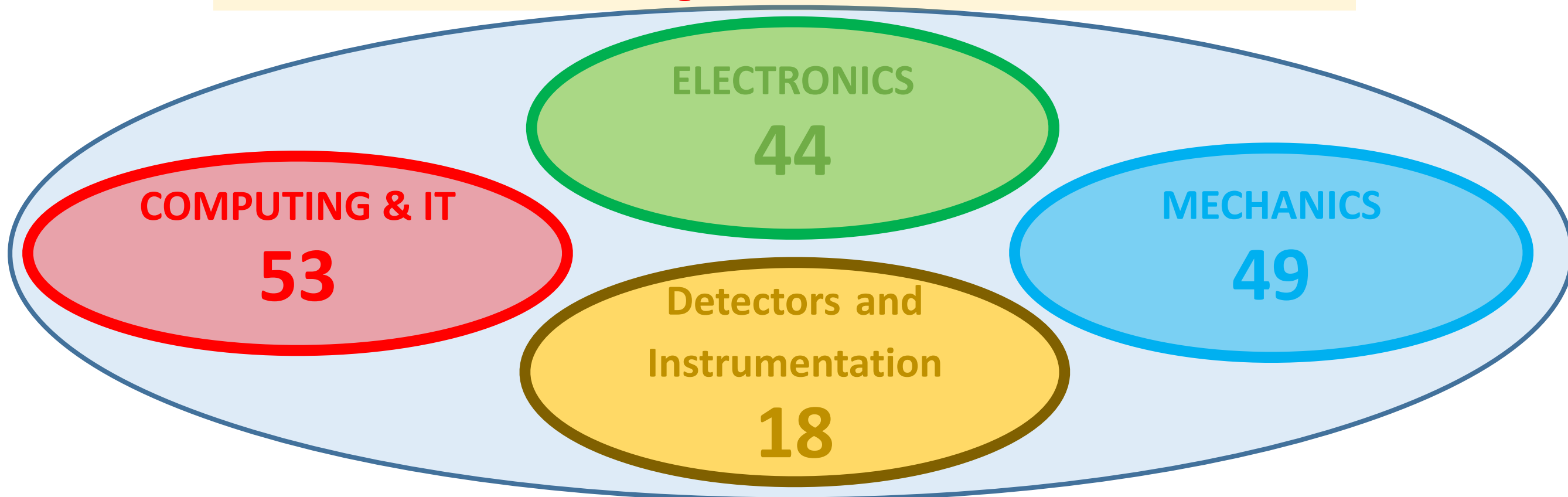


TOT (Perm/Postdoc/PhD/Emeriti)



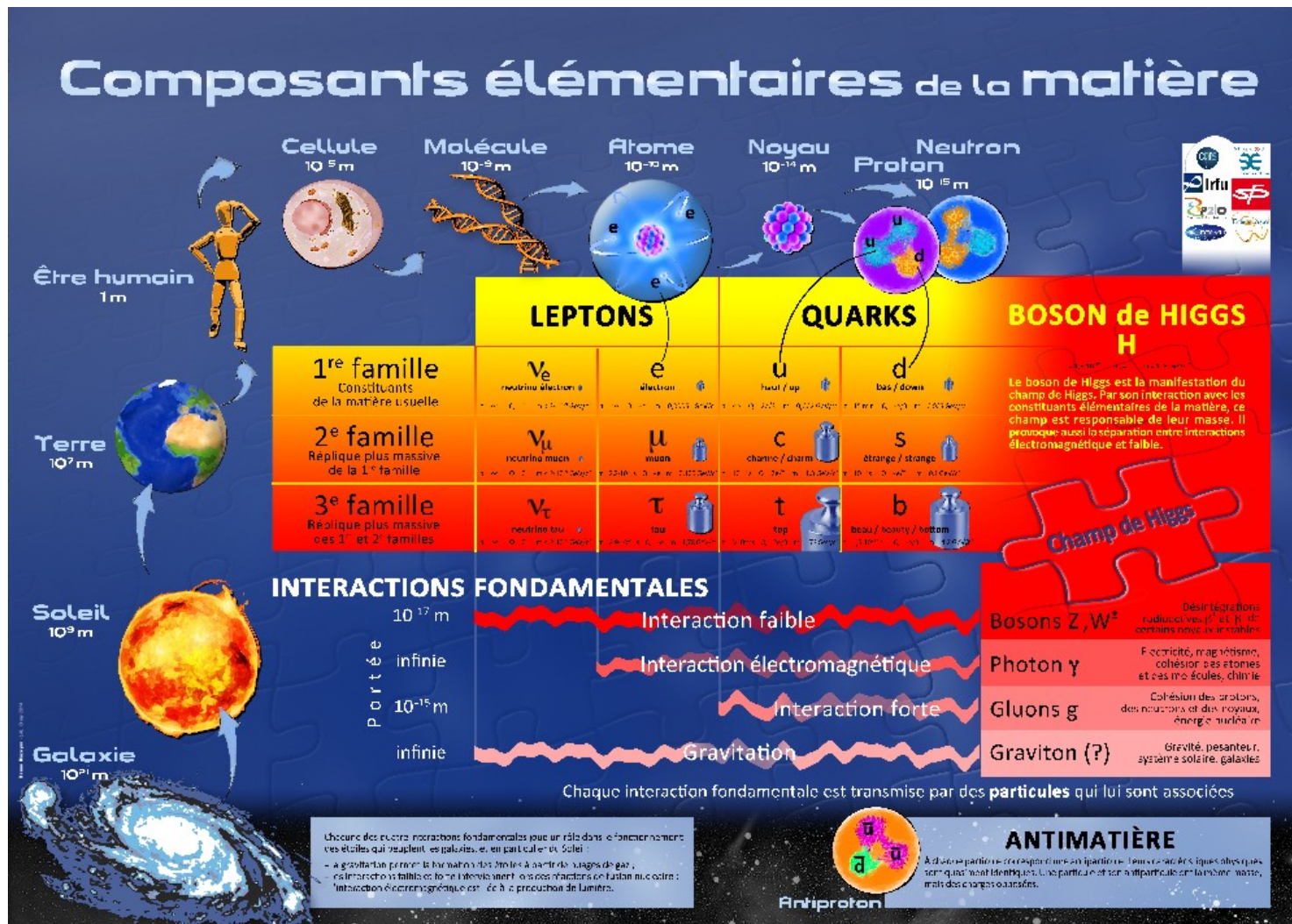
1 ENGINEERING POLE : 4 Technical Department with 11 Services

A strong center of competence, essential pillars for the laboratory to conceive, design and build the instruments.





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

(W,Z,H,t) physics

ATLAS, ILC

Weak & electromagnetic interactions

Neutrinos physics

QED in intense em field

Flavour physics

Belle2, LHCb

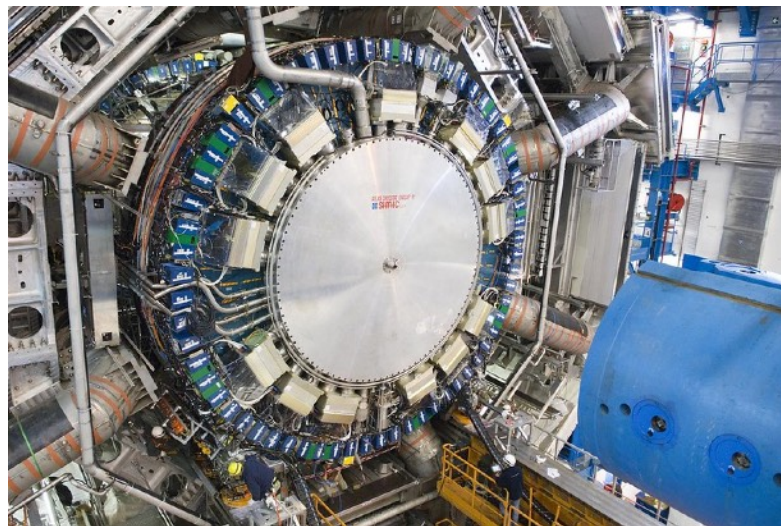
DOUBLE-CHOOZ

Beyond SM

DeLLight

JUNO, DUNE

**ATLAS, Solid,
(Super)NEMO**



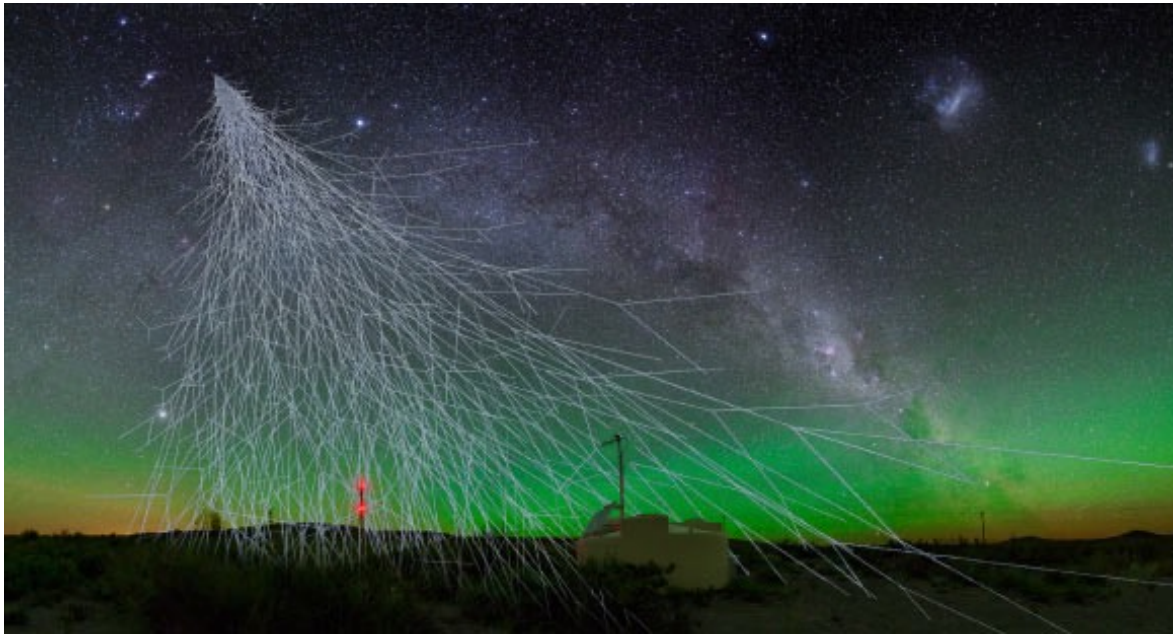
**Challenging
the SM**

direct searches

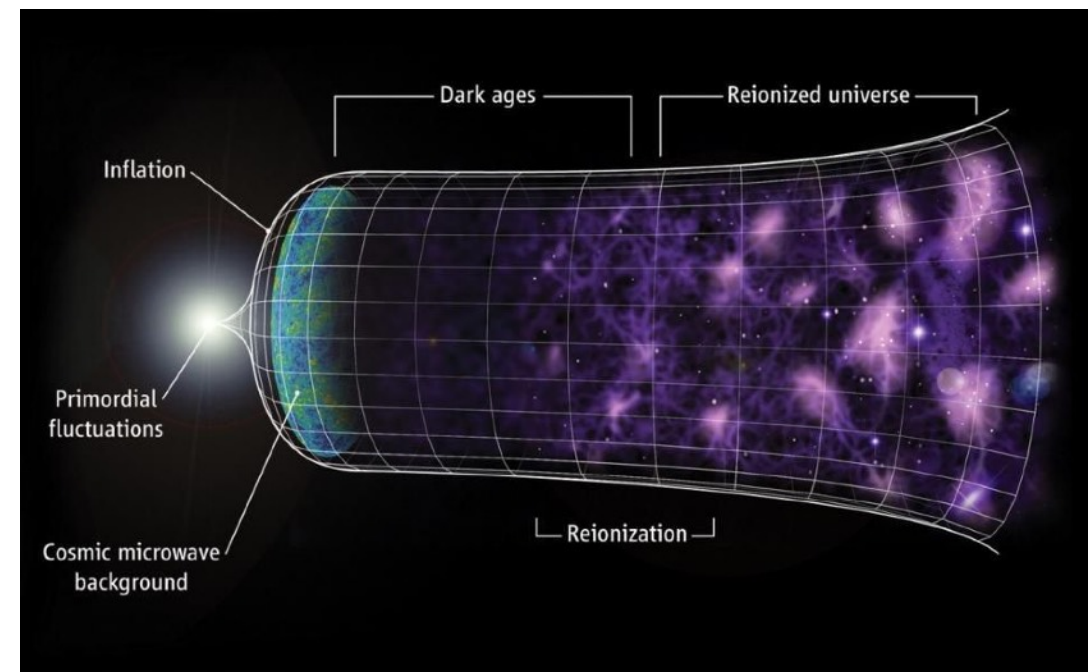
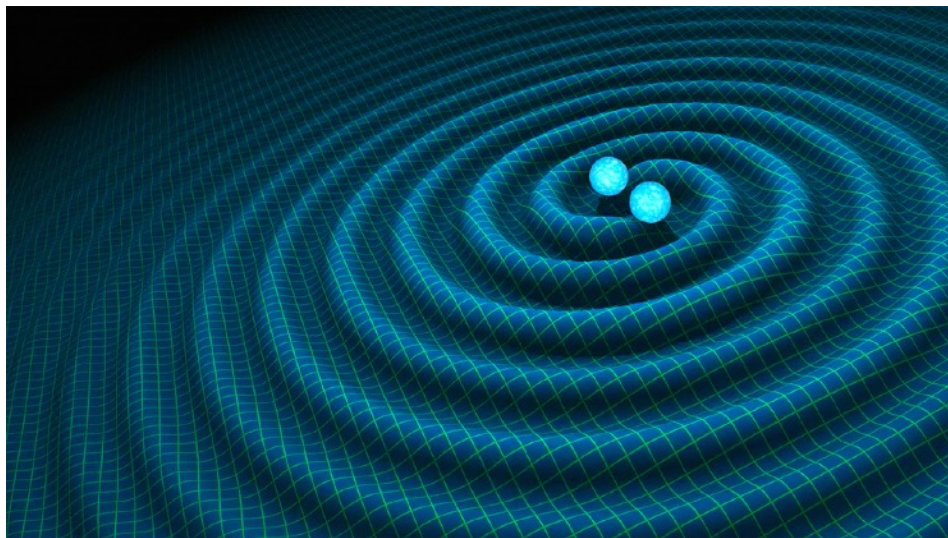
precise measurements



Astroparticle, astrophysics and cosmology



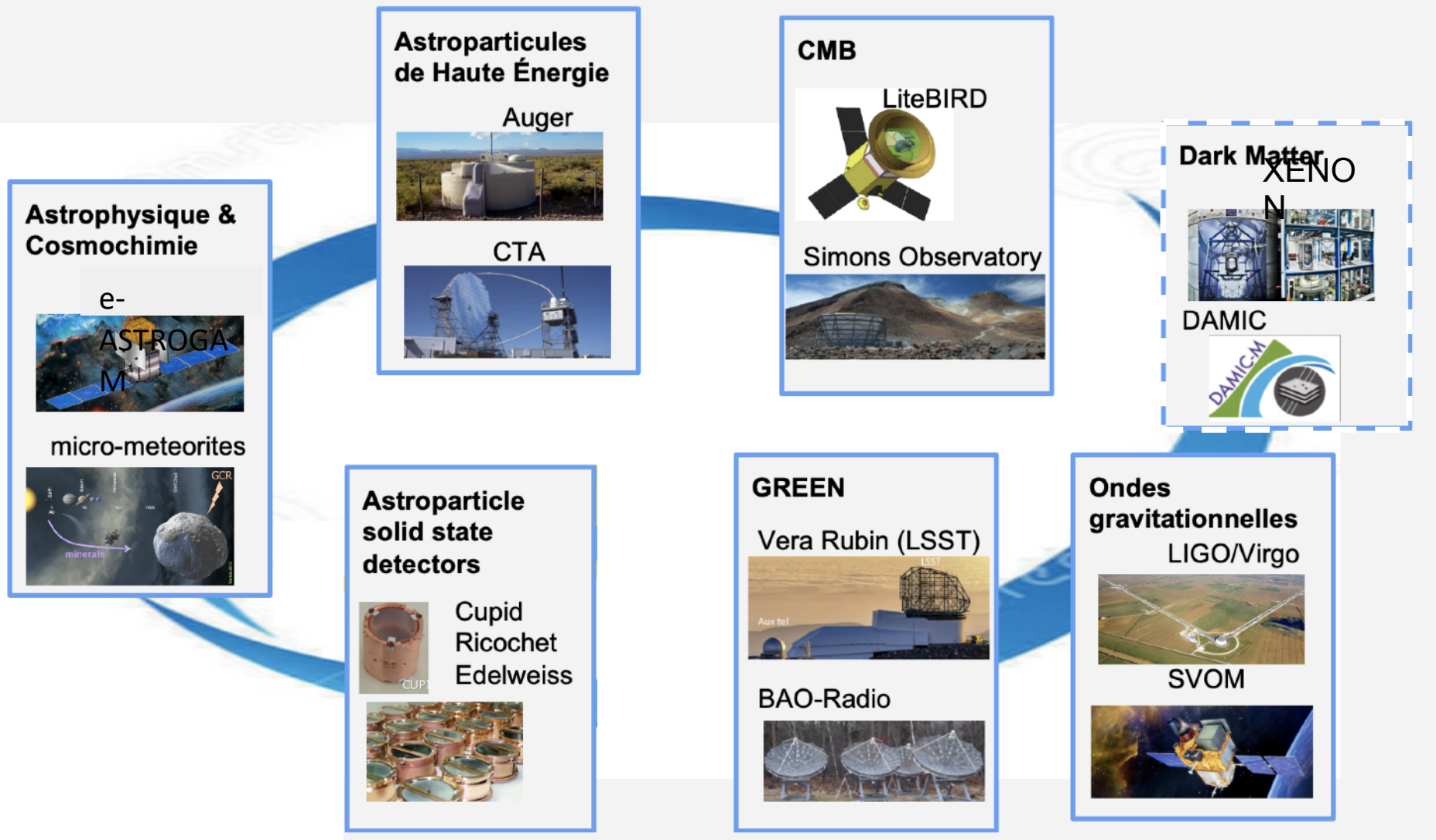
- Violent phenomena in the universe (neutron stars, black holes, AGN...)
- High-energy cosmic rays
- Evolution of the universe (CMB, LSS)
- Role of dark matter, dark energy
- Multi-messenger astronomy



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

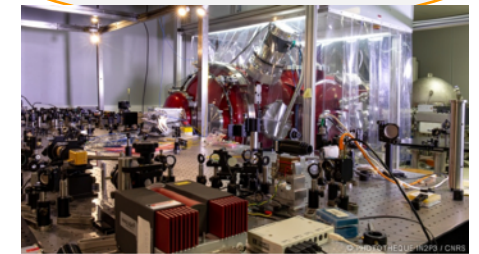


Astroparticle, astrophysics and cosmology



and 2

**CALVA/
Exsqueez**

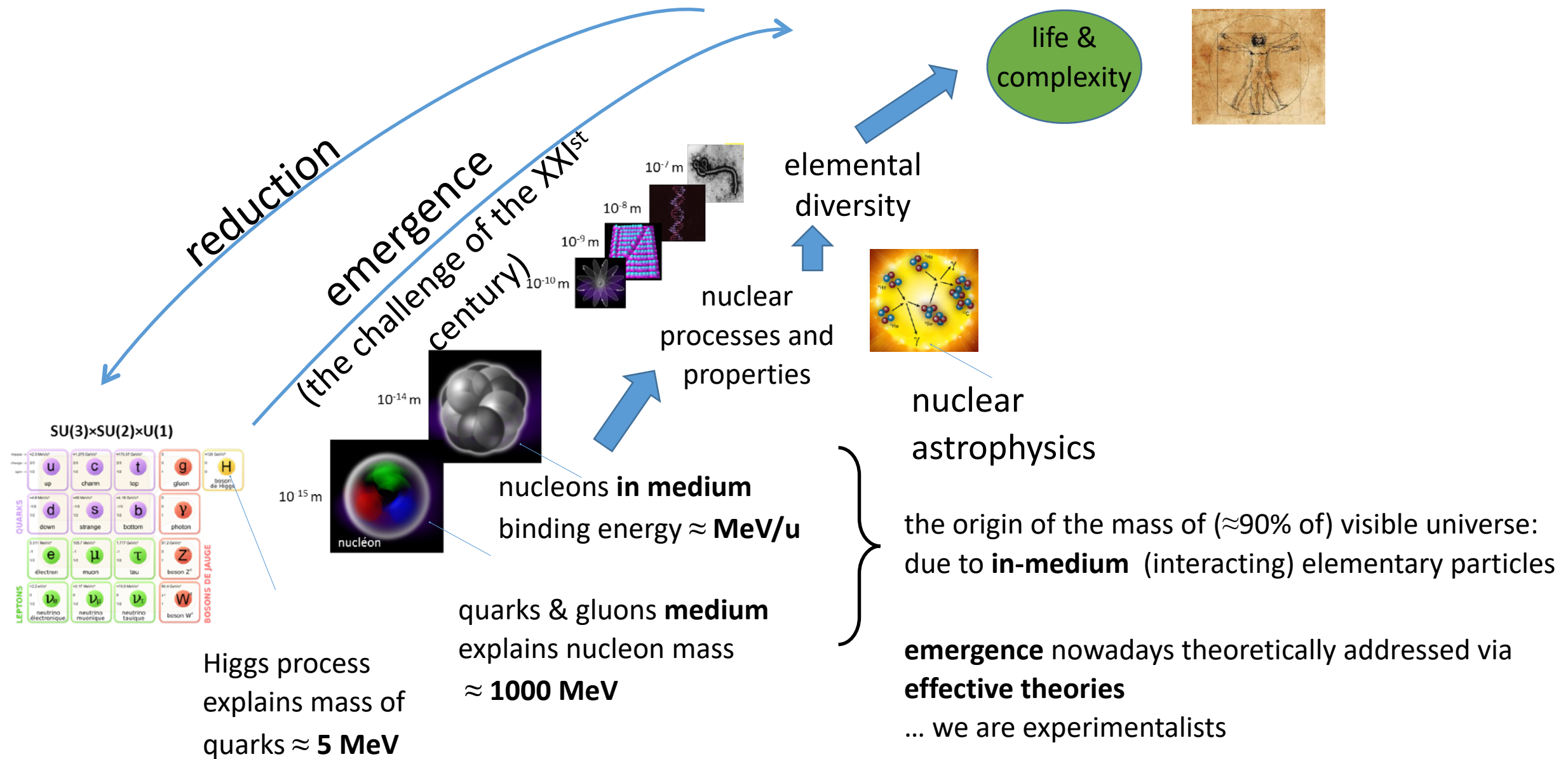


MYRTHO





Nuclear Physics





Nuclear Physics

a community of spectroscopists and builders

the discovery frontier
(synthesis of new nuclei)

the precision frontier
(network of observables)

Nuclear Spectroscopy : Orsay's 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

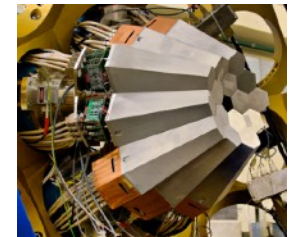
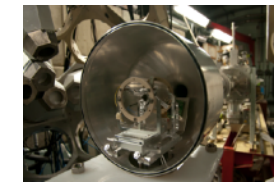
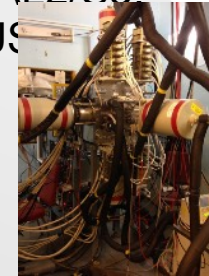
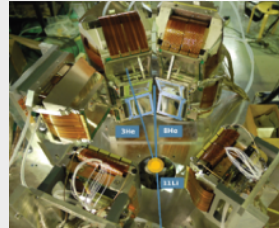
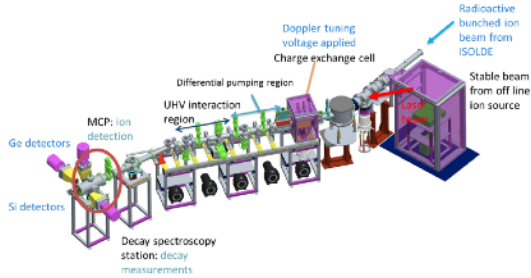
- GANIL : MUGAST, LISE, INDRA/FAZIA
- RIKEN (Japan)
- LNS (Italy): CHIMERA*

delayed/recoil spectroscopy

- ALTO : BEDO, TETRA, POLAREX
- GANIL : LISE
- JINR Dubna: GABRIELA
- SPIRAL 2/S3:

prompt g-spectroscopy

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



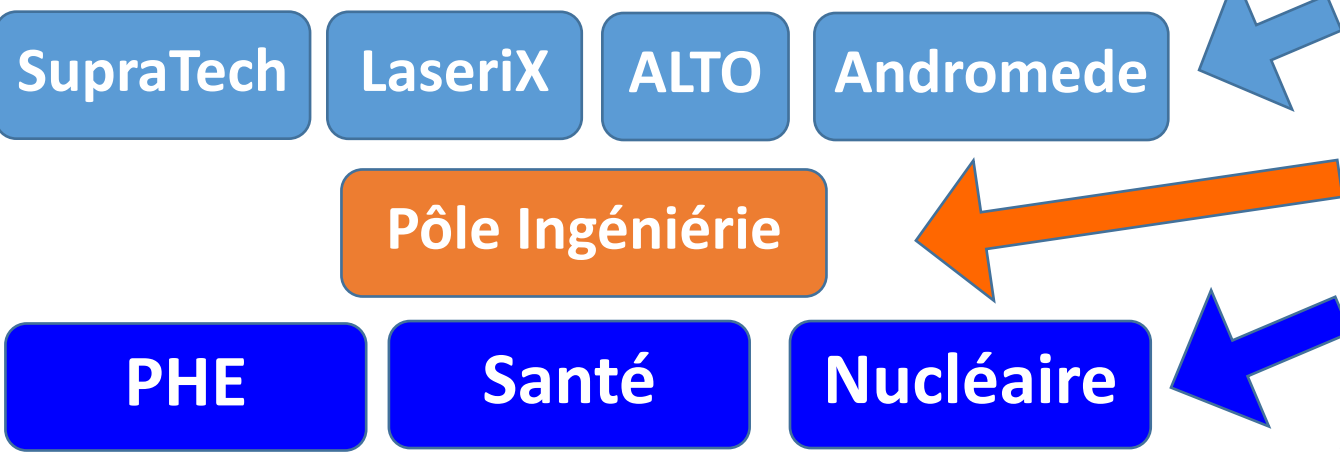


Accelerator Physics

Accelerator Physics Pole as of Nov 2020:

- 88 persons
- 20 researchers (1/2 CNRS, 1/2 University)
- 52 IT (among which 31 research engineers)
- 15 Ph-D students
- 8 HDR

Pôle Accélérateur									
Effectifs totaux: 89		Permanents: 61		CDD: 10		Doctorants: 15		Apprentis: 1	
Ens.chercheurs: 10		Chercheurs: 8		IR: 31		IE: 7		AI: 10 T: 5 Emérite: 2	
Equipe Physique, Instrumentation et Manipulation des Faisceaux									
Effectifs totaux: 24		Ens. chercheurs: 0		Chercheurs: 3		IR: 10		IE: 1	
Permanents: 12		CDD: 2		Doctorants: 9		Apprentis: 0		T: 0	
Service RF									
Effectifs totaux: 20		Ens. chercheurs: 0		Chercheurs: 0		IR: 9		IE: 2	
Permanents: 15		CDD: 4		Doctorants: 0		Apprentis: 1		AI: 6 T: 2	
Equipe Accélération Laser et Applications									
Effectifs totaux: 22		Ens. chercheurs: 9		Chercheurs: 3		IR: 4		IE: 1	
Permanents: 15		CDD: 2		Doctorants: 4		Apprentis: 0		Emérites: 1	
Service Cryogénie									
Effectifs totaux: 9		Ens. chercheurs: 0		Chercheurs: 0		IR: 4		IE: 3	
Permanents: 7		CDD: 2		Doctorants: 0		Apprentis: 0		AI: 2 T: 0	
Equipe Matériaux, Vide et Surfaces									
Effectifs totaux: 7		Ens. chercheurs: 1		Chercheurs: 2		IR: 2		IE: 0	
Permanents: 5		CDD: 0		Doctorants: 2		Apprentis: 0		AI: 0 T: 0	
Plateforme Panama/vide/surface									
Effectifs: 5		Permanents: 5		CDD: 0		AI: 2		T: 3	





Health Physics

Développer un projet intégré principalement en cancérologie (***des fondements biologiques à la thérapie***) au cœur d'un laboratoire à fort potentiel scientifique et technique

Imagerie multimodale
(*préclinique & clinique*)

Radiothérapie
(*radiobiologie, radiothérapie, thérapie vectorisée*)

Modélisation

(*physique statistique, modèles animaux*)

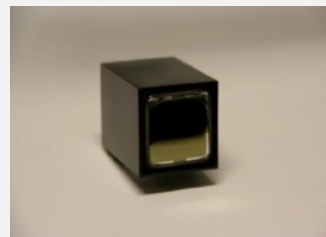
Biologie

(*du fondamental à l'expérimental*)

+ collaborations :

De l'amont

R&D IN2P3, pôles
ingénierie, nucléaire,
théorie et accélérateur,
IRSN, Soleil, U. Florida,



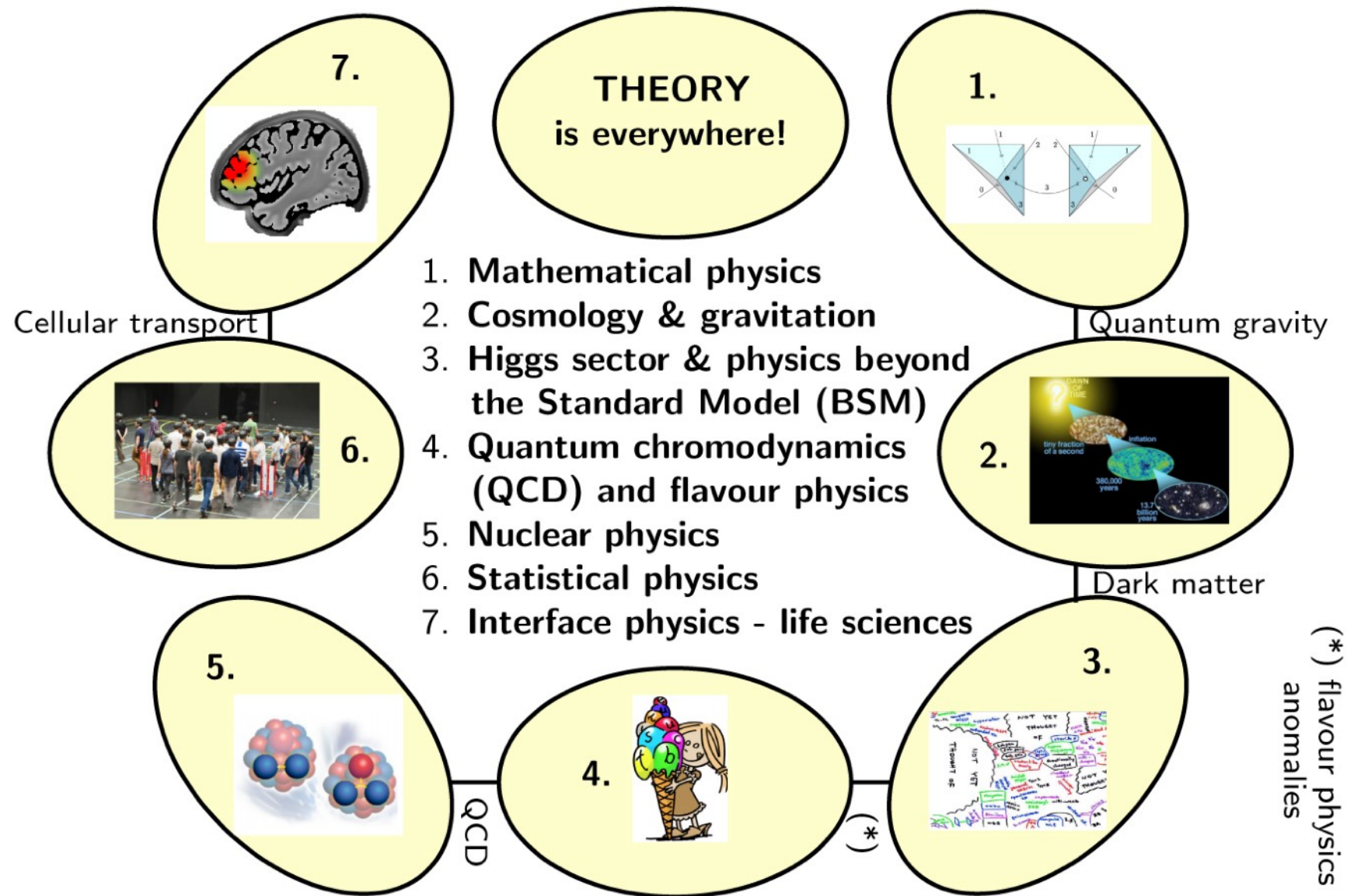
A l'aval

APHP, CPO, Inst.
Curie, NeuroPSI

industriels



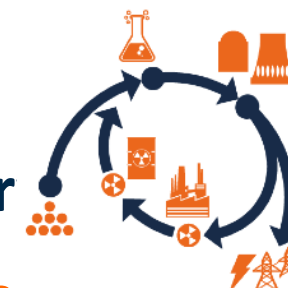
Theory





Energy & Environment

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



- **CHIMENE team:** Analytical chemistry in complex environment for nuclear energy, Materials and irradiation; Radionuclides in the environment
- **RAPHYNEE team:** 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

Few major scientific and historical milestones over the last 60 years at IJCLab@Orsay

A LAL biased view ...

- * 1956 - 57 : IPN & LAL buildings construction on site
- * ~ 1960 , first beams delivered by linac
- * 1963 : first e+e- collisions in ADA ring (built at Frascati, operated at LAL)
- * 1967 : Breakthrough in BBN on ${}^7\text{Li}$, Reeves & Bernas @ IPN
- * 1973 : Neutral current discovery with the Gargamelle at CERN , André Lagarrigue , LAL director , 1979 Nobel prize (Weinberg-Salam)
- * 1975 : Exotic nuclei, nuclear chart stability limits
- * 1983: W,Z discovery at CERN (UA1 & UA2) , 1984 Nobel prize C. Rubbia & S. van der Meer
- * 1990's : LEP , Z0 properties, 3 neutrinos
- * 2012 : Higgs discovery by ATLAS & CMS @ CERN, 2013 Nobel prize
- * 2013 : Planck CMB maps and cosmological parameters
- * 2015 : First direct observation of gravitational waves (BH binary coalescence) by LIGO (& VIRGO) , 2017 Nobel prize

IPN & LAL at Orsay campus, ~1957



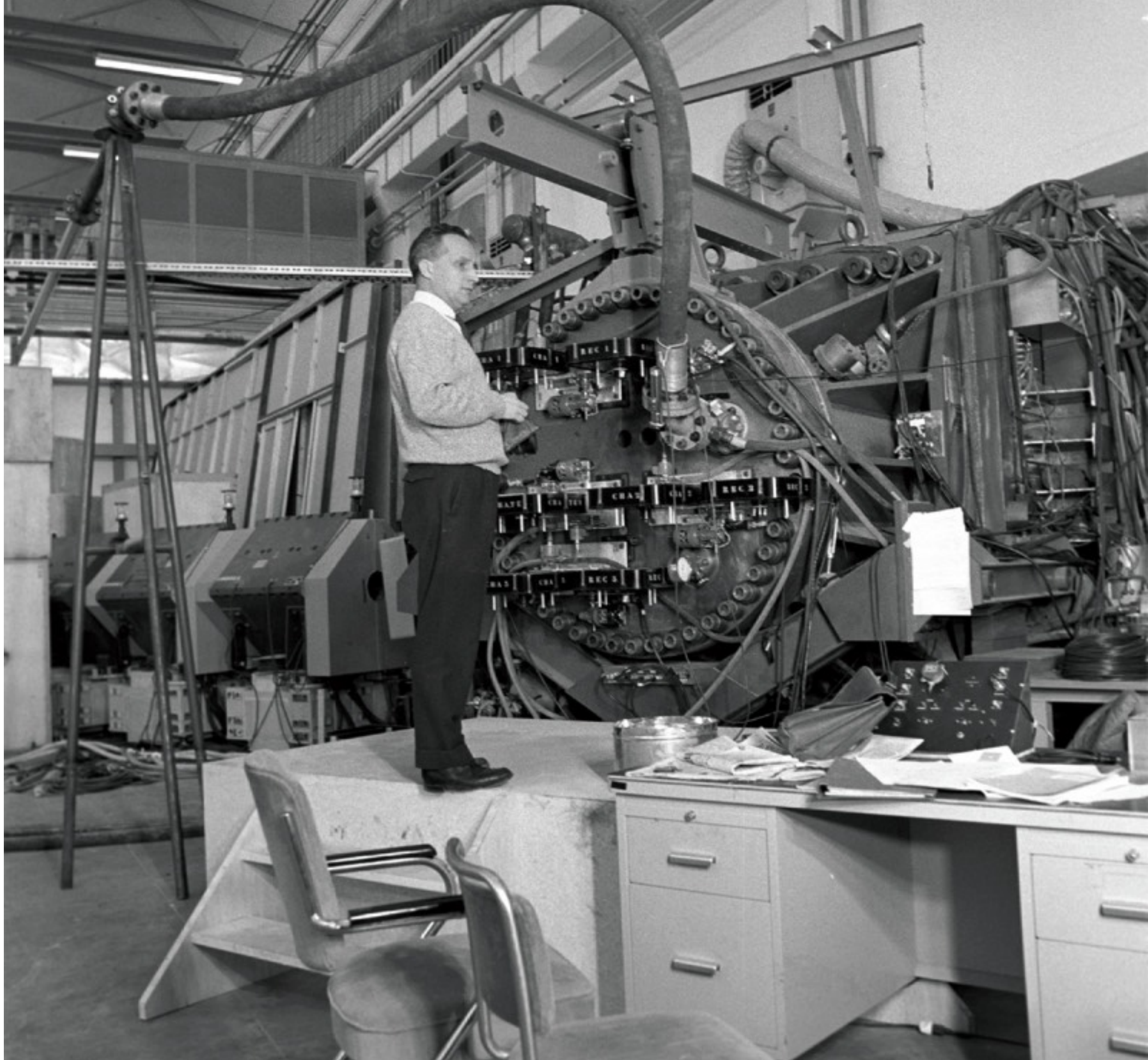


Linac hall with klystrons at LAL ~ 1968



Hubert Reeves (left) , René Bernas

Breakthrough in BBN computation , ~ 1965-1970



André Lagarrigue in front of BP3 Bubble chamber

End



Laboratory organization



Direction du laboratoire

Plateformes de Recherche

ALTO

ANDROMEDE

JANNUs/SCALP

SUPRAtech

LaserIX

Chargés de mission

740 members

220 researchers

370 engineers and technicians

7 Pôles de Recherche

31 équipes

1 Pôle Ingénierie

4 départements

11 Services

1 Pôle Administratif

3 Divisions

1 Service

8 services supports

5 plateformes de recherche

Services support

Documentation

Communication & Événementiel

Enseignement

Infrastructures

Management de projets

Prévention des risques

Qualité

STIRI

Pôles de Recherche

PHYSIQUE DES HAUTES ÉNERGIES

- ALICE
- ATLAS
- B Factories
- DeLight
- HADES
- ILC
- JLab/EIC
- LHCb
- Neutrinos

PHYSIQUE DES ACCÉLÉRATEURS

- ALEA
- MAVERICS
- BIMP
- Cryogénie
- Technologie RF
- Plateforme /PANAMA

PHYSIQUE SANTÉ

- Modélisation et vivant
- Radiation et vivant
- Imagerie multimodale et Imagerie tissulaire
- Service biologie

PHYSIQUE THÉORIQUE

PHYSIQUE NUCLÉAIRE

- Noyaux aux extrêmes
- Noyaux exotiques structures astrophysique réactions
- Noyaux ions matière
- Physique nucléaire théorique
- Spectroscopie décroissance et fission
- Faisceau ISOL, ions radioactifs et structure

ASTROPARTICULES, ASTROPHYSIQUE ET COSMOLOGIE

- Astrophysique & cosmochimie
- Astro-particules de haute énergie
- CMB
- Dark matter
- GREEN
- Ondes gravitationnelles
- Astroparticules Solid State detectors

ENERGIE ET ENVIRONNEMENT

- CHIMÈNE
- RAPHYNEE

Pôle Ingénierie

ELECTRONIQUE

- Systèmes numériques et acquisition
- Développements analogiques et microélectronique
- CAO prototypage et réalisation

INFORMATIQUE

- Développement
- Exploitation
- On-Line

DÉTECTEURS ET INSTRUMENTATION

- Détecteurs de particules & instrumentation associée
- Détecteurs cryogéniques de particules & instrumentation associée

MÉCANIQUE

- Bureau d'études
- Réalisations et montages mécaniques

Administration

Division accueil et ressources humaines

Division achats et logistique

Service logistique

Division financière

Service contrats

Service des marchés



université PARIS-SACLAY



<https://www.ijclab.in2p3.fr>

MAJ 03/11/2020

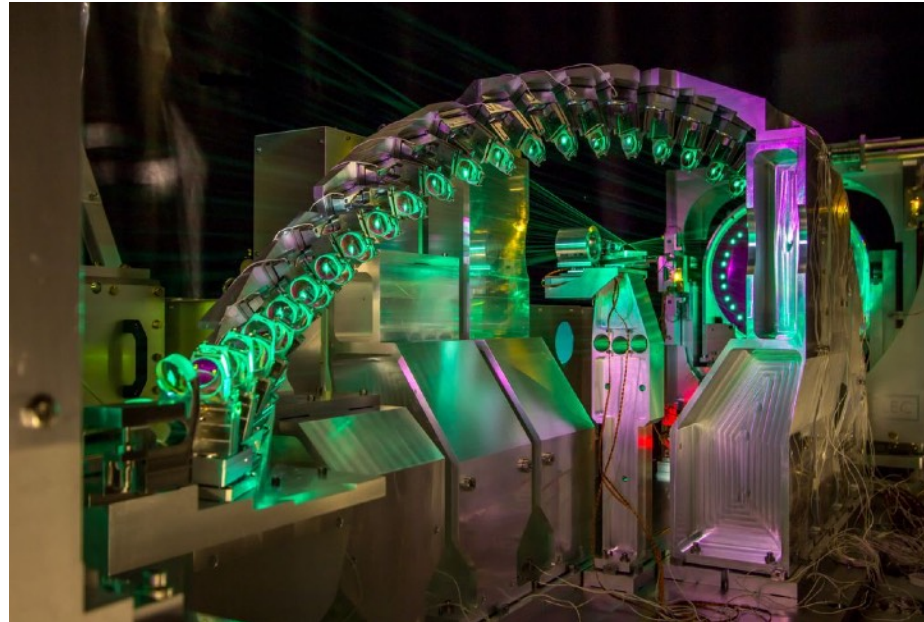
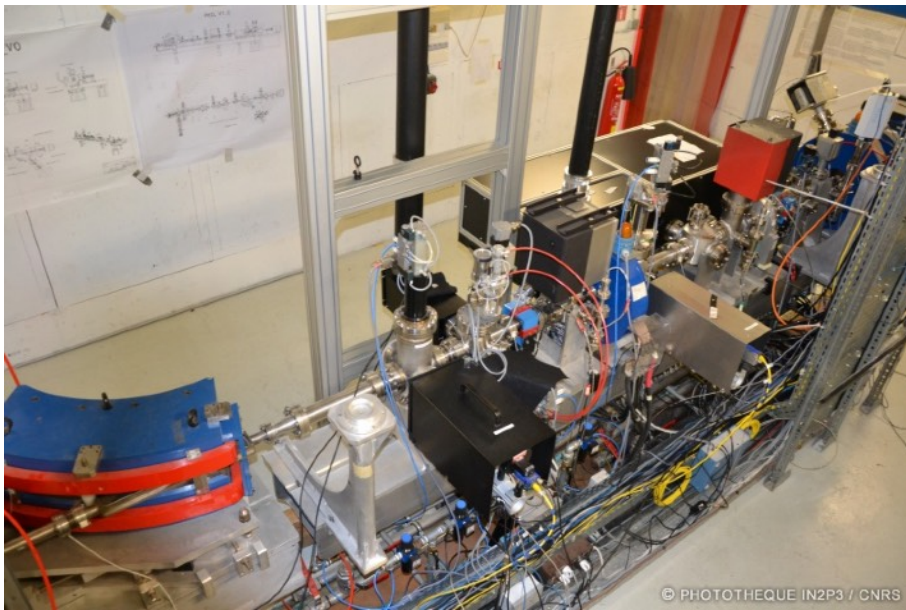
17/12/2020

IJCLab presentation

26



Accelerator Physics



Weighing in on a **European/global scale** by making a major contribution to the design and construction of **large machines**

Research Themes :

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



The Platforms - I

~30
Technical
staff

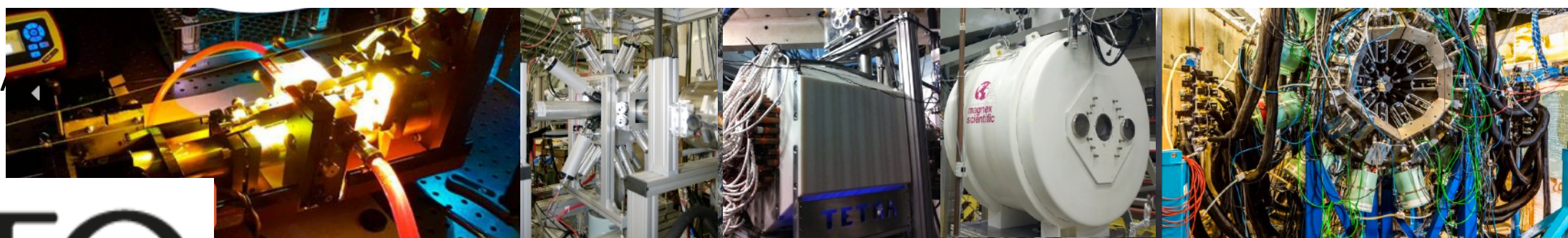
The **ALTO** platform with two accelerators unique in France :

➤ **15 MV Tandem type electrostatic** accelerator for accelerating stable beams from proton to aggregates

➤ **electron li**

10 physics lines

30 experiments



in the process of
obtaining the status of
national platform

Equipment delivering specific beams:

- Stable light beams with heavy ions
- Radioactive beams
- Aggregate bundles
- Neutron beams

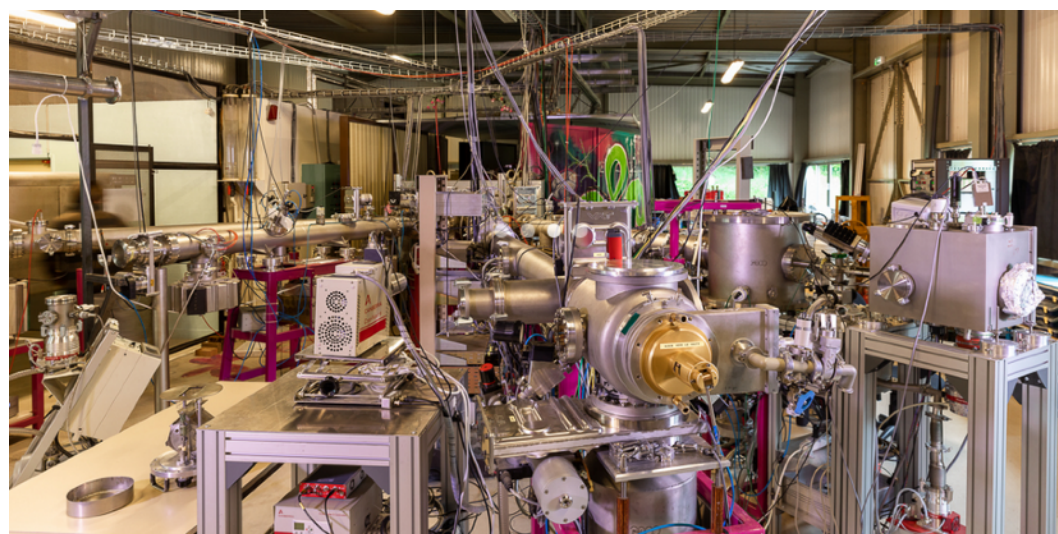


The Platforms - II



Andromede : multidisciplinary platform, unique in the range of beams of several MeVs delivered: protons, multicharged atomic ions, gold molecules and nanoparticles. Including an "ion source" R&D activity. It is equipped with two beam lines (90° and $1^\circ 29'$).

JANNuS-SCALP : interdisciplinary platform for fields ranging from materials sciences to astrophysics, including geology and nuclear physics.



ongoing extension in CPER and Equipex+

Different equipments for ion irradiation / implantation and analysis . Coupling of Transmission Electron Microscope with ARAMIS and IRMA lines unique in the world due to the diversity of elements and energies accelerated in situ inside the MET.

DIAPASON

IJCLab presentation



The Platforms - III

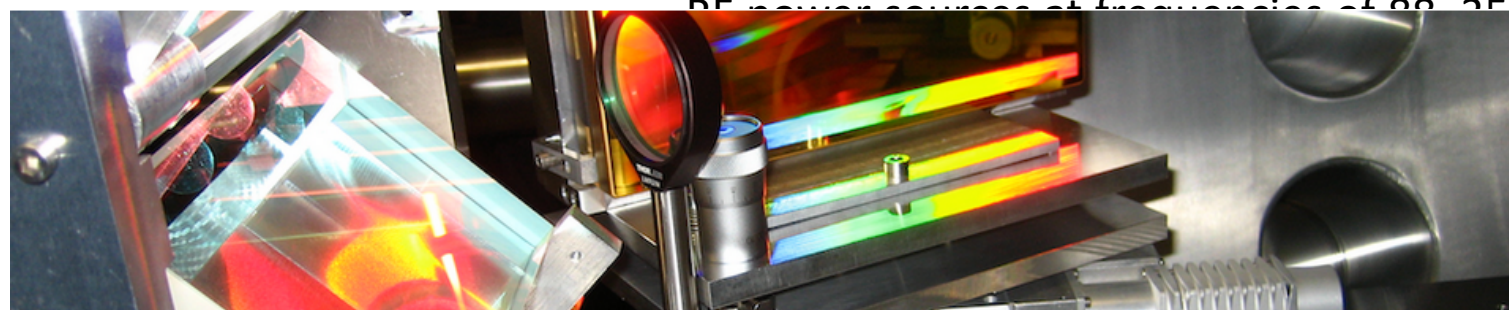
SUPRATECH platform dedicated to R&D on the superconducting cavities of the future high-energy, high-power particle accelerators. Equipment to prepare, package, assemble and test superconducting RF cavities for IJCLab projects.



- ✓ a chemistry room
- ✓ an ISO4 clean room (80 m², with 50 m² class10)
- ✓ an assembly hall, for the integration of cryostats
- ✓ two experiment halls (with vert. & hor. cryostats)

and equipped with :

LASERIX : laser platform providing coherent, intense and brief (50fs to 10 ps) sources in the near-infrared (800 nm) and EUV (30 to 90 eV) domains. Will be completed including the electron photo-injector (PHIL).



- a 400 kW cooling system (HF sources)