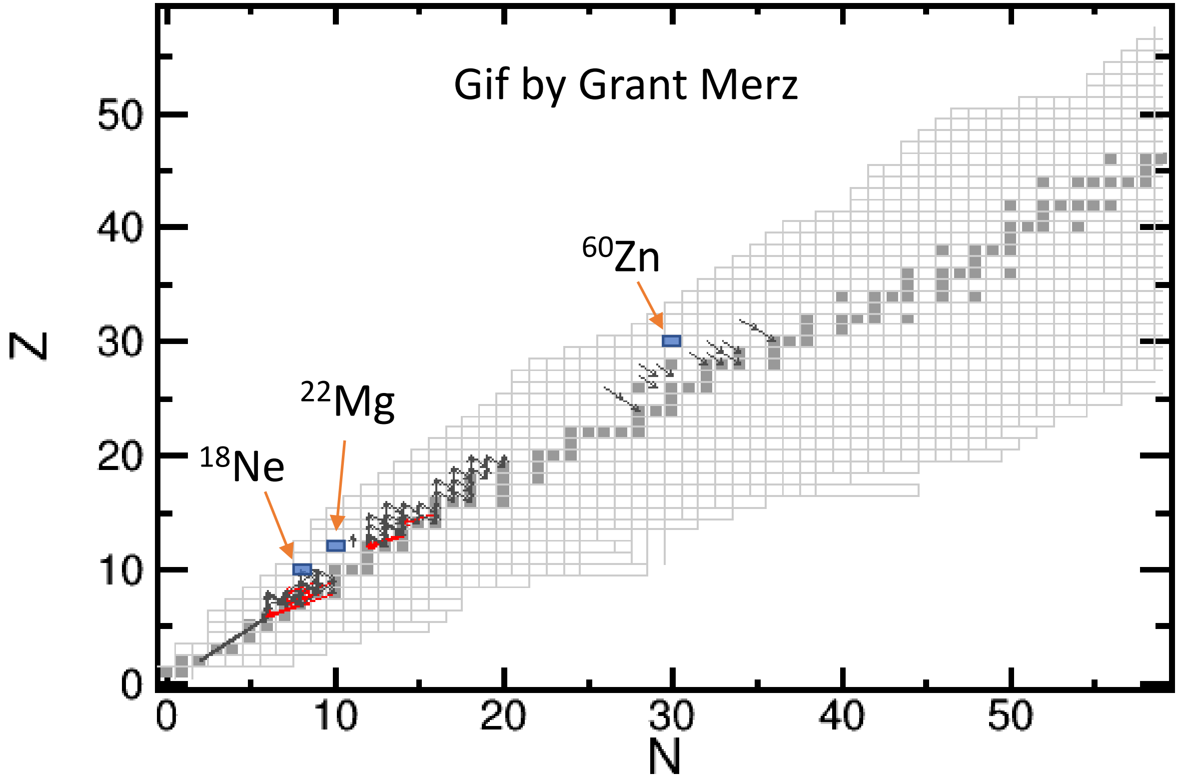
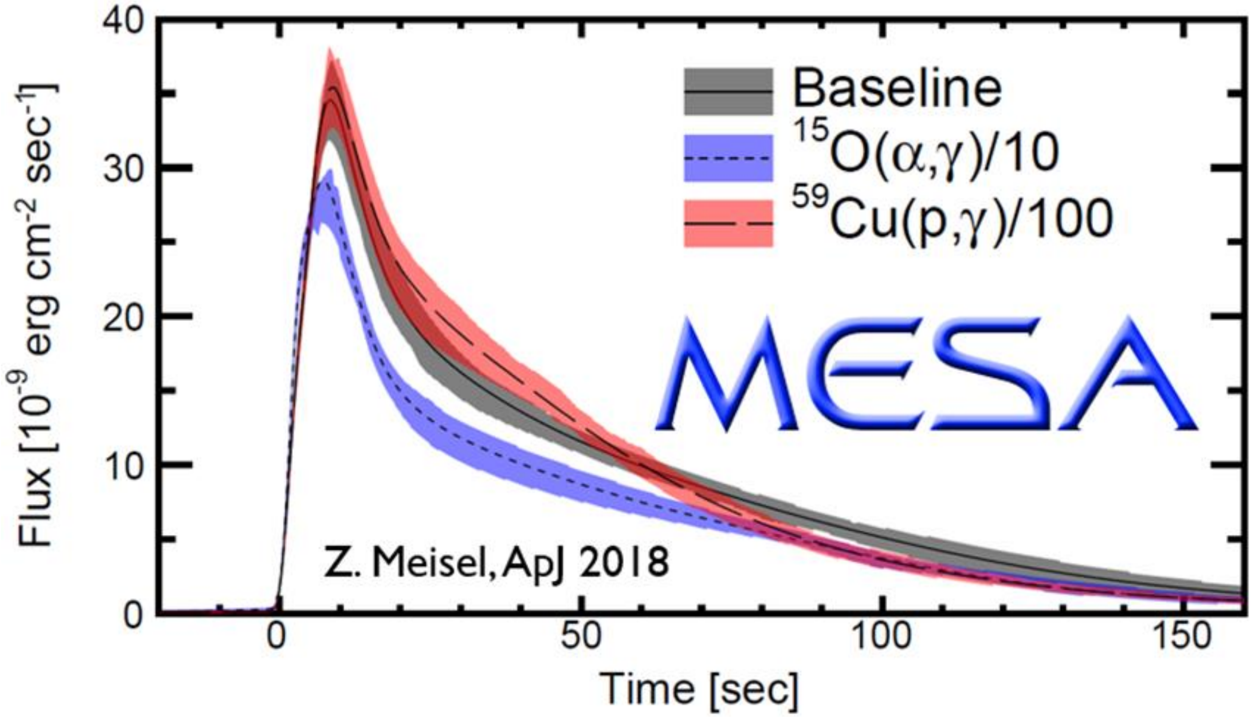
Use of (3He,n) reaction to constrain reaction rates having effect on X-Ray burst light curve

Doug Soltesz

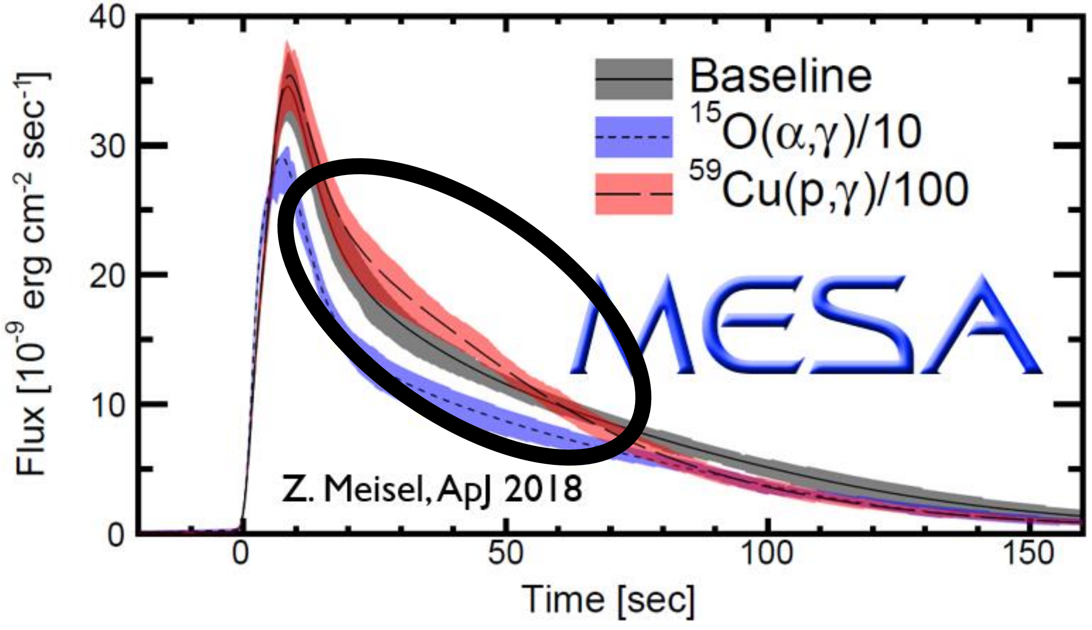
Reaction rates are important in modeling light curves

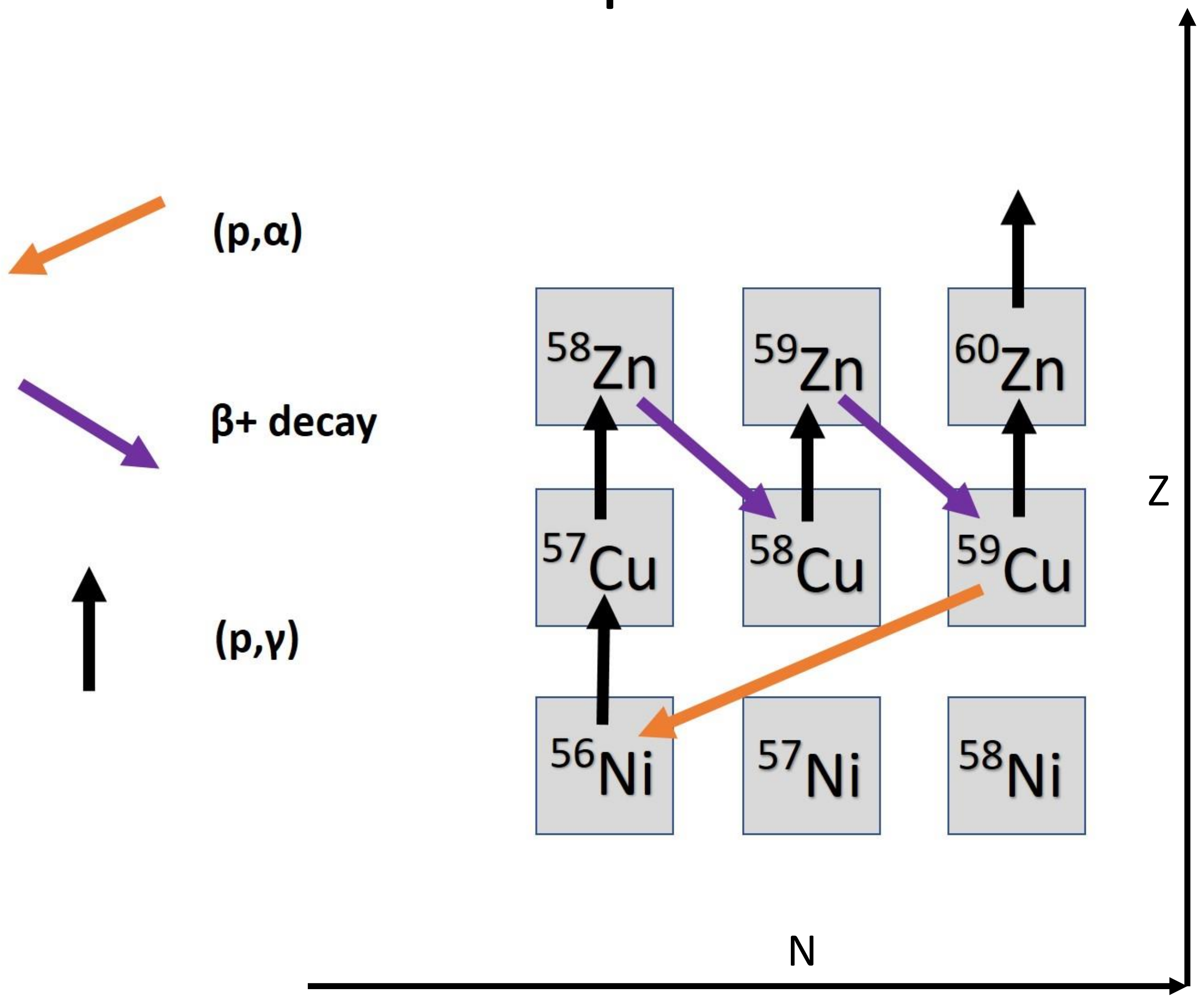
can access nuclei that are 2 protons above stable nuclei



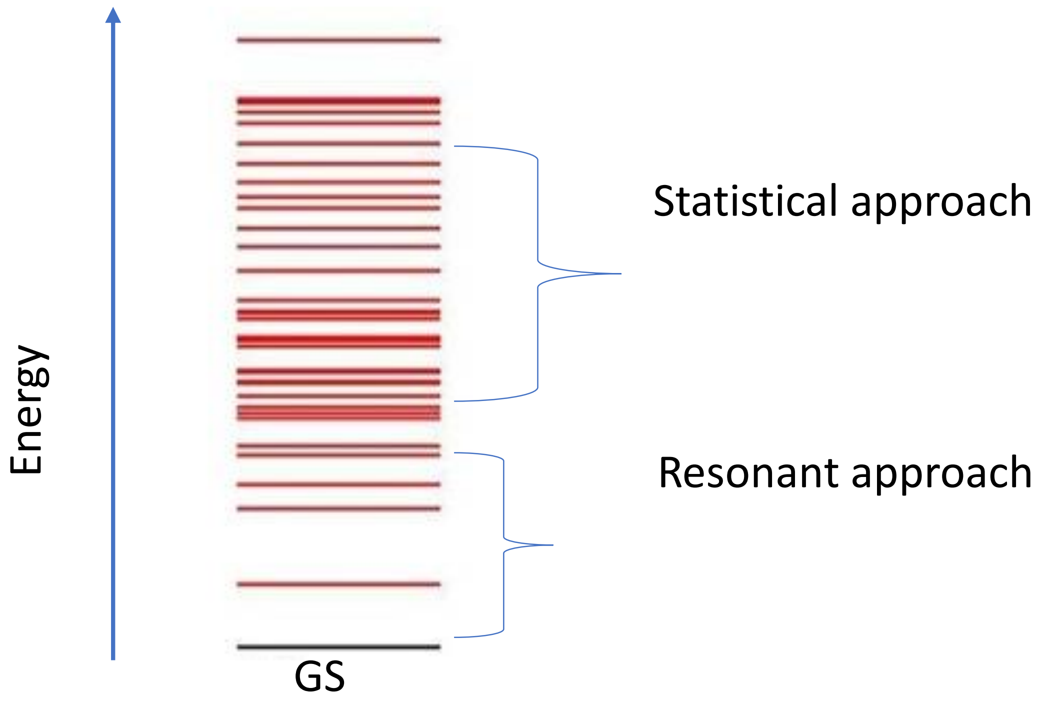


$^{59}Cu(p,\gamma)$ has a noticeable impact





^{60}Zn measurable via statistical approach



Statistical

$$\sigma_{ab}(\varepsilon_a, \varepsilon_b) = \sum_{J,\pi} \sigma_{J,\pi}^{CN}(\varepsilon_a) \frac{T_b(\varepsilon_b)\rho_b(E_b^*)}{\sum_c \int_{\varepsilon_c} T_c\,(\varepsilon_c)\rho_c(E_c^*)d\varepsilon_c}$$

Resonant

$$N_a\langle\sigma v\rangle = 1.54x10^{11}A^{-3/2}T_9^{-3/2}\sum_i \omega\,\gamma_i exp\left(-\frac{11.605E_i}{T_9}\right)$$

$$\omega\gamma = \frac{2J+1}{(2I_\alpha+1)(2I_T+1)}\frac{\Gamma_\alpha\Gamma_p}{\Gamma}$$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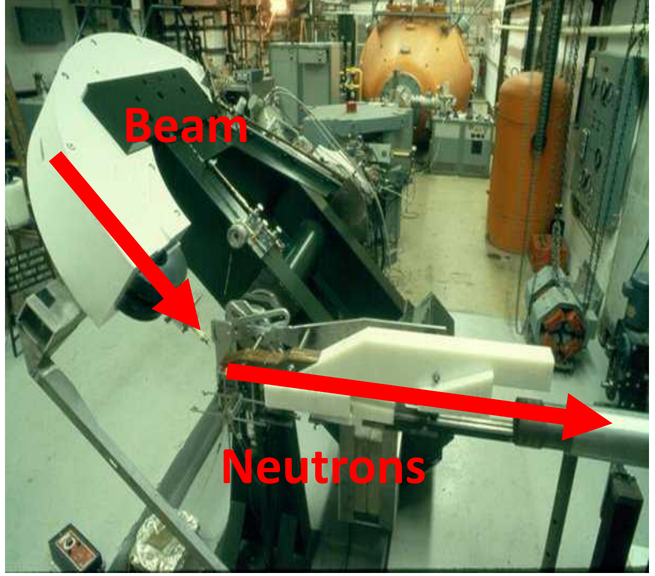
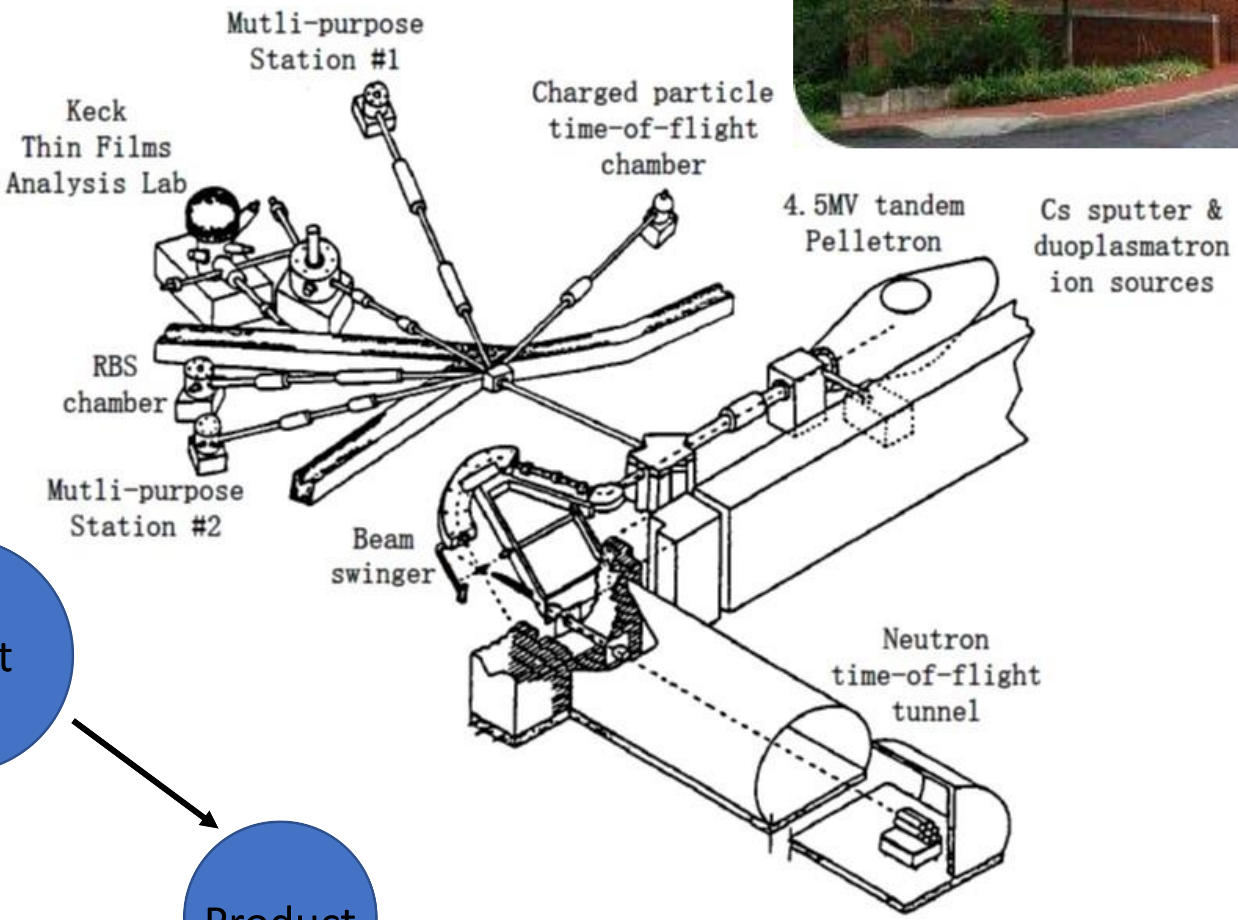
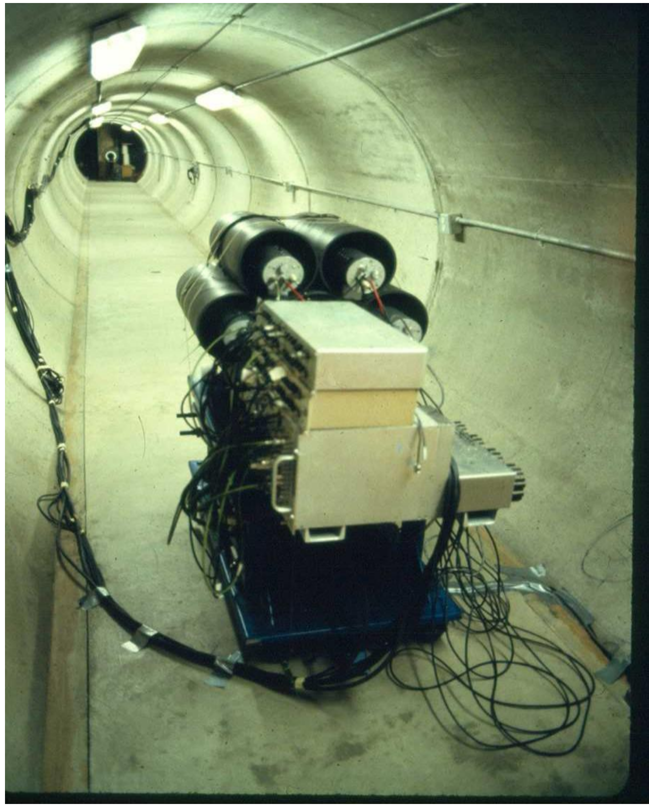
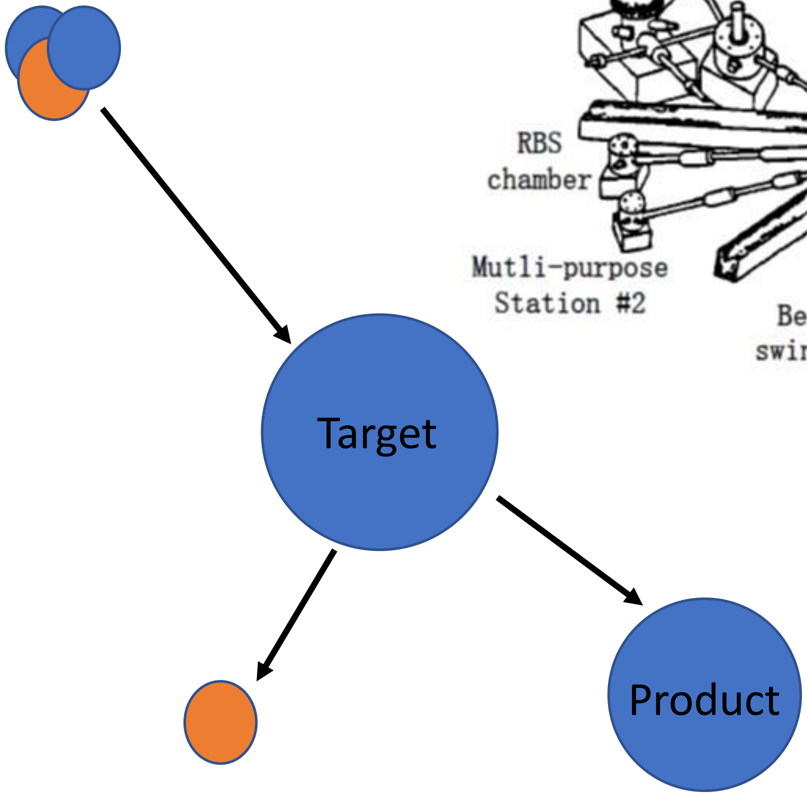
Edwards Accelerator Lab

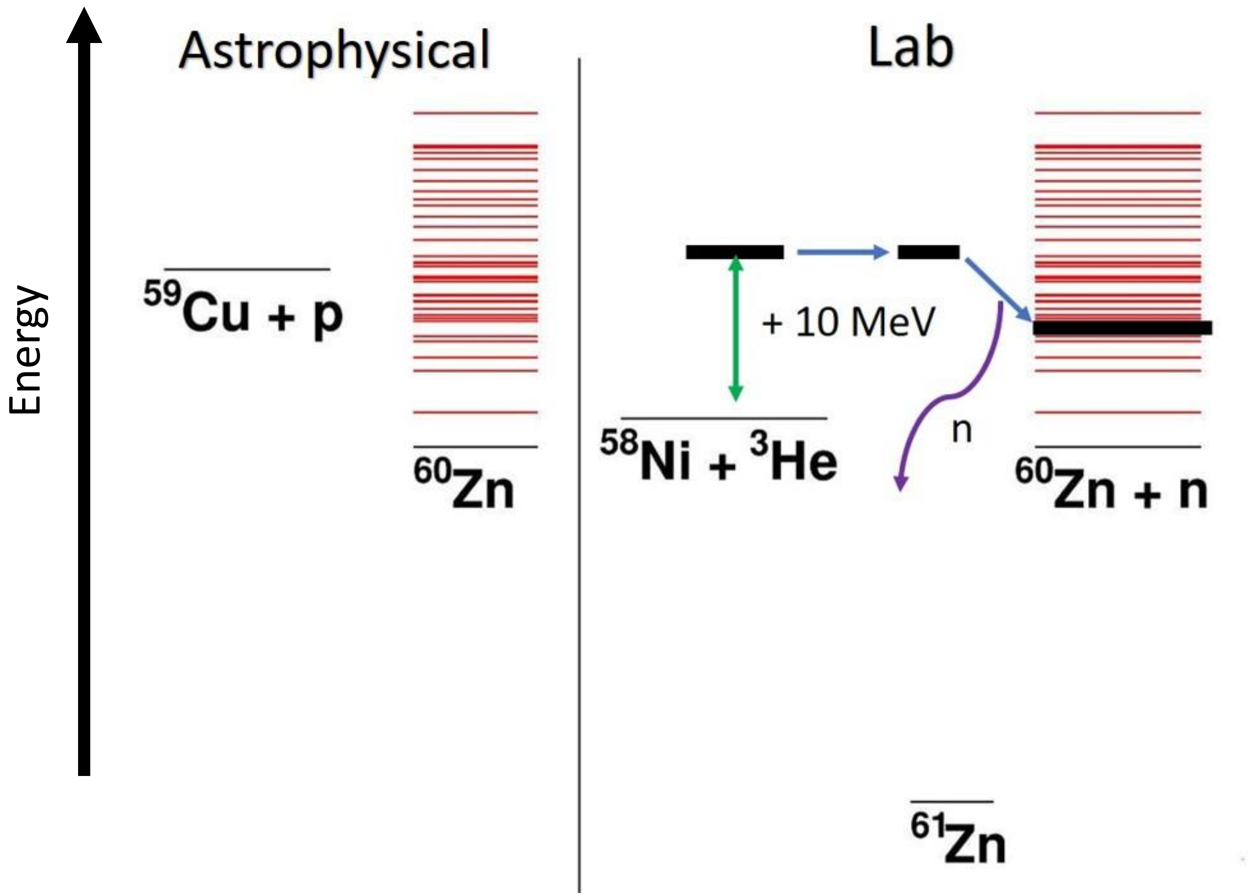




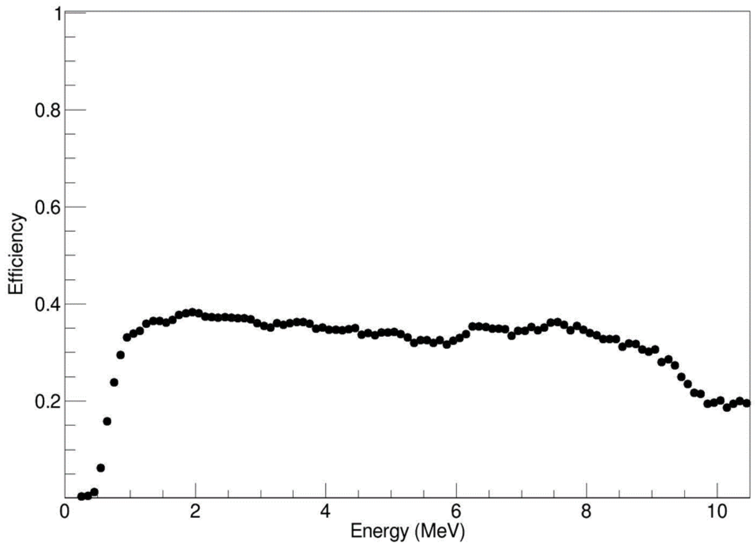


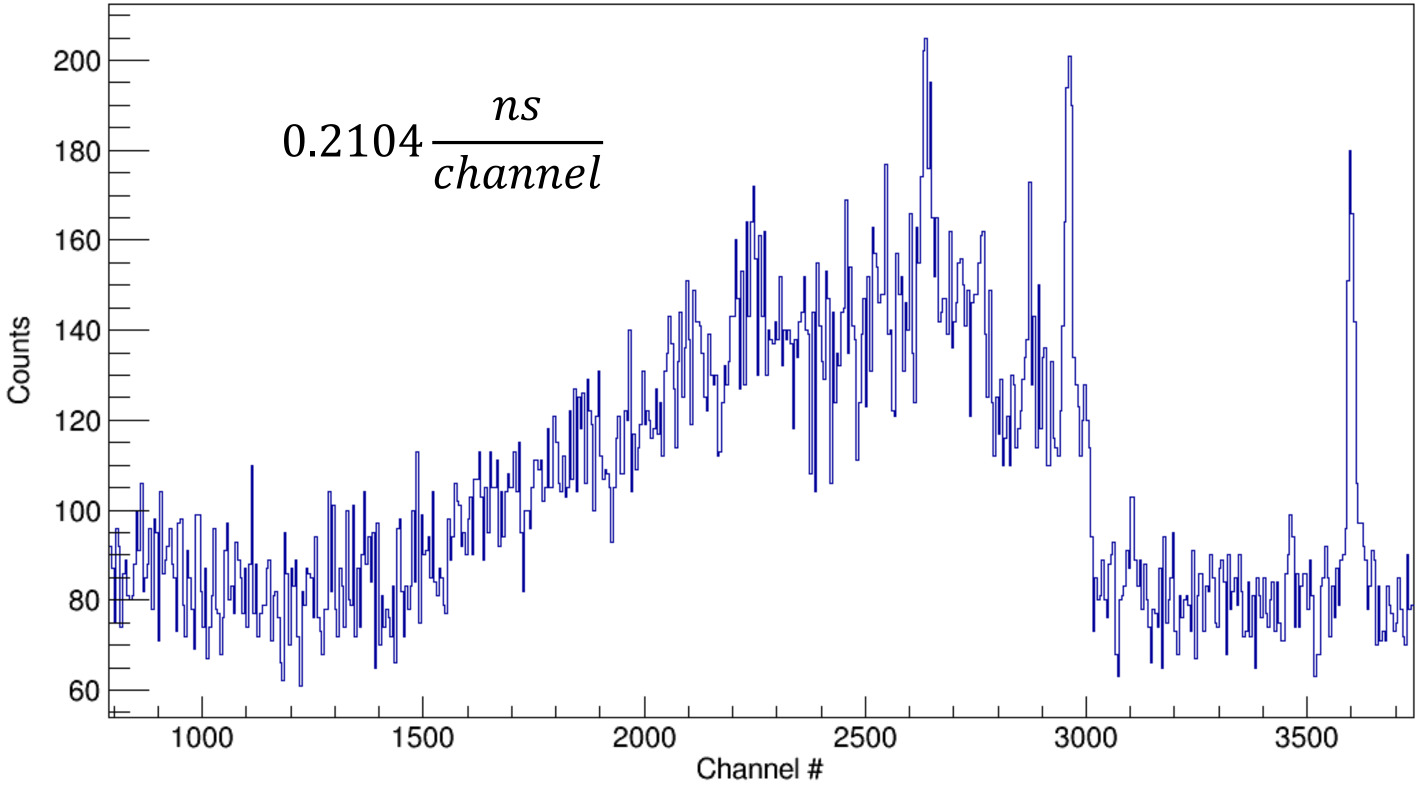


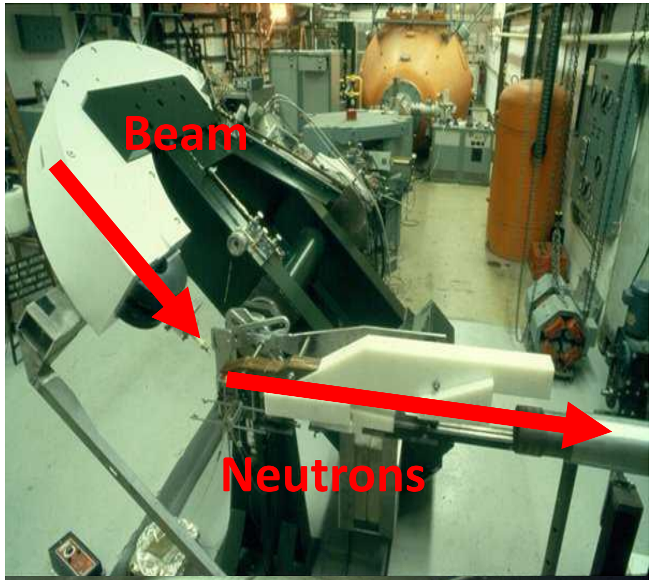
These reactions can’t be directly measured yet

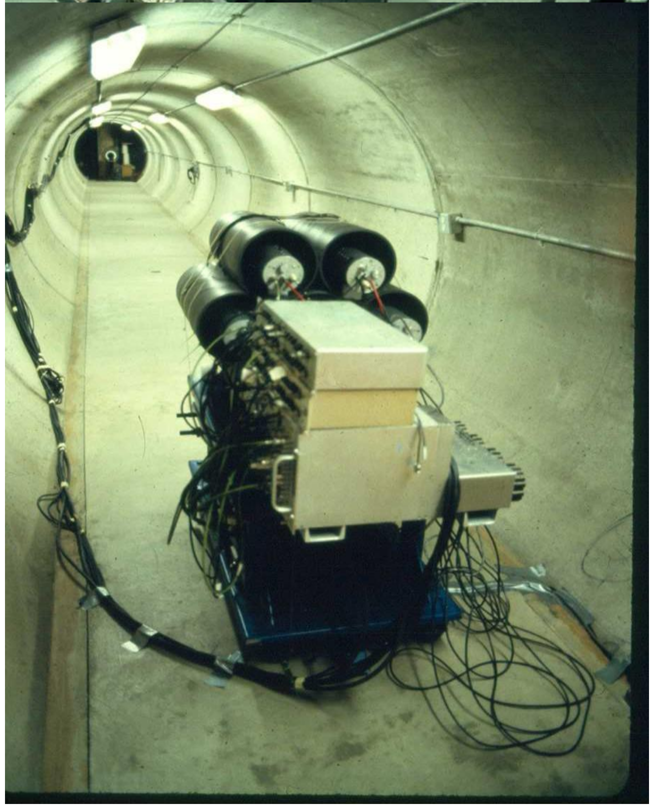


Measuring TOF of neutrons

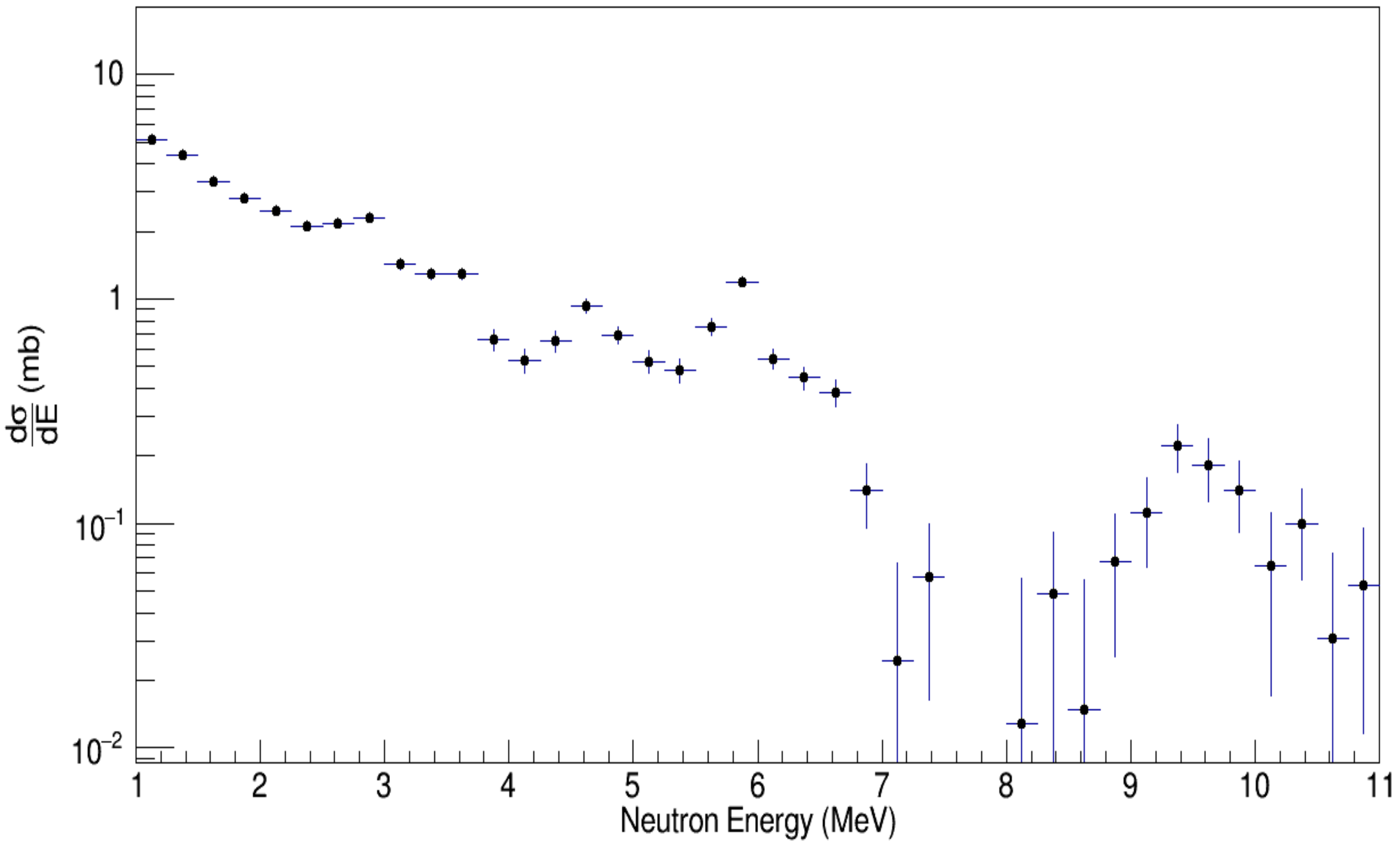


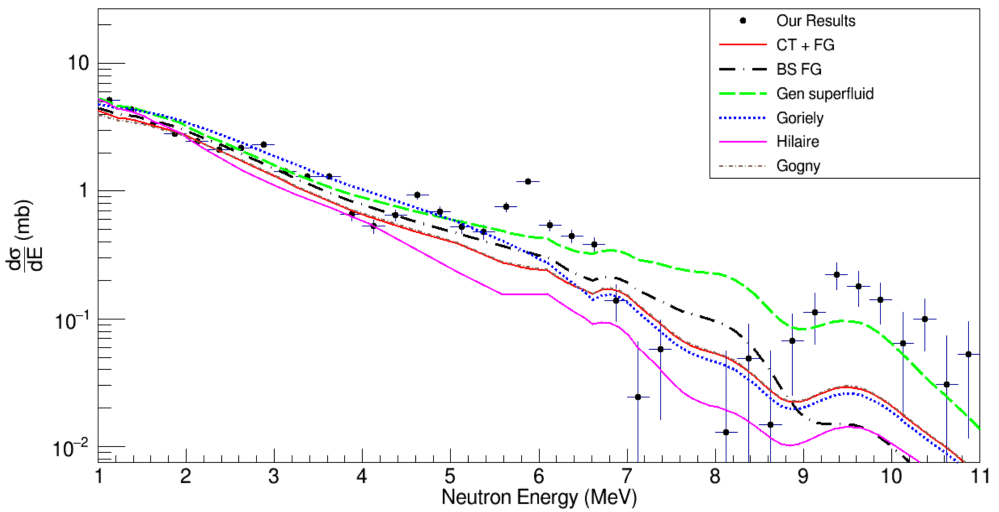






Determining level density from the differential cross section





$$\rho_{meas} = \rho_{calc} \frac{\frac{d\sigma}{dE_{meas}}}{\frac{d\sigma}{dE_{calc}}}$$

Will adjust Talys parameters to measurement

- Normalize level density to discrete states

$$a = \alpha A/\exp[\gamma(Z - Z_0)^2]$$

(from Steve Grimes)

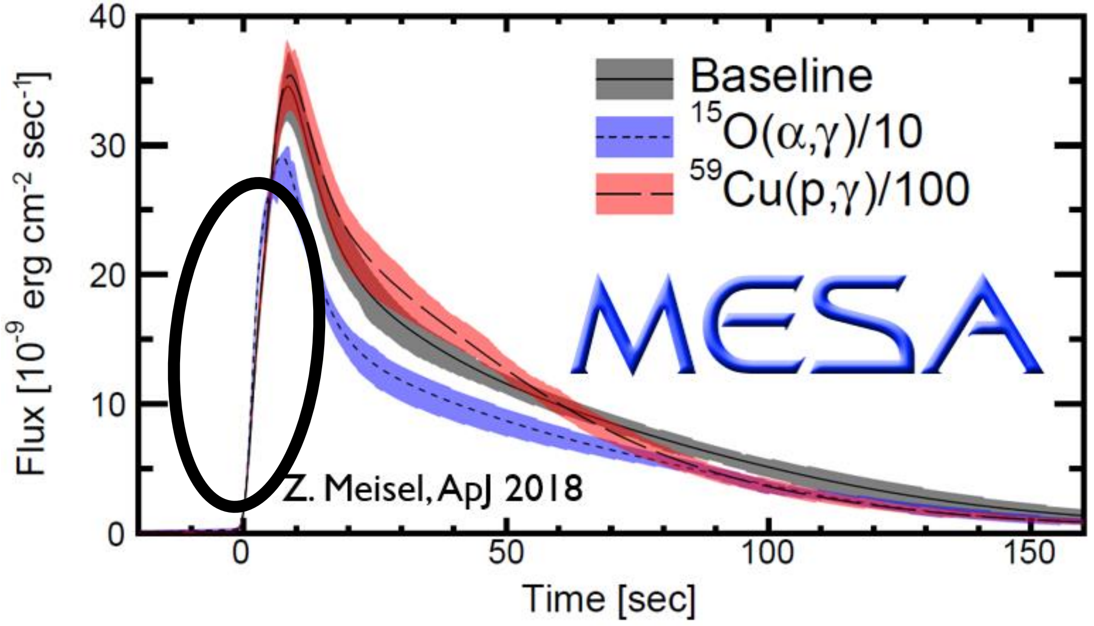
- 'Fit' Talys parameters to data

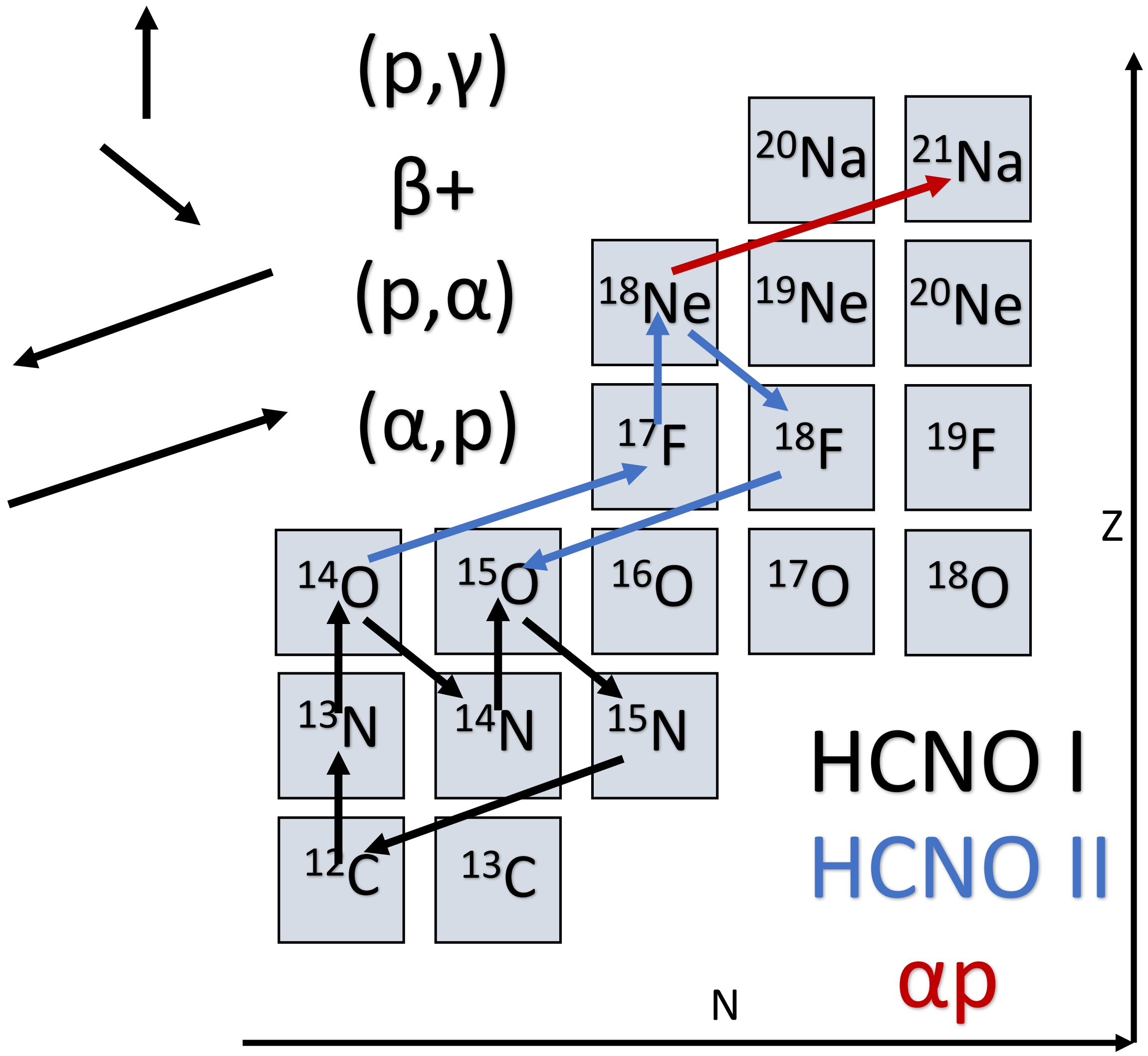
$$\rho_F^{tot}(E_x) = \frac{1}{\sqrt{2\pi}\sigma}\frac{\sqrt{\pi}}{12}\frac{exp\left[2\sqrt{aU}\right]}{a^{1/4}U^{5/4}}$$

- Note if reduction in level density is present.

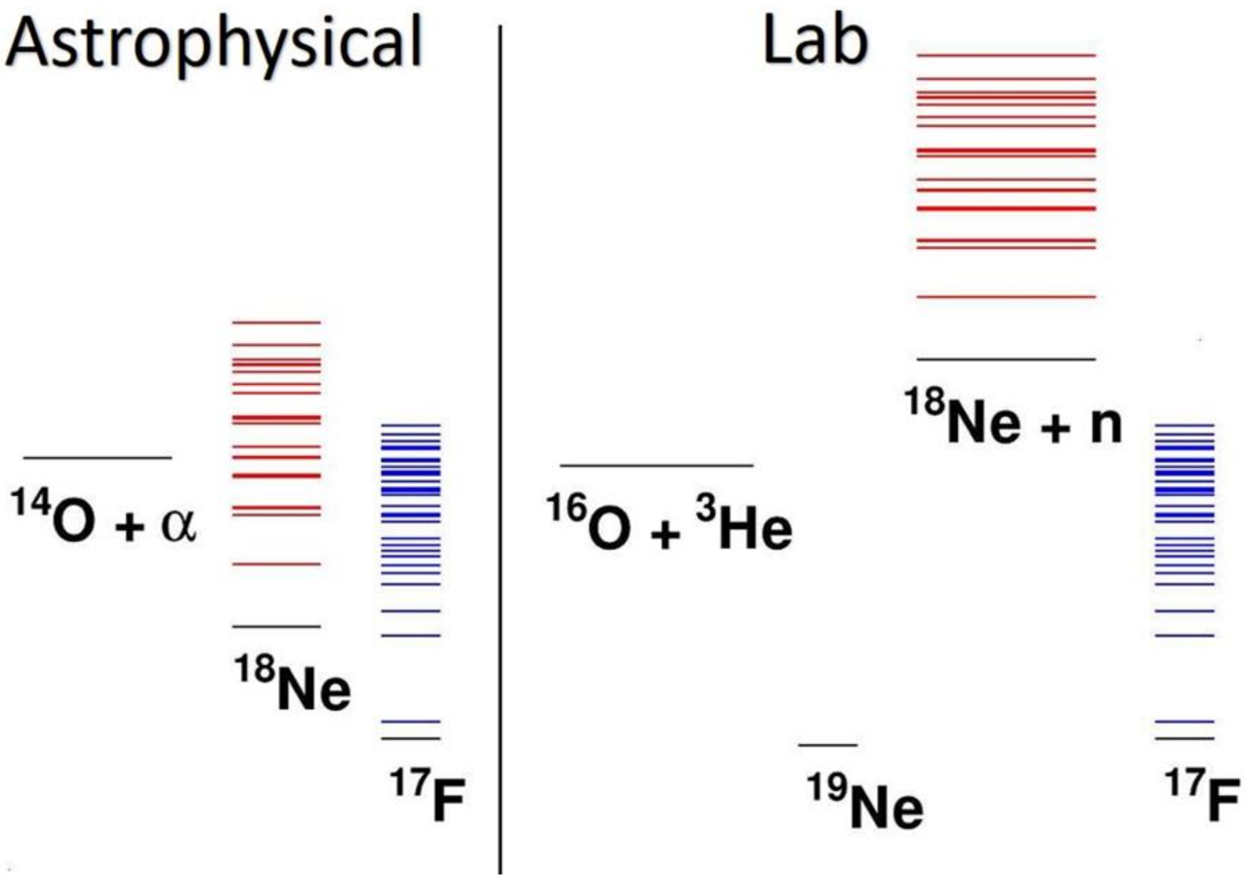
$$U = E_x - \Delta$$

$^{14}O(\alpha,p)$ important within the HCNO cycle

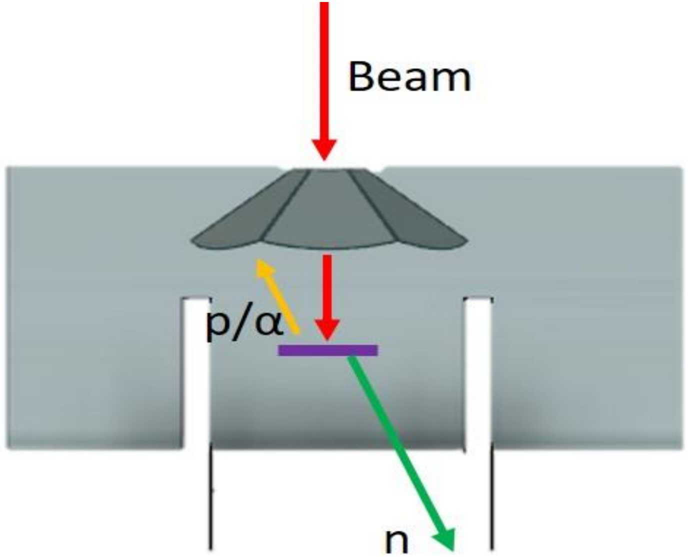




Indirect measurement also will be performed for $^{14}O(\alpha,p)$

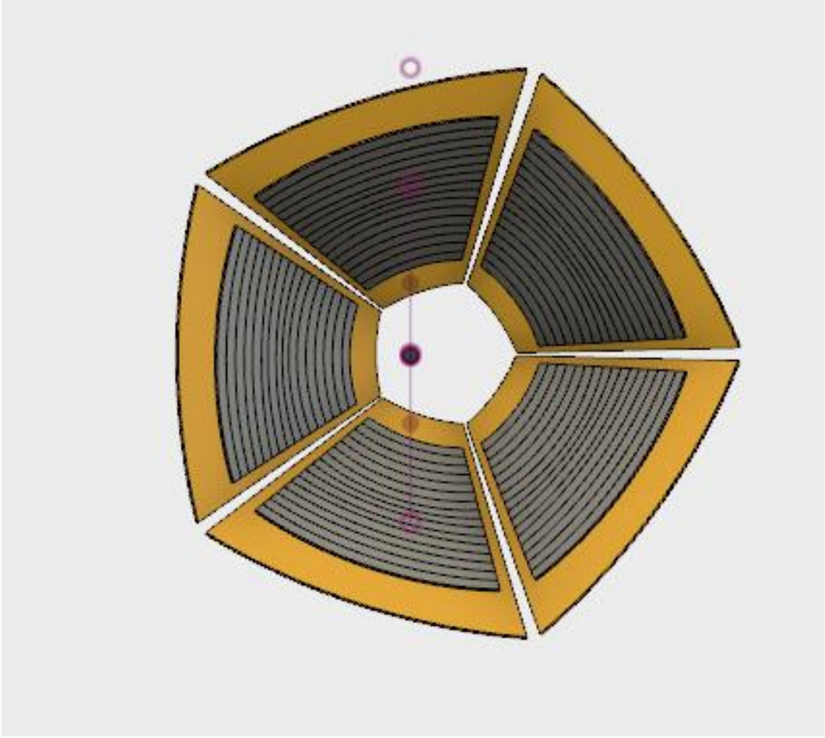


S. Almaraz-Calderon et al., Phys. Rev. C 86, 025801 (2012).



Silicon lampshade array in development to measure rate

$$N_a\langle\sigma v\rangle = 1.54x10^{11}A^{-3/2}T_9^{-3/2}\sum_i \omega\,\gamma_i exp\left(-\frac{11.605E_i}{T_9}\right)$$



$$\omega\gamma = \frac{2J+1}{(2I_\alpha+1)(2I_T+1)}\frac{\Gamma_\alpha\Gamma_p}{\Gamma}$$