



IN2P3

Institut national de **physique nucléaire**
et de **physique des particules**

Fanny Farget
IN2P3 Scientific Director
Nuclear Physics and Applications

"Nuclear Physics @ IN2P3 "

www.in2p3.fr

IN2P3, ONE OF 10 CNRS INSTITUTES

CNRS

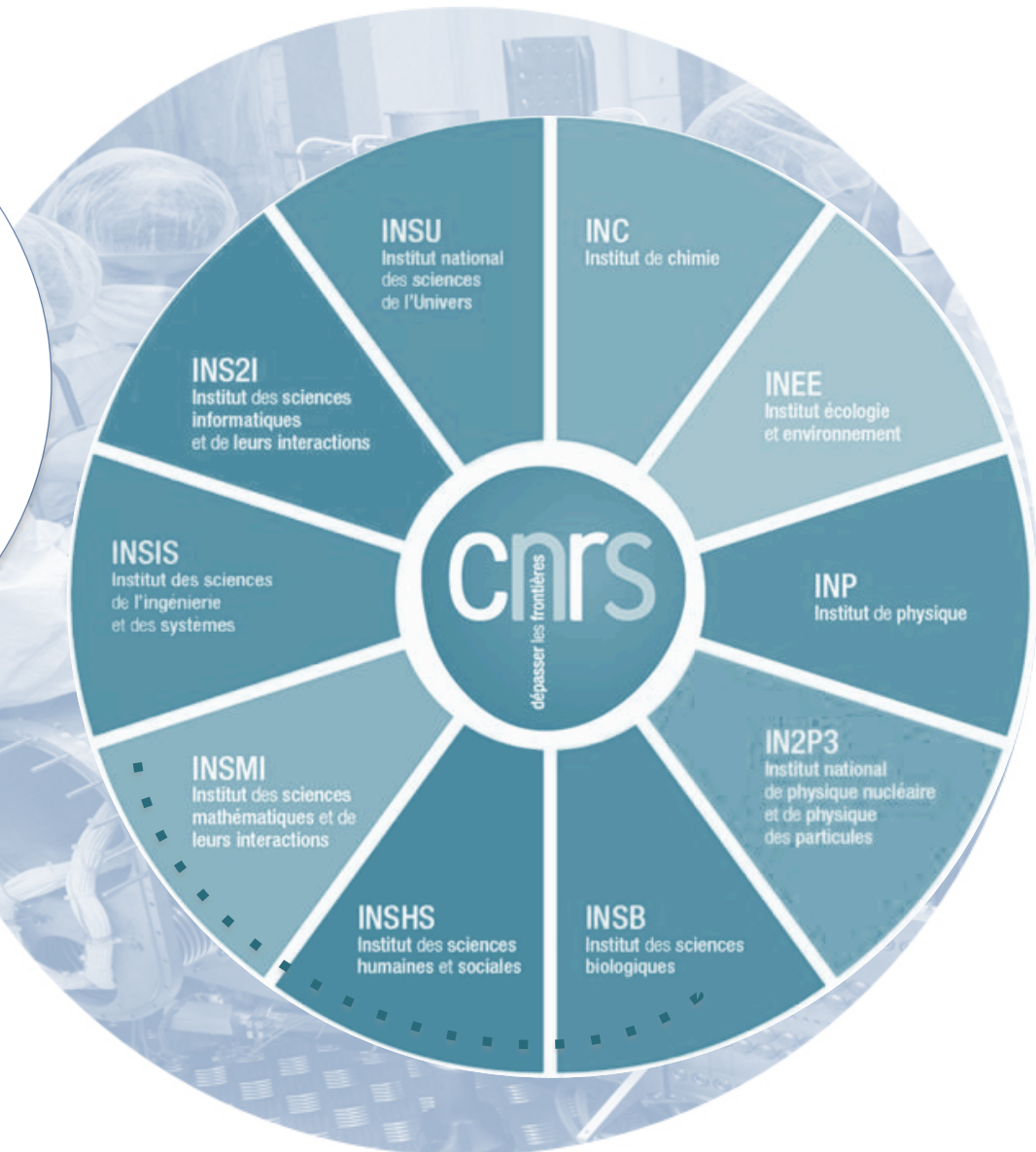
10 institutes

(**3** national institutes: INSMI, INSU, IN2P3)

1 100 research units
(95% in partnership)

33 000 researchers,
engineers, technicians

3.3 billion euros per year
(total budget)



PROMOTE AND UNIFY RESEARCH ACTIVITIES IN THE FIELD OF SUBATOMIC PHYSICS AND RELATED APPLICATIONS

COORDINATION

Programmes on behalf
of the CNRS and
universities

CEA partnership

NUCLEAR PHYSICS, PARTICLE AND ASTROPARTICLE PHYSICS

EXPLORATION

The infinities,
from particles
to Cosmos

PROVIDING

Competencies ,
expertise

Interdisciplinary research,
training, innovation

LINCKS WITH SOCIETY

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KEY FIGURES of IN2P3

40 major international projects

15 LIA (international associated laboratories)

1 international research network

2 european research networks

3 206

researchers,
engineers and technicians

71 M€

Annual budget
(excluding salaries in 2015)

TGIR

25 laboratories
and platforms

DISTRIBUTION OF STAFF

CNRS researchers: 503

University researchers: 372

PhD & post-docs: 482

1357 researchers

CNRS engineers & technicians: 1 316

Other engineers & technicians: 225

Short-term engineers & technicians: 308

Total staff members: 3 206

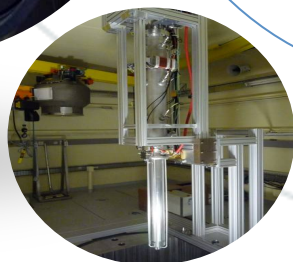
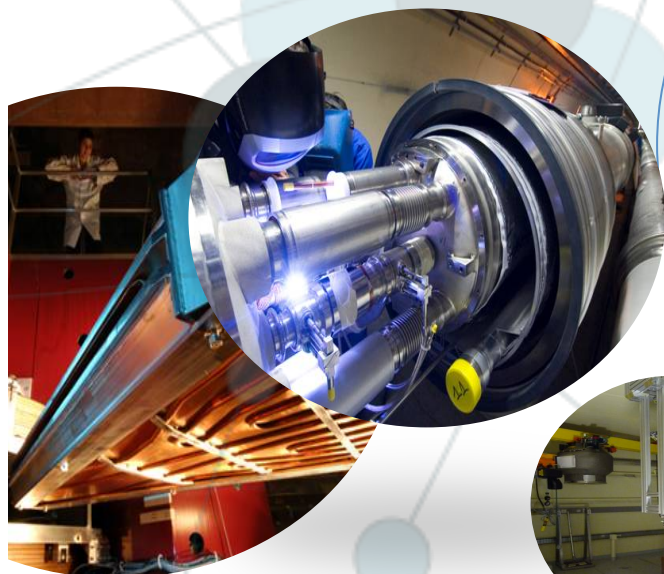
SCIENTIFIC THEMES

Particle physics Nuclear and hadronic physics

Matter's most elementary constituents
and fundamental interactions

Structure of nuclear matter

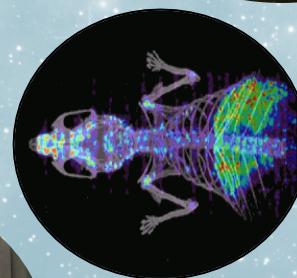
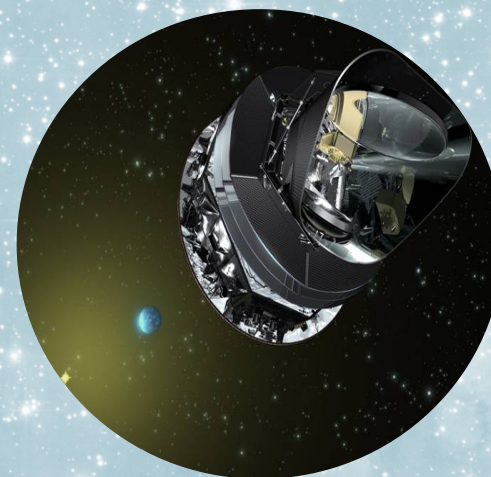
Theory



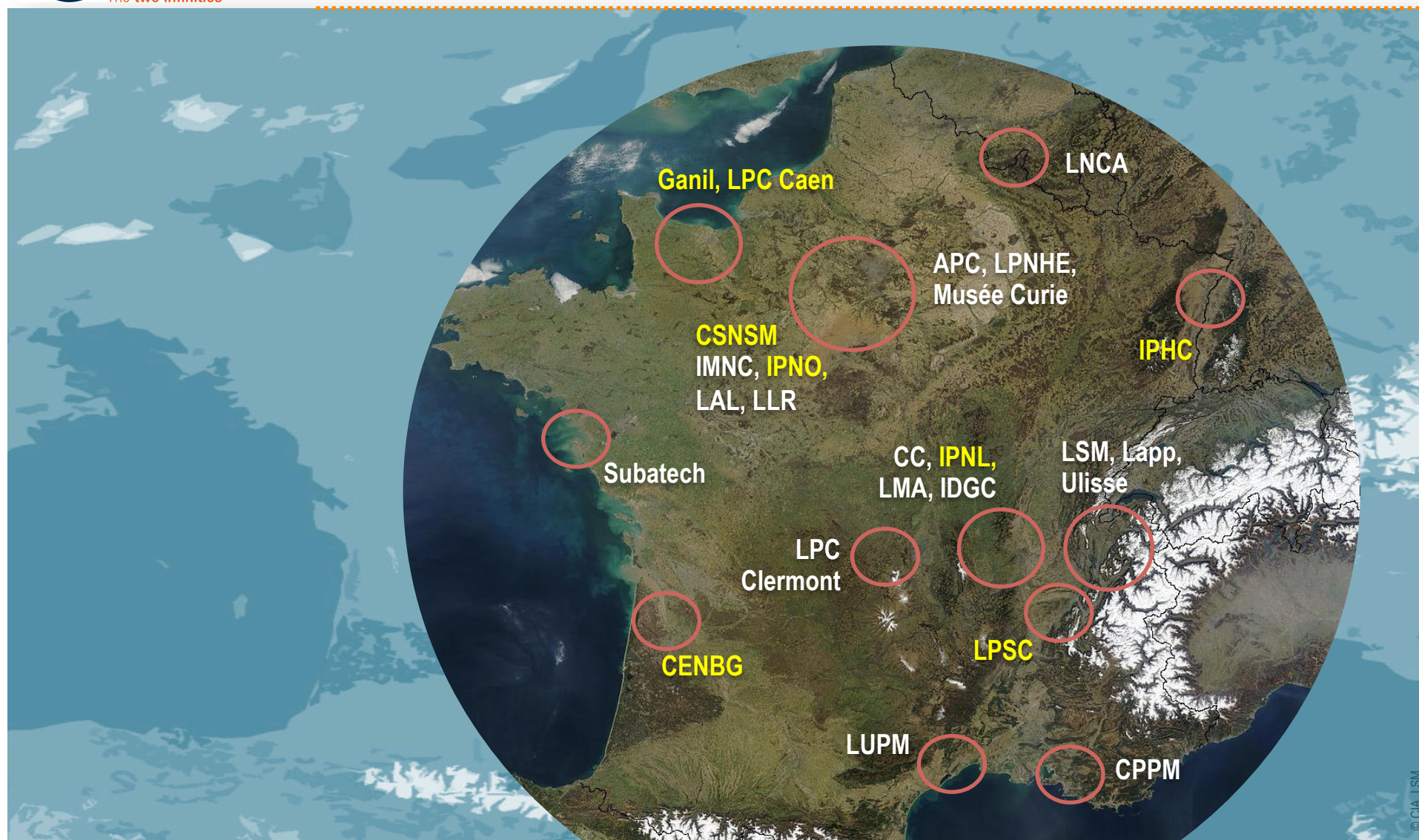
Instrumentation
Computing grids
Accelerator R&D
Nuclear energy
Medical applications



Astroparticle physics and neutrinos Universe's composition and behaviour



NETWORKED LABORATORIES



NUCLEAR PHYSICS AND APPLICATIONS

Fundamental research

- Nucleon structure
- Nuclear properties
- Structure and Dynamics
- Limits of cohesion
- Nuclear astrophysics
- Theory

250 researchers

Applications

- Cross sections for Hadrontherapy
Nuclear waste management
Astrophysics
- Detection
- Beam monitoring

35% of IN2P3 research staff

Interdisciplinary research

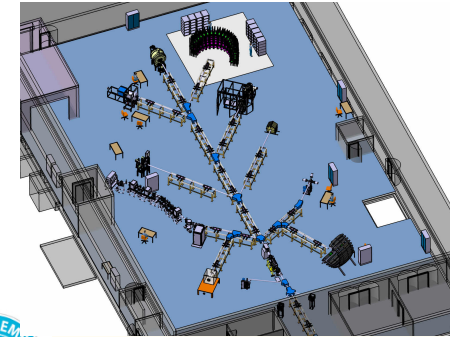
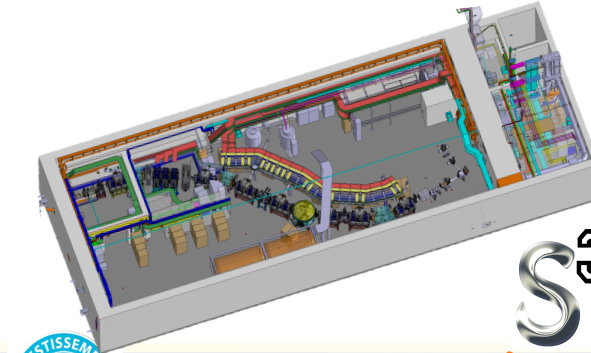
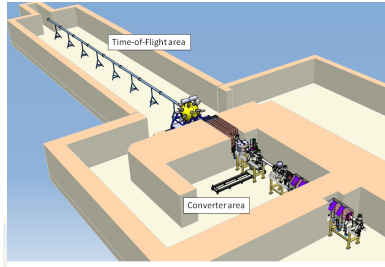
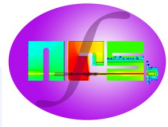
- Imaging
- Therapy
- Energy
- Radiochemistry
- Irradiation effects (cells and material)

230 researchers

EXTREME STATES STABILITY PARTONS
EXOTIC NUCLEI SUPERHEAVY APPLICATIONS

Nuclear Structure and Dynamics

Spiral2 Phase 1+(+)



Linac driver
33 MeV p, 40 MeV d (5mA)
14.5 A.MeV HI (1mA)

New RFQ A/Q=7 2021-?

Production
up to 10^{14} FF/s

SPIRAL1 upgrade

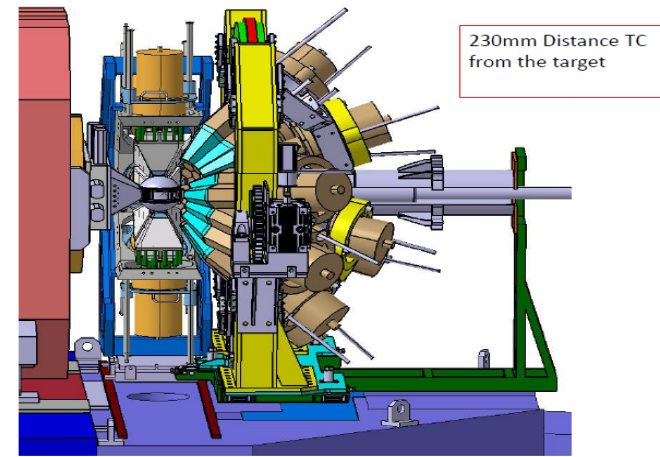
GANIL

EXTREMES STATES
EXOTIC NUCLEI

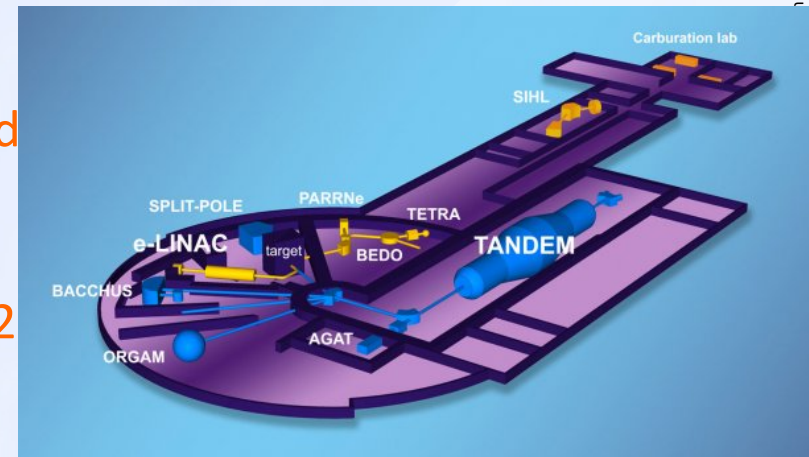
STABILITY
SUPERHEAVY

Nuclear Structure and Dynamics

- Agata campaign at Ganil 2015-2019 and the completion of Agata 1/3 and other experiments at GANIL (SPIRAL1 upgrade)
- Fazia-Indra campaign 2017-..
- First experiments @ NFS, installation of S3
- Running the ALTO facility at Orsay for its physics program and prepare the physics and instrumentation for DESIR
- Development of instrumentation for SPIRAL2 (FAZIA, ACTAR, GASPARD, PARIS, NEDA)
- Continue the program of physics at other installations (RIKEN, DUBNA, HIE Isolde, Jyväskylä, LNS, LNL, Triumf, NSCL...)



Philippe Stroppa, LSM, CNRS Photothèque / Hubert Raguet



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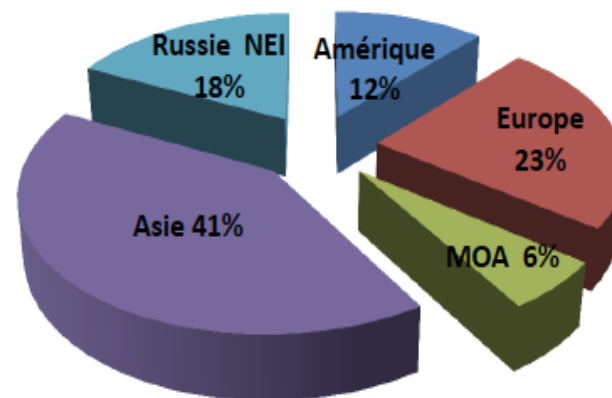
EXTREMELY STABLE
EXOTIC NUCLEI
STABILITY
SUPERHEAVY

PARTONS
APPLICATIONS

INTERNATIONAL COLLABORATIONS

On-going LIA

LIA Particle Physics	5
LIA Astroparticles	5
LIA Interdisciplinary	1



6 LIA around GANIL/ SPIRAL2 (Priority of IN2P3 and IRFU in nuclear Physics)

LIA FJ-NSP	"Laboratory for Nuclear Structure Problems »	RIKEN, Wako (Japan)
LIA FI-NS	«French-Indian international associated lab for nuclear science	BARC, Mumbai (India)
LEA NuAG	Nuclear Astrophysics and Grid	Prague (Tchech republic)
LEA COSMA	French-Romanian Collaborations	IFIN-HH Bucharest

LEA COPIGAL "The Collaboration COPIN-GANIL on physics of exotic nuclei » IFJ PAN, Cracovie COPIN (Pologne)

LEA COLL-AGAIN "The COLLaboration INFN - GANIL on nuclear structure, nuclear reactions « INFN Legnaro (Italie)



And the future...

For IN2P3 these two LIAs are very important and fruitful.
They are the results of a longstanding tradition of cooperation
between France and Italy and France and Poland

Reinforce the strength between our three countries on the already
on going thematics (ENSAR2, NuPECC...)

New directions in applications of nuclear physics e.g. nuclear
medecine (Legnaro, Warsaw, Krakow, Caen, Orsay, Strasbourg,
Nantes...)



And the future

*Thank you for your attention and looking forward
for the future of our collaboration between Italy,
Poland and France*

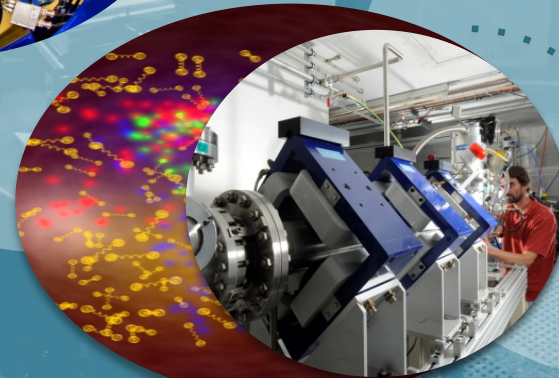
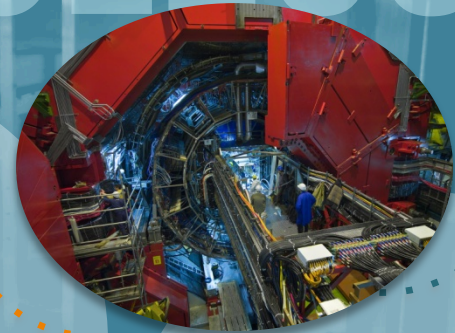
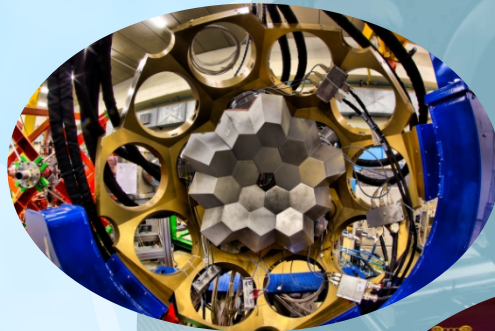


*Thanks to Dominique Guillemaud-Mueller
For her supporting and constructive actions*



NUCLEON AND NUCLEUS: THE EMERGENCE OF COMPLEXITY

- Nucleon's structure
- **Nuclear properties**
- **Structure and Dynamics**
- **Limits of cohesion**
- **Nuclear astrophysics**
- **Theory**
- **Societal and Industrial applications**



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EXTREME STATES
EXOTIC NUCLEI

STABILITY
SUPERHEAVY

PARTONS
APPLICATIONS

COPIGAL: Thematics and detector developments

Very large collaboration including all the nuclear physics labs of IN2P3 on the major thematics and detector developments. 18 publications and different common workshops (26 oral presentations)

Structure of exotic nuclei and halo nuclei for the investigation of shell effects via transfer reactions

Nuclear structure close to $N=Z=50$

Nuclear deformation in excited states

Studies of near barrier fusion for very heavy systems ($Z \approx 100$) with the GANIL facility and the S3 separator

Light particle and fragment detection for the study of nuclear spectroscopy, dynamics and thermodynamics at the new generation of Radioactive Ion Beam facilities – [FAZIA](#) collaboration

Photon Array for studies with Radioactive Ion and Stable beams [PARIS](#)

Highly excited exotic nuclei probed by the GDR gamma-decay and discrete gamma spectroscopy [ALTO-ORGAM](#), [VAMOS-AGATA](#)

Studies of neutron-rich nuclei using deep-inelastic collisions with radioactive beams

Symmetry breaking phenomena at high spins in atomic nuclei

Installation of the [AGATA](#) Demonstrator and upgrade of the [EXOAM2](#) array at GANIL

Electromagnetic moments of isomeric states in transfer and fragmentation reaction products

Theoretical investigations of nuclei far from stability

Spectral Predictive Power of the Nuclear Hamiltonians

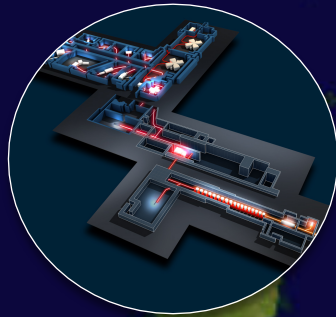
Barrier height distribution studies

Theoretical and experimental investigations of the highly collective bands in the $A \sim 40, 60$ nuclei

Correspondence between self-consistent and micro-macro predictions for very deformed and spin isomeric configurations

Preparatory work on installation of the Recoil Filter Detector at GANIL

FRANCE : INFRASTRUCTURES for Nuclear Physics



Spiral2 / Ganil



Alto Orsay



Very large collaboration including all the nuclear physics labs of IN2P3 on the major thematics and detector developments. 15 publications and different common workshops

Shell structure evolution in neutron rich nuclei

Shapes and symmetries in nuclei

Structure of neutron deficient nuclei

Reaction mechanism at the Coulomb barrier

Reaction mechanism at the Fermi energy

Nuclear dynamics and thermodynamics

Collective modes in nuclei

Clusters and molecules in nuclei

Nuclear theory

FAZIA

NEDA

PARIS

AGATA



BUT ALSO

ACCELERATOR R&D, TECHNOLOGICAL PLATFORMS

- Superconducting accelerator cavities and cryotechnology
- Ion and electron sources
- Target/source for radioactive beams



INSTRUMENTATION, DETECTORS

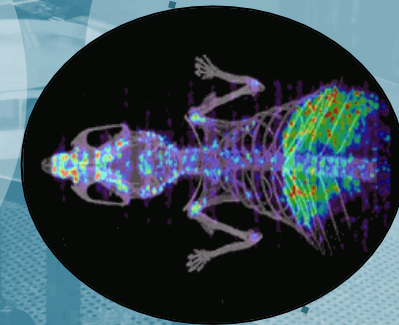
- Silicon detectors
- Photo-detectors, new generation scintillators



NEW DIAGNOSTIC AND THERAPY TOOLS

→ *Strong involvement of IN2P3 in the fight against cancer*

- Radioisotopes, radiobiology, radiotherapy
- Dosimetry, Imaging, simulations (Geant, Gate)



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INTENSE BEAMS
ION SOURCES

DETECTORS

SUPERCONDUCTING
RADIOISOTOPES