International Atomic Energy Agency

INDC(NDS)-207/L

INDC INTERNATIONAL NUCLEAR DATA COMMITTEE

MEASUREMENT AND ANALYSIS OF 14 MEV NEUTRON-INDUCED DOUBLE-DIFFERENTIAL NEUTRON EMISSION CROSS SECTIONS NEEDED FOR FISSION AND FUSION REACTOR TECHNOLOGY

Summary Report
of the First Research Co-ordination Meeting
organised by the
International Atomic Energy Agency
and held in Vienna, 20-22 April 1988

Prepared by
Wang DaHai and M.K. Mehta
Nuclear Data Section
International Atomic Energy Agency

July 1988

IAEA NUCLEAR DATA SECTION, WAGRAMERSTRASSE 5, A-1400 VIENNA

INDC(NDS)-207/L

MEASUREMENT AND ANALYSIS OF 14 MEV NEUTRON-INDUCED DOUBLE-DIFFERENTIAL NEUTRON EMISSION CROSS SECTIONS NEEDED FOR FISSION AND FUSION REACTOR TECHNOLOGY

Summary Report
of the First Research Co-ordination Meeting
organised by the
International Atomic Energy Agency
and held in Vienna, 20-22 April 1988

Prepared by
Wang DaHai and M.K. Mehta
Nuclear Data Section
International Atomic Energy Agency

July 1988

Printed by the IAEA in Austria
July 1988

88-03444

S U M M A R Y

The First Research Co-ordination Meeting (RCM-1) of the participants of the IAEA Co-ordinated Research Programme (CRP) on Measurements and Analysis of 14 MeV Neutron-Induced Double-Differential Neutron Emission Cross-Sections (DDCS) needed for Fission and Fusion Reactor Technology was convened at IAEA Headquarters in Vienna during 20-22 April 1988.

The RCM was organized by Mr. Wang DaHai as scientific secretary and was chaired by Mr. M.K. Mehta. The adopted agenda and list of participants are given in Appendices I and II to the full report.

The main objectives of the CRP are to improve the current status of data for 14 MeV neutron-induced double-differential neutron emission spectra of V, Cr, Fe, Nb, Ta and ^{238}U. Considering the unsatisfactory status of the DDCS data for ^{6}Li, ^{7}Li, ^{9}Be, Mo, W and Bi and their importance in fusion reactor technology, participants agreed to include these isotopes in the programme of the CRP.

The principal objectives of this first RCM were to report on the status of CRP participants' work under the CRP, exchange experiences in experimental work, and to specify the future work to be undertaken by each laboratory under the CRP.

The reports on work already done and planned for 1988-89 by each CSI were presented and discussed. The full report containing the conclusions and recommendations was agreed upon during the meeting.

As the next Research Co-ordination Meeting (RCM-II) cannot be held during 1989 due to budgetary limitations, the participants proposed that RCM-II should not be delayed beyond January 1990. The venue of the meeting will be decided later by NDS in consultation with the participants.

FULL REPORT

1. Introduction

The first meeting of the participants in the IAEA Co-ordinated Research Programme (CRP) on Measurement and Analysis of 14 MeV Neutron-Induced Double-Differential Neutron Emission Cross Sections needed for Fission and Fusion Reactor Technology was convened by the IAEA Nuclear Data Section at the IAEA Headquarters in Vienna. The Research Co-ordination Meeting was organized by the Scientific Secretary Mr. Wang DaHai and chaired by Mr. M.K. Mehta.

The main objectives of the CRP are to improve the current status of data for 14 MeV neutron-induced double-differential neutron emission spectra under bombardment by 14 MeV neutrons of V, Cr, Fe, Nb, Ta and ^{238}U. Considering the unsatisfactory status of the DDCS data for ^{6}Li, ^{7}Li, ^{9}Be, Mo, W and Bi and their importance in fusion reactor technology, participants agreed to include these isotopes in the programme of the CRP.

The principal objectives of this first RCM were to report on the status of CRP participants' work under the CRP, exchange experiences in experimental work, and to specify the future work to be undertaken by each laboratory under the CRP.

2. Organization of the meeting

The Agenda of the meeting is listed in Appendix I, the nine participants (six principal scientific officers, two observers and one consultant invited by the Agency for consultation on specific technical matters) who attended the meeting are listed in Appendix II. The CRP consists of three Research Agreements and three Research Contracts.

3. Reports by participants to the First RCM

Six participants presented reports on their recent work, and after the discussions, the proposed programme for the CRP was summarized (see Appendix III).

4. Summary of conclusions and recommendations

After presentation of the reports by each individual investigator, followed by extensive discussions, the participants of the RCM came to the following conclusions:

1. The primary objective of the CRP, namely to improve the current status of data for 14 MeV neutron-induced double differential neutron emission spectra of V, Cr, Fe. Nb. Ta and U-238, remains unaltered.

2. Good progress towards this goal was indicated as measurements were reported on U-238, Nb, Ta, V, Fe and Cr. The summary of the activities at each participant laboratory is given in Appendix III which describes work done till now and the programmes for the period 1988-89.

3. It was pointed out that the status of data on Mo, W and Bi - especially for higher neutron emission energies - was not satisfactory, and that these elements should be included in the programme of the CRP. A number of investigators agreed to include these in their plans. Similarly considering the unsatisfactory status of the DDCS data for Li-6, Li-7 and Be-9, and their importance in fusion reactor technology, participants agreed to include these isotopes in the programme of the CRP.

4. Dr. Seidel agreed to carry out an evaluation of all the experimental data for DDCS on U-238 measured at 14 MeV. He will include in this evaluation data measured under the CRP as well as data from the literature and also check the consistency of the evaluated data against the existing integral measurements.

5. The discussion also revealed that in most of the cases data below the neutron emission energy of 1 MeV were not measured. It was pointed out that separately optimised experimental set up should be used to measure the low energy part of the double-differential neutron emission spectrum. The associated alpha particle technique could be more convenient for these measurements as the low energy measurements require shorter flight paths and fewer angles. For such low energy measurements it is of special importance that proper attention is paid to reduce the background (e.g. by triple parameter techniques) and to determine the systematic corrections at these energies due to multiple scattering, and the energy dependence of the neutron detection efficiency.

6. Multiple scattering could be a very large source of systematic errors in general and it was recommended that for all measurements efforts should be made to keep the sample sizes small enough to restrict the multiple scattering correction to less than 15 %. The largest single source of error in the calculation of this correction factor is the available data base for 14 MeV incident neutron energy. To establish the consistency of calculation of this correction factor by various participants it was decided that they will all send the information on size and shape of their samples, the data base used and the numerical values of the correction factors calculated by them to Prof. Vonach, who will carry out his own calculations of these factors and report the results of the comparison at the next RCM.

7. The final reports of the results of the measurements should include a detailed list of errors, their sources and associated correlations. An excerpt from the Proceedings of an IAEA Specialists' Meeting [INDC(NDS)-192/L] convened on the relevant topic is included as Appendix IV which provides guidelines on reporting of errors.

8. The participants noted that error requirements specified by data requestors do not match the uncertainties occurring in actual measurements. It would be more meaningful if the energy bin-structure and accuracy for each bin are specified by the data requestors.

9. Some discussion took place on the actual flux distribution at the site of the sample. It was noted that this would be important and relevant information but no such measurements were known. Dr. Seidel would carry out calculations to this effect and will report them at the next RCM.

5. Next Meeting

The participants were informed that due to budgetary limitations the second RCM (RCM-II) cannot be held in 1989. They agreed to the proposed interval of almost two years and emphasized the RCM-II should not be delayed beyond January 1990. The venue of the meeting can be decided later by the NDS in consultation with the participants.

Coordinated Research Programme on "Measurement and Analysis of 14 MeV Neutron-induced Double-differential Neutron Emission Cross Sections needed for Fission and Fusion Reactor Technology"

First Research Co-ordination Meeting
Vienna, 20-22 April 1988

AGENDA

1. Opening of the meeting (10.00 hrs)
   - Opening statements
   - Adoption of the Agenda and election of the meeting chairman
   - Announcements

2. Reports by CRP participants on their work
   - A. Takahashi (Japan)
   - T. Vilaithong (Thailand)
   - Sa Jun (China)
   - K. Seidel (GDR)
   - G. Winkler (Austria)
   - J. Rahighi (Iran)

3. Discussions and conclusions/recommendations
   - Status of DDCS data
   - Technical problems with experiments
   - Theoretical analysis
   - Programme for 1988-1989

4. Next meeting

Coordinated Research Programme on "Measurement and Analysis of 14 MeV Neutron-induced Double-differential Neutron Emission Cross Sections needed for Fission and Fusion Reactor Technology"

First Research Co-ordination Meeting
Vienna, 20-22 April 1988

LIST OF PARTICIPANTS

AUSTRIA

Dr. Manfred Drosg	Institut für Experimentalphysik der Universität Wien Strudlhofgasse 4 1090 Wien
Prof. Dr. H.K. Vonach	Institut für Radiumforschung und Kernphysik Boltzmanngasse 3 1090 Wien
Dr. G. Winkler Research Agreement No. 4880/CF	Institut für Radiumforschung und Kernphysik Boltzmanngasse 3 1090 Wien

CHINA, PEOPLE'S REPUBLIC

Dr. Sa Jun Research Contract No. 4881/RB	Inst. of Atomic Energy P.O. Box 275 (3) Beijing

GERMAN DEMOCRATIC REPUBLIC

K. Seidel Research Agreement No. 4937/CF	Sektion Physik Technische Universität Dresden Mommsenstrasse 13 DDR-8027 Dresden

IRAN

Dr. J. Rahighi Research Contract No. 4883/RB	Esfahan Nuclear Technology Centre Nuclear Engineering Department P.O. Box 81465/1589 Esfahan

JAPAN

Dr. A. Takahashi
Research Agreement
No. 4884/CF

Dept. of Nuclear Engineering
Faculty of Engineering
Osaka University
2-1 Yamada-Oka, Suita
Osaka 565

THAILAND

Dr. T. Vilaithong
Research Contract
No. 4885/RB

Fast Neutron Research Facility
Department of Physics
Faculty of Science
Chiang Mai University
Chiang Mai

CONSULTANTS

Dr. J. Csikai

Institute of Experimental Physics
Kossuth University
P.O. Box 105
H-4001 Debrecen 1
Hungary

IAEA Staff Members

V. Goulo
N. Kocherov
M.K. Mehta
J.J. Schmidt
Wang DaHai (Scientific Secretary)

Appendix III

SUMMARY OF ACTIVITIES 1987 AND PROGRAMMES FOR 1988-89

Name	Research Agreement/Contract Number	Institution	Work completed to date	Proposed Programme for 1988-1989	Remarks
1. G. Winkler	No. 4880/CF	Inst. für Radium-forschung und Kern-physik der Universität Wien, Boltzmanngasse 3 A-1090 Wien		DDCS for Pb, W, Ta esp. high-energy part of inelastic scattering	Mo may also be taken into consideration
2. Sa Jun	No. 4881/RB	Institute of Atomic Energy P.O. Box 275-3 Beijing, China	1) DDCS for ^{238}U at E_n=14.2 MeV 2) DDCS for ^{93}Nb at θ=30°, 50°, 120° E_n=14.2 MeV	1) DDCS for ^{238}U at E_n=~10 MeV 2) DDCS for ^{93}Nb at θ=70°, 90° 3) DDCS for Bi at E_n=~10 MeV	Will send numerical data for U to Seidel for evaluation
3. K. Seidel	No. 4937/CF	Technical University Dresden	- Double-Differential Neutron Emission Cross Section of ^{238}U at 14 MeV neutron incident energy, measurements and calculations. - Measurement completed on Ta.	- Measurement and calculation of DDCS for V, W, Ta. - Evaluation of experimental DDCS data for ^{238}U.	

SUMMARY OF ACTIVITIES 1987 AND PROGRAMMES FOR 1988-89

Name	Research Agreement/Contract Number	Institution	Work completed to date	Proposed Programme	Remarks for 1988-1989
4. J. Rahighi	No. 4883/RB	Esfahan Nuclear Technology Centre AEOI, Iran	Neutron generator is tested and installed. The layout of experiments is decided. One of neutron detectors is made and it is ready for time resolution and P.S.D. test. A DWBA code (DWUCK 4) is being modified to run on our CDC-Cyber mainframe computer for future calculations.	The rest of the beam line and possibly magnets for focussing and deflecting will be installed. 5 neutron detectors to form an array of detectors will be made and tested. Target chamber and shielding of the system will be completed. The system will possibly be ready for data collection in mid 1989.	
5. A. Takahashi	No. 4884/CF	Osaka University	V at E_n=14.1 MeV Fe - " - Cr - " -	Nb at 14.1 MeV 1988 Ta - " - U-238 1989	Will send U data to Seidel for evaluation.
6. T. Vilaithong	No. 4885/RB	Chiang Mai University	- C-data with AAPTOF - Efficiency measurements - Multiparameter data acquisition & analysis system - Beam line & electronic components for pulsed beam facility.	- Installing & Testing pulsed beam facility, measurement of DDCS for Pb, Fe, Ta, Cr,...	

Information Needed from Experimentalists in order to be able to generate the Covariances needed for Evaluations

It is widely agreed by evaluators that experimenters should make available the following information on the uncertainties in their experiments.

1. A list of the sources of uncertainty in the experiment should be provided, with a brief description which will serve to clarify what the author has done.

2. The partial uncertainty values corresponding to each of these uncertainty sources should be explicitly tabulated, including energy uncertainty and resolution.

3. Critical information on the sensitivity of the experimental results to parameters which are uncertain (above) should be provided along with the actual values of the parameters used (e.g., half lives and other important standards information).

4. For (systematic) uncertainty components which are either partially or fully correlated, specific information on the nature of these correlations should be provided. That is, the degree of correlation (in the range -1 to +1) and the explicit data points involved should be specified. Information on correlations to previous data is also very important.

5. Provision of the final data set covariance matrix by the experimenter is not required. By no means should be experimenter provide only the final covariance matrix and not provide the component information indicated in items 1 to 4 above.