Foreword

Special Issue on Nuclear Data for Fusion Applications

Guest Editors

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Recent years have seen a large growth in fusion research with many private companies initiating ambitious plans to bring fusion-generated electricity to the grid and attracting millions of dollars of investment. Many of these proposals are based on exploitation the d(t,n)^{4}He reaction and as such will represent significant nuclear facilities. 1 GW of fusion power equates to the production of more than 3.5×10^{20} neutrons/s with a mean energy of 14 MeV. The facts that the mean energy is higher than that encountered in fission reactors and different materials not used in conventional nuclear power plants (for example, rare earth superconducting magnets) will be used imply that a reassessment and augmentation of existing nuclear data libraries is required for the design of fusion reactors if they are to be safe and economical. High-quality nuclear data are needed for radiation transport calculations to design shielding, estimate damage to materials, predict operation and shutdown dose rates, calculate tritium breeding, and estimate the generation of radioactive by-products, among several application areas.

The Workshop on Applied Nuclear Data Activities (WANDA) in 2024 [1] provided several recommendations to address such questions as, "What are the products of these reactions, and are there data needs for understanding secondary reactions? Do gaps exist in current neutronics code capabilities to accurately model the interactions? ND [nuclear data] must accurately predict shielding, activation, dose rates, and neutron diagnostics."

These recommendations included a call for renewed evaluations, benchmark experiments, and more. At WANDA in 2025 [2], the following was identified: "The most important obstacle to overcome in this field is the UQ [uncertainty quantification] of fusion reactor behavior due to ND uncertainties."

This special issue of *Fusion Science and Technology* is devoted to nuclear data for fusion applications. It covers the needs, status, and application of nuclear data to the design of fusion systems.

To establish which nuclear data are needed for fusion systems for higher energy ranges and with fusion-specific materials, it is necessary to evaluate the quality of existing nuclear data. This is covered in the review article on the evaluation of medium- and high-mass nuclei for fusion applications. The verification and validation of nuclear data libraries is addressed in the paper specific to the FENDL-3.2c library.

Experiments are an essential part of the verification process, and this issue contains a number of papers on this subject, which include looking at quasi-differential neutron scattering experiments and fusion decay heat benchmarking for the latest nuclear data libraries with FISPACT-II. Integral nuclear data and benchmarking needs for the fusion industry systems are described in the paper authored by Percher et al.

Last, and very importantly, the uncertainty analysis in the application of nuclear data and benchmark experiments is also reviewed.

Together, these papers provide broad coverage across the whole field of nuclear data for fusion applications.

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References

1. J. Brown et al., *Proceedings for the Workshop on Applied Nuclear Data Activities 2024*, ORNL/TM-2024/3462, Oak Ridge National Laboratory (2024); https://www.nndc.bnl.gov/ndwg/docs/wanda/WANDA-2024-Proceedings.pdf.
2. J. Brown et al., *Proceedings for the Workshop on Applied Nuclear Data Activities 2025*, ORNL/TM-2025/3966, Oak Ridge National Laboratory (2025); https://www.nndc.bnl.gov/ndwg/docs/wanda/WANDA-2025-Proceedings.pdf.