Level densities from neutron-induced Evaporated charged particle spectra

Workshop on Compound Nuclear Reactions 2024

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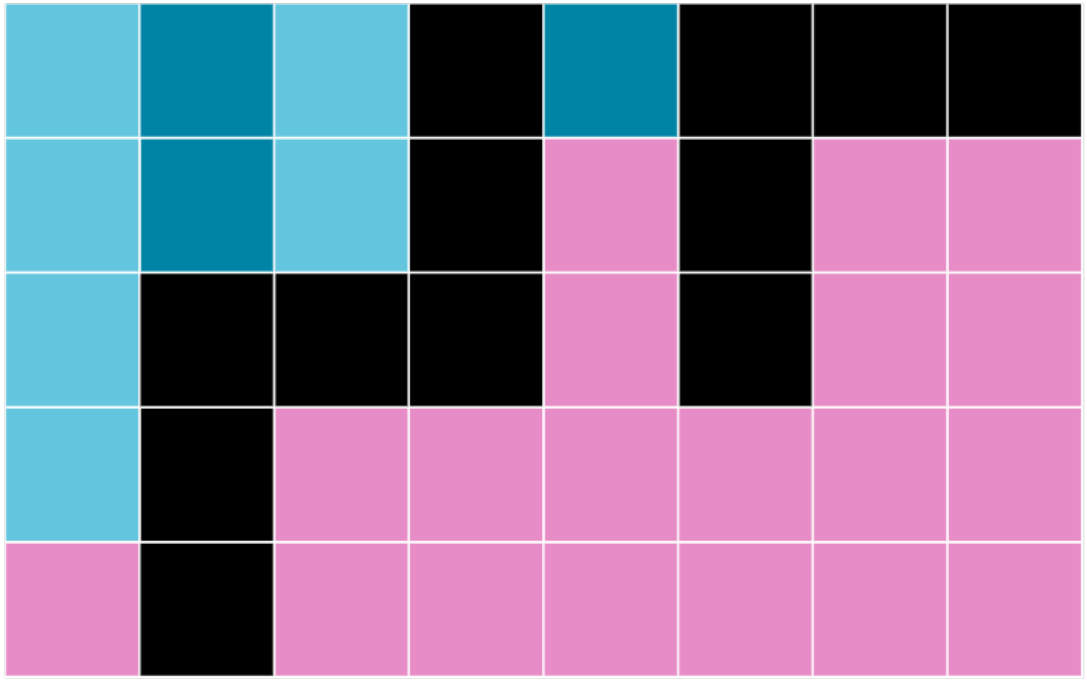
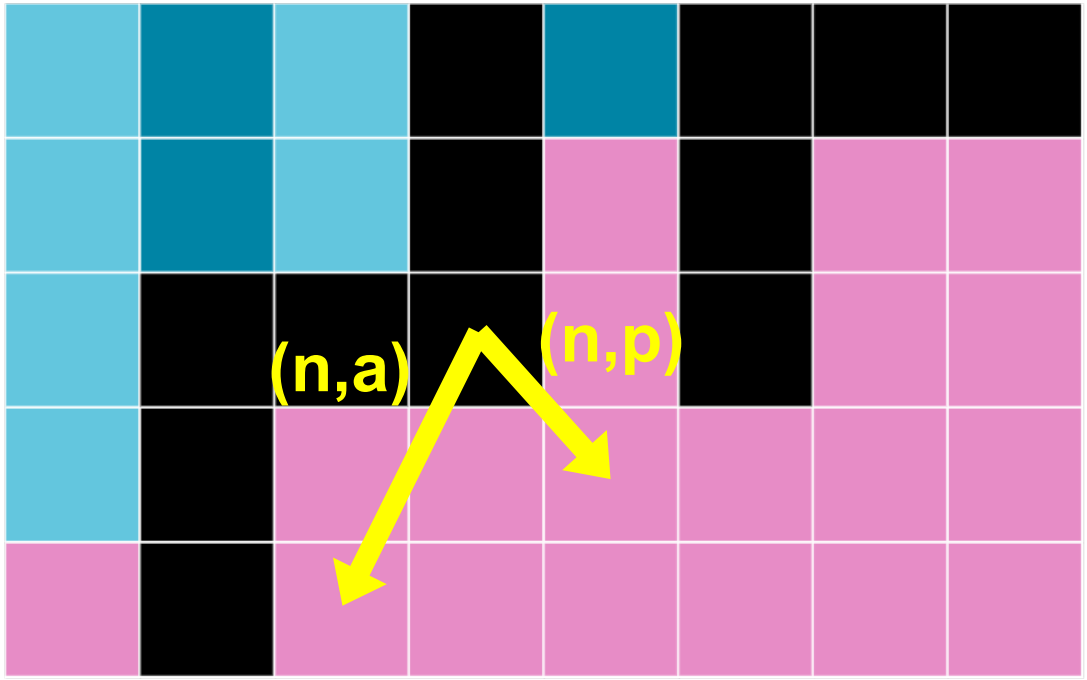
Vienna, July 10, 2024

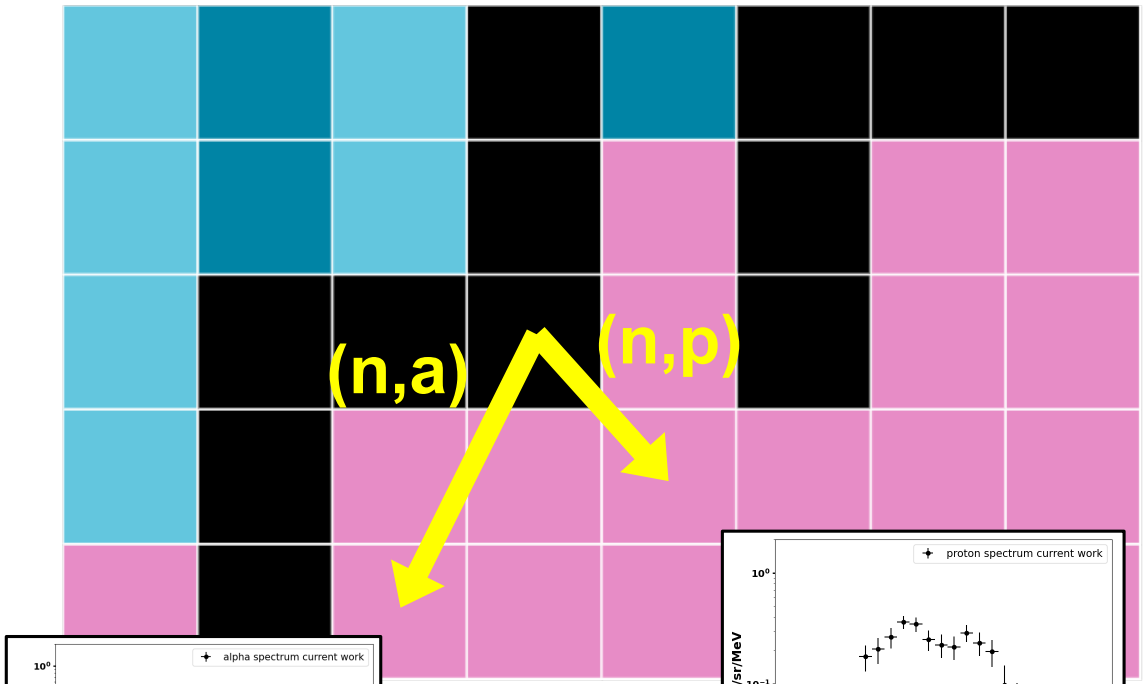
LNX works for unstable nuclei a few neutrons away from stability



LNX works for unstable nuclei a few neutrons away from stability



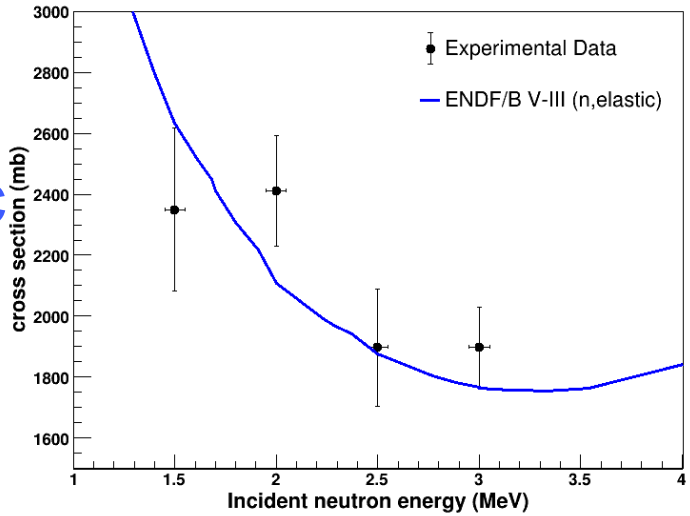
LNX works for unstable nuclei a few neutrons away from stability

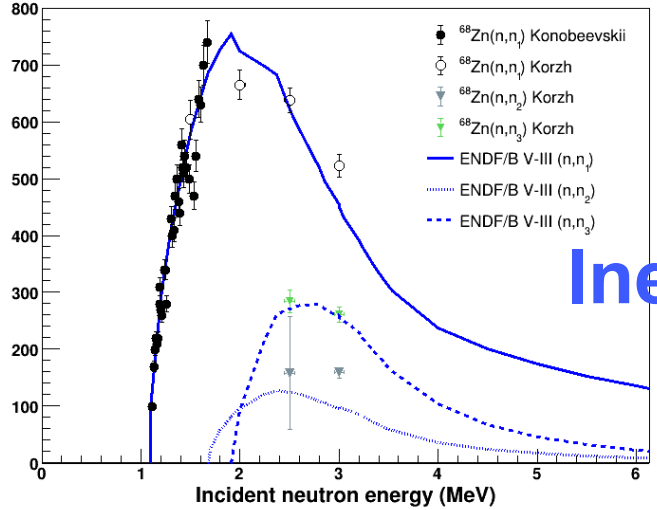


We use all available experimental information

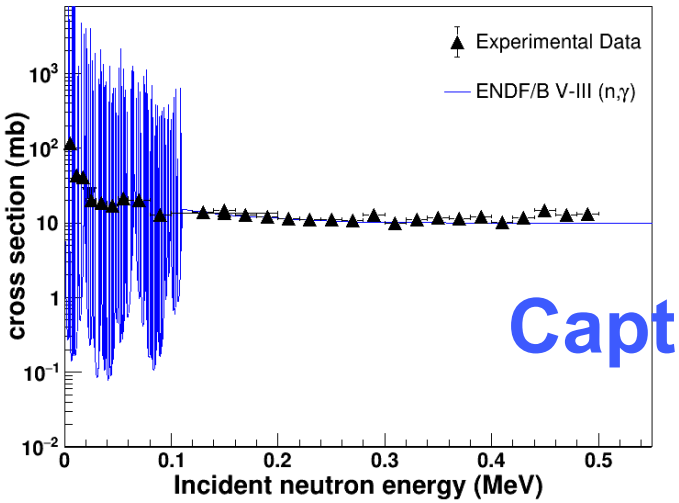
Thus constraining channel competition and compound formation

Elastic





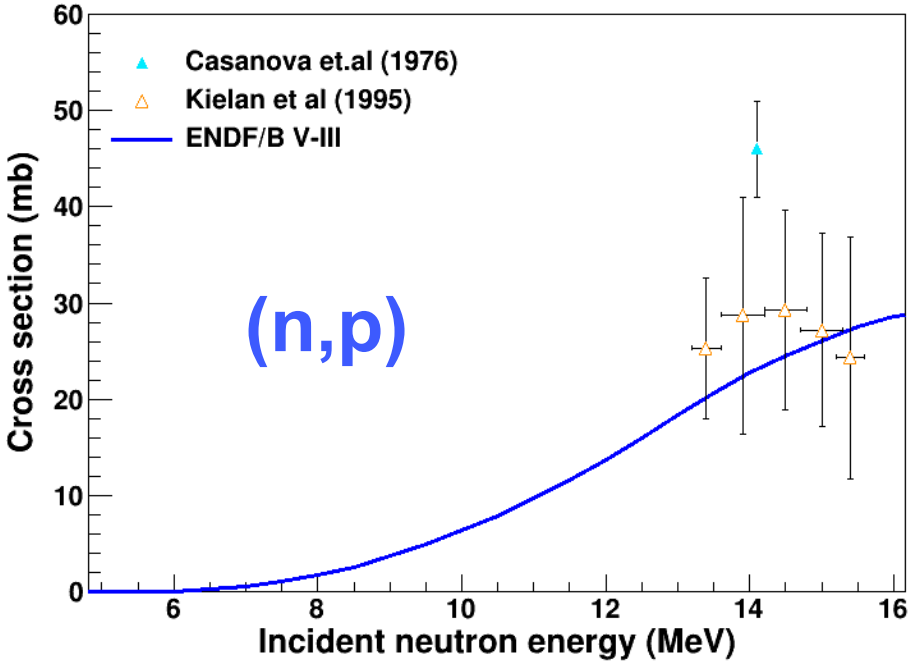
Inelastic

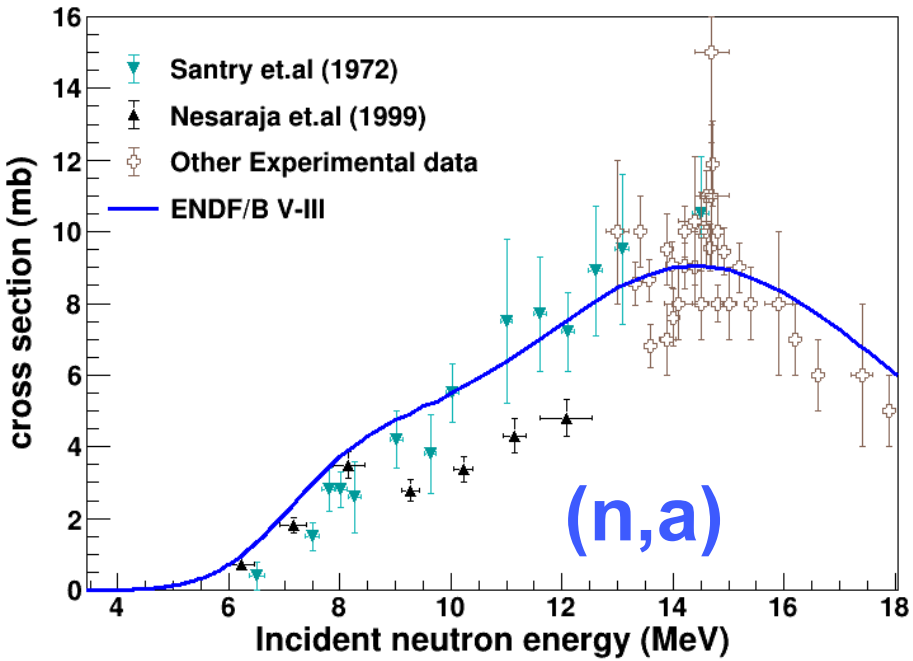


Capture

How does it work:

The case of ^{68}Zn(n,p)^{68}Cu and ^{68}Zn(n,a)^{65}Ni reactions

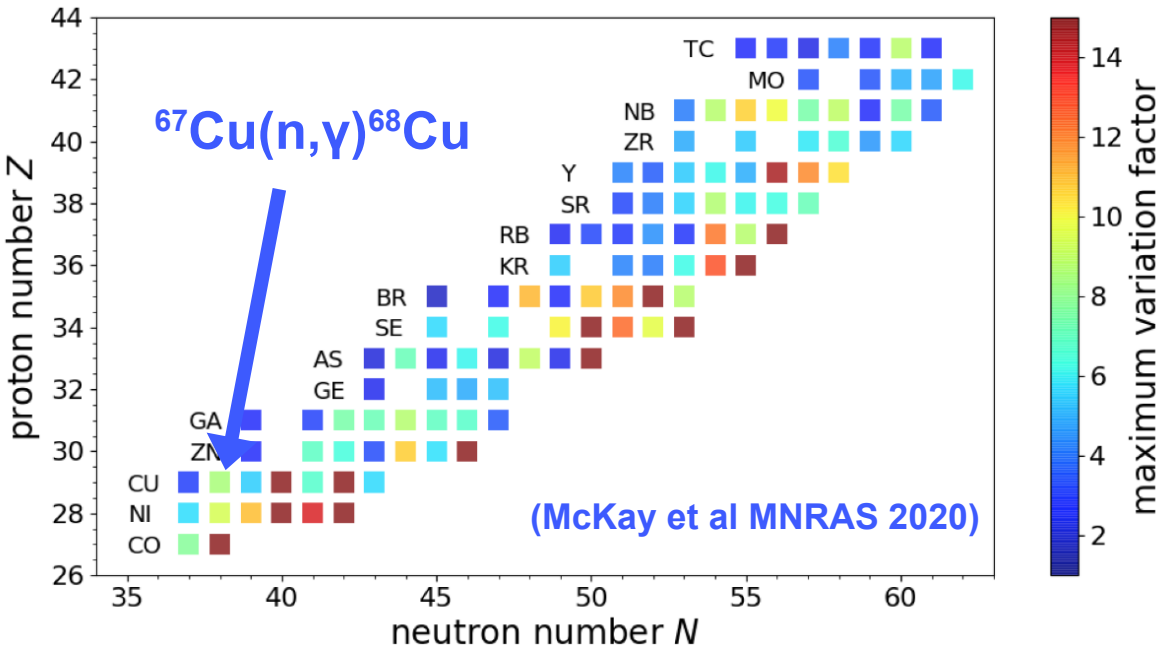




Current data status

^{68}Cu, ^{65}Ni, and related neutron captures in astrophysics

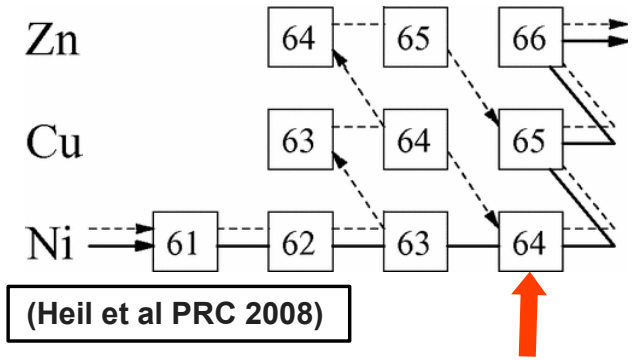
^{68}Cu i-process



neutron capture rate uncertainties for i-process

^{65}Ni s-process

neutron captures along the path of the weak s-process



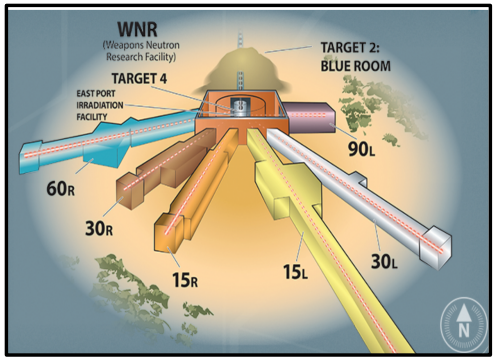
(Heil et al PRC 2008)

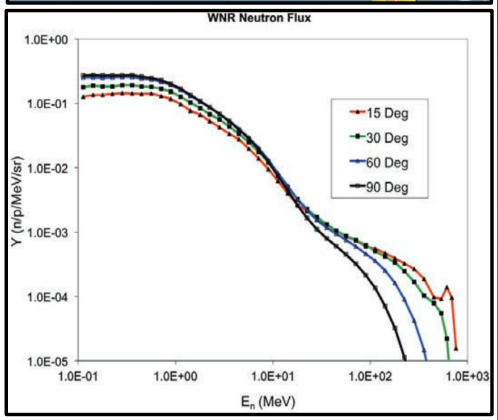
^{64}Ni(n,γ)^{65}Ni

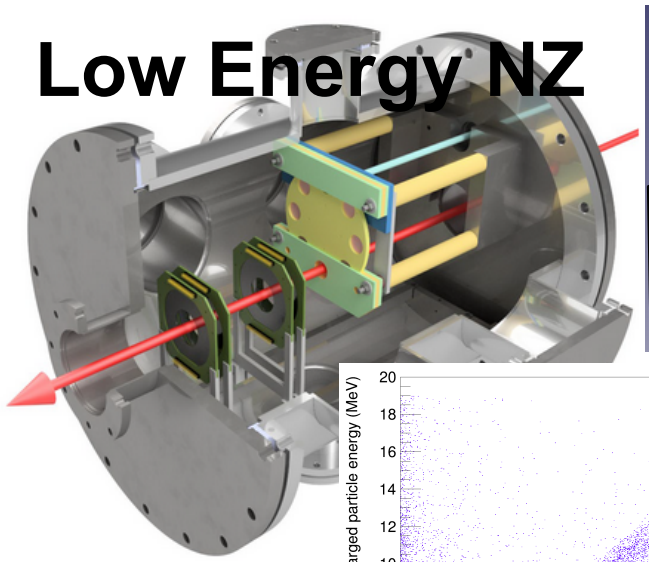
Measurements:
Heil et al PRC 2008,
Domingo-Pardo et al AIP Conf 2009

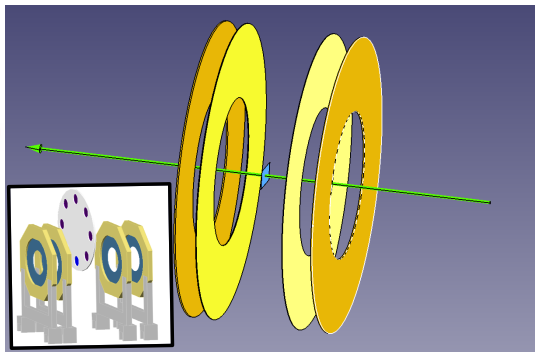
Experimental setup @ LANL

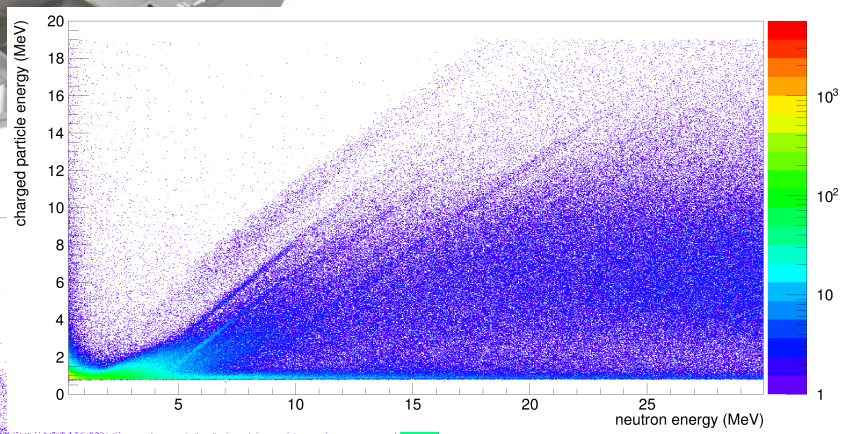
(talks by H.Y. Lee, T. Stamatopoulos on Monday)

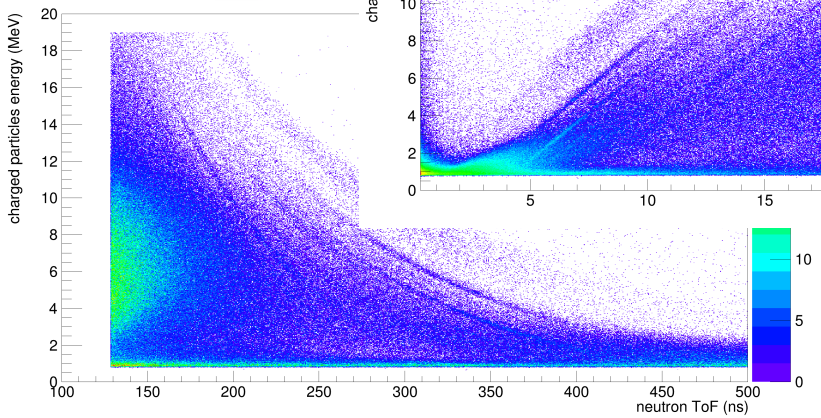






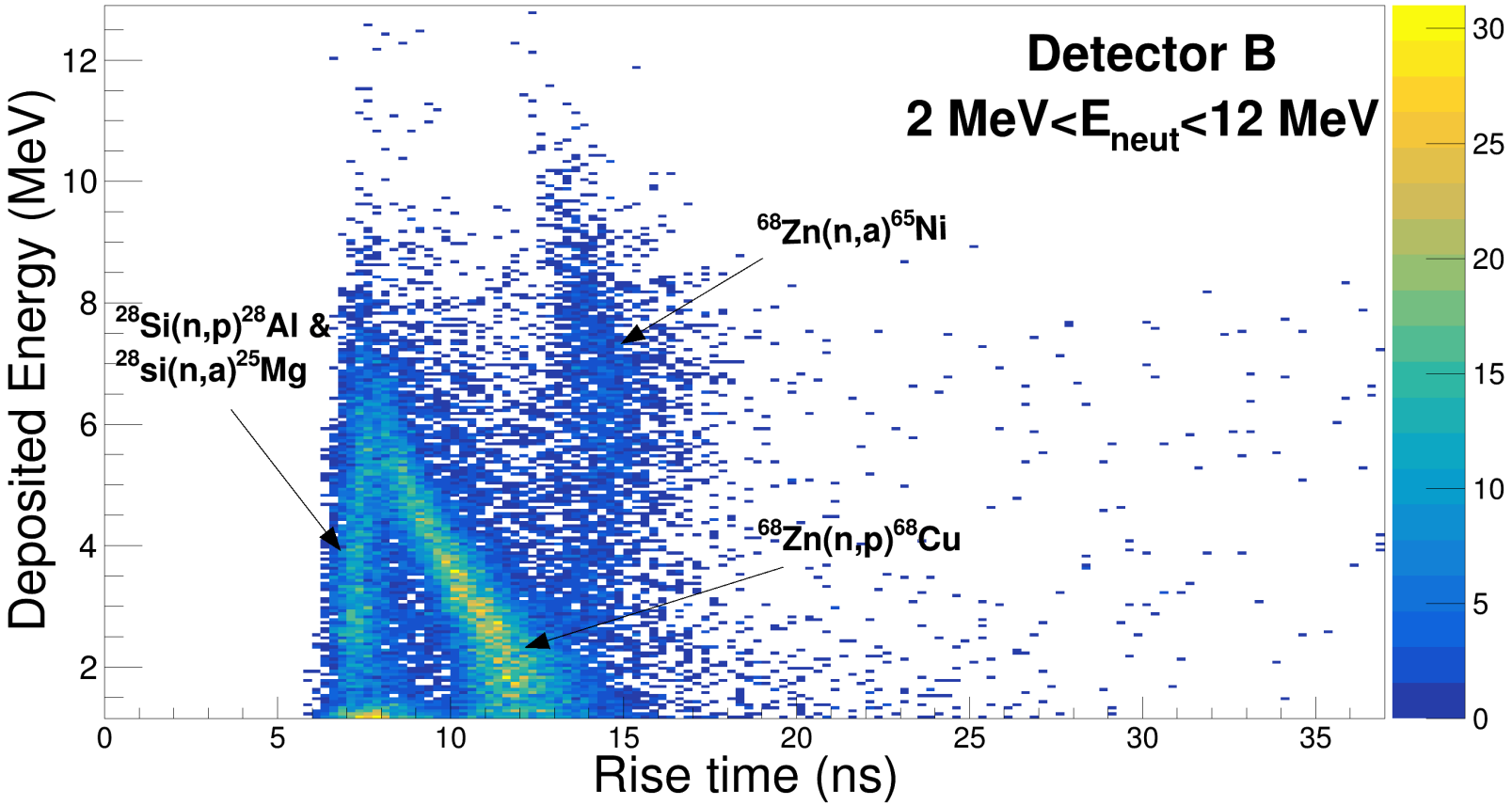






Analyzing particle spectra

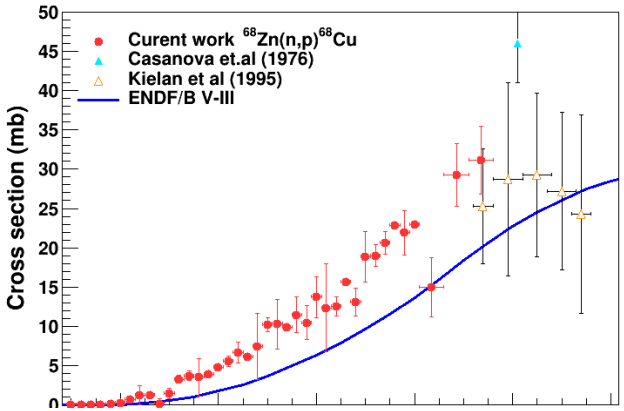
proton / alpha discrimination using pulse shape analysis on LENZ

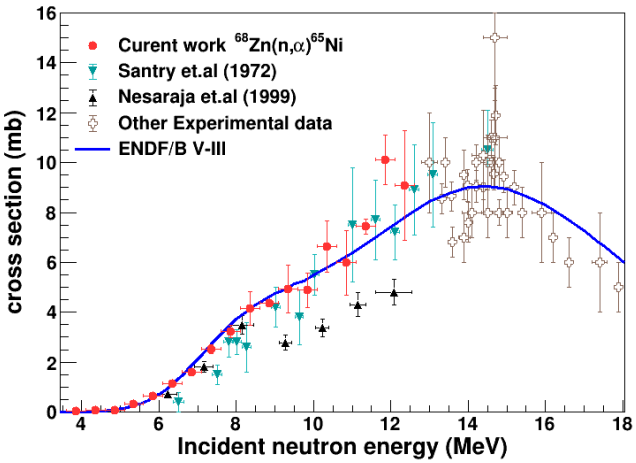


Data analysis results

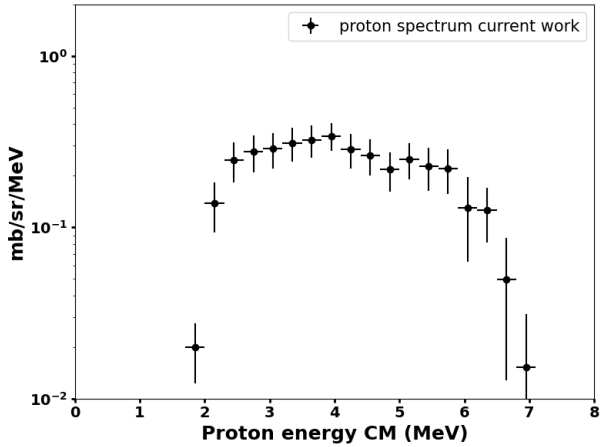
Total particle yields and Evaporation yields

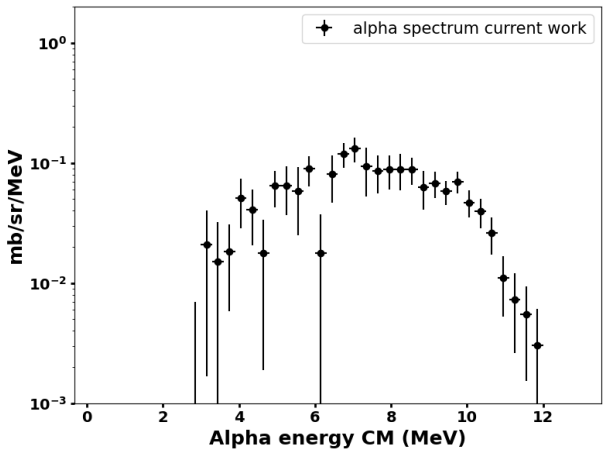
Cross-sections





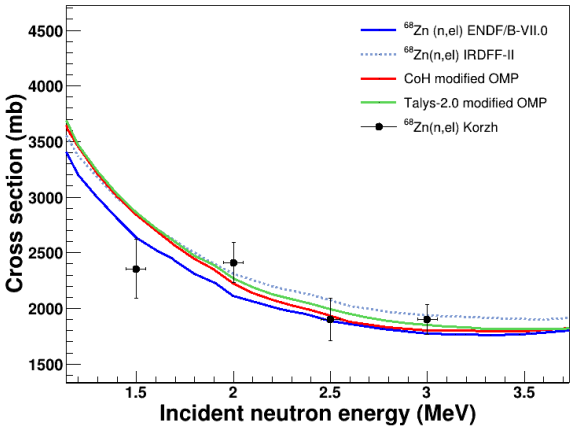
Evaporated particle spectra

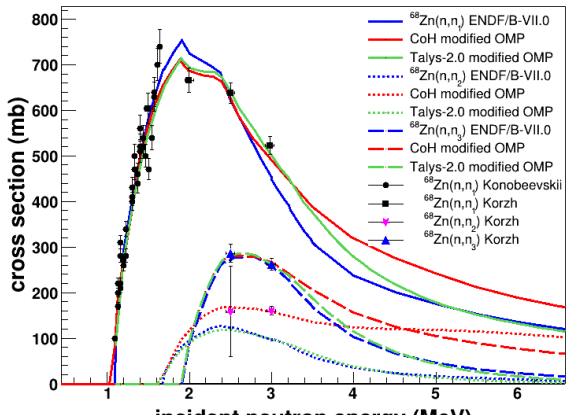


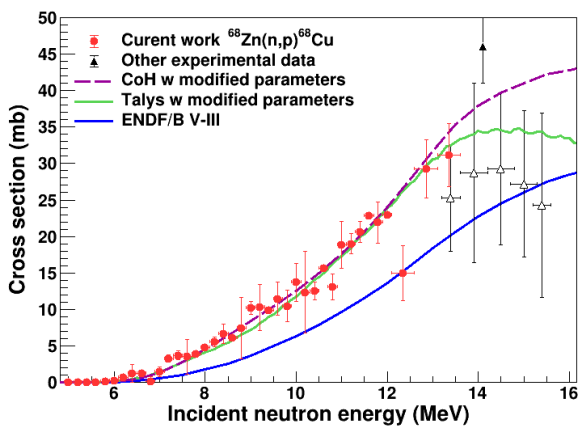


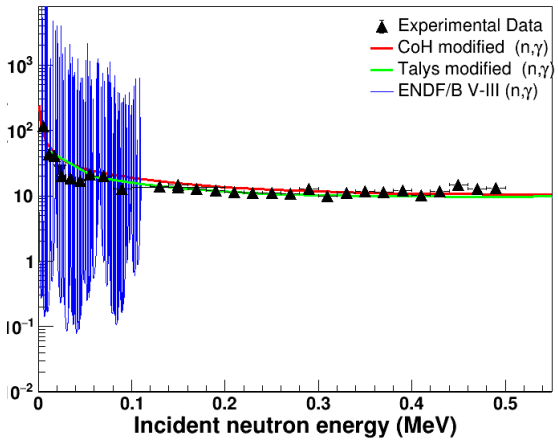
Extracting level densities

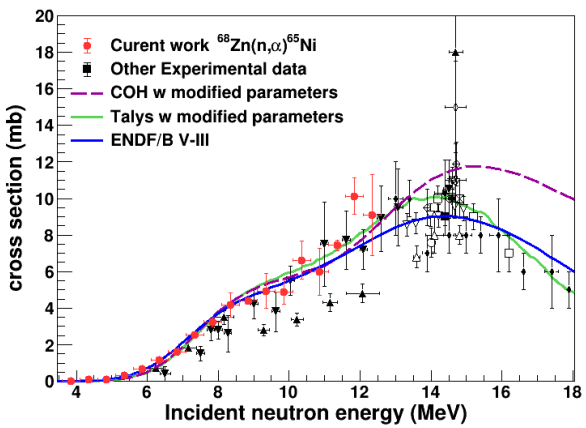
Step 1: Constraining Hauser-Feshbach model parameters with data





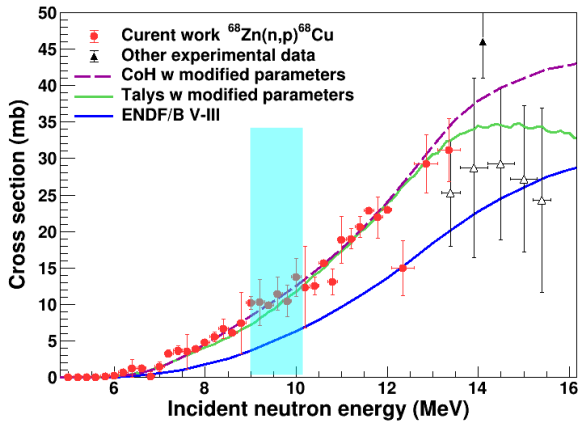


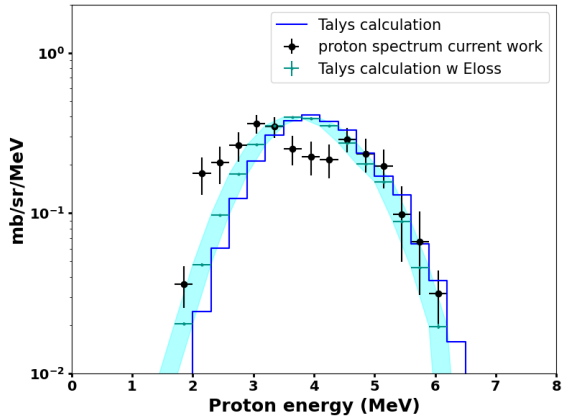


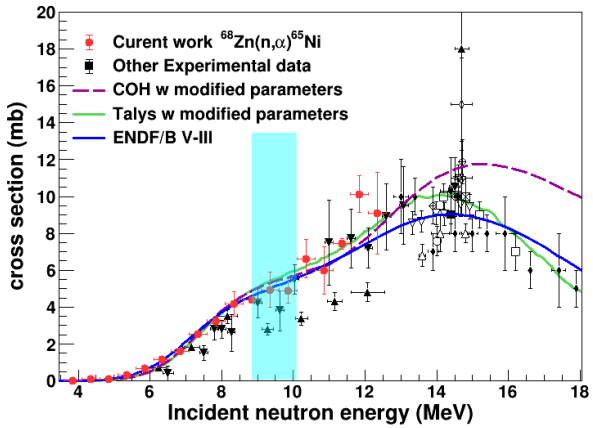


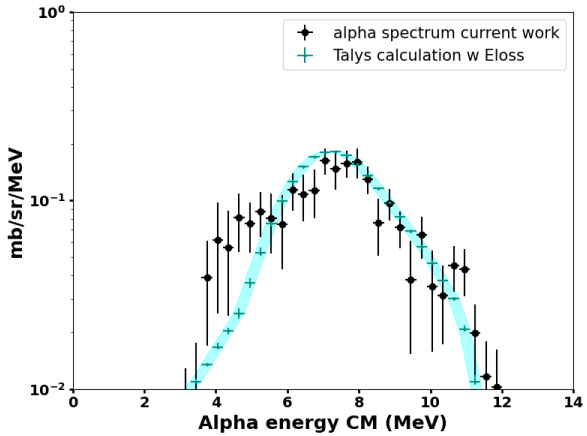
Extracting level densities

Step 2: Generating theoretical evaporated particle spectra that agree with our experiment



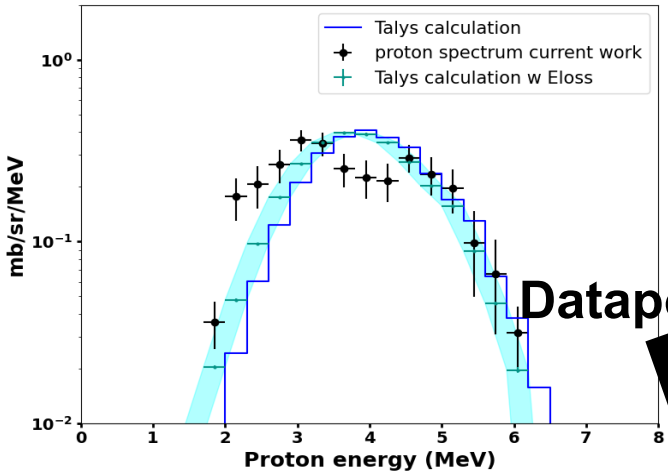






Extracting level densities

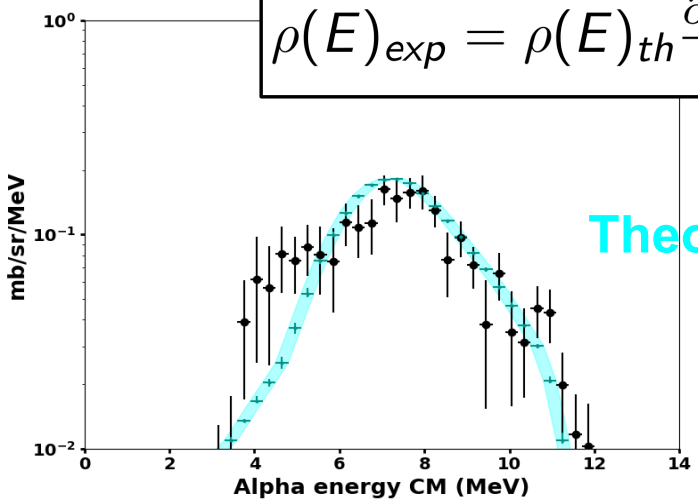
Step 3: Get the details of the level density shape by renormalizing the theoretical (energy-averaged) shape to the spectra

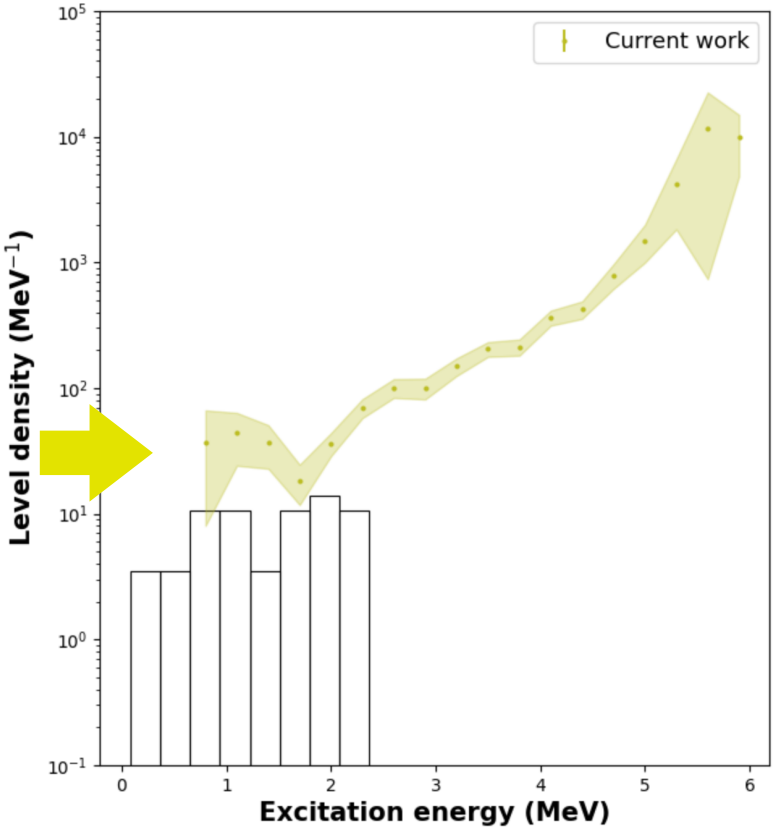


Datapoints

$$\rho(E)_{exp} = \rho(E)_{th} \frac{\partial\sigma(E)_{exp}}{\partial E \partial\Omega} / \frac{\partial\sigma(E)_{th}}{\partial E \partial\Omega}$$

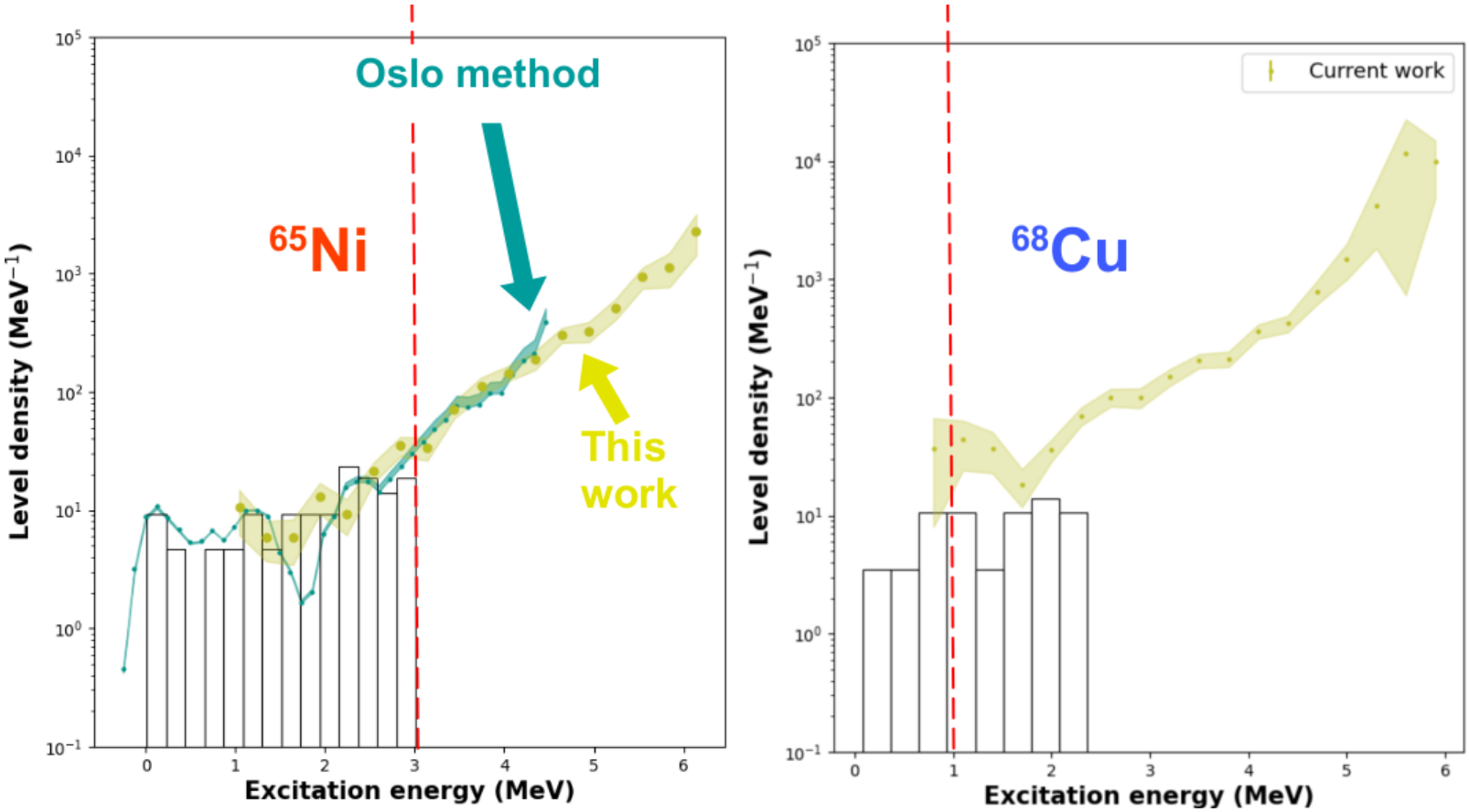
Theoretical fit





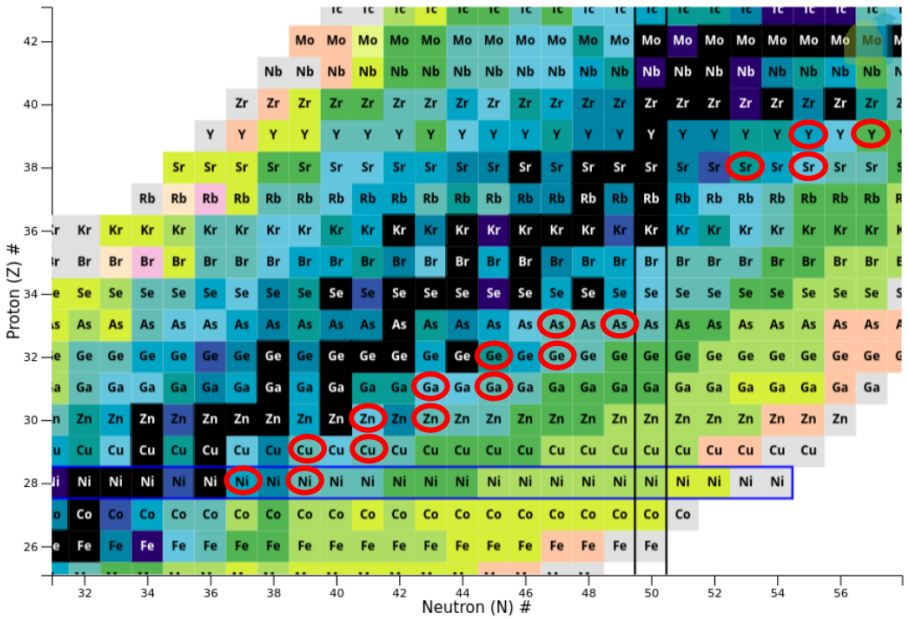
Preliminary results

Does it work?



Some final thoughts...

- LNX can map neutron rich side of the chart a few n away from stable
- No need for resonance spacing data or discrete levels to normalize
- Experimental limits in Z,A $\rightarrow$ to be determined
- Combine with other techniques (e.g. Oslo) $\rightarrow$ robust gamma strength
- work on detector setup optimization



LNX