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Photoexcitation of astrophysically important states in ^{26}Mg

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Astrophysical Motivation: the s-process

- Where can we get some neutrons to fuel the s-process?
  - Weak and Main s-process
    - $^{14}\mathrm{N}(\alpha,\gamma)^{18}\mathrm{F}(\beta^{+})^{18}\mathrm{O}(\alpha,\gamma)^{22}\mathrm{Ne}(\alpha,n)^{25}\mathrm{Mg}$

$$^{22}\mathrm{Ne}+\alpha \rightarrow {}^{26}\mathrm{Mg}^{*} \rightarrow \begin{cases} {}^{22}\mathrm{Ne}+\alpha \\ {}^{26}\mathrm{Mg}+\gamma \\ {}^{25}\mathrm{Mg}+n \quad (E_{\alpha} > 565\ \mathrm{keV}) \end{cases}$$

- Gamow Energy Range: 375 keV $< E_{\alpha} <$ 1055 keV ($T \sim$0.3 GK)
- Need J^{π}, energy, and partial widths of states in this energy region

Nuclear Motivation: previous experiments

- How can we study these reactions?
  - Directly: ^{22}Ne$(\alpha,\gamma)^{26}$Mg and ^{22}Ne$(\alpha,n)^{25}$Mg
  - Indirectly: ^{22}Ne$(^{6}Li,d)$, ^{25}Mg(n,γ), ^{26}Mg(γ,γ'), and ^{26}Mg(γ,n)
- Goal: Measure energy (and width?) of $E_\alpha = 635$ keV resonance ($E_\gamma = 11.15$ MeV)

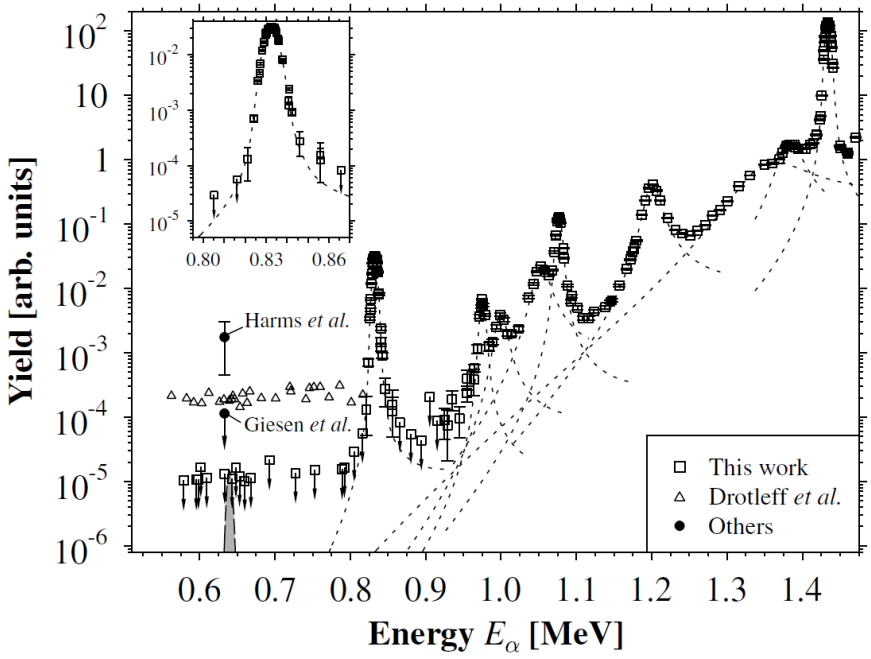


Figure: Jaeger *et al.* (2001)

High Intensity γ-ray Source

- Triangle Universities Nuclear Laboratory's (TUNL) High Intensity γ-ray Source (HIγS) produced by the Duke Free Electron Laser (DFELL).

- $E_\gamma = 1$ to 100 MeV
- "nearly monoenergetic" (Gaussian energy distribution – $\Gamma \sim 200$ keV @ 10 MeV)
- circular or linear polarization

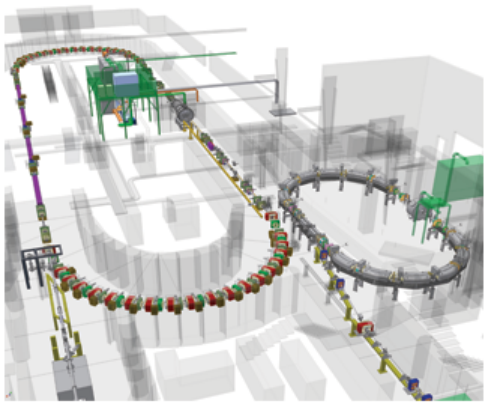


Figure: HIγS website

4π ^{3}He Counter Setup

- April 2010
- enriched ^{26}MgO powder
- Average cross section measurement (~200 keV)
- Test run for to check count rates and background for Time-of-Flight measurement

Average total cross section

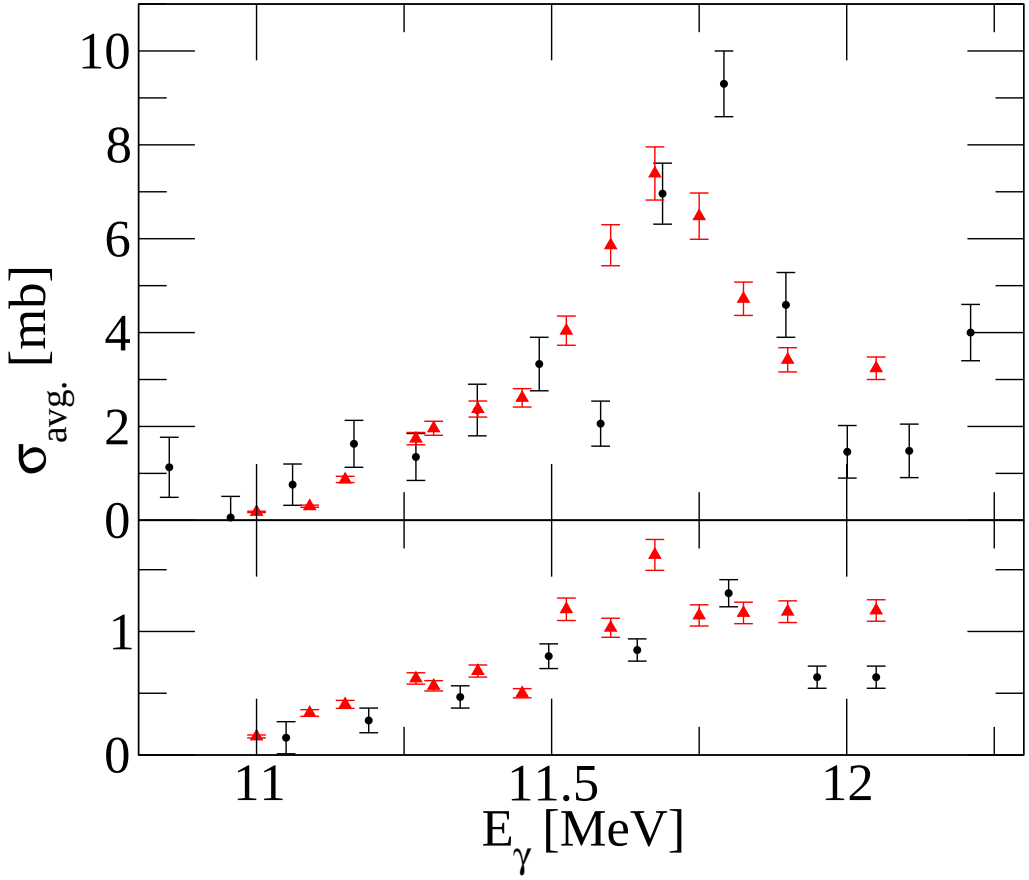
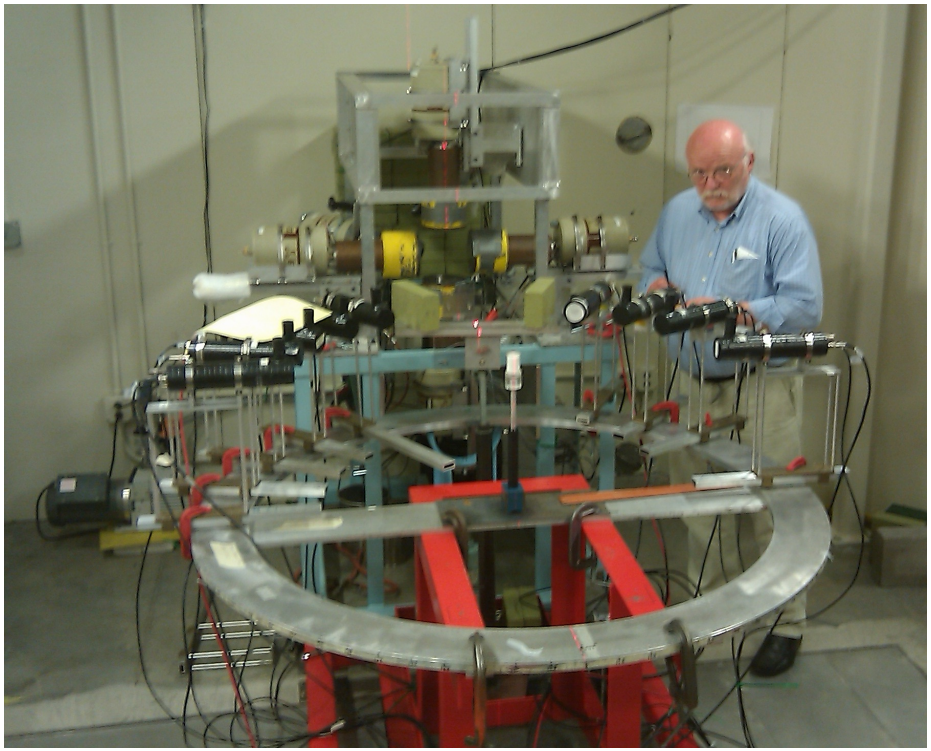


Figure: black points: Fultz *et al.*(1971), red points: current work ^{26}Mg$(\gamma, n)^{25}$Mg (top), ^{nat}Mg$(\gamma, n)^{25}$Mg (bottom)

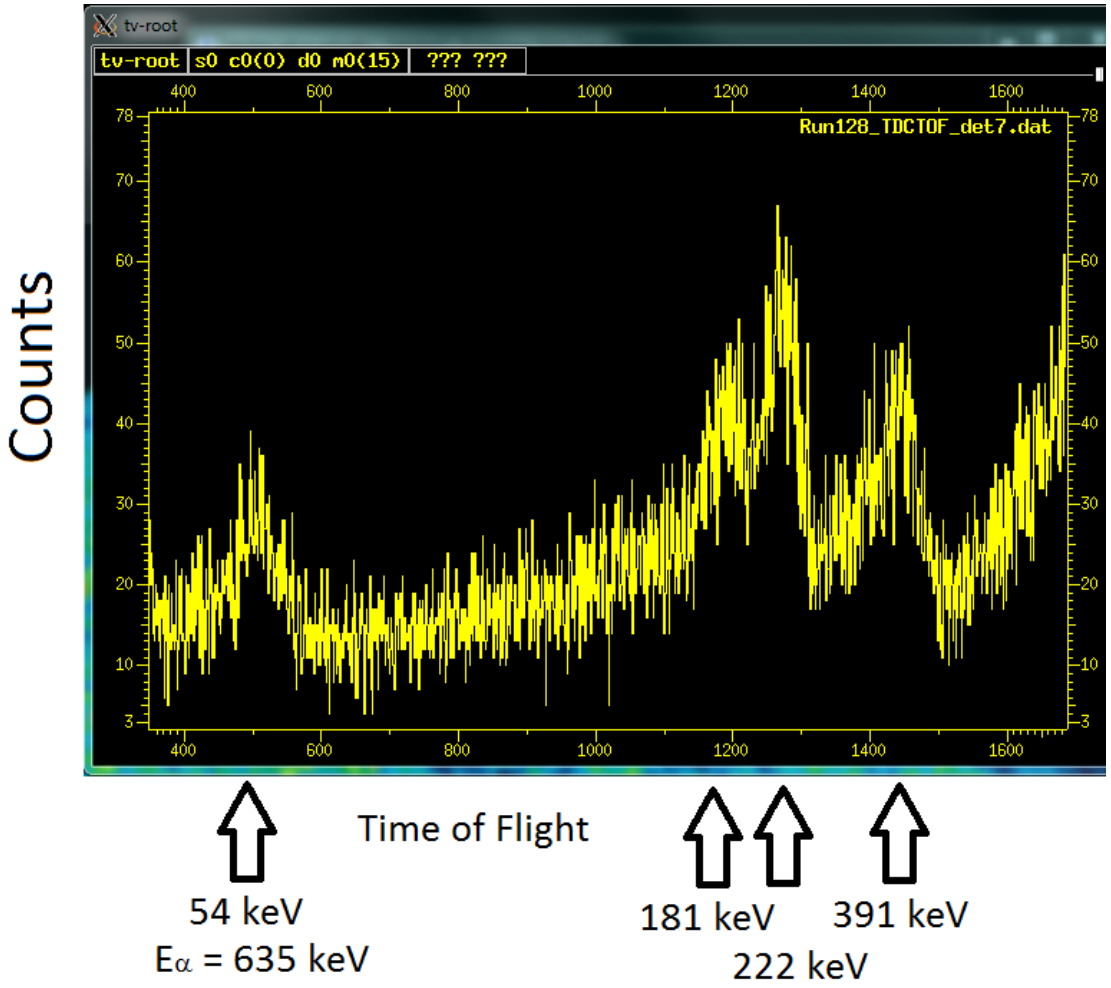
Neutron Time-of-Flight Setup

- August 2010
- B. L. Berman, R. L. Van Hemert, and C. D. Bowman, Phys. Rev. Lett. 23, 386 (1969)
- $E_n = 54$ keV ($E_\alpha = 635$ keV)
- Three Li-Glass scintillators, nine liquid scintillators
- 179 ns between 3 ns wide γ-pulses, target to detector distance $\sim$50 cm



Preliminary Results

- Liquid Scintellator Detectors (BC501A)



Summery

- Measured ^{26}Mg(γ, n) average cross section ($E_\gamma = 11.15$ to 12.2 MeV) agrees well with previous measurement
- Preliminary ToF (γ, n) data shows intresting and unexpected results
- Can extract energy and width information
- A future ^{26}Mg(γ, n) ToF run would be useful to determine J^π's