Status of the GANIL/SPIRAL2 facility

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on behalf of GANIL, SPIRAL2 Project Group & Physics Collaborations
Existing GANIL facility & SPIRAL2 under construction

Phase 1: High intensity stable beams + Experimental rooms ($S^3 + NFS$)
Phase 2: High-intensity low-energy (DESIR) & post-accelerated Radioactive Ion Beam facility

**Cost of SPIRAL2**: $210 \text{ M}\euro + 40 \text{ M}\euro$ spectrometers & detectors
Day 1 SPIRAL2 LINAC
stable-ion beams

Energy = 0.75-15 A.MeV for Heavy Ions

<table>
<thead>
<tr>
<th>Ion(s)</th>
<th>Energy Range (MeV/nucleon)</th>
<th>Maximum Intensity (pA)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>(^1)H(^+)</td>
<td>20-33</td>
<td>2-10</td>
<td>NFS beam line; Intensity with fast chopper I/100</td>
</tr>
<tr>
<td>(^2)H(^+)</td>
<td>10-20</td>
<td>2-10</td>
<td>NFS beam line; Intensity with fast chopper I/100</td>
</tr>
<tr>
<td>(^4)He(^{2+})</td>
<td>10-20</td>
<td>2-10</td>
<td>NFS beam line; Intensity with fast chopper I/100</td>
</tr>
<tr>
<td>(^{12})C(^{4+})</td>
<td>5-7</td>
<td>≥10(^{(*)})</td>
<td>S3 beam line</td>
</tr>
<tr>
<td>(^{18})O(^{6+})</td>
<td>5-7</td>
<td>≥10(^{(*)})</td>
<td>S3 beam line</td>
</tr>
<tr>
<td>(^{22})Ne(^{8+})</td>
<td>5-7</td>
<td>≥10(^{(*)})</td>
<td>S3 beam line</td>
</tr>
<tr>
<td>(^{40})Ar(^{14+})</td>
<td>4-5</td>
<td>≥10(^{(*)})</td>
<td>S3 beam line</td>
</tr>
<tr>
<td>(^{28-30})Si(^{10+}) or (^{32-36})S(^{12+})</td>
<td>5-7</td>
<td>≥10(^{(*)})</td>
<td>S3 beam line</td>
</tr>
<tr>
<td>(^{40})Ca(^{14+})</td>
<td>5-7</td>
<td>≥10(^{(*)})</td>
<td>S3 beam line</td>
</tr>
<tr>
<td>(^{48})Ca(^{16+})</td>
<td>5-7</td>
<td>≥10</td>
<td>S3 beam line</td>
</tr>
<tr>
<td>(^{58})Ni(^{18+})</td>
<td>4-14</td>
<td>≥1(^{(**)})</td>
<td>S3 beam line</td>
</tr>
</tbody>
</table>

✓ Starting HI ECR source for commissioning and first experiments ➔ Phoenix V2
✓ Upgrade of V2 -> V3 using EU CRISP funds
SPIRAL 2: Advanced ISOL RIB facility

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

SPIRAL2 – ISOL facilities

ISOL RIB beams:
- high intensity, optical quality & purity

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

SPIRAL2 – In flight facilities

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

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NuPECC 2012 Sevilla
Stable-ion & RIB at GANIL/SPIRAL2

- High-intensity stable-ion beams (from C to U): from few keV to 95 MeV/nucl.
- RIB in-flight at LISE separator: from few to 50 MeV/nucl.
- ISOL RIB from SPIRAL 1 & 2: ≤ 60 keV and 1-15 MeV/nucl.

N=Z Isol+In-flight

+ SPIRAL1 with new RIB!

ISOL RIB Fission Products

ISOL & in-flight RIB from transfer and deep inelastic Reactions

SHE In-flight S3

In-flight S3

GANIL/SPIRAL1/SPIRAL2 Beams

New Web interface

pro.ganil-spiral2.eu/users-guide/accelerators/chart-beams
GANIL/SPIRAL 2 Layout

3 new experimental halls: NFS, S3, DESIR
New generation of detectors: ACTAR-TPC, EXOGAM2, FAZIA, GASPARD, NEDA, PARIS
SPIRAL2 phase 1 civil construction

Status of buildings construction

The crane

Excavation work

Site before
ACCU LEVAGE : Livraison des équipements LHE et stockage à programmer

• Remblais périphériques (Niv-2) encours
• Fabrication du monte-charge en cours
• Pose du monte-charge à partir de S40
• Peinture : A terminer (hors zone non couverte)
• Résines en cours (75%) • A poursuivre et terminer au plus tôt
• Traitement fissures : en cours dans local 5 (plafonds)
• Finitions à effectuer (après résines)

CEGELEC : Tresses CEM voile encours (95%)

End of May 2012

LINAC Hall
SPIRAL2 phase 1 civil construction

- Installation of equipment ➔ Q3 2012 – Q4 2013
- Commissioning ➔ Q4 2013

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NuPECC 2012 Sevilla
3 new experimental halls: NFS, S3, DESIR

New generation of detectors: ACTAR-TPC, EXOGAM2, FAZIA, GASPARD, NEDA, PARIS
50 physicists, 18 institutions, 8 countries

Spokespersons:
Xavier Ledoux, CEA/DIF/DPTA/SPN, France
Stanislav Simakov, FZK, Germany

GANIL contact person: Fanny Rejmund

Technical co-ordinator R. Hue GANIL

Goal: to be ready for commissioning of NFS in the middle of 2013

D->n Converter (Under Construction)

Collimator

Clearing Magnet (Ordered)

Cost ≈ 523k€
Fully funded

Neutron beam dump

Time-of-flight area

NFS facility

2.2.4 Neutron flux in time-of-flight hall

By taking into account the neutron yield production, the beam division and the flight path, the neutron flux can be evaluated and compared to other major time-of-flight facilities in the world namely n_TOF at CERN, WNR at Los Alamos and Gelina at Geel. A flight path between 5 and 20 m is available at NFS allowing high intensity flux (5 m) and high resolution measurement (20 m). We can see on Figure 12 that between 1 and 35 MeV NFS is very competitive in terms of average flux in comparison with the 3 neutron beam facilities. It has to be stressed that it is mainly due to the high repetition rate (the flux by per single deuteron burst is clearly lower). Moreover, NFS presents some advantages thanks to the neutron production mechanism itself. In spallation sources (case of n-TOF and WNR), the high energy neutrons (up to hundreds MeV), can present challenges for collimation and background. Secondly the gamma-flash, which is known to be very penalizing especially because it induces a dead time, will be probably strongly reduced at NFS. Note that high energy gammas are produced by decay in spallation sources based on high energy proton accelerator (like CERN) and by bremsstrahlung process in photoneutron sources based on electron accelerator (like Gelina).
• Construction of S3 Phase 0 (separator-spectrometer with focal plane detectors) fully funded (10M€) and was launched in April 2011
• All magnetic dipoles ordered
• All SC multipoles ordered (CRYOMAGNETICS)
• First experiments by 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
3 new experimental halls: 
NFS, S3, DESIR 
New generation of detectors: 
ACTAR, EXOGAM2, FAZIA, GASPARD, NEDA, PARIS
RIB Production & transport

Phase 2

Intensive design work & prototyping is going on

- LINAC beam
- RIB Production hall
- Identification Station
- 1+ beam lines
- 1+ RIB to DESIR Hall
- 1+ beam lines
- RFQ Cooler & High Resolution Separator
- ECR Charge booster
- N+ beam transfer lines to CIME existing cyclotron
- CIME cyclotron

Production hall Details

- M. "Quiclet" Page
- 06.09.2012
- Synthèse cellule

• Pour avancer sur l'exploitation du MP et du convertisseur, nous avons besoin de la mise à jour de la machine d'intégration cellule.
DESIR experimental hall & associated detectors

Additional 9 M€ granted (EQUIPEX) in 2012

DECA Agreement

MLLTrap

N-TOF detector

LPCTrap

DECA Agreement

Additional 9 M€ granted (EQUIPEX) in 2012

Parties: 14 owners of DESIR experimental equipment
Commitment: ~5 M€ & 520 men.months
Multilateral Agreements for new GANIL/SPIRAL2 detectors

MoU’s

- FAZIA (Demonstrator)
  - 192 telescopes

- PARIS (Demonstrator)
  - 4 clusters (36 phoswiches)

- NEDA
  - 90 detectors & electronics

ACTAR TPC
- (R&D tests & prototypes)

Collaboration Agreements

- EXOGAM2

In progress: MoU S³, MoU for the construction of SPIRAL2
Timeline GANIL & SPIRAL2

GANIL
- GANIL 4 months
- Civil Construction Phase 1
  - LINAC, NFS, S3
- Detailed Design Study
  - Phase 2
  - RIB, DESIR

SPIRAL2 Phase 1
- SPIRAL2 Phase 1
  - LINAC, NFS, S3
- Commisioning
- Stable ion beams from LINAC
- PAC NFS
- NFS Experiments
- PAC S3
- S3 Experiments

SPIRAL2 Phase 2
- SPIRAL2 Phase 2 Update
- Civil Construction and assembly of equipment
  - Phase 2
  - RIB, DESIR
- Lol Day 1
- PAC Phase 2 RIB

AGATA at GANIL
- New beams
  - SPIRAL1 (1+)
  - End 2014 (N+)

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EXON 2012 Vladivostok
International Collaborations

15 MoU, 3 EU Associated Laboratories, 2 Intern. Associated Laboratories

- ANL, Argonne
- NSCL, MSU
- TRIUMF
- HRIBF, Oak Ridge
- IRNE, Bulgaria
- INFN, Italy
- ESS Bilbao
- SPAIN
- FAIR/GSI, Darmstadt
- ISOLDE
- Uppsala University
- RIKEN, Tokyo
- PKU-INST, Beijing
- IMP, Lanzhou
- BARC, TIFR Bombay
- FLNR, Dubna
- COPIGAL
- NIPNE Bucharest
- SARAF
- Uppsala University
- ANL, Argonne
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- FLNR, Dubna
- COPIGAL
- NIPNE Bucharest
- SARAF
- Uppsala University

3,9 M€, end in March 2012

FP7 EU contract 2011-2014 (collaboration with FAIR, ELI, …)
GANIL/SPIRAL 2 facility: status & outlook

SPIRAL2 Phase 1
Commissioning/experiments in 2014
NFS Funded MoU

SPIRAL2 Phase 2
(ISOL RIB)
Civil construction from 2015
S3 Funds granted

DESIR Coll. Agreement – DECA
Funds granted

ACTAR-TPC Coll. Agreement
Demonstrator funded

PARIS MoU
Demonstrator funded

GANIL EXISTANT

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

Challenges:
- Funds to construct SPIRAL2 Phase 2 in few years
- Funds for running the full GANIL/SPIRAL2 facility
FP8 EU contribution?