WPEC sub-group report

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Title:

Investigation of Covariance Data in General Purpose Nuclear Data Libraries

Subgroup Mandate

The motivation for the subgroup is to bring together the international covariance community to understand how the covariance data can be so different between the different evaluated nuclear data files, ENDF, JEFF, JENDL, CENDL, etc., while the mean values (cross sections, nu-bar, etc.) are generally very similar. Many questions have emerged from the groups applying covariance data for analysis, such as the Working Party on Nuclear Criticality Safety (WPNCS) Expert Group on Uncertainty Analysis for Criticality Safety Assessment (UACSA), on how the use of different covariance libraries (e.g. ENDF, JEFF, JENDL, etc.) affects uncertainty quantification and similarity assessment. Further, significant differences in covariance libraries lead to differences in the adjustment of parameters for fast reactors, which is an important topic for WPEC sub-group (SG) 39.

The CIELO project, WPEC SG-40, established an international effort of nuclear data evaluators from different nuclear data projects to provide nuclear data evaluations that may be consistently accepted by all major nuclear data projects. This work has certainly driven the progress towards minimizing the disagreement in the mean values (cross sections, nu-bar, etc.) between different nuclear data libraries. However, with that project coming to a close in the coming year, there has not yet been a concentrated effort on providing consistent covariance evaluations across the different nuclear data libraries. The maturity of the nuclear data evaluation process is such, at this time, that it is warranted to create an international collaboration on cross section covariance evaluation methodologies.

This sub-group will be tasked with the goal to investigate covariance data for a broad range of system types, not just fast reactors as is the focus of WPEC SG-39. This sub-group will leverage the work of previous sub-groups which investigated the generation of covariance data for specific physical regions, such as WPEC SG-24 and SG-36, which focused on evaluations of fast neutron region and the resolved resonance region, as well as WPEC SG-42 which focused on the evaluation and covariance generation for thermal scattering. This sub-group will focus its attention on providing guidance to the international community on methods for systematic and consistent evaluation of covariance data for the whole energy range, paying special attention to energy domain interface (resolved resonance/unresolved resonance/continuum). The group will also deliver examples of the application of the proposed methodology on a few selected isotopes. The ultimate goal of the subgroup is to provide an overview of the best practices of how to generate more consistent covariance data sets.

1. Introduction
2. Evaluation techniques
    a. Model defects: phenomenological models can be poor but with very low evaluated uncertainties
    b. Model biases: inference of biases from advanced models
    c. Treatment and representation of uncertainties in the unresolved resonance region where self-shielding is important for reactors
3. Analysis of experimental data
    a. Sources of experimental uncertainty
        i. Catalogue
        ii. Publication requirements (not only numbers)
        iii. Recommendations for EXFOR database
        iv. Algorithms/methods
    b. Commenting on autonomous/automatic methods
    c. Commenting on handling of discrepant data sets
4. Propagation of uncertainty and integral experiments - Collaboration with SG46
    a. Use of integral experiments in evaluations, documentation
    b. Other probability distributions for nuclear data uncertainty
        i. Document
        ii. Format
    c. Testing of covariance data
5. Cross-correlation
    a. Reactions (unitarity)
    b. Cross-isotope and when to neglect
    c. Other types of data, distributions
    d. Space for storing evaluation/integral experiments correlations
6. Formats and interpretation
    a. Documentation of covariance evaluation technique
        i. Clear interpretation by evaluator
        ii. Model parameters and code
        iii. Reporting known unknowns vs estimating unknown unknowns
        iv. Clear interpretation by user
    b. Verification: positive definite, robust, stable to numerical errors. How to deal with negative eigenvalues?
    c. Multigroup cross section covariance group and weighting assumptions
7. Processing codes wish list – Collaboration with SG43
    a. Cross-correlations
    b. Prompt fission neutron spectra (PFNS) correlations to cross section
    c. Covariances of secondary distributions (e.g., inelastic)
    d. Higher order angular distribution S(α,β) format
    e. Random files
8. Conclusion
9. References
10. Appendices