GANIL/SPIRAL2 & spirit of EFINION

nuclear ion beams & tools for society

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GANIL
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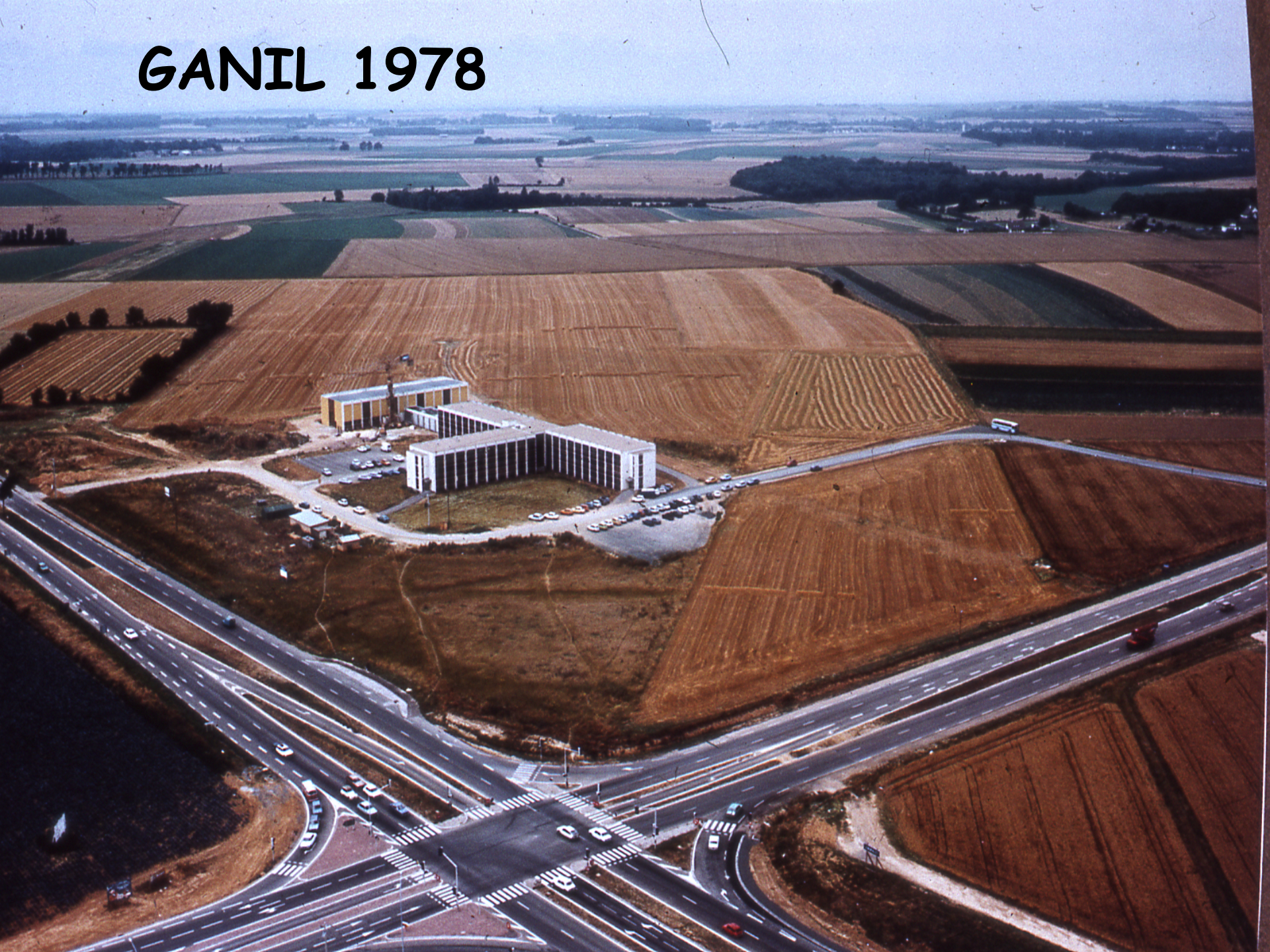
- GANIL/SPIRAL2 facility and campus
- Interdisciplinary Research at GANIL (ex.)
  - Radiobiology and medical applications at GANIL
- Industrial Applications & Innovation (ex.)
  - Electronic components for spatial industry
  - Microporous membranes
- Relations with industrial partners & socio-economical impact

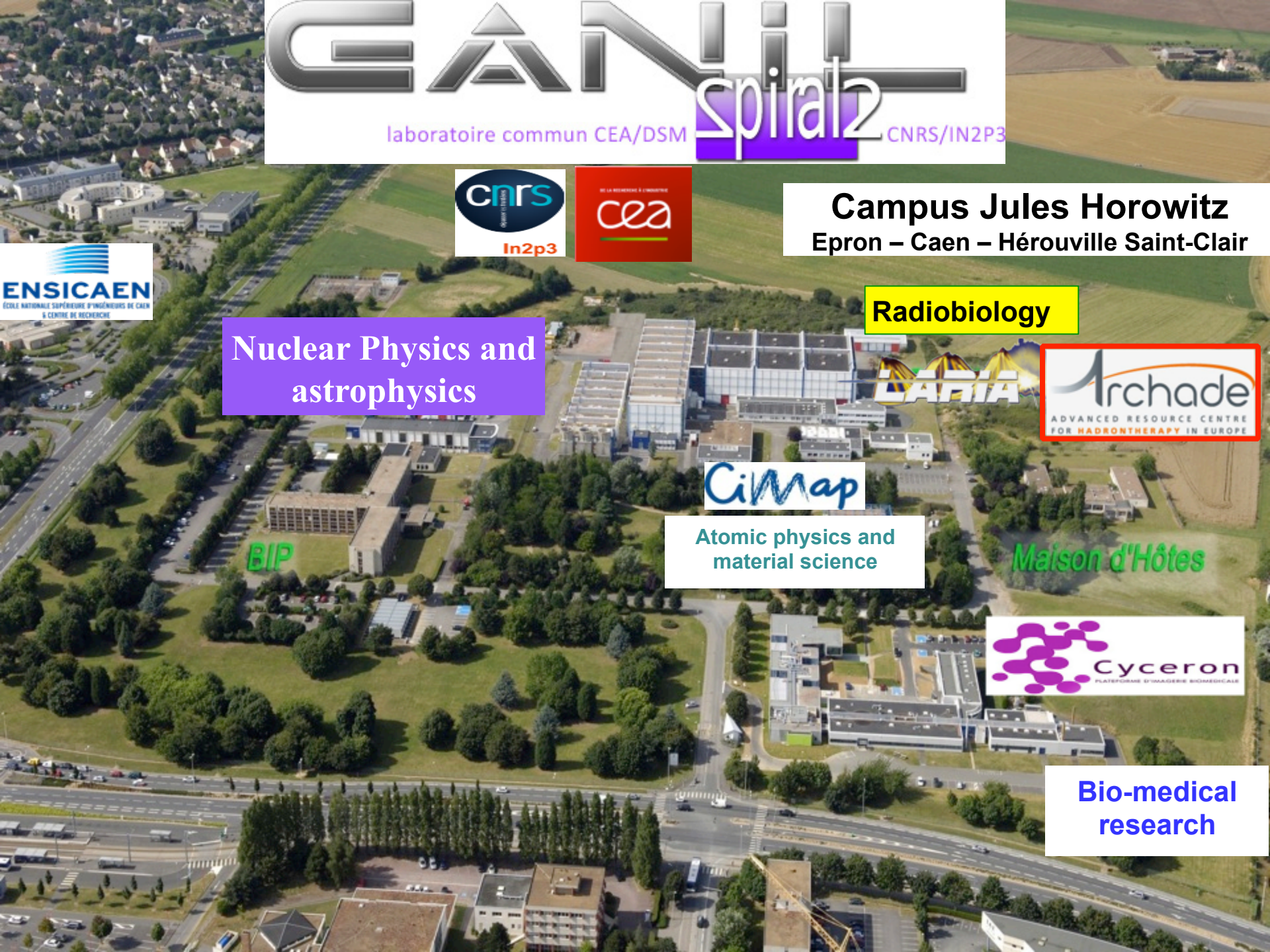
www.ganil-spiral2.eu

GANIL 1978




25 years later

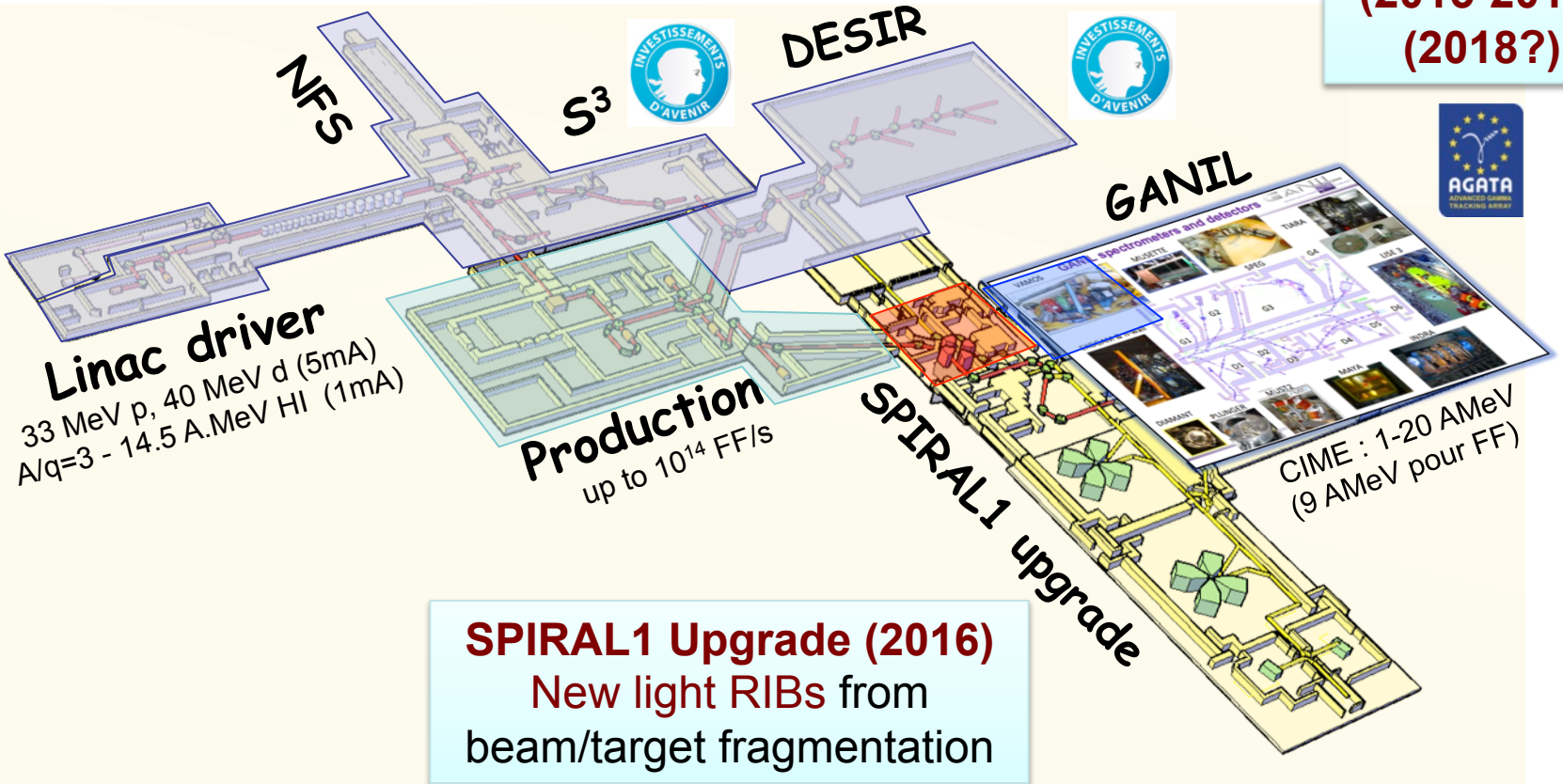

…and with SPIRAL2


GANIL
spiral2
laboratoire commun CEA/DSM
CNRS/IN2P3
cnrs
In2p3
cea
ENSICAEN
ÉCOLE NATIONALE SUPÉRIEURE D'INGÉNIEURS DE CAEN
& CENTRE DE RECHERCHE
Campus Jules Horowitz
Epron – Caen – Hérouville Saint-Clair
Nuclear Physics and astrophysics
Radiobiology
LARIA
Archade
ADVANCED RESOURCE CENTRE FOR HADRONTHERAPY IN EUROPE
CIMAP
Atomic physics and material science
BIP
Maison d'Hôtes
Cyceron
PLATEFORME D'IMAGERIE BIOMÉDICALE
Bio-medical research

GANIL/SPIRAL2

SPIRAL2 Phase1 (2015)
Increase the intensity of stable beams by a factor 10 to 100 – High intense neutron source
10pμA (6.10^{13}pps) A<50

AGATA (2015-2016) (2018?)

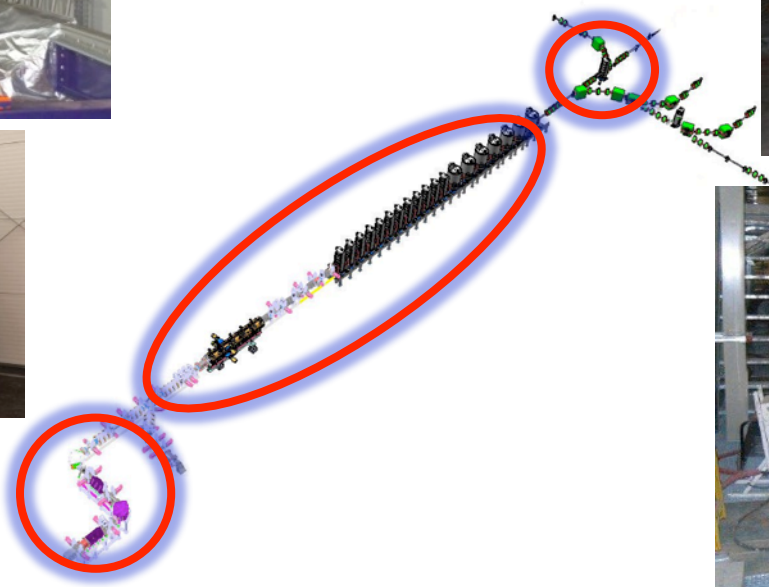


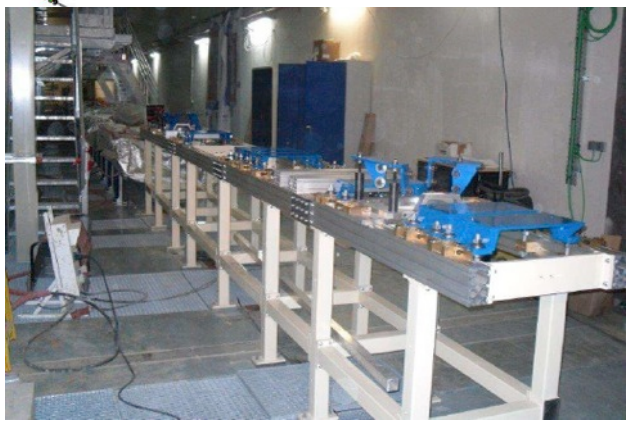
SPIRAL1 Upgrade (2016)
New light RIBs from beam/target fragmentation

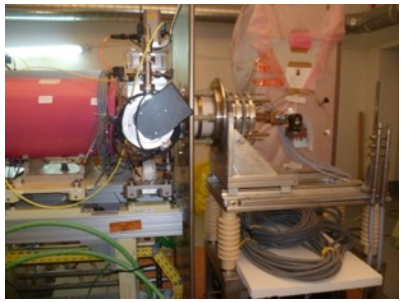
SPIRAL2 Phase 1 Civil Construction

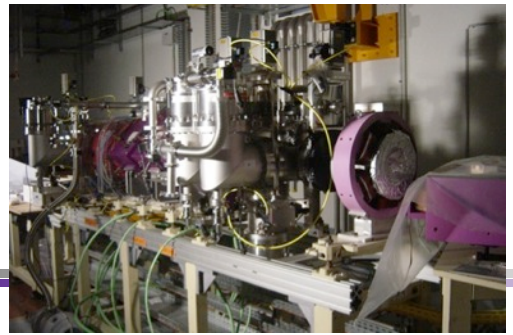
100 % of the concrete done (14000m^3)

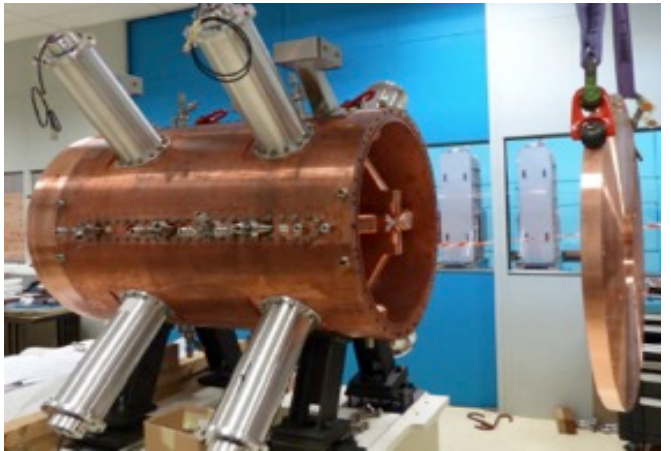
Installation is going on









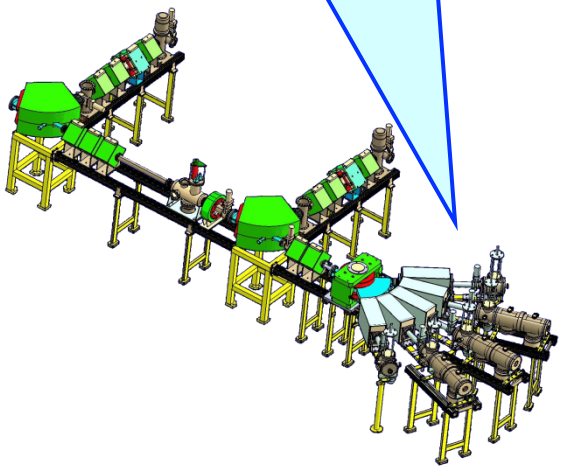


Interdisciplinary Research & Industrial applications

Up to 4 beams simultaneously, 4000-5000 hours/year

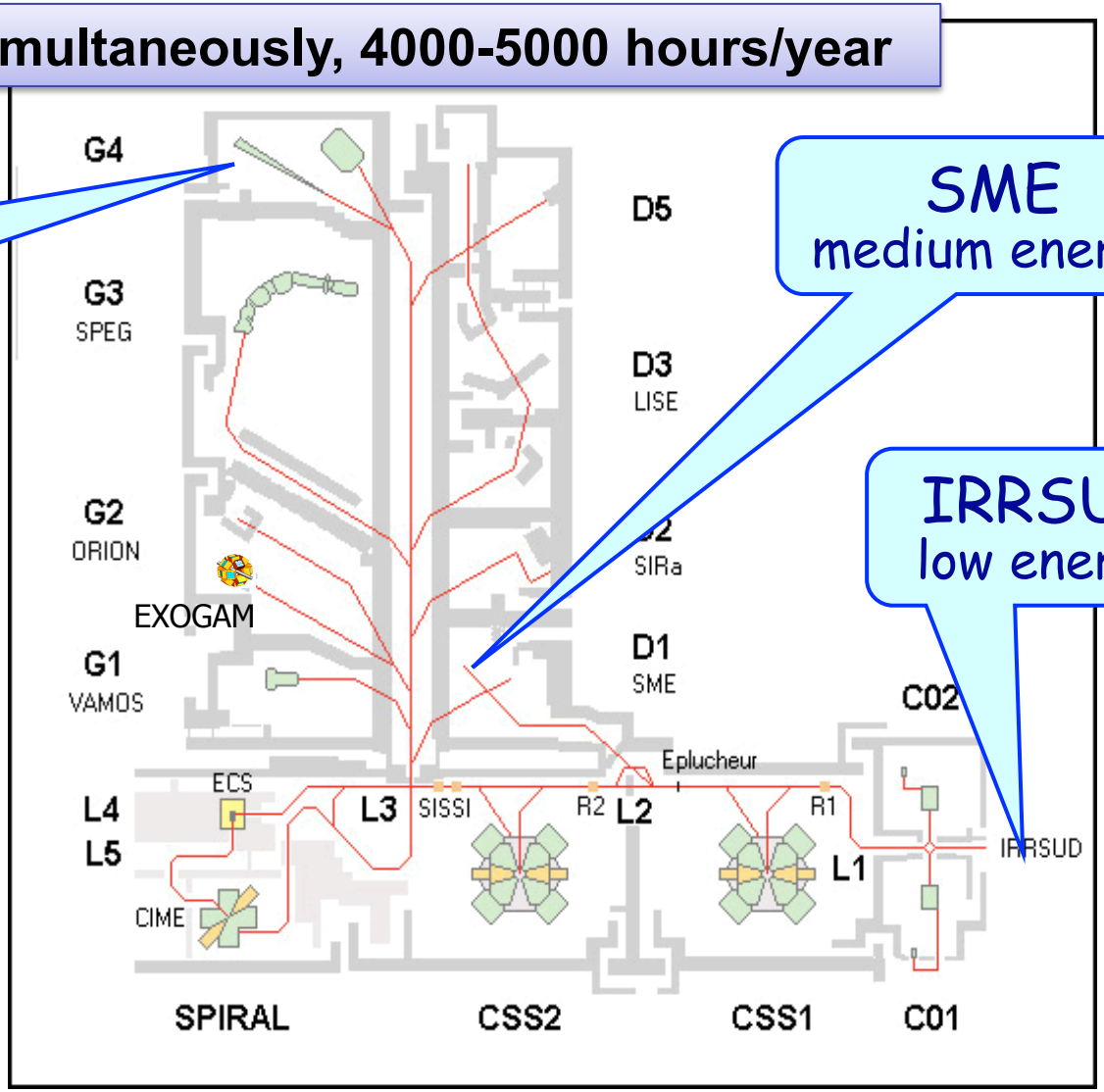
Cave G4
high or medium energy

ARIBE
very low energy



SME
medium energy

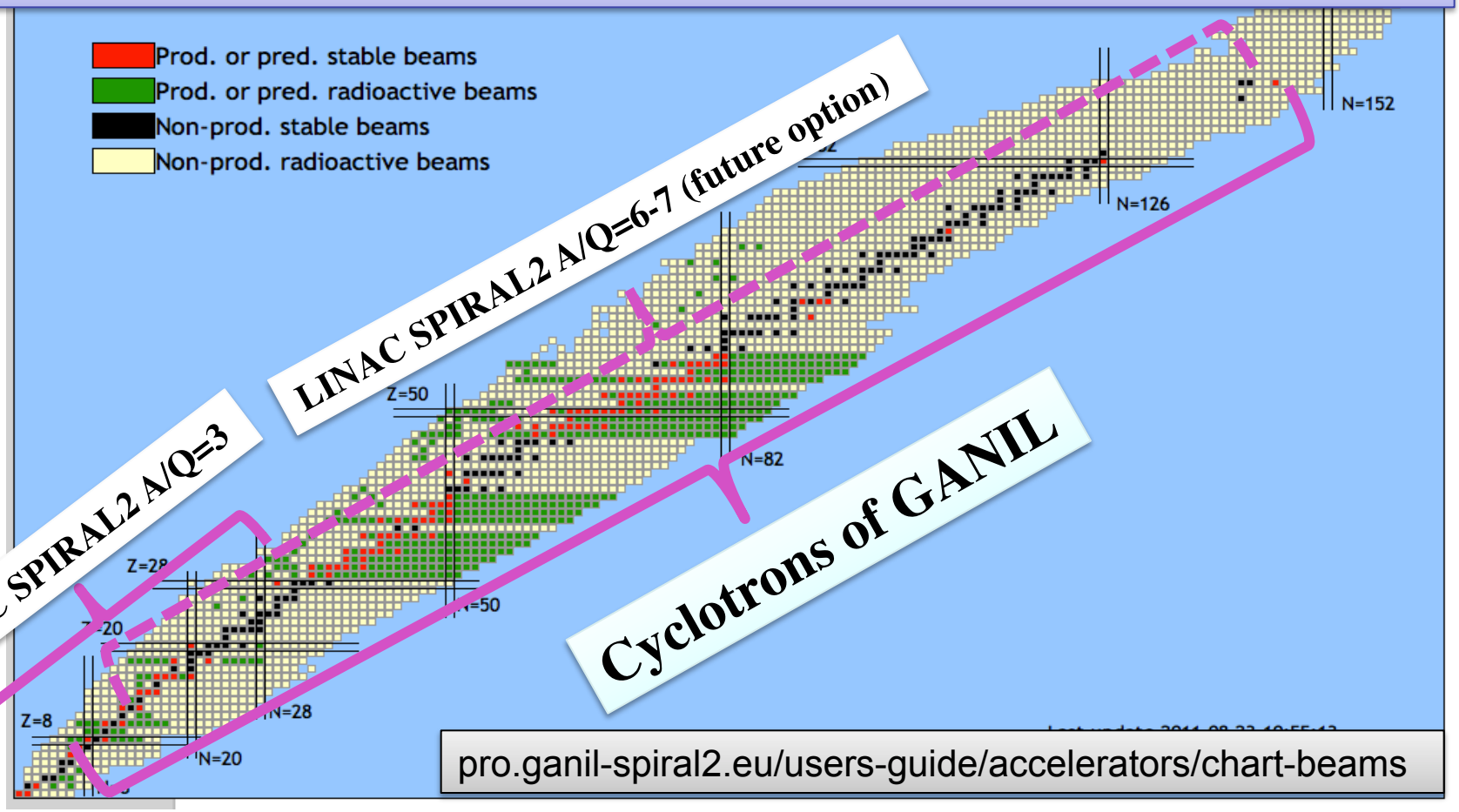
IRRSUD
low energy



Stable ion-beams of GANIL & LINAC SPIRAL2

- Cyclotrons: ≤10^{13} pps, from C to U, 1 MeV/n - 95 MeV/n
- LINAC SPIRAL2 (baseline project) ≤ 10^{15} pps from p to Ni, 0.75 MeV/n – 15 MeV/n

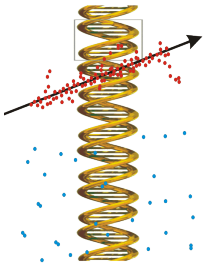
Rare stable-isotopes ^{36}S, ^{40,48}Ca, ^{50}Ti, ^{58}Ni, & unique in Europe ^{208}Pb, ^{238}U

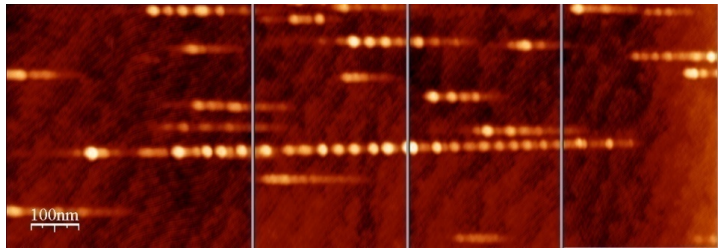


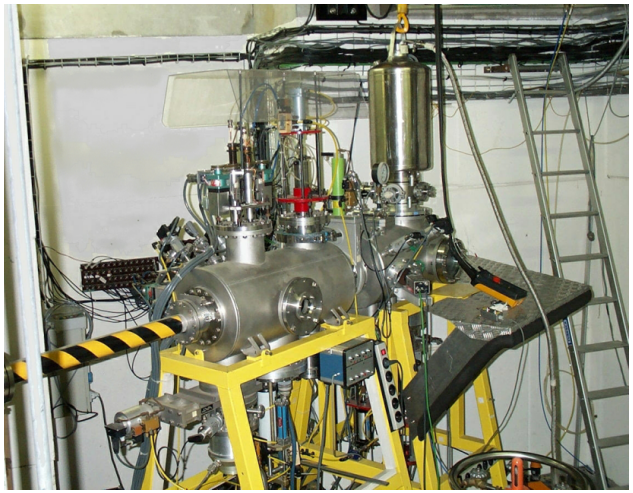
Interdisciplinary Researches at GANIL with CIMAP

GANIL offers a wide range of energies from keV to GeV.

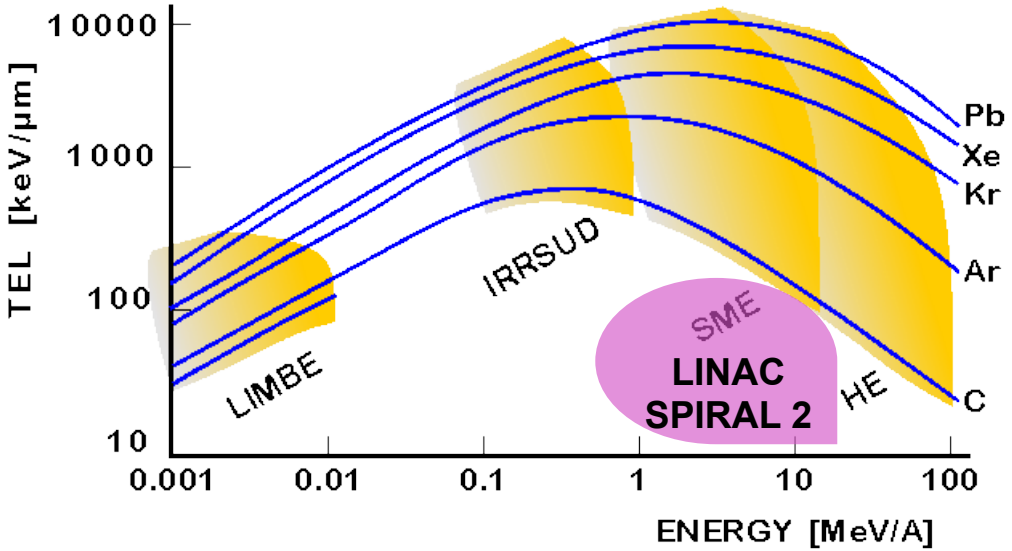
- *Atomic Physics,*
- *Condensed Matter Physics,*
- *Material Sciences,*
- *Chemistry under irradiation,*
- *Radiobiology,*
- *Applications*







Irradiation device IRABAT



France HADRON Program

A national infrastructure for hadrontherapy research

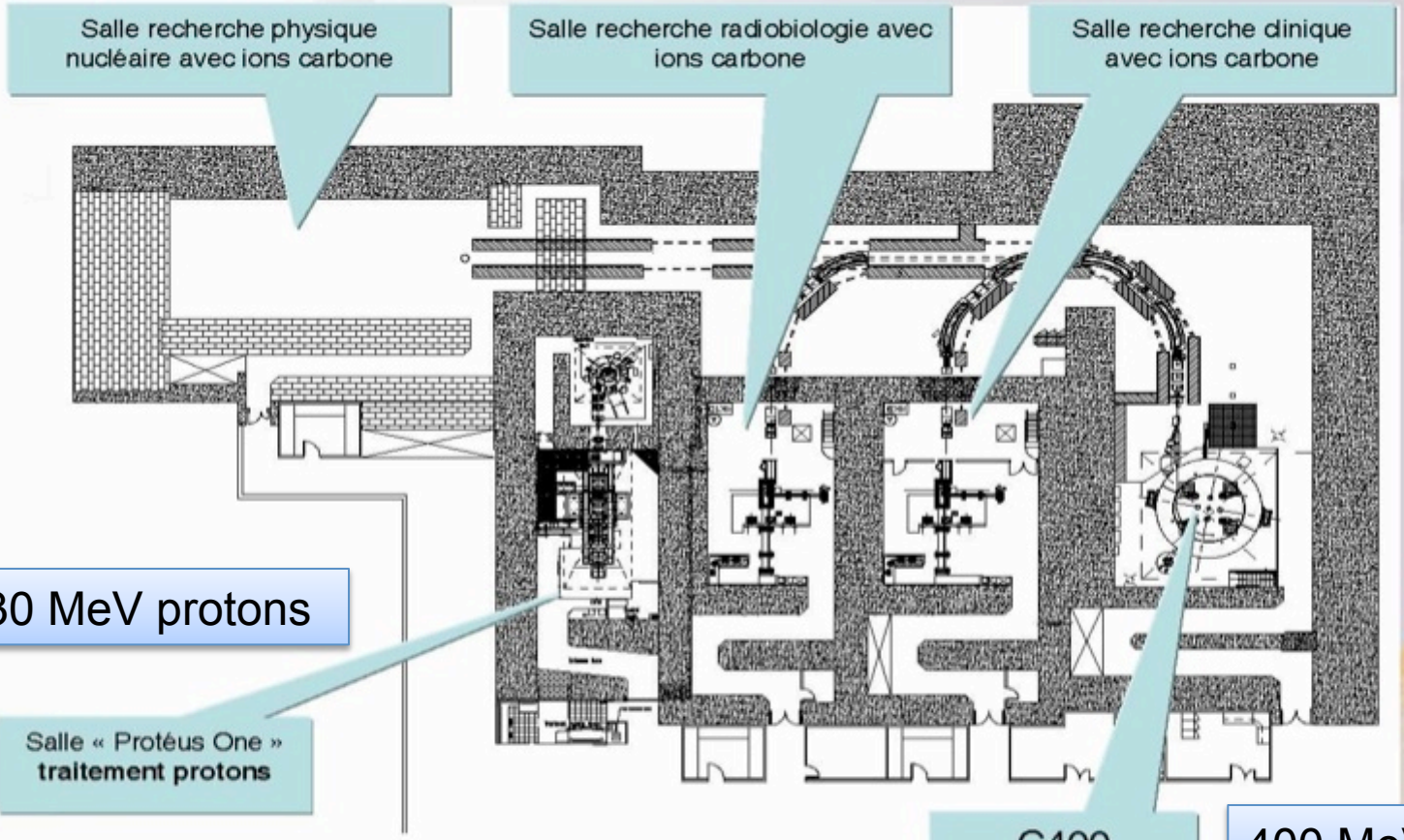
Budget of 15 M€ 2012-2020

GANIL provides 1-2 weeks of ^{12}C beam at 95 MeV/n per year for France HADRON

FrHA should also continue to participate actively in European programs in the frame of Horizon 2020

GANIL laboratoire commun CEA/DSM Spiral2 CNRS/IN2P3

ARCHADE: New therapy and medical research centre



Archade
ADVANCED RESOURCE CENTRE FOR HADRONTHERAPY IN EUROPE

To be operational by 2018

Test of electronic components and systems for space applications

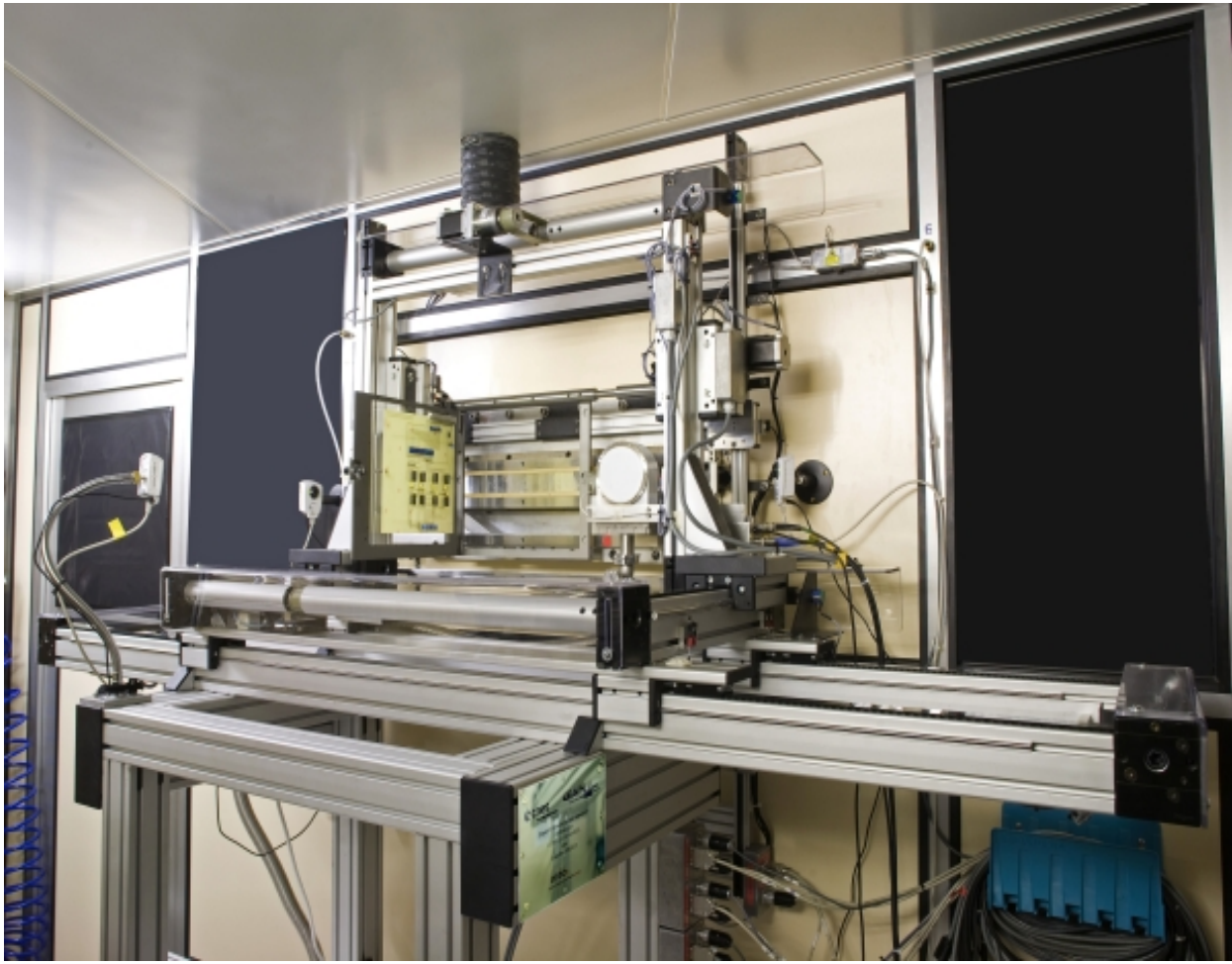
- In space, electronic systems are exposed to energetic particles (including heavy ions)
- Troubleshooting in the satellites are due to interactions between particles and components
- Test of the architecture of new components
  - Validation of projects
- Research on « SEE » (Single Event Effect)
  - To develop new, more efficient architectures
  - To improve international specifications for space applications

Test of electronic components and systems for space applications

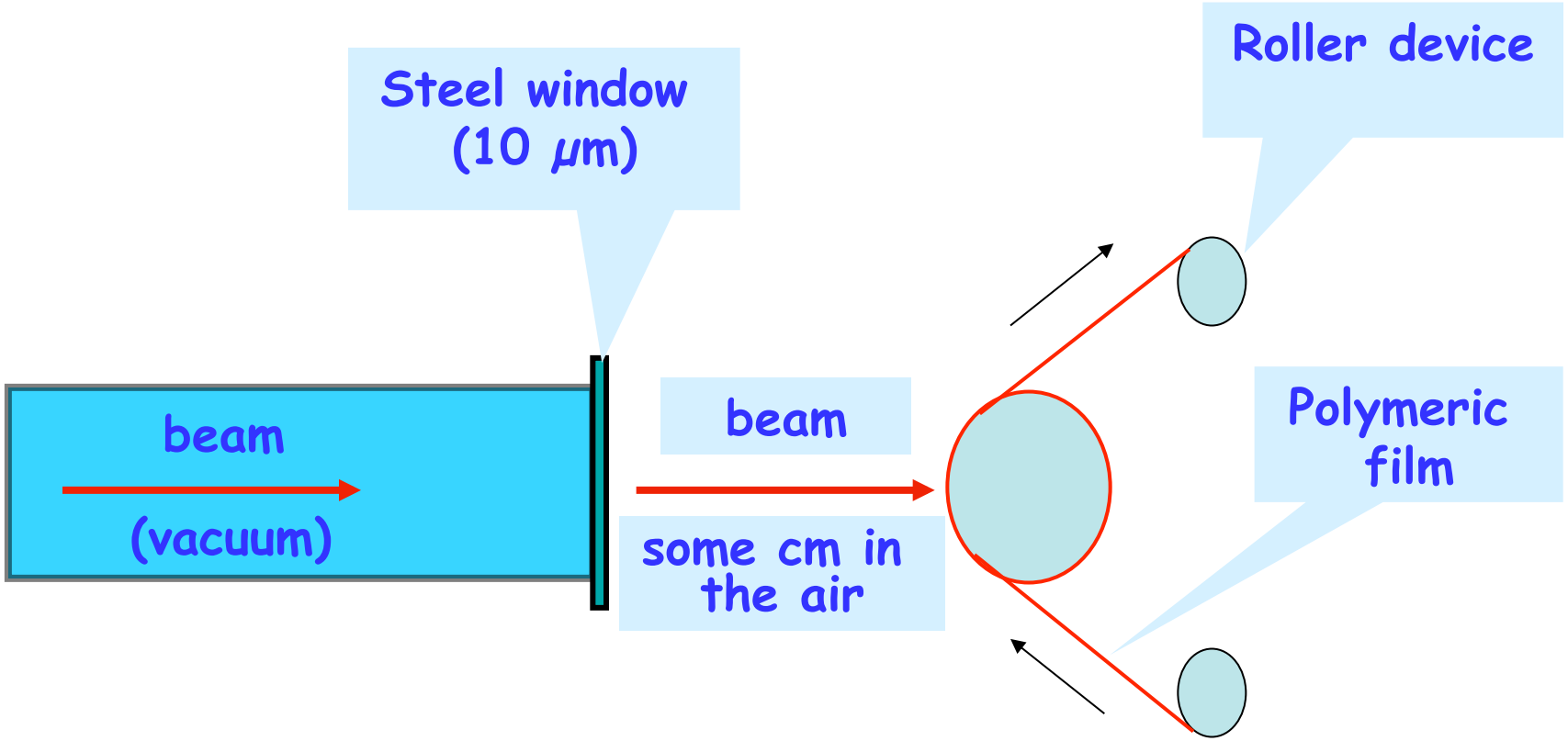
They work with the GANIL beam:

ASTRIUM,
ATMEL,
CNES,
EADS,
ESA,
INFINEON
JAXA,
ST Microelectronics
…

The sample holder



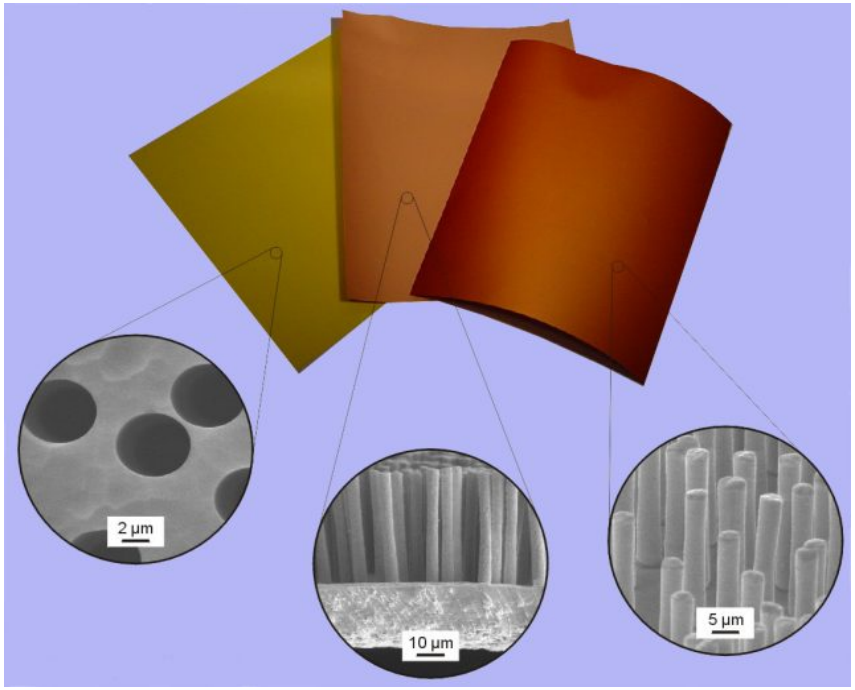
Experimental configuration for micro-porous membranes



The intensity of the GANIL beam allows the production of around 100 m²/h

Experimental configuration for micro-porous membranes

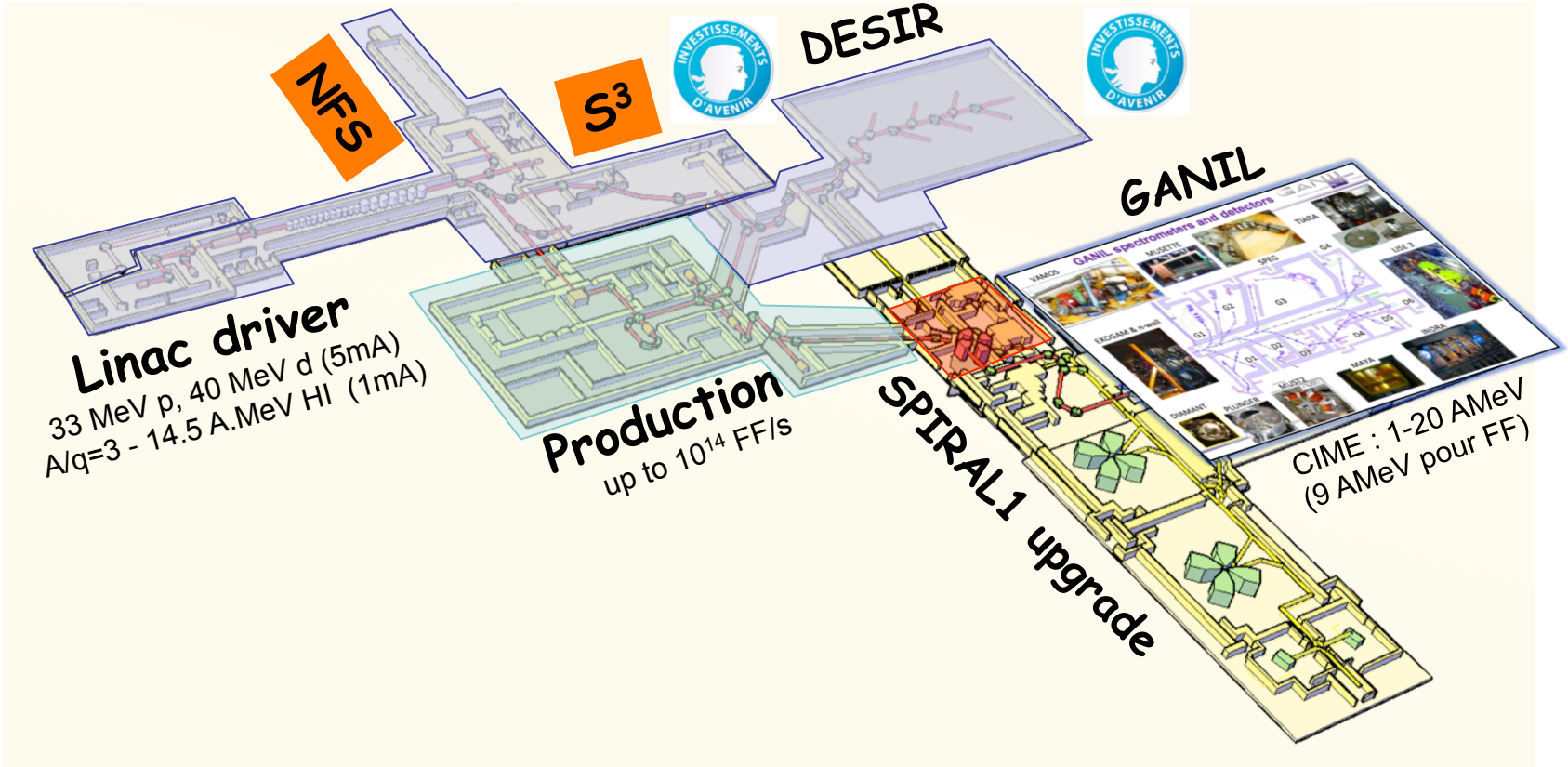
Companies from: Germany Belgium, Sweden,



Roller device

Opportunities for Interdisciplinary Research & Applications at SPIRAL2

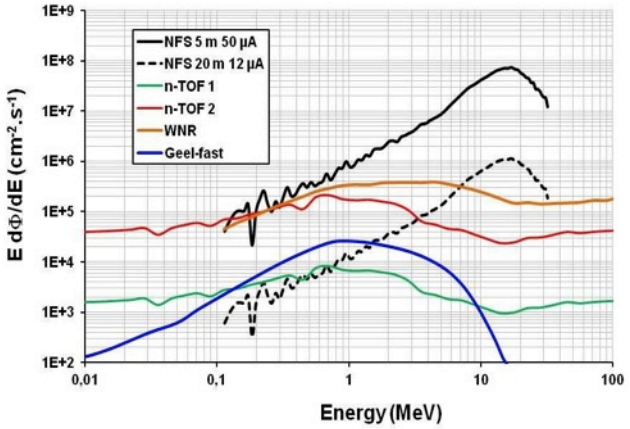
SPIRAL2 Phase1 (2015)
Increase the intensity of stable beams by a factor 10 to 100
Intense neutron source
New opportunities at NFS and S3



Neutrons For Science

NFS Physics case (11 LoIs)

- Fission reactors of new generation
- Fusion technology
- Studies related to hybrid reactors (ADS)
- Basic data for evaluated data bases
- Nuclear medicine and biology
- Development of new detectors



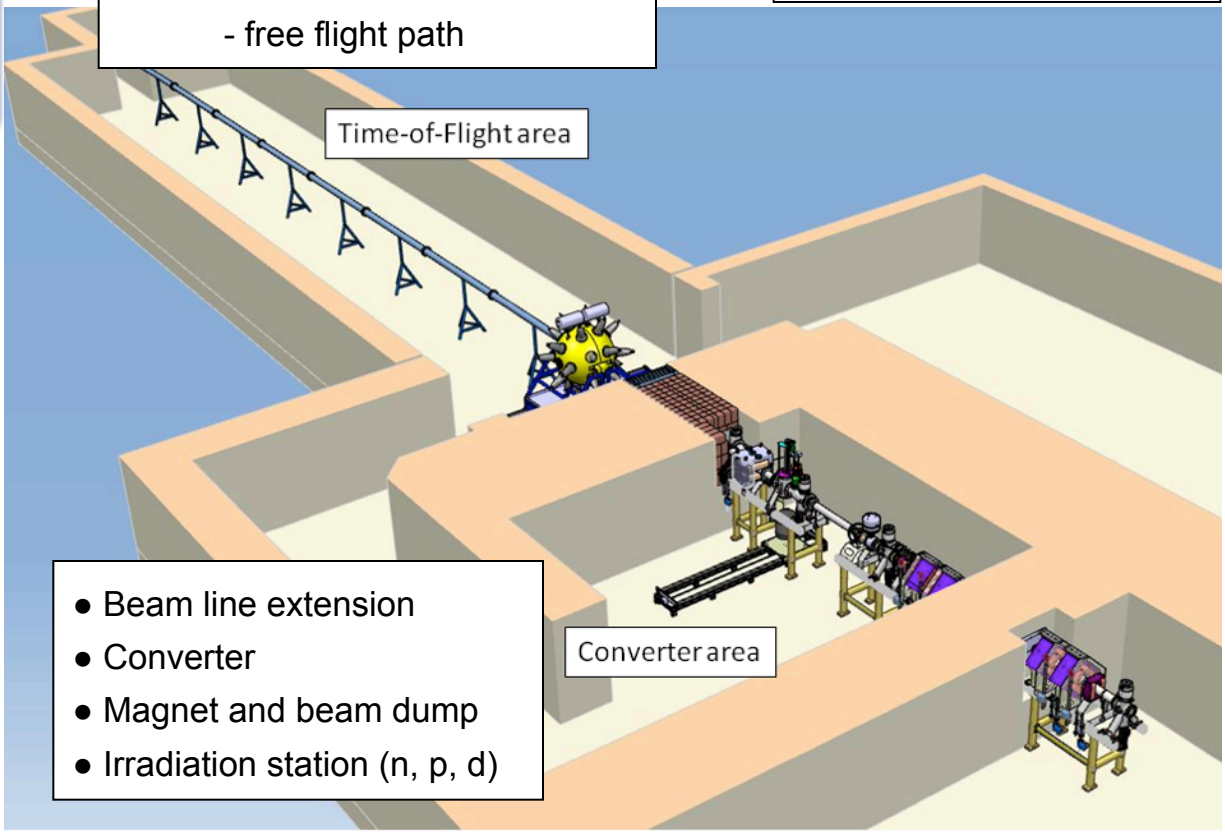
High intense neutron flux :
$\Phi > 1{,}5.10^{13}$ n/s in 4π
Continuous or mono energetic spectra
Well collimated neutron beam

First experiment in 2015

- Beam at 0°
- Collimator ↔ beam quality
- Size (L x l) ≈ (28m x 6m)
  - TOF measurements
  - free flight path

I < 50 µA
P < 2 kW

Use of radioactive samples
A< 1 GBq for thin layers
A< 10 GBq for thick samples

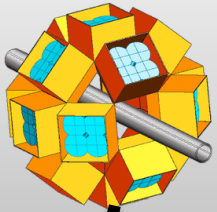


- Beam line extension
- Converter
- Magnet and beam dump
- Irradiation station (n, p, d)

Experimental Techniques

In-beam spectroscopy

Two step reactions
EXOGAM2
PARIS
AGATA
MUST2/GASPARD

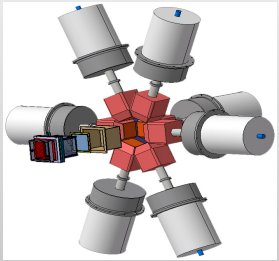


S3 Physics case (16 LoIs)

- VHE – SHE elements
- Proton drip-line and N=Z
- Nuclear astrophysics
- Atomic physics

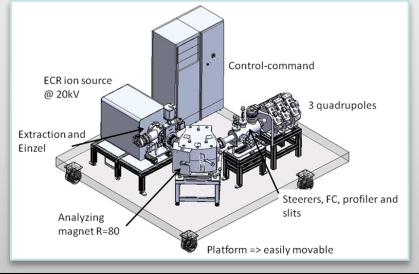
Delayed spectroscopy

SIRIUS setup
Implantation-decay station at the mass dispersive plan



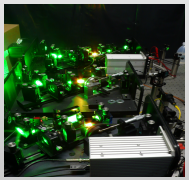
Atomic physics

FISIC setup
Fast Ion Slow Ion Collisions
Electron exchange



Ground state properties
(mass, size, moments, spins)

REGLIS³ setup
Low Energy Branch



DESIR

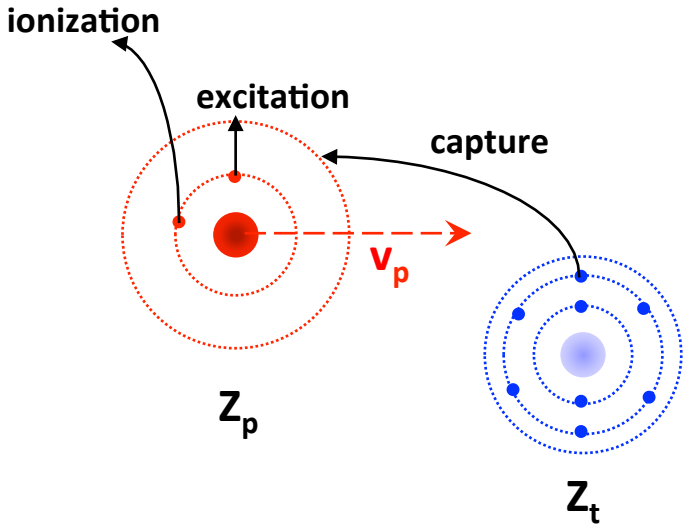
FISIC project @ S3/SPIRAL2

FISIC*: a collider project on SPIRAL2/GANIL for Atomic Physics of ion-ion collisions

one of the widespread phenomena in the universe and the least studied in laboratory!!

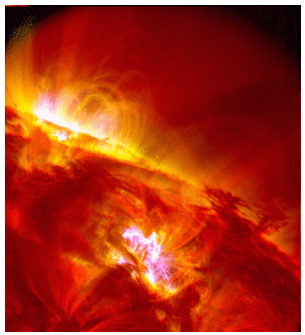
From the study of elementary processes

to damage in materials and ion energy transfer in plasmas

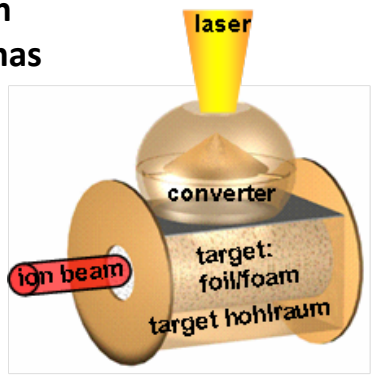


stopping power and ion-plasmas interaction

Stellar plasmas



inertial confinement fusion plasmas



@ GSI

How to work together for better results of Technology transfers in Normandy

✓Normandie Incubation:

- **Startup incubator**
- **Funding: Region,** State**, Europe**
- **70 projects,** 50 **companies, 300 employees**

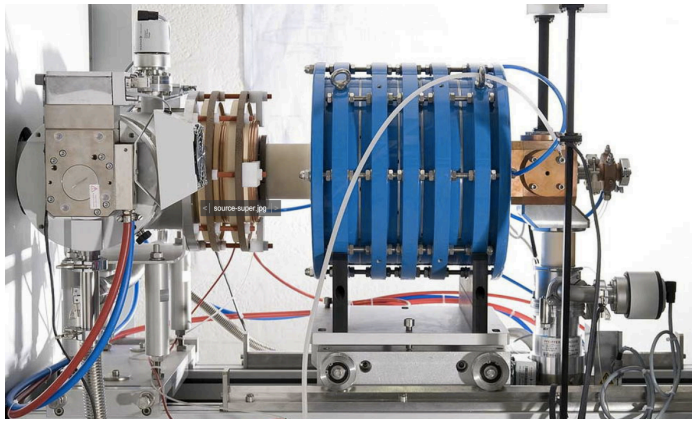
✓EP2I (Etape de Pré-Incubation et Innovation):

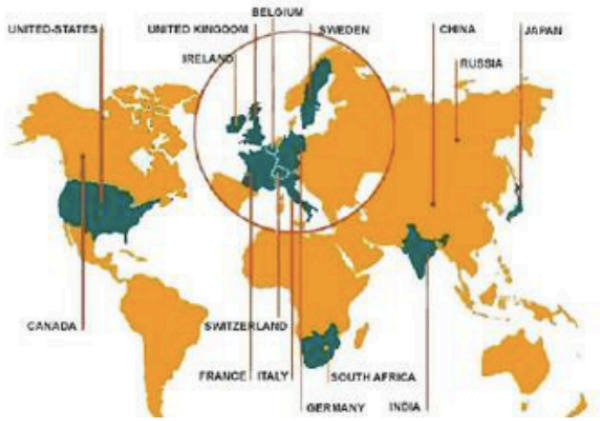
- **Helps the maturation of projects**
- *In the research* **labs**
- *half of the projects come to the incubator*
- **Fundings: Region and Europe**

Technology transfers: Ions sources « ECR »

PANTECHNIK

- Creation of PANTECHNIK in 1990 from a cooperative agreement with IN2P3 / CNRS and patent licences of GANIL
  - Today administrated by SOMINEX, IBA, SAPHYN and Dr Claude Detraz
  - 15 employees,4M€ turnover
  - 50 Pantechnik machines running over the world in 15 countries

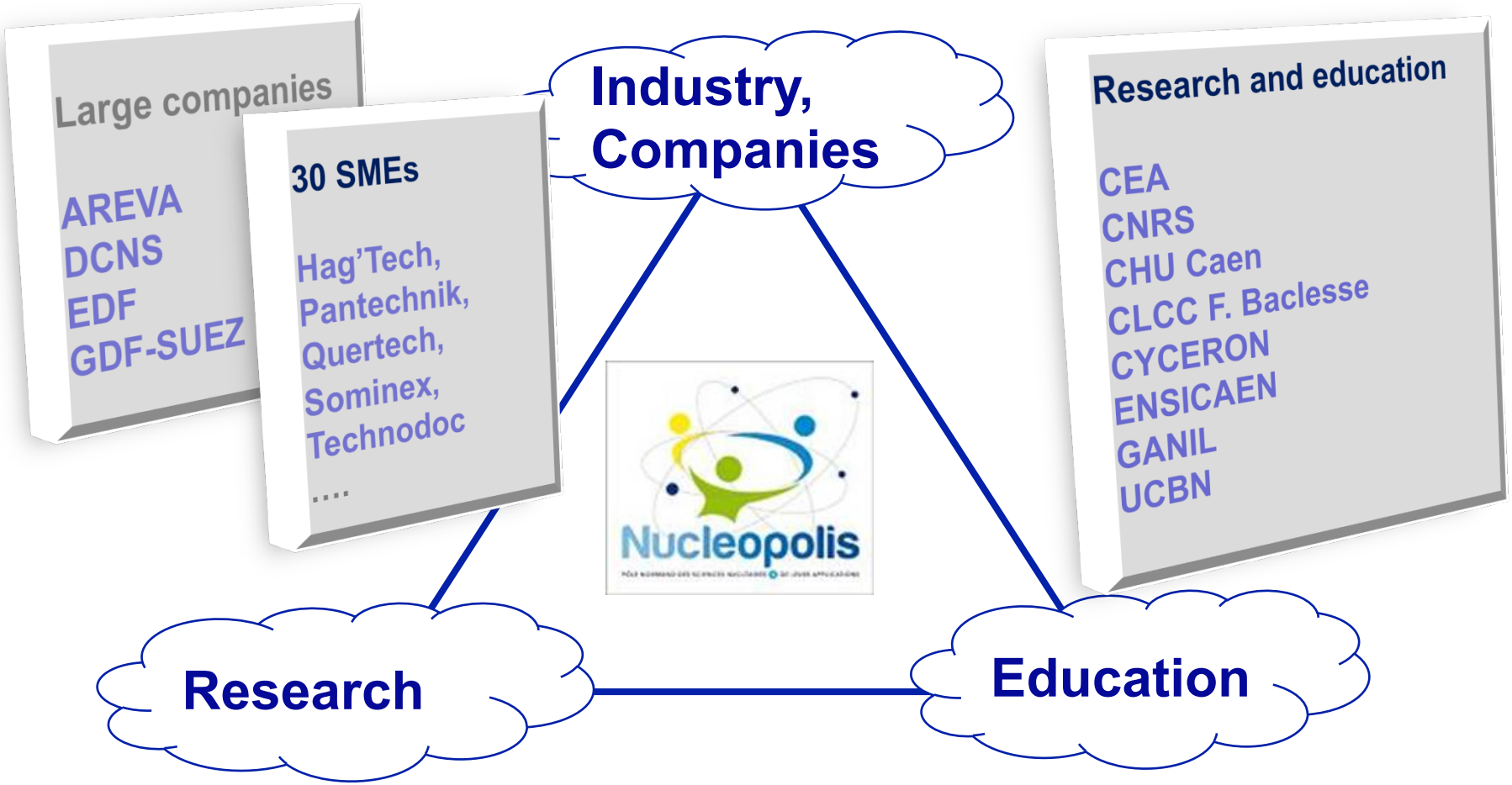




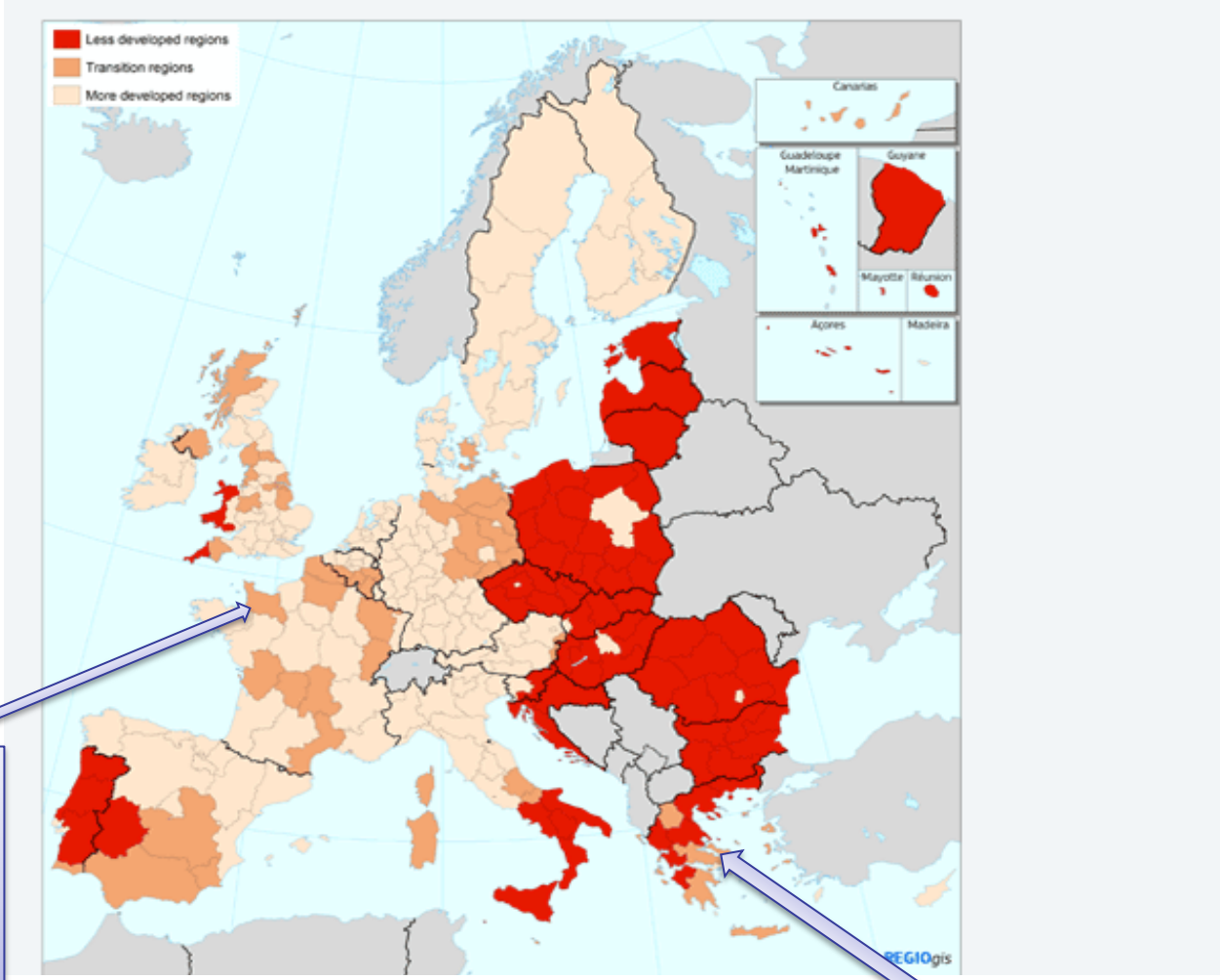
Strong collaboration

- Non disclosure agreement
- GANIL (CEA-CNRS) patents:
  - 5 already, 1 in progress, 1 en project
- 3 licences for PANTECHNIK (another in discussion)
- 1 R&D contract currently running (MULTIGAN)

Organization for nuclear sciences and their applications



Eligibility for the regional cehesion policy of EU 2014-2020



GANIL in "Transitional" region of the Basse – Normandie

Alkyon Resort Hotel & SPA

Socio-economical impact of GANIL

Construction of SPIRAL2 – economical impact

New competences developed in (regional) companies

Companies of "GRAND OUEST" :

Génie Civil: SOGEA (Rouen)
Electricité: CEGELEC (Rennes)
Fluide-Chauffage-Ventilation-Clim: CSO (Brest)
Assistance MO: EURIDIS (Cherbourg), SEGULA (Caen)
Contrôle technique: APAVE (Caen)
Coordinateur sécurité protection santé: VERITAS (Caen)
Entreposage gaz: AUXITEC (Cherbourg)
Mécanique: SOMINEX, ACE, JTMEQUAL, EFINOR, ACIEROC
Automatisme: ETM (Caen)
Câblages intégration: SICAP (Caen)
PCN spécifique: CIBEL (Caen)
Electronique: OUESTRONIC (Rennes)
Aimants: SIGMAPHI (Vannes)
UGB,TCA: CLEMECY (Le Mans)
…+ sub-contractors

➔ About 20 regional companies

Conclusion

- Interdisciplinary research program (eg. radiobiology) and industrial applications are developing rapidly at the GANIL campus
- GET electronics and its applications (see talk of E. Pollacco)
- New hadron-therapy (p and in the future ^{12}C) centre ARCHADE will be constructed at the GANIL campus
- New possibilities for radio-isotope production (eg. ^{211}At for clinical research on α-therapy) will be open with high intensity beams from the SPIRAL2 LINAC in collaboration with ARRONAX and ILL
- A construction of new research and production centre for α-therapy with ^{212}Pb in Caen was announced officially few months ago by AREVA Med company