Status of SPIRAL2
Synergies with EURISOL

Hervé Savajols (GANIL)
on behalf of the SPIRAL2 Project Group
&
Physics Collaborations

www.ganil-spiral2.eu


GANIL/SPIRAL2 by 2015

ISOL Roadmap in EUROPE

TODAY Generation 1

SPIRAL – GANIL

New SPIRAL beams (2014-2015)

2014-2025 Generation 2

GANIL spiral2 laboratoire commun CEA/DSM CNRS/IN2P3

ISOLDE CERN

10^{13}-10^{14} fission/s
10MeV/n (A=130)

HIE-ISOLDE

INFN LNS - EXCYT

SPES exotic beams for science

EURISOL

>10^{15} fission/s
150MeV/n (A=130)
+ fragmentation of RIB

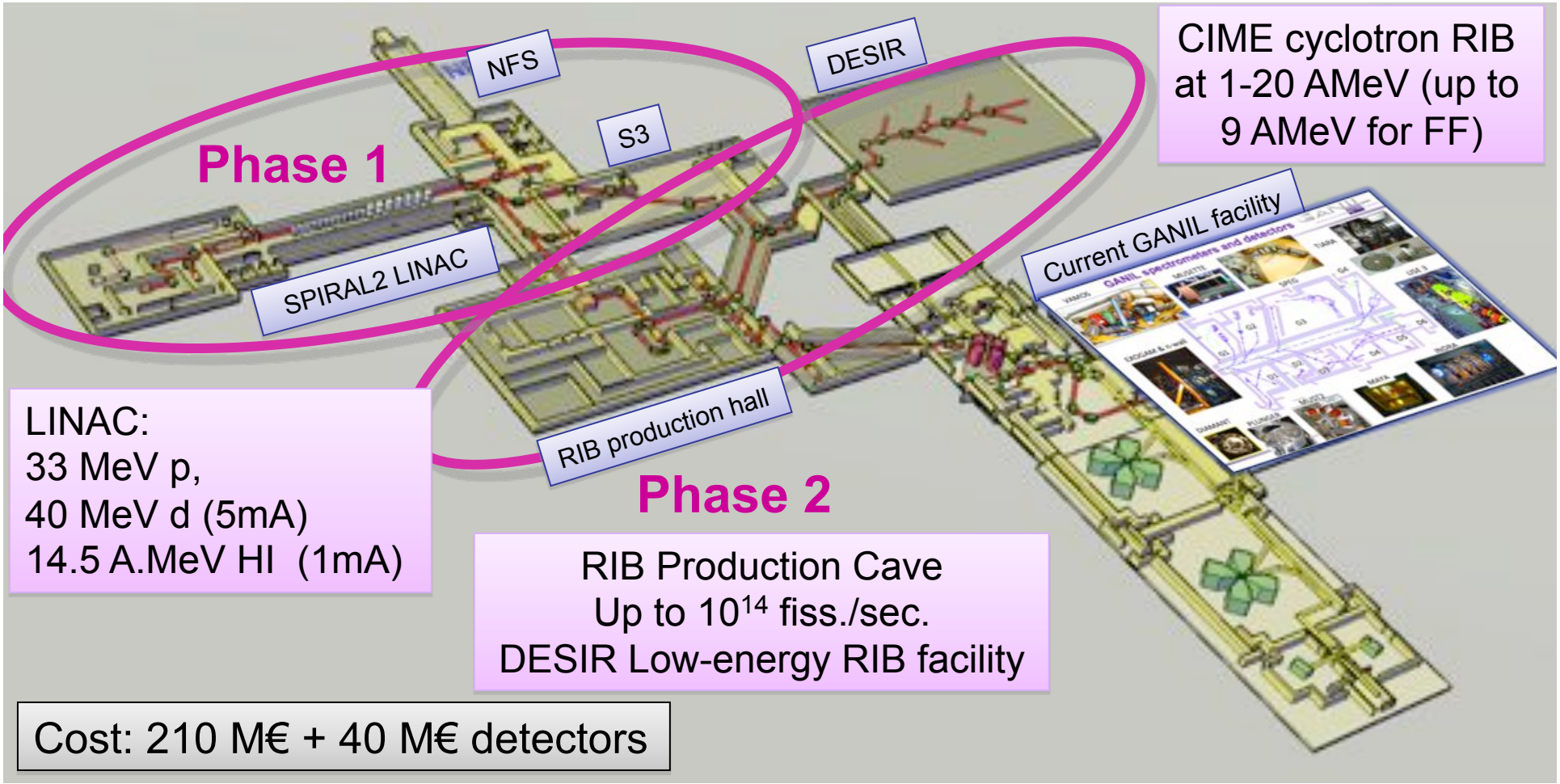
FROM 2025

EURISOL @ GANIL

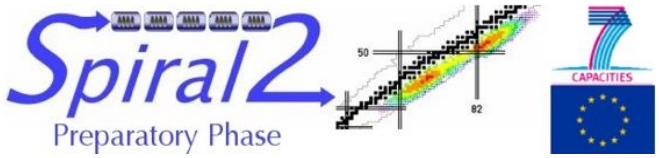
SPIRAL2 under construction

Phase 1: High intensity stable beams + Experimental rooms (S^3 + NFS) (First beam Sept 2014)

Phase 2: High-intensity low-energy (DESIR) & post-accelerated Radioactive Ion Beam facility



European Projects for SPIRAL2



(GANIL coordinator) - 3.9 M€
2007-2012
25 partners – 13 countries (France, Germany, Italy, UK, Romania, Poland, Czech Republic, Bulgaria, Hungary, Belgium, Netherlands, Spain, Israel)

CRISP **C**luster of **R**esearch **I**nfrastructures and **S**ynergies in **P**hysics

16 partners – 10 countries (France, Germany, Italy, UK, Switzerland, Sweden, Greece, Portugal, Hungary, Romania)
(GANIL & LPSC) - 1 M€ for SPIRAL2 (2011-2014)

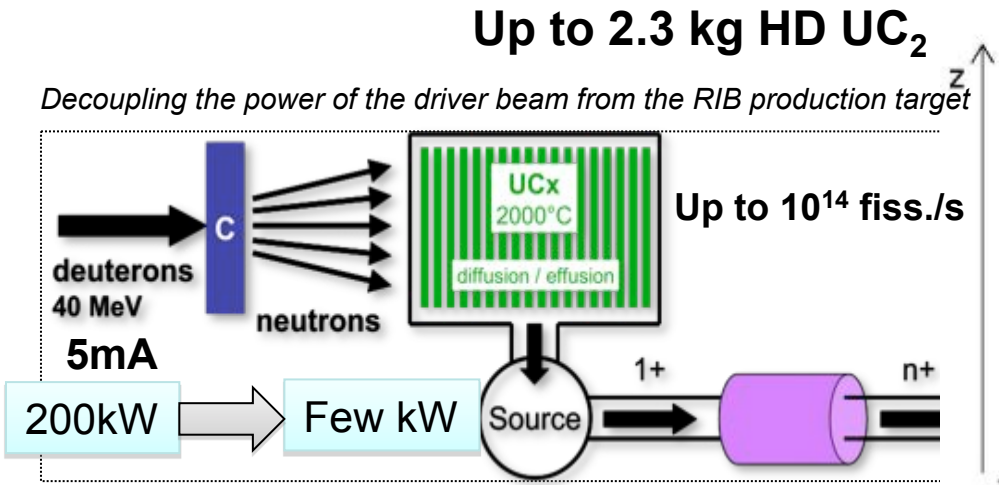
- 823 k€ for baseline project:
  - New generation heavy-ion source + Beam Diagnostics: : 553 k€
  - Target Ion-Source development for RIB: 270 k€
- 229 k€ for electronics of EXOGAM2, PARIS & NEDA detectors

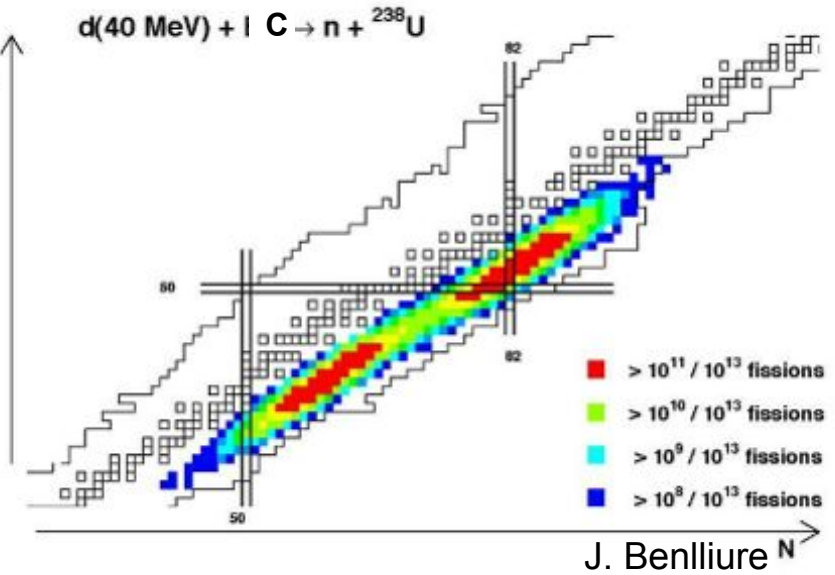
Bilateral Agreements for SPIRAL2

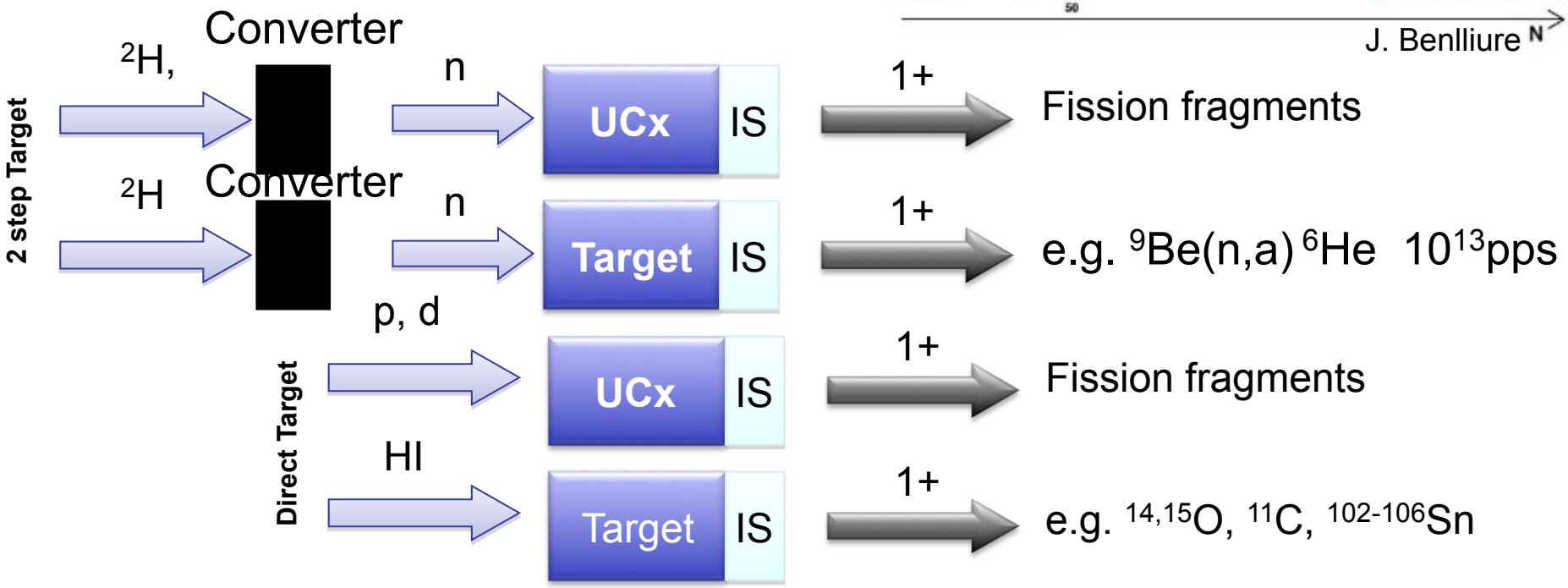
In progress: MoU SCK-CEN (Belgium), MoU KULeuven (Belgium), MoU LNS (Italy)
LEA with Bulgaria, MoU IBS (Korea)

SPIRAL2 Objectives

ISOL Rare Isotope Beams at SPIRAL 2

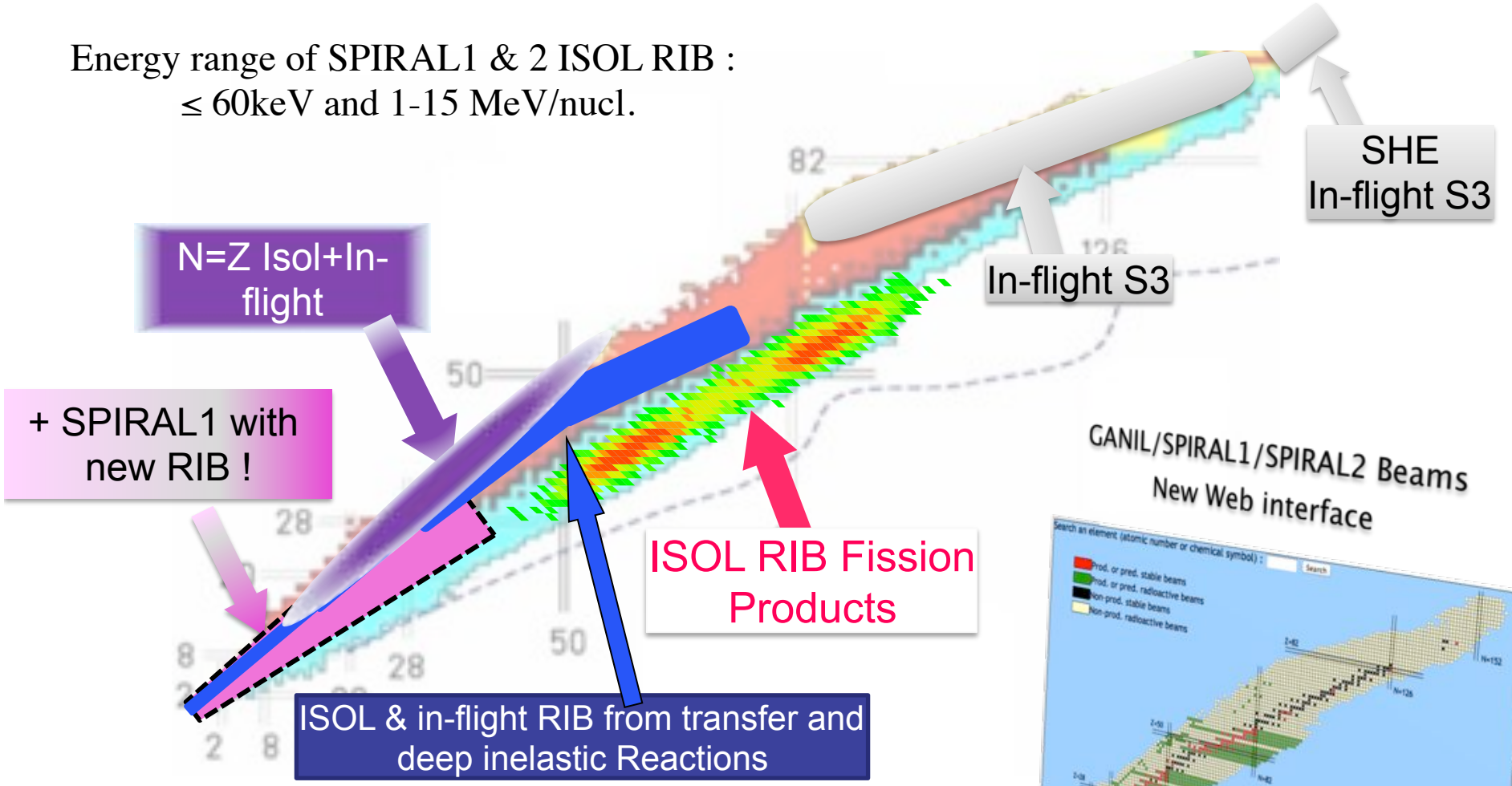






RIB with SPIRAL1 & SPIRAL2

Energy range of SPIRAL1 & 2 ISOL RIB :
≤ 60keV and 1-15 MeV/nucl.



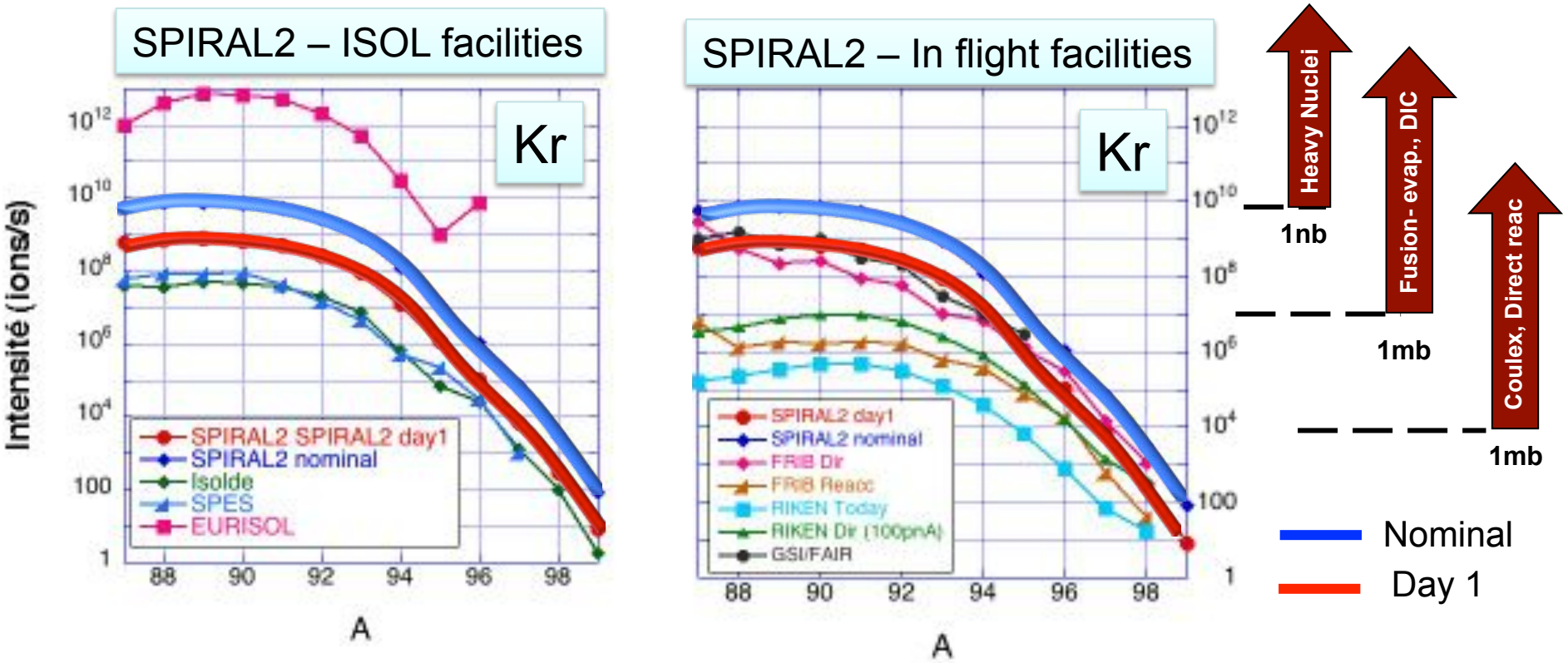
GANIL/SPIRAL1/SPIRAL2 Beams
New Web interface

Nominal operation of GANIL/SPIRAL2:
- ✓ up to 79 weeks/y of stable-ion beams
- ✓ up to 53 weeks/y of RIB
- ✓ up to 5 beams (2 RIBs) simultaneously
- ✓ 800-900 users

pro.ganil-spiral2.eu/users-guide/accelerators/chart-beams

SPIRAL 2: Advanced ISOL RIB facility

SPIRAL 2: Experiments with RIB at low cross sections and very exotic nuclei at few MeV/nucleon



ISOL RIB beams:

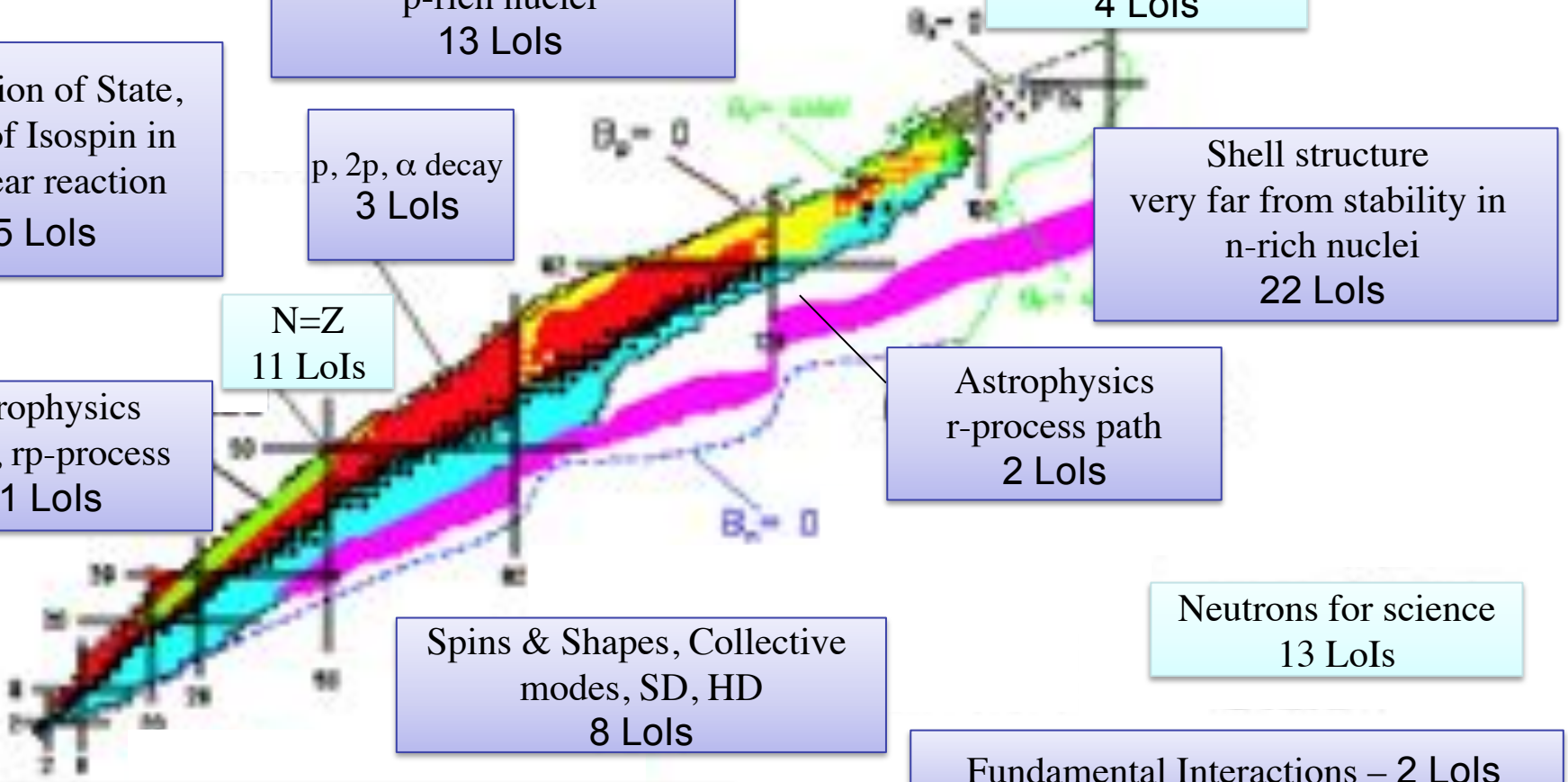
- high intensity, optical quality & purity

Versatility:

- light & HI, high-intensity stable-ion & RIB

- Multi-beam capabilities,
- Months of beam-time
- World-class arrays & detectors

82 Letters of Intend (>1000 authors) for the Day 1 experiments at SPIRAL2



Shell structure
very far from stability in
p-rich nuclei
13 LoIs

Heavy and Super
Heavy Elements
4 LoIs

Equation of State,
Role of Isospin in
nuclear reaction
5 LoIs

p, 2p, α decay
3 LoIs

Shell structure
very far from stability in
n-rich nuclei
22 LoIs

N=Z
11 LoIs

Astrophysics
r-process path
2 LoIs

Astrophysics
CNO, rp-process
11 LoIs

Neutrons for science
13 LoIs

Spins & Shapes, Collective
modes, SD, HD
8 LoIs

Fundamental Interactions – 2 LoIs

Atomic physics 1 LoI

29 LoIs Phase 1 *(16 for S3, 13 for NFS)*
53 LoIs Phase 2 *(21 for DESIR)*

SPIRAL2 Facility Design (PHASE1 & PHASE2)

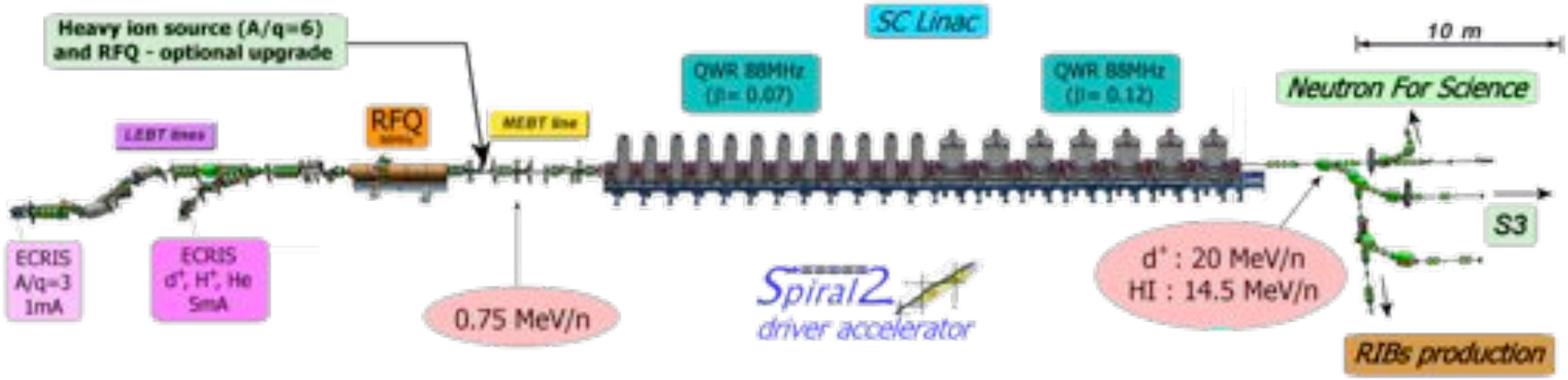
SPIRAL2 phase 1 civil construction

SPIRAL2 phase 1 civil construction


Octobre 2012 – dans le tunnel du Linac
sominex

Accelerator Configuration

Phase 1



Particles	H^+	$^3He^{2+}$	D^+	Ions	
Q/A	1	2/3	1/2	1/3	1/6
I (mA) max.	5	5	5	1	1
W_O max. (Mev/A)	33	24	20	15	9
CW max. beam power (KW)	165	180	200	44	48

Total length: 65 m (without HE lines)

Slow (LEBT) and Fast Chopper (MEBT)
RFQ (1/1, 1/2, 1/3) & 3 re-bunchers

12 QWR beta 0.07 (12 cryomodules)
14 (+2) QWR beta 0.12 (7+1 cryomodules)
1.1 kW Helium Liquifier (4.5 K)
Room Temperature Quadrupoles
Solid State RF amplifiers (10 & 20 KW)
6.5 MV/m max $E_{acc} = V_{acc}/(\beta_{opt}\lambda)$ with $V_{acc}=\int E_z(z)e^{i\omega z/c}dz$.

Based on the EURISOL post-accelerator design

Fast Choppers

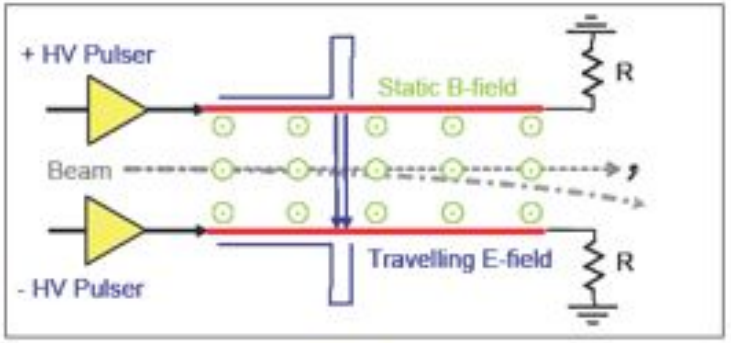
Collaboration GANIL – INFN/LNS (Italy)

SINGLE BUNCH SELECTOR (MEBT)

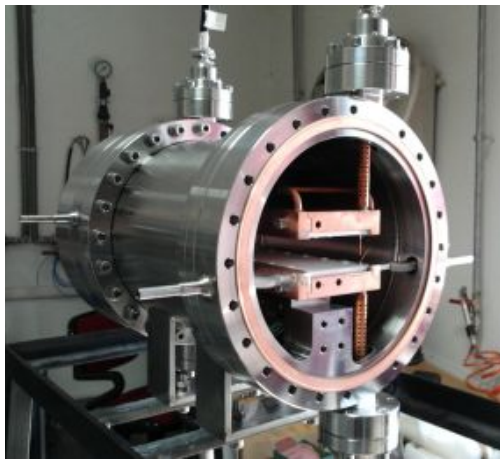
➔ Must reduce by 100 to 10000 the bunch rate (½ for HI)
➔ 7.5kW beam stopper,

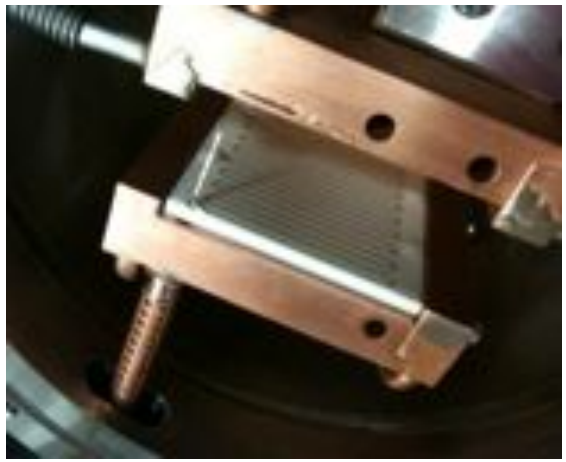
A vacuum chamber prototype equipped with 100Ω meanders and feed-through have been constructed in collaboration with NFN-LNS and successfully tested in Catania

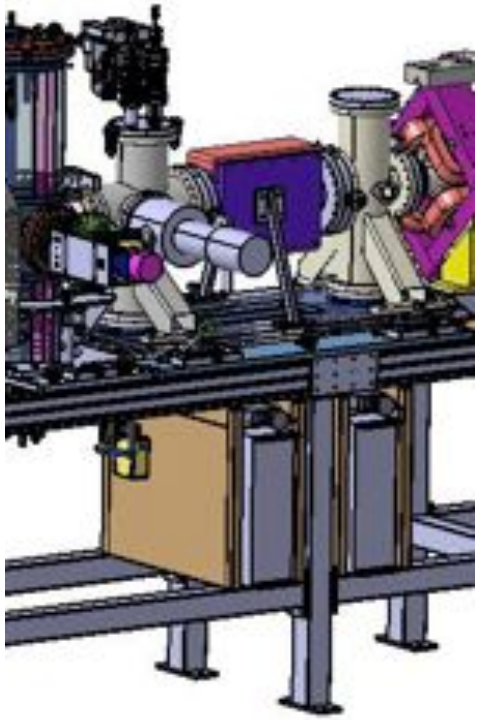
Final design in progress



superposed magnetic and electrical fields

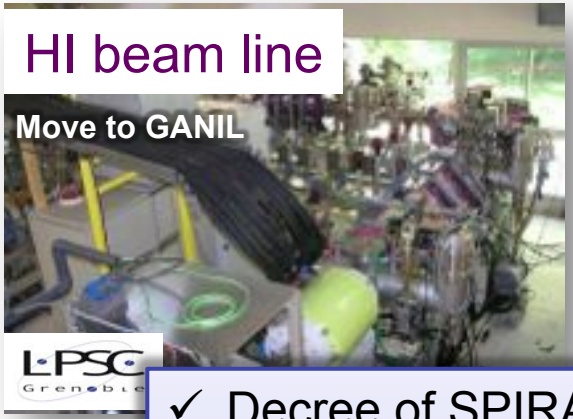


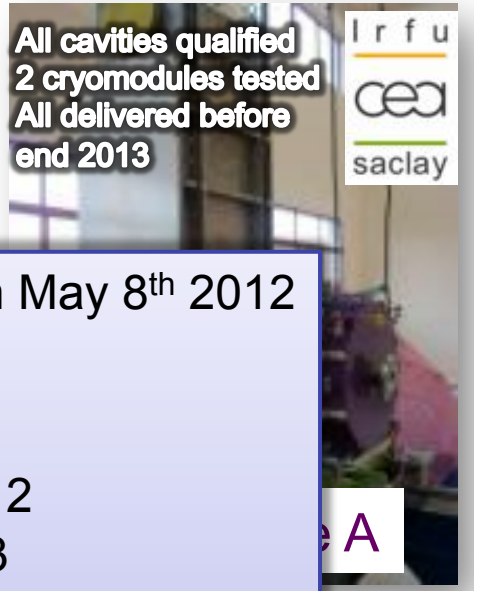




Necessary for most of the NFS experiments

Phase 1

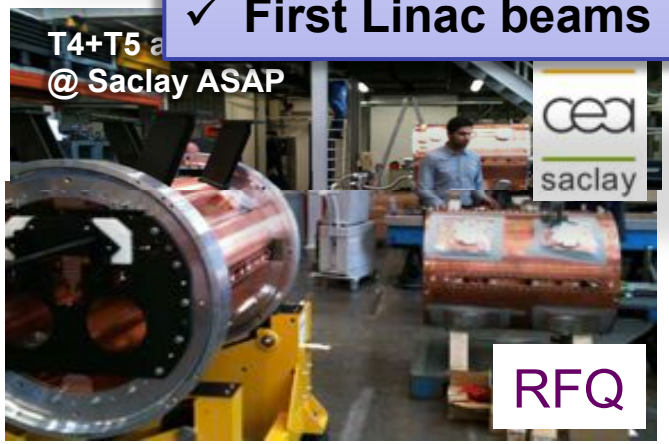




- ✓ Decree of SPIRAL2 Phase 1 signed by Prime Minister on May 8th 2012
- ✓ Operation permit expected by 2014

SPIRAL2 Phase1 schedule :

✓ Installation of the first equipment	➔October 2012
✓ Start of the RFQ installation	➔ March 2013
✓ Start of the Cryomodule installation	➔ July 2013
✓ LINAC cool down	➔ May 2014
✓ RFQ/BTI first beams	➔ April 2014
✓ **First Linac beams**	➔ **September 2014**

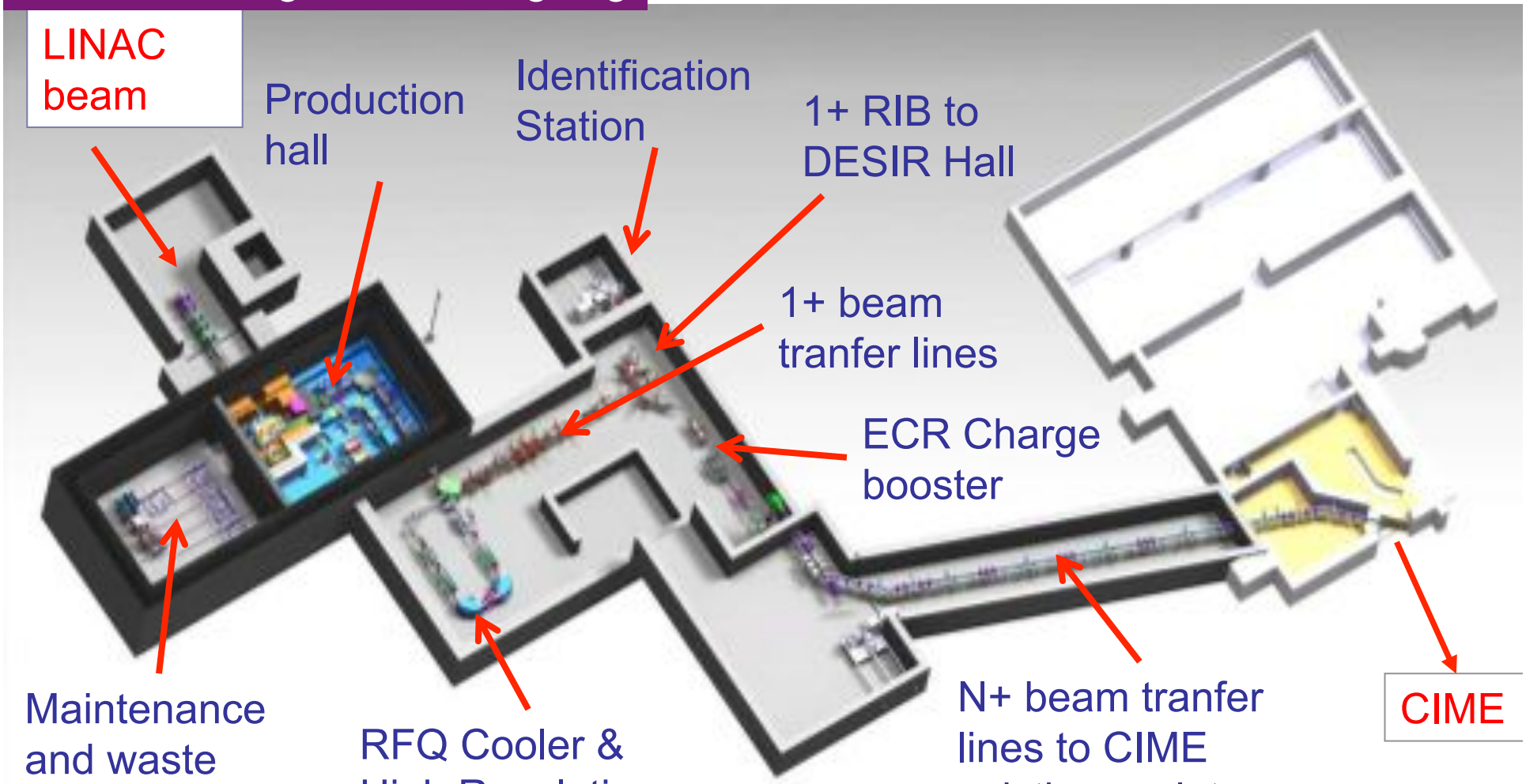


RIB Production & transport

Phase 2

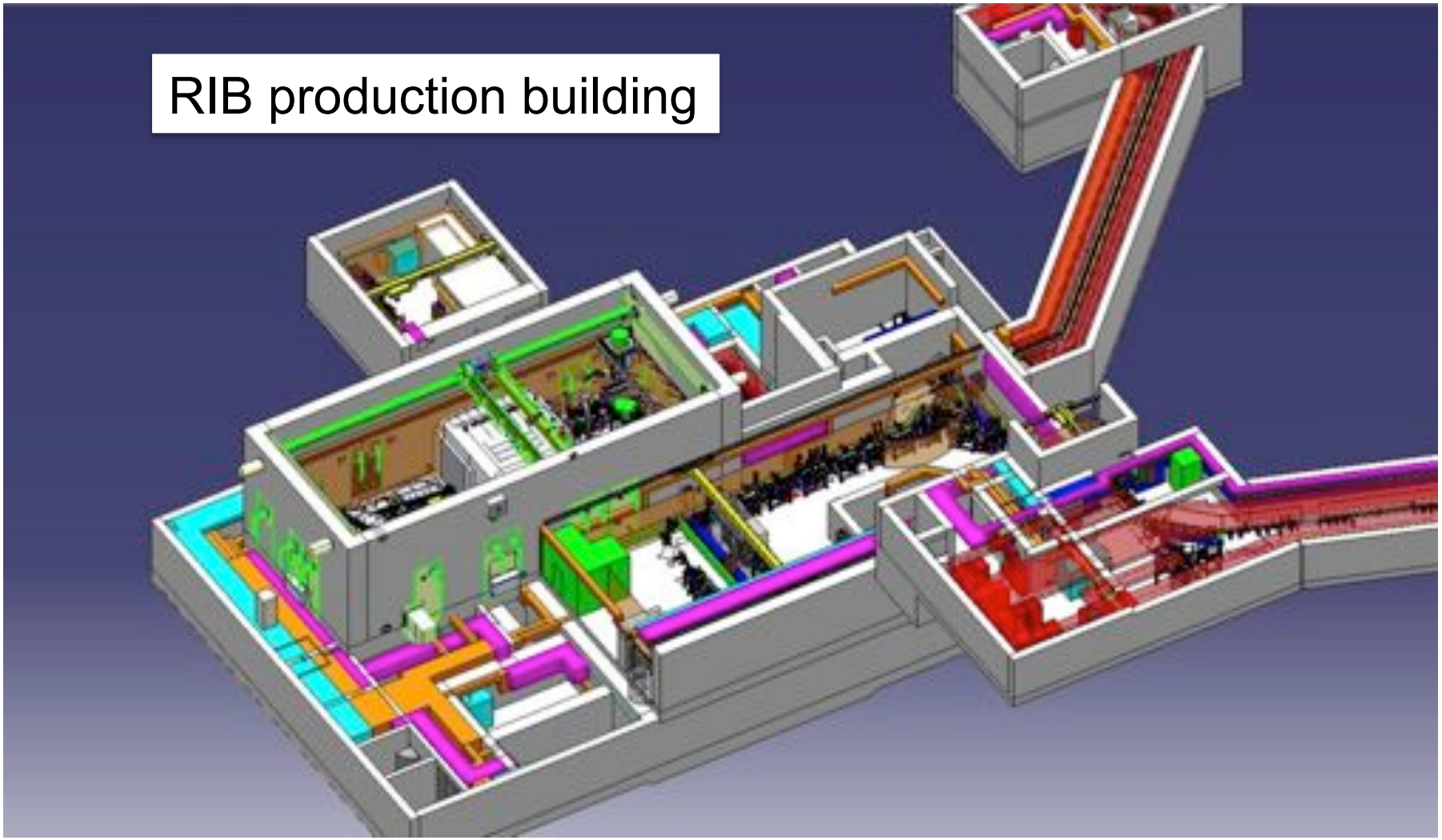
GANIL spiral2 laboratoire commun CEA/DSM CNRS/IN2P3

Intensive design work is ongoing



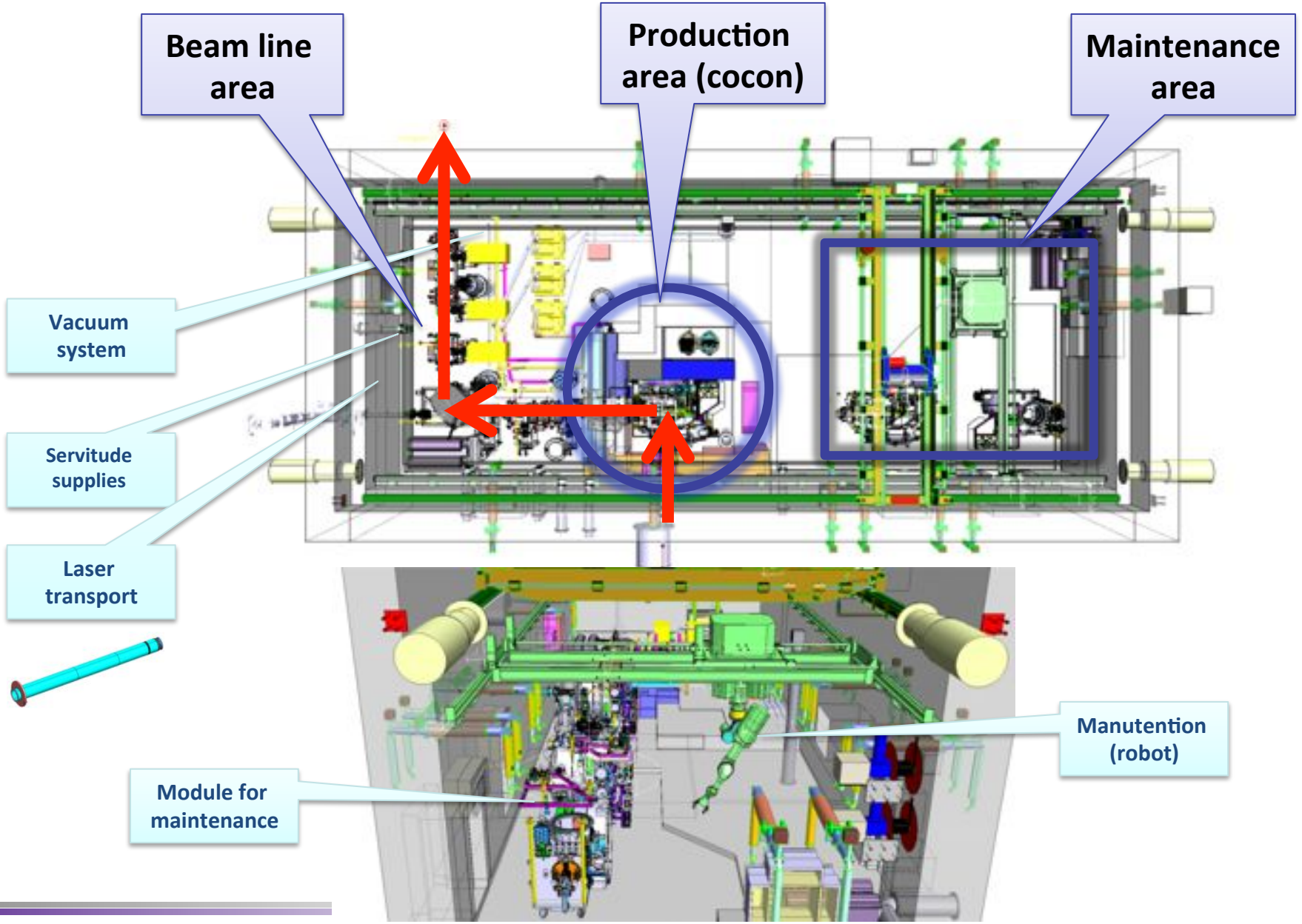
End detailed design study: Mid 2013

Integration of the process in the building

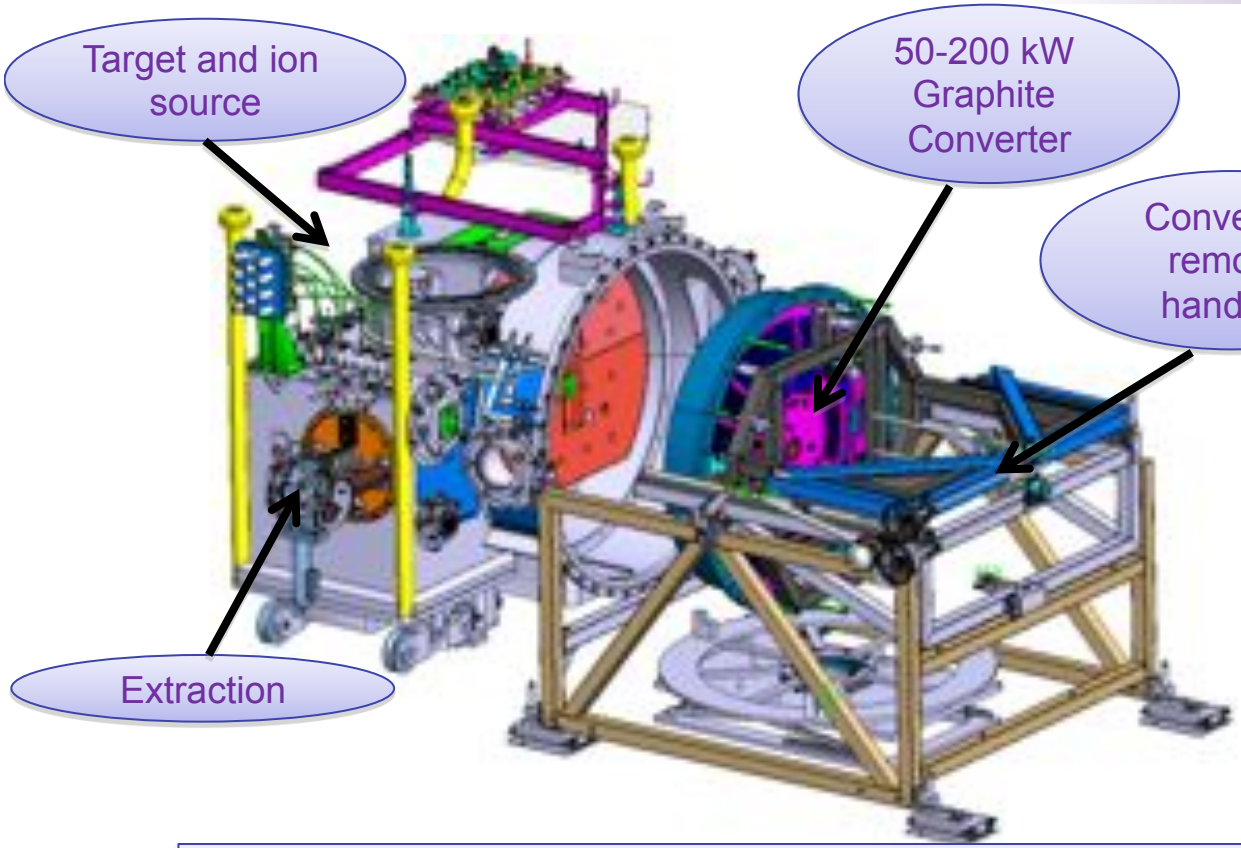


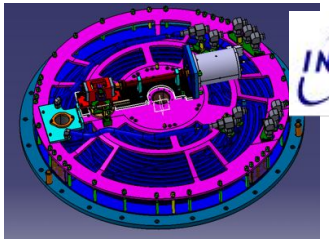
The design of buildings like SPIRAL2 requires the integration of many kinds of information into a synthetic whole.

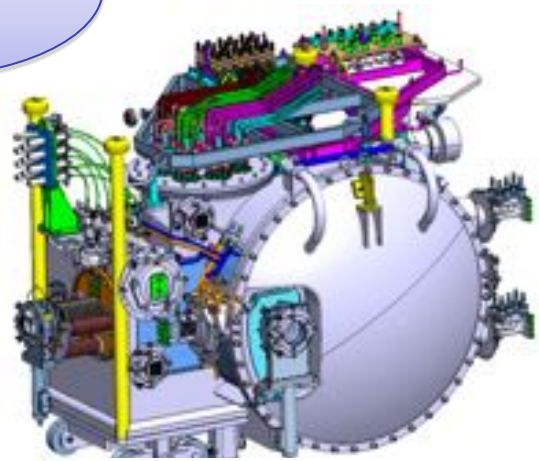
Production Module Cave



RIB Production module







GANIL & ESS Bilbao

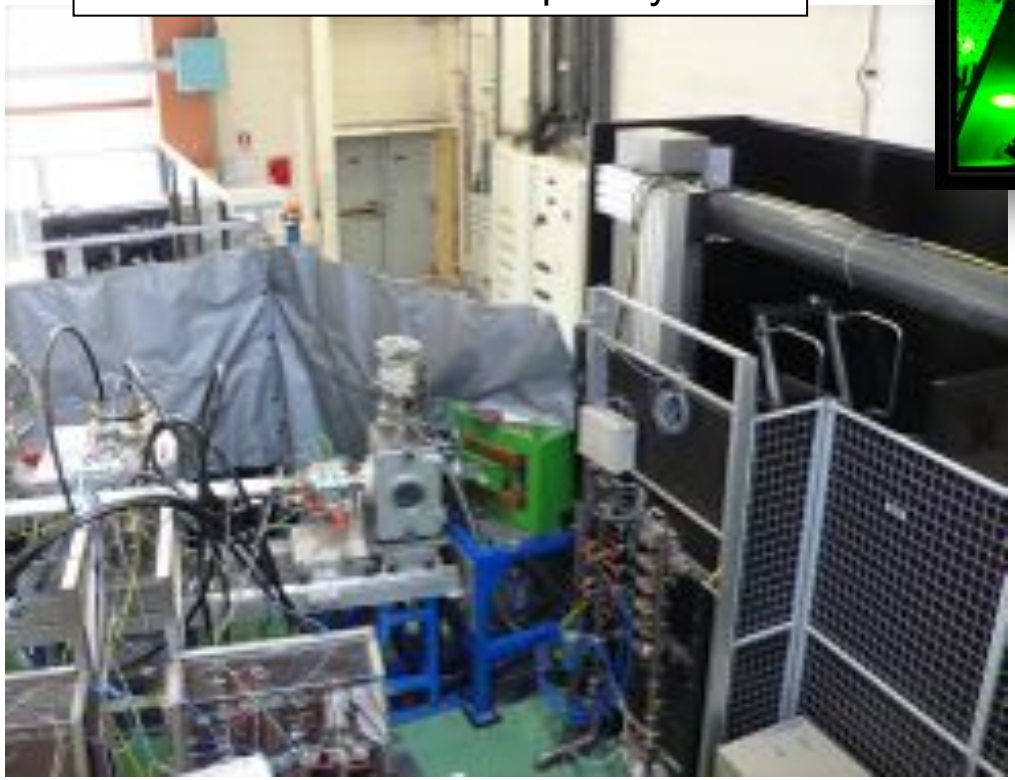
This equipment is very ambitious :

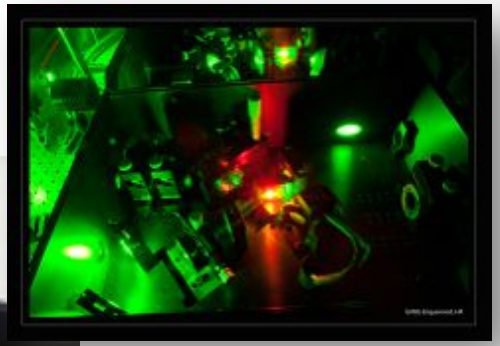
- Dimensions : 3,1x2,2x2 m and 9 T,
- Mounting and dismounting by robot every 3 month,
- HV : 60 KV,
- High neutron and gamma integrate dose (until 10^6 grey in 3 month),
- Positioning in all directions at +/-0,5 mm,
- Vacuum at 10^{-6} mbar,
- Many servitudes (water, HV, HF, 1000A, command control, diagnostics information,…).

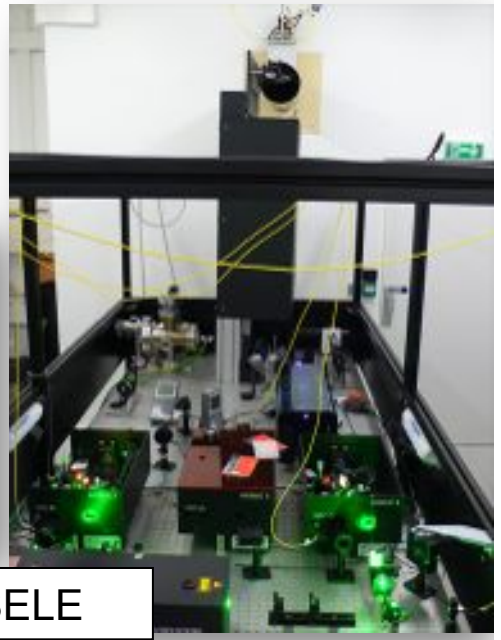
Laser Ion Source GISELE

- **Off line RILIS prototype for SPIRAL2**
- **TiSa laser, 20m transport path and hot cavity: June 2010-July 2011**
- **First Ga beam (July 2011)**
- **First Zn beam (June - November 2012)**
- **Next beams: Sn, Y, In**

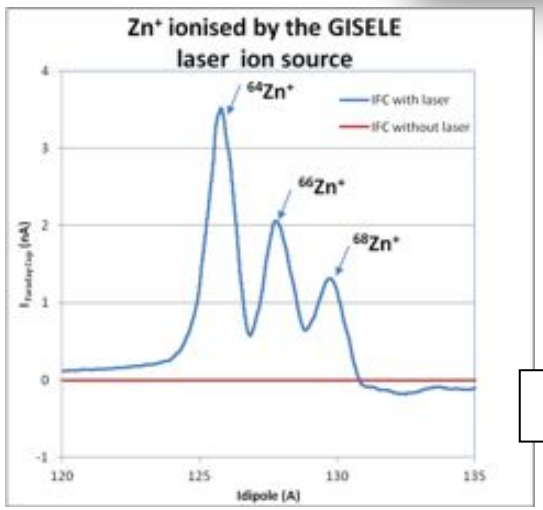
Bench 2 & Laser transport system







Laser system GISELE



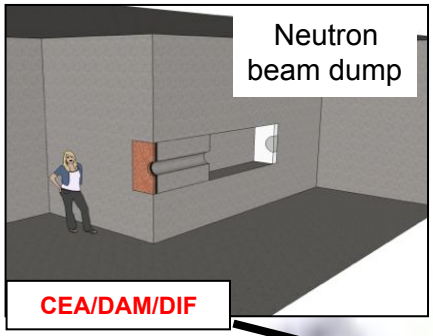
TRIUMF-Mainz collaborations

Zn^+ juin 2012

Lecesne et al, RSI 81 (2008) 02A910

SPIRAL2 New Experimental Facilities

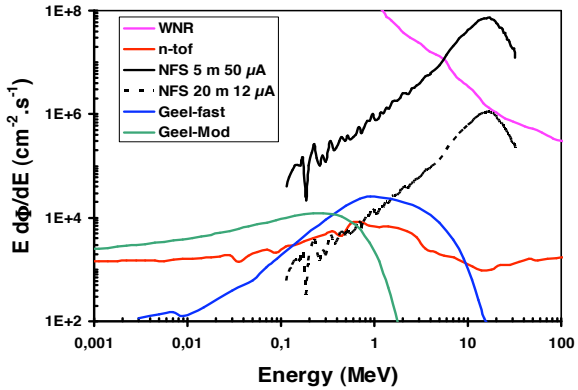
NFS facility



CEA/DAM/DIF

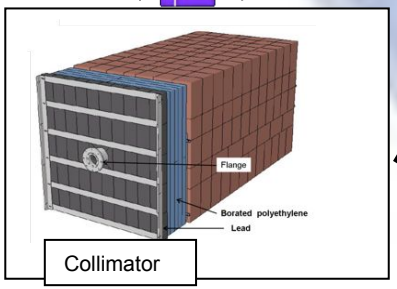
NFS Physics case (11 LoIs)

- 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

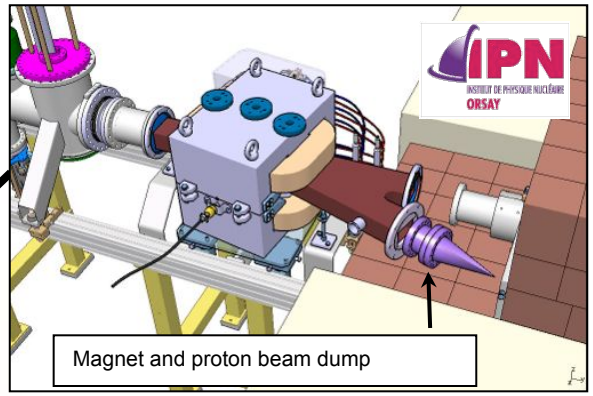


First experiment in 2014

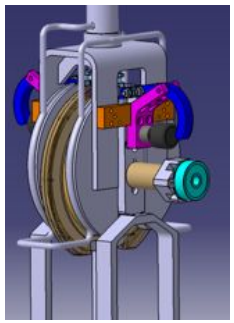
Time-of-flight area



Collimator

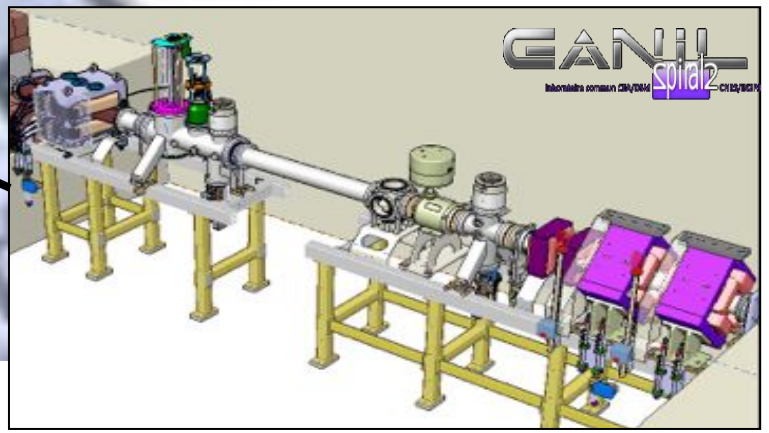


Magnet and proton beam dump



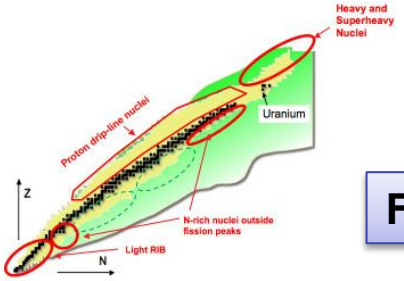
CEA/DSM/Irfu

Be converter for neutron production



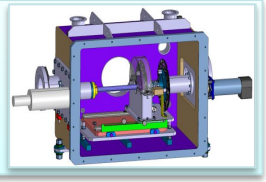
S3 Physics case (16 LoIs)

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

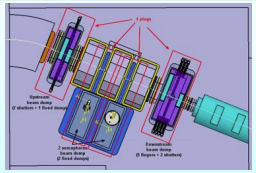


First experiment in 2015

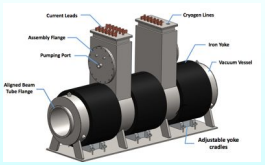
High power Rotating targets including actinides

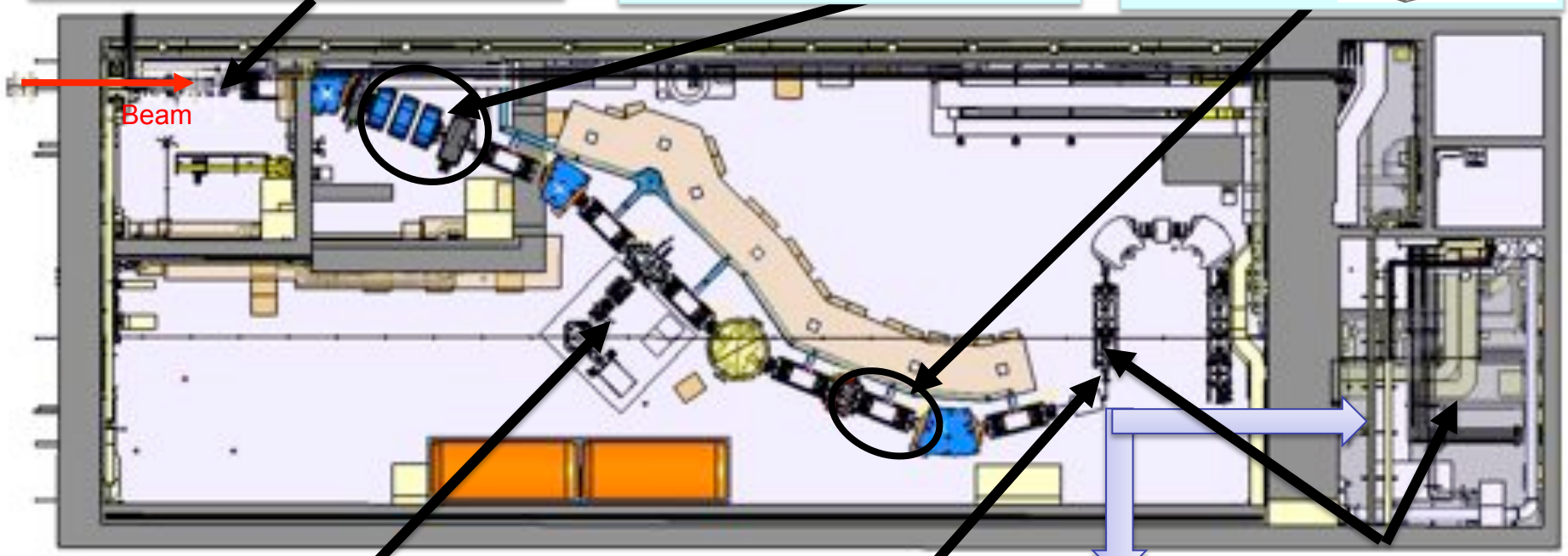


Beam dump & Movable fingers

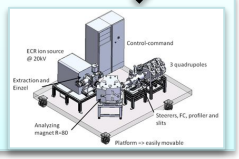


Large acceptance Multipoles

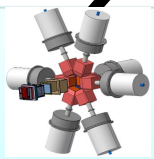




FISIC setup Fast Ion Slow Ion Collisions

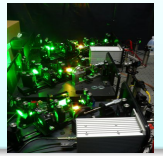


Implantation-decay station at the mass dispersive plan



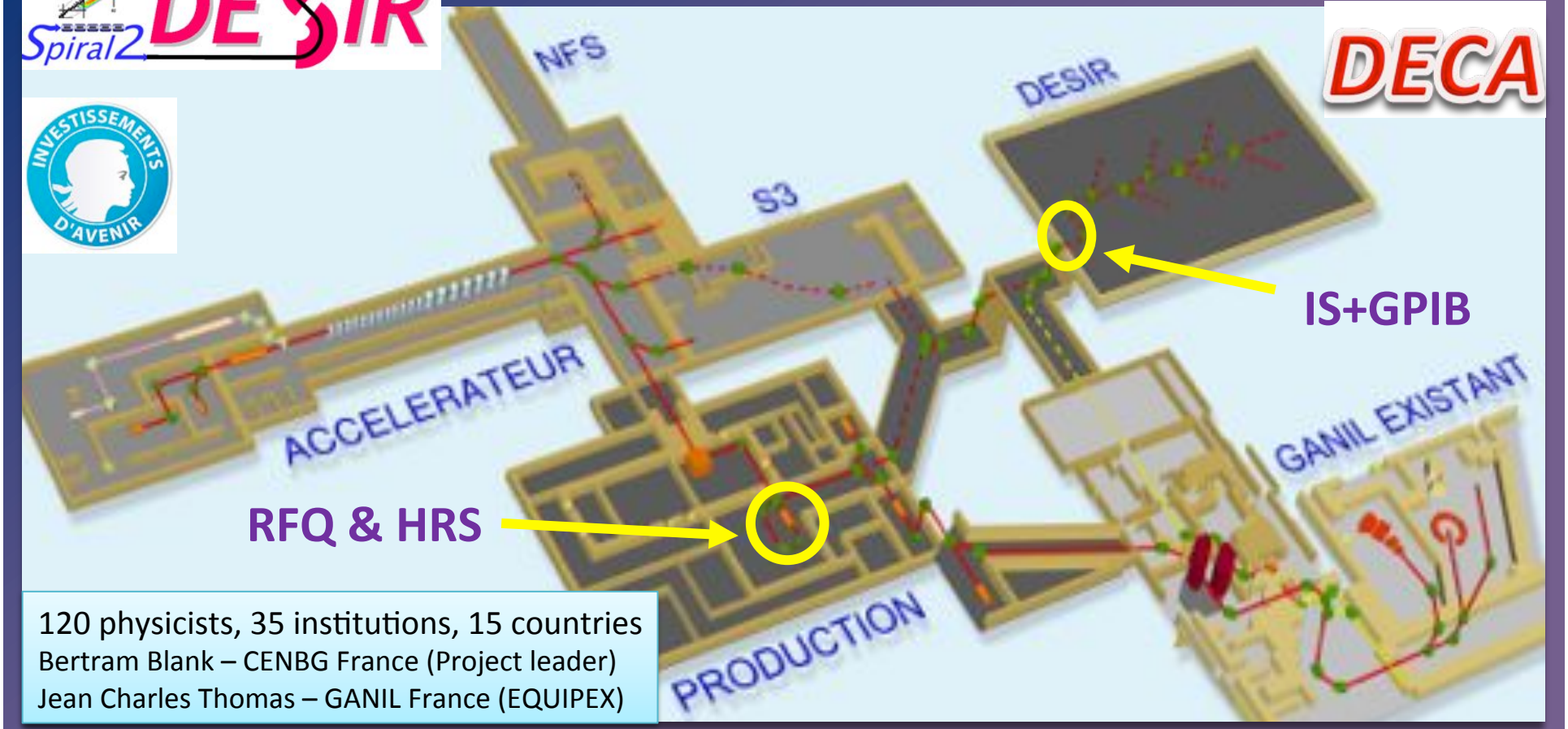
DESIR

Low Energy Branch



The DESIR facility at SPIRAL2

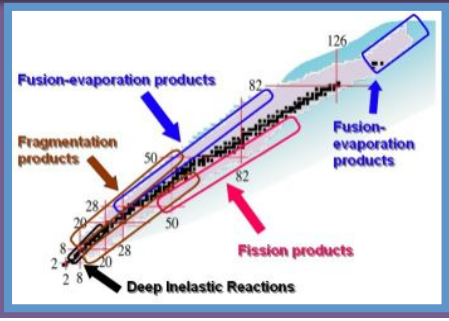
http://www.cenbg.in2p3.fr/desir



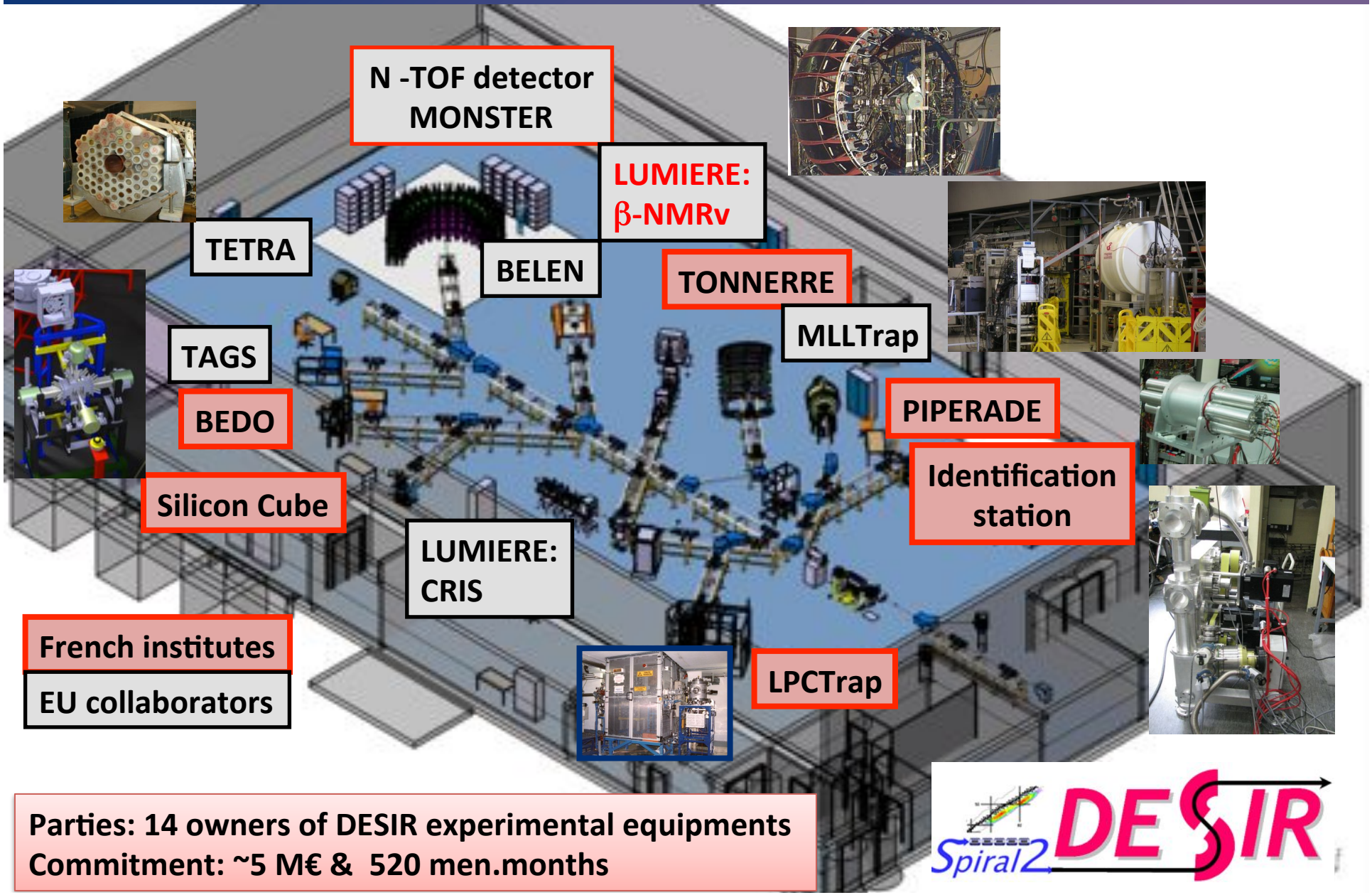
120 physicists, 35 institutions, 15 countries
Bertram Blank – CENBG France (Project leader)
Jean Charles Thomas – GANIL France (EQUIPEX)

High quality 1+ RIB of 10 to 60 kV from:

- **SPIRAL1** (light n-deficient nuclei from beam/target fragmentation)
- **SPIRAL2** (n-rich fission fragments, transfer and fusion-evaporation products)
- **S3** (fusion-evaporation products, refractory elements)



DESIR experimental equipment within the DECA



Parties: 14 owners of DESIR experimental equipments
Commitment: ~5 M€ & 520 men.months

Spiral2 DESIR

High synergies with EURISOL

SPIRAL2 SC LINAC driver :

- EURISOL post-accelerator
- Fast chopper
- Beam diagnostics

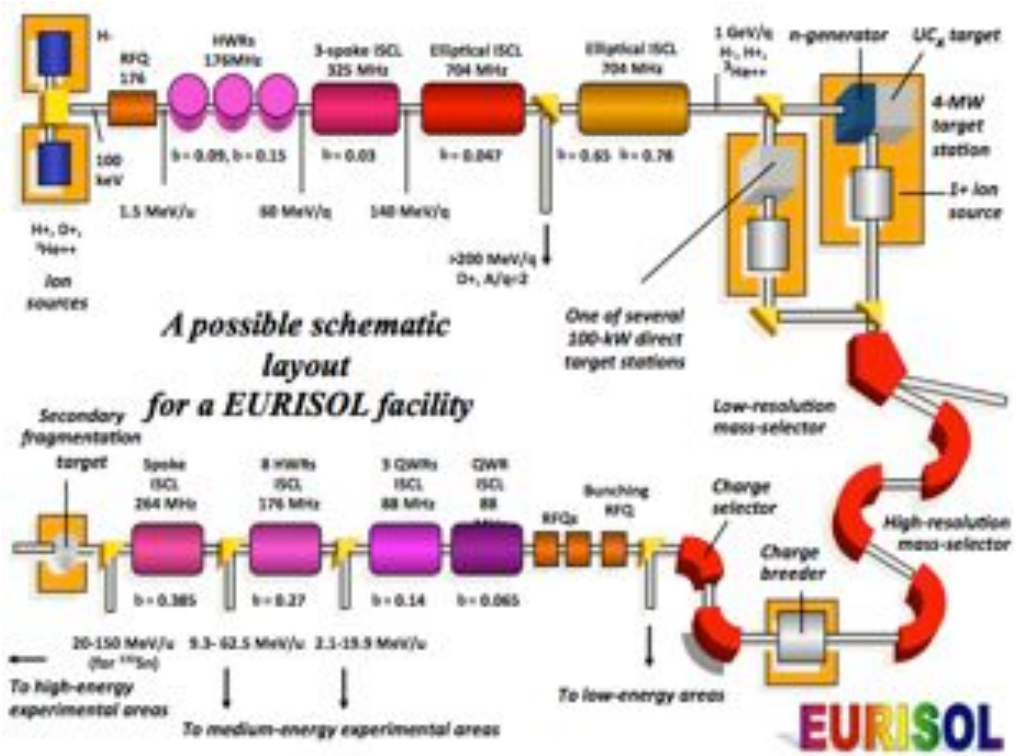
Ions source technologies

- Laser Ion Source
- ECR charge breeder

Production module

- Target, converteur, oven, IS
- Nuclear environement

Safety and Security files



Building and process integration

Experimental devices (DESIR,S3,NFS, VAMOS, EXOGAM, AGATA, LISE …)

Conclusions

- SPIRAL2 Phase 1 (LINAC, S3, NFS) under construction; civil construction to be finished by 2013
- First SPIRAL2 Phase 1 beam by Sept 2014
- NFS & S3 (8 M€ from EQUIPEX) fully funded and under construction
- SPIRAL 2 Phase 2 (RIB, DESIR) detailed design study Detailed Design finished by 2013, Civil construction from 2015
- DESIR: building and partially beam lines funded (9 M€ from EQUIPEX)
- CRISP: New EU project on implementation phase of the ESFRI facilities accepted = additional 1 M€ for the construction of SPIRAL2
- SPIRAL2 is candidate to host EURISOL
- New SPIRAL beams (2014-2015)
- **GANIL/SPIRAL will continue to run (6-8 months/year)**

GANIL/SPIRAL 2 facility: status & outlook

Phase 1
Commissioning/
experiments
in 2014

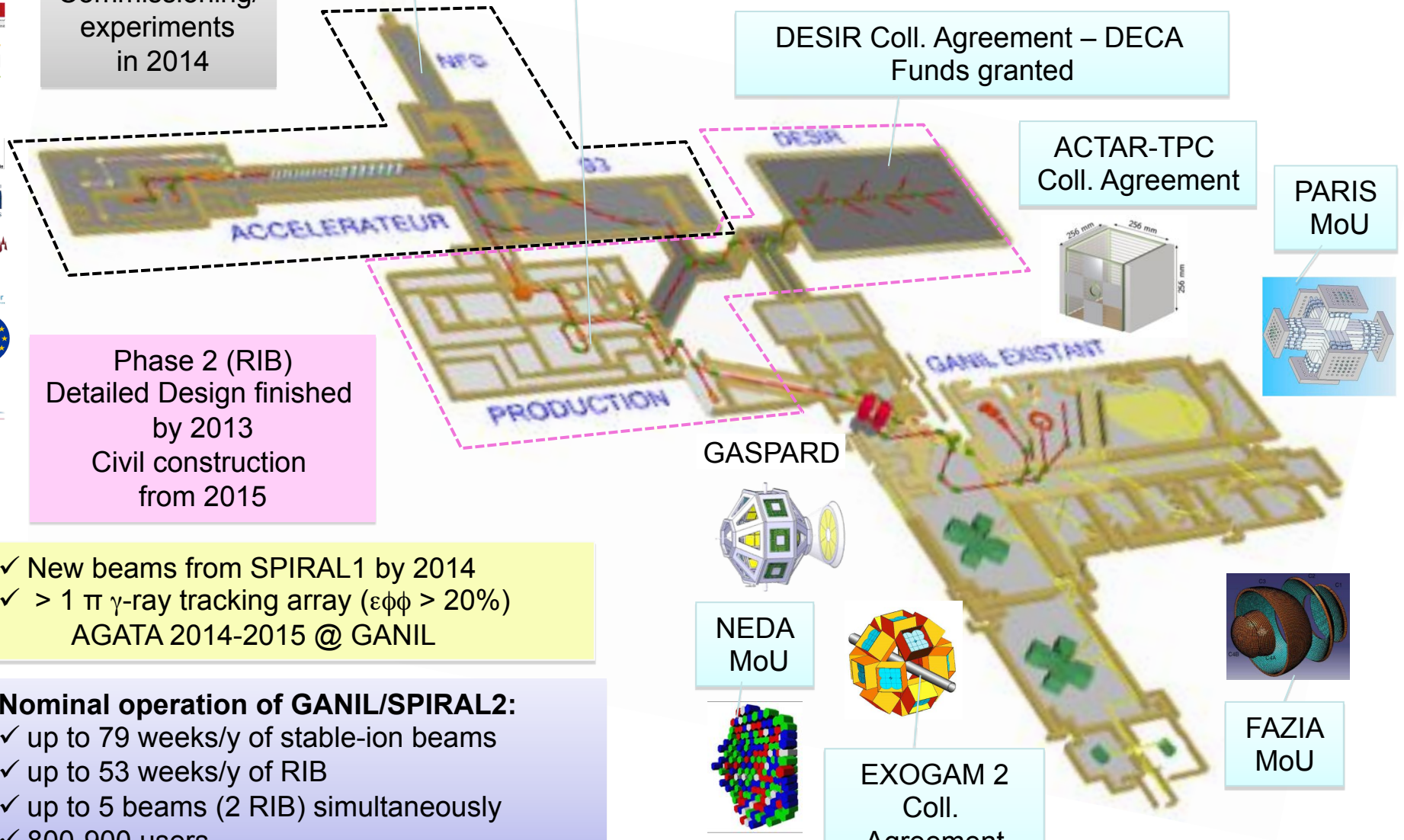
NFS MoU

S3 EQUIPEX ANR CONVENTION –
Funds granted

DESIR Coll. Agreement – DECA
Funds granted

ACTAR-TPC
Coll. Agreement

PARIS
MoU



Phase 2 (RIB)
Detailed Design finished
by 2013
Civil construction
from 2015

GASPARD

NEDA
MoU

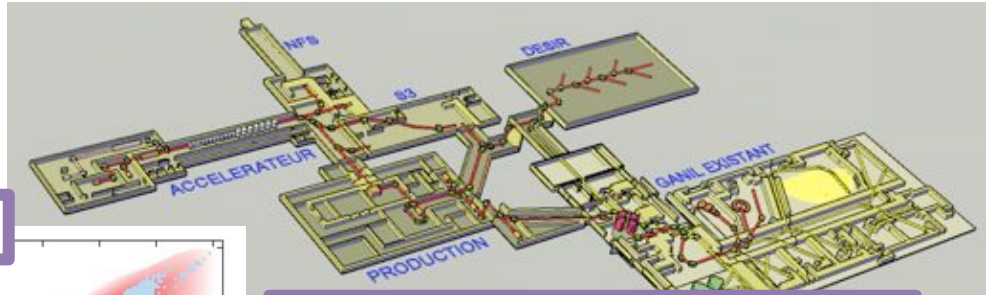
EXOGAM 2
Coll.
Agreement

FAZIA
MoU

✓ New beams from SPIRAL1 by 2014
✓ > 1 π γ-ray tracking array (εϕϕ > 20%)
AGATA 2014-2015 @ GANIL

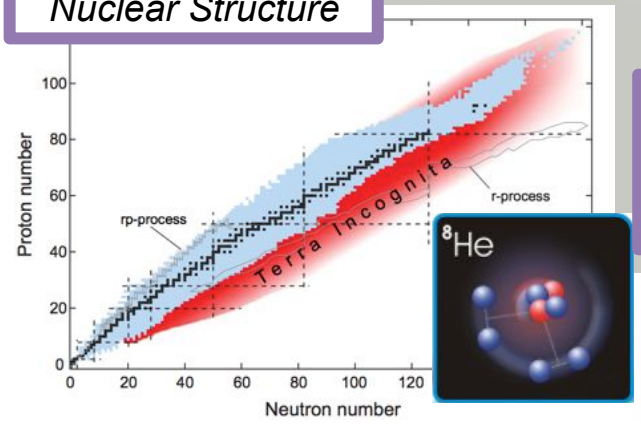
Nominal operation of GANIL/SPIRAL2:
✓ up to 79 weeks/y of stable-ion beams
✓ up to 53 weeks/y of RIB
✓ up to 5 beams (2 RIB) simultaneously
✓ 800-900 users

Nuclear Science and Applications



Radioactive ion beams
High intense stable ion beams
Neutrons for Science

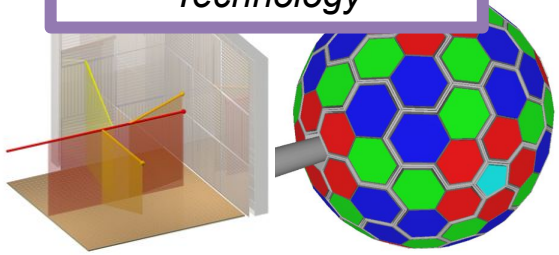
Nuclear Structure

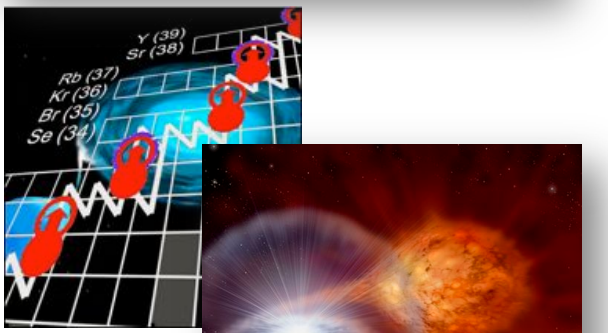


Fundamental Interactions

GANIL spiral2
laboratoire commun CEA/DSM CNRS/IN2P3

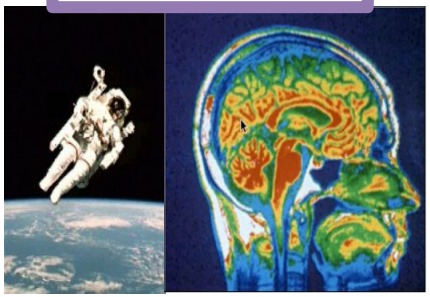
Accelerator Science & Technology





Nuclear Astrophysics

Applications



EURISOL @ GANIL