Program to improve the ion beam formation and transmission at JYFL

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IGISOL (Ion Guide Isotope Separator On-Line)

Our challenges (concerning the beam intensity):

We are not always able to meet the intensity requirement.
Background

Reference beam (concerning beam transmission development work)

Presently 8 µA available after cyclotron (10 kV extraction voltage, second harmonic)

Goal: at least double the available beam intensity
Transmission efficiency decreases when the beam intensity from the ECRIS increases!
Measured transmission efficiency of K130 cyclotron facility (typical behavior)

Typical Ar\(^{8+}\) ion beam transmission efficiency as a function of intensity extracted from the JYFL 14 GHz ECRIS.

What is wrong?
- originates from plasma?
- beam formation?
- beam transport?

![Graph showing Ar\(^{8+}\) intensities after ECRIS and cyclotron](chart)

**Conclusion:** problem between the ECRIS and the inflector!
Beam line

Better to start from beam transport!

What has been found (for example)?

- Wrong entrance/exit angle of dipole
  ➔ Asymmetric beam
DIMAD simulations (by X. Wu)

Horizontal plane/bending plane (parallel beam)

Vertical plane (diverging beam)
DIMAD simulations (by X. Wu)

Beam spot in viewer according to DIMAD-simulations

Beam spot in viewer (just after dipole)
Comprehensive experiments have to be performed in order to improve beam transport!!

- beam intensity
- stronger for lower q
Conclusion so far: it seems to us that two reasons for the transmission behavior has been found:

1) Asymmetric beam
   - wrong entrance/exit angle of dipole

2) Hollow beam
   - space charge effect?
   - hollow beam is formed in the ECRIS (proposed by P. Spädtke)?

In addition: Transport efficiency in the case of third harmonic acceleration is poor (50 % compared to 2nd harmonic)
How to improve the beam transmission?

1) Make the beam symmetric!
   - new dipole with correct entrance/exit angle or
   - add quadrupoles to correct the beam

2) Make uniformly distributed beam
   - understand how the hollow beam is formed?

3) Add beam viewers and beam profile instruments into the beam line

   Next step: the beam formation in ECRIS extraction!!
Other activities of ion source group

1) Development of metal ion beams (new ovens, sputtering, MIVOC, etc...)

2) Electron heating simulations, Bremsstrahlung, coupling of microwaves,

3) Better ion sources, more beam (European collaboration ... Complecs/FP7), take care of the beam quality and beam transmission!!
Development of metal ion beams

Several ion beams which require temperature above 1500°C have been asked! -> technique has to be improved

1. Resistively heated foil oven
   - Above 2000°C
   Reliability has to be improved:
     - Mechanical connections seem to be a problem
     - Temperature fluctuation from run to run)
Inductively heated oven

2000°C has been reached with the home made resonant circuit (P. Suominen and M. Savonen)

Life time and durability tests have been started

Very stable in the test bench (1820°C ± 2 for several days)