Covariance availability for neutron reaction data

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Desired Covariances

- Covariance matrices should describe
  - the uncertainties at particular energies and angles (diagonals)
  - the correlations between different energies, angles (off-diagonals).
- Should reflect:
  - Uncertainties in experimental measurements
  - Correlations between experiments induced by common calibrations:
    - Target thickness & purity, Beam energy and resolution, Detector calibrations
    - Correlations from ratio measurements etc., in GMA analysis.
  - Correlations between model predictions in different channels:
    - Common roles of level densities, optical potentials, fission barriers, etc.
- Rarely yet included:
  - Correlations from fitting integral experiments e.g. critical assemblies.
    - Induce correlations between fission cross-sections, multiplicities, fission spectra (not always representable in ENDF format)

Covariances in ENDF/B-VIII

- This library has the best covariance set to date.
- But no covariances at all for neutrons on:
  - N14, Fe58, Cu63,65, Zn67,68,
  - U237,239,240, Am242. (*)
- No covariances for some channels:
  - Charged-particle production on Al27, Si28, Au197, U235,238.
  - Au197(n,2n) *
- Some odd covariances:
  - Large: N15
  - Small: Pu240
- No covariances between fission and fission-neutron spectra.

* Early 'Lo-Fi' covariances exist in ENDL library at LLNL
R.C. Little, et. al., "Low-fidelity Covariance Project", Nucl. Data Sheets **109**, pp. 2828-2833 (2008)

Filling in the gaps

- Want (at first) without a new full evaluation.

- Construct simple covariances based on
  1. Differences between existing evaluation libraries.
  2. Comparison of mean values with spreads of experimental data
  3. Model-dependence between channels
     - Clone covariance pattern in library for neighbors in this nuclear region.
     - For example, elastic and inelastic are commonly anti-correlated.

- Use low-fidelity ('Lo-Fi') covariances described by Little *et al* (2008):
  - Based on variations of model parameters.
    - Use TENDL parameter sets if no other models available?
  - Still need to be validated against spreads of experimental data
  - Maybe reduce off-diagonal correlations to reflect uncorrelated data spreads.

- Eventually: new evaluations
  - The INDEN group (coordinated by IAEA Vienna) is currently re-evaluating:
    - Light: Be9, N14,15, Na23
    - Others: Fe55,56, Actinides, Pu chains.

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