Benchmarking of the ^{9}Be EFF-3.0/NMOD=3 evaluation

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Objective

- **Benchmarking of the ACE library by MCNP transport calculations of integral experiments**
- **Assessment of transport characteristics due to partial (n,2n) channels (MT875-890)**
- **Comments on new ACE format (allowing for tabular representation of angular distributions)**

^{9}Be EFF3.03

- **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 (n,2n)-cross section (MT16 as of EFF3.02) is given as a full consistent sum of the individual channels.*

^{9}Be EFF3.03

- **ACE library (cf. EFF-DOC 781)**
  - *Modifications to NJOY99 modules RECONR, ACER*
  - *Option newfor=1 used, i.e. arbitrary cosine bins*
  - *Contains all data from the ENDF library*
  - *Inelastic scattering to second level (MT876) with two separate neutron angular distributions combined to a single one*

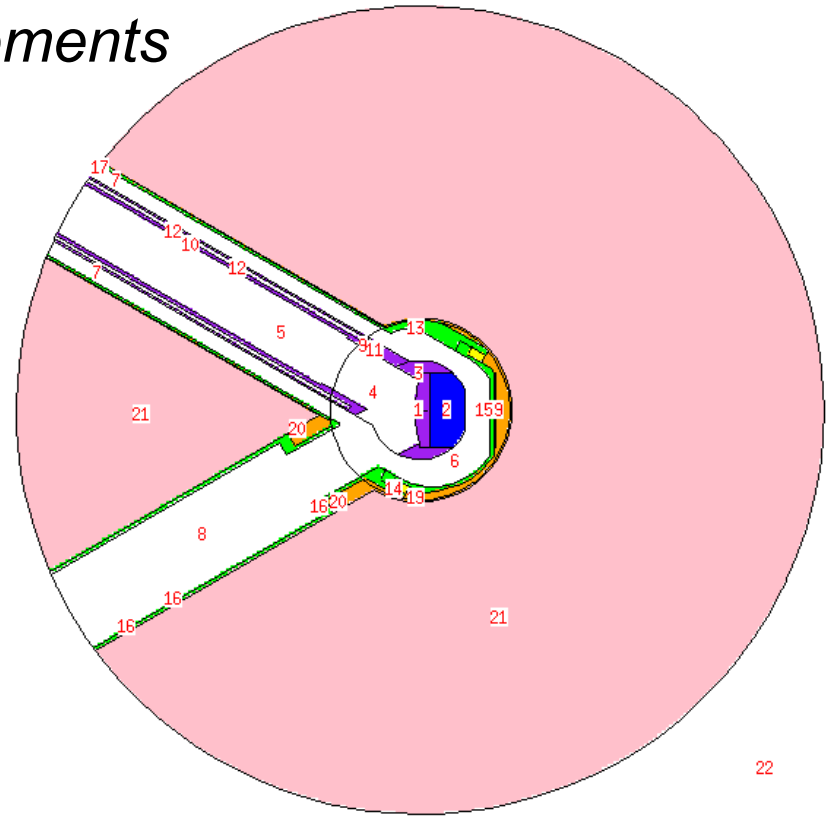
Datafiles for benchmark calculations

- **Full EFF3.03 (including MT875ff, excl. MT16)**
- **Restricted EFF3.03 (excl. MT875ff, incl. MT16)**
- **EFF3.02 (processed by FZK in 1998)**
- **EFF1**

  – *Restricted EFF3.03 and EFF3.02:*
    - differ only by lack of MF6 MT107 in EFF3.02
    - ENDF data is pointwise coincident
    - However: ACE libraries differ, mainly due to different angular representations

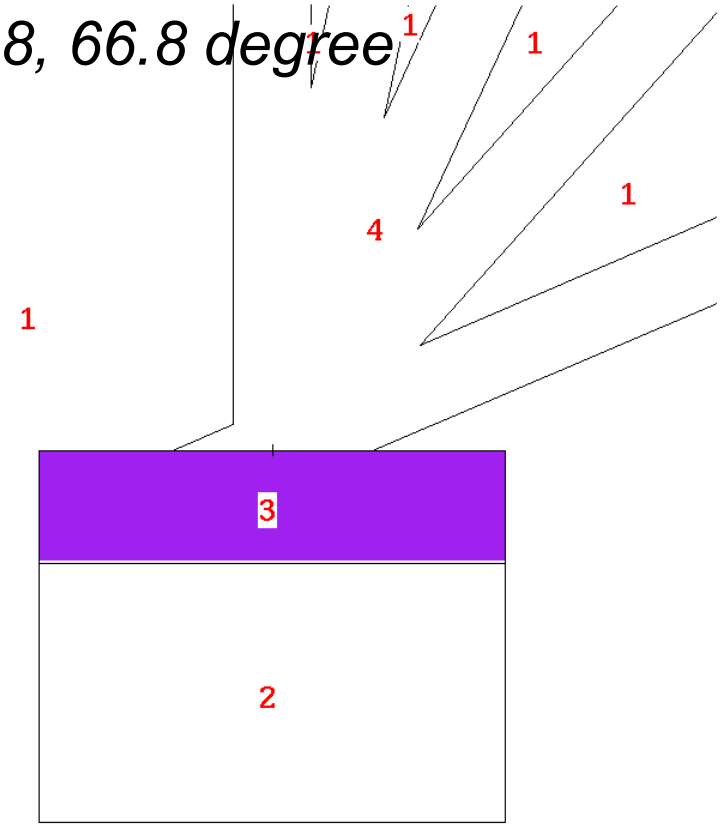
Integral Beryllium Benchmark Experiments

- **Karlsruhe spherical shell experiment KANT**
  - *Beryllium shell with thickness of 17cm*
  - *PRS and TOF measurements*



Integral Beryllium Benchmark Experiments

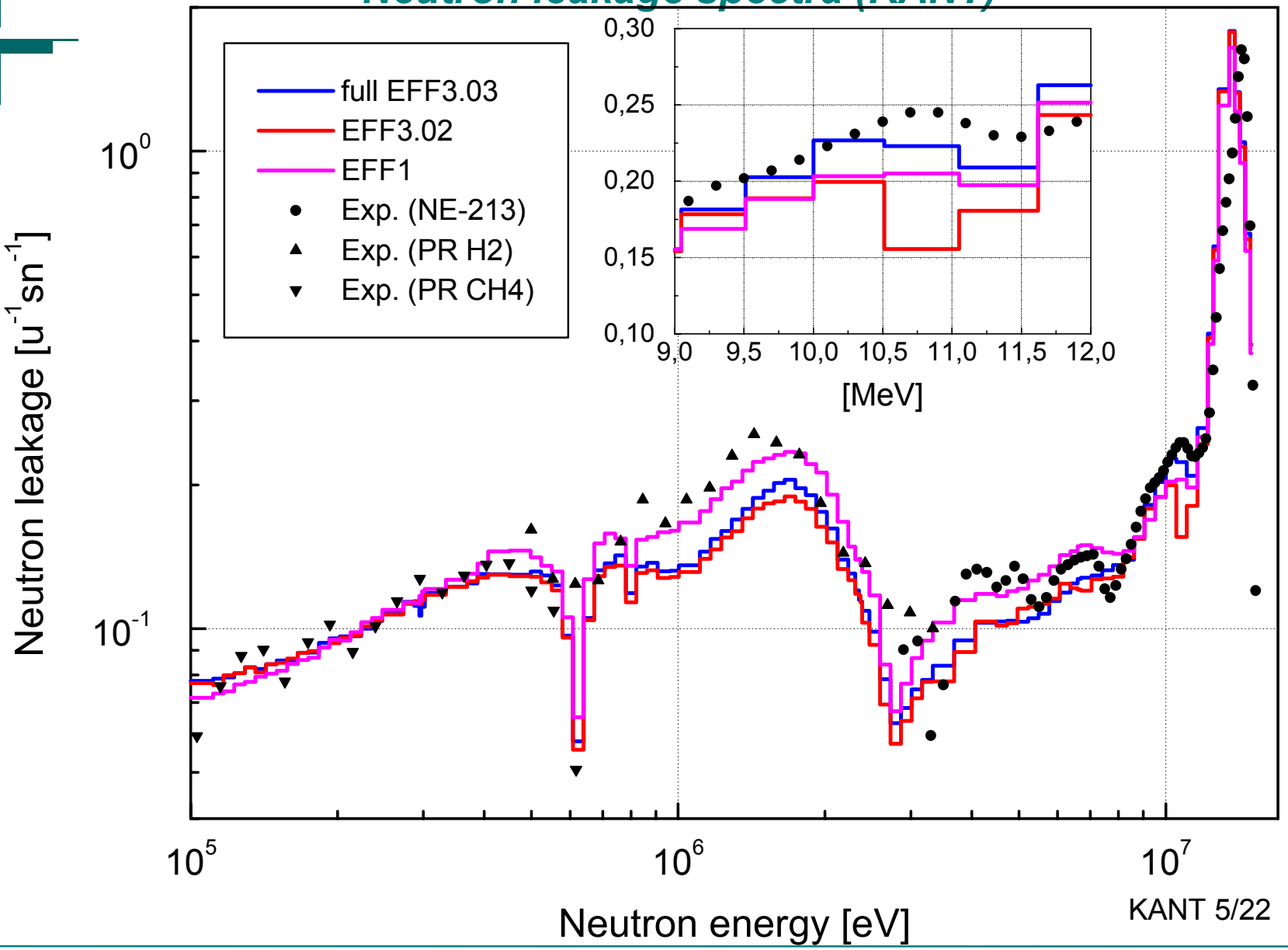
- **FNS cylindrical slab experiment FNS-TOF**
  - *Beryllium slab 15.24 cm thick*
  - *TOF at 0, 12.2, 24.9, 41.8, 66.8 degree*



Results for KANT

- **Neutron leakage multiplication factors**
  - *Full EFF3.03:* *M=1.696* *C/E=1.001*
  - *Restricted EFF3.03:* *M=1.684* *C/E=0.994*
  - *EFF3.02:* *M=1.684* *C/E=0.994*
  - *EFF1:* *M=1.696* *C/E=1.001*

Neutron leakage spectra (KANT)



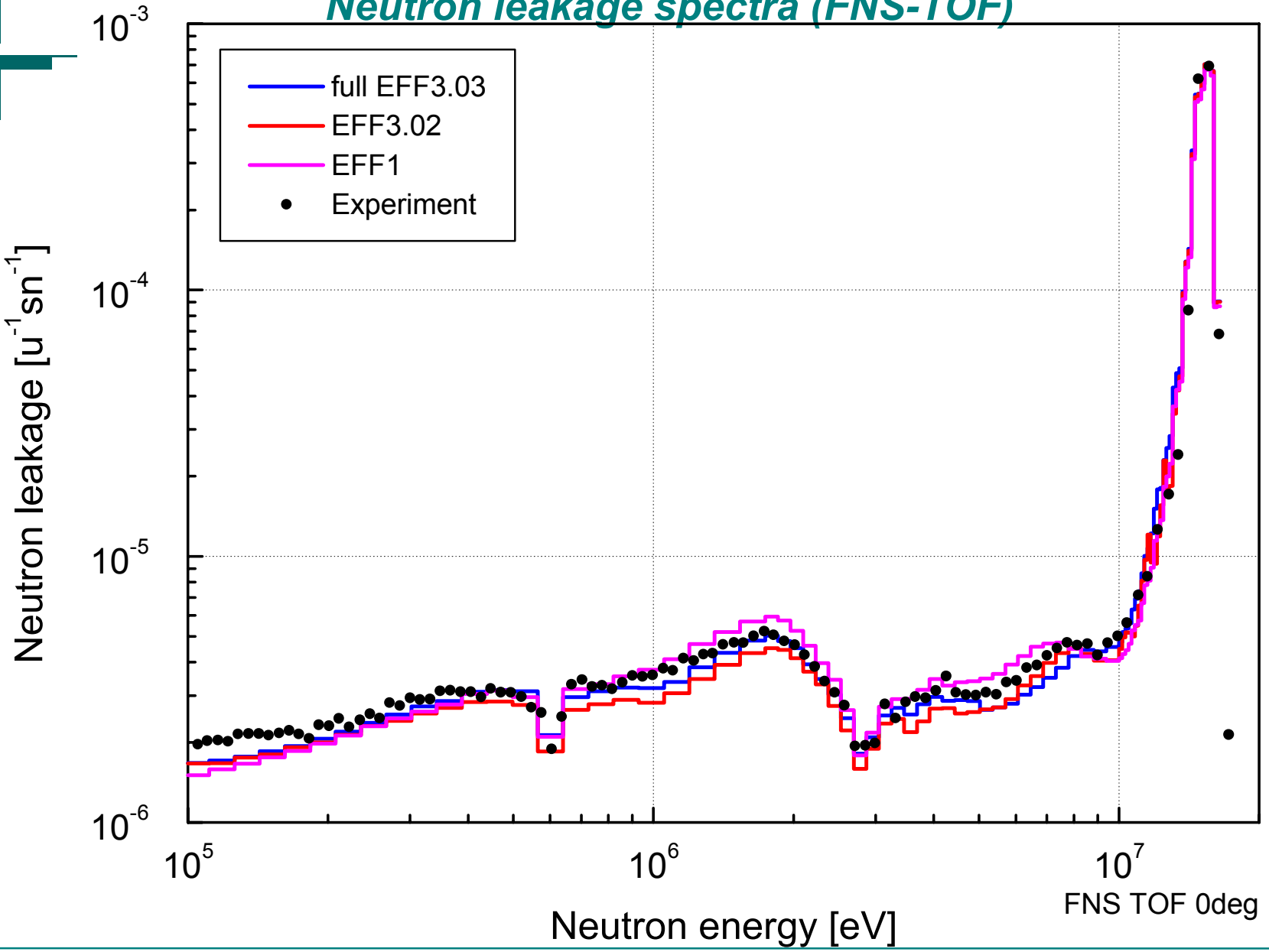
Results for KANT

- **Neutron leakage spectra**
  - *General good agreement between 3.03 and 3.02 (+/- 5%)*
  - *large positive deviation at 2.7 MeV: major elastic resonance*
  - *large positive deviation around 10…11.5 MeV:*
    - Probably scattering at 2nd excited level
    - ACE file contains correct distribution!
  - *Restricted 3.03 and 3.02 yield identical results*
  - *Better agreement of 3.03 with experimental data*
    - Esp. for the range 10…11.5 MeV, where 3.02 shows crude underestimation

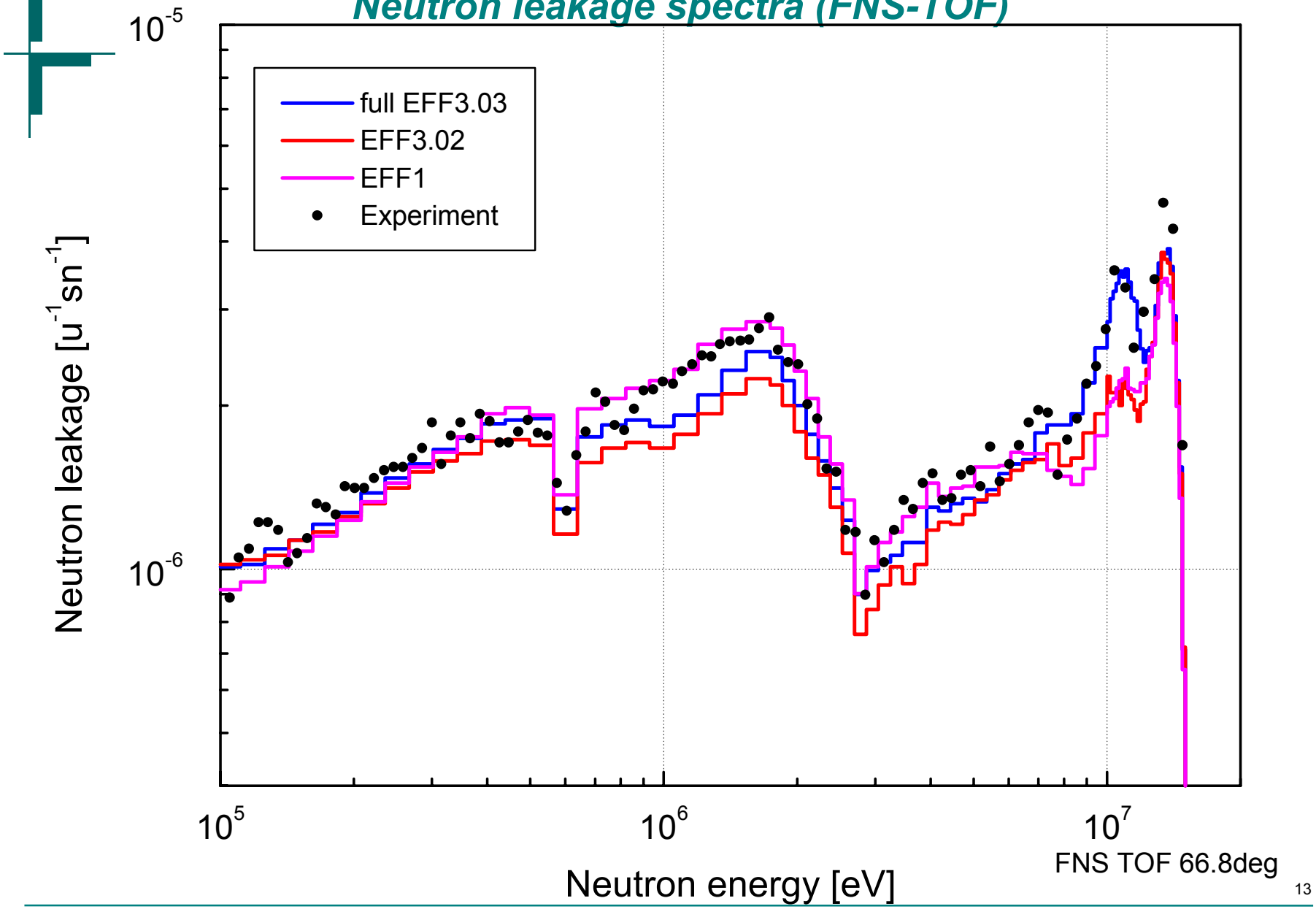
Results for FNS-TOF

- **Neutron leakage spectra**
  - *EFF3.03 gives larger values compared to 3.02 (+10%), except in few MeV range*
  - *Exceptional positive deviations again at 10…12 MeV, dependant now on detector angle*
  - *Smoother spectra above 10 MeV*
  - *Better agreement of 3.03 with experimental data*

Neutron leakage spectra (FNS-TOF)



Neutron leakage spectra (FNS-TOF)

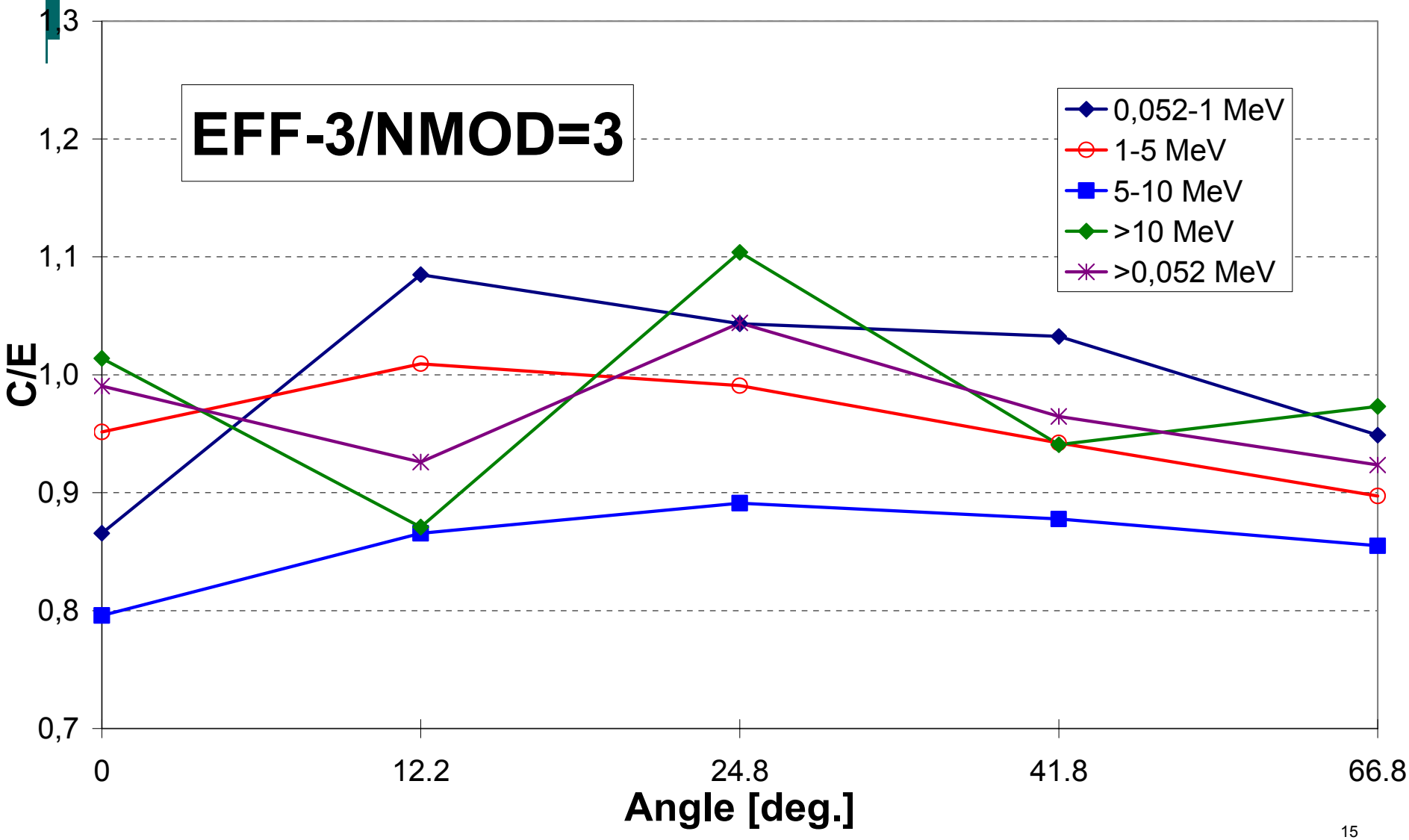


Results for FNS-TOF

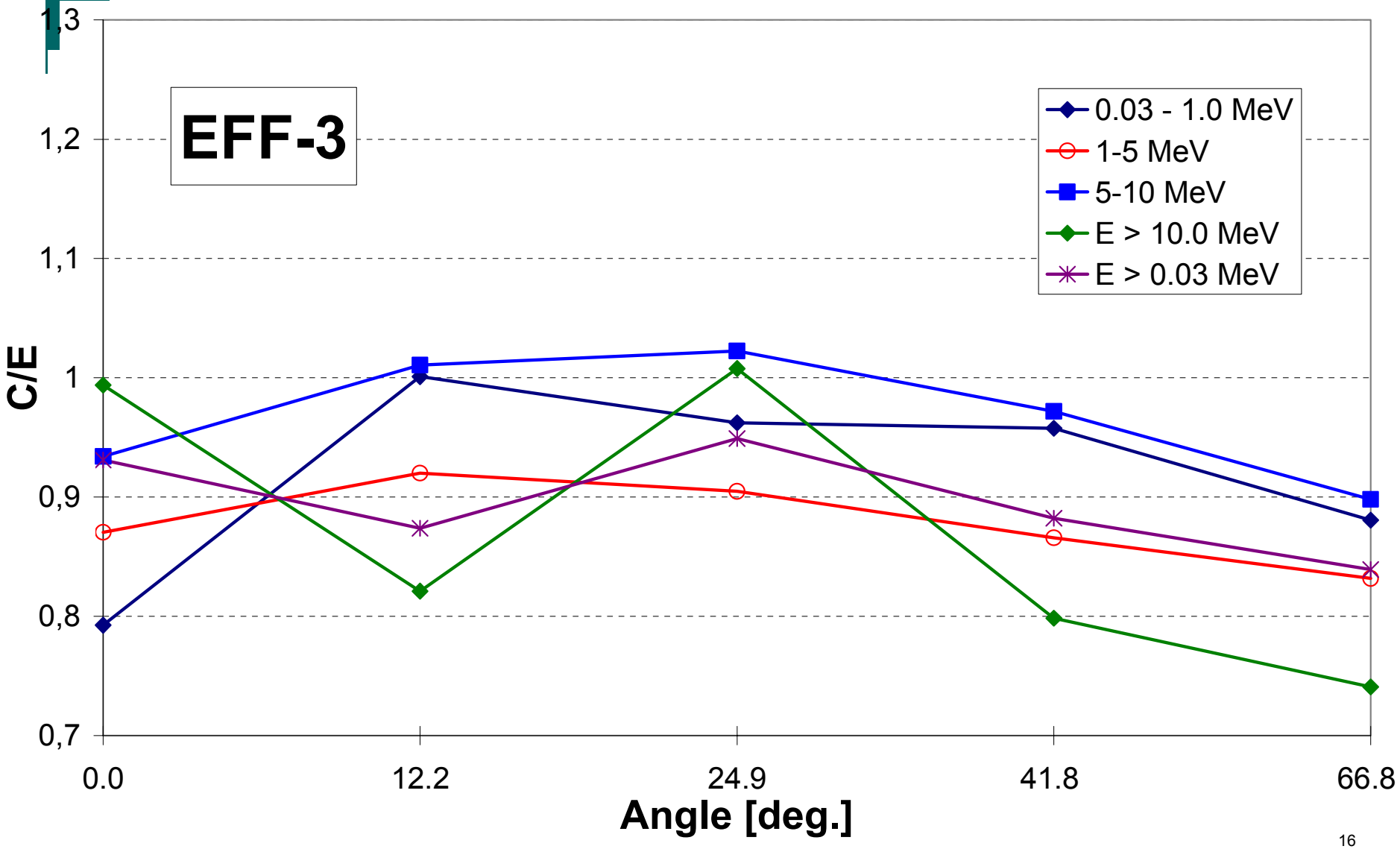
- **Neutron flux integrals**
  - *C/E values improved compared to EFF3.02*

	0 deg		12.2 deg		24.9 deg		41.8 deg		66.8 deg	
E [MeV]	EFF3	3.03	EFF3	3.03	EFF3	3.03	EFF3	3.03	EFF3	3.03
0.052-1	0,79	0,87	1,00	1,09	0,96	1,04	0,96	1,03	0,88	0,95
1-5	0,87	0,95	0,92	1,01	0,91	0,99	0,87	0,94	0,83	0,90
5-10	0,93	0,80	1,01	0,87	1,02	0,89	0,97	0,88	0,90	0,86
>10	0,99	1,01	0,82	0,87	1,01	1,10	0,80	0,94	0,74	0,97
>0.052	0,93	0,99	0,87	0,93	0,95	1,04	0,88	0,97	0,84	0,92

Neutron flux integrals C/E (FNS-TOF)



Neutron flux integrals C/E (FNS-TOF)



Conclusions and Comments

- **New ACE-format for ^{9}Be EFF-3.0/NMOD=3 evaluation works with MCNP4C**
- **Angular distributions are represented as tabular cumulative data, in contrast to 32 equiprobable bins of the old format**
- **Comparable files of EFF3.02 and EFF3.03 (only MT16) are pointwise identical in ENDF format**
  - *ACE format files do differ due to angular representations only.*
  - *In certain cases secondary energy distributions from MCNP calculations also differ (ACE content is identical). Yet unexplained!*

Conclusions and Comments

- **Although MT16 is supposed to be sum of MT875-890 integral benchmark calculations show differences, which are related to secondary distributions**
  - *Which is of some benefit to C/E!*
  - *MF6 MT16 should be constructed anew to coincide with partial distributions*
- **Todo's:**
  - *ENDF library to be completed (missing charged particles, gammas)*
  - *Sensitivity/uncertainty calculations by MCSEN*