Progress of SPIRAL2 project

IPAC 2011

San Sebastian, 5-9 September 2011

Eric Petit

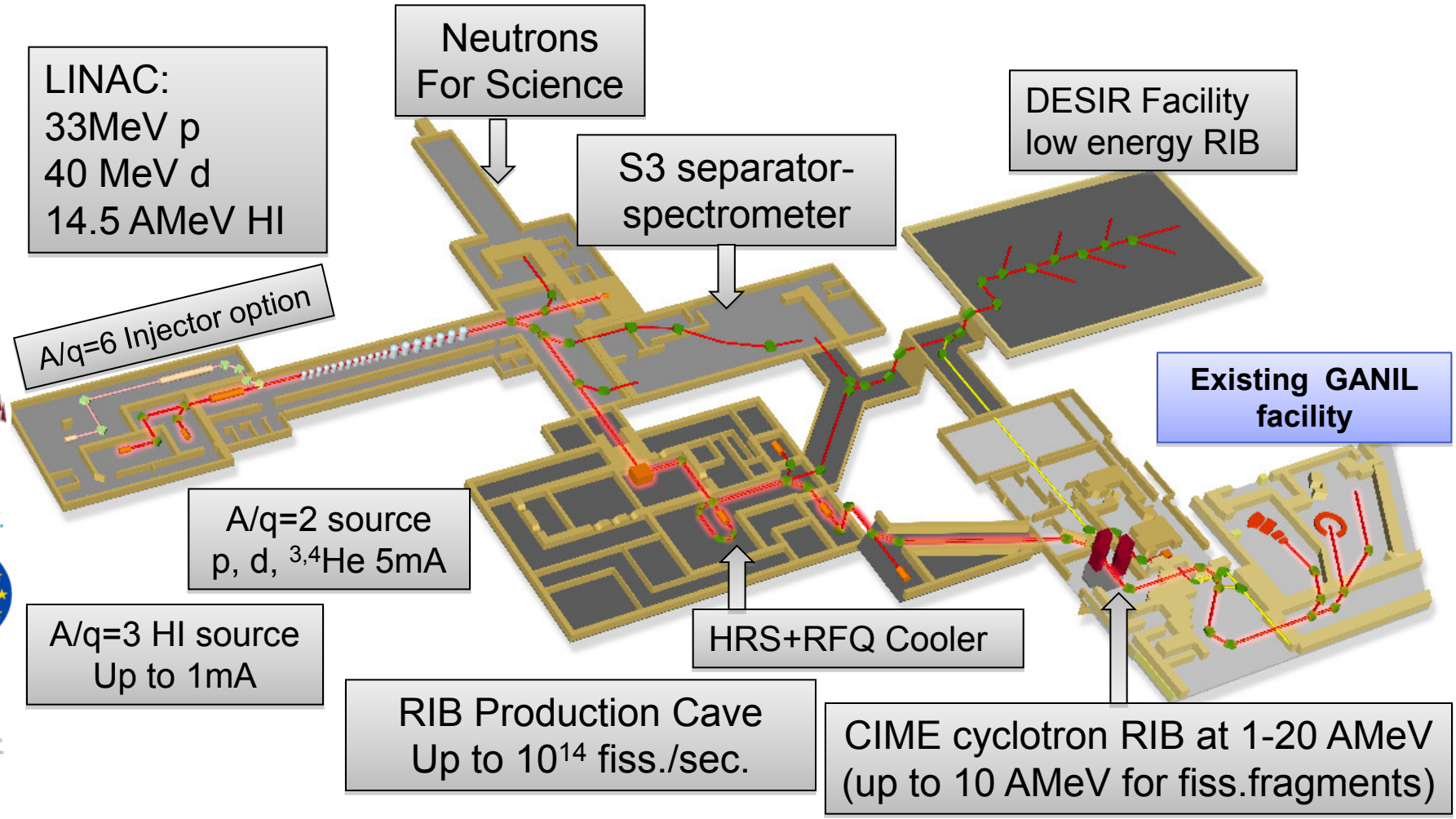
Progress of SPIRAL2 project:

- ✓ description of SPIRAL2 facility
- ✓ organization
- ✓ progress of the first phase of SPIRAL2
- ✓ progress of the second phase of SPIRAL2
- ✓ conclusions

Eric Petit

The SPIRAL2 facility

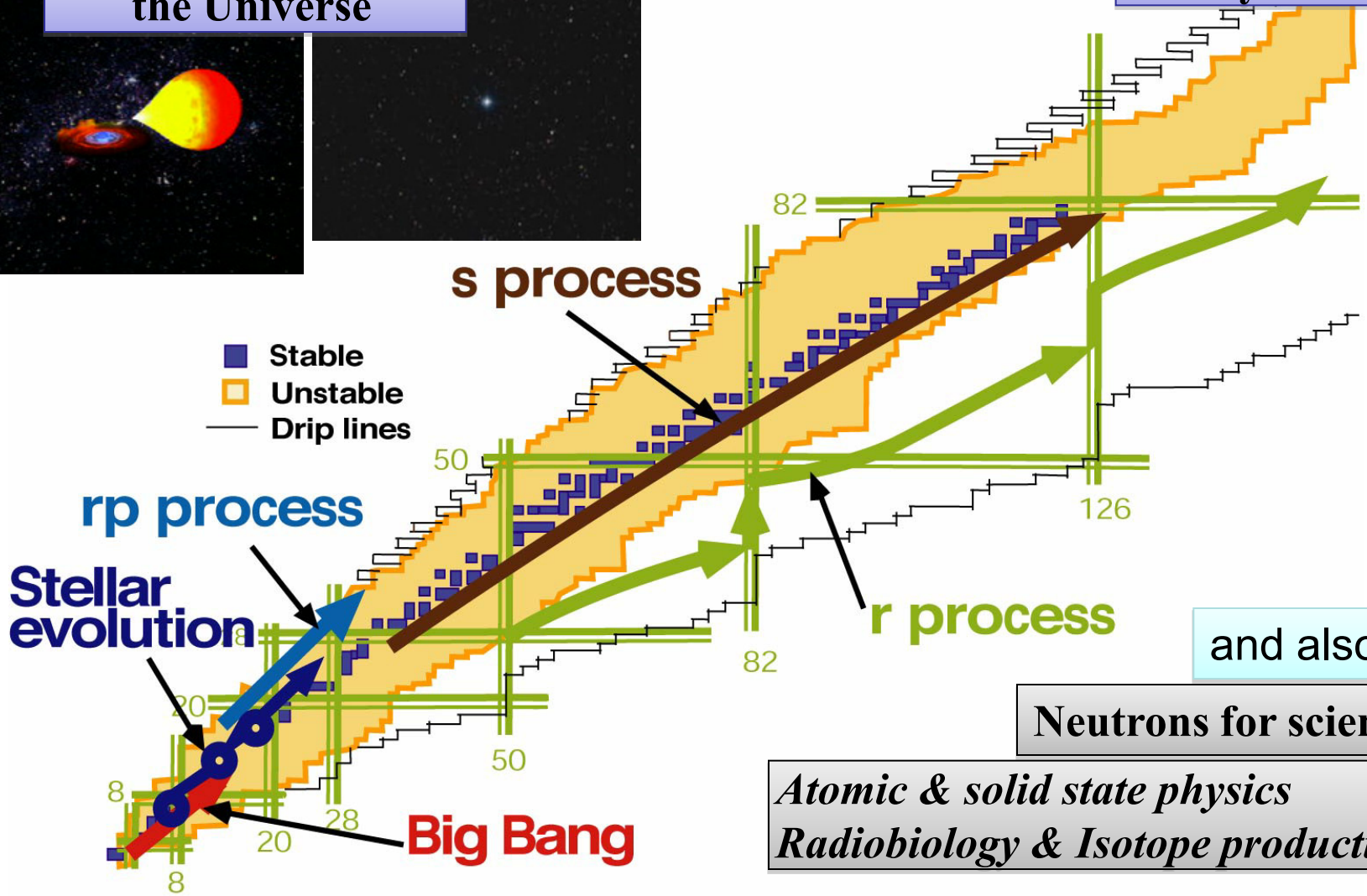
SPIRAL2 is one of the ESFRI list projects (45 most important EU research infrastructure projects)



Scientific case of GANIL/SPIRAL 2

Nucleosynthesis in the Universe

Heavy and Super Heavy Elements

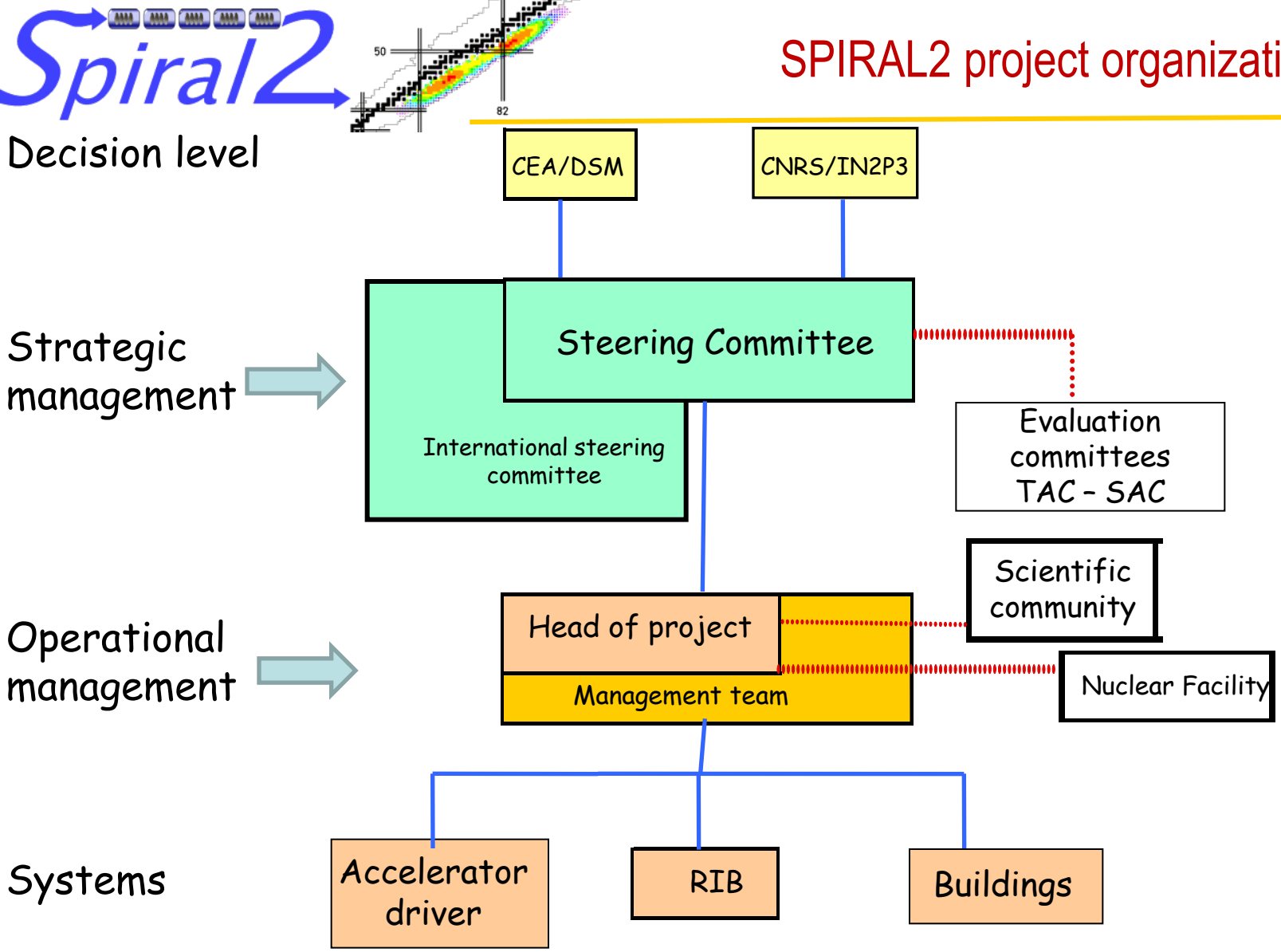


and also…

Neutrons for science

Atomic & solid state physics
Radiobiology & Isotope production

SPIRAL2 project organization



partner laboratories for SPIRAL2 construction

R§D and Construction

CEN Bordeaux-Gradignan (**CENBG**)

Centre de Spectro. Nucléaire et Spectro. de Masse Orsay (**CSNSM**)

Institut de Physique Nucléaire Orsay (**IPNO**)

Institut de Physique Nucléaire Lyon (**IPNL**)

Institut Pluridisciplinaire Hubert Curien Strasbourg (**IPHC**)

Laboratoire Accélérateur Linéaire Orsay (LAL) (**LPC**)

Laboratoire de Physique Nucléaire et de Htes Energies Paris (**LPNHE**)

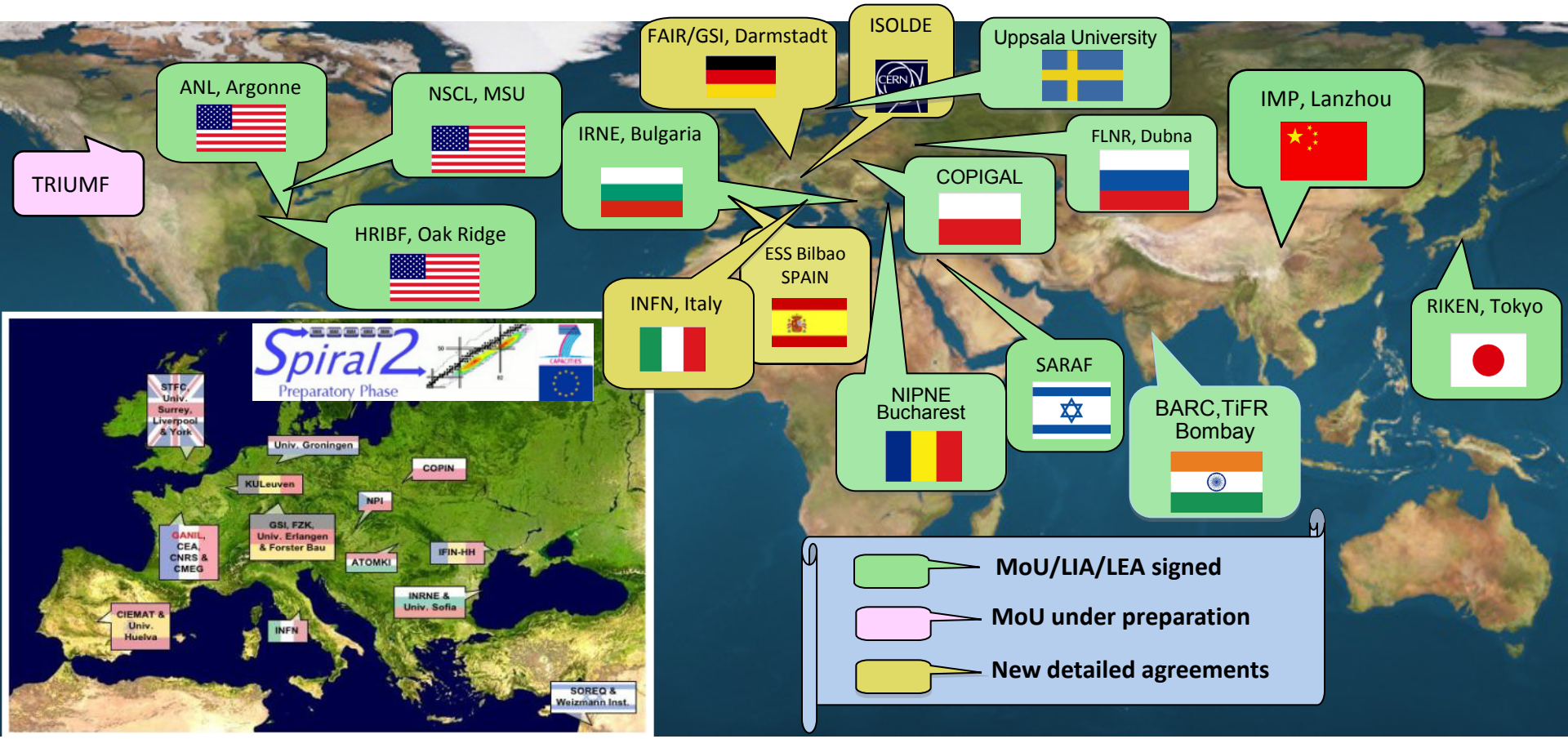
Laboratoire de Physique Subatom. et de Cosmol. Grenoble (**LPSC**)

	R§D	Construction
DSM	**IRFU/SPhN**	**IRFU/SACM**
DSM		**IRFU/SIS**
DSM		**IRFU/SENAC**
DSM – Saclay		Expertise
DAM	DPTA	**DASE et DP2I**
DEN		Expertise
DPSN		Expertise

Grand Accélérateur National d'Ions Lourds
GANIL
Laboratoire commun CEA / DSM - CNRS / IN²P³

International collaborations

International Collaborations

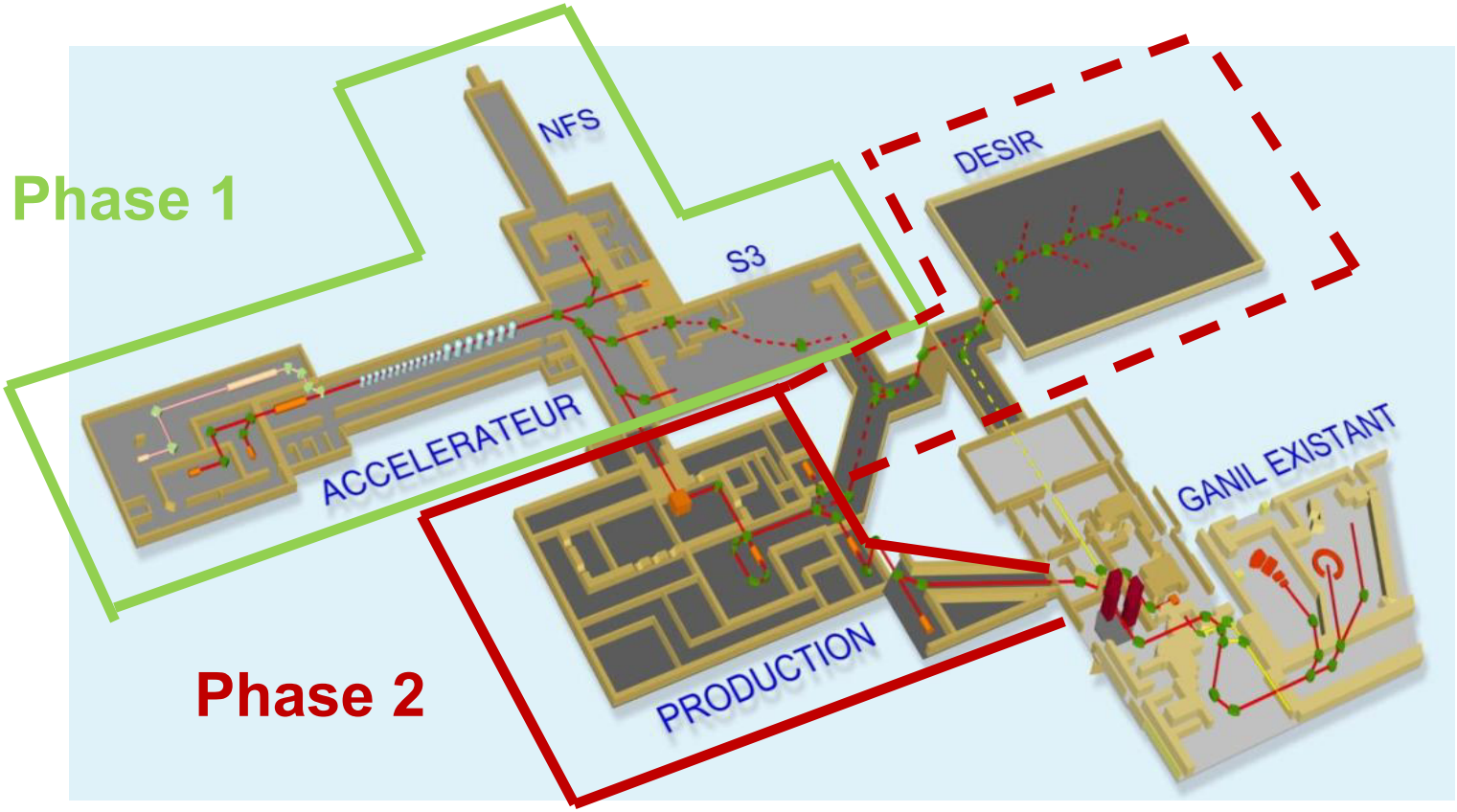


16 signed (LEA*, LIA**, MoU***) agreements
MoU with Bilbao (RIB production module,…) signed in March
2 agreements under preparation:
- MoU with GSI/FAIR (baseline project)
- LIA/MoU with TRIUMF (laser sources)

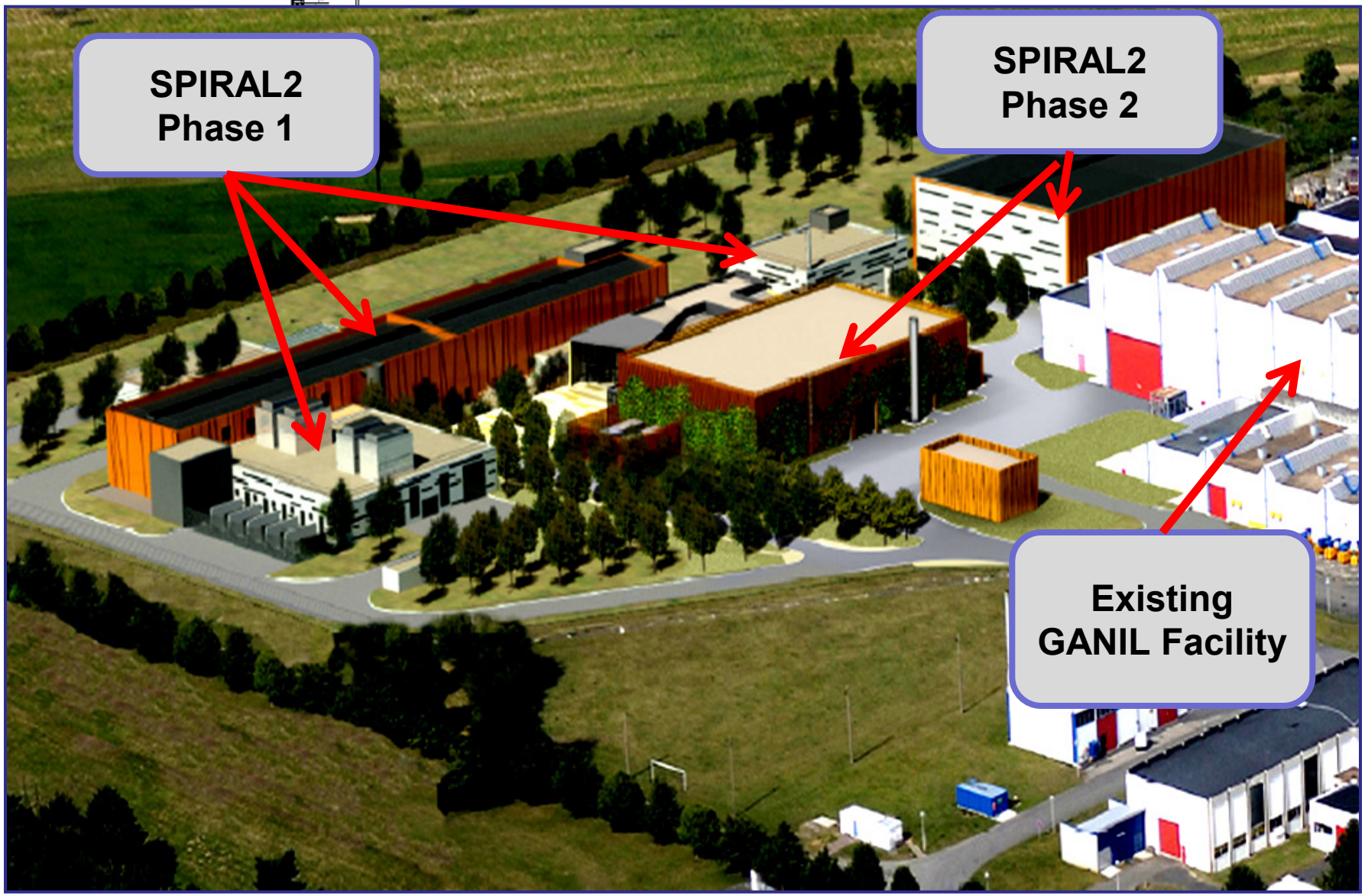
15-19/11/10 LEA Workshop with SPES
13/12/10 MoU with Sweden
5-8/01/11 LIA Symposium RIKEN
14-15/03/11 Workshop with FLNR Dubna
31/03/11 Workshop with ESS Bilbao

Construction of SPIRAL2 in 2 phases

End of 2007: 2 phases construction strategy with its licensing procedure and associated schedule presented to the National Safety Authority (ASN)
Beginning of 2008: strategy validated by ASN => one public enquiry, one DAM report and one decree for the two phases.



Construction of SPIRAL2 in 2 phases



Planning for SPIRAL2 Phase 1

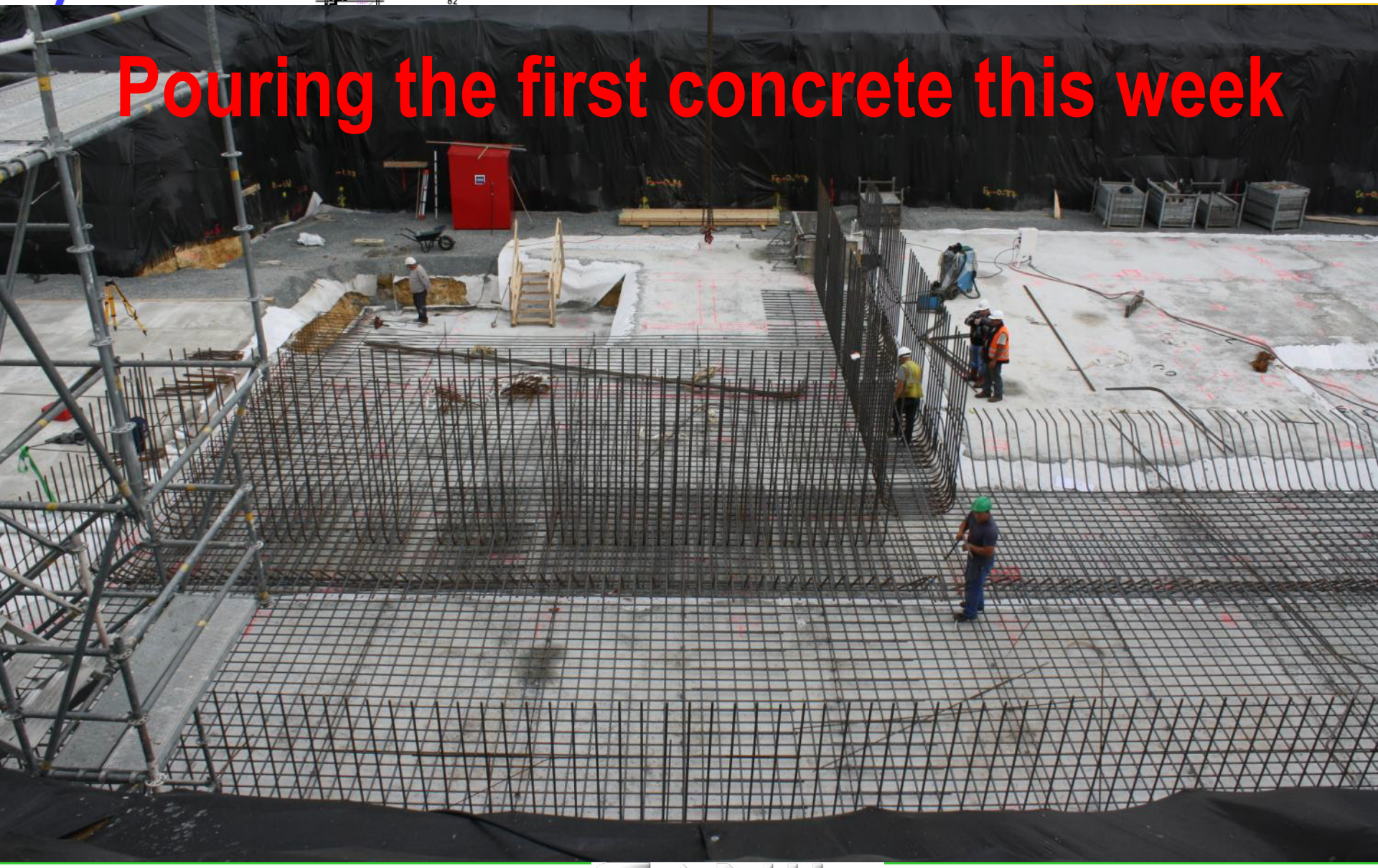
	2006	2007	2008	2009	2010	2011	2012	2013	2014
	T1 T2 T3 T4	T1 T2 T3 T4	T1 T2 T3 T4	T1 T2 T3 T4	T1 T2 T3 T4	T1 T2 T3 T4	T1 T2 T3 T4	T1 T2 T3 T4	T1 T2 T3 T4
Accelerator and associated experimental area buildings									
Definition of buildings specifications									
Competition and MOe choice			June 2008						
Preliminary design of buildings (APS +)									
DAM transmission				April 2009					
Submission of buildings permit				July 2009					
Detailed design of buildings (APD)									
Public enquiry and Instruction by IRSN									
Permit of construction obtained									
Site preparation- Buildings construction									
Receipt of first underground caves									
Receipt of first surface caves									
Equipments installation									
First beam tests									
Tests and operation									

status of buildings construction

The hole for the buildings

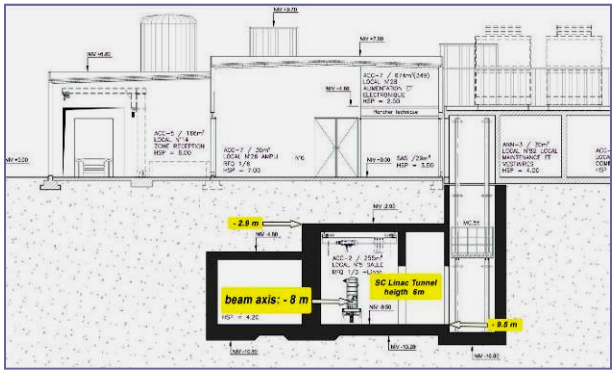
The crane

status of buildings construction

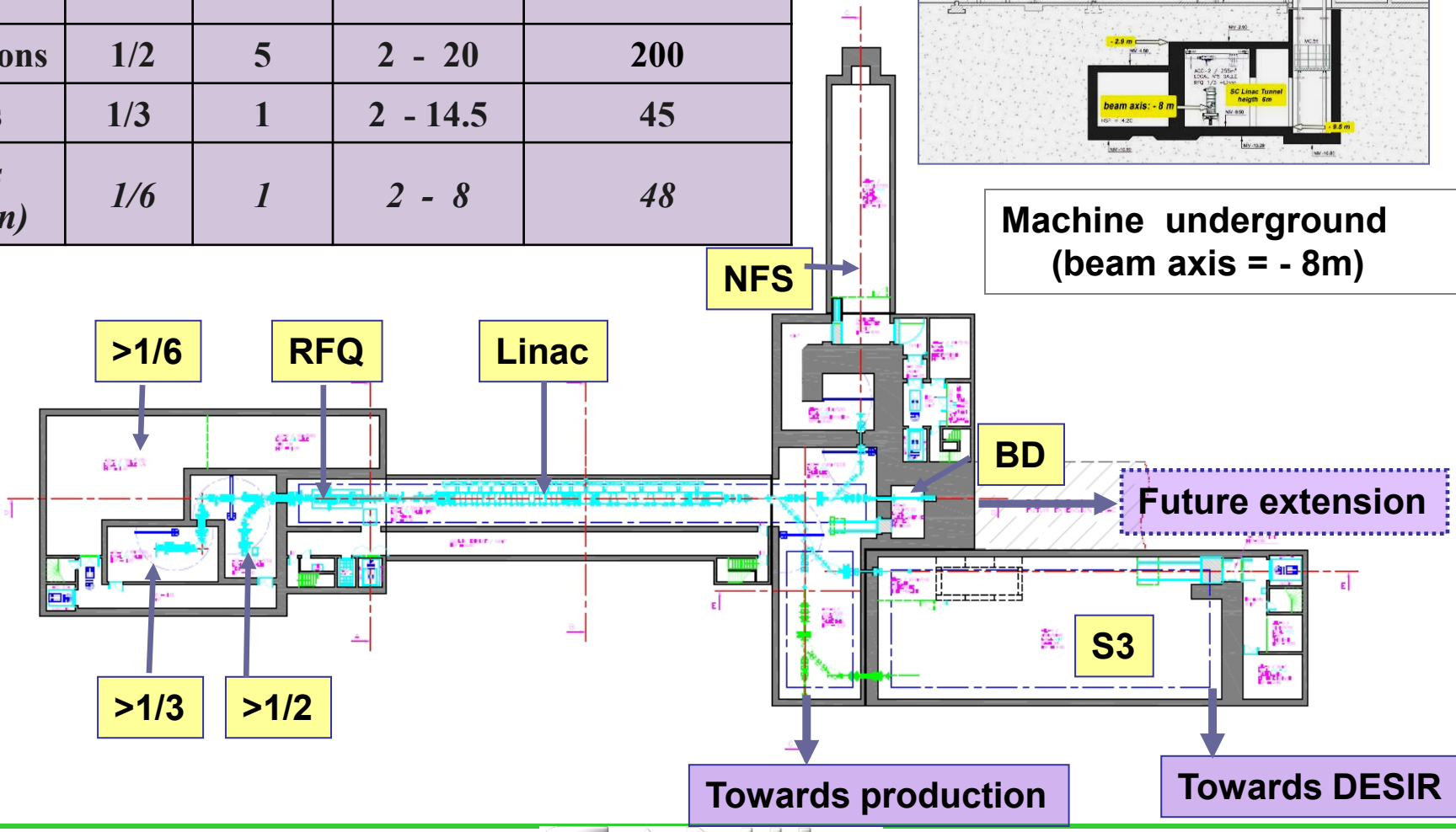


SPIRAL2 Phase 1: Driver Beam Characteristics

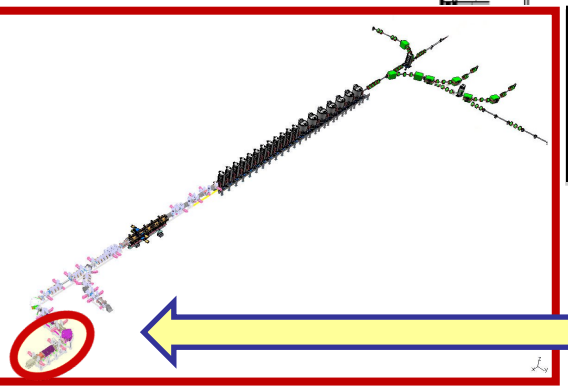
	Q/A	I (mA)	Energy (Mev/u)	CW max beam Power (KW)
Protons	1/1	5	2 - 33	165
Deuterons	1/2	5	2 - 20	200
Ions	1/3	1	2 - 14.5	45
Ions (option)	*1/6*	*1*	*2 - 8*	*48*



Machine underground (beam axis = - 8m)

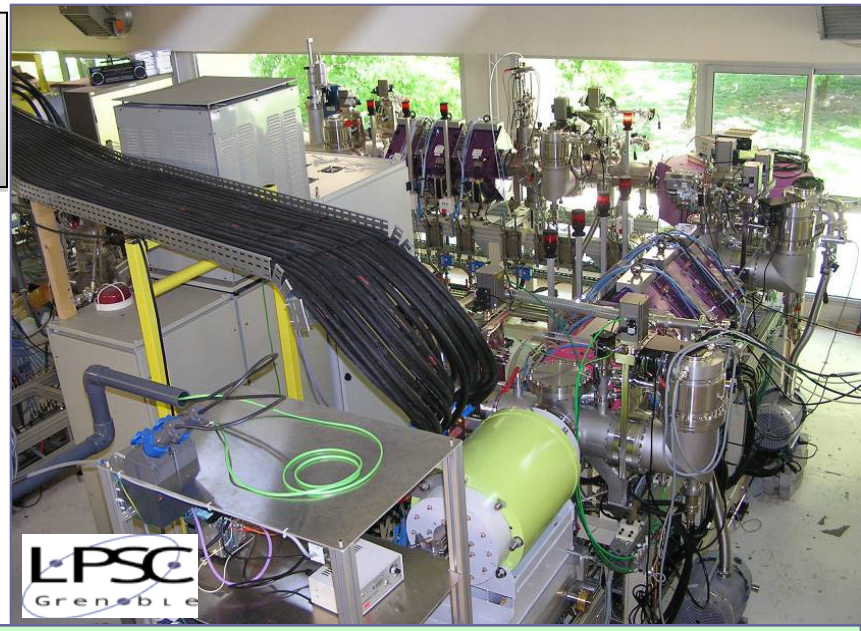


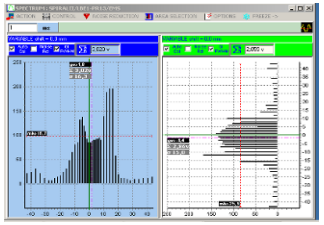
PhoenixV2 + LEBT1

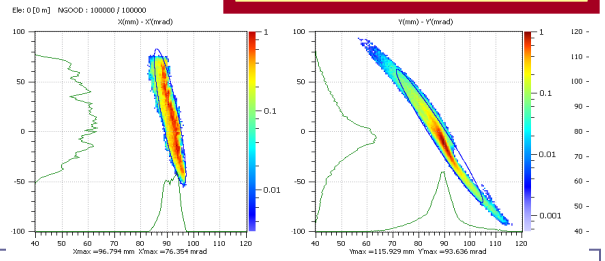


A/q=3 HI source
up to 1mA
with its associated LEBT

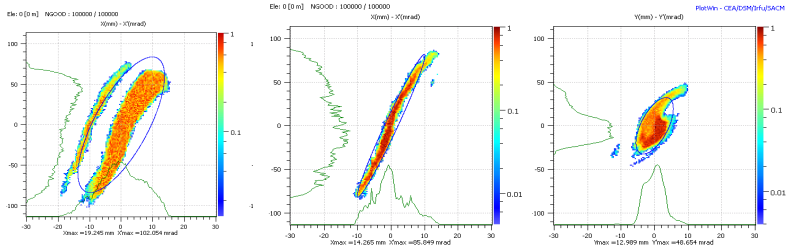
Irfu Saclay
LPSC Grenoble
IPHC Strasbourg
Ganil







Beam profiles and emittance 0,22 pi.mm.mrad (O16 6+, March 2010)

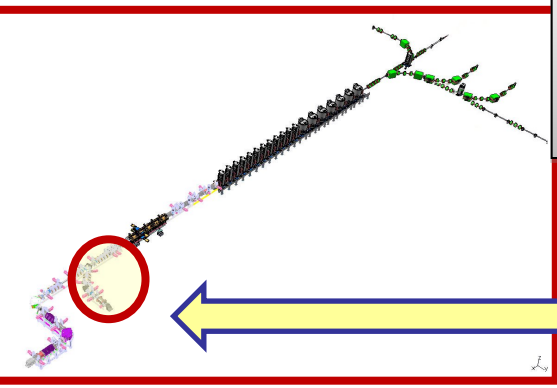


Xe132 25+
O16 3+

Xe132 25+
Separation using slits

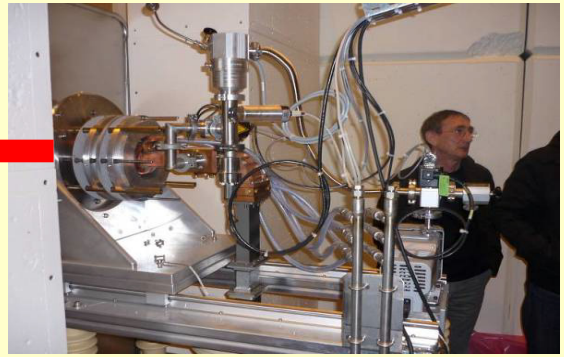
- **Technical & beam tests 2010/2011 :**
  - PLCs, C/C (Epics) , Vacuum…
  - Faraday cups, profilers
  - Emittance-meters, slits
  - ***Metallic beams developments:25 µA Ca40 13+ obtained (600 Watt HF power, 35 kV)***
- **Last beam tests (September 2011) :**
  - ***Oxygen beam obtained at 60 kV***

Deuteron/proton Source + LEBT2 +LEBTC



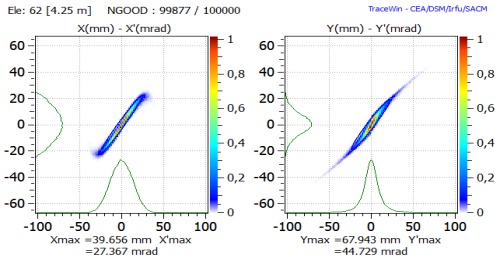
Deuteron and proton source
with its associated LEBT

Irfu Saclay
LPSC Grenoble
IPHC Strasbourg
INFN-LNS
Ganil

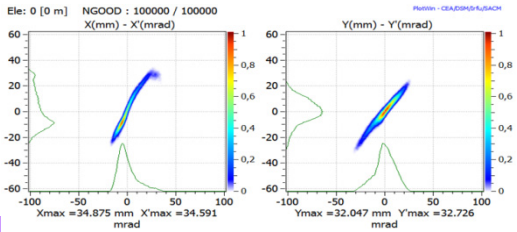


Deuteron 2.45 GHz ECR source tested successfully in March 2010 (Protons)

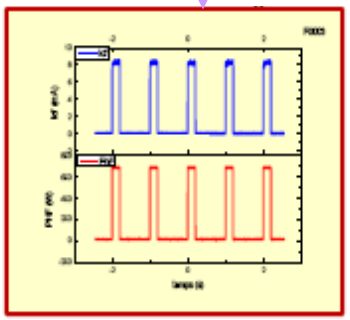
First beam observed after LEBT2 Bending magnet in October 2010



Simulation (Tracewin)

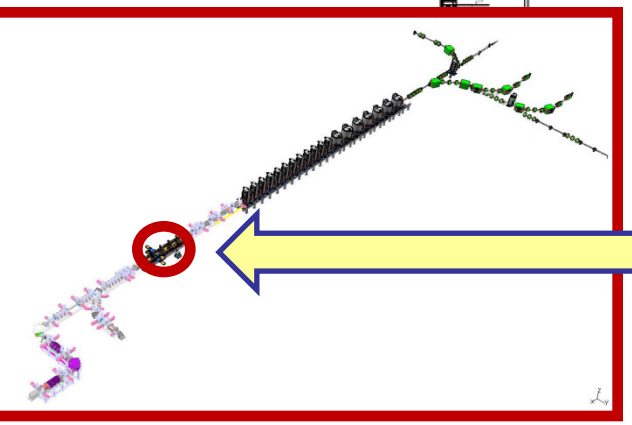


Experiment (Oct 2010)



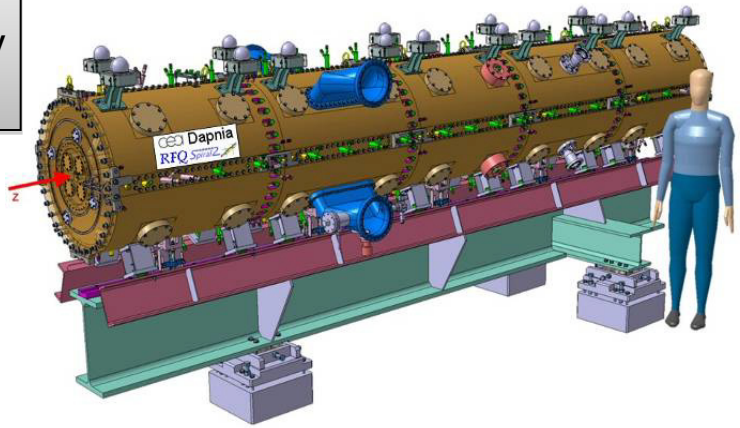
Deuteron beam

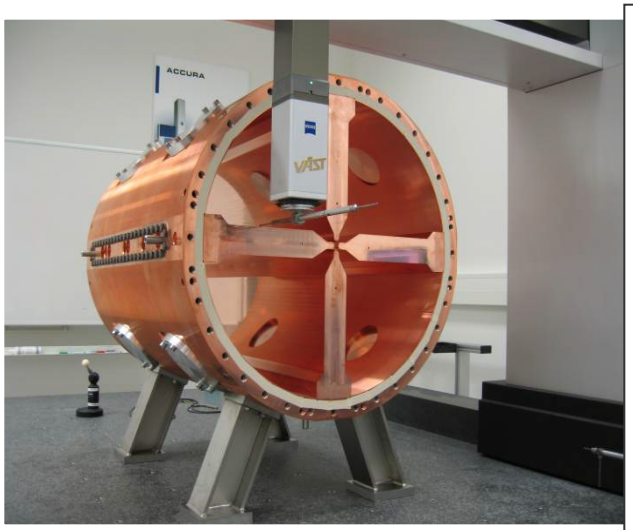
Status of RFQ



4 vanes- 5m long conducting copper cavity

Irfu Saclay





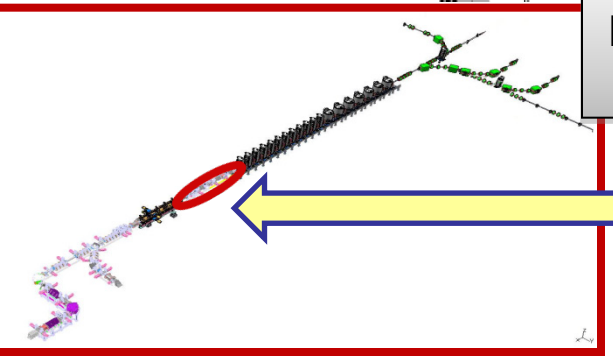
3D measurements promising but several non conformities imply delay and force us to reconsider the tolerance objectives.
We hope completely assembled T5 before end of march 2012.

4 other segments (T1-T4) should be delivered in june 2012.

T5 segment - 3D measurements

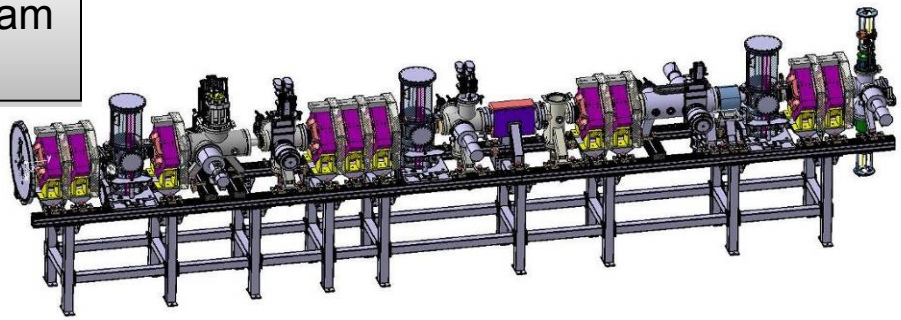
T4 segment machining

Status of LME line



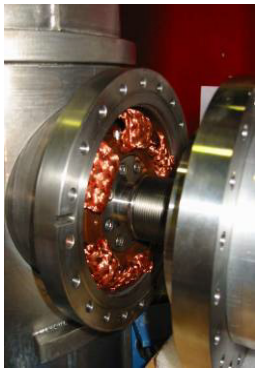
Line to match the beam for the LINAC

Ganil
IPHC Strasbourg
Irfu Saclay



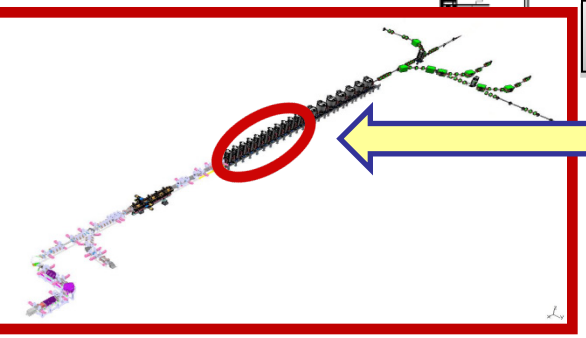
1st buncher power tests over in:June 2011
specifications OK(120kV CW and *180kV* pulsed)
bunchers 2 & 3 delivered end of 2012

All ten quadrupoles are built
Magnetic measurements OK



Call for tender of mechanics for supports and vacuum pipes ready to be launched end of this year

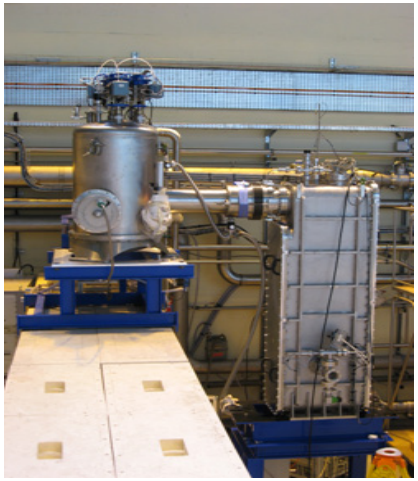
Status of LINAC β_0=0.07 cavities



12 x β_0=0.07 supraconductive cavities

Irfu Saclay	NIPNE Bucarest
LPSC Grenoble	LPNHE Paris
IPN Orsay	BARC India
LAL Orsay	Ganil

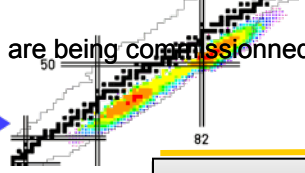
Supports for Cryomodules and Warm Sections under manufacturing



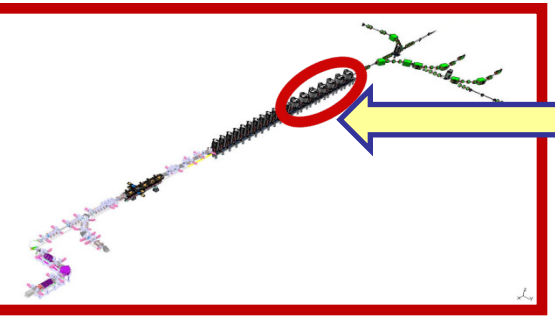
Quadrupoles under fabrication.
The first ones measured

The first β_0=0.07 cryomodule is under tests. We face pollution difficulties.

All the couplers are received and are being commissionned.



Status of LINAC β_0=0.12 cavities

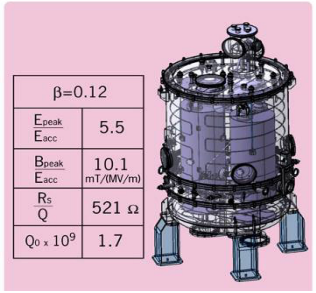


14 x β_0=0.12 supraconductive cavities

Irfu	NIPNE Bucarest
LPSC Grenoble	LPNHE Paris
IPN Orsay	BARC India
LAL Orsay	Ganil

All the couplers received and are being commissionned.

Solid-state amplifiers used to power the linac cavities are being manufactured



β=0.12	
$\frac{E_{peak}}{E_{acc}}$	5.5
$\frac{B_{peak}}{E_{acc}}$	10.1 mT/(MV/m)
$\frac{R_S}{Q}$	521 Ω
$Q_0 \times 10^9$	1.7

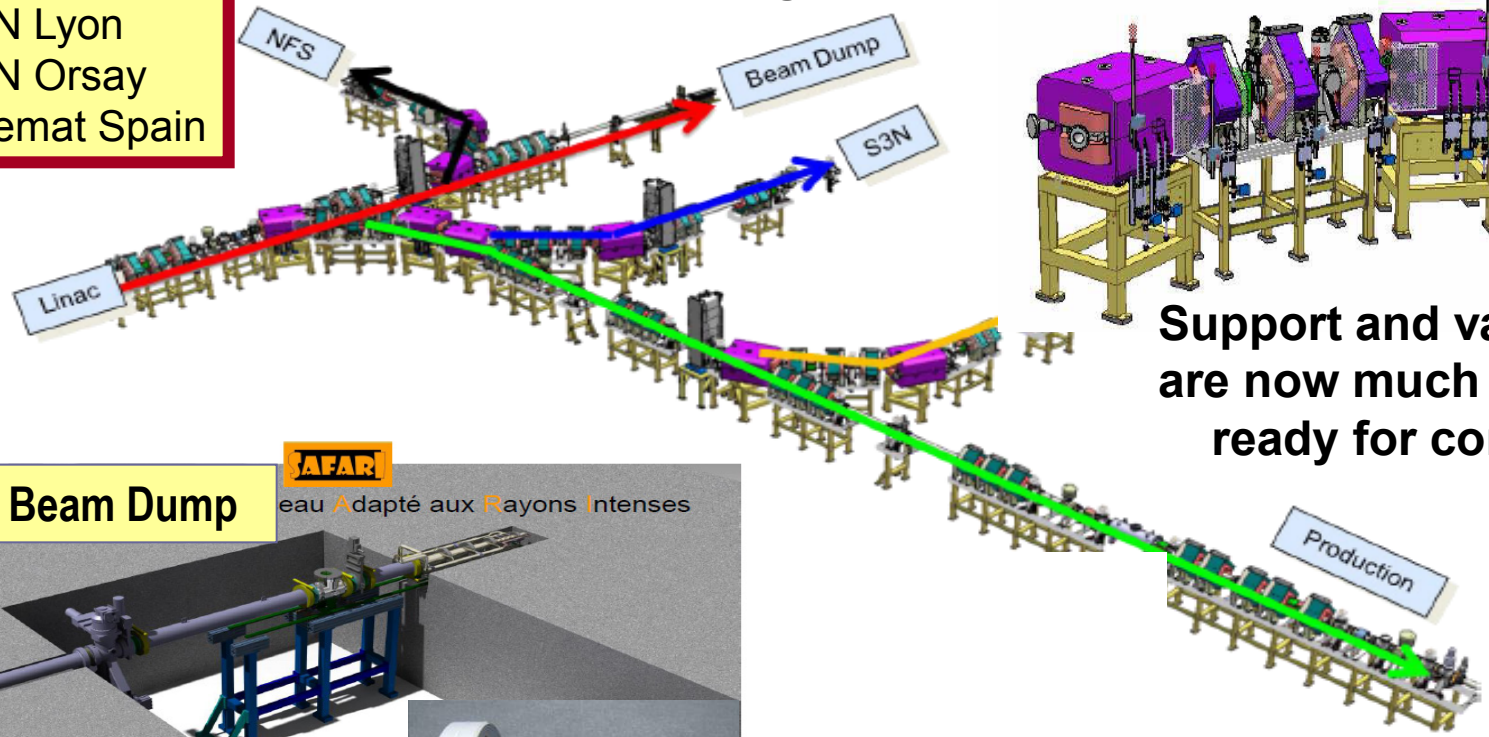
IPNO/Orsay

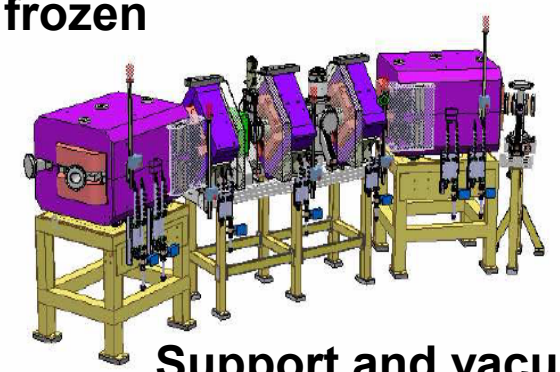
Qualifying cryomodule, for β_0=0.12 cavities, met the specifications but pollution difficulties (dust) with production cryomodules.

Status of HEBT line

Ganil
IPN Lyon
IPN Orsay
Ciemat Spain

HEBT design is now frozen

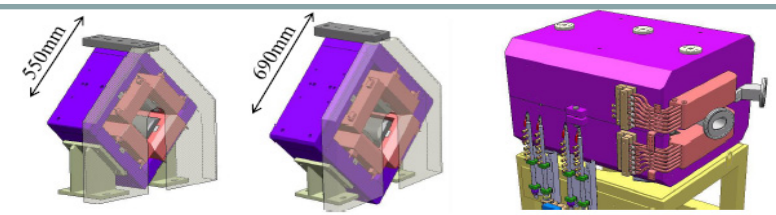




Support and vacuum pipes are now much detailed and ready for construction

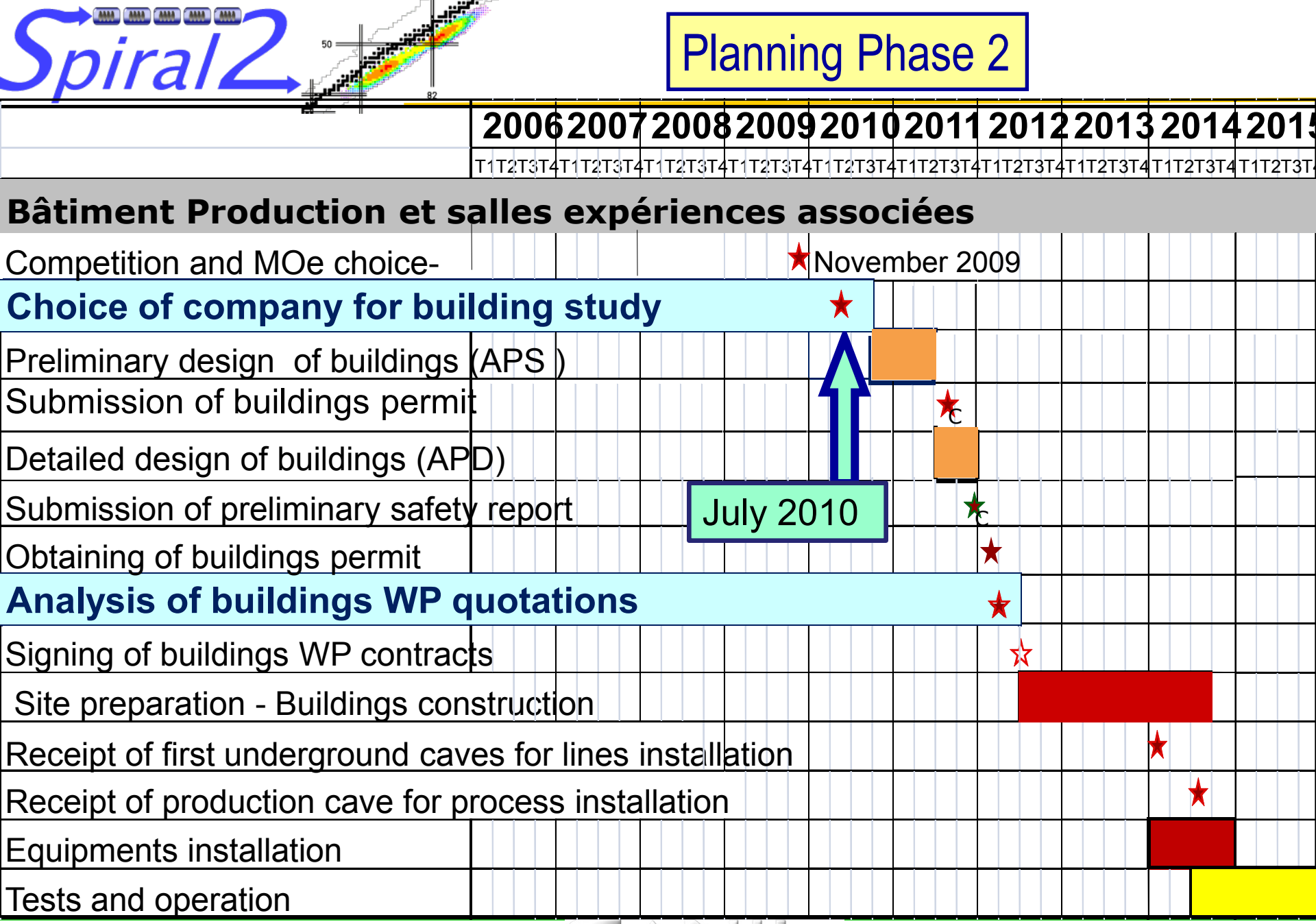
Beam Dump

Construction will be launched end of 2011

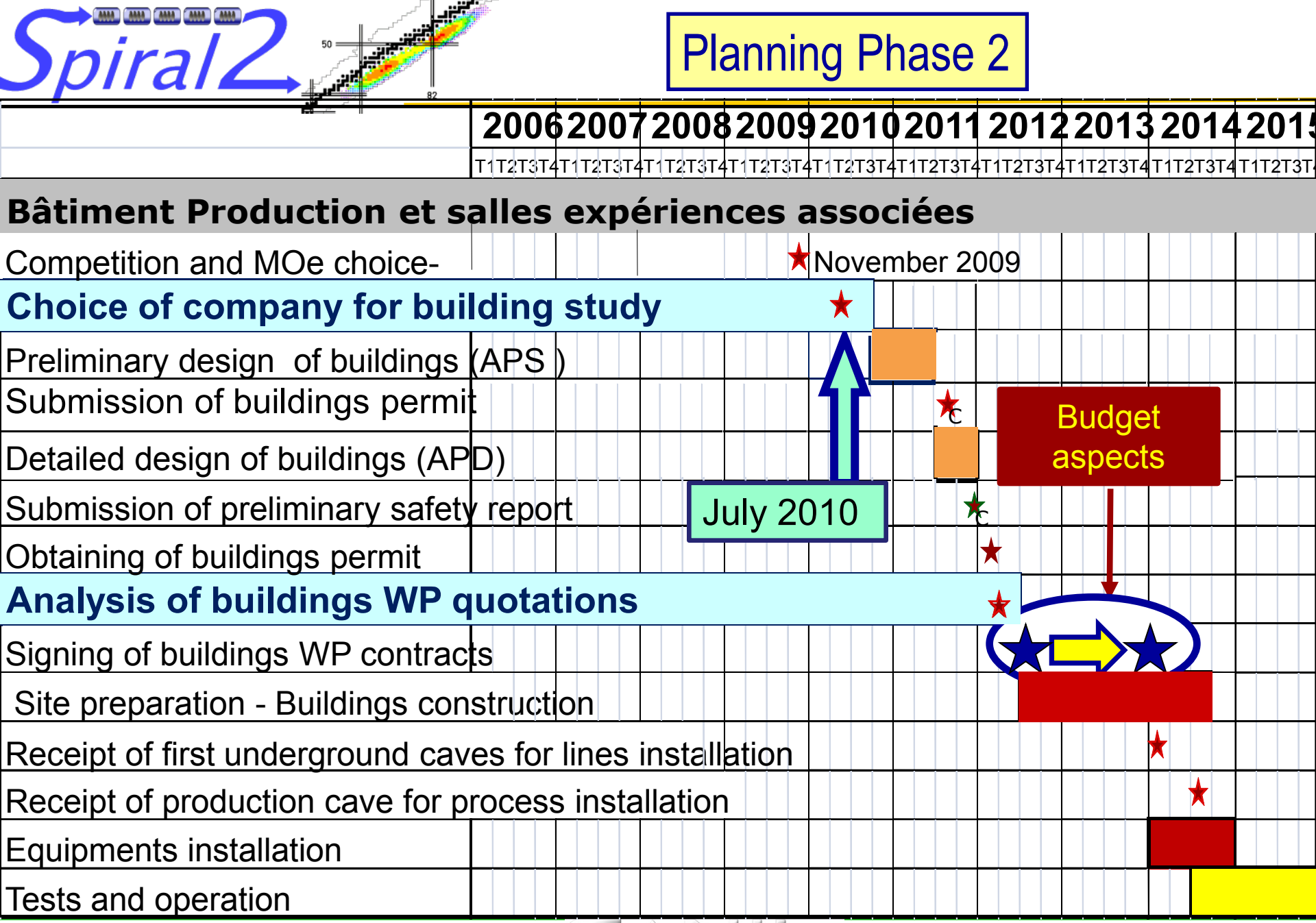


Quads and dipoles and power supplies under construction

Planning Phase 2



Planning Phase 2



Planning Phase 2

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
	T1 T2 T3 T4	T1 T2 T3 T4	T1 T2 T3 T4	T1 T2 T3 T4	T1 T2 T3 T4	T1 T2 T3 T4	T1 T2 T3 T4	T1 T2 T3 T4	T1 T2 T3 T4	T1 T2 T3 T4
Bâtiment Production et salles expériences associées										
Competition and MOe choice-					★ November 2009					
Choice of company for building study					★					
Preliminary design of buildings (APS)										
Submission of buildings permit										
Detailed design of buildings (APD)										
Submission of preliminary safety report										
Obtaining of buildings permit										
Analysis of buildings WP quotations										
Signing of buildings WP contracts										
Site preparation - B										
Receipt of first unde							stallation			
Receipt of production cave for process installation										
Equipments installation										
Tests and operation										

July 2010

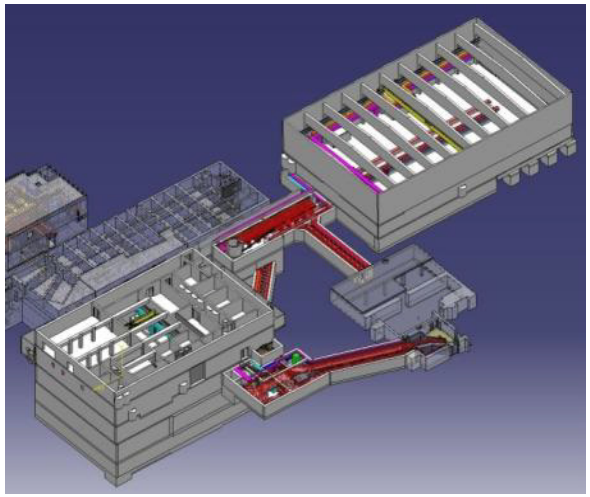
Budget aspects

New planning to built

SPIRAL2 Phase 2 buildings

contract is signed with the company in charge of building studies

Beginning of the preliminary design



end of the preliminary design

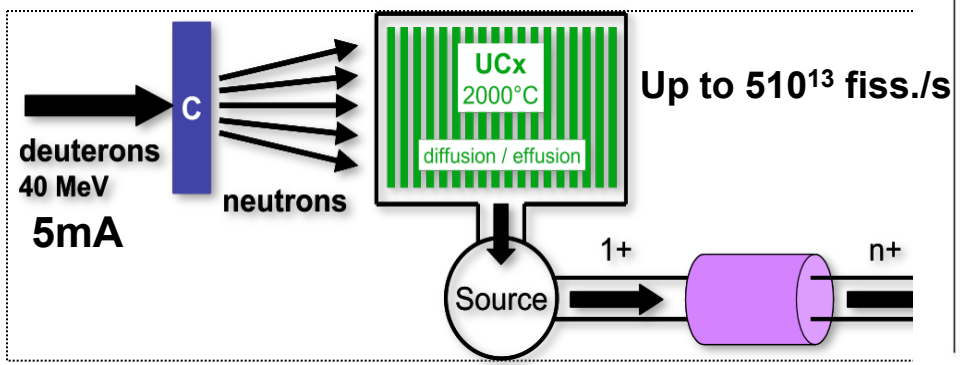
December 2011

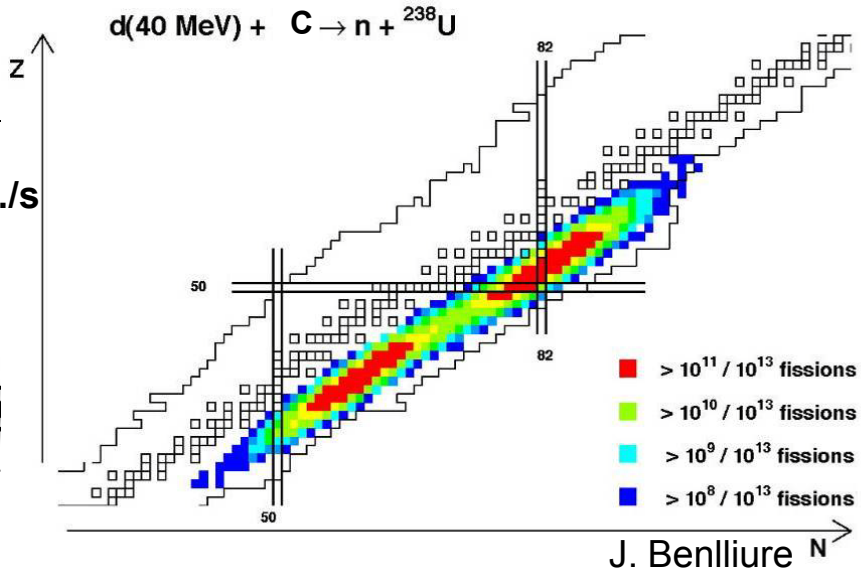
March 2011

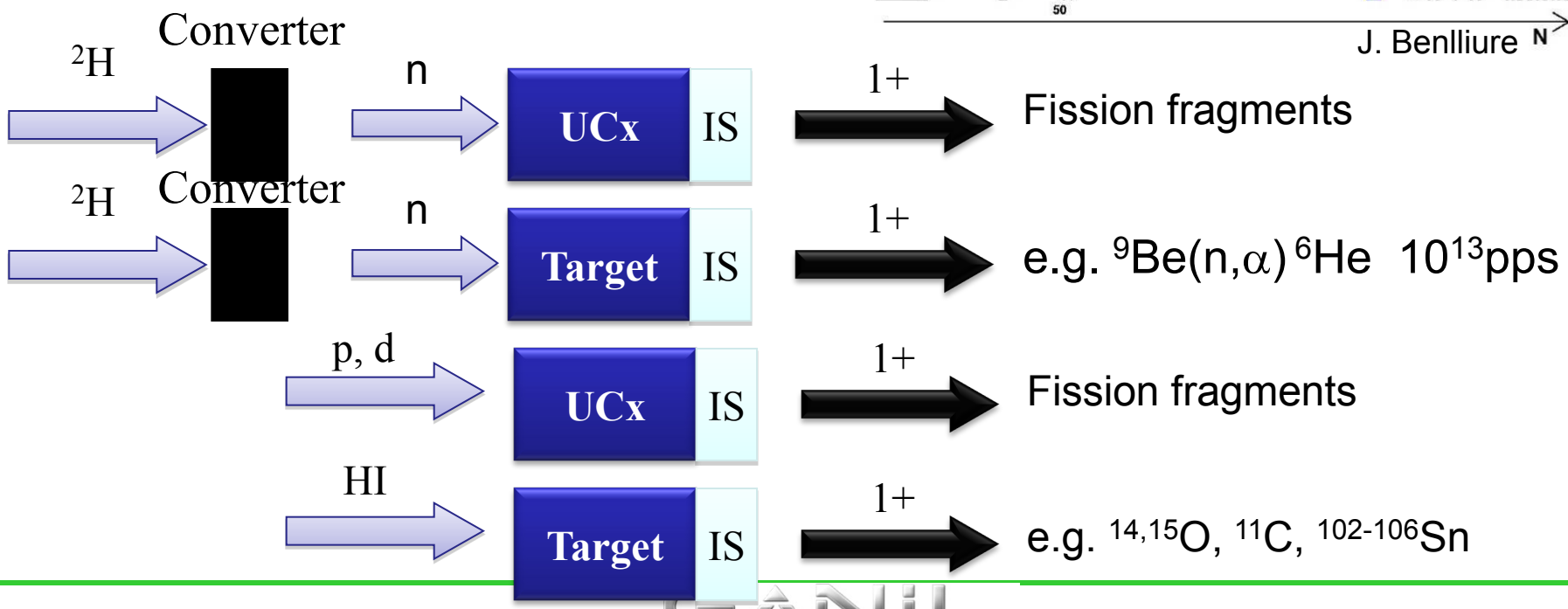
September 2011

We are currently analyzing the issue of preliminary design of the buildings before starting their detailed studies.

Layout of ISOL Rare Isotope Beams

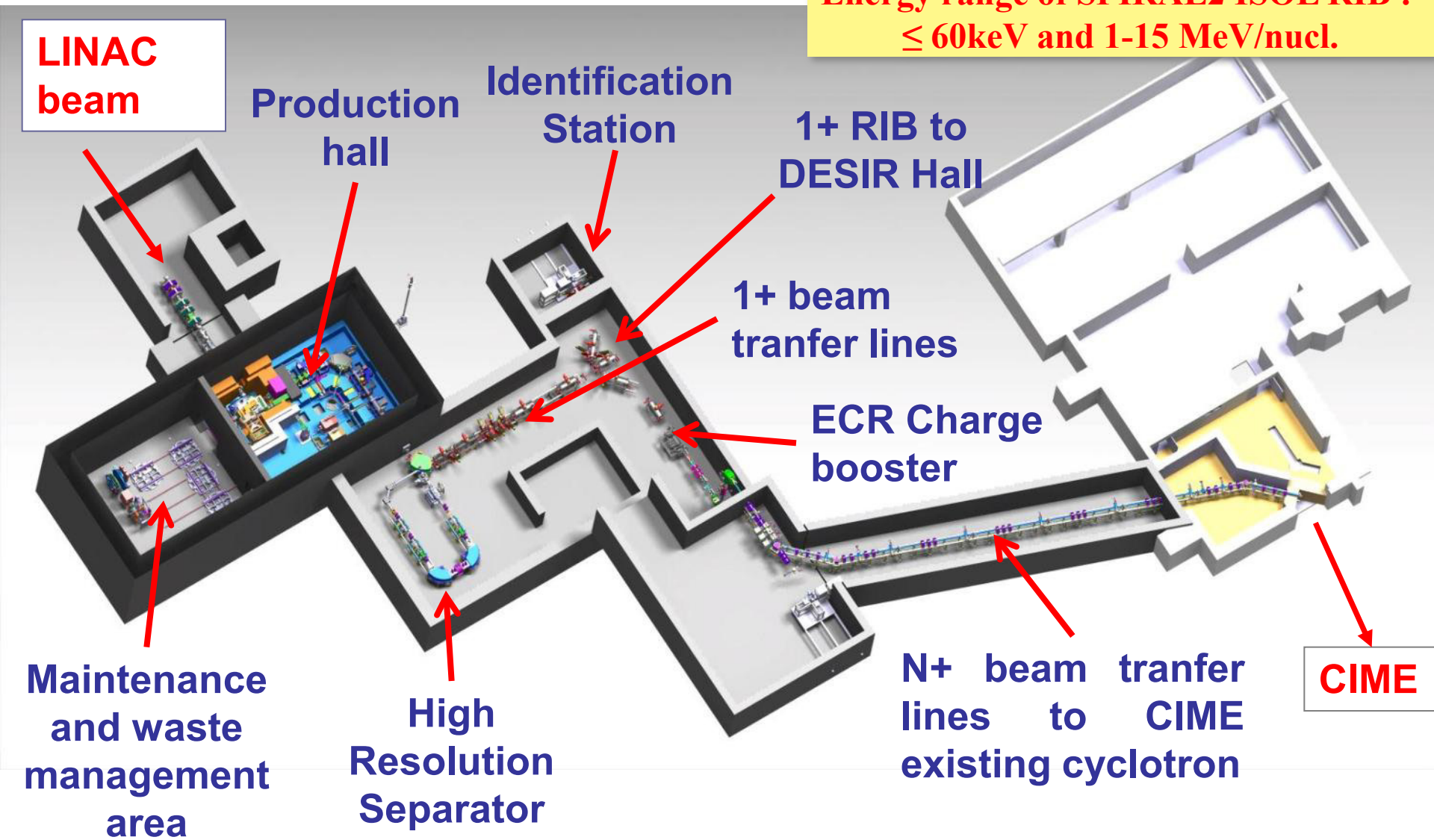




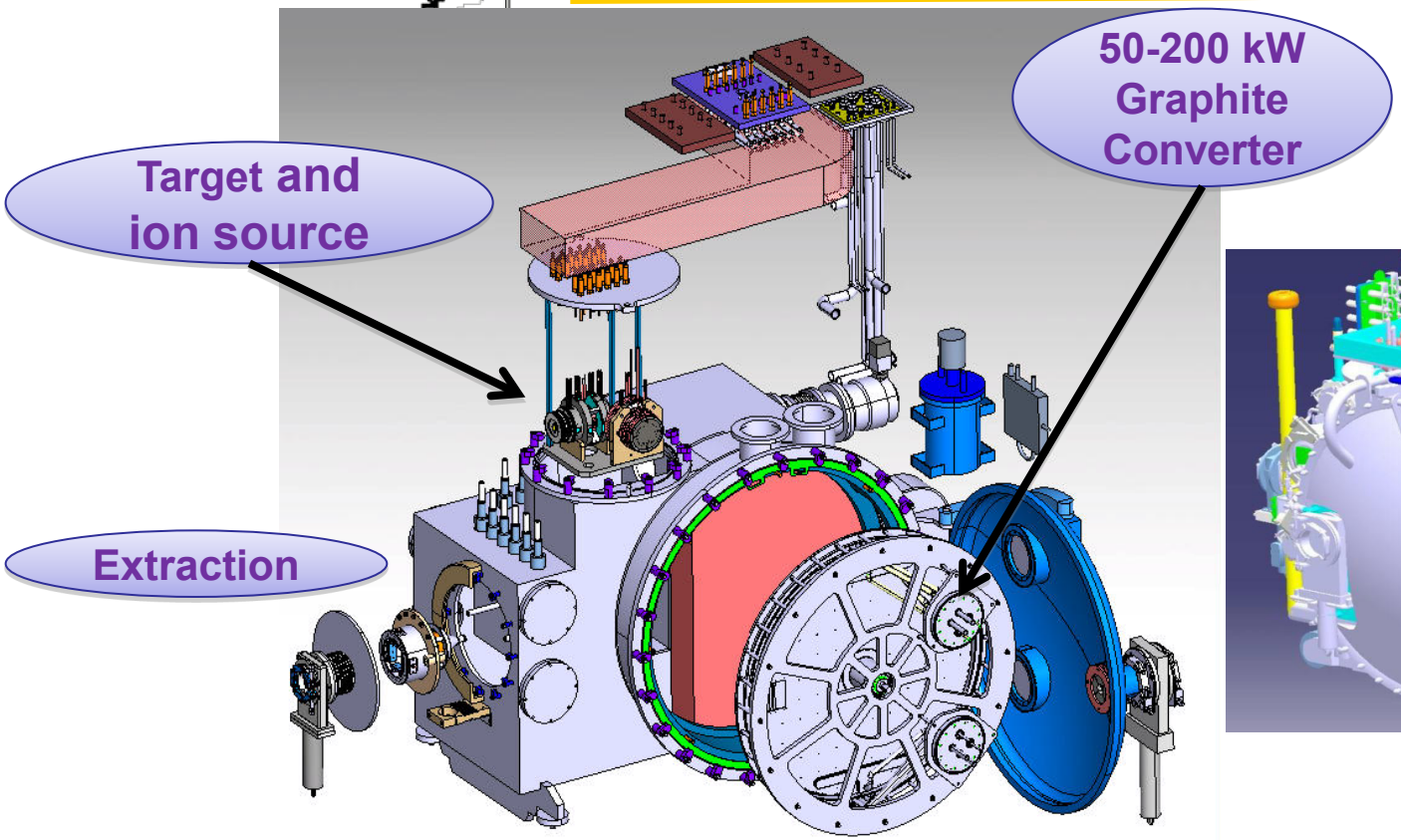


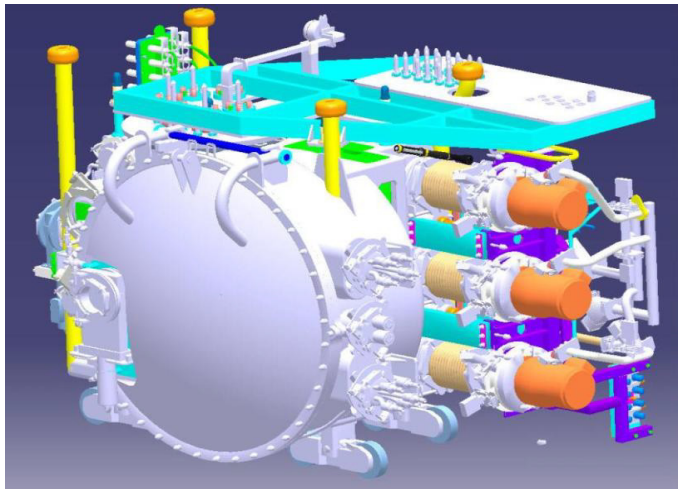
RIB Production and Transport

Energy range of SPIRAL2 ISOL RIB : ≤ 60keV and 1-15 MeV/nucl.



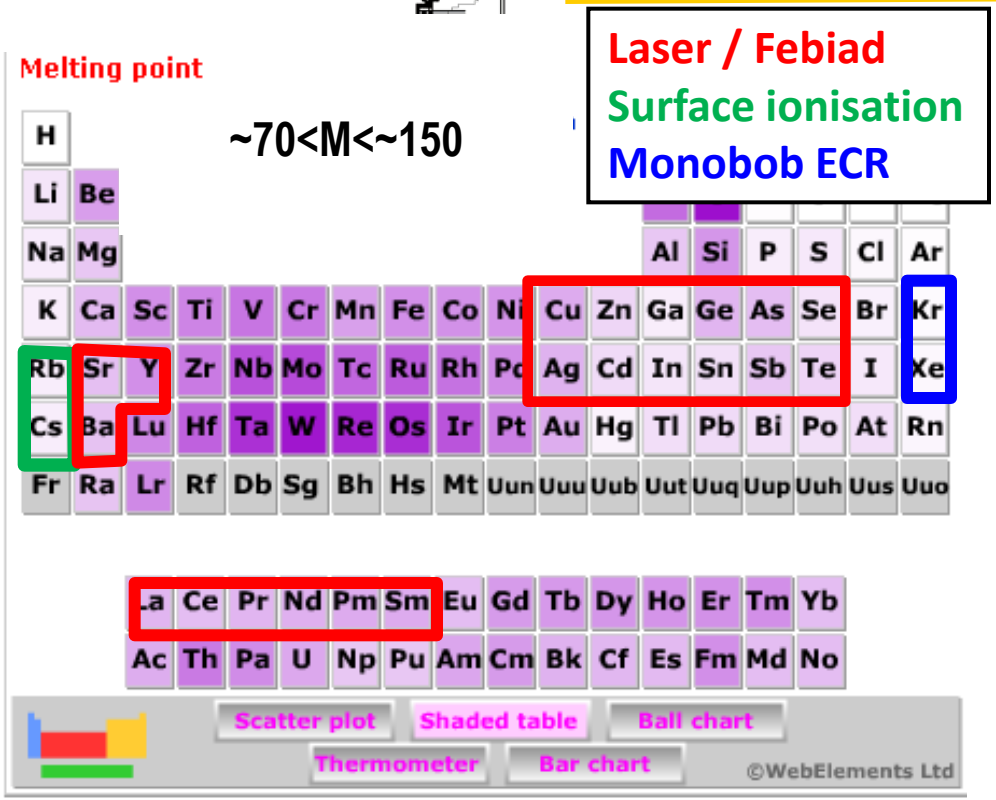
RIB Production Module

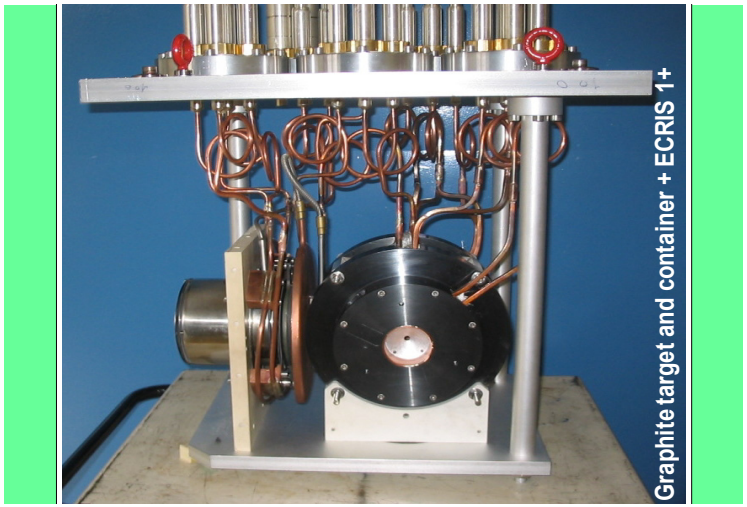


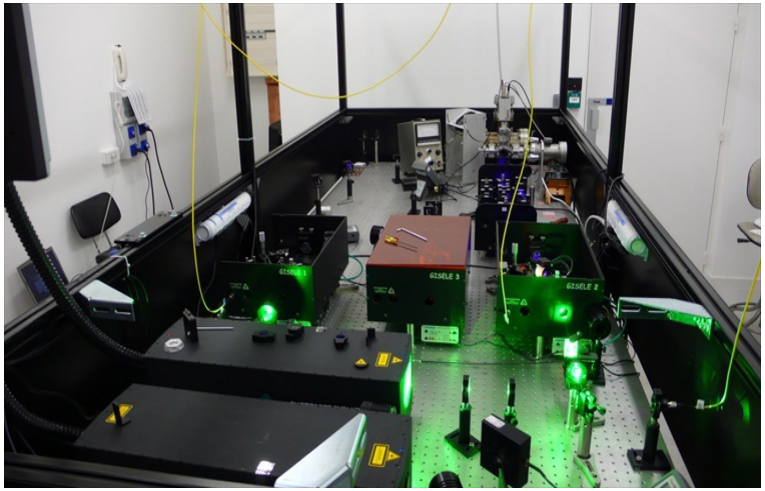


The detailed study of the TIS production module is completed .
The production module is a totally remote-operated system taking into account radiological environment, safety and contamination handling rules.
The construction of a prototype of the production module could begin in the fourth quarter of 2012.

4 ion sources for RIB production



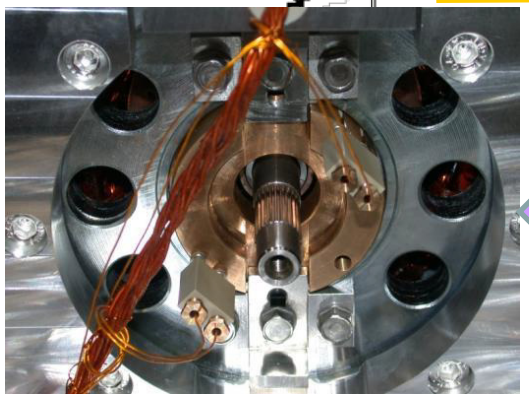




Ga+ produced with GISELE laser system, in collaboration Mainz University

- prototype of ECR tested (80% efficiency),
- Laser Ion source has to be developped, only the laser source is tested,
- FEBIAD Source under development,
- Surface Ionization Source under development,

Converter and targets

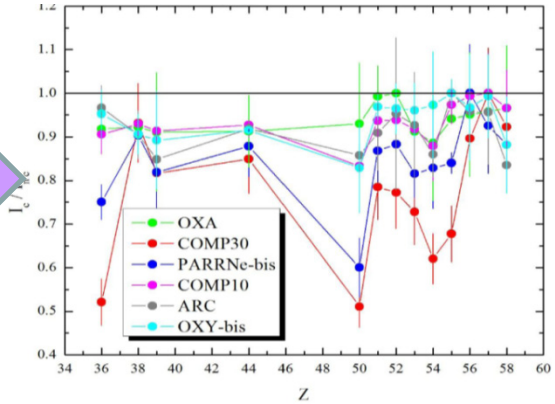


The first complete prototype of the 50kW size converter is under construction at INFN-LNL. The individual parts (graphite evaporation rate, ball bearings, cooling system and the mechanical rotation) has already been tested

Ucx target:

different structure and density have been irradiated at IPNO to find an optimum target for the production.

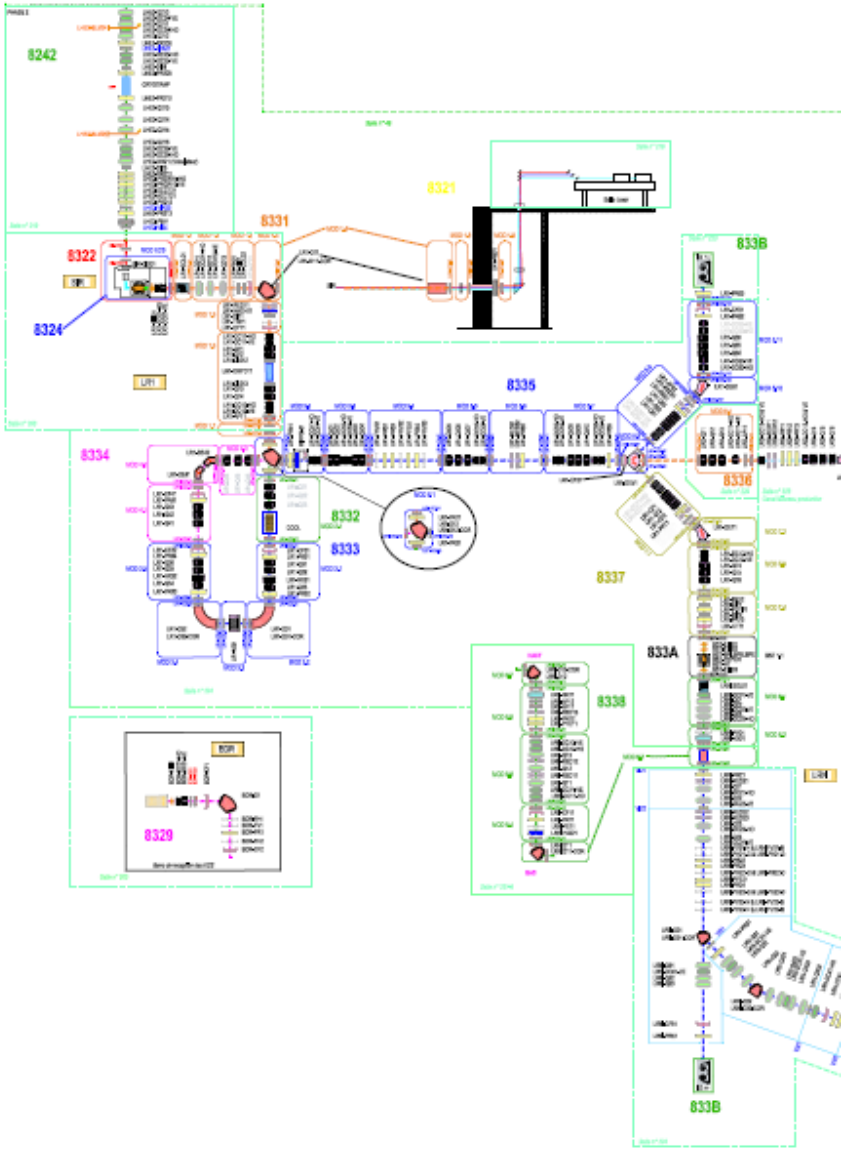
A new target laboratory dedicated to the Ucx development is under construction



Graphite oven manufactured to reach 2000°C temperature for Ucx target

Temperature tests in October 2011

RIB transport lines



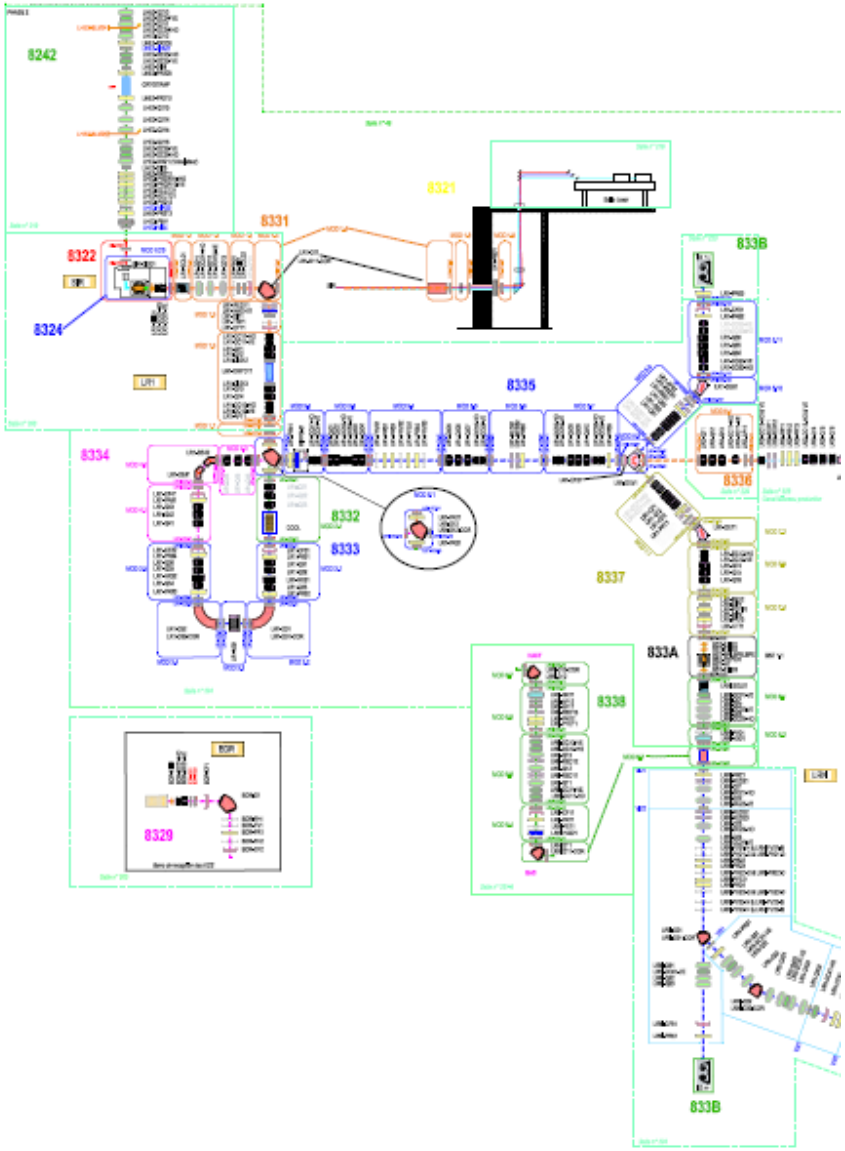
✓ **1+ line :**

The preliminary design of 1+ line is achieved. The integration studies in the buildings, taking into account the constraints of maintenance, are in progress. The mechanical design of the line is based on the use of independent modules that will be extracted with remotely operated tools from inaccessible places like the production caves.

✓**N+ line towards CIME existing cyclotron:**

The preliminary design of the n+ line is complete. The integration and the maintenance of these lines in the buildings have been taken into account. Their detailed study has still to be started.

RIB transport lines



✓ **Charge booster:**

charge breeding has been tested on the LPSC test bench with the MONOBOB ECR 1+ source. The nuclearization of its mechanical design is well advanced.

✓ **RFQ Cooler :**

prototype built and the tests with beam are in progress . The nuclearization of its mechanical design, for maintenance operation in a zone where radioactivity and/or contamination will become important, is under studies.

✓ **HRS:**

beam dynamics is fixed and now the feasibility study of the magnet is underway

✓ **Identification station ID1+:**

the detailed study is over.

Conclusions

Concerning SPIRAL2 phase1:

- Moreless all the equipments are under manufacturing or tests.
- All the tests in laboratories are very important to debug problems before final installation at GANIL.
- Buildings construction has started and the first poured concrete is expected this week.
- The very important task now is to prepare the installation phase of equipments in buildings. This task was initiated and is underway.

Concerning SPIRAL2 Phase2:

- Preliminary studies of sub-systems are completed.
- All detailed studies to be finished by the end of 2012.
- Beginning of construction of equipments and buildings at end of 2013 or beginning of 2014.

Thank you for your attention