Progress of SPIRAL2 project

IPAC 2011
San Sebastian, 5-9 September 2011
Progress of SPIRAL2 project:

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

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

LINAC:
- 33MeV p
- 40 MeV d
- 14.5 AMeV HI

A/q=6 Injector option

A/q=2 source
- p, d, ³He, ⁴He 5mA

A/q=3 HI source
- Up to 1mA

RIB Production Cave
- Up to $10^{14}$ fiss./sec.

Neutrons
- For Science

S3 separator-spectrometer

HRS+RFQ Cooler

DESIR Facility
- low energy RIB

CIME cyclotron RIB at 1-20 AMeV
- (up to 10 AMeV for fiss. fragments)

Existing GANIL 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

Atomic & solid state physics
Radiobiology & Isotope production

rp process

s process

Stellar evolution

Big Bang

and also…

Neutrons for science
SPIRAL2 project organization

Decision level

Strategic management

Operational management

Systems

Laboratories

CEA/DSM

CNRS/IN2P3

Steering Committee

International steering committee

Evaluation committees
TAC - SAC

Scientific community

Nuclear Facility

Head of project

Management team

Accelerator driver

RIB

Buildings

International steering committee

Evaluation committees
TAC - SAC

Scientific community

Nuclear Facility

Autres
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)

International collaborations

IRFU/SPhN
IRFU/SACM
IRFU/SIS
IRFU/SENAC
Expertise
Expertise
DASE et DP2I
Expertise

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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
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

SPIRAL2 Phase 1

SPIRAL2 Phase 2

Existing GANIL Facility
### Accelerator and associated experimental area buildings

<table>
<thead>
<tr>
<th>Event</th>
<th>Year(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definition of buildings specifications</td>
<td>2006-2007</td>
</tr>
<tr>
<td>Competition and MOe choice</td>
<td>2008</td>
</tr>
<tr>
<td>Preliminary design of buildings (APS +)</td>
<td>2009-2010</td>
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<tr>
<td>DAM transmission</td>
<td>2009-2011</td>
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<tr>
<td>Submission of buildings permit</td>
<td>2009</td>
</tr>
<tr>
<td>Detailed design of buildings (APD)</td>
<td>2011-2014</td>
</tr>
<tr>
<td>Public enquiry and Instruction by IRSN</td>
<td>2012-2014</td>
</tr>
<tr>
<td>Permit of construction obtained</td>
<td>2010-2011</td>
</tr>
<tr>
<td>Site preparation- Buildings construction</td>
<td>2011-2014</td>
</tr>
<tr>
<td>Receipt of first underground caves</td>
<td>2012</td>
</tr>
<tr>
<td>Receipt of first surface caves</td>
<td>2013</td>
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<tr>
<td>Equipments installation</td>
<td>2014</td>
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<tr>
<td>First beam tests</td>
<td>2014</td>
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<tr>
<td>Tests and operation</td>
<td>2014</td>
</tr>
</tbody>
</table>

*Note:* The table shows the planned timeline for the construction and commissioning phases of SPIRAL2 Phase 1. Key milestones include the definition of building specifications, competition and MOe choice, preliminary design, DAM transmission, submission of buildings permit, detailed design, public enquiry, permit of construction, site preparation, receipt of first underground and surface caves, equipments installation, first beam tests, and tests and operation.
Site before its preparation in November of last year
The hole for the buildings

status of buildings construction
The crane status of buildings construction
Pouring the first concrete this week

status of buildings construction
<table>
<thead>
<tr>
<th>Q/A</th>
<th>I (mA)</th>
<th>Energy (Mev/u)</th>
<th>CW max beam Power (KW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protons</td>
<td>1/1</td>
<td>5</td>
<td>2 - 33</td>
</tr>
<tr>
<td>Deuterons</td>
<td>1/2</td>
<td>5</td>
<td>2 - 20</td>
</tr>
<tr>
<td>Ions</td>
<td>1/3</td>
<td>1</td>
<td>2 - 14.5</td>
</tr>
<tr>
<td>Ions (option)</td>
<td>1/6</td>
<td>1</td>
<td>2 - 8</td>
</tr>
</tbody>
</table>

**SPIRAL2 Phase 1: Driver Beam Characteristics**

- **Protons**: 1/1, 5 mA, Energy = 2 - 33 MeV/u, CW max beam Power = 165 KW
- **Deuterons**: 1/2, 5 mA, Energy = 2 - 20 MeV/u, CW max beam Power = 200 KW
- **Ions**: 1/3, 1 mA, Energy = 2 - 14.5 MeV/u, CW max beam Power = 45 KW
- **Ions (option)**: 1/6, 1 mA, Energy = 2 - 8 MeV/u, CW max beam Power = 48 KW

- Machine underground (beam axis = - 8m)
- Future extension
- Towards production
- Towards DESIR

**Notes**

- Protons: 1/1, 5 mA, Energy = 2 - 33 MeV/u, CW max beam Power = 165 KW
- Deuterons: 1/2, 5 mA, Energy = 2 - 20 MeV/u, CW max beam Power = 200 KW
- Ions: 1/3, 1 mA, Energy = 2 - 14.5 MeV/u, CW max beam Power = 45 KW
- Ions (option): 1/6, 1 mA, Energy = 2 - 8 MeV/u, CW max beam Power = 48 KW
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

Beam profiles and emittance 0.22 pi.mm.mrad (O16 6+, March 2010)

Xe132 25+
O16 3+
Separation using slits
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)

Simulation (Tracewin)

First beam observed after LEBT2
Bending magnet in October 2010

Deuteron beam

Experiment (Oct 2010)
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.
All ten quadrupoles are built
Magnetic measurements OK

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

Call for tender of mechanics for supports and vacuum pipes ready to be launched end of this year
The first $\beta_0=0.07$ cryomodule is under tests. We face pollution difficulties.

Quadrupoles under fabrication. The first ones measured.
All the couplers are received and are being commissioned.

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

Qualifying cryomodule, for $\beta_0=0.12$ cavities, met the specifications but pollution difficulties (dust) with production cryomodules.

14 x $\beta_0=0.12$ superconductive cavities

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

Status of LINAC $\beta_0=0.12$ cavities

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Status of HEBT line

HEBT design is now frozen

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

Quads and dipoles and power supplies under construction

Construction will be launched end of 2011

Ganil
IPN Lyon
IPN Orsay
Ciemat Spain
Bâtiment Production et salles expériences associées

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IPAC 2011, 5-9 september 2011

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**IPAC 2011, 5-9 september 2011**

* Eric Petit
## Bâtiment Production et salles expériences associées

### Competition and MOe choice
- **November 2009**

### Choice of company for building study
- **July 2010**

- 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 - Buildings construction
- Receipt of first underground caves for lines installation
- Receipt of production cave for process installation
- Equipments installation
- Tests and operation

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We are currently analyzing the issue of preliminary design of the buildings before starting their detailed studies.
Up to 2.3 kg HD UC$_2$

Deuterons 40 MeV 5mA

UC$_x$ 2000°C

diffusion / effusion

Source 1+ n+

UC$_x$ IS

2H Converter

n

n

p, d

HI

Fission fragments
e.g. $^9$Be(n,α)$^6$He $10^{13}$pps

Target IS

1+

Fission fragments
e.g. $^{14,15}$O, $^{11}$C, $^{102-106}$Sn

Target IS

1+

J. Benlliure N

Layout of ISOL Rare Isotope Beams

d(40 MeV) + C → n + $^{238}$U

> $10^{11}$ / $10^{12}$ fissions

> $10^{10}$ / $10^{11}$ fissions

> $10^9$ / $10^{10}$ fissions

> $10^8$ / $10^{10}$ fissions

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RIB Production and Transport

Energy range of SPIRAL2 ISOL RIB: \( \leq 60 \text{keV} \) and 1-15 MeV/nucl.

- LINAC beam
- Production hall
- Identification Station
- 1+ RIB to DESIR Hall
- 1+ beam transfer lines
- ECR Charge booster
- N+ beam transfer lines to CIME existing cyclotron
- Maintenance and waste management area
- High Resolution Separator
- CIME
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

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

~70<M<~150

Laser / FEBIAD
Surface ionisation
Monobob ECR

Ga⁺ produced with GISELE laser system, in collaboration Mainz University
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.
Concerning SPIRAL2 phase 1:
• 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 Phase 2:
• 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