New Feature for Resonant ionization Laser Ion Source Development at GANIL

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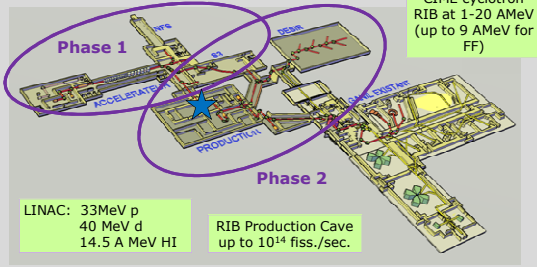
SPIRAL2 is a research facility under construction at GANIL for the production of Radioactive Ion Beams (RIB) by Isotope Separation On-Line (ISOL) methods and low-energy in-flight techniques. Resonant ionization Laser Ion Source (RILIS) will be one of the main techniques to generate the radioactive ion beam. GISELE (GANIL Ion Source using Electron Laser Excitation) is a test bench developed to study a fully operational laser ion source available for Day 1 operations at SPIRAL2 Phase2. The aim of this project is to find the best technical solution which combines high selectivity and ionization efficiency with small ion beam emittance and stable long term operation. Latest results concerning the new ion source geometry will be presented.

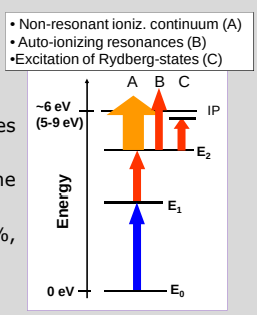
SPIRAL2

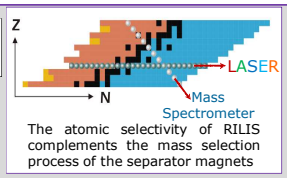


RILIS

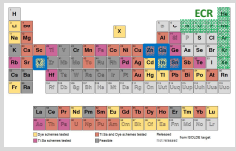
Ionization through:
Stepwise Resonant Excitation

- **Chemically selective:** reduces isobaric contamination
- **Versatile:** suitable for >80% of the elements below Uranium
- ionization efficiencies of up to 40 %, average **efficiency ~10%**
- Contamination by surface ions



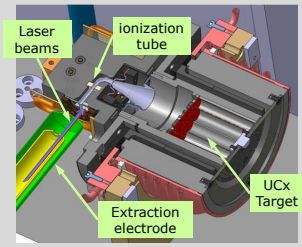


The atomic selectivity of RILIS complements the mass selection process of the separator magnets



GENERAL SET UP

SPIRAL2 On-line Ion Source:



Radioactive products will be created inside a UCx target by neutron induced fission reaction. After release from the target, they interact with overlapping laser-beams in a hot cavity. They will be ionized by multistep photo-ionization and extracted at 60 kV to produce RIBs.

GISELE Off-Line Test Bench:

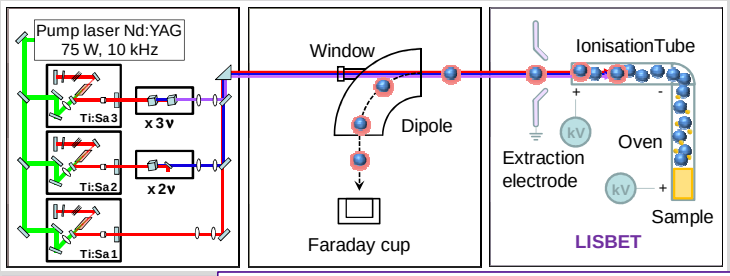
A calibrated stable sample is set in a heated oven in order to produce an atom flux. The atoms are ionized by resonance photo-ionization. Laser beams are produced by three tunable Ti:Sa lasers in the laser room and transported to the ion source (20 m). The ion beam intensity is detected with a faraday cup after the mass separator.

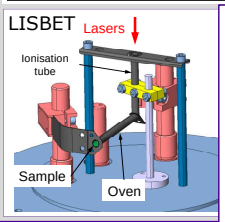
LISBET is the new ion source body to test geometries and behavior of the future ion source. It consists of two tubes (7 mm diameter) fixed in elbow-shape and allows specific control of the temperature.

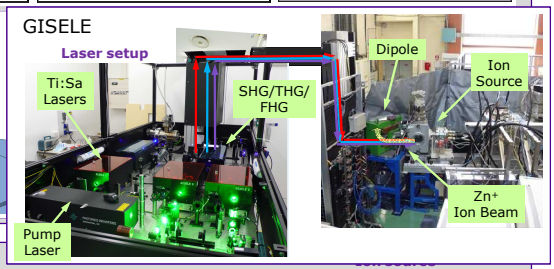
Goals:

- **Ion source development** for SPIRAL2
- **Optimization of the method**
- System characterization:
efficiencies and emittance

GISELE Test Bench: Laser beam transport, Separator & Ion Source

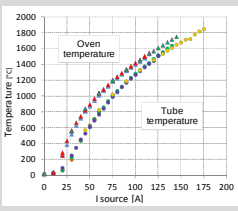


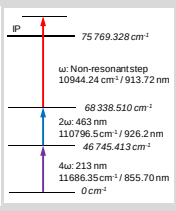


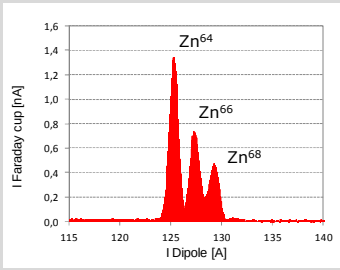


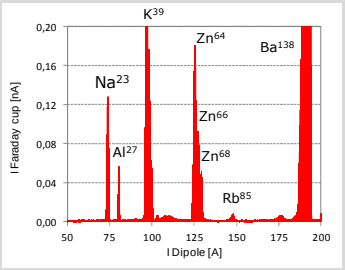
RESULTS

1.4 nA Zn^{64} beam was generated using the method described above. The ionization scheme used a non-resonant final step. Background was given to be around 10% of the main peak intensity. Also, temperature calibration was performed for LISBET ion source up to 1800ºC.



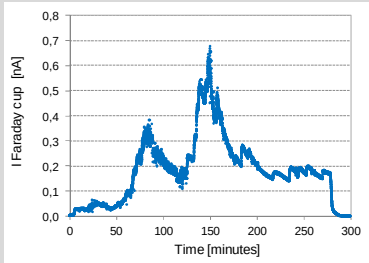






Different species were observed, most of them created by surface ionization. However, when the laser beams were set into the hot cavity, the natural isotopes of Zn were ionized and detected. Other elements were ionized by surface ionization like Na^{23}, Al^{27}, K^{39} or Rb^{85}, although those elements were eliminated by mass spectrometer.

An **efficiency value of 0.52%** was obtained for the experiments. Total efficiency corresponds to the relation between number of ions (integral of the output signal) and number of stable atoms (calibrated sample).



FUTURE PLANS

- Improvement of the ion source efficiency modifying tube design (diameter, thickness or length)
- Reduction of contaminants:
Low work function materials ➔ Reduce surface ionization of isobars & molecular sidebands
Carbides: **ZrC, TaC, HfC, TiC** (T_m ~3500ºC)
- Reduction of contaminants by electric fields
- Time profile measurements
- Specific control of the temperature for each part of LISBET
- Assembly of two extraction electrodes to improve emittance

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GISELE has been funded by the French Research National Agency (ANR contract number ANR-08-BLAN-0116-01) and is under development at GANIL in collaboration with IPN Orsay (France), University of Mainz (Germany), TRIUMF (Canada) and CERN (Switzerland). The author would like to thank LA3NET Marie Curie program. LA³NET is funded by the European Comission under Grant Agreement Number GA-ITN-2011-289191. In addition, GISELE team would like to thank FRENCH-GERMAN COLLABORATION AGREEMENT I N2 P3 - DSM/CEA and GSI number PN1064.