



भारत सरकार
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राजा रामन्ना प्रगत प्रौद्योगिकी केन्द्र
Government of India
Department of Atomic Energy
Raja Ramanna Centre for Advanced Technology



इंडस सिंक्रोट्रॉन्स: प्रचालन एवं उपयोगिता रिपोर्ट

Indus Synchrotrons: Operation and Utilization Report



वर्ष 2025

Year 2025



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Editorial team: Amit Chauhan, Pooja Gupta, Shruti Gupta, Arpit Vishnoi

Cover page photographs: Clockwise from top left – (1) 20 MeV Microtron
(2) 450/550 MeV Booster ring (3) 2.5 GeV Indus-2 ring with beamline
frontends (4) 450 MeV Indus-1 ring

Message from the Director

It gives me immense pleasure to present the Indus Synchrotrons: Operation and Utilization Report for the year 2025. The report is an account of salient facts and figures of the year-long operation of Indus-1 and Indus-2 synchrotron radiation sources and utilization by the researchers from scientific, academic and industrial community in India. As India's only synchrotron radiation facility, the Raja Ramanna Centre for Advanced Technology (RRCAT) remains deeply committed to providing continued support to Indus user community. Over the past year, our national user base- spanning universities, elite research institutes, and industrial partners- has leveraged the capabilities of Indus-1 and Indus-2 to carry out variety of scientific investigation for fundamental and applied research across diverse disciplines.

This year witnessed the best performance ever recorded for both Indus-1 and Indus-2 in terms of beam availability to the users. By optimizing operating parameters, the lifetime of the electron beam was also significantly enhanced in the low-emittance mode of operation.

During the year, several initiatives have been undertaken to maintain and upgrade the machine and beamline components. The focus was on replacing the components that are nearing the end of their service life or on the verge of obsolescence, and strengthening the capabilities of the beamlines. Collectively, these measures resulted in improving system reliability, maintainability, safety and the overall operational performance, while ensuring the sustained and enhanced utilization of the machine and beamline facilities.

The beamline user's footfall to the facility has mapped 100+ institutes, research labs and industries all across the country from Jammu and Kashmir in the north to Kerala in the south, from Mizoram in the east to Gujarat in the west, reflecting India's rising prowess in diverse fields of science and technology including chemistry, physics and astronomy, energy, structural biology, health, pharmacy, environment and nanotechnology. Through the Indus Beamline User Portal, we have seamlessly accommodated a large number of experimental proposals. It is heartening to know that our user community publish high-impact results in reputed international journals.

Looking ahead, our long-term strategies remain closely aligned with milestones and objectives outlined in the DAE's Amrit Kaal Vision Document. We look forward to enhance academic and industry outreach to further enhance the utilization avenues of Indus beamlines.

I would like to thank user community for their intellectual rigor and partnership in scientific utilization of the beamlines. I am confident that the insights and experiences presented in the report will serve as the source of inspiration and provide a strong foundation for fostering even greater collaboration, innovation and collective achievements in the future. I appreciate the efforts put in by the entire Indus team for excellent performance during the year. Hearty congratulations to Electron Accelerator Group for the initiative to bring out the annual operation and utilization report of Indus synchrotrons.

Viraj P. Bhanage
Director, RRCAT

Preface

The year 2025 marked the 15 years of round-the-clock operation of Indus synchrotrons as the National facility. Over the years, the facility has seen steady enhancements – in terms of the machine capabilities, beamlines, experimental facilities, userbase and the scientific utilization of the facility, aptly reflected in the annual statistics. This has been possible due to consistent efforts put in by the past and present members of the Team Indus. It is, therefore, thought to bring together the salient aspects of machine operation and utilization in the form of an annual activity report.

The report presents an overview of the facility, key performance indices reflecting operational aspects, utilization by the scientific community, a brief account of salient scientific experiments performed on Indus beamlines, significant developments & upgrades and research publications during the year.

During the year 2025, Indus-1 recorded 7603 hours and Indus-2 recorded 6317 hours of user beam time, both of which are highest annual numbers achieved in round-the-clock operation so far. The facility also maintained a consistent level of utilization, with researchers from 112 institutions from all over the country, carrying out 1028 user experiments across the available beamlines. Based on the data obtained at Indus beamlines, 281 papers were published in peer reviewed journals. This number is nearly 16% higher than the one reported during the previous year. Notably, nearly half of these publications appeared in journals having impact factor more than 5.

Round-the-clock operation of the Indus synchrotrons, including upgrade and upkeep of the systems, is an outcome of collaborative efforts of the Team Indus, comprising of a large number of technical and scientific personnel. The operation is now largely shouldered by permanent operating crew, and supported by trained and licensed personnel contributing in the partial mode. The contents of this report is a reflection of their contribution to this National Facility. Bringing the contents in the form of the report needs a lots of efforts, particularly when it is being done for the first issue. I appreciate the efforts of the editorial team.

Finally, I would like to thank the users who have utilized our facility. It has been a great year of scientific association with you and I look forward to more such collaborations in the year to come.

Mangesh B. Borage

Director, Electron Accelerator Group



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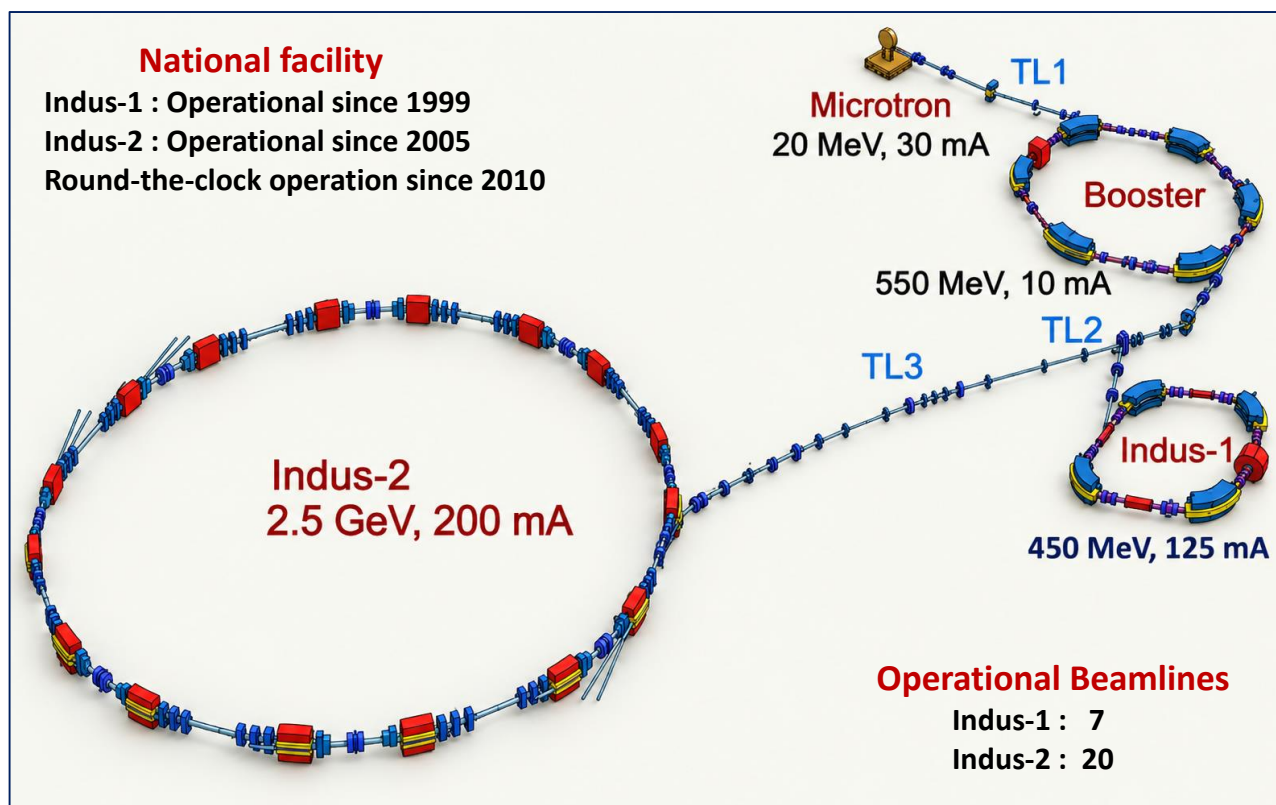
INTRODUCTION

Raja Ramanna Centre for Advanced Technology (RRCAT), Indore is a premier unit of the Department of Atomic Energy (DAE), engaged in the frontline areas of accelerator science, technology and applications.

The centre has indigenously designed, developed and commissioned two synchrotron radiation sources: Indus-1 and Indus-2, serving as a national facility. The facility is operational in round-the-clock mode since February 2010.

Indus-1 is a 450 MeV, 125 mA electron storage ring emitting radiation from mid-IR to soft X-ray with a critical wavelength of $\sim 61 \text{ \AA}$. Indus-2 is a 2.5 GeV, 200 mA electron storage ring emitting synchrotron radiation having broad spectrum covering soft and hard X-ray regions with a critical wavelength of $\sim 2 \text{ \AA}$. There is a common injector system for both Indus-1 and Indus-2 comprising of a 20 MeV microtron and a 450/550 MeV booster synchrotron.

Twenty beamlines on Indus-2 and seven beamlines on Indus-1 are being utilized by an increasing number of researchers from universities, academic institutions, national laboratories and industries.

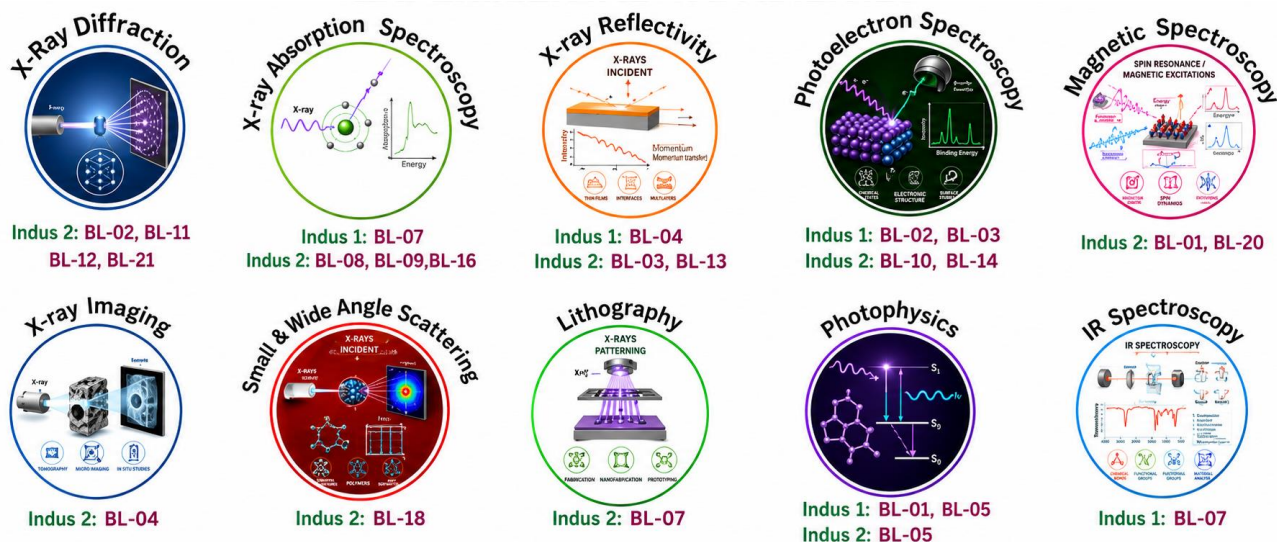


Schematic of Indus Synchrotron Facility

Indus-1 Beamlines		
BL-01	High Resolution Vacuum Ultraviolet (HRVUV) Beamline	BARC
BL-02	Angle Integrated Photoelectron Spectroscopy (AIPES) Beamline	UGC-DAE CSR
BL-03	Angle Resolved Photo Electron Spectroscopy (ARPES) Beamline	BARC
BL-04	Reflectivity Beamline	RRCAT
BL-05	Photophysics Beamline	BARC
BL-06	Infrared Beamline	BARC
BL-07	Photo Absorption Spectroscopic Studies (PASS) Beamline	BARC

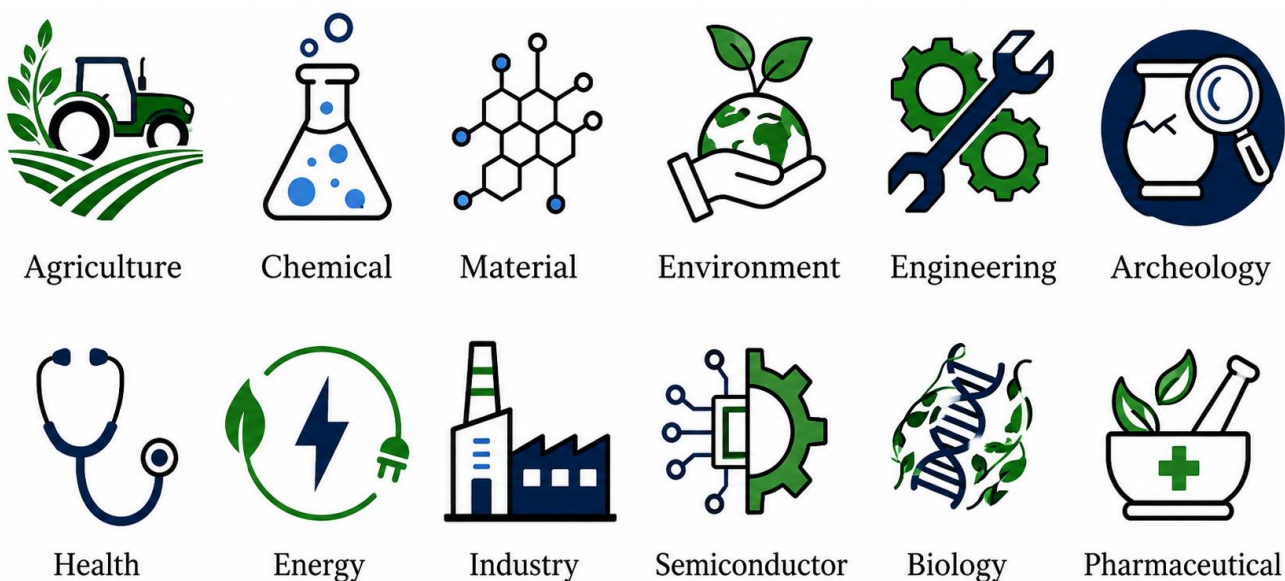
Indus-2 Beamlines		
BL-01	Polarized Light Beamline (Soft X-ray Absorption Spectroscopy)	UGC-DAE CSR
BL-02	Engineering Applications Beamline	RRCAT
BL-03	Soft X-ray Reflectivity (SXR) Beamline	RRCAT
BL-04	Imaging Beamline	BARC
BL-05	Atomic Molecular and Optical Studies (AMOS) Beamline	BARC
BL-07	Soft and Deep X-ray Lithography Beamline	RRCAT
BL-08	Extended X-ray Absorption Fine Structure (EXAFS) Beamline	BARC
BL-09	Scanning Extended X-ray Absorption Fine-Structure (S-EXAFS) Beamline	BARC
BL-10	Angle Resolved Photoelectron Spectroscopy (ARPES) Beamline	RRCAT
BL-11	Energy Dispersive X-ray Diffraction (EDXRD) Beamline (Extreme conditions XRD)	BARC
BL-12	Angle Dispersive X-Ray Diffraction (ADXRD) Beamline	RRCAT
BL-13	Grazing Incidence X-ray Scattering (GIXS) Beamline	UGC-DAE CSR
BL-14	Photo-Electron Spectroscopy (PES) Beamline	BARC
BL-16	X-ray fluorescence Microprobe (XRF-microprobe) Beamline	RRCAT
BL-18	Small and Wide Angle X-ray Scattering (SWAXS) Beamline	BARC
BL-20	X-ray Magnetic Circular Dichroism (XMCD) Beamline	RRCAT
BL-21	Protein Crystallography (PX) Beamline	BARC
BL-22	Photo-Emission Electron Microscopy (PEEM) Beamline	RRCAT
BL-23	Visible Diagnostic Beamline	RRCAT
BL-24	X-ray Diagnostic Beamline	RRCAT

The experimental facilities available at the Indus beamlines cover a wide range of X-ray and spectroscopic techniques, enabling investigations of materials, structures, surfaces, biological systems, and other scientific and technological applications across multiple research disciplines.



Experimental facilities available at Indus beamlines.

The representative fields of synchrotron-based research are illustrated in the figure below. The beamlines cater to multidisciplinary applications including agriculture, materials and chemical sciences, environmental studies, engineering, health, energy, industry, semiconductor research, biology, pharmaceuticals, petrochemicals, quantum materials, and archaeology.



Research areas supported by the Indus synchrotrons

Both Indus-1 and Indus-2, continuing its consistent performance, were operated for 337 days in round-the-clock mode during the year 2025.

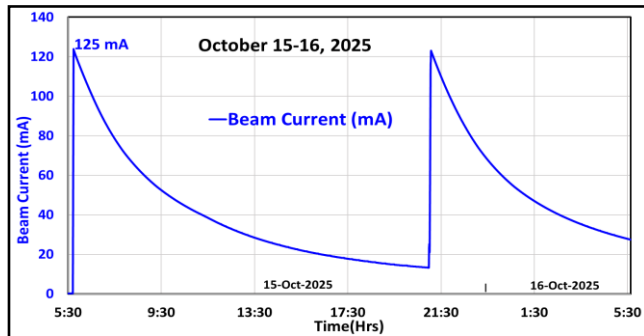
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OPERATION AND UTILIZATION STATISTICS

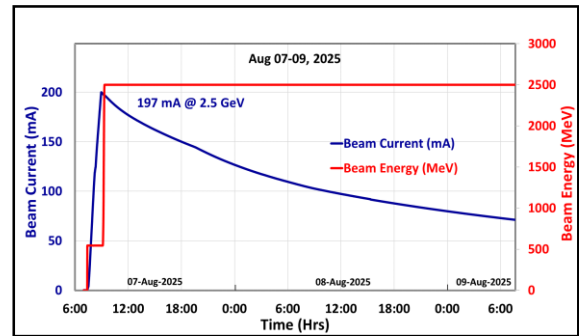
In the user mode, Indus-1 recorded a total beam availability of 7603 hours, corresponding to an average of approximately 22.5 hours per day. Similarly, Indus-2 achieved a user mode beam availability of 6317 hours at full energy, averaging about 18.7 hours per day. Notably, this represents the best performance ever recorded for both Indus-1 and Indus-2 in terms of beam availability to the users.

Since July 2024, Indus-2 has been regularly operated in a low beam emittance mode of ~ 45 nm·rad, compared to ~ 135 nm·rad. This transition has significantly improved beam quality and performance. In 2025, this mode of operation was further optimized by the incorporation of skew quadrupoles into regular operation. As a result, the beam lifetime at a current of 100 mA was substantially enhanced from ~ 55 hours to ~ 75 hours.

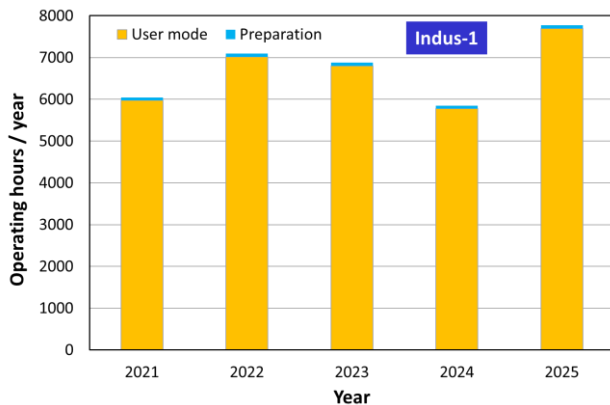
Periodic machine experiments were also carried out related to various studies including the lifetime improvement and beam-based alignments. Five planned shutdowns were taken amounting to 28 days. Activities related to upgrade, upkeep, obsolescence management and preventive maintenance, were undertaken during these shutdowns.



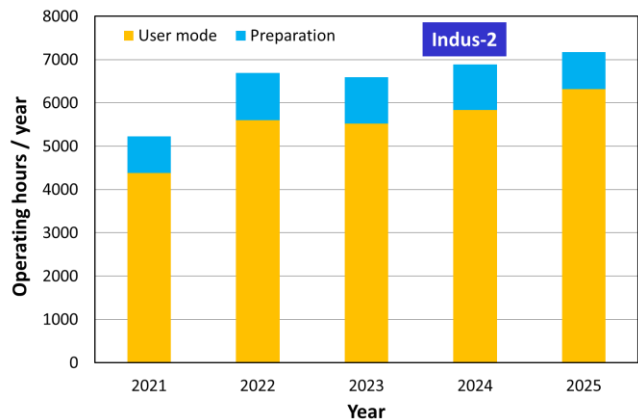
User mode operation of Indus-1



User mode operation of Indus-2

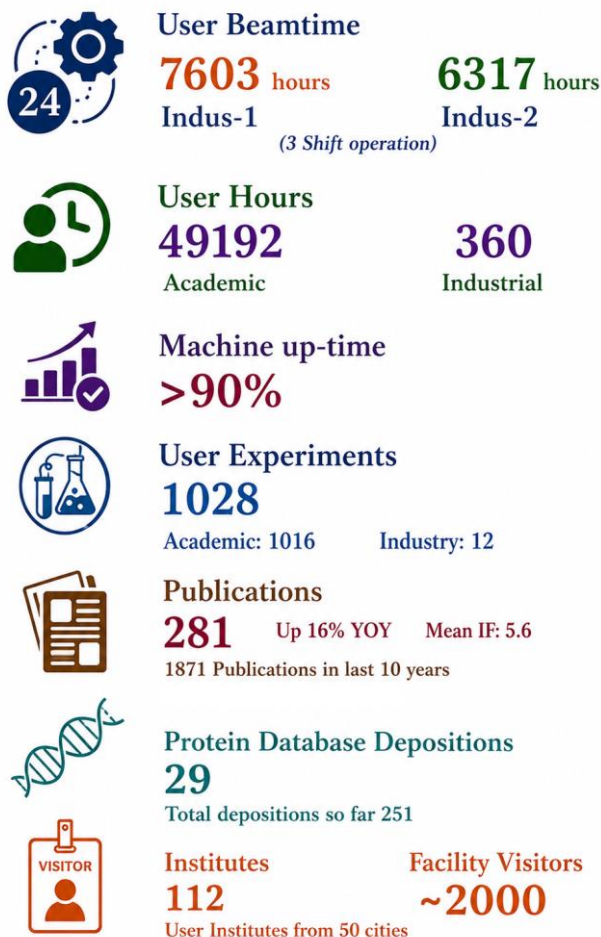


Beam availability in Indus-1



Beam availability in Indus-2

Key Performance Indicators (KPI) for 2025



Key Performance Indicators of Indus synchrotrons for 2025

Training, Qualification and Licensing Programme

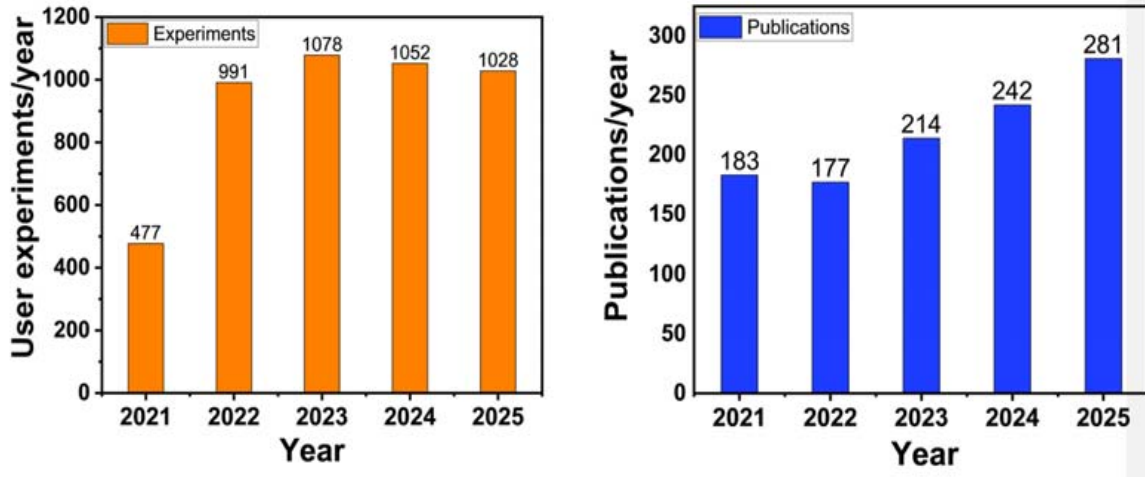
Training, Qualification and Licensing Programme (TQLP) for 6th batch of operation staff was completed in September-2025. Under this programme, 24 personnel have been trained and deployed as permanent operating staff.



TQLP Batch-6 in Indus Control Room

User Experiments and Publications statistics

The scientific utilization of the Indus beamlines has been consistent with the performance in the past years. Typically, annually 1000+ user experiments are being performed on Indus beamlines, resulting in 200+ publications. During the year 2025, 1028 user experiments have been performed. Based on the studies performed at Indus beamlines, in the year 2025, 281 publications appeared in peer reviewed journals - the highest number recorded so far.



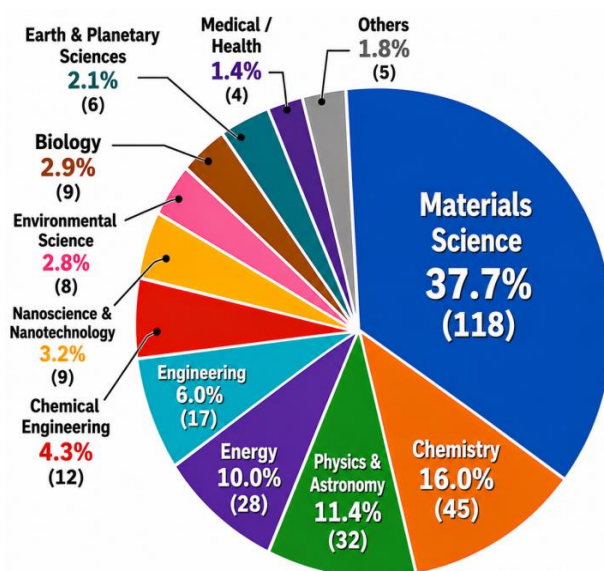
User experiments and publications statistics of Indus synchrotrons.

Researchers from 108 universities, national laboratories, research institutions, and 9 industries from different regions of India utilized Indus beamlines.



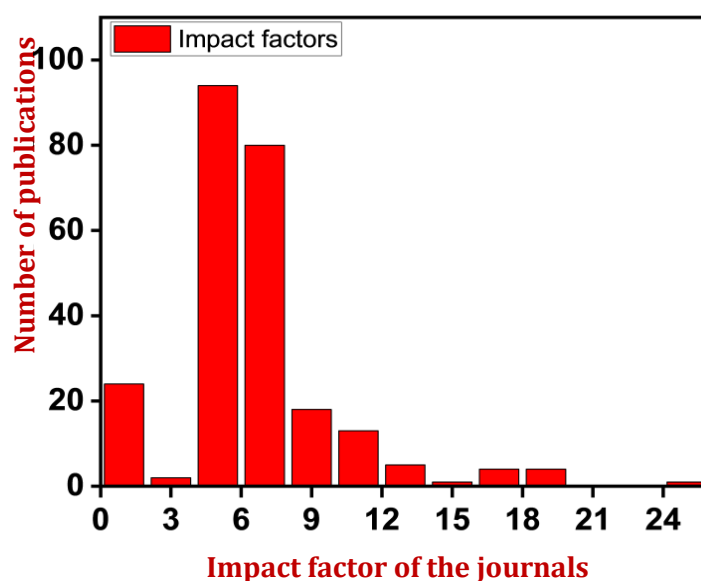
Userbase of Indus-1 and Indus-2 during the year 2025

The detailed list of the publications is given in Section-5. More than 50% of the total publications were published in the journal having impact factor 5 or more.



Subject Area	Materials Science	Chemistry	Physics & Astronomy	Energy	Engineering	Chemical Engineering	Nanoscience & Nanotechnology	Environmental Science	Earth & Planetary Sciences	Medical / Health	Others	Total
No. of Publications	118	45	32	28	17	12	9	8	6	4	5	281

Distribution of publications according to the area of research



A histogram of publications and impact factor of the journals

Industrial Users

During the year 2025, R&D departments of 9 pharmaceutical industries used Indus beamlines for investigations related to product development and characterization.

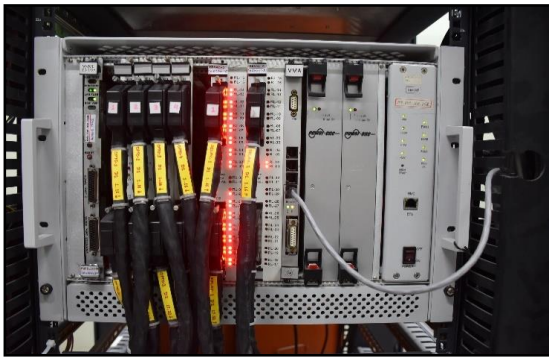
Serial No.	Industry name	Field/area of work of the industry	Types of experiments performed
BL-04: High resolution at X-ray Imaging beamline			
1.	Sahajanand Medical Technologies (SMT) Ltd, Surat Gujrat India	Design and fabrication of coronary and peripheral stents	Non-destructive X-ray micro-CT with dimensional measurement of stents struts
BL-09: Scanning EXAFS beamline			
1.	Lupin, Pune	Pharma	XAS on liquid samples
2.	Apothecon Pharmaceuticals Pvt. Ltd.	Pharma	XAS on liquid samples
3.	Orbicular Pharma Tech, Hyderabad	Pharma	XAS on liquid samples
BL-12: ADXRD beamline			
1.	Angeel Oak Specialty Chemtech Pvt. Ltd. Indore	Chemical	Powder XRD
2.	Technogreen, Pune	Pharma	Powder XRD
3.	Lupin, Pune	Pharma	Powder XRD
4.	MSN, Telangana	Pharma	Powder XRD
5.	Energion, Hyderabad	Pharma	Powder XRD
6.	Mankind Research Centre, Gurugram	Pharma	Powder XRD
BL-18: SWAXS Beamline			
1.	Lupin, Pune	Pharma	SAXS characterization of iron-sucrose complex
2.	Orbicular Pharmaceutical Technologies Pvt Ltd	Pharma	SAXS characterization of drug product (gel sample)

3

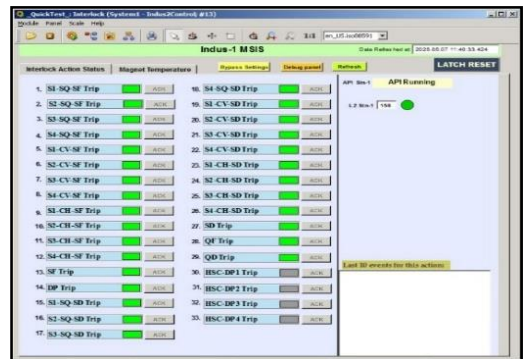
MAJOR UPGRADES AND NEW DEVELOPMENTS

Machine Safety Interlock System (MSIS) for upgraded Indus-1 Storage Ring

New multifunction magnets, having water-cooled sextupole coils and air-cooled corrector and skew-quadrupole coils magnet were installed during the upgradation of Indus-1 storage ring. A comprehensive machine safety and interlock system (MSIS) was integrated. The system takes status of 136 temperature switches mounted on all 52 magnets as system inputs. The system generates trip signals for 29 magnet power converters. VME DAQ station of this system comprises of digital output boards, with self-test feature and redundant power supplies. Supervisory control and data acquisition (SCADA) software, having API manager, GUI panels, data logging and web display, is deployed in the control room.



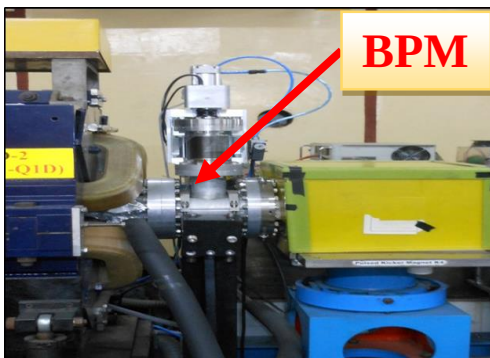
VME based DAQ station



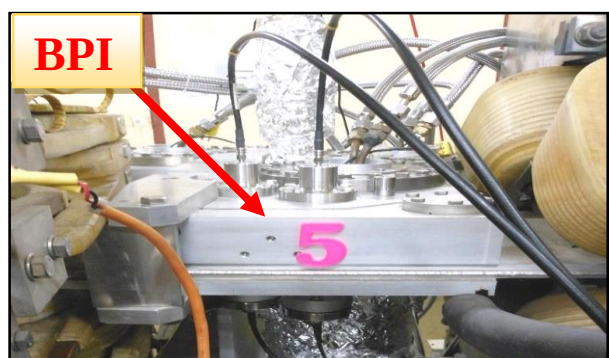
GUI panel showing interlock status

Upgradation of beam diagnostic devices in Indus-2

The edge-welded bellow of Beam Profile Monitor (BPM) installed in VS-1 was approaching its designed operating life, resulting in risk of vacuum failure. It was replaced with an upgraded version. Two Beam Position Indicators (BPIs) were also replaced with their upgraded versions. For this purpose, the vacuum segment VS-1 of length ~17m was vented. After this upgradation, the machine status was restored as planned for normal operation.



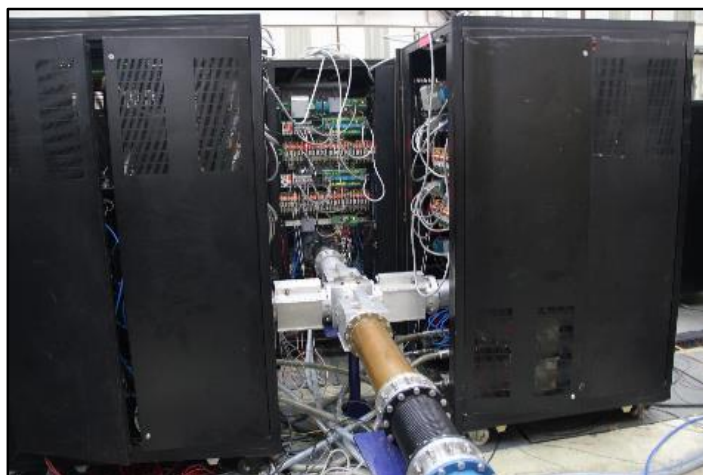
Upgraded BPM installed in VS-1



Upgraded BPI installed in Dipole Chamber-1 of VS-1

Upgradation of Indus-2 RF Amplifier System at RF Station-1

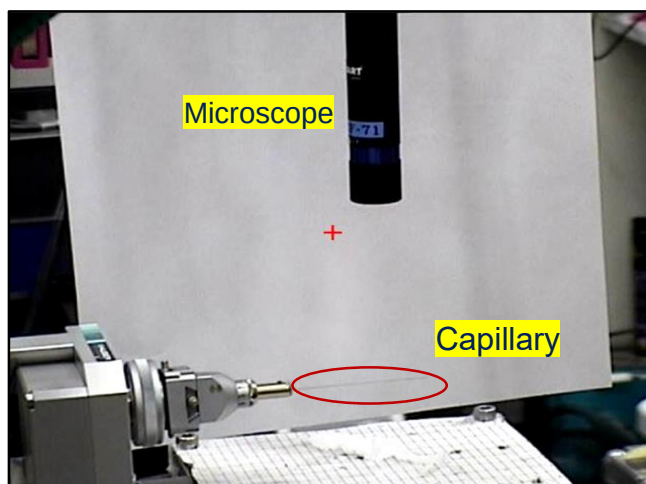
The existing 60 kW Inductive Output Tube (IOT) – based radio frequency (RF) amplifier at RF Station-1 was replaced with solid-state amplifier. The installed power level of this amplifier station was increased to 60 kW. The rated RF output power has been achieved by combining power of three 20 kW solid-state power amplifier (SSPA) racks using a 3-way RF power combiner. Each of the 20 kW SSPA rack has radial 64-way power dividing-power combining architecture.



The 60kW 505.8 MHz SSPA

Optical Microscope–Guided Capillary Alignment System for High Resolution XRD at Engineering Applications Beamline (BL-02) at Indus-2

Few micrograms of samples are placed inside a thin glass capillary of 0.1 mm outer diameter. The capillary needs to be kept in path of x-ray beam of 0.1-0.2 mm vertical size. The capillary alignment is therefore a challenging task. To facilitate this, a setup for capillary mounting has been developed at BL-02. For remote alignment of capillary on rotation stage, an optical microscope guided set-up was developed. The performance has been tested by performing x-ray diffraction at 15 keV with standard LaB_6 powder and the resolution better than 0.01° FWHM has been demonstrated.



Setup with capillary & microscope

Combined Transmission and Elemental Mapping at Indus-2 Imaging Beamline (BL-04)

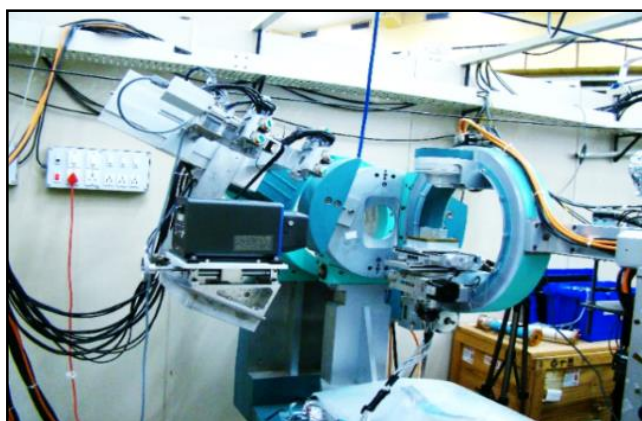
Combined transmission and 2D elemental mapping is performed using in-house developed phantoms with 0.1% concentration difference of elements. The set-up consists of a high resolution transmission-camera and fluorescence detectors at 90°, synchronized to a scanning set-up to raster scan the sample against a pencil beam. The stitching of transmission images and spectroscopic analysis of a series of spectrums provides a 2D elemental map and transmission radiography images to simultaneously provide the structure, density and composition information in the sample.



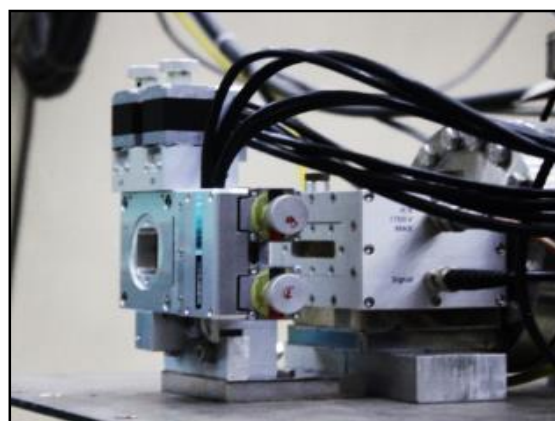
Combined transmission & elemental mapping experimental set-up at BL-04 with transmission image and fluorescence based elemental concentration

Installation of Area & Point Detectors and Entrance Slit at Indus-2 BL-13

A Pilatus 200K 2D detector and a new point detector have been installed on a goniometer at BL-13, Indus-2. This upgrade enables high-resolution, high-throughput powder diffraction, as well as in-operando studies of batteries and electric-field-dependent experiments. An entrance slit has also been installed to ensure the precise beam sizes required for a wide variety of samples. By combining focusing optics with this slit, the beamline can now provide either point or line beams depending on experimental requirements.



Pilatus 200K detector



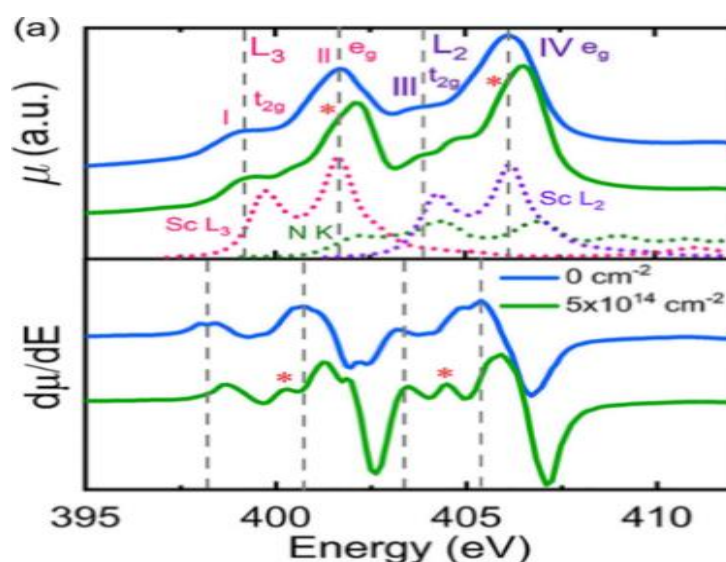
Entrance slit

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SALIENT SCIENTIFIC EXPERIMENTS AT INDUS BEAMLINES

Carbon ion implantation for electron compensation in epitaxial scandium nitride (*Phys. Rev. B 112, 165302, 2025*)

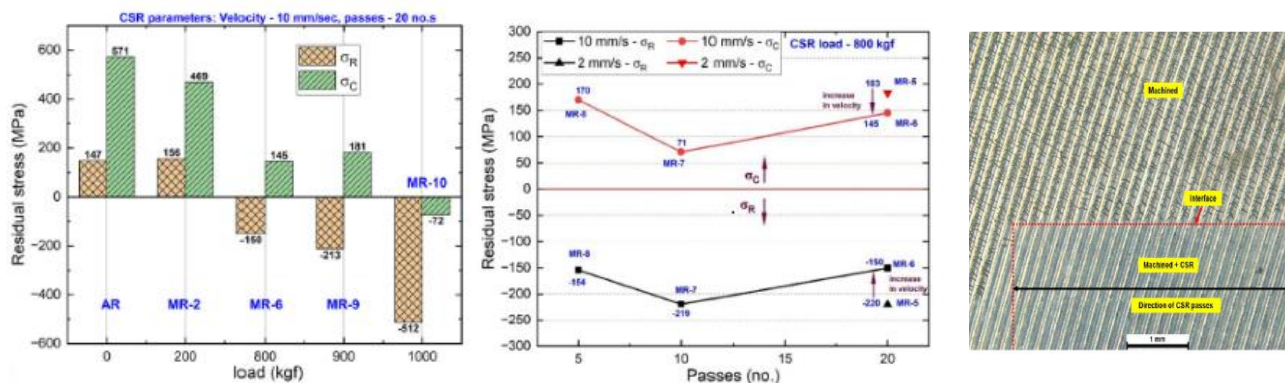
Scandium nitride (ScN), an emerging indirect bandgap semiconductor, has attracted significant interest in the recent times for thermoelectricity, infrared plasmon and phonon-polaritons, neuromorphic computing, and Schottky diode device applications. The work done at Indus-2 BL-09 demonstrated that hole doping in ScN with carbon ion-implantation presents a pathway to tune the electron concentration in ScN for device applications. Measurement of Sc $L_{3,2}$ edges proved to be critical to analyze the electronic structure of C doped ScN thin films.



Sc $L_{3,2}$ -edge XANES spectra of pristine ScN and C-implanted ScN thin films along with its derivative.

Controlled surface rolling (CSR) to mitigate stress corrosion cracking in machined SS304L (*J. Mater. Eng. Perform. 34, 11101, 2025*)

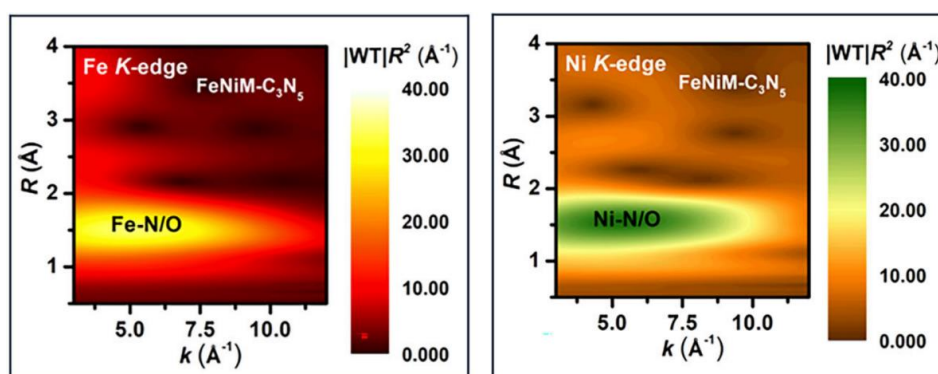
The circumferential and radial (σ_C and σ_R) residual stress values, after different CSR operation, were measured at Indus-2 BL-02. High tensile residual stress σ_C (571 MPa) and σ_R (147 MPa) were measured in the SS304L plates as-received (AR) and machine rolled (MR) specimens. These parameters were observed to reduce after CSR or were converted to compressive stresses. The effect of rolling load on residual stress is shown in figure below (left). This helped in deciding the optimum load needed to generate compressive residual stress. At a load of 800 kgf, the effect of rolling passes and roller velocity on residual stress is shown in the middle figure. Absence of SCC cracks in machined + CSR region is shown in right figure confirmed that required residual stress has been achieved. This work helped in developing procedure for controlled surface rolling to mitigate stress corrosion cracking.



Effect of CSR operation parameters rolling load (left), roller velocity and passes on residual stresses produced along circumferential and radial directions with respect to machining lines (middle), MR sample after ASTM G36 test for 24 h (right).

Atom-Scale Charge Reorganization for MOF-Driven Electrocatalytic Switching (*Adv. Funct. Mater.* 36, e15131, 2026)

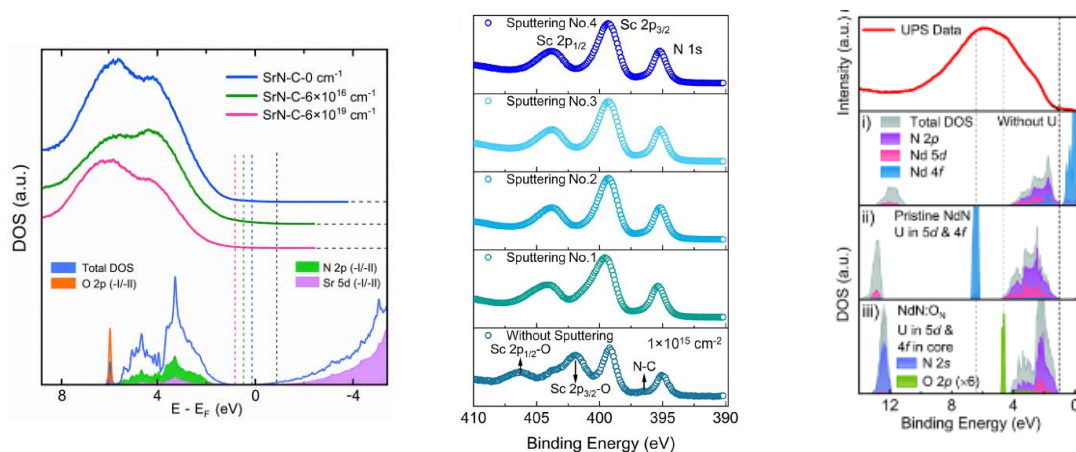
Rechargeable zinc-air batteries could deliver cheap, high-capacity energy storage, but their performance is limited by two sluggish reactions at the air electrode: oxygen reduction (ORR) and oxygen evolution (OER). Metal-organic frameworks (MOFs) are attractive catalysts because their structure and pores can be finely tuned, but most are monofunctional — good at OER, yet poor at ORR, where they often get stuck at a wasteful two-electron step that makes peroxide instead of water. The root cause is that the electronic state of the metal atoms is not naturally suited for both jobs at once. This study, carried out at Indus-2 BL-09, overcame that limit by anchoring a bimetallic Fe-Ni MOF onto a nitrogen-rich C_3N_5 support, forming metal-nitrogen ($M-N_x$) bonds at the interface that pulled electron density between the two metals. X-ray absorption spectroscopy (EXAFS and XANES) was the key tool that proved this: by precisely tracking shifts in the Fe and Ni absorption edges and fitting the local bonding environment around each atom, it directly showed iron becoming electron-rich and nickel becoming electron-poor, while also confirming the new metal-nitrogen bonds — insight no other technique in the study could provide. The resulting bifunctional catalyst gave the zinc-air battery higher power output and longer cycling life than benchmark noble-metal catalysts.



WT-EXAFS maps at Fe and Ni K-edges showing dominant M-N/O coordination and absence of metal-metal scattering, confirming atomic dispersion

Study of electronic properties of “Metal Nitrides” for energy harvesting and thermoelectricity (*Phys. Rev. B* 112, 165302, 2025), (*ACS Nano* 19, 36636, 2025)

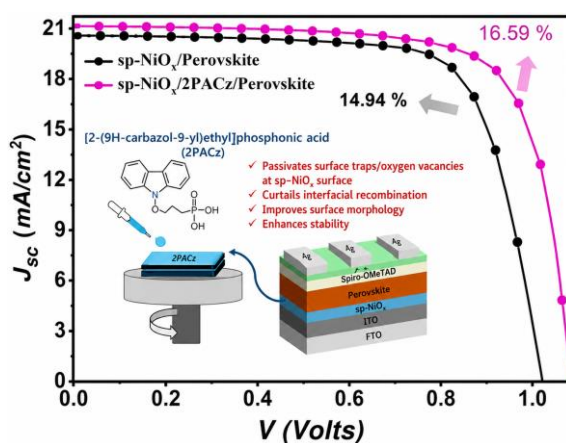
Nitrides are semiconductor materials known for extreme hardness, high-temperature stability, and unique electrical and optical properties with distinct applications in electronics, renewable energy, magnetic sensors, optoelectronic devices etc. Research on nitrides primarily focuses on developing high-performance materials. Hole doped ScN reported to have high thermoelectric power factor and NdN is a unique ferromagnetic semiconductor. Electronic structure studies of ScN and NdN at Indus-2 BL-10 reveal the character of valence electrons near the Fermi level responsible for the origin on novel properties of these materials.



Shift of the valence band maxima in Carbon ion-implanted ScN indicates hole doping (left). The sample surface shows strong oxygen contamination from strong Sc-O bonding, which eventually reduces inside the ScN:C sample with sputtering (middle). Valence band of NdN reveal contribution of occupied 4f states for the orbital driven ferromagnetism (right)

Tailoring sputter grown NiOx layer by synergistic surface passivation for efficient perovskite solar cells (*Sol. Energy* 288, 113286, 2025)

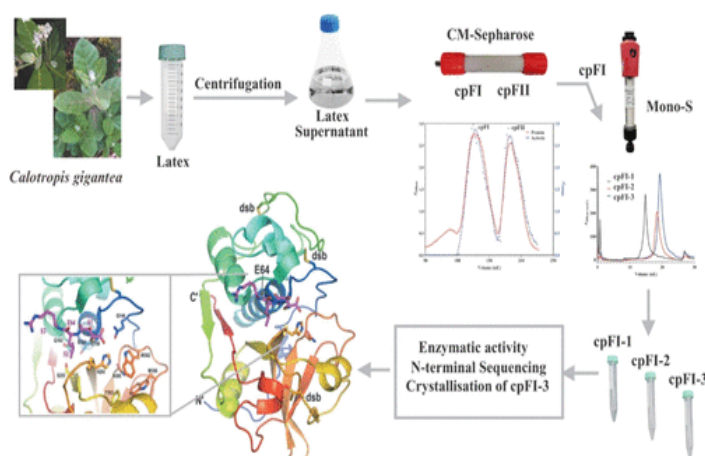
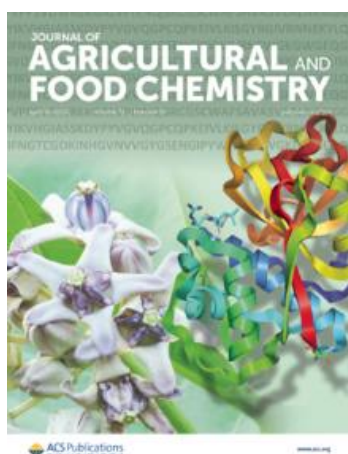
Sputtered nickel oxide (NiOx) serves as an appealing hole-transport layer for effective and stable p-i-n perovskite solar cells due to its ameliorated mobility of hole, outstanding stability, ease of fabrication and favorable fermi level for proficient transfer of holes. However, unfavourable chemical reactions and surface traps at the sputter grown NiOx/perovskite interface hinder its performance. To address these challenges, a novel passivation approach for the sputter grown NiOx/perovskite interface has been demonstrated by utilizing a self-assembled monolayer of [2-(9H-carbazol-9-yl) ethyl] phosphonic acid (2PACz). It was found that the 2PACz based passivation layer not only enhances the morphology of perovskite film with ameliorated domain size, it also diminishes carrier recombination amid sputter grown NiOx/perovskite interface, mitigating surface defects of the sputter grown NiOx film. Synchrotron XRD at Indus-2 BL-12 have verified the degree of crystallinity and phase analysis of the films using surface-sensitive grazing incidence X-ray diffraction (GIXRD) measurements.



J-V characteristics of perovskite solar cells with and without 2PACz modification

Crystal Structure of Papain-Like Cysteine Protease, Calotropain FI, Purified from the Latex of *Calotropis gigantea* (*Journal of Agricultural and Food Chemistry*, 2025)

This study reports the high-resolution crystal structure of Calotropain FI, a papain-like cysteine protease isolated from the latex of the medicinal plant *Calotropis gigantea* (*Aak in Hindi and Rui in Marathi*). Papain-like proteases are important enzymes widely used in food processing, pharmaceuticals, and biotechnology because of their strong proteolytic activity. The protein was purified and crystallized it in complex with the cysteine-protease inhibitor E64 to stabilize the enzyme and capture its active conformation. Crystal structures were determined at 1.25 Å resolution (at pH 6) and 1.4 Å resolution (at pH 9), providing detailed insight into the enzyme's catalytic architecture. The high-quality electron density maps of structures revealed the primary protein sequence of Calotropain FI which expands understanding of plant cysteine proteases and their catalytic mechanisms. These insights may facilitate biotechnological exploitation of plant proteases, including applications in food processing, pharmaceuticals, and protein hydrolysis. This paper was featured on cover page of a ACS Journal of Agricultural and Food Chemistry.



Cover page of the Journal of Agricultural and Food Chemistry (left). Isolation, biochemical characterization, crystallization and structure determination of Calotropain FI from latex of Calotropis gigantea plant (right).

5

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BL-01 Polarized Light Beamline (SXAS)

Energy Range: 100-1200 eV

Key Experiments

- XAS, XMCD
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Research Areas

- Chemical & Material Sciences
- Thin films, Biology

BL-02

Engineering Applications

Energy Range: 5-25 keV

Key Experiments

- XRD, GIXRD, Reflectivity
- Residual Stress Measurement
- PDF Analysis

Research Areas

- Engineering Applications, Thin films
- Materials, Additive Manufacturing

BL-03

Soft X-Ray Reflectivity

Energy Range: 100-1500 eV

Key Experiments

- Reflectivity, Absorption
- Fluorescence

Research Areas

- Thin films, Surfaces and interfaces
- X-ray devices: Mirrors and detectors

BL-04

IMAGING

Energy Range: 8-35 keV

Key Experiments

- Imaging: Absorption Contrast, Phase contrast, Micro-tomography
- 3D Elemental and Density mapping
- In-situ CT under mechanical load

Research Areas

- Biomedical and Materials
- Geology, Archaeology

BL-05

Atomic, Molecular and Optical Studies

Energy Range: 6-800 eV

Key Experiments

- Photoionisation
- Photochemistry, photoabsorption
- XAS of low Z elements

Research Areas

- Atmospheric Sciences
- Astrochemistry

BL-07

Soft and Deep X-ray Lithography

Energy Range: 3-20 keV

Key Experiments

- Soft and Deep X-ray lithography

Research Areas

- X-ray optics fabrication
- MEMS devices
- Micro-fluidic device

BL-08

EXAFS

Energy Range: 5 - 20 keV

Key Experiments

- X-ray absorption spectroscopy in the transmission mode
- XANES

Research Areas

- Materials
- Environmental Sciences

BL-09

Scanning EXAFS

Energy Range: 5 - 25 keV

Key Experiments

- EXAFS, XANES,
- In-situ/operando studies
- Temperature dependent EXAFS

Research Areas

- Pharmaceuticals, Catalysis
- Materials, Chemistry, Biomaterials
- Environment, Energy, Industrial R&D

BL-10

ARPES

Energy Range: 30-1000 eV

Key Experiments

- Angle-resolved photoelectron spectroscopy
- Synchrotron photoemission

Research Areas

- Surface Sciences, Spintronics
- Band Structure, Correlated Electron Systems, Quantum materials

BL-11

EDXRD/ECXRD

Energy Range: 10-40 keV

Key Experiments

- ADXRD (High pressure & High temperature)
- PDF analysis

Research Areas

- Materials Science,
- Advanced Materials

BL-12

ADXRD

Energy Range: 5-25 keV

Key Experiments

- XRD, XRR, GIXRD
- LT/HT XRD

Research Areas

- Pharmaceutical
- Material Sciences
- Microstructural Characterization

BL-13

GIXS

Energy Range: 5-20 keV

Key Experiments

- Single crystal diffraction, RSM
- XRR & Diffuse scattering
- In-plane and out-of-plane diffraction

Research Areas

- Materials Science, Semiconductors
- Nanoparticles

BL-14

Photo-electron spectroscopy

Energy Range: 2-15 keV

Key Experiments

- High-resolution photoelectron spectroscopy

Research Areas

- Chemical Sciences
- Surface Chemistry

BL-16

XRF-Microprobe

Energy Range: 5-20 keV

Key Experiments

- XRF, TXRF, μ -XRF, XRR and GIXRF

Research Areas

- Nano-materials, Thin films, Pharmaceuticals, Food, Environment, Life science
- Forensic applications, Agricultural

BL-18

SWAXS

Energy Range: 5-20 keV

Key Experiments

- Small angle X-ray scattering
- Wide angle X-ray scattering

Research Areas

- Material Sciences
- Nanoparticles, Soft-matter

BL-20

XMCD

Energy Range: 300- 2000 eV

Key Experiments

- XMCD, Polarized X-ray absorption
- Temperature dependent magnetic transitions

Research Areas

- Magnetic materials, Spintronics
- 2D and van der Waals magnets
- Energy and Quantum materials

BL-21

Protein Crystallography

Energy Range: 5- 20 keV

Key Experiments

- Macromolecular crystallography
- Single and Multi-wavelength anomalous dispersion

Research Areas

- Drug discovery, Structural biology
- High resolution proteins structure

BL-22

Photo-Emission Electron Microscopy (PEEM)

Energy Range: 100 eV - 8 keV

Key Experiments

- XRF

Research Areas

- Nanomaterials
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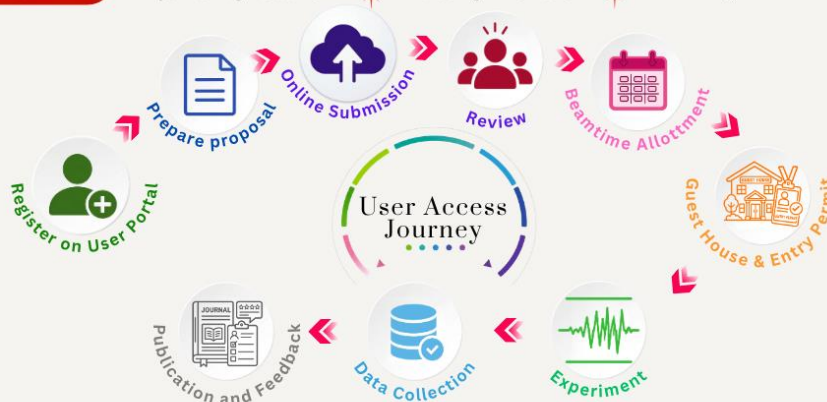


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- Angle-Resolved Photoemission Spectroscopy (**ARPES**)



Imaging

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- X-ray Computed tomography



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- Wide Angle X-ray Scattering (**WAXS**)



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