05/04/2018

S^3 Collaboration Meeting,
June 18 (13:30) to June 22 (12:30) 2018 at GANIL

The development and construction phase of the Super Separator Spectrometer S3 at GANIL/SPIRAL2 and its experimental devices to be placed at the end of the spectrometer are on the final stage. Consequently, it is the moment for the collaboration to revisit the scientific cases (and/or propose new ones) for early campaigns (Day1 experiments) and perspectives for the next phases (future campaigns-Day2). Therefore, **the main focus of this workshop will be to elaborate a detail experimental Day1 program and road map for future campaigns.** Even more, the scientific options at S3 were presented to the GANIL scientific council composed by international members. The committee acknowledged the decision of the collaboration to start with the convergent optical mode for the spectrometer, and advised the collaboration to elaborate the Day1 scientific program.

The roadmap of S3 can be schematically divided into two distinctive periods based on available S3 performances and experimental set-ups (Table 1).

Table 1: Optics modes, target, experimental set-ups and intensities available at different stages of the S3 project.

	Day 1 campaigns		**Future campaigns (Day2)**
Optics Modes	Convergent	High Resolution	Other
Target	Stable	Stable	Actinide
Exp. Set-Up	LEB SIRIUS	LEB SIRIUS	FISIC Other
LINAC Intensity	A/Q=3	A/Q=3	A/Q=3 – A/Q=7

To elaborate S3 Day1 physics programme we request the collaborators willing to propose experiments at S3, to **prepare pre-proposals for the Day 1 type experiments**. **Experimental programs based on Day2 type experiments should be presented as LoIs (**The S3 collaboration engages to provide technical information for the pre-proposal / LoI preparation to the new collaborators willing to join).
In order to organize the workshop, we ask you to **submit a letter following the proposed template including full pre-Proposal (for Day1 experiments) or LoI (for Day2 physics cases).** All letters must be sent to the S^3 scientific coordinator Hervé Savajols (savajols@ganil.fr) with a copy to WS18_S3@ganil.fr. **Deadline for submission is 27/05/2018.**

These letters will be presented and discussed during the S^3 collaboration meeting at GANIL on June 18-22th, 2018 with the goal to propose a detailed experimental Day-1 program. In addition, perspectives for the next sub-sequent campaigns will also be discussed to provide a road map to the collaboration towards future experiments. The proposed campaign will be discussed further in specific meetings with the **S3 User Collaboration Council (S3UCC)** to structure a SWOT analysis, so that a well motivated choice can be made for the Day-1 campaign.

In the following, the status of the S3 facility and expected performances that can serve as guidance in preparing the letters is summarized.

- **Targets:** A high power stable target system will be used (including uranium and thorium). This system can handle high intensities (>1pμA). For additional information, please contact Christelle Stodel (stodel@ganil.fr). The use of actinide targets will come in a second phase (Day2) and an update list of prioritised elements should be discussed at this collaboration meeting based on the LoI submission.

- **Optics and performances:** Two basic standard optical modes have been developed to meet the needs of Day 1 experiments: convergent and high mass resolution modes (Figure 2). Other modes will be considered for Day2 experiments.
  The converging mode will provide the highest transmission (~60% transmission of ^{100}Sn in the 10x10cm^2 DSSD of SIRIUS or 57% in the entrance window ϕ= 5cm of the LEB) with no mass resolution at the focal plane.
  The high mass resolution mode will provide mass selection of the order of ΔM/M = 450 for ^{100}Sn keeping a high transmission of 40% in a 10x10cm2 SIRIUS-DSSD at the focal plane. The development and the needs of this optical mode for the users will be discussed at the collaboration meeting.

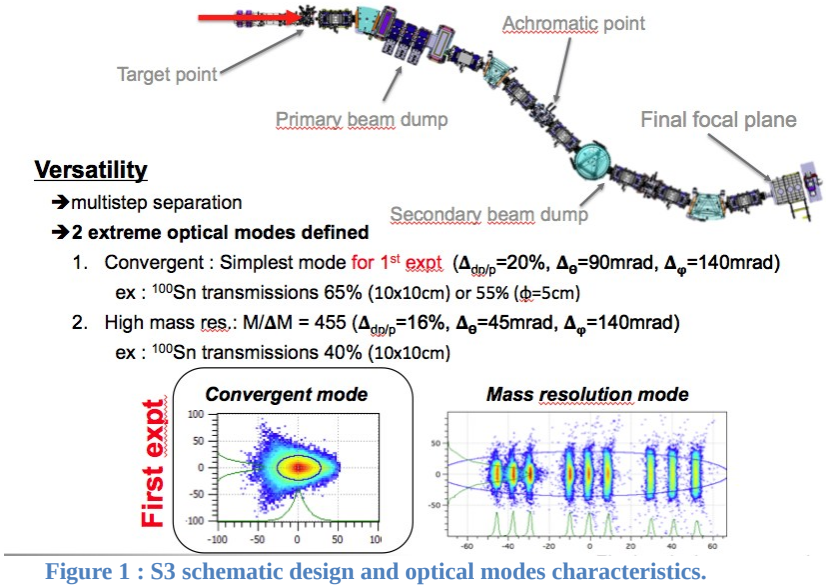

Figure 1 : S3 schematic design and optical modes characteristics.

For additional information, please contact Antoine Drouart (antoine.drouart@cea.fr).

- **Instrumentation:** The two setup "Spectroscopy and Identification of Rare Isotopes Using S3" (SIRIUS) and "Low Energy Branch" (LEB)

will be ready to start the Day-1 experimental program.

- **SIRIUS**

SIRIUS is composed of a highly segmented double-sided silicon strip detectors (DSSD) to detect the implantation of the produced nuclei transmitted through S3 as well as their decays. The DSSD is surrounded by a TUNNEL detector composed of silicon pad detectors, to measure charge particles (alpha, electrons and protons) escaping from the DSSD silicon detector following the decay of the implanted ion. Gamma decay spectroscopy will be performed in five Ge detectors, type EXOGAM2, placed in close geometry surrounding the implantation detector.

Upstream the silicon box, secondary electron detector (SED) will allow time of flight measurements and ion tracking. The ion optical system is tuned to maximize the recoil transmission in the 10 *cm* × 10 *cm* DSSD, while preserving the mass resolving power needed at the *m/q* dispersive focal plane for the high resolution optical mode.

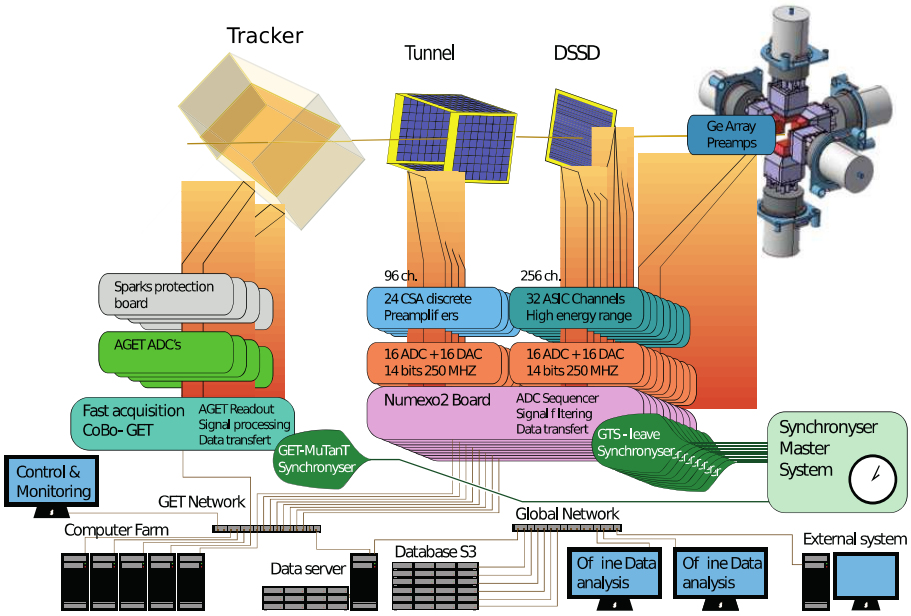

Figure 2 : Schematic picture of the SIRIUS set-up

The main characteristics of SIRIUS are summarized below:

- Time of flight ($\Delta t < 1ns$) and tracking ($\Delta x < 0.5mm$) of (super) heavy ions
- Implantation decay correlation ($10x10cm^2$, 128x128ch DSSD)
- Digital electronics for fast decays (low gain/high gain switching) $\Delta E_{alpha} < 20keV$

For additional information, please contact Barbara Sulignano (barbara.sulignano@cea.fr).

- **LEB**

The LEB system is composed of a gas cell to slow down and thermalize the transmitted ions. The thermalized and neutralized isotopes are embedded in a low-temperature gas jet and ionized using selective laser excitation and ionization thereby forming a low energy singly-charged ion beam. The ions are then pre-selected by a Radio Frequency Quadrupole system (RFQ) and/or a Multi-Reflection Time-Of-Flight Mass Separator (PILGRIM), accelerated up to few keV, and transported to a set-up for decay measurements or to the DESIR facility. The system allows performing in gas-jet laser spectroscopy to study $\delta\langle r^2\rangle$, spins of ground and isomeric states, as well as nuclear magnetic dipole and electric quadrupole moments *(Medium resolution laser spectroscopy 100MHz at very low rate <0.1/s*). Masses will be accessible with PILGRIM *(R>100000 and dm/m≈10^{-6})*. Decay studies on pure (isomeric) beams will be possible by placing a Si-Box & Instrumented tape station after the LEB. The system will deliver pure (isomer) beams at low-energy (3 – 50 keV) for further studies. The global efficiency of the system is 4-10% depending on the physics case.
According to the current development plan of the LEB, only TiSa laser system will be available for Day1 experiments. Therefore, the physics program will depend on which elements can be efficiently ionized by the TiSa system (conditions on laser flux and fluence/power). The most promising elements are Pd, Ag, Cd, In, Sn, Ac and Th. This list is not exhaustive and can be extended depending on the needs for experiments defined on the pre-Proposals and LoIs presented on this workshop. The complementary dye laser system to access all possible laser ionisable elements will come in a second stage, around 2022.
For additional information, please contact Piet Van Duppen (piet.vanduppen@kuleuven.be).

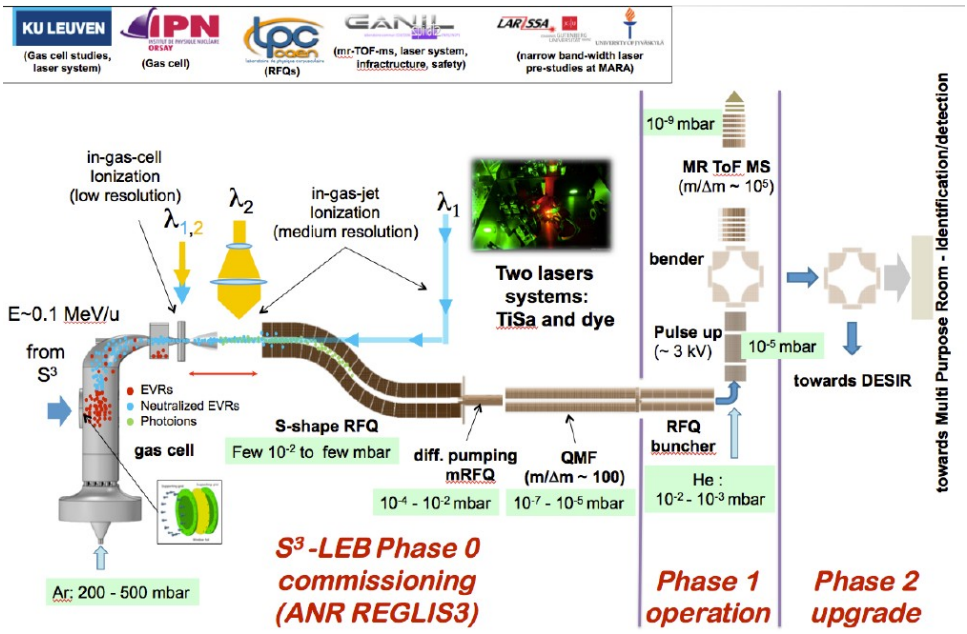

Figure 3: Schematic picture of the LEB set-up

- **Expected yields:**

Main information about radioactive beams potentially produced at S^3 in the converging mode can be found using the GANIL/SPIRAL2 interactive chart of ion beams: https://u.ganil-spiral2.eu/chartbeams/

Finally, further information on the S3 facility and envisaged physics programme can be found at http://pro.ganil-spiral2.eu/spiral2/instrumentation/s3.

References :

- Specifications, Design, and Commissioning of the Superconducting Multipole Triplets for the SPIRAL2 Super Separator Spectrometer, M. Authier & al. EMIS XVII - International Conference on Electromagnetic Isotope Separators and Related Topics, 2015
- The Super Separator Spectrometer S3 and the associated detection systems : SIRIUS & LEB-REGLIS3, F. Dechery et al., Nucl. Instruments and Methods in Physics Research B 376 (2016) 125
- In gas laser ionization and spectroscopy experiments at the Superconducting Separator Spectrometer (S3): Conceptual studies and preliminary design", R. Ferrer et al., Nucl. Instr.Meth. B317 (2013) 570