STATUS OF FISSION CROSS SECTIONS NUCLEAR DATA FOR MINOR ACTINIDES

FURSOV B.I.

Obninsk, Russian Federation

Director of Institute for Nuclear and Neutron Physics

State Scientific Center of the Russian Federation

Institute for Physics and Power Engineering

named after A.I.Leipunsky

Perspective technologies that demand "new" nuclear data for minor actinides

High fuel burn-up for all types of nuclear reactors

The utilization of the accumulated plutonium

Recycling of a nuclear fuel (closed cycle)

Transmutation of minor actinides in various reactors and accelerator-driven systems

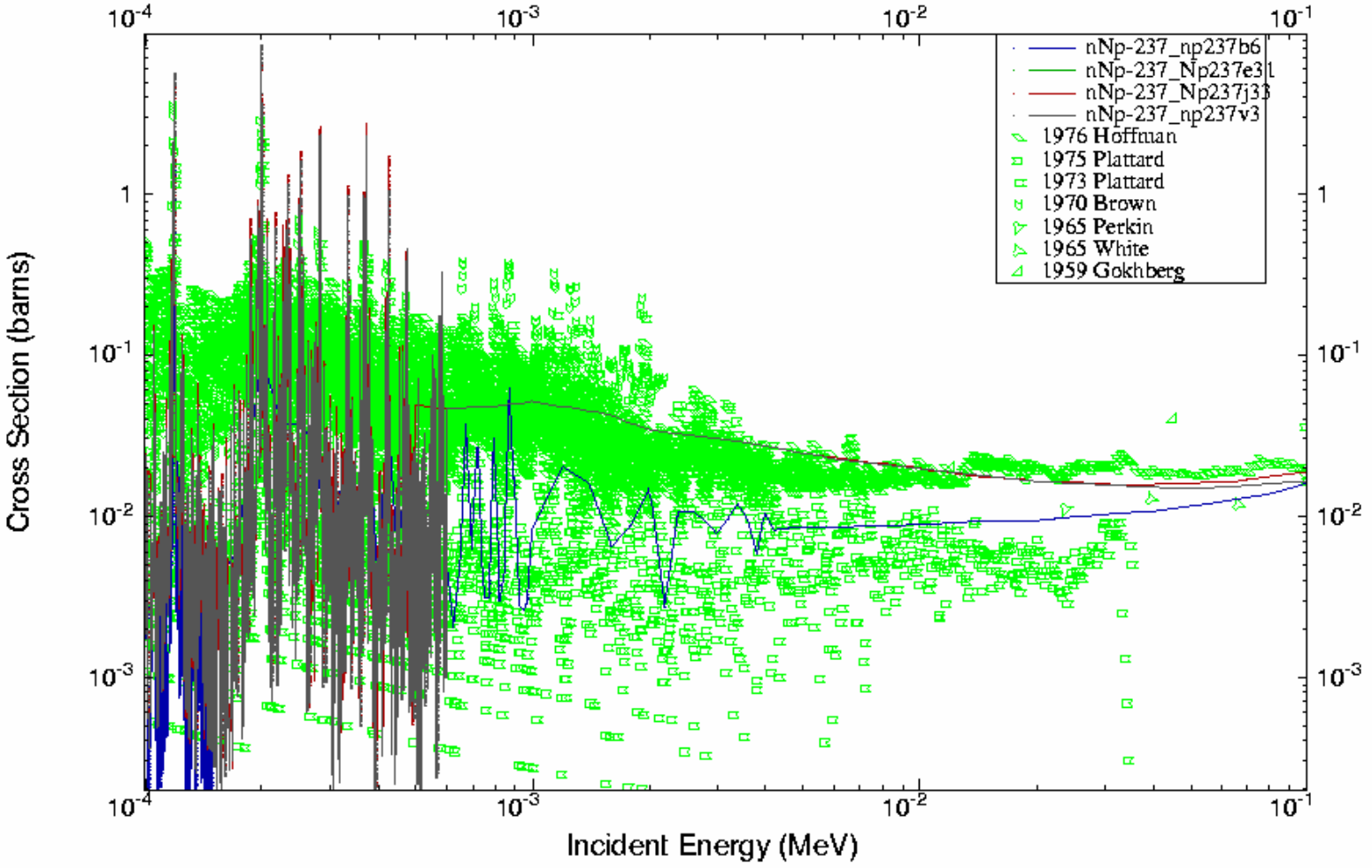
Achieved and required (in brackets) accuracy of neutron cross sections required for fast reactor-burner design

Nuclide	Capture %	Fission, %	Inelastic scattering, %
Np-237	15 (5)	7 (3)	30 (10)
Pu-238	25 (10)	10 (5)	40 (30)
Am-241	10 (5)	10 (5)	30 (10)
Am-242m	30 (10)	15 (5)	40 (30)
Am-243	30 (10)	10 (5)	30 (30)
Cm-242	50 (10)	20 (5)	30 (30)
Cm-243	50 (10)	15 (5)	30 (30)
Cm-244	30 (20)	10 (5)	30 (30)

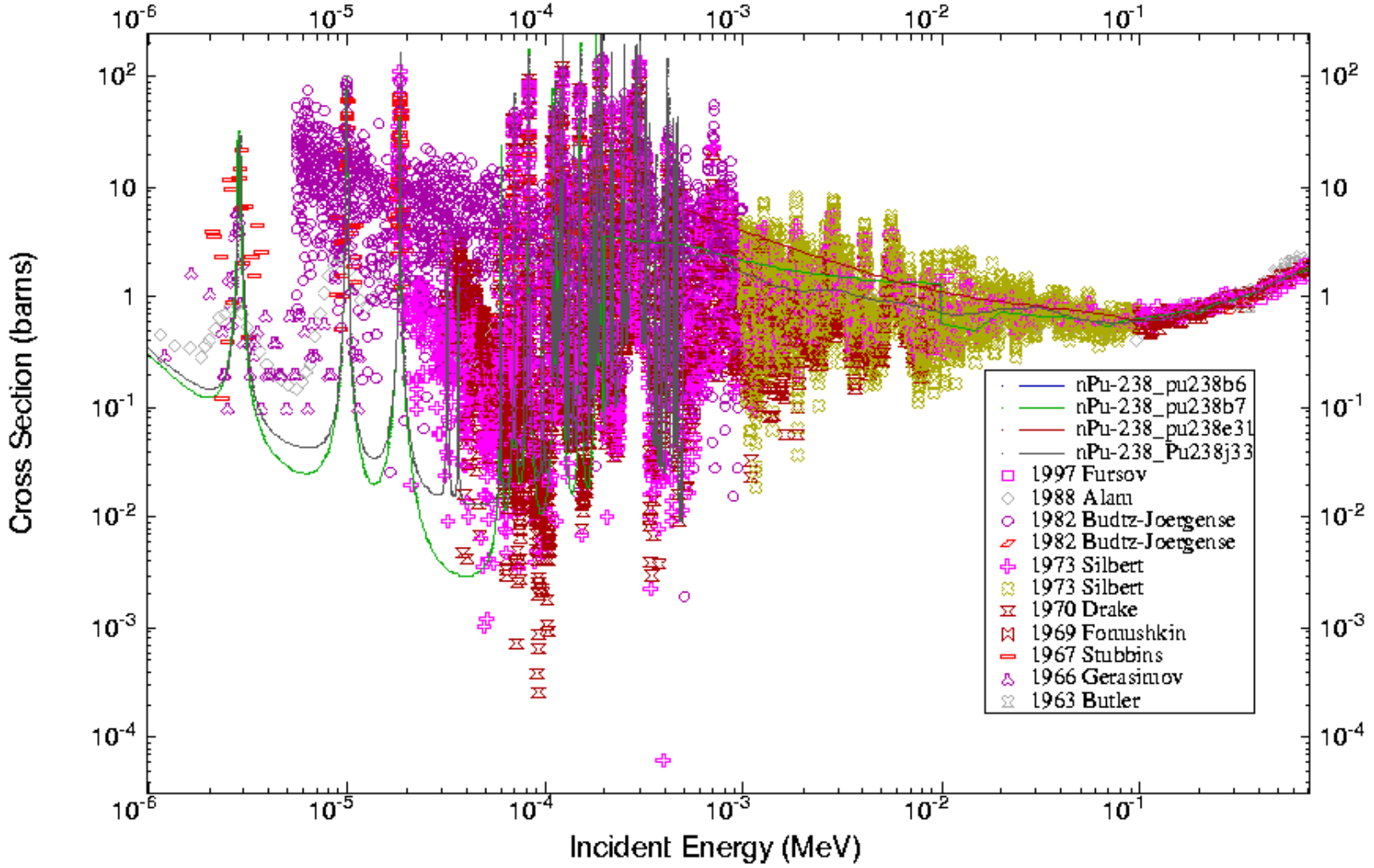
Fission resonance integrals of MA

	Np-237	Am-241	Am-243	Cm-244
ABBN	8.92E-01	8.38E+00	2.26E+00	5.98E+00
ENDF/B7	5.04E-01	8.37E+00	2.14E+00	5.98E+00
BROND	7.13E-01	8.37E+00	2.17E+00	6.56E+00
JEF 2.2	2.10E-01	9.98E+00	1.20E+00	1.18E+01
JEFF 3.1	6.42E-01	1.10E+01	2.20E+00	1.08E+01
JENDL 3.2	8.92E-01	7.48E+00	2.26E+00	5.98E+00
JENDL 3.3	6.42E-01	8.41E+00	2.20E+00	5.98E+00

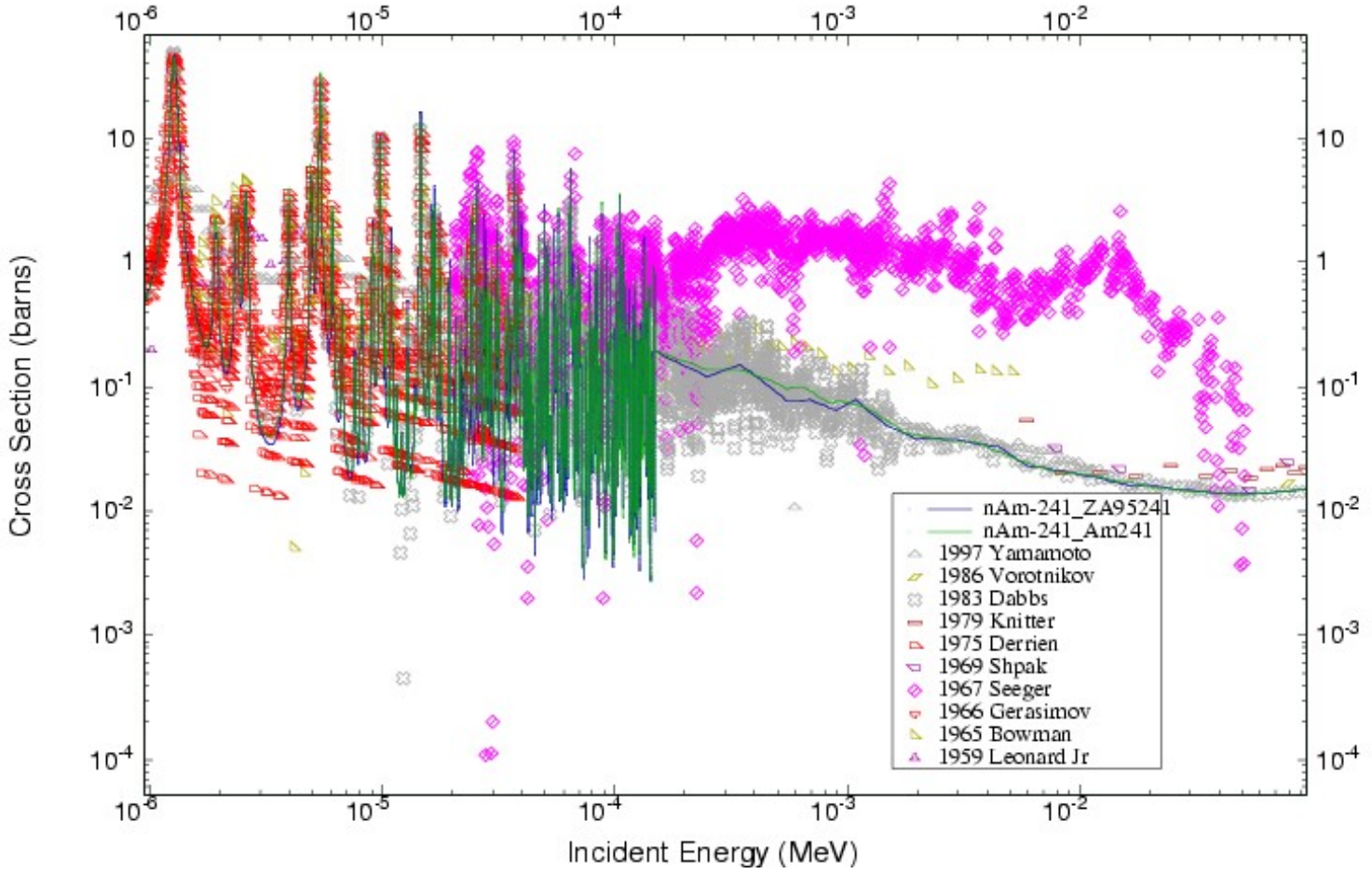
Experimental data and evaluated values of fission cross-section for Np-237



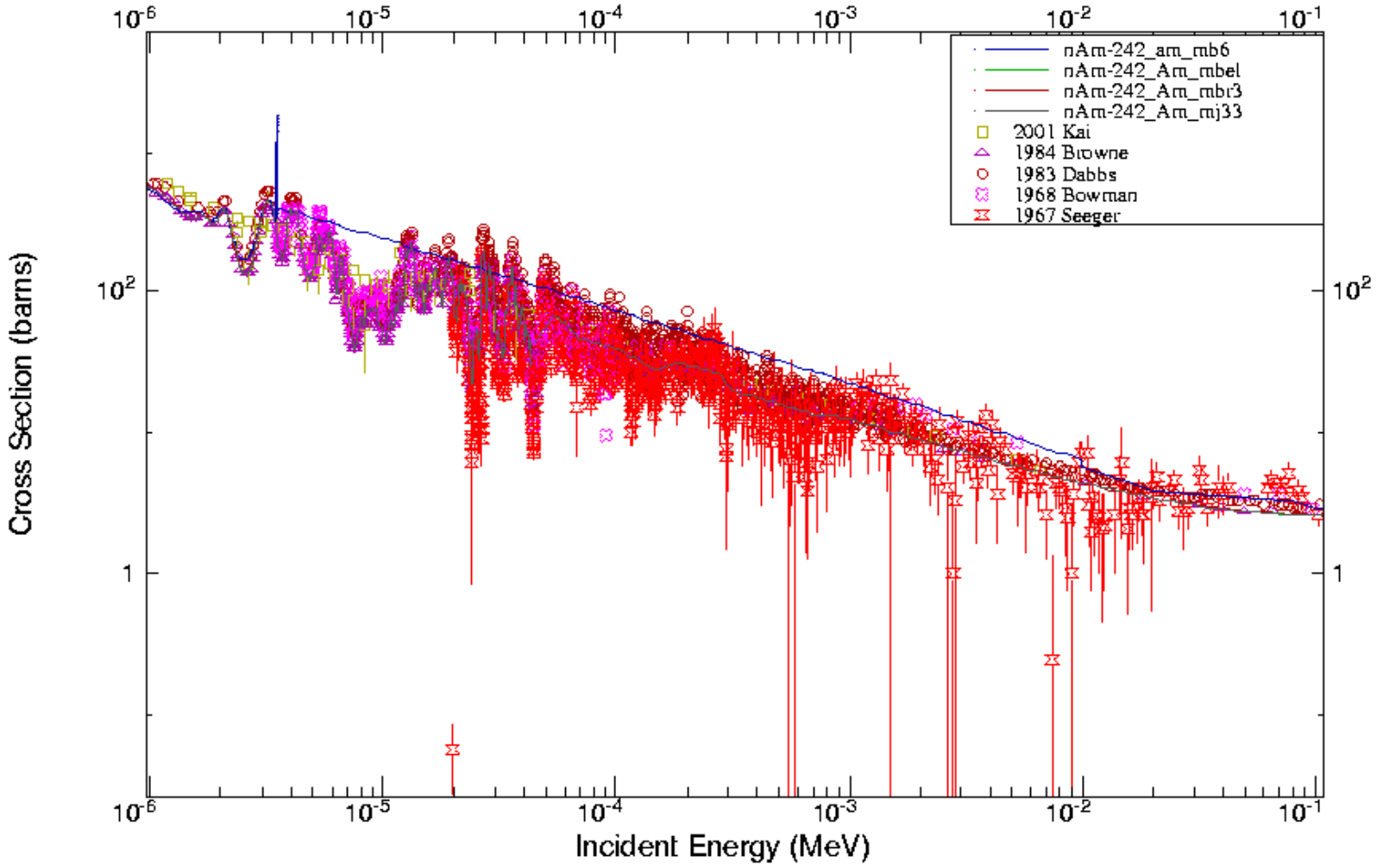
Experimental data and evaluated values of fission cross-section for Pu-238



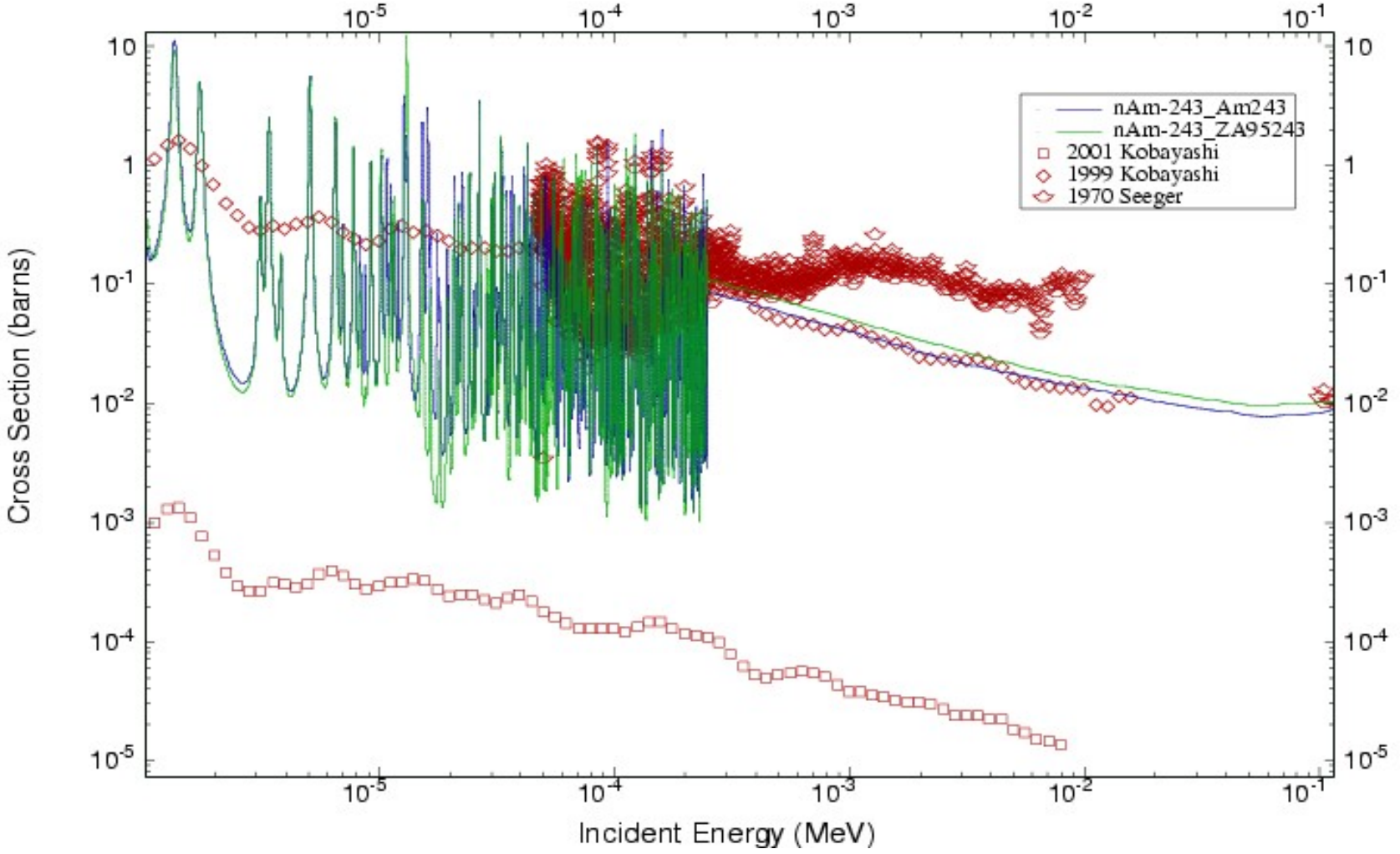
Experimental data and evaluated values of fission cross-section for Am-241



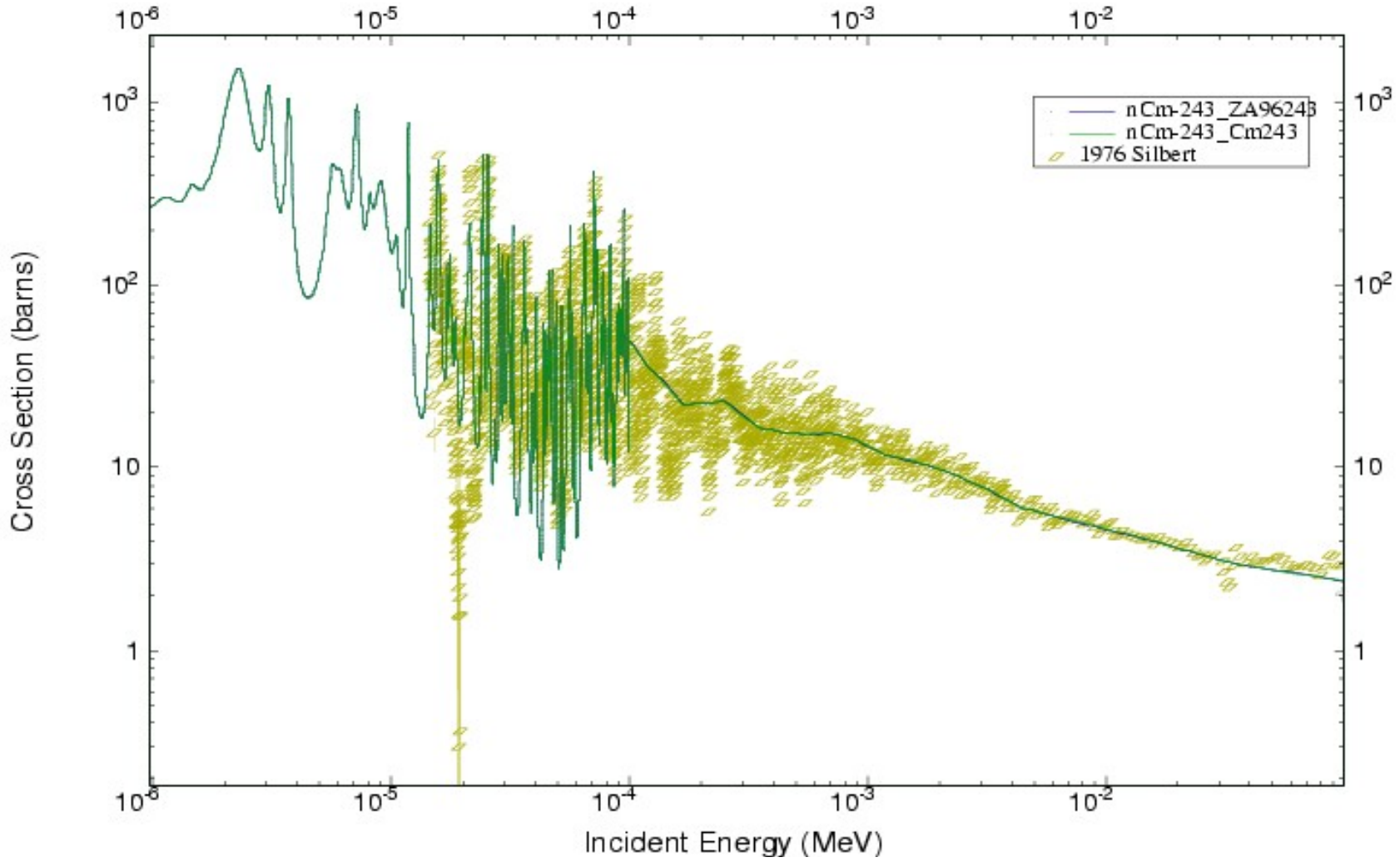
Experimental data and evaluated values of fission cross-section for Am-242m



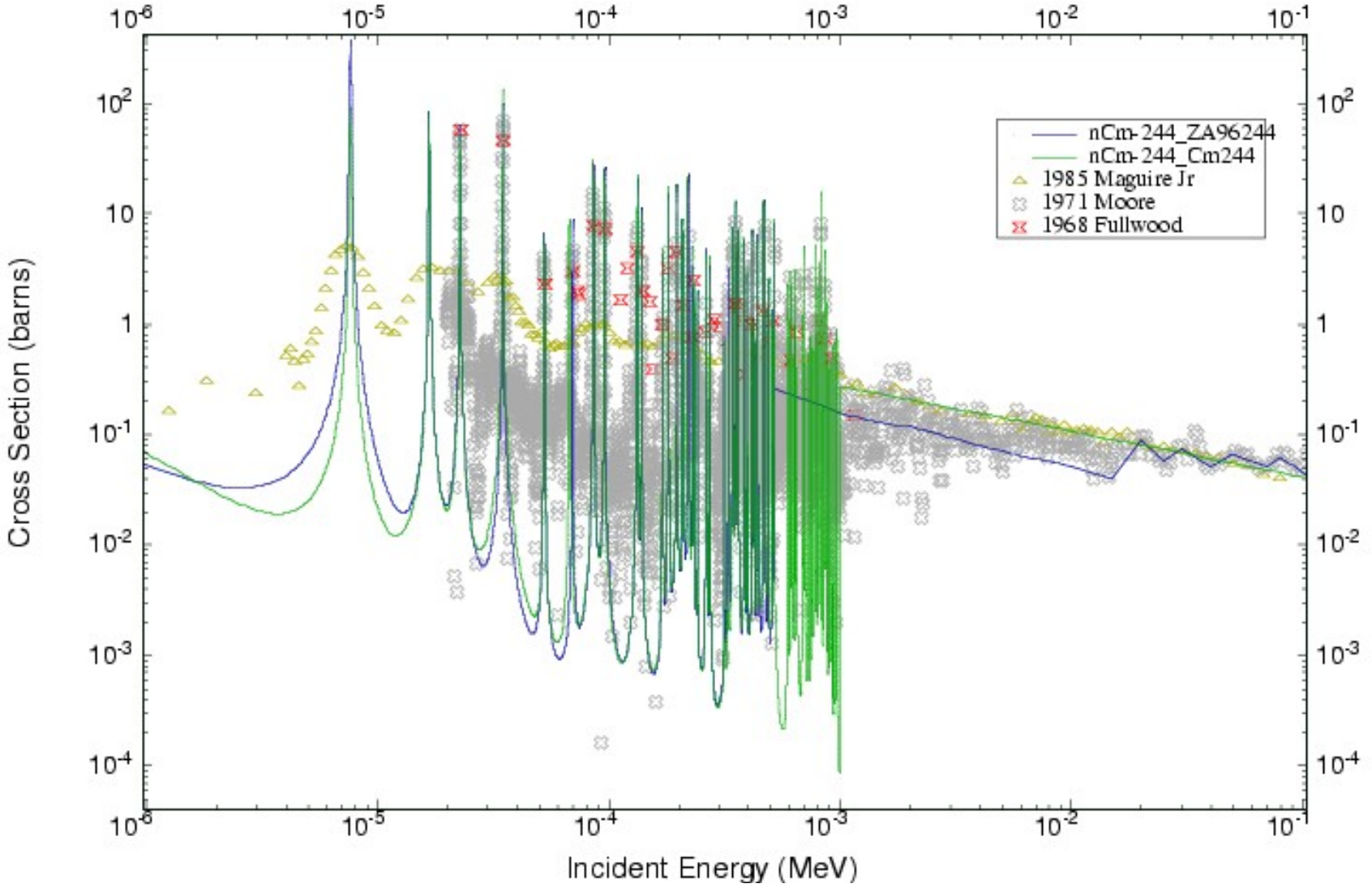
Experimental data and evaluated values of fission and captured cross-section for Am-243



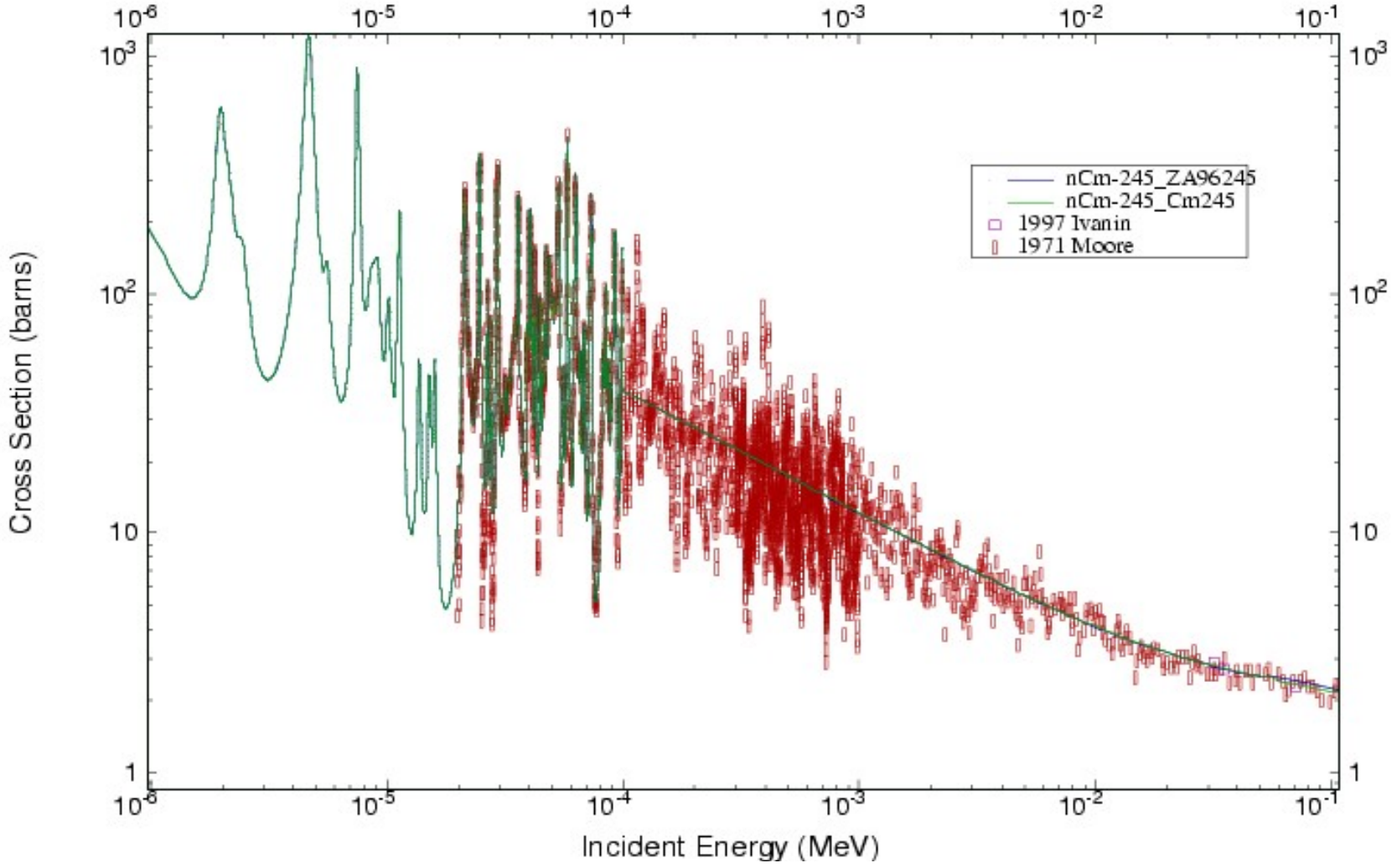
Experimental data and evaluated values of fission cross-section for Cm-243



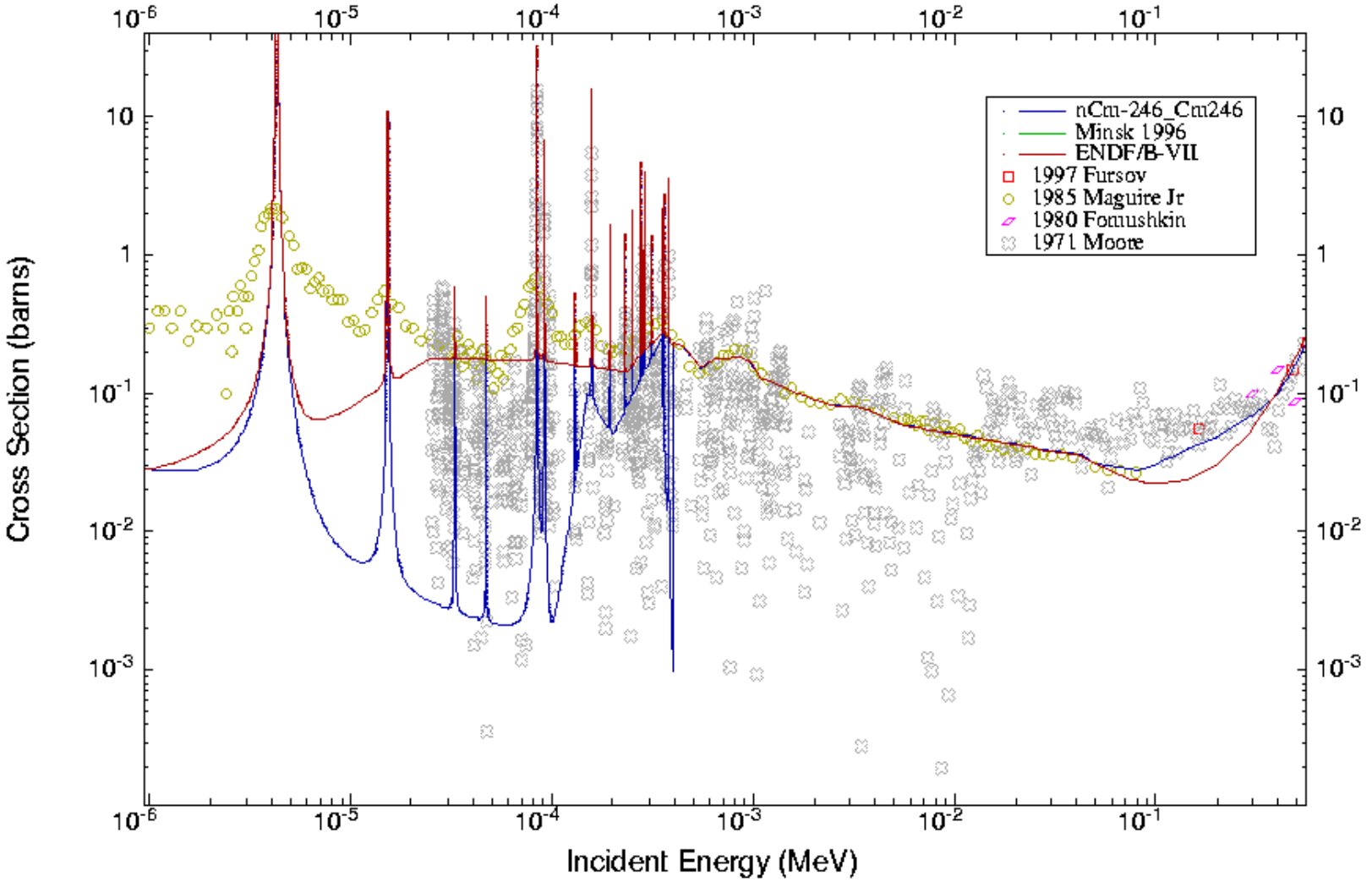
Experimental data and evaluated values of fission cross-section for Cm-244



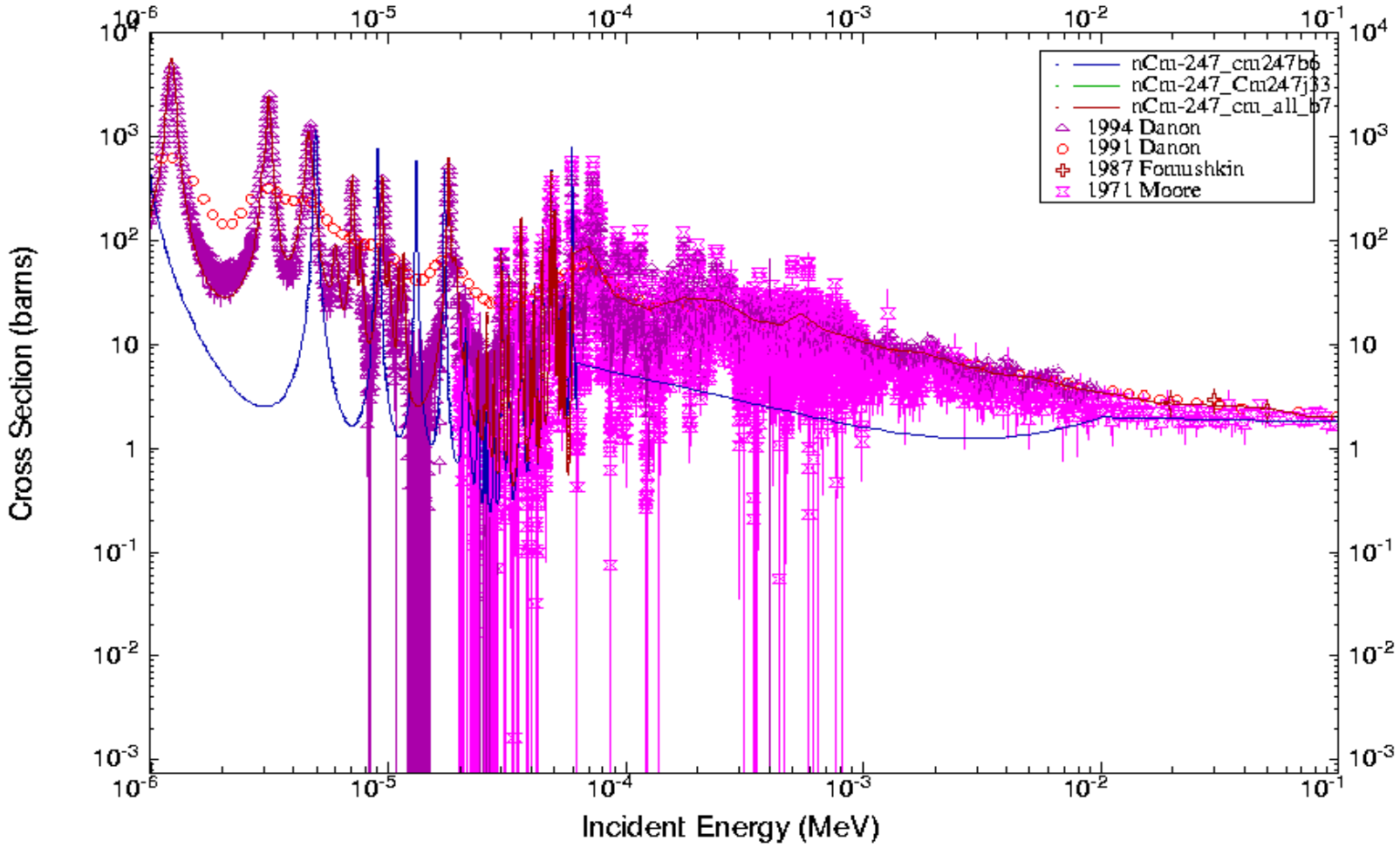
Experimental data and evaluated values of fission cross-section for Cm-245



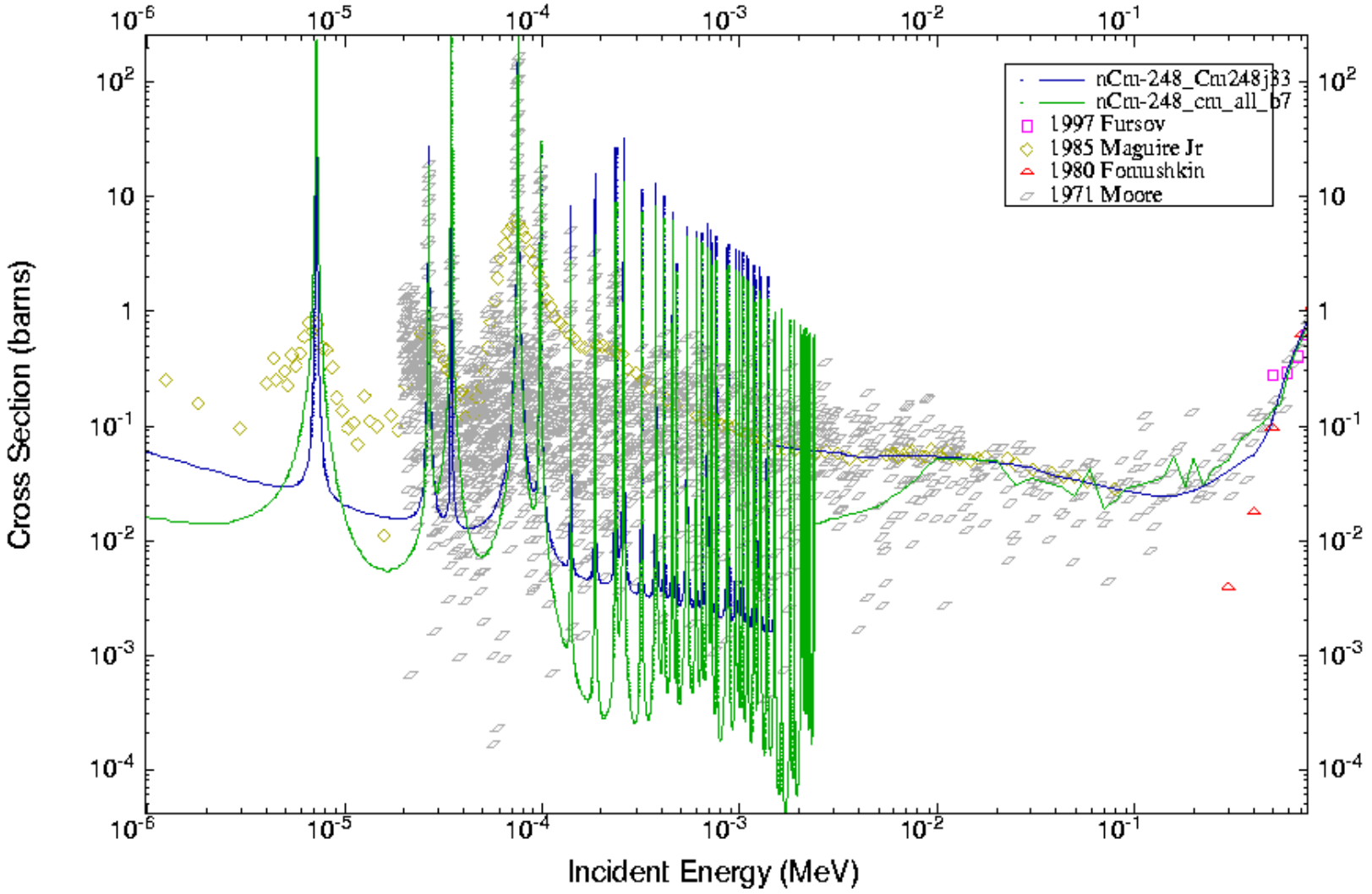
Experimental data and evaluated values of fission cross-section for Cm-246



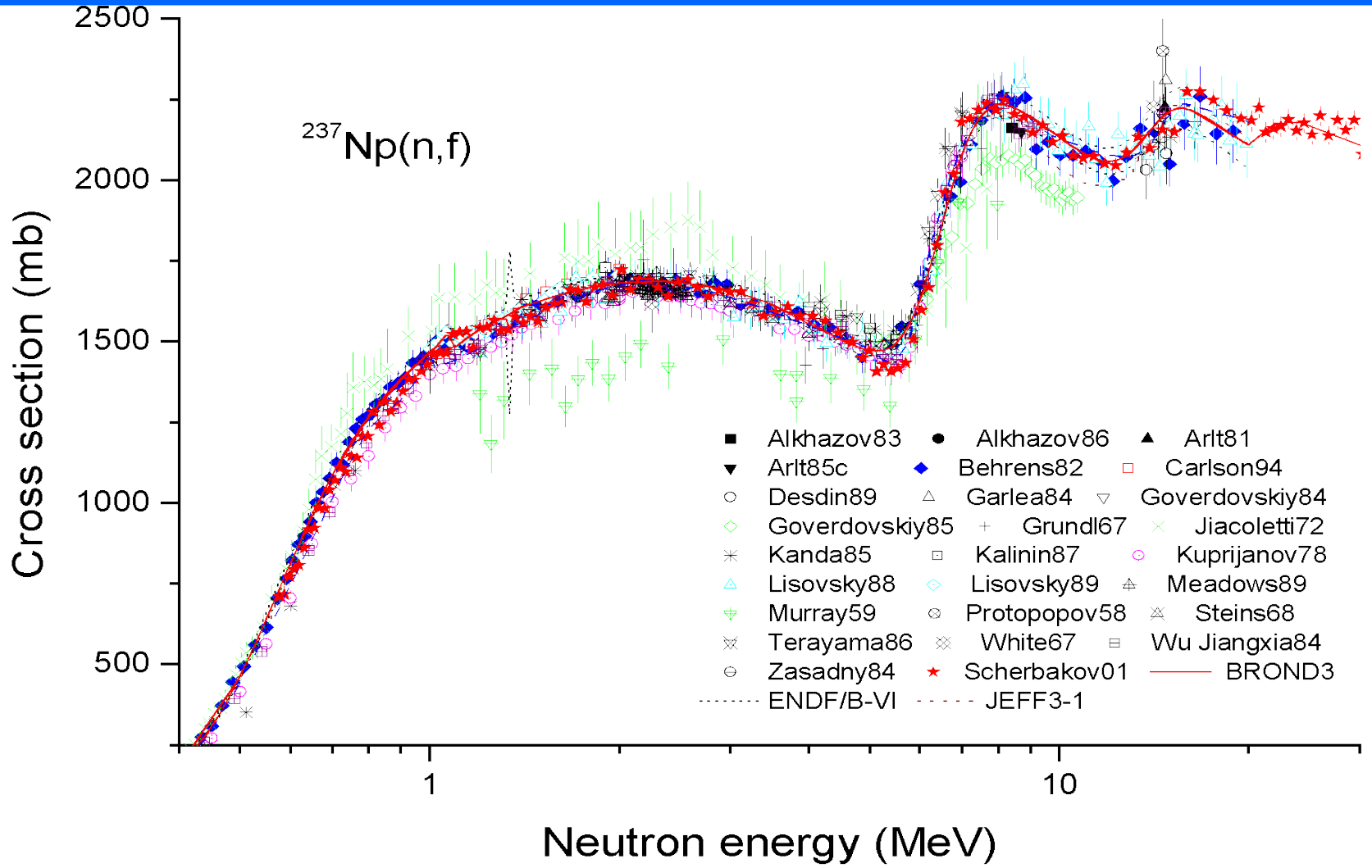
Experimental data and evaluated values of fission cross-section for Cm-247



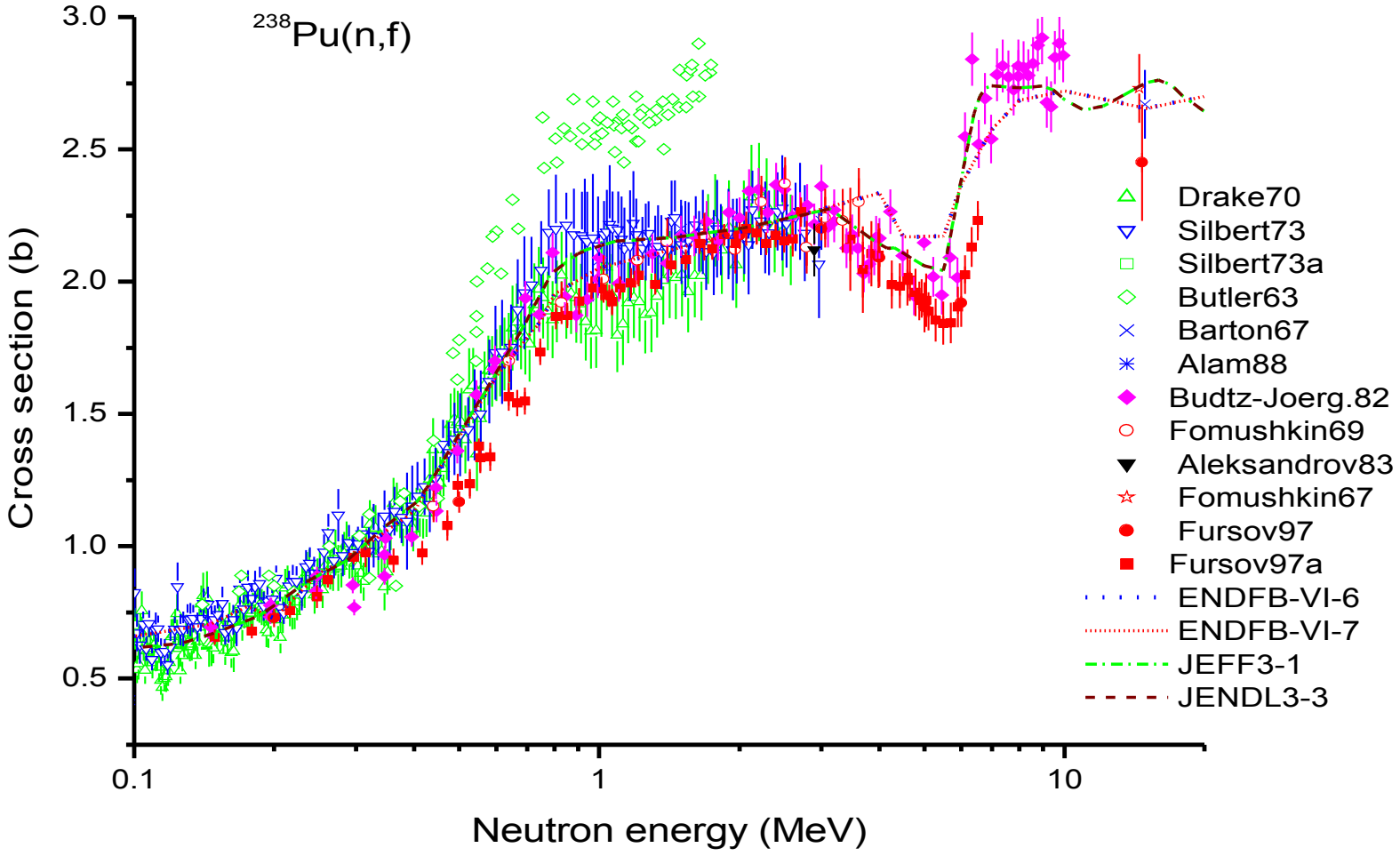
Experimental data and evaluated values of fission cross-section for Cm-248



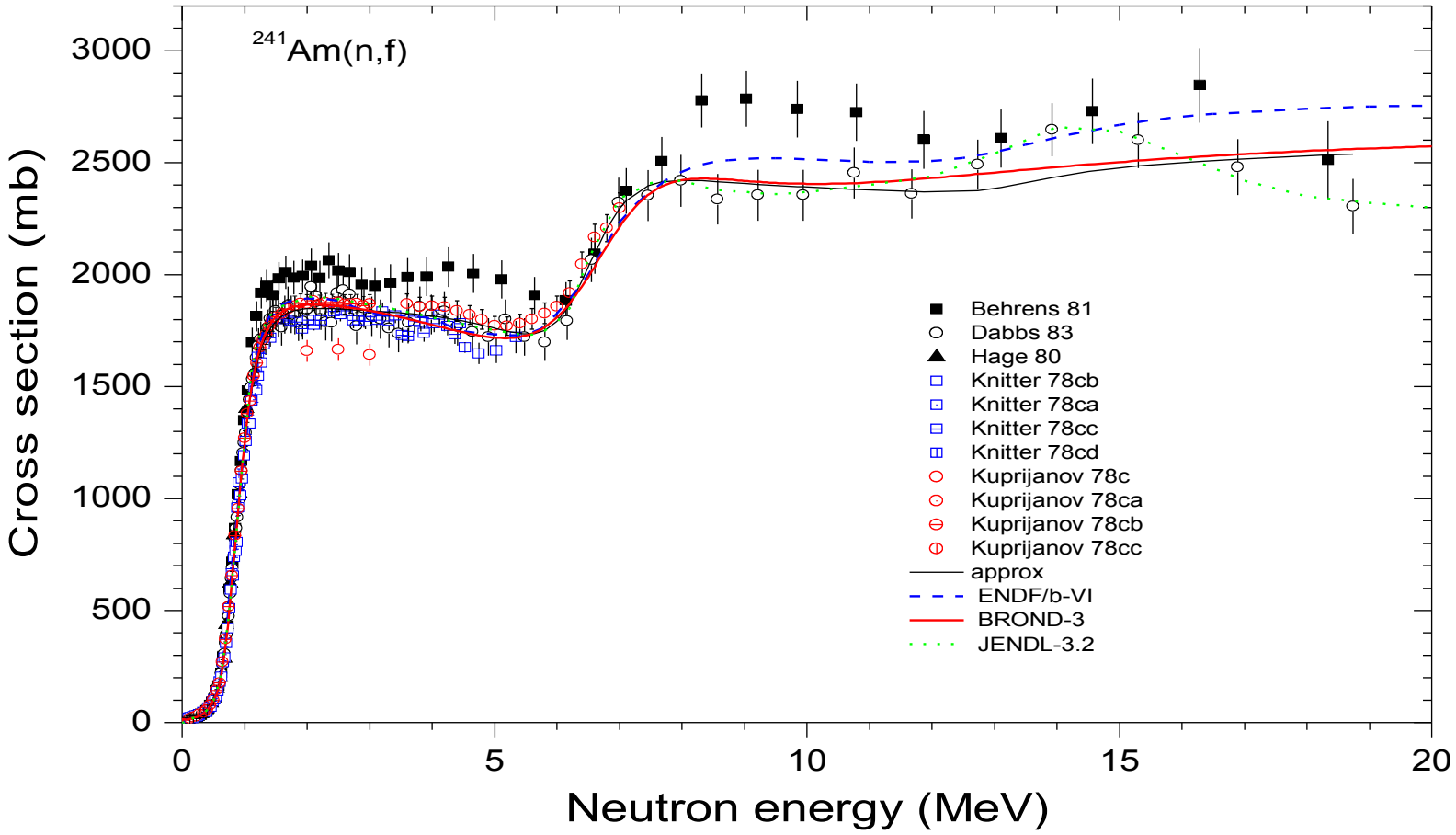
- **Experimental and evaluated fission cross section for Np-237 in the energy range above 400 keV**



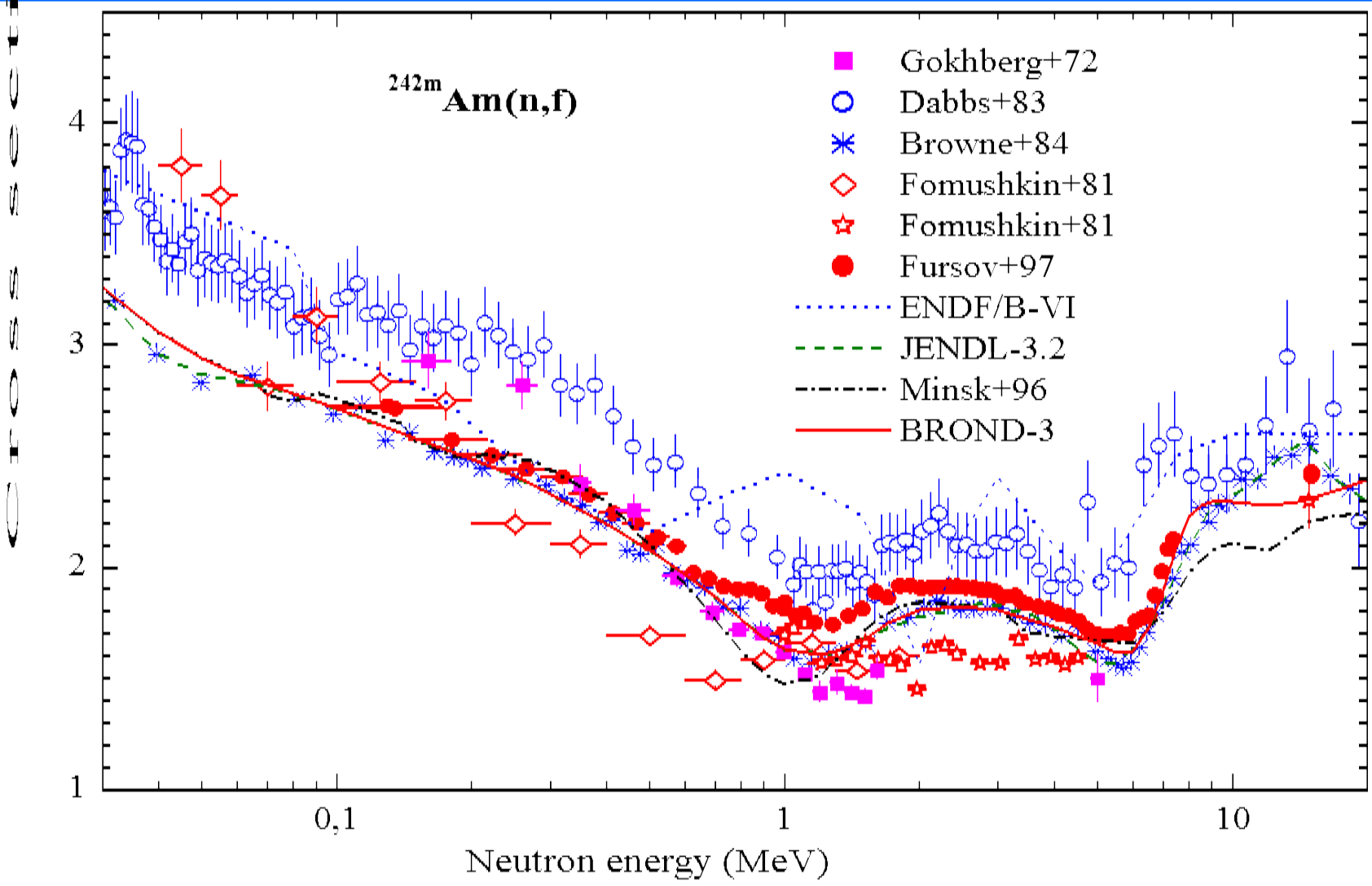
Experimental and evaluated fission cross section for Pu-238 in the energy range above 100 keV



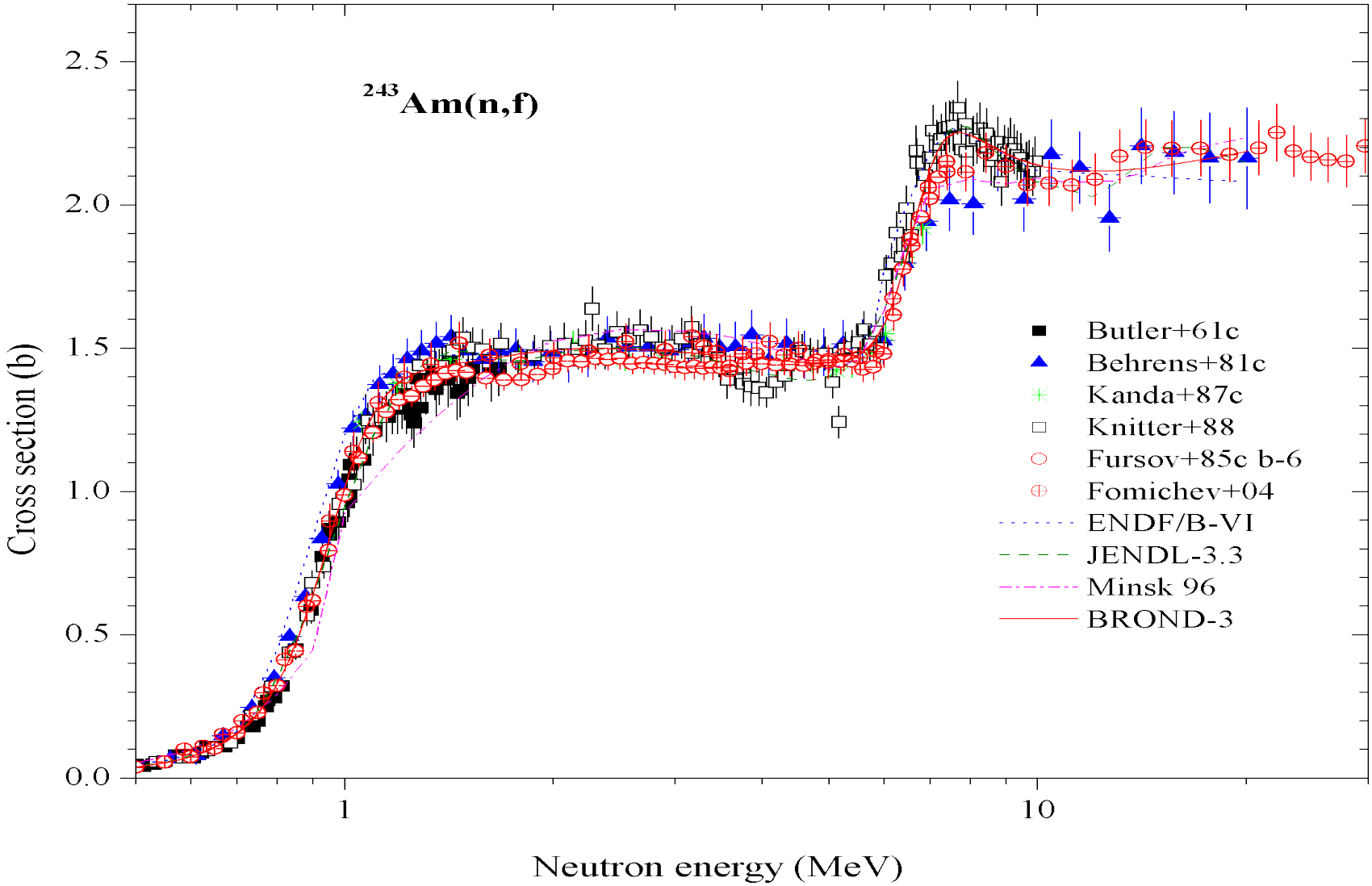
Experimental and evaluated fission cross section for Am-241 in the energy range above 100 keV



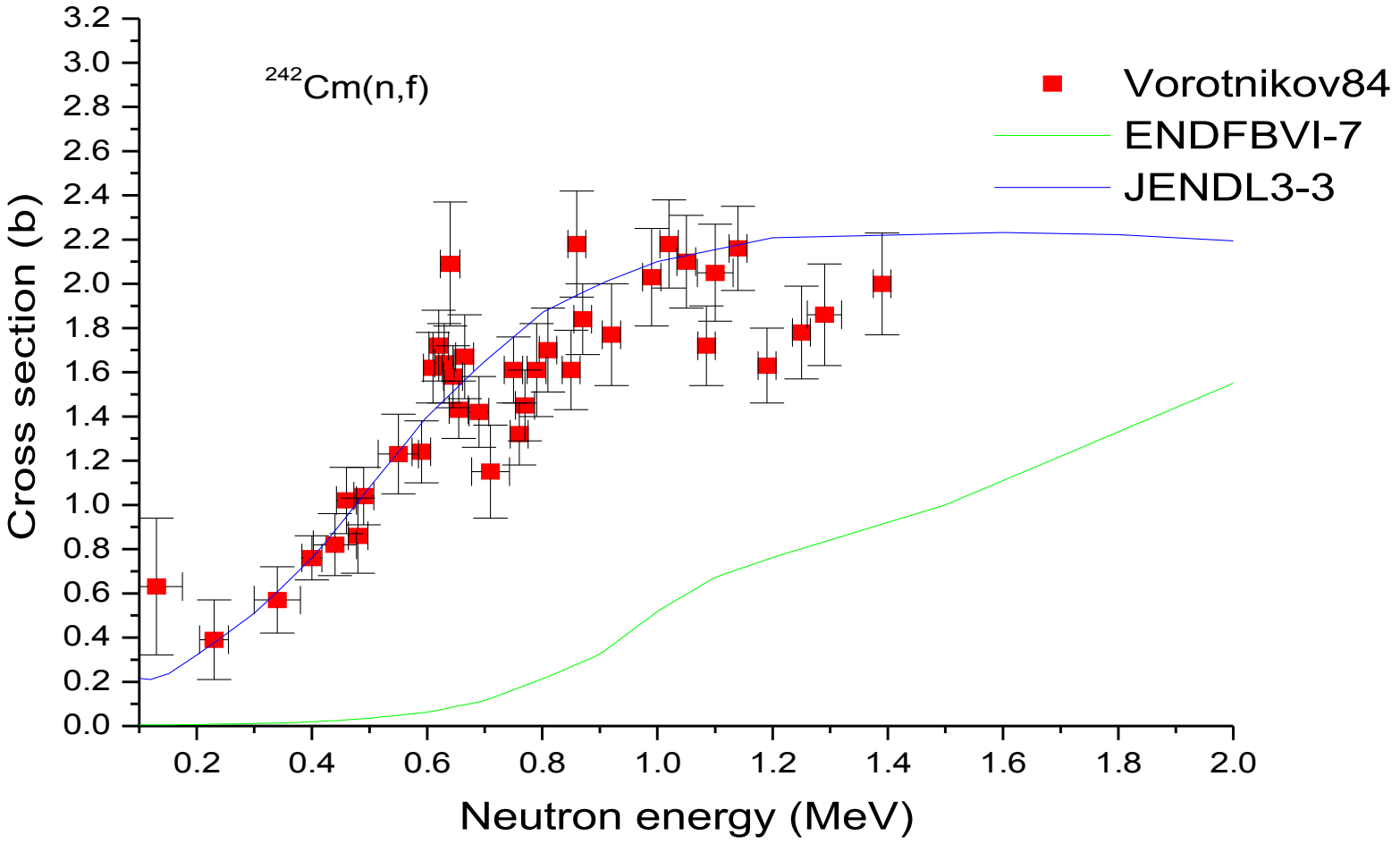
Experimental and evaluated fission cross section for Am-242m in the energy range above 100 keV



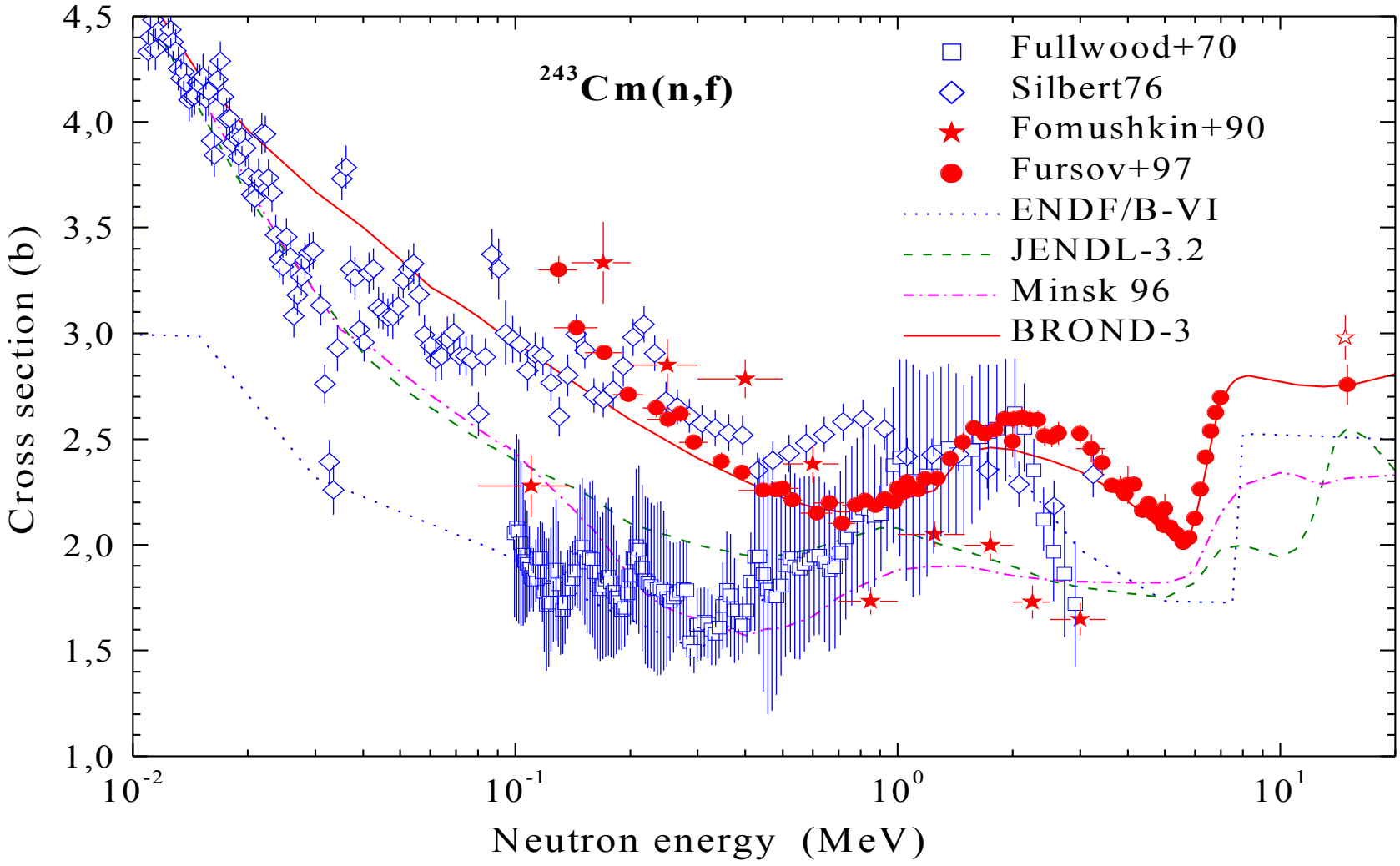
Experimental and evaluated fission cross section for Am-243 in the energy range above 100 keV



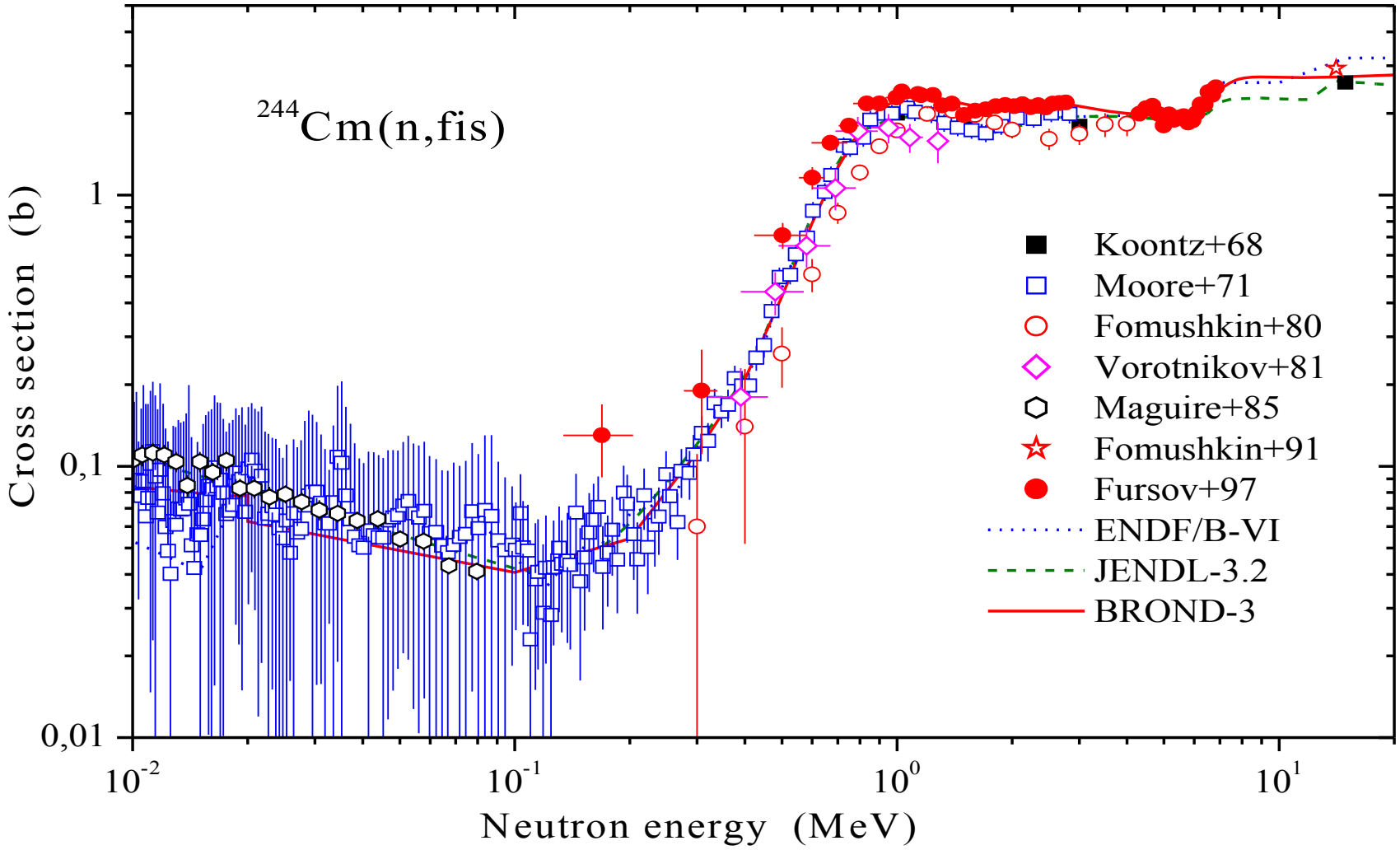
Experimental and evaluated fission cross section for Cm-242 in the energy range above 100 keV



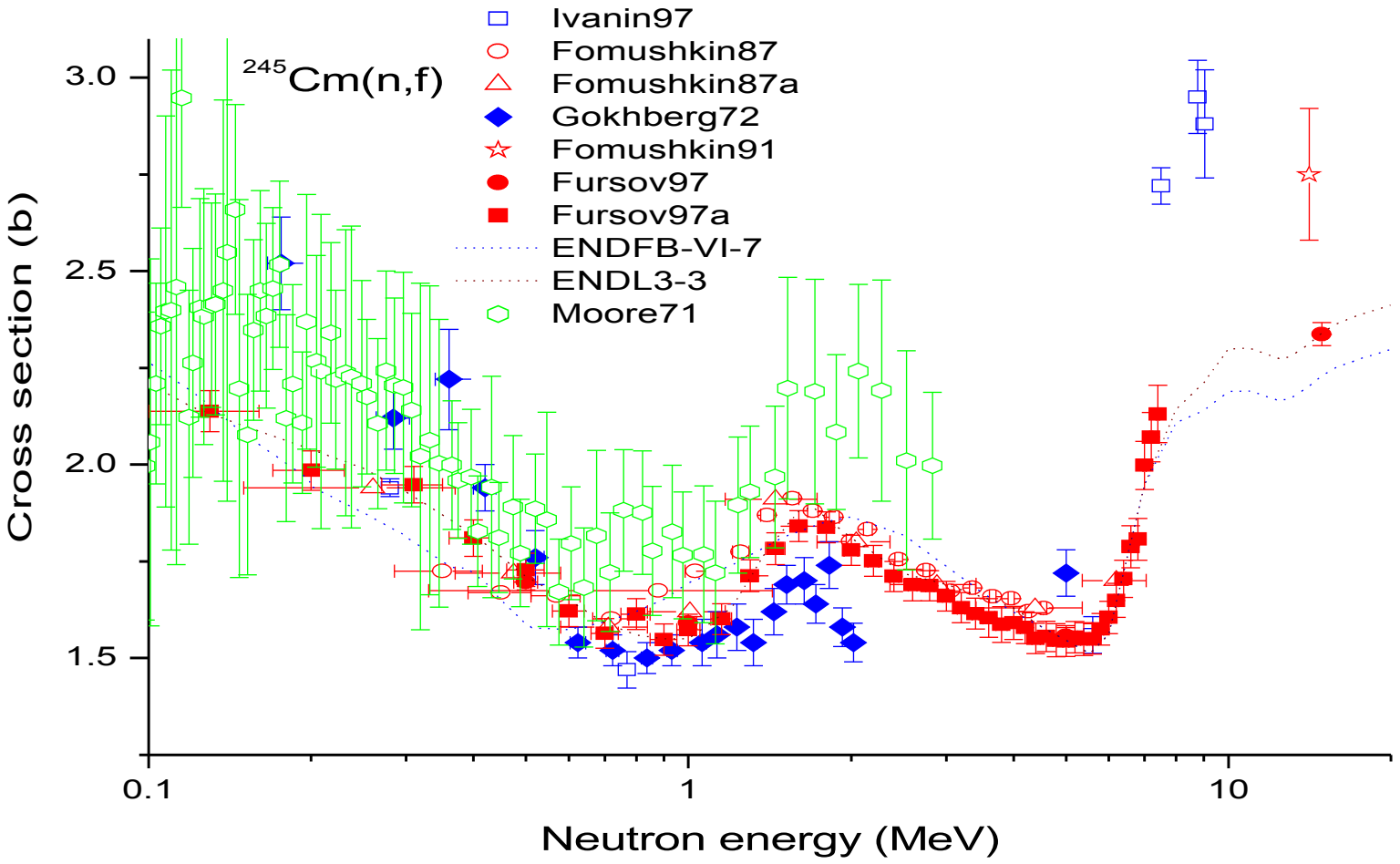
Experimental and evaluated fission cross section for Cm-243 in the energy range above 100 keV



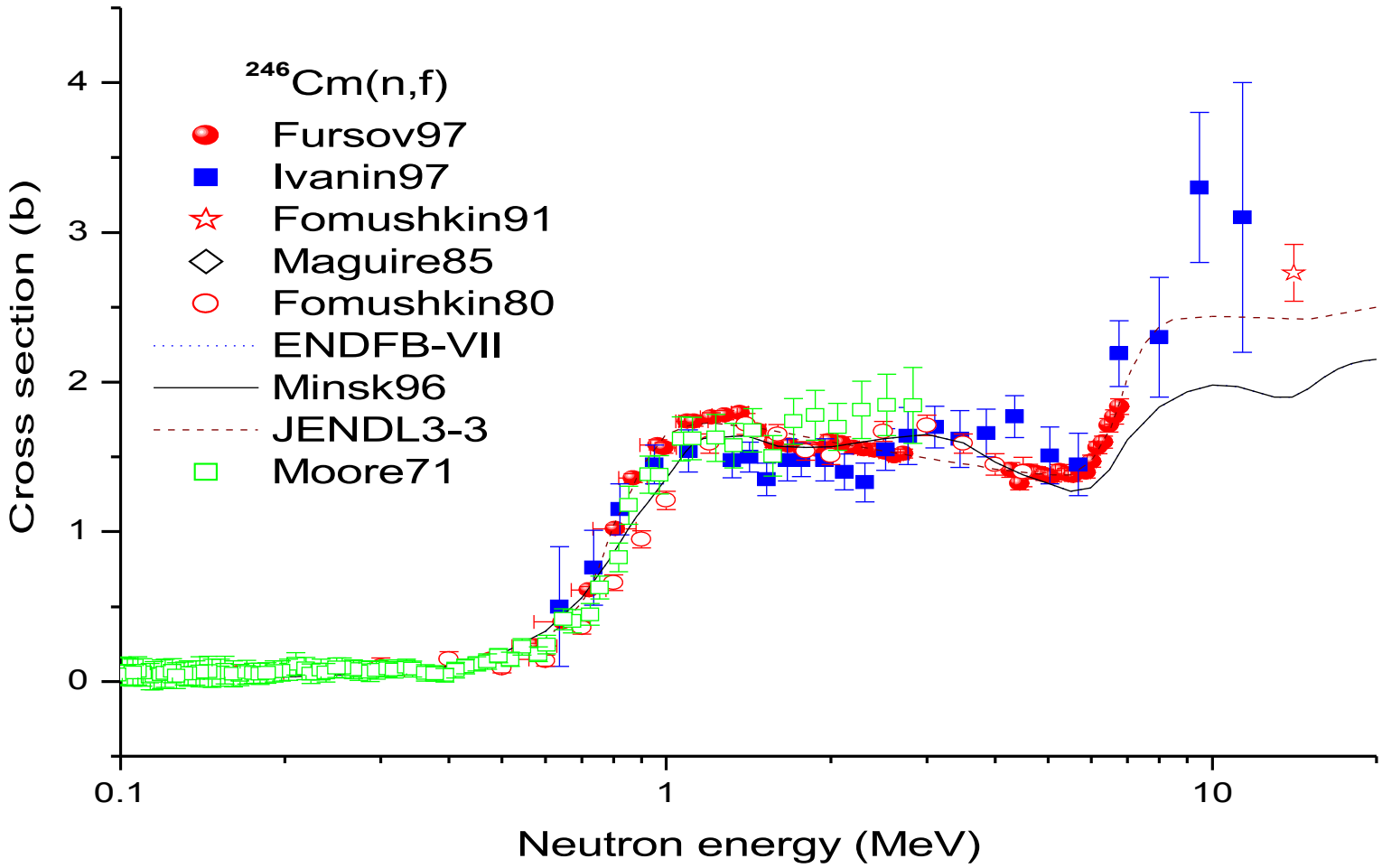
Experimental and evaluated fission cross section for Cm-244 in the energy range above 100 keV



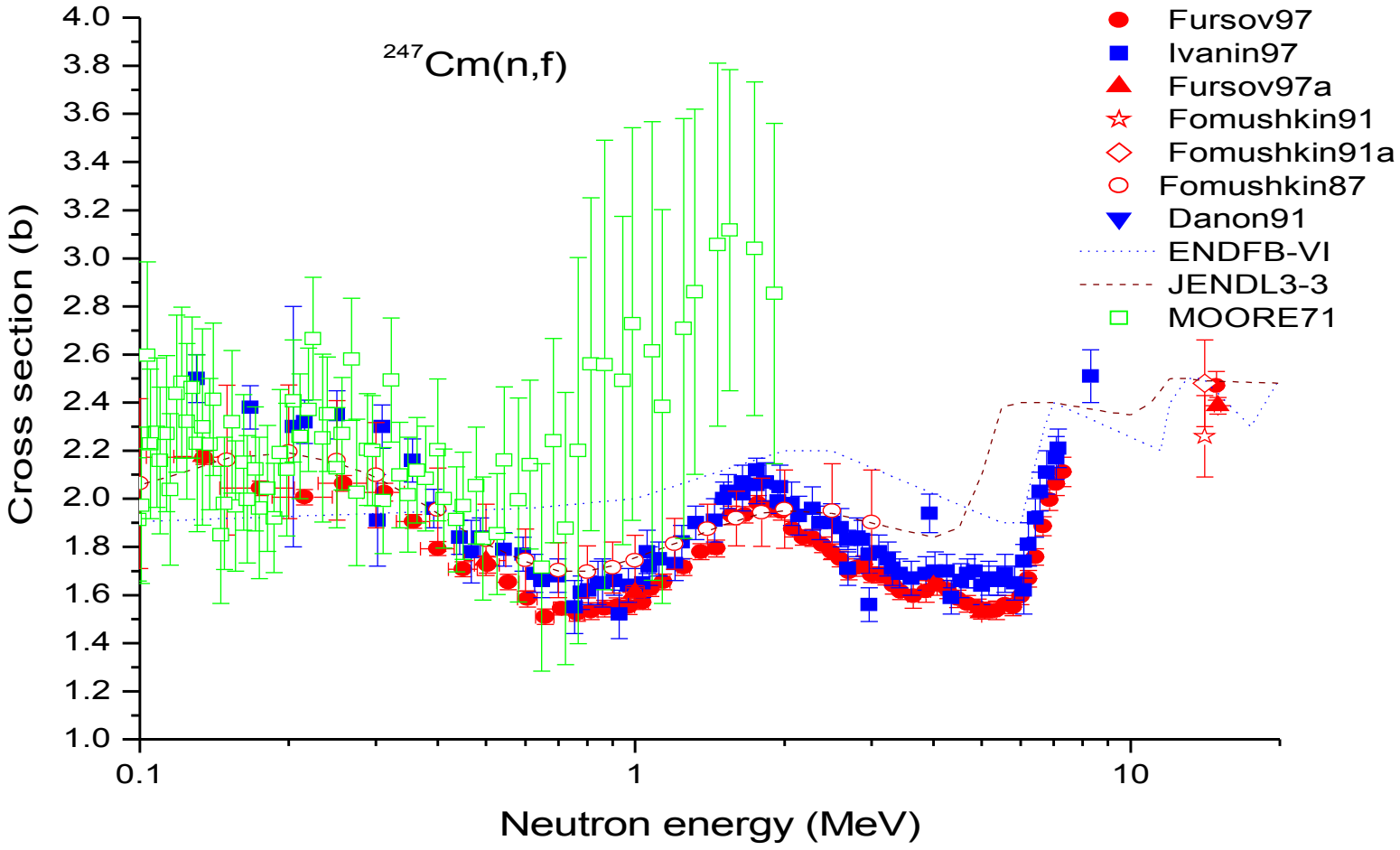
Experimental and evaluated fission cross section for Cm-245 in the energy range above 100 keV



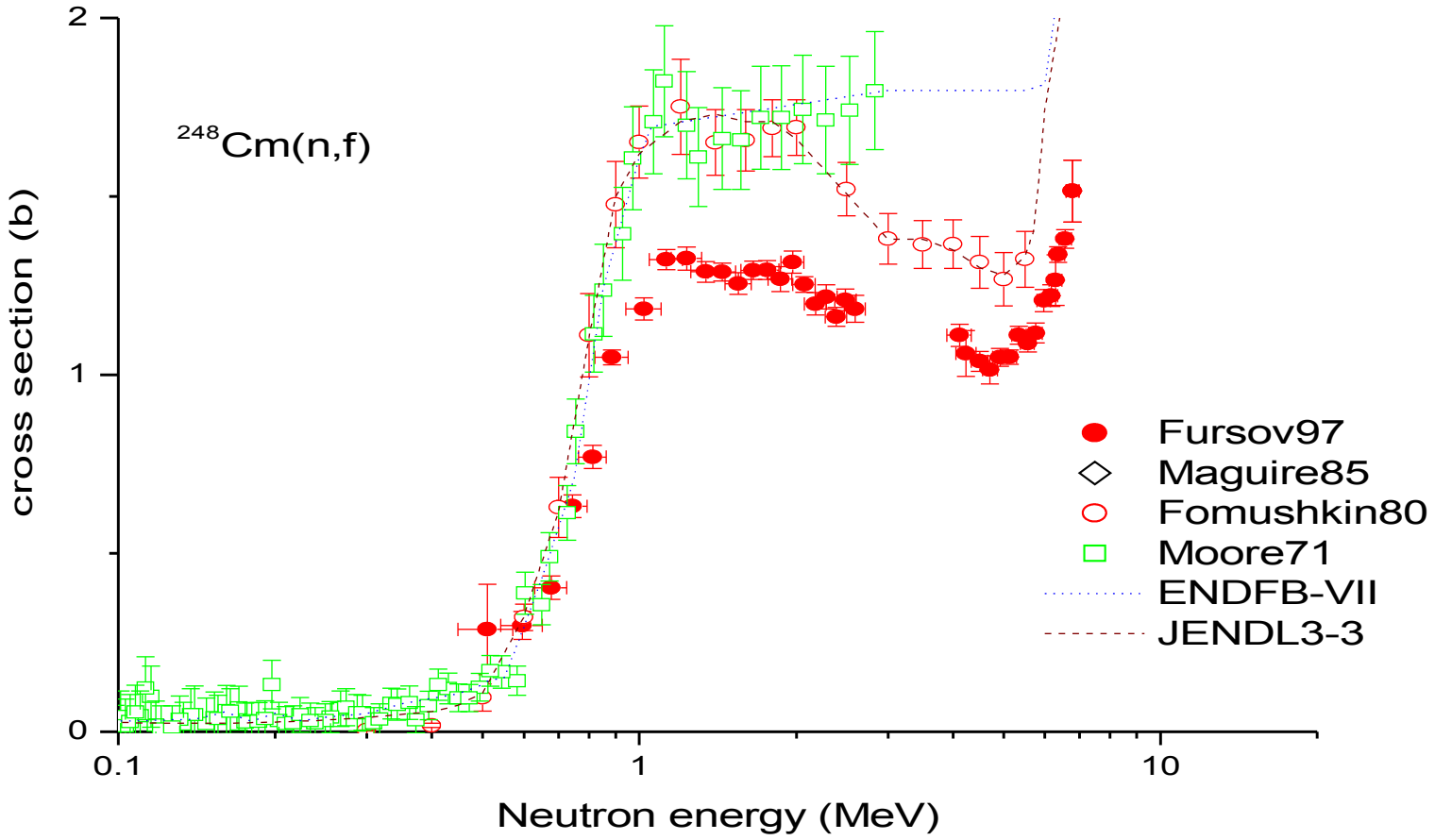
Experimental and evaluated fission cross section for Cm-246 in the energy range above 100 keV



Experimental and evaluated fission cross section for Cm-247 in the energy range above 100 keV



Experimental and evaluated fission cross section for Cm-248 in the energy range above 100 keV



CONCLUSION

- To improve accuracy of nuclear data for MA is necessary:
- Additional measurements of MA fission cross-sections, especially in the energy range below 100 keV and above 5 MeV ;
- Theoretical calculations and evaluations of other partial cross sections;
- Preparing full files of nuclear data for MA

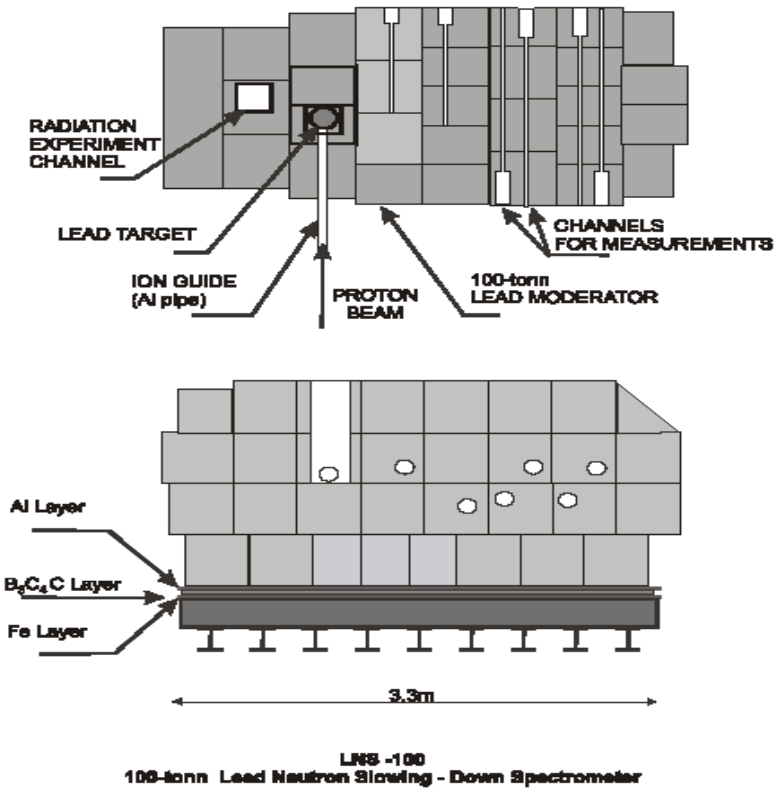
IPPE program (ISTC # 1749)

- Radiochemical preparing and reprocessing MA.
- Preparing fissile samples, twin fast fission chambers and electronics.
- Measurement of fissile samples mass ratios.
- Measurements of fission cross section ratios in the energy range from 0.1 eV to 30 keV using 100 t lead slowing down spectrometer (**LSDS**) on the base of proton Linac (**MMF**) **INR RAS**.
- Measurements of fission cross section ratios in the energy range from 5 MeV to 20 MeV on the base of pulsed tandem-generator (**IPPE**).

List of MA under investigation

- Pu-238
- Am-241
- Am-242m
- Am-243
- Cm-243
- Cm-244
- Cm-245
- Cm-246
- Cm-247
- Cm-248

Lead Slowing Down Spectrometer Institute for Nuclear Research (Troitsk)



(INR, Troitsk)

LSDS

- Proton Linac energy – 208 MeV
- t = 0.15÷1 μs
- f = 50 Hz
- <I>= 0.5÷5 μA
- Lead – super pure (99.99%)
- Lead blocks ~ 1 t
- Surface of blocks special prepared
- Energy resolution ~ 30 %

Monoenergetic neutrons

- Neutron sources:
- T(p,n)-, D(d,n)- and T(d,n)-reactions
- Pulsed accelerators EG-1, EGP-15
- t = 1 ns, f = 2 MHz, <I> = 2÷10 μA
- Pulse synchronization method in “close” geometry
- Energy range from 1 to 20 MeV
- Neutron backgrounds: experimental measurements (template) and calculations

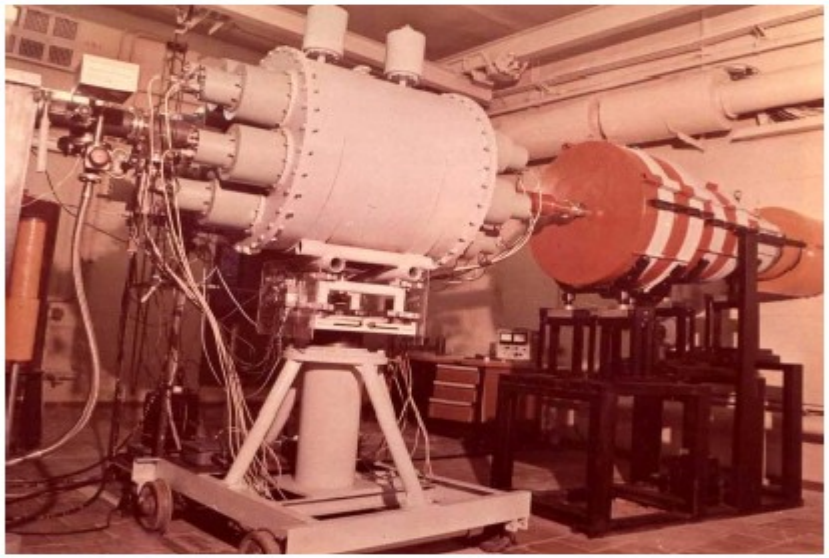
Tandem-generator EGP-15

Tandem generanor EGP-15
(IPPE, Obninsk)

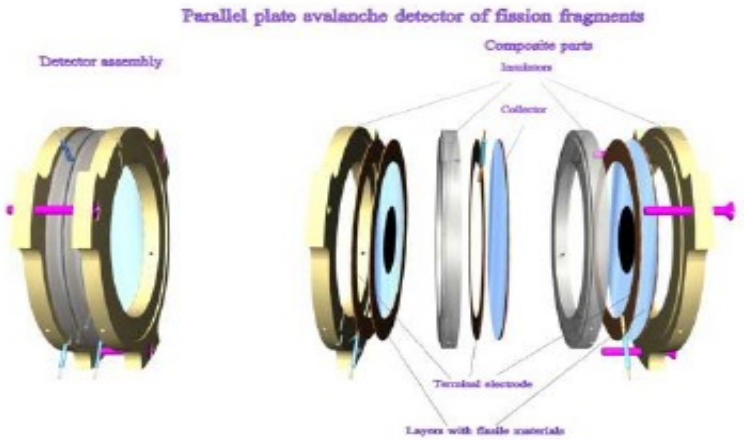
Program VNIIEF (ISTC # 2952)

- Time-of-flight spectrometer on the base of 50 MeV electron Linac
- Neutron energy range: from 40 keV to 10 MeV
- Electron energy: 50 MeV
- <I> = 220 μA
- f = 2400 Hz
- t = 12 ns
- Flight bases: 9 and 25 m

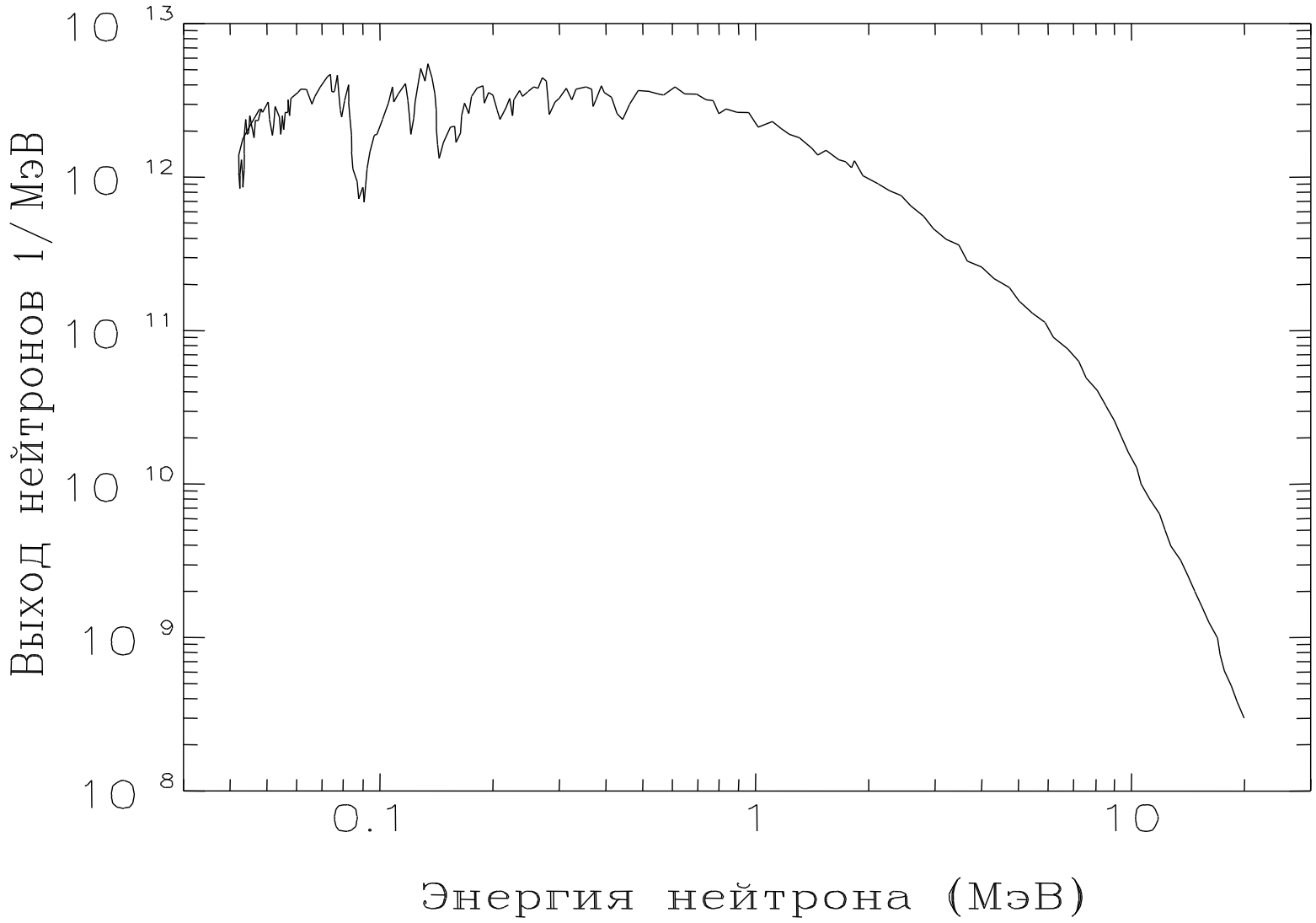
Linac LU-50



Neutron detector
(VNIIEF, Sarov)



Neutron spectrum of LU-50 target



Differential neutron data measurements

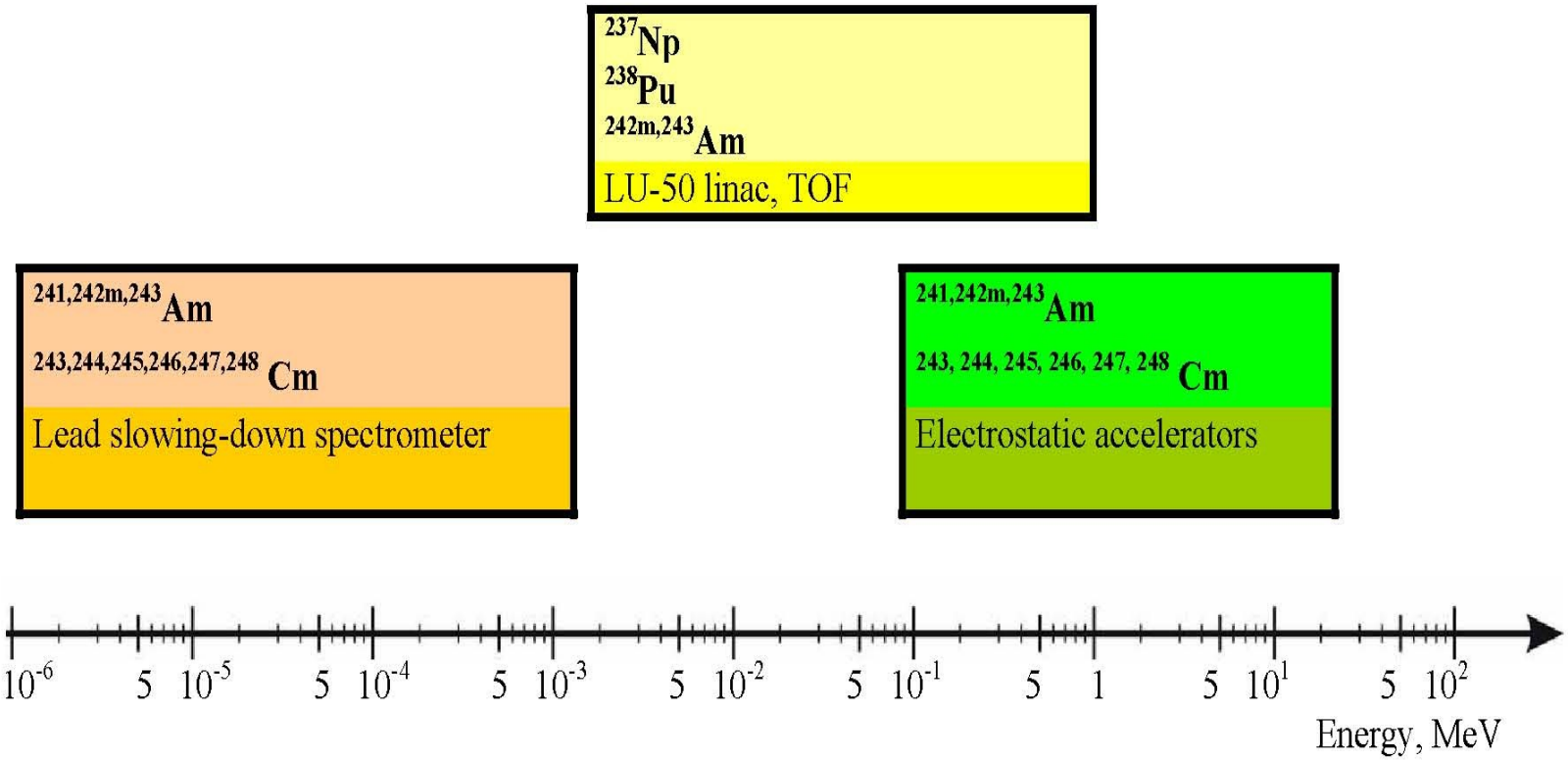
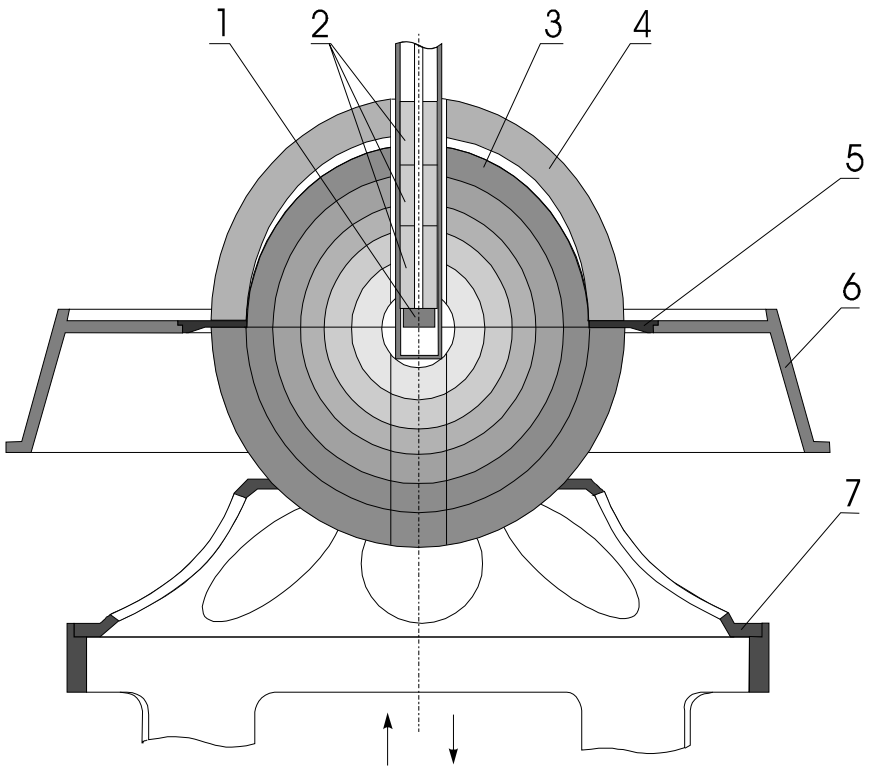
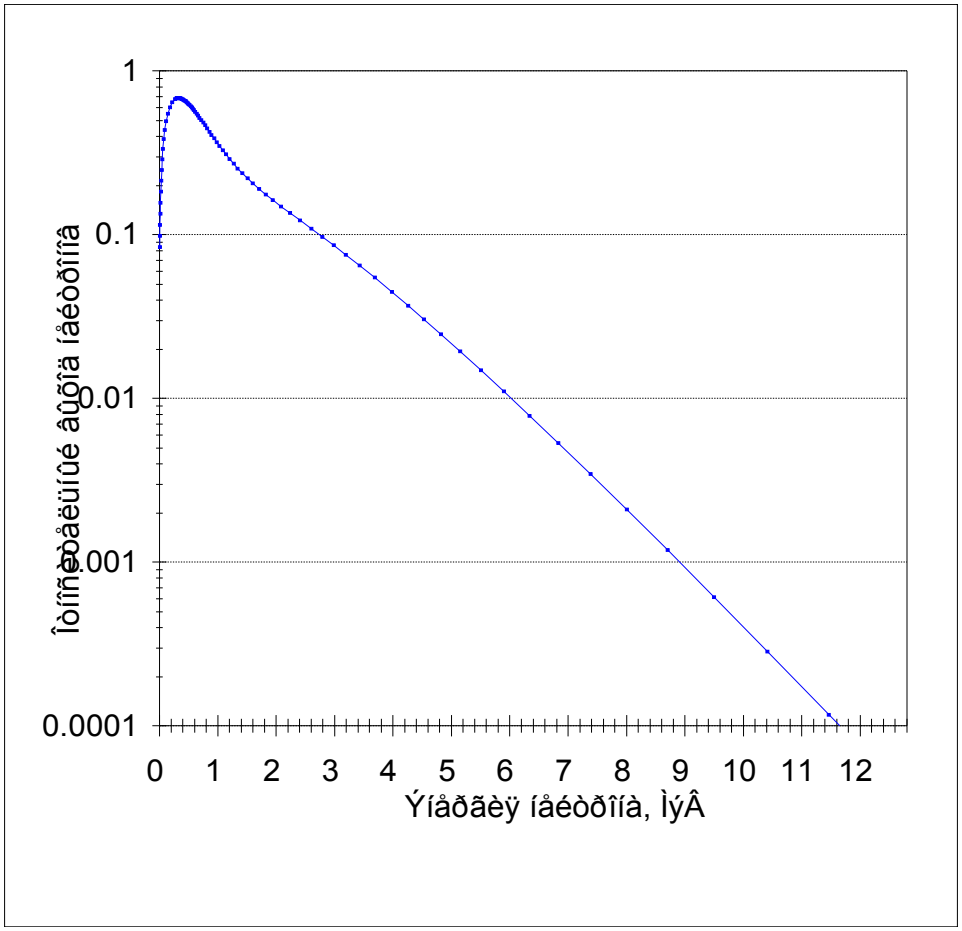


Fig. 3-5. Energy range of the differential neutron data measurements

Integral experiments (VNIIEF)

- **KS-1 critical assembly at the experimental FKBN-2M facility**





Total Russian program of experiments

Fission cross section measurements of Pu-238, Am-241,Am-242m, Am-243, Cm-243, Cm-244, Cm-245, Cm-246, Cm-247, Cm-248 in the neutron energy range from 0.1 eV to 30 keV (**LSDS**).

Fission cross section measurements of Pu-238, Am-241, Am-242m, Am-243, Cm-243, Cm-244, Cm-245, Cm-246, Cm-247, Cm-248 in the neutron energy range from 5 to 20 MeV (**electrostatic accelerators**).

Fission cross section measurements of Np-237, Pu-238, Am-241, Am-242m, Am-243, in the neutron energy range from 40 keV to 10 MeV (**LU-50**).

Integral experiment of all set of MA (**FKBN-2M facility**)

Final goal of Russian program

- New experimental data for MA fission cross section in the neutron energy range from 0.1 eV to 20 Mev.
- New theoretical calculations of MA partial cross sections.
- Chance analysis of fission cross sections for chains of Am and Cm isotopes (2 ÷50 MeV).
- New MA fission cross section evaluations in fast reactor neutron energy region.
- New nuclear data files for MA.