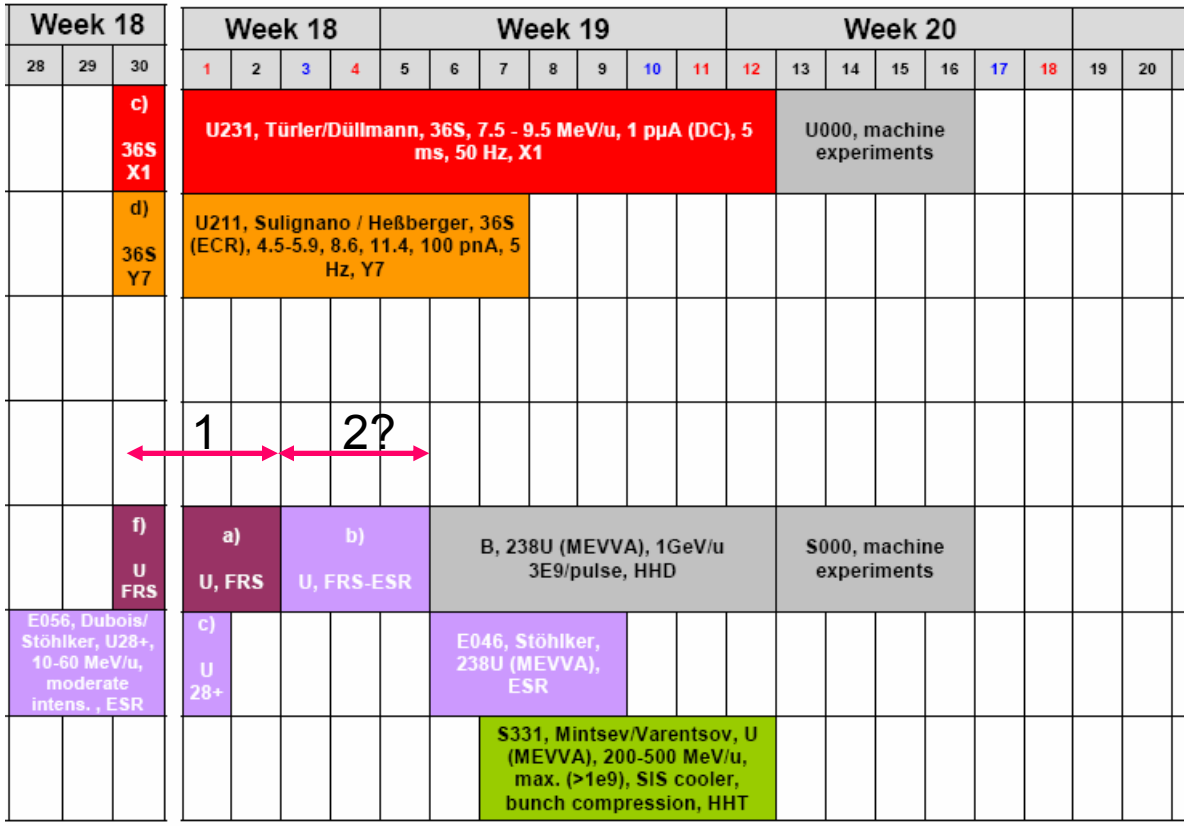
Experimental Proposal E073: Electron Screening and alpha-decay



Allocated blocks include the accelerator tuning time
a) E073, Musumarra/Nociforo, 238U (MEVVA), 400-600 MeV/u, 1e9/spill, SIS cooler, vacuum at S2, FRS
b) E073, Musumarra/Nociforo, 238U (MEVVA), 400-600 MeV/u, 1e9/spill, SIS cooler, vacuum at S2, FRS-ESR
c) E056, Dubois/Stöhlker, U28+, 10-60 MeV/u, moderate intens., ESR / jet target

- Shifts: 41 approved , 0 used
  9 proposed

Physics Motivation

- Search for evidence of electron screening effects in alpha-decay by modifications in lifetimes and Q_α-values of fully stripped, H-like, He-like α-emitters → faced only theoretically !

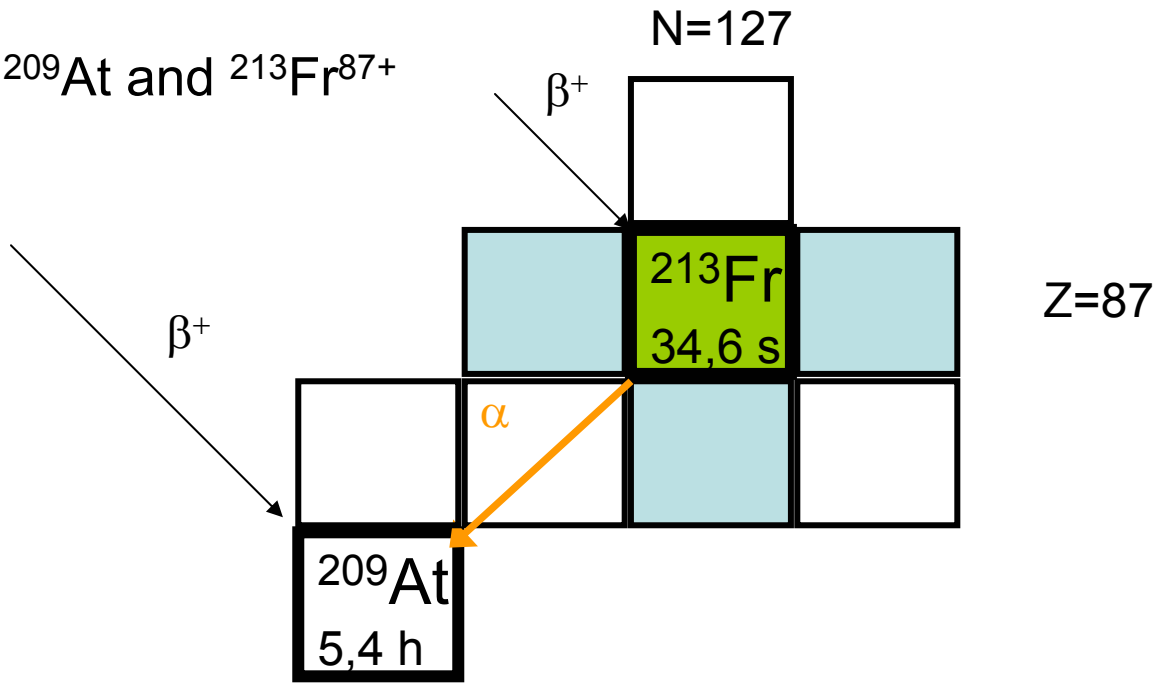
- Selected cases :

Nucleus	$T_{1/2}$	α–Branch (%)	Q_α(MeV)	U^{ad}(keV)
$^{213}Fr^{87+}$	34.6 s (*3*)	99.45	6.905	38.0
$^{220}Fr^{87+}$	27.4 s (*3*)	99.65	6.801	38.0
$^{212}Rn^{86+}$	23.9 m (*12*)	100	6.385	37.3

Matching ESR storage time

$^{213}Fr^{87+}$ case : ion accepted into the ESR

no repopulation of ^{209}At and $^{213}Fr^{87+}$ by β-decay !

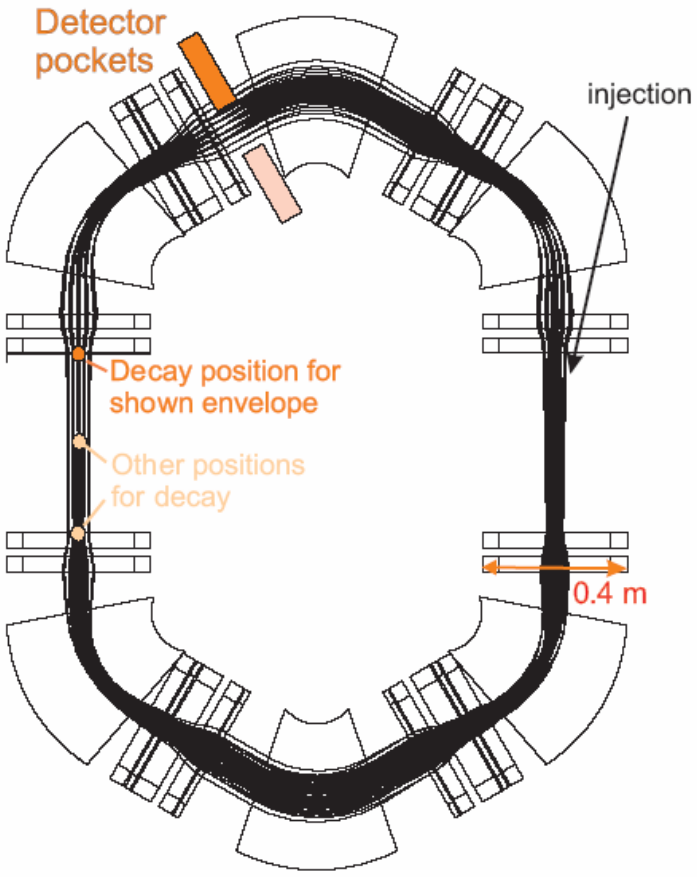


FRS Simulation :
^{238}U @ 566 MeV/u +Be(1035+Nb(223))
S2 achrom. wedge Al (737mg/cm^2)
$^{213}Fr^{87+}$ @ 400 MeV/u

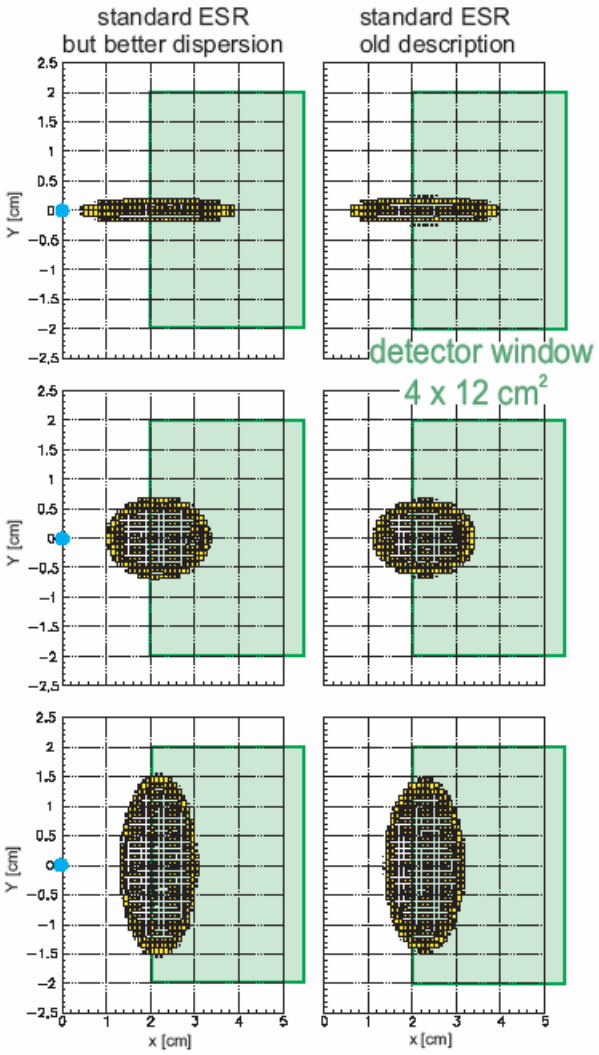
^{213}Fr case : detection into the ring

Tue Dec 4 19:54 CET 2007
Helmut Weick

Beam envelope in ESR like after alpha decay on straight section
start with well cooled ^{213}Fr beam



Spotsize of ^{209}At on detector after alpha decay



Alpha decay kinematics for 213Fr at 400 MeV/nucleon (two body decay)

$A_{max} = B_{max} = \pm 1.13$ mrad
spread $\Delta B\rho/B\rho_{max} = \pm 0.162\%$
shift in $\Delta B\rho/B\rho = 0.43\%$

T = 100% to detector plane
but detector cannot go to the center.

Beam planning

1. FRS (S4) : (re)measuring neutral halflives of **^{213}Fr** at the implantation setup at the final focal plane (rate kept <10^2/s)

The equipment at the second half of the separator is immediately available → Standard ID-setup + Rising implantation setup

→ 9 Shifts ^{238}U slow-extracted beam

Preparation (S4 part)

Status :

- running DAQ and on-line analysis program
- available ID detector (calibrated)
- available DSSSD (calibrated)
- promising FRS simulation (ex. σ_{pro}~0.2 mb ,Tr~3% with i=10^8 U/s)
- precise ID and high resolution required, low rate on the SDDDS detector, same pre-amp of Rising?
- τ~34 s , i.e. if 25 spill/hour → 600 spill/day, $\langle n \rangle_{fs}$ =15 → 9000 decays/day.

People : FRS(?) + Rising(?) + Catania (3) + Japan(?)

Beam planning

2. FRS (ESR) : lifetime measurements of injected $^{213}Fr^{87+}$ (many-particle mode) by
   - observation of the disappearance of the mother and the appearance of the daughter nuclei by Schottky measurements
   - counting ^{213}Fr rates with SCI detector

→ 9 Shifts ^{238}U fast-extracted beam

Preparation (ESR part)

Status :

- promising simulations up to ESR (if i=10^9 U/spill → 400 $^{213}Fr^{87+}$/spill)
- existing standard equipment
- existing and tested SCI detector (Mar '08)
- technique never used for alpha emitters
- ESR settings : el.+stoc. cooling, ring looses (hours or days?)
- DAQ?, on-line analysis program?, data storage?
- so far few simulations into ESR

People : ESR(?) + FRS(?) + Catania(3) + Japan(?) + other(?)

Options

a) extend to 4 days for the S4 part only → sufficient to test the technique and get results (high precision ?)

b) extend to 4 days for the ESR part only → too short time, are ESR experts and FRS people available ?, maybe one can get only the answer if the daughter stays inside the ring or not

c) nothing → no U beam in the next 12 months

d) both parts together → no possible with the current schedule !