EURISOL JRA WP 14 Second Periodic Scientific Report

Highlights

- During the second commissioning iteration of the MEDeGUN electron gun, a 1 A electron current with an energy of <3 keV could be transmitted through the TwinEBIS solenoid. We can conclude that a Brillouin gun design is a viable solution for an EBIS aiming at rapid charge breeding. Firm values on the transverse emittance of an EBIS operating under nominal conditions have also been obtained, which is of major importance for the design of post accelerating structures. (task ICBT; towards deliverable 14.3)

- At GANIL the tests of the EMILIE debuncher prototype proved the principle of the debuncher concept and successfully demonstrated uniform extraction and the trapping times up to 1 s with no detectable losses of trapped ions with injection energies of 30 eV. The proof of principle reported here clearly offers interesting perspectives for such a device to be used in combination with existing or future EBIS sources at ISOL facilities. (task ICBT, deliverable 14.1)

- At CNRS-IPN Orsay the simulation and design of new prototype of IRENA ion source w as fully achieved. (task Beamlab; deliverable 14.2)

- CERN-ISOLDE has developed a novel target concept, which fully avoids diffusion through condensed matter, and makes use of the fission recoil effect to extract elements like molybdenum, technetium or ruthenium as volatile carbonyl compounds of type M(CO)x. (task Beamlab, towards deliverable 14.4)

Difficulties

A delay of deliverable D14.3: “Conceptual design report of a new generation charge breeder” from month 36 to month 44 was requested and accepted in an amendment to the contract. This request was due to the resignation of a postdoc before the end of his contract. His replacement was hired in October 2017, and the work is now proceeding on schedule with the deliverable foreseen for month 44.

Website

A website for the EURISOL JRA hosted at CNRS-IPN Orsay was put in place in month 23. This site is accessible at https://eurisol-jra.in2p3.fr/. It includes a general description of the work package, a list of participants, minutes of the various meetings, submitted milestones and deliverables…

Milestones and Deliverables

The following milestones and deliverables were achieved on time during the second reporting period.

MS51: Experiments for the optimal breeder configuration (month 24)
MS52: Nuclear data of produced beams (month 36)
D14.1: Report on performances of the EBIS debuncher (month 24)
D14.2: Report on R&D on radioactive plasma ion sources (month 36)

Meetings

The following meetings were organized during the reporting period

March 6, 2018 Task 1 (ICBT) meeting at GANIL : 4 participants

April 3, 2018: Task 2 (Beamlab) meeting at CERN: 10 participants

July 2-4, 2018: 8 talks devoted to EURISOL JRA at EURISOL Town Meeting organized by WP2 NUSPRASEN. Details at https://agenda.infn.it/event/14402/timetable/?view=standard or in milestone MS57 and deliverable D2.3.

Publications

1. "EBIS debuncher experimental performance", P. Ujić et al., Nucl. Instrum. Meth. A 918, 30-36, February 2019, https://doi.org/10.1016/j.nima.2018.11.043
2. "A low energy ion beamline for TwinEBIS", H. Pahl et al., JINST 13 P08012 (2018), https://doi.org/10.1088/1748-0221/13/08/P08012
3. "Pepperpot Emittance Measurements of Ion Beams from an Electron Beam Ion Source", J. Pitters et al., Nucl. Instrum. Meth. A, vol922, 1 April 2019, Pages 28-35, https://doi.org/10.1016/j.nima.2018.12.072
4. "MEDeGUN commissioning results", M. Breitenfeldt et al., AIP Conf. Proc. 2011, 040004 (2018), https://doi.org/10.1063/1.5053278
5. "Charge breeding of CO+ beams at REX-ISOLDE", J. Pitters et al., AIP Conf. Proc. 2011 070012 (2018), https://doi.org/10.1063/1.5053354
6. "Summary of charge breeding investigations for a future 11C treatment facility", J. Pitters et al., CERN-ACC-NOTE-2018-0078, https://cds.cern.ch/record/2648691
7. "The TwinEBIS setup: Machine description", M. Breitenfeldt et al., Nucl. Instrum. Meth. A, 856 (2017) 139-146, https://doi.org/10.1016/j.nima.2016.12.037
8. M. Cheikh-Mhamed, A. ZHANG, An optimized plasma ion source for difficult ISOL beams, submitted for proceedings of the EMIS 2018 conference, to appear in Nucl. Instrum. Meth. B.
9. J.Ballof, C.Seiffert et al., Radioactive Boron Beams Produced by Isotope OnLine Mass Separation at CERN-ISOLDE, Eur. Phys. J, accepted for publication (2019)
10. P. Delahaye et al., arXiv:1903.02220 [physics.acc-ph], proceedings of the EMIS 2018 conference, to appear in Nucl. Instrum. Meth. B.

Conference Presentations

1. ENSAR2 Town Meeting, 17-19 April 2018, Groningen, oral presentation "Innovative Charge Breeding Techniques"
2. EURORIB 2018, May 27-June 1, Giens, an oral presentation "Performances of the EBIS debuncher"
3. EURISOL Town Meeting, 2-4 July 2018, Pisa, oral presentation "Accomplishments of ICBT task of the EURISOL JRA"
4. EMIS 2018, 16-21 September 2018, CERN, oral presentation "EBIS debuncher performances"
5. EMIS 2018, 16-21 September 2018, CERN, poster presentation "Challenges in 11C charge breeding"
6. German Physics Society meeting, March 2018, oral presentation "Progress of the MEDeGUN commissioning and extension of the TwinEBIS test bench"
7. ICIS 2017, 15-20 October 2017, Geneva, poster "MEDeGUN Commissioning Results"
8. EBIST 2018, 23-27 October 2018, oral presentation "Progress of EBIS research and development at CERN"
9. ENSAR2 Town Meeting, 17-19 April 2018, Groningen, oral presentation "Target & Ion studies: "BeamLab Task"

10. EMIS 2018, 16-21 September 2018, CERN, oral presentation “New exotic beams from the SPIRAL1 upgrade”
11. EMIS 2018, 16-21 September 2018, CERN, poster presentation “An optimized plasma ion source for difficult ISOL beams”

Task 1: Innovative Charge Breeding Techniques (ICBT)
Coordinator: Fredrik Wenander (CERN)

Introduction

During the last decade the Electron-Beam Ion-Source (EBIS) technology has established itself as a key method for preparation of radioactive beams for further post-acceleration. The future challenges for these breeders lie in the higher beam intensities delivered by the primary target, the request for curbed breeding times and the demand for fully stripped heavy ions (or few-electron systems) to be injected into consecutive storage rings. In addition, the experiments would profit from a continuous wave (CW) extracted beam structure, which could be obtained by using a Paul trap. Furthermore, charge breeders of ECR ion-source (ECRIS) type are of interest for several facilities within Europe and elsewhere. One of the ICBT tasks is to optimise the capture and ionisation efficiency inside the ECR cavity.

Deliverables and milestones

Deliverables

- D14.1 Report on performances of the EBIS debuncher (Month 24) submitted on time
- D14.3 Conceptual design report of a new generation charge breeder (Month 36) delayed to month 44

Milestone

- MS 51 Experiments to find the optimal breeder configuration (Month 24) submitted on time

CERN – EBIS activities

One of the objectives of the ICBT task is to reduce the charge breeding times in order to access even shorter-lived radioactive ions, but also to increase the repetition rate of the post-accelerating linac. We are addressing this point by developing a high-compression electron gun, MEDeGUN, that is being tested at the TwinEBIS setup. During the first commissioning run early summer 2017, the design goals for the electron current and energy (1 A at 10 keV) were already reached.

Mechanical improvements of MEDeGUN and the TwinEBIS setup

We have since then made some modifications to the setup. First of all the adjustment mechanism for the alignment of the electron gun cross has been upgraded to obtain a better movement reproducibility. The insulation of the internal drift tubes in the EBIS has been increased so higher voltages can be applied to the trapping and barrier tubes, a necessity when ions are to be extracted as the space charge potential of the electron beam is very high (>1.5 kV). A gas feed line, to be used for injecting seed gas into the trapping region, has also been implemented. Finally, the MEDeGUN electron gun itself has been modified: a solid molybdenum Wehnelt is now in use, and the cathode has been moved 50 μm into the Wehnelt as previous perveance measurements pointed in the direction of a protruding cathode. The modifications were carried out during autumn 2017 and installation to place during spring 2018.

Second commission round of MEDeGUN

We have focussed on running the electron beam with a lower beam energy inside the trapping region of the EBIS. By doing so, we can examine how the electron beam would behave if injected into a stronger magnetic field, something that is a necessity for a very rapid charge breeding. Preliminary tests show that we can reduce the electron beam energy down to <3 keV for a current of 1 A with maintained low anode losses, indicating that the electron beam is sufficiently well-behaved to be injected into at least a 5 T solenoid.

Recently we have also shown that a 1.5 A beam can be transmitted at 8 kV acceleration voltage. The high current at a moderate acceleration voltage result in a large trapping capacity of the EBIS. Thereby we are addressing another of the ICBT objectives - higher radioactive ion intensities expected from future radioactive beam facilities. The positive results from the MEDeGUN tests are key input for the last deliverable D14.3: Conceptual design report of a new generation charge breeder.

Transverse emittance measurements of EBIS beams

Of importance for the extracted beam from an EBIS is the pulse length, but also the transverse emittance. We have carried out a measurement campaign using a pepper-pot emittance meter (PPEM), equipped with a sensitive micro-channel detector in combination with a phosphor plate, as diagnostics tool for the transverse emittance of the pulsed, multiply charged beam exiting REXEBIS.

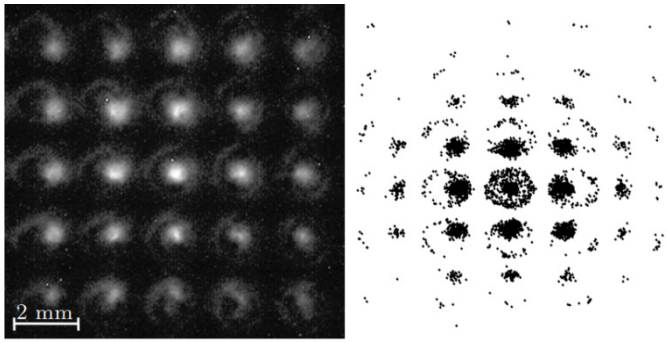

Figure 1 Left: Emittance picture (zoom) of a Xe beam at 67% space charge neutralization. Right: SIMION simulation of a beam passing theroug an Einzel lens (filling factor 60%) and a pepperpot mask.

First of all a careful analysis of the optimal operating parameters of the PPEM for ion beams of varying intensities was carried out. Thereafter emittance values for mass-separated and non-separated beams for different operating modes of the EBIS could be determined. The agreement with theoretical predictions was good. Furthermore, we could report on unexpected aberrations created in our injection-extraction system, and their signature in the detection plane of the PPEM (see Fig. 1). The finding lead us to take precautionary steps when designing the focusing system for the ion-extraction beam line for the TwinEBIS setup.

HIL – ECRIS activities

The objective is to study the effect of slanting beam injection into the ECR plasma region and its influence on the high charge yield. The experimental setup consists of an ECRIS connected with the 1+ ion source via a special injection system and electromagnet analyser connected to a measuring chamber and forming a mass spectrometer. The ECRIS is powered with a 300 W, 10 GHz frequency generator.

Performed tasks:

a) Installation of the beam injection system was carried out. In order to implement a skewed beam injection into the plasma, a special dissipation electrode was calculated, constructed and installed. This axial symmetric deflector gives a possibility to decouple injected 1+ beam flight time from its energy. This, in turn, allows optimization of both injection energy and interaction time within the plasma.

b) In order to study the entrance optics into the ECRIS plasma chamber, a small thermal source for Li^{1+} ions was constructed.

c) The injection system was assembled into the ECRIS stand and initial tests of beam transmission and microwave injection were conducted. The optical behaviour of the Li^{1+} beam when passing through the chamber was initially tested without plasma, so tests of the 1+ beam transmission through the ECR magnetic trap with and without magnetic field were conducted. The beam current was optimized on the profiler by adjusting the magnetic field and the source potential. Performance measurements of the ion deflector were also carried out. The total beam current was measured with a probing device of the diffracted beam - a ring placed on an insulator surrounding the defector electrode. A strong dependence between diffracted beam current and injected beam energy was observed.

d) Beam capture and intensity measurements of the primary Li^{1+} beam passing through Ar plasma were conducted. The preliminary results of 1+ beam capture by ECR plasma showed the expected effect. Primary beam is captured by the ECR plasma when proper plasma density is obtained while adjusting microwave power and buffer gas pressure. If an ECR plasma is not present, the primary beam is passing through unaffected, suggesting insignificant interaction with buffer gas molecules. The use of lithium as an ion beam is convenient for these initial tests, but to determine capture efficiency more precisely it is necessary to do measurements for heavier elements.

GANIL – debuncher and ECRIS activities

In nuclear physics experiments CW beams are preferred to bunched beams as the latter induce larger dead-times, more pile-ups and random coincidences in the detectors due to the higher instantaneous counting rate at the moment of the bunch arrival. Thus, one of the goals of ICBT is to explore the realization of CW beams from an EBIS charge breeder. The beam is prepared in a debunching Paul trap, a project that started within the EMILIE-NUPNET when the prototype was built.

Debuncher results

During the period December 2017 – January 2018, a test experiment was conducted on the debuncher prototype using light Li^{1+} ions for debunching. The debuncher prototype has a set of electrodes, which allows simple manipulation of the potential inside the trap. The main concept of the uniform extraction was to apply sequences of ramp potentials starting from the injection side towards the ejection side of the trap and hence to “squeeze out” the trapped ions towards the exit out of the trap. However, this concept proved to produce a series of pulses instead of a CW beam. Therefore a new method, the so-called “inverse function method” was applied. Essentially, a time dependent potential based on the inverse integral of the energy distribution of the trapped ions was applied simultaneously on all inner electrodes. Using this method CW beams with extraction times up to at least 1 s were demonstrated.

During the test, it was also demonstrated that it is possible to perform simultaneous beam extraction and beam injection with this debuncher prototype, thus achieving a fully CW beam. This

was possible due to the flexible potential arrangement of the DC segment groups. Although, eventual space charge limitations have not been measured, considerations based on calculations and the performance of existing RF devices show that the debuncher principle should be safe up to 10^9-10^{10} ions per bunch, which is well in the limit of the existing EBIS devices.

Details can be found in deliverable 14.2 and in an article published in NIM A.

ECRIS charge breeding results

The main element of the SPIRAL 1 upgrade at GANIL is the introduction of a Forced Electron Beam Induced Arc Discharge (FEBIAD) type ion-source providing 1+ beams of condensable elements, coupled to the 14.5 GHz SPIRAL1 ECR charge breeder, which increases the charge state of the radioactive ions from 1+ to n+. Therefore, a series of tests on the SPIRAL 1 charge breeder were performed in the periods of June-July and November-December 2018. The aim was to optimize the capture and ionization efficiency inside the ECR cavity through studies of the impact of the ion scattering on the support gas, and the injection beam energy.

The following features related to the ICBT task were measured: transmission efficiencies and charge breeding efficiency as function of deceleration tube position, 1+ beam emittance and ion injection energy. The results were compared with simulation, where possible, in order to improve the understanding of these processes. In December 2018, a measurement of the characteristic charge breeding times for different charge states of ^{39}K for varying RF power, buffer gas injection pressure and buffer gas species was carried out. The results are under analysis.

Task 2 BEAMLAB
Coordinator: M. Cheikh-Mhamed – CNRS/IPNO

Deliverables

D 14.2: R&D on radioactive plasma ion sources (Month 36) submitted on time
D14.4: New targets, ion sources and beams (Month 48)

We recall the objective of this task which is to address the required developments on target-ion source systems to produce nuclear beams for isotopes which are challenging because of the chemical reactivity of the element.

LNL activities

Performed tasks:

- The SPES plasma ion source (based on the ISOLDE MK5 design) was properly optimized, concentrating on its thermal-structural behavior, on thermionic emission and beam extraction. The source was characterized off-line by means of ionization efficiency and transversal emittance measurements.
- SnS^+ stable beams were successfully produced combining Sn with S powder, both inserted in a dedicated tubular oven. During these tests the higher volatility of the SnS molecule with respect to elemental Sn was demonstrated.
- The LNL-SPES group completed the design and the high temperature testing of the target that will be used for the first radioactive ion beam production at SPES. Monte-Carlo simulations

(FLUKA code) for production and power deposition were performed, together with detailed coupled field electrical-thermal-structural analyses (ANSYS code). High temperature tests allowed the investigation of the target behavior (validating the above mentioned electrical-thermal numerical models) and of all the temperature sensors that will be used for the machine protection system.

IPNO activities

Performed tasks:

- The main geometrical optimizations for the third prototype of IRENA ion source were achieved through a particle trajectory simulations work with the LORENTZ-3EM Code. The thermal optimization work was achieved by the ANSYS code and the mechanical design was realized basing on these thermal optimization results. The main outlines of the simulation work and design criteria have been reported in the frame of the deliverable D14.2 and results are submitted for publication as part of the proceedings of the EMIS 2018 conference.
- A new injection gas system was designed for the PARRNe mass separator. The fluorination offline experimental campaign with the new injection gas system is planned for week 16 of this year (2019).
- The Alto target-ion source group has reviewed and finalized the geometrical design of the new UCx target. In this new design, the volume of fissile material (UCx) has been reduced by a factor of three while the fission rate is reduced by only 10 % due to a gain on the release efficiency. This new target design will be irradiated in the next online ISOL experiment planned by middle June 2019 and production yields will be measured.

CERN- Isolde activities

Molecular beams obtained by fluorination

Intense and pure radioactive boron beams are highly requested by scientists. The boron beam intensities available at thin target facilities are insufficient for many of the desired investigations. Within ISOLDE target developments, we could not only provide highly intense beams of exotic boron isotopes (^{8}B , ^{12}B), but also gain insight into the ionization behavior of boron fluoride molecules and diffusion properties of boron in different target materials.

Performed tasks:

Two dedicated experiments were performed to set up a model for the release of radioactive boron as fluoride ($^{8}BF_3$) from multiwalled carbon nanotubes (CNT). One dedicated experiment addressed the diffusion of boron in the nano material using a neutron depth profiling technique and the results have been accepted for publication in the European Physical Journal A.

Towards refractory transition metal and carbonyl selenide beams

The transition metals of the fifth and sixth row of the periodic table are refractory and could not up to now be extracted as beams from ISOL facilities.

Performed tasks:

To extract these beams, ISOLDE has developed a novel target concept, which fully avoids diffusion through condensed matter, and makes use of the fission recoil effect to extract elements like molybdenum, technetium or ruthenium as volatile carbonyl compounds of type M(CO)x.

Radioisotopes are produced at ISOLDE with an intense high-energetic proton beam impinging on a target material. Since the decomposition of molecules in beam-induced plasmas is a known concern, an irradiation unit to study carbonyl formation and survival at different proton and neutron fluences at ISOLDE was built and prepared for commissioning (fig.2). At the time of writing, the unit and accompanying gas handling setup have undergone testing and safety survey, and are ready to be used in experiments.

Selenium also forms volatile compounds with carbon monoxide. Recently the beam formation of SeCO was further investigated.

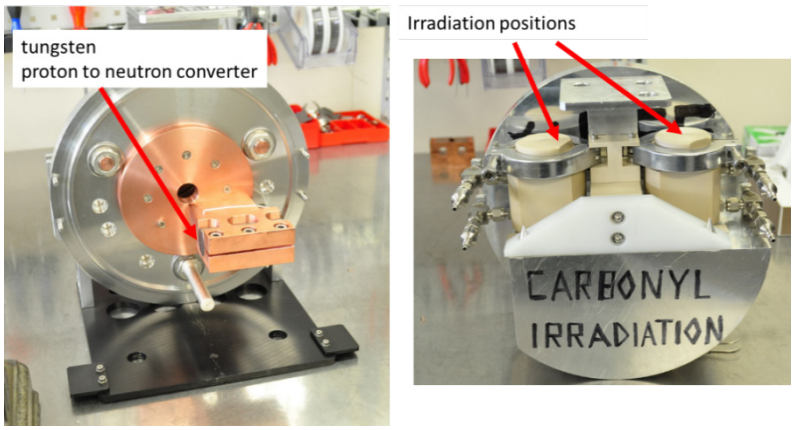

Figure 2: The carbonyl irradiation unit developed at CERN-ISOLDE

Sulfide tins (SnS) molecular beams

The improvement of the delivery of neutron deficient tin isotopes is currently investigated. One route for efficient extraction of the short-lived isotopes is via the route of tin sulfide (SnS) molecules. The CERN-ISOLDE group has reported in deliverable D 14.2 on the improvement of the delivery of Sulphur as a reactive component and the first on-line application of this new design. It is planned to apply for a dedicated beam time at ALTO to study production and release of SnS from UCx targets.

GANIL - Activities

At GANIL, the FEBIAD Target Ion Source System (TISS) couples standard SPIRAL 1 1200W C targets to the VADIS FEBIAD type ion source via an ohmic heated tantalum transfer tube.

In April and May 2018, the SPIRAL 1 upgraded facility was commissioned for radioactive ion beam production with the FEBIAD ion source. In the first commissioning experiment unexpectedly, the FEBIAD has failed and the anode insulators were identified as the probable cause. A new FEBIAD ion source was conditioned with a different configuration of heat shields permitting to cool down the insulators. With these modifications, the FEBIAD target ion source could be run with first a low power (100-200W) ^{40}Ca beam and finally a high power (>800W) ^{36}Ar beam, both at 95A MeV without failure.

The ionization efficiencies of the FEBIAD have been repeatedly monitored on the off-line test bench with stable rare gases. These ionization efficiencies are generally reproducing the efficiencies of the traditional MK5 of ISOLDE, which are a factor of ~4 lower than the VADIS ones. ISOLDE equally reports that similarly lower efficiencies are regularly obtained on-line with the VADIS. The conditions for stabilizing this enhanced ionization regime have not yet been found, and are being investigated.

In order to identify the most important mechanisms that govern the ionization performances of the FEBIAD, simulations calculating the trajectory of charged particles (electrons and ions) in fields, and accounting for space charge effects, are being undertaken

The FEBIAD on-line commissioning and performance investigations have been reported in the frame of the deliverable D 14.2. Results will be published as part of the EMIS 2018 conference proceedings.

IFJ-PAN (Krakow) - Activities

The physicochemical interactions at the material surface, like Ta and W, used in the construction of the target, transfer line and ion source systems play an important role in the overall efficiency of the production of radioactive ion beams (RIB). In vacuum conditions residual gases, for example oxygen, can react with Ta, and in this way may change the physicochemical properties of surface. For this reason studies on oxidation kinetics of Ta at low oxygen pressures were carried out at IFJ-PAN.

Study results

Oxidation of tantalum has been studied at low oxygen pressures from $1x10^{-3}$ mbar to $2.5x10^{-4}$ mbar at 1003-1363 K. The oxidation kinetics were measured by gravimetry. On this basis, we can conclude that the cut and scratched surfaces of tantalum are more sensitive to the oxidation process. Therefore particular attention must be given to the surface condition of the different parts of the target, transfer line and ion source systems.

Task 3: CRIBE
Coordination: Nicolas Ménard (GANIL)

Deliverables and milestones

MS 52: Nuclear data of produced beams (Month 36) submitted on time
D14.5: Chart of Beams (Month 48)

General overview

The EURISOL JRA Task CRIBE is dedicated to the development of a tool (called in the following CRIBE) aiming in a presentation of the main characteristics of Radioactive Ion Beams (RIB) produced in major European ISOL facilities. These characteristics will be mainly the nature of the produced isotope, its acceleration and/or pre-acceleration energy, the RIB purity when it is available and its intensity.

Until now, four facilities have clearly shown their will to collaborate and to contribute to this work and their intention to publish their data on CRIBE: GANIL (SPIRAL1 and S3) (France), ISOLDE/CERN, JYFL (Finland) and SPES/LNL (Italy).

The work on CRIBE is divided in two big chapters:

1. The first deals with the technical development of the chart of beams. In this part, the mode of the visualization of the data, of their presentation, of the way of the uploading and downloading the data will be defined. It is an important amount of programming work.
2. The second deals with the data itself. In this part, the choice of the parameters characterizing RIBs, the format of the presentation and a compilation of the data have to be specified.

RIB data

RIB Data format

The format of the presentation of RIB data was accepted and validated by all the partners: GANIL, CERN/ISOLDE, LNL and Physics Department of Jyväskylä University. This means that all received data will be presented on the single and uniform chart of beams CRIBE. The biggest advantage of this standardization is that one can compare easily the available data for each nuclear ISOL facility in Europe. It will be the first time for these facilities that such an easy comparison will be available on-line.

The following table is an example of the data that will be available in CRIBE :

Z	A	Metastability	Half-life	Intensity [pps]	Intensity estimation method	Purity	Primary beam	Primary beam intensity [pps]	Target	Availability	Comments/ Link to details
2	6	g	0.8 s	2E+08	[A]		13C	1,6E+13	Carbon	2017	https://u.ganil-spiral2.eu/chartbeams/

RIB Data compilation and the database

The RIB data of four European facilities were compiled and provided on four excel files: ISOLDE, JYFL, SPIRAL1 and S3. Since we have to make the differentiation between pre-accelerated and post-accelerated beams for some facilities, we compiled two kinds of data ; for example for SPIRAL1: SPIRAL1_POSTACC and SPIRAL1_PREACC.

A dedicated database was developed. This database will present the data of the RIB of each facility and will be linked dynamically to the database of CERN/ISOLDE.

Laboratories involved in the compilation

A video-conference was organized on March 2018 where the details of the format and the standardization were discussed and validated. Three laboratories participated in this video-conference: GANIL, CERN/ISOLDE and JYFL. The forth laboratory, LNL, validated later these data format. Finally, all these laboratories provided their RIB data, which were subsequently compiled by GANIL.

Development of the Chart of RIB

Technical specification

The technical specifications of the chart were worked out during 2017 and 2018. These specifications define the guidelines of three facets of the chart:

1. Functionality: the chart has to be interactive and dynamic. This interactivity will allow distinguishing the already available beams from those that are expected in future. It will also allow visualizing the RIBs data just with one click on any isotope. Thank to this interactivity a user (physicists, engineer, layman) can search for any beam of interest

considering one or more criteria: production facility, beam energy, intensity and availability.

2. Administration: we define two levels of the chart administrators: a principal and a secondary one. The principal administrator who will have rights to modify the chart (adding or removing isotopes, elements, creation of administrator account…). The secondary administrator, appointed at each involved facility, will have rights to add, to remove or to modify the local RIB data.
3. Presentation: two ideas of the chart presentation were proposed: Z versus N presentation (similar to Karlsruhe chart of nuclides https://en.wikipedia.org/wiki/Karlsruhe_Nuclide_Chart) or Mendeleev table (table of elements).

Realization and progress

A senior developer at GANIL managed the collaboration between developers of the application.

A Junior IT student (4 students) company called “APLICAEN” (4 students) was icharge of the first design of the chart of beams. Two designs are now available and achieved: the design of the chart on Z versus N presentation and the design of Mendeleev table presentation. These two designs still need to be improved and to be linked to the developed data basis of RIB data.

A junior developer of IFJ-PAN worked to develop the interface between the web service provided by CERN for ISOLDE data and the application. This part of the work was described in a dedicated Master Thesis of Mateusz Celary (in Polish): “Baza danych radioaktywnych wiązek jonów” (Data Base of Radioactive Ion Beams), AGH, Krakow 2018 https://misio.ftj.agh.edu.pl/media/misiofiles/72a5ae64edeb12b9d8479d4aee05402e.pdf