EXTREME OF LANDSCAPE IN NUCLEAR PHYSICS VIA HIGH POWER ACCELERATORS AND INNOVATIVE INSTRUMENTATION

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The advent of high power light and heavy ion accelerators producing intense secondary radioactive ion beams (RIB) made possible the exploration of a new territory of nuclei with extreme in Mass and/or N/Z ratios. To pursue the investigation of this "terra incognita" several projects, based on second generation accelerators producing intense stables and RIB, all aiming at the increase by several orders of magnitude of the RIB intensities are now under construction and/or planned for the end of this decade in the world. RIB production at SPES@Legnaro, SPIRAL2@GANIL, ALTO@Orsay, ISAC@TRIUMPF and HIE-ISOLDE@CERN are based on the ISOL method, RIBF@RIKEN, FRIB@MSU-NSCL, FAIR@GSI with the new Super-FRS fragment –separator takes advantage of the "In Flight" technique. Projects of high intensity heavy ions, and low energy drivers (< 10 MeV/n) are also foreseen at Flerov Laboratory @DUBNA, GSI, RIKEN and GANIL. Technical performances, innovative new instrumentation and methods, and keys experiments in connection with these second generation high intensity facilities will be reviewed.

1. INTRODUCTION

The frontiers of nuclear science today require new tools, technologies and accelerators .The quest is to understand the origin, evolution, and structure of the visible matter in the universe. High intensity stables and secondary Radioactive Ion Beams (RIB) are central to this quest worldwide.
The scientific progress has been largely driven by advancements in technology that have enabled the construction of these new classes of high power particle and heavy ions accelerators, associated to impressive innovation in instrumentation and backed by a strong development in Nuclear Theory.

As illustrated in fig.1 the physics with intense stable and RIB cover a broad range of themes. In Nuclear structure and reactions as well as in Nuclear Astrophysics, physicists have started to explore a completely unknown "Terra Incognita" of nuclei with extreme proton to neutron ratios, including very neutron rich isotopes which play a critical role in the formation of many of the chemical elements in the Universe.

Nuclear collisions investigated along isotopic chains with large variation of the N/Z ration of the colliding species can shed light on the Equation of state and in particular its Isospin dependence.

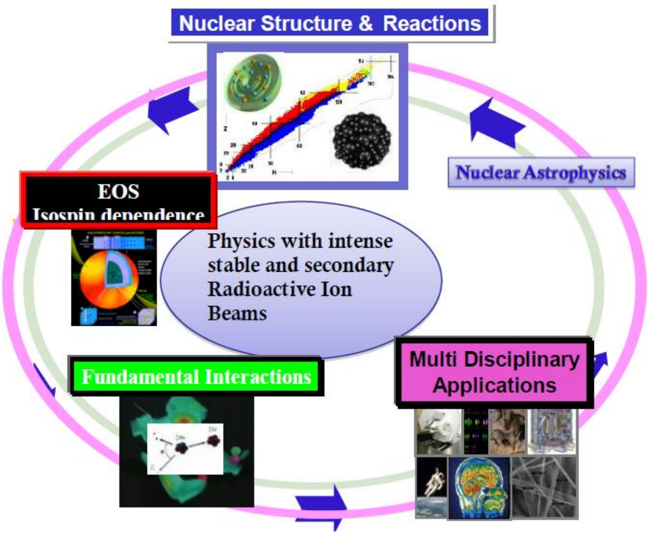

Figure.1 Schematic representation of the physics themes which can be addressed by intense stable and secondary RIB.

Neutron and proton rich nuclei can be used as a laboratory to study fundamental interactions and last but not least these beams have numerous multidisciplinary applications in many fields and subjects of societal importance like biology, medicine, space, material and energy.

2. THE SCIENCE DRIVERS

Among the key questions in Nuclear Physics, **the synthesis of Super Heavy Elements** (SHE) is certainly a subject where the interplay between theory and experiments is the most active. From the experimental point of view, pushing the limit for the discovery of SHE up to Z= 118 in fusion reactions was made possible due to the tremendous progress in the intensity and stability of stable light and medium mass heavy ion beams which was possible to achieve by both cyclotrons and low energy Linac (up to 2pμA for ^{48}Ca beams). The status of the quest to SHE has been recently reviewed [1-5]. Recent attempts by Dubna and GSI to populate Z=119,120 SHE give lower limits in terms of cross-sections for these elements around 60fb. Therefore, it is mandatory to explore what are the

technical developments and the associated gain factors for the production of SHE in the coming decade.
New high current accelerators are under construction at Flerov laboratory at Dubna, namely DC280 with beam energy up to 10 MeV/n and ECR ion source able to deliver 2-5 pμA of medium mass heavy ion projectiles (A=20-60). Also under construction at Ganil (Caen) is the Spiral 2 accelerator complex [6], based on high power low energy superconducting LINAC able to deliver up to 5kW of medium mass heavy ion beams (10-20 pμA of 48Ca for example). A new generation of Spectrometer –Separator, with high rejection power and excellent mass resolution at the focal plane, S3 [7] under construction, will be coupled to the high intensity heavy ion beams of SPIRAL2. Design of the future replacement of the UNILAC machine at GSI is also foreseen with the same goal of higher beam intensities.
In addition associated R&D are pursued for target materials which can sustain these high currents as well as in the domain of high Z, long live trans-actinide targets [3].
To explore new region of the nuclear mass chart well beyond the stability domain the developments of RIB, i.e. beams of synthesized radioactive isotopes, have been recognized by the international scientific community as one of the most promising avenue for the development of fundamental nuclear physics and astrophysics.
Let me illustrate the discovery potential of the field using recent results where both the accelerator capabilities in term of production of secondary RIB but also new instruments have been essential in the exploration of this new territory.

As shown in fig.1, “exotic” nuclei could be used as a **laboratory to study fundamental interactions**, for example, in low-energy tests of the Standard Model of electroweak interaction. These studies are performed on samples of radioactive ions captured in ion traps where they are available for high-precision experiments. These new techniques are developed by many group around existing and/or under construction RIB facilities around the world (ISOLDE@CERN, CPT@CARIBU-ANL, LPC-Penning Trap@GANIL, NSCL, JYL, TRIUMF SHIPTRAP@GSI, etc..) to efficiently capture short-lived isotopes of essentially any species in ion trap allow us to select isotopes with decay properties which enhance and isolate specific effects and hence increase our sensitivity to the physics of interest. At GANIL the present experimental program is looking at a more precise determination of the weak vector coupling constant and a more precise test of CVC and the unitarity of the Cabibbo-Kobayashi-Maskawa matrix. In a recent experiment using low energy “intense” and pure ^{6}He and ^{35}Ar SPIRAL beams, high precision measurements of the β-ν angular correlation in the β decay of $^{6}He^{+}$ ions using a transparent Paul trap have been achieved by X.Fléchard et al [8].

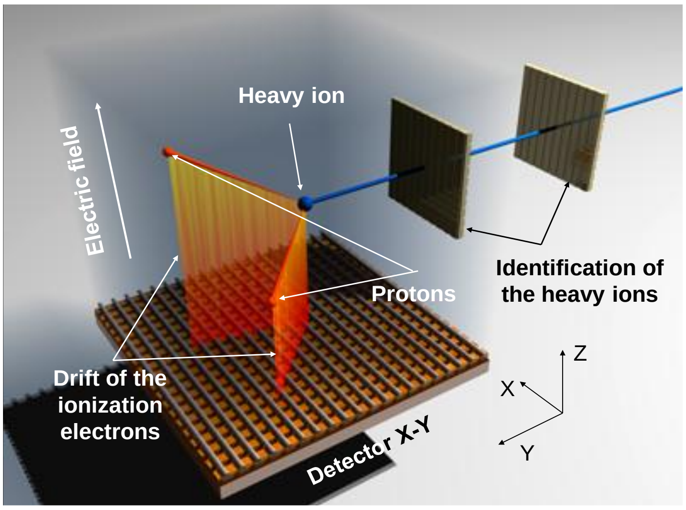

Figure.2 The two proton decay process as "observed" in the TPC device of Ref [14].

They find $a_{\beta\nu} = -0.3335\ (73)_{\text{stat}}\ (75)_{\text{syst}}$, in agreement with the standard model prediction for a pure Gamow–Teller transition. Report on recent activities at the CPT mass spectrometer by G.Savard [9] using the first neutron rich fission fragments produced by the newly commissioned CARIBU facility at Argonne National Lab also demonstrate the high potential of these new devices ,with in particular the precision mass measurements they can reach. **In the domain of exotic decays**, in particular, the emission of two protons from the ground state of a radioactive nucleus has been searched for since1960, for nuclei beyond the proton drip line, for which one-proton emission is energetically prohibited. This new nuclear decay mode was observed first in the decay of ^{45}Fe in two independent experiments [10, 11]. In an experiment performed in 2005 at GANIL, emission of two protons in the decay of ^{45}Fe was observed directly for the first time with a Time Projection Chamber (TPC) [12]. The purpose of this detection set-up is to reconstruct the proton tracks in three dimensions. In another experiment performed at MSU [13], the 2p emission in the decay of ^{45}Fe was observed with an Opti-cal Time Projection Chamber in which images of ionizing particle trajectories are recorded optically. These new devices (TPC, Active targets) will allow, among many other applications in nuclear physics, investigation of the angular and energy correlations of the two protons in the decay of ^{54}Zn as shown in fig.2 and reported by recently by P. Asher et al [14]. A fundamental challenge in **Nuclear Astrophysics** is our lack of understanding of the formation of trans-ferric elements. The site for the production of many of the elements heavier than iron, including gold, platinum and uranium is still unknown. Nuclear physics is needed to provide the data required to understand the underlying reaction processes. The experimental determinations of masses and half-lives in the region of very neutron rich nuclei where we believe the rapid neutron capture processes take place are crucial to understand the formation of heavy elements in our universe.

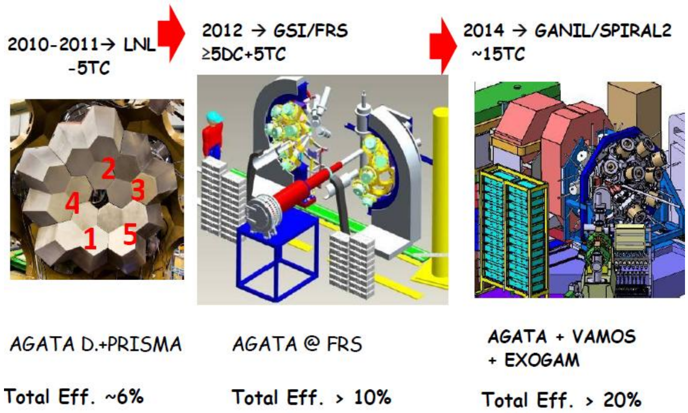

Figure.3 Preparing the future. Coupling AGATA to spectrometers during its travelling campaigns at Legnaro, GSI and GANIL.

High energy and high intensity "fragmentation" facilities can take advantage of high cross section production of in flight fission and spallation processes:

a) In "flight" fission of ^{238}U, neutron rich isotopes near the r- process path are produced at high rates with allow mass and half life measurements.
This was recently accomplished at RIBF-RIKEN facility using a 345 MeV/n intense U beam. For 45 new isotopes, in the mass region A=90-120, Z=36-44, selected and purified by BIG-RIPS fragment separator, the half-lives were measured for the first time and data analysis revealed a more rapid flow in the r-capture process than expected [15].

b) At relativistic energies, e.g. 1GeV/n, at GSI, the spallation process dominates. The reaction ^{238}U+ ^{7}Be , in conjunction with the high resolution fragment separator FRS and a new detector set-up has allowed the discovery of 57 new very neutron rich isotopes located south of 208Pb , a region where are located key nuclei (^{202}Os) near and within the third peak of the nuclear synthesis abundance curve [16].

The last trend I would like to discuss in this section about the science drivers is the role played, in the structure and reaction themes, by the coupling of very powerful spectrometer and separator or both with very large and efficient detector arrays for gammas and charged particles. Let us mention EXOGAM coupled to VAMOS at GANIL, and more recently AGATA demonstrator [17] coupled to PRISMA at Legnaro and later coupled to the FRS device at GSI in the so called PRESPEC In flight spectroscopy set-up. On the same physics grounds, a large European-Japanese collaboration, EURICA, was built using Euroball Ge clusters at RIKEN-RIBF facility to investigate gamma-spectroscopy around ^{100}Sn and ^{110}Zr. In Europe, the AGATA array has started its travelling campaigns as illustrated in fig.3. After a first physics campaign at Legnaro (LNL) and a second one in progress at GSI, the AGATA array will be installed at GANIL in 2014 coupled to the VAMOS spectrometer.

3. NEXT GENERATION OF HIGH POWER ACCELERATORS THE WORLD ROAMAP

The importance of the RIB's has been underlined by NuPECC [18] (Nuclear Physics European Collaboration Committee - an expert committee of the European Science Foundation). NuPECC working group on future RIB facilities has made in its conclusions more than a decade ago the following recommendations:

Next generation of RIB facilities should aim at intensities 1000 times higher than in the facilities presently running or at the commissioning stage. Truly complementary facilities based respectively on the « In flight and Isol » methods are needed to cover the foreseen physics issues, and they should be second to none world-wide.

In addition through the successive European framework program (FP5, FP6, FP7) strong R&D programs have been developed by large consortium of laboratories both on low and high energy high power drivers for proton, deuterons and heavy ions beams on large acceptance separator spectrometer, on target-ion source and post accelerator systems for ISOL type facilities. During about one decade (1995-2005) a few projects based on the "In flight" method, on the ISOL or combinations of the two have emerged all around the world. Let me summarize recent developments of RIB facilities and projects as well as associated main instruments

In the category of In-Flight installations belonging to the new generation

3.1. *RIKEN RIBF [19]*

was the first to start operation in 2007. Based on two injectors (Heavy ion linac and AVF cyclotron) and four booster cyclotrons, all types of ions from proton to Uranium up to 350 MeV/n in CW Mode. The main accelerator is the first and the largest superconducting ring cyclotron in the world, with a K value of 2600 MeV. Goal for beam intensities were set to 1pμA for all beams, so far this goal was reached for light beams (d, ^{4}He, ^{18}O) and about 0,5 to 0,3 pμA for ^{48}Ca and ^{136}Xe . Recently a new injector was commissioned, RIKEN LAC2, specialized for very heavy ion (> Kr). A record intensity of 4 pnA has been achieved for ^{238}U beam.

After target fragmentation, the produced secondary RIB is transferred to BigRIPS. BigRIPS can be also associated to new set of specialized and powerful spectrometers (O° Spec, SHARAQ, SAMURAI). Both high power accelerator capabilities and new experimental devices make today RIKEN-RIBF a world leading facility in this field.

Two others major fragmentation facilities are being built in Europe and in the US.

3.2. *FAIR@GSI [20]*

During the past decade the GSI facility has obtained outstanding results in the field of RIB. Let us mention the Schotty and TOF methods that involve the FRS spectrometer and cooler-storage ring ESR. In the coming years the new international accelerator facility FAIR [20], one of the largest research projects worldwide, will be built at GSI. FAIR will provide antiproton and ion beams with unprecedented intensity and quality. At its heart is a double ring facility with a circumference of 1100 meters. The existing GSI accelerators - together with the planned proton-linac - serve as injector for the new facility. The double-ring synchrotron (SIS100/S300) will provide ion beams of unprecedented intensities (up to 10^{12}pps of ^{238}U beam) as well as of considerably increased energy. Thereby intense beams of secondary beams - unstable nuclei or antiprotons - can be produced. Based on the success of the existing GSI facility FAIR will also built a system of storage-cooler rings that allows the quality of these secondary beams - their energy spread and emittance - to be drastically improved.

One of the four major science programs of FAIR is the NUSTAR collaboration [20]. As illustrated in fig.4, the workhorse of this physics program devoted to the study of nuclear structure and reactions as well as Nuclear Astrophysics at the drip line is the Super-FRS fragment separator and its three experimental branches where a very large and international collaboration of 700 scientists from 170 institutes and 38 countries are developing the tools for masses and laser spectroscopy (MATS,LASPEC) for high and low energy gamma, beta and particle decay spectroscopy at the limits (HISPEC- DESPEC) in the Low Energy Branch (LEB), for reactions studies with “exotic” nuclei at relativistic energies with R3B (HEB branch). The third one will be connected to the cooler storage ring facility (RIN) where EXEL, ILIMA and ELISE experiments will be installed. The total Investment is of the order of 82 M€ for Super-FRS and of about 73 M€ for the other experiments. NUSTAR@FAIR represents truly the realization of the world class “in flight facility which was recommended by the NuPECC working group in 2000 for EUROPE.

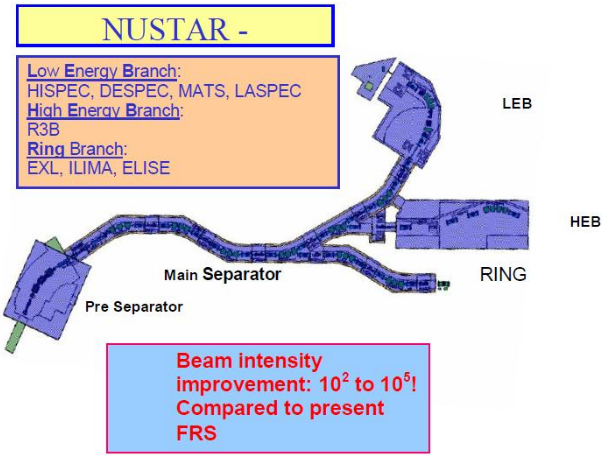

Figure.4 Lay out of the workhorse of the NUSTAR collaboration, the Super-FRS superconducting fragment and its three experimental branches at the future FAIR Facility.

The European Strategic Committee for Future Research Infrastructures (ESFRI) has acknowledged the NUPECC strategy by recommending in its first report in October 2006 the construction of FAIR and SPIRAL2 facilities in order to support and develop Europe leadership in the field of nuclei far of stability [21].

3.3. *FRIB at NSCL-MSU [22]*

In the other side of the Atlantic, the United States DOE project FRIB is well underway at NSCL-Michigan State University [22]. The driver accelerator for the production of intense secondary RIB belongs to this next generation of superconducting Linac able to produce a 400 kW uranium beam and 200MeV/n. Maximum transmission of this intense very heavy ion beams is based on the innovative concept of multi-charge acceleration. FRIB will have the following capabilities:

-Fast, stopped and reaccelerated beam capability (ReA3). The re-accelerator part of the FRIB project is almost completed using the existing NSCL coupled cyclotrons and a gas stopper cell to guide the singly charge ions though an electrostatic plate-form to a EBIT charge breeder, followed by an RFQ and a superconducting linac, to reach in a first phase 3MeV/n for heavy ions .

-Upgrade options: Energy 400 MeV/u for uranium and ISOL production together with Multi-user capability.

-The Production of rare isotope beams with 400 kW beam power using light to heavy ions up to ^{238}U with energy ≥ 200 MeV/u are achieved by coupling the target area to a large acceptance: ± 40 mrad (angular) and ± 5% (momentum) and high magnetic rigidity: 8 Tm fragment separator with three separation stages for high beam purity plus operational versatility.

In addition to Nuclear structure and Reaction, Astrophysics (the origin of the elements in the cosmos, properties of neutron stars, …), and tests of Fundamental Symmetries effects, Societal Applications and benefits in Bio-Medicine, energy, material sciences, national security are integral part of the science program.

Final design of the technical systems—accelerator and experimental equipment—is underway and anticipated to be complete in 2014. Project completion is expected in 2021, managing to early completion in 2019.

In a similar way quite a few new projects for intense secondary RIB based on **ISOL** method are under construction and/or just started operation around the world.

3.4. *ISAC at TRIUMPF [23]*

Since 1990, The TRIUMF Isotope Separator and Accelerator (ISAC) facility uses the isotope separation on-line (ISOL) technique to produce rare-isotope beams (RIB). In the ISAC-I facility, 500 MeV protons at up to 100µA (50 kW) can be steered onto one of two production targets to produce radioactive isotopes. The targets can be coupled to a wide variety of ion sources to produce very intense RIB's for certain isotopes such as ^{11}Li, ^{11}Be, ^{21}Na, ^{18}F, ^{23}Mg and ^{26g}Al. Low-energy (<60 keV) RIB's have been available at ISAC since spring 1999. Few years later an RFQ and variable energy DTL became operational to provide reaccelerated radioactive beams in the energy range from 0.15 to 1.8 A MeV (ISAC1) for nuclear reaction studies of importance in explosive nucleosynthesis environments. For high-energy delivery, the drift tube linac (DTL) beam is deflected to the ISAC-II superconducting linear accelerator (SC-linac) to reach energies above the Coulomb barrier (5-11 MeV/u). Therefore with ISAC-II, the potential for nuclear structure studies, with the set of instruments TIGRESS, EMMA, IRIS, TUDA and HERACLES has been recently greatly enhanced.

TRIUMF has recently embarked on the construction of ARIEL, the Advanced Rare Isotope Laboratory, with the goal to significantly expand the Rare Isotope

Beam (RIB) program for Nuclear Physics and Astrophysics, Nuclear Medicine and Materials Science. ARIEL will use proton induced spallation and electron-driven photo-fission of ISOL targets for the production of short-lived rare isotopes that are delivered to experiments at the existing ISAC facility. The ARIEL complex comprises a new Superconducting RF (SRF) 50 MeV 10mA CW electron linac photo-fission driver and beam line to the targets; one new proton beam line from the 500 MeV cyclotron to the targets; two new high power target stations; mass separators and ion transport to the ISAC-I and ISAC-II accelerator complexes; a new building and a tunnel for the proton and electron beam lines. Combined with ISAC, ARIEL will support delivery of three simultaneous RIB's, up to two accelerated, new beam species.

During the engineering design study of the EURISOL-DS (Design-Study) project, the necessary R&D program lead to the expected beginning of operation of the EURISOL facility around 2020[24]. Because of the time-line for EURISOL, NuPECC recommends the construction of intermediate-generation facilities that will benefit the EURISOL project in terms of R&D and that will give the community opportunities to perform research and applications with RIB. A short overview of these intermediate –generation facilities in Europe is presented below.

3.5. *HIE-ISOLDE at CERN [25]*

The High Intensity and Energy ISOLDE (HIE-ISOLDE) project forms part of the European nuclear physics strategy. HIE-ISOLDE is a major upgrade of the existing ISOLDE and REX-ISOLDE facilities with the objective of increasing the energy and the intensity of the delivered radioactive ion beam (RIB). This project aims to fill the request for a more energetic post accelerated beam by means of a new superconducting (SC) linac based on Quarter Wave Resonators (QWRs). For that goal, three main upgrades are foreseen:

a) Increase proton intensity 2 → 6 μA (LINAC4, PSB upgrade) with associated target and frontend upgrades.

b) RFQ cooler, REX ‑ TRAP, REX ‑ EBIS required modification

c) REX ‑ ECR upgrades, Super ‑ HRS for isobaric separation and RILIS laser ion source.

Once these upgrades and modifications achieved, the final energy of in REX beams will increase from 3 to 5.5 MeV/u and later increase to 10 MeV/u is possible.

3.6. *SPES at LNL [26]*

The aim of the SPES project is to provide high intensity and high-quality beams of neutron-rich nuclei to perform forefront research in nuclear structure, reaction dynamics and interdisciplinary fields like medical, biological and material sciences. SPES is a second generation ISOL radioactive ion beam facility [26]. It represents an intermediate step toward the future generation European ISOL facility EURISOL. The SPES project is part of the INFN Road Map for the Nuclear Physics; it is supported by the Italian national laboratories LNL (Legnaro) and LNS (Catania). It is based on the ISOL method with an UCx Direct Target able to sustain a power of 10 kW. The primary proton beam is delivered by a Cyclotron accelerator with energy of more then 40 MeV and a beam current of 200 μA. Neutron-rich radioactive ions will be produced by Uranium fission at an expected fission rate in the target of the order of 10^{13} fissions per second. The exotic isotopes will be re-accelerated by the ALPI superconducting LINAC at energies of 10 AMeV and higher, for masses in the region of A=130, with an expected rate on the secondary target of 10^8 pps.

The production target system is one of the most crucial components in ISOL facilities. This project is characterized by R&D activities pertaining to a uranium-carbide target and is collaboration among the INFN laboratories and Italian universities. The target system is made of uranium carbide multi-foil on which protons with a power of 8 kW will impinge. The configuration is carefully designed to keep the fission rate as high as 10^{13}/s with moderate heat deposition, as well as to release the produced ions in a short time. A prototype of the target system has been manufactured at Legnaro and various tests are under progress.

Two facilities for applied physics are planned: a neutron facility that make use of the proton beam to produce neutrons and an irradiation facility for production and study of radioisotopes for medical use.

3.7. *SPIRA2 at GANIL [6]*

Among the proposed intermediate facilities SPIRAL2 at GANIL (Caen, France)[6], meets in terms of physics potential, site and size of the investments, the criteria of European dimension as it was recognized recently in the ESFRI (European Strategy Forum on Research Infrastructures) roadmap [21].

The SPIRAL 2 facility (Figure. 5) is based on a high power, superconducting driver LINAC, which will deliver a 5mA, 40 MeV deuteron beam as well as a variety of heavy-ion beams with mass over charge ratio equals to 3 and energy up to 14.5 AMeV. Using a carbon converter, the 5mA deuteron beam and a uranium carbide target, fast-neutron induced fission is expected to reach a rate of up to 10^{14} fissions/s. The RIB intensities in the mass range from A=60 to A=140 will surpass by one or two order of magnitude any existing facilities in the world.

The stable heavy-ions available at the exit of the linac accelerator will reach intensities from 1pμA to 1pmA.These heavy ions beams will be used to induce fusion and deep inelastic processes leading to the production of neutron and proton rich isotopes. The extracted RIB will be subsequently accelerated to energies of up to 20 AMeV, (Typically 6-7 AMeV for fission fragments), by the existing CIME cyclotron. Thus using different production mechanisms and techniques, one of the important features of the future GANIL/SPIRAL/SPIRAL 2 facility will be a possibility to deliver up to five stable or radioactive beams simultaneously in the energy range from KeV to several tens of AMeV.

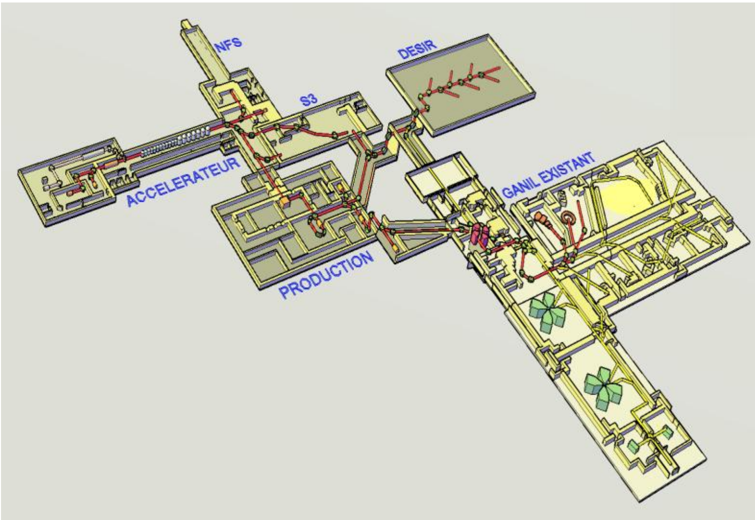

Figure 5. Schematic layout of the SPIRAL 2 facility at GANIL

SPIRAL2 has also a remarkable potential for neutron-based research both for fundamental physics and various applications. In particular, in the neutron energy range from a few MeV to about 35 MeV this research would have a leading position for the next 10-15 years if compared to other neutron facilities in operation or under construction worldwide.

The civil construction of SPIRAL2 has started .It is divided into two phases. Phase 1 includes the LINAC building and associated experimental areas (AEL) and is planned to be completed by t 2013 with the commissioning of first beams from LINAC. The second phase (RIB production building and dedicated area low energy ISOL facility, DESIR) is foreseen to start in 2014 aiming to be ready by 2017. A complete review status of this project can be found in the contribution by M. Lewitowicz to this meeting.

3.8. *The ALTO facility at ORSAY*

(Accélérateur Linaire et Tandem d'Orsay) at the "Institut de Physique Nucléaire d'Orsay" has been recently commissioned [27, 28], and has received green light from the safety authorities in June 2012.

The ALTO accelerator is an electron accelerator (50 MeV, 10µA) used as a driver to induce photo-fission in a thick heated uranium carbide target. The number of fissions reached in the target is $10^{\mathbf{11}}$ fissions per second. The idea to use photo-fission to induce fission gives the opportunity to produce very exotic neutron rich nuclei without isobaric contaminants. Fission fragments are extracted at 30 kV towards the on-line isotope separator PARRNe or can be selectively ionized with a laser ion source. Research and development on target and ion sources for all the futures second generation radioactive ion beam project (SPIRAL2, EURISOL …) is also in the heart of the activity at ALTO.

Currently the facility provides physicists with intense exotic beams of neutron-rich nuclei in the regions of double magic ^{78}Ni and ^{132}Sn.

First generation experiments at ALTO are focused at the spectroscopy of neutron rich nuclei around the N=50 shell closure. Beta decay properties are among the easiest and therefore, the first ones to be measured to study new neutron rich isotopes. Eventually it could be sufficient just a few number of nuclei to estimate its lifetime and neutron emission probability. To study beta decay properties of such nuclei at ALTO a new experimental setup including the beta –gamma coincidence set-up BEDO and the neutron detector TETRA of high efficiency was developed and commissioned.

4. CONCLUSIONS

Nuclear physics has been revolutionized by the recent development of the ability to produce accelerated beams of radioactive nuclei. For the first time it will be possible to study reactions to produce the 6000 to 7000 nuclei we believe exist. At the larger scale one wants not only to understand the limits of nuclear stability by producing exotic nuclei with vastly different numbers of neutrons and protons but also to be able to investigate the full spectrum of nuclear reactions with these intense secondary beams and innovative new instrumentation. The considerable R&D on new accelerator technology, target-ion sources and experimental devices has provided the essential knowledge allowing us to design and built worldwide a new generation of facilities. The foreseen scientific program, proposes the investigation of the most challenging nuclear and astrophysics questions aiming at the deeper understanding of the nature of matter.

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