LANL Evaluations for ENDF/B-VII

M.B.Chadwick, P.G. Young, R.E. MacFarlane, T. Kawano, P. Talou

T-16, Nuclear Physics Group
Los Alamos National Laboratory

U-235 Evaluation. Changes for beta-1 cf. beta-0

Our u235la31b is very similar to our Beta 0 version except for the following:

1. We included the changes suggested by Lubitz in prompt nubar at low energies (< 1000 eV).

2. We inserted 5 energies from the standards analysis into the MT=18 energy grid. These had been inadvertently skipped in Beta 0.

3. We replaced the MT=18 x/s in the unresolved resonance region with Leal's 10/1/2003 values, renormalized to give an average cross section in the URR exactly the same as the standards x/s evaluation. The normalization factor is 0.980395. Of course, we resummed everything to get an appropriate MT=2 x/s. The resonance parameters in the evaluation are also from Leal's 101/2003 evaluation.

4. We made some minor changes in file 1.

Note that the thermal standards data are not explicitly included but the differences are not large.

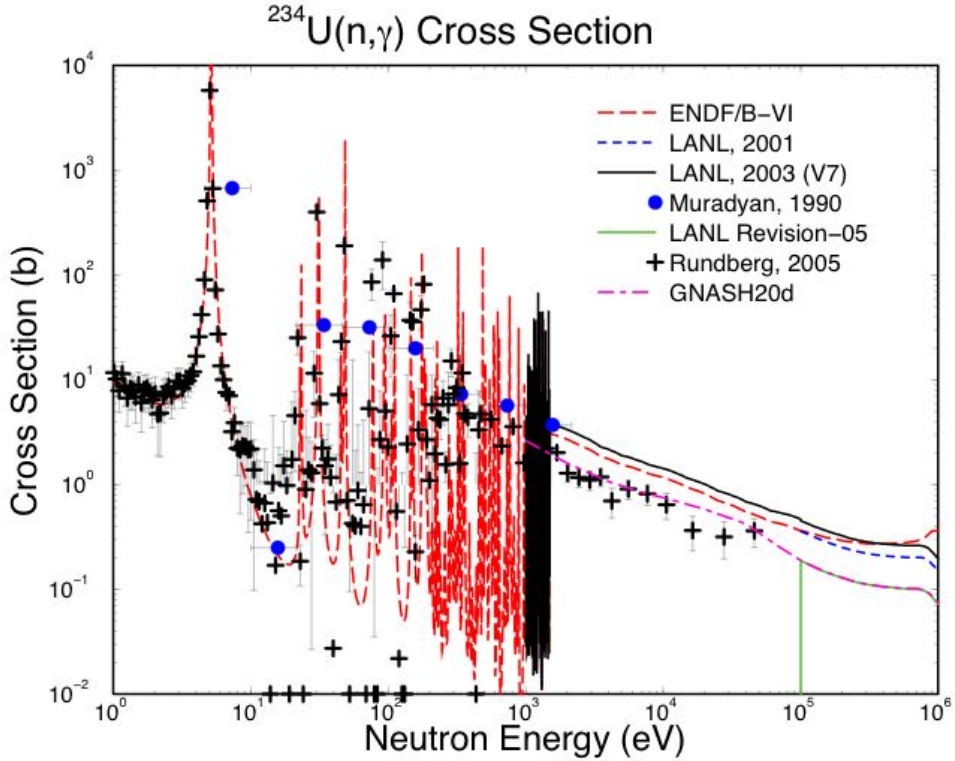
U-234 Evaluation. New Capture Evaluation from DANCE significantly lower

- New data lower than previous experiment from Russia

- Negative consideration - the gamma-ray strength function we used for GNASH was significantly below systematics

- Positive consideration - DANCE also measured 236 capture, and these data consistent with previous measurements

Note: ~1% 234U in Godiva HEU, and leads to ~ 0.1% increase in calculated k-eff.

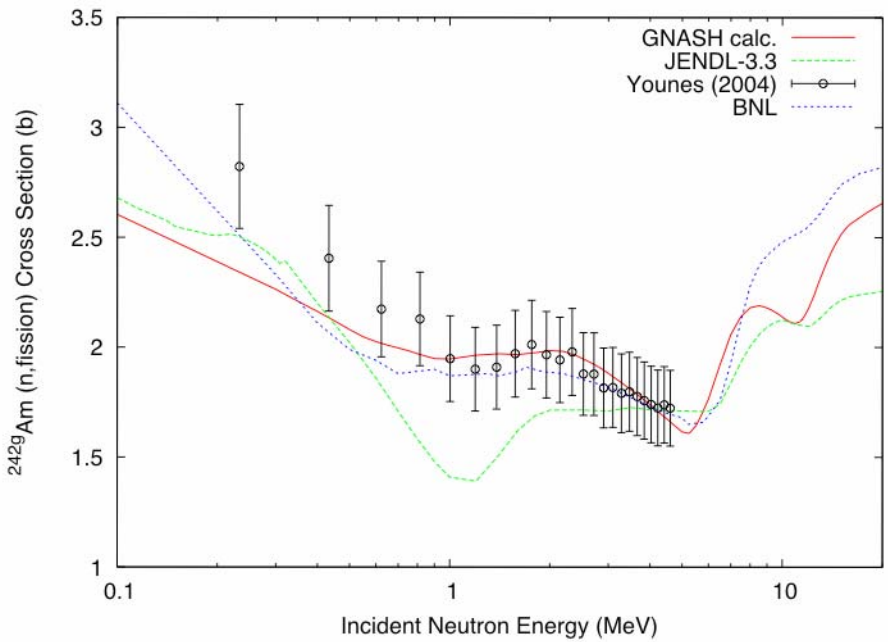


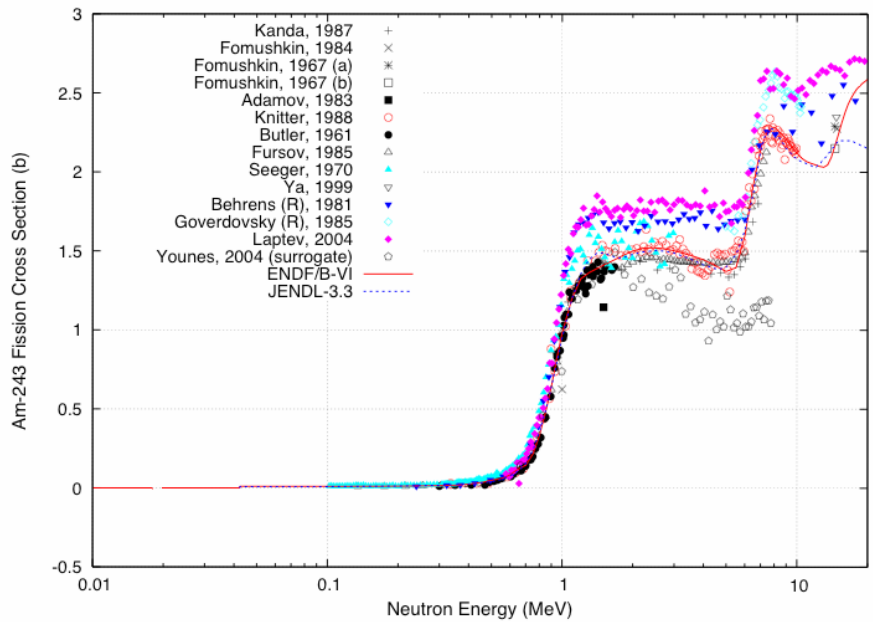
U-234 Evaluation. Phil's comments.

However, I want to call your attention to the fact that it was difficult to do the matching with the URR in u234la5d, and they are still not very good. I changed gamma-gamma from 0.0375 eV to 0.0150 eV, whereas the average gamma-gamma in the resolved resonance region is 0.040 eV. Also, I scaled down the gamma-f widths by a factor of 0.70. These changes improved the match at the top of the URR, but they are still not real good. However, I was reluctant to reduce gamma-gamma any more. Also, the changes made the matching between the RRR and the URR somewhat worse. Of course, the latter does not mean too much because of the fluctuations in the RRR. On the positive side, the fission and capture resonance integrals were not changed too much.

Americium Evaluations Update. 241,242g,m,243

^{242g}Am (n,f) cross section obtained with fission barrier parameters from ^{242m}Am Bayesian statistical analysis.





^{243}Am (n,f) cross section between 1-6 MeV. Our analysis favors the lower cross-section values, due to integral data (ZEBRA reactor) and strong correlation between Laptev (2004) and Behrens (1981) data.

Photonuclear evaluations: 235,238U, 239,240Pu, 237Np, and 241Am

LANL (and CEA) have produced full ENDF evaluations for actinides, to add to the IAEA CRP suite:

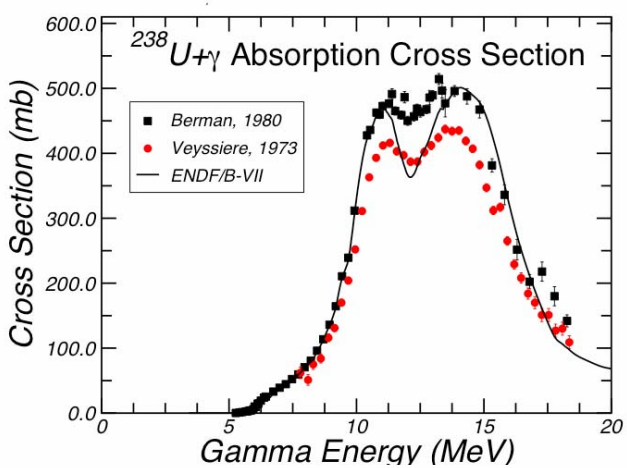
- GNASH calculations, especially important for providing (unmeasured) info on spectra and angular distributions
- We decided to adopt the same channel cross sections as evaluated by Obninsk, except for Pu
- Prompt fission spectra provided, generally obtained from neutron-induced evaluations; nubar from various sources, including direct measurements from LLNL
-Delayed neutrons added - obtained from various sources, including direct measurements from LANL and SLAC

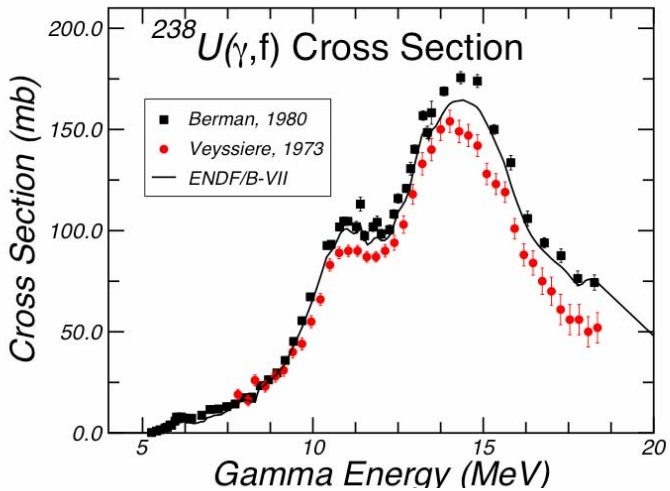
NOTES ON PHOTONUCLEAR EVALUATIONS
9/1/2005

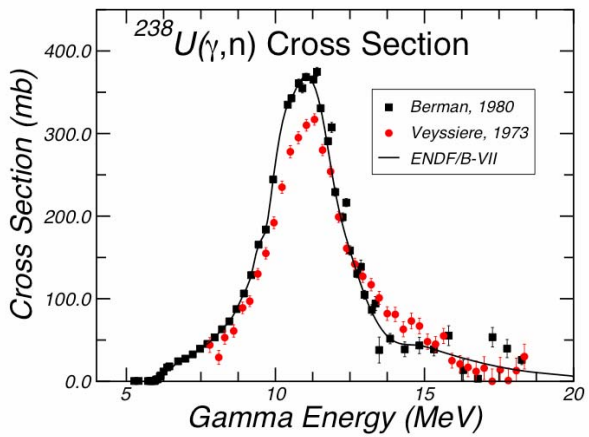
Target	Cross Sections	Prompt Nubar	Delayed Nubar	Prompt χ Spectra[+]
^{235}U	Taken from Bloh kin evaluation (based on experimental data of Caldwell, 1980, and evaluation of Varlamov, 1987).	Taken from Bloh kin evaluation (based on experimental data of Caldwell, 1980).	n+^{234}U ENDF/B-VI evaluation, shifted by Sn & renormalized to exp. data of Caldwell and Dowdy, 1975.	Taken from Bloh kin evaluation (Maxwellian distributions).
^{238}U	Taken from Bloh kin evaluation (based on experimental data of Caldwell, 1980, and Veyssiere, 1973).	Taken from Bloh kin evaluation (based on experimental data of Caldwell, 1980).	n+^{237}U ENDF/B-VI evaluation, shifted by Sn & renormalized to exp. data of Caldwell and Dowdy, 1975.	Taken from Bloh kin evaluation (Maxwellian distributions).
^{239}Pu	(γ,n) GNASH (γ,2n) GNASH (γ,f) exp. data of Berman, 1986, & Moreas, 1993 + GNASH above 10 MeV	Based on Berman, 1986, experimental data.	n+^{238}Pu ENDF/B-VI evaluation, shifted by Sn & renormalized to exp. data of Caldwell and Dowdy, 1975.	n+^{238}Pu ENDF/B-VI evaluation, shifted by Sn (Maxwellian distributions).
^{240}Pu	(γ,n) GNASH (γ,2n) GNASH (γ,f) GNASH + Soldatov, 2000	n+^{239}Pu ENDF/B-VII evaluation, shifted by Sn.	n+^{239}Pu ENDF/B-VII evaluation, shifted by Sn.	n+^{239}Pu ENDF/B-VII evaluation, shifted by Sn (tabulated distributions).
^{237}Np	(γ,n) GNASH (γ,2n) GNASH (γ,f) GNASH + exp. data of Berman, 1986, and Veyssiere, 1973.	Based on Berman, 1986 experimental data.	n+^{236}Np ENDF/B-VI evaluation, shifted by Sn & renormalized to exp. data of Caldwell and Dowdy, 1975.	n+^{236}Np ENDF/B-VI evaluation, shifted by Sn (Maxwellian distributions).
^{241}Am	(γ,n) GNASH (γ,2n) GNASH (γ,f) GNASH + exp. data of Soldatov.	n+^{241}Am ENDF/B-VI evaluation, shifted by Sn.	n+^{241}Am ENDF/B-VI evaluation, shifted by Sn.	n+^{241}Am ENDF/B-VI evaluation, shifted by Sn (Madland-Nix Law 12 distributions).

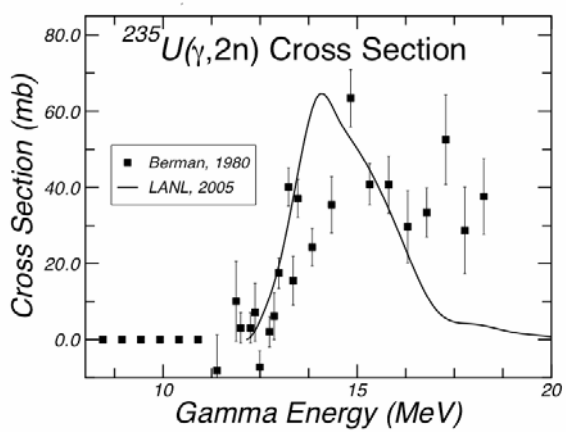
[+] In all cases the energy-angle correlated spectra of neutrons from (γ,n), (γ,2n), (γ,3n) reactions come from the GNASH calculations.

Photonuclear Evaluations. New LANL Actinides









Gerry Hale info for light reactions (1) neutron reactions

Among the neutron-induced evaluations were those for 1H, 3H, 6Li, 9Be, and 10B. For the light-element standards, R-matrix results for 1H, 6Li(n,alpha) and 10B(n,\alpha) were contributed to the standards process

The 3H evaluation resulted from a charge-symmetric reflection of the parameters from a $p+^3$He analysis that was done some time ago. This prediction resulted in good agreement with $n+t$ scattering lengths and total cross sections that were newly measured at the time, and which gave a substantially higher total cross section at low energies than did the ENDF/B-VI evaluation

The n+9Be evaluation was based on a preliminary analysis of the 10Be system that did a single-channel fit only to the total cross section data at energies up to about 14 MeV. A more complete analysis is underway that takes into account the multichannel partitioning of the total cross section, especially into the (n,2n) channels.

Gerry Hale info for light reactions (2) Charged-particle reactions

Among the neutron-induced evaluations were those for p+ 7Li, d+6Li,d+7Li, t+6Li, 3He+6Li, and p+10B. These resulted from R-matrix analyses of reactions in the A=8,9, and 11 systems, and include also spectra for some of the reactions coming from breakup into three-body final states, calculated with the 3-body resonance-model code SPECT. Having been developed primarily for thermonuclear and astrophysical applications, these evaluations do not always cover the energy range up to 20 MeV. However, they are complete transport evaluations (including all angular distributions and spectra) over their specified energy ranges.

Gerry Hale info for light reactions (3) n+1H

The hydrogen evaluation came from an analysis of the $N-N$ system that includes data for $p+p$ and $n+p$ scattering, as well as data for the reaction ^{1}H$(n,\gamma)^2$H in the forward (capture) and reverse (photodisintegration) directions. The R-matrix parametrization, which is completely relativistic, uses charge independent constraints to relate the data in the $p+p$ system to those in the $n+p$ system. It also uses a new treatment of photon channels in R-matrix theory that is more consistent with identifying the vector potential with a photon ``wavefunction''. In the last stages of the analysis, the thermal capture cross section was forced to a value of 332.0 mb, rather than the ``best" experimental value of 332.6 mb [1], since preliminary data testing of aqueous thermal systems showed a slight preference for the lower value. Also, the latest measurement [2] of the coherent $n-p$ scattering length was used, resulting in close agreement with that value, and with an earlier measurement of the thermal scattering cross section [3], but not with a later, more precise value [4]. This analysis also improved a problem with the $n+p$ angular distribution in ENDF/B VI near 14 MeV, by including new measurements [5,6] and making corrections to some of the earlier data that had strongly influenced the previous evaluation.

Updates in Blue, to my viewgraphs 6 months ago

Actinide Standards data: “-thmod files”.

Phil Young made some test versions of the actinides, that use some of the Standards thermal constants:
235,238U and 239Pu.

Adopted the thermal nubar values.
(235: nubar standard is 0.05% lower; 238 is 0.3% lower, 239Pu is 0.2% higher, compared to the B-VI values).

We haven’t modified ORNL fission cross sec, capture etc, since this requires ORNL resonance work. (But 233,235 fiss x/s almost identical. 239Pu resonance treatment older and doesn’t hit thermal (off by 0.3%)).

Capture: Standard 235 & 233 is 0.7% higher, and 239 is 0.3% lower).

Scattering: Standard 235 is 7% lower than prelim B-VII.

We decided not to adopt the Standard thermal values into our beta-1 files. They are pretty close anyway, & within uncertainties.

Actinide Standards data: H

New S-alpha-beta treatment for H, same physics, better method. Needs patch of MCNP, patch of NJOY. 293.6K in MCNP, but inconsistent 296K in ENDF. New files has both conistent at 293.6K, with more alpha-beta values for better calc of total cross section above 2 eV.
HS22-3: goes UP by 0.05%. HST9-2 up by 0.06%. LCT-6 is no 0.99965(26).
MACFARLANE ADOPTED NEW MATTES S-alpha-beta

New Results for Thermal n-p Capture and Scattering… New new result from Hale! This differs from the B-VII beta 0 data tested.

- Capture cross section forced to 332.0 mb at thermal. Gave no significant overall increase in chi-square from the high-precision measured value of 332.6 mb.
- New high-precision (NIST) measurement of n-p coherent scattering length included. Fitted cross sections now agree with this thermal measurement, and are perfectly consistent with earlier measurements of the polarized cross section and "zero-energy" scattering cross section (Houk, 1971, but *not* Dilg, 1975).
- n-p scattering cross sections are ≤ 0.3% lower than the pre-ENDF/B VII values.

- Question to Hale, Carlson, Lubitz et al…:

  - Should we use this new new result in standards result and in B-VII? **YES- in Beta-1**

  - Should we use 332.0 instead of 332.6 mb at thermal? Hale, surprisingly, didn't push for 332.0! **Yes, we use 332.0**

Beryllium: total cross section for reflection

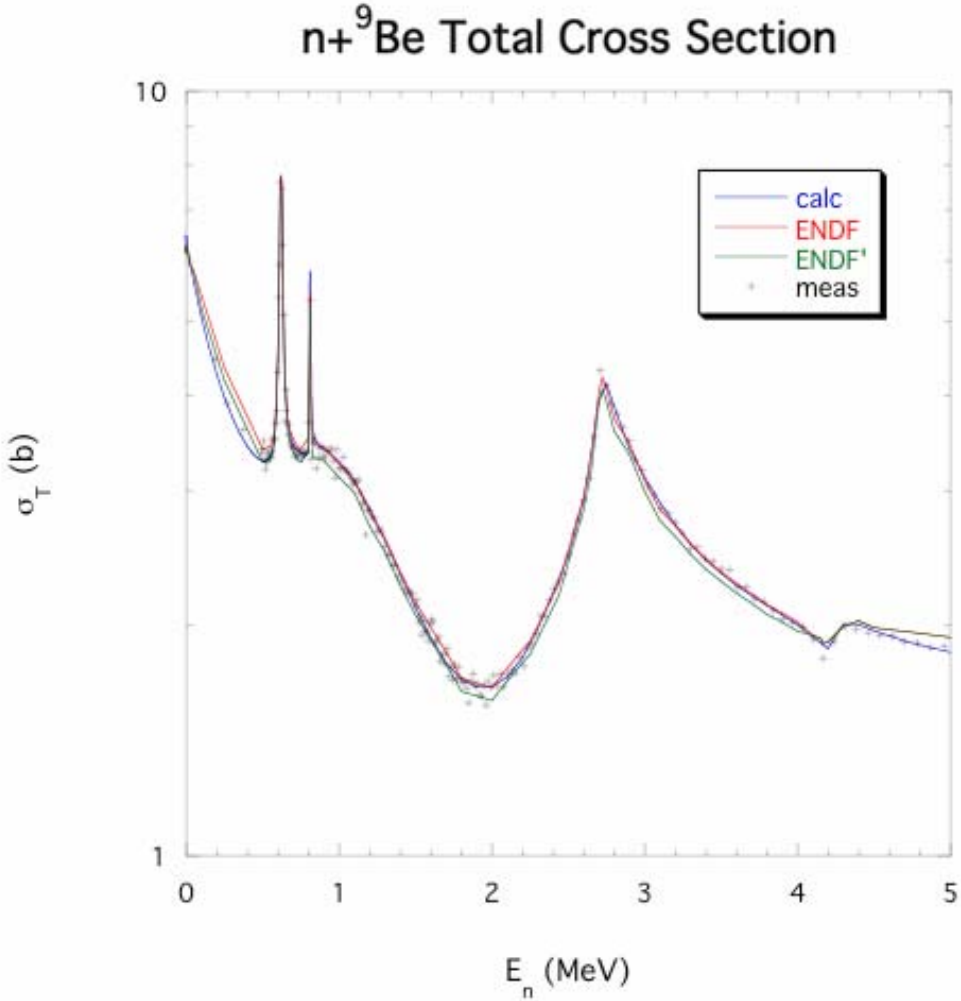
Trial 9Be file. MacFarlane has noted a Be-reflector bias for fast Be-reflected criticals using LLNL evaluation.

2004 work: MacFarlane made a patch with 4% lower elastic (and total) above 100 keV. Bob's new results show less bias on Be reflector thickness, for fast systems.

2005: Gerry Hale has a latest R-matrix calculation, that we have tried to use just for the total cross section. Good performance, not quite as good as Bob's trial. Should we use Gerry's result? We're also studying angular distributions, to see how Gerry's new angular distributions impact the results.

At last CSEWG meeting at ORNL, we agreed to adopt this Hale-modified 9Be evaluation … but LANL may have fergotten to submit!

Beryllium: total cross section for reflection



LANL-related Issues to discuss at last meeting

- 1H file. Beta-0, with 332.0 & 332.6; New 1H Hale evaluation? Yes
- Thermal standards. Trial 235,238U and 239Pu with thermal standards values for nu-bar. We would need ORNL work to explore versions that use standard fission, capture, etc. Should we bother?
- New 9Be and 208Pb evaluations. 9Be testing presented.
- 233U… explore use of standards nubar (lower by 0.3%). See Little talk
- 232Th. Explore use of JEFF/Maslov. See Little's talk on Mosteller data testing result for 232Th. What about the new IAEA/Herman/Leal file?
- S-alpha-beta. Bob can explain…. Should we adopt his new work? Patches needed for NJOY and MCNP. Should we use Mattes' work. Impacts LST benchmark results….
- What about the temp-dependence results that are causing confusion?
- New photonuclear actinide evaluations based on GNASH will be available for B-VII beta-1 testing, to replace Obninsk files
- Covariance data. 233U; Gd isotopes (make consistent), Rh. (Not 235,8,239…)