STEK and SEG expriments: Analysis available in several documents, in particular at CEA-Cadarache and at former JNC

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Integral Test of Neutron Data and Comparison of Codes by Re-analysis of the SEG and STEK Experiments

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Integral Test of JENDL-3.2 Data by Re-analysis of Sample Reactivity Measurements at Fast Critical Facilities

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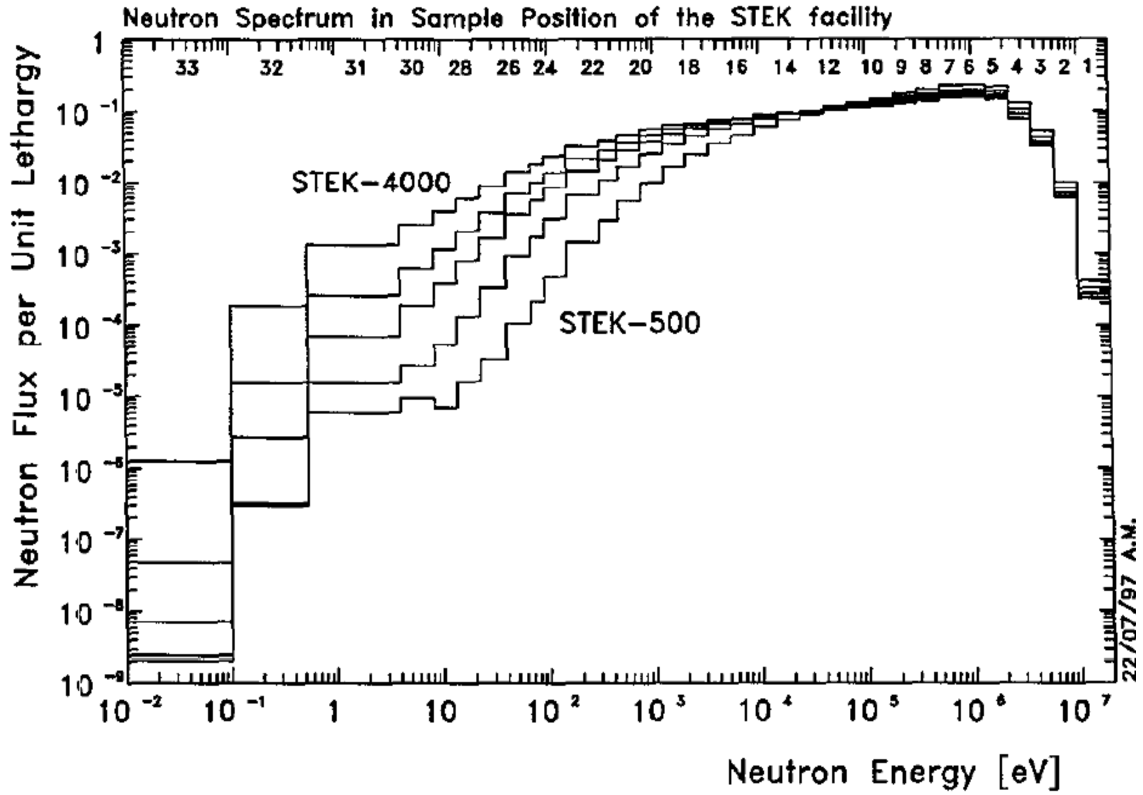
The STEK experiments

The STEK-experiments have been performed to check neutron data of the most important reactor materials, especially of fission product nuclides, fuel isotopes and structural materials. The measured central reactivity worths (CRW) of small samples were compared with calculated values. These C/E-ratios have been used then for data corrections or in adjustment procedures.

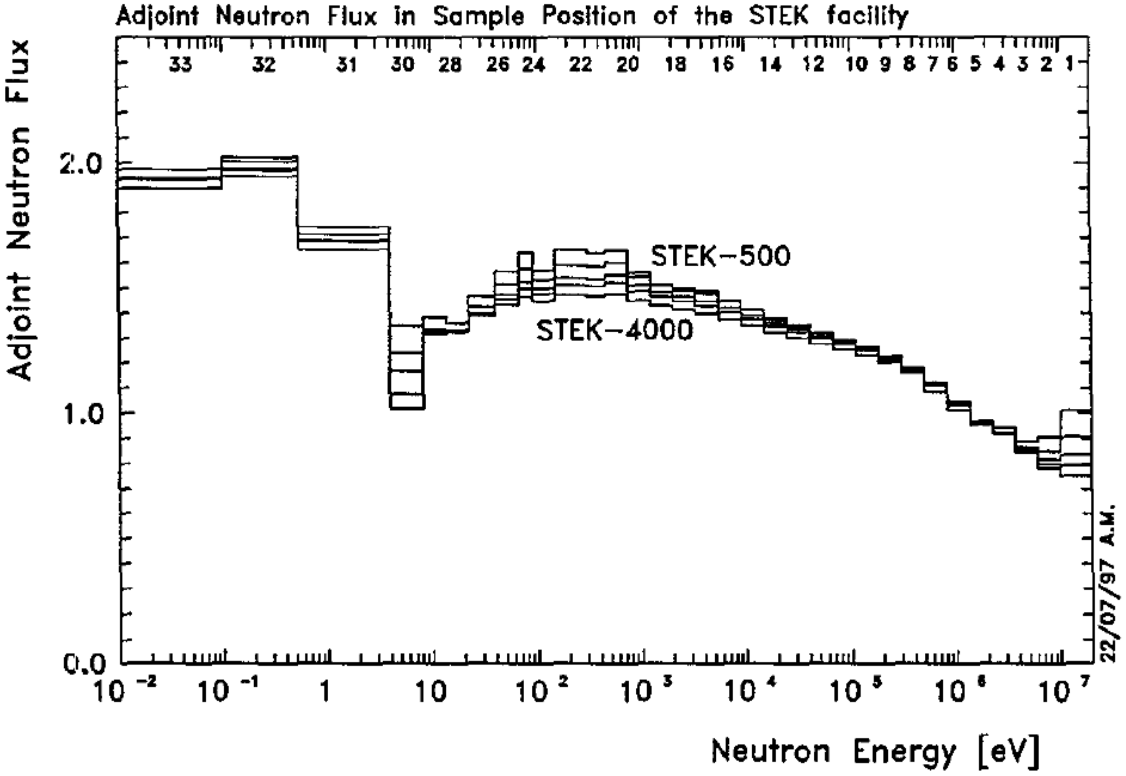
The reactors STEK (ECN Petten/ Netherlands) was a fast-thermal coupled facility of zero power. The annular thermal drivers were filled by fuel assemblies and moderated by water. The inner insertion lattices were loaded with pellets of fuel and other materials producing the fast neutron flux. The characteristics of the neutron and adjoint spectra were obtained by special arrangements of these pellets in unit cells. In this way, a hard or soft neutron spectrum or a special energy behavior of the adjoint function could be reached. The samples were moved by means of tubes to the central position (pile-oscillation technique). The original information about the facility and measurements is compiled in RCN-209, ECN-10

The 5 STEK configurations cover a broad energy range due to their increasing softness. The experiments are very valuable because of the extensive program of sample reactivity measurements with many fission product nuclides important in reactor burn-up calculations.

At first, analyses of the experiments have been performed in Petten. Newer analyses were done later in Cadarache / CEA France using the European scheme for reactor calculation JEF-2.2 / ECCO / ERANOS (see Note Techniques and JEF/DOC-746). Furthermore, re-analyses were performed in O-arai / JNC Japan with the JNC standard route JENDL-3.2 / SLAROM / CITATION / PERKY. Results obtained with both code systems and different data evaluations (JEF-2.2 and JENDL-3.2) are compared in JEF/DOC-861.



Neutron Spectrum in Sample Position of the STEK facility
Neutron Flux per Unit Lethargy
STEK-4000
STEK-500
Neutron Energy [eV]
22/07/97 A.M.



Adjoint Neutron Flux in Sample Position of the STEK facility
Adjoint Neutron Flux
STEK-500
STEK-4000
Neutron Energy [eV]
22/07/97 A.M.

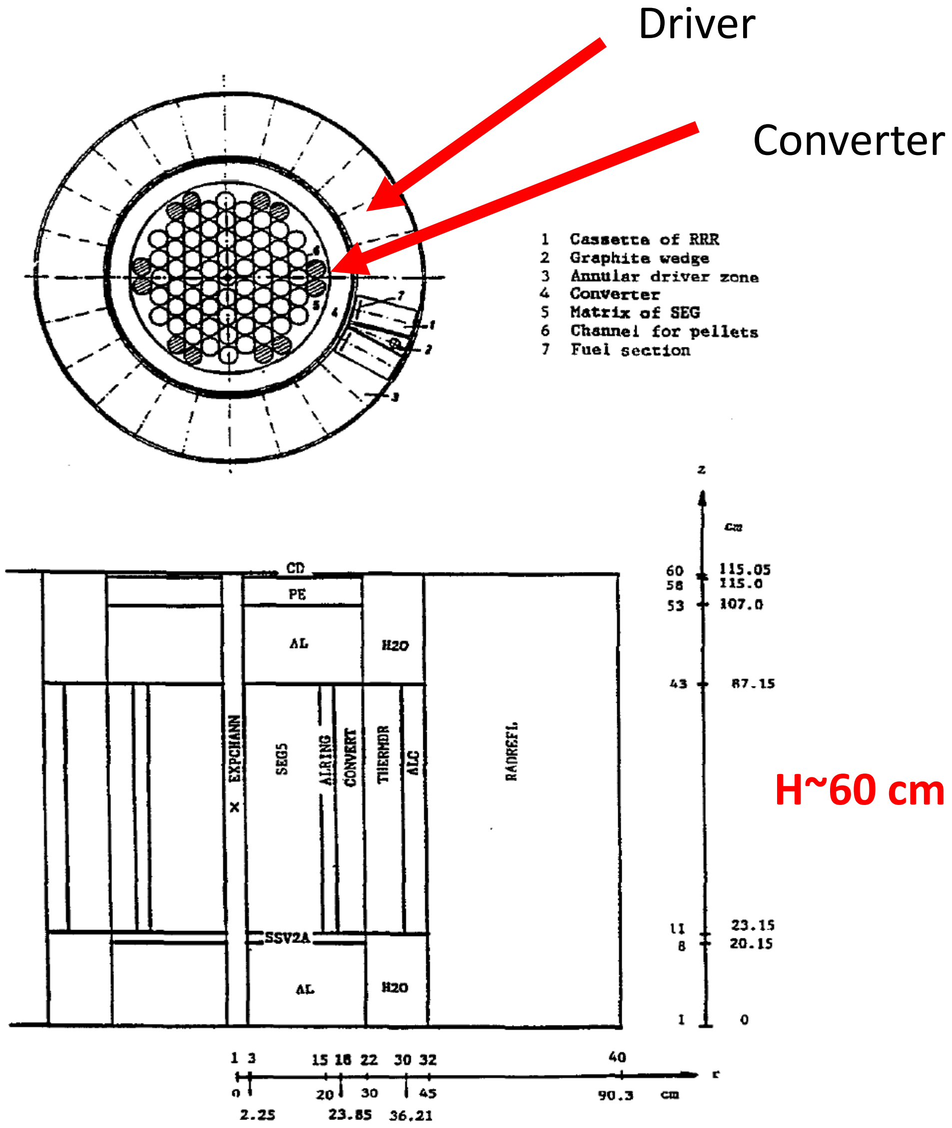
Softest spectrum

Hardest spectrum

Table 6:
C/E-values of infinitely dilute sample reactivities in STEK, normalized to the C/E-value of boron-10, obtained with the JNC standard route in 70 energy groups

MAT	ID	STEK-4000	STEK-3000	STEK-2000	STEK-1000	STEK-500	Comment
B-10	105	1.00 ± 4%	1.00 ± 5%	1.00 ± 4%	1.00 ± 4%	1.00 ± 4%	Normalization
H	1	1.01 ± 7%	0.96 ± 6%	0.97 ± 6%	1.00 ± 5%	0.98 ± 6%	Standard
C	6	1.03 ± 5%	0.93 ± 6%	0.94 ± 8%	0.96 ± 6%	0.94 ± 6%	Standard
O	8	0.91 ±20%	0.96 ± 7%	0.93 ± 6%	0.96 ± 5%	1.01 ± 6%	
Al	13	1.05 ± 6%	0.97 ± 8%	0.99 ± 8%	1.06 ± 5%	1.07 ± 7%	
Si	**14**	**0.87 ± 6%**	**0.77 ±13%**	**0.78 ±12%**	**0.84 ± 6%**	-	**!**
Cl	17	1.09 ± 9%	1.13 ± 9%	1.32 ±12%	1.53 ±13%	1.11 ±14%	
V	**23**	x	**0.54 ± 8%**	**0.59 ± 8%**	**0.73 ± 8%**	-	**Small effect, !**
Cr	**24**	x	**0.41 ± 7%**	**0.47 ± 9%**	**0.56 ± 8%**	-	**Small effect, !**
Fe	**26**	x	**0.38 ±10%**	**0.50 ± 8%**	**0.70 ± 7%**	**0.86 ± 6%**	**Small effect, !**
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pb	**82**	**1.67 ± 7%**	**1.98 ± 9%**	**1.53 ±13%**	**1.55 ± 7%**	**1.72 ± 6%**	**Small effect, !**
Th-232	**902**	**1.64 ± 7%**	-	-	**1.32 ±10%**	-	**!**
U-235	925	1.09 ± 6%	0.98 ± 7%	0.96 ± 6%	1.00 ± 5%	1.01 ± 5%	Standard
U-236	926	1.27 ±12%	-	-	0.81 ±29%	-	
U-238	928	0.87 ±15%	0.90 ±20%	1.11 ±22%	1.41 ±24%	x	
Pu-239	949	1.13 ± 8%	0.94 ± 8%	0.96 ± 7%	1.01 ± 8%	1.03 ± 7%	
Pu-240	**940**	**1.62 ±20%**	**1.65 ±45%**	**1.28 ±53%**	x	-	**Large err., ?**

The ROSSENDORF experiments include sample reactivity measurements at the central position of the fast-thermal coupled system RRR/SEG, well described and documented now in /2/. The measurements are based on the pile-oscillator method developed to a high perfection.



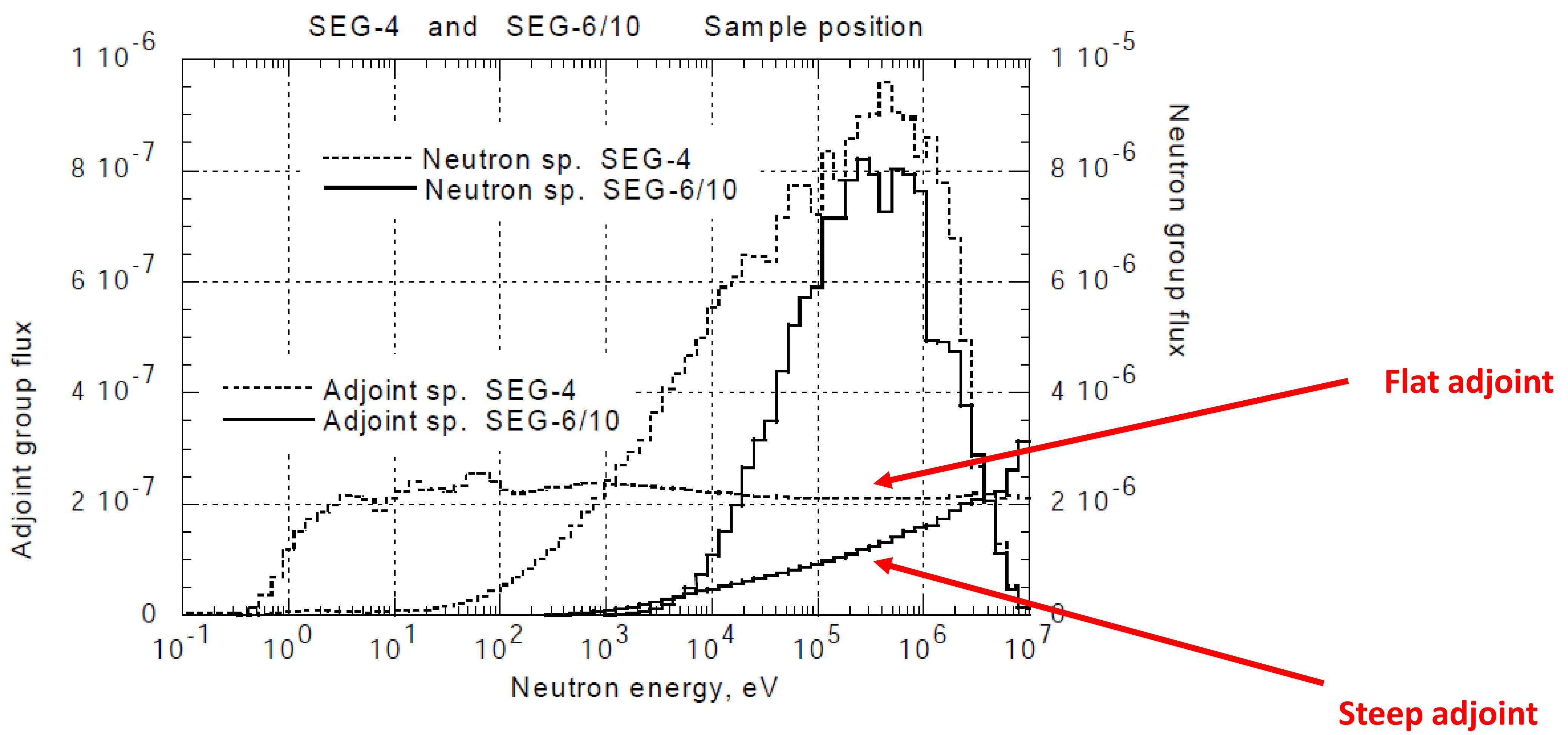


Fig. 4:
Neutron fluxes and adjoint functions at the central position of SEG-4 and SEG-6/10 calculated with the JNC standard route

Table 9:
C/E-values of infinitely dilute sample reactivities in SEG-6/45, normalized to the C/E-value of hydrogen (European scheme: graphite), obtained with the JNC standard route, the European scheme, and a cross-wise use of JEF-2.2 with JNC codes

Sample Material	ID-No.	C/E-values 70g JNC route JENDL/JNC codes	C/E-values 70g Cross-wise JEF/JNC codes	C/E-values 33g European scheme JEF/ECCO/ERANOS	Error (%)
H	1	1.000	1.000	1.071	5
C	6	0.918	0.959	1.000	8
B-10	105	**0.823**	**0.821**	0.896	12
Mo	42	0.935	0.898	0.913	7
Fe	26	**0.925**	0.952	**0.916**	7
U-235	925	0.898	0.907	0.978	7
U-238	928	0.906	0.881	0.923	12
Th	902	**0.858**	**0.832**	**0.865**	9

Both STEK and SEG experiments are very interesting from the physics point of view:

- **Systematically variable neutron spectrum hardness (STEK)**
- **Ad-hoc tailored adjoint flux shapes to reduce/amplify reactivity effects due to scattering (SEG)**

Mostly devoted to FP isotope data

Experiments not easy to analyse:

- **Thermal-fast coupled experiments**
- **Self-shielding effects**
- **Etc**

Experimental uncertainties sometimes significant:

- **Statistical**
- **Normalisation (usually a hard point)**

Results available could incite to revisit to some extent the analysis (any suggestions from the groups involved in previous analysis?): Oxygen (!), U-238