Beta – proton emission from ^{20}Mg, and the breakout from the hot CNO cycles

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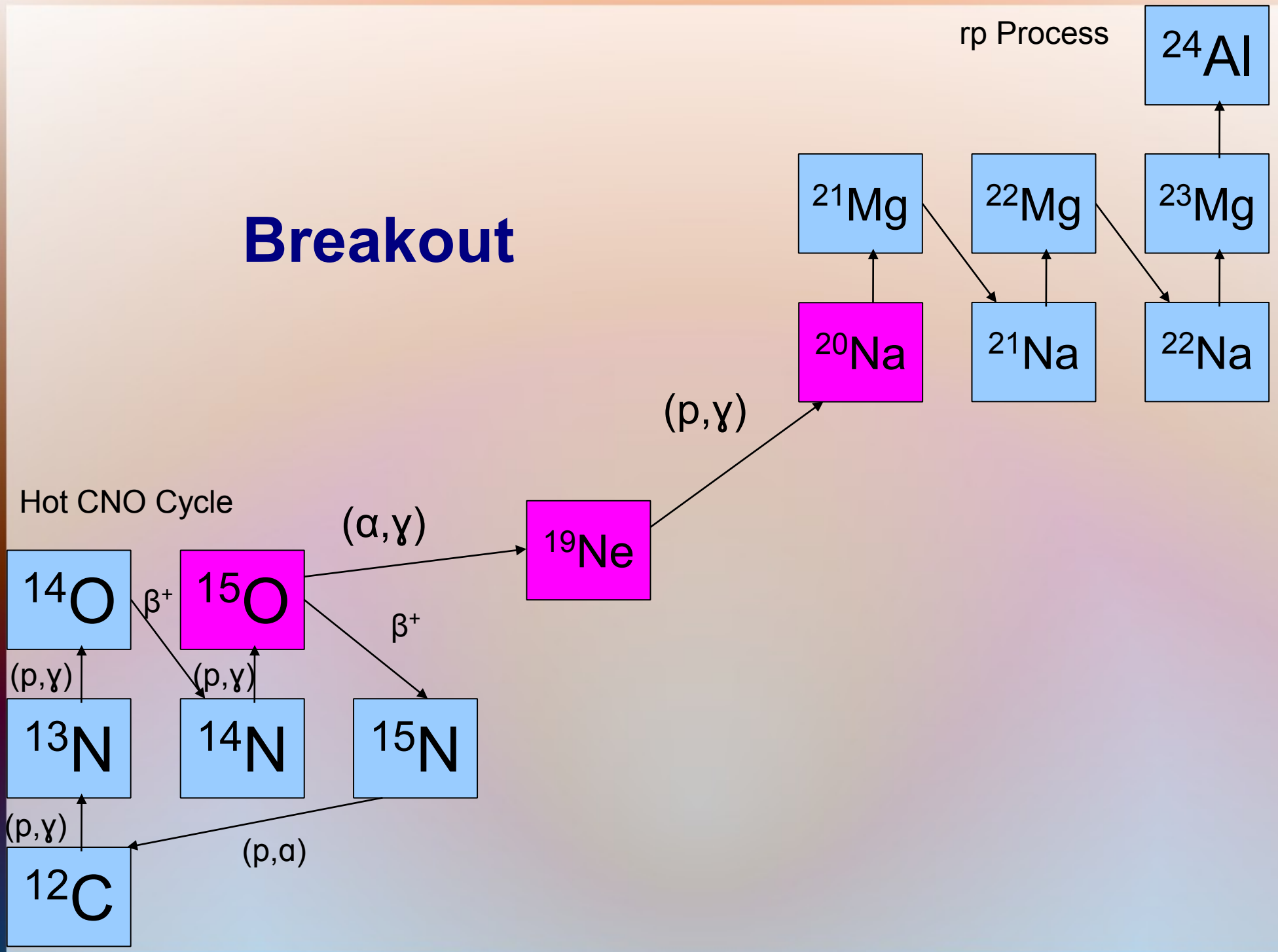
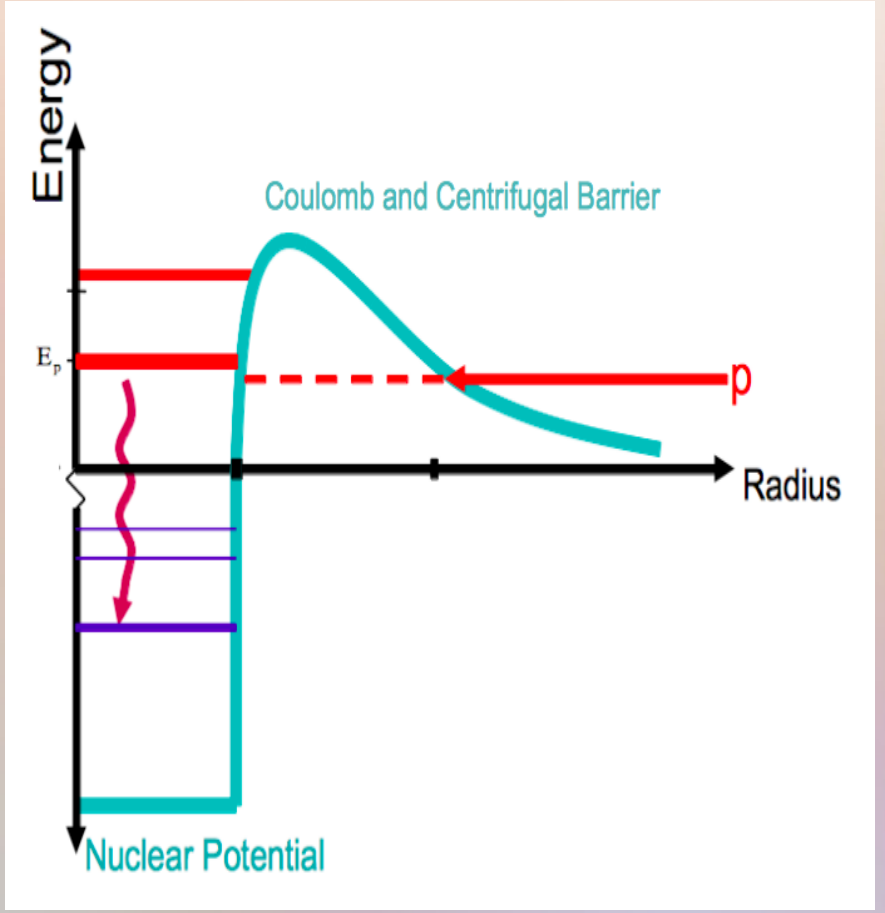
Breakout


rp Process
^{24}Al
^{21}Mg
^{22}Mg
^{23}Mg
^{20}Na
^{21}Na
^{22}Na
(p,γ)
Hot CNO Cycle
(α,γ)
^{19}Ne
^{14}O
β+
^{15}O
β+
(p,γ)
(p,γ)
^{13}N
^{14}N
^{15}N
(p,γ)
(p,α)
^{12}C

The $^{19}Ne(p,\gamma)^{20}Na$ reaction

- Dominated at astrophysical temperatures by first resonance above proton threshold.
- Energy, spin and parity of first resonance vital for accurate reaction rate.

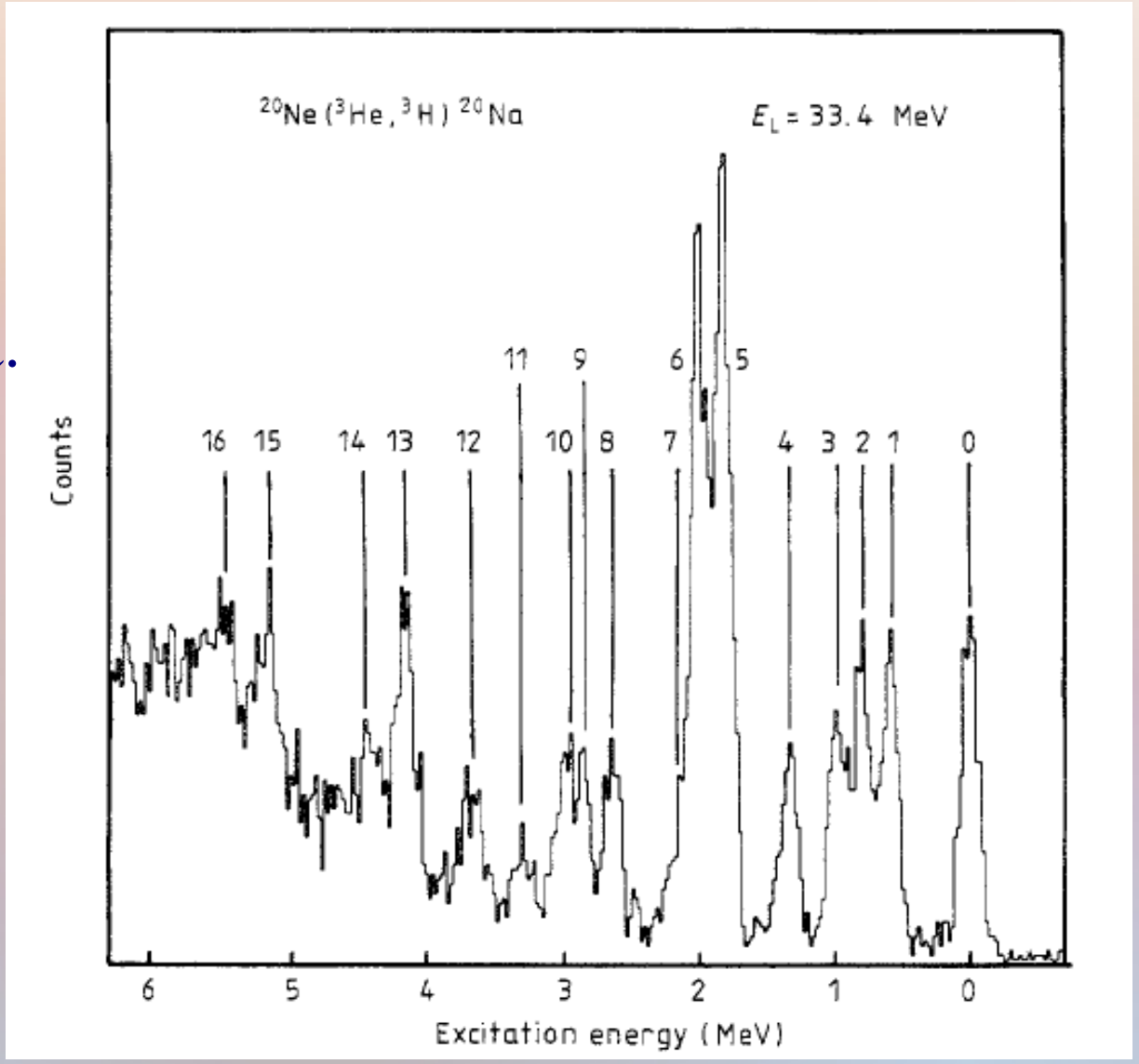


$$< \sigma v >= \left(\frac{2\pi}{\mu kT}\right)^{3/2} \hbar^2 \omega\gamma \exp\left[-\frac{E_R}{kT}\right]$$

Previous Studies of the $^{19}Ne(p,\gamma)^{20}Na$ reaction

- Charge exchange reactions : $^{20}Ne(^{3}He,t)^{20}Na$ and $^{20}Ne(p,n)^{20}Na$.
- Discrepancy in spin-parity assignment :

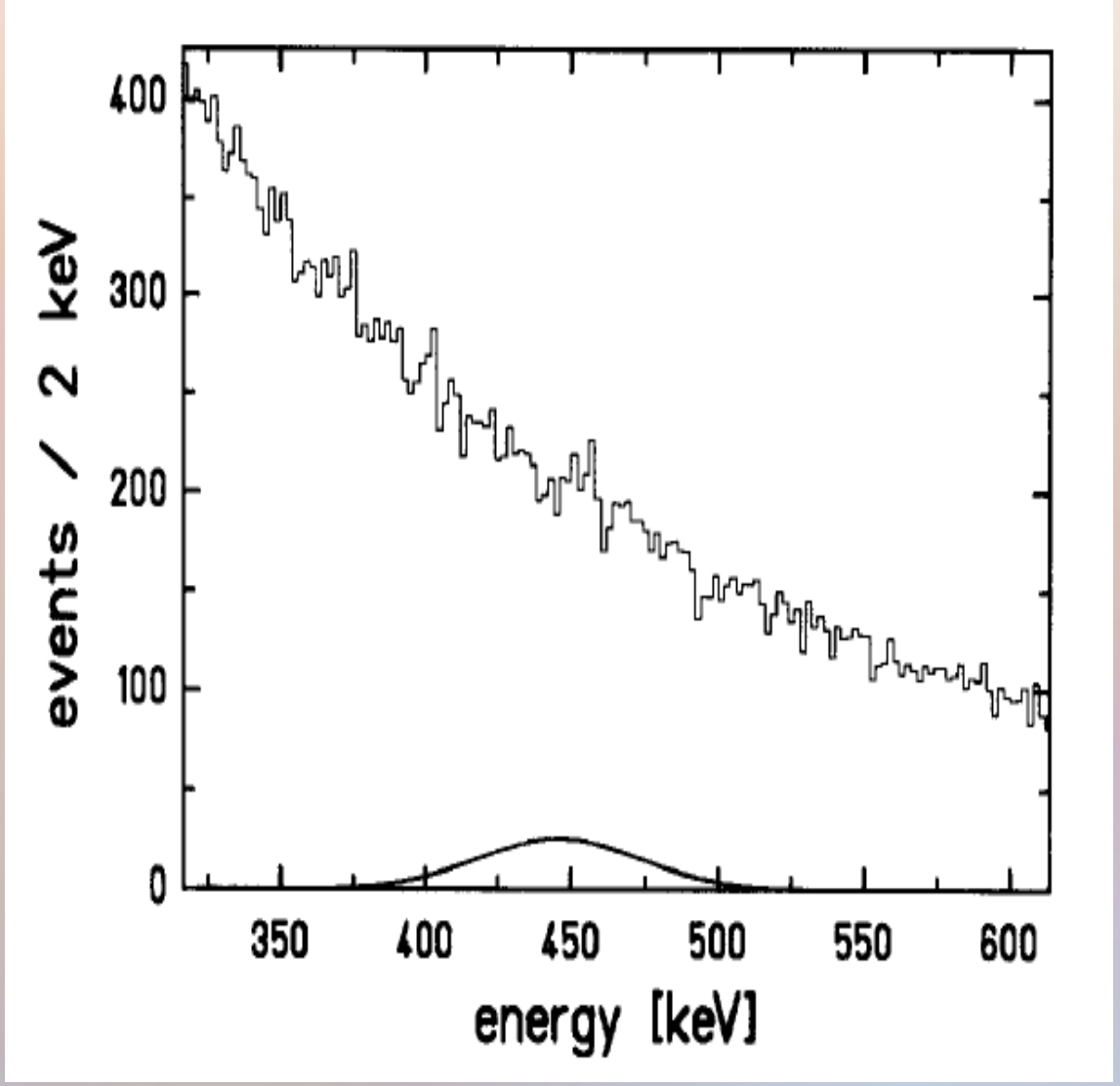
1^+ or 3^+



N M Clarke et al J. Phys. G: Nucl. Part. Phys. **16** (1990) 1547-1552

Previous Studies of the $^{19}Ne(p,\gamma)^{20}Na$ reaction

- Direct studies
- Measurement of the beta-delayed proton decay of ^{20}Mg.
- Insufficiently sensitive measurement, unable to rule out 1^+ state.



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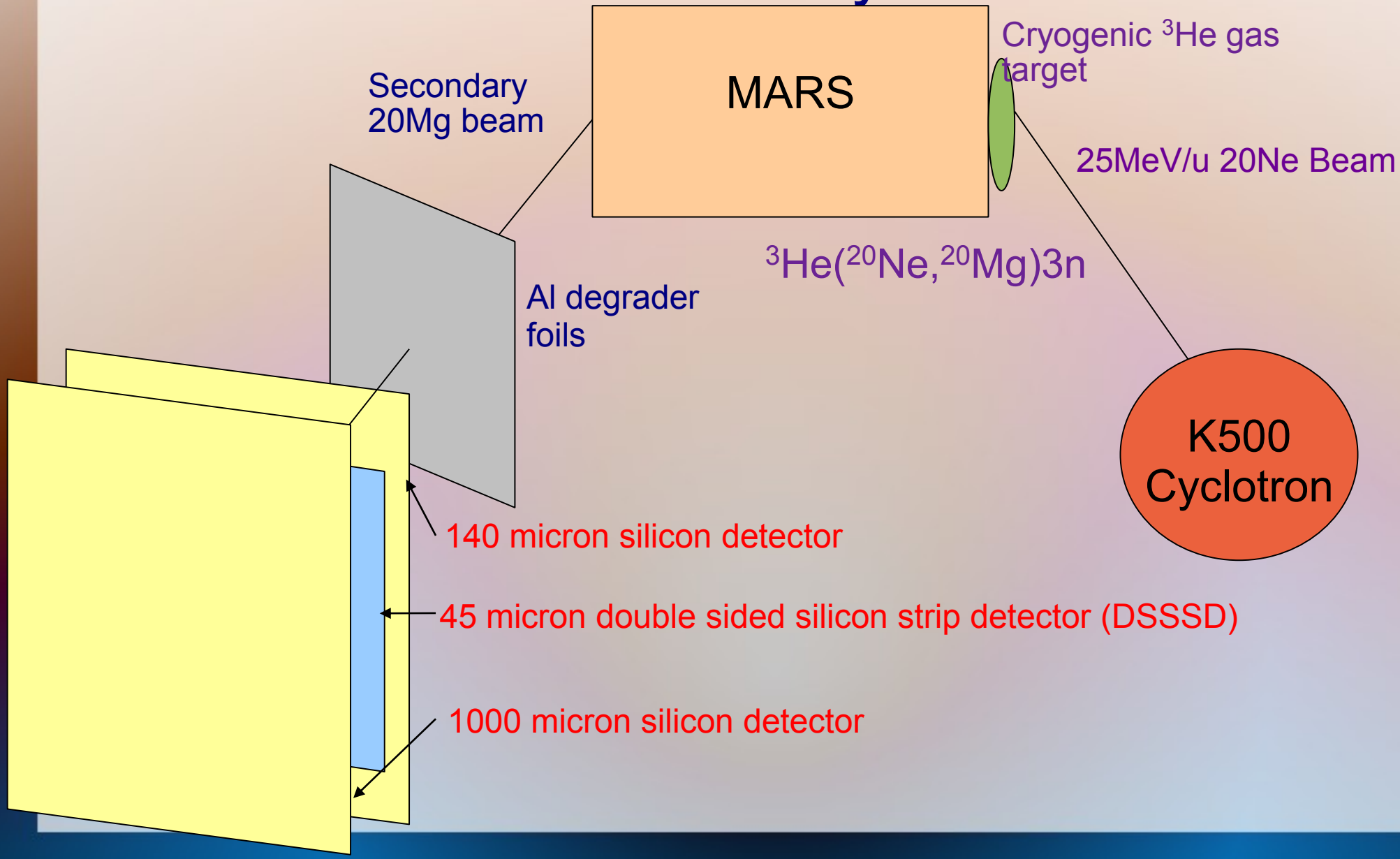
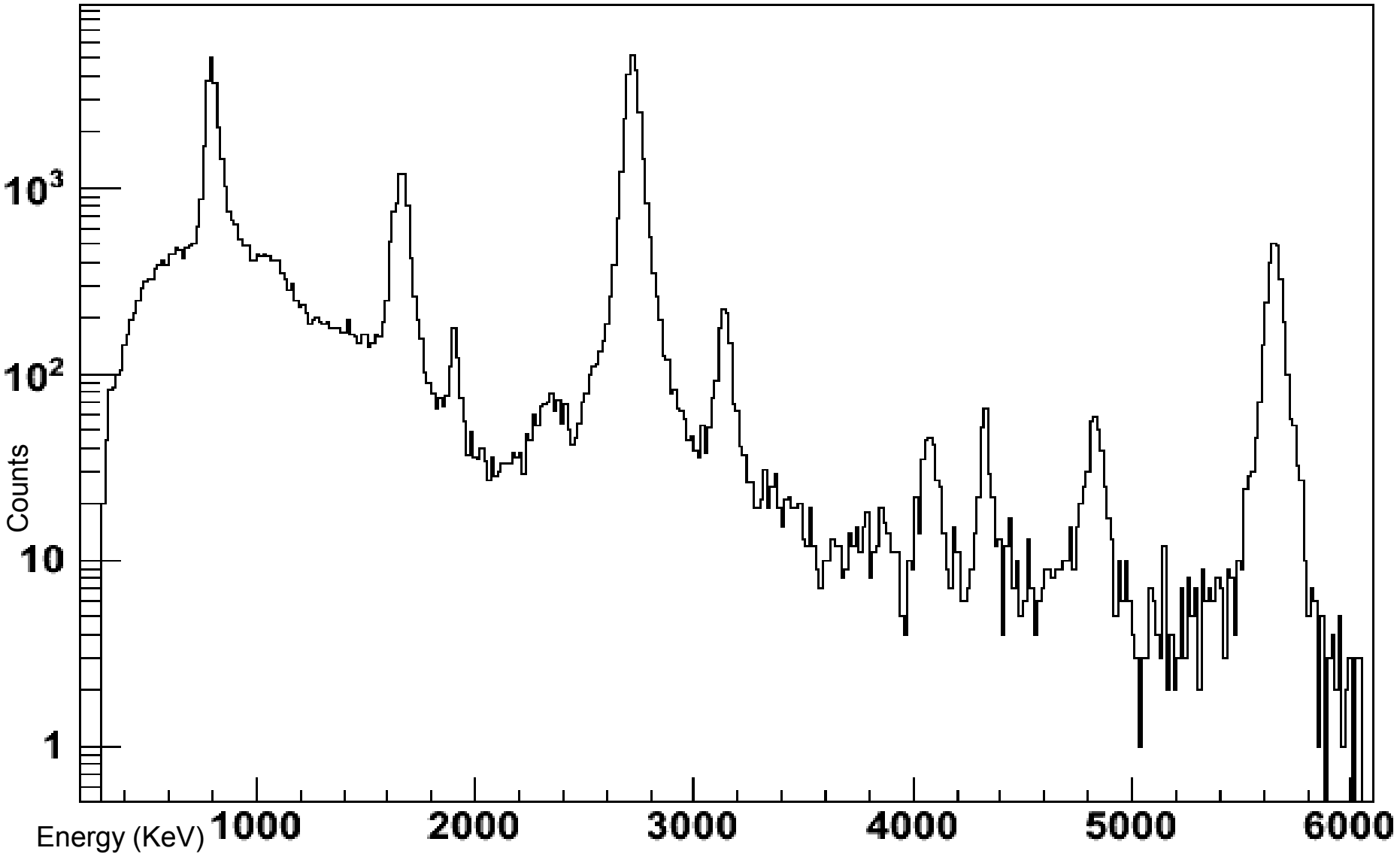
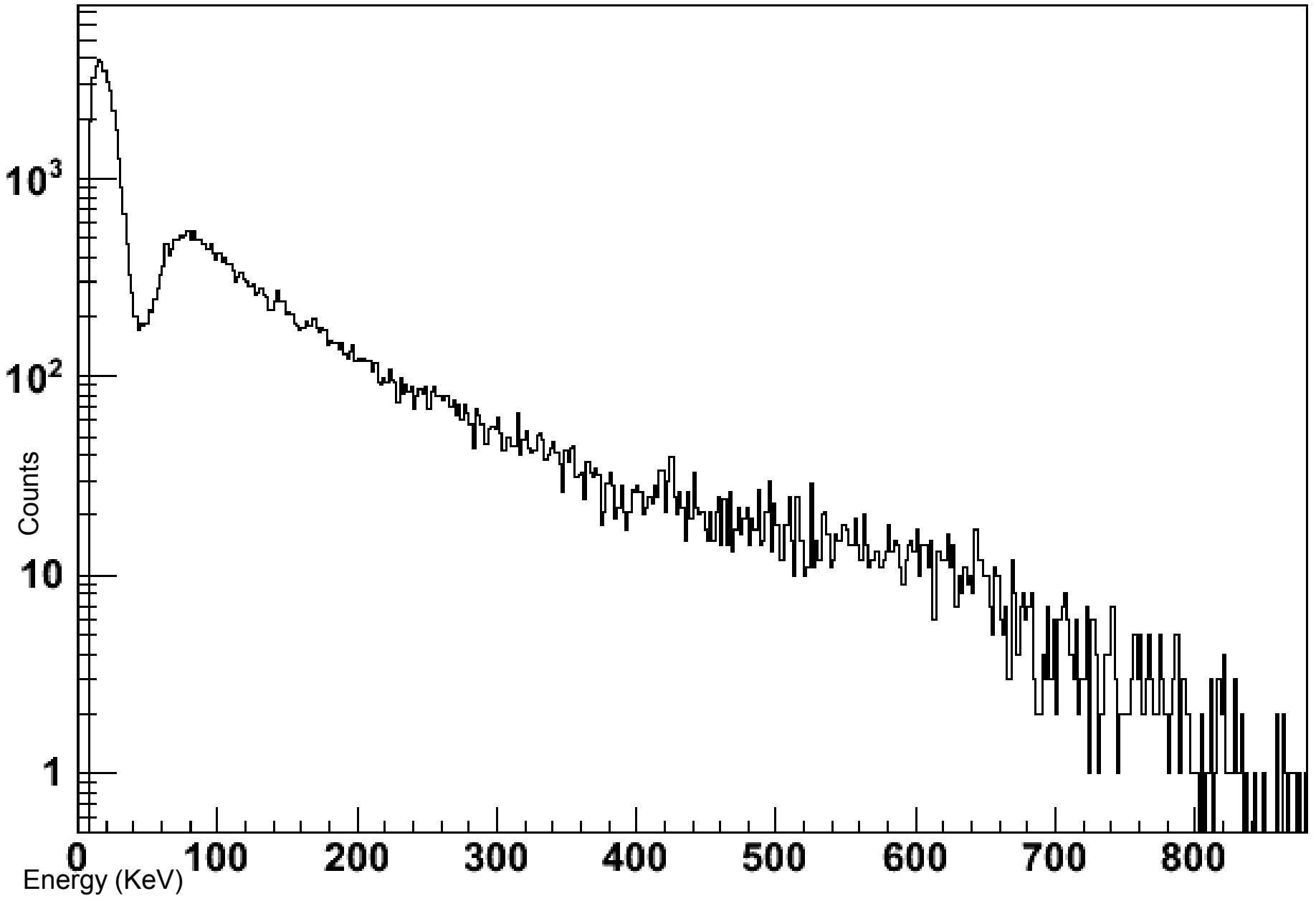
Set-Up at Cyclotron Institute, Texas A & M University



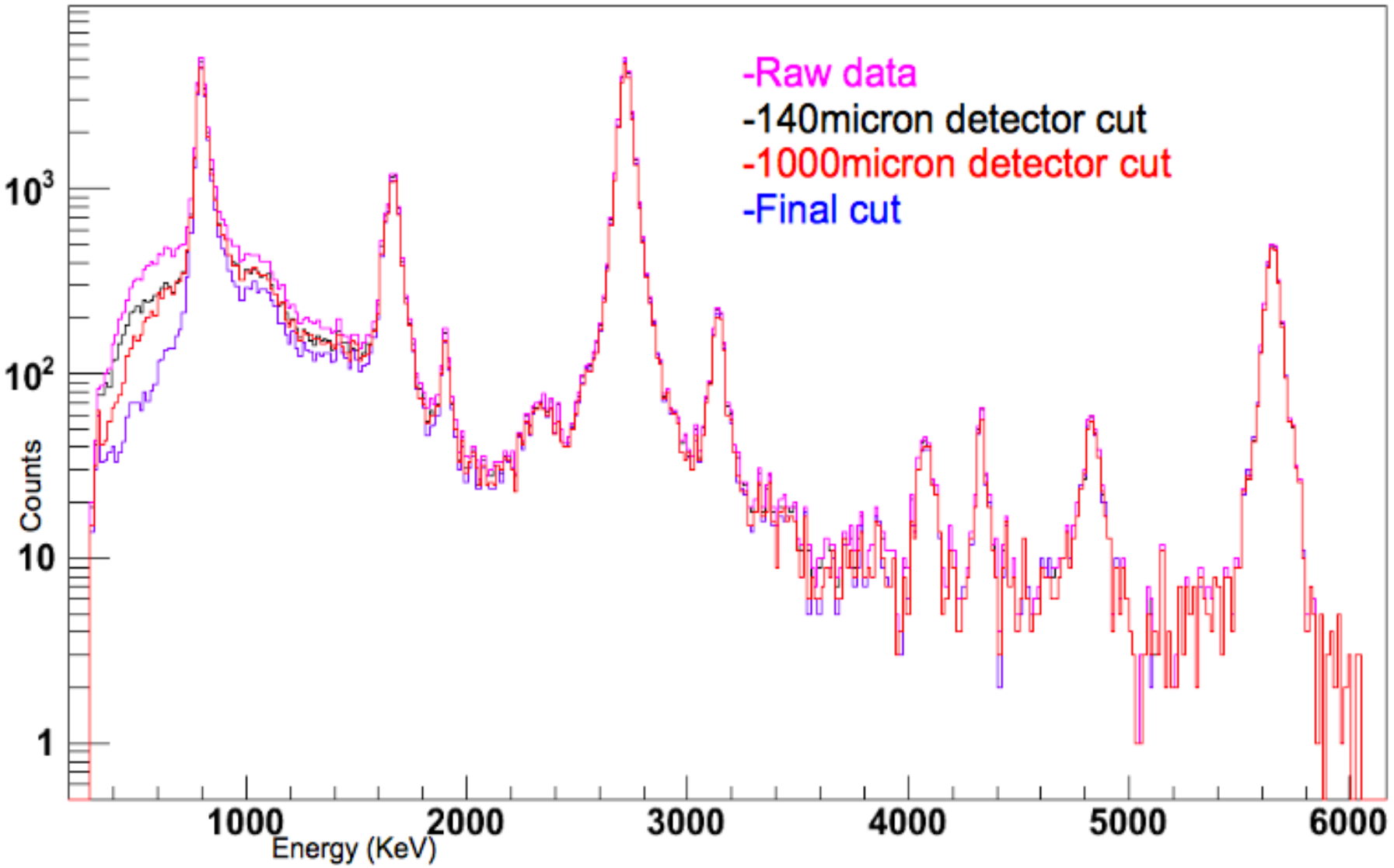
Raw Proton Energy Spectrum



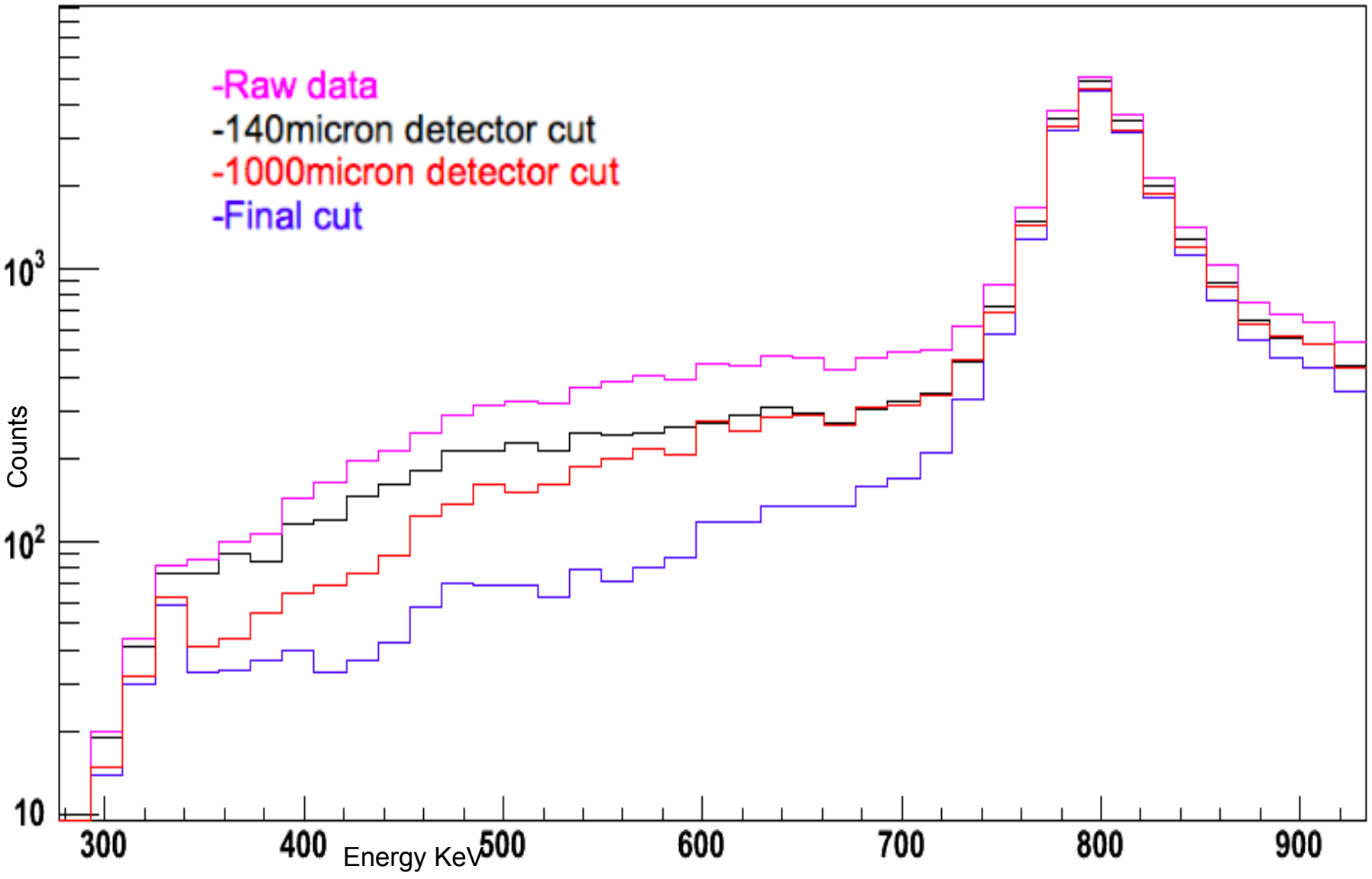
Spectrum from 1000micron silicon detector



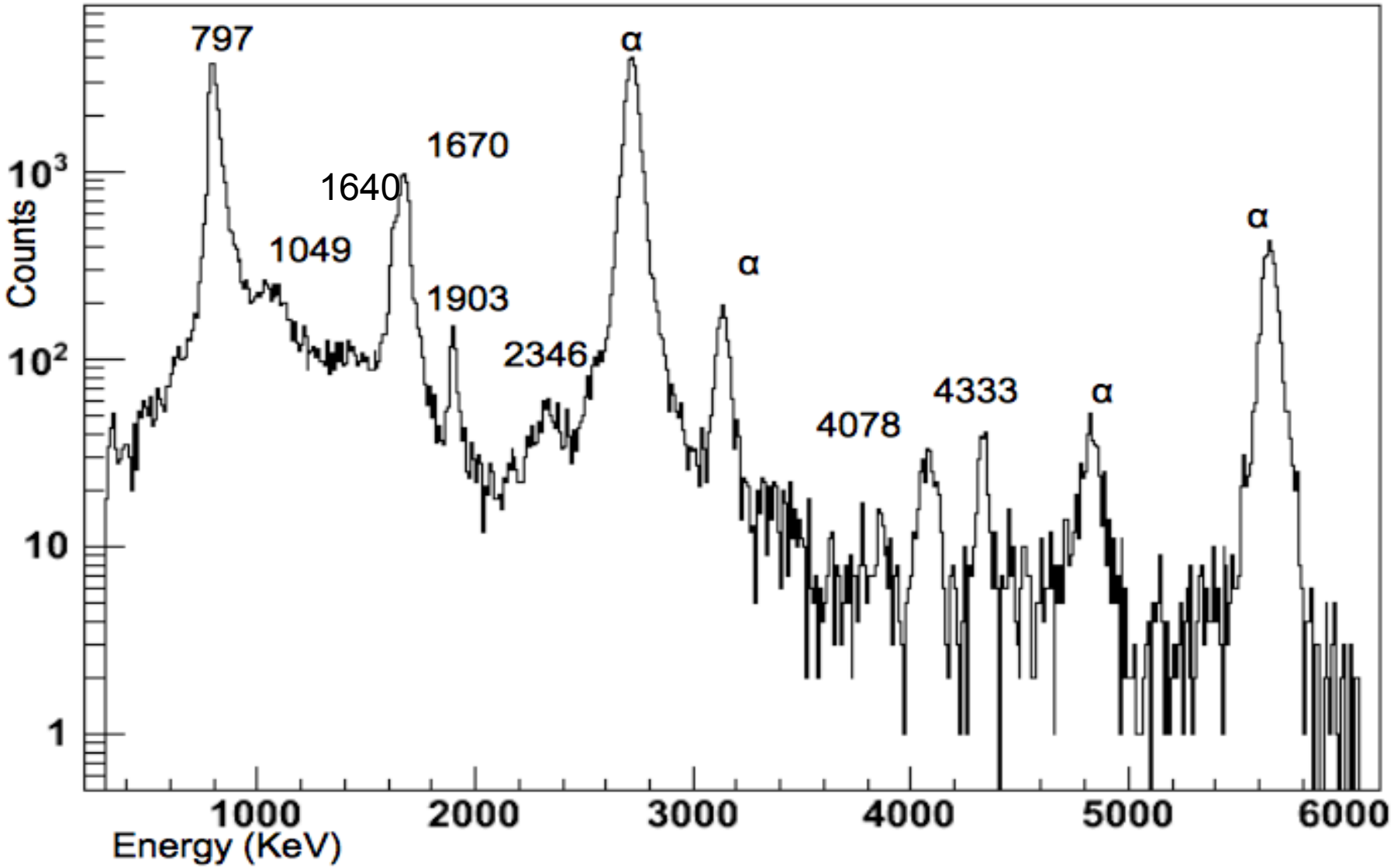
Cleaning up the Spectrum



Cleaning up the Spectrum



Latest Spectrum



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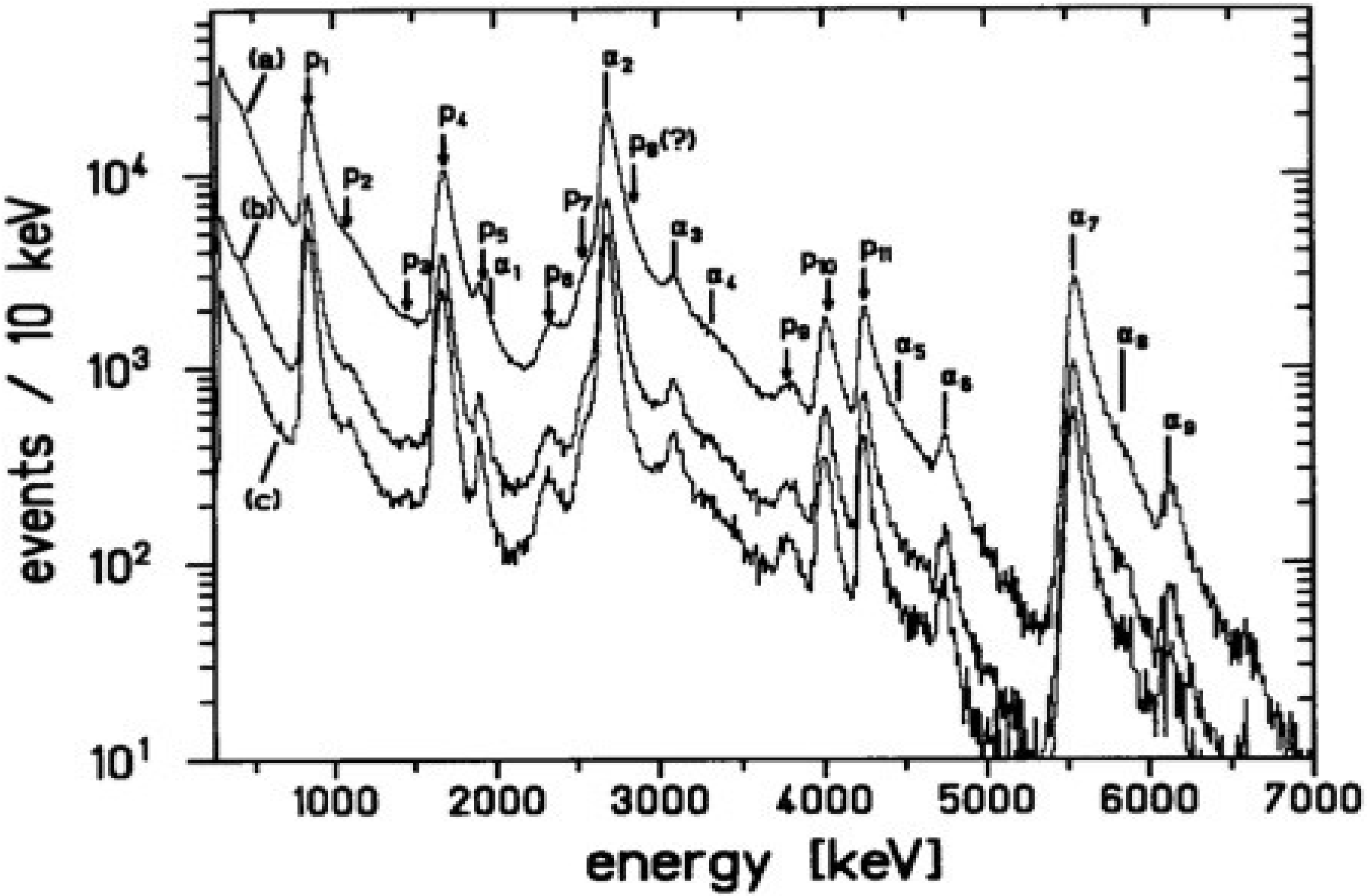

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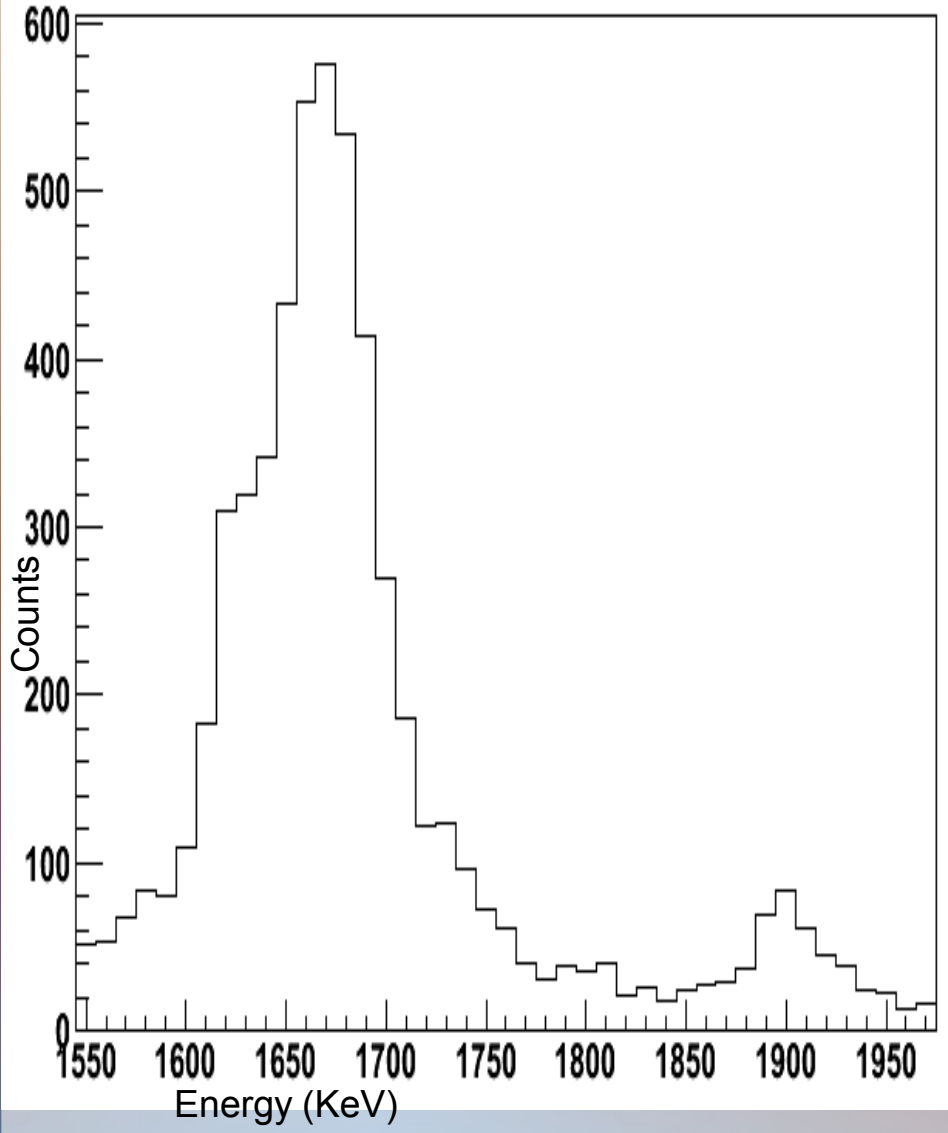
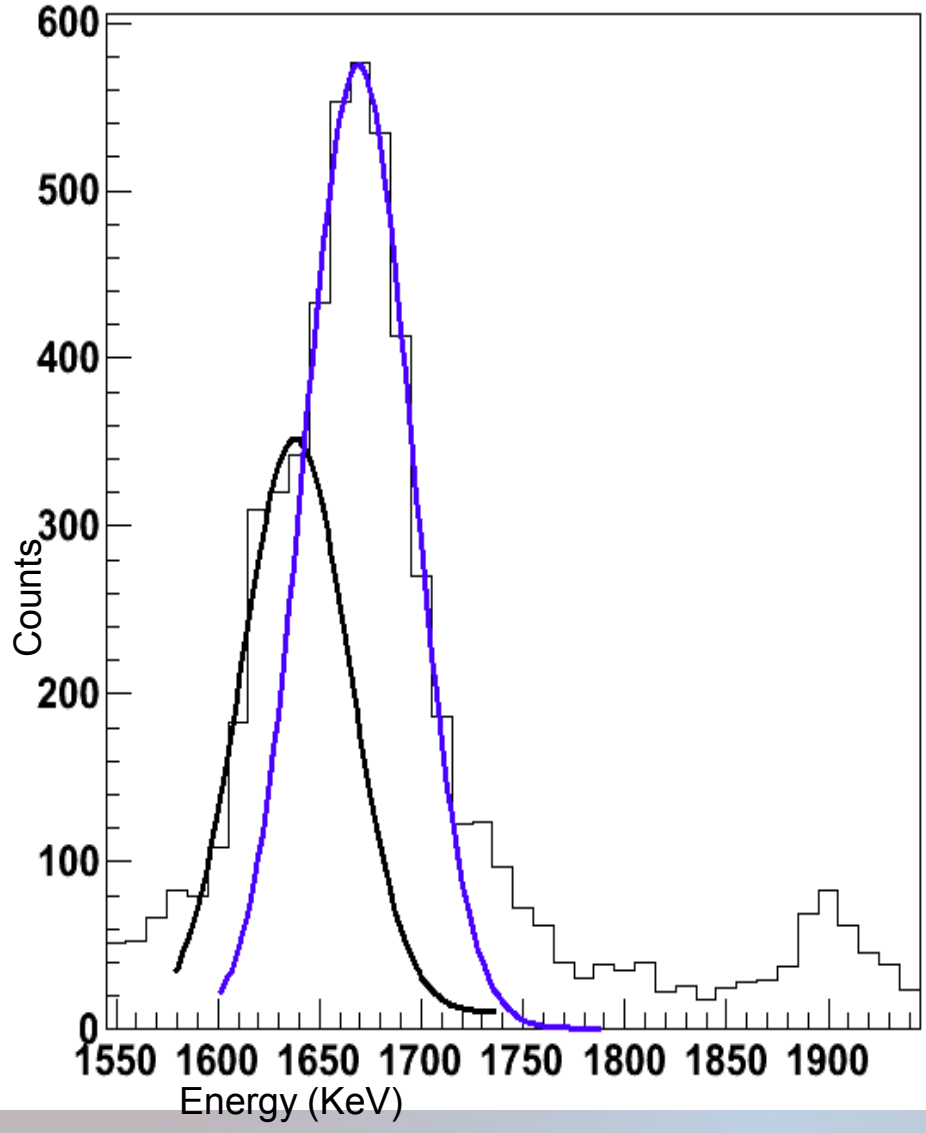
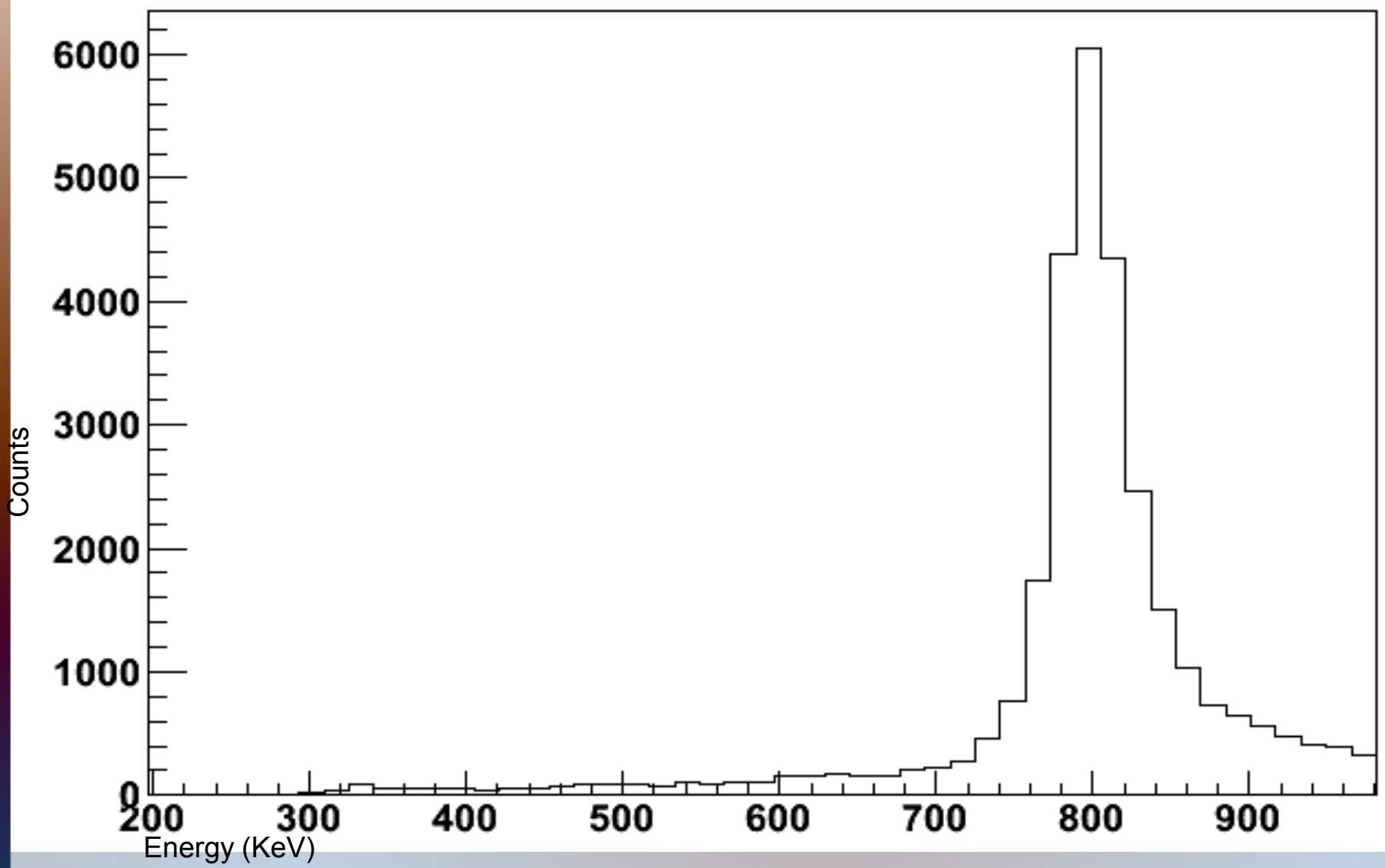
Double Peak

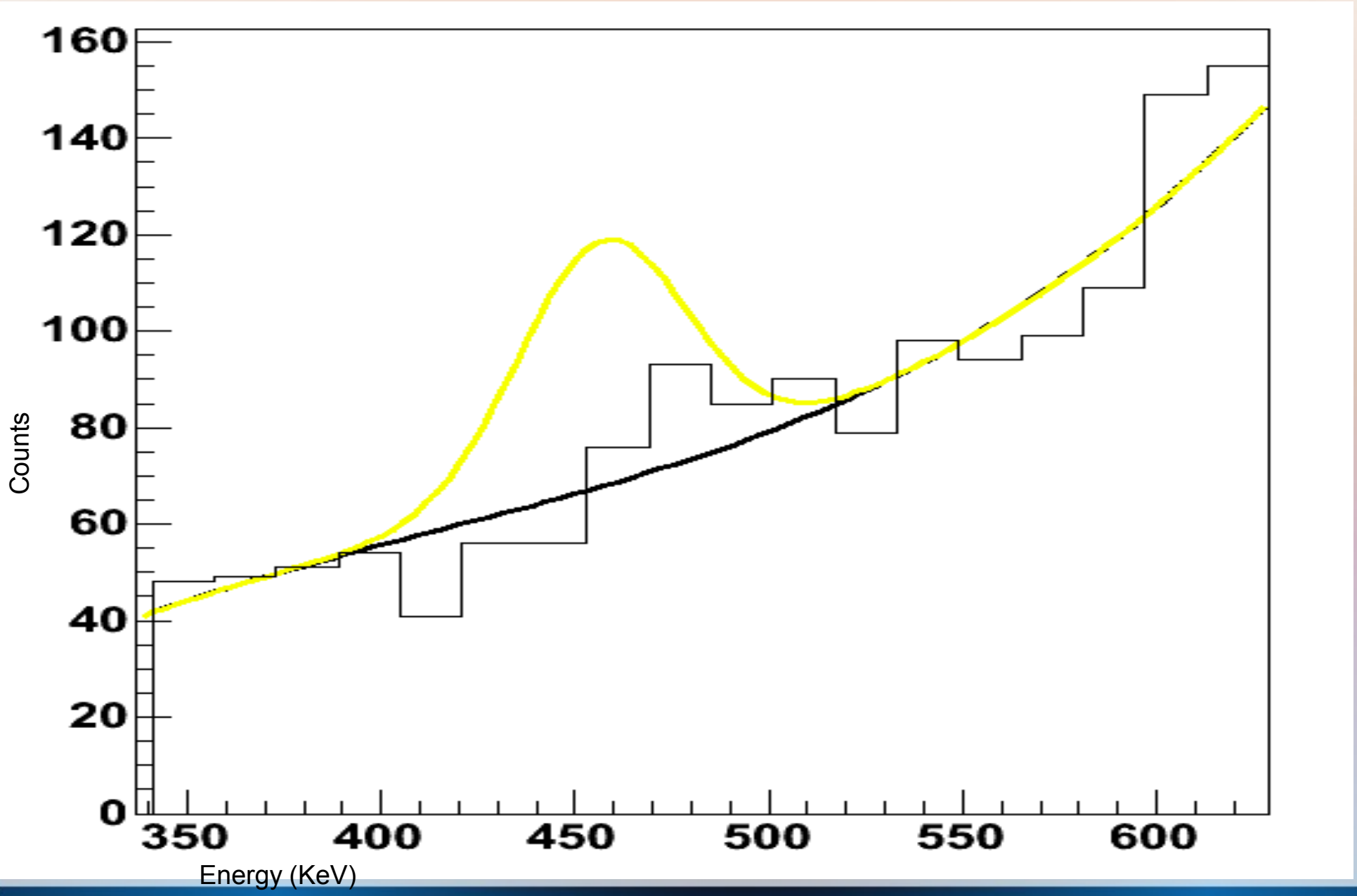

600
500
400
300
200
100
0
Counts
1550
1600
1650
1700
1750
1800
1850
1900
1950
Energy (KeV)


600
500
400
300
200
100
0
Counts
1550
1600
1650
1700
1750
1800
1850
1900
Energy (KeV)

Region of Interest



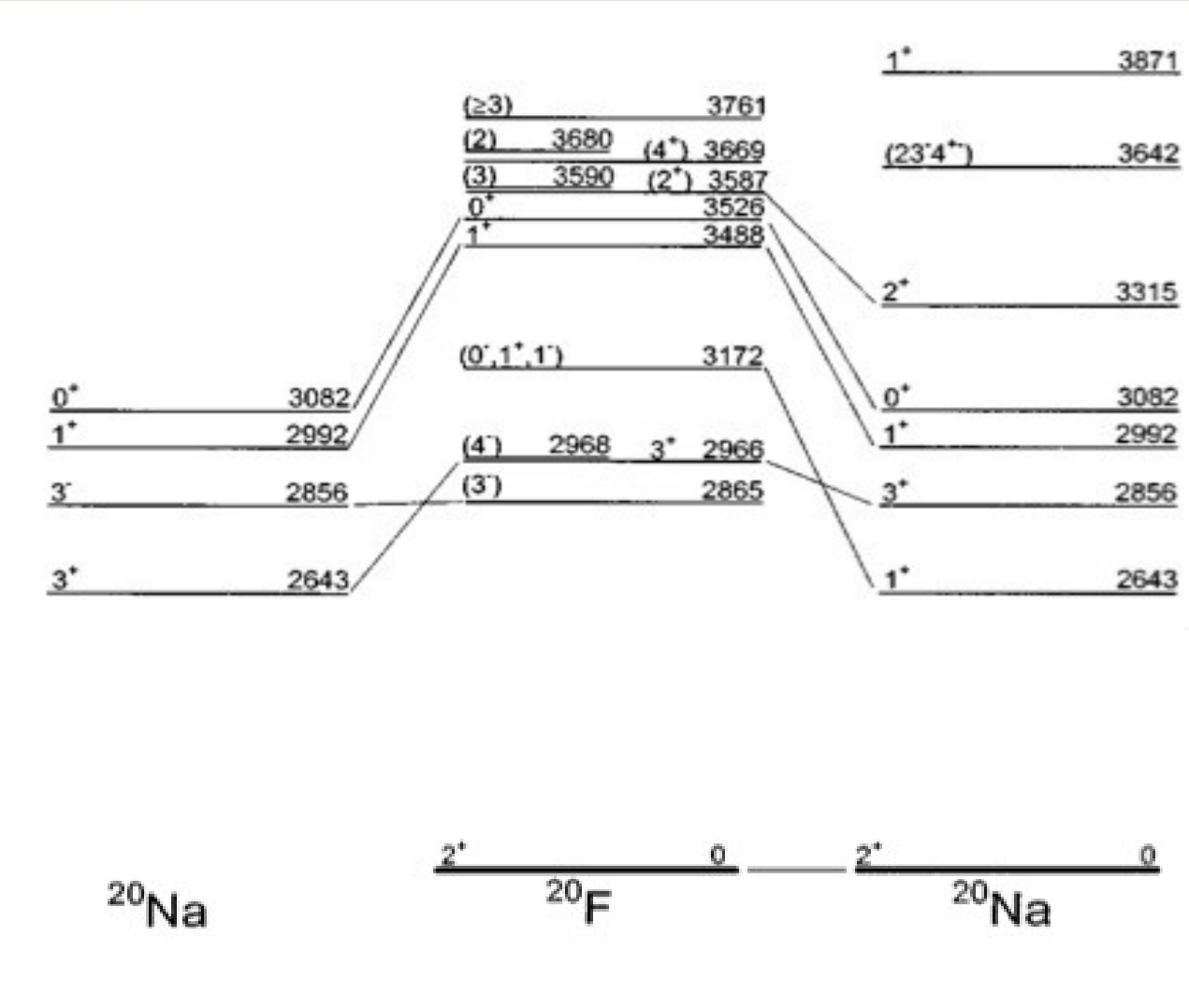
Theoretical peak with a 0.1% branching ratio



Summary

- Performed a high sensitivity experiment looking at key resonant in the compound nucleus ^{20}Na.
- Entering the final stage of analysis.
- Vast improvement on sensitivity, placing greater constraints on branching ratio and logft value for key resonant state.

Spin Parity Assignment and Mirror Studies



G. Vancraeynest, *et al*. Phys. Rev. C 57, 2711 (1998)

MARS:Momentum Achromat Recoil Spectrometer