Study of ^{22}Ne(^{6}Li,t)^{25}Mg three particle transfer reaction using TIARA and MDM spectrometer

Esha S. Rao

Advisor: Dr. Greg Christian

esha.rao@rutgers.edu

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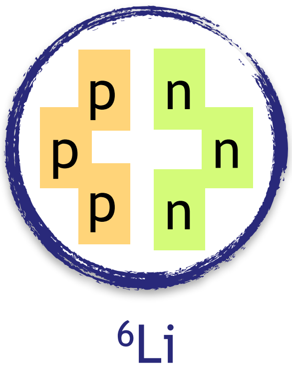
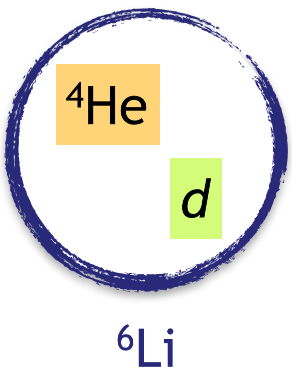
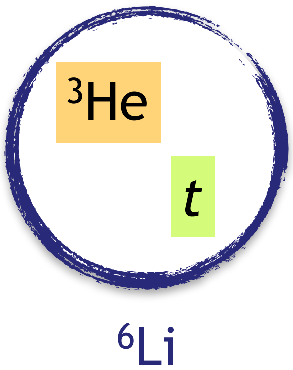
Why?

- ^{6}Li known to have ^{3}He + ^{3}H and ^{4}He + *d* clustering properties
    - (^{6}Li,*t*) reaction could be powerful tool to study nuclear physics
        - ^{3}He clustering states of some nuclei
    - three particle transfer reaction mechanism not studied well
        - ^{22}Ne(^{6}Li,*t*)^{25}Mg in inverse kinematics never been studied before

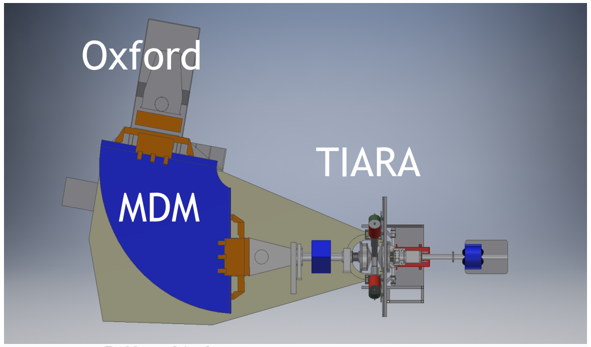


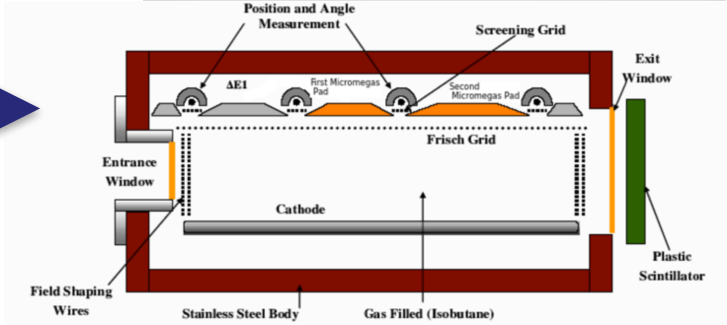


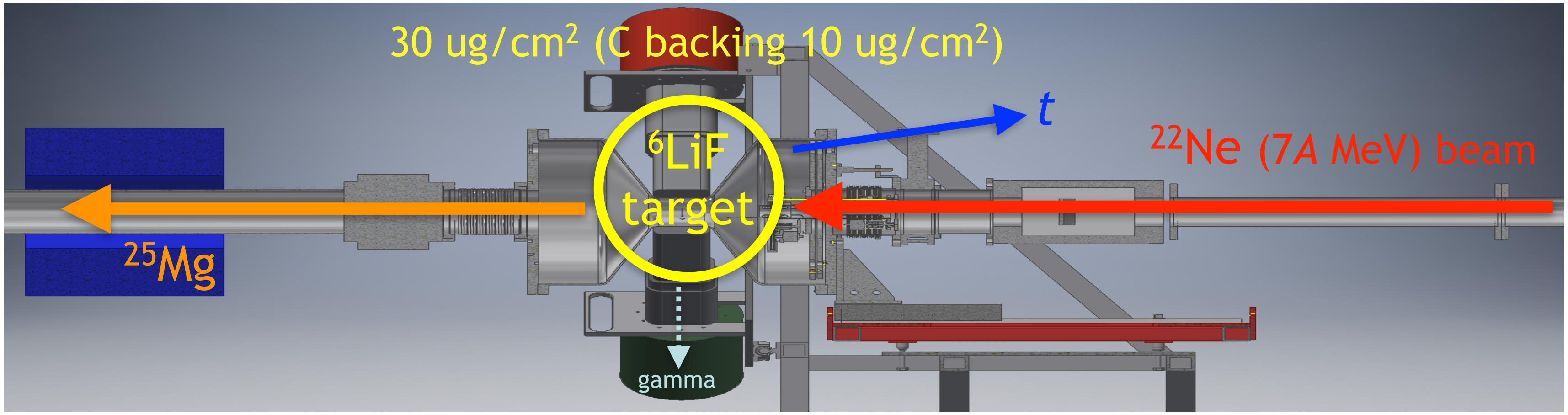


Set-Up

- Transfer and Inelastic scattering All-angle Reaction Array (TIARA)
  - Si (segmented) and Ge detectors
- Multipole-Dipole-Multipole (MDM)
- Oxford detector
  - isobutane (35 Torr)
  - wire chamber (micromegas)



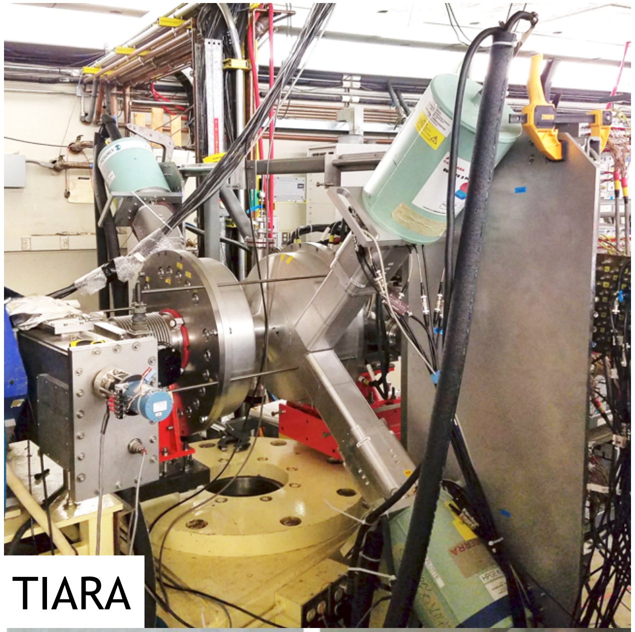


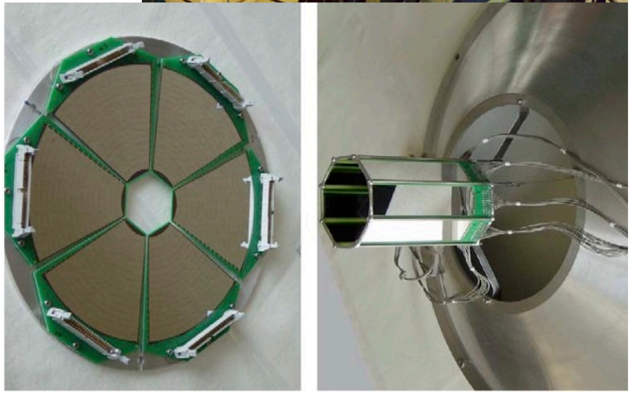


Pictures 1 and 3: E. Bennett
Picture 2: A. Spiridon et al., Nuclear Instruments and Methods B376 (2016)

How?

- look at coincidences using MDM spectrometer, Si, and Ge detectors
  - measurements of *t* energy and scattering angles to get ^{25}Mg excitation energy
- various gates on variables such as Delta E - E and x-position
  - extract Mg
  - extract ^{25}Mg
  - extract (^{6}Li,*t*) direct reaction
  - obtained ^{25}Mg excitation spectrum from ^{22}Ne(^{6}Li,*t*)^{25}Mg



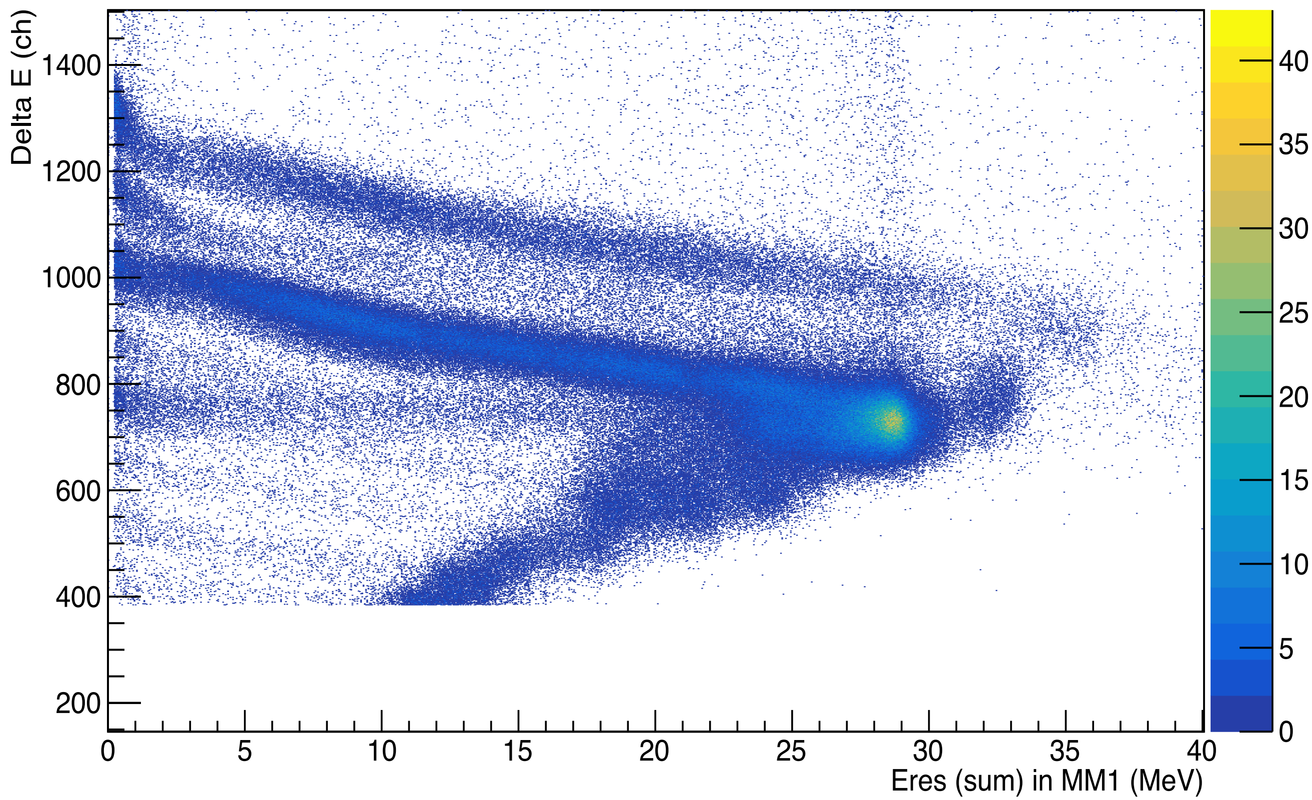


Left: Segmented backward annular detector (HYBALL). Right: Barrel.

Picture 1: S. Ota
Pictures 2 and 3: M. Labiche et al., Nuclear Instruments and Method A614 (2010)

Step 1

Delta E vs. E_{res} in Micromega 1



Delta E vs. E_{res} in Micromega 1 of some runs. This is used to gate on Mg.

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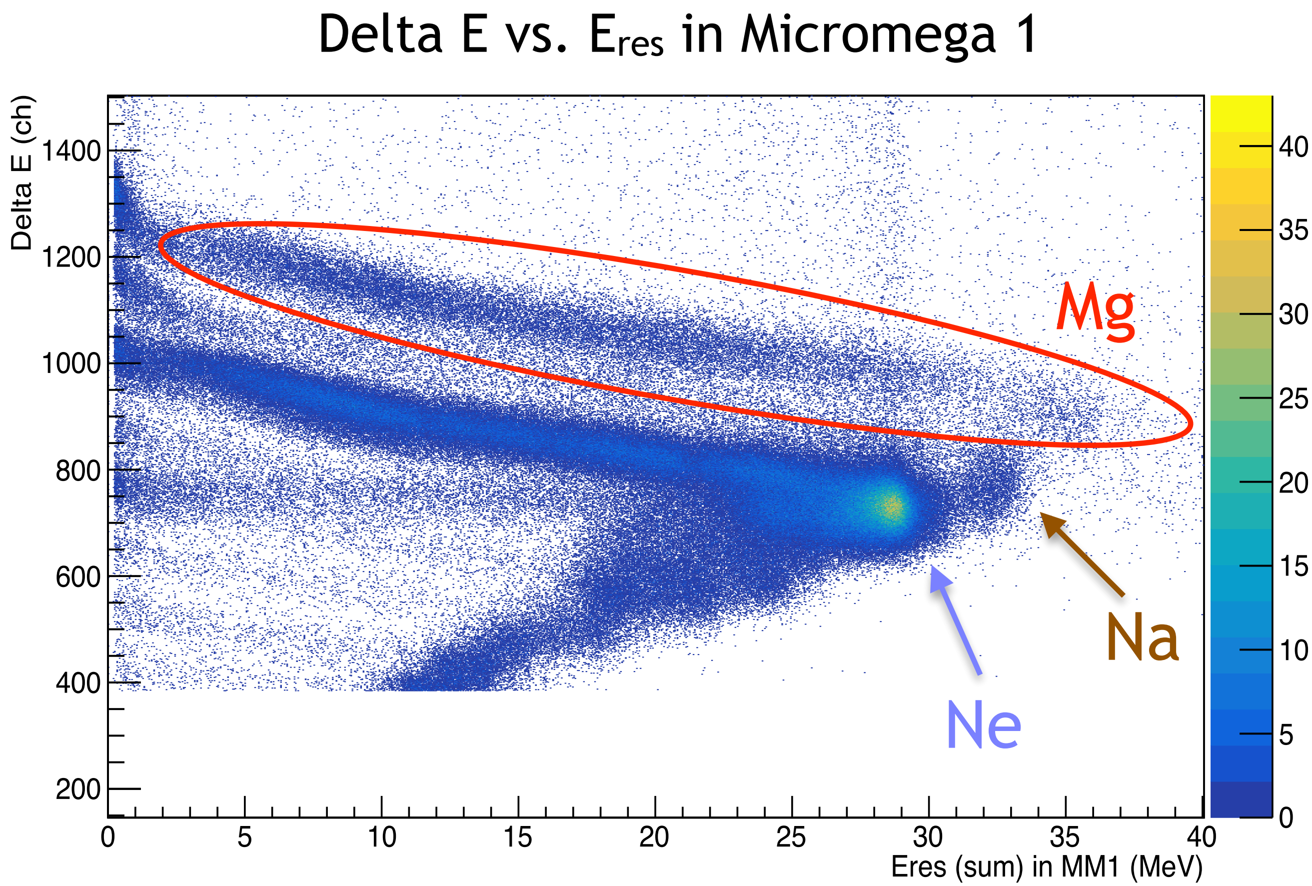
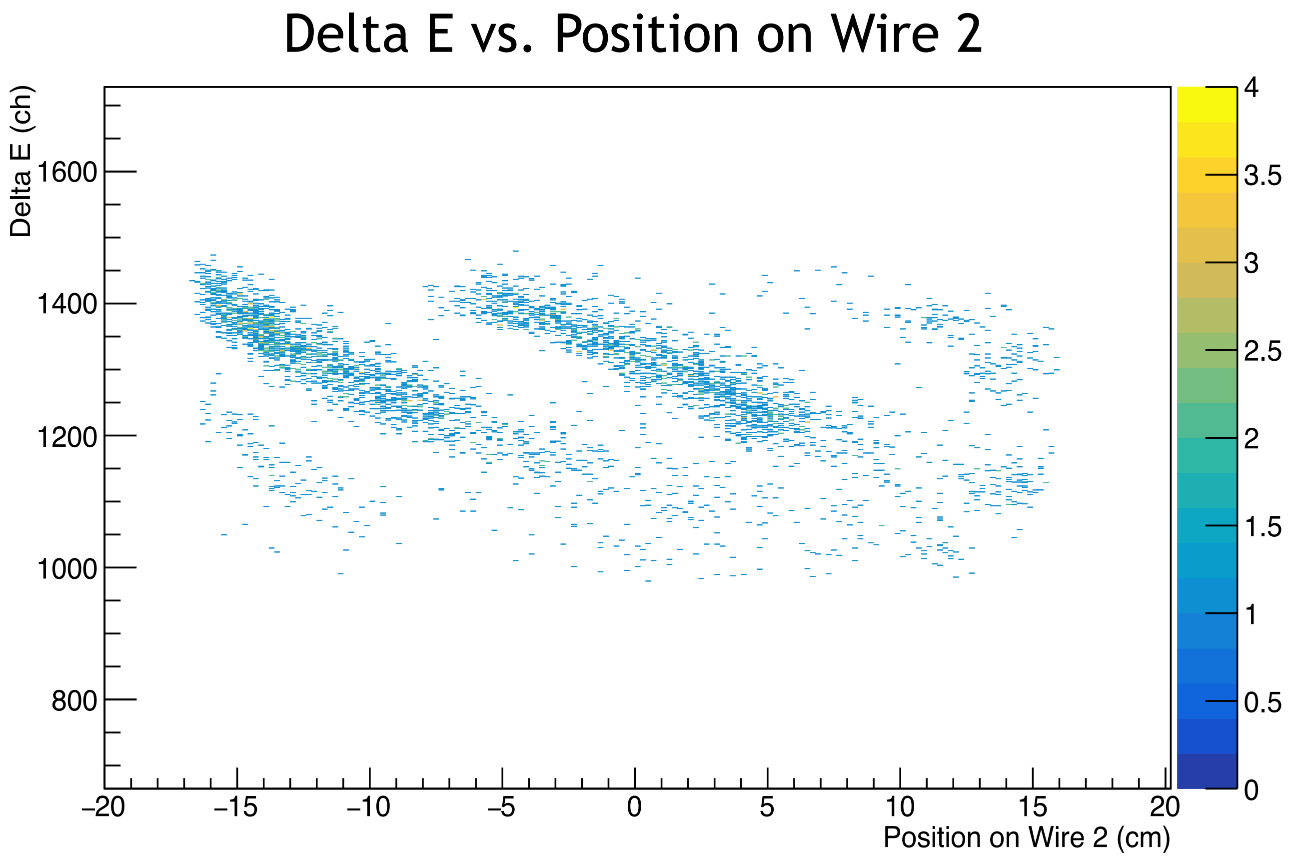


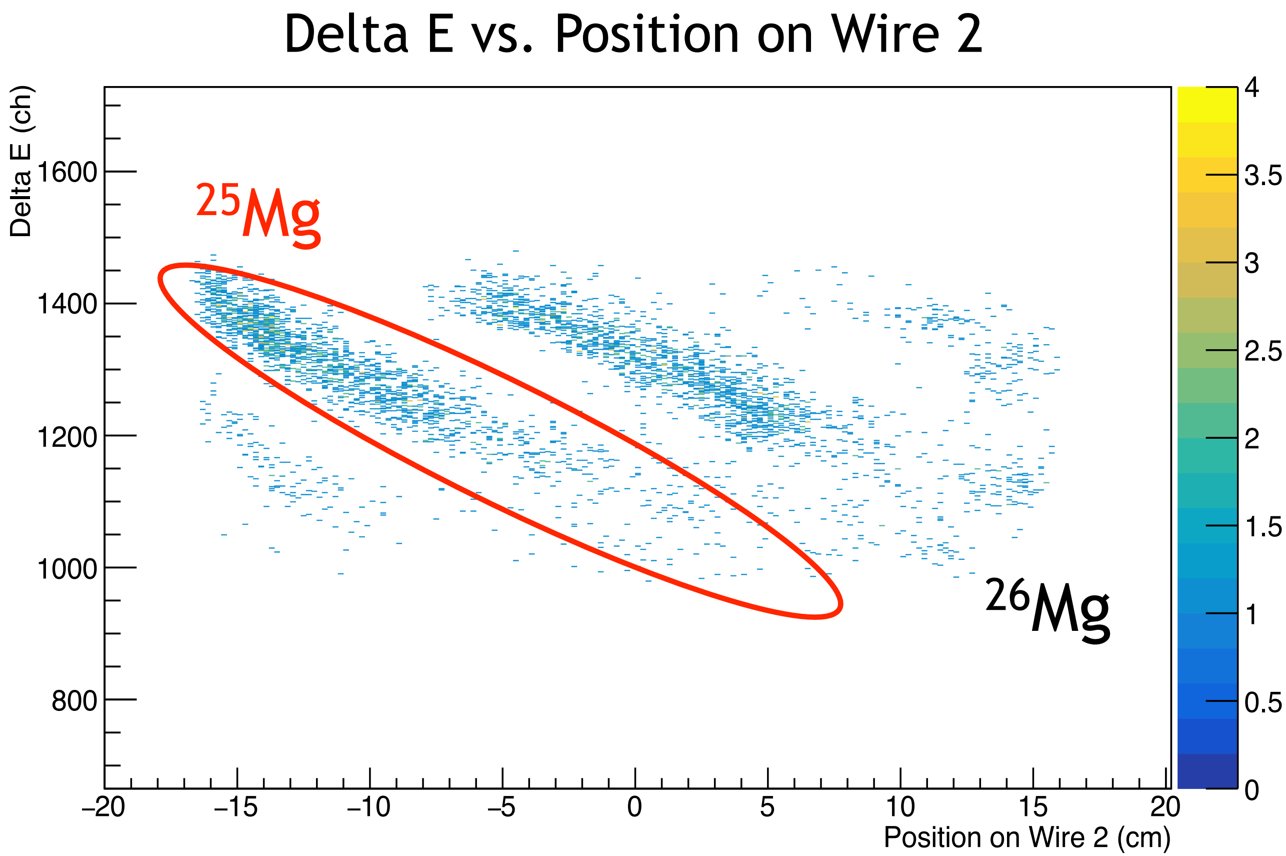
Delta E vs. E_{res} in Micromega 1 of some runs. This is used to gate on Mg.

Step 2



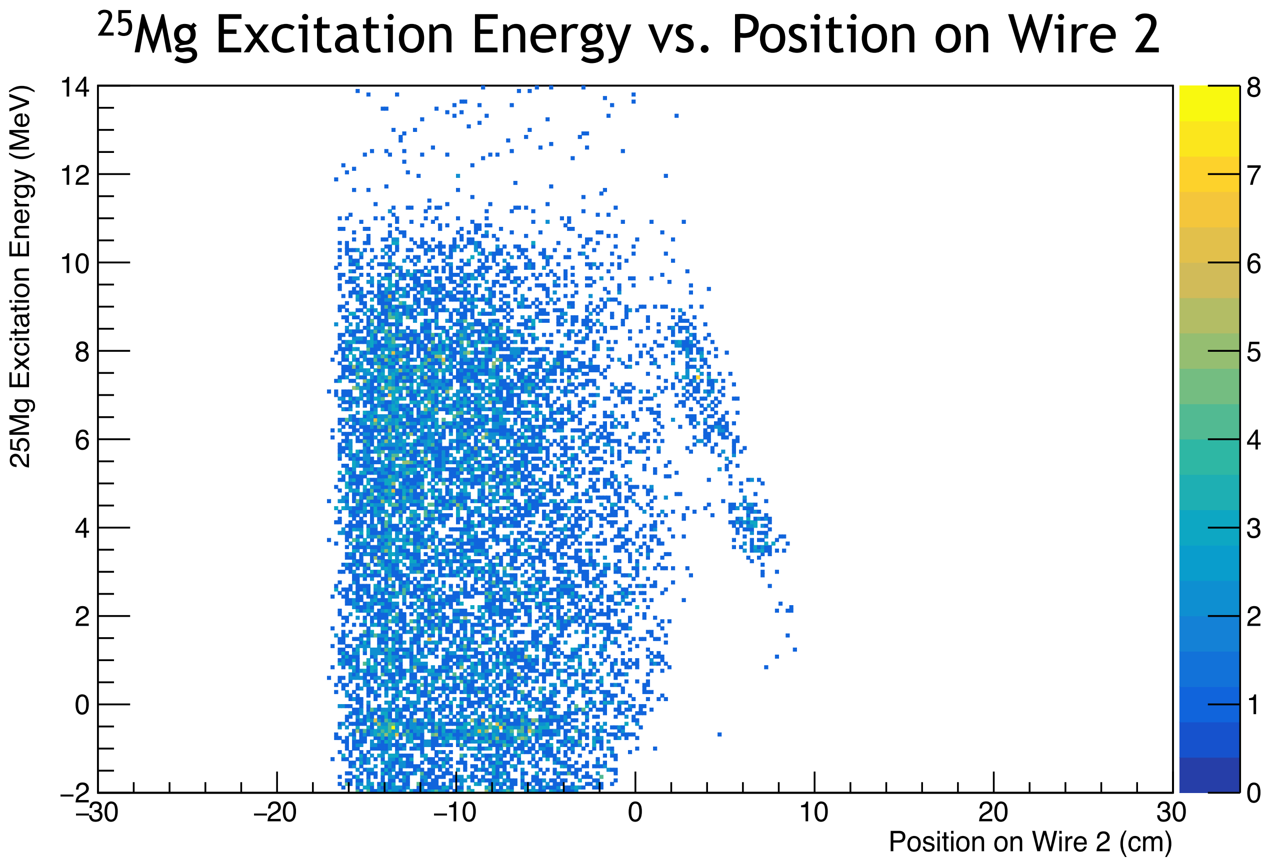
Delta E vs. Position on Wire 2 of some runs. This is used to gate on ^{25}Mg.

Step 2



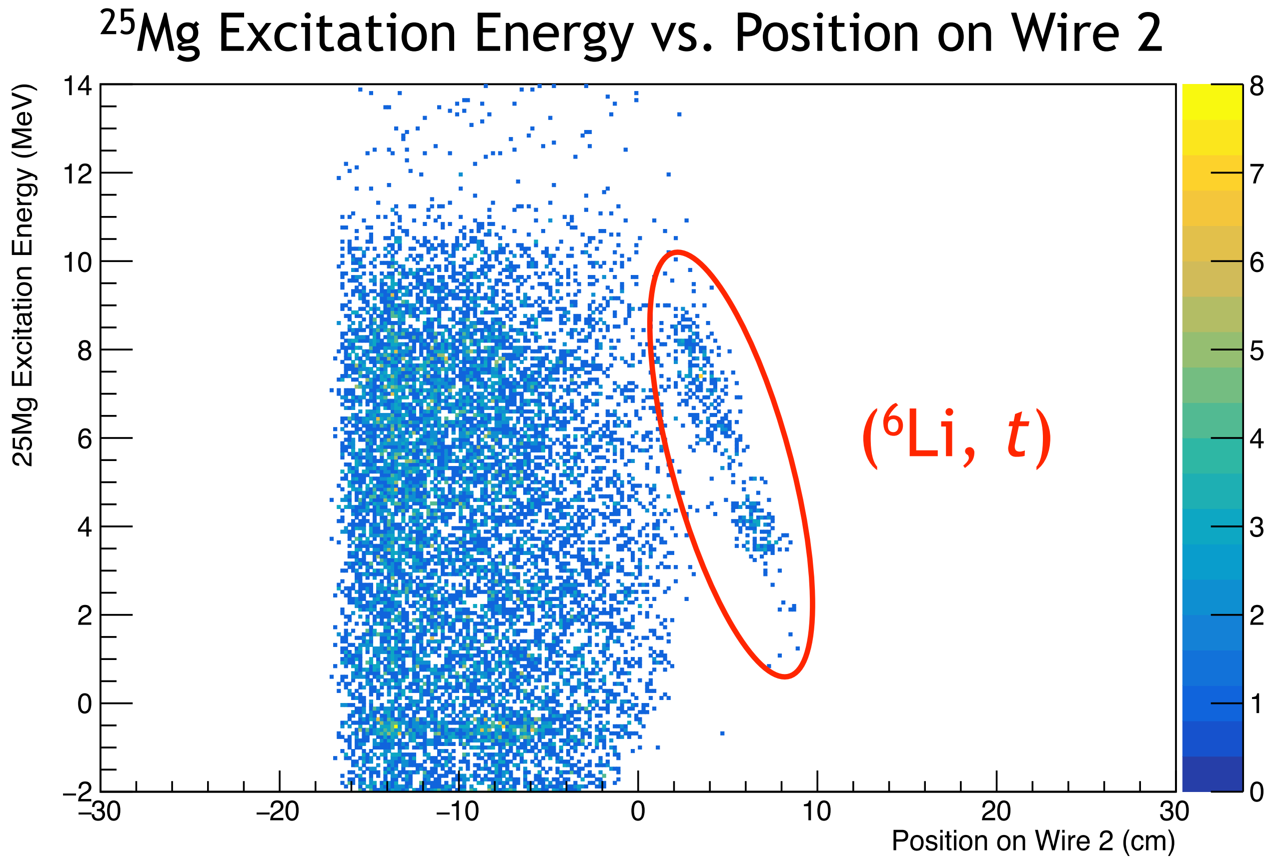
Delta E vs. Position on Wire 2 of some runs. This is used to gate on ^{25}Mg.

Step 3



^{25}Mg Excitation Energy vs. Position on Wire 2 of some runs.
This is used to gate on (^{6}Li,t).

Step 3



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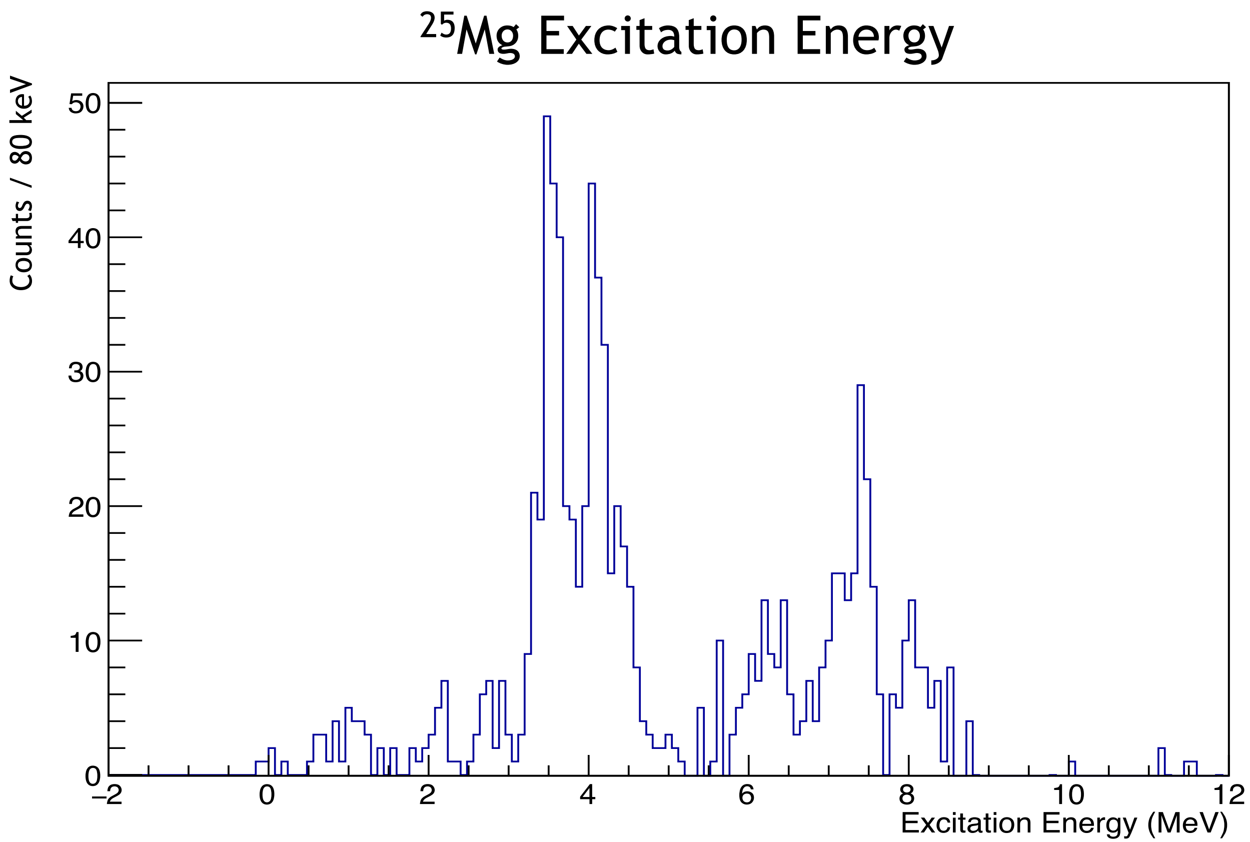
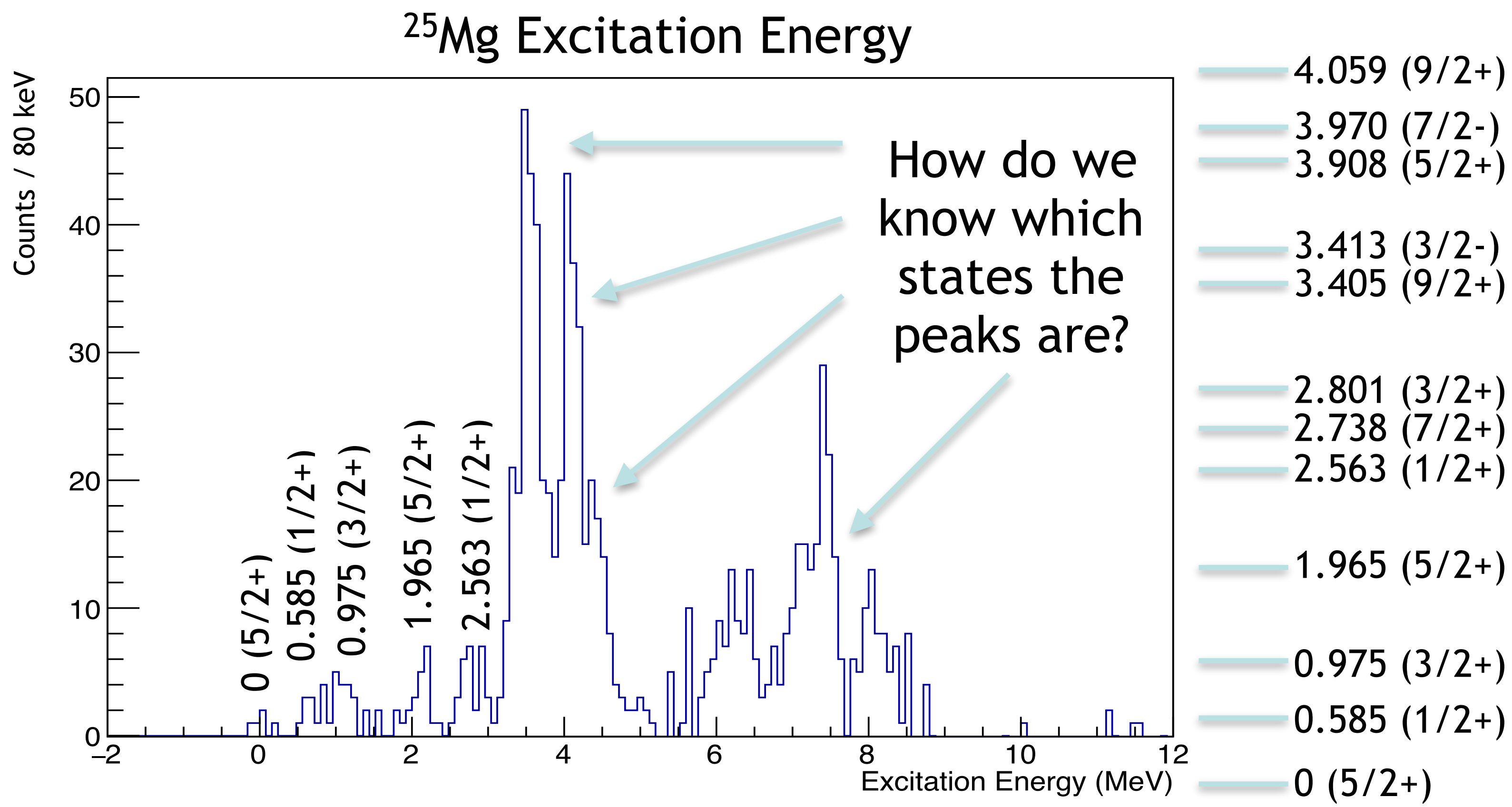
Analysis



^{25}Mg Excitation Energy of all runs. This shows the populated states of ^{25}Mg.

Analysis



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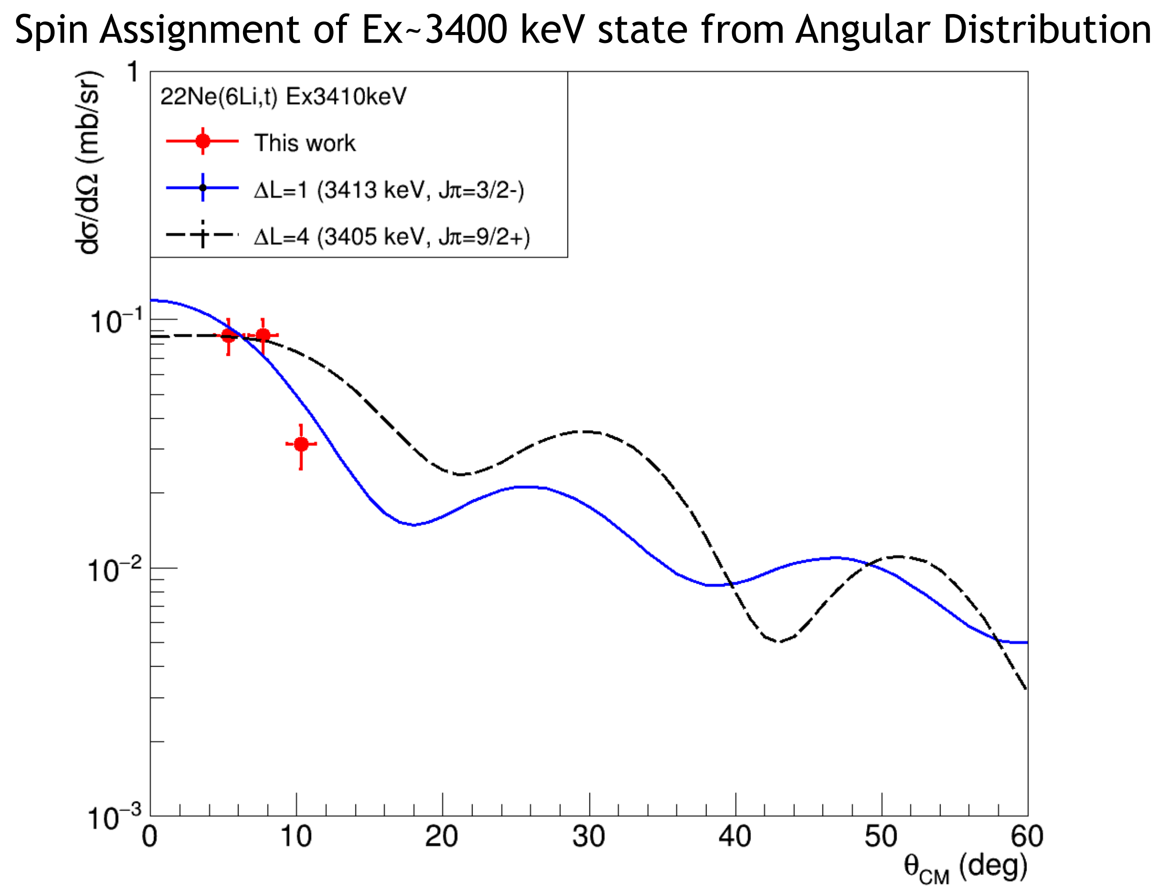
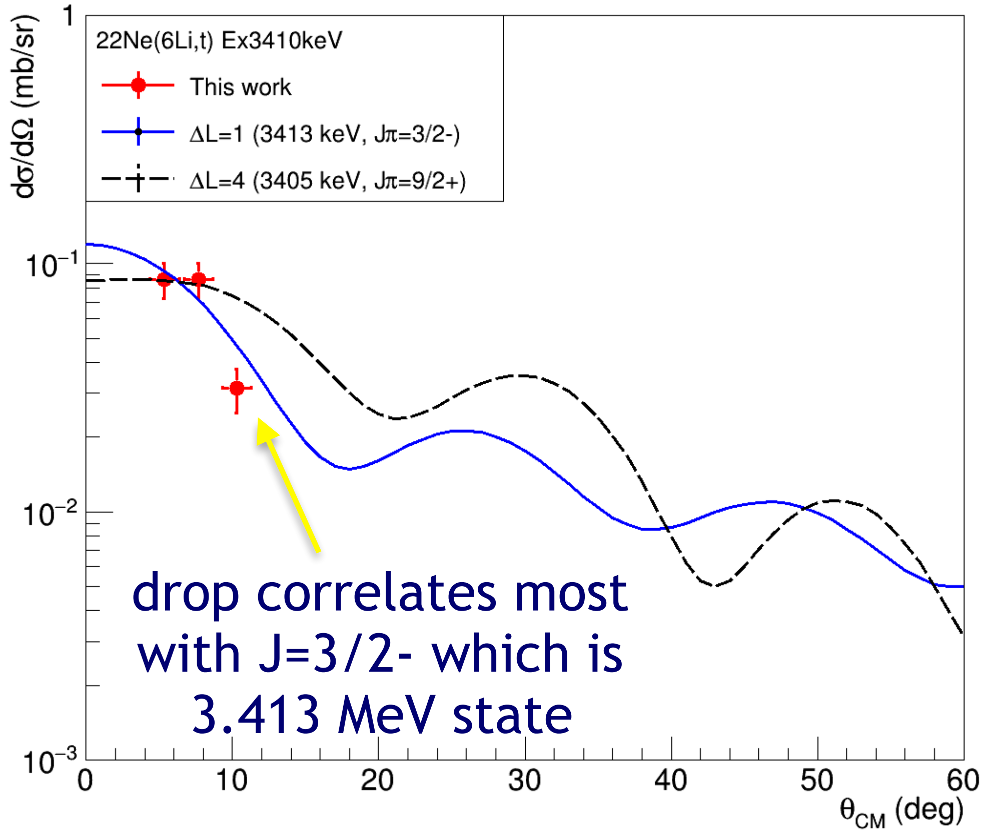
Angular Distribution



Angular distribution of 3400 keV excited state in ^{25}Mg with theoretical plots J=9/2+ and J=3/2- created by FRESCO.

Angular Distribution

Spin Assignment of Ex~3400 keV state from Angular Distribution



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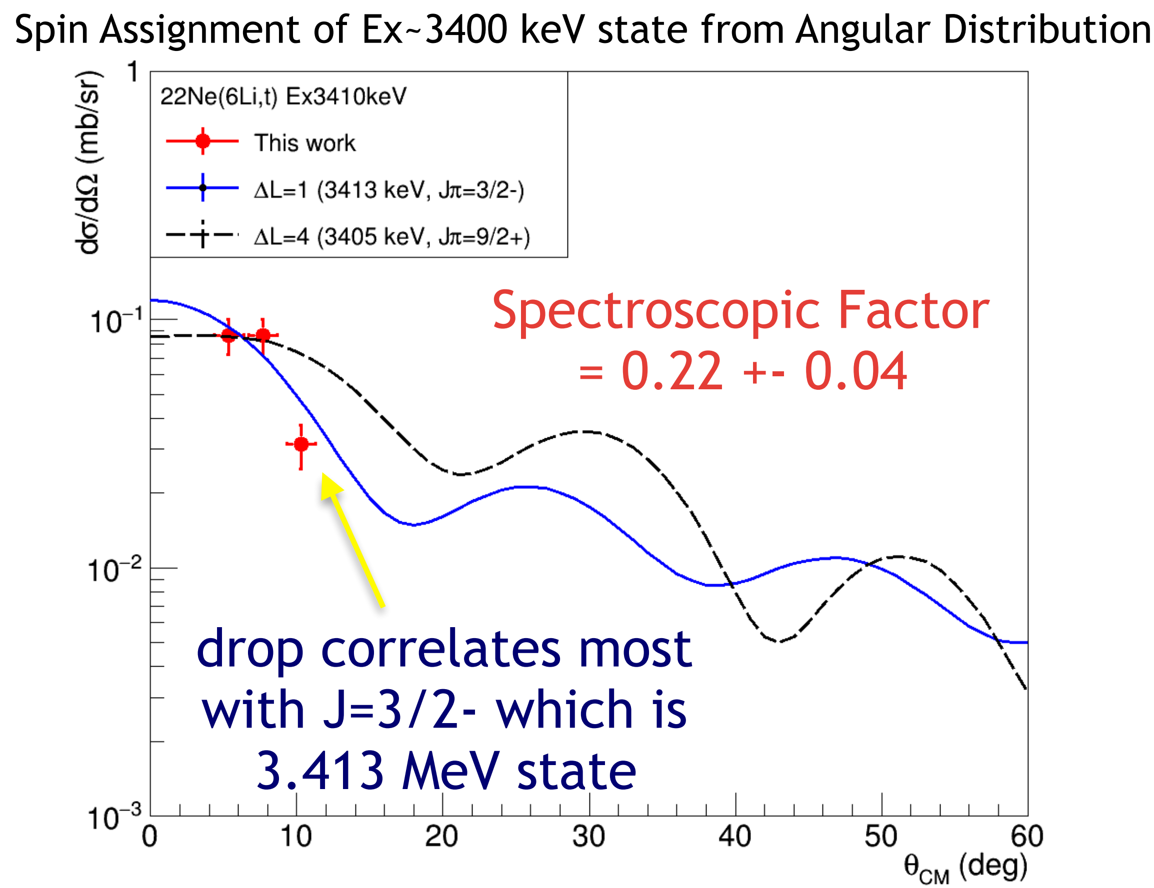
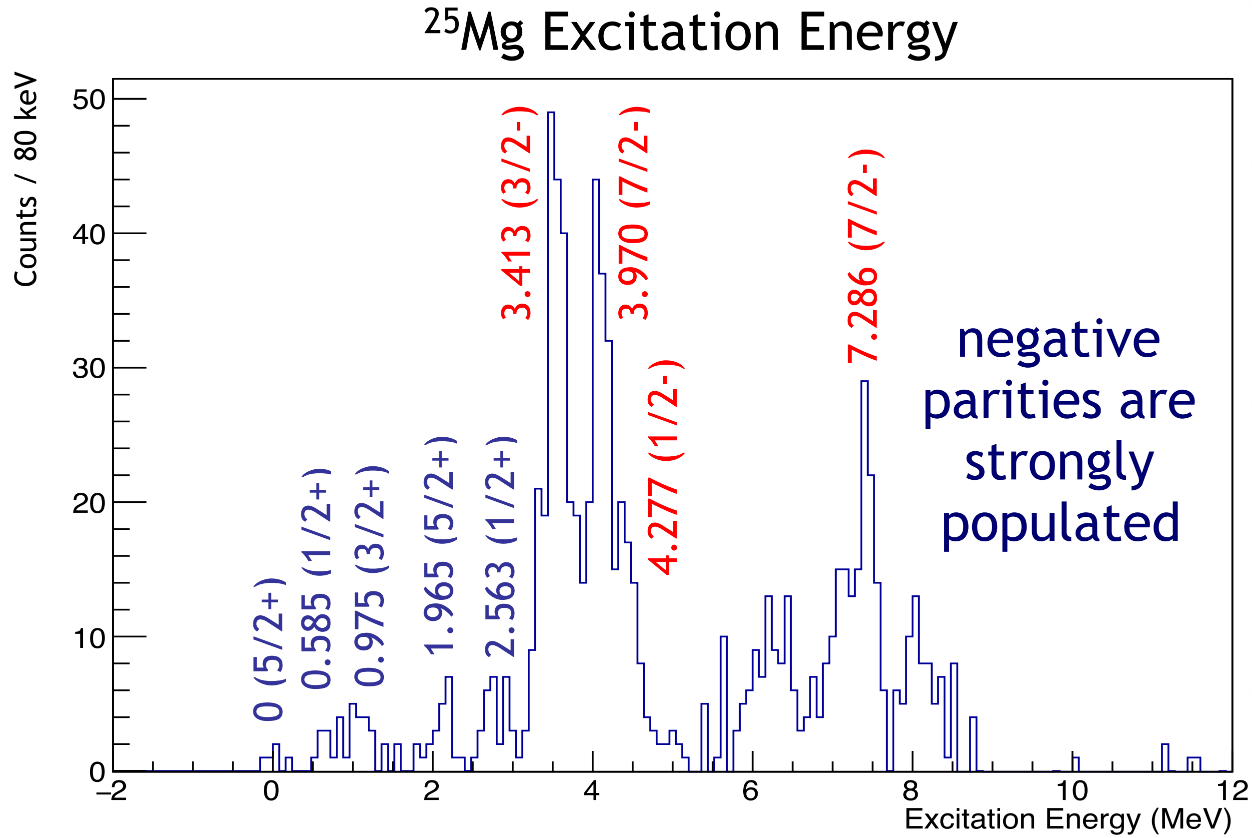
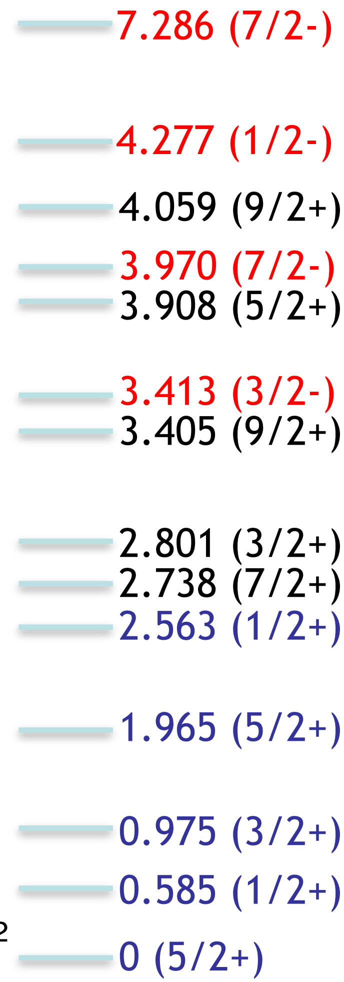
Angular Distribution



Angular distribution of 3400 keV excited state in ^{25}Mg with theoretical plots J=9/2+ and J=3/2- created by FRESCO.

Results





^{25}Mg Excitation Energy of all runs. This shows the populated states of ^{25}Mg.

Conclusion

- observed strong selectivity of (^{6}Li,t) three particle transfer reaction in ^{22}Ne(^{6}Li,t)^{25}Mg experiments
  - negative parity states are strongly populated
  - spectroscopic factor is observed for 3.4 MeV state (= 0.22 +- 0.04)

What's Next?

- finalize determining spectroscopic factors
  - other high energy states
  - error analysis
- compare to shell model theory calculations

Acknowledgements

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- I would also like to thank **Dr. Mike Youngs** for finding a way for me to do this REU program along with military training.
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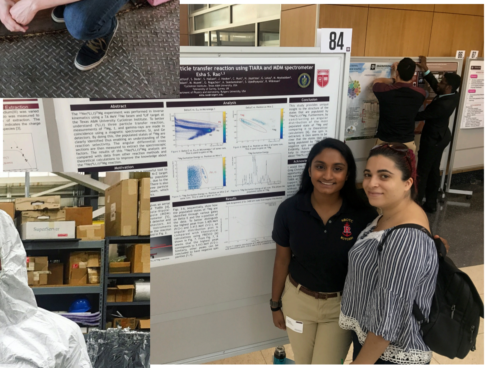

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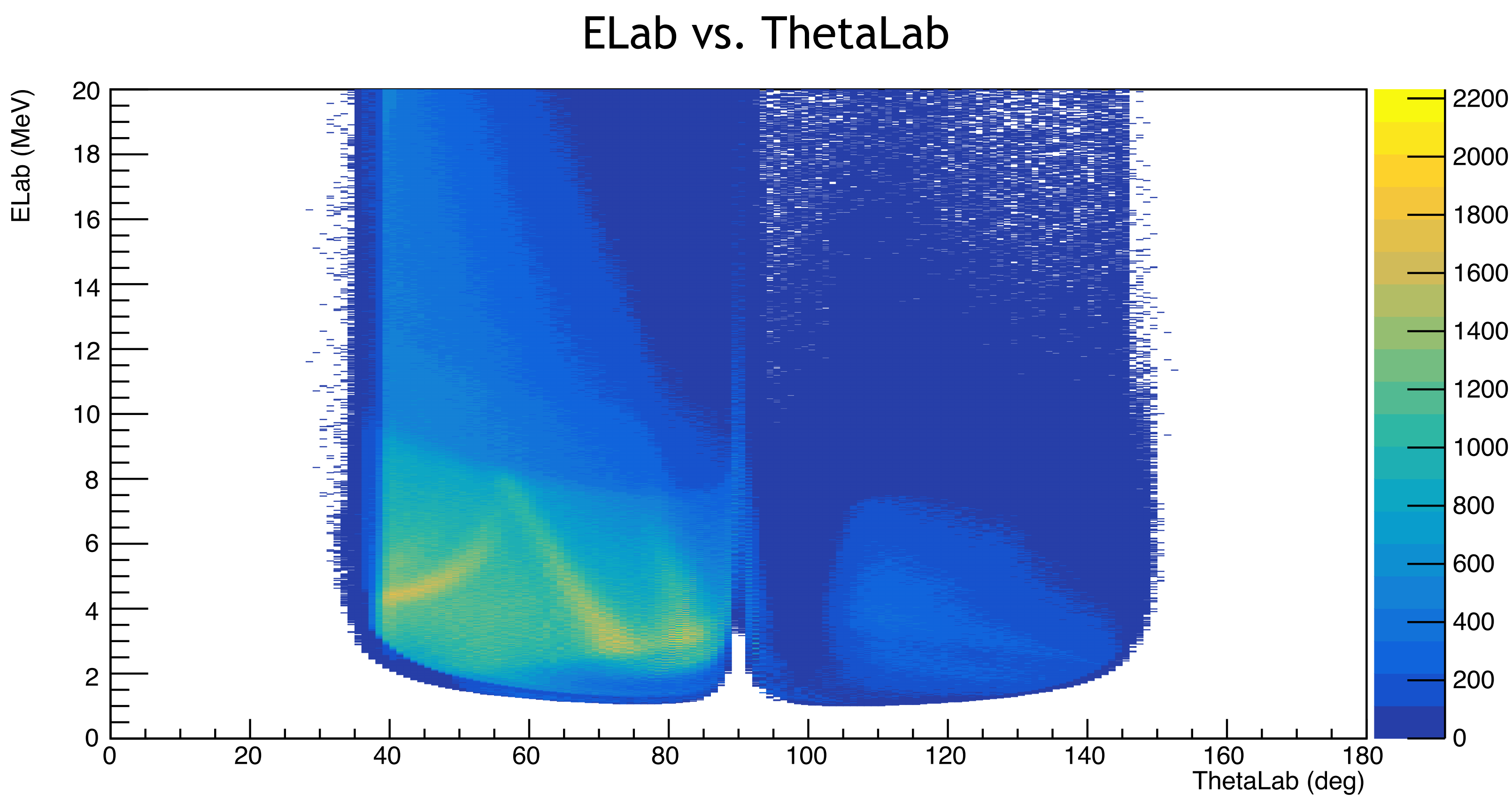
Normalization



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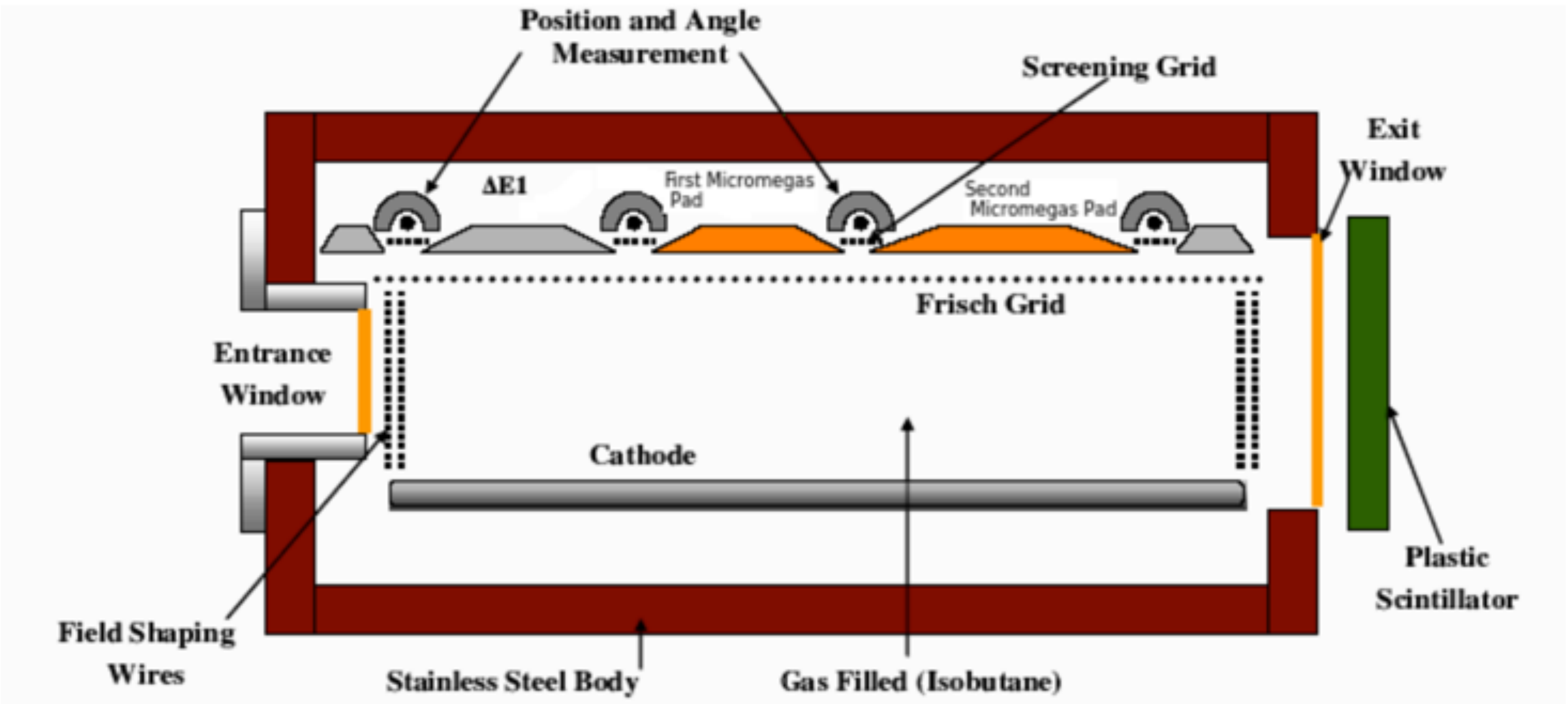
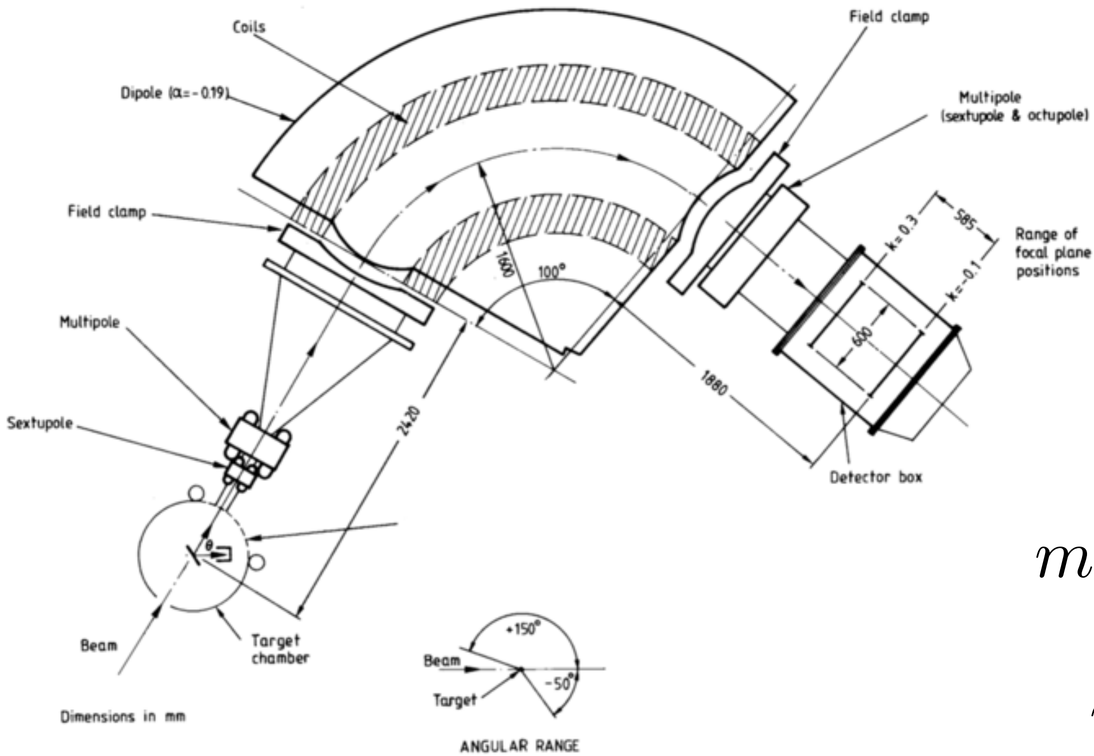
Oxford Detector



Multipole-Dipole-Multipole Spectrometer (MDM)



$$\frac{m\mathbf{v}^2}{r} = q\mathbf{v} \times \mathbf{B}$$

$$mv = qrB$$

$$m_1 v = qr_1 B \quad m_2 v = qr_2 B$$

$$\frac{m_1}{m_2} = \frac{r_1}{r_2} \qquad \frac{q_2}{q_1} = \frac{r_1}{r_2}$$