Tungsten Benchmark Experiments: Re-analysis Using JENDL-3.3

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JENDL-3.3

- **FSXLIB** (MCNP) and **MATXSLIB** (TRANSX-->DORT) cross-sections libraries based on JENDL-3.3.

  – FNG-Tungsten (DORT/GRTUNCL, SUSD3D)
  – OKTAVIAN Tungsten sphere (MCNP/4C)
  – FNS Tungsten Cylindrical Assembly (MCNP/4C)

  Comparison with FENDL-2 results using DORT and MCNP (EFF-DOC-867)

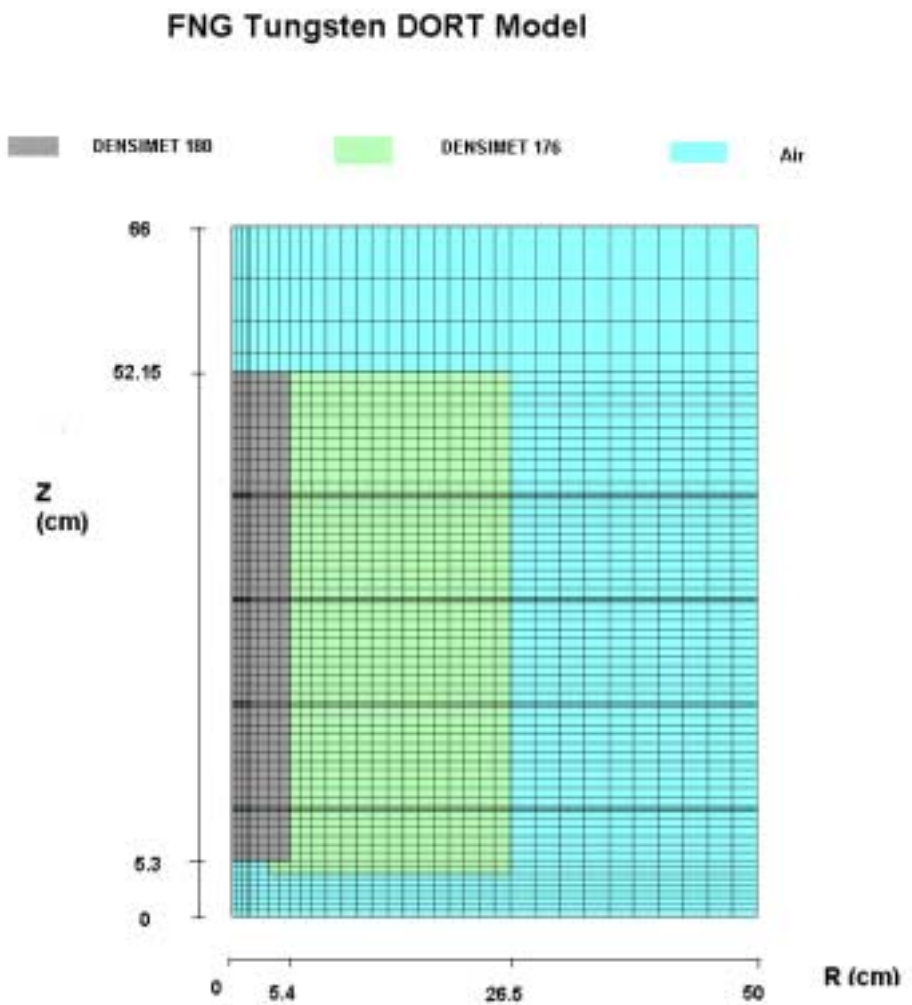
FNG W Benchmark

Measured reaction rates

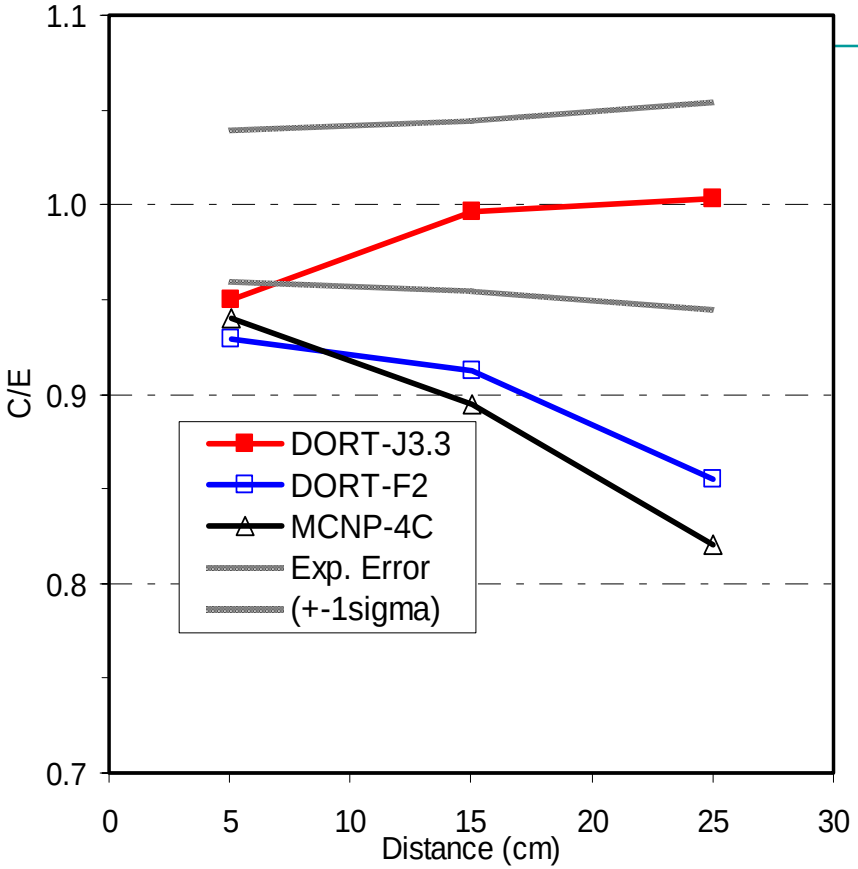
- Ni-58(n,2n)
- Zr90(n,2n)
- Nb-93(n,2n)
- Al-27(n,α)
- Fe56(n,p)
- Ni-58(n,p)
- In115(n,n')
- Au-197(n,γ)
- Mn55(n,γ)

Detector positions:

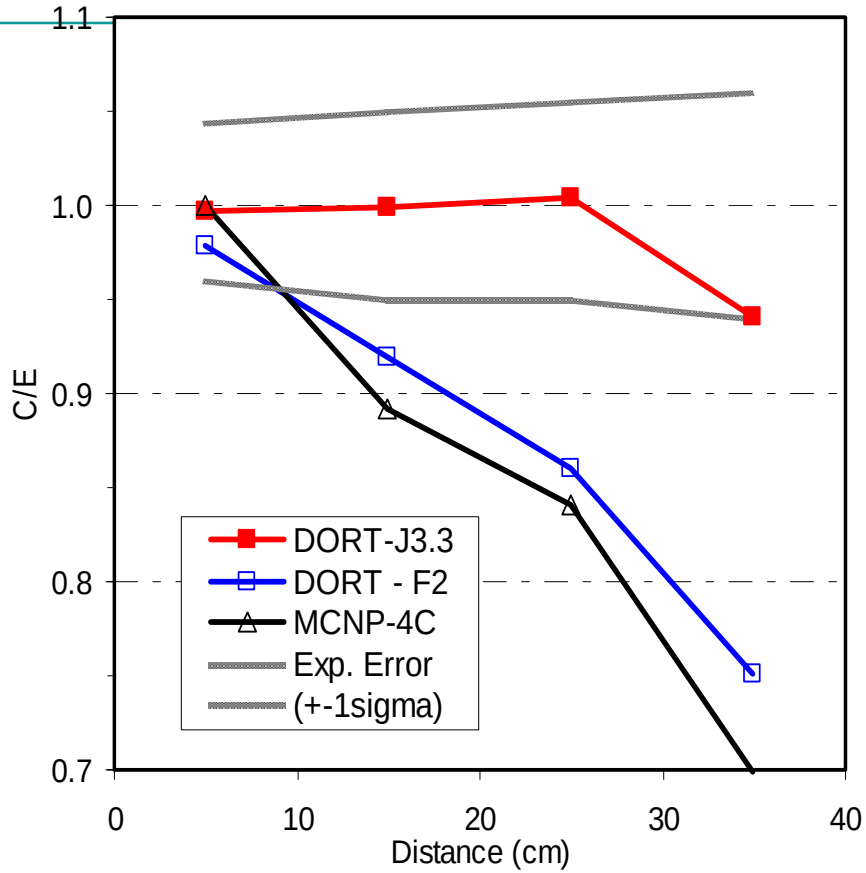
- 5 cm
- 15 cm
- 25 cm
- 35 cm

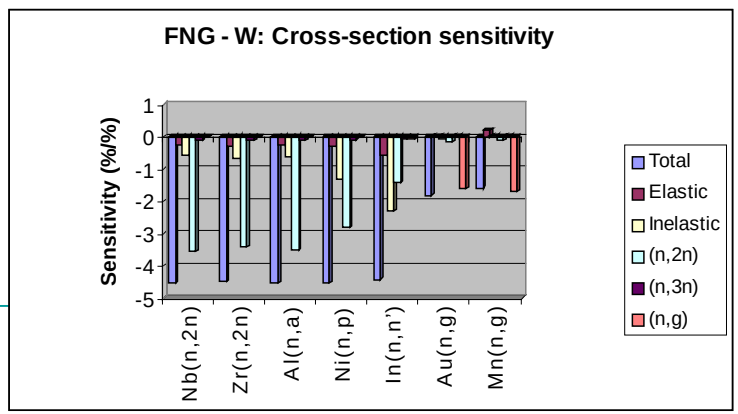


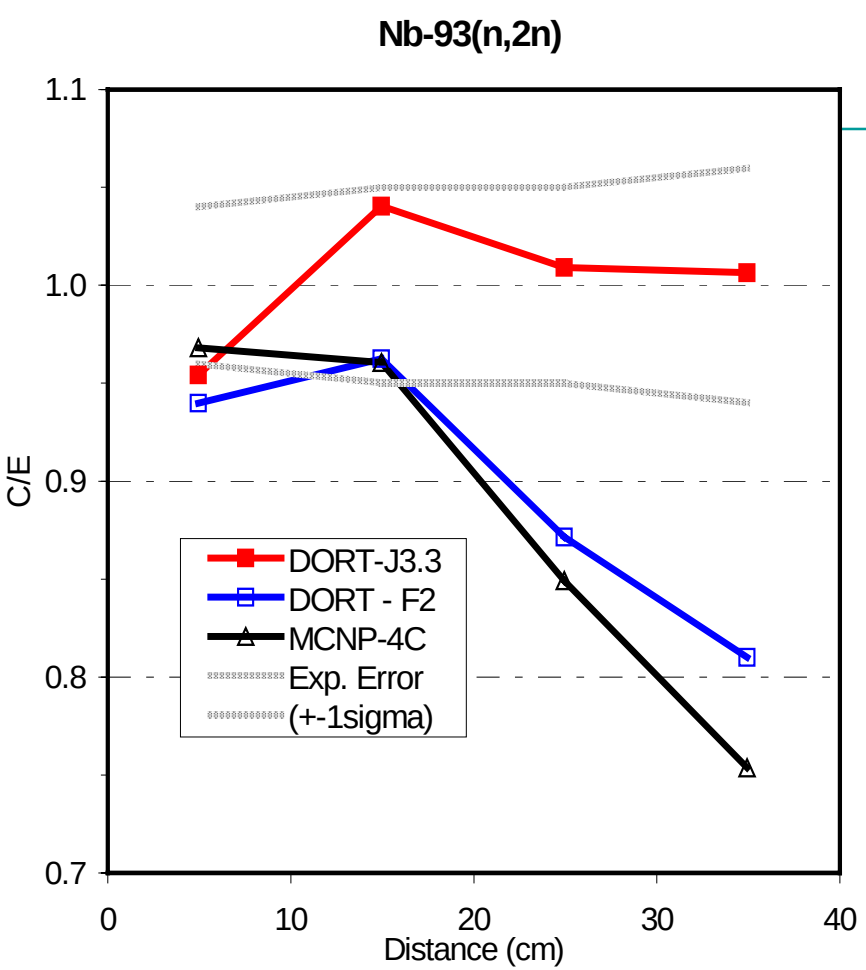
Ni-58(n,2n)

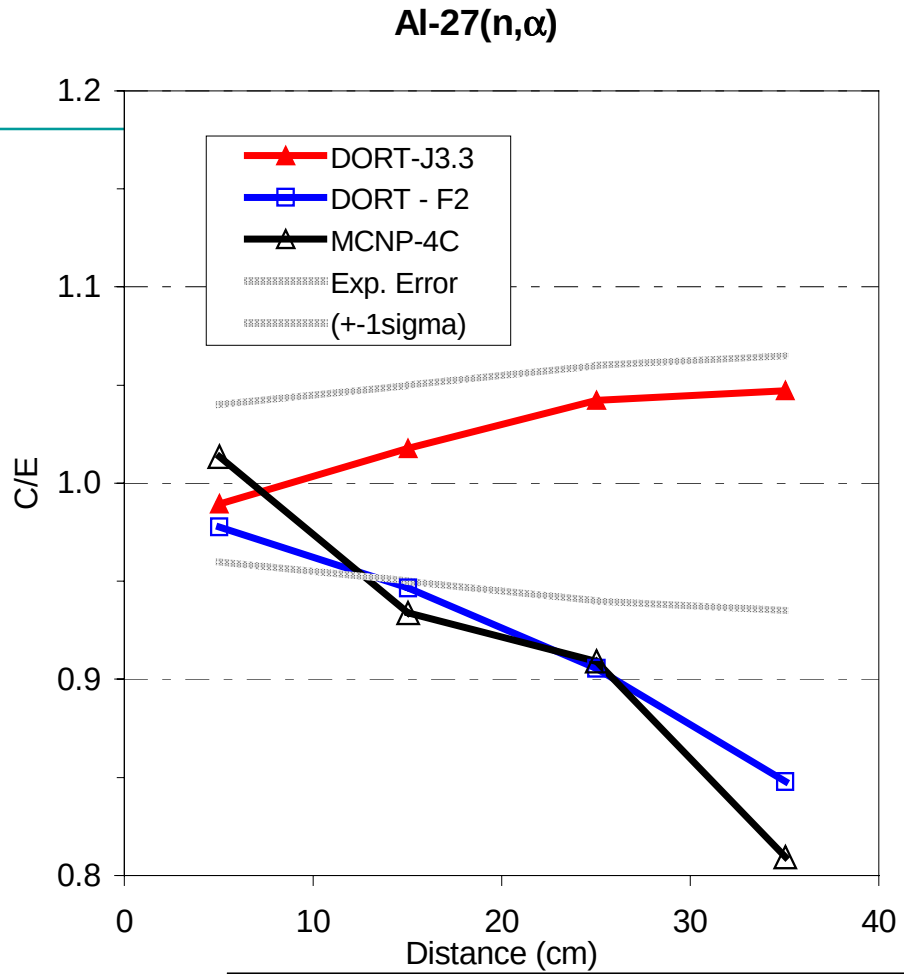


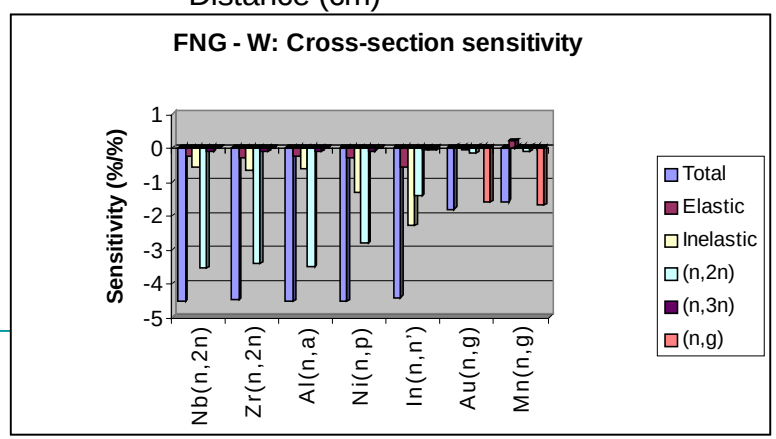
Zr-90(n,2n)

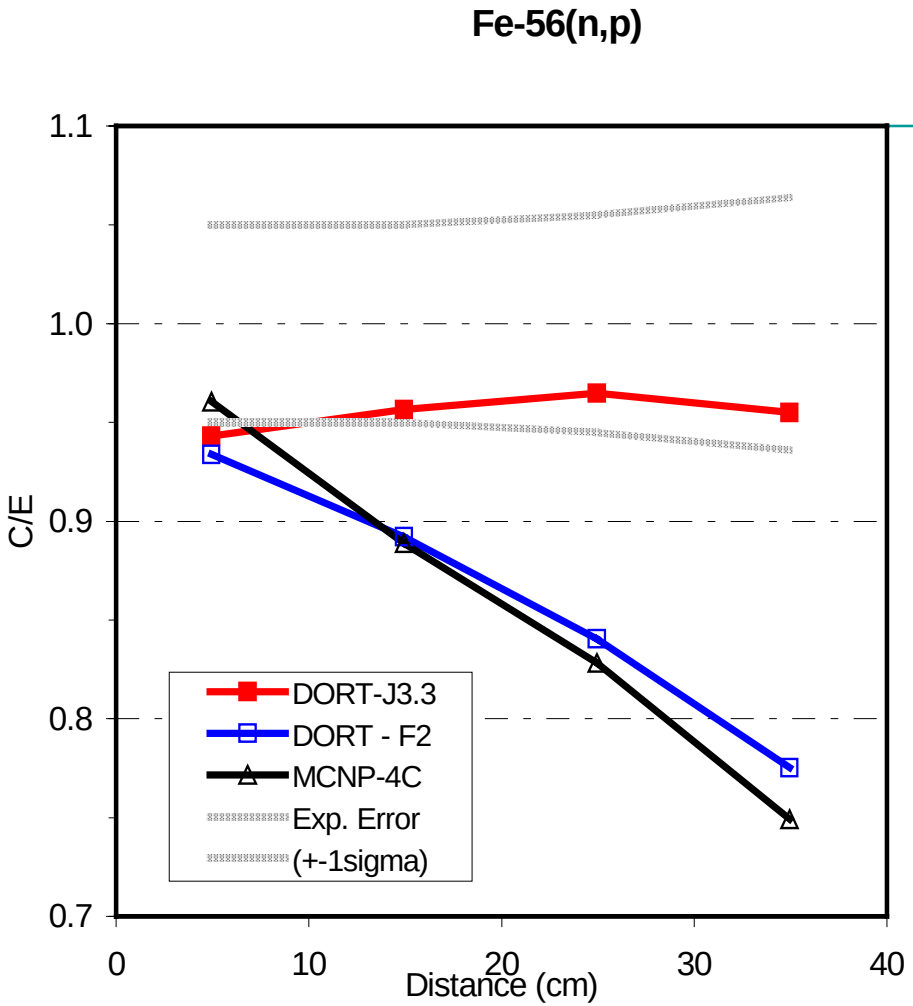


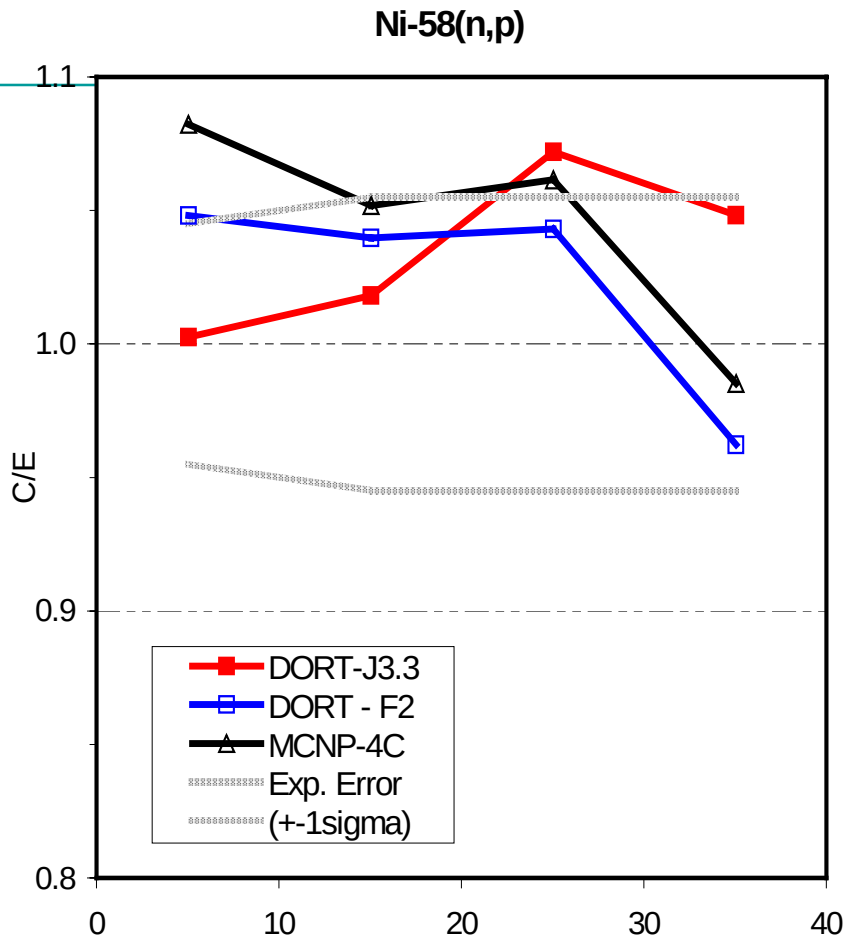


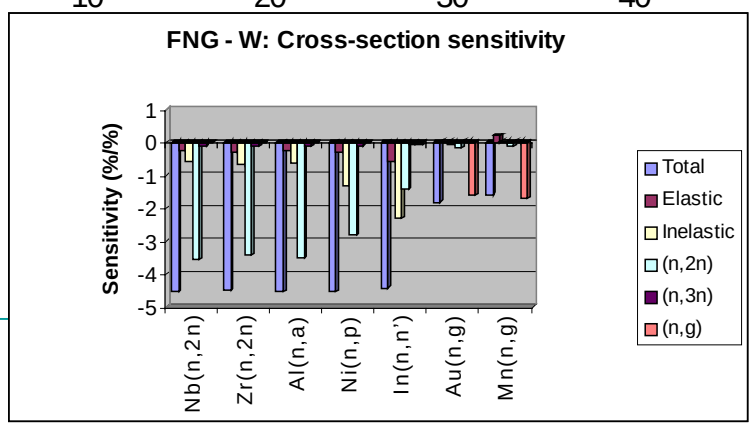

Nb-93(n,2n)
C/E
Distance (cm)
DORT-J3.3
DORT - F2
MCNP-4C
Exp. Error
(+-1sigma)

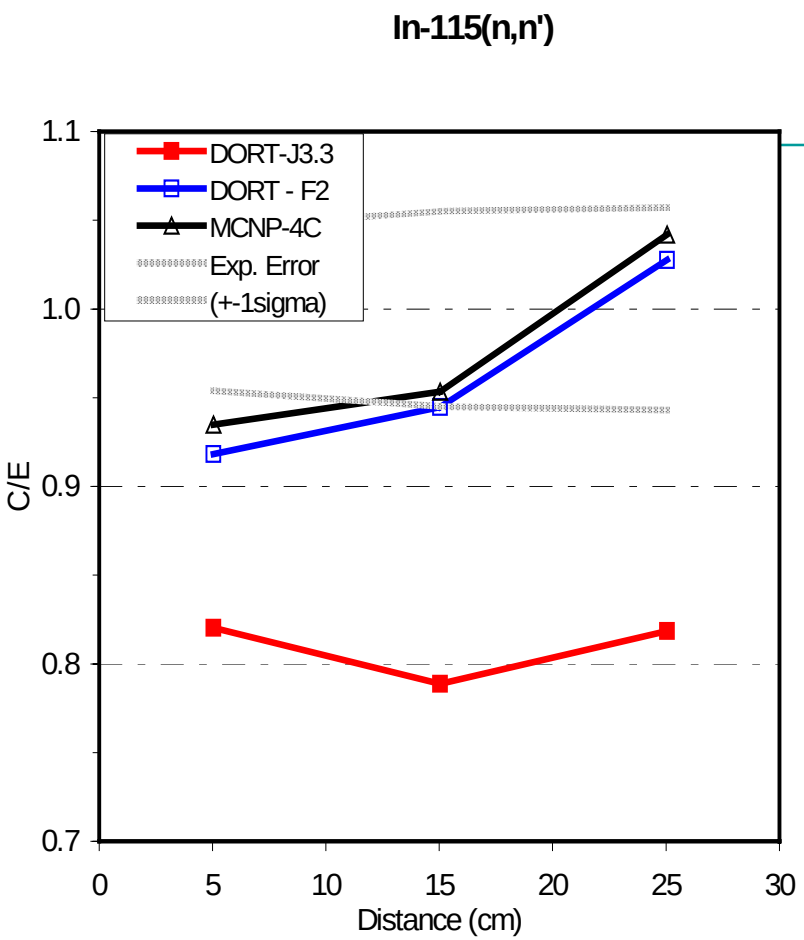

Al-27(n,α)
C/E
Distance (cm)
DORT-J3.3
DORT - F2
MCNP-4C
Exp. Error
(+-1sigma)

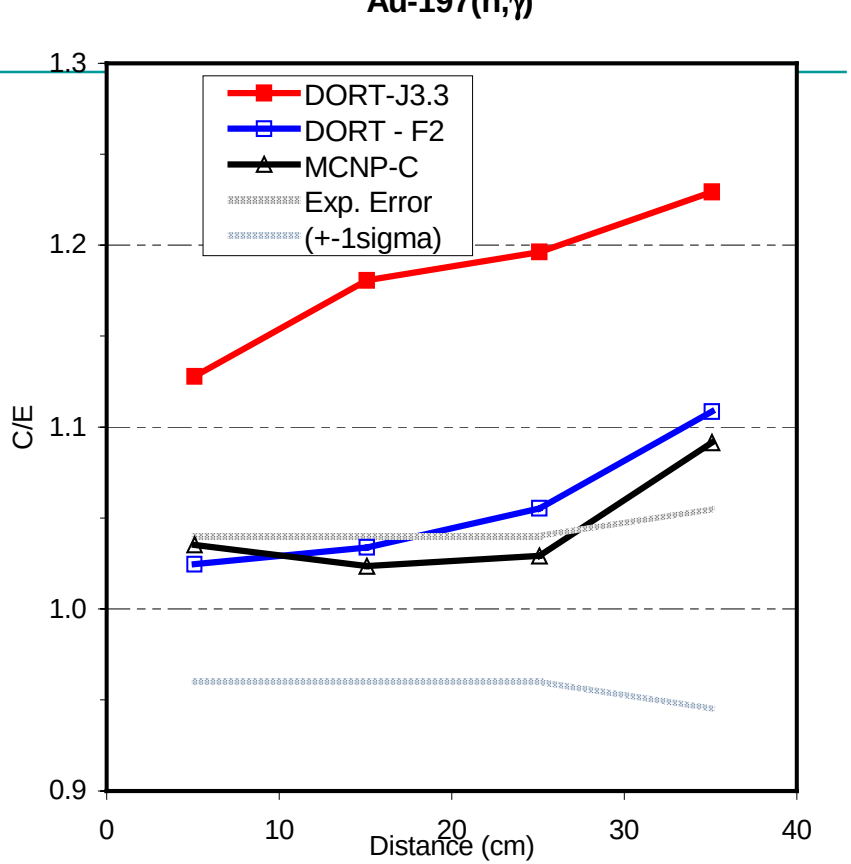

FNG - W: Cross-section sensitivity
Sensitivity (%/%)
Nb(n,2n)
Zr(n,2n)
Al(n,a)
Ni(n,p)
In(n,n')
Au(n,g)
Mn(n,g)
Total
Elastic
Inelastic
(n,2n)
(n,3n)
(n,g)

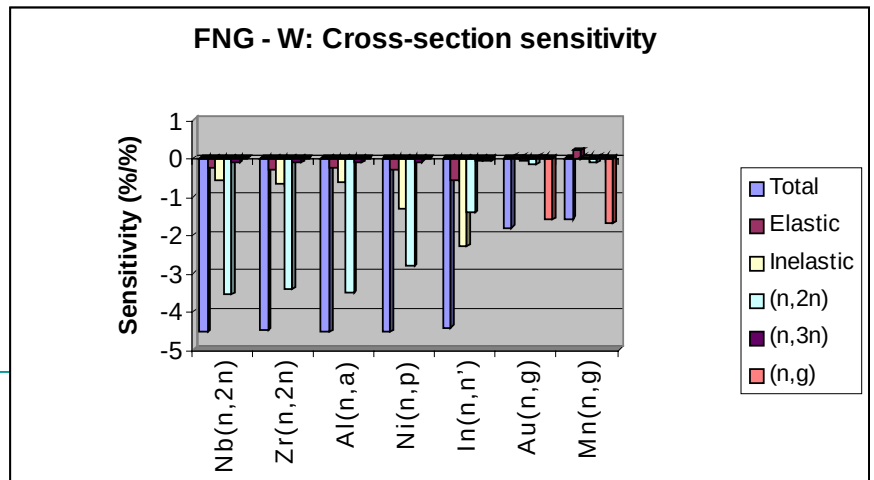

Fe-56(n,p)
C/E
Distance (cm)
1.1
1.0
0.9
0.8
0.7
0
10
20
30
40
DORT-J3.3
DORT - F2
MCNP-4C
Exp. Error
(+-1sigma)

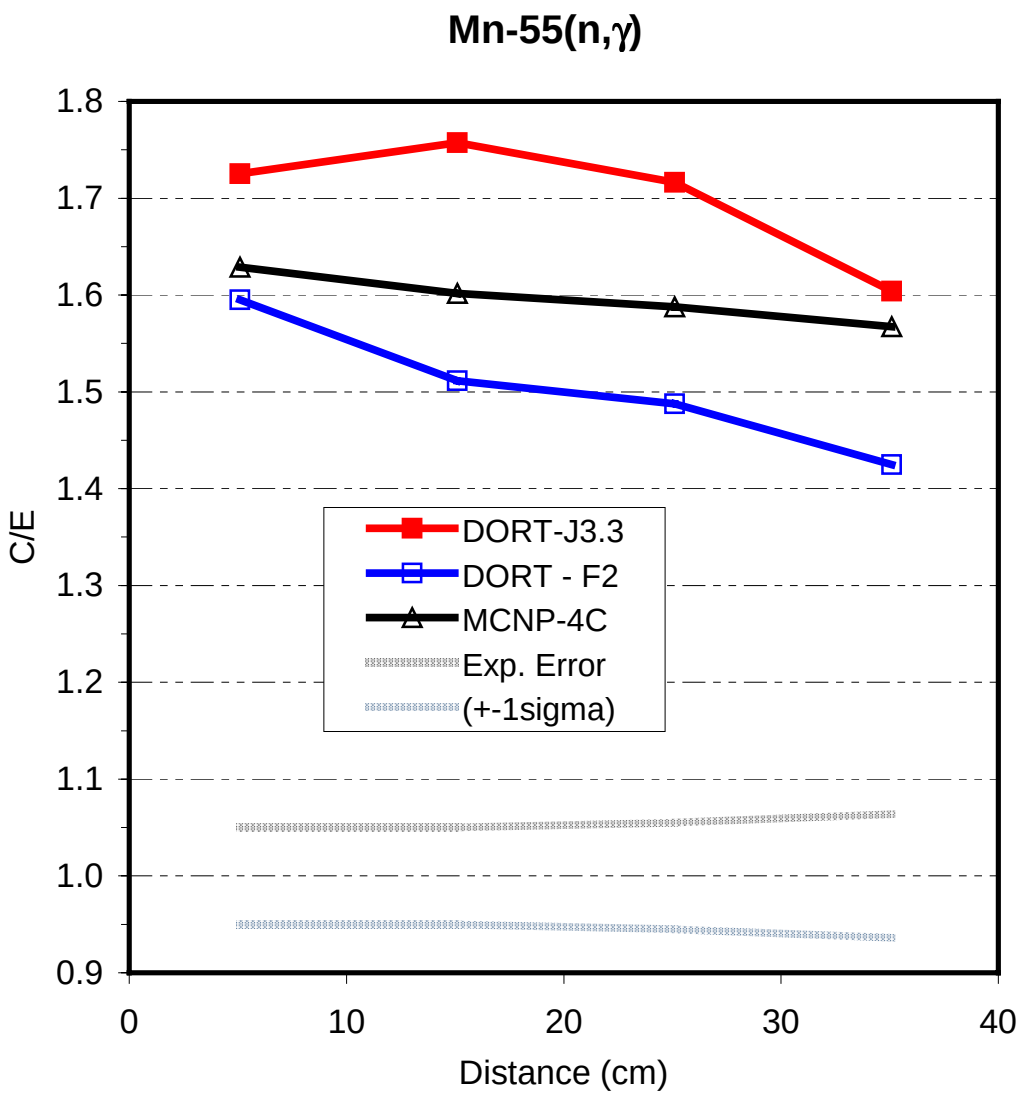

Ni-58(n,p)
C/E
1.1
1.0
0.9
0.8
0
10
20
30
40
DORT-J3.3
DORT - F2
MCNP-4C
Exp. Error
(+-1sigma)


FNG - W: Cross-section sensitivity
Sensitivity (%/%)
1
0
-1
-2
-3
-4
-5
Nb(n,2n)
Zr(n,2n)
Al(n,a)
Ni(n,p)
In(n,n')
Au(n,g)
Mn(n,g)
Total
Elastic
Inelastic
(n,2n)
(n,3n)
(n,g)

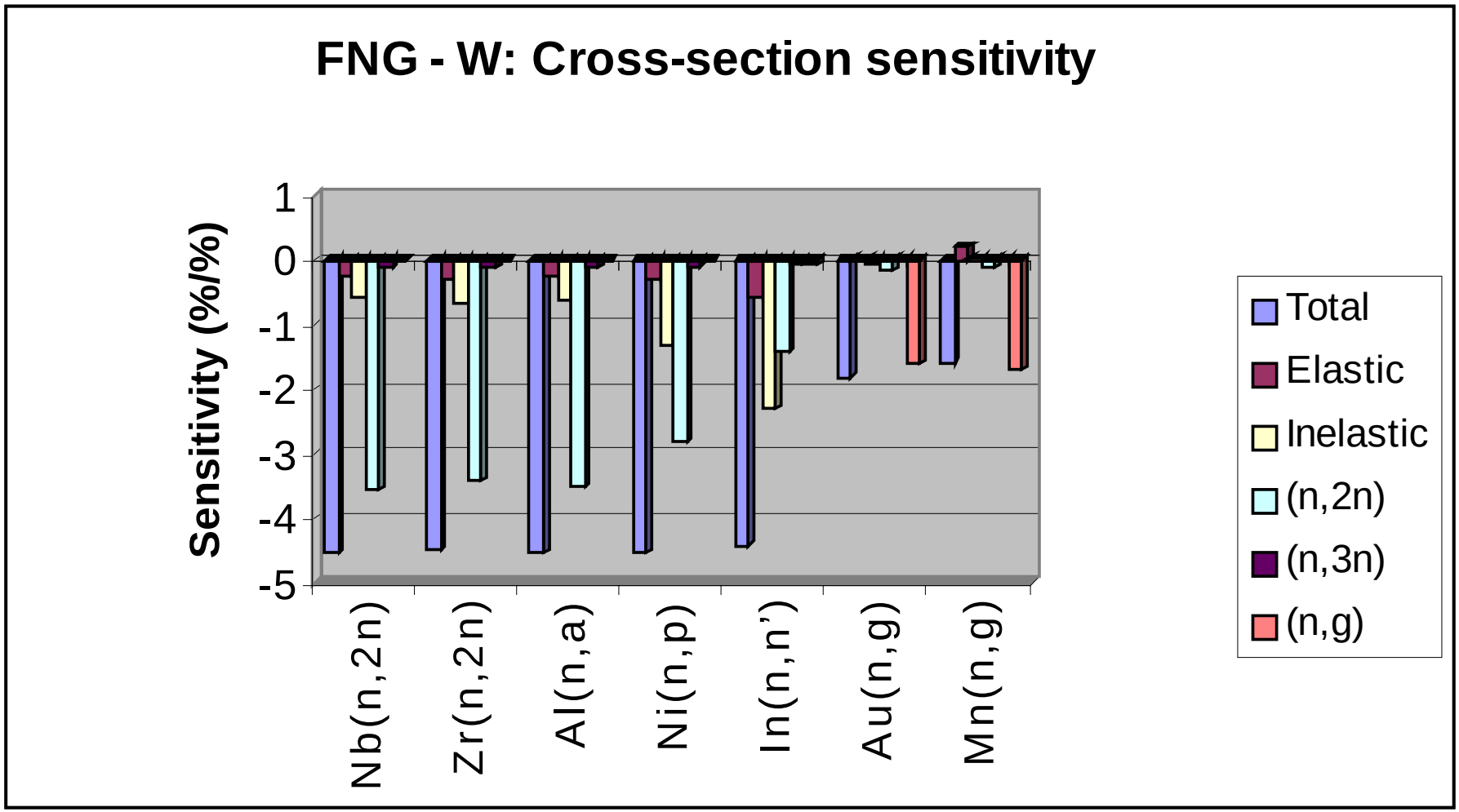

In-115(n,n')
DORT-J3.3
DORT - F2
MCNP-4C
Exp. Error
(+-1sigma)
C/E
Distance (cm)
1.1
1.0
0.9
0.8
0.7
0
5
10
15
20
25
30


Au-197(n,γ)
DORT-J3.3
DORT - F2
MCNP-C
Exp. Error
(+-1sigma)
C/E
Distance (cm)
1.3
1.2
1.1
1.0
0.9
0
10
20
30
40

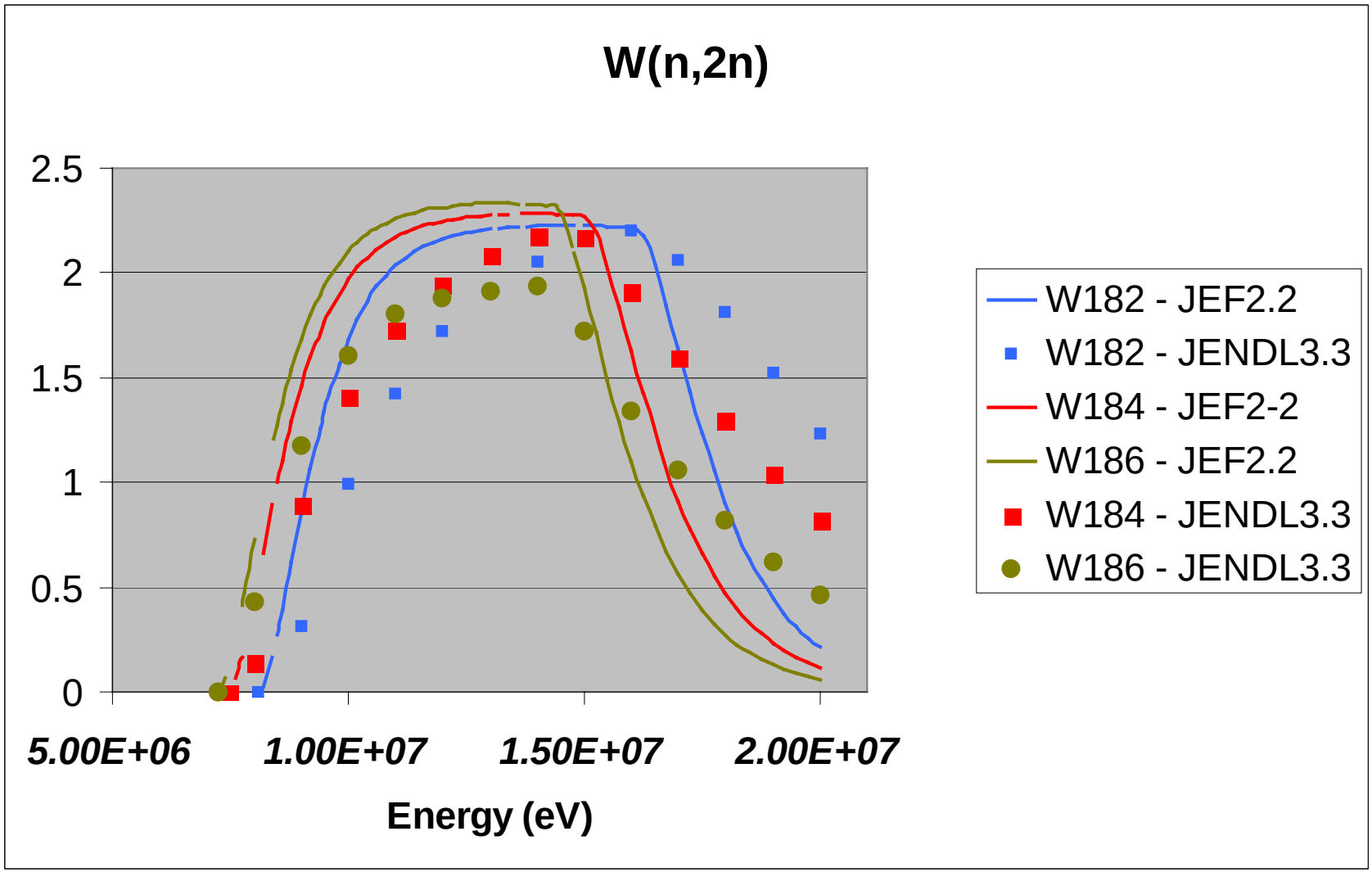

FNG - W: Cross-section sensitivity
Sensitivity (%/%)
1
0
-1
-2
-3
-4
-5
Nb(n,2n)
Zr(n,2n)
Al(n,a)
Ni(n,p)
In(n,n')
Au(n,g)
Mn(n,g)
Total
Elastic
Inelastic
(n,2n)
(n,3n)
(n,g)

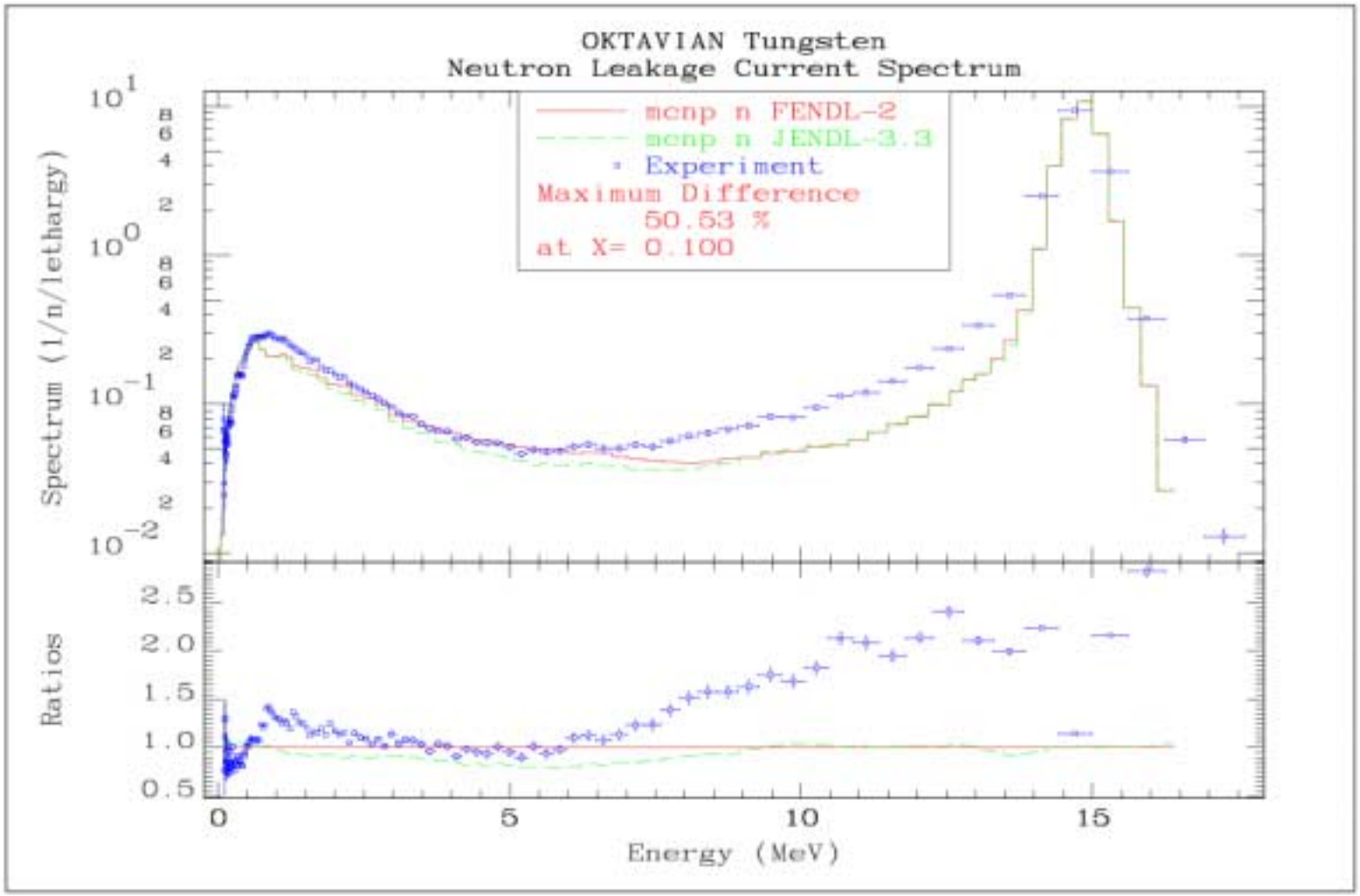

Mn-55(n,γ)
C/E
Distance (cm)
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0
10
20
30
40
DORT-J3.3
DORT - F2
MCNP-4C
Exp. Error
(+-1sigma)

Sensitivity to W cross sections (%/%)

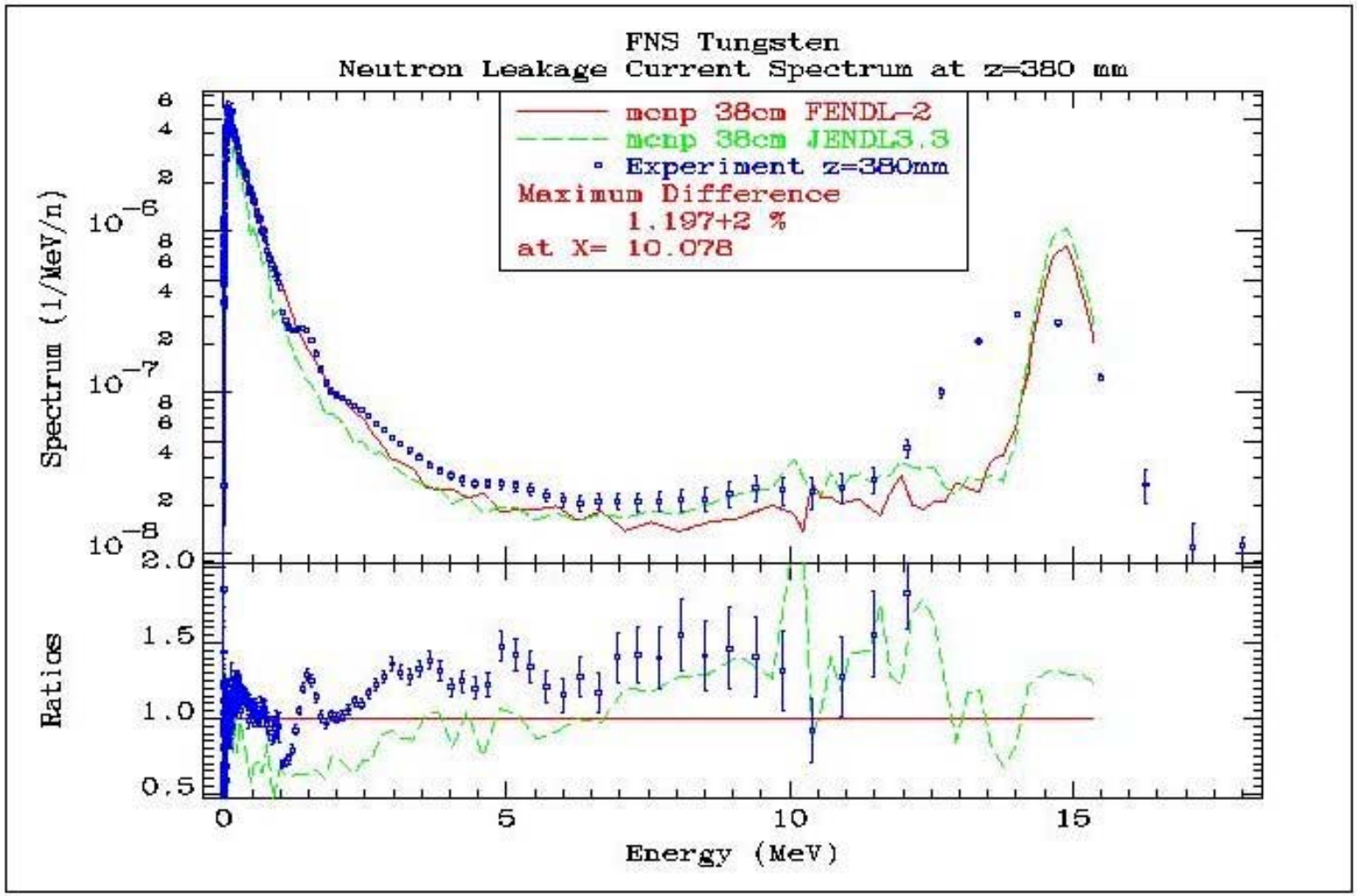


W(n,2n) FENDL-2 / JENDL-3.3




OKTAVIAN Tungsten
Neutron Leakage Current Spectrum
mcnp n FENDL-2
mcnp n JENDL-3.3
Experiment
Maximum Difference
50.53 %
at X= 0.100
Spectrum (1/n/lethargy)
Ratios
Energy (MeV)
0
5
10
15

FNS Tungsten



Conclusions

- Fast neutron reaction rates (>~6MeV): good agreement using JENDL-3.3, underestimated by FENDL-2 by up to 20-30%. The most important neutron reaction is (n,2n).
- Ni-58(n,p) covering energy range >~1 MeV, with most important reactions inelastic, (n,2n) and elastic are within 1 σ experimental uncertainty.
- In115(n,n'), covering energy range >~1 MeV, with most important reactions inelastic, (n,2n) and elastic ; underestimated (-20 %) by JENDL-3.3, within 1 σ experimental uncertainty using FENDL-2.
- Au-197(n,γ), covering thermal energies, is in good agreement using FENDL-2, overestimated (+~20%) using JENDL-3.3. Predominantly sensitive to (n,γ) reaction.
- Mn55(n,γ): discrepancy is due to the uncertainty in response function in the resonance range.