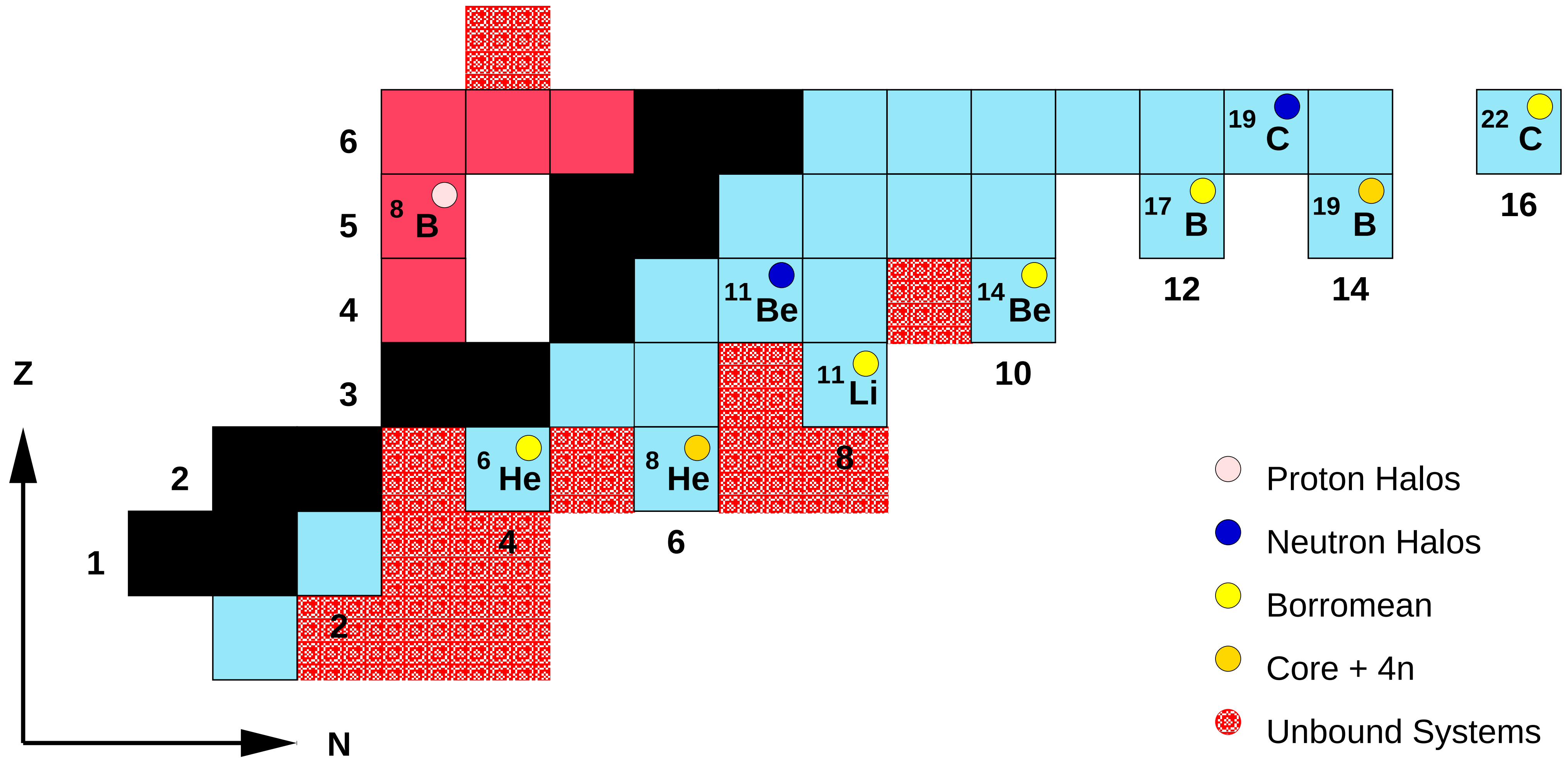
Correlations in 2 and 3 particle decay



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? How to study (loosely bound) 3 body systems (Borromean):

✍ Preparation of an unbound final state

☞ e.g. @ GSI:
$E \gtrsim 100$ A MeV $\Leftrightarrow$ $\beta_{beam} >> \beta_{intrinsic}$

✎ Determine and chose reaction mechanism

✍ What is the structure of these nuclei ?
single particle states, core polarisation, intruder states, shell gaps, . . .

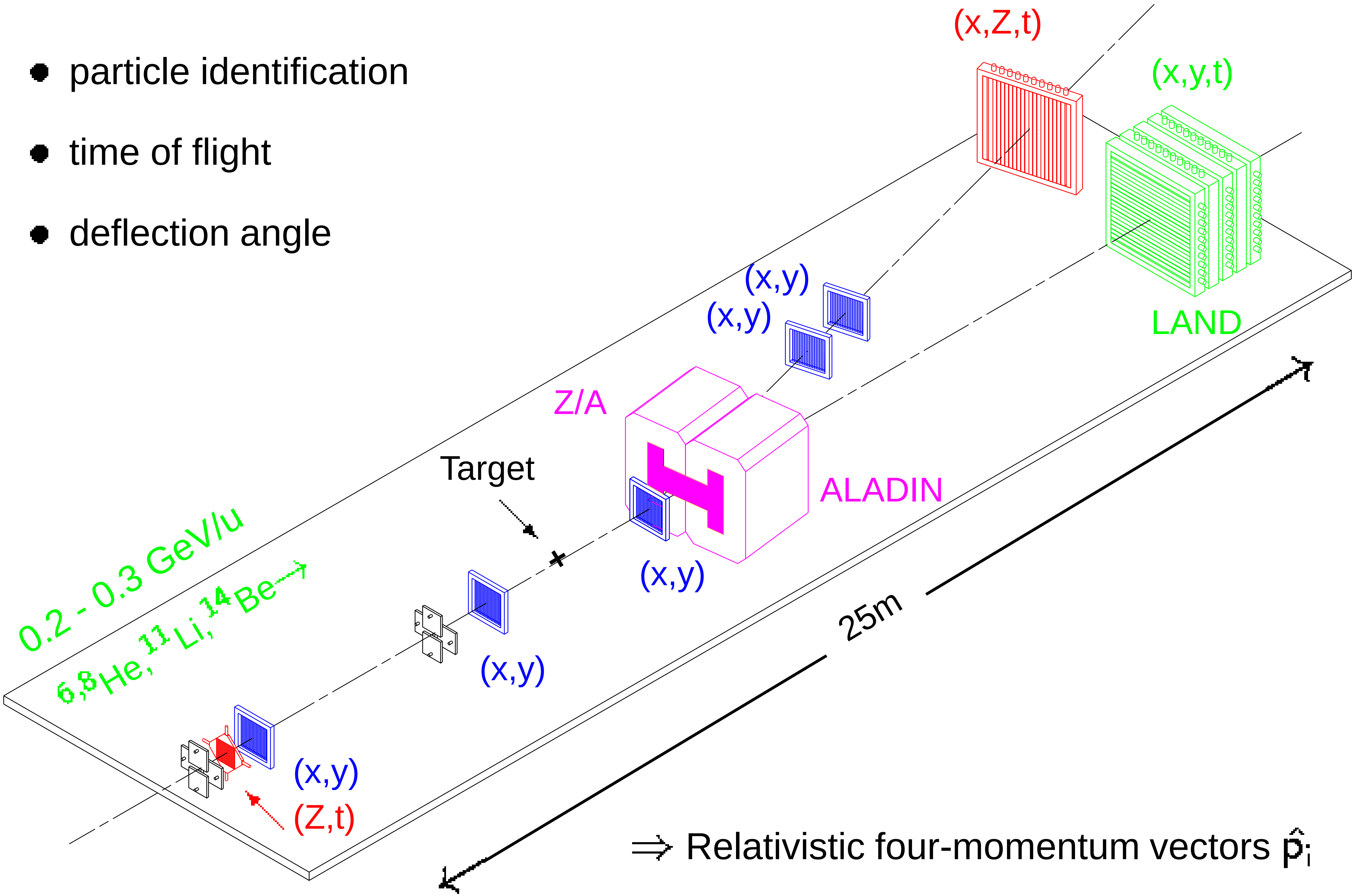
☞ Multiparticle and γ –coincidences:
β-decay studies, transfer reactions, coulomb excitation or quasielastic processes

✎ Study unbound subsystems (2 body)

✎ Study unbound systems (3 body)

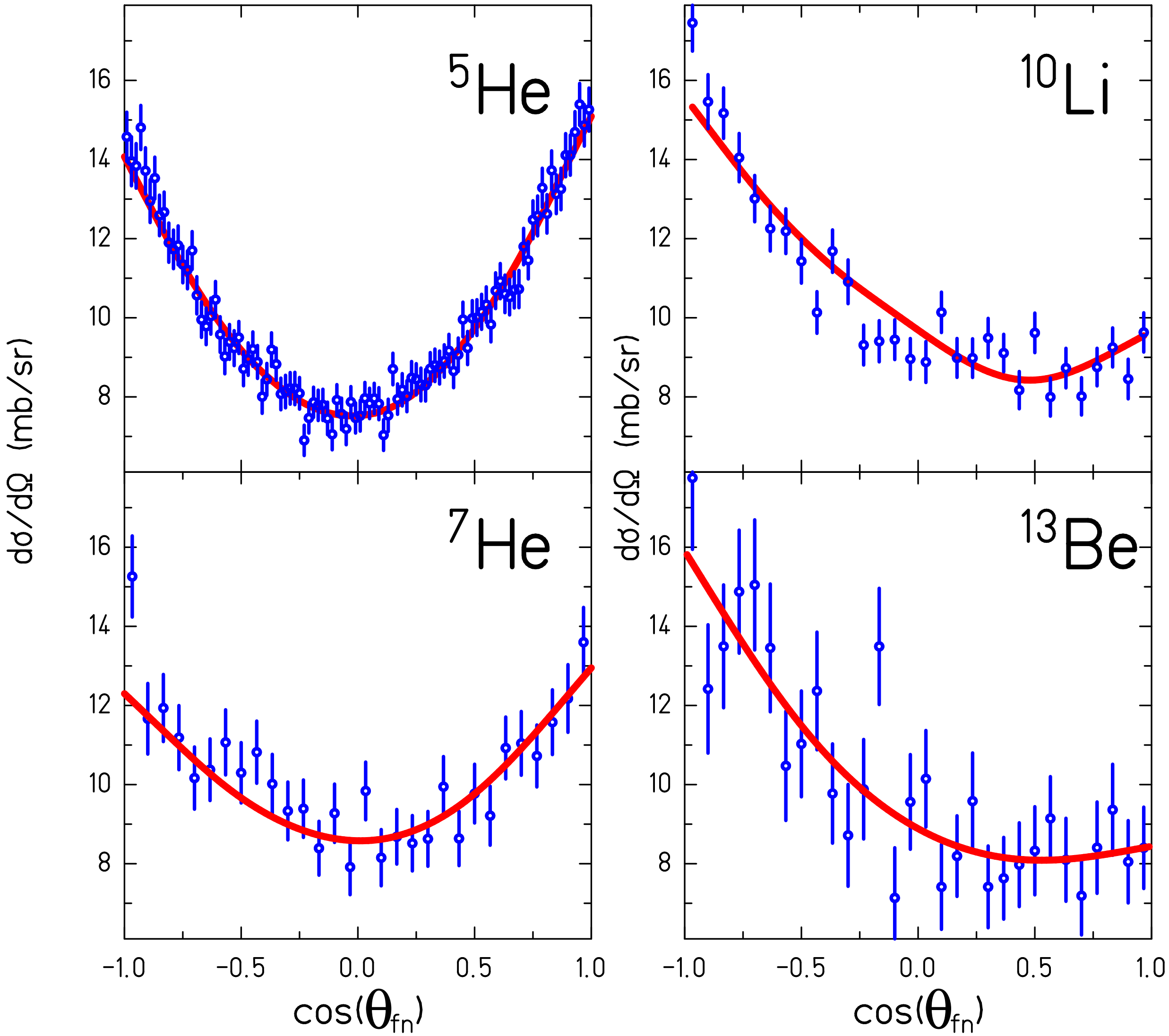
Kinematically complete experiment (GSI)

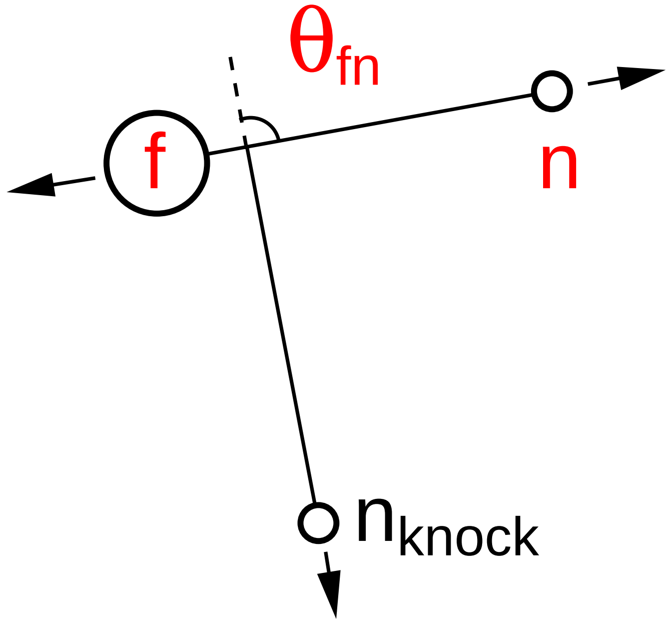
- particle identification
- time of flight
- deflection angle



$\Rightarrow$ Relativistic four-momentum vectors $\hat{\mathbf{p}}_i$

Angular correlations

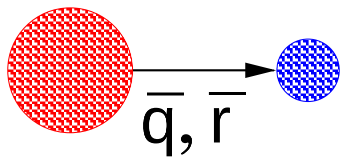




He: p-states

Li/Be: different parity states

Two-Body



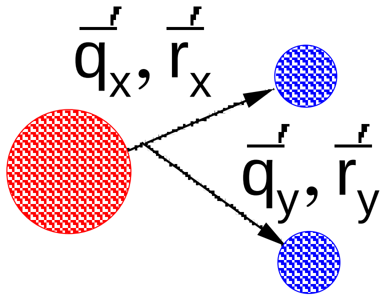
$$\hat{T} \propto \frac{\partial^2}{\partial r^2} + \frac{2}{r}\frac{\partial}{\partial r} - \frac{\ell(\ell+1)}{r^2}$$

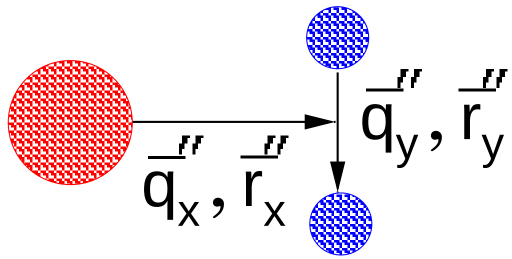
$$\hat{\ell}^2 Y = \ell(\ell+1) Y^{\ell}_{m}(\Omega_2)$$

$$d\tau \propto d\Omega$$

Observable $\dfrac{d\sigma}{d\Omega}$

Three-Body





$$\hat{T} \propto \frac{\partial^2}{\partial \rho^2} + \frac{5}{\rho}\frac{\partial}{\partial \rho} - \frac{K(K+4)}{\rho^2}$$

$$\rho^2 = |\bar{r}_x|^2 + |\bar{r}_y|^2$$

$$\hat{K}^2 \mathcal{Y} = K(K+4)\mathcal{Y}^{K\,\ell_x \ell_y}_{m_x m_y}(\Omega_5)$$

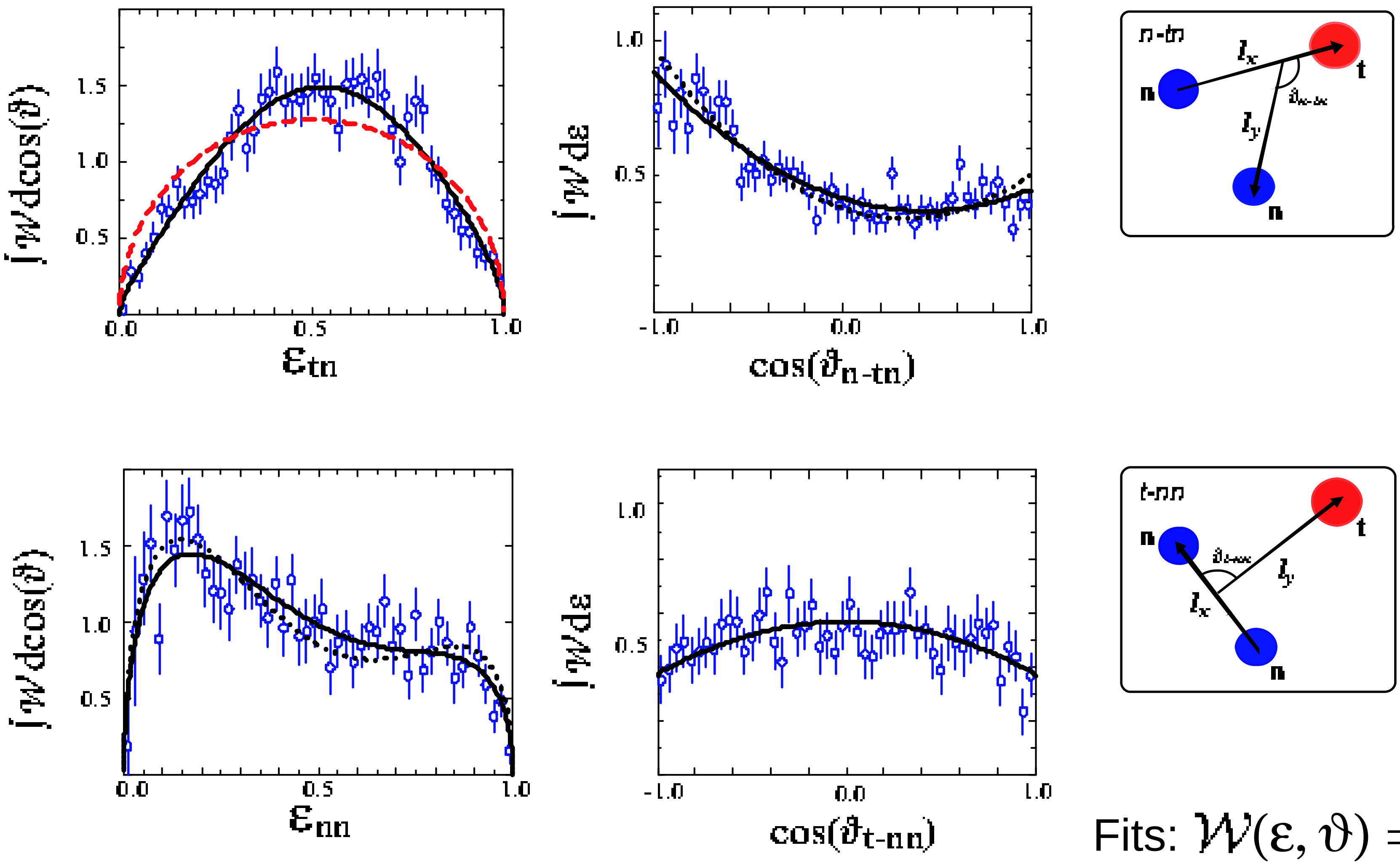
$$\bar{\ell} = \bar{\ell}_x + \bar{\ell}_y, \quad K = 2n + \ell_x + \ell_y$$

$$d\tau \propto \sqrt{\varepsilon(1-\varepsilon)}\, d\varepsilon\, d\Omega_x\, d\Omega_y$$

$$\varepsilon = E_x / (E_x + E_y)$$

Observable $\dfrac{d^3\sigma}{d\Omega_x\, d\Omega_y\, d\varepsilon}$

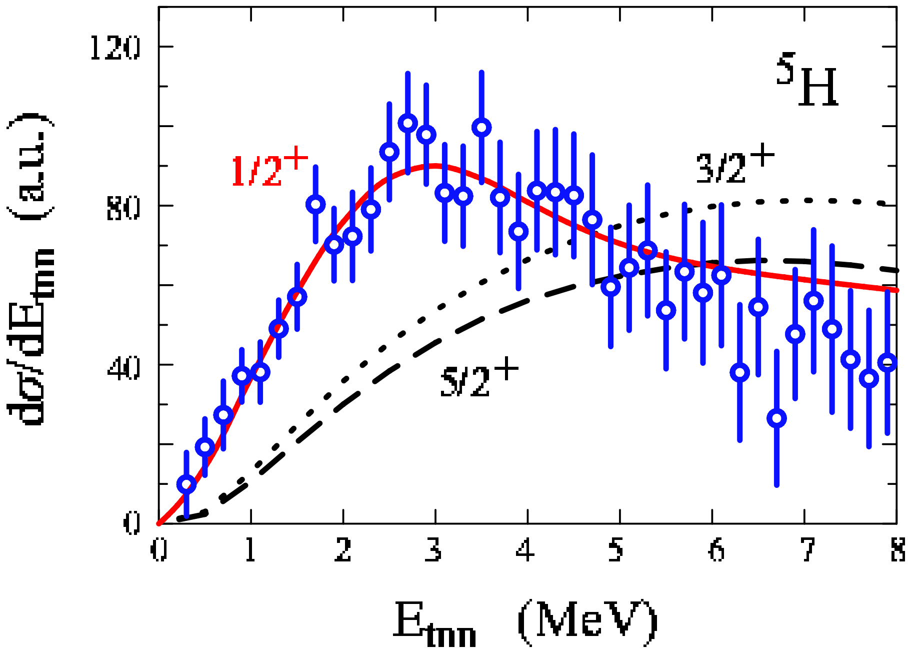
^{5}H: Hyperspherical Harmonics expansion K=0,2



Fits: $\mathcal{W}(\varepsilon,\vartheta) \Rightarrow A_{S\,K\,\ell_x\,\ell_y}$

$$\mathcal{W} = \frac{4}{\pi}\sqrt{\varepsilon(1-\varepsilon)}\left(8\varepsilon(1-\varepsilon)\sin^2\vartheta\left|A_{1211}\right|^2 + \left|A_{0000} - 2(2\varepsilon-1)A_{0200} + 4\sqrt{\varepsilon(1-\varepsilon)}\cos\vartheta A_{0211}\right|^2\right)$$

^{5}H: Results



SK$\ell_x\ell_y$: t-nn system	0000(%)	0200(%)	1211(%)	Ref.
^{6}He	4	78	15	[1] th.
^{6}Be	6(5)	44(12)	50(17)	[2] ex.
^{5}H	18(3)	45(3)	37(4)	*this

[1] NUP **A632** (1998) 383 / [2] NUP **A505** (1989) 215

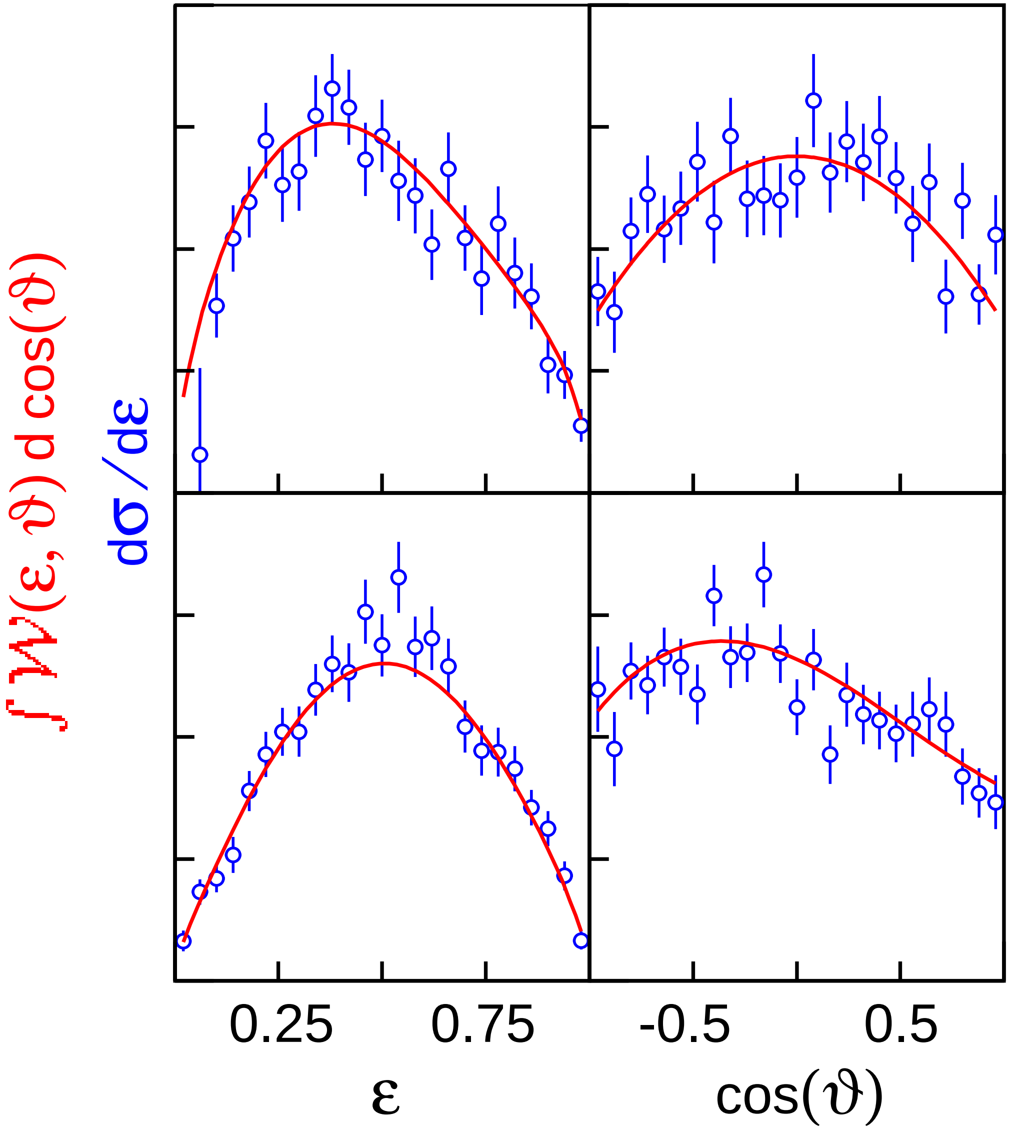
- Pauli forbidden 0211 component: 0.02(9) %
- Consistent description in "T" and "Y" systems (Raynal-Revai coefficients)
- Described by microscopic dynamical calculation assuming a 1/2$^+$ state Phys. Rev **C62** (2000) 014312

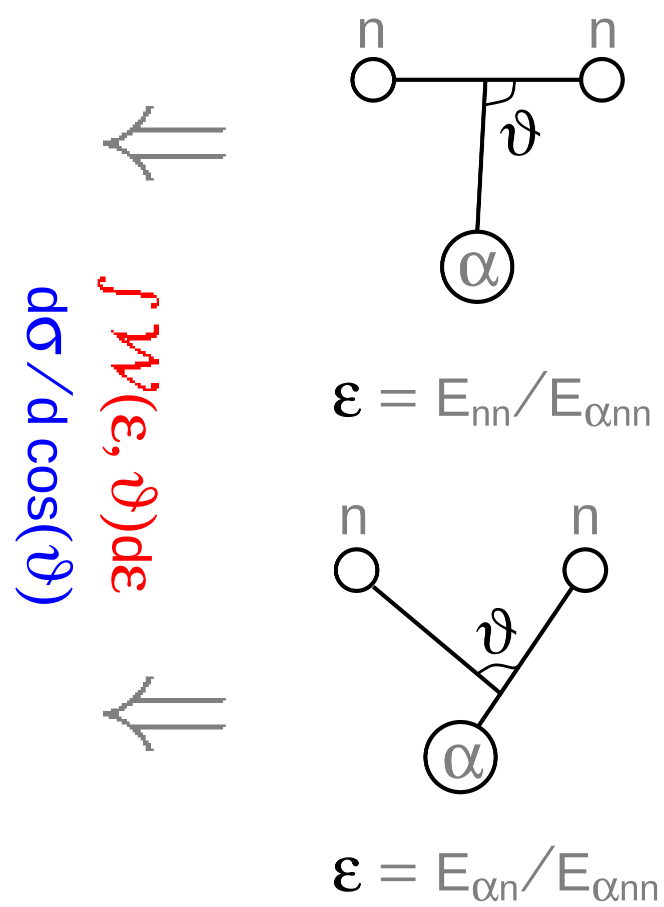
$\Rightarrow$ Recent GSI work: L.V. Grigorenko et al., in prep.

3-body decay: $^{6}He^{*} \longrightarrow \alpha + n + n$ (1 - 3 MeV)

Ansatz for $\mathcal{W}(\varepsilon, \vartheta)$ based on theoretical calculation for $< \Psi_{exc} \,|\, \mathcal{E}1 \,|\, \Psi_{gs} >$

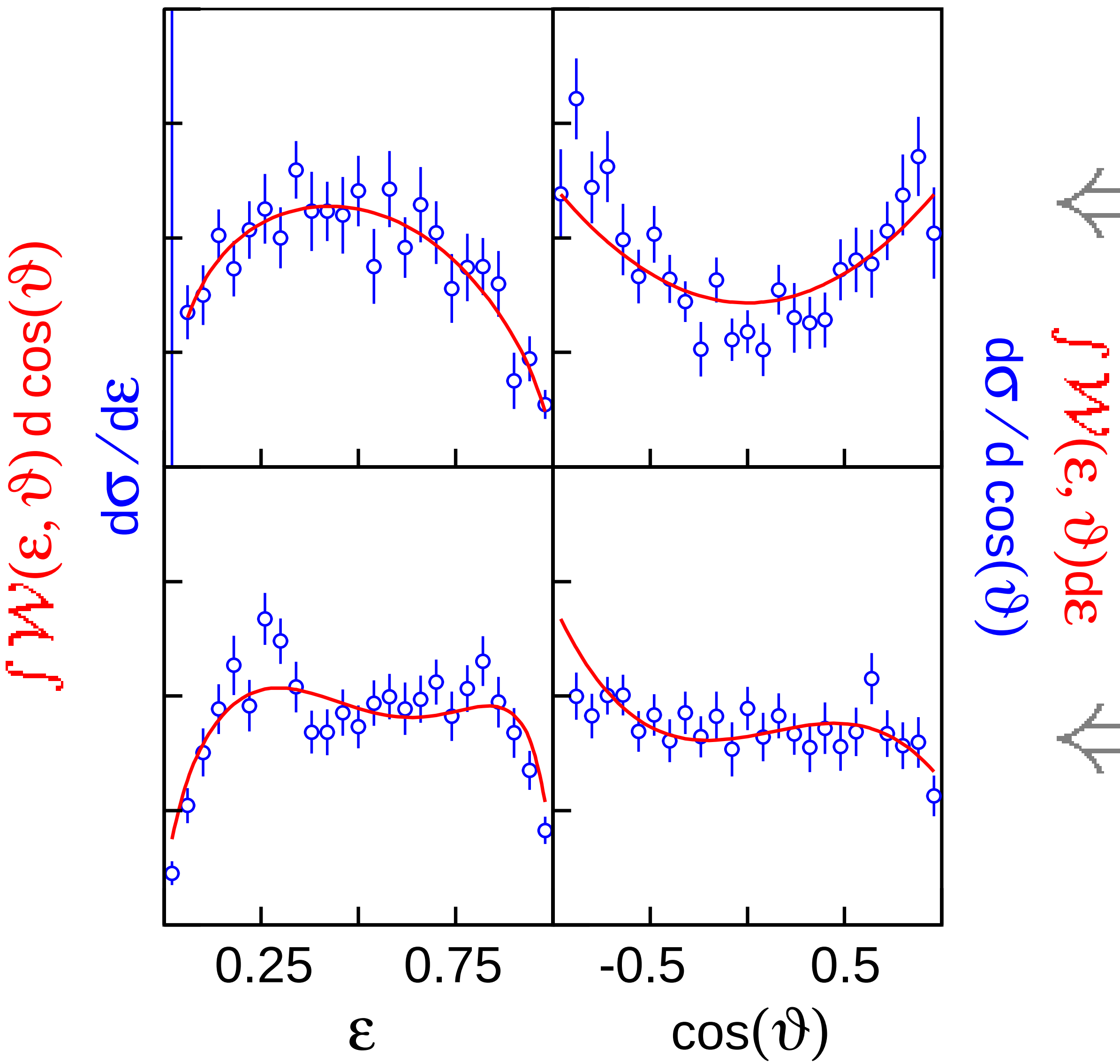
B.V. Danilin et al., NUP**A632** (1998) 383

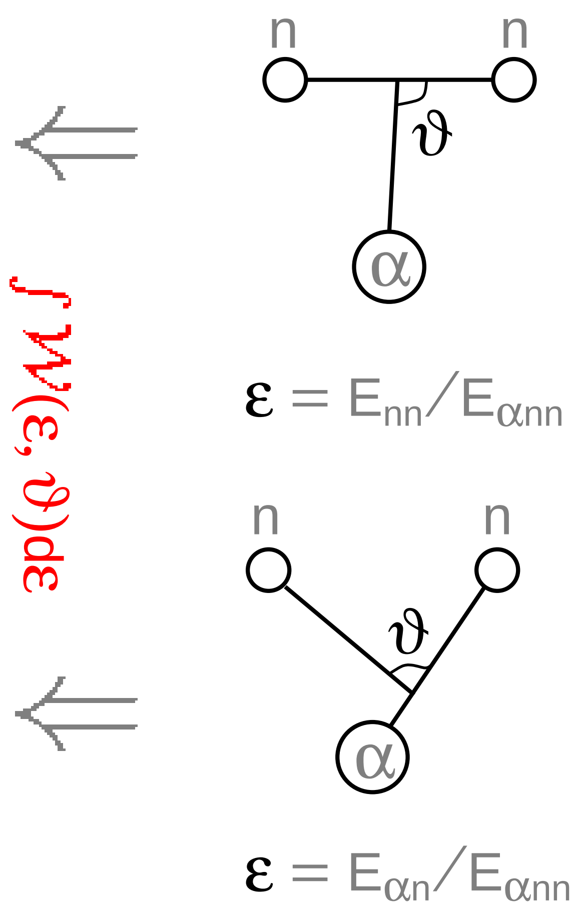




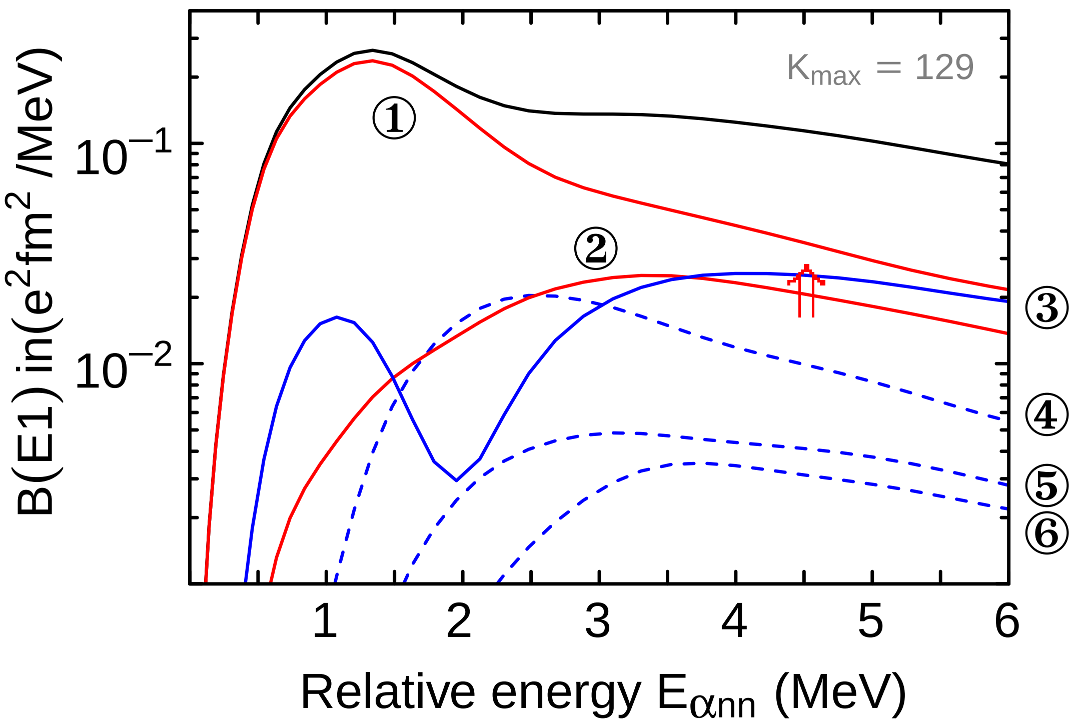
3-body decay: $^{6}\mathrm{He}^{*} \longrightarrow \alpha + n + n$ (3 - 6 MeV)

Higher energy, form of $\mathcal{W}(\varepsilon, \vartheta)$ kept $\Rightarrow$ different configuration $\Leftrightarrow$ different amplitudes





3-body decay: $^{6}He^{*}$ comparison with theory



B.V. Danilin et al., NUP**A632** (1998) 383

$KL\ell_x\ell_y$

Main components (exp.):

S = 0: 1101 ①, 3121 ②

Additionally Predicted:

S = 0: 3101 ③

S = 1: 1110 ④, 3112 ⑤,3110 ⑥

^{6}He groundstate:

S = 0: 2000 / 0000 & S=1

- Consistent picture ! (preliminary)