the Ohio University Neutron Long-Counter

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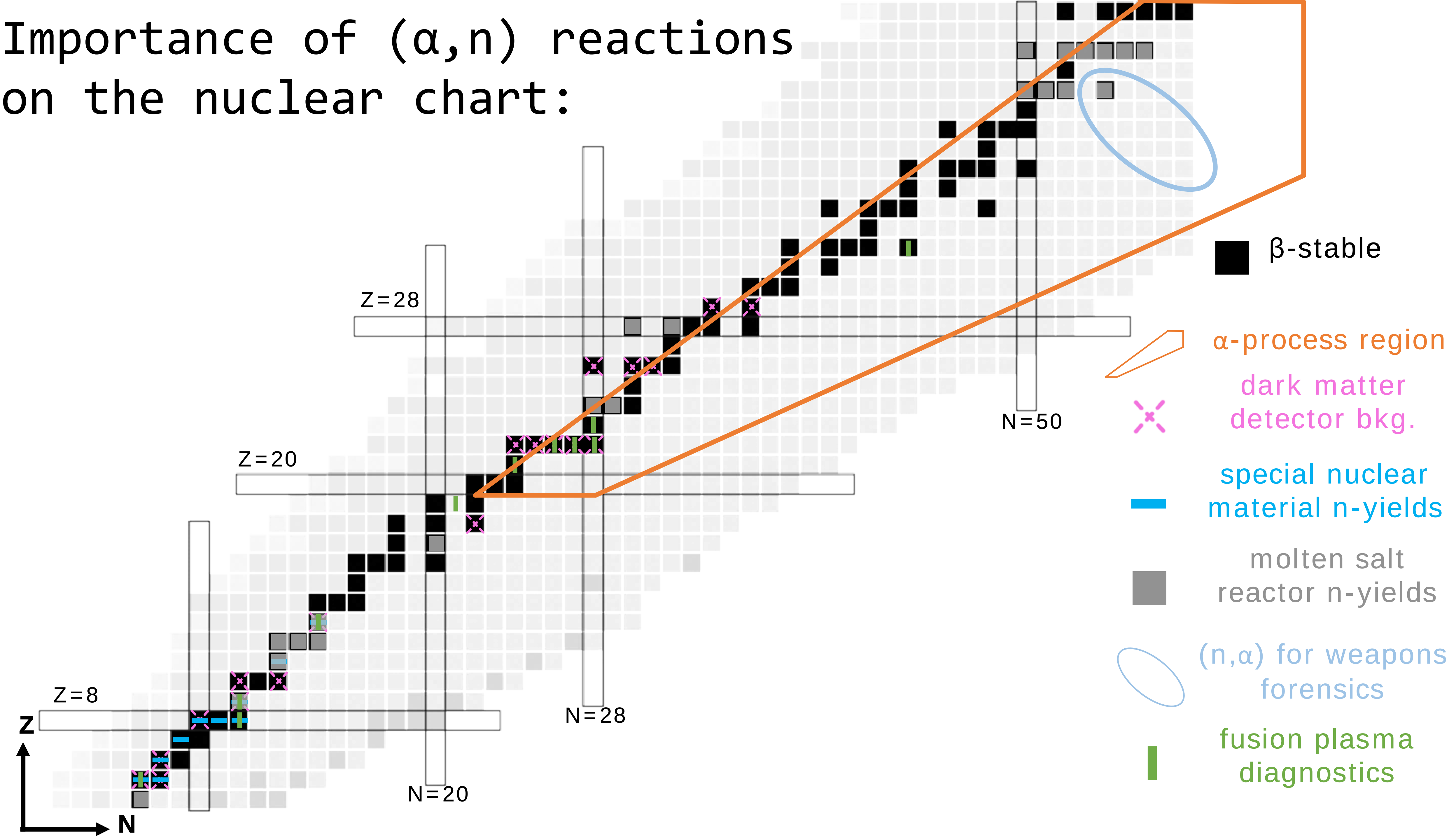
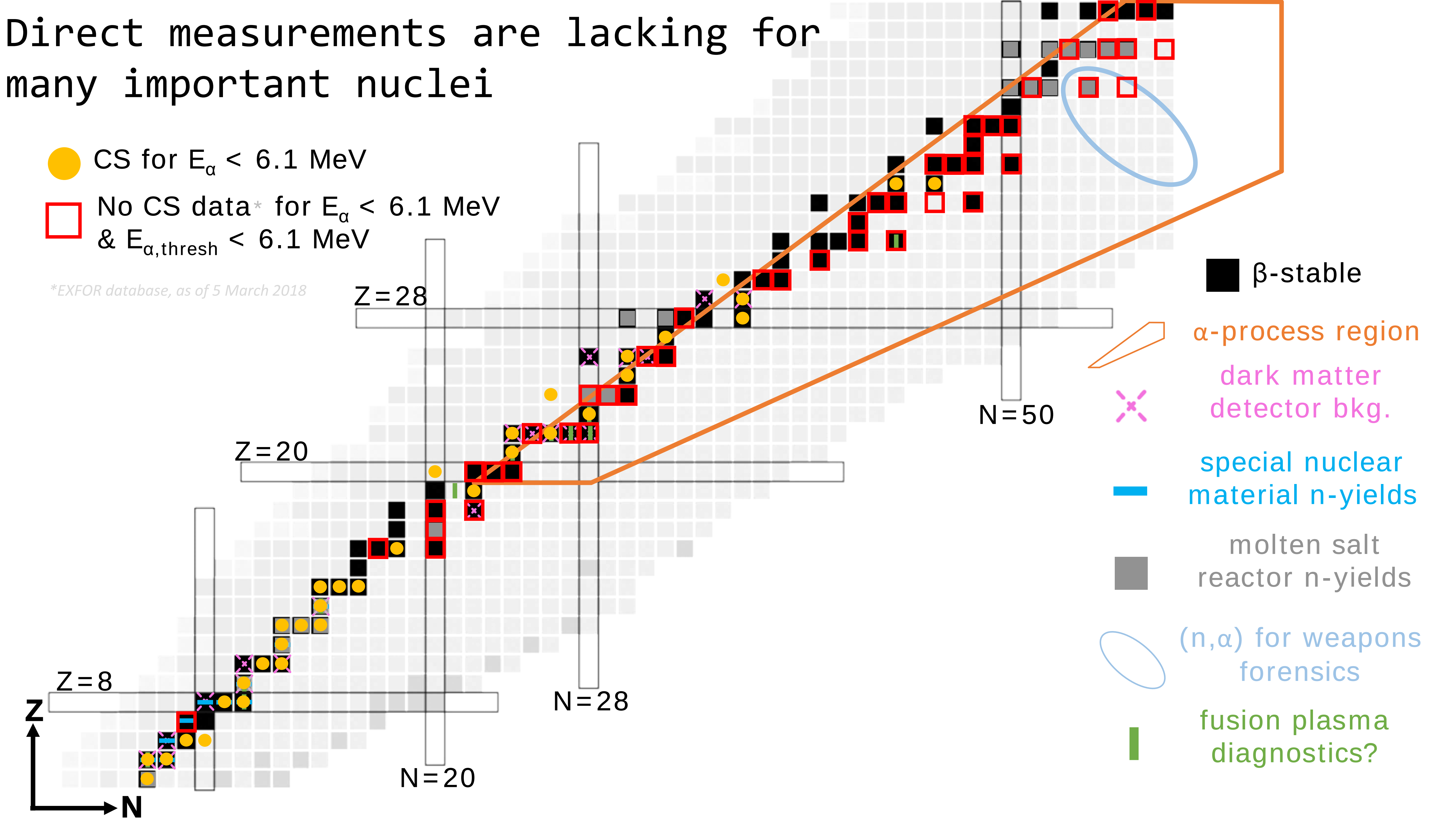
Importance of (α,n) reactions on the nuclear chart:



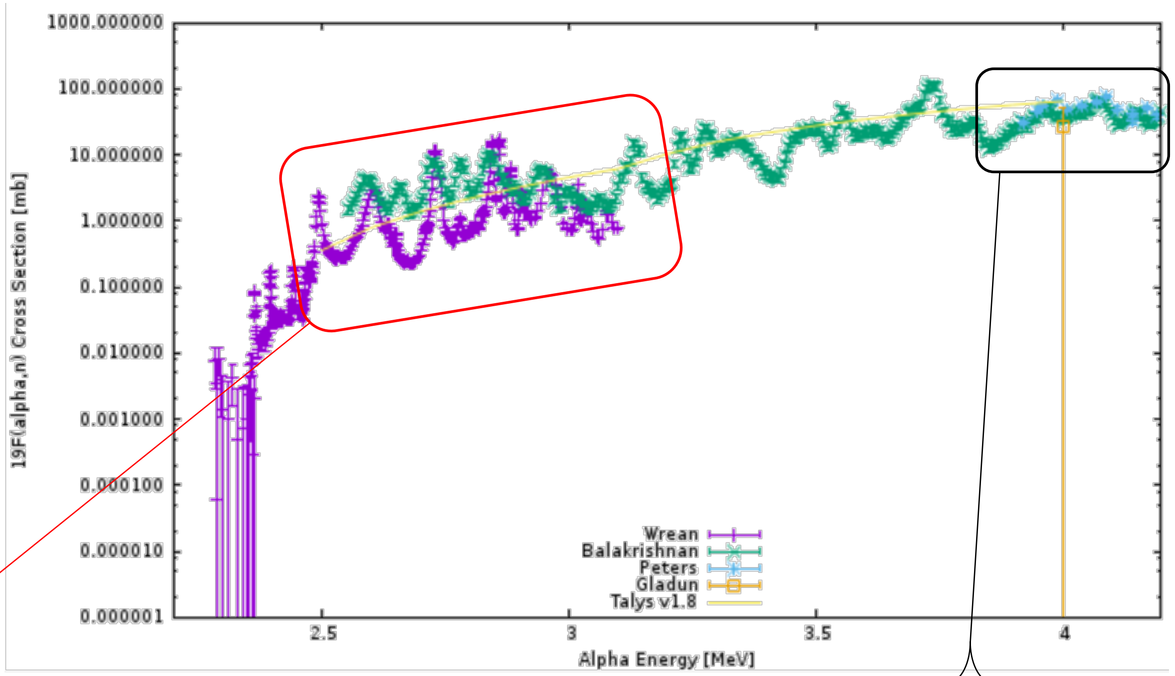
Direct measurements are lacking for many important nuclei

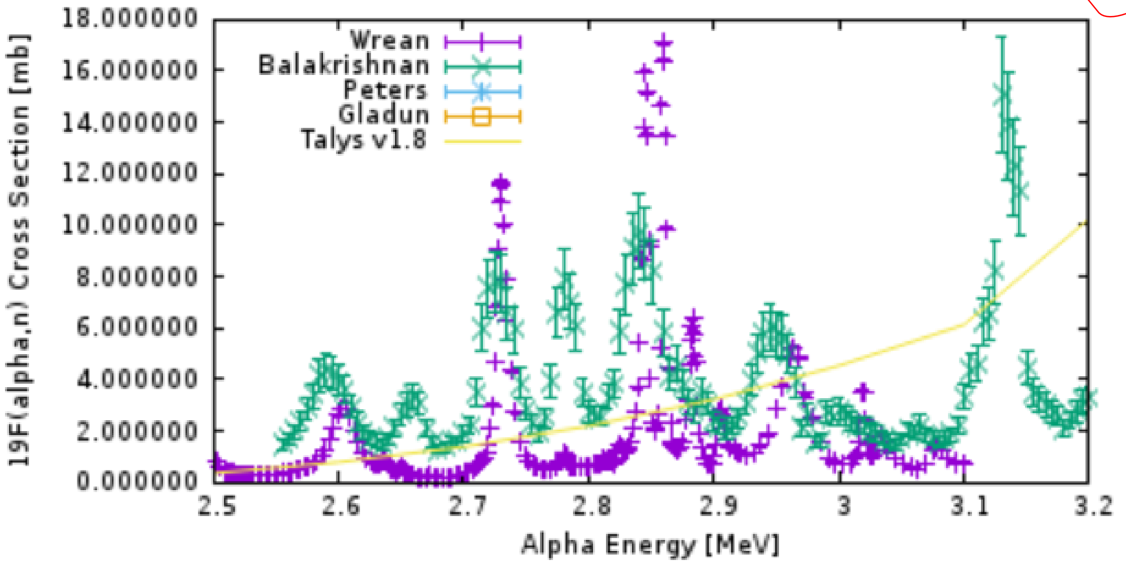


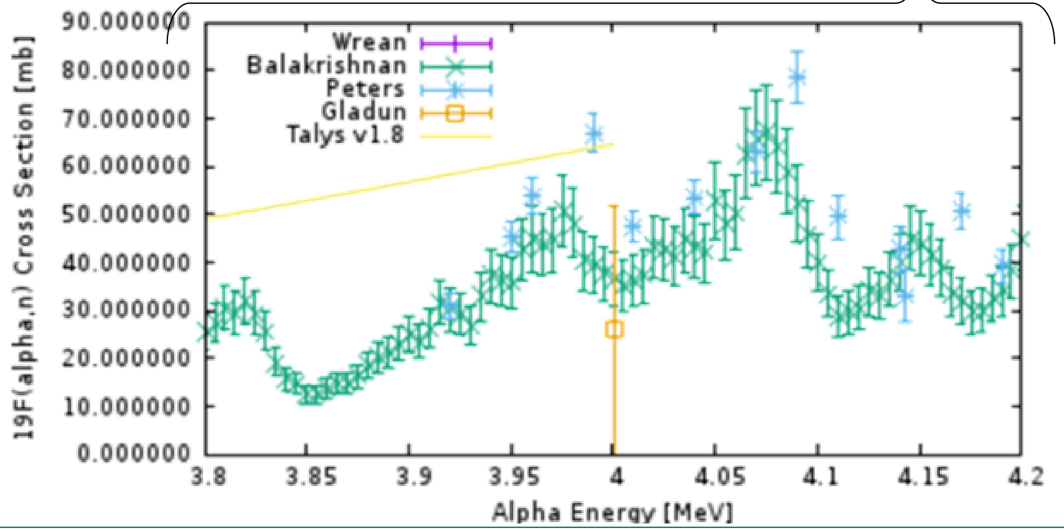
Where (α,n) data exist, they often do not agree

Example: **^{19}F(α,n)**

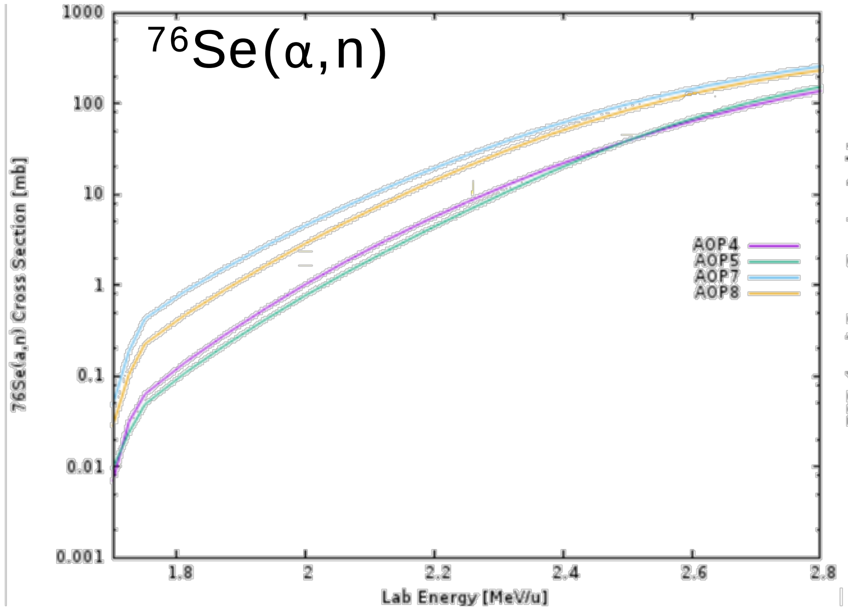
- Importance: SNM, MSR, DM, HEDP
- Disagreement by more than an order of magnitude for some energies
- Only coverage for ~MeV-wide energy region is a data set suspected to have background issues

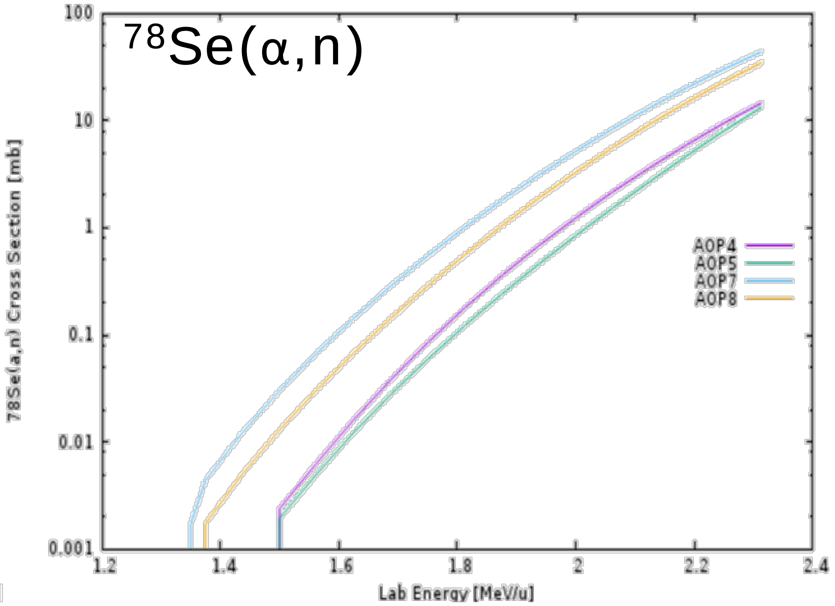


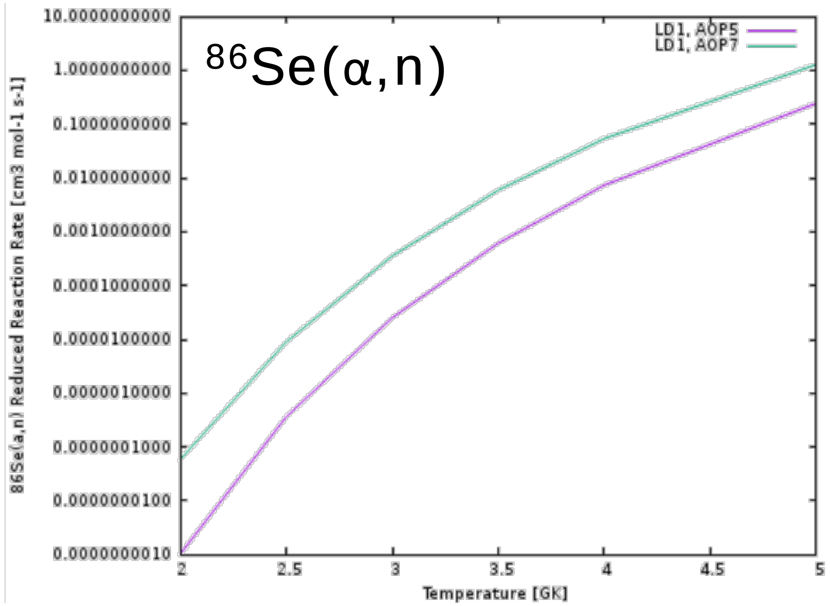




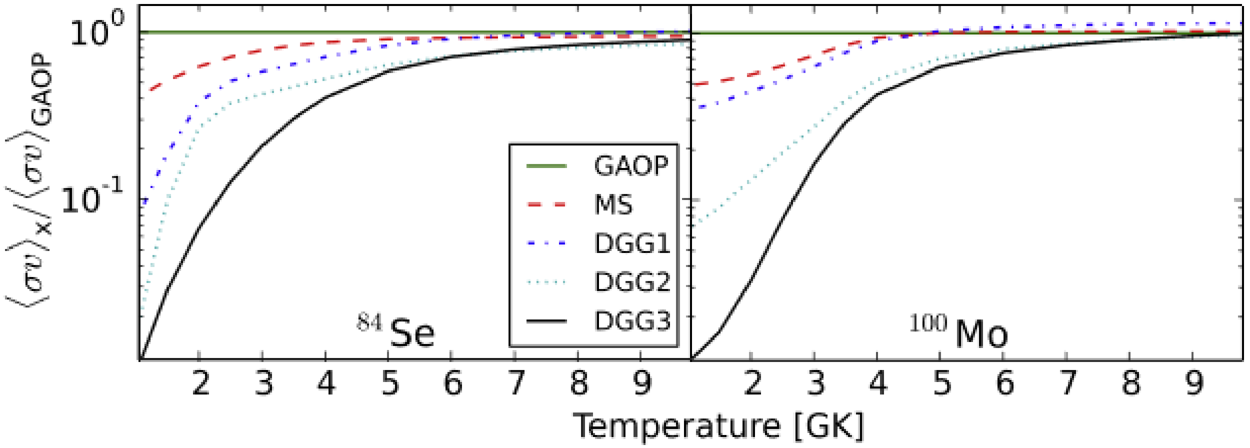
Theoretical estimates of (α,n) cross sections often vary by an order of magnitude or more







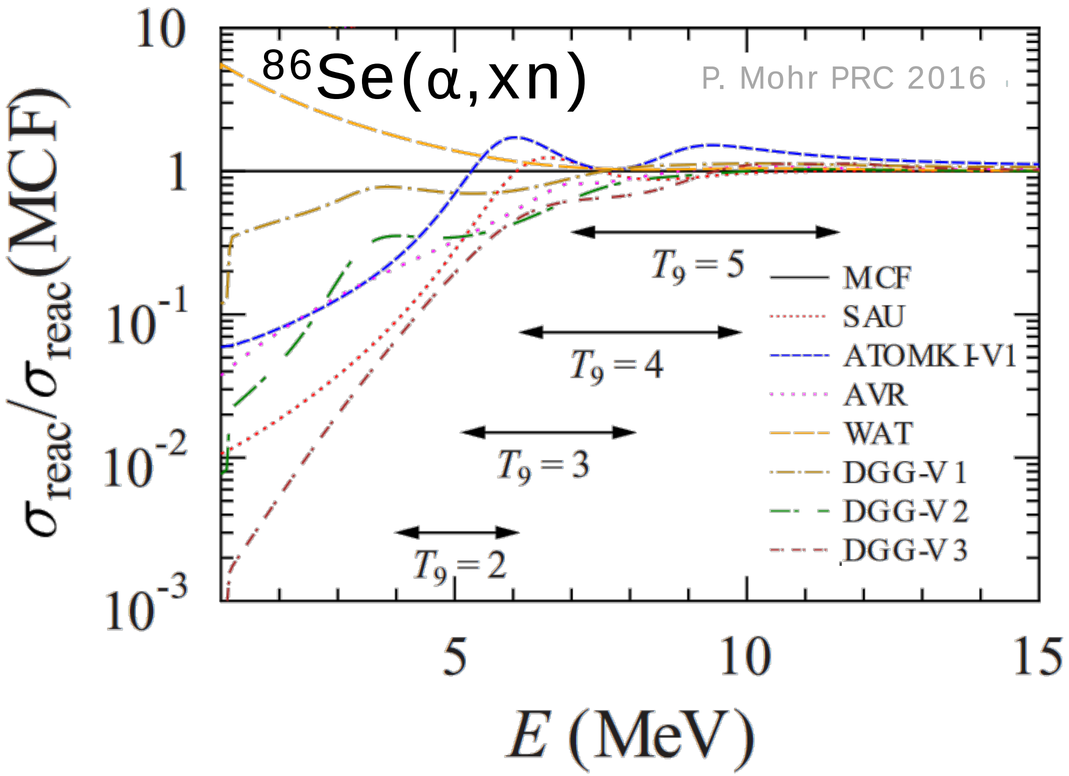
...with significant consequences for the astrophysical reaction rate:

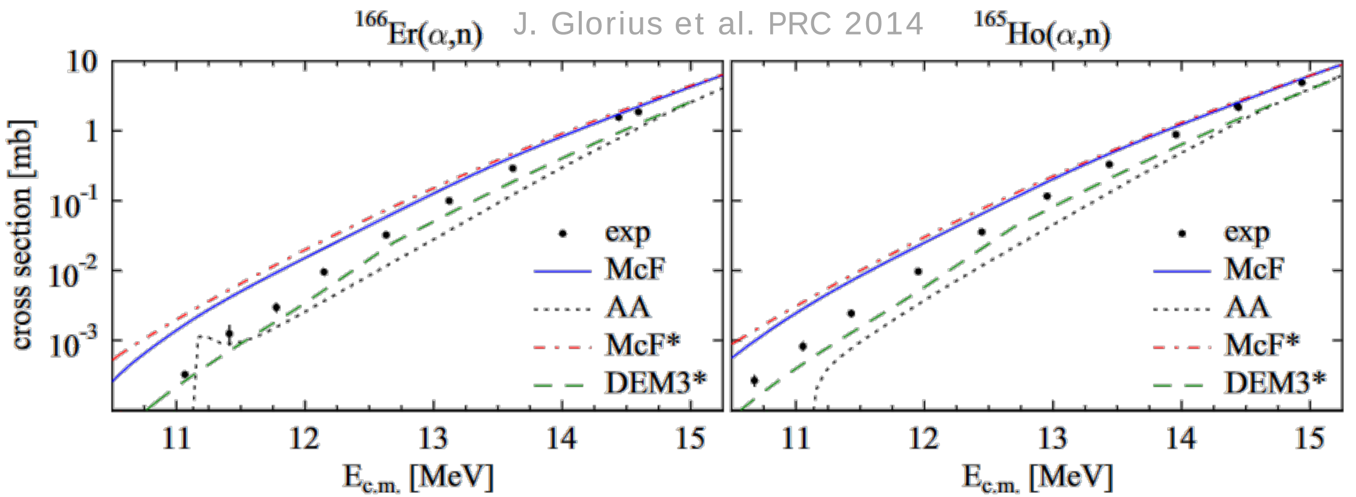


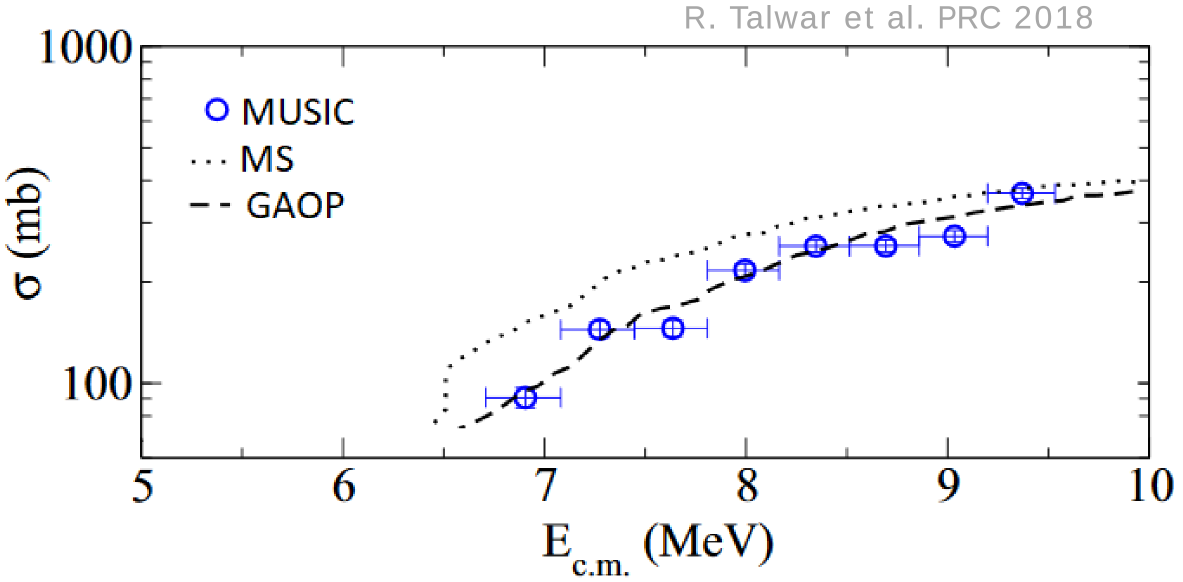
J. Bliss et al. JPG 2017

The (α,n) rate uncertainty is mostly from αOMPs

The (α,n) cross section dependency on the αOMP means that measurements can improve theoretical estimates for nuclides in a similar region of the nuclear chart





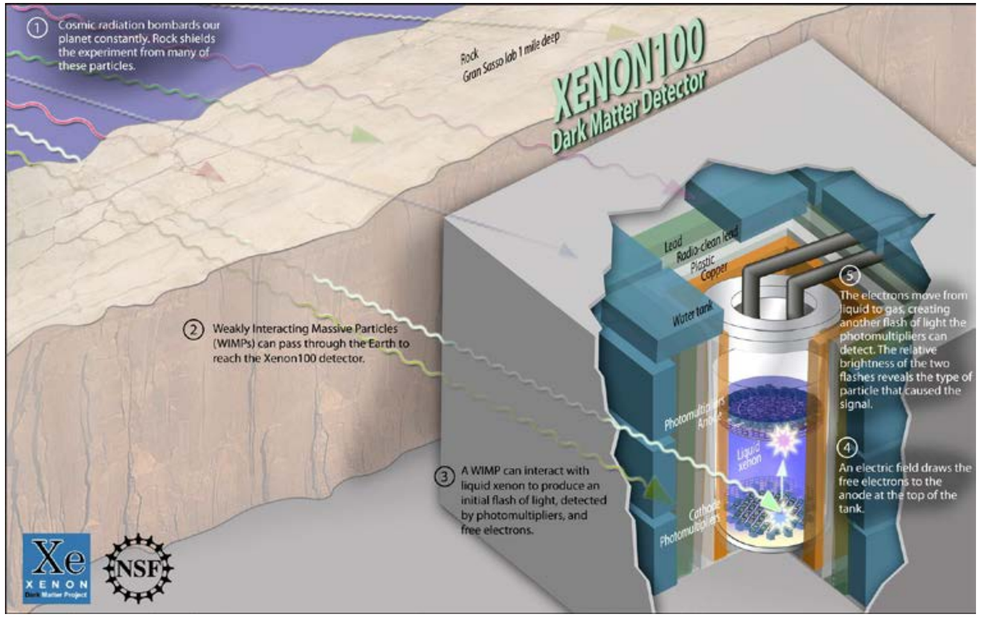


We need more (α,n) cross section measurements for a wide range of nuclei using a variety of techniques.

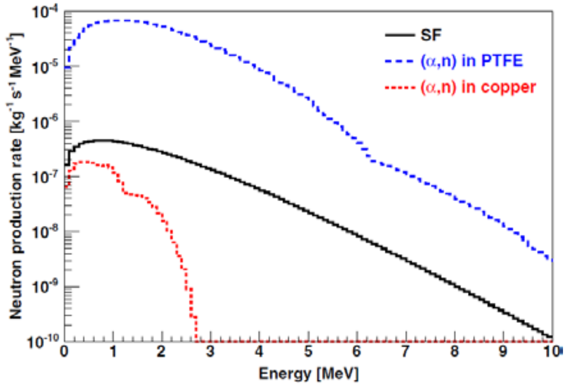
HEBGB was designed to perform direct cross section measurements via neutron counting with limited sensitivity to neutron angular & energy distributions.

$^{13}C(\alpha,n)^{16}O$ is of broad interest

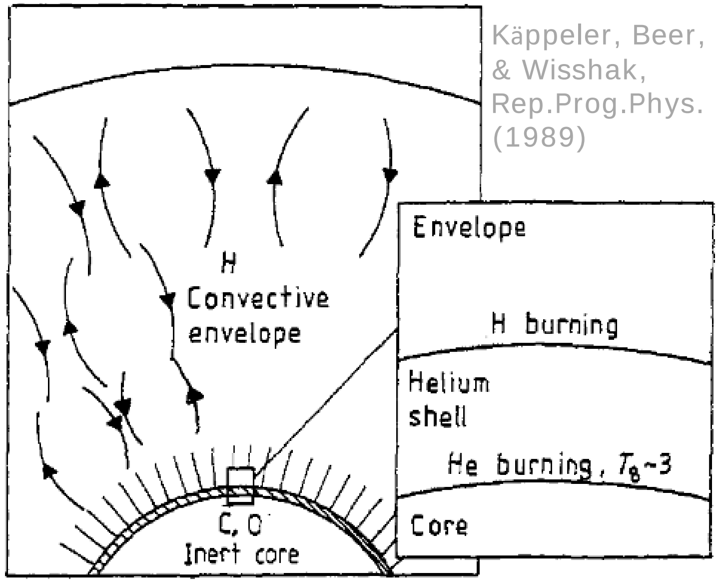
(α,n) reactions mimic WIMP & geoneutrino detection



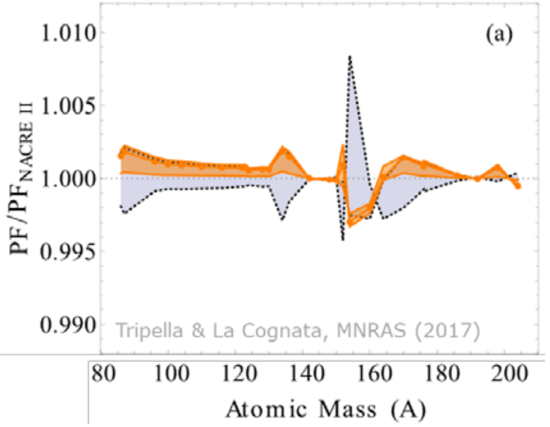
E. Aprile et al. JPG 2013



$^{13}C(\alpha,n)$ fuels heavy element production

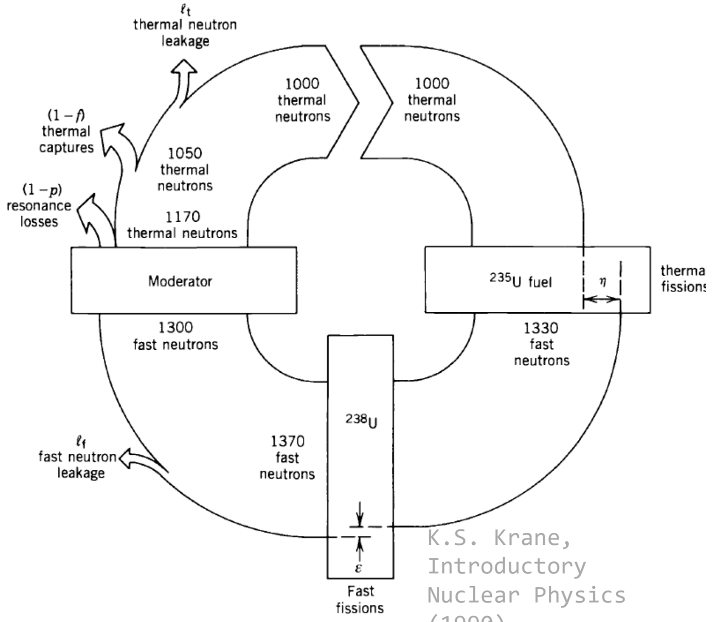


Käppeler, Beer, & Wisshak, Rep.Prog.Phys. (1989)



Tripella & La Cognata, MNRAS (2017)

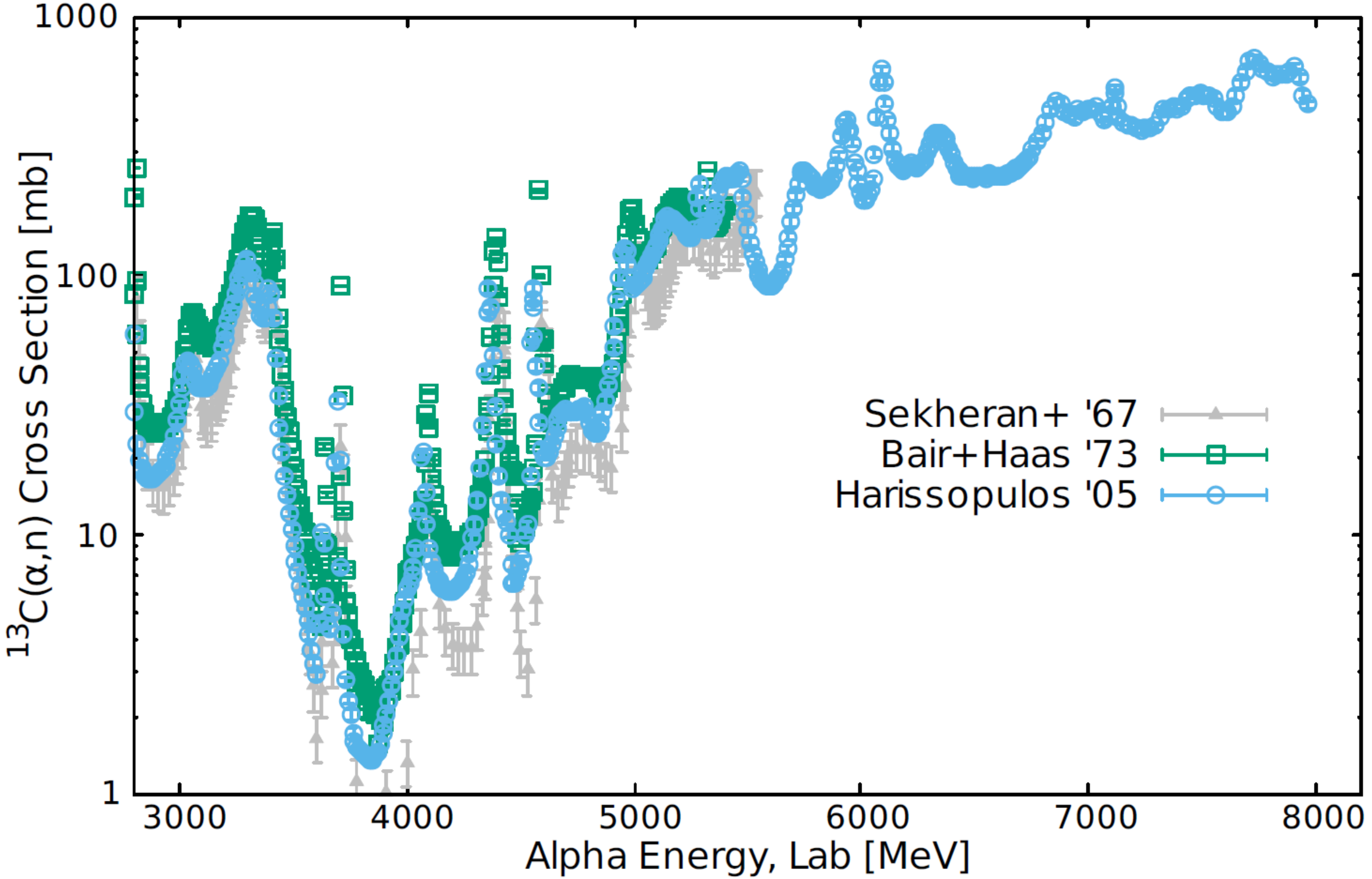
$^{16}O(n,\alpha)^{13}C$ common in applications with neutrons



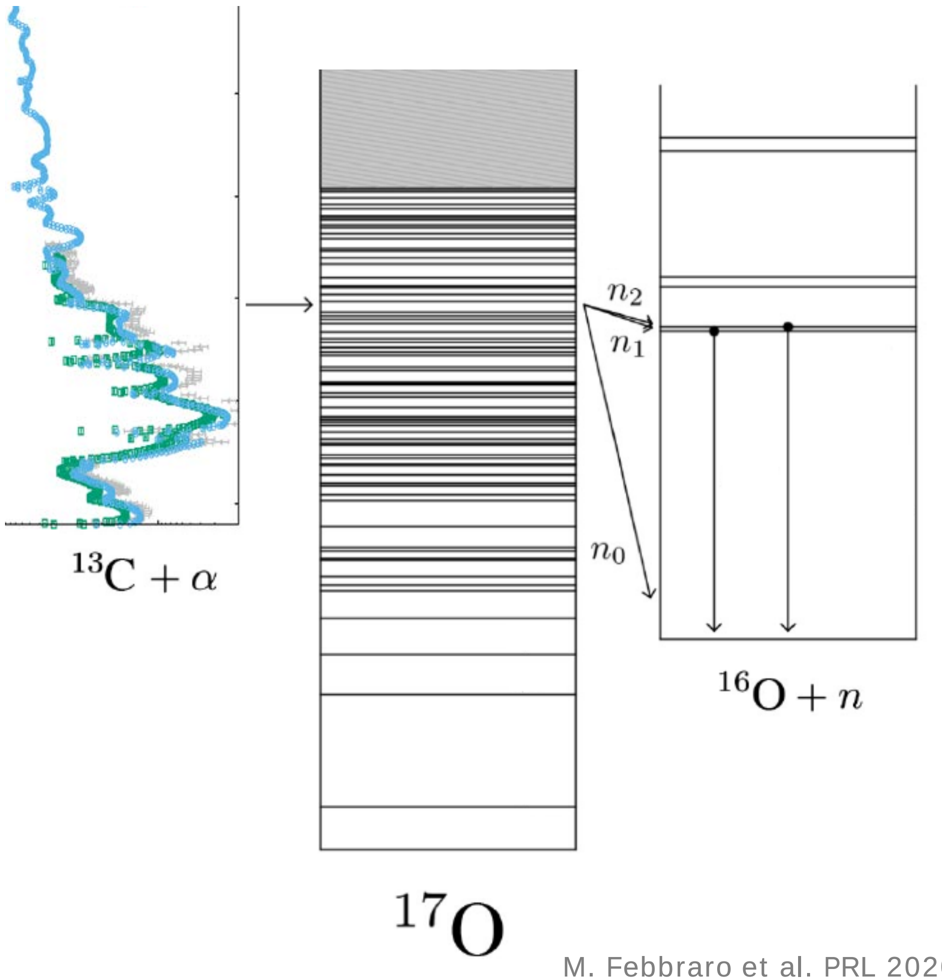
K.S. Krane, Introductory Nuclear Physics (1990)

- *Neutron multiplication*
- *Helium production*

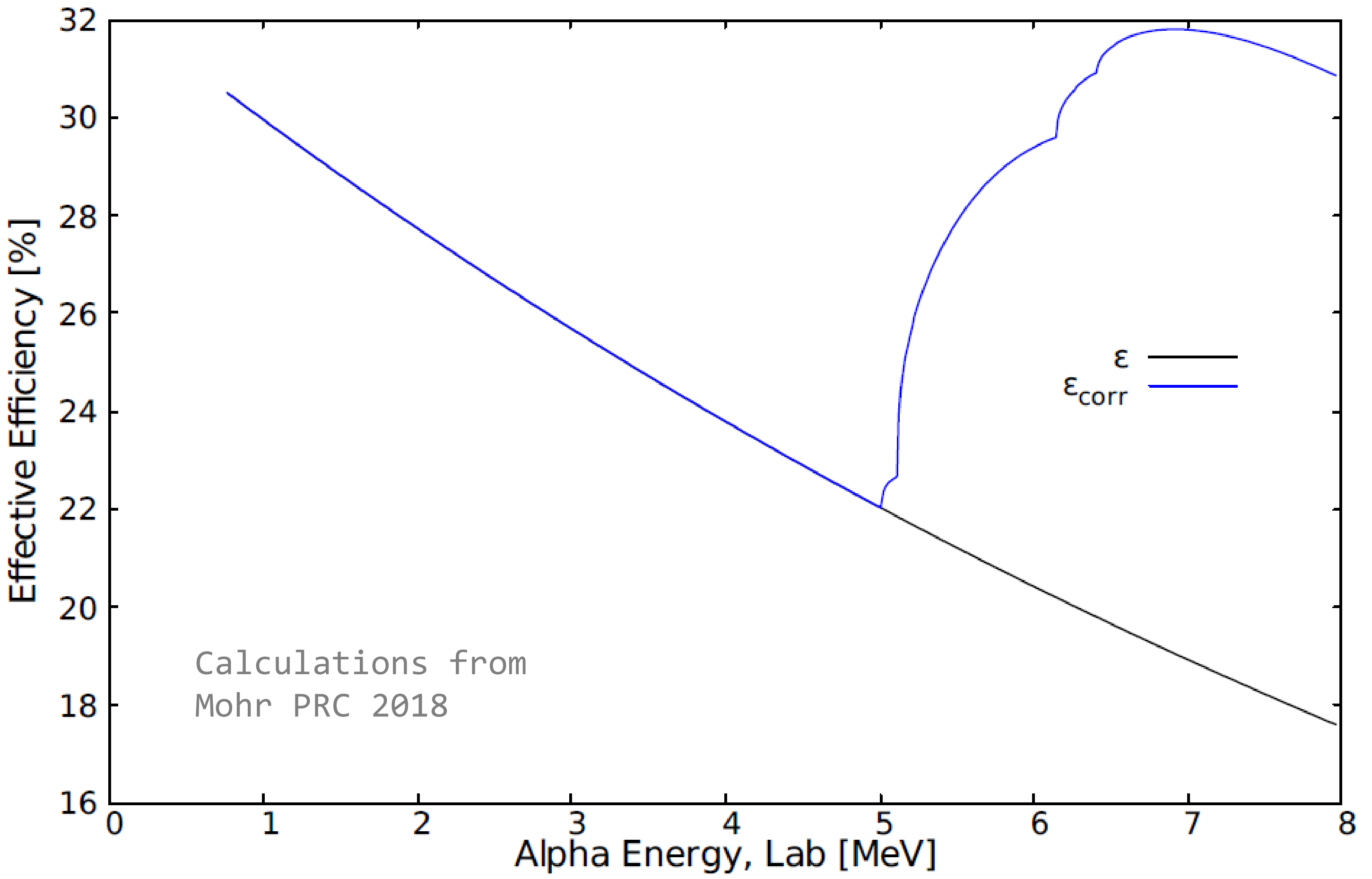
$^{13}C(\alpha,n)^{16}O$ total cross section data above 3MeV



$^{13}C(\alpha,n)^{16}O$ data have a problem above ~5MeV

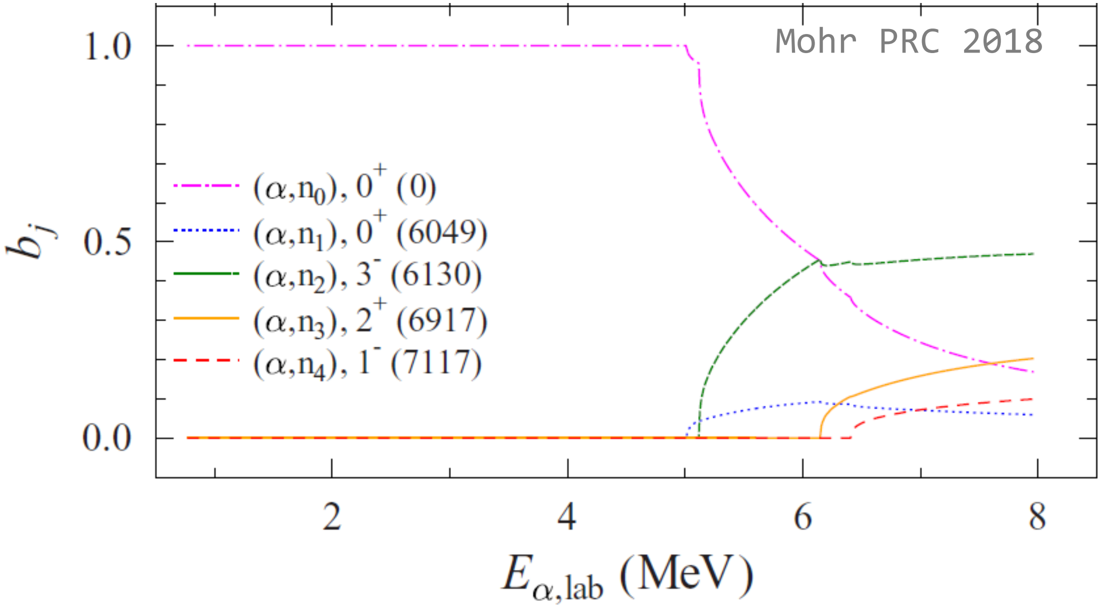


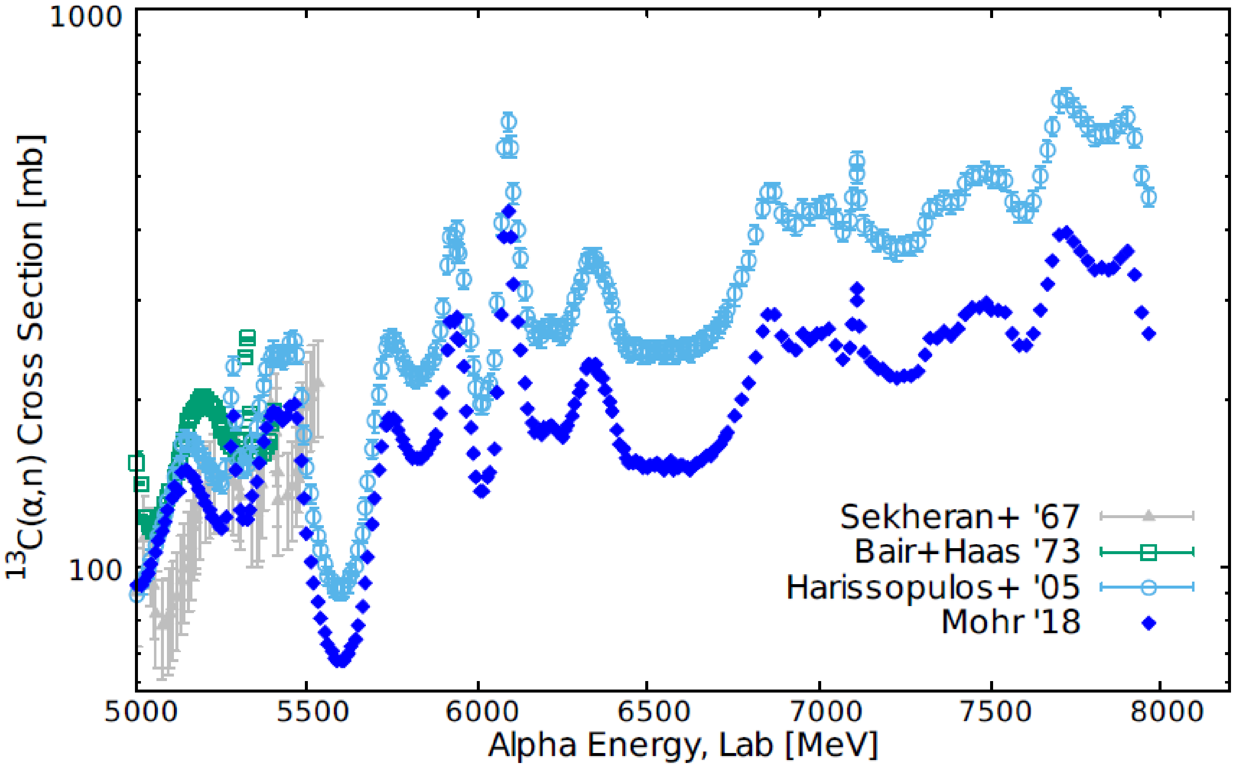
M. Febbraro et al. PRL 2020



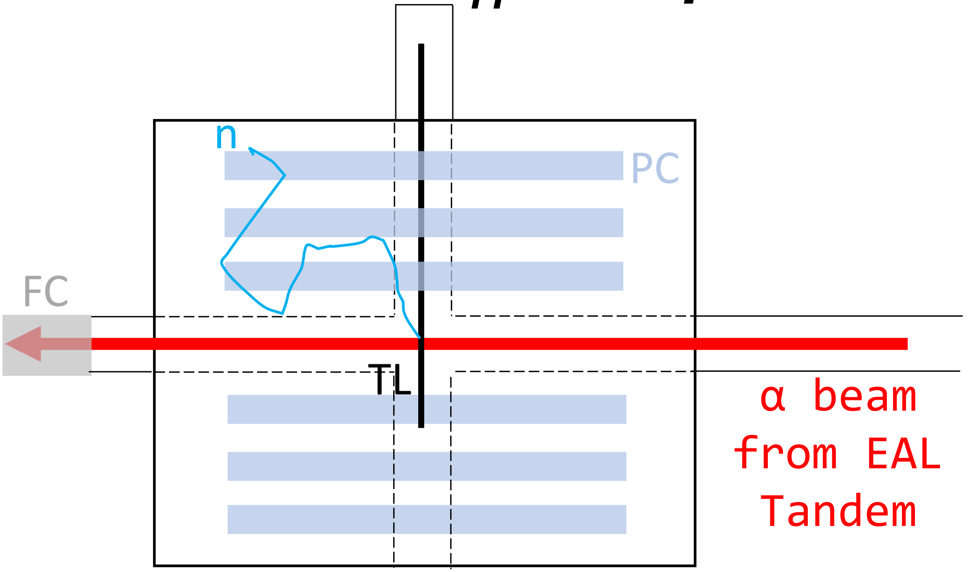
Current solution above 5MeV is an HF-patch

$$\varepsilon_{corr} = \sum_{j=0}^{4} b_j(E_\alpha)\varepsilon_j\left(E_{n,j}\right)$$

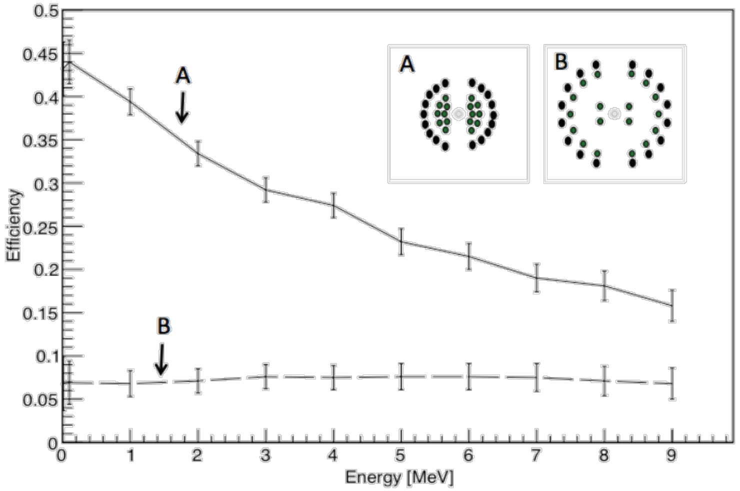


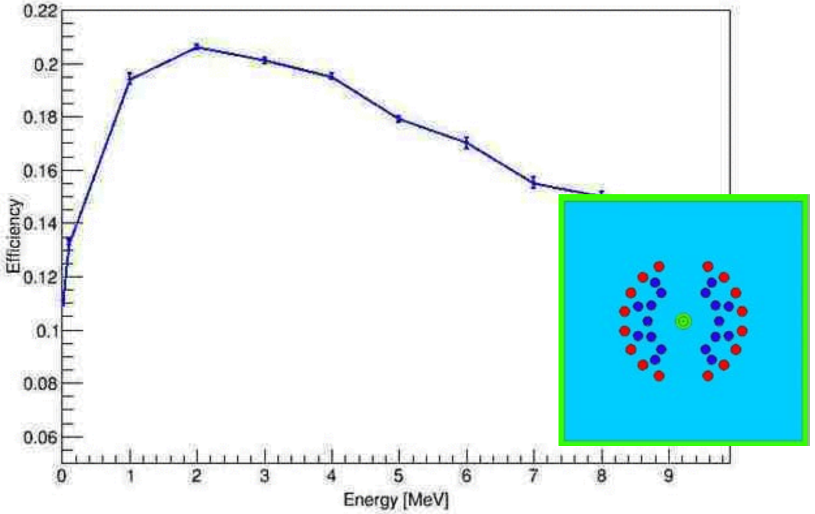


Our Solution: *Reduce E_n-dependence of ε*



K. Brandenburg MS Thesis (OU) 2017





Other improvements:

- target ladder (consistency)
- borated poly (background)
- gold-lining (background)
- Multi-ring (rough branching)

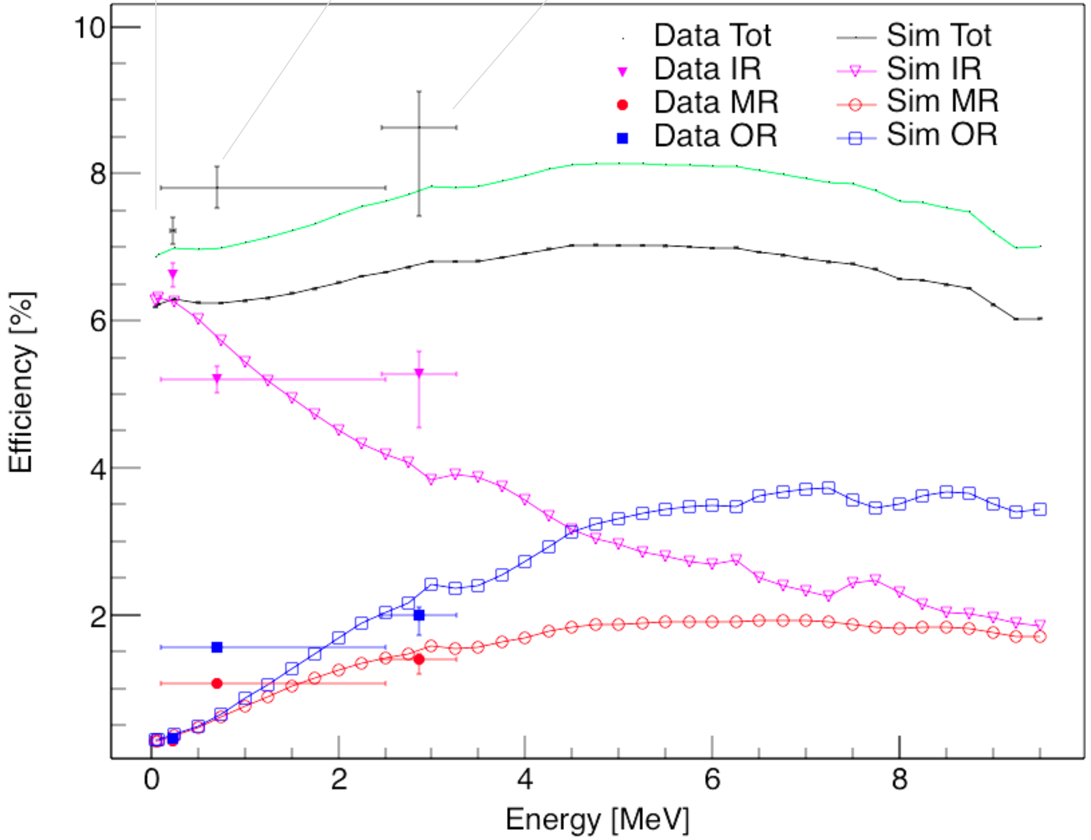
Validate performance with sources & reactions

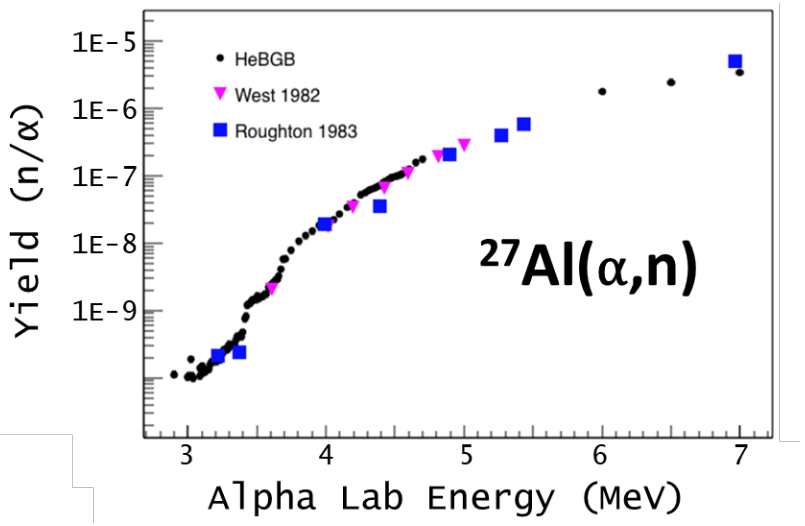
7.6±0.6 %

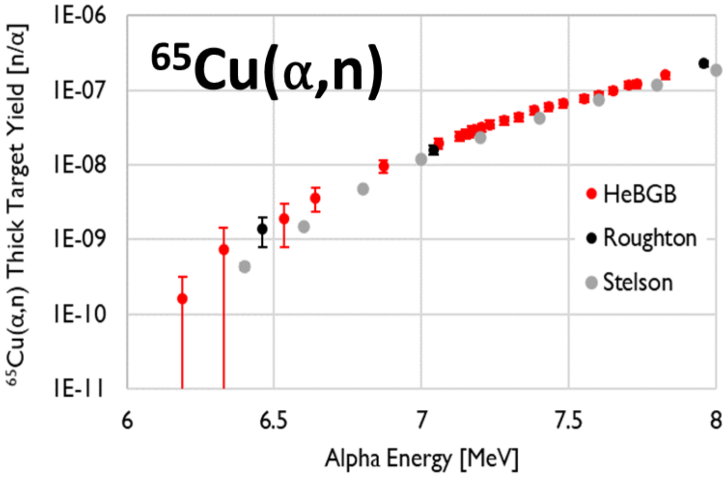
^{51}V(p,n) activation

^{252}Cf source

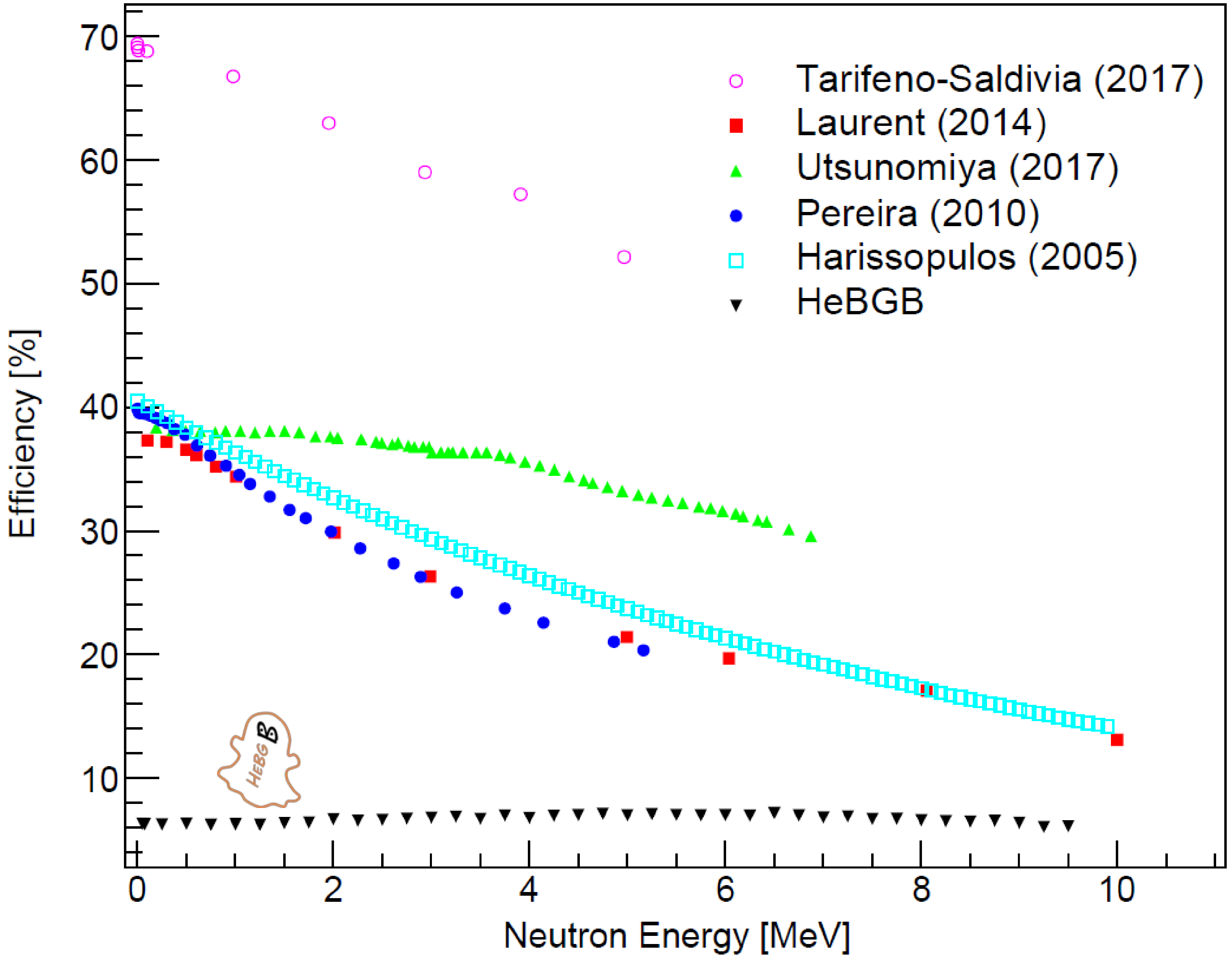
^{13}C(α,n) resonance





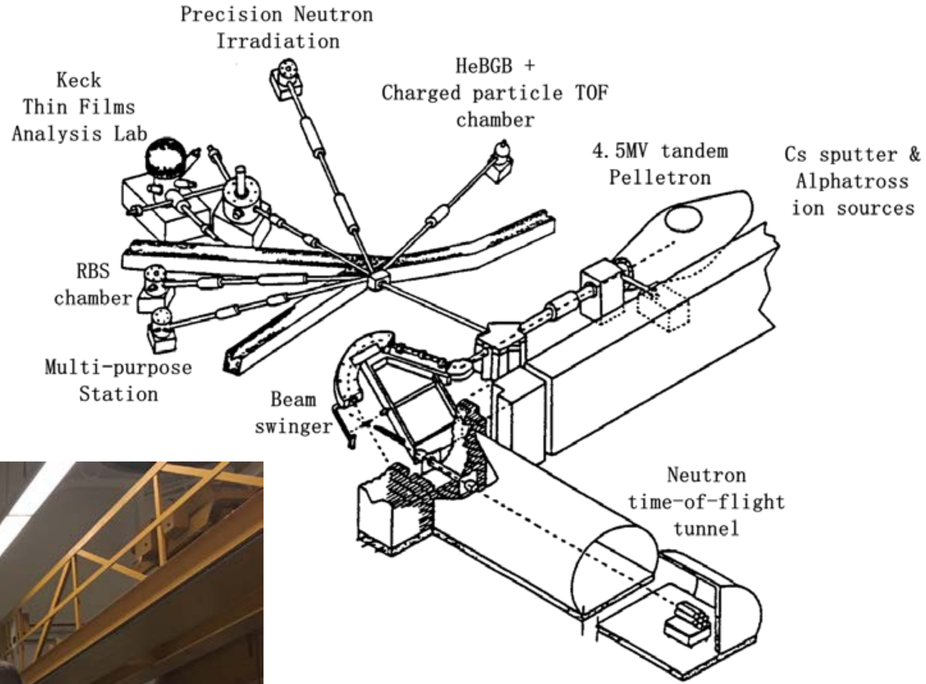


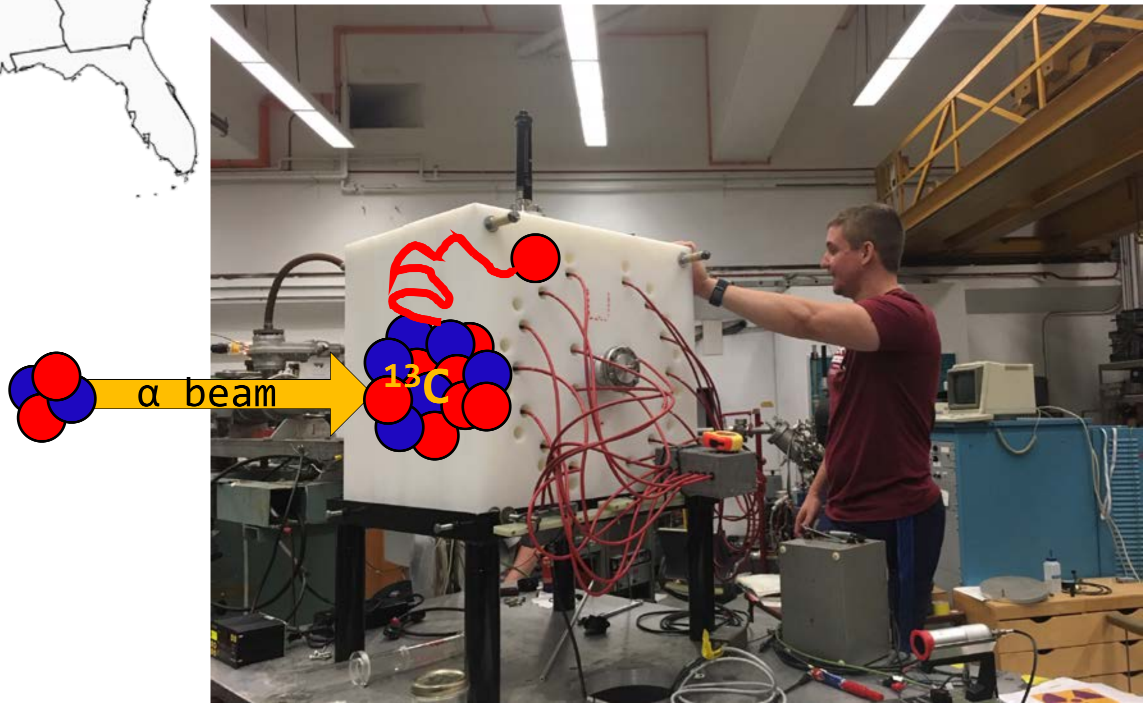
Comparison to Other Long-Counters



Measured $^{13}C(\alpha,n)^{16}O$ at the EAL at Ohio

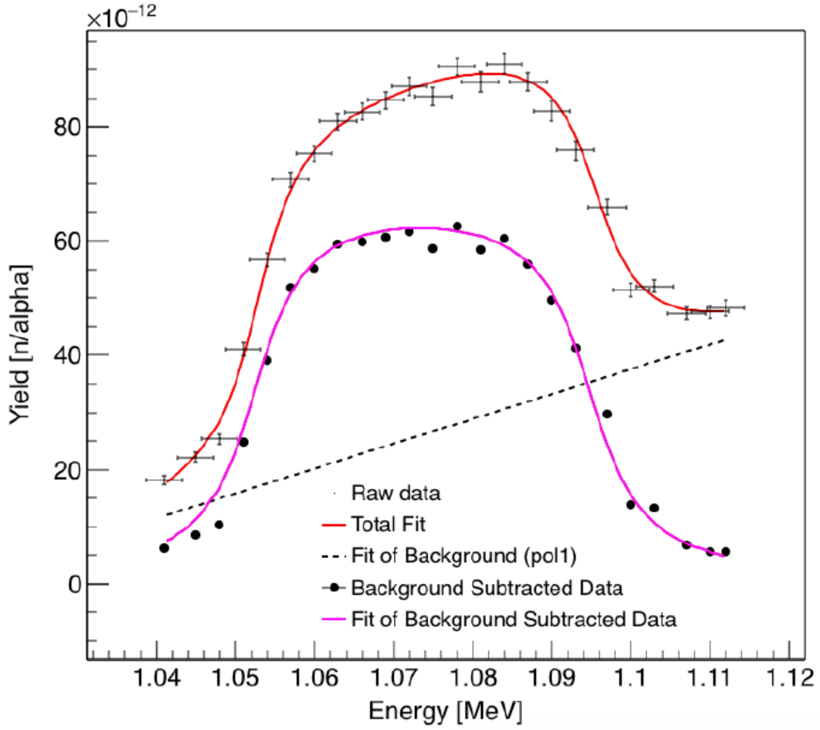
*Oldest university in the Northwest Territory





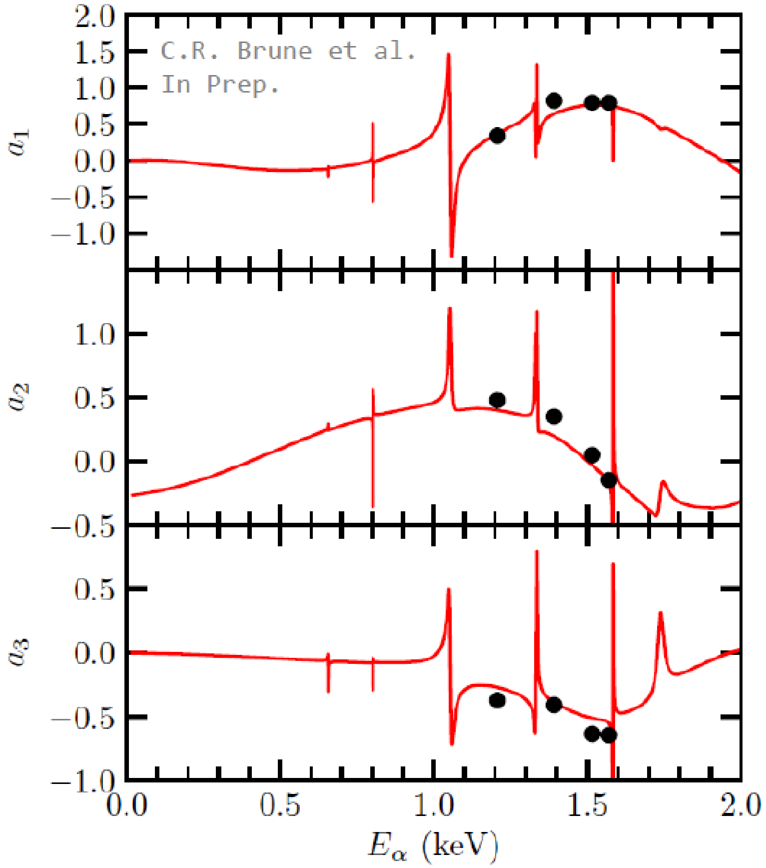
Additional Considerations

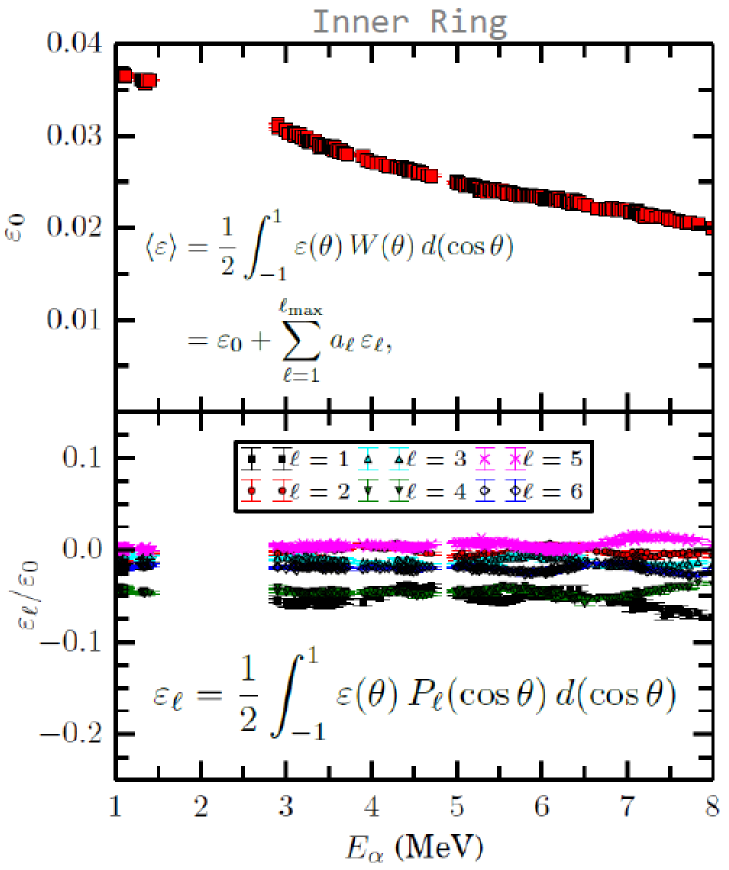
Target Thickness



+ *energy loss*
+ *Rutherford scatteing*

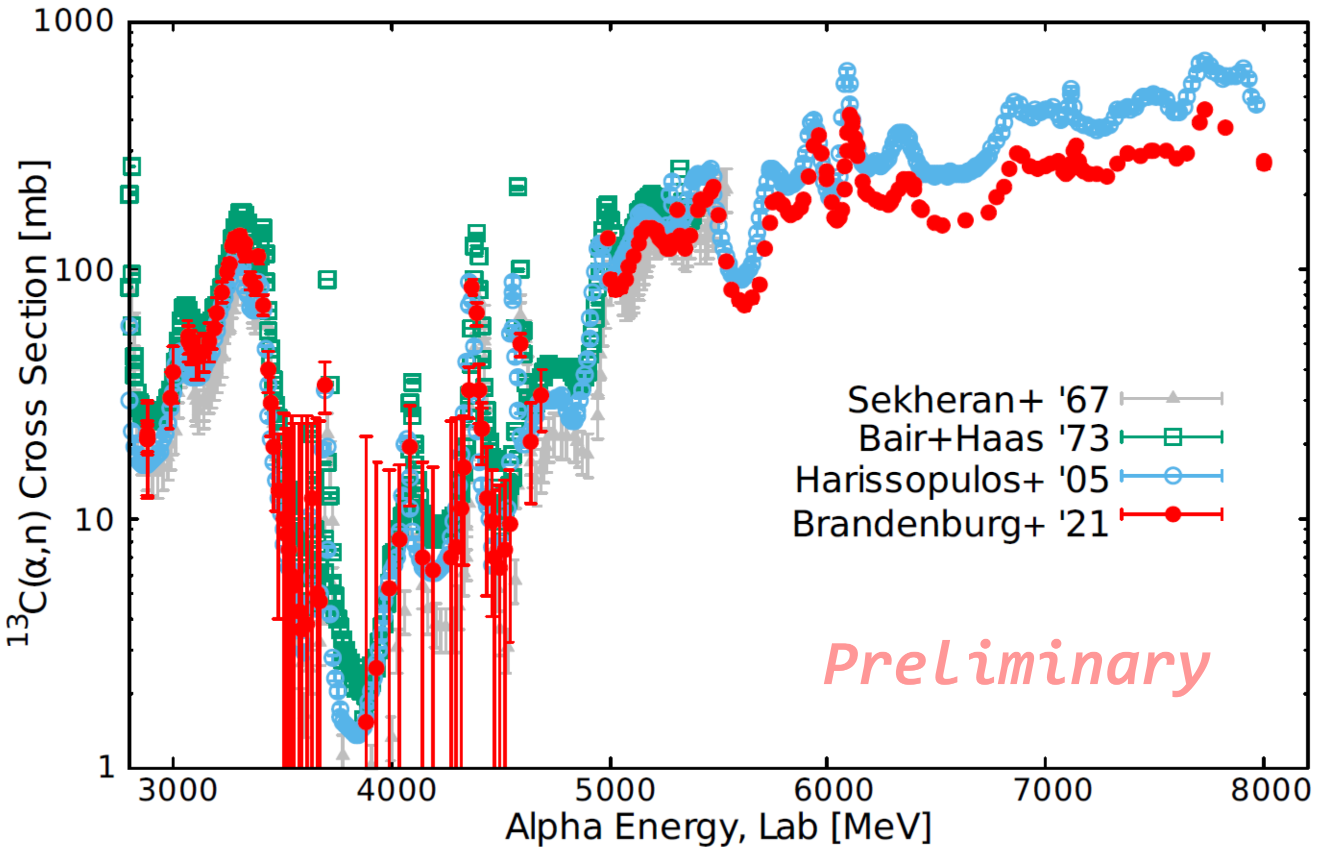
Neutron Angular Distribution*

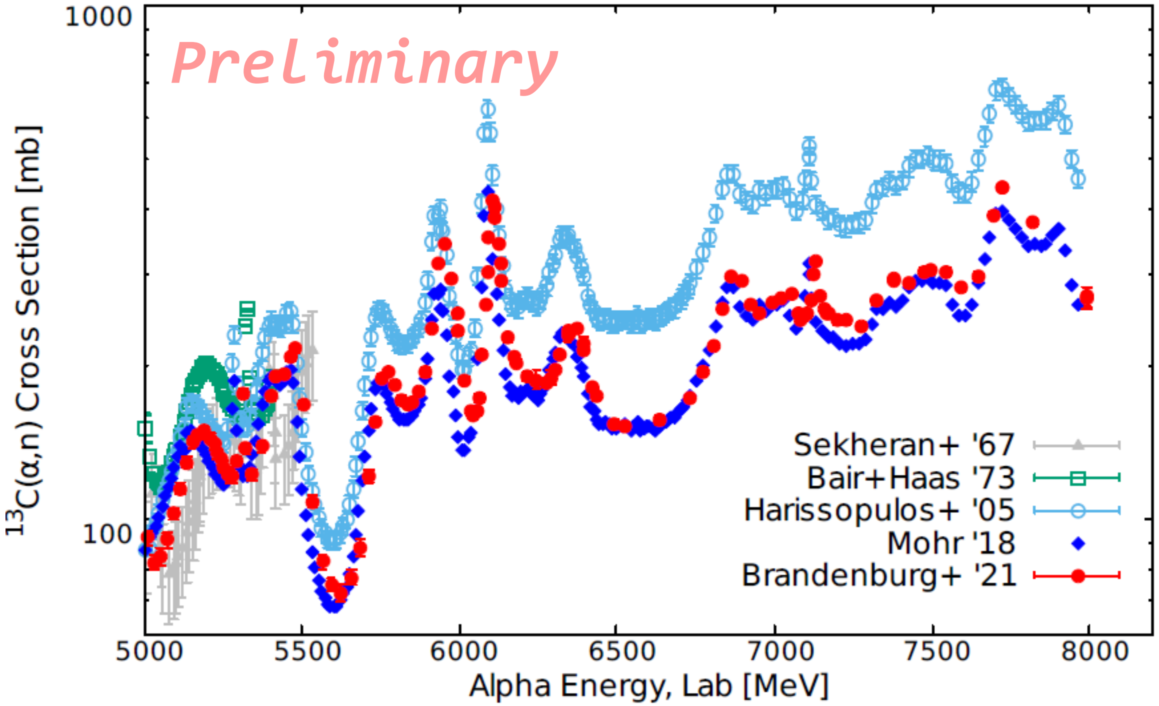




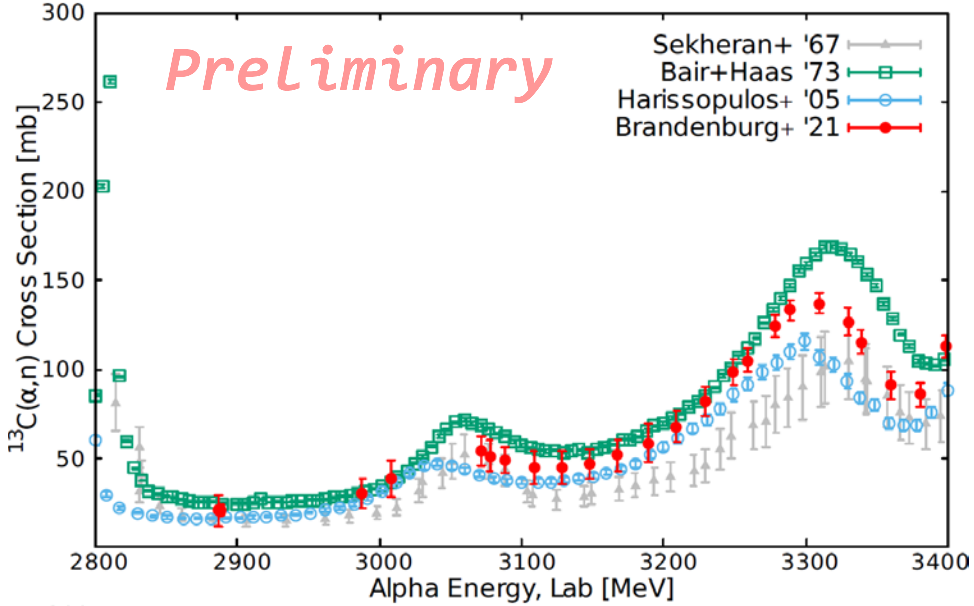
**only a few % correction because of ~4π-coverage*

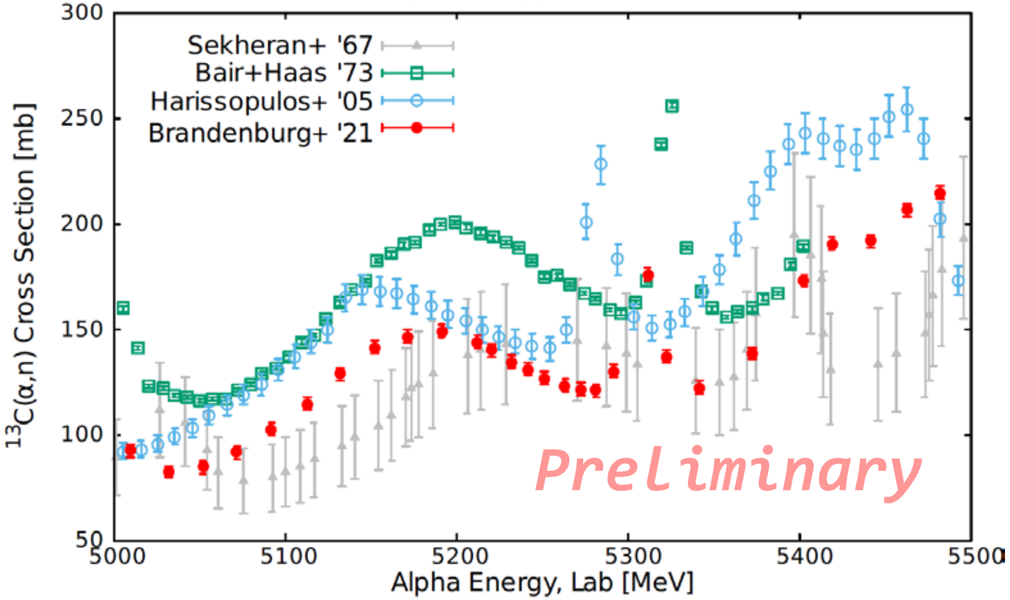
$^{13}C(\alpha,n)^{16}O$ total cross section data above 3MeV

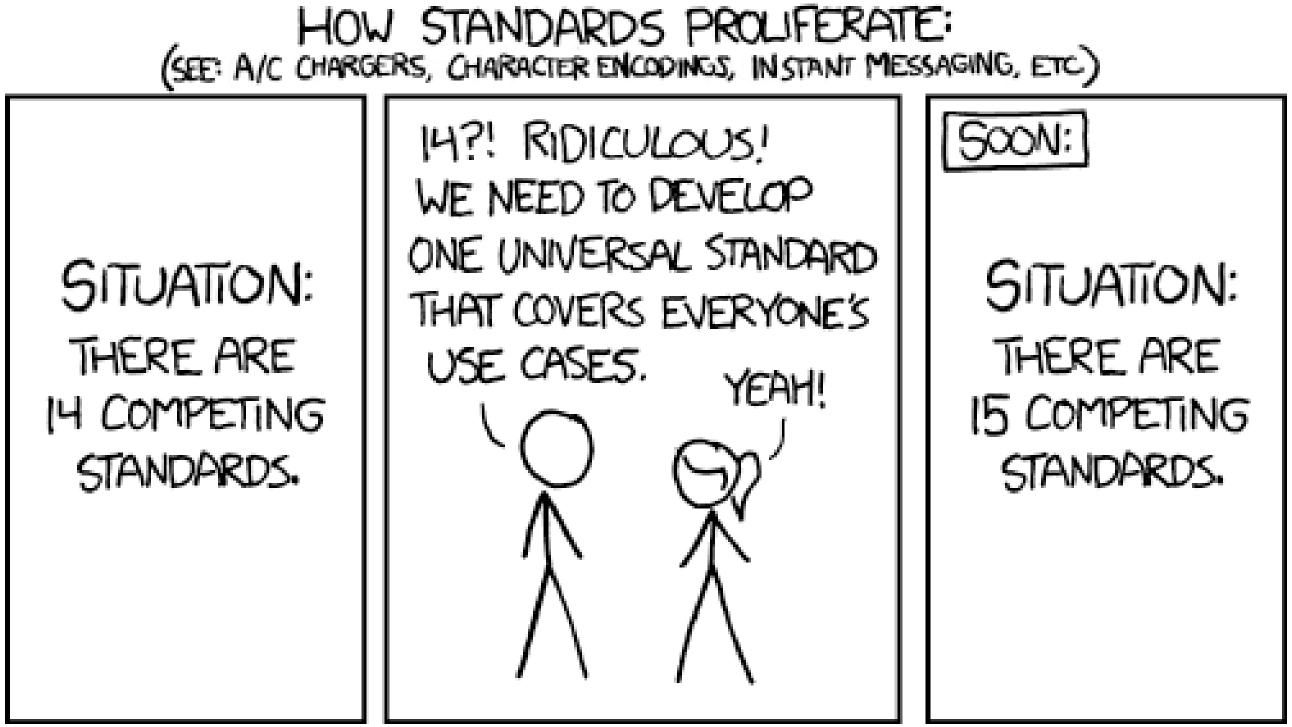




$^{13}C(\alpha,n)^{16}O$ total cross section data above 3MeV



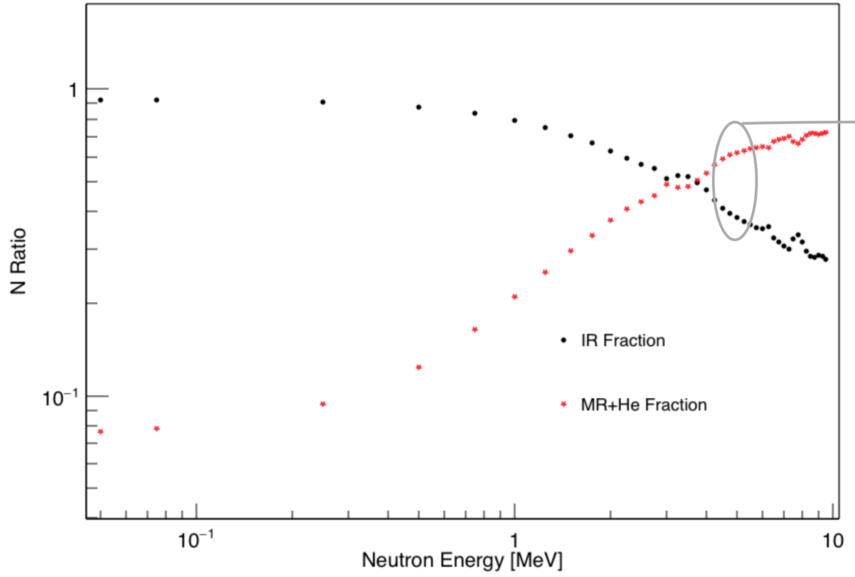




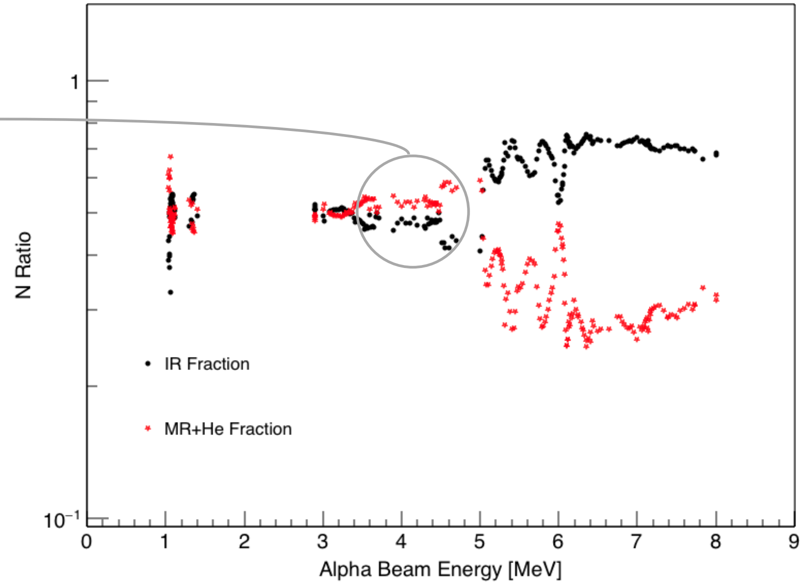
xkcd

Can we constrain branchings from the ring ratio?

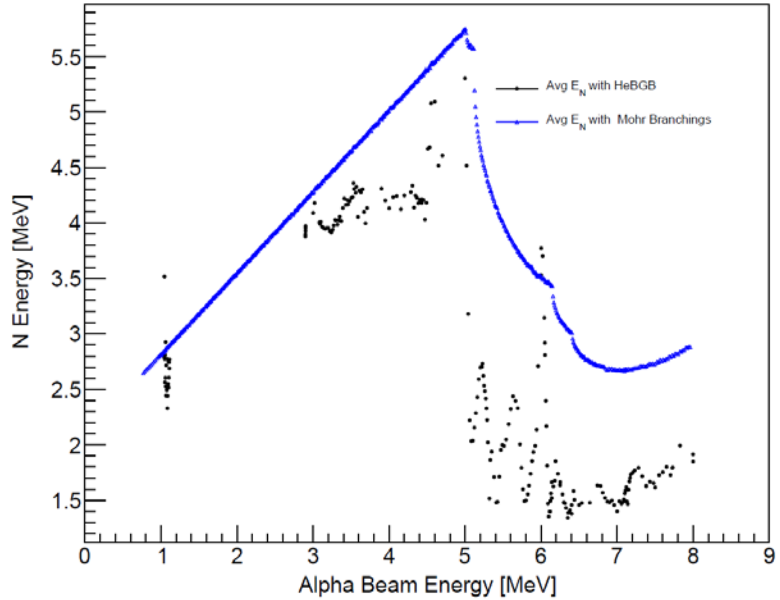
Simulated



Measured



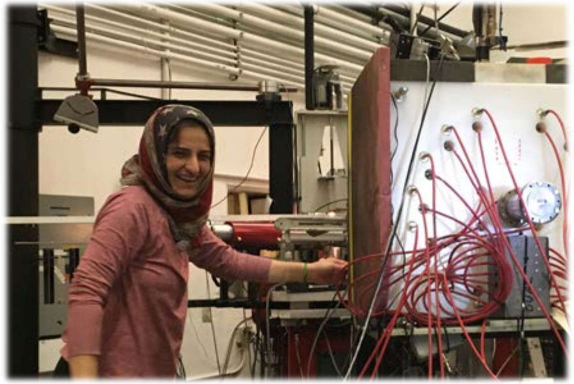
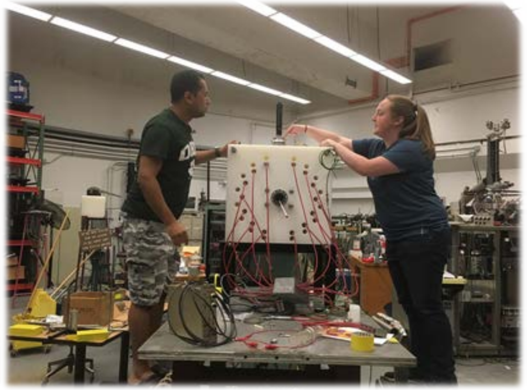
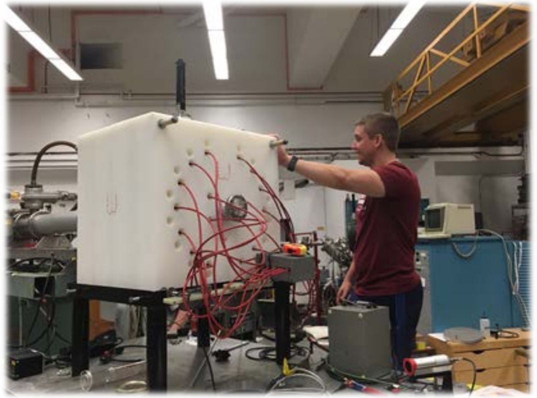
Applied



Preliminary

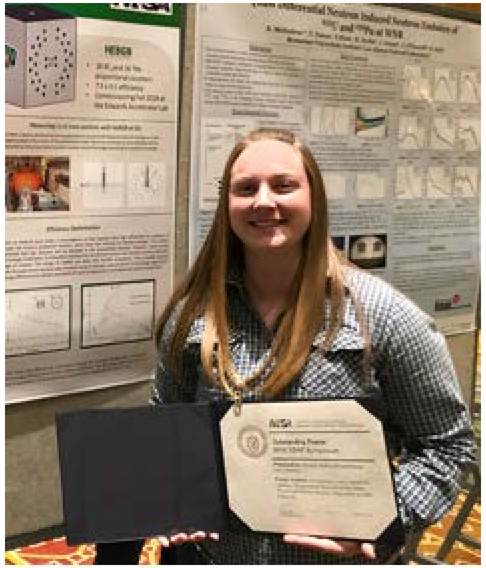
...get some idea, but obviously want direct measurements of branchings (see DeBoer talk tomorrow)

Thanks





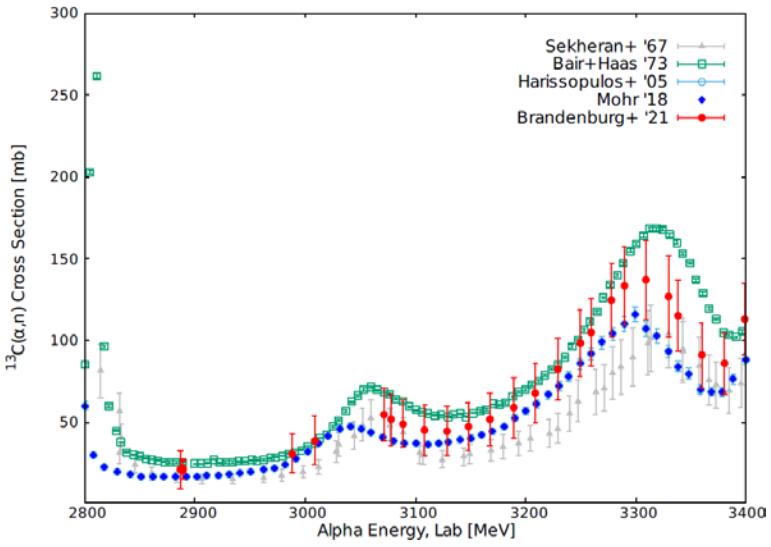



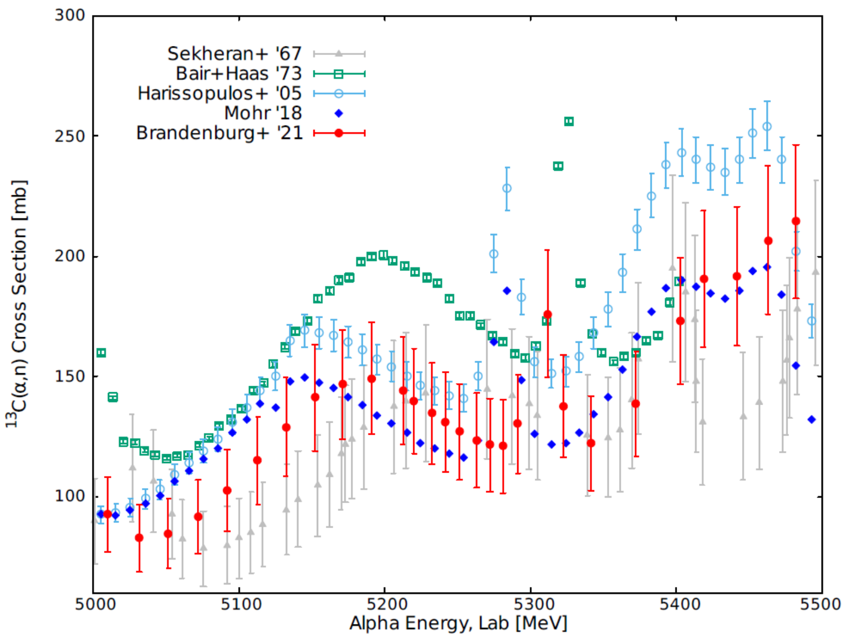
Kristyn Brandenburg

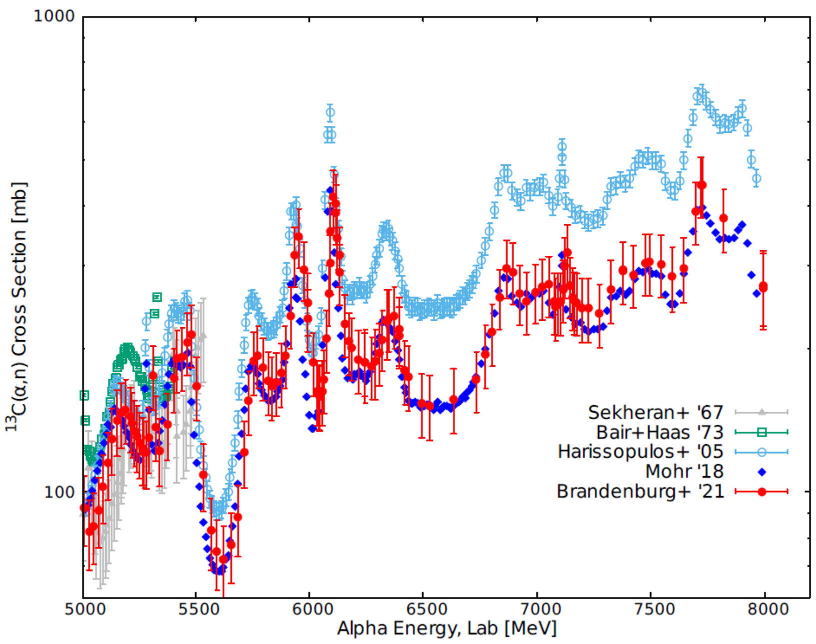
Supplemental

Including Our Systematic Uncertainty
(~5% stopping power, ~8% efficiency)

Preliminary







Efficiencies (and Therefore Ring Ratios) are Impacted by Angular Distributions

Simulated