INDC(CCP)-0459
Distr. AD/G/IN/J/PF/RD/ST

IAEA
International Atomic Energy Agency

INDC International Nuclear Data Committee

Relative measurements of $^{233}U+n_{th}$, $^{235}U+n_{th}$ and $^{239}Pu+n_{th}$ prompt fission neutron spectra (PFNS) in the energy range 0.01 - 5 MeV

A.A. Boytsov, A.F. Semenov, B.I. Starostov

V.I. Lenin Scientific Research Institute for Atomic Reactors (NIIAR)

Dimitrovgrad

(English translation of the Proceedings of Neutron Physics Conference, Kiev, 1983, Vol. 2, p. 294; Russian Original distributed as INDC(CCP)-235 VOL II)

Translated by IAEA-NDS

July 2014

IAEA Nuclear Data Section
Vienna International Centre, P.O. Box 100, 1400 Vienna, Austria

Selected INDC documents may be downloaded in electronic form from
http://www-nds.iaea.org/publications
or sent as an e-mail attachment.
Requests for hardcopy or e-mail transmittal should be directed to
NDS.Contact-Point@iaea.org
or to:
Nuclear Data Section
International Atomic Energy Agency
Vienna International Centre
PO Box 100
1400 Vienna
Austria

Printed by the IAEA in Austria

July 2014

INDC(CCP)-0459
Distr. AD/G/IN/J/PF/RD/ST

Relative measurements of $^{233}U+n_{th}$, $^{235}U+n_{th}$ and $^{239}Pu+n_{th}$ prompt fission neutron spectra (PFNS) in the energy range 0.01 - 5 MeV

A.A. Boytsov, A.F. Semenov, B.I. Starostov

V.I. Lenin Scientific Research Institute for Atomic Reactors (NIIAR)

Dimitrovgrad

ABSTRACT

By using the time-of-flight method the spectra of $^{233}U+n_{th}$, $^{235}U+n_{th}$, $^{239}Pu+n_{th}$ fission neutrons have been measured as related to the ^{252}Cf fission neutron spectrum described by the Maxwell distribution with the parameter of T = 1.42 MeV. In relation to this standard the spectra are in a good agreement with the Maxwell distributions having the parameters of T = 1.336 ± 0.035, 1.296 ± 0.035, and 1.382 ± 0.035 MeV respectively.

July 2014

Relative measurements of $^{233}U+n_{th}$, $^{235}U+n_{th}$ and $^{239}Pu+n_{th}$ prompt fission neutron spectra (PFNS) in the energy range 0.01 - 5 MeV

A.A. Boytsov, A.F. Semenov, B.I. Starostov

(V.I. Lenin NIIAR)

Abstract

By using the time-of-flight method the spectra of $^{233}U+n_{th}$, $^{235}U+n_{th}$, $^{239}Pu+n_{th}$ fission neutrons have been measured as related to the ^{252}Cf fission neutron spectrum described by the Maxwell distribution with the parameter of T = 1.42 MeV. In relation to this standard the spectra are in a good agreement with the Maxwell distributions having the parameters of T = 1.336 ± 0.035, 1.296 ± 0.035, and 1.382 ± 0.035 MeV respectively.

In the Ref. [1] PFNS for $^{233}U+n_{th}$, $^{235}U+n_{th}$ and $^{239}Pu+n_{th}$ reactions were presented relative to the PFNS of $^{252}Cf(sf)$ which was measured in the same work. Recently, new high-precision measurements of PFNS of $^{252}Cf(sf)$ were published [2,3]; which differ from the $^{252}Cf(sf)$ PFNS of Ref. [1] for outgoing neutron energies below 0.17 MeV. Our new PFNS data presented at this conference confirm the results of Refs. [2,3]. From all these works it follows that $^{252}Cf(sf)$ PFNS can be described in the outgoing neutron energy region from 0.0003 to 7 MeV by a Maxwellian distribution $n(E) = C\,E^{1/2}\exp(-E/T)$ with parameter T = 1.418 ± 0.024 MeV. Therefore, in this work we undertake a revision of the results presented in the Ref. [1] to consider PFNS for $^{252}Cf(sf)$ described by a Maxwellian distribution with T = 1.42 MeV.

Revised data are resented in Figs. 1-3. We used the LSQ method to fit experimental distributions with Maxwellian functions. For PFNS of $^{233}U+n_{th}$, $^{235}U+n_{th}$ and $^{239}Pu+n_{th}$ we obtained the temperature value T equal to 1.336 ± 0.035; 1.296 ± 0.035 and 1.382 ± 0.035 MeV, respectively. After this, all data were averaged following the method described in Ref. [4].

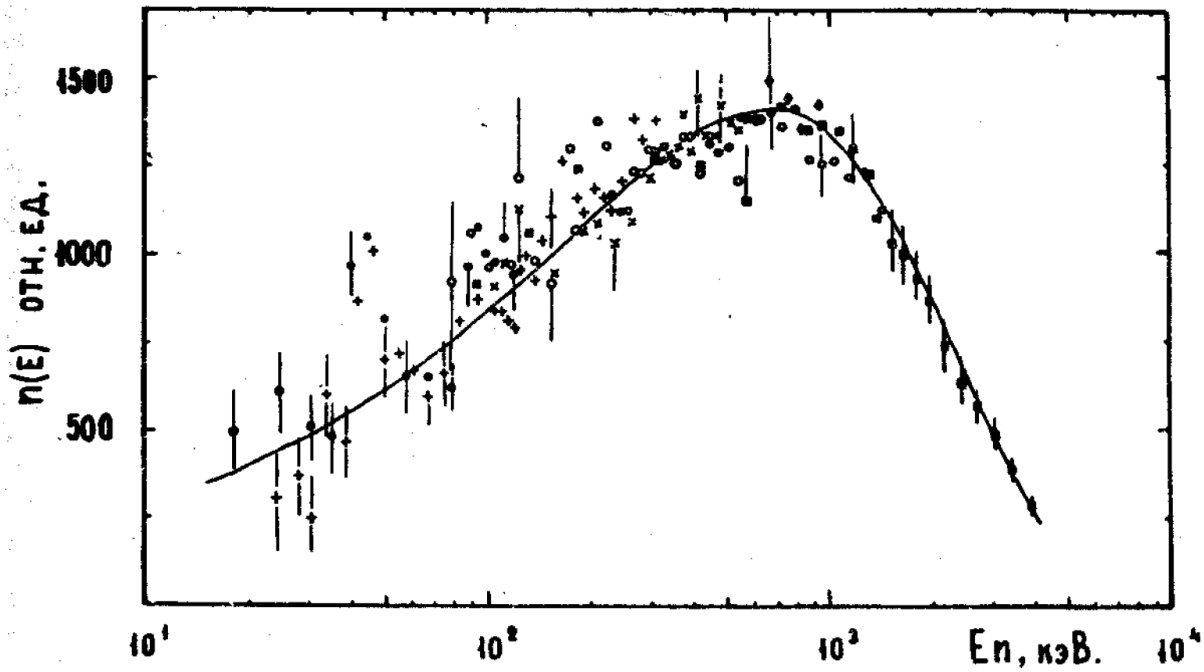

Fig. 1. PFNS for $^{233}U+n_{th}$:
1st cycle: • - L = 0.104 m; ○ – L = 0.214 m; square ▪ – L = 0.295 m;
2nd cycle: + - L = 0.124 m; x – L = 0.214 m; diamond ◊– L = 0.396 m.
Solid line corresponds to the Maxwellian function with T=1.336 MeV

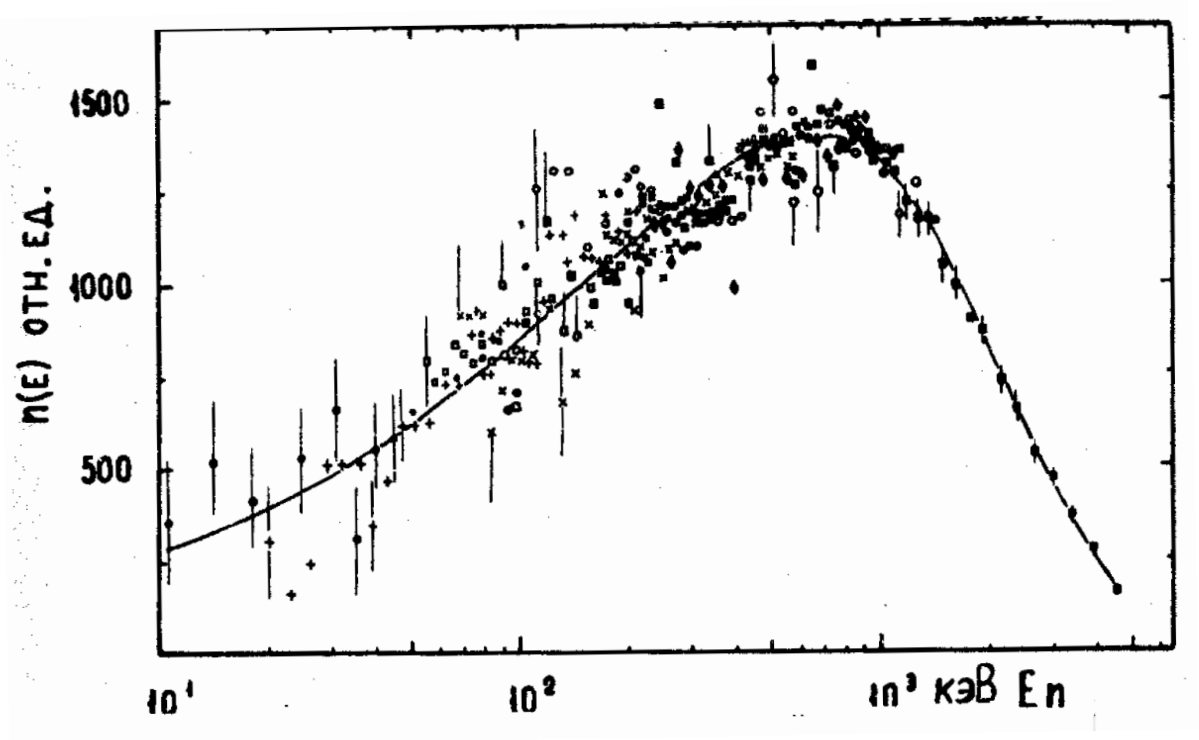

Fig. 2. PFNS for $^{235}U+n_{th}$:
1st cycle: • - L = 0.104 m; ○ – L = 0.214 m; square ▪ – L = 0.295 m;
2nd cycle: + - L = 0.124 m; x – L = 0.214 m; diamond ◊ – L = 0.396 m.
Solid line corresponds to the Maxwellian function with T = 1.296 MeV

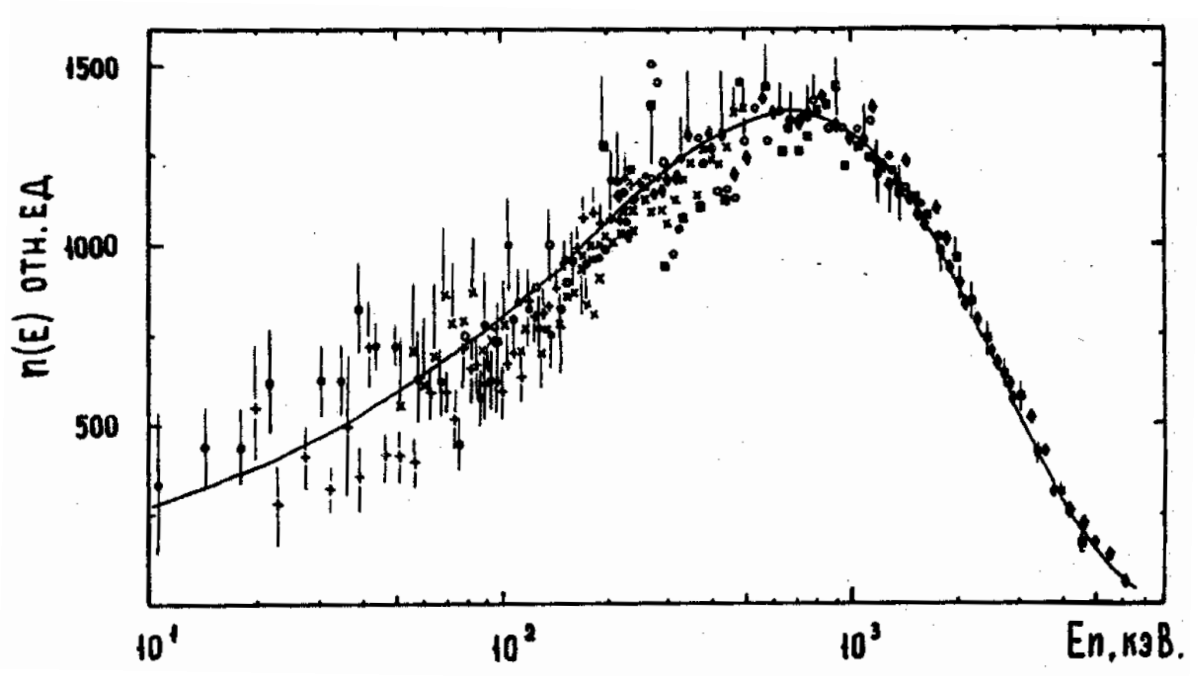

Fig. 3. PFNS for $^{239}Pu+n_{th}$:
1st cycle: • - L = 0.104 m; ○ – L = 0.214 m; square ▪ - L = 0.295 m;
2nd cycle: + - L = 0.124 m; x – L = 0.214 m; diamond ◊ – L = 0.396 m.
Solid line corresponds to the Maxwellian function with T=1.382 Me

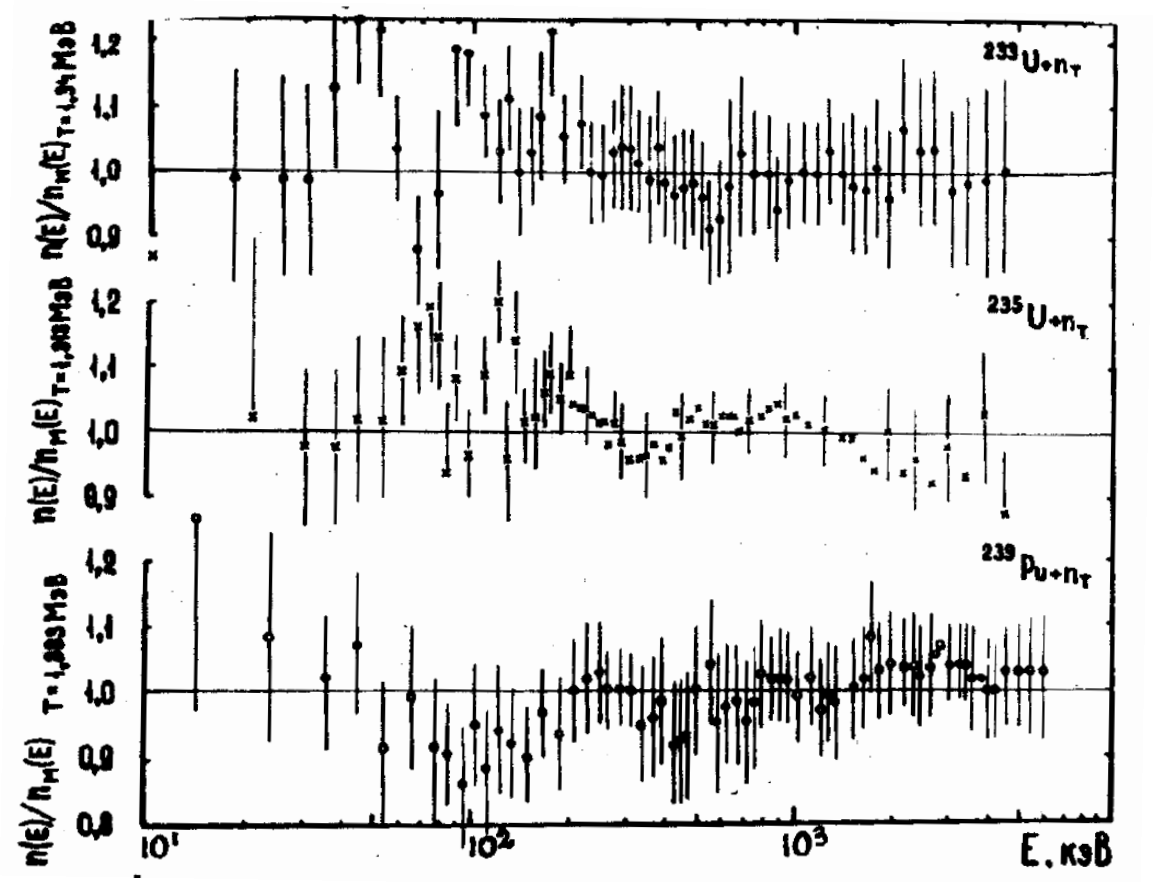

Fig. 4. Ratios of PFNS for $^{233}U+n_{th}$, $^{235}U+n_{th}$, and $^{239}Pu+n_{th}$ to the corresponding Maxwellian distributions with T = 1.34; 1.313 and 1.382 MeV, respectively.

In fig. 4 the ratios of the averaged PFNS relative to the Maxwellian distributions $n_M(E)$ with T = 1.34; 1.313 and 1.382 MeV are shown. The shown uncertainties correspond to the total uncertainties including the statistical uncertainty, the uncertainty of the determination of the TOF, the uncertainty in the measurement of the flight path, and the uncertainty of the neutron detection efficiency. All spectra are described in the energy interval 0.01 - 5 MeV by quoted Maxwellian distributions within 5-7%.

References:

1. Starostov B.I., Semenov A.F., Nefedov V.N., NIIAR, P-22(356) (in Russian), Dimitrovgrad, 1978 (translated by the IAEA as INDC(CCP)-164)
2. Blinov M.V., Vitenko V.A., Yurevich V.I., Neutronnaya Fizika, Moscow 1980, part 3, p. 109-113 (in Russian)
3. Blinov M.V., Boykov G.S., Vitenko V.A., In: Proc. Int. Conf. on "Nuclear Data for Science and Technology", Antwerp., 6-10 Sept., 1982, p. 479-483
4. Starostov B.I., Semenov A.F., Nefedov V.N., Voprosy atomnoi nauki i techniki (Yadernye Konstanty), Moscow, Atomizdat 1980, vol. 37 (issue 2), p. 3-44 (in Russian) (to be translated by the IAEA)

Nuclear Data Section
International Atomic Energy Agency
Vienna International Centre, P.O. Box 100
A-1400 Vienna
Austria

e-mail: services@iaeand.iaea.org
fax: (43-1) 26007
telephone: (43-1) 2600-21710
Web: http://www-nds.iaea.org/