RELIABILITY OF TARGET ION SOURCE SYSTEM ON SPIRAL1-GANIL FACILITY

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Abstract

The SPIRAL1 facility at GANIL produces radioactive ions beams (RIB) since 2001. Target Ion Source Systems (TISS) are exposed to severe neutron and gamma dose rates, requiring both simple and radiation hard technologies. Moreover, the production is performed in a Nuclear Installation Plant, where all the processes must cope with constraining safety rules. Once the TISS is irradiated by primary beams of heavy ions, the dose rate, the activation level and the potential contamination in the surrounding of the TISS make the access and the maintenance prohibited. All parts of the production system must thus be highly reliable. An important process for the preparation, operation and recycling of the TISS has been developed to minimize the failure probability and optimize the availability of the beam for the users.

Up to now, 45 target ion source systems have produced 76 Radioactive Ion Beams for physics experiments. Only 4 TISSs have failed.

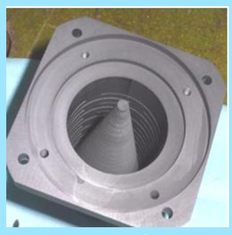
The organization and methods to achieve these results will be presented.

SPIRAL 1 at GANIL: Radioactive Ion Beam (RIB) facility

Since 2001, Exotic elements are produced by fragmentation of stable beams in thick targets. Once stopped in the target material, radioactive isotopes diffuse out of the target and effuse up to an ion source where they are ionized. All the TISSs are located on a High Voltage platform for reaching energy up to 34keV/A. Up to now, only TISS based on ECR ion source were used. In the frame of the UPGRADE SPIRAL1 project, new TISSs will be designed to offer new radioactive isotopes.

Target Ion Source

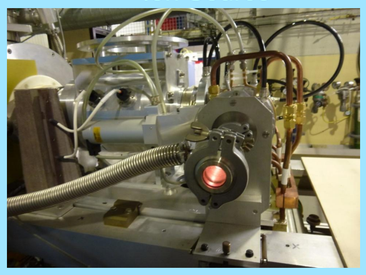
Thick Targets



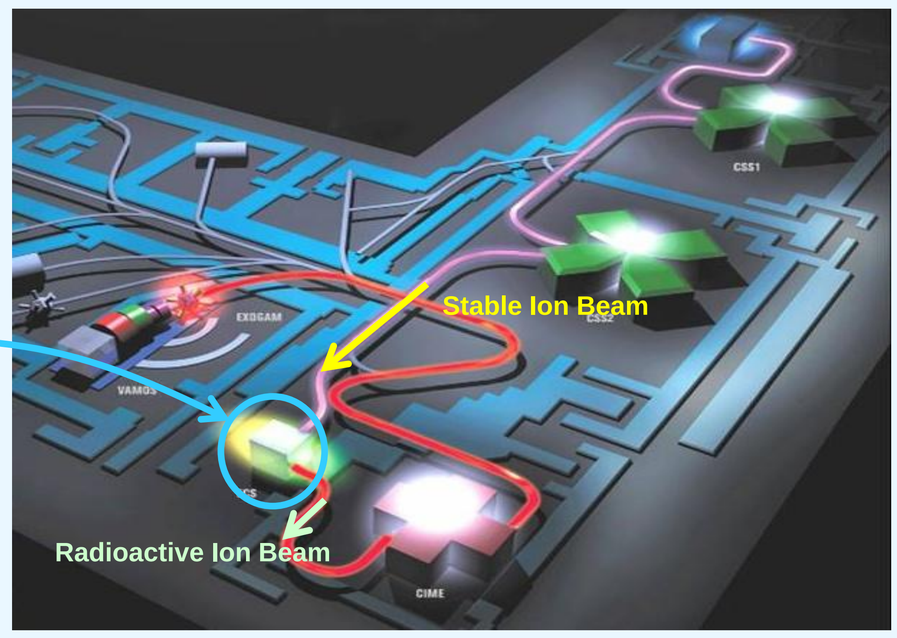
Ar, Ne, Kr, O, N production (4kW)

He production (3,3kW)

Ion Source



FEBIAD, ECR, Surface Ionization



SPIRAL 1:

76 Experiments since 2001
35 isotopes >10^{+4}pps
$T_{1/2}$min > 100ms (^{8}He)
Up to 20 MeV/A

Environment

- High power primary beam : (4kW)
- High radiations dose (Neutron, β, γ)
- Residual gas pressure (10^{-8}mbar)
- High Voltage (34kV)
- High Temperature (Up to 2000°)

Reliability, why?

To guaranty the yields of radioactive isotopes and production time to physics experiments

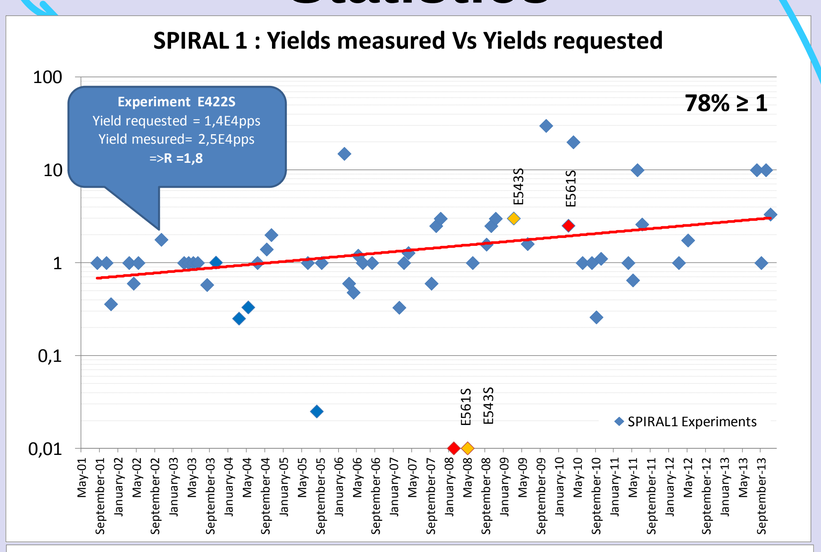
The high radiation level which can stop the beam delivery for few days before repairing.

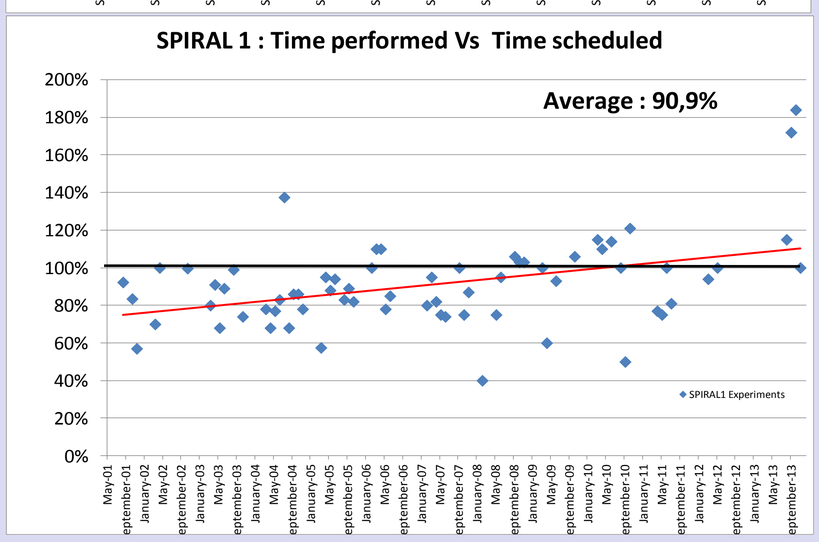
To limit the cost of the operation (a TISS costs between 50k€ to 80k€ for 3 weeks)

Objectives

- Lifetime > 3weeks
- Efficiency which guarantee an intensity >10^{6}pps
- Stability of the beam
- Cost optimization

Statistics

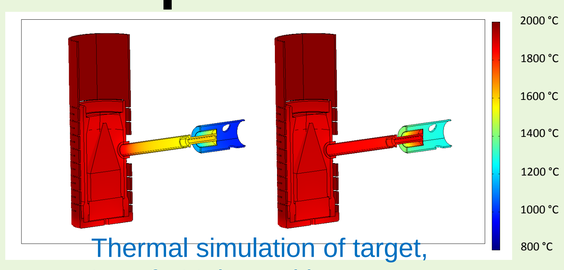




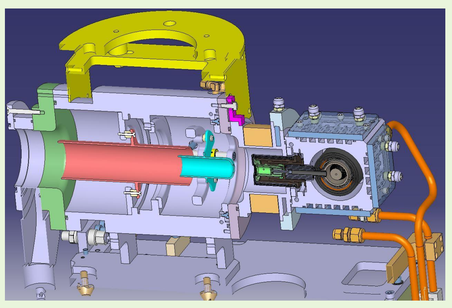
Target Ion Source System Development

Many simulations and tests are performed to increase the life time and efficiency of the target ion sources. Moreover, a cost optimization is performed.

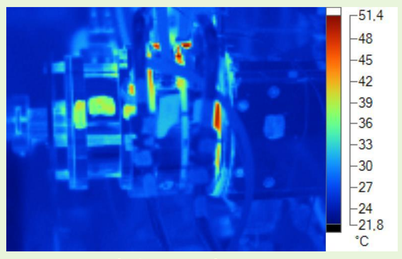
Optimization of insulator



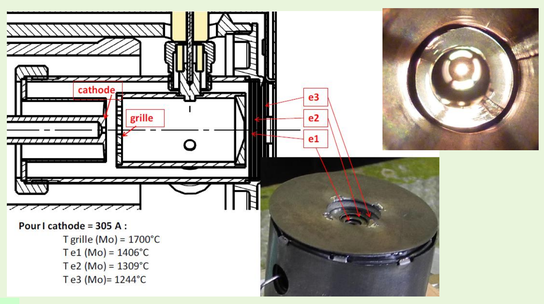
Thermal simulation of target, transfert tube and ion source



Development of FEBIAD +C TISS



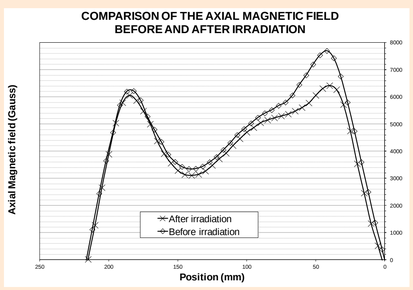
External thermal measurment

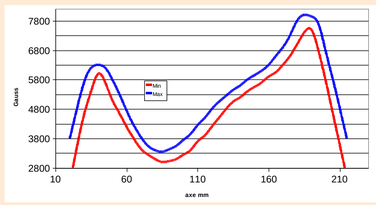


Thermal measurment of ion source

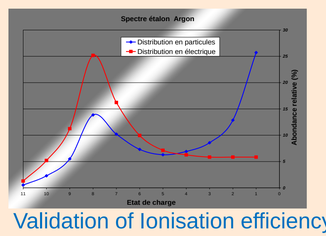
Ionization efficiencies measured during more than 3 weeks on tests bench

Target Ion Source System Operation

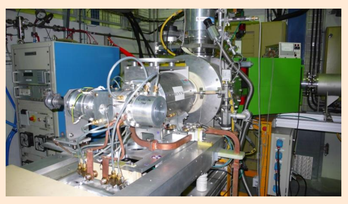




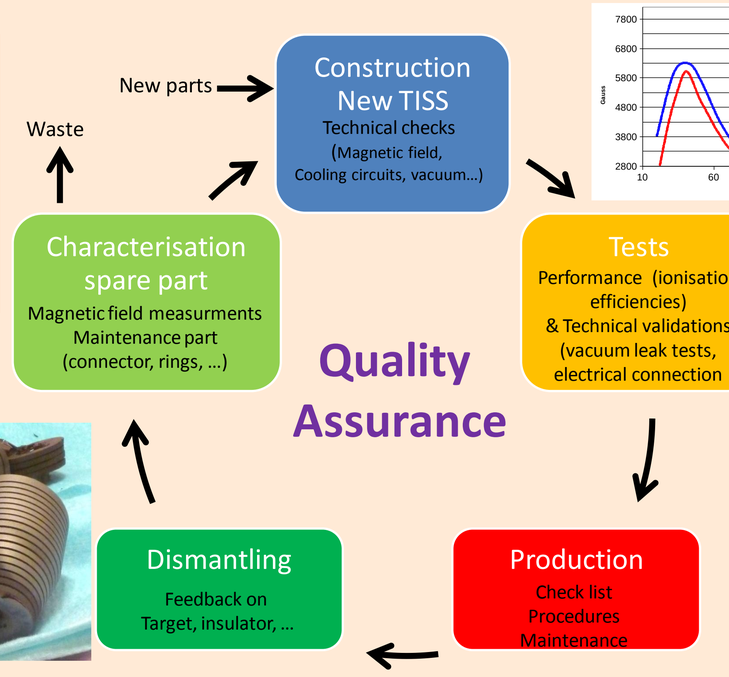
Acceptance range for magnetic field after mounting



Validation of Ionisation efficiency



Target analysis after irradiation



Each step is link to specific procedures which defines objectives to guarantee the yields and production time for the physicist. More than 20 procedures have to be used and 5 check list have to be completed.

Maintenance

Preventive maintenance is performed on all technical system needed for the running of TISS (Nuclear ventilation, gas storage, vacuum, cooling system, High voltage devices,…) or for safety checking.