FRS setup

- FRS web page
- Standard FRS detectors
- Detectors needed for simulations

FRS web page

The FRS web page for technical information is :
http://www-w2k.gsi.de/frs/technical.asp .

This web page is important for preparing the FRS proposals, making realistic simulations and running FRS experiments.

FRS setting: http://www-w2k.gsi.de/frs-setup/

On the right there is the FRS drawing with active links on the FRS areas:

- TA area: http://www-w2k.gsi.de/frs-setup/AREAS/AREAS_TA.htm (with link to pictures, distances, cable connections)
  - 1st target station with list: TS1ET5
  - 2nd target station with list: TS2ET2 (closest to the first quadrupole)
- Seetram (http://www-wnt.gsi.de/charms/seetraminfo/seetram2.htm)
- S1 area (with link to pictures, distances, cable connections)
  - beam plug
  - MWPC detector (http://www-linux.gsi.de/~weick/frs/mwpc.html)

- S2 area with link to pictures, distances, cable connections
  - SC21 thickness list
  - S2 degrader (TS3ED7*): ladder, wedge and disk (degrader calculator)
    ladders thickness: 16, 32, 48, 64, 80 mm
    wedge thickness (135-3375 mg/cm2)
    disc thickness (737 mg/cm2) and angle (achromatic, monoenergetic)

- S4 area with link to picture, distances, cable connections
  - SC41 thickness list
  - Music detector (TUMusic80 : http://www-w2k.gsi.de/frs/technical/FRSsetup/detectors/music80/music80_manual.pdf , Music tunig-fork : http://www-wnt.gsi.de/charms/music.htm)
  - TPC detectors (http://www-w2k.gsi.de/frs/technical/FRSsetup/detectors/tpc.asp)
  - ITAG station (http://www-w2k.gsi.de/frs/technical/FRSsetup/detectors/itag/itag_manual.pdf)

In addition you can find information on:

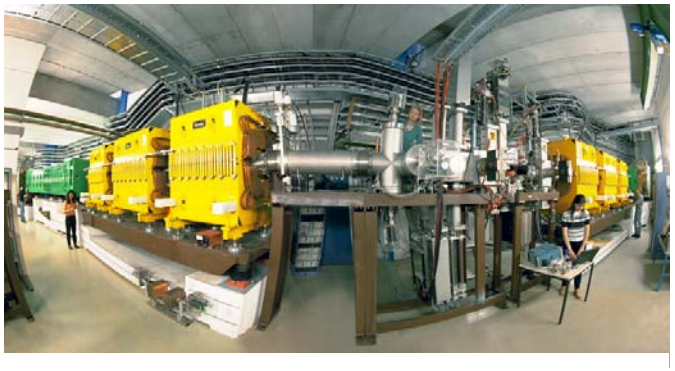
How to operate the FRS: http://www-linux.gsi.de/~weick/frs/frs-steps.html

Electronics: http://www-w2k.gsi.de/frs/technical/electronics/overview.asp

Data acquisition: http://www-w2k.gsi.de/frs/technical/daq/overview.asp

Standard FRS detectors: http://www-w2k.gsi.de/frs/technical/FRSsetup/detectors-new.asp

FRS



H. Geissel *et al.*, NIMB 70(1992)286

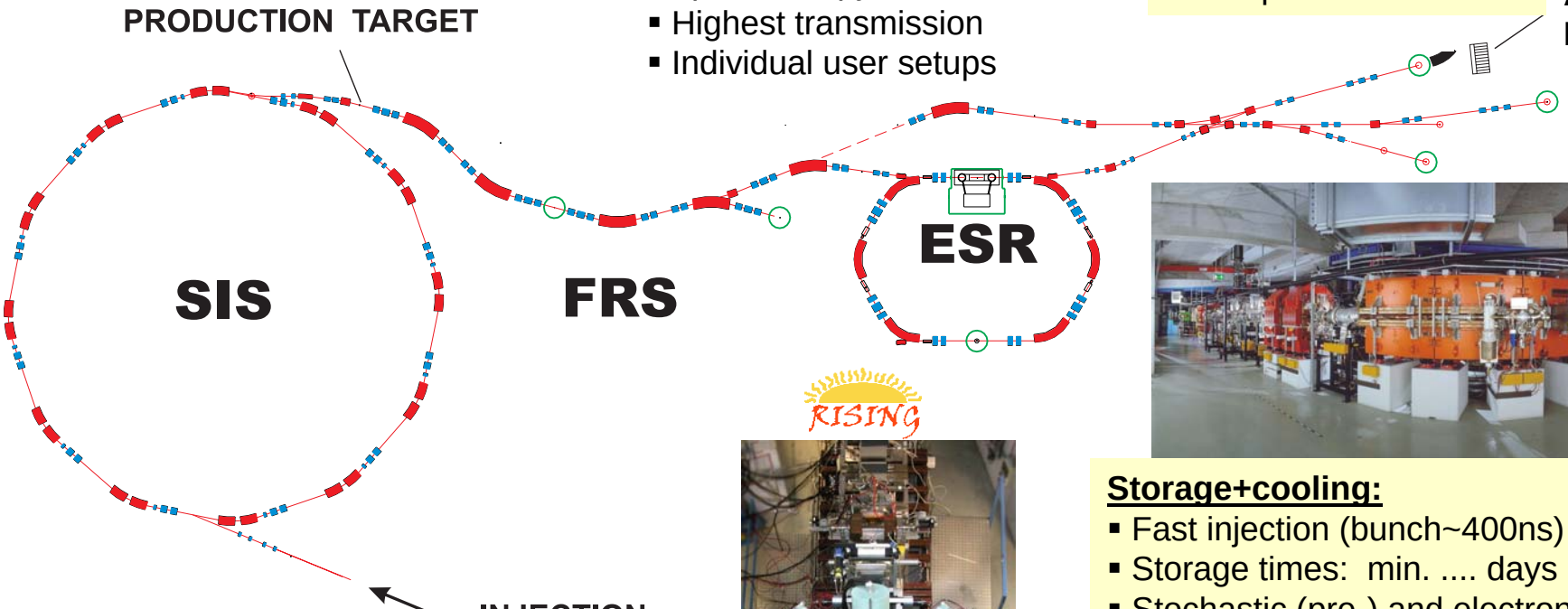
Production:
- Projectile fragmentation, ED, fission
- Yields: ~ 10^{5}/s.... 10^{-5}/s
- Bare, H-, He-, Li-like

Separation:
- Bρ-analysis (cocktail beams)
- Bρ-ΔE-Bρ method (mono.)

Experiments:
- High-resolution momentum spectroscopy
- Highest transmission
- Individual user setups

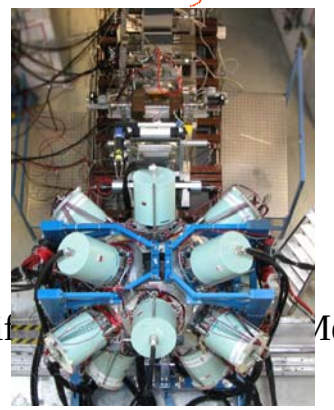
Reactions with relativistic radioactive beams:
- Neutron detection
- Complete kinematics

ALADIN-LAND



Primary beams:
- H.....U, ~100...1000MeV/u
- Fast (500ns) and slow (0,1...10s) extraction
- Intensities ~ 10^{8}...10^{10} / s

RISING

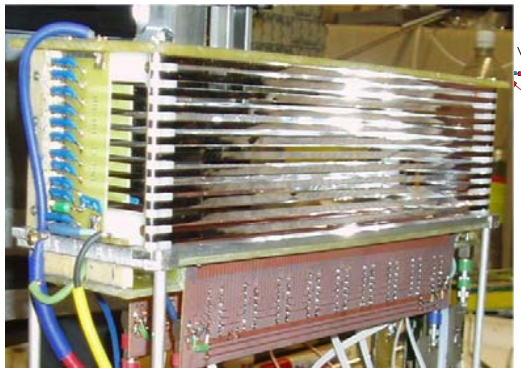


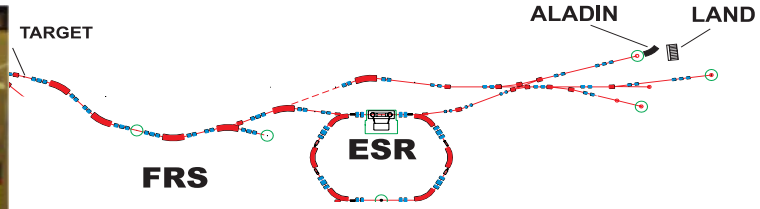
Storage+cooling:
- Fast injection (bunch~400ns)
- Storage times: min. .... days
- Stochastic (pre-) and electron cooling

Experiments:
- Time-resolved Schottky spectroscopy
- Isochronous Mass Spectrometry
- Reactions and scattering off int. targets

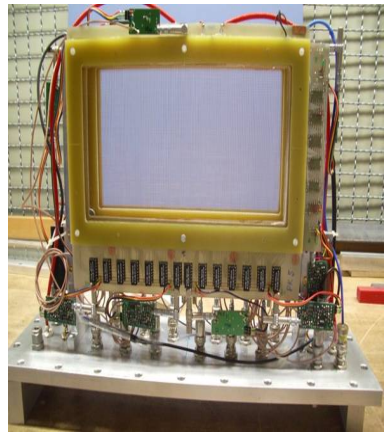
Standard FRS equipments

TPC-x,y position @S2,S4





Beam profile @TA,S1,S2 S3,S5,S6



Target

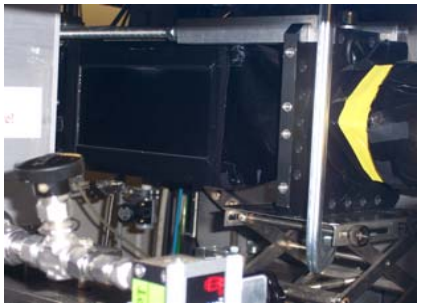
$$Z \leftarrow -dE/dx = \mathrm{f}(Z, \beta)$$

$$A/Q = \frac{B\rho}{\gamma\beta m_u}$$

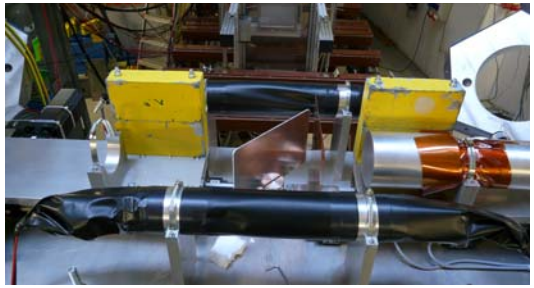
$$A = \frac{T_{\mathrm{KE}}}{(\gamma - 1) m_u}$$

$$Q = \frac{A}{A/Q}$$

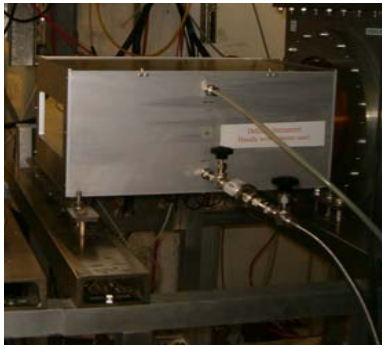
Plastic scintillator (TOF) @TA,S1 S2,S3, S4,S8



HPGe @S4 for isomer γ-decay measurement (isomer PID)



MUSIC (ΔE) @S2,S4

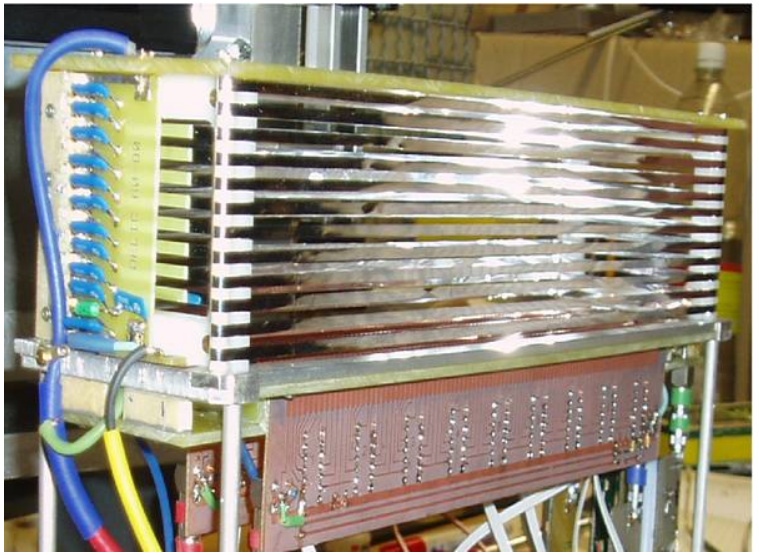


SEETRAM Intensity monitor (primary beams) @TA

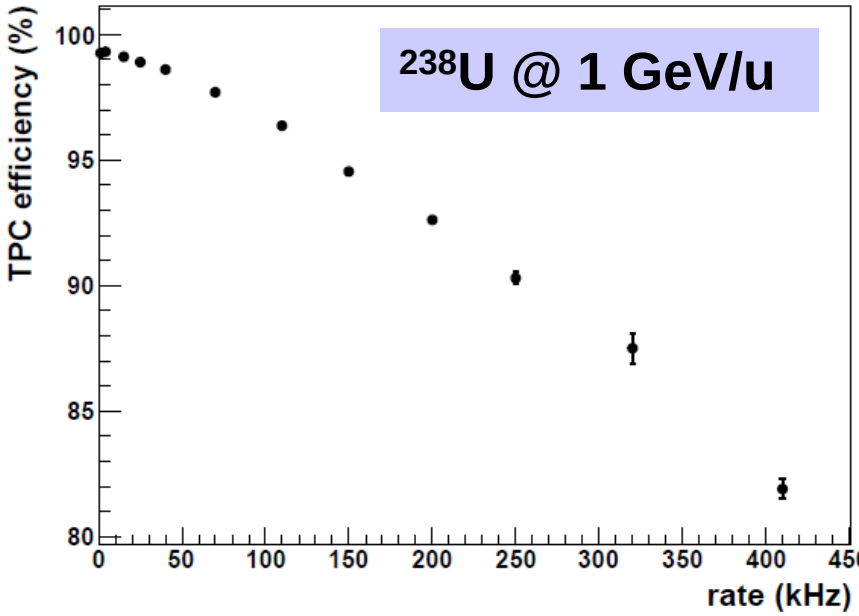
Tracking detectors at the FRS

Time Projection Chamber

- (240x100) mm^2 active area
- Gas P10 at 1 atm
- Integrated delay lines (2x-pos, 4y-pos)
- $\sigma_x \sim 0.1$ mm, $\sigma_y \sim 0.05$ mm



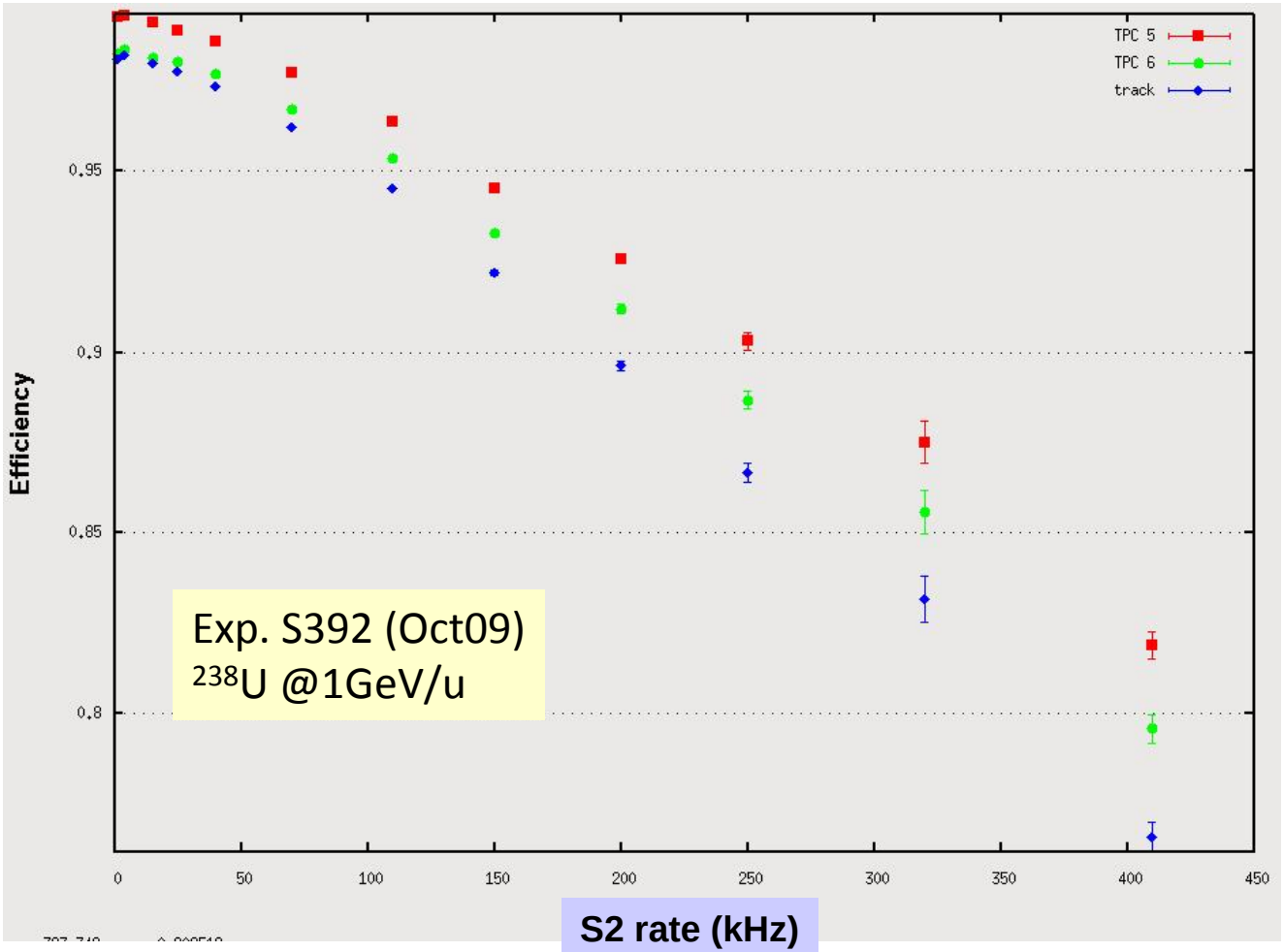
R. Janik, *et al.*, NIM A 598 (2009) 681



- On-line calibrations
- VME standard electronics
- 95% efficiency at ~100kHz

CUB Bratislava & GSI

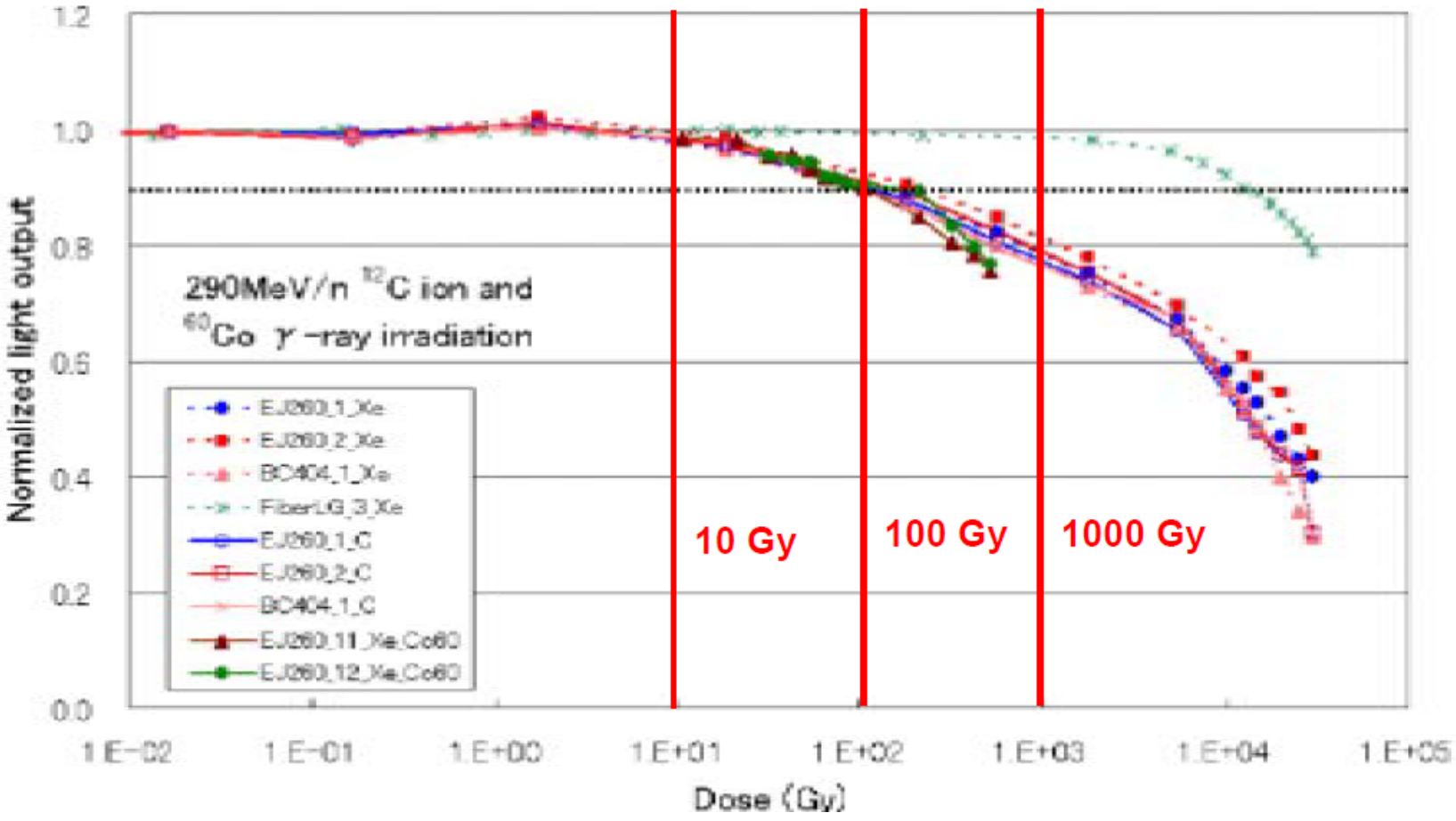
Tracking efficency at S2



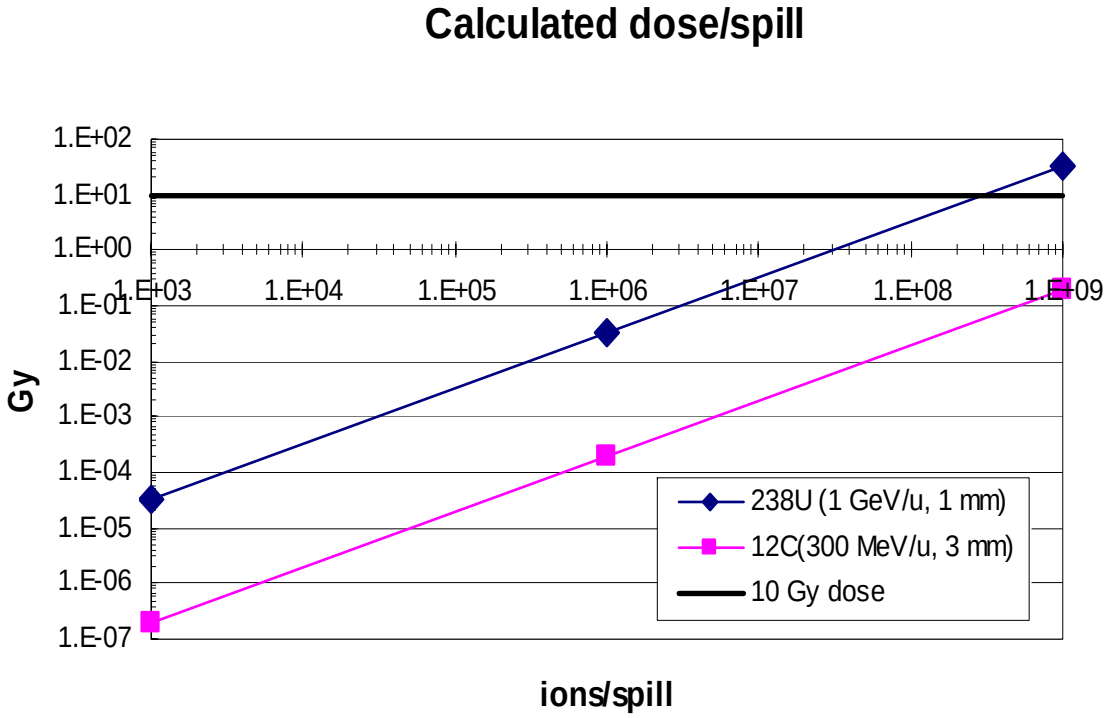
Radiation damage studies

courtesy of O. Adriani

- Plastic scintillator starts to degrade at 10 Gy



Some numbers about safe rates



Energy loss calculated in BC-400 material by LISE

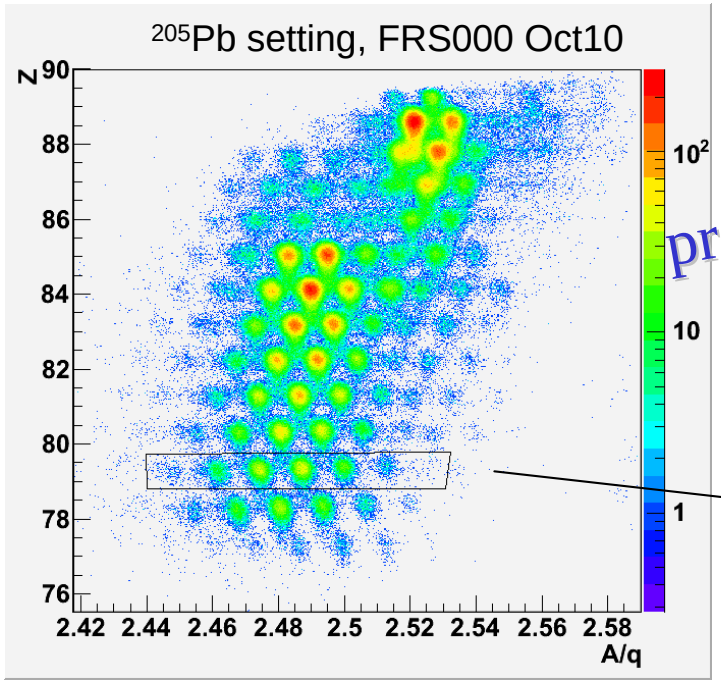
To get 10 Gy:

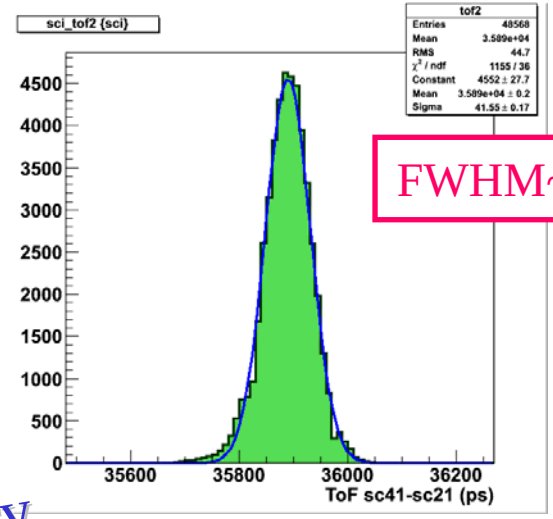
- 300 spills at I=10^6 ^{238}U/s

- 13 h at I=10^6 ^{12}C/s

ToF resolution

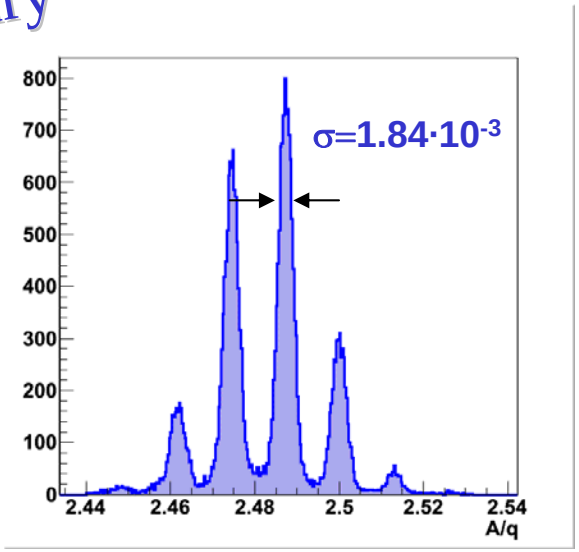
Exp. FRS000 (Oct10)
^{238}U @1GeV/u, slits S2: (-1,1), S3: (-0.5,0)





FWHM~100 ps

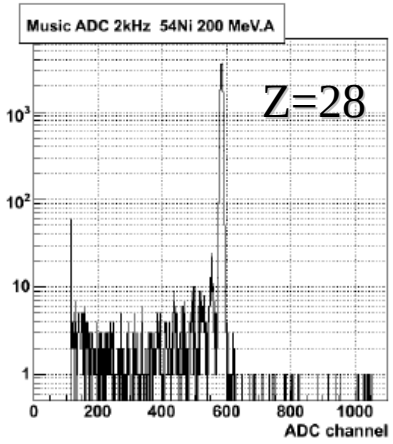
preliminary

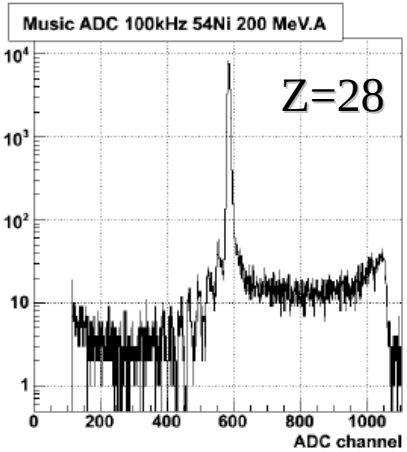


MUSIC detector status

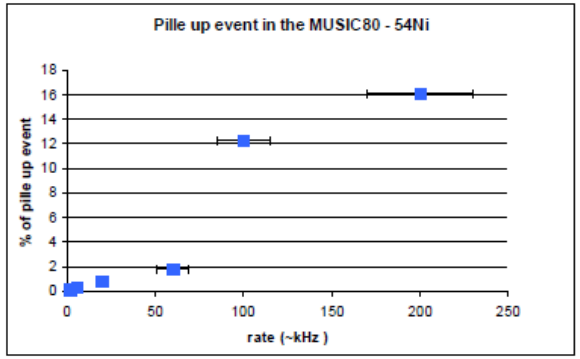
- Available
  - Two 200 x 80 mm^2 TUM MUSIC80s (CF_4 or P10 gas)
  - Two 450 mm Ø "old" MUSICs (P10 gas)
  - Two 200 x 200 mm^2 "older" MUSICs (P10 gas)
  - One Twin (2-stacked) MUSIC (P10 gas)

- Towards higher counting rate (pile-up discrimination)



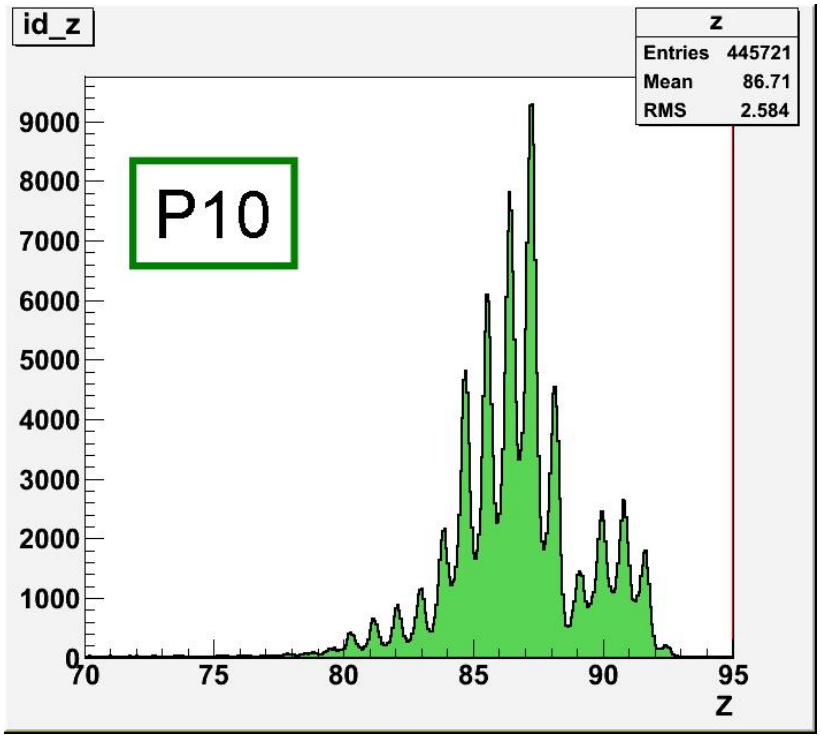


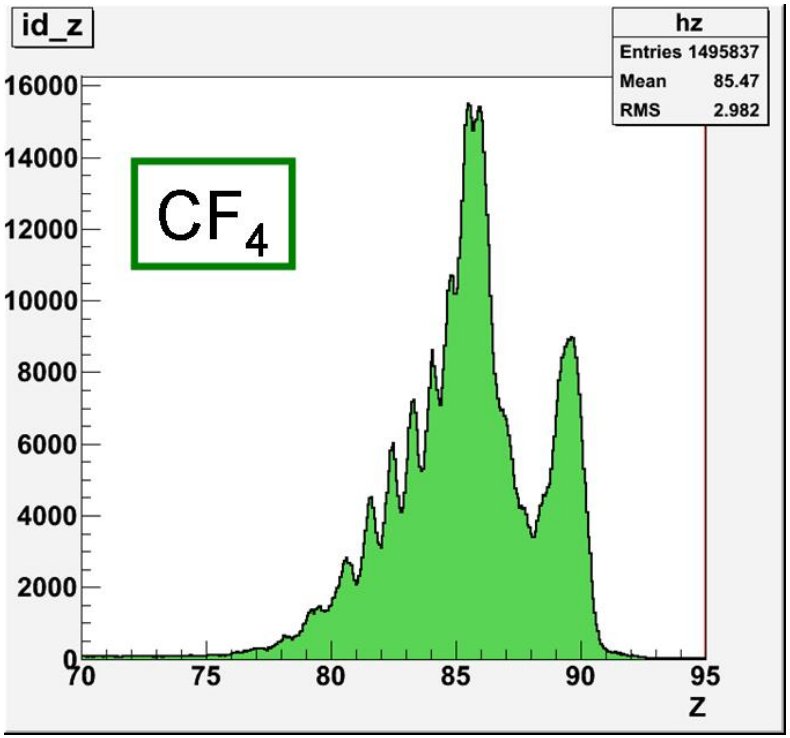
At high rate : pille up in the music shaper output gives wrong Z identification



- Drift with T and p

Z distribution





P10 gas mixture is better for higher Z values but slower than CF_4 one.

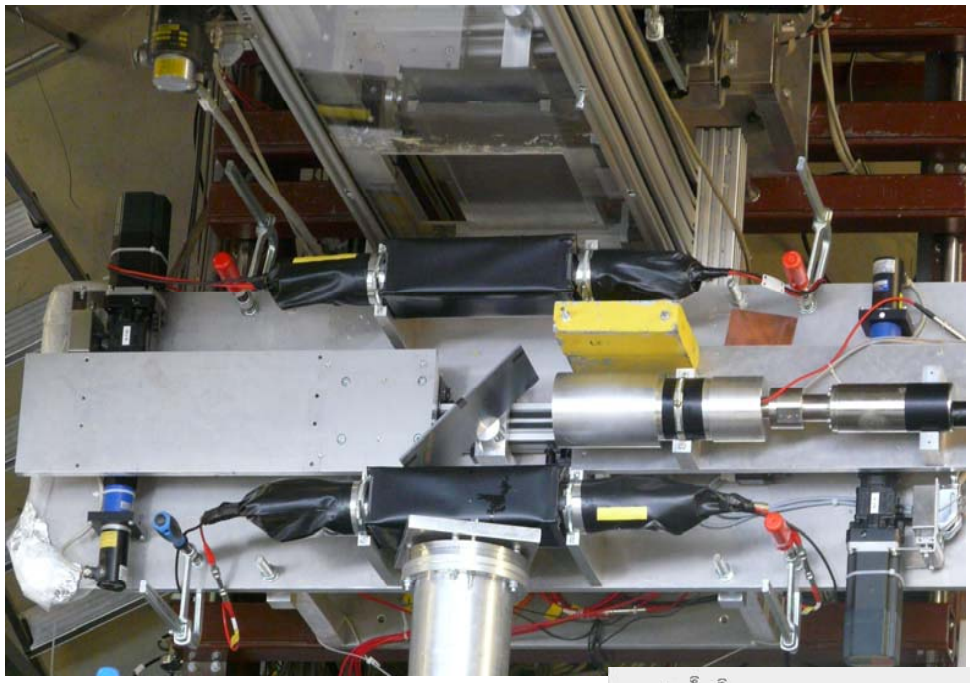
Isomer TAGger (ITAG) at FRS focal plane

HPGe: mechanical cooling system, mounted in a movable holder, shielded with 50 mm Pb, 1 capsule available, the second ordered

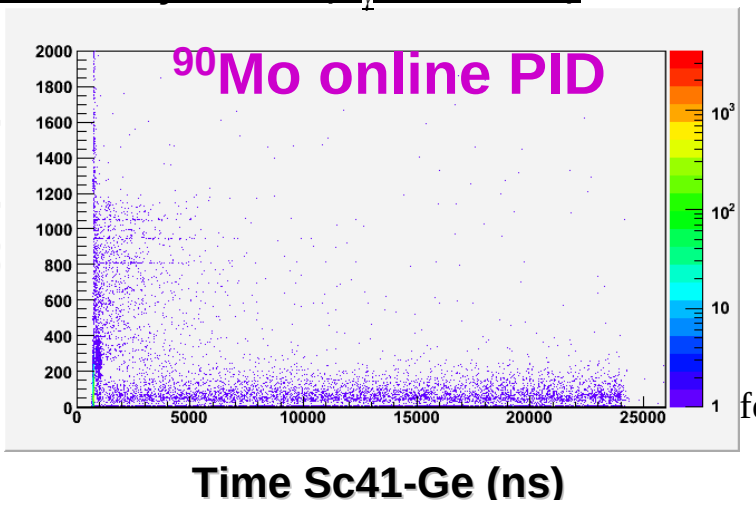
F. Farinon *et al.*, GSI report (2009)

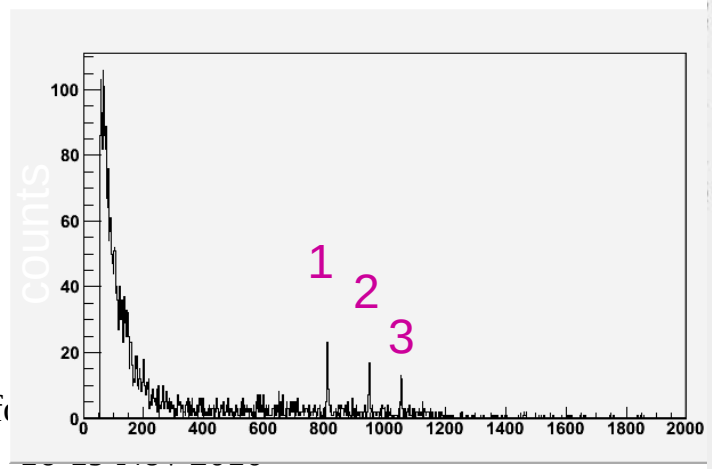
2 Scintillators: 5 mm BC-400

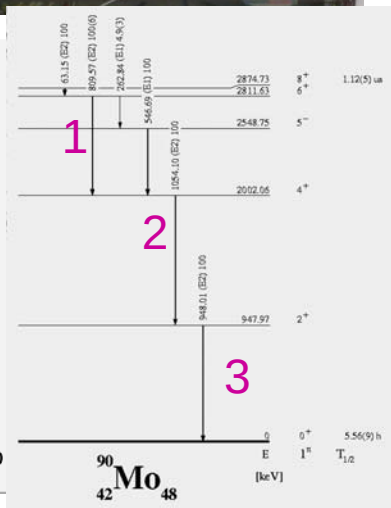
Stopper: (150 x 150) mm^2 Al thickness 4.2 mm



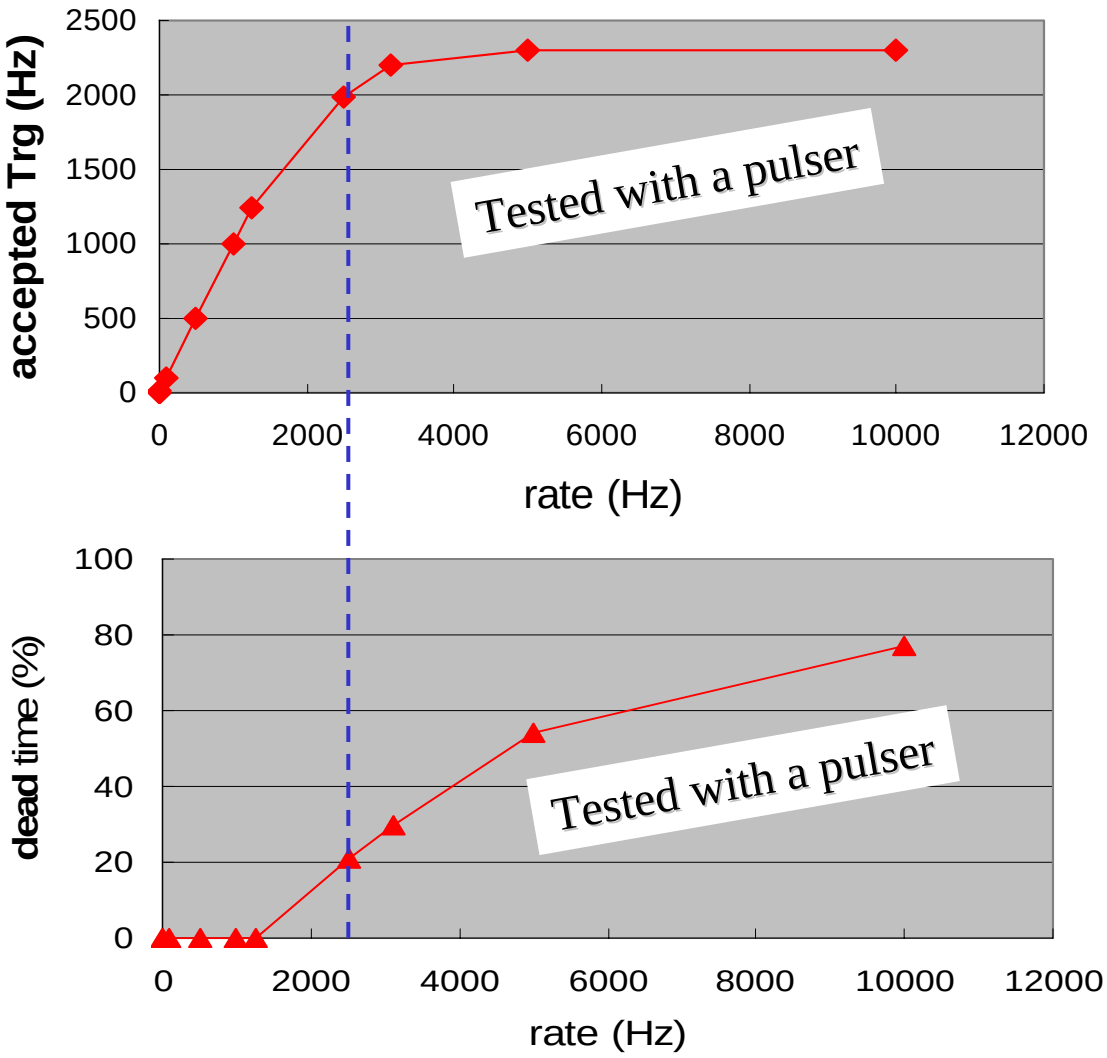
Efficency: 0.5% (E_γ=1332keV)







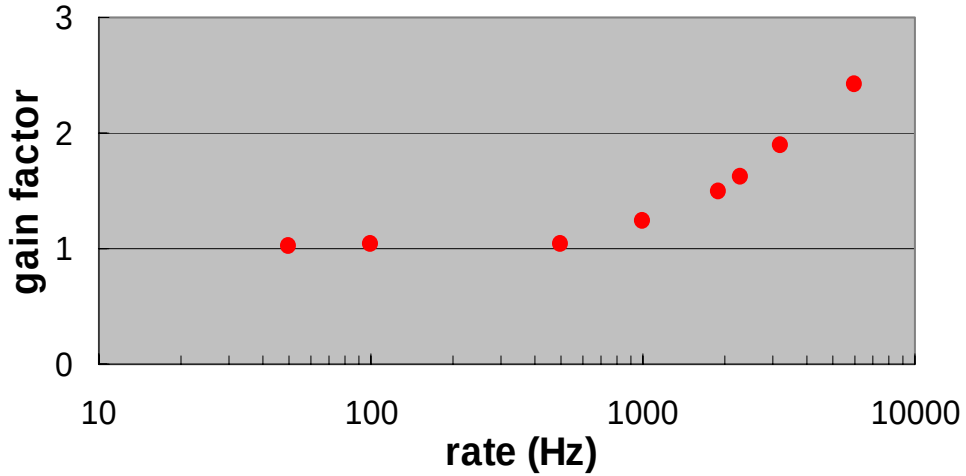
Standard FRS DAQ



Multi-event FRS DAQ

FRS multi-event DAQ tested with real particle rate and compared to single-event one:

- runs in stable condition
- more effective starting from 400 Hz
- gain factor = 2 at 4 kHz
- dead time at 10 kHz : 48%



C. Nociforo, N. Kurz, GSI report (2009)