

| | | |
|---|---|--------------|
|  | EUROPEAN COMMISSION RESEARCH AND INNOVATION DG | Final Report |
|---|---|--------------|

Project No: 212692
Project Acronym: SPIRAL2PP
Project Full Name: SPIRAL2 PREPARATORY PHASE

Final Report

Period covered: from 01/11/2007 to 31/03/2012

Start date of project: 01/11/2007

Project coordinator name:
Dr. Marek Lewitowicz

Version: 1

Date of preparation: 08/05/2012

Date of submission (SESAM): 13/07/2012

Project coordinator organisation name:
GRAND ACCELERATEUR NATIONAL D'IONS
LOURDS

Final Report

PROJECT FINAL REPORT

| | |
|---|--|
| Grant Agreement number: | 212692 |
| Project acronym: | SPIRAL2PP |
| Project title: | SPIRAL2 PREPARATORY PHASE |
| Funding Scheme: | CP-CSA |
| Project starting date: | 01/11/2007 |
| Project end date: | 31/03/2012 |
| Name of the scientific representative of the project's coordinator and organisation: | Dr. Marek Lewitowicz GRAND ACCELERATEUR NATIONAL D'IONS LOURDS |
| Tel: | +33231454574 |
| Fax: | +33231454586 |
| E-mail: | Lewitowicz@ganil.fr |
| Project website address: | http://www.spiral2pp.eu |

Final Report

Please note that the contents of the Final Report can be found in the attachment.

4.1 Final publishable summary report

Executive Summary

The main goal of the SPIRAL2 Preparatory Phase was to develop and negotiate the Consortium Agreement allowing for the construction and operation of the facility as a European research infrastructure. The current legal and management infrastructures of the GANIL will be adapted to the international character of the SPIRAL2 project. The SPIRAL2 project located at the GANIL facility (Caen, France) will deliver energetic rare (radioactive) isotope beams with intensities not yet available with presently running machines. The study of the properties of nuclei forming these beams or their interaction with stable nuclei is a rapidly developing field of contemporary nuclear physics, astrophysics and interdisciplinary research.

The Preparatory Phase dealt with the critical financial, legal and organisational issues related to the international character of the SPIRAL2 facility during its construction and operation phases. The text of the Memorandum of Understanding for the SPIRAL2 construction was prepared and approved by the members of the SPIRAL2 Preparatory Phase (deliverable: Validation of the GANIL-SPIRAL2 Consortium Agreement by the General Assembly). Searching for new funding partners was achieved by direct contacts and negotiations between international partners and their funding agencies as established through the official visits, meetings and organisation of international events (deliverable: Joint public event EURORIB conference, milestone: SPIRAL2 Weeks).

The Region Basse-Normandie and the French funding agencies (CNRS and CEA) are financing the investment to the extent of 80% for the baseline project. The budget for several important extensions of the baseline project (new experimental halls: NFS, S3 and DESIR) and for the new detectors (FAZIA, EXOGAM2, PARIS, NEDA, ACTAR TPC), essential for the full exploitation of the SPIRAL2 facility is partially achieved today, thanks to the success of the Preparatory Phase.

Several critical technical issues were addressed in order to construct the SPIRAL2 facility and associated instrumentation (deliverables: agreements for construction of the SPIRAL2 BLM and the SPIRAL2 slow chopper, proposal for construction of the Beam Dump, final report on SPIRAL2 ion Beam Diagnostics, prototype of a whole set of Single Bunch Selector, preliminary design of a demonstrator target, production of Radioactive Nuclear Beams from fusion-evaporation, conceptual design and cost estimate of neutron converter, design of the SPIRAL2 buildings). The corresponding tasks were chosen in order to solve the remaining technical challenges as well as to attract efficiently European partners. In particular, the accent was put on the new scientific instrumentation for SPIRAL2 (signatures of the Memoranda of Understanding for the DESIR, EXOGAM2, FAZIA, PARIS, NFS, S3 and NEDA collaborations, final report for the GASPARD project, conceptual design report of ACTAR TPC, reports of Instrumentation Coordination Committee). This topic, being the most attractive for scientists, was an excellent tool to convince the funding agencies of international partners to commit for the construction phase, via new bilateral agreements (India, China, Sweden, Spain, Poland, Czech Republic). The attractiveness of SPIRAL2 for outside users should be improved by the proposed new infrastructures (deliverable: design for the building of a "Maison Européenne des Sciences").

Summary description of project context and objectives

SPIRAL2 (Second Generation System On-Line Production of Radioactive Ions) is a linear particle accelerator project for the study of fundamental nuclear physics and multidisciplinary research.

This facility, which is as large as the current GANIL installation, will produce the only beams of their kind in the world, starting in 2014.

The main goal of the SPIRAL2 Preparatory Phase was to develop and sign the consortium agreement allowing for the construction and operation of the facility as a fully international structure. The current legal structure of the GANIL is not compatible with the challenges of the international character of the SPIRAL2 project. The Preparatory Phase was aiming at its transformation into a European entity, by offering a concrete structure of partnership, but still taking into account the current legal structure of GANIL as GIE (Groupement d'Intérêt Economique) and Nuclear Base Installation (INB). During the renewal of the GIE in 2005,

The Members Assembly clearly stated that GANIL should evolve towards a European structure (cf art 1. VI of the Resolution adopted by the Members Assembly 01/19/2005: "The growing European Dimension of the GIE is inevitably leading it to evolve towards a European legal structure"). The above transformation was to be prepared by the coordinated activities of the SPIRAL2 PP General Assembly (representatives of all beneficiaries), Management Board (Coordinator and work-package leaders) and the International Steering Committee of SPIRAL2 (representatives of the involved funding agencies being at the same time responsible for the nuclear physics policy in their countries of origin). The latter committee will be progressively transformed during the Preparatory Phase into the decision-taking body for the new European GANIL/SPIRAL2 facility.

Although the Region Basse-Normandie and the French funding agencies (CNRS and CEA) are financing the investment to the extent of 80% for the baseline project, the remaining budget for the baseline project and its several important extensions (estimated cost 29.3M€) and for the new detectors (estimated cost 40M€), essential for the full exploitation of the GANIL/SPIRAL2 facility is not ensured today and entirely depends on the success of the Preparatory Phase. The EU contribution has a leveraging effect and that EU label is decisive in order to convince new investors. The operation cost of the facility including new instruments is to be taken into account in the funding strategy.

In this context, the Preparatory Phase dealt with the critical financial, legal and organisational issues related to the international character of the GANIL/SPIRAL2 facility during its construction and operation phases. The management structure of the SPIRAL2 Preparatory Phase is inspired by the organization anticipated for the future GANIL/SPIRAL2 consortium. Searching for scientific and funding partners implies a significant improvement of communication and direct contacts between international partners. In this context Preparatory Phase will establish, through official visits, meetings and workshops, solid links with the international partners, their funding agencies and the European Commission.

Several critical technical issues were addressed in order to construct the SPIRAL2 facility and associated instrumentation. The corresponding tasks were chosen in order to solve some remaining technical challenges as well as to attract efficiently European partners. In particular, the emphasis was put on the new instrumentation for SPIRAL2. This topic, being the most attractive for scientists, is an excellent tool to convince the funding agencies of international partners to commit for the construction phase.

The SPIRAL2 project aims at delivering energetic rare (radioactive) isotope beams with intensities not yet available from presently running machines. It is based on the ISOL method in which the radioactive nuclear reaction products formed by the intense stable beams are stopped and extracted from a thick target, mass separated and subsequently re-accelerated. The ISOL method allows the attainment of large intensities of Radioactive Isotope Beams (RIB) with energies ranging from keV to several tens of MeV per nucleon. The study of the properties of nuclei forming these beams or their interaction with stable nuclei is a rapidly developing field of contemporary nuclear physics.

The SPIRAL2 project is an intermediate step on the road to EURISOL, the most powerful, presently imaginable nuclear physics research facility, based on the ISOL principle. It is expected that the realisation of SPIRAL2 will enable a world-leading research programme in nuclear science and will substantially increase the know-how of technical solutions to be applied not only to EURISOL but also in a number of other European/world projects.

SPIRAL2 is based on a superconducting linear accelerator (the driver), able to accelerate deuterons up to an energy of 40 MeV with an intensity up to 5 mA, plus stable heavy ions of mass-to-charge

ratio $A/q=3$ with intensities up to 1 mA and energy about 14 MeV/nucleon. The fast-neutron-induced fission after the deuteron interaction with the carbon converter (up to 200 kW power released) followed by the Uranium Carbide target or alternatively the direct interaction of deuterons with the UCx target (up to 6kW power released) will be the main process for the radioactive species production. After their release from the target, the unstable, radioactive beams will be formed by on-line isotopic separation and directly used in the low energy experiments or post-accelerated in the already existing CIME cyclotron up to the energies of 15 MeV/nucleon. Besides the radioactive beams formed by the Uranium fission products, fusion-evaporation and transfer reaction products produced by heavy ion beams interacting with different thick targets will be available as well (these should also be available at low energy). Finally, the in-flight techniques using thin targets and light and medium heavy projectiles will be used.

From the scientific point of view the much larger impact of the new facility in comparison with those presently operating will come from

- a substantial increase (up to a factor of 100) in the intensities of the available radioactive species;
- the availability of a large energy range (from keV to several tens of MeV/nucleon) of the produced RIB's;
- the diversified methods of radioactive isotope production: fission induced by fast neutrons, fusion-evaporation residues produced
 - by very intense stable heavy ions or neutron rich RIB's, deep inelastic reactions of RIB's, fusion-evaporation residues produced inflight
 - by the thin target method;
- the already existing post-accelerator and beam lines as well as a number of currently operating or proposed new detectors like gamma-rays, charged particle and neutron detectors;
- the multi-user access to the radioactive beams (two users at the same time) with the simultaneous running of the existing stable beam accelerators (three stable beams at the same time), which will make GANIL/SPIRAL2 a real multi-user facility.

The scientific programme of the facility elaborated by more than 600 scientists from 34 countries proposes the investigation of the most challenging contemporary nuclear physics and astrophysics questions aimed at a deeper understanding of the nature of matter. The programme includes the studies of the structure of exotic nuclei, the investigation of nuclear dynamics with RIBs, the elucidation of some nuclear questions related to astrophysics and the quest of a new physics beyond the Standard Model.

An important part of the research will be based on the availability of intense, pulsed neutron fluxes ($\sim 10^{15}$ n/s) with peak energy around 14MeV. The material science research and the neutron induced reaction cross-section measurements using nTOF methods will be clearly connected to such European projects as the European Spallation Source, Accelerator Driven Systems or controlled fusion devices (ITER, DEMO).

Description of main S & T results/foregrounds

- WP2 – Coordination of the Preparatory Phase

- o Meeting administration

The meetings administration at the University of Surrey (UNIS) has supported the organisation of collaboration and coordination meetings by work package and task leaders, providing information on available funding in advance of meetings and afterwards, ensuring prompt reimbursement to participants and providers of facilities.

Coherence in the meetings administration process is ensured by regular liaison between UNIS and the Management Group at GANIL over the practical implementation of the reimbursement procedure. The main on-going joint task is liaising over the costs incurred by GANIL for supporting SPIRAL2-PP meetings based in France, which are recovered from the project through periodic consolidated invoices from GANIL to UNIS.

An additional role of the administrator at UNIS has been to collate information relating to each