Karlsruhe Institute of Technology

Institute for Neutron Physics and Reactor Technology
Reactor Physics and Dynamics

Assessment of Fission Product Yields Nuclear Data Needs in Nuclear Reactor Applications

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Kilian Kern, Maarten Becker, Cornelis Broeders

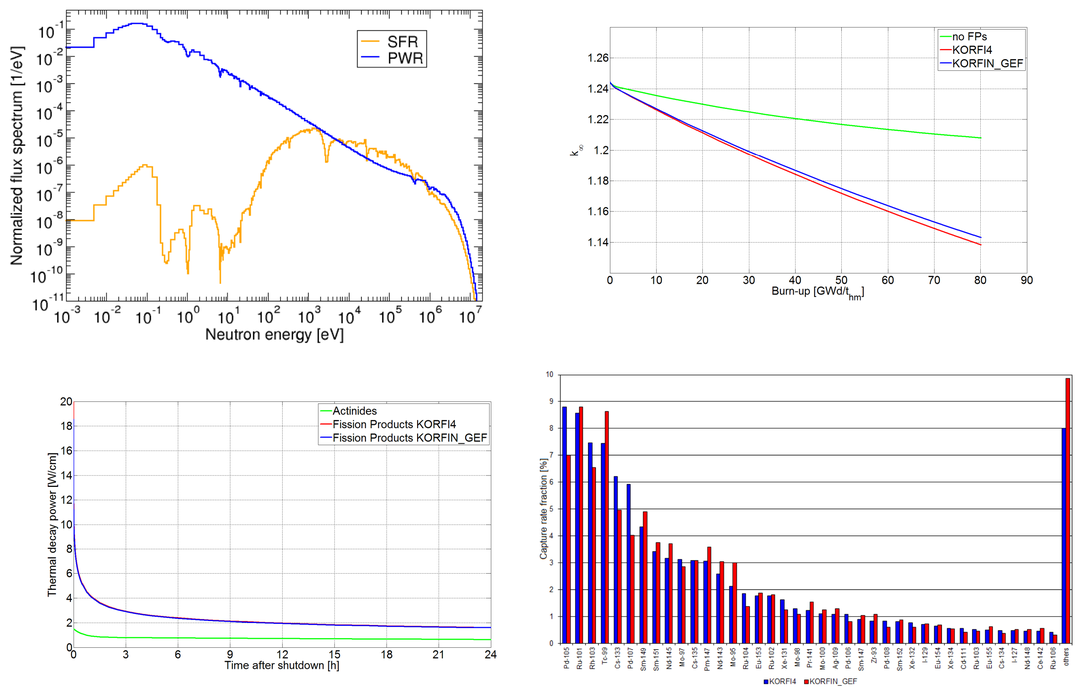
Several important reactor physics issues are related to fission products, which implies the need to know the amounts of single fission product nuclides in irradiated nuclear fuel. Fission yields depend on the target, the projectile and its energy, and the fission process is subject to a number of physical effects. Advances in the understanding and modeling of nuclear fission since the 1990s include:

- More experimental insight into the systematics of mean masses and proton numbers of fission fragments
- Insight into dynamical effects of nuclear fission by Langevin calculations
- Proof and consequent application of the “Separability Principle”: nascent fission fragments already have their own nuclear temperature and microscopic potential
- Macroscopic-microscopic nuclear potential calculations for the fissioning system in five dimensions
- First applications of time-dependent Hartree-Fock-Bogoliubov equations
- New model descriptions for fragment excitation energies and even-odd effects of fission yields are in good agreement with experimental observations

Current evaluated data libraries provide fission yields in up to three coarse energy groups, with one “fast” group ranging from 400 keV to 14 or 20 MeV (JEFF-3.1.1). Reliable fission models could help to evaluate fast fission yields data in a more detailed energy group structure.

Fast fission gains importance in liquid metal cooled reactors. The total fission rate fraction above 400 keV is only 10.7% in the PWR, but 41.5% in the SFR. For the SFR spectrum, weighted fission yields have been calculated by a code based on GEF 2010/5c and were applied in a KANEXT depletion calculation. The results were compared to a calculation with the standard KORFI4 burn-up library.

GEF is being developed by K.-H. Schmidt and B. Jurado on behalf of the OECD NEA.



Figures:
Neutron flux spectra of a SFR and PWR cell at BOC (upper left)
k_∞ of the SFR cell over burn-up (upper right)
Thermal decay power for SFR in the first 24 hours (lower left)
Neutron capture by single fission products in the SFR at EOC (lower right)

Results:

- Largest deviations in densities of single fission product nuclides
- Deviation in k_∞ about 500 pcm at 80 $\frac{GWd}{t}$
- Good agreement of thermal decay power

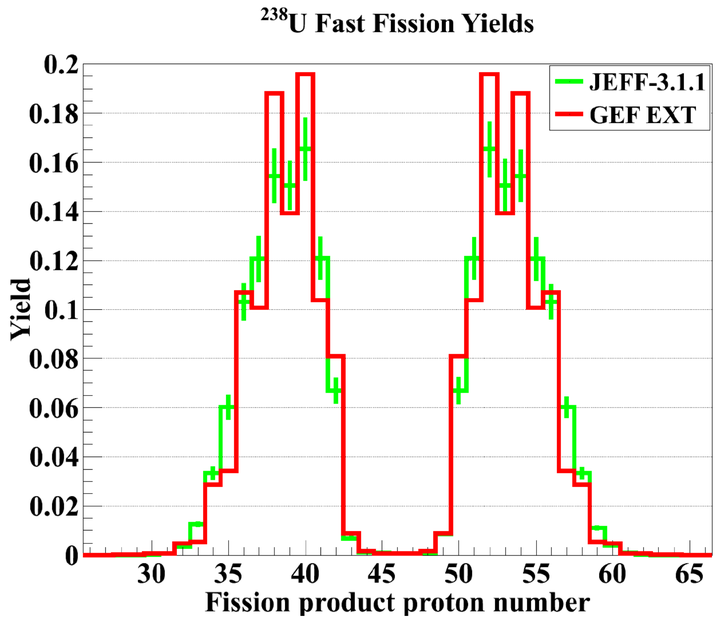


Figure: JEFF-3.1.1 fast fission yields and calculation results for the SFR

Concerning the proton even-odd effect, evaluated fission yields could be improved by calculating unknown fractional independent yields by GEF. Its model is more well-founded and in better agreement with experiments than the model applied in JEFF-3.1.1 evaluation.

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