Nuclear Data Measurements in Russia

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Measurements at IPPE (Obninsk)

i) In last years essential improvements were achieved in measurements of the (n,α) and (n,p) reactions on light nuclei by means of the ionization chambers, the working gas of which serves simultaneously the target material. The methods of a digital spectrometry are widely used in such measurements for identification of reaction product parameters inside a gas-volume, and the corresponding high-precision equipment was developed successfully in a collaboration of IPPE and IMMR (Geel). The cross sections of the ^{16}O(n, α) reactions were essentially improved at the energy region between 4 and 9 MeV on basis of the measurements performed by the Georginis group [ND-2007] and the obtained data were used for adjustments of the ENDF/B-VII evaluations at energies above 4 MeV. Such a ionization chamber was also manufactured in IPPE and the results of the independent recent measurements performed by the Khryachkov group are compared in Fig. 1 with the previous data and evaluations. The data of the Geel group are still under a publication and not presented in the plot, but they are very closed to the IPPE results. So, both the Geel and IPPE data well agree with the ENDF/B-VII evaluation adjusted to experimental data at the energy region from 4 to 6.3 MeV, but an essential contradiction between this evaluation and the experimental data arise at the energies above 6.3 MeV. To remove this contradiction the new improved BROND-3 evaluation was prepared during this year, the results of which are shown in Fig. 1 too. The new evaluation is tested now against the available fast-reactor benchmarks.

On bases of the same approach the cross sections of the (n, α_0), (n, α_1) and (n, α_2) reactions for ^{14}N were measured and the obtained total (n, α) cross section is compared with the previous data and the ENDF/B-VII evaluation in Fig. 2. Deviations of the new data from the previous ones are not so large as the ^{16}O target, and any conclusions concerning the evaluation updating may be justified

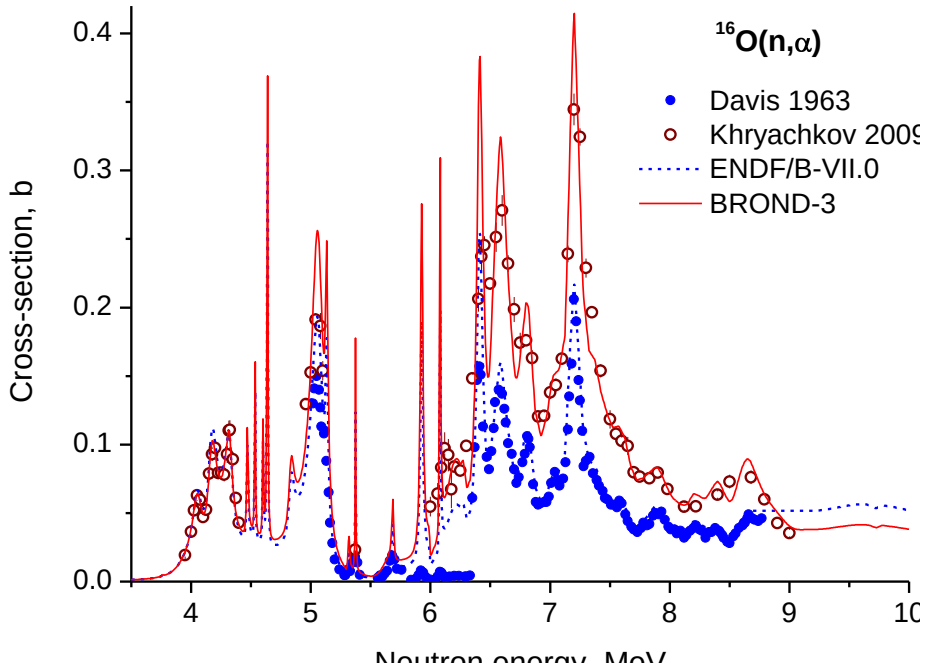

Fig. 1. New experimental data on the ^{16}O(n,α) cross section compared with the recent evaluations

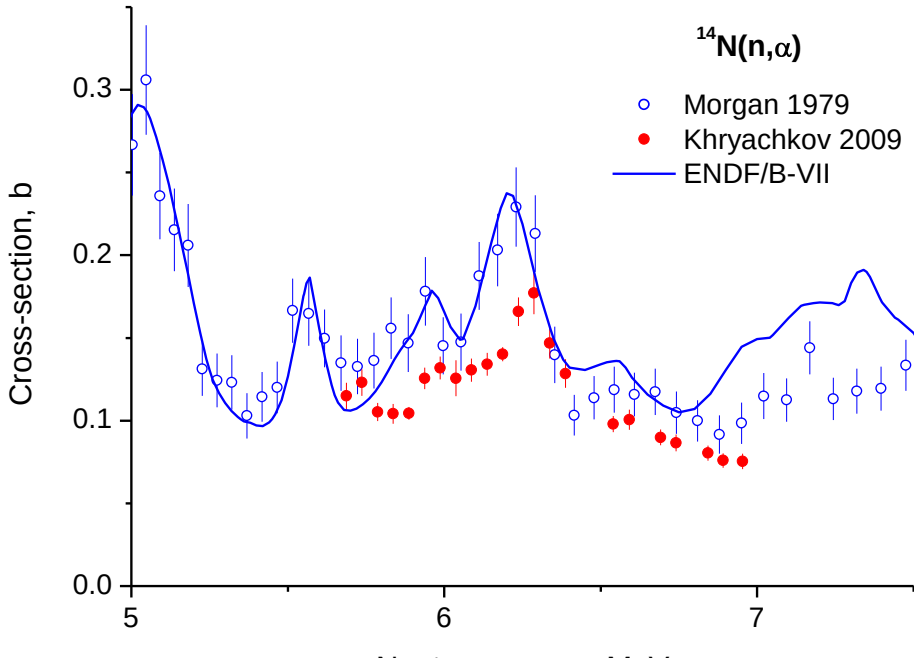

Fig. 2. New experimental data on the ^{14}N(n,α) cross section compared with the previous data and the ENDF/B-VII evaluation

after additional measurements at the extended energy interval. For ^{14}N the cross sections of the (n,t) and (n,p) reactions were measured together with the (n,α) channel. These data are under processing now.

ii) Systematic measurements of the fission cross-sections for highly radioactive minor actinides (MA) were started several years ago on the lead slowing-down spectrometer (INR, Troitsk) by a collaboration of the IPPE and INR experimental groups. The spectrometer consist of the high purity lead (99.9999%) with the total mass of 10^5 kg assembled from blocks with the mass about 1 t, the surface of which was specially cleaned to decrease an amount of oxides. Such a cleaning allows to achieve the energy resolution close to the theoretical limit ~ 27-28%. As the neutron source the spallation reaction on a lead sample irradiated by 208 MeV proton beam of the INR linear accelerator is used. The IPPE group supplies the MA fissile sample, the corresponding detectors and the processing codes. The measurements with the samples of U-238, U-236 and Am-242m were performed in 2006. The measurements were continued for Cm-245 in 2007 and for Cm-243, -244 in 2008. The results of two last years are compared with the previous measurements and the corresponding evaluations in the Figs. 3 – 5.
The available experimental data for minor actinides demonstrate a rather large spread of results that reflects in large uncertainties of evaluated data used for advanced reactor designs. The main purpose of the current measurements should be an essential reduction of data uncertainties of minor actinides, transmutation of which relates nowadays to one of the most topical task.

iii) In addition to the previous results for main fissile nuclei and some important minor actinides the total and relative group yields of delayed neutrons, as well as the corresponding group half-life times, were measured in the last year for ^{236}U in the energy range from 1 and 5 MeV. The total delayed neutron yields are compared with the previous experimental data and evaluations in Fig. 6. The new data agree quite well with ENDF/B-VII and JFFF-3.1 evaluations at the energies below 5 MeV, but the studied energy interval is still limited for conclusions about the delayed neutron yields at higher energies.

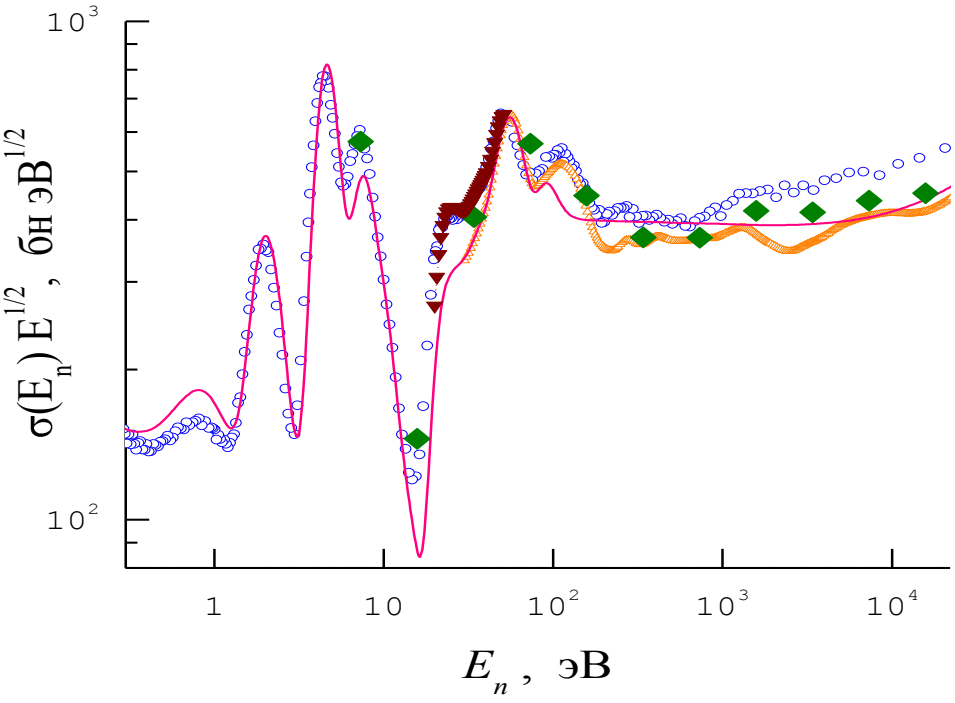

Fig. 3. Results of the LSDS measurements of the neutron-induced fission cross-section for Cm-245 (open circles) compared with the previous experimental data (Λ– LSDS-44 [Gerasimov]; B – [White]; 9 – [Moore]) and the ENDF/B-VII evaluation (a solid curve) averaged over the energy resolution of LSDS.

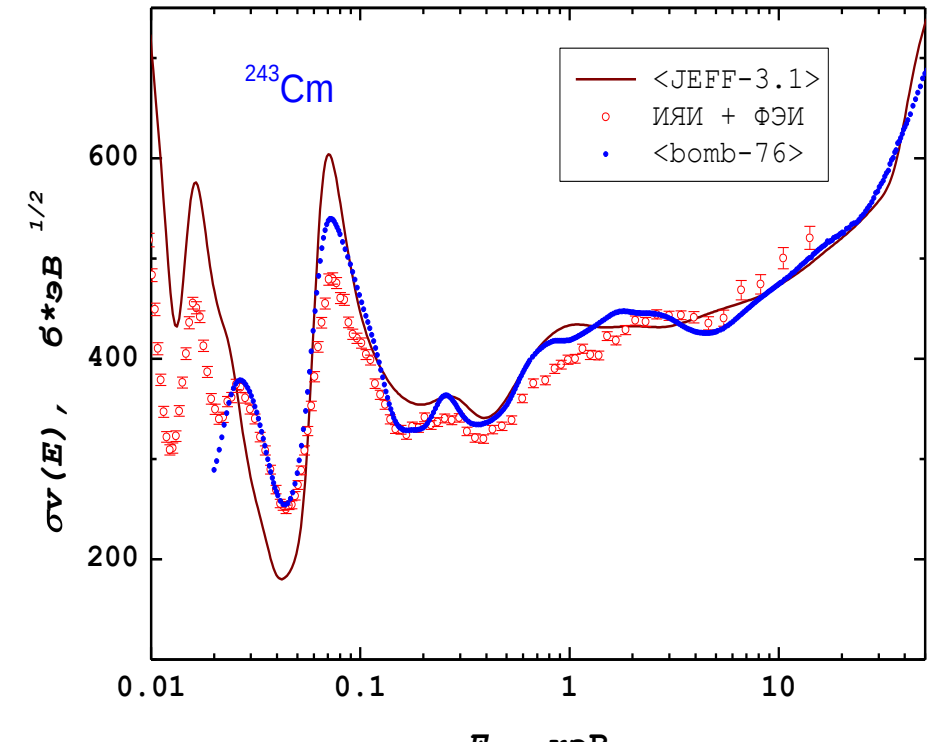

Fig. 4. The same as in Fig. 3 for Cm-243

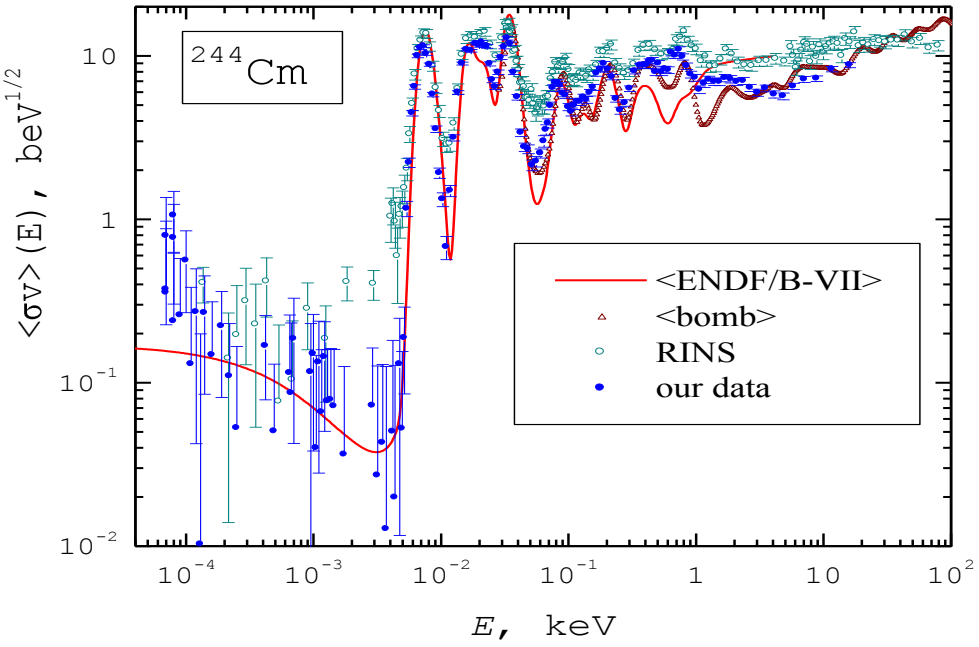

Fig. 5. The same as in Fig. 3 for Cm-244

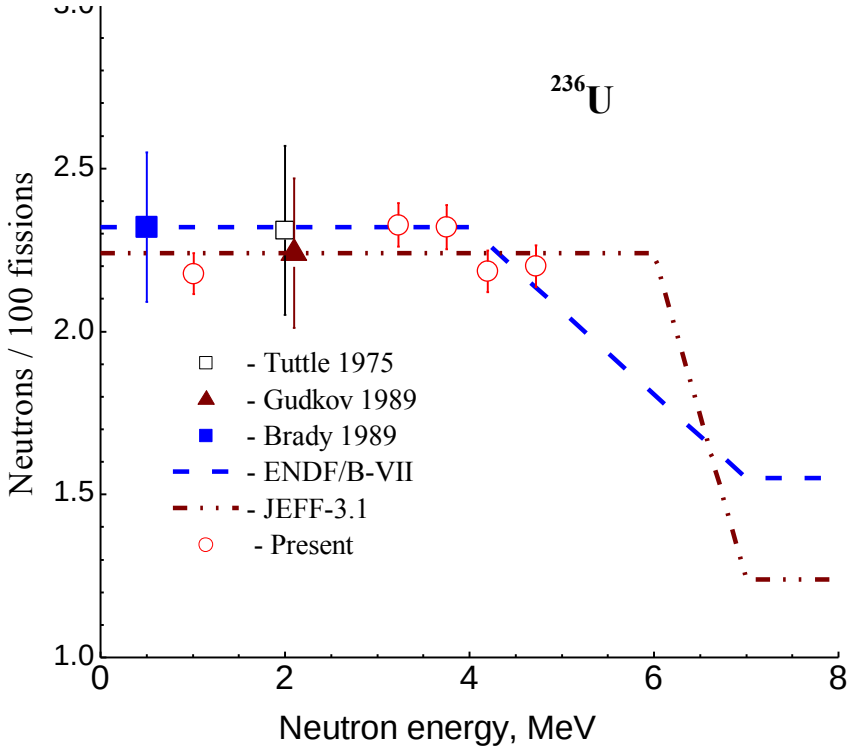

Fig. 6. New measurements of the delayed neutron yields for U-236 compared with the previous data and evaluations.

Measurements at the ITEP (Moscow)

The yields of spallation and multi-fragmentation reaction products from the highly enriched ^{56}Fe target irradiated by protons were measured in 2006 on the ITEP U-10 accelerator for the proton energies from 300 MeV to 2.6 GeV. Such data are important for the analysis of radiation damages and residual activities of structural materials used in the ADS target. Residual nuclei were identified by the gamma-

spectroscopy method and the cumulative and independent yields of all residuals with the half-life time from 6.5 min to 312 days were estimated. The measure yields were compared with the similar data obtained at the GSI (Darmstadt) by the inverse kinematics method and with different versions of the intranuclear cascade model codes. The data were presented on several international meetings and published finally in 2008 [Phys.Rev., C78, 034611].
During 2007 and 2008 similar measurements were performed for ^{93}Nb, ^{181}Ta and also for natural Cr, Ni and W targets. For all targets the experimental data were obtained for the incident proton energies from 300 MeV to 2.6 GeV. The processing of data is completed now, as well as the theoretical calculations with various versions of the intranuclear cascade model. The work was supported by the Project ISTC-3266, and all results are now under preparation to a publication.