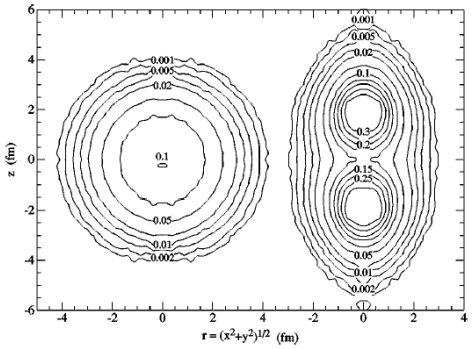
Structure of Be and B isotopes using break-up reactions

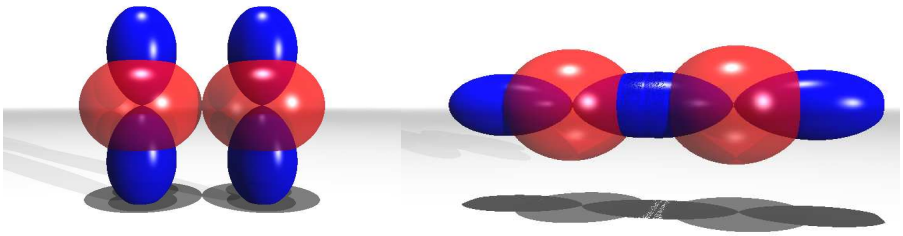
Martin Freer – University of Birmingham



Greens function Monte Carlo

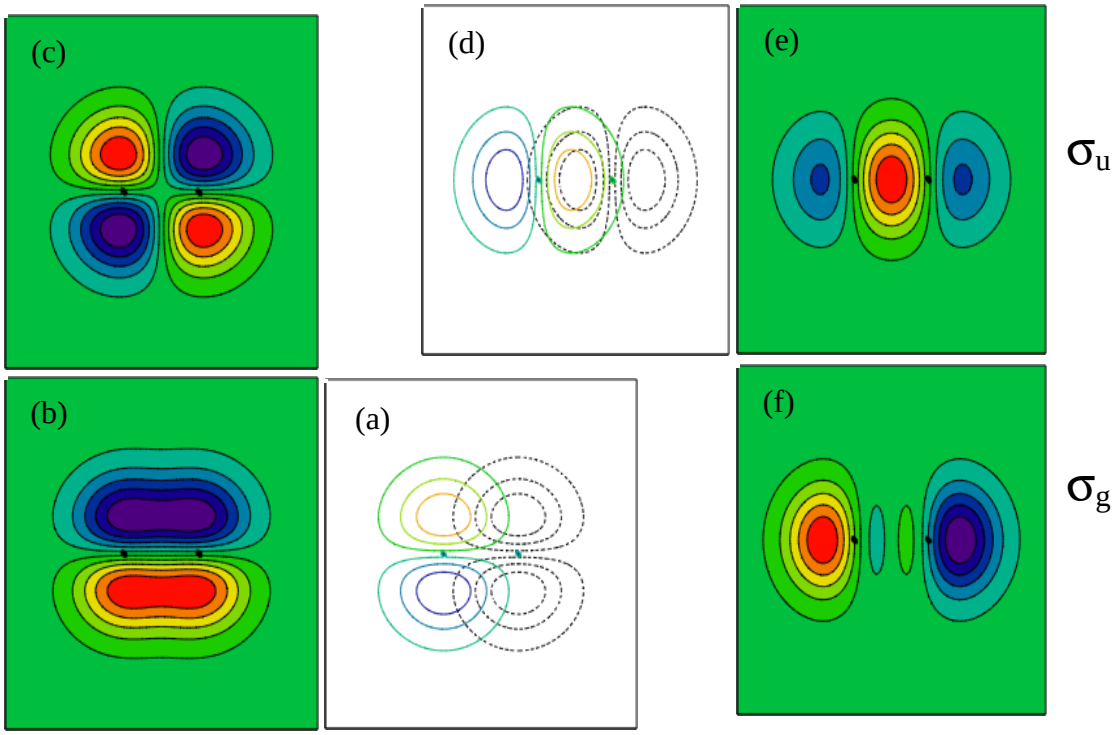
R. B. Wiringa, Steven C. Pieper, J. Carlson, and V. R. Pandharipande, Phys. Rev. C **62**, 014001 (2000)

Neutron-rich Beryllium Isotopes



π_u

π_g



σ_u

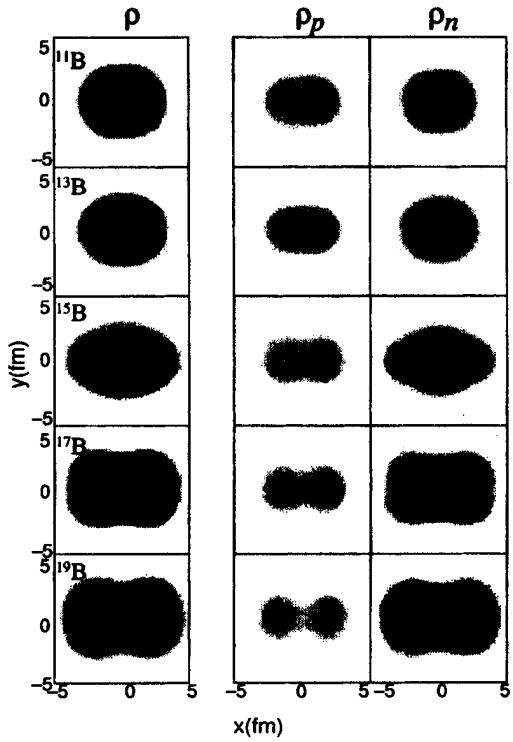
σ_g

Molecular Orbit approach – Itagaki *et al.*

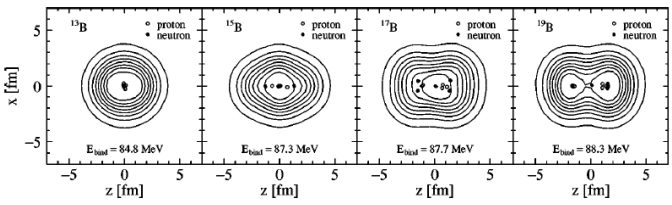
Gain in binding 1.5 MeV – von Oertzen

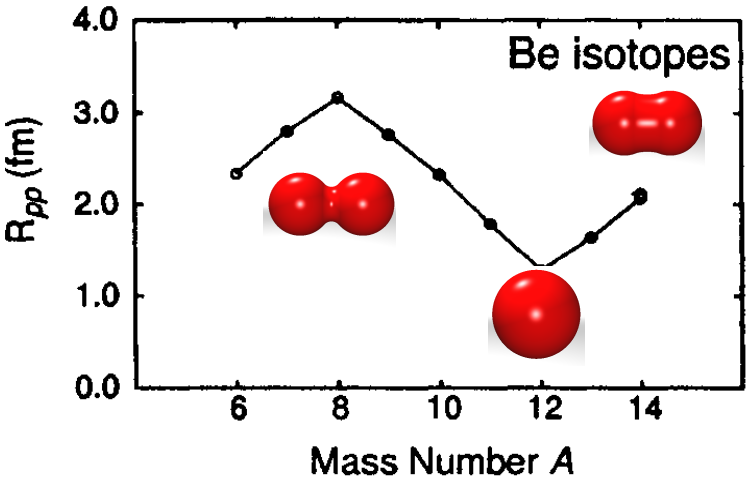
Clustering in ground states of Boron Isotopes

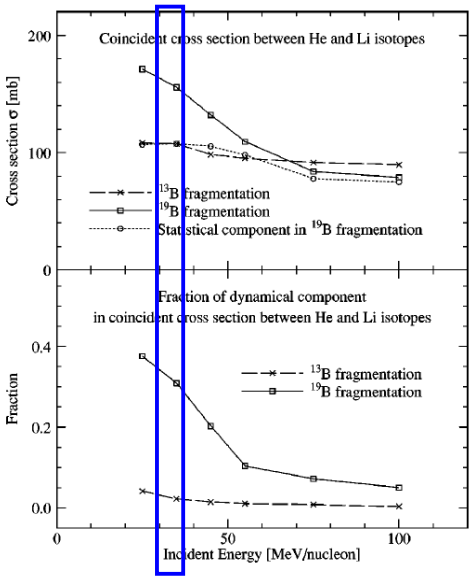
AMD –
Kanada En'yo,
Horiuchi, *et al.*



Phys. Rev. C
63(2001) 034615

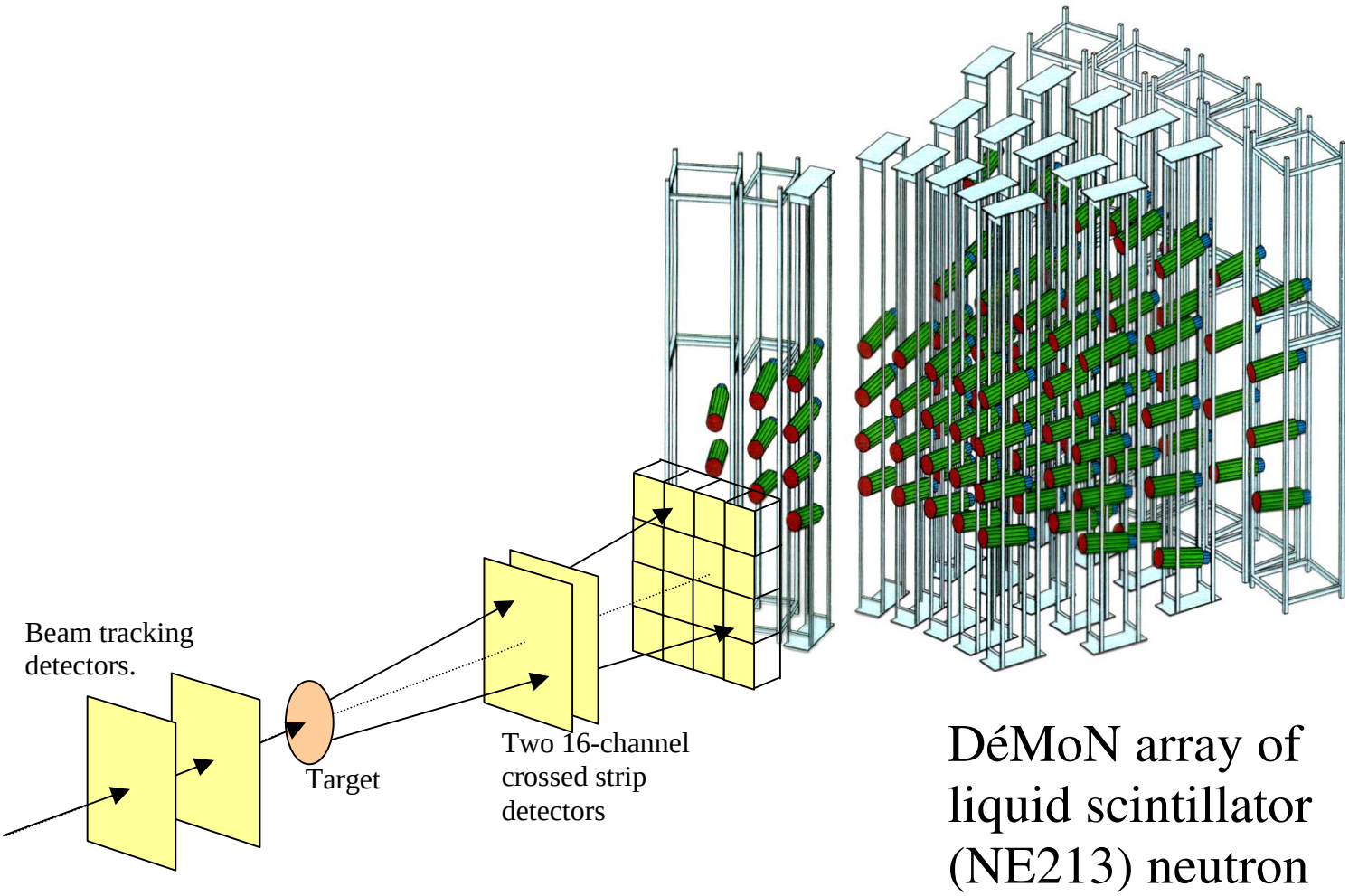






AMD – Kanada En'yo, Horiuchi, *et al.*, *1995*

Experimental Probes?



DéMoN array of liquid scintillator (NE213) neutron detectors

Beams:

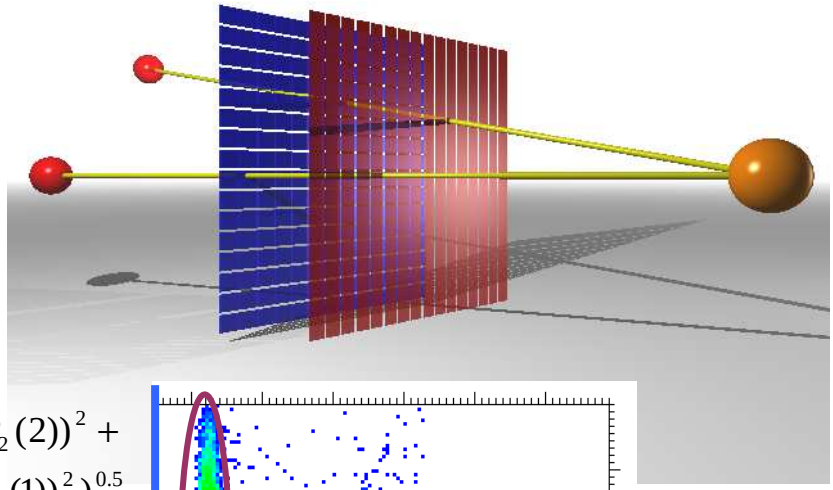
^{10}Be, ^{11}Be, ^{12}Be, ^{14}Be and ^{14}B

30.9, 41.7, 41.8, 34.4 and 40.8 MeV/nucleon

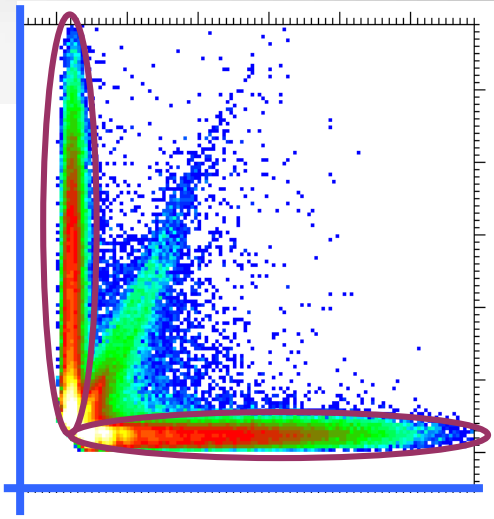
10^4 pps 50 pps

Produced and separated using LISE3@GANIL

Multiplicity 2 events

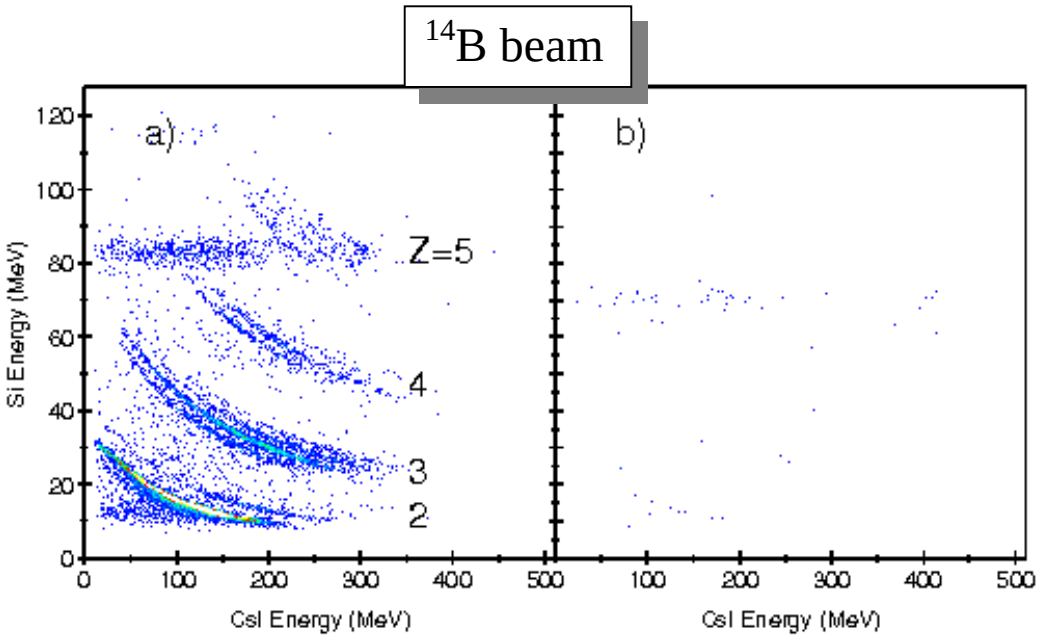


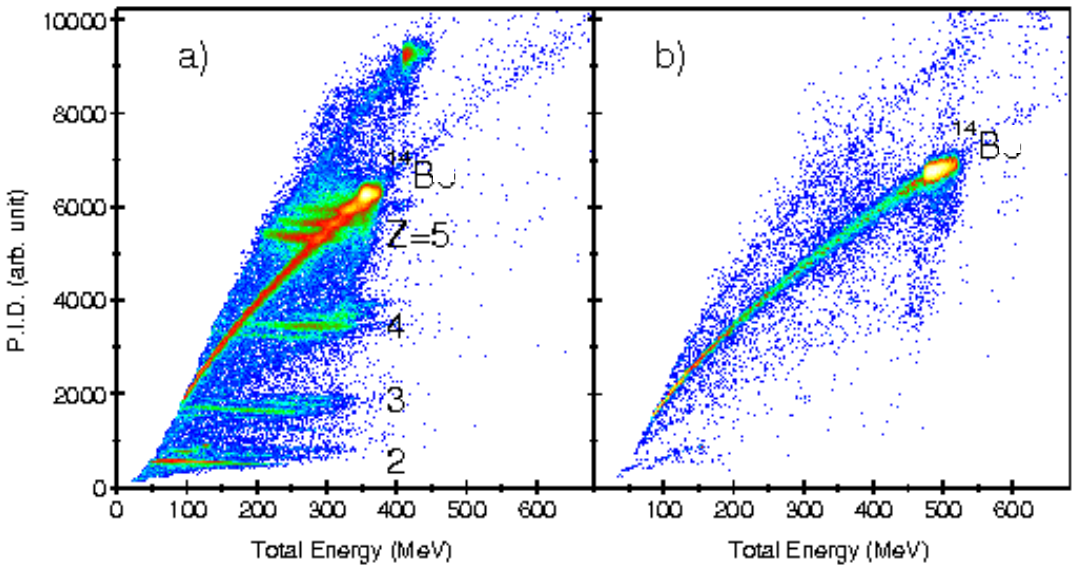
$((P_1(1)-P_2(2))^2 +$
$(P_1(2)-P_2(1))^2)^{0.5}$

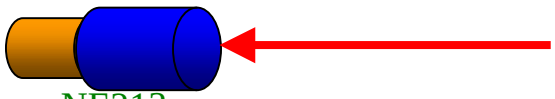


$((P_1(1)-P_2(1))^2 +$
$(P_1(2)-P_2(2))^2)^{0.5}$

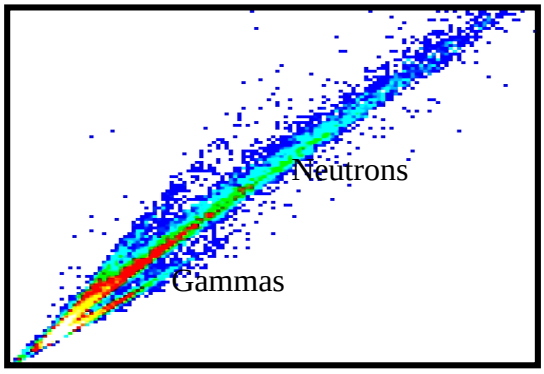
Particle Identification Spectra for M=2 events (with and without target).





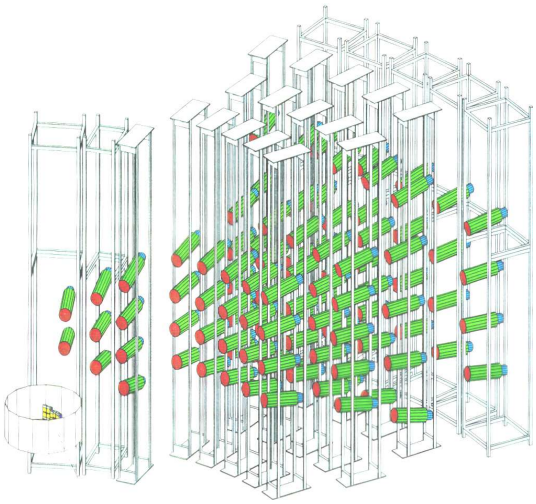


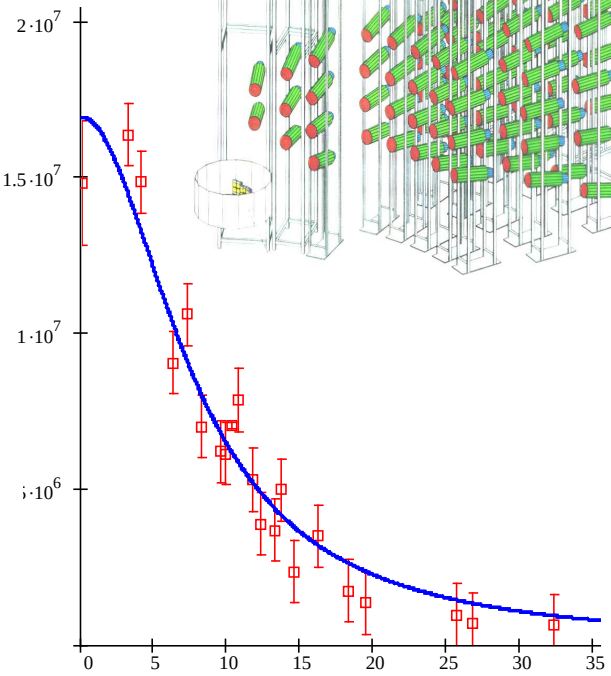
NE213



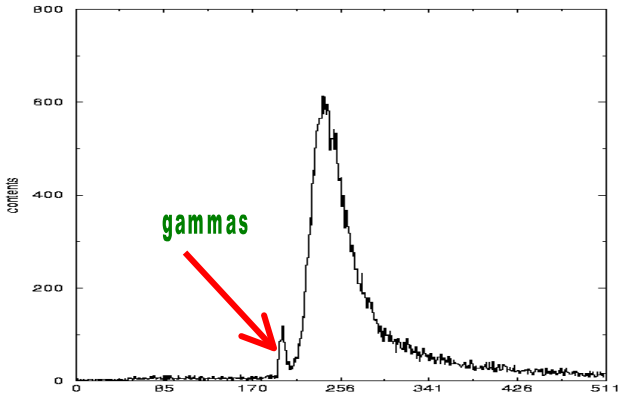
Fast

Total

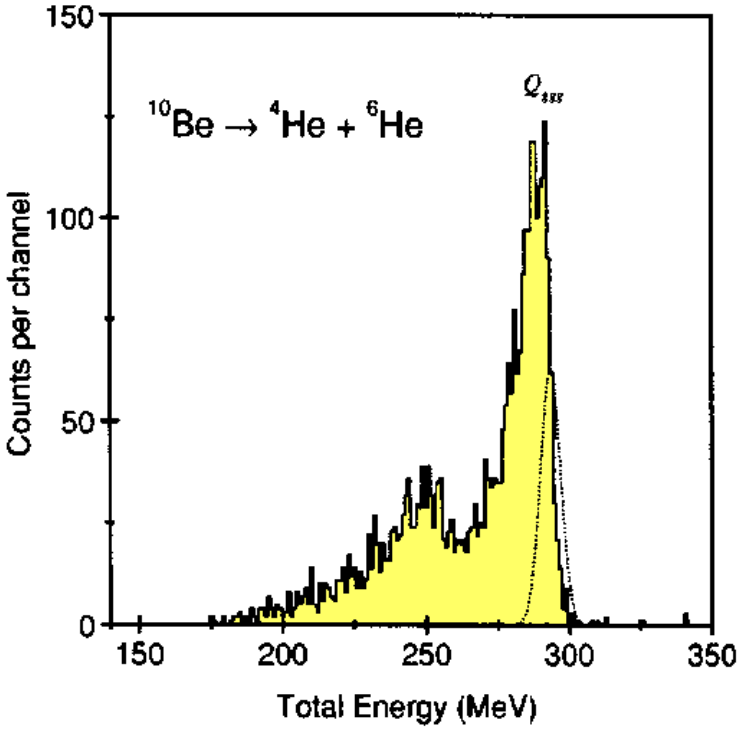


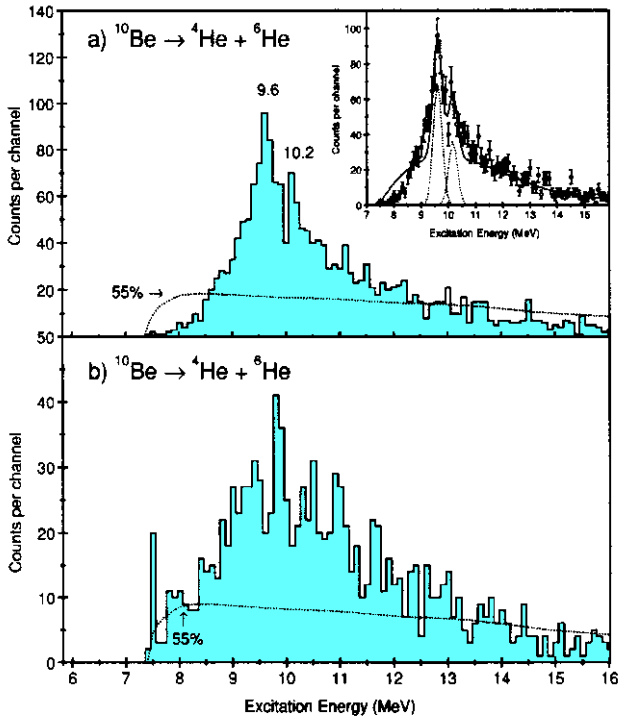


Neutron angle

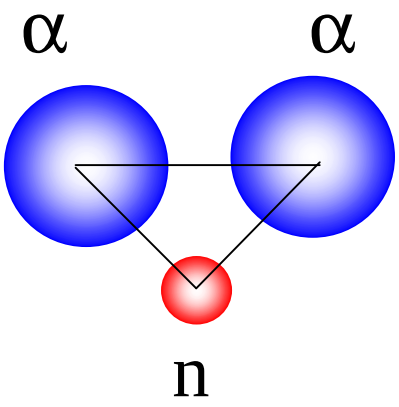


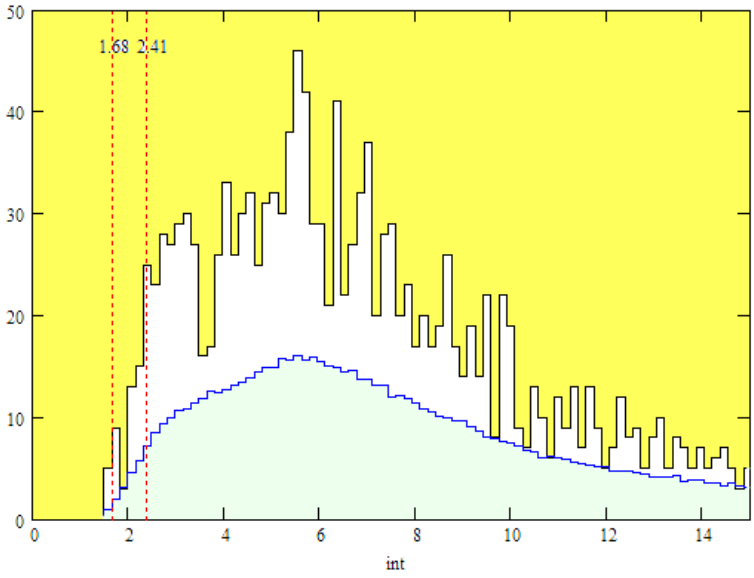
Time of flight

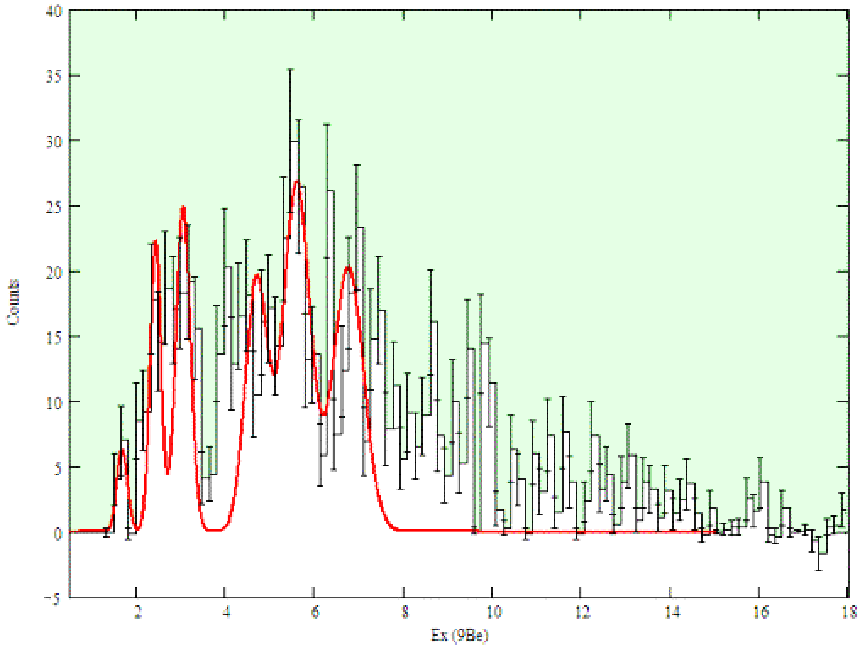




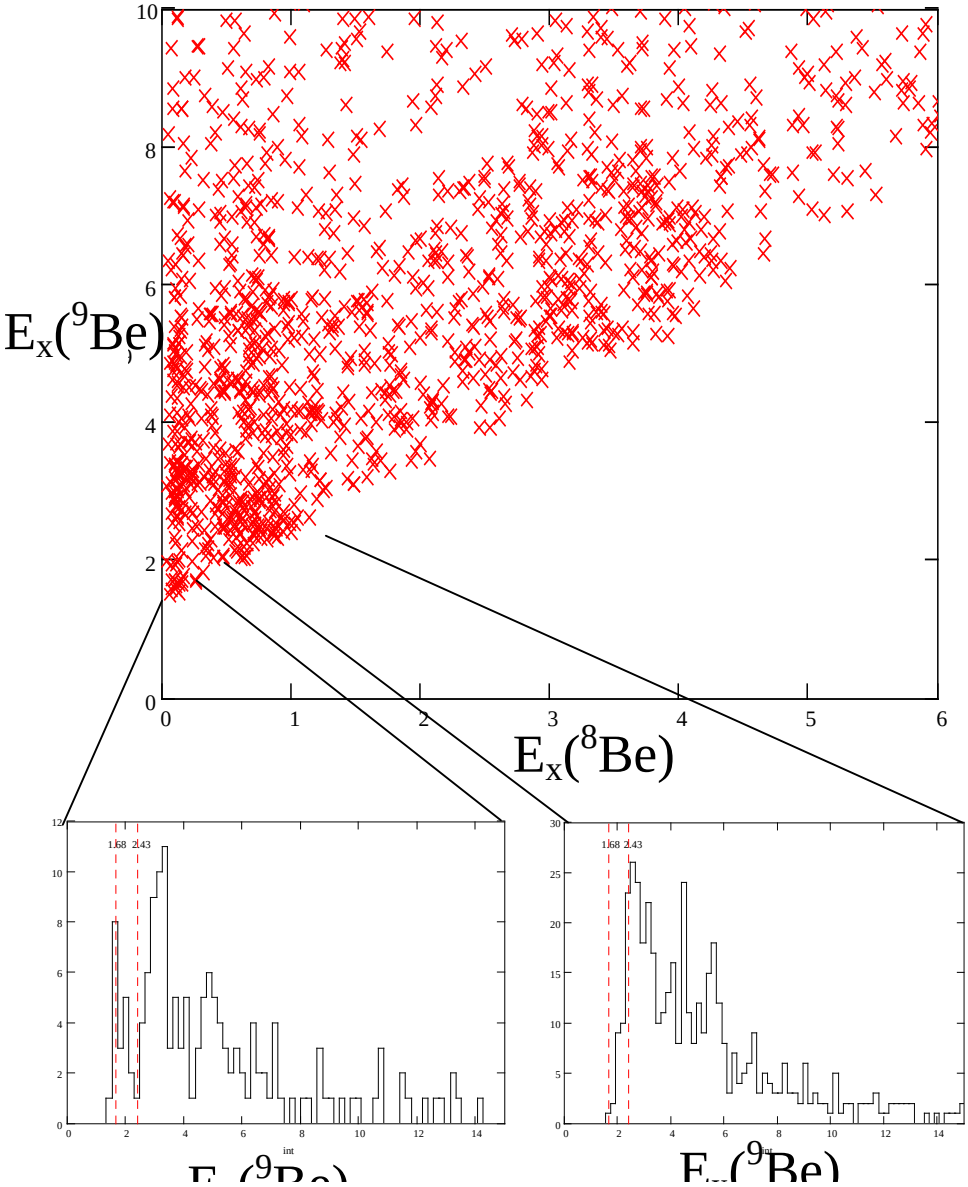
Ex(^{10}Be)	Cross section (mb)
9.6	0.24(0.02)
10.1	0.13(0.01)

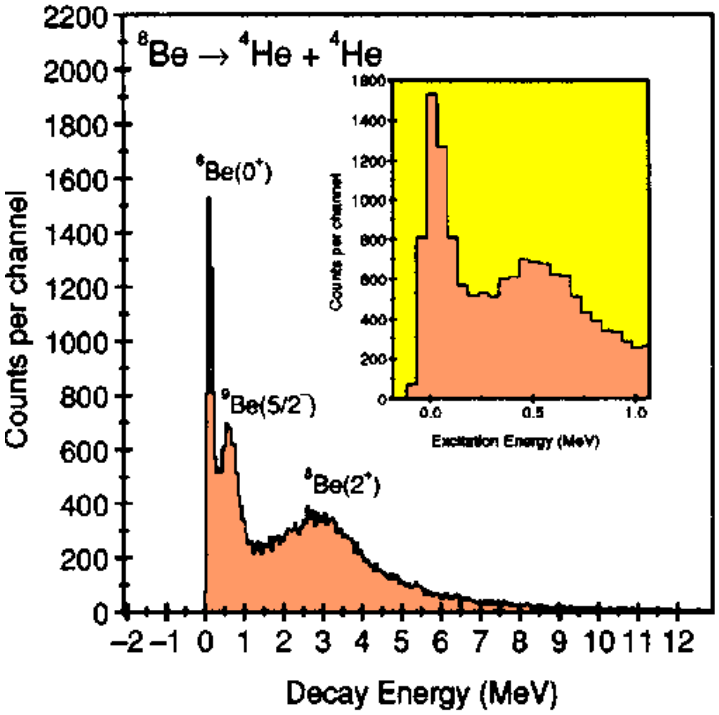

α
α
n


1.68
2.41
int


Counts
Ex (9Be)

Ex (MeV)	J^{π}	Decay to ^{8}Be gs	Decay to ^{8}Be (2^{+})	Cross section (mb)
1.68	$1/2^{+}$	100% *l=0*	~0 *l=2*	1.7
2.43	$5/2^{-}$	7.5% *l=3*	92.5% *l=1*	7.3
2.8	$1/2^{-}$	~100% *l=1*	~0% *l=1,3*	12.3
3.05	$5/2^{+}$	~100% *l=2*	~0% *l=0*	
4.70	$(3/2^{+})$	13% *l=2*	*l=0*	19.6
5.6	$(3/2^{-})$	*l=1*	*l=0*	37.5
6.4	$(7/2^{-})$	*l=3*	*l=1*	39.2
6.8	$(9/2^{+})$	<2% *l=4*	*l=2*	





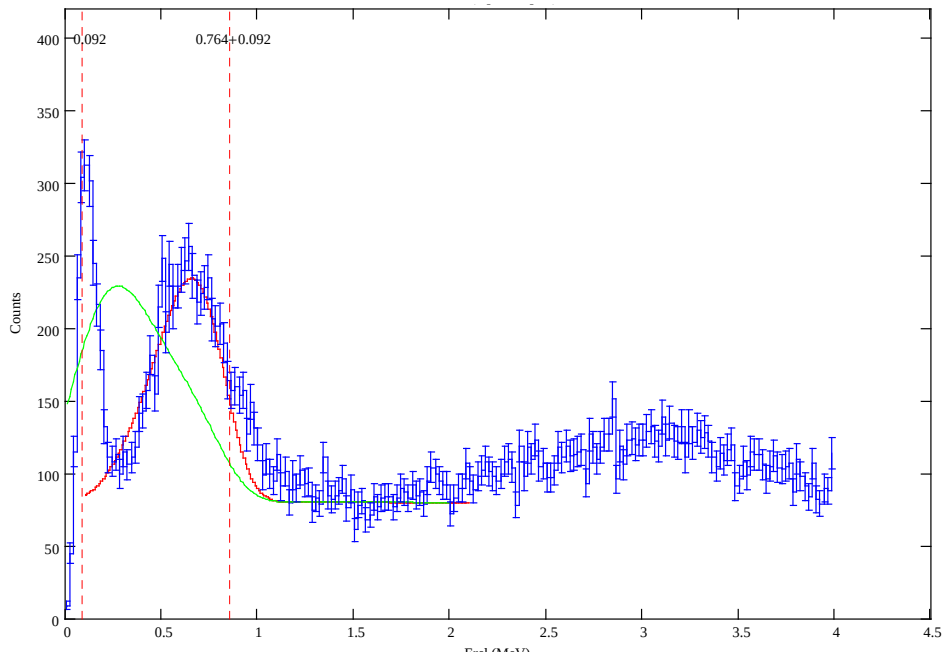
Ex (^{8}Be)	Cross section (mb)
gs	8.0(0.4)
2.9 (2^+)	21.6(1.1)
2.9 (2^+)/ $5/2^-$ (^{9}Be)	7.3(0.3)

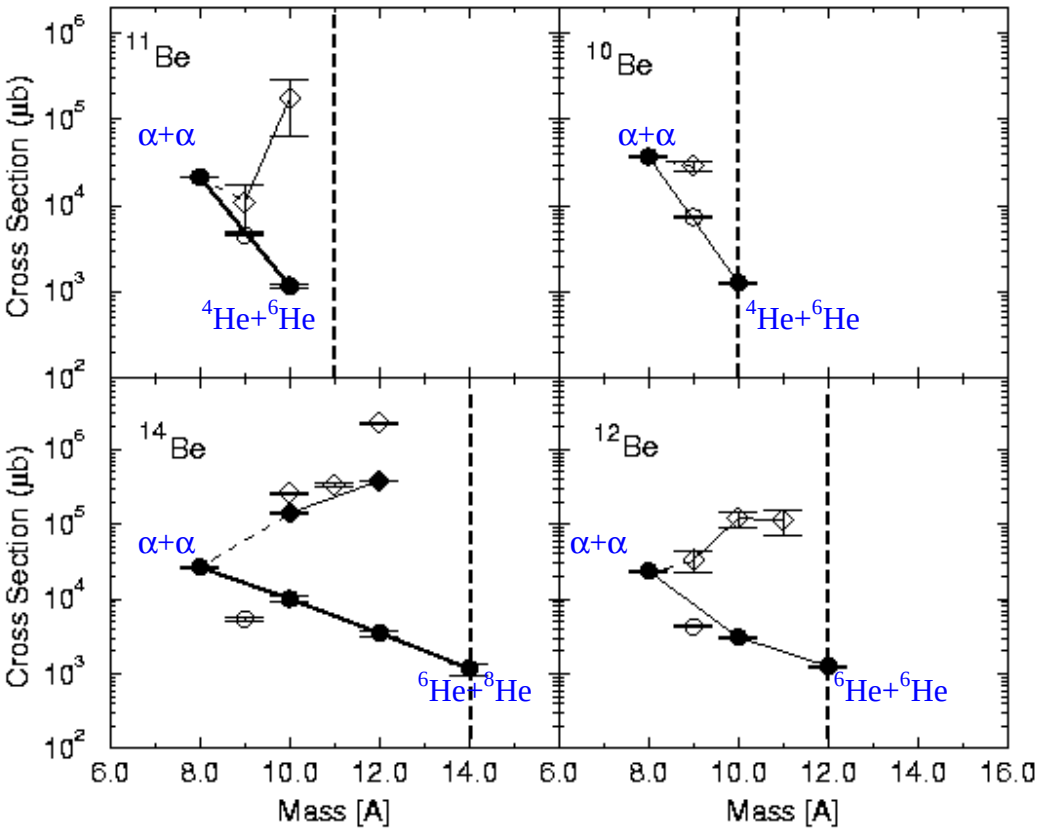
$$\frac{dN}{dE_n}(E_n) = A\{kRP_l(kR)\}_{Be-n}\left[\frac{\sin^2\beta_l}{kRP_l(kR)}\right]_{\alpha-\alpha}$$

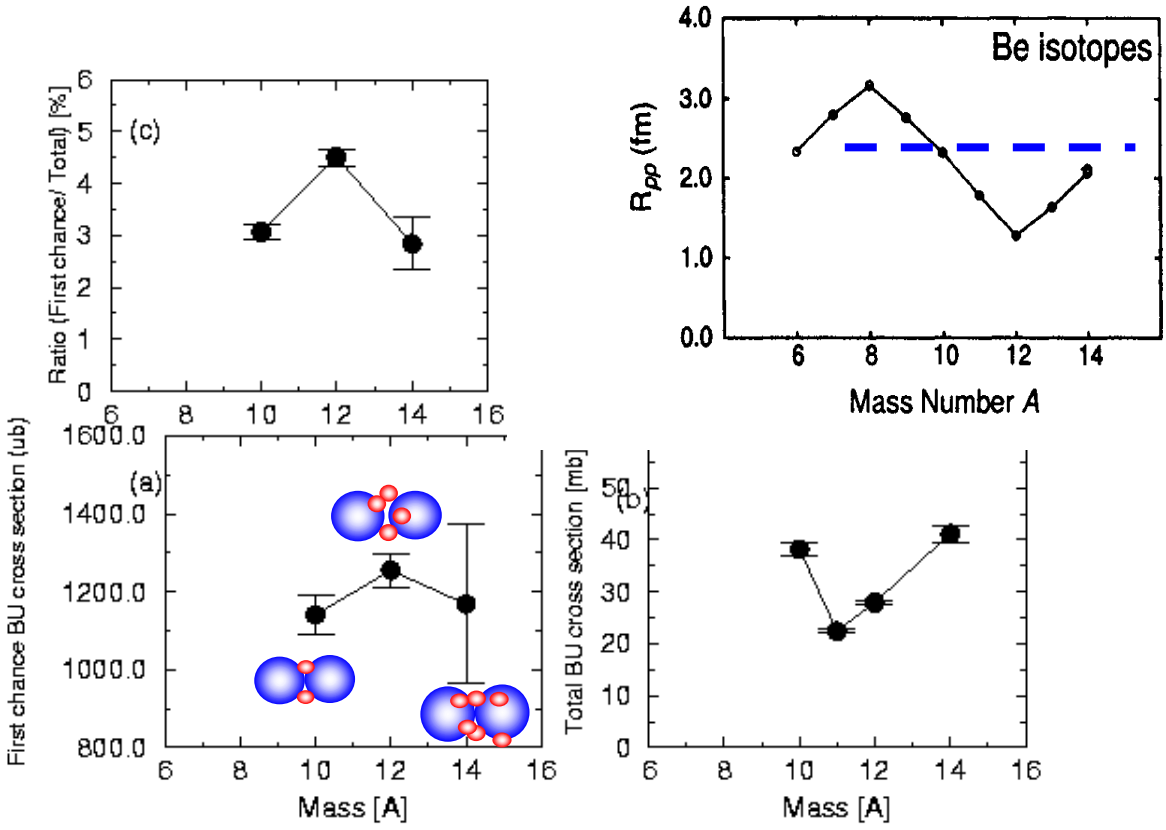
$$R_{\alpha-\alpha} = 4.0\ fm \quad l = 2$$

$$R_n = 4.35\ fm \quad l = 1$$

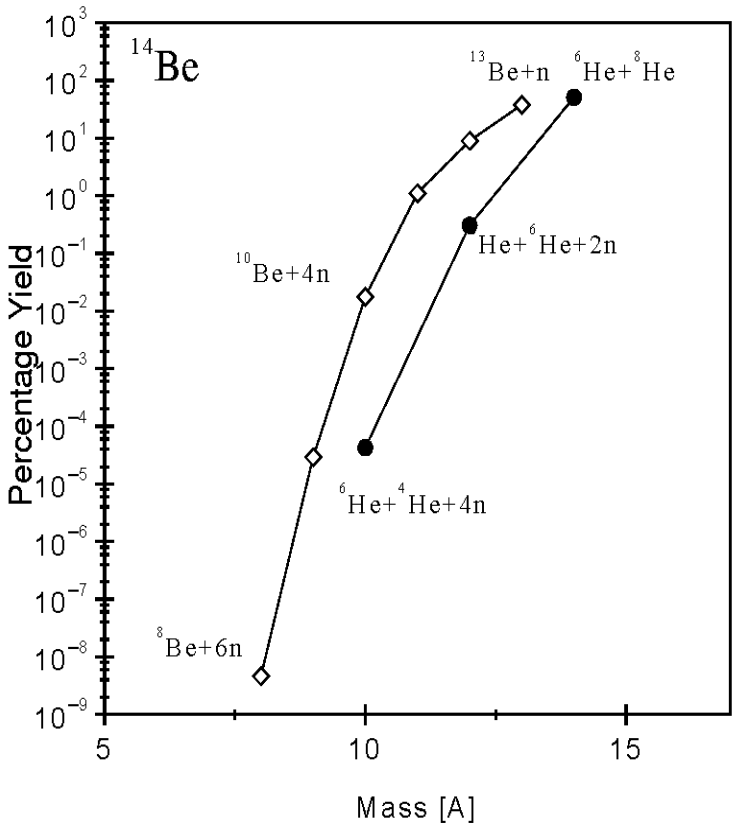
Cocke and Christensen, NPA111 (1968)623



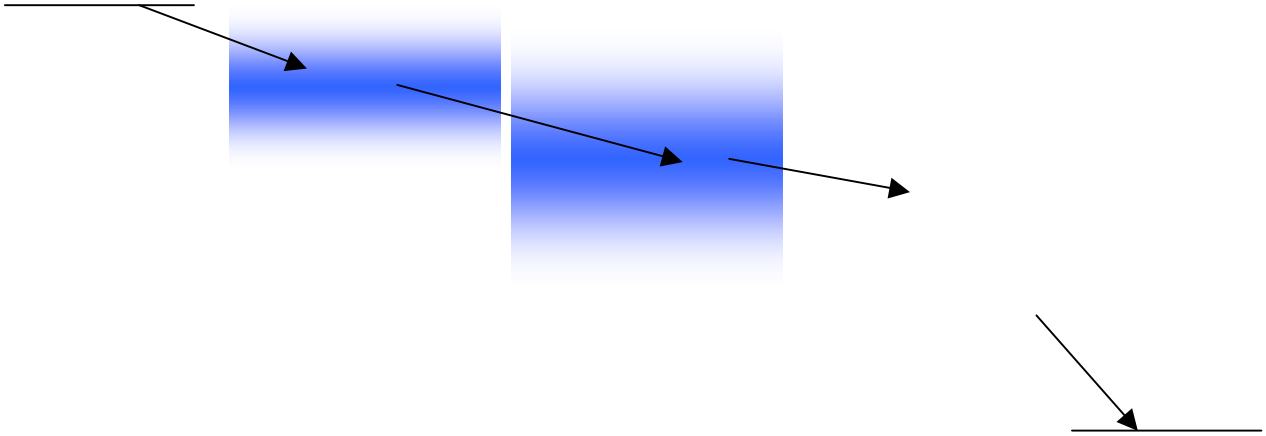

11Be
α+α
4He+6He
10Be
α+α
4He+6He
14Be
α+α
6He+8He
12Be
α+α
6He+6He
Cross Section (μb)
Mass [A]

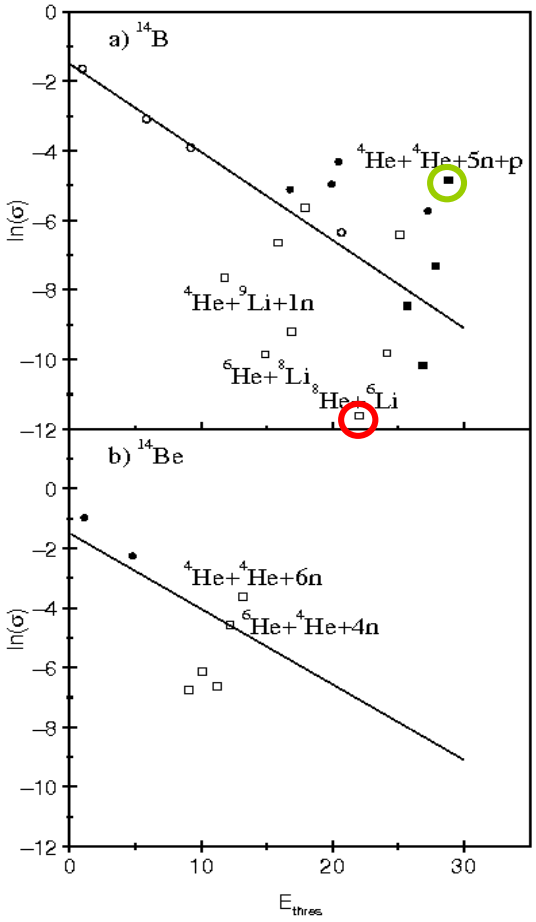

(c)
Ratio (First chance/ Total) [%]
Be isotopes
Rpp (fm)
Mass Number A
(a)
First chance BU cross section (ub)
(b)
Total BU cross section [mb]
Mass [A]

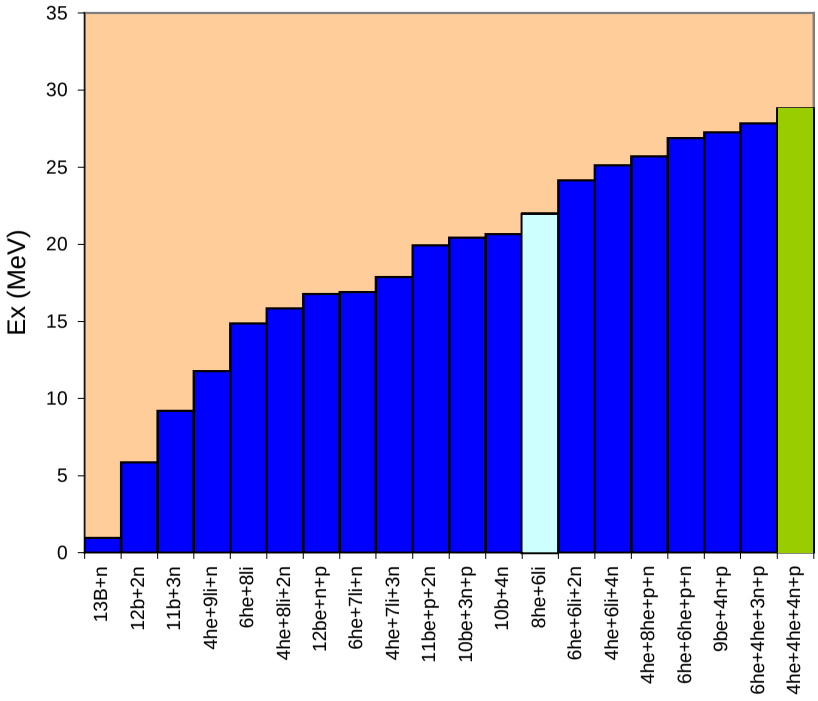
Fermi Break-up of ^{14}Be



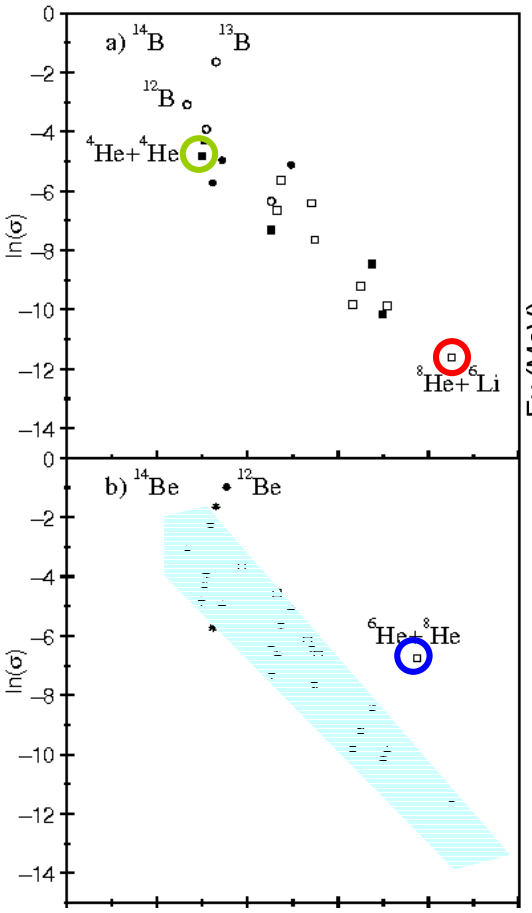
^{14}Be ^{13}Be ^{12}Be ..... ^{8}Be

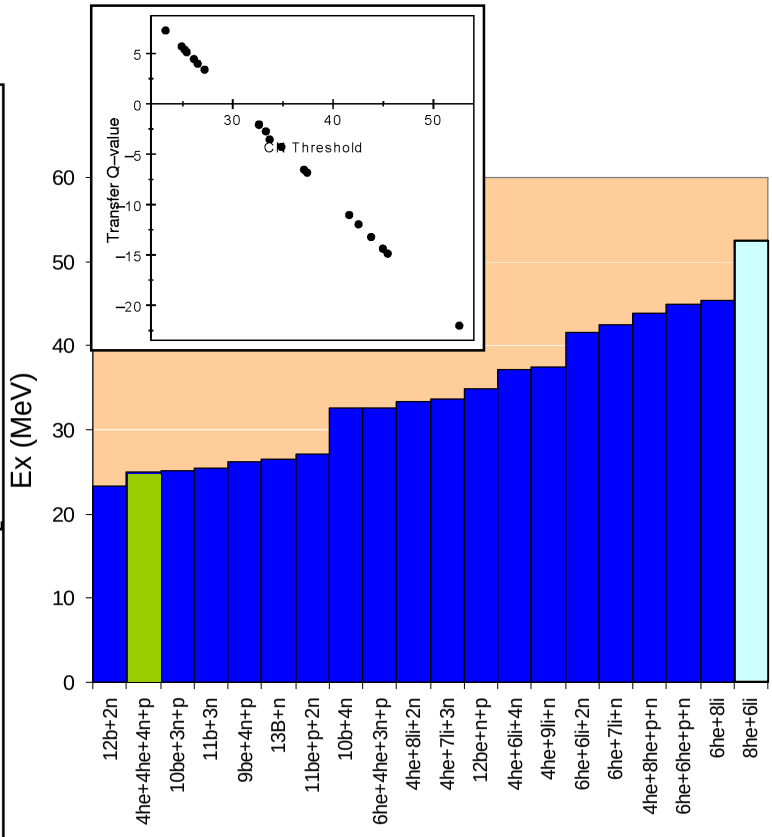






Decay thresholds in ^{14}B





Decay thresholds in ^{14}B+^{12}C=^{26}Al

Summary

- Used break-up reactions to characterize clusterization of beryllium isotopes.
- Clustering does not change from $^{10\text{-}14}$Be
- Comparison of ^{14}B and ^{14}Be suggests may be increase in clustering in ^{14}Be
- Opportunity for calculations of Be reactions.
- Extract spectroscopic information for $^{10}\text{Be} \rightarrow {}^{9}\text{Be}+\text{n} \rightarrow {}^{8}\text{Be}+2\text{n} \rightarrow \alpha+\alpha+2\text{n}$
- Indicates that core excitations (2^{+}) are important and at ~30-40 MeV/nucleon neutron removal reactions are more complex than the direct knockout picture.