

# Impact of ENDF/B-VII.0 Release on FENDL-2.1

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# FENDL-2.1 Background

- Revision to FENDL-2.0 (1995/96)
- Compiled November 2003, INDC(NDS)-451
- 71 elements/isotopes
- Working libraries prepared by IAEA/NDS, see INDC(NDS)-467 (2004)
- Processing performed using NJOY-99.90 at IAEA-NDS and resulting processed files are available in ACE format for MCNP and in MATXS format for multi-group transport calculations (175n-42g)
- New reference data library for ITER neutronics calculations

# Data Source for FENDL-2.1

No.	Library	NMAT	Materials
1	ENDF/B-VI.8 (E6)	40	<sup>2</sup> H, <sup>3</sup> H, <sup>4</sup> He, <sup>6</sup> Li, <sup>7</sup> Li, <sup>9</sup> Be, <sup>10</sup> B, <sup>11</sup> B, <sup>16</sup> O, <sup>19</sup> F, <sup>28-30</sup> Si, <sup>31</sup> P, S, <sup>35,37</sup> Cl, K, <sup>50,52-54</sup> Cr, <sup>54,57,58</sup> Fe, <sup>59</sup> Co, <sup>61,62,64</sup> Ni, <sup>63,65</sup> Cu, <sup>197</sup> Au, <sup>206-208</sup> Pb, <sup>209</sup> Bi, <sup>182-184,186</sup> W
2	JENDL-3.3 (J33)	18	<sup>1</sup> H, <sup>3</sup> He, <sup>23</sup> Na, <sup>46-50</sup> Ti, <sup>55</sup> Mn, <sup>92,94-98,100</sup> Mo, <sup>181</sup> Ta, V
3	JENDL-3.2 (J32)	3	Mg, Ca, Ga
4	JENDL-FF (JFF)	4	<sup>12</sup> C, <sup>14</sup> N, Zr, <sup>93</sup> Nb
5	JEFF-3 (EFF) JEFF3	4	<sup>27</sup> Al, <sup>56</sup> Fe, <sup>58</sup> Ni, <sup>60</sup> Ni
6	BROND-2.1 (BR2)	2	<sup>15</sup> N, Sn

- Data for 40 isotopes/elements were taken from ENDF/B-VI.8
- ENDF/B-VII.0 library was officially released on December 15, 2006
- Compared data for these 40 elements/isotopes



# Assessment of changes made in data for the 40 isotopes/elements taken from ENDF/B-VI.8

## Isotopes for which data did not change **(7 isotopes)**

***H-2, He-4, Li-7, B-11, Fe-58, Co-59, Bi-209***

“ENDF/B-VII CONVERTED FROM ENDF/B-VI BY NNDC OCT 2004”

\*For Bi-209, covariance data removed except for total (MF/MT=33/1) that were judged to be of high quality



## Assessment of changes made in data for the 40 isotopes/elements taken from ENDF/B-VI.8

For the following isotopes only change is in the product energy-angle distributions (MF=6) using corrected gnash code to fix an earlier bug  
**(19 isotopes)**

*Si-28, Si-29, Si-30, P-31, Cr-50, Cr-52, Cr53, Cr-54, fe-54, Fe-57, Ni-61, Ni-62, Ni-64, Cu-63, Cu-65, W-182, W-183, W-184, W-186*

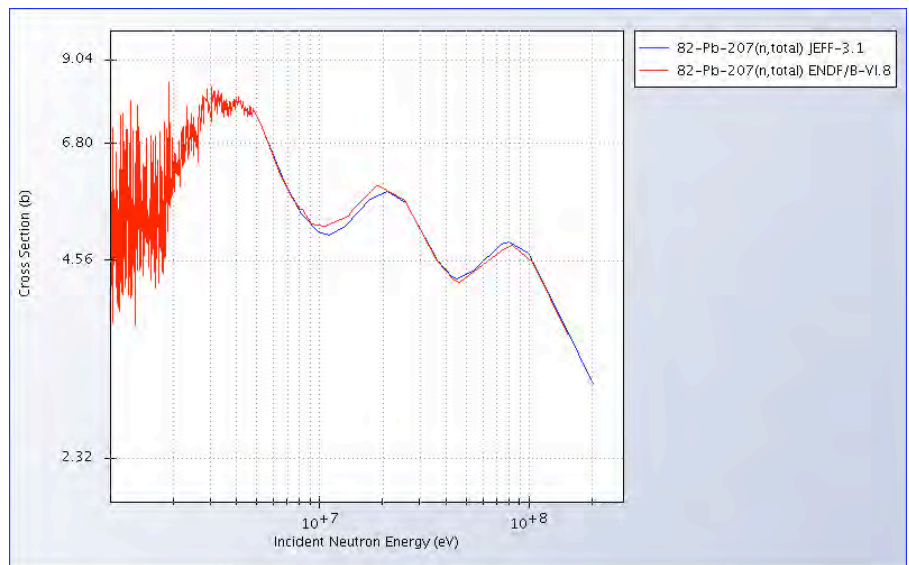
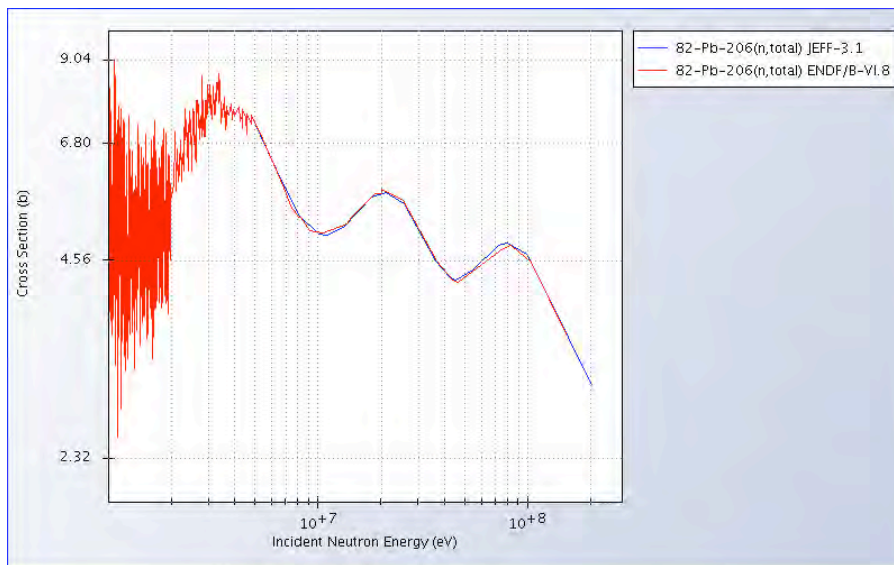
“Possible impact is reduced secondary particle production for new ENDF/B-VII release”

\*For Si-28 changes were made only  $> 20$  MeV and impact is mainly better alpha production data

# Assessment of changes made in data for the 40 isotopes/elements taken from ENDF/B-VI.8

For following isotopes ENDF/B-VII.0 data were taken from JEFF-3.1  
(2 isotopes)

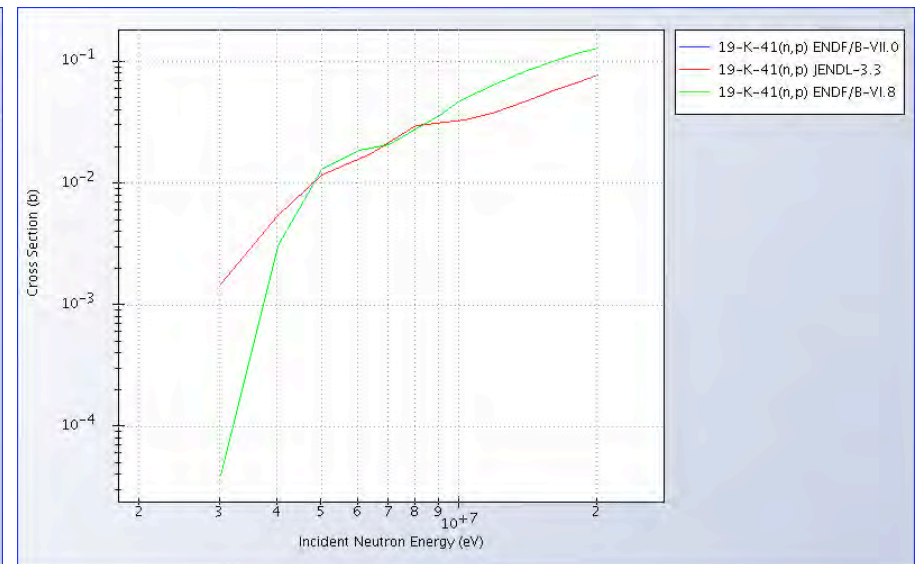
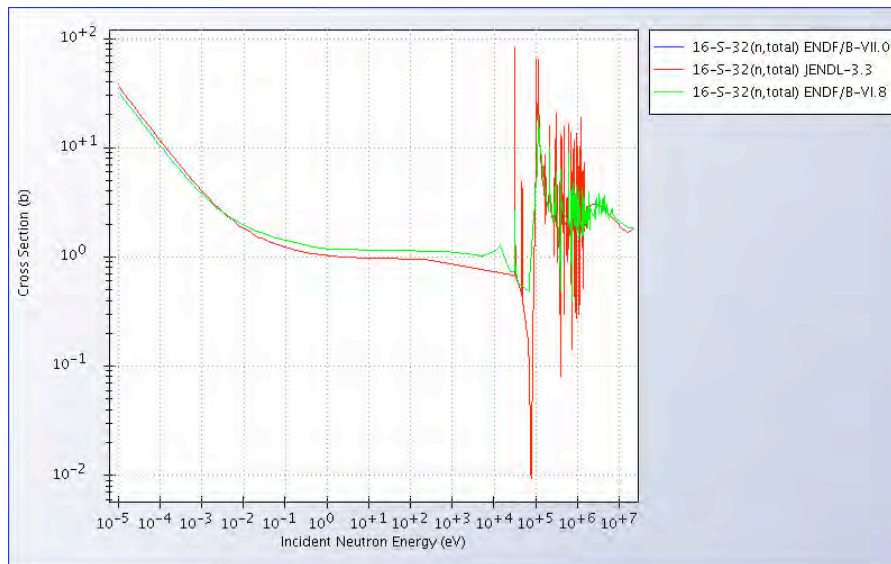
## ***Pb-206, Pb-207***



Only minor change in cross sections above  $\sim 5$  MeV

# Assessment of changes made in data for the 40 isotopes/elements taken from ENDF/B-VI.8

Only isotopic data are provided in ENDF/B-VII.0 for S and K  
 Data for S isotopes (**S-32, S-33, S-34, S-36**) and K isotopes (**K-39, K-40, K-41**) were taken from JENDL-3.3

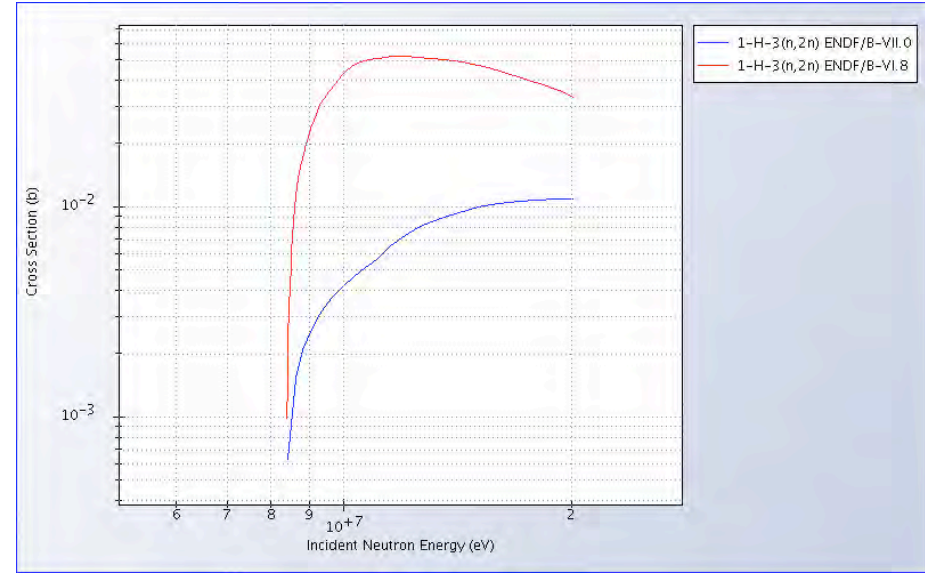
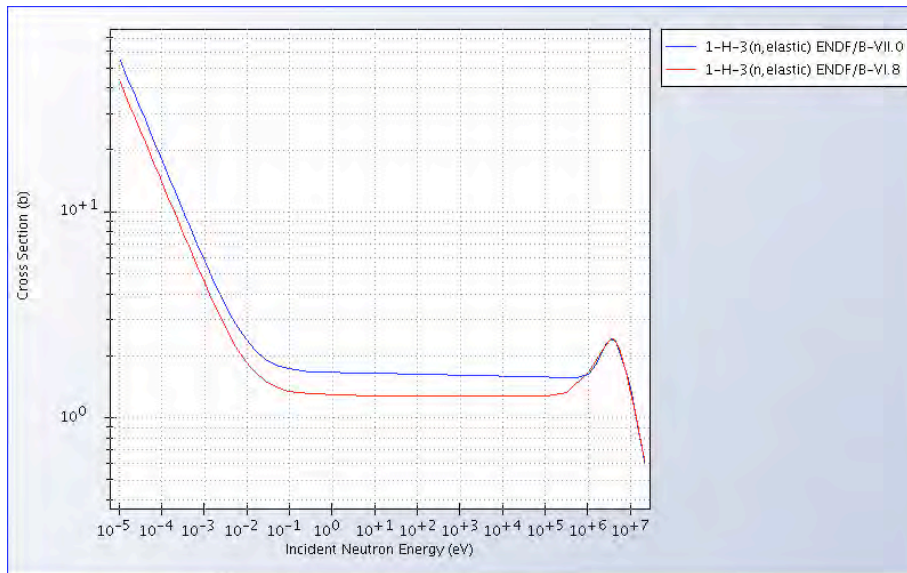


No isotopic data for K in ENDF/B-VI.8 (except for K-41(n,p))  
 Large changes in cross sections

# Assessment of changes made in data for the 40 isotopes/elements taken from ENDF/B-VI.8

## H-3

Changes in (n,total), (n,elastic) and (n,2n) cross sections



Large changes in (n,2n) and elastic scattering cross sections

Only possible impact on ICF target neutronics

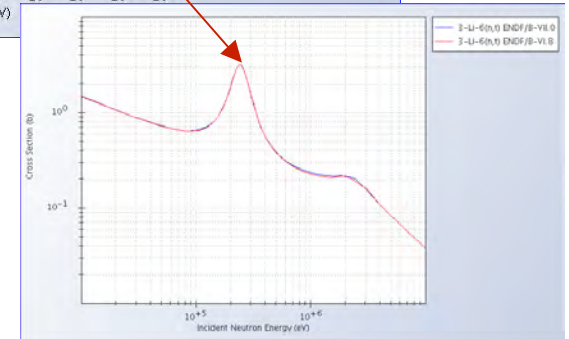
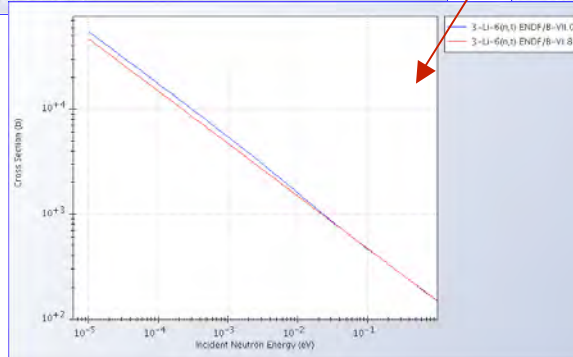
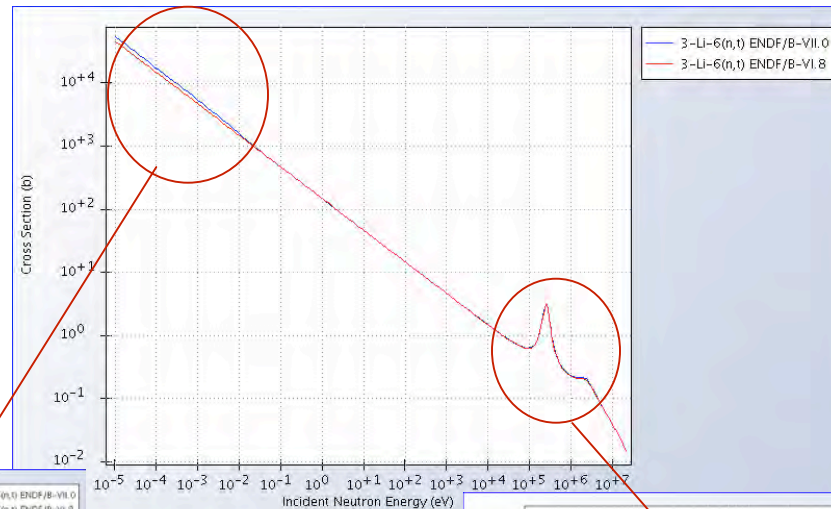
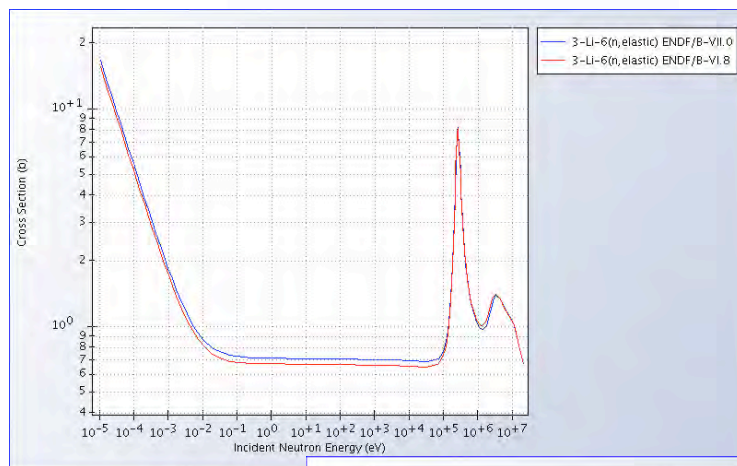
Does not impact ITER



# Assessment of changes made in data for the 40 isotopes/elements taken from ENDF/B-VI.8

## *Li-6*

Changes in (n,total), (n,elastic) and (n,t) cross sections, angular distribution and covariance data

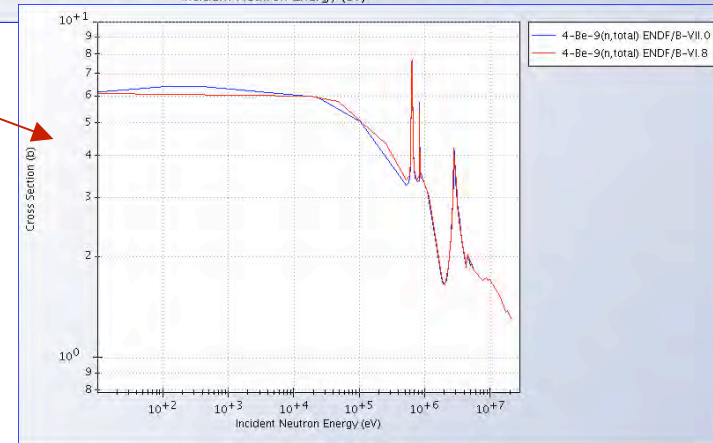
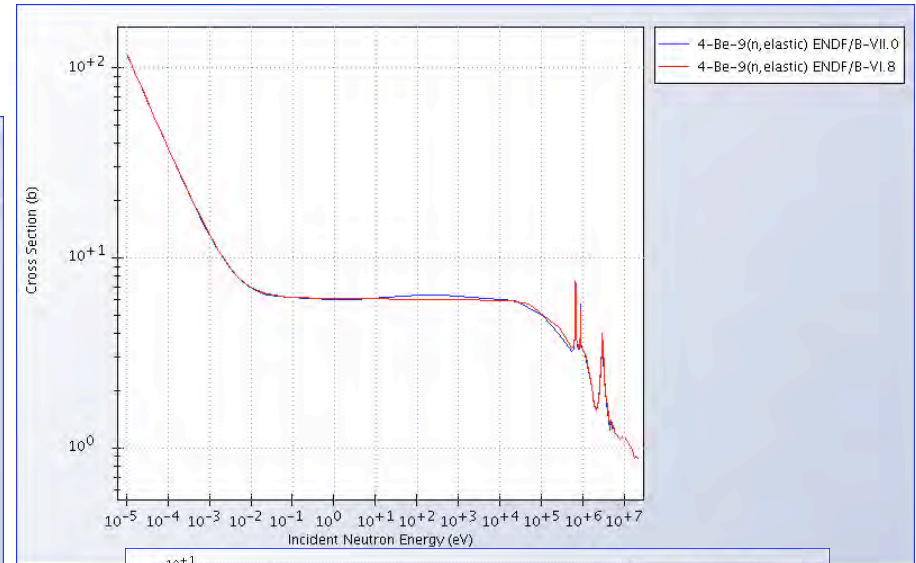
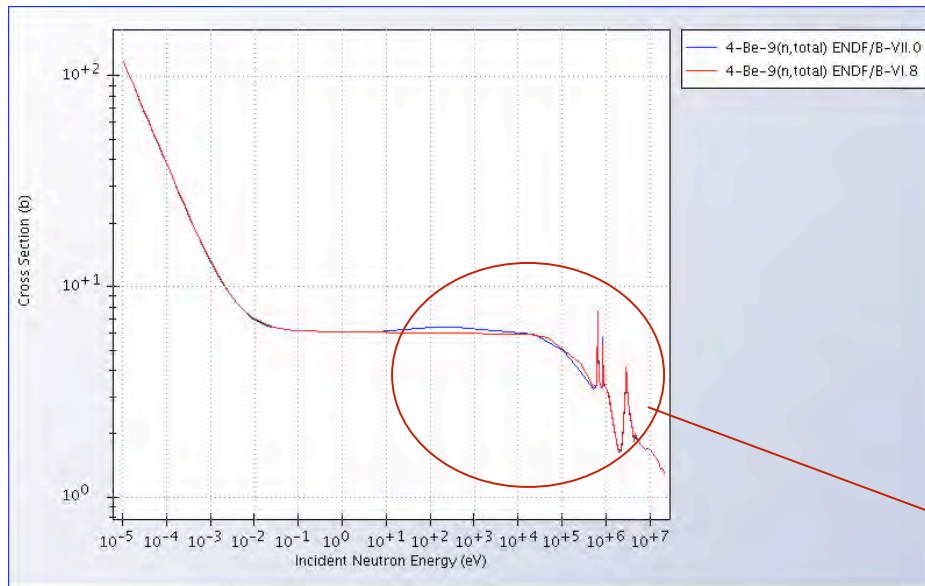


Minor increase in (n,t) at very low and high energies  
Minor impact on ITER-TBM expected

# Assessment of changes made in data for the 40 isotopes/elements taken from ENDF/B-VI.8

## Be-9

Changes in (n,total), (n,elastic) cross sections

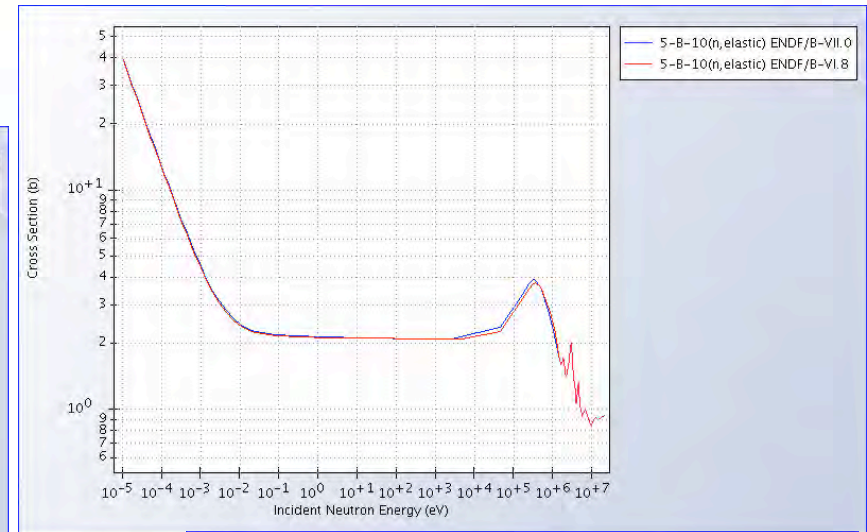


Only minor change in elastic scattering  
 Minor impact on ITER expected

# Assessment of changes made in data for the 40 isotopes/elements taken from ENDF/B-VI.8

## B-10

Changes in (n,total), (n,elastic), (n, $\alpha$ ), angular distribution and covariance data



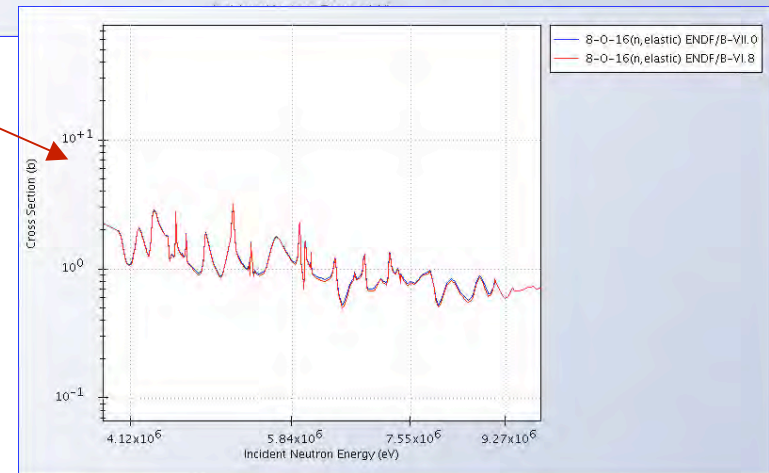
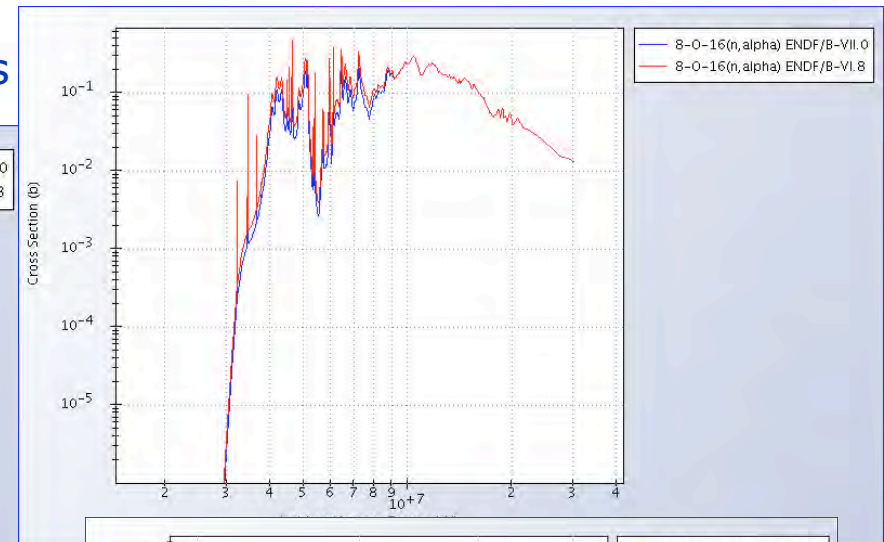
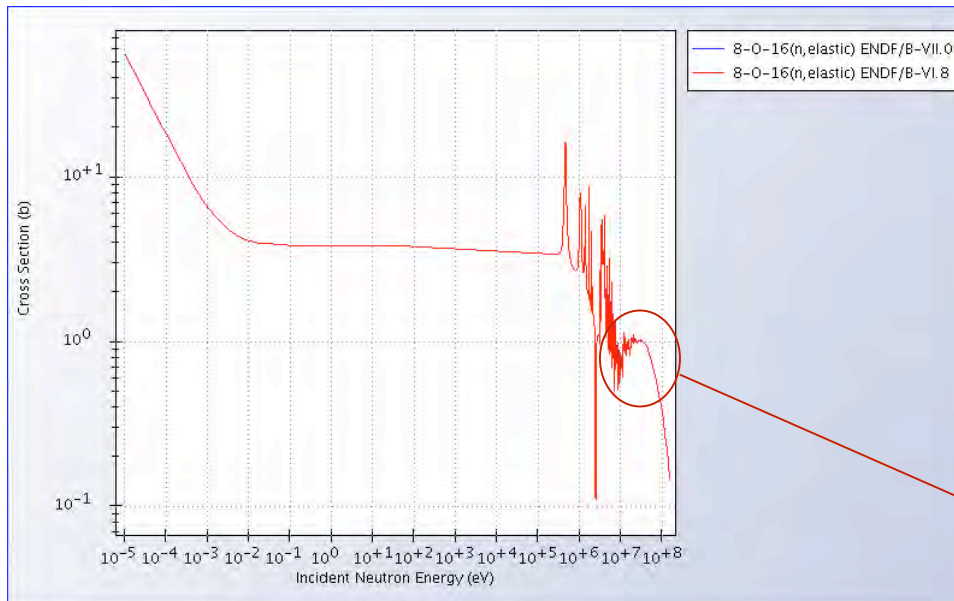
Only minor change in (n, $\alpha$ ) and elastic scattering

Minor impact on ITER expected

# Assessment of changes made in data for the 40 isotopes/elements taken from ENDF/B-VI.8

## O-16

Changes in (n,elastic) and (n, $\alpha$ ) cross sections



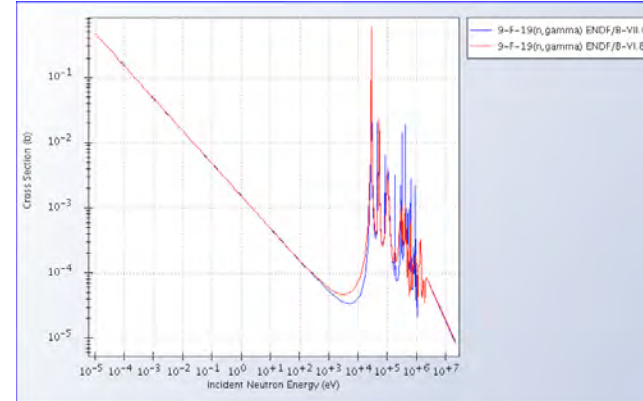
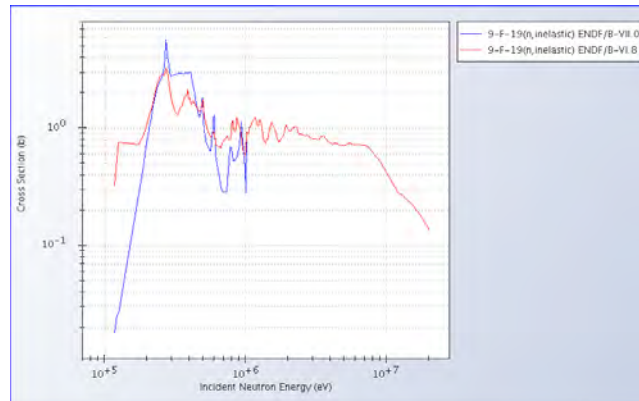
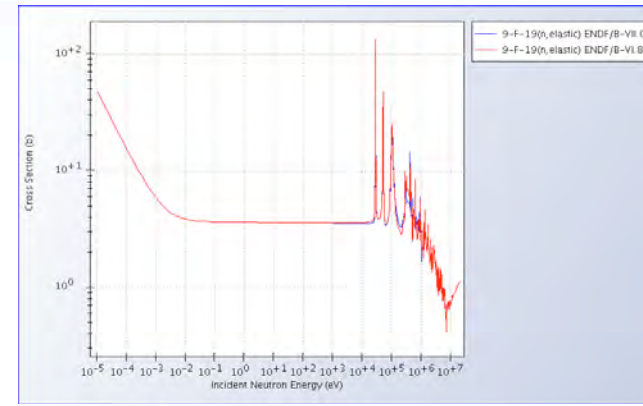
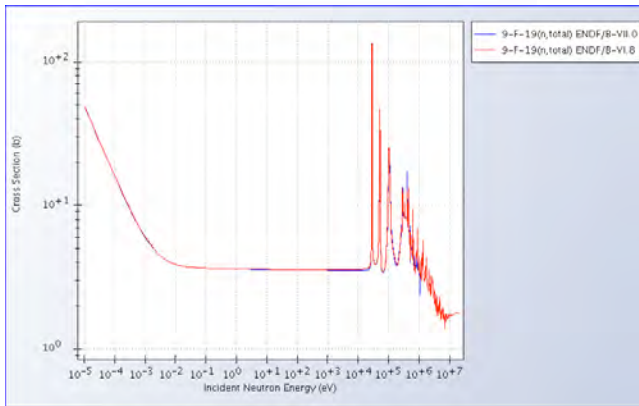
Only minor change in (n, $\alpha$ ) and elastic scattering in range 3-9 MeV

Minor impact on ITER expected

# Assessment of changes made in data for the 40 isotopes/elements taken from ENDF/B-VI.8

## F-19

Changes in (n,total), (n,elastic), (n,inelastic) and (n, $\gamma$ ) cross sections

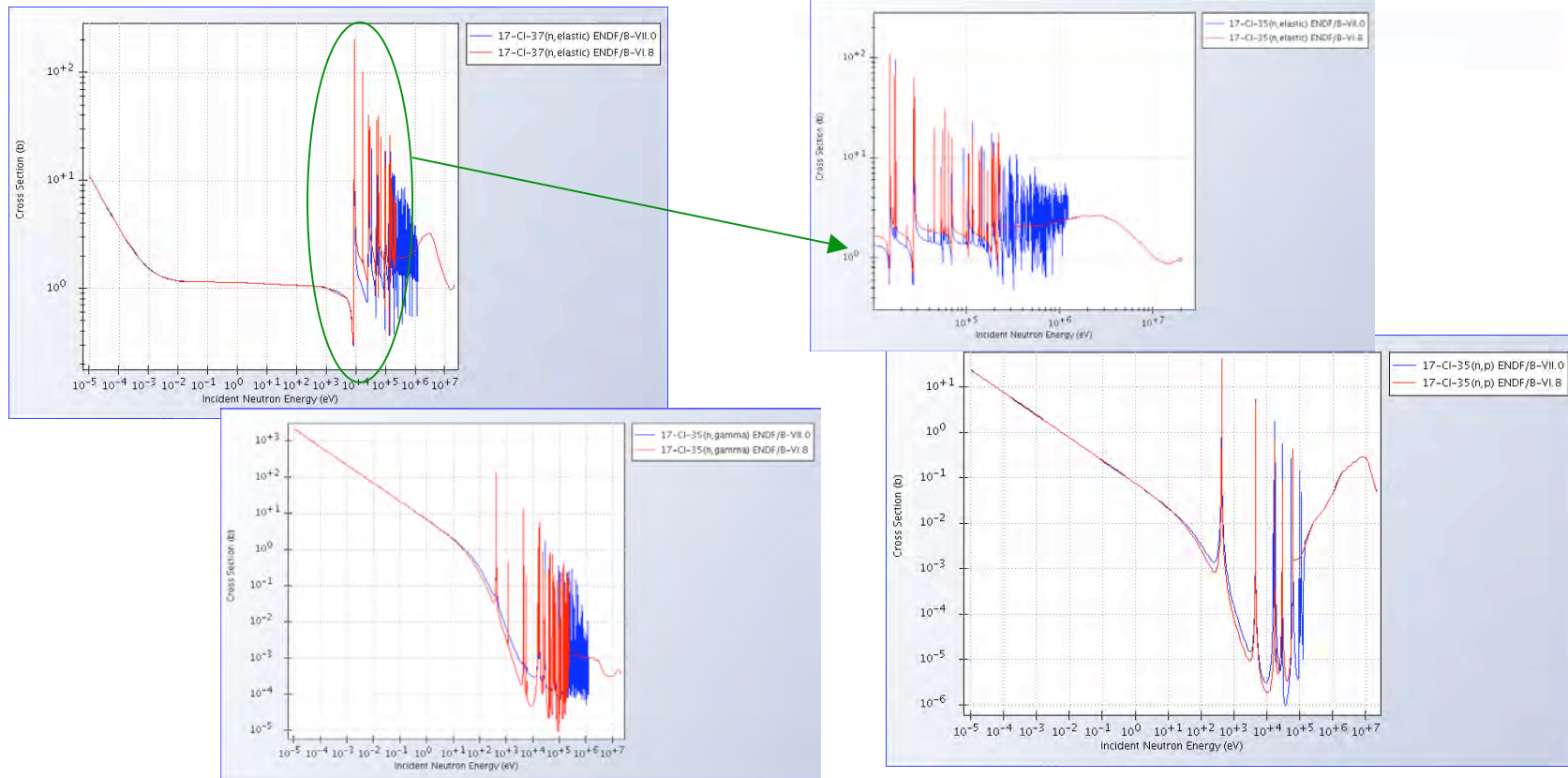


Some large change in (n, $\gamma$ ) and inelastic scattering  
Minor impact on ITER expected unless Flibe is used in TBM

# Assessment of changes made in data for the 40 isotopes/elements taken from ENDF/B-VI.8

## Cl-35

Changes in (n,total), (n,elastic), (n,p) and (n, $\gamma$ ) cross sections

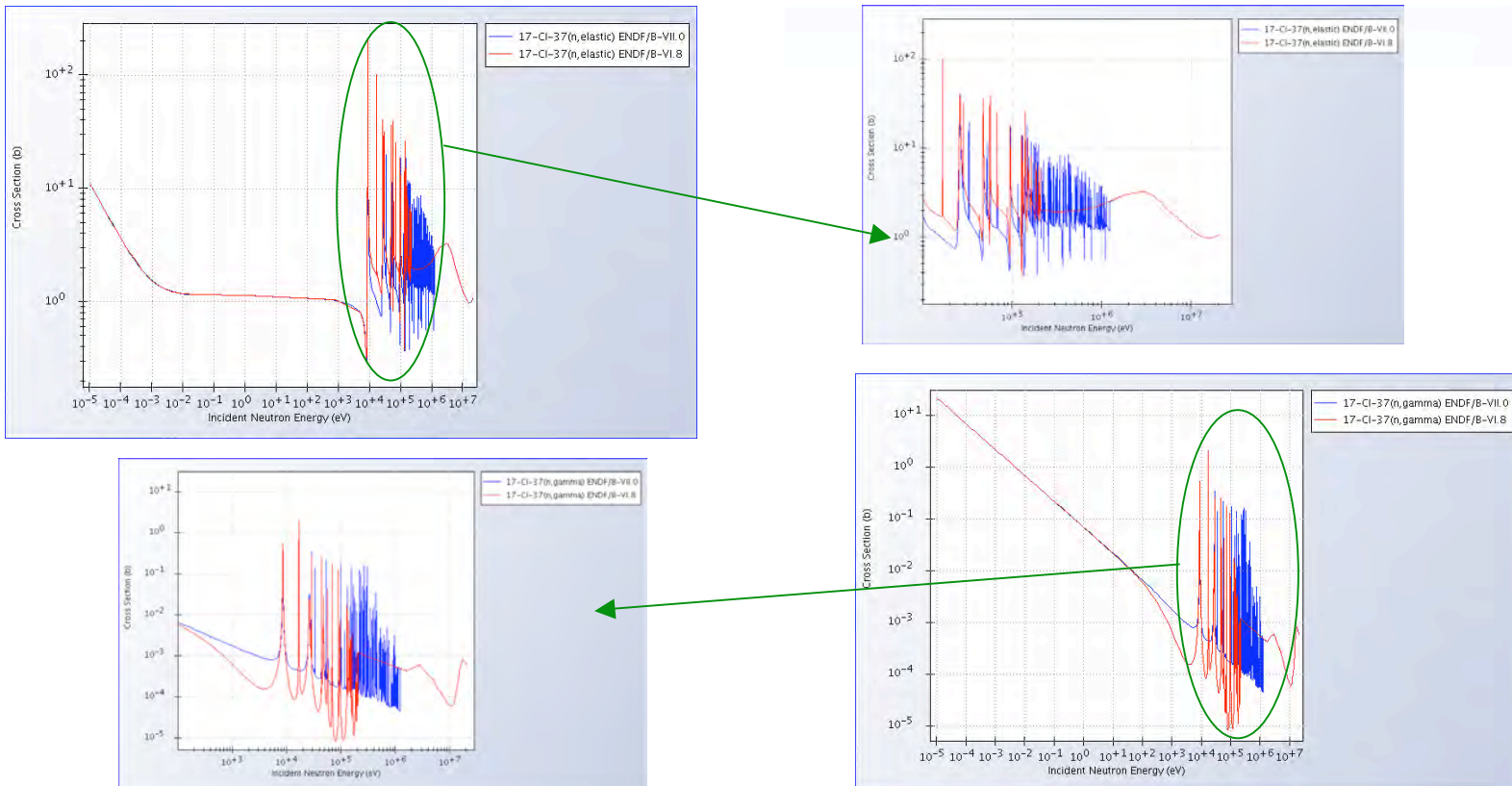


Some large changes in (n, $\gamma$ ), (n,p) and elastic scattering  
 Minor impact on ITER expected since Cl is not used

# Assessment of changes made in data for the 40 isotopes/elements taken from ENDF/B-VI.8

## Cl-37

Changes in (n,total), (n,elastic), and (n, $\gamma$ ) cross sections

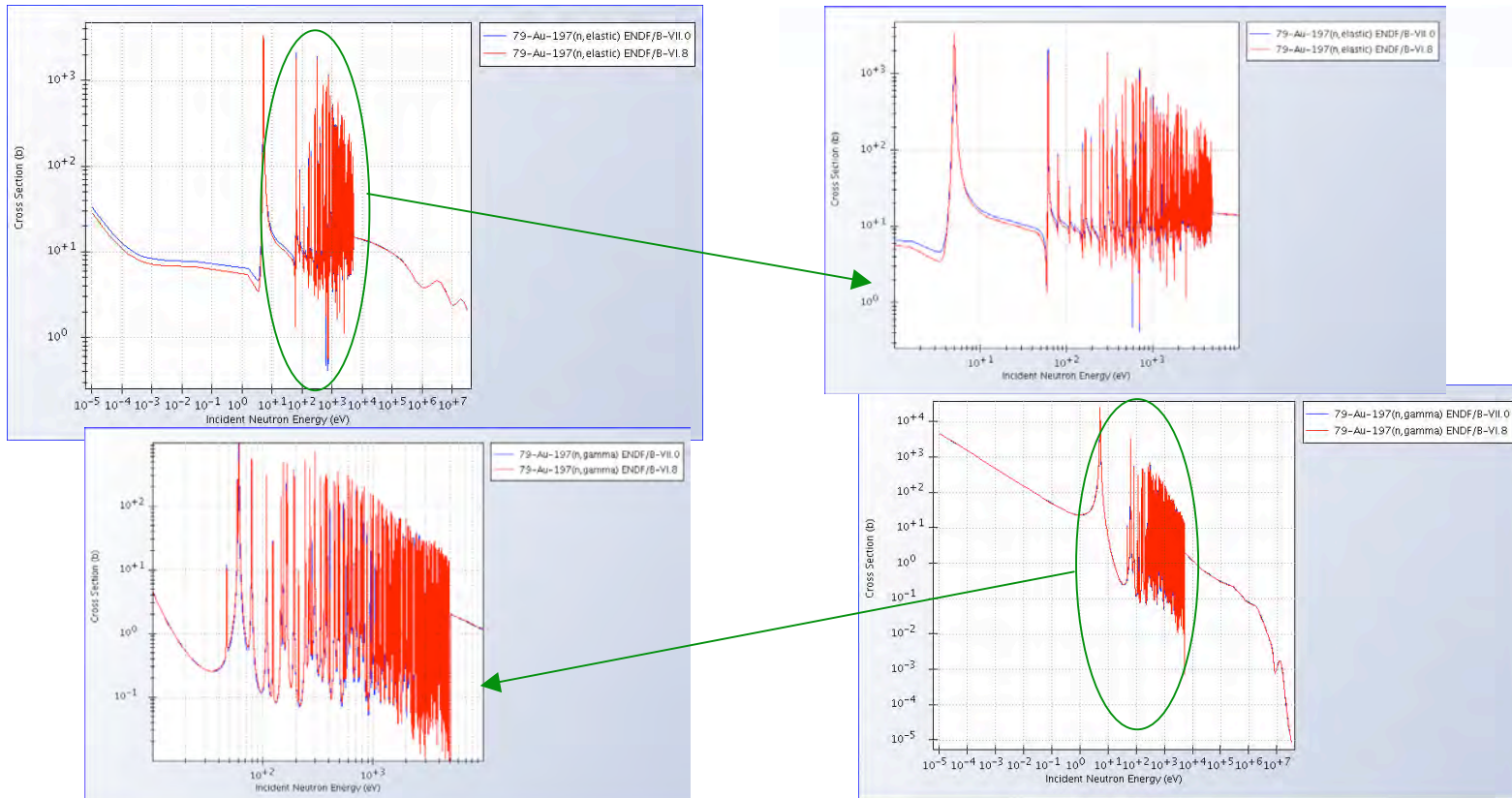


Some large changes in (n, $\gamma$ ) and elastic scattering  
Minor impact on ITER expected since Cl is not used

# Assessment of changes made in data for the 40 isotopes/elements taken from ENDF/B-VI.8

## Au-197

Changes in (n,total), (n,elastic), and (n, $\gamma$ ) cross sections



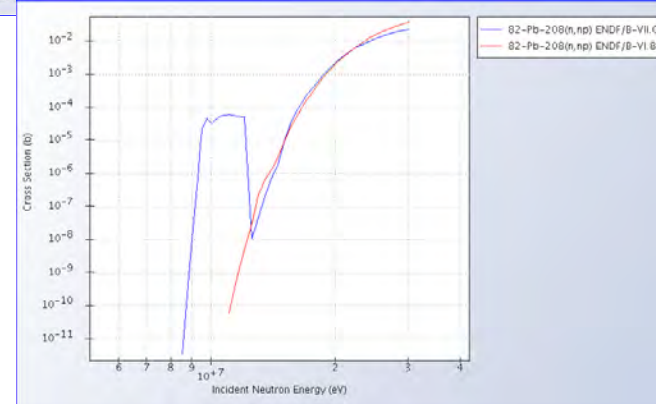
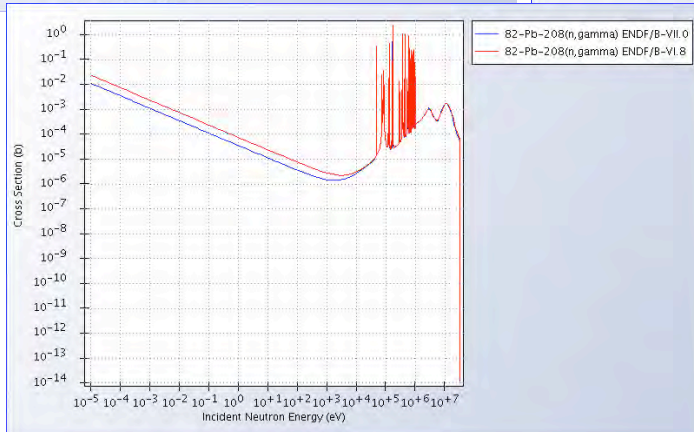
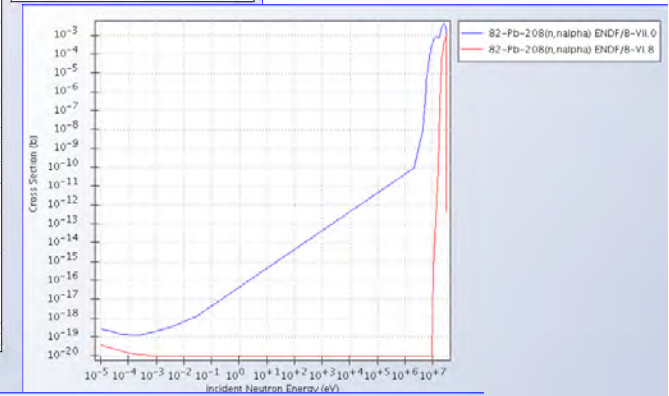
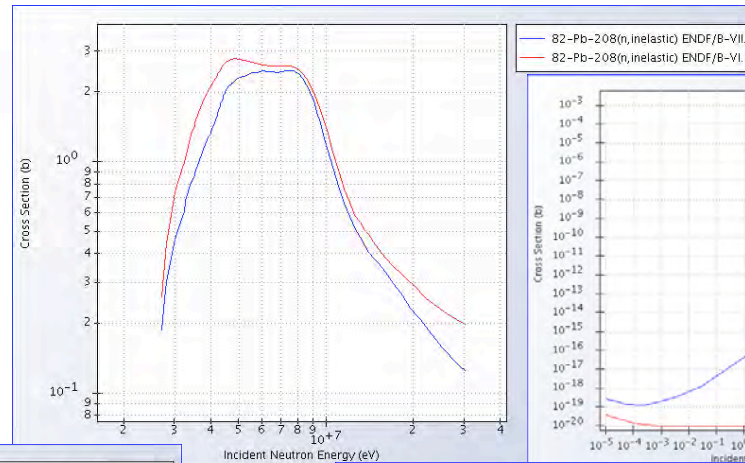
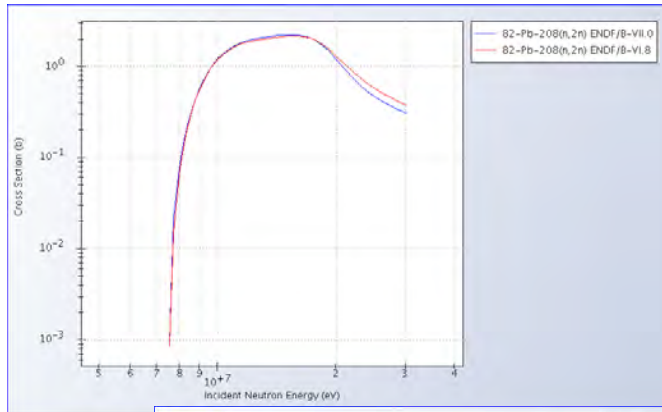
Moderate changes in (n, $\gamma$ ) and elastic scattering in resonance region  
 Only possible impact on ICF target neutronics. Does not impact ITER



# Assessment of changes made in data for the 40 isotopes/elements taken from ENDF/B-VI.8

## *Pb-208*

Many cross sections changed

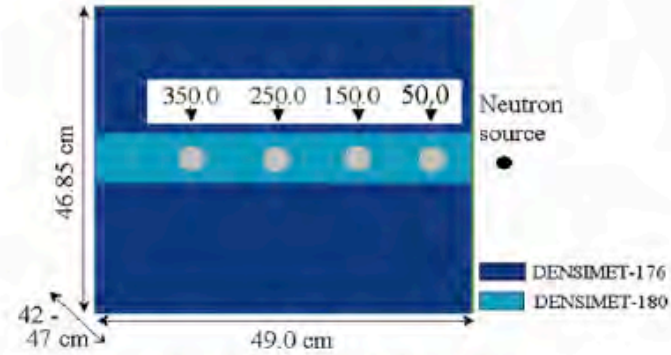
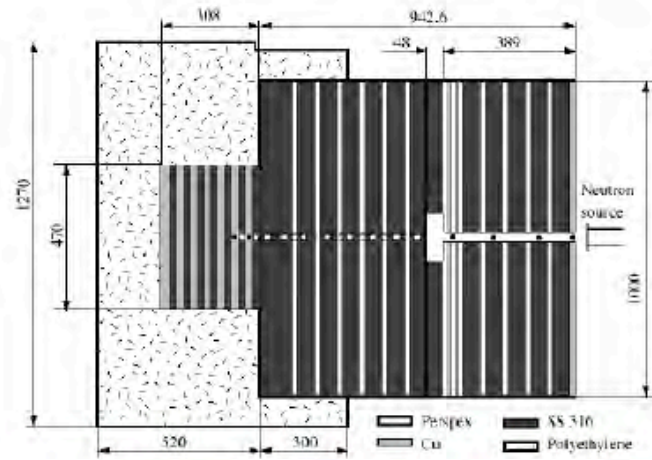


Large changes in several cross sections  
Possible impact on ITER-TBM

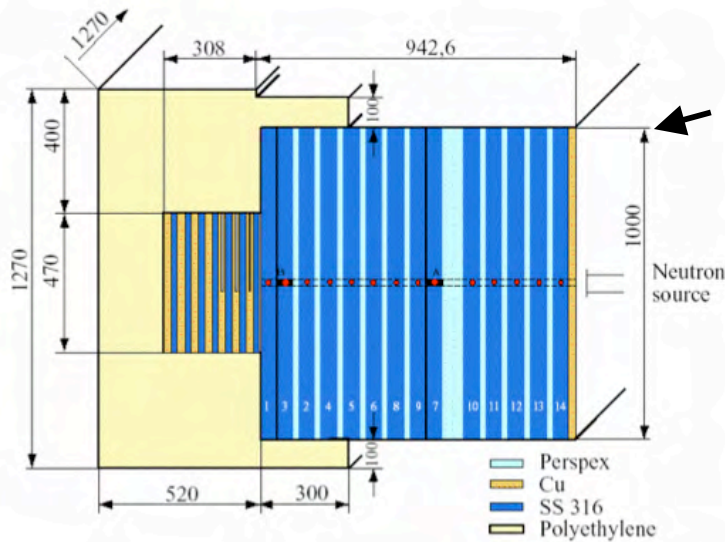
# Findings

- Minor impact on ITER nuclear analysis is expected except for ITER-TBM nuclear analysis due to changes in data for Li-6, Pb-208, and F-19
- Effects of changes could be large in other fusion systems
  - Power plants with breeding blankets
  - Inertial fusion systems (e.g., H-3 and Au-197 data are important for ICF target neutronics)
- Calculation benchmarks will be used to assess possible impact on relevant nuclear parameters
  - M. Sawan, "FENDL Neutronics Benchmark: Specifications for the Computational Neutronics and Shielding Benchmark," IAEA Nuclear Data Section Report INDC(NDS)-316 (December 1994).
- Calculations will also be made for the FNG integral experimental benchmarks
- Impact of changes introduced in JENDL-3.3, JEFF-3.1, BROND-2.2 should also be assessed
- FENDL-2.1 needs a new update (FENDL-2.2 or 3.0?) for fusion neutronics but this update is not urgently needed for ITER analysis pending the outcome of benchmark calculations

# Benchmark Experiments (FNG Facility)



Tungsten Experiment



Streaming Experiment  
Bulk Shielding Experiment

