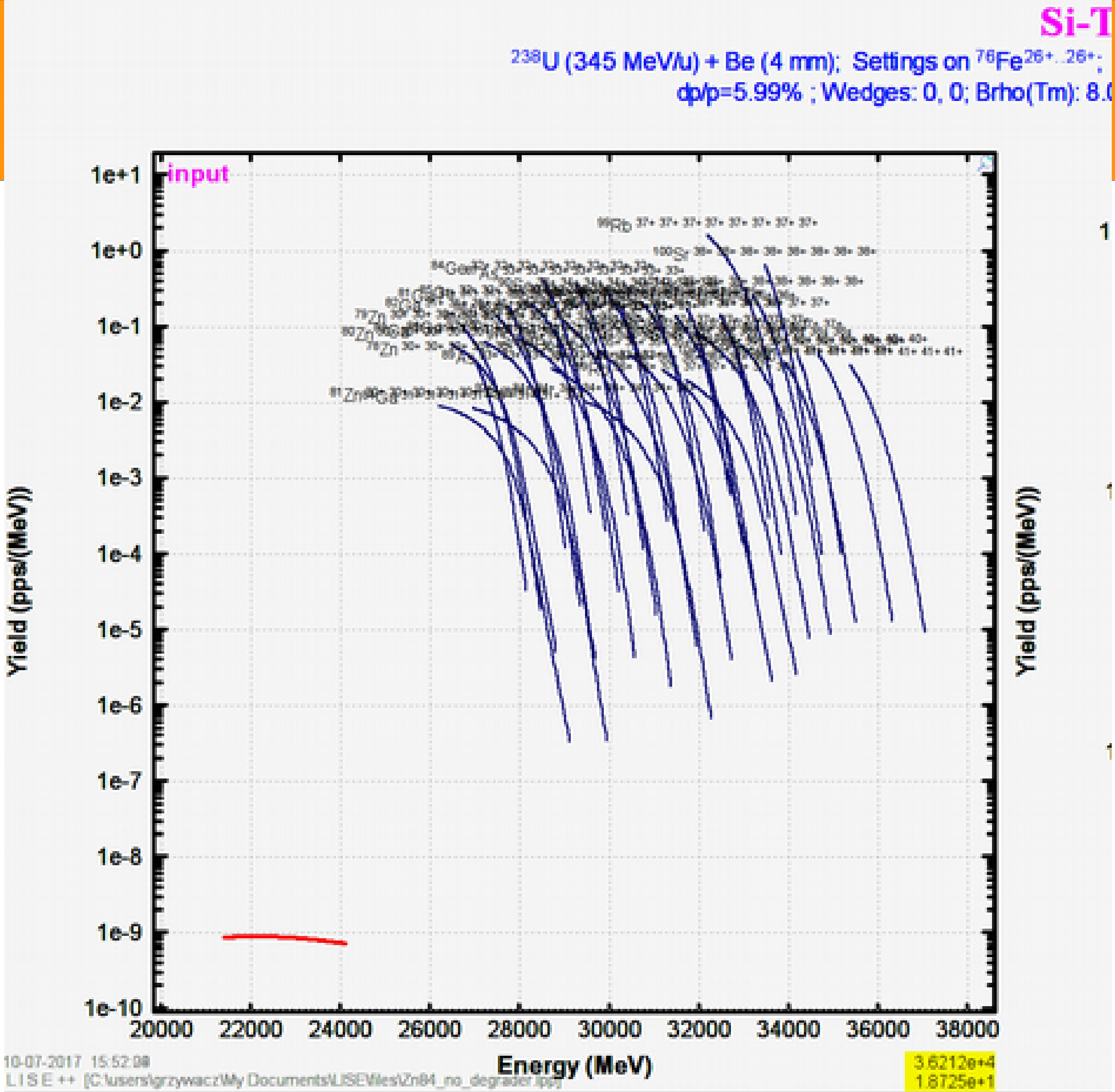
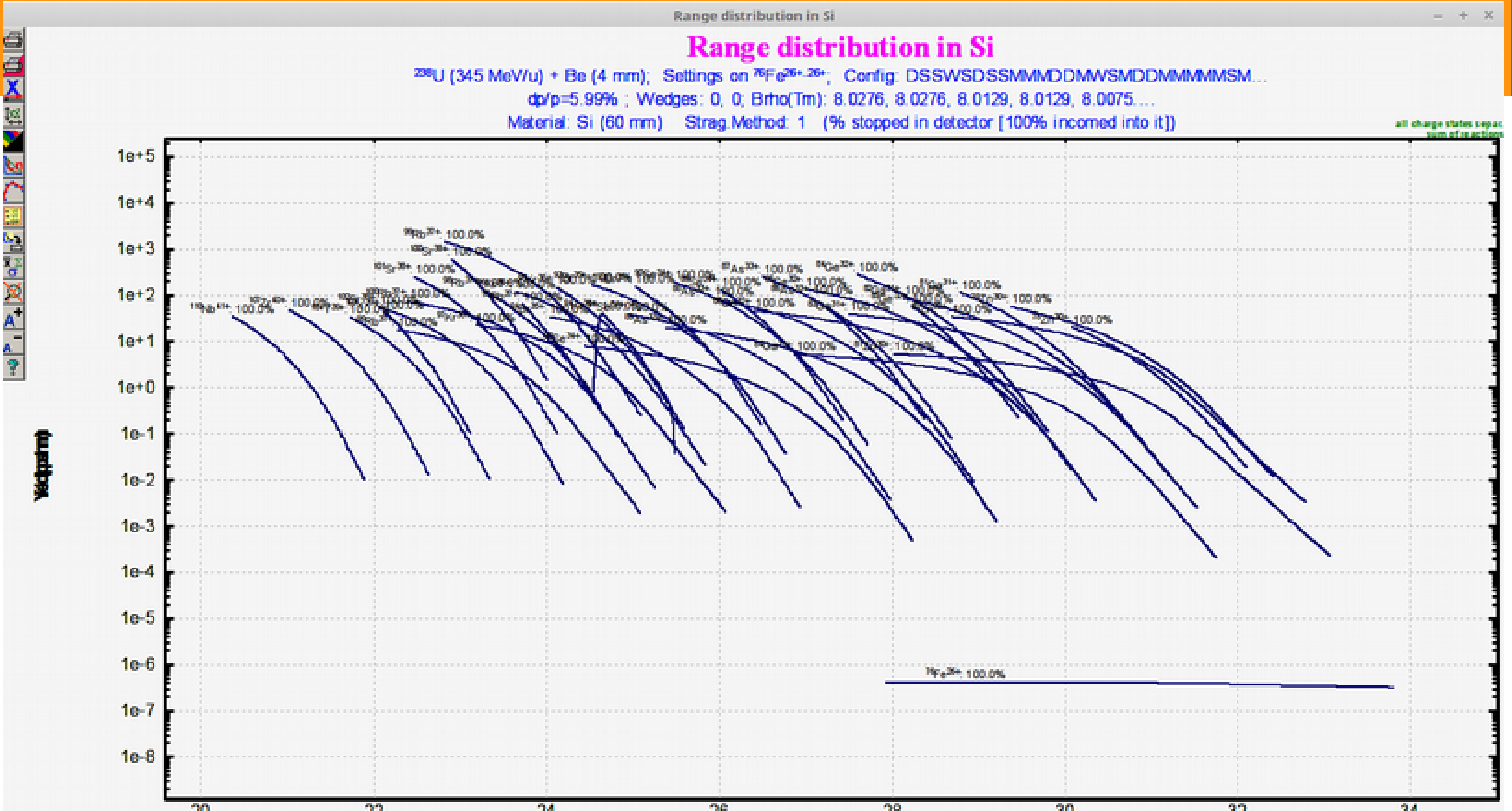
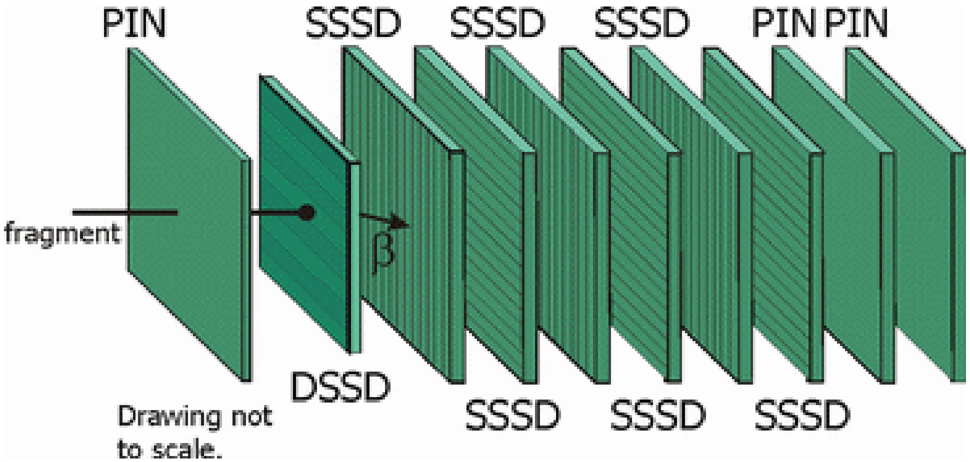
Energy distribution of fragments

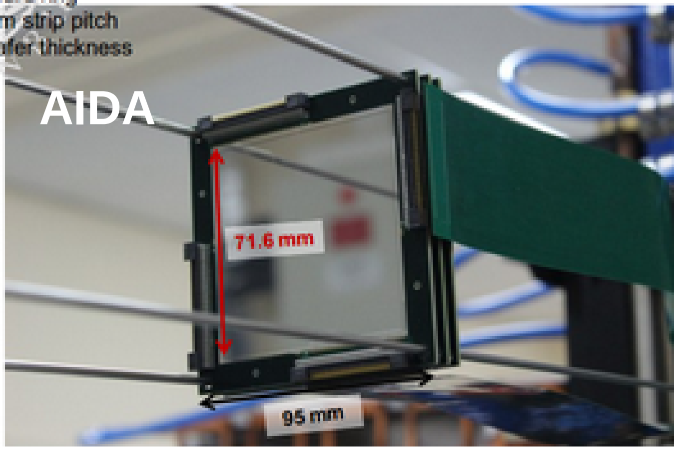



Range distribution in Si
Range distribution in Si
²³⁸U (345 MeV/u) + Be (4 mm); Settings on ⁷⁶Fe²⁶⁺,²⁶⁺; Config: DSSWSDSSMMMDDMWSMDDMMMMMSM...
dp/p=5.99% ; Wedges: 0, 0; Brho(Tm): 8.0276, 8.0276, 8.0129, 8.0129, 8.0075....
Material: Si (60 mm) Strag.Method: 1 (% stopped in detector [100% incomed into it])
1e+5
1e+4
1e+3
1e+2
1e+1
1e+0
1e-1
1e-2
1e-3
1e-4
1e-5
1e-6
1e-7
1e-8
Yield (pps/mm)
⁷⁶Fe²⁶⁺: 100.0%

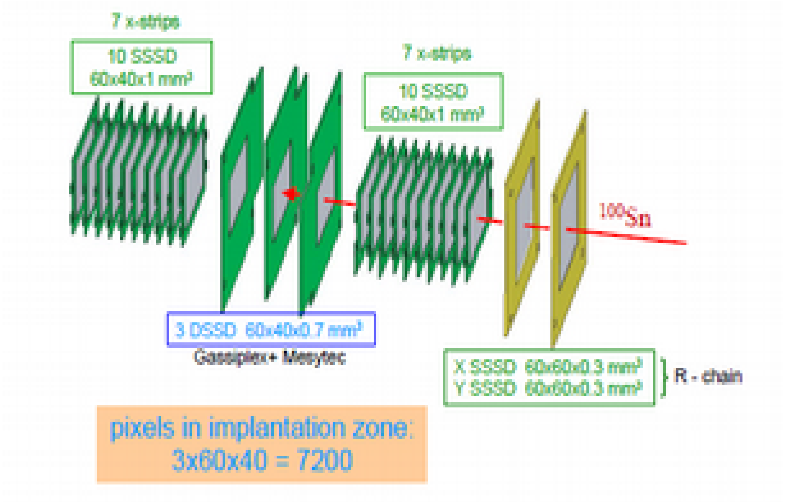
Double-sided Silicon Strip Detector arrays



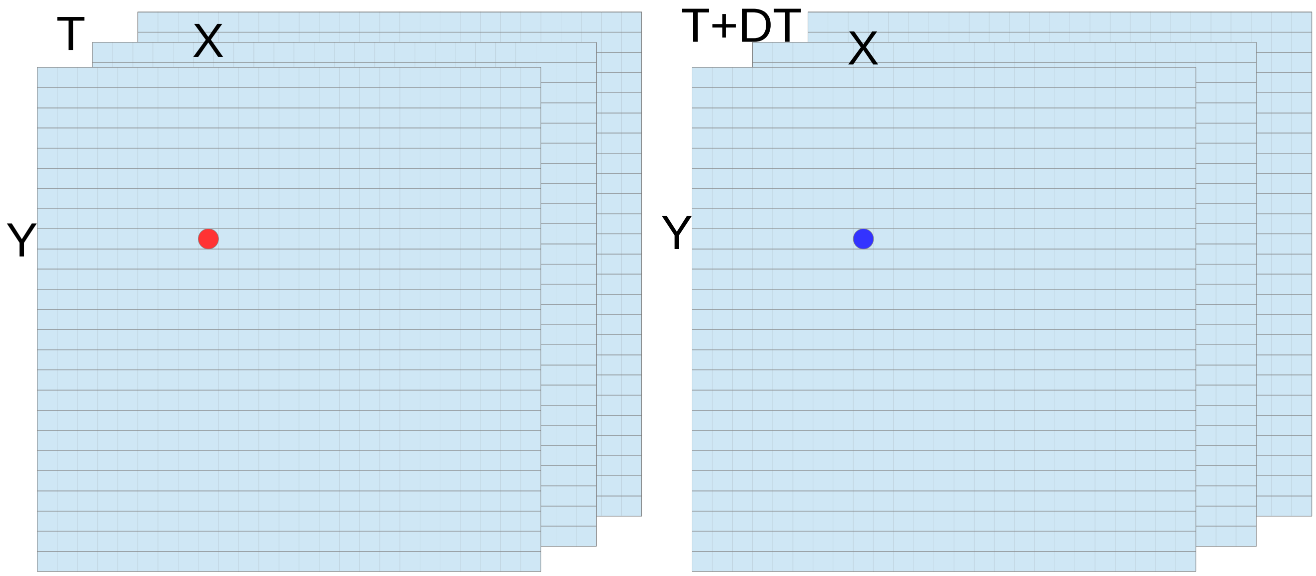
128 x 128 strips (16384 pixels)
multi-guard ring
0.560mm strip pitch
1mm wafer thickness

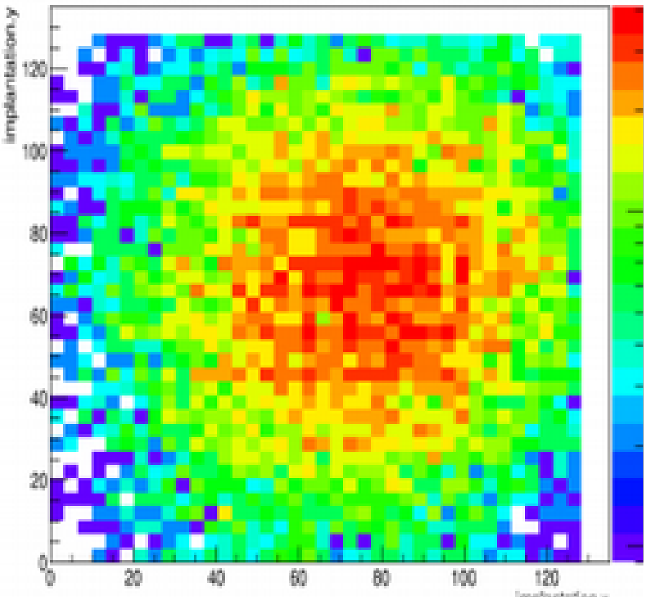


Silicon Implantation Detector
and Beta Absorber
SIMBA



Double-sided Silicon Strip Detector arrays





Implantation
(~GeV)

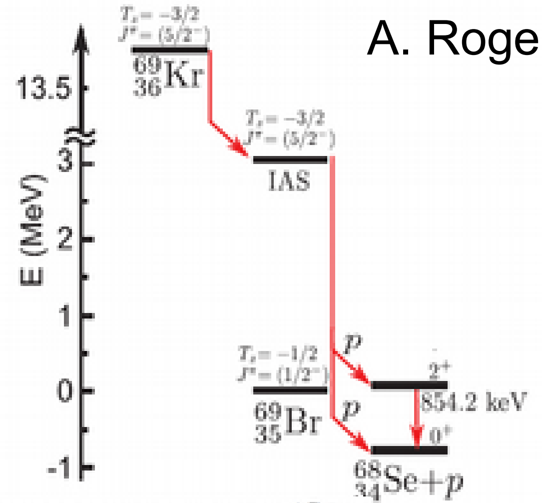
n-detectors

Decay
(keV-MeV)

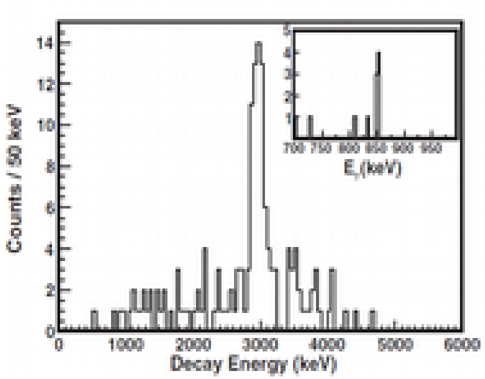
n-detectors

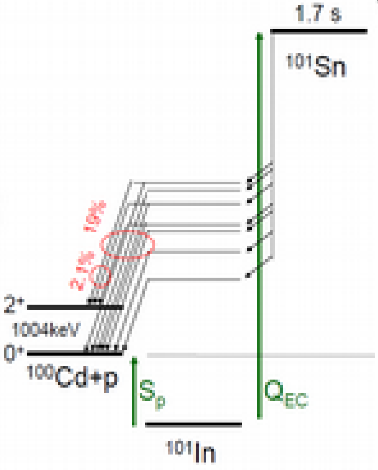
Spread the radioactivity over $n*N_x*N_Y$ pixels

Beta delayed protons

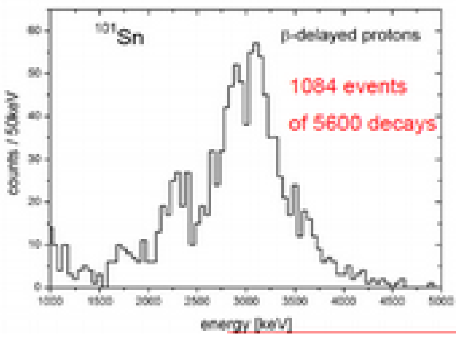


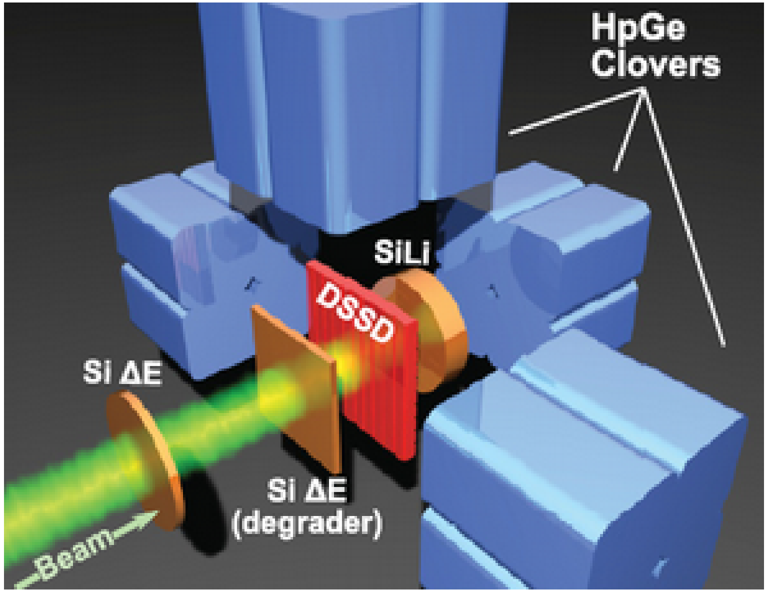
A. Rogers



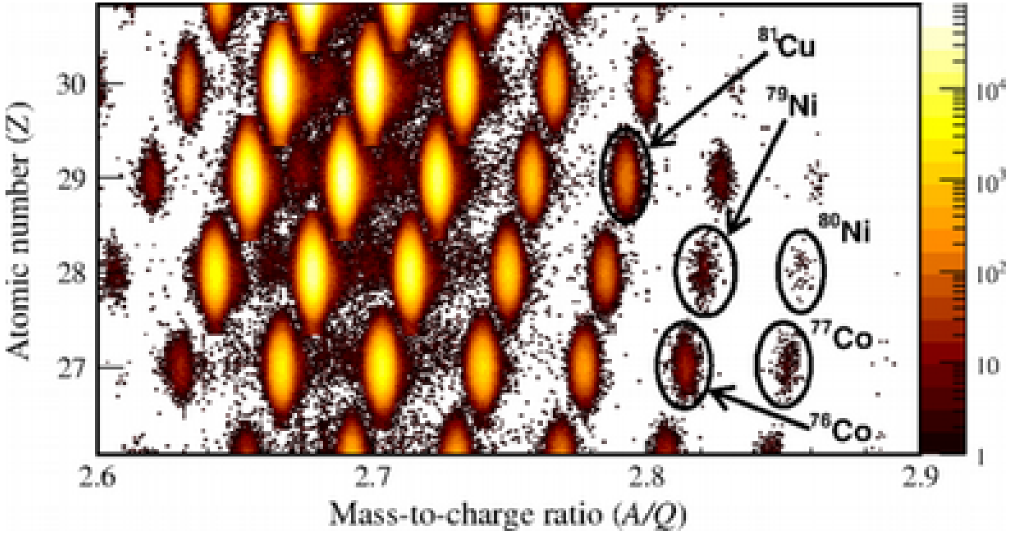


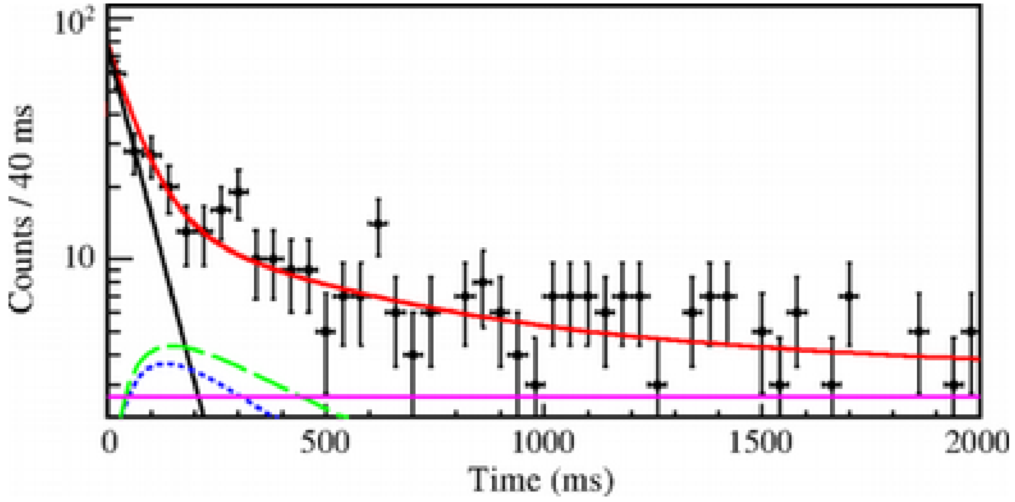
T. Feasterman

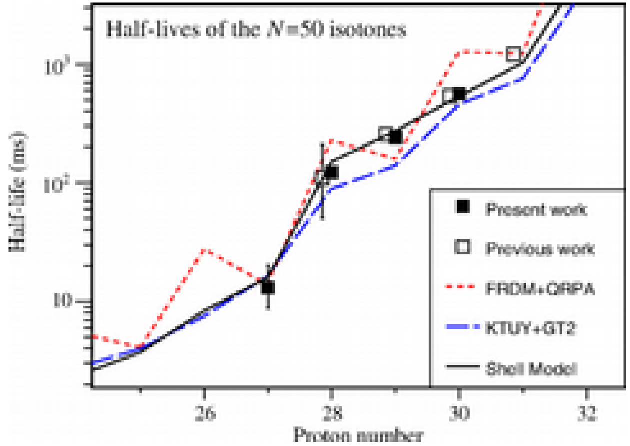




Beta decay lifetimes



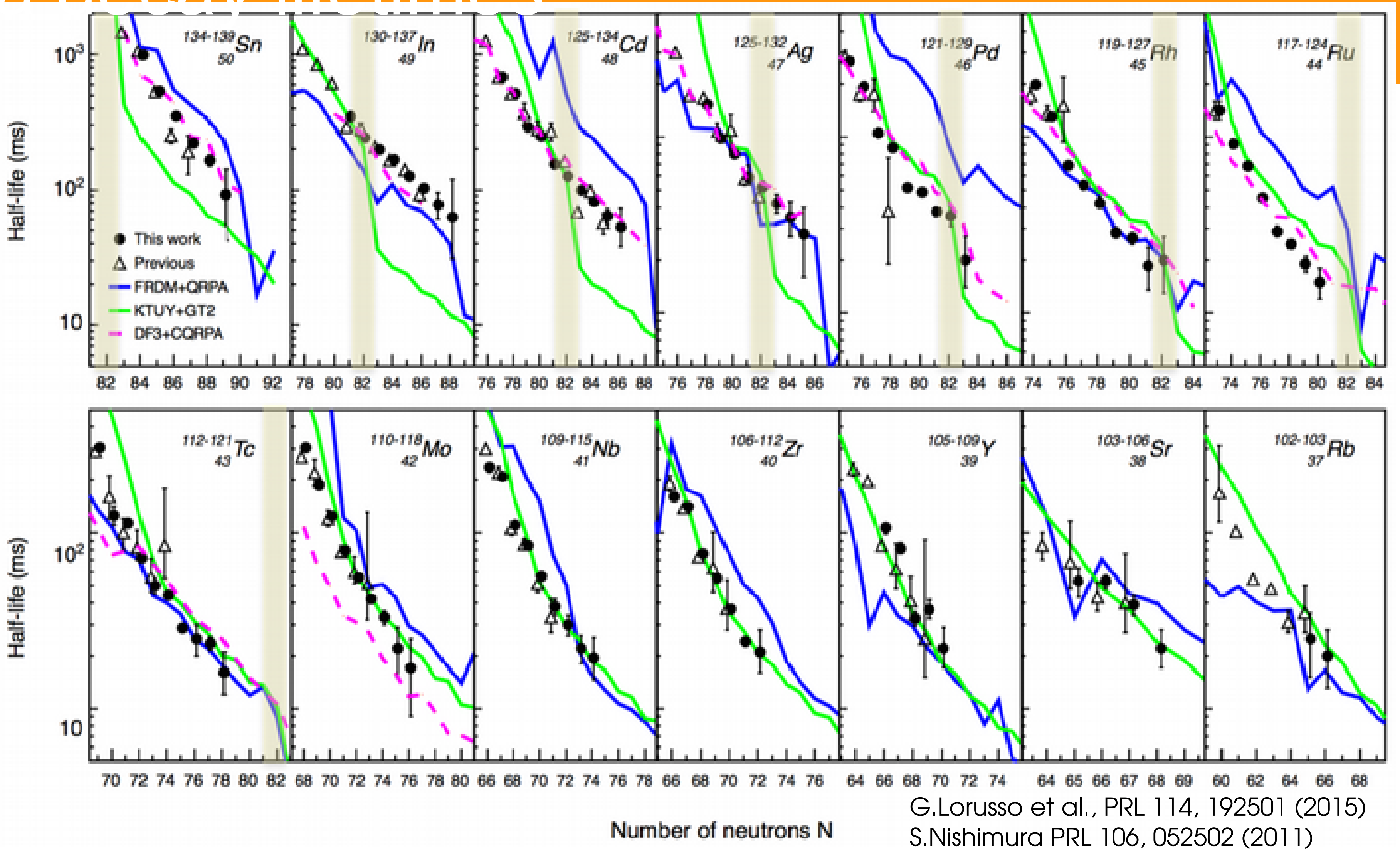




β-Decay Half-Lives of ^{76,77}Co, ^{79,80}Ni, and ^{81}Cu: Experimental Indication of a Doubly Magic ^{78}Ni

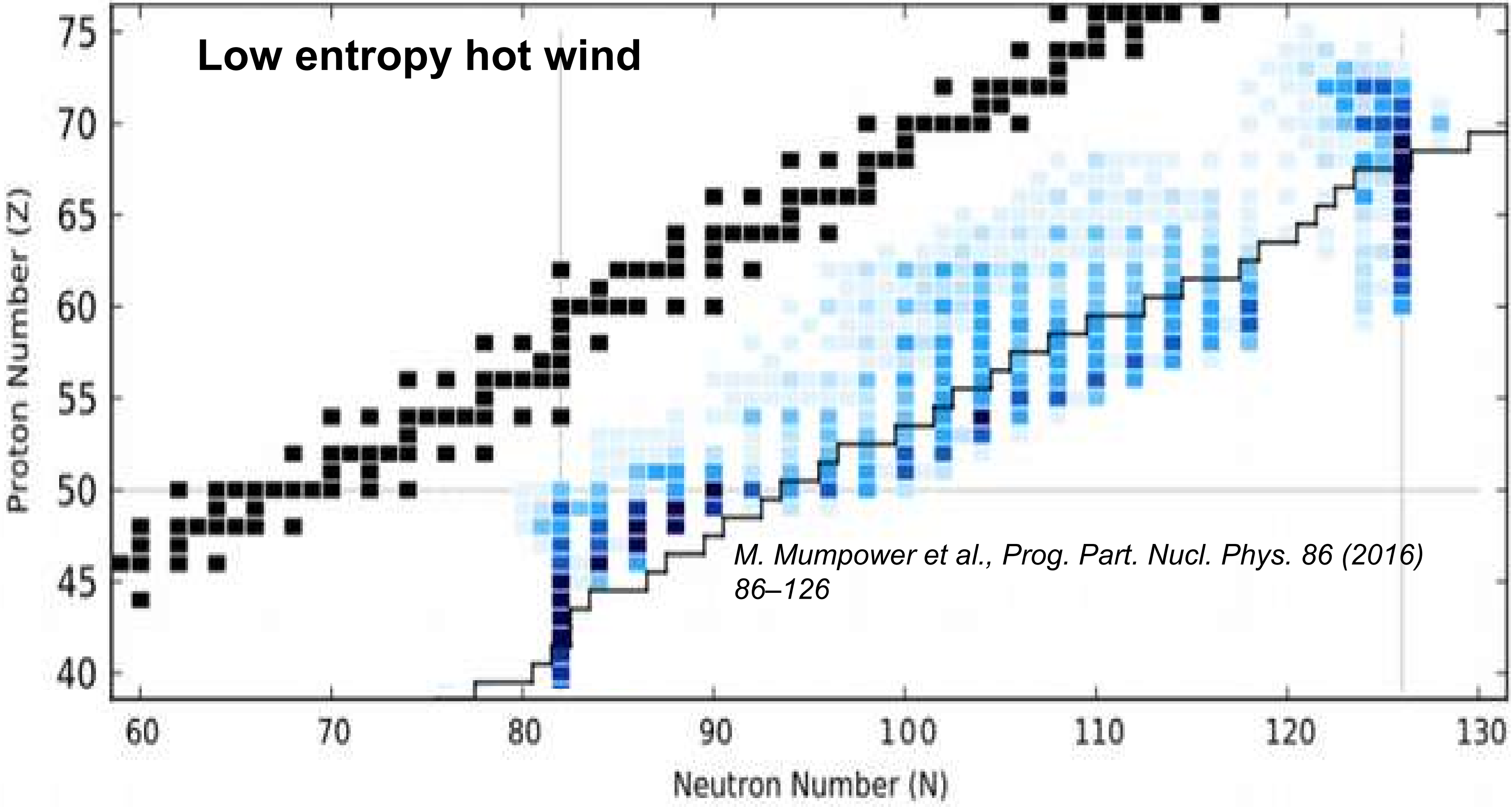
Z. Y. Xu *et al.*
Phys. Rev. Lett. **113**, 032505 – Published 16 July 2014

Beta decay lifetimes



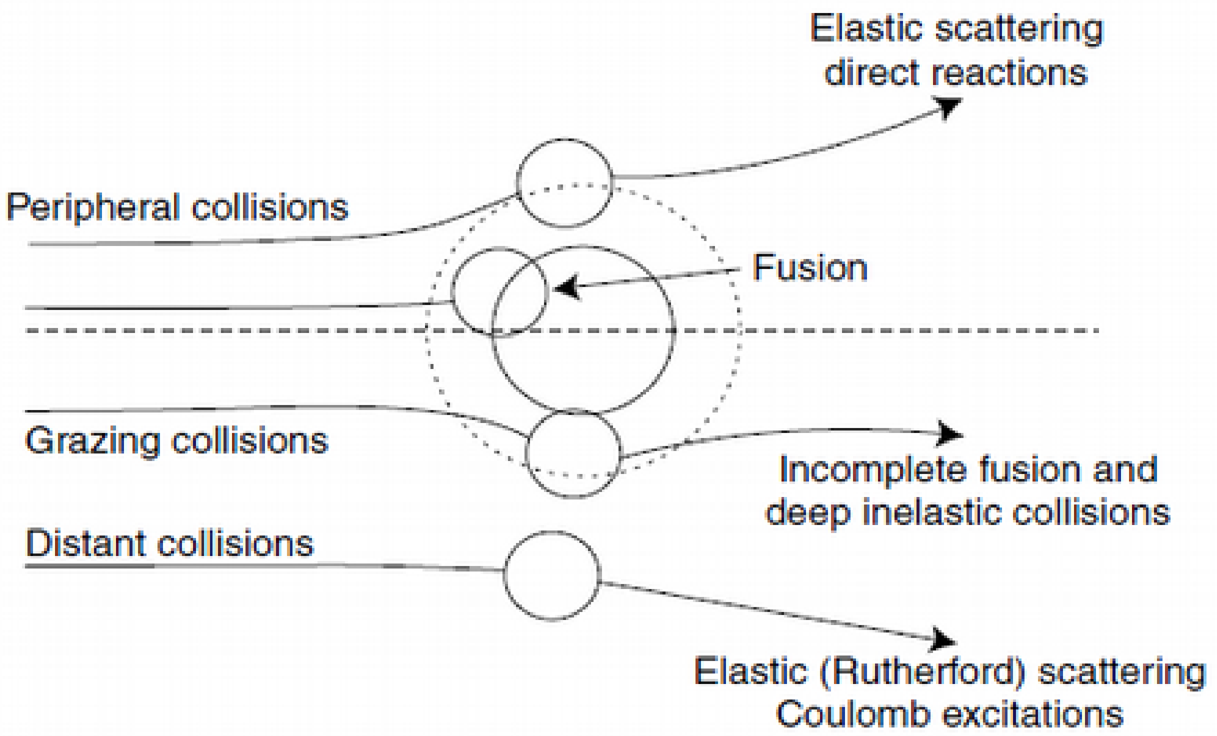
G.Lorusso et al., PRL 114, 192501 (2015)
S.Nishimura PRL 106, 052502 (2011)

Beta decay lifetimes and r-process

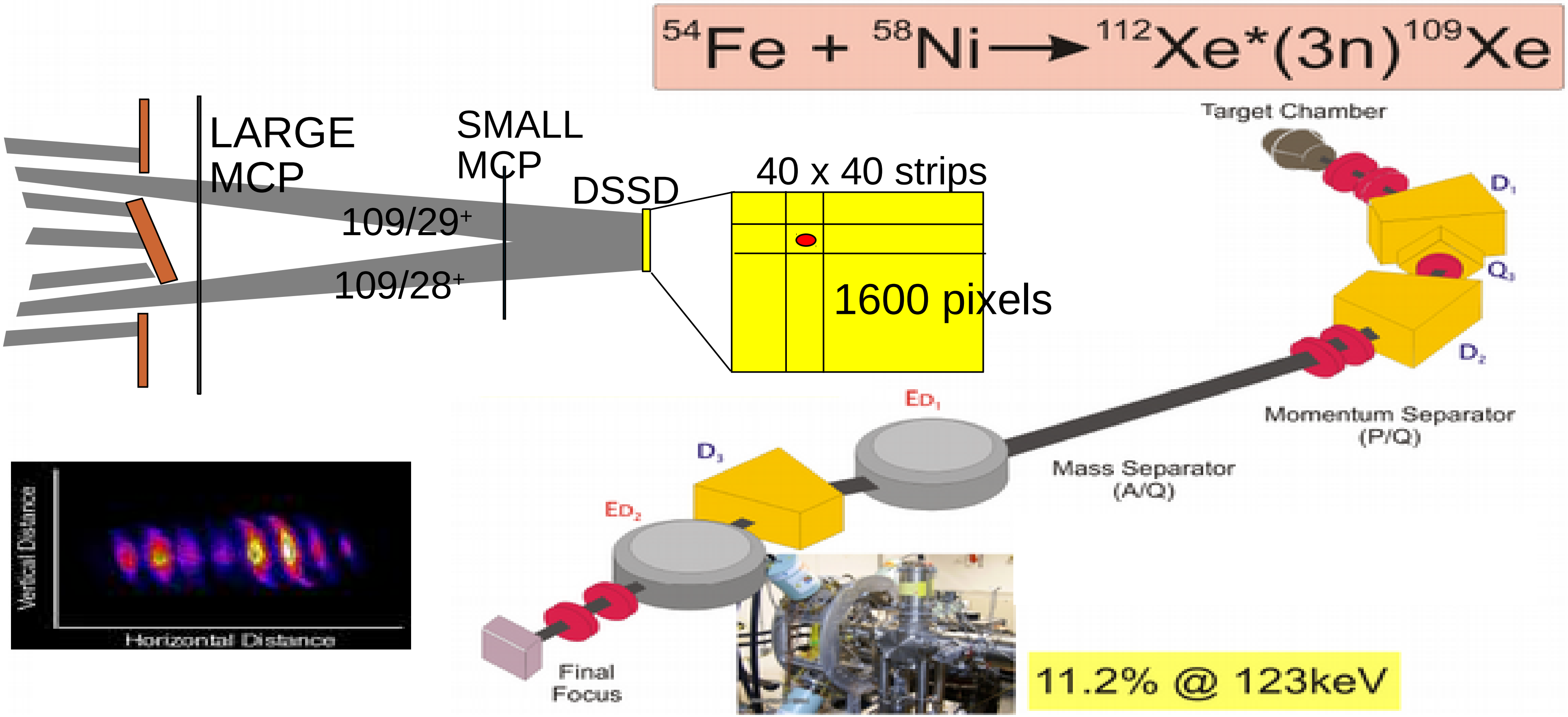


M. Mumpower et al., Prog. Part. Nucl. Phys. 86 (2016) 86–126

Heavy ion reactions



Recoil Mass Spectrometer
Spectroscopy required for ion identification



Principle of separation in a Recoil Mass Spectrometer

$$\frac{A}{Q} = \frac{B\rho}{v\gamma}$$

Typically

$$v \sim 0.02c \Rightarrow \gamma \approx 1$$

$$\frac{A}{Q} = \frac{B\rho}{v}$$

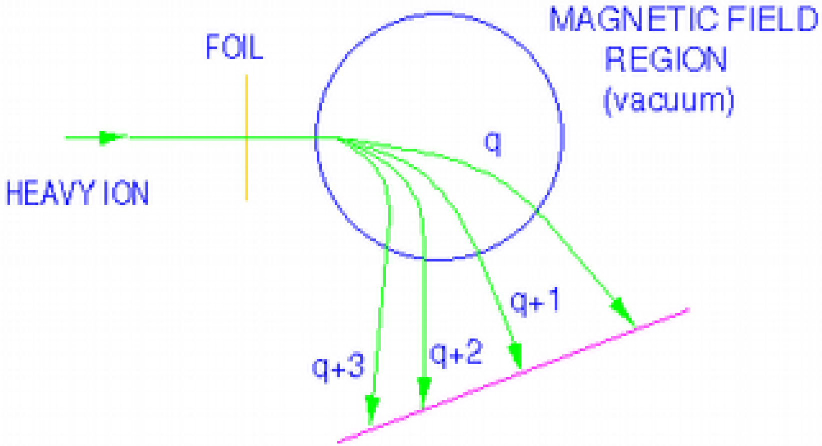
Cannot measure TOF, but can restrict v $\left(E = const\right)$

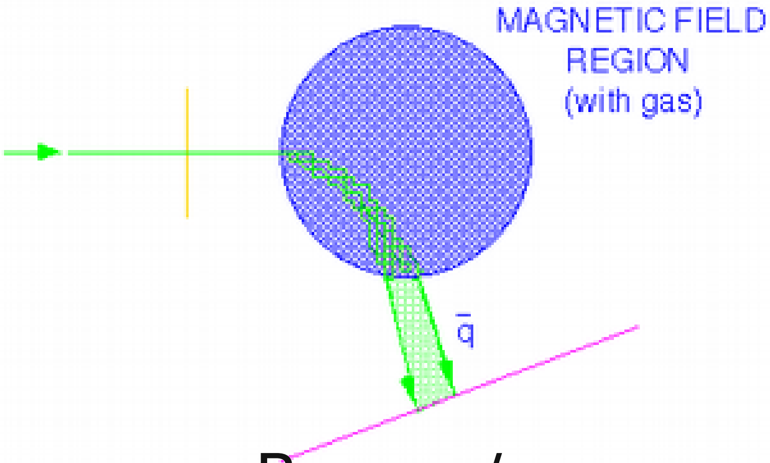
$$\frac{A}{Q} \sim B\rho$$

Because of the low energy - many charge states

Very thin targets: d= 0.5 – 1mg/cm^2

Gas-filled separators





$$B\rho = p/q_{ave}$$

$$q_{ave} \sim (v/v_0)\, Z^{1/3}$$

$$B\rho \sim 0.0227\ A/Z^{1/3}\ [\mathrm{Tm}]$$

http://www.phy.ornl.gov/nuclear/ribphysics/reactions/gasfill.html

Dubna Gas-Filled Recoil Separator

Fusion reaction
$^{48}Ca + ^{249}Bk \rightarrow ^{297}117 \rightarrow ^{293}117$

Superheavy elements

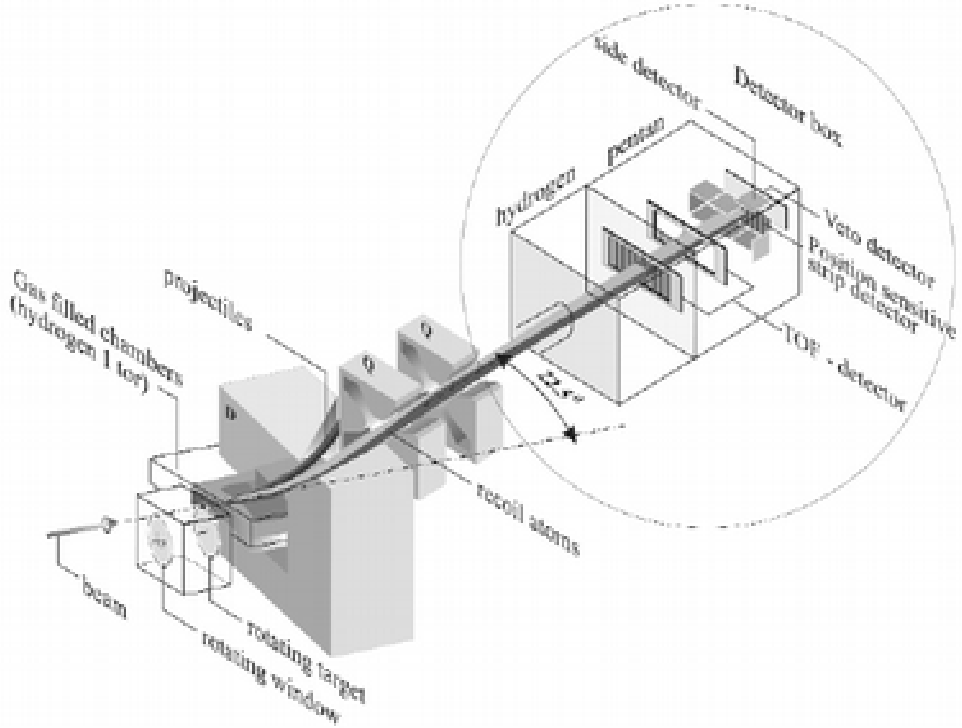
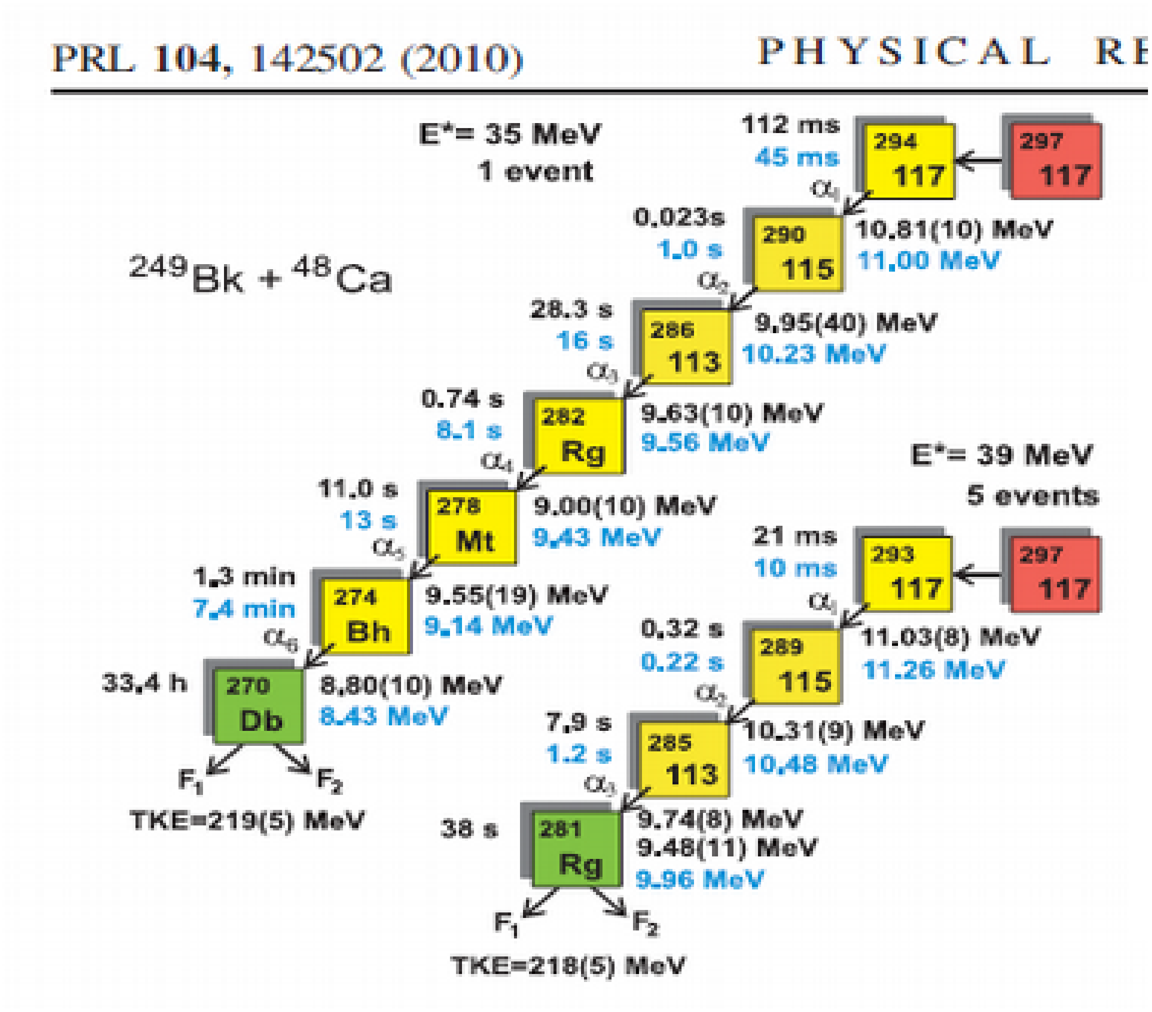
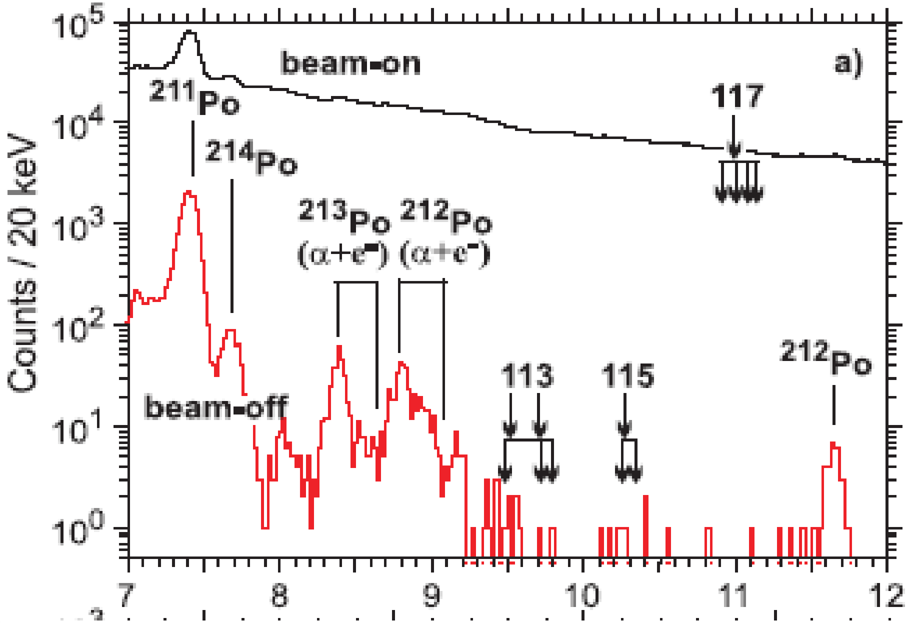


Fig. 2 A schematic view of the Dubna Gas-Filled Recoil Separator.

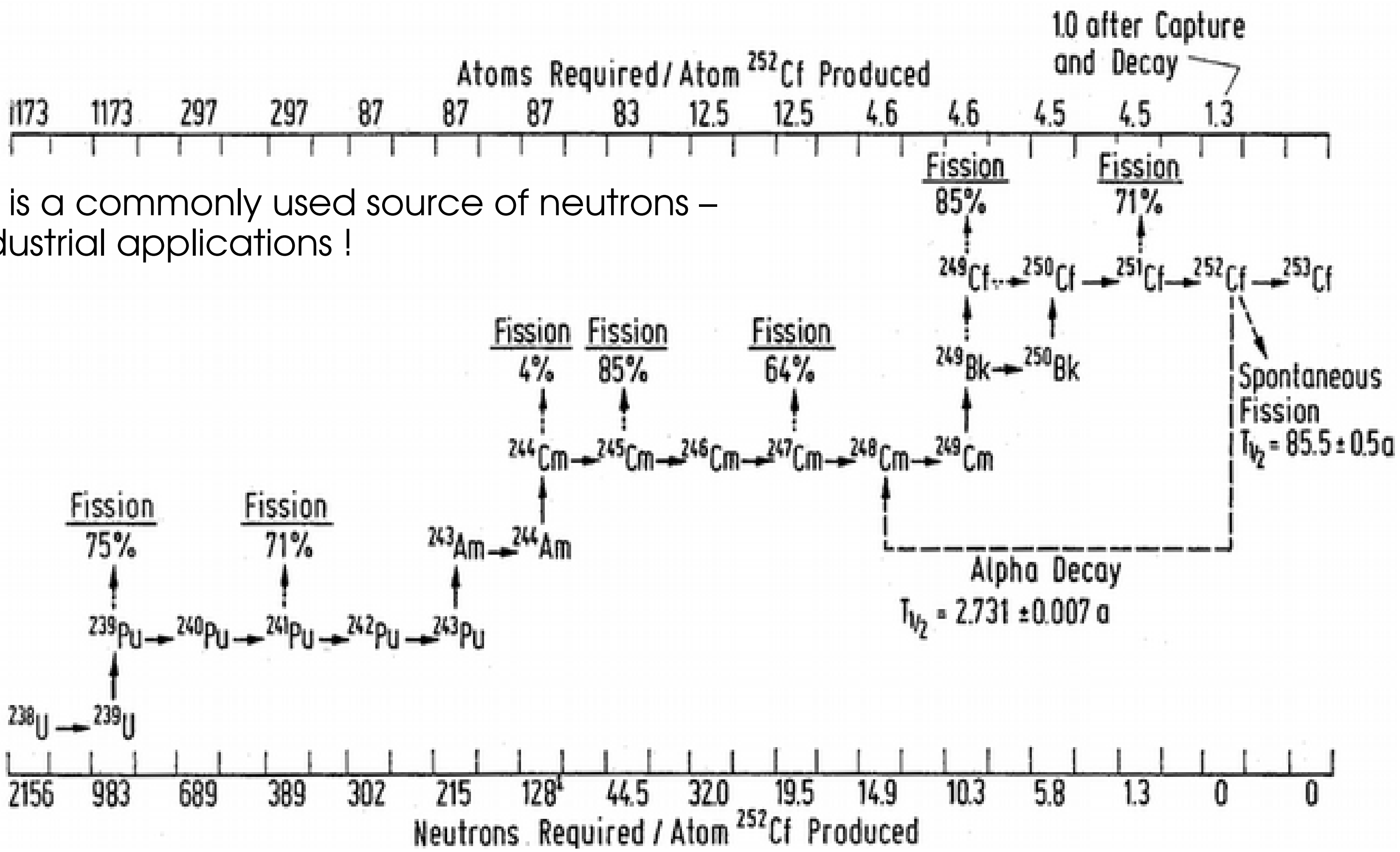
Decay of superheavy elements





Production of ^{252}Cf at HFIR

252Cf is a commonly used source of neutrons –
for industrial applications !



Laws of radioactive decays

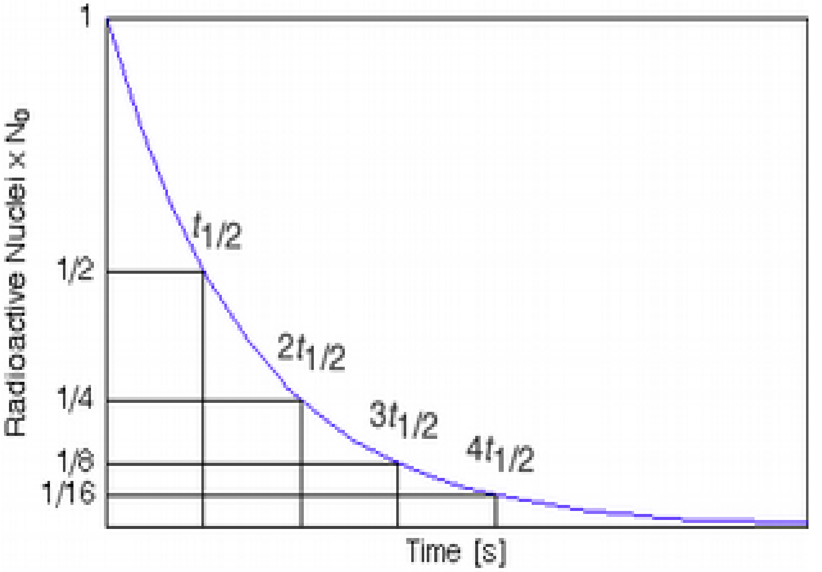
$$Law\ of\ radioactive\ decay$$

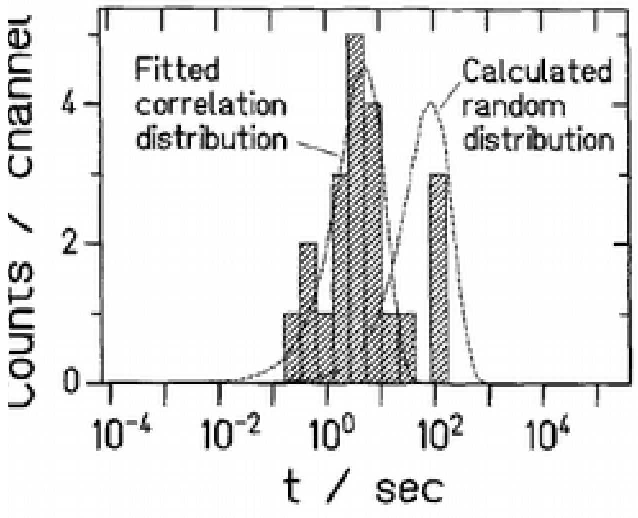
$$\frac{dn}{dt} = N\lambda e^{-\lambda t}$$

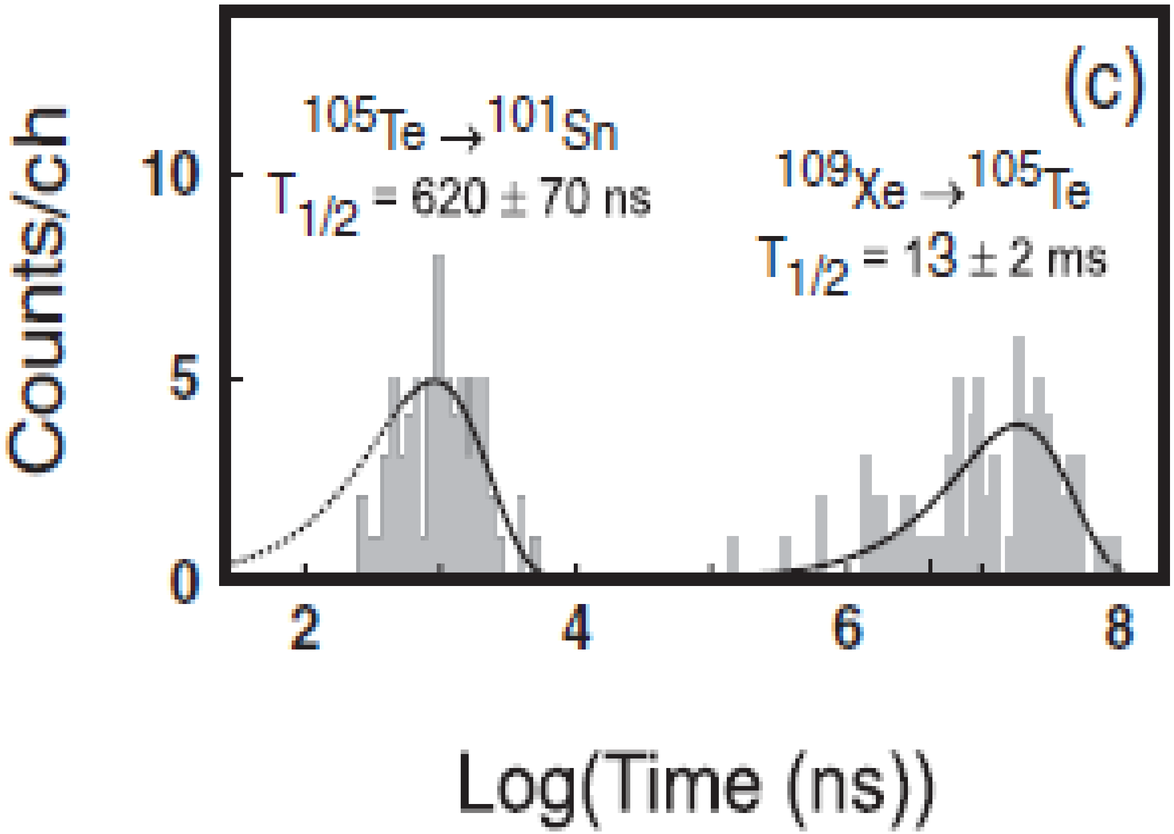
$$if\ we\ substitute\ \theta = \ln t \qquad d\theta = \frac{1}{t}dt \qquad d\theta\, e^{\theta} = dt$$

$$\frac{dn}{d\theta} = N\lambda e^{\theta} e^{-\lambda e^{\theta}}$$

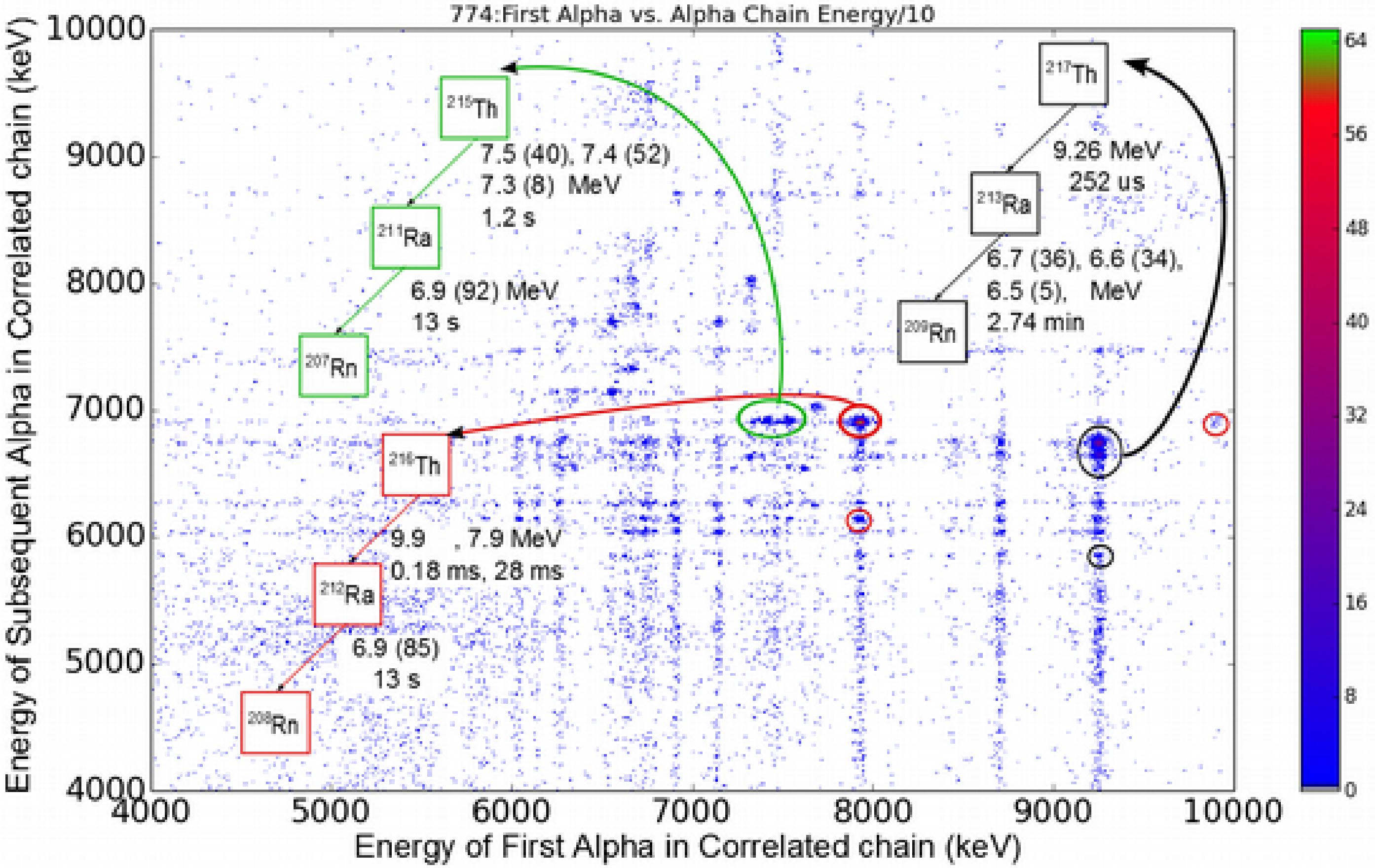
Very usefull method for small statistics measurements





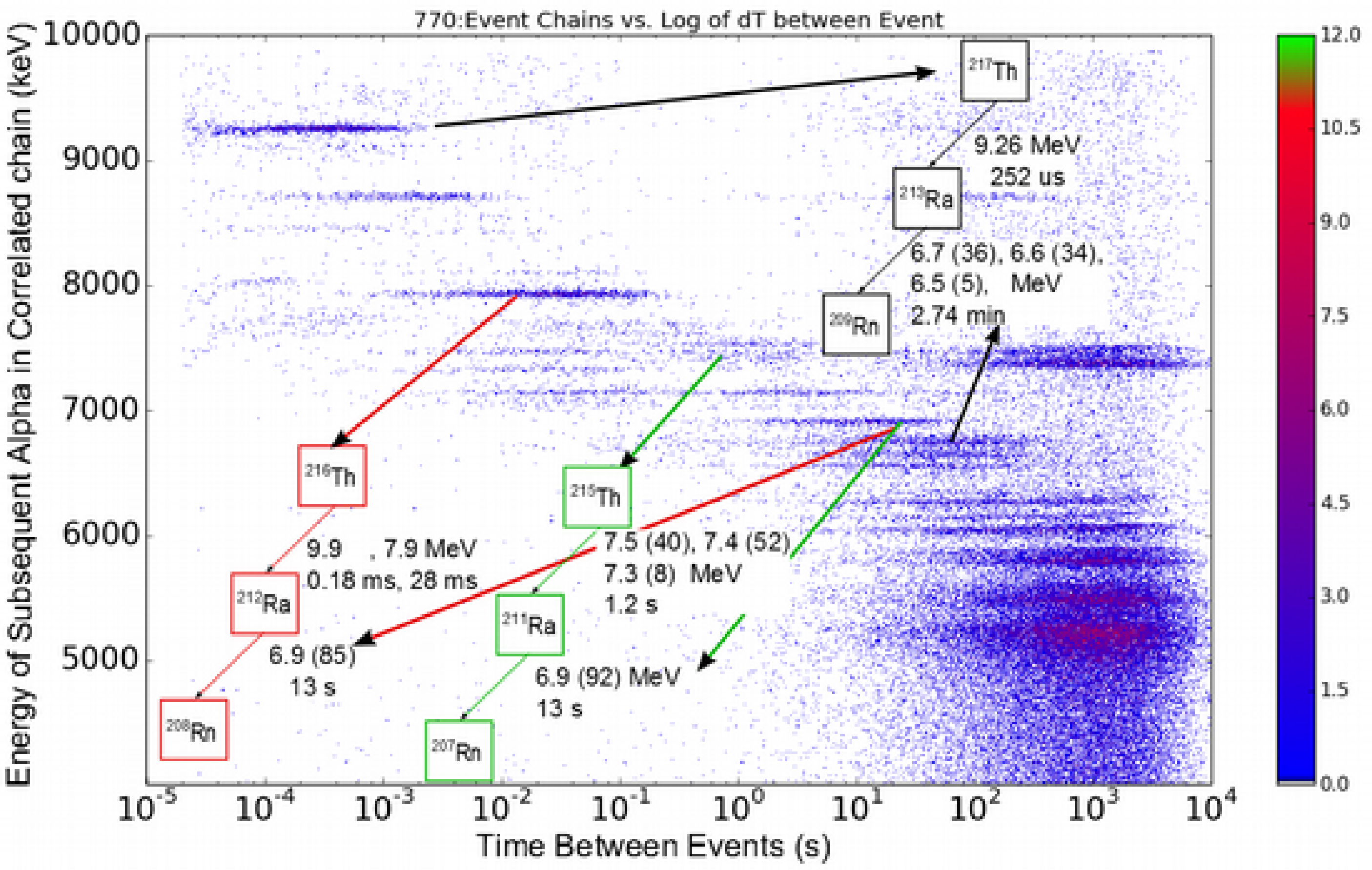

(c)
105Te → 101Sn
T1/2 = 620 ± 70 ns
109Xe → 105Te
T1/2 = 13 ± 2 ms
Counts/ch
10
5
0
2
4
6
8
Log(Time (ns))

Test Reaction of $^{48}Ca+^{nat}Yb \rightarrow ^{214-219}Th$ Standard Mode (Energy Correlations)



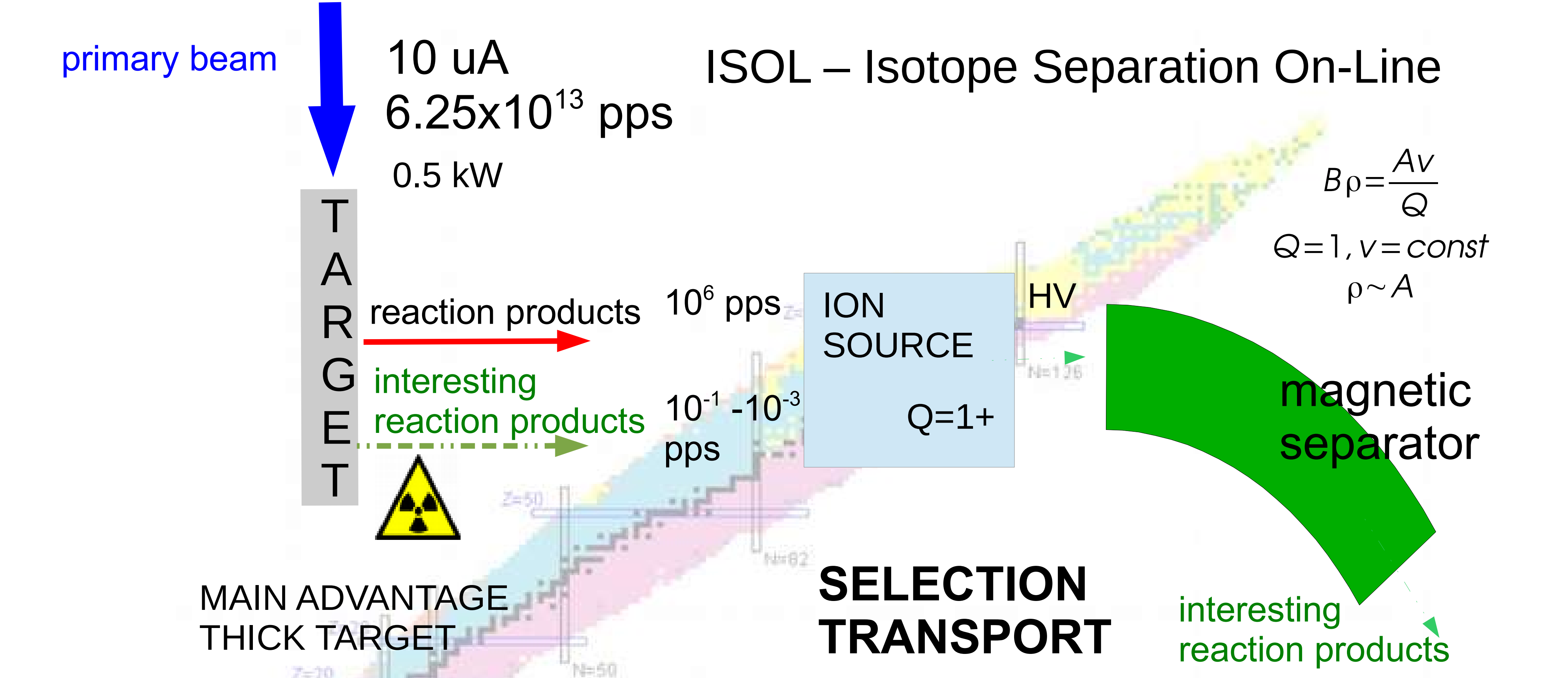
N. Brewer (ORNL)

Test Reaction of ^{48}Ca+^{nat}Yb ->$^{214-219}Th$ Standard Mode (Time Correlations)



N. Brewer (ORNL)

ROLE OF ELECTROMAGNETIC SEPARATORS: CLASSIC “ISOL”



The spallation reaction proton + heavy target

Used to produce exotic isotopes (ISOLDE, CERN)
or large fluxes of neutrons (SNS, ORNL)

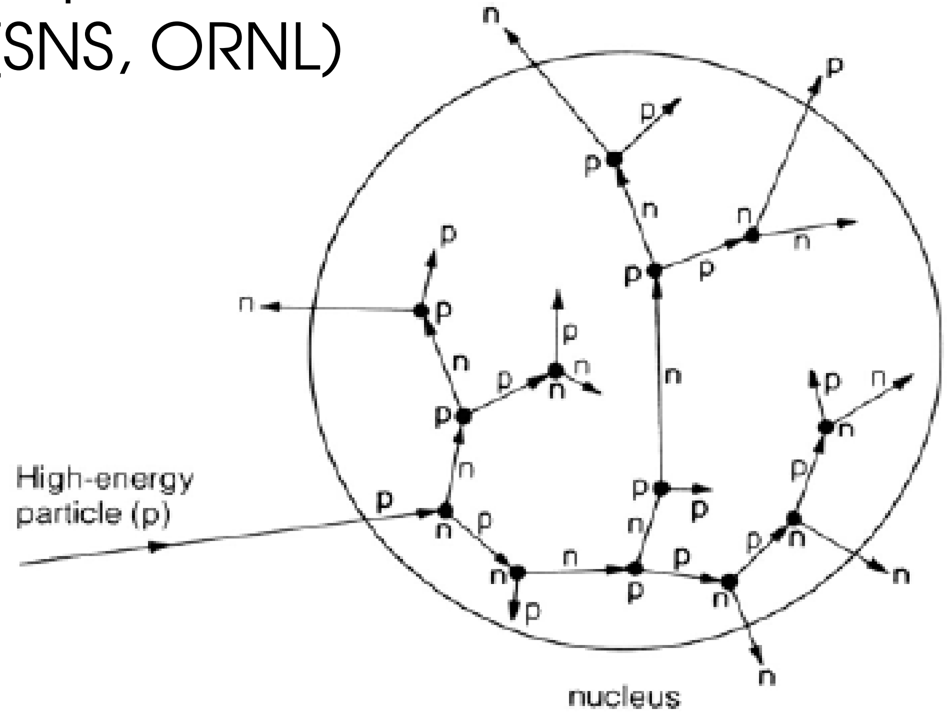
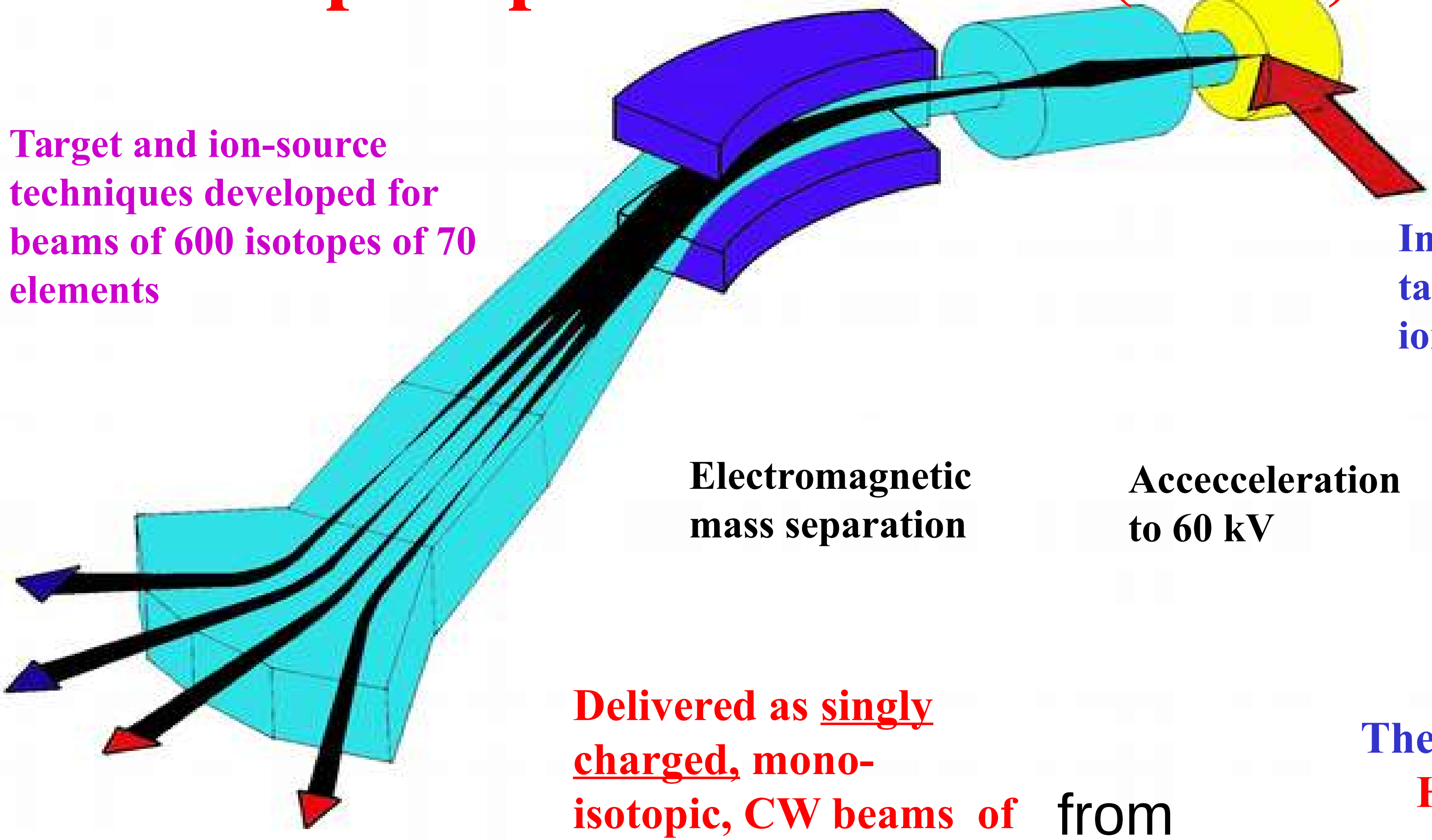


Figure 10.31 Schematic view of nuclear cascade. [From Lieser (1997).]

The Isotope Separator On-Line (ISOL)



Target and ion-source techniques developed for beams of 600 isotopes of 70 elements

Integrated target and ion source

Electromagnetic mass separation

Acceceleration to 60 kV

Driver beams:

Spallation neutrons

Thermal neutrons

High energy protons

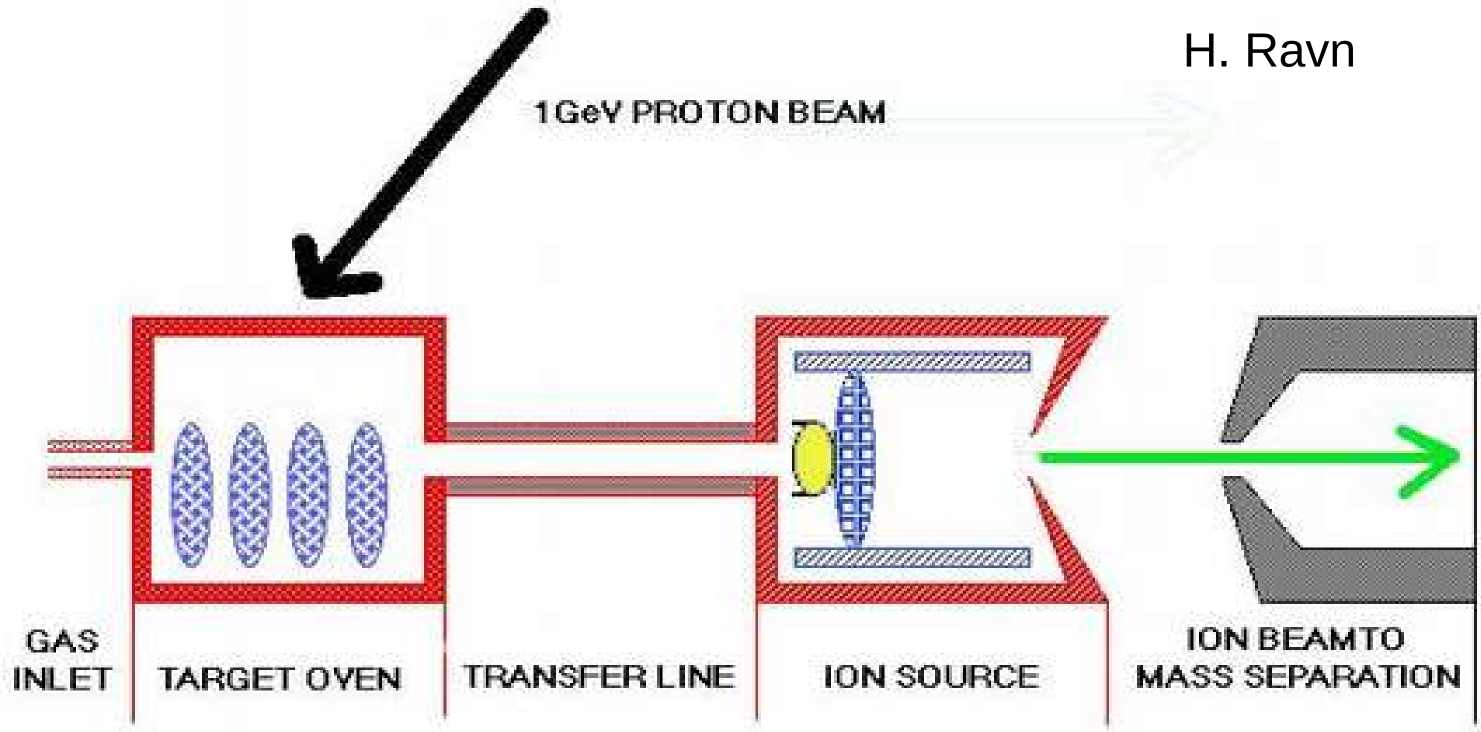
Heavy ions

Delivered as <u>singly charged,</u> mono-isotopic, CW beams of 60 kV energy

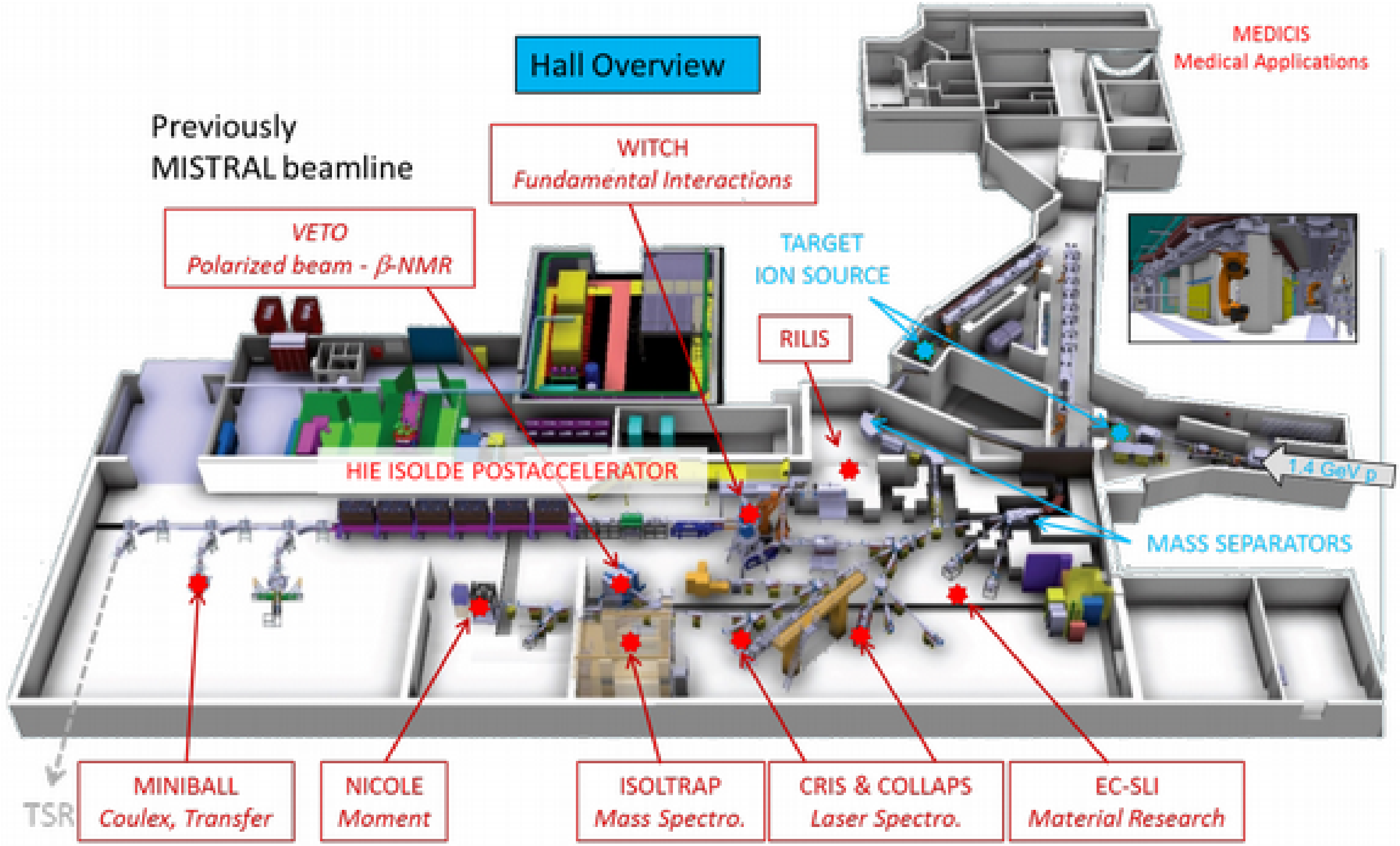
from H. Ravn

The principle of the integrated target and ion source

H. Ravn

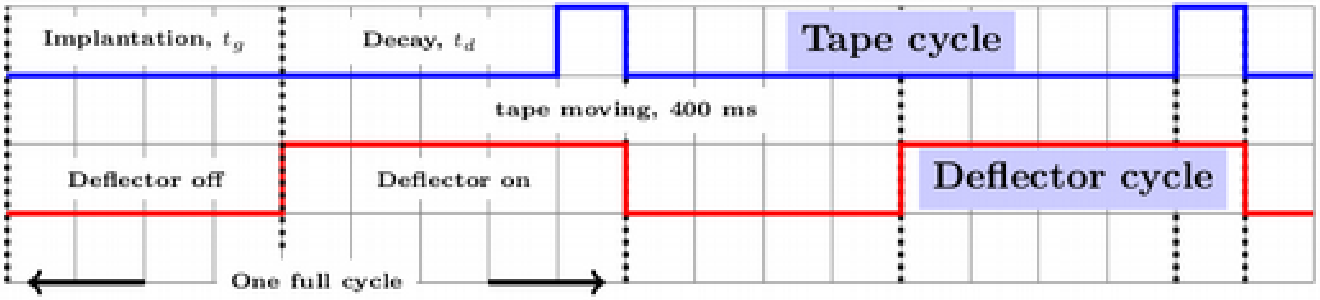


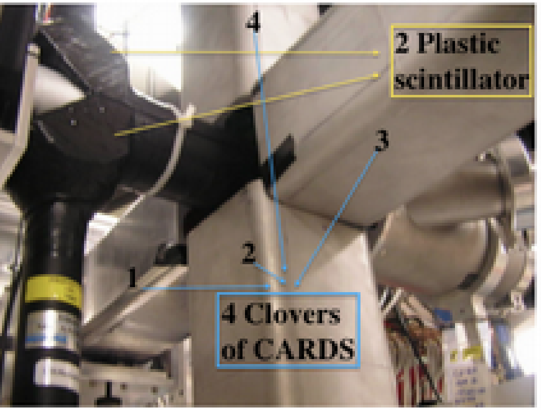
ISOLDE @ CERN

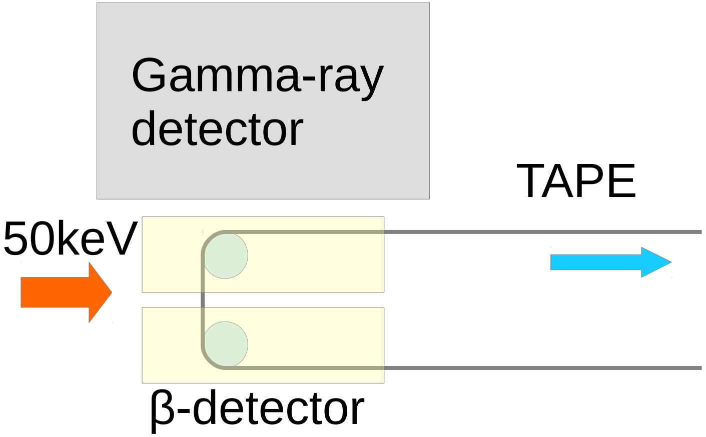


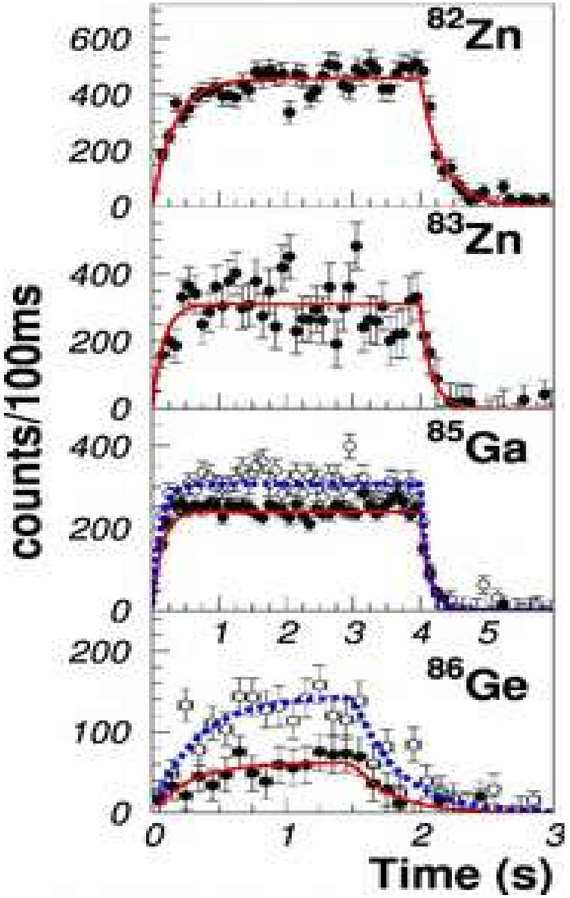
Hall Overview
MEDICIS
Medical Applications
Previously
MISTRAL beamline
WITCH
Fundamental Interactions
VETO
Polarized beam - β-NMR
TARGET
ION SOURCE
RILIS
HIE ISOLDE POSTACCELERATOR
1.4 GeV p
MASS SEPARATORS
TSR
MINIBALL
Coulex, Transfer
NICOLE
Moment
ISOLTRAP
Mass Spectro.
CRIS & COLLAPS
Laser Spectro.
EC-SLI
Material Research

Lifetime measurements at ISOL









M. Madurga et al. Phys. Rev. Lett.