Impact of Unrealistic or Missing Cross Section Covariances

Workshop for Applied Nuclear Data Activities 2020

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Distribution of data with select covariances

Evaluations that include \((n,\text{el}), (n,n'), (n,2n), \text{ and } (n,\gamma)\) covariances:

Uncertainties:
- ENDF/B–VIII.0
- ENDF/B–VII.1
- Lo–Fi
- None

- Naturally abundant
Missing and questionable covariances

Missing \((n,n')\), \((n,2n)\), or \((n,z)\) covariances: Gamma production, transport, destruction

ENDF/B-VIII.0 100% abundant

Questionable covariances: Overestimates uncertainty contribution
Low-Fi evaluations with available experimental data

Could experimental data be used to test whether these are credible or improve them?
LLNL consensus needs for covariances

- Complete nuclear data covariances needed for applied UQ studies.
  - Needs can’t be established without these.

- Methods for determining credibility of evaluation needed:
  - Visual validation provides initial approximation.

- Covariances in \((n,n')\), \((n,2n)\), and \((n,z)\) needed for many isotopes:
  - \((n,n')\) and \((n,2n)\) covariances often missing from ENDF/B-VIII.0.
  - Some ENDF/B-VIII.0 covariances are difficult to interpret (e.g. sums like \((n,2n)+(n,2np)\)).
  - \((n,z)\) covariances frequently missing from ENDF/B-VIII.0 and Low-Fi.

- Approximate methods for filling in missing and bad covariances needed:
  - Extension of Low-Fi strategy could be a useful starting point for missing reactions.
  - Kyle Wendt will present about a machine learning technique applied to experimental data.

- Need for proper estimation of model and parameter uncertainties and their impact on pure theory covariances.
Some nuclear cross sections of interest with missing, limited, or inconsistent data

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Reaction</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^9$Be</td>
<td>n-g</td>
<td>Two lines are fitted to one point</td>
</tr>
<tr>
<td>$^{12}$C/$^{14}$N/$^{16}$O</td>
<td>n-n‘g</td>
<td>Very limited data</td>
</tr>
<tr>
<td>$^{58}$Fe</td>
<td>n-g</td>
<td>Very limited data</td>
</tr>
<tr>
<td>$^{183}$W</td>
<td>n-p</td>
<td>No data to constrain the threshold</td>
</tr>
<tr>
<td>$^{190}$Pt</td>
<td>n-2n</td>
<td>No data to constrain the threshold</td>
</tr>
<tr>
<td>$^{190}$Pt</td>
<td>n-p</td>
<td>No data available</td>
</tr>
<tr>
<td>$^{233}$U</td>
<td>n-2n</td>
<td>No data available</td>
</tr>
<tr>
<td>$^{235}$U/$^{239}$Pu</td>
<td>n-n’</td>
<td>Incomplete energy-angle data</td>
</tr>
<tr>
<td>$^{239}$U</td>
<td>n-g</td>
<td>Only one data point available</td>
</tr>
</tbody>
</table>

- Peer review from LANL has begun
- We would like help in assessing, choosing, or performing measurements with a minimum of 10% uncertainty

LLNL Presented this slide last year; we will continue to update this as needed and present it
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