Study of β-delayed neutron decay of ^{8}He

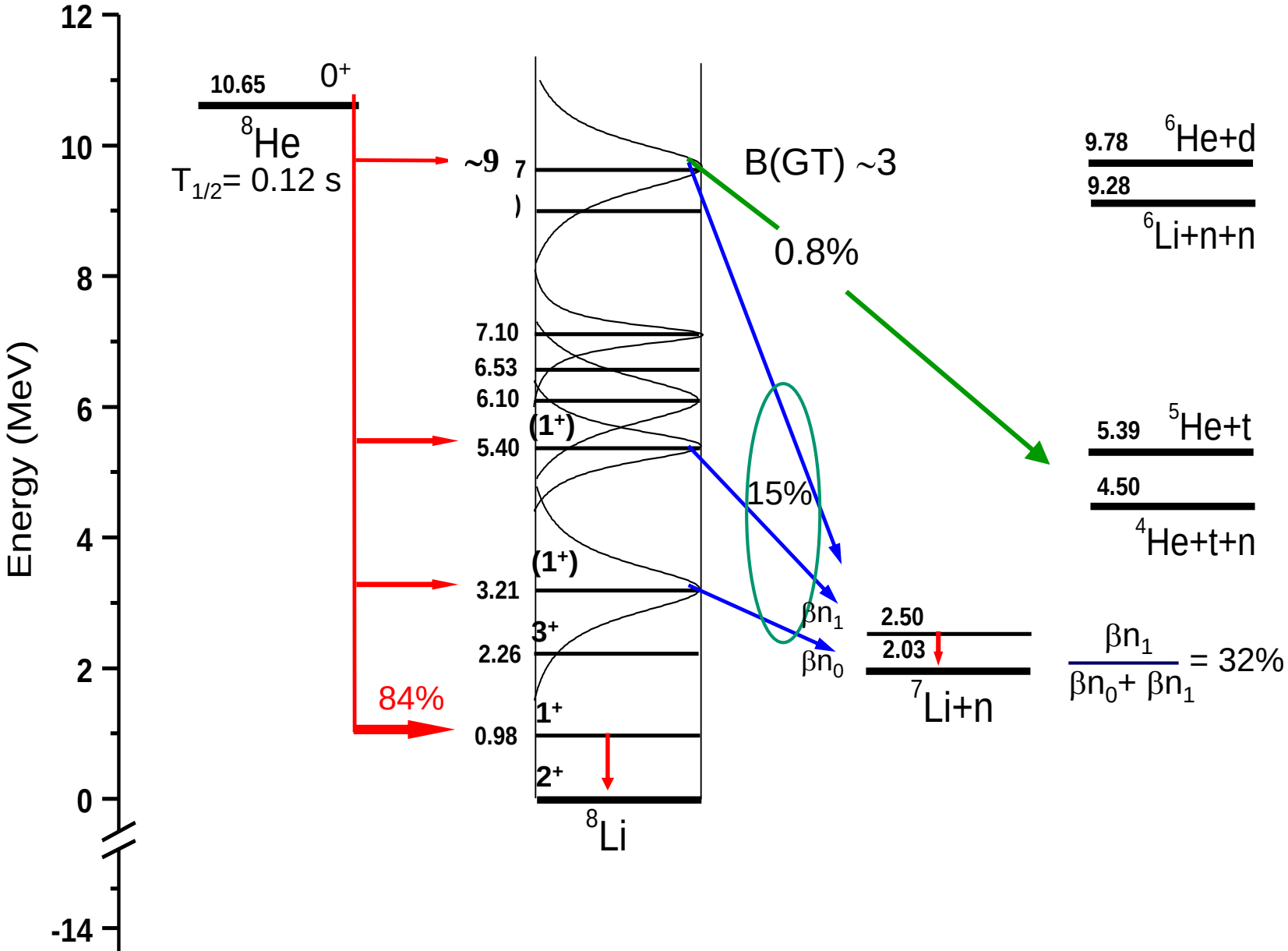
Z. Janas

for

UW-Warsaw, UT- Knoxville, ISOLDE-CERN, JINR-Dubna, AU-Aarhus, CSIC-Madrid

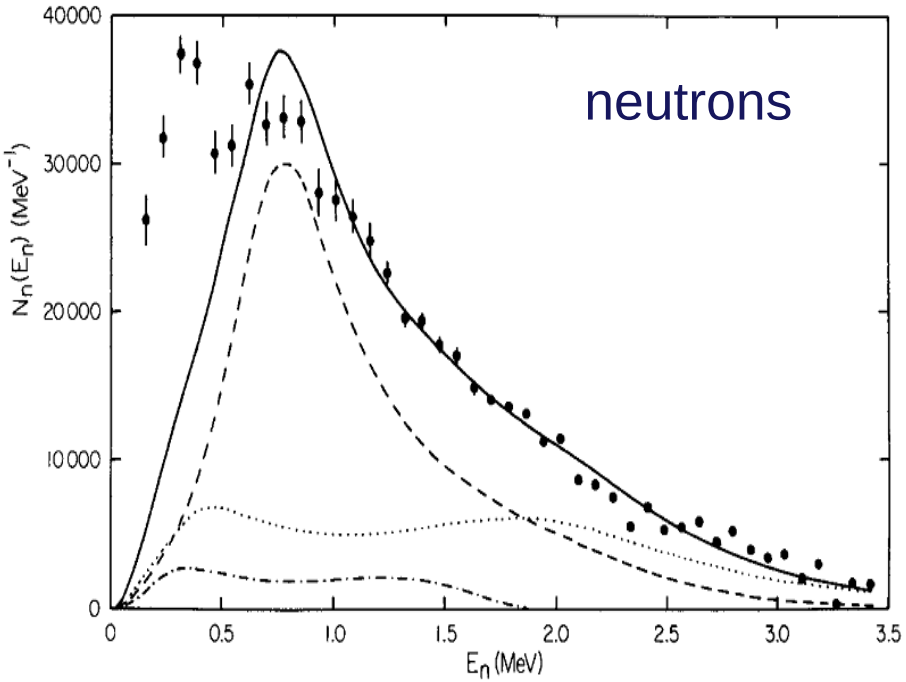
collaboration

Decay scheme of ^{8}He

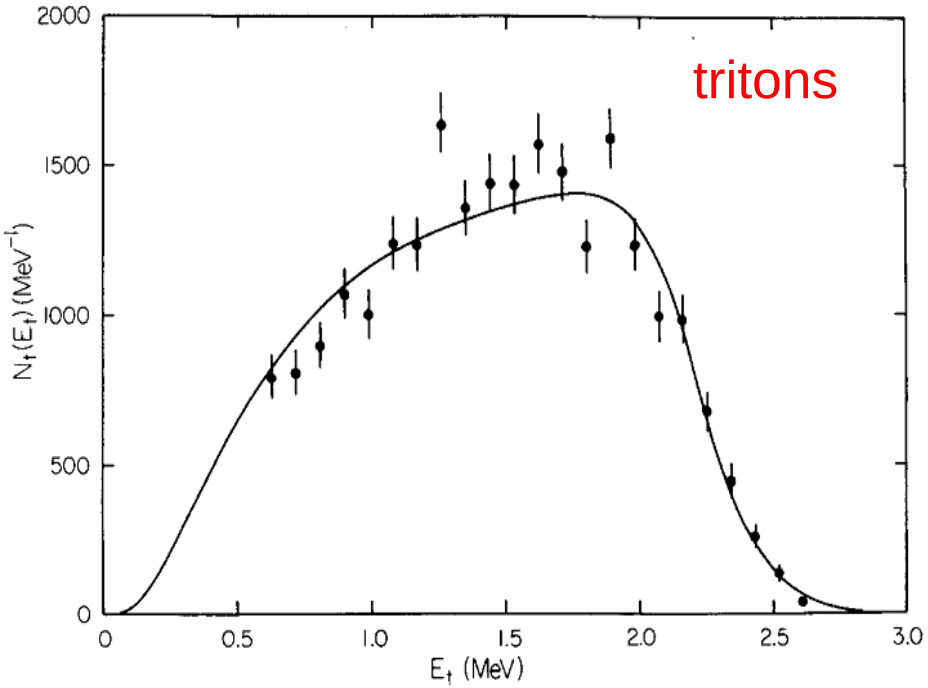


Energy spectra of β-delayed neutrons and tritons

T. Bjornstad at al., Nucl. Phys. A366(1981)461



M. Borge *et al.*, Nucl. Phys. A460 (1986) 373



Results of multi-level, multi-channel R-matrix analysis:

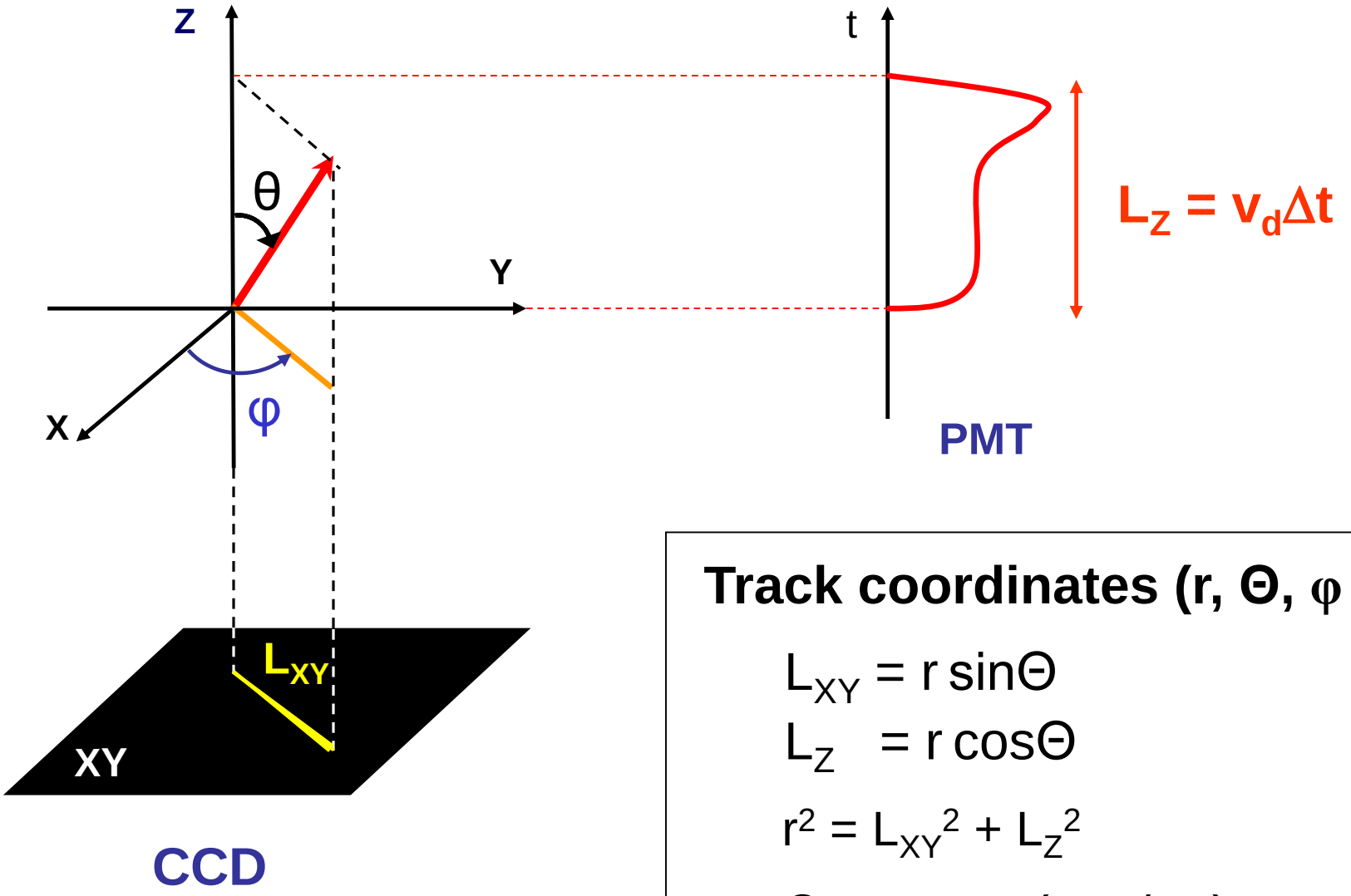
$E_x(1^+)$ = **9.1** MeV

BR = **2.4 %**

B(GT) = **3.1**

F.C. Barker at al., Nucl. Phys. A487 (1988) 269

Track reconstruction in OTPC



Track coordinates (r, Θ, φ)

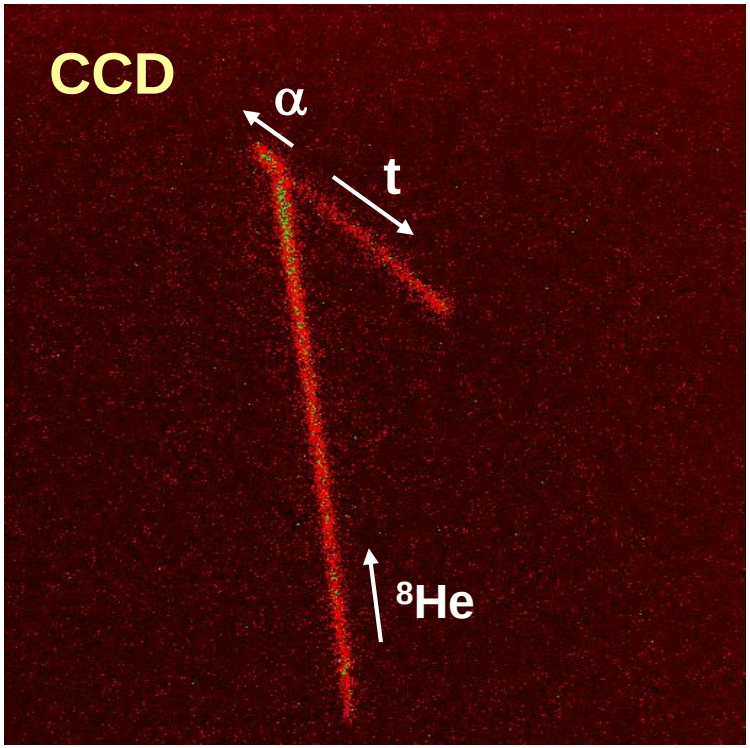
$L_{XY} = r \sin\Theta$

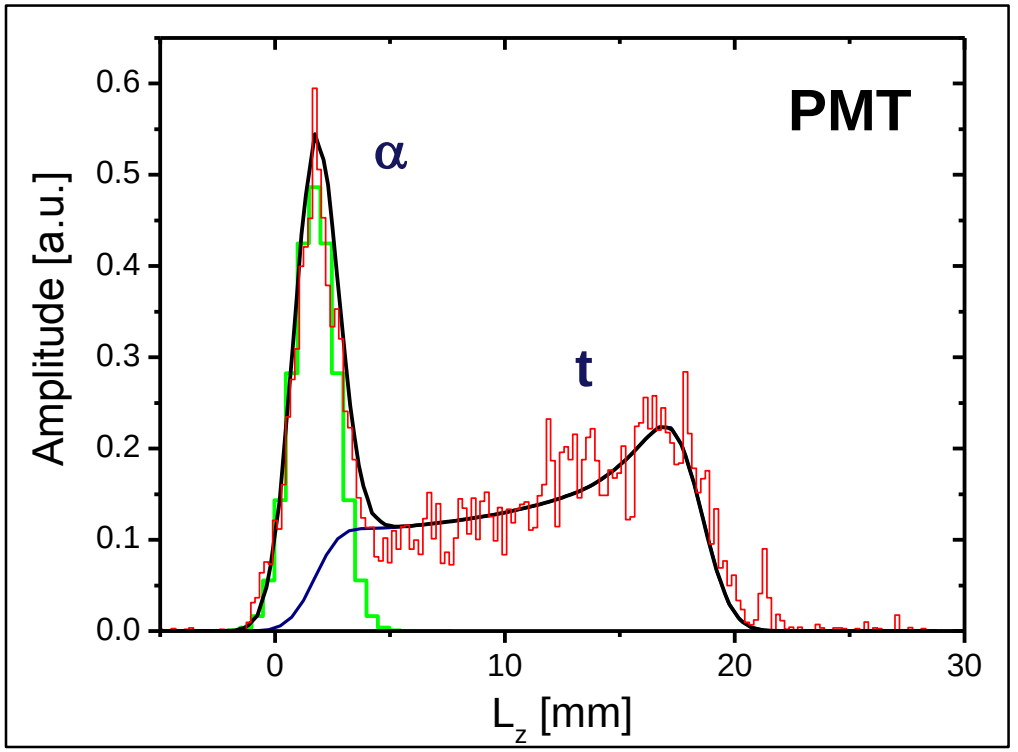
$L_Z = r \cos\Theta$

$r^2 = L_{XY}^2 + L_Z^2$

$\Theta = \arctan(L_{XY}/L_Z)$

Reconstruction of α-t-n decay events





α:

E = 1150 keV
Θ = 92°
φ = 173°

t:

E = 2570 keV
Θ = 80°
φ = 0°

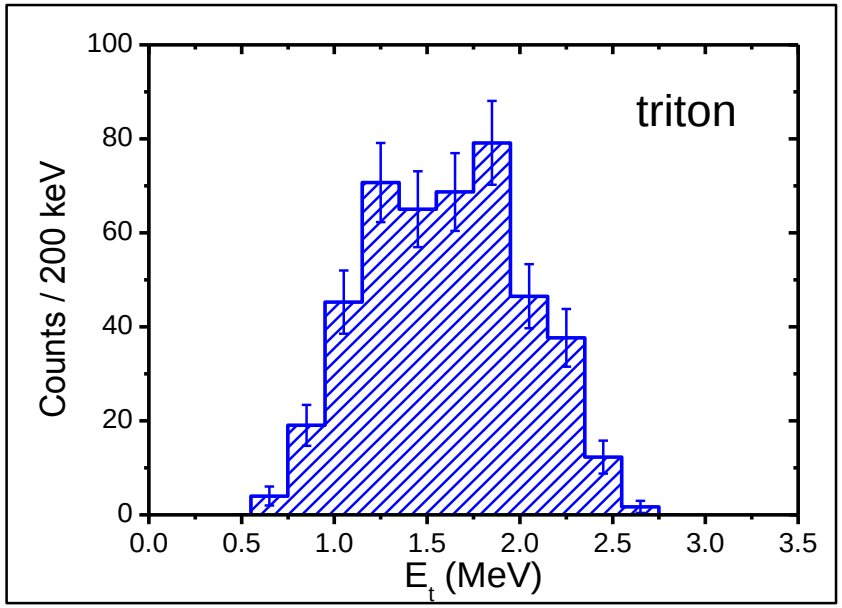
n:

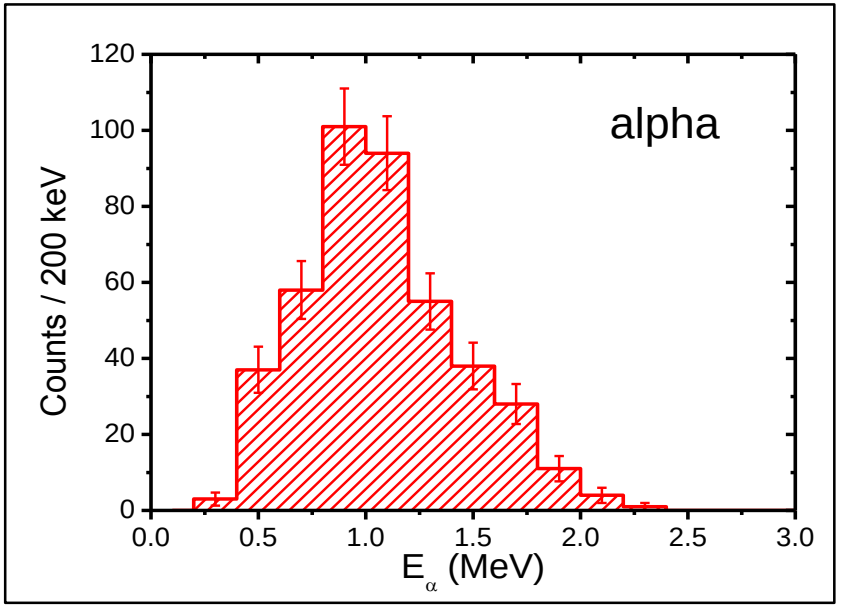
E = 610 keV

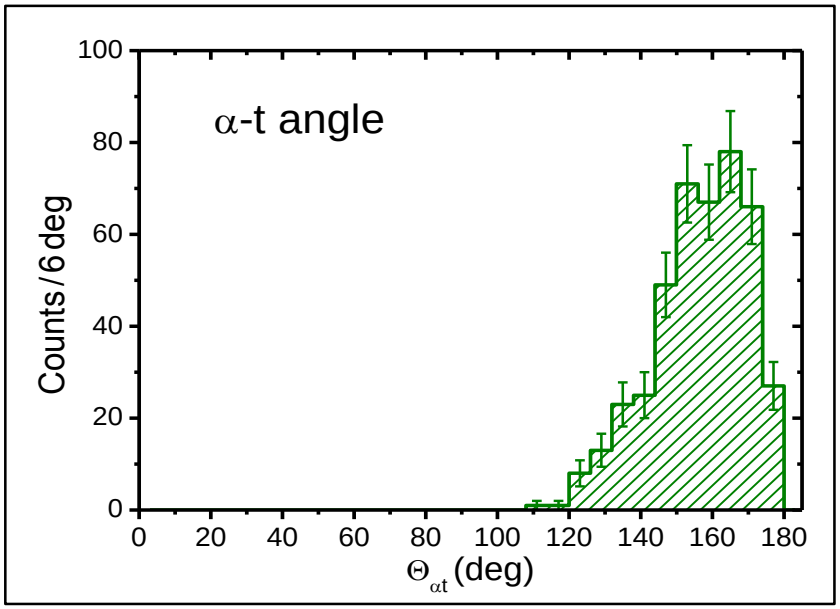
Q = 4.3 MeV

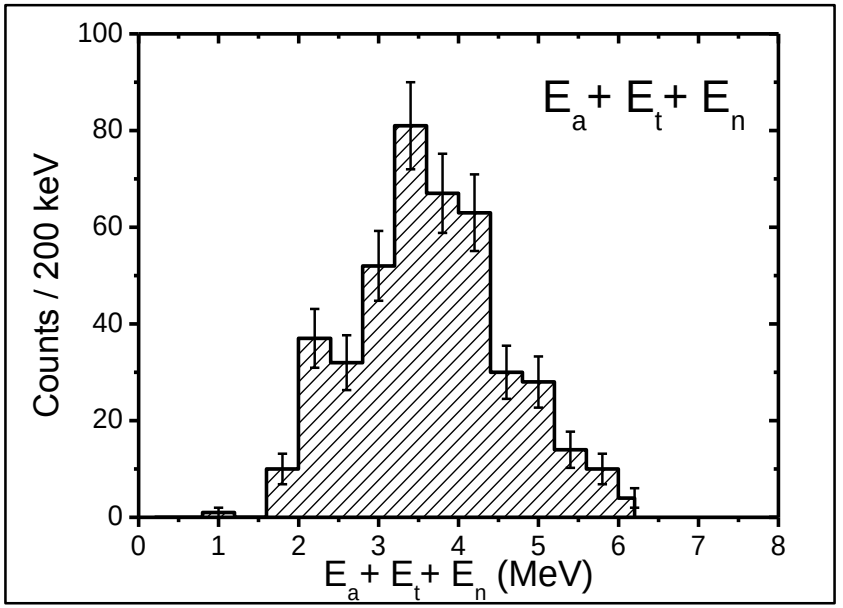
S. Mianowski, PhD thesis

Measured spectra

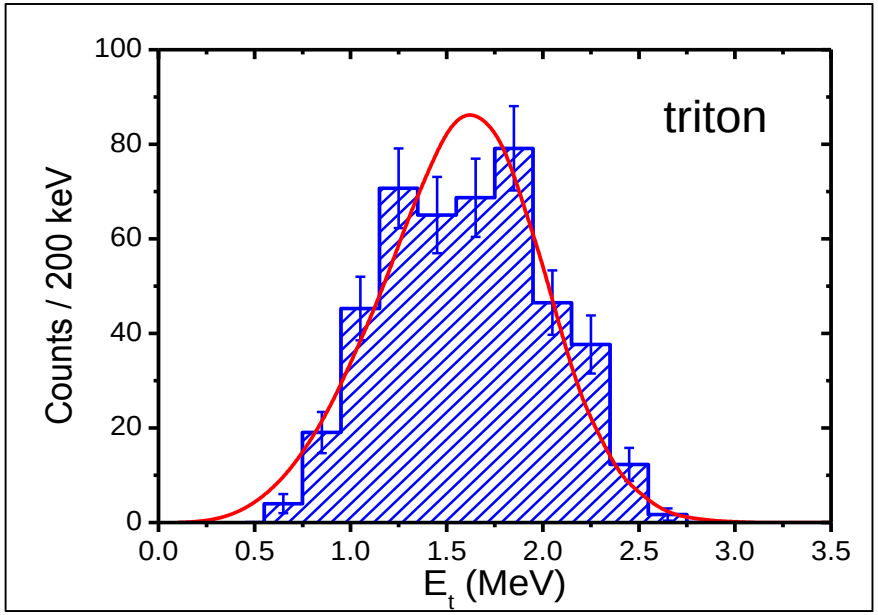


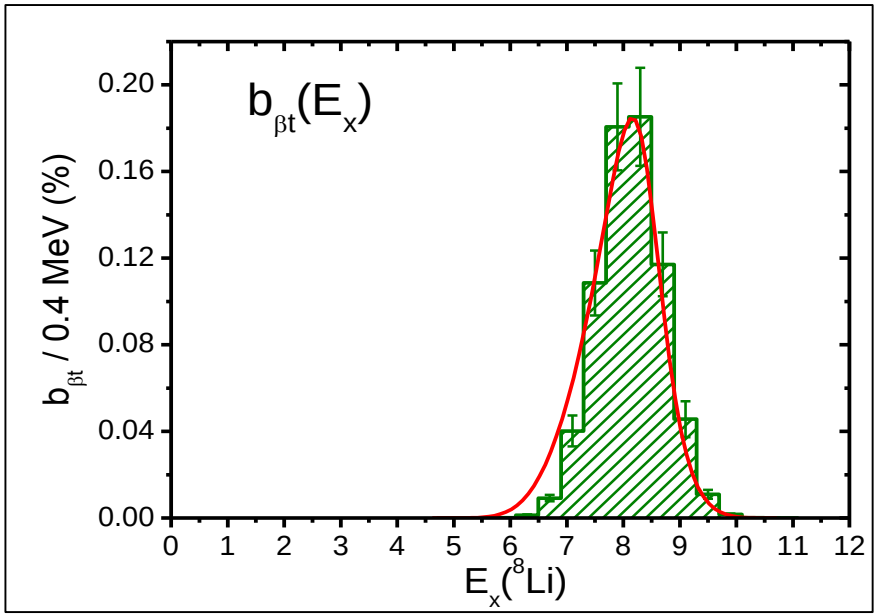






Fit results





Assumption

- all neutrons from 1^+(8.3 MeV) state

Constrains

$\Sigma b_{\beta n} = 16\%$

$\frac{n_1}{n_0 + n_1} = 32\%$

Best fit

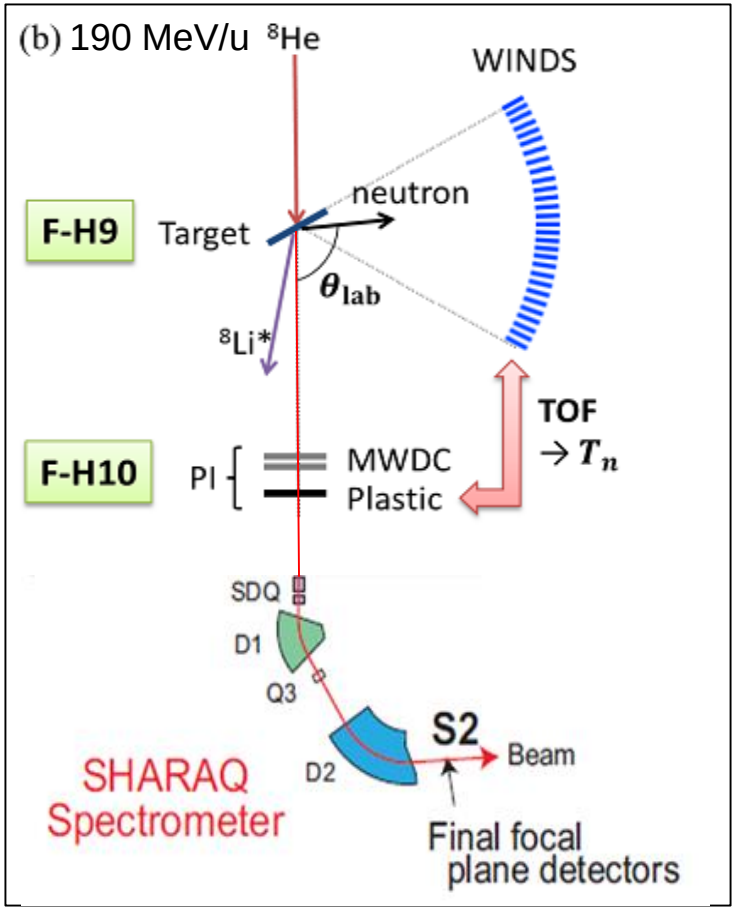
$E_x(1^+) = \mathbf{8.3} \pm 0.2$ MeV

$\Gamma = \mathbf{1.5} \pm 0.2$ MeV

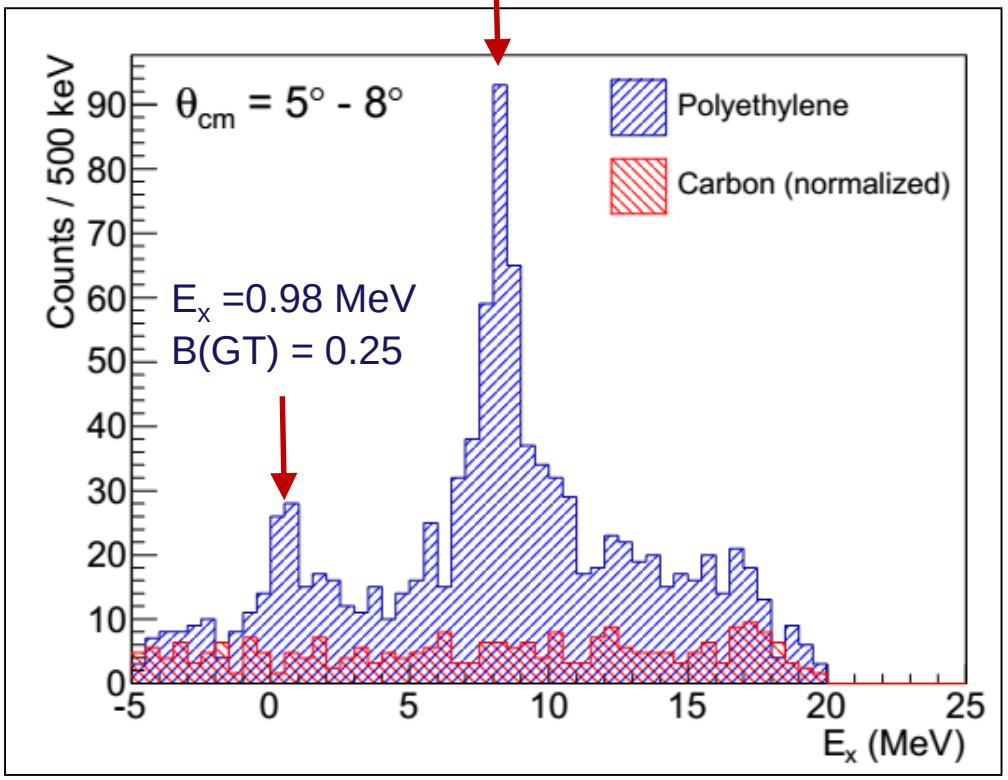
B(GT) = **4.6** ±1.6

B(GT) from ^{8}He(p,n)^{8}Li reaction

$$\frac{d\sigma}{d\Omega}(0^\circ) = \hat{\sigma}_{GT} \cdot F(q,\omega) \cdot B(GT)$$

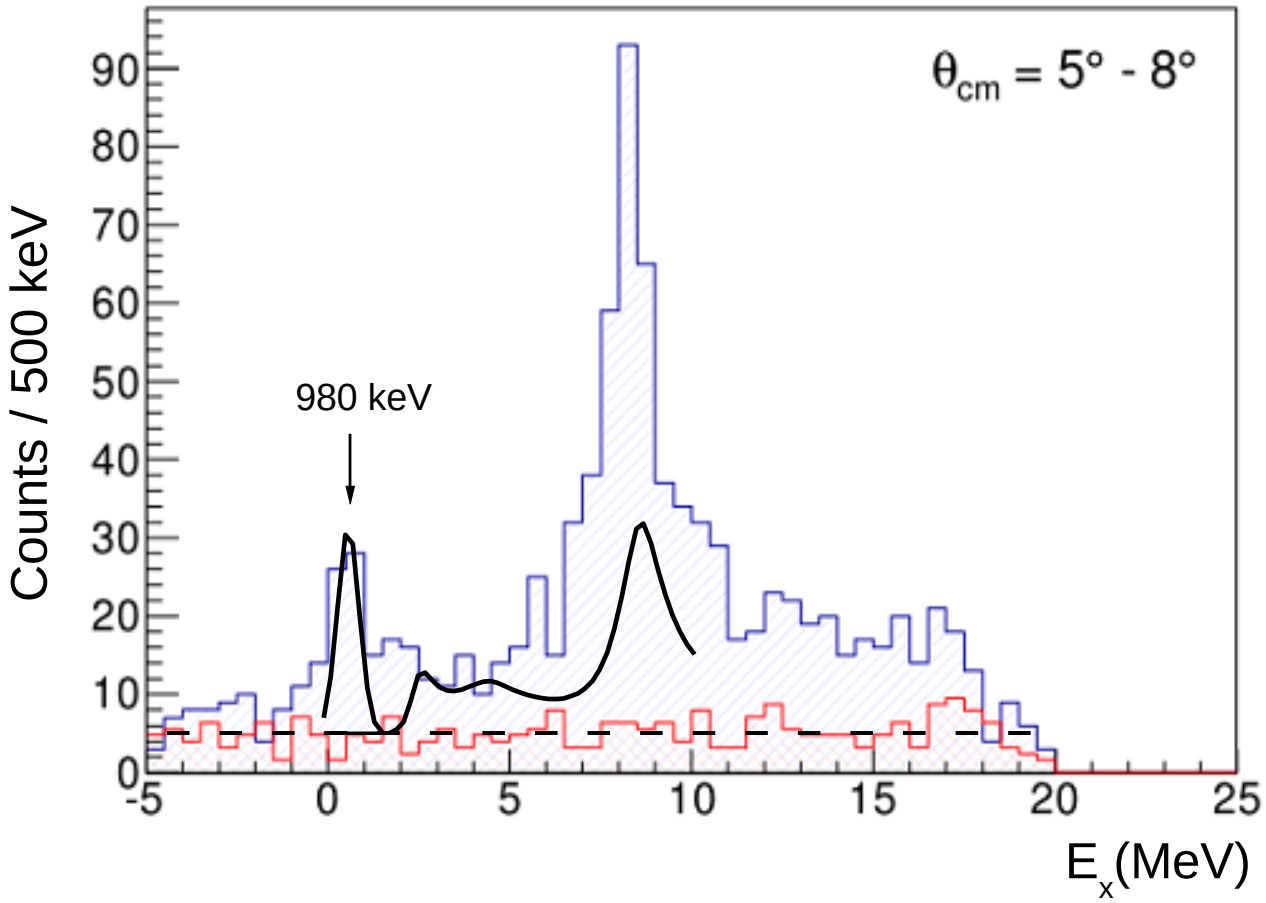


E_x ~ 8 MeV
B(GT) = 8±4



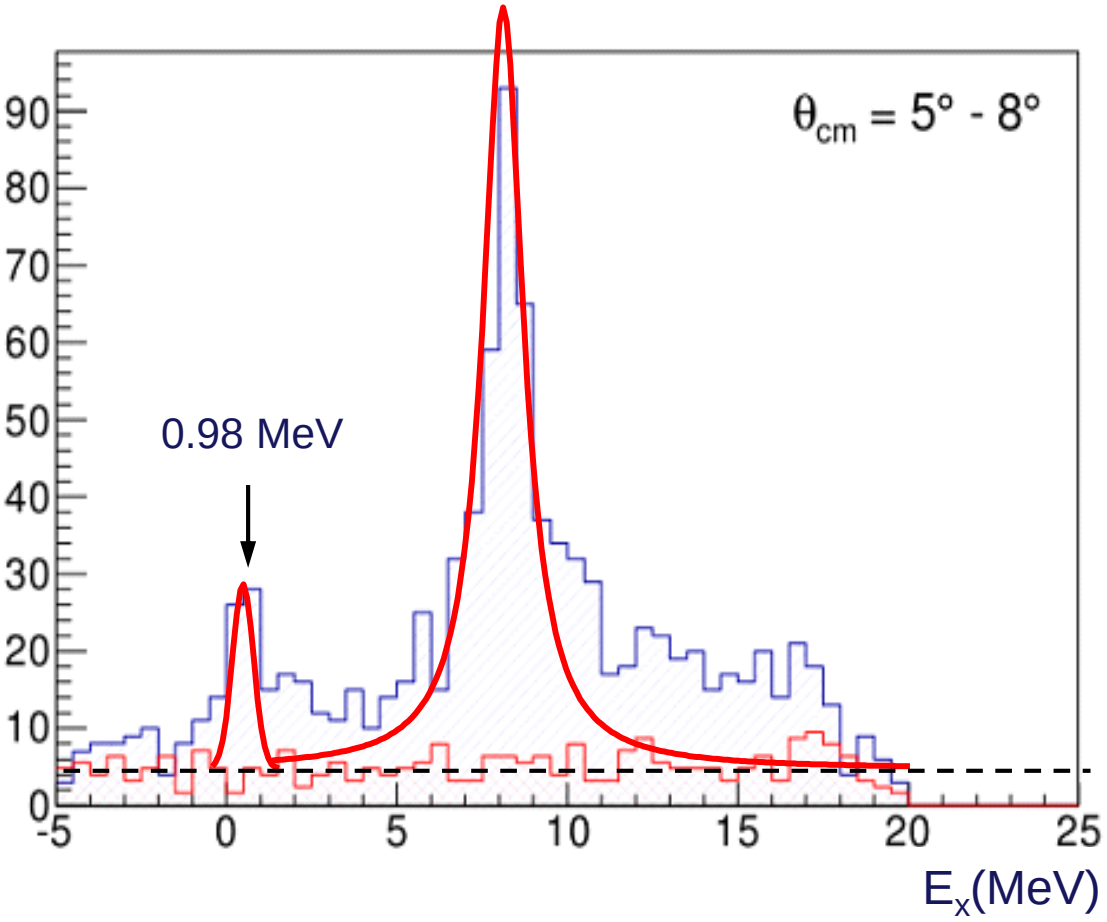
M. Kobayashi et al., JPS Conf. Proc., 013034 (2014)

$B(GT)_{\beta n}$ from Barker88 vs $B(GT)_{\beta n}$ from (p,n) reaction



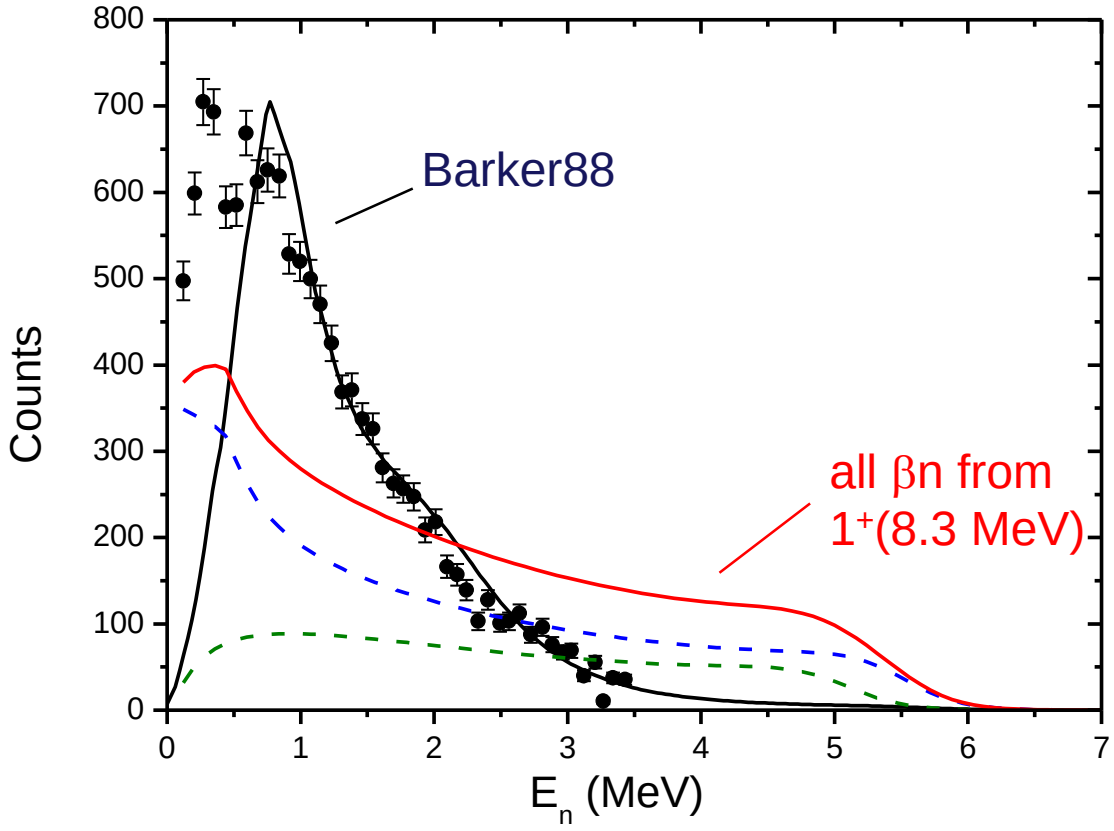
Inconsistency of B(GT) in the βn branch !

$B(GT)_{\beta n}$ for all βn from 8.3 MeV vs $B(GT)_{\beta n}$ from (p,n) reaction



Much better agreement, but…

β-delayed neutrons from ^{8}He decay



Defficiencies of the know βn spectrum:

- energies measured only up to ~3.5 MeV
- correction for the response function ??

Experiment

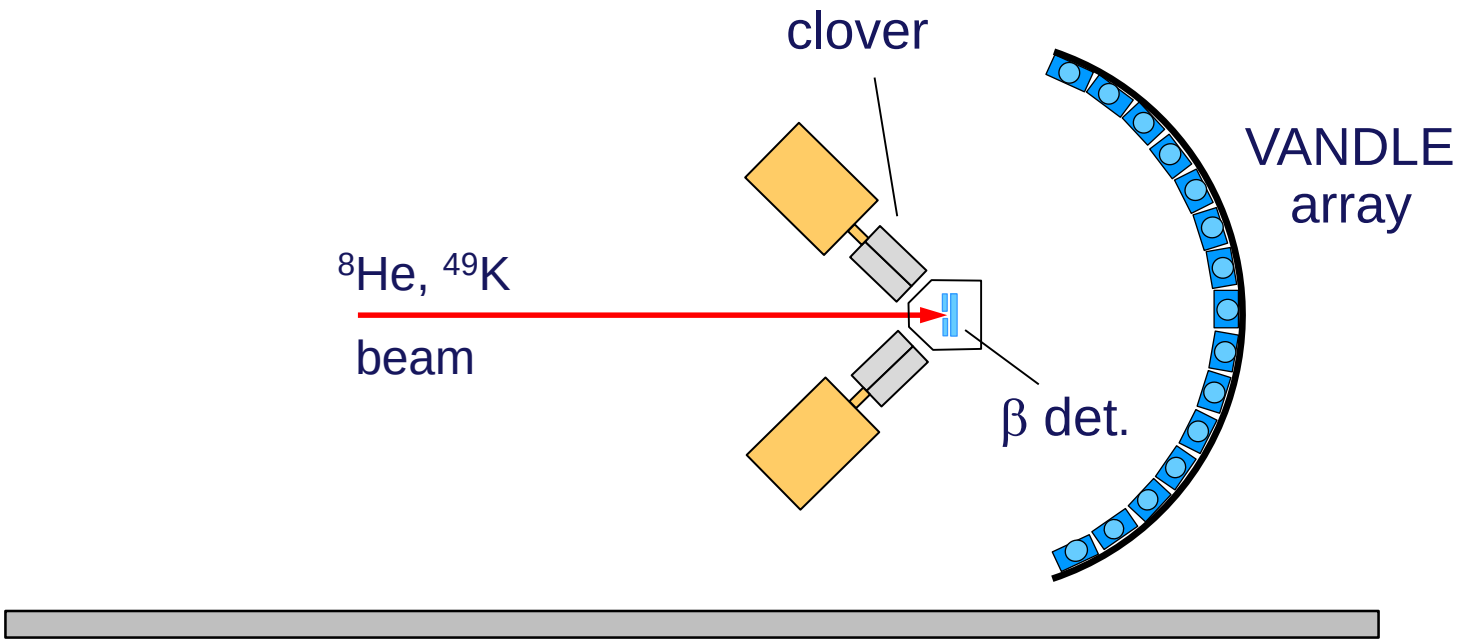
- production of ^{8}He

  p + UC_x target

- separation

  GPS + FEBIAD type ion source with cooled transfer line

- detection setup at IDS



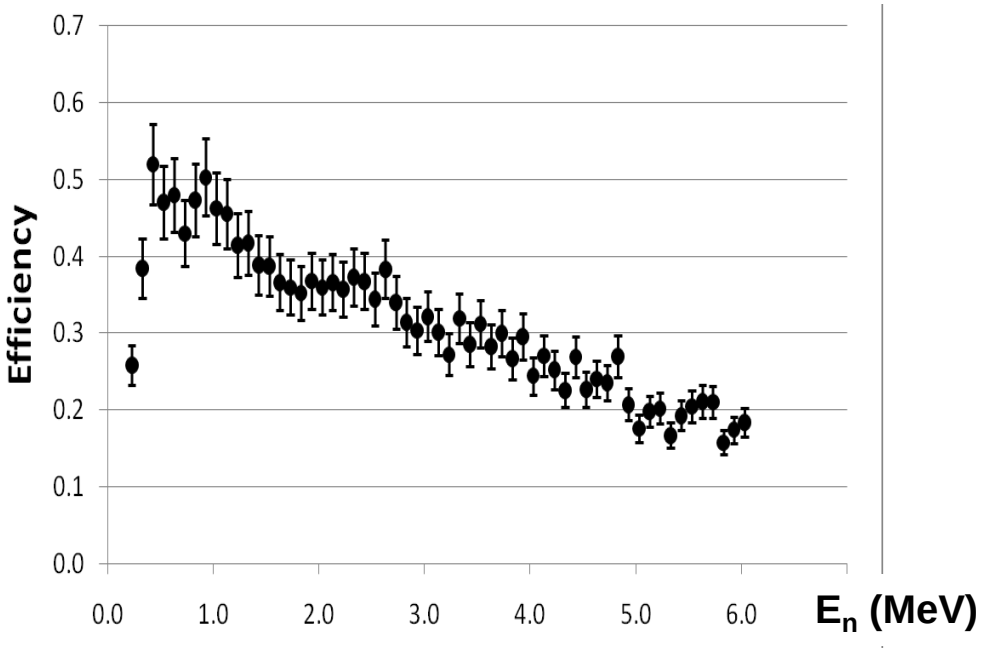
Versatile **A**rray of **N**eutron **D**etectors at **L**ow **E**nergies

- neutron Time of Flight spectrometer

  4π plastic scintillator β-particle detector

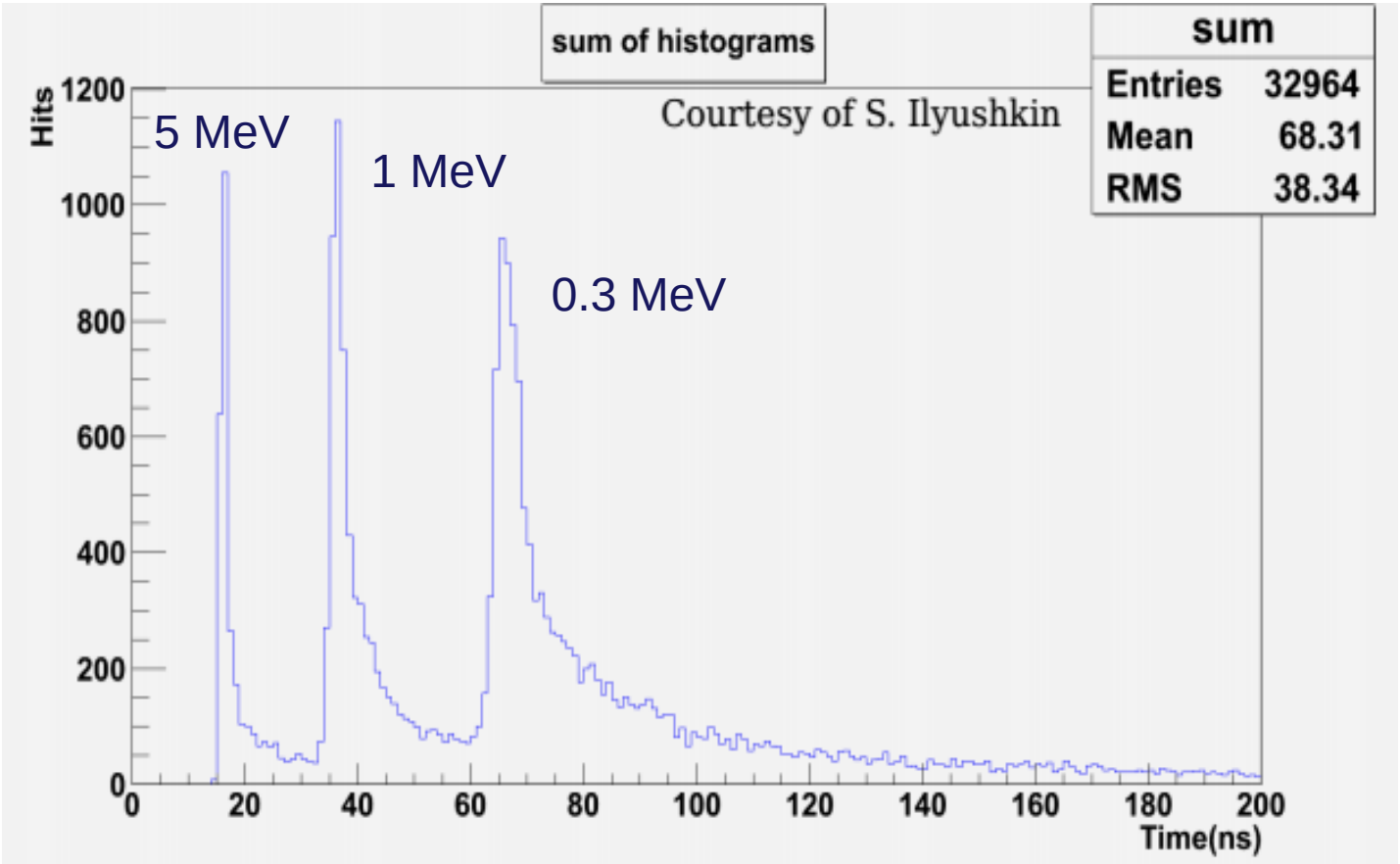
  32 of $3\times6\times120$ cm^3 plastic scintillator neutron detectors

- digital signal processing
- energy resolution from 6% at 1MeV to 15% at 6 MeV
- solid angle coverage of 18% of 4π
- intrinsic efficiency

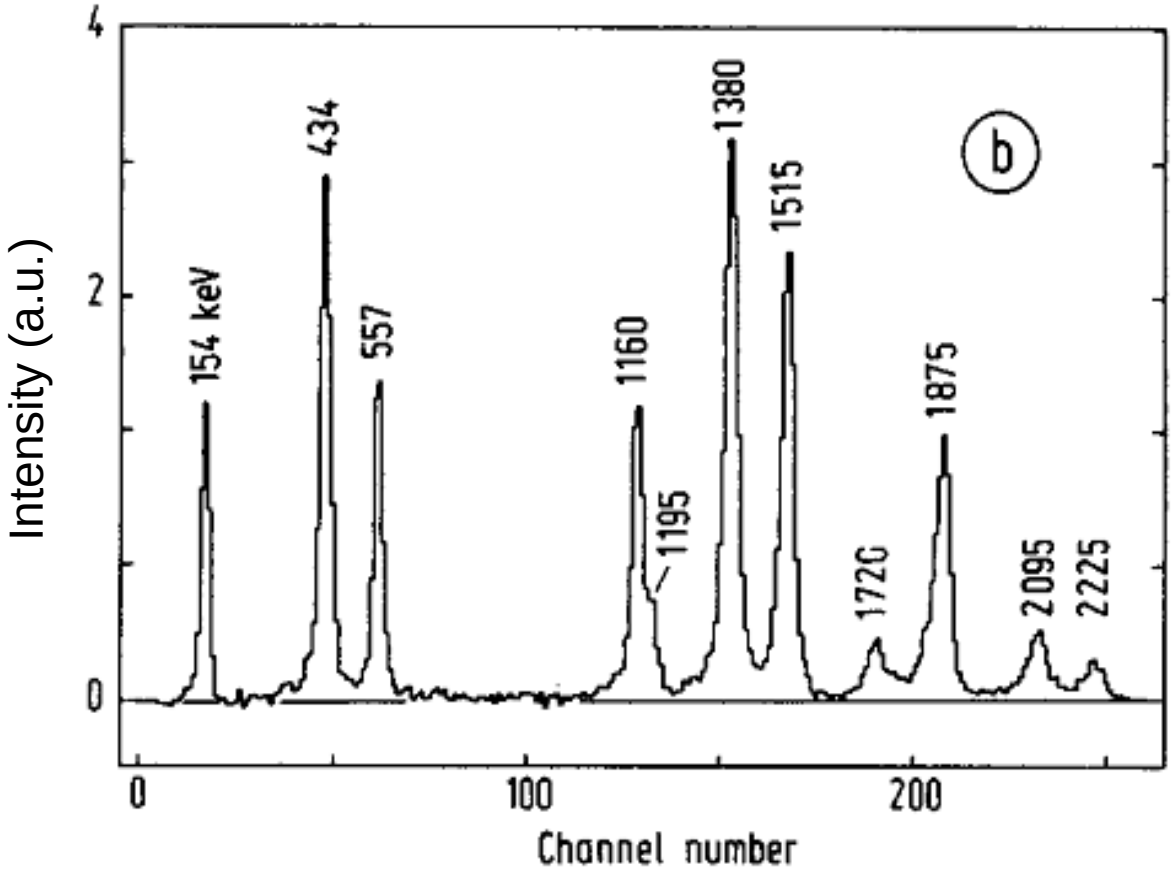


Response function of VANDLE

- specific to the setup configuration
- simulations and test measurements are needed



Energy spectrum of β-delayed neutrons from ^{49}K ($T_{1/2}$=1.3 s)



H. Ohm et al., NIM A256(1987)76

Beam time estimate

Isotope	P_n	Yield ions/s	Efficiency	Neutrons (n/hour)	Shifts
^{8}He	P_{n0+n1}= 16%	5000	ε_n = 6.3%	1.7 $\times 10^5$	**5**
	P_{n1} = 5%		ε_n= 6.3% ε_g = 8%	4.3 $\times 10^3$	
^{49}K (calibration)	86%	5000	ε_n = 6.3%	9 $\times 10^5$	**2**

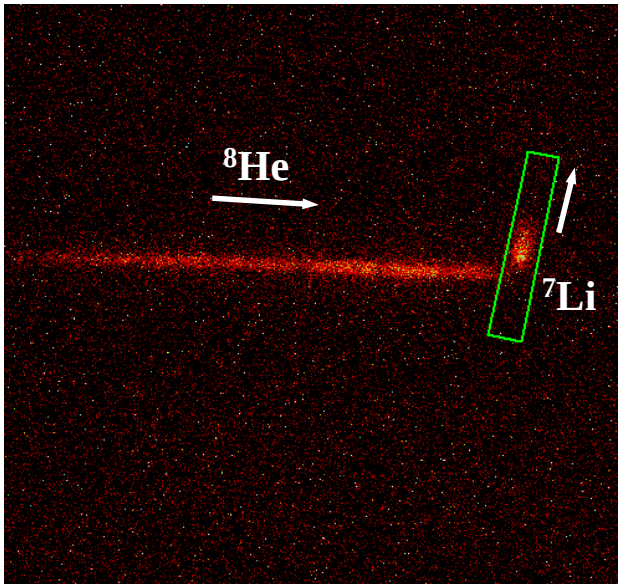
Beam time request

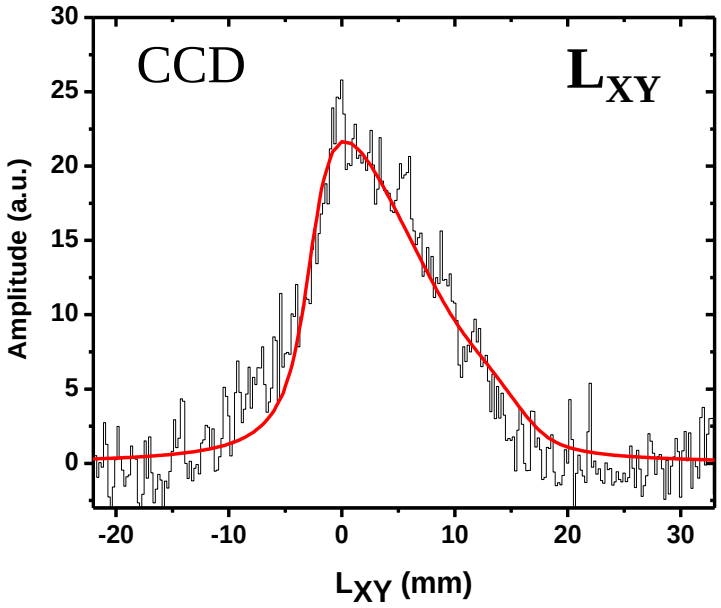
5 shifts for ^{8}He β-delayed neutron decay study

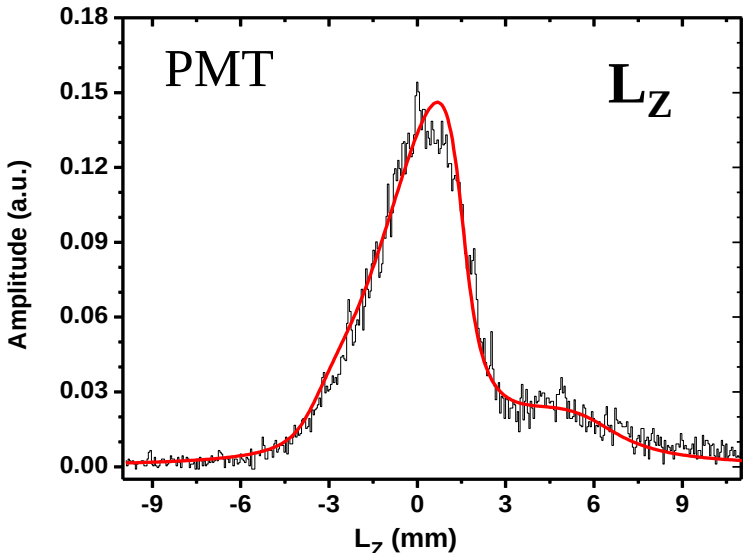
2 shifts for ^{49}K calibration source measurement

β-delayed neutron emission in ^{8}He decay

- detection of ^{7}Li recoil







$L = (21 \pm 2)$ mm

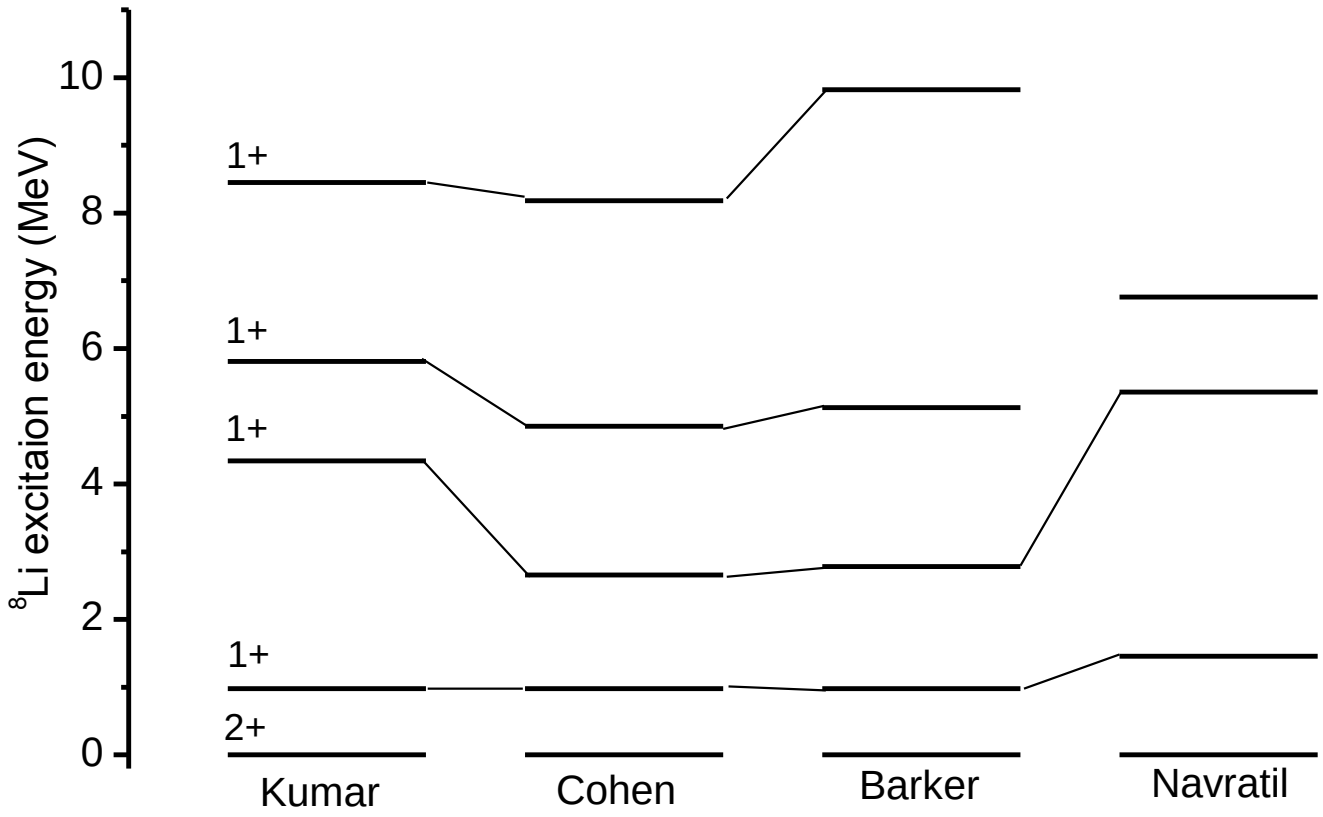
$E = (800 \pm 50)$ keV

$\Theta = (105 \pm 10)°$

$\varphi = (83 \pm 5)°$

$Q = (6.4 \pm 0.4)$ MeV

Predicted positions of the 1^+ states in ^{8}Li



N. Kumar, Nucl. Phys. A225(1974) 221

S. Cohen et al., Nucl. Phys. 83 (1965) 1

F.C. Barker, Austr. J. Phys. 34(1981) 7

P. Navratil et al., Phys. Rev C. 57(1998) 3119