SENSITIVITY TO NUCLEAR DATA AND UNCERTAINTY ANALYSIS: THE EXPERIENCE OF VENUS2 OECD/NEA BENCHMARKS.

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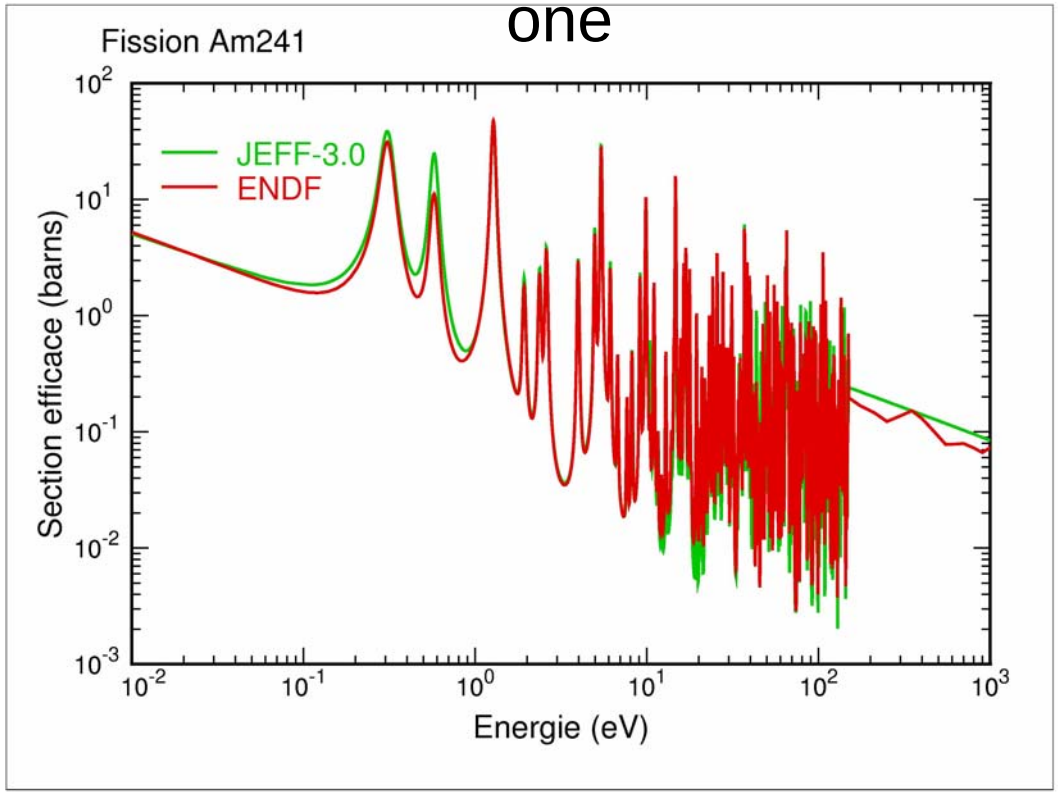
OECD/NEA Data Bank, Issy les moulineaux

One **certainty** about nuclear data : they are not the « *good* » one




```
----JEFF-30          MATERIAL  600
-----INCIDENT NEUTRON DATA
------ENDF-6 FORMAT
**************************  JEFF-3.0  ************************
DATA TAKEN FROM   :-   ENDF/B-VI.3 (DIST-SEP91 REV1-JUL91)
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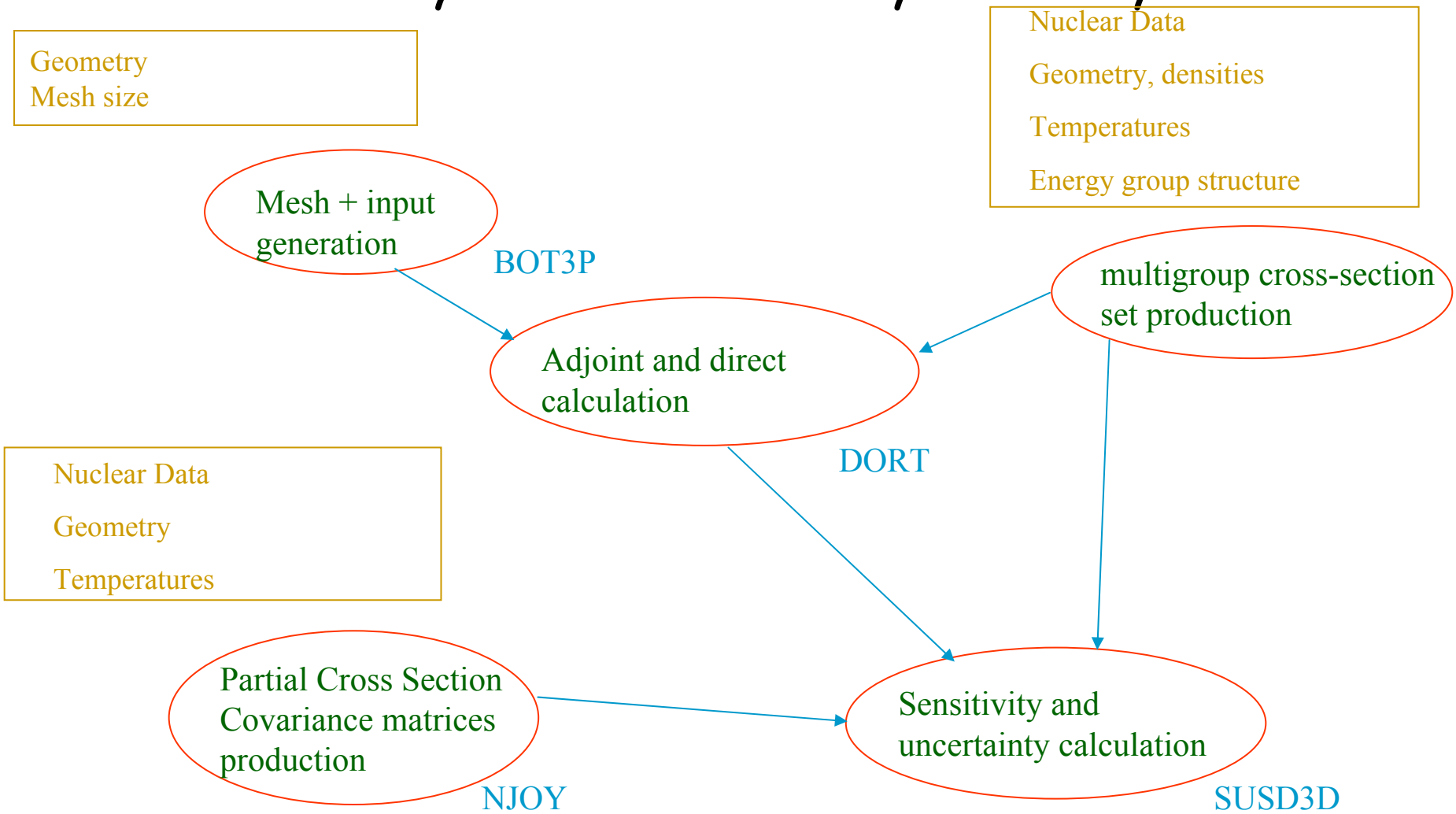
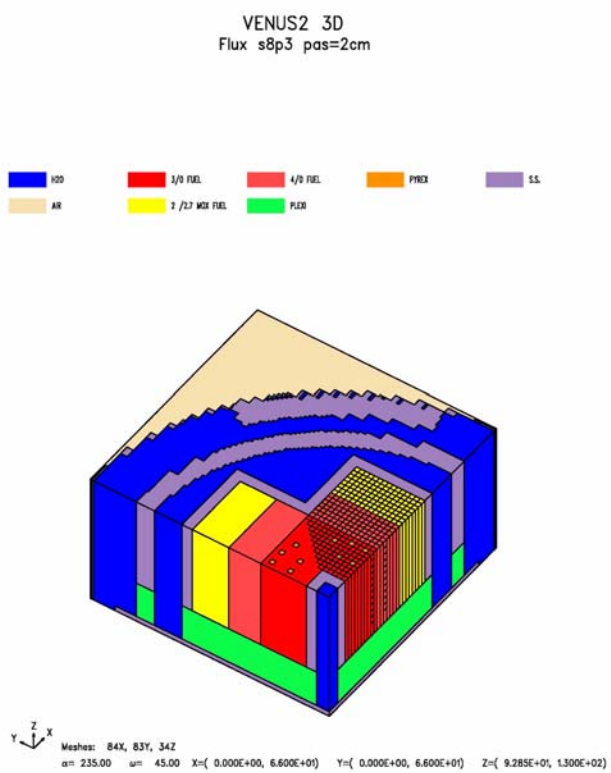
Sensitivity and Uncertainty Code System



VENUS 2 Benchmark

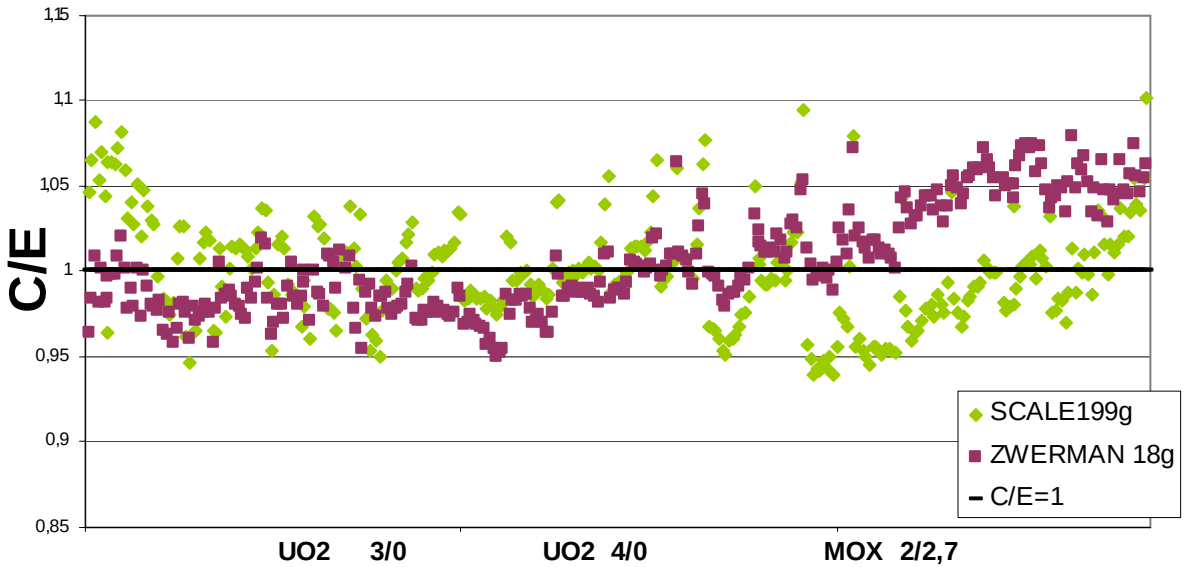


- Zero power Thermal Water reactor in SCK*CEN (Belgium) Partial MOX fuelled
- Axial and radial pin power distribution measurements are available
- Deterministic and Monte-Carlo calculations are compared
- Most recent data libraries were used

Cross section preparation

- 199 group library based on VITAMIN-B6 fine group library processed with SCALE4.4
- 18 group library processed by RESMOD code, provided by W. Zwermann(GRS)
- 2D and 3D calculations with both library
- Impact of Buckling factor on 2D results

Calculation	Kinf or keff	Participant's average
UO2 3,3% Cell	1,40642	1,40646
UO2 4,0% Cell	1,33735	1,33769
MOX Cell	1,25469	1,25737
3D 199g core	0,99466	1,00122
3D 18g Core	1,0052	



material	H1	B10	O16
	(n,gamma)	(n,alpha)	(n,gamma)
2D zwermann	-3,86E-02	-4,35E-02	-2,05E-05
3D zwermann	-4,63E-02	-4,27E-02	-2,21E-05
2D 199g	-3,98E-02	-3,18E-02	-2,10E-05
3D 199g	-5,41E-02	-3,28E-02	-2,49E-05

material	U235			U238			Pu239		
reaction	(n,gamma)	fission	Nu total	(n,gamma)	fission	Nu total	(n,gamma)	fission	Nu total
2D zwermann	-1,05E-01	3,21E-01	8,06E-01	-1,75E+00	5,74E-02	7,97E-02	-3,25E-02	5,39E-02	1,15E-01
3D zwermann	-1,04E-01	3,23E-01	8,06E-01	-1,70E+00	5,73E-02	7,91E-02	-3,25E-02	5,41E-02	1,15E-01
2D 199g	-1,09E-01	3,45E-01	8,38E-01	-1,66E+00	4,00E-02	6,12E-02	-2,79E-02	4,87E-02	1,00E-01
3D 199g	-1,16E-01	3,10E-01	8,36E-01	-1,73E+00	4,13E-02	6,21E-02	-3,03E-02	4,57E-02	1,02E-01

2D-3D Comparison

3D allows axial reflector explicit model

=>more H2O atoms in the 3D model!

Mat.	Reaction	2D	3D(Volume corrected)
H-1	Elastic	3.37E-1	3.74E-1 (3.55E-1)
	(n,γ)	-3.86E-2	-4.63E-2 (-3.84E-2)
O-16	Elastic	3.59E-2	5.11E-2 (4.69E-2)
	(n,γ)	-6.54E3	-6.45E-3 (-6.40E-3)

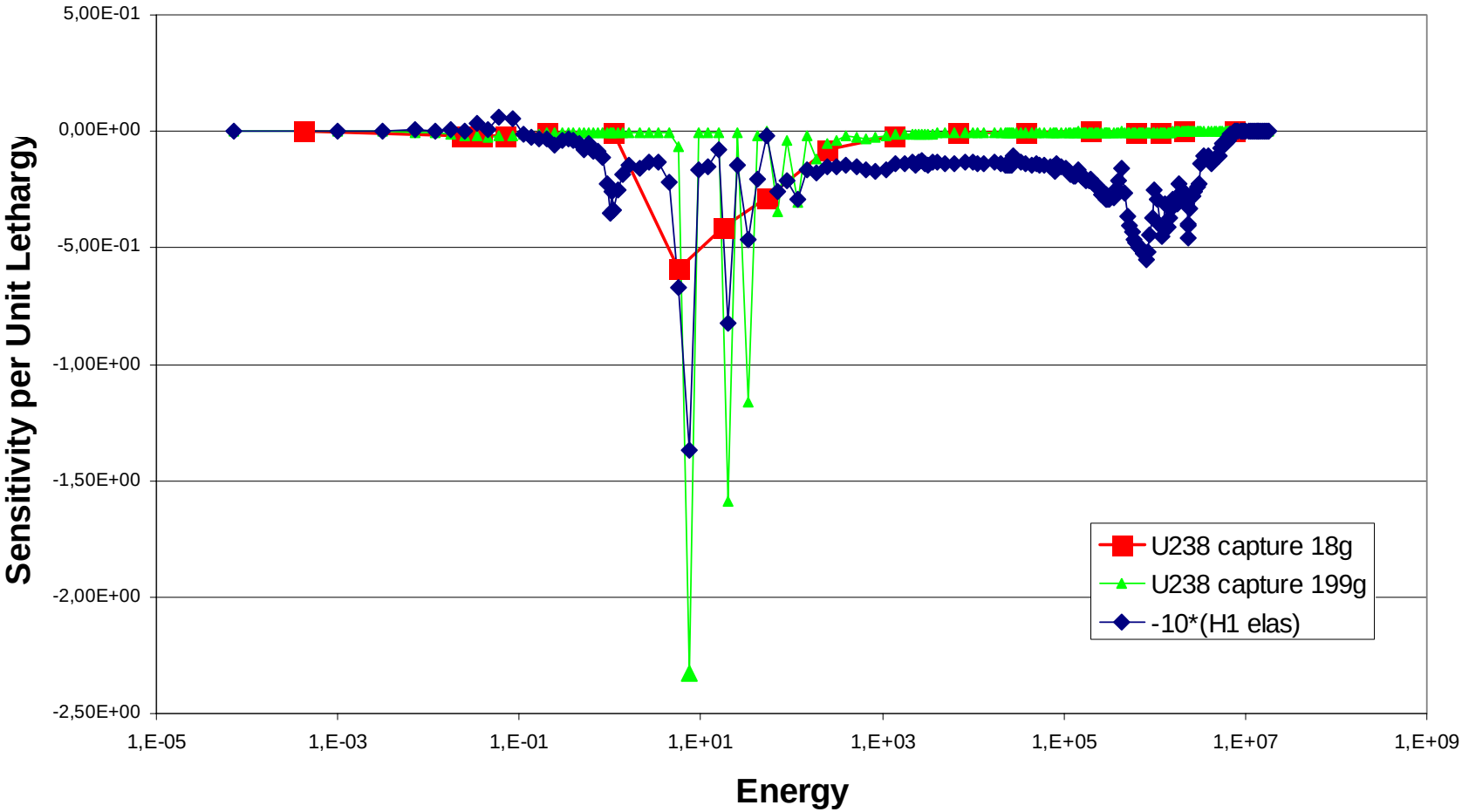
Buckling Effect

Material	reaction	2D 199g	critical B2
H1	(n,gamma)	-3,98E-02	-3,93E-02
B10	(n,alpha)	-3,18E-02	-3,59E-02
O16	(n,gamma)	-2,10E-05	-2,08E-05
	(n,gamma)	-1,09E-01	-1,09E-01
U235	fission	3,45E-01	3,47E-01
	Nu total	8,38E-01	8,40E-01
	(n,gamma)	-1,66E+00	-1,67E+00
U238	fission	4,00E-02	4,09E-02
	Nu total	6,12E-02	6,26E-02
	(n,gamma)	-2,79E-02	-2,69E-02
Pu239	fission	4,87E-02	4,79E-02
	Nu total	1,00E-01	9,78E-02

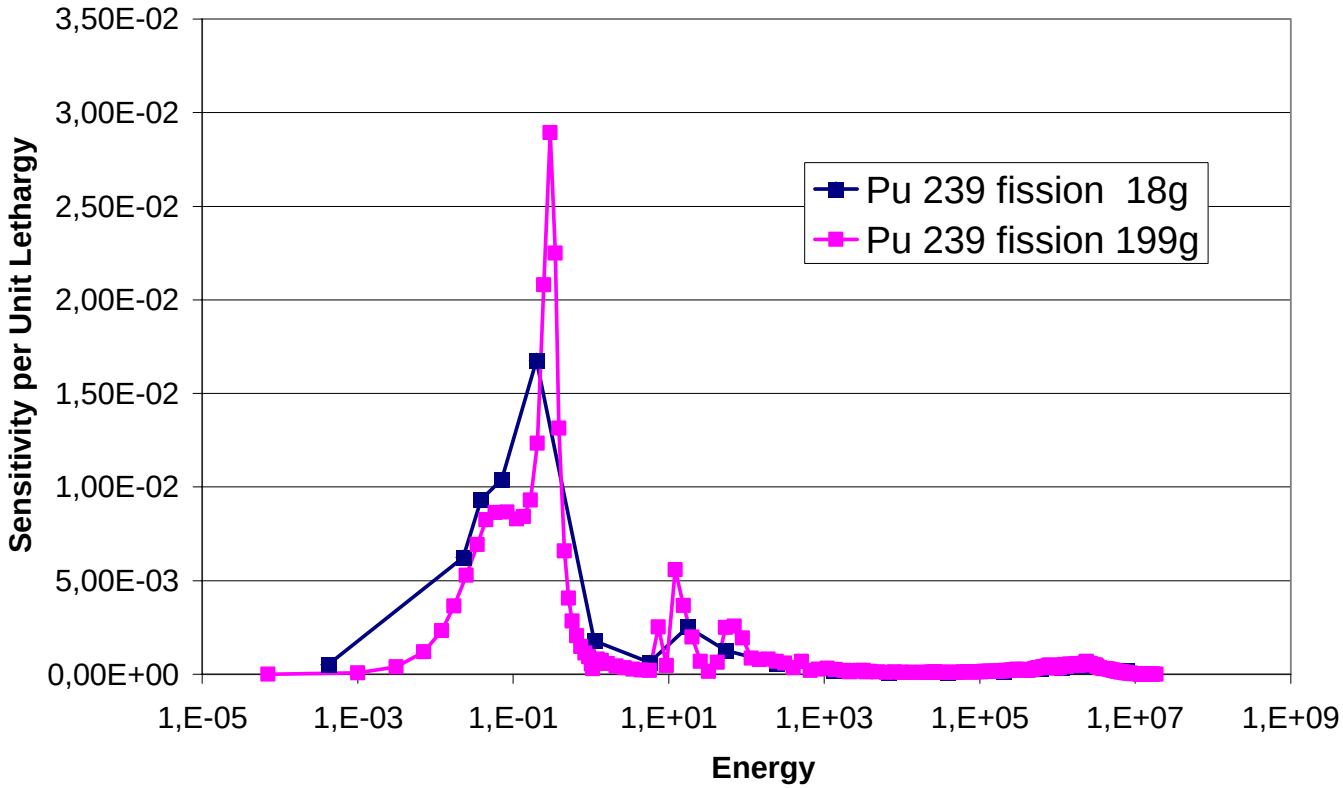
No real impact but for boron

=>Strong impact of self shielding effect

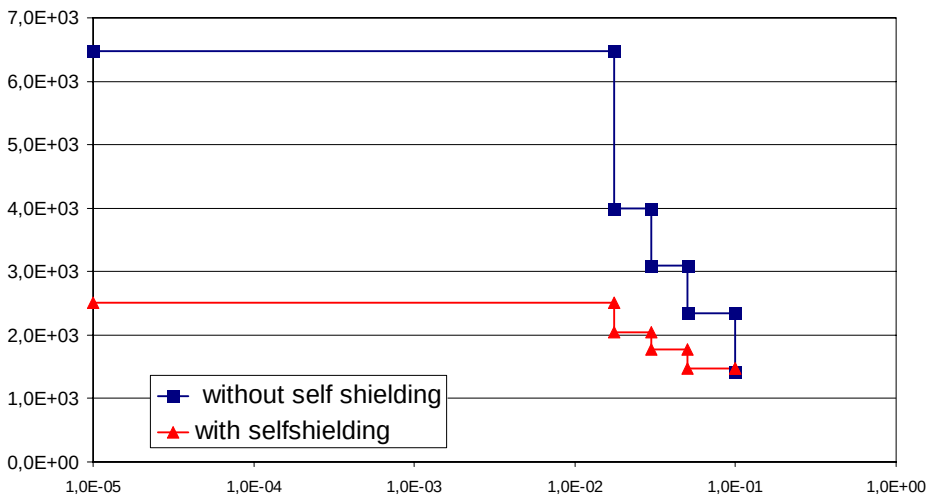
Sensitivity profile

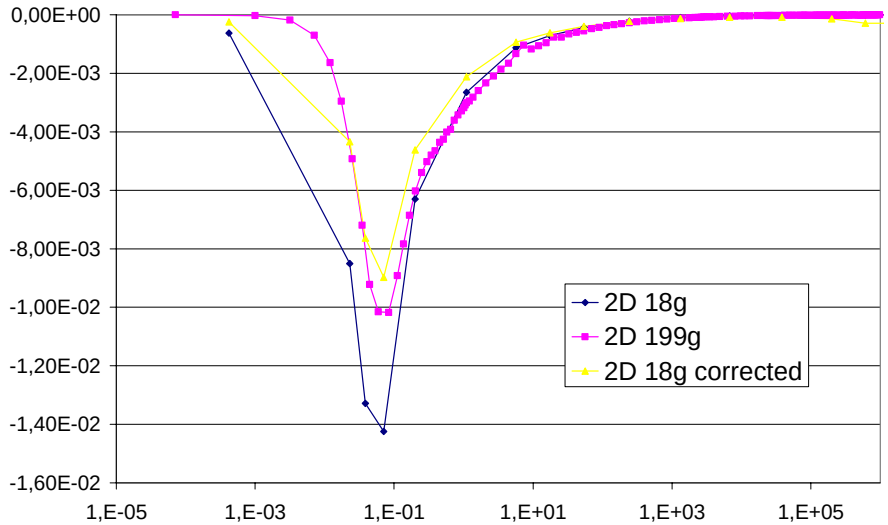


5% underestimation on fission rates == 15% underestimation in sensitivity

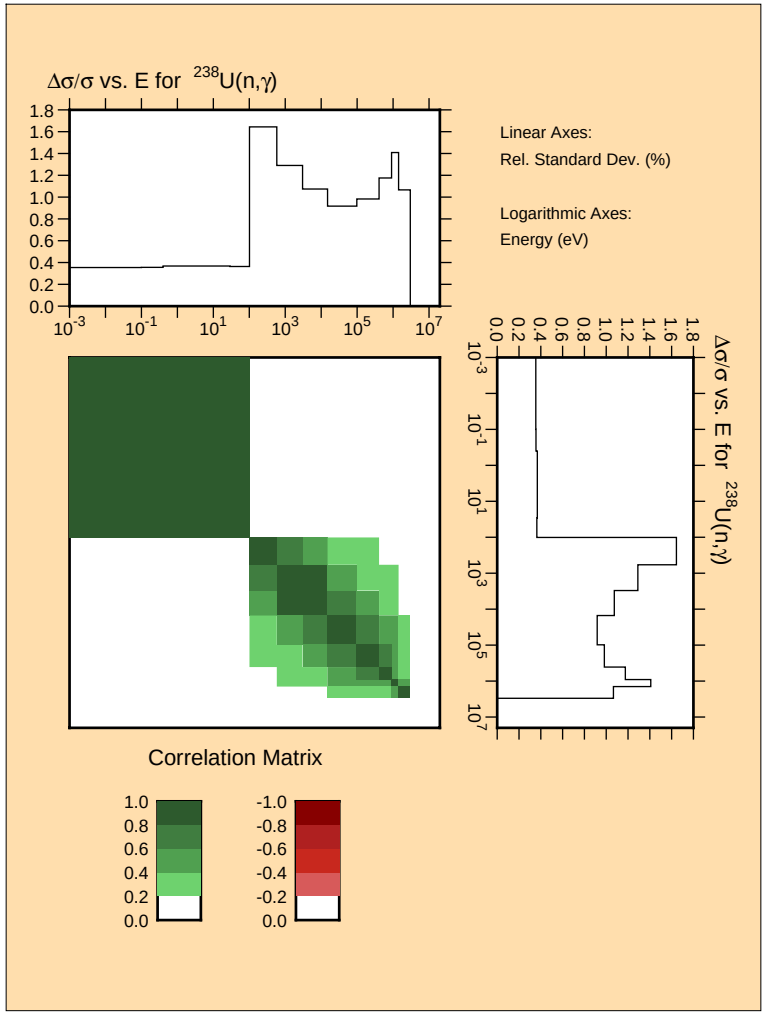


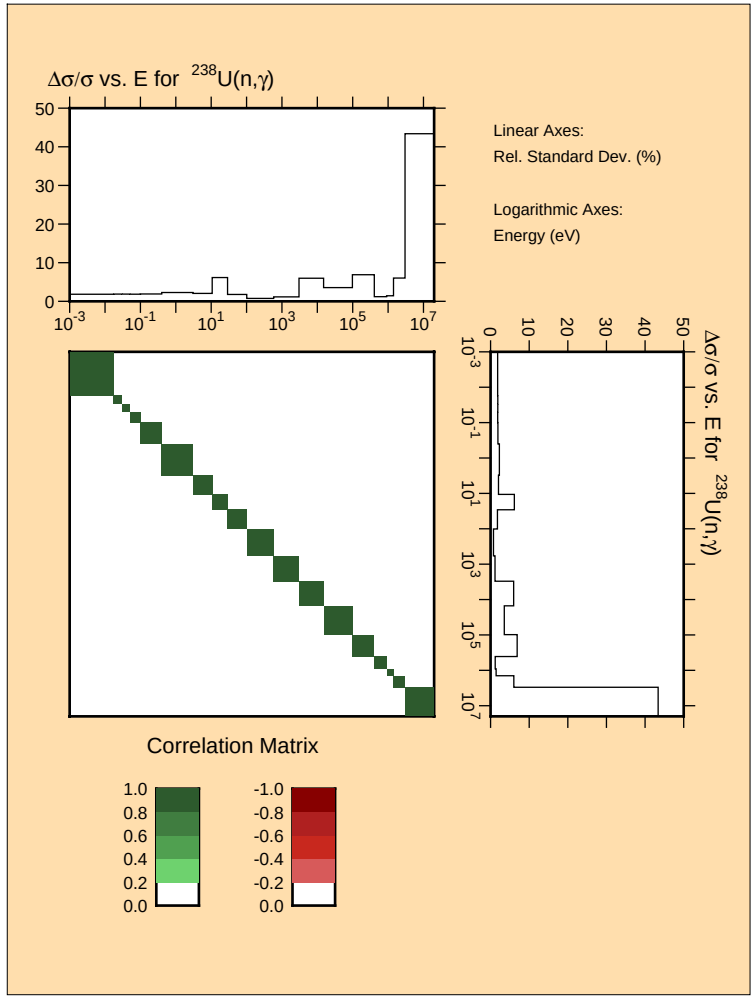
Impact of Boron macrocell calculation





Covariances matrices : U238 capture





Uncertainties based on various covariance data

Material	reaction	Sensitivity (%/%)	Uncertainty JENDL 3.2 (pcm)	Uncertainty IRDF-90 (pcm)
B10	(n,alpha)	-4,35E-02	20	7
U235	(n,gamma)	-1,05E-01	88	_
	fission	3,21E-01	74	60
	Nu total	8,06E-01	211	_
U238	(n,gamma)	-1,75E+00	3012	625
	fission	5,74E-02	29	31
	Nu total	7,97E-02	68	_
Pu239	(n,gamma)	-3,25E-02	168	_
	fission	5,39E-02	129	14
	Nu total	1,15E-01	6	_
Total (pcm)			3050	628

Conclusions (1)

- Our multidimentional tests shows that :
  - Sensitivities to fuel isotopes are not much sensitive to geometrical modelisation
  - Errors on reaction rates due to cross section preparation impacts the sensitivities
  - For some isotopes with strong self-shielding, the partial cross sections needed for sensitivity analysis done with NJOY bodarenko's method can be inacurrate.

Conclusions (2)

- Total uncertainty is about 1% which is larger than participant results' spread.
- U238 first resonances are responsible for a very large part of it.
- Neutron yelds are the second source of uncertainties.
- Analysis results are limited by poor nuclear data uncertainty information (lack of covariance matrices in evaluated files).