Forschungszentrum Karlsruhe
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Benchmarking of Vanadium evaluated data for fusion neutron transport calculations

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Objective and Content

Ø Objective:

- validation of the Vanadium evaluated data relevant for fusion neutron transport calculations

Ø Content of presentation:

- available Evaluations for Vanadium
- available Experimental Benchmark and DDX data for V
- comparison of Transport Calculations and DDX with Experiments
- conclusions

Vanadium evaluated cross sections files

File	ENDF/B-VII, beta 3 (V-00)	JENDL-3.3 (V-00)	JEFF-3.1 (V-51)	FENDL-2.1 (V-00)
Release	Oct. 2006	2002	2005	2004
Origin & Comments	ENDF/B-VI, with revised (n,np), (n,t), (n,n'cont)	JENDL-3.2, and FF with minor modification	ENDF/B-VI, + calculated n- & γ-DDX + angul. distr. discr. levl. from JENDL-3	JENDL-3.3

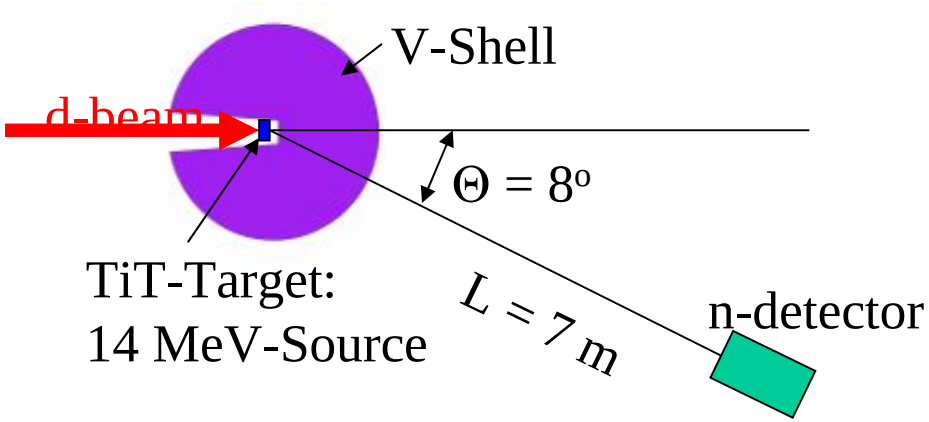
Four independent evaluations do exist: ENDF/B-VII (beta 3), ENDF-B6, JENDL-3.3 & JEFF-3.1

Two Vanadium benchmarks available in SINBAD Collection

IPPE (1997):

/S.P. Simakov et al.
http://www-nds.iaea.org/reports/indc-ccp-417.pdf/

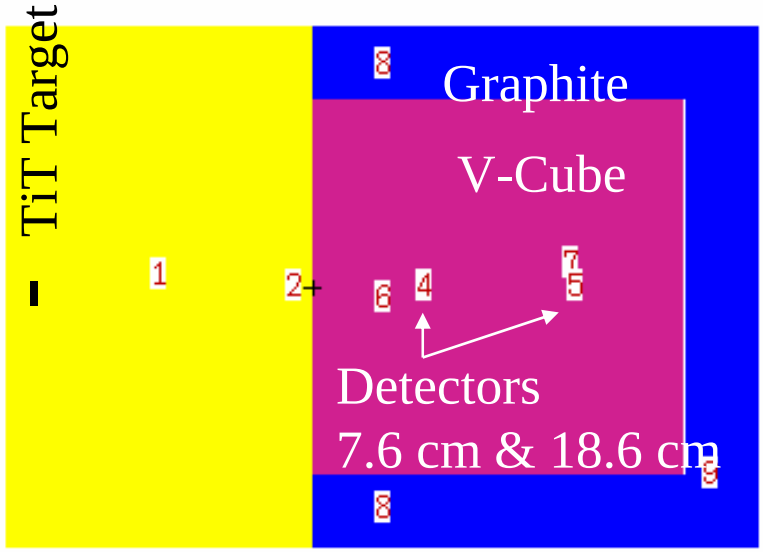
V-shell #1: outer/inner radius = 5/1.5cm (0.6 mfp)
V-shell #2: outer/inner radius =12/1.5cm (1.8 mfp)
14 MeV-neutron source: TiT +d, E_d = 400 keV
Method: Time-of-Flight, L = 7 m
n-detector: $\Theta = 8^o$, $E_{thresh} > 50$ keV



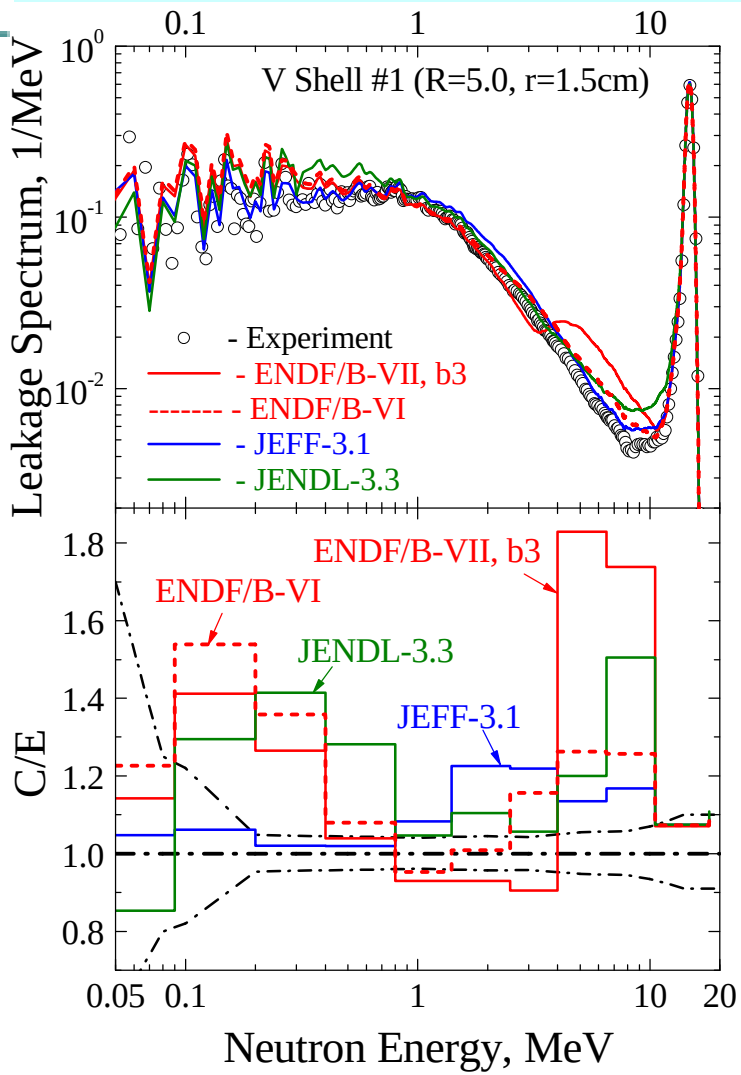
FNS (1998):

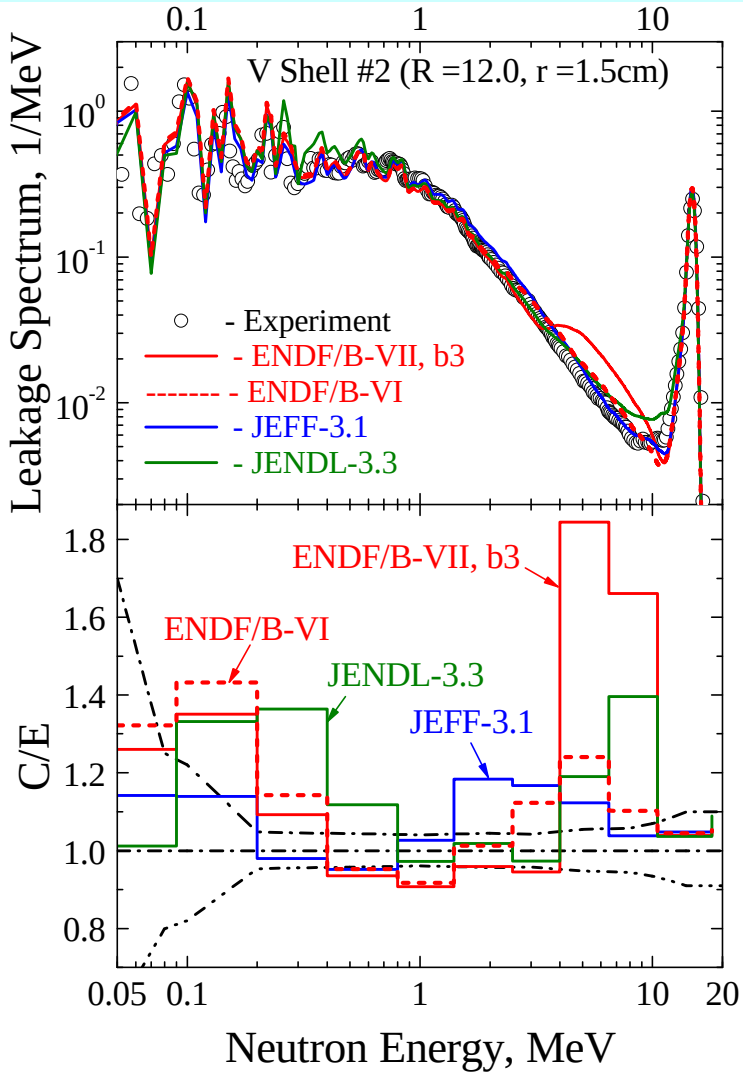
/F. Maekawa et al.,
Journ. Nucl. Sci. & Techn. 36(1999)242/

V-cube 25.4 cm, surrounded by 5 cm graphite
14 MeV neutron source at 20 cm
Method: n spectra - NE, PRC, SDT,
reaction rates – Al, Nb, In, Au foils
γ-spectra – scintillator
γ-heat – TLD



Validation vs. IPPE V-Shells n-Leakage Experiment with 14 MeV Source

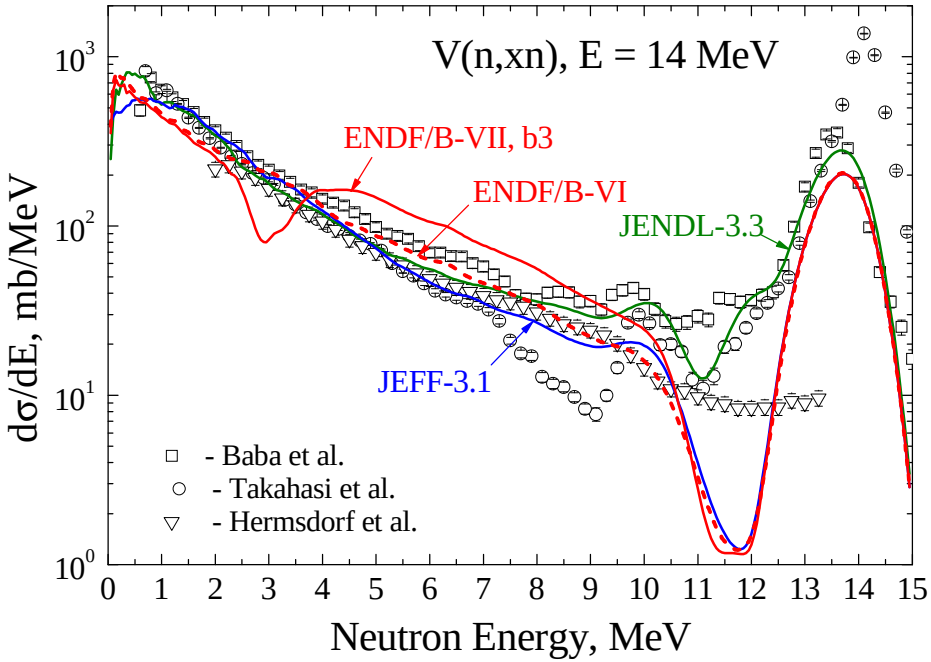




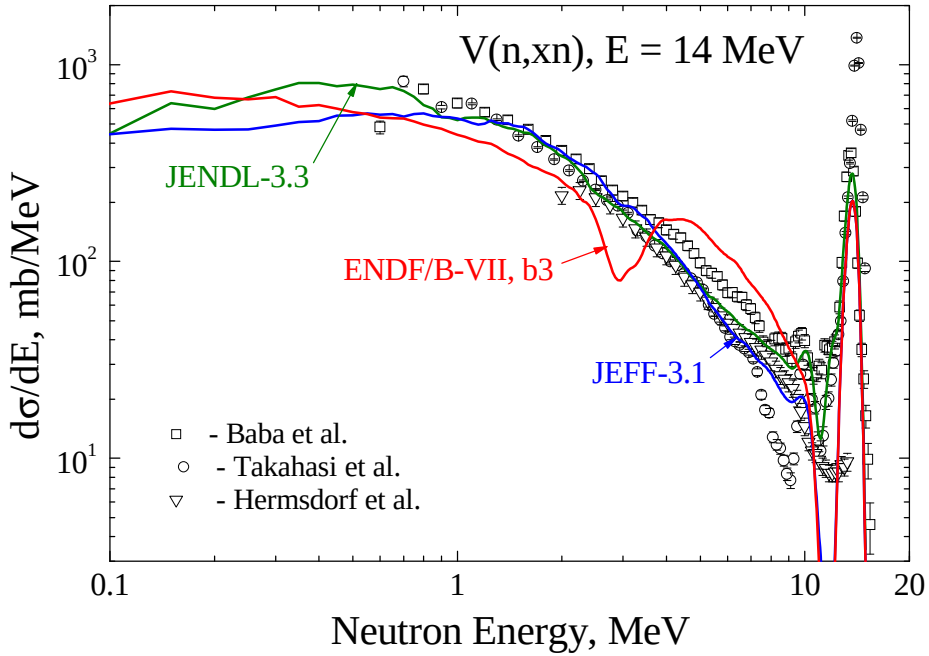
Findings: ***- JEFF-3.1 with higher accuracy (20%) reproduces n-leakage spectra than others***
- ENDF/B-VII beta 3 definitely worse than ENDF/B-VI

Validation vs. Secondary Neutron Emission Spectra from V(n,xn) reaction at 14 MeV

Linear Energy Scale:



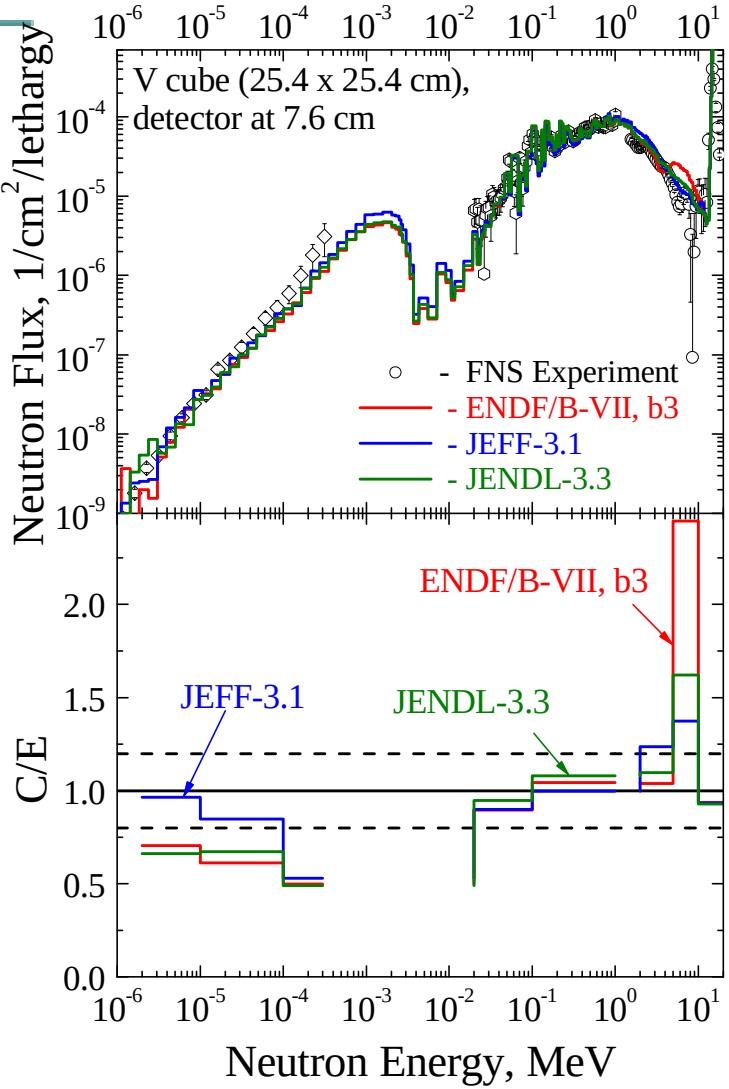
Logarithmic Energy Scale:

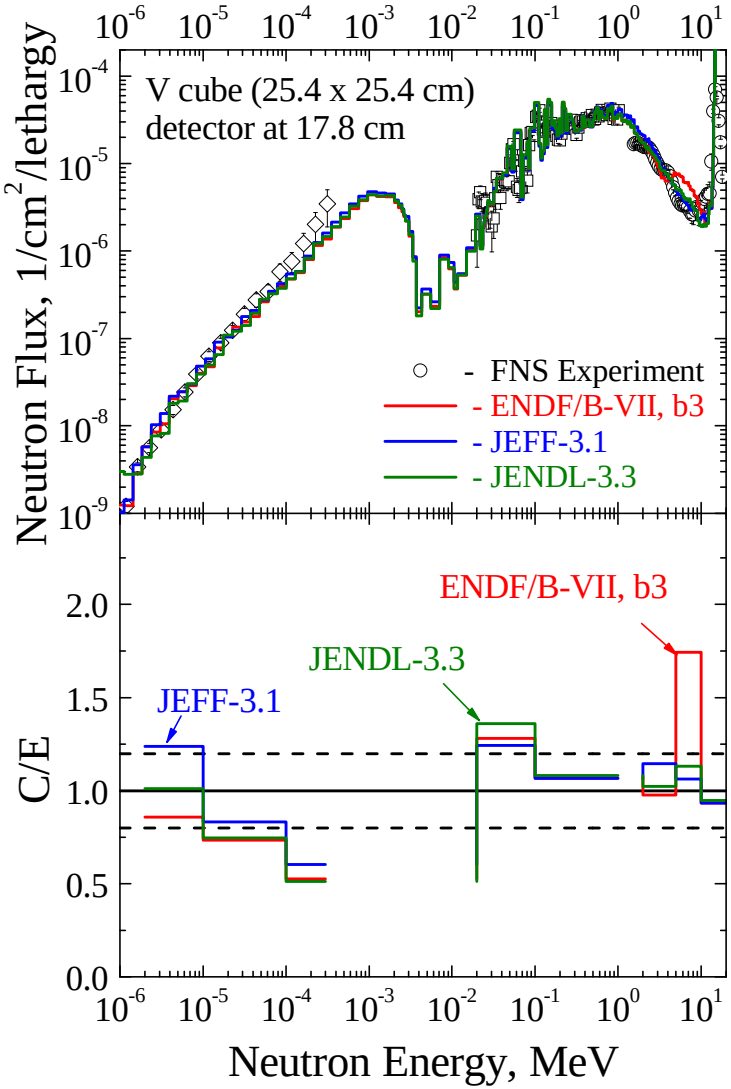


Findings:

- ***JEFF-3.1 and ENDF/B-VII,-VI do not reproduce 10-13 bin of V(n,n') spectra at 14 MeV***
- ***ENDF/B-VII beta 3 do not reproduce the whole (n,xn) spectra***

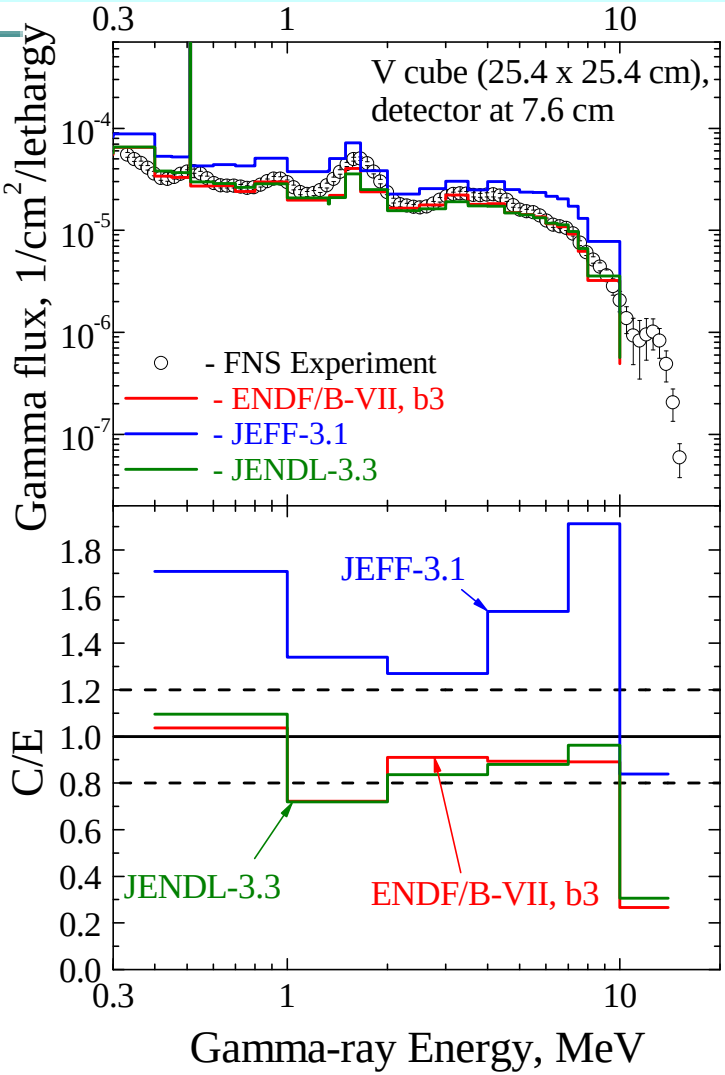
Validation vs. FNS-Cube Experiment with 14 MeV Source: *Neutron Spectra*

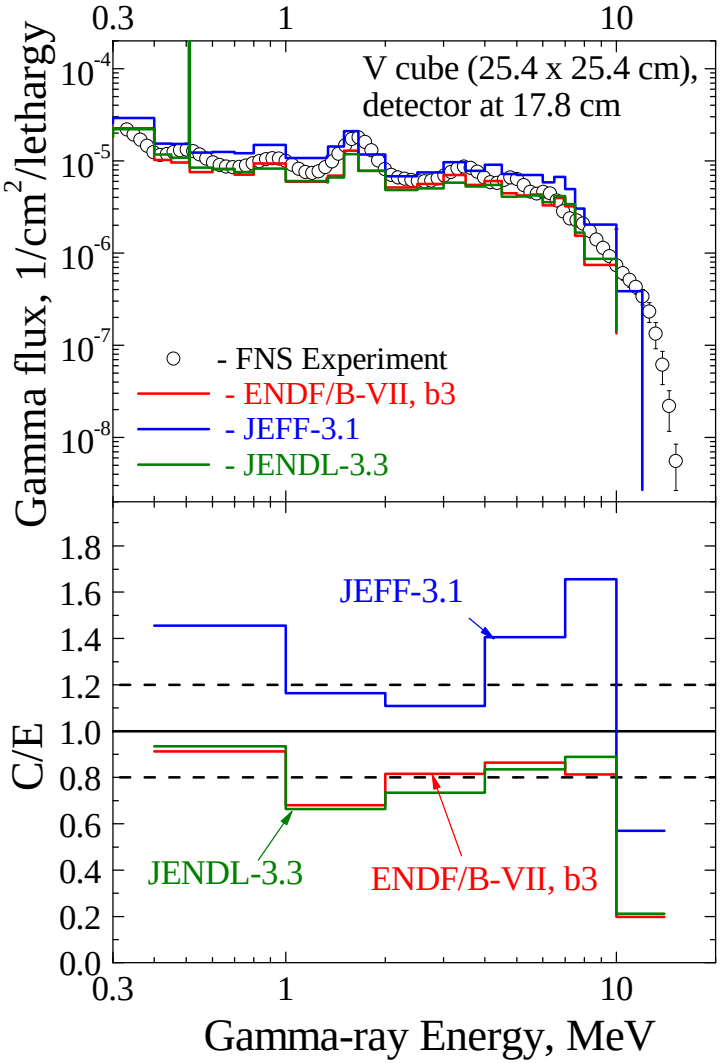




***Findings*: - JEFF-3.1 within 20% reproduces transport neutron spectra**
- ENDF/BVII beta 3 overestimates 2-3 times neutrons with energy 5-10 MeV

Validation vs. FNS-Cube Experiment with 14 MeV Source: *Gamma Spectra*

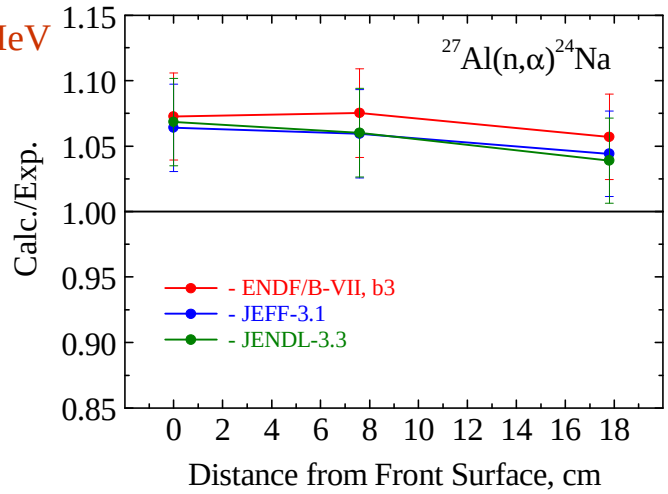




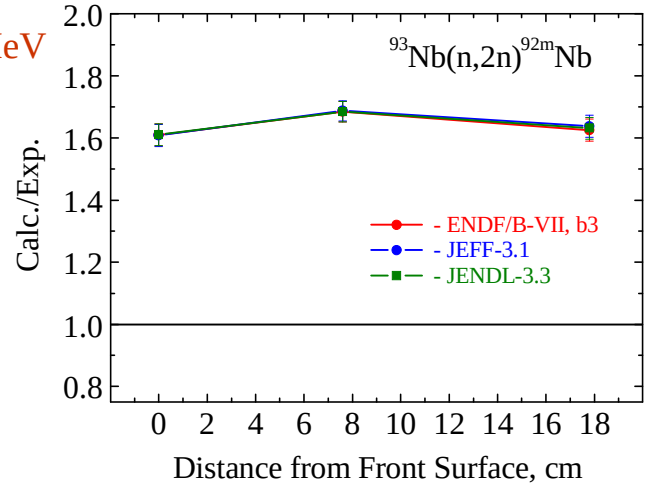
Findings*:** ***- JEFF-3.1 overestimates by 20 – 90% gamma spectra
- ENDF/B-VII & JENDL-3.3 better agree or slightly (20%) underestimate them

Validation vs. FNS-Cube Experiment with 14 MeV Source: *Reaction Rates*

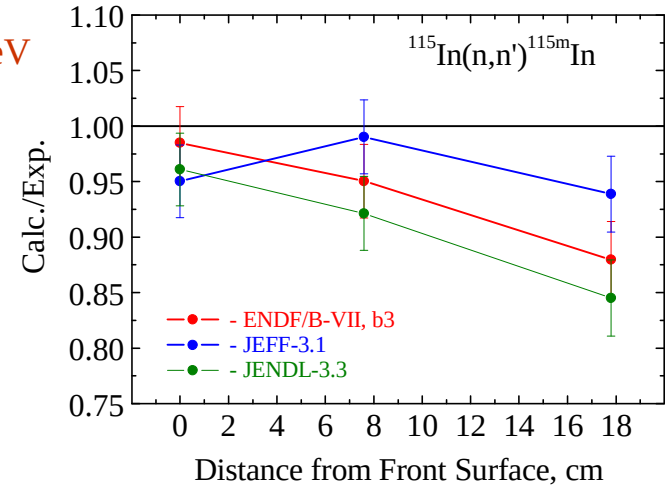
E_{sens} ≈14 MeV



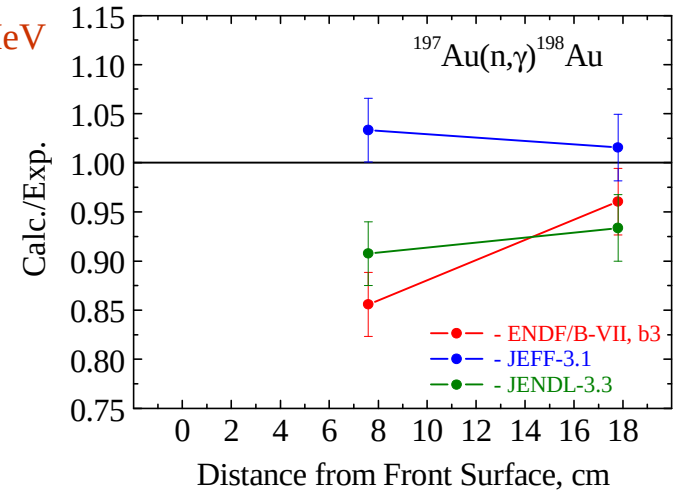
E_{sens} ≈14 MeV



E_{sens} ≈1-10 MeV



E_{sens} < 1 MeV



Findings: ***- JEFF-3.1 better predicts ^{115}In(n,n') and ^{197}Au(n,γ) reaction rates than other files***
- all files overestimate ^{27}Al(n,α) and ^{93}Nb(n,2n) by the same factor (?)

Conclusions: Vanadium Fusion Data

- JEFF-3.1 better predicts neutron transports spectra and activation reaction rates than JENDL-3.3, ENDF/B-VII (beta 3) and B-VI do
- JEFF-3.1 needs improvement of n-spectra from V(n,n') at 14 MeV
- JEFF-3.1 needs improvement of γ-ray production spectra (JENDL-3.3, ENDF/B-VII (beta 3) and B-VI look better)
- ENDF/B-VII beta3 looks as a step backward vs. ENDF/B-VI in respect of neutron emission spectra at 14 MeV