SG39: Advances, results and perspectives. Some open issues

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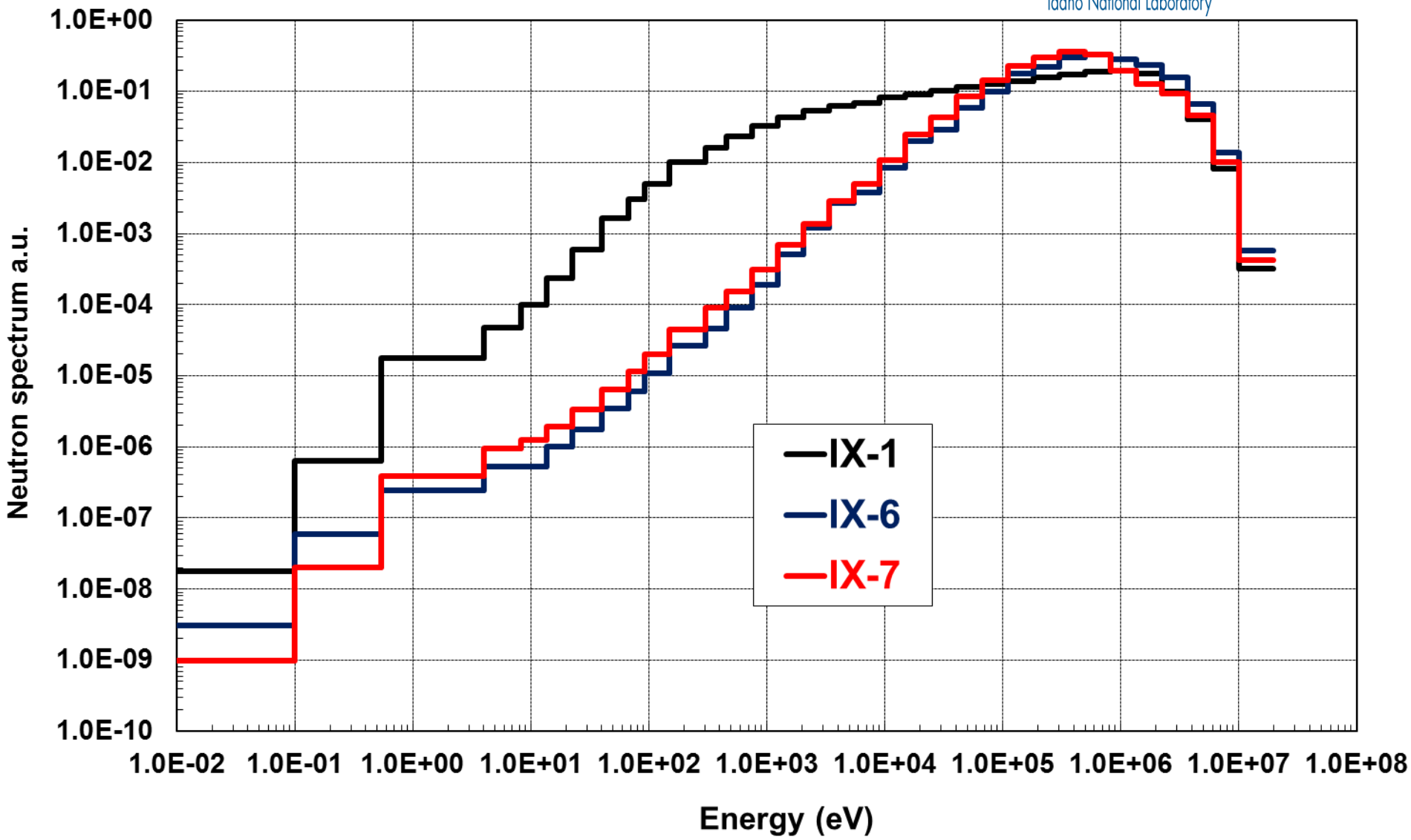
Last year we did point out the need to use *new integral experiments for separate physics effects* as a basic requirement to avoid the compensations often associated to the use of global parameters as keff.

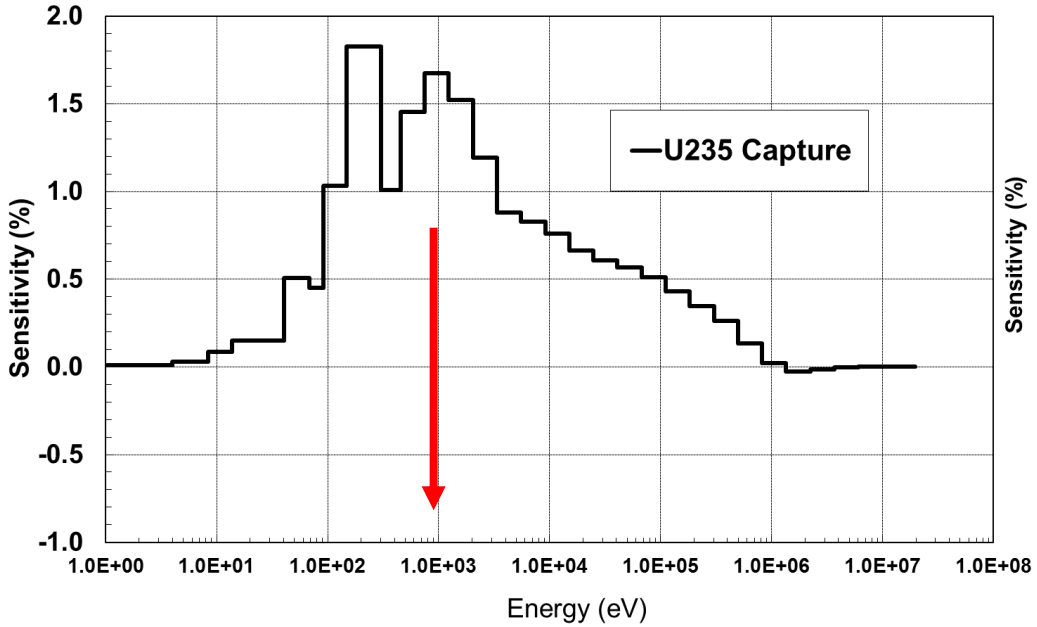
- **Most of the experiments suggested at the time are now available as well as the associated sensitivity coefficients:**

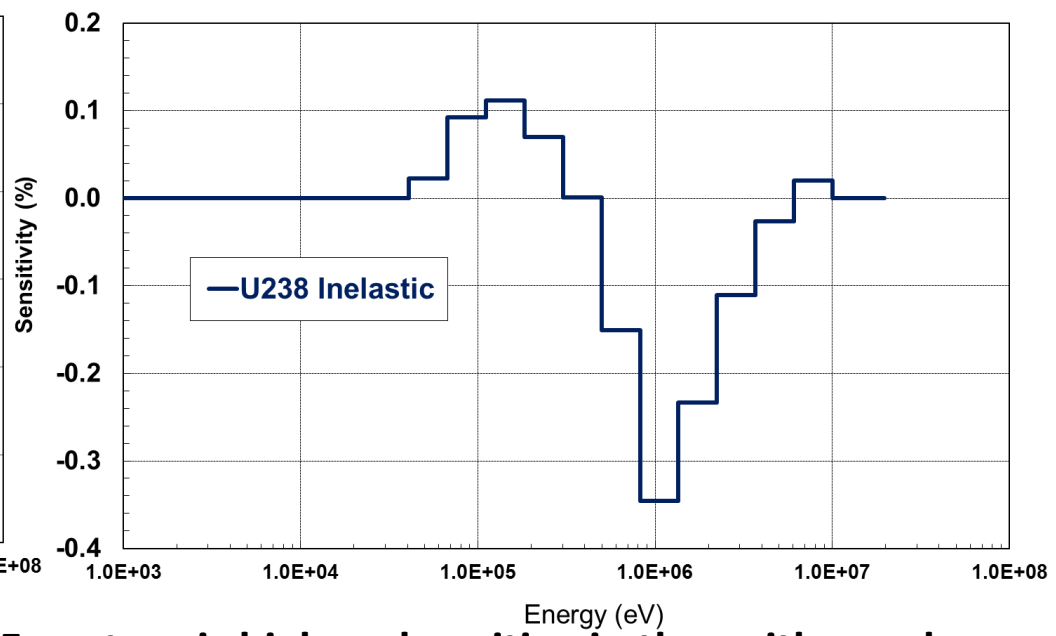
- **PROTEUS (link between epithermal and fast energy range: k- infinity, void coefficient, reaction rate ratios): U-238, Pu isotopes**
- **Beff experiments (new inelastic information, but need delayed nubar uncertainty). U-238, Pu-239, U-235**
- **Variable adjoint experiments (SEG) to separate inelastic from absorption effects.**
- **Selected neutron propagation experiments (inelastic, elastic). Mostly Fe, also Na-23**
- **FCA experiments, related to actinide data (MA and higher Pu isotopes)**

Neutron Spectra in the Reactor Center



IX-1: Sensitivity of Np-237/Pu-239 spectrum index to ^{235}U σ_{cap} and ^{238}U σ_{inel}

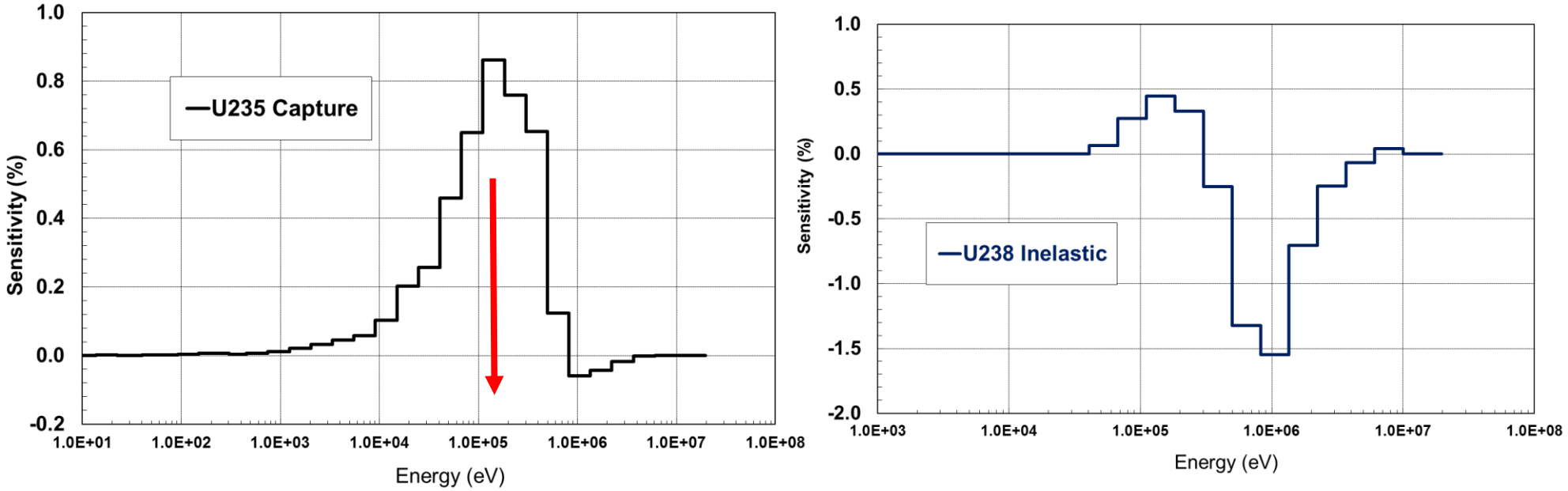




- IX-1 spectrum fairly soft and sensitivity to U-235 capture is high and positive in the epithermal energy region: any increase of U-235 low energy capture will reduce the low energy nueutron contribution to the denominator.

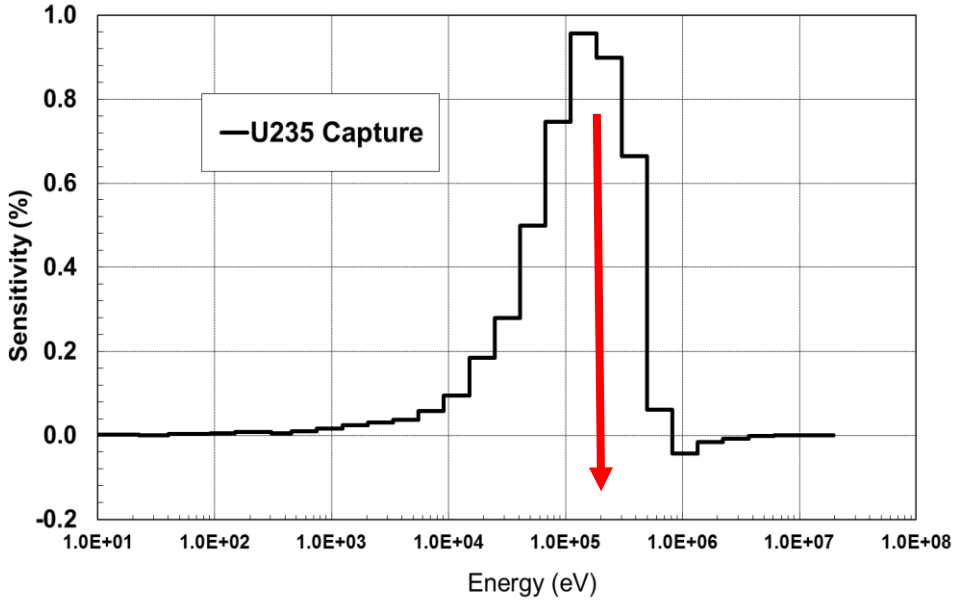
- Inelastic cross sections sensitivity is high (and negative) at energies above the Np-237 fission threshold: the elastic/inelastic x-section increase in this energy region will reduce the high energy neutron contribution to the numerator

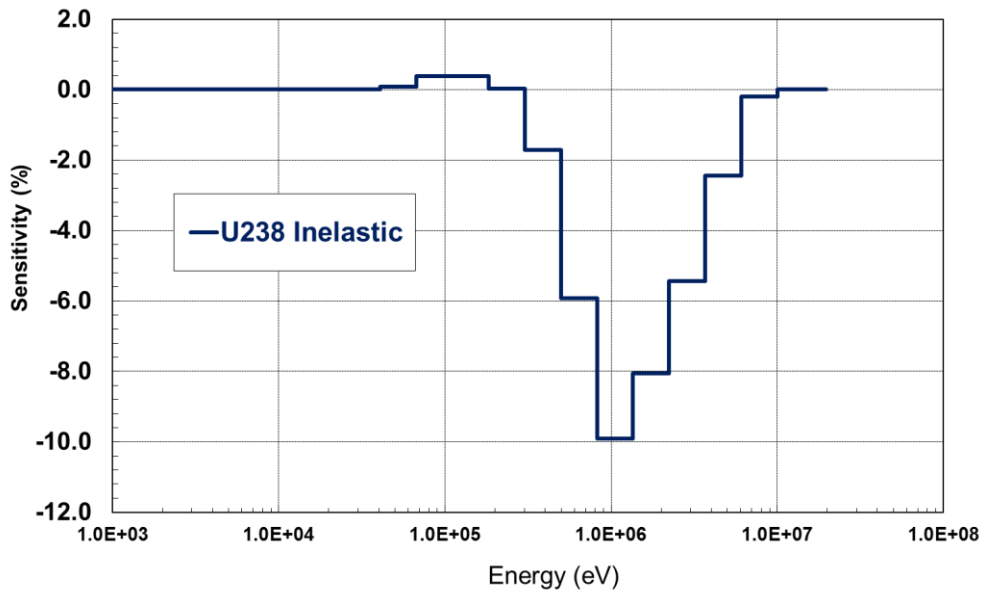
IX-6: Sensitivity of Np-237/Pu-239 spectrum index to ^{235}U σ_{cap} and ^{238}U σ_{inel}



- **IX-6 spectrum is hard. Inelastic cross sections sensitivity is high (and negative) at energies above the Np-237 fission threshold: the elastic/inelastic x-section increase in this energy region will reduce the high energy neutron contribution to the numerator**
- **Sensitivity to U-235 capture is still relatively high and positive in the high energy region: any increase of U-235 high energy capture will slightly reduce the high energy neutron contribution to the denominator.**

IX-7 (LEU): Sensitivity of Np-237/Pu-239 spectrum index to ^{235}U σ_{cap} and ^{238}U σ_{inel}





- **IX-7 spectrum is the hardest. Inelastic cross sections sensitivity is high (and negative) at energies above the Np-237 fission threshold: the elastic/inelastic x-section increase in this energy region will reduce the high energy neutron contribution to the numerator**
- **Sensitivity to U-235 capture is still relatively high and positive in the high energy region: any increase of U-235 high energy capture will slightly reduce the high energy neutron contribution to the denominator.**

***There have been crucial advances in the methodologies to improve the credibility and applicability of an adjustment*:**

- **The PIA method (G. Palmiotti)**
- **The continuous energy XGPT adjustment (M.Aufiero) but also V. Sobes at ORNL**

- **New adjustments will be the major source of reliable indications as feedback to new evaluations e.g. in CIELO**
- **Some results will be already presented today (L.Plavnik, G. Palmiotti)**
- **Most new results will be available by October/December 2016**

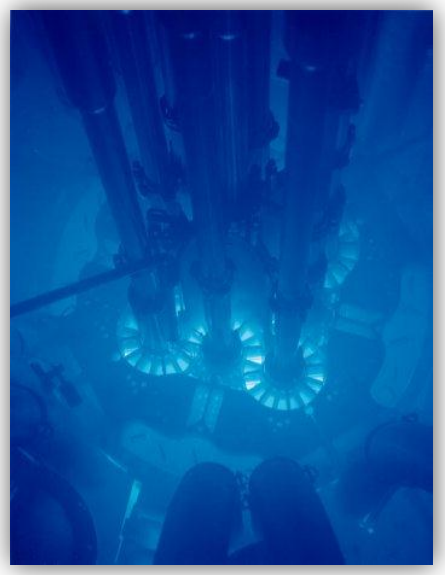
- **Issues:**
  - **Covariance issues: completeness, cross correlations, some low values. Revival of user oriented efforts in this field seem necessary**
  - **Benchmark exercises oriented to industrial applications (TerraPower, ASTRID) and in general to fuel cycle issues (see EGIEMAN-II benchmarks and the coming MONJU benchmark), still show spread of results sometimes larger than what expected from current announced evaluation performances**

- **Work of SG39 could also benefit new advanced reactor projects (e.g. China)**

Neutronic parameters				
	ENDF/B7	JEFF 3.1	JEFF 3.2	JENDL 4.0
Reactivity (pcm) →	1549	2967	-1645	2138
Beff (pcm)	290,4	287,3	292,1	289,3
Beff per group (pcm)				
Group 1	4,58	4,53	4,55	4,59
Group 2	48,55	48,16	48,61	48,50
Group 3	17,79	17,59	17,74	17,78
Group 4	43,84	43,38	44,02	43,68
Group 5	91,59	90,63	92,00	91,29
Group 6	35,05	34,60	35,57	34,76
Group 7	33,34	32,94	33,61	33,16
Group 8	15,65	15,44	15,94	15,49
Mean neutron generation time (s)	4,24E-07	4,22E-07	3,97E-07	4,29E-07
Kd core (pcm)	-272,4	-278,9	-236,1	-261,70
Kd fuel (pcm)	-260,3	-266,6	-225,7	-249,8
Kd blanket (pcm)	-12,1	-12,3	-10,4	-12,2
Inner core sodium void worth ($)	3,67	3,61	3,82	3,94
Outer core sodium void worth ($)	1,47	1,38	1,39	1,60
Core sodium void worth ($)	5,02	4,88	5,1	5,40
Extended sodium void worth (w/ plenum) ($) →	0,592	0,239	0,314	0,892

Gérald Rimpault, Timothée Kooyman, BENCHMARK ON LOW VOID SFR BURNER CORE: CEA CADARACHE RESULTS, EGIEMAM-II Meeting, NEA, Paris, 2016, April 6-7.

***Validation and experimental activities are key issues*:**



Some new integral experiments have been performed, other are planned and, in some cases, the NEA could play an important role.

All of them are consistent of the new paradigms of simplicity and focused on separated effects. Some examples:

- **The CALIBAN experiments (CEA) (U-238 inelastic cross section)**
- **The MANTRA irradiations (INL) in variable spectra (capture of actinides in different spectra)**
- **A new MANTRA-2 campaign (extended number of isotopes)**
- **The new planned experiments at NRAD (INL): high accuracy reaction rates and reactivity measurements of actinides and fission products, in different well tailored spectra**
- **The TAPIRO (ENEA-Casaccia) experiments: high accuracy reaction rate measurements**

This last three experiments are under consideration to be part of an international program coordinated by NEA