ORNL R-matrix Analyses for Non-Fissile Materials within NCSP

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Nuclear Data Cycle: Foundational Measurements

Motivation

Differential Measurements

Data Evaluations

Evaluated Nuclear Data Files (ENDF)

Nuclear Data Processing

Validation / Applications

Foundation

<table>
<thead>
<tr>
<th>Evaluation</th>
<th>End Date</th>
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</thead>
<tbody>
<tr>
<td>$^{35}$Cl</td>
<td>2025</td>
</tr>
<tr>
<td>$^{63,65}$Cu</td>
<td>2023</td>
</tr>
<tr>
<td>$^{176,177,178,179,180}$Hf</td>
<td>2025</td>
</tr>
<tr>
<td>$^{139}$La</td>
<td>2023</td>
</tr>
<tr>
<td>$^{88}$Sr</td>
<td>2023</td>
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<tr>
<td>$^{181}$Ta</td>
<td>2023</td>
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</tbody>
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$^{181}$Ta

- New capture and transmission data (RPI)
- RRR evaluation (NNL)
- URR evaluation (ORNL)
- Fast evaluation (LANL)

- File assembly in progress
  - NNDC GitLab for details
- Validation ongoing
Strontium evaluation

- **Motivation**
  - Existing $R$-matrix analysis of $^{88}$Sr in the RRR was performed from the fit of ORELA transmission and capture measurements
  - The evaluation work was never included in the ENDF/B-VIII.0 library
  - Resonance parameters taken from Kohler’s paper (Phys. Rev. C62, 055803, 2000) and compared to ENDF/B-VIII.0
  - Overall good agreement with measured data and ENDF/B-VIII.0 except in the low-energy region

- **Action(s):** Calibration of the negative levels and possible extension up 1 MeV (Currently ENDF is up to 300 keV).
Chlorine evaluation

**Motivation**

- The $^{35}$Cl(n,p) cross sections largely underestimated in ENDF/B-VIII.0 library
- Methodology to derive (n,p) data from total cross section developed and preliminary set up of the evaluation procedure
- New measurements are in progress (LANL, OU, nTOF, ...) and needed to updated the (n,p) reaction channel

**Action(s):** Inclusion of newly measured data when available
Hf – preliminary work

- Evaluation in conjunction with IER-532 (TEX-Hf benchmark)
- Multi-institute collaboration (ORNL, IRSN, NNL)
- Review of resolved and unresolved resonance regions indicate updated evaluations for all isotopes is warranted
  - RRR: can extend upper energy limit by several keV for each isotope
  - URR: affected by changes in RRR and need to include previously unincorporated experimental data
**176,177,178,179,180** Hf – preliminary work

- Fast energy region also analyzed; lack of experimental data made comparison difficult

- Evaluation will require new transmission measurements
  - Cannot use samples from JEFF evaluation, so new samples will be required
  - Previous capture measurements from Ware might be useable if suspected experimental contamination can be quantified
The $(n, \gamma)$ cross section for $^{63}\text{Cu}$ has been increased, in order to agree with recent measurements by Weigand et al (2017).

The Legendre coefficients for both $^{63,65}\text{Cu}$ have been adjusted to fit the measured data reported by Popov (1986) and Smith (1967).
The adjustment to the Legendre coefficients contributes to overall agreement, and the increase in the $^{63}$Cu capture cross section reduces the trend in the ZEUS (HMI-006) series with respect to EALF.
The preliminary $R$-matrix analysis for $^{139}$La has fit resonance parameters to new capture and transmission measurements from Guber et al. The maximum energy for the resolved resonance region is under investigation.
Acknowledgements

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The entire Nuclear Data Group at ORNL