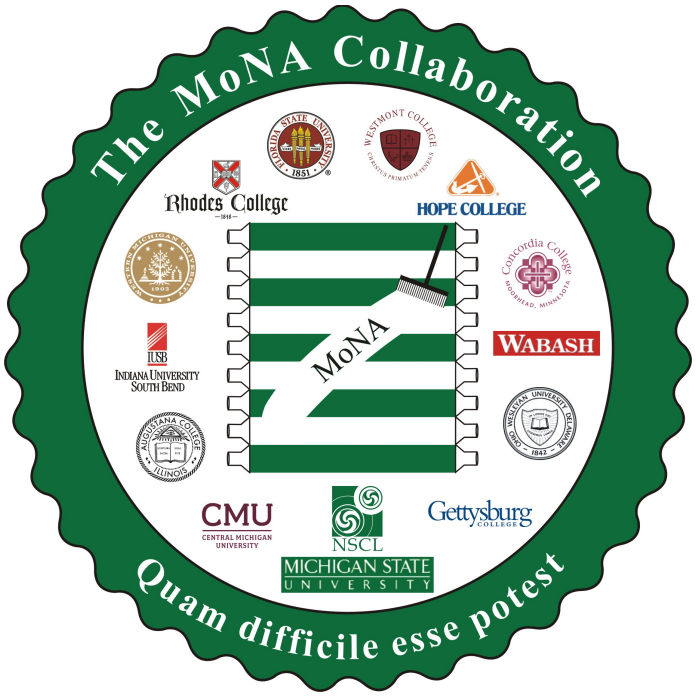
First observation of ground state di-neutron decay: ^{16}Be

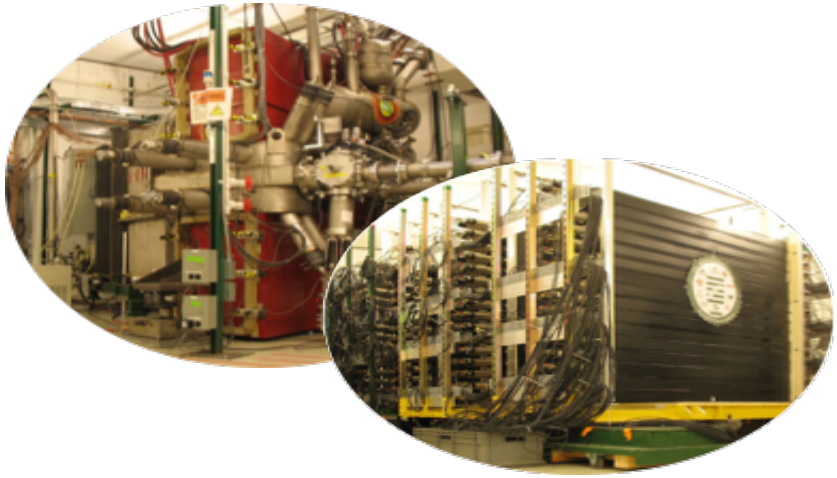
Artemis Spyrou

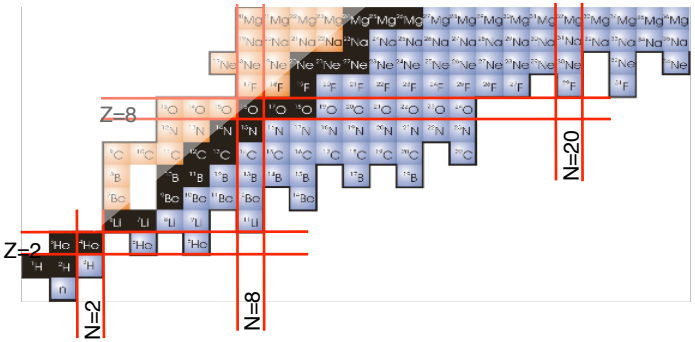


National Science Foundation
Michigan State University

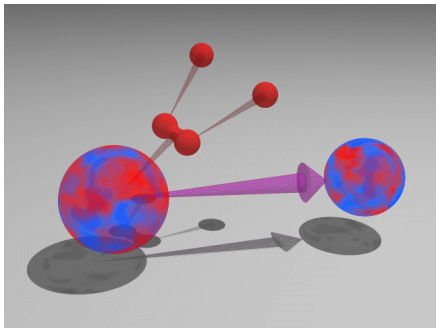
Overview

* Introduction - Motivation



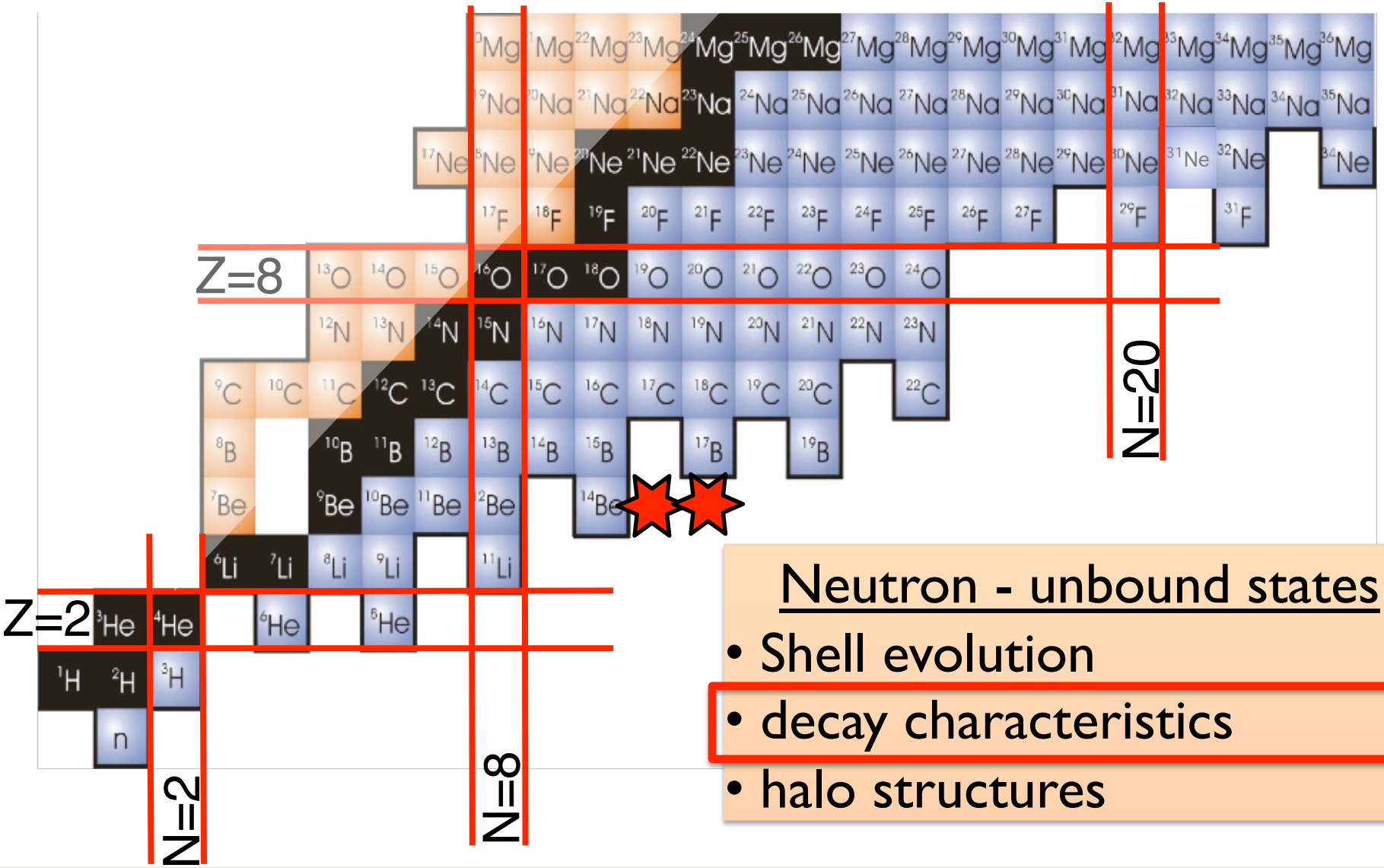


* Experimental
  - MoNA/Sweeper setup
  - 2n analysis



* Results: ^{15}Be - ^{16}Be

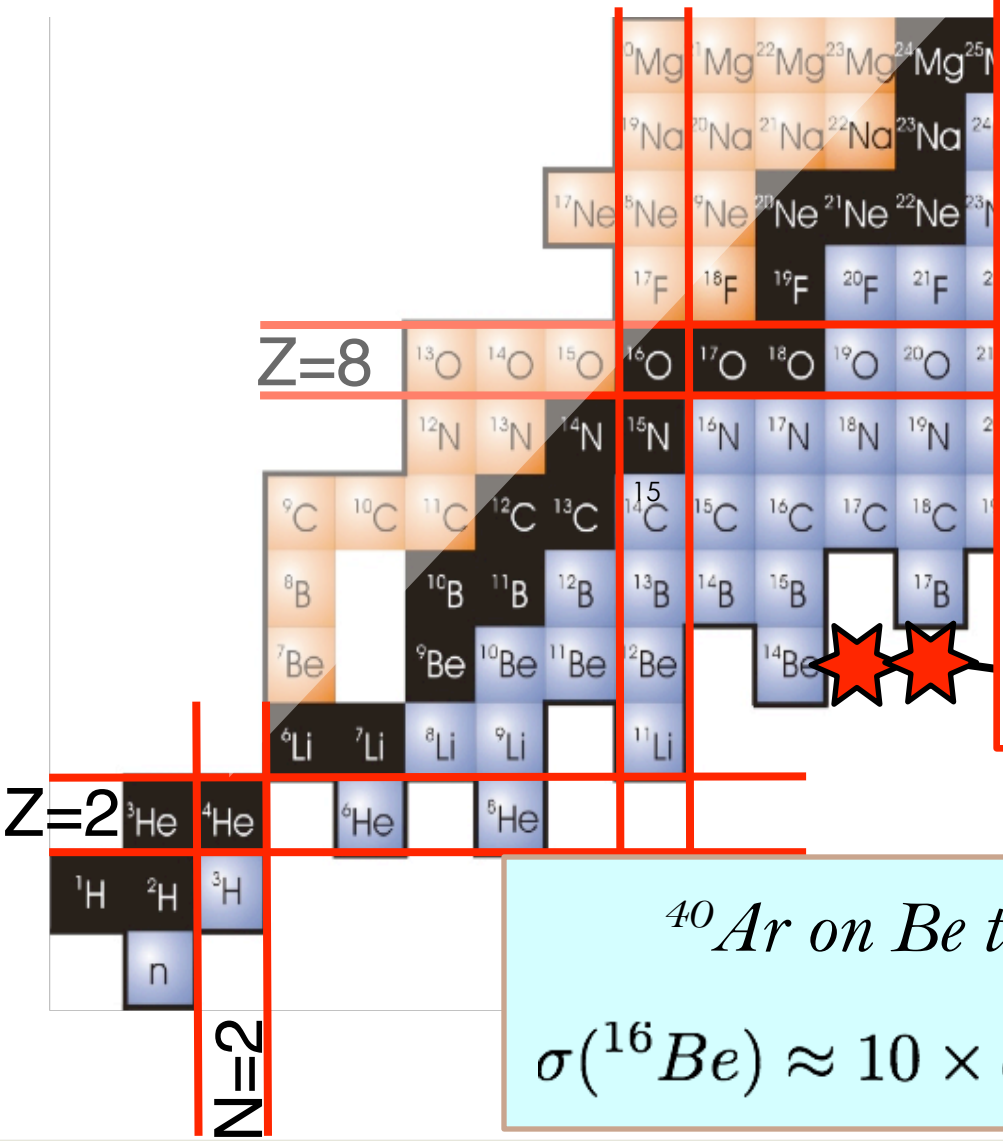
Motivation

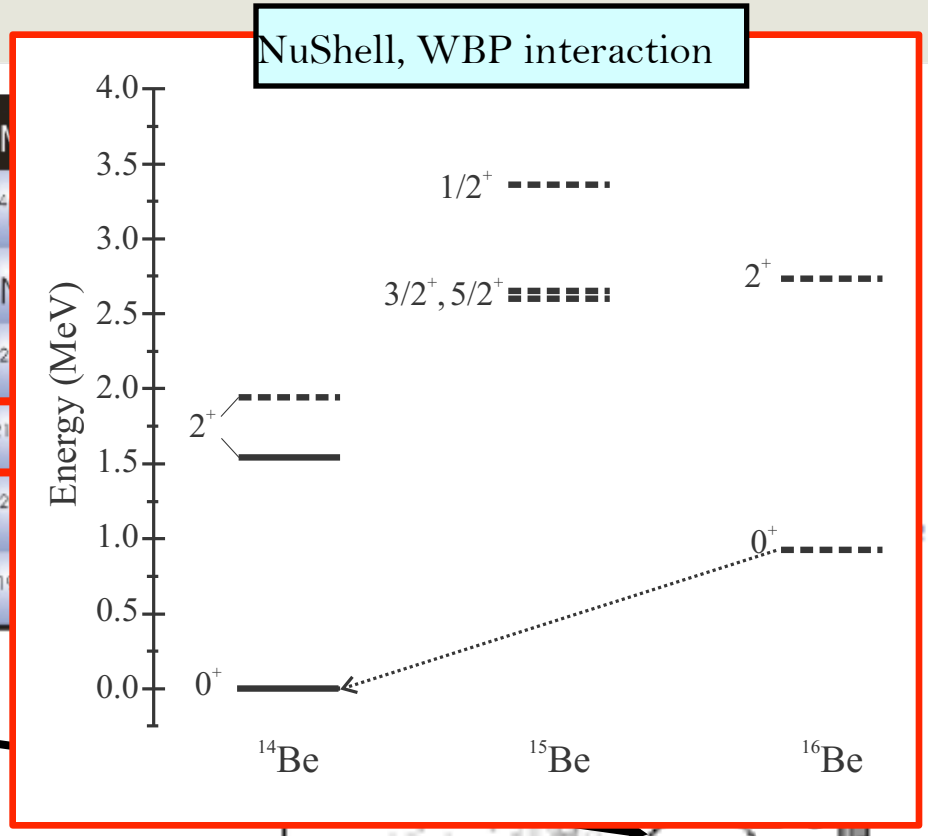


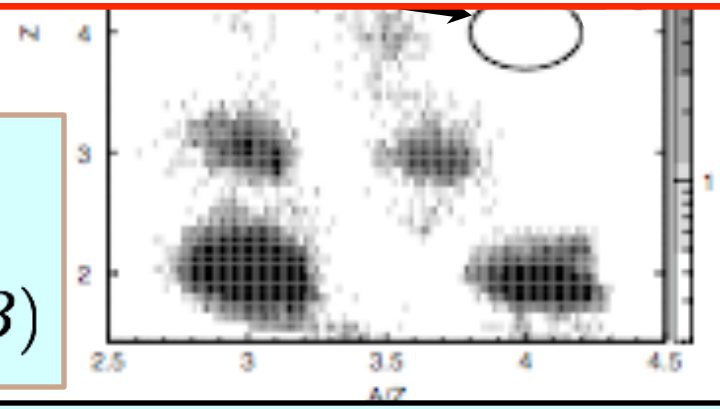
Neutron - unbound states

- Shell evolution
- decay characteristics
- halo structures

Motivation





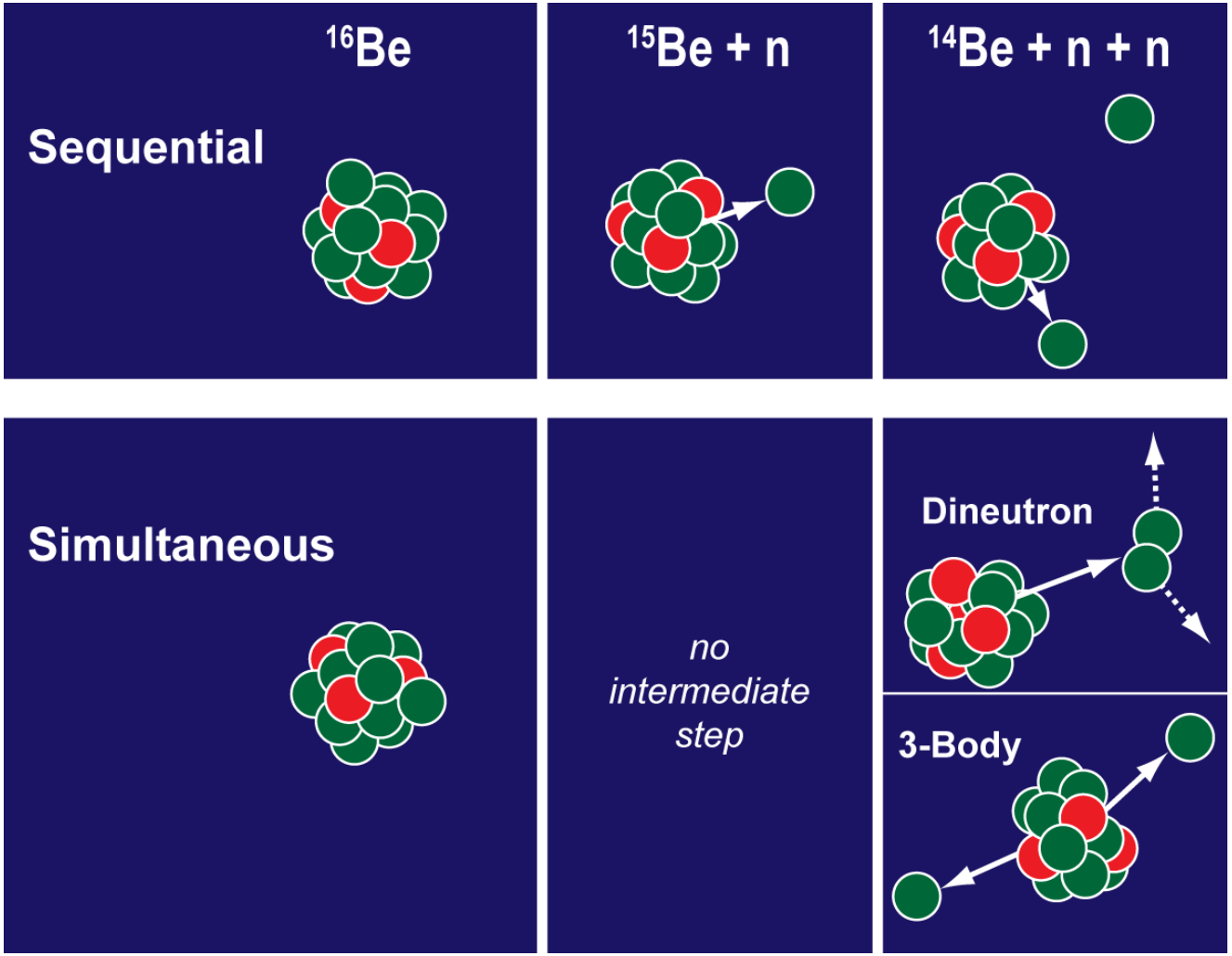


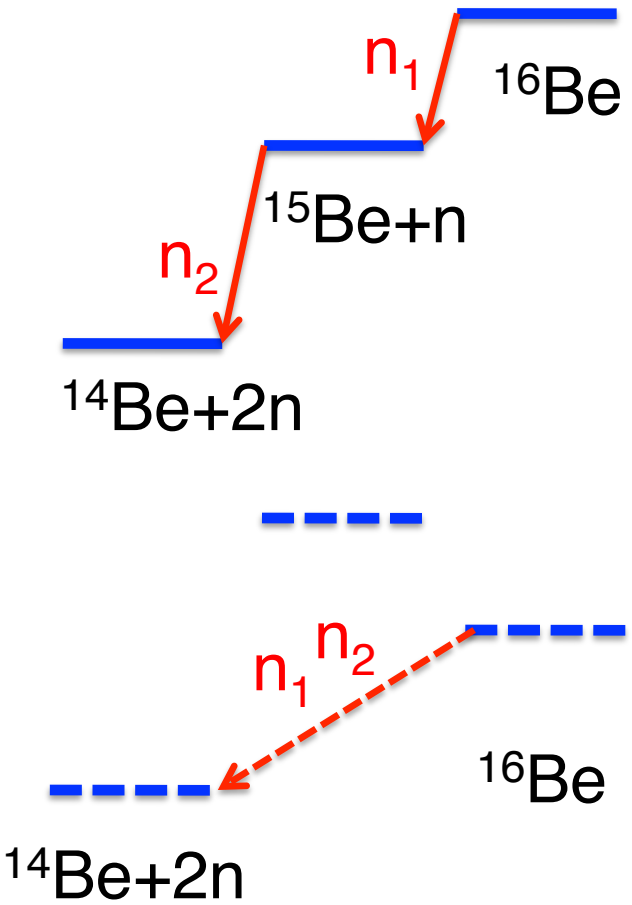
^{40}Ar on Be target

$$\sigma(^{16}Be) \approx 10 \times \sigma(^{19}B)$$

T. Baumann et al., Phys. Rev. C 67, 061303(R), (2003)

Decay modes


^{16}Be
^{15}Be + n
^{14}Be + n + n
Sequential
Simultaneous
no intermediate step
Dineutron
3-Body


n_1
^{16}Be
^{15}Be+n
n_2
^{14}Be+2n
n_1 n_2
^{16}Be
^{14}Be+2n

Di-neutron

P. Hansen and B. Jonson, Europhys. Lett 4, 409 (1987).

- ^{11}Li – dineutron cluster
- Experimentally: Is there a bound dineutron in ^{11}Li?

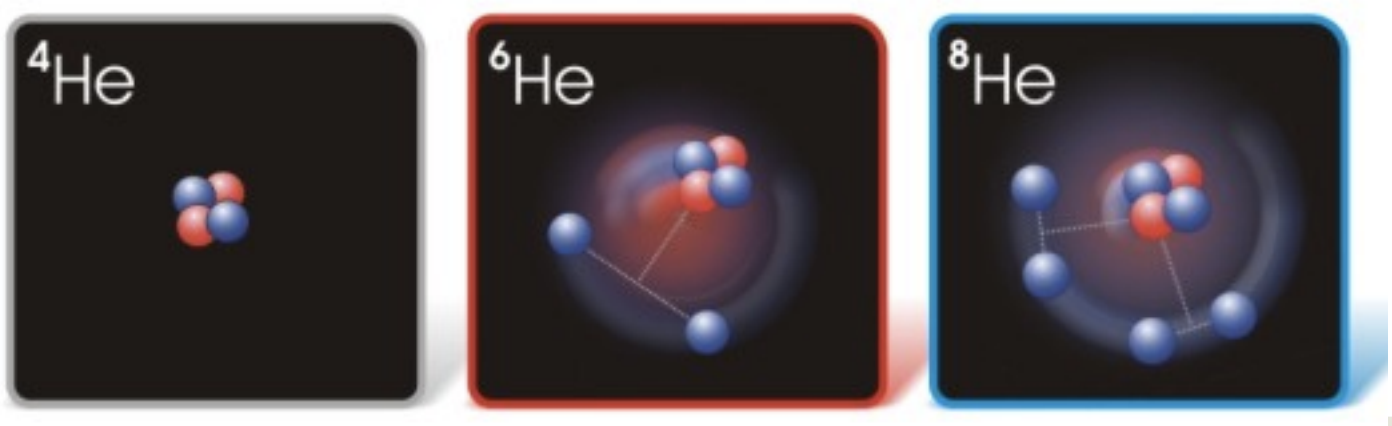
Most experiments answer NO

Ieki et al., PRC54(1996)1589

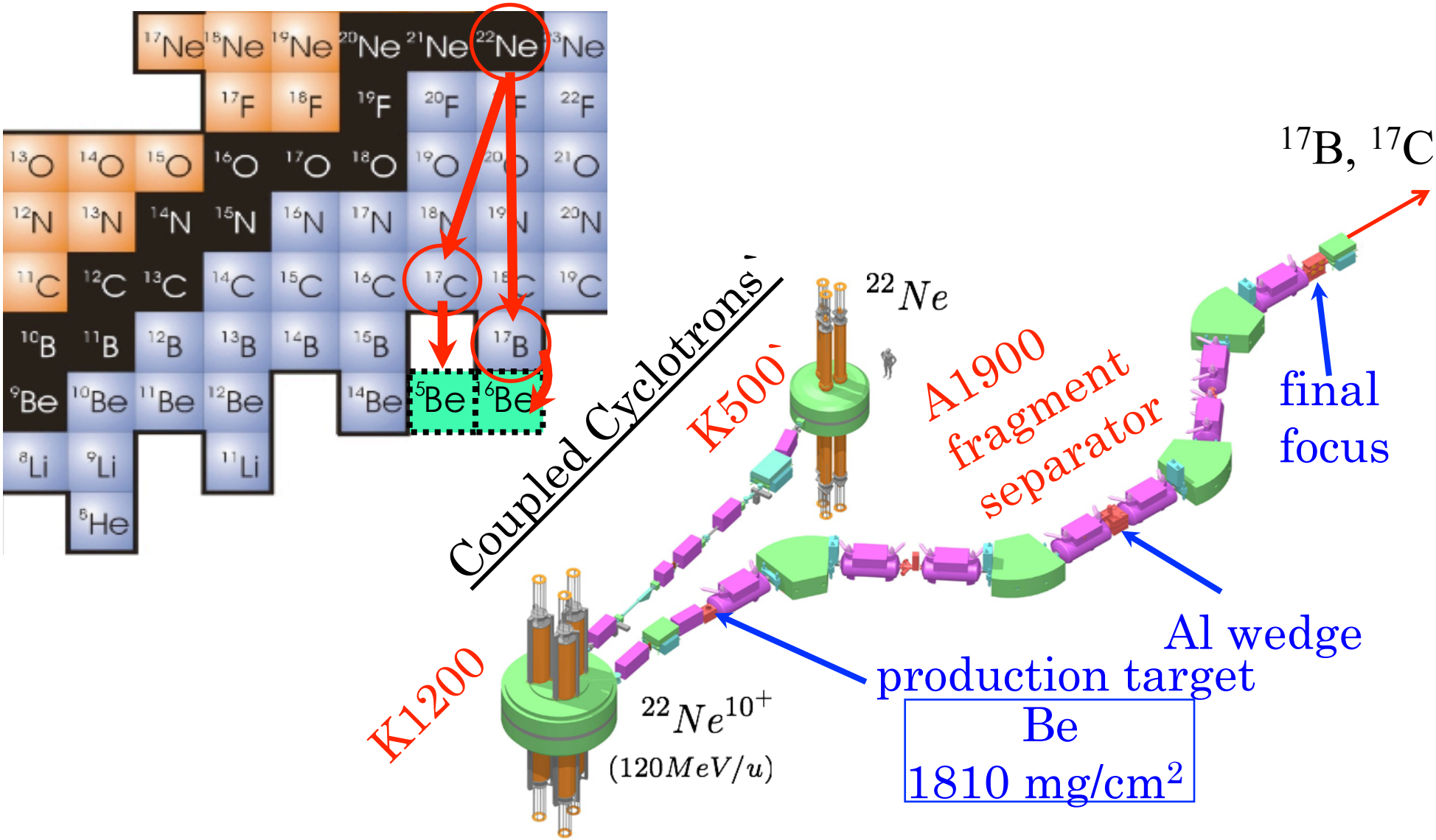
Zinser et al., NPA619(1997)151

P. Mueller, PRL **99,** 252501 (2007)

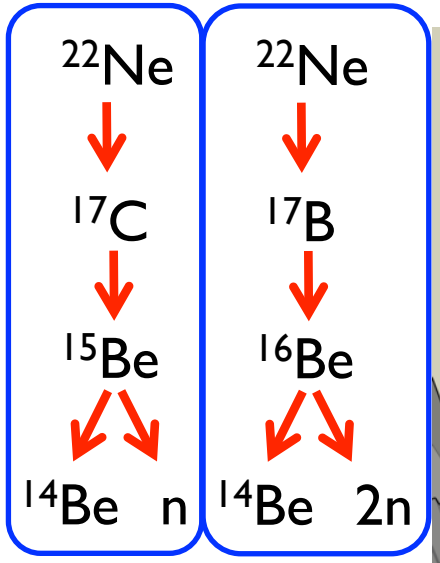
Charge radii in neutron rich He isotopes

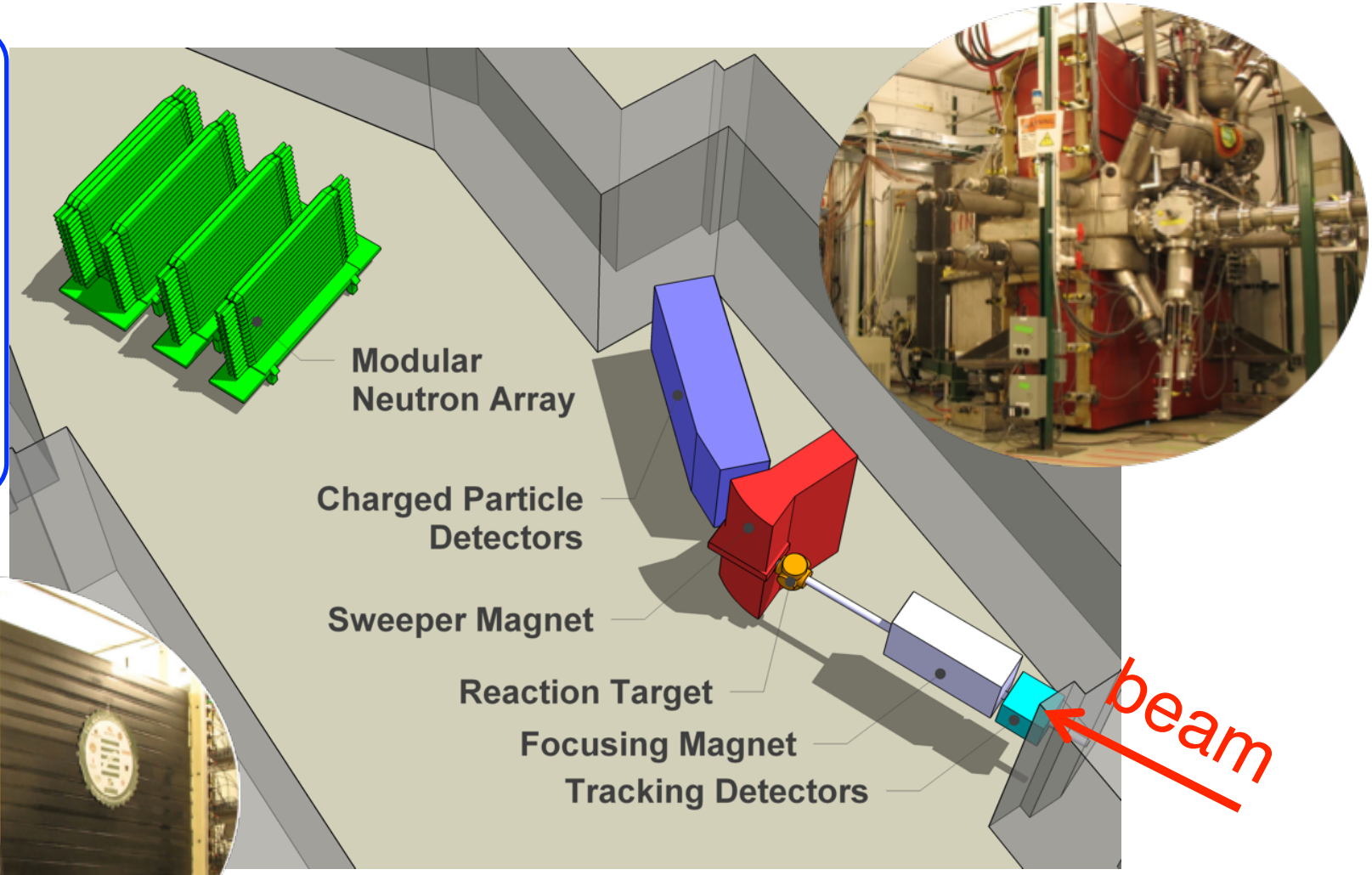


Making ^{15,16}Be



Invariant mass analysis

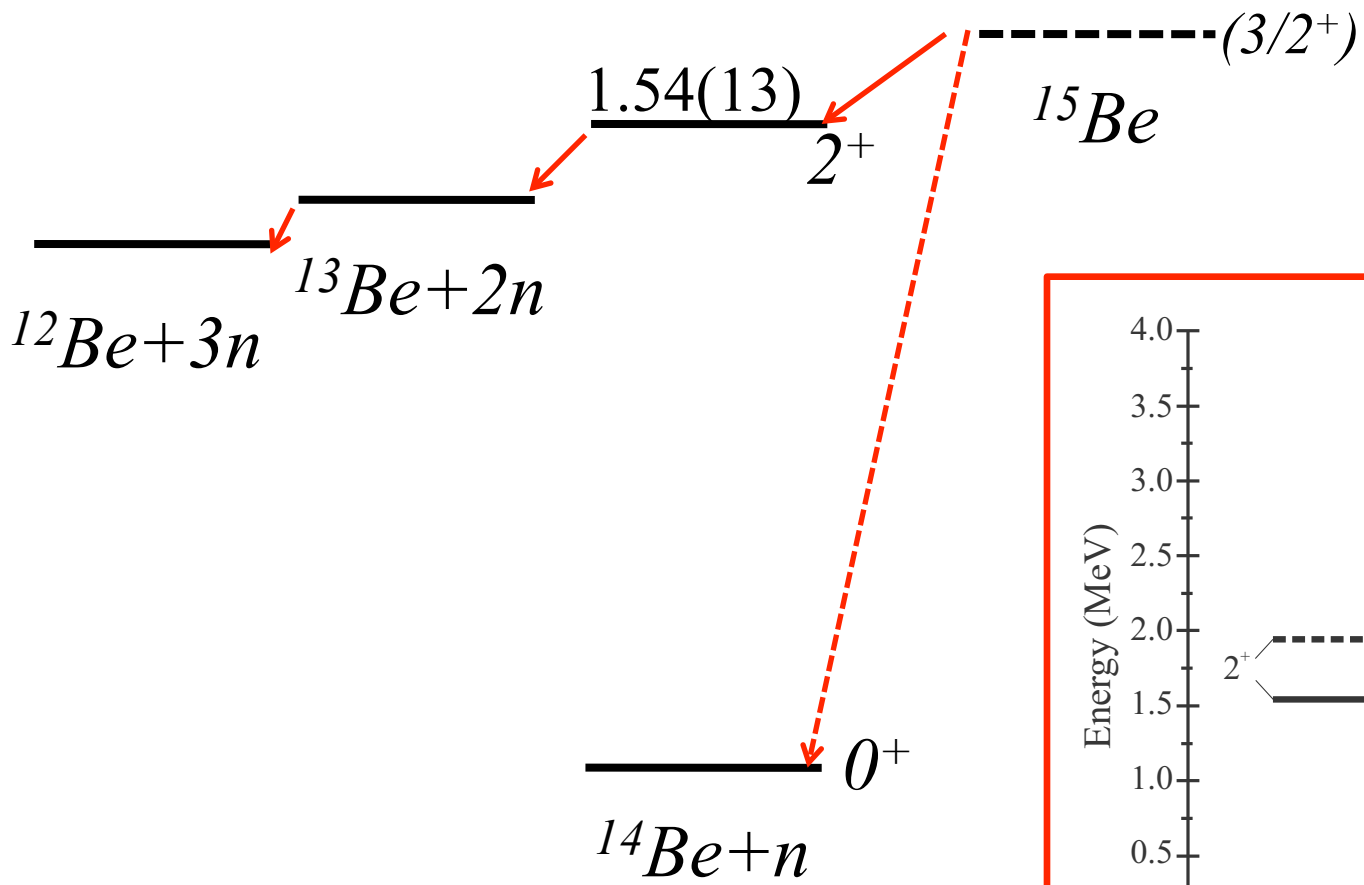


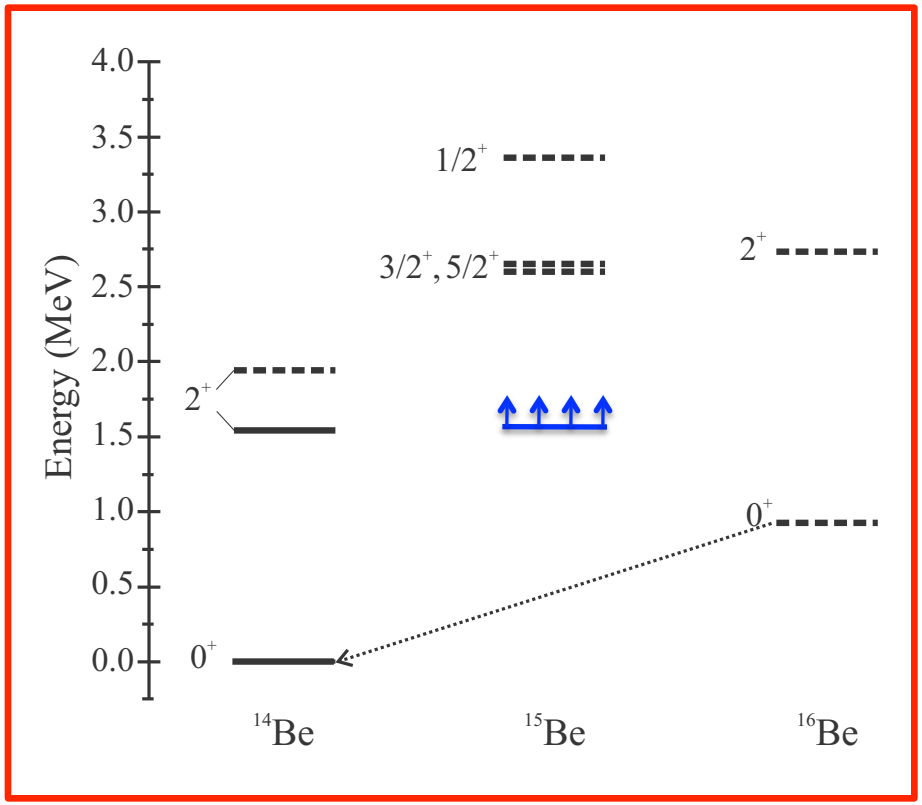


National Science Foundation
Michigan State University

Design: Thomas Baumann

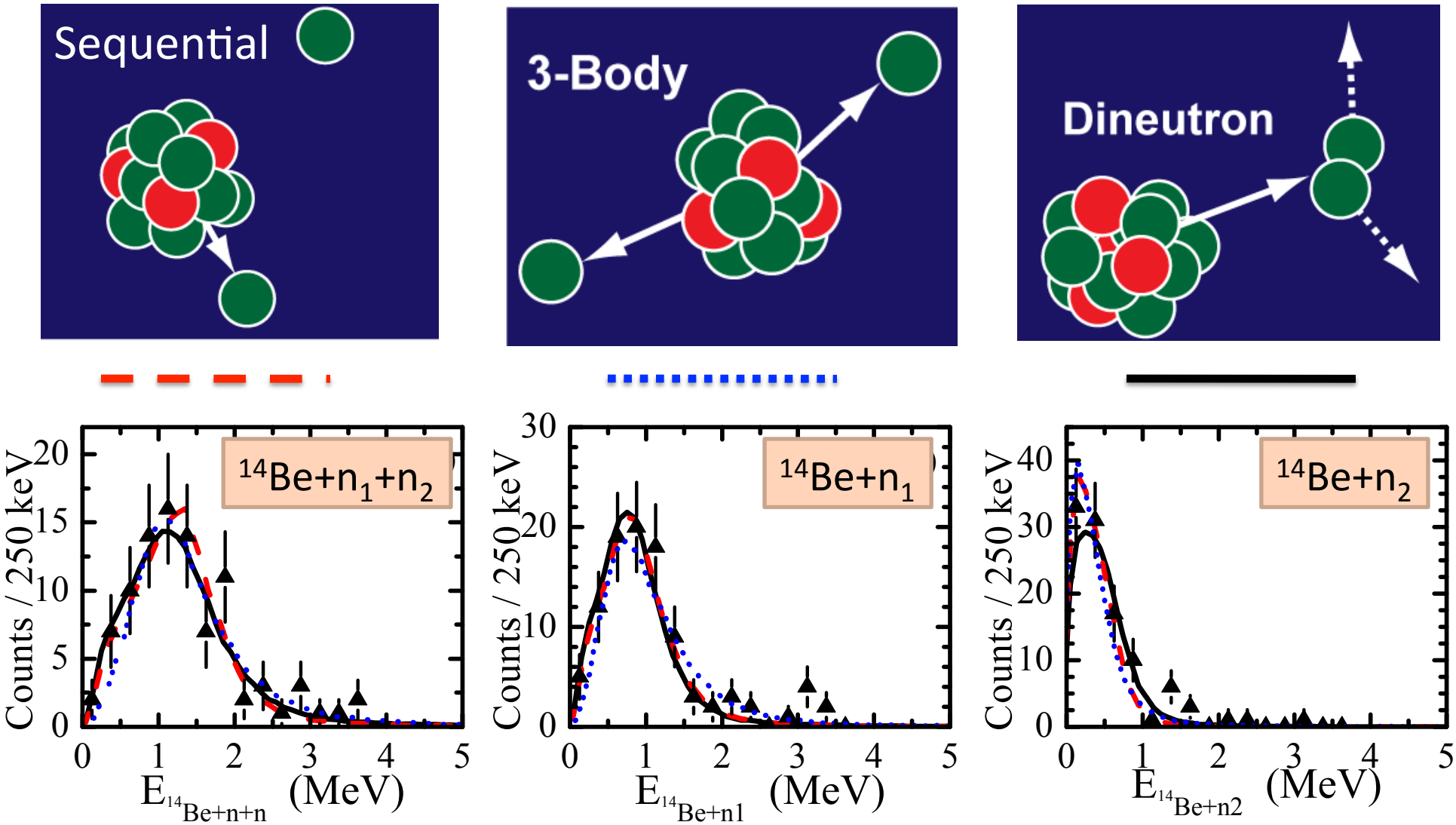
Results: ^{15}Be





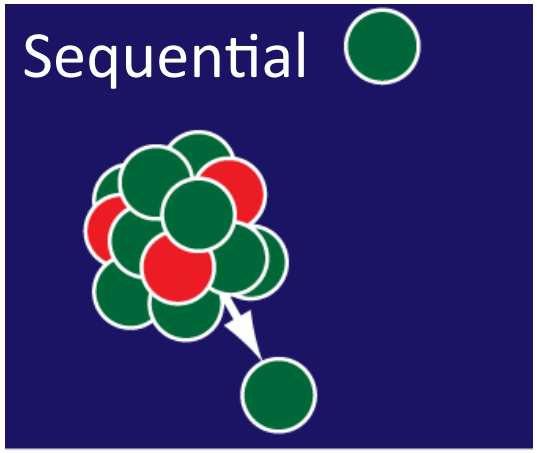
A. Spyrou, J.K. Smith et al, Phys Rev C84(2011)044309

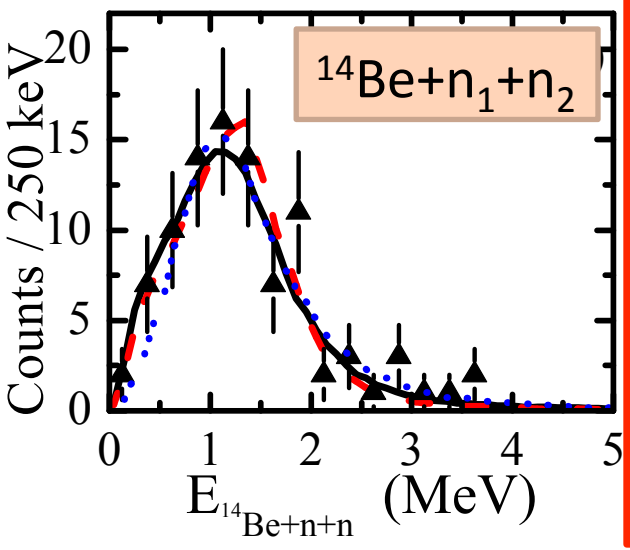
Results: ^{16}Be – Energy signatures

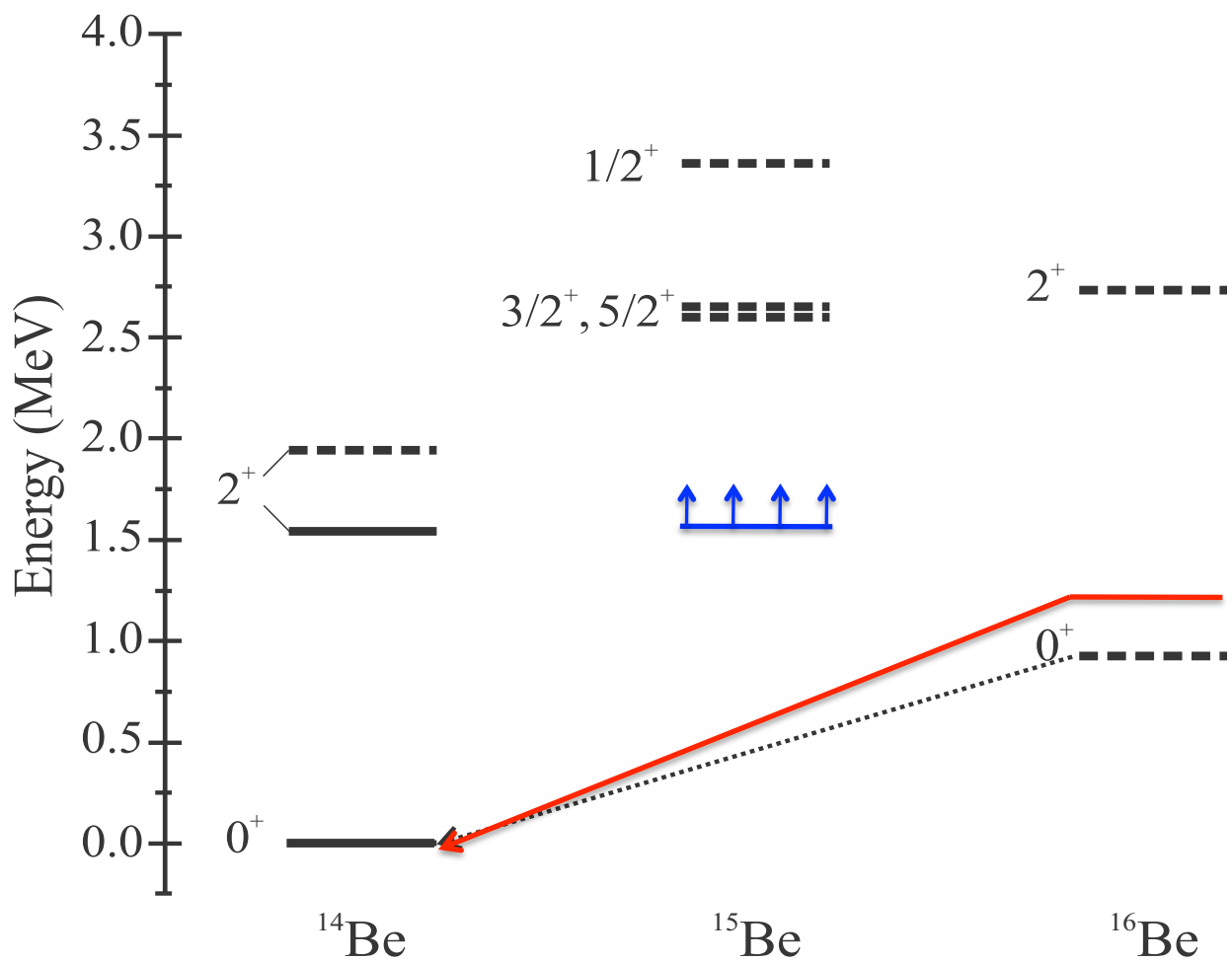


A. Spyrou, Z. Kohley et al, Phys Rev Lett. 108(2012)102501

Results: ^{16}Be – Energy signatures

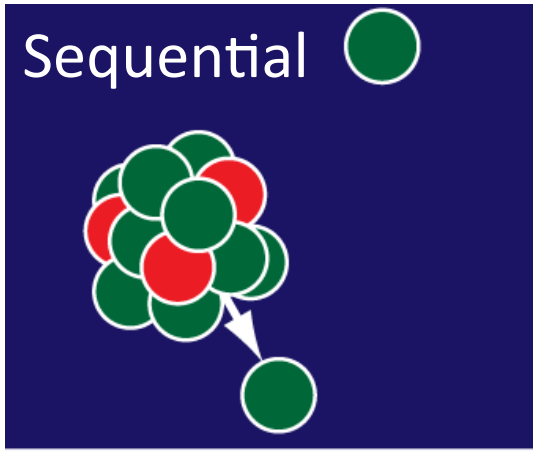


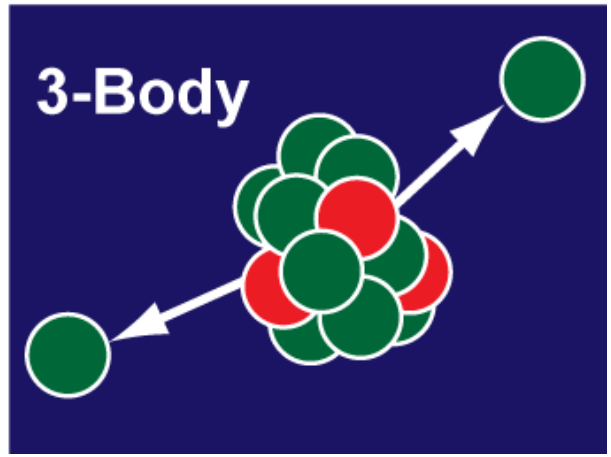


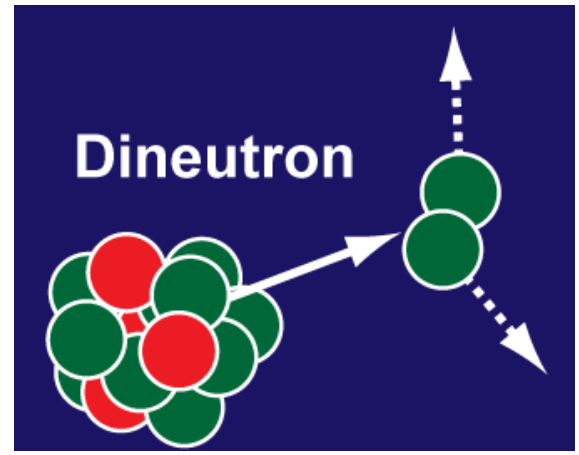


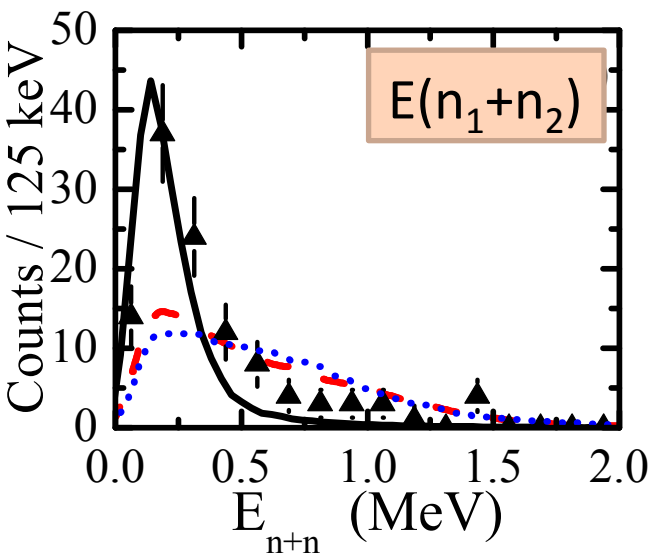
A. Spyrou, Z. Kohley et al, Phys Rev Lett. 108(2012)102501

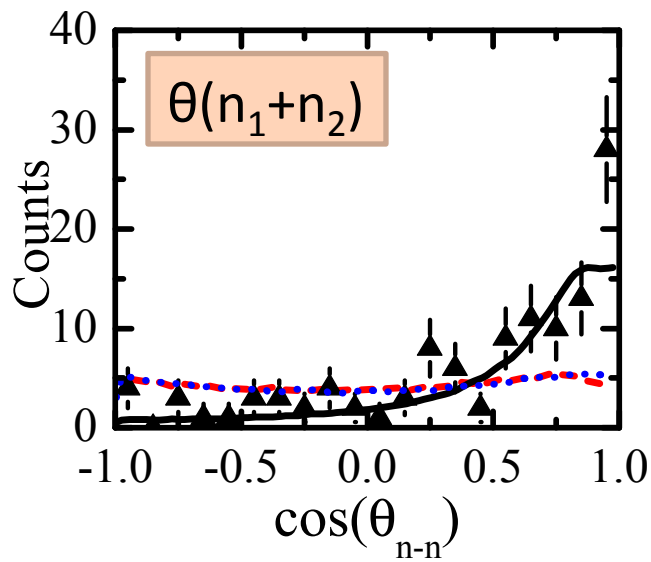
Results: ^{16}Be – correlations

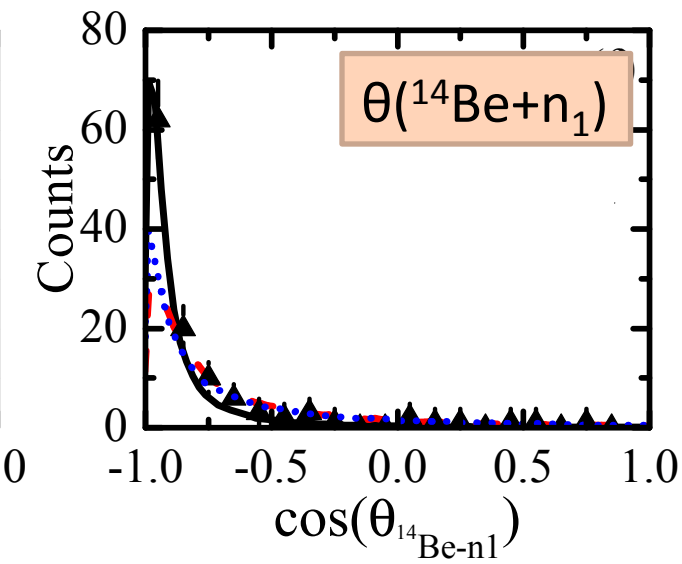












A. Spyrou, Z. Kohley et al, Phys Rev Lett. 108(2012)102501

Summary - Conclusions

- Studied neutron-unbound ^{15,16}Be
- Set a lower limit for the location of the ^{15}Be ground state
- Measured the location of the ground state of ^{16}Be: 1.35(10) MeV
- First observation of ground-state di-neutron decay!!!!

Thanks

Thomas Baumann
Daniel Bazin
Greg Christian
Zach Kohley
Shea Mosby
Michelle Mosby
Jenna Smith
Jesse Snyder
Michael Strongman
Michael Thoennessen

Theory

Alex Brown
Jeff Tostevin
Alexander Volya