Accelerator Science Assessment

- *Situation in France* -

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Outline

- Very brief reminder of accelerator / accelerator science in France

- THE QUESTIONS:
  - acc. science training in universities ↔ big labs
  - joint research in universities ↔ big labs
  - local ↔ large (inter)national acc. facilities
  - accelerator science ↔ French academia
  - some approaches for visibility and attractiveness

- Input from Maud Baylac (Grenoble), Bernard Launé (IN2P3), Sébastien Bousson (IPNO), Frédéric Chautard (GANIL), Amor Nadji (SOLEIL), Jean-Luc Révol (ESRF)

- Material:
  - accelerator activity report at r-ECFA visit to France (2013)
  - TIARA-WP5 report
  - IN2P3-IRFU research plan (2012) / acc. WG

- Largely based on own experience & assessment

Accelerators at IN2P3 and IRFU

- **CNRS : IN2P3 - Institute for Nuclear and Particle Physics (~ 3000 FTE, 22 labs)**

Accelerators within IN2P3:

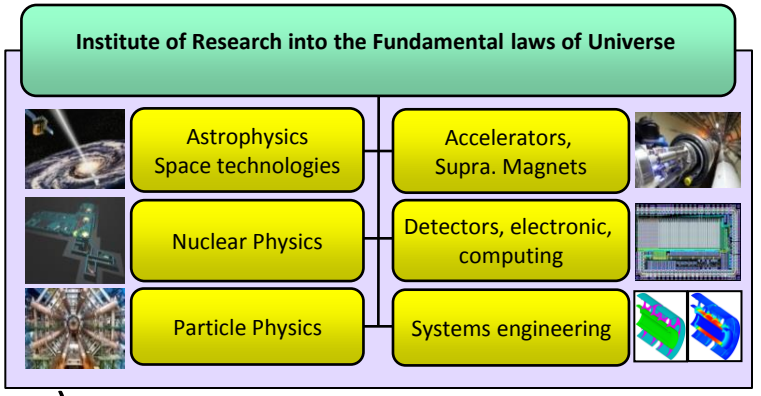
- 6 main laboratories nationwide
- ~ 280 FTE, including ~ 100 for machines operation

(7 research positions filled at IN2P3 since 2007)

- **CEA : IRFU - Institute for Research into Fundamental Laws of Universe (~ 800 FTE, 1 site)**

Accelerators within IRFU:

- One site : Paris Saclay
- ~ 170 FTE, including medical & fusion app.



- **In France (IN2P3 & IRFU) :**

~ 6 faculty staff professors or equivalent

(can act as formal academic PhD advisors or reviewers)

Main operating accelerators in France

- **ESRF at Grenoble (French civil company), since 1994**
  - third generation synchrotron, 6 GeV
  - X-ray beam to 42 beamlines (insertions & bending magnets)
  - Upgrades underway : straight sections increased, HOM free cavities, solid state amplifiers, canted undulators, new linac pre-injector

ESRF

- **SOLEIL at Saclay (French civil company), since 2006**
  - third generation synchrotron, 2.75 GeV
  - X-ray beam to 35 beamlines (insertions & bending magnets)
  - Important R&D activities on ultrashort pulses, solid state amplifiers, undulators, power supplies, kickers


SOLEIL

- **GANIL at Caen, lab operated by CEA and CNRS, since 1983**
  - Heavy ion beams for physics, 5 cyclotrons : keV -100 MeV per nucleon
  - Isotope Separation On Line technique (SPIRAL1) since 2001
  - **Major upgrade underway : construction of SPIRAL2**

GANIL

Accelerator science : driving forces and strategies

Our general strategy:

- ✓ Develop and sustain R&D programs
- ✓ Participate in European R&D programs (EUCARD, TIARA, MAX…)
- ✓ Develop technological platforms (-> required for high level R&D and participation to facility construction)
- ✓ Participate in world class accelerator development & construction: SPIRAL2, ESS, XFEL by taking in charge large WP responsibilities
- ✓ Develop partnerships with CERN, DESY, KEK, JLAB… & emerging countries in the field of accelerators
- ✓ Propose innovative accelerators for application
- ✓ Technology transfer to industry and close collaborations

IN2P3 platforms for research & applications

Multiple applications accelerators

Materials, radiobiology, environment

ANAFIRE (Lyon)

AIFIRA (Bordeaux)

JANNUS (Orsay)

Nuclear medicine and radiochemistry

CYRCé (Strasbourg)

ARRONAX (Nantes)

+ ALTO (Orsay) : RIB facility
+ PHIL (Orsay) : photoinjector

Platforms for SC Accelerator development

SupraTech (IPNO)

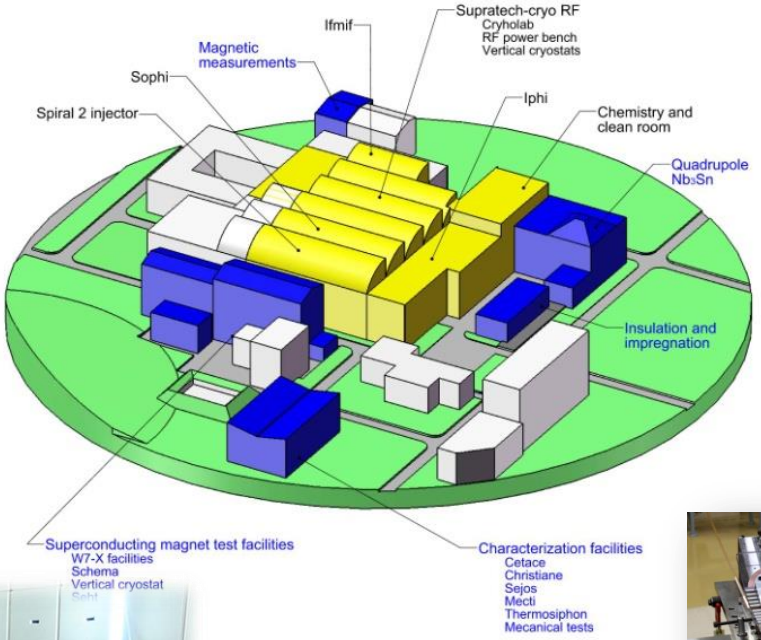
Power coupler dev. platform (LAL Orsay)

IRFU platforms for research & applications

- **Synergium Platform (25000 m^2)**
  - Modularity to accomodate projects requirements

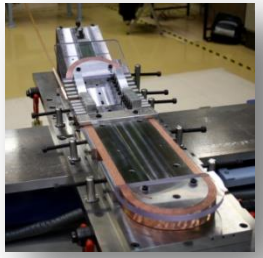
- **Platforms for accelerator R&D (and accelerator sections under tests)**
  - High intensity source and IPHI injector
  - Superconducting RF cavity preparation and tests
  - Superconducting magnets developments and measurements

SUPRAtech - CEA clean room



SPIRAL2 cryomodule A type test

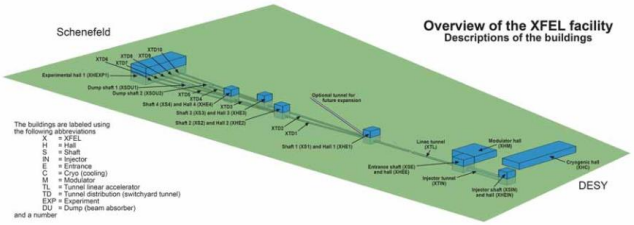
IPHI (100 mA injector @ 100 keV)



Magnet windings bending tests

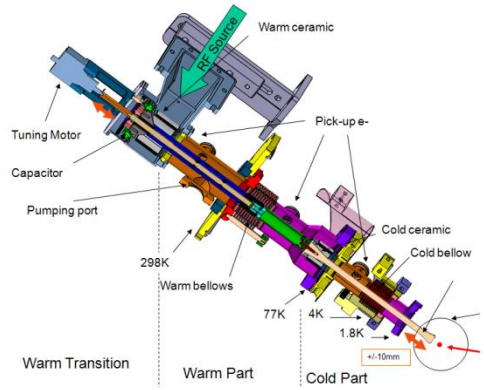
French contribution to XFEL

- **XFEL : Extremely Intense Xray production in DESY (Hamburg)**



- **Irfu (Saclay) : Integration of 83 (100) cryomodules**
  - Cryomodules integrated in a new dedicated facility
  - Assembly in clean room of 83 cavity strings
  - Assembly of 83 cold masses in their vacuum vessel
  - Series operation sub-contracted to an industrial operator (ALSYOM, ALCEN group)

- **IN2P3/LAL (Orsay) : Delivery of over 650 (800) Couplers**
  - LAL hosts all the conditionning process
  - Contract attributed to a Thales / RI consortium
  - Couplers received, prepared, conditionned & sent for integration in the cryomodules



Couplers industrialization (Orsay)

Integration of XFEL cryomodules (Saclay)

- Each cavity string contains 8 cavities, 8 RF couplers , one quadrupole, one BPM and two vacuum valves

Transfer of cryomodule in clean room roll-out area

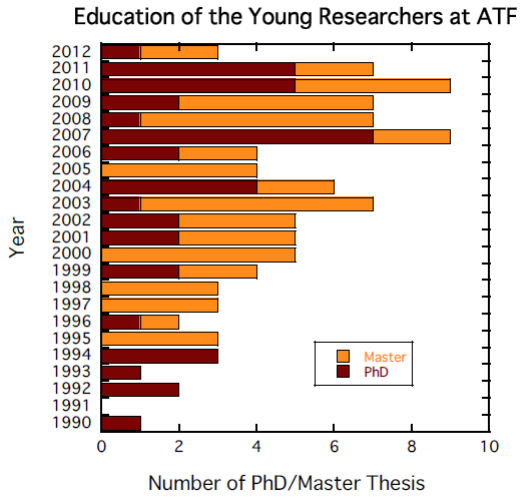
Transfer of cryomodule in RF coupler assembly area

ATFに参加している代表的研究機関
- ATF International Collaboration -

欧州原子核研究機構(CERN)
ドイツ(Germany)
　電子シンクロトロン研究所(DESY)
フランス(France)
　IN2P3; LAL, LAPP, LLR
イギリス(UK)
　Univ. of Oxford
　Royal Holloway Univ. of London
　STFC, Daresbury
　Univ. of Manchester
　Univ. of Liverpool
　Univ. College London
イタリア(Italy)
　INFN, Frascati
スペイン(Spain)
　IFIC-CSIC/UV
ロシア(Russia)
　Tomsk Polytechnic Univ.

アメリカ(USA)
　SLAC国立加速器研究所
　ローレンス・バークレー国立研究所(LBNL)
　フェルミ国立加速器研究所(FNAL)
　ローレンス・リバモア国立研究所(LLNL)
　ブルックヘブン国立研究所(BNL)
　コーネル大学(Cornell Univ.)
　ノートルダム大学(Notre Dome Univ.)

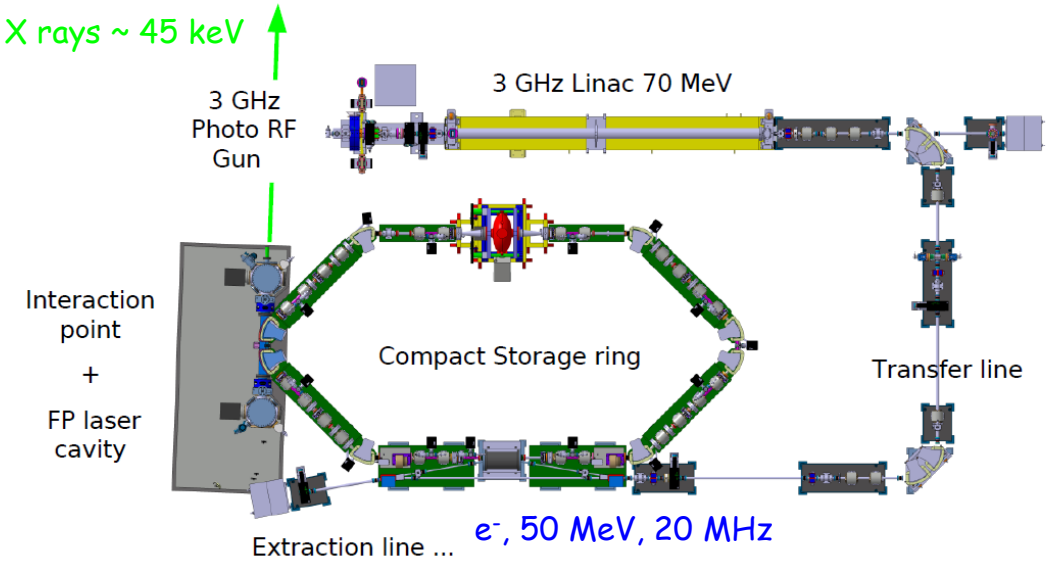
日本(Japan)
　高エネルギー加速器研究機構(KEK)
　東北大学　(Tohoku Univ.)
　東京大学　(Univ. of Tokyo)
　早稲田大学(Waseda Univ.)
　名古屋大学(Nagoya Univ.)
　京都大学　(Kyoto Univ.)
　広島大学　(Hiroshima Univ.)
中国(China)
　中国科学院高能物理研究所(IHEP
韓国(Korea)
　ポハン加速器研究所(PAL)
　キョンプク大学(KNU)
インド(India)
　Raja Ramanna Centre for Advanced Technology



relatively independent R&D teams

ThomX

- **ThomX : compact & intense Xray source for imaging based on Compton backscattering**
  - Compact e^- storage ring coupled to optical cavity for light amplification (~2015)
  - Demonstrator for multiple possible applications
    - Compact enough to be installed in hospital or museum



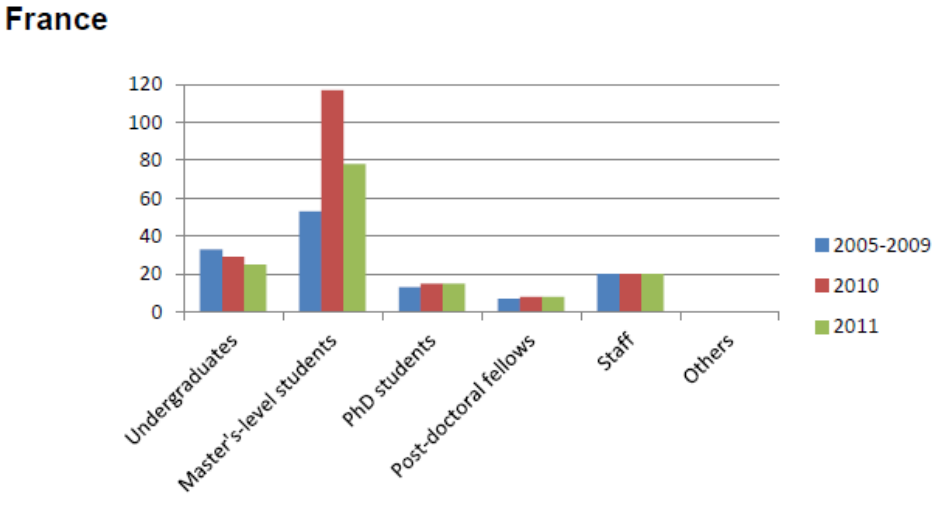
~ 70 m²

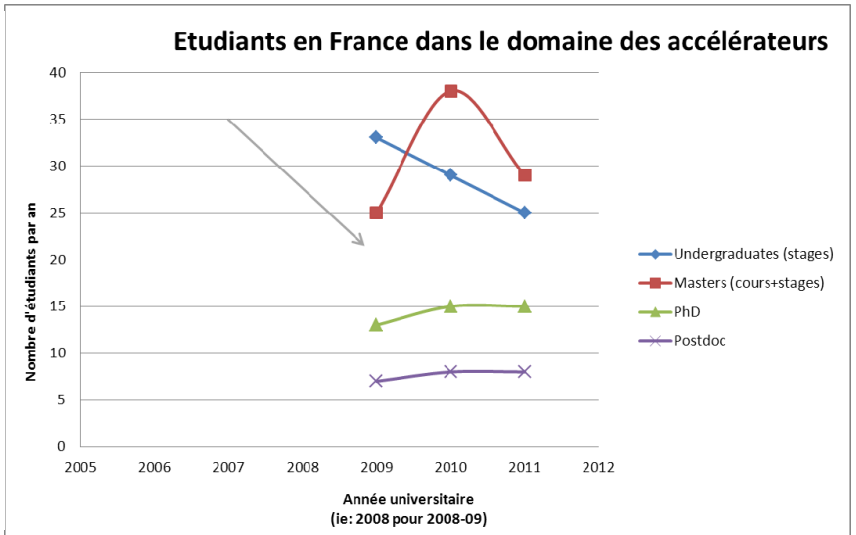
- IN2P3/LAL (~80% of project) + SOLEIL, Univ. Paris Sud, Celia, Thalès, Inst. Néel, ESRF, CNRS LAMS, Inserm Grenoble, total ~1250 p.m (until 2020)

- Mainly financed by French EQUIPEX (*Investissements d'avenir*)

Personnel and training in acc. science research

- Research engineers ➔ still majority
- Researchers, lecturers, professors ➔ ~ 1 per year since 2007
- ~ 6 professors or equivalent (habilitation or state doctorate)
- 1 acc. science member of habilitation committee at Univ. Paris Sud
- No “chair“ in accelerator science yet in France…
- Master-2 programs in Univ. Paris Sud and in UJF (Grenoble)
- INP-PHELMA (Engineering school in Grenoble)
- UJF and INP-PHELMA programs partly based on JUAS
- Large number of short term undergraduate and Master-1 internships, both locally and abroad (required in student curriculum)





Strengths / weaknesses → evolutions

- Different review criteria for recruitment and promotions of engineers and researchers / academic staff
- Local facilities (R&D platforms, small accelerators) are major assets to attract undergraduate and master students
- Harder to attract top level doctoral students from France (rate is ~ steady thanks to foreign students)
- Good doctoral / postdoctoral training opportunities at SOLEIL, ESRF, GANIL, and through participation in international facilities / laboratories (CERN, KEK, JLAB, SLAC and DESY…)
- Difficult recruitment of accelerator engineers & physicists - criticism: “candidate pressure” less than in other areas
- Increased involvement (and success !) in several FP7/H2020 training schemes: ITN, IF, RISE,…

Factors for attractiveness & visibility

- Balancing the support for local infrastructure and R&D and for international projects
  - ideal to pursue both (synergy / complementary aspects)
  - demanding (cost, maintenance, mobility…)
  - essential to keep local skills while engaging at state of art
  - jointly defined & managed projects better than pure subcontracting
- Jointly defined and supervised (and funded ?) doctoral projects efficient to enhance existing or to create new collaborations between acc. scientists in universities and large labs (e.g. Orsay-KEK, Annecy-CERN,…)
  - better than university partner playing mainly admin. role
  - students benefit from two complementary environments and from international exposure
- Coordination and networking, e.g. EU level: TIARA, ITNs,…
  - guidelines and recommendations for good practice
- Promote / enhance multi-disciplinary aspect and connection to science applications of accelerators