PAUL SCHERRER INSTITUT

PSI

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Parameter and model effects: mixing TALYS and EMPIRE

JEFDOC-1914

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Introduction

- Goal: Evaluations with best C/E for differential and integral data (not *toy models*)

- Bayesian methods are powerful to combine different sources of information:
  - Models
  - Differential data
  - Integral data

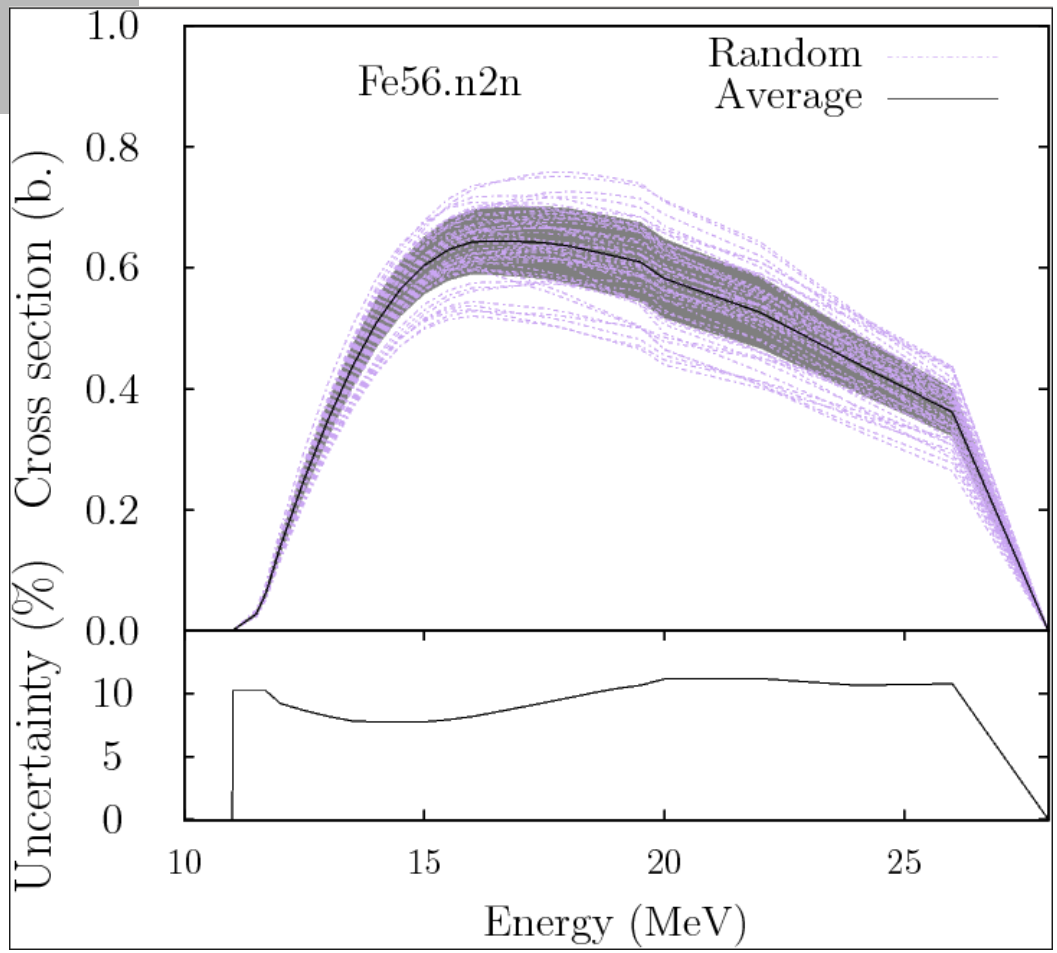
- As we consider many differential data, many integral data, many model parameters, we should also consider many models. It helps to
  - broaden the prior
  - avoid user selection of “best model”
  - have a similar approach in “differential, integral and model spaces”.

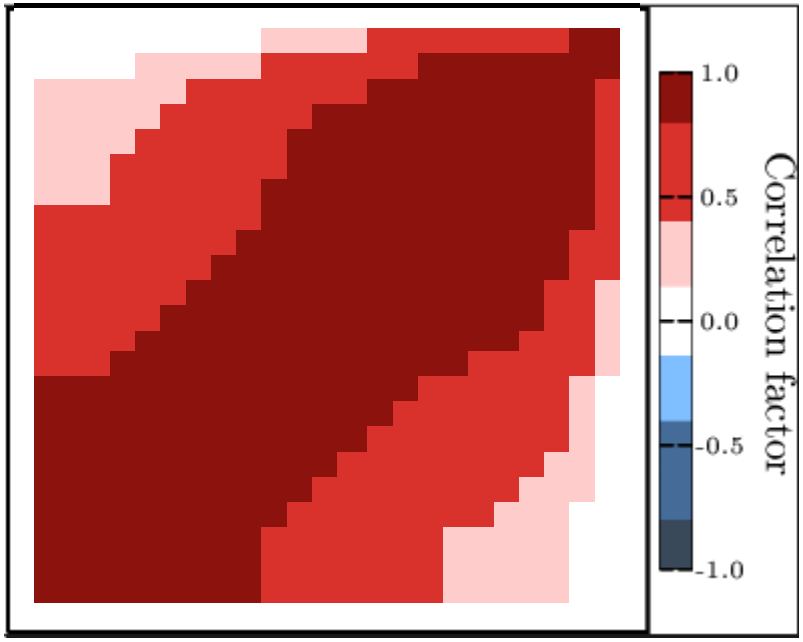
- This presentation will show examples of mixing models, with random parameters within the Bayesian approach (BFMC)

All slides can be found here: https://tendl.web.psi.ch/bib_rochman/presentation.html

Example for ^{56}Fe(n,2n): TALYS+EXFOR+BFMC

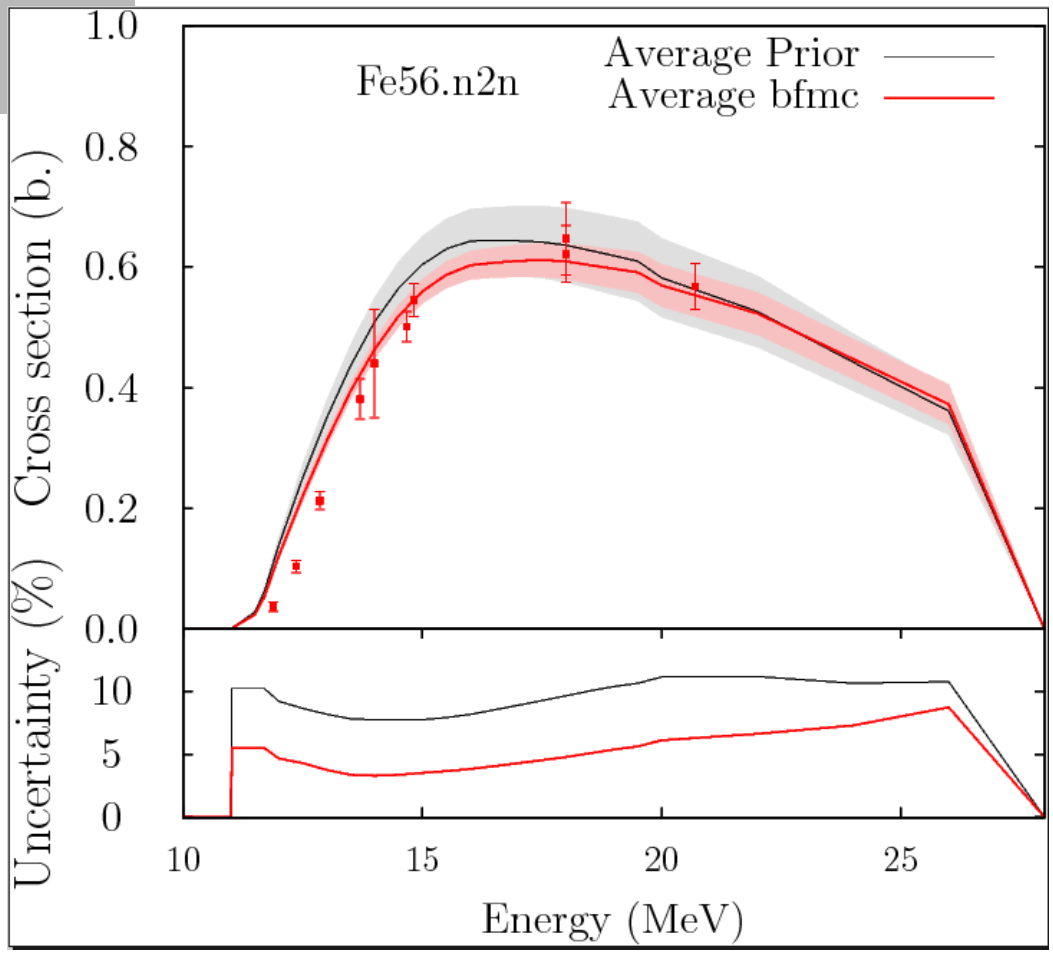
- Prior: random sampling of model parameters (TALYS, 1 OMP, 1 level density…)

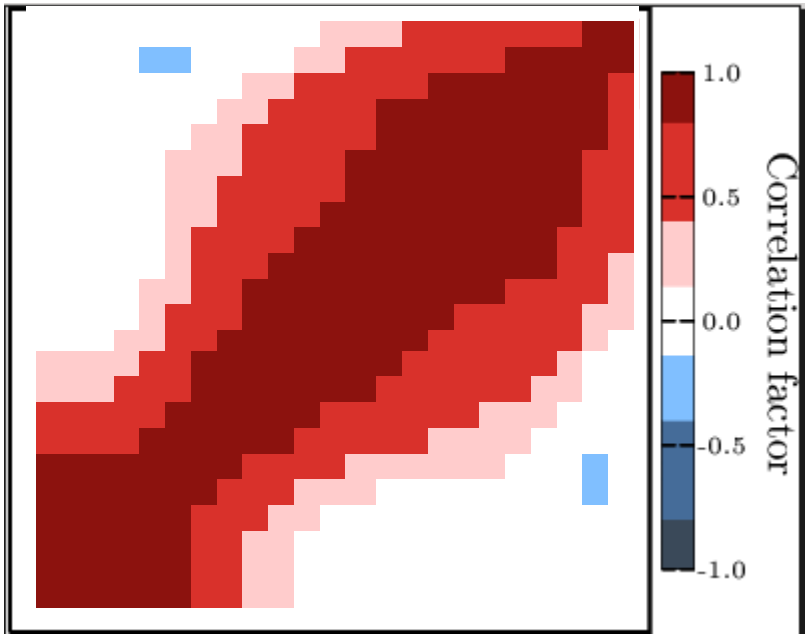




Example for ^{56}Fe(n,2n): TALYS+EXFOR+BFMC

- Posterior: Backward-Forward Monte Carlo

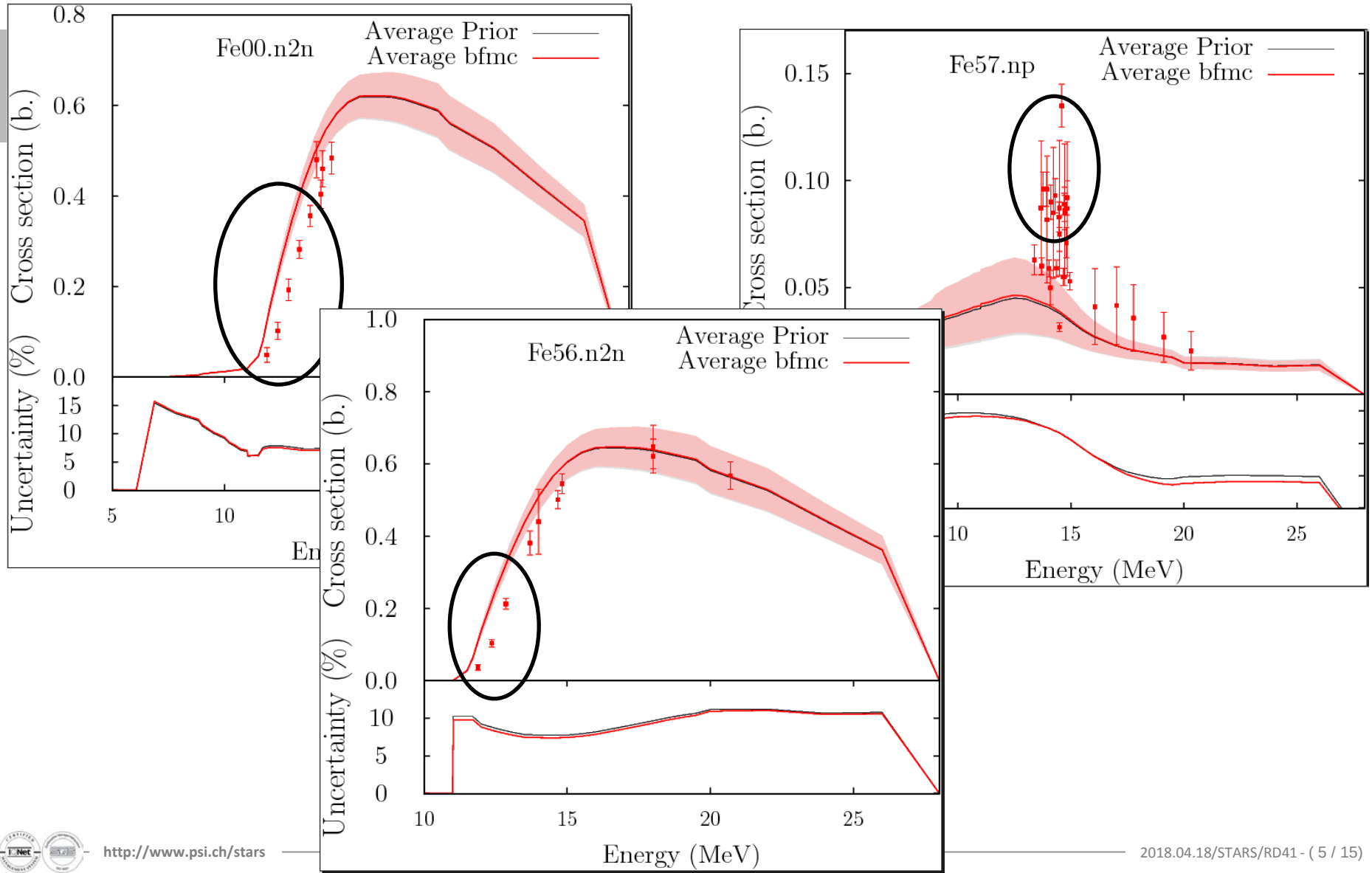




- Problem at the threshold, what to do ?

Example for Fe: TALYS+EXFOR+BFMC

- What can we do with discrepant data ?



Models used for the calculations

- One single model might not be enough to “fit” all experimental data,

- Usually only one set of model is used for a full evaluation, e.g. in TENDL:
  - OMP — Local Koning-Delaroche
  - Gamma-strength function: — Kopecky-Uhl generalized Lorentzian
  - Level density model: — Constant temperature + Fermi gas model

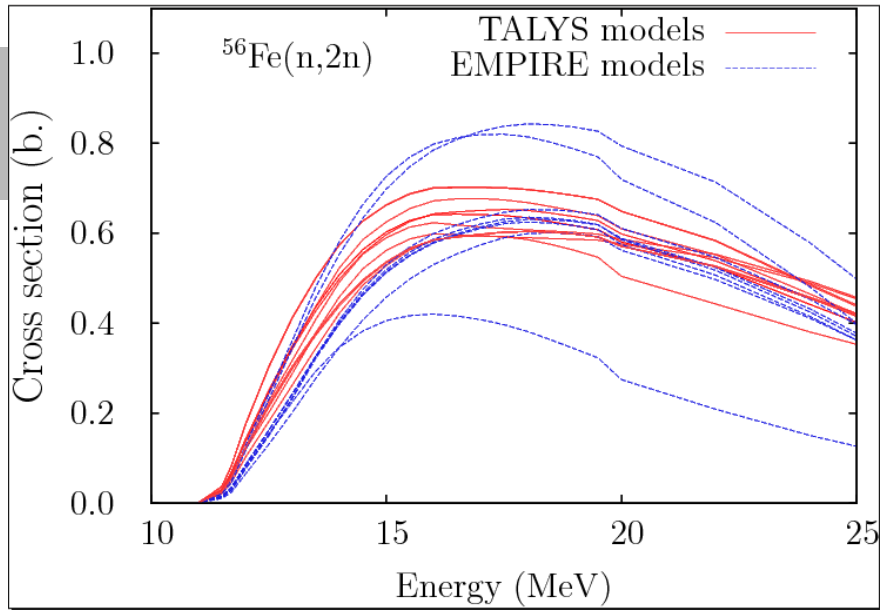
- Other options are available in TALYS:
  - 8 gamma-strength functions (called *i*)
  - 6 level density models (called *j*)
  - Different OMP (local, general, microscopic) (called *k*)

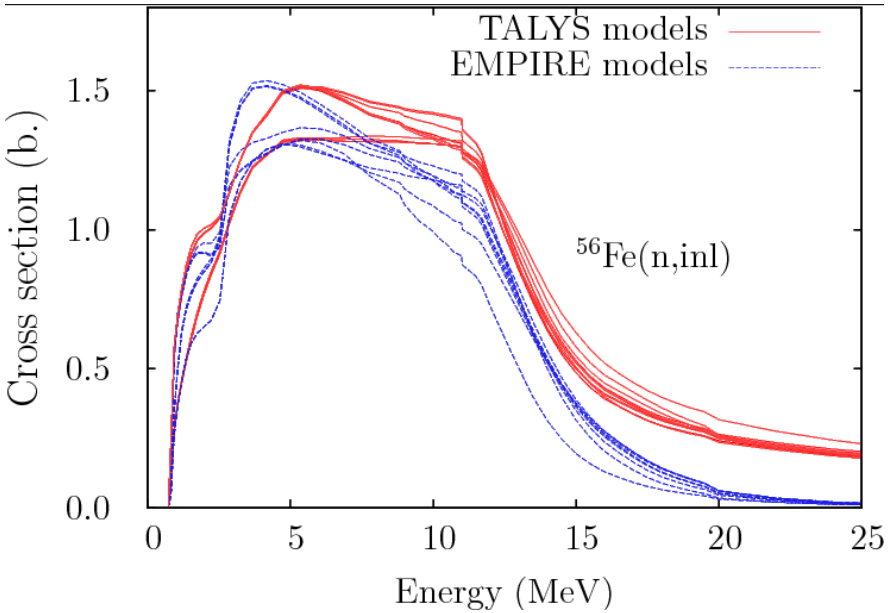
  - In total: *i* x *j* x *k* possibilities (11n, 12n, 58n…)
  - For each of these possibilities, one can sample model parameters

- Other extreme solution: EMPIRE.

- In the following: -10 TALYS models (semi-empirical and microscopic)
  -8 EMPIRE models (semi-empirical and microscopic)

Example for ^{56}Fe(n,2n) and (n,inl)



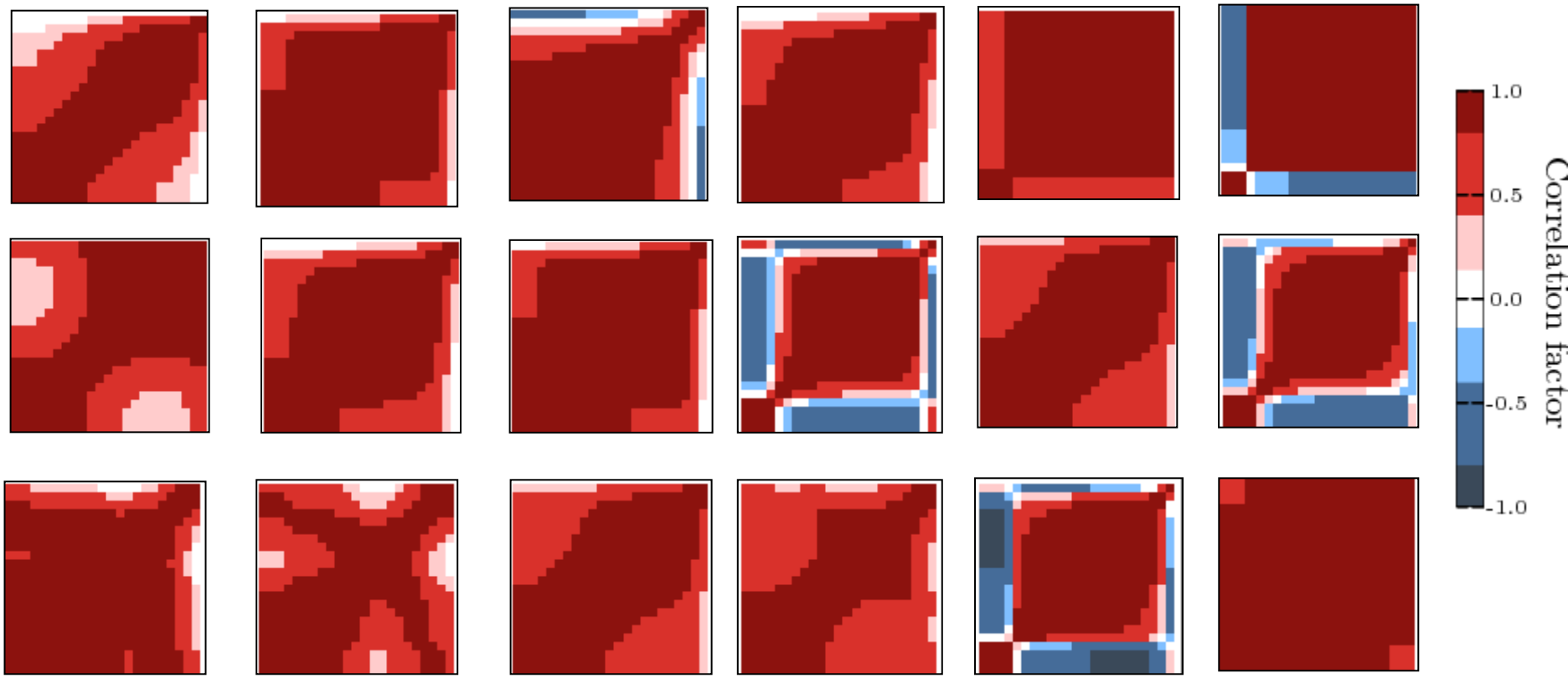


- All these models can be used as prior
- For each of these 18 models, 500 ENDF are produced by randomizing parameters.

Example for ^{56}Fe(n,2n): TALYS+EMPIRE

- Many prior correlation matrices can be obtained depending on the models/combination, all for the same reaction

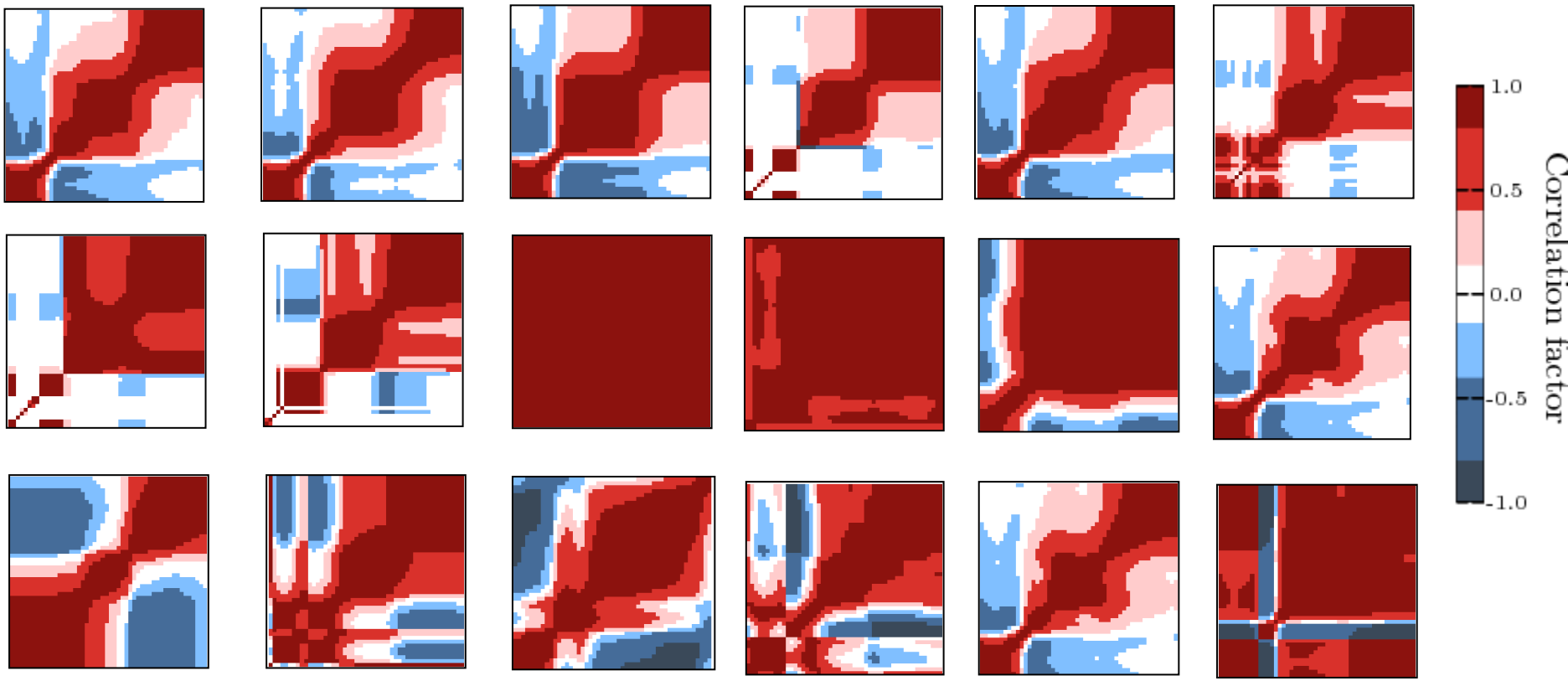
Examples for ^{56}Fe(n,n2n)



Example for ^{56}Fe(n,inl): TALYS+EMPIRE

- Many prior correlation matrices can be obtained depending on the models/combination, all for the same reaction

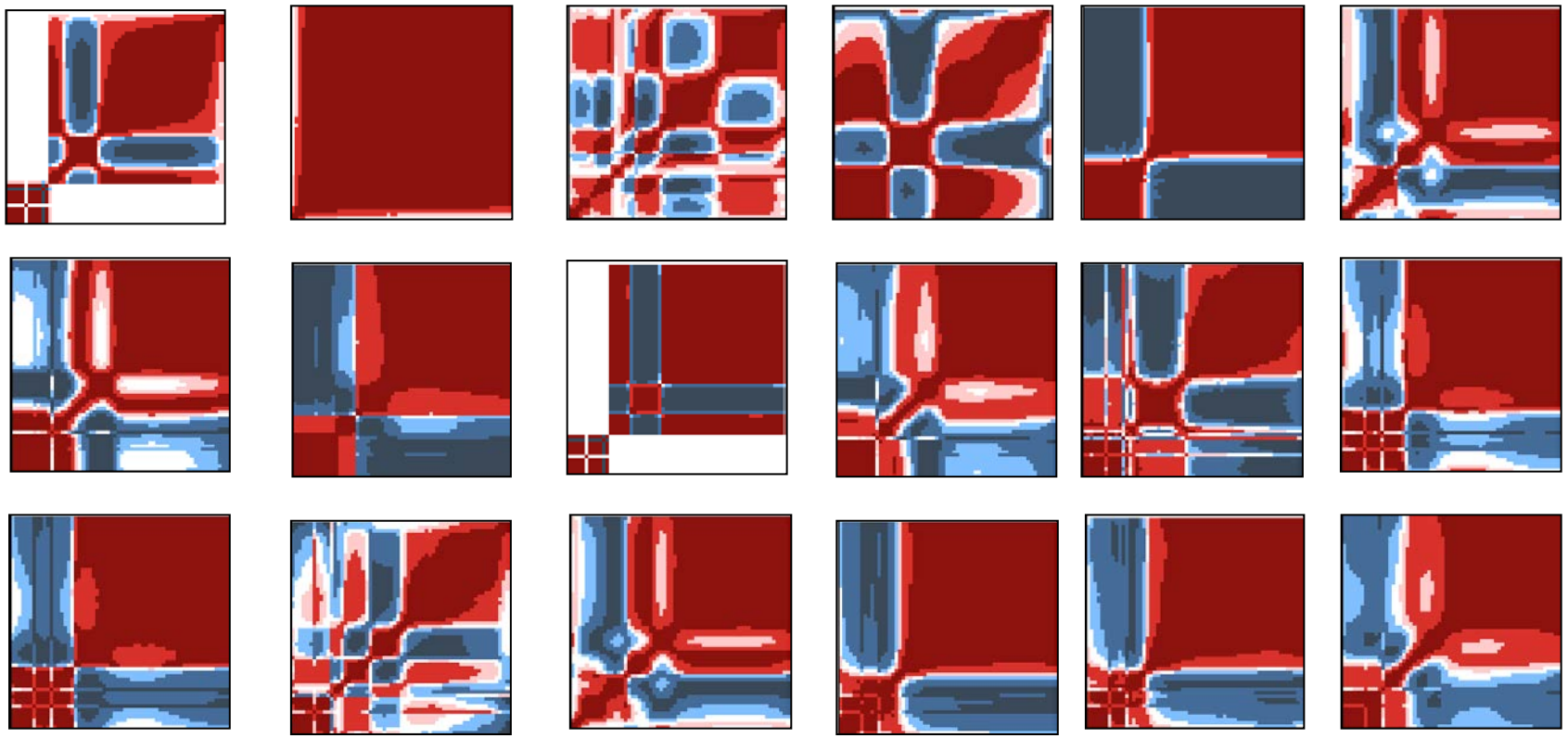
Examples for ^{56}Fe(n,inl)



Example for ^{56}Fe(n,tot): TALYS+EMPIRE

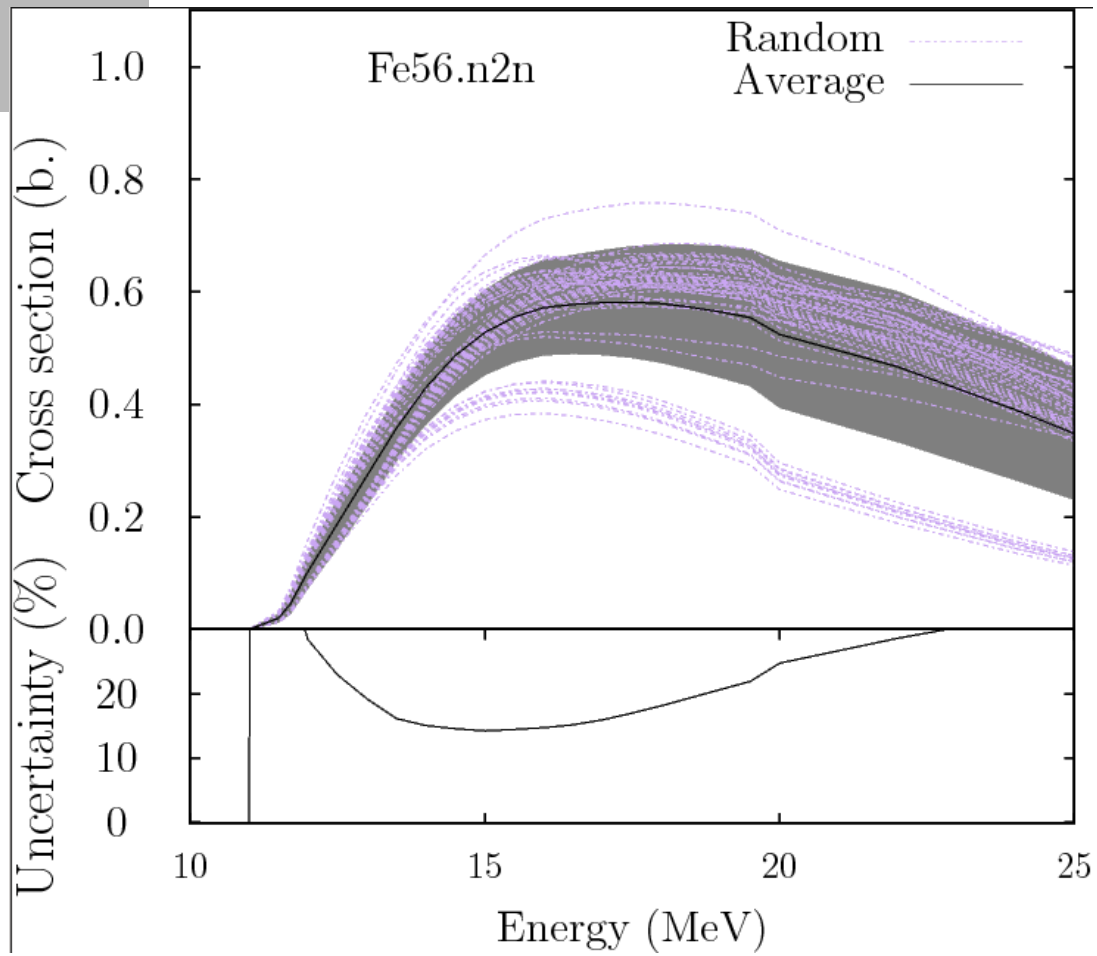
- Many prior correlation matrices can be obtained depending on the models/combination, all for the same reaction

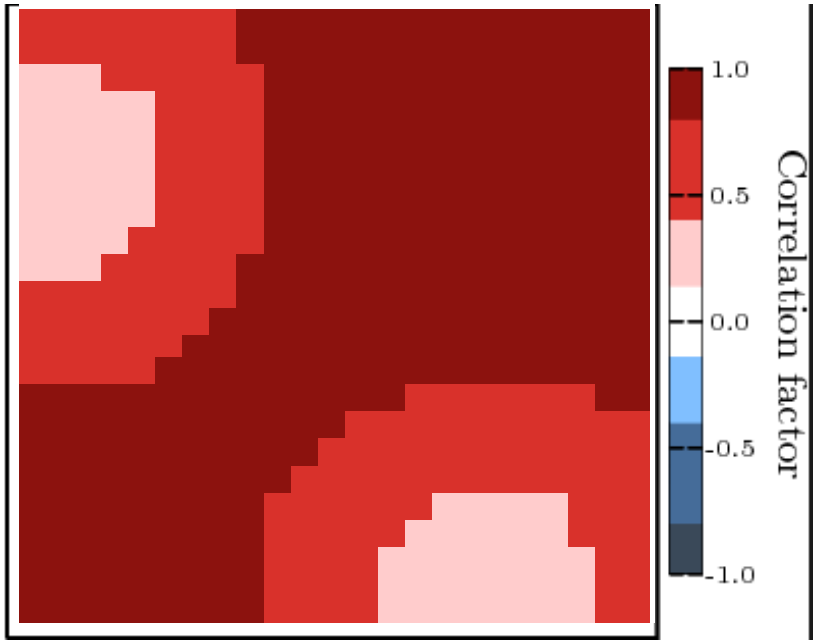
Examples for ^{56}Fe(n,tot)



^{56}Fe(n,2n): TALYS+EMPIRE+EXFOR+BFMC

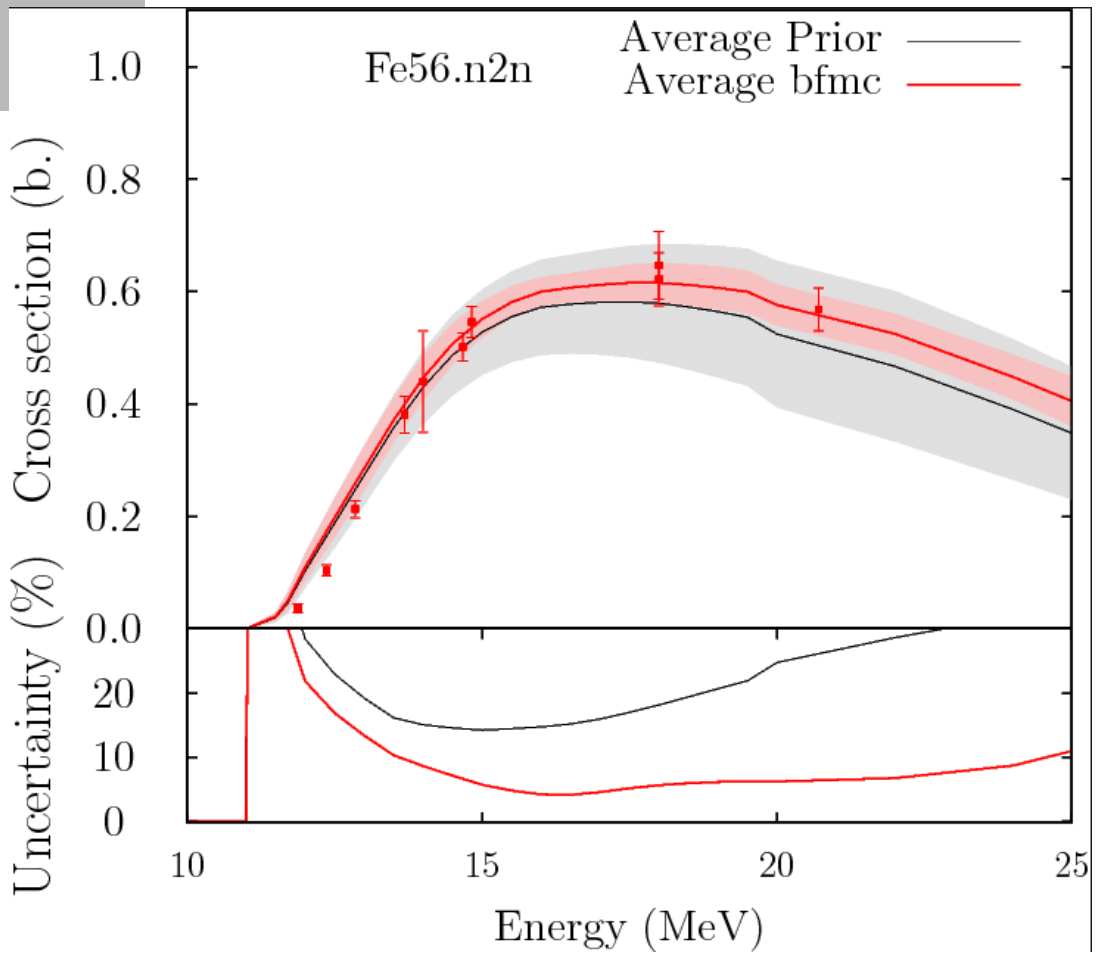
- Prior: random sampling of model parameters + models.

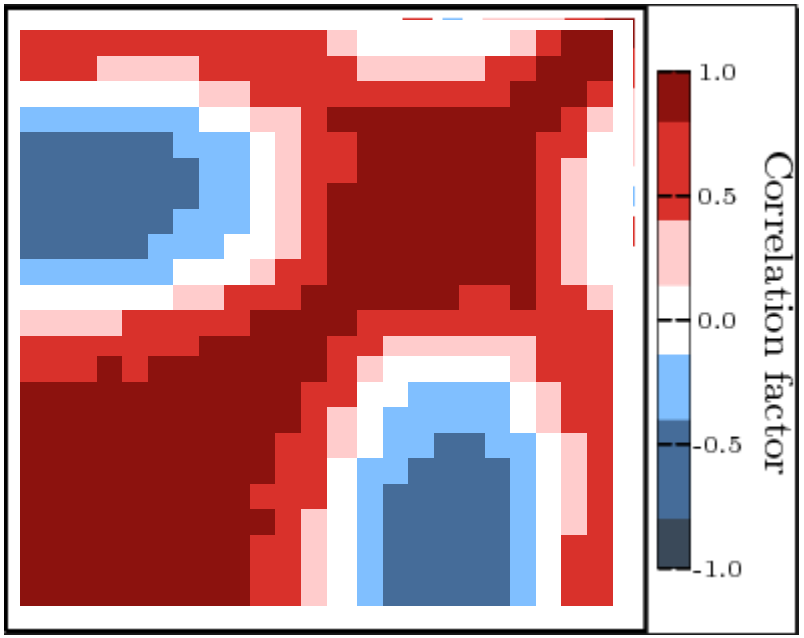




^{56}Fe(n,2n): TALYS+EMPIRE+EXFOR+BFMC

- Posterior: Backward-Forward Monte Carlo (random models + random parameters)





- Large phase-space sampling,
- Still, threshold missed.

Experimental data for ^{56}Fe $E_n > 2$ MeV

- Total of 2173 experimental data considered in this work

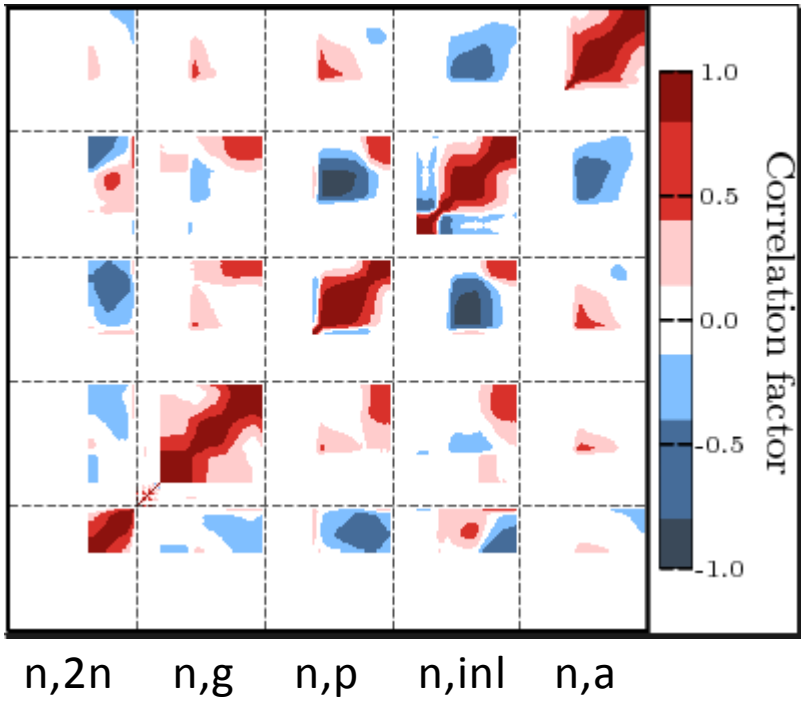
	n,tot	n,el	n,non	n,inl	n,p	n,a	n,g	n,2n
Fe54	17*	18	-	-	216	106	-	73
Fe56	181*	23	2	55*	349	4	1	10
Fe57	40*	-	-	-	33	4	-	-
Fe58	-	-	-	-	-	2	-	-
Fe0	116*	43	45	8	1	12	4	9

*Partial set of experimental data

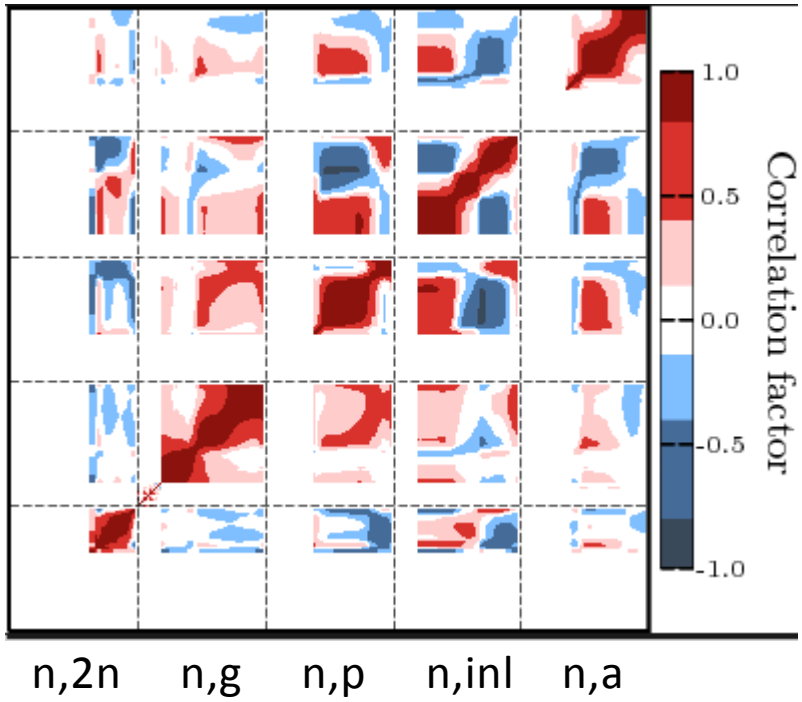
^{56}Fe: TALYS+EMPIRE+EXFOR+BFMC

- Generalization for many reactions (random models + random parameters)

1 model



2 models



Conclusion

- General conclusions
  - Prior correlations can be anything,
  - There is no truth in “absolute covariance” (it is only an outcome of a method)

- For future evaluations, to be as general as possible (in terms of prior)
  - Sampling models as well as model parameters is necessary
  - But not enough (yet)
    - Models have to be improved, or
    - Some exp. data need to be discarded, or
    - Model defect needs to be included

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