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Correlation U-Pu from measured boron letdown curve

JEFF meeting, NEA, Paris, 28-30 November 2018

Summary

- Motivation
- Short description on BFMC/BMC
- Previous correlations found in the fast range
- System considered in the thermal range
- Results

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

BMC/BFMC + integral data

- Motivation 1: integral data are already used during adjustment
- Motivation 2: This should be done at the evaluation level
- Motivation 3: It leads to uncertainty reduction and cross-isotope correlations
- Motivation 4: nothing new: already done with GLLS by SG… at the OECD

BMC/BFMC + integral data

- Step 1 - Preliminary work: in-depth cross section evaluation (traditional method of parameters/models adjustment)

- Step 2 - BMC: Based on step 1,
  - Generate n=100 000 (or 1000) random files (TMC-way)
  - Calculate n times the benchmarks
  - Assign weights to all realizations *i* with a chi2 and update the parameter distributions

For a random file i and a set of p benchmarks:

$$\chi_i = \sum_j^p \left(\frac{\mathrm{k}_{\mathrm{eff,i}}^{(\mathrm{j})} - \mathrm{k}_{\mathrm{exp}}^{(\mathrm{j})}}{\Delta \mathrm{k}^{(\mathrm{j})}} \right)^2 \quad (1)$$

$$w_i = \exp(-\frac{\chi_i}{2}) \quad (2)$$

$$\begin{cases} \omega = \sum_i^n w_i \\ \omega_\sigma = \sum_i^n w_i \cdot \sigma_i / \omega \end{cases}$$

  - Update the cross sections with the weights.

- Some BMC/BFMC references:
  - EPJ/A 51 (2015) 184, Nucl. Data Sheets 123 (2015) 201, EPJ/N 3, 14 (2017)

BMC/BFMC + integral data: example 1/3

- Fast range:

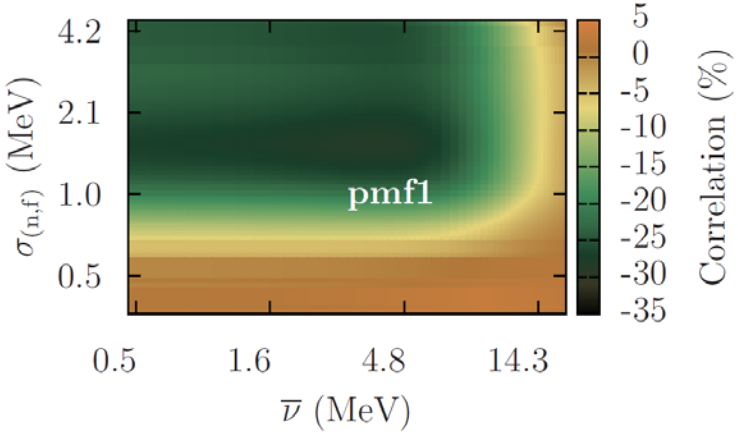

Fig. 3. Correlation matrix between ^{239}Pu ν and σ considering the fast pmf1 benchmark. The X- and Y-axis are in log scale.

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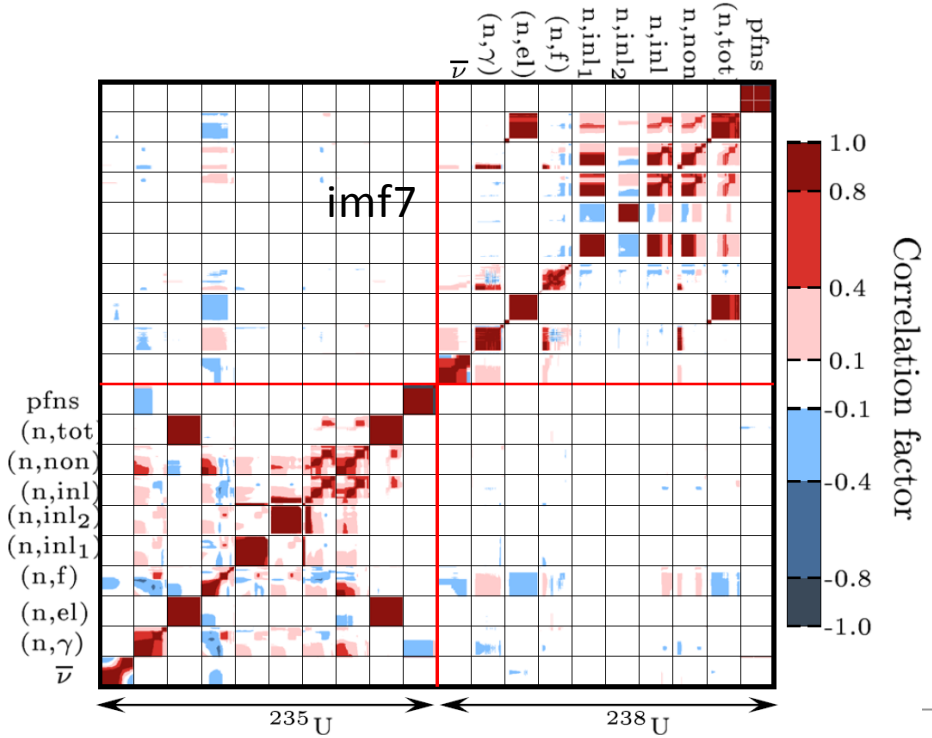

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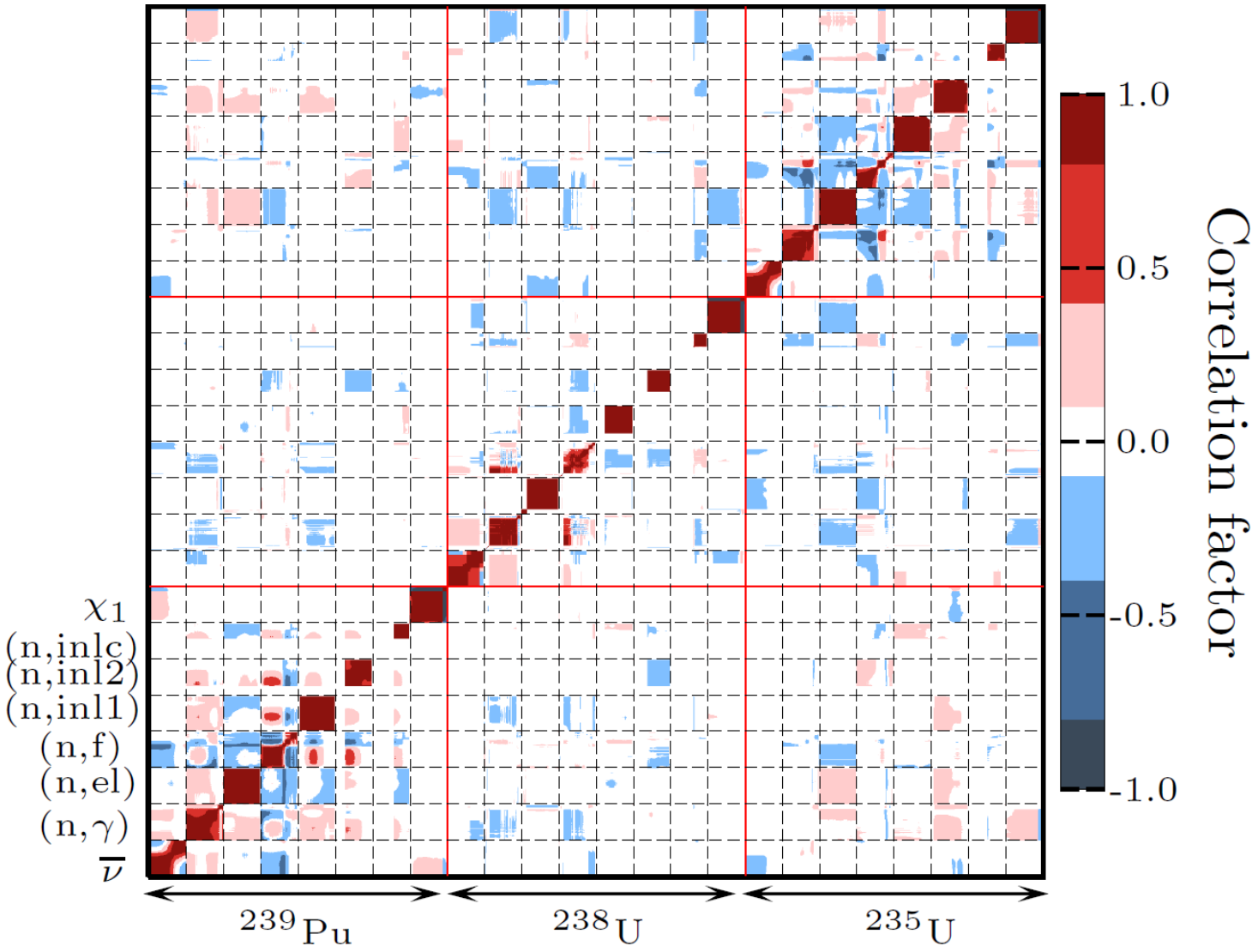
BMC/BFMC + integral data: example 2/3

- Fast range: 14 reactions together (k_{eff} and reaction rates)



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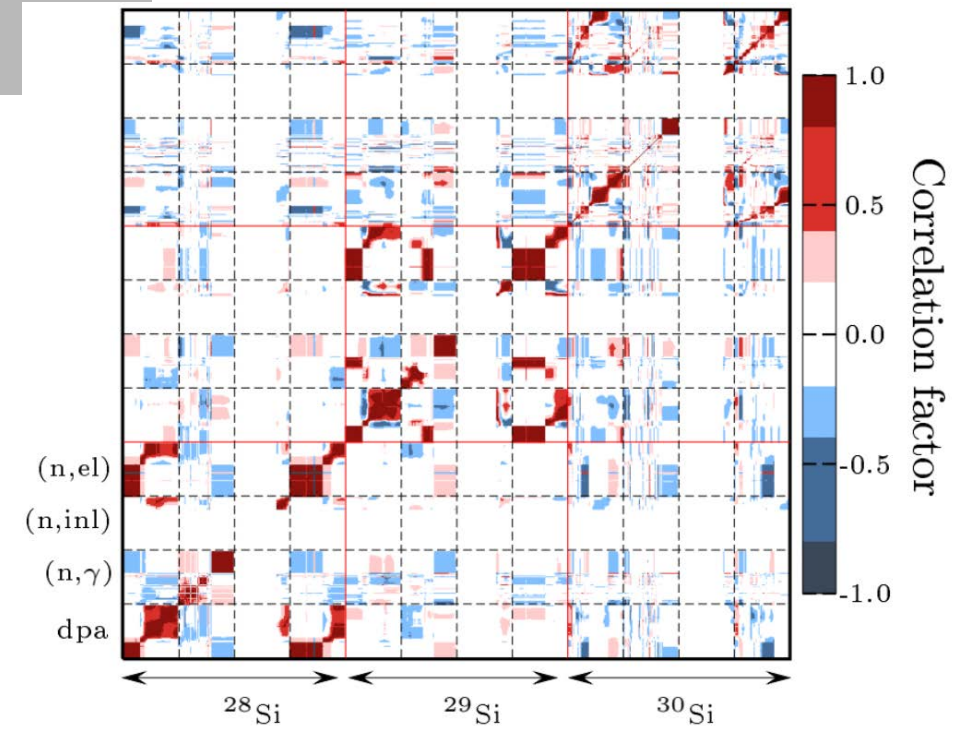
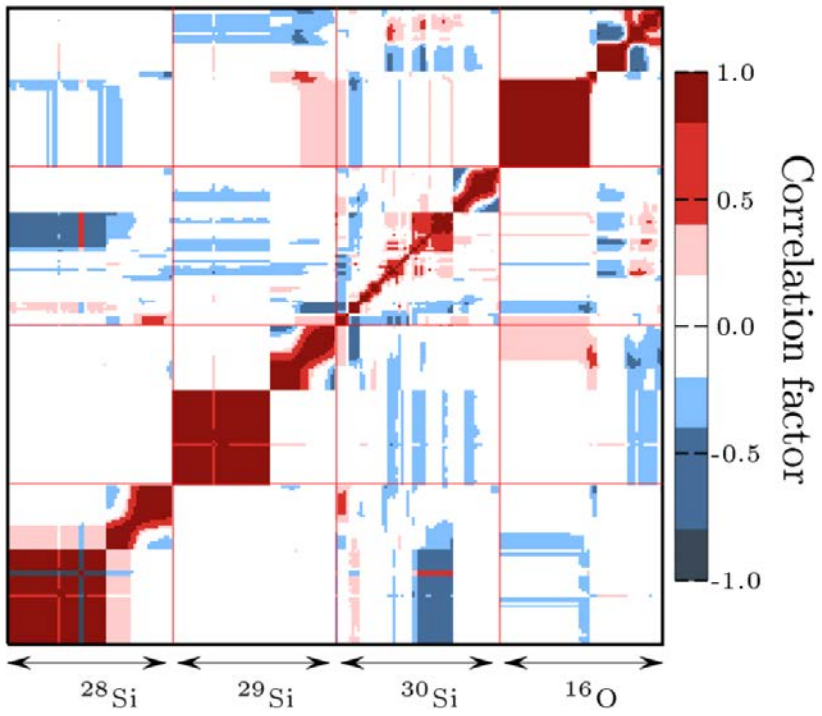
BMC/BFMC + integral data: example 3/3

- Based on EXFOR only: Si + SiO_2 + ^{16}O



with SiO_2



(n,tot) only

BFMC with a PWR boron concentration

- System: realistic PWR cycle with measured boron concentration
- Random nuclear data: generated based on the ENDF/B-VII.1 library for all isotopes
- Simulation tool: (CASMO5 + SIMULATE5) x (a few thousands of random files)

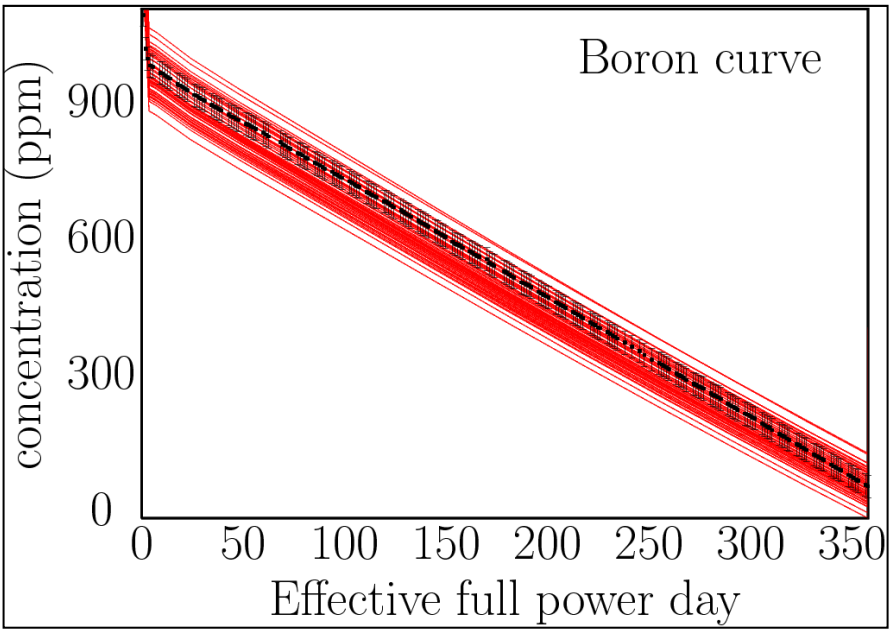
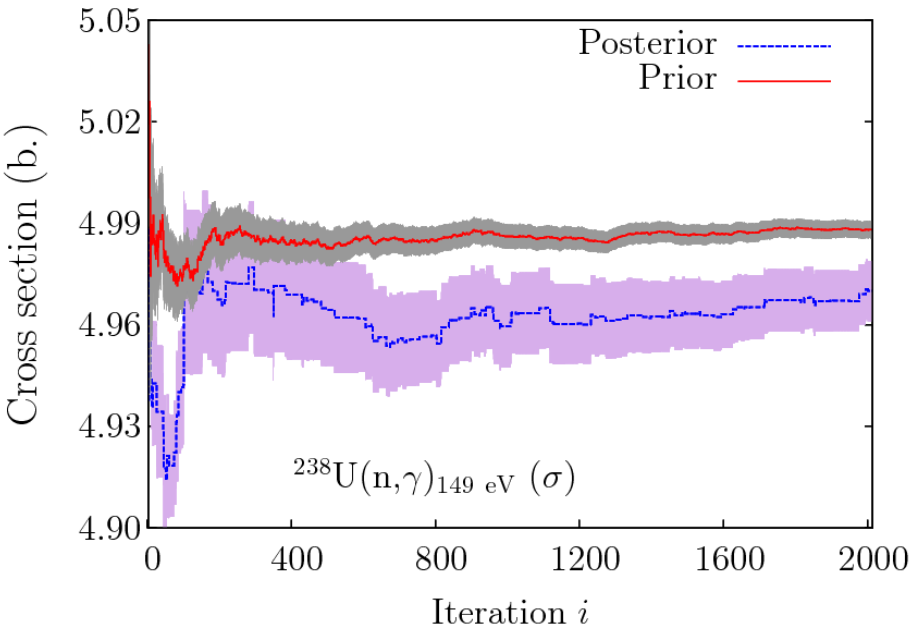


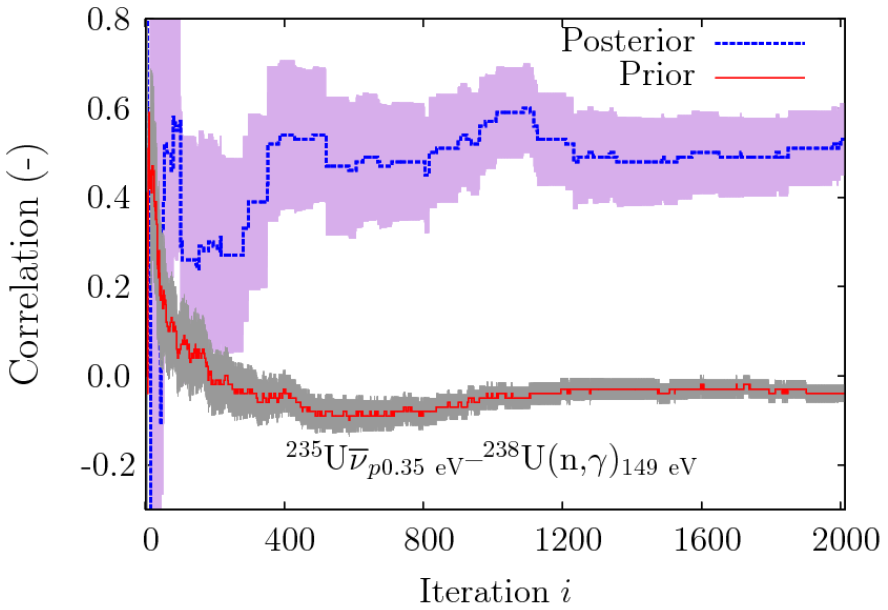
Table 2. Impact in percent of the variations of specific nuclear data at the middle of cycle (close to 150 efpd). The 5 reactions are $^{235}U_{\overline{\nu}_p}$, $^{235}U(n,f)$, $^{238}U(n,\gamma)$, $^{239}Pu(n,f)$ and $^{239}Pu_{\overline{\nu}_p}$.

Data	All	light	minor actinides	5 reactions considered here
Impact (%)	12	1.2	1.9	11

BFMC with a PWR boron concentration

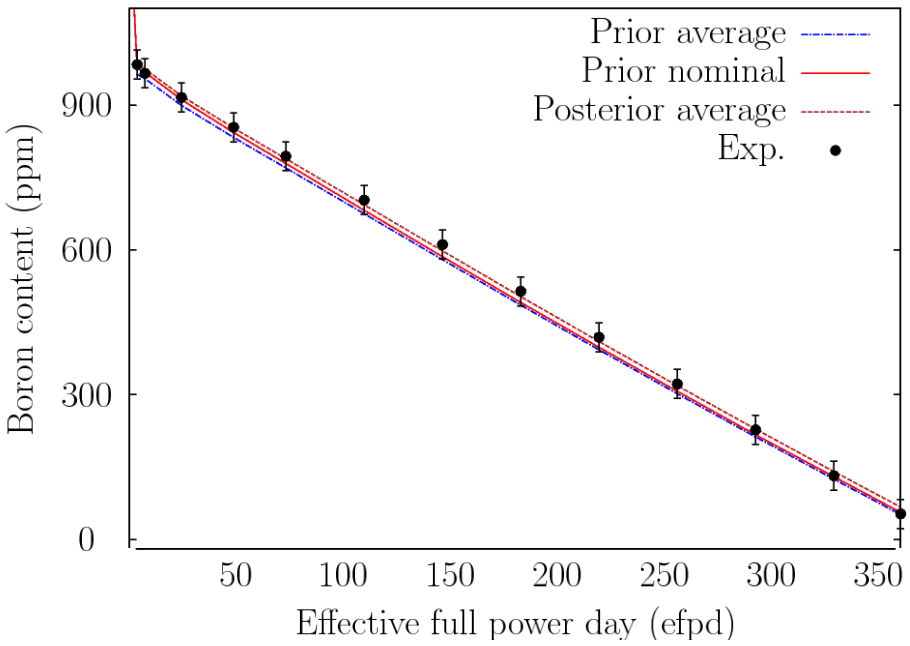
- Reactions: only 5 considered: ^{235}U-nubar, ^{235}U(n,f), ^{238}U(n,g), ^{239}Pu-nubar, ^{239}Pu(n,f)
- Convergence: 2000 runs

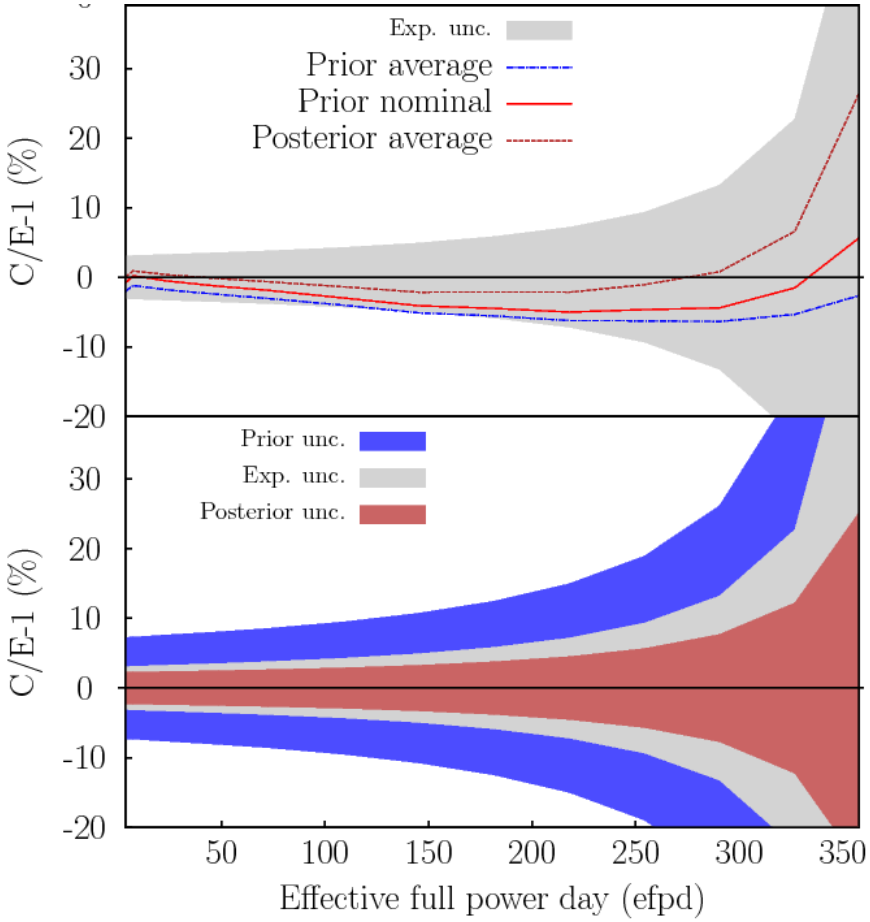




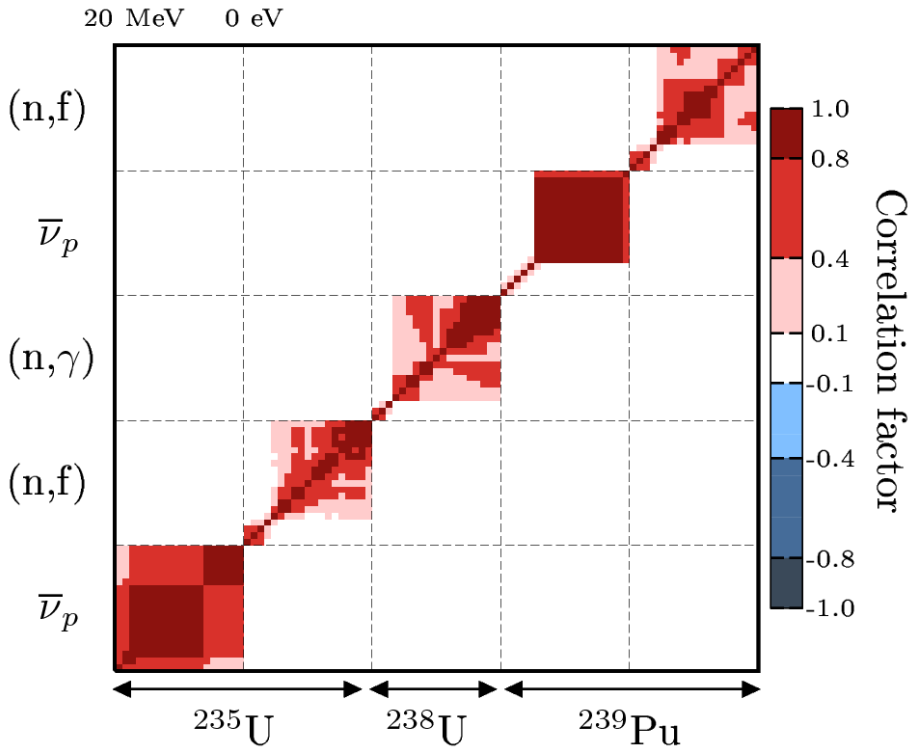
BFMC with a PWR boron concentration

- Impact on the boron concentration

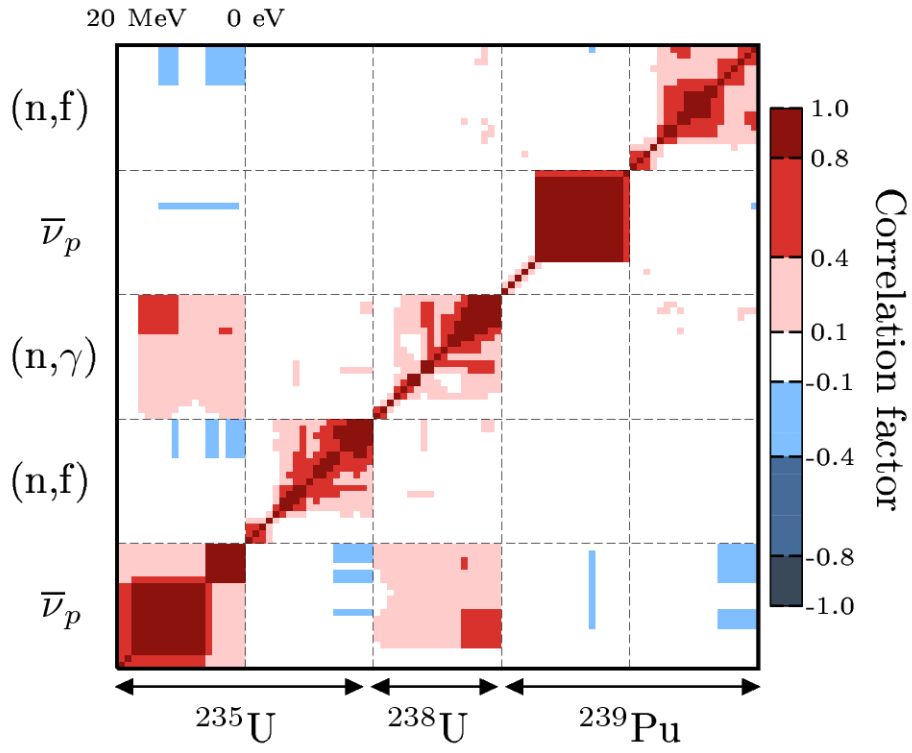




Correlation matrices

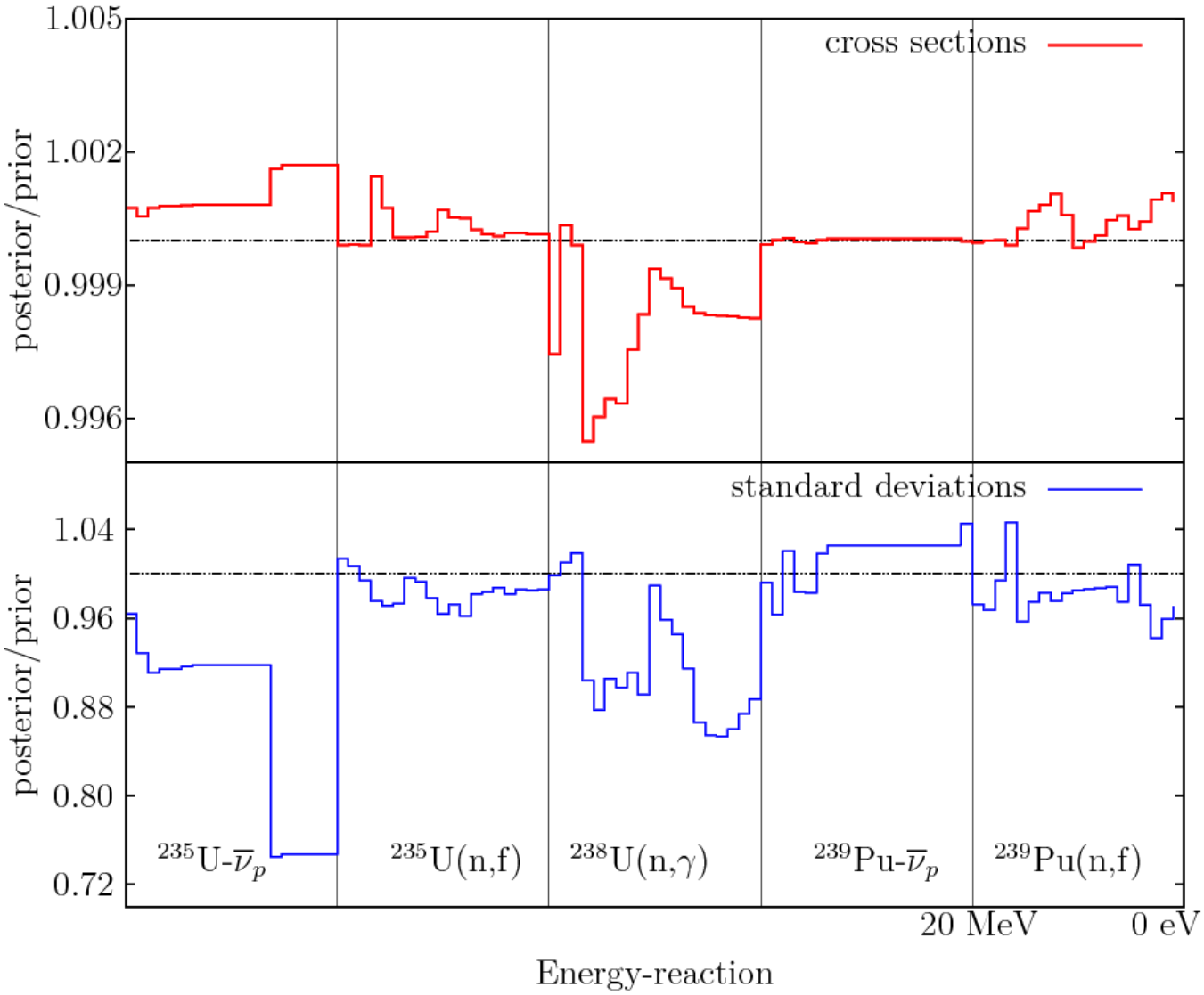


Prior



Posterior

Posterior cross sections and uncertainties



Conclusions

- Cross-correlations found between isotopes in the fast and thermal ranges
- Decrease of the uncertainties for posterior quantities
- A suggestion: use integral data during the evaluation process,
- Outcome: more correlations, smaller uncertainties and less biaises

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PSI

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