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Covariance in Ni-59 for JEFF 3.3 – A TMC based uncertainty approach

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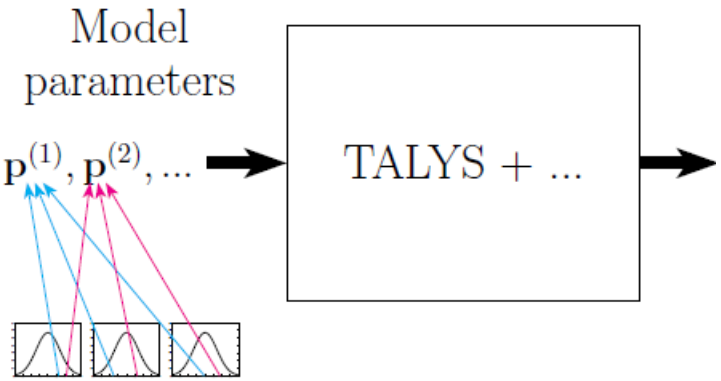
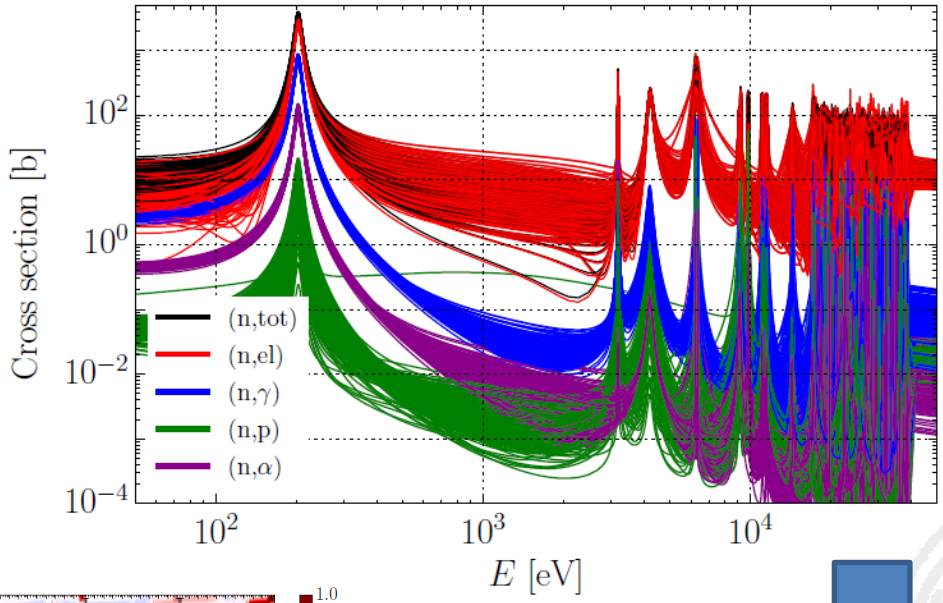
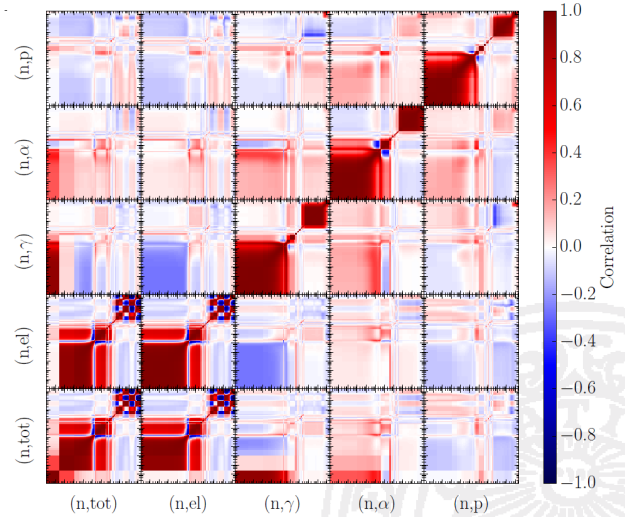
Sampling based evaluation and uncertainty quantification: TMC







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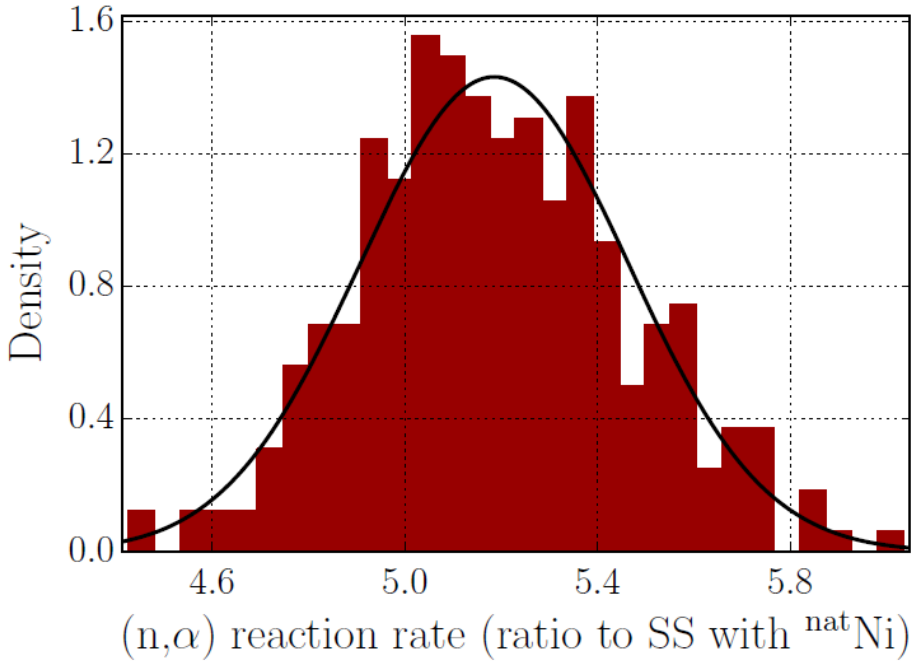
Total Monte Carlo U.Q.

- Straight forward and transparent treatment of the uncertainty propagation
- Bias free uncertainty propagation, e.g. no linearization.

- Non Gaussian behavior in input and output can be modelled.
  - ✓ Higher moments included.
- More complete U.Q.
  - ✓ More correlations included



Creating Ni-59 random files

Consistency over the entire energy range

- For each file:
  1. Run TALYS with random parameters [1]
  2. Sample thermal xs
  3. Sample Harvey's resonance parameters
     - with exp. unc. + additional component approximating systematic errors in experiments (correlated to thermal exp.)
  4. Sample bound resonances and lower URR
     - Using URR parameters from *the same* TALYS run
  5. Adjust bound resonances to match thermal cross sections
     - If thermal cross sections unreachable: combination "unphysical" ⇒ start over at item 2
     - Otherwise: file complete; continue

[1] A. Koning and D. Rochman, "Modern Nuclear Data Evaluation With The TALYS Code System", Nuclear Data Sheets **113**, 2841 (2012)

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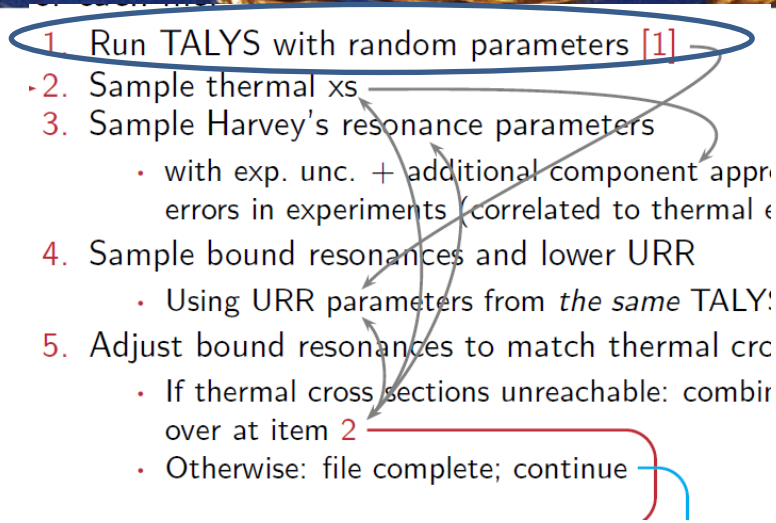
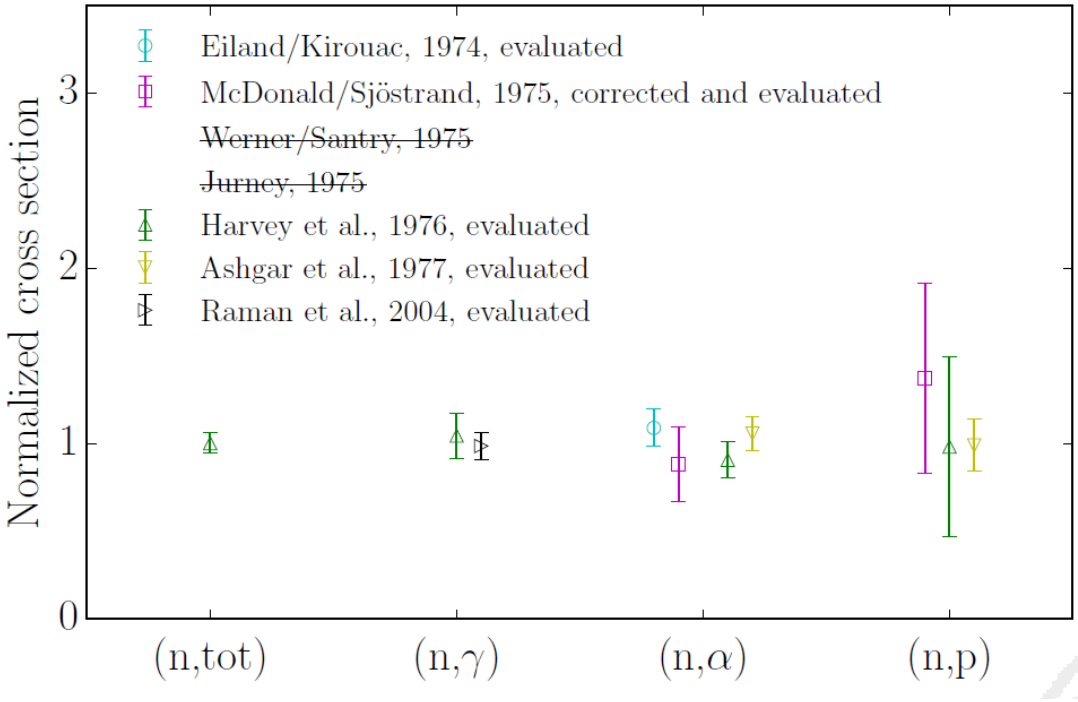


- Taken from TENDL 2015 parameters distribution.
- TENDL2015 Ni^{59} parameter distribution is extrapolated from investigating the predictive power of default TALYS for isotopes where experimental data is available.*

**A. Koning, "Bayesian Monte Carlo for nuclear data evaluation", The European Physics Journal A 51, 184 (2015)*



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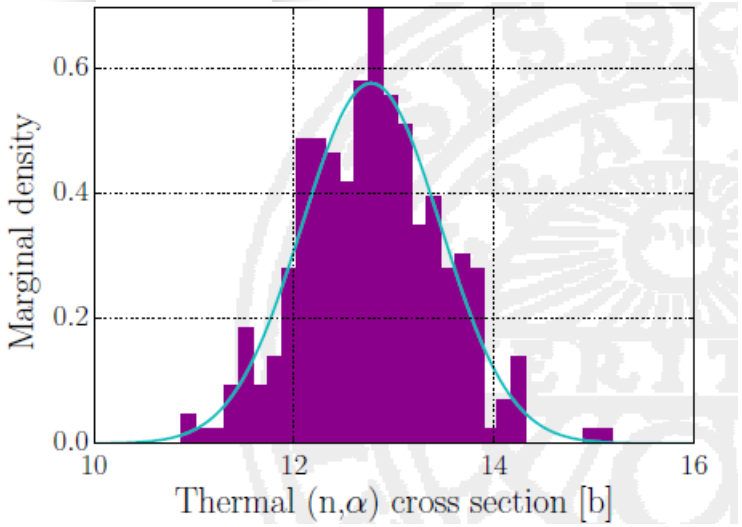
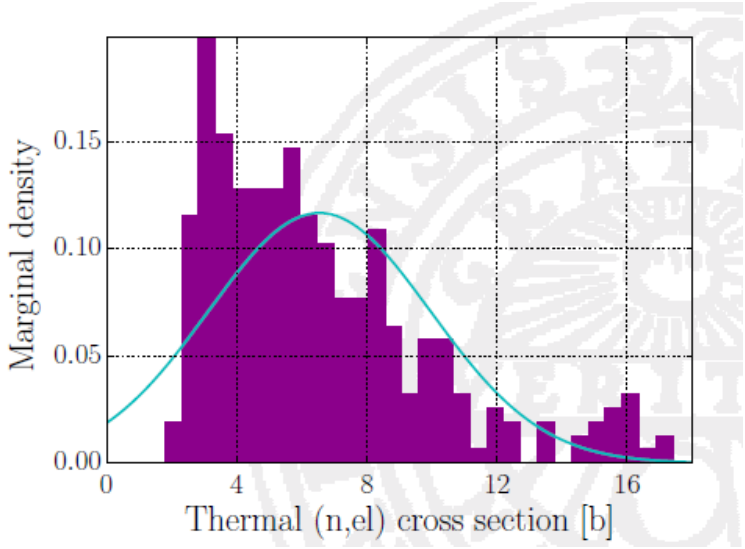
Sample the individual error components provides experimental correlations.

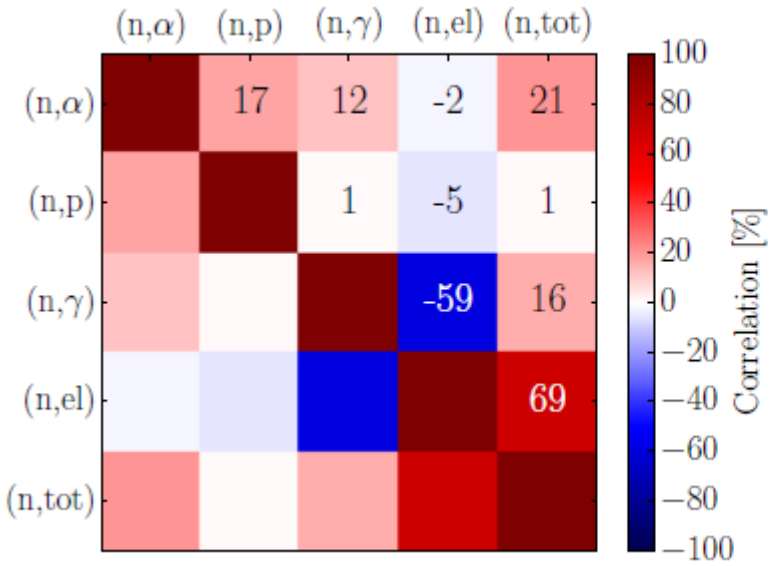
$$\sigma = \frac{C\mathcal{N}'}{C'\mathcal{N}}\frac{\epsilon'}{\epsilon}\frac{\Phi'}{\Phi}\sigma' \quad \text{or} \quad \sigma_{\text{tot}} = -\frac{\log\left(\frac{C\Phi'}{C'\Phi}\right)}{\mathcal{N}},$$

- C = counts, ϵ = det. eff., $\mathcal{N}$ = # nuclides/area, Φ = fluence
- Prime ($'$) indicates reference measurement

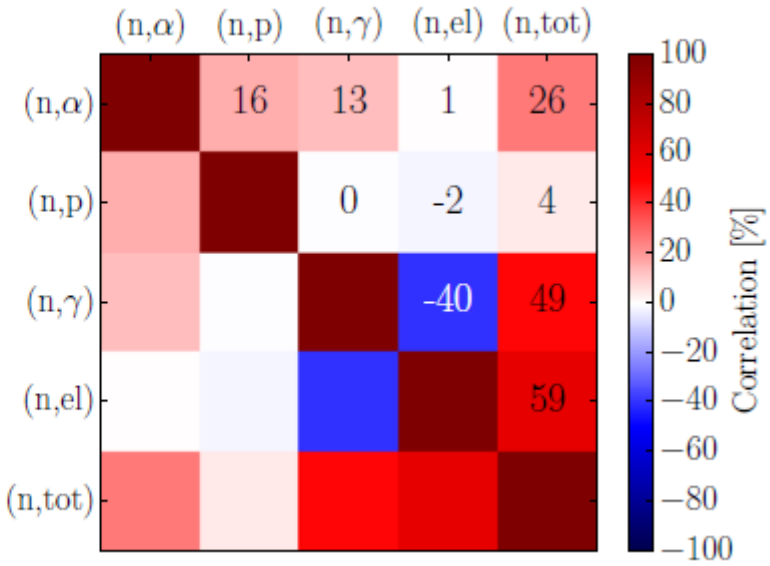
Physical constrains included







No constrains



Positive (n,el)

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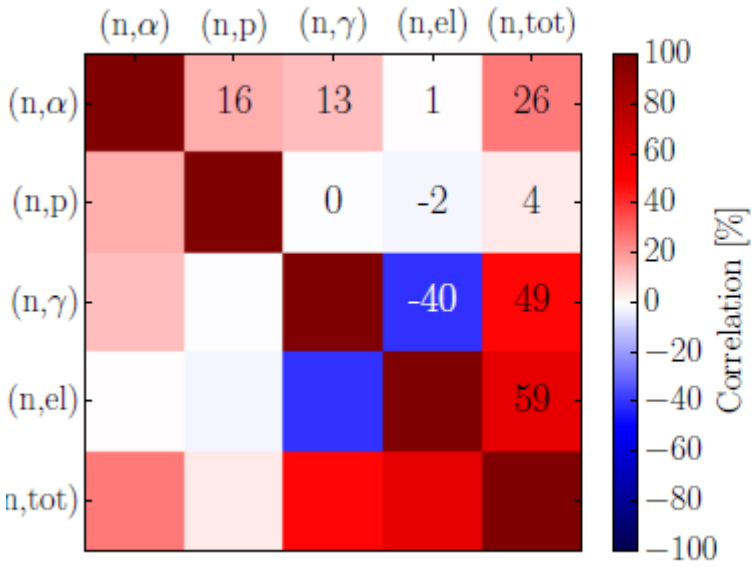

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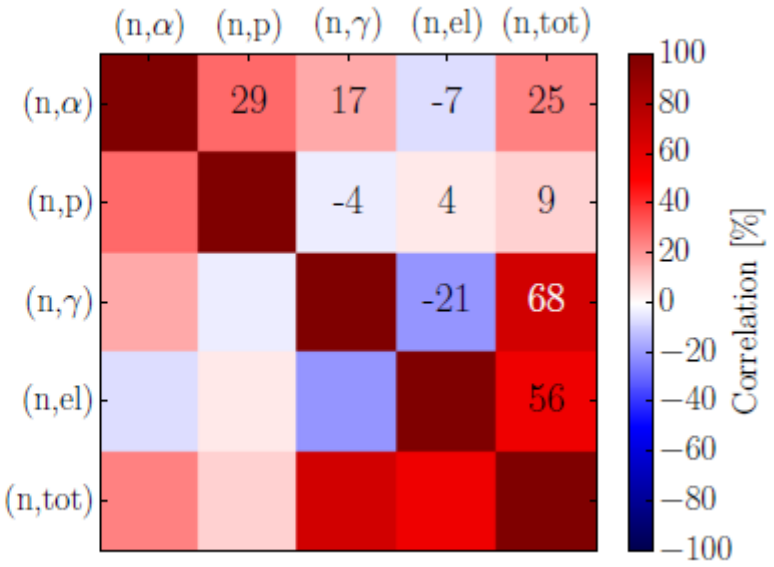

Final thermal correlations

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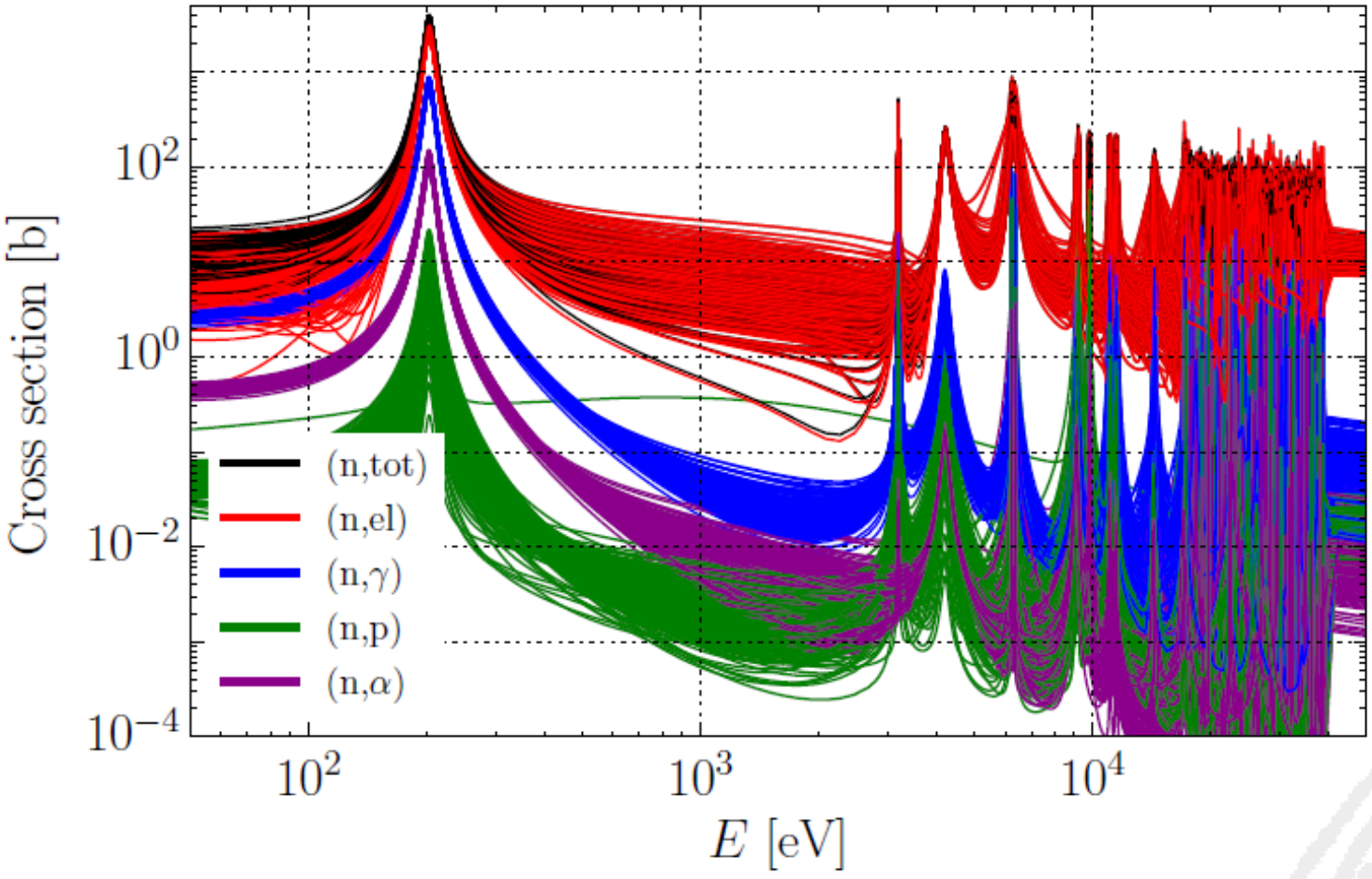
Resulting cross sections



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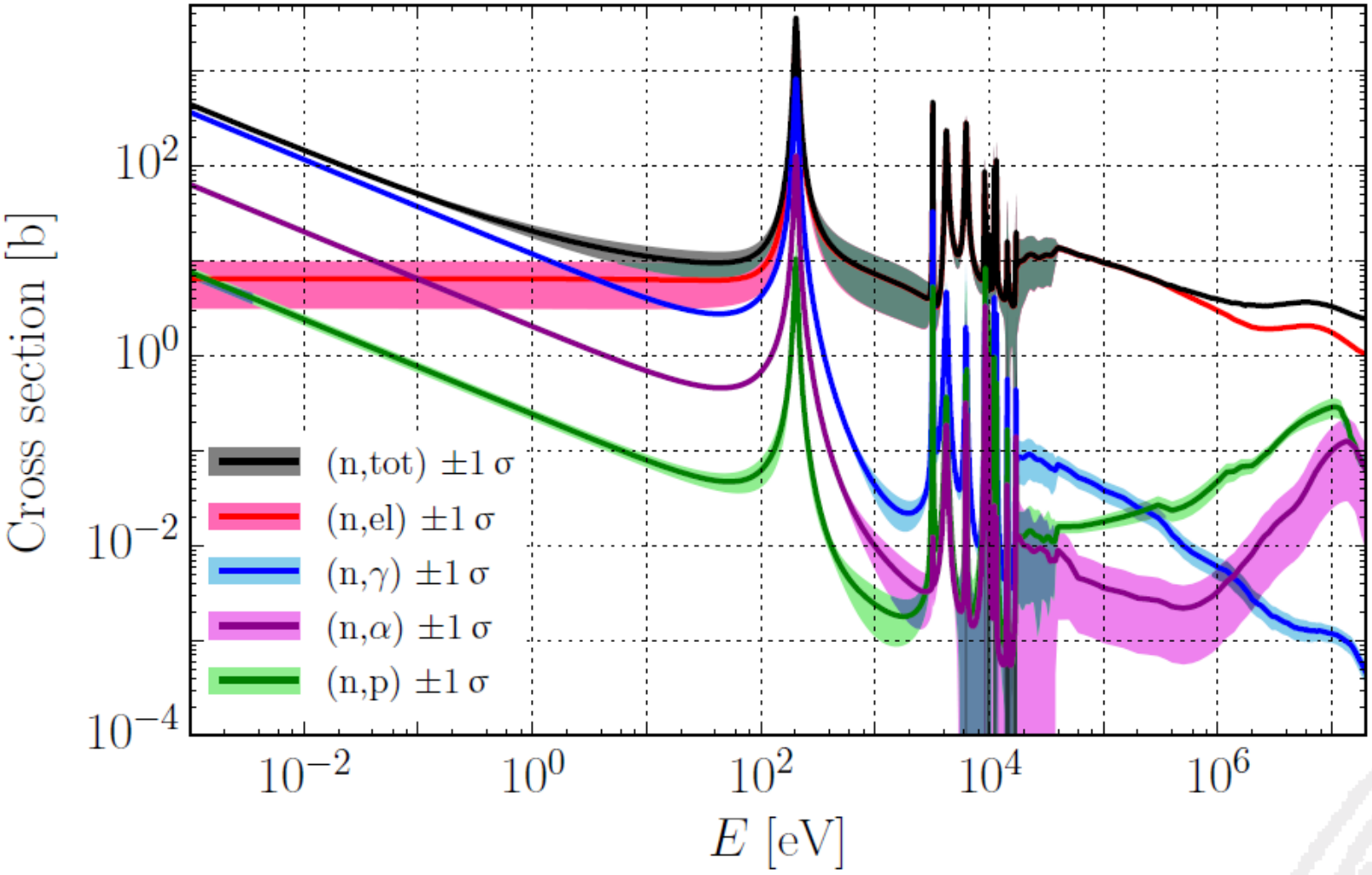

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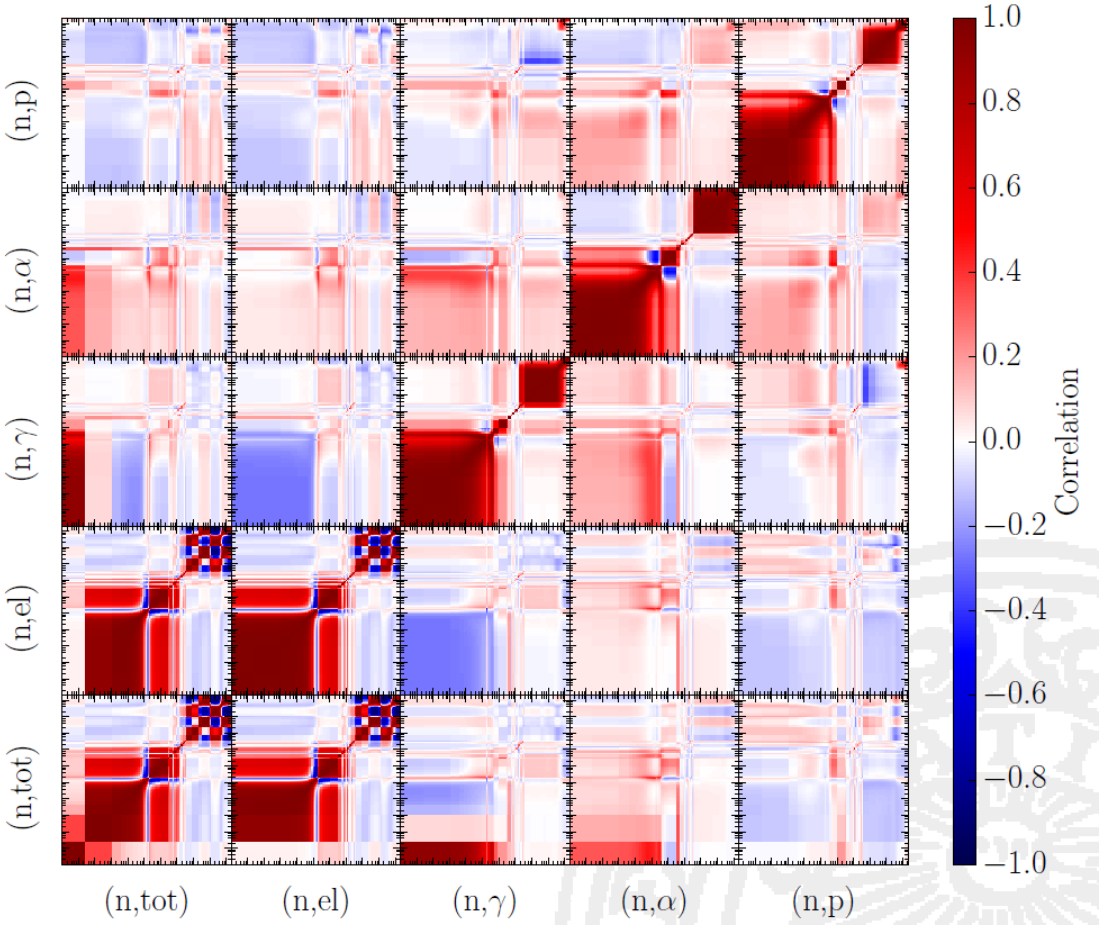
Consistent co-variances



- Community is still asking for co-variances
  - Loss of information
- Computed from the random files

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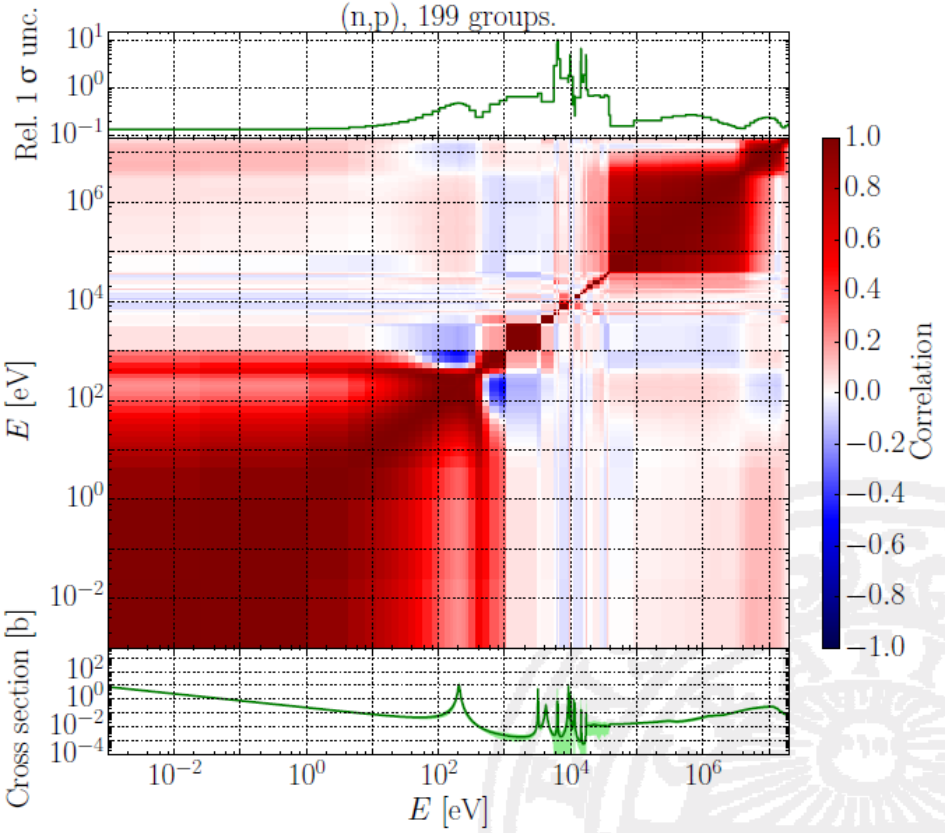
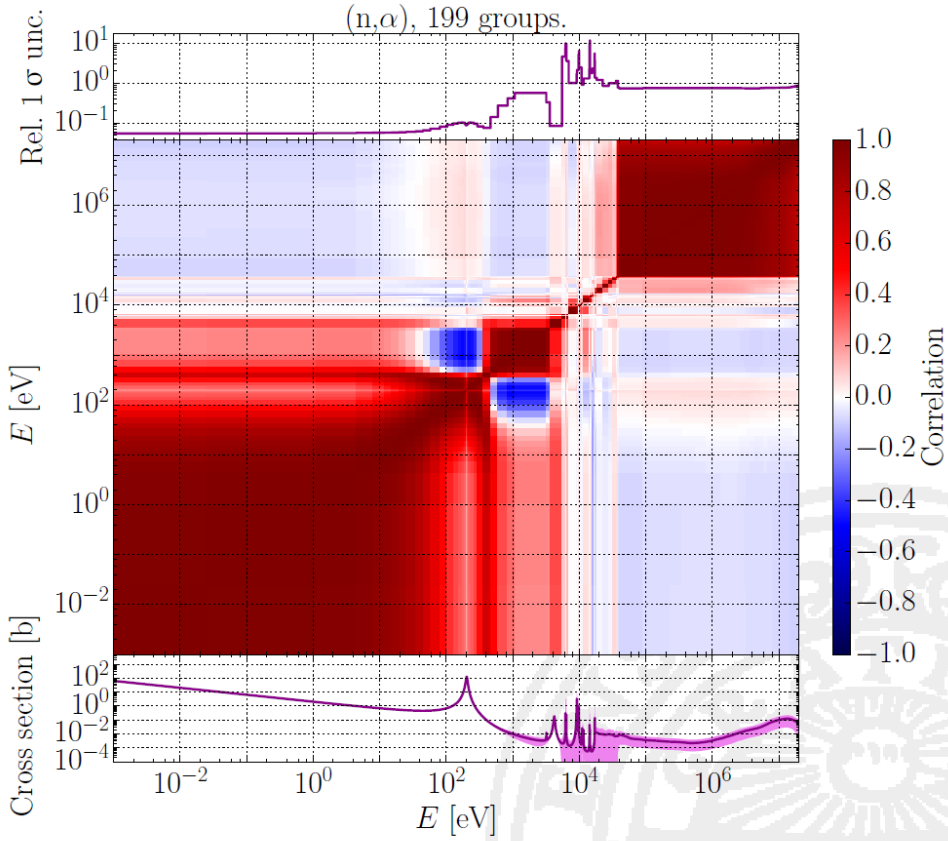
Consistent co-variances





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Conclusion: New ^{59}Ni evaluation with covariances

- JEFF 2.2-3.2
  - No covariance information
- This file
  - Uncertainties propagated all the way from individual experimental error components
  - Combining resonances (exp), thermal data (exp),and TALYS (URR and fast range)
  - Uncertainties stored MF33
- Some information lost using co-variances
  - Use randomfiles

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Acknowledgement

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- Special thanks to Jean-Cristophe Sublet (UKAEA, Abingdon, UK) for discussions on the ENDF format, to
- Denise Neudecker (LANL, Los Alamos, NM, USA) for discussions on experimental uncertainties, and to
- Arjan Koning (IAEA-NDS, Vienna, Austria) for general discussionson nuclear data uncertainties and TMC.