ANAMARI Code for Gas-Filled Separators as Tool for Super Separator Spectrometer Design Study

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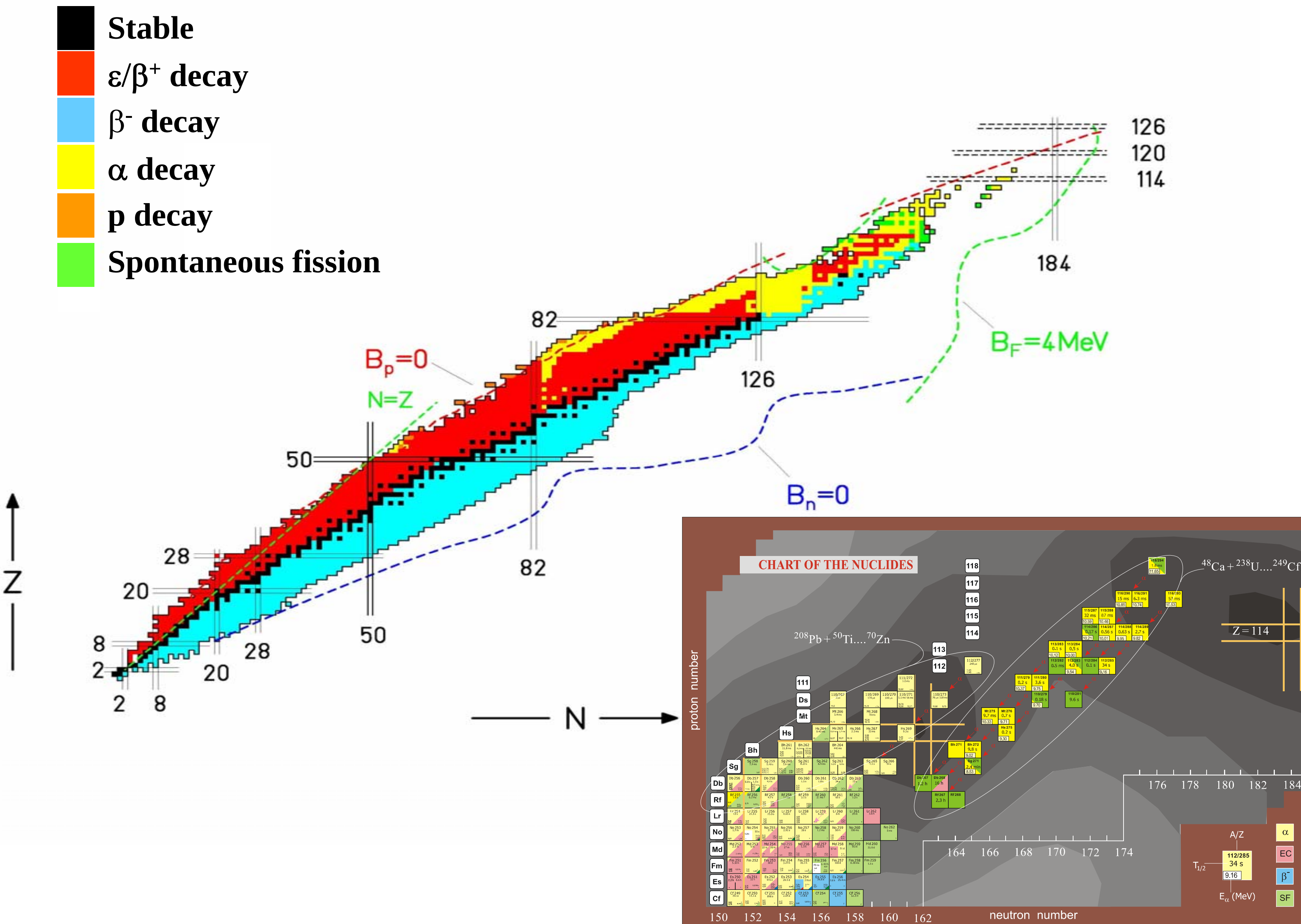
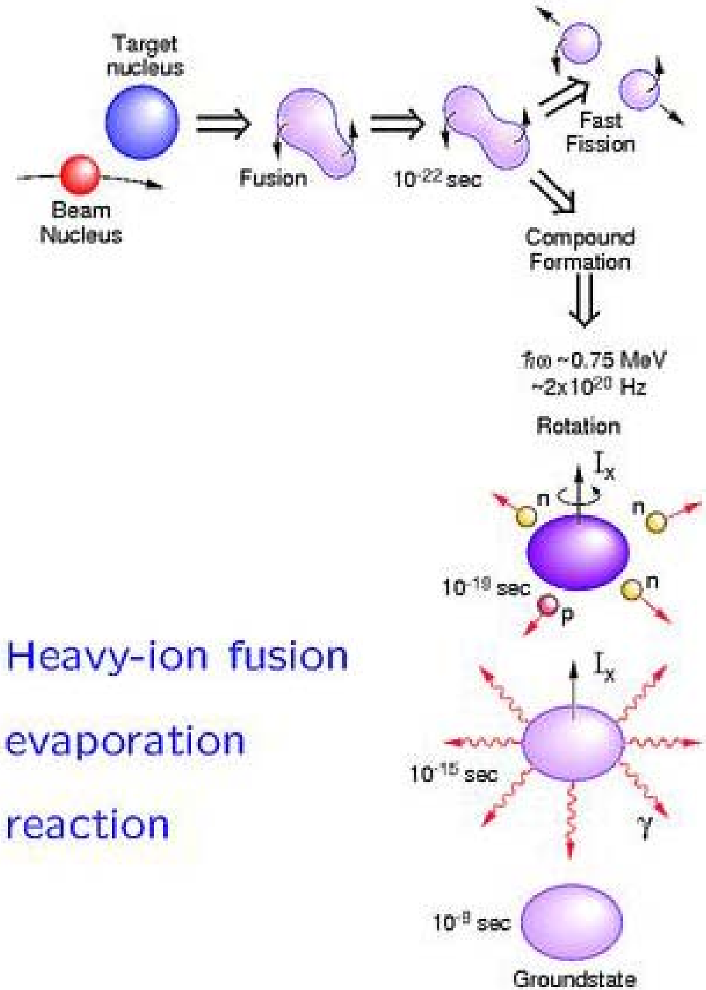

Stable
ε/β+ decay
β- decay
α decay
p decay
Spontaneous fission
126
120
114
184
82
Bp=0
N=Z
126
BF=4MeV
50
Bn=0
28
20
82
8
2
28
50
20
2
8
Z
N
CHART OF THE NUCLIDES
48Ca + 238U....249Cf
208Pb + 50Ti....70Zn
Z = 114
proton number
neutron number
150
152
154
156
158
160
162
164
166
168
170
172
174
176
178
180
182
184
A/Z
α
EC
β-
SF

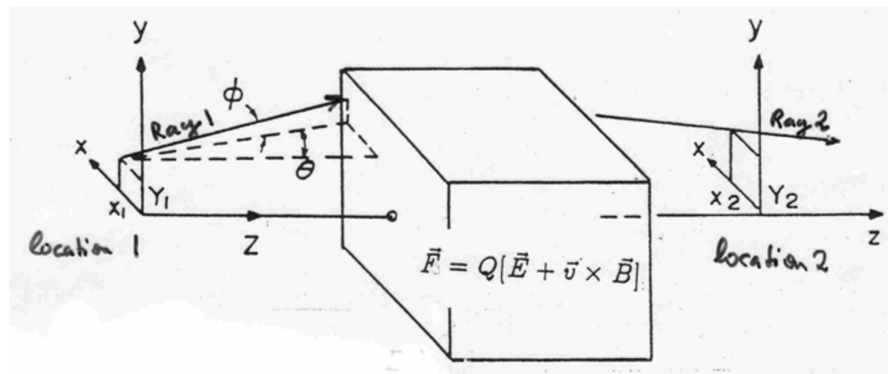
Compound nucleus (CN) and evaporation residue (EVR)



Magnetic separation

$$\frac{\mathrm{d}}{\mathrm{d}t}\left(m \cdot \vec{v}\right) = m_0 \cdot \frac{\mathrm{d}}{\mathrm{d}t}\left(\gamma \cdot \vec{v}\right) = q \cdot \vec{v} \times \vec{B}$$

$$B\rho = \frac{m_0 \cdot \gamma \cdot v}{q} = \frac{p}{q}$$



$$\gamma = \sqrt{\left(1 - \beta^2\right)^{-1}} \qquad \beta = |v|/c$$

p/q = $B\rho$ – **magnetic rigidity**

Ion charge state

- Bor's approximation

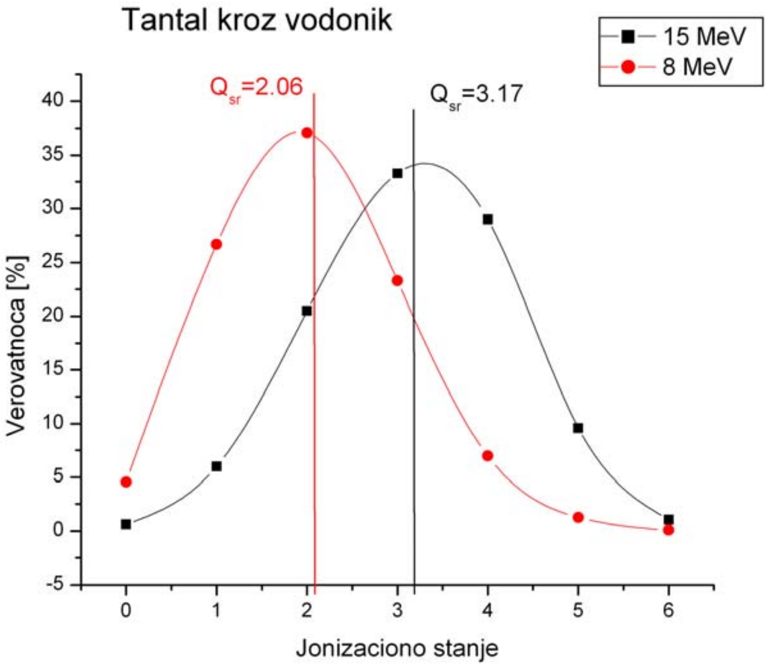
$$q \approx \frac{v}{v_0} Z_{ion}^{1/3}$$

- Dmitriev i Nikolaev (1964)

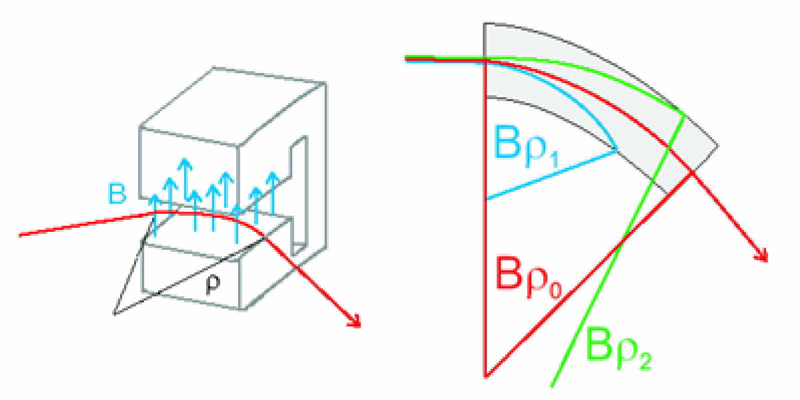
$$\bar{q} = Z_{ion} \frac{\log\left(2.43 \frac{v_{ion}}{Z_{ion}^{0.4}}\right)}{\log\left(7 \cdot Z_{ion}^{0.3}\right)} \qquad \Delta q = \left(0.32 \cdot Z_{ion}^{0.45}\right)^2$$

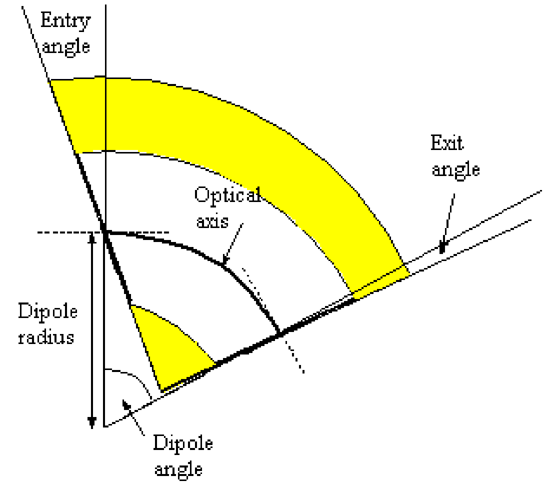
- Betz (1983)

$$\bar{q} = Z_{ion}\left(1 - \exp\left(-0.555 \frac{v_{ion}^{1.175}}{Z_{ion}^{0.607}}\right)\right) \qquad \Delta q = 0.0729 \cdot Z_{ion}$$

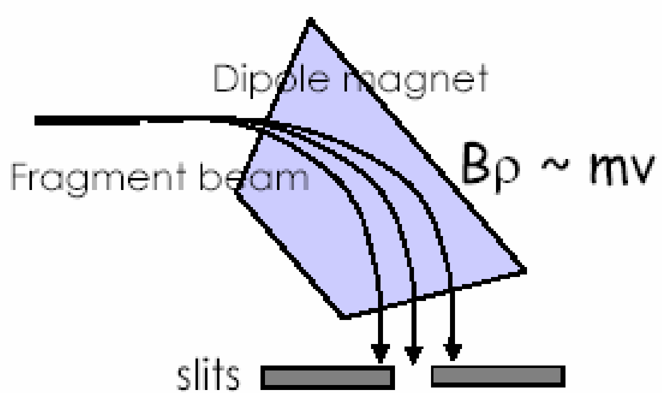


Dipole



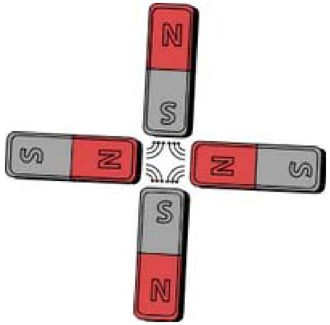


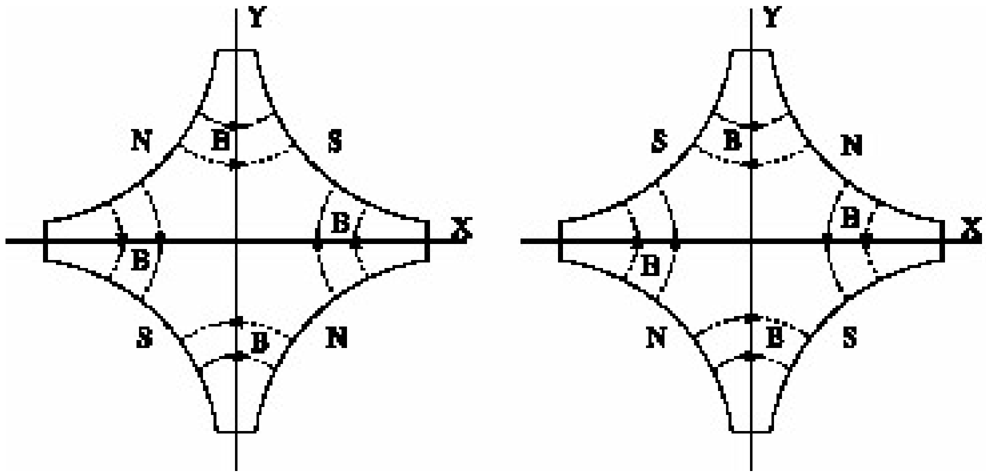
DIPOLE SELECTION

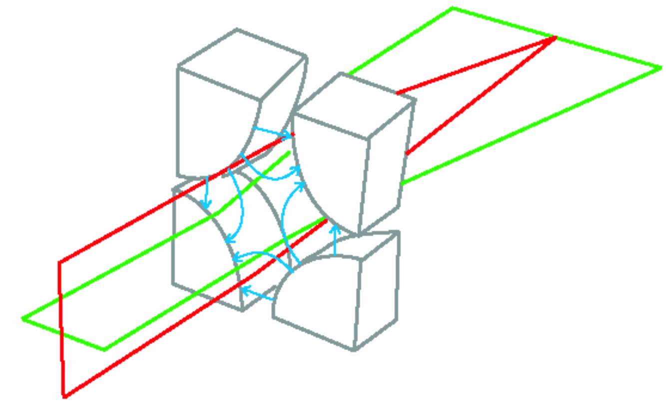


$$\begin{bmatrix} x_2 \\ x_2' \\ \delta \end{bmatrix} = \begin{bmatrix} \cos\phi & \rho\sin\phi & \rho(1-\cos\phi) \\ \dfrac{-\sin\phi}{\rho} & \cos\phi & \sin\phi \end{bmatrix} \begin{bmatrix} x_1 \\ x_1' \\ \delta \end{bmatrix}$$

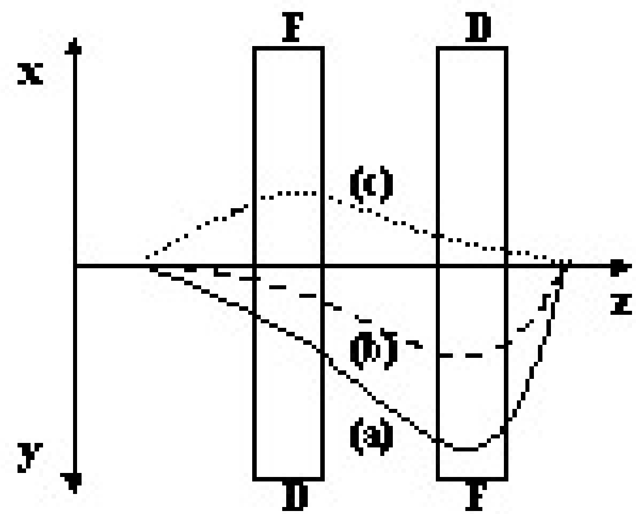
Quadrupole





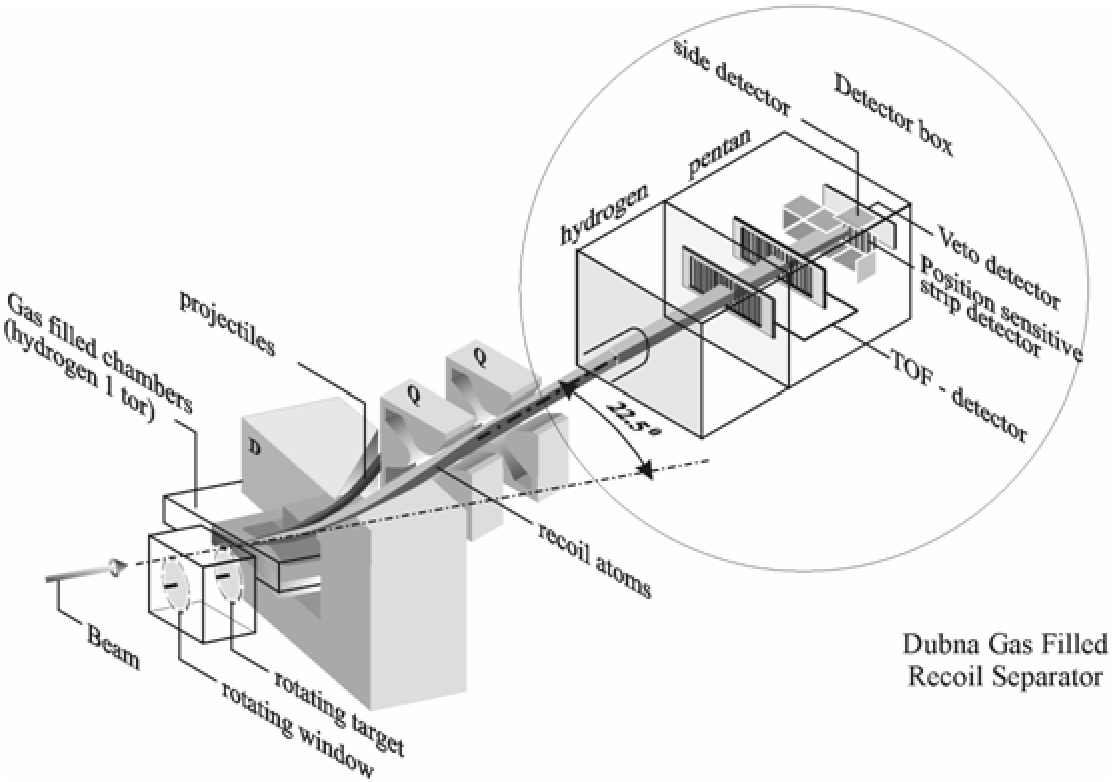


$$T_f = \begin{bmatrix} \cos kL & \frac{1}{k}\sin kL \\ -k\sin kL & \cos kL \end{bmatrix}$$

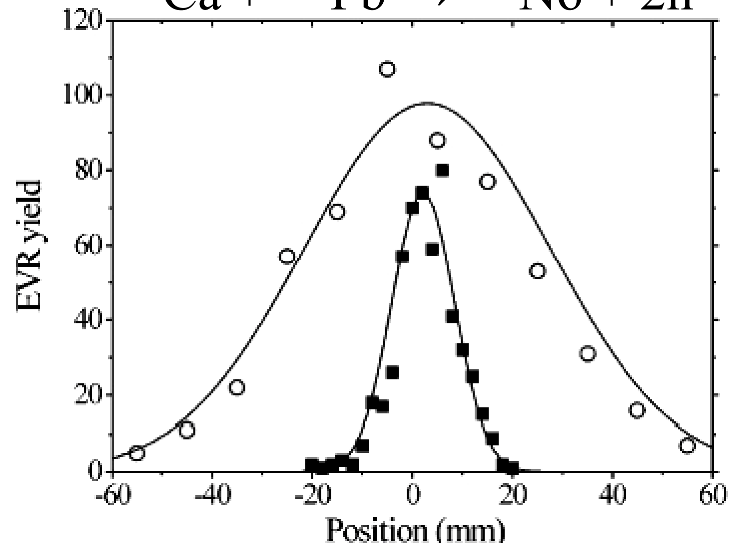


$$T_d = \begin{bmatrix} \cosh kL & \frac{1}{k}\sinh kL \\ k\sinh kL & \cosh kL \end{bmatrix}$$

Dubna gas-filled magnetic separator



$^{48}Ca + ^{206}Pb \rightarrow ^{252}No + 2n$



Anglular distribution of EVR

Angular distribution of EVRs is described by Gaussian function

$$P(\theta) = \frac{1}{\sqrt{2\pi\omega}} \exp\left(-\frac{\theta^2}{2\omega} \right) \qquad \omega = \sqrt{\Omega_s^2 + \Omega_n^2}$$

Recoil angle due to neutron evaporation (Sagaidak, 1989)

$$\Omega_n = \sum \frac{P_i^2}{3P_{CN}^2}$$

Multiple scattering (Meyer, 1971)

$$\theta_{1/2} = \frac{2ZZ_2 e^2 \tilde{\theta}_{1/2}}{aE_r} \qquad \tilde{\theta}_{1/2} = g_1(\tau) + \frac{a^2}{r_0^2} g_2(\tau)$$

$$a = \frac{0.885 a_0}{\left(Z^{2/3} + Z_2^{2/3}\right)^{1/2}} \qquad \tau = N_L \pi a^2 t / A_2$$

Calculated position spectra for S^3

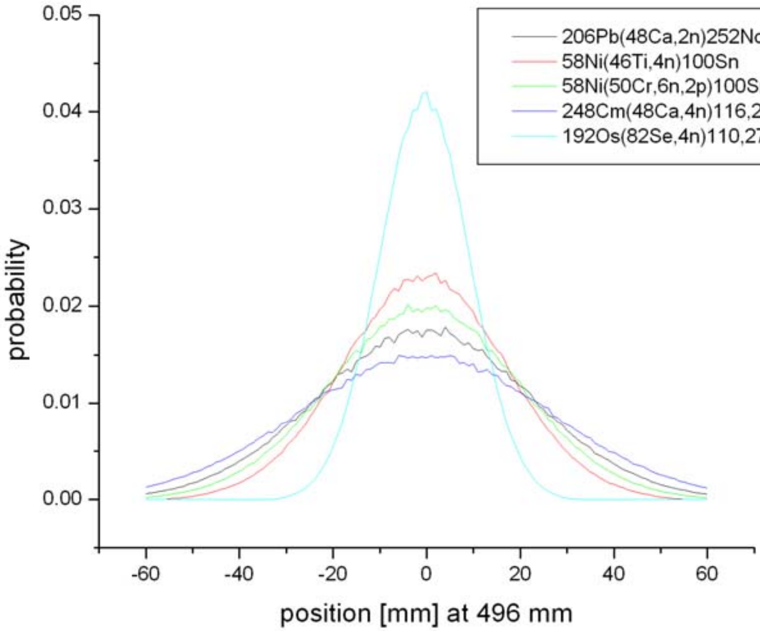


Figure1. Position spectra of EVR from direct kinematics at 496 mm from target

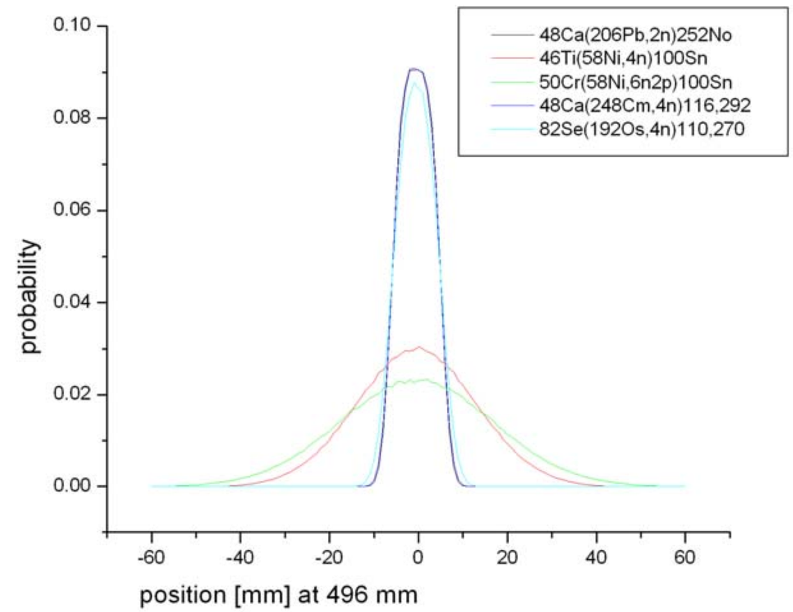
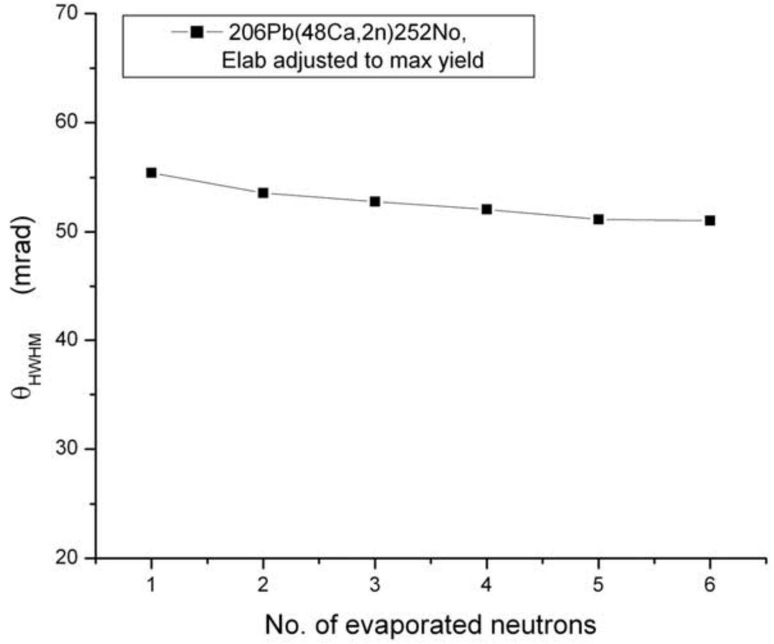
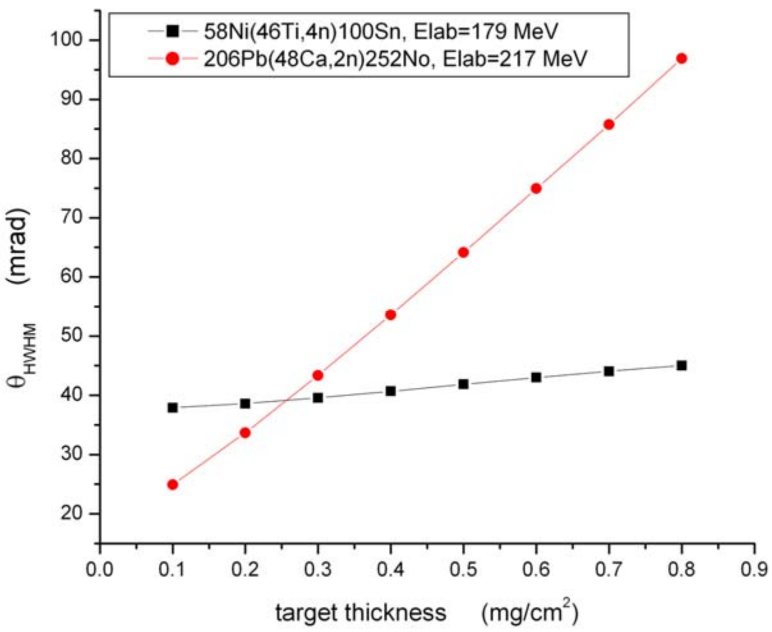


Figure 2. Position spectra of EVR from inverse kinematics at 496 mm from targ.

Calculated EVR's angular dispersion

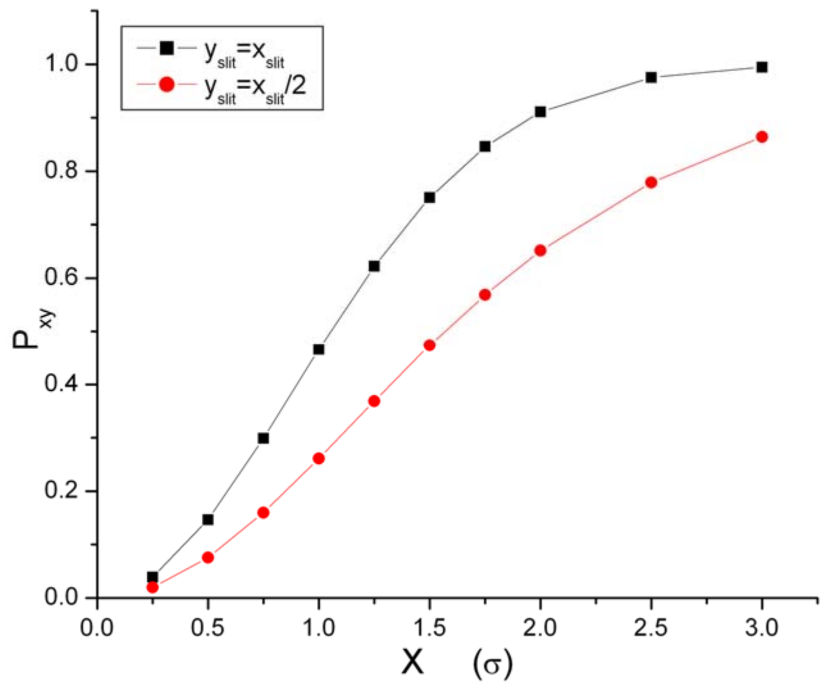


The change of EVR angular dispersion with number of evaporated nucleons for reaction 48Ca +206Pb

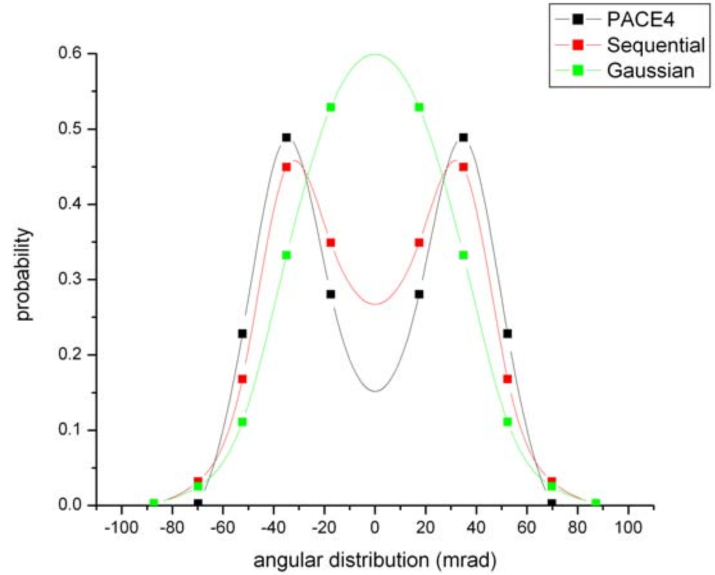


Dependence of EVR angular dispersion on target thickness for symmetric and asymmetric fusion.

Combined probability of EVR acceptance dependence on size of x and y apertures



Tanks for your attention!



PACE4
Sequential
Gaussian
probability
0.0
0.1
0.2
0.3
0.4
0.5
0.6
-100
-80
-60
-40
-20
0
20
40
60
80
100
angular distribution (mrad)