DE LA RECHERCHE À L'INDUSTRIE

DISCUSSIONS ON LIGHT WATER

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Generation of covariance matrix between model parameters

Description of the method implemented in the CONRAD code for calculating covariance matrix between model parameters ⇒ **LEAPR parameters (JEFF-3.1.1)**

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Covariance matrices of the hydrogen neutron cross sections bound in light water for the JEFF-3.1.1 neutron library

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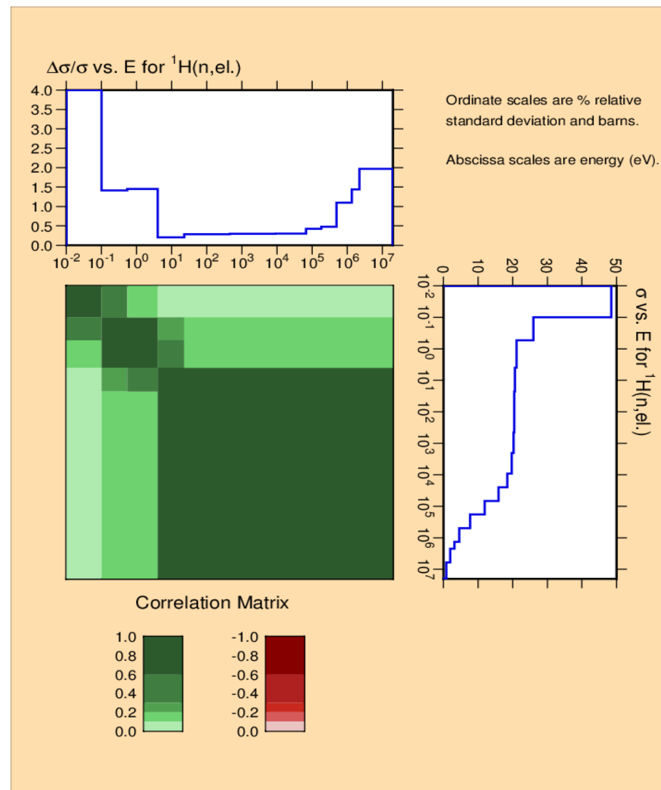
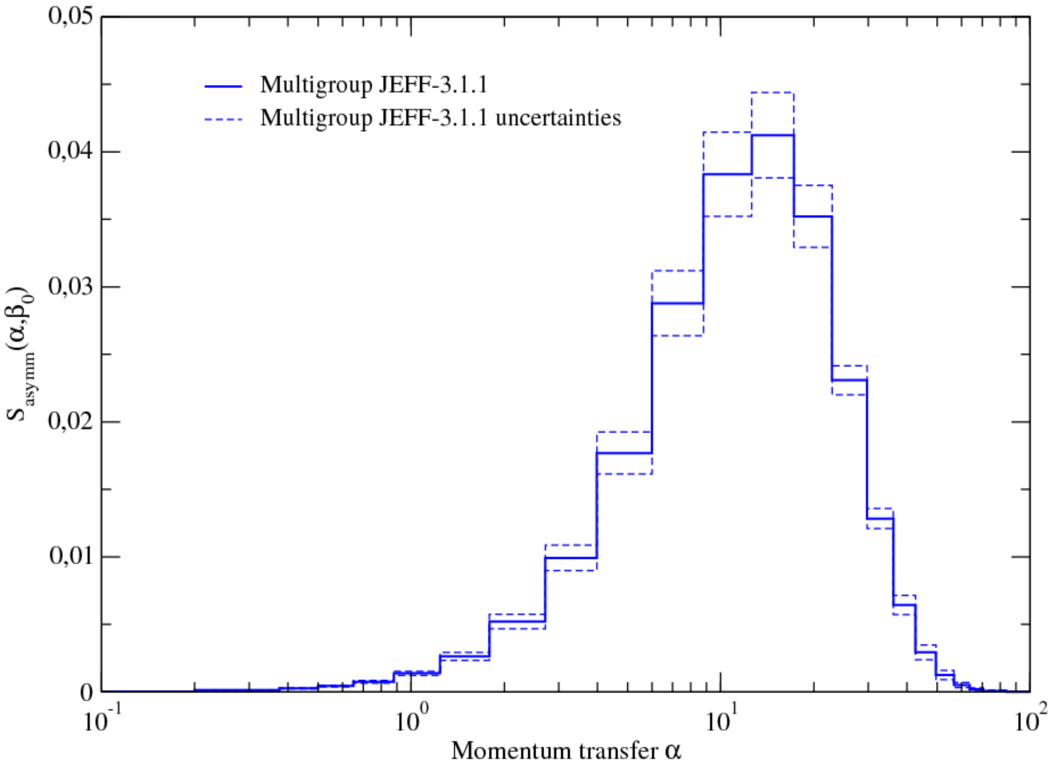
Full covariance matrix on the elastic scattering cross section of H1 in H2O from thermal to MeV energy range by using **contraints on the bound cross section**



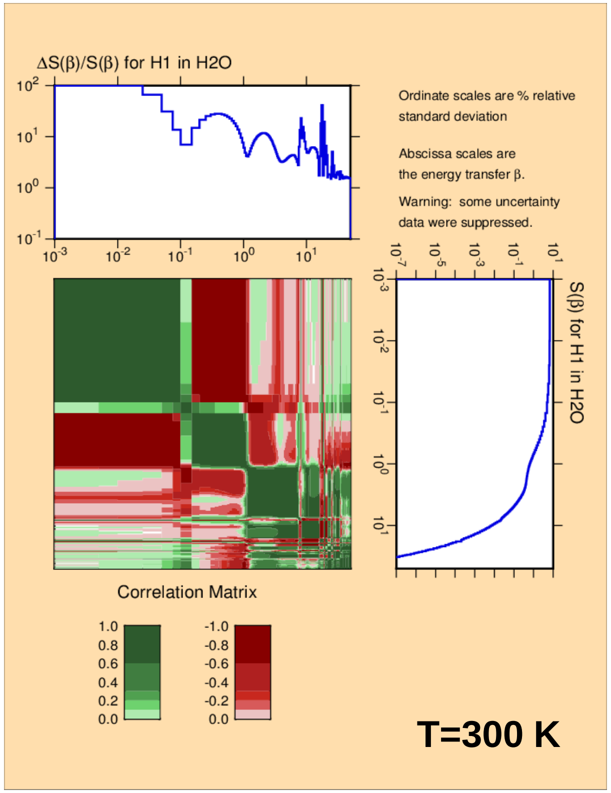
Generation of covariance matrix between $S(\alpha_g,\beta)$

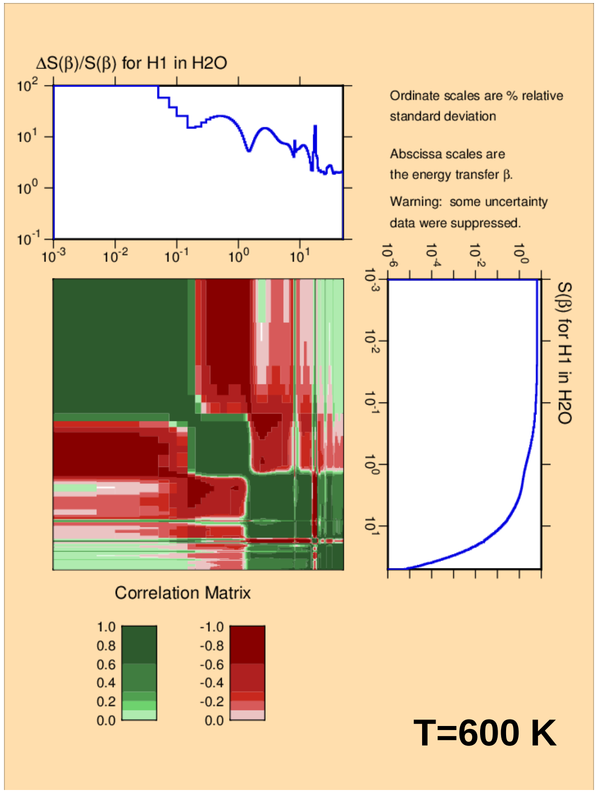
Because of the size of the $S(\alpha,\beta)$ matrix, it is not possible to create a full covariance matrix between the $S(\alpha,\beta)$ $\Rightarrow$ **we use a multigroup representation $S(\alpha_g\beta)$**



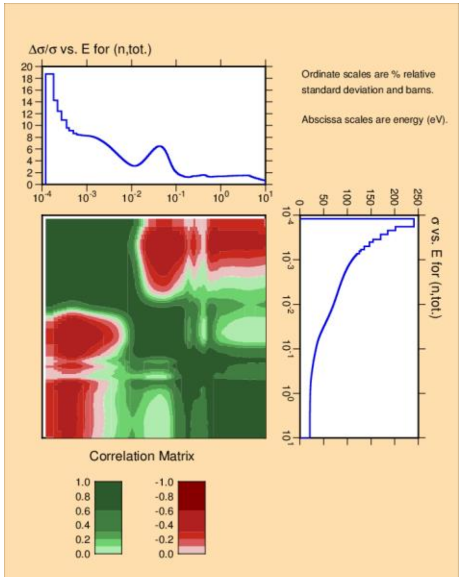
Generation of covariance matrix between S(⟨α⟩,β)

The extreme multigroup representation is to average the S(α,β) over the α grid ⇒ **one-group description S(⟨α⟩,β)**

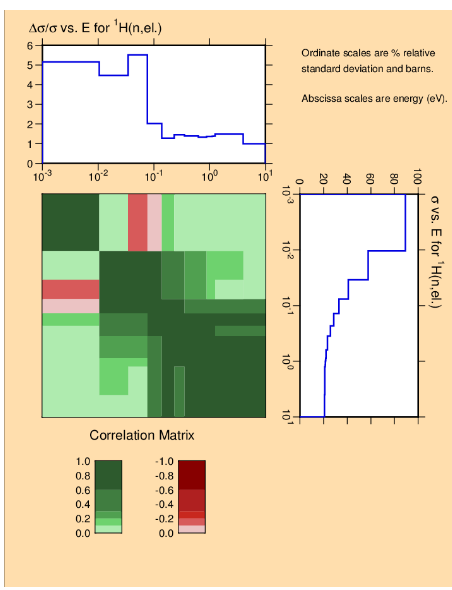


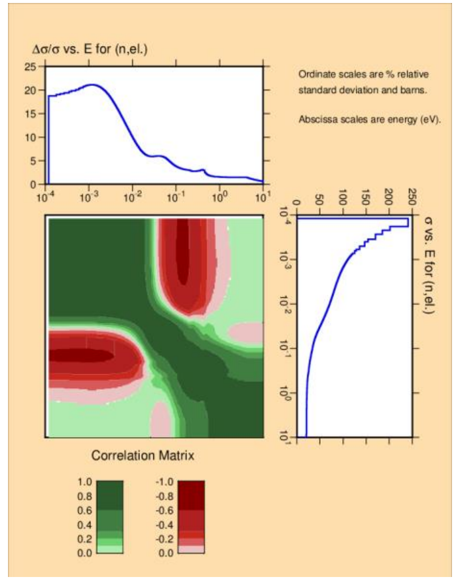


Covariance matrix for the elastic cross section

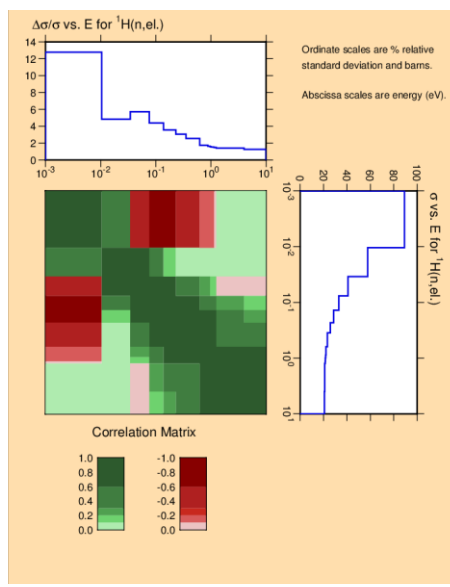


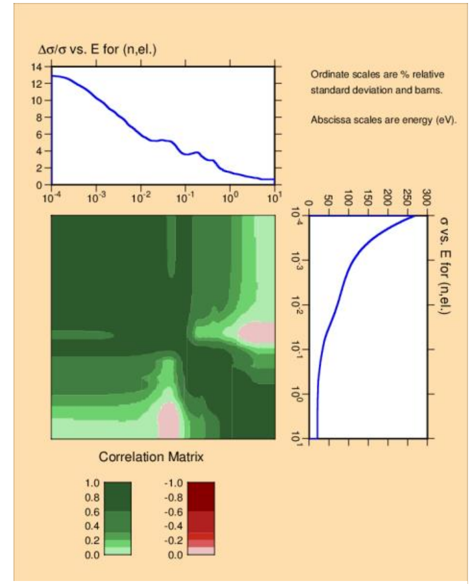
From LEAPR parameters



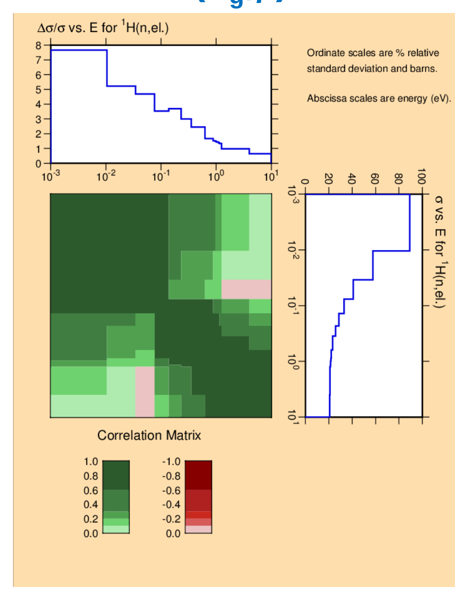


From S(⟨α⟩,β) matrix





From S(α_g,β) matrix

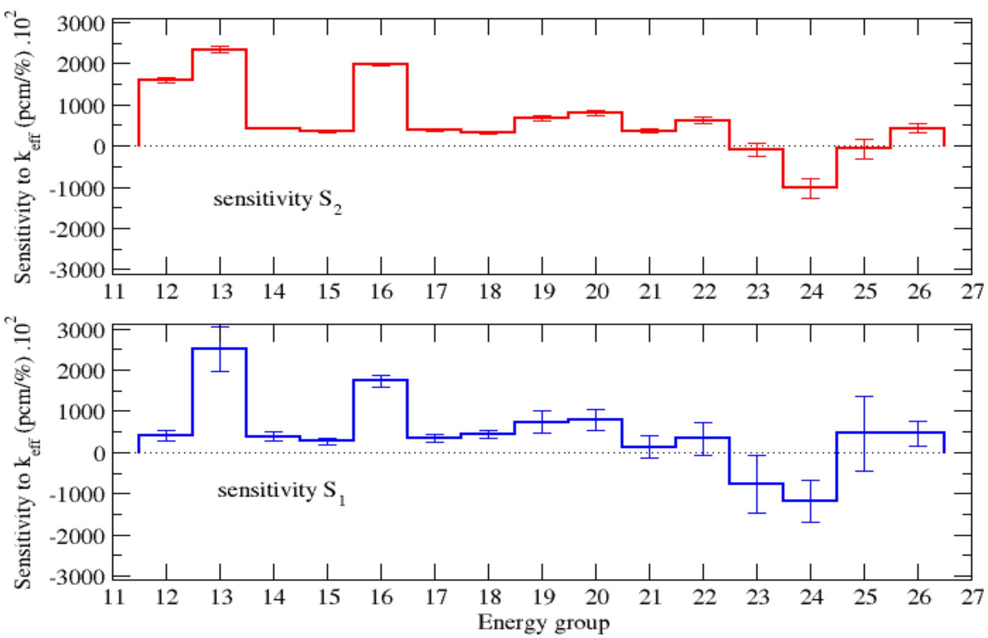


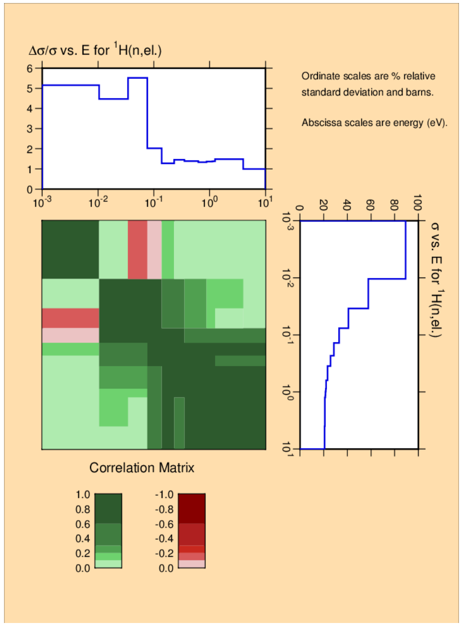
Propagation of the uncertainties : IFP method

In theory, the IFP method implemented in the Monte-Carlo code TRIPOLI4 can be used to calculate the sensitivity to the elastic cross section and to the $S(\alpha_{g},\beta)$ or $S(\langle\alpha\rangle,\beta)$ elements

In practice, we are limited by the convergence of the IFP method for the $S(\alpha_{g},\beta)$ or $S(\langle\alpha\rangle,\beta)$ elements

$\Rightarrow$ For the moment, the IFP method of TRIPOLI4 can only be applied to the <u>elastic cross section</u>





Propagation of the uncertainties : IFP method – PST001.1

In theory, the IFP method implemented in the Monte-Carlo code TRIPOLI4 can be used to calculate the sensitivity to the elastic cross section and to the $S(\alpha_{g,}\beta)$ or $S(\langle\alpha\rangle,\beta)$ elements

In practice, we are limited by the convergence of the IFP method for the $S(\alpha_{g,}\beta)$ or $S(\langle\alpha\rangle,\beta)$ elements

$\Rightarrow$ For the moment, the IFP method of TRIPOLI4 can only be applied to the <u>elastic cross section</u>

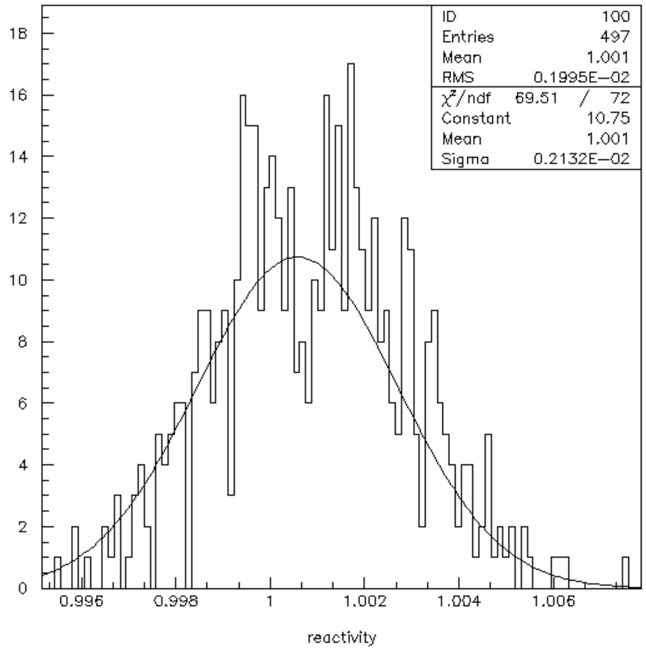
IFP sensitivity	IFP uncertainty	Origin of the covariance matrix		
		LEAPR parameters	$S(\langle\alpha\rangle,\beta)$	$S(\alpha_g,\beta)$
sensitivity $S_1(\sigma_n)$	$\pm$70 pcm	114 pcm	159 pcm	125 pcm
sensitivity $S_2(\sigma_n)$	$\pm$ 10 pcm	130 pcm	161 pcm	132 pcm

The three covariance matrices provide nealy equivalent results close to 140 pcm

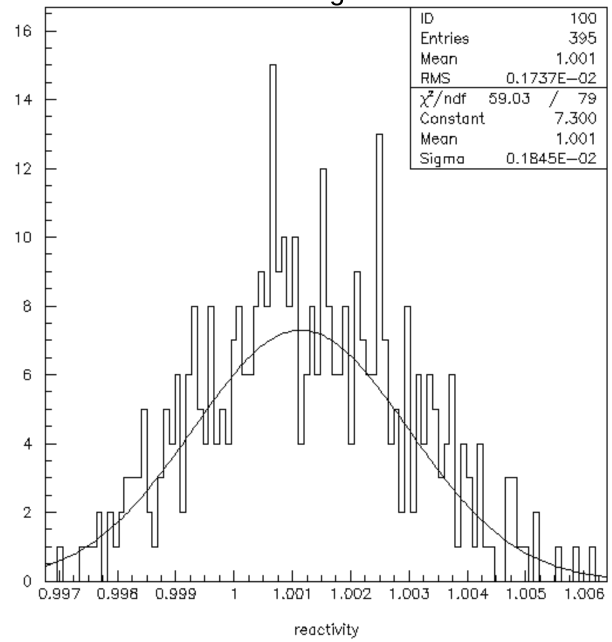
Propagation of the uncertainties : TMC method – PST001.1

Méthode de propagation	Origin of the covariance matrix	
	$S(\langle\alpha\rangle,\beta)$	$S(\alpha_g,\beta)$
Sensibilité IFP $S_2(\sigma_n)$	161 pcm	132 pcm
Total Monte Carlo	213 pcm	184 pcm

From $S(\langle\alpha\rangle,\beta)$ matrix



From $S(\alpha_g,\beta)$ matrix



IFP and TMC provide nearly equivalent results ⇒ difference of 50 pcm

IFP method - Application to UOX cell

Decomposition of the keff uncertainty **without the S(α,β) contribution**

Isotope	FISSION	CAPTURE	ELASTIC	INELASTIC	NXN	NU	DISTRIBUTION	DISTRIBUTION_TH	TOTAL
H1		150	17						**151**
B10		26							**26**
O16		97	14	2					**98**
Zr90		11	72	4					**72**
Zr91		27	30	2					**40**
Zr92		27	20	2					**33**
Zr94		2	8	2					**8**
Zr96		2	6						**6**
U234	1	6	2						**6**
U235	104	174	13			276		142	**371**
U236		1							**1**
U238	29	165	83	38	18	32	9		**195**
TOTAL	**108**	**303**	**118**	**39**	**18**	**277**	**9**	**142**	**465**

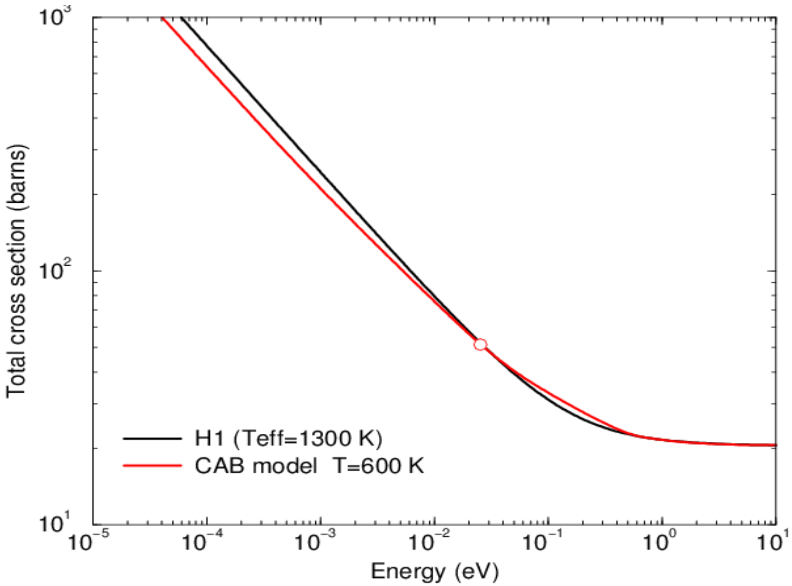
IFP method - Application to UOX cell

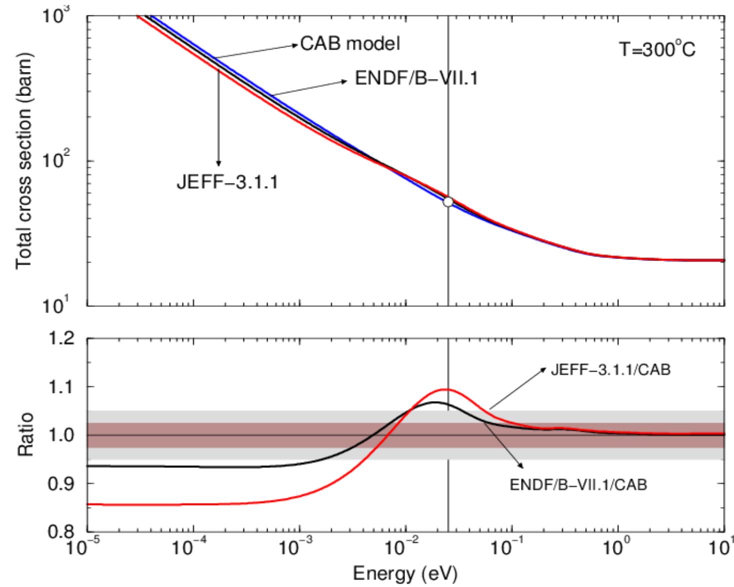
Decomposition of the keff uncertainty **with the S(α,β) contribution**

Isotope	FISSION	CAPTURE	ELASTIC	INELASTIC	NXN	NU	DISTRIBUTION	DISTRIBUTION_TH	TOTAL
H1_H2O		150	105						**183**
B10		26							**26**
O16		97	14	2					**98**
Zr90		11	72	4					**72**
Zr91		27	30	2					**40**
Zr92		27	20	2					**33**
Zr94		2	8	2					**8**
Zr96		2	6						**6**
U234	1	6	2						**6**
U235	104	174	13			276		142	**371**
U236		1							**1**
U238	29	165	83	38	18	32	9		**195**
TOTAL	**108**	**303**	**158**	**39**	**18**	**277**	**9**	**142**	**477**

$\Rightarrow$ Low impact on the final uncertainty

Impact of the S(α,β) in hot conditions





Benchmarks	Temperature	H(H2O)	Δ
Configuration HFP	600 K	C(JEFF-3.1.1)-C(CAB model)	-10 pcm
		C(FGM)-C(CAB model)	-66 pcm
Configuration HZP		C(JEFF-3.1.1)-C(CAB model)	-10 pcm
		C(FGM)-C(CAB model)	-61 pcm

Low impact of the S(α,β) in hot conditions ⇒ SVT in TRIPOLI with an effective temperature