MAGISOL decay experiments in 2015

A tale of two studies of β-delayed p-emission

Jacob G. Johansen
on behalf of the IS507 and IS541 collaborations
Aarhus University

December 4th 2015

The two experiments

IS507

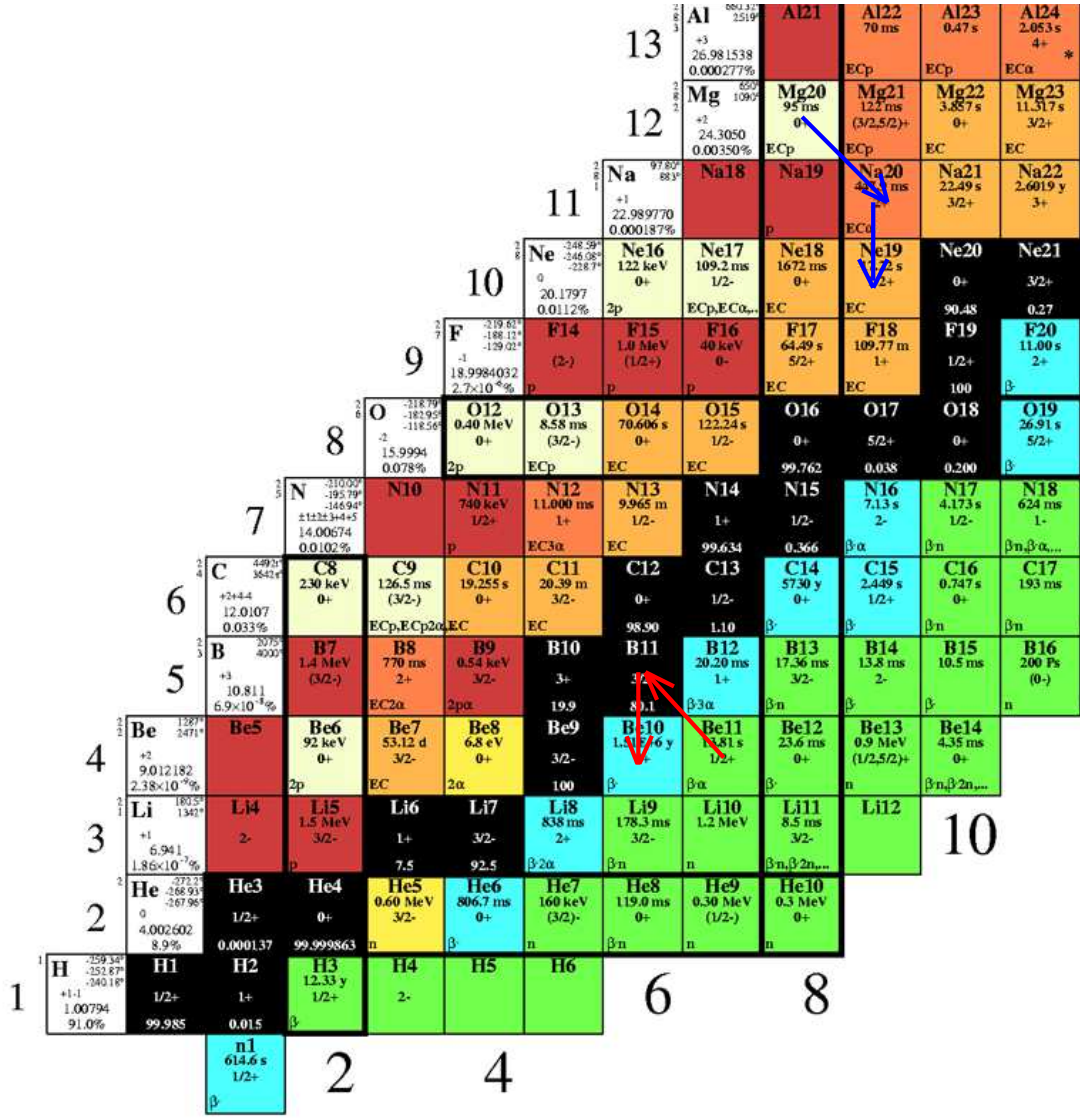
^{20}Mg(β^+p)^{19}Ne

- Performed April 2015
- Second part of IS507
* **Morten V. Lund**

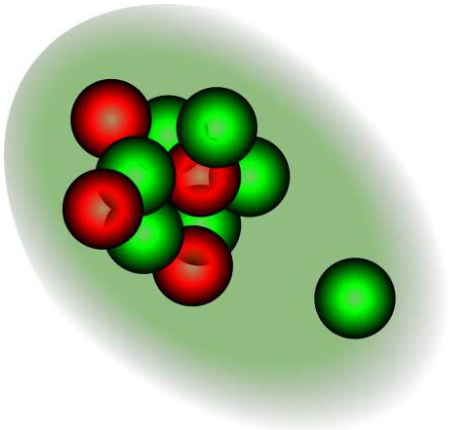
IS541

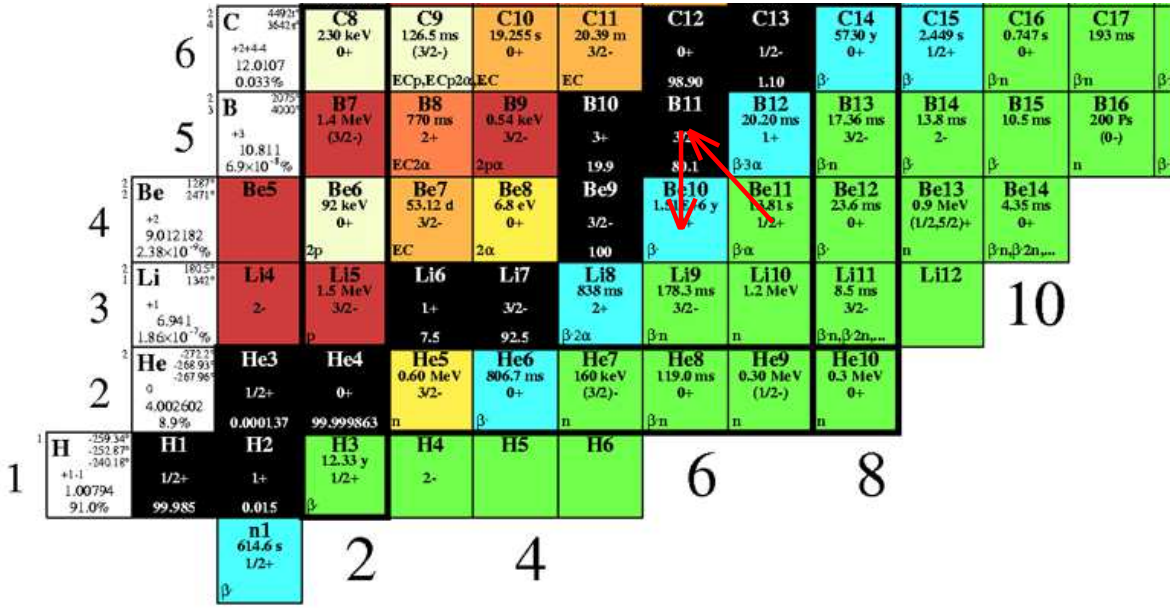
^{11}Be(β^-p)^{10}Be

- Performed May 2015
- Second part of IS541
* **Karsten V. Riisager**

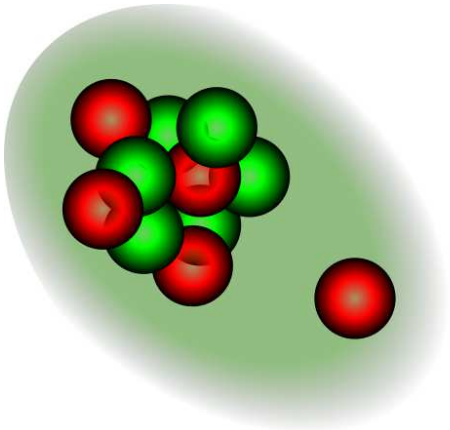


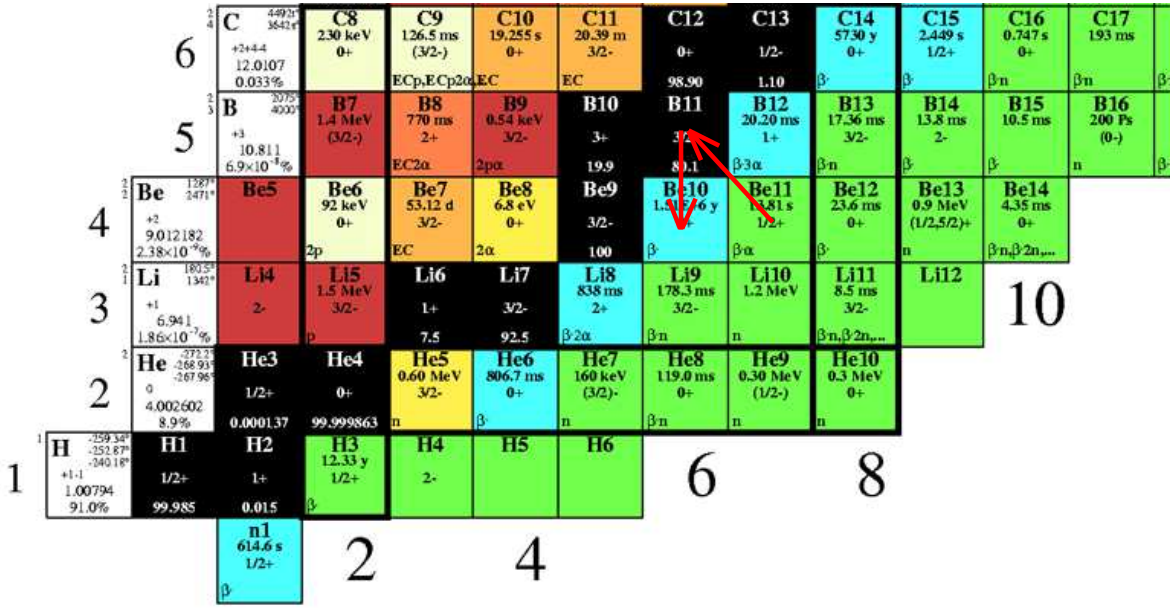
$^{11}\mathrm{Be}(\beta^{-}\mathrm{p})^{10}\mathrm{Be}$

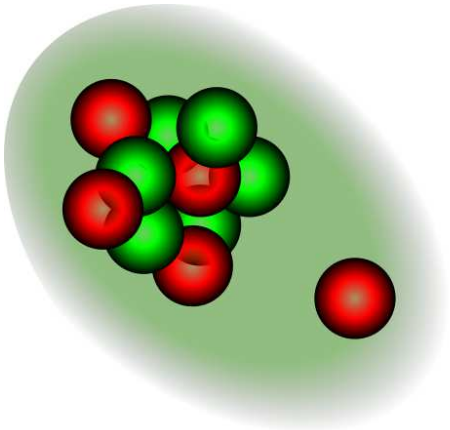


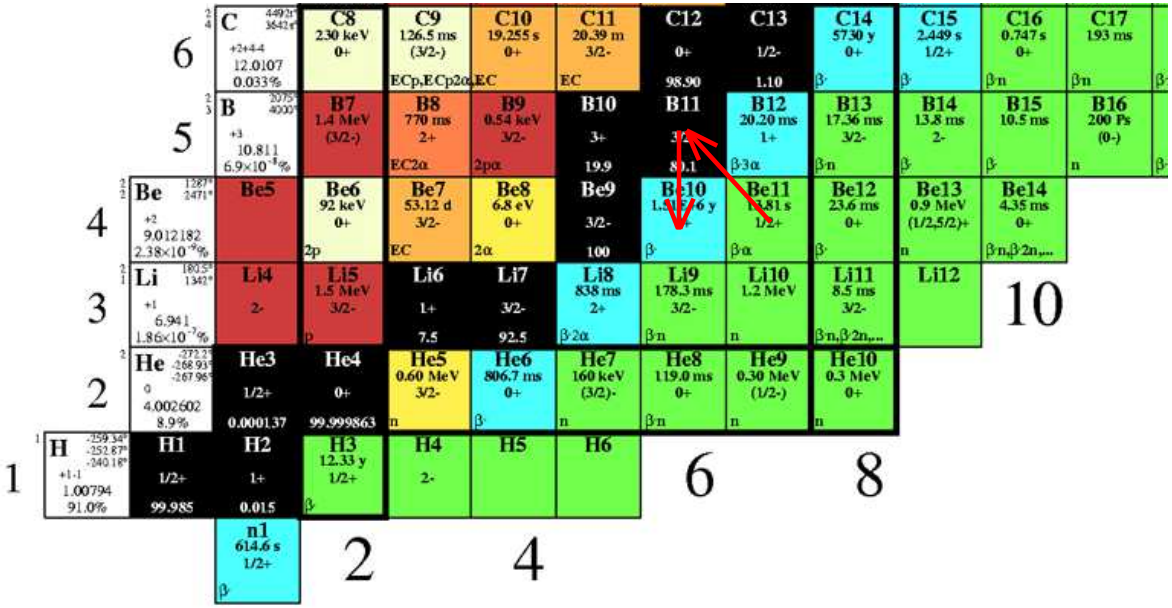


IS541 $^{11}\mathrm{Be}(\beta^{-}\mathrm{p})^{10}\mathrm{Be}$



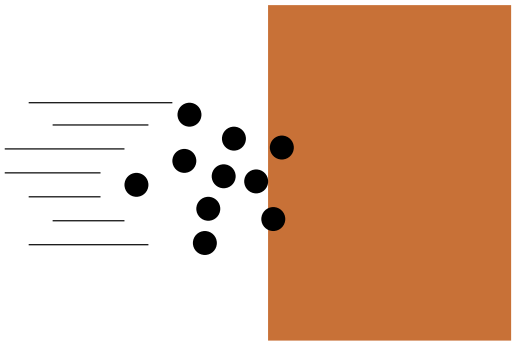






- BR(Theoretical)$= 3.0 \cdot 10^{-8}$ - D. Baye and E.M. Tursonov, Phys Lett B696 (2011) 464
- BR(Experimental)$= 8.3(9) \cdot 10^{-6}$ - K. Riisager et al, Phys Lett B732 (2014) 305
- $E_p = 50 - 240$ keV - Hard to detect.

The experiment



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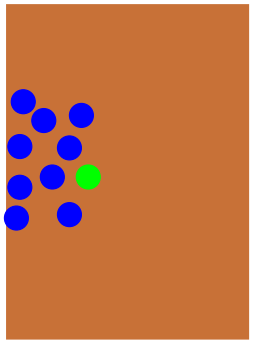
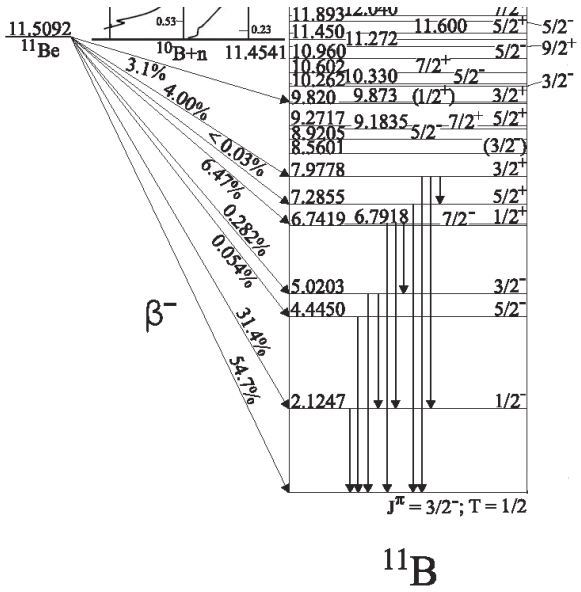
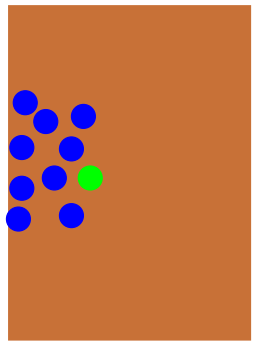


The experiment

- $BR = \frac{N_{^{10}Be}}{N_{^{11}Be}}$
- $N_{^{10}Be}$ measured using AMS at VERA, Vienna.
  - Beginning of next year by O. Forstner.
- $N_{^{11}Be} = \frac{N_{2125keV}}{BR\ \epsilon\ (1-\tau)}$ 1xGe and 4xCsI.





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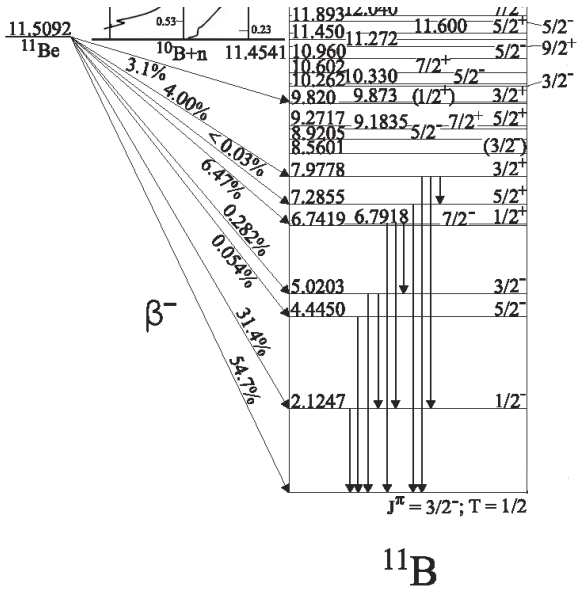

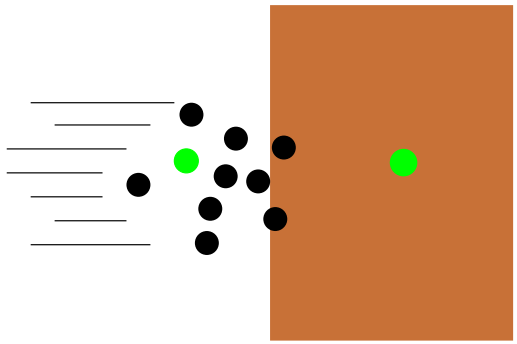

- Control of contaminations extremely important!! (BR $\sim 10^{-6}$)

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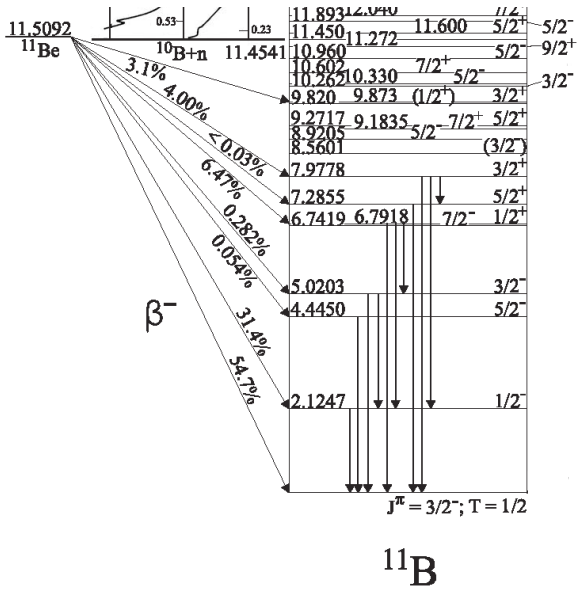

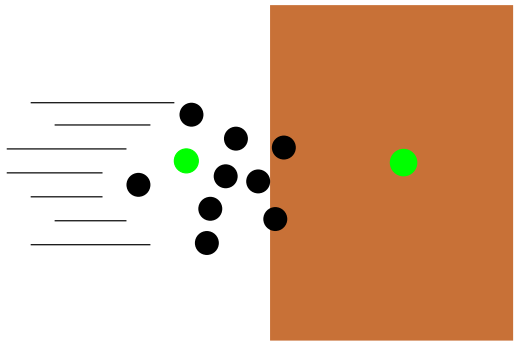

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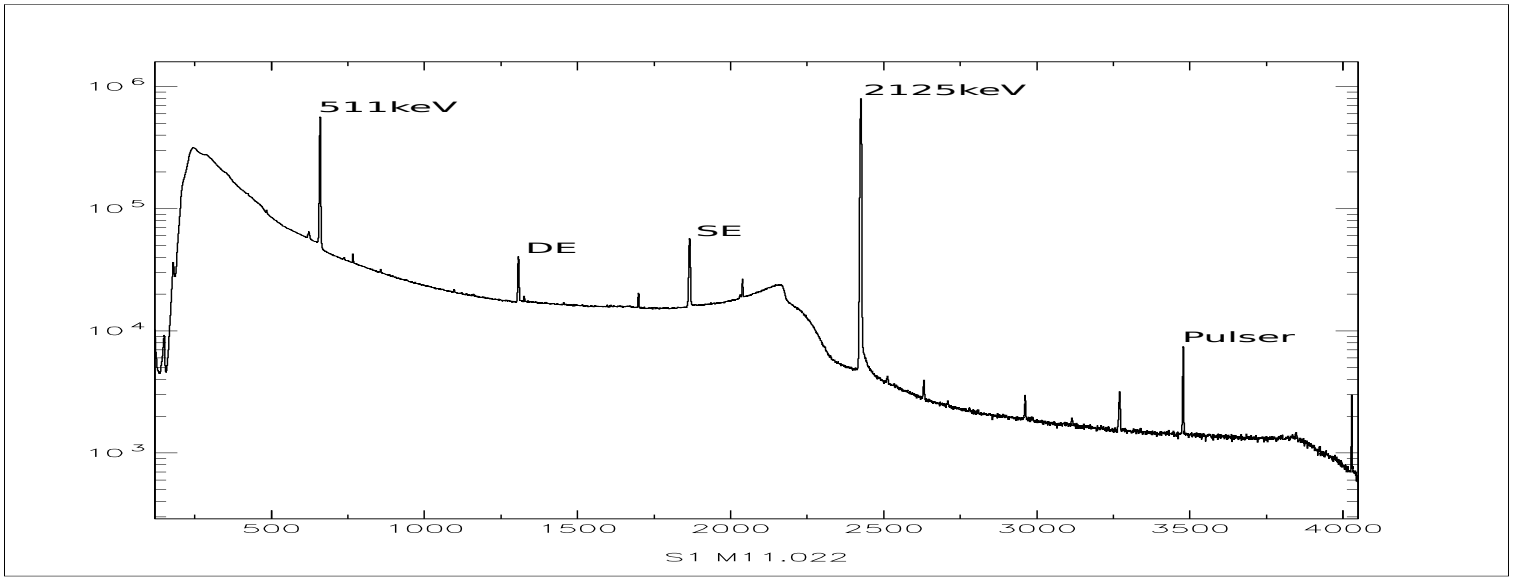
Determining $N_{^{11}\mathrm{Be}}$

γ-energy spectrum:



Uncertaintites:

- $\frac{\Delta N_{2125\mathrm{keV}}}{N_{2125\mathrm{kev}}} \approx 0.06\%$

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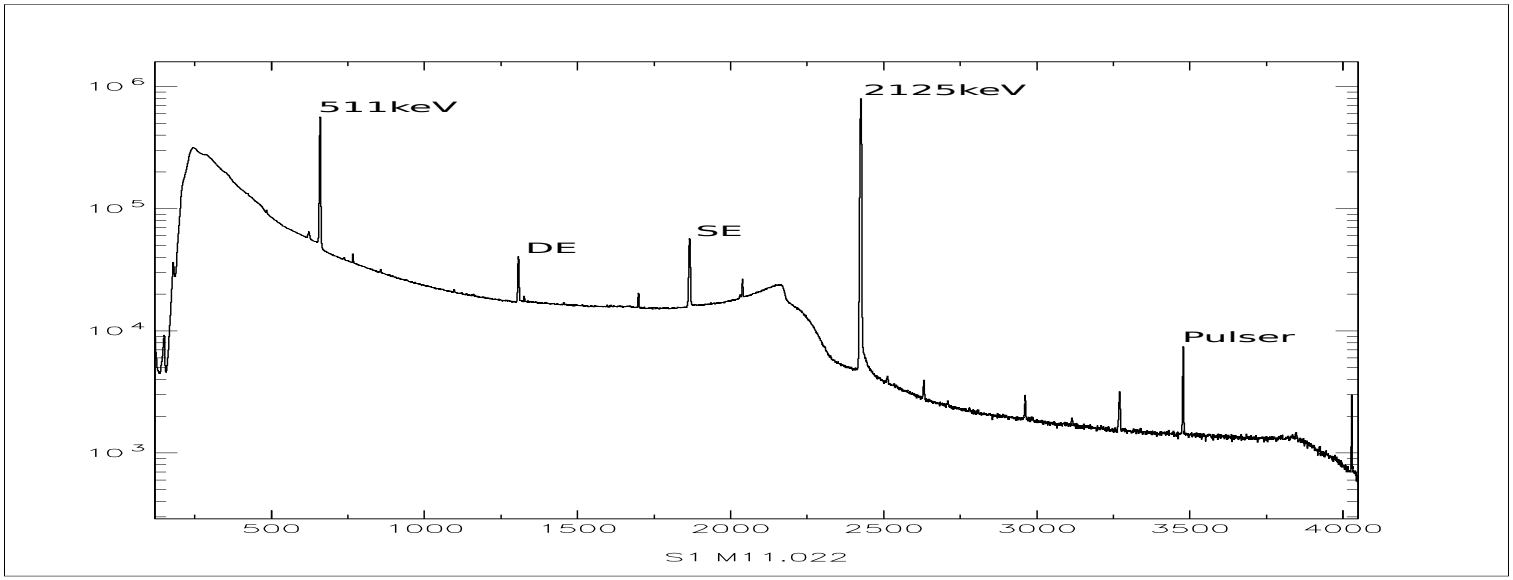

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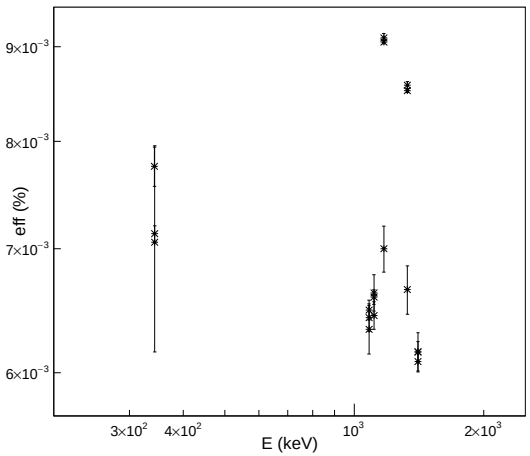

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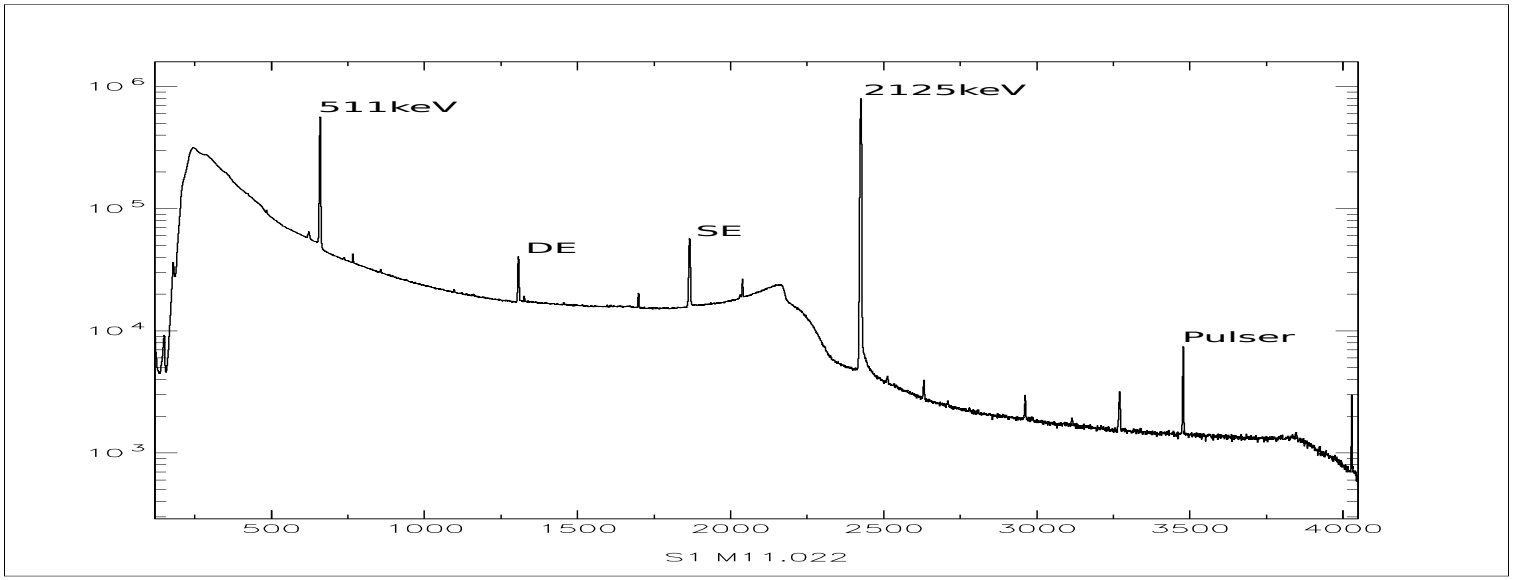

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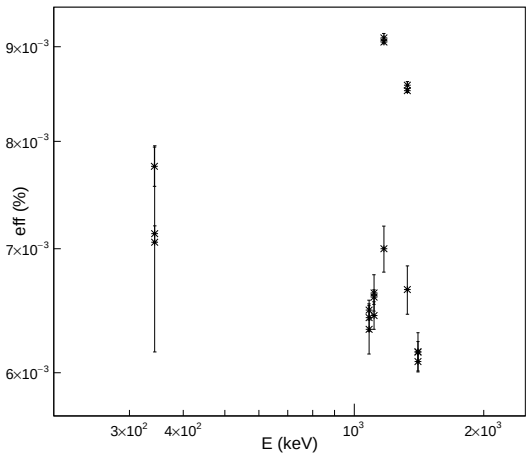
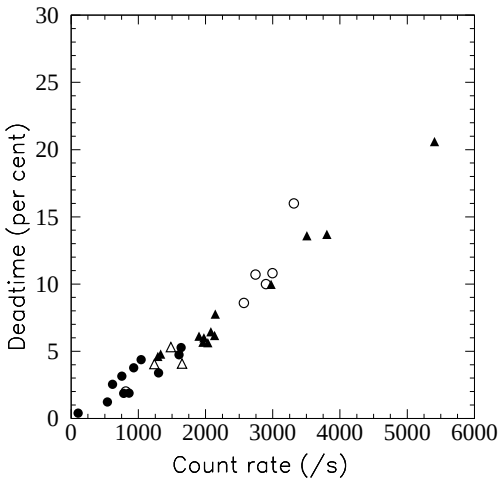


Deadtime:



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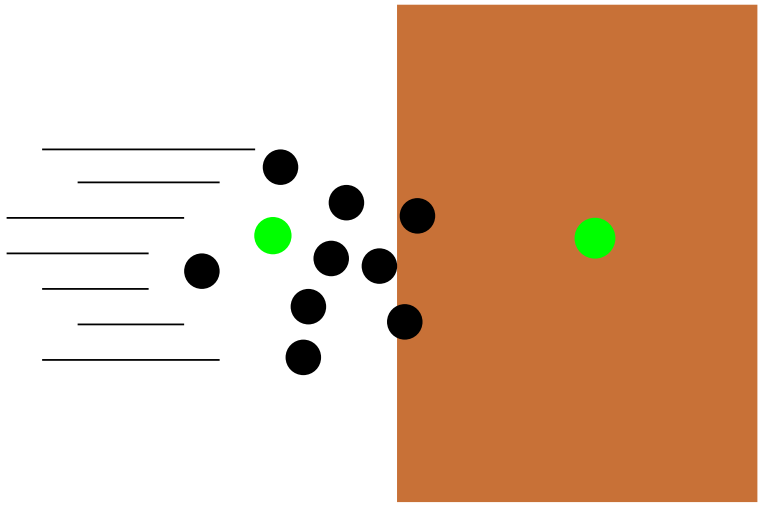
- $\frac{\Delta \epsilon}{\epsilon} \approx 3.7\%$
- $\frac{\Delta \tau}{\tau} \approx 3.5\%$
- $\frac{\Delta N_{^{11}\mathrm{Be}}}{N_{^{11}\mathrm{Be}}} \approx 6.5\%$

Contamination

- ^{10}Be in the plate:
  - Pure copperplate
  - Blank sample
- Possible sources in beam:
  - ^{11}Li(βn) ($M = 11.044$)
  - ^{10}BeH ($M = 11.021$)
  - ^{10}Be ($M = 10.014$)



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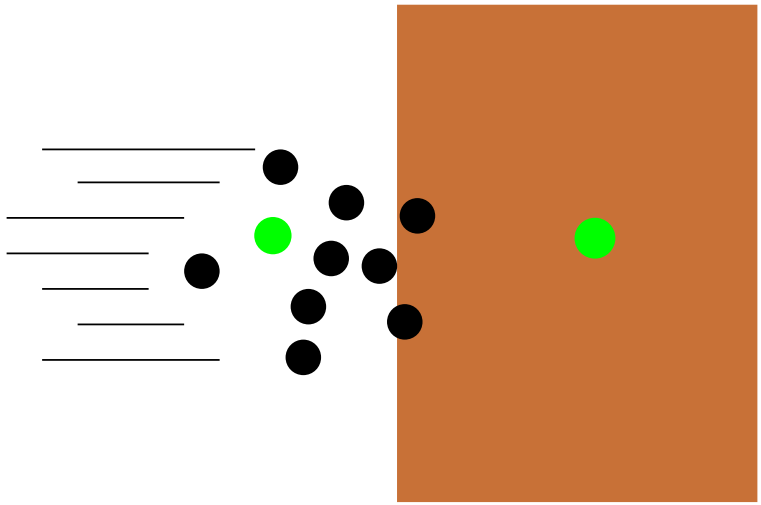

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  - Slits - Lower all offmasses
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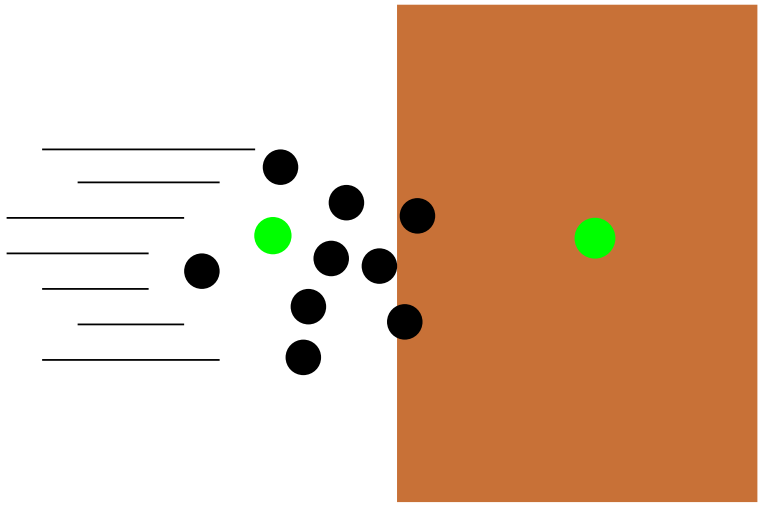

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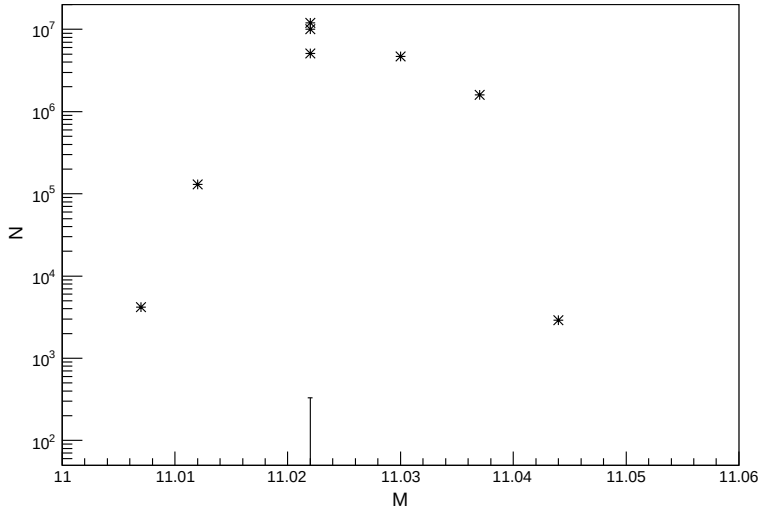
Mass scan. $N_{^{11}\mathrm{Be}}$:



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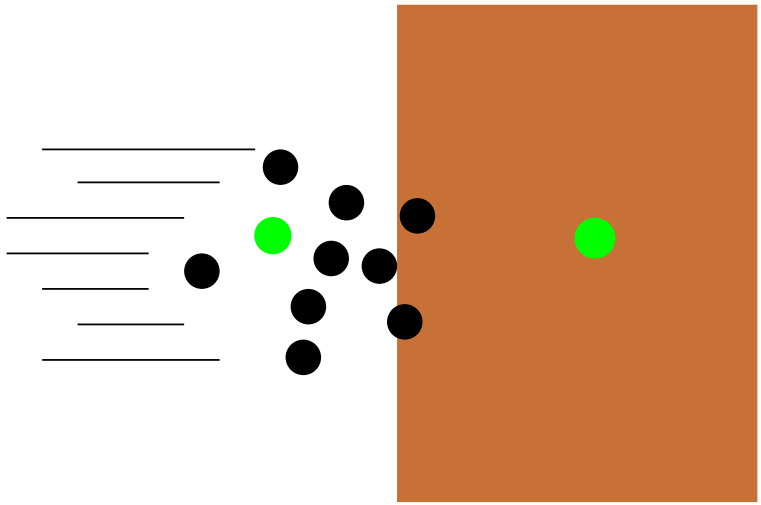

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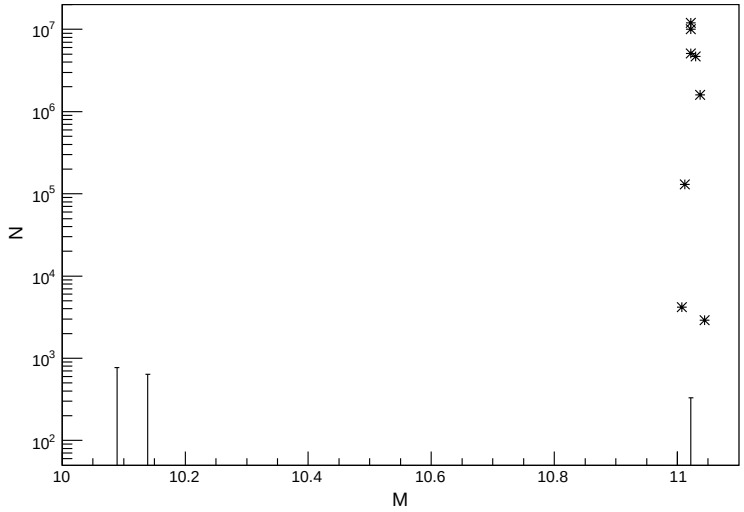
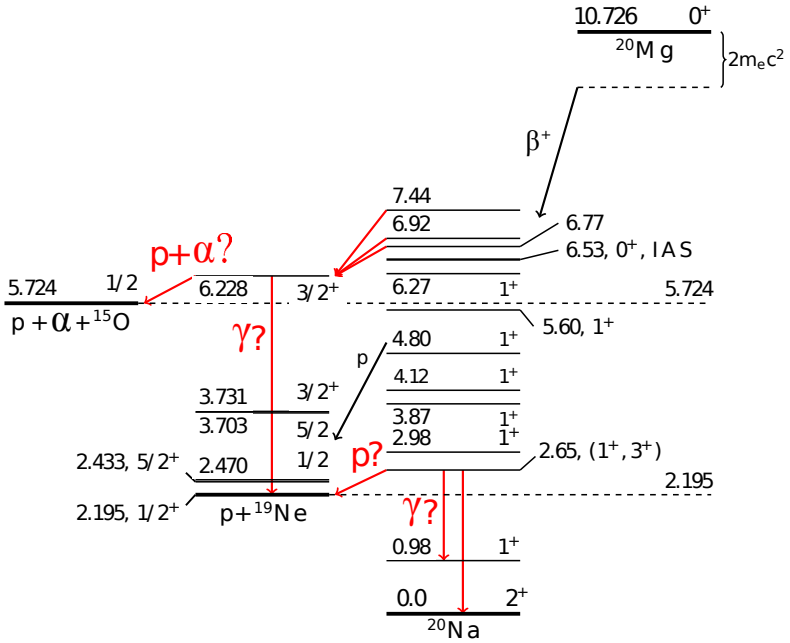
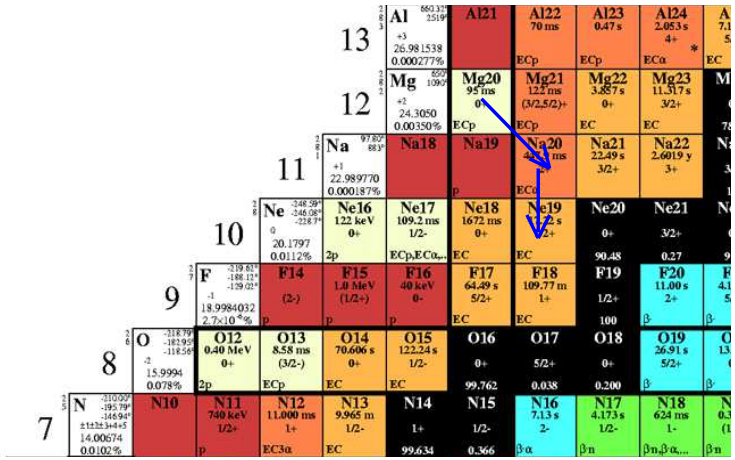
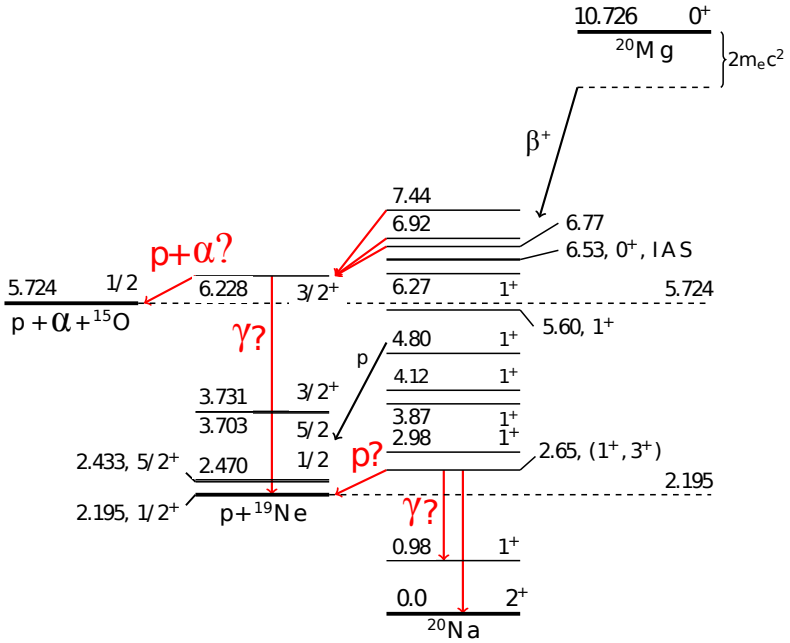


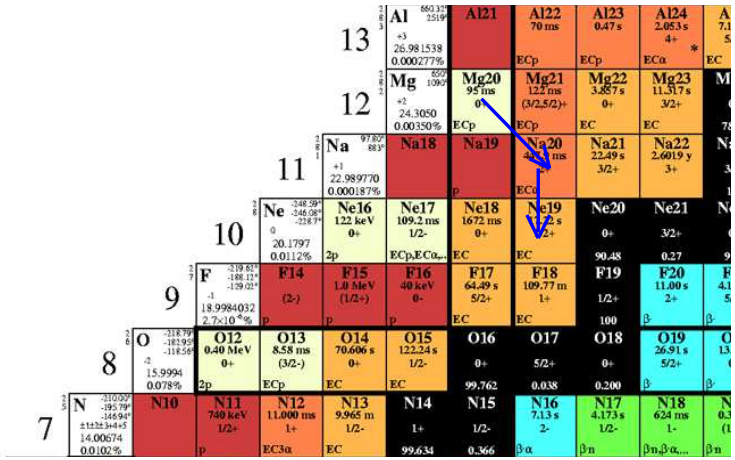




Hot CNO breakout: $^{15}O(\alpha,\gamma)^{19}Ne(p,\gamma)^{20}Na$

- $^{20}Mg(\beta\gamma)^{20}Na$
- $^{20}Mg(\beta p\gamma)^{19}Ne$
- $^{20}Mg(\beta p\alpha)^{15}O$
- $^{20}Mg(\beta\alpha p)^{15}O$

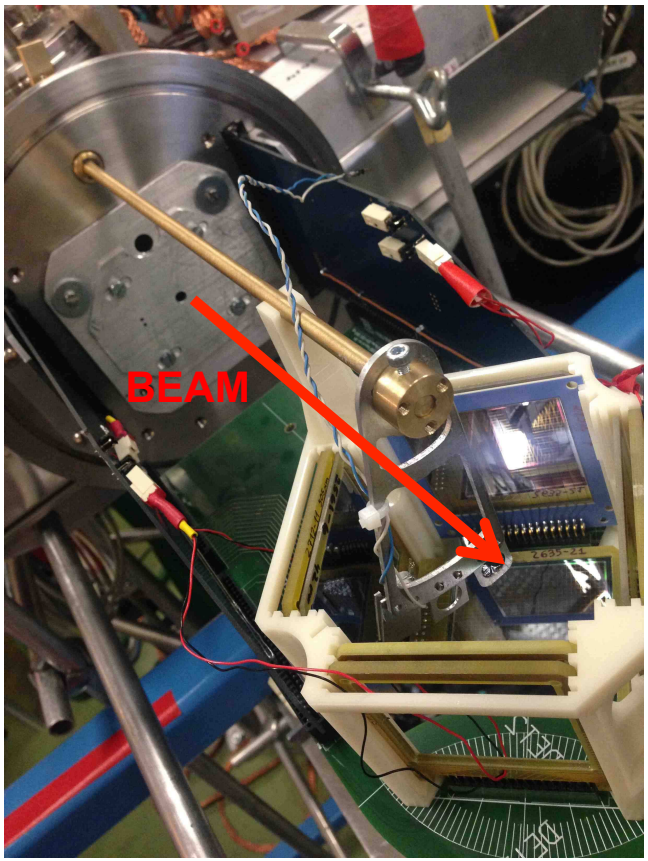


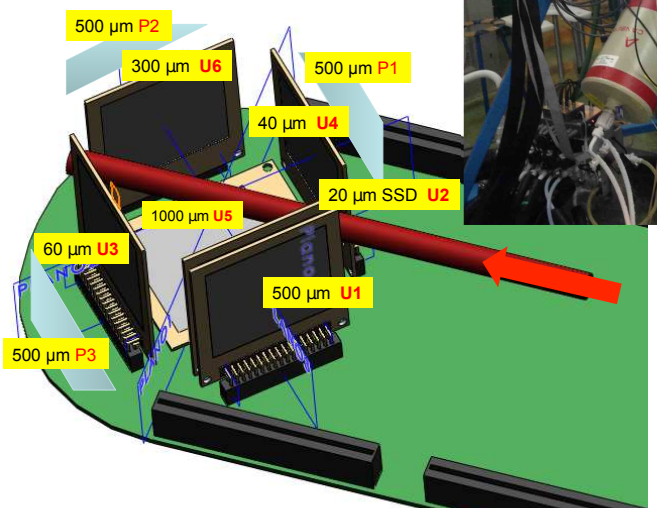


Hot CNO breakout: ^{15}O$(\alpha,\gamma)^{19}$Ne$(p,\gamma)^{20}$Na

- ^{20}Mg$(\beta\gamma)^{20}$Na - Absolute normalisation
- ^{20}Mg$(\beta p\gamma)^{19}$Ne
- ^{20}Mg$(\beta p\alpha)^{15}$O
- ^{20}Mg$(\beta\alpha p)^{15}$O

The setup @ IDS



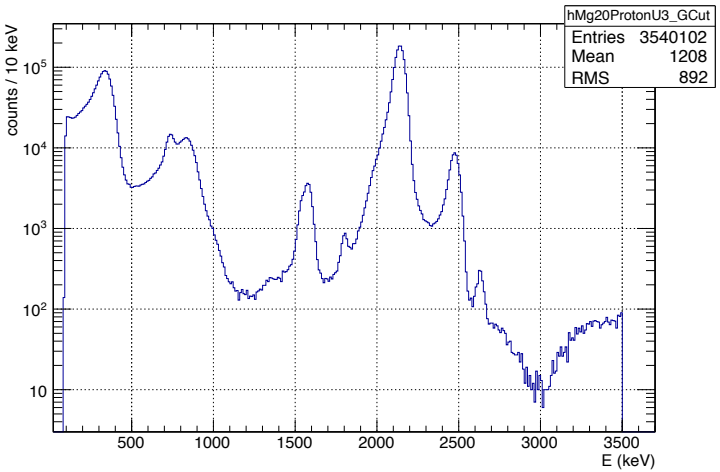


Beam @ target (70% transmission):

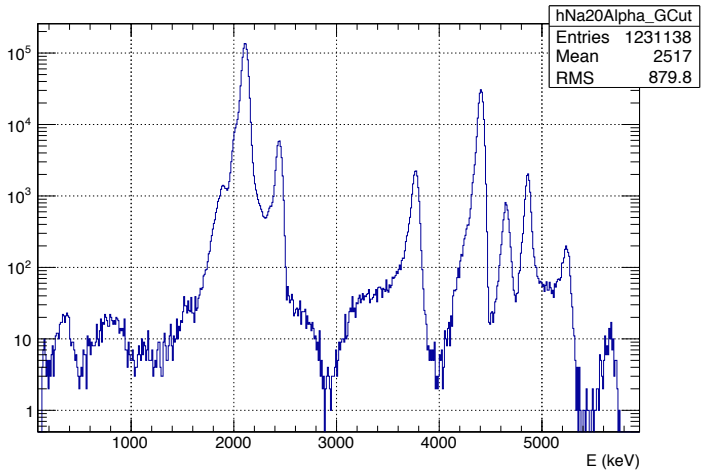
- ^{20}Mg: $I = 60$ Hz (p's from ^{20}Mg(βp))
- ^{20}Na: $I = 500$ Hz (α's from ^{20}Na($\beta\alpha$))

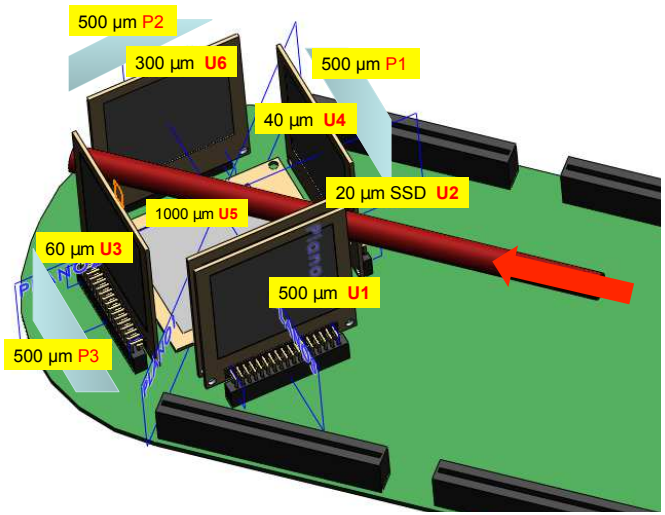
Particle identification

ΔE:



ΔE (Coincidence with ^{16}O):





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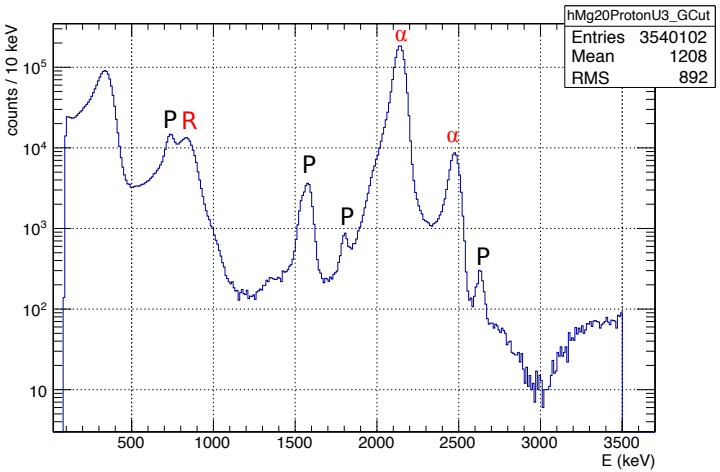

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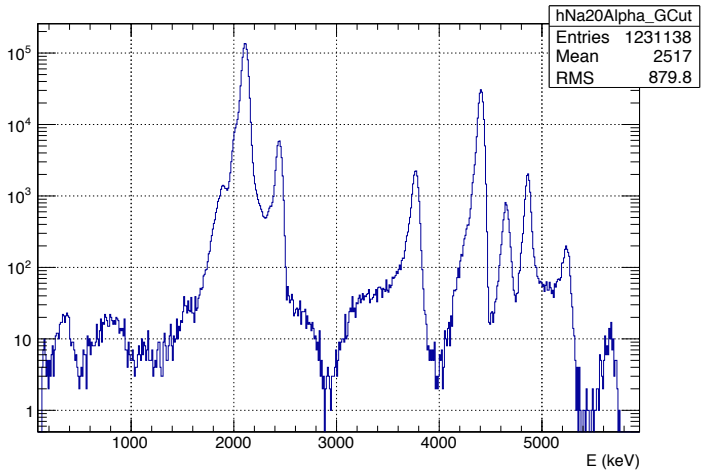

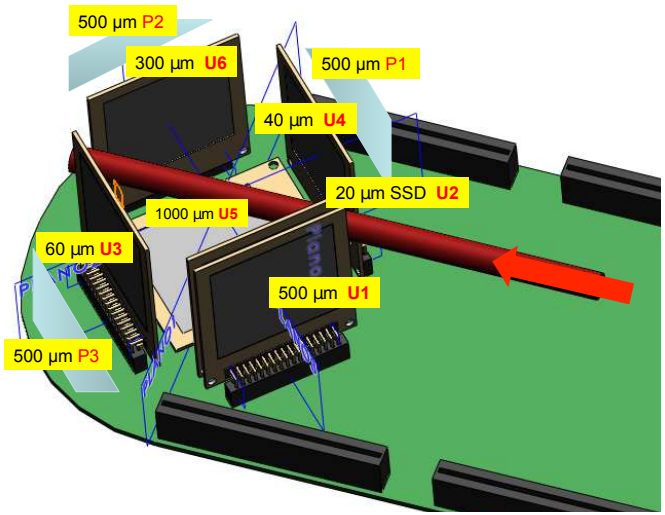

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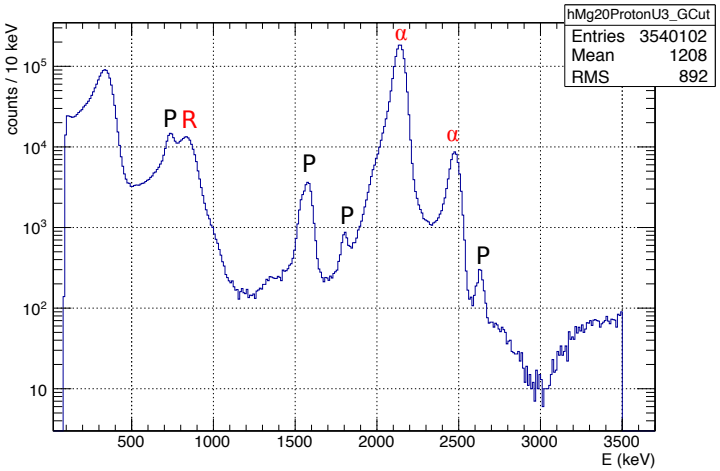

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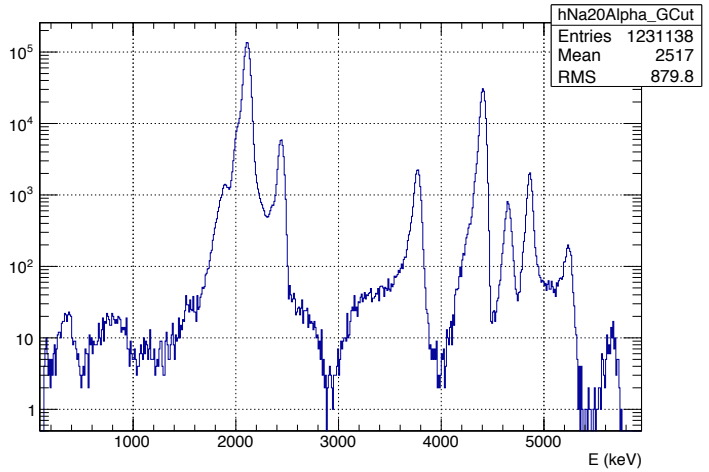
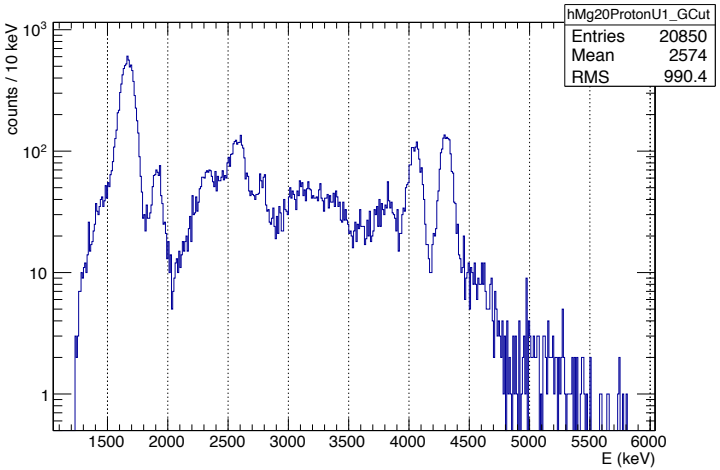
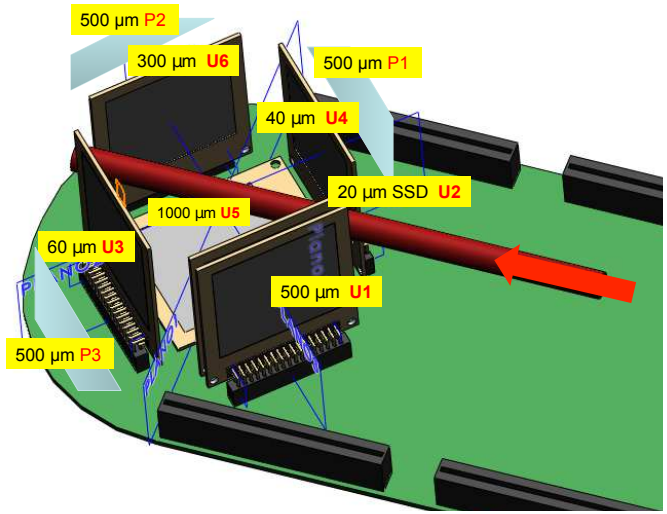


$\Delta E + E$ for $E > 0$ (p):





$p - \gamma$ coincidences

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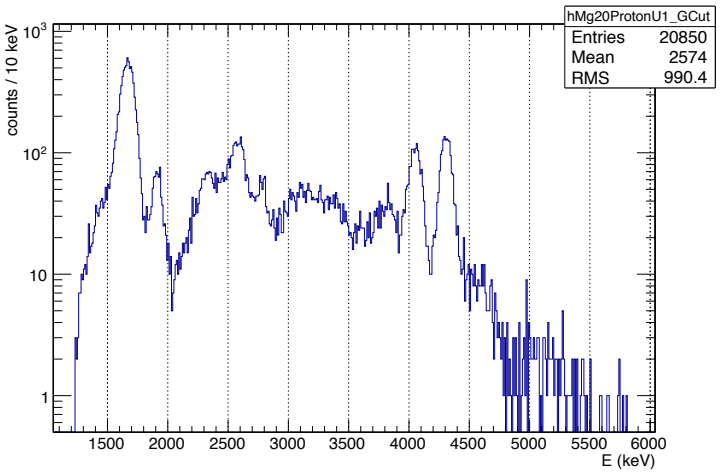

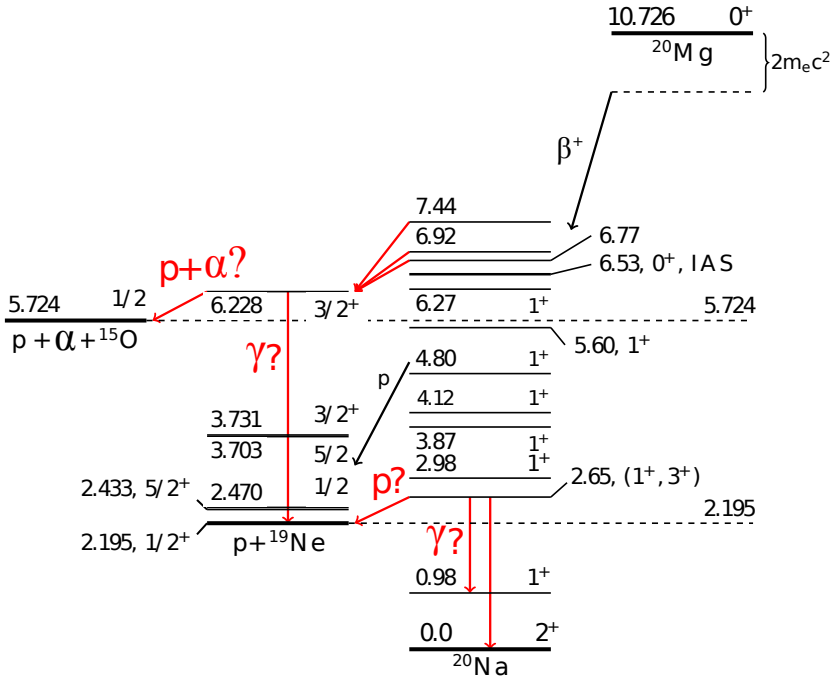

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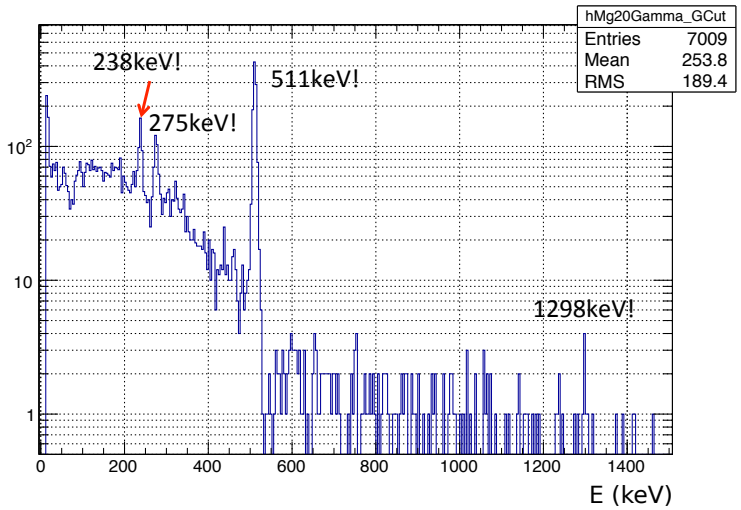
p-gated γ:



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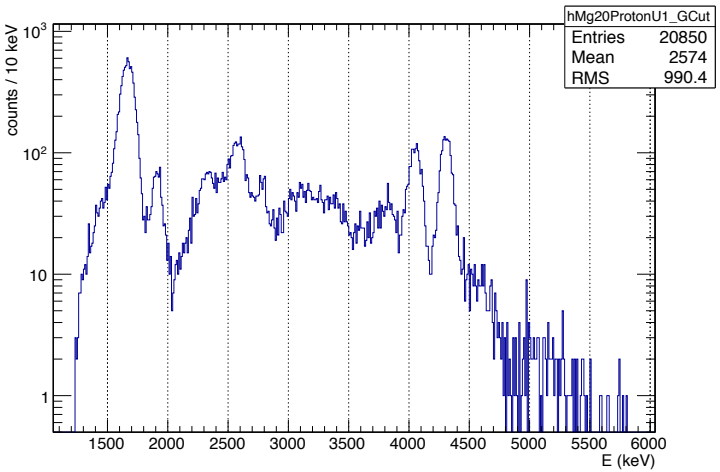
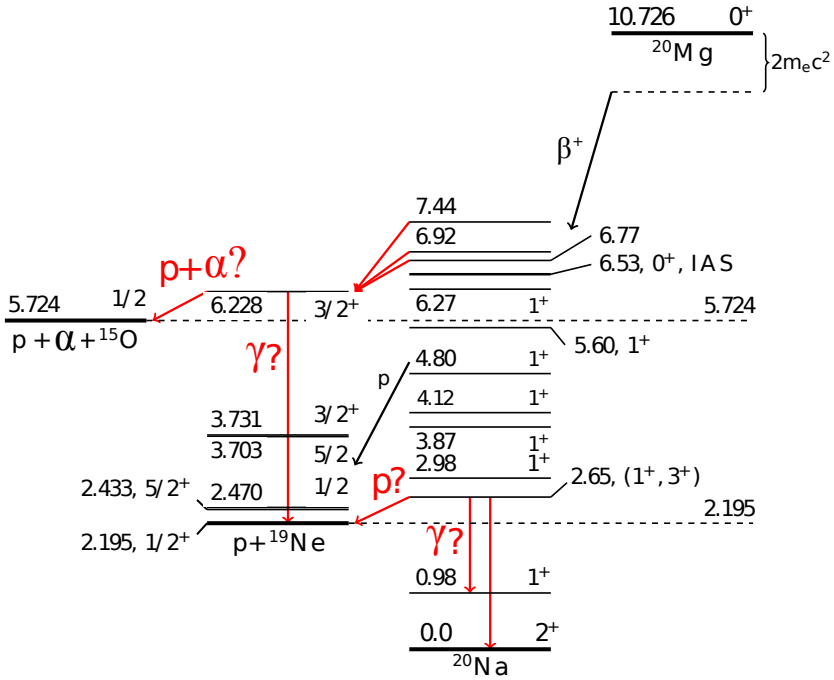
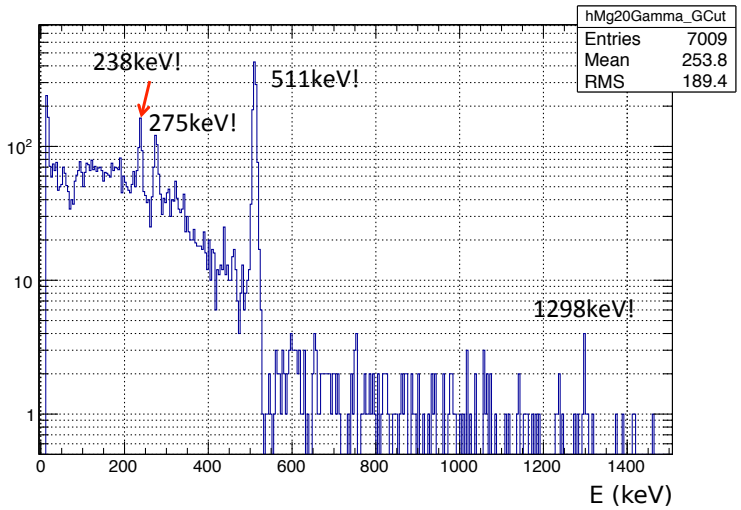


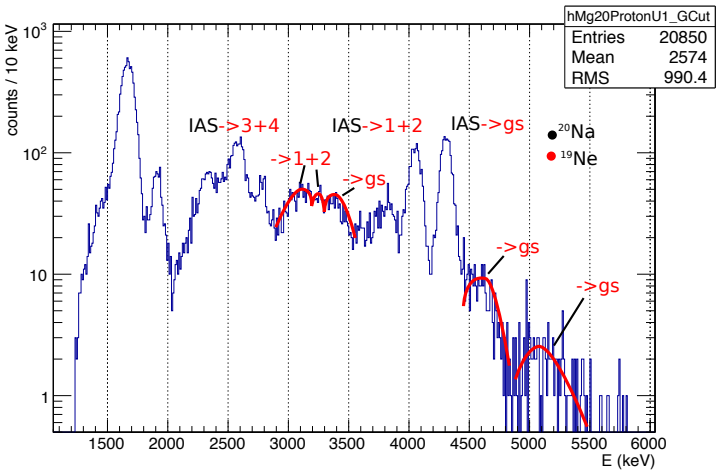


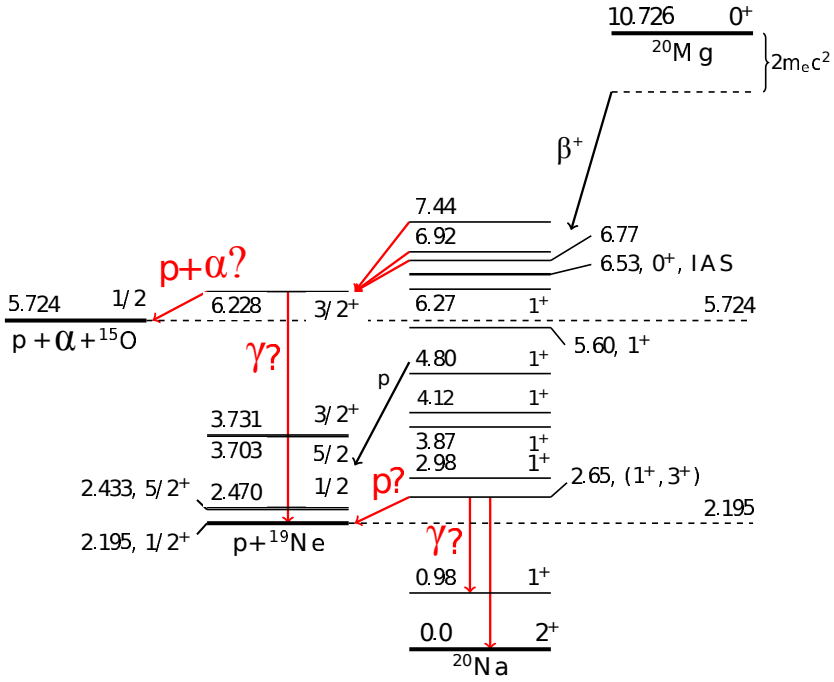
$p - \gamma$ coincidences

p-gated γ:



$\Delta E + E$ for $E > 0$ (p):

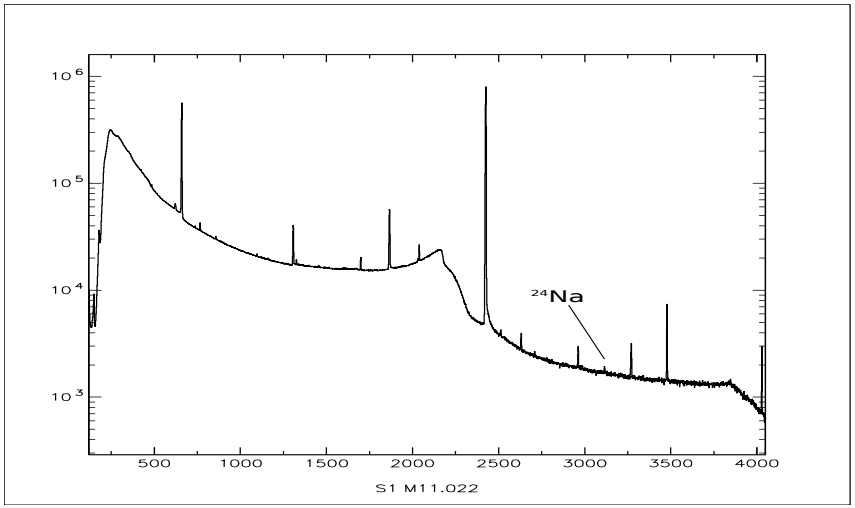




One more isotope for the coffee

One more isotope for the coffee - ^{24}Na

γ-spectrum (beginning IS541):



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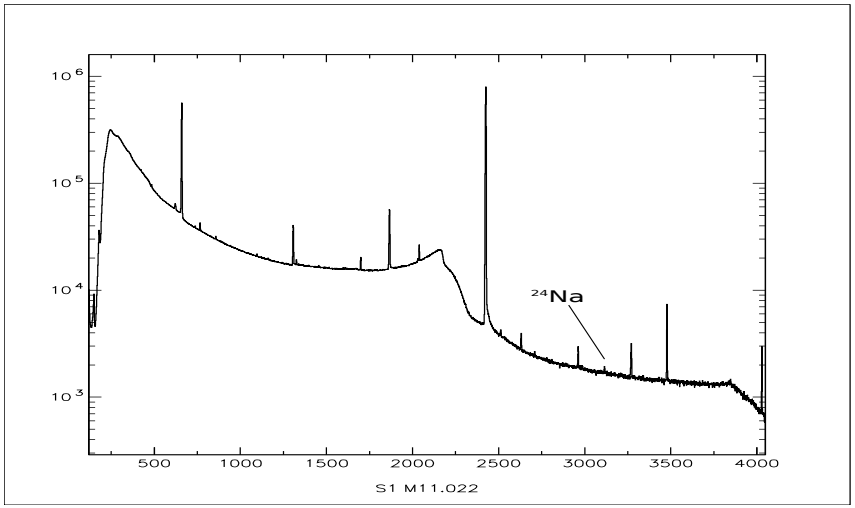
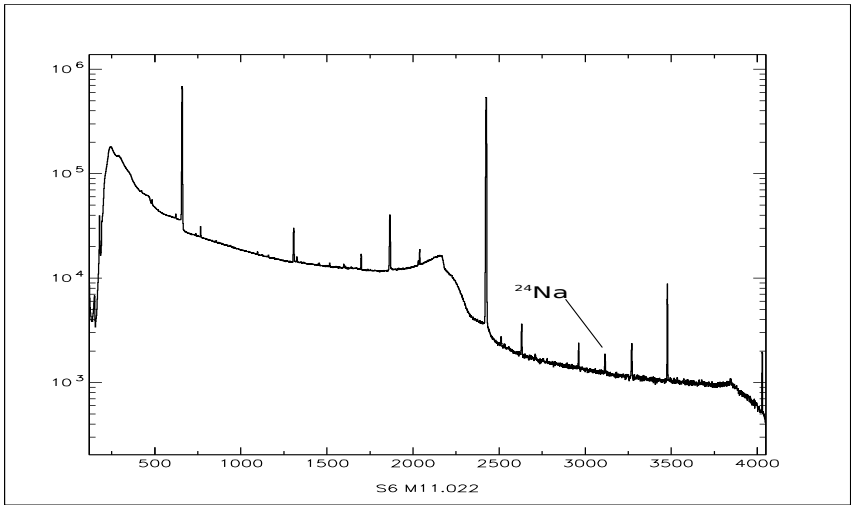
γ-spectrum (beginning IS541):

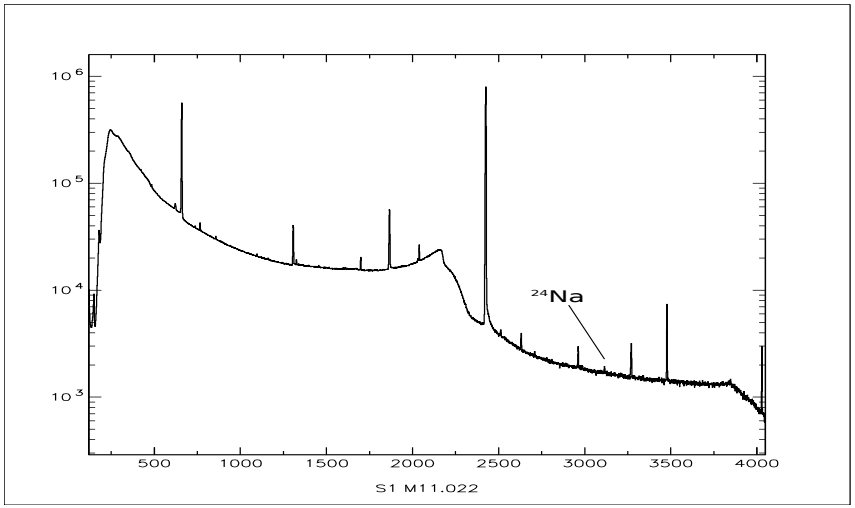


γ-spectrum (end IS541):

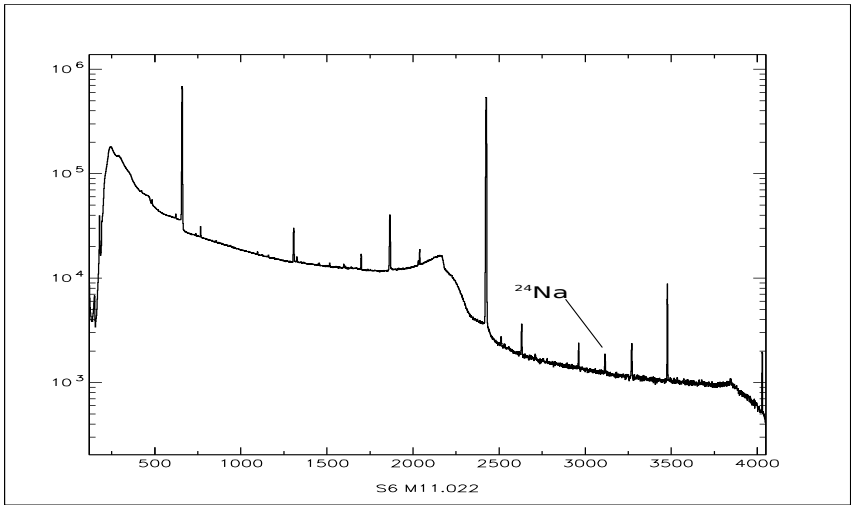


One more isotope for the coffee - ^{24}Na ($T_{1/2} = 15$h)

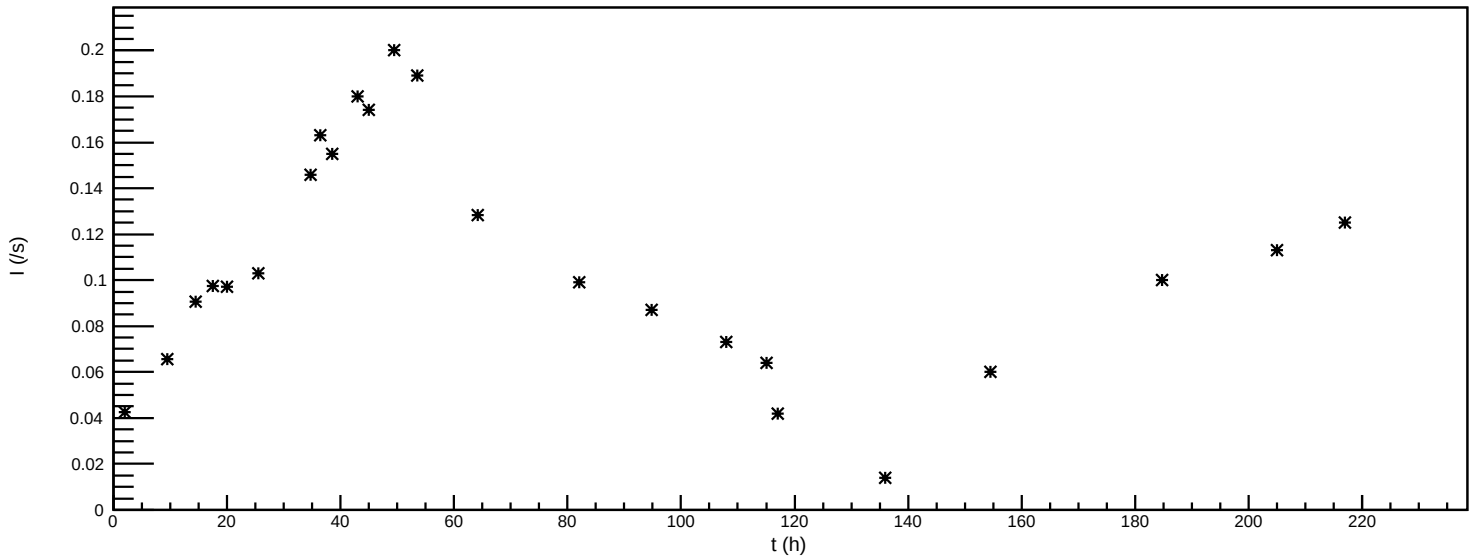
γ-spectrum (beginning IS541):



γ-spectrum (end IS541):



$I_{2754\text{keV}}$ ($I_{^{24}\text{Na}}$) throughout and after the experiment:



Summary

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- $N_{^{11}\mathrm{Be}}$ determined
- Mass scan around $M = 11.022$
- Efficiency and deadtime determined

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- States in ^{20}Na identified
- Two new states discovered
- log ft-values determined

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Thank you:
Karsten Riisager, Morten Vinther Lund
and the IS541 and IS507 collaborations

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Thank you for your attention