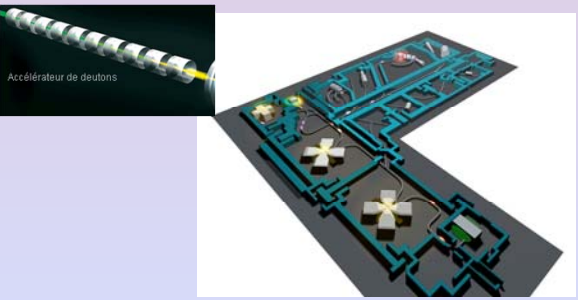
GANIL/SPIRAL2 –The adventure continues

ISOL

Smoking Gun-Discovery-Precision

ESFRI list

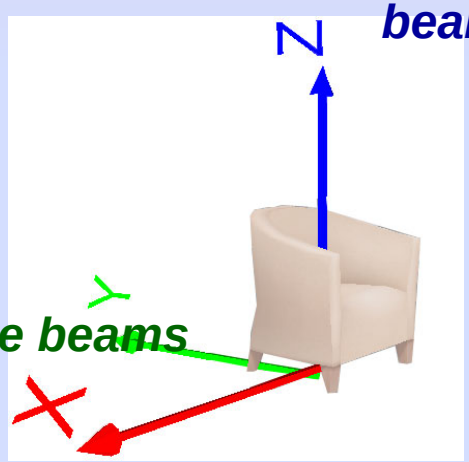


A. Navin
Grand Accélérateur National d'Ions Lourds
Caen, France

A very happy new year 2017 from GANIL

Xperiment Xplore Xperience

Intense Stable beams



ISOL Radioactive beams

Fragmentation beams

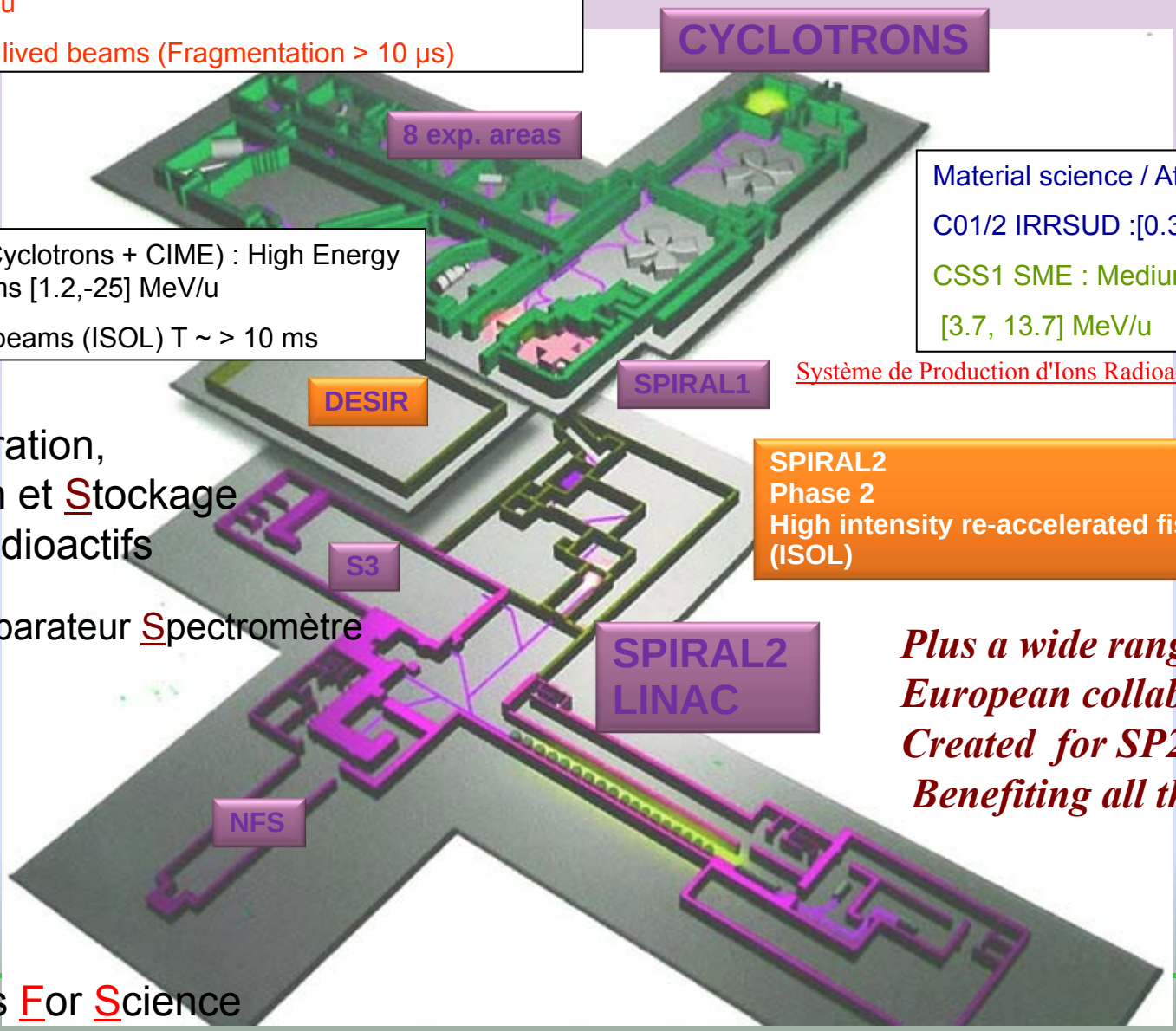
Look for new signals of simplicity in complexity in the new phase space of E* J T

The GANIL facility

C01/2+CSS1/CSS2 : High Energy Beams GANIL

[24- 95] MeV/u

Stable +Short lived beams (Fragmentation > 10 µs)



SPIRAL1 (Cyclotrons + CIME) : High Energy Exotic Beams [1.2,-25] MeV/u

Short lived beams (ISOL) T ~ > 10 ms

Material science / Atomic physics

C01/2 IRRSUD :[0.3,-1.0] MeV/u

CSS1 SME : Medium energy

[3.7, 13.7] MeV/u

Système de Production d'Ions Radioactifs Accélérés en Ligne

Désintégration,
Excitation et Stockage
d'Ions Radioactifs

Super Séparateur Spectromètre

SPIRAL2
Phase 2
High intensity re-accelerated fission fragment beams (ISOL)

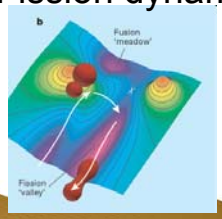
Plus a wide range of detectors
European collab^{n}
Created for SP2 in 2006
Benefiting all the ISOL facilities

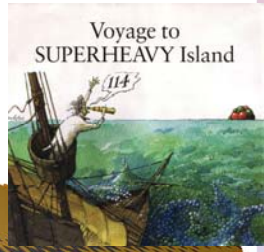
Neutrons For Science

Physics at the Femtometer scale Today

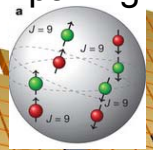
Fission dynamics

Equation of state



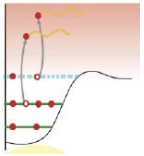


$\nu-\pi$ pairing

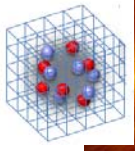


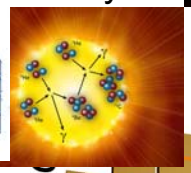
2p radioactivity

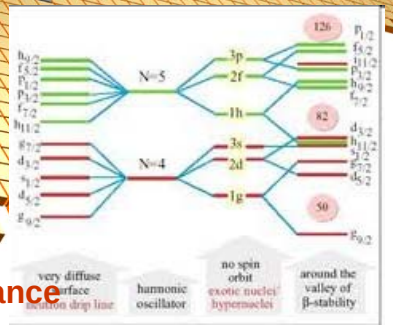
Coupling to continuum



Lattice Effective Field Theory

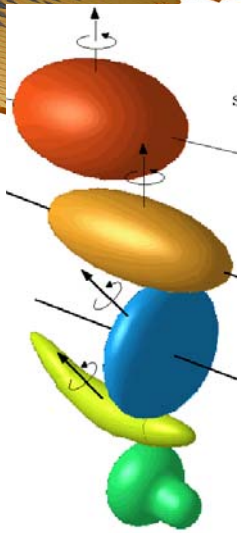




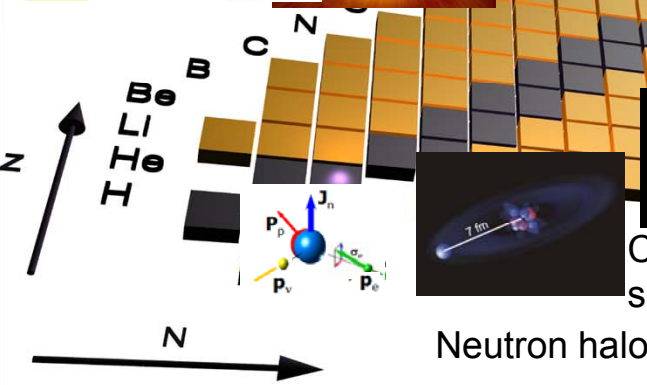


Limits of existance

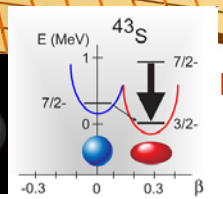
New magic numbers



Exotic Shapes



Clusters



Shape Coexistance

Neutron halos

Search and UNDERSTAND regular and simple patterns that emerge in the structure of complex nuclei

*By characterizing nuclei under **EXTREME conditions (E*,J,T)**:*

EXPLOIT *amplify different aspects of the interaction*

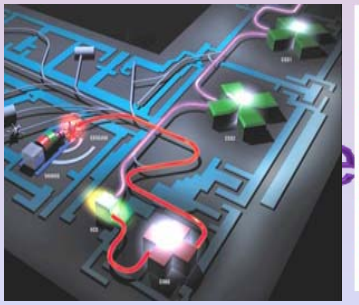
Elemental Abundances in the Universe

Improved reactors, Burning of nuclear waste ..

New isotopes for medicine …

Reaccelerated beams from SPIRAL 1 upgrade

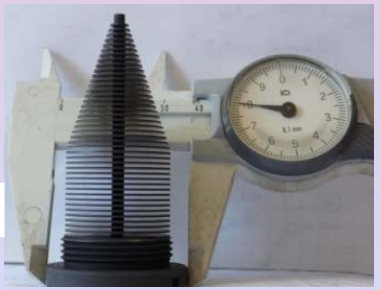
Enlarging the number of elements with new sources and new targets



FEBIAD

Surface

NANOGAN

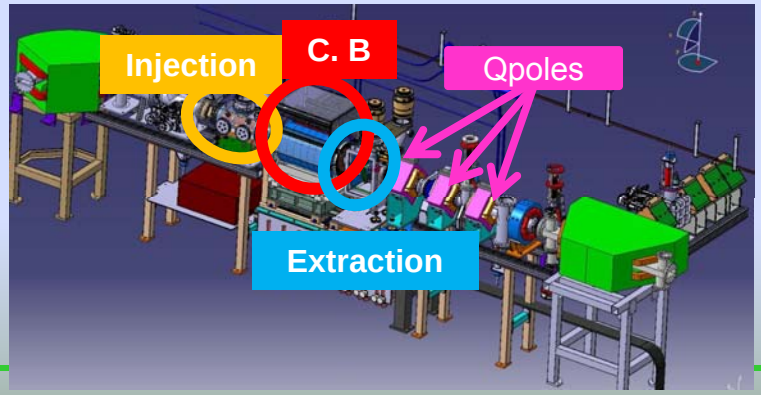


ISOLDE VADIS (FEBIAD source)

- 1+ beams from metallic elements with T_{fusion} <2000° C
- Already tested at SPIRAL at nominal power in Dec. 2013

Already 7 new elements
Na, Mg, Al, P, Cl, Cu, Fe **+ many more to come**

Insertion of an **ECR charge breeder**: highly charged ions for CIME

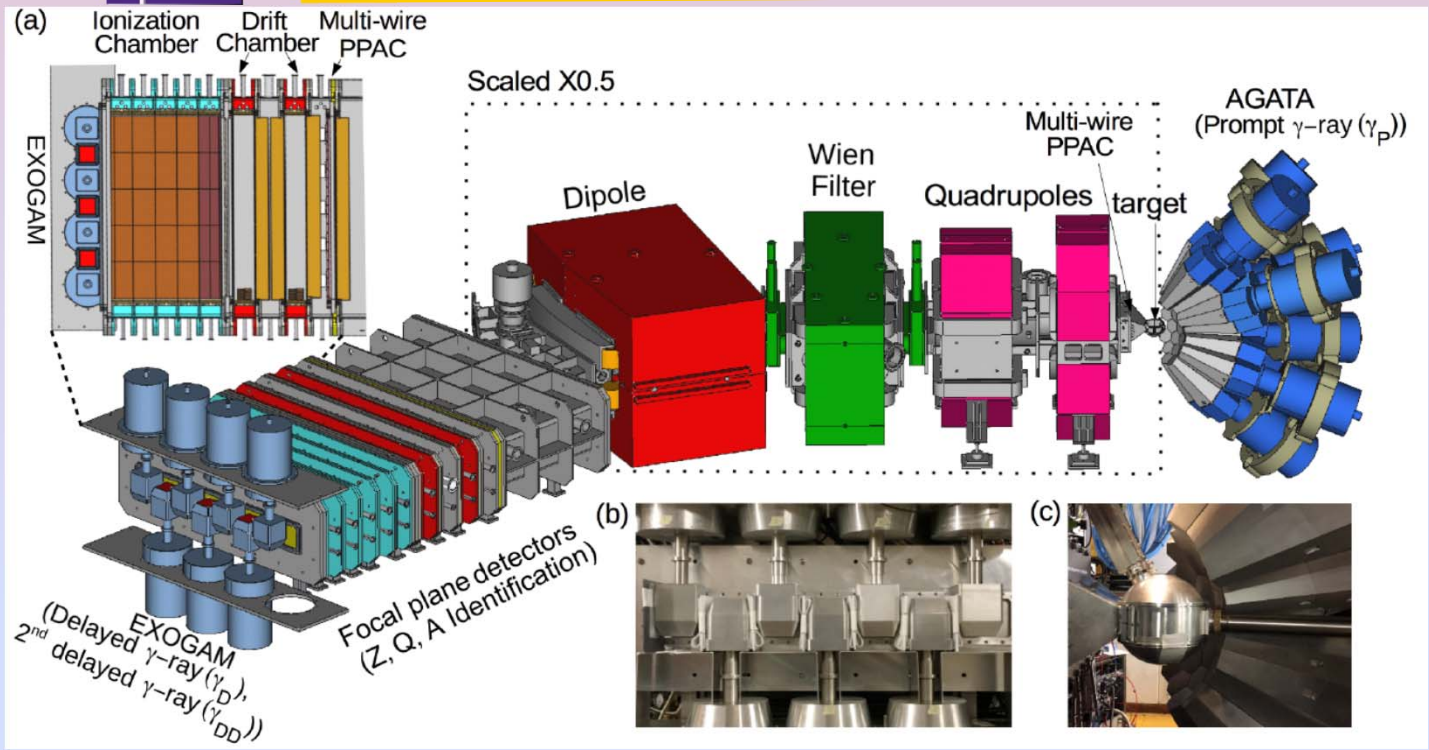


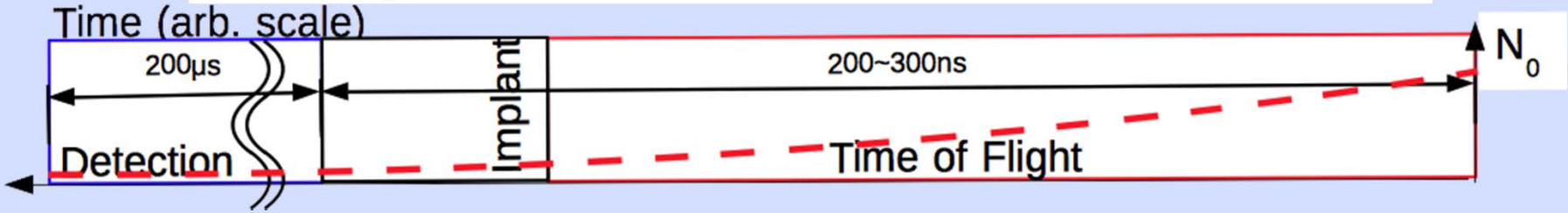
ISOL facility running since 2001

Collaborations within EURISOL/Beamlab within ENSAR2

Balancing the present with the future

Accessing Nuclear structure at High Spin and Isospin





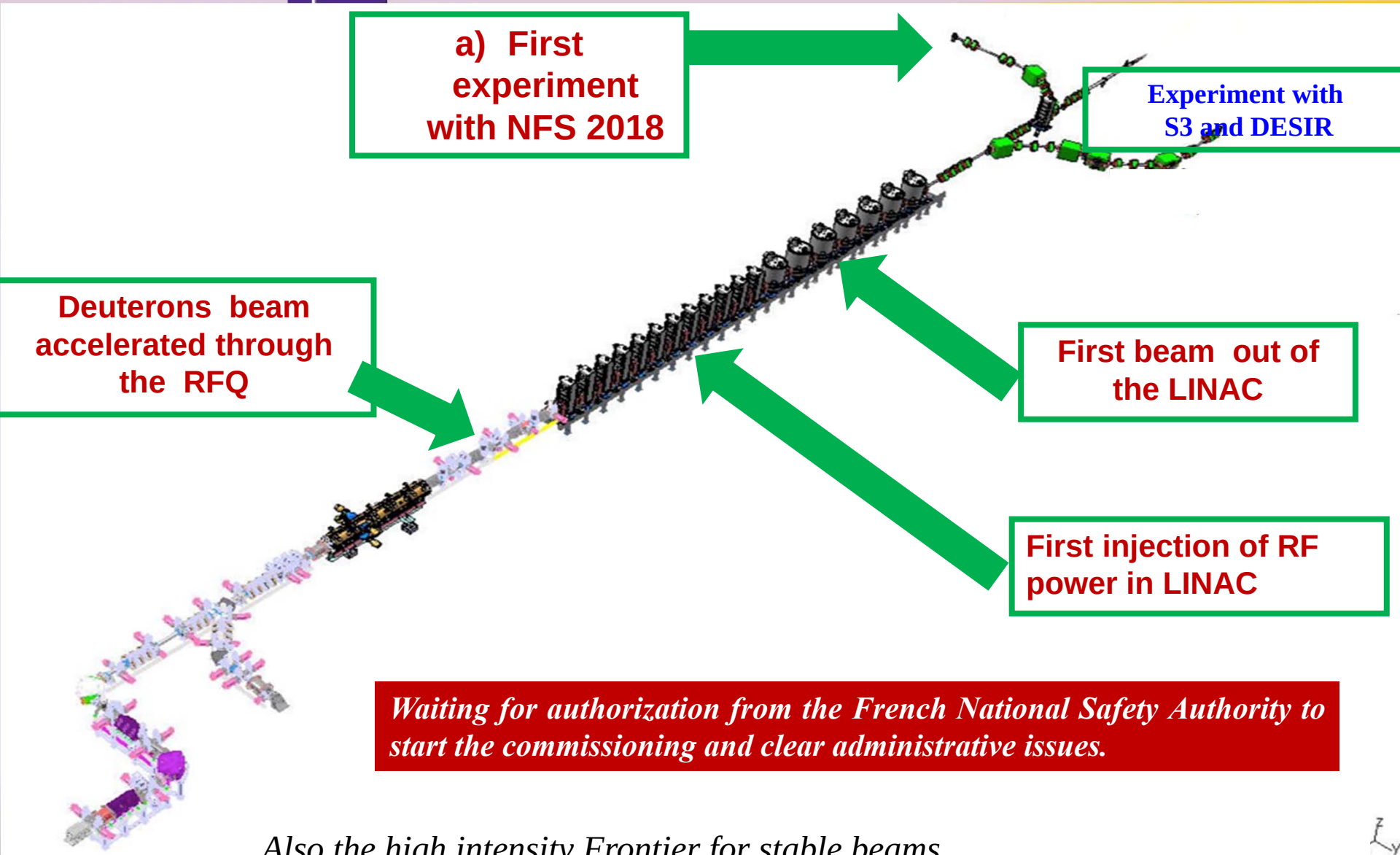
Prompt – Delayed γ–ray spectroscopy of M,Z identified exotic fragment at high angular momentum

Correlations >2ns- 0.2 to 200 microsecs

Opening new vistas in EUROPE

AGATA+EXOGAM+VAMOS++ Unique European combination and collaboration

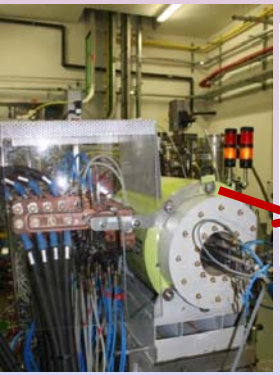
Status SPIRAL2 LINAC & more

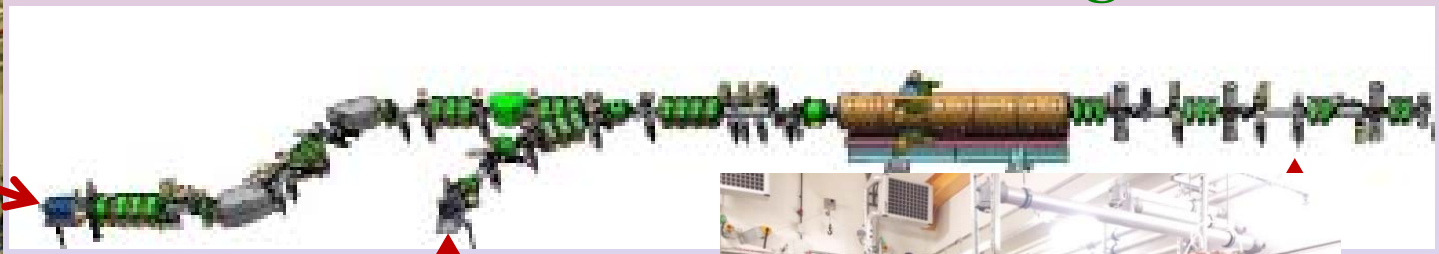


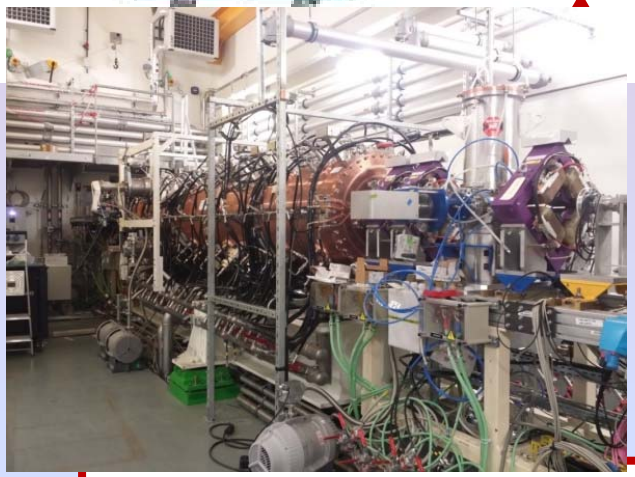
Waiting for authorization from the French National Safety Authority to start the commissioning and clear administrative issues.

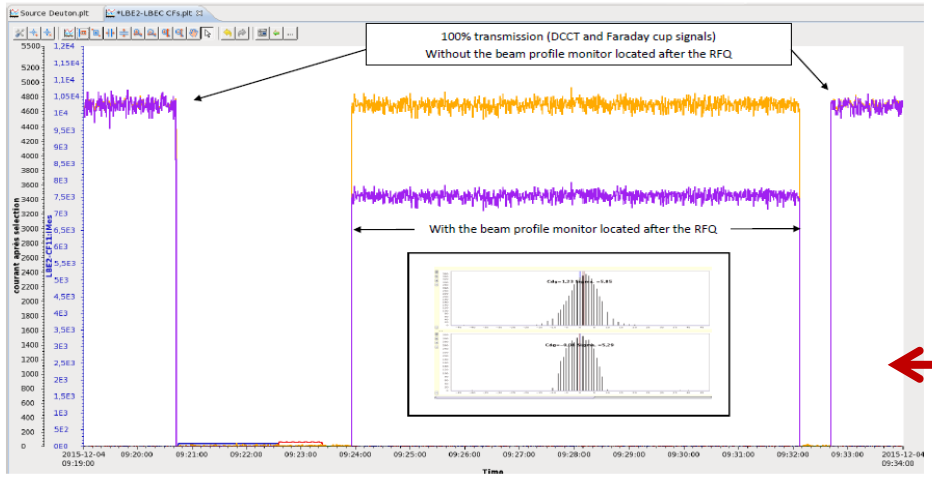
Also the high intensity Frontier for stable beams

Sources and RFQ beam commissioning









Proton beam current measurement after RFQ

RFQ performances :

- H^+ beam (A/Q=1) : Nominal, 5mA CW
- $^4He^{2+}$ beam (A/Q = 2) : Nominal, 1.35 mAe CW
- $^{18}O^{6+}$ (A/Q=3): preliminary results, 600 µAe (≈100% transmission but beam characteristics to be measured : energy, emittance,….)

- RFQ transmission : ~ 100% :
- RFQ Energy : 730 keV/nucleus : nominal

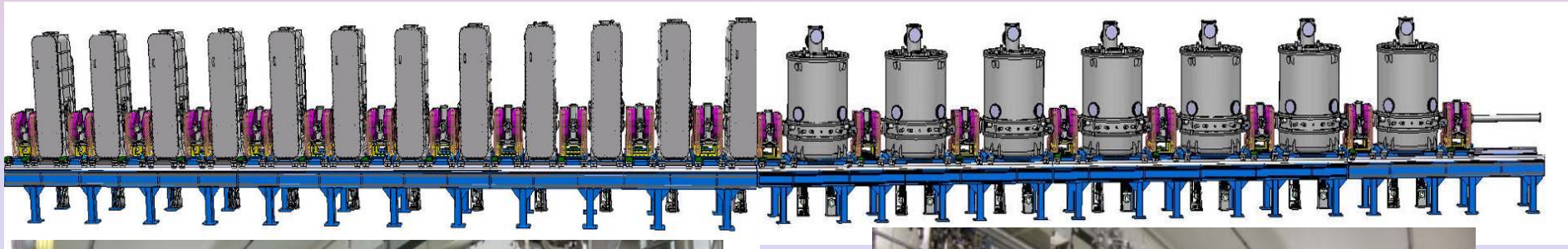
Next step Deuteron beams

DSCN4912.JPG

laboratoire commun CEA/DSM spiral2 CNRS/IN2P3

SPIRAL2 LINAC: SC cavities

88 MHz QWR 12 x 1 = 12 β = 0.07 cavities 7 x 2 = 14 β = 0.12 cavities



Low β and high β cryomodules installed and connected to their valve boxes.

Warm sections are installed and mechanically connected to the cryomodules

- Cooled down to 4K -July, 2016 (third low β and last high β)
  - A major part of the cryogenic installation was tested

An important visitor

Thanks to French and international labs + GANIL staff

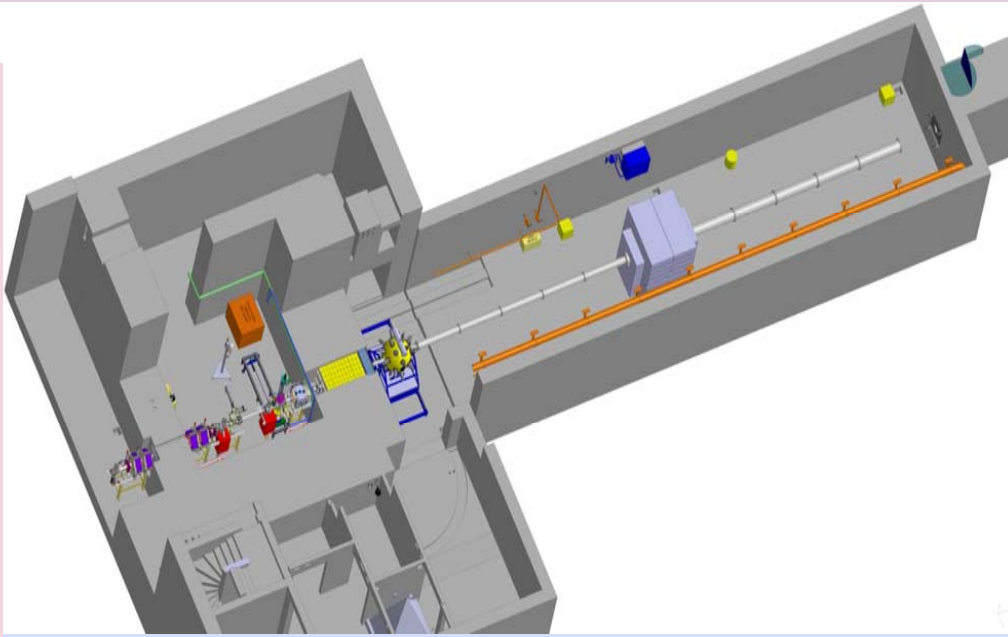
laboratoire commun CEA/DSM GANIL spiral2 CNRS/IN2P3

Neutrons For Science

High intense neutron beams (p,α beams)

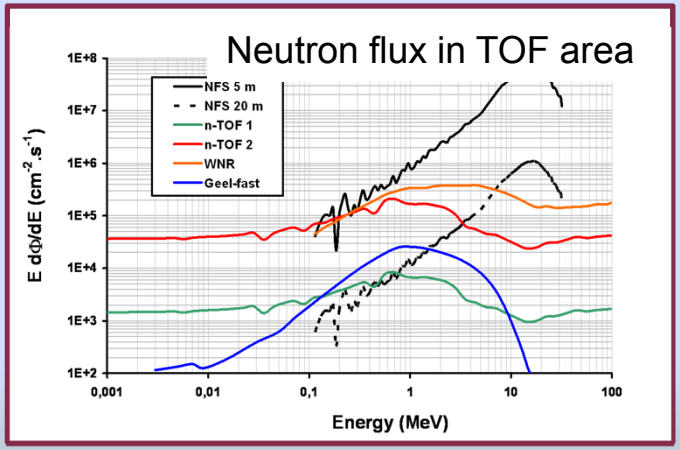
Physics cases

- **Fundamental physics**
- **Fission reactors of new generation**
- **Fusion technology**
- **Studies related to hybrid reactors (ADS)**
- **Nuclear medicine**
- **Development and characterization of new detectors**
- **Radioisotopes production for medical applications**
- **Biology**
- **Study of the single-event upsets**



Technical Characteristics

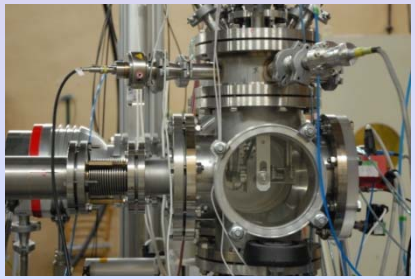
- Neutron beam between 100 keV and 40 MeV
- Continuous and quasi-mono energetic spectra
- Large experimental area for TOF measurement
- Irradiation station for n, p, d and ions induced reactions



Collaboration : 8 partners
50 physicists

Neutrons For Science- Status

- Building and beam line: Ready
- Cables and automation: under progress
- Lithium converter: Ready
- Rotating converter : Final tests

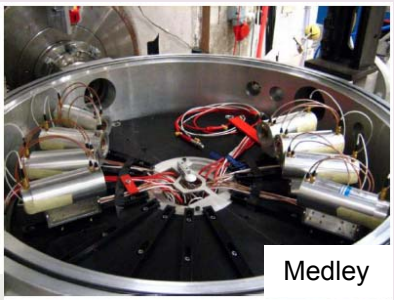


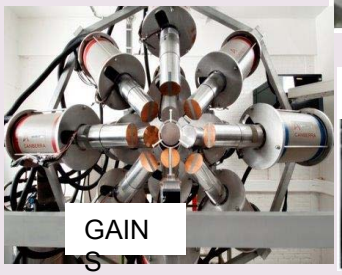
7 experiments accepted by the PAC for intail step
Measurement of (n,xn) reaction cross sections on U238
Prompt fission neutron spectra measurement in neutron induced fission reactions
Excitation functions of short-lived isotopes in proton induced reactions on natFe
Measurements of the excitation function for the production of possible candidates for targeted alpha therapy at SPIRAL2
Precise direct measurements of the $^{28}Si(p,\gamma)^{29}P$ and $^{29}Si(p,\gamma)^{30}P$ reaction rates to understand the origin of presolar nova grains
Measurement of the absolute neutron detection efficiency of FAZIA telescopes
LIONS - Light-Ion Production Studies with Medley at the NFS facility

19 Letters Of Intent
First PAC June 2016

Detectors


Fission chamber


Medley

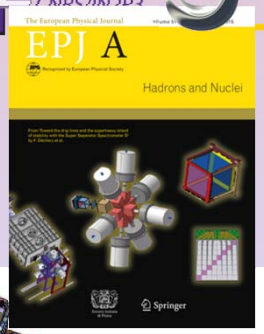

GAIN S


FALSTAFF

50µa pulsed deutron beam for the full science program

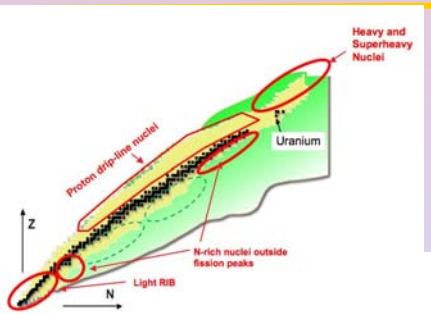
Looking for Rare phenomena

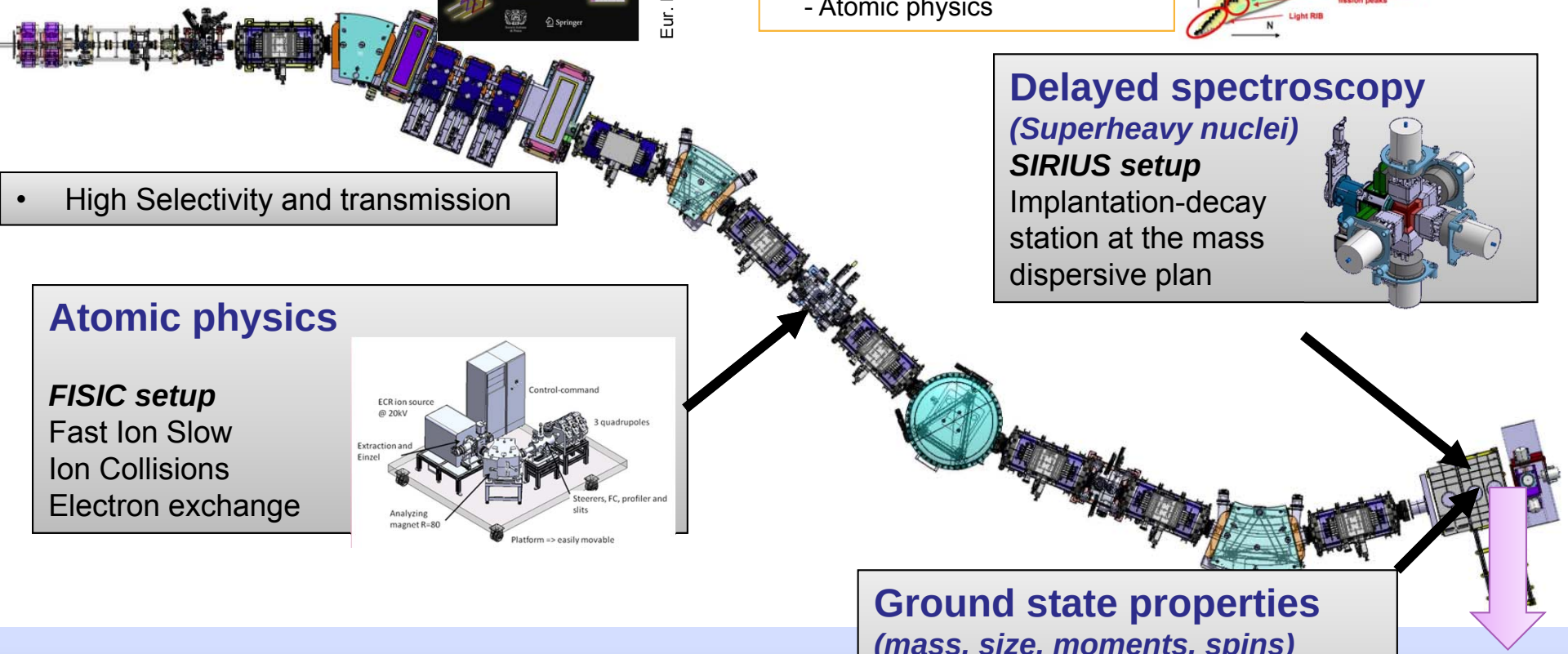
laboratoire commun CEA/DSM — GANIL — SPIRAL2 — S3



Eur. Phys. J. A (2015) 51: 66

S3 Physics case (26 LoIs)
- VHE-SHE nuclei
- Proton drip-line & N=Z
- Nuclear Astrophysics
- Atomic physics





- High Selectivity and transmission

Delayed spectroscopy

(Superheavy nuclei)

SIRIUS setup

Implantation-decay station at the mass dispersive plan

Atomic physics

FISIC setup

Fast Ion Slow Ion Collisions

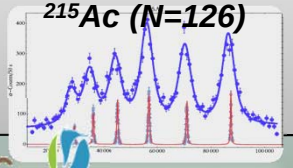
Electron exchange

Ground state properties

(mass, size, moments, spins)

REGLIS³ setup

IGLIS + Mr-ToF



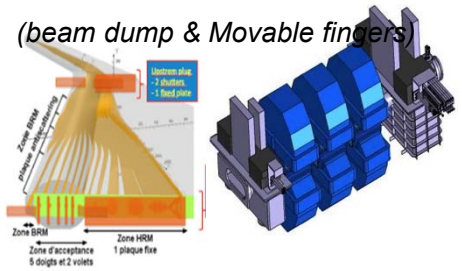
DESIR

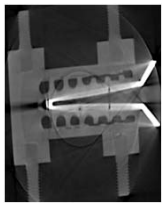
120 Collaborators

Creating step by step

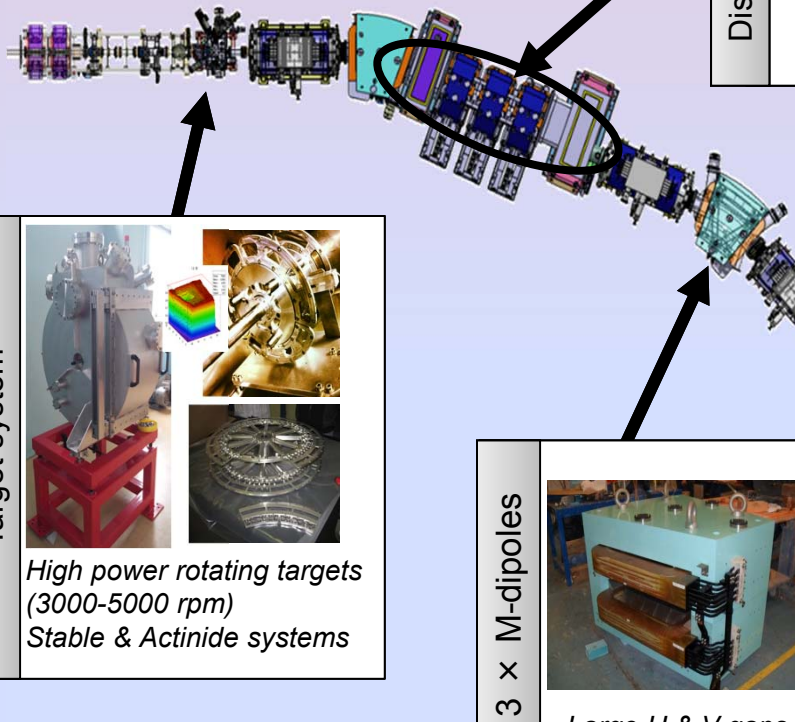
Dispersive zone

(beam dump & Movable fingers)





tested for 5kW/cm²



(L=26m)

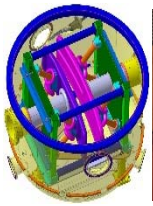
Target system

High power rotating targets (3000-5000 rpm)
Stable & Actinide systems

3 × M-dipoles

Large H & V gaps

E-Dipole



20 cm gap & +/- 350 kV
Epmax : 12-14 MeV
Open slit in the anode

SC Multipoles

Q+S+O fields

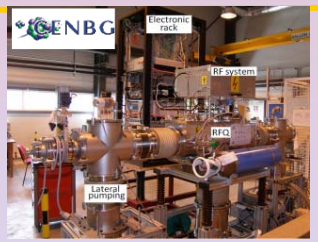
PSS

Cold Box

F. Dechery et al., Eur. Phys. J. A (2015) 51: 66
F. Dechery et al., NIMB 376 (2016) 125


RFQ SHIRaC

HRS

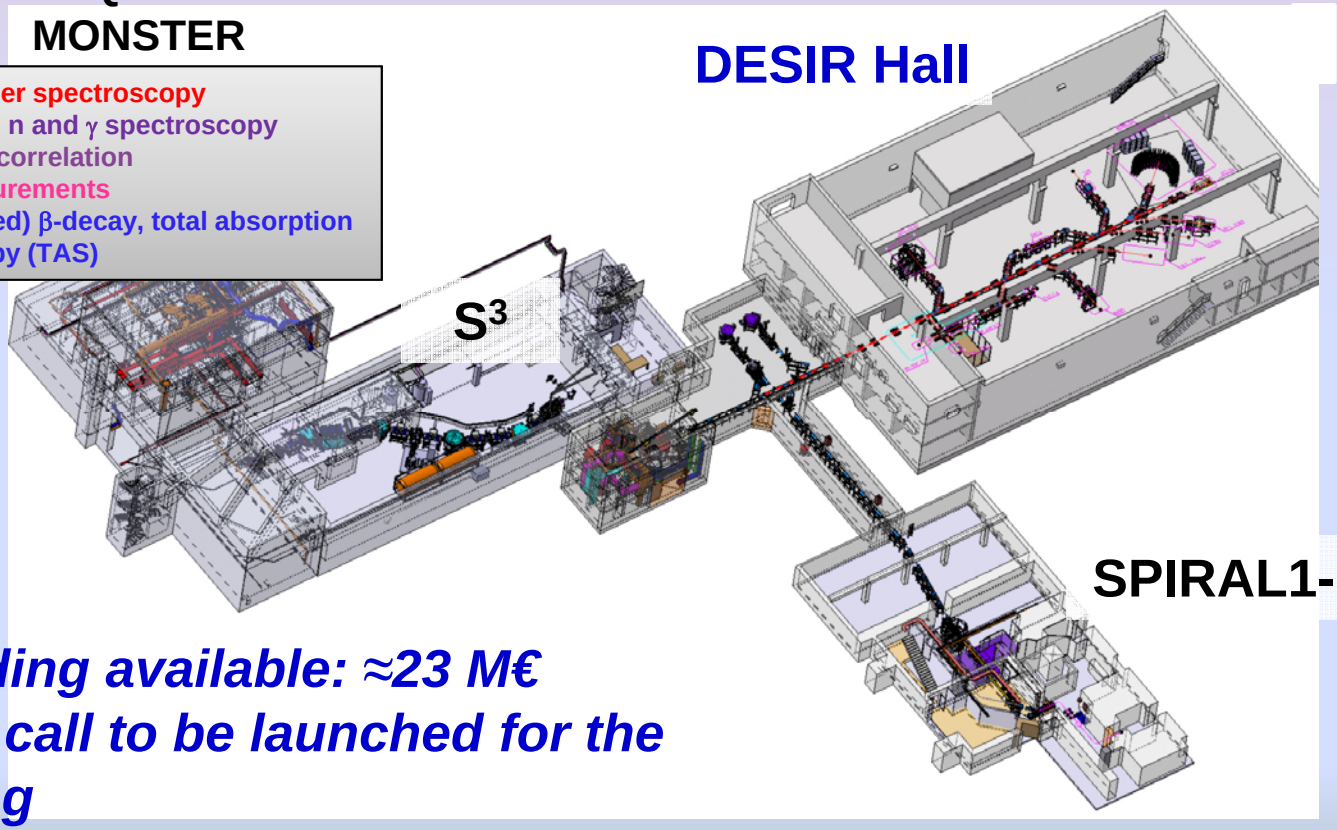


PIPERADE

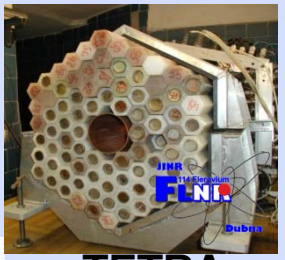
MLL Penning-trap


MONSTER

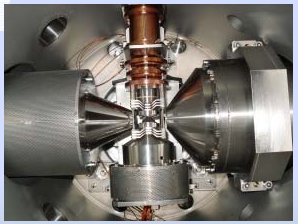
- collinear laser spectroscopy
- β-delayed p, n and γ spectroscopy
- β-ν angular correlation
- mass measurements
- (trap-assisted) β-decay, total absorption spectroscopy (TAS)



TAGS

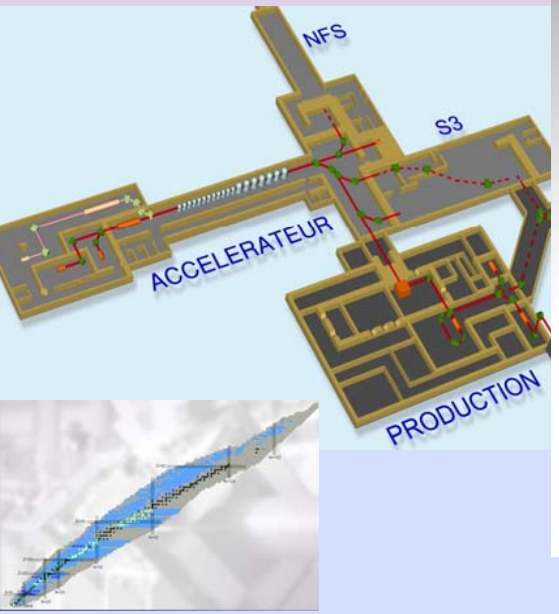


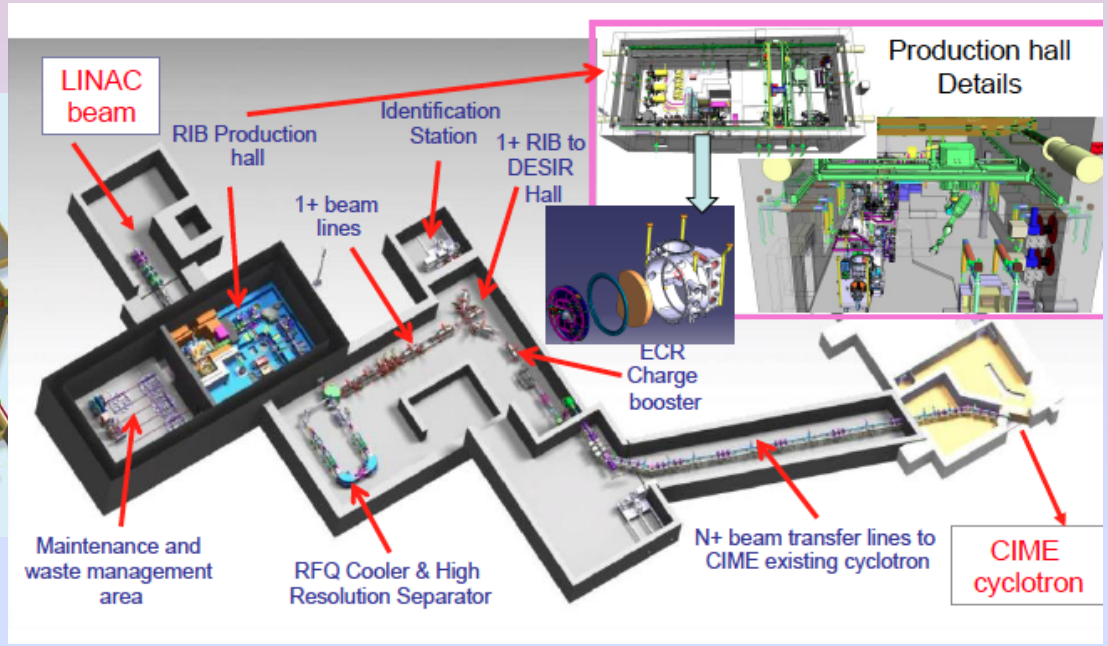
TETRA


LPCTRAP

- ***Funding available: ≈23 M€***
- ***New call to be launched for the building study and construction***

Reaccelerated Fission Fragments Phase 2





- *As part of the strategy of going to the next generation ISOL facility EURISOL SPIRAL2 phase 2*

The first step towards high intensity frontier for reaccelerated beams around the Coulomb barrier (10^9 p/s)

- *200kw - A crucial step for the next generation.*

Our Funding organizations ready to re-discuss

- *(EURISOL-DF) with all ISOL facilities to mutually benefit and put EUROPE ahead*

laboratoire commun CEA/DSM GANIL spiral2 CNRS/IN2P3

Summary

Transforming our future to the present

Enthusiastic bright ideas and an action plan for a great future in physics at the femtoscale

The woods are lovely dark and deep,

But we have miles to go before we sleep,

Miles to go before we sleeps……..

Robert Frost (with modifications)