

JEFF-3 Delayed neutron data

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Outline

- Introduction
- Delayed neutron data in MCNP
- Delayed neutron data in NJOY
- Verification
- Conclusions

Introduction

- Since many years delayed neutron data are represented in 6 time groups, according to 6 "families" of precursors
- Effect of delayed neutrons: shift in energy distribution of fission neutrons:
 - prompt fission neutrons: $E_{ave} \approx 2 \text{ MeV}$
 - delayed fission neutrons: $E_{ave} \approx 0.5 \text{ MeV}$
- Delayed neutron fraction is only small: $\beta_0 \lesssim 0.7\% \Rightarrow$ effect on k_{eff} is usually very limited
- However, substantial effect on reactor kinetics
- More faithful representation when precursors are subdivided in 8 families \Rightarrow JEFF-3

Delayed data in MCNP

- Delayed neutron data were only recently included in MCNP (MCNP4C; Feb. 2000):
 - only limited effect on k_{eff}
 - reactor *kinetics* used to be field of deterministic codes
 - faster computers \Rightarrow Monte Carlo codes are increasingly used, also for detailed reactor kinetics
- Format for delayed neutron data on ACE libraries: defined by MCNP team
- Data format *general*: *arbitrary* number of delayed neutron groups is allowed

Delayed data in NJOY

- Delayed neutron data processing capability was included in GROUPR since long
- Originally, *only* processing was allowed of data in well-known structure with 6 time constants (8 groups allowed since NJOY99.73)
- Delayed neutron data processing capability in ACER was included in NJOY99.63
- Processing is possible of delayed data in up to 8 groups (JEFF-3 default)

Verification

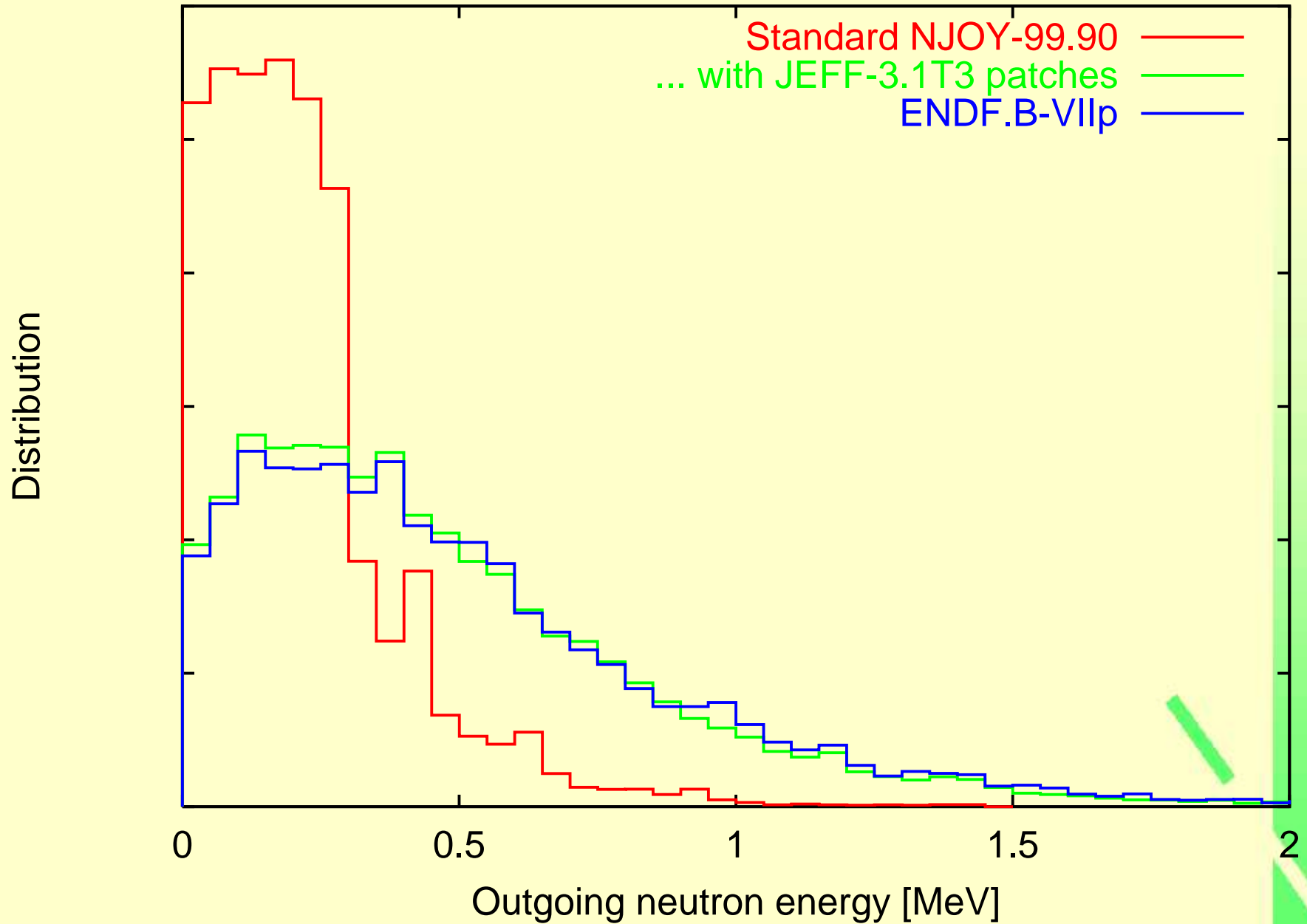
- Verification/validation should be essential aspect of nuclear data processing: by
 - Criticality benchmarks (ICSBEP)
 - Shielding benchmarks (SINBAD)
- How to verify delayed neutron data processing for ACE libraries?
 - Effect of delayed neutrons on k_{eff} is only small ($\beta_{eff} < 1\%$)
 - Reactor kinetics benchmarks are very time consuming
- Dedicated verification is needed

NRG Verification of delayed neutron data

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- Calculation of β_{eff} with NRG's addition to MCNP (to be included in MCNP5, see *R. Klein Meulekamp and S.C. van der Marck, Nuclear Science and Engineering, to be published*)
- However, only few experimental β_{eff} data are available
- Additional verification should be performed by inspection of energy spectrum of delayed neutron data *as used by MCNP*
- However, no standard feature of MCNP exists to inspect neutron energy spectra...
- Solution: modify MCNP!
- NRG modified MCNP in order to carry out the verification
- Result: incorrect treatment of 8-group delayed neutron data in ACER in NJOY99.90

Verification result



Discussion

- Representation of delayed neutron data in 8 time groups causes problems in NJOY99.90
- Effect of incorrect processing of delayed neutron data hardly visible in k_{eff}
- NRG-Bob MacFarlane collaboration resulted in updated version of NJOY99.90

Conclusions

- Delayed neutron data on JEFF-3.1T3 (in 8 groups representation) verified by NRG
- Verification by dedicated tools, showing correct use in MCNP
- Correct use of 8-groups data in MCNP only possible if processed with updated version of NJOY99.90
- JEFF-3.1T3 should only be distributed with this updated version