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PRESENT AND FUTURE ACTIVITIES ON NUCLEAR DATA IN JAERI AND SOME OTHER ORGANIZATIONS OF JAPAN

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Compiled by Shigeya TANAKA

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Present and Future Activities on Nuclear Data in JAERI and Some Other Organizations

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This is a compilation of progress reports and some future plans on nuclear data activities in Japan, and was prepared as a material for an oral presentation by the INDC Member, Dr. Harada in an agenda of the 11th Meeting of International Nuclear Data Committee(INDC) held at Vienna on 16-20 June, 1980. In this compilation, some developments of nuclear data works since June, 1989 and a few future plans are contained. This was not intended to cover all nuclear data activities in Japan, because wider activities are to be collected soon in Progress Report, 1980.

JAERI−memo 8960

原研および他の機関における核データの現在および将来の活動

東海研究所物理部核データセンター
田 中 茂 也（編）

（1980年6月受理）

これは日本における核データ活動の進展といくつかの将来計画を集め，1980年国際核データ委員会第11回会合（5／16〜20，ウィーン）の一議題中で原田委員が日本の活動を報告するための資料として作成したものである。この中には1979年7月以降の進展と，二三の今後の研究予定が含まれている。この資料作成に当っては，近く1980年プログレスレポートを作成することになっているので，凡ての日本における活動を網羅することは行わなかった。

Contents

JAERI

The Present Status of JENDL-2

JAERI/Nuclear Data Center & JNDC

Since the first version of Japanese Evaluated Nuclear Data Library (JENDL-1) was released in autumn 1977, various information has been reported on the merits and demerits of JENDL-1 through its use. Compilation work for JENDL-2 was started at the beginning of 1978 fiscal year. Taking the above mentioned information into consideration, the JENDL compilation group asked re-evaluation to the evaluators who took charge of the evaluations for Cr, Fe, Ni ^{235}U, ^{238}U, ^{239}Pu, ^{240}Pu and ^{241}Pu.

JENDL-2 includes the nuclear data for thermal reactors, shielding problems, fusion researches, fuel-cycle problems, safety analyses, etc. as well as for fast-breeding reactors. Therefore, many nuclides were newly added to those in JENDL-1, and the energy range covered was extended up to 20 MeV. The nuclides to be stored in JENDL-2 are the following:

H	$\underline{^{4}\mathrm{He}}$	$\underline{^{6,7}\mathrm{Li}}$	$\underline{^{9}\mathrm{Be}}$	$^{10,11}\mathrm{B}$	$^{12}\mathrm{C}$	$^{16}\mathrm{O}$	
$\underline{^{19}\mathrm{F}}$	$^{23}\mathrm{Na}$	$^{27}\mathrm{Al}$	$\underline{\mathrm{Si}}$	$\underline{\mathrm{Ca}}$	$\underline{\mathrm{Ti}}$	$\underline{\mathrm{V}}$	
$\underline{\mathrm{Cr}}$	Mn	$\underline{\mathrm{Fe}}$	$\underline{^{59}\mathrm{Co}}$	$\underline{\mathrm{Ni}}$	$\underline{\mathrm{Cu}}$		[67 FP Nuclides]
Zr	Nb	Mo	Eu	$\underline{\mathrm{Gd}}$	$^{197}\mathrm{Au}$	Pb	

$^{228,230,\underline{232}-234}\mathrm{Th}$ $\quad$ $^{231,\underline{233},234}\mathrm{Pa}$ $\quad$ $\underline{^{233-236,238}\mathrm{U}}$

$^{\underline{237},239}\mathrm{Np}$ $\quad$ $\underline{^{236,238-242}\mathrm{Pu}}$ $\quad$ $^{241,\underline{242},\underline{242m},\underline{243}}\mathrm{Am}$

$^{\underline{242}-245}\mathrm{Cm}$

Here, the elemental symbol without mass number means that it includes natural element and natural isotopes. The underline shows that evaluation has been completed or almost finished.

In the evaluation for JENDL-2, the NDES code, which makes use of an interactive CRT display, has been conveniently, hence frequently, used. With this code. one can make comparison of the Breit-Wigner calculation with experimental data, parameter search of the optical potential, corrections of stored data, additions of new data to the stored data, etc., while watching the graphic display on the CRT. Therefore, characteristic features of the JENDL-2 evaluation are itemized as follows:

(1) Resonance parameters were obtained so that the results calculated with the Breit-Wigner multilevel formula were well fitted to experimental cross sections.

(2) The evaluated total cross sections in the fluctuation region were given by following experimental data. In the case of the medium-weight nuclides, this was performed up to several MeV.

(3) The total, elastic, inelastic and (n,γ) cross sections for the medium-weight nuclides above several MeV were mainly evaluated based on the optical and statistical models. The optical-model parameters used in the calculations were obtained by means of "SPRT" fit, and the level-density parameters were newly determined by smoothly connecting a constant temperature plot and a Fermi-gas model plot.

(4) The fission cross sections of ^{233}U, ^{236}U, ^{238}U, ^{239}Pu, ^{240}Pu, ^{241}Pu and ^{242}Pu were evaluated so that the consistency was kept between the absolute data and the ratio data to the ^{235}U fission cross section. On the other hand, the latter was re-evaluated on the basis of the resent experimental data published since 1975.

At the first step of the JENDL-2 compilation, the highest priority was put to evaluation of most important nuclides for fast reactors: ^{235}U, ^{238}U, ^{239}Pu, ^{240}Pu, ^{241}Pu, Cr, Fe and Ni. Benchmark tests were made on a combined set of these evaluated data and the JENDL-1 data for the other nuclides than these 8 nuclides. This combined library is called JENDL-2B. Satisfactory results were obtained in the tests.
(As for the tests and the results, see the paper of Kikuchi et al. which is to be submitted to J. Nucl. Sci. Tech.)

JAERI

JENDL-3 Plan (Draft)

JAERI/NDS & JNDC

Nuclear Data Center of JAERI and JNDC (Japanese Nuclear Data Committee) have been prepared Japanese evaluated nuclear data libraries, JENDL-1 and JENDL-2 to be mainly used for fast reactor development and the latter aimed at also partial fulfilment of the requests from fusion-reactor development. However, in order to fulfil the requests from the wider field of nuclear energy development, such as shielding of fast reactors, anihilation of trans-plutonium nuclides, fusion-reactor development, etc., these libraries do not always contain enough data. It is necessary to improve the quality of nuclear data with respect to accurary, and to make addition of reaction cross sections being missed in JENDL-1 and JENDL-2. Such improvements will be most smoothly made in the occasion of evaluation work for the next version of JENDL, i.e. JENDL-3.

1. Yearly Plan

Although JENDL-3 should be a widely usable library, emphasis will be placed on applications for fast reactor and fusion reactor developments. Requests from thermal reactor technology will also be taken into consideration.

The yearly plan is as follows: in 1980 and 1981, computer codes for theoretical calculations such as the coupled-channel theory, the preequilibrium theory, the direct reaction theory, etc. will be prepared. On the other hand, experimental data will be collected and surveyed, and evaluation methods will be discussed and some of them will be adopted. In 1981 and 1982, according to these arrangements and using these prepared materials, evaluations will be carried out. The compilation of evaluated data will bigin in 1982. In 1983, effort will be mainly paid to the benchmark tests of JENDL-3. The C/E tests should also be made on the integral experiments for fusion reactor development. If this plan will be realized, use of JENDL-3 will be in time for the safty assessment of the PNC fast reactor of the next demonstration stage, and for JAERI's next project of fusion reactor development.

2 Contents of JENDL-3

a) Energy range: 20 MeV is enough for the upper limit of the energy range, except for special cases such as the nuclear data for FMIT.

b) Nuclides and reactions: From the very nature, nuclides and reactions for JENDL-3 should cover those for JENDL-2. Addition of nuclides and reactions will be made with reference to the results of inquiries to users.
c) Evaluated data: Evaluators will be asked to improve the quality of evaluated data, especially the data in high energy region. Instead of adopting isotropic approximation, the angular distributions of reactions should be carefully taken into the evaluated data. The energy spectra of outgoing particles should also be included. Moveover, gamma-producing cross sections and energy spectra of gamma rays are needed for the study of heat generation in the fast reactor and the fusion research. These data are requested also for the calculations of the shielding of fast reactors.
d) Covariance file: It is defficult to maintain enough manpower to make covariance files for the wide range of nuclides. On the other hand, there are strong requests for these files from users. Compromizing these two, preparation of the files will be limited within nuclides of high priority.
e) Special purpose files: Special purpose files such as the standard file, the dosimetry file, etc., will not be prepared in JENDL-3. But there are urgent requests for the data on decay heat and level scheme. The data activity for these purposes will be continued in a different framework from JENDL-3.

3. Remarks

Most important thing to complete JENDL-3 is to maintain enough manpower. To do this, we will ask for more cooperations of speciallists in the fields of universities and reactor manufacturers than before.

JAERI

Simultaneous Evaluation of the Nuclear Data for Heavy Nuclides

H. Matsunobu*, Y. Kanda**, M. Kawai†
T. Murata†, and Y. Kikuchi††

Evaluation work of the nuclear data for heavy nuclides was continued as a part of the activities in Working Group on Heavy-Nuclide Nuclear Data of Japanese Nuclear Data Committee after publication of the previous progress report[1].

Preliminary results of evaluation described in the above report were examined through the benchmark tests with the integral measurements for fast reactor. The prelimary data were reevaluated by taking account of the results of these tests.

The final results were presented as a contribution paper with the above title and by the same authors to the International Conference on Nuclear Cross Sections for Technology held at Knoxville in October, 1979. The abstract is as follows.

The nuclear data of ^{235}U, ^{238}U, ^{239}Pu, ^{240}Pu, and ^{241}Pu were simultaneously evaluated in the energy range of 100 eV to 20 MeV by using recent experimental data and theoretical calculations for Japanese Evaluated Nuclear Data Library-Version 2 (JENDL-2). In this work, a special care was paid for evaluating the fission cross section of ^{235}U so that the consistency could be kept between the relative and absolute measurements for the other heavy nuclides.

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The other cross sections of the above five nuclides were also reevaluated by using the experimental data and theoretical calculations in keeping with modification of the fission cross sections. In relation to these reevaluation, the optical potential parameters were so searched for that the experimental data of total cross sections for the above five nuclides were well reproduced by the calculations with simple systematics. In reevaluation of number of prompt neutron per fission, the evaluated data compiled in JENDL-1 were renormalized using the current weighted average value of ^{252}Cf, $^{252}\bar{\nu}_p$=3.756.

Reference

1) H. Matsunobu, Y. Kanda, M. Kawai, T. Murata, and Y. Kikuchi
: NEANDC(J)-61/U, p.50 (1979)

JAERI

Evaluation of Neutron Cross Sections for Lead

T. Asami*

Data evaluation was performed for the neutron cross sections of natural Pb and the Pb isotopes (^{204}Pb, ^{206}Pb, ^{207}Pb and ^{208}Pb) in the energy range of 10^{-5} eV to 20 MeV. The evaluation was completed for the resonance parameters and the threshold reaction cross sections of the Pb isotopes.

The resonance parameters were taken mainly from recent high resolution measurements at ORELA, and for unknown radiative widths the averaged values were given. These parameters were used to generate the Pb cross sections below 300 keV. The generated total cross section for natural Pb were compared with the experimental data to check the evaluated parameters.

The cross sections for threshold reactions ((n,2n), (n,3n), (n,p), (n,α), etc.) were drived from multi-step evaporation model calculations because of the lack of available experimental data. The level density parameters, needed for calculating cross sections, were adjusted with experimental neutron resonance data and level scheme data. The calculated (n,2n) cross sections for natural Pb and ^{204}Pb agree well with the experimental data without any additional adjustment. The other cross sections also give reasonable values around 14 MeV where a few experimental data are available.

Evaluations for the other Pb data are now in progress. These data are to be compiled in JENDL-2.

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JAERI

Status Report on Japanese Activities in Nuclear Structure and Decay Data

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Nuclear Data Center, Japan Atomic Energy Research Institute

Activities in Nuclear Structure and Decay Data have been mainly promoted by the Nuclear Structure Data Working Group of Japanese Nuclear Data Committee(JNDC) and is summarized as follows:

1. Evaluators --- manpower and training
At present, 9 experimental nuclear physicists have been cooperating in the mass-chain evaluation on the part-time basis. All these evaluators participated in the Orientation Seminar conducted by an ORNL staff held at Japan Atomic Energy Research Institute on 3-7 December, 1979.

2. Computer --- The ORNL ENSDF programs and their BNL version have been successfully operated on IBM 370 and partially on FACOM 230/75(JAERI in house) computers until March 1980. FACOM M-200, newly replaced in house JAERI computer, has begun utilized for all the evaluation work without the help of IBM 370.

3. Time schedule --- Mass-chain evaluation
Up to now, evaluation of 4 masses has been completed. Evaluation of 12 masses in 4 years as allotted for Japanese contribution in the 1977 NSDD meeting will be fulfilled according to the following schedule:

A=121, 119*	July 1977 - Oct. 1978
A=123, 125, 127	Aug. 1978 - Oct. 1979
- - - - - - - -	- - - - - - - -
A=126, 128, 129	Aug. 1979 Aug. 1980
A=120, 122, 124	Aug. 1980 - Aug. 1981
A=118, 119, 121	Aug. 1981 - Aug. 1982

4. Compilation of Japanese References --- Due to the shortage of manpower in this activity, compilation of Japanese references has been delayed. A new group was assigned in April 1980, and will make the first contribution of the keyword-input data around May 1980.

5. Other NSDD activities in JNDC --- ENSDF data have been applied in the decay heat evaluation and revision of the Chart of Nuclides**. Revised edition of the Chart of Nuclides will be published around March 1981.
A meeting on the evaluation and application of NSDD was held on 10-11, December 1979.

* Evaluation of A=119 was made by ORNL center.

** Y. Yoshizawa, T. Horiguchi and M. Yamada: Chart of Nuclides, Feb. 1977 Japanese Nuclear Data Committee/Nuclear Data Center .

JAERI

Activity on the Evaluation of Decay Heat

R. Nakasima, Z. Matumoto, K. Tasaka, T. Yoshida,
M. Akiyama, and H. Ihara

Working Group on the Evaluation of Decay Heat is now making a basic data file to be used for the summation calculation of decay powers of fission products. The decay energies have been calculated by using PROFP code for 639 fission product nuclides from A=66 to A=172, of which decay data are taken from the Table of Isotopes, Nuclear Data Sheets, ENSDF and journals scanned by ourselves. The results can be tabulated from PROFP output file which includes 150 stable nuclides and 100 nuclides identified by only their half-lives in addition to above mentioned 639 nuclides. Tabulated quantities are; half-life, decay constant, Q_β (excitation energy in tha case of isomer), Q_{EC}, mean total energy released, mean energy of β, mean energy of γ, mean enrgy of conversion electron, parent nuclide, decay type and branching ratio from the parent nuclide, and the error of each quantity.

For the nuclides, whose decay schemes are unknown, their half-lives if necessary and their average decay energies are estimated based on the gross theory of β-decay by using Q-values derived from Uno-Yamada's mass formula.

The cumulative fission yields for the decay chain adopted by ourselves are being calculated using Rider-Meek's evaluated values of independent fission yields (1977 version).

Neutron capture cross sections have been taken from JENDL-1, JENDL-2 and ENDF/B-IV.

JAERI

Fast Neutron Facility Using the Ion-Beam from the JAERI 20 MV Tandem Accelerator

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Installation of a 20 MV tandem accelerator and its experimental apparatuses is in progress at Tokai,JAERI. The accelerator will be used mainly for four research fields: nuclear physics, solid-state physics,nuclear chemistry and fast neutron physics. In the following, status of the preparation for the fast neutron facility is mentioned.

In order to study the elastic and inelastic scattering of neutrons in the energy range from 10 to about 40 MeV a new time-of-flight facility has been constructed. Neutron scattering cross sections in this energy range are needed strongly for the development of nuclear fusion, accelerator breeding,etc. as well as for the study of neutron physics. Fig.1 shows a general view of the facility.

In order to remove the position of the gas target a few meters away from the concrete wall, a beam line is branched off by a 20° beam-bending magnet. This beam line corresponds to the thirteenth beam line from the tandem accelerator. For generation of fast neutrons by the $D(d,n)^3He$ reaction, a gas target of the Ohio University type[1] is mainly to be used. This has a window of a 5μm thick single foil of molybdenum. Immediately upstream from the target, a pressure sensor, a 100 l/sec turbomolecular pump, a low conductance tube, a fast-acting gate valve and a 500 l/sec turbomolecular pump are attached in order to protect the acceleration tubes from poor vacuum, when a pin hole develops in the target foil.

A sector-shape rotating platform, which is capable to mount four neutron detectors in 10° steps with flight paths of 8m, has been installed. The rotating platform is remotely controllable in the control room. In order to multiply the neutron detection rate, two sets of very large detector with a length of 80 cm and a diameter of 10 cm are now being prepared. These are similar to the large efficiency detector of Munich type, which has been successfully used for the (^{3}He,n) reaction[2]. The four neutron detectors with 5"ϕ x 4" NE213 liquid scintillator, which have been used with the 5.5 MV Van de Graaff accelerator,are also available on the rotating platform. The time compensator circuit shown in Fig.2 cancels the time jitter originated from neutron detections at different positions in the long scintillator. The very large detectors are positioned perpendicular to the incident neutrons, and are encased in large shield tanks of about 4.5 tons each. Moreover, as seen in Fig.1, three collimators in series are needed for each detector to block the air scattered neutrons near the scattering sample. Two sets of such collimators and shield tanks have been constructed.

References:

1) J.D.Carlson, Nucl.Instr.Meth. 113, 541(1973) and private communication.

2) D.Evers, E.Spindler, R.Konrad, K.Rudolph, W.Assmann and P.Sperr, Nucl.Instr. Meth.,124, 23(1975).

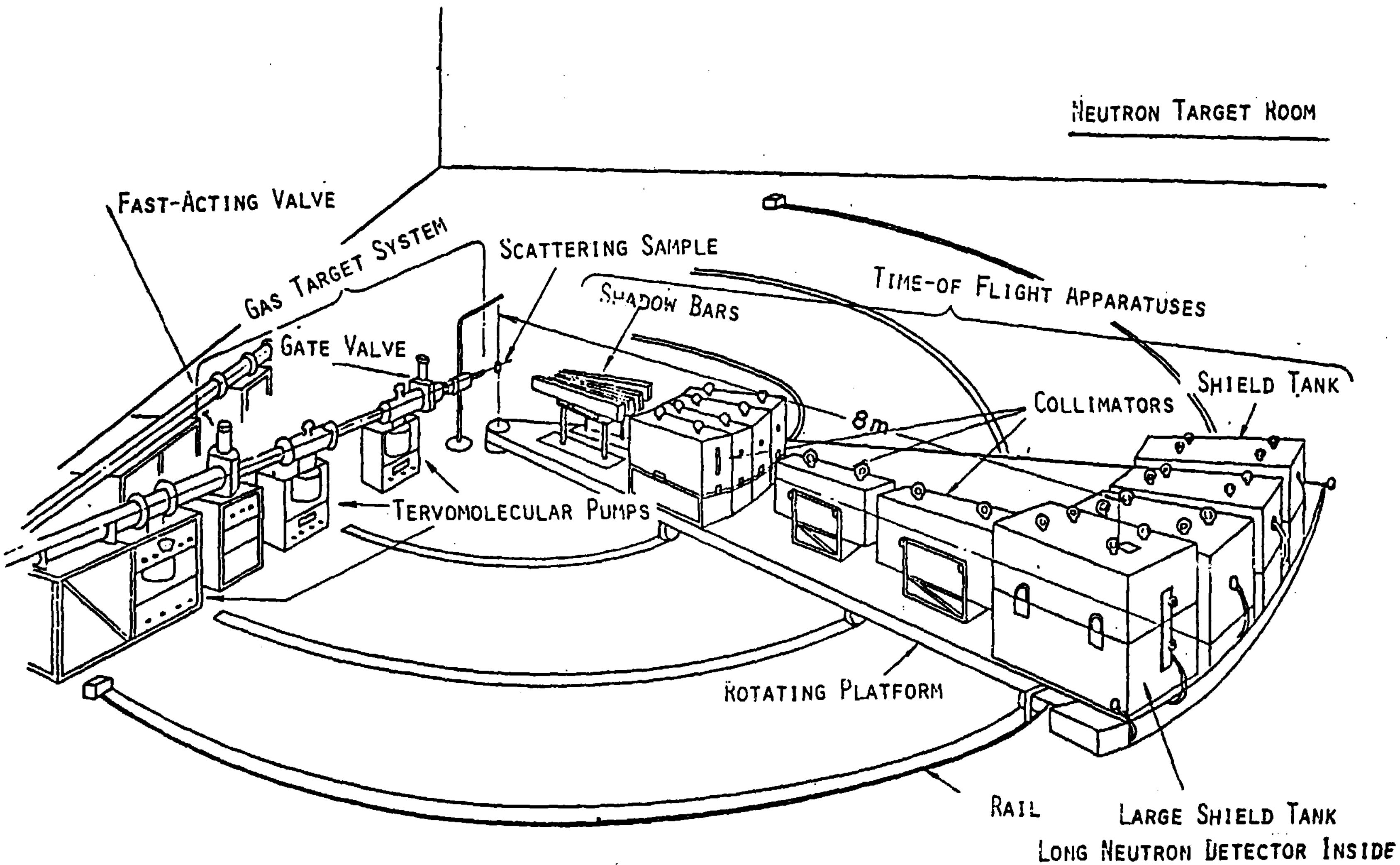
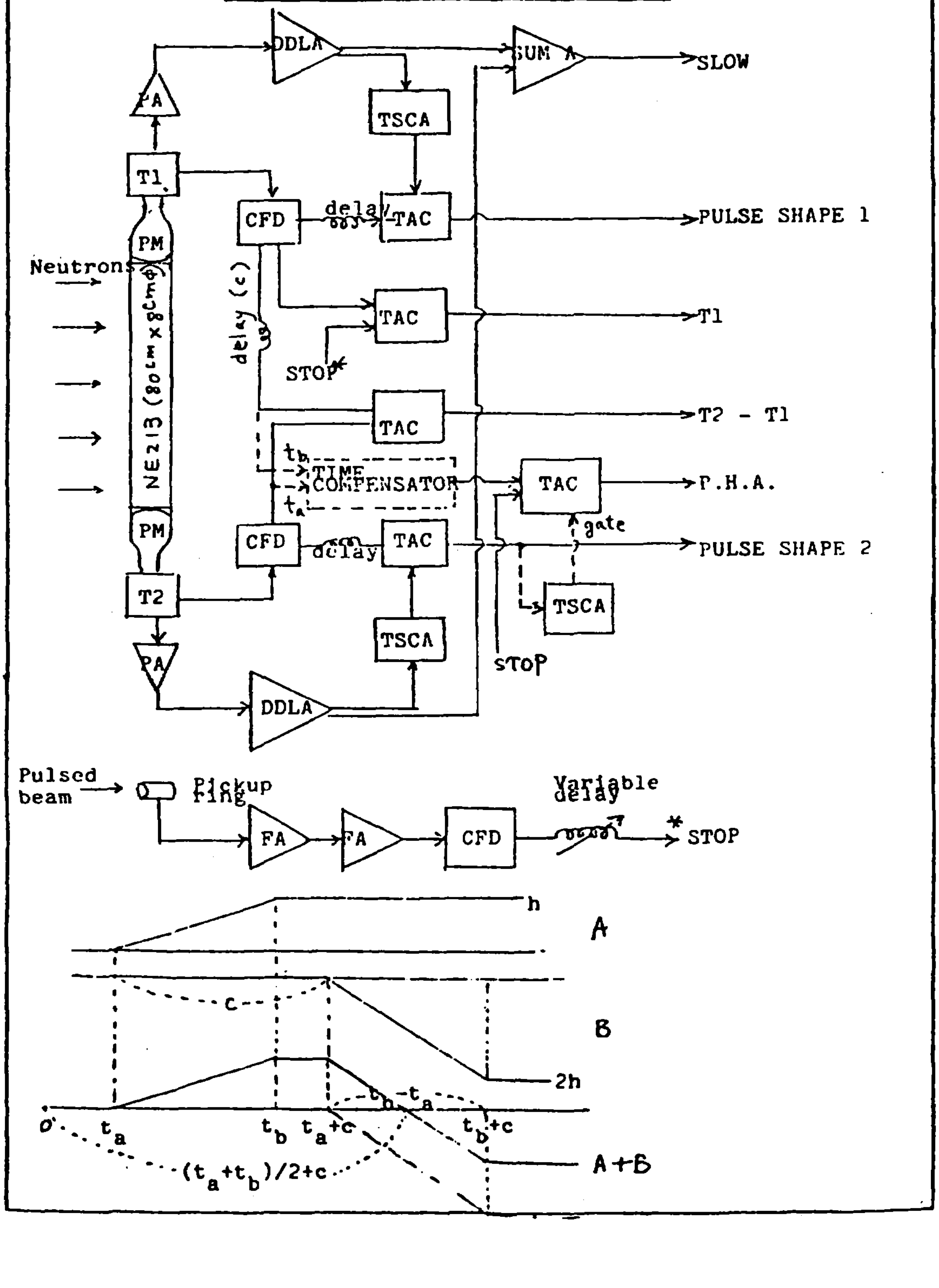


Fig. 1 GENERAL VIEW OF THE TIME-OF FLIGHT FACILITY.

April 14, 1979

Fig. 2 Circuits for Neutron Scattering Experiment



JAERI

Neutron Radiative Capture and Transmission Measurements of ^{147}Sm and ^{149}Sm.

M. Mizumoto, M. Sugimoto*, Y. Nakajima, Y. Kawarasaki,

Y. Furuta and A. Asami

A paper on this subject was presented at the International Conference on Nuclear Cross Sections for Technology, October 22-26, 1979, Knoxville with an abstract as follows:

The neutron capture and transmission of ^{147}Sm and ^{149}Sm were measured at the 55 m time-of-flight station of the Japan Atomic Energy Research Institute Electron Linear Accelerator. Measurements were carried out with a large liquid scintillation detector, a ^{6}Li glass detector and ^{10}B-NaI detector using enriched samples of ^{147}Sm (98.34 %) and ^{149}Sm (97.72 %). The average capture cross sections were deduced from 3.3 to 300 keV with an estimated accuracy of 5 to 15 %. The transmission data were analyzed with a multi-level Breit Wigner formula to obtain neutron widths of resonances up to 2 keV for ^{147}Sm (212 resonances) and 520 eV for ^{149}Sm (157 resonances). The s-wave strength functions and average level spacings were found to be $10^4 \cdot S_0 = 4.8 \pm 0.5$, $\bar{D} = 5.7 \pm 0.5$ eV for ^{147}Sm and $10^4 \cdot S_0 = 4.6 \pm 0.6$, $\bar{D} = 2.2 \pm 0.2$ eV for ^{149}Sm.

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JAERI

Neutron Resonances of $^{79,81}Br$ and Rb

1) Resonance Parameters of ^{79}Br and ^{81}Br up to 15 keV

M.Ohkubo, Y.Kawarasaki and M.Mizumoto

An article titled above was reported in the Int.Conf. "Nuclear Cross Sections for Technology", held at Knoxville in Oct 1979, with the following abstract.

Resonance parameters of separated isotopes of bromine were measured using TOF spectrometer of Japan Atomic Energy Research Institute linear accelerator. Transmission and capture measurements were made with ^{6}Li-glass and Moxon-Rae detectors, on separated isotopes(~98%) of ^{79}Br and ^{81}Br. Resonance analyses were made on transmission data with an area analysis code, and on capture data with a Monte-Carlo program CAFIT. For ^{79}Br $g\Gamma_n^0$ values for 156 levels below 10 keV are obtained, and for ^{81}Br 100 levels below 15 keV. Strength functions are obtained; for ^{79}Br $S_0=(1.27\pm0.14)10^{-4}$ below 10 keV, and for ^{81}Br $S_0=(0.86\pm0.14)10^{-4}$ below 15 keV. Intermediate structures are observed in the resonances of ^{81}Br showing clusters of levels at 1.2, (4), 10,11.5 and 14 keV, where the sum of $g\Gamma_n^0$ vs. neutron energy shows steep rises.

2) Resonance Parameters of Rubidium

M.Ohkubo

Transmission and capture measurements on natural rubdium were made using the 47-m station of the JAERI linac TOF spectrometer. About 80 levels below 14 keV are observed. Resonance analyses are in progress.

JAERI

An effect of the 56 keV resonance of ^{28}Si on the detection efficiency of a ^{6}Li-glass detector

M. Sugimoto*, M. Mizumoto and A. Asami

The efficiency of a 0.64 cm thick ^{6}Li-glass scintillation detector was calculated by a Monte Carlo method. The neutron multiple-scattering correction to the efficiency was made using evaluated cross sections and resonance parameters of the constituents of the detector. The effect of the neutrons scattered back from the photo-multiplier window was also taken into account. The measured neutron flux was derived using the calculated efficiency and compared with the assumed smooth flux shape ($\sim E_n^{const.}$) from a neutron target. The observed peak at 56 keV is attributed to the enhancement of the efficiency due to the sharp s-wave resonance of ^{28}Si contained both in the scintillator (25 % enhancement) and the photomultiplier window (15 % enhancement).

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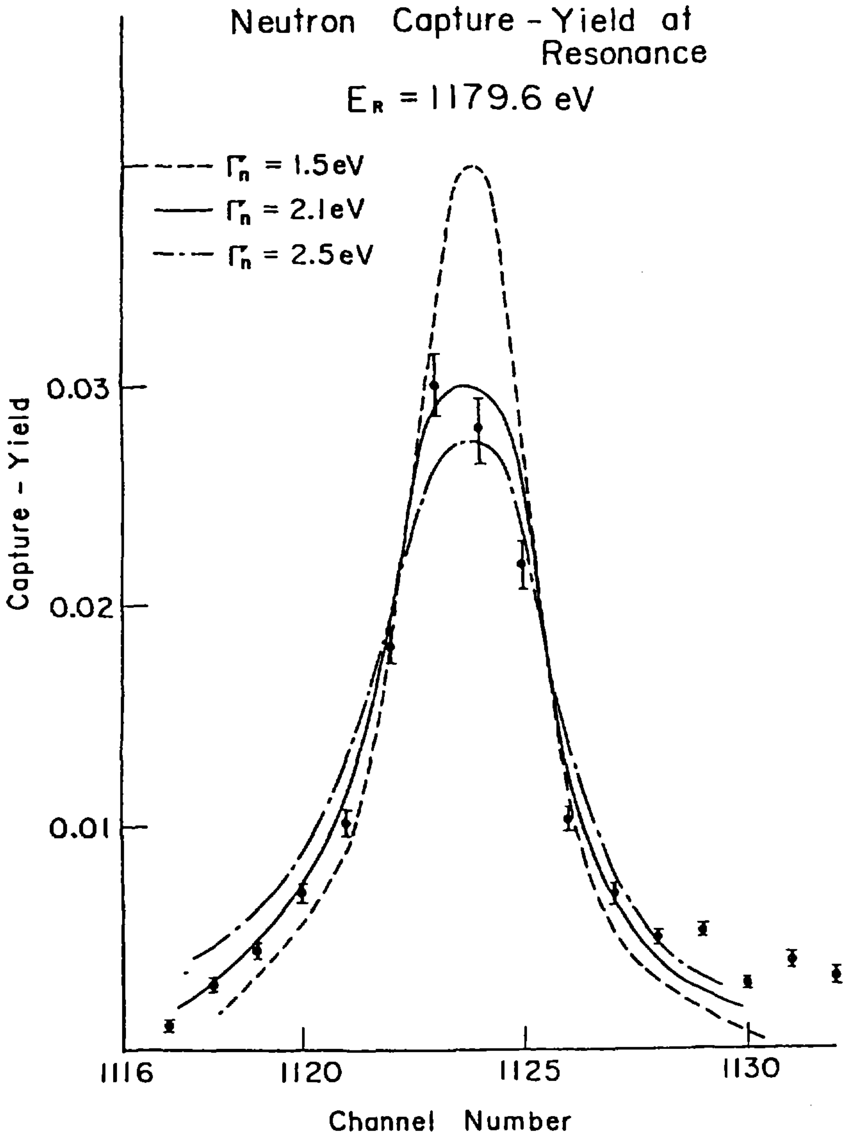
JAERI

Neutron Resonance Capture in ^{139}La below 2.5 keV

Yutaka Nakajima, Nobuyuki Ohnishi*, Yukinori Kanda**, Motoharu Mizumoto, Masayoshi Sugimoto, Yuuki Kawarasaki, Yutaka Furuta and Akira Asami

The neutron capture cross section of ^{139}La has been measured up to 2.5 keV at the neutron time-of-flight facility of Japan Atomic Energy Research Institute linac. The capture events were detected by a 3,500 l liquid scintillation detector at 52 m from the neutron producing target and the neutron flux was measured at 56 m by means of a 11.11-cm diameter by 0.635-cm thick ^{6}Li-glass detector. The main pruposes of this experiment are to offer the accurate radiation widths for the calculation of reactivety effects of fission product poisons in fast reactors and to investigate the dependence of the magnitude of the radiation widths on the spin and prity of the resonances and the correlation between the neutron widths and the radiation widths.

The resonance areas of the capture yield were analyzed by the computer code TACASI[1], in which the multiple scattering and self-shielding in the sample was taken into account by the Monte-Carlo method. An example of the analysis is shown in Fig. 1. Employing the neutron widths obtained by the transmission measurements[2], the radiation widths have been deduced for nine s-wave resonances. The analysis of the p-wave resonances is in progress.



References:

1) F. H. Fröhner, GA-6909 (1966)

2) G. Hacken et al., Phys. Rev. C 13 (1976) 1884

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JAERI

Development of a Multi-Detector System for Scattering Experiments

Yutaka Furuta and Yutaka Nakajima

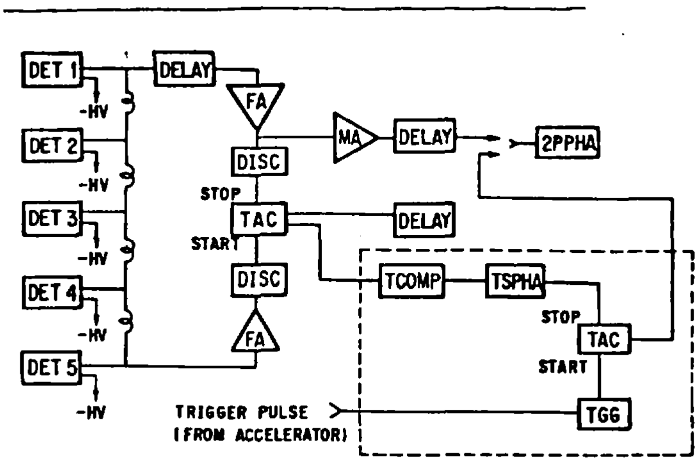
An economical system using for a large number of the same kind of detectors is developed. This system was intended to use to measure the angular distribution of elastically scattered neutrons. In such experiments, plural number of detectors and the same number of associate amplifiers and discriminators are usually used. In the present method, the main feature is that only two amplifiers and discriminators are used independently of the number of detector used.

A typical block diagram is shown in Fig. 1. Each detector is connected with other detectors by delay lines (1 meter long and 50 ohm impedance coaxial cables were used in the present study).

Signals generated in each detector are taken out from the both ends of the detector line and fed to a time-to-amplitude converter (TAC) after amplified and discriminated. The time difference between the signals taken from the both ends of detector line, i.e. the output pulse height of the TAC, is corresponding to the origin detector of the signal and we can determine in which detector the signal is generated by the pulse height.

Figure 2 shows a pulse height distribution of the output signal of TAC obtained in the case of using five detectors and the same length (1 meter) coaxial cables. In Fig. 1, circuits enclosed by bloken line is used for the compensation of time difference between the signal generated time and the output produced time of TAC.

This system is also applicable for another experiments using a large number of the same kind of detectors.



DET	DETECTOR
FA	FAST AMPLIFIER
MA	MAIN AMPLIFIER
HV	HIGH-VOLTAGE POWER SUPPLY
DISC	DISCRIMINATOR
TAC	TIME TO AMPLITUDE CONVERTER
TCOMP	TIME COMPENSATOR
TSPHA	TIMING SINGLE-CHANNEL PULSE-HEIGHT ANALYZER
TGG	TIME-GATE GENERATOR
2PPHA	2-PARAMETER PULSE-HEIGHT ANALYZER

Fig. 1. System block diagram

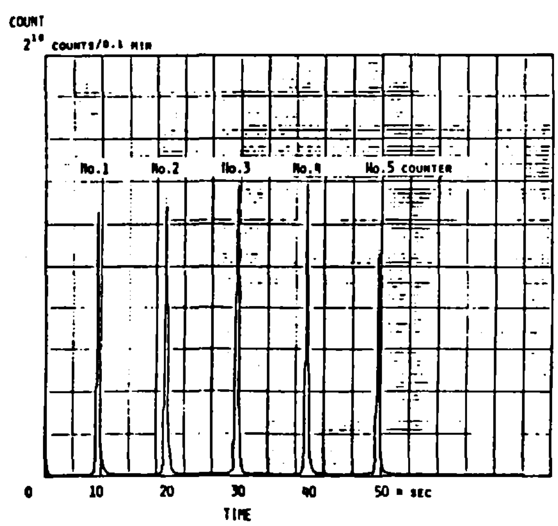


Fig. 2. Pulse height distribution of detector identify pulse.

JAERI

Fusion Neutron Source (FNS) Facility

T. Nakamura and H. Maekawa
Reactor Engineering Division, JAERI

The FNS is a high intensity 14 MeV neutron source that is used for the studies of neutronics in D-T fusion reactor blanket and shielding. This facility is basically a 400 kV Cockcroft-Walton type accerelator with the D^+ beam intensity up to 20 mA at target. By using a tritium metal rotating target system similar to RTNS-1, the maximum 14 MeV neutron yield of 5×10^{12} n/sec is expected. Other than DC operation, the acceralator can be run in pulsed mode with the pulse width ranging from 2 ns to 10 μs.

The FNS has two beam lines each leading to separate target rooms. The integral experiment on bulk media such as lithium oxide fusion blanket mockup or shielding bench-mark test is performed in the large target room. The experimental results are compared with the analysis such as cross section sensitivity of constituents of the mockup (i.e. ^{6}Li, ^{7}Li, ^{12}C, ^{16}O Cr, Fe, Ni and Mo). The small target room is devoted to the sample activation and dosimetry experiments to evaluate the generation cross sections and resulting doses of the constituent nuclides of fusion reactor components.

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Decay Study of ^{144}La

Y. Ideda, H. Yamamoto, K. Kawade, T. Katoh
and T. Nagahara*

A paper on this subfect was published in J. Phys. Soc. Japan vol. 47, p. 1389 (1979).

The decay of a short lived nucleus ^{144}La to levels of ^{144}Ce was investigated with Ge(Li), NaI(Tl) and plastic detectors in singles and coincidence modes. Radioactive sources were prepared by the chemical separation, a rapid paper electrophoresis, from fission products of ^{235}U. The half-life of ^{144}La is 40.6 ± 1.0 sec. Fifty-four gamma-rays, including 17 new ones, were observed. Energies and intensities of gamma-rays are shown in Table 1. A new decay scheme of ^{144}La was constructed and 11 new levels of ^{144}Ce were proposed. The Q_β value was deduced to be 4.3 ± 0.1 MeV on the basis of the results of the γ-β coincidence measurements.

* Institute for Atomic Energy, Rikkyo University

Table I. Energies and relative intensities of γ-rays in the decay of ^{144}La.

E_γ (keV)	I_γ	E_γ (keV)	I_γ
*164.7 ± 0.3	1.7 ± 0.1	*1536.8 ± 0.5	0.7 ± 0.1
303.5 ± 0.3	1.4 ± 0.2	1631.7 ± 0.5	1.6 ± 0.2
367.8 ± 0.3	1.5 ± 0.1	1641.2 ± 0.5	1.2 ± 0.2
397.58 ± 0.15	100 ± 5	1674.0 ± 0.4	1.6 ± 0.2
431.7 ± 0.3	5.8 ± 0.3	1715.5 ± 0.4	1.7 ± 0.2
453.8 ± 0.3	2.4 ± 0.2	1757.0 ± 0.4	2.3 ± 0.2
468.0 ± 0.5	0.7 ± 0.1	*1845.1 ± 0.8	0.6 ± 0.1
541.43 ± 0.15	41.1 ± 2.1	1942.7 ± 0.5	1.9 ± 0.2
585.25 ± 0.20	10.1 ± 0.5	1955.6 ± 0.6	1.3 ± 0.2
662.7 ± 0.4	1.0 ± 0.1	*1993.2 ± 0.5	0.7 ± 0.1
705.4 ± 0.3	5.4 ± 0.3	1998.1 ± 0.4	3.0 ± 0.2
735.46 ± 0.15	8.0 ± 0.4	2008.7 ± 0.4	1.5 ± 0.2
752.3 ± 0.3	1.6 ± 0.1	2052.5 ± 0.5	1.2 ± 0.1
844.89 ± 0.15	25.7 ± 1.3	2064.2 ± 1.0	0.4 ± 0.1
*890.6 ± 0.3	2.0 ± 0.2	2137.9 ± 0.8	0.5 ± 0.1
952.6 ± 0.3	5.0 ± 0.3	*2185.4 ± 0.8	0.5 ± 0.1
968.8 ± 0.3	4.3 ± 0.3	2191.9 ± 1.0	0.5 ± 0.1
978.8 ± 0.5	2.9 ± 0.2	*2205.0 ± 1.0	0.6 ± 0.1
1052.9 ± 0.3	2.3 ± 0.2	*2307.5 ± 1.0	0.6 ± 0.1
1070.2 ± 0.5	0.4 ± 0.1	2325.3 ± 0.7	1.2 ± 0.1
1092.3 ± 0.5	1.5 ± 0.2	2360.3 ± 1.0	0.8 ± 0.1
1102.5 ± 0.4	1.6 ± 0.2	]663.8 ± 0.5	2.1 ± 0.2
1276.5 ± 0.4	2.5 ± 0.2	2866.7 ± 0.6	1.5 ± 0.1
1294.64 ± 0.25	7.6 ± 0.4	2885.0 ± 1.0	0.3 ± 0.1
1422.2 ± 0.8	2.3 ± 0.2	2897.5 ± 1.0	0.6 ± 0.1
1432.2 ± 0.3	5.0 ± 0.3		
1467.6 ± 0.5	0.9 ± 0.1		
1489.4 ± 0.4	2.0 ± 0.2		
1524.0 ± 0.3	3.8 ± 0.3		

* Not placed in the proposed decay scheme.

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Gamma-Ray Production Cross Sections for Fast Neutron Interactions with Tin and Barium

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Previous studies[1] on fast neutron induced gamma-ray production cross sections were continued for natural samples of tin and barium at the neutron energies of 4.8, 5.3, 5.9 and 6.4 MeV. The pulsed monoenergetic neutrons were produced from the D(d,n) reactions using the 4.5 MV Dynamitron accelerator at Tohoku University. The gamma-rays from the sample were observed with a 70 cm^3 Ge(Li) detector at an angle of 125°. The details of the experimental procedures have been reported elsewhere[1]. Through the data analysis, cross sections for resolved gamma-lines were obtained, and those for unresolved gamma-rays were computed with a modified "FERDOR" unfolding code. The results have been fitted with the Howerton's semiempirical formula[2] in order to study the systematics of the fitting parameters. For the example, tentative results are shown in Figs. 1 and 2.

References:

1) Y. Hino, T. Yamamoto, T. Saito, Y. Arai, S. Itagaki and K. Sugiyama, J. Nucl. Sci. Tech., 15, 85 (1978), and Y. Hino T. Yamamoto, S. Itagaki and K. Sugiyama, International conf. on Nuclear Cross Sections for Technology, (1979, Knoxville).

2) R.J. Howerton and E.F. Plechaty, Nucl. Sci. Eng., 82, 178 (1968).

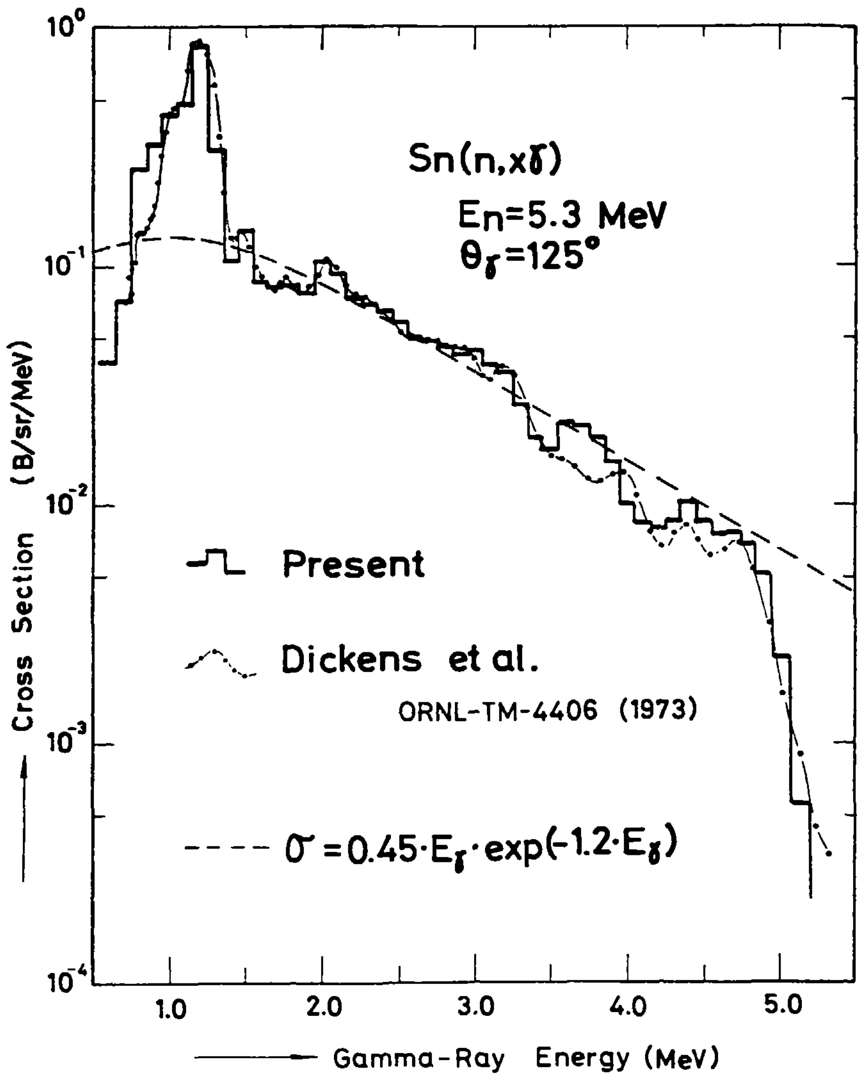

Fig. 1 Gamma-ray production cross sections for tin at 5.3 MeV.

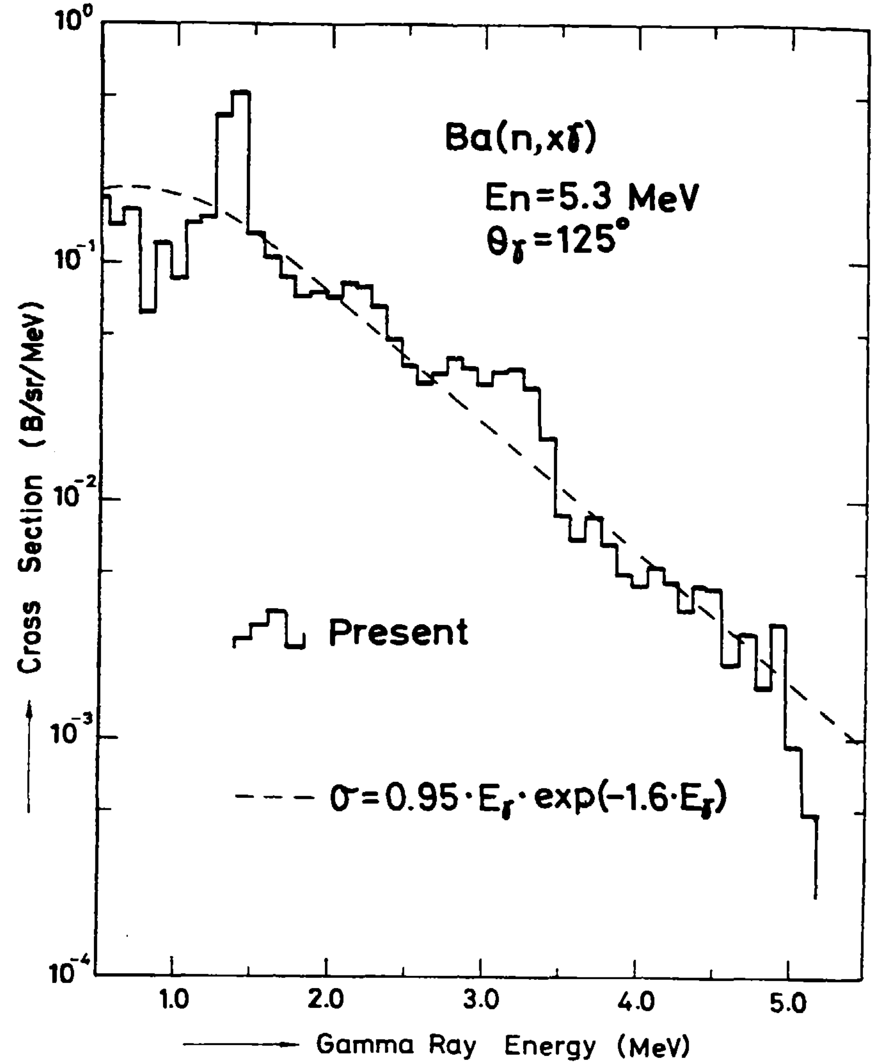

Fig. 2 Gamma-ray production cross sections for barium at 5.3 MeV.

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Measurement of total-neutron cross sections of Thorium from 50 KeV to 10 MeV

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Total-neutron cross sections of Thorium were measured in the energy range from 50 KeV to 10 MeV with transmission method. Thorium samples*) were metalic plate with thickness of 0.0276 - 0.0554 atoms/barn. Data for carbon were also taken to confirm the experimental and data processing procedure.

Tohoku University 4.5MV Dynamitron accelerator provided pulsed and pseudo-white neutrons with energy range of this study via (p,n) and (d,n) reaction on thick Li target. Monoenergetic neutrons with energy spread of 30 - 60 KeV were also used in 300 - 700 KeV region, where the uncertainty in estimating the background made it difficult to rely on the measurement with pseudo-white neutrons.

A NE213 liquid scintillator employing gamma-ray rejection circuit served as a transmission detector. Two different monitors were used to normalize the sample-out to sample-in runs.

Experimental uncertainties were estimated to be <2%, by comparing the measured carbon cross sections with those in evaluated files. For the present thickness of the Thorium sample, the effect of resonance self-shielding could not be neglected below a few hundred KeV, and it was taken into account in data reduction. The results were agreed reasonably well with other recent measurements and with the optical model calculation.

*) on loan from Research Reactor Institute of Kyoto University

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