PAUL SCHERRER INSTITUT

PSI

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Fusion work: status and plan

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PPPT Task specifications

1. Prepare up-to-date evaluation methods to incorporate differential and integral observables in general purpose cross-section data evaluations for the inclusion in nuclear data libraries (such as TENDL); application to Fe nuclides

2. Improve specific activation cross sections as required for PPPT neutronics, activation and safety analyses.

Status and plans

1. Prepare up-to-date evaluation methods to incorporate differential and integral observables in general purpose cross-section data evaluations for the inclusion in nuclear data libraries (such as TENDL); application to Fe nuclides

- Select differential data for all Fe isotopes (and natural), including angular distributions
- Produce random files from random parameters and mixing models (TMC)
- Applying a Bayesian updating method (BMC or BFMC)
- Possibly applying some “model defects” (Gaussian process ?)

- Select integral data (criticality, shielding,…) with the help of other partners
- Use the TMC files +BMC/BFMC on integral data

- Combine both weights (differential and integral) for a final evaluation set.

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

Random files TMC ^{56}Fe

- Random files using TALYS and EMPIRE
- Many models can be changed (OMP, level density, gamma strength function…)
- Examples of produced random files and models:

	TALYS 11n	TALYS 22n	TALYS 54n	TALYS 68y	EMPIRE 614	EMPIRE 1475	EMPIRE 2001	EMPIRE 2407
Fe54	5400	5400	-	-	-	-	-	-
Fe56	8990	8200	3000	700	500	500	500	500
Fe57	5250	-	-	-	-	-	-	-
Fe58	6250	5200	-	-	-	-	-	-

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

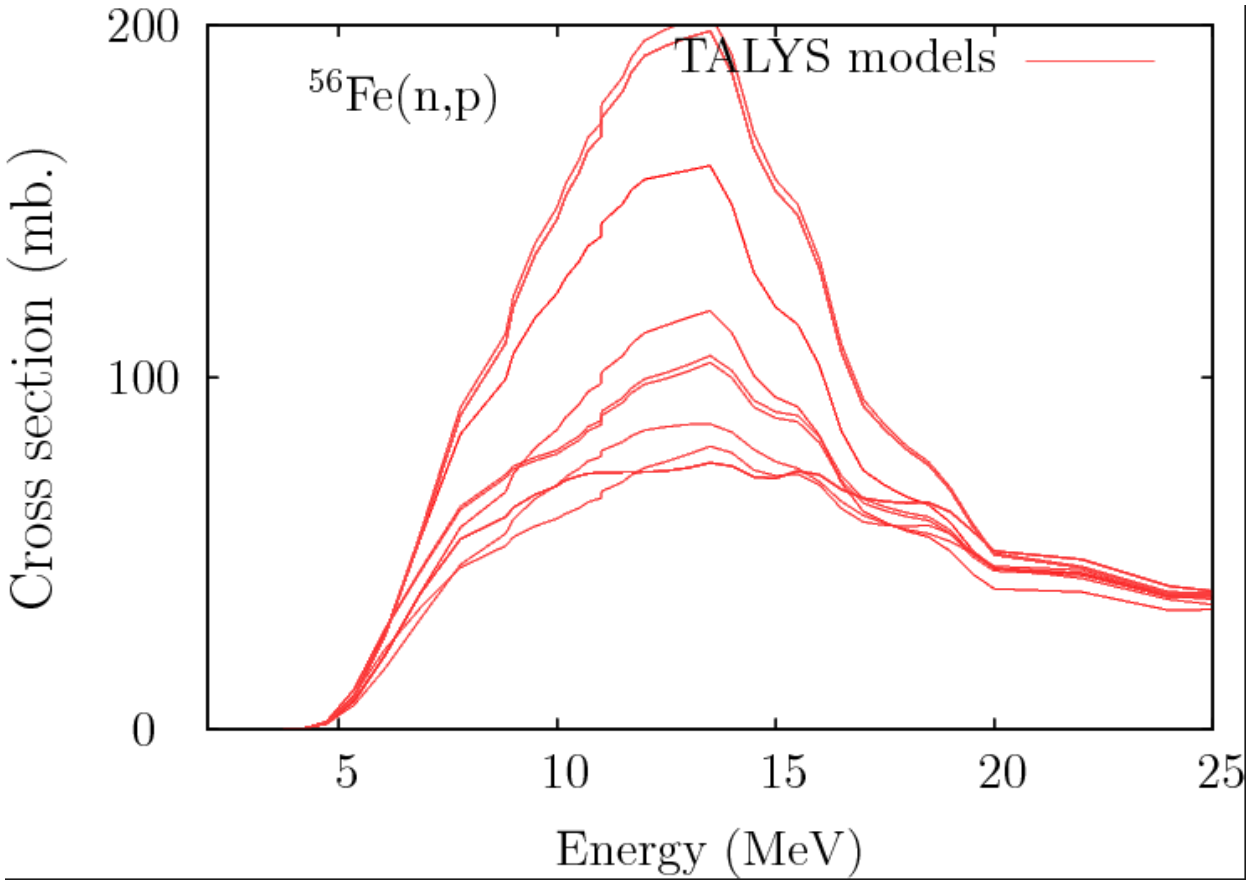
- Other options are available in TALYS:
  - 8 gamma-strength functions (called *i*)
  - 6 level density models (called *j*)
  - Different OMP (local, general, microscopic) (called *k*)

  - 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,p)

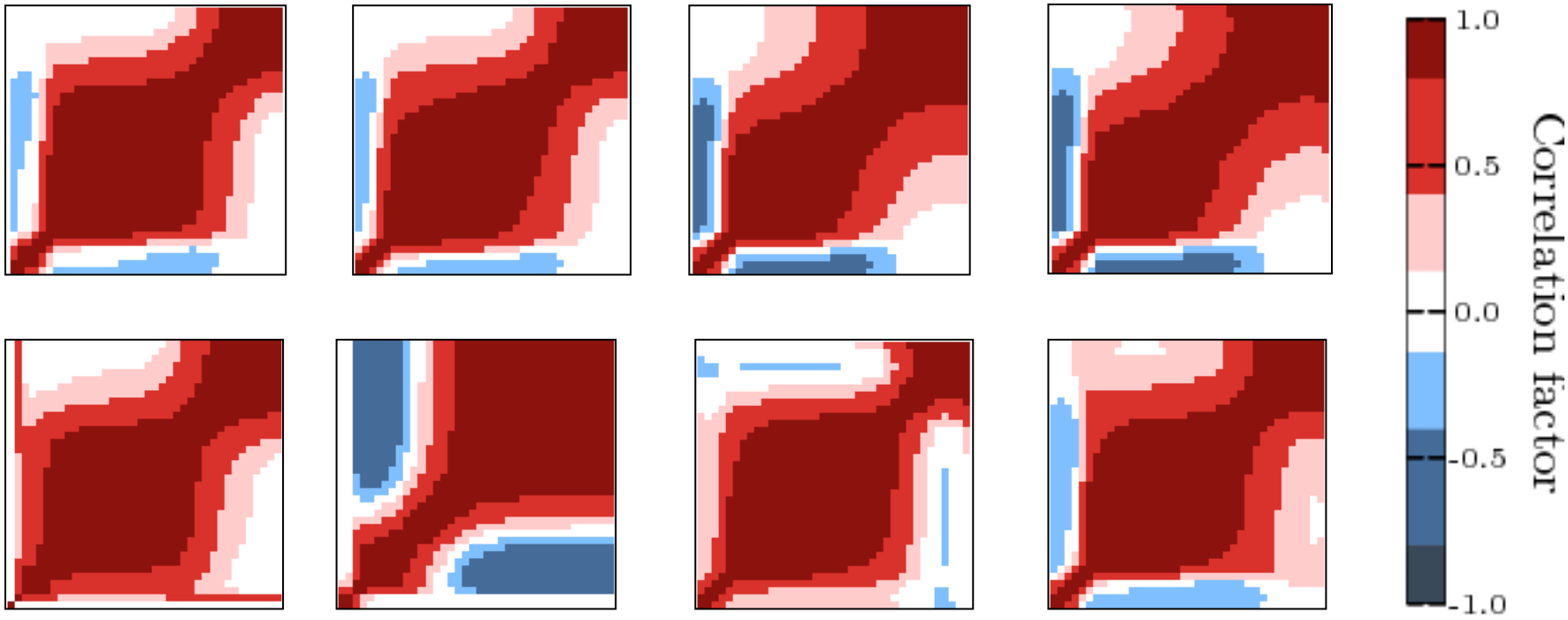


- All these models can be used as prior
- For each of these models, > 500 ENDF are produced by randomizing parameters.

Example for ^{56}Fe(n,p): TALYS models

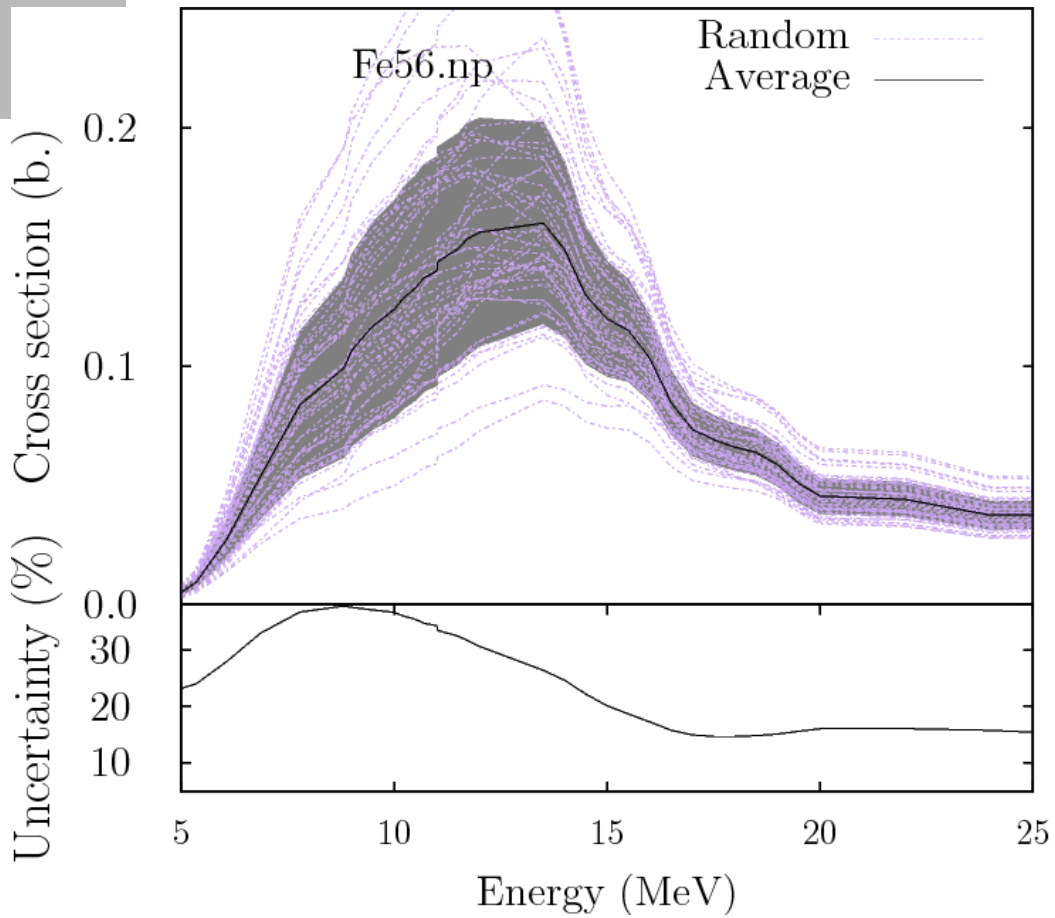
- Many prior correlation matrices can be obtained depending on the models/combination, all for the same reaction

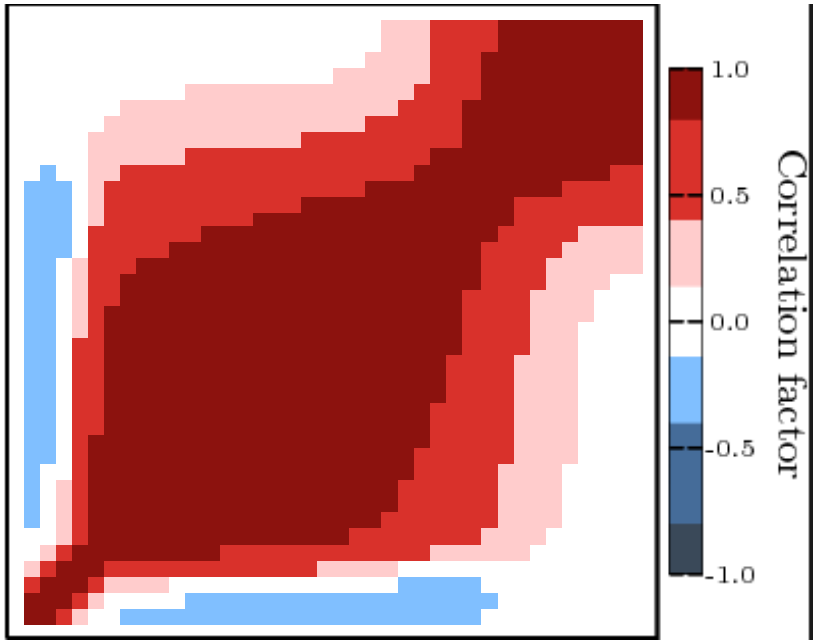
Examples for ^{56}Fe(n,p)



^{56}Fe(n,2n): TALYS (11n)+EXFOR+BFMC

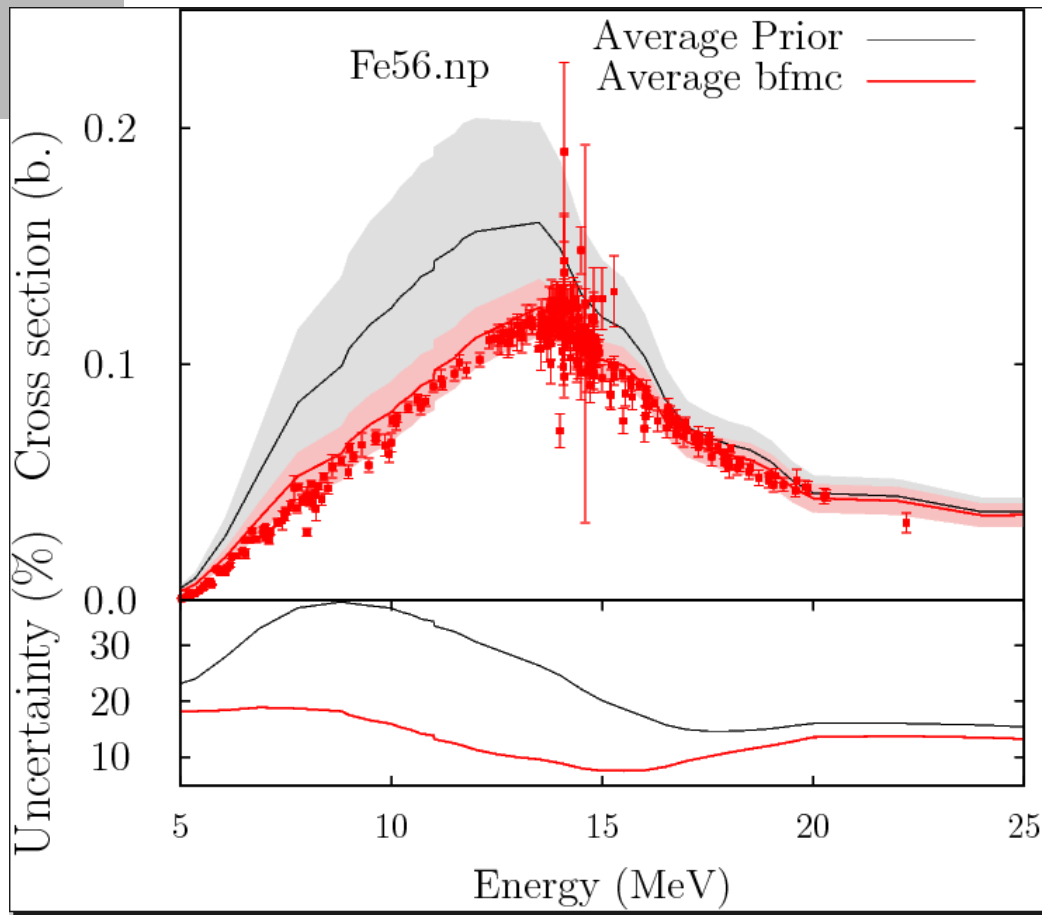
- Prior: random sampling of model parameters.

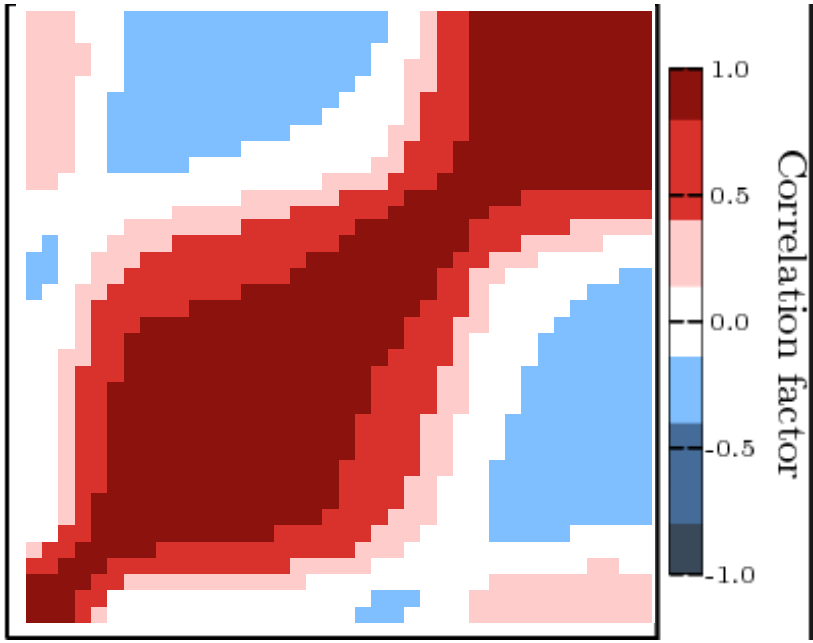




^{56}Fe(n,2n): TALYS (11n)+EXFOR+BFMC

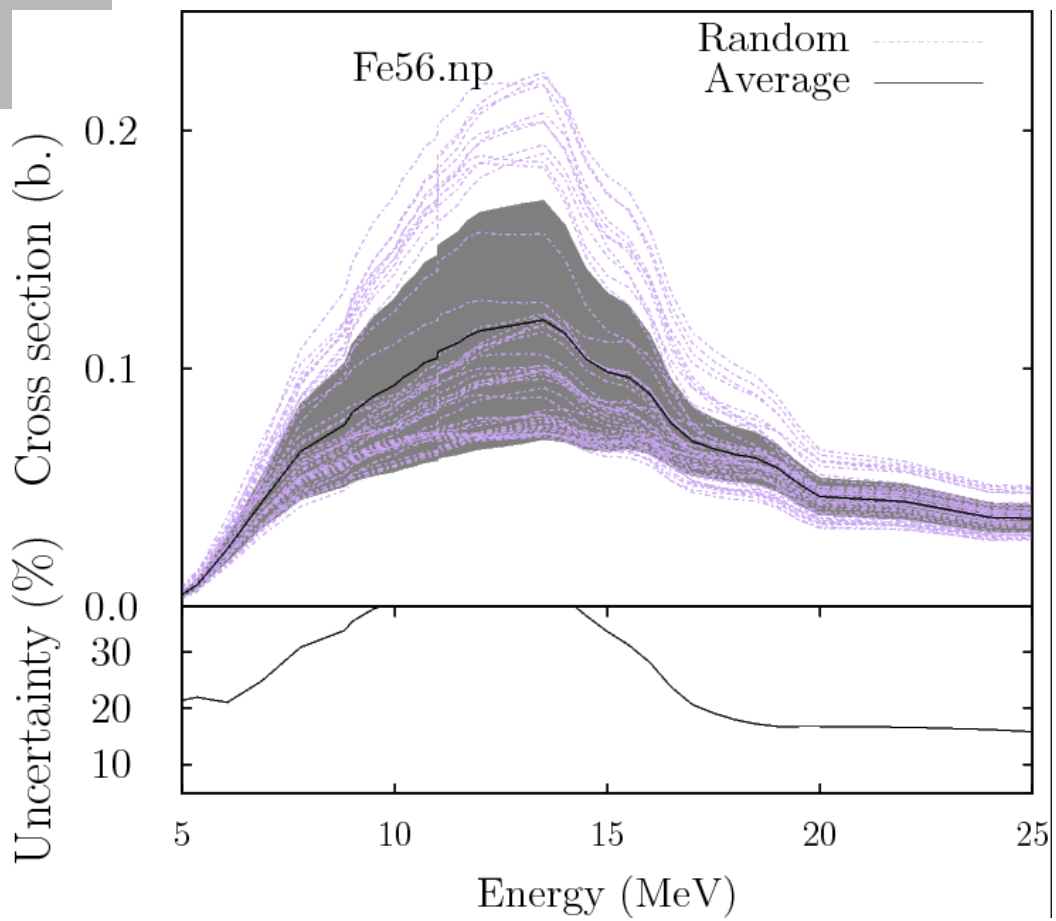
- Posterior: random sampling of model parameters.

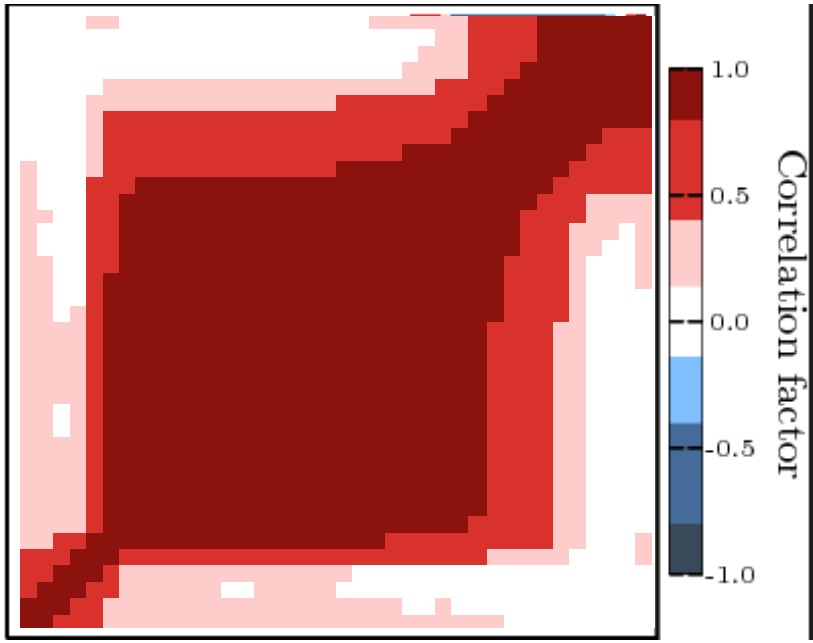




^{56}Fe(n,2n): TALYS (10 models)+EXFOR+BFMC

- Prior: random sampling of model parameters + models.





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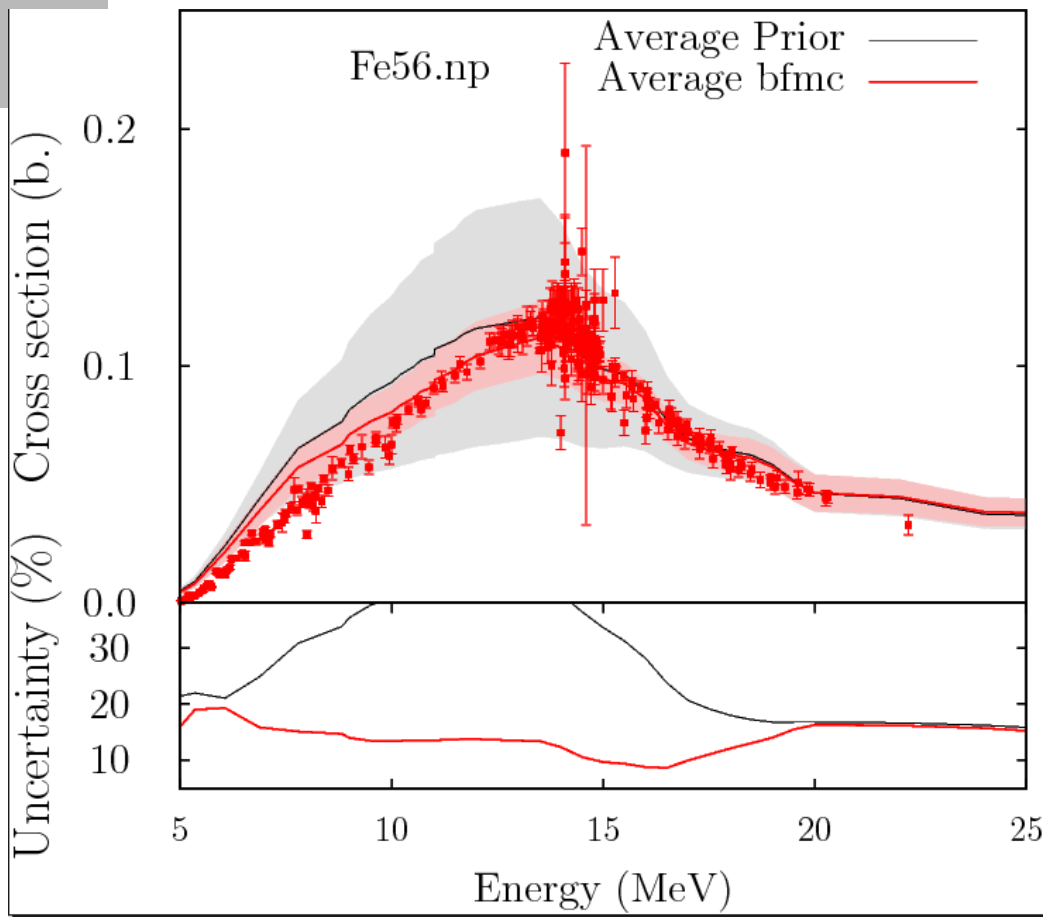
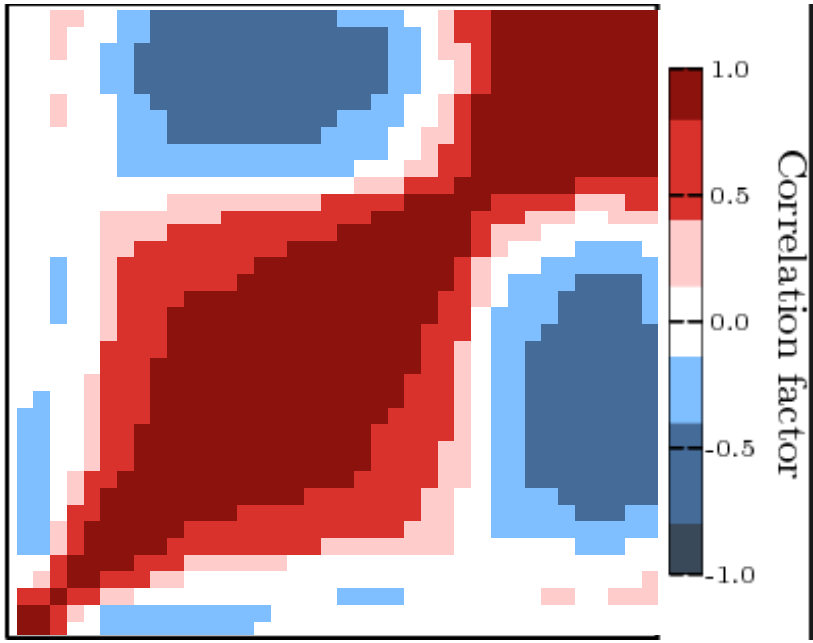
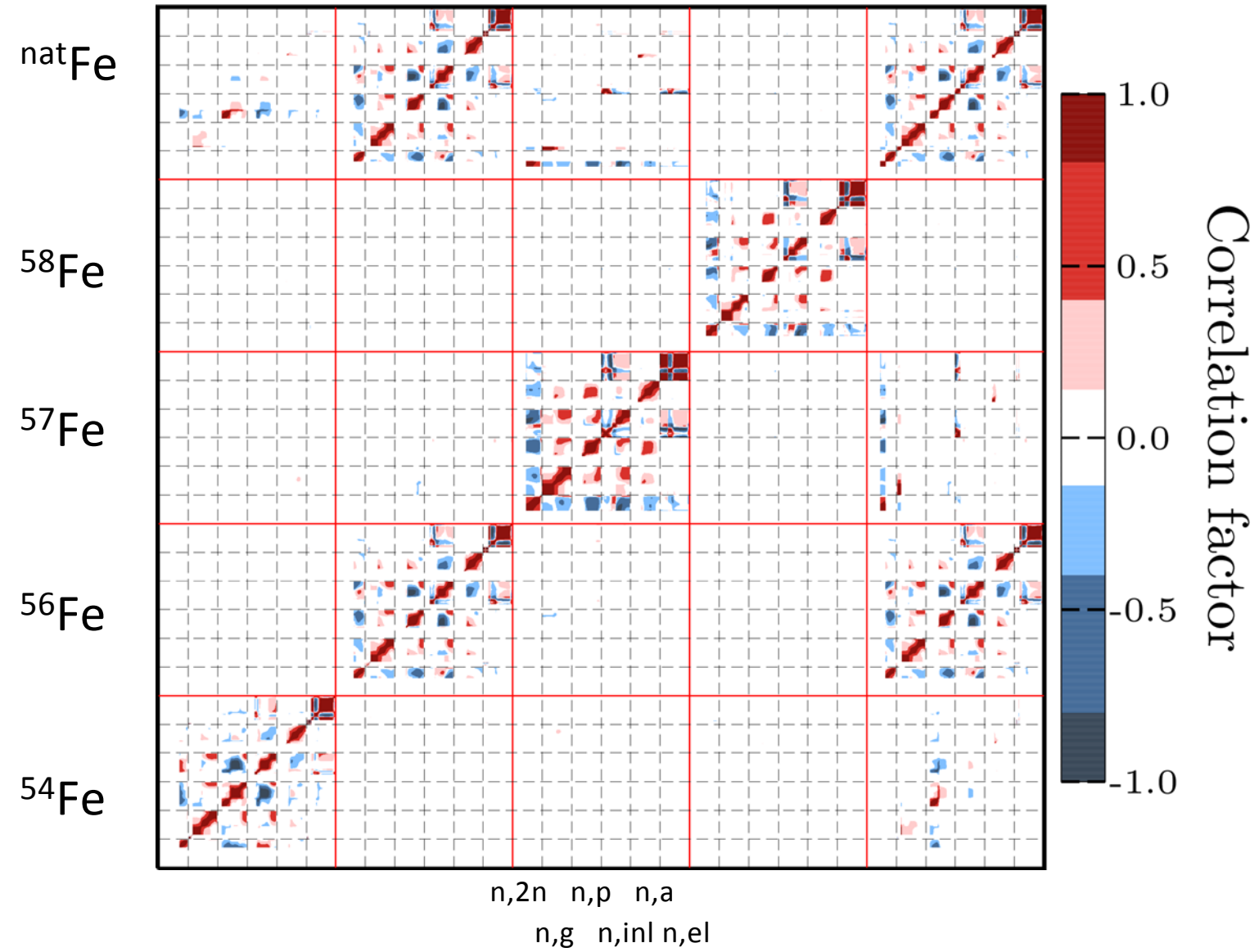




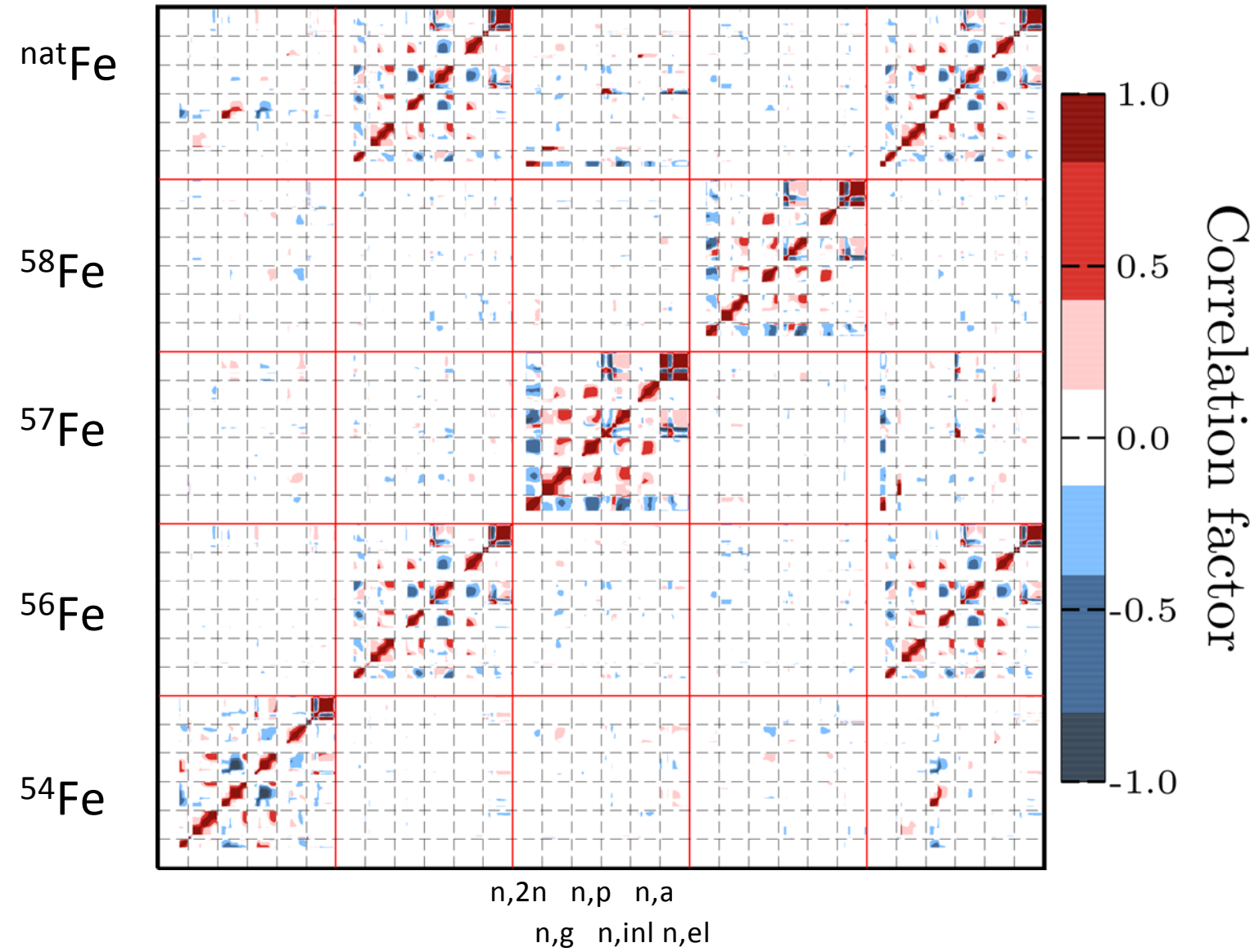
^{54,56,57,58,nat}Fe: TALYS+EXFOR+BFMC

- Many reactions and isotopes (1 single model for the time being): prior



^{54,56,57,58,nat}Fe: TALYS+EXFOR+BFMC

- Many reactions and isotopes (1 single model for the time being): posterior



Status and plans

2. Improve specific activation cross sections as required for PPPT neutronics, activation and safety analyses.

   – Not done yet
   – Would need a list of reactions to be improved.

Conclusion

- Task 1:
  - Well started,
  - To be done: include more models, check model defects
  - Will be summarized in a TENDL publication

- Task 2:
  - Not started yet,
  - Can use specific feedback from users ?

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Wir schaffen Wissen – heute für morgen