HORIZON 2020

Research Infrastructures

H2020-INFRADEV-2016-1

INDIVIDUAL SUPPORT TO ESFRI AND OTHER WORLD-CLASS RESEARCH INFRASTRUCTURES

IDEAAL

International Development of gAnil-spirAL2

Grant Agreement Number: 730989

D4.2 – Report on the technology transfers developed in the framework of the project

Version: 1.0
Author: M-H.MOSCATELLO/N.RENARD
Date: March 23rd 2021

PROJECT AND DELIVERABLE INFORMATION SHEET

IDEAAL Project Ref. №	730989
Project Title	International DEvelopment of gAnil-spirAL2
Project Web Site	https://ideaal.ganil-spiral2.eu/
Deliverable ID	D4.2
Deliverable Nature	Report
Deliverable Level*	PU
Contractual Date of Delivery	March 31st 2021
Actual Date of Delivery	March 24th 2021
EC Project Officer	Blagovesta CHOLOVA

* The dissemination level are indicated as follows: PU – Public, PP – Restricted to other participants (including the Commission Services), RE – Restricted to a group specified by the consortium (including the Commission Services). CO – Confidential, only for members of the consortium (including the Commission Services).

DOCUMENT CONTROL SHEET

Document	Title: Report on the technology transfers developed in the framework of the project	
	ID: D4.2	
	Version: 1.0	
	Available at: https://ideaal.ganil-spiral2.eu/	
	Software Tool: Microsoft Office Word 2007	
	File: IDEAAL-Deliverable_WP4D4.2_Report_on_the_technology_transfers_developed_in_the_framework_of_the_project	
Authorship	Written by:	Marie-Hélène MOSCATELLO - GANIL
	Contributors:	Nadine RENARD – Normandie Energies
	Reviewed by:	Sabrina LECERF - GANIL
	Approved by:	Marek LEWITOWICZ - GANIL

DOCUMENT STATUS SHEET

Version	Date	Status	Comments
V1.0	23/03/2021	For internal review	
		For internal review	
V1.0	24/03/2021	Submitted on EC Participant Portal	
		Final version	

DOCUMENT KEYWORDS

Keywords	Know-How, Innovation, Technology Transfer, Patent

Disclaimer

This deliverable has been prepared by Work Package 4 (Innovation and Industries) of the Project in accordance with the Consortium Agreement and the Grant Agreement n°730989. It solely reflects the opinion of the parties to such agreements on a collective basis in the context of the Project and to the extent foreseen in such agreements.

Copyright notices

TABLE OF CONTENTS

Executive Summary

This document presents the report on technology transfers identified and developed in the framework of Task2 of the Work Package 4 – Innovation and Industries. It describes the work realized for the establishment of the GANIL know-how mapping, the resulting market study, and the knowhow/technology transfers realized during the IDEAAL project period.

1. INTRODUCTION

The Work Package 4 – Innovation and Industries – has focused on actions towards industrial users and on actions on industrial valorisation and innovation. They are of general interest: access dedicated for industries for new applications to the existing GANIL accelerators and to the new SPIRAL2 facility, and proposal on involvement of industrial users within GANIL-SPIRAL2 organisation (Task1), general support for industrial valorisation and technology transfer (Task2), and study of the increase of innovation potential of GANIL-SPIRAL2 (Task3).

The main objective of Task 2 is to reinforce the links between GANIL and industrial companies, in particular for the valorisation activities: R&D collaborations, technology transfers.

In order to identify possible technology transfers from GANIL and to develop some of them, the study has been divided into three actions:

- Identify and map the existing knowhow of GANIL laboratory
- Identify industrial applications that could be based on this knowhow
- Provide support for the technology transfer activities developed within the framework of the IDEAAL project

Specifically, the task 2 is focused on industrial application and technology transfer. Technology transfers concern development of the accelerators, instrumentation leads to studies, and different applications in many industrial sectors (health, aeronautics, chemistry…).
Technology transfers activities represent a large potential for the laboratory, which could be a major source of revenue.
In this part, Normandie Energies' participation was important, with the GANIL collaboration, in order to develop relationships between the laboratory and companies.

WP4 team made the mapping of existing potential industrial applications at GANIL and new contacts were created with industries in this aim. The contract for the transfer of know-how for the beam profile monitors is signed and the R&D collaboration contract on this topic is reached.
In terms of innovation potential, several application domains have been identified.

2. GANIL KNOW-HOW MAPPING

2.1. ASSESSMENT METHODOLOGY

In order to map the GANIL existing know-how, the Task2 team organised meetings (approximately 40) from March 2017 until January 2018, with the different technical and physics groups at GANIL.

The aim of these meetings was to collect information on the activities in the group, their competences, know-how, technologies developed, existing partnership with laboratories and/or companies (even those informal). The meetings were organised in the form of brainstorming sessions with the entire group, in order to collect as many information as possible.

A "non-exhaustive" but rather complete list of technologies, knowhow and competences was established, for each technical/physics group, as presented in § 2.2. From this list, a global vision of what can be interesting for the market and therefore transferred to industrial companies can be constructed.

2.2. KNOW-HOW MAPPING RESULTS

The following technologies and know-how were selected from the discussions with the various groups:

Physics Group

For this group, only the technical developments have been discussed: pre-amplifiers, airtight feedthroughs under vacuum, electronic treatment of detector signals, targets (carbon foils). Some of these existing know-hows have been already transferred and used by companies and other research laboratories.

The development program for innovative alpha-emitters radionuclides has been considered in the framework of another action of Task2, and will not be described in this study as a potential subject for valorization. The scientific group in charge of these developments has decided to build only scientific collaborations around this subject, and not to position itself on a valorization and innovation (in the original meaning, i.e. industrial and commercial application of an invention) approach.

Accelerator Electronics Group

For the SPIRAL2 project, new systems have been developed by this group. The main know-how is related to:

- Beam current diagnostics as high-power faraday cups, low-intensity faraday-cups, fast faraday-cups
- Associated electronic for signal treatment (high current and very low current)
- Mechanical integration of commercial intensities converters, and associated electronic for signal treatment
- Various detectors for beam parameter measurements (beam phase, beam energy, beam velocity).

Some industrial companies seem to be interested by several of these technologies.

Ion Source Group

Several activities have been mentioned by the group and that could be developed in collaboration with industrial companies or transferred to them:

- Operation of Ion Sources: various beam productions (metal ion beams), beam tuning, organization for ion source operation, operation in nuclear environment (hot cells)
- R&D on Ion Sources:
    - Simulations: magnetic structure 3D simulations, high temperature system simulations, charged particles simulations, atom diffusion and effusion.
    - Technology: High voltage, CEM, plasma physics, ion beam production, mechanical design

- Measurements and characterization: magnetic structures mounting, mass spectrometry, gas analysis, thermal measurements, available test benches with ion sources

Radio Frequency System Group

The following know-how have been identified: accelerating cavities (normal conducting and superconducting) design, construction and operation; electromagnetic simulations for resonators, power amplifier design

Power Supply and Magnet Group

The following know-how have been identified: Industrial data with microprocessors/remote control and magnet design. This group operates around 2000 power supplies, and a magnetic measurement bench, which can be of interest for some companies, which would need to realise magnetic measurements on magnets they would manufacture. A partnership with an industrial company existed for a few years, based on the objective of magnet design and manufacturing cost optimisation.

General Maintenance Group

This group develops and maintains security systems, based on programmable local controllers, in the following technical fields: classified systems (safety), nuclear ventilation, security processors, expert control for vacuum systems.

Vacuum and Cryogenics Group

Two domains are specific to this group: vacuum and cryogenic systems. Regarding the vacuum system, the group designs and operates complex vacuum systems, gas storage systems, performs leakage measurements and material characterisation under vacuum. For the cryogenic part, they develop control systems for complex cryogenic facilities (like for a superconducting linear accelerator). They develop cryogenic targets used by experimental teams all over the world.

Accelerator Control System Group

This group develops and operates remote control systems for complex accelerator facilities: data base management, beam tuning, real time control, and various control systems for complex equipment.

Mechanical Study Group

The group has developed innovative mechanical systems and technologies. Interesting subjects for industry can be the orientable flanges for nuclear environments, and high temperature ovens for heated production targets.

Mechanical Manufacturing Group

In particular in this group, know how is strongly linked to available individual expertise, as the manufacturing processes might depend on the individual skills. Several innovative systems have been developed and manufactured by this group. For instance, vacuum chambers, passivation procedures, aluminium flanges (from which a patent has been filed, cf.§4).

Physics Instrumentation Group

This group develops instrumentation systems for the physics experiments. It has already a transfer experience to an industrial company, with the beam profile monitors (described in §4).

Physics Detection Group

The group has a specific activity: active targets (gas targets) and gas detection systems, wire chambers, electrostatic mirrors, weaving machines for profilers.

Physics Data Acquisition Group

This group develops and operates complex electronic detection systems, which are distributed to many nuclear physics laboratories all over the world.

Radioprotection Group

The neutron measurements represent an important competence and activity for the group, in particular for the low radioactivity levels. It could be interesting for training activities of industrial company employees. Relating to these competences, the group has also links with a company for the qualification of detectors in the framework of their R&D activities.

2.3. Conclusion on GANIL know-how Mapping

Many different know-how and competences have been identified. Some of them can be valorised through technology transfers to companies. In order to select the most appropriate subjects, a market analysis has been identified to be the right tool to do this selection.

3. Market analysis by ERDYN

The results on GANIL know-how mapping have been communicated as input to the ERDYN company, specialised in innovation studies for companies and research organisations.

They have firstly analysed all the subjects, and identified various industrial applications to be potentially based on the large GANIL know-how. Almost 40 applications have been identified, and each of them was evaluated for its assets and attractiveness (cf. Figure 1).

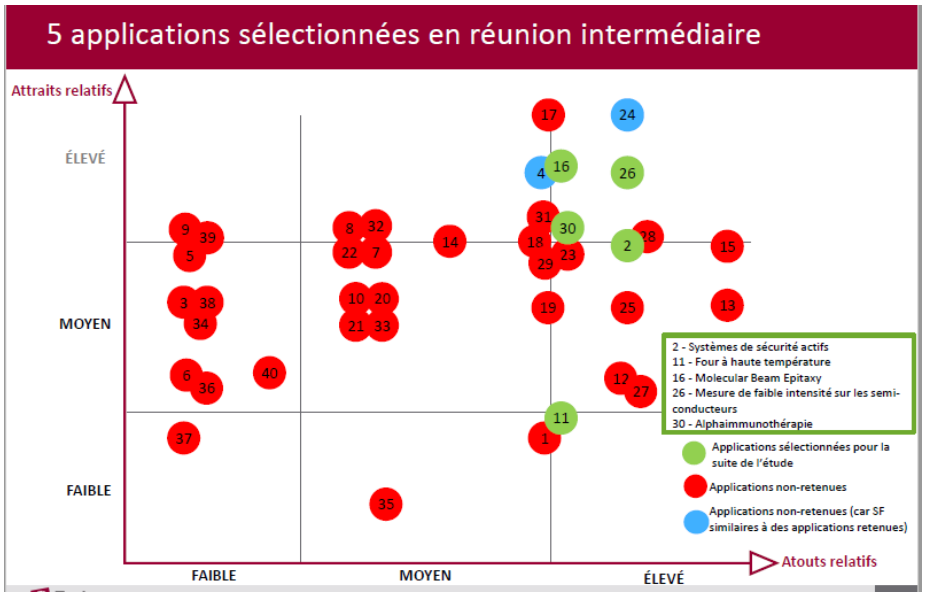

Figure 1: Positioning of the identified applications, with their relative assets and attractiveness

The following step was then to select five applications among the 40, this limitation having been decided when defining the financial volume of the contract with ERDYN, in order to study into more details these few applications, organise interviews with companies and perform a market study for each of them. The selection was made by

ERDYN and Work Package 4 teams together, considering the assets/attractiveness classification and GANIL know-how valorisation effective possibilities, which led to the following choice:

Systems of industrial safety

They are automated systems of industrial safety designed to minimize risk environmental and human accidents. They are made up of sensors and decision systems (generally duplicated or even tripled) in order to react to emergency situations. “Higher added value" applications such as aeronautics or nuclear industry with the highest demands in terms of safety could be interested. The GANIL know-how concerns: safety automatisms, experience with complex systems operation, gas plant for gas detectors.

No interest was identified during the interviews with the selected companies, for GANIL's know-how use in their respective industrial sectors. Indeed, there is little reward for innovation due to the supervision of the sectors by standards. Applications such as the nuclear industry or aeronautics must obtain higher levels of safety, this leads to the development of solutions specific to each application, which are often carried out internally (as GANIL has proceeded in fact for its own facilities).

High temperature ovens

High temperature ovens heat objects with temperatures up to 3000 °C. These ovens are used in the heat treatment processes of ceramics or metals (sintering or vacuum brazing, manufacturing of technical ceramics). GANIL know how is focused on: high temperature ovens, development of vacuum systems (training and services) and complex welding methods. GANIL also has several know-hows to meet the challenges of this technical field, as gas management and skills in vacuum technologies.

The R&D dynamic of the market seems relatively important. Indeed, oven builders are continuously looking for new materials and new design methods.

GANIL can position itself by contacting industrial companies, and assess the relevance of its know-how on the areas of R&D and the challenges of the sector. Manufacturers are used to partnerships with research laboratories, the creation of research collaborations with manufacturers in the sector would seem relevant.

Molecular Beam Epitaxy (MBE)

It consists of growing one or more layers of atoms on a solid substrate. These atoms are sent to the target using one or more molecular jets. The GANIL has competences in MBE: development of vacuum systems, complex welds, empty air crossings, high temperature ovens.

This market seems rather closed. For R&D activities, it could be possible for GANIL to explore manufacture of complete systems to meet the needs of manufacturers and research centres.

Research collaborations can be considered with manufacturers of molecular beam epitaxy systems. To do this, it is necessary to get in touch with market players in order to assess the relevance of each of GANIL's know-how in the sector.

Low intensity measurements for semiconductors

The semiconductor market has high volume commercial applications, dominated by large players. The market also includes start-ups positioned more on niche applications.

There are three main types of players in the market: manufacturers who design, manufacture and market integrated circuits; fabless companies that design and market chips by outsourcing their manufacture to foundries; foundries that produce the chips designed by their customers.

The semiconductor test segment does not show a strong innovation dynamic. Nevertheless, the GANIL competence on measurement of very low intensities has been identified as a potential interesting knowhow for the circuit designers.

Alpha immunotherapy

Alpha-radioimmunotherapy (α-RIT) is a targeted anti-tumor therapy using usually a monoclonal antibody specific for a tumor antigen that is coupled to an α-particle emitter. α-emitters represent an ideal tool to eradicate disseminated tumors or metastases. Recent data demonstrate that ionizing radiation in addition to its direct cytotoxic ability can also induce an efficient anti-tumor immunity. This suggests that biologic effects on irradiated tissues could be used to potentiate immunotherapy efficacy and opens the way for development of new therapies combining α-RIT and different types of immunotherapy.

As described in §2.2, GANIL has launched a development program for innovative α-emitters for medical use, that will remain in the framework of scientific collaborations.

Conclusion on the ERDYN Study

An important potential for R&D activities at GANIL has been identified by the ERDYN company, with the aim of developing them for industrial applications. The five selected applications have been presented to the GANIL valorisation referents group. The next step will be to concentrate on one or two subjects to start with: the high temperature ovens and the low intensity measurements for superconductors seem to be the first two subjects of interest.

4. TECHNOLOGY TRANSFERS:

4.1. SUPPORT FOR THE TECHNOLOGY TRANSFER OF THE BEAM PROFILE MONITORS

GANIL has been developing for many years a type of beam diagnostic called a “Beam profile monitor”, used to measure the beam dimensions. Up to 2015, GANIL used to produce itself the units necessary for its own needs and for the needs of other nuclear physics laboratories as well. In 2016, it was decided to transfer the know-how on this technology towards an industrial company and to implement an associated R&D collaboration contract between GANIL and the company. Both contracts have been established, after studies on legal, economical and marketing aspects, undertaken in the framework of the IDEAAL project. These contracts have been signed by both GANIL authorities, CNRS and CEA. After some delay due to the change of the GANIL Directorate at the beginning of 2017, the contract for transfer of know-how was signed at the end of 2017, while the R&D collaboration contract was signed in January 2020 only, due to a long negotiation between national research organisations on a new technology transfer policy.

4.2. SUPPORT FOR THE TECHNOLOGY TRANSFER OF ALUMINIUM FLANGES

A new type of hardened aluminium flange was developed by the GANIL mechanical manufacturing group, initially for the need of the SPIRAL2 project in the 2010s. It was decided to file a patent on this development in 2016-2017, and all the process was elaborated within the framework of the IDEAAL Work Package 4 Task2 actions. The patent

has been deposited in France, Europe, United-States. It was accepted in United-States in 2019, which gives a strong value to this patent.

A French start-up has shown its strong interest to sign an exploitation licence for this patent. The establishment of the licence between CEA/GANIL (CNRS refused to be co-owner) and the start-up is in progress, and the licence is planned to be signed during the first semester 2021. The French start-up has identified an important market, and new applications for these flanges beyond the field of particle accelerators.

5. CONCLUSION

Without IDEAAL project, it wouldn't have been possible to progress in this direction of GANIL know-how mapping, and market study by a private innovation company. Now, GANIL owns an important information source to proceed for further studies and develop more technology transfers and research collaborations with companies.

The development of research collaborations with industrial companies seems an appropriate mean of valorisation at the present time. Research collaborations make it possible to monitor and clarify the specific needs and expectations of stakeholders, they also allow the dissemination of know-how internally, and can participate in perpetuating it. Services (study, design, development, etc.) and / or training may be considered once the needs and expectations of manufacturers have been clarified during research collaborations.

The development of technology transfer can be interesting if a market for applications of the technical development is identified. Nevertheless, even in this case, a research collaboration associated to the technology transfer is important to continue to maintain the skill in the laboratory.