	EUROPEAN COMMISSION RESEARCH AND INNOVATION DG	Final Report

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Project Acronym: SPIRAL2PP

Project Full Name: SPIRAL2 PREPARATORY PHASE

Final Report

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Final Report

PROJECT FINAL REPORT

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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 if 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 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 fo 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 (~ 1015 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

meeting (i.e. minutes, attendance lists, individual reimbursements made) from which it has been possible to continue to build the meetings database giving an overview of activity and expenditure on meetings for each work package and task, hence providing a vital management tool.

More than 100 collaboration, coordination and management meetings have been held during the SPIRAL2 Preparatory Phase, ensuring the good collaboration between teams spread over 13 countries or more.

o SPIRAL2 Weeks

Five editions of the SPIRAL2 Week were in Caen, France. The main goal of the meeting was to present and discuss the current status of the SPIRAL 2 project in front of a large community of scientists and engineers. The programme of the meetings included presentations on scientific and technical developments related to the baseline project and the new instrumentation for experiments. The copies of presentations are available on the professional version of the SP2 web site at http://pro.ganil-spiral2.eu/events/sp2/.

Each edition was a great success as more than 350 physicists, engineers and technicians participated in this event. The SPIRAL2 PP project participated, along with GANIL and SPIRAL2 project, in the organization and the budget of the SPIRAL2 Week.

o Organisation of a Joint Event

The international conference “EURORIB’08” was held from 9th to June 13th 2008 in Giens (France). The collaborations built around the future facilities – NUSTAR@FAIR, SPIRAL2@GANIL, HIE-ISOLDE@CERN, SPES@LNL and future EURISOL – have jointly organised this scientific event, gathering 200 participants. They presented new experimental and theoretical ideas that will advance our understanding of nuclear structure through studies of exotic nuclei. It was also an occasion to explore the synergies within the research programmes based around the different accelerator projects.

The second international EURORIB conference, EURORIB’10, was held from 6th – 11th June 2010 in Lamoura, France and the third EURORIB conference, EURORIB’12, will be organised in Abano Terme, Italy, from May 21 to 25, 2012.

o Implementation of a collaborative website

The address of the collaborative web site is http://www.spiral2pp.eu/. Information available on the site includes: project contacts; work plan; financial information; schedule and budgets for collaboration, coordination meetings for all work packages/tasks; minutes of meetings and lists of participants; job offers; press and events information.

o External communication about SPIRAL2

A Web site has been established aimed at presenting information to the layman about the SPIRAL2 Facility. The site is hosted at GANIL and is available as http://www.ganil-spiral2.eu/spiral2. GANIL/SPIRAL2 staff is responsible for the setup and functioning of the site, as for the content.

The Web site provides basic information about the project: physics key issues, technological challenges, international partners, future. News, pictures and agenda of SPIRAL2 are also presented.

The Web site is available in French and in English.

Web site: http://www.ganil-spiral2.eu/spiral2
http://www.ganil-spiral2.eu/spiral2-us?set_language=en

In the same goal, a general public brochure for a large audience was edited, as posters on the

GANIL-SPIRAL2 facility.

o Communication with agencies

During the Project, the SPIRAL2 PP team had regular contacts with French national agencies (CNRS/IN2P3 and CEA/DSM) and the European Commission (invitations to SPIRAL2 Week, meetings in Brussels).

Several agreements (MoU's, LIA's, LEA's, etc) are currently going on or were signed during the Project with various partners as Germany, Italy, India, Romania, Israel, Russia, USA, Bulgaria, China and Sweden.

The SPIRAL2 PP collaboration participated in EURISOL, NuPECC, and NuPNET meetings.

- WP3 – Legal Aspects

The current legal structure of GANIL is a GIE (Groupement d'Intérêt Economique) that is constituted of French members (CEA/DSM and CNRS/IN2P3). GANIL firmly stated that it has to improve the conditions of the participation of its international partners during the operation of the future facility GANIL/SPIRAL2. This evolution will integrate the partners more strongly into both the governance of the project construction and of the facility.

GANIL has established a contract with a firm of legal advisors in order to provide a draft of the consortium agreement for GANIL-SPIRAL2.

The result of this collaboration and the combined work of legal services at GANIL and its parent bodies is the report on studies about the legal development of GANIL.

A text of a Memorandum of Understanding for the construction of SPIRAL2 has also been prepared and approved by GANIL parent bodies – CEA and CNRS.

- WP4 – Financial aspects

One of the principal aims of this work package was to elaborate a first draft of the business plan for the SPIRAL2 baseline project. Contacts with partners in order to discuss the possibilities of participation in the financing are going on.

Concerning the operation and dismantling of the GANIL/SPIRAL2 facility, the estimation is not completed yet. The different options funding will be study as soon as the thought about the future legal status of GANIL/SPIRAL2 facility will be finalized.

The international financial contributions to the new instruments for SPIRAL2 have been defined within the Memoranda of Understanding and the Collaboration Agreements signed for each instrument.

- WP5 – Instrumentation for SPIRAL2

o DESIR

The DESIR facility is one of the new large installations proposed for SPIRAL2. The idea of the DESIR facility is to use the low energy beams delivered by SPIRAL and SPIRAL2 before acceleration. Therefore, a large experimental hall will accommodate the instrumentation needed to

perform the ISOL type experiments envisaged at DESIR.

Through SPIRAL2 PP, the DESIR collaboration has developed a MLL trap (double Penning trap facility designed to combine several novel technologies to purify, charge breed, (laser-) cool and bunch radioactive species and perform high-accuracy nuclear mass measurements as well as in-trap or trap-assisted spectroscopy studies) and the design of the DESIR beam lines and switchyards. The design of the High Resolution Spectrometer has also been finalised.

The DESIR Collaboration Agreement has been signed between main partners of the DESIR project.

o EXOGAM2

The goal was the consolidation the High Resolution Gamma-ray Spectroscopy (HiReGS) collaboration through the development of new, fast digital electronics for the EXOGAM gamma-ray detector array installed at GANIL.
The EXOGAM array is an ensemble of 16 Hyperpure germanium detectors, each being surrounded by an anti-Compton suppression shield. In the context of the future SPIRAL2 facility, the international Scientific Advisory Committee “urged the community to equip EXOGAM with digital electronics”, which will ensure high quality signals needed to study gamma rays from reactions induced by the SPIRAL2 beams.
To achieve the goal, several points have been achieved:
- Evaluation of the realistic performance of EXOGAM detectors using pulse shape analysis; realistic simulation calculations
- Evaluation of the ADONIS method with resistive preamplifiers (the ADONIS technique is a new technique designed to perform measurements with the HPGe detectors up to very high count rates with low dead time, whilst preserving good resolution of the Ge detectors). Tests using pulser, sources will be conducted. Essential part of the evaluation will be carried out using in-beam measurements.
- Implementation of the ADONIS algorithm in the EXOGAM2. Architectural implementation and methodology solution will be developed to deliver the gamma-ray energy on an event-by-event basis.
- Modification of the existing preamplifiers and motherboards on Clover detectors to ensure high quality of the signal delivered by the preamplifier.
- Definition of design specifications for EXOGAM2: digitizer; synchronization and triggering with ancillaries; readout and data acquisition system. An important point here is to ensure a large overlap between the AGATA and EXOGAM2 developments.
- Implementing the pulse-shaping algorithm into an FPGA for charged particle discrimination with CsI detectors. An FPGA-based new instrumentation with four digitizing channels has been designed, which has to be interfaced to an improved version of DIAMANT-style CsI(Tl) detectors. The pulse-shaping algorithm is based on the existing analogue solutions.
- Completion of the prototype and its tests and implementation.
- Preparing and signing the Memorandum of Understanding for EXOGAM2 and for the use of AGATA at GANIL.

o FAZIA

The FAZIA collaboration has performed many developments within the SPIRAL2 PP project for the new 4# detector for studies of reaction mechanisms, FAZIA:

- PSAS (Pulse Shape Analysis in Silicon): for the low-energy charged particles expected at SPIRAL2 a significant reduction of identification thresholds is essential. Pulse Shape measurement of the charge and current signals in Silicon detectors for stopped particles is expected to give a significant improvement, namely identification up to Z~70 and A~50, also using Time of Flight.
- ToF: the time resolution anticipated for the SPIRAL2 beams (few ns) is not sufficient for Time of Flight resolutions necessary to improve the mass identification of stopped particles. We plan to implement a time synchronization of the Silicon Detectors with fast pulses from a UV laser.
- FND: Study of the feasibility of neutron detection exploiting a special configuration of the charged particle telescope under study (SCT). Use of the Silicon element of SCT as a veto for neutral detection in the scintillator.
- SiRe: simulations of nuclear reactions induced by RNB at SPIRAL2 to define the large solid angle

detector array necessary for the physics addressed in the FAZIA LoI at SPIRAL2. These simulations proceeded along with the advances on the detector side, to make them as realistic as possible. A detailed study was also performed to couple the detecting elements of FAZIA with existing apparatus.

o GASPARD

During the SPIRAL2 preparatory phase, working groups have been set up to begin the final detailed design study. In parallel, some effort in RTD was required to help to specify very basic aspects of the design concerning silicon strip technology. A key issue has indeed been identified in view of the final design of GASPARD. For the identification of low energy light charged particles, promising developments in pulse shape analysis (PSA) from solid-state devices needed to be assessed with regard to particles detected with thin (~50mm) highly segmented silicon layers. The RTD consisted of physics modelling of the detailed silicon response under various segmentation topologies. This had direct implications on the performances and design of GASPARD and eventually its modular design and coupling with other major devices like AGATA.

The GASPARD collaboration produced a preliminary design study of GASPARD and a report on silicon response modelling. This led to a test of GASPARD modelling.

- PARIS

Design work was carried out into the layout of a prototype detector. This consisted of an inner part comprising a novel material such as LaBr3(Ce) in conjunction with an outer part comprising an existing material such as a large BaF2 crystal. Following this initial design, scintillator materials and photomultiplier tubes of appropriate dimensions were purchased and testing and evaluation were carried out. These materials were collected centrally and constructed into the prototype detector. In order to test, in particular, the high-energy response of the detector, in-beam tests were carried out. The results of the testing were used to benchmark the outputs of a GEANT4 simulation carried out in parallel. The scaling-up of the prototype to a full calorimeter was explored. In turn, the tests and simulations informed the design towards the latter part of this project of a series of possible calorimeter scenarios in CAD form.
Emphasis in this design was given to mechanical compatibility with other arrays such as e.g. AGATA or GASPARD.

o NFS

- Instrumentation and data acquisition for NFS
The goal was to gather all existing data on instrumentation and data acquisition systems presently used at different n_TOF facilities, to examine their potential use for experiments planned at NFS, and finally to identify new specific RTD needed in this respect.
Some of the experiments proposed in the Letter Of Intent (LOI) required detailed studies. The study of the fission process will needs a special effort in detection and (A, Z) identification of fission fragments. The light charged particle (lcp) detection in the (n,lcp) reaction from threshold to 50 MeV will need special adaptation of existing facilities.
- Neutron production targets
Dedicated neutron production targets were optimized providing both the white neutron energy spectra (from 0.1 MeV to 50 MeV) as well as quasi-mono-energetic neutrons.
- Collimation of neutron beam
Once the neutrons are produced on the production targets, an efficient neutron beam collimator has to ensure a high quality beam delivered in the experimental hall. Different materials and their geometrical configuration were used and optimized for characteristic energy spectra of neutrons expected at NFS, namely from 0.1 MeV up to 50 MeV. The work was mainly done using Monte Carlo methods to design the collimation system that will provide the required neutron beam dimensions in the experimental hall including the best signal to noise ratio.
- Monitoring of neutron beam
For all physics experiments at NFS a precise characterization of the neutron beam is necessary. Fission chambers and/or BC501 liquid scintillators can of course be used for neutron flux measurements but a dedicated on-line beam-monitoring detector based on Micromegas technology

seems to be the most attractive option. In brief, this gas detector is based on converting incident neutrons into charged particles or fission fragments and subsequently detecting them. It has the advantage of allowing a measurement of the neutron beam profile. The work consisted of adopting the best-suited materials-converters and detector geometry for NFS neutron beams and specific background environment (e.g., gamma field). Once the prototype was constructed, it was tested at different mono-energetic neutron sources covering the expected neutron energy range of NFS.
- Digital Acquisition System
Digitized acquisition systems have developed recently. They allow high counting rates, low dead times, an easy transfer to computers and sometimes even a first on-line analysis. However they are fairly specific and have to be designed considering:
- the type of detector, especially the rise-time of its signal
- the characteristics of the beam, such as its frequency
- the data which have to be measured, and the required precision
A prototype was designed to investigate the possibility to adapt this concept to a new card based on 12 bit 500MS/s digitizers, run by a common clock with the existing cards. A system based on the two kinds of cards could cover all requirements of most experiments at NFS.

The NFS Memorandum of Understanding was signed between the main partners of the NFS project.

o S3

The S3 collaboration focused on two major aspects of the spectrometer: the optics and the target.
The optics of the spectrometer is naturally a fundamental aspect of the project. A preliminary study was established as a detailed proposal for the spectrometer set-up.
The target is another critical aspect of the subject since it has to sustain unprecedented intensities. For physics requirements, it is essential to strip the 14 MeV/A ions. The main objective was to study and propose technical solutions for stripping high power ion beams: stripping foils (resistance to beam) or atomic or molecular cluster targets (H2, He…)
Any target type needs dedicated equipment for its environment (pumps, valves, diagnostics…). This equipment was used for the test of the different target types (rotating wheel, gaseous targets…) that was developed outside the frame of this Project.
The S3 collaboration produced a complete detailed design study.

An agreement was signed between the French partners of the S3 project for a funding provided by the French government.

o NEDA

To satisfy the requirements for the Neutron Detector (NEDA), a new design study of the detector geometry was performed in order to optimize the granularity and the solid angle coverage together with the time of flight performances. In addition to the use of standard liquid scintillators, new detector materials, with better response functions and better energy resolution for detection of neutrons were tested. Digital electronics, using a fast sampling ADC, were used for direct digitization of the detector signal.
Since the good discrimination of neutrons and gamma rays is particularly important due to much increased gamma-ray background on radioactive ion beams, efficient pulse-shape algorithms for discrimination of neutrons and gamma rays, neutron scattering reduction, pile-up rejection etc., were developed.

The NEDA collaboration studied the detector materials, the design development, and the Monte Carlo simulations. The design of the detector device was performed. Source and in-beam tests of the new/commercial prototype were also done during the SPIRAL2 Preparatory Phase. Eventually, the NEDA collaboration completed tests of the digital electronics.

o ACTAR

Direct reactions will be one of the highlights of the SPIRAL2 facility. New regions of the nuclear chart will become accessible to test the evolution of shell structure far from stability. The energy range will be ideally suited for transfer reactions and resonant scattering. The plan is to investigate

this domain with the original and unique method of an active target. The extremely low energy threshold and the high efficiency of an active target detector make such a device complementary to more classical detectors such as charged particles arrays of Si-Si(Li)-CsI telescopes (MUST, MUST2, TIARA…). The “niche” for experiments with an active target corresponds to reactions where the fragments have such a low energy that they cannot get out of a standard target, of reasonable thickness, and to reactions exploring the most exotic regions, where the low counting rates can be counterbalanced by the relative large thickness of the active target, typically one or two orders of magnitude larger than standard targets.
The aim of the ACTAR collaboration is to build a new active target detector dedicated to experiments on direct and resonant reactions with SPIRAL2 beams. The new detector will benefit from the expertise gained with the MAYA active target at GANIL, and TACTIC at TRIUMF. The ACTAR collaboration gathers laboratories with various types of know-how in all the domains related to the development of gas detectors and associated electronics, data acquisition, and ancillary detectors.
Within the SPIRAL2 Preparatory Phase, the ACTAR collaboration defined the sharing of tasks responsibilities and finalised a conceptual design of the ACTAR detector. A collaboration Agreement was signed by the main partners of the ACTAR TPC project.

o Instrumentation Coordination Committee

The ICC ensured assistance in preparing and signing the consortium agreements for each instrument. The ICC will provided coordination of activities conducted within various RTD programs that are addressed to the instrumentation for SPIRAL2.
The role of the ICC was to ensure the synergies and coordinate efforts between 8 major collaborations on new detectors in order to reach RTD milestones and sign corresponding MoUs by organising specialised technical working groups on electronics and data acquisition and collaboration bilateral or general meetings.
The ICC was organised in a close collaboration and reported to Scientific Advisory Committee of SPIRAL2.
The representative of GSI participated to the Instrumentation Coordination Committee in order to exploit the synergies with NUSTAR/ FAIR, EURISOL and currently operating facilities.

- WP6 – The Linear Accelerator

o Beam Loss Monitor (BLM)
The Beam Loss Monitors are essential components for most high-power accelerators around the world, aiming to protect the accelerator components from high activation and from beam damage. In particular for SPIRAL2, the aim is to avoid quenching of the superconducting cavities.
In order to achieve these goals, a BLM has to:
- measure with the maximum possible accuracy the intensity and position of beam losses, providing data for beam tuning and
beam loss minimization,
- deliver a fast signal to stop the beam when beam losses increase above a given threshold.
The BLM systems consist of detectors of different types, sensitive to escaping beam particles or to secondary particles produced in interactions with accelerator components. Taking into account the ions, the energies and intensities of beam losses expected for SPIRAL2, the BLM here developed is based on plastic scintillators sensitive to gamma and fast neutrons.
Difficulties in the design arise from the strong dependence of neutron and gamma emissions on beam energy and emission angle, as well as from absorption or scattering of emitted radiation on accelerator components. The flux of X-rays emitted at the level of superconducting cavities and the high frequency electromagnetic noise generate background that has to be minimized in order to improve detector sensitivity.

o Low Energy Beam Transport-line (LEBT) Chopper.
The chopper is the device allowing for changing the beam intensity during the commissioning and tuning phases of the accelerator. It will play also an essential role for the safe and reliable operation of the Driver Accelerator adjusting the beam power needed at the experimental sites (RNB

production, stable beams experiments, etc).

The collaboration working on the LEBT Chopper provided the design and the prototype for this chopper.

o Beam Dump for the SPIRAL2 Driver Accelerator
The purpose was the design of a Beam Dump for the SPIRAL2 Driver Accelerator. Installed at the exit the SC Linac, in one of the High Energy lines, it must allow different types of beam tests during the commissioning, routine operation and maintenance phases of the accelerator. One of the more critical aspects of this design is to define the maximum power handled by this device for the different beam particles and energies available at SPIRAL2 (deuterons 40 MeV, protons 35 MeV, and heavy ions at 14.5 MeV/A). This component must fulfil the safety regulation goals of the facility (authorization procedures), in terms of shielding, materials activation and handling.
The work on the Beam Dump included:
1) Definition of the maximum beam power for each particle: optimization of beam power needs for the different phases of the Linac operation.
2) Calculation of beam activation for different materials. Beam tests of samples at dedicated facilities
3) Definition of the geometry and position in the beam line: beam dynamics study, thermo-mechanical calculations and cooling
4) Definition of the associated beam diagnostics needed to control the Beam Dump for a safe operation
The overall idea was to develop two parallel beam dump designs, one based on a low risk approach and the other one with more advanced proposals including different materials, different working temperatures and/or different power densities.

A construction agreement has been signed between partners.

o Tests of ion beam diagnostic systems for SPIRAL2 facility
Different types of beam diagnostics will be used at the SPIRAL2 facility during the commissioning period and routine operation.
The diagnostic instrumentation must provide sufficient information for the facility operation including the machine safety. Such diagnostics include: beam profiling, monitoring of beam position, beam loss, beam halo etc. The high intensity of SPIRAL beams presents numerous challenges for beam diagnostics.

Phase I of SARAF corresponds to a few mA proton beam with energy up to5 MeV (only weak deuteron beams are planned to be used at Phase I) delivered, as in the case of SPIRAL2, by a linear accelerator with superconducting cavities.
Availability of these beams presents a unique possibility for testing versatile diagnostic equipment that is being developed at several laboratories for the SPIRAL2 accelerator. The result of these studies will facilitate decision-making regarding beam diagnostic tools to be installed at the SPIRAL2 facility.
In order to perform the tests, a special experimental station was built. The station had to satisfy the following demands:
a. flexibility to perform a number of different applications
b. to be as short as possible to minimize the section of the beam line without focusing elements
c. to satisfy high vacuum standards.
One of the main elements of the station is a load-lock chamber for prompt and safe introduction and replacement of samples.
The chamber has a gate valve, separate pre-pumping and venting possibility. The samples will to be introduced into the beam by a linear motion feed-through. The samples have to be electrically isolated and with a water-cooling option.
The main diagnostic devices that are proposed for tests are:
- residual gas monitor, an elegant and interesting device that allows for non destructive beam profile measurements based on ionisation of residual gas. The main question is if the relatively high vacuum associated with cryogenic resonator will provide a good environment for the residual gas technique. An artificial weak leak of He inert gas could be introduced in the chamber to verify the monitor performance.
- beam position monitors. A beam position monitor (BPM) based on capacitance pick-ups electrodes

is being developed and tested for theSPIRAL2 facility. At SARAF, the performance of BPMs can be tested as a function of beam current, bunch structure and energy. If two BPMs are used they could be crosschecked against each other. Simultaneous use of BPMs and a residual gas monitor also could be useful for cross-calibration of both devices. Moreover the use of two BPMs may allow one to obtain some estimate of the beam energy using a time of flight technique.
- diamond detectors. (TBD) These are small, fast and radiation-hard solid-state detectors for charged particles that could be used to measure the beam energy resolution and bunch width at low beam intensities or as beam halo monitors at high intensities.
- fluorescence monitor, a device that also allows for non destructive beam profile measurements based on the fluorescence emitted by the residual gas. In this case it is also important if the relatively high vacuum associated with cryogenic resonator provides enough light emission for this technique. An artificial weak leak of He inert gas (or maybe others) could be introduced in the chamber to verify the monitor performance.

o Single bunch selector
The SPIRAL2 accelerator frequency is 88.0505 MHz. This value is too high for some physicist experiments and it is required to reduce the rate of bunches at the experimental target. It is extremely important that only one bunch at slower rate reaches the target, with no residual particles of the suppressed bunches.
The single bunch selector is essential in order to start the experimental program with the SPIRAL2 facility, as it is required since the first experiments with the new SPIRAL 2 beams. The experimental facility NFS requires for instance a bunch rate reduction ranging from 1/100 to 1/10 000.
Three main subsystems compose the whole device:
1. Line section with
• Electrodes
• 100 Ohm distribution line
• Pulse generators and dummy loads
• Control electronics (taking care of the synchronism between the two generators, of the alarm board and of the computer control interface).
2. Deflecting static magnet (Steerer)
3. Beam dump

The design study focused on the vacuum chamber and electrodes:
• Understanding whether the different behaviour comes from simulation error or simulations limitations,
• Designing the RF interface between the meander line itself and the connectors out of the vacuum chamber,
• Prototyping a whole set equipped with electrodes and connectors.

- WP7 - Production of Radioactive Nuclear Beams

o Production of light RNB (GANIL)
The aim was to investigate the production and extraction yields of He-6 from a Be target which will be designed on the basis of detailed computer simulations. This isotope is chosen since it has a wide interest in nuclear physics, nuclear astrophysics and as a candidate for a future beta-beam facility. The He-6 production is based on the neutron converter technology which could also be used for the production of several light radioisotopes 8Li via the 11B(n,a)8Li reaction. It will enlarge the SPIRAL2 RIB experimental opportunity to deliver light isotopes that are of high interest in astrophysics.
Therefore, the preliminary design of a demonstrator target has been produced.

o RNB from fusion-evaporation reactions
The high-intensity heavy-ion stable beams delivered by the SPIRAL2 driver accelerator are well suited for production of proton-rich radioactive beams through fusion-evaporation reactions, as well as neutron-rich RNBs through multi-nucleon transfer and deep-inelastic collisions. To exploit this possibility, it was performed the study of the key component of
the production system in the ISOL method, namely the target/ion-source assembly adapted

specifically to the fusion-evaporation mechanism, and also to propose a basic design of the whole production system and to provide a first cost estimate.
The work on RNB production from fusion-evaporation included:
- development of a computer code for calculating in-target yields for different geometries and different target-projectile combinations, as a tool for rough estimation of radioactive beam intensities and for determination of optimal values of parameters such as target thickness, incident beam energy, etc.
- calculation for multi-nucleon transfer and deep-inelastic collisions.
- experimental and theoretical thermal studies of target/ion-source assemblies
- experimental validation of prototypes on a test bench using high intensity and focussed beams of light ions
- production yield measurement of a number of proton-rich isotopes for a target/ion-source assembly using stable heavy ions beam delivered by an electrostatic accelerator.

o d # n Converter
In the SPIRAL2 facility the neutron converter has to produce an intense flux of fast neutrons, mainly in the forward direction with respect to the incoming deuteron beam, enable to induce up to 1014 fissions per second in the Uranium Carbide target located upstream of the converter. The primary beam is constituted by deuterons of energy 40 MeV and current 5 mA (200 kW). The neutron converter is conceived as a high speed-rotating target, which limits the peak surface temperature of converter materials well below 2000 °C. Graphite made of natural carbon has been chosen as converter material. The converter lifetime has to be at least three months. Operational conditions at lower power (50 or 100 kW) are also important and these will fix the sizes of the wheel and the beam spot on the carbon converter.
The thermal power (200 kW) deposited in the converter material is dissipated only by thermal radiation. Heat removal from the vacuum chamber is carried out by water circulating inside copper cooling channels, fixed to the chamber's walls. As an alternative to the water-cooling system, a liquid lead system may provide a more efficient and safe power dissipation at full
operation conditions. Hence, a liquid lead cooling system and a rotary system integrated with the neutron converter will also be investigated.
Removal of the converter assembly has to be performed only by a remote handling device. The disassembly of the converter and part replacement, or conditioning of elements, has to be conducted inside a hot-cell to ensure that the radioactivity is confined.
The vacuum system has do be properly designed for efficient evacuation while avoiding, as much as possible, activation and contamination of the pumps.

Three main actions have been performed to develop the converter:
1. Design of neutron converter and radiation hardening
2. Integration of the neutron converter with other sub-system
3. Delay window: construction of the prototype

This work was concluded by a report on the conceptual design and cost estimate of the neutron converter.

- WP8 – Infrastructures of SPIRAL2

o Preparatory Work for the construction of the “Maison Européenne des Sciences”
The Users Representatives group of the present GANIL facility has received several requests from users, in order to upgrade the present guesthouse to proper European standards. At present, the guesthouse provides about 36 rooms with a common bathroom area (showers and toilets). No facilities are included for handicapped persons (e.g. access with a wheel chair is impossible). Following the request of the growing international users group, the plan was to construct a new guesthouse according to the European standard (with shower and toilet in each room, a few rooms equipped for handicapped persons, a few double rooms for users bringing a partner, and so on).

The market survey, estimating the carrying out and running of the “Maison Européenne des Sciences” has been performed by specialised firms. However, the lack of funds of one of the main contributors has as consequence the cancellation of the project.

o Implementation of SPIRAL2 (GANIL)
The goal was to produce a coherent design of the SPIRAL2 buildings (Accelerator building, Production of Radioactive Nuclear Beams building and DESIR building) in order to implement them at the GANIL site.
The site infrastructure has been conceived around the basic version of the project and all the short-term options. However, the planned facilities have been designed to make provision for possible future extensions, such as a 100-MeV/u linac or an extension of the experimental areas. The infrastructure also takes into account the data provided by those responsible for the design of the equipment and the constraints imposed by the safety regulations.
In particular, the measures needed to satisfy the safety regulations require rigorous study, which was carried out by a SPIRAL2 project group. Finally, the complete optimisation of the building design taking into account users, safety and technical requirements was done by the industrial sub-contractor in close collaboration with the SPIRAL2 project group.

The construction of the SPIRAL2 buildings started in 2011.

o Radiological Shielding Optimisation
Instruments with higher and higher performances are needed to continue to make progress in fundamental physics since the basic phenomena are more and more difficult to observe and understand. When a “light” is needed for matter studies (lasers, synchrotron radiation sources, neutron sources, accelerators for nuclear or particle physics…), performance increase means higher beam brightness. The beam intensities must be higher and higher leading to more and more difficulties associated with radioprotection and material activations (safety issues, construction and deconstruction costs).
The optimisation of the radiation shielding needed for SPIRAL2 and the new generation of high power particle accelerators for fundamental research is then a serious issue. This is also the case for particle accelerator applications such as sterilisation, radioisotope production for medicine, radiotherapy, hybrid systems for nuclear waste transmutation…
A promising concept of radiation-shielded building construction technique has been recently developed in Germany by Jan Forster from Forster Bau GmbH with the help of Prof. Dr. Reinhold G. Müller from UNI-ERLANGEN. This “sandwich method of construction” is based on the use of low cost materials filling the gap within two prefabricated concrete thin walls.
The goal was to optimise the sandwich method of construction in terms of choice and arrangement of the sandwich materials and, with respect to standard concrete shielding, produce an evaluation of the sandwich construction method in terms of:
- radiation shielding efficiency,
- material activation,
- construction cost,
- flexibility for the evolution of the facility,
- deconstruction cost.

In addition, a study of seismic impacts on concrete was performed during the SPIRAL2 Preparatory Phase.

- WP9 - Consortium Agreement for the European GANIL/SPIRAL2 facility

o Writing of the GANIL/SPIRAL2 Consortium Agreement
The Project Coordinator, using all the work done in the other work packages of the Preparatory Phase and the decisions taken during the different meetings organized during this Phase, prepared an initial version of the GANIL/SPIRAL2 Consortium Agreement, with the help of the legal services of the partners and of the study of the legal cabinet contracted for WP3.

The result of these studies was a Memorandum of Understanding for the Construction of SPIRAL2.

This Memorandum of Understanding was validated by the General Assembly of the SPIRAL2PP.

o Contact with new partners

Several meetings and visits essential for the strengthening and the formalization of the new collaborations were organised by the Coordinator. New potential partners were identified and invited for negotiations.

o Negotiation with the partners
The GANIL parent bodies – CEA and CNRS – validated the Memorandum of Understanding for the Construction of SPIRAL2. Even though the initial text of this agreement is the result of the work done in the other work packages, some articles need to be discussed again during the negotiation phase.
The negotiations are organised both via bilateral meetings of the representatives of GANIL and European partners.

o Signature of the GANIL/SPIRAL2 Consortium Agreement by all members
The Coordinator has prepared the final text of the Memorandum of Understanding for the Construction of SPIRAL2. The text has been validated by the SPIRAL2 PP General Assembly.

A signature Ceremony will take place at GANIL.

Potential impact and main dissemination activities and exploitation results

Potential impact

Following the Lisbon Strategy, SPIRAL2 will be a highly efficient and relevant tool to support the knowledge growth in the European Community. It is also stimulation and necessary demonstration phase for future projects, and a source of technology transfers as well as training of scientists, preparing them to the next generation of accelerators. The increase of the know-how will not only benefit to the EURISOL project – the next generation of Nuclear physics Infrastructures – but also to several European/world projects. In particular, the fast construction of SPIRAL2 was recommended as a necessary intermediate step for EURISOL in the Roadmap of NuPECC, the expert committee of the European Science Foundation in matter of Nuclear Physics.

Here SPIRAL2 serves as a test bench for the following issues:
- construction and operation of the heavy-ion high power linear accelerator, which tested technical issues related to the EURISOL driver and post-accelerators,
- development of high power converter and targets – key point for the whole EURISOL concept,
- construction of the facility infrastructures solving in a cost effective way problems related to safety and radioprotection.

By hosting a world-leading facility for basic research, maintaining the “open access policy”, Europe helps retaining its trained scientists and engineers and attracts expertise from outside Europe. The complementarity of SPIRAL2 with the Research infrastructure NUSTAR/FAIR at GSI, and the strong links established between the two facilities, will also be an advantage for the European nuclear physics research.

SPIRAL2 will contribute to the physics of nuclear fission and fusion based on the collection of unprecedented detailed basic nuclear data, to the production of rare radioisotopes for medicine, to radiology and to material science. The scientific programme of the facility is focused on the investigation of the most challenging contemporary nuclear – and astrophysics questions aiming at the deeper understanding of the nature of matter. The programme includes the studies of the structure of exotic nuclei, the investigation of nuclear dynamics, the elucidation of some nuclear questions, related to astrophysics, the quest of a new physics beyond the Standard Model.

The important part of the research will be based on the availability of the intense, pulsed neutron fluxes. The material science research and the research on neutrons will be clearly connected to such European projects like European Spallation Source, Accelerator Driven Systems or controlled fusion devices (ITER, DEMO).

The reinforcement of such a Research Infrastructure in Caen (Basse-Normandie) will also contribute to the achievement of the balanced territorial development within the European Research Area. GANIL/SPIRAL2 facility is the only world-leading large research infrastructure in this region of

France. The SPIRAL2 facility will increase a number of mostly European researchers coming for experiments and research training by about 50% thus even more than before, GANIL/SPIRAL2 together with associated local partners and laboratories (CIRIL, CYCERON, LPC Caen, University of Basse Normandie and others) will constitute a research-based cluster of excellence.

The catalytic effect of GANIL on Research in Basse-Normandie is already recognized by the Regional Economic and Social Council ("L'avenir européen du GANIL", December 2002). It is considered as an example of successful implementation of a structuring facility, with technology transfer activities. It contributed to the scientific and technologic development of Caen, to the emergence of the Technopole SYNERGIA and to the notoriety of the Basse-Normandie research. The strong participation of the Region to SPIRAL2 and even to the Preparatory Phase is evidence of this support.

The European Commission contribution has a leveraging effect and helps obtaining the additional funding necessary for the construction of SPIRAL2. The project has already explored extensively the French national mechanisms in order to find resources. Two SPIRAL2 facilities, S3 and DESIR, have been selected as « Equipement d'Excellence » and obtain strong Financial support from the French government.

The Preparatory Phase was an essential tool to attract new partners with tasks appealing to them in Research & Development topics.

The preparatory phase was also an excellent inducement for French and international partners in accelerating the structural evolution of GANIL and SPIRAL2.

Main dissemination activities

The dissemination activities of the Project are mainly performed by the SPIRAL2 PP web site, the numerous meetings of the Project and the participation in the organisation and the funding of international conferences:

• Publications:
o "The PARIS project" by A. Maj et al, Acta Phys. Pol. B40, 565 (2009)
o "Measurements of high-energy #-rays with LaBr3:Ce detectors" by M. Ciemala et al., Nucl. Inst. Meth. A, 608(2009) 76
o "Production of short lived radioactive beams of radium" by P.D. Shidling et al., Nucl. Inst. Meth. A, 606(2009) 305
o "SPIRAL2-DESIR Physics Workshop, Leuven, May 26-28, 2010" by B. Blank et al., Nuclear Physics News, 20, 3(2010)33
o "New digital techniques applied to A and Z identification using pulse shape discrimination of silicon detector current signals" by S. Barlini et al., NIM A 600 (2009) 644
o "A method for non-destructive resistivity mapping in silicon detectors" by L. Bardelli et al., NIM A 602 (2009) 501
o "Influence of crystal-orientation effects on pulse-shape-based identification of heavy-ions stopped in silicon detectors" by L. Bardelli et al., NIM A 605 (2009) 353
o "An artificial neural network based neutron–gamma discrimination and pile-up rejection framework for the BC-501 liquid scintillation detector" by E. Ronchi et al., NIMA 610 (2009) 534
o "Digital pulse-shape discrimination of fast neutrons and gamma rays" by P.-A. Söderström et al., NIMA 594 (2008) 79
o "Description of current pulses induced by heavy ions in Silicon detectors" by M. Parlog et al., Nucl. Inst. Meth. A, 613(2010) 290

• SPIRAL2 Weeks:

The SPIRAL2 Weeks 2007, 2009, 2010, 2011 and 2012 were held in Caen (France).

The main goal of the conferences is to present and discuss the current status of the SPIRAL 2 project in front of a large community of scientists and engineers.

The program of the conferences includes presentations on scientific and technical developments related to the baseline project and the new instrumentation for experiments.

The international scientific community shows a very high interest for the SPIRAL2 Weeks: each edition gathered close to 400 participants.
SPIRAL2 Weeks web site: http://pro.ganil-spiral2.eu/events/sp2

• EURORIB conference:

The international conference “EURORIB’08” was held from June 9th to June 13th, 2008, in Giens (France).
Our nuclear physics community is eagerly awaiting the construction of the next generation of Radioactive Ion Beam (RIB) facilities in Europe: NUSTAR@FAIR, SPIRAL2@GANIL, HIE-ISOLDE@CERN, SPES@LNL and future EURISOL. The collaborations built around these facilities are exploring new experimental and theoretical ideas that will advance our understanding of nuclear structure through studies of exotic nuclei. The Giens meeting provided the opportunity for the different collaborations (200 participants) to come together, present these ideas and explore the synergies within the research programmes based around the different accelerator projects.
The 3rd edition of the EURORIB conference will be held in Italy, in May 2012.

EURORIB web site: http://eurorib08.ganil.fr/

• The Coordinator organised on February 23rd, 2009, in Caen, a forum on European Projects in order to present the SPIRAL2 PP Project.

• The Project participates in the external communication about SPIRAL2: developing a new public website (http://www.ganil-spiral2.eu/), editing posters and brochures, a page dedicated to SPIRAL2 on Wikipedia with the intervention of trainees contracted by the Project.

Exploitation of results

The results of the SPIRAL2 Preparatory Phase are exploited for the construction of the SPIRAL2 facility in Caen, France. These results will be further exploited for the running period of the facility.

The SPIRAL2 Weeks and the EURORIB conference have gathered the international Nuclear Physics community for rich exchanges.

The MoU for the construction of SPIRAL2 will officialise the strong collaborations between GANIL-SPIRAL2 and its international partners.

The financial studies have identified the several contributions to the baseline project and to the instrument projects. They will help to the finalisation of the MoU for the construction of SPIRAL2.

R&D around the instruments for SPIRAL2 – new experimental facilities and detectors – has strengthened and accelerated the development of these instruments. These results will be fully exploited with the first experiments of NFS and S3 in 2014 and with the experiments with the other instruments starting from 2017.

The development of parts of the linear accelerator of SPIRAL2 – the Beam Loss Monitor, the Low Energy Beam Line Chopper, the Single Bunch Selector, and the Beam Dump – was essential for the construction of the whole accelerator and will be exploited starting in 2013 with the first tests of SPIRAL2.

The SPIRAL2 Preparatory Phase has also supported the second phase of SPIRAL2 with the R&D work on the developments of new radioactive beams and the construction of the neutron converter.

The preliminary studies for a new guesthouse (“Maison Européenne des Sciences”) will not be

immediately exploited due to lack of budget for the construction of this guesthouse. The work on the implementation of SPIRAL2 is exploited for the construction of the facility. The study of the "Sandwich" technique for radiological shielding will need the agreement of the French organism for Nuclear Safety (Agence pour la Sûreté Nucléaire - ASN) to be fully exploited in France.

During the SPIRAL2 Preparatory Phase, numerous bilateral agreements have been signed between GANIL-SPIRAL2 and new partners: Bulgaria, Czech Republic, Germany, Italy, Poland, Spain, Sweden, USA, India, and China.

All these results and foreground are and will be exploited for an optimized performance of the new facility GANIL-SPIRAL2. Beyond the technological challenges, this facility is the key for the future discoveries in Nuclear Physics: the quest of superheavies, the revolution of magic numbers, the nuclear cohesion of forces, the origin of heavy elements in the Universe, the nuclear matter of stars, and the fundamental interactions. GANIL-SPIRAL2 will also provide to the scientists a high-performance fast neutron source and a multidisciplinary platform.

Address of project public website and relevant contact details

Web site: http://www.ganil-spiral2.eu/?set_language=en
Contact: communication@ganil.fr

4.2 Use and dissemination of foreground

Section A (public)

Publications

LIST OF SCIENTIFIC PUBLICATIONS, STARTING WITH THE MOST IMPORTANT ONES											
No.	Title / DOI	Main author	Title of the periodical or the series	Number, date or frequency	Publisher	Place of publication	Date of publication	Relevant pages	Permanent identifiers (if applicable)	Is open access provided to this publication ?	Type
1	THE PARIS PROJECT	A. Maj	ACTA PHYSICA POLONICA B	Vol.40, N°3	Jagellonian University & Polish Academy of Arts and Sciences	Krakow, Poland	22/01/2009	565-575		Yes	
2	Measurements of high-energy #-rays with LaBr3:Ce detectors	M. Ciema#a	Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detector	608	Elsevier	Amsterdam, The Netherlands	01/09/2009	76-79		Yes	
3	Production of short lived radioactive beams of radium	P.D. Shidling	Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detector	606	Elsevier	Amsterdam, The Netherlands	21/07/2009	305-309		Yes	
4	Digital pulse-shape discrimination of fast neutrons and gamma rays	P.-A. Söderström	Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detector	594	Elsevier	Amsterdam, The Netherlands	21/08/2008	79-89		Yes	
5	An artificial neural network based neutron–gamma discrimination and pile-up rejection framework for	E. Ronchi	Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detector	610	Elsevier	Amsterdam, The Netherlands	01/11/2009	534-539		Yes	

6	Influence of crystal-orienta tion effects on pulse-shape-bas ed identification of heavy-ions	L. Bardelli	Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detector	605	Elsevier	Amsterdam, The Netherlands	01/07/2009	353-358		Yes	
7	A method for non-destructive resistivity mapping in silicon detectors	L. Bardelli	Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detector	602	Elsevier	Amsterdam, The Netherlands	21/04/2009	501-505		Yes	
8	New digital techniques applied to A and Z identification using pulse shape discrimination	S. Barlini	Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detector	600	Elsevier	Amsterdam, The Netherlands	11/03/2009	644-650		Yes	
9	Description of current pulses induced by heavy ions in Silicon detectors	M. Parlog	Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detector	613	Elsevier	Amsterdam, The Netherlands	01/02/2010	290-294		Yes	
10	A rotating target for Ra production	M. Sohani et al.	Nuclear Instruments and Methods in Physics Research A	679			29/03/2012	25-28		Yes	
11	Description of current pulses induced by heavy ions in Silicon detectors (II)	H. Hamrita	Nuclear Instruments and Methods in Physics Research Section A	642			21/06/2011	59-64		Yes	
12	Progresses in the pulse shape identification with silicon detectors within the FAZIA Collaboration	L. Bardelli	Nuclear Instruments and Methods in Physics Research Section A	654			21/10/2011	272-278		Yes	
13	Particle identification using the DE2E technique and pulse shape discrimination with the silicon detectors of the FAZIA project	S. Carboni	Nuclear Instruments and Methods in Physics Research Section A	664			01/02/2012	251-263		Yes	
14	Probing the nuclear equation of state in heavy-ion collisions at Fermi energy in isospin-sensiti ve exclusive experiments	P. Napolitani	Physical Review C	81, 044619			30/04/2010	1-11		Yes	
15	Performances of the future multidetector PARIS illustrated on the radiative capture physics case	D. Lebhertz	Acta Physica Polonica B	42			30/04/2011	721-724		Yes	

16	Testing and development of a novel phoswich scintillator detector for PARIS	O.J. Roberts	Acta Physica Polonica B	42			30/04/2011	729-734		Yes	
17	S3: the Super Separator Spectrometer for LINAG http://dx.doi.o rg/10.1063/1.27 46621	A.C.C. Villari	AIP Conference Proceedings	912				436-445		Yes	
18	Design study of a pre-separator for the LINAG super separator spectrometer	A. Drouart	Nuclear Instruments and Methods in Physics Research Section B	266			31/10/2008	4162-4166		Yes	
19	Super separator spectrometer for the LINAG heavy ion beams 10.1142/S021830 1309014482	A. Drouart	International Journal of Modern Physics E	18						Yes	
20	The Super Separator Spectrometer (S3) for SPIRAL2 stable beams	A. Drouart	Nuclear Physics A	834			01/03/2010	747c-750c		Yes	
21	Optical studies for the super separator spectrometer S3	D. Boutin	IPAC Proceedings	2010			30/06/2010	4464		Yes	
22	A Homogeneous Superconducting Combined Multipole Magnet for the Large Acceptance Spectrometer S3, based on Flat Racetrack Coils	O. Delferrièr e	IPAC Proceedings	2010			30/06/2010	328		Yes	
23	S3: The Super Separator Spectrometer for SPIRAL2 stable beams http://dx.doi.o rg/10.1063/1.34 55944	H. Savajols	AIP Conference Proceedings							Yes	
24	Fusion-evaporat ion studies with the Super Separator spectrometer (S3) at Spiral2 http://dx.doi.o rg/10.1051/epjc onf/20111714004	A. Drouart	EPJ Web of Conferences							Yes	
25	Pushing the limit of spectroscopy with S3	B. Gall	Acta Physica Polonica B	42			30/04/2011	597-604		Yes	
26	Monte Carlo simulation of a single detector unit for the neutron detector array NEDA	G. Jaworski	Nuclear Instruments and Methods in Physics Research Section A	673			01/05/2012	64-72		Yes	
27	Light radio-isotopes for nuclear astrophysics and neutrino physics doi:10.1088/095 4-3899/35/1/014 042	M. Hass	Journal of Physics G							Yes	

28	A new cross-section measurement of reactions induced by 3He particles on a carbon target 10.1140/epja/i2 011-11072-9	A. Pichard	European Physics Journal A	47						Yes	
29	Preliminary results of SPIRAL-2 thermo mechanical neutron converter characteristics http://dx.doi.o rg/10.1063/1.36 88847	E. Udup	AIP Conference Proceedings							Yes	
30	POCO graphite radiation damage of Spiral 2 neutron converter assembly http://dx.doi.o rg/10.1063/1.36 88848	J. Bermudez	AIP Conference Proceedings							Yes	
31	Measurements of the Thermophysical Properties of Graphite Composites for a Neutron Target Converter	E.I. Zhmurikov	Nuclear Instruments and Methods in Physics Research Section A	674			11/05/2012	79-84		Yes	
32	A safety device for the neutron converter of the SPIRAL2 project http://dx.doi.o rg/10.1016/j.ni ma.2012.04.070	G. Acosta et al.	Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detector	684			11/05/2012	1-6		Yes	

LIST OF DISSEMINATION ACTIVITIES								
No.	Type of activities	Main Leader	Title	Date	Place	Type of audience	Size of audience	Countries addressed
1	Web sites/Applications	GRAND ACCELERATEUR NATIONAL D'IONS LOURDS	GANIL-SPIRAL2	01/09/2008	http://www.ganil-spiral2.eu	Civil society		all
2	Conference	GRAND ACCELERATEUR NATIONAL D'IONS LOURDS	EURORIB'08	13/06/2008	Giens, France	Scientific community (higher education, Research)		all
3	Conference	GRAND ACCELERATEUR NATIONAL D'IONS LOURDS	SPIRAL2 Week 2007	30/11/2007	Caen, France	Scientific community (higher education, Research) - Industry		all
4	Conference	GRAND ACCELERATEUR NATIONAL D'IONS LOURDS	SPIRAL2 Week 2009	29/01/2009	Caen, France	Scientific community (higher education, Research) - Industry		all
5	Conference	GRAND ACCELERATEUR NATIONAL D'IONS LOURDS	SPIRAL2 Week 2010	28/01/2010	Caen, France	Scientific community (higher education, Research) - Industry		all
6	Conference	GRAND ACCELERATEUR NATIONAL D'IONS LOURDS	SPIRAL2 Week 2011	27/01/2011	Caen, France	Scientific community (higher education, Research) - Industry		all
7	Conference	GRAND ACCELERATEUR NATIONAL D'IONS LOURDS	SPIRAL2 Week 2012	26/01/2012	Caen, France	Scientific community (higher education, Research) - Industry		all
8	Flyers	GRAND ACCELERATEUR NATIONAL D'IONS LOURDS	GANIL-SPIRAL2	31/07/2008	Caen, France	Scientific community (higher education, Research) -		all

						Industry - Civil society - Policy makers - Medias		
9	Posters	GRAND ACCELERATEUR NATIONAL D'IONS LOURDS	GANIL-SPIRAL2	13/06/2008	Giens, France	Scientific community (higher education, Research)		all
10	Posters	GRAND ACCELERATEUR NATIONAL D'IONS LOURDS	GANIL-SPIRAL2	10/12/2008	Versailles, France	Scientific community (higher education, Research) - Industry - Civil society - Policy makers - Medias		EU
11	Exhibitions	GRAND ACCELERATEUR NATIONAL D'IONS LOURDS	Fête de la Science	23/11/2008	Caen, France	Civil society - Policy makers - Medias		France
12	Exhibitions	GRAND ACCELERATEUR NATIONAL D'IONS LOURDS	Fête de la Science 2009	22/11/2009	Caen, France	Civil society - Policy makers - Medias		France
13	Exhibitions	GRAND ACCELERATEUR NATIONAL D'IONS LOURDS	Fête de la Science 2010	24/10/2010	Caen, France	Civil society - Policy makers - Medias		France
14	Exhibitions	GRAND ACCELERATEUR NATIONAL D'IONS LOURDS	Fête de la Science 2011	16/10/2011	Caen, France	Civil society - Policy makers - Medias		France
15	Flyers	GRAND ACCELERATEUR NATIONAL D'IONS LOURDS	GANIL-SPIRAL2 for the kids	31/07/2010	Caen, France	Civil society		France
16	Press releases	GRAND ACCELERATEUR NATIONAL D'IONS LOURDS	SPIRAL2 Week 2007	30/11/2007	Caen, France	Medias		France
17	Press releases	GRAND ACCELERATEUR NATIONAL	SPIRAL2 Week 2009	29/01/2009	Caen, France	Medias		France

		D'IONS LOURDS						
18	Press releases	GRAND ACCELERATEUR NATIONAL D'IONS LOURDS	SPIRAL2 Week 2010	28/01/2010	Caen, France	Medias		France
19	Press releases	GRAND ACCELERATEUR NATIONAL D'IONS LOURDS	Start of the SPIRAL2 construction	17/10/2011	Caen, France	Medias		France
20	Press releases	GRAND ACCELERATEUR NATIONAL D'IONS LOURDS	SPIRAL2 Week 2011	27/01/2012	Caen, France	Medias		France
21	Press releases	GRAND ACCELERATEUR NATIONAL D'IONS LOURDS	SPIRAL2 Week 2012	26/01/2012	Caen, France	Medias		France
22	Flyers	GRAND ACCELERATEUR NATIONAL D'IONS LOURDS	GANIL-SPIRAL2 for our neighbours	31/07/2010	Caen, France	Civil society - Policy makers - Medias		France
23	Posters	GRAND ACCELERATEUR NATIONAL D'IONS LOURDS	GANIL-SPIRAL2: what is it?	31/10/2009	Caen, France	Civil society - Policy makers - Medias		France

Section B (Confidential or public: confidential information marked clearly)

LIST OF APPLICATIONS FOR PATENTS, TRADEMARKS, REGISTERED DESIGNS,UTILITY MODELS, ETC.					
Type of IP Rights	Confidential	Foreseen embargo date dd/mm/yyyy	Application reference(s) (e.g. EP123456)	Subject or title of application	Applicant(s) (as on the application)

OVERVIEW TABLE WITH EXPLOITABLE FOREGROUND								
Type of Exploitable Foreground	Description of Exploitable Foreground	Confidential	Foreseen embargo date dd/mm/yyyy	Exploitable product(s) or measure(s)	Sector(s) of application	Timetable for commercial use or any other use	Patents or other IPR exploitation (licences)	Owner and Other Beneficiary(s) involved

ADDITIONAL TEMPLATE B2: OVERVIEW TABLE WITH EXPLOITABLE FOREGROUND	
Description of Exploitable Foreground	Explain of the Exploitable Foreground

4.3 Report on societal implications

B. Ethics

1. Did your project undergo an Ethics Review (and/or Screening)?	No
If Yes: have you described the progress of compliance with the relevant Ethics Review/Screening Requirements in the frame of the periodic/final reports?	

2. Please indicate whether your project involved any of the following issues :

RESEARCH ON HUMANS

Did the project involve children?	No
Did the project involve patients?	No
Did the project involve persons not able to consent?	No
Did the project involve adult healthy volunteers?	No
Did the project involve Human genetic material?	No
Did the project involve Human biological samples?	No
Did the project involve Human data collection?	No

RESEARCH ON HUMAN EMBRYO/FOETUS

Did the project involve Human Embryos?	No
Did the project involve Human Foetal Tissue / Cells?	No
Did the project involve Human Embryonic Stem Cells (hESCs)?	No
Did the project on human Embryonic Stem Cells involve cells in culture?	No
Did the project on human Embryonic Stem Cells involve the derivation of cells from Embryos?	No

PRIVACY

Did the project involve processing of genetic information or personal data (eg. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)?	No
Did the project involve tracking the location or observation of people?	No

RESEARCH ON ANIMALS

Did the project involve research on animals?	No
Were those animals transgenic small laboratory animals?	No
Were those animals transgenic farm animals?	No
Were those animals cloned farm animals?	No
Were those animals non-human primates?	No

RESEARCH INVOLVING DEVELOPING COUNTRIES

Did the project involve the use of local resources (genetic, animal, plant etc)?	No
Was the project of benefit to local community (capacity building, access to healthcare, education etc)?	No

DUAL USE

Research having direct military use	No
Research having potential for terrorist abuse	No

C. Workforce Statistics

3. Workforce statistics for the project: Please indicate in the table below the number of people who worked on the project (on a headcount basis).

Type of Position	Number of Women	Number of Men
Scientific Coordinator	0	1
Work package leaders	1	8
Experienced researchers (i.e. PhD holders)	21	104
PhD student	2	1
Other	11	48

4. How many additional researchers (in companies and universities) were recruited specifically for this project?	41
Of which, indicate the number of men:	29

D. Gender Aspects

5. Did you carry out specific Gender Equality Actions under the project ?	No

6. Which of the following actions did you carry out and how effective were they?	
Design and implement an equal opportunity policy	Not Applicable
Set targets to achieve a gender balance in the workforce	Not Applicable
Organise conferences and workshops on gender	Not Applicable
Actions to improve work-life balance	Not Applicable
Other:	

7. Was there a gender dimension associated with the research content - i.e. wherever people were the focus of the research as, for example, consumers, users, patients or in trials, was the issue of gender considered and addressed?	No
If yes, please specify:	

E. Synergies with Science Education

8. Did your project involve working with students and/or school pupils (e.g. open days, participation in science festivals and events, prizes/competitions or joint projects)?	Yes
If yes, please specify:	paticipation in science festivals and visits of the facilities

9. Did the project generate any science education material (e.g. kits, websites, explanatory booklets, DVDs)?	Yes

F. Interdisciplinarity

10. Which disciplines (see list below) are involved in your project?	
Main discipline:	1.2 Physical sciences (astronomy and space sciences, physics and other allied subjects)
Associated discipline:	
Associated discipline:	

G. Engaging with Civil society and policy makers

11a. Did your project engage with societal actors beyond the research community? (if	No

'No', go to Question 14)	
11b. If yes, did you engage with citizens (citizens' panels / juries) or organised civil society (NGOs, patients' groups etc.)?	
11c. In doing so, did your project involve actors whose role is mainly to organise the dialogue with citizens and organised civil society (e.g. professional mediator; communication company, science museums)?	
12. Did you engage with government / public bodies or policy makers (including international organisations)	
13a. Will the project generate outputs (expertise or scientific advice) which could be used by policy makers?	

H. Use and dissemination

14. How many Articles were published/accepted for publication in peer-reviewed journals?	32
To how many of these is open access provided?	32
How many of these are published in open access journals?	32
How many of these are published in open repositories?	0
To how many of these is open access not provided?	0
Please check all applicable reasons for not providing open access:	
publisher's licensing agreement would not permit publishing in a repository	No
no suitable repository available	No
no suitable open access journal available	No
no funds available to publish in an open access journal	No
lack of time and resources	No
lack of information on open access	No
If other - please specify	
15. How many new patent applications ('priority filings') have been made? ("Technologically unique": multiple applications for the same invention in different jurisdictions should be counted as just one application of grant).	0

16. Indicate how many of the following Intellectual Property Rights were applied for (give number in each box).	
Trademark	0
Registered design	0
Other	0

17. How many spin-off companies were created / are planned as a direct result of the project?	0
Indicate the approximate number of additional jobs in these companies:	0

18. Please indicate whether your project has a potential impact on employment, in comparison with the situation before your project:	Increase in employment, None of the above / not relevant to the project
19. For your project partnership please estimate the employment effect resulting directly from your participation in Full Time Equivalent (FTE = one person working fulltime for a year) jobs:	42

I. Media and Communication to the general public

20. As part of the project, were any of the beneficiaries professionals in communication or media relations?	No

21. As part of the project, have any beneficiaries received professional media / communication training / advice to improve communication with the general public?	No

22. Which of the following have been used to communicate information about your project to the general public, or have resulted from your project?	
Press Release	Yes
Media briefing	Yes
TV coverage / report	Yes
Radio coverage / report	Yes
Brochures /posters / flyers	Yes
DVD /Film /Multimedia	Yes
Coverage in specialist press	Yes
Coverage in general (non-specialist) press	Yes
Coverage in national press	Yes
Coverage in international press	No
Website for the general public / internet	Yes

Event targeting general public (festival, conference, exhibition, science café)	Yes

23. In which languages are the information products for the general public produced?	
Language of the coordinator	Yes
Other language(s)	No
English	Yes

Attachments	logo_spiral2pp_europe.jpg
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
Name	
Date	

This declaration was visaed electronically by Marek LEWITOWICZ (ECAS user name nlewitma) on