AFCI 1.3/2.0

covariance data

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Outline

- Overview of AFCI-1.3 library
- Additions and changes in 1.3
- Quality Assurance
- Plans for AFCI-2.0
1: Overview of the library

- 110 materials (20 Actinides, 12 Light materials, 78 structural + FP)
- Important materials treated individually at several institutions.
- Bulk of library (approximately 70 of 110 files, FPs and structural) based on the ‘low-fidelity’ covariance estimates from LANL, ORNL, BNL
Major Actinides produced by LANL/ORNL
- $^{232}$Th from ENDF/B-VII
- $^{233,235,238}$U and $^{239}$Pu from ENDF/A

Structural materials produced by BNL
- $^{23}$Na, $^{52}$Cr, $^{56}$Fe, $^{58}$Ni

Light nuclei from LANL ($^{1}$H, $^{16}$O,...)

Minor Actinides partly based on V.Maslov estimates, partly on BNL and LANL efforts

Fission Products based on low-fidelity covariance estimates
33-group structure

- AFCI is a processed covariance library, using 33 energy bins.
- Group boundaries chosen so that in most cases, \( \log(E_2) - \log(E_1) = 0.5 \)
Key dates for AFCI library

- Initial version (GNEP 1.0) released October 2008
- GNEP 1.1 April 2009, mainly fixes for structural materials
- AFCI 1.2 August 2009, many fixes for minor actinides, structural and fission products
- AFCI 1.3 April 2010, improved structural materials and minor actinides
Overview of library

- Active user community (INL and ANL) are providing valuable feedback

- Library is currently available only for testing and development. As the project evolves, a future version will become available for general use
2: Changes for AFCI-1.3

- Structural materials produced at NNDC
  - kernel approximation in RRR
  - Modified VI.8 covariances in fast neutron range

- Improvements for prompt fission neutron spectra

- New content for minor actinides
Changes: Structural Materials

- Structural materials $^{52}$Cr, $^{56}$Fe and $^{58}$Ni: ENDF/B-VI.8 reinstated; inelastic uncertainties increased in the threshold region following dispersion analysis.

- ‘Kernel approximation’ (Y.S. Cho and P. Oblozinsky) used in resonance region:
  - capture kernel defined as $\left( \Gamma_n \Gamma_\gamma \right)/\Gamma_{tot}$
  - for structural materials, $\Gamma_{tot} \approx \Gamma_n$, so kernel is dominated by capture width and we estimate $\Delta(\text{kernel})$ from capture width uncertainties
  - works very well for $(n,\gamma)$, less so for elastic
AFCI-1.2 based on Atlas (MF32) new version uses kernel approximation (Y.S.Cho)
Fission Spectra

- $^{239}$Pu PFNS was present in AFCI-1.2

- Problem in v1.2: rows/columns of PFNS did not sum to zero as expected for covariance matrix of normalized distribution

- AFCI-1.3: added $^{240}$Pu PFNS, both matrices now obey sum-to-zero condition
Fix: PFNS covariance matrices now obey sum-to-zero condition
Minor Actinides

- $^{240,241}\text{Pu}$ new files from LANL
- $^{237}\text{Np}, \, ^{242}\text{Pu}$ new files from BNL (EMPIRE/KALMAN)
- These replace older estimates based on V. Maslov recommendations
Using new input for EMPIRE (M.Sin), varying fission barrier and optical model parameters

- Experimental data for (n,tot), (n,el), (n,f)
  - For fission, have new data from Tovesson et al (2009)
- Covariances produced with KALMAN filter
- At lower energies, still using ‘low-fidelity’ values
$^{242}$Pu (cont.)

C.M. Mattoon, ND2010
Checking covariances visually for major channels

- unCor-1.1 applied to full library, gives warnings for
  - small uncertainties: \((n,\text{tot})<1\%\), \((n,\text{el})\) and \((n,\gamma)<2\%,\) etc
  - non-positive-definite matrices
  - PFNS covariance not summing to zero
  - peaks, jumps in uncertainty

- non-positive-definite matrices may be fixed at price of modifying correlations (usually small changes)
program ‘unCor’ checks output of PUFF/NJOY for problems in ‘uncertainties’ and ‘correlations’

Small uncertainties still appear in v1.3 of library
4: Plans for AFCI-2.0

- New covariances for the remaining major structural materials (Cr, Fe, Ni) using the same methodology (VI.8 + modified inelastic + kernel approximation in RRR).
- Adopt JENDL Actinoid covariances for the minor actinides (except 242Pu and 237Np done at BNL)
- Covariances for fission spectra for $^{240}\text{Pu}$ (LANL)
Plans for AFCI-2.0 (cont.)

- Replacement of the remaining ‘low-fidelity’ covariances (at least most of them)
  - Adjustment of the RRR upper limit in the ‘low-fidelity’ files from 5 keV to the actual (or more sensible) value.
  - Replacement of the RRR covariances with kernel approximation for most of the cases
  - Replacement of the fast neutron covariances with new estimates based on more advanced EMPIRE calculations
    - CC instead of spherical OM
    - More model parameters varied
    - Use of experimental data
Summary

- AFCI-1.3 covariance library released April 2010
  - New: $^{240}\text{Pu}$, $^{241}\text{Pu}(n,f)$, $^{237}\text{Np}$, $^{242}\text{Pu}$
  - Revised structural materials
- ANL and INL users are providing valuable feedback towards improving the library
- Files are being tested visually and using automatic procedure for quality assurance
- AFCI-2.0 to be completed in August 2010

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