ISOL ion source & beam manipulation R&D

# Metallic beams and charge breeding

## Collaborative R&D

P. Delahaye, H. Franberg – Delahaye, T. Stora and F. Wenander for the « Hoplites » and « EMILIE » projects

# Why metallic beams and charge breeding are ‘hot topics’*

- **Metallic (+ halogen + non metallic) elements**
  - effusion times from ISOL targets are usually a penalty compared to rare gases
  - High ionization efficiencies require dedicated developments (FEBIAD or RILIS), whereas for rare gases almost any ECRIS can do the job
- **N+ beams for post-acceleration**
  - SPIRAL concept: 0 to n+ ionization efficiencies are very high for rare gases
  - BUT application to metallic beams not straightforward as ECRIS are cold wall sources
  - 1+ n+ (=charge breeding) works fairly well with EBIS but pulsed beams (not suited to GANIL experiments)
  - 1+ n+ with ECRIS works well in CW even with high intensities but several weaknesses:
    - Comparably lower charge states
    - Beam purity not guaranted
    - Low efficiencies with light metallic beams: <5% up to K

*** Seen from GANIL**

# Collaborative R&D

- **SPIRAL Upgrade at GANIL: « hoplites » project**
  - Metallic beams from a FEBIAD
    - VADIS from ISOLDE
  - 1+ n+ for SPIRAL with an ECRIS
    - Phoenix ECRIS from Daresbury, tested at CERN, on a design from LPSC, recently given to GANIL
    - upgrade with the help of LPSC and ANL
  - Target development
    - Nb, $Y_2O_3$ … targets with the help of ISOLDE

**Submitted to the french national research agency: ANR**

- **Charge breeding for future ISOL facilities: « EMILIE » project:**
  - Test of a CW EBIS charge breeder concept
    - A Paul trap as debuncher
    - REXEBIS –like charge breeder
    - Partnership between GANIL, CERN ISOLDE, JYFL, LPC Caen and CSNSM Orsay
  - Optimization of the SPIRAL 2 Phoenix ECRCB from LPSC
    - INFN as task leader (A. Galata), optimization initiated for the SPES project
    - LPSC, GANIL, JYFL and Warsaw as partners

**Submitted to Nupnet « EURISOL R&D »**

# Latest news: SPIRAL upgrade

- **First beams from VADIS coupled to the SPIRAL targets**
  - Promising results with radioactive Cu, Fe, Mn
  - Consolidation to be done
    - Transfer tube broke after 5 days of heating

# Results: 1+ beams from VADIS

PRELIMINARY

From Gamma line intensities at saturation

| ISOTOPE | Half-life (s) | Power (W) | Measured 1+ intensity | 1+ intensity (1.5kW) | Efficiency /EPAX (%) |
|---|---|---|---|---|---|
| **38K** | 456 | 4 | 3.8E+04 | **1.5E+07** | 2.08E+01 |
| **38mK** | 0.923 | 4 | - | **-** | |
| **53Fe** | 510.6 | 34 | 6.6E+04 | **2.9E+06** | 1.07E+00 |
| **53mFe** | 154.8 | 34 | 1.4E+04 | **6.1E+05** | 2.24E-01 |
| **58Mn** | 3 | 37 | 5.7E+04 | **2.3E+06** | |
| **58Cu** | 3.204 | 37 | 4.3E+03 | **1.8E+05** | |
| **59Cu** | 81.5 | 38 | 7.3E+04 | **2.9E+06** | |
| **60Cu** | 1422 | 35 | 2.5E+03 | **1.0E+05** | |

>$10^5$ pps!

Despite reliability and a rather low target temperature, the target ion source exhibits performances as good as one could wish!

**Contains:**
**Release efficiency**
**(diffusion + effusion delays)**
**Ionisation efficiency**

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    - Transfer tube broke after 5 days of heating
- **Design of the new charge breeder ongoing**
  - Should be ready by December this year
  - Booster upgrade – 2012 - Installation  2013
  - First beams in SPIRAL at the end of 2013

# Latest news: « EMILIE » project

- Evaluation of the « EMILIE » project  is ongoing
  - Results of the Nupnet call by the end of July

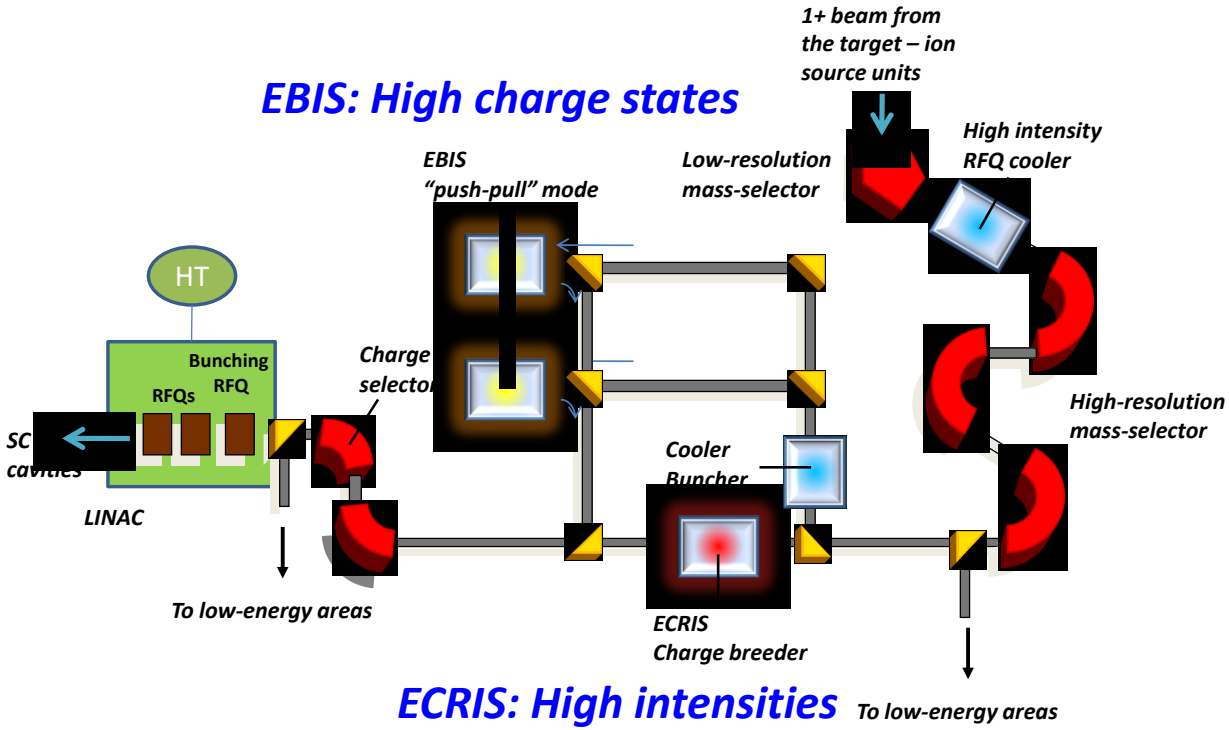
# Summary

- The SPIRAL upgrade and « Hoplites » project

- And the « EMILIE » project

Can bring interesting results concerning the charge breeding of metallic beams for EURISOL…

… as it was (almost) considered in the EURISOL DS




Detail of the EURISOL Layout

Modified from P. Butler's presentation, NuPECC meeting June 2007

**EBIS + ECRIS in parallel**

P. Delahaye, O. Kester, C. Barton, T. Lamy, M. Marie-Jeanne, F. Wenander Eur. Phys. J. A 46(2010)421