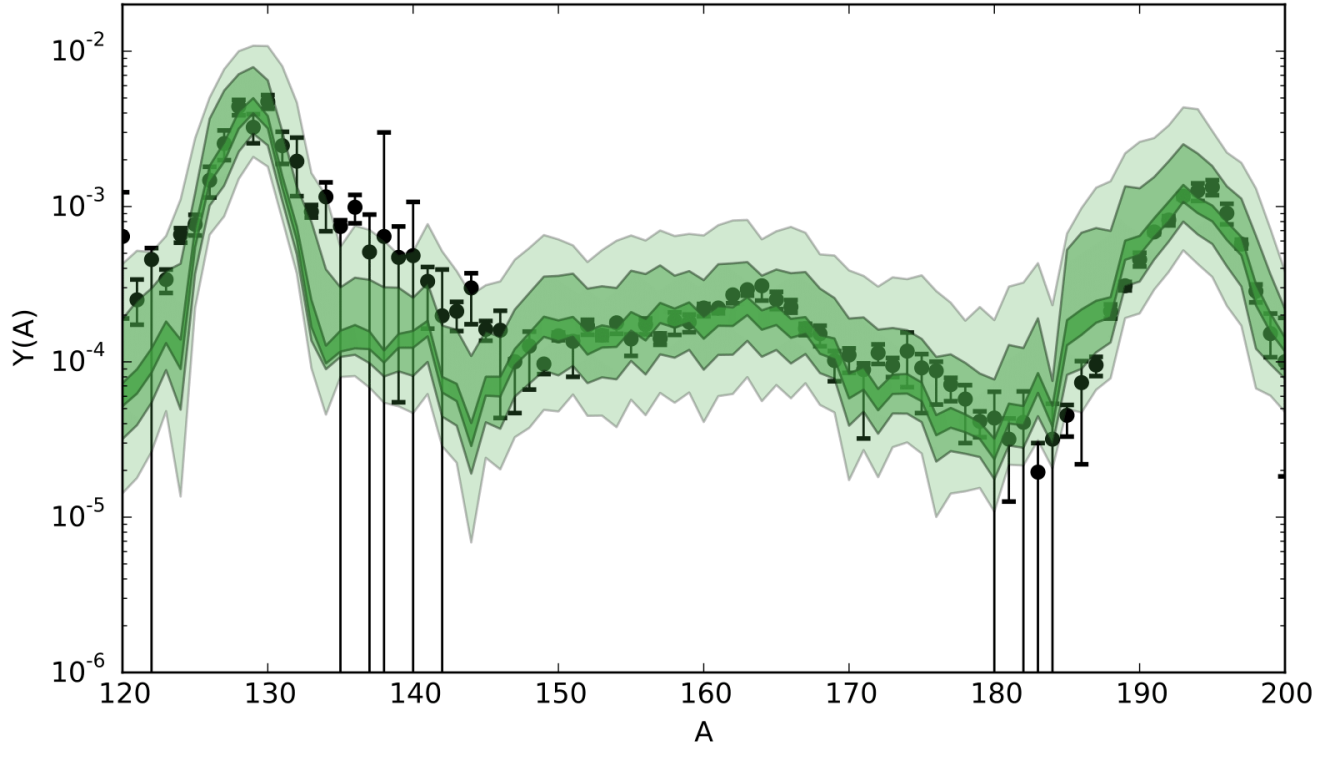
APPLICATION OF LANL FISSION MODELS TO THE ASTROPHYSICAL r-PROCESS OF NUCLEOSYNTHESIS



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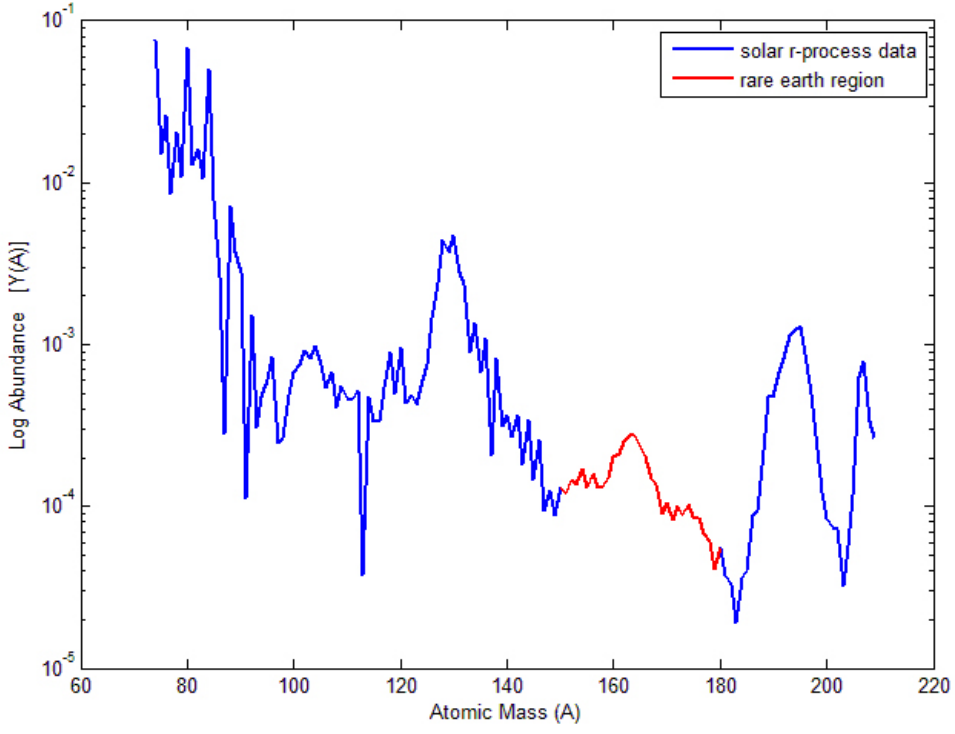
Los Alamos National Lab

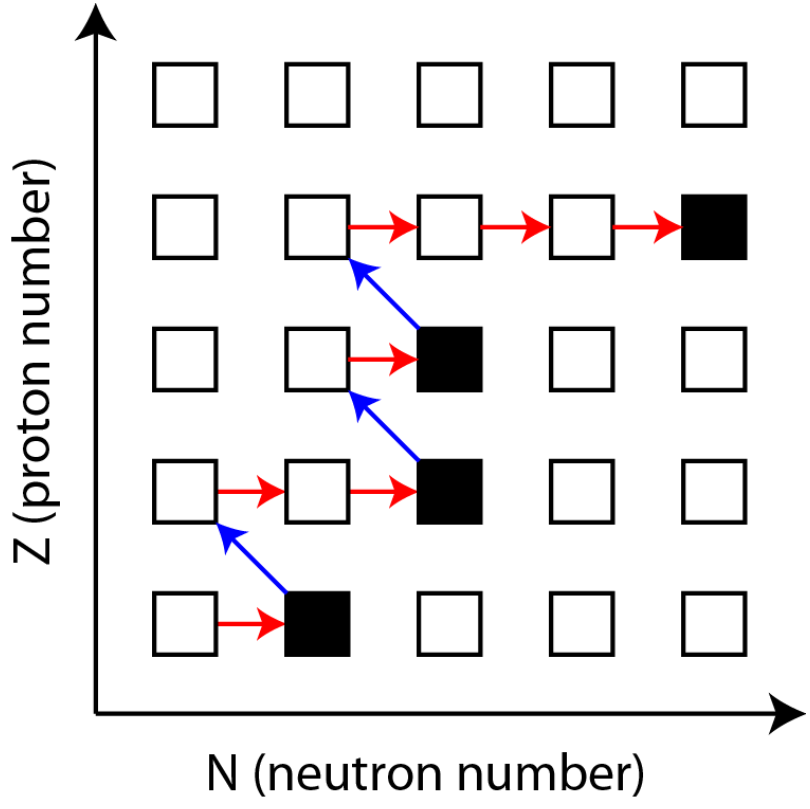
FIESTA

Friday Sept 22nd 2017

FIRE Collaboration

THE r-PROCESS





Believed to be responsible for the production of half the heavy elements in the solar system

Most improtant question: What is the astrophysical location where this can occur?

Supernova? Merging of compact objects like neutron stars?

See review paper: Mumpower *et al.* PPNP 86 (2016)

INPUTS FROM NUCLEAR PHYSICS

1st order: masses, β-decay rates, reaction rates & branching ratios

FISSION IN THE R-PROCESS

It's all about the real estate

Where do particular rates dominate in the NZ-plane?

Both (n,f) & βdf

Are likely to play an important role

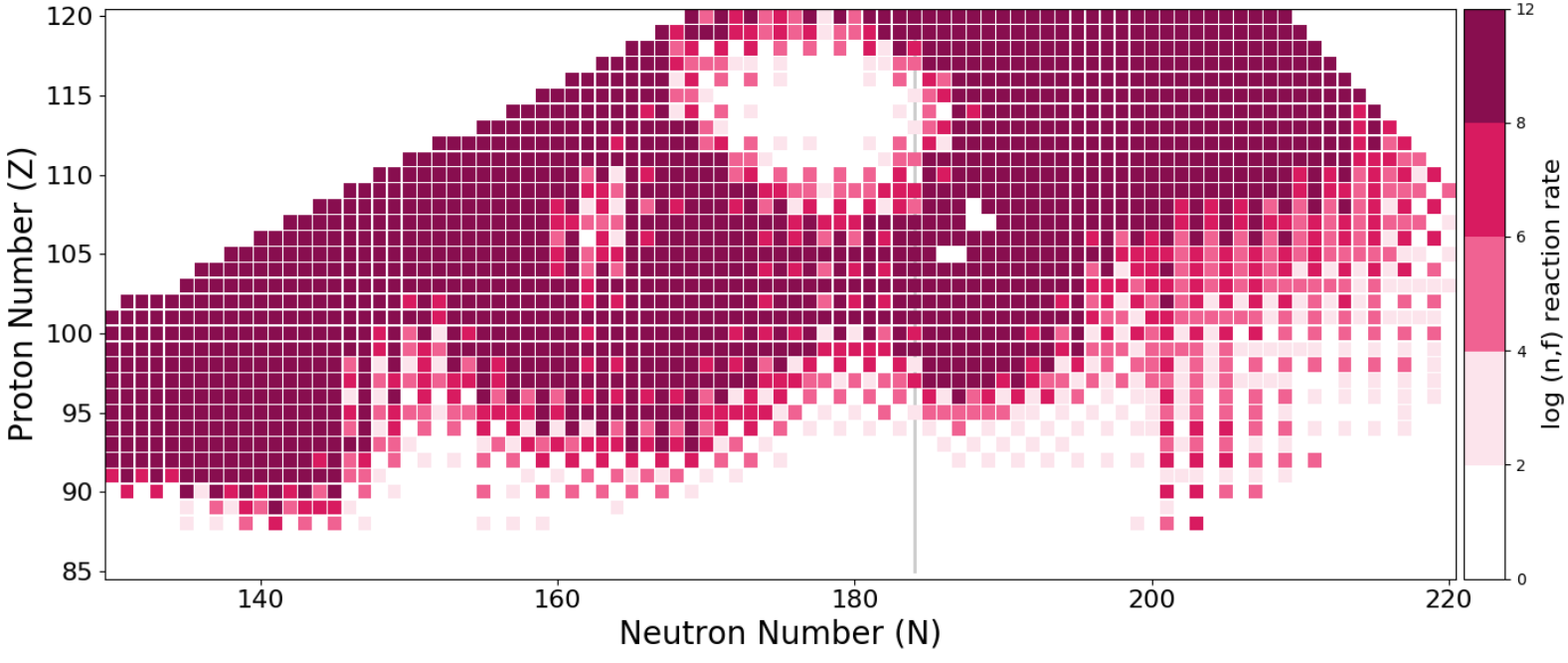
Yields during freeze-out

Are most important for shaping the final pattern

~~Prompt neutron emission~~

~~How will this impact our results?~~

NEUTRON-INDUCED FISSION RATES



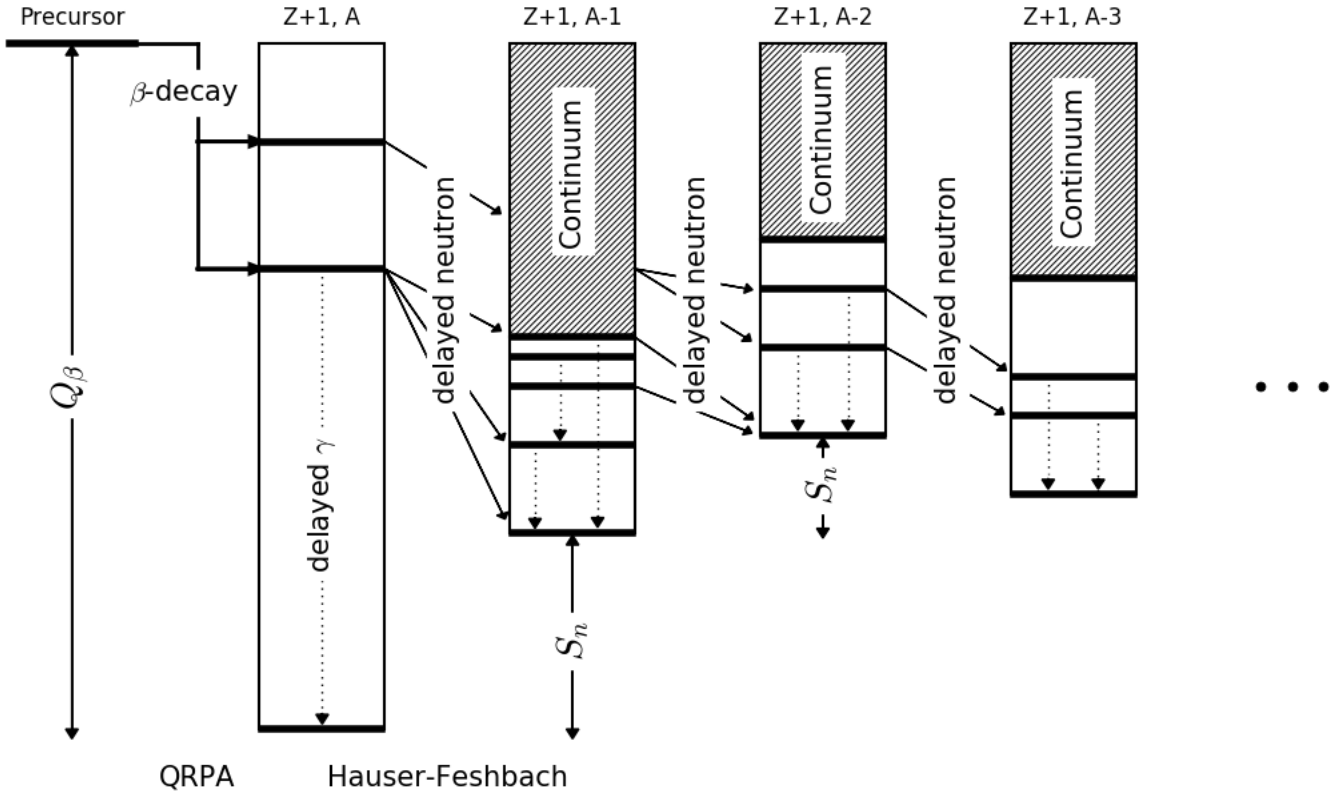
Apply CoH: Los Alamos statistical Hauser-Feshbach

Barrier heights from Möller *et al.* PRC 91 024310 (2015)

Assumes a Hill-Wheeler form for fission transmission

Many channels calculated: (n, γ), $(n, 2n)$, (n, f)

COMBINING QRPA + HF

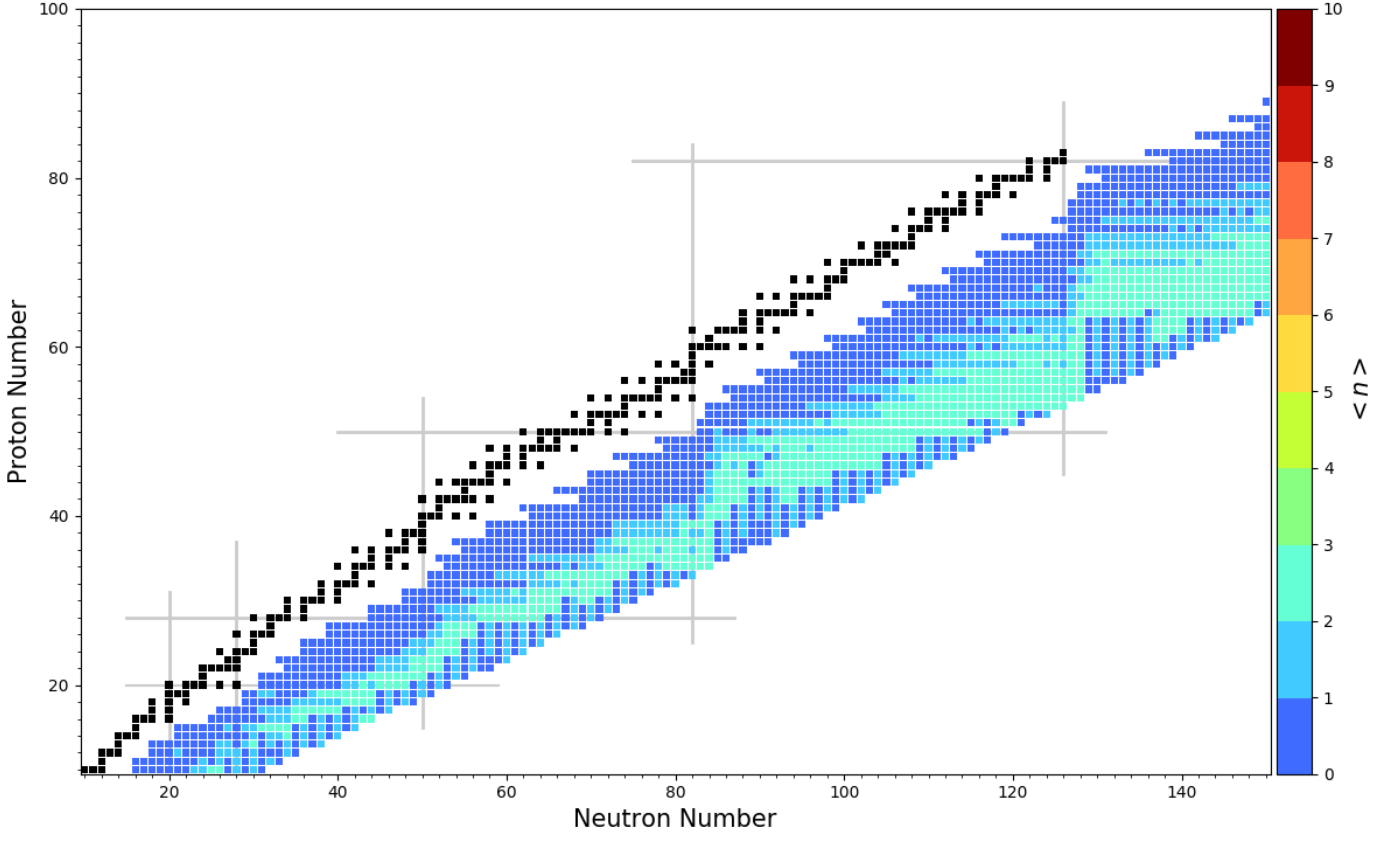


Initial population from the β-decay strength function from P. Möller's QRPA.

Follow the statistical decay until all excitation energy is exhausted.

Mumpower *et al.* PRC 94 064317 (2016)

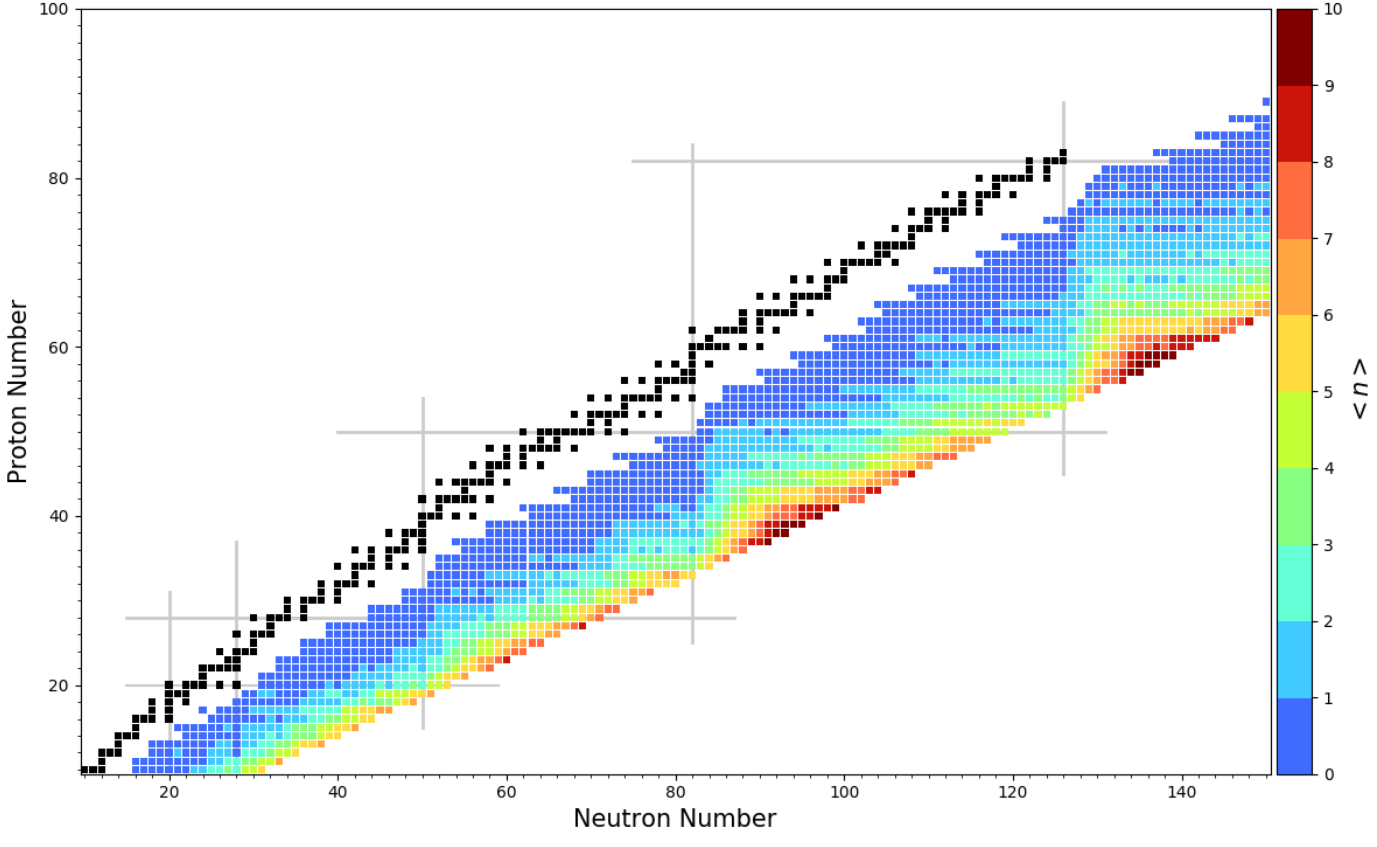
AVERAGE NEUTRON EMISSION



Apply energy window method to the entire chart of nuclides

Mumpower *et al.* PRC 94 064317 (2016)

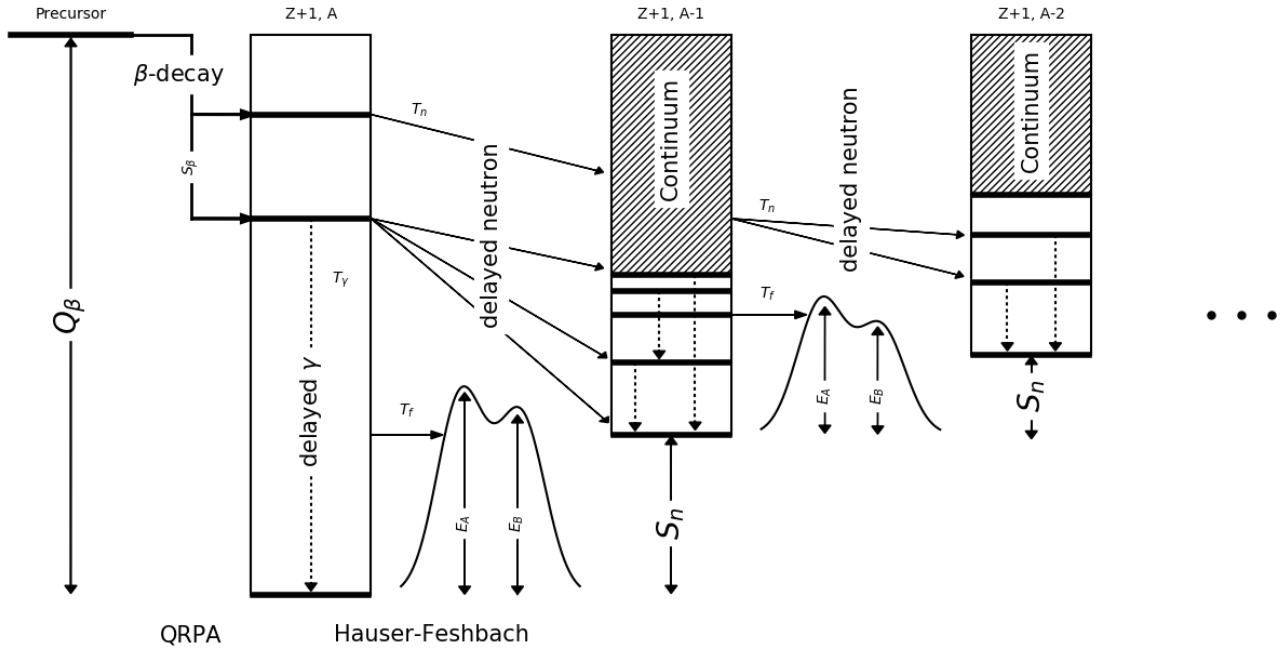
AVERAGE NEUTRON EMISSION



Apply the QRPA+HF method to the entire chart of nuclides

Mumpower *et al.* PRC 94 064317 (2016)

β-DELAYED FISSION



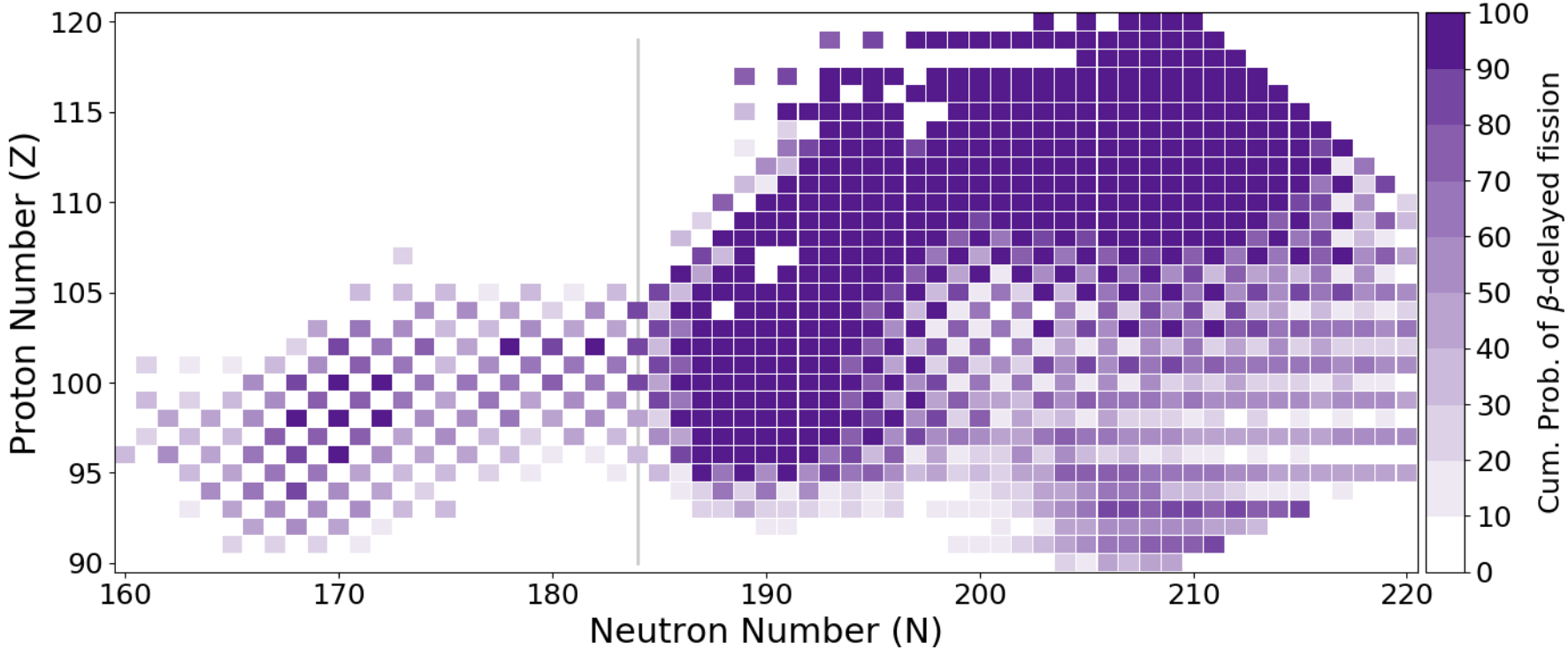
Apply LANL model assuming a Hill-Wheeler form for fission transmission

Something new and exciting was found!

An entirely new decay channel for neutron-rich nuclei!

Mumpower *et al.* to be submitted (2017)

β-DELAYED FISSION



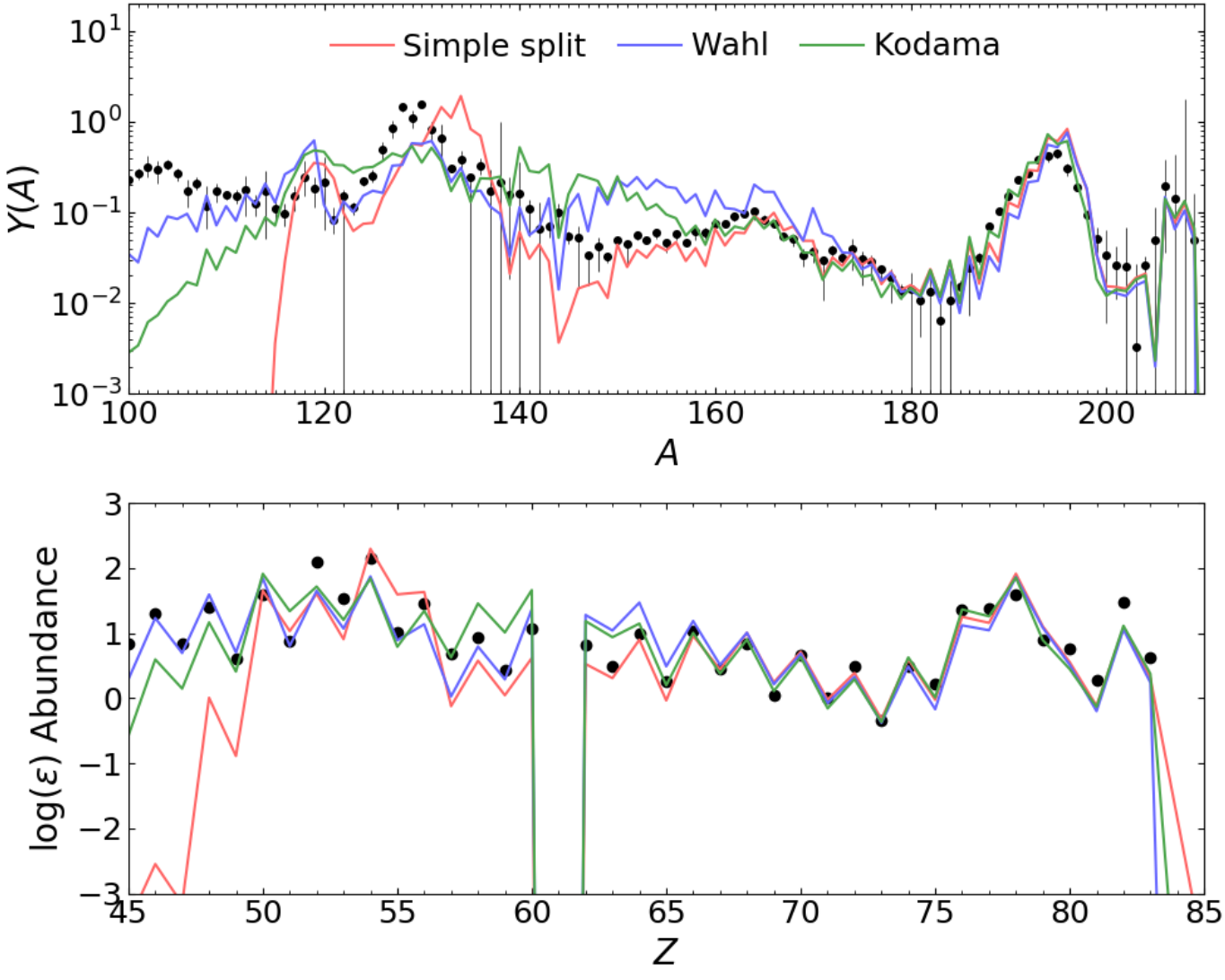
We find βdf occupies a large amount of real estate!

Mumpower *et al.* to be submitted (2017)

PRISM MOVIE

Nucleosynthesis of two neutron stars colliding

IMPACT OF DIFFERENT YIELDS



Fission yields, especially of nuclei populated at the end are crucial for setting the final pattern

SUMMARY

We have performed new calculations of neutron-induced and beta-delayed fission for r-process nuclei

A combination of both channels "end" the r process (termination at high A) **AND** set the final pattern

Using systematics for fragment yields do not work well far from stability

We are working on more microscopic description of fission yields consistent with FRDM / FRLDM