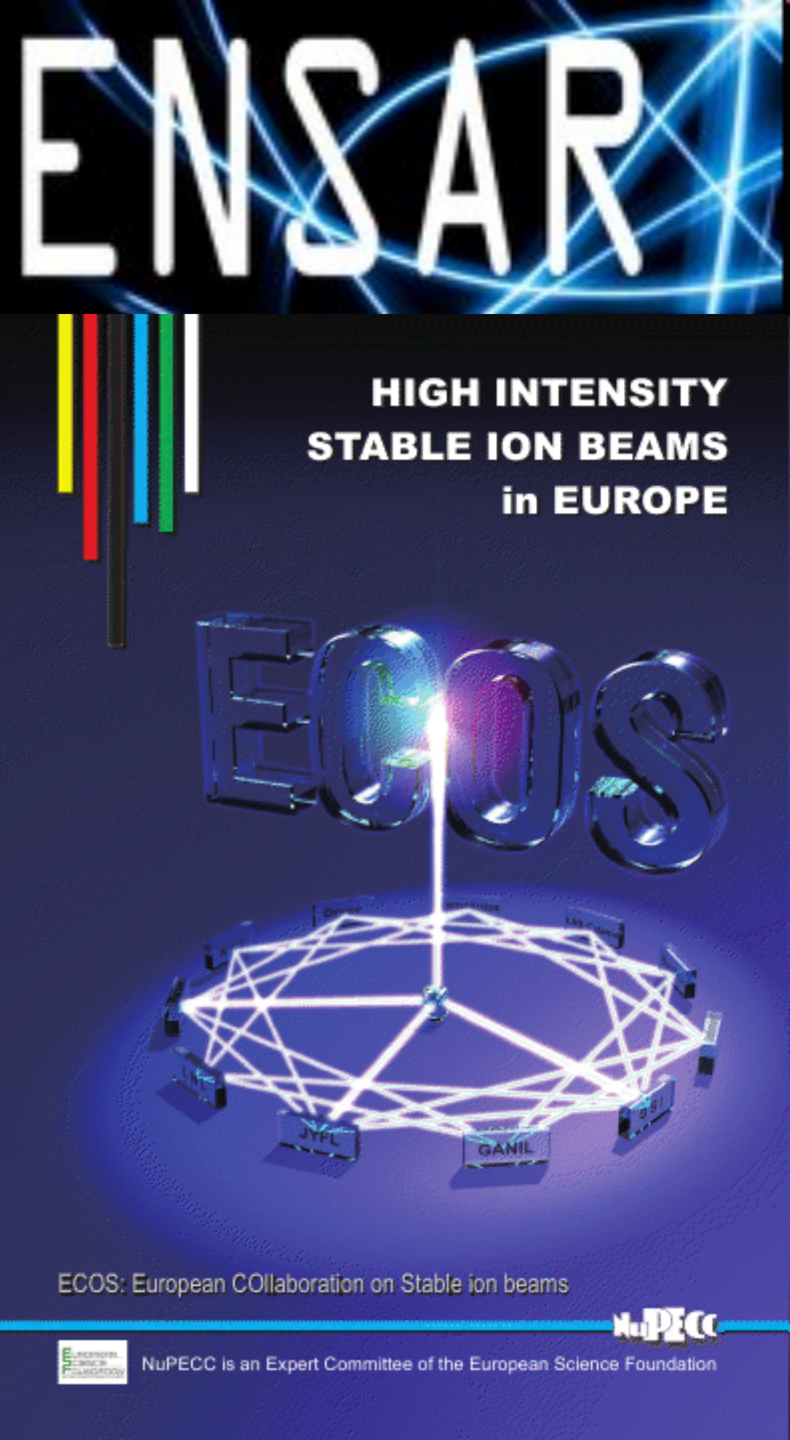


FUSHE 2012

Workshop on

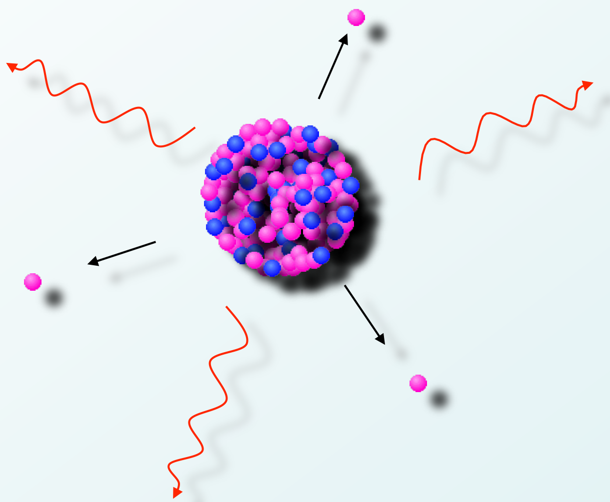
FUture **S**uper-**H**eavy **E**lement **S**trategy

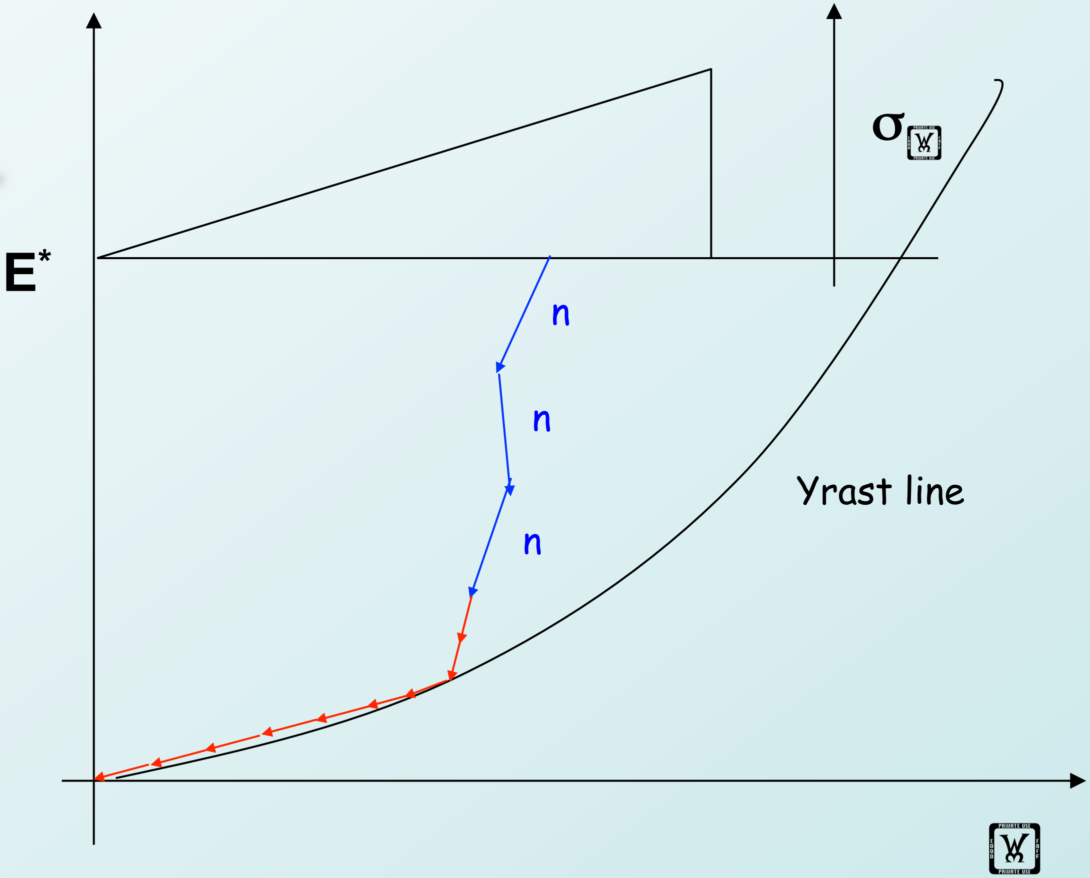
ENSAR ECOS task 2

synergies in the field of SHE research

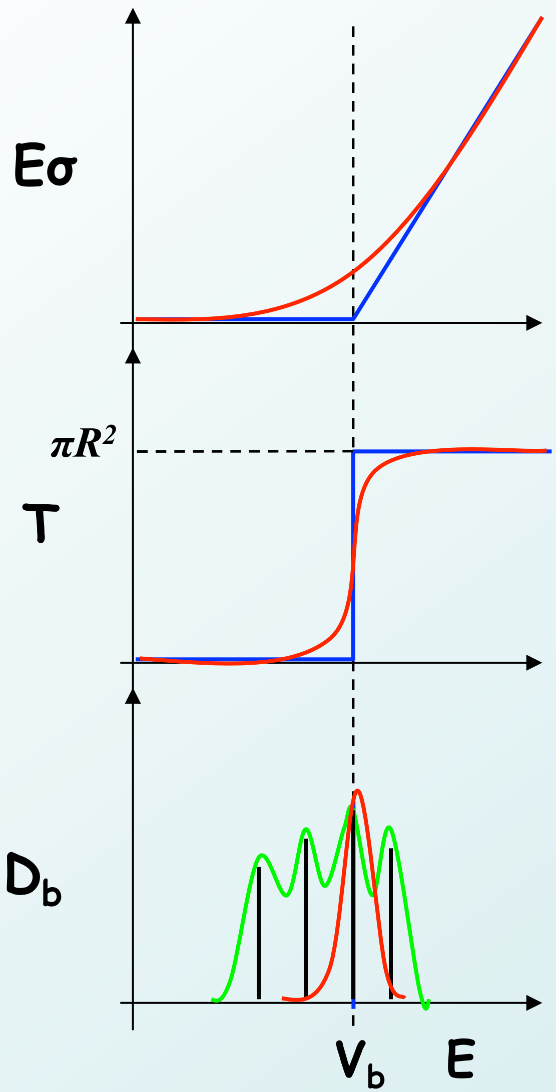
The Statistical Model

- de-excitation of the Hot Compound System





Fusion Barrier Distribution
- the Concept



$$\sigma E\left(E,V_b\right)=\pi R^2\left(1-\frac{V_b}{E}\right) \quad , E>V_b$$

$$\sigma E\left(E,V_b\right)=0 \quad , E<V_b$$

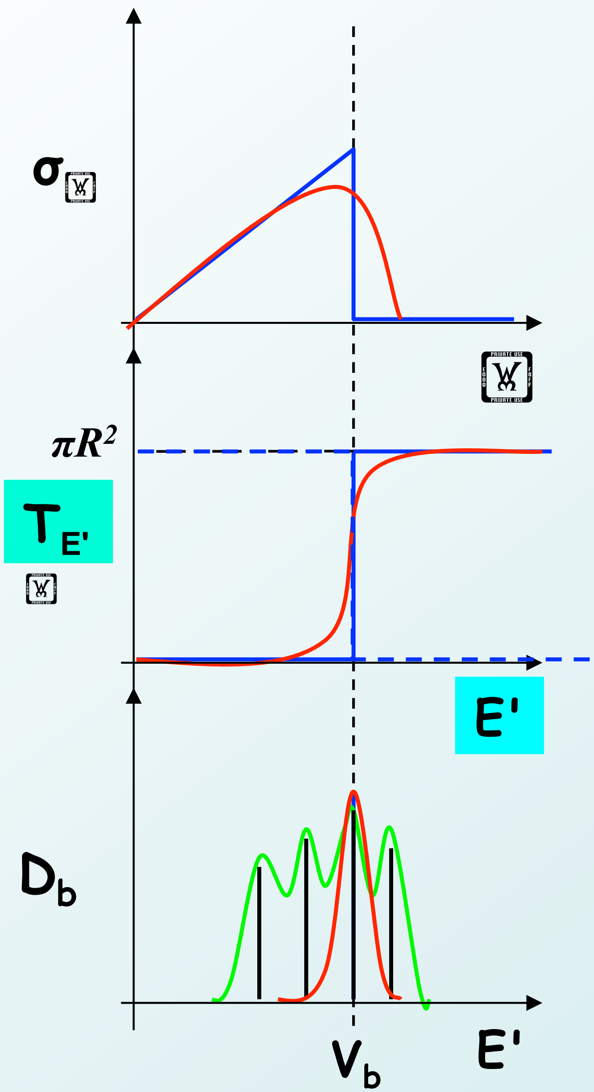
$$\frac{d\left(E\sigma\left(E,V_b\right)\right)}{dE}=\pi R^2 \quad , E>V_b$$

$$\frac{d\left(E\sigma\left(E,V_b\right)\right)}{dE}=0 \quad , E<V_b$$

$$\frac{d^2\left(E\sigma\left(E,V_b\right)\right)}{dE^2}=\pi R^2\delta\left(E\text{-}V_b\right)$$

Fusion Barrier Distribution

- Partial Wave Cross sections: the CN Spin Distribution



$$\sigma_\ell(E) = T_\ell(E,\ell)(2\ell+1)\pi\bar{\lambda}^2$$

$$\bar{\lambda} = \frac{\hbar}{\sqrt{2\mu E}} \quad \rightarrow \quad \text{de Broglie wave length}$$

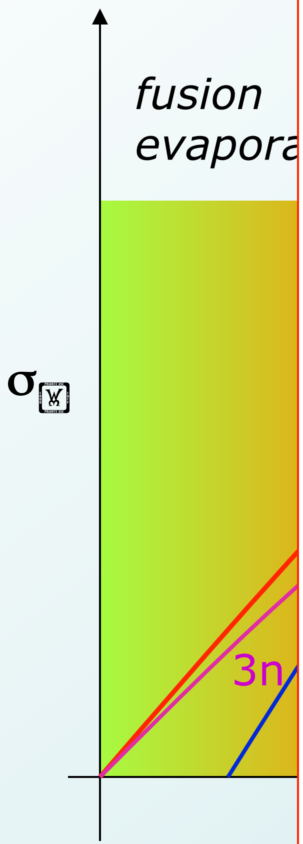
$$T_\ell(E,\ell) = \frac{\sigma_\ell(E)}{(2\ell+1)\pi\bar{\lambda}^2}$$

$$\ell \rightarrow E' \quad \text{with} \quad E' = E - E_{rot}, \quad E_{rot}(\ell) = \frac{\ell(\ell+1)}{2\mu R_b^2}$$

$$T_\ell \rightarrow T_{E'}$$

$$T_{E'} = \frac{1}{\pi R_b}\frac{d\left(E'\sigma(E',V_b)\right)}{dE'} = \frac{\sigma(E')}{(2\ell+1)\pi\bar{\lambda}^2}$$

Fusion Dynamics and the Spin Distribution



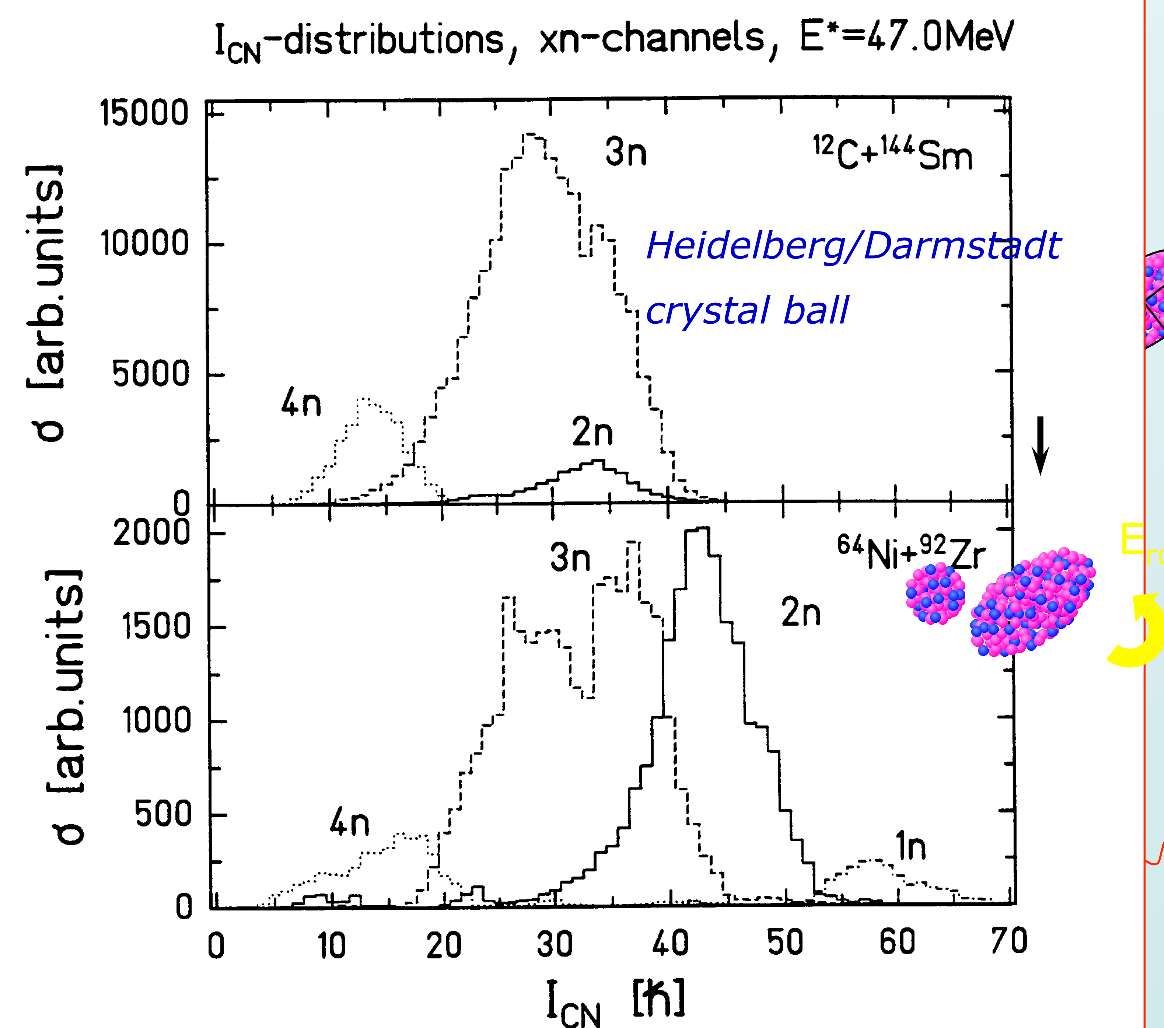
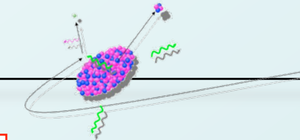
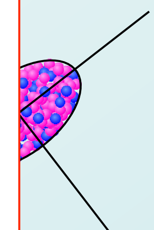


Abbildung 4.33. Die I_{CN}-Verteilungen der ungeladenen Kanäle der beiden Eingangskanäle.

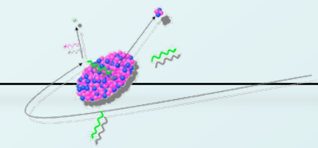
F. Heller, Ph.D. thesis, University of Heidelberg, 1995)

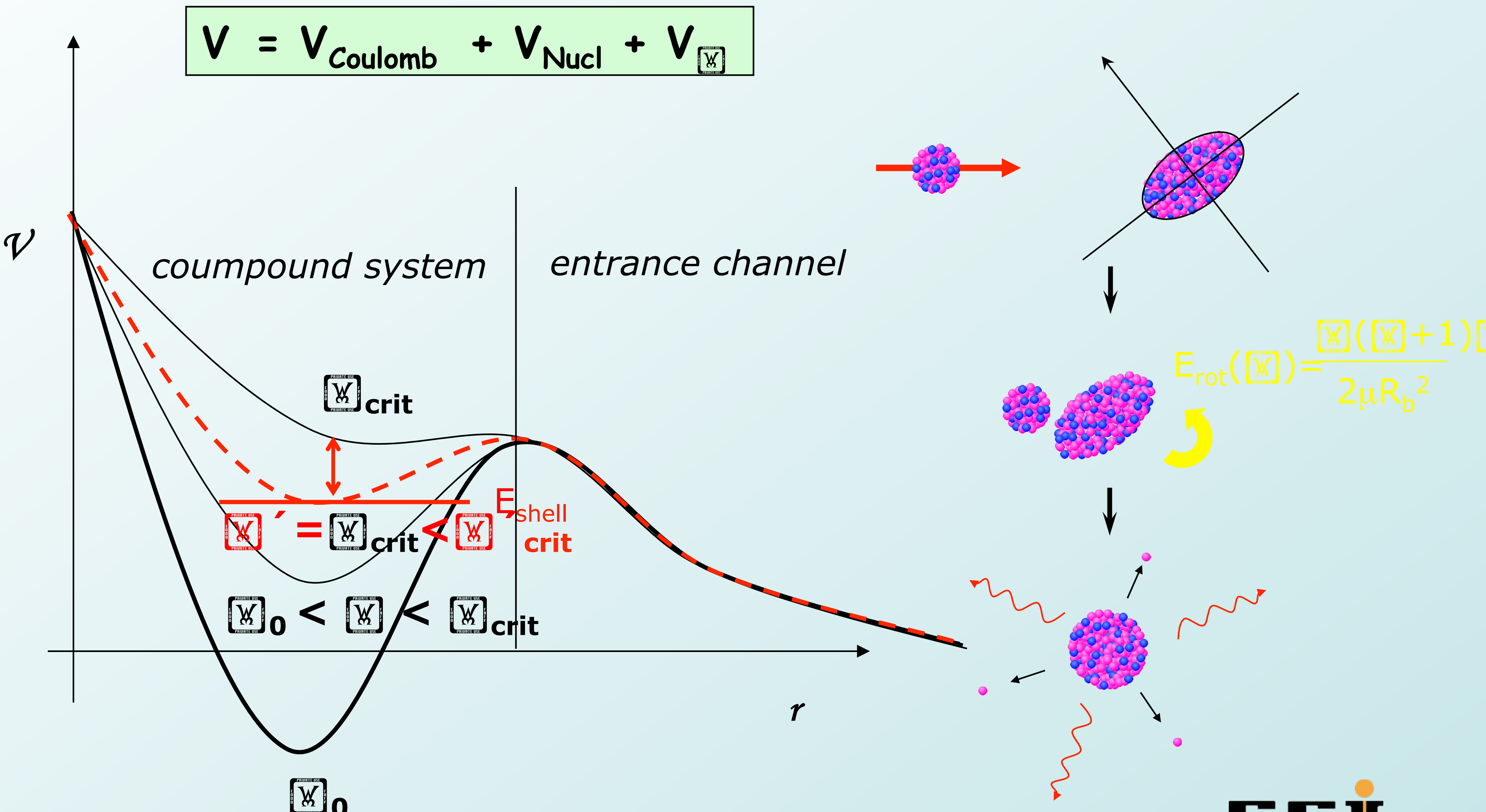




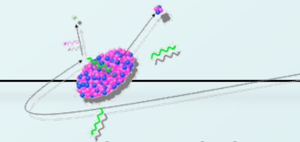
$E_{rot}(\ell)=\frac{\ell(\ell+1)\hbar^2}{2\mu R_b^2}$

Fusion Dynamics and the Spin Distribution

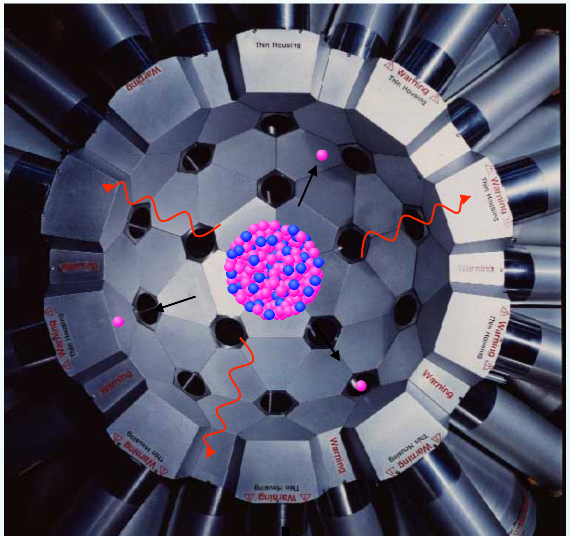




Experimental Approach to the Spin Distribution with GASP



1 *GASP – inner ball (80 BGO-crystals)*



↓

γ-ray fold

GASP ↓ *response function*

$\mathbf{M_\gamma}$

2 *GASP – high resolution Ge-detectors*

↓

$\mathbf{E_\gamma}$

↓

ER identification

3 *statistical model (codes like PACE, EVAP, HIVAP…)*

↓

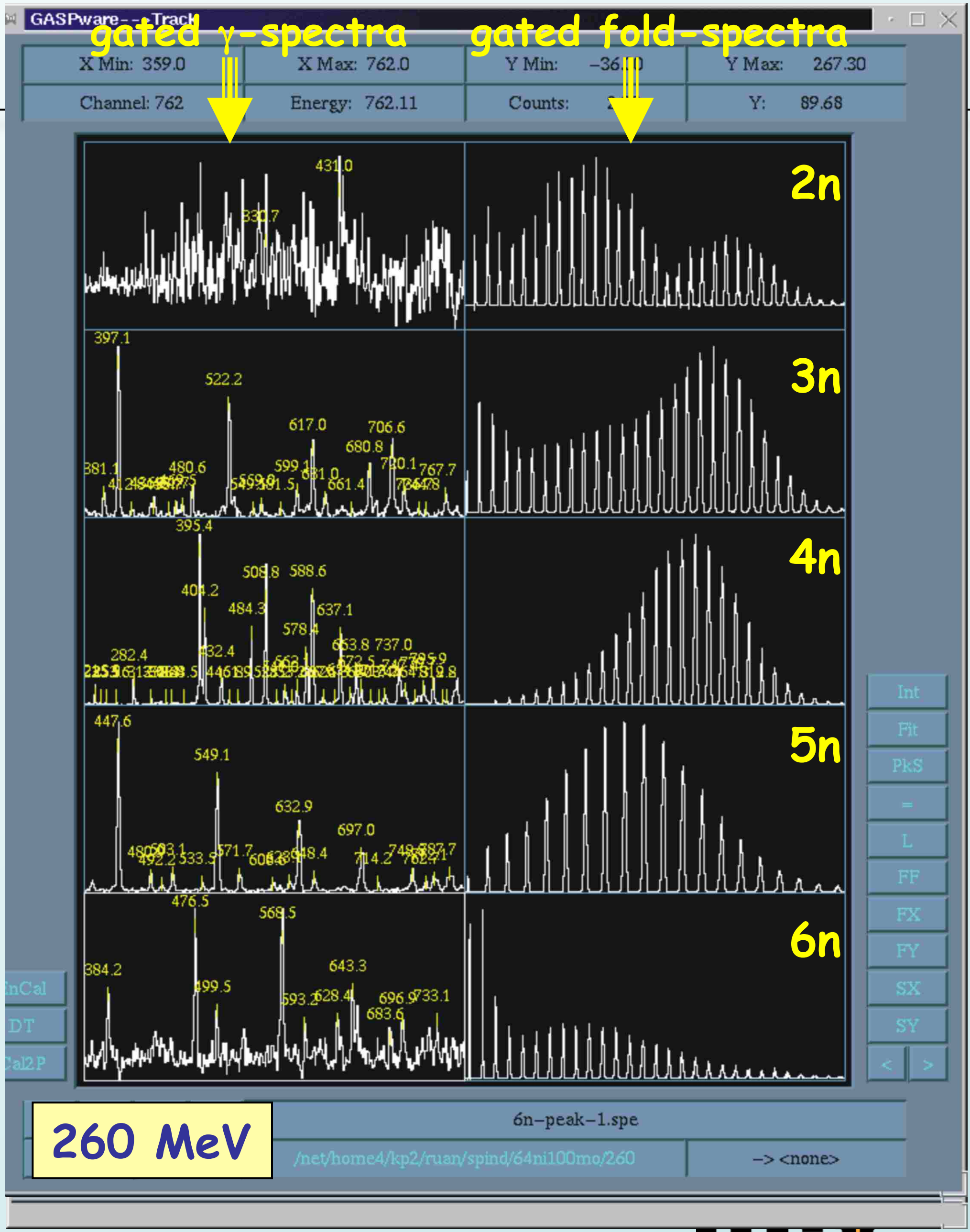
evaporation parameters

↓

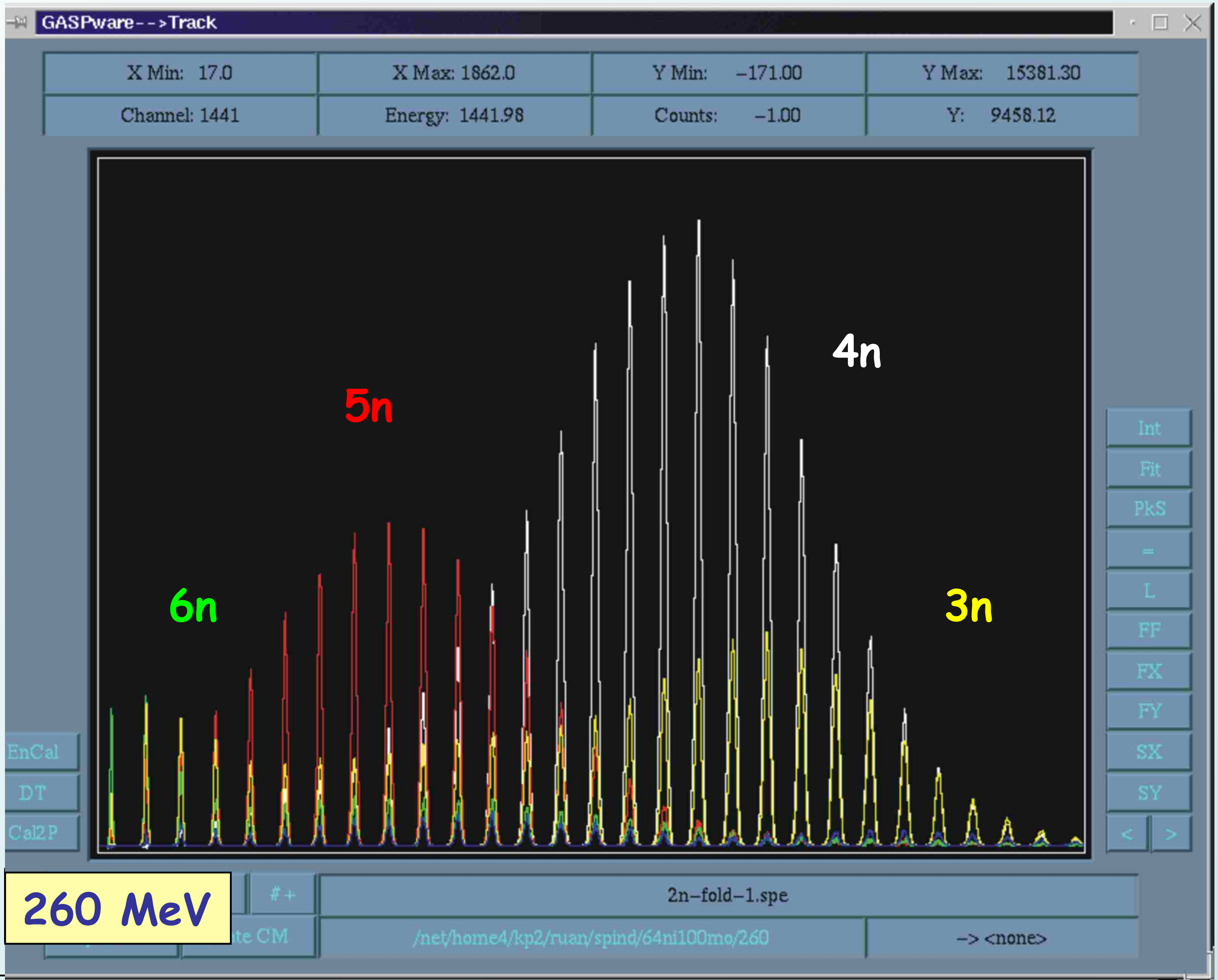
spin removed by particles and statistical γ-rays

$$\ell_{CN} = (\mathbf{M_\gamma} - \mathbf{M_{\gamma s}})\Delta \ell_{\gamma} + \mathbf{M_{\gamma s}}\Delta \ell_{\gamma s} + \ell_{i}\mathbf{M_i}\Delta \ell_{i} + \Delta \ell_{gs/m} \; ; \quad i = p, n, \alpha$$

Fold Distributions with GASP for $^{64}Ni+^{100}Mo$



Fold Distributions with GASP for $^{64}Ni+^{100}Mo$



Fold Distributions with GASP for $^{64}Ni+^{100}Mo$

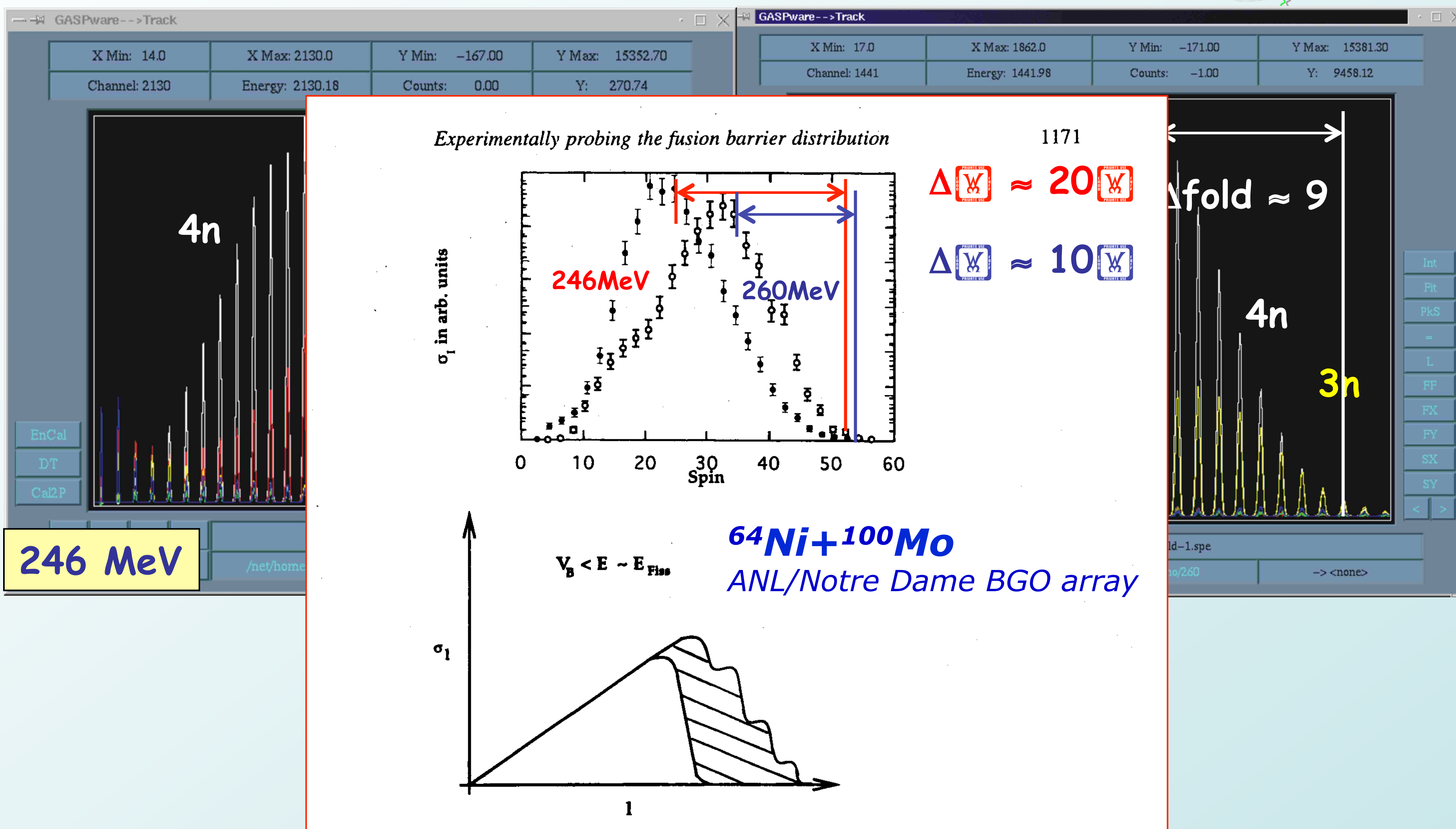


Figure 4. Comparison of the spin distributions at the two higher energies (figures 3(e) and (f)). The shaded area in the bottom figure illustrates the truncation of the distribution by fission.

D.Ackermann et al., J. Phys. G 23 (1997)

Fold Distributions with GASP for $^{34}S+^{170}Er \rightarrow ^{204}Po^{*}$

GASP – inner ball (80 BGO-crystals)