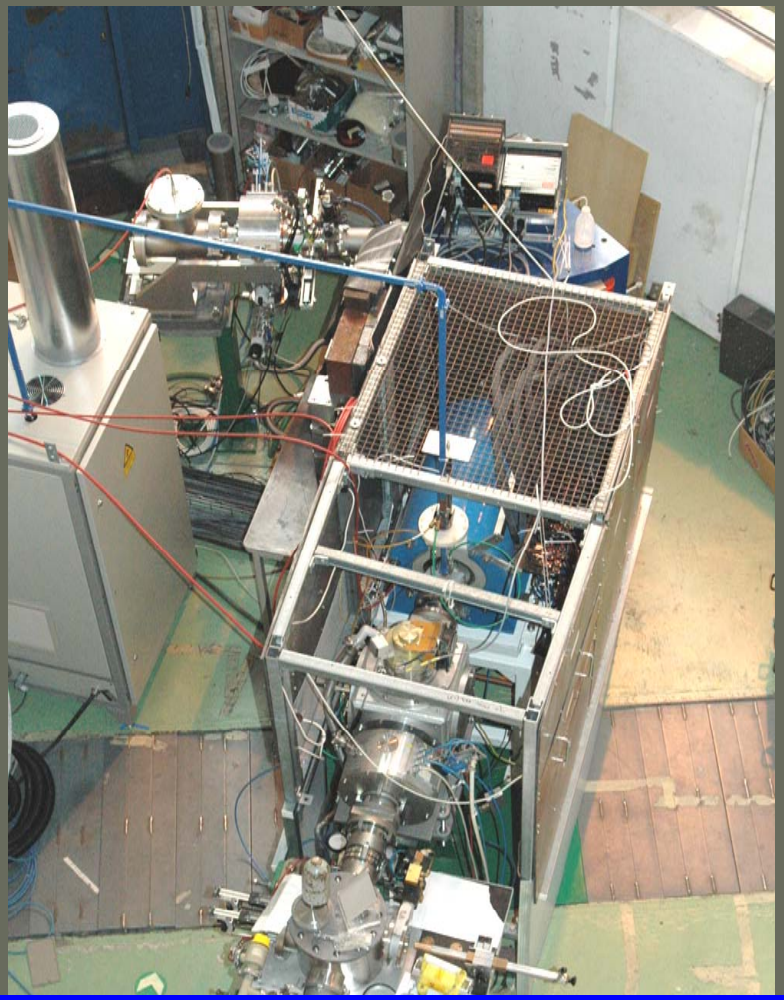
ECR charge breeding at ISOLDE

Results of the IS397 experiment



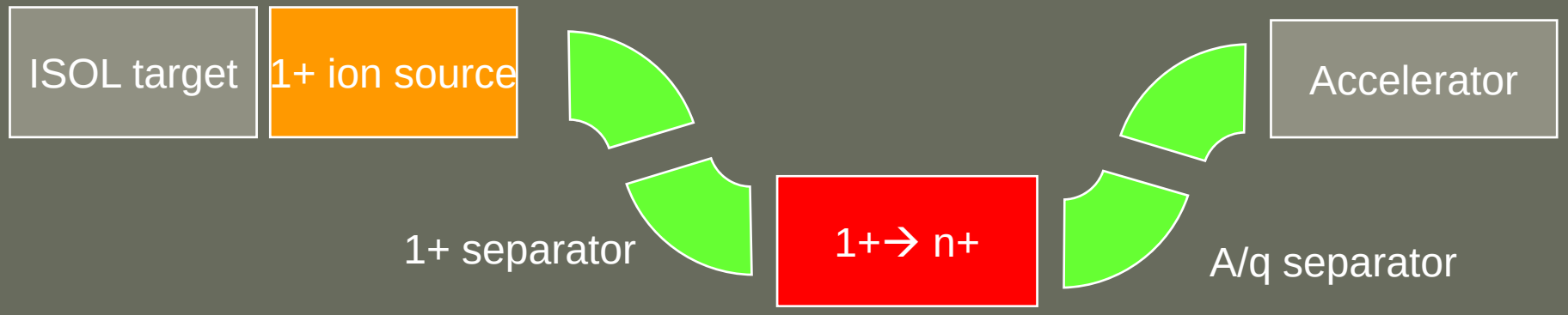
C. Barton, J. Cederkall, P. Delahaye, C. Eleon, O. Kester, T. Lamy, M. Marie-Jeanne, M.G. Saint-Laurent and the IS397 collaboration

The 1+→n+ scenario for ISOL post-accelerators

- Stripping foils

Very efficient for light and short-lived ions
But:
- drop in efficiency for heavy ions
- preacceleration stage required

- ECRIS and EBIS charge breeders

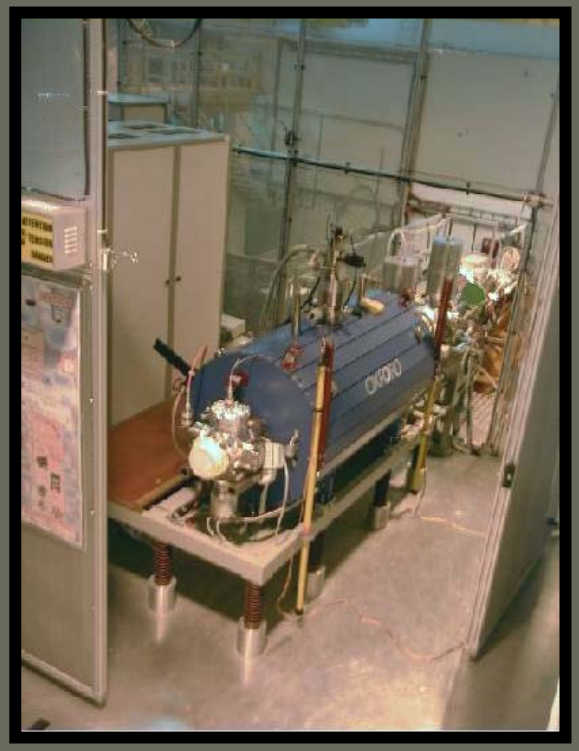


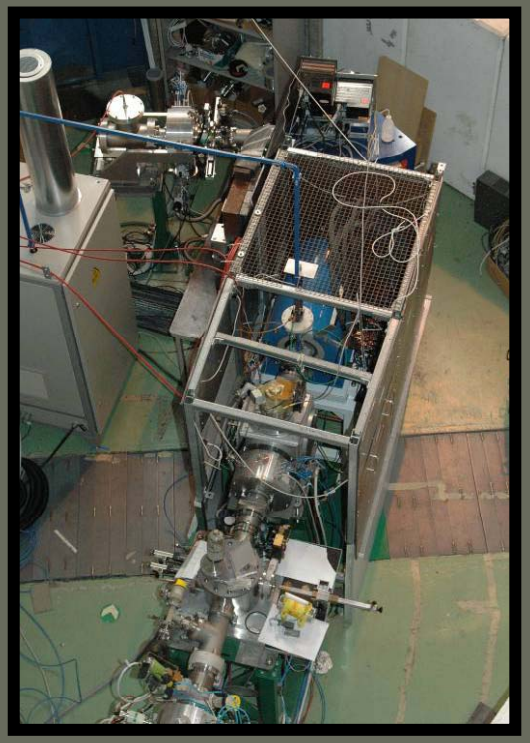
Matching the A/q acceptance of the post-accelerator

Charge breeders at ISOLDE

REX-EBIS

Operational at REX-ISOLDE





Phoenix ECRIS 14GHz

Test stand at ISOLDE

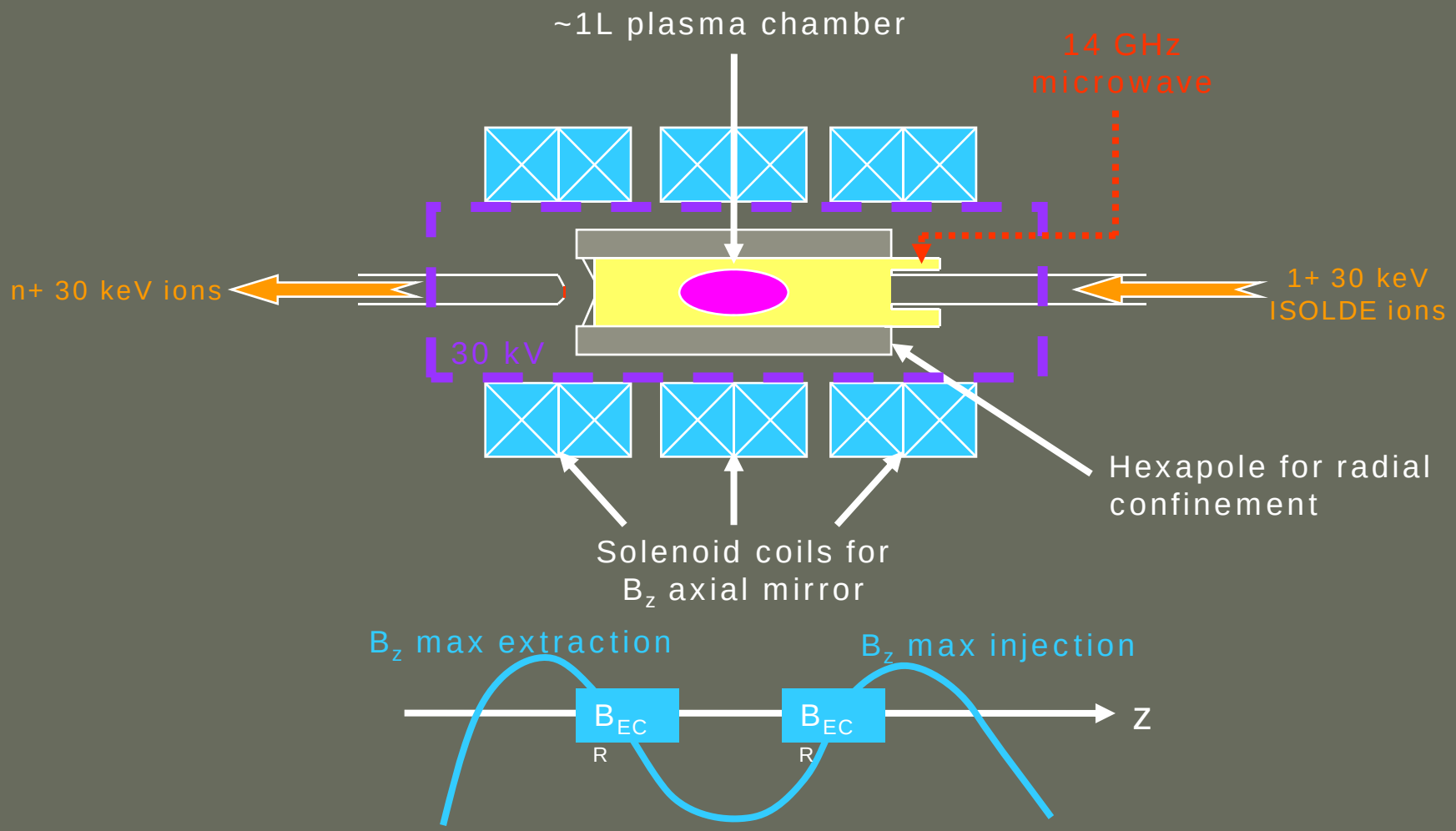
Singly charged ions →n+ ions transformation

- More post-accelerated beams available
- More radioactive isotopes available
- Better purity in some cases

} Molecular sidebands from the ISOLDE targets

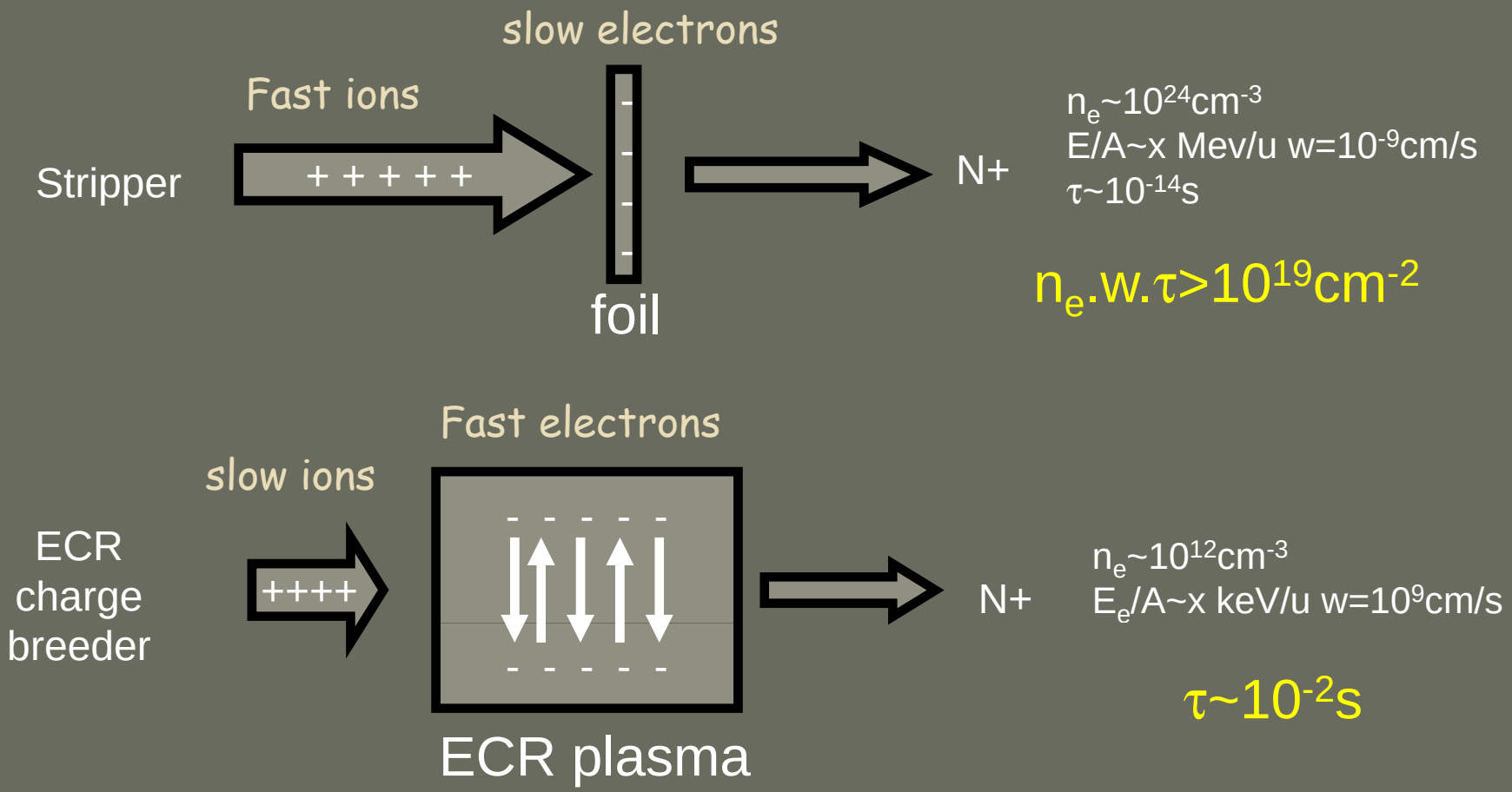
- Some applications for physics experiments of charge bred beams
- Efficiency: 1 - 20% in one charge state depending on Z

The PHOENIX ECR Booster



Analogy

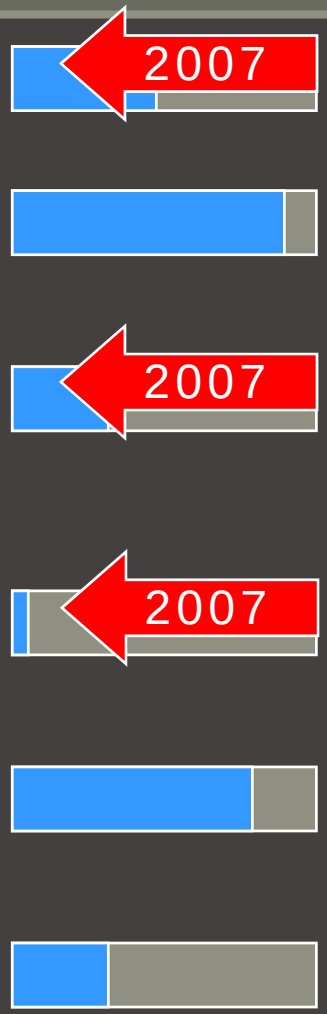
- $\langle q \rangle \sim \log(n_e.w.\tau)$



R. Geller, Annu. Rev. Part. Sci. 40,15(1990)

Status of IS397 “Charge breeding of radioactive ions with a ECR ion source at ISOLDE”

- Pulsed mode investigation (“afterglow”)
- Charge breeding of intense beams (Kr, Xe)
- Investigation of the chemistry role in the charge breeding process →What charge breeding efficiency for what element?
- The trapping and charge breeding of daughter nuclides
- The molecular sidebands injection
- The charge breeding of NUPECC elements
  → Light ion injection difficult



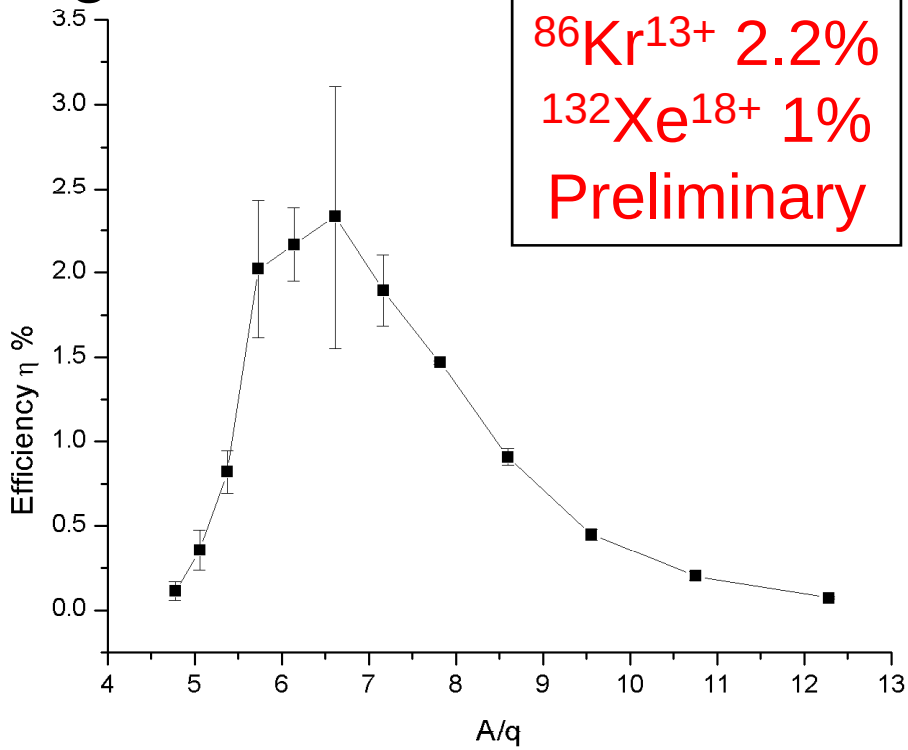
Results obtained so far

CW

Pulsed

86Kr13+

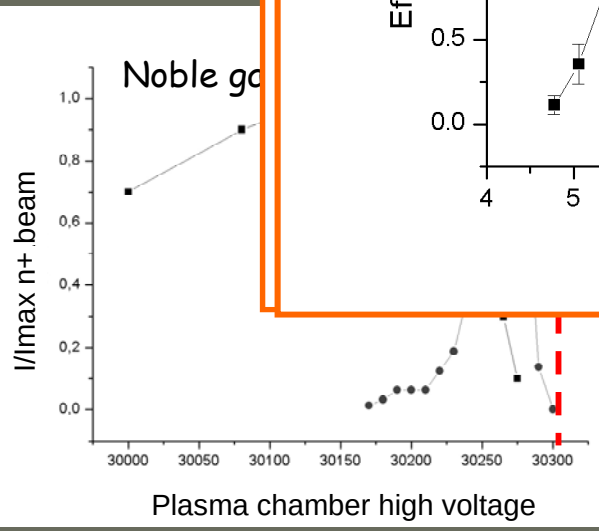
Afterglow

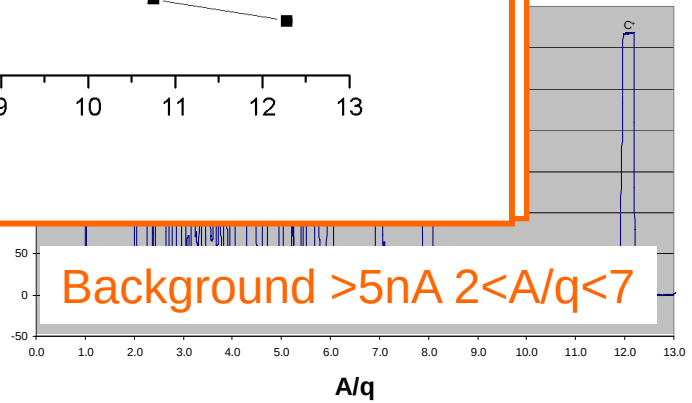


$^{86}Kr^{13+}$ 2.2%

$^{132}Xe^{18+}$ 1%

Preliminary





Background >5nA 2<A/q<7

2 experiments

- Investigation of the role of chemistry in the charge breeding process

→ **Injection of a cocktail beam m=142**

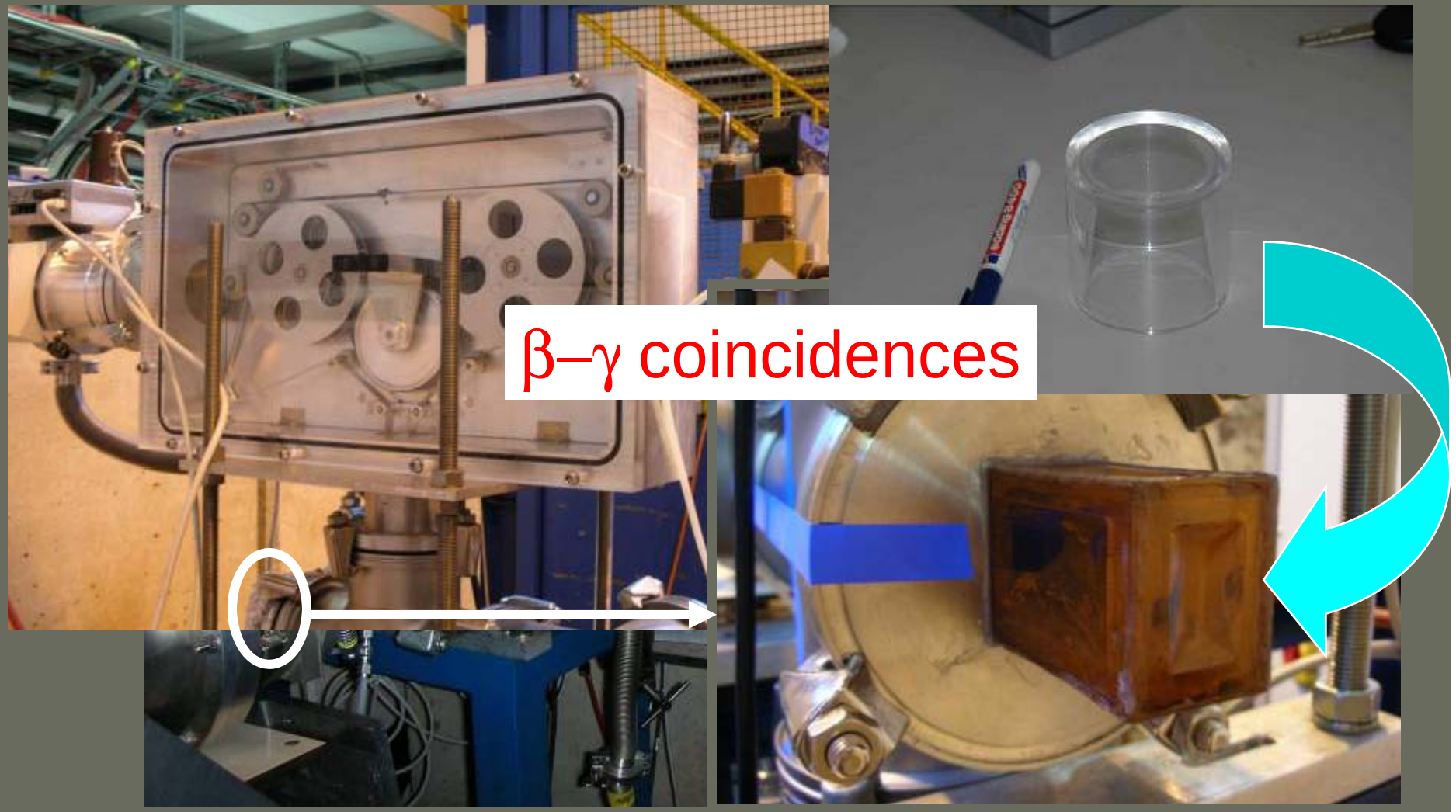
- The trapping and charge breeding of daughter nuclides

- Pulsed mode investigation (“afterglow”)

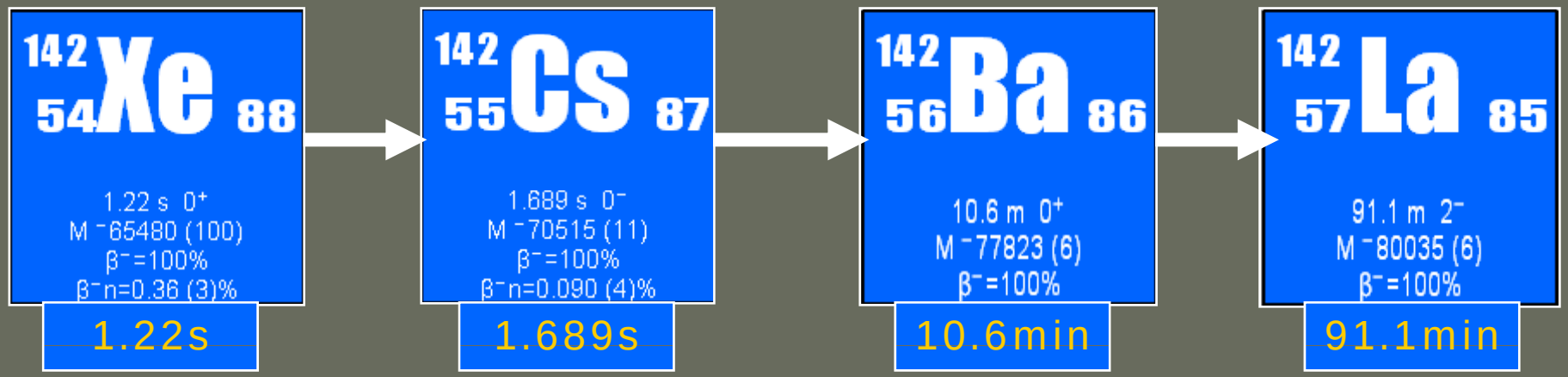
→ **Trapping and charge breeding of $^{61}Mn^{+}/^{61}Fe^{x+}$**

Still under analysis
M. Marie-Jeanne

The detection setup for radioactive ions

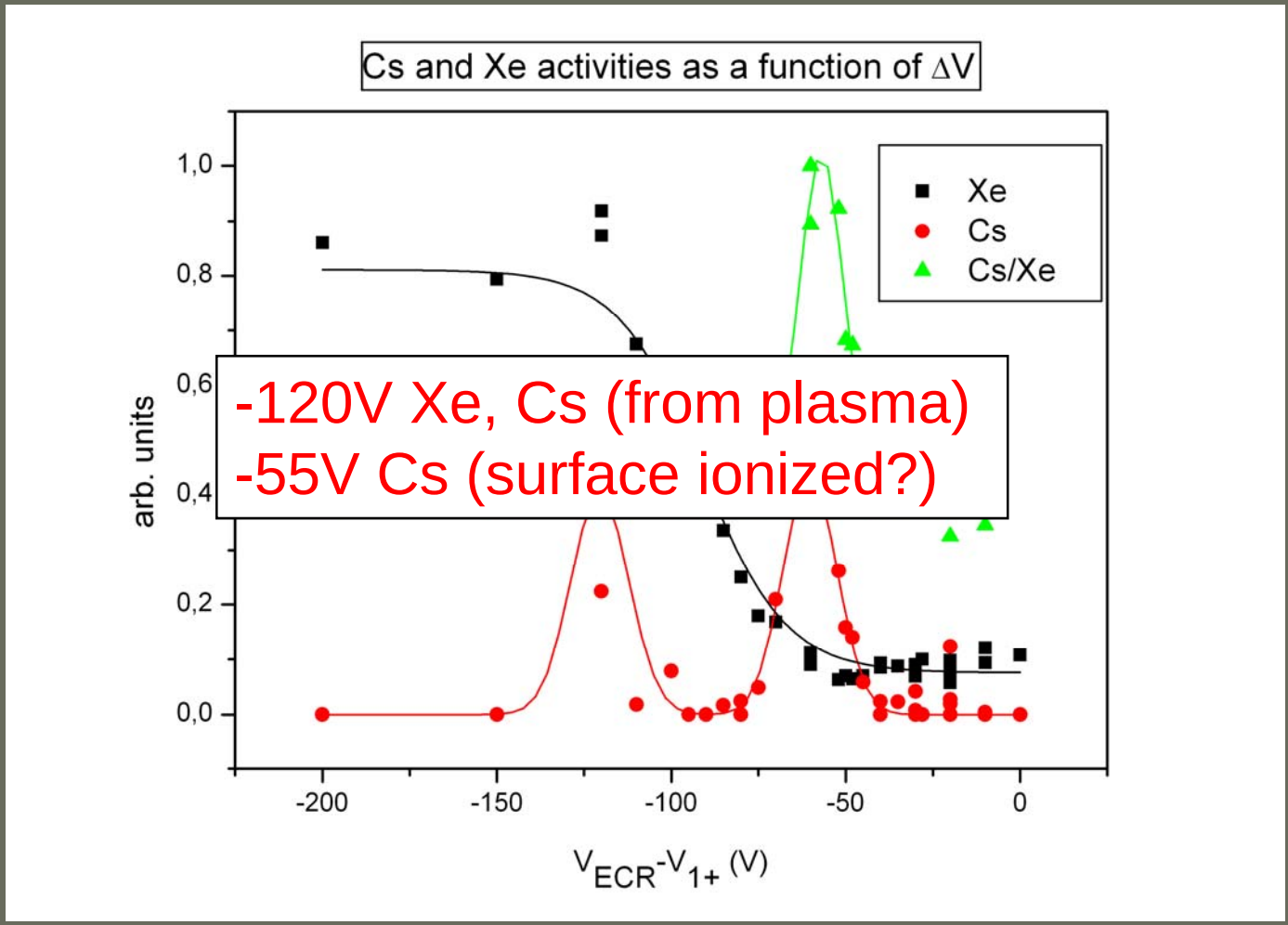


Mass 142 cocktail beam



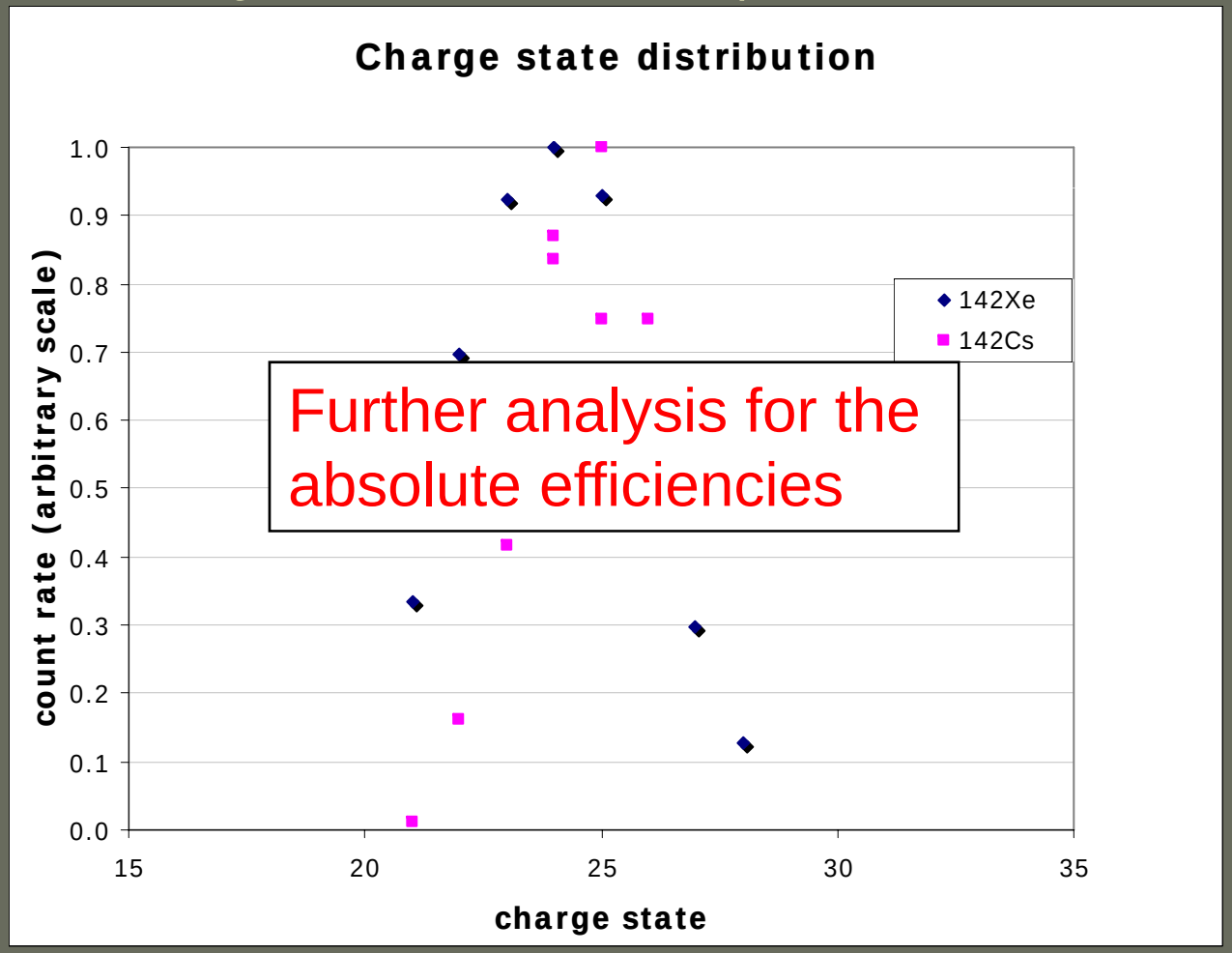
- UCx target with hot-plasma ion source
- No absolute branching ratio for ^{142}Xe
  - Got much more Xe than expected!!
- CW mode

Injection efficiencies

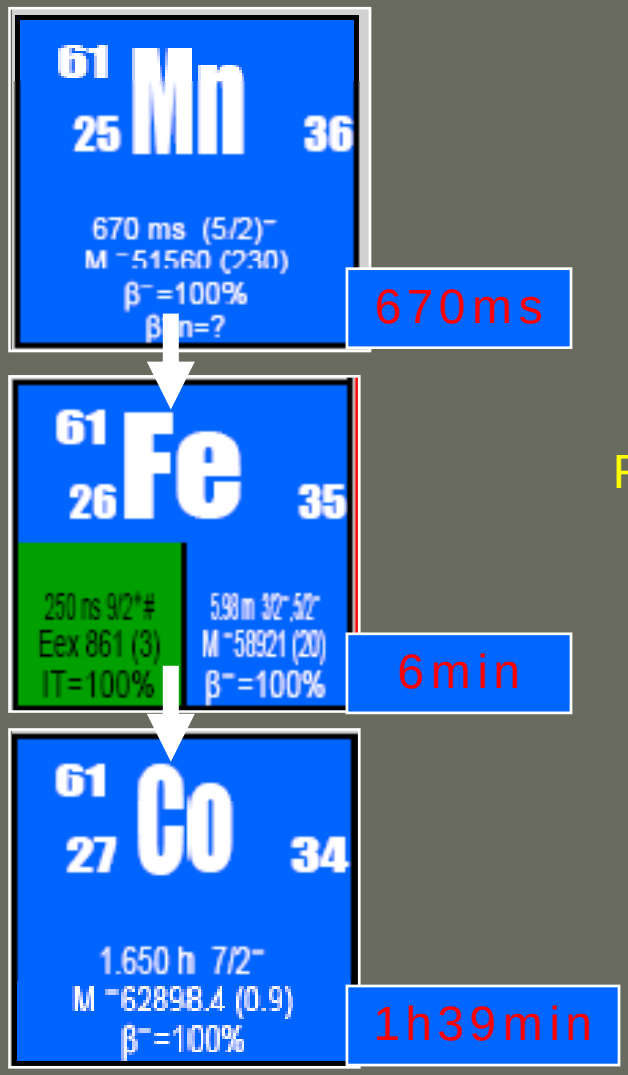


Charge state distribution

- Optimal charge state is 24+, i.e. A/q=5.9

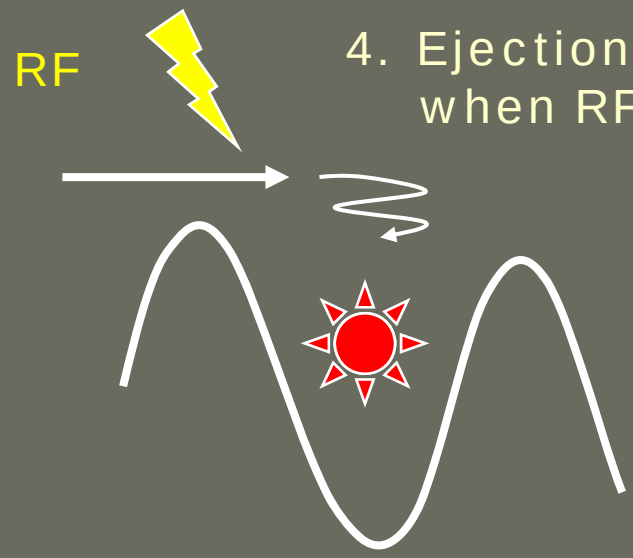


Charge breeding of daughter nuclides



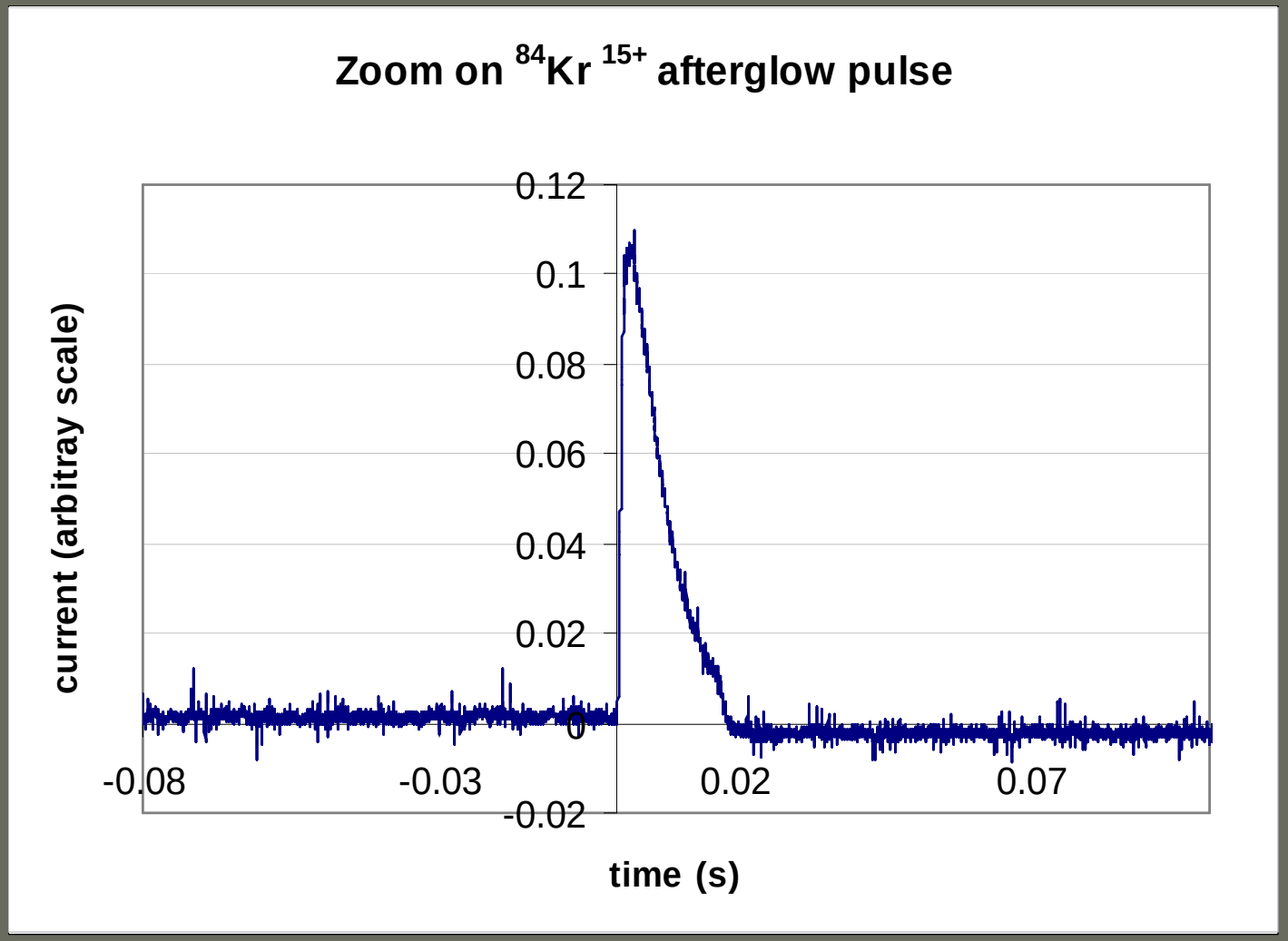
Measurement cycle:

1. ECR plasma is on
2. ^{61}Mn injected into the ECR
3. RF is kept on for a time that can be varied (0s, 800ms...)
4. Ejection of the ions as a pulse when RF is switched off

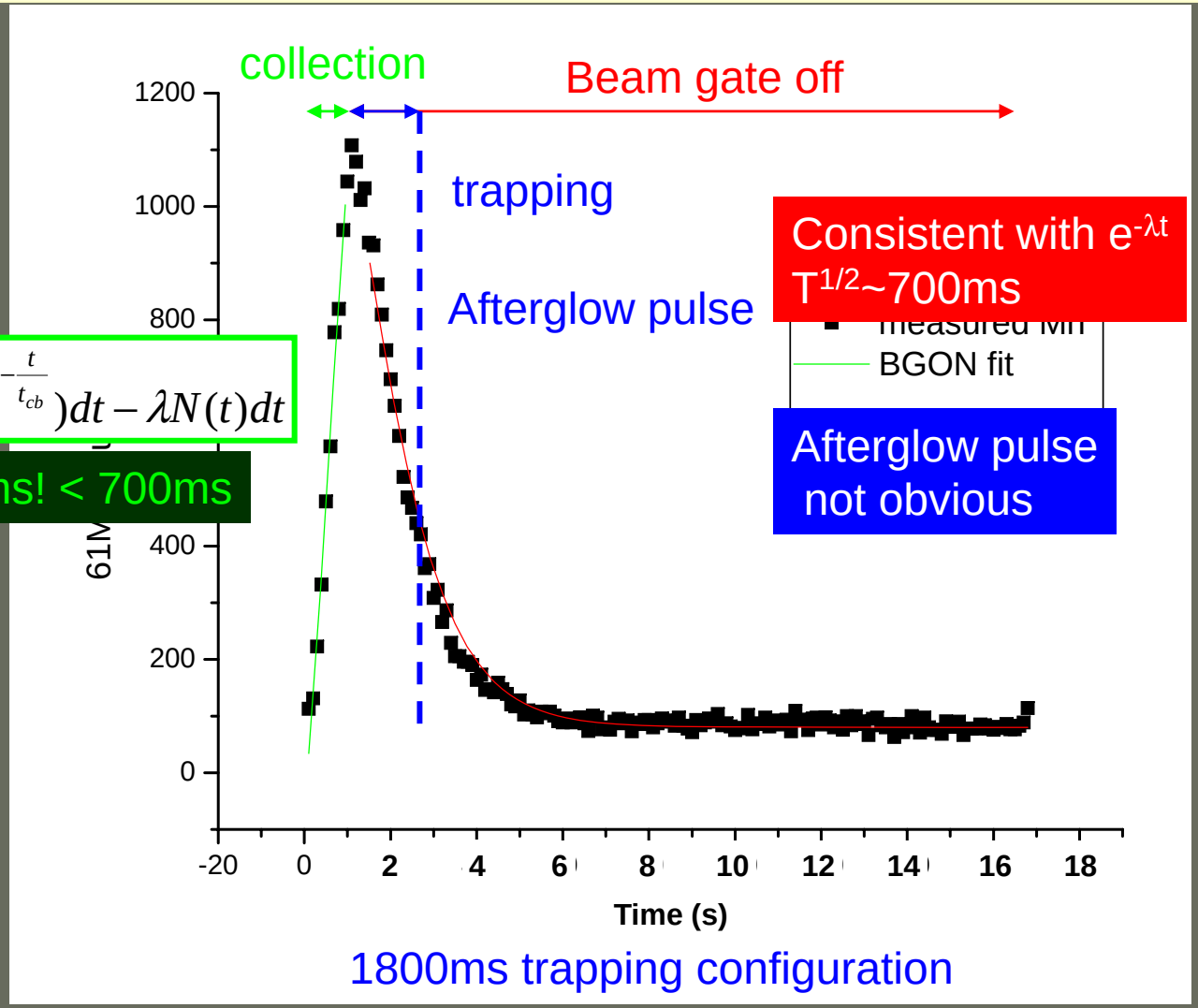


B field in a trap configuration

Afterglow conditioning with $^{84}Kr^{15+}$

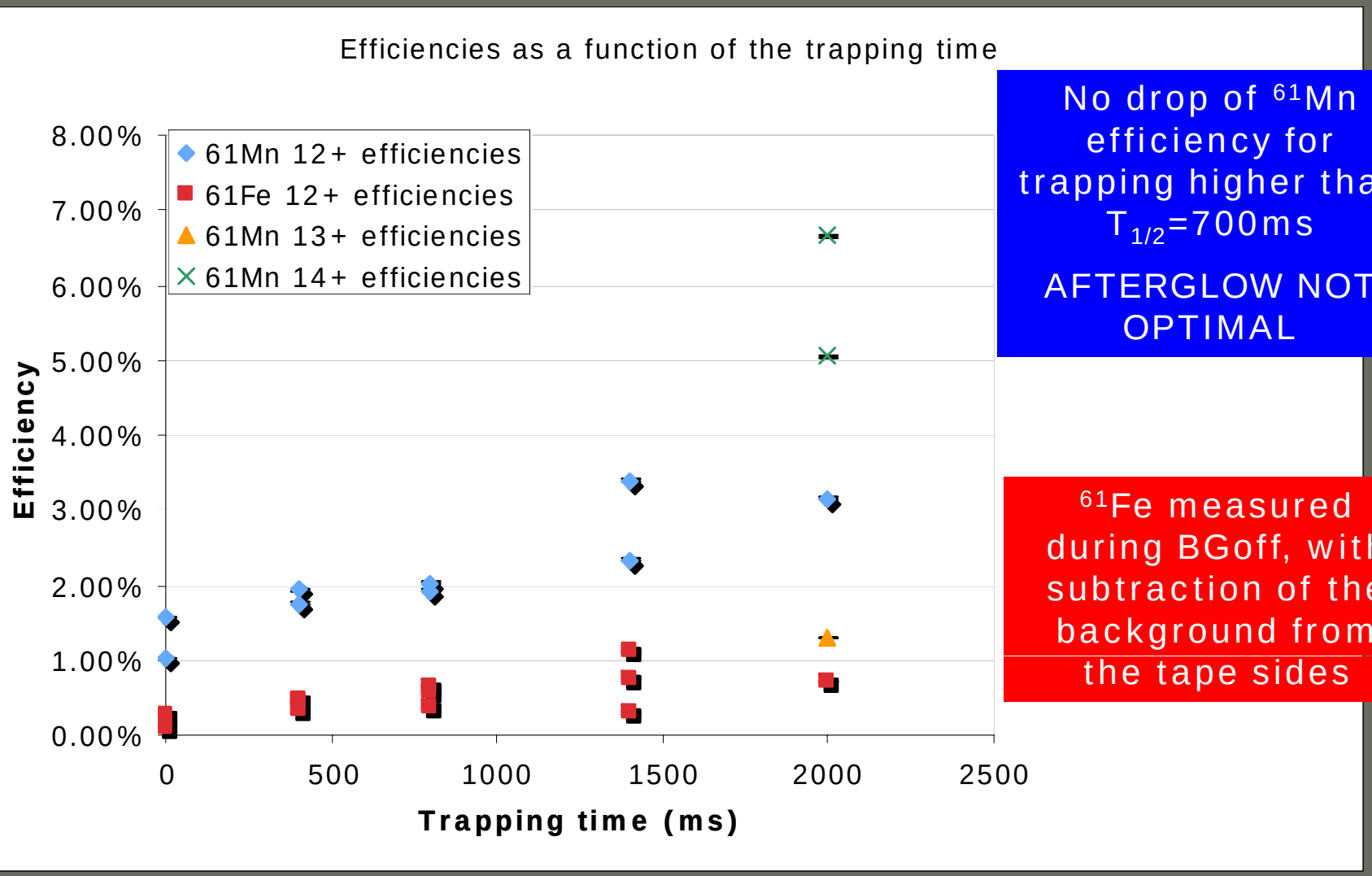


First charge breeding times for ^{61}Mn



1800ms trapping configuration

First efficiencies



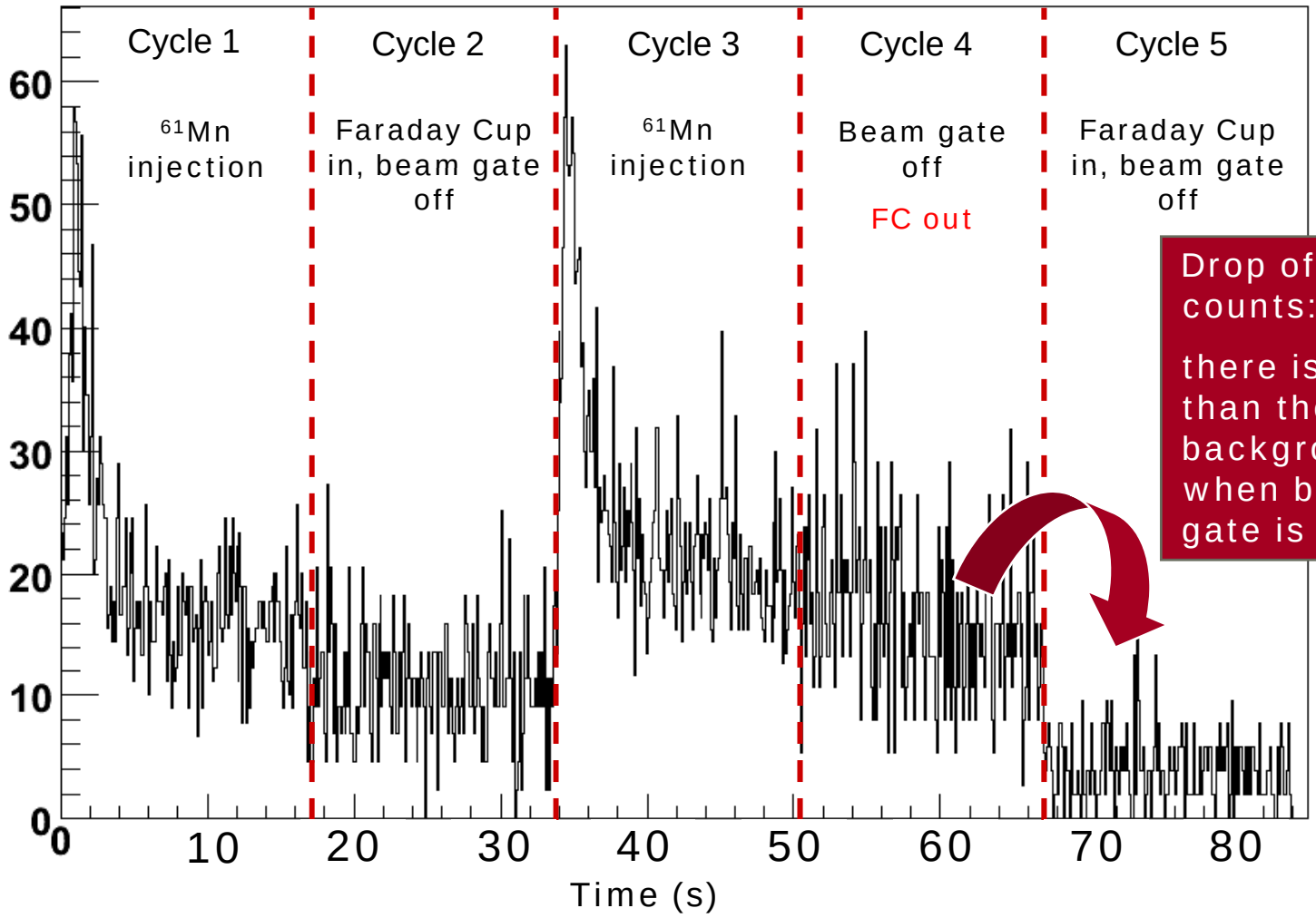
No drop of ^{61}Mn efficiency for trapping higher than $T_{1/2}$=700ms

AFTERGLOW NOT OPTIMAL

^{61}Fe measured during BGoff, with subtraction of the background from the tape sides

^{61}Fe quest

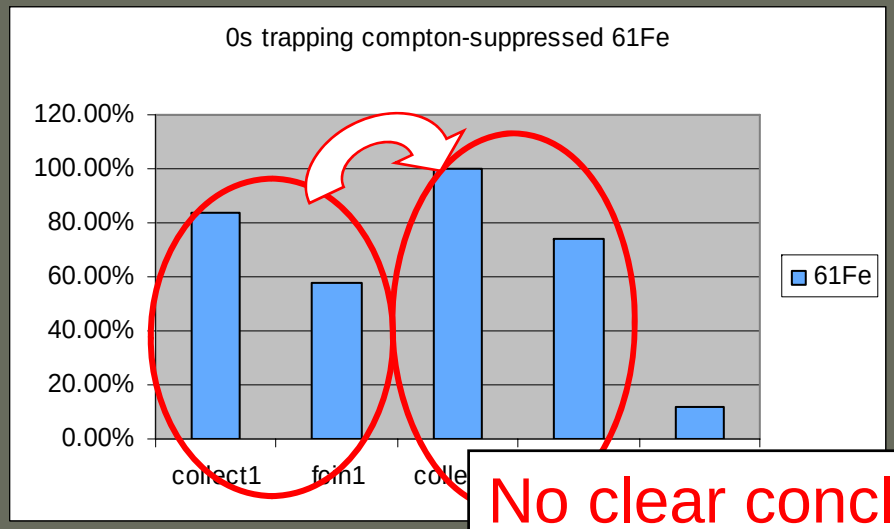
First observations

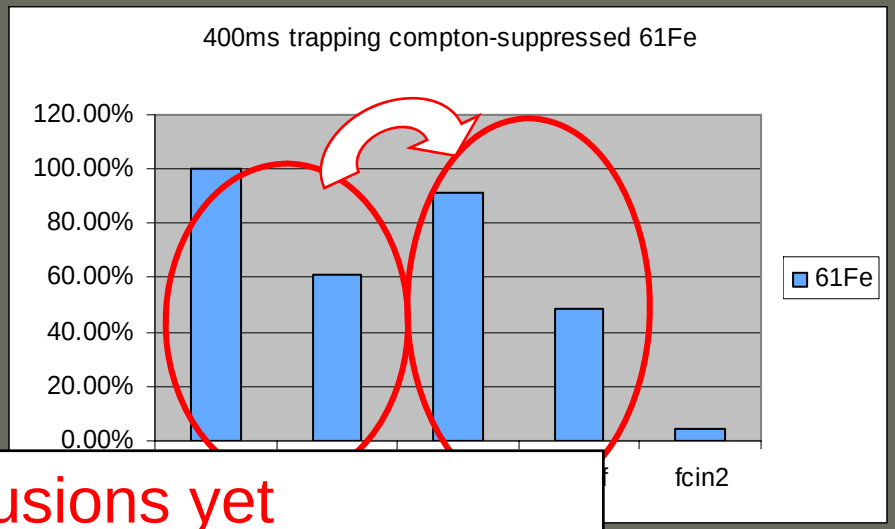


Drop of the Fe counts:

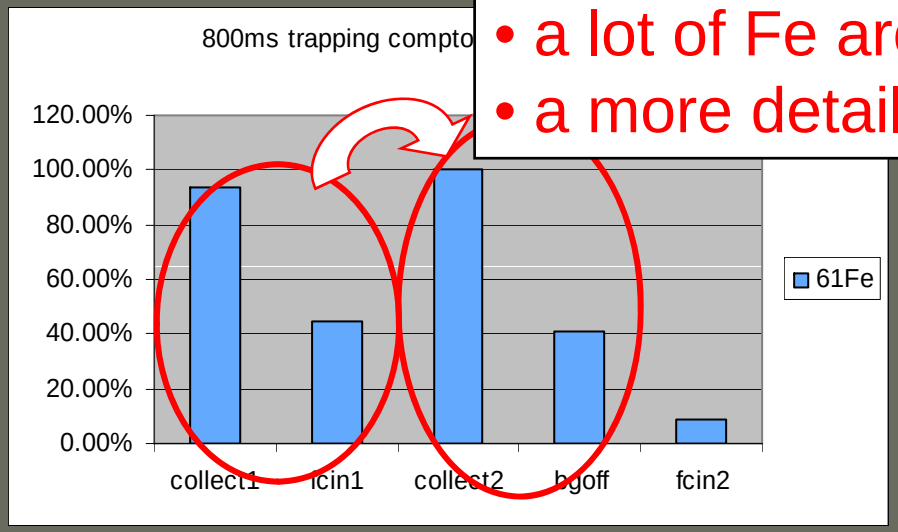
there is more than the background when beam gate is off

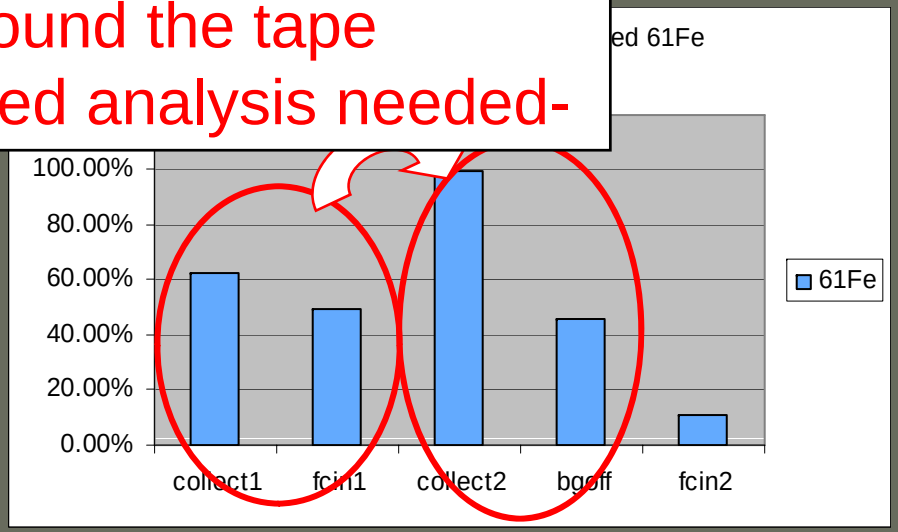
^{61}Fe compton suppressed Preliminary





No clear conclusions yet
- a lot of Fe around the tape
- a more detailed analysis needed-

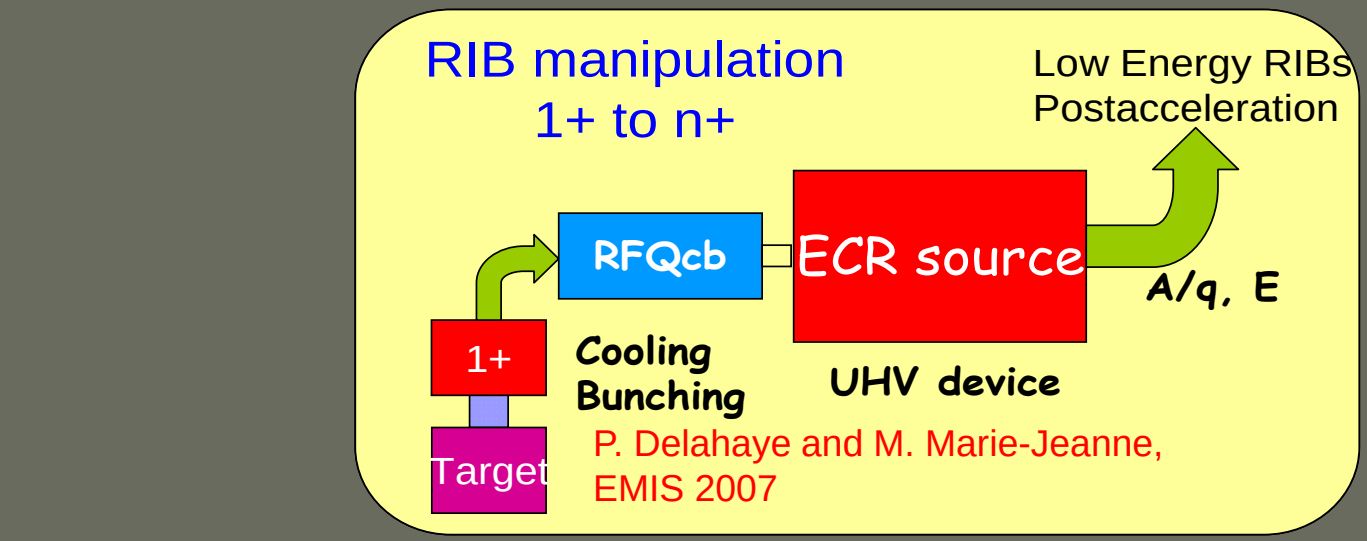




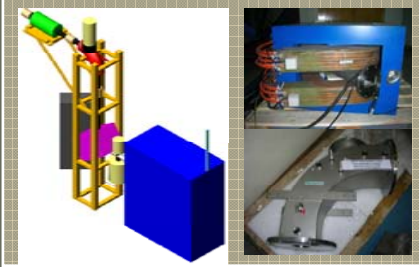
Outlook

- 2 experiments with interesting results
  - cocktail beam ΔV measurement quite successful
  - Trapping experiment still requires a careful analysis
    - afterglow effect on the Mn activity
    - Fe is trapped or not and if yes with what mechanism?

Charge breeding of intense RIBs



UHV design
and A/q,E separator



Cooled and
bunched beams!