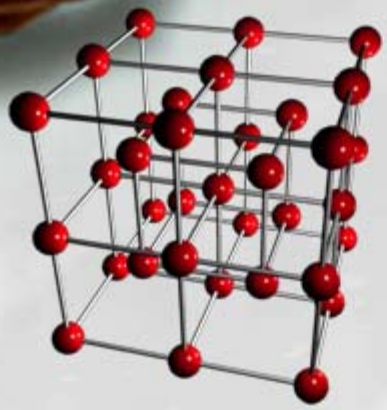
Briques élémentaires de la matière

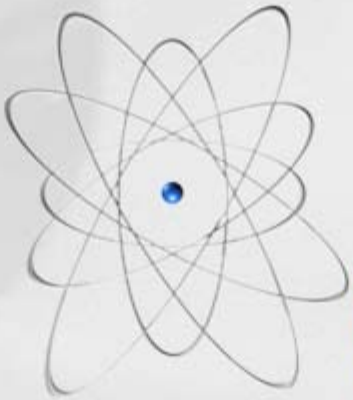
Matière

Cristal



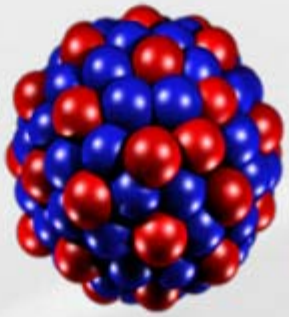
10^{-3} m
(macroscopique)

Atome



10^{-10} m

Noyau



10^{-14} m

Nucléon

10^{-15} m

Quarks
et
Gluons

•

$<10^{-18}$ m

Jacques Martino

IN2P3
Institut national de **physique nucléaire**
et de **physique des particules**

March 2012

www.in2p3.fr

IN2P3, an Institute in CNRS

CNRS

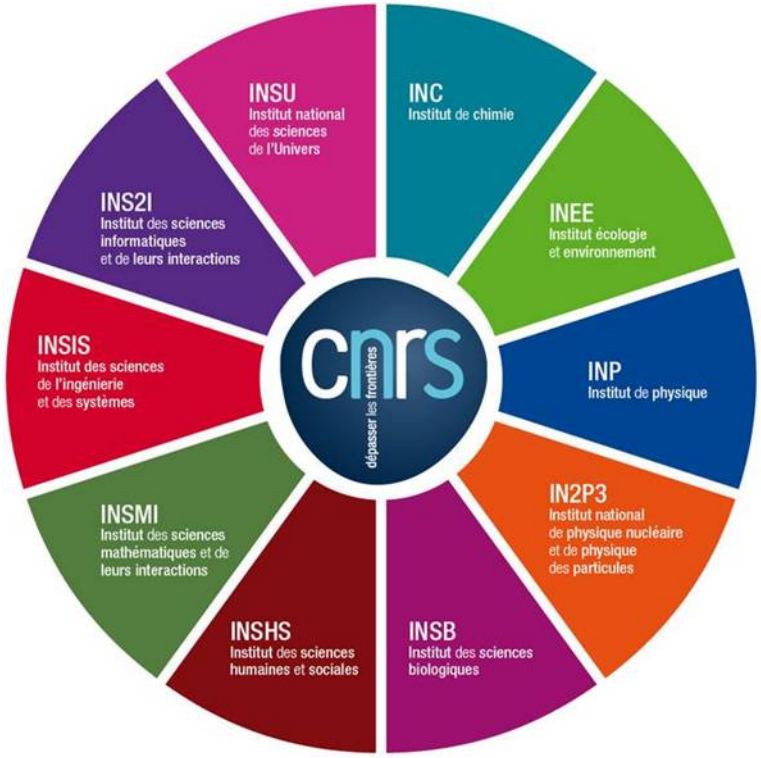
- Under the authority of the ministry for higher education and research
- 32 000 employees performing and accompanying research
  - 25 700 permanent staff
  - 11 500 researchers
  - 14 200 engineers, technicians, administration

IN2P3, an Institute in CNRS

CNRS

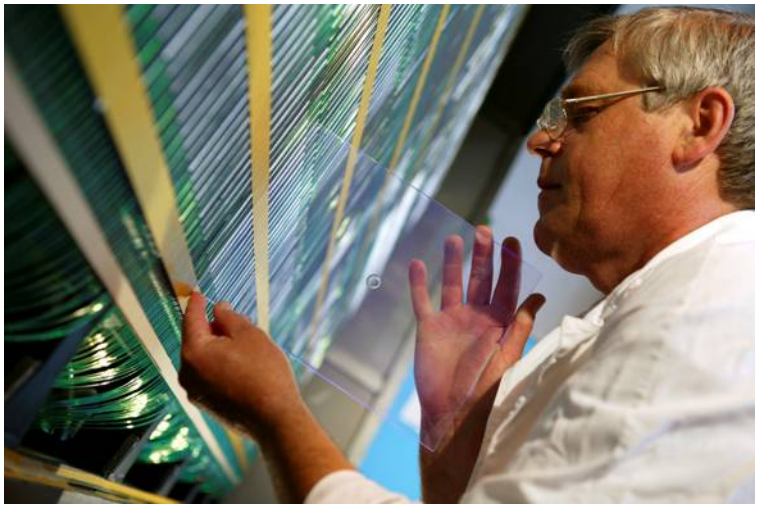
- 1 200 research and service units (labs)
- research in all the fields of knowledge

→ 10 thematic **institutes**,
including 3 *national institutes*
IN2P3 (created in 1971), INSU
and INSMI



IN2P3 key figures

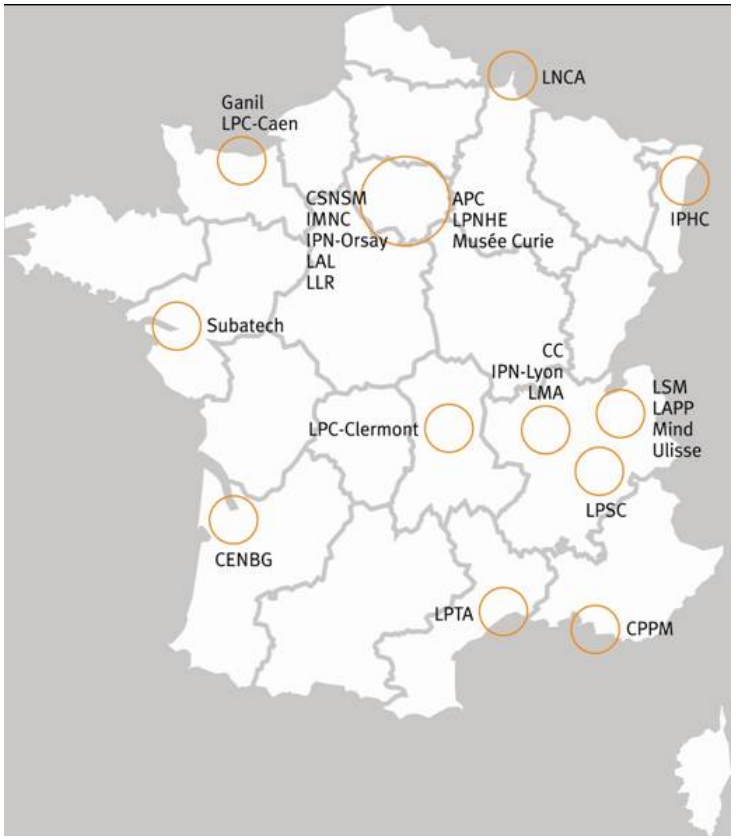
- 3 200 people (Dec. 2011)
- 1 880 CNRS staff, researchers (500), engineers and technicians (1380)
- 630 from universities and CEA
- budget from CNRS (not counting salaries): around 40 M€ (2011)
- other ressources: 33 M€
- 26 laboratories and platforms, most in common with an university or a "grande école"
- about 40 large international projects



Expérience LHCb - © LHCb, Cern

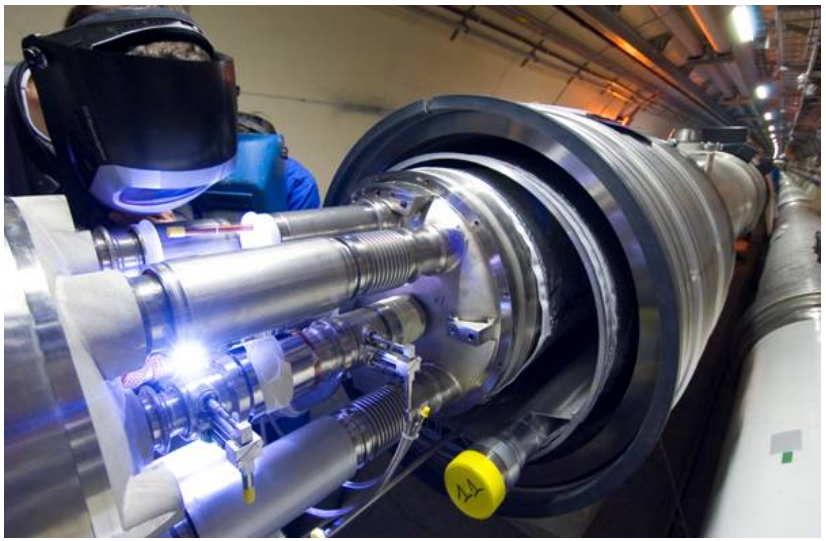
Laboratories structured in a network

- Sharing and optimisation of the ressources and competences of the Institute
  - large laboratories, infrastructures or technological platforms in **limited number** (~ 20, 150 FTE in average)
  - permanent **concertation and interactions**
    - between **laboratories**
    - with other units of CNRS, CEA, universities, grandes écoles, foreign institutes,…



IN2P3 Missions

- **Promote and federate** research in nuclear, particle, astroparticle physics
- **Coordinate** the programs in the name of CNRS and Universities, in partnership with CEA
- **Explore**
  - the physics of elementary particle
  - their fundamental interactions
  - their bounding in atomic nuclei
  - the properties of these nuclei
  - the connections between infinitely small and infinitely large scales



LHC - © Cern

Scientific themes

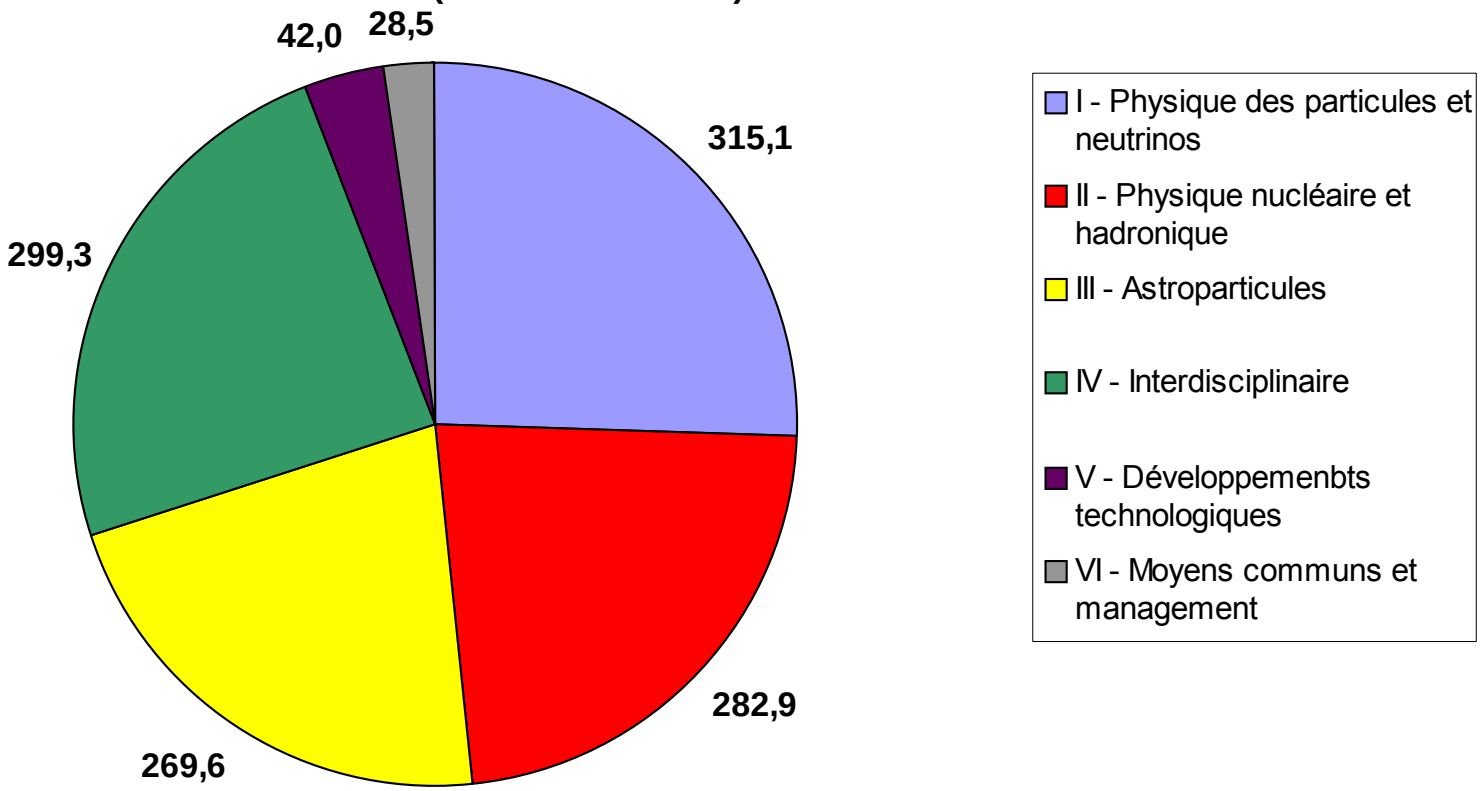
- Particle Physics
- Nuclear and Hadronic Physics
- Astroparticles and Neutrinos
- Experiments and Theory

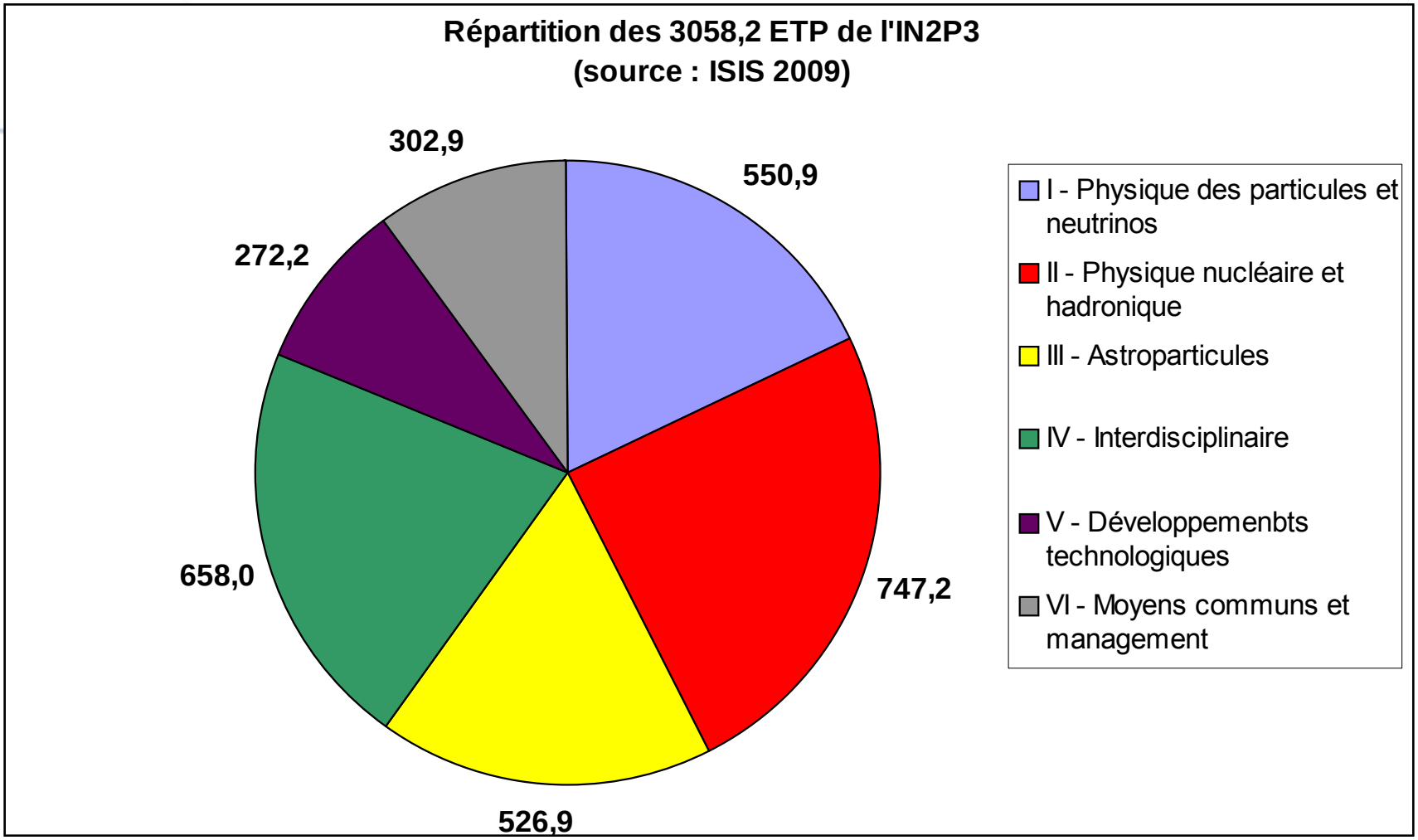
- Detectors and Instrumentation
- Accelerators
- Computing Grids

- Nuclear Physics and Energy
- Nuclear Physics and Health

Expérience Hess - © Coll. Hess

Répartition des 1237,3 ETP Chercheurs, Enseignants et Doctorants/Postdocs de l'IN2P3
(source : ISIS 2009)

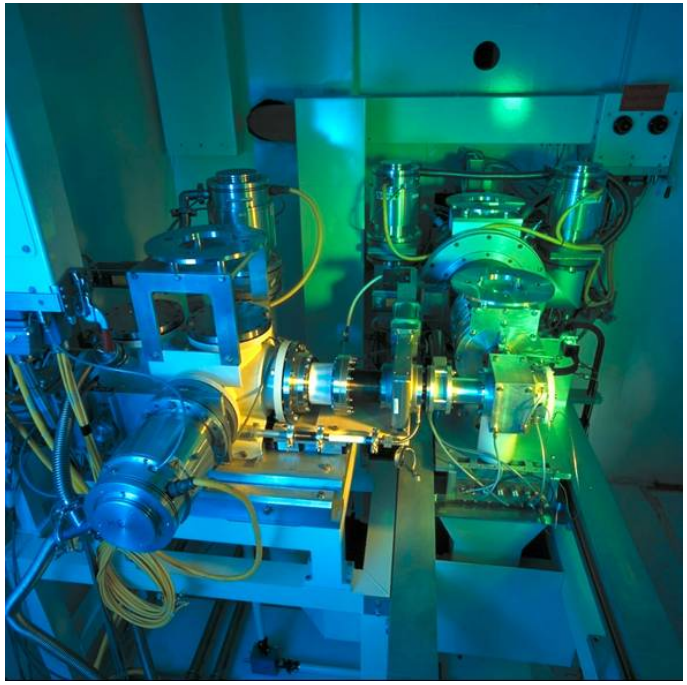



Répartition des 3058,2 ETP de l'IN2P3
(source : ISIS 2009)
302,9
550,9
272,2
658,0
747,2
526,9
I - Physique des particules et neutrinos
II - Physique nucléaire et hadronique
III - Astroparticules
IV - Interdisciplinaire
V - Développemenbts technologiques
VI - Moyens communs et management

Fundamental research at IN2P3

→ Some major questions

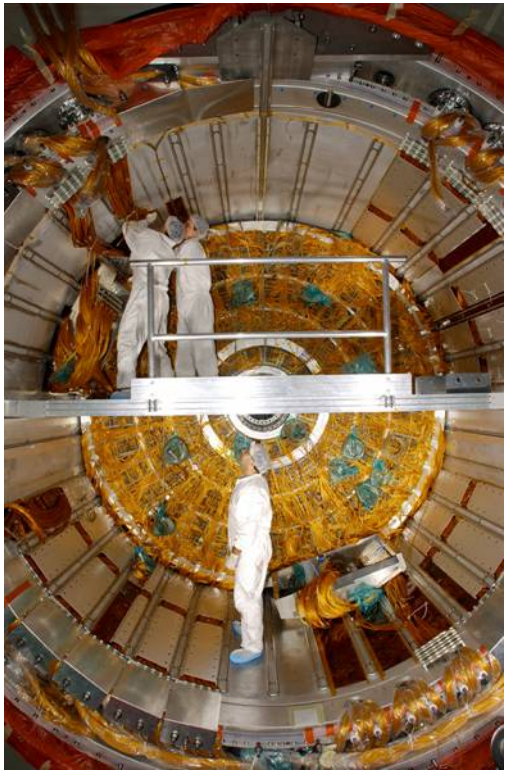
- Higgs and post Standard Model Physics
- Neutrino
- Antimatter
- Dark Matter, Dark Energy, Inflation
- Nucleon structure
- Phases of Nuclear Matter
- Nuclear Structure and Limits of Stability
- Heavy Nuclei Nucleosynthesis and Superheavy Elements



Spiral - © Ganil

Fundamental research at IN2P3

- Ultimate components and fundamental interactions: Elementary Particle Physics
  - particle masses
  - neutrino nature and mass
  - unification of fundamental interactions
  - antimatter
  - supersymmetry
  - physics beyond the Standard Model



Expérience Atlas - © Coll. Atlas, Cern

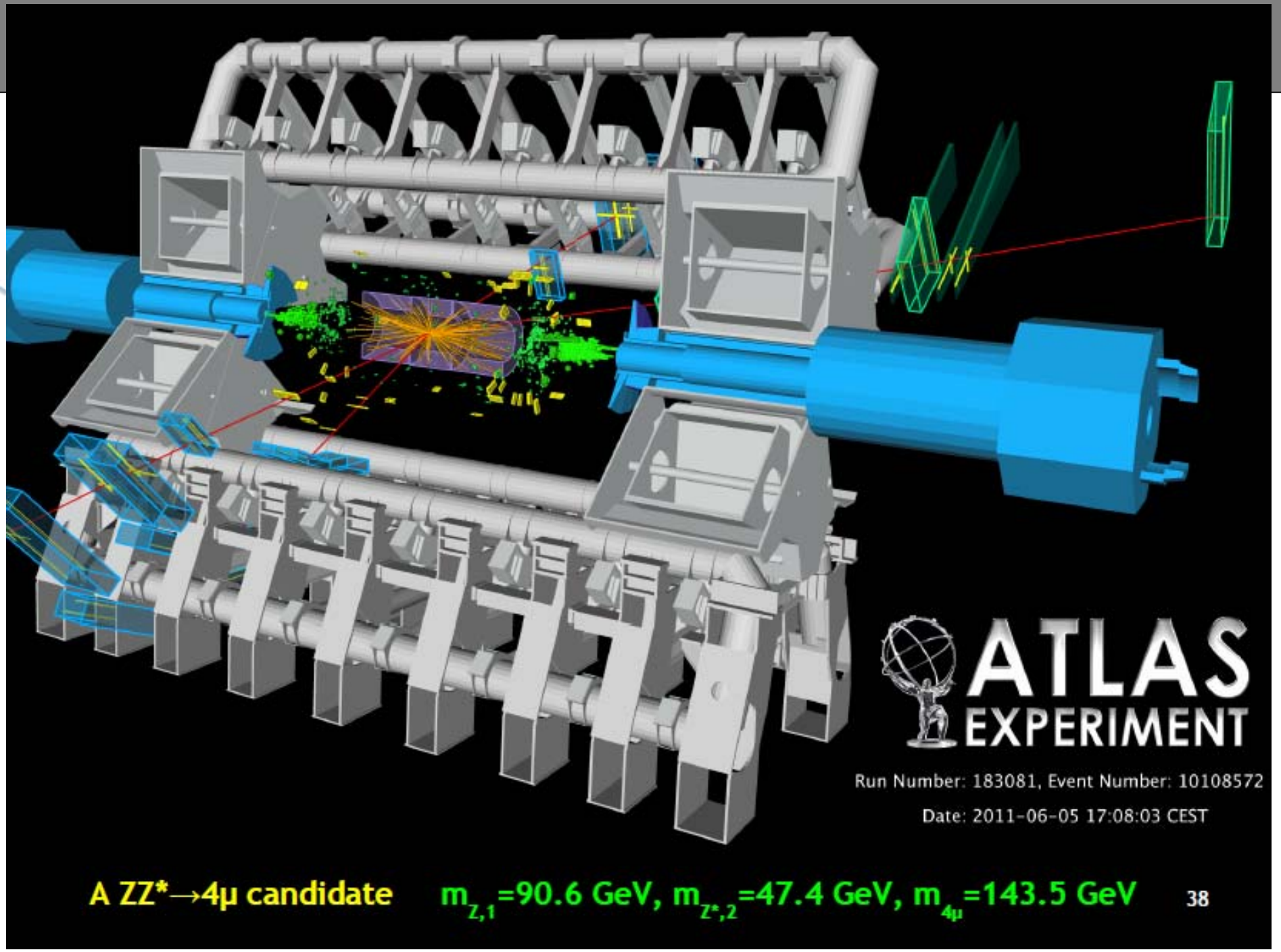
Particle physics

Ultimate components and fundamental interactions

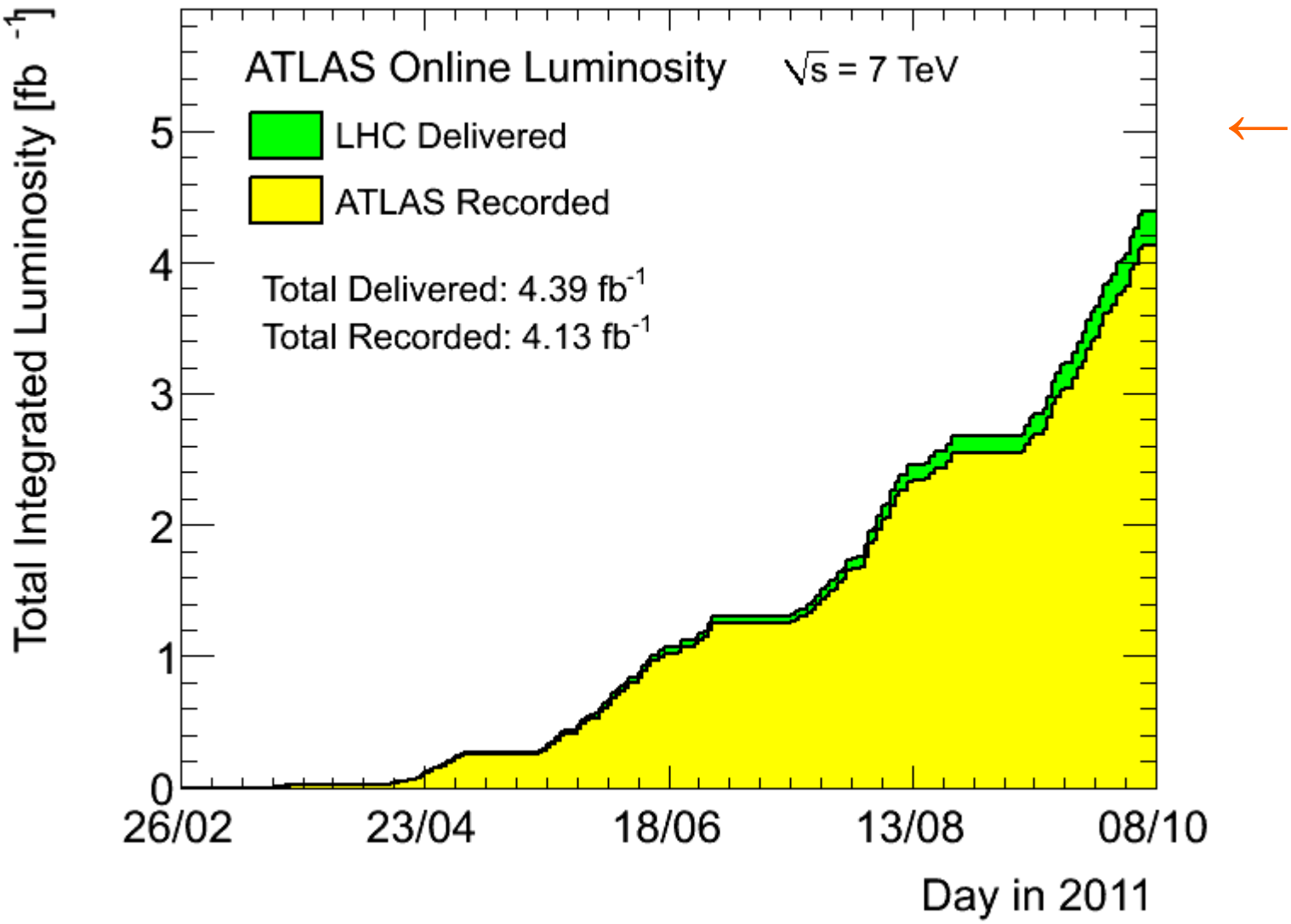
- Experiments / Projects

  - LHC : Atlas, CMS, LHCb
  - LCG (grid)
  - Opera, DChooz, T2K
  - "Possible" future projects… *(Super B, low energy precision measurements,…)*

Experiment Double Chooz

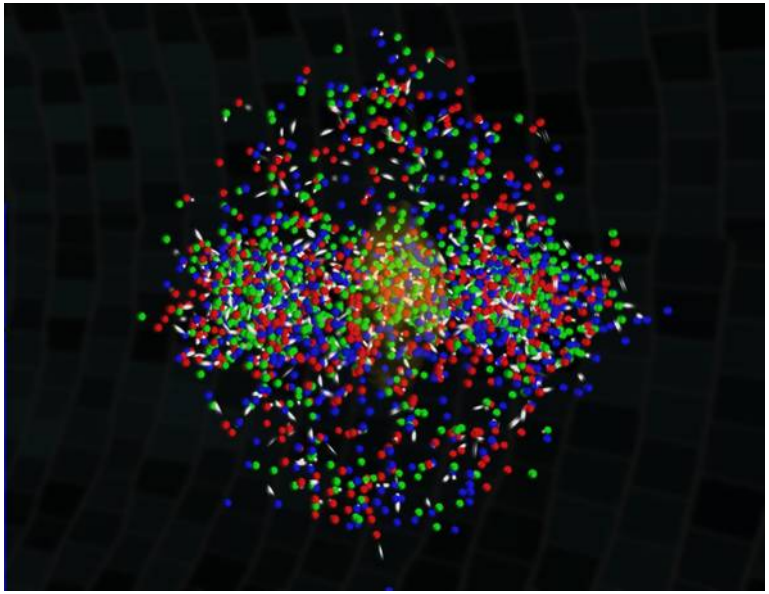


A ZZ*→4μ candidate $m_{Z,1}$=90.6 GeV, $m_{Z^*,2}$=47.4 GeV, $m_{4\mu}$=143.5 GeV


ATLAS Online Luminosity
√s = 7 TeV
LHC Delivered
ATLAS Recorded
Total Delivered: 4.39 fb-1
Total Recorded: 4.13 fb-1
Total Integrated Luminosity [fb-1]
0
1
2
3
4
5
26/02
23/04
18/06
13/08
08/10
Day in 2011

Fundamental research at IN2P3

- Structure of nuclear matter : Nuclear Physics
  - quarks confinement
  - quark-gluon plasma
  - nucleon structure
  - nuclei properties and dynamics
  - exotic nuclei and stability limits
  - superheavy nuclei
  - nuclear astrophysics

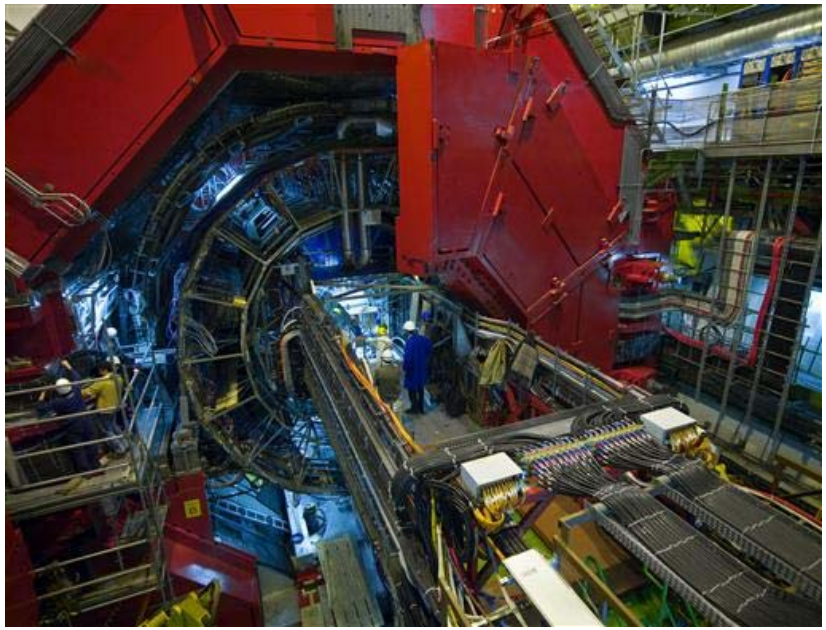


Expériences Phenix et Star - © BNL

Nuclear physics

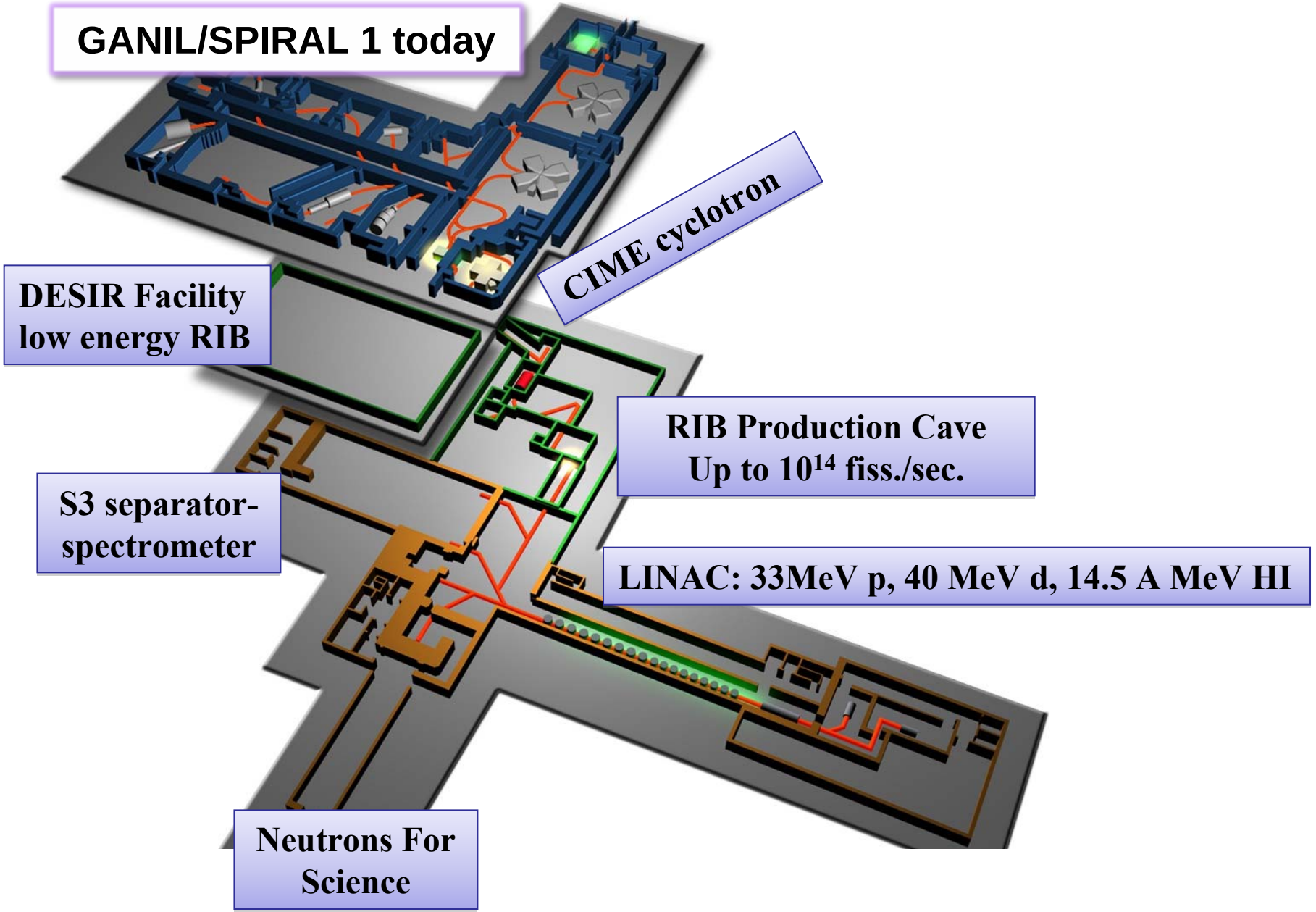
The proton and the nucleus : emergence of complexity

- Experiments / projects
  - Ganil, Spiral, Spiral-2
  - Alto (Orsay)
  - Riken, Jyväskyla, GSI, MSU, Dubna, Isolde, ILL
  - Alice (LHC)
  - Star and Phenix (RHIC)
  - JLab, GSI-FAIR
  - Agata



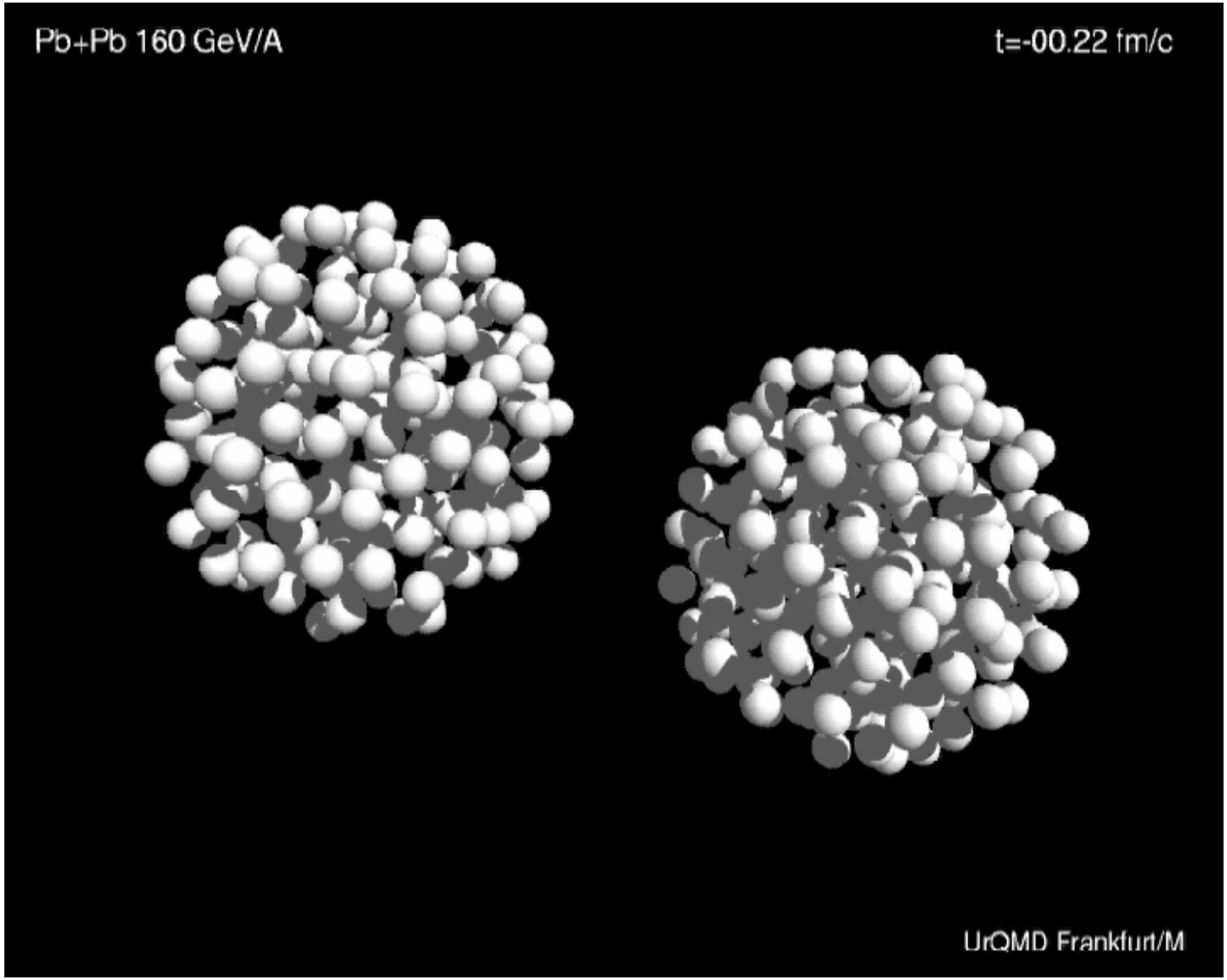
ALICE experiment - © CERN

GANIL / SPIRAL1 / SPIRAL2



Mise en évidence du plasma de quarks et gluons

Mise en évidence du plasma de quarks et gluons



Fundamental research at IN2P3

- Composition and behavior of the Universe: Astroparticle Physics
  - past and origin of the Universe
  - heavy elements formation
  - dark matter
  - dark energy
  - antimatter
  - UHE cosmic rays
  - gravitational waves

Expérience Hess - © Hess/IN2P3/Max Planck

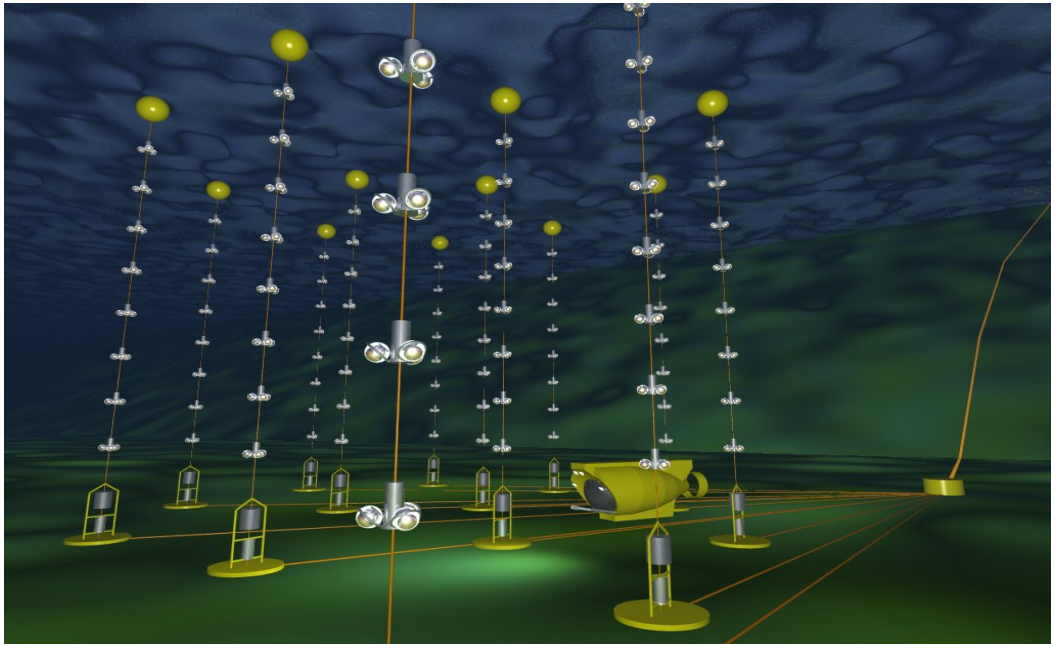
Astroparticles and neutrinos

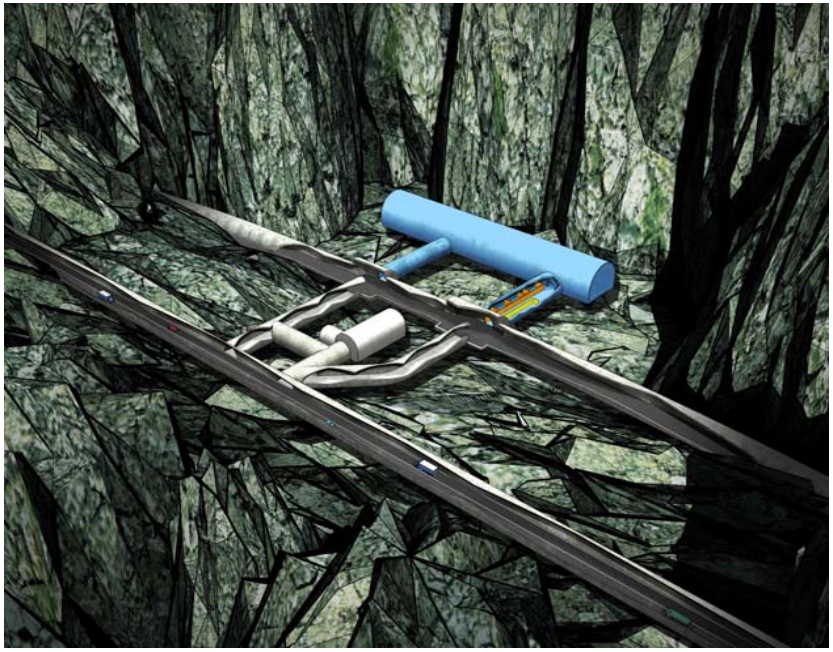
Composition and behavior of the Universe

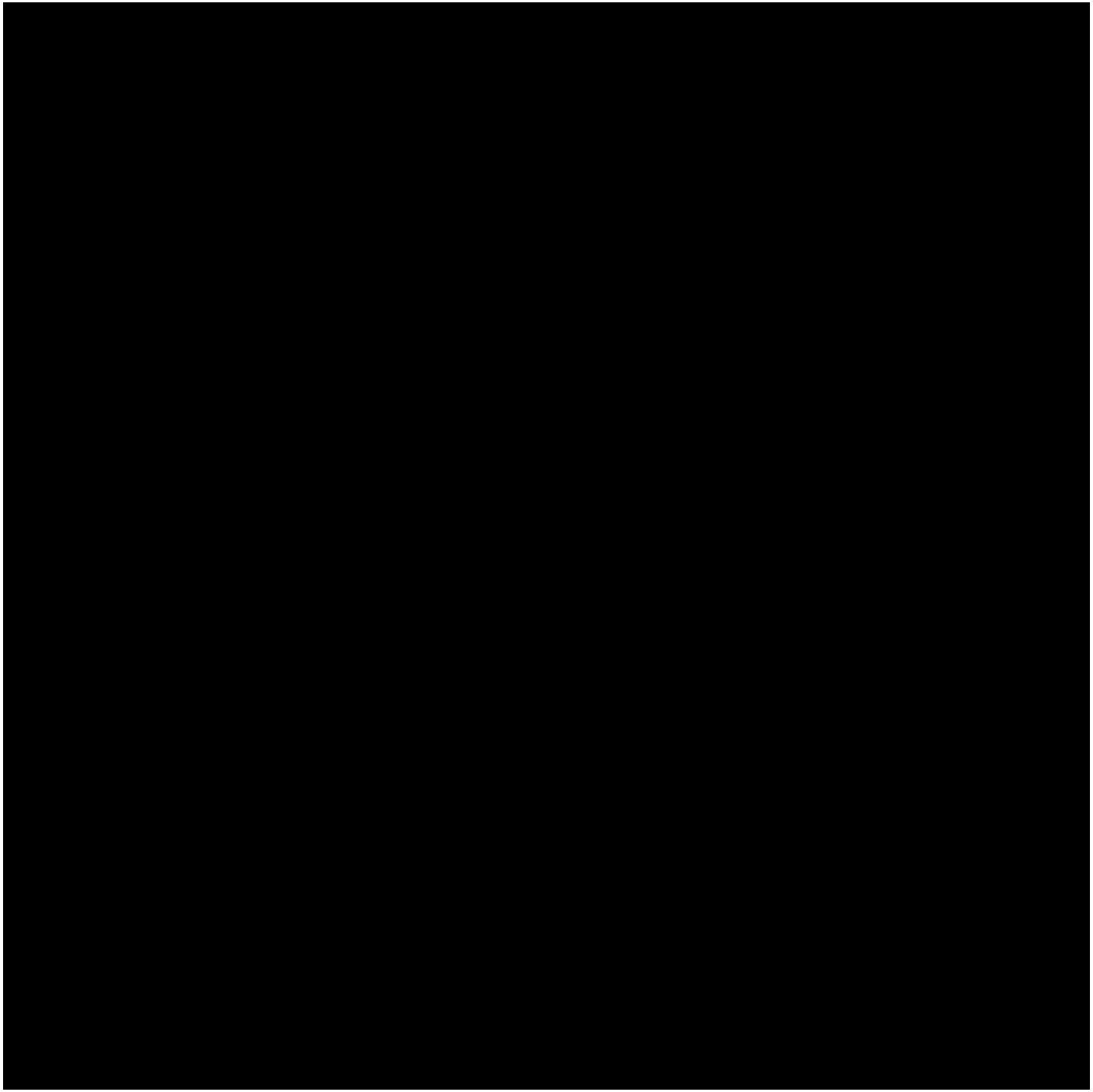
- Themes
  - new messengers: gravitational waves, neutrinos, HE gamma rays, HE cosmic rays, antimatter
  - neutrinos properties
  - comology: dark energy, dark matter

Auger Experiment - © Auger

- Experiments / Projects
  - Virgo, Lisa, Antares, Hess, CTA, Fermi, Auger, AMS
  - SuperNemo, Edelweiss (LSM), Xenon
  - Planck, LSST, Euclid



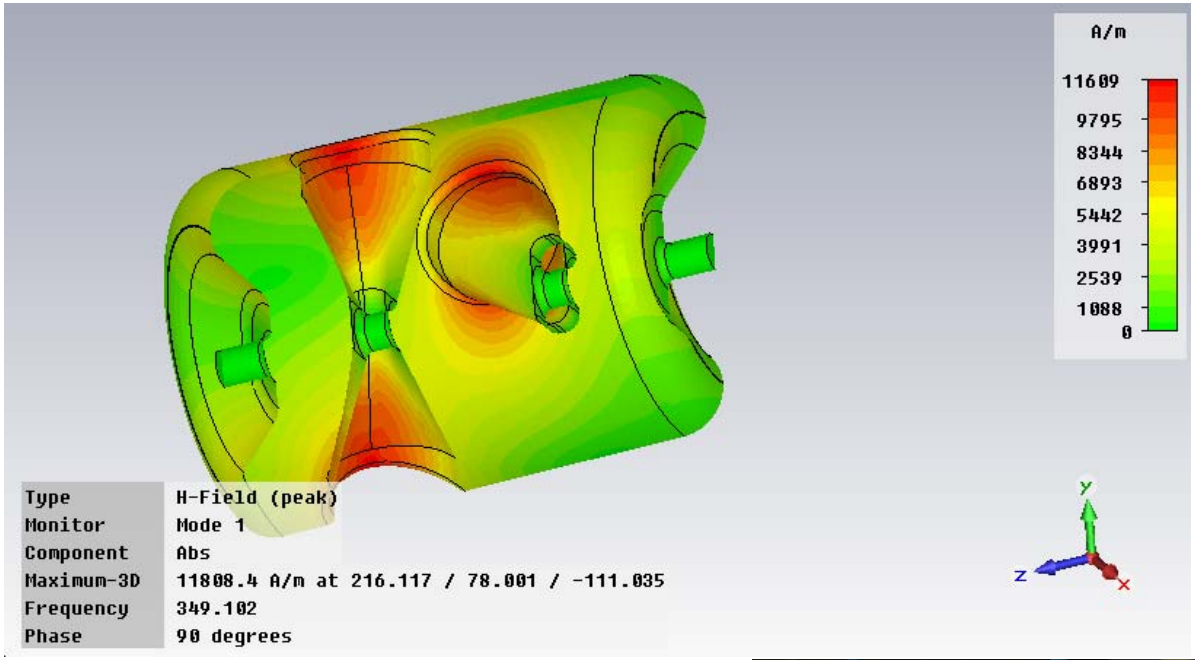


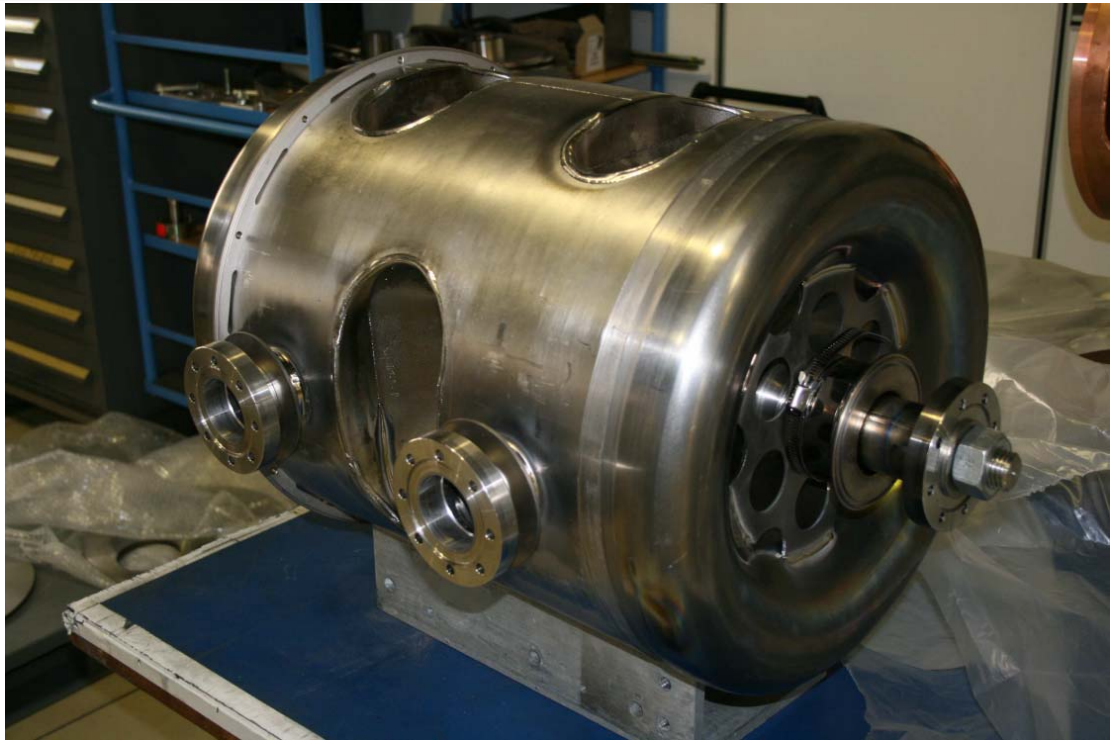


Accelerators

- Themes
  - superconducting cavities, cryotechnology
  - ion and electron sources
  - target / source for radioactive beams
  - beam dynamics
  - laser acceleration
- Experiments / Projects
  - Spiral-2, XFEL, Fair, ESS, ILC, S-LHC
  - Phil, Alto, Aifira, Jannus, Arronax

Tesla, ILC Projects- © Desy Hamburg


A/m
11609
9795
8344
6893
5442
3991
2539
1088
0
Type H-Field (peak)
Monitor Mode 1
Component Abs
Maximum-3D 11808.4 A/m at 216.117 / 78.001 / -111.035
Frequency 349.102
Phase 90 degrees
Y
Z
X



Transnational projects and research instruments

- Particle accelerators

  LHC at Cern, Spiral at Ganil, JParc …
- Particle detectors

  around these high energy accelerators or underground (Modane, Gran Sasso)
- Ground based or embedded instruments

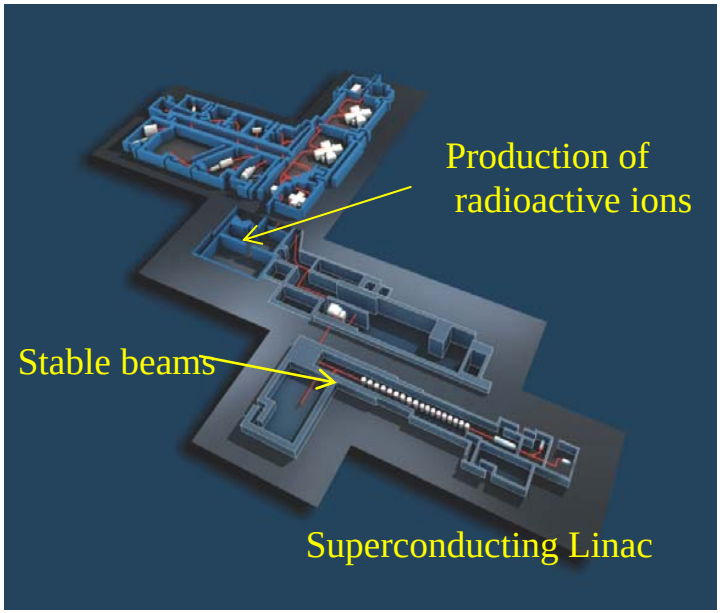
  gravitationnal antenna Virgo

  cosmic ray observatory Auger and gamma ray observatory Hess (CTA)

  undersea observatory Antares

  satellites Planck, AMS,...
- Future…

  LSST, Euclid…

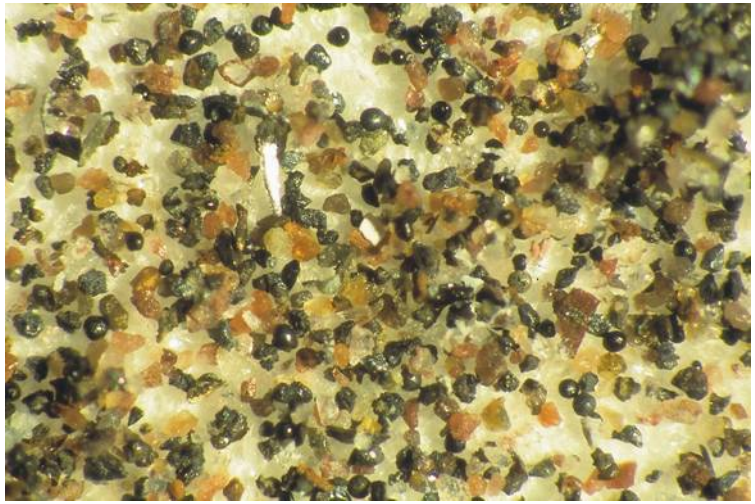


Spiral2 @GANIL

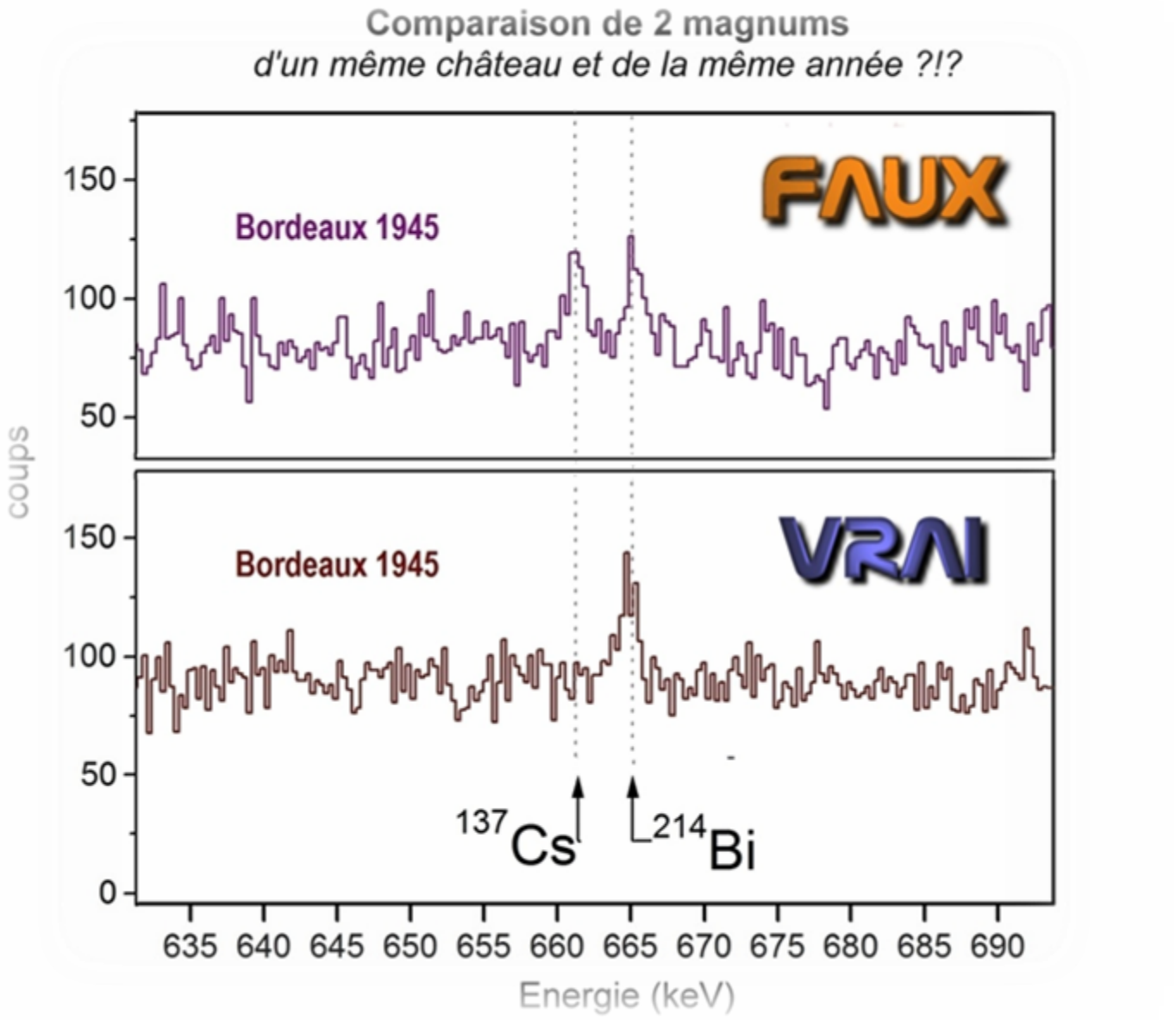
Closed links with other disciplines

- Astrophysics and cosmology
  - → Nuclear and particle astrophysics
- Chemical science
  - → Nuclear chemistry and radiochemistry
  - → Radioactivity in the environment
- Material science
  - → Irradiation tools
- Life science
  - → Instrumentation and " radio-xxx "

    medical imaging,
    radionuclids,
    accelerators for therapy,…
    computing grids

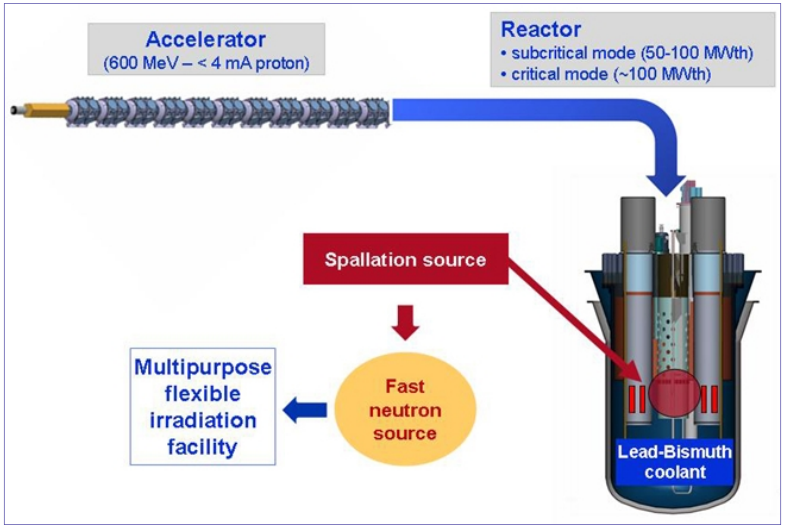


Micrométéorites - © CNRS Photothèque


Comparaison de 2 magnums
d'un même château et de la même année ?!?
FAUX
Bordeaux 1945
VRAI
Bordeaux 1945
coups
150
100
50
150
100
50
0
137Cs
214Bi
635 640 645 650 655 660 665 670 675 680 685 690
Energie (keV)

Closed links with other disciplines

- The electronuclear cycle
  - → Cooperation with chemistry / earth science : storage of radioactive waste
  - → Conception of innovating systems to burn waste (ADS,…)
  - → New technologies (molten salts, Thorium reactors…)
  - → Scenarios and simulation
  - → Radioactivity in the environment: Becquerel network



Myrrha Project - SCK Mol

Nuclear physics and Energy

- Themes

→ transmutation of present nuclear waste by ADS

→ innovating nuclear systems with low wastes (thorium)

  - developments in radiochemistry
  - accelerator and target R&D for ADS
  - accelerator-reactor coupling experiments
  - measurements of nuclear data
  - molten salt technology
  - scenarios and simulations

- Experiments / projects
  - Peren, Megapie, … , MYRRHA

Guinevere Project - © CNRS

Nuclear physics and Health

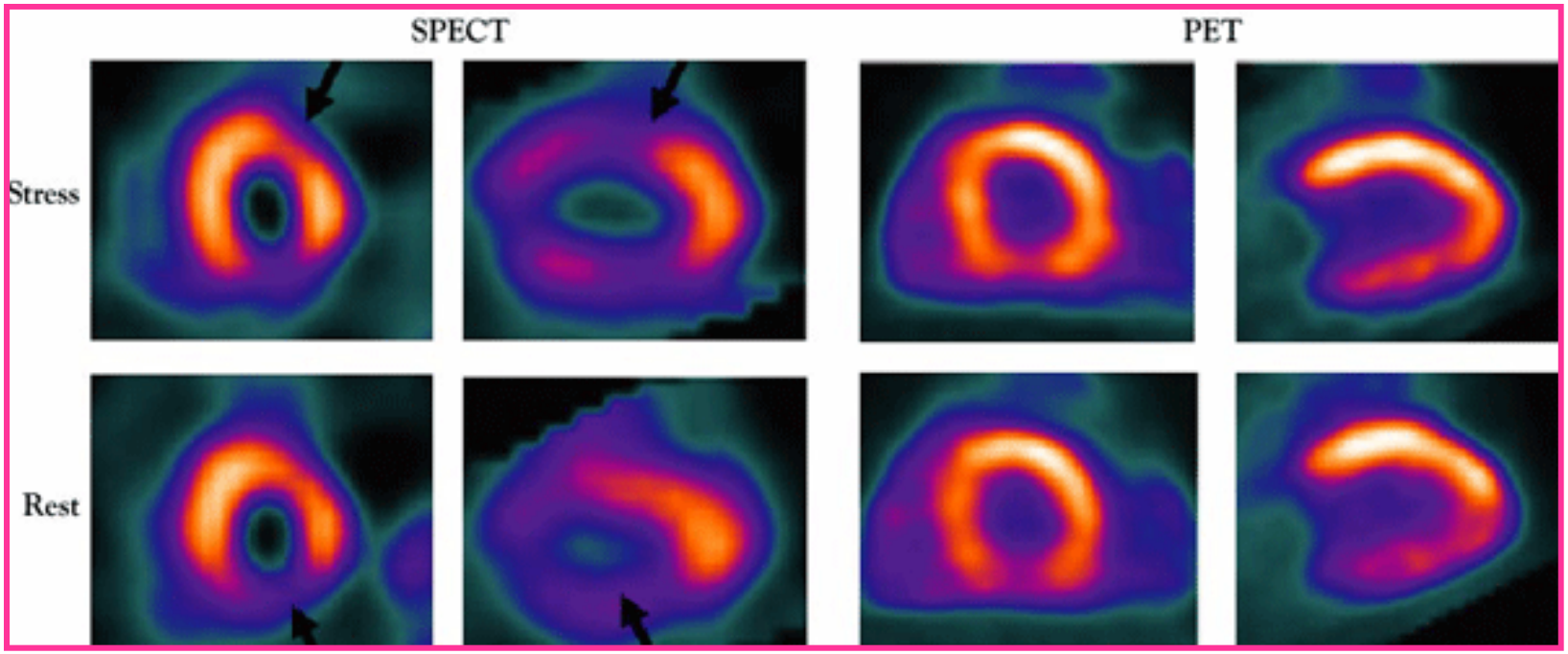
→ Strong involvement of IN2P3 in the fight against cancer

Themes

- radioisotopes, radiobiology, radiothérapy
- dosimetry / beam monitors R&D
- accelerator technology
- imaging, simulations (Geant, Gate)

- Experiments / projects
  - Aifira, Arronax, Etoile, Archade
  - Maestro, Imabio
  - Poci, Imhotep, Pixscan…

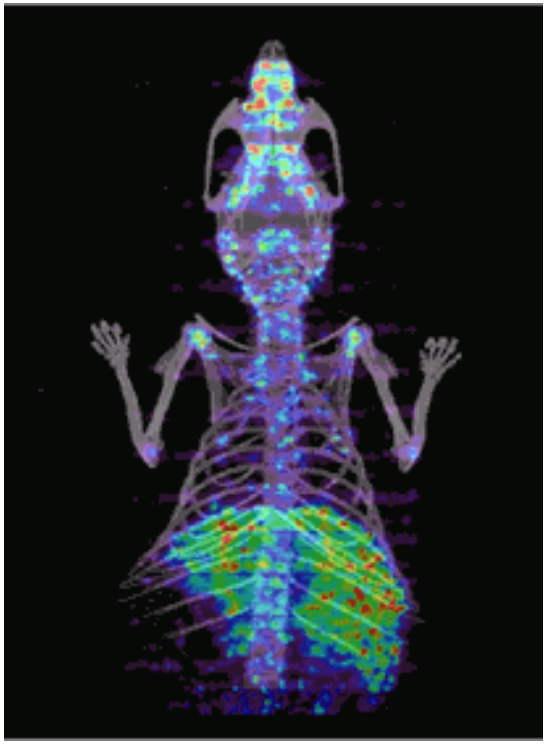
Poci Camera - © IMNC/CNRS



Tc-99m / Rb-82

Links with the society and the industrial world

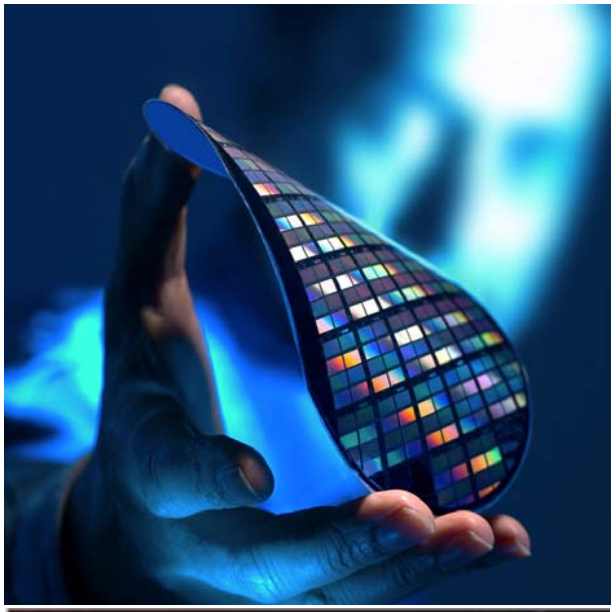
- Energy
  - radioactive waste and future production modes of nuclear energy
- Health
  - new diagnostic and therapy tools for (nuclear) medicine
- Technology
  - high technology ressources transferred to industry
  - microelectronics
  - precision optics
  - simulations, grids,…

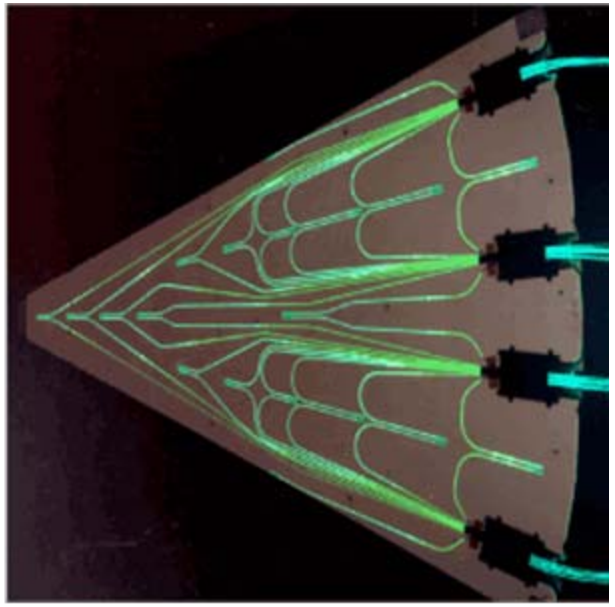


Composante SPECT d'AMISSA © IPHC/CNRS

Instrumentation

- Fast CMOS imagers
- Single photon photo-detectors
- Ultra-granulary calorimeters
- 3D integrated detectors
- Bolometer matrices
- Hodoscopes





Links with the society and the industrial world

- Computing grid

→ availability of the competence for the treatment of large data sets

→ distributed computing grids, coordinated by the CNRS
Institut des grilles
(decisive contribution from IN2P3)

Ferme de PC au Cern - © Cern

Computing grids

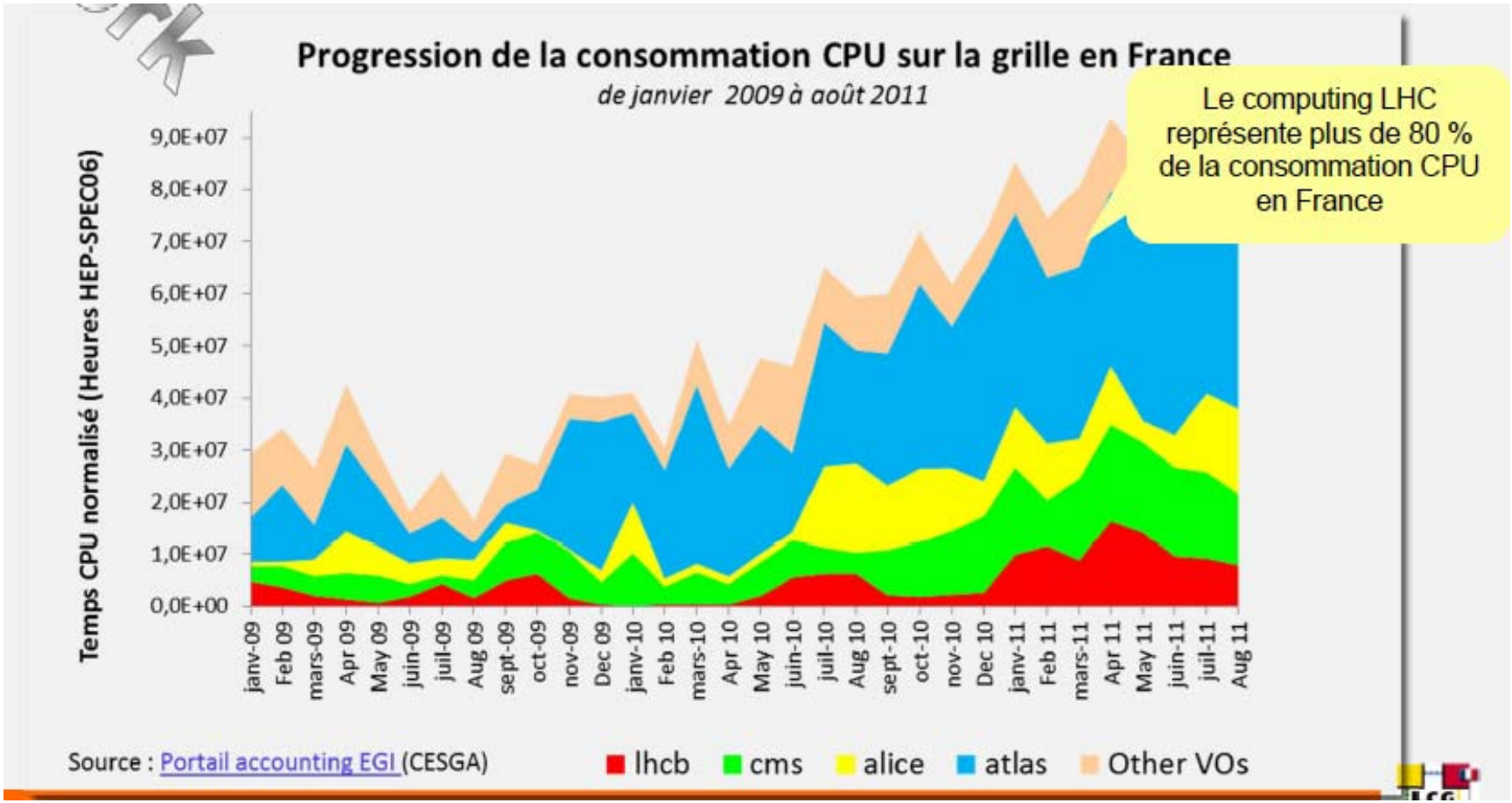
→ european and international level
→ major role of CC-IN2P3 (Lyon)

- Themes
  - high energy physics
  - biomedical applications

- Experiments / projects
  - LCG
  - Egee
  - Institut des Grilles

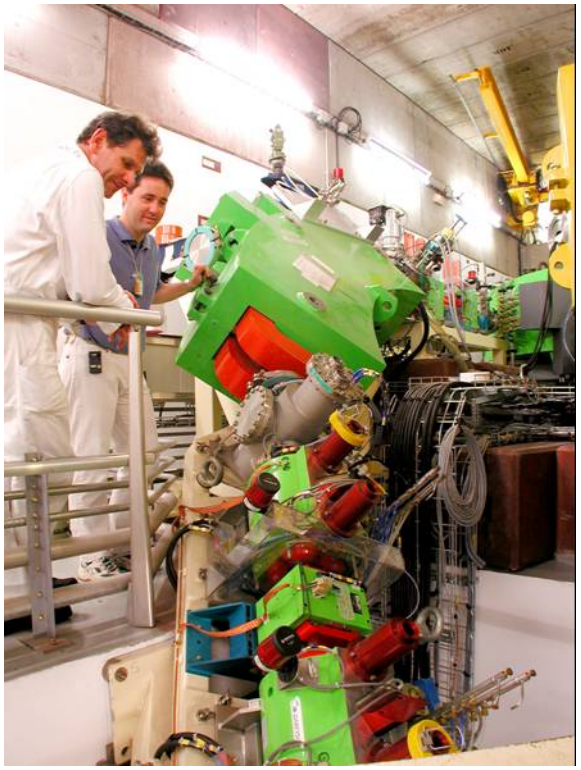
CC-IN2P3 - © CNRS

Grille France / LHC



An project oriented organisation

- Institutional Project management
  - Coordination with Irfu/CEA
  - Operating modes and tools in accordance with the needs of the French and European research



Spiral - © Ganil

Publications

2008	1128 / 1200
2009	1411 / 1527
2010	1233 / 1314
2011	*889*

More than 500 citations	2
250 to 499	3
100 to 249	19
50 to 99	65
10 to 49	808
1 to 9	2128
0	1016

Physical Review D	429	4.964
Physical Review Letters	408	7.622
Physical Review C	368	3.416
NIM A	235	1.142
Physics Letters B	180	5.255
Astronomy Astrophysics	170	4.425
Astrophysical Journal	155	6.063
AIP Conference Proceedings	134	
Journal of Instrumentation	119	3.148
European Physical Journal C	115	3.248
Nature	15	
Science	16	

Relations with Higher Education

- IN2P3 projects

  ⇒ large european and international visibility of universities

  Contracts with the laboratories

  – definition of the objectives and of the resources allocated by the partners

  – annual discussion on the achieved results versus the objectives

  – discussion organised by IN2P3 between IN2P3/CNRS, Universities and/or *grandes écoles*, other partners and laboratories

Expérience Nemo 3 - © CNRS

Relations with Higher Education

- regular meetings
  IN2P3 / university presidents
- training of students by the
  university staff in IN2P3

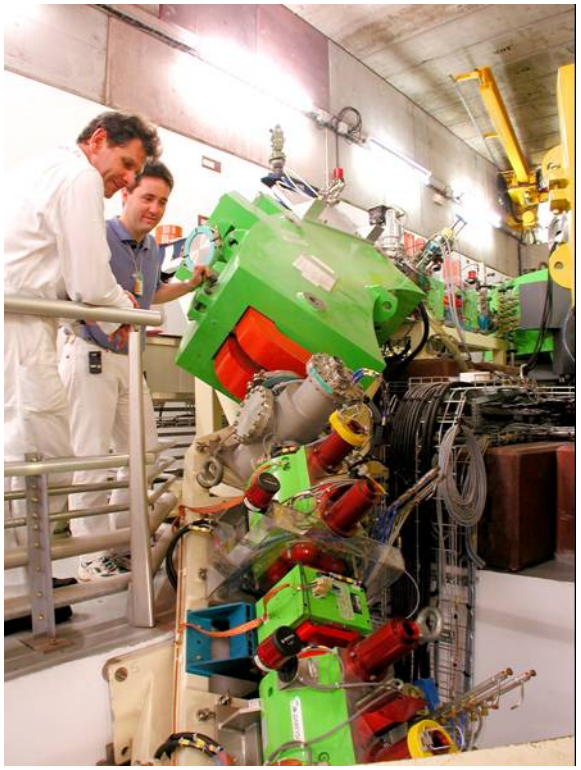
→ many french and foreign doctorants in the IN2P3 laboratories

→ development of trainings towards nuclear energy and nuclear medicine

Star Experiment - © Collaboration Star

An project oriented organisation

- Institutional Project management
  - Coordination with Irfu/CEA
  - Operating modes and tools in accordance with the needs of the French and European research



Spiral - © Ganil

IN2P3

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

Thank you for your attention

www.in2p3.fr