Processing and Benchmarking of the ^{9}Be JEFF-3.1T Data for Fusion Applications

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Outline

- **Nuclear data and processing**
- **Benchmark calculations with FNS-TOF Experiment**
  - *Validation of neutron transport cross sections*
- **Results and Discussion**
- **Comments**
- **Acknowledgements**
  - *U. Fischer, I. Schmuck (FZK)*
  - *S. van der Marck (NRG)*
  - *J.C. Sublet (CEA)*

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^{9}Be EFF3 nmod x

- **S. Tagesen et al. (IRK Vienna)**
- **Content of ENDF-file (cf. EFF-DOC-689)**
  - *Neutron emission channels as partial (n,2n) cross sections (MT875-890)*
  - *Including energy-angle distributions (subsections of MF6, LAW=7, yield=2) and covariances*
  - *Redundant MT16 (total (n,2n)) included*
  - *No neutron capture and photon production*
  - *Since nmod 6: MT102 added*

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^{9}Be JEFF-3.1T

- **J.-C. Sublet (CEA, Cadarache)**
- **Modifications of underlying EFF3 nmod 6:**
  - *Corrections to MF2*
  - *Added MF12/14, MT102 (from ENDF/B-VI.8)*
  - *Removed: MF3/6/33, MT16 (redundant)*

^{9}Be FENDL 2.1

- **A. Trkov et al. (IAEA, Vienna)**
- **Adoption of ENDF/B-VI.8**

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F ^{9}Be ACE processing and curiosities

- ## JEFF 3.1T Original (Sublet)
  - *NJOY 99.90 Standard*
  - *LAW61, Filesize 50 MB*

```
ACELST - List contents of an ACE-lib
====================================

4-BE-9 IRK-VIENNA, processed by NJOY99
                  Source file :  j31_be9.ace
      Material ZAID identifier :   4009.95c
                  Processed on :   02/18/05
              MAT identifier :     mat 425
              Temperature [K] :        300.0
          Atomic weight ratio :      8.93478
           Data table length :      2517684
      Number of energy points :          801
```

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^{9}Be ACE processing and curiosities

- **JEFF 3.1T NRG (van der Marck)**
  - *NJOY 99.90 Standard*
  - *LAW61, Filesize 50 MB*

```
ACELST - List contents of an ACE-lib
====================================

9Be fast ACER JEFF-3.1T3 library; T=293.16K
                        Source file : j31_vdmarck.ace
          Material ZAID identifier :   4009.70c
                     Processed on :   04/01/05
                  MAT identifier :    mat 425
                 Temperature [K] :       293.2
           Atomic weight ratio :      8.93478
           Data table length :      2518954
      Number of energy points :        1084
```

F ⁹Be ACE processing and curiosities

- **JEFF 3.1T FZK local (Leichtle)**
  - *NJOY 99.50 local (cf. EFF-DOC-782)*
  - *LAW67, Filesize 33 MB*

```
ACELST - List contents of an ACE-lib
====================================


4-Be-9 from JEFF-3.1T
                        Source file : jeff31t_be9.ace
            Material ZAID identifier :    4009.95c
                       Processed on :   25/04/05
                  MAT identifier :      mat 425
                 Temperature [K] :          300.0
             Atomic weight ratio :        8.93478
              Data table length :        1635355
      Number of energy points :            944
```
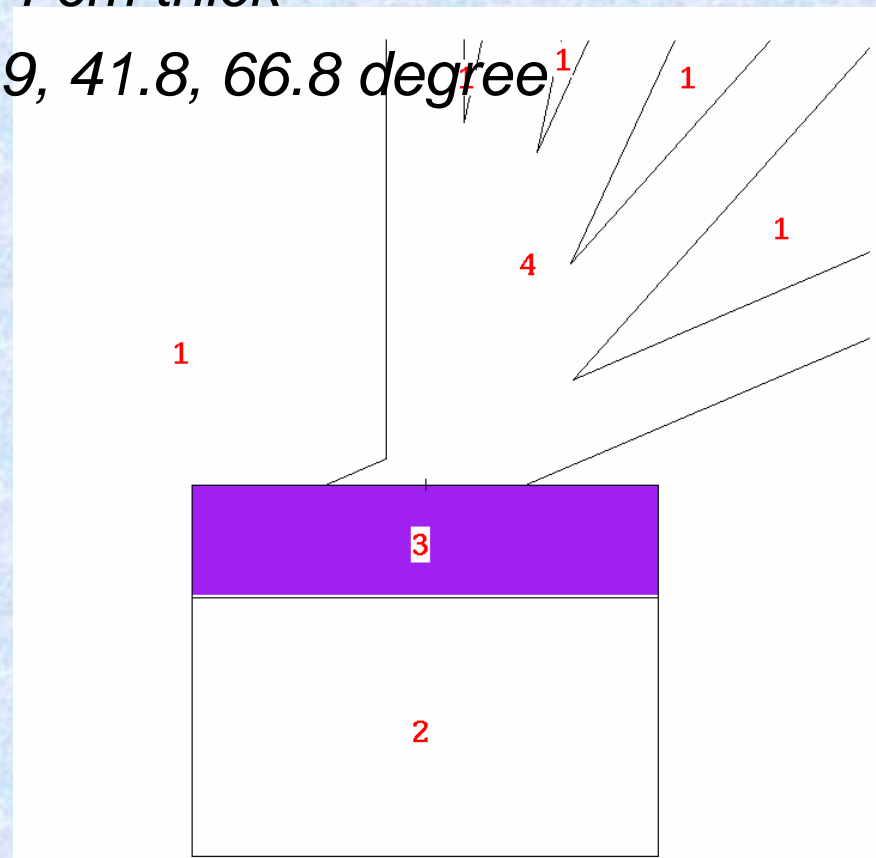
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F ^{9}Be ACE processing and curiosities

- **For comparison: EFF3 nmod5 FZK local (Leichtle)**
  - *NJOY 99.50 local (cf. EFF-DOC-782)*
  - *no MT102, but not serious for FNS-TOF*
  - *LAW67, Filesize 33 MB*

```
ACELST - List contents of an ACE-lib
====================================


4-Be-9 from EFF-3

                        Source file : eff3.05be9
               Material ZAID identifier :   4009.95c
                       Processed on :   13/11/01
                   MAT identifier :     mat 425
                  Temperature [K] :        300.0
            Atomic weight ratio :      8.93478
             Data table length :      1632739
    Number of energy points :          855
```
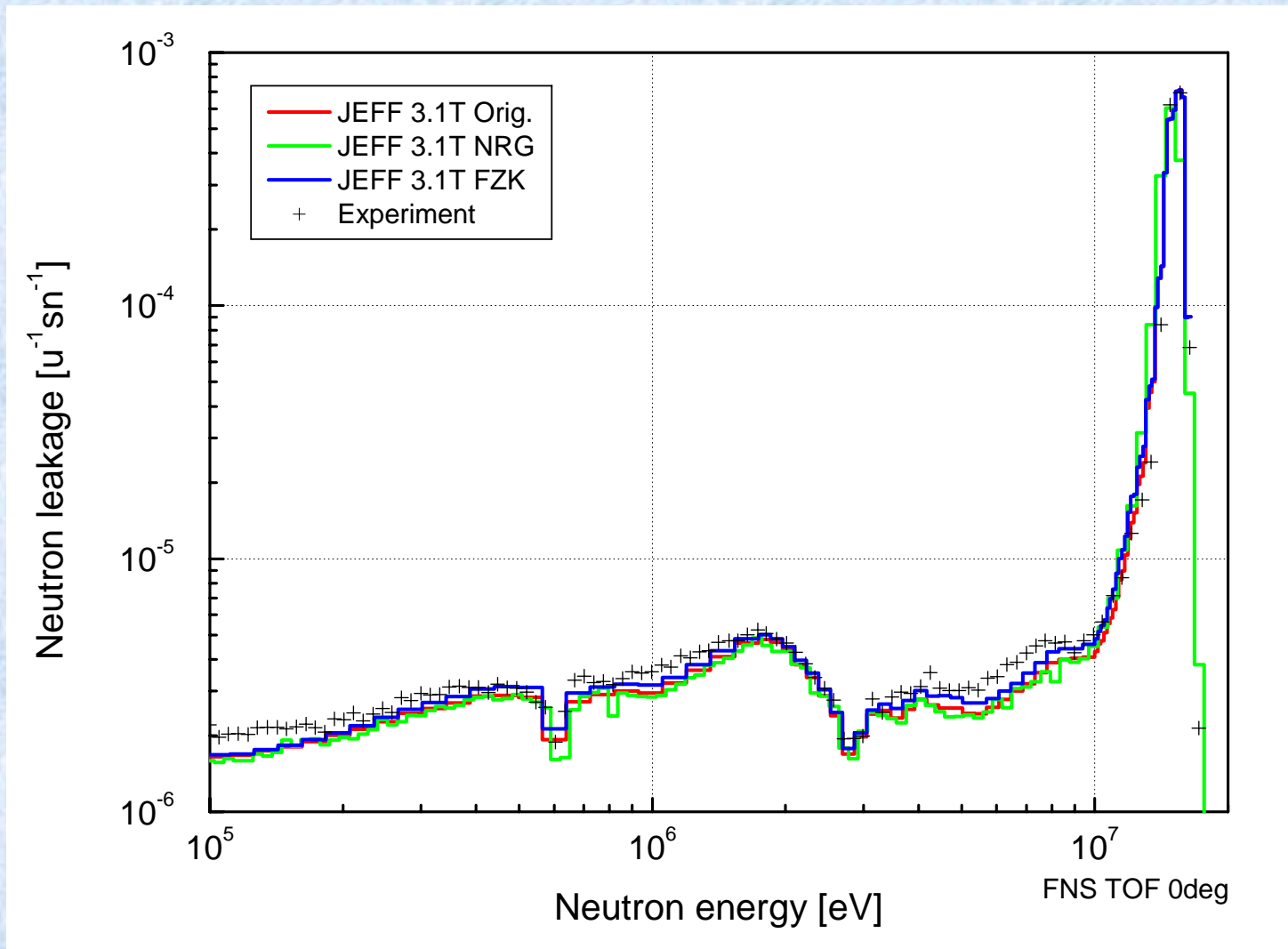
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Datafiles for benchmark calculations

- **JEFF 3.1T Original**

- **JEFF 3.1T NRG**

- **JEFF 3.1T FZK**

- **EFF3.05 (nmod 5)**

- **FENDL 2.1**

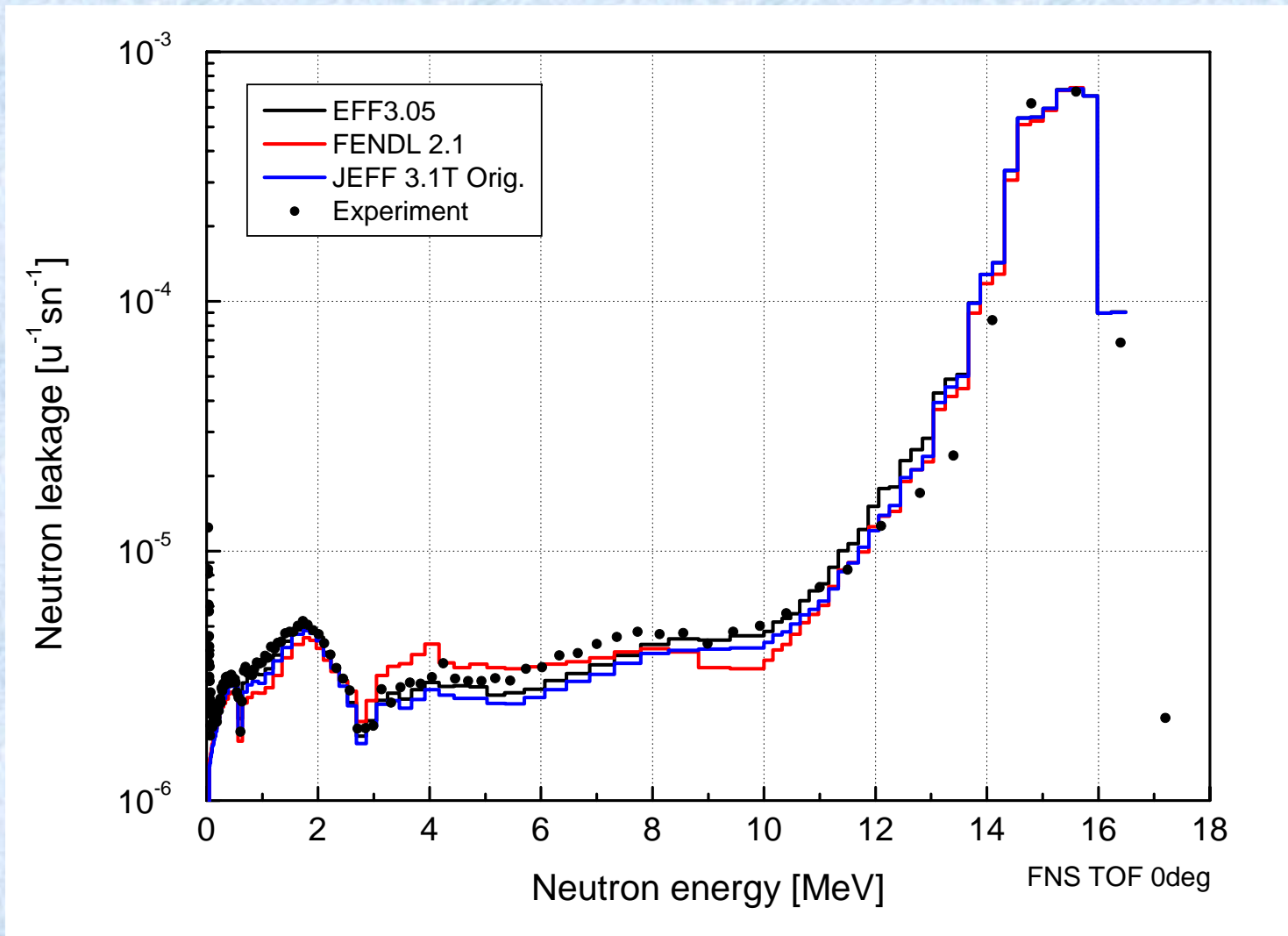D. Leichtle, U. Fischer

FNS-TOF Benchmark Experiment

- **FNS cylindrical slab experiment FNS-TOF**
  - *Beryllium slab 15.24 cm thick*
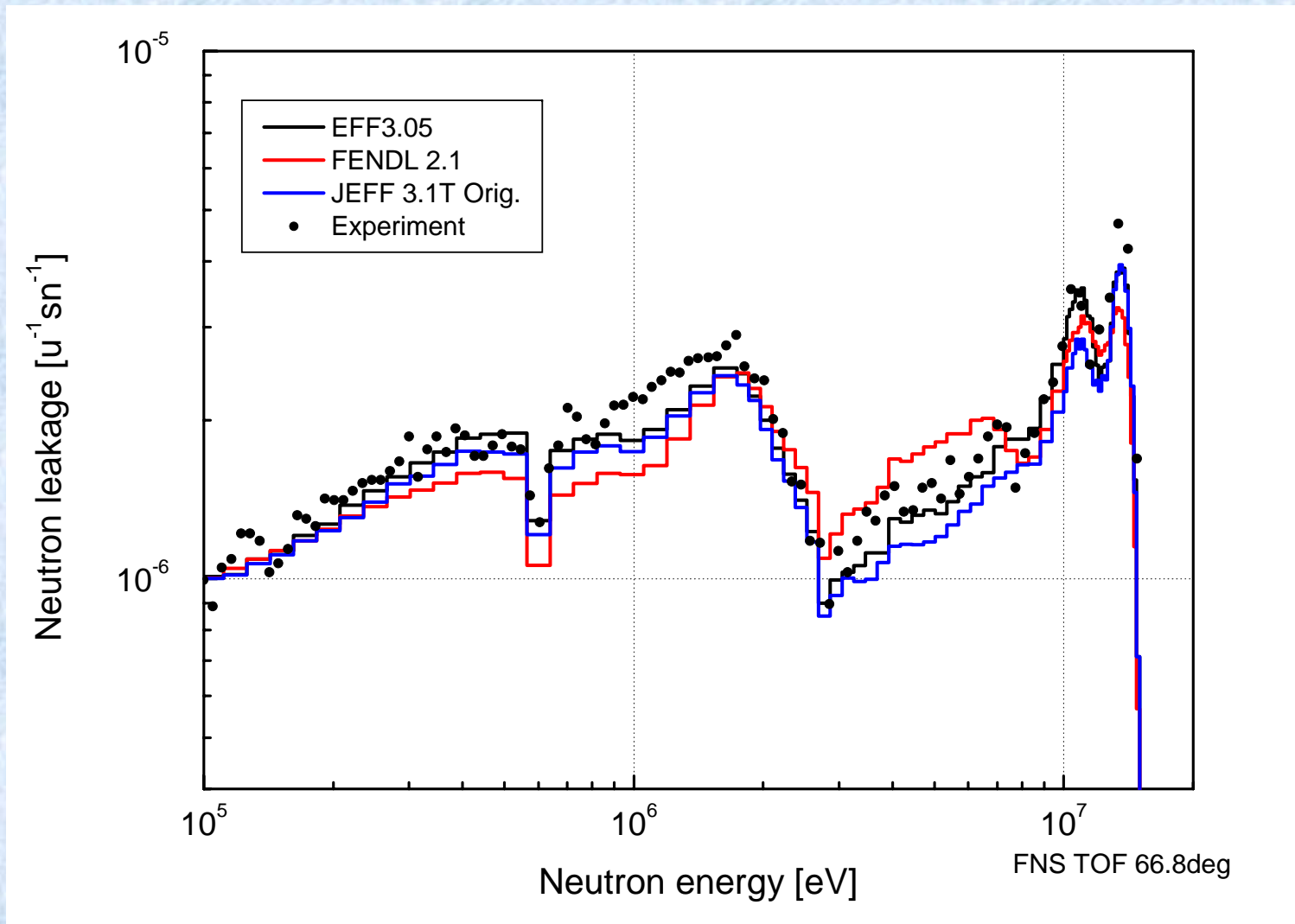 - *TOF at 0, 12.2, 24.9, 41.8, 66.8 degree*

Neutron leakage spectra (FNS-TOF)

FNS TOF 0deg

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Neutron leakage spectra (FNS-TOF)

FNS TOF 0deg

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Neutron leakage spectra (FNS-TOF)

FNS TOF 66.8deg

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Results for FNS-TOF

- **Neutron leakage spectra**
  - *JEFF 3.1T Original and NRG are consistent (except some minor deviations by bad statistics)*
  - *JEFF 3.1T FZK and EFF3.05 are consistent (only small deviations seen at large detector angles)*
  - *But: JEFF 3.1T Original and EFF3.05 differ substantially*
    - in particular at large angles
    - EFF3.05 performs better in terms of reproducing experimental results
  - *FENDL 2.1 (ENDF/B-VI) is not as good as any of the JEFF 3.1*

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Neutron flux integrals C/E (FNS-TOF)

Neutron angular fluxes at 0 deg
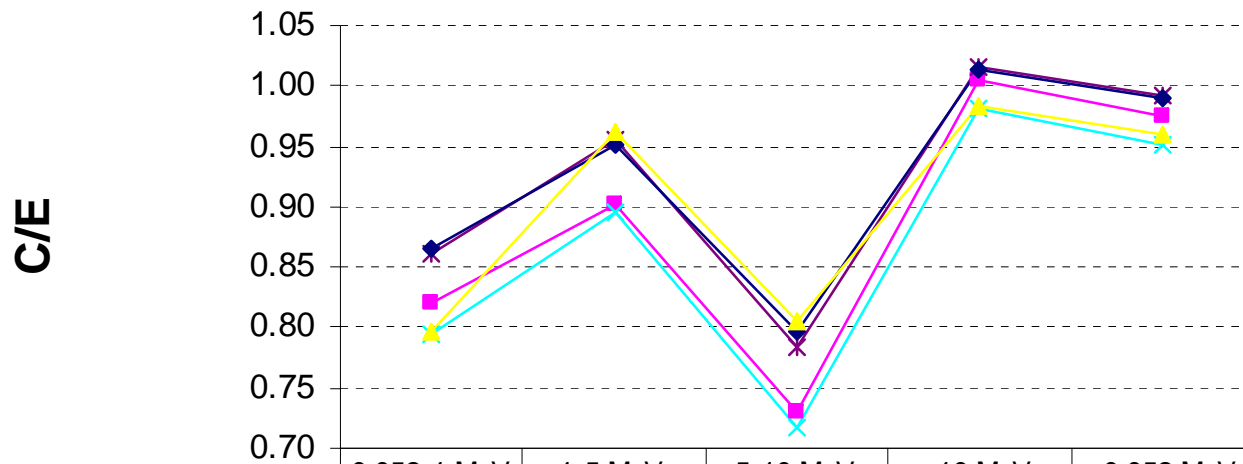
	0,052-1 MeV	1-5 MeV	5-10 MeV	>10 MeV	>0,052 MeV
JEFF3.1 orig.	8.21E-01	9.03E-01	7.29E-01	1.01E+00	9.74E-01
JEFF3.1 NRG	7.94E-01	8.96E-01	7.18E-01	9.81E-01	9.51E-01
JEFF3.1 FZK	8.60E-01	9.56E-01	7.83E-01	1.02E+00	9.91E-01
EFF3.05	8.66E-01	9.52E-01	7.96E-01	1.01E+00	9.90E-01
FENDL2.1	7.97E-01	9.62E-01	8.05E-01	9.83E-01	9.60E-01

Energy Interval

Neutron flux integrals C/E (FNS-TOF)

Neutron angular fluxes at 66.8 deg

C/E (y-axis, range 0.70–1.10)
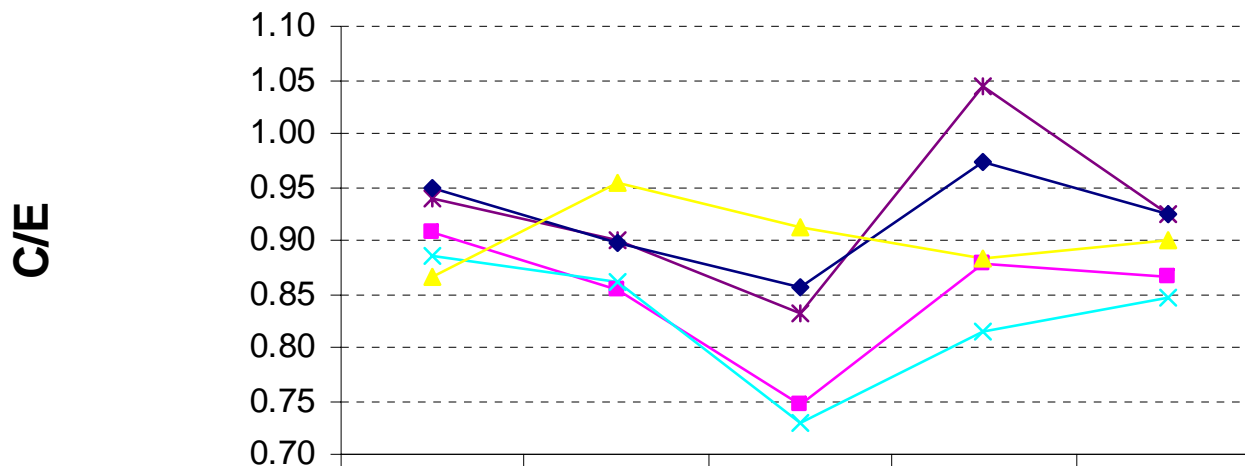
	0,052-1 MeV	1-5 MeV	5-10 MeV	>10 MeV	>0,052 MeV
JEFF3.1 orig.	9.07E-01	8.55E-01	7.47E-01	8.78E-01	8.65E-01
JEFF3.1 NRG	8.84E-01	8.62E-01	7.29E-01	8.14E-01	8.46E-01
JEFF3.1 FZK	9.39E-01	9.01E-01	8.31E-01	1.04E+00	9.24E-01
EFF3.05	9.49E-01	8.97E-01	8.55E-01	9.73E-01	9.23E-01
FENDL2.1	8.65E-01	9.53E-01	9.13E-01	8.83E-01	9.00E-01

Energy Interval

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Neutron flux integrals

- **Neutron flux integrals**
  - *Reference case was and is still EFF3.05*
- **JEFF 3.1T Original (also NRG)**
  - *Larger underestimation compared to EFF3.05*
  - *-27% at 5-10MeV (0° det.)*
  - *-12% at >10MeV (66.8° det.)*
- **JEFF 3.1T FZK**
  - *Very good agreement with EFF3.05, only small deviations at 66.8° det.*

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Conclusions and Comments

- **Standard NJOY99.90 seems to have issues with JEFF-3.1T:**
  - *Tries to transform the MF6 data given in LAW7 (angle-energy distributions) to LAW1 (energy-angle distributions)*

- **The FZK local NJOY99.50 with patches derived from the EFF3.05 exercise works as expected:**
  - *The original LAW7 is mantained*

- **Provided a proper ACE-file is given, the neutron transport has been validated on the FNS-TOF benchmark experiment**

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