NDPCI Progress report: Nuclear Data Activities in India 2020-2021

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This report summarizes the Regular compilation activities of NDPCI bringing from year 2020-2021. All works were carried out in close cooperation with IAEA Nuclear Reaction Data Centre Network.

Report

The Nuclear Data Physics Centre of India (NDPCI) is a research center for nuclear data activities in Bhabha Atomic Research Centre (BARC) in India. BARC (Bhabha Atomic Research Centre) is the nodal centre for design, development and the application of nuclear technology for the welfare of mankind. BARC is responsible for broad range of nuclear data activities in India. BARC, Mumbai, is part of DAE (Department of atomic Energy) and is the nodal centre for the collaboration with IAEA-NDS, CERN, NRDC and others. The main objectives of NDPCI are as follows:

Main Objectives of NDPCI

- Compilation of nuclear reaction data.
- Promoting collaborative research on experimental nuclear reaction, nuclear structure data, and compilation of the data by providing project to research groups in universities and institutes Evaluation of nuclear reaction data
- Journal survey of Indian Published Journal such as Indian journal Pure and Applied Physics and Pramana etc.

List of EXFOR Entries Compiled and Checked 2020-2021

S.No.	Entry No.	Reference	Author
1.	G0513	J,RCA,106,345,2018	R.Ghosh
2.	33113	J,ARI,141,10,2018	S.Mukherjee
3.	33114	J,EPJ/A,54,168,2018	H.Naik
4.	33115	J,JRN,318,1893,2018	H.Naik
5.	33116	J,PR/C,98,014625,2018	S.Parashari
6.	33117	J,RCA,106,877,2018	H.Naik
7.	33118	J,RCA, 37, 63,1984	H.C.Jain
8.	33119	J,RCA,54163,1991	A.Ramaswami
9.	33120	J,JRN,140,215,1990	A.G.C.Nair
10.	33121	C,65SALZBURG,2,397,1965	V.A.Hattangadi
11.	33122	C,80WALTAI,,150,1980	A.G.C.Nair
12.	33123	P,BARC-(1381),25,1987	A.V.R.Reddy
13.	33124	P,BARC-1381,33,1987	A.Goswami
14.	33125	P,BARC-1381,47,1987	A.V.R.Reddy
15.	33126	J,ARI,143,72,2019	S.Mukherjee
16.	33127	J,ARI,146,10,2019	V.D.Bharud
17.	33128	J,EPJ/A,55,51,2019	S.Mukherjee

18.	33129	J,JRN,320,561,2019	H.Naik
19.	33131	J,PR/C,99,044602,2019	S.Mukherjee
20.	33132	J,NP/A,992,121613,2019	R.Pachuau
21.	33133	J,ARI,154,108866,2019	N.Shetty
22.	33134	J,ARI,153,108819,2019	P.Panikkath
23	33135	J,EPJ/A,56,116,2020	S.De
24.	33136	J,JRN,322,817,2019	H.Naik
25.	33137	J,JRN,322,2057,2019	H.Naik
26.	33138	J,PR/C,100,054613,2019	R.Gandhi
27.	33139	J,EPJ/A,56,82,2020	H.Naik
28.	33140	J,EPJ/P,135,300,2020	B.Soni
29.	33141	J,IPA,58,218,2020	A.M.Sunitha
30.	33142	J,IPA,58,228,2020	B.K.Soni
31.	33143	J,IPA,58,241,2020	I.Pasha
32.	33144	J,EPJ/A,56,186,2020	H.Naik
33.	33145	J,EPJ/A,56,227,2020	H.Naik
34.	33146	J,JRN,325,175,2020	I.Pasha
35.	33147	J,JRN,325,831,2020	S.P.Ram
36.	33148	J,JRN,325,863,2020	I.Pasha
37.	33149	J,JRN,325,885,2020	S.R.Manohara
38.	33150	J,PR/C,102,014603,2020	A.Gandhi
39.	33151	J,PR/C,102,014603,2020	H.Naik
40.	D6336	J,NP/A,979,102,2018	S.Parashari
41.	D6337	J,PR/C,97,014607,2018	V.V.Parkar
42.	D6338	J,PR/C,97,034603,2018	B.J.Roy
43.	D6339	J,PR/C,97,034607,2018	S.Mukherjee
44.	D6340	J,PR/C,97,051601,2018	D.Chattopadhyay
45.	D6341	J,PR/C,97,064610,2018	D.Singh
46.	D6342	J,PR/C,98,014601,2018	V.V.Parkar
47.	D6343	J,PR/C,98,014605,2018	Mohd.Shuaib
48.	D6344	J,PR/C,98,014609,2018	D.Chattopadhyay
49.	D6345	J,PR/C,98,031601,2018	A.Pal
50.	D6346	J,PR/C,98,034603,2018	M.Gull
51.	D6347	J,PR/C,98,041601,2018	Y.K.Gupta
52.	D6348	J,PR/C,98,054607,2018	M.K.Sharma
52.	D6349	J,RCA,106,743,2018	S.Lahiri
53.	D6350	J,RCA,48,7,1989	R.Guin
54.	D6251	J,RCA,51,97,1990	R.Guin
55.	D6352	J,JRN,319,695,2019	H.Naik
56.	D6353	J,NP/A,987,128,2019	S.Mukherjee
57.	D6354	J,PR/C,99,024620,2019	A.Pal
58.	D6355	J,PR/C,99,034608,2019	M.Maiti
59.	D6356	J,PR/C,99,034609,2019	A.Kundu
60.	D6357	J,PR/C,99,064609,2019	M.Maiti
61.	D6358	J,PR/C,100,024614,2019	A.Kundu
62.	D6359	J,PR/C,100,024622,2019	M.Afzal Ansari
63.	D6360	J,PR/C,99,024607,2019	R.N.Sahoo
64.	D6361	J,PR/C,99,024617,2019	M.Shuaib

65.	D6363	J,PR/C,99,034615,2019	J.Gehlot
66.	D6364	J,PR/C,99,034617,2019	B.P.Singh
67.	D6365	J,PR/C,99,061601,2019	J.Gehlot
68.	D6366	J,PR/C,100,014614,2019	N.K.Rai
69.	D6368	J,PR/C,100,024621,2019	D.Singh
70.	D6369	J,PR/C,100,034616,2019	A.Agarwal
71.	D6370	J,IMP/E,26,1750064,2017	V.Srivastava
72.	D6372	J,EPJ/A,55,168,2019	S.Lahiri
73.	D6373	J,PR/C,100,044611,2019	K.K.Rajesh
74.	D6375	J,PR/C,100,064607,2019	S.Ali

BRNS funded research project on experimental nuclear data and nuclear data compilation

Sanction Number/File No.	**Title of the Project**	**Principal Investigator**	**Principal Collaborator**	**Cost and Duration**	**Status**
36(6)/14/92/2014-BRNS	Compilation of Experimental Nuclear Reaction data using EXFOR Editor and Measurement of Nuclear Reaction Cross section using Kamini Reactor	Dr. Rudraswamy B., Department of Physics, Jnanabharathi campus, Bangalore University, Bangalore – 560056	Dr. G. Pandikumar, IGCAR, Dr. E. Radha, IGCAR	24.12 Lakhs 3 Years 2014-2017 (Extended)	Completed (2020)
36(6)/14/21/2016-BRNS	EXFOR compilation of Nuclear Data	Dr. Vidya Devi, Department of Physics, IET Bhaddal Technical Campus, Bhaddal, Ropar	Dr. Alok Saxena, Head, NPD, BARC Devesh Raj, RPDD, BARC	16.00 Lakhs 3 Years 2016-2019	Completed (2020)
36(6)/14/23/2016-BRNS	Cross section measurements for Sodium, Iron and Data compilation	Dr. Ajay Kumar, B-42, Brij Enclave, Sunderpur, Near Life Line Hospital, Varanasi, Uttar Pradesh	Dr. B. K. Nayak, NPD, BARC	19.43 Lakhs 3 Years	Completed (2020)
36(6)/14/22/2016-BRNS	Study of neutron induces reaction cross section up to 18 MeV for advanced reactor design	Professor Surjit Mukherjee, Physics Department, M.S. University of Baroda, Vadodara	Dr. B. K. Nayak, NPD, BARC, Dr. S. V. Suryanarayana, NPD, BARC	16.18 Lakhs 3 Years	Completed (2020)
36(6)/14/30/2017-BRNS	Measurement Analysis, Evaluation and Compilation of Nuclear	Dr. M.M. Musthafa, Professor of Physics, University of Calicut	Dr. S. Jagdeesan, BARC	30.0 Lakhs 3 Years	Project ongoing

	Reaction Data at Low and Medium Energy				
36(6)/14/49/2016-BRNS	Measurement of section of metastable states of a few nuclei produced through Photon	Dr. Sanjay Daga, Professor of Physics, Mhatama Jyoti Ba Phule Pune University, Pune	Dr. Rahul, RCD, BARC	42.13 Lakhs 3 Years	Project ongoing
36(6)/14/60/2016-BRNS	Nuclear Structure & Decay Data Evaluation for Nuclear Models and Dosimetric Applications	Dr. Sukhjeet S. Dhindsa, Associate Professor, Physics, Akal University	Dr. Gopal Mukherjee, VECC, Kolkata	23.00 Lakhs 3 Years	Project ongoing

Experimental work done at Bangalore University under DAE-BRNS Research Project

Irradiation of following samples ^{nat}Cr, ^{55}Mn, ^{nat}Zn, ^{89}Y, ^{58}Ni, ^{93}Nb, ^{197}Au, ^{nat}Mo, ^{nat}Nd and ^{nat}Pd using facility of PURNIMA neutron generator, BARC, Mumbai.

Evaluation Work

Covariance Analysis of some experimental data. India's programme of nuclear data science includes nuclear data physics experiments, Cross-section evaluations and processing of covariances, raw data compilations in EXFOR (IAEA) formats, use of covariances to define error margins due to uncertainties in nuclear data.

We calculated uncertainty propagation in cross section measurement by using three different methods such as Sandwich formula, Unscented Transform method and Monte Carlo method. We also study the application of the modified unscented transformation (MUT) method for uncertainty propagation in neutron induced cross section measurement in Nuclear Science

We examined the application of MUT method for covariance analysis of cross section measurement in comparison to the first order sensitivity analysis method and Monte Carlo methods.

Paper Published

1. Estimation of optical model parameters and their correlation matrix using Unscented Transform Kalman Filter technique, Aman Sharma, A. Gandhi, Ajay Kumar, **Physics Letters B**, 815, 136179 (2021).
2. Neutron radiative capture cross section for sodium with covariance analysis, A. Gandhi, Aman Sharma, A. Kumar, Rebecca Pachuau, B. Lalremruata, Mayur Mehta, Prashant N. Patil, S.V Suryanarayana, L.S. Danu, B.K. Nayak and A. Kumar, **European Physical Journal A**, 57(1), 1-12 (2021).
3. Measurement of (n,γ), (n,p), and (n,2n) reaction cross sections for sodium, potassium, copper, and iodine at neutron energy 14.92 ± 0.02 MeV with covariance analysis, A. Gandhi, Aman

Sharma, A. Kumar, Rebecca Pachuau, B. Lalremruata, S.V. Suryanarayana, L. S. Danu, Tarun Patel, Saroj Bishnoi, and B. K. Nayak, **Physical Review C** 102, 014603 (2020).

4. Exploitation of surrogate reaction method for deriving proton induced fission cross sections of short lived actinides, Aman Sharma, A. Gandhi, Namrata Singh, S.V. Suryanarayana, B.K. Nayak, and Ajay Kumar, **J. Phys. G: Nucl. Part. Phys.** *47,* 065106 (2020).
5. Quasielastic scattering measurements in the ^{28}Si + ^{142,150}Nd systems, Saumyajit Biswas, A. Chakraborty, A. Jhingan, D. Arora, B. R. Behera, Rohan Biswas, Nabendu Kumar Deb, S. S. Ghugre, Pankaj K. Giri, K. S. Golda, G. Kaur, A. Kumar, M. Kumar, B. Mukherjee, B. K. Nayak, A. Parihari, N. K. Rai, S. Rai, R. Raut, Rudra N. Sahoo, and A. K. Sinha, **Physical Review C** 102, 014613 (2020).
6. A. Gandhi, N.K. Rai, P.K. Prajapati, B.K. Nayak, A. Saxena, B.J. Roy, N.L. Singh, S. Mukherjee, Yu. N. Kopatch, I.N. Ruskov, D.N. Grozdanov, N.A. Fedorov and A. Kumar, "Evaluation of the nuclear excitation functions of fast neutron-induced reactions on ^{52}Cr and ^{56}Fe isotopes", Published Online on 8-2-2019 in **Indian Journal of Physics** (2019)
7. A. Gandhi, A. Sharma, B.J. Roy, B.K. Nayak, Yu. N. Kopatch, I.N. Ruskov, D.N. Grozdanov, N.A. Fedorov and A. Kumar, "Cross section calculation of (n,p) and (n,2n) nuclear reactions on Zn, Mo and Pb isotopes with ~14 MeV neutrons", **Communicated in Journal of Radioanalytical and Nuclear Chemistry** (2019).
8. S. Mukhopadhyay, B.P. Crider, B.A. Brown, A. Chakraborty, A. Kumar, M.T. McEllistrem, E.E. Peters, F.M. Prados-Estevez and S.W. Yates, "Inelastic neutron scattering studies of ^{76}Se", **Physical Review C**, 99, 014313, (2019).
9. M. Matejska-Minda, R. Kumar , P.J. Napiorkowski, M. Saxena, S. Dutt, A. Agarwal, I. Ahmed, S. Bhattacharya, A. Jhingan, J. Kaur, M. Kicińska-Habior, M. Kumar, S. Kumar, D. Kumar, V. Nanal, R. Palit, N.K. Rai, M. Shuaib, A. Sood, A. Stolarz, T. Trivedi, A.K. Tyagi , R.K. Bhowmik, H.J. Wollersheim, "Investigation of an Intruder Band in ^{45}Sc via Coulomb Excitation", **Acta Physica Polonica B**, No. 3, 411, Vol.50, (2019).
10. N.K. Rai, A. Gandhi, Ajay Kumar et al., "Measurement of neutron multiplicity to investigate the role of entrance channel parameters on the nuclear dissipation", **Communicated in Physical Review C** (2019).
11. Uncertainty propagation of cross section reaction using Monte Carlo and Uncertainty transformation method, Jagjit Singh Matharu, and Vidya Devi, **Nuclear Science Engineering** ,193, 314, (2019).
12. A modified Unscented Transformation method for uncertainty propagation in neutron induced cross section measurement, Jagjit Singh Matharu, and Vidya Devi, **Annals of Nuclear Energy**, 149, 107777 (2020).
13. Band head spin assignment in superdeformed rotational band of nuclei in A~80 mass region, Vidya Devi and Jagjit Singh Matharu, **Phys. Scr**. 96, 065309 (2021).

14. Imran pasha, Rudraswamy B, Santhi Sheela Y, Suryanarayana S V, Meghna Karkera, Naik H, Manjunatha Prasad Karantha, Danu L S, Saroj Bishnoi, Tarun Patel, Rajeev Kumar, "^{93}Nb(n,2n)^{92m}Nb, ^{93}Nb(n,α)^{90m}Y and ^{92}Mo(n,p)^{92m}Nb reactions at 14.78 MeV and covariance analysis", **Journal of Radioanalytical and Nuclear chemistry** (accepted for Publication).
15. Imran Pasha, Rudraswamy B, Santhi S Y, Suryanarayana S V, Naik H, Meghna Karkera, Sunitha A M, Sachhidananda H B, Radha E, Pandi K, Measurement of ^{67}Zn(n,p)^{67}Cu, ^{64}Zn(n,2n)^{63}Zn, ^{89}Y(n,γ)^{90m}Y and ^{89}Y(n,2n)^{88}Y reactions cross sections at the neutron energy 14.54 with covariance analysis. Journal of **Radioanalytical and Nuclear chemistry**, 322, 2057, (2019).
16. Imran Pasha, B Rudraswamy, Y.S Santhi, S. V Suryanarayana, E Radha, Rebecca Pachuau, ^{58}Ni(n,p)^{58}Co and ^{58}Ni(n,2n)^{57}Ni reactions at the neutron energy of 14.54 MeV with covariance analysis. **Indian Journal of Pure and Applied Physics**, 58, 241, (2020).
17. A M Sunitha, B Rudraswamy, S V Suryanarayana, Kamasali Nagaraja, Meghna Karkera, Imran Pasha, H B Sachhidananda, Y S Sheela, Manjunatha Prasad, Measurement of ^{92}Mo(n,a)^{89}Zr and ^{97}Mo(n,p)^{97}Nb reactions at the neutron energy of 13.52 MeV with covariance analysis. **Indian Journal of Pure and Applied Physics**, 58, 218, (2020).
18. Imran Pasha, Rudraswamy B, Santhi S Y, Suryanarayana S V, Naik H, Midhun C V, TarunPatel, Measurement of 14.54 MeV neutron induced reaction cross sections of Cr and Mn with covariance analysis. **Radiochimica Acta** 108, 679, (2020).