List of Facilities built and operated by Solid State Physics Division, Physics Group, BARC to be offered for collaboration with UGC-DAE CSR

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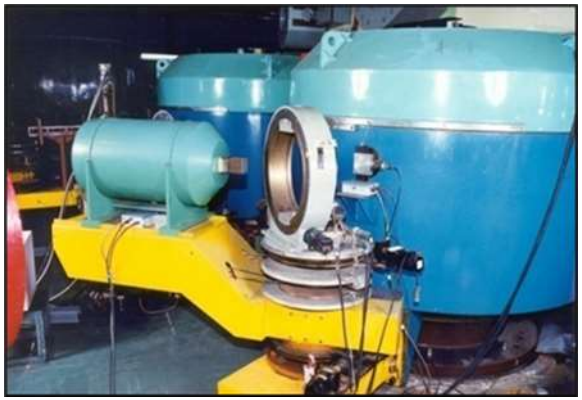
Sr. No.	Facility (Name, and Parameters)	Research Area	Representative publications	Instrument Responsible(s), and Photograph of the facility
1.	**Single Crystal Diffractometer** **Wavelength:** **0.995 Å** **Optimum sample size: 3 mm x 3 mm x 3 mm** **$(\sin\theta/\lambda)_{max}$: 0.71 Å^{-1}** **Average time per sample: Three months for highly symmetric crystal system**	Study of high precision 3D structure of materials	1. "Deterioration of hydrogen-bonded superprotonic conductors belonging to $CsHSO_4$–CsH_2PO_4–H_2O salt system: a single-crystal neutron diffraction Investigation", R. R. Choudhury, R. Chitra, I. P. Makarova, E. V. Selezneva and V. A. Komornikov, Bull. Mater. Sci. 44 (2021) 108. 2. "L-Histidine with nitric acid: A comparison of crystal structures and Hirshfeld surfaces analysis", R. Chitra, R.R. Choudhury, R. V. Rajan, D. Sajan, Mukesh Kumar, Journal of Molecular Structure 1267 (2022) 133550.	Dr. R. Chitra, Email: rchitra@barc.gov.in Dr. Rajul R. Choudhury, Email: rajul@barc.gov.in 
2.	**Powder Diffractometer I** **Wavelength:** **1.094 Å** **Scattering angle: $3^o \leq 2\theta \leq 70^o$** **$(Q)_{max}$: 6.5 Å^{-1}** **Resolution ($\Delta d/d$): 1 %** **Sample temperature range: 3 – 300 K**	Study of magnetic ordering/phases in technologically important polycrystalline magnetic materials	1."Correlated negative magnetization, exchange-bias, and electrical properties in $La_{1-x}Pr_xCrO_3$", Deepak, A. Kumar, A.K. Bera, and S. M. Yusuf, Physical Review Materials 6 (2022) 074405.	Dr. Anup Kumar Bera, Email: akbera@barc.gov.in Dr. Amit Kumar, Email: amitkr@barc.gov.in Dr. Anil Jain, Email: ajain@barc.gov.in

	Sample requirements: **Powder sample (2-5 g) or pellet of 10 mm diameter and height 6 cm** **Average time per sample: 4-5 hours per diffraction pattern, 5-6 hours at each temperature for temperature variation**		2. "Two-dimensional short-range spin-spin correlations in the layered spin- 3/2 maple leaf lattice antiferromagnet $Na_2Mn_3O_7$ with crystal stacking disorder", B. Saha, A. K. Bera, S. M. Yusuf, and A. Hoser, Physical Review B 107 (2023) 064419. 3. "Intertwined magnetization and exchange bias reversals across compensation temperature in $YbCrO_3$ compound", Deepak, A. Kumar, and S. M. Yusuf, Physical Review Mater. 5 (2021) 124402	
3.	**<u>Powder Diffractometer II</u>** **Wavelength: 1.2443 Å** **Scattering angle: $4^o < 2\theta < 140^o$** **Q range: 0.4 – 9.4 $Å^{-1}$** **Resolution (Δd/d): 0.8%** **Sample temperature range: 2 – 1400 K** **Sample requirements: Powder sample (8-10 g) or pellet of 6-8 mm diameter and height 4.5 cm** **Average time per sample:4-5 hours per diffraction pattern, 7-8 hours at each temperature for temperature variation**	Delineation of chemical and magnetic structure phase diagrams of poly-crystalline materials	1."Role of correlated disorder on structural stability and functional properties in (Na,Ba)(Nb, Ti)O_3", Sourabh Wajhal, S.K. Mishra, A.B. Shinde, P.S.R. Krishna and R. Mittal, Journal of Alloys and Compounds 866 (2021) 158982. 2. "Collinear order in the spin- 5/2 triangular-lattice antiferromagnet $Na_3Fe\ (PO_4\ )_2$, Sebin J. Sebastian, S. S. Islam, A. Jain, S. M. Yusuf, M. Uhlarz, and R. Nath, Physical Review B 105 (2022) 104425. 3."Mixed ionic-electronic conduction and magnetoelectric coupling in $Li_{0.5}Fe_{2.5-x}Cr_xO_4$ (x= 1.0, 1.1, 1.3, 1.5, and 1.6) involving magnetization compensation phenomenon", Madhu Ghanathe, A. K. Bera, Amit Kumar and S. M. Yusuf, ACS-Applied Electronic Materials 4 (2022) 394.	Dr. S. K Mishra, Email: skmsspd@barc.gov.in Sourabh Wajhal, Email: swajhal@barc.gov.in A. B. Shinde, Email: abshinde@barc.gov.in 

4.	**High Q Diffractometer** **Wavelength: 0.783 Å, 1.107 Å, 1.278 Å, 0.667 Å** **Scattering angle: $4^o \leq 2\theta \leq 140^o$** **(Q)max : 15 $Å^{-1}$** **Resolution (ΔQ/Q): 0.73 – 1.6 %** **Sample temperature range: 2 – 1400 K** **Sample Pressure range: up to 2 GPa** **Sample requirements: Powder sample (8-10 g) or pellet of 6-8 mm diameter and height 4.5 cm** **Average time per sample: 4-5 hours per diffraction pattern, 7-8 hours at each temperature for temperature variation**	Study of short and intermediate range order in glasses, liquids and disordered crystals, e.g., Molecular Liquids, Disordered crystals (local structure), High pressure structural phase transitions	1."Structures of Iron-Lithium-Calcium-Silicate Glass and its Devitrified State", Manjunath T. Nayak, J. A. Erwin Desa, P.S.R. Krishna, A.B. Shinde, Margit Fabian, C. Nayak, D. Bhattacharya and S.N. Jha, Silicon, 14 (2022) 10337. 2. "Structure of copper tellurite and borotellurite glasses by neutron diffraction, Raman, ^{11}B MAS NMR and FTIR spectroscopy", Amandeep Kaur, Atul Khanna, P. S. R. Krishna, A. B. Shinde, M. González-Barriuso, Fernando González and Banghao Chen, Phys. Chem. Glasses: Eur. J. Glass Sci. Technol. B 61 (2020) 27. 3. "Neutron irradiation induced magnetization and persistent defects at high temperatures in graphite", Ranjan Mittal, et. al, Phys. Rev. B 105 (2022) 104106	Sourabh Wajhal, Email: swajhal@barc.gov.in Dr. S. K. Mishra, Email: skmsspd@barc.gov.in P. S. R. Krishna, Email: glass@barc.gov.in 
5.	**Polarized Neutron Spectrometer** **Wavelength: 1.201 Å** **Scattering angle: Up to 90º** **Sample temperature range: 1.5 – 400 K** **Magnetic field range: ± 1.2 kOe** **Electric field range: Up to 100 KV/cm (typically for 10 mm dia, 1mm thick pellet)**	Study of 1.Size/magnetization of magnetic domains or clusters at mesoscopic length scales 2. Magnetic correlations	1. "Linear magnetoelectric coupling and type-II multiferroic order in $NiMn_2O_4$, A. Chatterjee, A. Kumar, P. K. Manna, S. Bedanta, A. Sarma, S. Majumdar, S. M. Yusuf, and S. Giri, J. Appl. Phys. 134 (2023) 104103. 2. "Intertwined magnetization and exchange bias reversals across compensation temperature in $YbCrO_3$ compound" Deepak, Amit Kumar, S. M. Yusuf, Phys. Rev. Materials 5 (2021) 124402.	Dr. Amit Kumar, Email: amitkr@barc.gov.in Dr. Anil Jain, Email: ajain@barc.gov.in Kuldeep S. Chikara, Email: kchikara@barc.gov.in

	Sample requirements: Powder sample (2 g) or pellet of 5-6 mm diameter and height 15 mm **Average time per sample: 2-3 days per temperature/ magnetic field**		3. "Investigation of magnetic ordering and origin of exchange-bias effect in doped manganite, $Sm_{0.4}Ca_{0.6}MnO_3$", Amit Kumar, S. K. Giri, T. K. Nath, C. Ritter, S. M. Yusuf, Journal of Applied Physics 128 (2020) 203901.	
6.	**Small Angle Neutron Scattering (SANS) Instrument** **Wavelength (average): 4 - 10 Å** **Sample size: Larger than 15 mm (H) x 10 mm (W) x 1 mm (T) (approximately 2 ml in volume for liquids and 1 g for solids)** **Resolution ($\Delta\lambda/\lambda$): 10 – 20 %** **Sample Temperature Range: 20 – 80° C** **Q range: 0.01 – 0.3 $Å^{-1}$** **Average time per sample: 4 hours or more, for each run**	Determination of the structure and interactions at nanometre length scales in systems such as: 1. Self-assembly of amphiphiles (micelles, vesicles, bilayers) 2. Biomolecules and drugs 3. Nanomaterials (synthetic or natural) 4. Gels, colloids, polymers etc.	1. "Small-angle neutron scattering studies suggest the mechanism of BinAB protein internalization", M. Sharma, V.K. Aswal, V. Kumar and R. Chidambaram, IUCrJ 7 (2020) 166. 2. "Unusual stability of protein molecules in the presence of multivalent counterions", Sugam Kumar, D. Saha, D. Ray, S. Abbas and V.K. Aswal, Phys. Rev. E (Letters) 104 (2021) L012603. 3. "Modifying interprotein interactions for controlling heat-induced protein gelation", S. Kumar, D. Saha, V. K. Aswal, Physical Review Materials 7 (2023) 015601.	Dr. Sugam Kumar, Email: sugam@barc.gov.in Dr. Debes Ray, Email: debes@barc.gov.in Dr. Sohrab Abbas, Email: abbas@barc.gov.in 

7.	**Double Crystal Based Small-Angle Neutron Scattering (SANS) instrument** **Wavelength: 0.312 nm** **Minimum required sample size: Larger than 15 mm (H) × 15 mm (W) × 2 mm (T)** **Accessible q range: 0.003 – 0.173 nm^{-1}** **Resolution (Δλ/λ): 1%** **Sample temperature range: RT – 100° C** **Average time per sample: ~15 hours for each run**	Mesoscopic structure in synthesized and naturally occurring materials including porous materials, granular materials, ceramics and metallurgical alloys.	1. "A novel approach to identify accessible and inaccessible pores in gas shales using combined low-pressure sorption and SAXS/SANS analysis", D. Chandra, V. Vishal, J. Bahadur, D. Sen, International Journal of Coal Geology 228 (2020) 103556. 2. "Unravelling the structural hierarchy in microemulsion droplet templated dendritic fibrous nano silica", D. Sen, A. Maity, J. Bahadur, A. Das, V. Polshettiwar, Microporous and Mesoporous Materials 323 (2021) 111234 3. "Jamming of Nano-Ellipsoids in a Microsphere: A Quantitative Analysis of Packing Fraction by Small-Angle Scattering", A. Das, R. Mondal, D. Sen, J. Bahadur, D. K. Satapathy, M. G. Basavaraj, Langmuir 38 (2022) 3832.	Dr. Debasis Sen, Email: debasis@barc.gov.in Dr. J. Bahadur, Email: jbahadur@barc.gov.in Dr. Avik Das, Email: avikd@barc.gov.in 
8.	**Polarised Neutron Reflectometer** **Wavelength: 2.9 Å** **Magnetic field (fixed): 2 kGauss** **Sample size: More than 20 mm x 20 mm** **Resolution (ΔQ/Q): 0.141 –0.411** **Reflectivity range: 1 – 10^{-4}** **Average time per sample: 24 hours per run**	Structural and magnetic characterization of thin film and multilayer samples, using specular and off-specular (diffuse) reflectivity techniques, with vertical sample geometry	1."Formation of B2-ordered FeRh alloy thin films on annealing of pure and nitrogen doped Fe/Rh multilayers", Preeti Negi, Mukul Gupta, Rajeev Rawat, Rajeev Joshi, Harsh Bhatt, Surendra Singh, V.R. Reddy, Hardeep Kumar Journal of Magnetism and Magnetic Materials 581 (2023) 170941.	Dr. Surendra Singh, Email: surendra@barc.gov.in Dr. D. Bhattacharya, Email: debarati@barc.gov.in Harsh Bhatt, Email: harshbhatt@barc.gov.in

			2. “Thermal stability of interfacial mixed layers in c-Ni/a-Zr multilayer during annealing: Structural and magnetic properties”, Debarati Bhattacharya, Vijay Karki, Surendra Singh, T.V. Chandrasekhar Rao, Applied Surface Science 572 (2022) 151300. 3. “Interface morphology driven exchange interaction and magnetization reversal in a Gd/Co multilayer”, Surendra Singh, M. A. Basha, Harsh Bhatt, Yogesh Kumar and M. Gupta, Physical Chemistry Chemical Physics 24 (2022) 6580.	
9.	**Triple Axis neutron Spectrometer** **Energy transfer range: Up to 100 meV** **Momentum transfer range: 1 – 7 $Å^{-1}$** **Elastic energy resolution: 15%** **Sample temperature range: 10 – 300 K** **Sample requirements: Powder sample (10-15 g) or pellet of 20 mm diameter and height 3-4 cm, single crystal 8-10 cc volume** **Average time per sample: 1 week at each temperature for powder samples, 3-4 months for single crystal samples**	Inelastic neutron scattering experiments from single crystals/ polycrystalline samples for measurements of phonon dispersion curves, phonon density of states, crystal field excitations, and quasielastic scattering	1.“Lattice dynamics in kesterite-type Cu_2ZnSnS_4: Inelastic neutron scattering studies and thermoelectric properties”, S.P. Kandare, Mala N. Rao, S.S. Dahiwale, Rekha Rao, S.D. Dhole, S.L. Chaplot, Journal of Physics and Chemistry of Solids 150 (2021) 109819. 2. “Phonons and Thermal Expansion Behavior of NiSi and NiGe”, Prabhatasree Goel, Mayanak K. Gupta, Sanjay K. Mishra, Baltej Singh, Ranjan Mittal and Samrath L. Chaplot, Front. Chem. 6 (2018) 331. 3. “Phonons and anisotropic thermal expansion behavior of NiX (X = S, Se, Te)”, Prabhatasree Goel, M. K. Gupta, S. K. Mishra, Baltej Singh, R. Mittal, P. U. Sastry, A. Thamizhavel, J. Appl. Phys. 125 (2019) 205106.	Dr. Ranjan Mittal, Email: rmittal@barc.gov.in Dr. Prabhatasree Goel, Email: knp@barc.gov.in Dr. M. K. Gupta, Email: mayankg@barc.gov.in 

10.	**Quasi Elastic Neutron Spectrometer** **Wavelength range: 1.3 – 4.7 Å** **Scattering angle: 2θ < 80°** **ΔE range (for E_i=4 meV): 2.3 meV** **Resolution (ΔE/E): 4% (200 μ with incident wavelength 4 Å)** **Q range: 0.6 – 1.8 $Å^{-1}$** **Sample temperature range: RT – 70° C** **Sample requirements: Powder/ liquid samples (6 g) (~ 5 cc volume)** **Average time per sample: 24 hours per momentum transfer (Q) value at each temperature**	Study of stochastic molecular motion in pico second time scales along with geometry of motion	1. "Diffusion of Confined Fluids in Microporous Zeolites and Clay Materials", S. Mitra, V. K. Sharma and R. Mukhopadhyay, Reports on Progress in Physics 84 (2021) 066501. 2. "Can the microscopic and macroscopic transport phenomena in deep eutectic solvents be reconciled?", H Srinivasan, V. K. Sharma, S. Mitra, Physical Chemistry Chemical Physics 23 (2021) 22854. 3. "Modulation of Diffusion Mechanism and Its Correlation with Complexation in Aqueous Deep Eutectic Solvents", H. Srinivasan, V. K. Sharma, and S. Mitra, J. Phys. Chem. B 126 (2022) 9026.	Dr. Subhankur Mitra, Email: smitra@barc.gov.in Dr. V. K. Sharma, Email: sharmavk@barc.gov.in Harish Srinivasan, Email: harishs@barc.gov.in 
11.	**Time of flight neutron Spectrometer** **Energy transfer range: Up to 100 meV** **Momentum transfer range: 1 – 7 $Å^{-1}$** **Elastic energy resolution: 10%** **Sample temperature range: 10 – 300 K** **Sample requirements: Powder sample (10-15 g) or pellet of 20 mm diameter and height 3-4 cm** **Average time per sample: 1 week at each temperature for powder samples**	Inelastic neutron scattering experiments from polycrystalline samples, for measurements of phonon density of states, crystal field excitations, and quasielastic scattering, allows measurement of the scattering function in (Q, E) space	"Design and commissioning of neutron time-of-flight spectrometer at Dhruva reactor", Mala N. Rao, Shraddha S. Desai, Rohit Chandak, S. S. Naik, V. Kulkarni, S. K. Mishra, Santosh Kumar, S. Mitra, P. Goel, R. Mittal, Somesh Rai, R. Mukhopadhyay, and S. L. Chaplot, Proc. Solid State Phys. Symposium 55 (2021) 358.	Dr. Mala N. Rao, Email: mala@barc.gov.in