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NOWADAYS ISSUES OF 238U DATA EVALUATION

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ABSTRACT

The comparison of neutron spectra data of ENDF/B-6, JENDL-3, BROND-2 and recent experimental results have revealed essential disagreement between experimental and evaluated data. The reevaluation of the ^{238}U data file is needed very much.

BACKGROUND

The secondary neutron spectra of ^{238}U (inelastic scattering, fission and so on) were investigated in energy range from ~1MeV to ~14Mev with time of flight facilities of IPPE.

- E_0~ 2.5, 6, 7, 8, 9, 14 MeV. The energy-angular distributions of secondary neutron (sample experiment) were measured with EGP-10 tandem and neutron generator TOF spectrometers [1,2,3,4],
- E_0~ 6, 7, 8, 9, 14 MeV. The fission neutron spectra (fission chamber experiment) were investigated with the same facilities [3,5,6]
- E_0= 1.17, 1.79, 2.19 MeV. The inelastic scattering neutron spectra were measured with EG-1 TOF spectrometer. The T-solid target. [7,8],
- E_0~0.2-0.6 MeV. The first level inelastic scattering cross section. EG-1 TOF spectrometer, Li-metal target. The data are in progress.

1. ENERGY RANGE 1-2 MEV

The total inelastic cross sections of ^{238}U measured in IPPE are in reasonable agreement with Smith A.B. 1982 and Baba 1990 data. The data of this works put between ENDF/B-6 and BROND-2 evaluated data. (Fig. 1). But it is necessary have in mind the correlation of experimental data in Fig. 1 and ENDF/B-6. The ENDF/B-6 cross section of the first level was added to experimental data to calculate the total inelastic cross section. A dramatic disagreement reveals for neutron inelastic scattering spectra. The ENDF/B-6 and JENDL-3 overestimate the cross section for levels $0.55<E<0.85$ MeV and

0.85<Q<1.32 MeV to factor 2-3 (Fig.2). The JENDL-3 do not reproduce the transition from discrete levels to continuum. Fig.3 display the cross section of two groups levels versus incident neutron energy. The IPPE (Kor91, Kor77), Baba 90 and Shao 86 data agree very well and lies below of the ENDF/B-6 cross section.

2. HIGH ENERGY RANGE (Eo>Q2n)

The inelastic scattering neutron can not carry off the energy less than Eo-Q2n. In other case the residual nuclei has enough energy to emit the second neutron. So in this energy range the inelastic neutron spectrum has to have "table like" shape with low boundary (Eo-Q2n) (see fig.4). At the same time all files use Maxwell distribution with average energy ~1MeV to calculate inelastic continuum spectra (Fig.4).

The data file use the Watt distribution to predict fission neutron spectra. This approach is valid in energy range Eo<Q(n,nxf). At higher energy due to pre-fission emission a surplus of low energy neutrons appears. The shape of the spectrum and absolute yield of this neutrons may be calculated by statistical and pre-equilibrium models. This peculiarity have to be included in new file.

3. THE FIRST LEVEL CROSS SECTION

The main problems of this experiment are:

- non-stability and non-uniformity of the Li-metal target,
- multi-scattering correction which change not only the absolute cross-section but the shape of the neutron peaks. The way of experimental data evaluation was developed in IPPE. It includes:
- modeling of the Li-target profile and checking by monitor neutron spectra, direct target spectra, elastic scattering spectra.
- The Monte-Carlo simulation of the experiment from the target to the neutron detector with all angular, energy and time spreads of TOF spectrometer.

The experimental and MC simulation results are shown in Fig.5. The data was taken from ENDF/B-6 file. To find the level cross section a set of calculations with σ1=cor*σB-6 (cor=0.6-1.2) were done. The changing of σ1 cross section was compensated by elastic or total cross section (labels (el) or (tot) in Fig.5). The χ^2 values versus

correction values are displayed in Fig.6. Now we submit only preliminary result. The experimental data at incident energies ~0.25,0.32, 0.42,0.5, 0.6 MeV with more stable and uniform Li-target are in progress . The preliminary results put into interval (0.8-1) of ENDF/B-6 cross section. We hope to reach ~8% errors of the first level inelastic cross section.

REFERENCE

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2. Kornilov N.V., Baryba V.Ja. Salnikov O.A. Proceed. of 5 All-Union Conf. Kiev 1980. v1,p44
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6. Kornilov N.V., Baryba V.Ja. Salnikov O.A. Proceed. of 5 All-Union Conf. Kiev 1980. v3, p40.
7. Kornilov N.V.,Kagalenko A.B. et all, preprint FEI-2226,1991. will be published as IAEA report.
8. Kornilov N.V. et all was submited to Julich 1990 Conference. Was not included into proceeding.

FIGURE CAPTIONS

Fig.1 The total inelastic cross section. The solid and dashed lines are ENDF/B-6 and BROND-2 evaluations.

Fig.2 The experimental spectra (circles connected with solid line and multi group spectra calculated with different data files as functions of excitation energy.

Fig.3 The excitation functions of levels with $0.55<Q<0.65$ MeV and $0.85<Q<1.32$ MeV

Fig.4 The inelastic continuum spectra. The dot-dashed line show qualitatively the real distribution.

Fig.5 The experimental and MC simulations TOF spectra of elasti and inelastic scattered neutrons. The time channel width is 0.989ns. The flight path is 200.5 cm. The vertical bars show the region of xi^2 calculation.

Fig.6 The xi^2 values as function of cross section corrections. The dashed line shows the 68% confidence interval.

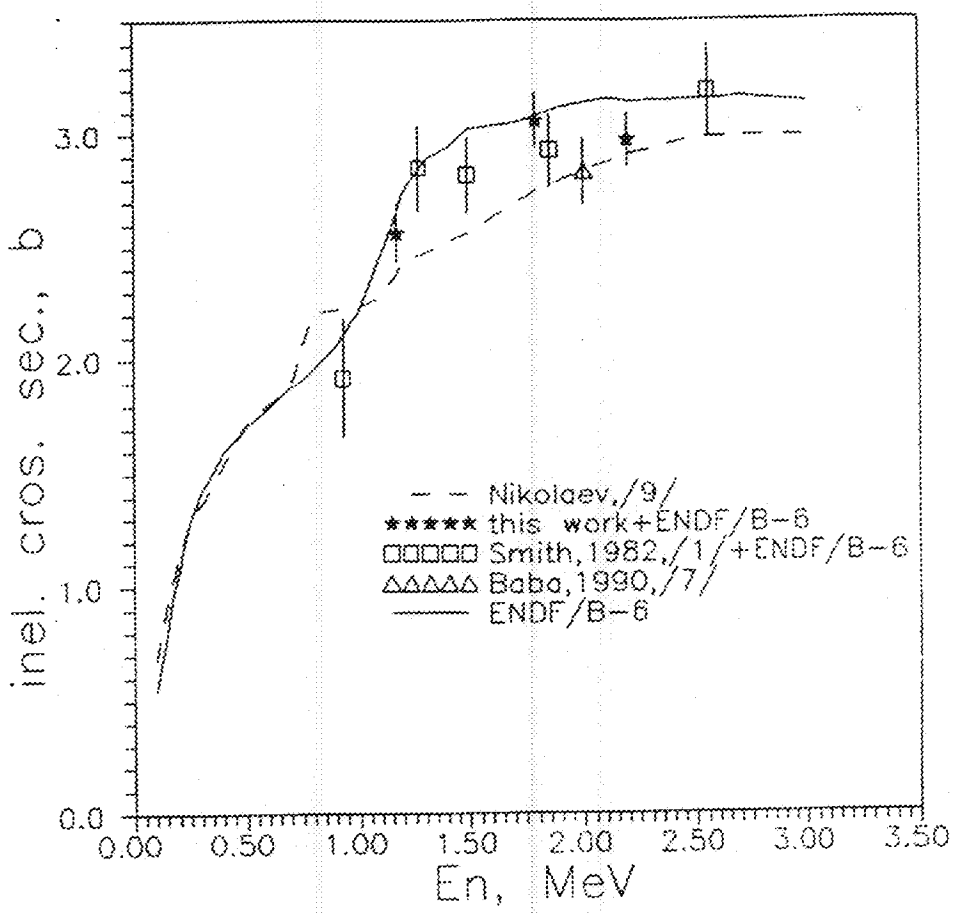
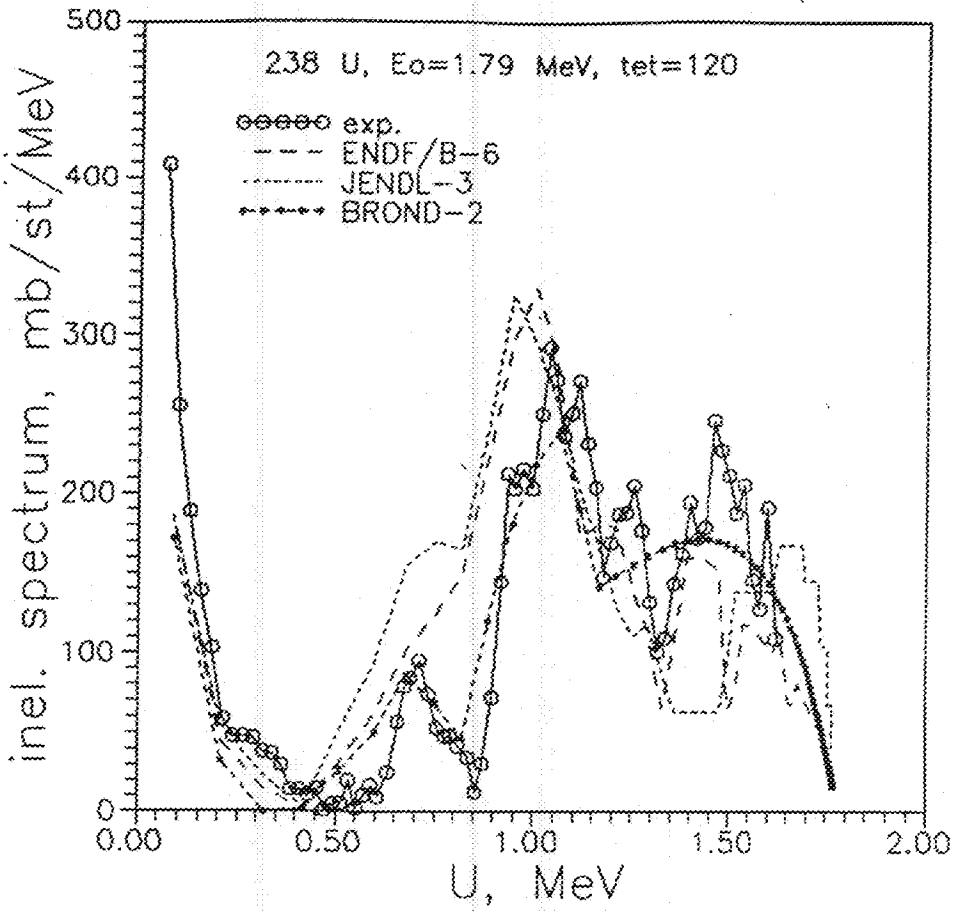

inel. cros. sec., b
3.0
2.0
1.0
0.0
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
En, MeV
– – Nikolaev,/9/
***** this work+ENDF/B-6
□□□□□ Smith,1982,/1/+ENDF/B-6
ΔΔΔΔΔ Baba,1990,/7/
—— ENDF/B-6

Fig 1


238 U, Eo=1.79 MeV, tet=120
exp.
ENDF/B-6
JENDL-3
BROND-2
inel. spectrum, mb/st/MeV
U, MeV
0
100
200
300
400
500
0.00
0.50
1.00
1.50
2.00

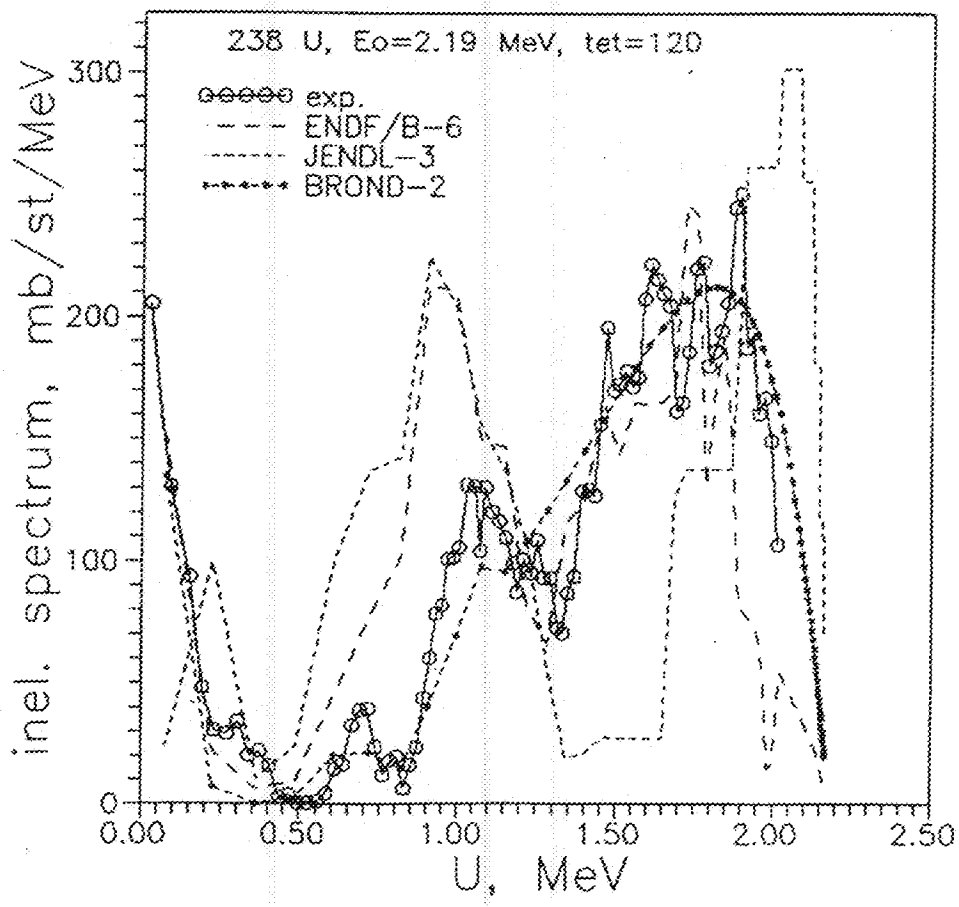
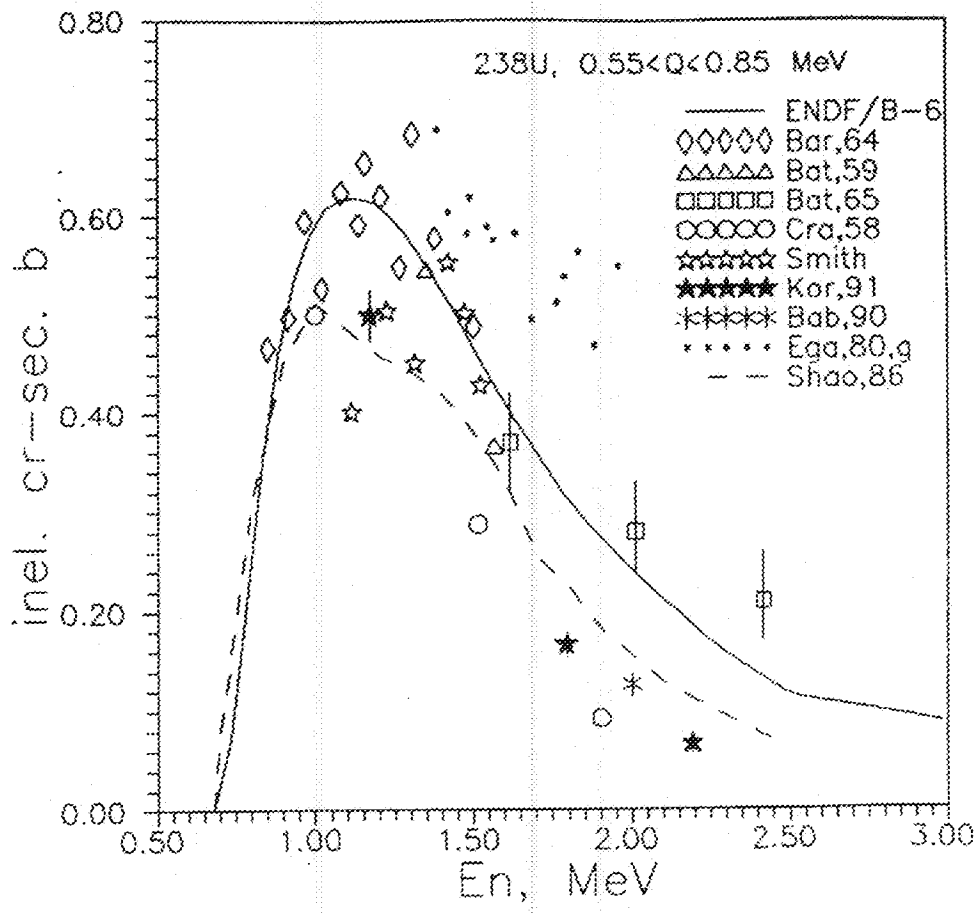

238 U, Eo=2.19 MeV, tet=120
exp.
ENDF/B-6
JENDL-3
BROND-2
inel. spectrum, mb/st/MeV
U, MeV
0
100
200
300
0.00
0.50
1.00
1.50
2.00
2.50

Fig 2.


238U, 0.55<Q<0.85 MeV
ENDF/B-6
Bar,64
Bat,59
Bat,65
Cra,58
Smith
Kor,91
Bab,90
Ega,80,g
Shao,86
inel. cr-sec. b
0.80
0.60
0.40
0.20
0.00
0.50
1.00
1.50
2.00
2.50
3.00
En, MeV

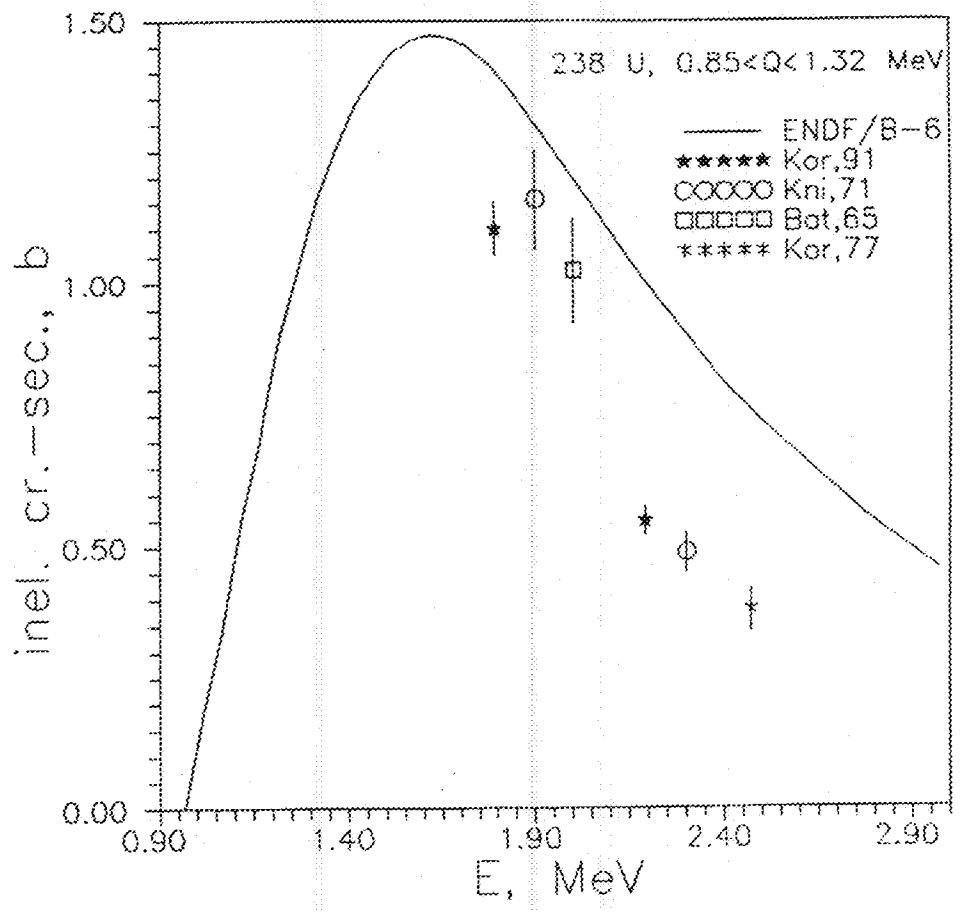

238 U, 0.85<Q<1.32 MeV
ENDF/B-6
Kor,91
Kni,71
Bat,65
Kor,77
inel. cr.-sec., b
1.50
1.00
0.50
0.00
0.90
1.40
1.90
2.40
2.90
E, MeV

Fig 3.

(n,n'). continuum, $E_0 = 10$ MeV

REACTION CROSS SECTIONS

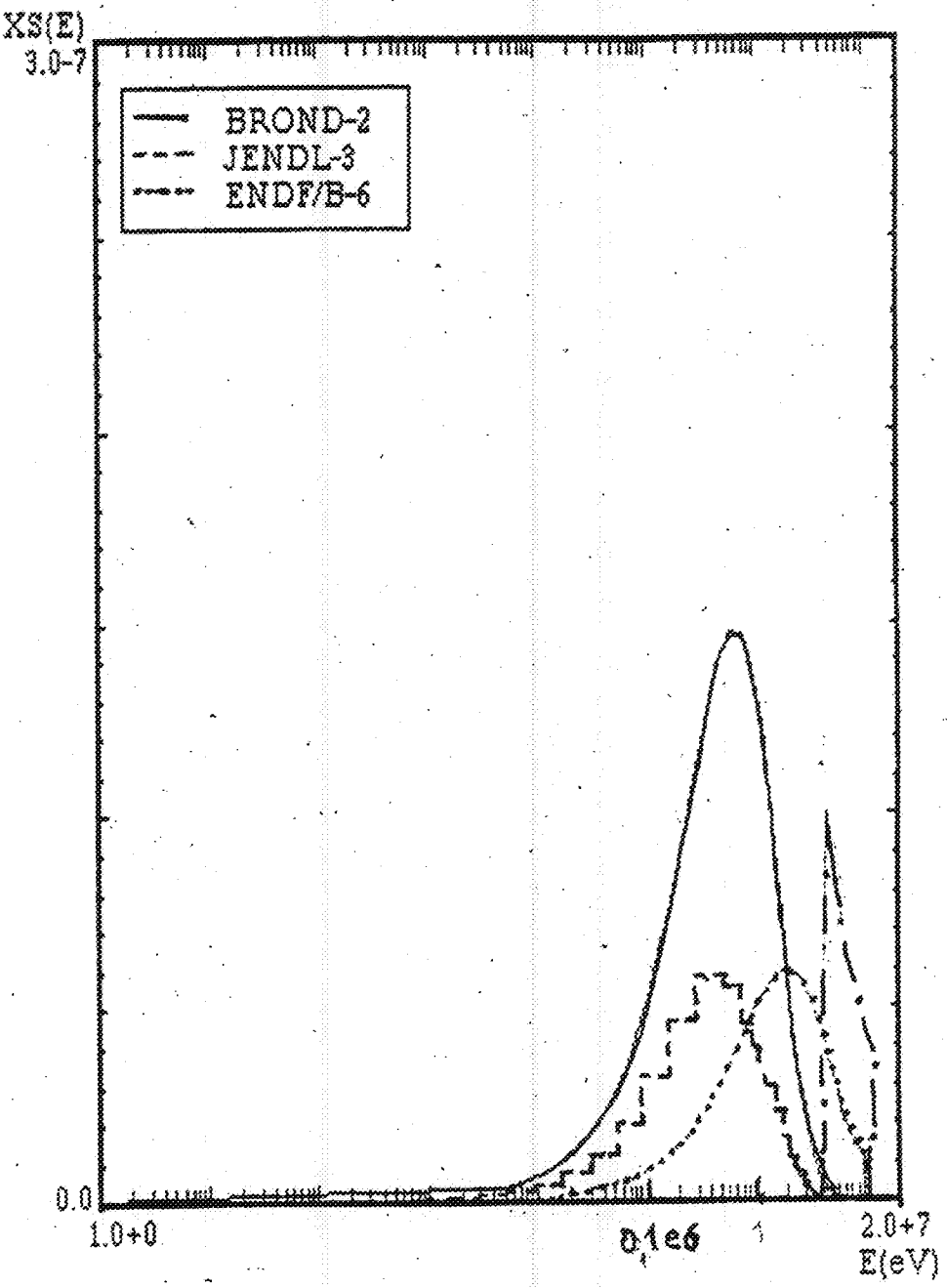


Fig. 4.

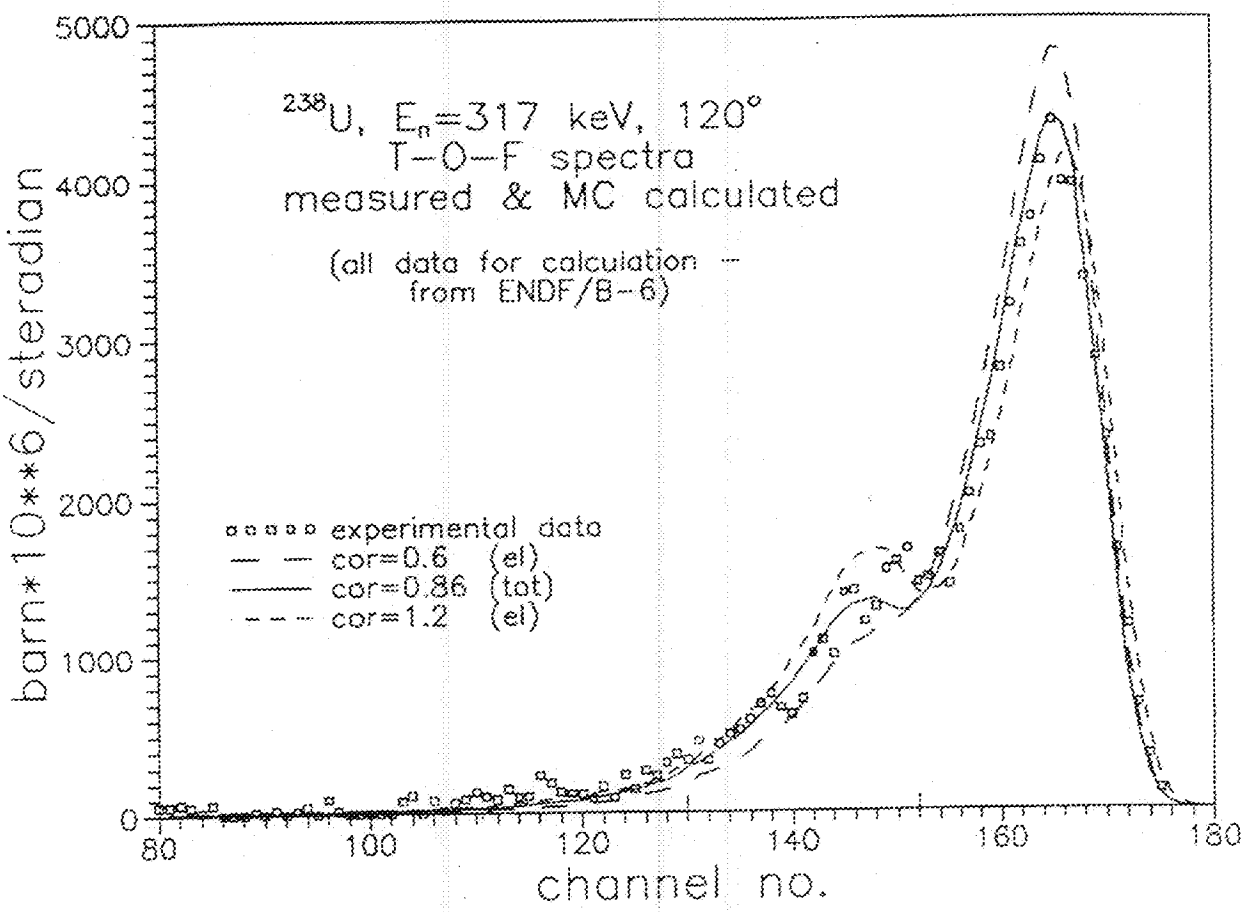

^{238}U, E_n=317 keV, 120°
T-O-F spectra
measured & MC calculated
(all data for calculation -
from ENDF/B-6)
experimental data
cor=0.6 (el)
cor=0.86 (tot)
cor=1.2 (el)
barn*10**6/steradian
channel no.
0
1000
2000
3000
4000
5000
80
100
120
140
160
180

Fig 5.

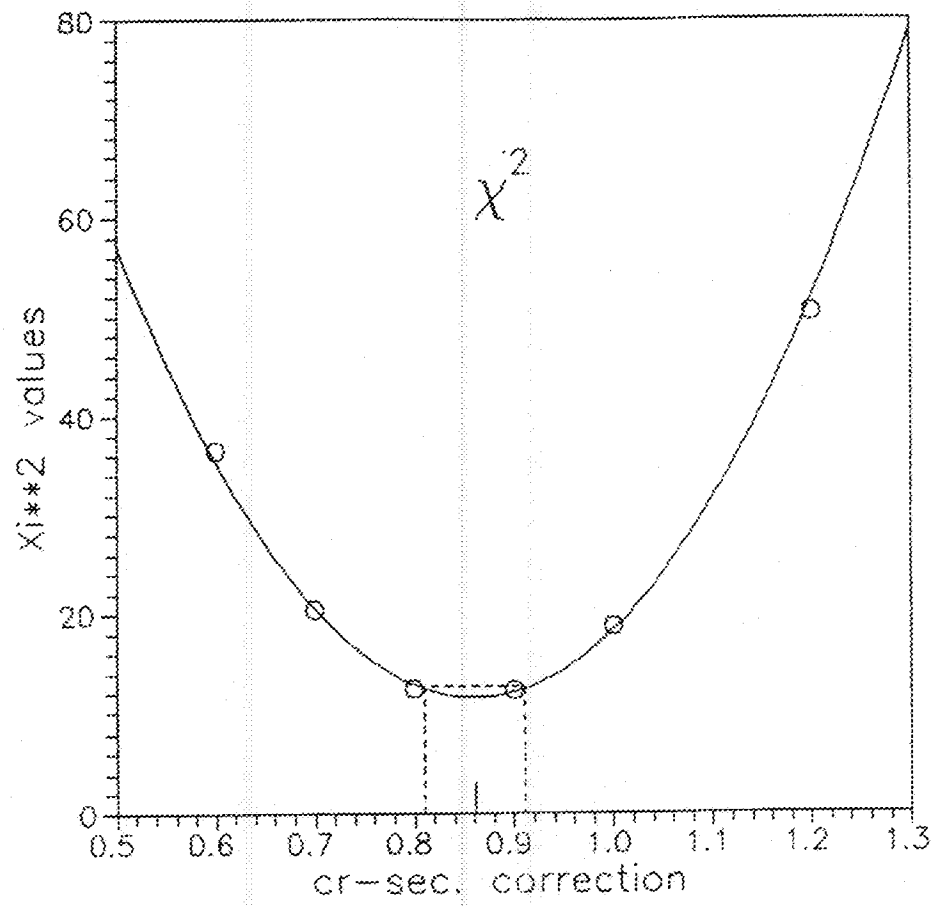

80
60
40
20
0
Xi**2 values
χ^2
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
cr-sec. correction

Fig. 6.