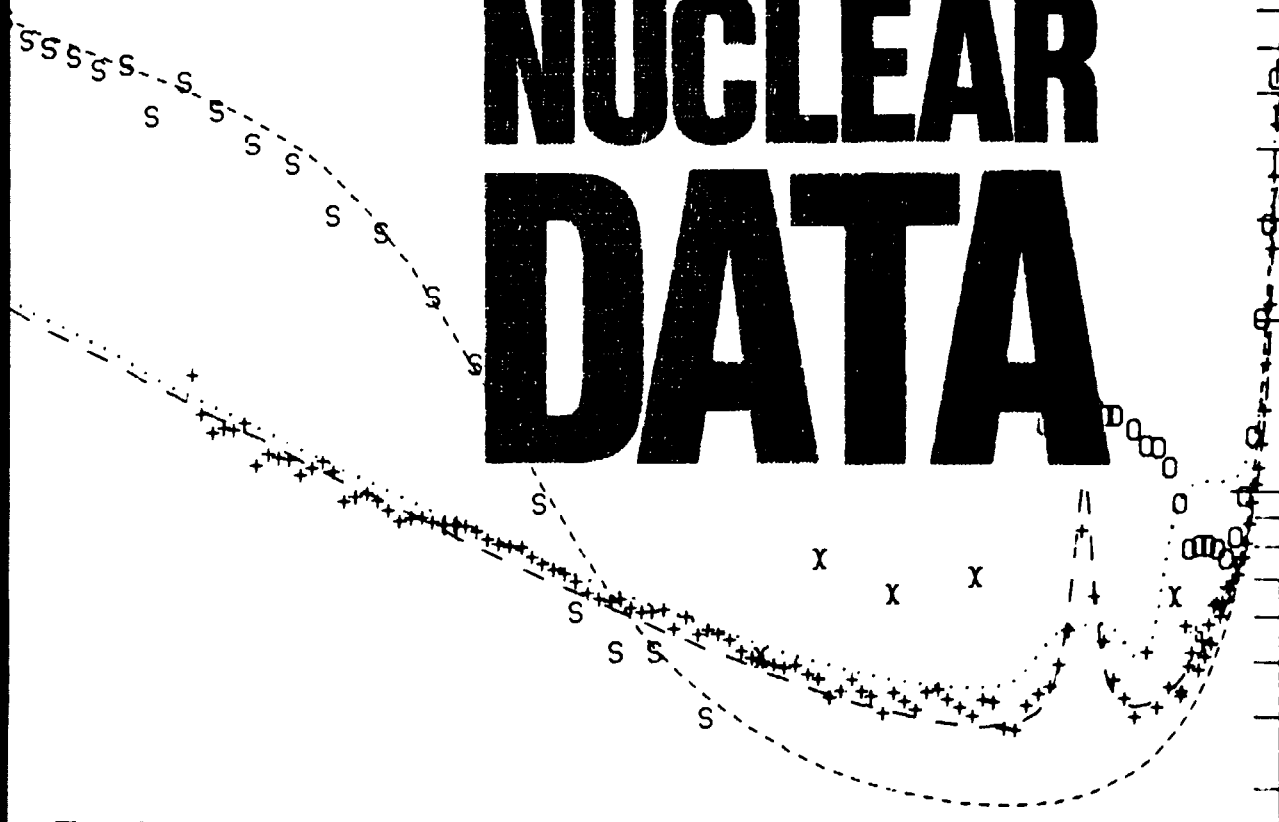
KDK-35
NEANDC(OR) 153/L
INDC(SWD) 13/L
SKI B32/78

COMPILATION OF ACTINIDE NEUTRON NUCLEAR DATA



SWEDISH NUCLEAR DATA COMMITTEE · ACTINIDE NUCLEAR DATA WORKING GROUP

STOCKHOLM 1979

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Stockholm

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CONTENTS

1. INTRODUCTION

The neutron cross sections for ^{235}U, ^{238}U and ^{239}Pu are of main importance in reactor physics calculations. Recently, an increased interest has been expressed in neutron cross section data for ^{232}Th and ^{233}U but also for the higher Pu-isotopes and the Am- and Cm-isotopes. This is related to the discussions of using the ^{232}Th cycle as an alternative fuel cycle for fission reactors and to investigations of different possibilities to handle and store nuclear waste. Thus, the neutron cross sections for the higher actinides are for instance needed to calculate the production rates of ^{241}Am and ^{244}Cm in a fission reactor and to study different schemes for nuclear incineration of the actinides by neutron irradiation.

Consequently, the Swedish Nuclear Data Committee initiated a compilation of a selected set of neutron cross section data for the 16 most important actinide isotopes. The compilation work has been done by a working group consisting of experts in experimental nuclear physics. The work has been sponsered by the Swedish Board for Energy Source Development and the Swedish Nuclear Power Inspectorate.

The main part of the data information has been obtained from the OECD/NEA Nuclear Data Bank at Saclay, Frankrike. It consists of 5 evaluated neutron data libraries used in USA, Japan and Western Europe (including Sweden) and of a file (NEUDADA) of experimental neutron data. Besides, recent experimental data have been obtained from laboratory and conference reports.

The aim of the present report is to present available data in a comprehensible way to allow a comparison between different evaluated libraries and to judge about the reliability of these libraries from the experimental data.

Because of the large amount of experimental data the compilers have in a subjective manner selected a representative subset of these data in each case. Evaluated data are also missing in some cases because the libraries

are not always complete or fully available. Comments about the compilation procedure and certain characteristics of the experimental and evaluated data are given for each isotope. For a complete information about the compiled data the reader is referred to the addresses given in section 5 of this report.

The data are given in graphical form below about 1 eV and above about 10 keV while the 2200 m/s cross sections and resonance integrals are given in numerical form.

The 2200 m/s cross sections and the resonance integrals above 0.5 eV have been processed from the data libraries ENDF/B-IV and ENDL -76 for 16 heavy nuclides. Point-by-point cross sections were processed using the ETOS and DSPENG codes (1,2). Averaging over the epithermal energies was made by the SPENG code (2) using a thermal reactor spectrum. When resonance parameters were given, resonance integrals were calculated using the code DORIX (1). For comparison, data from BNL 325 (1973) and from a list provided by NEA Data Bank, Saclay are also given. As a rule, only experimental data obtained after 1969 were choosen from the NEA Data Bank list. Exceptions are the ^{246}Cm 2200 m/s cross sections and resonance integrals for which no data published later than 1968 could be found.

References

1. Häggblom H
The ETOS and DORIX Programmes for Processing ENDF/B Data
NEACRP-U-52 (1973)

2. Nyman K
SPENG - a computer program for calculation of neutron flux energy spectrum and group cross sections in a fissile homogenous medium.
AB Atomenergi internal report RD-76-131 (1976)

2.1 LIST OF COMPILED CROSS SECTION DATA

Isotopes	Neutron Energy interval	Cross sections
^{232}Th, ^{233}U, ^{235}U, ^{238}U, ^{237}Np, ^{239}Pu, ^{240}Pu, ^{241}Pu, ^{242}Pu, ^{241}Am, ^{243}Am, ^{244}Cm, ^{245}Cm, ^{246}Cm, ^{247}Cm, ^{248}Cm	thermal	$\sigma_t, \sigma_f, \sigma_\gamma, \bar{\nu}_t$
	0.5 eV - 50 keV	RI_γ, RI_f
	$\lesssim$ 1 eV and ~ 10 keV - 20 MeV	$\sigma_t, \sigma_f, \sigma_\gamma$
^{232}Th, ^{233}U, ^{235}U, ^{238}U, ^{239}Pu	thermal - 20 MeV	$\bar{\nu}$
^{235}U, ^{238}U, ^{239}Pu	$\lesssim$ 1 eV and ~ 10 keV - 20 MeV	$\sigma_{n,n}$
^{238}U	threshold - 20 MeV	$\sigma_{n,n'}$ and $\sigma_{n,2n}$

2.2 LIST OF EVALUATED AND EXPERIMENTAL DATA LIBRARIES

ENDF/B: Evaluated Nuclear Data File, Version B, National Neutron Cross Section Center, Brookhaven National Laboratory, Upton, New York 11973

UKNDL: United Kingdom Atomic Energy Authority Nuclear Data Library

ENDL: Lawrence Livermore Laboratory Evaluated Nuclear Data Library, Lawrence Livermore Laboratory, University of California, Livermore, California 94550

KEDAK: Karlsruhe Evaluated Nuclear Data Library, Kernforschungszentrum Karlsruhe, Karlsruhe, Germany

JENDL: Japanese Evaluated Neutron Data Library, Japan Atomic Energy Research Institute, Tokai, Ibaraki, Japan

NEUDADA: (Experimental) Neutron Data under Direct Access, OECD/NEA Nuclear Data Bank, Saclay, France

EXFOR: Computerized system of codes and formats used for the exchange of experimental neutron nuclear data between the Four Neutron Data Centres

BNL 325: Neutron Cross Section Analysis Report, National Neutron Cross Section Center, Brookhaven National Laboratory, Upton, New York 11973

IAEA: International Atomic Energy Agency Evaluation of the 2200 m/s and 20°C Maxwellian Neutron Data for ^{233}U, ^{235}U, ^{239}Pu and ^{241}Pu, Nuclear Data Section, IAEA, Vienna

2.3 QUANTITY DEFINITIONS

Quantity	Definition
σ_t, σ_{tot}	Total neutron cross section
σ_f, σ_{fiss}	Neutron induced fission cross section
σ_γ	Radiative capture cross section
$\sigma_{n,n}$	Total neutron elastic scattering cross section
$\sigma_{n,n'}$	Total neutron inelastic scattering cross section
$\sigma_{n,2n}$	Cross section for neutron induced reactions resulting in the emission of two neutrons
σ^{th}	Cross section for thermal neutrons
RI	Resonance integral (RI_γ = RI for capture, RI_f = RI for fission)
$\bar{\nu}$	Average number of neutrons emitted per fission ($\bar{\nu}_p$ = number of prompt neutrons, $\bar{\nu}_d$ = number of delayed neutrons, $\bar{\nu}^{sp} = \bar{\nu}$ for spontaneous fission, $\bar{\nu}^{th} = \bar{\nu}$ for thermal fission)
$T_{1/2}$	Half life
E_α	Alpha disintegration energy
ν_α	Number of alpha particles of energy E_α per disintegration

$^{232}_{90}Th$

Natural isotopic abundance 100 %

3.1 ^{232}Th

NUCLEAR PROPERTIES (Ref. Nuclear Data Sheets)

Spin and parity of ground state: 0^+

Ground state decay:

$T_{1/2} = 1.41 \times 10^{10}$ y

β stable

spontaneous fission $<10^{-9}$ %

$T_{1/2} > 10^{21}$ y

α to ^{228}Ra, 100 %, $Q_\alpha = 4.082$ MeV

E_α (MeV)	I_α (%)
4.01	77
3.95	23
3.83	0.2

$\gamma(^{228}Ra)$

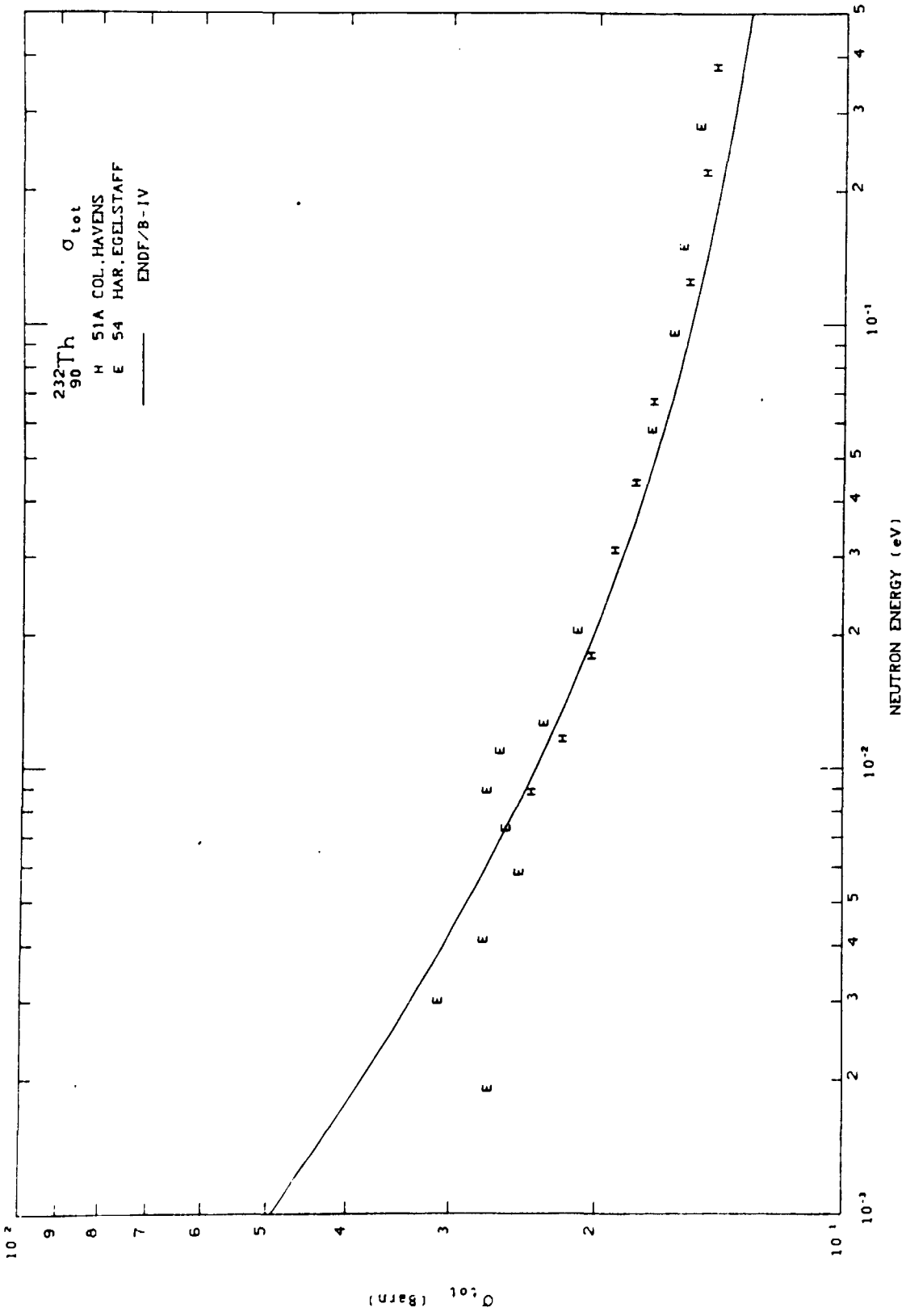
E_γ (keV)	Intensity per 100 α-particles
59	0.15

THERMAL CROSS SECTIONS

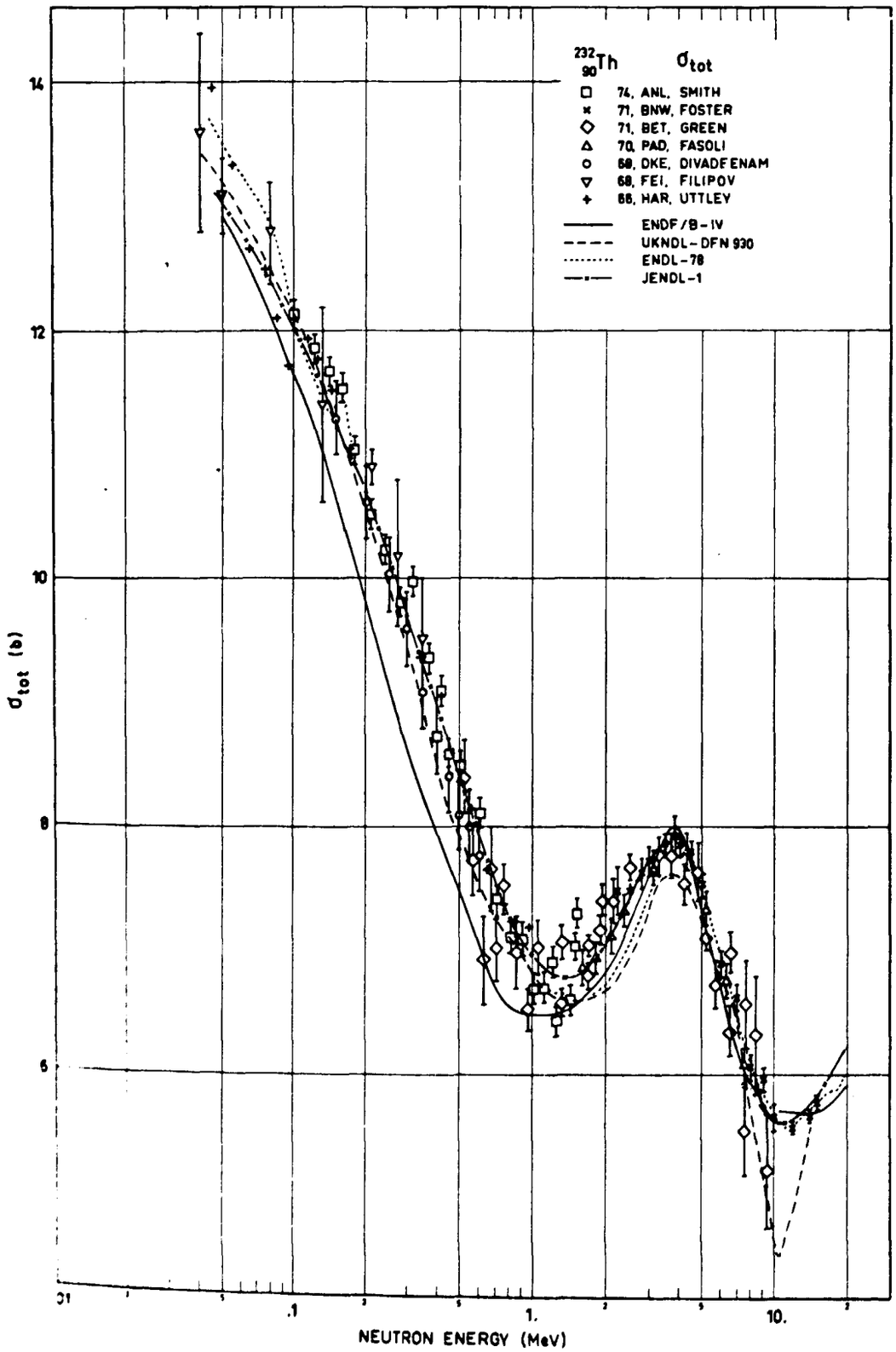
Reference	σ_γ barns	σ_f barns	σ_t barns
ENDF/B - IV	7.41	0.00	19.2
ENDF/B - V	7.40		
BNL 325 (1973)	7.40	0.04	20.1

RESONANCE INTEGRALS

Reference	RI_γ barns	RI_f barns
ENDF/B - IV	83.6	0.0
BNL 325 (1973)	85	0.0
MUGHABGHAB,ALIAN	86	

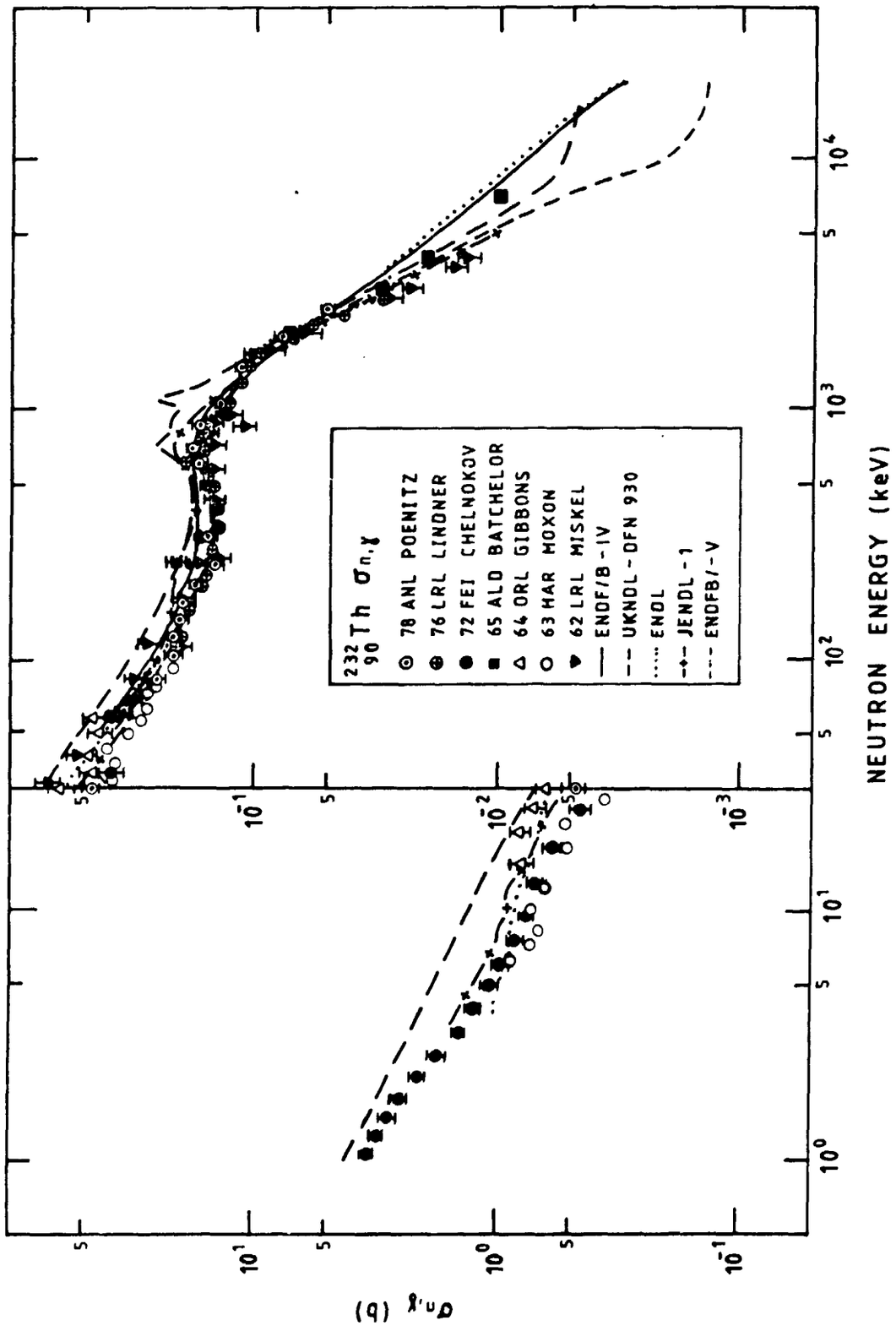

$^{232}_{90}Th$
H 51A COL.HAVENS
E 54 HAR.EGELSTAFF
ENDF/B-IV
σ_{tot}
σ_{tot} (barn)
NEUTRON ENERGY (eV)

$^{232}_{90}Th$


$^{232}_{90}Th$ σ_{tot}
74, ANL, SMITH
71, BNW, FOSTER
71, BET, GREEN
70, PAD, FASOLI
68, DKE, DIVADFENAM
68, FEI, FILIPOV
66, HAR, UTTLEY
ENDF/B-IV
UKNDL-DFN 930
ENDL-78
JENDL-1
14
12
10
8
6
σ_{tot} (b)
.01
.1
1.
10.
NEUTRON ENERGY (MeV)

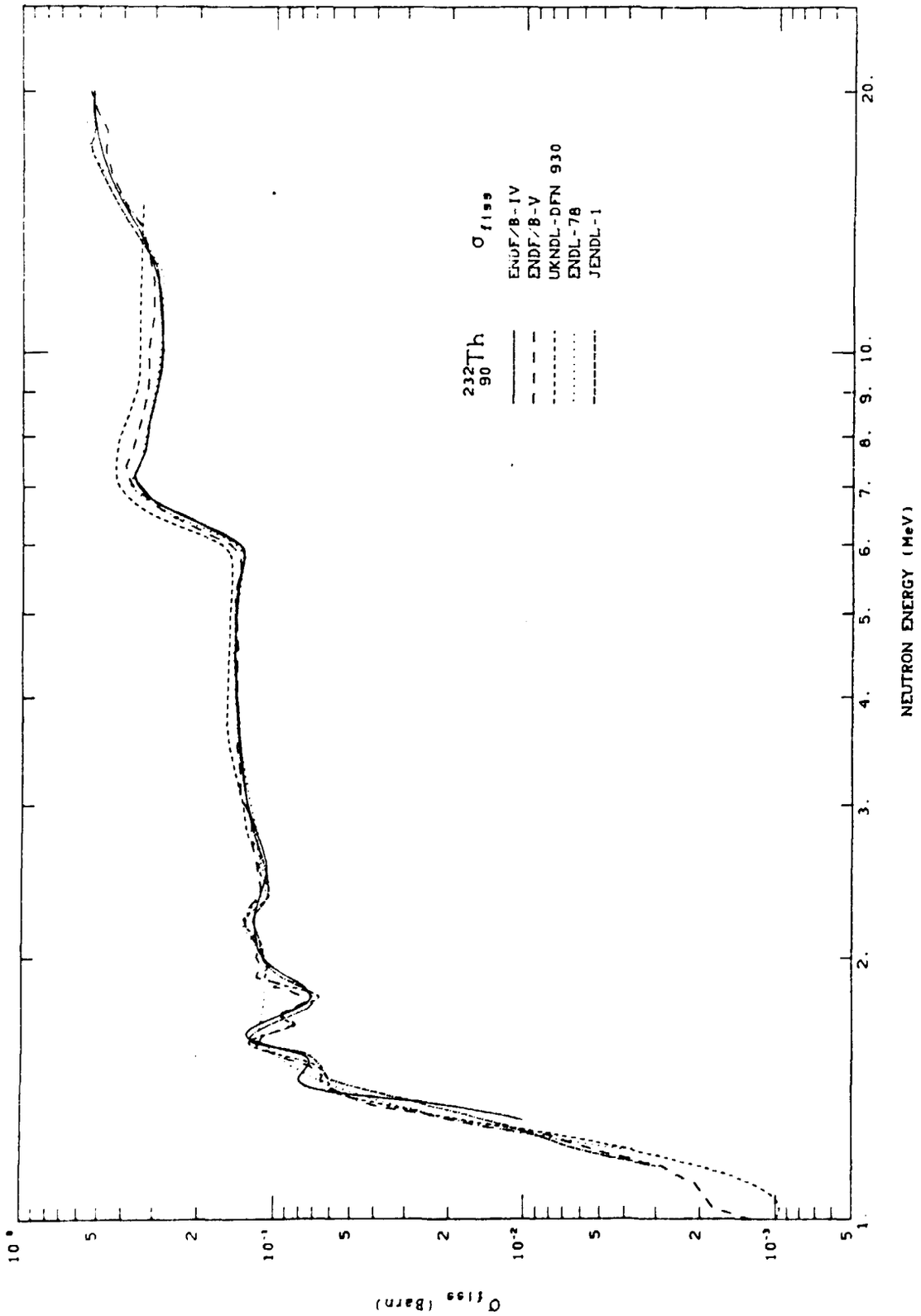
Experimental information ^{232}Th, σ_{tot}

Reference	Points	Range	Standard	Error	Comments
51A COL, HAVENS	66	0.01-5.8 eV	ABS.		
54 HAR, EGELSTAFF	52	0.002-2.5 eV	ABS.		
66 HAR, UTTLEY	28	6.5-95 keV	ABS.		
68 DKE, DIVADEENAM	10	150-600 keV	ABS.	4 %	
68 FEI, FILIPOV	8	20-350 keV	ABS.	3-5 %	
70 PAD, FASOLI	139	1.5-8.6 MeV	ABS.	1-2 %	
71 BET, GREEN	356	0.5-9.6 MeV	ABS.	2-3 %	
71 BNW, FOSTER	242	2.3-14.9 MeV	ABS.	1-3 %	
74 ANL, SMITH	513	0.1-1.5 MeV	ABS.	2 %	

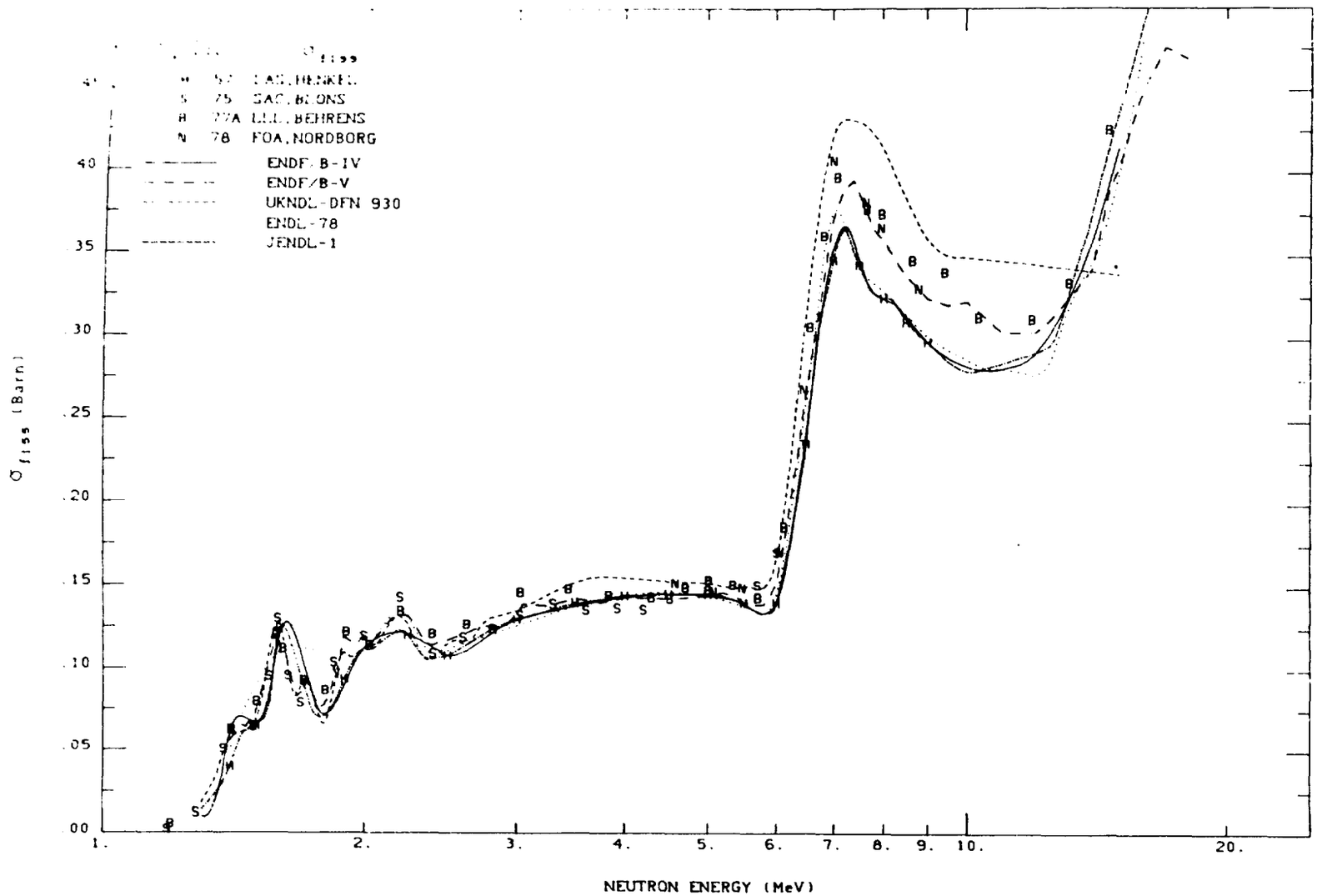

$^{232}_{90}Th$ $\sigma_{n,\gamma}$
78 ANL POENITZ
76 LRL LINDNER
72 FEI CHELNOKOV
65 ALD BATCHELOR
64 ORL GIBBONS
63 HAR MOXON
62 LRL MISKEL
ENDF/B-IV
UKNDL-DFN 930
ENDL
JENDL-1
ENDFB/-V
NEUTRON ENERGY (keV)
$\sigma_{n,\gamma}$ (b)

Experimental information ^{232}Th, σ_γ

	Reference	Points	Range	Standard	Error	Comments
62	LRL, MISKEL	26	0.03-4 MeV	^{235}U, σ_f	10 %	Data renorm. to ^{235}U, σ_f BNL-325 (1964) Energy spread 2-30 %
63	HAR, MOXON	98	5.5-148 keV			
64	ORL, GIBBONS	127	10-58.5 keV		10-30 %	The data points given represent average values for the energy intervals $(E_n-10^{-2}E_n)$ - $(E_n+10^{-2}E_n)$
65	ALD, BATCHELOR	4	2-7 MeV			
72	FEI, CHELNOKOV	26	0.2-35 keV	^{197}Au, σ_γ	6-13 %	
76	LRL, LINDNER	30	0.1-2.7 MeV	^{235}U, σ_f	0.6-4 %	Energy spread 1- 61 %
78	ANL, POENITZ	23	30-850 keV	^{235}U, σ_f and ^{197}Au, σ_γ	5-10 %	Energy spread 1-10 %


$^{232}_{90}Th$
σ_{fiss}
ENDF/B-IV
ENDF/B-V
UKNDL-DFN 930
ENDL-78
JENDL-1
σ_{fiss} (Barn)
NEUTRON ENERGY (MeV)
10^{0}
5
2
10^{-1}
5
2
10^{-2}
5
2
10^{-3}
5
1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
20.

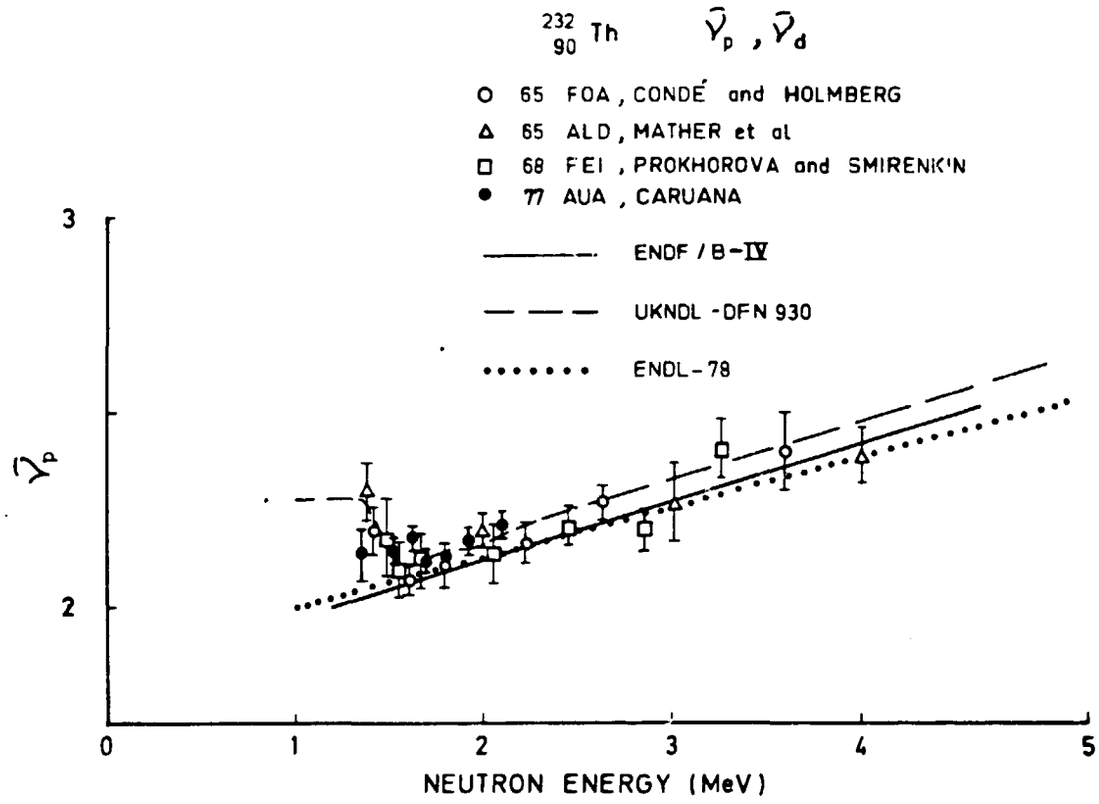
$^{232}_{90}Th$

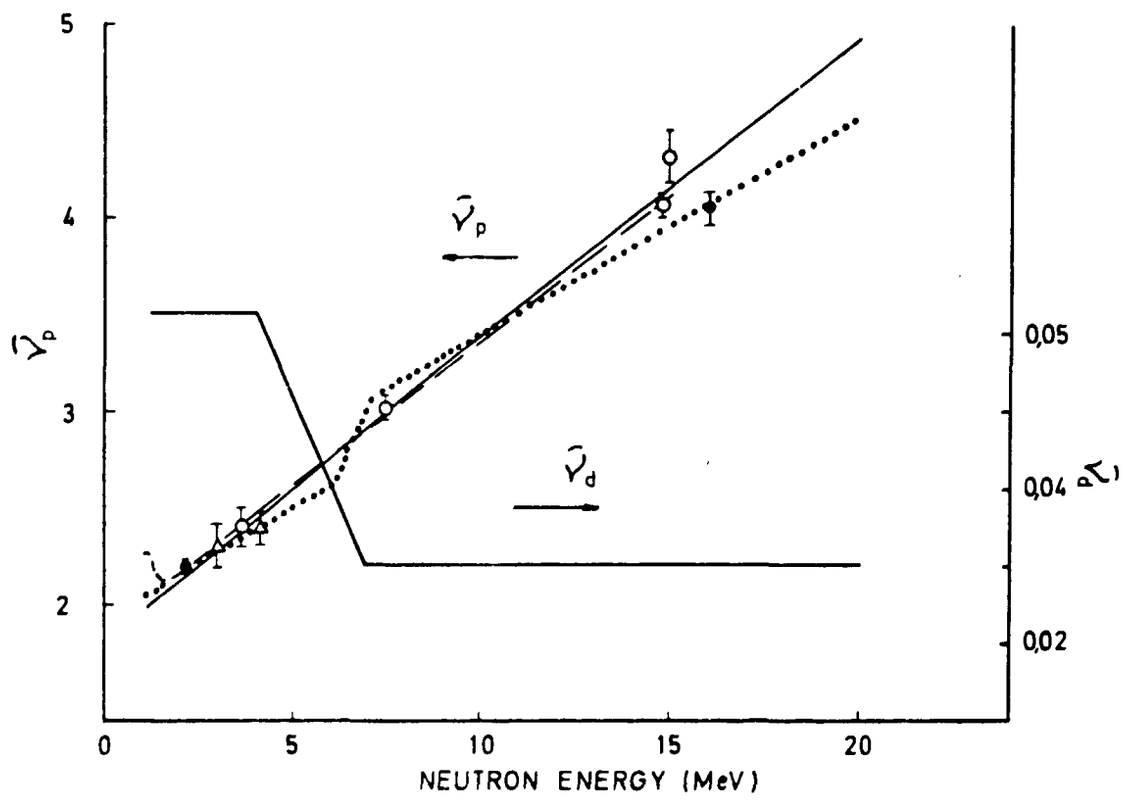

σ fiss
H 57 LAS,HENKEL
S 75 SAC,BLONS
B 77A LLL,BEHRENS
N 78 FOA,NORDBORG
ENDF/B-IV
ENDF/B-V
UKNDL-DFN 930
ENDL-78
JENDL-1
σ fiss (Barn)
.40
.35
.30
.25
.20
.15
.10
.05
.00
1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
20.
NEUTRON ENERGY (MeV)

Experimental information ^{232}Th, σ_{fiss}

Reference	Points	Range	Standard	Error	Comments
57 LAS, HENKEL	209	1-9 MeV	^{235}U, σ_f		
75 SAC, BLONS	823	1-6 MeV		2 %	Norm. to integrated ^{232}Th, σ_f between 1.4-2 MeV from UKNDL-DFN 930. Stat. error
77A LLL, BEHRENS	145	0.7-30 MeV	^{235}U, σ_f		
78 FOA, NORDBORG	23	4.6-8.8 MeV	^{235}U, σ_f	2 %	Stat. error
79 ANL, MEADOWS		1.2-10 MeV	^{235}U, σ_f	1.5 %	Late reference not presented in the figure

General comments: Experimental data from ratio measurements given in the figures are calculated using cross sections from ENDF/B-IV as standards


$^{232}_{90}$ Th $\bar{\nu}_p$, $\bar{\nu}_d$
65 FOA , CONDÉ and HOLMBERG
65 ALD , MATHER et al
68 FEI , PROKHOROVA and SMIRENKIN
77 AUA , CARUANA
ENDF / B-IV
UKNDL - DFN 930
ENDL-78
$\bar{\nu}_p$
NEUTRON ENERGY (MeV)


$\bar{\nu}_p$
$\bar{\nu}_d$
NEUTRON ENERGY (MeV)

3.2 ^{233}U

NUCLEAR PROPERTIES (Ref. Nuclear Data Sheets)

Spin and parity of ground state: $5/2^+$

Ground state decay:

$T_{1/2} = 1.592 \times 10^5$ y

α to ^{229}Th, 100%, $Q_\alpha = 4.909$ MeV

E_α (MeV)	I_α (%)
4.824	84.4
4.784	13.2
4.729	1.6

$\gamma(^{229}Th)$

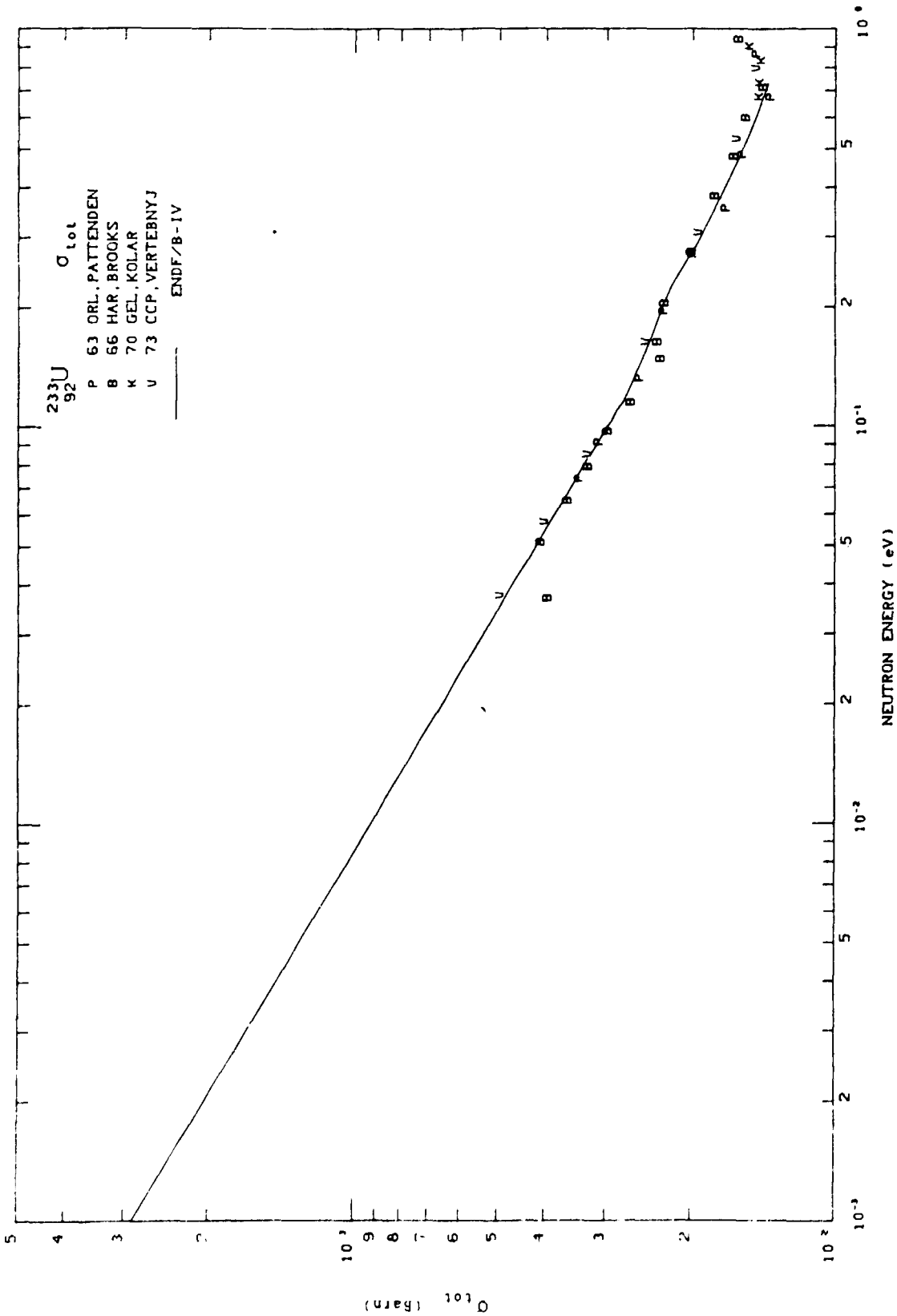
E_γ (keV)	Intensity per 100 α particles, $\times 10^{-2}$
42.5	6.03
97.1	2.22
54.7	1.40
317.2	0.82
164.5	0.67
146.4	0.63
291.3	0.58

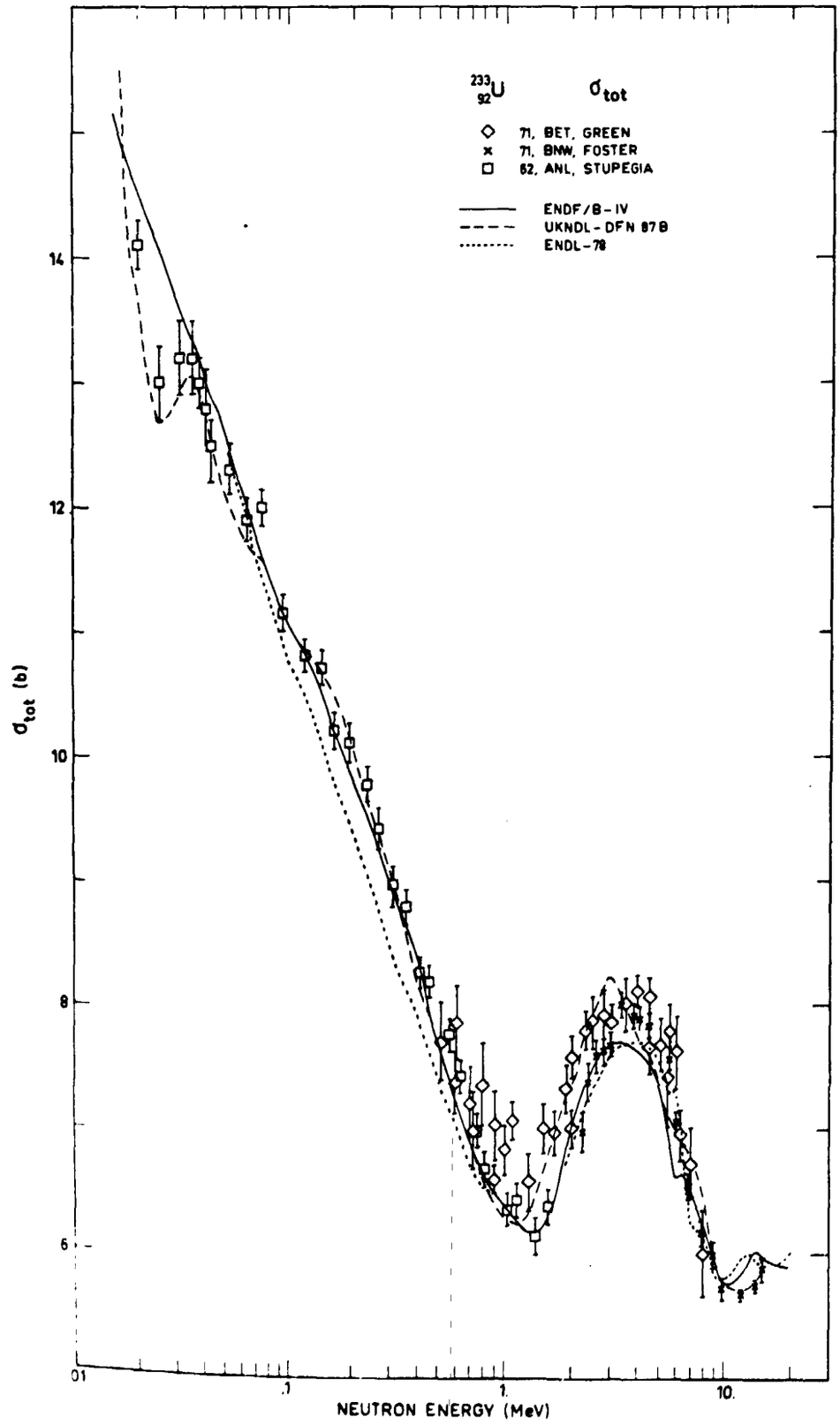
THERMAL CROSS SECTIONS

Reference	σ_γ barns	σ_f barns	σ_t barns	$\bar{\nu}_t$ barns
ENDF/B - IV	45.8	524.3	585.4	2.498
ENDL -76	45.9	525.1		
IAEA-3 (1975)	45.3	529.9	587.3	2.479
BNL 325 (1973)	47.7	531.1	587.0	2.492
71 KAP, CABELL	48.3			

RESONANCE INTEGRALS

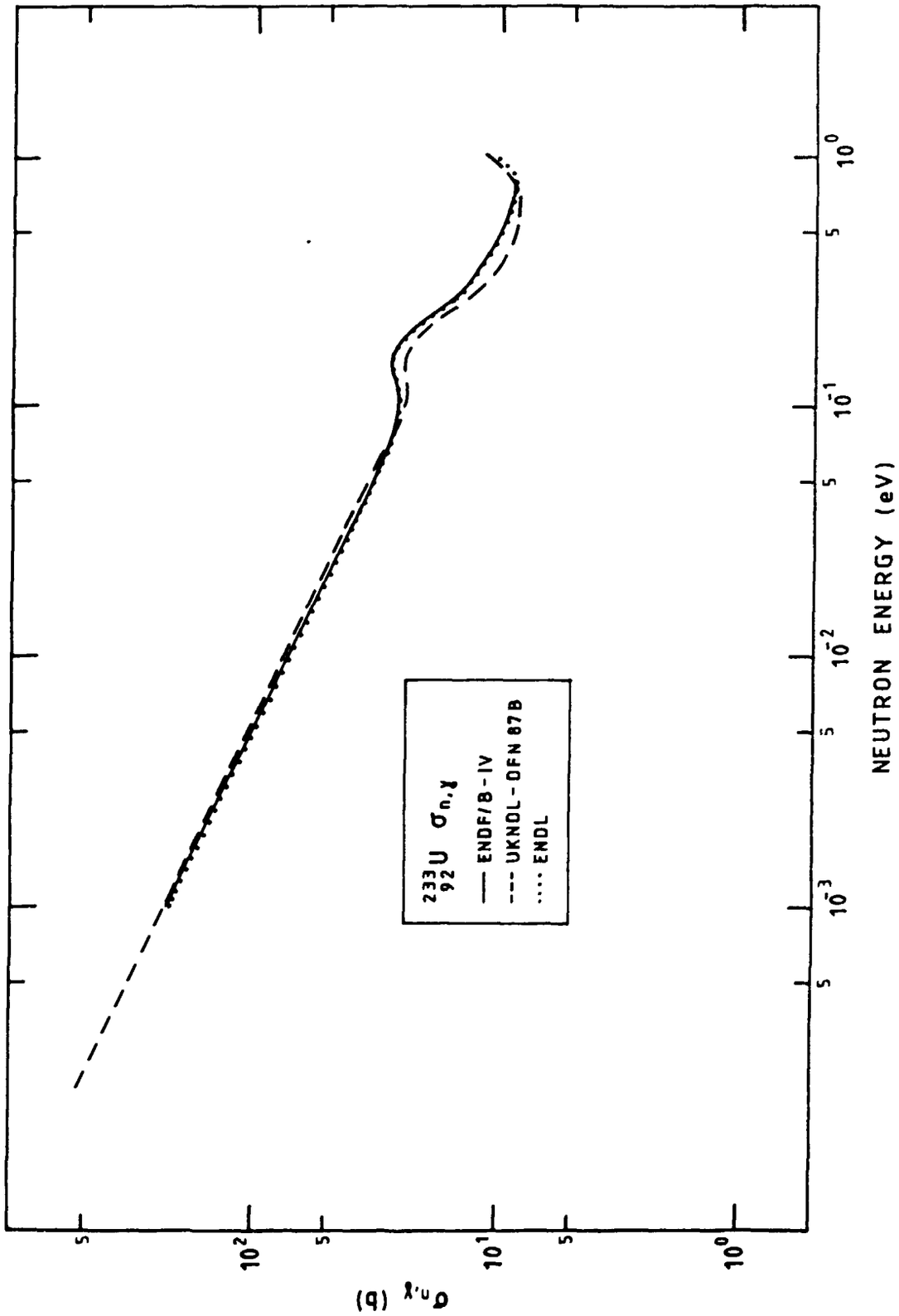
Reference	RI_γ barns	RI_f barns
ENDF/B IV	142.2	702.9
ENDL -76	125.1	700.2
BNL 325 (1973)	140	764
KAP, EILAND	146	830


$^{233}_{92}U$
σ_{tot}
P 63 ORL, PATTENDEN
B 66 HAR, BROOKS
K 70 GEL, KOLAR
U 73 CCP, VERTEBNYJ
ENDF/B-IV
NEUTRON ENERGY (eV)
σ_{tot} (barn)

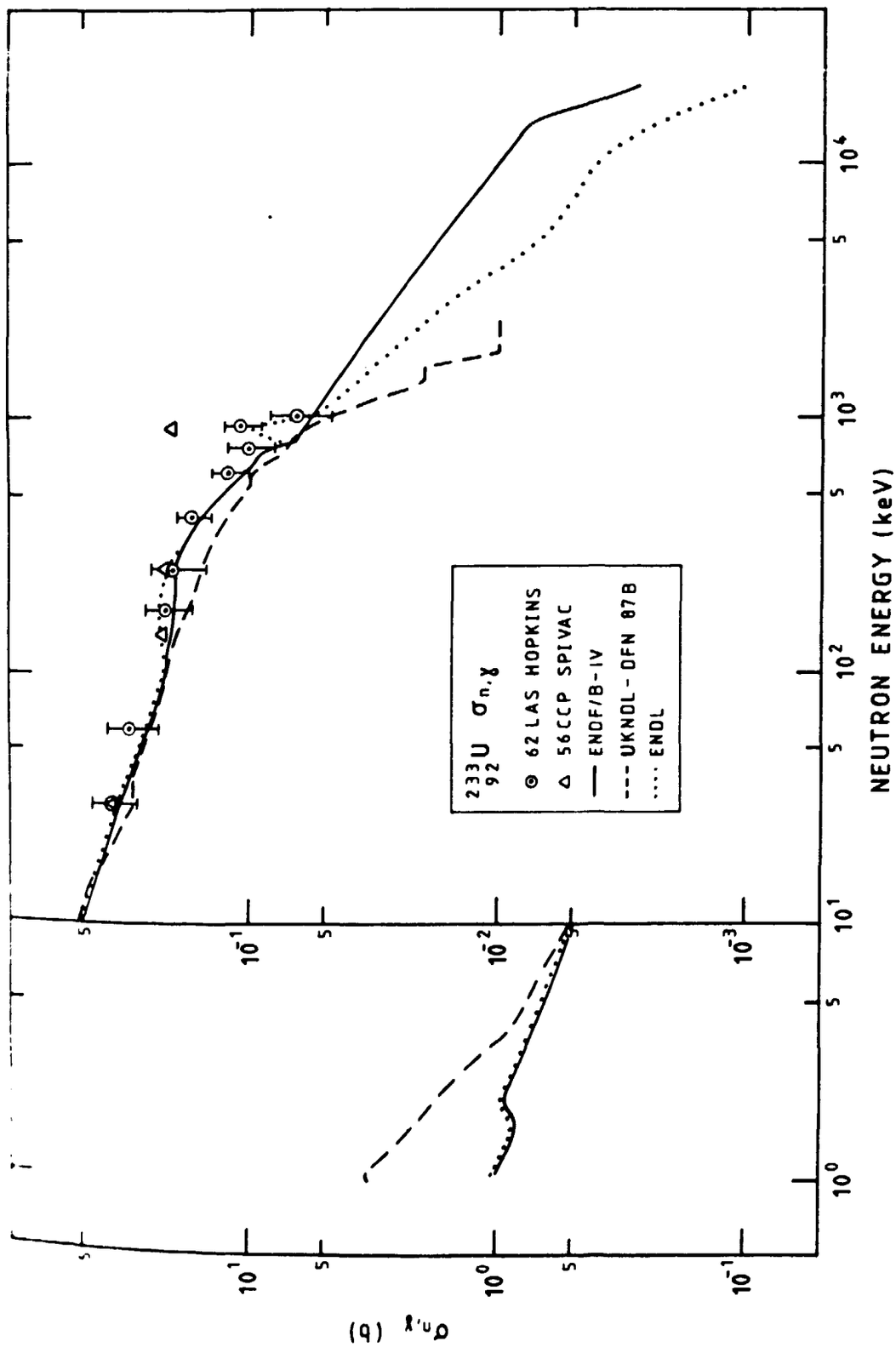

$^{233}_{92}U$ σ_{tot}
71, BET, GREEN
71, BNW, FOSTER
62, ANL, STUPEGIA
ENDF/B-IV
UKNDL-DFN 87B
ENDL-78
14
12
10
8
6
σ_{tot} (b)
.01
.1
1.
10.
NEUTRON ENERGY (MeV)

Experimental information ^{233}U, σ_{tot}

	Reference	Points	Range	Standard	Error	Comments
62	ANL, STUPEGIA	45	3.4 keV-1.6 MeV	ABS.		
63	ORL, PATTENDEN	1 512	0.07 eV-8.8 keV			
66	HAR, BROOKS	663	0.035-11 eV		1-3 %	
70	GEL, KOLAR	3 189	0.7-320 eV	ABS.	0.6-1.5 %	Stat. error
71	BET, GREEN I	336	0.9-10 MeV	ABS.	1-3 %	Sample 0.114 atoms/b
71	BET, GREEN II	360	0.5-8 MeV	ABS.	1-3 %	Sample 0.962 atoms/b
71	BNW, FOSTER	244	2.3-15 MeV	ABS.	1-3 %	
73	CCP, VERTEBNYJ	29	0.035-1 eV	ABS.	1.5 %	

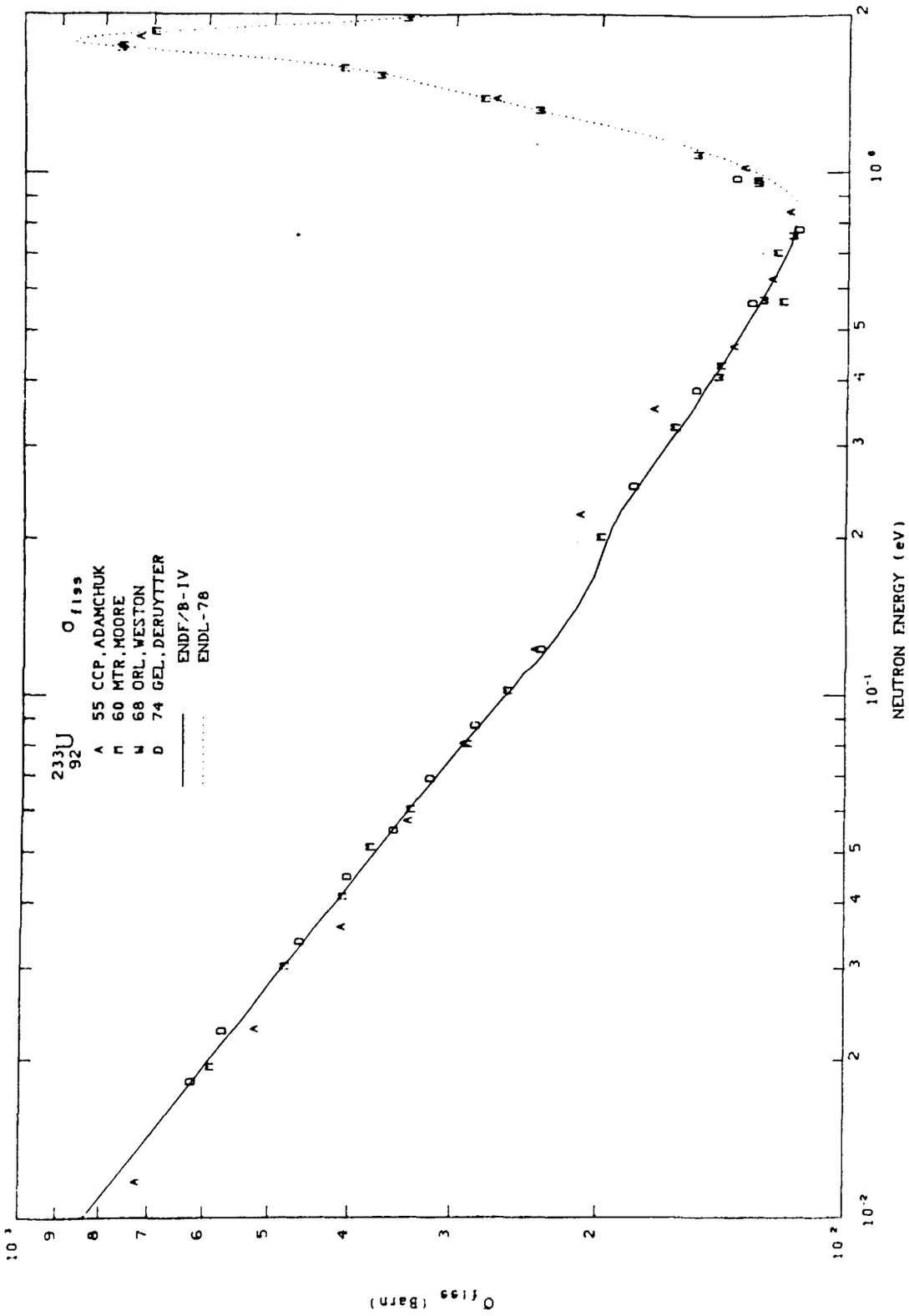

$^{233}_{92}U$ $\sigma_{n,\gamma}$
ENDF/B-IV
UKNDL-DFN 87B
ENDL
$\sigma_{n,\gamma}$ (b)
NEUTRON ENERGY (eV)
10^0
10^1
10^2
10^{-3}
10^{-2}
10^{-1}
10^0

$^{233}_{92}U$

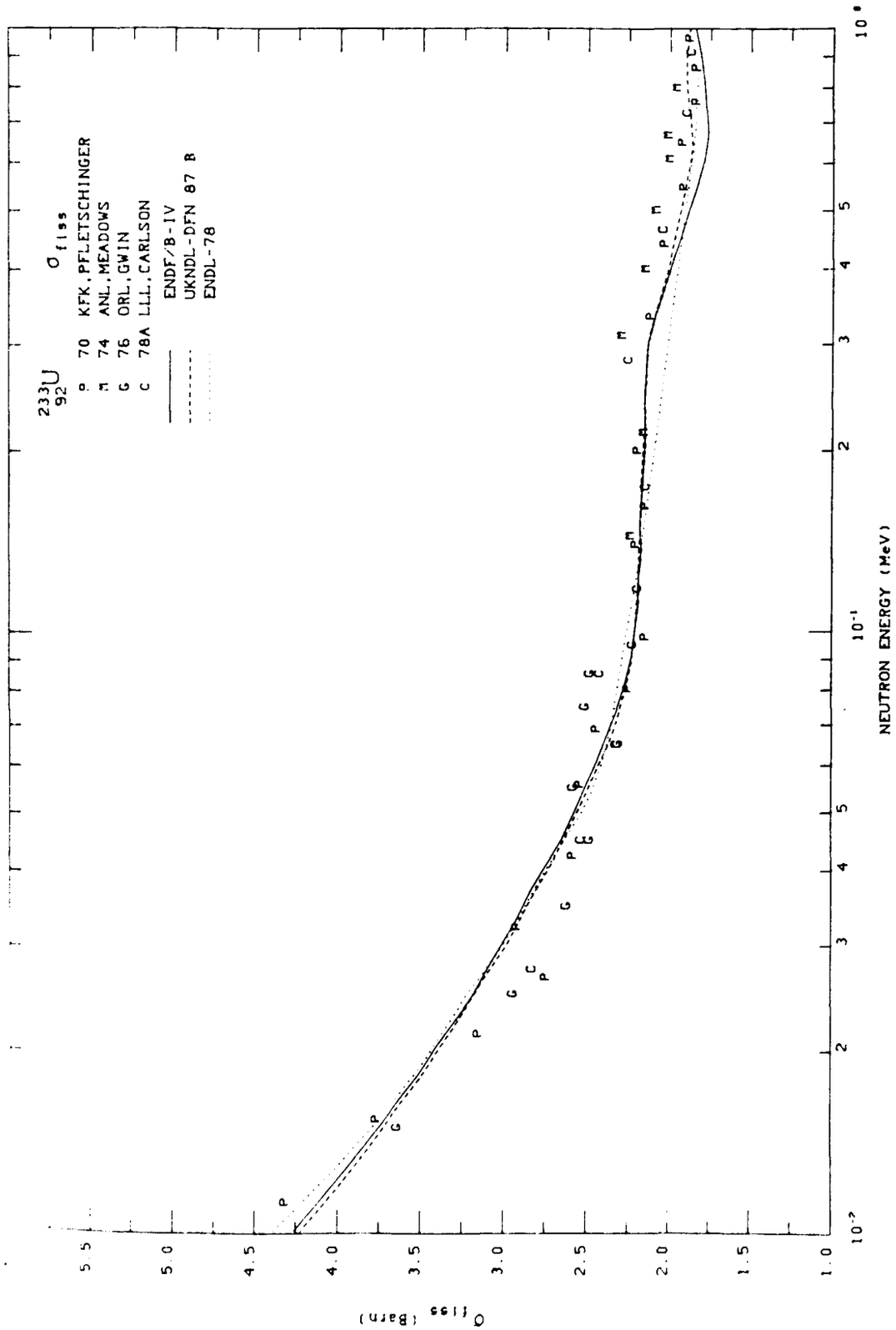

$^{233}_{92}U$ $\sigma_{n,\gamma}$
62 LAS HOPKINS
56CCP SPIVAC
ENDF/B-IV
UKNDL-DFN 87B
ENDL
NEUTRON ENERGY (keV)
$\sigma_{n,\gamma}$ (b)

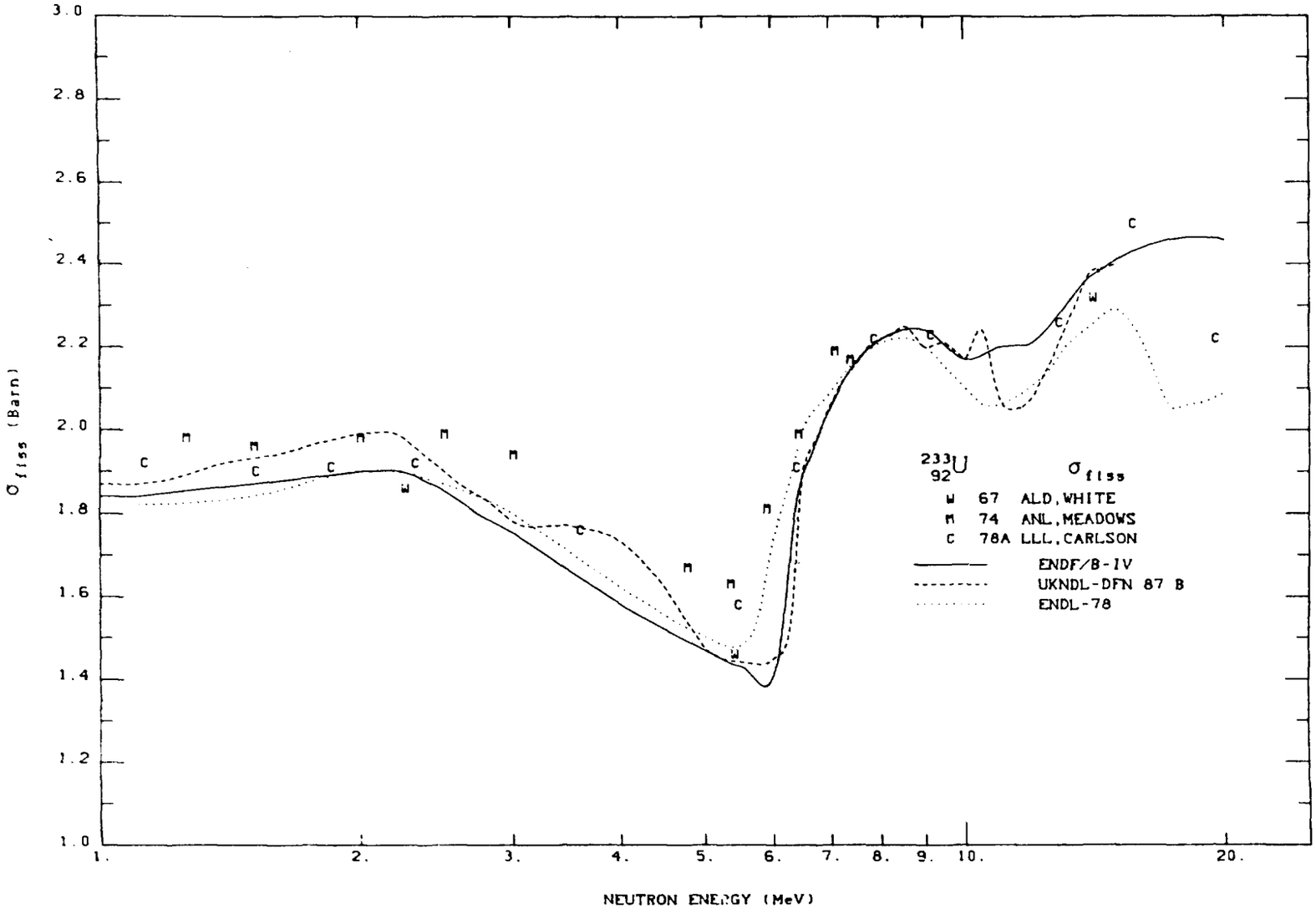
Experimental information ^{233}U, σ_γ

	Reference	Points	Range	Standard	Error	Comments
56	CCP, SPIVAC	4	30-900 keV	^{235}U, σ_f		
62	LAS, HOPKINS	9	0.03-1 MeV	^{233}U, σ_f	14-24 %	Renorm. to BNL-325(1965), σ_f


$^{233}_{92}U$
σ fiss
A 55 CCP, ADAMCHUK
m 60 MTR, MOORE
W 68 ORL, WESTON
D 74 GEL, DERUYTTER
ENDF/B-IV
ENDL-78
NEUTRON ENERGY (eV)
σ fiss (Barn)

$^{233}_{92}U$


$^{233}_{92}U$
σ_{fiss}
P 70 KFK, PFLETSCHINGER
M 74 ANL, MEADOWS
G 76 ORL, GWIN
C 78A LLL, CARLSON
ENDF/B-IV
UKNDL-DFN 87 B
ENDL-78
σ_{fiss} (Barn)
NEUTRON ENERGY (MeV)
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
10^{-2}
10^{-1}
10^{0}

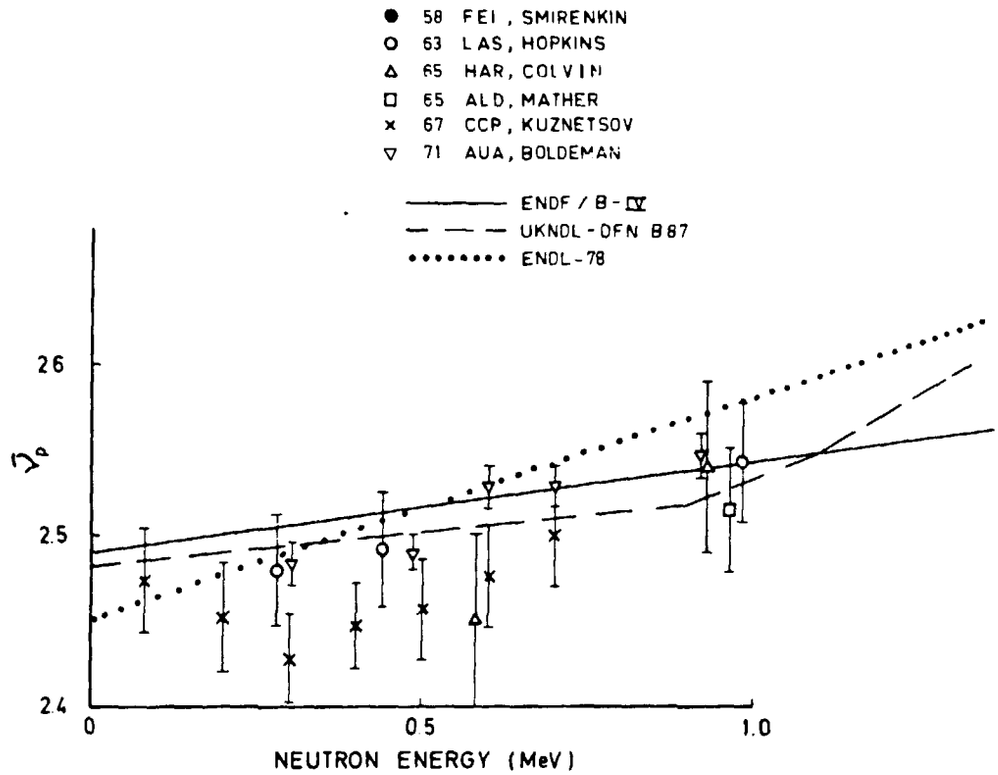

$^{233}_{92}U$
σ_{fiss}
W 67 ALD,WHITE
M 74 ANL,MEADOWS
C 78A LLL,CARLSON
ENDF/B-IV
UKNDL-DFN 87 B
ENDL-78
σ_{fiss} (Barn)
NEUTRON ENERGY (MeV)
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
20.

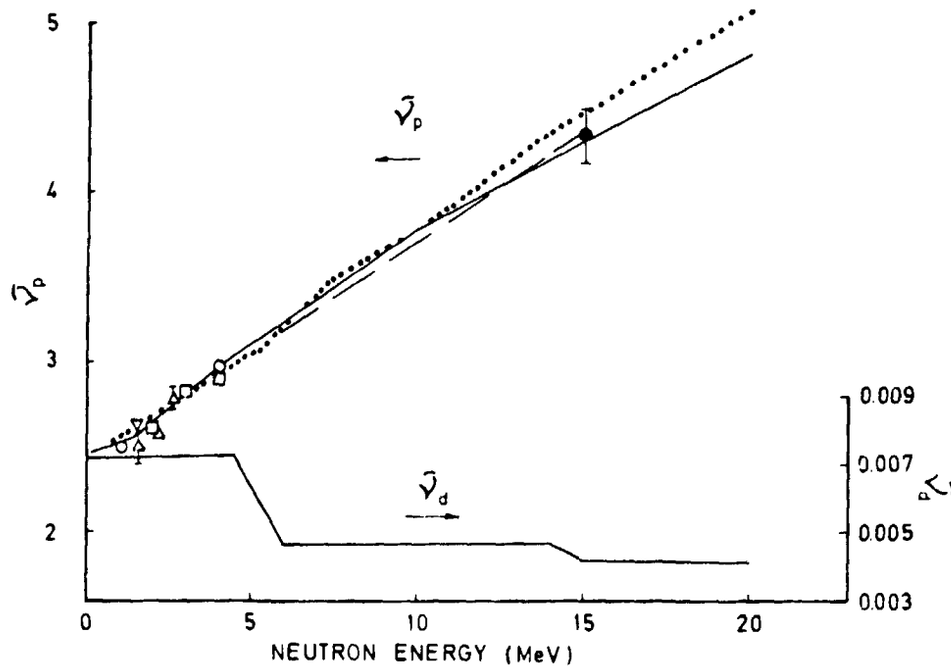
Experimental information ^{233}U, σ_{fiss}

	Reference	Points	Range	Standard	Error	Comments
55	CCP, ADAMCHUK	224	0.01 eV-0.7 keV	^{233}U, σ_f^{th}		
60	MTR, MOORE	953	0.02 eV-1 keV	^{233}U, σ_f^{th}		
67	ALD, WHITE	4	1-14 MeV	^{235}U, σ_f	2 %	Error in relative value
68	ORL, WESTON	3 416	0.4 eV-2 keV	^{233}U, σ_{tot}^{th}	3-4 %	Data norm. to σ_{tot} from 63 ORL, PATTENDEN
70	KFK, PFLETSCHINGER	49	5.2-1 015 keV	^{235}U, σ_f	1.6-2.7 %	Error in relative value
74	ANL, MEADOWS	20	0.1-7.5 MeV	^{235}U, σ_f	1 %	Error in relative value
74	GEL, DERUYTTER	1 121	0.018-30 eV	^{233}U, σ_f^{th}		Two series of measurements 0.018-10 eV and 0.5-30 eV. Abs. fission integral $\int_{8.1\ eV}^{17.6\ eV} \sigma_f(E)dE = (968.7 \pm 10)$ b·eV
76	ORL, GWIN	12	0.02-200 keV	^{235}U, σ_f	5-8 %	Error in relative value
78A	LLL, CARLSON	107	1 keV-30 MeV	^{235}U, σ_f	2-4 %	

General comments: Experimental data from ratio measurements given in the figures are calculated using cross sections from ENDF/B-IV as standards

$^{233}_{92}U$ $\bar{\nu}_p$, $\bar{\nu}_d$





Experimental information ^{233}U, $\bar{\nu}$

	Reference	Points	Range	Standard	Error	Comments
58	FEI, SMIRENKIN	2	4 and 15 MeV	^{233}U, $\bar{\nu}_p^{th}$	4 %	
63	LAS, HOPKINS	5	0.3-3.9 MeV	^{252}Cf, $\bar{\nu}_p^{sp}$	1.5 %	Stat. error
65	ALD, MATHER	4	1-4 MeV	^{252}Cf, $\bar{\nu}_p^{sp}$	1.5 %	
65	HAR, COLVIN	5	0.6-2.6 MeV	^{252}Cf, $\bar{\nu}_p^{sp}$	2-4 %	
67	CCP, KUZNETSOV	7	0.08-0.7 MeV	^{233}U, $\bar{\nu}_p^{0.4\ MeV}$	1.5 %	$\bar{\nu}^{th}/\bar{\nu}^{0.4\ MeV}=1.010$
71	AUA, BOLDEMAN	7	0.3-1.9 MeV	^{252}Cf, $\bar{\nu}_p^{sp}$	0.5-1 %	

General comments: Data normalized to $\bar{\nu}_p^{sp}(^{252}Cf) = 3.756$ and $\bar{\nu}_p^{th}(^{233}U) = 2.480$

$^{235}_{92}U$

Natural isotopic abundance 0.720 %

3.3 ^{235}U

NUCLEAR PROPERTIES (Ref. Nuclear Data Sheets)

Spin and parity of ground state: $7/2^-$

Ground state decay:

$T_{1/2} = 7.038 \times 10^8$ y

β stable

spontaneous fission $< 4.2 \times 10^{-8}$ %

α to ^{231}Th, 100 %, $Q_\alpha = 4.679$ MeV

E_α (MeV)	I_α (%)	E_α (MeV)	I_α (%)
4.396	55	4.598	5.0
4.364	11	4.325	4.6
4.370	6	4.556	4.2
4.217	5.7	4.414	2.1

$\gamma(^{231}Th)$

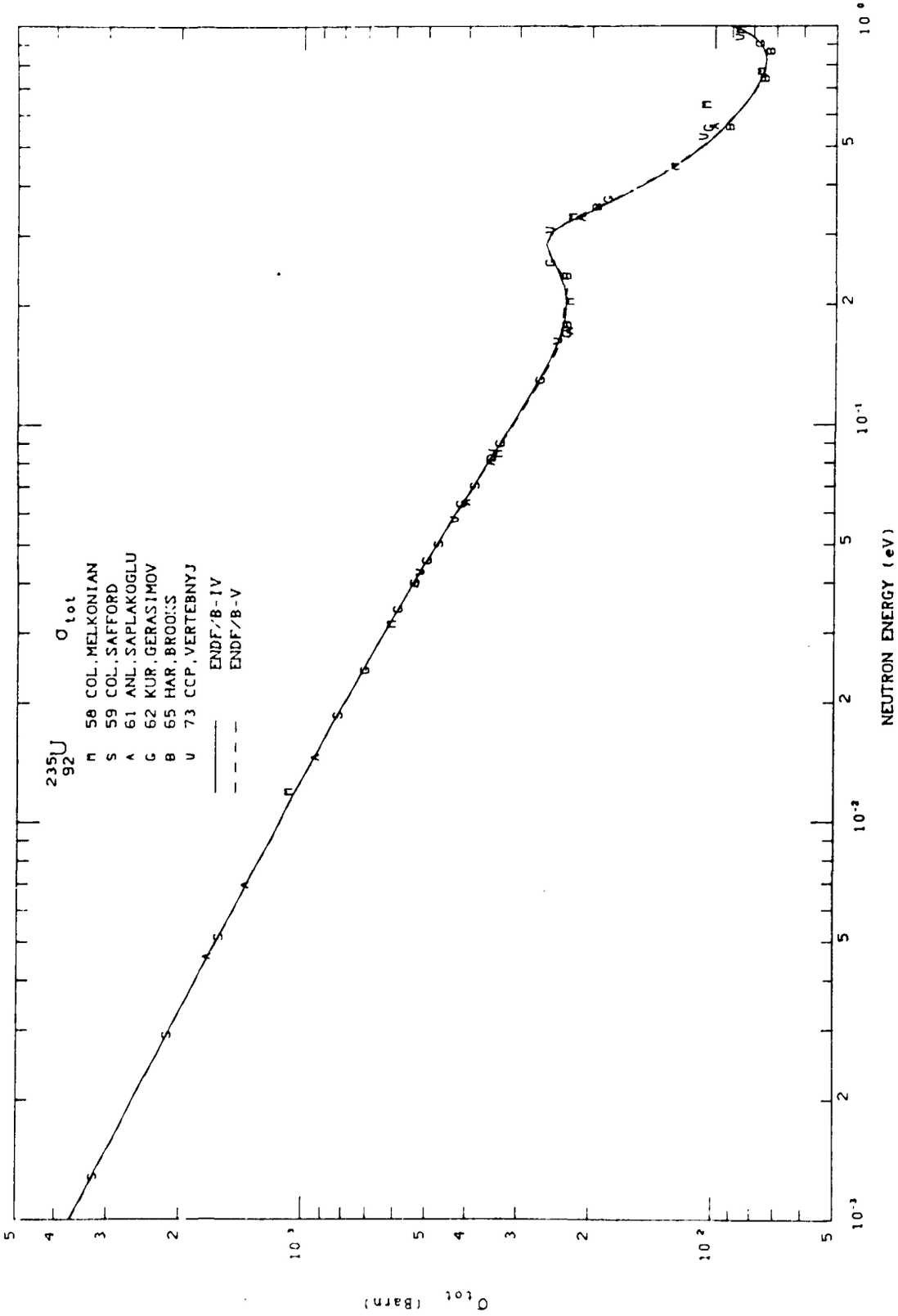
E_γ (keV)	Intensity per 100 α particles
185.7	54
143.8	10.5
163.4	4.7
205.3	4.7

THERMAL CROSS SECTIONS

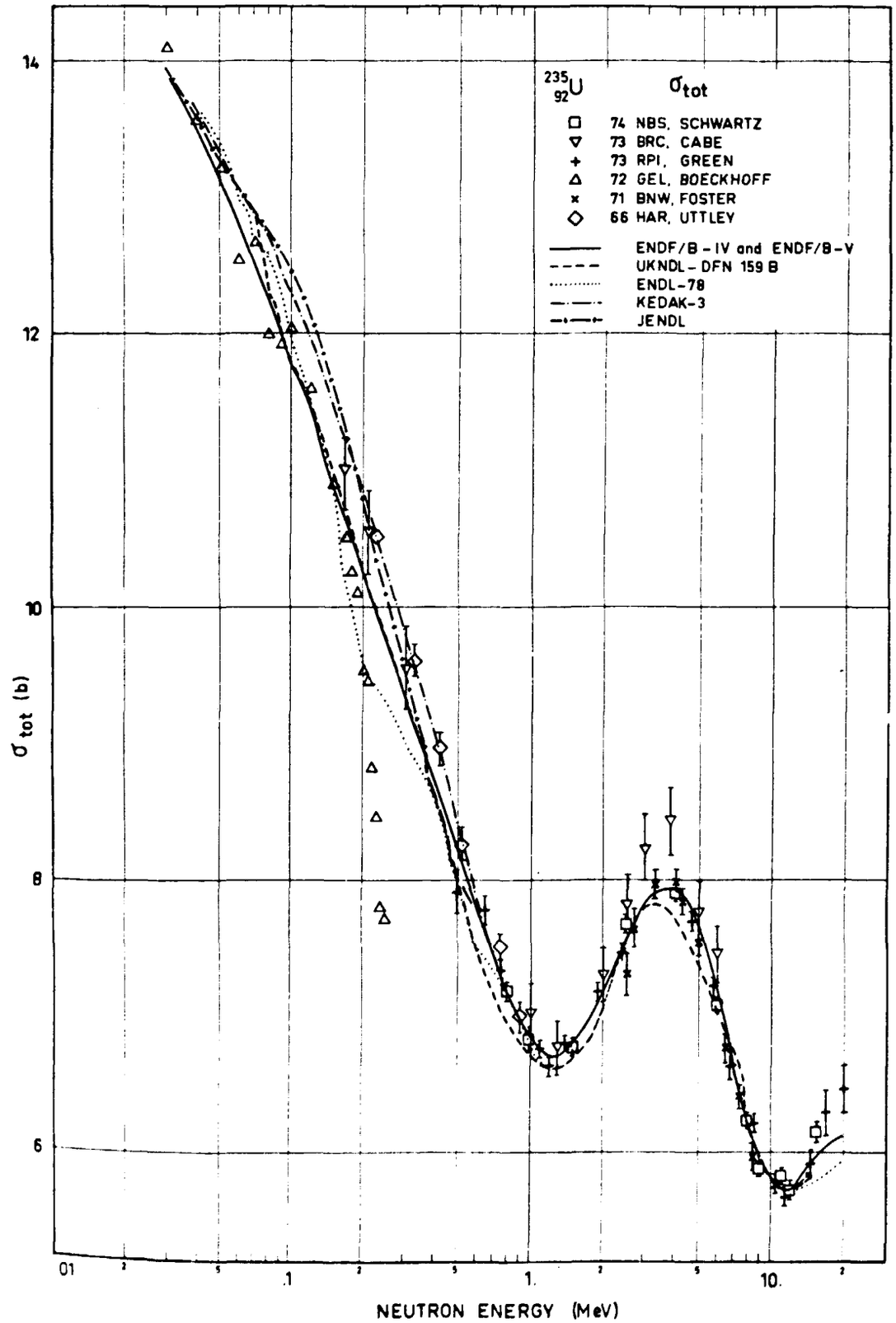
Reference	σ_γ barns	σ_f barns	σ_t barns	$\bar{\nu}_t$
ENDF/B - IV	97.7	585.4	698.6	2.419
ENDF/B - V	98.4	583.5	696.6	2.437
ENDL -76	97.8	601.0		
IAEA-3 (1975)	97.4	583.5		2.416
BNL 325 (1973)	98.6	582.2	694.6	2.418
1 GEL,DERUYTTER		590.5		

RESONANCE INTEGRALS

Reference	RI_γ barns	RI_f barns
ENDF/B - IV	127.8	261.4
ENDL -76	133.1	264.0
BNL 325 (1973)	144	275
[illegible] AB,EILAND	150	292

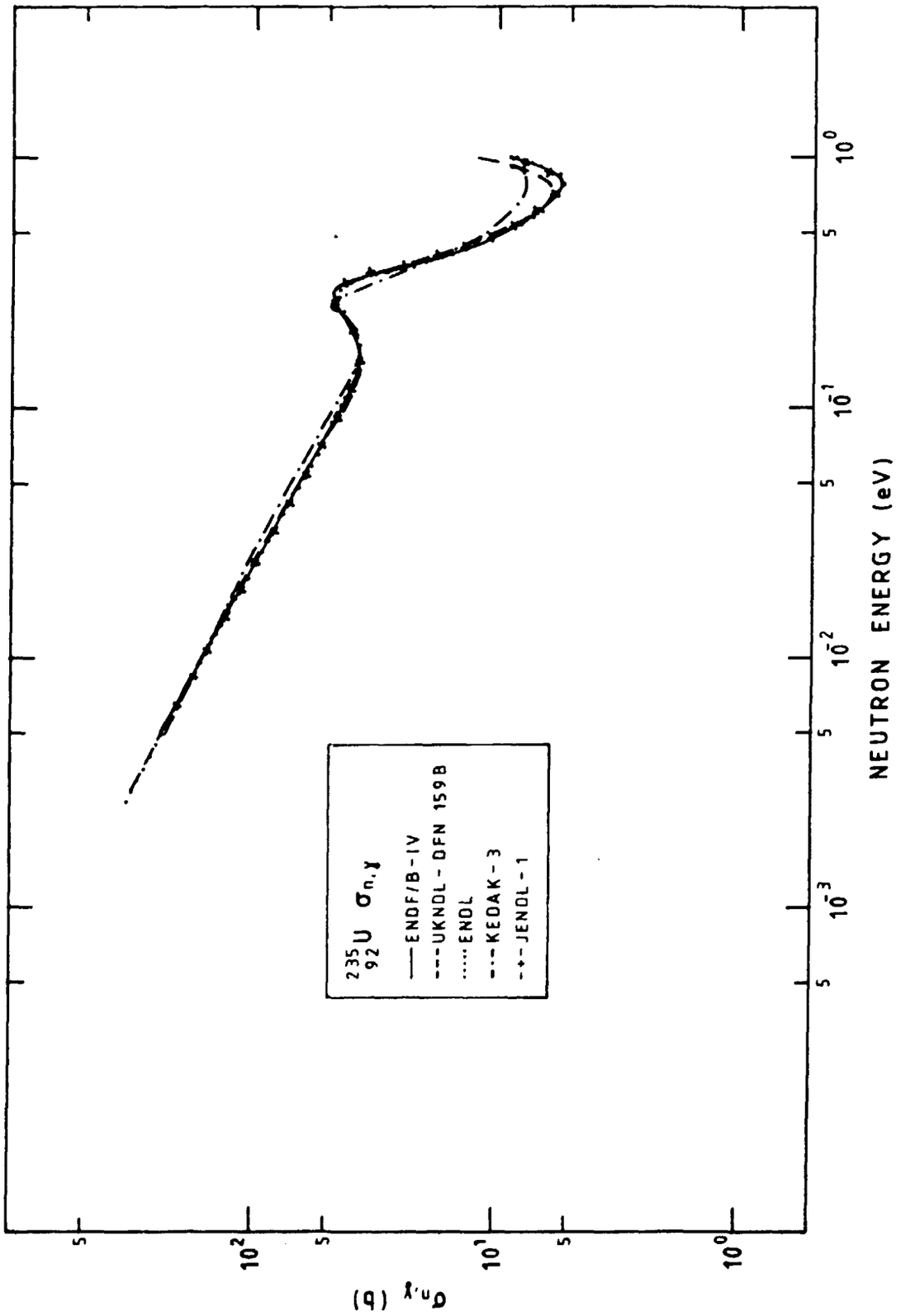

$^{235}_{92}U$
σ_{tot}
m 58 COL.MELKONIAN
S 59 COL.SAFFORD
A 61 ANL.SAPLAKOGLU
G 62 KUR.GERASIMOV
B 65 HAR.BROOKS
U 73 CCP.VERTEBNYJ
ENDF/B-IV
ENDF/B-V
NEUTRON ENERGY (eV)
σ_{tot} (Barn)

$^{235}_{92}U$

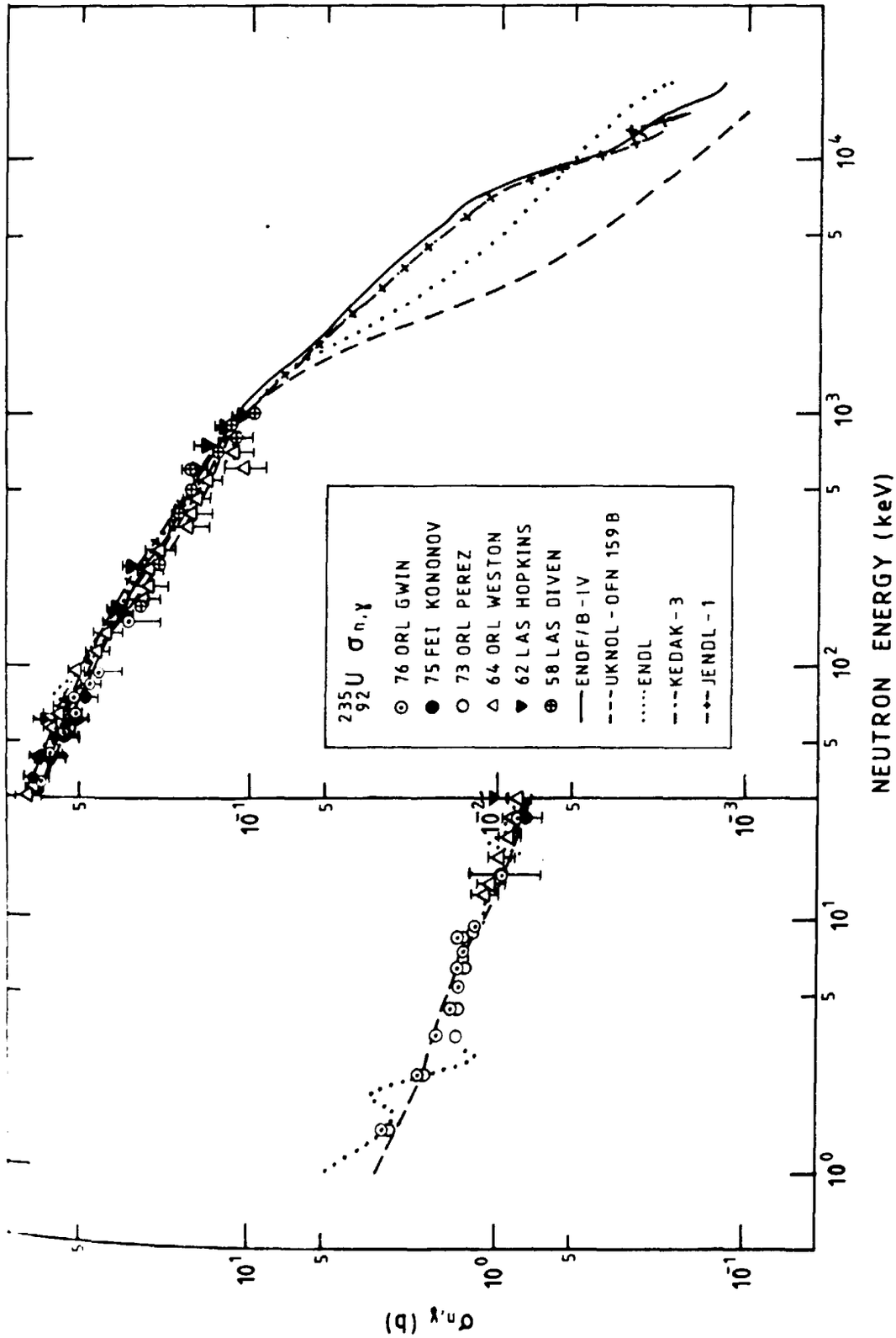

$^{235}_{92}U$ σ_{tot}
74 NBS, SCHWARTZ
73 BRC, CABE
73 RPI, GREEN
72 GEL, BOECKHOFF
71 BNW, FOSTER
66 HAR, UTTLEY
ENDF/B-IV and ENDF/B-V
UKNDL-DFN 159 B
ENDL-78
KEDAK-3
JENDL
14
12
10
8
6
σ_{tot} (b)
01
.1
1.
10.
NEUTRON ENERGY (MeV)

Experimental information ^{235}U, σ_{tot}

	Reference	Points	Range	Standard	Error	Comments
58	COL, MELKONIAN	223	0.01 eV-48 keV	ABS.	2-3 %	
59	COL, SAFFORD	31	0.0008-0.08 eV	ABS.	0.5 %	
61	ANL, SAPLAKOGLU	31	0.0045-0.56 eV		0.5-1 %	
62	KUR, GERASIMOV	130	0.02-2.2 eV			
65	HAR, BROOKS	1 489	0.02 eV-0.2 keV	ABS.	1.5 %	
66	HAR, UTTLEY	57	0.15-950 keV	ABS.		
71	BNW, FOSTER	243	2.2-14.9 MeV	ABS.	1-3 %	
72	GEL, BOECKHOFF	4 093	5.8-270 keV			
73	BRC, CABE	388	0.1-6 MeV	ABS.	3 %	
73	CCP, VERTEBNYJ	27	0.04-1 eV	ABS.	1.5 %	
73	RPI, GREEN	716	0.5-30 MeV	ABS.	1 %	
74	NBS, SCHWARTZ	1 680	0.5-15 MeV	ABS.	1 %	Stat. error


$^{235}_{92}U$ $\sigma_{n,\gamma}$
ENDF/B-IV
UKNDL - DFN 159B
ENDL
KEDAK-3
JENDL-1
$\sigma_{n,\gamma}$ (b)
NEUTRON ENERGY (eV)
10^2
10^1
10^0
10^{-3}
10^{-2}
10^{-1}
10^0
5

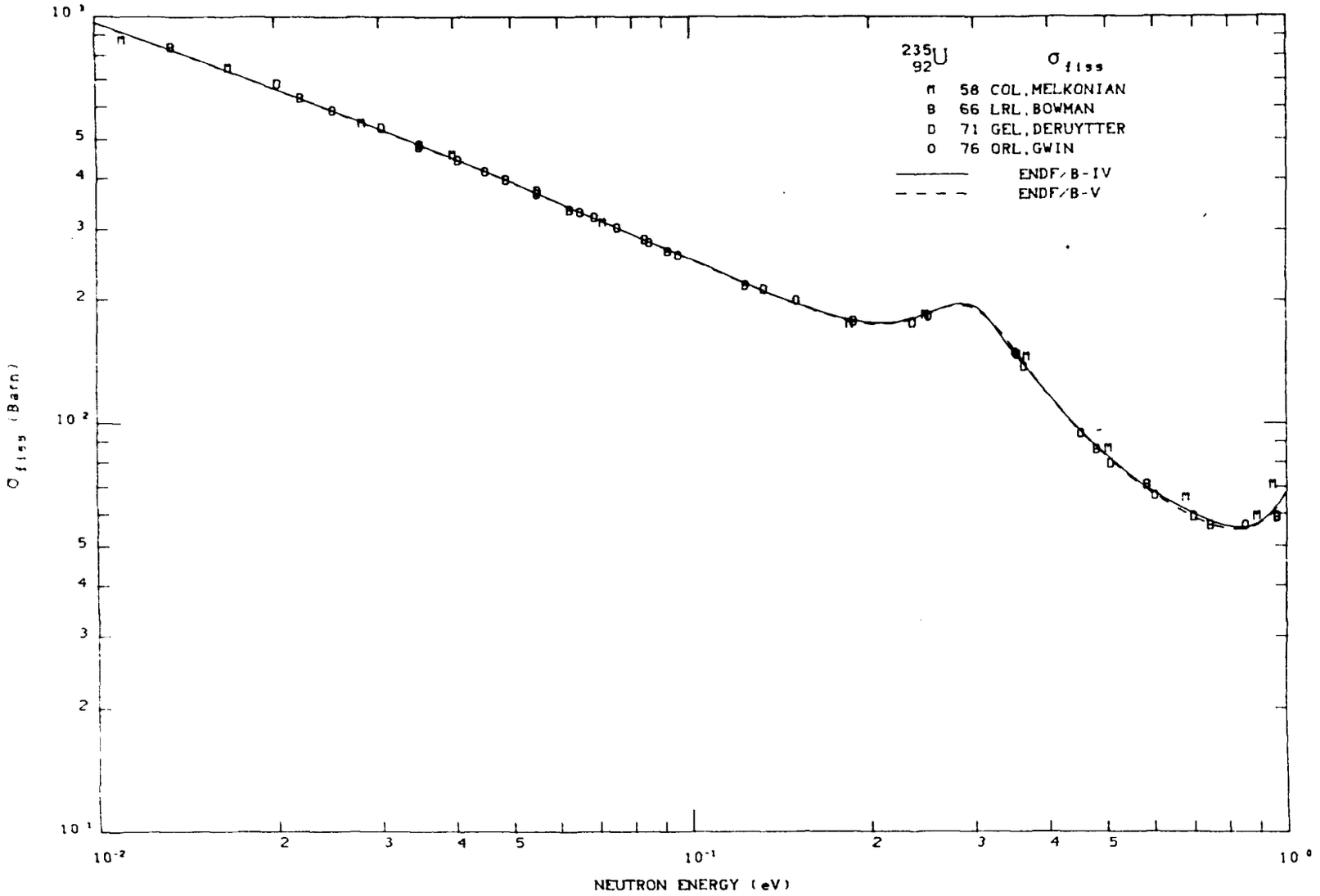
$^{235}_{92}U$


$^{235}_{92}U$ $\sigma_{n,\gamma}$
76 ORL GWIN
75 FEI KONONOV
73 ORL PEREZ
64 ORL WESTON
62 LAS HOPKINS
58 LAS DIVEN
ENDF/B-IV
UKNOL-OFN 159B
ENDL
KEDAK-3
JENDL-1
NEUTRON ENERGY (keV)
$\sigma_{n,\gamma}$ (b)

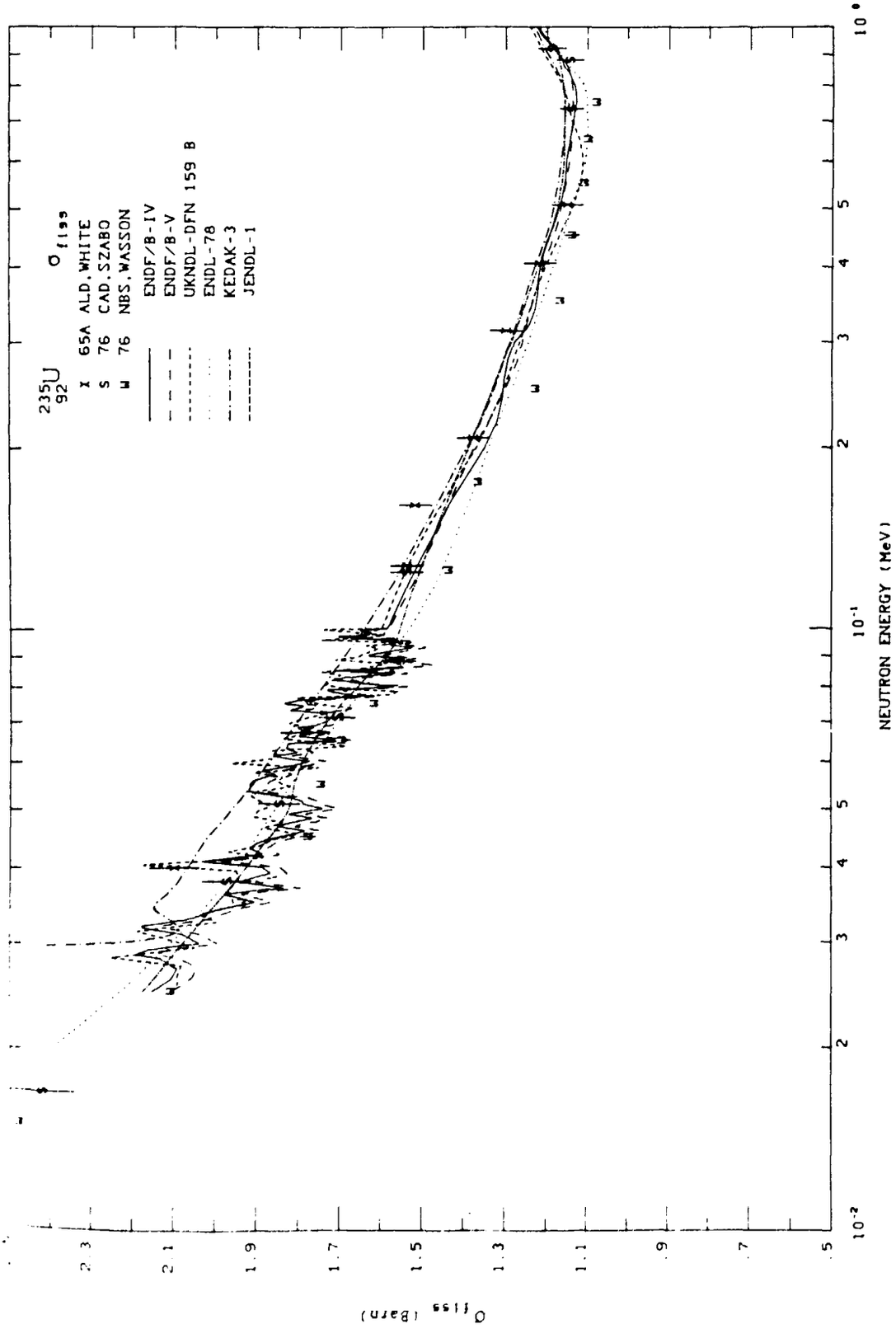
Experimental information ^{235}U, σ_γ

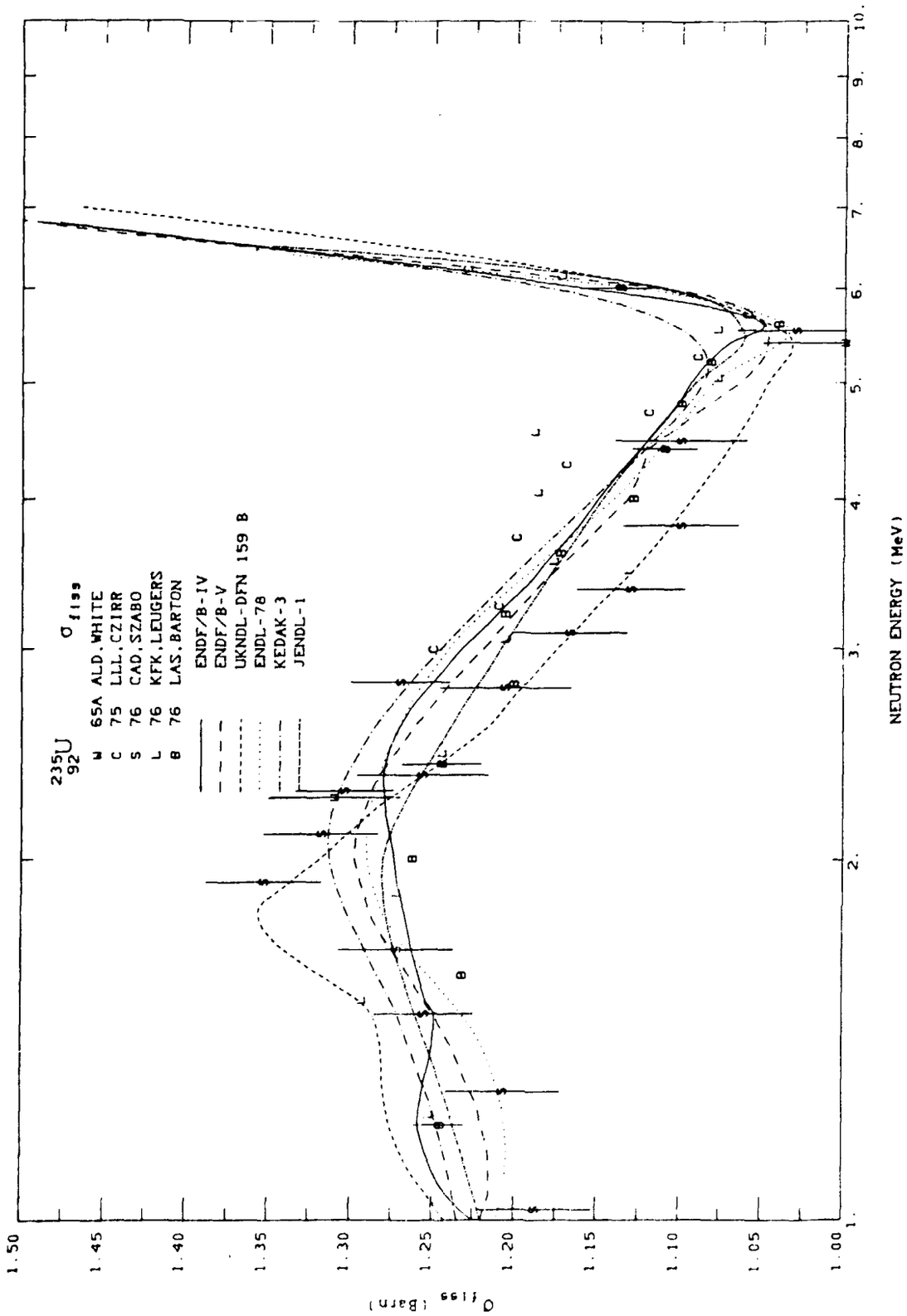
	Reference	Points	Range	Standard	Error	Comments
58	LAS, DIVEN	9	0.18-1 MeV	^{235}U, σ_f	10-15 %	Uncertainties for individual data points are not given. Norm. to BNL 325 (1965), σ_f
62	LAS, HOPKINS	9	0.03-1 MeV	^{235}U, σ_f	10-13 %	
64	ORL, WESTON	26	12-690 keV	^{235}U, σ_f	8-20 %	Energy spread: 1-34 %. Norm. to BNL 325(1965), σ_f
73	ORL, PEREZ	22	0.02-10 keV			
75	FEI, KONONOV	7	20-80 keV	^{197}Au, σ_γ	10-14 %	
76	ORL, GWIN	29	0.05-200 keV	^{235}U, σ_f	5-25 %	

General comments: ENDF/B-IV $\approx$ ENDF/B-V

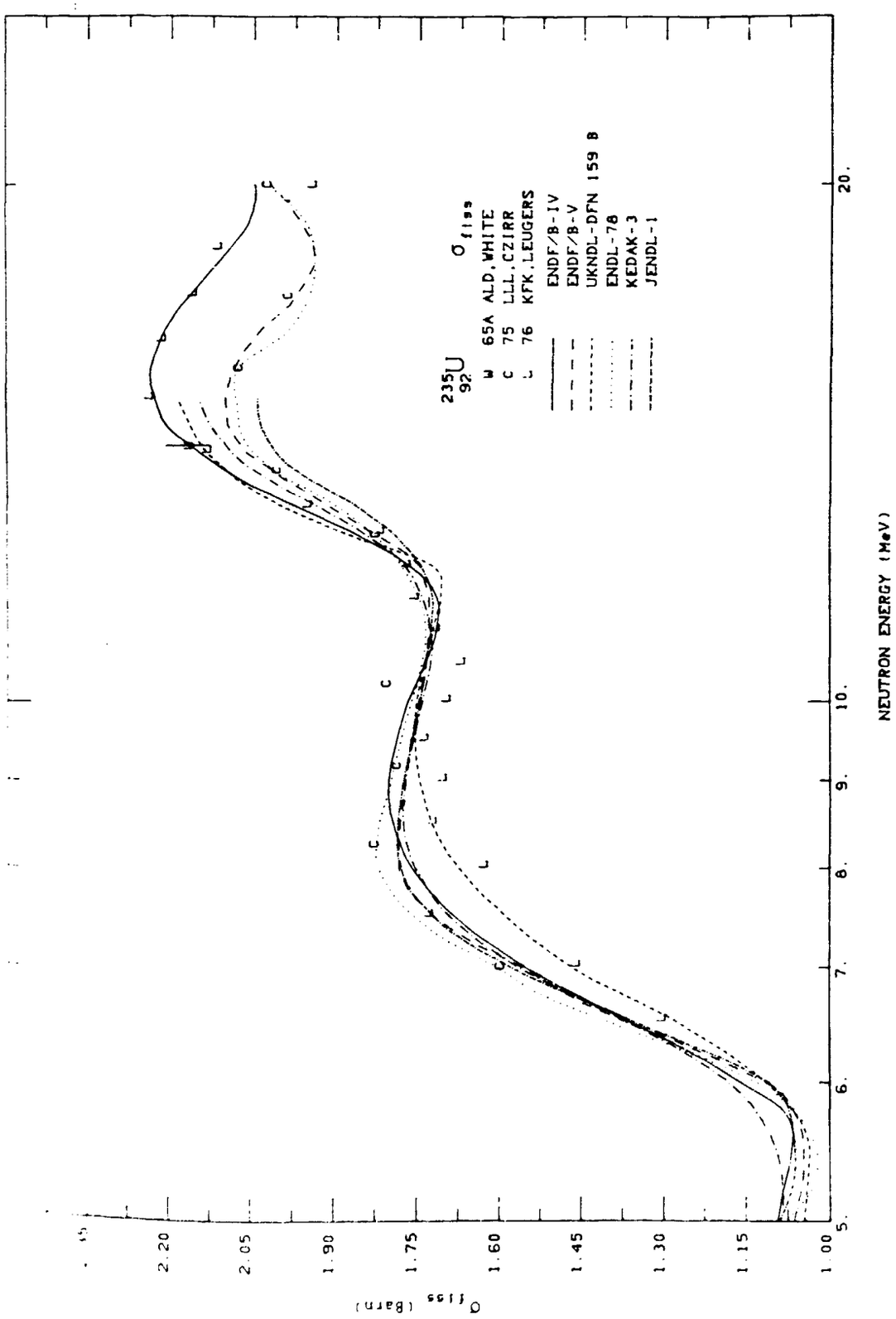

$^{235}_{92}U$
σ_{fiss}
M 58 COL.MELKONIAN
B 66 LRL.BOWMAN
D 71 GEL.DERUYTTER
O 76 ORL.GWIN
ENDF/B-IV
ENDF/B-V
σ_{fiss} (Barn)
NEUTRON ENERGY (eV)
10^3
10^2
10^1
10^{-2}
10^{-1}
10^0

$^{235}_{92}U$


$^{235}_{92}U$
σ_{fiss}
X 65A ALD.WHITE
S 76 CAD.SZABO
W 76 NBS.WASSON
ENDF/B-IV
ENDF/B-V
UKNDL-DFN 159 B
ENDL-78
KEDAK-3
JENDL-1
σ_{fiss} (Barn)
NEUTRON ENERGY (MeV)
2.3
2.1
1.9
1.7
1.5
1.3
1.1
.9
.7
.5
10^{-2}
10^{-1}
10^{0}


$^{235}_{92}U$
σ_{f199}
W 65A ALD.WHITE
C 75 LLL.CZIRR
S 76 CAD.SZABO
L 76 KFK.LEUGERS
B 76 LAS.BARTON
ENDF/B-IV
ENDF/B-V
UKNDL-DFN 159 B
ENDL-78
KEDAK-3
JENDL-1
σ_{f199} (barn)
NEUTRON ENERGY (MeV)
1.50
1.45
1.40
1.35
1.30
1.25
1.20
1.15
1.10
1.05
1.00
1.
2.
3.
4.
5.
6.
7.
8.
9.
10.

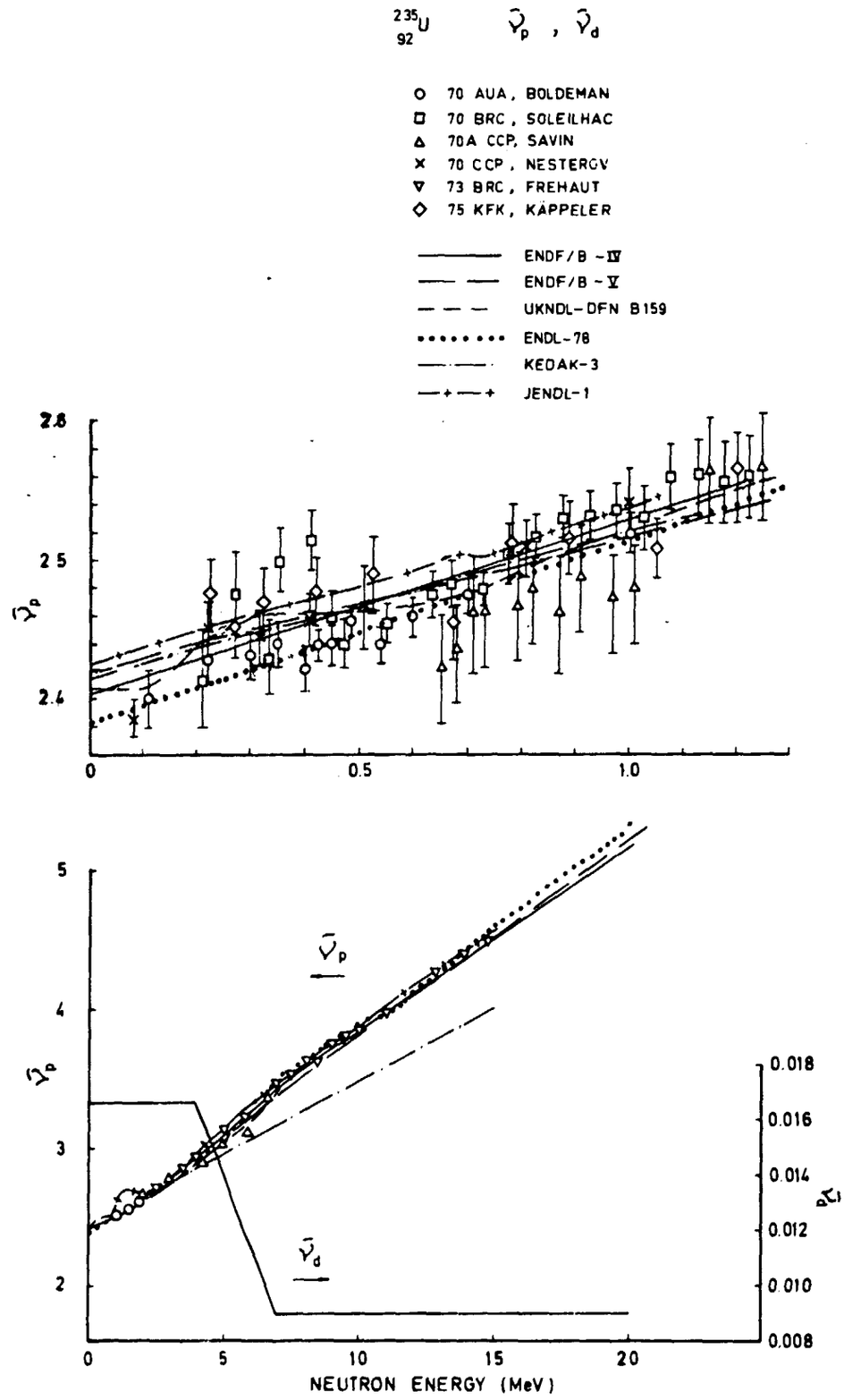
$^{235}_{92}U$


$^{235}_{92}U$
σ_{fiss}
W 65A ALD,WHITE
C 75 LLL,CZIRR
L 76 KFK,LEUGERS
ENDF/B-IV
ENDF/B-V
UKNDL-DFN 159 B
ENDL-78
KEDAK-3
JENDL-1
σ_{fiss} (barn)
2.20
2.05
1.90
1.75
1.60
1.45
1.30
1.15
1.00
5.
6.
7.
8.
9.
10.
20.
NEUTRON ENERGY (MeV)

Experimental information ^{235}U, σ_{fiss}

Reference	Points	Range	Standard	Error	Comments
58 COL, MELKONIAN	336	0.01 eV-40 keV	^{235}U, σ_f^{th}		
65A ALD, WHITE	12	40 keV-14.1 MeV	ABS.	2.5-3 %	
66 LRL, BOWMAN	1 596	0.02-80 eV	^{235}U, σ_f^{th}	3 %	Error in matching high-energy to low-energy data
71 GEL, DERUYTTER	870	0.01-11 eV	^{235}U, σ_f^{th}		Error 0.8 % in fission integral between 7.8-11 eV
75 LLL, CZIRR	61	3-20 MeV	H, $\sigma_{n,n}$	1-6 %	Stat. error
76 CAD, SZABO	31	17 keV-2.8 MeV	ABS.	2.5-3.5 %	
76 KFK, LEUGERS	144	1.2-20 MeV	H, $\sigma_{n,n}$	1-3 %	Stat. error
76 LAS, BARTON	41	1-6 MeV	H, $\sigma_{n,n}$	1-2 %	
76 NBS, WASSON	22	5-800 keV	H, $\sigma_{n,n}$	2 %	
76 ORL, GWIN	23	0.02 eV-200 keV		4-7 %	Norm. to ^{235}U, σ_f from ENDF/B-III between 0.02-0.4 eV

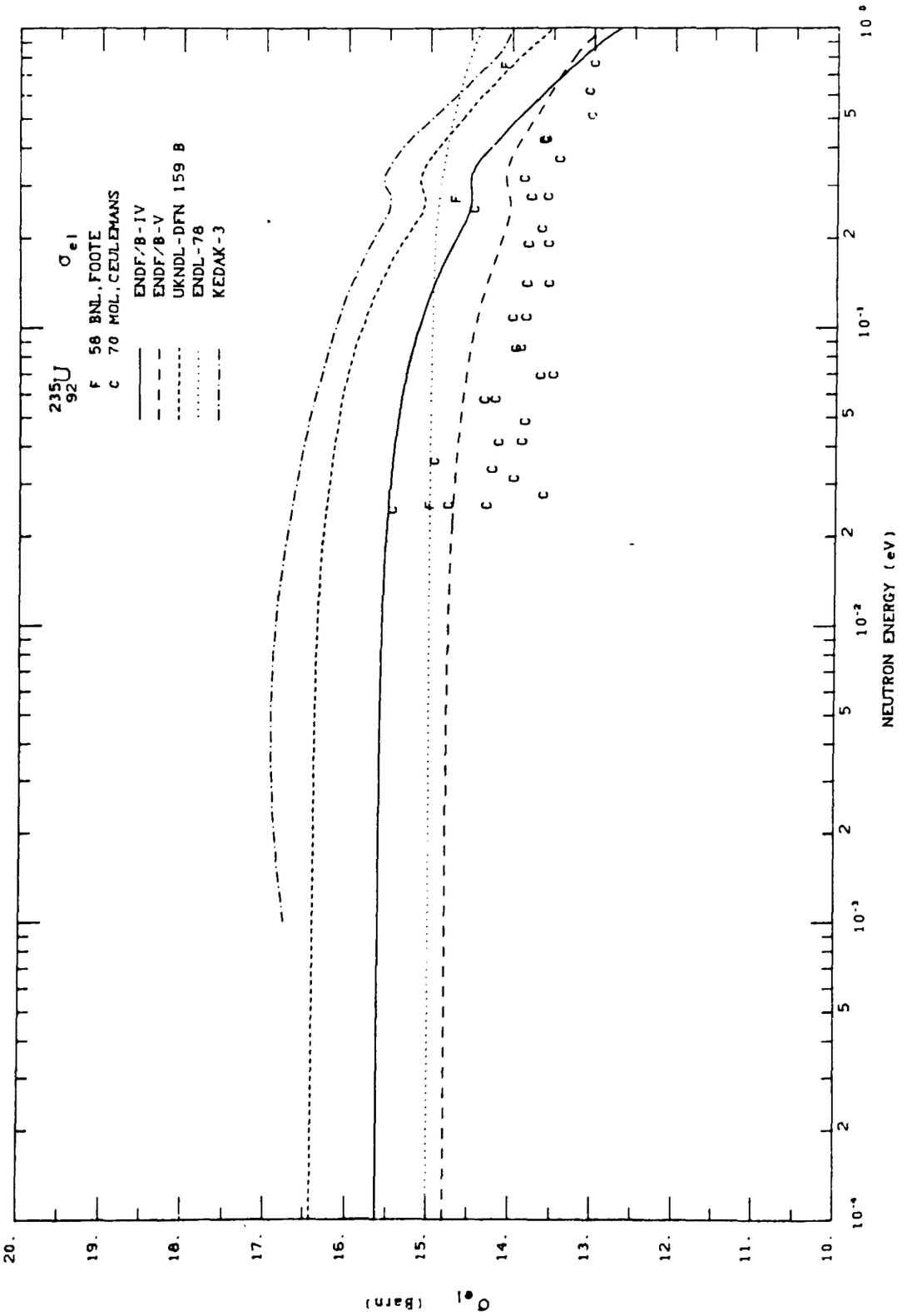
General comments: Experimental data from ratio measurements given in the figures are calculated using cross sections from ENDF/B-IV as standards

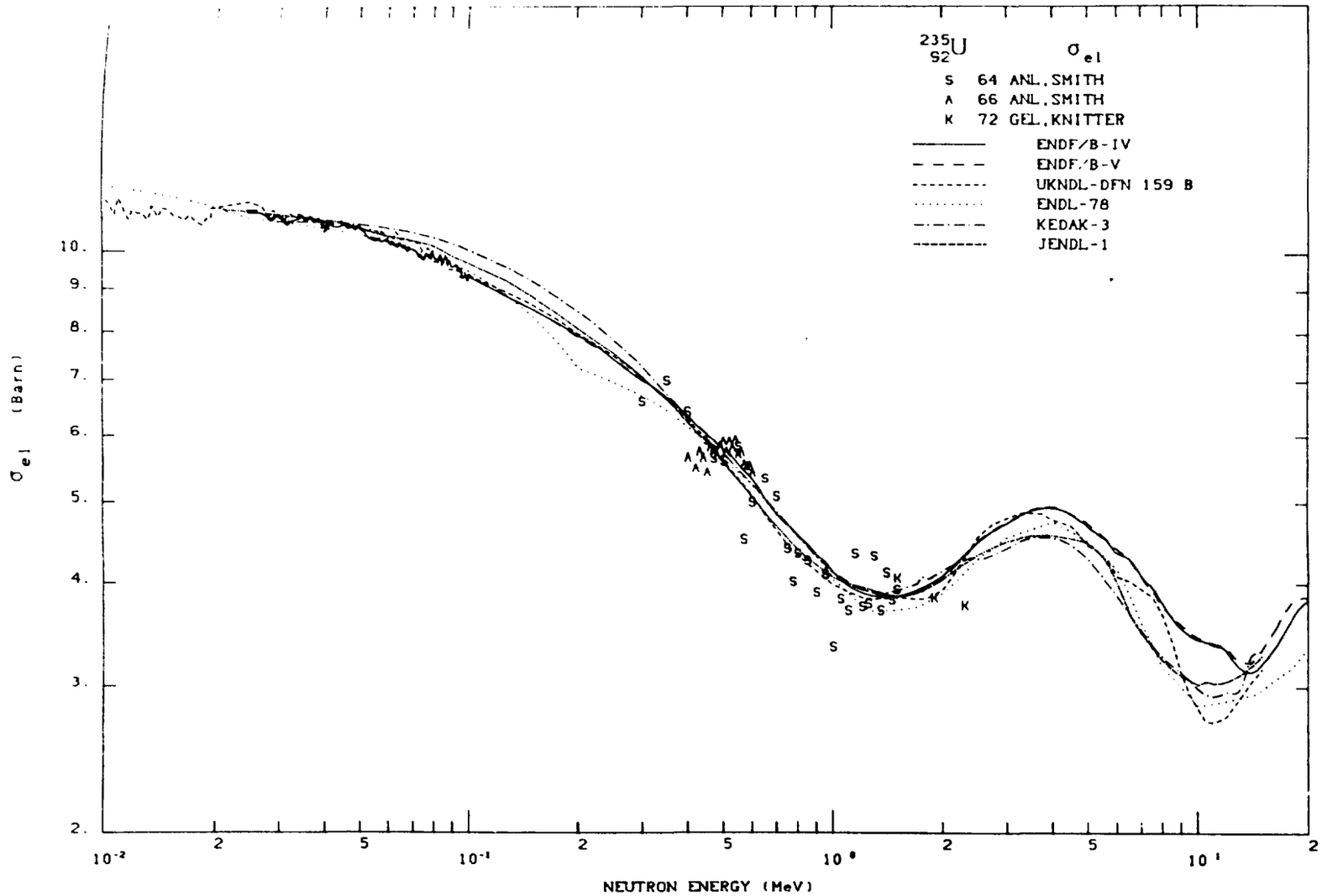

$^{235}_{92}U$ $\bar{\nu}_p$, $\bar{\nu}_d$
70 AUA, BOLDEMAN
70 BRC, SOLEILHAC
70A CCP, SAVIN
70 CCP, NESTEROV
73 BRC, FREHAUT
75 KFK, KAPPELER
ENDF/B -IV
ENDF/B -V
UKNDL-DFN B159
ENDL-78
KEDAK-3
JENDL-1
2.8
2.5
2.4
$\bar{\nu}_p$
0
0.5
1.0
5
4
3
2
$\bar{\nu}_p$
$\bar{\nu}_d$
0.018
0.016
0.014
0.012
0.010
0.008
0
5
10
15
20
NEUTRON ENERGY (MeV)

Experimental information ^{235}U, $\bar{\nu}$

Reference	Points	Range	Standard	Error	Comments
70 AUA, BOLDEMAN	14	0.1-1.9 MeV	^{252}Cf, $\bar{\nu}_p^{sp}$	0.5 %	
70 BRC, SOLEILHAC	40	0.2-1.4 MeV	^{252}Cf, $\bar{\nu}_p^{sp}$	1 %	
70 CCP, NESTEROV	13	Therm.-1.5 MeV	^{252}Cf, $\bar{\nu}_p^{sp}$	0.5-1 %	
70A CCP, SAVIN	37	0.65-6.6 MeV	^{252}Cf, $\bar{\nu}_p^{sp}$	1.5 %	
73 BRC, FREHAUT	22	1.9-14.8 MeV	^{252}Cf, $\bar{\nu}_p^{sp}$	1 %	
75 KFK, KÄPPELER	22	0.2-1.4 MeV	^{235}U, $\bar{\nu}_p$	1-1.5 %	Shape measurement. Norm. to value recommended by Manero and Konshin, At. En. Rev. 10, IAEA (1972) p. 637

General comments: Data normalized to $\bar{\nu}_p^{sp}(^{252}Cp) = 3.756$


$^{235}_{92}U$
σ_{el}
F 58 BNL, FOOTE
C 70 MOL, CEULEMANS
ENDF/B-IV
ENDF/B-V
UKNDL-DFN 159 B
ENDL-78
KEDAK-3
σ_{el} (barn)
NEUTRON ENERGY (eV)
20.
19.
18.
17.
16.
15.
14.
13.
12.
11.
10.
10^{-4}
10^{-3}
10^{-2}
10^{-1}
10^{0}


$^{235}_{92}U$
σ_{el}
S 64 ANL, SMITH
A 66 ANL, SMITH
K 72 GEL, KNITTER
ENDF/B-IV
ENDF/B-V
UKNDL-DFN 159 B
ENDL-78
KEDAK-3
JENDL-1
σ_{el} (Barn)
NEUTRON ENERGY (MeV)

Experimental information ^{235}U, $\sigma_{n,n}$

	Reference	Points	Range	Standard	Error	Comments
58	BNL, FOOTE	8	0.025-7.7 eV	Pb		Meas. ratio $\sigma_{n,n}/\sigma_{tot}$ for ^{235}U to same quantity for Pb
64	ANL, SMITH	28	0.3-1.5 MeV	C, $\sigma_{n,n}$		Sum of elastic and unresolved inelastic cross sections. Exp. resolution 24-62 keV
66	ANL, SMITH	20	0.4-0.6 MeV	C, $\sigma_{n,n}$		Sum of elastic and unresolved inelastic cross sections. Exp. resolution 25 keV
70	MOL, CEULEMANS	33	0.02-0.8 eV	V, $\sigma_{n,n}$		
72	GEL, KNITTER	3	1.5-2.3 MeV	H, $\sigma_{n,n}$		Sum of elastic and unresolved inelastic cross sections. Exp. resolution 500 keV

General comments: For E_n < 1 eV is JENDL-I = ENDF/B-IV

$^{238}_{92}U$

Natural isotopic abundance 99.274 %

3.4 ^{238}U

NUCLEAR PROPERTIES (Ref. Nuclear Data Sheets)

Spin and parity of ground state: 0^+

Ground state decay:

$T_{1/2} = 4.468 \times 10^9$ y

β stable

spontaneous fission 5.4×10^{-5} %

$T_{1/2} = 8 \times 10^{15}$ y

α to ^{234}Th, 100 %, $Q_\alpha = 4.270$ MeV

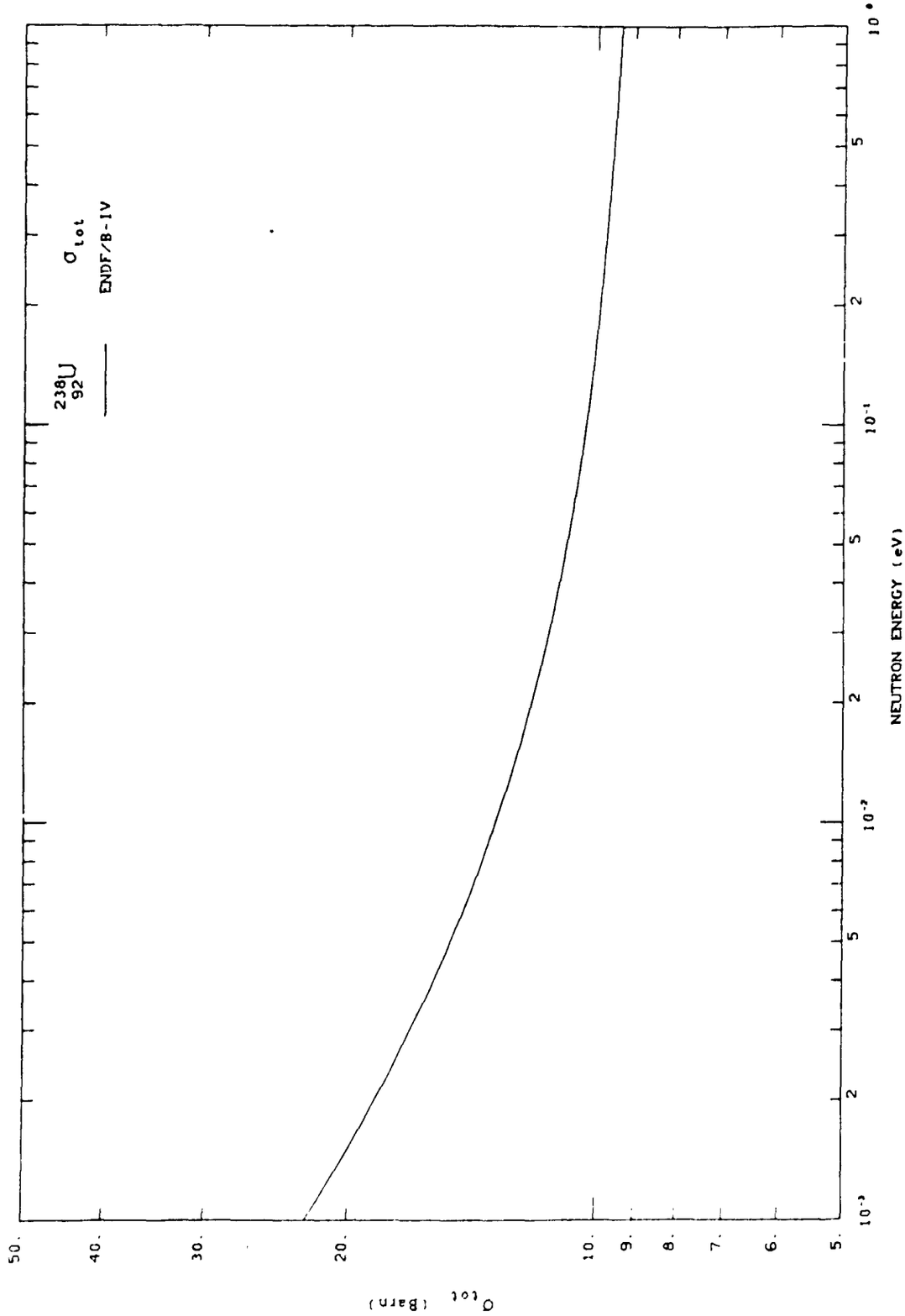
E_α (MeV)	I_α (%)
4.196	77
4.147	23
4.039	0.23

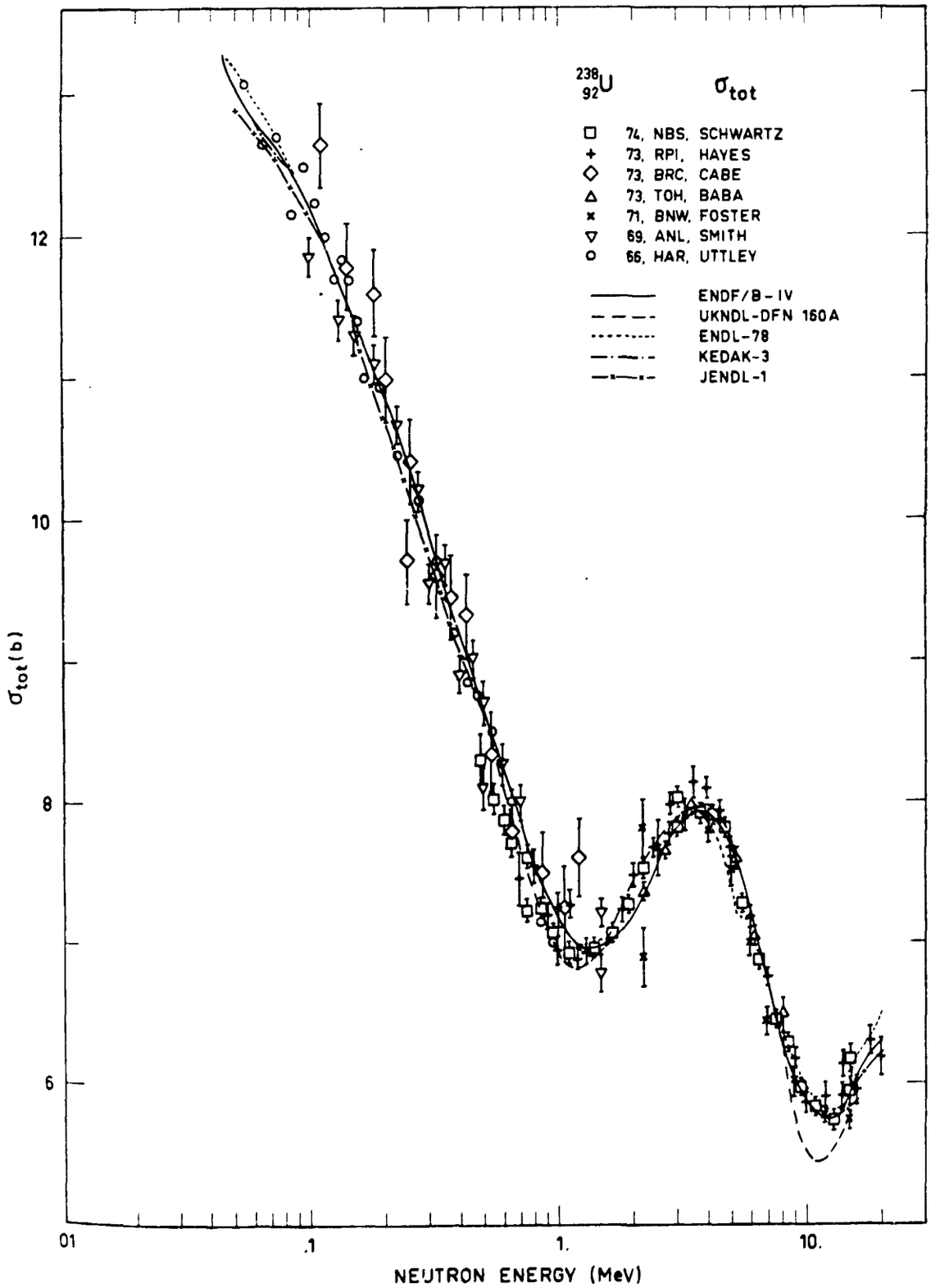
THERMAL CROSS SECTIONS

Reference	σ_γ barns	σ_f barns	σ_t barns
ENDF/B - IV	2.70	0.00	11.65
ENDF/B - V	2.70		11.60
ENDL -76	2.70	0.00	
BNL 325 (1973)	2.70	0.00	11.6

RESONANCE INTEGRALS

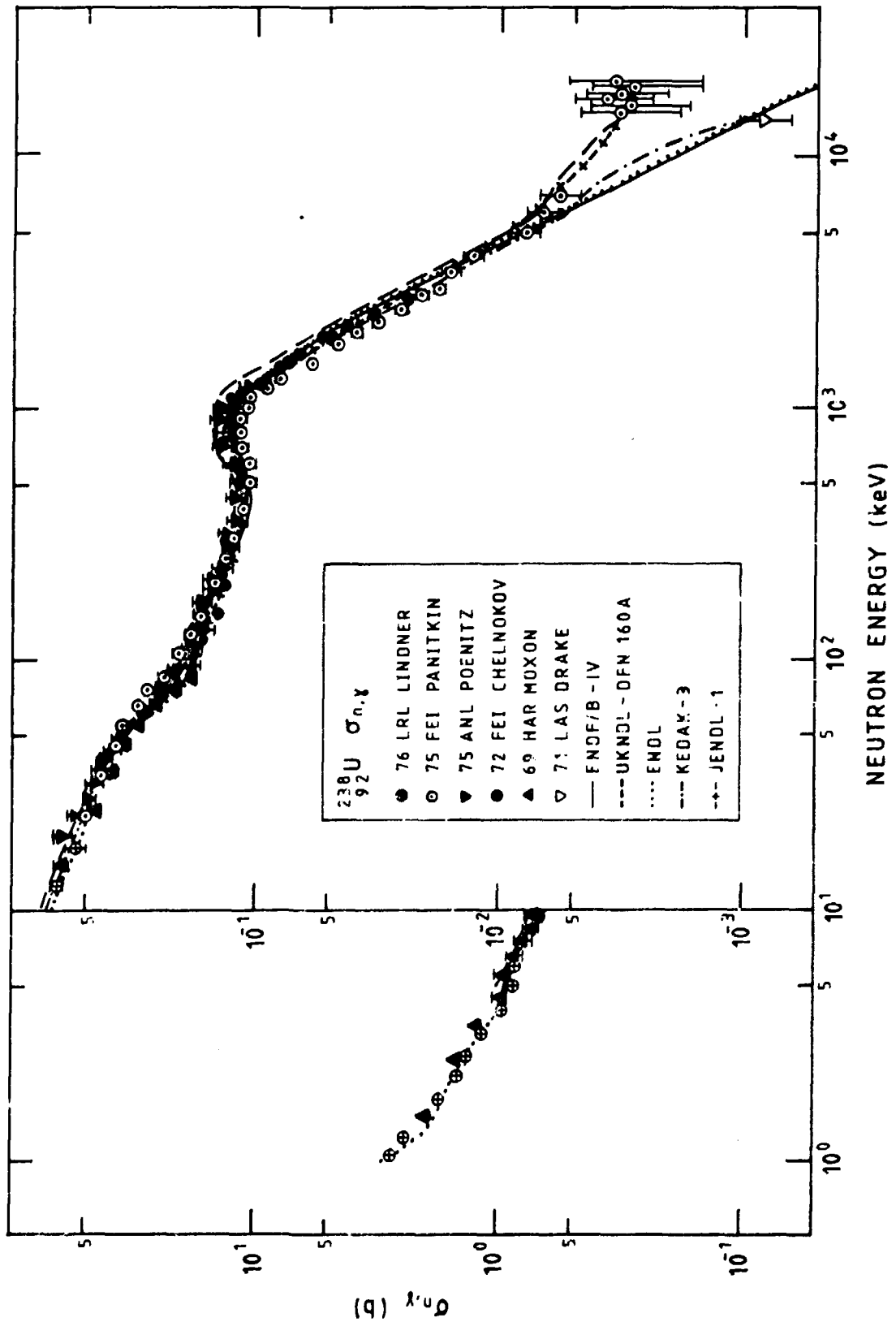
Reference	RI_γ barns	RI_f barns
ENDF/B - IV	268.0	0.0
ENDL -76	261.8	0.0
BNL 325 (1973)	275	0.0
72 KJL,STEINNES	267	0.0


$^{238}_{92}U$
σ_{tot}
ENDF/B-IV
σ_{tot} (Barn)
50.
40.
30.
20.
10.
9.
8.
7.
6.
5.
10^{-3}
2
5
10^{-2}
2
5
10^{-1}
2
5
10^{0}
NEUTRON ENERGY (eV)


$^{238}_{92}U$
σ_{tot}
74, NBS, SCHWARTZ
73, RPI, HAYES
73, BRC, CABE
73, TOH, BABA
71, BNW, FOSTER
69, ANL, SMITH
66, HAR, UTTLEY
ENDF/B-IV
UKNDL-DFN 160A
ENDL-78
KEDAK-3
JENDL-1
12
10
8
6
σ_{tot} (b)
01
.1
1.
10.
NEUTRON ENERGY (MeV)

Experimental information ^{238}U, σ_{tot}

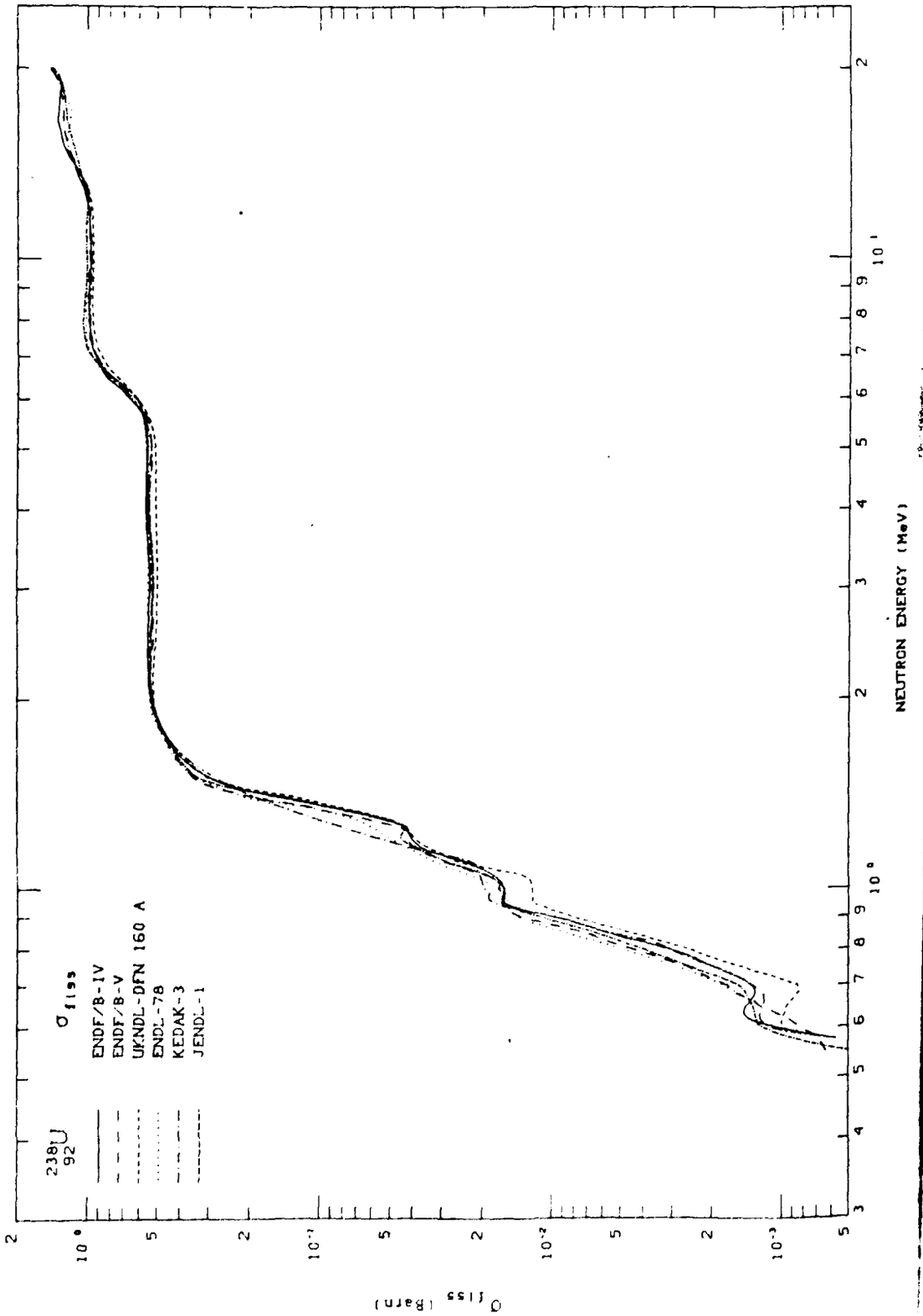
Reference	Points	Range	Standard	Error	Comments
66 HAR, UTTLEY	34	6.5-950 keV	ABS.		
69 ANL, SMITH	524	0.1-1.5 MeV	ABS.	1.5-2 %	Stat. error
71 BNW, FOSTER	244	2.2-14.9 MeV	ABS.	1-3 %	
73 BRC, CABE	431	0.1-6.1 MeV	ABS.	3 %	Stat. error
73 RPI, HAYES	747	0.7-30 MeV	ABS.	1 %	Stat. error
73 TOH, BABA	369	2.2-8 MeV	ABS.		
74 NBS, SCHWARTZ	1 706	0.5-15.2 MeV	ABS.	1 %	Stat. error

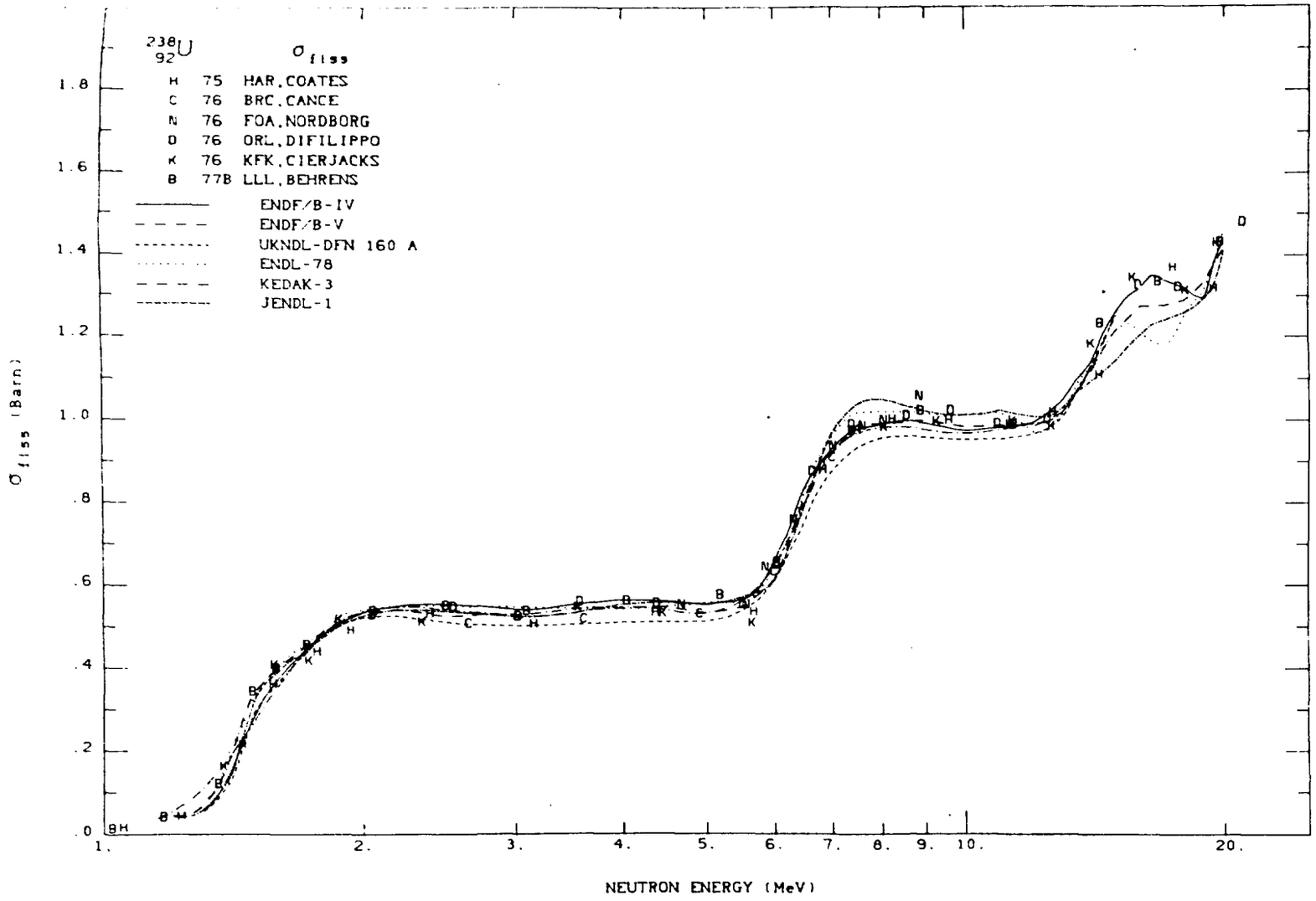

$^{238}_{92}U$ $\sigma_{n,\gamma}$
76 LRL LINDNER
75 FEI PANITKIN
75 ANL POENITZ
72 FEI CHELNOKOV
69 HAR MOXON
71 LAS DRAKE
ENDF/B-IV
UKNDL-DFN 160A
ENDL
KEDAK-3
JENDL-1
NEUTRON ENERGY (keV)
$\sigma_{n,\gamma}$ (b)

Experimental information ^{238}U, σ_γ

	Reference	Points	Range	Standard	Error	Comments
69	HAR, MOXON	18	2-100 keV	^{10}B, σ_α	5-8 %	
71	LAS, DRAKE	1	14 MeV	H, $\sigma_{n,n}$	25 %	
72	FEI, CHELNOKOV	26	0.2-35 keV	^{197}Au, σ_γ	<13 %	
75	ANL, POENITZ	54	0.02-1.2 MeV	^{197}Au, σ_γ	8-10 %	Energy spread: 5-22 %
75	FEI, PANITKIN	41	0.024-20 MeV	ABS.	5-50 %	Energy spread: 10-14 % for E_n > 10 MeV and only a few percent for E_n < 10 MeV
76	LRL, LINDNER	23	0.12-2.7 MeV	^{235}U, σ_f	0.6-4.8 %	Energy spread: 7-44 %

General comments: KEDAK-3 and ENDF/B-V within 10 % between 150 keV and 7 MeV

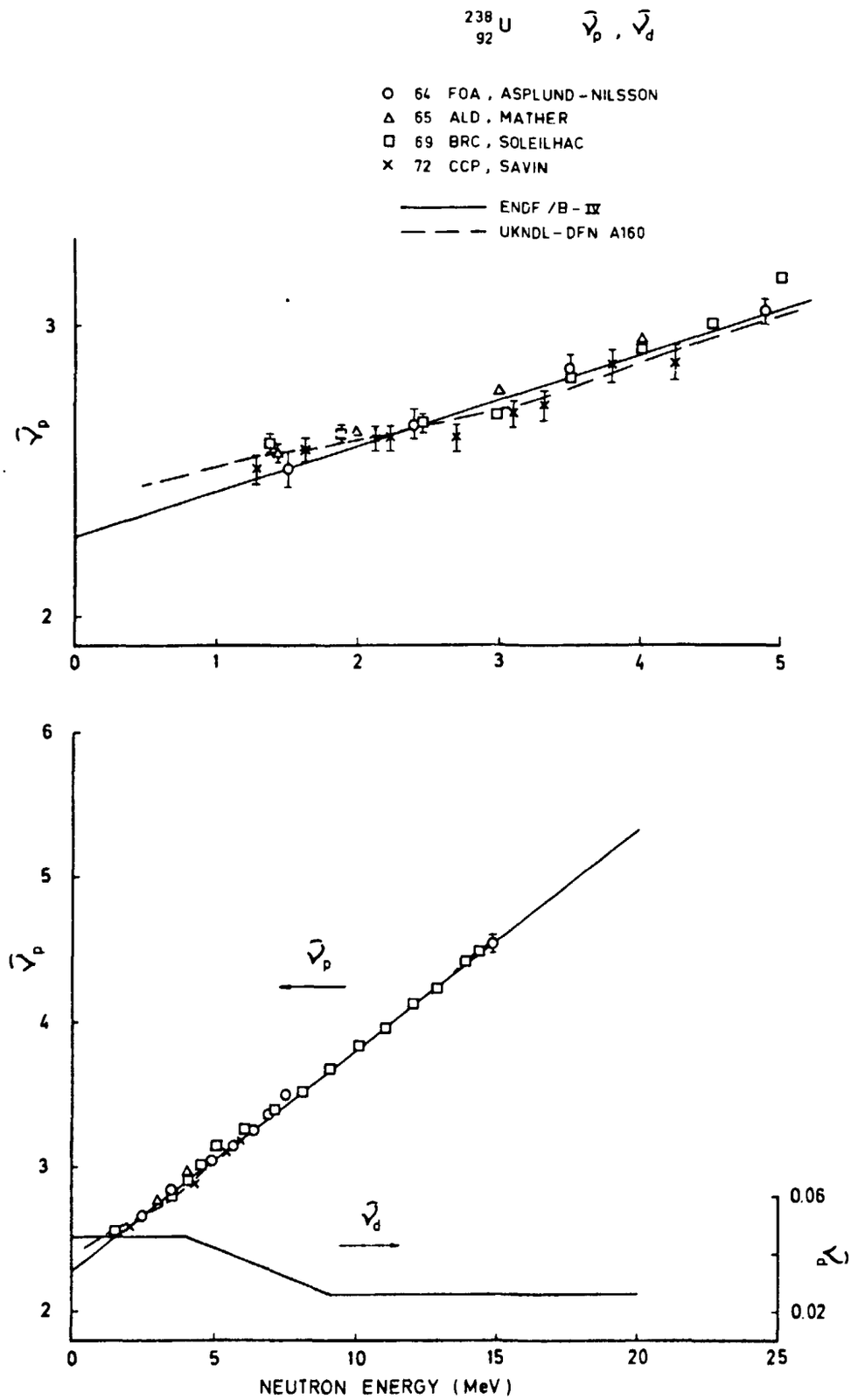

$^{238}_{92}U$
σ_{fiss}
ENDF/B-IV
ENDF/B-V
UKNDL-DFN 160 A
ENDL-78
KEDAK-3
JENDL-1
σ_{fiss} (Barn)
NEUTRON ENERGY (MeV)


238 92 U
σ fiss
H 75 HAR,COATES
C 76 BRC,CANCE
N 76 FOA,NORDBORG
D 76 ORL,DIFILIPPO
K 76 KFK,CIERJACKS
B 77B LLL,BEHRENS
ENDF/B-IV
ENDF/B-V
UKNDL-DFN 160 A
ENDL-78
KEDAK-3
JENDL-1
σ fiss (Barn)
NEUTRON ENERGY (MeV)

Experimental information ^{238}U, σ_{fiss}

Reference	Points	Range	Standard	Error	Comments
75 HAR, COATES	225	0.6-22 MeV	^{235}U, σ_f	2.5 %	
76 BRC, CANCE	9	2-7 MeV	^{235}U, σ_f	3 %	
76 FOA, NORDBORG	23	4.7-8.9 MeV	^{235}U, σ_f	3 %	
76 KFK, CIERJACKS	89	0.5-30 MeV	^{235}U, σ_f	3 %	Stat. error
76 ORL, DIFILIPPO	77	2-25 MeV	^{235}U, σ_f	1.5-2 %	
77B LLL, BEHRENS	154	0.1-30 MeV	^{235}U, σ_f	1.5 %	

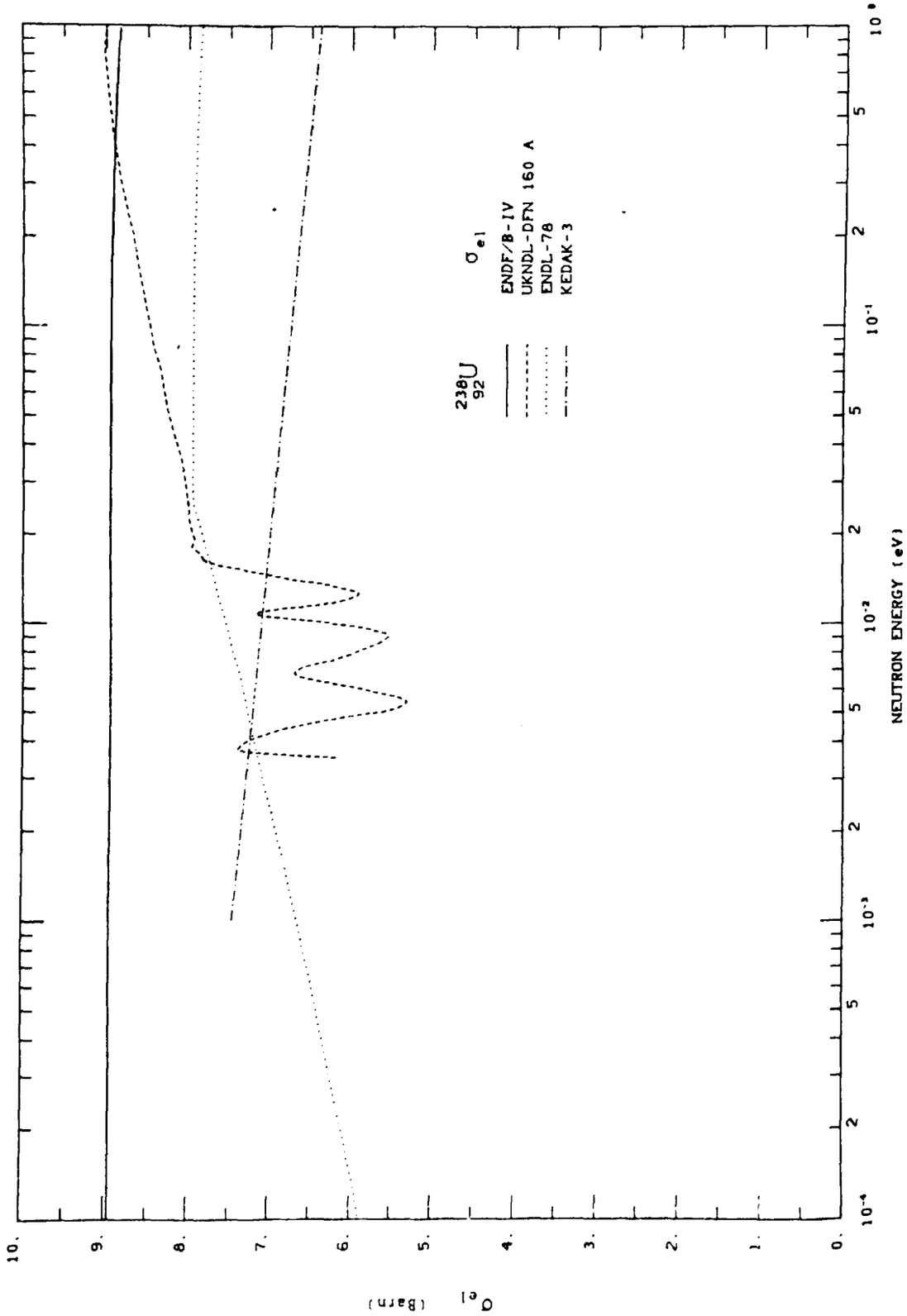
General comments: Experimental data from ratio measurements given in the figures are calculated using cross sections from ENDF/B-IV as standards

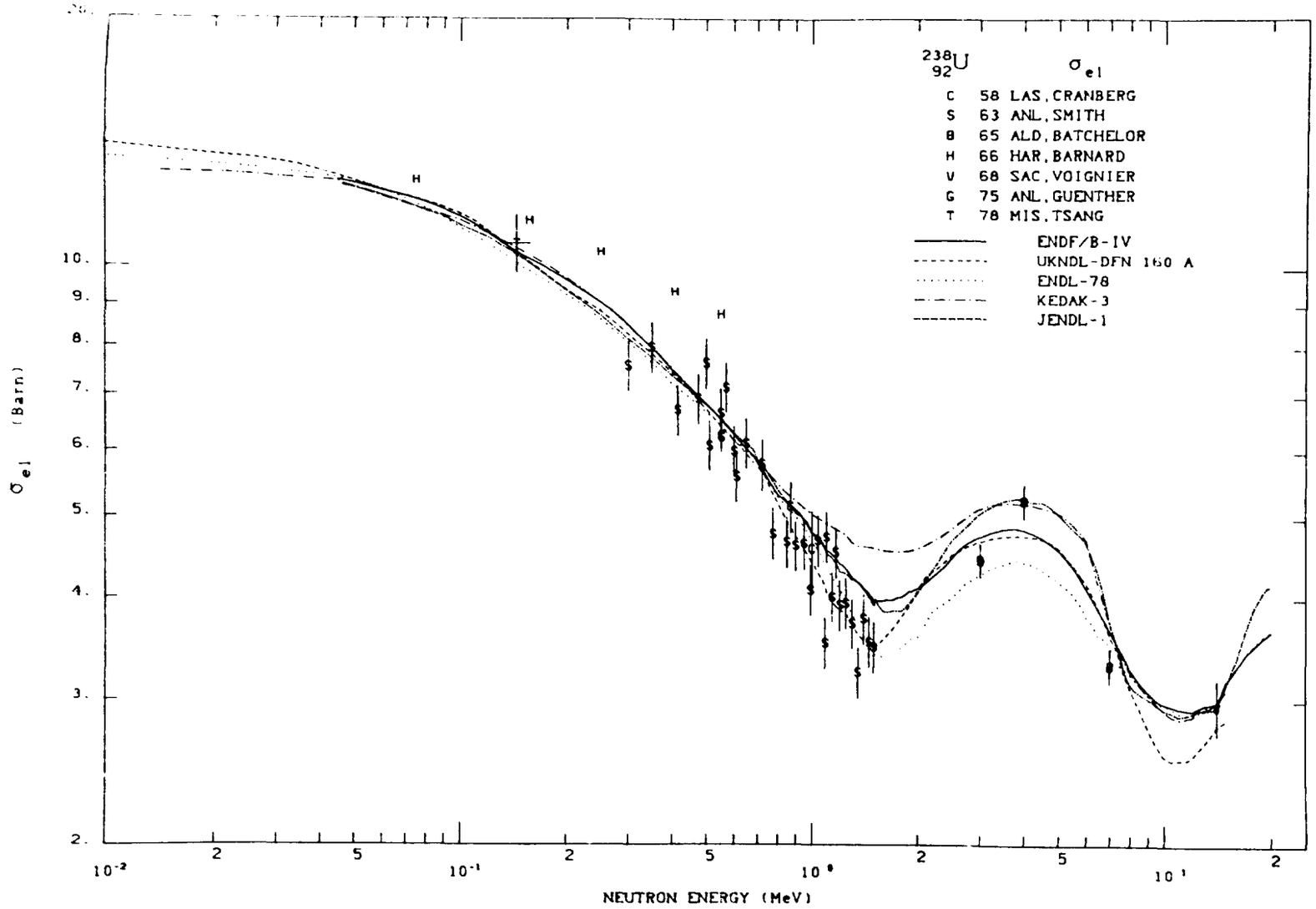

$^{238}_{92}U$ $\bar{\nu}_p$, $\bar{\nu}_d$
O 64 FOA , ASPLUND - NILSSON
Δ 65 ALD , MATHER
□ 69 BRC , SOLEILHAC
× 72 CCP , SAVIN
ENDF /B - IV
UKNDL - DFN A160
$\bar{\nu}_p$
$\bar{\nu}_d$
NEUTRON ENERGY (MeV)

Experimental information ^{238}U, $\bar{\nu}$

	Reference	Points	Range	Standard	Error	Comments
64	FOA, ASPLUND-NILSSON	9	1.5-15 MeV	^{252}Cf, $\bar{\nu}_p^{sp}$	2 %	
65	ALD, MATHER	4	1.4-4 MeV	^{252}Cf, $\bar{\nu}_p^{sp}$	1 %	
69	BRC, SOLEILHAC	35	1.4-30 MeV	^{252}Cf, $\bar{\nu}_p^{sp}$	0.5-1 %	
72	CCP, SAVIN	46	1.3-6 MeV	^{252}Cf, $\bar{\nu}_p^{sp}$	1.5-2 %	

General comments: Data normalized to $\bar{\nu}_p^{sp}(^{252}Cf) = 3.756$

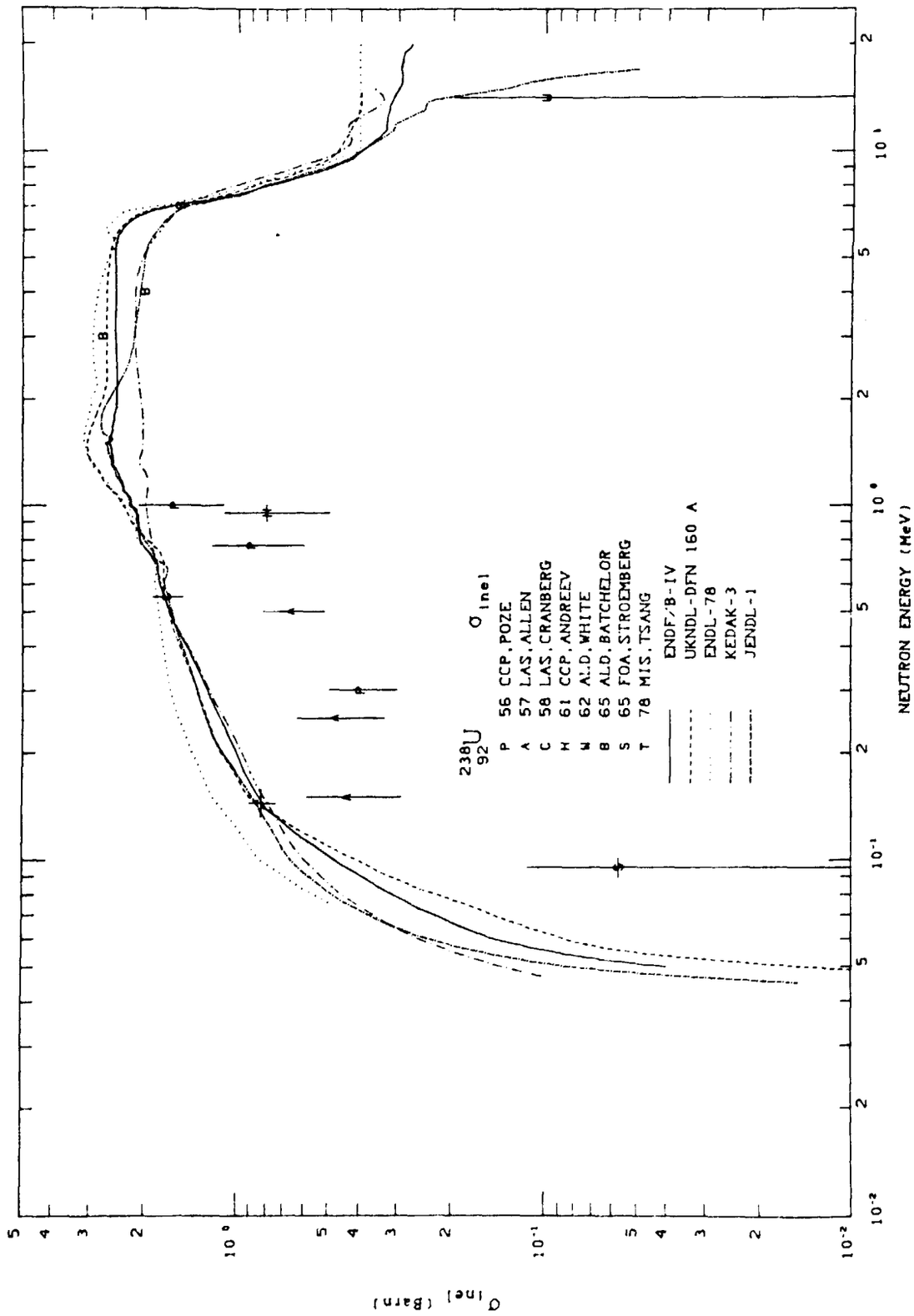

$^{238}_{92}U$
σ_{el}
ENDF/B-IV
UKNDL-DFN 160 A
ENDL-78
KEDAK-3
NEUTRON ENERGY (eV)
σ_{el} (Barn)
10.
9.
8.
7.
6.
5.
4.
3.
2.
1.
0.
10^{-4}
10^{-3}
10^{-2}
10^{-1}
10^{0}


238 92 U
σ el
C 58 LAS, CRANBERG
S 63 ANL, SMITH
B 65 ALD, BATCHELOR
H 66 HAR, BARNARD
V 68 SAC, VOIGNIER
G 75 ANL, GUENTHER
T 78 MIS, TSANG
ENDF/B-IV
UKNDL-DFN 160 A
ENDL-78
KEDAK-3
JENDL-1
σ el (Barn)
NEUTRON ENERGY (MeV)

Experimental information ^{238}U, $\sigma_{n,n}$

	Reference	Points	Range	Standard	Error	Comments
58	LAS, CRANBERG	3	0.55-2.0 MeV	H, $\sigma_{n,n}$	5-10 %	
63	ANL, SMITH	30	0.3-1.5 MeV	C, $\sigma_{n,n}$	7 %	
65	ALD, BATCHELOR	4	2-7 MeV	H, $\sigma_{n,n}$	5 %	
66	HAR, BARNARD	5	0.075-0.550 MeV			
68	SAC, VOIGNIER	1	14.1 MeV	ABS.	8 %	
75	ANL, GUENTER	1	0.55 MeV	C, $\sigma_{n,n}$	3 %	
78	MIS, TSANG	1	0.144 MeV	Pb, $\sigma_{n,n}$	10 %	

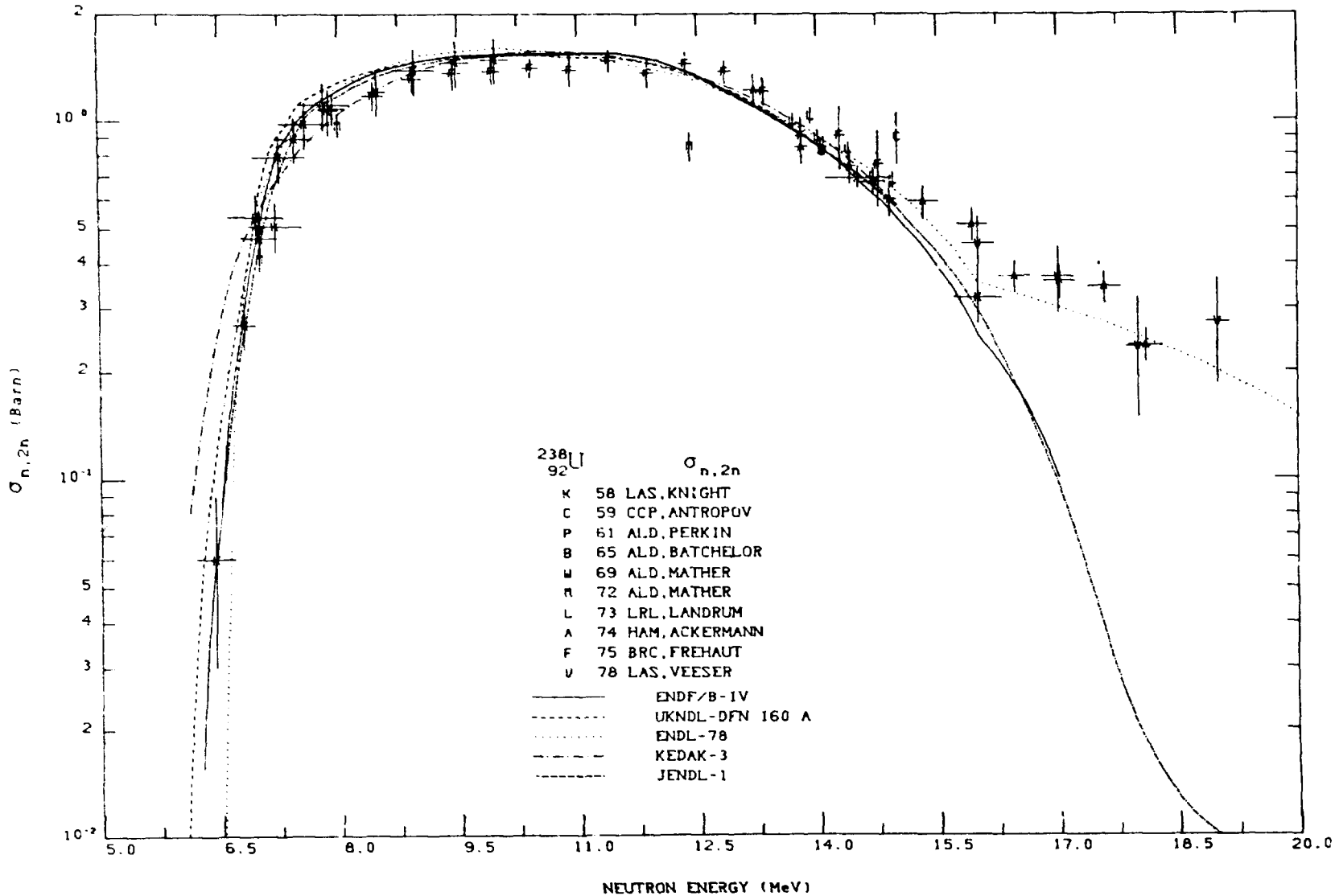
General comments: *For E_n < 1 eV is JENDL-1 = ENDF/B-IV*


$^{238}_{92}U$
σ_{inel}
P 56 CCP,POZE
A 57 LAS,ALLEN
C 58 LAS,CRANBERG
H 61 CCP,ANDREEV
W 62 ALD,WHITE
B 65 ALD,BATCHELOR
S 65 FOA,STROEMBERG
T 78 MIS,TSANG
ENDF/B-IV
UKNDL-DFN 160 A
ENDL-78
KEDAK-3
JENDL-1
NEUTRON ENERGY (MeV)
σ_{inel} (Barn)

Experimental information ^{238}U, $\sigma_{n,n'}$

	Reference	Points	Range	Standard	Error	Comments
56	CCP, POZE	3	0.3-1.0 MeV		30 %	
57	LAS, ALLEN	3	0.15-0.5 MeV		20-40 %	
58	LAS, CRANBERG	1	0.55 MeV	H, $\sigma_{n,n}$	12 %	
61	CCP, ANDREEV	1	0.95 MeV		40 %	
62	ALD, WHITE	1	14.2 MeV		200 %	
63	ANL, SMITH		0.3-1.5 MeV			Inelastic cross sections to individual levels
65	ALD, BATCHELOR	3	3-7 MeV	H, $\sigma_{n,n}$		
65	FOA, STROEMBERG	1	0.095 MeV	^{238}U, $\sigma_{n,n}$	250 %	
66	HAR, BARNARD		0.1-1.6 MeV			Inelastic cross sections to individual levels
75	ANL, GUENTHER		0.15-3.0 MeV			Inelastic cross sections to individual levels
78	MIS, TSANG	1	0.144 MeV	Pb, $\sigma_{n,n}$	10 %	

General comments: Data from measurements of inelastic cross sections to individual levels are not given in the figure. The data for UKNDL DFN 160 A are obtained from a summation of inelastic cross sections to individual levels


$^{238}_{92}U$ $\sigma_{n,2n}$
K 58 LAS.KNIGHT
C 59 CCP.ANTROPOV
P 61 ALD.PERKIN
B 65 ALD.BATCHELOR
W 69 ALD.MATHER
M 72 ALD.MATHER
L 73 LRL.LANDRUM
A 74 HAM.ACKERMANN
F 75 BRC.FREHAUT
V 78 LAS.VEESER
ENDF/B-IV
UKNDL-DFN 160 A
ENDL-78
KEDAK-3
JENDL-1
$\sigma_{n,2n}$ (Barn)
NEUTRON ENERGY (MeV)
5.0
6.5
8.0
9.5
11.0
12.5
14.0
15.5
17.0
18.5
20.0

Experimental information ^{238}U, $\sigma_{n,2n}$

	Reference	Points	Range	Standard	Error	Comments
58	LAS, KNIGHT	17	6-16 MeV	^{238}U, σ_f	15 %	
59	CCP, ANTROPOV	1	15 MeV	^{238}U, σ_f	17 %	
61	ALD, PERKIN	1	14.5 MeV	Cu, $\sigma_{n,2n}$	6 %	
65	ALD, BATCHELOR	1	7 MeV		12 %	
69	ALD, MATHER	1	14 MeV	^{252}Cf, $\bar{\nu}$	4 %	
72	ALD, MATHER	3	7.0-12.4 MeV	^{238}U, σ_f	7-10 %	
73	LRL, LANDRUM	7	13.7-14.9 MeV	Al, $\sigma_{n,\alpha}$	5 %	
74	HAM, ACKERMANN	10	13.2-18.1 MeV	H, $\sigma_{n,n}$	10 %	
75	BRC, FREHAUT	15	7.9-14.8 MeV	^{238}U, σ_f	10 %	
78	LAS, VEESER	5	14.7-19.0 MeV		10-35 %	

3.5 ^{237}Np

NUCLEAR PROPERTIES (Ref. Nuclear Data Sheets)

Spin and parity of ground state: $5/2^+$

Ground state decay:

$T_{1/2} = 2.14 \times 10^6$ y

β stable

spontaneous fission $< 2 \times 10^{-10}$ %

$T_{1/2} \geq 10^{18}$ y

α to ^{233}Pa, 100 %, $Q_\alpha = 4.957$ MeV

E_α (MeV)	I_α (%)	E_α (MeV)	I_α (%)
4.788	47	4.664	3.3
4.771	25	4.873	2.6
4.766	8	4.817	2.5
4.640	6		

γ (^{233}Pa)

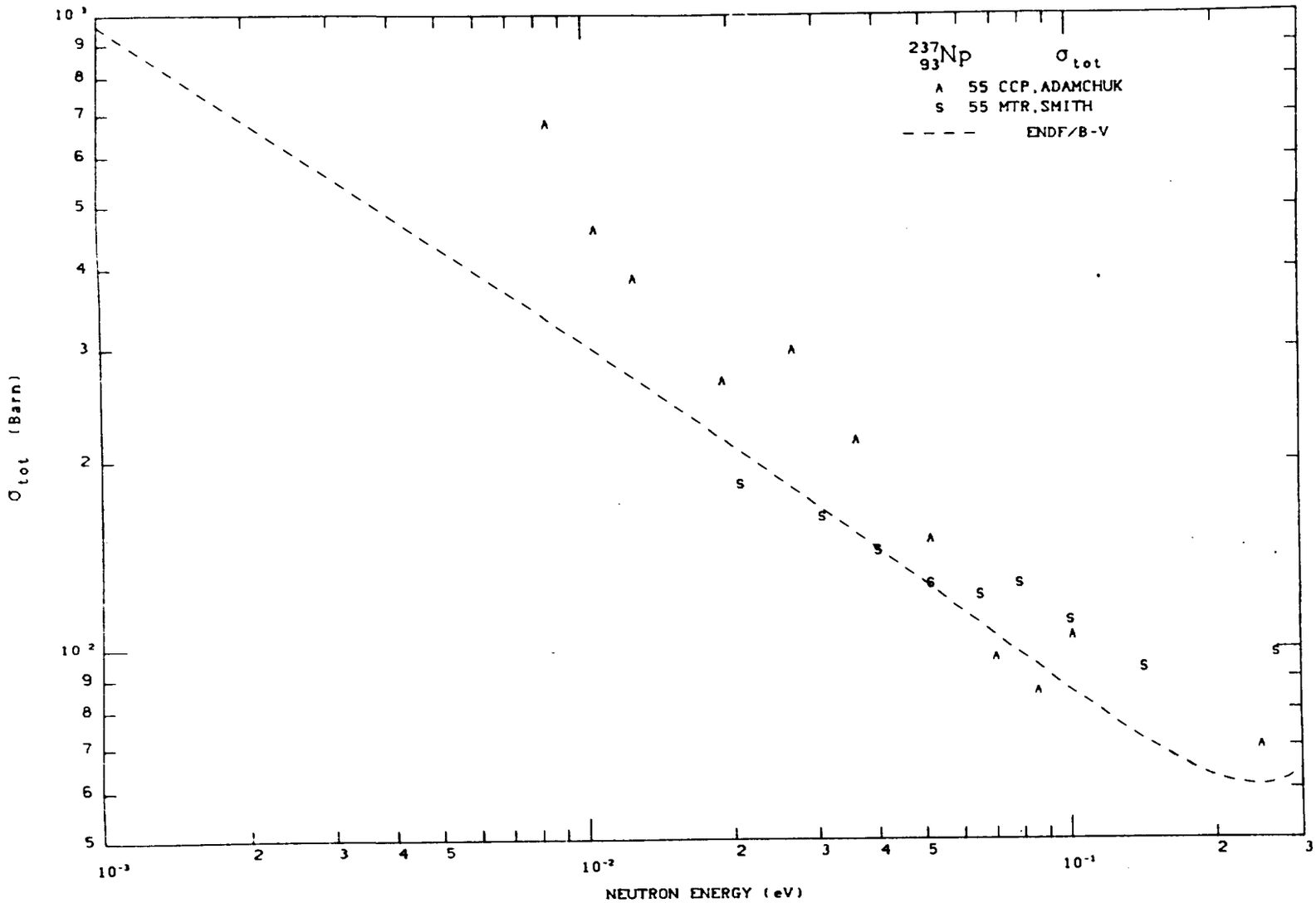
E_γ (keV)	Intensity per 100 α -particles
29.3	14
86.5	13
94.7	0.8

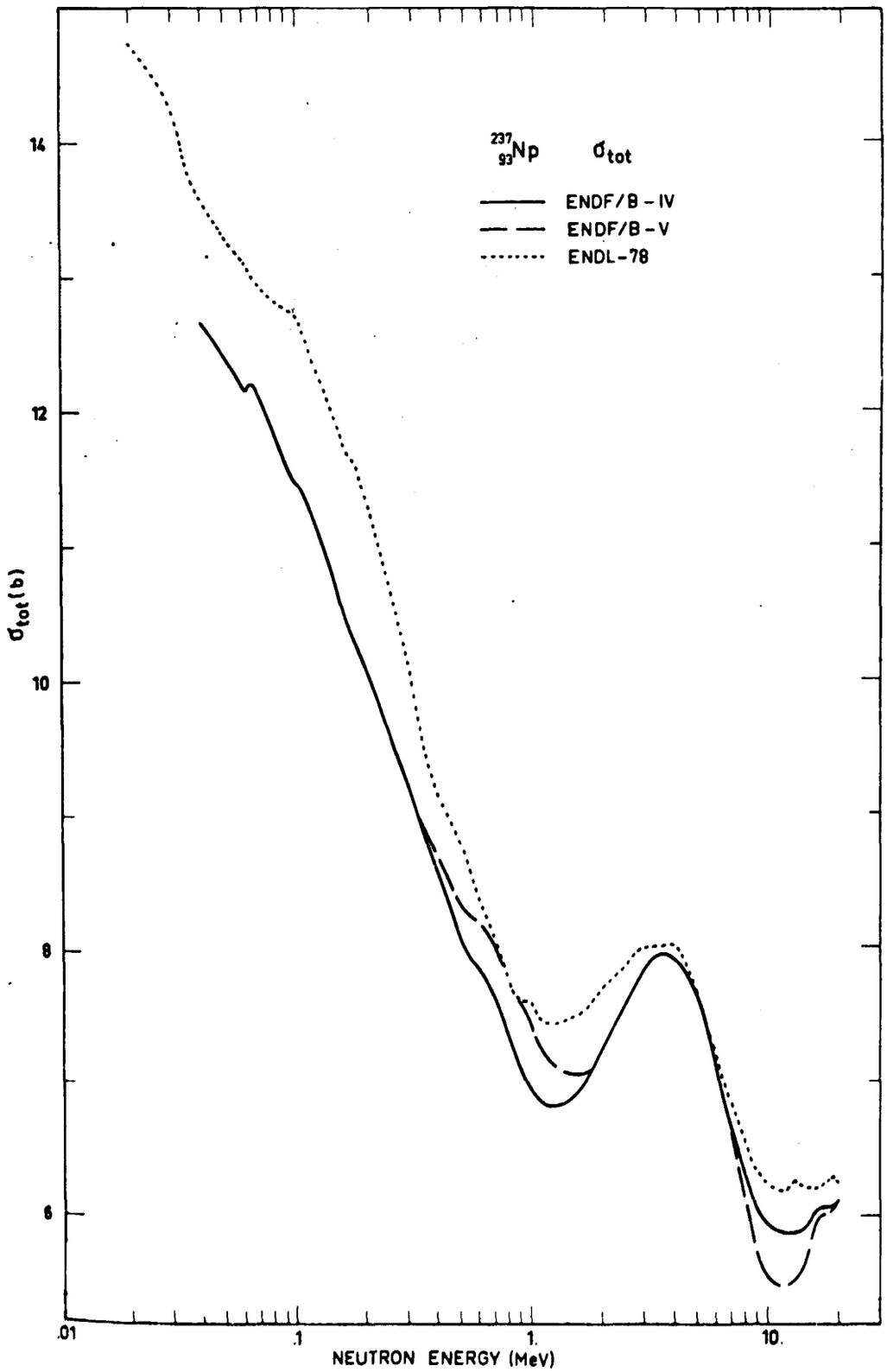
THERMAL CROSS SECTIONS

Reference	σ_γ barns	σ_f barns	σ_t barns
ENDF/B - IV and ENDF/B - V	169.1	0.02	186.6
ENDL -76	169.0	0.01	
BNL 325 (1973)	169.0	0.02	

RESONANCE INTEGRALS

Reference	RI_γ barns	RI_f barns
ENDF/B - IV	634.6	0.26
ENDL -76	558.2	1.41
BNL 325 (1973)	660	0.0
68 MTR,SCOVILLE	900	

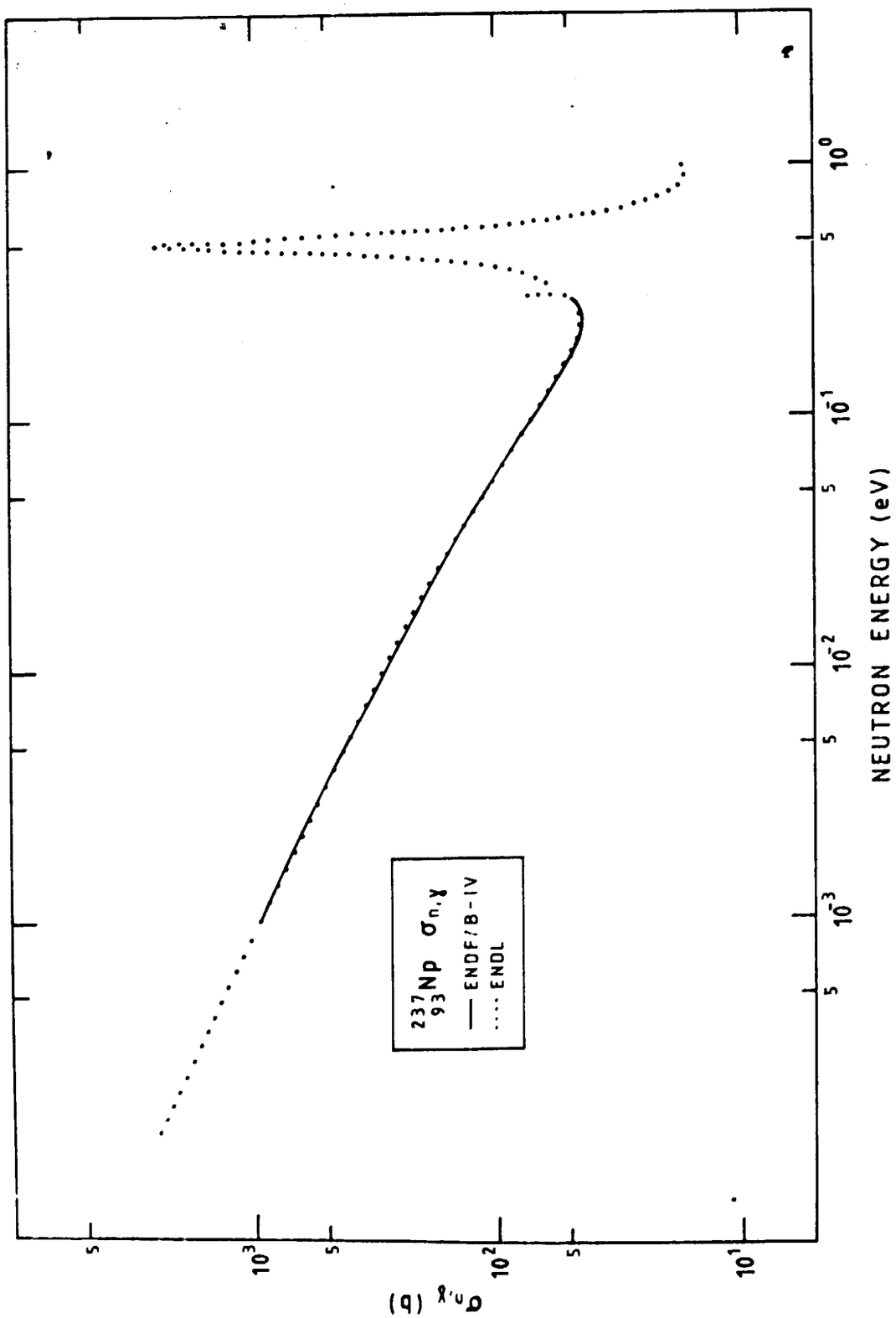

$^{237}_{93}Np$ σ_{tot}
A 55 CCP,ADAMCHUK
S 55 MTR,SMITH
ENDF/B-V
σ_{tot} (Barn)
NEUTRON ENERGY (eV)

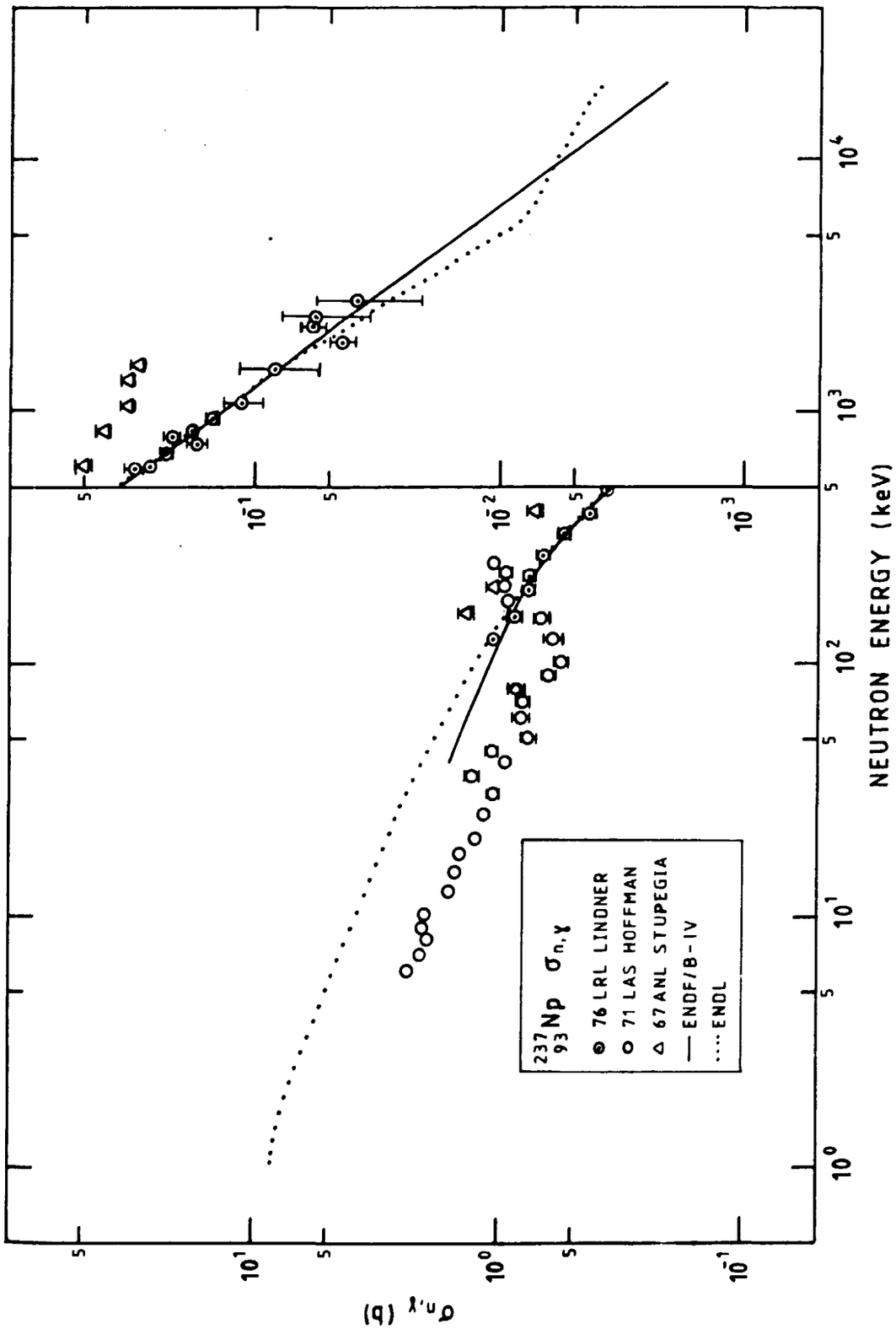

$^{237}_{93}Np$ σ_{tot}
ENDF/B - IV
ENDF/B - V
ENDL-78
14
12
10
8
6
σ_{tot} (b)
.01
.1
1.
10.
NEUTRON ENERGY (MeV)

Experimental information ^{237}Np, σ_{tot}

	Reference	Points	Range	Standard	Error	Comments
55	CCP, ADAMCHUK	88	0.008-9.7 eV	ABS.		
55	MTR, SMITH	312	0.02-2.8 eV	ABS.		

General comments: ENDF/B-IV = ENDF/B-V for E_n < 0.3 eV

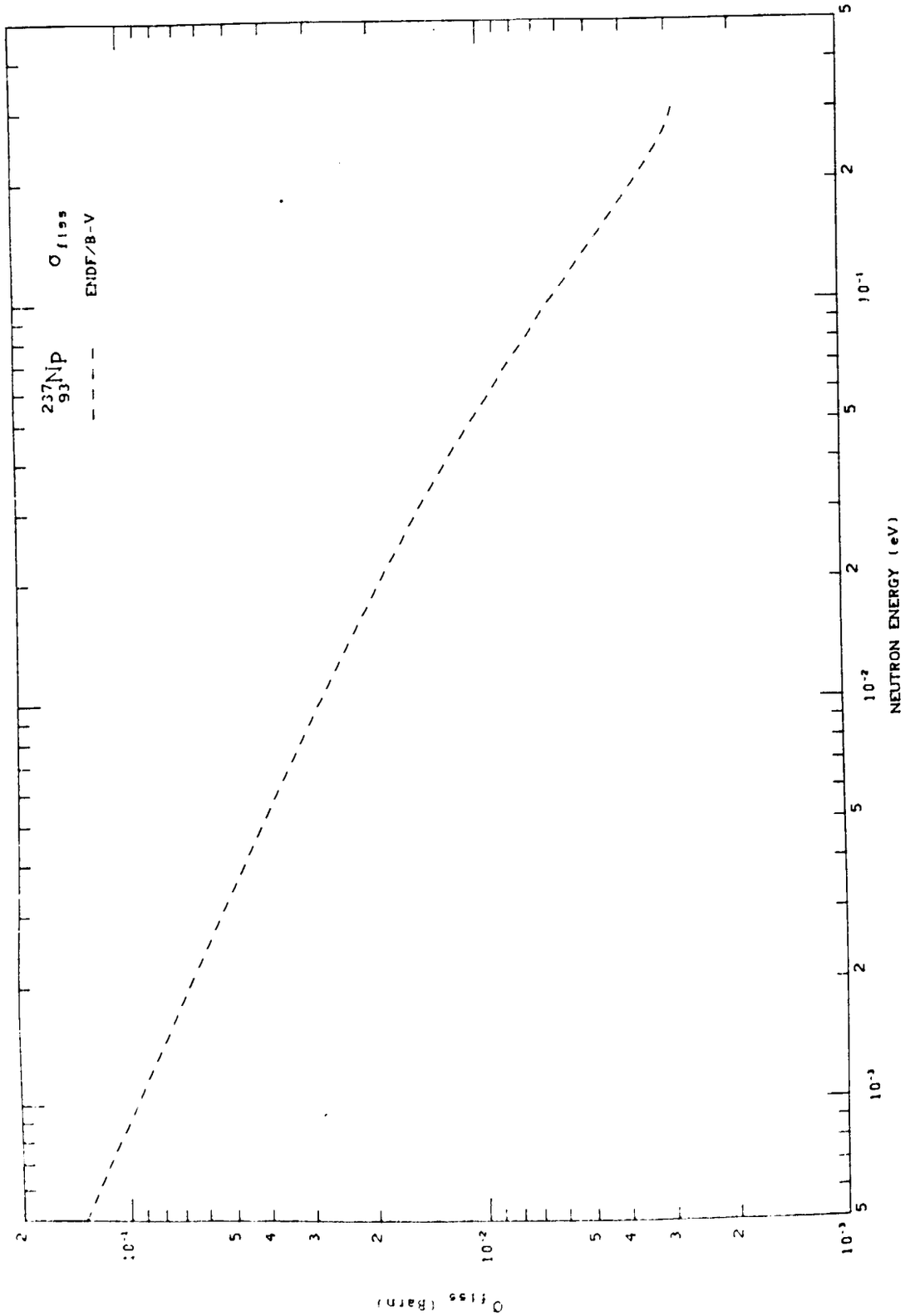

$^{237}_{93}Np$ $\sigma_{n,\gamma}$
— ENDF/B-IV
···· ENDL
$\sigma_{n,\gamma}$ (b)
NEUTRON ENERGY (eV)
10^3
10^2
10^1
10^{-3}
10^{-2}
10^{-1}
10^0
5


$^{237}_{93}Np$ $\sigma_{n,\gamma}$
76 LRL LINDNER
71 LAS HOFFMAN
67 ANL STUPEGIA
ENDF/B-IV
ENDL
NEUTRON ENERGY (keV)
$\sigma_{n,\gamma}$ (b)

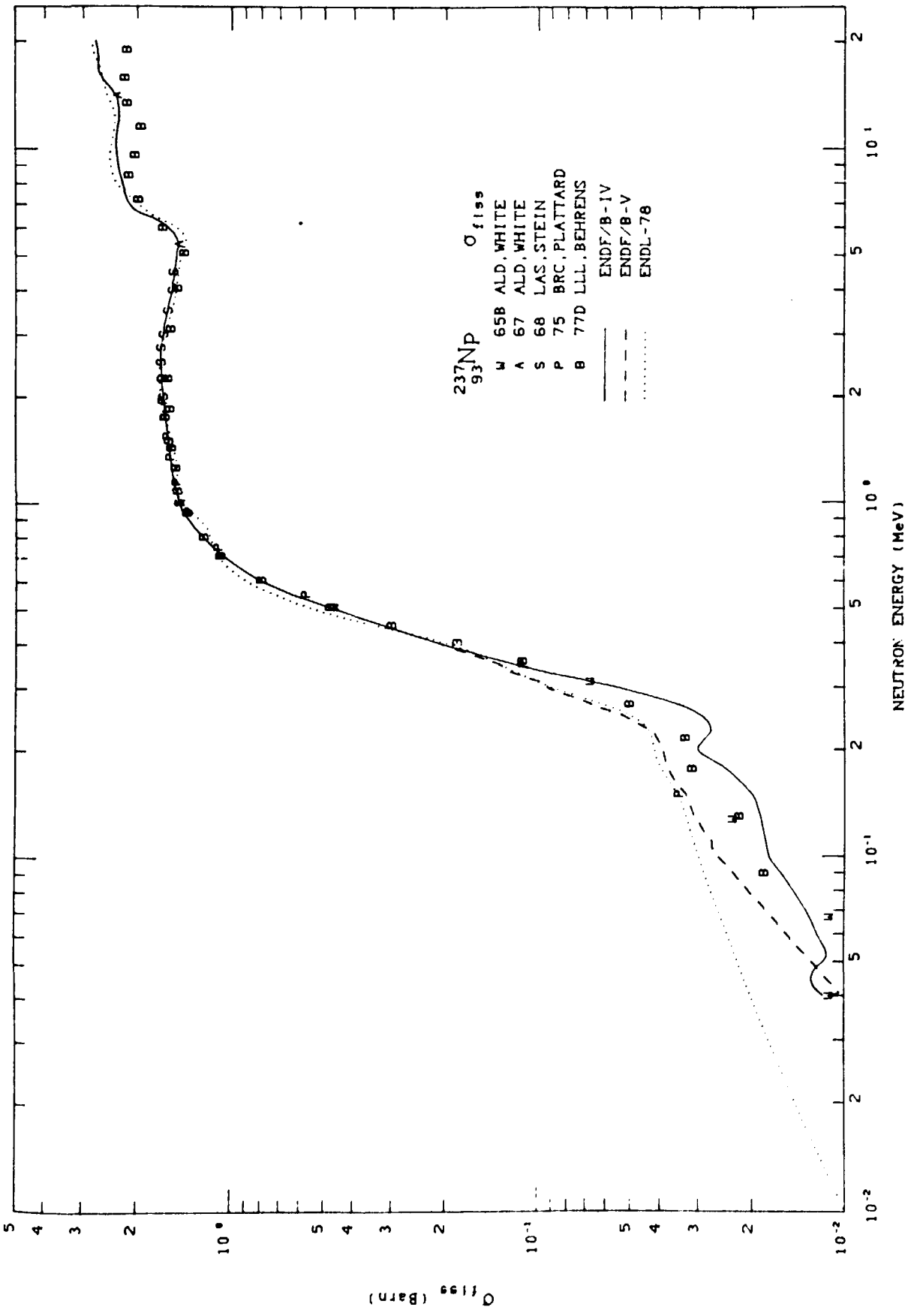
Experimental information ^{237}Np, σ_γ

	Reference	Points	Range	Standard	Error	Comments
67	ANL, STUPEGIA	8	0.15-1.5 MeV	^{235}U, σ_f	6-7 %	Energy spread: 4-16 %
71	LAS, HOFFMAN	19 300	0.02-255 keV	^{235}U, σ_f	30 %	The data points given represent average values for the energy intervals $(E_n-10^{-2}E_n)$ - $(E_n+10^{-2}E_n)$
76	LRL, LINDNER	23	0.12-2.7 MeV	^{235}U, σ_f	4-44 %	Energy spread: 6-61 %

General comments: ENDF/B-IV $\approx$ ENDF/B-V


$^{237}_{93}Np$
σ_{fiss}
ENDF/B-V
NEUTRON ENERGY (eV)
σ_{fiss} (Barn)
10^{-3}
10^{-2}
10^{-1}

$^{237}_{93}Np$


$^{237}_{93}Np$
σ_{fiss}
W 65B ALD.WHITE
A 67 ALD.WHITE
S 68 LAS.STEIN
P 75 BRC.PLATTARD
B 77D LLL.BEHRENS
ENDF/B-IV
ENDF/B-V
ENDL-78
NEUTRON ENERGY (MeV)
σ_{fiss} (Barn)

Experimental information ^{237}Np, σ_f

Reference	Points	Range	Standard	Error	Comments
65B ALD, WHITE	5	40-500 keV	^{235}U, σ_f	3 %	
67 ALD, WHITE	4	1-14 MeV	^{235}U, σ_f	3.5 %	
68 LAS, STEIN	12	1-5 MeV	^{235}U, σ_f	2.6 %	
75 BRC, PLATTARD	19	0.1-2 MeV	^{235}U, σ_f	1-2 %	Error at 0.1 MeV about 20 %
77D LLL, BEHRENS	129	0.02-30 MeV	^{235}U, σ_f	~ 2 %	
79 NBS, CARLSSON		1-20 MeV	^{235}U, σ_f	2-3 %	Relative error. Shape measurement made relative to H(n,n) cross section. Late reference not presented in the figure

General comments: Experimental data from ratio measurements given in the figures are calculated using cross sections from ENDF/B-IV as standards. ENDF/B-IV = ENDF/B-V för E_n < 0.3 eV

3.6 ^{239}Pu

NUCLEAR PROPERTIES (Ref. Nuclear Data Sheets)

Spin and parity of ground state: $1/2^+$

Ground state decay:

$T_{1/2}$ = 24110 y

β stable

spontaneous fission 4.4 x 10^{-10} %

$T_{1/2}$ = 5.5 x 10^{15} y

α to ^{235}U, 100 %, Q_α = 5.244 MeV

E_α (MeV)	I_α (%)
5.155	73.3
5.143	15.1
5.105	11.5

γ(^{235}U)

E_γ(keV)	Intensity per 100 α particles	E_γ(keV)	Intensity per 100 α particles
51.6	208x10^{-4}	375.0	16x10^{-4}
129.3	62 -"-	413.7	15 -"-
38.7	59 -"-	98.8	13 -"-

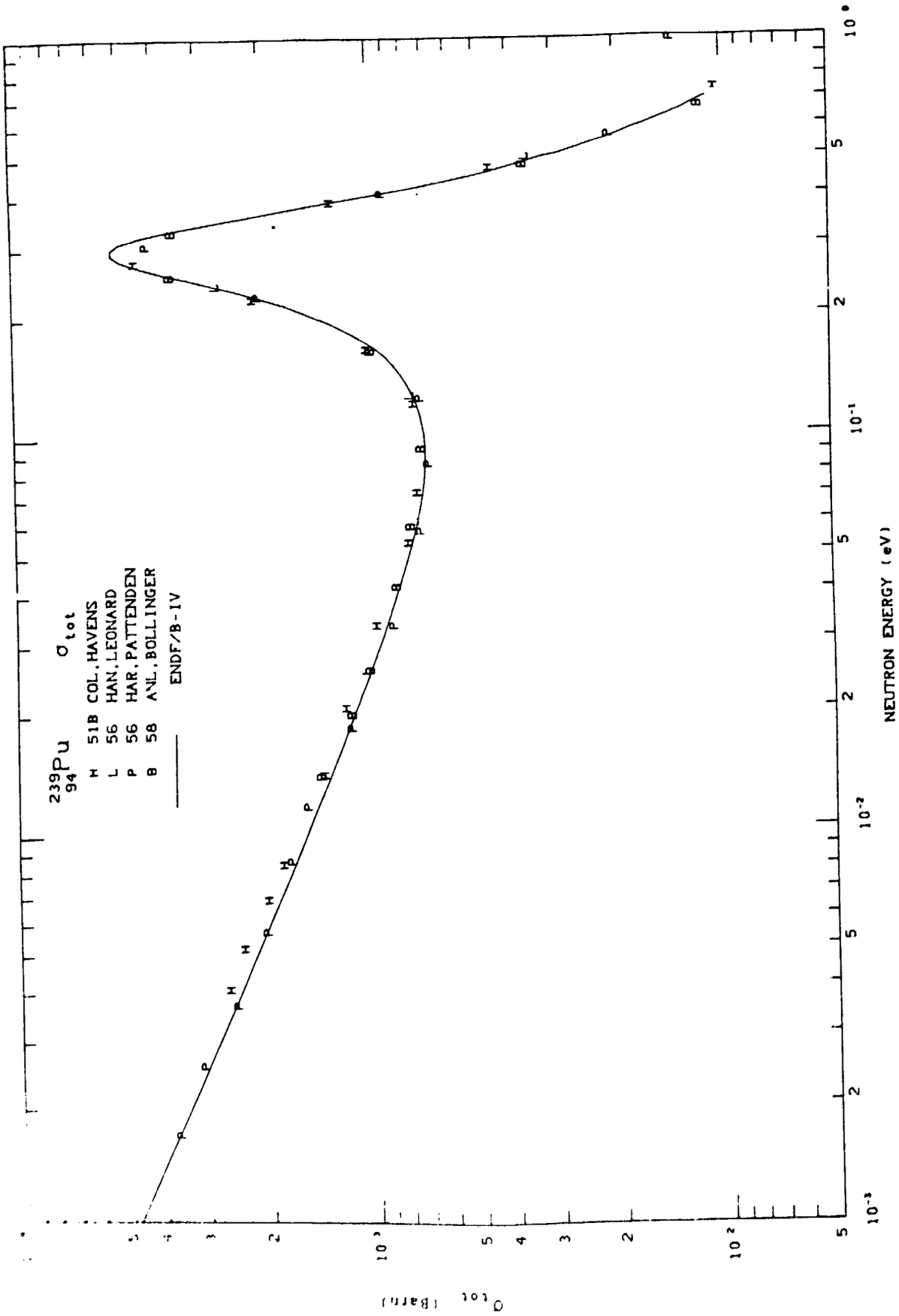
THERMAL CROSS SECTIONS

Reference	σ_γ barns	σ_f barns	σ_t barns	$\bar{\nu}_t$
ENDF/B - IV	270.2	741.7	1020.	2.873
ENDL -76	275.5	783.0		
IAEA-3 (1975)	267.2	744.0		2.862
BNL 325 (1973)	268.8	742.5	1019.	2.871
70 GEL,DERUYTTER		742.5		

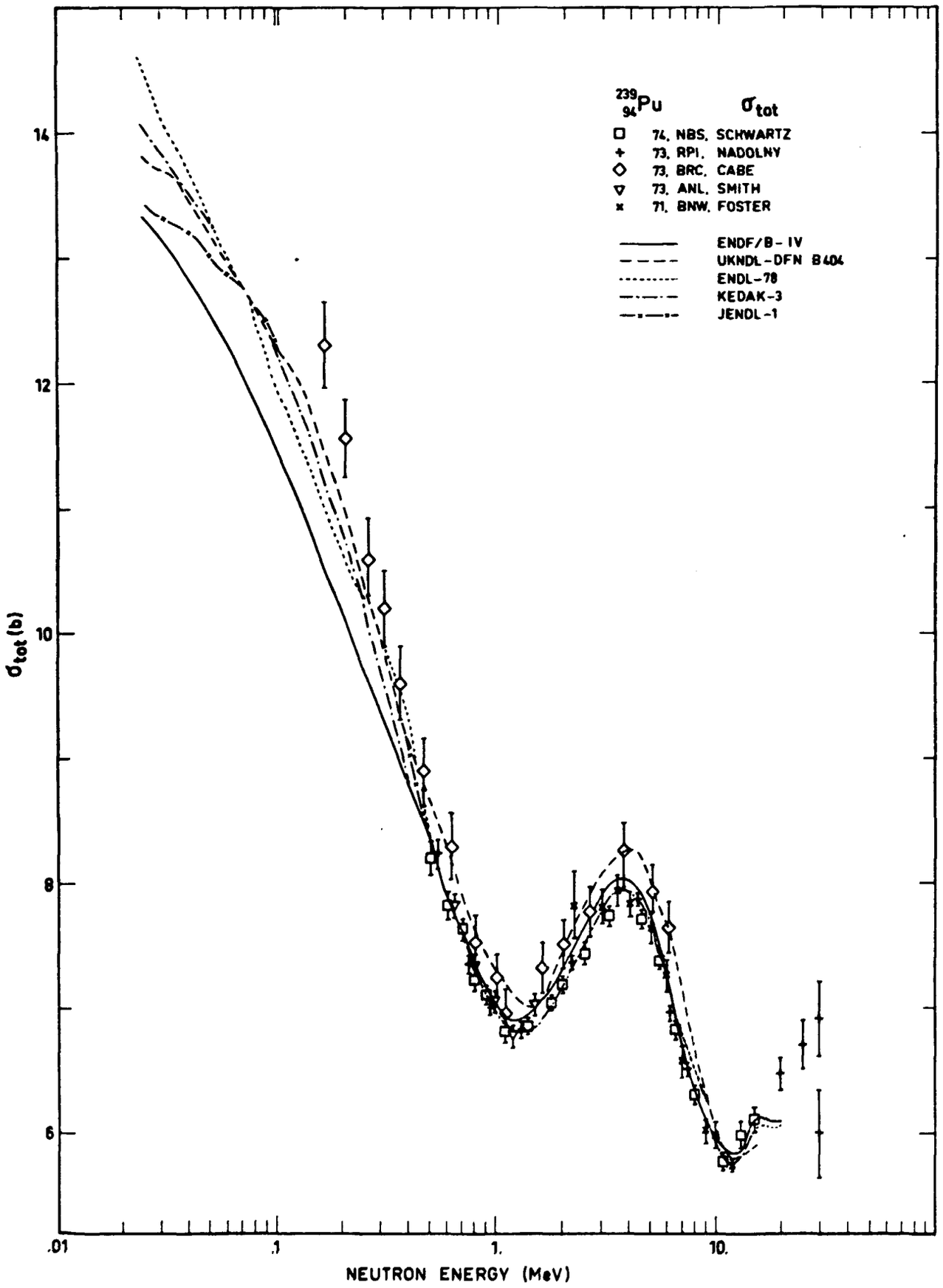
RESONANCE INTEGRALS

Reference	RI_γ barns	RI_f barns
ENDF/B - IV	192.4	288.0
ENDL -76	196.4	283.1
BNL 325 (1973)	200	301
71 KAP,EILAND		327

$^{239}_{94}Pu$

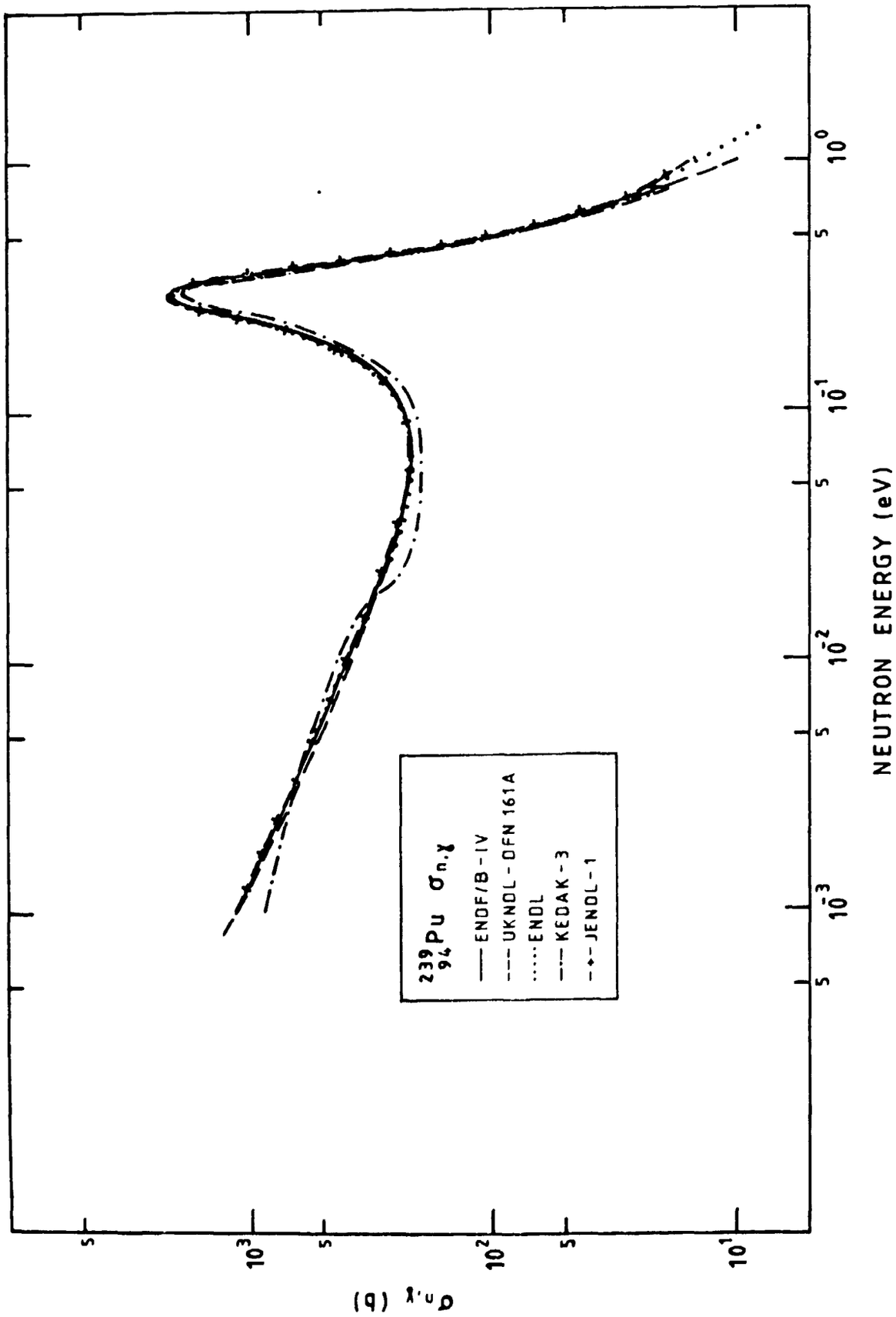

$^{239}_{94}Pu$
σ_{tot}
H 51B COL.HAVENS
L 56 HAN.LEONARD
P 56 HAR.PATTENDEN
B 58 ANL.BOLLINGER
ENDF/B-IV
NEUTRON ENERGY (eV)
σ_{tot} (Barn)

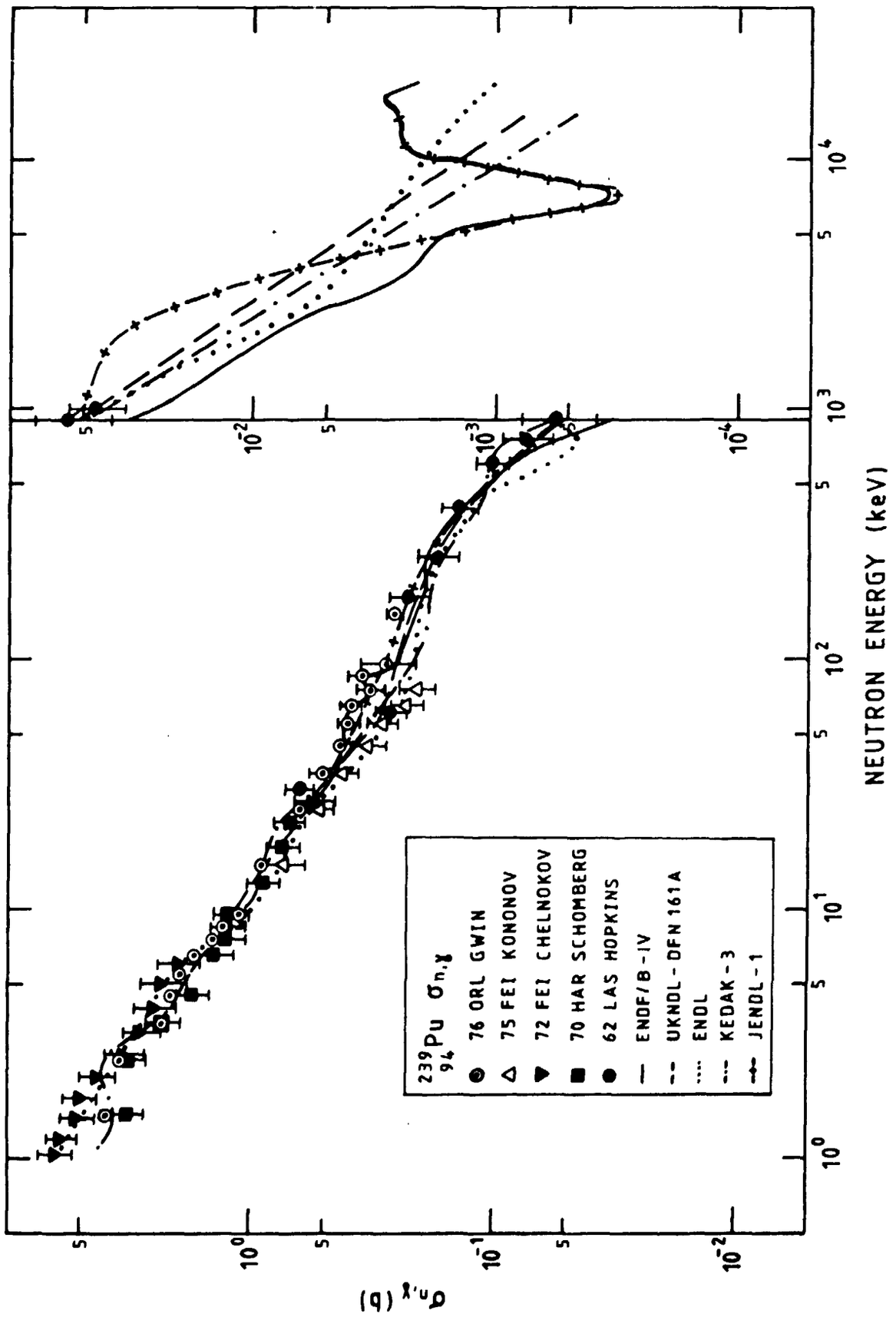
$^{239}_{94}Pu$


$^{239}_{94}Pu$ σ_{tot}
74. NBS. SCHWARTZ
73. RPI. NADOLNY
73. BRC. CABE
73. ANL. SMITH
71. BNW. FOSTER
ENDF/B-IV
UKNDL-DFN B404
ENDL-78
KEDAK-3
JENDL-1
14
12
10
8
6
σ_{tot} (b)
.01
.1
1.
10.
NEUTRON ENERGY (MeV)

Experimental information ^{239}Pu, σ_{tot}

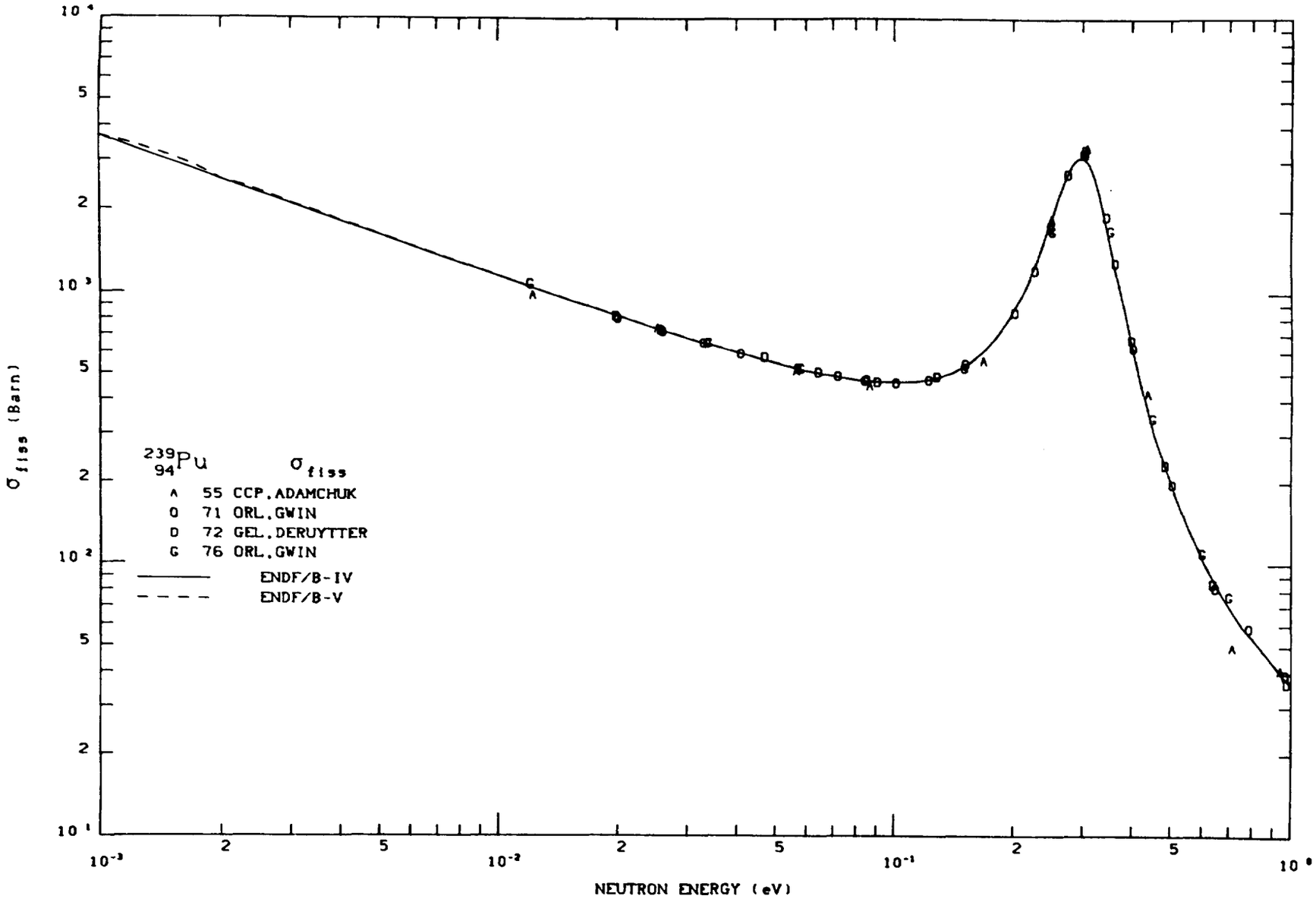
Reference	Points	Range	Standard	Error	Comments
51B COL, HAVENS	58	0.004-0.74 eV	ABS.		
56 HAN, LEONARD	22	0.0253-0.5 eV	ABS.		
56 HAR, PATTENDEN	178	0.017-19 eV	ABS.		
58 ANL, BOLLINGER	97	0.014-0.72 eV	ABS.		
71 BNW, FOSTER	243	2.2-15 MeV	ABS.	1-3 %	
73 ANL, SMITH	393	0.65-1.5 MeV	ABS.	1-2 %	
73 BRC, CABE	148	0.2-6 MeV	ABS.	3 %	
73 RPI, NADOLNY	719	0.5-30 MeV	ABS.	1-2 %	
74 NBS, SCHWARTZ	1 680	0.5-15 MeV	ABS.	1 %	Stat. error

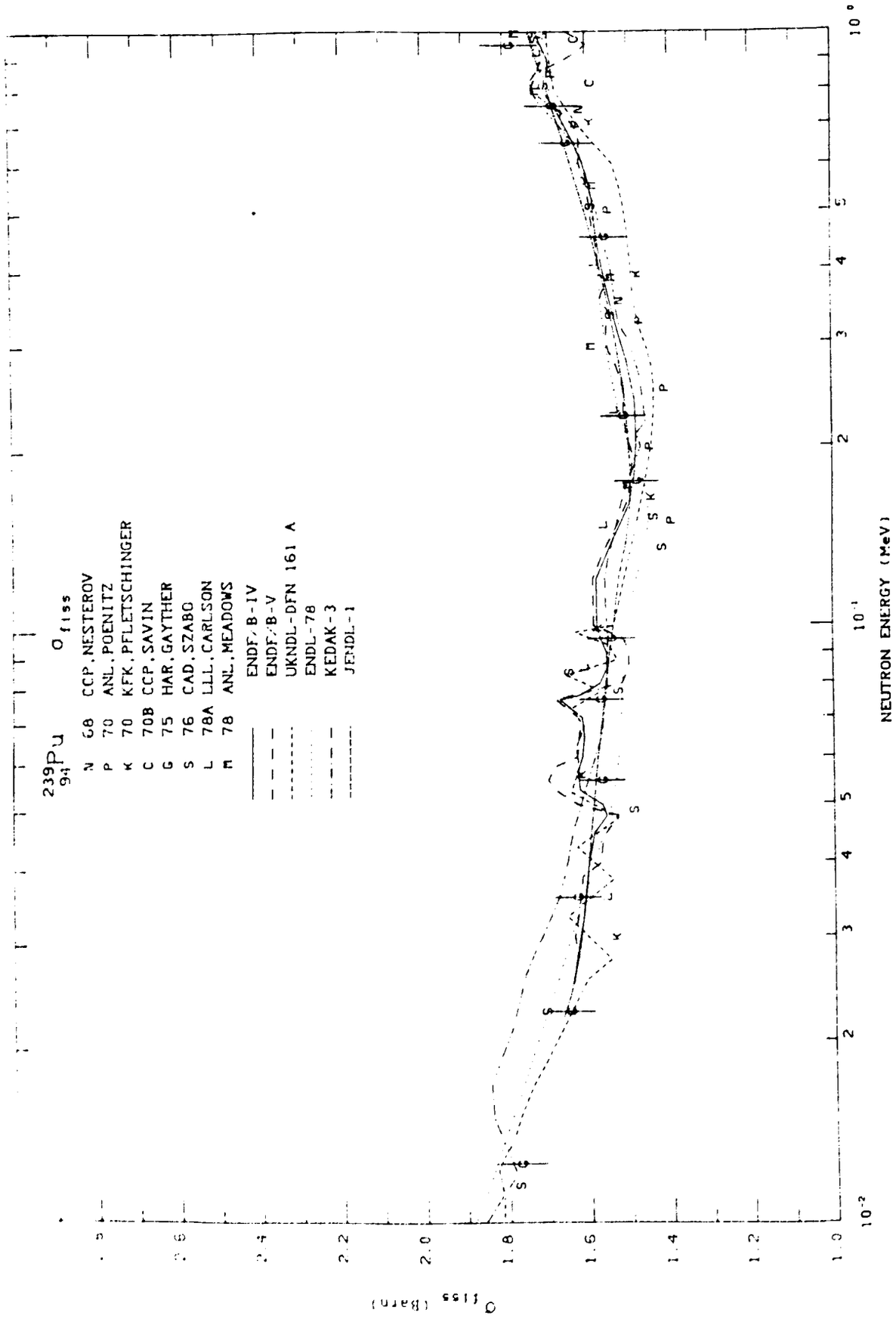

$^{239}_{94}Pu$ $\sigma_{n,\gamma}$
ENDF/B-IV
UKNDL-DFN 161A
ENDL
KEDAK-3
JENDL-1
$\sigma_{n,\gamma}$ (b)
NEUTRON ENERGY (eV)
10^3
10^2
10^1
10^{-3}
10^{-2}
10^{-1}
10^0
5


$^{239}_{94}Pu$ $\sigma_{n,\gamma}$
76 ORL GWIN
75 FEI KONONOV
72 FEI CHELNOKOV
70 HAR SCHOMBERG
62 LAS HOPKINS
ENDF/B-IV
UKNDL-DFN 161A
ENDL
KEDAK-3
JENDL-1
NEUTRON ENERGY (keV)
$\sigma_{n,\gamma}$ (b)

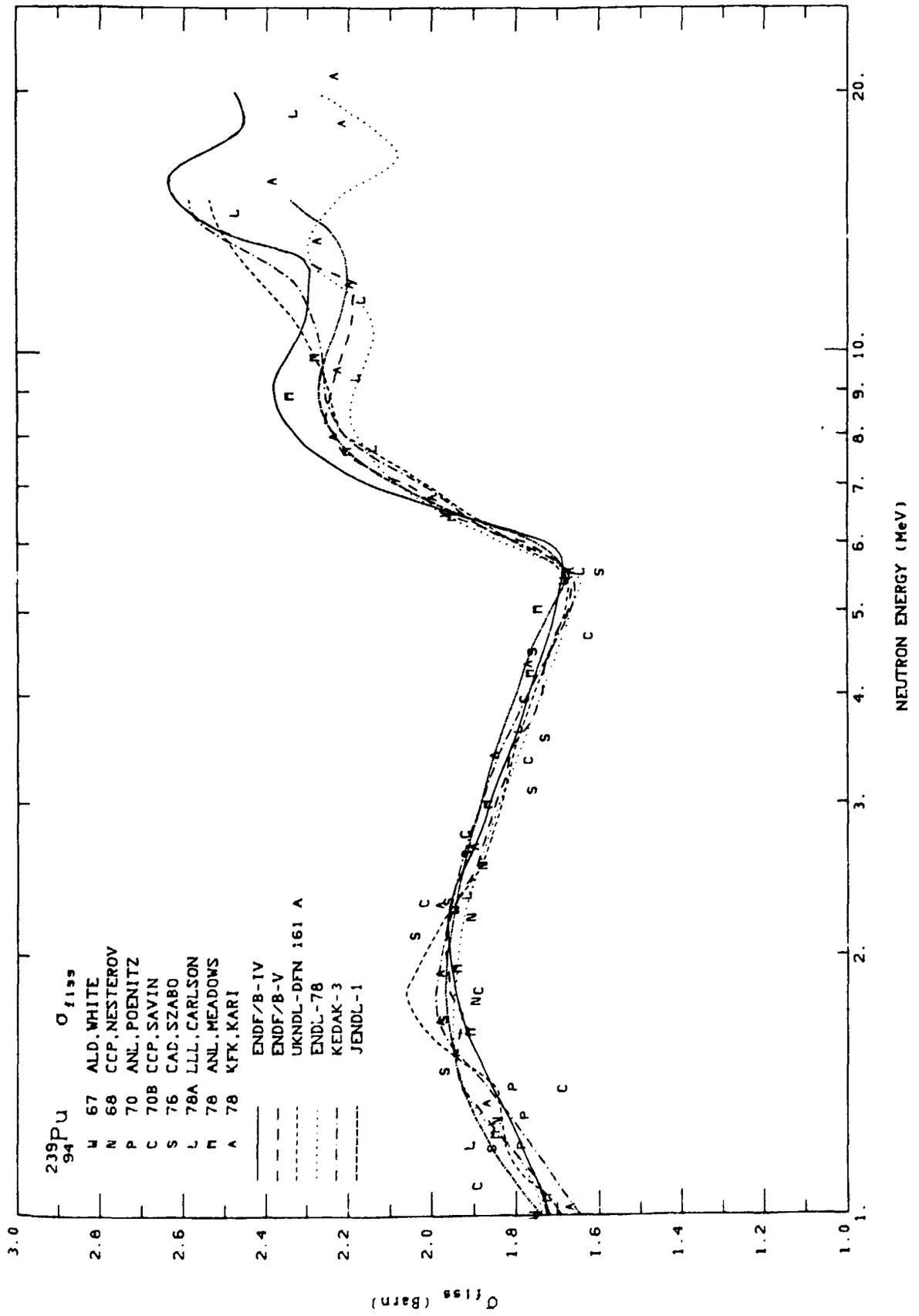
Experimental information ^{239}Pu, σ_γ

	Reference	Points	Range	Standard	Error	Comments
62	LAS, HOPKINS	9	30-1 000 keV	^{239}Pu, σ_f	14-34 %	Renorm. to BNL 325, σ_f
70	HAR, SCHOMBERG	21	0.2-11 30 keV	^{239}Pu, σ_f	15-20 %	
72	FEI, CHELNOKOV	22	0.2-6 keV			
75	FEI, KONONOV	7	10-80 keV	^{197}Au, σ_γ	2-8 %	
76	ORL, GWIN	29	0.05-200 keV	^{239}Pu, σ_f	2-27 %	


$^{239}_{94}$Pu
σ_{fiss}
A 55 CCP.ADAMCHUK
O 71 ORL.GWIN
D 72 GEL.DERUYTTER
G 76 ORL.GWIN
ENDF/B-IV
ENDF/B-V
σ_{fiss} (Barn)
NEUTRON ENERGY (eV)
10^{4}
5
2
10^{3}
5
2
10^{2}
5
2
10^{1}
10^{-3}
2
5
10^{-2}
2
5
10^{-1}
2
5
10^{0}


$^{239}_{94}Pu$
σ_{fiss}
N 68 CCP,NESTEROV
P 70 ANL,POENITZ
K 70 KFK,PFLETSCHINGER
C 70B CCP,SAVIN
G 75 HAR,GAYTHER
S 76 CAD,SZABO
L 78A LLL,CARLSON
M 78 ANL,MEADOWS
ENDF/B-IV
ENDF/B-V
UKNDL-DFN 161 A
ENDL-78
KEDAK-3
JENDL-1
NEUTRON ENERGY (MeV)
σ_{fiss} (barn)

$^{239}_{94}Pu$


$^{239}_{94}Pu$
σ_{fiss}
W 67 ALD.WHITE
N 68 CCP.NESTEROV
P 70 ANL.POENITZ
C 70B CCP.SAVIN
S 76 CAD.SZABO
L 78A LLL.CARLSON
M 78 ANL.MEADOWS
A 78 KFK.KARI
ENDF/B-IV
ENDF/B-V
UKNDL-DFN 161 A
ENDL-78
KEDAK-3
JENDL-1
σ_{fiss} (barn)
NEUTRON ENERGY (MeV)

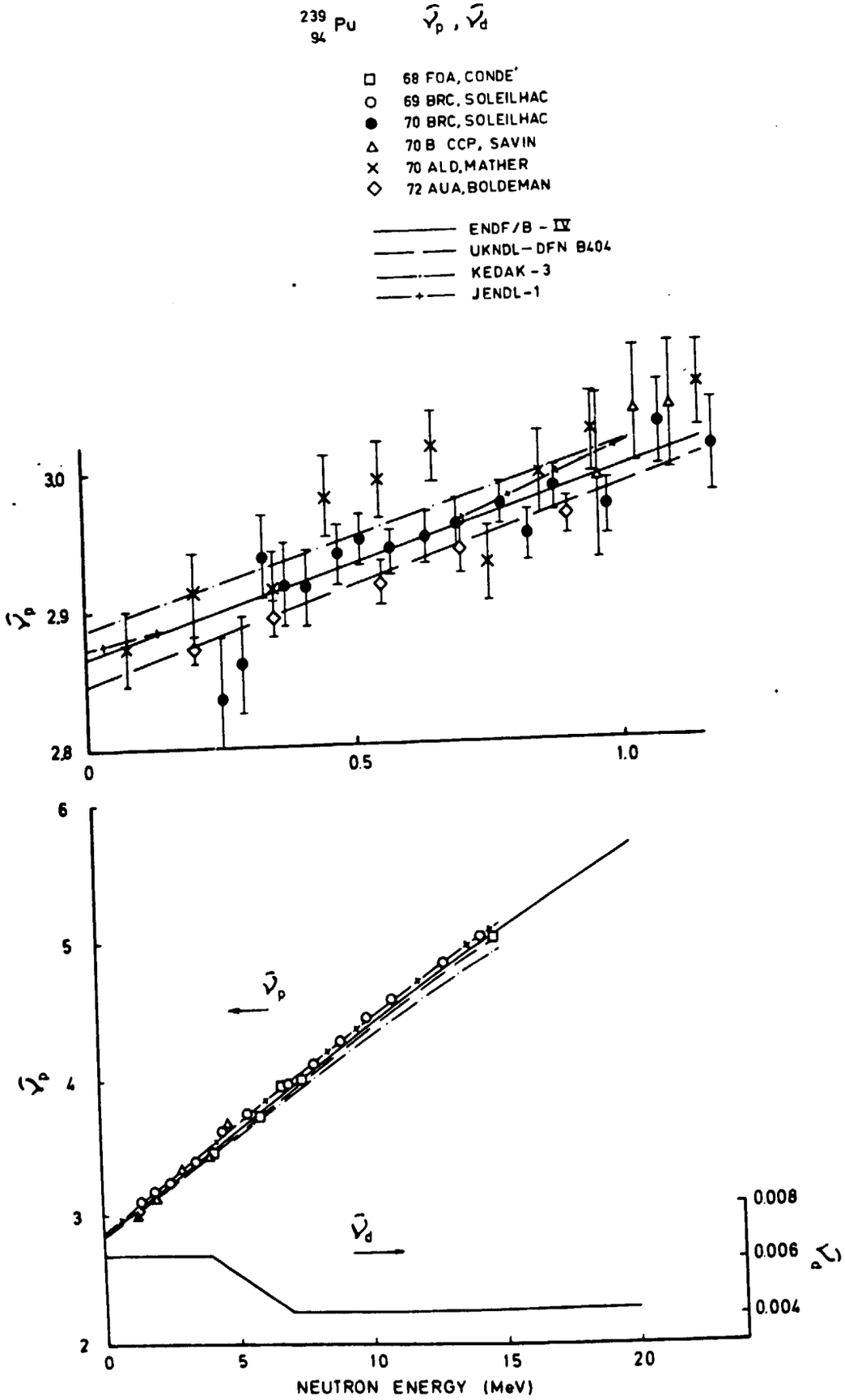
Experimental information ^{239}Pu, σ_f

	Reference	Points	Range	Standard	Error	Comments
55	CCP, ADAMCHUK	237	0.01-1 000 eV	^{239}Pu, σ_f^{th}		.
67	ALD, WHITE	4	1-14 MeV	^{235}U, σ_f	3.5 %	
68	CCP, NESTEROV	87	0.3-2.6 MeV	^{235}U, σ_f^{th}	3 %	Two independent meas. with 3 and 2.7 % errors, respectively
70	ANL, POENITZ	11	0.15-1.4 MeV	^{235}U, σ_f	2-3.5 %	
70B	CCP, SAVIN	35	0.8-5.5 MeV	^{235}U, σ_f	2-4 %	
70	KFK, PFLETSCHINGER	48	5 keV-1 MeV	^{235}U, σ_f	2-2.5 %	
71	ORL, GWIN	1 317	0.02-30 keV	^{239}Pu, σ_f^{th}	2-5 %	Two independent meas. using ionization chamber and metal foil
72	GEL, DERUYTTER	560	0.02-30 eV			Norm. to fiss. integral between 0.02-0.06 eV = = 25.15 b. Error 10 % in integral between 9-20 eV

Experimental information ^{239}Pu, σ_f (cont.)

Reference	Points	Range	Standard	Error	Comments
75 HAR, GAYTHER	33	1 keV-1 MeV	^{235}U, σ_f	3.5-4 %	$\sigma_f(239):\sigma_f(235)$ norm. to average values between 10-30 keV from eval. by Sowerby et al (Annals Nucl. Sci. Eng. 409 (1974))
76 CAD, SZABO	56	0.012-5.5 MeV	ABS.	2-4 %	Final results of four meas. are given
76 ORL, GWIN	127	0.02 eV-200 keV		3-10 %	Error in relative value
78 ANL, MEADOWS	75	0.15-9.8 MeV	^{235}U, σ_f	2.5 %	Error in relative value
78 KFK, KARI	169	1.0-20 MeV	H, $\sigma_{n,n}$	3-4 %	
78A LLL, CARLSON	107	1 keV-30 MeV	^{235}U, σ_f	1-4 %	Error in relative value

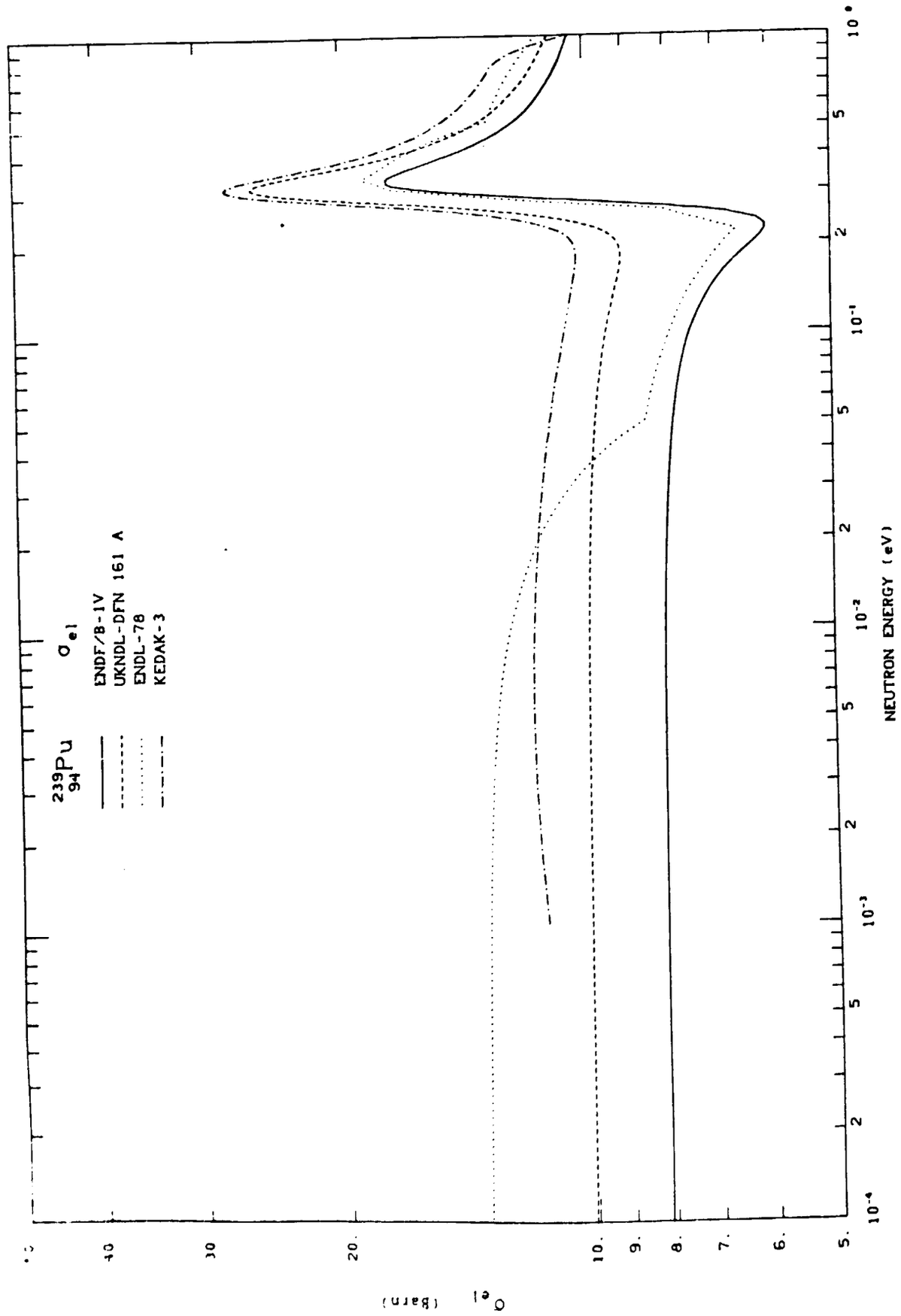
General comments: Experimental data from ratio measurements given in the figures are calculated using cross sections from ENDF/B-IV as standards. ENDF/B-V fission cross section evaluation in the thermal energy range has been calculated from resonance parameters using the computer code RESEND (NEA Nuclear Data Bank)

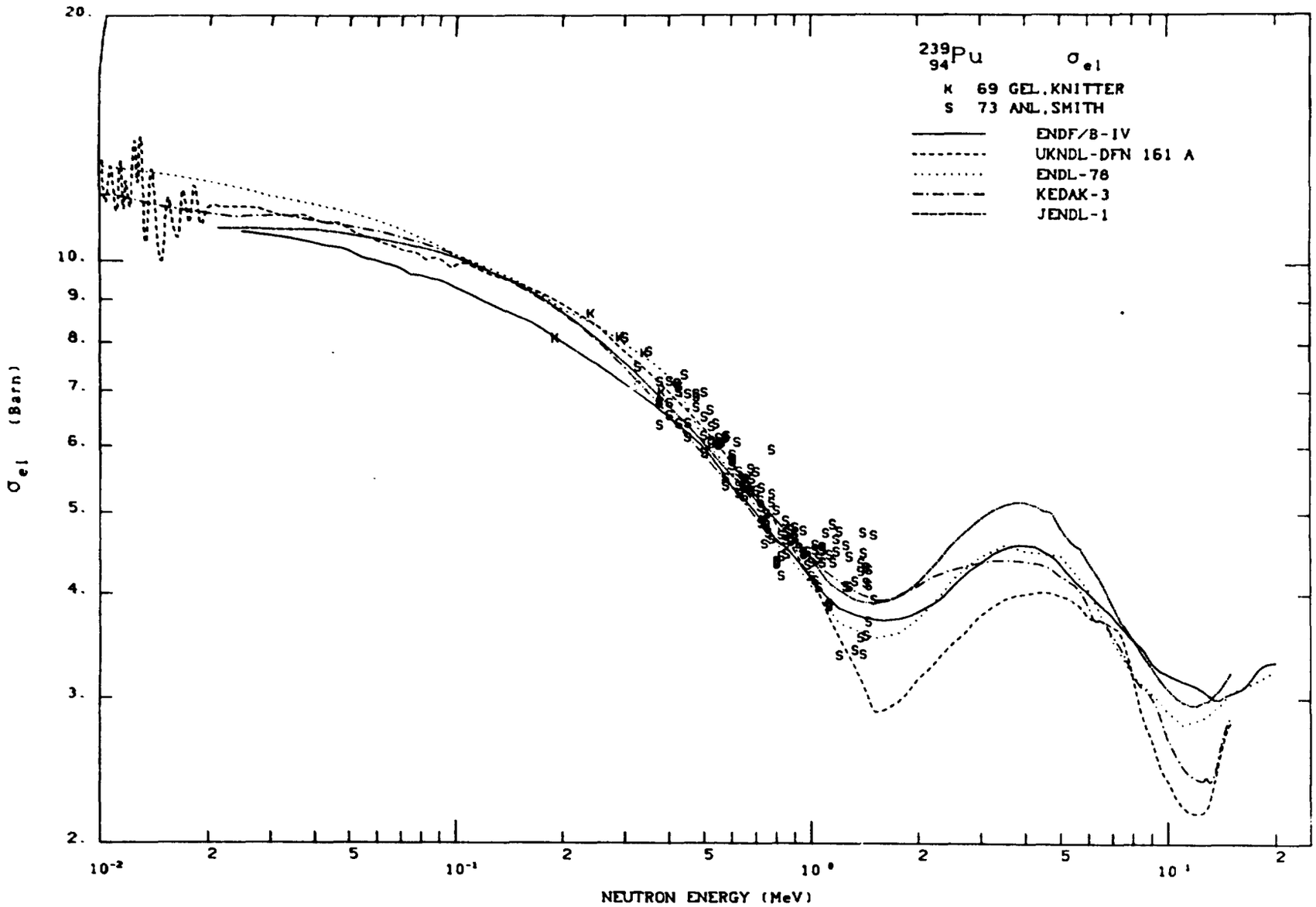

$^{239}_{94}Pu$ $\bar{\nu}_p$, $\bar{\nu}_d$
68 FOA, CONDE'
69 BRC, SOLEILHAC
70 BRC, SOLEILHAC
70 B CCP, SAVIN
70 ALD, MATHER
72 AUA, BOLDEMAN
ENDF/B - IV
UKNDL - DFN B404
KEDAK - 3
JENDL-1
3.0
2.9
2.8
0
0.5
1.0
6
5
4
3
2
$\bar{\nu}_p$
$\bar{\nu}_d$
0.008
0.006
0.004
0
5
10
15
20
NEUTRON ENERGY (MeV)

Experimental information ^{239}Pu, $\bar{\nu}$

	Reference	Points	Range	Standard	Error	Comments
68	FOA, CONDÉ	5	4.2-14.8 MeV	^{252}Cf, $\bar{\nu}_p^{sp}$	2 %	
69	BRC, SOLEILHAC	35	1.4-30 MeV	^{252}Cf, $\bar{\nu}_p^{sp}$	0.5-1 %	
70	ALD, MATHER	18	0.08-1.2 MeV	^{252}Cf, $\bar{\nu}_p^{sp}$	1-1.5 %	
70	BRC, SOLEILHAC	40	0.2-1.4 MeV	^{252}Cf, $\bar{\nu}_p^{sp}$	0.5-2 %	
70A	CCP, SAVIN	41	0.9-4.7 MeV	^{252}Cf, $\bar{\nu}_p^{sp}$	1-2 %	
72	AUA, BOLDEMAN	8	0.2-1.9 MeV	^{252}Cf, $\bar{\nu}_p^{sp}$	0.5 %	

General comments: Data normalized to $\bar{\nu}_p^{sp}(^{252}Cf) = 3.756$


$^{239}_{94}Pu$
σ_{el}
ENDF/B-IV
UKNDL-DFN 161 A
ENDL-78
KEDAK-3
NEUTRON ENERGY (eV)
σ_{el} (barn)
40
30
20.
10.
9.
8.
7.
6.
5.
10^{-4}
10^{-3}
10^{-2}
10^{-1}
10^{0}


$^{239}_{94}$Pu σ_{el}
K 69 GEL.KNITTER
S 73 ANL.SMITH
ENDF/B-IV
UKNDL-DFN 161 A
ENDL-78
KEDAK-3
JENDL-1
σ_{el} (Barn)
NEUTRON ENERGY (MeV)

Experimental information ^{239}Pu, $\sigma_{n,n}$

	Reference	Points	Range	Standard	Error	Comments
69	GEL, KNITTER	5	0.19-0.38 MeV	H, $\sigma_{n,n}$		Sum of elastic and unresolved inelastic cross sections to the 7.8, 57 and 76 keV levels
73	ANL, SMITH	135	0.3-1.5 MeV	C, $\sigma_{n,n}$		Sum of elastic and unresolved inelastic cross sections to 7.8 keV level for $E_n \lesssim 550$ keV, to 7.8 and 57 keV levels for $550 \leq E_n \leq 900$ keV and to 7.8, 57 and 76 keV levels for $E_n > 900$ keV

General comments: For $E_n < 1$ eV is JENDL-1 = ENDF/B-IV

3.7 ^{240}Pu

NUCLEAR PROPERTIES (Ref. Nuclear Data Sheets)

Spin and parity of ground state: 0^+

Ground state decay:

$T_{1/2}$ = 6537 y

β stable

spontaneous fission 4.95 x 10^{-6} %

$T_{1/2}$ = 1.3 x 10^{11} y

α to ^{236}U, 100 %, Q_α = 5.256 MeV

E_α (MeV)	I_α (%)
5.168	73.4
5.123	26.5

γ(^{236}U)

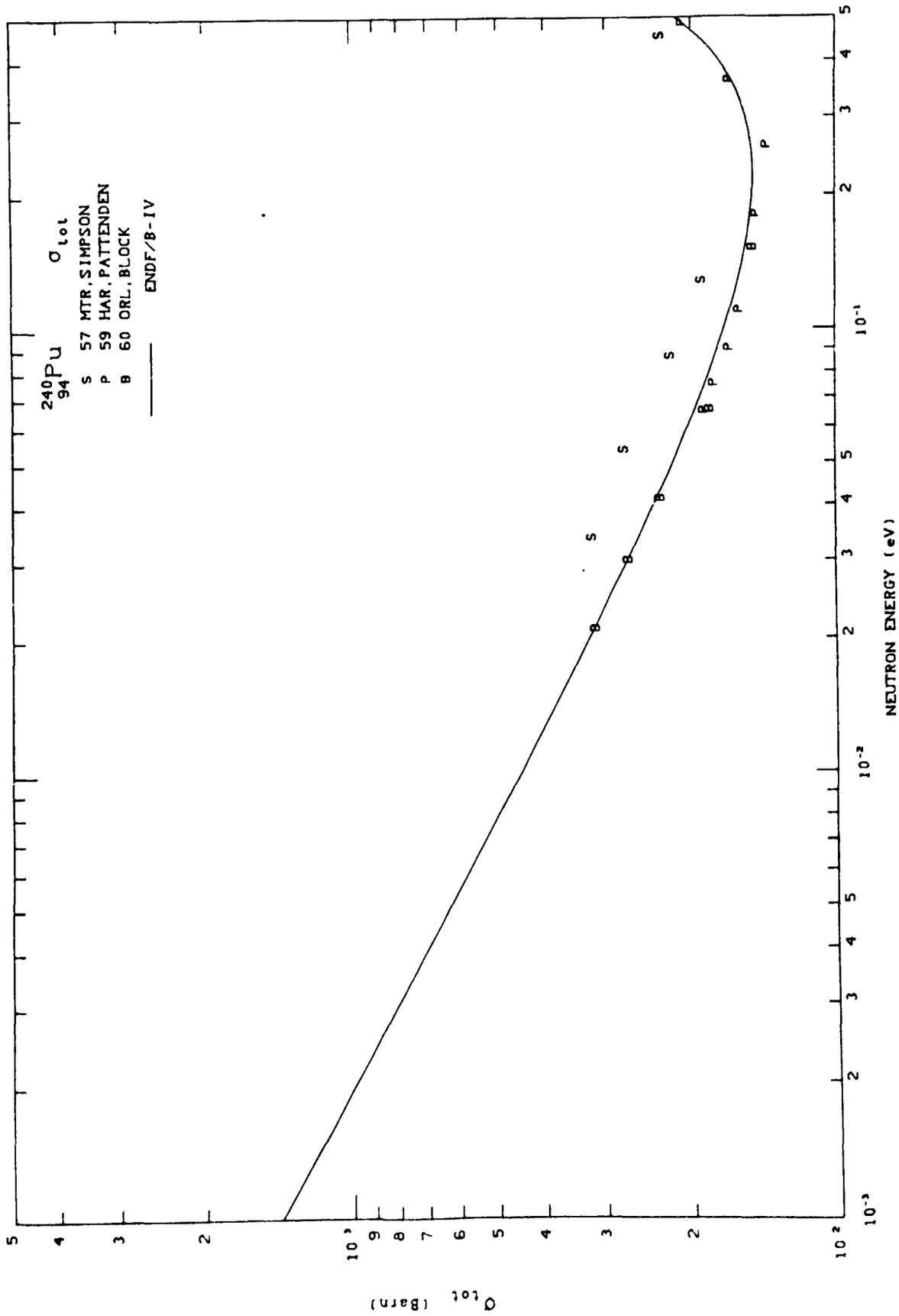
E_γ (keV)	Intensity per 100 α particles
45.2	45 x 10^{-3}
104.2	7 -"-
160.3	0.4 -"-

THERMAL CROSS SECTIONS

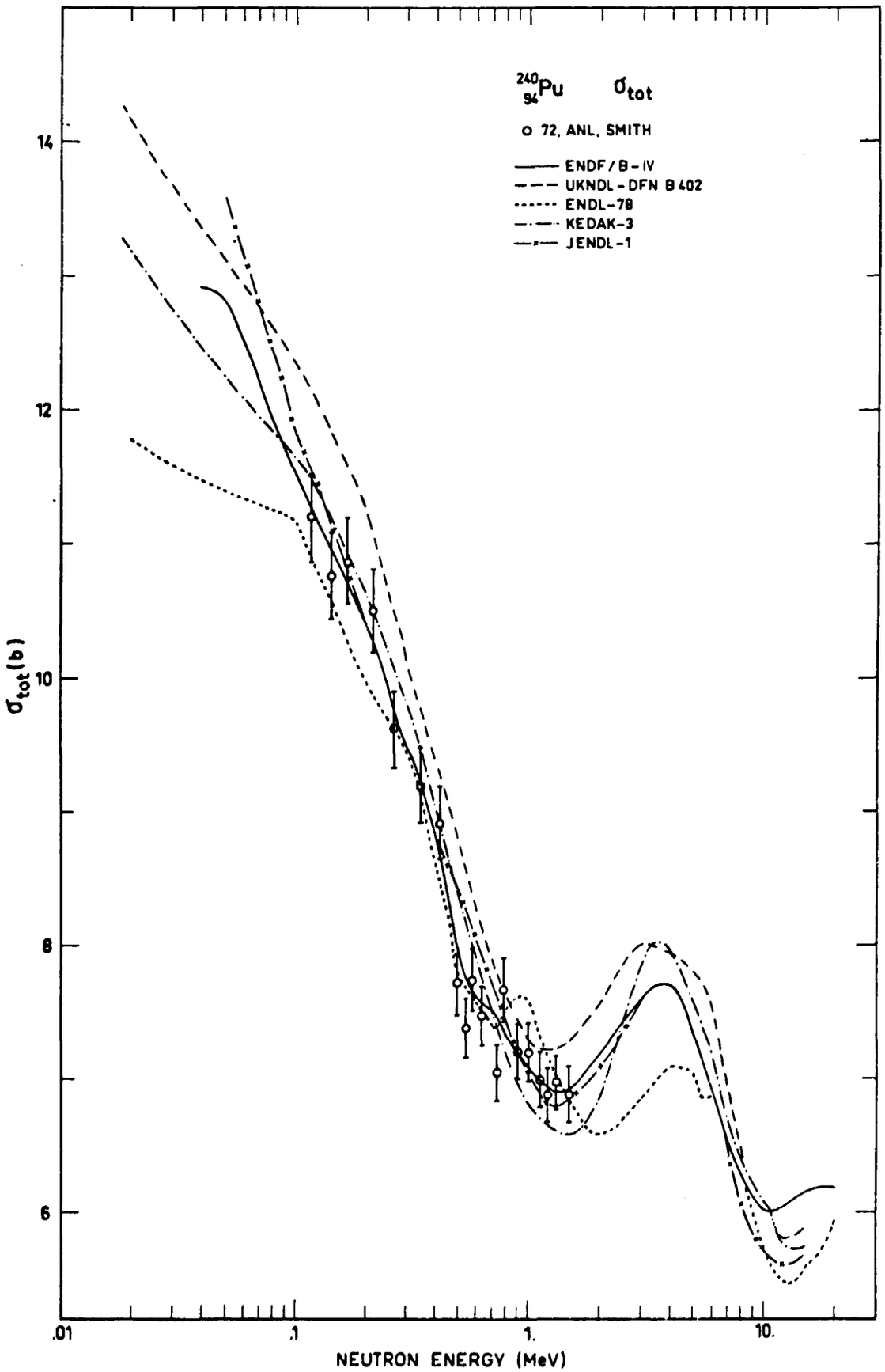
Reference	σ_γ barns	σ_f barns	σ_t barns
ENDF/B - IV	290.0	0.06	293.8
ENDL -76	290.0	0.06	
BNL 325 (1973)	289.5	0.03	291
70 CRC,LOUNSBURY	289.5		

RESONANCE INTEGRALS

Reference	RI_γ barns	RI_f barns
ENDF/B - IV	7793	3.2
ENDL -76	7721	3.2
BNL 325 (1973)	8013	0.0

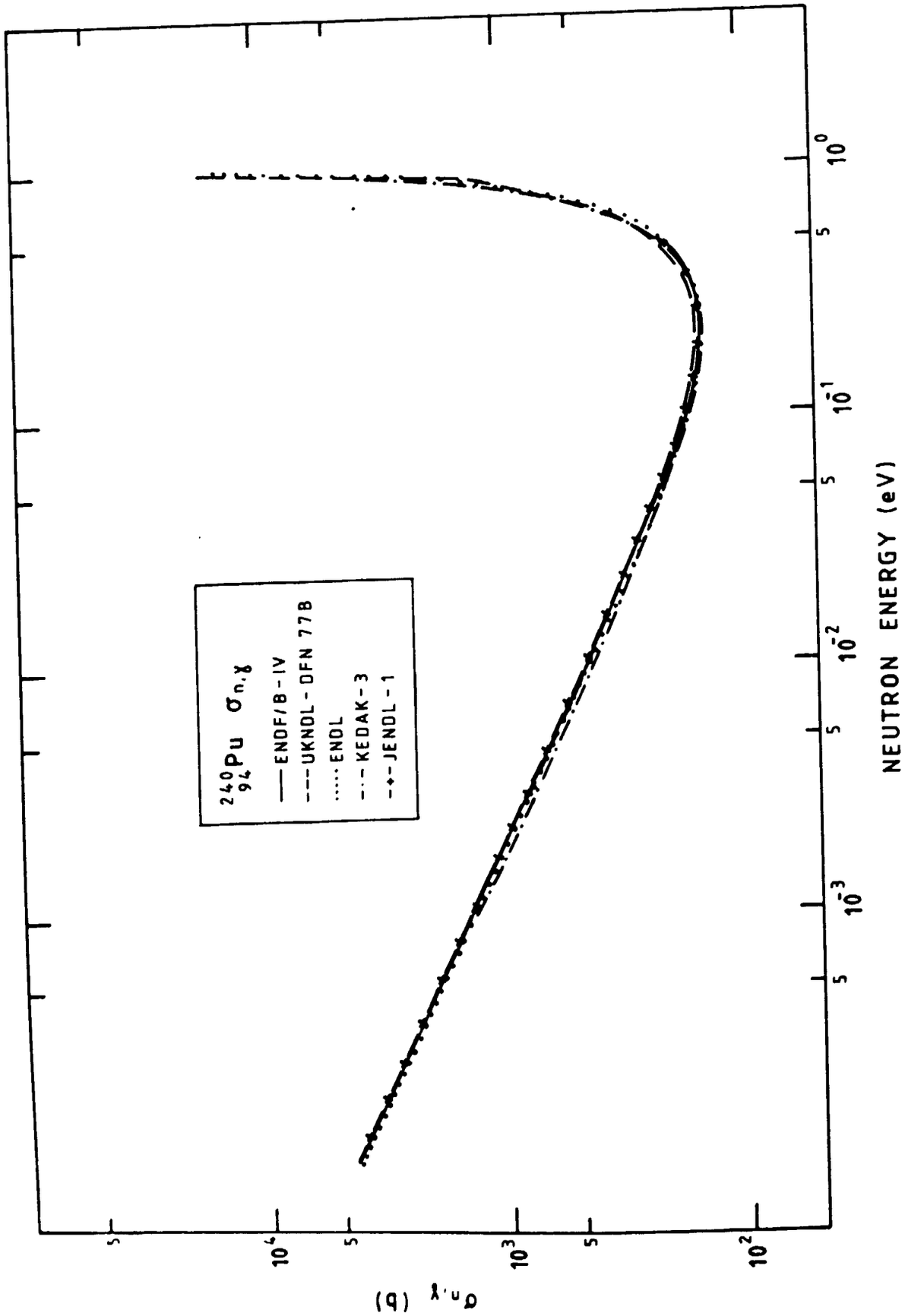

$^{240}_{94}Pu$
σ_{tot}
S 57 MTR, SIMPSON
P 59 HAR, PATTENDEN
B 60 ORL, BLOCK
ENDF/B-IV
NEUTRON ENERGY (eV)
σ_{tot} (barn)

$^{240}_{94}Pu$

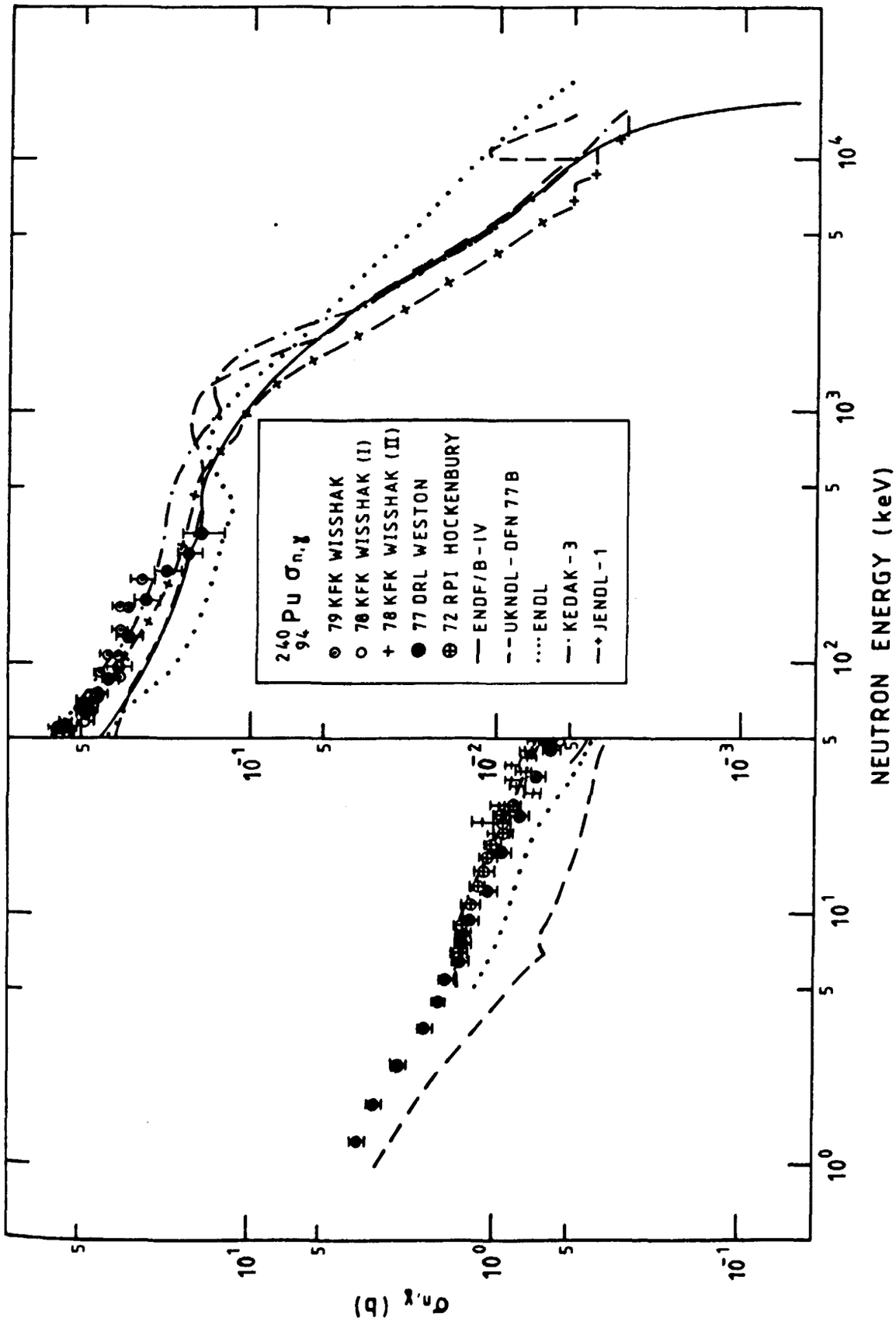

$^{240}_{94}Pu$ σ_{tot}
o 72, ANL, SMITH
ENDF/B-IV
UKNDL-DFN B 402
ENDL-78
KEDAK-3
JENDL-1
14
12
10
8
6
σ_{tot} (b)
.01
.1
1.
10.
NEUTRON ENERGY (MeV)

Experimental information ^{240}Pu, σ_{tot}

	Reference	Points	Range	Standard	Error	Comments
57	MTR, SIMPSON	240	0.033-43 eV	ABS.		
59	HAR, PATTENDEN	288	0.065-0.8 eV	ABS.		
60	ORL, BLOCK	35	0.02-0.15 eV	ABS.		
72	ANL, SMITH	55	0.1-1.5 MeV	ABS.	5 %	

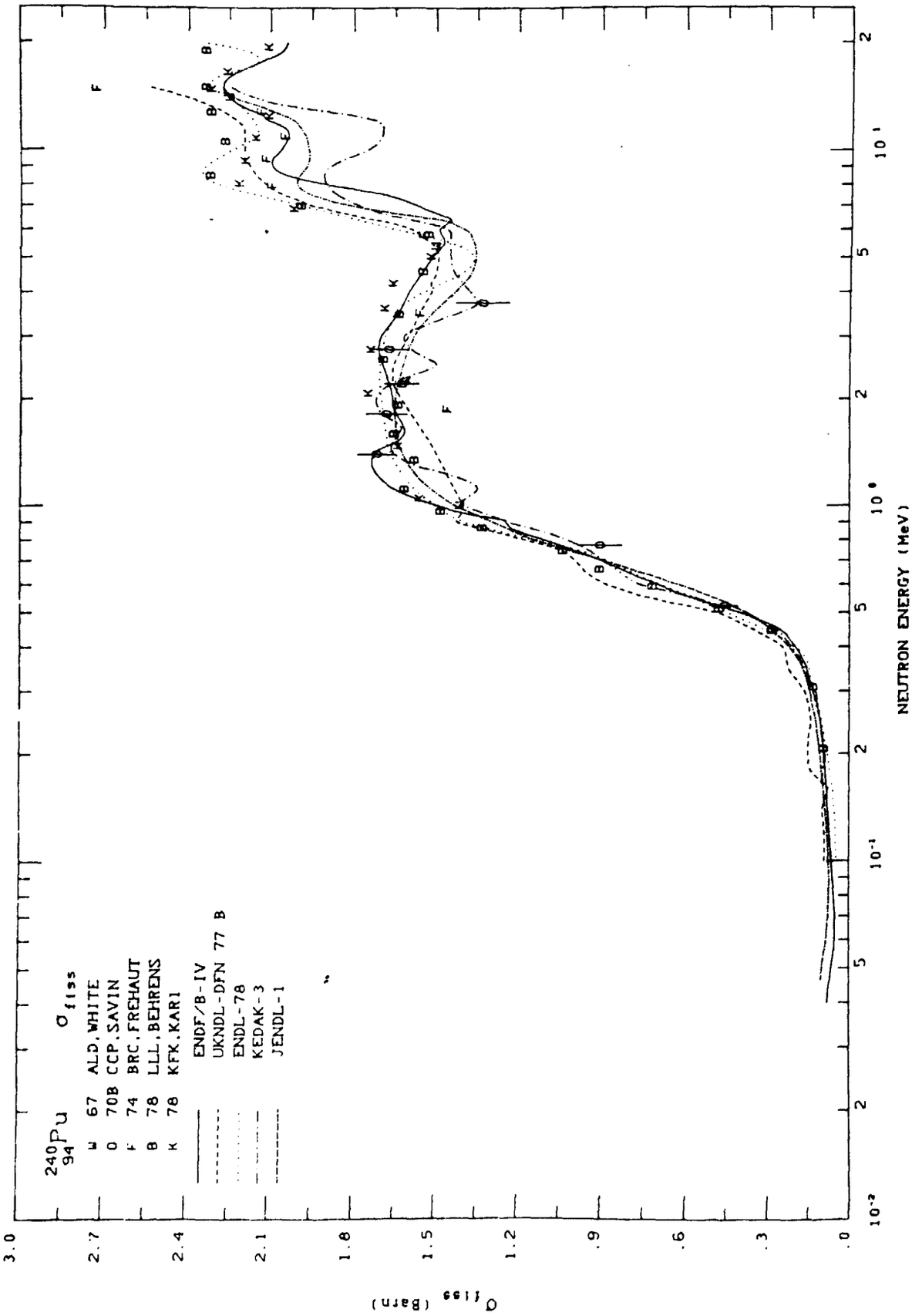

$^{240}_{94}Pu$ $\sigma_{n,\gamma}$
ENDF/B-IV
UKNDL-DFN 77B
ENDL
KEDAK-3
JENDL-1
$\sigma_{n,\gamma}$ (b)
10^4
10^3
10^2
5
10^{-3}
10^{-2}
10^{-1}
10^0
NEUTRON ENERGY (eV)

$^{240}_{94}Pu$


$^{240}_{94}Pu\ \sigma_{n,\gamma}$
79 KFK WISSHAK
78 KFK WISSHAK (I)
78 KFK WISSHAK (II)
77 ORL WESTON
72 RPI HOCKENBURY
ENDF/B-IV
UKNDL-DFN 77B
ENDL
KEDAK-3
JENDL-1
$\sigma_{n,\gamma}$ (b)
NEUTRON ENERGY (keV)

Experimental information ^{240}Pu, σ_γ

	Reference	Points	Range	Standard	Error	Comments
72	RPI, HOCKENBURY	11	6-28 keV	Transm. calc.	8 %	
77	ORL, WESTON	33	0.2-350 keV	^{240}Pu, σ_γ^{th}	7-20 %	
78	KFK, WISSHAK(I)	16	21-71 keV	^{238}U, σ_γ	7-11 %	Norm. to $\sigma_\gamma(^{238}U)$ ENDF/B-IV. Energy spread ~5 %
78	KFK, WISSHAK(II)	16	21-71 keV	^{197}Au, σ_γ	5-10 %	Norm. to $\sigma_\gamma(^{197}Au)$ ENDF/B-IV. Flight path 135 mm. Energy spread ~5 %
79	KFK, WISSHAK	17	48-213 keV	^{197}Au, σ_γ	6-13 %	Norm. to $\sigma_\gamma(^{197}Au)$ ENDF/B-IV. Energy spread 9-14 %. Includes two separate measurements


$^{240}_{94}Pu$
σ_{fiss}
W 67 ALD.WHITE
O 70B CCP.SAVIN
F 74 BRC.FREHAUT
B 78 LLL.BEHRENS
K 78 KFK.KARI
ENDF/B-IV
UKNDL-DFN 77 B
ENDL-78
KEDAK-3
JENDL-1
σ_{fiss} (barn)
NEUTRON ENERGY (MeV)

Experimental information ^{240}Pu, σ_f

	Reference	Points	Range	Standard	Error	Comments
67	ALD, WHITE	4	1-14 MeV	^{235}U, σ_f	3-5 %	
70B	CCP, SAVIN	26	0.5-3.7 MeV	^{235}U, σ_f	5-10 %	Error in relative value
74	BRC, FREHAUT	22	1.5-15 MeV	^{235}U, σ_f	2-4 %	Error in relative value
78	KFK, KARI	124	1-20 MeV	H, $\sigma_{n.n}$	3-4 %	Meas. rel. $\sigma_f(^{235}U)$ 0.5-20 MeV, rel. $\sigma_{n,n}(H)$ 1-20 MeV
78	LLL, BEHRENS	135	0.1-30 MeV	^{235}U, σ_f	2-3 %	Error in relative value

General comments: Experimental data from ratio measurements given in the figures are calculated using cross sections from ENDF/B-IV as standards

3.8 ^{241}Pu

NUCLEAR PROPERTIES (Ref. Nuclear Data Sheets)

Spin and parity of ground state: $5/2^+$

Ground state decay:

$T_{1/2}$ = 14.4 y

β^- to ^{241}Am ≈100 %

E_β (keV)	I_β (%)
20.8	100

α to ^{237}U, 0.0024 %, Q_α = 5.139 MeV

E_α (MeV)	I_α (%)
4.897	83
4.853	12

$\gamma(^{237}U)$

E_γ (keV)	Intensity per 100 decays
149	1.9×10^{-4}
104	1.0 -"-

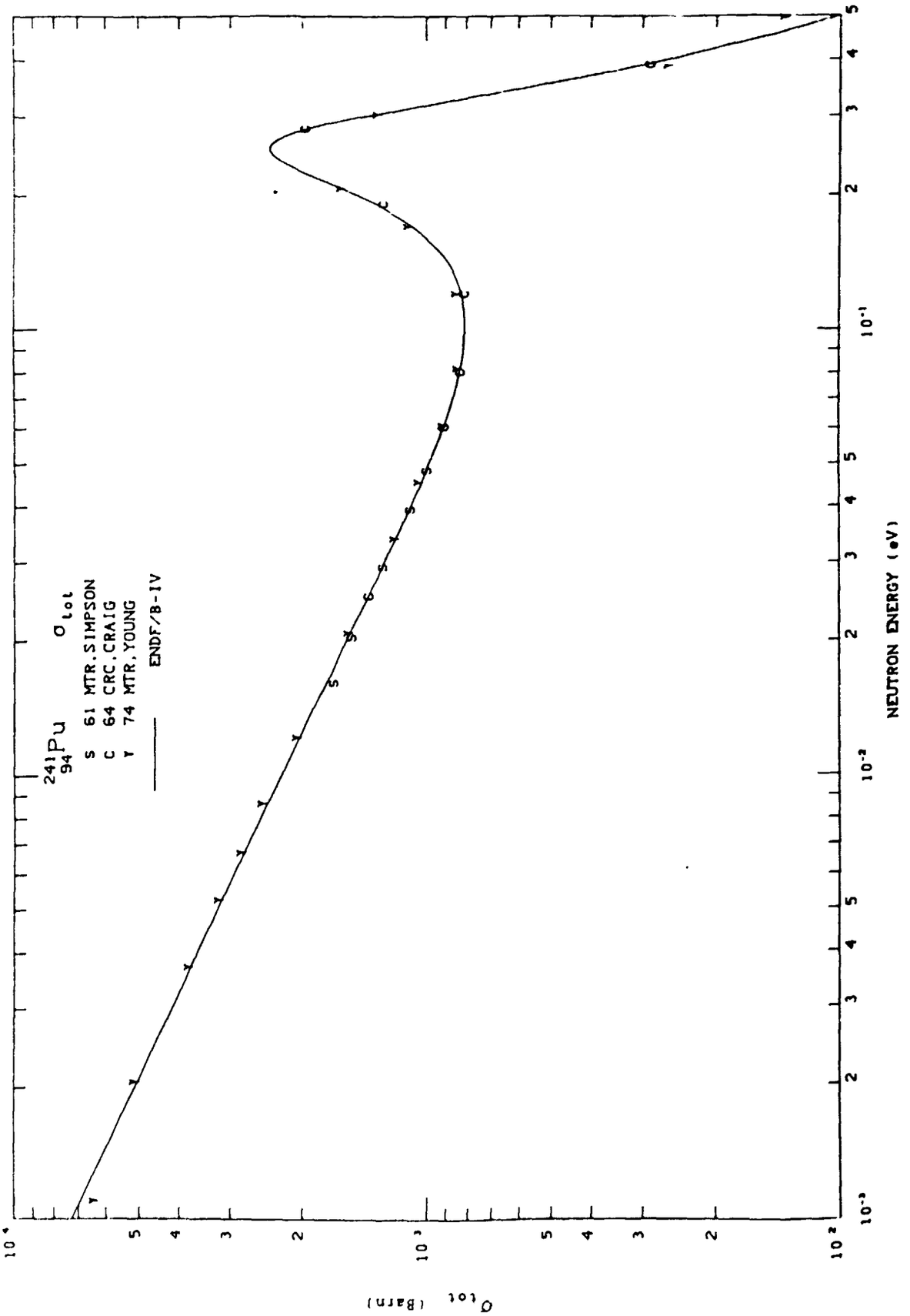
THERMAL CROSS SECTIONS

Reference	σ_γ barns	σ_f barns	σ_t barns	$\bar{\nu}_t$
ENDF/B - IV	366.3	1008	1385	
ENDL -76	396.6	995.4		
IAEA-3 (1975)	363	1015		2.924
BNL 325 (1973)	368	1009	1388	2.927
76 ALD,WHITE		1022		

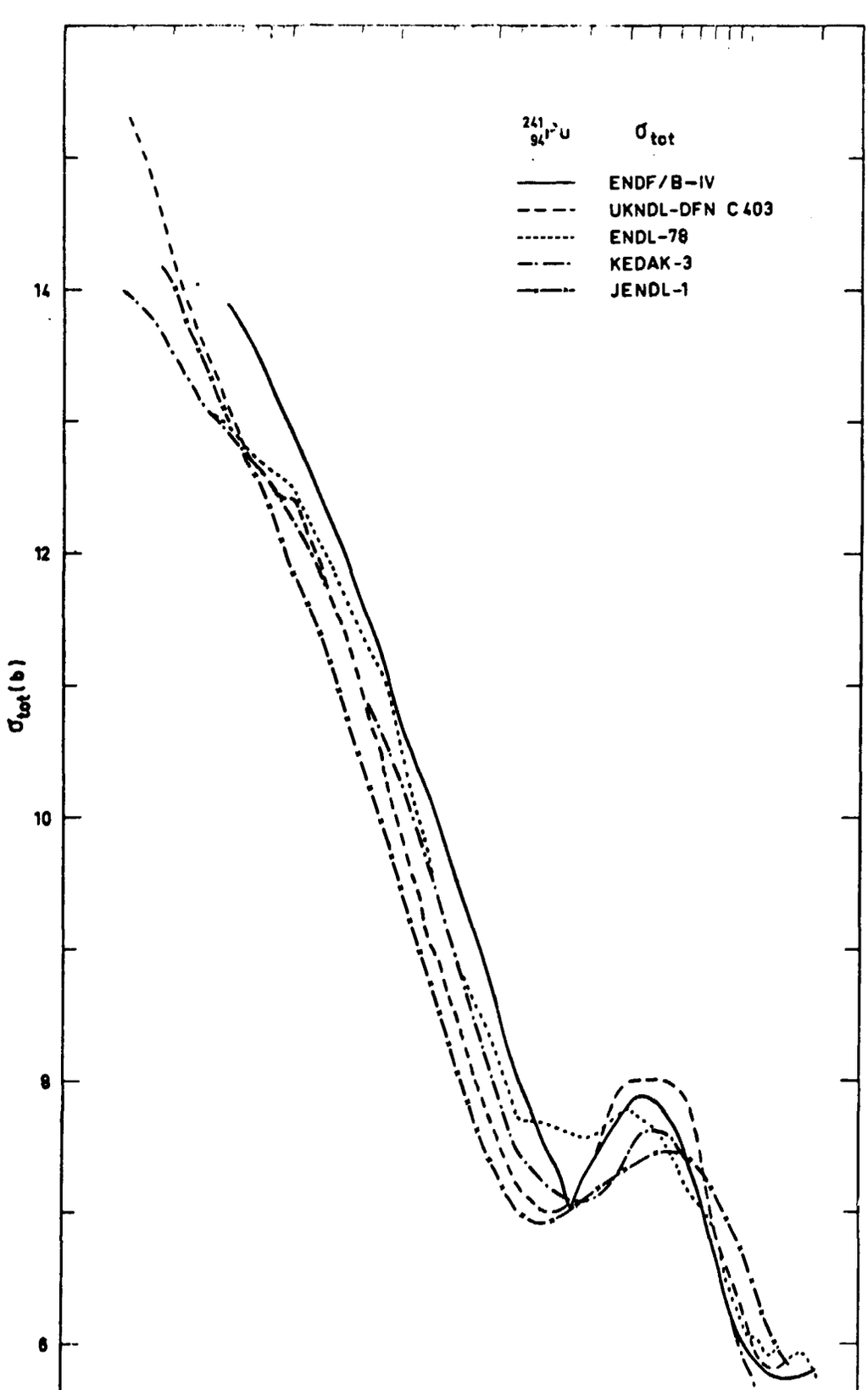
RESONANCE INTEGRALS

Reference	RI_γ barns	RI_f barns
ENDF/B - IV	121.0	570.5
ENDL -76	214.1	545.0
BNL 325 (1973)	162	570
KAP, EILAND	162	569

$^{241}_{94}Pu$

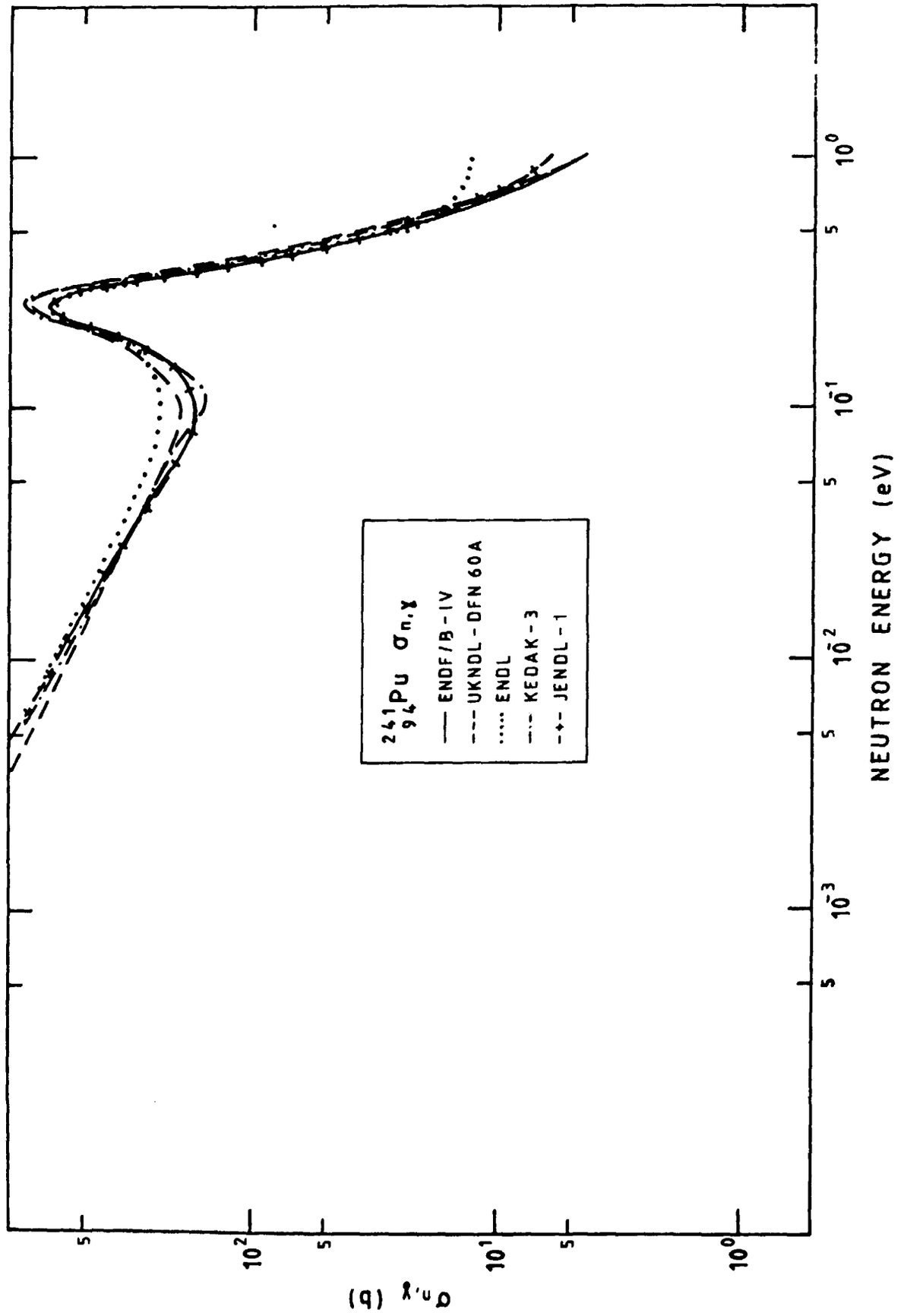

$^{241}_{94}Pu$
σ_{tot}
S 61 MTR.SIMPSON
C 64 CRC.CRAIG
Y 74 MTR.YOUNG
ENDF/B-IV
NEUTRON ENERGY (eV)
σ_{tot} (Barn)

$^{241}_{94}Pu$

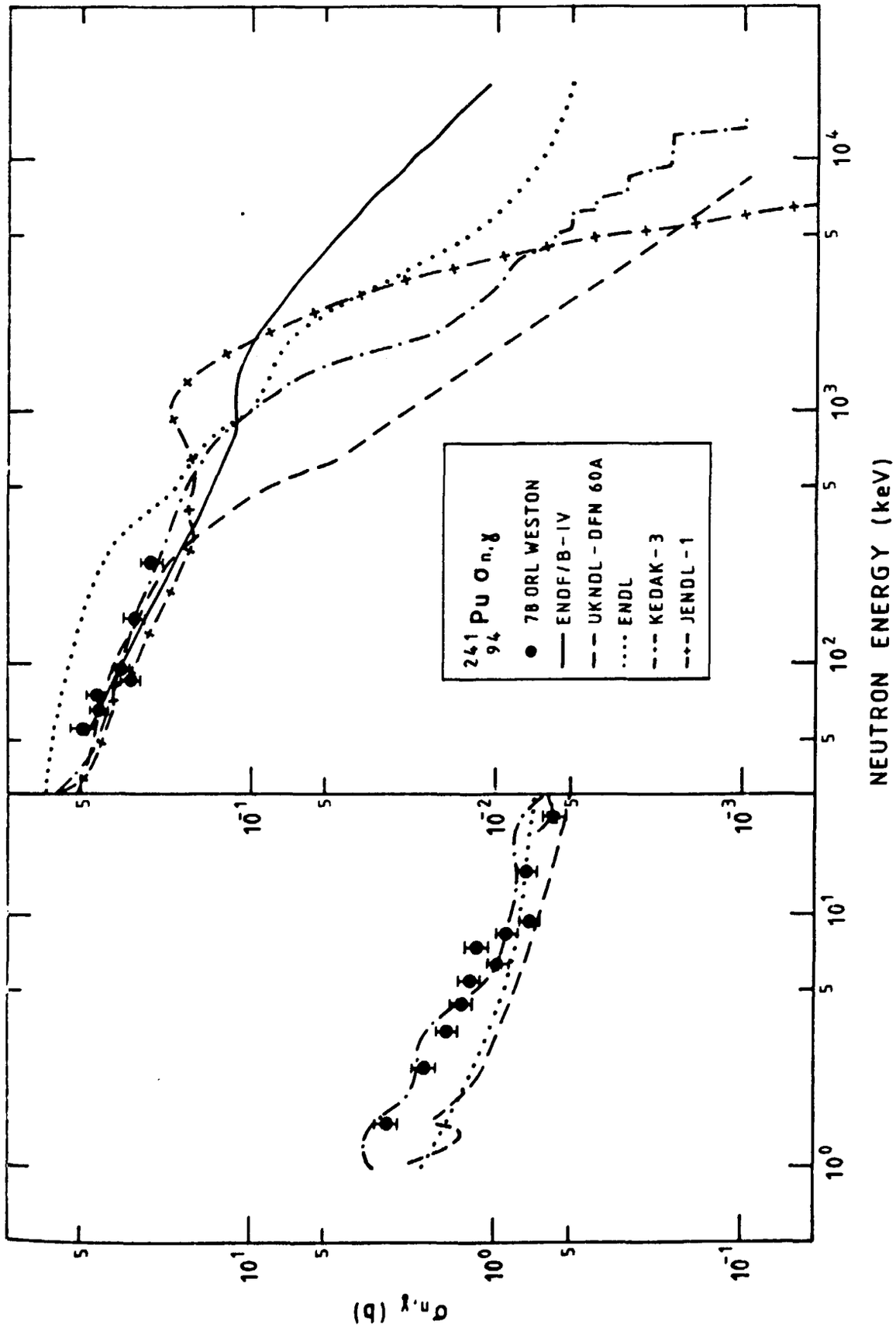

$^{241}_{94}Pu$ σ_{tot}
ENDF/B-IV
UKNDL-DFN C 403
ENDL-78
KEDAK-3
JENDL-1
14
12
10
8
6
σ_{tot} (b)
.01
.1
1.
10.
NEUTRON ENERGY (MeV)

Experimental information ^{241}Pu, σ_{tot}

	Reference	Points	Range	Standard	Error	Comments
61	MTR, SIMPSON	1 797	0.016-2 keV	ABS.	<5 %	Max. error at 0.264 eV
64	CRC, CRAIG	4 438	0.025 eV-1 keV	ABS.		Meas. at 0.025-0.7 eV and 13.8-1 000 eV. σ_{tot}^{th} = 1383 ± 30 b
74	MTR, YOUNG	374	0.001-3.5 eV			

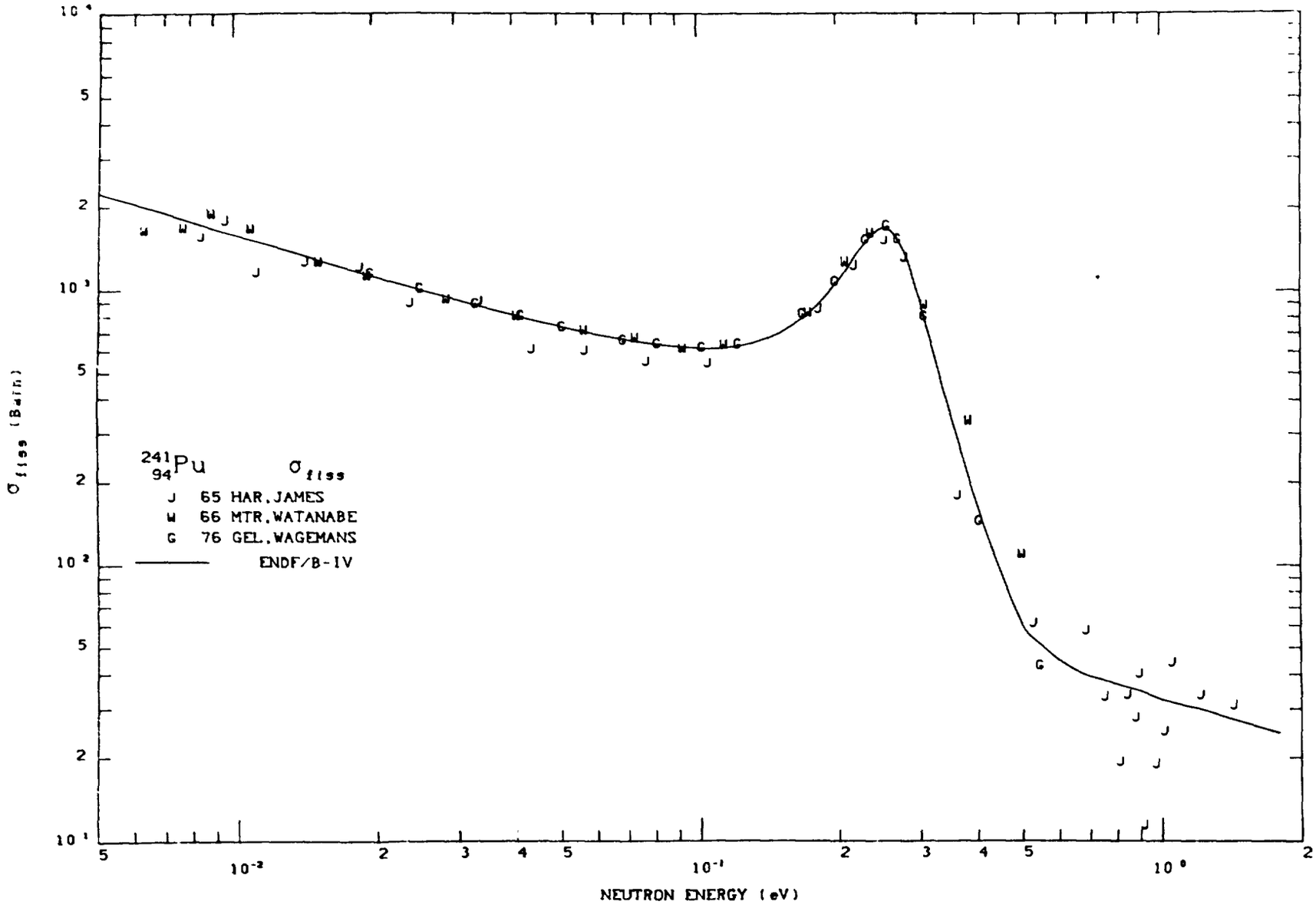

$^{241}_{94}Pu$ $\sigma_{n,\gamma}$
ENDF/B-IV
UKNDL-DFN 60A
ENDL
KEDAK-3
JENDL-1
$\sigma_{n,\gamma}$ (b)
NEUTRON ENERGY (eV)
10^0
10^1
10^2
10^{-3}
10^{-2}
10^{-1}
10^0
5

$^{241}_{94}Pu$

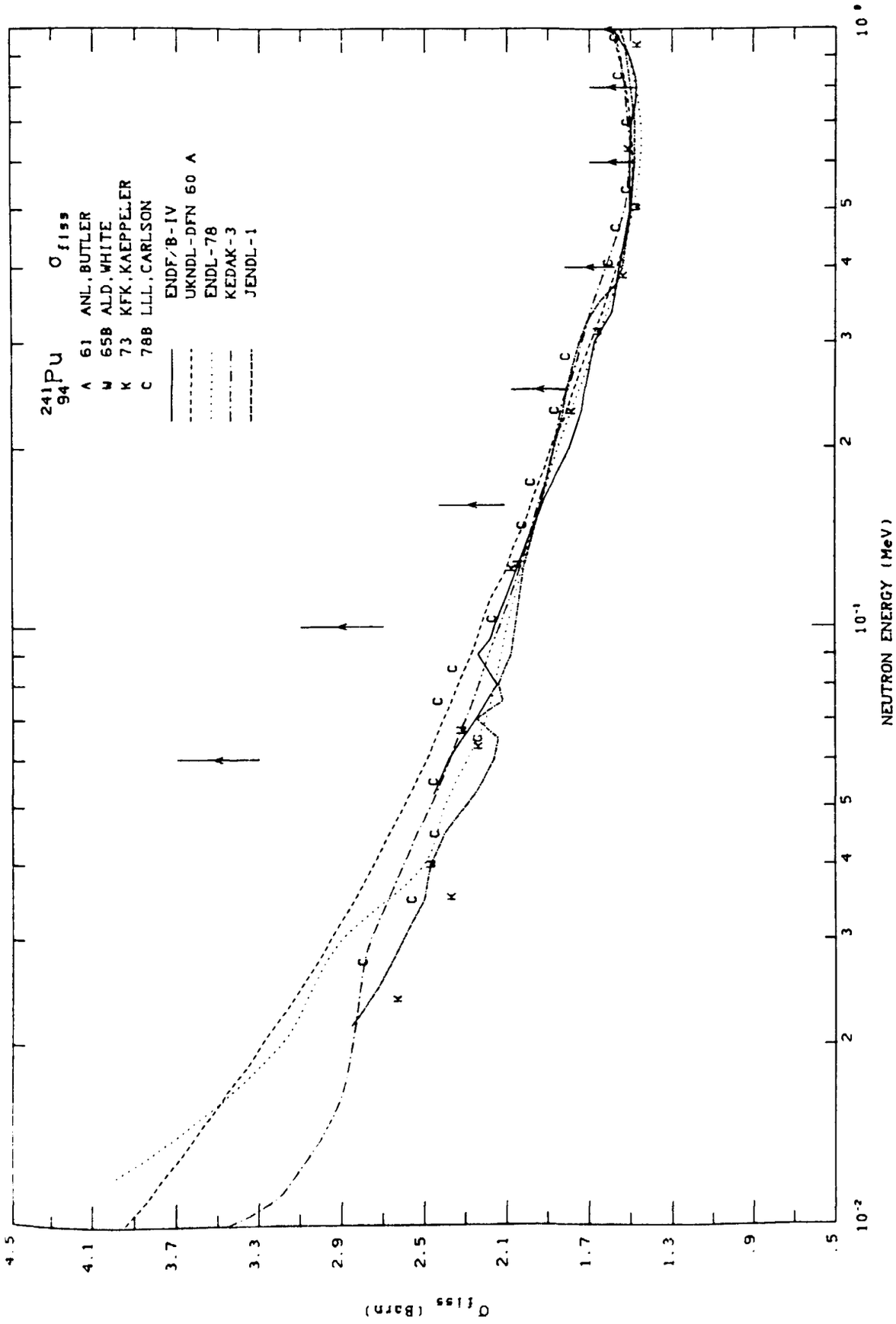

$^{241}_{94}Pu\ \sigma_{n,\gamma}$
78 ORL WESTON
ENDF/B-IV
UKNDL-DFN 60A
ENDL
KEDAK-3
JENDL-1
$\sigma_{n,\gamma}$ (b)
NEUTRON ENERGY (keV)

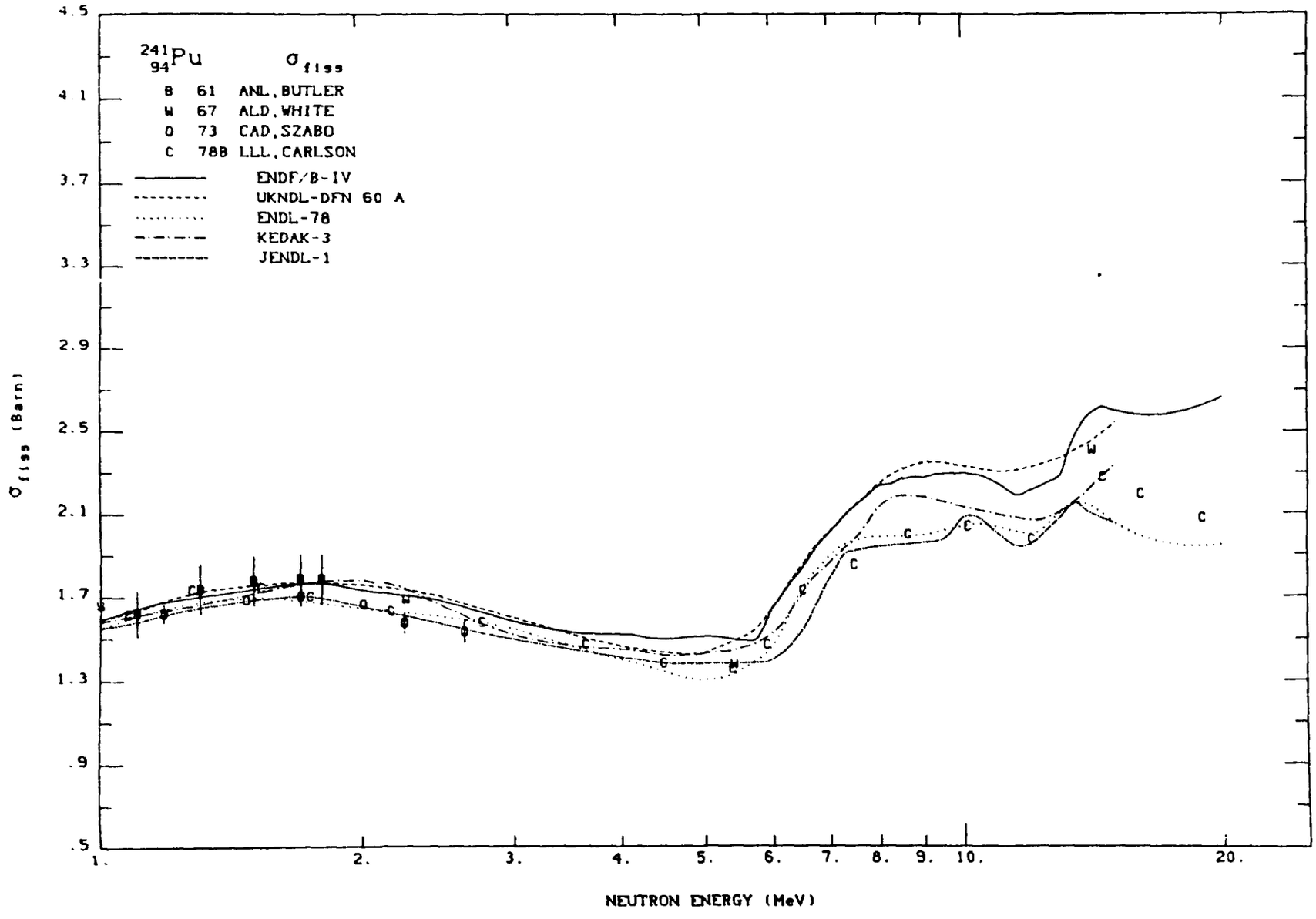
Experimental information ^{241}Pu, σ_γ

	Reference	Points	Range	Standard	Error	Comments
78	ORL, WESTON	38	0.01-300 keV	^{241}Pu, σ_f	6-10 %	Norm. to $\sigma_f(^{241}Pu)$ ENDF/B-IV


$^{241}_{94}Pu$ σ_{fiss}
J 65 HAR.JAMES
W 66 MTR.WATANABE
G 76 GEL.WAGEMANS
ENDF/B-IV
σ_{fiss} (Barn)
NEUTRON ENERGY (eV)

$^{241}_{94}Pu$


$^{241}_{94}Pu$
σ_{fiss}
A 61 ANL, BUTLER
W 65B ALD, WHITE
K 73 KFK, KAEPPELER
C 78B LLL, CARLSON
ENDF/B-IV
UKNDL-DFN 60 A
ENDL-78
KEDAK-3
JENDL-1
NEUTRON ENERGY (MeV)
σ_{fiss} (Barn)
4.5
4.1
3.7
3.3
2.9
2.5
2.1
1.7
1.3
.9
.5
10^{-2}
10^{-1}
10^{0}


$^{241}_{94}Pu$
σ_{fiss}
B 61 ANL, BUTLER
W 67 ALD, WHITE
O 73 CAD, SZABO
C 78B LLL, CARLSON
ENDF/B-IV
UKNDL-DFN 60 A
ENDL-78
KEDAK-3
JENDL-1
σ_{fiss} (Barn)
NEUTRON ENERGY (MeV)
4.5
4.1
3.7
3.3
2.9
2.5
2.1
1.7
1.3
.9
.5
1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
20.

Experimental information ^{241}Pu, σ_f

	Reference	Points	Range	Standard	Error	Comments
61	ANL, BUTLER	25	0.02-1.8 MeV	^{235}U, σ_f	>7 %	Error in relative value
65B	ALD, WHITE	5	40-500 keV	^{235}U, σ_f	3 %	
65	HAR, JAMES	1 633	0.01 eV-3 keV	^{241}Pu, σ_f^{th}	3 % 8 %	Below 0.5 eV 0.5-1 eV
66	MTR, WATANABE	258	0.006-11 eV	^{241}Pu, σ_f^{th}	2.5 %	
67	ALD, WHITE	4	1-14 MeV	^{235}U, σ_f	3.5 %	
73	CAD, SZABO	6	1.2-2.6 MeV	ABS.	3 %	
73	KFK, KÄPPELER	43	5 keV-1.2 MeV	^{235}U, σ_f	3-4 %	
76	GEL, WAGEMANS	340	0.01-50 eV	^{241}Pu, σ_f^{th}		Abs. fission integral obtained $\int_{12\,eV}^{20\,eV} \sigma_f(E)dE =$ $= (1363 \pm 14)$b eV
78B	LLL, CARLSON	107	1 keV-30 MeV	^{235}U, σ_f	2 %	Error in relative value

General comments: Experimental data from ratio measurements given in the figures are calculated using cross sections from ENDF/B-IV as standard

3.9 ^{242}Pu

NUCLEAR PROPERTIES (Ref. Nuclear Data Sheets)

Spin and parity of ground state: 0^+

Ground state decay:

$T_{1/2} = 3.76 \times 10^5$ y

β stable

spontaneous fission 5.50×10^{-4} %

$T_{1/2} = 6.8 \times 10^{10}$ y

α to ^{238}U, ≈100 %, $Q_\alpha = 4.983$ MeV

E_α (MeV)	I_α (%)
4.901	78
4.856	22

$\gamma(^{238}U)$

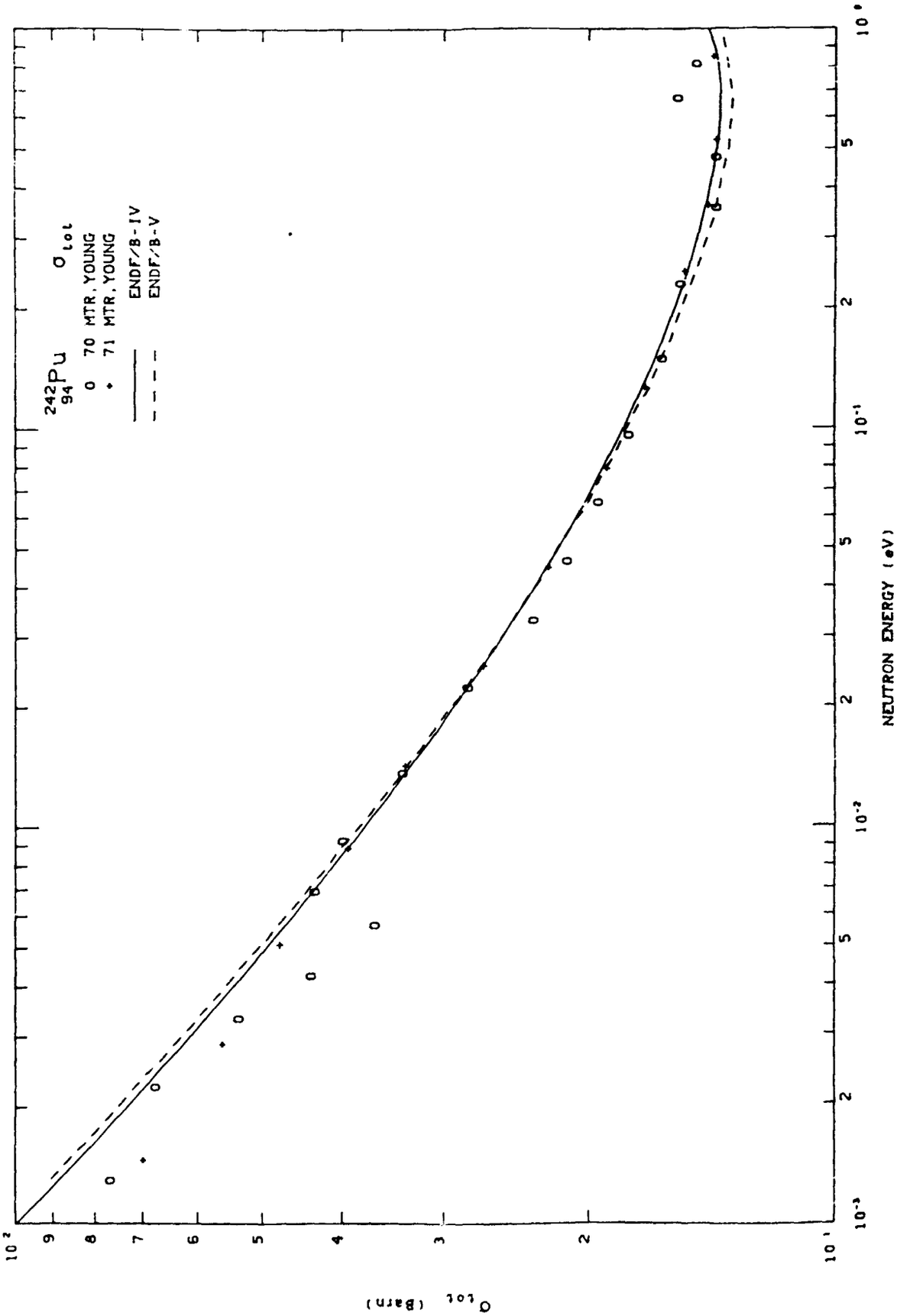
E_γ (keV)	Intensity per 100 α particles
44.9	3.6
103.5	0.78

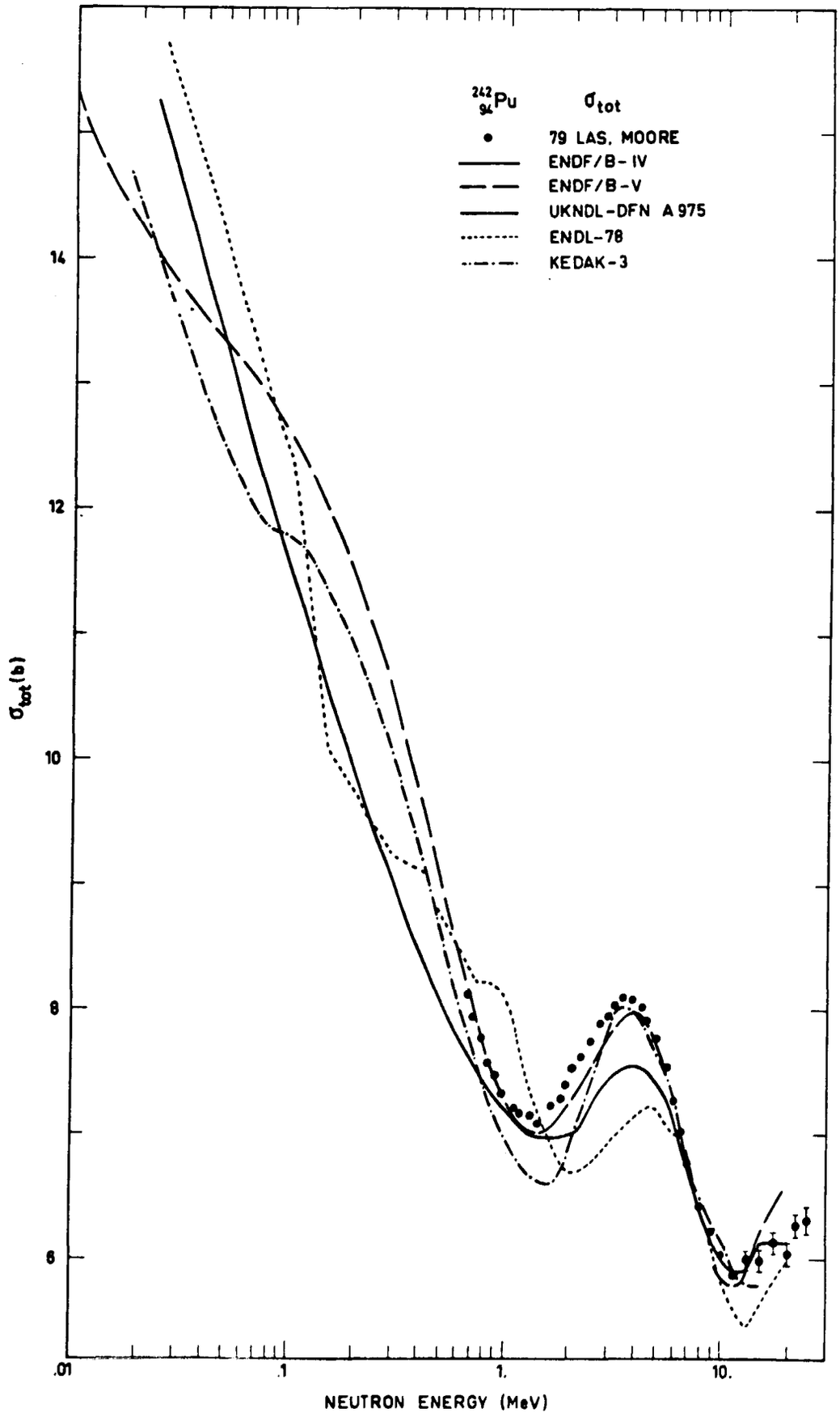
THERMAL CROSS SECTIONS

Reference	σ_γ barns	σ_f barns	σ_t barns
ENDF/B - IV	18.5	0.0	26.9
ENDL -76	18.8	0.0	30.1
BNL 325 (1973)	18.5	< 0.2	26.5
70 CRC,DURHAM	18.7		

RESONANCE INTEGRALS

Reference	RI_γ barns	RI_f barns
ENDF/B - IV	1122	0.08
ENDL -76	1208	32.1
BNL 325 (1973)	1130	5.0
70 MTR,YOUNG	1110	

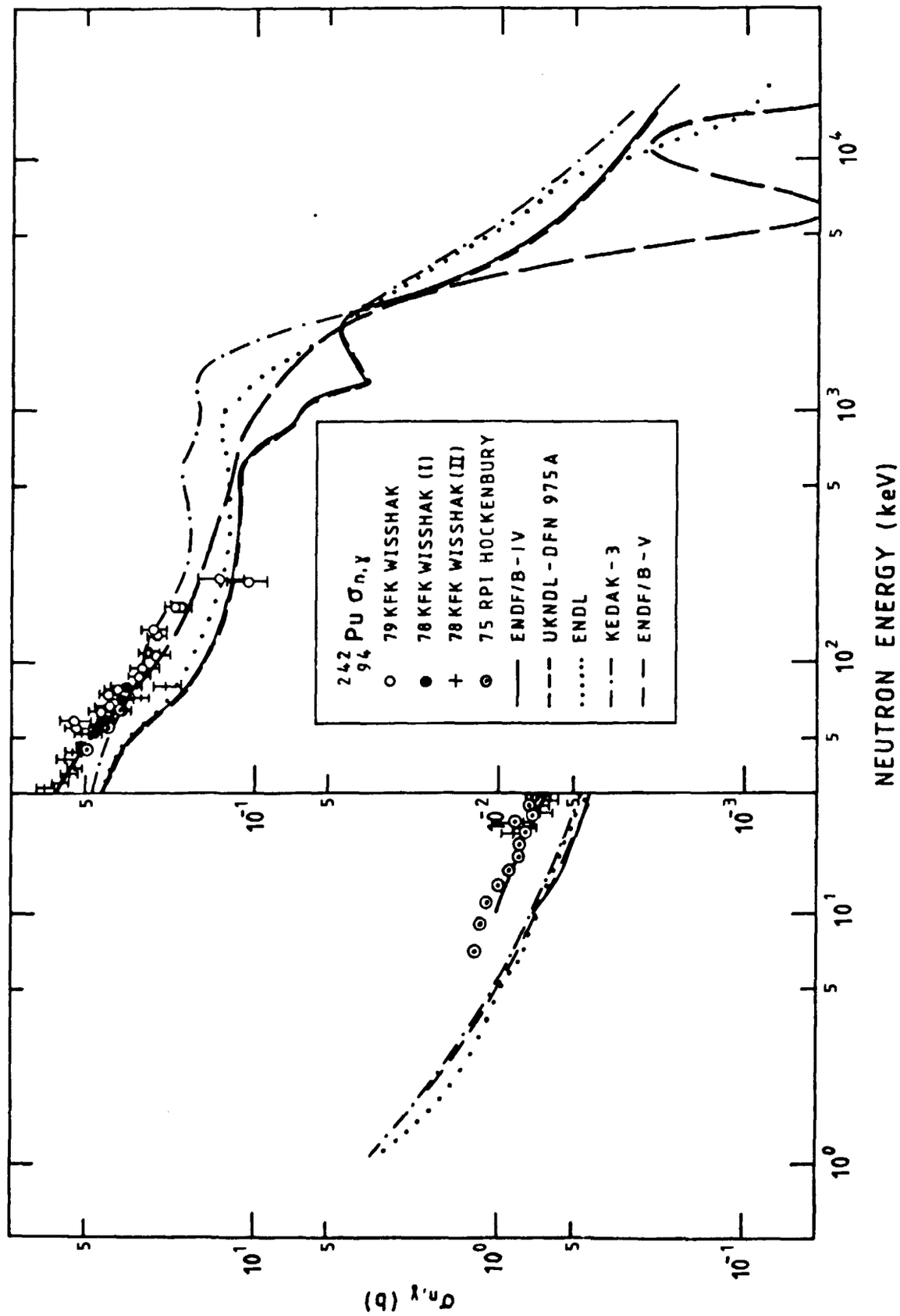

$^{242}_{94}Pu$
σ_{tot}
o 70 MTR, YOUNG
+ 71 MTR, YOUNG
ENDF/B-IV
ENDF/B-V
NEUTRON ENERGY (eV)
σ_{tot} (Barn)


$^{242}_{94}Pu$ σ_{tot}
79 LAS. MOORE
ENDF/B-IV
ENDF/B-V
UKNDL-DFN A 975
ENDL-78
KEDAK-3
14
12
10
8
6
σ_{tot}(b)
.01
.1
1.
10.
NEUTRON ENERGY (MeV)

Experimental information ^{242}Pu, σ_{tot}

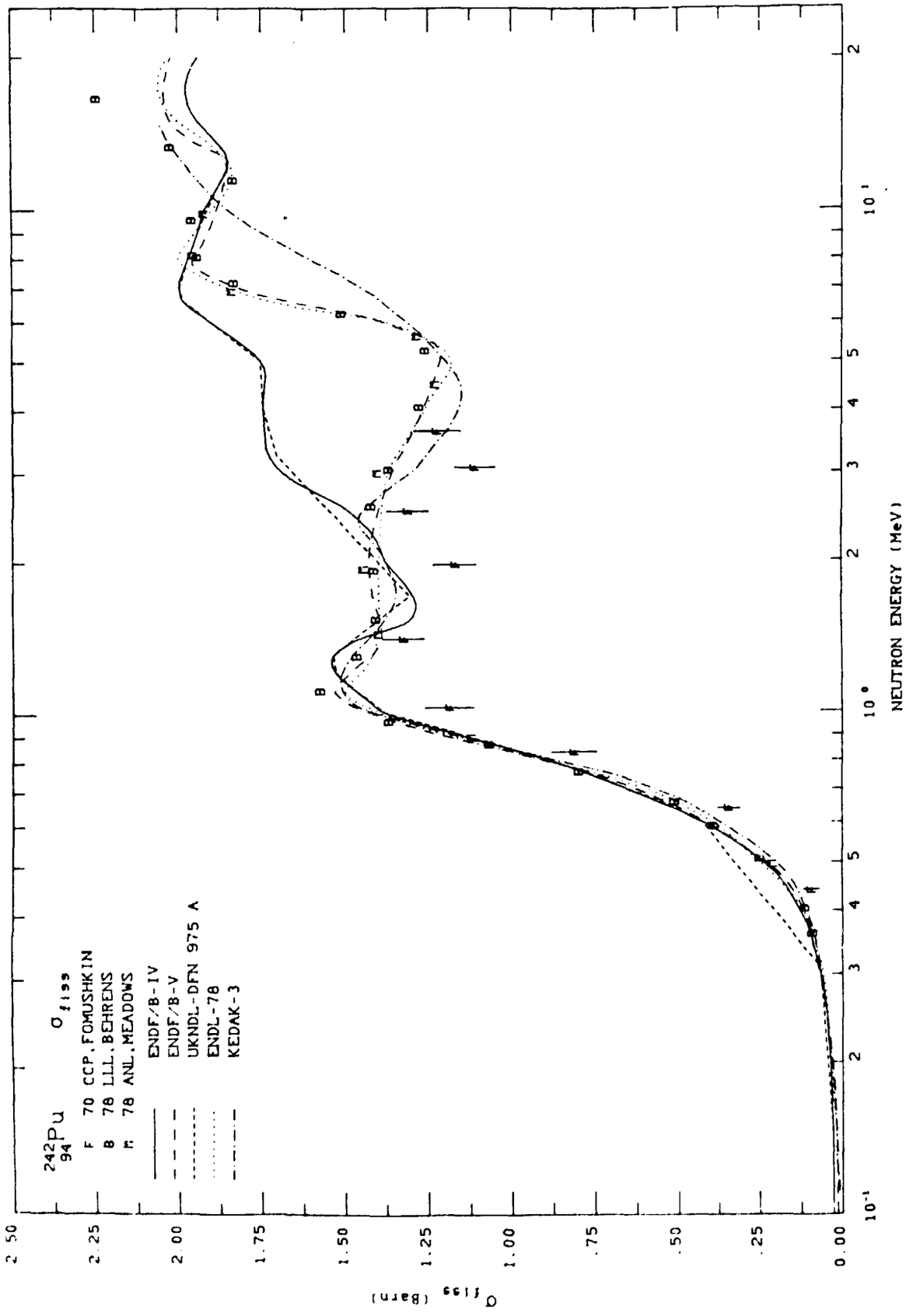
	Reference	Points	Range	Standard	Error	Comments
70	MTR, YOUNG	1 017	0.0015 eV-8 keV	ABS.	±2b	Oxide sample
71	MTR, YOUNG	79	0.0013-2 eV	ABS.		Metal sample. Combined results from 70 MTR, YOUNG and 71 MTR, YOUNG gives σ_t^{th}=(26.9±1)b
79	LAS, MOORE	120	0.7-170 MeV	ABS.	1-1.5 %	

General comments: ENDF/B-V total corss section evaluation in the thermal energy range has been calculated from resonance parameters using the computer code RESEND (NEA Nuclear Data Bank)


$^{242}_{94}$Pu $\sigma_{n,\gamma}$
79 KFK WISSHAK
78 KFK WISSHAK (I)
78 KFK WISSHAK (II)
75 RPI HOCKENBURY
ENDF/B-IV
UKNDL-DFN 975A
ENDL
KEDAK-3
ENDF/B-V
$\sigma_{n,\gamma}$ (b)
NEUTRON ENERGY (keV)

Experimental information ^{242}Pu, σ_γ

	Reference	Points	Range	Standard	Error	Comments
75	RPI, HOCKENBURY	15	8-70 keV			
78	KFK, WISSHAK(I)	20	20-80 keV	^{238}U, σ_γ	6-15 %	Norm. to $\sigma_\gamma(^{238}U)$ ENDF/B-IV. Energy spread ~5 %
78	KFK, WISSHAK(II)	20	29-80 keV	^{197}Au, σ_γ	6-12 %	Norm. to $\sigma_\gamma(^{197}Au)$ ENDF/B-IV. Flight path 133 mm. Energy spread ~5 %
79	KFK, WISSHAK	16	55-213 keV	^{197}Au, σ_γ	9-20 %	Norm. to $\sigma_\gamma(^{197}Au)$ ENDF/B-IV. Includes two separate meassurements. Energy spread 10-15 %


$^{242}_{94}Pu$
σ_{fiss}
F 70 CCP, FOMUSHKIN
B 78 LLL, BEHRENS
M 78 ANL, MEADOWS
ENDF/B-IV
ENDF/B-V
UKNDL-DFN 975 A
ENDL-78
KEDAK-3
σ_{fiss} (Barn)
NEUTRON ENERGY (MeV)
2.50
2.25
2.00
1.75
1.50
1.25
1.00
.75
.50
.25
0.00
10^{-1}
10^{0}
10^{1}

Experimental information ^{242}Pu, σ_f

	Reference	Points	Range	Standard	Error	Comments
70	CCP, FOMUSHKIN	14	0.4-3.6 MeV	^{235}U, σ_f	4-6 %	Error in relative value
78	ANL, MEADOWS	50	0.4-9.8 MeV	^{235}U, σ_f	2 %	
78	LLL, BEHRENS	140	0.1-30 MeV	^{235}U, σ_f	3-5 %	Error in relative value

General comments: Experimental data from ratio measurements given in the figures are calculated using cross sections from ENDF/B-IV as standard

3.10 ^{241}Am

NUCLEAR PROPERTIES (Ref. Nuclear Data Sheets)

Spin and parity of ground state: $5/2^-$

Ground state decay:

$T_{1/2}$ = 432.2 y

β stable

spontaneous fission 3.77×10^{-10} %

$T_{1/2} = 1.15 \times 10^{14}$ y

α to ^{237}Np, 100 %, Q_α = 5.638 MeV

E_α (MeV)	I_α (%)
5.49	85.2
5.44	12.8
5.39	1.4

γ(^{237}Np)

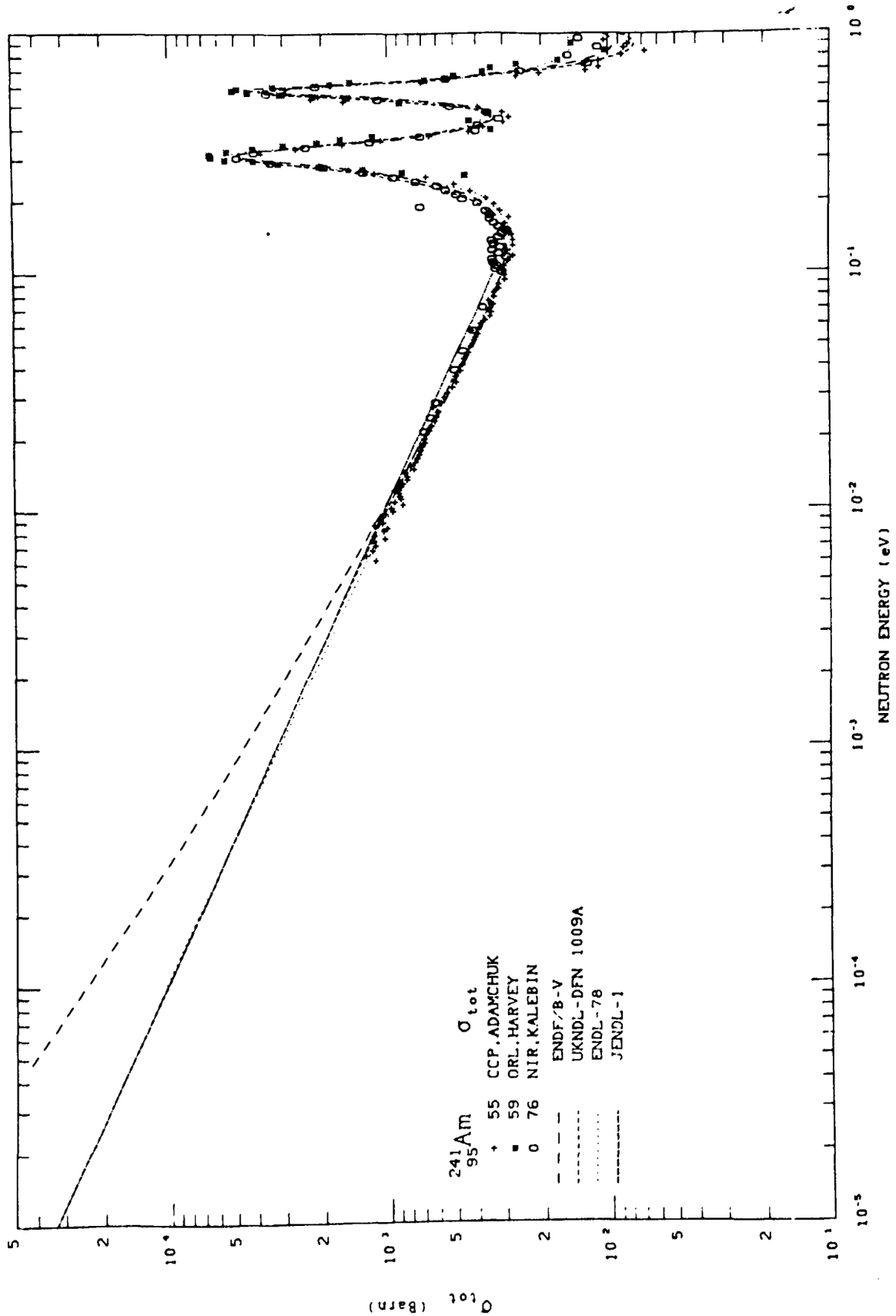
E_γ (keV)	Intensity per 100 α-particles
59.5	35.9
26.3	2.4

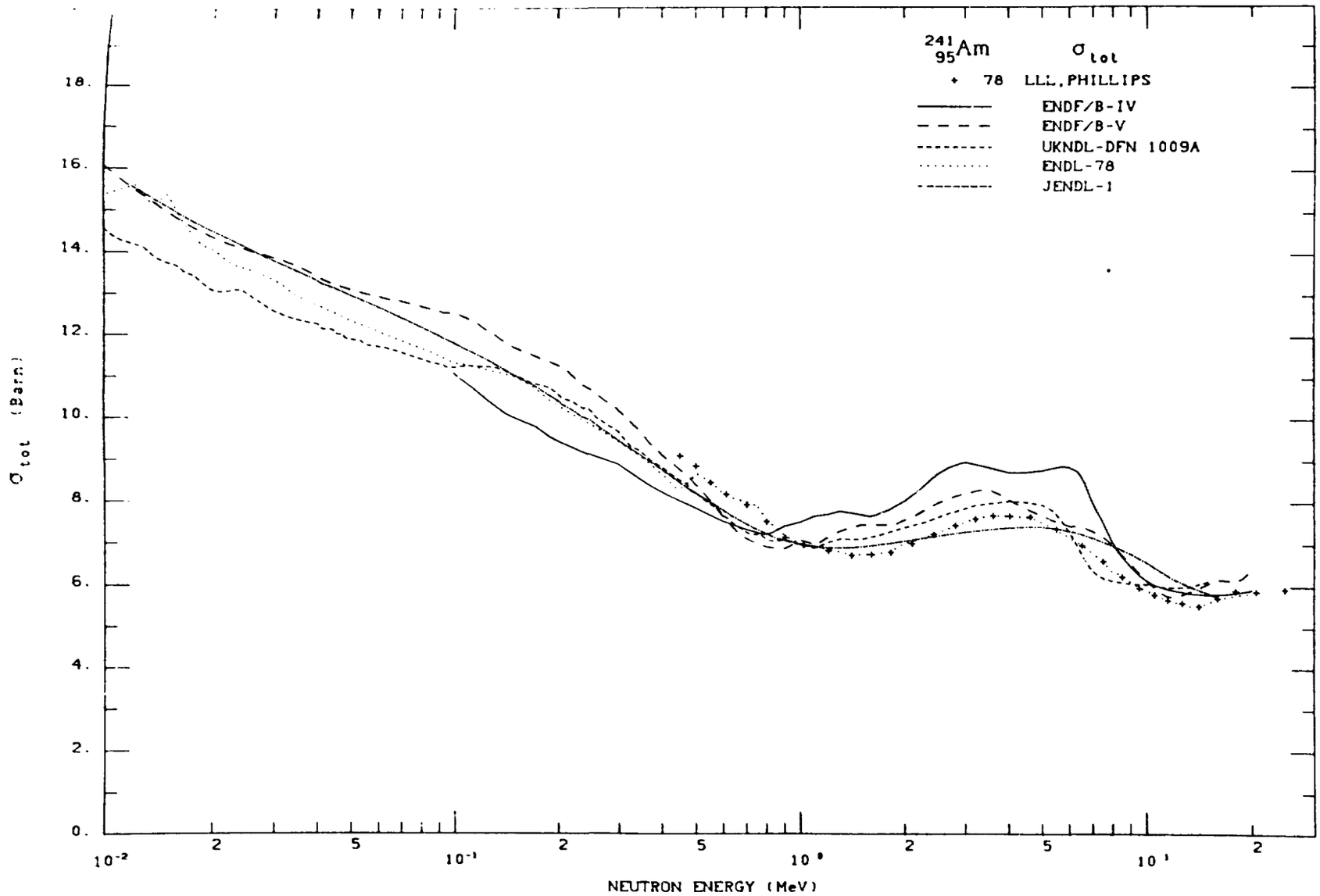
THERMAL CROSS SECTIONS

Reference	σ_γ barns	σ_f barns	σ_t barns
ENDF/B - IV	581.5	3.3	594.8
ENDF/B - V	580	3.3	
ENDL -76	584	3.3	600.5
BNL 325 (1973)	832	3.15	

RESONANCE INTEGRALS

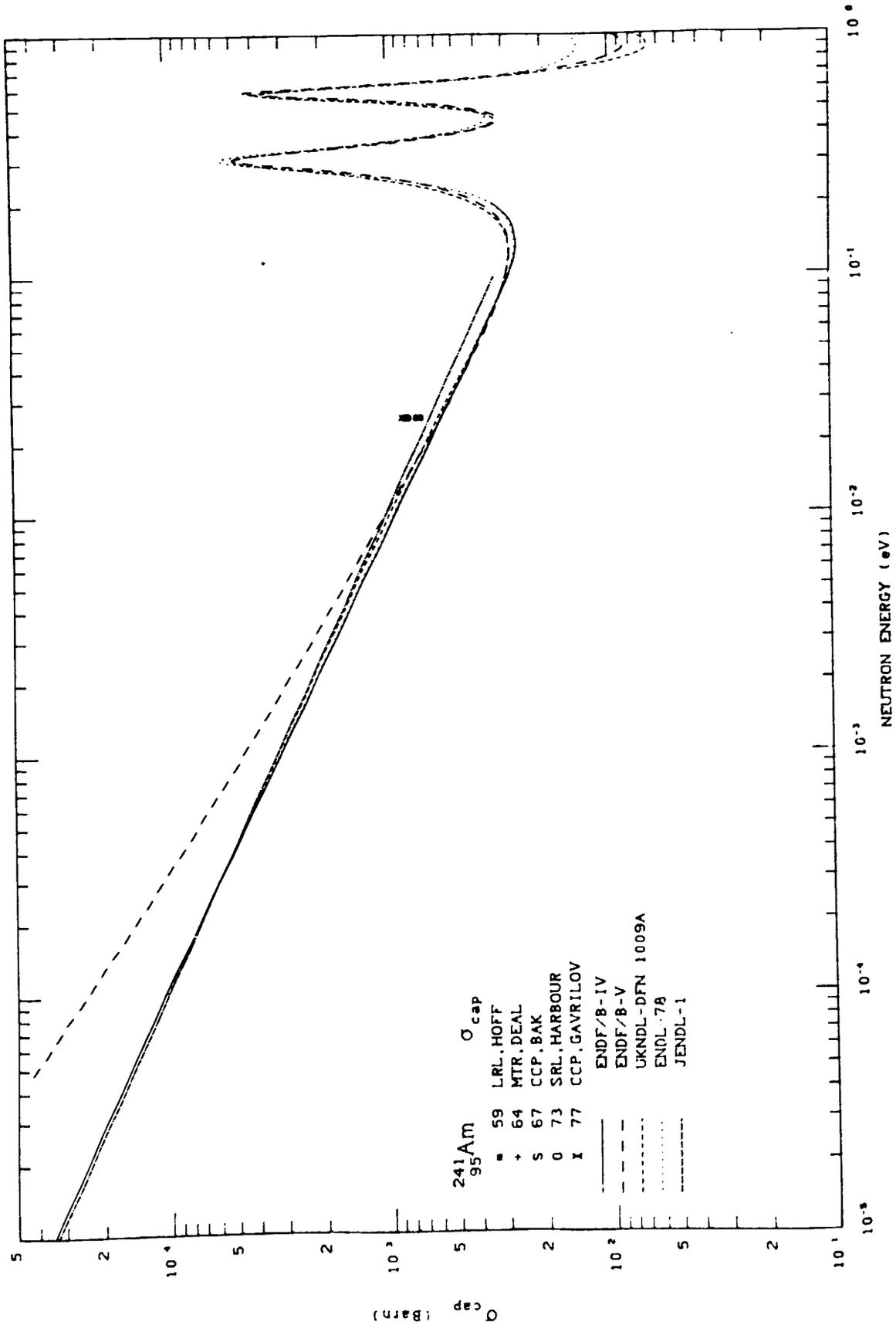
Reference	RI_γ barns	RI_f barns
ENDF/B - IV	1623	14.7
ENDL -76	1563	14.1
BNL 325 (1973)	1477	21


$^{241}_{95}Am$
+ 55 CCP.ADAMCHUK
■ 59 ORL.HARVEY
o 76 NIR.KALEBIN
ENDF/B-V
UKNDL-DFN 1009A
ENDL-78
JENDL-1
σ_{tot}
σ_{tot} (barn)
NEUTRON ENERGY (eV)

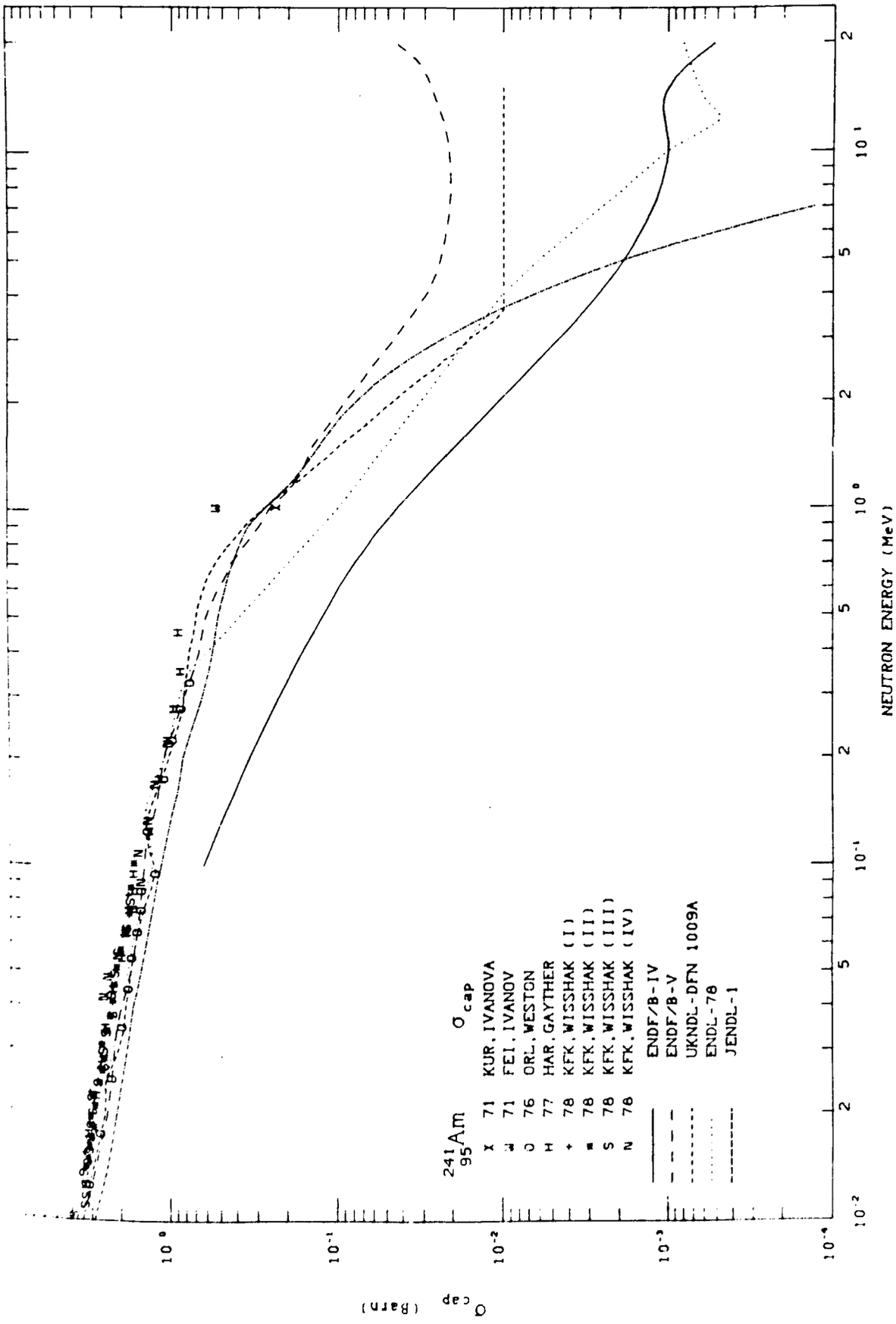

$^{241}_{95}Am$ σ_{tot}
+ 78 LLL,PHILLIPS
ENDF/B-IV
ENDF/B-V
UKNDL-DFN 1009A
ENDL-78
JENDL-1
σ_{tot} (Barn)
NEUTRON ENERGY (MeV)
0.
2.
4.
6.
8.
10.
12.
14.
16.
18.
10^{-2}
10^{-1}
10^{0}
10^{1}
2
5

Experimental information ^{241}Am, σ_{tot}

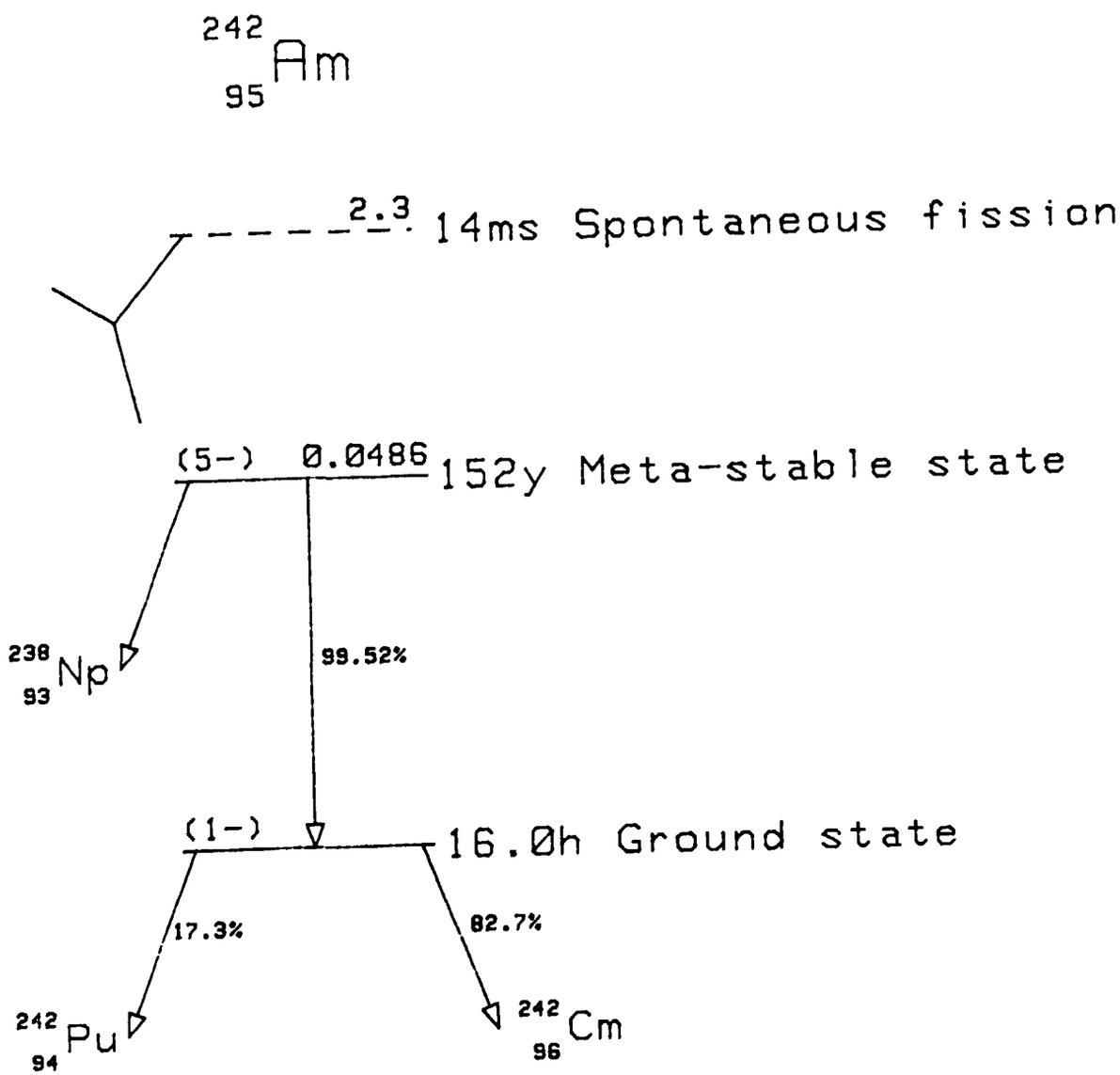
	Reference	Points	Range	Standard	Error	Comments
55	CCP, ADAMCHUK	198	0.006-82 eV	ABS.		
59	ORL, HARVEY	454	0.25-42 eV	ABS.		
76	NIR, KALEBIN	2 985	0.021-398 eV	ABS.		Selected every tenth point
78	LLL, PHILLIPS	32	0.45-25 MeV	^{12}C	≤1.5 %	


$^{241}_{95}Am$
■ 59 LRL,HOFF
+ 64 MTR,DEAL
S 67 CCP,BAK
O 73 SRL,HARBOUR
X 77 CCP,GAVRILOV
σ_{cap}
ENDF/B-IV
ENDF/B-V
UKNDL-DFN 1009A
ENDL 78
JENDL-1
σ_{cap} (barn)
NEUTRON ENERGY (eV)

$^{241}_{95}Am$


$^{241}_{95}Am$
σ_{cap}
X 71 KUR.IVANOVA
W 71 FEI.IVANOV
O 76 ORL.WESTON
H 77 HAR.GAYTHER
+ 78 KFK.WISSHAK (I)
■ 78 KFK.WISSHAK (II)
S 78 KFK.WISSHAK (III)
N 78 KFK.WISSHAK (IV)
ENDF/B-IV
ENDF/B-V
UKNDL-DFN 1009A
ENDL-78
JENDL-1
σ_{cap} (barn)
NEUTRON ENERGY (MeV)

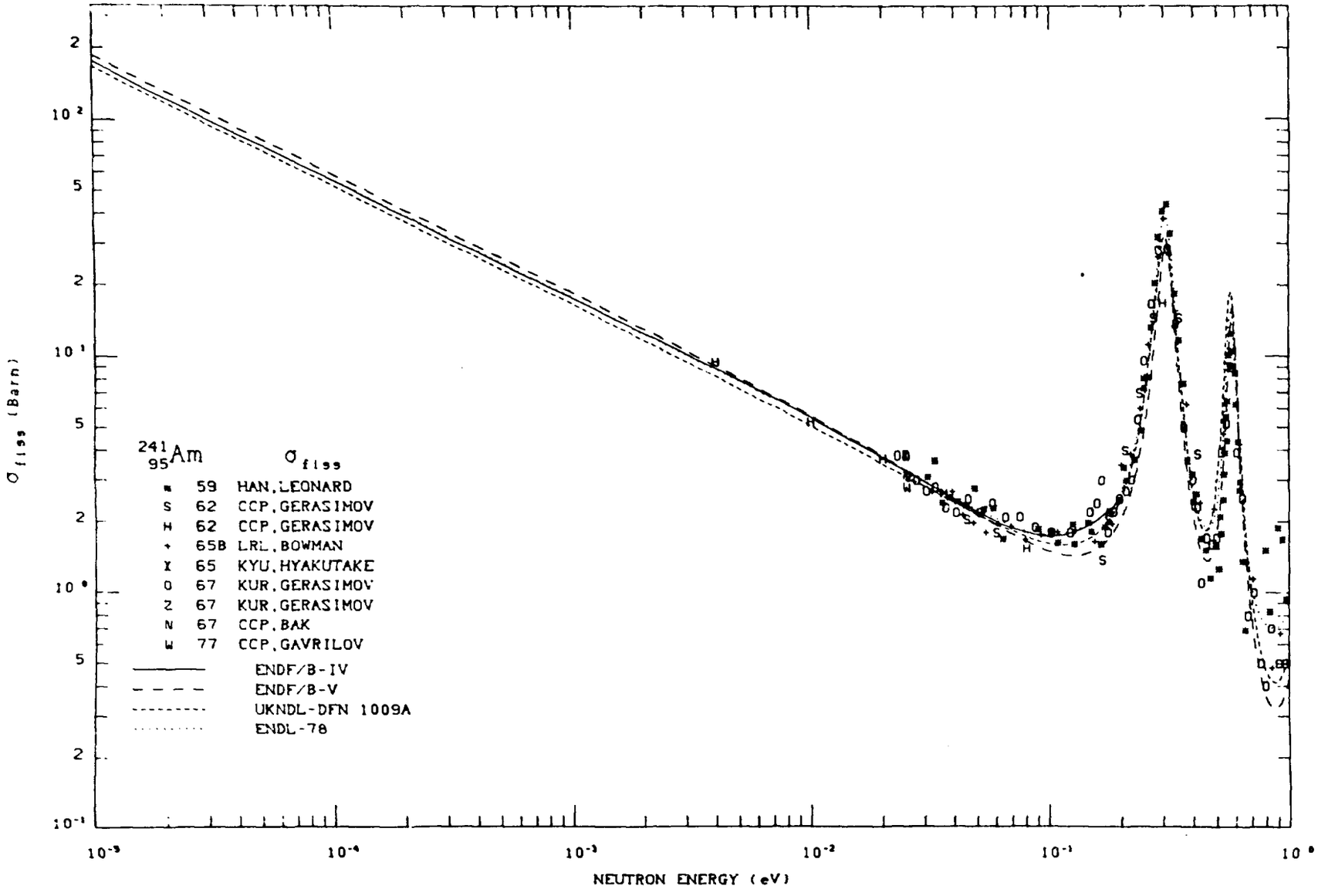
NUCLEAR DECAY SCHEME FOR $^{242}_{95}Am$

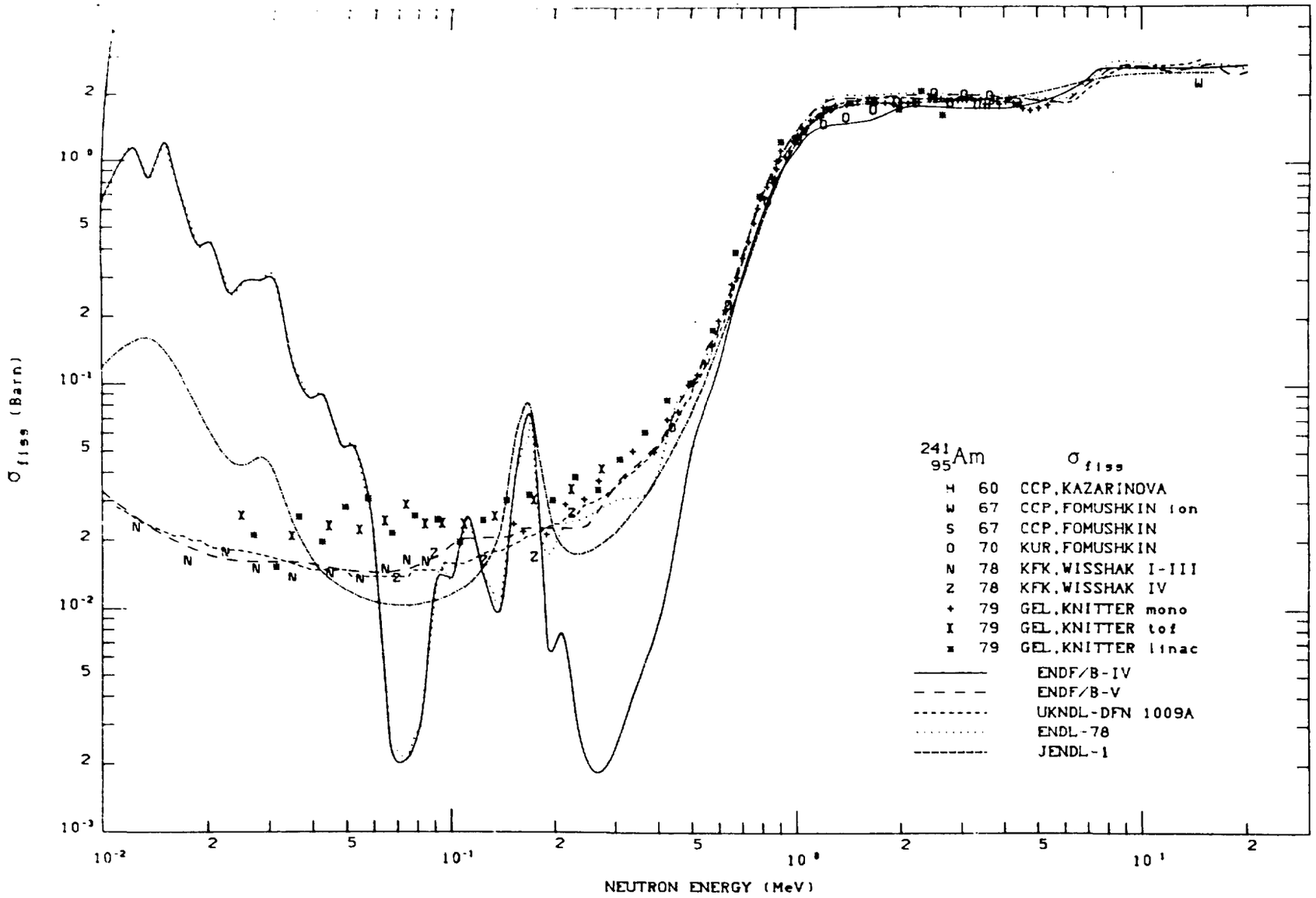


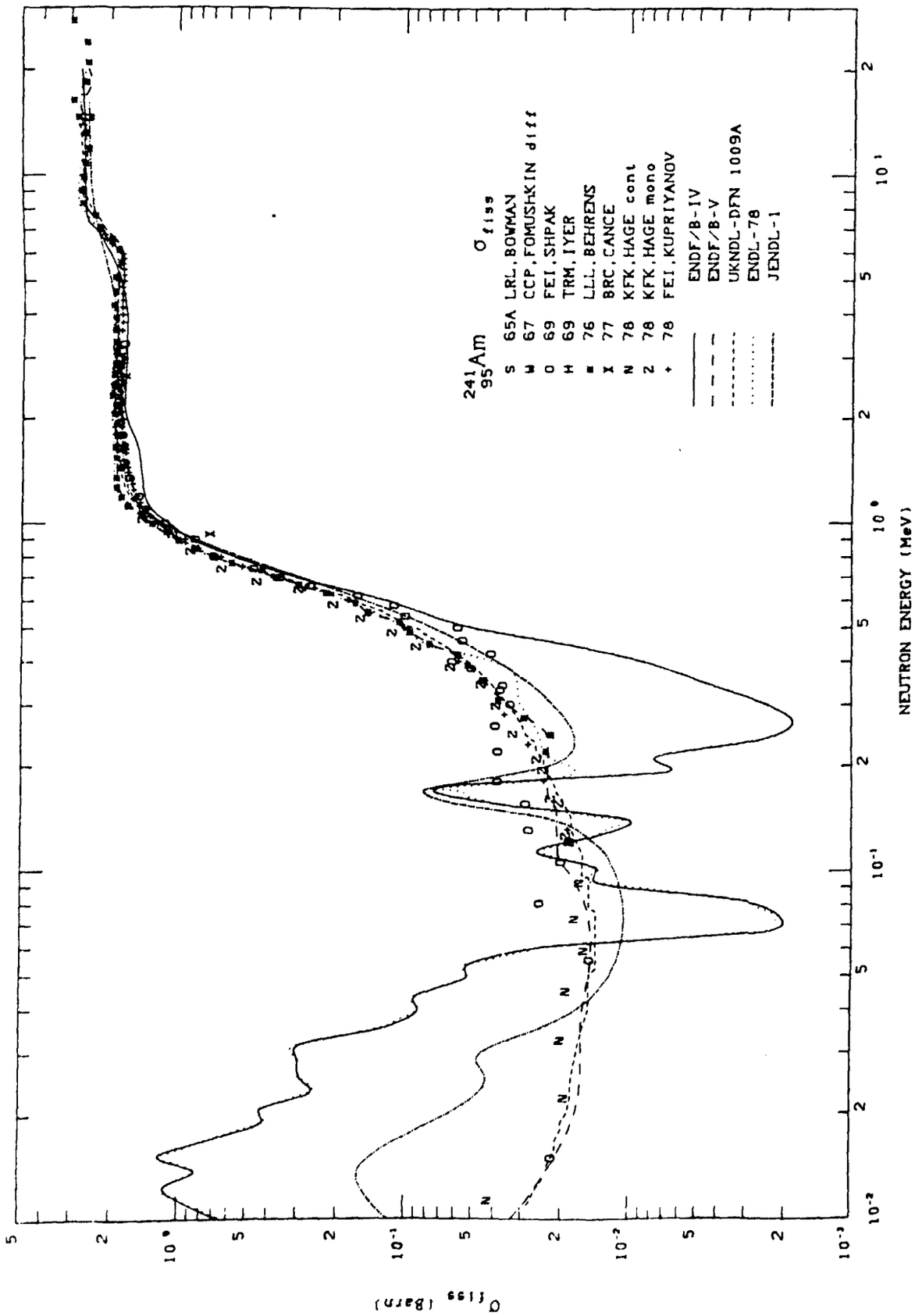
Experimental information ^{241}Am, σ_γ

	Reference	Points	Range	Standard	Error	Comments
59	LRL, HOFF	1	0.0253 eV	Activation	10.5 %	
64	MTR, DEAL	1	0.0253 eV	Activation		σ_γ(g.s.) + B.R. = σ_γ
67	CCP, BAK	1	0.0253 eV	^{197}Au, σ_γ	9 %	
71	FEI, IVANOV	1	1.0 MeV	^{238}U	3 %	
71	KUR, IVANOVA	1	1.0 MeV	ABS.	12.5 %	
73	SRL, HARBOUR	1	0.0253 eV	^{59}Co	3 %	
76	ORL, WESTON	44	10 eV-350 keV	Activation		
77	CCP, GAVRILOV	1	0.0253 eV	^{197}Au, σ_γ and ^{59}Co, σ_γ	7.5 %	
77	HAR, GAYTHER	39	0.1-500 keV	Activation	12 %	
78	KFK, WISSHAK(I)	22	14-83 keV	^{197}Au, σ_γ	4-13 %	Run I, FP=66.4 mm
78	KFK, WISSHAK(II)	22	14-102 keV	^{197}Au, σ_γ	4-28 %	Run II, FP=64 mm
78	KFK, WISSHAK(III)	21	10-80 keV	^{197}Au, σ_γ	5-13 %	Run III, FP=50 mm
78	KFK, WISSHAK(IV)	10	42-220 keV	^{197}Au, σ_γ	5-14 %	Run IV, FP=64.2 mm

General comments: The experimental data of Hoff, Bak and Harbour for the 0.0253 eV cross section in the figure are given as the sum of the contribution from the ground state and the metastable state. Deal only gives the cross section to the ground state. By using his assumption for the branching ratio (1:15) we have calculated the sum


$^{241}_{95}Am$
σ_{fiss}
59 HAN,LEONARD
62 CCP,GERASIMOV
62 CCP,GERASIMOV
65B LRL,BOWMAN
65 KYU,HYAKUTAKE
67 KUR,GERASIMOV
67 KUR,GERASIMOV
67 CCP,BAK
77 CCP,GAVRILOV
ENDF/B-IV
ENDF/B-V
UKNDL-DFN 1009A
ENDL-78
σ_{fiss} (Barn)
NEUTRON ENERGY (eV)


$^{241}_{95}$Am
σ_{fiss}
H 60 CCP,KAZARINOVA
W 67 CCP,FOMUSHKIN ion
S 67 CCP,FOMUSHKIN
O 70 KUR,FOMUSHKIN
N 78 KFK,WISSHAK I-III
Z 78 KFK,WISSHAK IV
+ 79 GEL,KNITTER mono
X 79 GEL,KNITTER tof
* 79 GEL,KNITTER linac
ENDF/B-IV
ENDF/B-V
UKNDL-DFN 1009A
ENDL-78
JENDL-1
σ_{fiss} (Barn)
NEUTRON ENERGY (MeV)


$^{241}_{95}Am$
σ_{fiss}
S 65A LRL,BOWMAN
W 67 CCP,FOMUSHKIN diff
O 69 FEI,SHPAK
H 69 TRM,IYER
■ 76 LLL,BEHRENS
X 77 BRC,CANCE
N 78 KFK,HAGE cont
Z 78 KFK,HAGE mono
+ 78 FEI,KUPRIYANOV
ENDF/B-IV
ENDF/B-V
UKNDL-DFN 1009A
ENDL-78
JENDL-1
NEUTRON ENERGY (MeV)
σ_{fiss} (barn)

Experimental information ^{241}Am, σ_{fiss}

	Reference	Points	Range	Standard	Error	Comments
59	HAN, LEONARD	109	0.03-5.3 keV	ABS.	5-70 %	
60	CCP, KAZARINOVA	2	2.5 & 14,6 MeV	^{238}U	6.4 %	
60	CCP, PROTOPOPOV	1	14.6 MeV	ABS.	6.4 %	
62	CCP, GERASIMOV	9	0.045-0.42 eV	ABS.		
62	CCP, GERASIMOV	6	0.004-0.3 eV	ABS.	9-58 %	
65A	LRL, BOWMAN	1	2.5 MeV	^{239}Pu	11 %	
65B	LRL, BOWMAN	486	0.03 eV-5 keV	ABS.		Selected every fifth point
65	KYU, HYAKUTAKE	1	0.0235 eV	^{235}U, σ_f	5.3 %	
67	CCP, BAK	1	0.0253 eV	^{197}Au, σ_γ	3.2 %	
67	CCP, FOMUSHKIN(ion)	1	14.5 MeV	^{238}U, σ_f	6.5 %	Ion chamber
67	CCP, FOMUSHKIN(diff)	1	14.5 MeV	^{238}U	4.7 %	Diff. Sig. Int.
67	CCP, FOMUSHKIN	1	1.0 MeV	^{238}U	6.3 %	
67	KUR, GERASIMOV	583	0.023-50 eV	^{241}Am, σ_f^{th}		Selected every fifth point
67	KUR, GERASIMOV	5	0.025-15 eV	^{241}Am, σ_f^{th}	13 %	
69	FEI, SHPAK	43	8 keV-3.3 MeV	^{239}Pu	5-27 %	
69	TRM, IYER	1	14.1 MeV	^{238}U	17 %	

Experimental information ^{241}Am, σ_{fiss} (cont.)

	Reference	Points	Range	Standard	Error	Comments
70	KUR, FOMUSHKIN	14	0.44-3.6 MeV	^{235}U	3-5 %	
76	LLL, BEHRENS	69	1 keV-30 MeV	^{235}U, σ_f	1-38 %	Stat. error in relative value
77	BRC, CANCE	3	0.93-2.66 MeV	^{235}U, σ_f	2-7 %	.
77	CCP, GAVRILOV	1	0.0253 eV	^{197}Au, σ_γ and ^{59}Co, σ_γ	8.9 %	
78	FEI, KUPRIYANOV	61	0.13-7 MeV	^{239}Pu, σ_f	2.2-4.5 %	Error in relative value
78	KFK, HAGE(cont)	8	11-120 keV	^{235}U, σ_f	5-13 %	Cont. neutr. spec.
78	KFK, HAGE(mono)	20	18 keV-1.5 MeV	^{235}U, σ_f	6-12 %	Monoenergetic neutr.
78	KFK, WISSHAK(I-III)	10	10-90 keV	^{235}U, σ_f	13-27 %	Averaged, Run I-III
78	KFK, WISSHAK(IV)	5	60-250 keV	^{235}U, σ_f	12-25 %	Run IV
79	GEL, KNITTER(linac)	59	0.15 keV-2.7 MeV	^{235}U, σ_f	9-20 %	Linac - tof, error in relative value
79	GEL, KNITTER(tof)	17	6-275 keV	^{235}U, σ_f	8-35 %	VdG - tof, error in retive value
79	GEL, KNITTER(mono)	79	0.15-5.3 MeV	^{235}U, σ_f	3-15 %	VdG - monoenergetic neutr. error in relative value

General comments: In the keV-region, ENDF/B-IV and ENDL-78 are based on data from Pommard Nuclear Explosion (Seeger LA-4420, 1970). These data are today not considered to be reliable, which explains the great discrepancies

3.11 ^{243}Am

NUCLEAR PROPERTIES (Ref. Nuclear Data Sheets)

Spin and parity of ground state: $5/2^-$

Ground state decay:

$T_{1/2}$ = 7380 y

β stable

spontaneous fission 3.69 x 10^{-9} %

$T_{1/2} = 2 \times 10^{14}$ y

α to ^{239}Np, 100 %, Q_α = 5.439 MeV

E_α (MeV)	I_α (%)
5.28	87.9
5.23	10.6
5.18	1.1

γ(^{239}Np)

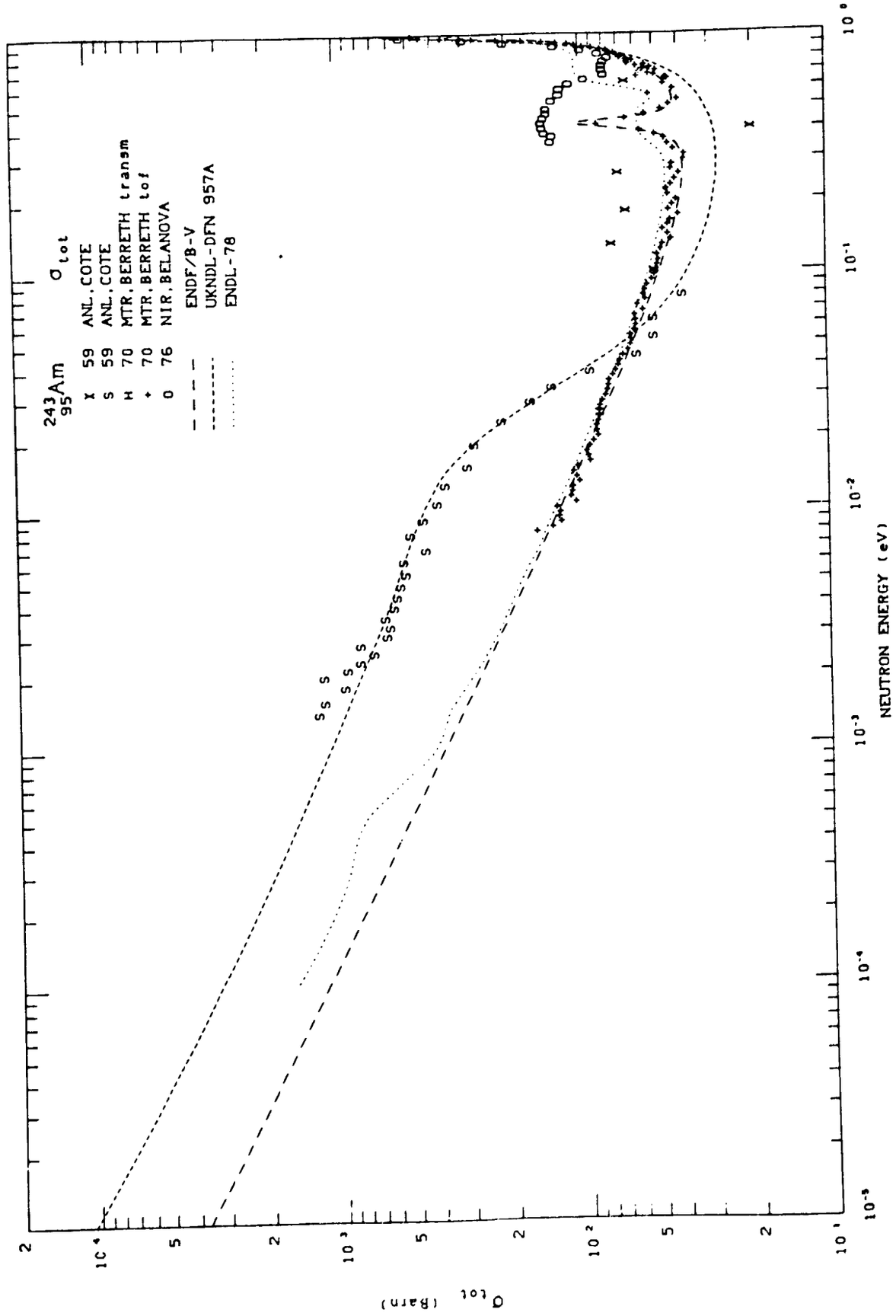
E_γ (keV)	Intensity per 100 α particles
74.7	66
43.5	5.5

THERMAL CROSS SECTIONS

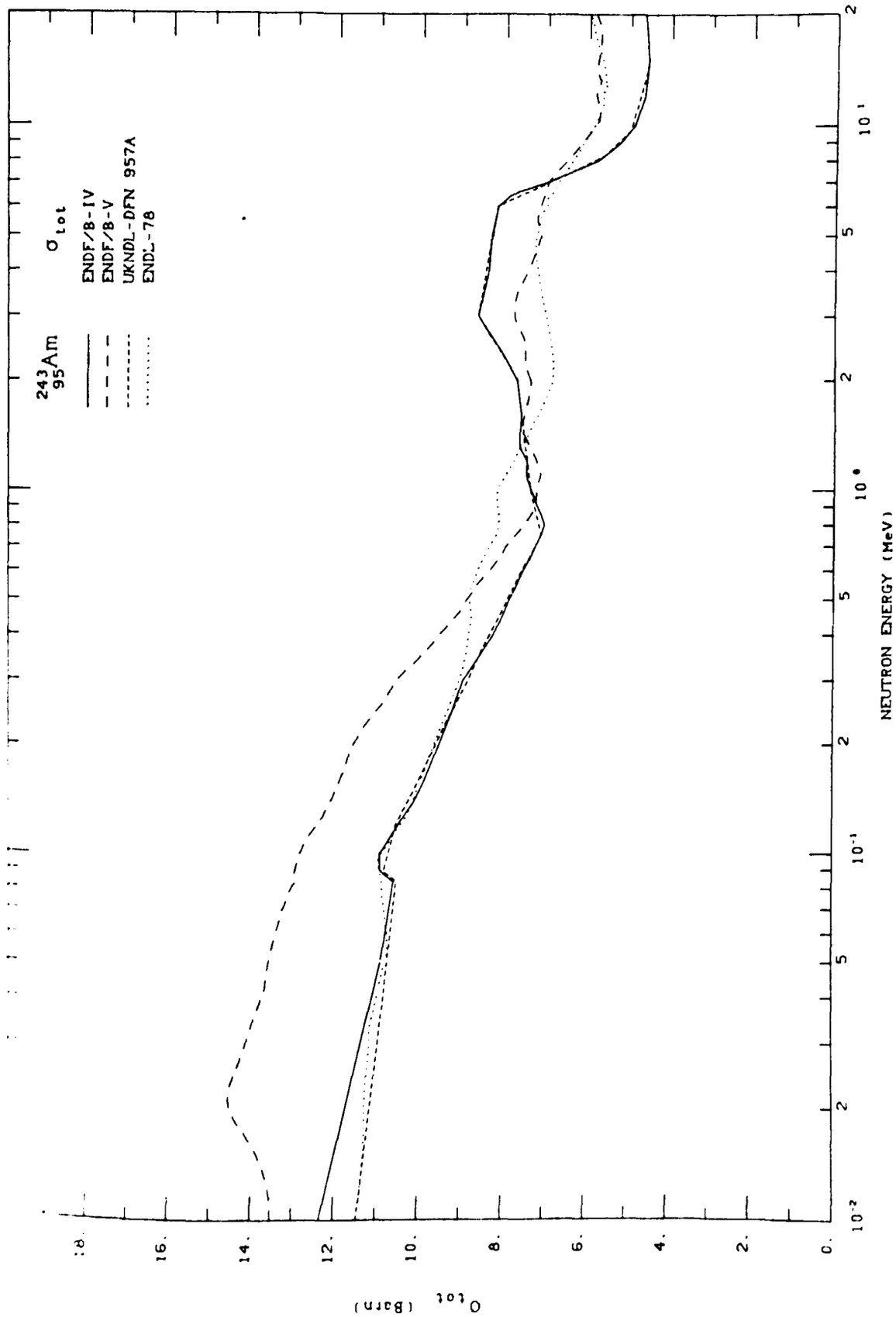
Reference	σ_γ barns	σ_f barns	σ_t barns
ENDF/B - IV	122.3	0.0	
ENDL -76	74.6	0.89	86.9
NL 325 (1973)	79.3	< 0.07	85

RESONANCE INTEGRALS

Reference	RI_γ barns	RI_f barns
ENDF/B - IV	1235	0.0
ENDL -76	1698	3.6
NL 325 (1973)	1820	0.0

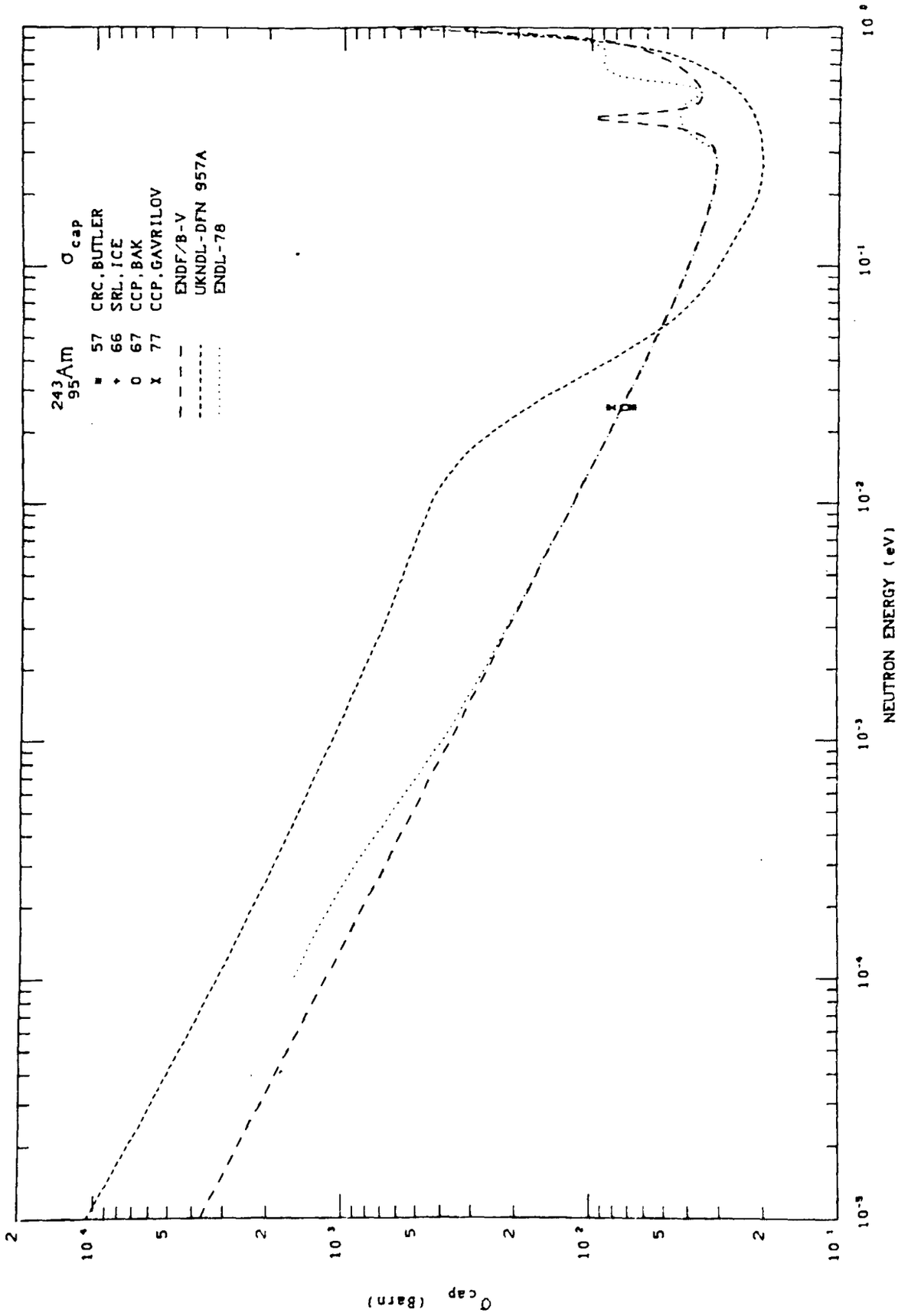

$^{243}_{95}Am$
σ_{tot}
X 59 ANL.COTE
S 59 ANL.COTE
H 70 MTR.BERRETH transm
+ 70 MTR.BERRETH tof
O 76 NIR.BELANOVA
ENDF/B-V
UKNDL-DFN 957A
ENDL-78
NEUTRON ENERGY (eV)
σ_{tot} (Barn)

$^{243}_{95}Am$

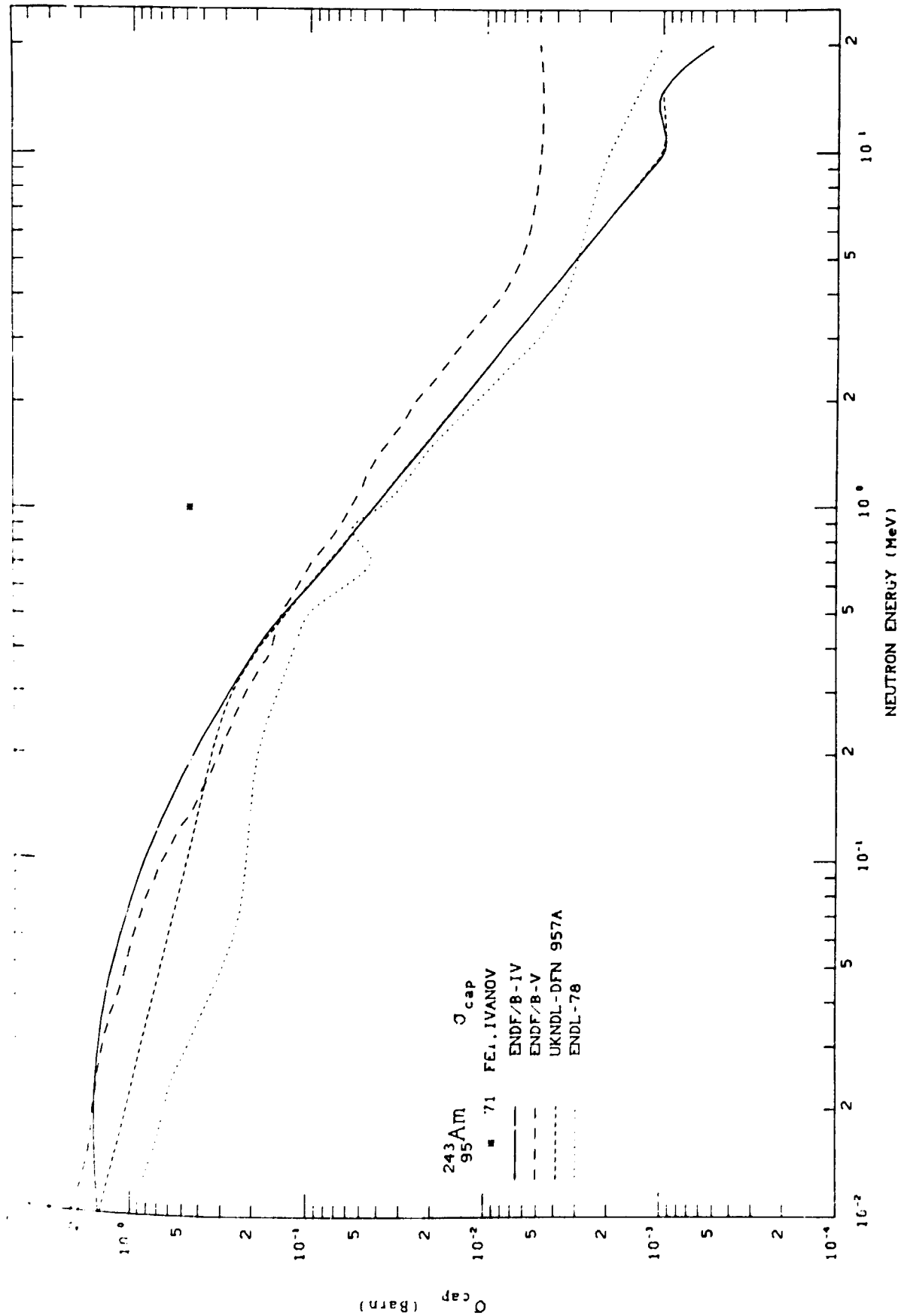

$^{243}_{95}Am$
σ_{tot}
ENDF/B-IV
ENDF/B-V
UKNDL-DFN 957A
ENDL-78
σ_{tot} (Barn)
NEUTRON ENERGY (MeV)
0.
2.
4.
6.
8.
10.
12.
14.
16.
18.
10^{-2}
10^{-1}
10^{0}
10^{1}

Experimental information ^{243}Am, σ_{tot}

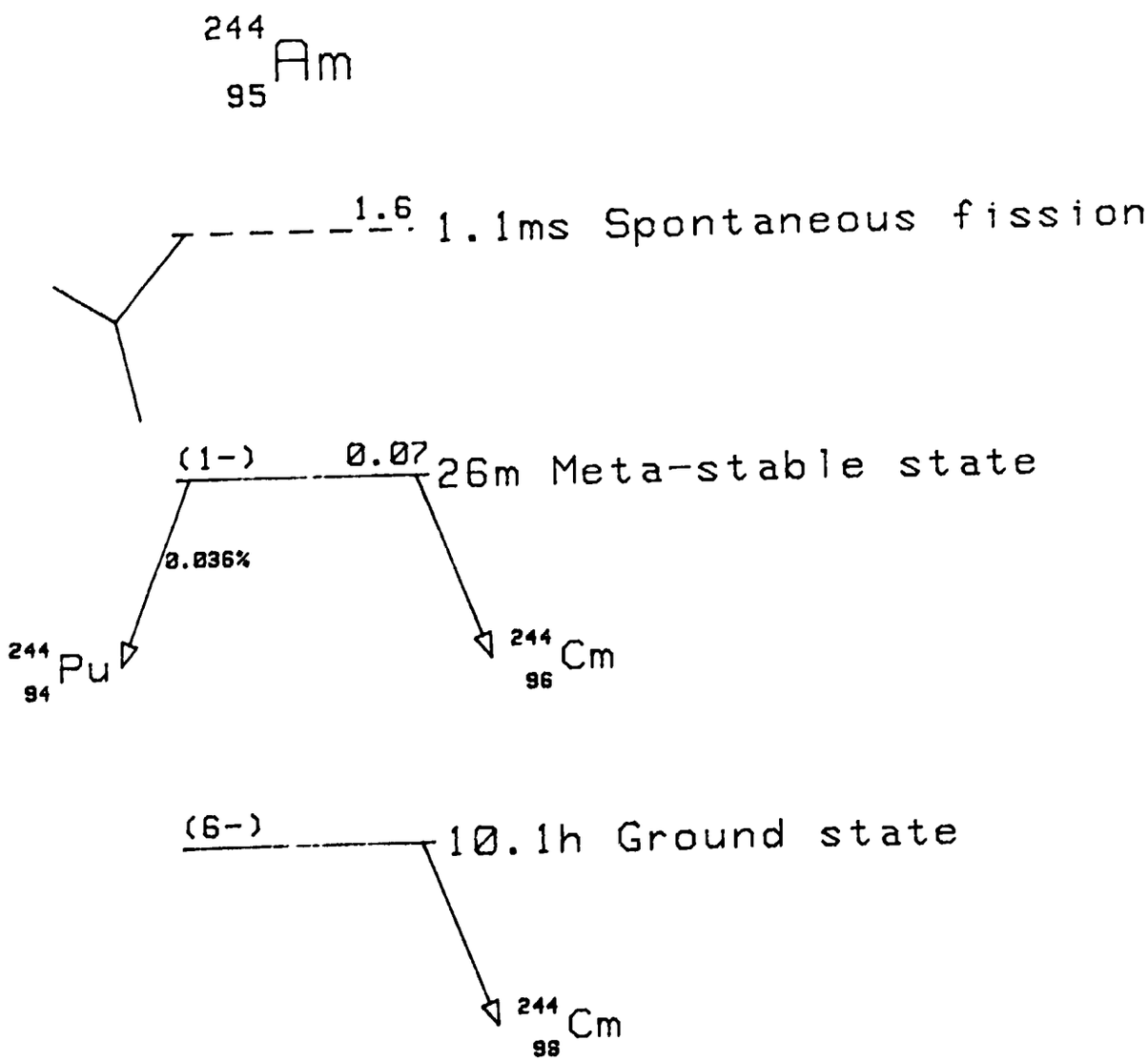
	Reference	Points	Range	Standard	Error	Comments
59	ANL, COTÉ	6	0.1-0.63 eV	ABS.	14-54 %	
59	ANL, COTÉ	31	0.0014-15 eV	ABS.		
70	MTR, BERRETH(tof)	922	0.008-26 eV	ABS.		Selected every third point between 0.5-1 eV
70	MTR, BERRETH(transm.)	1	0.0253 eV	ABS.	5 %	
76	NIR, BELANOVA	1 972	0.4-35 eV	ABS.		Selected every third point


$^{243}_{95}Am$
σ_{cap}
57 CRC, BUTLER
66 SRL, ICE
67 CCP, BAK
77 CCP, GAVRILOV
ENDF/B-V
UKNDL-DFN 957A
ENDL-78
NEUTRON ENERGY (eV)
σ_{cap} (Barn)

$^{243}_{95}Am$


$^{243}_{95}Am$
71 FEL.IVANOV
σ_{cap}
ENDF/B-IV
ENDF/B-V
UKNDL-DFN 957A
ENDL-78
σ_{cap} (Barn)
NEUTRON ENERGY (MeV)

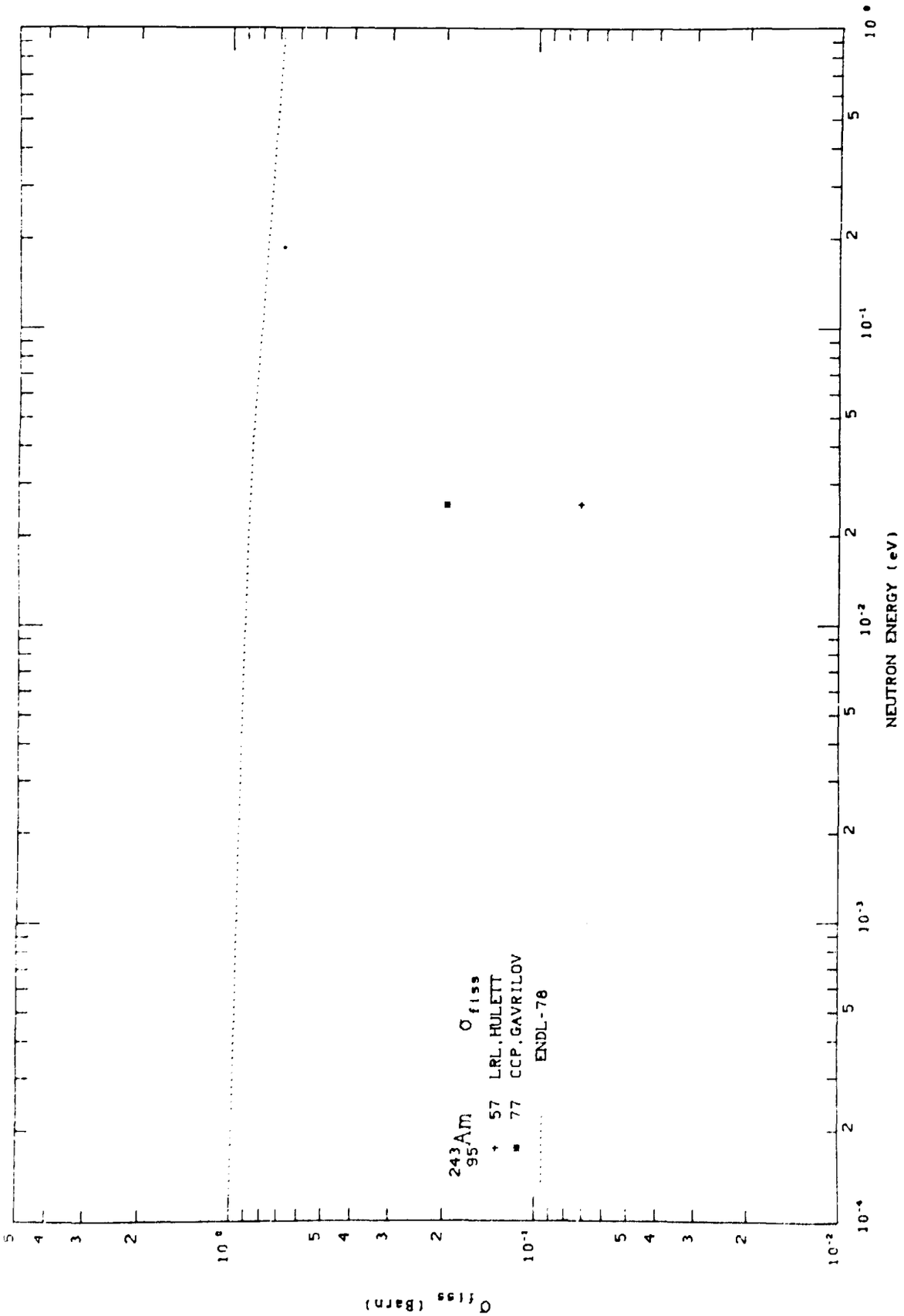
NUCLEAR DECAY SCHEME FOR $^{244}_{95}AM$

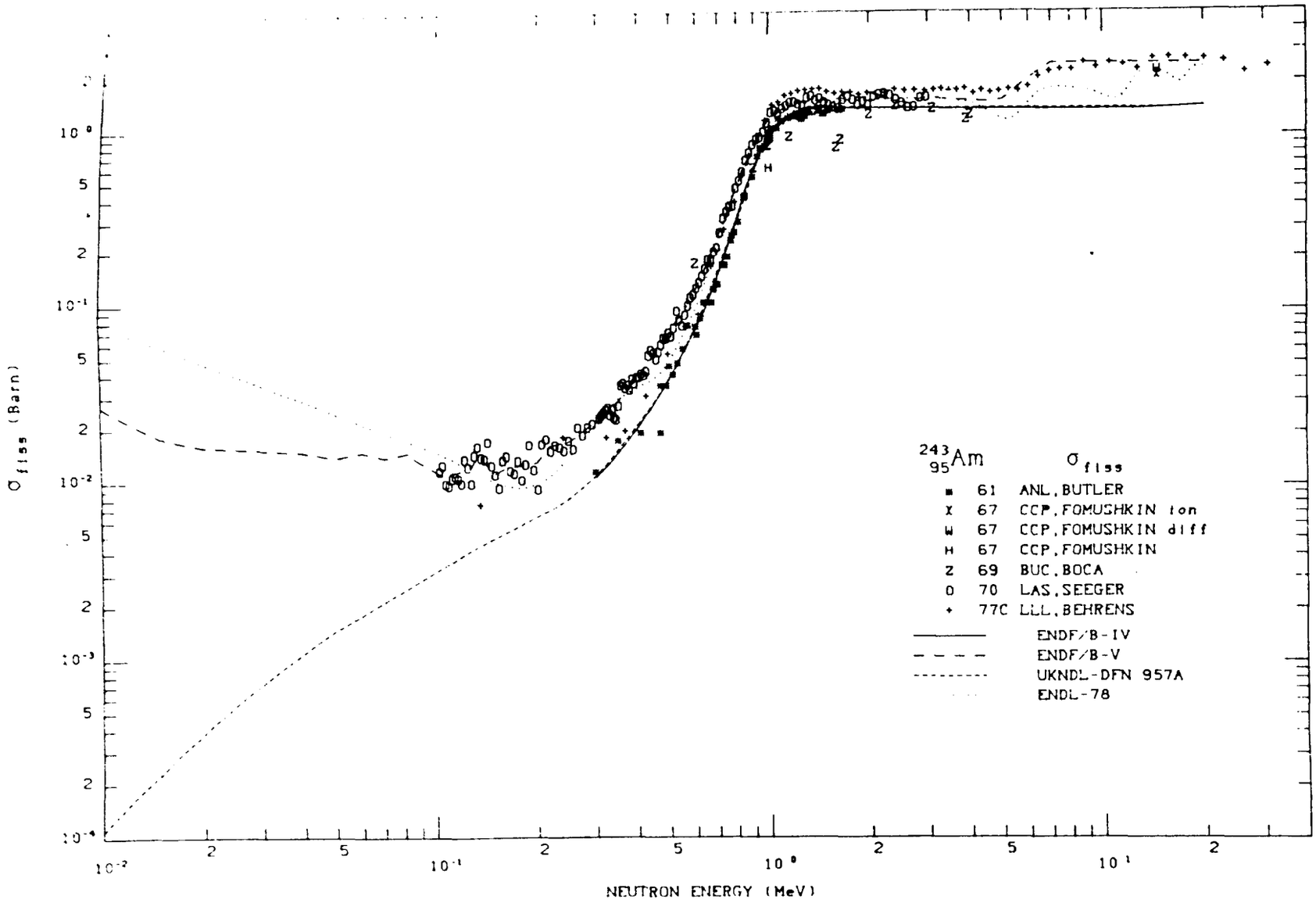


Experimental information ^{243}Am, σ_γ

	Reference	Points	Range	Standard	Error	Comments
57	CRC, BUTLER	1	0.0253 eV	^{59}Co, σ_γ	3 %	
66	SRL, ICE	1	0.0253 eV	Activation		
67	CCP, BAK	1	0.0253 eV	^{197}Au, σ_γ	20 %	
71	FEI, IVANOV	1	1.0 MeV	^{238}U, σ_γ	4 %	
77	CCP, GAVRILOV	1	0.0253 eV	^{197}Au, σ_γ and ^{59}Co, σ_γ	7.2 %	

General comments: The experimental data point of Ice is the sum of the meatastable and the ground state contribution


$^{243}_{95}Am$
+ 57 LRL, HULETT
■ 77 CCP, GAVRILOV
ENDL-78
σ_{fiss}
NEUTRON ENERGY (eV)
σ_{fiss} (barn)


$^{243}_{95}$Am
σ_{fiss}
61 ANL, BUTLER
67 CCP, FOMUSHKIN ion
67 CCP, FOMUSHKIN diff
67 CCP, FOMUSHKIN
69 BUC, BOCA
70 LAS, SEEGER
77C LLL, BEHRENS
ENDF/B-IV
ENDF/B-V
UKNDL-DFN 957A
ENDL-78
σ_{fiss} (Barn)
NEUTRON ENERGY (MeV)

Experimental information ^{243}Am, σ_{fiss}

	Reference	Points	Range	Standard	Error	Comments
57	LRL, HULETT	1	0.0253 eV	^{239}Pu, σ_f		Based on $T_{1/2}(^{243}Am)$ = = 8200 y
61	ANL, BUTLER	65	0.3-1.67 MeV	^{235}U, σ_f		
67	CCP, FOMUSHKIN(ion)	1	14.5 MeV	^{238}U, σ_f	6 %	Ion chamber
67	CCP, FOMUSHKIN(diff)	1	14.5 MeV	^{238}U, σ_f	5 %	Diff. Sig. Int.
67	CCP, FOMUSHKIN	1	1.0 MeV	^{238}U, σ_f	8 %	
69	BUC, BOCA	11	0.6-4 MeV		$\leq$20 %	
70	LAS, SEEGER	2 199	48 eV-3 MeV	^{235}U, σ_f		
77	CCP, GAVRILOV	1	0.0253 eV	^{197}Au, σ_γ and ^{59}Co, σ_γ	55 %	
77C	LLL, BEHRENS	63	0.1-30 MeV	^{235}U, σ_f	1.5-48 %	

General comments: The ENDL evaluation does not show the expected 1/v-behaviour (see UCRL-50400 Vol. 15 Part B and D)

3.12 ^{244}Cm

NUCLEAR PROPERTIES (Ref. Nuclear Data Sheets)

Spin and parity of ground state: 0^+

Ground state decay:

$T_{1/2}$ = 18.11 y

spontaneous fission 1.347×10^{-4} %

$T_{1/2} = 1.250 \times 10^{7}$ y

α to ^{240}Pu

E_α(MeV)	I_α (%)
5.805	76.4
5.763	23.6

$\gamma(^{240}Pu)$

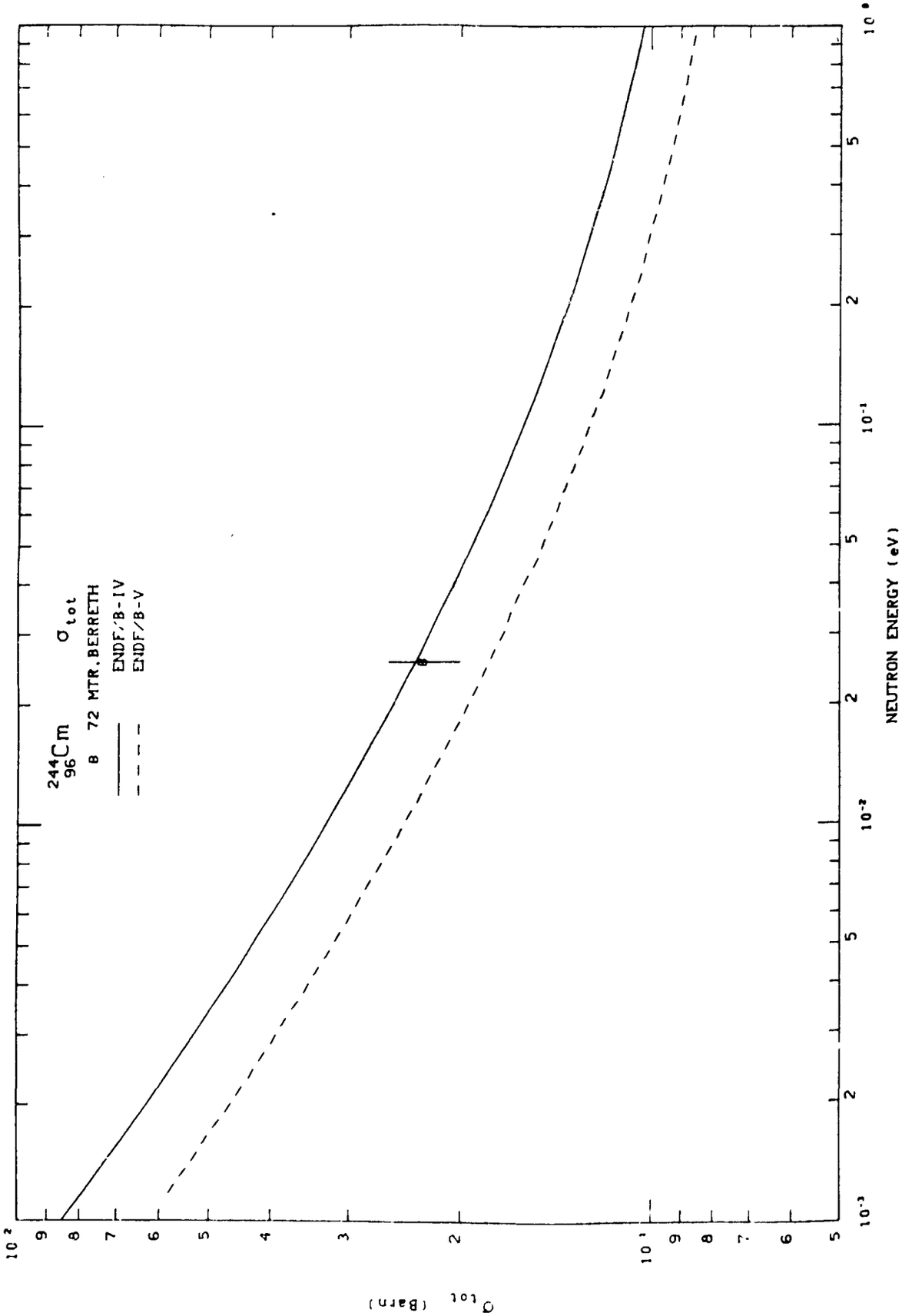
E_γ (keV)	Intensity per 100 α particles
42.8	255×10^{-4}
98.9	15.4 -"-
152.6	9.8 -"-

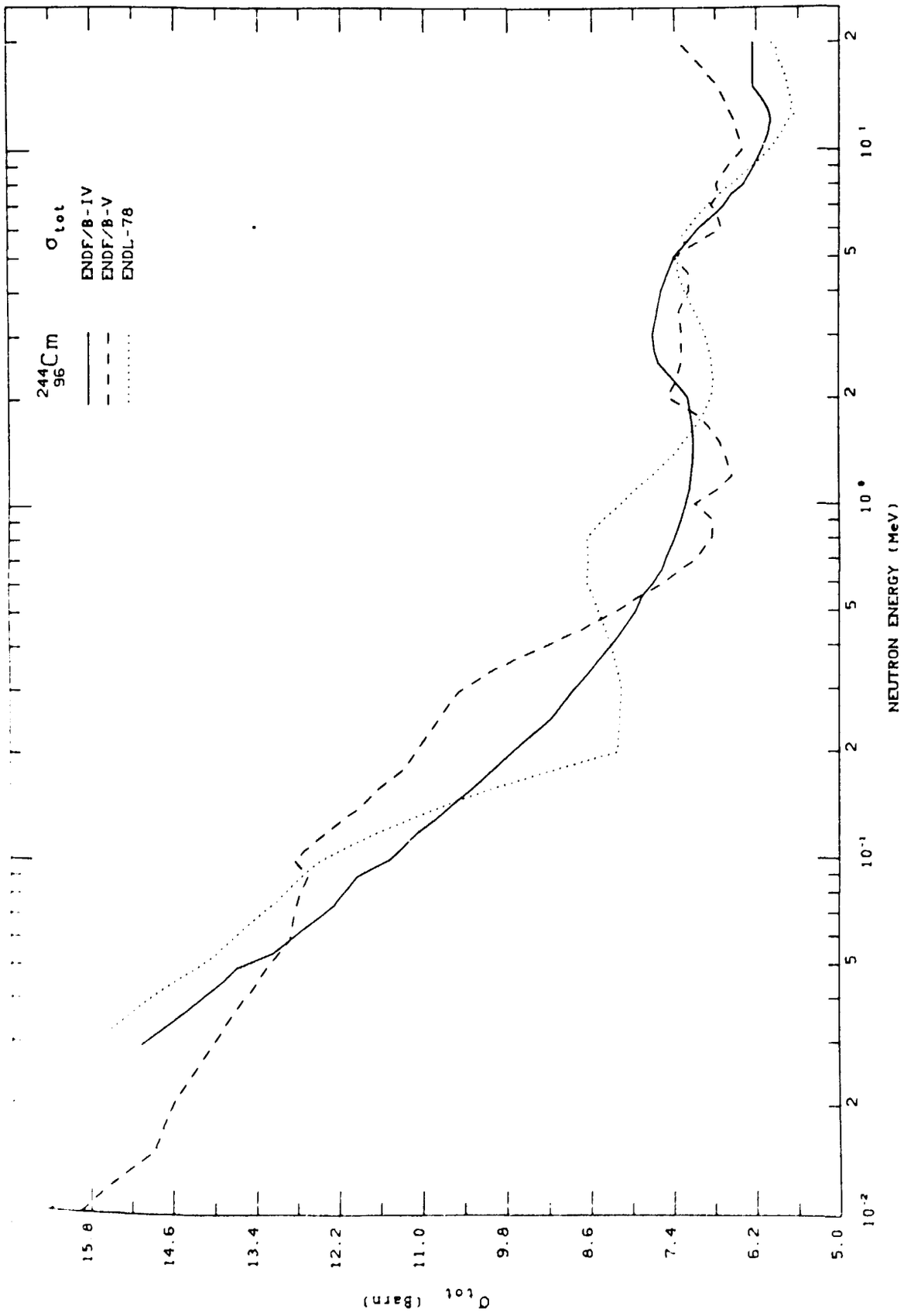
THERMAL CROSS SECTIONS

Reference	σ_γ barns	σ_f barns	σ_t barns	$\bar{\nu}_t$
ENDF/B - IV	13.4	0.88	23.6	
ENDF/B - V	10.4	0.60	18.1	3.460
INDL -78	11.0	1.1	23.4	
NSE 325 (1973)	13.9	1.2	23	
[illegible]PL, BENJAMIN		1.1		

RESONANCE INTEGRALS

Reference	RI_γ barns	RI_f barns
[illegible] - IV	558.5	34.1
[illegible]	580.3	27.0
[illegible] (1973)	650	12.5
[illegible]BERRETH	587	
[illegible]BENJAMIN		18

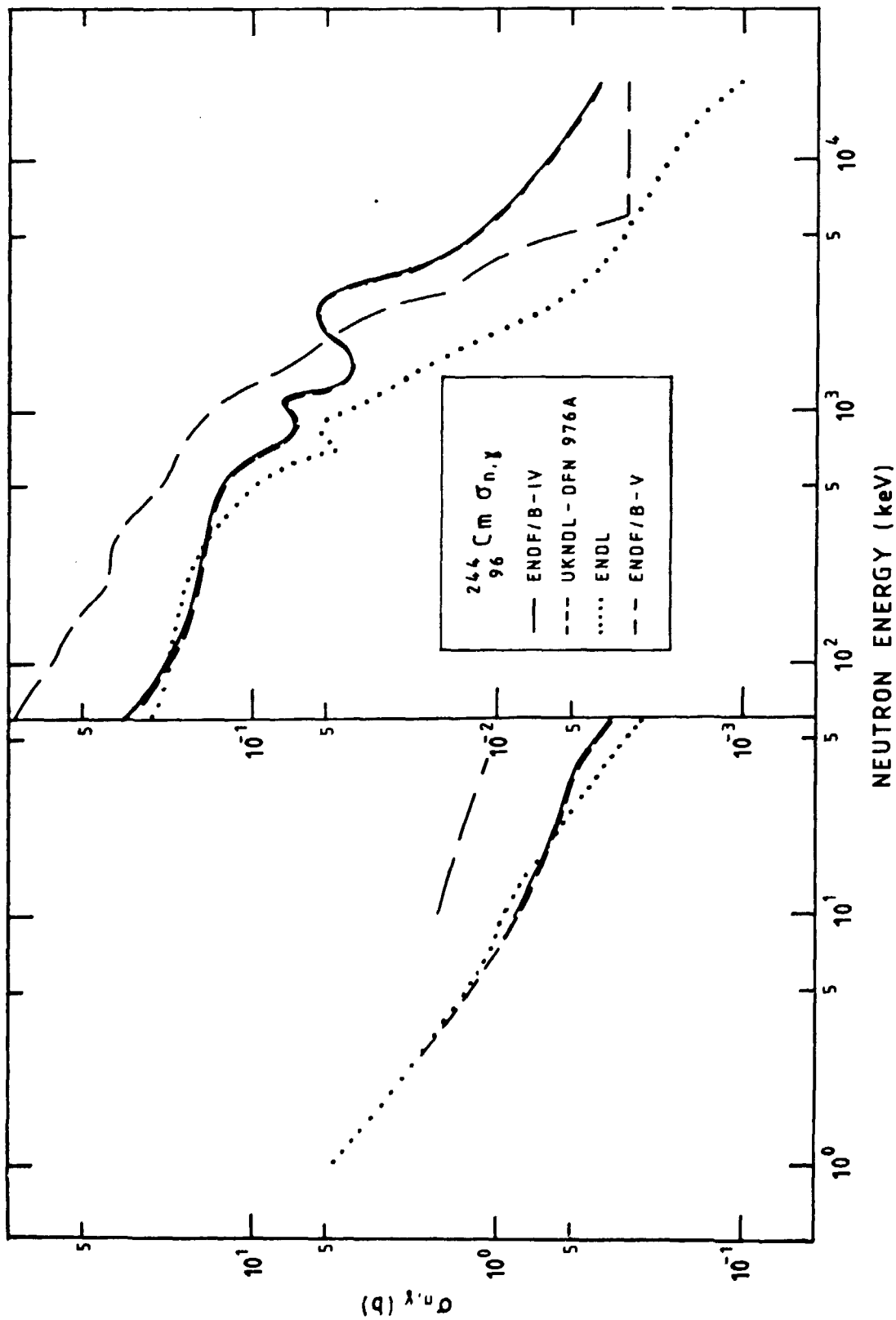

$^{244}_{96}Cm$
B 72 MTR.BERRETH
σ_{tot}
ENDF/B-IV
ENDF/B-V
NEUTRON ENERGY (eV)
σ_{tot} (Barn)


$^{244}_{96}Cm$
σ_{tot}
ENDF/B-IV
ENDF/B-V
ENDL-78
15.8
14.6
13.4
12.2
11.0
9.8
8.6
7.4
6.2
5.0
σ_{tot} (Barn)
10^{-2}
2
5
10^{-1}
2
5
10^{0}
2
5
10^{1}
2
NEUTRON ENERGY (MeV)

Experimental information ^{244}Cm, σ_{tot}

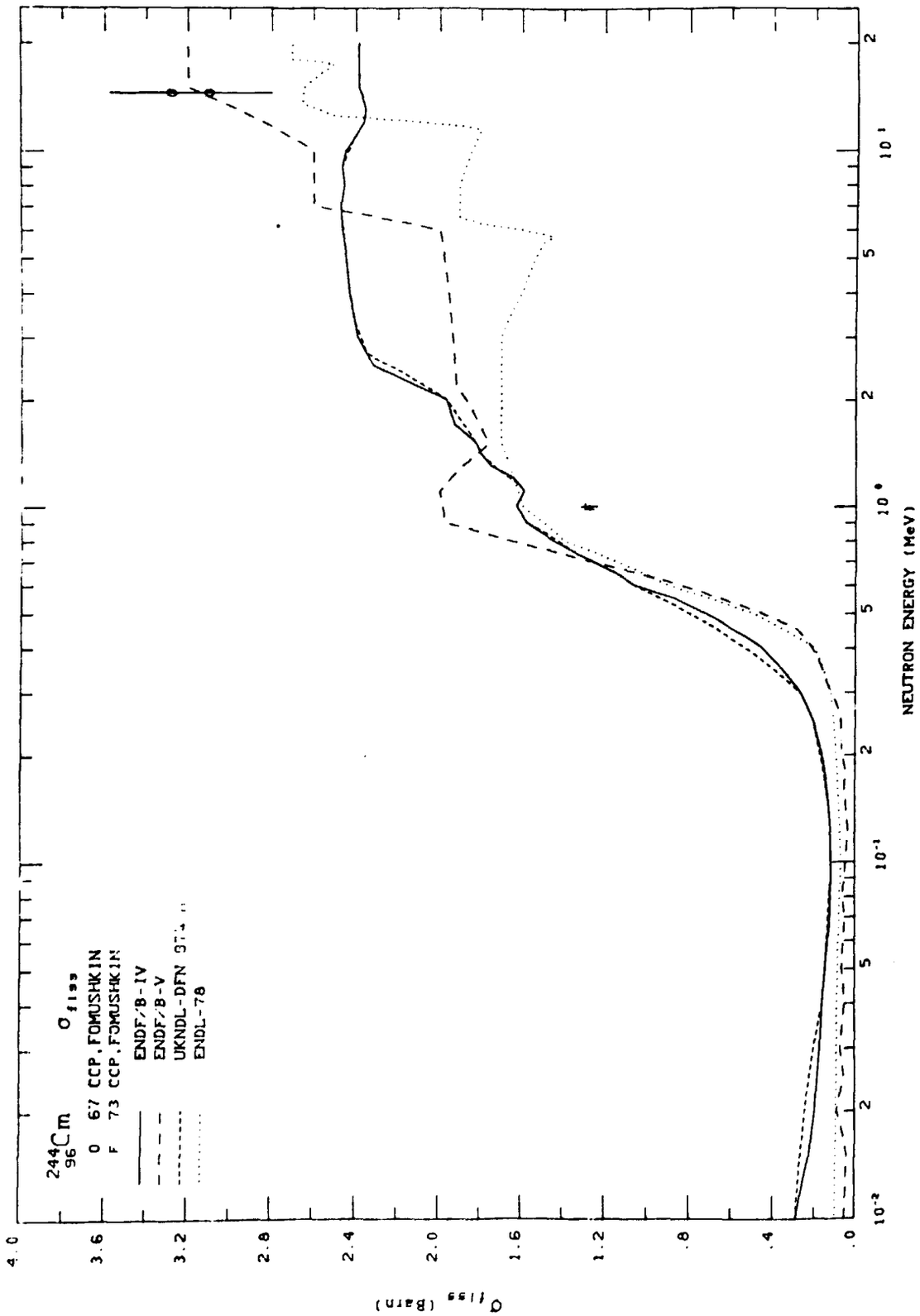
Reference	Points	Range	Standard	Error	Comments
72 MTR, BERRETH	1	0.0253 eV	ABS.	13 %	

General comments: ENDF/B-V total cross section evaluation in the thermal energy range has been calculated from resonance parameters using the computer code RESEND (NEA Nuclear Data Bank)


$^{244}_{96}Cm\ \sigma_{n,\gamma}$
ENDF/B-IV
UKNDL - DFN 976A
ENDL
ENDF/B-V
NEUTRON ENERGY (keV)
$\sigma_{n,\gamma}$ (b)

General comments: ^{244}Cm, σ_γ

ENDF/B-IV and UKNDL are identical


$^{244}_{96}Cm$
σ_{fiss}
0 67 CCP,FOMUSHKIN
F 73 CCP,FOMUSHKIN
ENDF/B-IV
ENDF/B-V
UKNDL-DFN
ENDL-78
σ_{fiss} (Barn)
NEUTRON ENERGY (MeV)

Experimental information ^{244}Cm, σ_f

	Reference	Points	Range	Standard	Error	Comments
67	CCP, FOMUSHKIN	2	14.5 MeV	^{238}U, σ_f	9 %	Independent meas. made with glass-plate fragment detectors and ionization chamber
73	CCP, FOMUSHKIN	1	1 MeV	^{235}U, σ_f	3 %	

General comments: Experimental data shown in the figure are calculated using cross sections from ENDF/B-IV as standard

3.13 ^{245}Cm

NUCLEAR PROPERTIES (Ref. Nuclear Data Sheets)

Spin and parity of ground state: $7/2^+$

Ground state decay:

$T_{1/2}$ = 8500 y

β stable

α to ^{241}Pu, 100 %, Q_α = 5.623 MeV

E_α (MeV)	I_α (%)
5.362	93.2
5.304	4.97

$\gamma(^{241}Pu)$

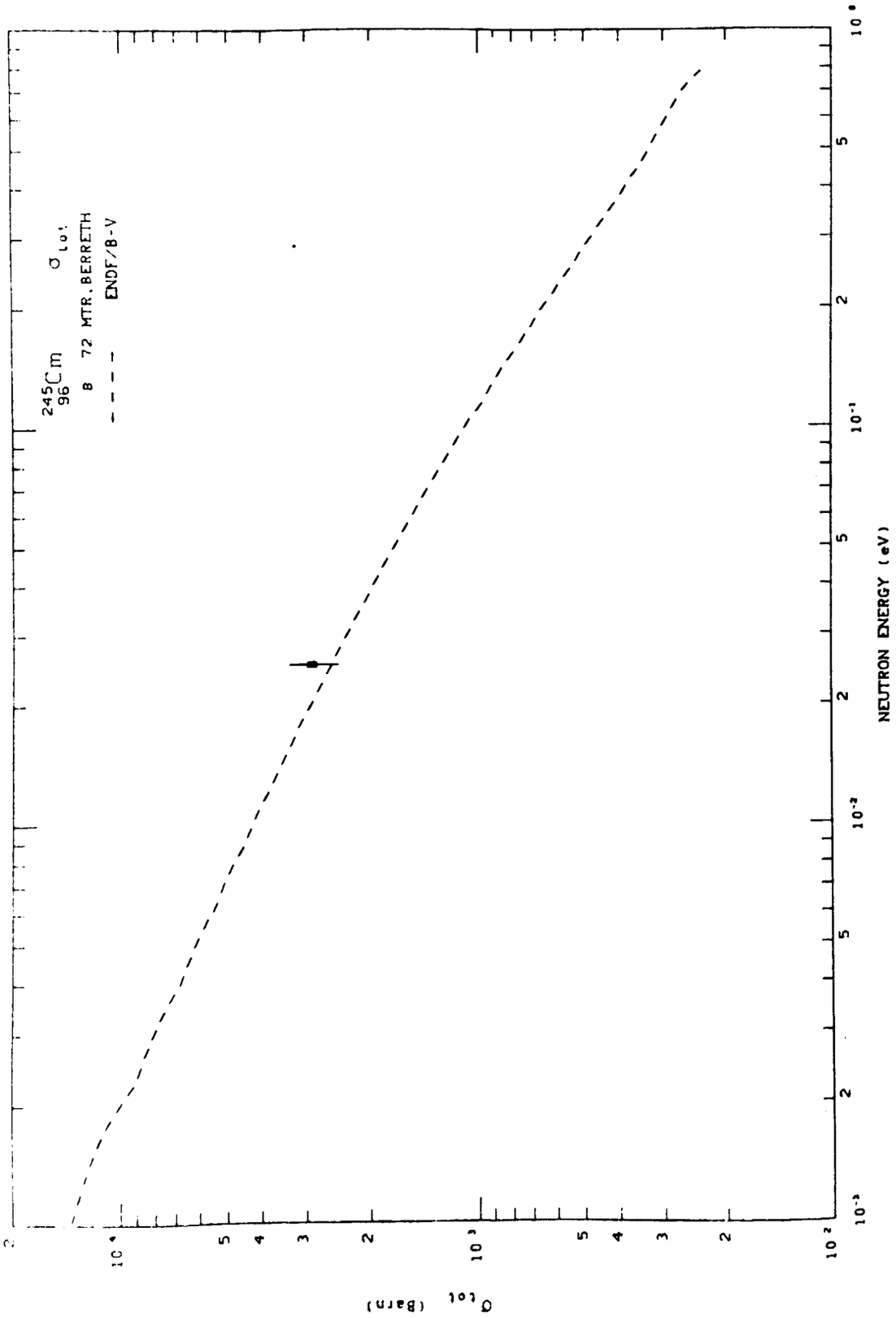
E_γ (keV)	Intensity per 100 α particles
174	47.1
133	46.1

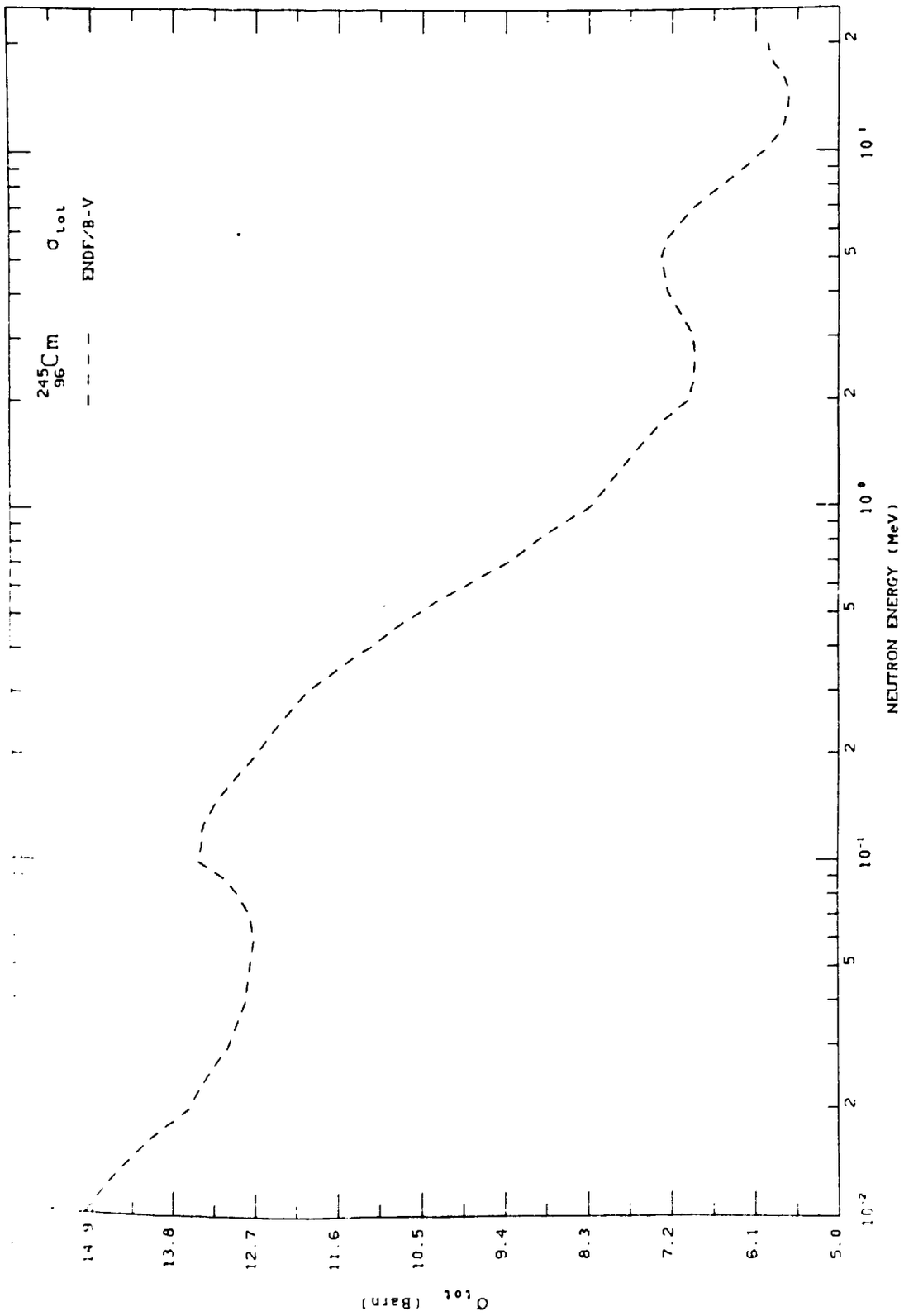
THERMAL CROSS SECTIONS

Reference	σ_γ barns	σ_f barns	σ_t barns	$\bar{\nu}_t$
ENDF/B - V	383	2161	2556	3.83
ENDL -78	391	2219	2630	
ENL 325 (1973)	345	2020	2375	3.83
72 SRL,BENJAMIN		2018		
73 LLL,BROWN		2143		

RESONANCE INTEGRALS

Reference	RI_γ barns	RI_f barns
ENDL -76	114.3	773.8
ENL 325 (1973)	101	750
[illegible] UTR,BERRETH	125	
[illegible] SRL,BENJAMIN		772


$^{245}_{96}Cm$
σ_{tot}
B 72 MTR.BERRETH
ENDF/B-V
NEUTRON ENERGY (eV)
σ_{tot} (barn)

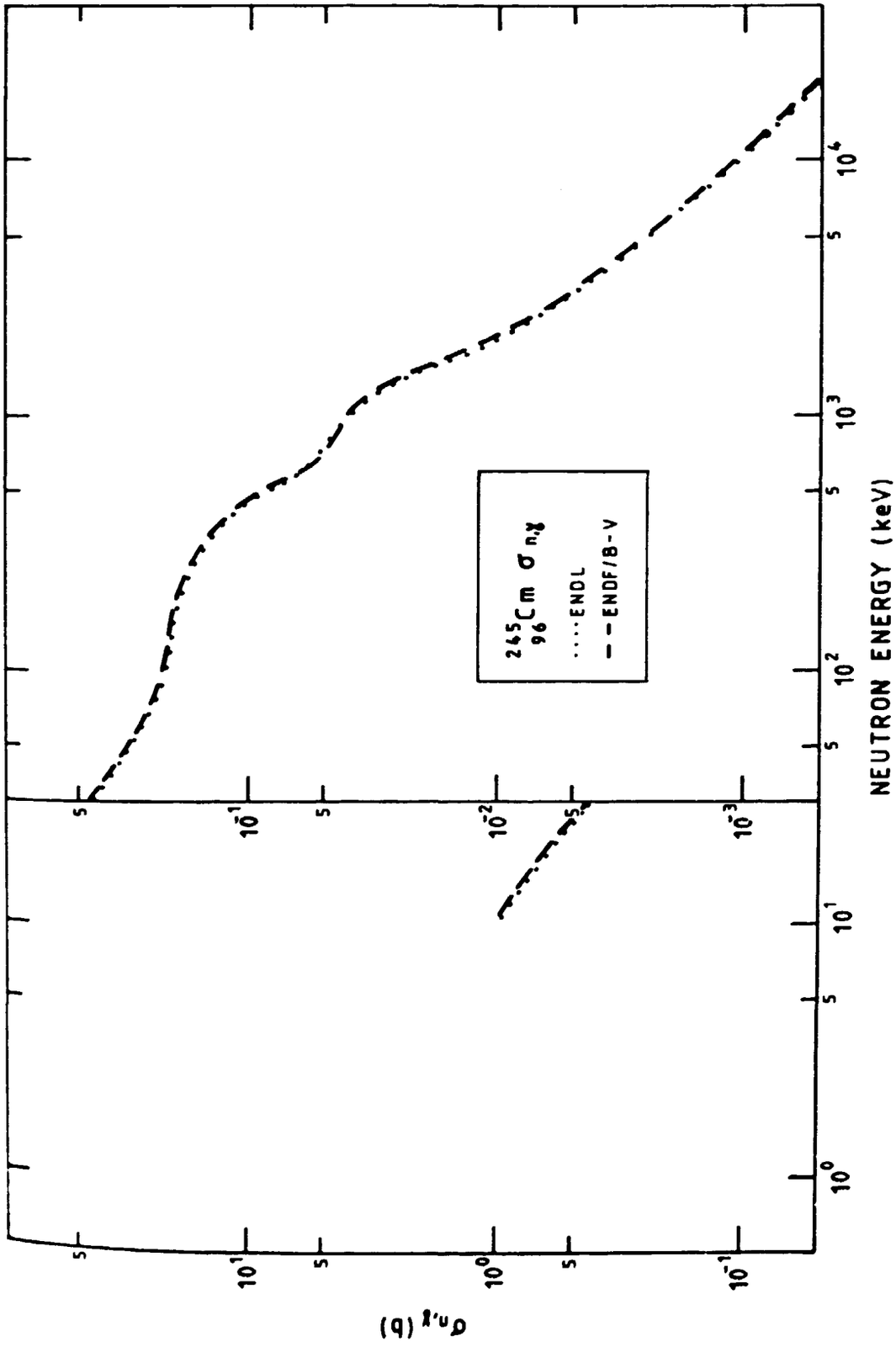

$^{245}_{96}Cm$
σ_{tot}
ENDF/B-V
14.9
13.8
12.7
11.6
10.5
9.4
8.3
7.2
6.1
5.0
σ_{tot} (Barn)
10^{-2}
2
5
10^{-1}
2
5
10^{0}
2
5
10^{1}
2
NEUTRON ENERGY (MeV)

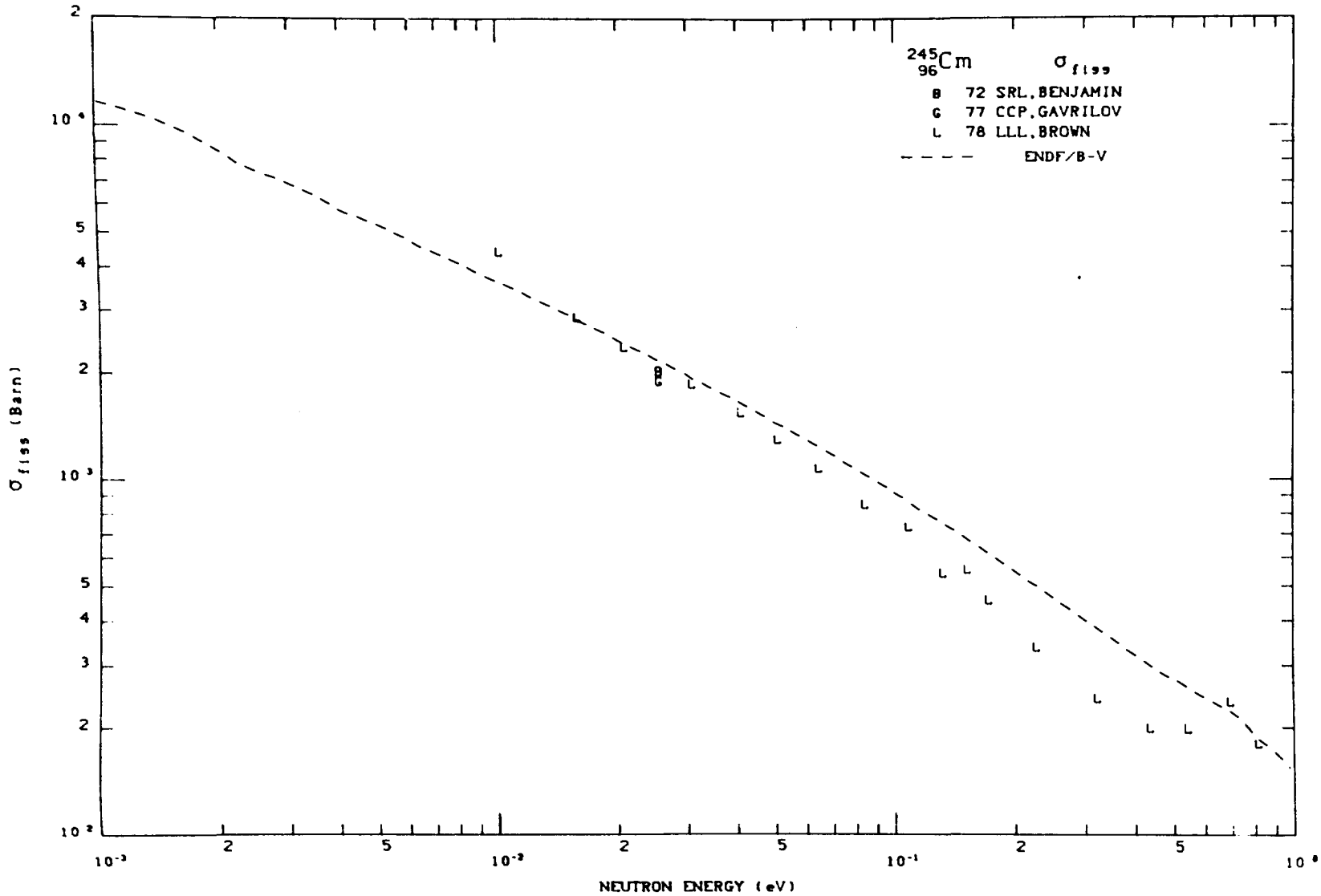
Experimental information ^{245}Cm, σ_{tot}

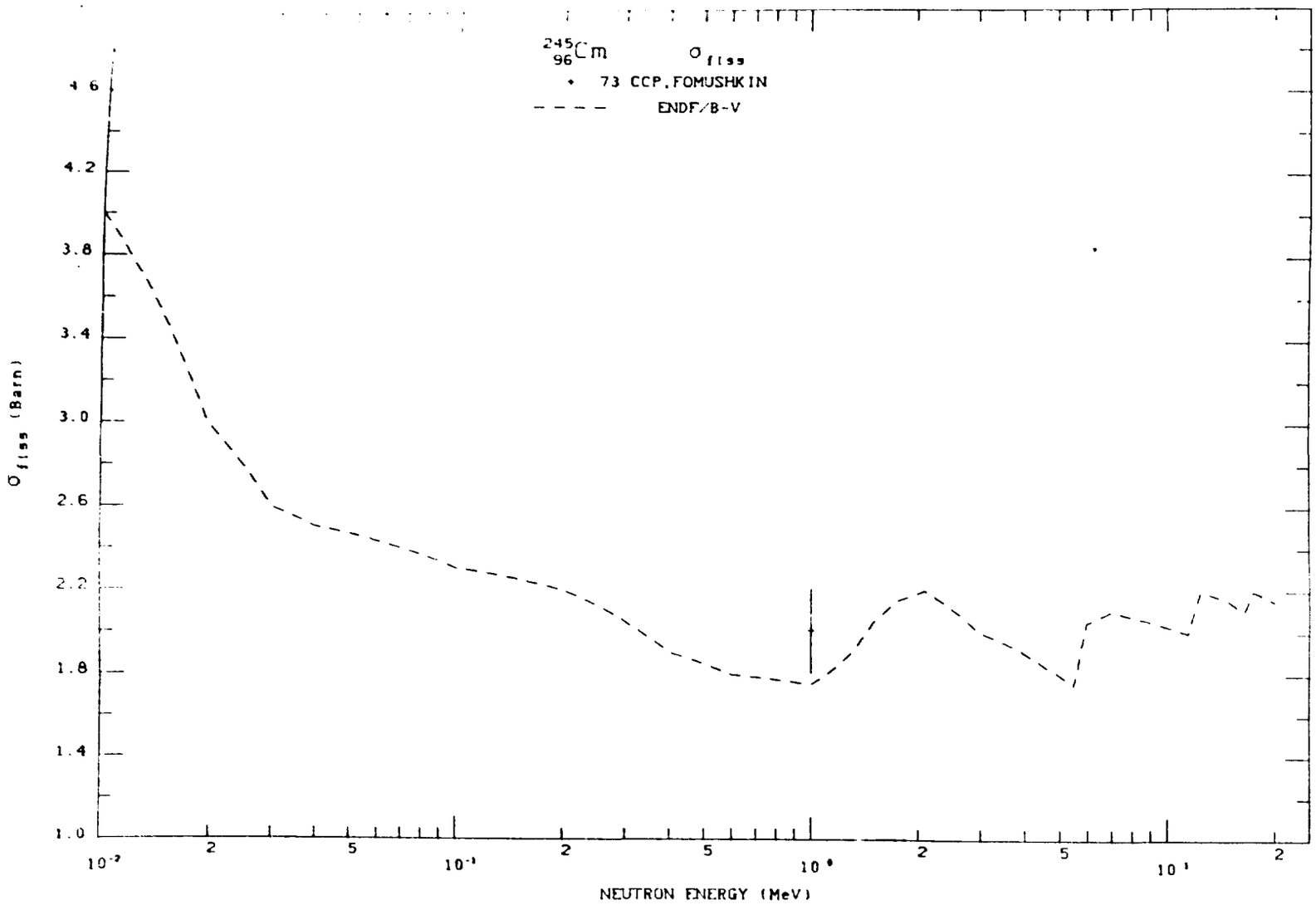
Reference	Points	Range	Standard	Error	Comments
72 MTR, BERRETH	1	0.0253 eV	ABS.	16 %	

General comments: ENDL-78 = ENDF/B-V for all energies

$^{245}_{96}Cm$


$^{245}_{96}Cm$ $\sigma_{n,\gamma}$
ENDL
ENDF/B-V
NEUTRON ENERGY (keV)
$\sigma_{n,\gamma}$ (b)


$^{245}_{96}Cm$ σ_{fiss}
B 72 SRL,BENJAMIN
G 77 CCP,GAVRILOV
L 78 LLL,BROWN
ENDF/B-V
σ_{fiss} (Barn)
NEUTRON ENERGY (eV)


$^{245}_{96}$Cm
σ_{fiss}
+ 73 CCP, FOMUSHKIN
ENDF/B-V
σ_{fiss} (Barn)
4.6
4.2
3.8
3.4
3.0
2.6
2.2
1.8
1.4
1.0
10^{-2}
2
5
10^{-1}
2
5
10^{0}
2
5
10^{1}
2
NEUTRON ENERGY (MeV)

Experimental information ^{245}Cm, σ_f

	Reference	Points	Range	Standard	Error	Comments
72	SRL, BENJAMIN	1	0.0253 eV	^{235}U, σ_f	2 %	
73	CCP, FOMUSHKIN	1	1 MeV	^{235}U, σ_f	10 %	
77	CCP, GAVRILOV	1	0.0253 eV		5 %	
78	LLL, BROWN	271	0.01-35 eV	^{6}Li, $\sigma_{n,\alpha}$	2-7 %	

General comments: Experimental data shown in the figures are calculated using cross sections from ENDF/B-IV as standard. ENDF/B-V = ENDL-78 for E_n < 1 eV

3.14 ^{246}Cm

NUCLEAR PROPERTIES (Ref. Nuclear Data Sheets)

Spin and parity of ground state: 0^+

Ground state decay:

$T_{1/2}$ = 4730 y

Spontaneous fission = 0.02614 %

$T_{1/2} = 1.8 \times 10^7$ y

α to ^{242}Pu, 99.97 %, Q_α = 5.476 MeV

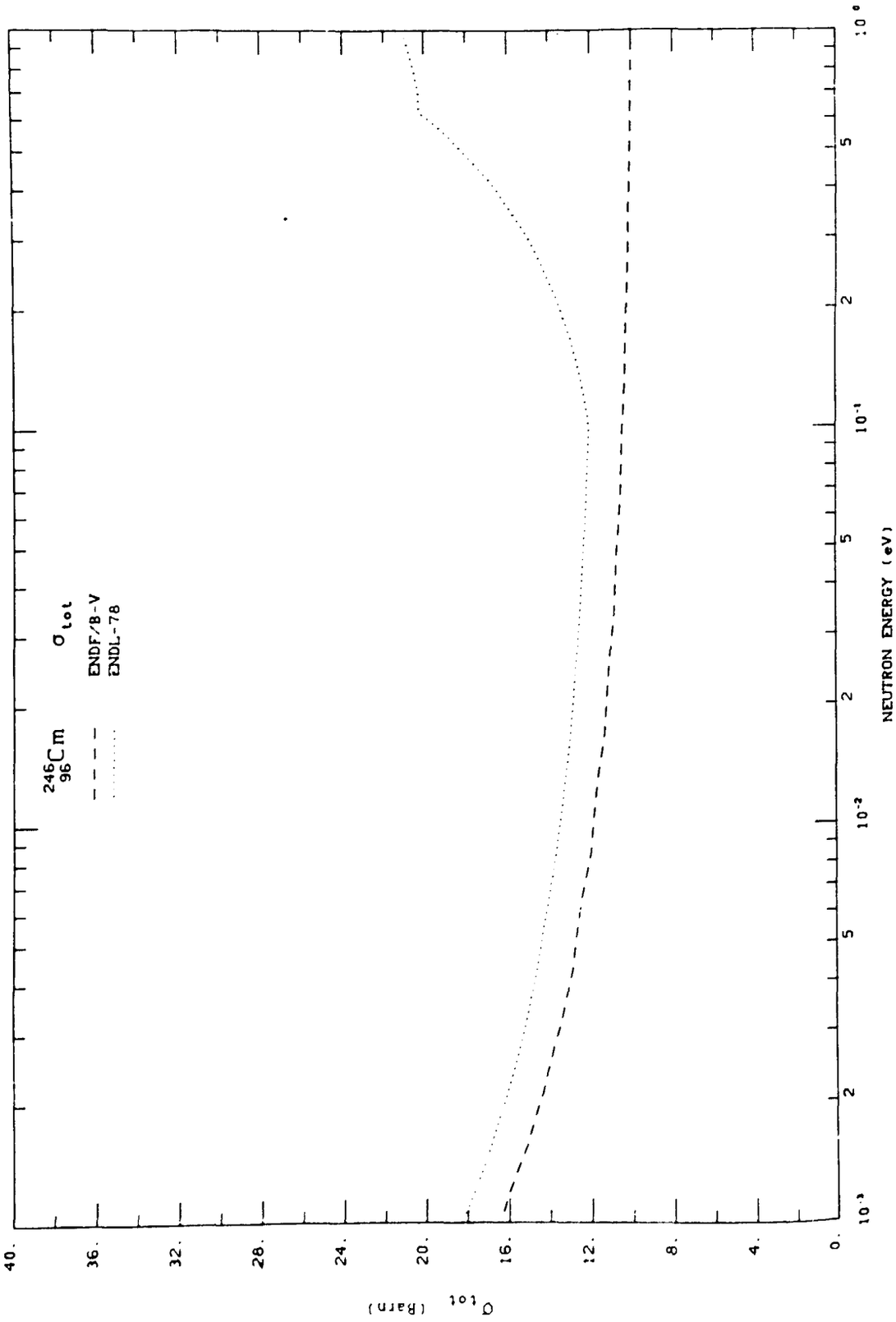
E_α (MeV)	I_α (%)
5.386	79
5.343	21

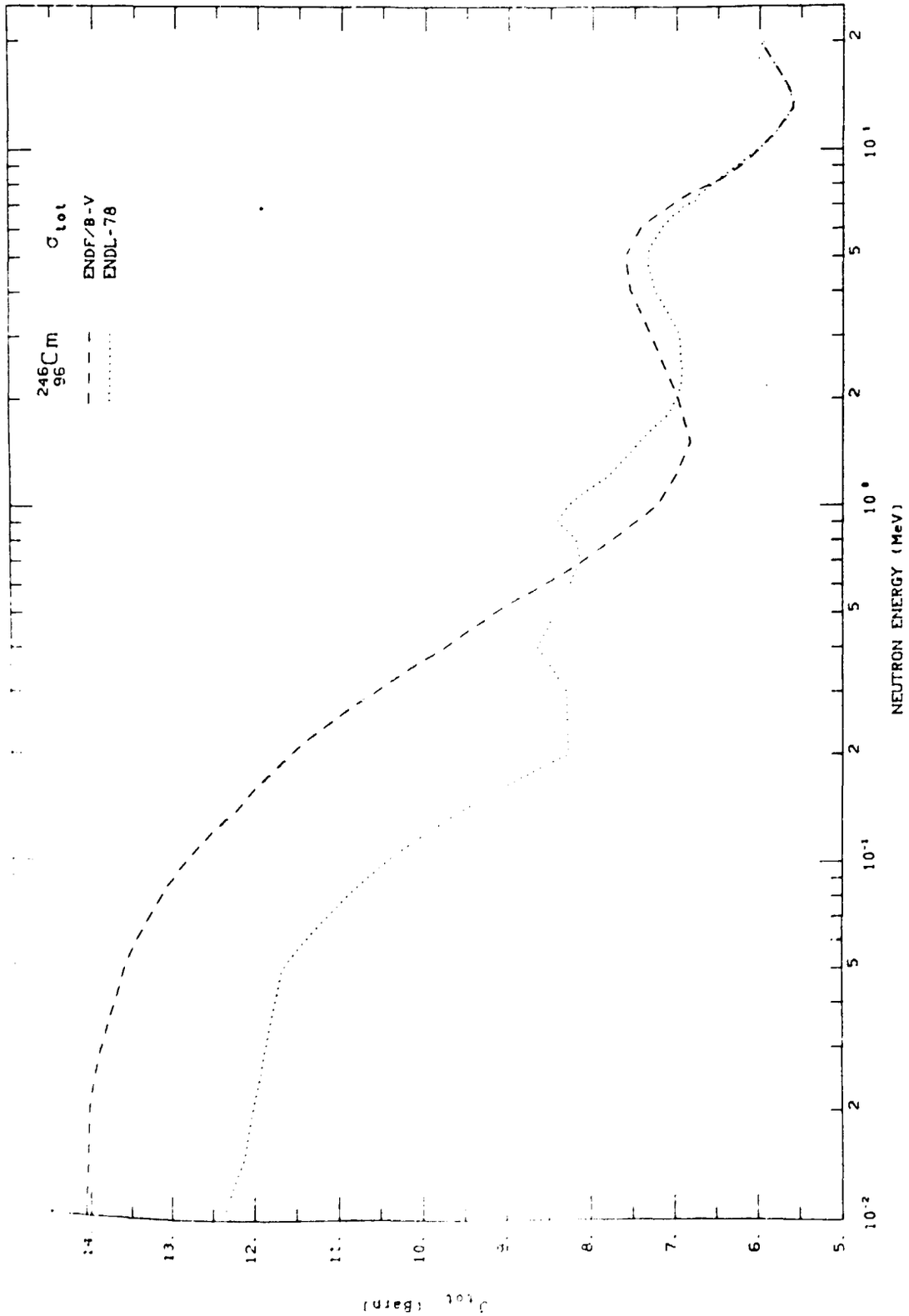
THERMAL CROSS SECTIONS

Reference	σ_γ barns	σ_f barns	σ_t barns
ENDF/B - V	1.30	0.063	11.05
ENDL -78	1.19	0.17	12.7
BNL 325 (1973)	1.3	0.17	
68 SRL,FOGLER	8.2 9.1		

RESONANCE INTEGRALS

Reference	RI_γ barns	RI_f barns
ENDL -76	132.8	1.6
BNL 325 (1973)	121	10
68 SRL,FOGLER	260	

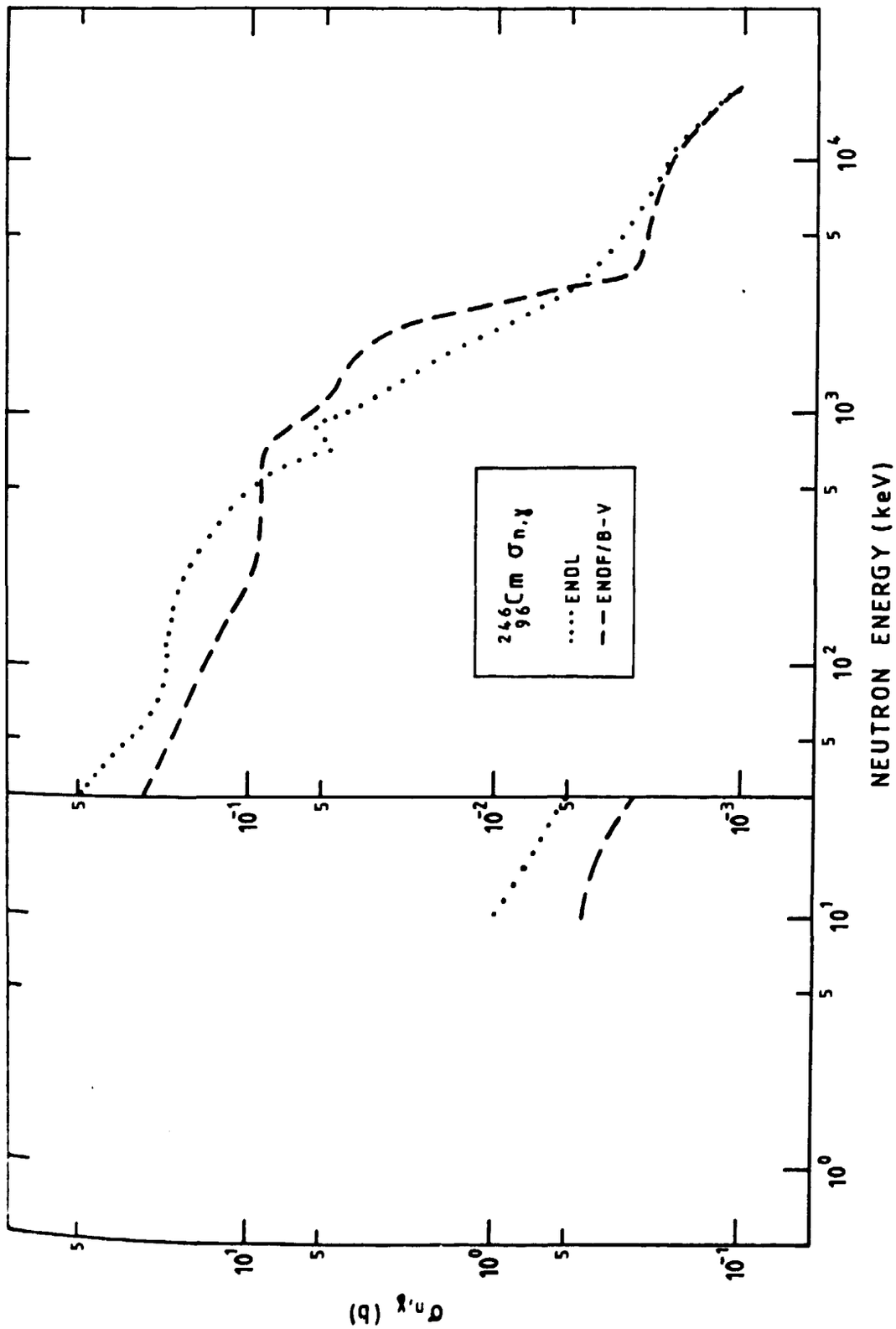

$^{246}_{96}Cm$
σ_{tot}
ENDF/B-V
ENDL-78
NEUTRON ENERGY (eV)
σ_{tot} (Barn)
40.
36.
32.
28.
24.
20.
16.
12.
8.
4.
0.
10^{-3}
10^{-2}
10^{-1}
10^{0}

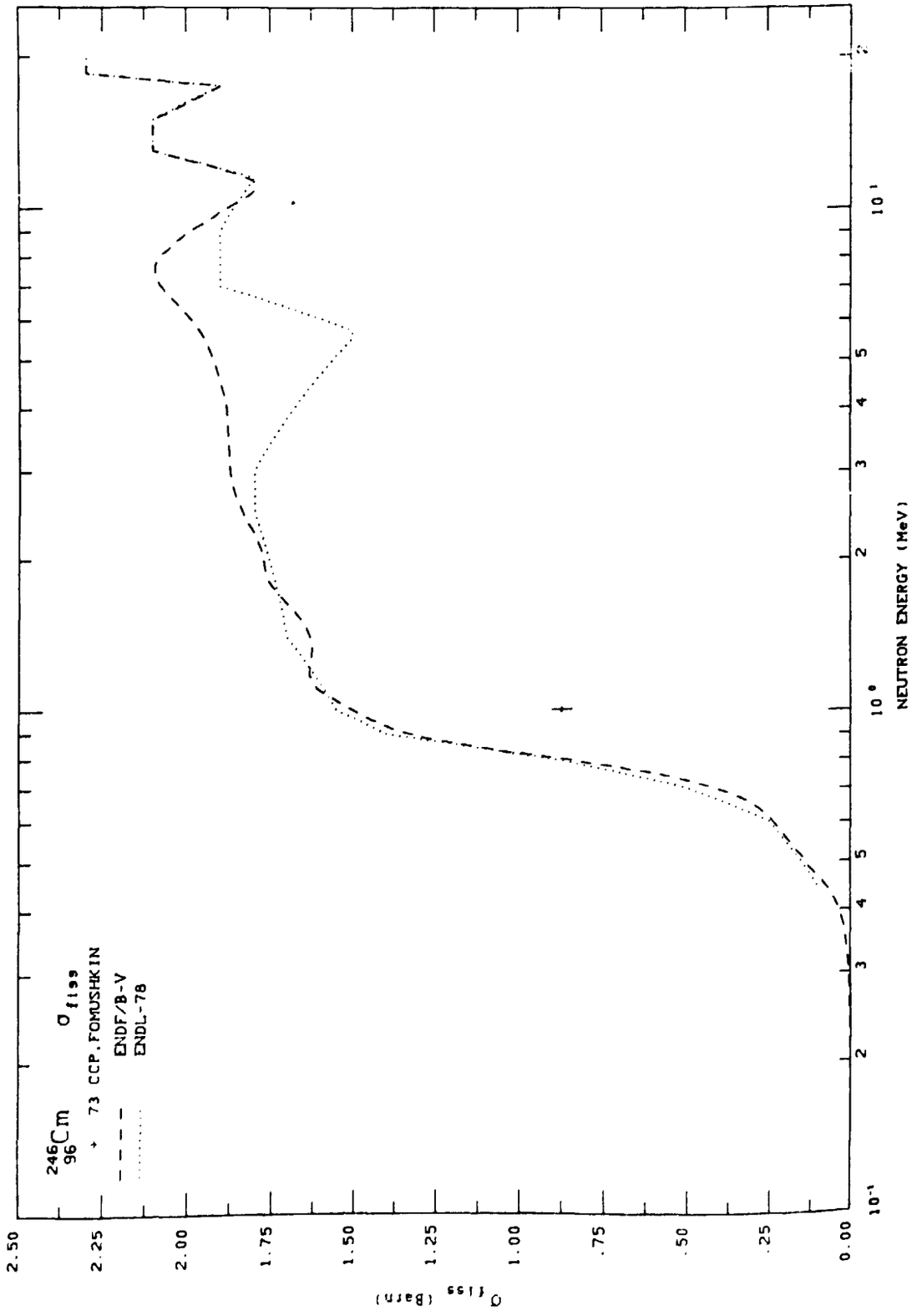

$^{246}_{96}Cm$
σ_{tot}
ENDF/B-V
ENDL-78
NEUTRON ENERGY (MeV)
σ_{tot} (barn)
14.
13.
12.
11.
10.
9.
8.
7.
6.
5.
10^{-2}
10^{-1}
10^{0}
10^{1}
2
5

General comments: ^{246}Cm, σ_{tot}

ENDF/B-V total cross section evaluation in the thermal energy range has been calculated from resonance parameters using the computer code RESEND (NEA Nuclear Data Bank)

$^{246}_{96}Cm$


$^{246}_{96}Cm$ $\sigma_{n,\gamma}$
ENDL
ENDF/B-V
NEUTRON ENERGY (keV)
$\sigma_{n,\gamma}$ (b)


$^{246}_{96}Cm$
+ 73 CCP.FOMUSHKIN
ENDF/B-V
ENDL-78
σ_{fiss}
2.50
2.25
2.00
1.75
1.50
1.25
1.00
.75
.50
.25
0.00
σ_{fiss} (barn)
10^{-1}
2
3
4
5
10^{0}
2
3
4
5
10^{1}
NEUTRON ENERGY (MeV)

Experimental information ^{246}Cm, σ_f

	Reference	Points	Range	Standard	Error	Comments
73	CCP, FOMUSHKIN	1	1 MeV	^{235}U, σ_f	3.5 %	

3.15 ^{247}Cm

NUCLEAR PROPERTIES (Ref. Nuclear Data Sheets)

Spin and parity of ground state: $9/2^-$

Ground state decay:

$T_{1/2} = 1.56 \times 10^7$ y

α to ^{243}Pu, 100 %, $Q_\alpha = 5.353$ MeV

E_α (MeV)	I_α (%)	E_α (MeV)	I_α (%)
4.868	71.0	4.983	2.0
5.265	13.8	4.941	1.6
5.210	5.7	5.145	1.2
4.818	4.7		

$\gamma(^{243}Pu)$

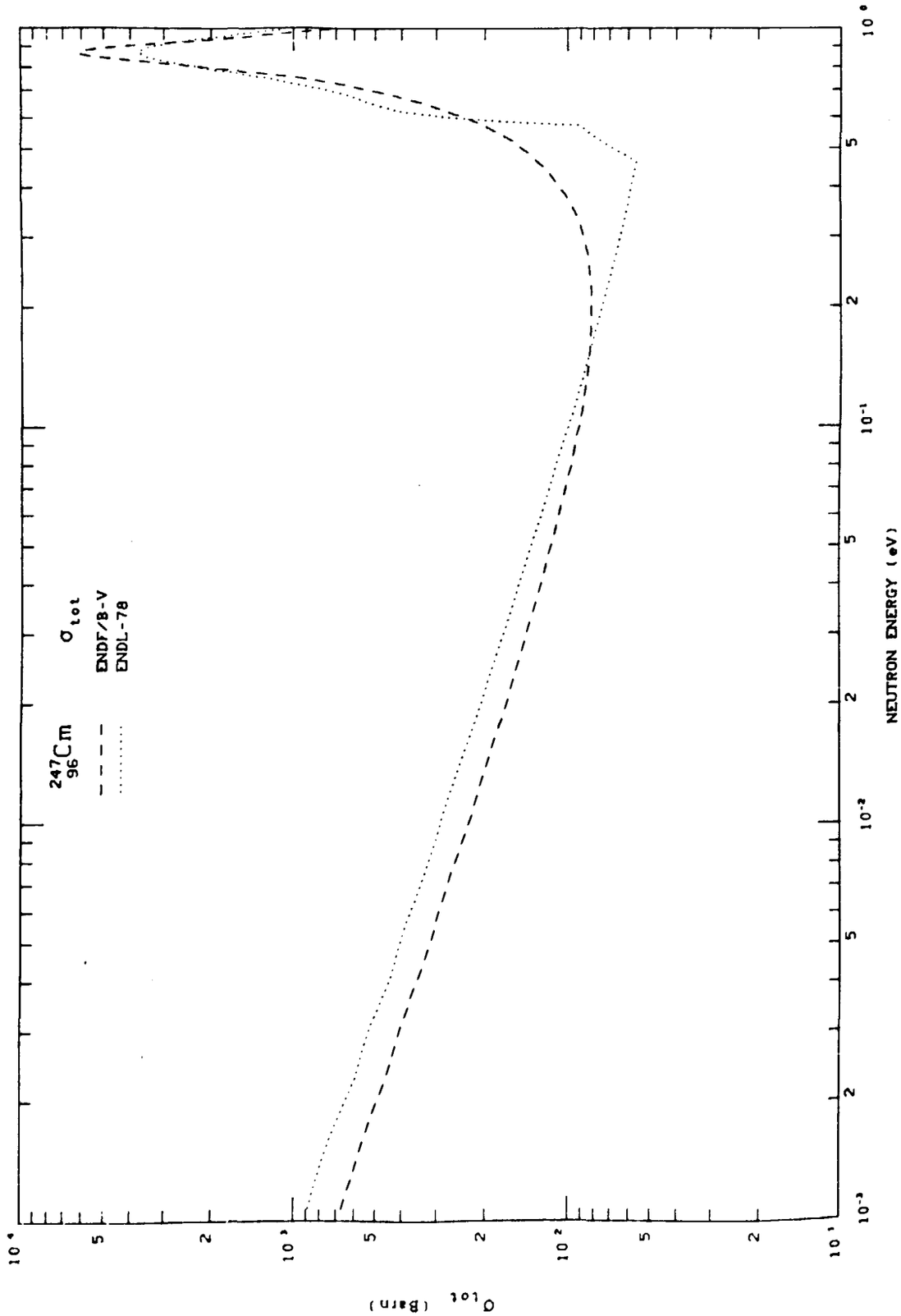
E_γ (keV)	Intensity per 100 α particles
402.4	72
278.0	3.4
287.5	2.0
346.0	$\sim$ 1.3

THERMAL CROSS SECTIONS

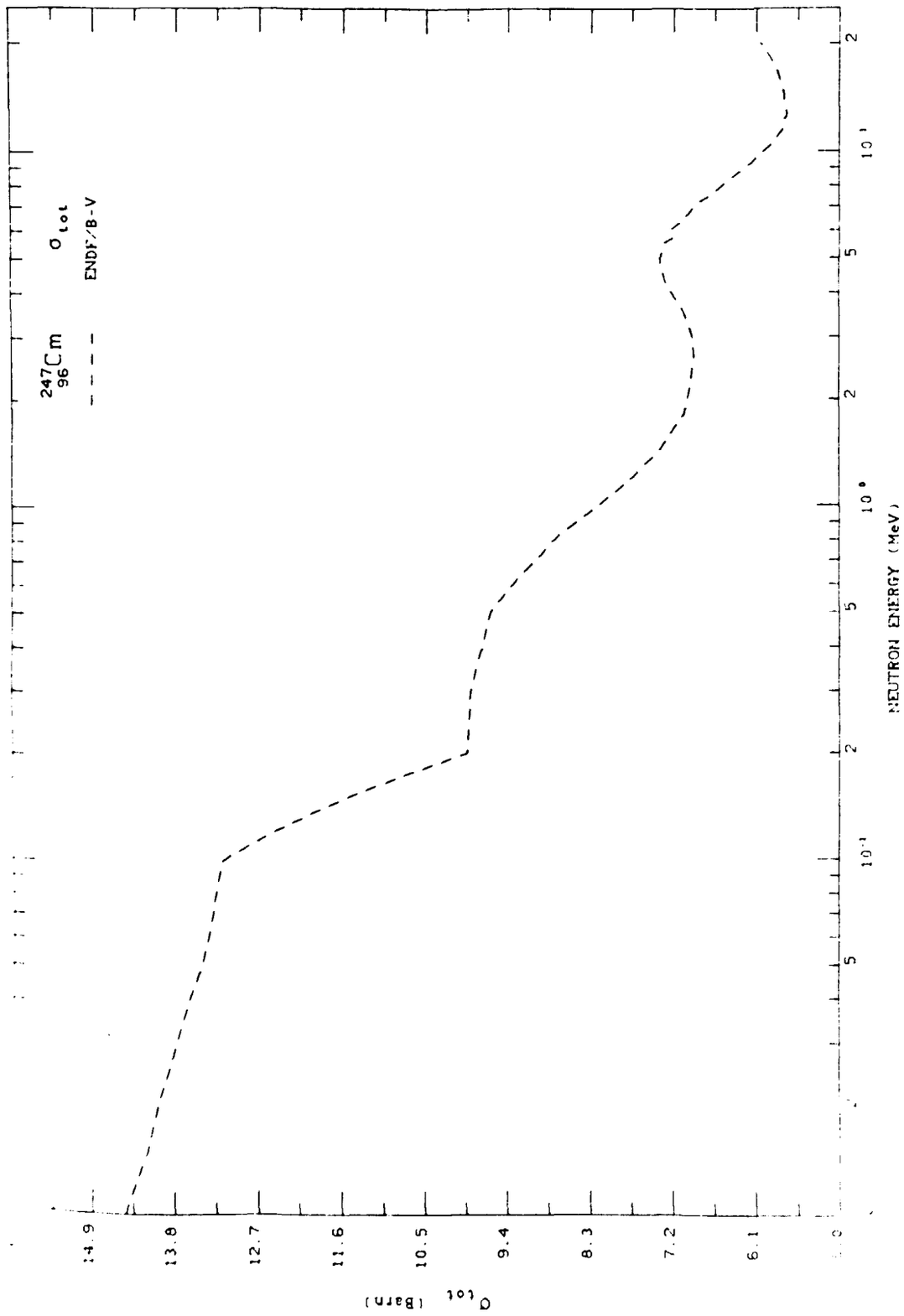
Reference	σ_γ barns	σ_f barns	σ_t barns	$\bar{\nu}_t$
ENDF/B - V	58.2	83.4	150.0	3.58
ENDL -78	90.1	82.5	184.0	
BNL 325 (1973)	60	90		
ORNL SRL,SMITH	48	409		

RESONANCE INTEGRALS

Reference	RI_γ barns	RI_f barns
ENDL -76	341.3	847.9
BNL 325 (1973)	800	880
ORNL SRL,BENJAMIN		778


$^{247}_{96}Cm$
σ_{tot}
ENDF/B-V
ENDL-78
NEUTRON ENERGY (eV)
σ_{tot} (barn)
10^{-3}
10^{-2}
10^{-1}
10^{0}
10^{1}
10^{2}
10^{3}
10^{4}
2
5

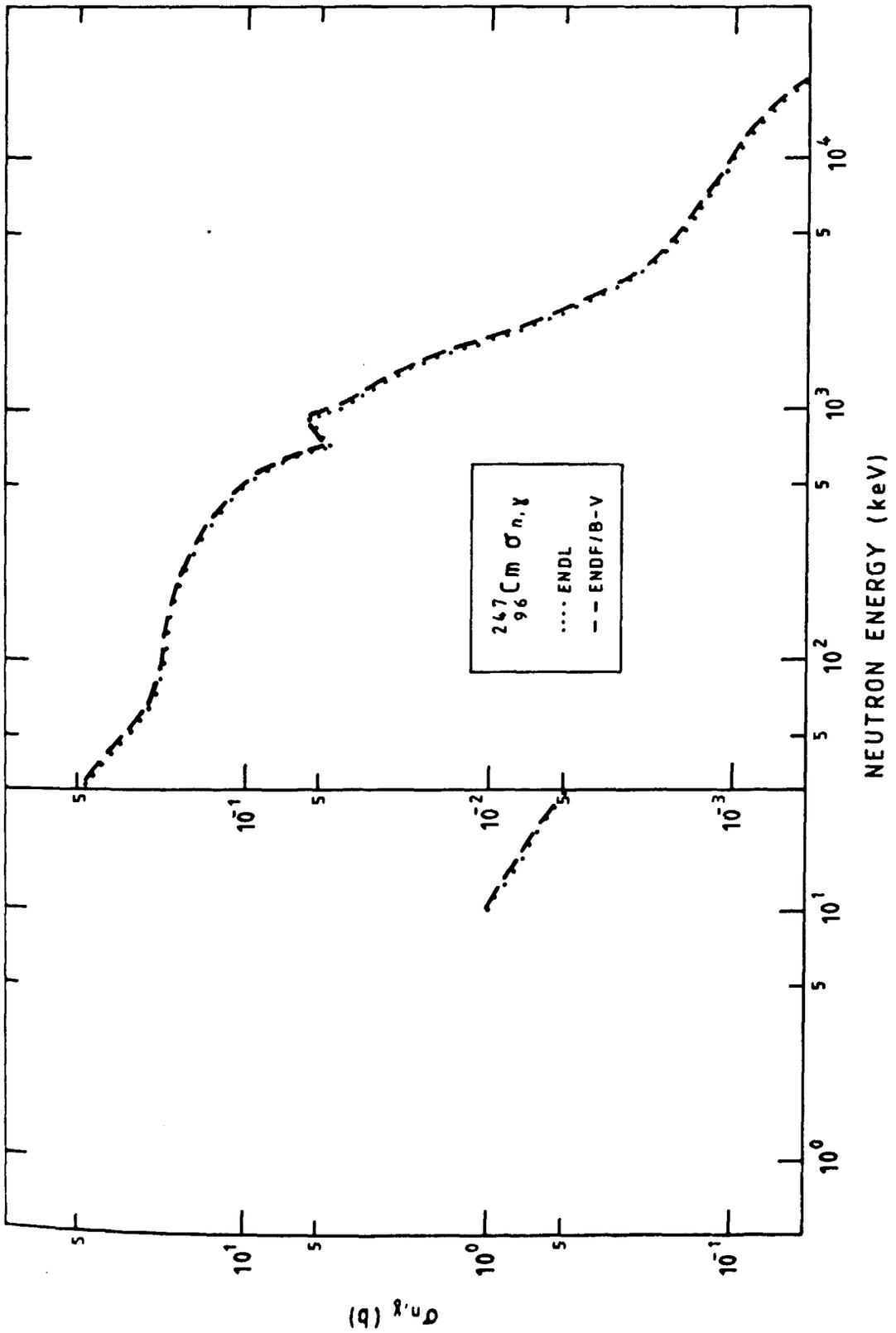
$^{247}_{96}Cm$

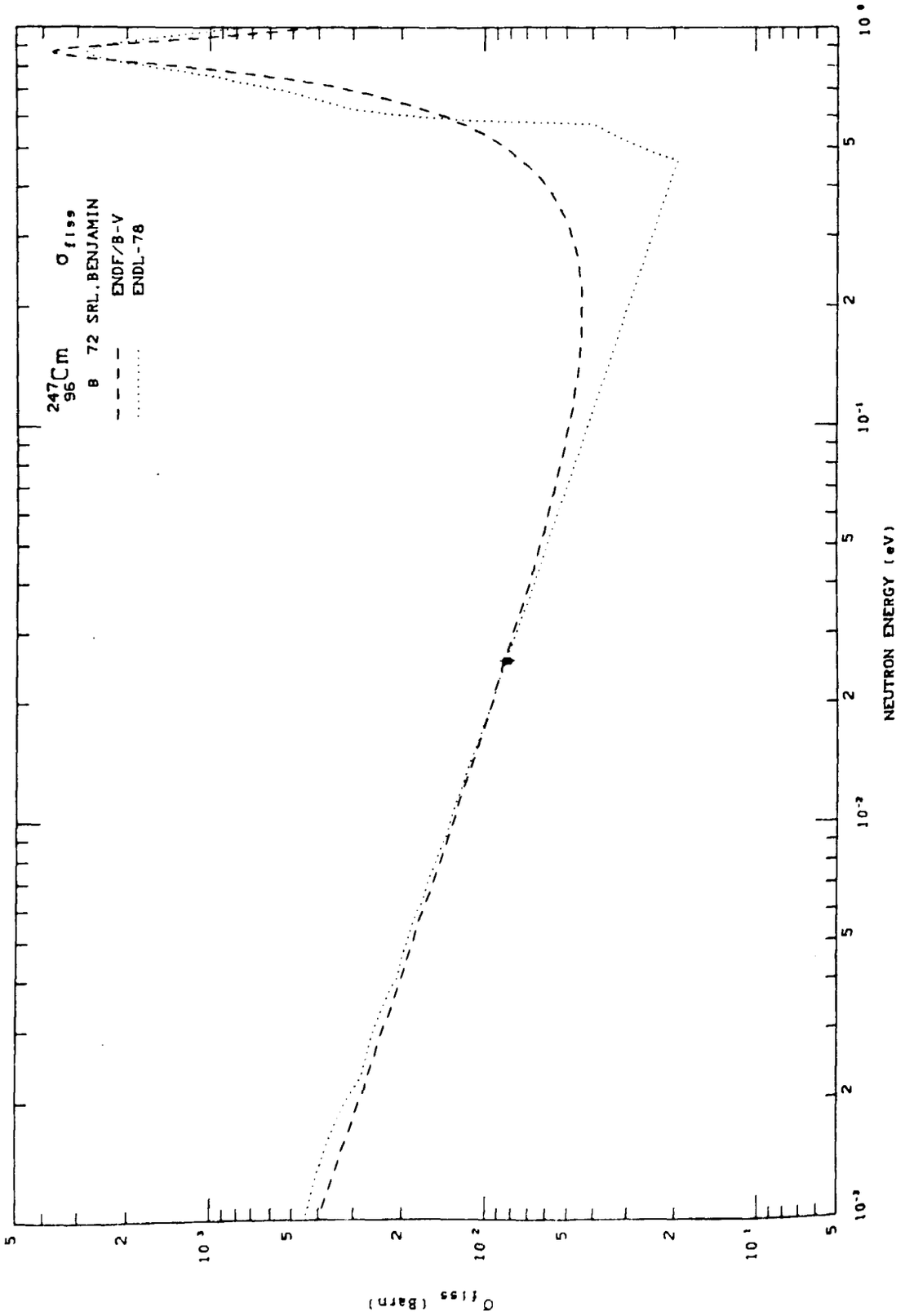

$^{247}_{96}Cm$
σ_{tot}
ENDF/B-V
14.9
13.8
12.7
11.6
10.5
9.4
8.3
7.2
6.1
σ_{tot} (Barn)
10^{-1}
10^{0}
10^{1}
NEUTRON ENERGY (MeV)

General comments: ^{247}Cm, σ_{tot}

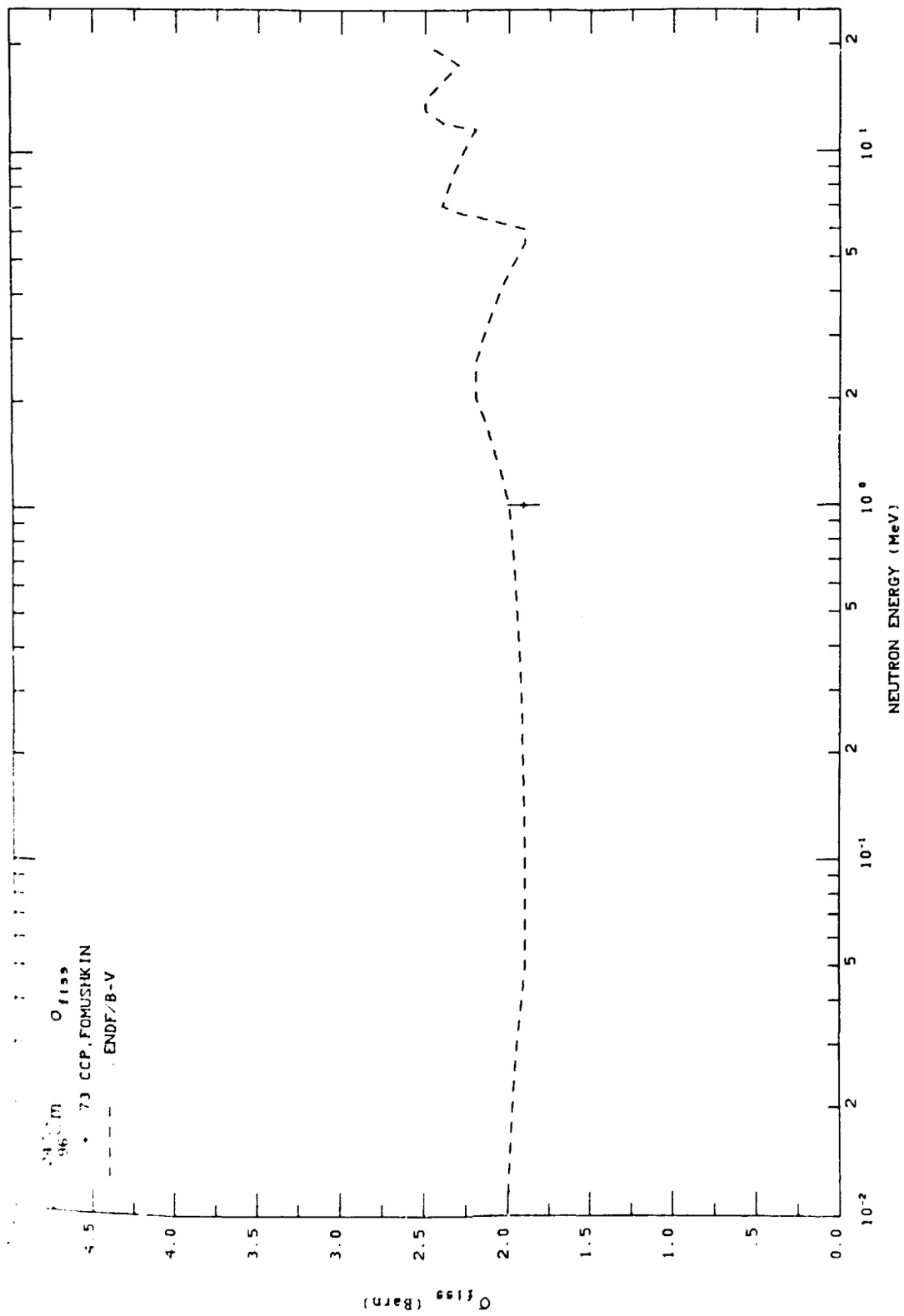
ENDL-78 = ENDF/B-V for energies between 0.01-20 MeV. ENDF/B-V total cross section evaluation in the thermal energy range has been calculated from resonance parameters using the computer code RESEND (NEA Nuclear Data Bank)

$^{247}_{96}Cm$


$^{247}_{96}Cm\ \sigma_{n,\gamma}$
.... ENDL
-- ENDF/B-V
NEUTRON ENERGY (keV)
$\sigma_{n,\gamma}$ (b)


$^{247}_{96}Cm$
B 72 SRL, BENJAMIN
ENDF/B-V
ENDL-78
σ_{fiss}
σ_{fiss} (barn)
NEUTRON ENERGY (eV)

$^{247}_{96}Cm$


$^{247}_{96}Cm$
σ_{fiss}
73 CCP, FOMUSHKIN
ENDF/B-V
σ_{fiss} (Barn)
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
.5
0.0
10^{-2}
10^{-1}
10^{0}
10^{1}
NEUTRON ENERGY (MeV)

Experimental information ^{247}Cm, σ_f

	Reference	Points	Range	Standard	Error	Comments
72	SRL, BENJAMIN	1	0.0253 eV	^{235}U, σ_f	6 %	
73	CCP, FOMUSHKIN	1	1 MeV	^{235}U, σ_f	5 %	

General comments: ENDL-78 = ENDF/B-V for energies between 0.01-20 MeV. ENDF/B-V fission cross section evaluation in the thermal energy range has been calculated from resonance parameters using the computer code RESEND (NEA Nuclear Data Bank)

3.16 ^{248}Cm

NUCLEAR PROPERTIES (Ref. Nuclear Data Sheets)

Spin and parity of ground state: 0^+

Ground state decay:

$T_{1/2} = 3.39 \times 10^5$ y

spontaneous fission: 8.26 %

$T_{1/2} = 4.1 \times 10^6$ y

α to ^{244}Pu, 91.74 %, $Q_\alpha = 5.161$ MeV

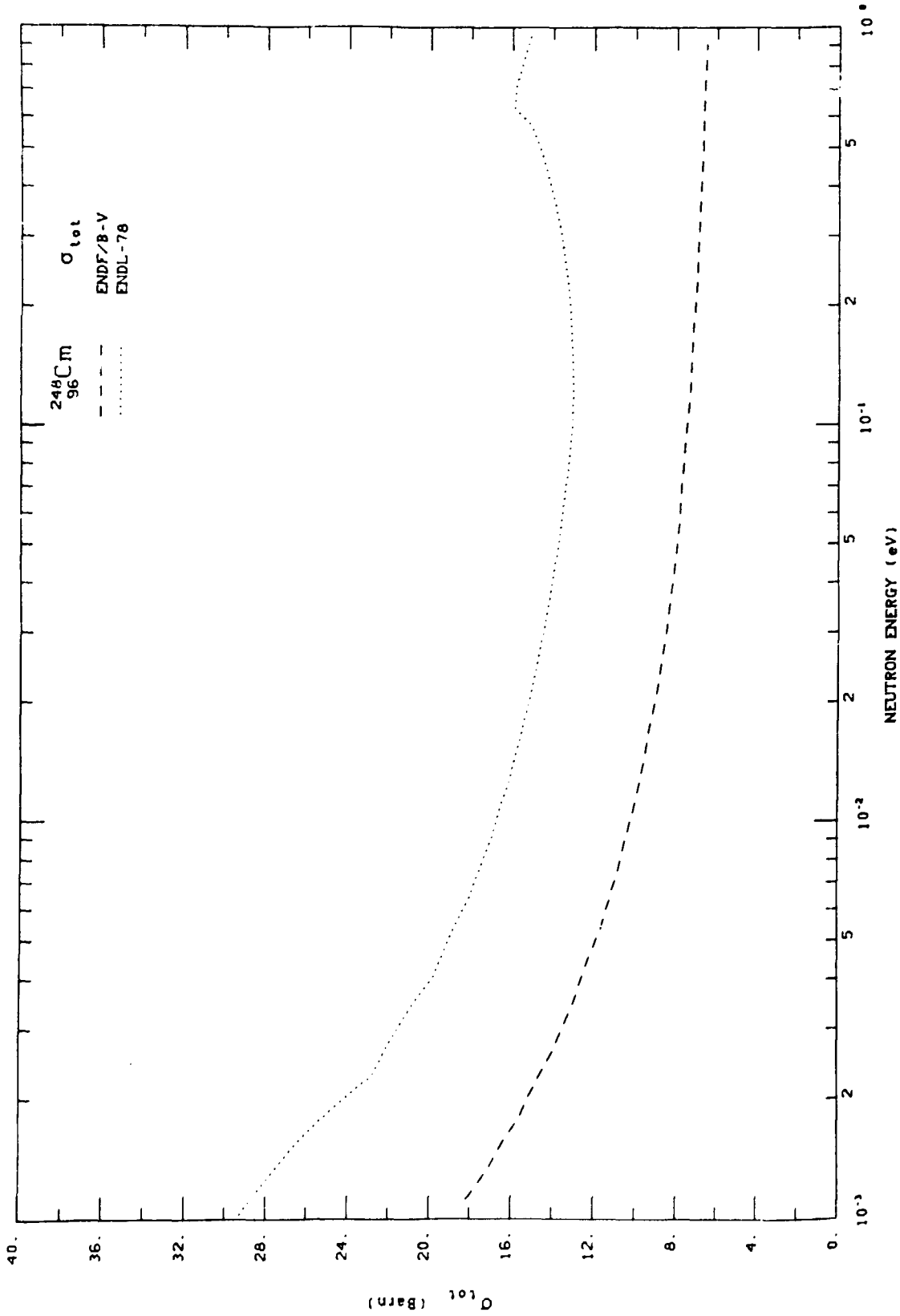
E_α (MeV)	I_α (%)
5.078	81.9
5.034	18.1

THERMAL CROSS SECTIONS

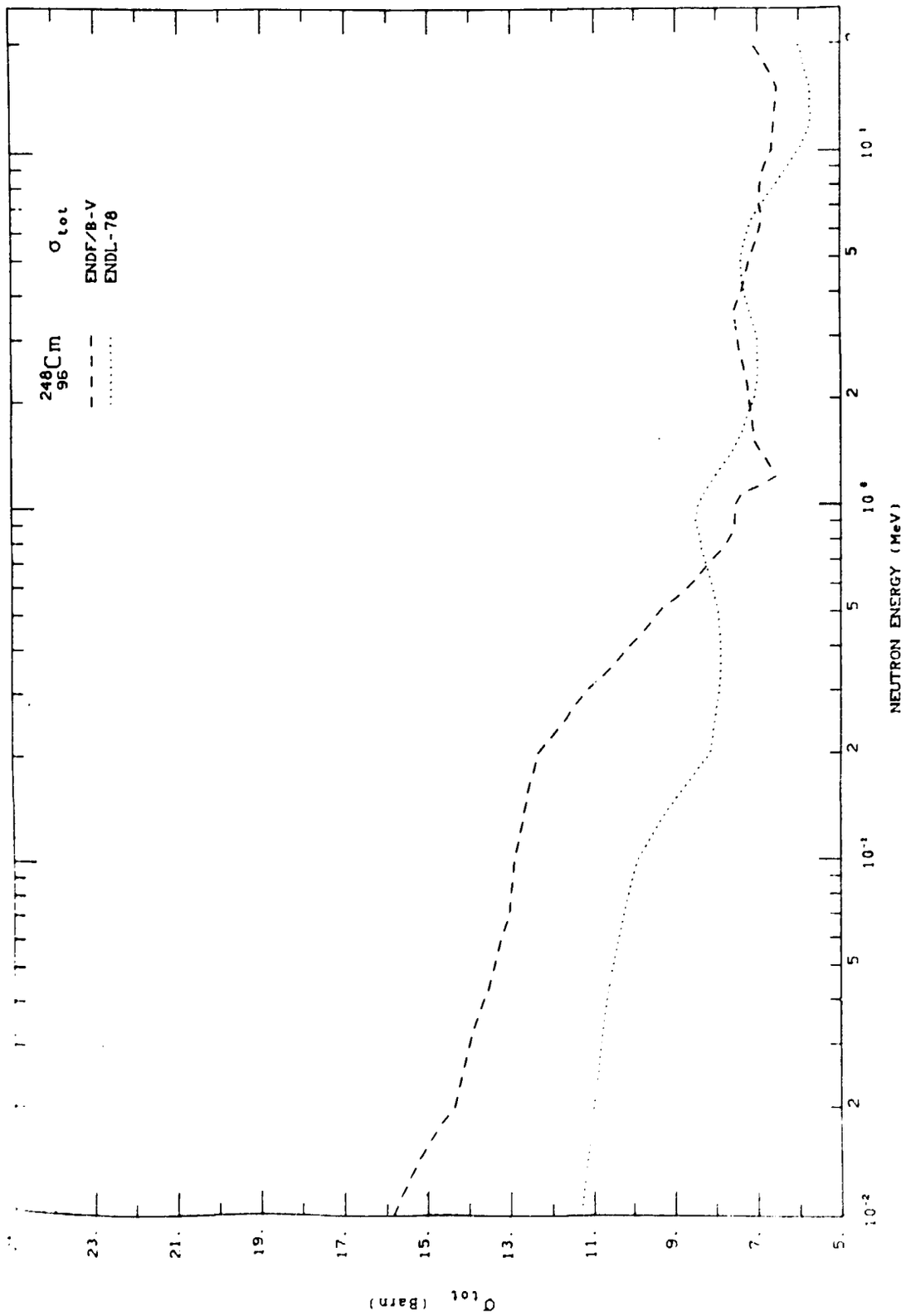
Reference	σ_γ barns	σ_f barns	σ_t barns
ENDL -78	2.7	0.34	14.7
BNL 325 (1973)	4	0.34	
73 SRL,SMITH	5.1		
72 SRL,BENJAMIN		0.34	

RESONANCE INTEGRALS

Reference	RI_γ barns	RI_f barns
ENDL -76	271.1	9.2
BNL 325 (1973)	275	13.2
SRL,BENJAMIN		13.2


$^{248}_{96}Cm$
σ_{tot}
ENDF/B-V
ENDL-78
40.
36.
32.
28.
24.
20.
16.
12.
8.
4.
0.
σ_{tot} (Barn)
10^{-3}
2
5
10^{-2}
2
5
10^{-1}
2
5
10^{0}
NEUTRON ENERGY (eV)

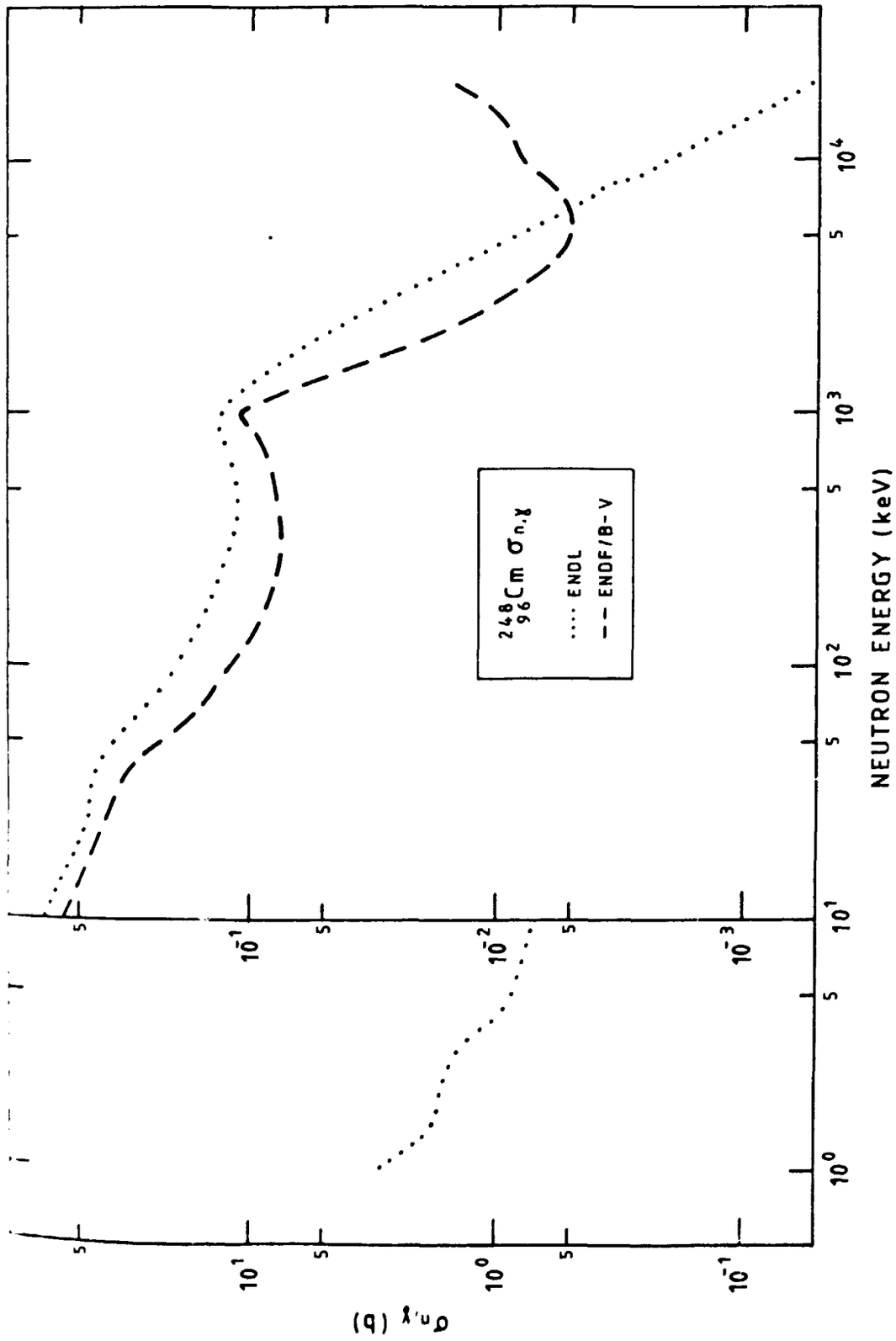
$^{248}_{96}Cm$

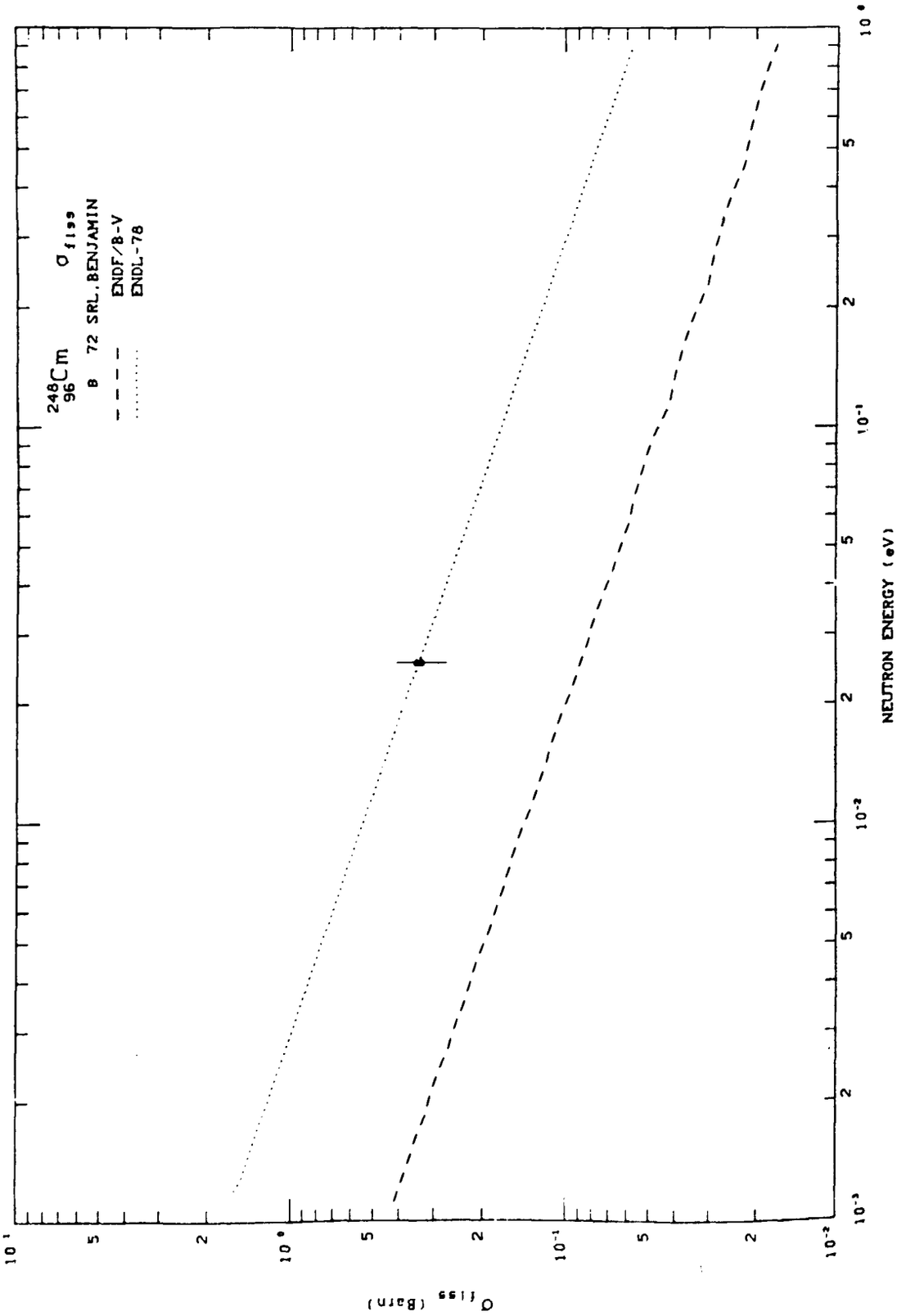

$^{248}_{96}Cm$
σ_{tot}
ENDF/B-V
ENDL-78
σ_{tot} (Barn)
23.
21.
19.
17.
15.
13.
11.
9.
7.
5.
10^{-2}
2
5
10^{-1}
2
5
10^{0}
2
5
10^{1}
NEUTRON ENERGY (MeV)

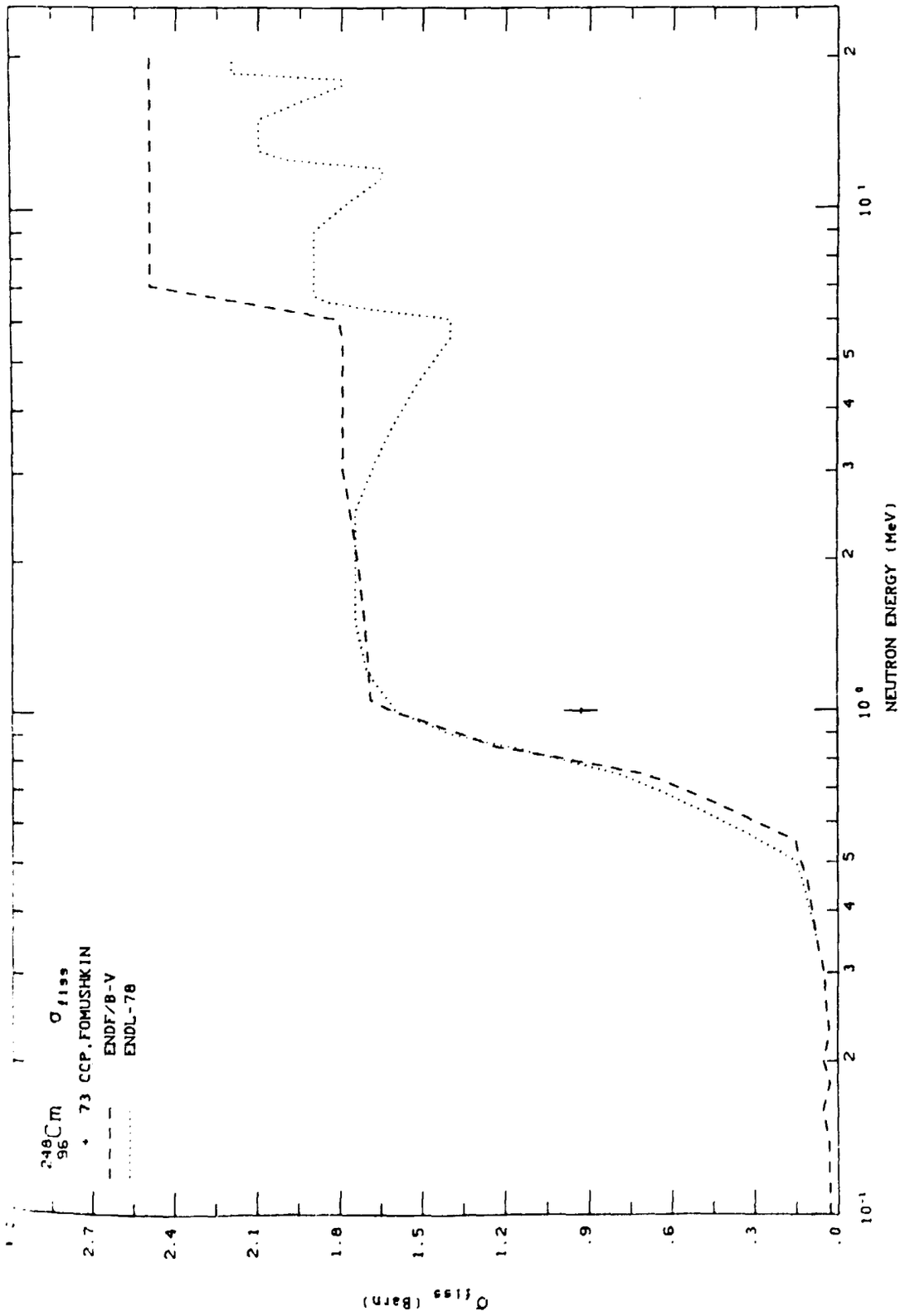
General comments: ^{248}Cm, σ_{tot}

ENDF/B-V total cross section evaluation in the thermal energy range has been calculated from resonance parameters using the computer code RESEND (NEA Nuclear Data Bank)

$^{248}_{96}Cm$


$^{248}_{96}Cm$ $\sigma_{n,\gamma}$
.... ENDL
-- ENDF/B-V
NEUTRON ENERGY (keV)
$\sigma_{n,\gamma}$ (b)


$^{248}_{96}Cm$
B 72 SRL.BENJAMIN
σ_{fiss}
ENDF/B-V
ENDL-78
NEUTRON ENERGY (eV)
σ_{fiss} (Barn)


$^{248}_{96}Cm$
+ 73 CCP,FOMUSHKIN
σ_{fiss}
ENDF/B-V
ENDL-78
2.7
2.4
2.1
1.8
1.5
1.2
.9
.6
.3
.0
σ_{fiss} (barn)
10^{-1}
2
3
4
5
10^{0}
2
3
4
5
10^{1}
2
NEUTRON ENERGY (MeV)

Experimental information ^{248}Cm, σ_f

	Reference	Points	Range	Standard	Error	Comments
72	SRL, BENJAMIN	1	0.0253 eV	^{235}U, σ_f	21 %	
73	CCP, FOMUSHKIN	1	1 MeV	^{235}U, σ_f	6.5 %	

General comments: ENDF/B-V fission cross section evaluation in the thermal energy range has been calculated from resonance parameters using the computer code RESEND (NEA Nuclear Data Bank)

4. REFERENCES

51A COL, HAVENS — Havens Jr. W.W., Report AECD-3288 (1951) Data obtained from NEA Data Bank. (EXFOR 12247.002).

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5. Members of the Swedish Actinide Neutron Data Working Group and Addresses for Inquiries

Nuclei	Data	Compiler
^{232}Th, ^{233}U, ^{235}U, ^{238}U ^{237}Np, ^{239}Pu, ^{240}Pu, ^{241}Pu ^{242}Pu, ^{244}Cm, ^{245}Cm, ^{246}Cm ^{247}Cm, ^{248}Cm	σ_{tot}	H Condé National Defence Research Institute, Fack S-104 50 STOCKHOLM
-"-	σ_{fiss}	C Nordborg* Tandem Accelerator Laboratory Box 533, S-751 21 UPPSALA
-"-	σ_{γ}	P Andersson Lund Institute of Technology Dept of Nuclear Physics Box 725, S-220 07 LUND
-"- and ^{241}Am, ^{243}Am	RI, σ^{2200}	H Häggblom Studsvik Energiteknik AB S-611 82 NYKÖPING
^{241}Am, ^{243}Am	σ_{tot}, σ_{fiss}, σ_{γ}	J-E Christiansson University of Göteborg Dept of Physics S-412 96 GÖTEBORG and H Sandberg Chalmers University of Technology Dept of Reactor Physics S-412 96 GÖTEBORG
^{235}U, ^{238}U, ^{239}Pu ^{238}U ^{239}U	$\sigma_{n,n}$ $\sigma_{n,n'}$ $\sigma_{n,2n}$	B Trostell The Studsvik Science Research Laboratory S-611 82 NYKÖPING
^{232}Th, ^{233}U, ^{235}U ^{238}U, ^{239}Pu	$\bar{\nu}_p$, $\bar{\nu}_d$	H Condé (address see above)

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