Theoretical predictions for radiative capture cross-sections of interest for astrophysics in the fast neutron region

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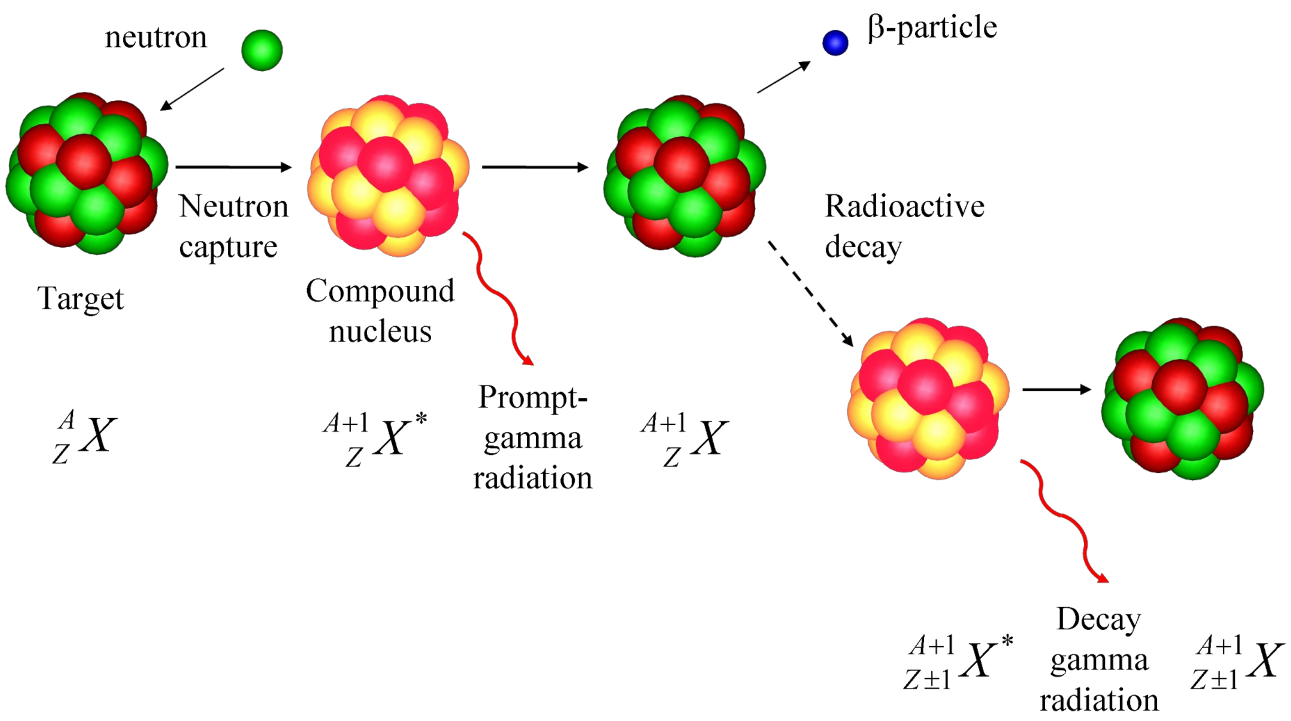
Importance and motivation

- Radiative neutron capture – very important for different fields (incl. astrophysics).
- A key role in nucleosynthesis; thousands of nuclei involved!
- Most of these nuclei are unstable => no experimental data available => we need theoretical predictions!



Importance and motivation

- Astrophysics = massive calculations for nuclei far from stability valley => simplified reaction models and microscopic inputs are used.
- Microscopically-calculated quantities have a sound physical support, but aren’t very accurate => normalization to exp. data is required.
- Lack of exp. data => high uncertainties of astrophysical data.

Goal

What do we want?

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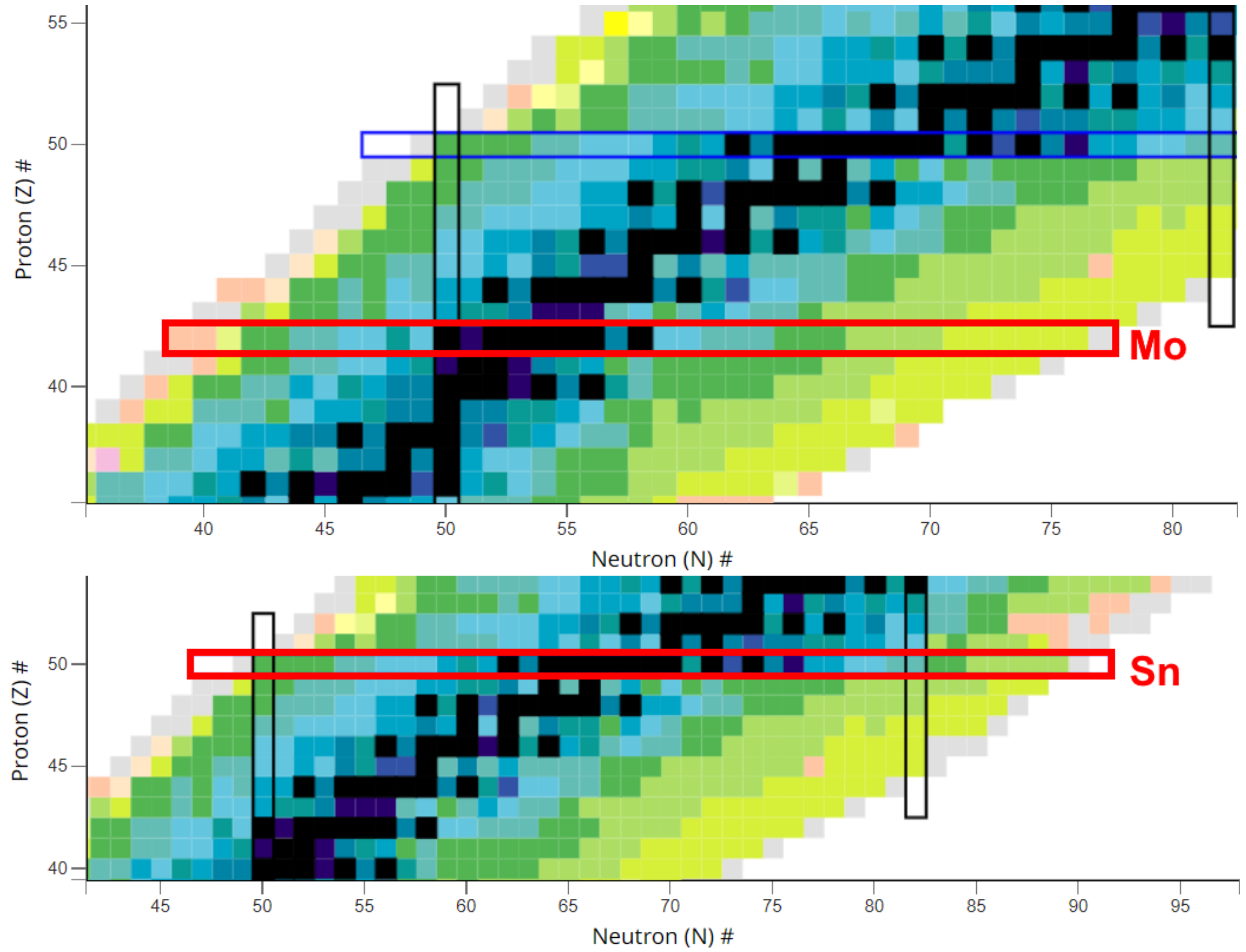
To see if we can employ reaction models with empirical parameters in codes (EMPIRE, TALYS) in order to estimate reaction cross sections of unstable isotopes at energies above the resonance region

Work description

- Providing a description for cross sections of neutron-induced reactions on Mo (A = [83 – 115]) and Sn (A = [99 – 139]); E up to 20 MeV



Work description

Why these isotopic chains?

- Have medium mass
- One has magic Z, the other doesn't
- The most stable isotopes in their chains
- Is used in various astrophysics studies

- Comparing results with evaluations from major libraries & exp. data
- Analysis of input parameter & cross sections behavior

Work description

Occurring reaction mechanisms:

- direct interaction
- formation and disintegration of the compound nucleus
- preequilibrium emission

Corresponding models used for calculations:

- spherical optical model
- Hauser-Feshbach with width fluctuations (HRTW)
- exciton model

Other models used:

- EGSM (Enhanced Generalized Superfluid Model) – gives us level densities
- MLO1 (Modified Lorentzian 1) – gives us gamma strength functions

Work description

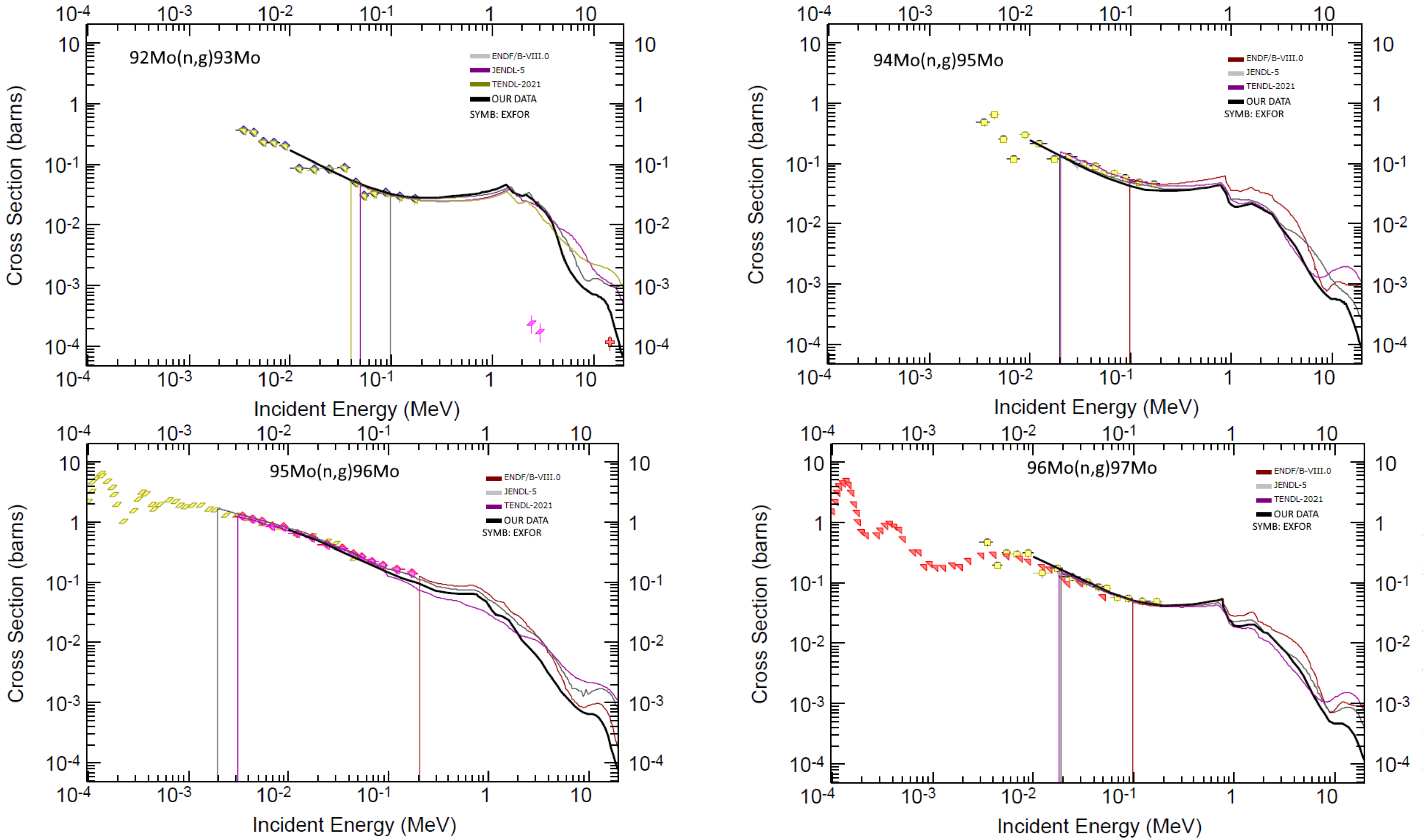
Analytical parameters:

- Spherical OMP
- masses
- Energies, widths and strengths of GDR and GQR

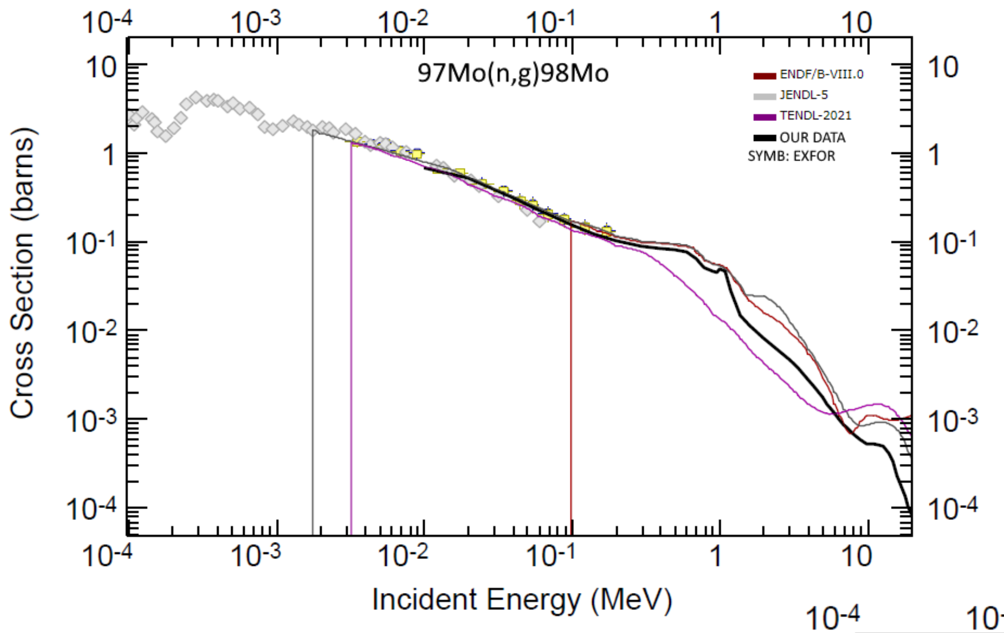
Experimentally-determined parameters:

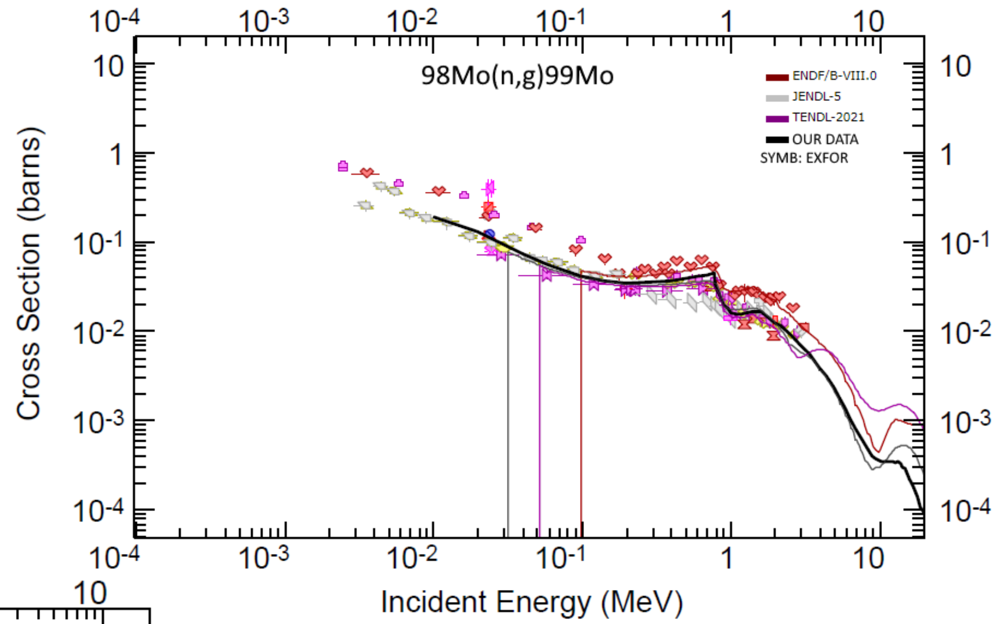
- Discrete level schemes
- Gamma and neutron strength functions
- Average level distance at neutron separation energy

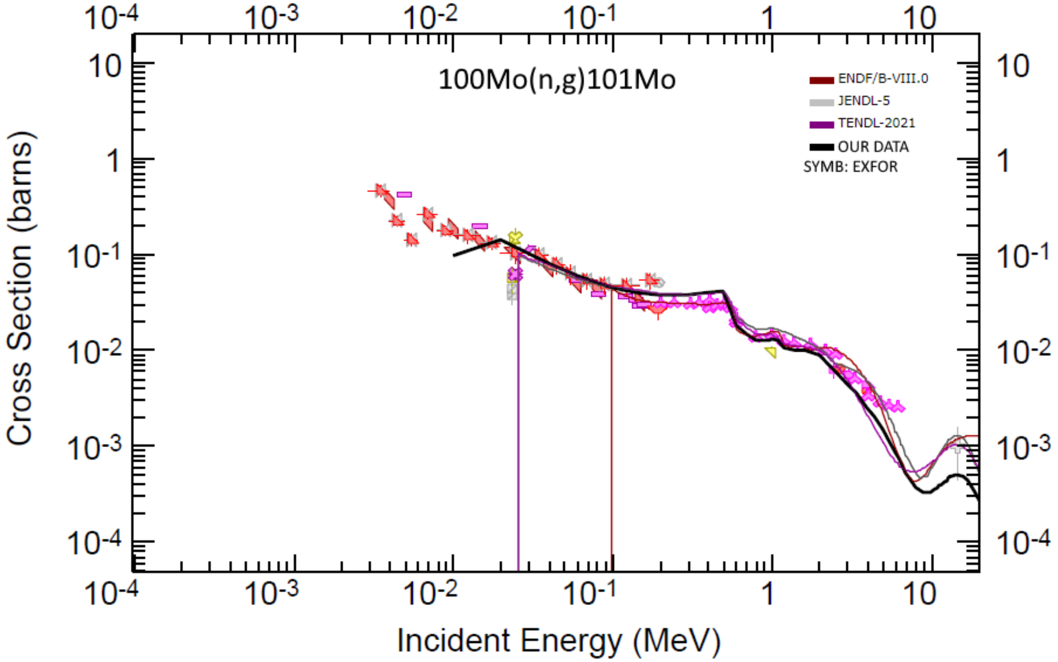
Results – Mo stable isotopes



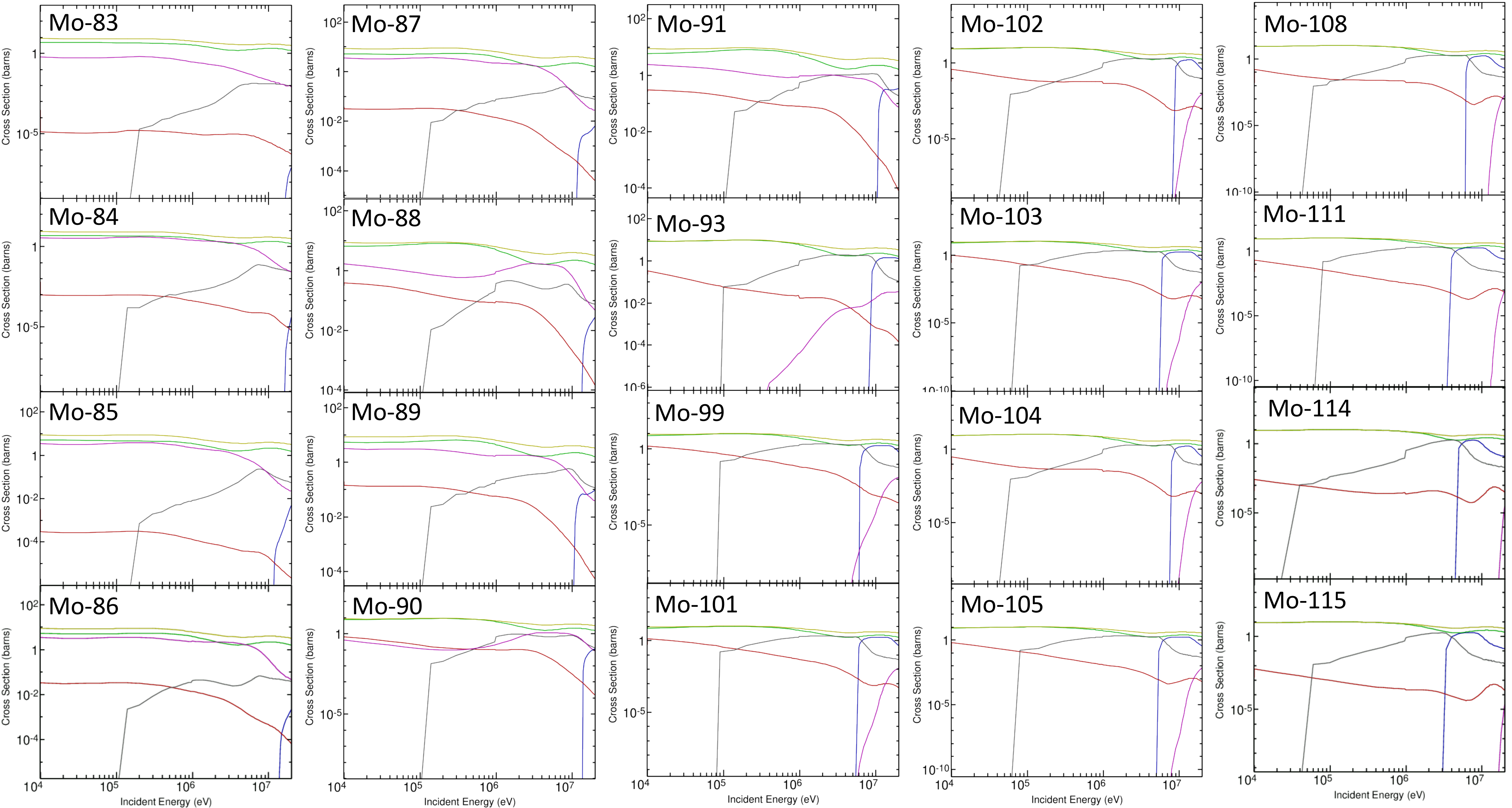
Results – Mo stable isotopes





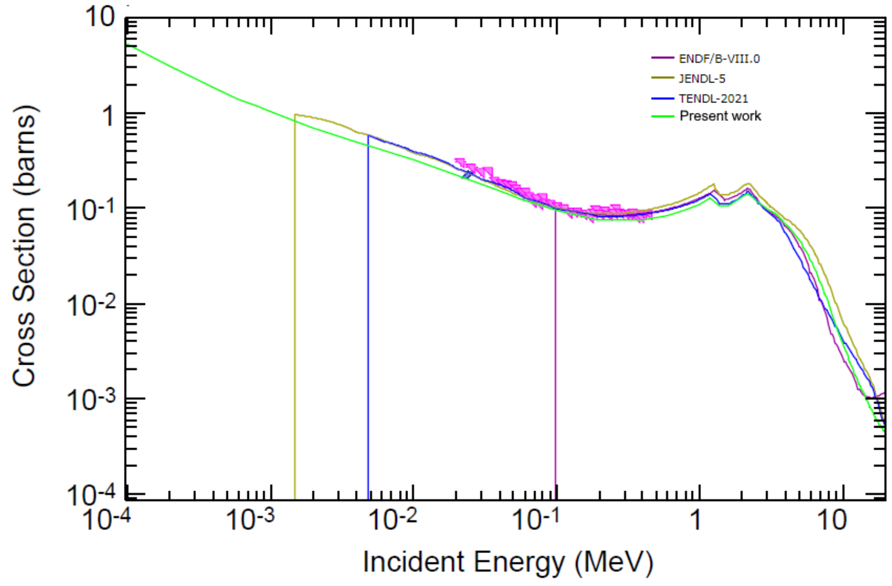


Results – Mo unstable isotopes

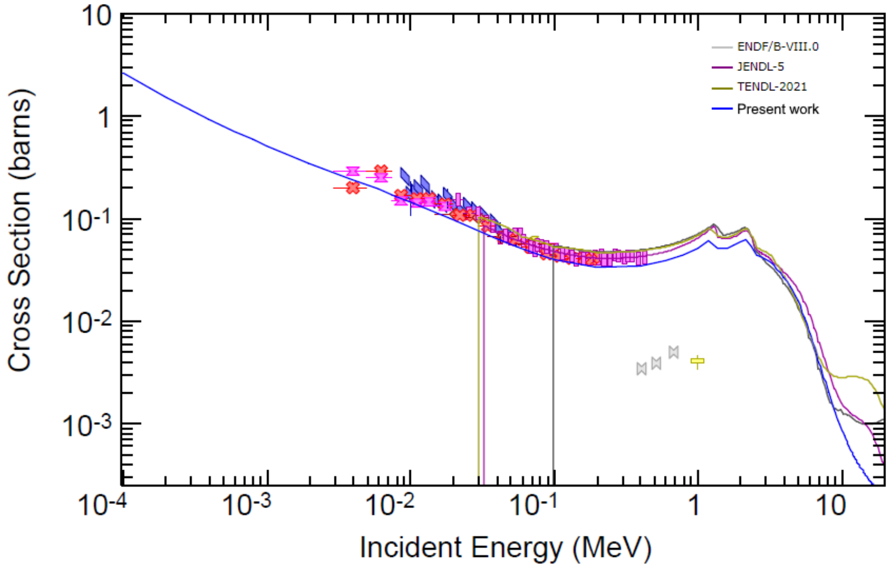


Results – Sn stable isotopes

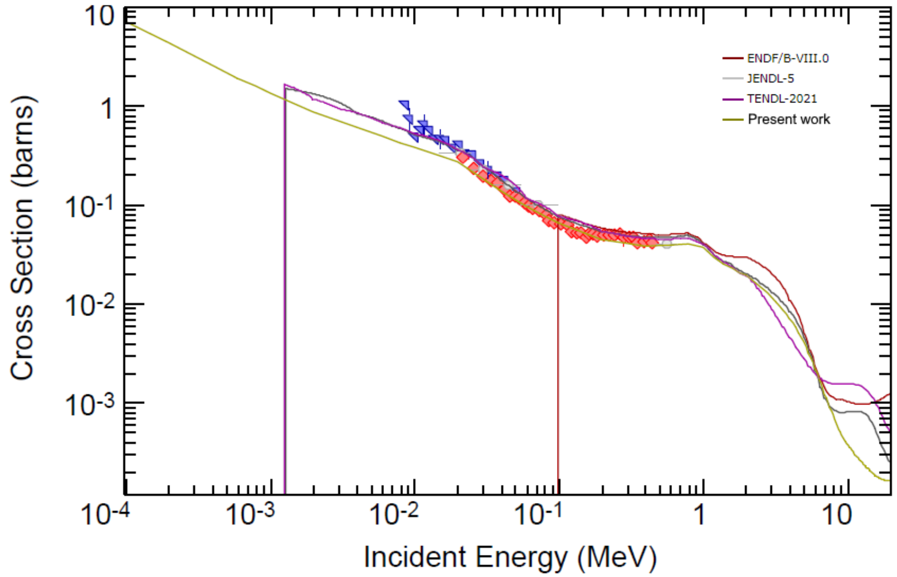
112Sn(n,g)113Sn



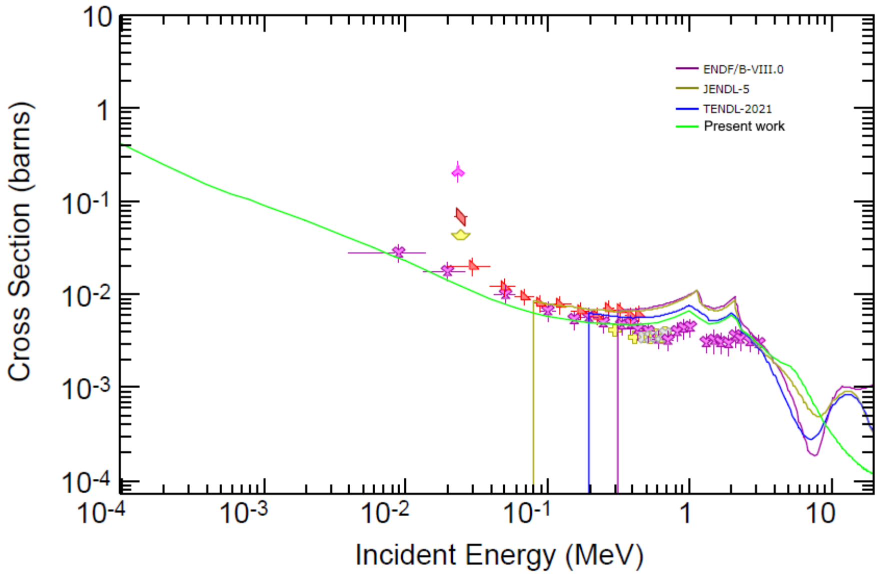
116Sn(n,g)117Sn



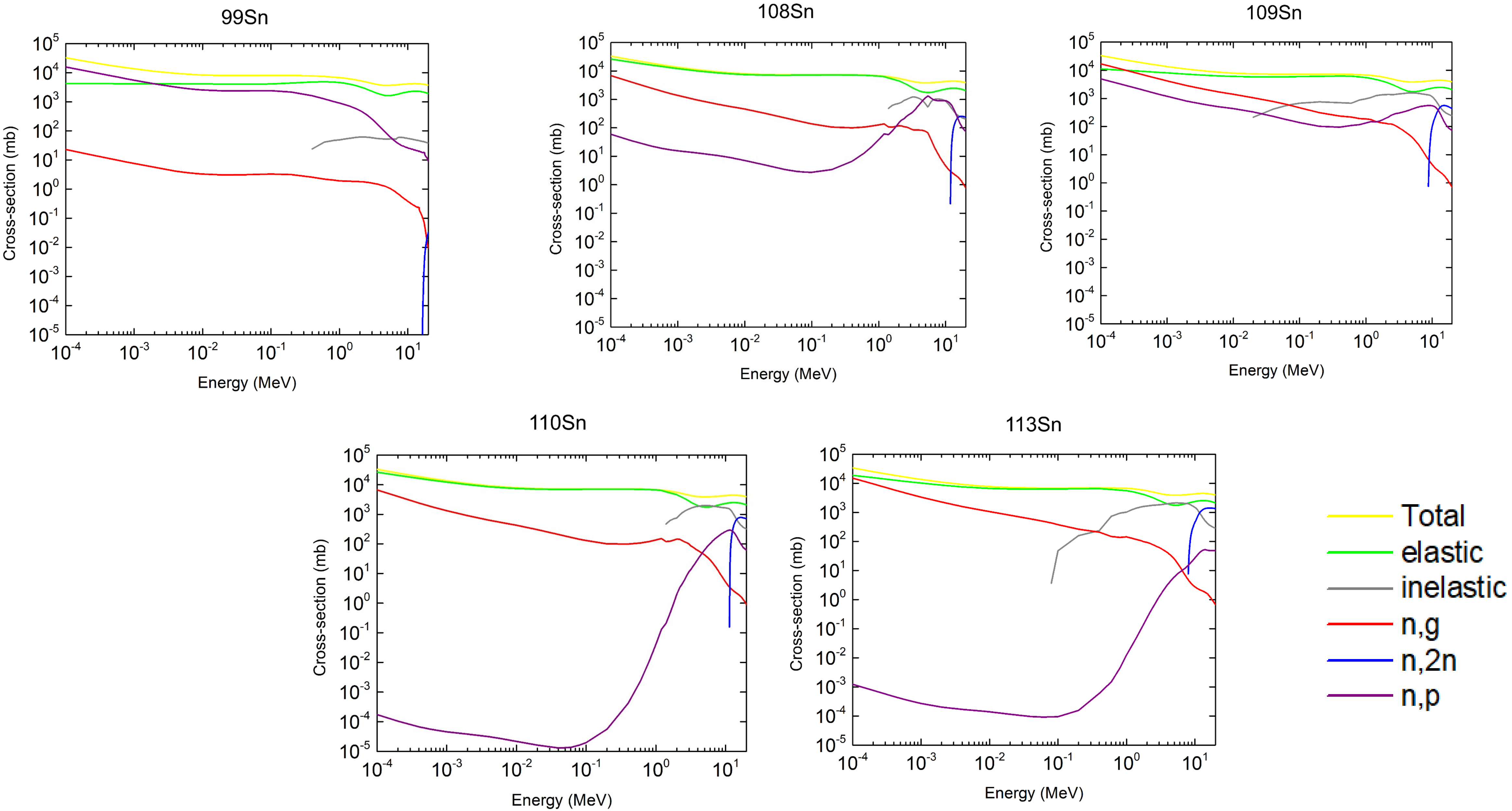
119Sn(n,g)120Sn



124Sn(n,g)125Sn



Results – Sn unstable isotopes



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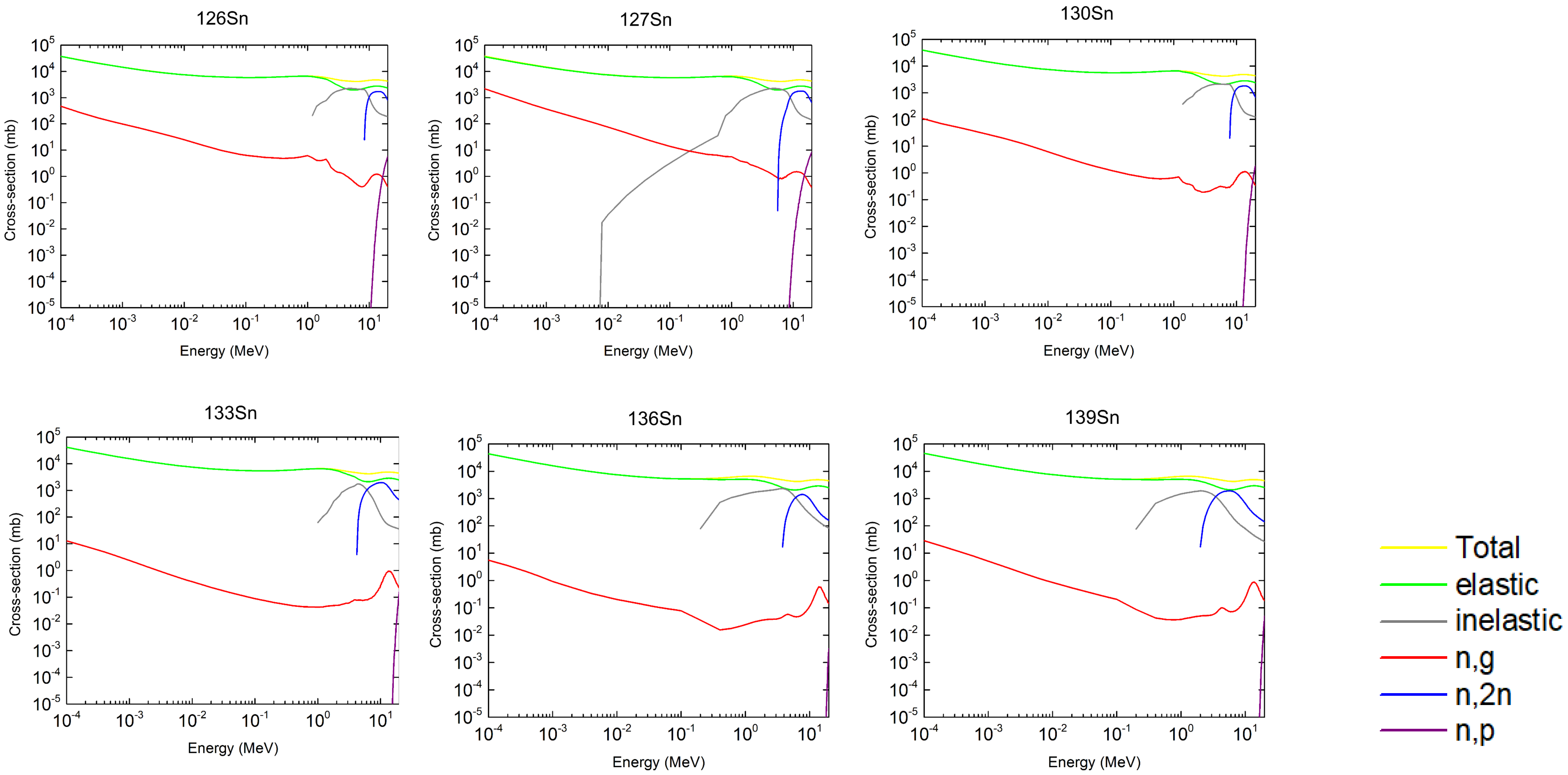

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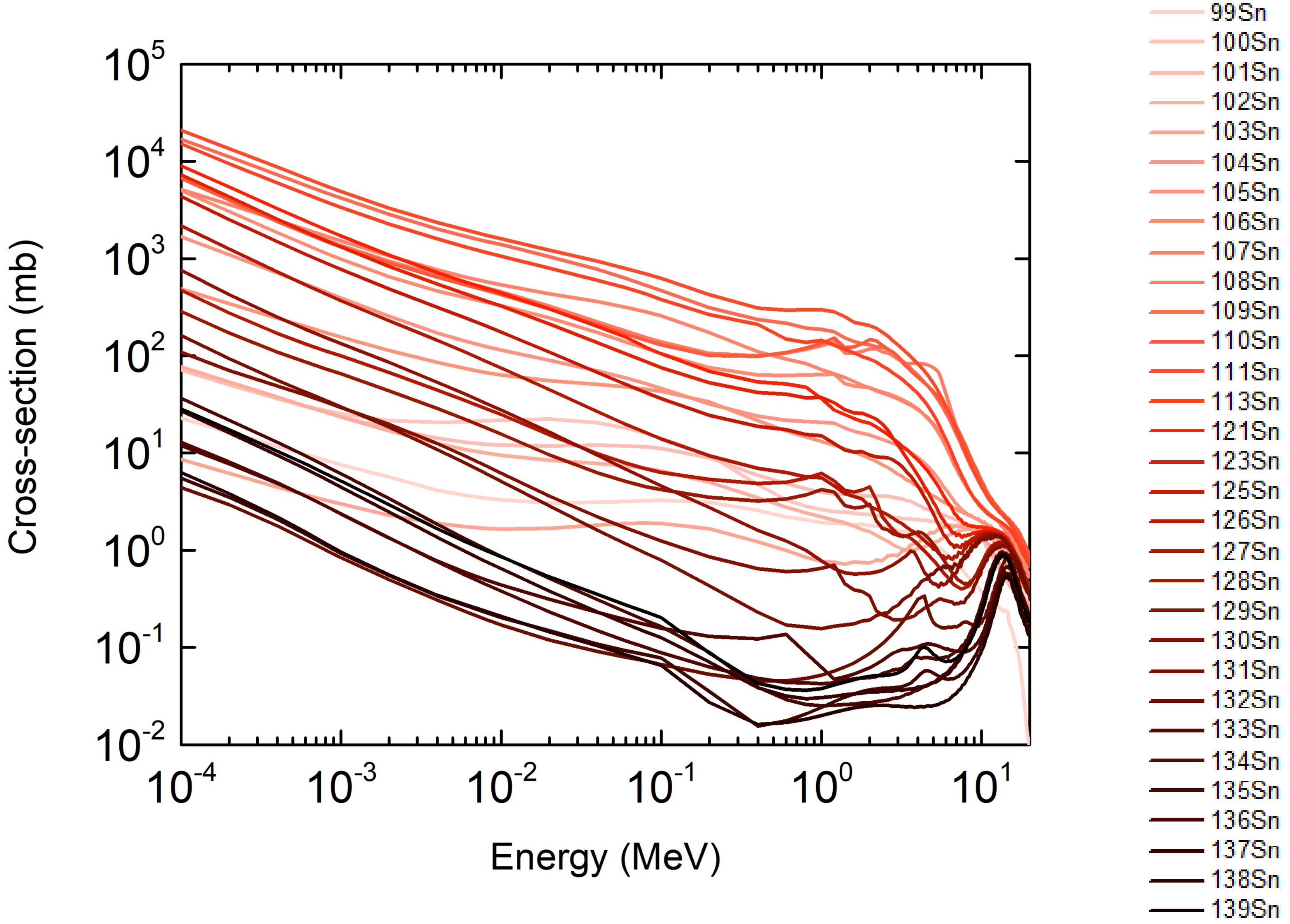

Conclusions

- Extending calculations towards drip lines gives us cross sections with reasonable values and expected energy dependency
- 110Sn and 113Sn show a peculiar behavior of (n,p) channel – to be investigated!
- We must test this method on other isotopic chains and other projectiles!