INDC(JPN) - 187/U

NOT FOR PUBLICATION

PROGRESS REPORT

(January 2000 to December 2000 inclusive)

March 2001

Editor

J. Katakura

Japanese Nuclear Data Committee

Japan Atomic Energy Research Institute
Tokai Research Establishment
Tokai-mura, Naka-gun, Ibaraki-ken, Japan

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C	12	DIFF INELAST		1.5+8	JAE	THEO-PROG	INDC(JPN)-187U	MAR 01	CHIBA+.P25.SOFT-ROTATOR MODEL.NDG
C	12	(N,ALPHA)	1.4+7		TOH	EXPT-PROG	INDC(JPN)-187U	MAR 01	SANAMI+.P61.GIC WITH GASEOUS SAMPLES
N	14	(N,2N)	1.3+7	1.5+7	NAG	EXPT-PROG	INDC(JPN)-187U	MAR 01	SAKANE+.P50.ACT SIG REL AL-27(N,A)
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NA	23	DIFF INELAST	TR	2.0+7	JAE	EVAL-PROG	INDC(JPN)-187U	MAR 01	SHIBATA.P19.FOR JENDL-3.3,FIG GIVEN
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AL	27	(N,P)	2.0+6	3.2+6	NAG	EXPT-PROG	INDC(JPN)-187U	MAR 01	SHIMIZU+.P51.ACT SIG. NDG
SI	29	(N,NP)	1.3+7	1.5+7	NAG	EXPT-PROG	INDC(JPN)-187U	MAR 01	SAKANE+.P49.ACT SIG FOR (N,NP+D)
SI	30	(N,NP)	1.3+7	1.5+7	NAG	EXPT-PROG	INDC(JPN)-187U	MAR 01	SAKANE+.P49.ACT SIG FOR (N,NP+D)
SI		DIFF ELASTIC	7.5+7		TOH	EXPT-PROG	INDC(JPN)-187U	MAR 01	IBARAKI+.P61.TOF, 2.6 TO 53 DEG.
SI		P EMISSION	1.4+7		OSA	EXPT-PROG	INDC(JPN)-187U	MAR 01	TAKAHASHI+.P56.DA/DE,DE.E-TOF METH.
P	31	(N,2N)	1.3+7	1.5+7	NAG	EXPT-PROG	INDC(JPN)-187U	MAR 01	SAKANE+.P50.ACT SIG REL AL-27(N,A)
V	51	(N,P)	2.0+6	3.2+6	NAG	EXPT-PROG	INDC(JPN)-187U	MAR 01	SHIMIZU+.P51.ACT SIG. NDG
CR	53	(N,NP)	1.3+7	1.5+7	NAG	EXPT-PROG	INDC(JPN)-187U	MAR 01	SAKANE+.P49.ACT SIG FOR (N,NP+D)
CR	54	(N,NP)	1.3+7	1.5+7	NAG	EXPT-PROG	INDC(JPN)-187U	MAR 01	SAKANE+.P49.ACT SIG FOR (N,NP+D)
FE	54	(N,2N)	1.3+7	1.5+7	NAG	EXPT-PROG	INDC(JPN)-187U	MAR 01	SAKANE+.P50.ACT SIG REL AL-27(N,A)
FE		DIFF ELASTIC	7.5+7		TOH	EXPT-PROG	INDC(JPN)-187U	MAR 01	IBARAKI+.P61.TOF, 2.6 TO 53 DEG.
NI	61	(N,P)	2.0+6	3.2+6	NAG	EXPT-PROG	INDC(JPN)-187U	MAR 01	SHIMIZU+.P51.ACT SIG. NDG

ELEMENT S	A	QUANTITY	ENERGY MIN	ENERGY MAX	LAB	TYPE	DOCUMENTATION REF VOL PAGE	DATE	COMMENTS
CU	63	(N,2N)	1.3+7	1.5+7	NAG	EXPT-PROG	INDC(JPN)-187U	MAR 01	SAKANE+.P50.ACT SIG REL AL-27(N,A)
CU	65	(N,P)	2.0+6	3.2+6	NAG	EXPT-PROG	INDC(JPN)-187U	MAR 01	SHIMIZU+.P51.ACT SIG. NDG
ZN	67	(N,NP)	1.3+7	1.5+7	NAG	EXPT-PROG	INDC(JPN)-187U	MAR 01	SAKANE+.P49.ACT SIG FOR (N,NP+D)
GA	69	(N,P)	2.0+6	3.2+6	NAG	EXPT-PROG	INDC(JPN)-187U	MAR 01	SHIMIZU+.P51.ACT SIG. NDG
BR	79	(N,2N)	1.3+7	1.5+7	NAG	EXPT-PROG	INDC(JPN)-187U	MAR 01	SAKANE+.P50.ACT SIG REL AL-27(N,A)
BR	87	(N,2N)	1.3+7	1.5+7	NAG	EXPT-PROG	INDC(JPN)-187U	MAR 01	SAKANE+.P50.ACT SIG REL AL-27(N,A)
SR	87	(N,NP)	1.3+7	1.5+7	NAG	EXPT-PROG	INDC(JPN)-187U	MAR 01	SAKANE+.P49.ACT SIG FOR (N,NP+D)
ZR		DIFF ELASTIC	7.5+7		TOH	EXPT-PROG	INDC(JPN)-187U	MAR 01	IBARAKI+.P61.TOF, 2.6 TO 53 DEG.
MO	92	(N,2N)	1.3+7	1.5+7	NAG	EXPT-PROG	INDC(JPN)-187U	MAR 01	SAKANE+.P50.ACT SIG REL AL-27(N,A)
MO	92	(N,P)	2.0+6	3.2+6	NAG	EXPT-PROG	INDC(JPN)-187U	MAR 01	SHIMIZU+.P51.ACT SIG. NDG
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MO	100	(N,NP)	1.3+7	1.5+7	NAG	EXPT-PROG	INDC(JPN)-187U	MAR 01	SAKANE+.P49.ACT SIG FOR (N,NP+D)
RU	102	(N,NP)	1.3+7	1.5+7	NAG	EXPT-PROG	INDC(JPN)-187U	MAR 01	SAKANE+.P49.ACT SIG FOR (N,NP+D)
PD	105	(N,NP)	1.3+7	1.5+7	NAG	EXPT-PROG	INDC(JPN)-187U	MAR 01	SAKANE+.P49.ACT SIG FOR (N,NP+D)
PD	106	(N,NP)	1.3+7	1.5+7	NAG	EXPT-PROG	INDC(JPN)-187U	MAR 01	SAKANE+.P49.ACT SIG FOR (N,NP+D)
PD	108	(N,2N)	1.3+7	1.5+7	NAG	EXPT-PROG	INDC(JPN)-187U	MAR 01	SAKANE+.P50.ACT SIG REL AL-27(N,A)
PD	108	(N,NP)	1.3+7	1.5+7	NAG	EXPT-PROG	INDC(JPN)-187U	MAR 01	SAKANE+.P49.ACT SIG FOR (N,NP+D)
IN	113	(N,2N)	1.3+7	1.5+7	NAG	EXPT-PROG	INDC(JPN)-187U	MAR 01	SAKANE+.P50.ACT SIG REL AL-27(N,A)
SN		NONELA GAMMA	1.4+7		OSA	EXPT-PROG	INDC(JPN)-187U	MAR 01	MURATA+.P58.GE DET. NDG
TE	123	(N,NP)	1.3+7	1.5+7	NAG	EXPT-PROG	INDC(JPN)-187U	MAR 01	SAKANE+.P49.ACT SIG FOR (N,NP+D)

ELEMENT S	A	QUANTITY	ENERGY MIN	ENERGY MAX	LAB	TYPE	DOCUMENTATION REF VOL PAGE	DATE	COMMENTS
CS	137	(N,GAMMA)	2.5-2		JNC	EXPT-PROG	INDC(JPN)-187U	MAR 01	WADA+.P30.TO META.ACT SIG=.27+-.03 B
BA	132	(N,2N)	1.3+7	1.5+7	NAG	EXPT-PROG	INDC(JPN)-187U	MAR 01	SAKANE+.P50.ACT SIG REL AL-27(N,A)
BA	138	(N,2N)	1.3+7	1.5+7	NAG	EXPT-PROG	INDC(JPN)-187U	MAR 01	SAKANE+.P50.ACT SIG REL AL-27(N,A)
CE	140	(N,GAMMA)	1.0+4	5.5+5	TIT	EXPT-PROG	INDC(JPN)-187U	MAR 01	IGASHIRA+.P65.TOF,NAI(TL).REL 197AU
CE	140	SPECT (N,G)	1.0+4	5.5+5	TIT	EXPT-PROG	INDC(JPN)-187U	MAR 01	IGASHIRA+.P65.TOF,NAI(TL).REL 197AU
CE	140	(N,2N)	1.3+7	1.5+7	NAG	EXPT-PROG	INDC(JPN)-187U	MAR 01	SAKANE+.P50.ACT SIG REL AL-27(N,A)
PR	141	(N,GAMMA)	1.0+4	5.5+5	TIT	EXPT-PROG	INDC(JPN)-187U	MAR 01	IGASHIRA+.P65.TOF,NAI(TL).REL 197AU
PR	141	SPECT (N,G)	1.0+4	5.5+5	TIT	EXPT-PROG	INDC(JPN)-187U	MAR 01	IGASHIRA+.P65.TOF,NAI(TL).REL 197AU
PR	141	(N,2N)	1.3+7	1.5+7	NAG	EXPT-PROG	INDC(JPN)-187U	MAR 01	SAKANE+.P50.ACT SIG REL AL-27(N,A)
SM	144	(N,2N)	1.3+7	1.5+7	NAG	EXPT-PROG	INDC(JPN)-187U	MAR 01	SAKANE+.P50.ACT SIG REL AL-27(N,A)
DY		TOTAL	2.0-3	1.0+5	KTO	EXPT-PROG	INDC(JPN)-187U	MAR 01	CHO+.P36.LINAC,TOF,LI-6 SCINT. FIG
DY	163	(N,NP)	1.3+7	1.5+7	NAG	EXPT-PROG	INDC(JPN)-187U	MAR 01	SAKANE+.P49.ACT SIG FOR (N,NP+D)
HO	165	(N,2N)	1.3+7	1.5+7	NAG	EXPT-PROG	INDC(JPN)-187U	MAR 01	SAKANE+.P50.ACT SIG REL AL-27(N,A)
HO	166	(N,GAMMA)	MAXW		JNC	EXPT-PROG	INDC(JPN)-187U	MAR 01	HARADA+.P29.M-STATE.ACT SIG=3+-1 KB
ER	167	(N,GAMMA)	1.0+4	5.5+5	TIT	EXPT-PROG	INDC(JPN)-187U	MAR 01	IGASHIRA+.P65.TOF,NAI(TL).REL 197AU
ER	167	SPECT (N,G)	1.0+4	5.5+5	TIT	EXPT-PROG	INDC(JPN)-187U	MAR 01	IGASHIRA+.P65.TOF,NAI(TL).REL 197AU
HF		TOTAL	2.0-3	1.0+5	KTO	EXPT-PROG	INDC(JPN)-187U	MAR 01	CHO+.P36.LINAC,TOF,LI-6 SCINT. FIG
HF	179	(N,NP)	1.3+7	1.5+7	NAG	EXPT-PROG	INDC(JPN)-187U	MAR 01	SAKANE+.P49.ACT SIG FOR (N,NP+D)
OS	189	(N,NP)	1.3+7	1.5+7	NAG	EXPT-PROG	INDC(JPN)-187U	MAR 01	SAKANE+.P49.ACT SIG FOR (N,NP+D)
PB		DIFF ELASTIC	7.5+7		TOH	EXPT-PROG	INDC(JPN)-187U	MAR 01	IBARAKI+.P61.TOF, 2.6 TO 53 DEG.

ELEMENT S	A	QUANTITY	ENERGY MIN	ENERGY MAX	LAB	TYPE	DOCUMENTATION REF VOL PAGE	DATE	COMMENTS
U	233	FISSION	NDG		KYU	EVAL-PROG	INDC(JPN)-187U	MAR 01	KAWANO+.P41.SIMUL EVAL FOR JENDL-3.3
U	235	FISSION	NDG		KYU	EVAL-PROG	INDC(JPN)-187U	MAR 01	KAWANO+.P41.SIMUL EVAL FOR JENDL-3.3
U	238	FISSION	NDG		KYU	EVAL-PROG	INDC(JPN)-187U	MAR 01	KAWANO+.P41.SIMUL EVAL FOR JENDL-3.3
NP	237	(N,GAMMA)	1.0-2	1.0+4	KTO	EXPT-PROG	INDC(JPN)-187U	MAR 01	LEE+.P35.LINAC,TOF,C6F6 SCINT. FIG
PU	239	FISSION	NDG		KYU	EVAL-PROG	INDC(JPN)-187U	MAR 01	KAWANO+.P41.SIMUL EVAL FOR JENDL-3.3
PU	240	FISSION	NDG		KYU	EVAL-PROG	INDC(JPN)-187U	MAR 01	KAWANO+.P41.SIMUL EVAL FOR JENDL-3.3
PU	241	FISSION	NDG		KYU	EVAL-PROG	INDC(JPN)-187U	MAR 01	KAWANO+.P41.SIMUL EVAL FOR JENDL-3.3
MANY		EVALUATION		3.0+9	JAE	EVAL-PROG	INDC(JPN)-187U	MAR 01	FUKAHORI+.P20.FOR JENDL HIGH E FILE

I. Aichi Shukutoku University

A. Department of Media Production and Theories

I-A-1

Properties of Fission-Product Decay Heat from Minor-Actinide Fissioning Systems

Kazuhiro Oyamatsu and Hideki Mori*

A paper on this subject was published in Proc. 1999 Nuclear Data Symposium (JAERI-Conf 2000-005, pp. 154-159, 2000) with the following abstract.

The aggregate Fission-Product (FP) decay heat after a pulse fission is examined for Minor Actinide (MA) fissiles ^{237}Np, ^{241}Am, ^{243}Am, ^{242}Cm and ^{244}Cm. We find that the MA decay heat is comparable but smaller than that of ^{235}U except for cooling times at about 10^8 s (≈3 y). At these cooling times, either the β or γ component of the FP decay heat for these MA's is substantially larger than the one for ^{235}U. This difference is found to originate from the cumulative fission yield of ^{106}Ru ($T_{1/2}=3.2\times10^7$ s). This nuclide is the parent of ^{106}Rh ($T_{1/2}=29.8$ s) which is the dominant source of the decay heat at 10^8 s (≈3 y). The fission yield is nearly an increasing function of the fissile mass number so that the FP decay heat is the largest for ^{244}Cm among the MA's at the cooling time.

* *Department of Engineering and Science, Nagoya University*

I-A-2

Simple estimate of fission rate during JCO criticality accident

Kazuhiro Oyamatsu

A paper on this subject was published in Proc. 1999 Nuclear Data Symposium (JAERI-Conf 2000-005, pp. 387-391, 2000) with the following abstract.

The fission rate during JCO criticality accident is estimated from fission-product (FP) radioactivities in a uranium solution sample taken from the preparation basin 20 days after the accident. The FP radioactivity data are taken from a report by JAERI released in the Accident Investigation Committee. The total fission number is found quite dependent on the FP radioactivities and estimated to be about 4×10^{16} per liter, or 2×10^{18} per 16kgU (assuming uranium concentration 278.9 g/liter). On the contrary, the time dependence of the fission rate is rather insensitive to the FP radioactivities. Hence, it is difficult to determine the fission number in the initial burst from the radioactivity data.

II. Aoyama University

A. Department of Physics

II-A-1

On the Analysis of Radioactivity by Using Accumulation Time for Set Number of Radiation

Takashi Awaya

New methods of radioactivity measurement and of its data-analysis are proposed. The new method of measurement requires to observe the accumulated time by which the set number of radiations are detected. The new method of analysis is constructed on the assumption that the measurements would be carried out according to the above-mentioned method.

The new analysis leads to get the theoretically exact confidence level of the interval estimation of the parent mean of radioactivity. This is because that the accumulated time is of the continuous variable and its probability distribution can be easily deduced from chi-square distribution. Useful tables to get the estimated interval are prepared. The results agree with those by computer simulations.

These methods are also applied to the hypothesis testing of radioactivity data. A comparison of two data is often required in order to check whether these data would belong to the same parent population. This comparison can be easily done by making use of an F-test, even for low-statistical data.

A new concept of the detection limit of radioactivities is also introduced by using these new method.

III. Electrotechnical Laboratory

A. Quantum Radiation Division

III-A-1

Photon spectrometry in thermal neutron standard field

K. Kudo, N. Takeda, S. Koshikawa, H. Toyokawa, H.Ohgaki and M. Matzke[1]

It is often necessary in neutron calibration fields to determine the dose of γ-rays because some types of neutron detector are sensitive both to neutrons and γ-rays. In measuring γ-rays mixed in a neutron field, conventional γ-ray detectors such as the GM counter, NaI scintillator and Ge detector are influenced by neutron-induced photons in the detector assembly. Such secondary photons produced in a detector cannot be separated easily from photons in a neutron field.

An NE213 scintillation counter was used to measure the mixed photon dose in a neutron field[(1),(2)]. The scintillator was encapsulated in a standard BA1 cylindrical cell (inner size: 5.08 cm in diameter and 5.08 cm long). Conventional measurement of pulse shape discrimination and multiparameter data acquisition was used to process signals from a photomultiplier tube (R329-02, Hamamatsu) and to separate photon signals from those neutron-induced. To remove thermal neutron-induced photons in the NE213 scintillator, natural lithium fluoride (LiF) powder was used to shield the NE213 scintillation counter assembly.

The γ-ray response function of the NE213 scintillation counter was measured using γ-ray reference sources of ^{88}Y, ^{60}Co, ^{22}Na, ^{54}Mn and ^{137}Cs (Amersham Buchler GmbH & Co KG). To calibrate the NE213 scintillation counter, sources were positioned 23 cm from the center of the NE213 scintillator on the cylindrical axis. Above 3 MeV, the response function was measured using a laser-Compton-scattered (LCS) photon beam to determine the nonlinear relationship between electron-deposited energy and light output from the NE213 counter assembly[(3)].

The γ-ray response function for the NE213 scintillation counter was calculated using EGS4 code coupled with the parameter-reduced electron-step transport algorithm (PRESTA) routine developed to minimize the dependence of results on step size in electron transport simulation[(4),(5)]. We used the HEPRO program package to unfold the measured pulse height spectra, choosing GRAVEL and MIEKE codes because of their better results[(6),(7)]. GRAVEL unfolds using a modified SAND-II algorithm. MIEKE is a Monte Carlo unfolding code including uncertainty analysis. The pulse height distributions of photons measured for reference γ-ray sources and in the thermal neutron field were unfolded to obtain energy distributions.

The pulse height spectrum measured in the thermal neutron field was unfolded by GRAVEL and the MIEKE codes. The measured pulse height spectrum and unfolded energy distributions are shown in Fig. 1-(a) and 1-(b). Photon spectra showed a very similar shape over the entire energy range. To confirm unfolding

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procedures, unfolded spectra were refolded to obtain a pulse height spectrum and compared to the experimental pulse height spectrum as shown in Fig. 1-(a). They agreed well with the measured pulse height spectrum. Fluence uncertainties of each energy bin obtained by MIEKE analysis ranged from ±1% to ±5% and up to ±40% above 5 MeV. A 2.2 MeV peak mainly caused by the H(n,γ) reaction in the NE213 scintillator is still observed among other peaks. By comparing total counts measured by the NE213 scintillator with LiF and without LiF, it was reduced to 30%, however could not be removed perfectly. One reason is that intermediate and fast neutrons contaminated in the thermal neutron field produce 2.2 MeV photons interacting with the scintillator.

To obtain the effective dose equivalent, the energy distribution was multiplied by the corresponding conversion coefficient from fluence to dose and integrated over the entire energy range. The effective dose equivalent under the irradiation geometries of anteroposterior (AP) and LAT (irradiation from either side of the body) were determined as (0.47 ±0.05) μSv/h and (0.35 ±0.05) μSv/h, compared to the dose of (0.57 ±0.1) μSv/h measured by the ^{3}He-filtered GM counter. The dose of 2.2 MeV photons contributed about 8% to the total effective dose equivalent.

References

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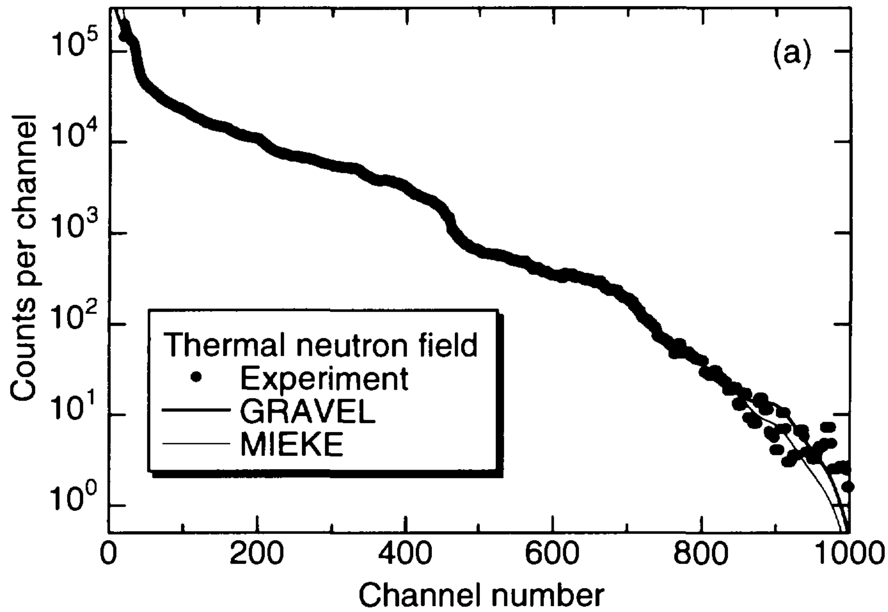

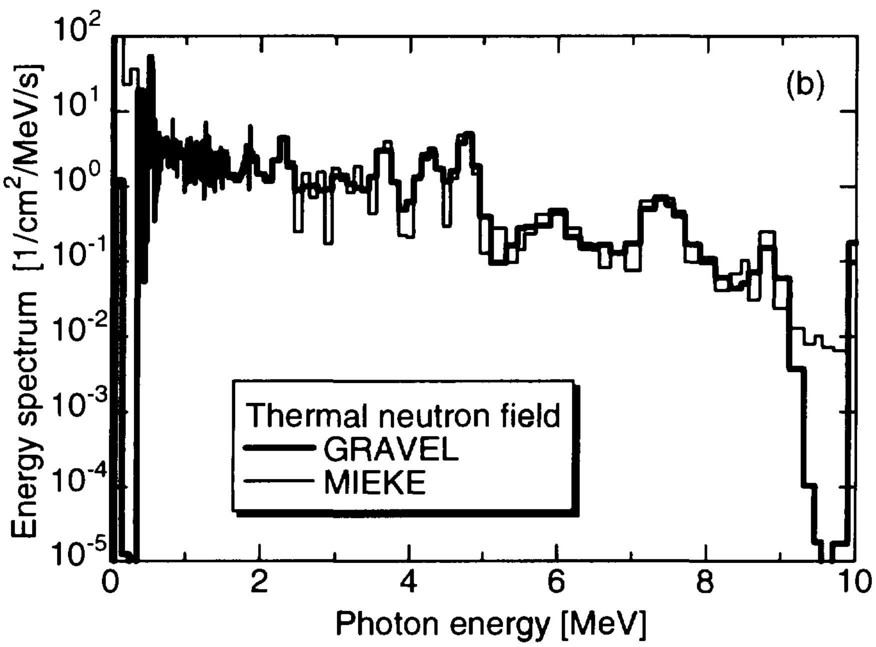

Fig. 1-(a) Measured pulse height spectrum (dots) and refolded spectra by MIEKE (thin line) and GRAVEL (thick line) code

Fig. 1-(b) Comparison of photon energy distribution in a thermal neutron field unfolded by MIEKE (thin line) and GRAVEL (thick line) code

III-A-2

Measurement of thermal neutron fluence rate at the KUR heavy water neutron irradiation facility

N. Takeda, K. Kudo, Y. Hino, S. Koshikawa,
K. Kobayashi[1], S. Yoshimoto[1], Y. Sakurai[1] and T. Kobayashi[1]

The primary national standard of thermal neutron fluence rate has been established with the uncertainty less than 1% at Electrotechnical Laboratory (ETL) by using a gold foil activation method in a standard graphite pile. However, the fluence rate for irradiation is below 10^5 [n/cm^2/s] and the calibration of neutron detecting device is limited. In order to increase the fluence rate of thermal neutrons up to 10^9 [n/cm^2/s], we started the cooperation with the Kyoto University Research Reactor Institute to establish the higher intensity field of thermal neutrons by using the heavy water neutron irradiation facility.

The heavy water neutron irradiation facility at the KUR (Kyoto University Research Reactor of 5MW reactor power) provides thermal neutrons and epi-thermal neutrons beam for neutron capture therapy or experimental studies of biological radiation effects. Figure 1 shows the schematic top view of the neutron irradiation room. T. Kobayashi et. al.[(1)] were measured basic irradiation characteristics (thermal neutron flux, epi-thermal neutron flux and gamma-ray dose equivalent etc.) at a nominal irradiation point by changing thickness of the heavy water. In the irradiation room, a removable rail device was installed for experimental studies of biological radiation effects. In this experiment, the nominal thermal neutron flux and epi-thermal neutron flux were 5.9×10^8 [n/cm^2/s] and 1.7×10^6 [n/cm^2/s] (irradiation mode OO-0111-F), respectively. The gold foils were irradiated at 1 cm from the nominal irradiation point and the induced radioactivity was measured by two different measuring systems of a Ge detector at KUR and a $4\pi\beta$-γ coincidence method at ETL.

The neutron flux derived from gold activation measurements performed last for 2 years showed the deviation due to the gold foil position in the room and the reactor conditions on a position of control rod and the relative burn-up rate among the fuel assemblies. Therefore, we planned to set ^{3}He gas proportional counters as a precise real time neutron fluence monitor.

The ^{3}He gas proportional counter used in this experiment has 7.5cm length and 1.27cm diameter, with 0.4MPa of ^{4}He gas, 0.2MPa of argon gas, and 0.1% of ^{3}He gas. To choose the suitable monitor position in the irradiation room, the counter was set on the movable apparatus along the central part of the room and the count-rate was measured along the rail from the nominal position to the end of straight part of the rail device positioned at about 140cm., as shown in Figure 1. The ^{3}He counter was covered with a B_4C rubber sheet to decrease the count rate. The measured count rate of ^{3}He counter along the rail device is shown in Figure 2. The count-rate measured at any point (except for near the nominal point) was less than 1000 cps. It means that the counter with the B_4C filter would be suitable as a monitor in the room without worrying about the correction of dead time or pulse pile up.

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[1] Research Reactor Institute, Kyoto University

Furthermore, the difference of counts rate between with and without the B_4C cover has been measured at 131.7cm and the nominal point, as listed in Table 1. The counts rate ratio changed depending on the position due to the different thermal and epi-thermal neutron distribution in the irradiation room. We will continue this experiment to establish the monitoring system required in the gold activation method.

Table 1. Comparison of counts rate between with and without the B_4C cover.

Position	131.7cm	Sample entrance
With B_4C cover	39.3 [c.p.s.]	8.5 [c.p.s.]
Without B_4C cover	18818.6 [c.p.s.]	6672.1 [c.p.s.]
Ratio (without/with)	478.8	785.0

Reference

(1) T. Kobayashi et. al., Proceedings of 10th Reactor Dosimetry held on Osaka in 1999. In press.

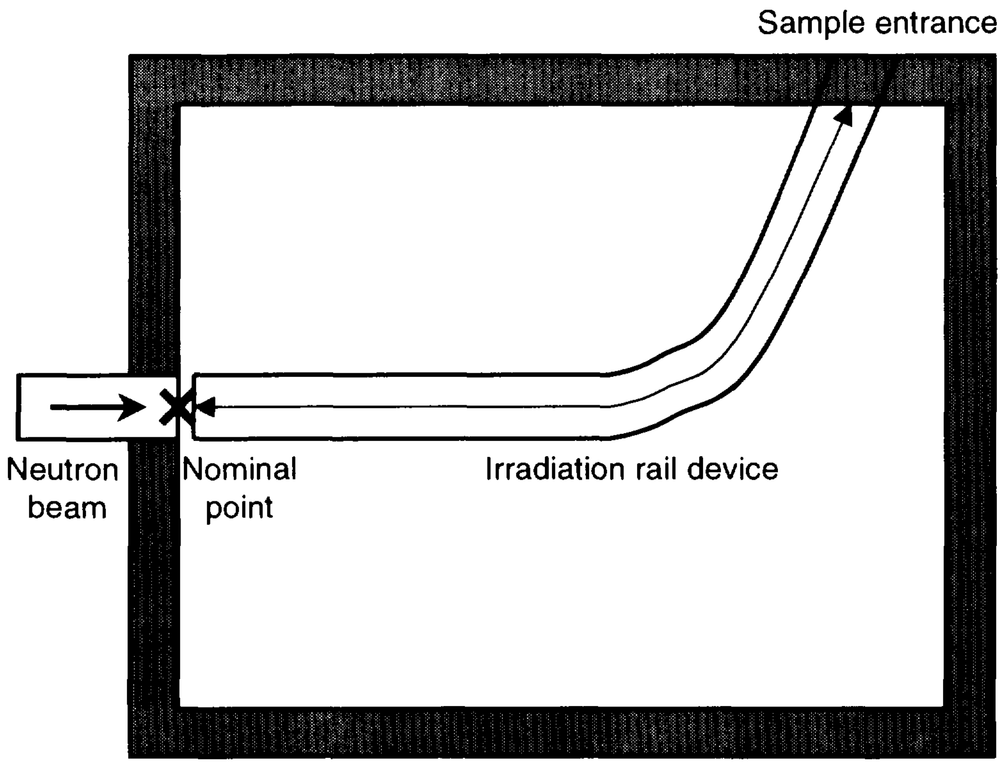

Figure 1. Schematic top view of the heavy water neutron irradiation facility.

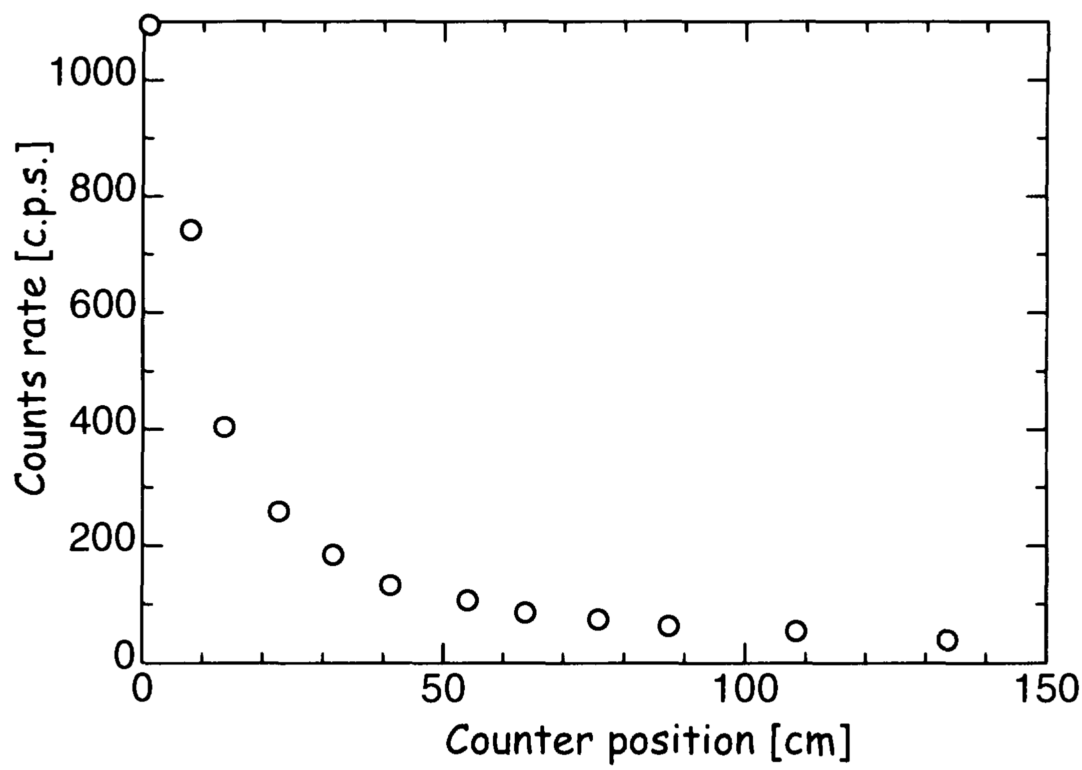

Figure 2. An example of the pulse height spectrum measured by the ^{3}He gas proportional counter.

IV. Japan Atomic Energy Research Institute

A. Nuclear Data Center and Working Groups of Japanese Nuclear Data Committee

IV-A-1

Evaluation of Sodium Data for JENDL-3.3

Keiichi SHIBATA

Neutorn nuclear data of sodium have been evaluated for JENDL-3.3. Most of the reaction cross sections were calculated by using the multi-step statistical model code TNG [1]. The Reference Input Parameter Library (RIPL) [2], which was developed at IAEA, was used to prepare data required as input to the TNG code. The neutron optical-model parameters were adjusted so as to reproduce measured total cross sections with the least-squares method. We adopted Perey's [3] and Huizenga-Igo's [4] optical-model parameters for protons and α-particles, respectively. As for nulcear level density, the composite formula was adopted for sodium isotopes, while the constant temperature model was used for fluorine and neon isotopes. The direct process for inelastic scattering was taken into account with DWBA calculations. Concerning the inelastic scattering to the first excited state, the calculated values were replaced with the high resolution measurements of IRMM [5] below 4 MeV.

Figure 1 shows the (n,n'γ) cross sections. The TNG calculations are in good agreement with the measurements. The presently evaluated data were compiled into JENDL-3.3.

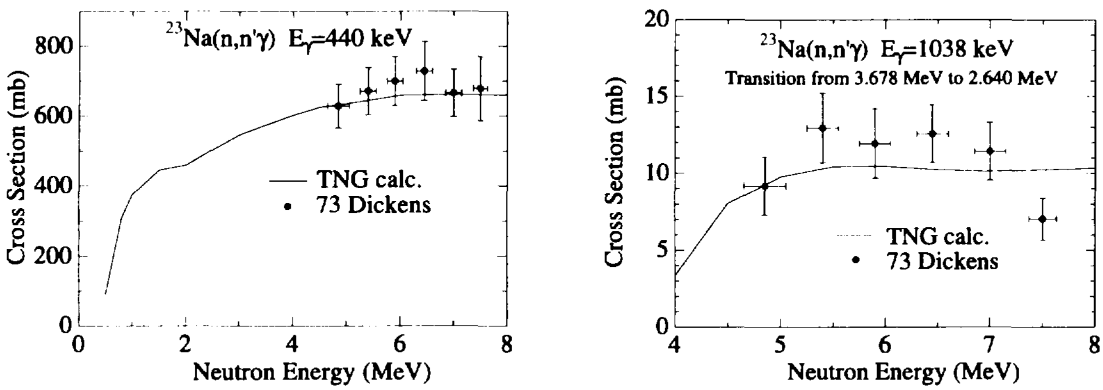

Fig. 1 ^{23}Na(n,n'γ) cross sections.

References

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[2] IAEA NDS: *IAEA-TECDOC*-1034 (1998).

[3] F.G. Perey: *Phys. Rev.*, **131**, 745 (1963).

[4] J.R. Huizenga and G. Igo: *Nucl. Phys.*, **29**, 462 (1962).

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IV-A-2 Nuclear Data Evaluation and Compilation for JENDL Intermediate Energy Files

T. Fukahori and High Energy Nuclear Data Evaluation WG (JNDC)

The JAERI Nuclear Data Center started evaluation work in cooperation with Japanese Nuclear Data Committee (JNDC) to produce files related intermediate energy.

The JENDL High Energy File includes nuclear data for proton- and neutron-induced reactions. Below 20 MeV, the data of JENDL Fusion File[1] or JENDL-3.2[2] were adopted. The compilation was done for the neutron file for IFMIF[3] in the energy range up to 50 MeV for the nuclides of ^{12}C, ^{23}Na, $^{24-26}$Mg, ^{27}Al, $^{28-30}$Si, ^{39}K, $^{40,42-44,46,48}$Ca, $^{46-50}$Ti, ^{51}V, $^{50,52-54}$Cr, ^{55}Mn, $^{54,56-58}$Fe, $^{58,60-62,64}$Ni, ^{63,65}Cu, ^{89}Y, $^{182-184,186}$W. The evaluation work for the neutron and proton files energy range up to 3 GeV was performed by mainly using the "quick-GNASH system"[4] and JQMD code[5]. The compiled nuclides for the JENDL High Energy File are ^{1}H, ^{52}Cr, $^{40,42-44,46,48}$Ca, $^{50,52-54}$Cr, ^{63,65}Cu, ^{55}Mn, $^{46-50}$Ti.

The JENDL Photonuclear Data File is provided for applications such as electron accelerator shielding and radiation therapy, and given for γ-ray induced reactions up to 140 MeV. The photon absorption cross section was evaluated with the giant dipole resonance model and quasi-deuteron model, and the decaying processes were estimated with the statistical model with preequilibrium correction by using MCPHOTO[6] and ALICE-F[7] codes. The nuclides of ^{2}H, ^{12}C, ^{14}N, ^{16}O, ^{29,30}Si, ^{51}V, ^{54,56}Fe, ^{58}Ni, ^{63,65}Cu, ^{64}Zn, ^{90}Zr, ^{93}Nb, ^{160}Gd, ^{181}Ta, ^{182,184,186}W, $^{206-208}$Pb, ^{235,238}U were compiled and their format was checked.

The JENDL PKA/KERMA File is generated to supply primary knock-on atom (PKA) spectra, damage energy spectra, DPA (displacement per atom) cross sections and kerma factors by neutron-induced reactions in the energy region up to 50 MeV. A processing code system, ESPERANT[8] was developed to calculate above quantities from evaluated nuclear data file by using effective single particle emission approximation (ESPEA).

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IV-A-3

Nuclear Data Sheets for A=119

ENSDF group*

The new evaluation of A=119 mass chain was published in Nucl. Data Sheets 89, 345 (2000) with the following abstract:

The experimental results from various decays and reactions for A=119 mass chain have been compiled and evaluated. Adopted values for the level and decay properties are tabulated and also shown in the drawings.

Cutoff Date: All data available up to March 1, 1999 have been considered.

IV-A-4

Nuclear Data Sheets for A=121

ENSDF group*

The new evaluation of A=121 mass chain was published in Nucl. Data Sheets 90, 107 (2000) with the following abstract:

The 1990 evaluation for A=121 mass chain (1999Ta18) has been revised using experimental results from decays and reactions. Adopted values for the level and decay properties are tabulated. Inconsistencies and discrepancies are noted. All data available before February 1999 have benn considered.

Cutoff Date: All data available up to July 1, 1999 have been considered for inclusion in this evaluation.

* Members are K. Kitao, M. Kambe, S. Ohya, T. Horiguchi, Y. Tendow, T. Tamura, M. Osima, H. Iimura and J. Katakura

B. Research Group for Hadron Science

IV-B-1

Shell Structure of Nuclei in Strong Magnetic Fields in Neutron Star Crust

V.N. Kondratyev, T. Maruyama and S. Chiba

A paper on this subject was published in Phys. Rev. Lett. **84**, 1086(2000) with the following abstract:

By employing Strutinsky's treatment we demonstrate that the magnetic field gives rise to ta phase shift of the shell oscillations in nuclear masses. The proton orbital magnetism is shown to enhance the nuclear shell effect especially when the field influence is comparable to the spin-orbit coupling. The magnetic field of the strength scale $B \sim 10^{16} - 10^{17}$ G is found to shift significantly the nuclear magic numbers of the iron region towards smaller mass numbers.

IV-B-2

Kinetics in Subbarrier Fusion of Spherical Nuclei

V.N. Kondratyev, A. Bonasera and A. Iwamoto

A paper on this subject was published in Phys. Rev. C**61**, 044613(2000) with the following abstract:

The semiclassical transport theory is applied to the description of heavy-ion fusion at energies below and above the Coulomb barrier. The paths connecting entrance and exit fusion reaction channels are found as a continuous solution of the Vlasov transport equation in classically allowed and forbidden regions associated with suitably defined collective variables. The effects of nuclear deformation, neck formation, and nonlocality are quantified on the basis of microscopic simulations and analyzed. The results of calculations give good fits to experimental data for fusion of nearly symmetric oxygen and nickel isotope pairs.

IV-B-3

Isoscalar Giant Quadrupole Resonance State in the Relativistic Approach with the Momentum-dependent Self-energies

Tomoyuki Maruyama and Satoshi Chiba

A paper on this subject was published in Phys. Rev. **C61**, 037301(2000) with the following abstract:

We study the excitation energy of the isoscalar giant quadrupole resonance by the scaling method in the relativistic many-body framework with the momentum-dependent parts of the Dirac self-energies arising from the one-pion exchange. It is shown that this momentum-dependence enhances the Landau mass significantly and thus suppresses the quadrupole resonance energy while the Dirac effective mass is kept to a reasonable value.

IV-B-4

QMD simulation of expanding nuclear matter

S. Chikazumi, T. Maruyama, K. Niita and A. Iwamoto

A paper on this subject was published in Phys. Lett. **B476**, 273(2000) with the following abstract:

We study the properties of dynamically expanding nuclear matter. For this purpose, we apply quantum molecular dynamics (QMD) model to homogeneously expanding three-dimensional system with periodic boundary condition. Simulation is performed for given initial temperatures and expanding velocities. The calculated fragment mass distribution for slow expansion obeys the power law predicted by Fisher's droplet model, while that for rapid expansion exhibits the exponential shape.

IV-B-5

MD simulation study of nuclear matter

T. Kido, T. Maruyama, K. Niita and S. Chiba

A paper on this subject was published in Nucl. Phys. **A663&664**, 877c(2000) with the following abstract:

Properties of nuclear matter below the saturation density is analyzed by molecular dynamics (MD) simulations with the periodic boundary condition. The equation of state at these densities is softened by the formation of cluster(s) with internal density nearly equal to the saturation density. The structure of nuclear matter shows some exotic shapes with variation of the density. Furthermore, it is found that the symmetry parameter $a_{sym}(\rho)$ is not a linear function of density at low density region.

IV-B-6

Color Molecular Dynamics for High Density Matter

T. Maruyama and T. Hatsuda

A paper on this subject was published in Phys. Rev. C**61**, 062201(2000) with the following abstract:

We propose a microscopic approach for quark many-body systems based on molecular dynamics. Using color confinement and one-gluon exchange potentials together with meson exchange potentials between quarks, we construct nucleons and nuclear/quark matter. Dynamical transition between confinement and deconfinement phases are studied at high baryon density with this molecular dynamics simulation.

IV-B-7

Incident-energy Dependence of the Fragmentation Mechanism Reflecting the Clustering Structure of the ^{19}B Nucleus

H. Takemoto, H. Horiuchi and A. Ono

A report on this subject was published as JAERI-Research 2000-027 (2000) with the following abstract:

We investigate how clustering structure of neutron drip-line nucleus ^{19}B is reflected in heavy-ion reactions. We compare ^{19}B fragmentation in ^{19}B + ^{14}N reactions with ^{13}B fragmentation in ^{13}B + ^{14}N reactions calculated by antisymmetrized molecular dynamics, where ^{19}B has a well developed cluster structure in its ground state while ^{13}B has no clustering features in its structure. The clustering structure of the ^{19}B nucleus is reflected in its fragmentation as the simultaneous breakup of ^{19}B into He and Li isotopes, and we investigate the dependence of this cluster breakup of the ^{19}B nucleus on incident energy. We find that the most adequate incident energy for verification of the clustering structure of the ^{19}B nucleus by the use of the coincident experiment between He and Li isotopes is around 30 MeV/nucleon. This incident-energy dependence can be explained in terms of the competition between the mean-field effect and nucleon-nucleon collision processes. The mean-field effect causes the cluster breakup of the ^{19}B nucleus, while nucleon-nucleon collision processes work to destroy constituent clusters of the ^{19}B nucleus. We also investigate the influence of the neutron-rich property of the ^{19}B nucleus.

Coupled-channels Optical Potential for Interaction of Nucleons with ^{12}C up to 150 MeV in the Soft-rotator Model

S. Chiba, O. Iwamoto, E.Sh. Sukhovitskiĩ, Y. Watanabe and T. Fukahori

A paper on this subject was published in J. Nucl. Sci. Technol. **37**, 498(2000) with the following abstract:

The soft-rotator model was employed for a consistent analysis of the collective nuclear structure, B(E2) and the nucleon (both neutron and proton) interaction with ^{12}C, and the optical potential parameters were deduced to describe the nucleon-induced cross sections up to 150 MeV. It was found that the state-dependent enhancement of the coupling strengths for various transitions as predicted by the soft-rotator model, determined from the analysis of the collective level structure, was inevitable to describe the nucleon scattering to different excited states in a unified manner. It was also recognized that inclusion of the proton scattering data is important to estimate the optical potential parameters up to high incident energies. As a consequence, the model could describe nucleon interaction data with a good accuracy up to 150 MeV, showing that the present method is a powerful tool for evaluation of nucleon-induced nuclear data, especially for the high energy libraries.

V. Japan Nuclear Cycle Development Institute

A. Waste Management and Fuel Cycle Research Center

V-A-1

Measurement of Effective Neutron Capture Cross Section of ^{166m}Ho using Two Step Irradiation Technique

Hideo HARADA[1], Hiroaki WADA[1], Shoji NAKAMURA[1], Kazuyoshi FURUTAKA[1], and Toshio KATOH[1),2)]

A paper on this subject was published in J. Nucl. Sci. Technol. Vol. 37, No. 9, p. 821, (2000) as a Short Note. The content is as follows.

The effective neutron capture cross section was measured by an activation method. Two step irradiation technique was introduced to make an activation method effective. Samples of ^{166m}Ho were made via the reaction ^{165}Ho(n, γ)^{166m}Ho. The neutron irradiation (1st irradiation) was made at the research reactor of Rikkyo University. The neutron flux of the reactor was (5.57 $\pm$ 0.06) x 10^{11} n/cm$^2\cdot$s. A Ho metallic foil (Sample No. 2) was irradiated for 6 h. and another Ho metallic foil(Sample No. 1) for 12 h. After this irradiation, the sample No.2 was cooled for 28 days to reduce the activity of ^{166g}Ho ($T_{1/2}$ = 26.83 $\pm$ 0.03 h), and the sample No. 1 was cooled for 26 days. The numbers of nucleus of ^{166m}Ho in the samples were estimated from the intensities of γ rays measured by a high purity Ge detector. After the period of cooling time, two samples were again irradiated (2nd irradiation) at the Rikkyo reactor to produce ^{167}Ho via the reaction ^{166m}Ho(n, γ)^{167}Ho during a period of 30 min. In this case, ^{167}Ho produced from ^{165}Ho via the double neutron capture process of ^{165}Ho are included in the samples after the 2nd irradiation. The amount produced by this process was estimated from the difference of activities of the two samples after the 2nd irradiation and corrected. The data obtained was analyzed by the Westcott convention. The effective neutron capture cross section obtained for ^{166m}Ho was 3 $\pm$ 1 kb and three times smaller than the value calculated from the resonance parameters by Masyanov et al.

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1) Tokai Works, Japan Nuclear Cycle Development Institute
2) Gifu College of Medical Technology

V-A-2

Production of the Isomeric State of ^{138}Cs in the Thermal Neutron Capture Reaction $^{137}Cs(n, \gamma)^{138}Cs$

Hiroaki WADA[1], Shoji NAKAMURA[1], Kazuyoshi FURUTAKA[1], Toshio KATOH[1,2], Hajimu YAMANA[3], Toshiyuki FUJII[3], Hideo HARADA[1]

A paper on this subject was published in J. Nucl. Sci. Technol. Vol. 37, No. 10, P. 827 (2000) with the following abstract.

In order to obtain precise data of the neutron capture cross section of the reaction $^{137}Cs(n, \gamma)^{138}Cs$, the production probability of isomer state ^{138m}Cs was measured in this work. Targets of about 0.37 MBq ^{137}Cs were irradiated for 3 mm in the pneumatic tube facility (Pn-3) of Kyoto University Reactor (KUR). The 1,436 keV γ ray emitted from both of ^{138g}Cs and ^{138m}Cs was measured. A ratio of the production probability between ^{138g}Cs and ^{138m}Cs was deduced from time dependence of peak counts of 1,436 keV γ ray by making use of difference of half-lives of ^{138g}Cs (33.41 min) and ^{138m}Cs (2.91 min). The production probability of ^{138m}Cs was obtained as 0.75 $\pm$ 0.18 and this value revised the effective cross section upwards by 9$\pm$ 2%. The effective cross section $\hat{\sigma}$ and the thermal neutron capture cross section σ_0 were obtained as $\hat{\sigma}$=0.29$\pm$ 0.02 b and σ_0 =0.27$\pm$ 0.03 with taking into account the production of ^{138m}Cs.

1) Tokai Works, Japan Nuclear Cycle Development Institute
2) Gifu College of Medical Technology
3) Research Reactor Institute, Kyoto University

V-A-3

Evaluation of β–γ Coincidence Measurement System Using Plastic Scintillation β–ray Detector Developed for the Determination of γ–ray Emission Probabilities of Short-lived Nuclides

Kazuyoshi FURUTAKA[1], Shoji NAKAMURA[1], Hideo HARADA[1]
and Toshio KATOH[1,2]

A paper on this subject was published in J. Nucl. Sci. Technol. Vol. 37, No. 10, p. 832 (2000) with the following abstract.

For precise determination of γ-ray emission probabilities of short-lived nuclides whose half-lives are less than a few minutes, a β–γ coincidence measurement system has been developed which used a plastic scintillator as a β–ray detector. The system was applied to a measurement of the absolute γ-ray emission probability of 1,779 keV γ ray in ^{28}Al ($T_{1/2}$ = 2.24 min), whose γ-ray emission probability is well known. The uncertainty of the measured γ-ray emission probability was smaller than 2%. Performance of the β–γ coincidence system has been determined for a short-lived nuclide, and the details of the corrections have been analyzed.

1) Tokai Works, Japan Nuclear Cycle Development Institute
2) Gifu College of Medical Technology

B. Reactor Physics Research Group

V-B-1

Decay Heat Measurement of Actinides at YAYOI

Yasushi OHKAWACHI Akira SHONO
Reactor Physics Research Group, System Engineering Technology division, OEC, JNC

The decay heat of U235 was measured for cooling times between 19 and 20,000 seconds, and Np-237 was measured for cooling times between 64 and 20,200 seconds. The samples were irradiated at the center of the grazing hole at YAYOI for time periods of 10 and 100 seconds for U235, 100 and 500 seconds for Np-237. Gamma-ray energy spectra were measured using a NaI(Tl) scintillation detector. Beta-ray energy spectra were measured using a plastic scintillation detector combined with a proportional counter to eliminate gamma-ray effects.The number of fission for normalization was evaluated from measured gamma spectra by Ge detector.

Measured pulse height data were corrected for background data, and unfolded using the FERDO code with the use of the response function of the detector. Each unfolded spectrum was divided by the number of fission per second to obtain the normalized spectra. The finite irradiation decay heat data were obtained from the normalized spectra. And, the finite irradiation decay heat were converted to the fission burst decay heat.

The experimental result for U-235 is shown in Fig.1. The present results on gamma-ray decay heat for U-235 agreed with Akiyama's data within experimental error. And, the present results agree with the summation calculations results using JNDC-V2 and ENDF-B/VI.

The experimental result for Np-237 is shown in Fig.2. The present results on gamma-ray decay heat for Np-237 agree with the summation calculations results using JNDC-V2 and ENDF-B/VI between 200 to 2,500 seconds. Between 60 to 200 seconds, the agreement is not so well. The reason may be a smaller correction factor used for converting finite irradiation decay heat to fission burst decay heat, in this time zone. The accuracy of the present results between 2,500 to 20,000 seconds is bad. The reason is gamma-rays released from Np-238, that were generated by neutron capture reaction of Np-237. As for this time zone, the decay heat corrected for gamma-rays released from Np-238 will improve the agreement with a summation calculation result using JNDC-V2.

Beta-ray decay heat were also measured using the same method. These data were converted to the fission burst decay heat and comparison with the summation calculations. In the future, these data will be considered.

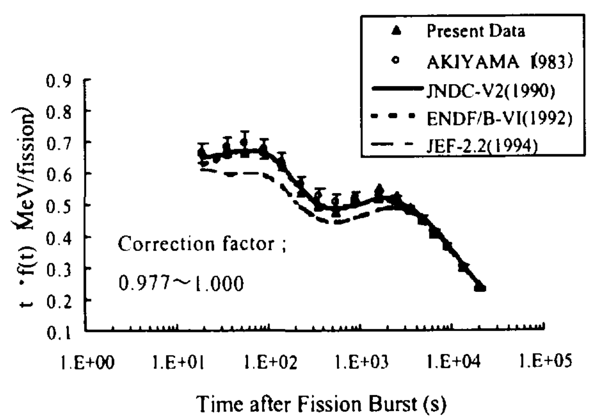

Fig. 1 Gamma Fission Burst Decay Heat for U-235

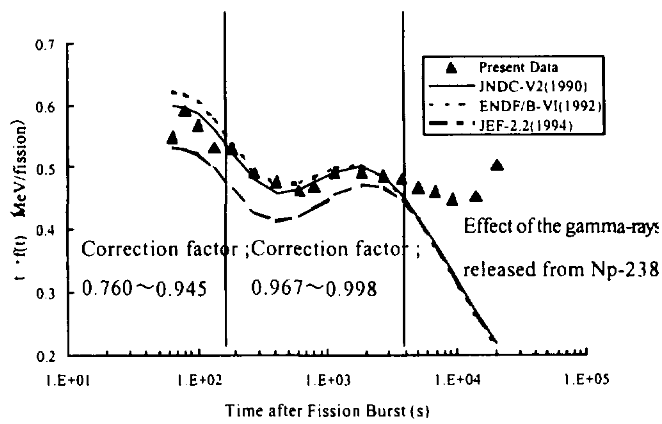

Fig. 2 Gamma Fission Burst Decay Heat for Np-237

VI. Kyoto University

A. Research Reactor Institute

VI-A-1

Neutron Capture Cross Section Measurement of Np-237 below 10 keV by Linac Time-of-Flight Method

Samyol Lee[1], Shuji Yamamoto[1], Hyun-Je Cho[1*], Takaaki Yoshimoto[1], Katsuhei Kobayashi[1], Yoshiaki Fujita[1], and Yasushi Ohkawachi[2]

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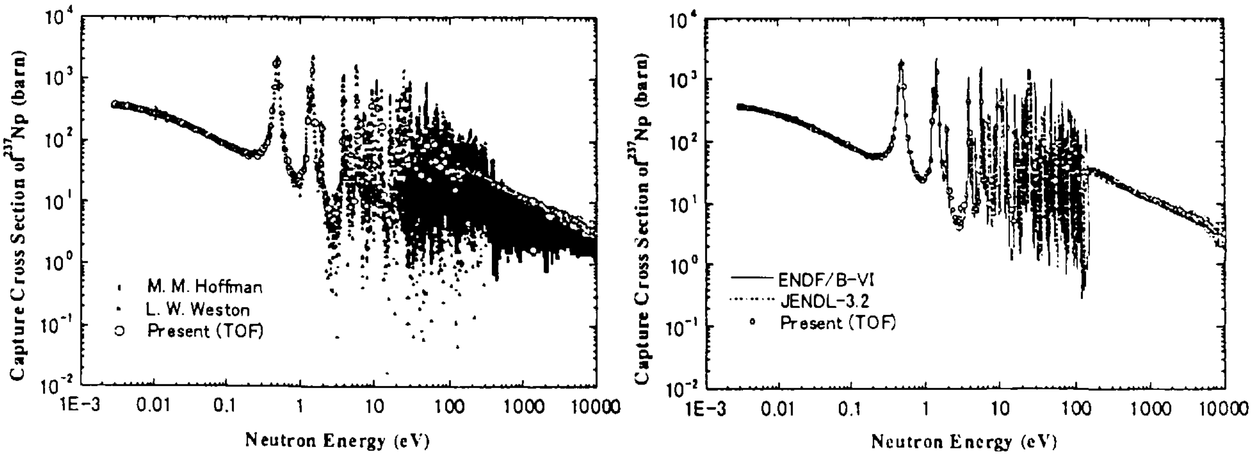
A paper on this subject was presented at the 2000 Symposium on Nuclear Data at Tokai-mura, JAERI held on Nov. 16-17, 2000 with the following abstract.

The neutron capture cross section of ^{237}Np has been measured in the energy region from 0.01 eV to 10 keV by using the neutron time-of-flight (TOF) method with a 46 MeV electron linear accelerator (linac) at the Research Reactor Institute, Kyoto University (KURRI). A pair of C_6D_6 scintillation detectors, which was placed at a distance of 12.0 ± 0.02 m from the pulsed neutron source, was employed for the prompt capture gamma-ray measurement from the ^{237}Np sample. The measured result has been normalized to the reference value (181 b) of the ^{237}Np(n,γ)^{238}Np reaction in ENDF/B-VI at 0.0253 eV.

The existing experimental and the evaluated capture cross sections in ENDF/B-VI and JENDL-3.2 have been compared with the present measurement. For the neutron capture cross section of ^{237}Np, the data by Weston et al. and the evaluated data are in good agreement with the present measurement. However, the data by Hoffman et al. are obviously lower in the relevant energy region.

The data, which were measured before using a lead slowing-down spectrometer at KURRI, have been in good agreement with the data obtained by energy-broadening the present TOF measurement.



Figs. Comparison of the experimental and the evaluated capture cross sections of ^{237}Np.

VI-A-2

Measurement of Neutron Total Cross-Sections of Dy and Hf in the Energy Region from 0.002 eV to 100 keV

H. J. Cho[1*], K. Kobayashi[1], S. Yamamoto[1], Y. Fujita[1], Y.S. Lee[2], G. N. Kim[2]
I.S. Ko[2], M. H. Cho[2], W. Namkung[2] and S. K. Ko[3]

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2 *Pohang Accelerator Laboratory, POSTECH*
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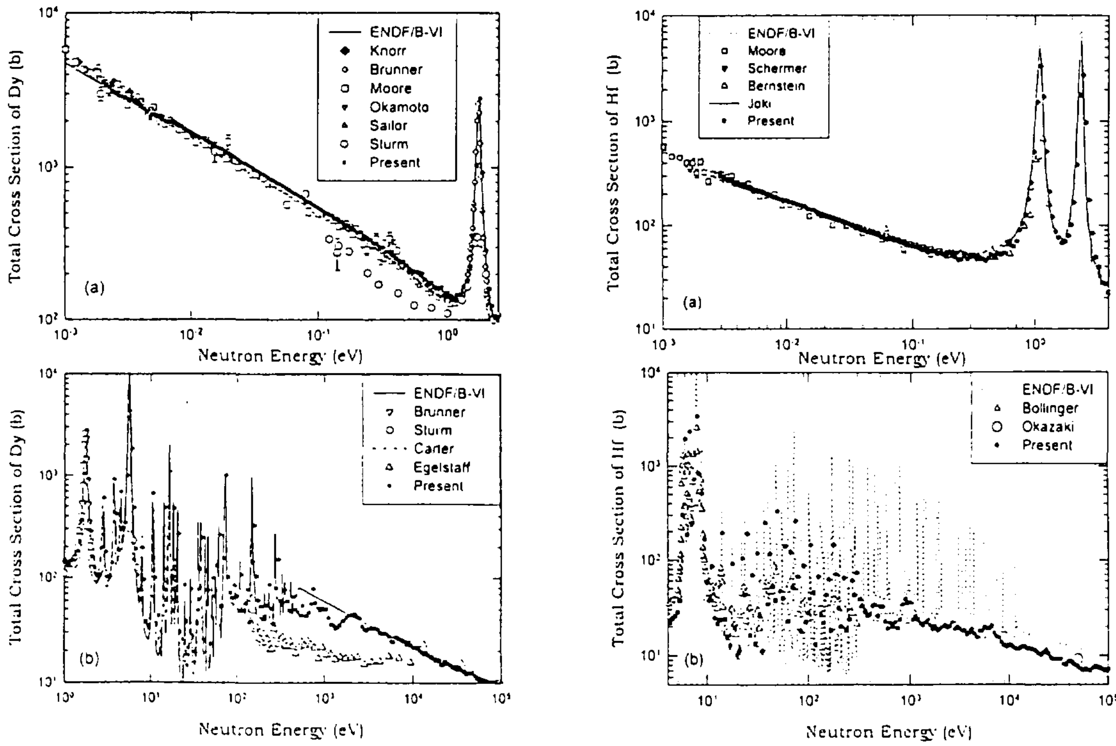
A paper on this subject was submitted Annals of Nuclear Energy 27, 1259-1269 (2000) with the following abstract.

The neutron total cross sections of Dy and Hf have been measured in the energy region from 0.002 eV to 100 keV by the neutron time-of-flight method with a 46 MeV electron linear accelerator of the Research Reactor Institute, Kyoto University. A ^{6}Li glass scintillator has been used as a neutron detector and metallic plates of Dy and Hf samples, 0.5 – 5.0 mm thick, have been used for the neutron transmission measurement. The neutron flight path from the water-cooled Ta target to the ^{6}Li glass scintillator is 22.1$\pm$0.01 m. The background level has been determined by the block-off method and/or by using notch-filters of Co (132eV), Ag (5.2 and 16.3eV) and Mn (336eV) and a Cd sheet. The present measurements are in general agreement with the previous ones and the evaluated data in ENDF/B-VI.



Figs. Comparison of the experimental and the evaluated neutron total cross sections of Dy and Hf.

VII. Kyushu University

A. Department of Advanced Energy Engineering and Science

VII-A-1

Measurement of Double Differential Cross Sections of Secondary Charged-Particles Produced by Proton-Induced Reactions at Several Tens of MeV

M. Harada, Y. Watanabe, A. Yamamoto, Y. Tanaka, Sun Weili, K. Shin*, S. Meigo†, O. Iwamoto†, H. Nakashima†, H. Takada†, S. Chiba†, T. Fukahori†, T. Sasa†, and S. Tanaka†

A paper on this subject was published in *J. of Nucl. Sci. and Technol., Suppl.* 1, 687 (2000) with the following abstract:

Double differential cross secitons (DDXs) were measured for production of light-charged particles in proton-induced reactions on ^{12}C and ^{27}Al at two incident energies of 42 and 68 MeV. The measured DDXs were in generally good agreement with LA150 evaluation, except for (p, xd) reactions. The experimental angular distributions of proton elastic and inelastic scattering from ^{12}C showed fairly good agreement with a coupled-channels calculation based on the soft-rotator model.

*Department of Nuclear Engineering, Kyoto University
†Japan Atomic Energy Research Institute

VII-A-2

Design and development of quasi-monoenergetic neutron source using the inverse kinematics of (p, n) reaction

Y. Matsuoka, Y. Watanabe, S. Hachiya, H. Nakamura, Y. Tanaka, N. Ikeda†, and K. Sagara†

A paper on this subject was published in Proc. of the 1999 Nuclear Data Symposium, JAERI Conf-2000-005 (2000) 266 with the following abstract:

We have started to develop a new quasi-monoenergetic neutron source using the inverse kinematics of (p, n) reaction at Kyushu University Tandem Laboratory. A preliminary experiment was performed for a neutron source using the $^{1}H(^{13}C,n)^{13}N$ reaction at an incident energy of 59.3 MeV. It was expetimentally observed that monoenergetic neutrons with about 7 MeV were produced at 0° to a forward cone restricted by the kinematics.

† Department of Physics, Kyushu University

VII-A-3

Inclusive reaction $^{40}Ca(p, p'x)$ at an incident energy of 392 MeV

A.A. Cowley*, G.F. Steyn**, Y. Watanabe, T. Noro†, K. Tamura†, M. Kawabata†, K. Hatanaka†, H. Sakaguchi‡, H. Takeda‡, and M. Itoh‡

A paper on this subject was published in *Phy. Rev. C* **62**, 064604 (2000) with the following abstract:

Emission-energy distributions were measured for the inclusive $^{40}Ca(p,p')$ reaction at an incident energy of 392 MeV and an angular range between 25° and 120°. A semiclassical distorted wave (SCDW) model gives a reasonably good description of the experimental data. The extent to which the observed yields are dominated by a two-particle rescattering emission contribution is estimated by a theoretical method that is known to describe experimental data for $^{40}Ca(p,p'p'')$ reasonably well. The energy distribution of the two-particle inclusive yield is found to agree well with the first-step contribution of the SCDW theory. Consequently this suggests strongly that the inclusive (p,p') yield at forward angles and high emission energy consists mostly of two high-energy nucleons emitted in the first-step of the collision.

*Department of Physics, University of Stellenbosch, South Africa
**National Accelerator Centre, South Africa
†Research Center for Nuclear Physics, Osaka University
‡Department of Physics, Kyoto University

VII-A-4

Nucleon-induced multistep direct reactions to the continuum — comparison between semi-classical and quantal models —

Y. Watanabe, Sun Weili, K. Ogata*, M. Kohno†, and M. Kawai*

A paper on this subject was published in Proc. of 9th Int. Conf. on Nuclear Reaction Mechanisms, Varenna, Italy, 5-9 June, 2000, with the following abstract:

The semiclassical distorted wave (SCDW) model with realistic single particle wave functions in a finite range potential is applied to analyses of multistep direct processes in $(p,p'x)$ reactions to the continuum for ^{12}C, ^{90}Zr, and ^{197}Au at incident energies up to 200 MeV. Comparisons between DWIA calculations and one-step SCDW calculations are shown for the $^{90}Zr(p,p'x)$ reaction, and discussions on effective NN interaction used in the calculations are given.

*Department of Physics, Kyushu University
†Physics Division, Kyushu Dental College

VII-A-5

Simultaneous Evaluation of Fission Cross Sections of Uranium and Plutonium Isotopes for JENDL-3.3

T. Kawano, H. Matsunobu*[1], T. Murata*[2], A. Zukeran*[3], Y. Nakajima*[4], M. Kawai*[5], O. Iwamoto*[6], K. Shibata*[6], T. Nakagawa*[6], T. Ohsawa*[7], M. Baba*[8], and T. Yoshida*[9]

A paper on this subject was published in *J. of Nucl. Sci. and Technol.*, **37**, 327 (2000) with the following abstract:

A simultaneous evaluation of the fission cross sections of ^{233}U, ^{235}U, ^{238}U, ^{239}Pu, ^{240}Pu and ^{241}Pu was carried out for the evaluated nuclear data library JENDL-3.3. A least-squares method was applied to selected absolute and relative measurements on the fission cross sections. Covariance matrices of the experimental data were constructed from the uncertainty information reported in the references. The fission cross sections obtained were compared with the JENDL-3.2 and ENDF/B-VI evaluations. It was found from the comparison that the present results are not so different from those in JENDL-3.2, except for the fission cross sections of ^{233}U and the cross sections above 15 MeV, and give smaller χ^2 value than the JENDL-3.2 cross sections. The averaged fission cross sections of ^{233}U, ^{238}U, and ^{239}Pu relative to that of ^{235}U were calculated for a neutron spectrum produced by ^{9}Be(d, xn) reaction. It was confirmed that the calculated cross-section ratios are in good agreement with the experimental data.

*[1] Data Engineering, Inc.
*[2] AITEL Corporation
*[3] Power & Industrial System R&D Division, Hitachi Ltd.
*[4] Research Organization for Information Science and Technology
*[5] High Energy Accelerator Research Organization
*[6] Japan Atomic Energy Research Institute
*[7] Department of Nuclear Engineering, Kinki University
*[8] Cyclotron and Radioisotope Center, Tohoku University
*[9] Faculty of Engineering, Musashi Institute of Technology

VII-A-6

Calculation of the MSD Two-Step Process with the Sudden Approximation

T. Kawano and S. Yoshida[†]

A paper on this subject was published in Proc. of 9th Int. Conf. on Nuclear Reaction Mechanisms, Varenna, Italy, 5-9 June, 2000, with the following abstract:

A method to calculate the two-step process is described according to the theory of Nishioka, Weidenmüller and Yoshida (NWY), in which the sudden approximation is used. The Green's function which connects the one-step matrix element to the two-step one is represented in r-space, and the Yukawa interaction is employed for a particle-hole pair creation. An effect of interference between the different intermediate states is investigated by means of a spectroscopic amplitude and a Boson approximation. Microscopically calculated two-step cross sections for ^{208}Pb(p, p') reactions are averaged together with the true level density to give a two-step cross section to the continuum.

[†] Department of Physics, Tohoku University

VII-A-7

Covariance Evaluation with the KALMAN System

T. Kawano and K. Shibata[†]

A paper on this subject was published in Proc. of the Nuclear Data Covariance Workshop, 22–23 April, 1999, BNL, Upton, New York, U.S.A., Eds. L.C. Leal and R.W. Roussin, ORNL/TM-2000/19, pp.121–129 (2000) with the following abstract:

The KALMAN system has been developed to evaluate covariances of the evaluated nuclear data libraries. Calculation codes of an optical model, a Hauser-Feshbach model, an improved Madland-Nix model, and Reich-Moore R-matrix theory were incorporated into the system to generate the covariances of various quantities. The system is applied to some simple examples to show how the system works and how to estimate covariances in case few experimental data are available.

[†] Japan Atomic Energy Research Institute

B. Department of Applied Quantum Physics and Nuclear Engineering

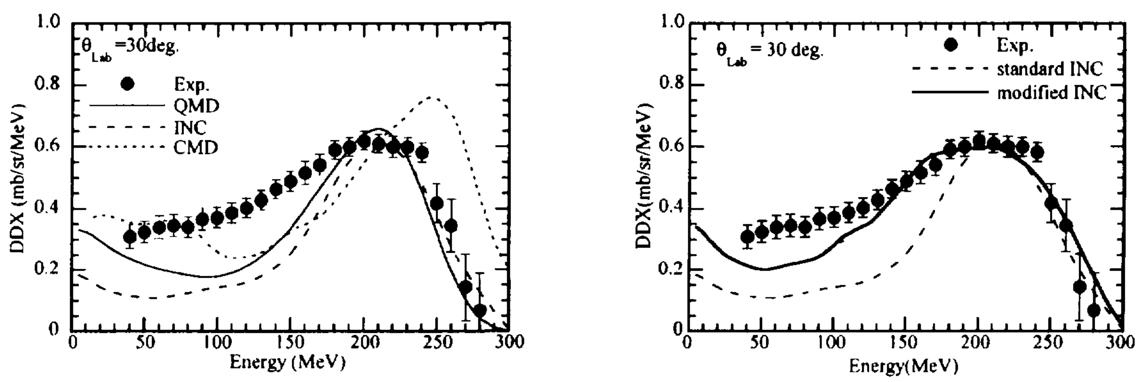
VII-B-1

Nuclear collective phenomena in proton inelastic scattering at 300 MeV

Yusuke Uozumi, Junji Tanaka, Fuminobu Saiho, Shinya Hohara, Bin Cao, Shozo Aoki, Genichiro Wakabayashi, Masaru Matoba, Takashi Maki[1], Masahiro Nakano[1] , Norihiko Koori[2]

Inclusive $^{12}C(p, p')$ spectra at 300 MeV were measured and were compared with three different theoretical models: the Quantum Molecular Dynamics (QMD), the Classical Molecular Dynamics (CMD) and the Intra-Nuclear Cascade (INC) models. For the three calculations, we employed similar parameters of NN cross sections and nuclear ground state properties. In Fig.1(a) is shown spectra at 30 deg. The calculation results are consistent to each other. Since CMD does not include the Pauli blocking, its result is too large in the higher energy part of the quasi-free peak.

In comparison with experiment, a large difference is shown in an energy range, roughly $50 < Ep < 150$ MeV. These theoretical models treat nucleons as point particles, and therefore, will miss the non-locality of wavefunctions, which governs the nuclear collective phenomena having large amplitude. In order to simulate this effect, we incorporated the nuclear response function into the INC model; the incident nucleon was assumed to excite the GR virtually via R. The result is shown in Fig.1(b). It is observed that the modified INC gives much better accounts.



(a) (b)

Figure 1: Double differential cross section for the reaction of $^{12}C(p, p')$ at 300 MeV

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[2]University of Tokushima

VII-B-2

Study of Proton and Deuteron Spectra from Proton Induced Reactions at Intermediate Energies

Fuminobu Saiho, Junji Tanaka, Shinya Hohara, Bin Cao, Shozo Aoki, Yusuke Uozumi, Genichiro Wakabayashi, Masaru Matoba, Takashi Maki[1], Masahiro Nakano[1] , Norihiko Koori[2]

The purpose of this work is to measure differential cross sections of protons and deuterons in the incident proton energy at 300- and 392-MeV, and to compare the measurements with the Quantum Molecular Dynamics (QMD) model calculations.

The beam experiment was performed at the Research Center for Nuclear Physics (RCNP), Osaka University. Protons accelerated up to 300- and 392-MeV by the ring cyclotron were bombarded onto targets set at the center of a vacuum chamber. The measurements were made for targets, ^{12}C, ^{27}Al, ^{93}Nb and ^{197}Au. We measured energy spectra from 19.7 deg. to 104.1 deg. in laboratory frame. The stacked GSO(Ce) scintillator spectrometer was used in the measurements. The size of GSO(Ce) scintillators used were $43 \times 43 \times 43$ mm^3 for cube and 62 mm in diameter and 120 mm long for cylinder.

Differential cross sections of proton and deuteron productions were measured for proton-induced reactions at 300- and 392-MeV. It is found that the production of protons and deuterons depend on $A^{2/3}$ approximately. A different behavior from other target nuclei are shown in ^{27}Al. The result of (p, d′) at 300MeV is shown in Figure 1 and Figure 2. In the same way, the results obtained via 392 MeV proton-induced reactions are shown in Figure 3 and Figure 4.

Differential cross sections of protons obtained from QMD model calculation agree with the measurements. But, large discrepancies are seen in deuteron production reactions. Figure 5 and Figure 6 for p and d, respectively, show differential cross sections obtained from the QMD model calculation via 300 MeV proton-induced reactions. Every dot shows the results by measurement. In the same way, the results obtained via 392 MeV proton-induced reactions are shown in Figure 7 and Figure 8.

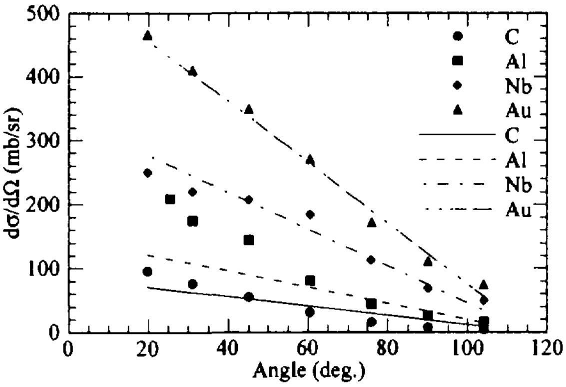

Figure 1: Angular distributions of proton production from 300 MeV proton-induced reactions

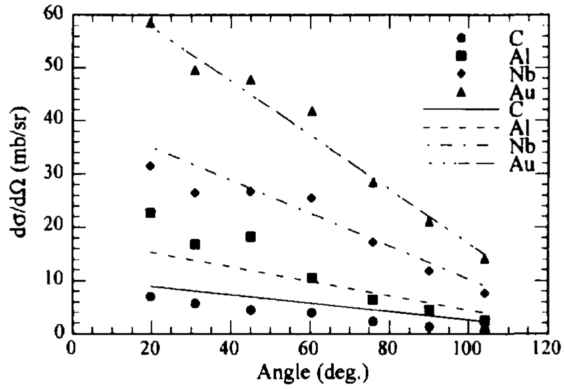

Figure 2: Angular distributions of deuteron production from 300 MeV proton-induced reactions

[1]University of Occupational and Environmental Health
[2]University of Tokushima

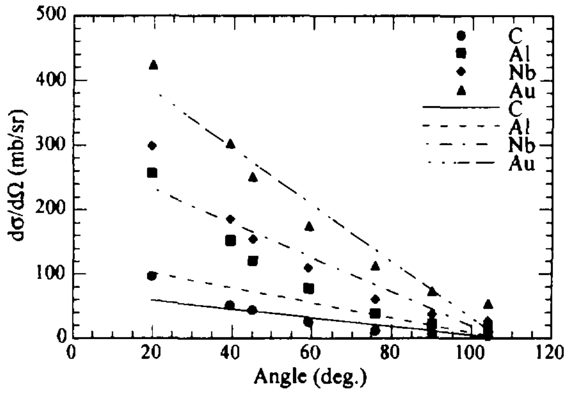

Figure 3: Angular distributions of proton production from 392 MeV proton-induced reactions

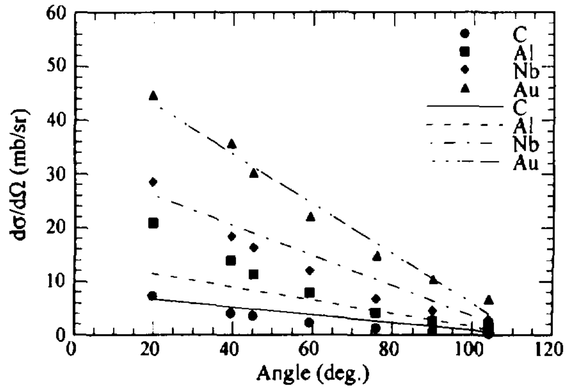

Figure 4: Angular distributions of deuteron production from 392 MeV proton-induced reactions

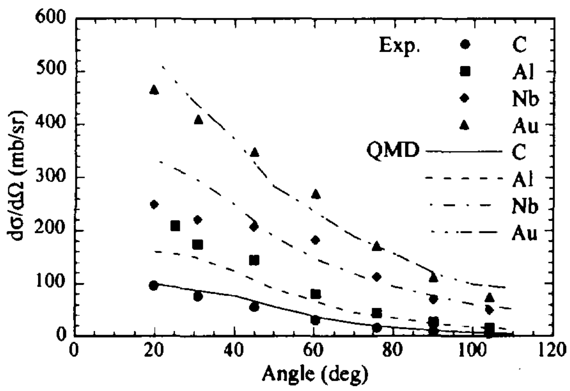

Figure 5: Comparison between the proton mesurements and QMD model calculations at incident proton energy of 300 MeV

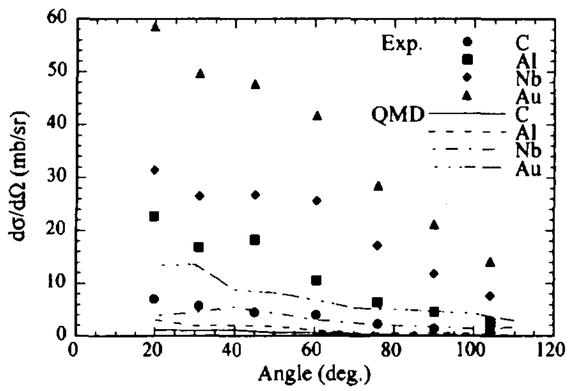

Figure 6: Comparison between the deuteron mesurements and QMD model calculations at incident proton energy of 300 MeV

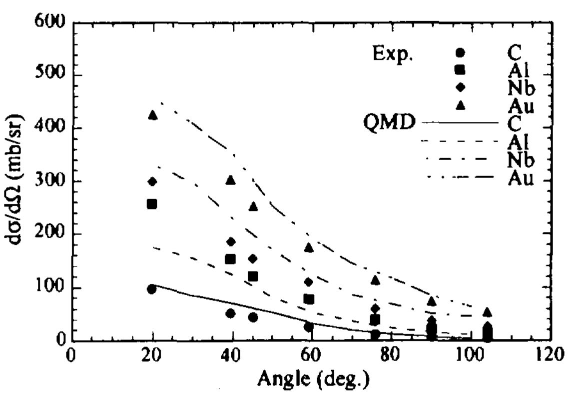

Figure 7: Comparison between the proton mesurements and QMD model calculations at incident proton energy of 392 MeV

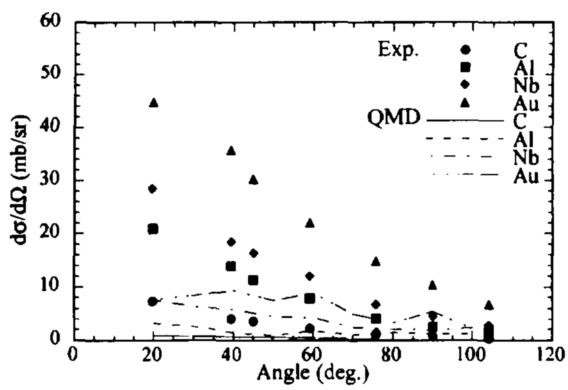

Figure 8: Comparison between the deuteron mesurements and QMD model calculations at incident proton energy of 392 MeV

VIII. Nagoya University

A. department of Energy Engineering and Science

VIII-A-1

Measurement of activation cross sections of (n, np+d) reactions producing short-lived nuclei in the energy range between 13.4 and 14.9 MeV using an intense neutron source OKTAVIAN

H. Sakane, Y. Kasugai, M. Shibata[1], T. Iida[1],
A. Takahashi[1], T. Fukahori[2] and K. Kawade

A paper on this subject was submitted to Annals of Nuclear Energy, with the following abstract.

Activation cross sections for seventeen (n,np+d) reactions producing short-lived nuclei with half-lives between 42 s and 23 min, were measured in the energy range between 13.4 and 14.9 MeV by an activation method. The measured target isotopes were ^{26}Mg, ^{29,30}Si, ^{53,54}Cr, ^{67}Zn, ^{87}Sr, ^{98,100}Mo, ^{102}Ru, ^{105,106,108}Pd, ^{123}Te, ^{163}Dy, ^{179}Hf and ^{189}Os. Eleven cross sections for ^{26}Mg, ^{30}Si, ^{87}Sr, ^{100}Mo, ^{102}Ru, ^{105,106}Pd, ^{123}Te, ^{163}Dy, ^{179}Hf and ^{189}Os were obtained for the first time, and four cross sections for ^{53,54}Cr, ^{67}Zn and ^{108}Pd were obtained at six-point energies for the first time.

An intense 14 MeV neutron source, OKTAVIAN at Osaka University was used for irradiation. All cross section values were relatively obtained on the basis of the standard cross section of ^{27}Al(n,α)^{24}Na reaction (ENDF/B-VI). To obtain reliable neutron activation cross sections, careful attention was paid to neutron irradiation and induced activity measurement.

The present results were compared with the evaluated data in JENDL-3.2, JENDL-Activation File and ENDF/B-VI. The cross sections are underestimated for ^{102}Ru and ^{108}Pd in JENDL-3.2.

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VIII-A-2

Measurement of activation cross sections for (n,2n) reactions producing short-lived nuclei in the energy range between 13.4 and 14.9 MeV

H. Sakane, Y. Kasugai, M. Shibata, T. Iida [1],
A. Takahashi [1], T. Fukahori [2] and K. Kawade

A paper on this subject will be published in Annals of Nuclear Energy, with the following abstract.

Activation cross sections for eighteen (n,2n) reactions producing short-lived nuclei with half-lives between 20 s and 38 min were measured in the energy range between 13.4 and 14.9 MeV by an activation method. The measured target isotopes were ^{14}N, ^{31}P, ^{54}Fe, ^{63}Cu, ^{79}Br, ^{87}Rb, ^{92}Mo, ^{108}Pd, ^{113}In, ^{132}Ba, ^{138}Ba, ^{140}Ce, ^{141}Pr, ^{144}Sm and ^{165}Ho. Four cross sections for ^{108}Pd, ^{132}Ba, ^{144}Sm and ^{165}Ho were obtained at six-point energies for the first time.

The intense 14 MeV neutron source facility (OKTAVIAN) at Osaka University was used for irradiation. All cross section values were relatively obtained on the basis of the standard cross section of ^{27}Al(n,α)^{24}Na reaction (ENDF/B-VI). To obtain reliable neutron activation cross sections, careful attention was paid to neutron irradiation and induced activities measurement.

The present results were compared with previous data and the evaluated data in JENDL-3.2, JENDL-Activation File and ENDF/B-VI. The previous data measured at multi-point energies show reasonable agreement with the present results in comparison with those at one-point energy. There are overestimations of the cross section for ^{31}P in JENDL-3.2 and ENDF/B-VI, and for ^{132}Ba and ^{165}Ho in JENDL-Activation File.

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[2] Japan Atomic Energy Research Institute, Tokai-mura, Ibaraki-ken, 319-1195, Japan.

VIII-A-3

Application of a total absorption detector to Q_β determination without knowledge of decay scheme

M.Shibata, Y.Kojima[1], H.Uno, K.Kawade, A.Taniguchi[2], Y.Kawase[2], S.Ichikawa[3], F.Maekawa[3] and Y.Ikeda[3]

A paper on this subject will be published in Nuclear Instruments and Methods A, with the following abstract.

For Q_β determination, we have developed a total absorption detector that can detect almost all radiation from the radioactive nuclei. The estimated efficiency is more than two orders of magnitude larger than those of Ge or Si detectors. The Q_β of ^{151}Ce in the fission products of ^{235}U was successfully determined to be 5.27(20) MeV using an on-line mass-separator for the first time. We have proposed the possibility of determining Q_β up to about 10 MeV using a total absorption detector without knowledge of the decay scheme.

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[2]Research Reactor Institute, Kyoto University, Kumatori 590-0494, Japan
[3]Japan Atomic Energy Research Institute, Tokai, 319-1195, Japan

VIII-A-4

Measurement of activation cross sections with d-D neutrons in the energy range of 2.0-3.2 MeV

T. Shimizu, S. Furuichi, H. Sakane, M. Shibata, K. Kawade, Y. Kasugai[1] and H. Takeuchi[1]

A paper on this subject will be published in Proceedings of the 2000 symposium on Nuclear Data, Nov. 16-17, 2000, JAERI Tokai, with the following abstract.

Activation cross sections for six (n,p) reactions were measured in the neutron energy range between 2.0 and 3.2 MeV. The measured target isotopes were ^{27}Al, ^{51}V, ^{61}Ni, ^{65}Cu, ^{69}Ga, and ^{92}Mo. The cross sections for ^{61}Ni, ^{69}Ga and ^{92}Mo were obtained at the first time. The cross sections are overestimated for ^{51}V, ^{69}Ga and ^{92}Mo in JENDL-3.2

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[1] Japan Atomic Energy Research Institute, Tokai-mura, Ibaraki-ken

IX. Osaka University

A. Department of Nuclear Engineering

IX-A-1

Measurement of Secondary Gamma-ray Spectra from Structural and Blanket Materials bombarded by D-T Fusion Neutrons

A. Takahashi, T. Nishio, I. Murata, F. Maekawa[1] and H. Takeuchi[1]

A paper on this subject was submitted to the 2000 Symposium on Nuclear Data and published in JAERI-Conf. 2000.

In a fusion reactor design, neutron reaction cross section data are required and usually the evaluated values in nuclear data files are used for the neutronics calculation. So it is very important to carry out the benchmark experiments for candidate blanket and structural materials and to analyze their results in order to validate the nuclear data. In this study, benchmark experiments have been carried out for blanket materials of $LiAlO_2$, Li_2TiO_3 and Li_2ZrO_3 and structural materials, i.e., C, V, Fe, SUS-316, Cu, W and Pb, at Fusion Neutronics Source (FNS) of JAERI, Japan. The former three are regarded as an advanced solid breeder material because of their inherent advantages such as chemical stability at high temperature, good tritium recovery characteristics and so on, however the experimental data of these blanket materials have not been obtained so far. The latters are important structural materials to be used in a fusion reactor.

Secondary gamma ray spectra from the slab assemblies were measured using an NaI (Tl) scintillation detector for three emission angles of 0, 24.9 and 50.0 deg. by using the time of flight (TOF) method. The dimensions of the assemblies are 654-2088cm^2 in the front surface (square or circle) and 5.0-40.6cm in thickness. The unfolding code HEPRO was used to convert measured pulse height spectrum into energy spectrum. The experimental energy spectra were compared with the calculated results obtained by using the Monte Carlo code MCNP-4B to discuss the validity of the evaluated nuclear data files of JENDL-3.2, JENDL-fusion file, FENDL/E-1.0, FENDL/E-2.0 and ENDF/B-VI.

From the comparison, some discrepancies between the experimental and calculated results were pointed out, e.g., the calculation results for Li_2ZrO_3 showed that the intensity of the 6130keV gamma-ray from the second excited level of ^{16}O was underestimated in JENDL fusion file and a discrete peak around 2 MeV was not represented in all nuclear data files, as shown Fig.1. For other samples, several discrepancies were also observed. It was found that there are some problems in the nuclear data files.

1) Japan Atomic Energy Research Institute

IX-A-2

Measurement of Double Differential Cross Section for Proton Emission Reactions of Silicon and Fluorine by Incident DT Neutrons

A.Takahashi, Y. Terada, H. Takagi and I. Murata

A paper on this subject was submitted to the 2000 Symposium on Nuclear Data and published in JAERI-Conf. 2000.

The double-differential cross section data of charged-particle emission reactions induced by incident DT neutrons (DDXc) are very important in fusion reactor design. In OKTAVIAN, the Intense 14MeV Neutron Source Facility of Osaka University, the author's group has measured the DDXc data for candidate materials of fusion reactor by two-dimensional analysis of the E-TOF spectrum. In the previous experiments, we could use relatively thin samples because they were mostly medium-heavy metals. However, in light elements, a thin sample cannot be prepared easily. In the last few years, the new unfolding method (spectrum type Bayes estimation method) was therefore introduced to realize measurements with a thick sample. In the present study, the DDXc measurements with thick ^{nat}Si (320 μm) and ^{19}F (500 μm) samples have been carried out. Silicon is a very important semiconductor material and can be used as a plasma facing material, blanket material, and so on. Fluorine is contained in FLIBE (Li_2BeF_4), which is one of the well-known liquid blanket materials.

In the present experiment, the pulsed 14MeV neutron source OKTAVIAN was used. Particles only emitted from the sample were counted by the E-TOF method, and background charged particles (p in α measurement and α in p measurement) were efficiently removed by the pulse shape discrimination technique using a CsI(Tl) scintillation detector. The detector was shielded with lead, iron and polyethylene, to eliminate backgrounds originated from the source neutrons. The emission angles of charged particles were changed by adjusting the sample position. The measurements of the DDXc were carried out at five angles of 45, 60, 70, 90 and 110 degrees.

For an example of experimental results, the DDX and EDX data of proton emission reaction for fluorine was shown in Fig. 1. From the comparison of the measured DDX spectra with JENDL-FF, JENDL-FF fairly reproduced the shape of the spectra, however, a slight underestimation was observed for both samples.

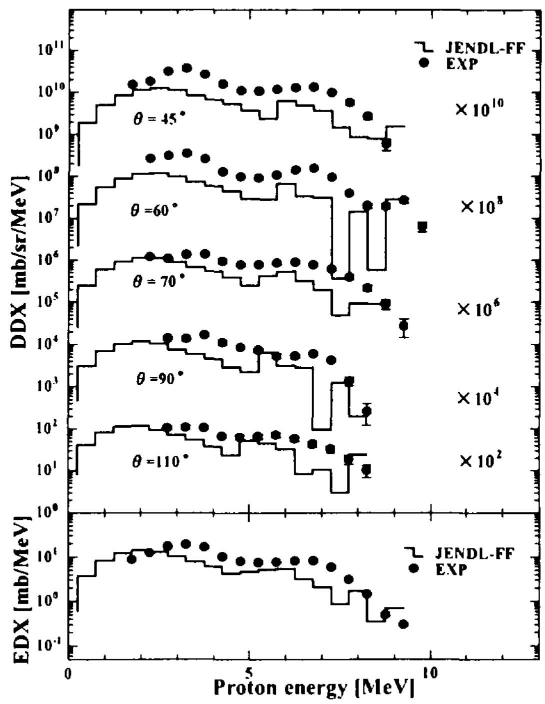

Fig. 1 The DDX and EDX data of F(n,xp)

(n,2n) Reaction Cross Section Measurement with A Beam DT Neutron Source -Measurement Method-

I. Murata, T. Nishio, Y. Terada, T. Hayashi, M. Mitsuda, A. Takahashi, K. Ochiai[1), F. Maekawa[1) and H. Takeuchi[1)

A paper on this subject was presented at the 2000 Symposium on Nuclear Data held at JAERI, Tokai on Nov. 16-17, 2000 with the following abstract.

The (n,2n) reaction plays a very important role in the design of fusion reactor, because it is a neutron multiplication reaction and has a large cross section value in the energy range of several to 14 MeV. In the previous experiments, the cross section was measured mainly by the foil activation method. However, the measurement became difficult unless appropriate radioisotopes were produced by (n,2n) reaction. There are many natural elements left the experimental values of which are not obtained. Also, especially for light elements measurements of the neutron energy spectrum for the (n,2n) reaction are important but were not carried out so far. In the present study, using a newly developed beam-type DT neutron source at fusion neutronics source (FNS), JAERI, the measurement of (n,2n) reaction cross section and its energy spectrum was carried out with the coincidence detection of emitted two neutrons.

Measurement of (n,2n) reaction cross section is possible in principle with coincidence detection method for two neutrons emitted simultaneously. However, an acceptable signal to noise (S/N) ratio could not be obtained because isotropically produced source neutrons, the great majority of which does not bombard the sample, act as a large amount of background signals in the measurement. The newly developed beam-type (2 cm ϕ-collimated) DT neutron source at FNS can realize the measurement by using the coincidence detection method, because we can arrange neutron detectors very close to the sample.

In the measurement, two spherical NE213 (4 cm ϕ) detectors were located at 20 cm from the sample. The coincident neutron signals of the two detectors were extracted from the time spectrum obtained with anode signals of the detectors. Also, the n/γ pulse shape discrimination technique was used to exclude n γ coincident signals emitted from nuclear reactions of (n,n'γ), (n,2nγ), (n,npγ) and so on. To cover the energy of emitted neutrons, two amplifiers were used to extend the dynamic neutron energy range, that is from 100 keV to 10 MeV. As for the neutron angular distribution, it is known that a slightly forward oriented distribution can be obtained. However, in the present measurement, the angular correlation of the emitted two neutrons should be taken into account to yield the cross section. Considering the symmetrical arrangement of the detectors, several measurements were carried out for one sample. As the sample, a cylindrical manganese (1.5 cm $\phi \times 3$ cm long), the (n,2n) cross section of which was measured precisely with the foil activation method, was used to check the experimental method.

From the measured time spectrum, a coincident peak of two simultaneously emitted neutrons was confirmed. Also, the dynodes signals corresponding to the peak were measured to obtain the neutron pulse height spectrum (PHS). The PHS was unfolded with FORIST code to convert it into the energy spectrum. For one sample, measurements for 5 azimuthal and 5 longitudinal angles were done. From the measured energy and angular spectra, it was confirmed that the angular dependence was, if any, very weak. However, In the energy spectrum, a fairly large spectrum fluctuation was observed after the unfolding procedure. The low statistical accuracy is a main reason for this fluctuation. Nevertheless the cross section, that is obtained by the integral of the spectrum, was in fairly good agreement with the values measured with the foil activation method.

1) Japan Atomic Energy Research Institute

IX-A-4

Measurement of Secondary Gamma-ray Production Cross Section for Tin Induced by DT Neutrons

I. Murata, M. Mitsuda, Y. Terada and A. Takahashi

Gamma-ray production cross section data are very important for estimation of nuclear heating, radiation damage, radiation exposure and so on in a fusion reactor design. In our group, separation measurement of discrete and continuum gamma-ray spectra with Ge detector was planned and has been carried out since 1999 to realize precise evaluation of secondary gamma-ray production cross section. In this year, gamma-ray spectrum has been measured for tin. Tin is planning to be used in superconducting magnet of the fusion reactor such as Nb_3Sn. However, the gamma-ray data were not measured until now. The measurement was carried out at OKTAVIAN facility of Osaka University, Japan. The discrete gamma-ray production cross section data were obtained and the continuum spectrum is now being processed by a new unfolding method coping with the difficulty in unfolding of high energy-resolution spectrum obtained by the Ge detector.

IX-A-5

Measurement of Secondary Gamma-ray Skyshine from Neutron Source Facilities

S. Yoshida, Y. Terada, T. Nishio, I. Murata and A. Takahashi

Evaluation of external radiation dose caused by skyshine effect plays an important role in the design of nuclear facilities. However, there are no experimental approaches for secondary gamma-ray skyshine induced by high energy neutrons. In the author's group, It was planning to measure leakage secondary gamma-ray spectra from the nuclear facilities and investigate the mechanism of the secondary gamma-ray skyshine. Also the effective shielding method for fusion reactor facilities is being discussed through comparisons of the experimental and numerical results.

In the present study, measurements of leakage secondary gamma-rays have been carried out around the 14 MeV neutron source facility FNS of JAERI and the fast neutron source reactor Yayoi of the University of Tokyo with an Hp-Ge and NaI(Tl) detectors. Skyshine, groundshine and direct gamma-rays originated from the facility building were measured separately with and without lead shields blocking the radiation path into the detectors. A hole of about 60 cm in diameter on the concrete ceiling was prepared at each facility so that generated neutrons can leak easily and shine outside the facility largely. Consequently, it becomes possible to perform experiment of measuring the leakage radiation efficiently at distances of until a few hundred meters. These results are to be used to investigate the skyshine mechanism, i.e., kind of related nuclear reactions, propagation paths of the produced secondary gamma-rays and the dependence of dose on the distance from the neutron source and so on.

X. Tohoku University

A. Cyclotron and Radioisotope Center

X-A-1

Measurement of Elastic Scattering Cross Sections of Carbon, Silocon, Iron, Zirconium and Lead for 75 MeV Neutrons

Masanobu Ibaraki, Mamoru Baba, Takako Miura, Yasushi Nauchi, Yoshitaka Hirasawa, Naohiro Hirakawa, Hiroshi Nakashima, Shin-ichiro Meigo, Osamu Iwamoto[1], and Susumu Tanaka[2]

A paper of the title was published in J. Nucl. Sci. Technol., Supl. 1 (March 2000) (Prof. of ninth Int. Conf. on Radiation Shielding) p.683-686, with the following abstract.

We performed measurements of neutron elastic scattering cross sections of carbon, silicon, iron, zirconium and lead at 75 MeV using a ^{7}Li(p,n) quasi-monoenergetic neutron source at TIARA of JAERI. Neutron spectra at 25 laboratory angles between 2.6°and 53°were measured by a time-of-flight method (TOF) using five liquid scintillation detectors. The data were corrected for the inelastic-scattering neutrons and sample-size effects. The experimental data were compared with the neutron cross-section libraries (DLC119/HILO86, LA150) and systematics used in the cascade/transport codes (HETC-KFA2, NMTC/JAERI). The DLC119 and systematics show large discrepancy from the present data, while the LA150 data are in fair agreement.

X-A-2

(n,α) Cross- section measurement using a gaseous samples and a gridded ionization chamber

Toshiya Sanami, Mamoru Baba, Keiichiro Saito, Naohiro Hirakawa

A paper of the title was published in Nucl. Instrum. Methods A440 (2000) p.403-408 with the following abstract.

We developed a method of (n, α) cross section measurement using a gaseous sample in a gridded ionization chamber (GIC). This method enables us to measure the cross section of gaseous samples, such as C, O, and N with very large solid angles close to 4π without distortion due to energy loss in the sample. The detection efficiency, which is difficult to estimate for gaseous samples, was estimated using GIC signals and tight neutron collimation. This method was verified through the ^{12}C(n, α_0)^{9}Be cross-section measurement for 14.1 MeV neutrons.

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X-A-3

Experimental method for neutron elastic scattering cross-section measurement in 40-90 MeV region at TIARA

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A paper of the title was published in Nucl. Instrum. Methods A446 (2000) p.536-544 with the following abstract.

An experimental setup and data correction method were established for the measurements of elastic scattering cross sections for neutrons of tens of MeV at TIARA facility of JAERI. Data were obtained for 25 laboratory angles between 2.6° and 53.0° by utilizing a ^{7}Li(p,n) quasi-monoenergetic neutron source and a time-of-flight method (TOF). Data correction for the effects of inelastic neutrons and a finite sample size is done using the LA150 data. Typical results of neutron elastic scattering are presented as well as the experimental and data correction methods.

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XI. Tokyo Institute of Technology

Measurements of keV-Neutron Capture Cross Sections and Capture Gamma-Ray Spectra of ^{140}Ce,^{141}Pr and ^{167}Er

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Two papers on this subject were published in J. Nucl. Sci. Technol., **37**, 421 and 740 (2000). The abstracts of those paper are unified as follows:

The neutron capture cross sections and capture gamma-ray spectra of ^{140}Ce, ^{141}Pr and ^{167}Er were measured in the neutron energy region of 10 to 90 keV and at 550 keV. A neutron time-of-flight method was adopted with a ns-pulsed neutron source by the ^{7}Li(p,n)^{7}Be reaction and with a large anti-Compton NaI(Tl) gamma-ray spectrometer. A pulse-height weighting technique was applied to observed capture gamma-ray pulse-height spectra to extract capture yields. The capture cross sections were obtained with the error of about 5% by using the standard capture cross sections of ^{197}Au. The present results were compared with previous measurements and the evaluated values of JENDL-3.2 or ENDF/B-VI. The capture gamma-ray spectra were obtained by unfolding the observed capture gamma-ray pulse-height spectra. An anomalous shoulder or bump was observed in the region of 1.5 to 3 MeV in the gamma-ray spectrum of each nuclide, and the energy position of the shoulder or bump was consistent with the systematics obtained in our previous work.

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