ISCOOL: cooled and bunched beams for ISOLDE

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Presenter: Ernesto Mané

Outline

- Motivation
- Scheme of ISCOOL
- How it works
- Off-line tests and results
- Next steps
- New opportunities
- Summary
- Conclusions

Motivation

Increasing demand for

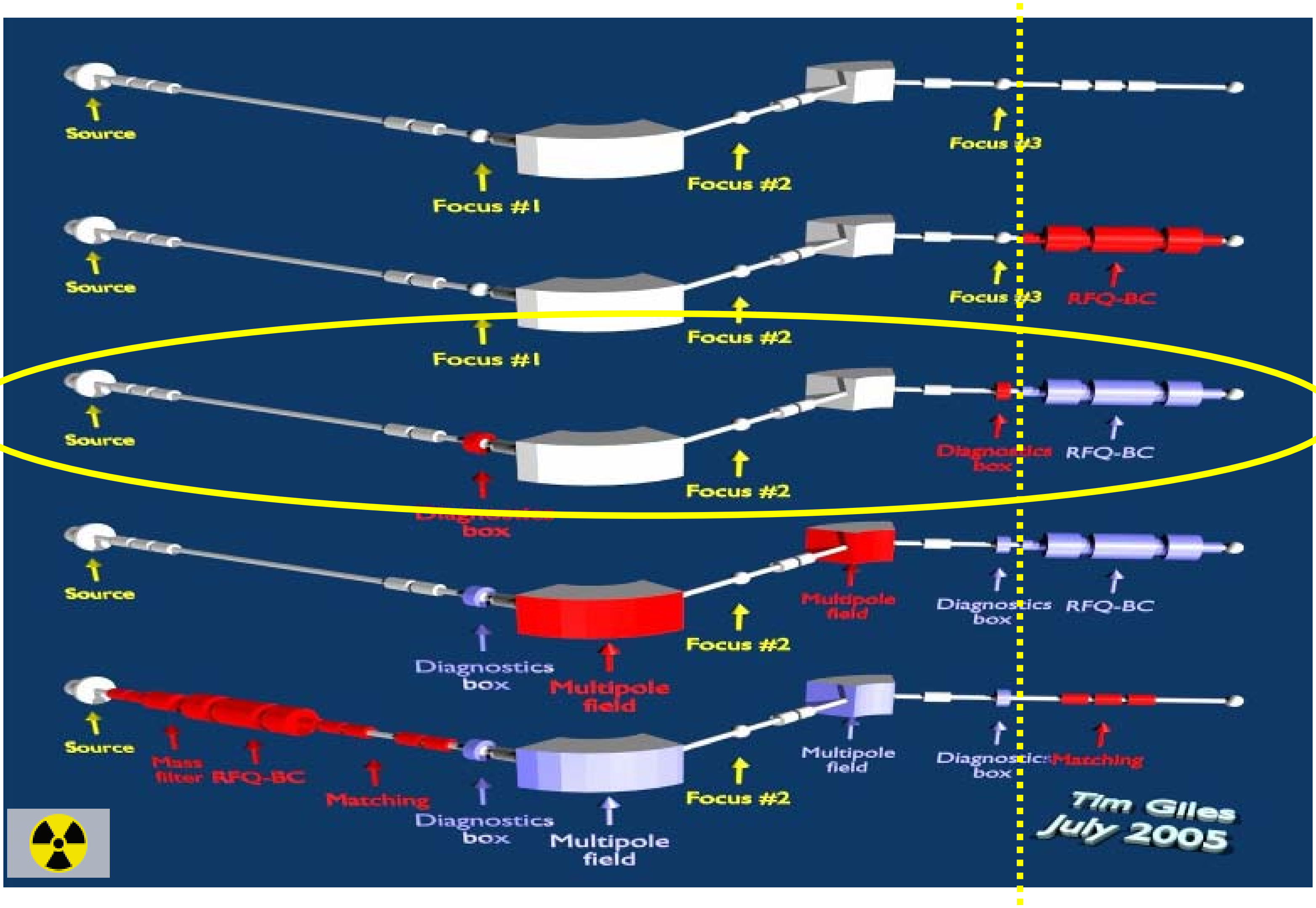
- a better beam quality matching downstream the acceptance of the experiments;
- a more efficient use of the HRS beam line;
- being able to manipulate radioactive ion beams.

The ISOLDE cooler is a radio-frequency quadrupole cooler and buncher (RFQCB) designed to meet those needs.

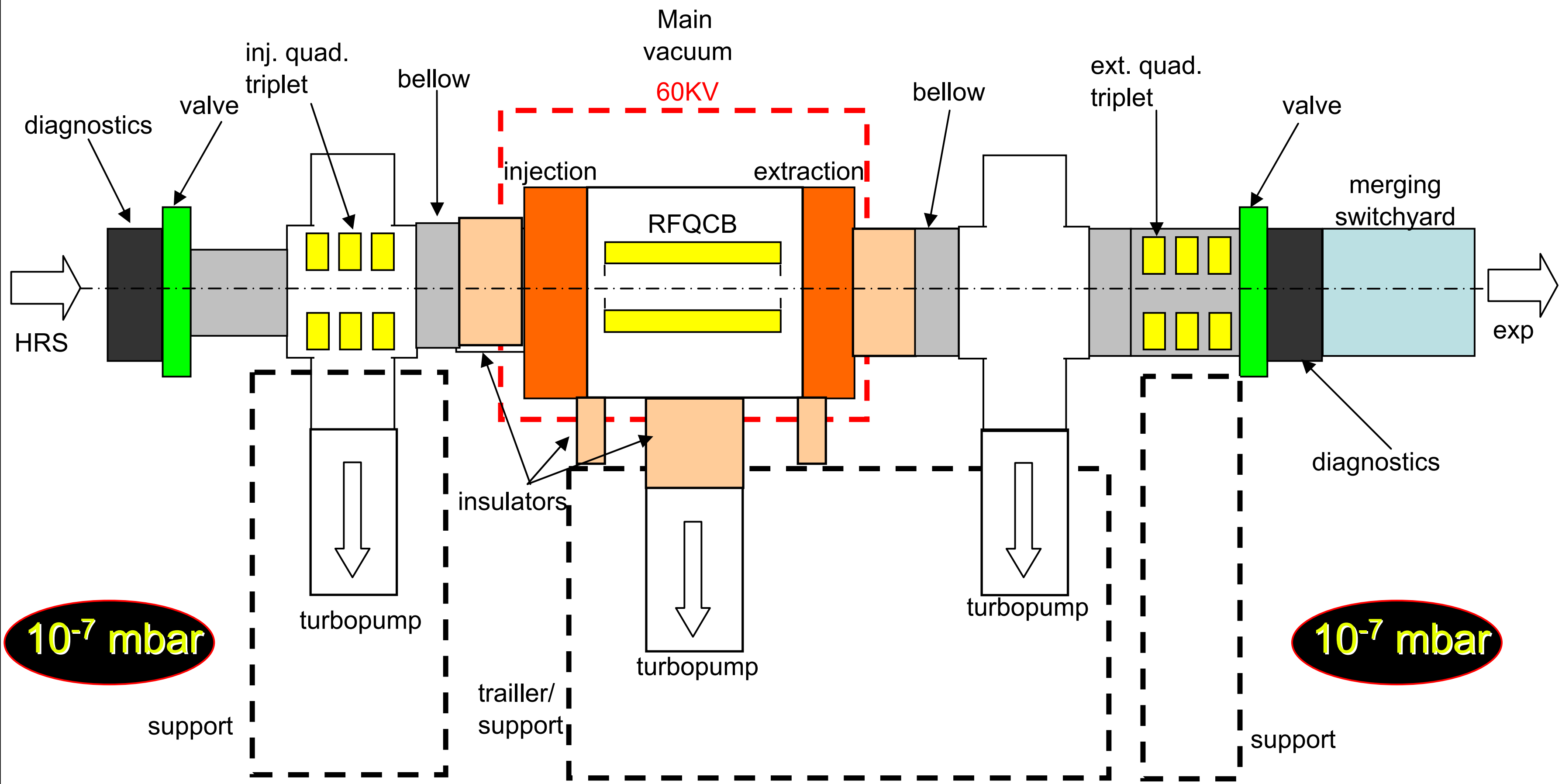
Because it can

- reduce the beam emittance and energy spread;
- control the time structure of the beam.

Scheme of ISCOOL



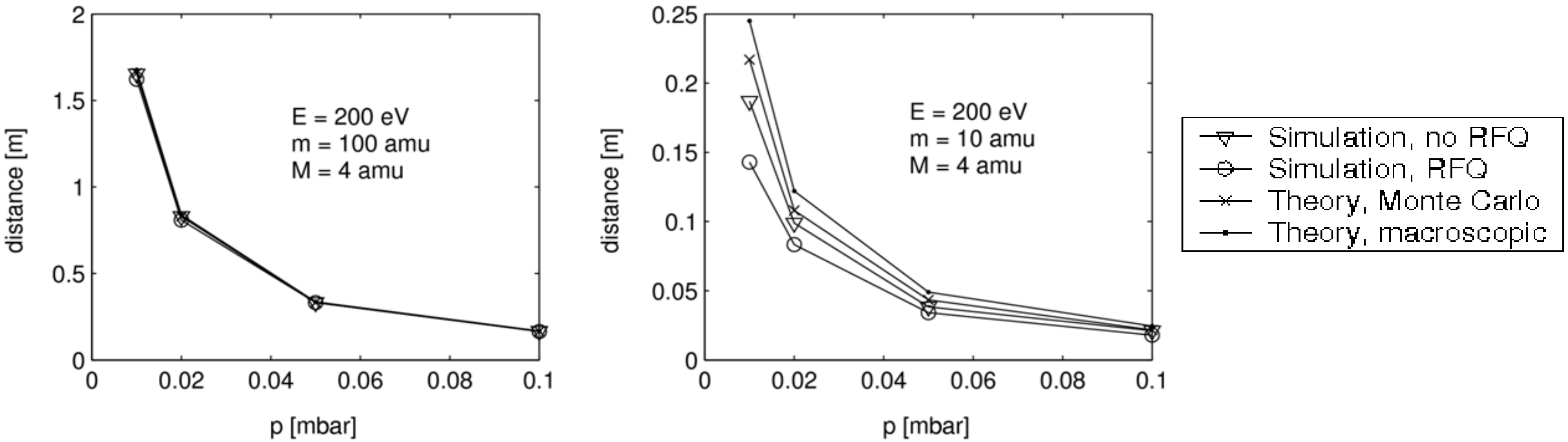
Scheme of ISCOOL

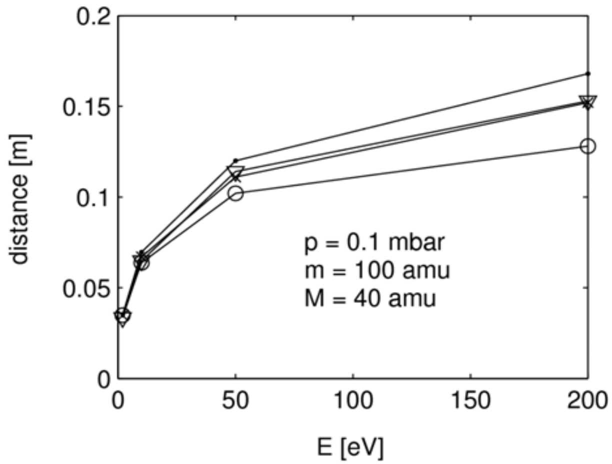


I. Podadera, CERN-2006-013

How it works:cooling

Longitudinal stopping distance



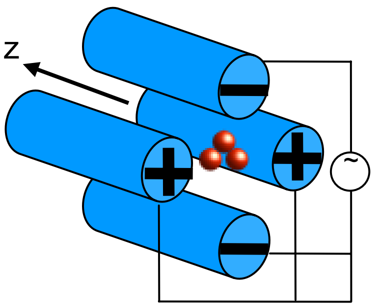


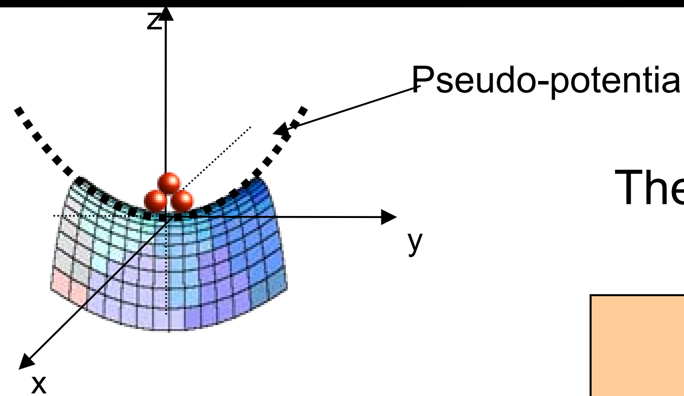
M. Peterson, Masters Thesis 2002

This distance will depend on the:

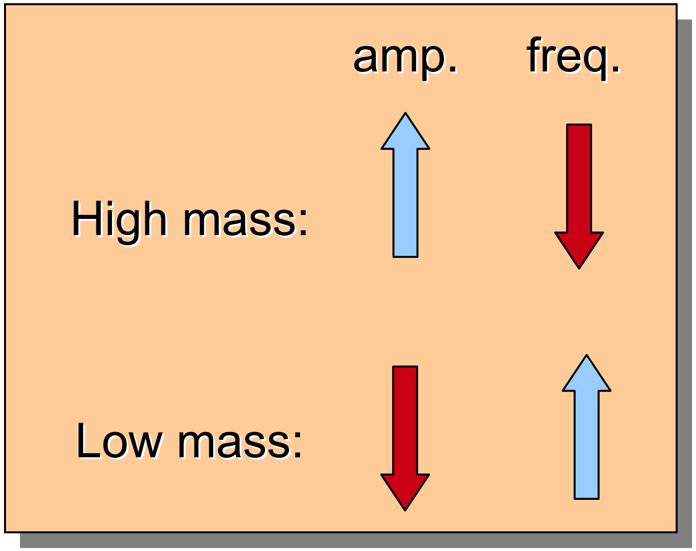
- beam energy at the injection (200 eV);
- ion mass;
- buffer gas mass (^{4}He);
- gas pressure

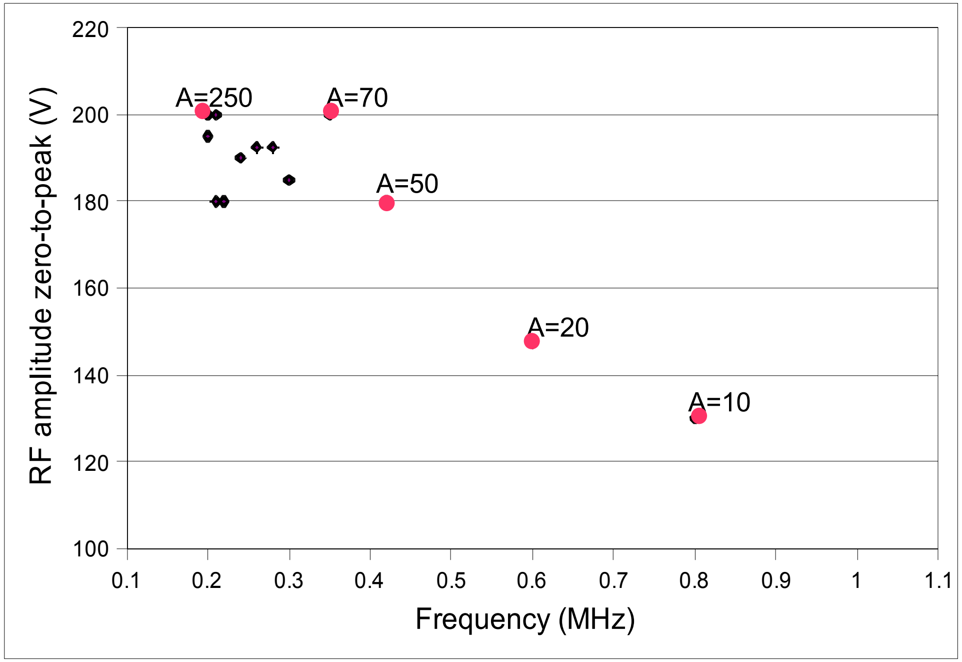
How it works: RFQ confinement





The RFQ potential is a rotating
“horse saddle”





I. Podadera, PhD thesis 2006

Solution:

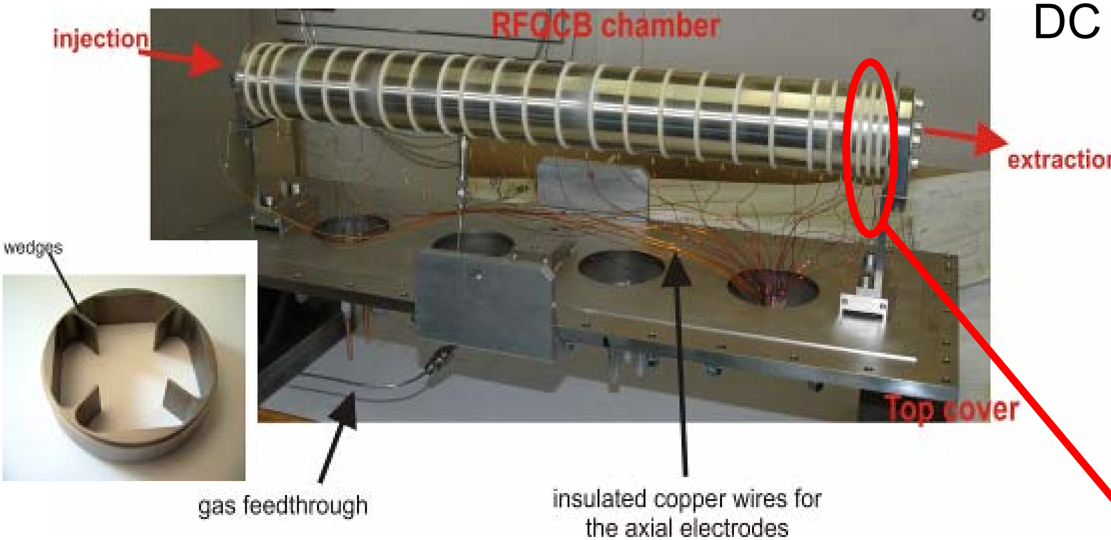
NG-VFO400/200-1200

K. Rudolph

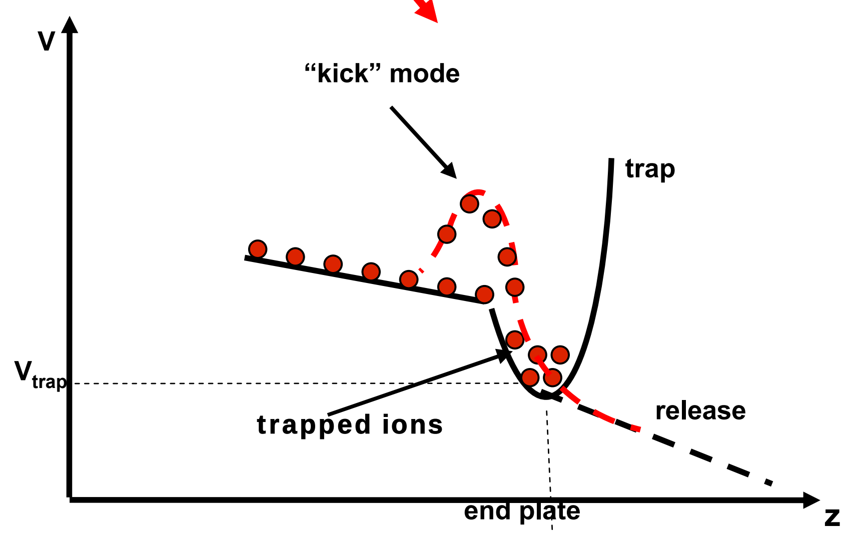
How it works: bunching

DC electrodes decoupled

from the RF field.



	Δt	Δ E
Normal ext:	↑	↓
"Kick" ext:	↓	↑



Off-line tests

They aim at a complete characterisation prior to the installation of ISCOOL:

- Behaviour of vacuum, electronics and high voltage;
- Tests in continuous mode;
- Tests in bunched mode.

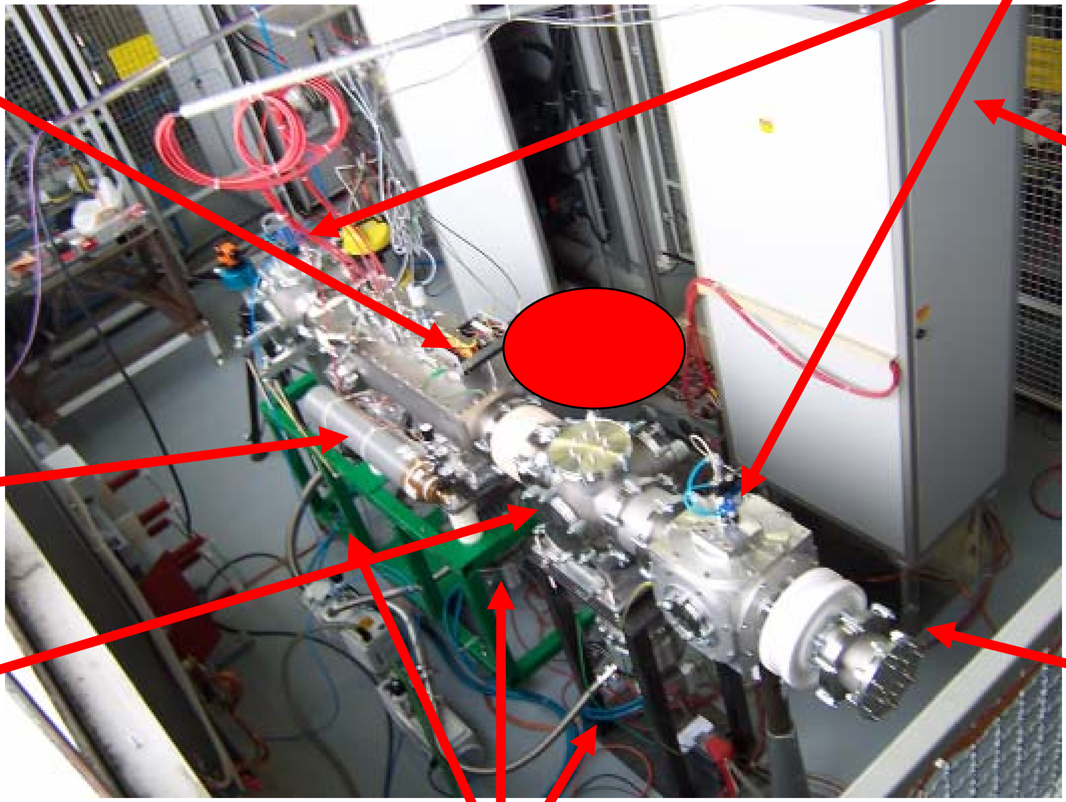
They have started in 09/2005 at building 275 in a dedicated test bench.

E. Mané and P. Delahaye

Test bench

Faraday cups
(d = 30mm)

RF



HV@60KV

^{4}He bottle

Inj quad. triplet

LPC ion source

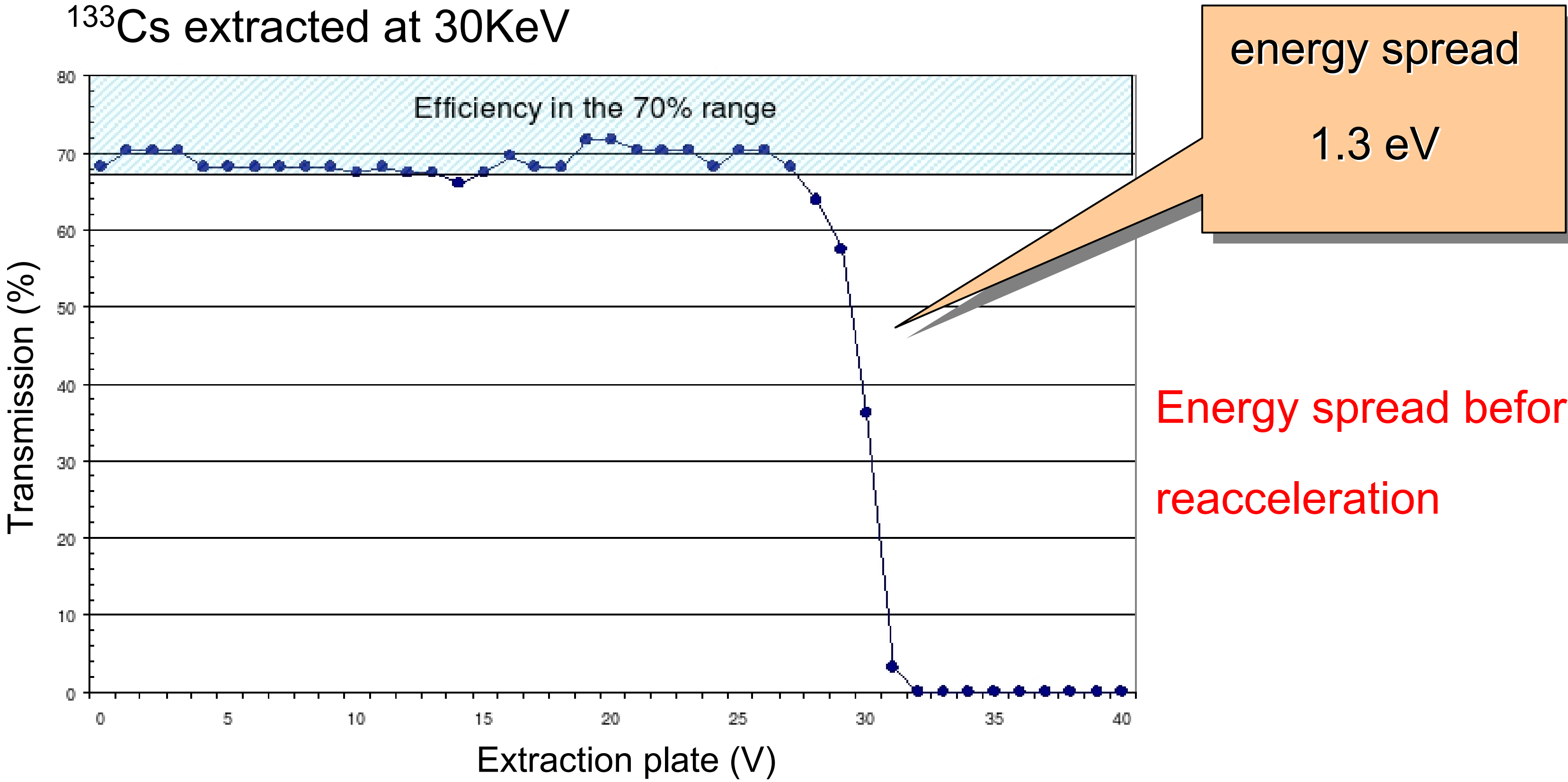
Li, Na, K, Cs

Turbopumps

Results

Transmission in continuous mode

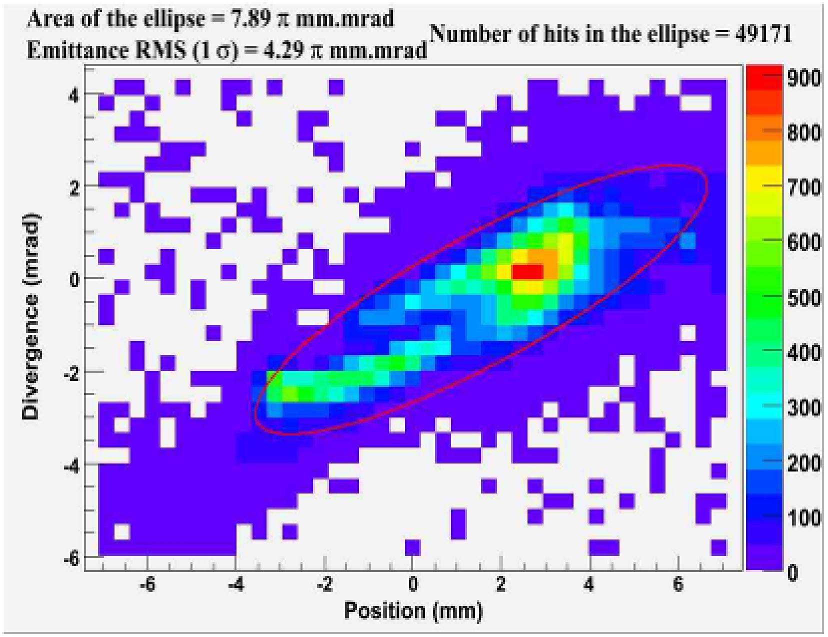
^{133}Cs extracted at 30KeV



Energy spread before reacceleration

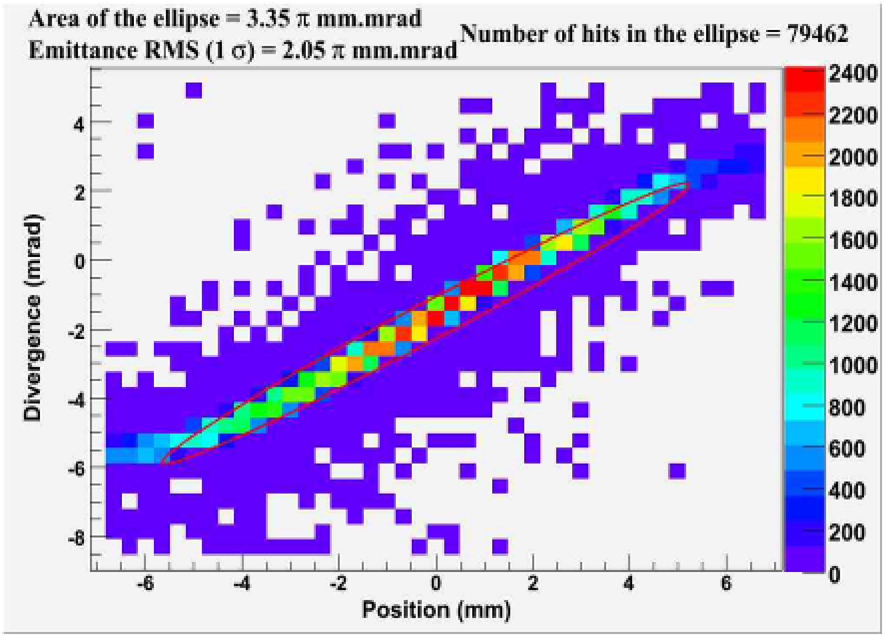
Results

No cooling, emittance 4π mm.mrad



10pA of ^{133}Cs at 30KeV
No buffer gas cooling
x% transmission

Cooled beam, emittance 2π mm.mrad



70pA of ^{133}Cs at 30KeV
He flow of $8X10^{-1}$ mbar l/s
X% transmission

Where is this value from??

LPC		ISOLDE		ISCOOL acceptance
4	**<**	**20**	**<**	**40**

The emittance at the exit of the RFQ is ~ independent of the incoming beam.

Next steps

Concerning the off-line commissioning, we should

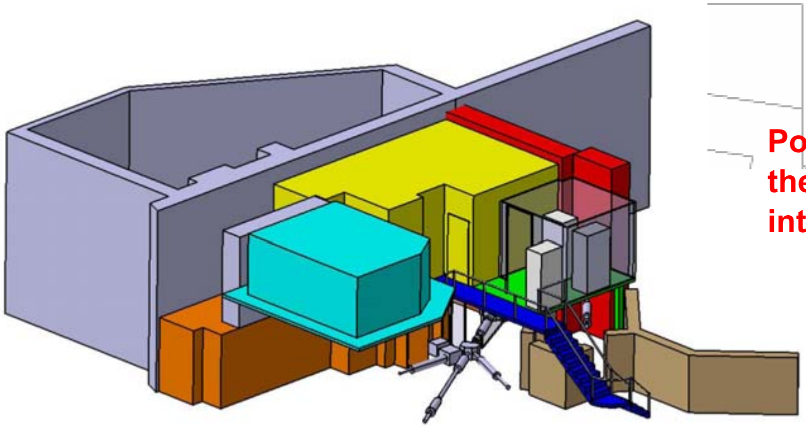
- **Finish the tests with the alkalis, in continuous and bunched modes;**
- **Extend the tests to other elements with an ISOLDE plasma ion source.**

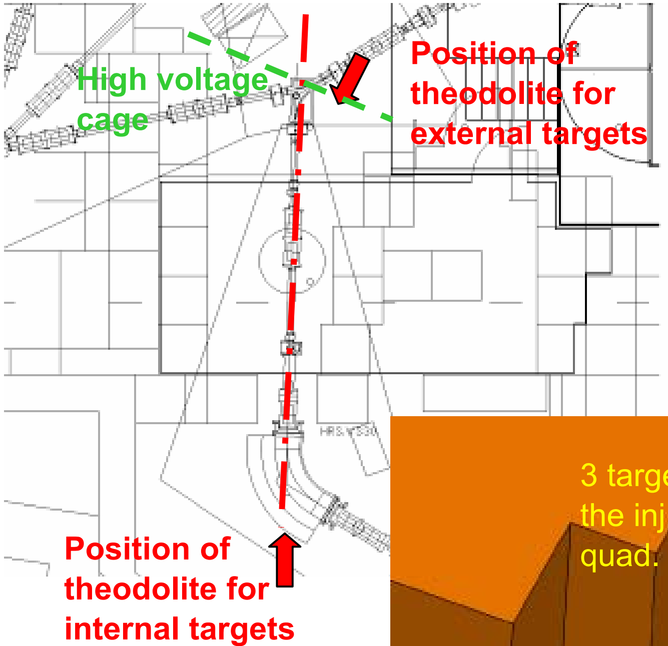
Next steps

On-line commissioning

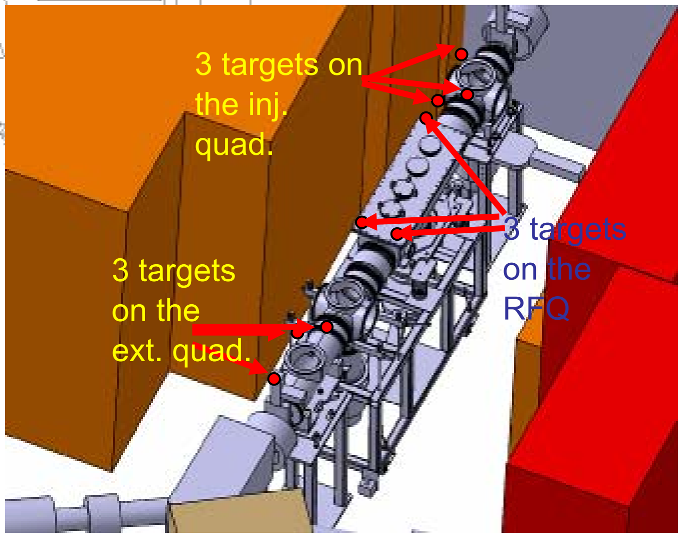
H. Franberg

- RFQ alignment (+- 1mm)
- Integration of vacuum
- High voltage platform
- High voltage cage
- Controls





Stefano Marzari



Richard Catherall

New opportunities for laser spectroscopy

Techniques:

- Conventional fluorescence-detection methods;
- Collinear Resonance Ionization Spectroscopy (CRIS).

small energy spread	→	**sub-Doppler precision**
small emittance	→	**better beam overlap**
bunching	→	**single atom sensitivity**

The cooler also offers a convenient environment for:

- performing optical pumping of ions;
- preparing ions in metastable state;
- producing polarised or aligned nuclear beams.

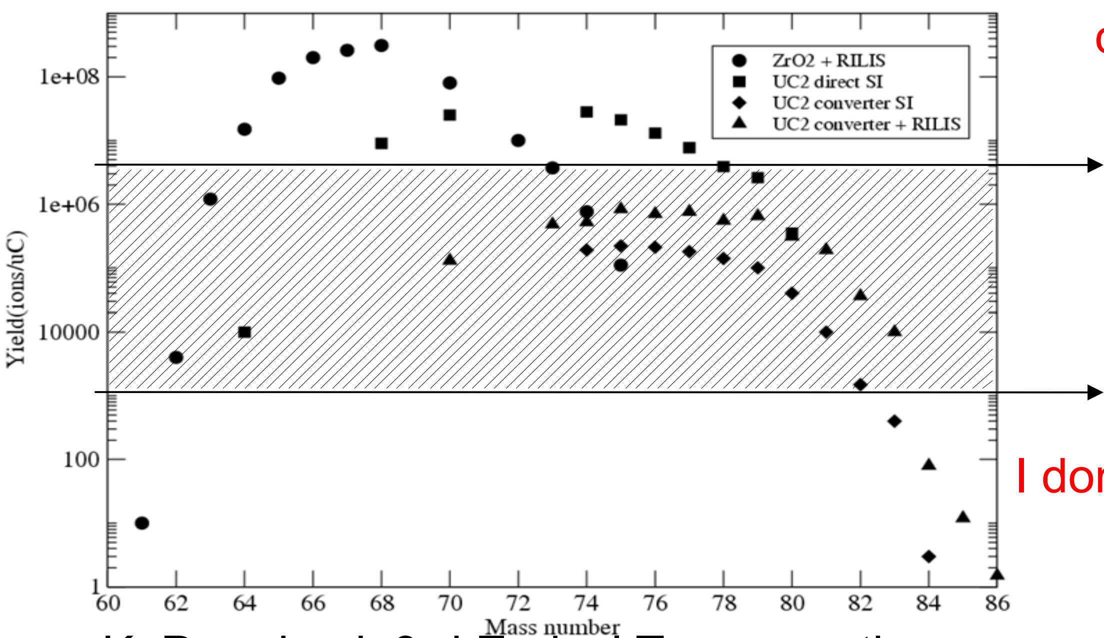
Ref to Jyväskylä

Example: Collinear laser technique + bunched ions

K. Flanagan *et. al*. Laser spectroscopy of radioactive *copper isotopes.* IS439

J. Billowes *et. al*. *Laser spectroscopy of gallium isotopes using the ISCOOL RFQ cooler*. CERN-INTC-2007-005

Yield curve for Ga isotopes



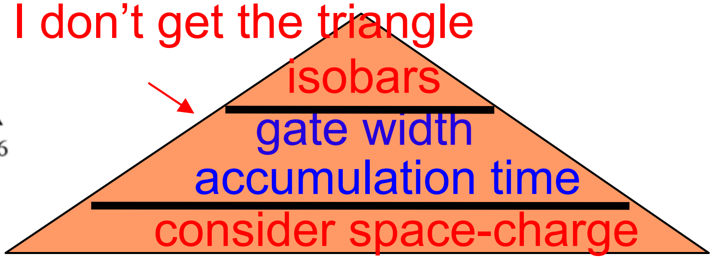
check efficiency with bradley

Without ISCOOL

With ISCOOL

K. Perarjarvi. 3rd Eurisol Town meeting

I don’t get the triangle



Summary

With ISCOOL at 30 keV and rf at 260 KHz, 480$V_{p\text{-}p}$, the following preliminary results were accomplished so far for ^{133}Cs :

- Greater than 70% efficiency in continuous mode;
- Transverse emittance ~ 2-4 π mm mrad;
- Energy spread of 1.3 eV

Conclusions

- The off-line tests so far suggest that ISCOOL will work as expected;
- The best efforts have been put to place it on-line ASAP (September 2007);
- And finally

The use of ISCOOL in conjunction with other techniques will enable us to further push the limits of the detection of radioactive nuclear beam observables.

Thank you for your attention