Analysis of Critical Experiments Using ENDF/B-VI.3 and Pre-B-VII Data

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BNFL

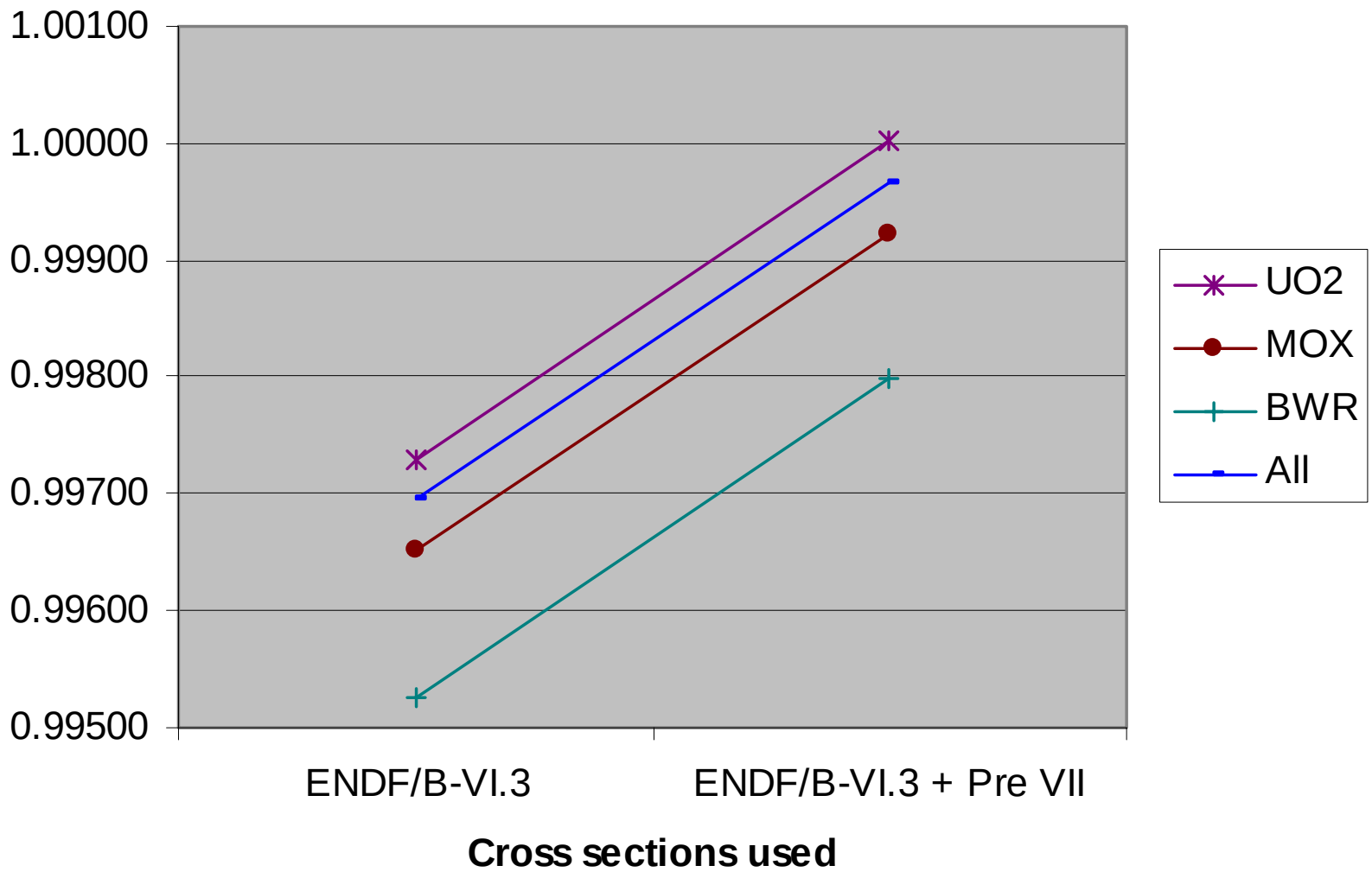
Westinghouse

Dataset	# of exp	A ENDF/B-VI.3	B Pre ENDF/VII U-235 and U238 with ENDF/B-VI.8 for O &H	C Column (B-A)
UO2 Lattices				
a) Kritz Critical Experiments (1.35 w/o Enr)	12	0.99309	0.99691	0.00382
b) B & W Critical Experiments with perturbing Rods	17	0.99723	0.99912	0.00189
c) B & W Critical Experiments with Gd and/or Control Rods	23	0.99957	1.00114	0.00157
d) LCT006 (TCA Critical Experiments) : Enr. 2.6 w/o	18	0.99451	0.99867	0.00416
e) LCT048 (3 w/o Enr. Rods)	5	0.99959	1.00408	0.00449
f) LCT039 (Valduc Series of Experiments with 4.738 w/o Enr)	10	0.99308	0.99687	0.00379
g) LCT007 (Valduc Series with 4.738 w/o Enr.)	4	0.99575	0.99805	0.00230
h) LCT019 (5 w/o Enr. Hexagonal pitch Experiments)	3	1.00800	1.01038	0.00238
i) LCT018 (Dimple Experiment with 7.0 w/o Enr)	1	0.99538	0.99815	0.00277
j) LCT022 (10 w/o Enr. Rods in Hexagonal Lattices)	7	1.00293	1.00431	0.00138
k) LCT024 (10 w/o Enr. Rods in Hexagonal Lattices)	2	1.00087	1.00302	0.00215
l) LCT025 (7.5 w/o Enr. Rods in Hexagonal Lattices)	4	0.99385	0.99570	0.00184
m) LCT026 (4.92 w/o Enr. - Hexagonally pitched lattices)	6	0.99670	1.00053	0.00383
n) LCT032 (10 w/o Enr. Rods in Hexagonal Lattices)	9	1.00159	1.00205	0.00046
o) TRX and BAPL Critical Experiments	5	0.99505	1.00000	0.00495
Average of UO2 lattices	**126**	**0.99730**	**1.00001**	**0.00271**
Uncertainty(not incl. a, c & o)		**0.00306**	**0.00306**	

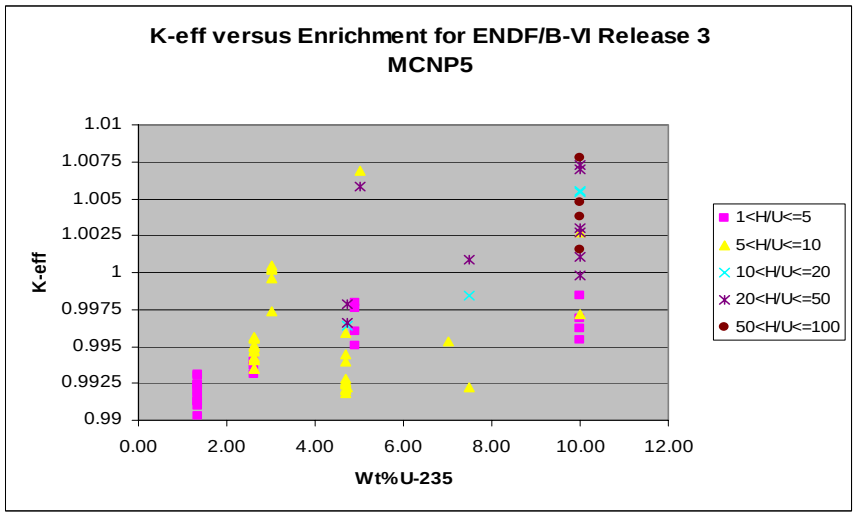
Dataset	# of exp	A ENDF/B-VI.3	B Pre ENDF/VII	C Column (B-A)
MOX Lattices				
a) MCT002 (PNL-30 through PNL-35) Critical Experiments	6	0.99785	1.00155	0.00370
b) MCT003 (SAXTON) Critical Experiments	6	0.99556	0.99828	0.00272
c) MCT004 (TCA MOX) Critical Experiments	4	0.99306	0.99542	0.00236
d) MCT005 (MOX Critical Experiments)	7	0.99808	1.00115	0.00307
e) MCT006 (MOX Critical Experiments)	8	0.99344	0.99655	0.00311
f) MCT007 (MOX Critical Experiments)	5	0.99633	0.99928	0.00295
g) MCT008 (MOX Critical Experiments)	6	0.99568	0.99893	0.00325
h) MCT011 (Rhapsodie MOX Critical Experiments	6	1.00179	1.00186	0.00007
Average of MOX lattices	**48**	**0.99653**	**0.99921**	**0.00269**
Uncertainty		**0.00412**	**0.00412**	

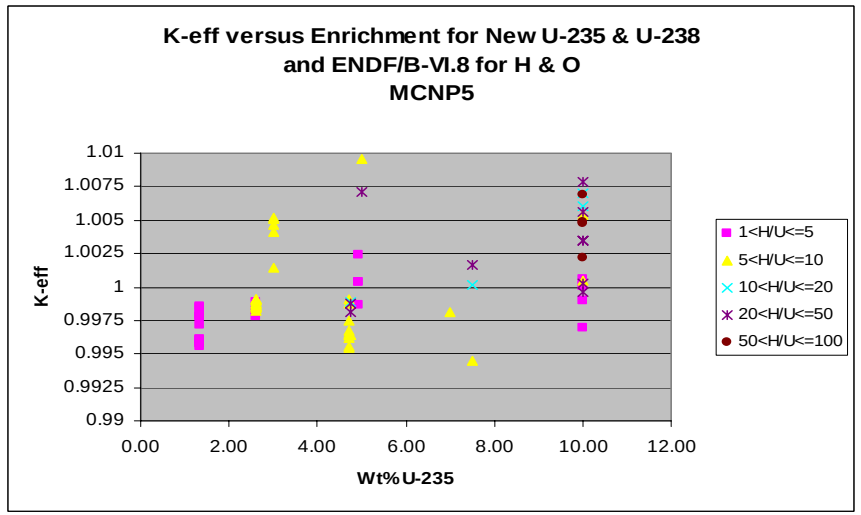
Dataset	# of exp	A ENDF/B-VI.3	B Pre ENDF/VII	C Column (B-A)
BWR Lattices				
a) KRITZ-BA-75 experiments	6	0.99568	0.99801	0.00233
b) KRITZ void experiments	4	0.99657	0.99902	0.00244
c) KRITZ MOX experiments	4	0.99331	0.99692	0.00361
Average of BWR lattices	14	**0.99526**	**0.99799**	0.00273
Grand Average	**188**	**0.99695**	**0.99966**	0.00271

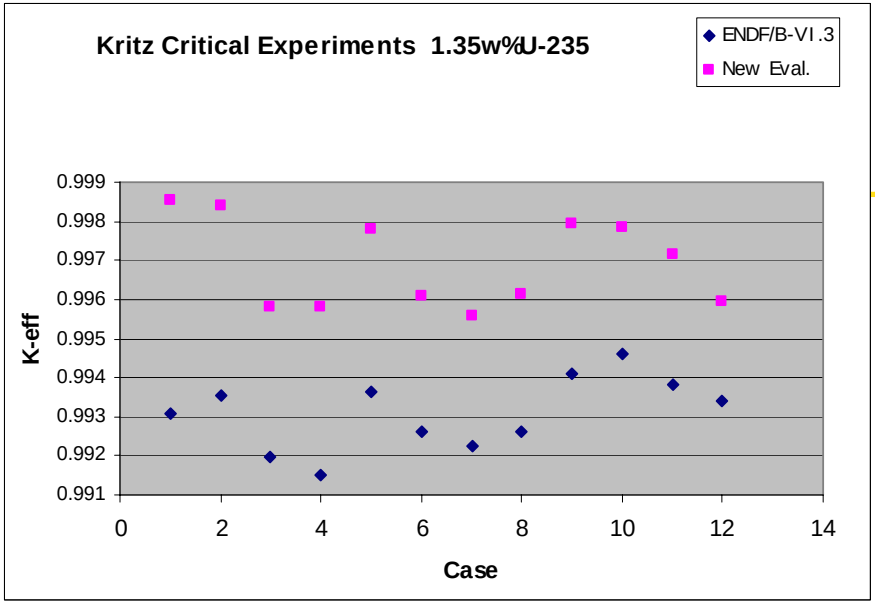
Average K-eff of Lattices

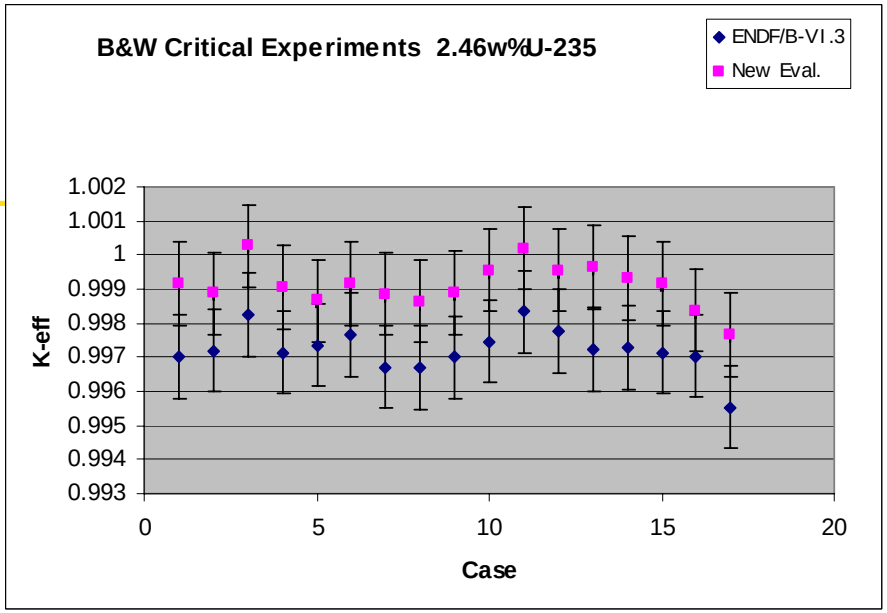


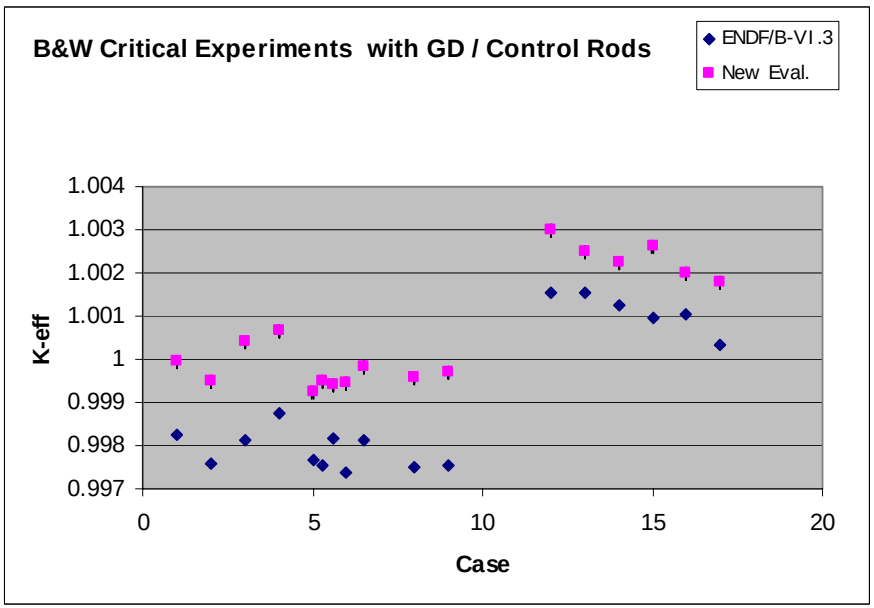
Comparison of the Eigenvalues

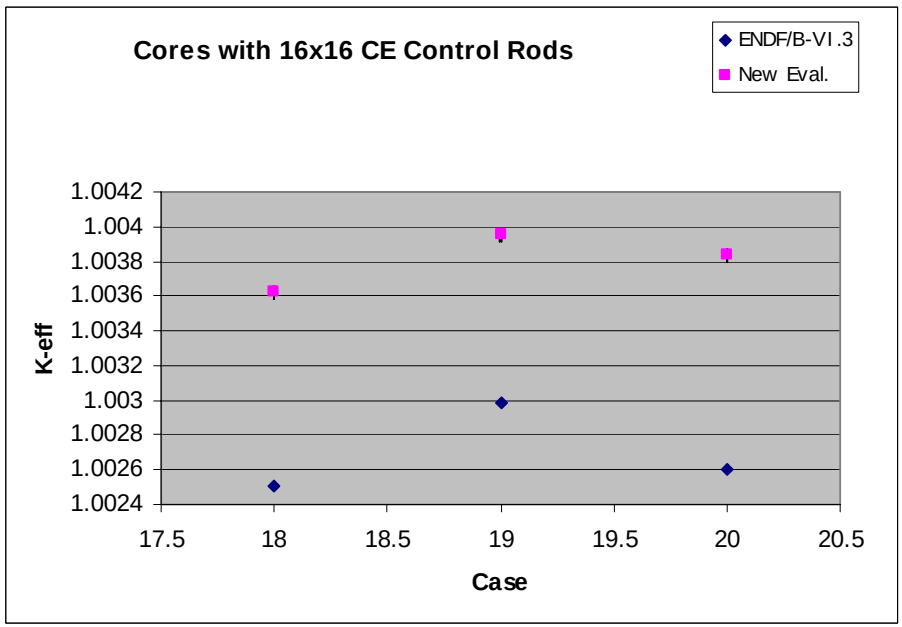


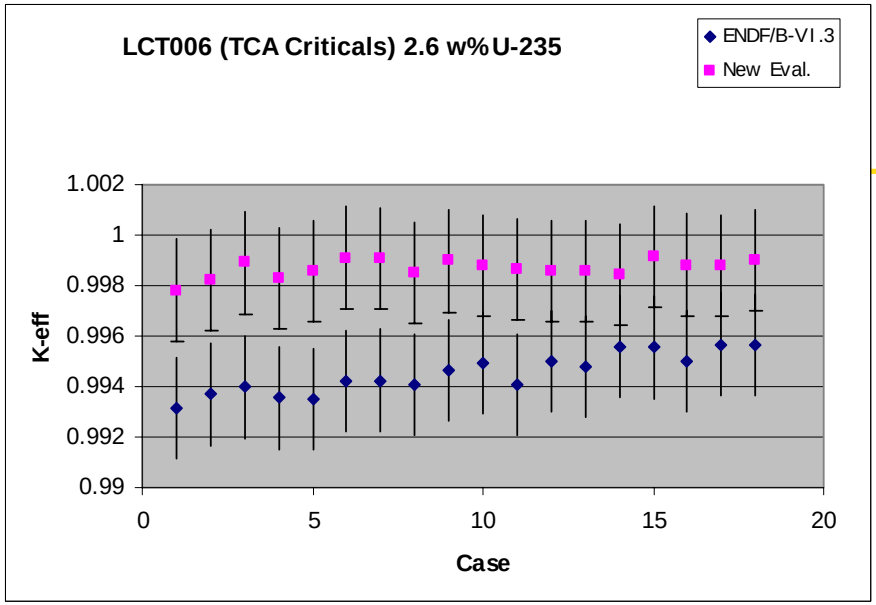


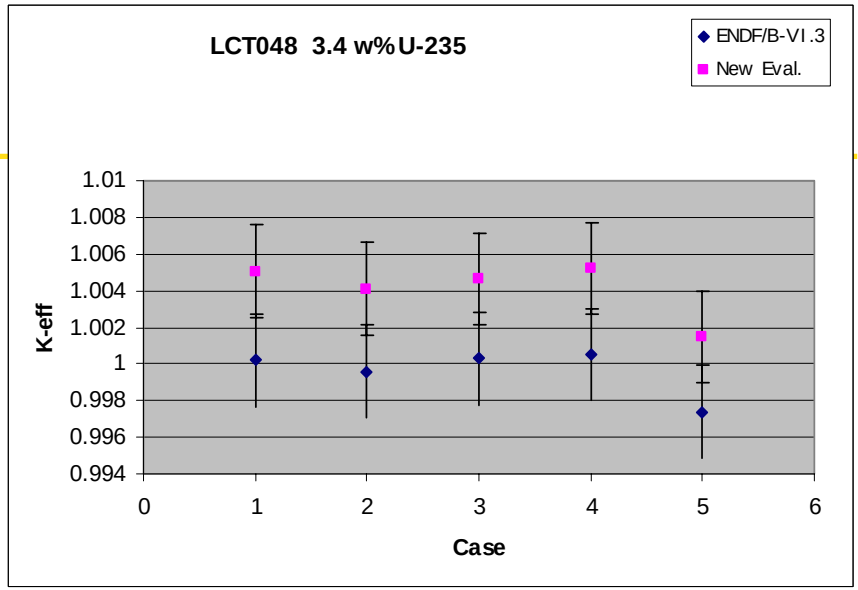

Kritz Critical Experiments 1.35w%U-235
ENDF/B-VI.3
New Eval.
K-eff
Case
0.999
0.998
0.997
0.996
0.995
0.994
0.993
0.992
0.991
0
2
4
6
8
10
12
14

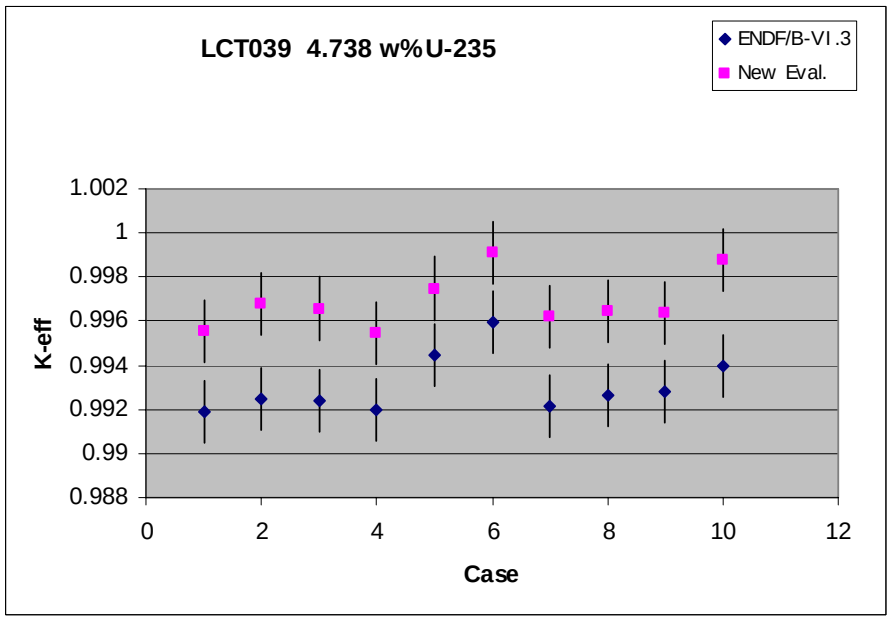

B&W Critical Experiments 2.46w%U-235
ENDF/B-VI.3
New Eval.
K-eff
Case
1.002
1.001
1
0.999
0.998
0.997
0.996
0.995
0.994
0.993
0
5
10
15
20

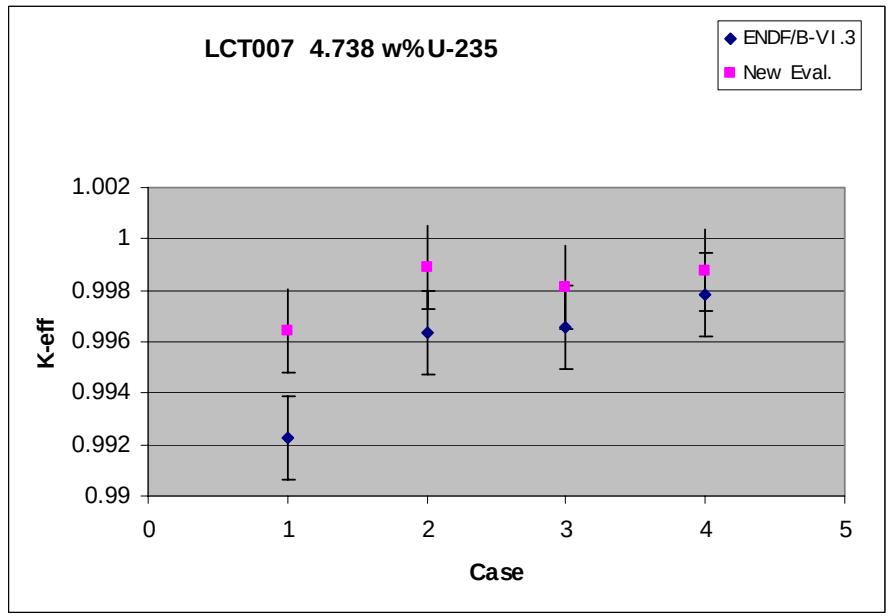

B&W Critical Experiments with GD / Control Rods
ENDF/B-VI.3
New Eval.
K-eff
Case
1.004
1.003
1.002
1.001
1
0.999
0.998
0.997
0
5
10
15
20

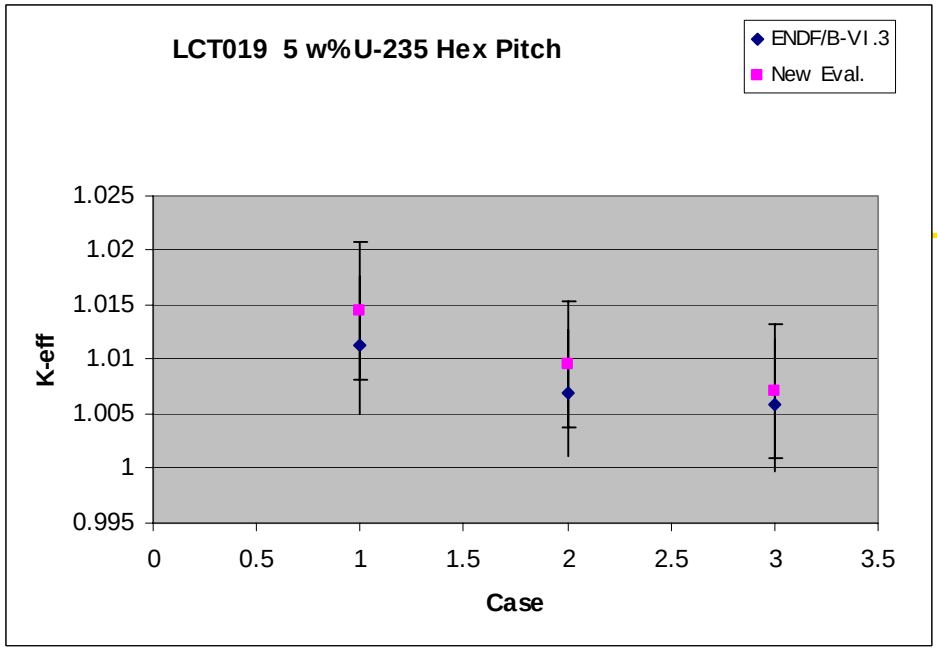

Cores with 16x16 CE Control Rods
ENDF/B-VI.3
New Eval.
K-eff
Case
1.0042
1.004
1.0038
1.0036
1.0034
1.0032
1.003
1.0028
1.0026
1.0024
17.5
18
18.5
19
19.5
20
20.5

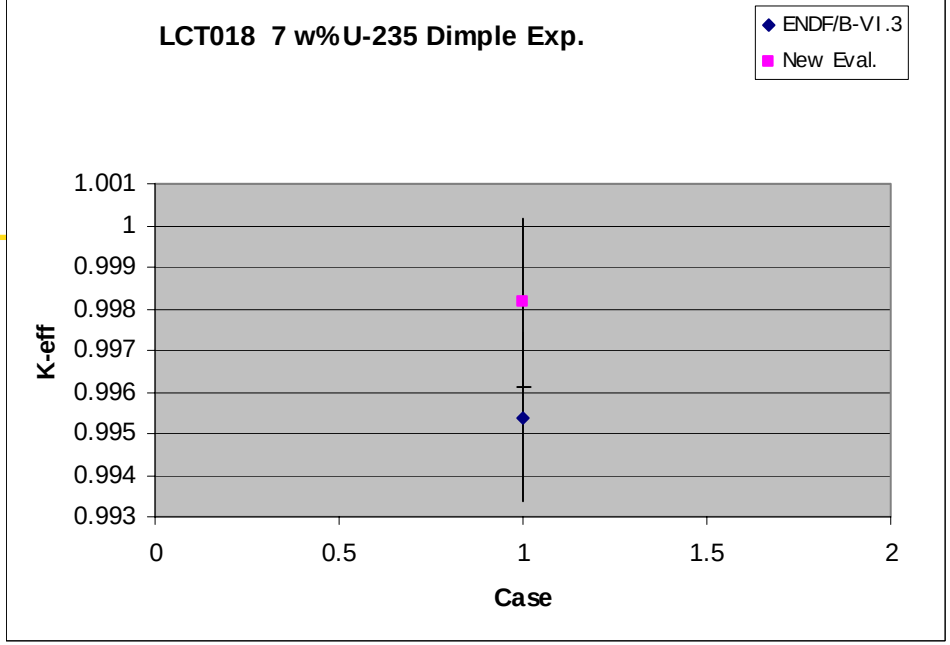

LCT006 (TCA Criticals) 2.6 w%U-235
ENDF/B-VI.3
New Eval.
K-eff
1.002
1
0.998
0.996
0.994
0.992
0.99
0
5
10
15
20
Case

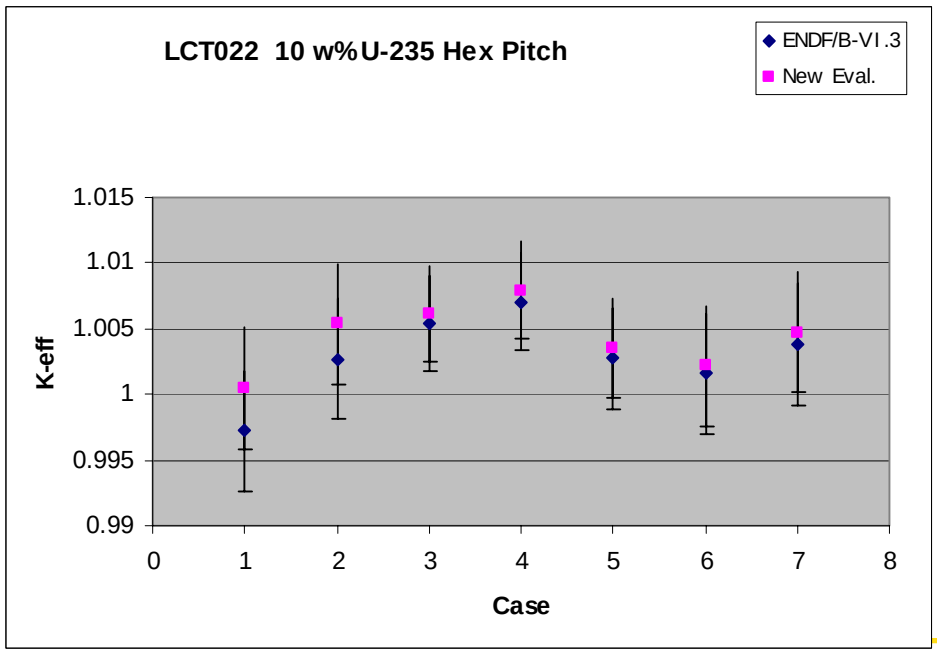

LCT048 3.4 w%U-235
ENDF/B-VI.3
New Eval.
K-eff
1.01
1.008
1.006
1.004
1.002
1
0.998
0.996
0.994
0
1
2
3
4
5
6
Case

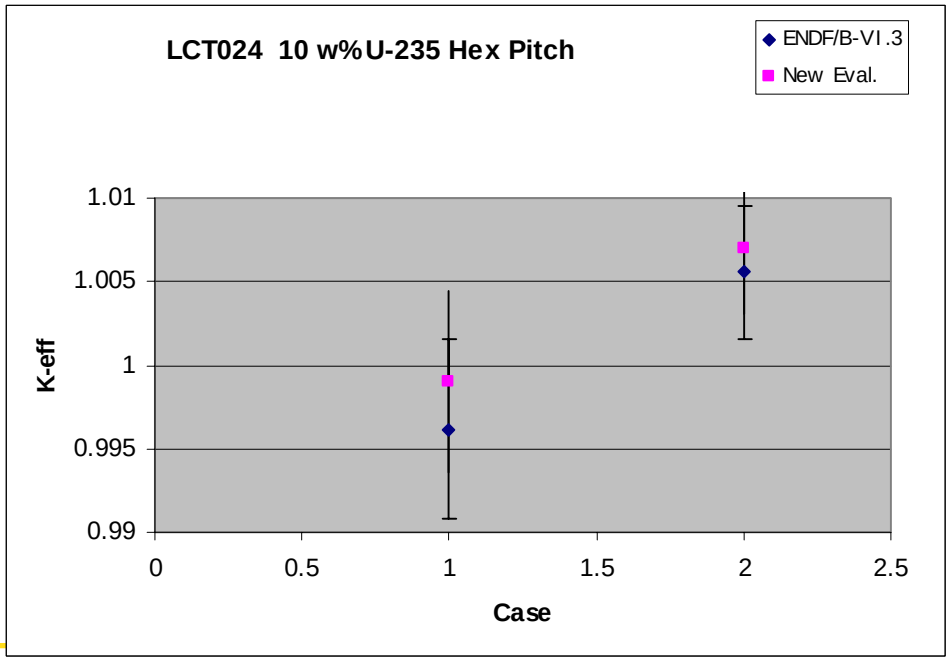

LCT039 4.738 w%U-235
ENDF/B-VI.3
New Eval.
K-eff
1.002
1
0.998
0.996
0.994
0.992
0.99
0.988
0
2
4
6
8
10
12
Case

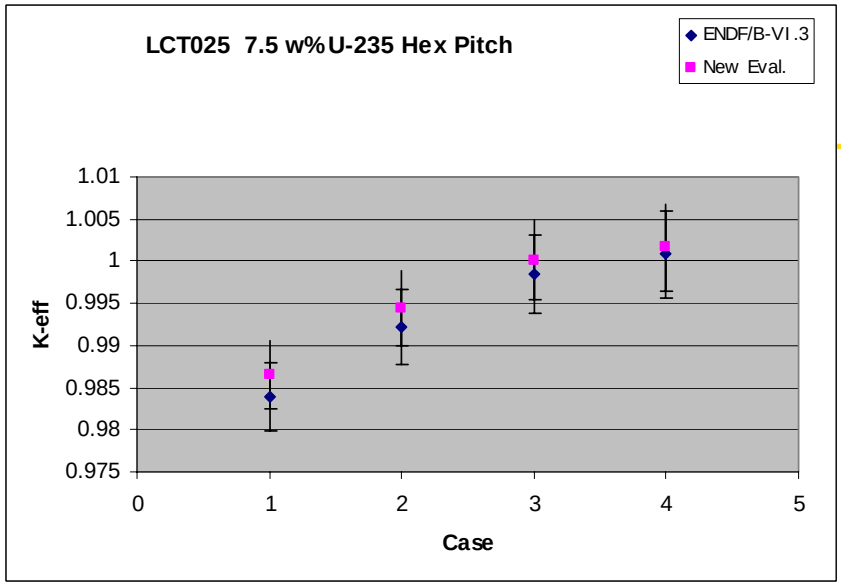

LCT007 4.738 w%U-235
ENDF/B-VI.3
New Eval.
K-eff
1.002
1
0.998
0.996
0.994
0.992
0.99
0
1
2
3
4
5
Case

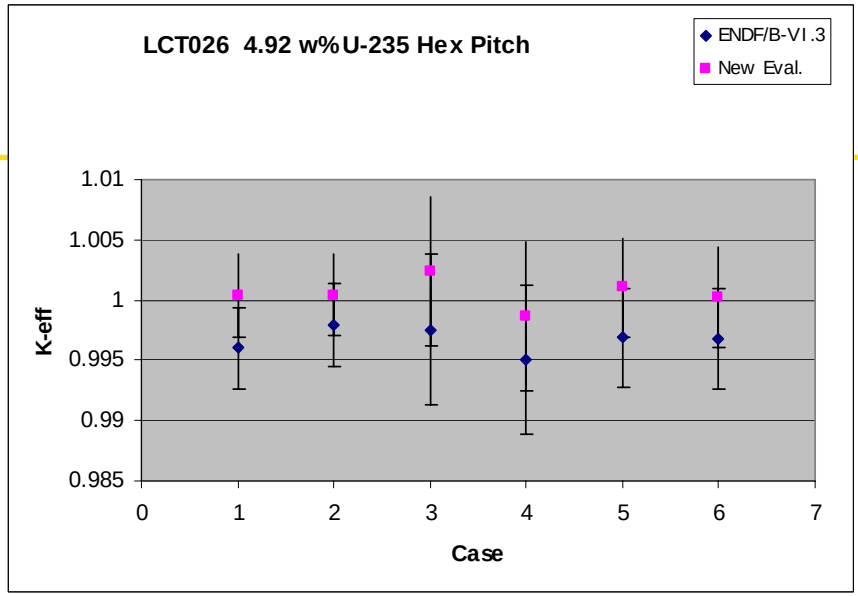

LCT019 5 w%U-235 Hex Pitch
ENDF/B-VI.3
New Eval.
K-eff
Case
1.025
1.02
1.015
1.01
1.005
1
0.995
0
0.5
1
1.5
2
2.5
3
3.5

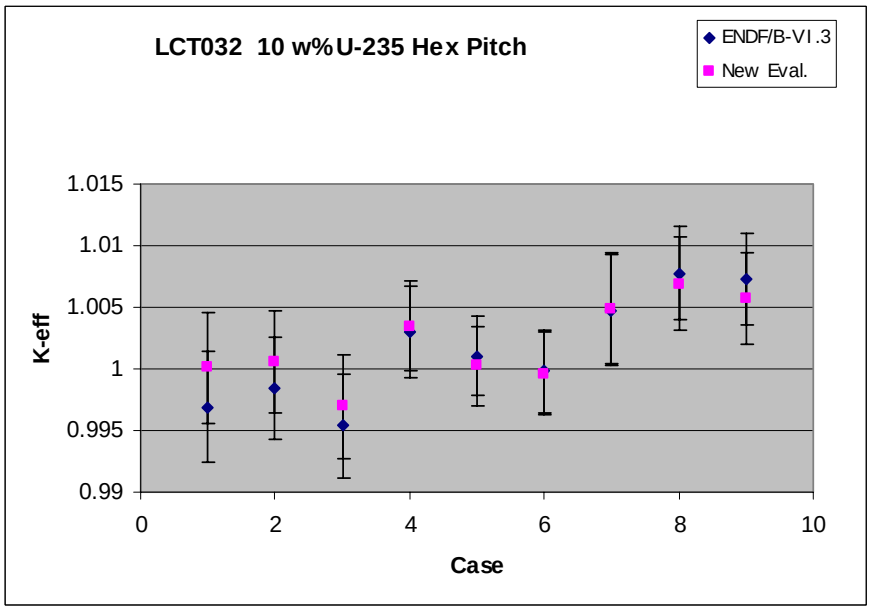

LCT018 7 w%U-235 Dimple Exp.
ENDF/B-VI.3
New Eval.
K-eff
Case
1.001
1
0.999
0.998
0.997
0.996
0.995
0.994
0.993
0
0.5
1
1.5
2

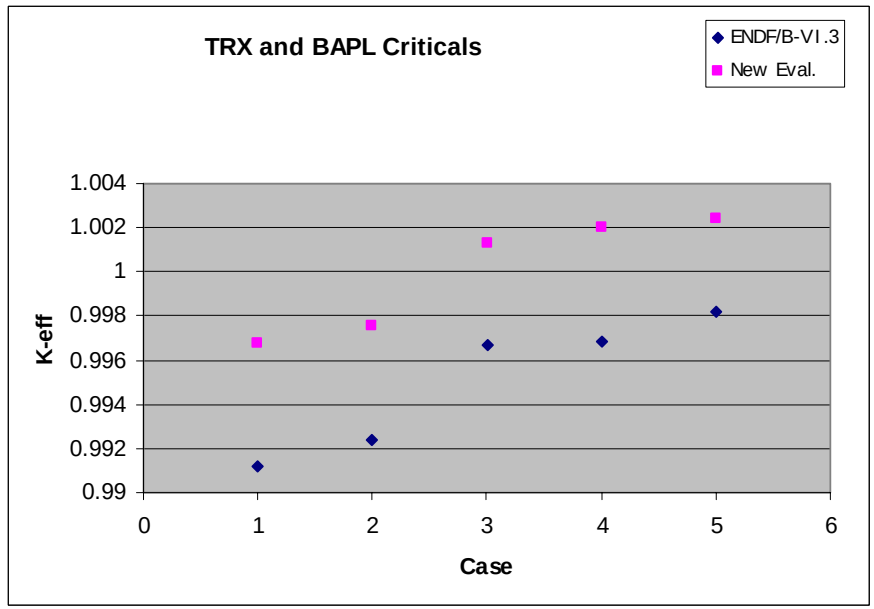

LCT022 10 w%U-235 Hex Pitch
ENDF/B-VI.3
New Eval.
K-eff
Case
1.015
1.01
1.005
1
0.995
0.99
0
1
2
3
4
5
6
7
8

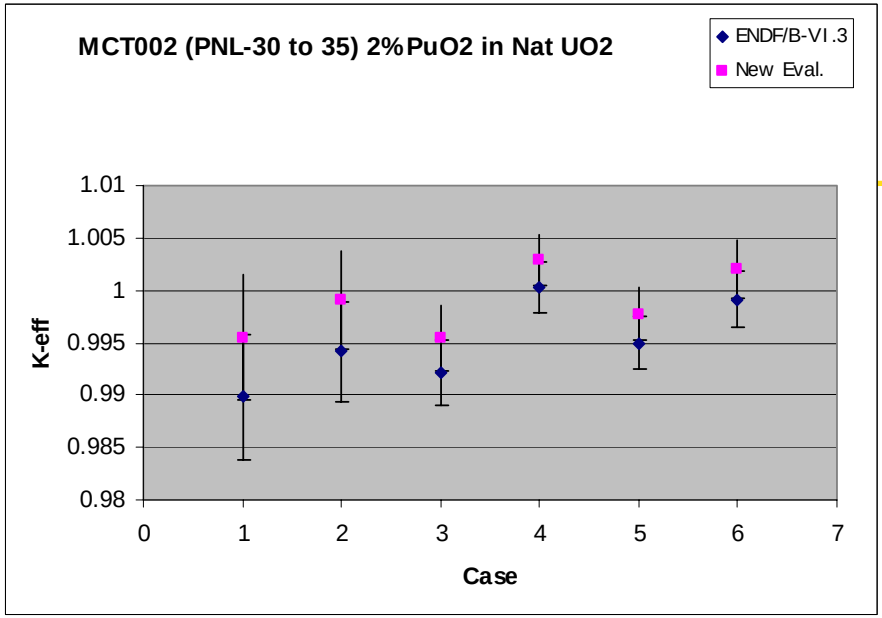

LCT024 10 w%U-235 Hex Pitch
ENDF/B-VI.3
New Eval.
K-eff
Case
1.01
1.005
1
0.995
0.99
0
0.5
1
1.5
2
2.5

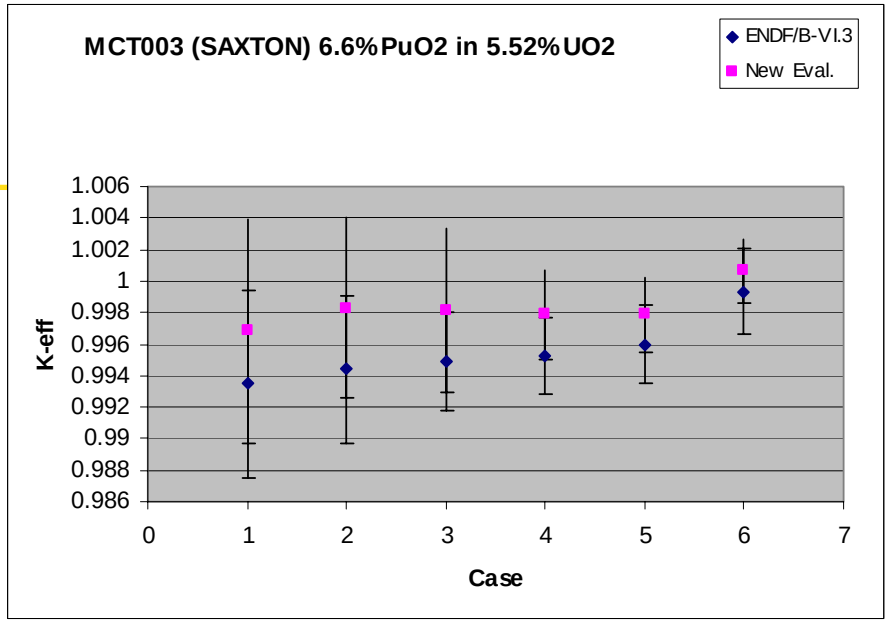

LCT025 7.5 w%U-235 Hex Pitch
ENDF/B-VI.3
New Eval.
K-eff
Case
1.01
1.005
1
0.995
0.99
0.985
0.98
0.975
0
1
2
3
4
5

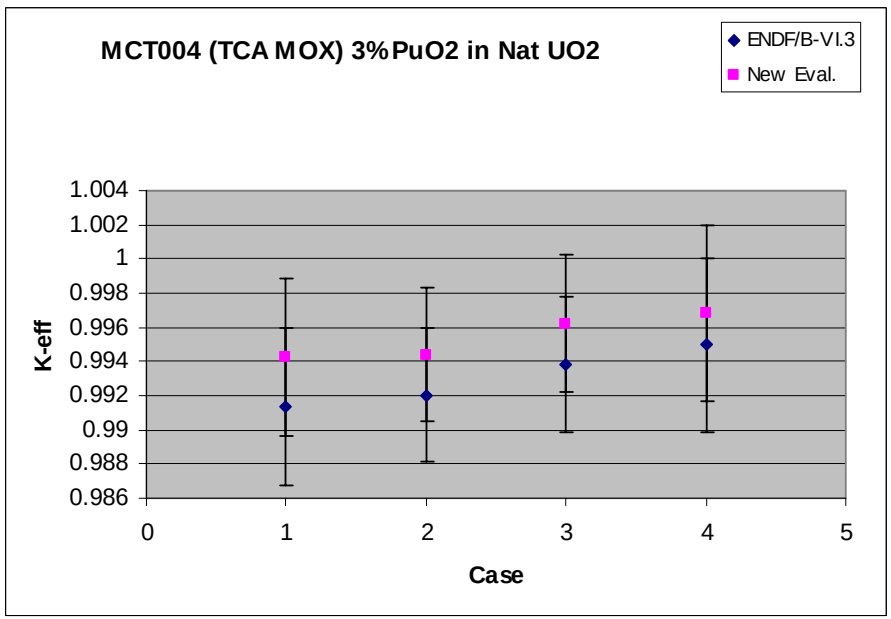

LCT026 4.92 w%U-235 Hex Pitch
ENDF/B-VI.3
New Eval.
K-eff
Case
1.01
1.005
1
0.995
0.99
0.985
0
1
2
3
4
5
6
7

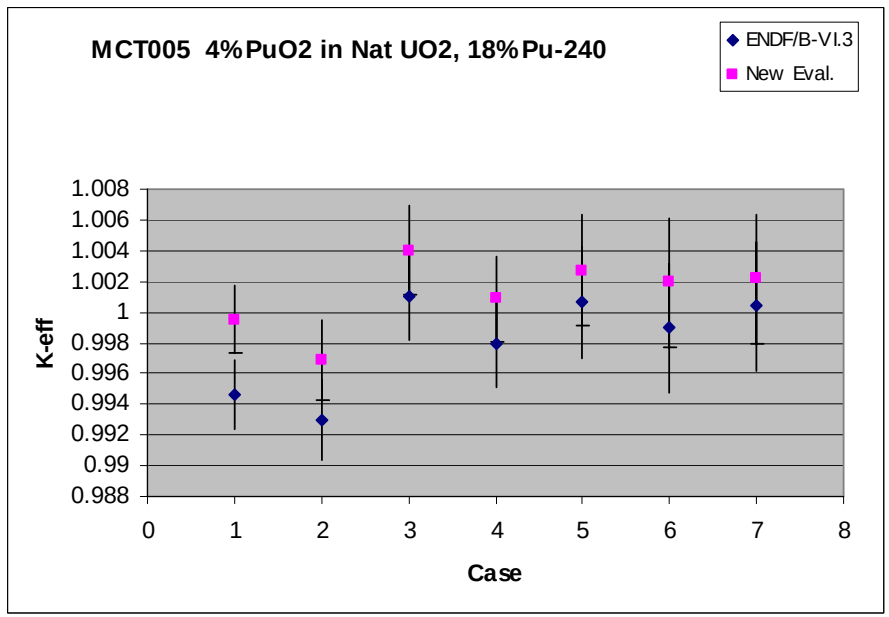

LCT032 10 w%U-235 Hex Pitch
ENDF/B-VI.3
New Eval.
K-eff
Case
1.015
1.01
1.005
1
0.995
0.99
0
2
4
6
8
10

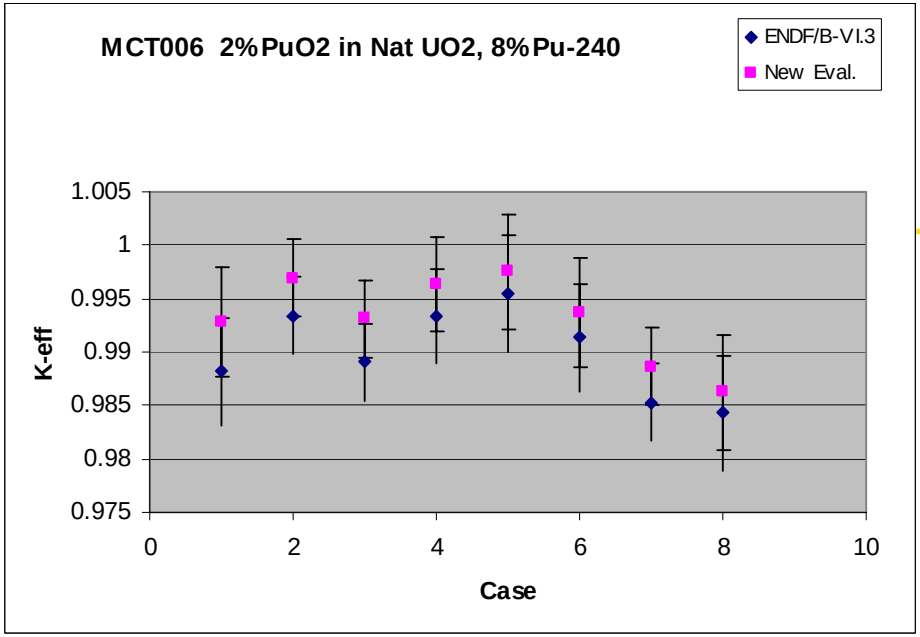

TRX and BAPL Criticals
ENDF/B-VI.3
New Eval.
K-eff
Case
1.004
1.002
1
0.998
0.996
0.994
0.992
0.99
0
1
2
3
4
5
6

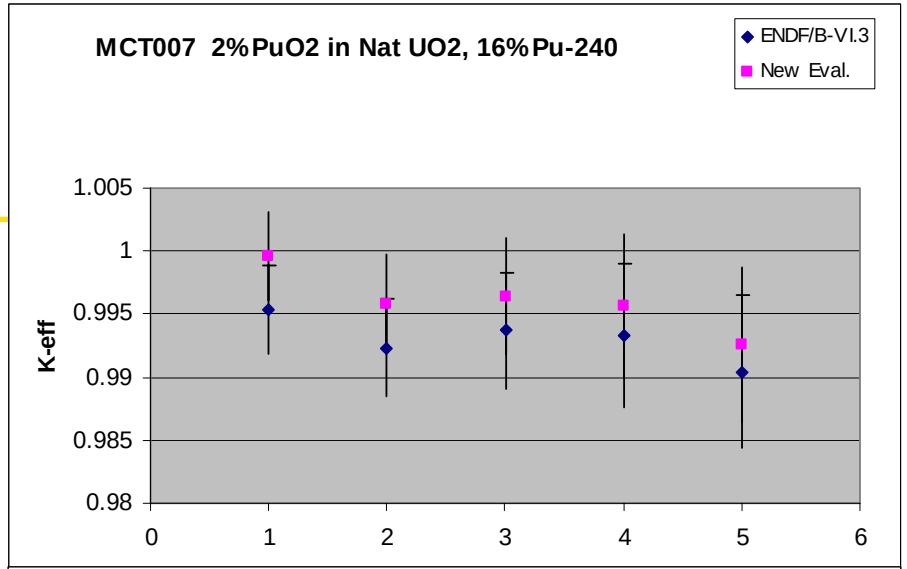

MCT002 (PNL-30 to 35) 2%PuO2 in Nat UO2
ENDF/B-VI.3
New Eval.
K-eff
1.01
1.005
1
0.995
0.99
0.985
0.98
0
1
2
3
4
5
6
7
Case

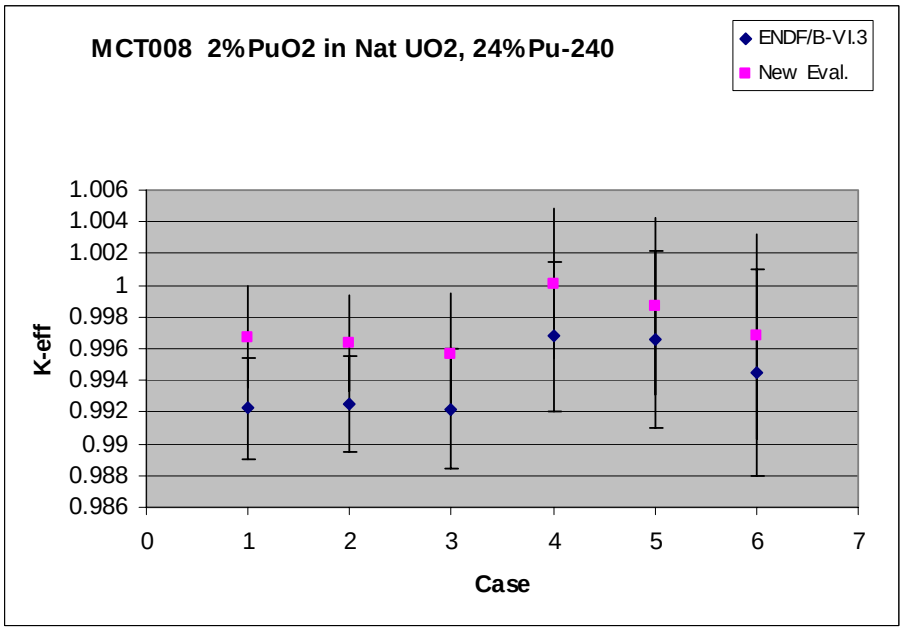

MCT003 (SAXTON) 6.6%PuO2 in 5.52%UO2
ENDF/B-VI.3
New Eval.
K-eff
1.006
1.004
1.002
1
0.998
0.996
0.994
0.992
0.99
0.988
0.986
0
1
2
3
4
5
6
7
Case

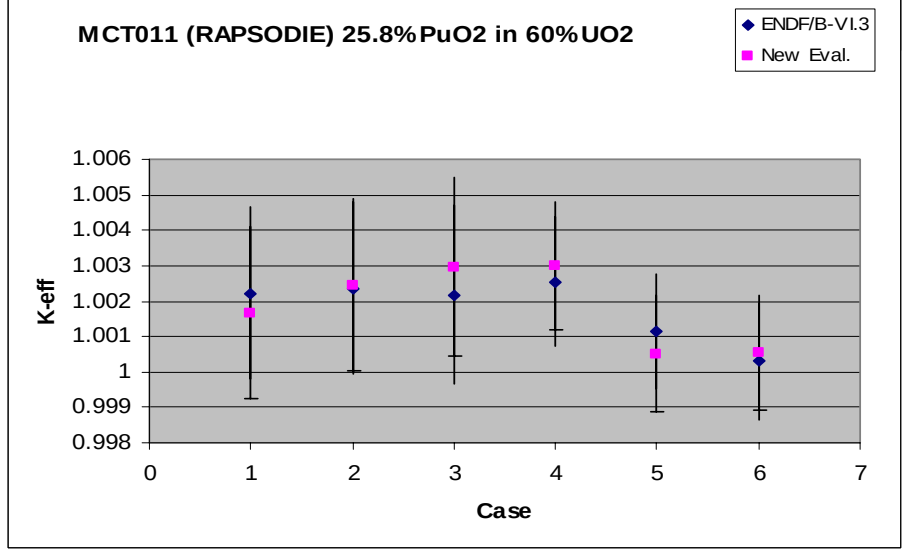

MCT004 (TCA MOX) 3%PuO2 in Nat UO2
ENDF/B-VI.3
New Eval.
K-eff
1.004
1.002
1
0.998
0.996
0.994
0.992
0.99
0.988
0.986
0
1
2
3
4
5
Case


MCT005 4%PuO2 in Nat UO2, 18%Pu-240
ENDF/B-VI.3
New Eval.
K-eff
1.008
1.006
1.004
1.002
1
0.998
0.996
0.994
0.992
0.99
0.988
0
1
2
3
4
5
6
7
8
Case

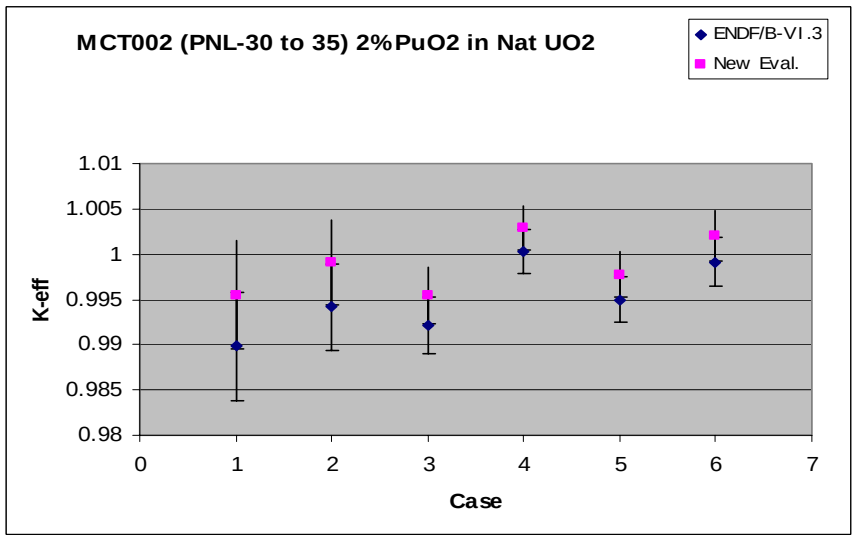

MCT006 2%PuO2 in Nat UO2, 8%Pu-240
ENDF/B-VI.3
New Eval.
K-eff
Case

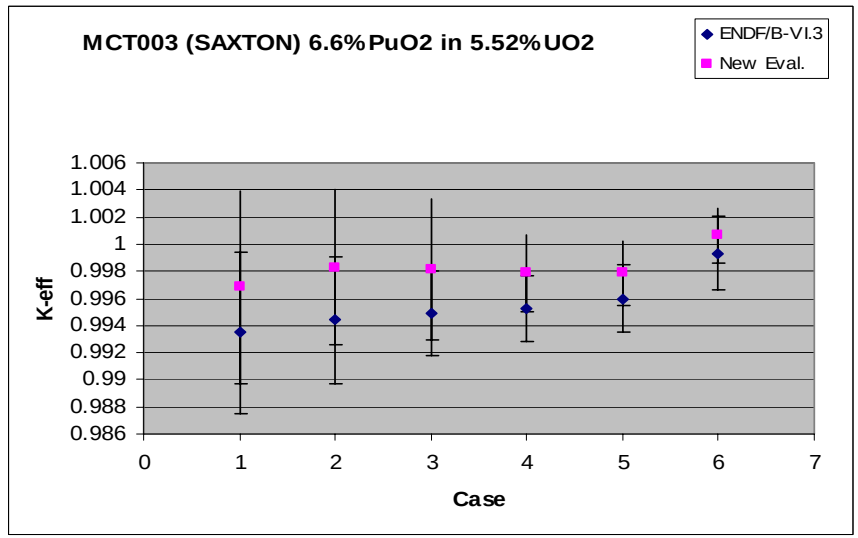

MCT007 2%PuO2 in Nat UO2, 16%Pu-240
ENDF/B-VI.3
New Eval.
K-eff


MCT008 2%PuO2 in Nat UO2, 24%Pu-240
ENDF/B-VI.3
New Eval.
K-eff
Case

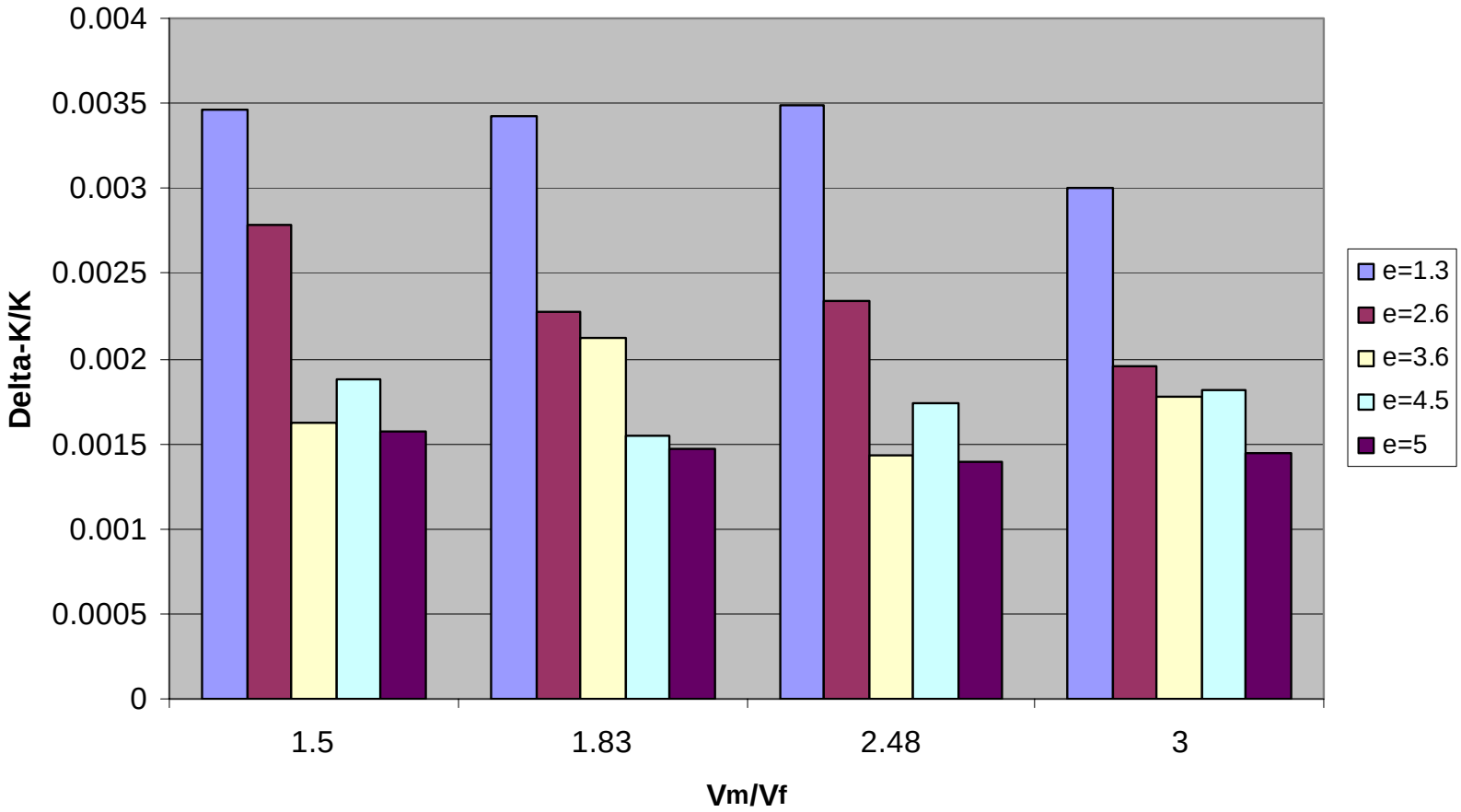

MCT011 (RAPSODIE) 25.8%PuO2 in 60%UO2
ENDF/B-VI.3
New Eval.
K-eff
Case

Comparison of the Eigenvalues for MOX Critical Experiments

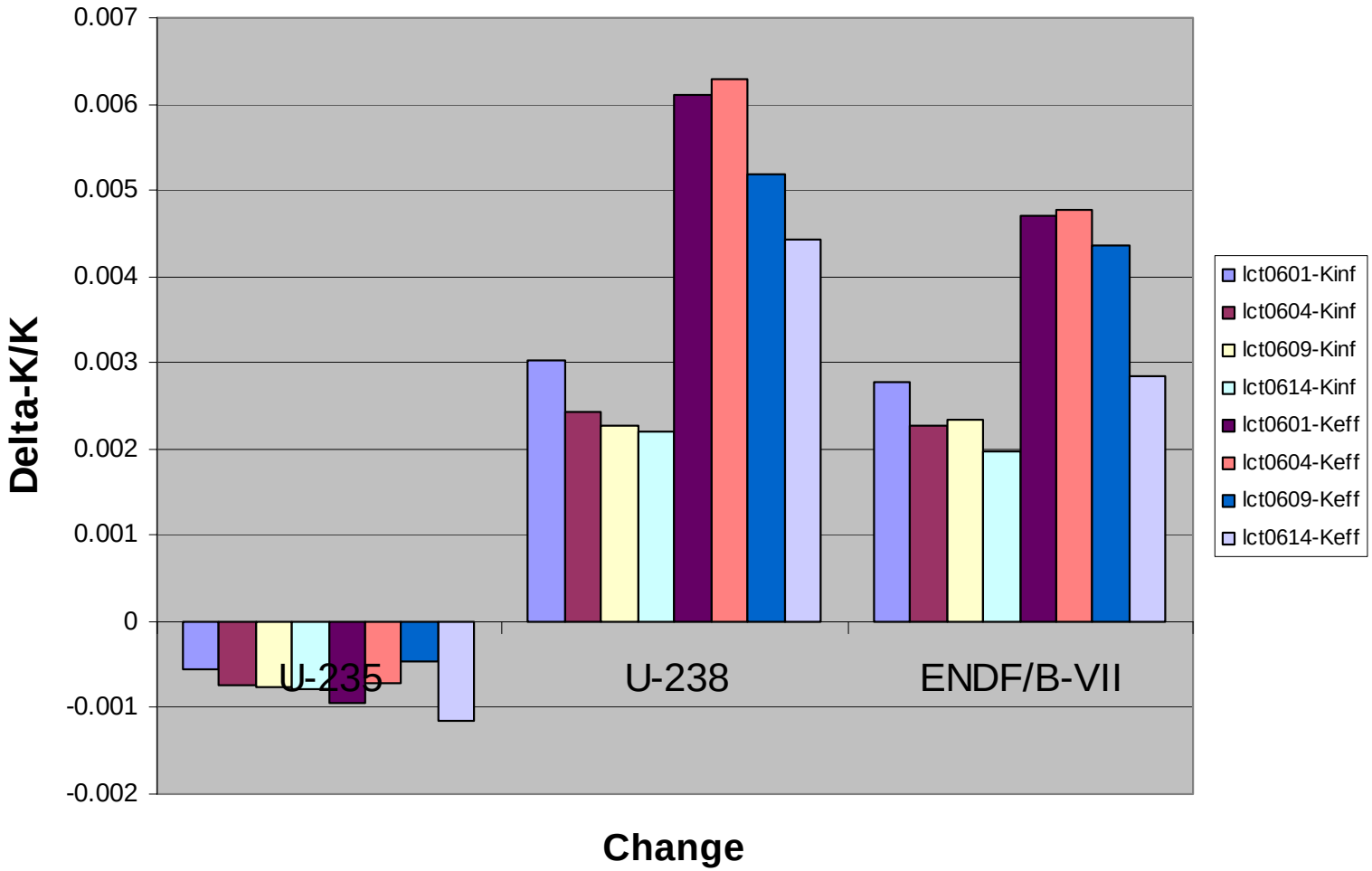


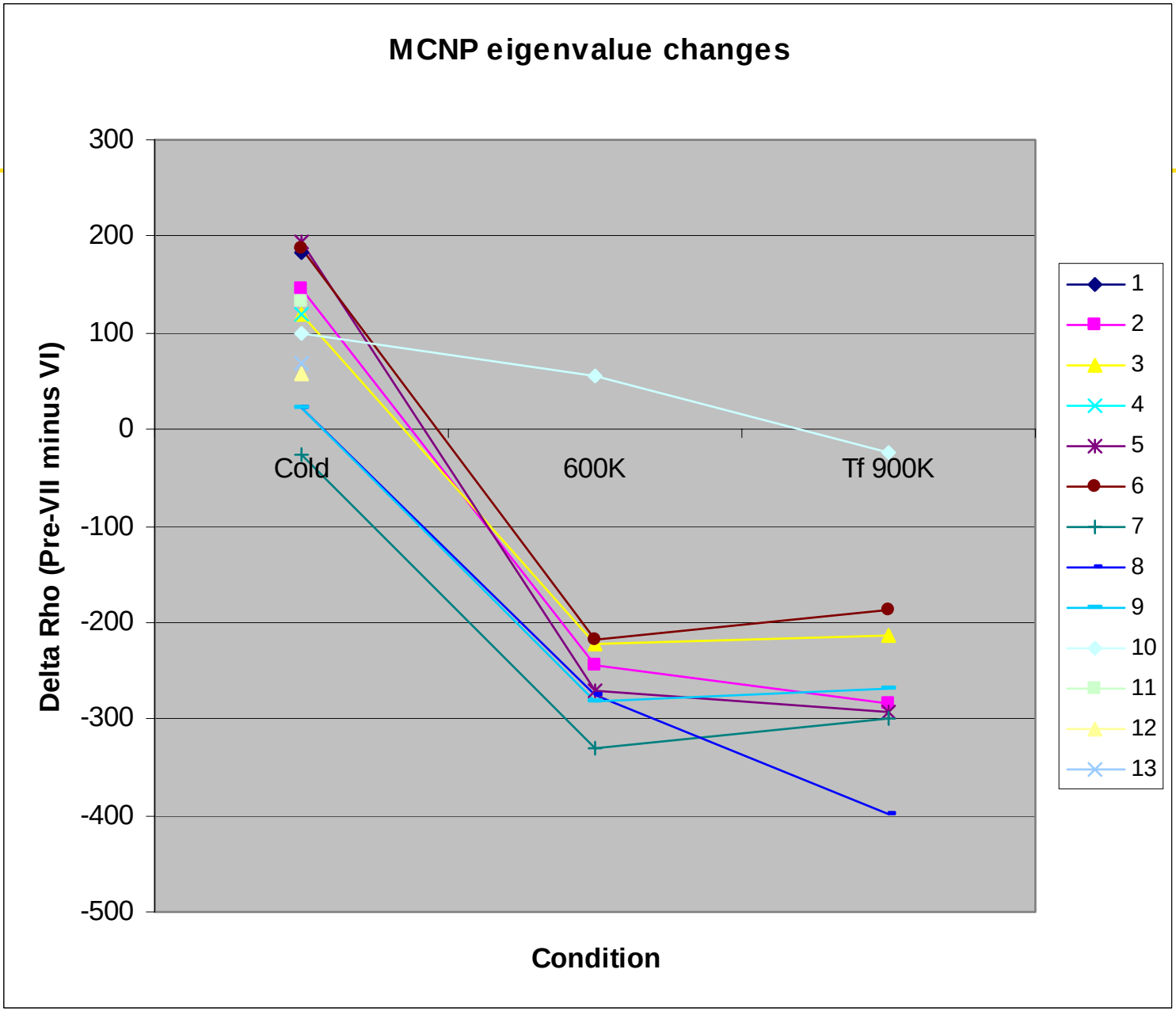


Delta-K_{inf} / K_{inf} versus V_m/V_f for various enrichments



Change in (Delta K)/K relative to ENDF/B-VI.3




MCNP eigenvalue changes
Delta Rho (Pre-VII minus VI)
300
200
100
0
-100
-200
-300
-400
-500
Cold
600K
Tf 900K
Condition
1
2
3
4
5
6
7
8
9
10
11
12
13

Conclusions

- Pre-ENDF.B-VII data for U-235 and U-238 result in significant improvement in the predicted eigenvalues in cold conditions.
- There is a visible dependence on enrichment and temperature
- For Hot Zero Power (Tf=600 K) and Hot Full Power (Tf=900 K) conditions, the new data leads to a loss in reactivity for both PWR and BWR systems
- For fuel assemblies with burnable absorbers, the new data again results in a drop in reactivity