



भा.प.अ.के. न्यूज़लेटर BARC NEWSLETTER



संस्थापक दिवस 2026 FOUNDER'S DAY 2026



सितंबर-अक्टूबर / SEPTEMBER-OCTOBER 2026

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September-October 2026

Nuclear Science & Technology Acquires Greater Resilience



Dr. Ajit Kumar Mohanty
Secretary, DAE
&
Chairman, AEC

Dr. Homi J. Bhabha was an extraordinary scientist, visionary nation-builder and institution-builder who recognised, much ahead of his time, that scientific and technological self-reliance ('Aatmanirbharta') would be fundamental to India's progress. His vision laid the foundation of an institution that has, over the decades, expanded into a symbol of scientific excellence, technological capability and national duty.

As India is advancing towards the goal of a Viksit Bharat by 2047, Dr. Bhabha's vision acquires renewed significance. The Nuclear Energy Mission announced by the Government of India in the form of SHANTI ACT, 2025 provides an important opportunity to accelerate the expansion of nuclear energy and strengthen indigenous capabilities across the nuclear value chain.

The achievements of the Department of Atomic Energy (DAE) during the past year reflect this continuing national endeavour. India's nuclear power programme has progressed with the advancement of indigenous 700 MWe reactors, important milestones in the fast reactor programme and continued progress towards advanced reactor systems, including small modular and high-temperature gas-cooled reactors.

Equally significant are the contributions of DAE institutions to healthcare, agriculture, food preservation, water resources management and other societal applications of nuclear science. Indigenous radioisotopes and radiopharmaceuticals are supporting cancer diagnosis and treatments, while radiation technologies and crop varieties are reaching farmers and industries across the country.

Our efforts in advanced materials, accelerators, lasers, hydrogen technologies, critical minerals, rare earths and other frontier areas are further strengthening India's technological capabilities. Increasing technology transfer, industry partnerships and entrepreneurship initiatives are helping convert scientific achievements into practical applications.

These accomplishments are made possible by the dedication of our scientists, engineers, technical personnel and support teams, whose collective efforts sustain the DAE's mission.

Founder's Day is therefore both a celebration of our heritage and a reaffirmation of our responsibility towards India's bright future. I am confident that, inspired by Dr. Bhabha's vision and guided by the spirit of scientific excellence and self-reliance, DAE will continue to make significant contributions to a secure, prosperous and technologically advanced India.

My best wishes to the entire BARC fraternity on this important occasion. I take this opportunity to express my congratulations to SIRD, KMG alongside others for their sustained efforts in bringing out the special issue of BARC Newsletter with impressions from various ongoing programmes to commemorate this special occasion.

नव-कीर्तिमान स्थापित करती नाभिकीय विज्ञान एवं प्रौद्योगिकी



डॉ. अजित कुमार मोहन्ती
सचिव, परमाणु ऊर्जा विभाग
एवं
अध्यक्ष, परमाणु ऊर्जा आयोग

डॉ. होमी जे. भाभा एक असाधारण वैज्ञानिक, दूरदर्शी राष्ट्र-निर्माता और संस्थान-निर्माता थे, जिन्होंने अपने दूरदर्शी दृष्टिकोण से यह जान लिया था कि वैज्ञानिक एवं तकनीकी 'आत्मनिर्भरता' ही भारत की प्रगति के लिए मूलाधार होगी।

उनके दृष्टिकोण ने एक ऐसे संस्थान की नींव रखी जो दशकों से वैज्ञानिक उत्कृष्टता, तकनीकी क्षमता और राष्ट्रीय कर्तव्य के प्रतीक के रूप में विस्तारित होता आया है।

जैसे-जैसे भारत वर्ष 2047 तक 'विकसित भारत' के लक्ष्य की ओर बढ़ रहा है, डॉ. भाभा का दृष्टिकोण नए सिरे से प्रासंगिक होता जा रहा है। शांति अधिनियम, 2025 के रूप में भारत सरकार द्वारा घोषित नाभिकीय ऊर्जा मिशन परमाणु ऊर्जा के विस्तार में तेज़ी लाने और नाभिकीय हितैषी श्रृंखला में स्वदेशी क्षमताओं को मज़बूत करने का एक महत्वपूर्ण अवसर प्रदान करता है।

पिछले वर्ष के दौरान परमाणु ऊर्जा विभाग (प.ऊ.वि.) की उपलब्धियाँ, इस सतत राष्ट्रीय प्रयास को दर्शाती हैं। भारत के नाभिकीय ऊर्जा कार्यक्रम ने स्वदेशी 700 MWe रिएक्टरों की प्रगति, द्रुत रिएक्टर कार्यक्रम में महत्वपूर्ण मील के पथर और छोटे मॉड्यूलर एवं उच्च तापमान वाले गैस-शीतित रिएक्टरों सहित प्रगत रिएक्टर प्रणालियों की दिशा में निरंतर उन्नति के साथ प्रगति की है।

स्वास्थ्य देखभाल, कृषि, खाद्य परिरक्षण, जल संसाधन प्रबंधन एवं नाभिकीय विज्ञान के अन्य सामाजिक अनुप्रयोगों में प.ऊ.वि. संस्थानों का योगदान भी उल्लेखनीय रहा है। स्वदेशी रेडियोआइसोटोप और रेडियो भेषजिक कैसर के निदान एवं उपचार को समर्थ बना रहे हैं, जबकि विकिरण प्रौद्योगिकियाँ एवं फसल की किस्में देश भर के किसानों और उद्योगों तक पहुंच रही हैं।

प्रगत पदार्थ, त्वरक, लेसर, हाइड्रोजन प्रौद्योगिकी, क्रांतिक खनिज, विरल मृदा एवं अन्य समकक्ष क्षेत्रों में हमारे प्रयास भारत की प्रौद्योगिकीय क्षमताओं को अधिक मज़बूत कर रहे हैं। प्रौद्योगिकी हस्तांतरण में वृद्धि, उद्योग साझेदारी और उद्यमिता पहल वैज्ञानिक उपलब्धियों को व्यावहारिक अनुप्रयोगों में परिवर्तित करने में सहायता कर रहे हैं।

ये उपलब्धियाँ हमारे वैज्ञानिकों, अभियंताओं, तकनीकी कर्मियों और सहायक दलों के समर्पण से संभव हुई हैं, जिनके सामूहिक प्रयासों से पऊवि के मिशन को सतत आगे बढ़ाया जा रहा है।

इस प्रकार, संस्थापक दिवस हमारी विरासत का उत्सव है और भारत के उज्ज्वल भविष्य के प्रति हमारे दायित्वों की पुष्टि करता है। मुझे विश्वास है कि डॉ. भाभा के दृष्टिकोण से प्रेरित और वैज्ञानिक उत्कृष्टता एवं आत्मनिर्भरता की भावना से निर्देशित, प.ऊ.वि. एक सुरक्षित, समृद्ध और तकनीकी रूप से प्रगत भारत में महत्वपूर्ण योगदान देता रहेगा।

इस पुनीत अवसर पर, पूरे भा.प.अ. केंद्र समुदाय को मेरी ओर से बहुत-बहुत बधाई। मैं इस अवसर पर आयोजित विभिन्न यादगार कार्यक्रमों के साथ एसआईआरडी, केएमजी एवं उनके सहायोगियों द्वारा भा.प.अ. केंद्र न्यूज़लेटर के इस विशेषांक को प्रकाशित करने में उनके निरंतर प्रयासों की सराहना करते हुए हार्दिक बधाई देता हूँ।

Nuclear Research & Development Opens Fresh Avenues for National Development



Vivek Bhasin
Director
Bhabha Atomic Research Centre

It is a matter of great privilege to extend my warm greetings to the Bhabha Atomic Research Centre Science & Technology community and all our well-wishers on the occasion of 117th Founder's Day, commemorating the birth anniversary of visionary Dr. Homi J. Bhabha (1909-1966).

Dr. Bhabha envisioned an institution that would combine fundamental research, technological innovation and human resource development. More than seven decades later, that vision continues to guide BARC as a multidisciplinary centre of excellence serving the nation across a wide spectrum of nuclear science and technology.

The year gone by has witnessed significant progress across our major programmes. Our research reactors have continued to operate safely and reliably, enabling isotope production, neutron research and diverse scientific and technological applications. Notable advances have also been made towards new research and reactor systems, including the High Flux Research Reactor (HFRR), Isotope Production Reactor (IPR), and High Temperature Gas Cooled Reactor (HTGCR).

Our capabilities in nuclear fuel cycle technologies, waste management, accelerators, lasers, materials, cryogenics, basic sciences and advanced instrumentation have continued to mature. Technologies developed in-house at BARC are increasingly finding applications in industry and strategic programmes, reinforcing the nation's pursuit of Aatmanirbharta.

The societal impact of our R&D work remains a source of satisfaction. Crop varieties developed through nuclear radiation techniques are benefiting farmers, while radiation processing, water purification through desalination technologies are addressing important societal needs. In healthcare, indigenous radioisotopes, radiopharmaceuticals and advanced treatment technologies are contributing to the diagnosis and management in healthcare.

Our commitment to basic and directed research remains equally strong. National facilities at BARC continue to serve researchers from universities and institutions across India.

The heart of every achievement is human resource capabilities. The dedication of our scientists, engineers, technical personnel, healthcare professionals and support teams has enabled BARC to maintain high standards of safety, reliability and excellence.

As we celebrate Founder's Day, we must remember that it is our collective responsibility to carry the institutional legacy forward and create fresh opportunities that will serve India for generations to come.

I extend my warm wishes to SIRD, KMG alongside others for their spirited efforts in bringing out the special issue of BARC Newsletter.

राष्ट्रीय विकास हेतु नए द्वार खोलता नाभिकीय अनुसंधान एवं विकास



विवेक भसीन
निदेशक
भाभा परमाणु अनुसंधान केंद्र

युगद्रष्टा डॉ. होमी जे. भाभा (1909-1966) की जयंती के पुण्यस्मरण में 117वें संस्थापक दिवस के शुभ अवसर पर भाभा परमाणु अनुसंधान (भा.प.अ.) केंद्र के विज्ञान एवं प्रौद्योगिकी समुदाय और हमारे सभी शुभचिंतकों को हार्दिक बधाई देना मेरे लिए सौभाग्य की बात है।

डॉ. भाभा ने एक ऐसे संस्थान की कल्पना की थी जो मूलभूत अनुसंधान, तकनीकी नवाचार एवं मानव संसाधन विकास को एकीकृत कर सके। सात दशकों से भी अधिक समय के पश्चात भी, इस दृष्टि ने भा.प.अ. केंद्र को नाभिकीय विज्ञान एवं प्रौद्योगिकी के एक व्यापक स्पेक्ट्रम में राष्ट्र की सेवा करने वाले उत्कृष्टतम बहु-विषयक केंद्र के रूप में मार्गदर्शन करना जारी रखा है।

पिछले वर्ष हमारे प्रमुख कार्यक्रमों में महत्वपूर्ण प्रगति हुई है। हमारे शोध रिएक्टरों ने आइसोटोप उत्पादन, न्यूट्रॉन अनुसंधान और विविध वैज्ञानिक और तकनीकी अनुप्रयोगों को समर्थ बनाते हुए संरक्षित एवं विश्वसनीय रूप से कार्य करना जारी रखा है। उच्च अभिवाह अनुसंधान रिएक्टर (एचएफआरआर), आइसोटोप उत्पादन रिएक्टर (आईपीआर) और उच्च तापमान गैस शीतित रिएक्टर (एचटीजीसीआर) सहित नए अनुसंधान और रिएक्टर प्रणालियों की दिशा में भी उल्लेखनीय प्रगति हुई है।

नाभिकीय ईंधन चक्र प्रौद्योगिकियों, अपशिष्ट प्रबंधन, त्वरकों, लेसरों, पदार्थों, क्रायोजेनिकों, आधारभूत विज्ञान और प्रगत यंत्रीकरण में हमारी क्षमताएं लगातार परिपक्व हो रही हैं। भा.प.अ. केंद्र में आंतरिक रूप से विकसित प्रौद्योगिकियों का उद्योग और कार्यनीतिक कार्यक्रमों में तेज़ी से उपयोग हो रहा है, जो राष्ट्र की आत्मनिर्भरता की दिशा और दशा को सुदृढ़ कर रहा है।

हमारे अनुसंधान एवं विकास कार्य का सामाजिक प्रभाव संतोषप्रद स्रोत बना हुआ है। नाभिकीय विकिरण तकनीकों के माध्यम से विकसित फसलों की किस्में किसानों को लाभान्वित कर रही हैं, जबकि विकिरण प्रसंस्करण, विलवणीकरण प्रौद्योगिकियों के माध्यम से जल शोधन महत्वपूर्ण सामाजिक जरूरतों को पूरा कर रहे हैं। स्वास्थ्य देखभाल के क्षेत्र में, स्वदेशी रेडियोआइसोटोप, रेडियोभेषजिकों एवं प्रगत उपचार प्रौद्योगिकियों स्वास्थ्य देखभाल में निदान और प्रबंधन में योगदान दे रही हैं।

आधारभूत एवं निर्देशित अनुसंधान के प्रति हमारी प्रतिबद्धता समरूपता से सुदृढ़ बनी हुई है। भा.प.अ. केंद्र में राष्ट्रीय सुविधाएं देश भर के विश्वविद्यालयों और संस्थानों के शोधकर्ताओं की सेवाएँ प्रदान करना जारी रखी हैं।

मानव संसाधन क्षमताएँ ही प्रत्येक उपलब्धि का केंद्र है। हमारे वैज्ञानिकों, अभियंताओं, तकनीकी कर्मियों, स्वास्थ्य देखभाल पेशेवरों और सहायक दलों के समर्पण ने भा.प.अ. केंद्र को संरक्षा, विश्वसनीयता और उत्कृष्टता के उच्च मानकों को बनाए रखने में समर्थ बनाया है।

जब हम संस्थापक दिवस मना रहे हैं, तो हमें याद रखना चाहिए कि यह हमारी सामूहिक जिम्मेदारी है कि हम संस्थागत विरासत को आगे बढ़ाएं और नए अवसर सृजित करें जो भारत की भावी पीढ़ियों के लिए सेवाएँ प्रदान करें।

मैं, भा.प.अ. केंद्र न्यूज़लेटर के विशेष अंक को प्रकाशित करने में, इसके उत्साही प्रयासों के लिए अन्य व्यक्तियों के साथ-साथ एस.आई.आर.डी., के.एम.जी. को हार्दिक बधाई देता हूँ।

इस अंक के आकर्षण

अनुसंधान रिएक्टर

विस्तारशील पुनर्संसाधन

त्वरकों में आत्मनिर्भरता

अग्रेषित कर्णपुंज

प्रगत रेडियोआइसोटोप

आधारभूत विज्ञान

प्रगत प्रौद्योगिकियां

स्वास्थ्य संरक्षा

सशक्त प्रशिक्षण

एचबीएसटी मानपत्र

पुरस्कार एवं सम्मान

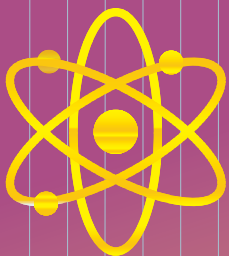
राजभाषा लोकप्रियकरण

हमारे प्रतिष्ठित आगंतुक

युगद्रष्टा डॉ. होमी जे. भाभा

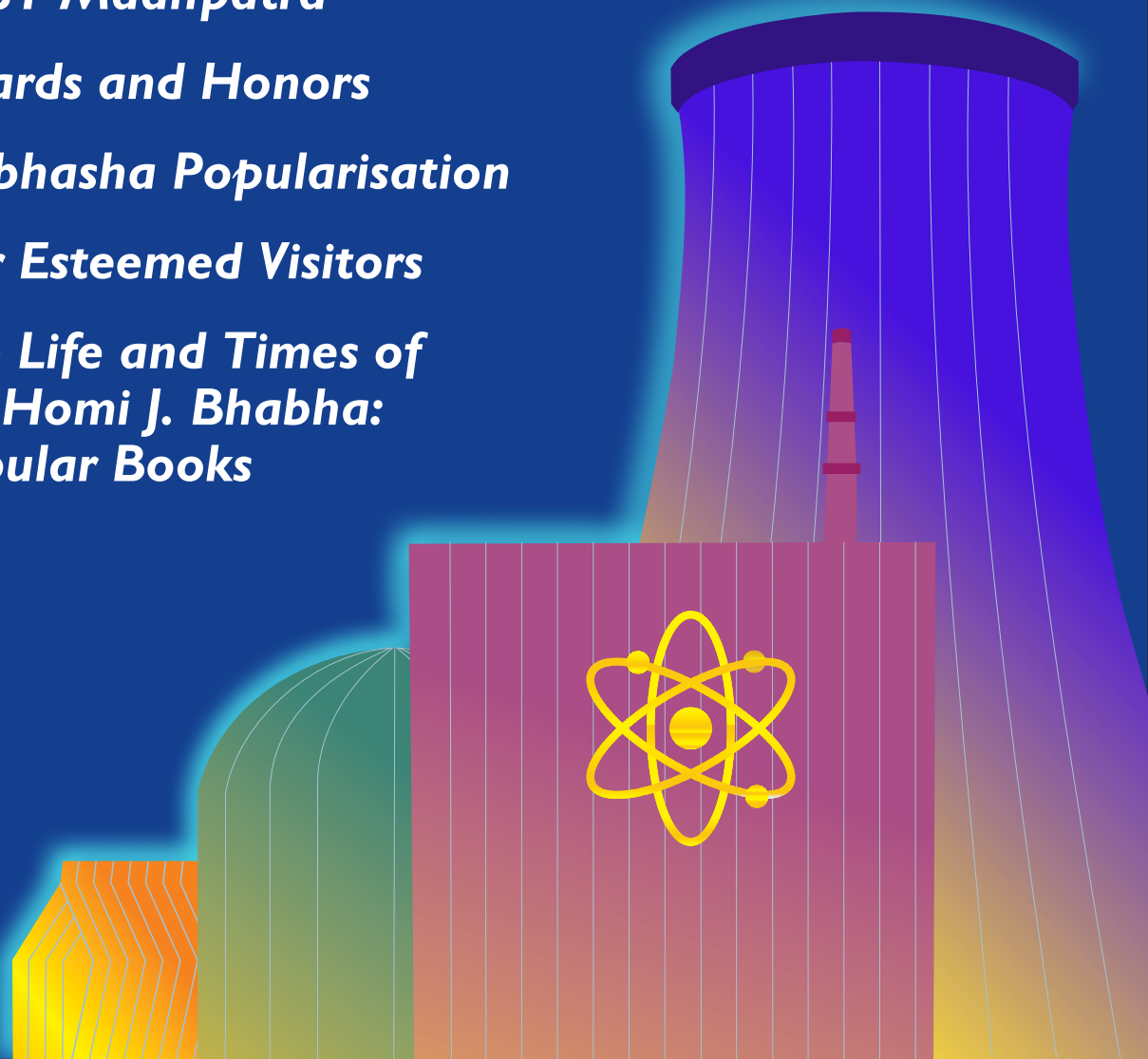
का जीवन एवं काल-खंडः

लोकप्रिय पुस्तकें



At a Glance

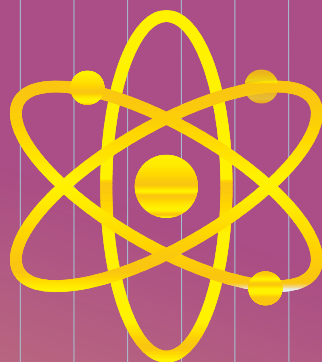
- I** *Research Reactors*
- 6** *Expanding Reprocessing*
- 10** *Aatmanirbhar Accelerators*
- 14** *Forwarding Beams*
- 18** *Advancing Radioisotopes*
- 24** *Basic Sciences*
- 30** *Advanced Technologies*
- 34** *Health Safety*
- 38** *Robust Training*
- 42** *HBST Maanpatra*
- 50** *Awards and Honors*
- 54** *Rajbhasha Popularisation*
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- 60** *The Life and Times of
Dr. Homi J. Bhabha:
Popular Books*





*...If Indian industry is to take off
and be capable of independent
flight it must be powered by
science and technology
based in the country...*

Homi J. Bhabha



RESEARCH **R** *The Mainstay of Nuclear Programme enroute Viksit Bharat* **Reactors**

अनुसंधान रिएक्टर: विकसित भारत की ओर अग्रसर नाभिकीय कार्यक्रम

High Flux Research Reactor Takes Shape in BARC Visakhapatnam: BARC has reached a significant milestone in its efforts to develop and establish advanced research reactor facilities in the country. The High Flux Research Reactor (HFRR), planned at the greenfield Visakhapatnam campus, has now moved to the construction stage with the successful breaking of ground for one of its key facilities.

The ceremonial 'Bhumi Pujan' (Ground Breaking) for the Reactor Common Services Building (RCSB) of the HFRR was held on 19 August 2026. Senior officials from BARC, particularly from the Reactor Projects Group (RPG) leading the project, along with NPCIL officials, were present on the occasion.

With a thermal power of 40 MW, the HFRR is being developed as a major facility to support advanced nuclear research and related

activities. The reactor is expected to strengthen the country's capabilities in high-flux research and provide an important platform for future scientific and technological programmes.

The RCSB will form a vital part of the reactor's support infrastructure. It will house critical reactor services, including six 315 kW secondary coolant water system pumps and six 11 MW induced-draft cooling towers, along with the reactor heat-sink systems. These facilities will play a crucial role in ensuring reliable heat removal and supporting the safe and efficient operation of the reactor.



HFRR Core Team and the ceremonial Ground Breaking for the Reactor Common Services Building of the HFRR held on 19 August 2026 (Inset Photo).

Construction of the RCSB is being taken up in parallel with other major activities associated with the establishment of the HFRR. The building is targeted for completion within 24 months, marking another important step towards bringing the new research reactor facility to fruition.

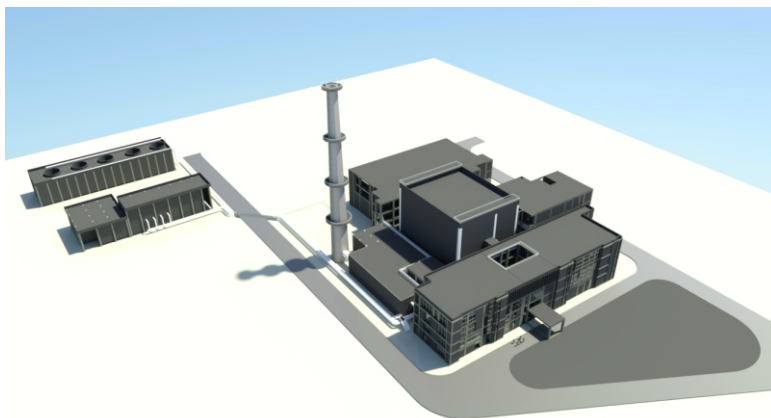
Isotope Production Reactor: Advancing India's capacity in vital radioisotopes for healthcare and others: The 40 MW Isotope Production Reactor (IPR), an open-pool-type, high-flux research reactor, is being developed at BARC, Visakhapatnam, to support large-scale production of critical radioisotopes for nuclear medicine and other strategic applications, including ^{177}Lu , ^{131}I , ^{192}Ir , ^{60}Co , ^{99}Mo , ^{153}Sm , ^{166}Ho and ^{188}W .

The Detailed Project Report (DPR) has been prepared, and administrative and financial sanction has been obtained from DAE. The Notice Inviting Tender (NIT) for engineering and construction has been floated. Award of the EPC contract and commencement of major project activities are targeted by the end-2026, with First Approach to Criticality (FAC) targeted for 2031.

Basic design and engineering of major reactor and plant systems, core mechanical design and associated analyses, and basic civil, structural and architectural designs have been completed. Detailed technical specifications required for construction and commissioning have also been prepared.

The Radiological Impact Assessment (RIA) has been completed, and siting clearance has been obtained from the BARC Safety Council. The Preliminary Safety Analysis Report (PSAR) required for excavation clearance have been prepared and independently reviewed. For environmental clearance, requisite documents have been submitted to MoEFCC, resulting in issuance of the Terms of Reference (ToR) for EIA studies. An EIA consultant has been appointed to support Environmental Clearance and Consent-to-Establish. Geo-technical investigations at the identified site locations have also been completed.

The IPR has therefore made substantial progress across design, safety, regulatory, environmental and site-preparation stages. The project is now poised for EPC award and



3D (architectural) view of the proposed IPR facility.

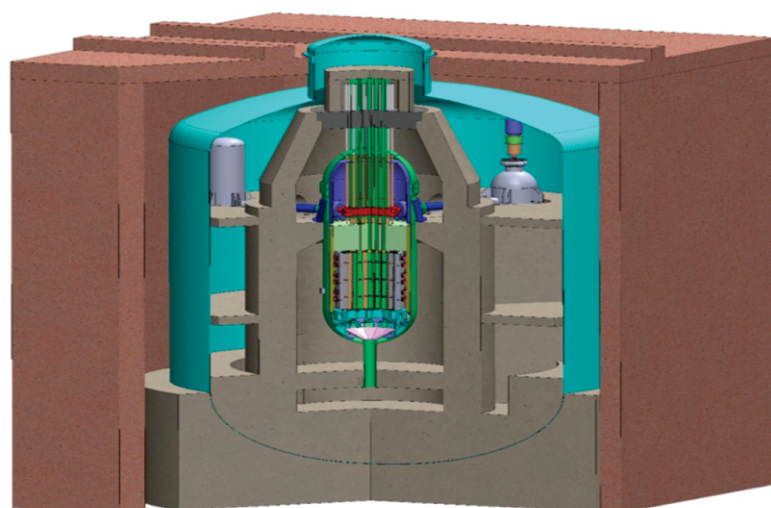
construction, followed by commissioning and FAC by 2031-strengthening India's capacity to produce vital radioisotopes for healthcare.

High Temperature Gas Cooled Reactor - Design & Development:

BARC is committed to the design and development of advanced nuclear reactors to support India's vision of energy security, global industrial competitiveness, and long-term environmental sustainability. A targeted technology push towards High Temperature Reactors (HTRs) aims to integrate nuclear energy with the green hydrogen economy.

As a lead step, BARC is developing an indigenous 5 MW_{th} High Temperature Gas Cooled Reactor (HTGCR) to demonstrate clean hydrogen production using nuclear energy. Its high-grade heat, available at around 650°C, can also support clean ammonia production, hydrocarbon cracking, industrial heating, and other applications.

The Indian HTGCR employs slightly enriched Uranium dioxide (UO₂) fuel, CO₂ as the primary coolant, and graphite as the neutron moderator. Advanced physics and thermal-hydraulic analyses have led to an optimized fuel assembly comprising a 24-pin fuel cluster enclosed in double graphite sleeves. The physics design provides adequate excess reactivity for an extended core life of



Cross sectional view of major primary components & containment of HTGCR.

approximately 4 full power years with fresh fuel loading. The reactor core, comprising fuel assemblies, reactivity control devices, and graphite moderator and reflector, is housed within a reactor pressure vessel (RPV) fabricated from conventional $2\frac{1}{4}\text{Cr-1Mo}$ steel widely used in chemical plants.

Key technological challenges include structural design of the graphite core, high-temperature and neutron-irradiated metallic components, and safe, robust coupling of the nuclear reactor with a chemical plant for hydrogen production. The heat transport system incorporates provisions for safe nuclear heat removal during normal operation and chemical-plant unavailability. The entire primary heat transport (PHT) system is enclosed in a nitrogen-inerted metallic containment.

Design-basis accidents, including loss of coolant accident (LOCA) and prolonged station blackout (SBO), along with anticipated operational occurrences (AOOs), are addressed through engineered safety systems (ESS). These advanced safety provisions, including protection against postulated reactivity-initiated accidents, ensure HTGCR safety comparable to modern Gen-IV nuclear reactors. Demonstration of clean H_2 production using HTGCR heat will advance decarbonisation of transport and process industries while reducing India's dependence on imported fossil fuels.

The Mainstay Operating Research Reactors: Research reactors Apsara-U and Dhruva operated safely and reliably, supporting medical, agricultural and industrial isotope production, fundamental research, materials testing and studies for future power reactor programmes. The Critical Facility (CF) met research community requirements.

Apsara-U reactor achieved approximately 89% availability, supporting research and radioisotope production. Following shielding augmentation, successful operation at core position A enabled commissioning of the thermal column for irradiation and detector testing. Ten new B-10-lined Gamma Compensated Ion Chambers (GCICs) were tested.

The beam tube neutron imaging facility supported non-destructive investigations, including PGNA experiments. A single-crystal

alignment facility was commissioned in beam tube #6, while commissioning of a neutron detector test facility at beam tube #8 is underway. Twenty-five cans in tray rods were irradiated, and 109 samples were processed using Neutron Activation Analysis (NAA). Other activities included testing five IRM miniature fission counters for TAPS-1 and TAPS-2 after their long shutdown, and irradiation of neutron detector coaxial cables, SS 316L-glass fibre composite joints for cryogenic applications, and foils for neutron and gamma flux characterisation.

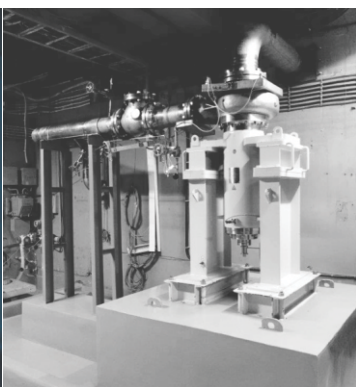
Dhruva reactor achieved approximately 85% of its maximum achievable availability. Production included 413 medical and industrial radioisotopes and 18 NAA samples. Fission molybdenum targets were irradiated as required, and 60 plates were delivered to the Fission Moly Processing Plant.

Major upgradation and life-management activities in Dhruva included replacement of Shut-Off Rod (SOR) position guide tube sealing O-rings for the first time since commissioning, and inspection of the SOR lattice and absorber guide tubes. Studies of O-rings removed after 40 years of radiation exposure informed future use. An additional canned-motor shutdown cooling pump was commissioned. A modified bearing-mounted SOR electromagnetic clutch assembly was qualified, tested and installed in one SOR. Replacement of rotameters with integral orifices, flow transmitters and current switches is underway. Underground HDPE effluent pipelines were inspected for ageing studies. TPLC software for alarm annunciation and start-up logic was upgraded, and Channel A setups of the bulk coolant gamma monitoring system were replaced.

On the other hand, the Critical Facility was operated on 71 occasions for detector testing and activation of large NAA samples. Twenty-seven nuclear detectors were tested, and 47 samples and five foils were activated. Special irradiation studies investigated organic dye stability and interactions with biological cells under neutron exposure. SNDs, GCICs and B-10-lined proportional counters for Nuclear Power Corporation of India Limited were tested. Hot commissioning trials of the iodine processing facility at CIRUS were completed.



Top view of Apsara-U Core.

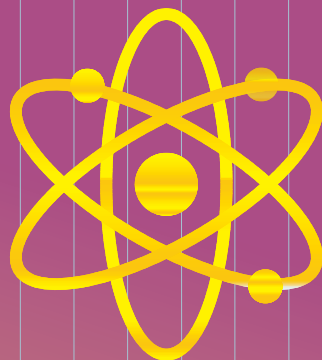


Dhruva canned-motor shutdown cooling pump.



...atomic energy is not merely an aid, it is an absolute necessity. The acquisition by man of knowledge of how to release and use atomic energy must be recognised as the third epoch of human history...

Amn J Shabha



EXPANDING **R** *Expertise in Nuclear Fuels* Reprocessing

विस्तारशील पुनर्संसाधन: परमाणु ईंधन में विशेषज्ञता

India has established indigenous reprocessing capabilities for spent fuel from Pressurised Heavy Water Reactors (PHWRs), supported by decades of experience in spent-fuel handling, head-end operations, solvent-extraction based separation, and management of highly radioactive process streams. This experience provides a technological foundation for extending reprocessing expertise to advanced nuclear fuels. Research and development (R&D) are essential to address challenges in fuel dissolution, separation chemistry, material compatibility, and waste management, thereby demonstrating process feasibility, recovering valuable fissile materials, minimizing secondary waste, and ensuring safe, efficient, and economically viable reprocessing. This article presents experimental studies addressing challenges in processing uranium silicide fuel and spent uranium precipitate filters.

Reprocessing of Uranium Silicide Fuel:

Uranium silicide fuel dispersed in an aluminium matrix and clad in aluminium alloy is used in the Apsara-U reactor. This plate-type fuel contains low-enriched uranium (LEU) and differs

significantly from fuel types for which reprocessing technologies are established in India. Uranium silicide dispersion fuel is also proposed for the upcoming High Flux Research Reactor and Isotope Production Reactor at Visakhapatnam. Given the absence of prior reprocessing experience with this fuel, investigations into its dissolution and solvent extraction behaviour were necessary. Process optimisation also requires removal of undissolved silicon, selection of suitable solvent compositions and partitioning agents, and control of dissolved silica, which can cause crud formation during solvent extraction.

Extensive laboratory-scale experiments identified an

aqueous PUREX based route for silicide fuel reprocessing. Both acidic dissolution and alkali treatment followed by acid dissolution were investigated. The resulting process scheme comprises nitric acid dissolution, silica removal, feed conditioning, and PUREX-based solvent extraction.

Since dissolution is a major challenge, detailed studies investigated the fuel's behaviour in nitric acid. Aluminium constitutes more than 60% of the fuel, and its dissolution was identified as the rate-determining step. Kinetic studies of Al 6061 cladding and aluminium matrix dissolution examined the effects of nitric acid concentration and surface area to support engineering-scale process development. Kinetic modelling indicated zero-order dependence on aluminium concentration, characteristic of a surface-controlled reaction, and second-order dependence on nitric acid concentration. The dissolution rate decreased above 8 M nitric acid because of passive-layer interference. Dissolution below 2 M nitric acid should be avoided because of the potential generation of hydrogen gas. Further studies using a 5 L pilot-scale experimental setup are planned to validate laboratory findings.

Spent Uranium Precipitate Filters - Development of a Process Scheme:

At the Fission Moly Plant (FMP), BRIT, irradiated uranium aluminide plates dispersed in an aluminium matrix and clad in aluminium are processed to recover Mo-99, which is used to generate Tc-99 for radiodiagnostic applications. This process generates spent uranium precipitate filters (SUPFs) containing unused uranium as sodium diuranate (SDU), alongside fission products such as ^{144}Ce , ^{144}Pr , and ^{90}Sr . Because these plates have relatively low irradiation levels, most feed uranium remains unused and reports to the SUPF, necessitating recovery and reuse. The process involves dissolution, uranium recovery, and purification. SDU dissolution in nitric acid is rapid. However, uranium recovery presents challenges owing to the considerable U-235 fraction and required product purity. The low uranium inventory per batch necessitates handling in appropriately shielded glove boxes (GBs).

Two approaches were investigated for uranium recovery and purification. The first



Dissolution setup for Al 6061.

employed solvent extraction using 15% TBP and simulated solutions. Laboratory-scale mixer-settler units were used to evaluate uranium recovery and fission-product decontamination. Decontamination factors achieved in a single cycle using eight extraction stages and four scrubbing stages are presented in the corresponding table.

Solvent extraction within GBs presents challenges in organic-solvent handling and maintaining the required leak tightness. Accordingly, membrane-based recovery studies were initiated through an intra-BARC collaboration to develop a functionalised-resin-based process. A styrene-divinylbenzene resin functionalised with phosphonate groups (PHP) showed promise. From 4 M HNO_3 , the resin exhibited a uranium uptake capacity of 80 mg/g and very low fission-product uptake, with K_d values below 0.5 mL/g.



Laboratory scale mixer-settler for recovery and decontamination of U.

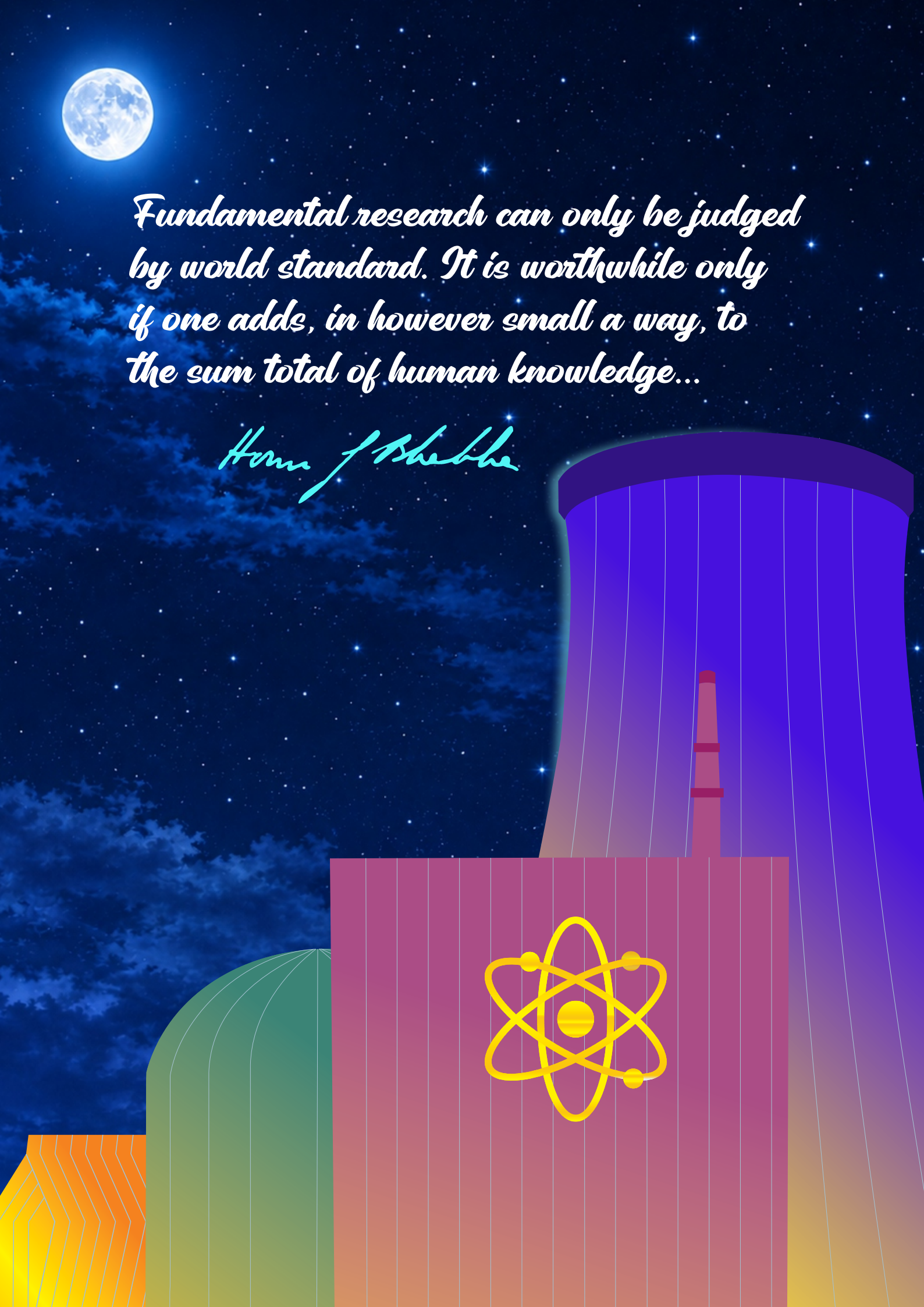


Pilot scale experimental setup for remote handling of unirradiated simulated SUPF.

Uranium was readily stripped using 1 M ammonium carbonate. The corresponding decontamination factors at different acidities are presented in the relevant table. The resin maintained its loading capacity and stripping behaviour over six cycles and showed radiation resistance, with no observed changes following irradiation to 10 kGy. Considering operational simplicity and improved decontamination performance, the resin-based process will be adopted for uranium recovery from dissolved SUPF.

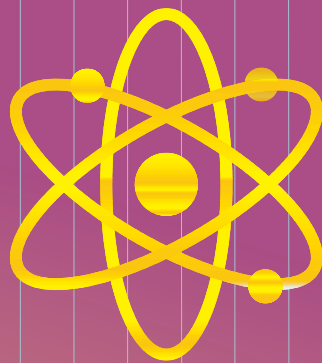
Pilot-Scale Experimental Set-up: A pilot-scale experimental system has been established at Trombay to demonstrate remote handling of unirradiated simulated SUPF and dissolution of its uranium precipitate. The system comprises a 5 L batch dissolver, material-handling equipment, and an off-gas cleaning system. Uranium recovery from the dissolved solution will be investigated using resin-based methods. The setup will subsequently be extended to validate dissolution studies using unirradiated silicide fuel and uranium recovery from the resulting solution. It will support process-parameter optimisation for designing equipment to process silicide fuel and SUPFs.





*Fundamental research can only be judged
by world standard. It is worthwhile only
if one adds, in however small a way, to
the sum total of human knowledge...*

Homi J. Bhabha



AATMANIRBHAR *Innovative Advancements in Healthcare, Energy, Materials & Science* Accelerators

स्वास्थ्य सेवा, ऊर्जा, विज्ञान और पदार्थ विज्ञान के क्षेत्र में नवाचारी प्रगति

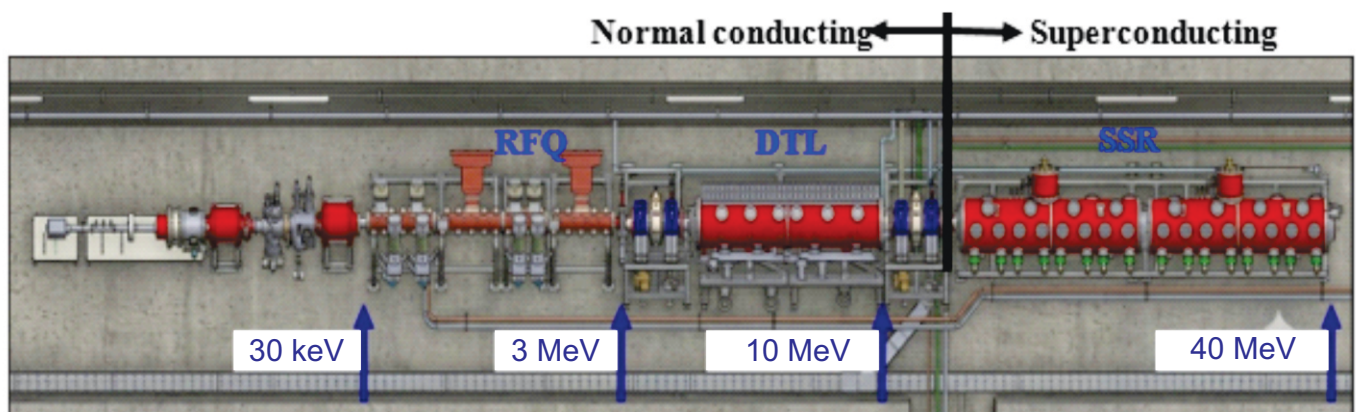
The Amrit Kaal Vision of the Department of Atomic Energy (DAE) envisages the phased development and establishment of a High-Energy (~ 1 GeV), High-Intensity (>10 mA) Proton Accelerator to support the growing nuclear power programme. The Medium Energy High Intensity Proton Accelerator (MEHIPA) represents the next step towards this goal, aimed at developing and demonstrating superconducting accelerating structures and associated technologies essential for high-intensity proton beams at high energies. The performance of normal-conducting accelerating structures has already been demonstrated through the Low Energy High Intensity Proton Accelerator (LEHIPA), where the proton beam was accelerated to 20 MeV for the first time on August 04, 2023. In parallel, the development of superconducting (SC) cavities and associated technologies has been initiated as part of India's in-kind Contribution to the Proton Improvement Plan (PIP-II) of Fermi National Accelerator Laboratory (FNAL), under the Indian Institutions & Fermilab Collaboration (IIFC). This collaboration has facilitated the establishment of indigenous expertise in SC technologies.

MEHIPA-I, a 40 MeV proton linac planned at BARC Visakhapatnam, builds on the experience gained through LEHIPA and the

development of SC technologies under IIFC. Work on establishing the required infrastructure has already commenced. The design of MEHIPA-I's normal-conducting accelerating structures has been adopted from LEHIPA. Key subsystem developments and near-term plans for MEHIPA-I are presented below.

Multi-Cusp Ion Source Development: Compared with conventional solenoidal Electron Cyclotron Resonance (ECR) ion sources, multi-cusp ion sources offer lower ion temperatures and negligible on-axis magnetic fields, resulting in low emittance for high-intensity beams. Further online optimisation of beam emittance can be achieved through the spatial and angular arrangement of magnetic multipoles.

SC Spoke Resonator Cavity: A Single Spoke Resonator (SSR) cavity has been



40 MeV Proton Accelerator: Layout schematic.



SC-Single Spoke Resonator and 7 kW Solid State Power Amplifier systems: Other in-kind contributions of India to FNAL.

indigenously fabricated and delivered to FNAL, where it was successfully used for 17 MeV beam acceleration. The cavity demonstrated the best performance among all cavities. A nearly identical SSR cavity design is envisaged for MEHIPA-I.

High-Power RF Amplifiers: Solid-State Power Amplifiers (SSAs) of 7 kW capacity, developed by BARC, were supplied to FNAL as part of India's in-kind Contribution, and their performance was demonstrated during 17 MeV acceleration. The design has been extrapolated to the 50 kW capacity required for MEHIPA-I. Normal-conducting structures, however, demand much higher power. At LEHIPA, this requirement is met using three 1 MW klystrons. Given the challenges

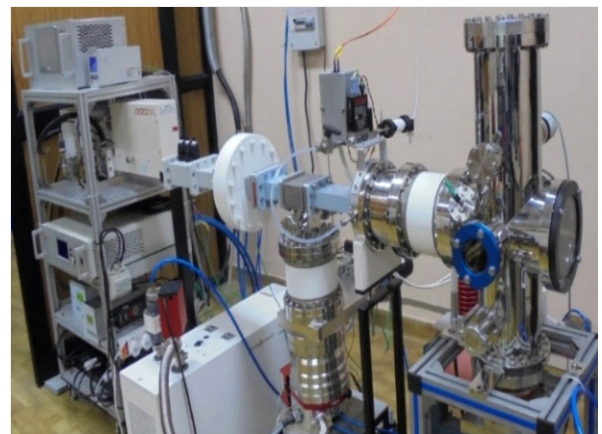
associated with klystron availability, SSAs are being developed as an alternative. The scheme and design of a 350 kW SSPA have already been worked out.

Conduction-Cooled Superconducting Magnets: Alongside SC cavities, multiple superconducting solenoids will be housed within the cryomodule for beam focusing. The design of SC magnets for MEHIPA-I has been adopted from components originally designed and developed under IIFC.

LLRF and RFPI: The in-house-developed EPICS-based Low-Level RF (LLRF) control and RF Protection and Interlock (RFPI) system was successfully demonstrated at the Spoke Test Cryostat (STC) at Fermilab. Building on this experience, an upgraded LLRF and RFPI system is being developed for MEHIPA using BARC PARAS (BARC Particle Accelerator Real-time Automation System), an indigenous software platform. The upgraded system will provide enhanced performance and functionality for real-time RF control, monitoring, and protection.



Multi-cusp ECR Ion Source.



Helium screw compressor installed in BARC.

Development of Indigenous Cryogenic Systems for Superconducting Structures: Most of the cryogenic system for MEHIPA is envisaged to be developed indigenously, including the helium compression system, 2 K refrigerator cold boxes, and cryogenic distribution system. Critical components of these

subsystems include helium screw compressors, turbo expanders, and plate-fin heat exchangers. An indigenously developed helium screw compressor has recently been received and installed at BARC for testing.



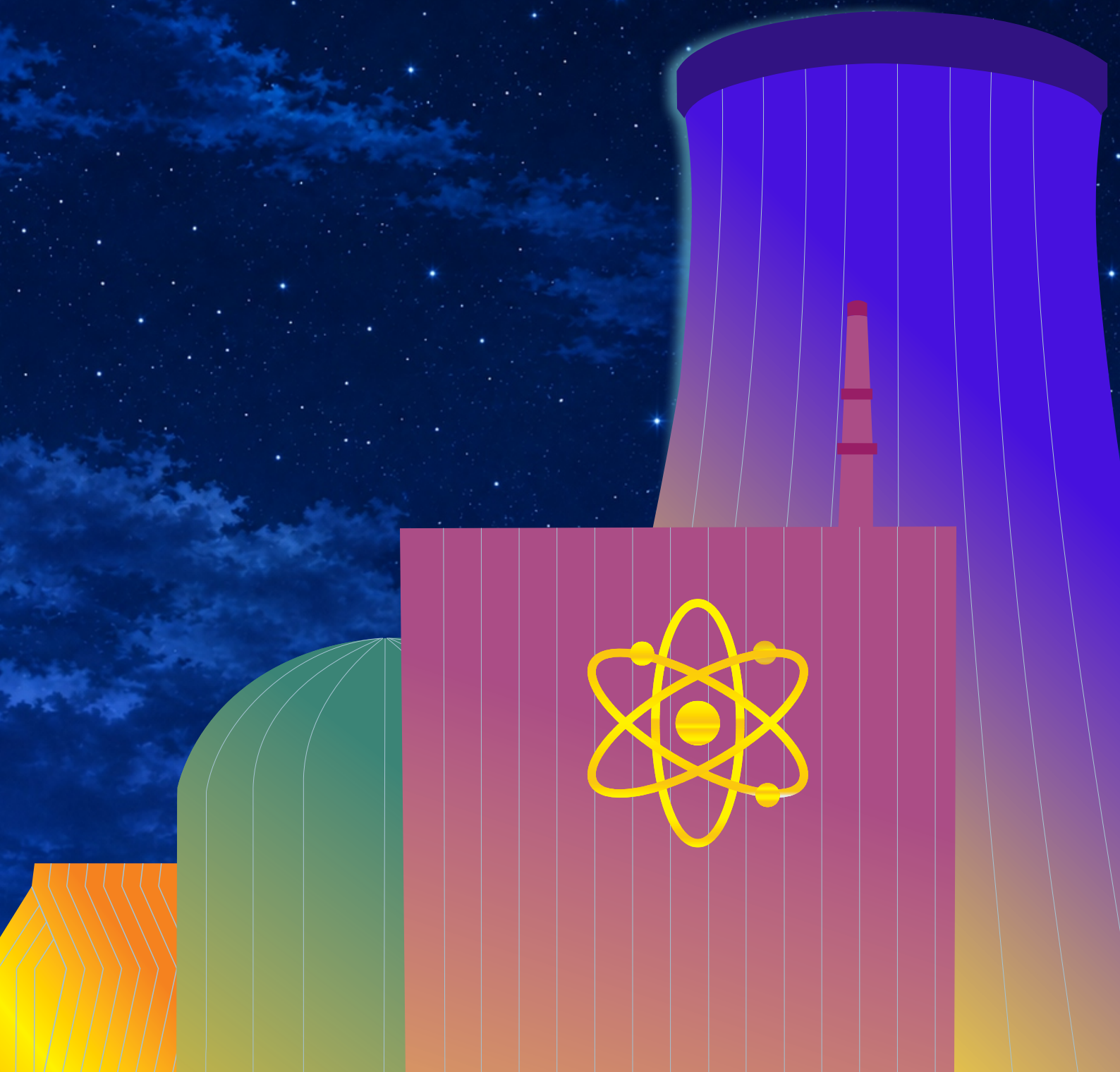
A 2 kW Cryoplant: Among important in-kind contributions of India to FNAL.





*No power is as expensive as
no power...*

Home / Shabbat



FORWARDING

B Excellence in Lasers, Plasma, Electromagnetics & Quantum Beams

अग्रोषित कर्णपुंज: लेसर, प्लाज़्मा, विद्युत चुंबक एवं क्वांटम में उत्कृष्टता

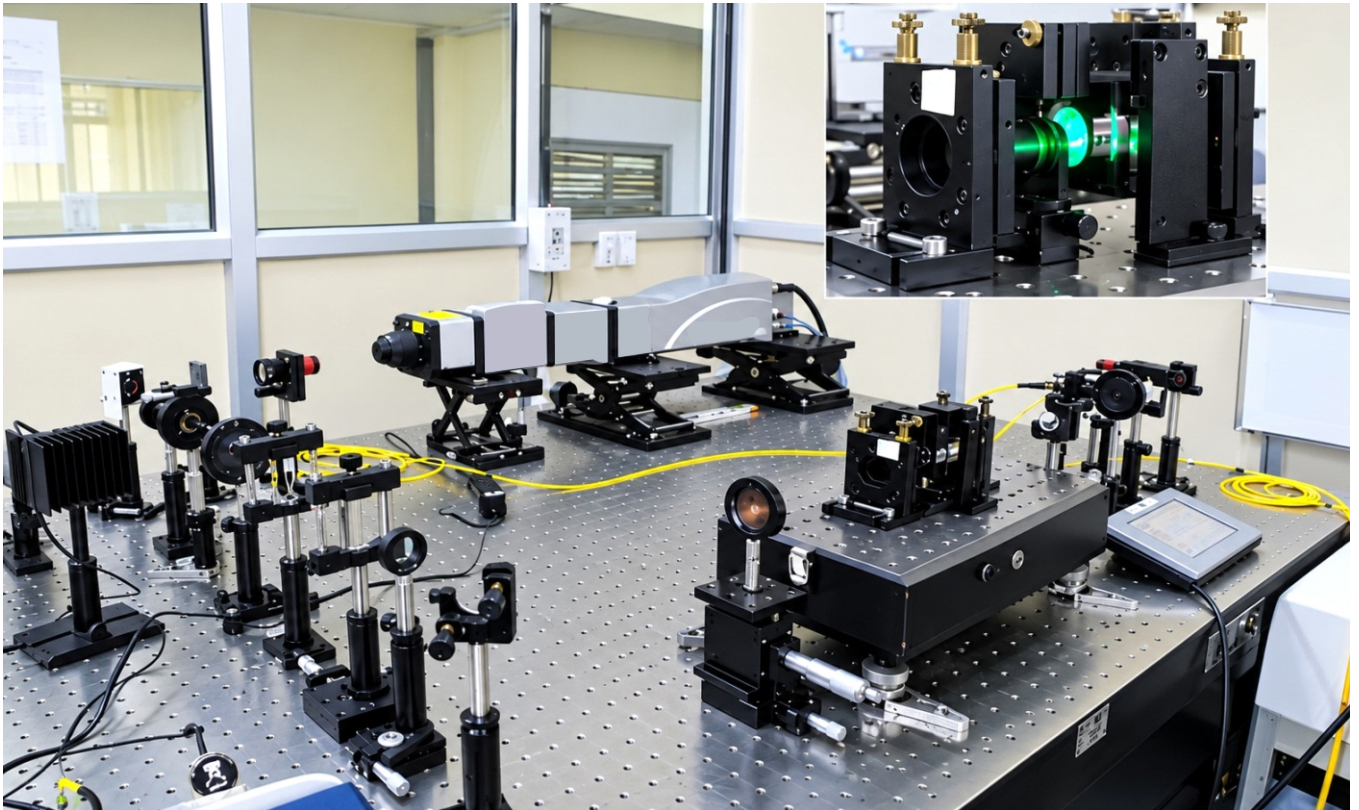
The development of enabling technologies in lasers, plasmas, and electron beams is an important research area at BARC, with applications spanning the front end and back end of the nuclear fuel cycle, as well as industrial and societal needs. Research in lasers focuses on the indigenization of widely tunable laser systems and their application in selective excitation schemes. Laser-based instrumentation is also being developed for reactor operations, security, and medical applications.

Plasma research emphasizes the development of industrial-grade torches for active waste incineration. Thermal plasma technologies for corrosion-resistant spray coatings and aerosol generation have attained maturity, while non-thermal plasma research addresses

surface functionalization, NO_x generation, etching, and medical applications.

Electron beam activities include the development of electron accelerators, electron beam welding and melting systems, and non-thermal electron beam applications for sterilization, mutation, and wastewater treatment.

The scientific and R&D activities are organized under five major areas: Accelerator and Pulse Power, Advanced Tunable Laser Applications, Laser and Plasma Technologies, Pulsed



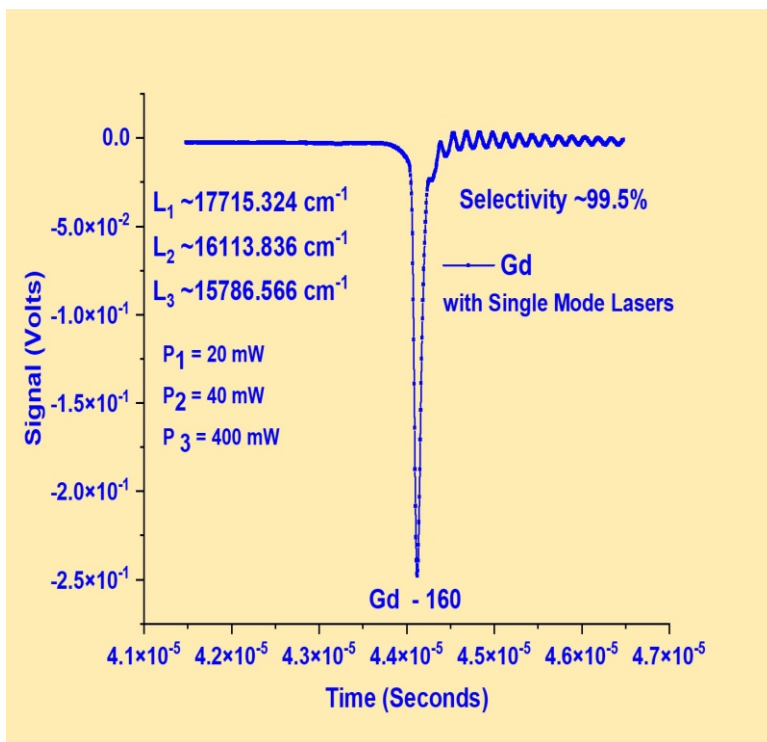
Tunable OPO set-up.

Power and Electromagnetics, and Trapped Ion Quantum Technology. Selected achievements are outlined below.

Advanced Tunable Laser Applications:

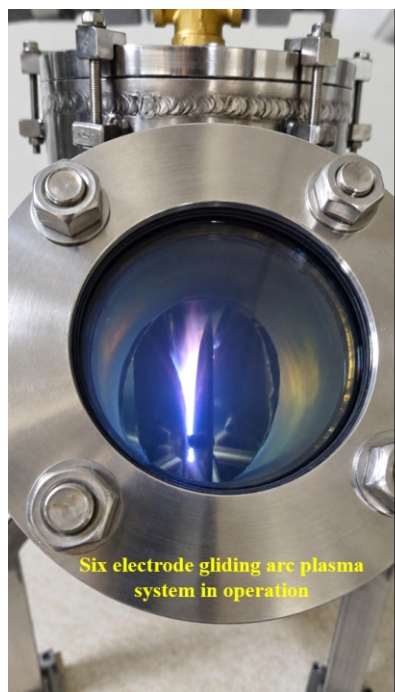
Research focuses on developing technologies for producing enriched stable isotopes for medical and R&D applications. The production capacity of enriched Lu-176 was doubled to 10 mg/month. Approximately 100 mg of enriched lutetium, containing over 85% Lu-176, was produced and used to prepare 1200 Ci of Lu-177-based radiopharmaceuticals, contributing to the treatment of approximately 4800 patients across India. Ytterbium-176 (Yb-176) enrichment exceeding 99% isotopic purity was consistently achieved, surpassing the 95% requirement for producing Lu-177 through the no-carrier-added (NCA) route. Gadolinium-160 (Gd-160) feasibility studies demonstrated enrichment with over 99.5% spectroscopic selectivity using time-of-flight mass spectrometry (TOFMS), supporting future theranostic applications.

Laser and Plasma: Research in this area develops advanced laser and plasma-based technologies relevant to DAE programmes and relevant industrial and societal applications. For Tunable laser sources, an all-solid-state pulsed optical parametric oscillator, tunable across 400-700 nm with a spectral emission width as narrow as 170 MHz, was demonstrated for spectroscopy. A two-step picosecond laser



Gadolinium-160 (Gd-160) Spectrum SLM.

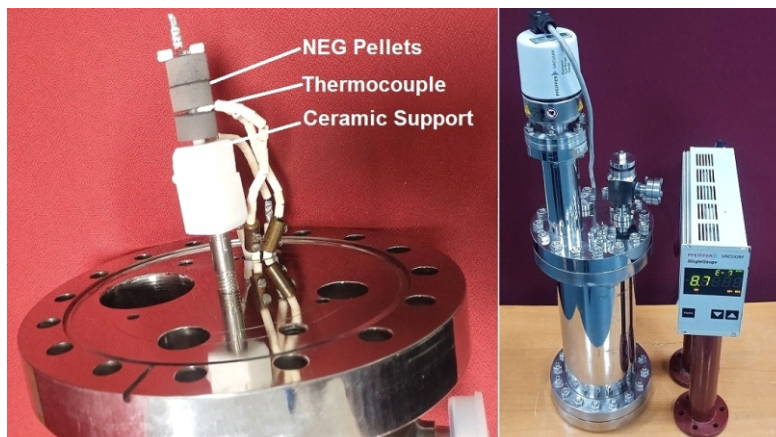
process for fabricating surface-enhanced Raman spectroscopy (SERS) substrates enabled detection limits of 10^{-10} M for rhodamine B and 10^{-7} M for crystal violet. Collaborative development within BARC resulted in fluorescence-based tabletop analysers for heparin and albumin, offering high sensitivity, good linearity, and response times of 1-2 minutes, advancing medical diagnostics. A yttria coating on graphite, incorporating a reactive silicon interlayer, demonstrated strong adhesion through repeated thermal cycles, indicating its suitability for nuclear applications. A cold atmospheric-pressure plasma system was developed for single-step synthesis of MXenes, two-dimensional advanced materials with potential applications in sensing and energy storage.



NO_x generation using gliding arc plasma torch.

Laser surface modification using nano second pulsed laser in BARC.





NEG pump and Sealed-off Vacuum Chamber.

An indigenous six-electrode gliding arc plasma system demonstrated on-demand production of NO_x -rich gas from compressed air. NO_2 concentrations exceeding 4000 ppm were achieved and independently validated using an electrochemical sensor and the Saltzman UV-V is spectroscopic method. The technology offers a potential alternative for NO-mediated plutonium valency adjustment in nuclear fuel reprocessing.

Pulsed Power and Electromagnetics: Key developments demonstrate the application of pulsed power and electromagnetic technologies to nuclear safeguards, accelerator systems, resource recovery, and advanced materials processing. An indigenously developed, compact plasma-focus neutron generator

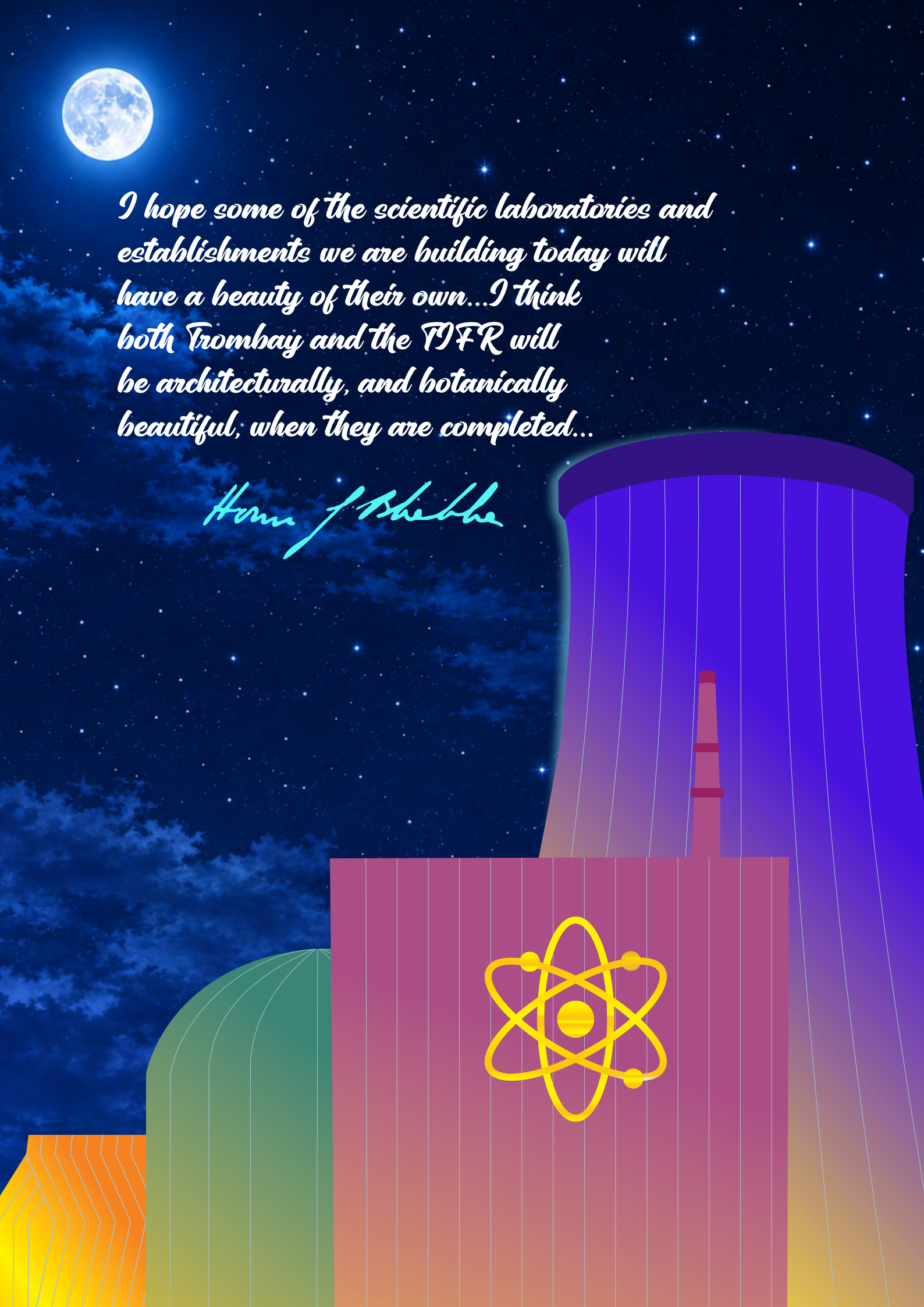
(10^8 neutrons/pulse) successfully demonstrated real-time active interrogation of plutonium at PREFRE-2, NRB Tarapur, with a linear response to plutonium mass. An in-house fabricated deuterated titanium target sustained a neutron yield of approximately 3×10^6 n/s for over 100 hours at 120 kV and 100 μA , establishing a potential indigenous substitute for imported targets. A non-evaporable getter (NEG) pump using ZrCo sintered pellets achieved approximately 10^{-7} mbar in a prototype non-baked vacuum system and maintained the vacuum for several months. An indigenous 6 kW repetitive pulsed electro-hydraulic discharge system was developed for shockwave-assisted leaching to enhance rare earth element recovery from incinerated radioactive ash. Preliminary extraction trials were conducted at a BARC materials facility in Hyderabad. Magnetic pulse compaction achieved green densities exceeding 90%, demonstrating potential for high-density powder consolidation. Indigenous pulsed power techniques successfully demonstrated nanopowder generation of high-density materials, including tungsten and niobium.



The ultra-high-vacuum chamber.

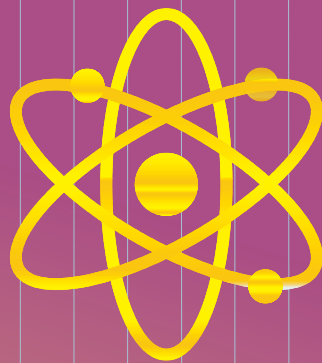
Trapped Ion Quantum Technology: Development of a five-qubit trapped-ion quantum computer is in works in BARC. An ultra-high-vacuum chamber and a Paul-type linear ion trap have been designed, fabricated, and installed. The trap employs quadrupolar electrodes for radial confinement and ring electrodes for axial confinement. Four laser systems operating at 423, 375, 397, and 866 nm have been installed and commissioned for isotope-selective calcium photoionization and Doppler cooling. The experimental setup is designed to cool trapped ions to approximately 600 μK . Experiments on laser cooling are currently in progress, advancing the development of indigenous trapped-ion quantum computing capabilities.





I hope some of the scientific laboratories and establishments we are building today will have a beauty of their own...I think both Trombay and the TIFR will be architecturally, and botanically beautiful, when they are completed...

Amn J Shetty



ADVANCING **R**obust Nuclear Medicine, Radiation Technologies & Water Management **Radioisotopes**

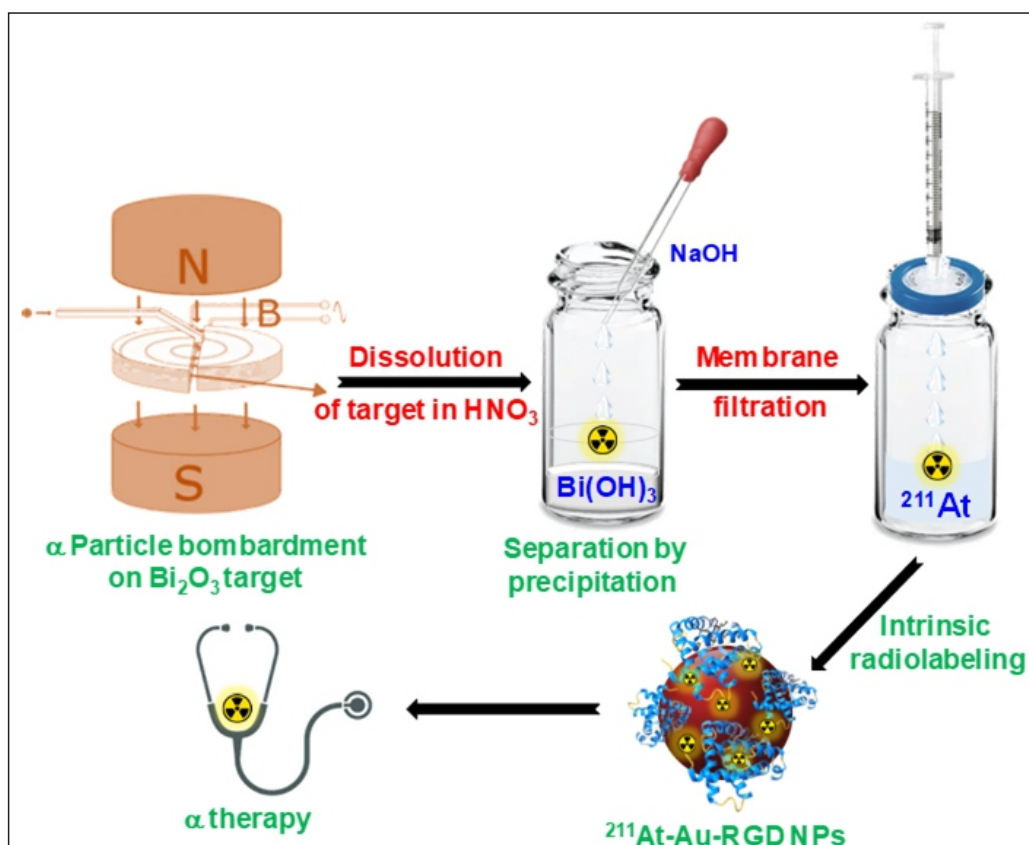
प्रगत रेडियोआइसोटोप: सुदृढ़ परमाणु चिकित्सा, विकिरण तकनीकें और जल प्रबंधन

Indigenous Radioisotope Production for Healthcare: The Dhruva research reactor at BARC underpins India's indigenous radioisotope production programme, supporting diagnostic, therapeutic and theranostic applications through sustained production, radiochemical processing and stringent quality standards.

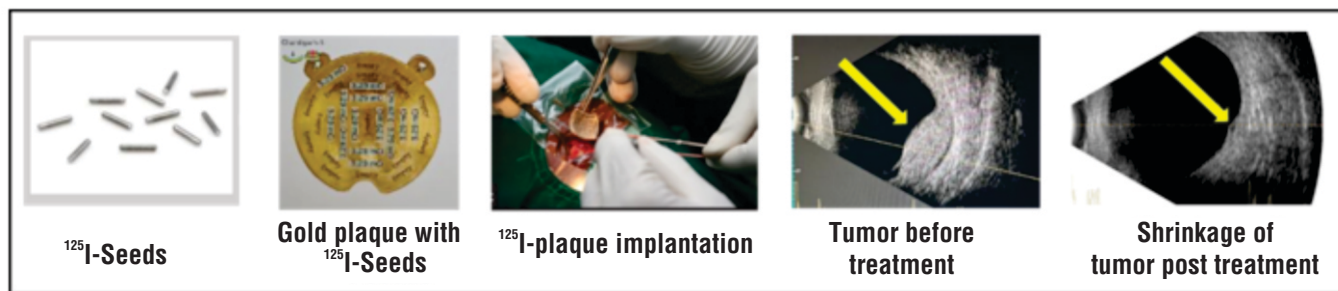
Lutetium-177 is a key radionuclide for targeted radionuclide therapy. Indigenous target materials and established production technologies enabled the production of approximately 1,400 Ci through 40 batches. This is helping cater to the growing demand for precision cancer therapy. Iodine-131 continues to support national

clinical requirements, with over 330 Ci produced and distributed through numerous consignments. A new radioiodine processing facility at the CIRUS facility has been commissioned in accordance with regulatory requirements. Successful production of 50 Ci batches has demonstrated its capability; regulatory clearance for routine production and supply is awaited.

BARC also produces carrier-added Yttrium-90 and Samarium-153 for therapeutic



Production, radiochemical separation and purification of ^{211}At for targeted alpha therapy.



Implantation of 125 Iodine seeds in the patient and shrinkage of tumor post-treatment.

applications. Indigenous ^{90}Y glass microspheres (BhabhaSpheres) offer an affordable option for localized treatment of unresectable liver cancer, while Iodine-125 supports brachytherapy for ocular and prostate cancers. Together, these capabilities strengthen India's self-reliance in radioisotope production and provide a foundation for precision diagnosis, targeted therapy and theranostics.

Emerging Radionuclides for Precision Nuclear Medicine: BARC is developing indigenous production and radiochemical separation technologies for emerging radionuclides using DAE research reactors and accelerator facilities.

Using the Dhruva reactor, production routes have been developed for no-carrier-added (NCA) Holmium-166 and Terbium-161. NCA ^{166}Ho is produced from dysprosium through successive neutron-capture reactions, followed by selective radiochemical separation. Extraction chromatography and electrochemical methods enable efficient recovery and purification for radiopharmaceutical development. Parallel efforts aim to establish indigenous production of ^{161}Tb from gadolinium.

The BARC-TIFR Pelletron has enabled accelerator-based production of Manganese-52 and Iodine-124. NCA ^{52}Mn is produced by proton irradiation of chromium targets and purified electrochemically for PET imaging and nano-theranostic applications. ^{124}I is produced through the $^{124}\text{Te}(p,n)^{124}\text{I}$ reaction and purified using a mesoporous-alumina-based separation strategy. At VECC, Astatine-211 is produced by alpha irradiation of bismuth targets, followed by rapid precipitation-based separation to obtain NCA

^{211}At with high recovery and low target-derived impurities.

These developments integrate radionuclide production, purification and radiopharmaceutical applications, expanding indigenous capabilities for advanced PET imaging, targeted radionuclide therapy and targeted alpha therapy.

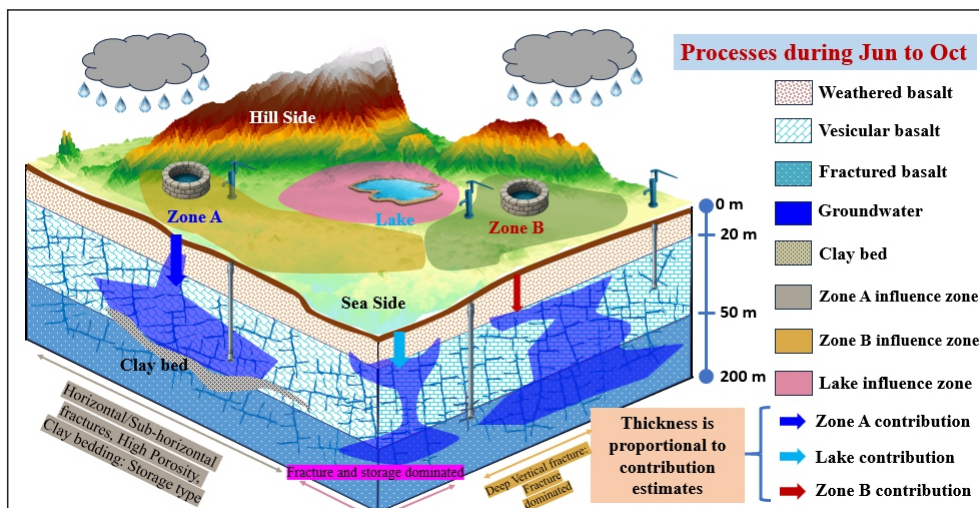
Ambient-Stable $^{99\text{m}}\text{Tc}$ -HYNIC-TOC Kits: $^{99\text{m}}\text{Tc}$ -HYNIC-TOC is a SPECT radiopharmaceutical used to diagnose and localize neuroendocrine tumours (NETs). Conventional freeze-dried kits require dry-ice transportation, increasing costs and complicating distribution.

BARC developed an ambient-temperature-stable freeze-dried formulation using mannitol as a bulking agent. Optimization of mannitol content, buffer volume and pH yielded a sterile, non-pyrogenic kit containing approximately 30 μg HYNIC-TOC, 40 μg stannous chloride dihydrate, 20 mg tricine, 10 mg EDDA, 26.3 mg sodium dihydrogen phosphate dihydrate, 5.6 mg disodium hydrogen phosphate dihydrate and 50 mg mannitol. The HYNIC-TOC ligand was synthesized in-house.

The formulation exhibited a uniform lyophilized cake, rapid reconstitution and stability for up to six weeks at ambient temperature, consistently producing radiolabelled material with high radiochemical purity. Following laboratory evaluation, kits were supplied to selected nuclear medicine centres for limited clinical evaluation. This development could reduce logistics costs,



Cathode ray assembly, Digital radiograph and Volume CT image.



Conceptual map showing potential rainwater harvesting areas in BARC Trombay Campus.

simplify distribution and improve access to NET imaging, particularly where cold-chain infrastructure is limited.

Isotope Hydrology for Sustainable Water Management: BARC employs stable and radioactive isotopes to assess groundwater recharge, surface-water interactions and sustainable water resource management.

In collaboration with Andhra Pradesh's Ground Water and Water Audit Department (GW&WAD), BARC is investigating the surface water - groundwater interactions along ~550 km Handri-Neeva Sujala Sravanthi canal system, which is expected to cater irrigation needs to ~6 lakh acres of farm land and provide drinking water to several hundreds of villages and mandals across drought-prone regions. Preliminary isotopic studies suggest canal-seepage up to 0.5 km. This three-year study will investigate over 50 sites along the canal system covering different seasons.

An isotope hydrology investigation carried out as a part of R&D111 assessed the potential zones for groundwater recharge, aquifer interconnectivity and lake water - groundwater interactions within BARC premises, Trombay. The investigation was carried out in seven phases for three years and covered over 300 water samples for isotope-geochemical analysis and model development. The findings helped to propose effective measures for rainwater harvesting and revive defunct borewells as well as floodwater utilization. The outcome fosters self-sufficiency and sustainable water resources management.

Radiation Technology for Industrial Effluent Treatment: Following successful demonstration of a 75 KLD radiation-grafted cellulose-based adsorbent plant for cotton-textile effluent treatment, a 15 KLD pilot plant was installed at the Heavy Water Plant (HWP) Vadodara premises. Its four-cartridge system was demonstrated to HWP officials using simulated dye effluent, familiarizing them with operation and maintenance. Seven technology transfers have been completed to support commercialization, wider dissemination and market adoption.

Indigenous ¹⁷⁷Lu-Rituximab Kit for Radioimmunotherapy: Radioimmunotherapy combines antibody-mediated tumour targeting with radiation-induced cytotoxicity, offering a targeted approach to CD20-positive B-cell lymphomas.



A 15 KLD pilot plant installed at the Heavy Water Plant at Vadodara.

BARC developed an indigenous freeze-dried kit for on-site preparation of ^{177}Lu -labelled rituximab. Rituximab was conjugated with the bifunctional chelator p-NCS-Bz-DTPA, and the immunoconjugate was purified using PD-10 columns. Each kit contained 3 mg purified rituximab-DTPA, 5 mg ascorbic acid at pH 5 as a stabilizer and 5 mg sucrose as a cryoprotectant. The formulation was optimized to preserve immunoconjugate integrity during lyophilization and support radiolabelling with activities up to 70 mCi of ^{177}Lu .

High radiolabelling efficiency and formulation robustness support decentralized preparation in clinical radiopharmacies. This technology offers potential to simplify logistics, improve accessibility and advance self-reliant, clinically scalable radioimmunotherapy for non-Hodgkin's lymphoma.

^{125}I Seeds for Ocular Brachytherapy: BARC's AERB-approved ^{125}I -OcuProsta Seeds (OPS1; classification C-43211) treat choroidal melanoma and other intraocular malignancies. With a half-life of 59.40 days, ^{125}I decays by electron capture, emitting X-rays and gamma radiation up to approximately 35 keV. Its localized radiation delivery helps spare adjacent healthy tissues and reduce recurrence risk.

Manufacturing involves loading 3-5 mCi of ^{125}I onto palladium-coated silver rods (0.5 mm diameter $\times$ 3 mm length), which are encapsulated in titanium holders (0.8 mm outer diameter $\times$ 4.75 mm length) using an Nd:YAG laser. Seeds are mounted on gold plaques that shield approximately 99.9% of outward radiation and direct the dose towards the tumour. Visual inspection, leachability, swipe and activity tests ensure compliance with AERB requirements.

Typically, 10-20 seeds are implanted, with activity and treatment duration adjusted to tumour size to deliver approximately 40-80 Gy over 5-8 days. Through BRIT, BARC supplied 27 seeds to P.D. Hinduja Hospital, Mumbai, and 20 to Government Medical College and Hospital, Chandigarh, during the past year.

Advanced Radiation Imaging for Non-Destructive Evaluation:

BARC provides radiography and industrial computed tomography (CT) using 220 and 450 keV X-ray generators, a 7 MeV system and sealed sources including ^{192}Ir , ^{60}Co and ^{137}Cs , supporting research and non-destructive evaluation for BARC, DAE units, academia and universities.

A 225 keV X-ray facility with a flat-panel detector was used to examine a cathode ray assembly intended for accelerator applications. Digital radiography and multi-angle CT reconstruction revealed the locations, geometries and spatial distribution of internal features within the approximately 1 mm-thick metal casing. The findings support structural-integrity assessment and improved design.

Radiation Hygienization of Municipal Sewage Sludge:

The Sludge Hygienisation Research Irradiator (SHRI) facility, Vadodara, continued safe, uninterrupted gamma irradiation of municipal sewage sludge. During the past year, approximately 654,000 litres of liquid sludge were treated, yielding around 39,000 kg of irradiated dry sludge. Vadodara Municipal Corporation expressed interest in integrating its upcoming 130 MLD sequencing batch reactor sewage treatment plant at Gajerawadi with the facility.

Collaborative studies also investigated radiation-induced damage to antimicrobial resistance genes in wastewater and sewage-sludge microorganisms. Initial experiments indicated complete damage to the targeted genes. Large-scale sludge hygienization plants at Ahmedabad Municipal Corporation (AMC) and Indore Municipal Corporation (IMC) continued operating, with additional source loading successfully completed.

Collectively, these initiatives demonstrate the application of indigenous nuclear science and radiation technologies to healthcare, industrial wastewater treatment, public sanitation and sustainable water-resource management.



BARC's RMRC Facility in Kolkata.

Advanced Diagnostic and Therapeutic Patient Services at RMC Mumbai: Established on September 3, 1963, by Dr. Homi Jehangir Bhabha, the Radiation Medicine Centre (RMC), Parel, Mumbai, provides Nuclear Medicine services and promotes radioisotope-based research. Its three core mandates are patient care, human resource development through postgraduate education, and basic and clinical research.

Over the past two and a half years, RMC has introduced five diagnostic studies and one therapeutic radiopharmaceutical for routine patient care and clinical research in oncology and neurological disorders.

^{68}Ga -DOTA-FAPI-04 PET-CT performed in over 300 patients, primarily for comparative disease staging in head and neck squamous cell carcinoma, metastatic medullary thyroid carcinoma, radioiodine-refractory thyroid carcinoma and TENIS. ^{68}Ga -Pentixafor PET-CT had been employed for over 50 patients with multiple myeloma, lymphoma and other haematolymphoid malignancies. It targets CXCR4, a receptor associated with several malignancies. ^{68}Ga -NODAGA-Exendin-04 PET-CT was used for over 40 patients with suspected or confirmed insulinoma. By targeting GLP-1 receptors, it facilitates sensitive detection of small tumours that may be difficult to localise anatomically. ^{68}Ga -NODAGA-RGD PET is under clinical investigation for radioiodine-refractory thyroid carcinoma, parathyroid adenoma and peripheral vascular disease. RGD peptides target $\alpha_v\beta_3$ integrins associated with tumour neoangiogenesis. $^{99\text{m}}\text{Tc}$ -TRODAT SPECT had been used for evaluating Parkinson's disease and other movement disorders. ^{177}Lu -DOTA-FAPI-2286 therapy was initiated in June 2025 for metastatic medullary thyroid carcinoma and breast cancer.



Senior officers and support staff administer patient services at RMRC, Kolkata.

Fibroblast activation protein (FAP) is overexpressed in the tumour microenvironment of many epithelial cancers, with relatively low expression in most normal tissues. Its presence in pancreatic, colorectal, breast and ovarian cancers, sarcomas and medullary thyroid cancer makes it a promising target for ^{68}Ga -DOTA-FAPI-04 imaging and ^{177}Lu -DOTA-FAPI-2286 radioligand therapy.

Patient Services at RMRC Kolkata: Established and commissioned by RMC Mumbai under BARC, RMRC Kolkata is a modern Nuclear Medicine facility providing affordable diagnostic and therapeutic services, particularly to Eastern and Northeastern India.

Routine FDG-PET/CT services are established. ^{68}Ga -PSMA-11 PET-CT for prostate cancer and ^{68}Ga -DOTATATE PET-CT for neuroendocrine tumours commenced in July-August 2026. Regular I-131 therapy for thyroid cancer began in July 2025.

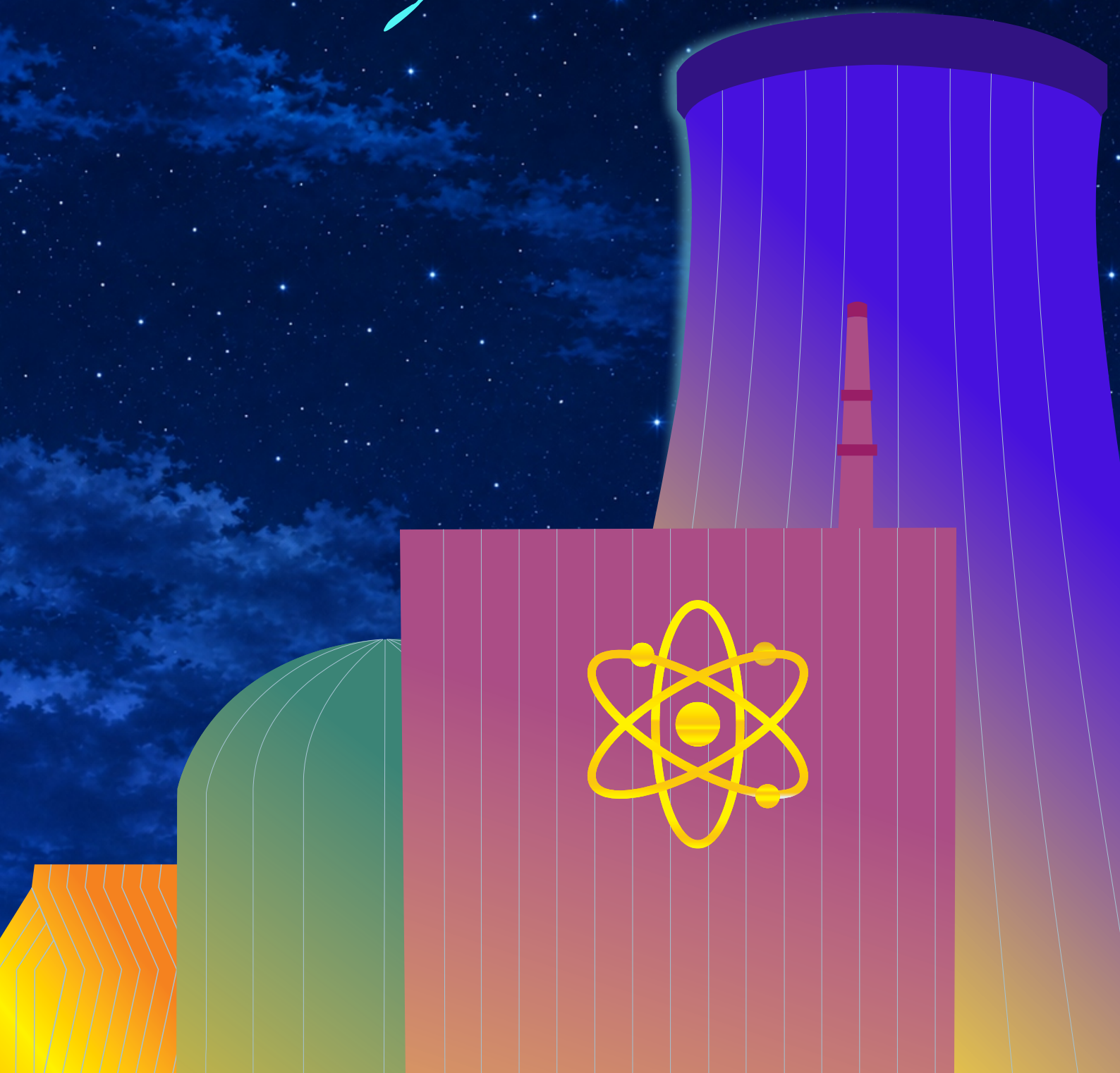
Therapeutic services include ^{177}Lu -PSMA-617 for metastatic castration-resistant prostate cancer, ^{177}Lu -DOTATATE for neuroendocrine tumours, and ^{131}I -mIBG for appropriate patients with metastatic neural crest tumours. Patient numbers continue to increase. RMC Mumbai and Tata Memorial Hospital's IT team are working to extend electronic medical record (EMR) facilities to RMRC Kolkata, strengthening inter-centre connectivity and access to treatment administration records.





*Science forms the basis of our whole social
structure without which life as we know
it would be inconceivable...*

Amir J. Shabbe



BASIC *Expanding Frontiers in Fundamental Research* Sciences

आधारभूत विज्ञान: मौलिक अनुसंधान के विस्तृत क्षितिज

Radiation-Induced Mutation Breeding: BARC has developed 17 improved Trombay Groundnut (TG) varieties through radiation-induced mutation breeding, contributing to groundnut improvement, seed dissemination and agricultural production across India. Initiated in 1957, the programme generated genetic variations for desirable agronomic and economic traits, leading to the release of varieties for commercial cultivation in different agro-ecological regions of the country.

The programme began with X-ray treatment of seeds of the groundnut cultivar Spanish Improved, followed by the use of gamma rays. Repeated cycles of mutation, selection and evaluation generated diverse plant types with desirable characteristics. These

mutants were used both for direct selection and as parents in recombination breeding, in collaboration with the ICAR and State Agricultural Universities.

TG-1, the first induced mutant variety developed by BARC, was released in 1973. Subsequently, 16 additional TG varieties were developed and released. Their traits include early maturity, moisture-stress tolerance, compact plant architecture, fresh-seed dormancy and large seeds. These characteristics support cultivation under



▲ Dispatch of breeder seed of Trombay (TG) variety groundnut.

► A farmer from interior Maharashtra region proudly holds a bunch of freshly harvested Trombay (TG-88) variety groundnut pods.

different growing conditions, while selected varieties are suitable for confectionery, export and oil-quality requirements.

The varieties have also contributed significantly to national groundnut breeding. Ten TG varieties served as national, zonal or local check varieties in ICAR-All India Coordinated Groundnut Research Project trials since 1997. TAG 24 served as a check variety for 30 years, while TG 26 and TG 37A have each served for 22 years. Their continued use reflects their role as benchmarks for evaluating newly developed groundnut breeding lines.

Beyond their direct cultivation, TG varieties have served as valuable genetic resources. Twenty-one TG varieties and lines have been used as parents by 20 research stations associated with SAUs, contributing to the development of 128 superior breeding lines. Another 15 groundnut varieties have been released through breeding programmes that used TG lines as parents. TAG 24 has been the most preferred TG parent for developing new lines and varieties.

BARC has also supported large-scale seed dissemination. During 2004-2026, it supplied 8,362 quintals of breeder seed from 13 TG varieties to seed agencies and agricultural institutions across 20 states. Gujarat, Odisha and Maharashtra, alongside the National Seeds Corporation and other public and private organisations were the major recipients. TG 37A accounted for 31% of the supplied seed, followed by TAG 24 at 16%, TPG 41 at 15% and TG 51 at 12%.

Based on breeder-seed supply and estimated seed multiplication, BARC's contribution is projected to support an average annual cultivation area of 24,239 hectares and production of approximately 360,319 quintals of groundnut. At the stated market price of Rs. 6,942 per quintal, this production represents an estimated annual value of around Rs. 250 crore.

Additionally, ICAR institutes and SAUs supplied 31,641 quintals of TG breeder seed during the same period. The resulting seed multiplication is estimated to support a further



Fumigation-free preservation protocol developed in BARC implemented at a makhana (fox nuts) processing facility near Patna, Bihar.

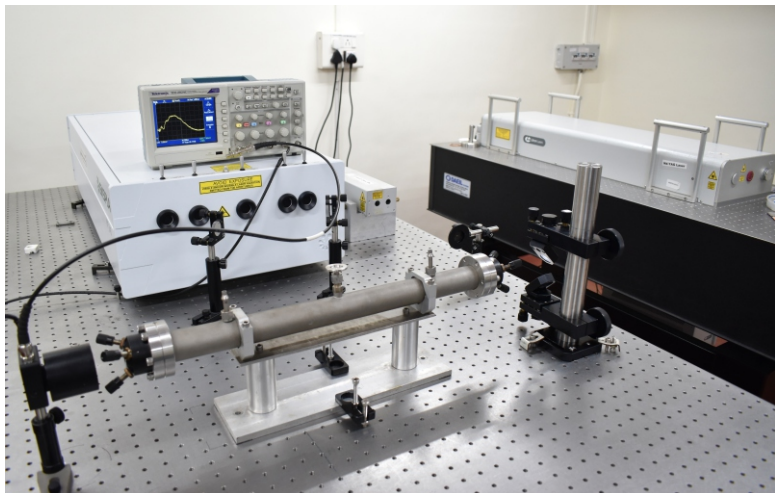
90,000 hectares and annual production of approximately 13,83,300 quintals, valued at around Rs. 960 crore.

The programme demonstrates the progression of radiation-induced genetic variation into released varieties, breeding resources, seed distribution and estimated agricultural production, with groundnut farmers across India among its beneficiaries.

Trade of Chemical-Free Makhana Using Radiation Technology: A radiation-based protocol for fumigation-free preservation of makhana (fox nuts) was developed in BARC. The technology was implemented at the recently commissioned food irradiation facility near Patna in Bihar, established by the Government of Bihar and operated under an operations and maintenance (O&M) arrangement. On 8 August 2026, an 18-tonne consignment of irradiated makhana was exported from Bihar to Australia by sea in seven containers. This achievement demonstrates the potential of radiation technology as an alternative to conventional chemical fumigation, supporting phytosanitary compliance, international market access, value addition, and agricultural trade.

Mushroom Preservation Technology: The technology of shelf-life extension of mushroom by combining gamma irradiation with complementary treatment was developed in BARC. The technology know-how was transferred to the industry partner M/s. Jitban Supply Chain Pvt. Ltd. A commercial-scale trial involving approximately 1.5 tonnes of mushrooms resulted in successful export to Thimphu, Bhutan. The mushrooms retained good quality for up to 21 days under chilled storage and received positive consumer responses. Interest in larger-volume procurement highlights the technology's commercial potential for reducing post-harvest losses, extending distribution networks, and facilitating the international marketing of fresh mushrooms.

Enriched Lutetium-176 & Nickel-62 using an in-house Electromagnetic Isotope Separator: BARC has developed an Electromagnetic Isotope Separator through in-house efforts and successfully produced Lutetium-176 and Nickel-62 with



Laser Cavity Ring-Down set-up for measurement of reflectivity of high reflection mirrors.

enrichment exceeding 99.5%. Lutetium-176 is an important precursor for producing Lutetium-177, widely used in targeted radionuclide therapy. Highly enriched Nickel-62 is required to produce Nickel-63, a long-lived beta emitter used in nuclear batteries, gas chromatography electron-capture detectors, and ion mobility spectrometers. The EMIS comprises a high-current metal-vapour/sputter ion source, beam extraction and transport optics, a 90° sector electromagnet, and dedicated collectors. The system can produce approximately 1 mg of enriched Nickel-62 every two days, strengthening domestic capabilities in isotope production.

Proton Beamline at the Medical Cyclotron Facility in Kolkata: A new 30 MeV proton beamline has been installed at the Medical Cyclotron Facility, Kolkata, to support Accelerator Driven System research, target-window development, and fast-neutron spectrometry. The beamline includes horizontal transport optics,

diagnostic and control systems, and a 90° bending magnet directing the beam to a shielded target cave eight metres underground. Its EPICS-based control system enables remote operation and monitoring. The facility is designed for proton currents up to 350 μA to irradiate target materials, generate fast neutrons and gamma rays, and produce radioisotopes for physics studies and computational-code validation. A semi-automated irradiation module supports beam qualification, neutron-yield measurements, and safe handling of irradiated targets. A key milestone has been achieved by transporting a 30 MeV, 10 μA proton beam to the beam dump, with a beam spot size of 35-55 mm at the target location.

Laser Cavity Ring-Down Facility for High-Reflectivity Mirrors: A Cavity Ring-Down (CRD) facility was setup in BARC to measure the reflectivity of high-reflectivity optical mirrors at 1064 nm, including mirrors relevant to Laser Interferometer Gravitational-Wave Observatory (LIGO) applications. The technique measures the exponential decay of laser light trapped between two mirrors to determine reflectivity with high precision. The facility was validated using a commercial reference mirror. An indigenously developed 33-layer Ta O /SiO₂ multilayer mirror



Horizontal section of the ADS beamline at Medical Cyclotron Facility, Kolkata.



Prototype formulations of DsePA.

demonstrated a reflectivity of $99.930 \pm 0.002\%$ at 1064 nm. This capability supports the development of advanced optical thin-film coatings for high-performance mirrors.

Indigenous Technology for Large Single-Crystal Growth: The technology for growing Germanium and Silicon single crystals up to 50 mm in diameter and 150 mm in length using the Czochralski technique was developed in BARC. The development includes hot-zone and system design, along with optimization of material-specific crystal-growth parameters. These semiconductors are essential for microelectronics and radiation detectors. To facilitate technology transfer and commercialization, an incubation agreement was signed in March 2025 between Rana Semiconductor Pvt. Ltd. and the Atal Incubation Centre, Anushakti Nagar, under the Atal Innovation Mission. This initiative advances indigenous semiconductor technology under the Atmanirbhar Bharat vision.

Condensed Matter Research Using Neutrons and Synchrotron Radiation: Advanced materials were extensively investigated in BARC using neutrons at Dhruva and synchrotron radiation at Indus-2. Research covers quantum materials, including topological insulators and low-dimensional magnets; functional materials, such as battery materials, molecular magnets, and thermoelectrics; and soft matter, including polymer membranes, hydrogels, and biomaterials. These studies establish structure–function relationships and support materials development. Both national facilities also serve researchers from universities, IITs,

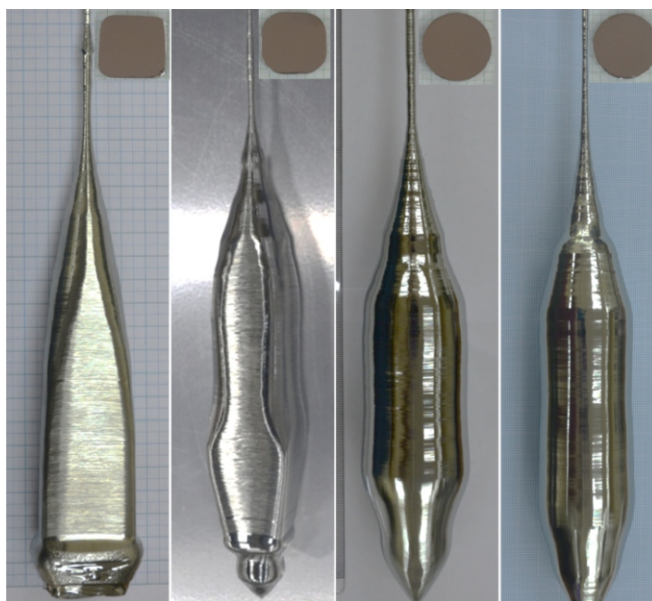
national laboratories, and industry across India, strengthening collaborative research and scientific capacity.

Clinical Translation of DSePA (Organo-selenium) as a Radiotherapy Adjuvant: Radiation pneumonitis (RP), a serious complication of thoracic radiotherapy, compromises treatment intensity and the therapeutic ratio, resulting in poorer clinical outcomes. Steroids are the current standard of care for RP; however, prolonged administration can cause associated complications, necessitating the development of specific therapeutic agents.

Systematic chemico-biological evaluation of organoselenium compounds at Chemistry Group (CG), BARC, has identified 3,3'-diselenodipropionic acid (DSePA) as a potent candidate, with efficacy against RP validated in cellular and murine models. For clinical translation, prototype oral and inhalation formulations have been indigenously developed using FDA-approved excipients. Bioequivalence studies in murine models confirmed DSePA absorption in lung tissue within the desired concentration range.

An intellectual property rights proposal covering DSePA formulations, methods of use, and associated devices was filed in India (TEMP/E-1/123701/2025-MUM, dated 14-Nov-2025). Detailed toxicity studies were completed in rodent models at a GLP-compliant laboratory in accordance with CDSCO guidelines. Licences for manufacturing GMP-grade DSePA and its formulation were subsequently secured from CDSCO (SW/IND/CT-15/2025/000002072, dated 31-Dec-2025; FDA/MFG/SR-2072/2025-2026, dated 04-Apr-2026).

The Institutional Human Ethics Committee of Tata Memorial Centre and CDSCO reviewed the investigational new drug (IND) dossier for DSePA as a radiotherapy adjuvant and granted in-principle approval for a Phase I single-ascending-dose (SAD) trial, subject to minor protocol amendments and completion of GMP manufacturing



Germanium single crystal growth.



Curcumin loaded
Pickering emulsion



Prototype
formulation

Development of curcumin formulation for higher cellular uptake.

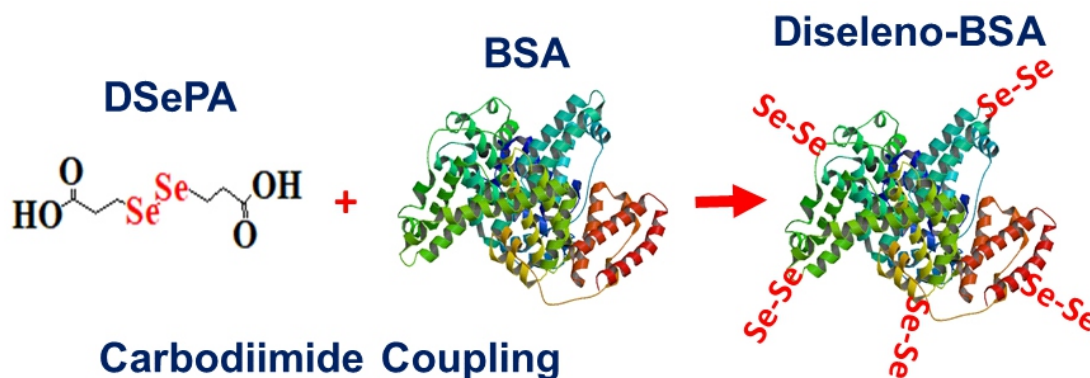
(OIEC/4346/2026/00001, dated 10-Feb-2026). GMP manufacturing of DSePA and its tablet formulation is currently underway. The GMP batches will be used for the Phase I safety study in humans at TMC.

Protein-Based Oral Curcumin Formulations for Improved Cellular Uptake: Curcumin, the active ingredient of turmeric (*Curcuma longa*), has recognized health benefits, but its therapeutic use is limited by poor aqueous solubility, chemical stability, and cellular uptake. An in-house methodology to prepare curcumin-loaded gels/Pickering emulsions was developed in BARC using FDA-approved proteins and lipids for oral and/or buccal delivery. The formulations significantly improved curcumin solubility and stability and enhanced cellular uptake by approximately threefold.

The methodology know-how has been transferred to an industry partner, where successful scale-up and prototype manufacturing have been completed. Administrative procedures for obtaining regulatory and commercialization licences from the competent authority, FSSAI, are currently underway.

Synthetic Selenoproteins for Healthcare Applications: Protein-based bioconjugates offer potential pharmacokinetic advantages over small molecules for therapeutic applications. Building on research at BARC, for establishing organoselenium compounds as promising chemoradiotherapeutic agents, an in-house method was developed to synthesize diselenide-functionalized gelatin and albumin for anti-cancer applications.

The bioconjugates demonstrated potent anticancer activity in the A549 lung cancer cellular model, retaining selenium's therapeutic potential. Mechanistic studies established that their anticancer activity involves targeting Ero1 α -driven protein folding, leading to lethal endoplasmic reticulum (ER) stress and mitochondrial oxidation. Pharmacokinetic studies in mice demonstrated an approximately fourfold longer circulation half-life of selenium compared with the free diselenide. In vivo efficacy studies using xenograft tumour models are currently underway.



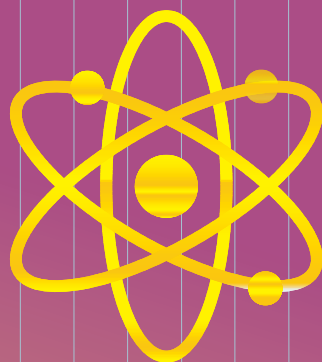
Design of selenium- functionalized bovine serum albumin (BSA).





...People tell me that I am too fussy and want perfection in everything. I know I can move ahead faster if I relax standards... I want to prove that we (in India) are once again capable of achieving that perfection...

Homi J. Bhabha



ADVANCED **T** *Engineering new solutions for cutting edge nuclear technologies* **echnologies**

प्रगत प्रौद्योगिकियां: अत्याधुनिक नाभिकीय प्रौद्योगिकियों हेतु नव अभियांत्रिकीय समाधान

Cu-Cl Thermochemical Cycle Integrated with FBTR: A copper-chlorine (Cu-Cl) facility was integrated with the secondary sodium loop of the Fast Breeder Test Reactor (FBTR) for nuclear heat driven hydrogen production. Following pre-commissioning, the closed-loop facility operated round-the-clock at its design capacity of 50 NL/h. Approximately 85 hours of operation established safe functioning and performance according to design requirements. This was the first facility of its kind worldwide.

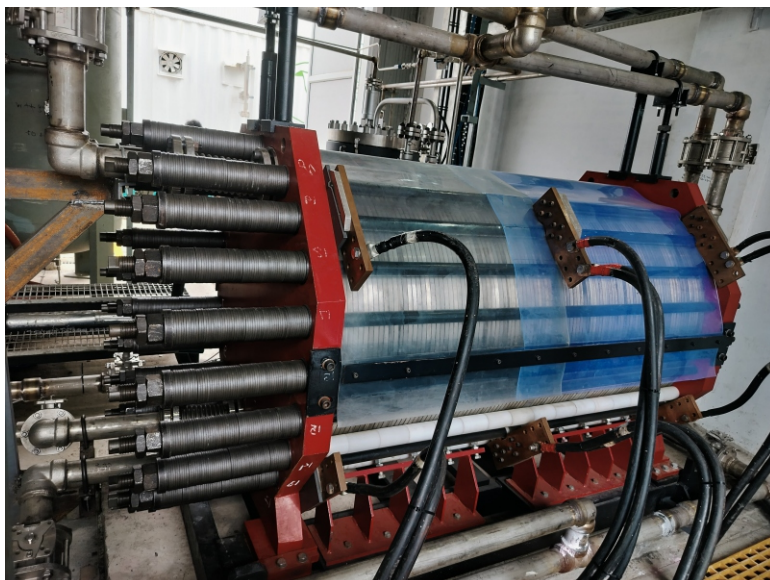
Pulsed Disc and Doughnut Columns (PDDCs): PDDCs are passive, maintenance-free contactors that intensify solvent extraction in

front-end and back-end processes. Their advantages include reduced plant footprint and solvent inventory, faster start-up and shutdown, solids-handling capability, and enhanced mass transfer, reducing equipment height for desired separation. A pilot plant demonstrated sustained uranium refining, while a 6-inch-diameter facility generated scale-up data. Computational models for multiphase hydrodynamics and mass transfer were developed and validated using experimental data.



Copper-Chlorine thermochemical cycle pilot plant of BARC coupled with secondary sodium system of FBTR.

Indigenous 0.5 MW Alkaline Water Electrolyser: An advanced 0.5 MW alkaline water electrolyser (AWE) stack was designed, fabricated, and assembled using a non-conventional bipolar configuration. Integrity and leak testing confirmed its mechanical robustness and sealing. Integrated with the 1 MW electrolyser plant developed with BPCL at Cochin International Airport, the stack successfully completed an operational campaign at rated capacity. This demonstrated the readiness of indigenous technology for larger-scale green hydrogen production and marked the first demonstration of a large-scale electrolyser stack designed and fabricated entirely indigenously.



Thermal cycling of the advanced 0.5 MW AWE stack in progress.

Indigenous Synthesis of DTBDCH18C6: Pilot-scale production of the strontium-selective crown ether 4,4'-(5')-di-tert-butylidicyclohexano-18-crown-6 (DTBDCH18C6) was demonstrated for selective recovery of strontium (Sr) from high-level waste (HLW). Recovered Sr is used in radiomedicine, radioisotope thermoelectric generators (RTGs), and radiation heater units (RHUs). Indigenous production was demonstrated at 1 kg per batch, with product assay exceeding 90%. A total of 3 kg was supplied to INRP, NRB, Kalpakkam.

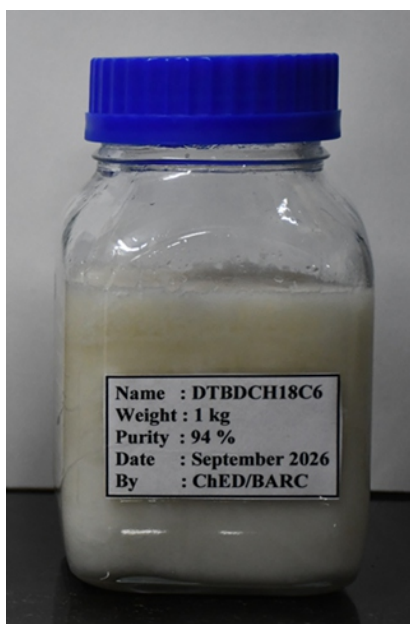
high-recovery desalination and zero liquid discharge (ZLD). A single-effect hollow-fibre vacuum membrane distillation (VMD) unit treated brine with conductivity of 50–80 mS/cm at 60–80°C and 100–200 mbar absolute vacuum. It achieved distillate production of 7–11 LPH, permeate fluxes of 1.8–3.9 LMH, and salt rejection above 99.9%. Results supported the design and experimental validation of an energy-efficient multi-effect VMD system.

An indigenous pilot-scale plate-and-frame air gap membrane distillation (AGMD) unit using commercial PTFE membranes produced 1.2–1.5 LPH of distillate with 99.9% salt rejection. Indigenous hydrophobic PVDF nanocomposite membranes were also developed using vapour-induced phase separation, incorporating 2 wt.% carbon black or 4 wt.% graphene. These membranes exhibited enhanced hydrothermal stability, water contact angles up to 117°, and pure-water permeability up to 93.6 LMH. Laboratory AGMD testing achieved vapour fluxes of 2.5–3.5 LMH and solute rejection above 99.2%.

Membrane Distillation and Hydrophobic Membranes: Membrane distillation (MD) technology advanced from laboratory development to pilot-scale demonstration for



6" diameter PDDC facility.



Product – DTBDCH18C6.



Forced Circulation Crystallizer Unit at BARC.



BARC's OSCOM Plant: Supplying potable water to Odisha Villages.

ZLD Desalination and NaCl Recovery: A near-ZLD process recovered high-purity sodium chloride (NaCl). A 10 kg bench-scale batch with purity exceeding 99.8% was produced through reactive precipitation, filtration, ion-exchange polishing, and rotary evaporation. A pilot-scale forced circulation crystallizer (FCC), designed for 10 kg/h salt recovery, was integrated with steam, seawater, and vacuum utilities. Pre-commissioning included leak testing and verification of control logic and process interlocks. FCC testing demonstrated distillate production of 50 kg/h at 55 mbar vacuum.

5 MLD Seawater Desalination Plant: BARC's OSCOM Odisha plant comprises 4.5 MLD indigenous seawater reverse osmosis (SWRO)

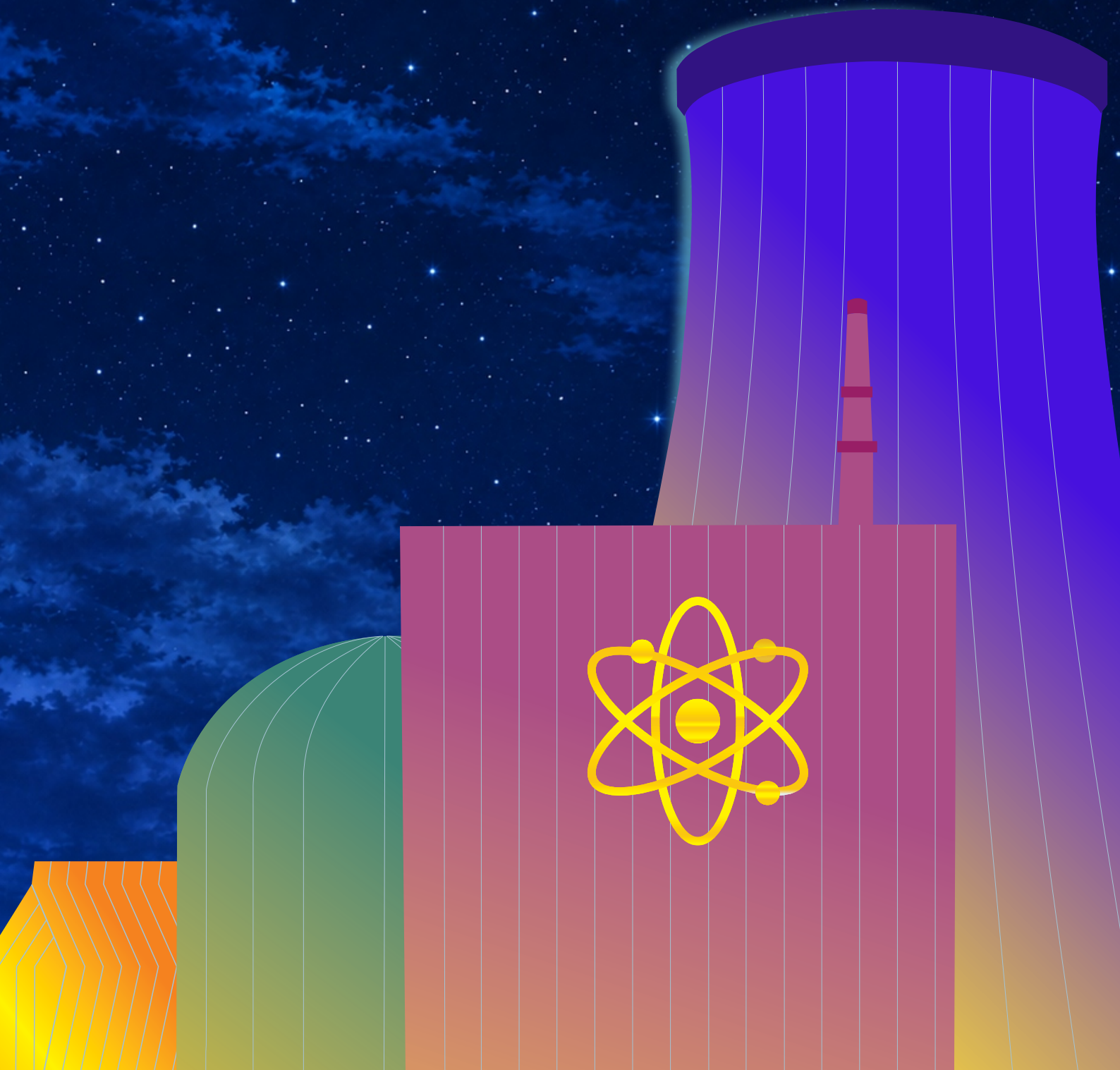
and 0.5 MLD multiple-effect distillation with thermal vapour compression (MED-TVC) facilities. Operating round the clock, it supplies potable water to OSCOM facilities. Following stable performance, IREL signed an MoU with the State Government to supply 1.5 MLD to Matikhalo and Aryapalli villages. Public distribution of SWRO water was inaugurated by the Union Minister on 10 August 2025. BARC continues to provide technical support, troubleshooting, and maintenance guidance.





*An institute, be it a laboratory or an
academy, has to be grown with
great care like a tree...*

Homi J. Bhabha



HEALTH **S**afety

Establishing fool-proof standards in Radiation Protections & Regulatory Aspects

स्वास्थ्य संरक्षा: विकिरण सुरक्षा एवं विनियामक पक्षों में प्रमाणित मानकों का निर्धारण

Hazard Categorisation for Nuclear and Radiological Facilities:

Hazard categorisation of nuclear, radiological and chemical facilities is essential for regulatory clearance and civil structure design. It is based on the radioactive inventory and radiological consequences of an unmitigated release resulting from structural failure. It determines the building class from radiological and chemical safety perspectives and guides emergency response planning. Hazard categorisation of upcoming BARC facilities has been carried out.

Indigenous Radon Trend Analyser: BhaRaT-Rn (Bhabha Radon Technology - Radon Trend Analyser) is a low-cost, indigenous, continuous radon monitoring system developed in BARC as an import substitute. Its silicon photomultiplier (SiPM)-based design is compact, low-power and portable, eliminates the conventional high-voltage photomultiplier tube and enables unattended monitoring. Applications include occupational radon monitoring in NORM industries, uranium mines, phosphate industries and thorium processing plants, as well as monitoring in homes,

workplaces, indoor and underground environments. It is also suitable for continuous soil-gas radon monitoring for earthquake precursory research. The technology is available for transfer from BARC.

Criticality Safety Evaluation: Criticality Safety Evaluation (CSE) demonstrates that facility designs and operating conditions maintain controlled parameters within the subcritical range. Evaluations cover normal operation, anticipated operational occurrences and design-basis accidents, establishing that fissionable material systems and processes remain subcritical under normal and credible abnormal conditions. CSEs of BARC facilities have been carried out as per the requirements.



Bhabha Radon Technology - Radon Trend Analyser.



Mobile Radiological Assessment Laboratory.

Radiological Impact Assessment:

Radiological Impact Assessment (RIA) evaluates and predicts radiation doses to human health and the environment from routine operations and accidental releases at radioactive facilities. RIAs of selected BARC facilities were carried out during the reporting period, as required.

Implementation of the Indian Registry of Occupational Dose:

The Indian Registry of Occupational Dose (IROD), an in-house web application for registering and managing occupational radiation dose records, has been successfully implemented. Hosted on ANUNET, it is accessible to all connected DAE sites. The system provides a secure, centrally monitored platform with advanced features, reduced hardware requirements and lower operational costs, while accommodating future expansion and increasing workloads in the nuclear sector.

Deployment of Mobile Radiological Assessment Laboratories:

BARC developed vehicle-based Mobile Radiological Assessment Laboratories (MRALs) to strengthen DAE Radiation Emergency Response Centres. MRALs were handed over to NPCIL for deployment at nuclear power

plant sites to support emergency response and routine radiological mapping, sampling and surveillance.

For CBRN preparedness during major public events, an MRAL was deployed at the Red Fort, New Delhi, for Independence Day celebrations and during the BRICS Summit in New Delhi from September 9-14, 2026.

MRAL development was recognised as an “Area of Good Performance by India” at the IAEA’s 10th Review Meeting of the Contracting Parties to the Convention on Nuclear Safety, held in Vienna from April 13-24, 2026. The technology was also highlighted in India’s National Report under the Convention for its role in supporting protective-action decisions during nuclear and radiological emergencies.

Computational Assessment of Ac-225 Production using a Medical Cyclotron:

A computational study assessed the feasibility of producing ^{225}Ac through the $^{226}\text{Ra}(p,2n)^{225}\text{Ac}$ reaction using a sealed ^{226}Ra target in a medical cyclotron. FLUKA simulations evaluated target integrity, radiation safety and radiochemical feasibility before handling ^{226}Ra . Silver and barium were used as surrogate target materials before evaluating a ^{226}Ra -loaded target for production yield, isotopic purity and radiation fields.

For a 16.5 MeV proton beam at 35 μA , simulations indicated a favourable energy window for the desired reaction. A 1.5 μm ^{226}Ra layer with an initial activity of 38-39 MBq was estimated to yield approximately 1.98 MBq of ^{225}Ac at end of bombardment. The study provides a computational basis for optimising irradiation, shielding, handling and post-irradiation processing, supporting potential ^{225}Ac production using hospital-based medical cyclotrons.

LET-Dependent Response of Unlaminated Gafchromic EBT3 Film for Proton Dosimetry:

A study characterised and corrected the linear energy transfer (LET)-dependent response of unlaminated Gafchromic EBT3 film for proton dosimetry. Unlike its near-water-equivalent response in photon beams, the film exhibits quenching in proton beams, causing dose under-response in high-LET regions. Pristine spot-scanning proton beams at 70.8, 100 and 150 MeV were used to derive an LET-quenching correction factor linear in dose-weighted LET (LET_d).

Applying the LET_d correction improved agreement between film-measured and treatment-planning system (TPS)-calculated doses. Before correction, dose differences ranged from -8.26% to 1.19%, with approximately 8.3% under-response at the distal edge. After correction, the range narrowed to -1.75% to 1.41%, demonstrating improved EBT3 film dosimetry accuracy in clinical proton beams.

Strengthening of IERMON Network:

The Indian Environmental Radiation Monitoring Network (IERMON) was strengthened by installing Environmental Radiation Monitors with Satellite Communication (ERM-SAT) at additional locations, expanding coverage across states and Union Territories. IERMON currently operates more than 600 environmental radiation monitors across 170 cities to detect increases in background gamma radiation



ERMSAT installed in Mizoram.



Display of BARC Safety Council Publications Corner at Central Library.

caused by transboundary radioactive migration or radiological and nuclear emergencies.

BARC Membership of the Consultative Committee for Ionizing Radiation: BARC became a member of the Consultative Committee for Ionizing Radiation (CCRI) on March 30, 2026. As India's Designated Institution for ionizing radiation metrology, BARC qualified for full membership through its technical activities across CCRI's three sections viz., Radiation Dosimetry, Radionuclide Measurements and Neutron Measurements. The International Committee for Weights and Measures (CIPM) accepted its membership request.

The membership enables BARC to participate in CCRI activities, advise the CIPM on scientific matters pertaining to ionizing radiation metrology, contribute to work involving the Ionizing Radiation Department at the BIPM, and support globally recognised national measurement standards, methods and facilities.

Environmental Radiological Surveillance: Radiological surveillance activities continued at BARC facilities at Trombay and Visakhapatnam, and NPP sites in the interest of occupational workers, general public and the environment. Annual doses to general public were evaluated and found to be well below regulatory limits. Pre-operational environmental surveillance at upcoming NPP sites, including GHAVP, Mahi Banswara and Chutka, continued to establish baseline data.



Display of Posters at Central Complex Auditorium during National Safety Day 2026 event celebration.

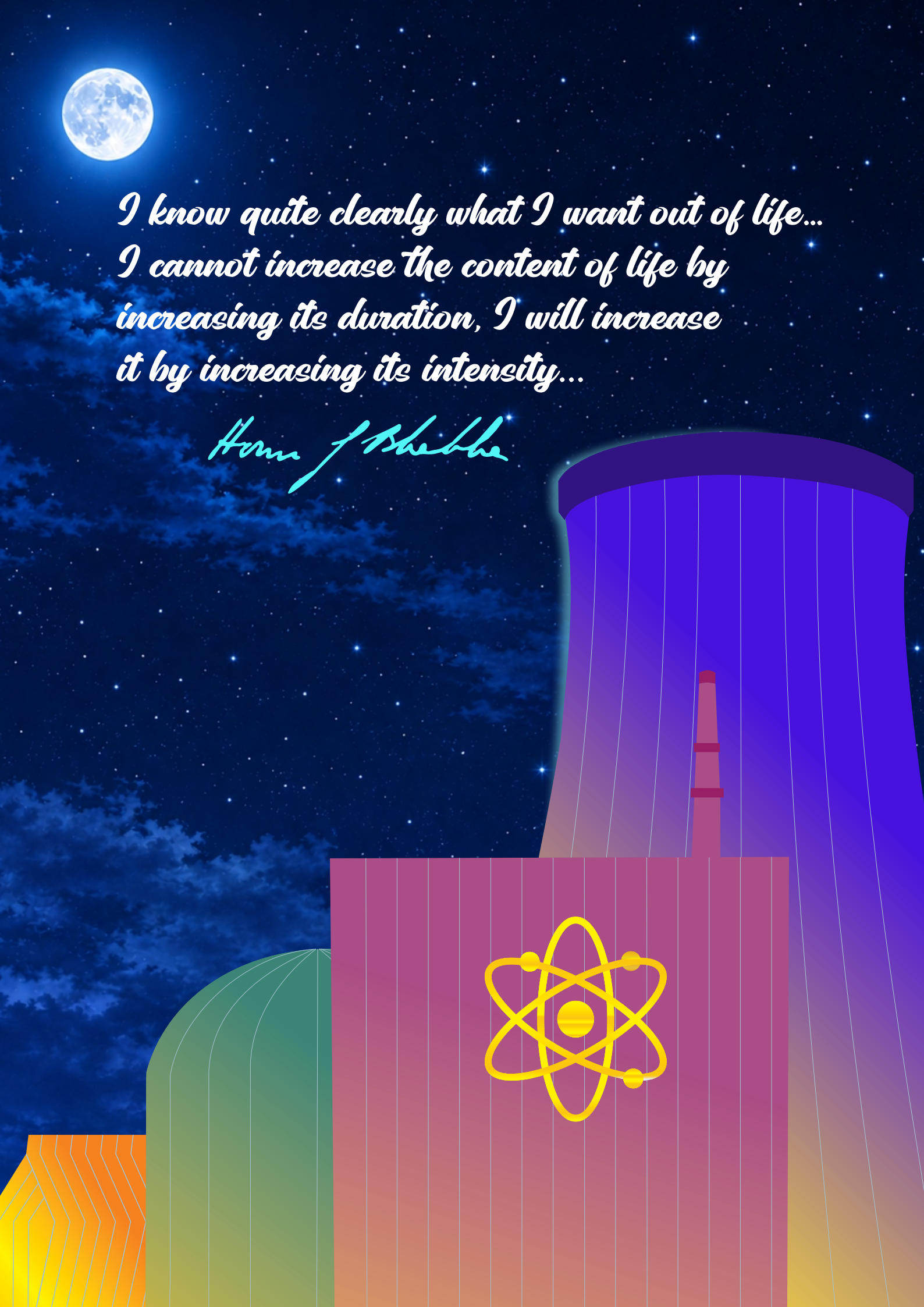
Environmental thermoluminescent dosimeters (TLDs) were used across nuclear facilities nationwide to measure cumulative external gamma radiation. Nationwide soil measurements of naturally occurring radioactive materials (NORMs) were also conducted to estimate the terrestrial contribution to public radiation doses.

BARC Safety Council: The BARC Safety Council (BSC) continued its 26-year regulatory oversight of BARC facilities in Mumbai and elsewhere, strengthening safety culture and continuous improvement. During the reporting period, BSC issued 102 regulatory clearances covering siting, construction, equipment erection, commissioning and operation. It granted 20 authorisations and 14 special authorisations for radioactive waste transfer and disposal; approved the procurement or use of 248 radiation sources and three radiological laboratories; issued 37 radioactive material shipment approvals; and approved 76 Radiological Safety Officers for BARC and defence facilities.

BSC safety committees held 221 meetings, and regulatory inspections covered 96 facilities and projects. Observers participated in emergency exercises at 48 facilities to improve radiation and fire emergency preparedness. Industrial hygiene surveys, safety investigations and accident-prevention activities continued. An online colour-changing filter-paper swipe technique for beryllium detection was developed and successfully used during surveillance of beryllia reflector-block cutting.

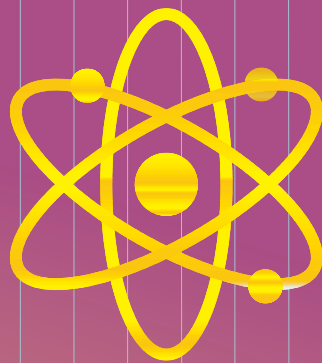
BSC published two safety guides, *Safety in Laser Facilities* and *Cyber Security of I&C Systems and Physical Protection Systems*, and launched the biannual e-magazine 'Safety Sentinel' to enhance safety awareness.

Training programmes covered crane and forklift operation, safety and regulatory measures for BARC facilities, accelerator safety, laser safety and beryllium safety at various BARC locations. A safety training course was also conducted for Heavy Water Division staff at Rawatbhata. The programmes received wide participation and positive feedback.



*I know quite clearly what I want out of life...
I cannot increase the content of life by
increasing its duration, I will increase
it by increasing its intensity...*

Homer J. Stribbe



ROBUST Training

*Building Human Resource Capital
for a Resilient Nuclear
Power Programme*

सशक्त प्रशिक्षण: नाभिकीय ऊर्जा कार्यक्रम हेतु मानव संसाधन संपदा का निर्माण

Human Resource Development and Research: Recognizing the pivotal role of skilled scientific and technical personnel in advancing India's three-stage nuclear power programme, Dr. Homi J. Bhabha established the BARC Training School at Trombay in 1957. Since its inception, the Training School has emerged as a premier centre for developing human resources in nuclear science and technology, having trained nearly 11,200 scientists and engineers. Through rigorous multidisciplinary education, experimental training and research, BARC continues to nurture scientific excellence and technological self-reliance.

During 2025-2026, the 69th batch of the Orientation Course for Engineering Graduates and Science Postgraduates (OCES) successfully completed its training, with 185 Trainee Scientific Officers graduating and joining various units of the Department of Atomic Energy (DAE). The graduation ceremony was held on 30 July 2026. Reflecting the programme's national significance and competitiveness, OCES/DGFS-2026 received over 93,000 applications, from which 266 candidates were selected. The 70th batch commenced training in August 2026, alongside participants from the defence sector and NTPC. Complementary initiatives, including the DAE Graduate Fellowship Scheme (DGFS), provide

specialized training through postgraduate education at premier institutions.

BARC further strengthened its research-oriented human-resource development through project training, internships and doctoral programmes under the Homi Bhabha National Institute. During the year, 468 students completed project work at BARC, while doctoral research opportunities expanded through the induction of 82 Ph.D. scholars. The JRF-2026 and DDFS-2026 programmes additionally attracted research scholars across engineering, physical, chemical and life sciences. Technical study tours, professional-skills workshops and nationwide outreach programmes complemented formal training, with 150 DAE officers engaging approximately 11,500 students across 110 institutions in 23 states.

Beyond institutional training, the Board of Research in Nuclear Sciences strengthened



Release of Souvenir by the Chief Guest and senior officials of DAE and BARC during the Graduation Function event on July 30, 2026.

India's broader research ecosystem by supporting extra-mural projects, fellowships and scientific events. During 2025-2026, 70 research projects were sanctioned, while completed projects underwent systematic evaluation, fostering innovation and interdisciplinary collaboration across universities and research institutions.

Scientific Resources Management: During the review period, BARC's information, documentation, publication and outreach activities significantly contributed to disseminating scientific knowledge, preserving research outputs and promoting public awareness. Key publications included the BARC VISTA, presenting major annual R&D achievements for 2025 in format aligned with DAE's Amrit Kaal Vision, and BARC Newsletters highlighting multidisciplinary nuclear R&D, materials science, biotechnology applications for a circular economy, & hydrogen generation technologies. 12 issues of the SIRB were released, alongside regular Nuclear News Web Digests & newspaper clippings on the Saraswati portal.

Scientific documentation and knowledge management activities continued. A total of 5,795 bibliographic Indian records were added to the INIS database, and 49 BARC Technical Reports were published across internal, external and restricted categories. Inter-library loan services addressed over 2000 resource-sharing requests, while approximately 1,750 research publications by BARC S&T community were showcased at the Central Library. Plagiarism and similarity screening covered 704 research articles and 210 theses. Foreign Language Translation services, scientometric analyses, and scientific illustrations for prospective journal covers further strengthened research support.

Audiovisual services supported all official events conducted in Central Complex, BARC, DAE Convention Centre in Anushakti Nagar, complemented by photography, videography, desktop publishing, printing, binding and timely production of diverse institutional publications. The Central Library organised exhibitions and thematic book displays commemorating eminent scientists, technological achievements and specialised scientific subjects in addition to display corner



A gallery honouring Dr. Vikram Sarabhai, the visionary of India's atomic energy and space programmes, was organised at the Central Library on his birth anniversary.



Students from District Welfare Office, Jharkhand visited BARC.

on BARC Safety Council publications. BARC hosted 12 institutions, engaging approximately 355 students and 32 teachers from Mumbai and across India during the review period.

The "OpenGRID - Exploring Beyond Boundaries" initiative aimed at promoting Open Access publishing by BARC researchers continued through the One Nation One Subscription (ONOS), One DAE One Subscription (ODOS) and the Institute of Physics (IOP) Publishing, UK for Open Access (OA) publishing programmes. During this period, Open Access publishing tallied more than 100 Open Access articles in Gold and Hybrid journals. 74 OA articles were contributed by ODOS and 26 by IOP, while one article was published using the ONOS scheme.

Technology Transfer, Commercialisation and Entrepreneurship:

During the past year, 24 new BARC technologies were released into the public domain for commercialization. A total of 122 technology transfer agreements were signed, covering 66 technologies transferred to 91 companies. The USB-Powered Tele-ECG Machine was transferred to 13 parties, while the Portable Raman Spectroscopy System for Oral Cancer Detection was transferred to five parties. The technology for Recovery of Rare Earth Values from the Ankeritic Ore Body of Ambadongar, Gujarat (CH48MinD), was transferred to M/s Gujarat Mineral Development Corporation (GMDC).



Inauguration of AKRUTI Kendra at Jai Hind College, Mumbai.

Two new AKRUTI centres were established, bringing the nationwide network to 14 centres. These centres facilitate the dissemination and commercialization of BARC technologies while fostering entrepreneurship, particularly in remote areas. The AKRUTI centres at Tarapur, MGU Kerala, and GITAM Vizag organized workshops and awareness exhibitions to promote BARC technologies. M/s 6C NanoCarb Pvt. Ltd. commercialized BARC-developed large-scale carbon nanotube (CNT) fabrication technology. Additionally, M/s Enthutech, Pune, and M/s

Emprotech, Chhatrapati Sambhajinagar, commercialized the USB-Powered Tele-ECG Machine.

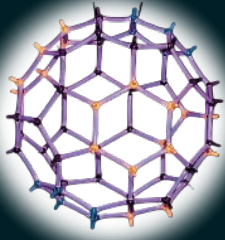
The Deep Tech Summit 2026, jointly organized by AIC Anushakti Foundation and TT&CD, BARC, marked a significant milestone with the launch of the DAE Incubator Alliance, bringing together AIC Anushakti, AIC FAST, AIC PI HUB, and AIC PLASMATECH. The summit featured 12 technology transfer agreements, a BARC Deep Technology Exhibition, the launch of Deep Tech Cohort 1.0, and policy discussions on startup development and MSME funding.

On 22 May 2026, AIC ANUSHAKTI, CII, and HBNI jointly organized the Research Scholars' Summit at the DAE Convention Centre. AIC ANUSHAKTI also launched its Deep Tech Talk Series and promoted BARC technologies through national industry platforms, including India Food Forum and Medically, strengthening industry engagement and technology adoption.

Indigenous Development of Advanced Alkaline Water Electrolyser Stack for Hydrogen Generation



An advanced 0.5 MW alkaline water electrolyser stack has been developed through in-house process and mechanical design, engineering, and analysis of a bipolar type configuration in BARC. The stack was successfully integrated with the 1 MW electrolyser plant being developed in collaboration with PSU oil major Bharat Petroleum Corporation Limited at Kochi. Multiple successful operational campaigns at rated capacity have demonstrated the performance and readiness of this indigenous technology for integration into larger scale green hydrogen production systems.



एचबीएसटी मानपत्र

नाभिकीय विज्ञान एवं प्रौद्योगिकी में उत्कृष्टता के लिए

HBST Maanpatra

for excellence in science, engineering & technology





Mr. B. N. Rath

नाभिकीय नाभिकीय ईंधनों के पश्च-किरणन एवं नाभिकीय घटकों के विश्लेषण में योगदान

Contributions to Post irradiation of nuclear fuels, analysis of nuclear components

यह मान-पत्र श्री बी. एन. रथ की नाभिकीय ईंधनों के पश्च-किरणन परीक्षण, दा.भा.पा.रि. (पीएचडब्ल्यूआर) दाब नलिकाओं, एवं बाह्य-कोर संरचनात्मक नाभिकीय घटकों के विफलता विश्लेषण सहित अन्य क्षेत्रों में उनके उल्लेखनीय उपलब्धियों को मान्यता प्रदान करता है।

The Maanpatra recognises notable achievements of Mr. B.N. Rath in the Post Irradiation Examination of nuclear fuels, PHWR pressure tubes, and failure analysis of out-of-core structural nuclear components among others.

Mr. B. N. Rath, a metallurgist from 46th batch of OCES programme of the BARC Training School, made notable contributions to post irradiation examination (PIE) of nuclear fuel and pressure tubes from pressurised heavy water reactors (PHWRs). Through non-destructive examination, fractography and microstructural characterization, he successfully established the root cause of failure of pressure tubes of Madras Atomic Power Station (MAPS) and provided deep insight on the healthiness of other pressure tubes in the reactor core by meticulously correlating in-service inspection data with PIE findings. His comprehensive investigations during PIE of pressure tubes from Tarapur Atomic Power Station (TAPS) helped in meeting the regulatory requirements for continued operation of TAPS Unit-3&4. Another significant work carried out by Mr. Rath had been the PIE of research reactor Apsara-U fuel sub-assembly and dispersion fuel being developed for compact light water reactors. He carried out extensive investigations involving non-destructive examination, metrology, gamma scanning and microstructure characterization, which provided vital insight on performance of fuel during irradiation. Through variety of destructive and non-destructive tests, Mr. Rath successfully carried out failure analysis of large number of pressure boundary components from nuclear plants. Mr. Rath validated advanced phased array ultrasonic technique for detection and depth sizing of intergranular stress corrosion cracks in recirculation line of TAPS Unit-1&2, which was crucial in taking decision on replacement of pipelines for long term operation of the reactors.

विरल मृदा धातुओं एवं मिश्रधातुओं के उत्पादन हेतु प्रौद्योगिकियों के निरूपण में योगदान

Contributions to Demonstration of technologies for rare earth metals & alloys production



Dr. D. K. Sahoo

Dr. D. K. Sahoo, a Scientific Officer in the Materials Group, BARC, is actively engaged in advancing indigenous technologies for value addition of rare earth elements (REE), a critical step towards establishing the self-reliant rare earth value chain in the country. He made significant contributions towards the development of rare earth metals, alloys and permanent magnets, aligning with department's mandate towards an "Aatmanirbhar Bharat" (self-reliant India).

To start with, he demonstrated the molten salt electrolysis technology to produce RE metals such Lanthanum (La), Cerium (Ce) and Praseodymium (Pr) from domestically available raw materials. The technologies for the production of La and Ce metals were transferred to IREL and subsequently deployed at the Rare Earth and Titanium Theme Park (RETTP), Bhopal for pilot-scale production. He played a key role in the successful deployment at the pilot-plant scale, which laid an important foundation, for further scale-up and transformation of the technology towards commercial-scale production of these metals. One of his notable contributions lies in the development of reduction-diffusion (R-D) technology for the production Sm-Co based alloy powder required for making Sm-Co (1:5) permanent magnet. He has been instrumental in providing technical inputs and facilitating activities in setting up rare earth permanent magnet (REPM) plant at BARC, Visakhapatnam. Recently, he demonstrated the preparation of samarium metal, which marks as a significant achievement aimed at furthering self-sufficiency.

One of the his most notable contributions is the development and demonstration of calciothermic reduction (CTR) based technology for the production of Neodymium (Nd) and Didymium (NdPr) metals using the raw materials available in the country. These technologies were developed under "Aatmanirbhar Bharat" initiatives to manufacture NdFeB magnet in the country. He also demonstrated the processes for producing Dysprosium (Dy) and Terbium (Tb) metal, which are required for producing higher-grade NdFeB magnet. Performance evaluations confirmed that magnets produced using these indigenously developed metals are on par with imported alternatives. Following the success, CTR technology has been successfully implemented at RETTP, Bhopal and a private industry with his incubation support for the production of RE metals required for making NdFeB magnet.

यह मान-पत्र डॉ. डी. के. साहू की विरल मृदा धातुओं, मिश्रधातुओं एवं चुम्बकों के निर्माण हेतु स्वदेशी प्रौद्योगिकियों के विकास में उल्लेखनीय उपलब्धियों को मान्यता प्रदान करता है, जो कि प्रौद्योगिकीय आत्मनिर्भरता प्राप्त करने में महत्वपूर्ण हैं और भारत में एक पूर्ण विरल मृदा पारिस्थितिक तंत्र स्थापित करने की दिशा में व्यापक प्रयास हैं।

The Maanpatra recognises notable achievements of Dr. D.K. Sahoo in the development of indigenous technologies for preparation of rare earth metals, alloys and magnets, which is key to gaining technological independence in the overall efforts for establishing a complete rare earths ecosystem in India among others.



Dr. Dibakar Goswami

यह मान-पत्र डॉ. दिबाकर गोस्वामी की कैंसर के निदान एवं उपचार में व्यापक रूप से प्रयुक्त प्रमुख रेडियोभेषजिक लिगेण्डों के स्व-गृह संश्लेषण में उल्लेखनीय उपलब्धियों को मान्यता प्रदान करता है। इसके अतिरिक्त, उन्होंने कैंसर चिकित्सा की चयनात्मकता एवं प्रभाविकता बढ़ाने के लिए विवेकपूर्ण प्रबंधित आप्विक एवं फ्रेमवर्क-आधारित प्रणालियों की संभावनाओं का भी निरूपण किया है।

The Maanpatra recognises notable achievements of Dr. Dibakar Goswami in the in-house synthesis of key radiopharmaceutical ligands which are widely employed in cancer diagnosis and cancer therapies. Additionally, he demonstrated the potential of rationally engineered molecular and framework-based systems to enhance the selectivity and effectiveness of cancer therapeutics.

संश्लेषित कार्बनिक रसायन, रसायनचिकित्सीय औषधियों के विकास में योगदान

Contributions to Synthetic organic chemistry, efforts in chemotherapeutic drugs development

Dr. Dibakar Goswami, a Scientific Officer in BioScience Group, BARC was conferred with the prestigious “Homi Bhabha Science and Technology Maanpatra (HBSTM)-2025” by DAE for his contributions in the field of “Synthetic Organic Chemistry.”

Dr. Dibakar Goswami joined BARC in 2004 through 47th batch of Training School (Chemistry) after completing his MSc (Chemistry) from The University of Burdwan, West Bengal. He received his PhD (Chemical sciences) from HBNI and subsequently pursued postdoctoral research at The University of Sao Paulo, Brazil under “FAPESP Fellowship”. His research focuses on targeted ligands for radiopharmaceuticals and chemotherapeutics, along with the development of organic-inorganic hybrid materials for safer and more specific delivery of chemotherapeutic drugs.

In-house synthesis of radiopharmaceutical ligands is of utmost importance in an endeavor to achieve affordable healthcare, and also to promise uninterrupted supply in hospitals. Dr. Goswami has actively contributed in the synthesis of several radiopharmaceutical ligands like [Cu(MIBI)₄]BF₄ (for use in myocardial perfusion imaging), mIBG hemisulfate (for use in therapy of neuroblastoma), Tetrofosmin (for use in myocardial imaging), NOTA-bisphosphonate (for use in early diagnosis of bone metastasis), FAPI-2286 (for use in tumor imaging) etc. Radiopharmaceutical kits made using in-house synthesized ligands have benefitted thousands of patients undergoing treatments in multiple hospitals across India. Apart from that, aiming towards separating carrier free ⁹⁰Y (from a mixture of ⁹⁰Sr-⁹⁰Y) for use in radiopharmaceuticals, he synthesized a rigidified dicarboxamide in multigram scale, which showed satisfactory performance when used in a supported liquid membrane developed through an inter-collaboration in BARC. Besides, Dr. Goswami has also been instrumental in developing the indigenous process for the synthesis of the active drug intermediate, o-Tolylbenzonitrile, one of the highest imported drug intermediates in India.

Through his research on targeted chemotherapeutics, he has successfully synthesized novel small-molecule drug conjugates specifically designed for the targeted treatment of neuroblastoma and prostate cancer. Further conceptual advancement was achieved via employing nanosized metal-organic frameworks (MOFs) and hydrogen-bonded organic frameworks (HOFs) as host platforms for the tumor-targeted delivery of chemotherapeutic agents. These studies demonstrated the potential of rationally engineered molecular and framework-based systems to enhance the selectivity and effectiveness of cancer therapeutics.

अभिक्रियाशील एवं दुर्गलनीय धातुओं हेतु गलित लवण विद्युत-अपघटकों के विकास में योगदान

Contributions to Development of Molten Salt Electrolysers for Reactive & Refractory Metals



Mr. Gaurav Varshney

Mr. Gaurav Varshney, a chemical engineer, graduated from the 47th OCES batch of the BARC Training School. Since joining the Chemical Engineering Group as a Scientific Officer in 2004, he has devoted over two decades to the design, development and operation of pilot-scale molten salt electrolyzers. The Homi Bhabha Science & Technology Maanpatra-2025 has been conferred upon him in recognition of his outstanding contributions towards "Electrolysers for Critical Metal Production."

A major contribution of Mr. Varshney has been his technical leadership in the operational and R&D activities of the metal production facility, where he has played a key role in ensuring the safe, sustained and efficient production of high-purity metals. Through systematic engineering interventions, he reconfigured critical electrolyser design features to enhance productivity, process efficiency and operational reliability. He further optimized the process flowsheet by incorporating recycling of metal values and conversion of legacy stockpiles into usable metal products. This approach not only improved resource utilization but also significantly reduced the operational load on the precursor plant.

He established a pilot-scale electrolyser facility for the production of refractory metals. He led the systematic optimization of electrode configurations and operating parameters to achieve a high-quality metal powder with favourable consolidation characteristics and enhanced downstream recovery. Under his technical leadership, kilogram-scale production of the metal powder was demonstrated and subsequently transformed into solid blades. These blades were successfully tested in the Critical Facility, demonstrating the required performance and reactivity for effective neutron absorption.

In another important technological achievement, Mr. Varshney played a pivotal role in the scale-up of catalytic hydrogenation at the Advanced Crown Ether Synthesis Plant (ACESP). He led the team in achieving a major breakthrough in the indigenous bulk-scale production of strontium-selective crown ether, successfully demonstrating production at 1 kg/batch scale. The specialized solvent serves as an import substitute for the recovery of Strontium-90 from high-level nuclear waste and which has potential applications in Radiomedicine and Radioisotope Thermoelectric Generators (RTGs).

Through innovative engineering and process expertise, Mr. Varshney has contributed significantly to the safe, reliable and highly efficient production of high-purity reactive and refractory metals vital for departmental applications. His work has strengthened indigenous technological capabilities in critical metal production while advancing the development and scale-up of specialized electrochemical and chemical processes.

यह मान-पत्र श्री गौरव वार्ष्णेय की क्रांतिक धातु उत्पादन हेतु विद्युत-अपघटन के विकास में उल्लेखनीय उपलब्धियों को मान्यता प्रदान करता है। व्यवस्थित अभियांत्रिकीय परिवर्तनों के माध्यम से, उन्होंने उत्पादकता, प्रक्रम दक्षता एवं परिचालन विश्वसनीयता में वृद्धि करने हेतु विद्युत-अपघटन की क्रांतिक अभिकल्पन विशेषताओं को पुनःविन्यासित करने सहित अन्य कार्यों में महत्वपूर्ण योगदान दिया है।

The Maanpatra recognises notable achievements of Mr. Gaurav Varshney in the development of Electrolysers for Critical Metal Production. Through systematic engineering interventions, he reconfigured critical electrolyser design features to enhance productivity, process efficiency and operational reliability among others.



Dr. Jyoti Prakash

यह मान-पत्र डॉ. ज्योति प्रकाश की विविध अनुप्रयोगों विशेषकर भारत की सबसे हल्की बुलेट-प्रूफ जैकेट, भाभा कवच के विकास को संभव बनाने के लिए CNT-संयुक्त UHMWPE मिश्रित परतों के निर्माण के अंतर्गत, नाभिकीय-ग्रेड के ग्रेफाइट, लेपन प्रौद्योगिकी, कार्बन नैनोपदार्थ सहित कार्बन पदार्थ एवं प्रौद्योगिकियों में उल्लेखनीय उपलब्धियों को मान्यता प्रदान करता है।

The Maanpatra recognises Dr. Jyoti Prakash's notable achievements in carbon materials and technologies, including nuclear-grade graphite, coating technologies, carbon nanomaterials, and composites for diverse applications, notably CNT-incorporated UHMWPE composite layers enabling India's lightest bulletproof jacket, Bhabha Kavach.

बृहत अनुप्रयोगों हेतु प्रगत कार्बन-आधारित पदार्थों के विकास में योगदान

Contributions to Advanced carbon-based materials development for major applications

Dr. Jyoti Prakash, a Scientific Officer in the Materials Group of BARC, was conferred with the prestigious 'Homi Bhabha Science & Technology Maanpatra (HBSTM) - 2025' by DAE for his outstanding contributions to advanced carbon-based materials development for strategic and societal applications.

Briefly, there is a stringent requirement for indigenous isotropic high-density graphite for the molten salt breeder reactor under development in India, with no reliable external supply chain. To address this critical gap, Dr. Prakash proposed and developed a novel flowsheet utilizing meso-carbon microbeads as a starting material. He successfully demonstrated the lab-scale production of high-density, pure isotropic graphite requiring fewer steps than conventional methods. Furthermore, he achieved low-temperature coating of Silicon Carbide layers on these graphite components using an in-house atmospheric pressure chemical vapor deposition process. By proposing a uniform deposition model based on deposition kinetics and evaluating the adherence and permeability properties as per nuclear ASTM standards, his work provided valuable insights into high-temperature oxidation behavior in actual reactor environments. This indigenous process is currently being scaled up to cater to reactor requirements.

Beyond nuclear materials, Dr. Prakash has pioneered the development of carbon nanomaterials, including carbon nanotubes (CNTs) and graphene. A major strategic milestone was his development of a process for CNT-incorporated UHMWPE composite layers, enabling the fabrication of "Bhabha Kavach," India's lightest bullet-proof jacket. Furthermore, he achieved the large-scale indigenous manufacturing of self-assembled, standalone CNT aerogel electrodes. Utilizing these novel architectures, he developed rapid, ultra-sensitive, and robust sensors capable of detecting hazardous gases, sulfides, and VOC biomarkers at parts-per-billion (ppb) levels.

Dr. Prakash's scientific excellence has been widely acknowledged globally and nationally. He is a recipient of the prestigious Fulbright-Nehru Post-doctoral Fellowship (2017), the DAE Young Applied Scientist Award (2013), the DAE Group Achievement Award (2019) for delivering Bhabha Kavach, and the Dr. R. L. Thakur Memorial Award (2016). Recently, he was honored with the B.D. Bangur Award (2026) and the Birla Carbon Best Innovation Award (2026). Dr. Prakash is an elected Young Associate of the Maharashtra Academy of Sciences, an Associate of the Royal Society of Chemistry, and a life member of multiple esteemed professional societies.

विकिरण आपात-स्थितियों एवं सटीक औषधि हेतु जैव-मात्रामापी को उन्नत बनाने में योगदान

Contributions to Advancing Biodosimetry for Radiation Emergencies and Precision Medicine



Dr. Rajesh Kumar Chaurasia

Dr. Rajesh Kumar Chaurasia, a Scientific Officer in the Health, Safety and Environment Group, BARC was conferred with the prestigious “Homi Bhabha Science & Technology Maanpatra (HBSTM), 2025” by DAE for his outstanding contribution in the field of “Advancing Biodosimetry Tools and Their Applications in Radiation Emergency Response and Precision Medicine”.

Dr. Chaurasia joined BARC in 2012 through the 55th batch of Training School (Bioscience) after completing his M. Tech. (Biotechnology) from IIT Guwahati. He received his PhD (Life Sciences) from HBNI. His research interests span advancing biodosimetry techniques, ranging from rapid emergency dose assessment to long-term retrospective dose estimation, coupled with cytogenetic investigations of rare genetic syndromes and radiation sensitivity in paediatric patients.

Dr. Chaurasia has strengthened national capabilities in radiation dose assessment by developing and validating three major biodosimetry tools, along with their reference calibration curves: a rapid emergency biodosimetry tool that enables dose assessment much faster than conventional methods, supporting effective emergency preparedness; a retrospective dosimetry tool, enabling reliable dose estimation for exposures ranging from decades to lifetime; and an mBAND-FISH-based approach that discriminates between low- and high-LET radiation exposures.

He led the establishment of India's first biodosimetry network (IN-BioDoS), integrating seven laboratories nationwide to strengthen radiological emergency preparedness. He also led the country's first inter-laboratory comparison to set quality assurance standards in biodosimetry. He has collaborated extensively on biodosimetry and its clinical applications with several institutions across India, including, SRU (Chennai), UPES (Dehradun), NITTE University (Mangalore), ACTREC-TMH (Navi Mumbai), ICMR-NIIH (Mumbai), and IGCAR (Kalpakkam).

Dr. Chaurasia also developed a patented novel formulation, Fixative Composition Saline (FCS). It is a single-step formulation that lyses RBCs while preserving WBC nuclear morphology and genomic integrity. FCS remains stable for over a year at ambient temperature, simplifying blood sample handling, transport, and long-term storage, particularly benefiting sample collection in remote areas.

His clinical research has translated cytogenetic and DNA-DSB repair protein analysis into direct patient benefit, by assessing genomic instability and radiosensitivity to guide personalized treatment for children with rare immunodeficiencies, including Wiskott-Aldrich Syndrome, Fanconi Anemia, DOCK8 Deficiency, and LADD Syndrome.

Dr. Chaurasia has represented India on the global stage under the Indo-US Technical Exchange Program at REAC/TS, USA, advancing biodosimetry techniques for high-LET radiation. He also represented India at the 7th Plenary Meeting of the High-Level Group on Low Dose Research (HLG-LDR), organized by the Nuclear Energy Agency (NEA) in France, contributing to global policy coordination on low-dose radiation research. He has mentored master's and Ph.D. scholars from institutions across the country, as well as an international fellow under the ASEAN-India Research and Training Fellowship, strengthening India's leadership in regional biodosimetry capacity-building.

यह मान-पत्र डॉ. राजेश कुमार चौरसिया को भारत के प्रथम जैव-मात्रामिति नेटवर्क (IN-BioDoS) के गठन में उल्लेखनीय उपलब्धियों को मान्यता प्रदान करता है, जो देशभर में सात प्रयोगशालाओं को एकीकृत करता है और देश के प्रथम अंतर प्रयोगशाला तुलना के माध्यम से गुणवत्ता मानकों को स्थापित करता है। अन्य कार्यों के साथ, उनके इस अध्ययनों से, असाधारण प्रतिरक्षाविहीनता सिंड्रोम से ग्रस्त बच्चों में विकिरण संवेदनशीलता एवं जीनोमिक अस्थिरता के संबंध में नई अंतर्दृष्टि प्राप्त हुई है और वैयक्तिकृत रेडियोथेरेपी हेतु अनुशंसित करता है।

The Maanpatra recognises notable achievements of Dr. Rajesh Kumar Chaurasia in establishment of India's first biodosimetry network (IN-BioDoS) - integrating seven laboratories nationwide and setting quality standards through the country's first inter laboratory comparison. His analyses provided new insight into radiosensitivity and genomic instability in children with rare immunodeficiency syndromes, recommending personalized radiotherapy among others.



Dr. Rubel Chakravarty

रेडियोसमस्थानिकों एवं रेडियोभेषजिकों के विकास हेतु नव प्रौद्योगिकियों में योगदान

Contributions to New technologies for radioisotopes & radiopharmaceuticals development

यह मान-पत्र डॉ. रुबेल चक्रवर्ती को रेडियोआइसोटोप उत्पादन एवं रेडियोभेषजिक के लिए अग्रणी स्वदेशी प्रौद्योगिकियों के विकास में उल्लेखनीय उपलब्धियों को मान्यता प्रदान करता है। उन्होंने प्रयोगशाला-आधारित नवाचारों को कैसर प्रतिबिम्बन एवं लक्षित चिकित्सा के नैदानिक अनुप्रयोगों में रूपांतरित करने में महत्वपूर्ण योगदान दिया है।

The Maanpatra recognises notable achievements of Dr. Rubel Chakravarty encompassing pioneering indigenous technologies for radioisotope production and radiopharmaceutical development, translating laboratory innovations into clinical applications for cancer imaging and targeted therapy.

Dr. Rubel Chakravarty, Scientific Officer in the Radio Chemistry & Isotope Group, BARC and Associate Professor, Homi Bhabha National Institute (HBNI), was conferred the Homi Bhabha Science & Technology Maanpatra (HBSTM) – 2025 for his contributions to the production of medically important radioisotopes and development of radiopharmaceuticals. His research has focused on developing indigenous technologies that take radioisotopes from production and radiochemical separation through radiopharmaceutical formulation and, ultimately, to clinical application.

A significant part of this work has involved the production and radiochemical separation of clinically relevant radioisotopes, including ^{177}Lu , $^{43/44}\text{Sc}$, ^{47}Sc , ^{52}Mn , ^{64}Cu , ^{124}I , ^{161}Tb , ^{166}Ho , ^{169}Er , and ^{211}At . In particular, he developed an electrochemical process for the separation of no-carrier-added (NCA) ^{177}Lu from irradiated ^{177}Yb . The NCA ^{177}Lu obtained by this indigenous process was successfully used for preparation of therapeutic radiopharmaceuticals and subsequently administered to cancer patients in clinical practice.

Another important achievement has been the development of reactor-produced ^{64}Cu and its radiochemical separation for preparation of clinical-grade ^{64}Cu . Following regulatory clearance, the radiopharmaceutical was used for PET imaging in clinical studies. His work in radiopharmaceutical chemistry has also resulted in targeted agents such as ^{177}Lu -DOTA-Trastuzumab-Fab, which progressed to a first-in-human clinical study in breast cancer.

His research has subsequently extended into radio-nanomedicine, combining radionuclides with engineered nanomaterials for localized and targeted cancer therapy. Notably, his intrinsically radiolabeled ^{177}Lu - Lu_2O_3 nanoparticles were taken into a clinical study involving patients with locally advanced breast cancer. This work provided a clinical demonstration of the emerging concept of “nanoscale brachytherapy,” using radioactive nanoseeds to deliver localized radiation within the tumour.

The common thread across these efforts is the translation of radioisotope production, radiopharmaceutical chemistry and nanotechnology into patient-oriented applications. Several of these technologies have received regulatory approval and progressed towards clinical use and wider deployment, contributing to indigenous capabilities in nuclear medicine.

साधारण-जल रिएक्टर के पंप हेतु विशेष संहत कैन्ड मोटरों के विकास में योगदान

Contributions to Development of special compact canned motors for pumps of LWR

Mr. Rupendra Singh, Scientific Officer in the Reactor Projects Group, BARC was conferred with 'Homi Bhabha Science & Technology Maanpatra-2025' by DAE as recognition of his outstanding contributions in the field of "Development of Special Compact Canned Motors for Pumps of Light Water Reactor".

He has significantly contributed in design and development of indigenous compact, silent and high reliability Canned Motors (CM) for Primary Circulating Pump, Shut Down Cooling Pump & Component Cooling Water Pump for Compact Light Water Reactors of critical projects. His work also includes development of state-of-art fabrication and testing equipment for design, development, testing and qualification of the indigenised CMs. Multiple units of these CM Pumps were qualified and deployed in the service.



Mr. Rupendra Singh

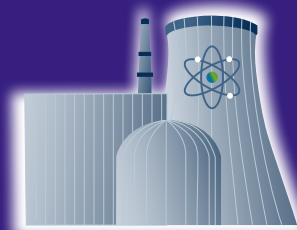
यह मान-पत्र श्री रुपेन्द्र सिंह को आत्म-निर्भरता की दिशा में राष्ट्रीय नाभिकीय क्षमताओं को सशक्त बनाने के लिए साधारण जल रिएक्टरों हेतु क्रांतिक पंपों के विशेष कैन्ड मोटरों के स्वदेशी विकास एवं परिनियोजन को संभव बनाने में उल्लेखनीय योगदान को मान्यता प्रदान करता है।

The Maanpatra recognises the notable achievements by Mr. Rupendra Singh, which enabled indigenous development and deployment of Special Canned Motors of Critical Pumps for Light Water Reactors to strengthen national nuclear capabilities for self-reliance.



भाभा परमाणु अनुसंधान केंद्र के विज्ञान एवं प्रौद्योगिकी जगत के पुरस्कार एवं सम्मान

Awards and Honors to BARC Science and Technology Community



Dr. Atindra Mohan Banerjee

Dr. Atindra Mohan Banerjee is a Scientific Officer in the Chemistry Group, BARC. He joined BARC in 2005 after completing his M.Sc. from the University of Calcutta and the 48th BARC Training School, and obtained his Ph.D. from HBNI in 2012 on iron oxide-based catalysts for high-temperature sulfuric acid decomposition in the Iodine-Sulfur (I-S) hydrogen generation process. His postdoctoral research at the University of Kansas focused on plasma-catalytic CO conversion. His research spans heterogeneous catalysis, thermochemical water-splitting cycles (I-S, Cu-Cl and Hybrid-Sulfur), electrocatalysis, alkaline water electrolysis, photocatalytic hydrogen production and plasma catalysis. His contributions include catalysts for I-S demonstration plants, Pt/C and low-Pt/bimetallic electrocatalysts, Mo-carbide catalysts, Ni-based coatings and LDH catalysts. He has more than 40 publications, 4 book chapters, and received several DAE and scientific awards including the DAE Group achievement Award (2010), DAE Young Scientist Award (2014) besides ITAS Young Scientist Award (2014) and **SMC Bronze Medal** (2025).

<<< Dr. Dimple P. Dutta

Dr. Dimple P. Dutta, Scientific Officer in the Knowledge Management Group, received the **CRS-Silver Star Medal from Chirantan Rasayan Sanstha (CRS)**, India, for notable contributions to energy storage. Her research focuses on developing materials through soft chemical techniques for energy storage and water remediation. She has designed and optimized novel electrode materials for lithium and sodium-ion batteries and explored functional materials for efficient removal of water contaminants, contributing to sustainable technologies. Her other distinctions include the DAE Scientific and Technical Excellence Award for contributions to the National Energy Storage Initiative, CRSI Bronze Medal, MRSI Medal, Silver Medal from the Society of Materials Chemistry, DAE Young Scientist Award, and ACS Award. Dr. Dutta is a Fellow of the Royal Society of Chemistry, London, and Maharashtra Academy of Sciences, and an elected Member of the National Academy of Sciences, India. She also actively contributes to DAE outreach.



Dr. Mohit Tyagi

Dr. Mohit Tyagi is a Scientific Officer in Physics Group. He joined BARC in 2005 after completing the 48th BARC Training School. His research focuses on advanced scintillating materials and indigenous radiation detection technologies for DAE applications. He has authored over 115 peer-reviewed publications and holds 8 patents, including grants in the USA, Germany, China and India, besides PCT. He played a key role in developing single-crystal scintillators and compact radiation detectors for gamma rays, neutrons, X-rays, electrons and charged particles, several of which are deployed across DAE units. His innovations include high-performance Ce-doped GGAG scintillators, a GGAG:Ce/B-Csl:TI phoswich detector and a portable radiation detector. His contributions have earned major DAE and national awards, including HBSTM-2024. He is a **Fellow of the Maharashtra Academy of Sciences**, NASI member and **Chairperson of INYAS-INSIA**. His current work addresses emerging indigenous radiation-detection needs.



Dr. K. Sandeep Rao

Dr. K. Sandeep Rao, a Scientific Officer in the Chemistry Group, joined BARC after graduating from the 58th batch of the BARC Training School. His foundational academic excellence is marked by an INSPIRE fellowship (2009-2014), a 2014 Gold Medal for his Integrated MSc in Chemistry from NISER, Bhubaneswar, and the 2015 Bhabha Gold Medal from HRDD, BARC. Dr. Rao specializes in the research and development of advanced functional materials for clean energy, with a primary focus on lithium-based batteries, oxygen-ion conductors, and dielectric ceramics. He has made highly impactful contributions to lithium-sulfur battery technologies, effectively addressing polysulfide shuttling and sulfur utilization limitations through innovative separator modifications using GO and MXene/rGO matrices. His expertise also extends to developing bio-derived carbon cathodes and exploring defect-mediated conduction pathways in complex perovskites. This deep-rooted interest in structure-composition-property correlations builds upon his early computational and experimental work on magnetic interactions in iron nitrides. His blend of experimental rigor and technological relevance is documented across 19 international journal research papers, one book chapter, three bulletin articles, and a BARC internal report. Recognizing his scientific contributions, the Society for Materials Chemistry (SMC) honored him with the 2025 **Emerging Scientist Award**. Beyond his research, Dr. Rao is a dedicated educator and science communicator. He has taught NMR Spectroscopy and Material Science to OCS Chemistry trainees. He was also an active participant in the 2022 DAE Parmanu Jyoti Programme, wherein he travelled to Jawahar Navodaya Vidyalaya schools in the Union Territory of Andaman & Nicobar Islands to popularize science and DAE activities among high school students.

<<< Dr. Raghunath Acharya

Dr. Raghunath Acharya, an Outstanding Scientist & Head, Isotope and Radiation Application Division of RC&IG, BARC was elected as a **Fellow of Maharashtra Academy of Sciences (FMASc)** in 2025 for his contributions in the field of Chemical Sciences. Additionally, he received **Silver Medal** by Society of Materials Chemistry in 2025 for his notable contributions on non-destructive chemical characterization of materials by Nuclear Analytical Techniques utilizing research reactors and particle accelerators of BARC.



Mr. Rajath Alexander

Mr. Rajath Alexander, a Scientific Officer in Materials Group, BARC, has been selected for the **INAE Young Engineer Award 2026** and inducted as an INAE Young Associate. The recognition acknowledges his work in carbon nanomaterials. Mr. Alexander developed, for the first time in India, the technology for producing kilometre-long carbon nanotube (CNT) fibres, a capability achieved by only a few laboratories worldwide. The fibres exceed 7.5 GPa in tensile strength, the highest reported for indigenously produced CNT fibres, and also offer high electrical conductivity. They were produced on an indigenously developed Floating Catalyst CVD reactor with an integrated precision winding system. Key design features include bi-directional catalyst injection, in-situ radial mixing for selective synthesis of semiconducting SWCNTs, and in-situ twisting, which increased specific tensile strength by 125%. An Indian patent has been awarded for the method and system for enhanced carbon conversion and selective synthesis of semiconducting SWCNT fibres. The CNT sheet technology was transferred to M/s 6C Nanocarb Pvt. Ltd. for industrial-scale production. He also developed boron carbide-CNT nanocomposite armour tiles, transferred to M/s. Bhukhanvala Industries Private Limited, and was involved in the production and supply of more than 150 Bhabha Kavach bulletproof jackets to the CISF, BSF, CRPF and NSG. His work has been evaluated for lightweight aerospace and defence structural panels, thermoelectric waste heat harvesting, and wearable gas sensors.



Dr. Ratikanta Mishra

Dr. Ratikanta Mishra, Outstanding Scientist, joined Bhabha Atomic Research Centre (BARC) as a Scientific Officer after graduating from the 36th batch of the BARC Training School. He is presently heading Analytical Chemistry Division, Chemistry Group in BARC. Dr. Mishra expertises in thermal analysis and chemical thermodynamics, with significant contributions to thermodynamics of nuclear materials relevant to India's nuclear energy programme. His research includes development of thermodynamic databases for Advanced Heavy Water Reactor (AHWR) nuclear fuel systems and investigations into high-temperature chemistry and thermophysical properties of fuel systems for Molten Salt Breeder Reactors (MSBRs). He has also successfully led a team in synthesizing ultra-pure materials for strategic applications and developed novel lead-free nanostructured solder materials for high-temperature applications. Dr. Mishra published over 180 research articles in peer-reviewed international journals, in addition to several book chapters and review articles. His contributions have been recognized through several prestigious honours and fellowships, including the **ISMC Silver Medal**, the Netzsch-ITAS Award, the Marie Curie International Fellowship, and the Alexander von Humboldt Fellowship.

<<< Dr. Shashwati Sen

Dr. Shashwati Sen joined BARC in 1996 after graduating from the 40th batch of Training School. Prior to this, she did her M.Sc in Physics from Devi Ahilya Vishwavidyalaya, Indore. She joined Physics Group of BARC in 1997 and obtained her PhD degree from Mumbai University in 2003. She has worked on various high end technologies in the last 30 years including development of toxic gas sensors and growth of single crystals for application in radiation detection. Currently, she is heading the Crystal Technology Section of TPD and is involved in the growth of single crystals, which include halide crystals like CsI, NaI, LaBr₃, BaF₂, LiI, CaF₂ and oxides like YAG and YAP and development of detectors for gamma-rays, charged particles and neutron and delivering them to various users in DAE. She is also actively involved in the indigenous technology development of HPGe detector at BARC. She was instrumental in transferring the technology for the growth of scintillator crystals to various industries and through incubation (three technology transfers and two technology incubations). Led by her efforts, for the first time in India, private firms started commercial production of CsI and YAG as well as crystal growth furnaces in India. Dr. Shashwati has published over 150 research papers in peer reviewed journals, mentored three PhD students and is a **fellow of Maharashtra Academy of Sciences** (2025). She is the recipient of many awards including the DAE Science and Technology Excellence Award (2017), DAE-Group achievement award for her work on SS-Ti diffusion bonding (2019), Single crystal growth (2012) and Gas sensors (2009) and DAE-Solid State Symposium Young Achievers Award (2008).



Dr. Soumyaditya Mula

Dr. Soumyaditya Mula, a Scientific Officer and Head, Functional Organic Material Section, joined Bio Science Group in 2003 after graduating from the 46th batch of the BARC Training School (discipline: Chemistry). He is an Associate Professor at HBNI and a registered PhD guide at the University of Mumbai. Dr. Mula is engaged in developing advanced organic materials for departmental and societal applications, including laser dyes, Boron Neutron Capture Therapeutic (BNCT) agents, gamma-dosimeters, and cancer theranostic agents. Notably, he developed large-scale syntheses for BODIPY and Rhodamine laser dyes and established an indigenous method for large-scale production of ¹B-enriched L-BPA, a vital BNCT agent. He also developed first-of-its-kind, highly sensitive fluorometric gamma-dosimeters for blood and food irradiation, alongside twisted BODIPY dyes serving as heavy-atom-free triplet photosensitizers for photodynamic therapy (PDT). He also innovatively designed fluorescent sensors for detection of bio-medically important analytes as well as for cellular imaging. His research portfolio includes 85 research articles and four book chapters. His work has been featured on the cover pages of prestigious journals like JACS Au, Chem. Commun., Chem. Eur. J. etc, and highlighted in ChemistryViews, Synfacts and ChemInform. Dr. Mula developed three technologies, two of which regarding BODIPY laser dye synthesis were successfully transferred to an Indian company. He is a Fellow of the Maharashtra Academy of Sciences (MASc), a Member of the National Academy of Sciences, India (NASI), and an Editorial Board Member for Scientific Reports (Nature). He also received **SMC Bronze Medal**, DAE Young Scientist Award, ANR Fellowship for postdoctoral research in France, Young Associateship Award of Maharashtra Academy of Sciences and Raman-Charpak Fellowship for doctoral research in France.



Dr. Srinivasu Kancharlapalli

Dr. Srinivasu Kancharlapalli, Scientific Officer, Chemistry Group, BARC has been awarded SMC bronze medal. He has been recognized for his research contributions in the field of computational chemistry and materials modeling, mainly focused on energy and environmental applications. He made important contributions in areas such as photocatalytic water splitting, hydrogen storage, computational catalysis, porous materials for separation and storage of gases, advanced nuclear materials, etc. He proposed an s-triazine based graphitic carbon nitride as a possible photocatalyst for solar water splitting which was experimentally verified later. Dr. Srinivasu explored varieties of metal decorated molecules and materials for efficient hydrogen adsorption. He also studied the electronic structure, surface oxidation and thermodynamic properties of nuclear fuel materials like U_3Si_2 , UAl_3 , U_2Mo , etc. Recently, he has been actively working on developing computational high-throughput screening strategies to screen large database of metal organic frameworks (MOFs) to identify the top performing MOFs for CO_2 capture, Xe/Kr separation and Iodine entrapment. He trained a machine learning model for fast and accurate calculation of atomic charges in MOFs which was deployed as a python library for open-source usage and is being used by many researches in the field. Considering the excellence of his contributions, he was awarded with 'Young Scientist Award' by DAE, India (2014), 'Outstanding PhD Theses Award' by HBNI (2015), Fulbright-Nehru postdoctoral Research Fellowship (2018-2020), Member of The National Academy of Sciences, India (NASI) (2020) and **Society for Materials Chemistry (SMC) - Bronze Medal** (2025).

<<< Dr. Sugam Kumar

Dr. Sugam Kumar is a Scientific Officer in Physics Group, BARC, and Associate Professor at Homi Bhabha National Institute (HBNI), Mumbai. He joined BARC in 2009 after completing the OCES (2008–09) program, where he secured first position in Physics and was awarded the prestigious Homi Bhabha Prize. He was University Medalist in both his undergraduate (B.Sc.) and postgraduate (M.Sc.) studies. He earned his Ph.D. from HBNI and received the Best Thesis Award of the Indian Physics Association. He subsequently carried out post-doctoral research at Stockholm University, Sweden. Dr. Kumar is an expert in neutron scattering methods, and his research focuses on elucidating the physical interactions and principles governing emergent properties and phenomena in multicomponent soft-matter systems using neutron scattering and complementary techniques. He has published more than 120 research articles in internationally reputed journals, contributing to understanding of structure–interaction–property correlations in complex soft materials. He has made significant contributions to the upgradation, operation, and nationwide utilization of the Small-Angle Neutron Scattering (SANS) instrument at Dhruva reactor. He also contributes to human-resource development through the supervision and mentoring of Ph.D scholars, master's students, and trainee scientific officer. His scientific contributions have been recognized through prestigious awards, including the Young Scientist Platinum Jubilee Award of the National Academy of Sciences, India (NASI), DAE Young Scientist Award, DAE–SSPS Young Achiever Award, and **Bronze Medal of the Society of Materials Chemistry**. He is a selected Associate of the Indian Academy of Sciences and Maharashtra Academy of Sciences, as well as member of NASI.



Dr. Swayam Kesari

Dr. Swayam Kesari is a Scientific Officer in Physics Group, BARC, and Assistant Professor, Homi Bhabha National Institute (HBNI) Mumbai. He joined BARC after graduating from the 57th batch of BARC Training School. He is also involved in teaching at BARC training school. Dr. Kesari has contributed significantly in developing state-of-the-art Raman spectroscopy laboratory of SSPD, BARC and has published about 45 research articles in various reputed journals. His field of research interests are structure & dynamics studies of quantum & energy materials under extreme conditions of pressure and temperatures. A notable scientific contribution of Dr. Kesari is the recent discovery of Giant Negative Linear Compressibility (NLC) in orthorhombic CuCN, which was published in Physical Review Letters in 2025. Dr. Kesari is a recipient of **Society of Materials Chemistry (SMC) Emerging Scientist Award 2025** and best oral presentation award at International Conference on Recent Advances in High Pressure Science and Technology in 2022.



BARC Fire Services Section

The Director General, Civil Defence and Fire Services, Ministry of Home Affairs, Govt. of India recognised the services of BARC Fire Services Section personnel and honored the organisation with a key recognition. BARC secured the 'Director General (DG) DISC', which importantly recognised the exceptional services rendered by Mr. B.C. Sahoo (Divisional Chief Operator), Mr. S. B. Rahate (Leading Fireman) and Mr. D. B. Wagmare (Fireman) towards strengthening the fire and emergency response capabilities.



 **भाभा परमाणु अनुसंधान केंद्र**



भा.प.अ. केंद्र के विविध प्रकाशनों में प्रतिबिंबित होती राजभाषा

भा.प.अ. केंद्र द्वारा सामाजिक सरोकार से जुड़ी हिंदी वैज्ञानिक पत्रिका 'परमाणु विज्ञान' के प्रथम एवं द्वितीय अंकों का प्रकाशन कर देश के शैक्षणिक संस्थानों, शोधार्थियों और केंद्र सरकार के कार्यालयों आदि में निःशुल्क वितरित किया गया। इसके अतिरिक्त, 'भा.प.अ. केंद्र राजभाषा समन्वय समिति' द्वारा विविध अवसरों पर बैठकें आयोजित कर कार्यक्रमों की रूप-रेखा पर चर्चा कर अंतिम रूप दिया गया। कार्यान्वयन को नई ऊँचाइयों तक पहुँचाने के उद्देश्य से, भा.प.अ. केंद्र, मुंबई के विविध प्रकाशनों में राजभाषा को प्रमुख रूप से जगह दी गई। वैज्ञानिक अधिकारियों द्वारा विविध पत्र-पत्रिकाओं में शोध-पत्रों के सारांश विशेषकर हिंदी में प्रकाशित किए गए। भाभा परमाणु अनुसंधान (भा.प.अ.) केंद्र, मुंबई में राजभाषा के प्रभावी कार्यान्वयन के अंतर्गत निदेशक महोदय के नेतृत्व में गठित राजभाषा कार्यान्वयन समिति (ओलिक) की बैठकें नियमित आयोजित कर कार्यान्वयन के संबंध में लिए गए निर्णयों का सफल अनुपालन किया गया। राजभाषा विभाग द्वारा निर्धारित लक्ष्यों को सफलतापूर्वक प्राप्त किया गया। इस प्रकार, केंद्र में राजभाषा को पुष्पित एवं पल्लवित करने हेतु गठित विभिन्न समितियां सक्रिय रूप से सम्मिलित योगदान दे रही हैं।

अटॉलिस

165 पदाधिकारी वित्तीय प्रोत्साहन प्रदत्त

हिंदी कार्यशालाओं में प्रशिक्षित

168 पदाधिकारी



आंतरिक निरीक्षण से प्रभावी कार्यान्वयन तक प्रगति के पथ पर अग्रसर राजभाषा

हिंदी माह, 2026

कुल 11 प्रतियोगिताएँ

945 प्रतिभागिता

राजभाषा

आंतरिक

निरीक्षण

67 अनुभाग

राजभाषा को बढ़ावा देने के संघ सरकार के उद्देश्यों की पूर्ति हेतु, भाभा परमाणु अनुसंधान (भा.प.अ.) केंद्र, मुंबई में अंतरराष्ट्रीय महत्व के कार्यक्रम 'विश्व हिंदी दिवस, 2026' का आयोजन किया गया। भा.प.अ. केंद्र के पदाधिकारियों के बीच राजभाषा की लोकप्रियता बढ़ाने एवं हिंदी में कार्य करने हेतु उत्साहपूर्ण वातावरण सृजित करने के लिए, राजभाषा का महापर्व हिंदी माह, 2026 मनाया गया। इसके अंतर्गत संचालित आकर्षक एवं ज्ञानवर्धक प्रतियोगिताओं में प्रतियोगियों ने सक्रिय रूप से प्रतिभागिता दर्ज कर, केंद्र में राजभाषा के पुष्पित एवं पल्लवित होने का प्रमाण दिया। संघ सरकार की राजभाषा नीति के व्यापक प्रचार-प्रसार के तहत कर्मचारियों में हिंदी पुस्तकों के पठन की अभिरुचि जगाने और लेखन क्षमता को उभारने के लिए, एस.आई.आर.डी., भा.प.अ. केंद्र द्वारा हिंदी पुस्तकों की विशेष प्रदर्शनियां भी आयोजित की गईं। राजभाषा कार्यान्वयन को सुदृढ़ करने हेतु प्रशासन, लेखा, सुरक्षा आदि अनुभागों का प्रत्यक्ष निरीक्षण, समीक्षा बैठकें और तत्संबंधी रिपोर्टें संबंधित अनुभागों को भेजी गईं।



भाषाई (हिंदी) शिक्षण-प्रशिक्षण से दक्षता की ओर...

भा.प.अ. केंद्र, मुंबई में कार्यरत वैज्ञानिक अधिकारियों हेतु @प्रत्येक तिमाही एक हिंदी कार्यशाला का आयोजन किया गया। इसका प्रमुख उद्देश्य हिंदी में कार्य करने में आ रही कठिनाइयों को दूर करना, संघ सरकार की राजभाषा नीति से परिचित कराना और हिंदी में कार्य हेतु प्रेरित एवं प्रोत्साहित करना रहा। नवीन संसदीय राजभाषा निरीक्षण प्रश्नावली के अनुरूप, तिमाही प्रगति रिपोर्ट प्रोफॉर्मा से संबंधित जानकारी साझा करने हेतु विशेष परिचर्चा कार्यक्रम आयोजित किए गए। हिंदी भाषा में अप्रशिक्षित पदाधिकारियों को विविध सत्रों में उनकी पालतानुसार हिंदी भाषा (प्रबोध, प्रवीण, प्राज्ञ एवं पारंगत) और हिंदी टंकण का प्रशिक्षण प्रदान किया गया। हिंदी में मूल रूप से कार्य करने वाले पदाधिकारियों को परमाणु ऊर्जा राजभाषा प्रोत्साहन योजना (अटॉलिस) के अंतर्गत पुरस्कृत किया गया। नराकास, नवी मुंबई और नराकास, ठाणे द्वारा आयोजित प्रतियोगिताओं में केंद्र के पदाधिकारियों नामतः डॉ. कुलवंत सिंह, वै.अ.-एच, एम.एस.डी, श्री जितेश धमीजा, वै.अ.-ई, सी.एस.डी. और श्री हार्दिक वर्मा, प्र.श्रे.लि., भर्ती अनुभाग-I को पुरस्कृत एवं सम्मानित किया गया।

भाषा प्रशिक्षण

43 प्रशिक्षित और
09 प्रशिक्षणरत

टंकण प्रशिक्षण

23 प्रशिक्षित और
25 प्रशिक्षणरत

General N.S. Raja Subramani, India's Chief of Defence Staff, visited BARC and graced the Passing Out Ceremony (Annual Graduation Function) of the successful graduates of the 69th Batch of the BARC Training School. In his address on the occasion, he shared valuable, life-transforming lessons with the young scientific officers, emphasising the importance of integrity, discipline, adapting to changing times, leadership, teamwork, time management, and national self-reliance. As part of his visit, General Raja Subramani also returned to his alma mater, Atomic Energy Central School-2 (AECS-2), Anushakti Nagar, after five decades. He studied at the school up to Class VI before continuing his education at Narora, where his father was posted at the Narora Atomic Power Station.



हमारे प्रतिष्ठित आगंतुक

Prof. Rana Adhikari, Professor of Physics at the Caltech, USA, delivered a talk titled "LIGO-India: The First AI Controlled, Quantum Enhanced Gravitational Wave Detector" at the Trombay Colloquium. The talk highlighted India's significant role in advancing gravitational-wave astronomy through its integration into the global Laser Interferometer Gravitational-Wave Observatory (LIGO) network. With two detectors in the United States and one each in Italy, Japan and India, the expanded network is expected to improve the detection and localization of gravitational-wave events. LIGO-India Phase I is slated for completion in 2033. Prof. Adhikari also outlined major technological and scientific challenges associated with the project.



India's solar energy journey marks a significant milestone in 2026, celebrating five decades of progress and innovation. Speaking at the Trombay Colloquium, Professor Juser Vasi, Professor Emeritus, IIT Bombay, highlighted the country's bright solar future and the challenges ahead in his talk entitled 50 Years of Solar in India: Achievements and Challenges. India is poised to become the world's second or third largest deployer of solar energy capacity over the next decade, he said. The country is also on track to achieve its COP26 target of sourcing 50% of its installed electricity capacity from non-fossil fuel sources by 2030. However, large-scale solar deployment faces key challenges, including land availability, acquisition, and infrastructure development.





Professor Mark Thomson, Director General of the European Organization for Nuclear Research (CERN), visited BARC on August 31, 2026, to deliver a talk titled "Particle Physics - Today & Tomorrow" at the popular Trombay Colloquium. His second visit to BARC, and the first since assuming office as CERN's Director General, benefited the BARC community. He highlighted key questions driving future research, including the nature of dark matter, matter-antimatter asymmetry, the Higgs boson's properties, and the weakness of gravity. He also outlined the proposed 91-km Future Circular Collider (FCC), with an estimated cost of 15 billion Swiss francs and targeted operations in 2045–48. Highlighting CERN's recent achievements, he noted that 2025 was a record-breaking year for the LHC.

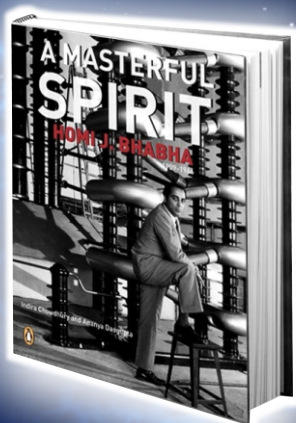
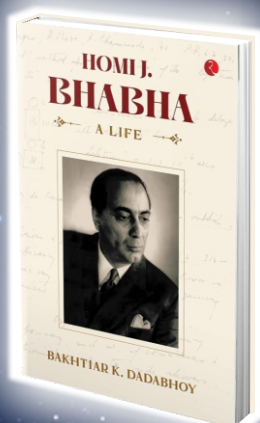
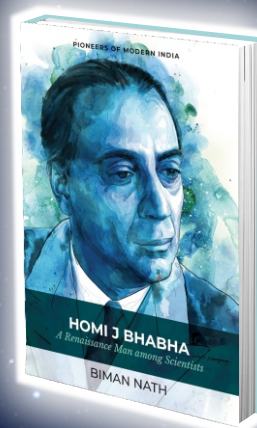
Our Esteemed Visitors

Dr. Sudeep Gupta, Director of TMC, graced the inaugural programme of National Science Day 2026 at the Bhabha Atomic Research Centre (BARC) as the Chief Guest, underscoring the vital role of scientific innovation in advancing cancer care. Addressing students, Dr. Gupta presented an overview of cancer in India, spanning diagnosis and treatment, and highlighted the transformative potential of radiopharmaceutical innovations in tackling the disease. Emphasising the real-world impact of scientific research, he noted that science is solving pressing human challenges. He also stressed the importance of training and empowering healthcare professionals to meet society's evolving needs, describing this as an essential component of multidimensional and multisectoral security.



Prof. Dr. Ravindra Dattatray Kulkarni, Vice-Chancellor of the University of Mumbai, served as the chief guest for the National Technology Day (NTD) inaugural day programme held at Bhabha Atomic Research Centre in May 2026. Addressing the gathering, Dr. Kulkarni said science and technology are the key pillars for advancement of modern-day life and added that students should imbibe the spirit of greater scientific inquiry as India makes considerable strides in realising the long term goal of becoming 'Aatmanirbhar Bharat'.

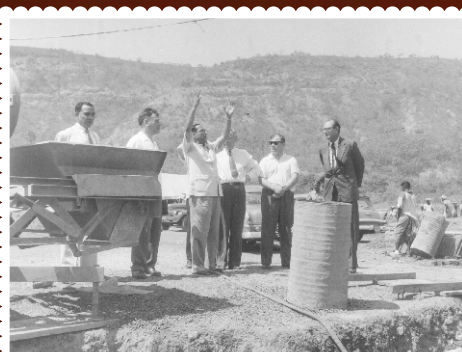
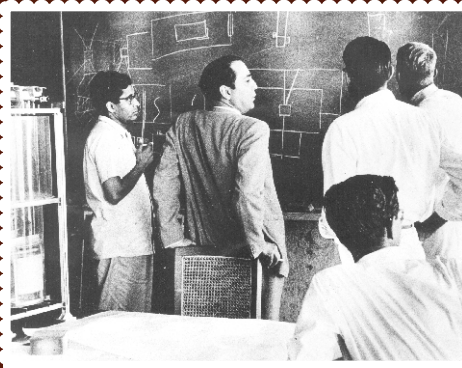


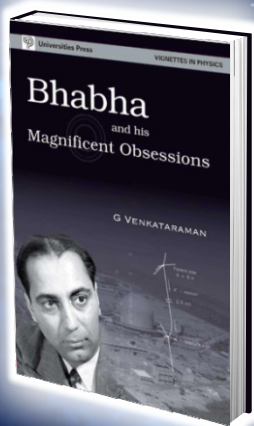
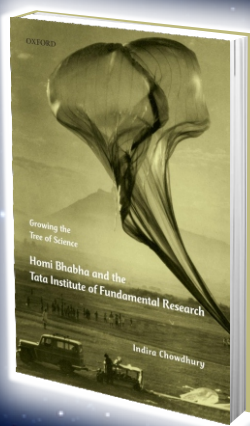
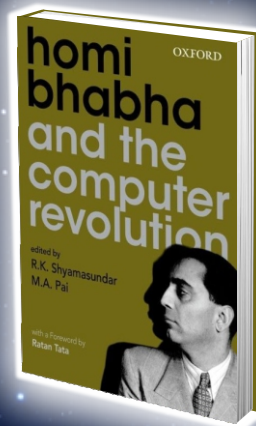


Through letters, photographs, paintings and personal recollections, *A Masterful Spirit* reveals Dr. Homi Bhabha in all his facets. Architect of India's nuclear programme and builder of pioneering scientific institutions, Bhabha emerges as a Renaissance visionary whose brilliance spanned science, art and aesthetics, leaving an enduring imprint on modern India.

Bakhtiar K. Dadabhoy's meticulously researched biography captures Homi J. Bhabha as physicist, institution-builder and architect of India's atomic energy programme. Beyond his scientific brilliance, it reveals a Renaissance personality drawn to music and painting, while tracing the formative years of TIFR and the emergence of modern Indian science through his extraordinary vision and leadership.

This evocative monograph portrays Homi J. Bhabha as scientist, institution-builder and visionary architect of India's nuclear programme. Tracing his pioneering research, diplomatic stature and quest for scientific self-reliance, it also reveals his passions for art, architecture and classical music, illuminating the remarkable Renaissance spirit behind modern India's scientific enterprise.

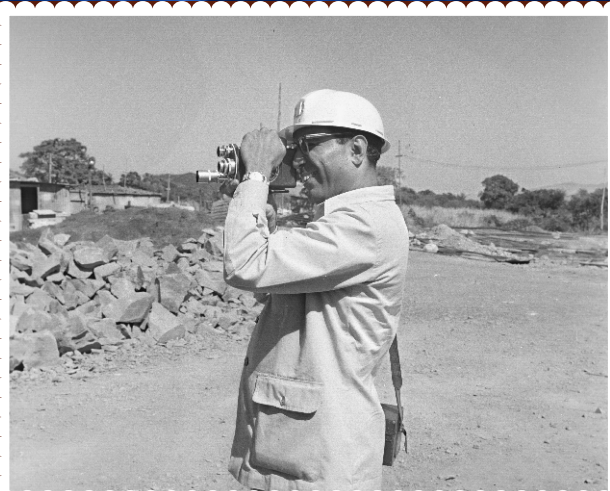
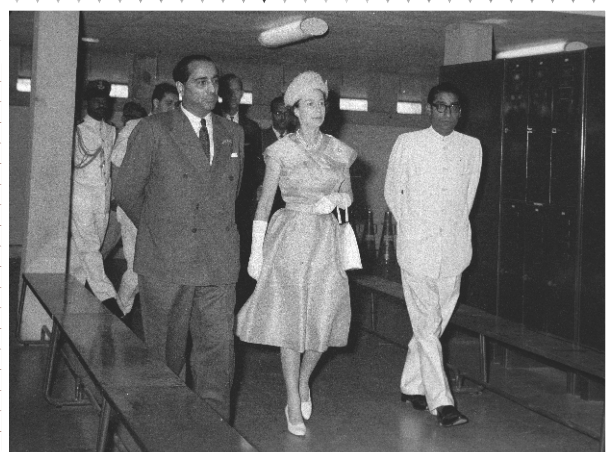




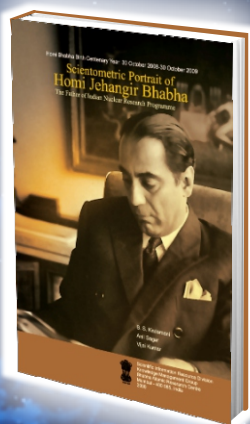
Bhabha and His Magnificent Obsessions explores the scientific genius and many-sided legacy of Homi J. Bhabha. Blending the intricacies of physics with the story of a visionary who shaped India's scientific destiny, G. Venkataraman portrays a remarkable mind whose intellectual pursuits, institution-building and determination helped lay the foundations of modern Indian science.

Growing the Tree of Science chronicles the making of TIFR, founded by Dr. Homi J. Bhabha in 1945 as a pioneering home for scientific inquiry in independent India. Drawing on archival records and personal recollections, Indira Chowdhury illuminates the people, patronage, ideas and cultural vision that nurtured a distinctive institution and helped shape India's scientific future.

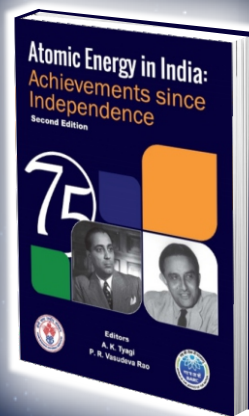
A tribute to Dr. Homi J. Bhabha's pioneering vision, this volume traces the journey from TIFRAC, India's first indigenous digital computer, to the nation's emergence as a global force in IT and telecommunications. Bringing together leading scientists, technologists and industry visionaries, it illuminates how scientific ambition, institutional foresight and indigenous innovation helped lay the foundations of India's digital transformation.



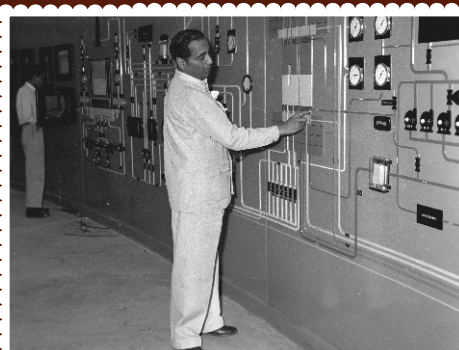
युगद्रष्टा
डॉ. होमी
जे. भाभा
का जीवन
एवं काल-खंड

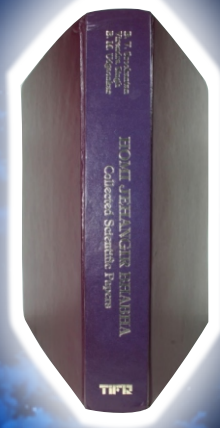


The book - *Scientometric Portrait of Homi J. Bhabha: The Father of Indian Nuclear Research Programme* – published by SIRD, BARC presents a quantitative analysis of Homi Bhabha's scientific contributions. It examines his publications, citations, research areas, collaborators, highly cited papers, and influence on scientific research worldwide.



Atomic Energy in India: Achievements Since Independence by A. K. Tyagi and P. R. Vasudeva Rao documents India's progress in nuclear science and technology after independence. The book includes a chapter on Dr. Homi J. Bhabha's life and contributions, alongside discussions of other prominent scientists, institutional developments, and achievements in India's atomic energy programme.

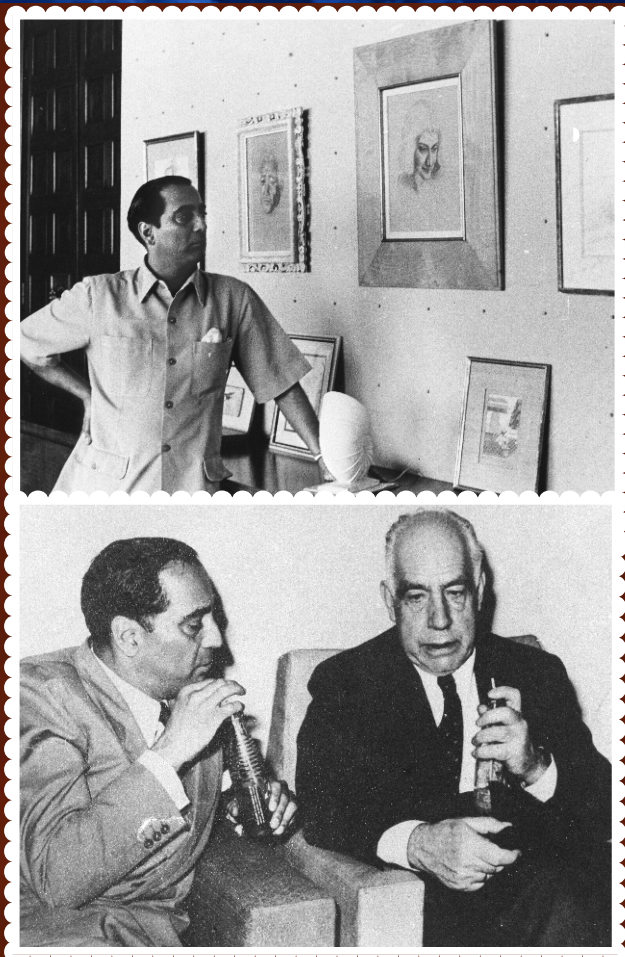




This volume compiles the major scientific papers of Homi J. Bhabha, a pioneering Indian physicist. It highlights his contributions to cosmic ray physics, quantum theory, and elementary particle physics. Introductory essays by the editors examine his scientific achievements, research legacy, and influence on the development of modern physics and Indian science.



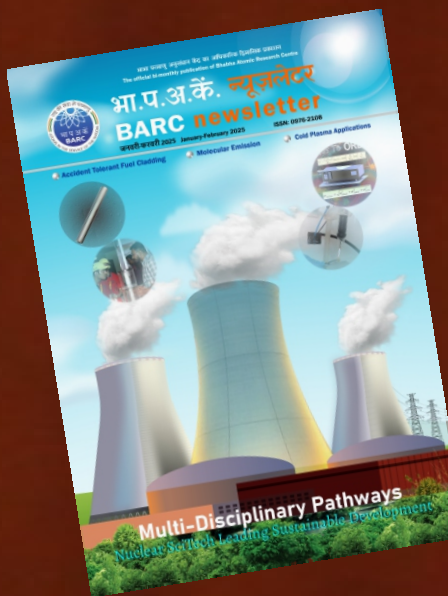
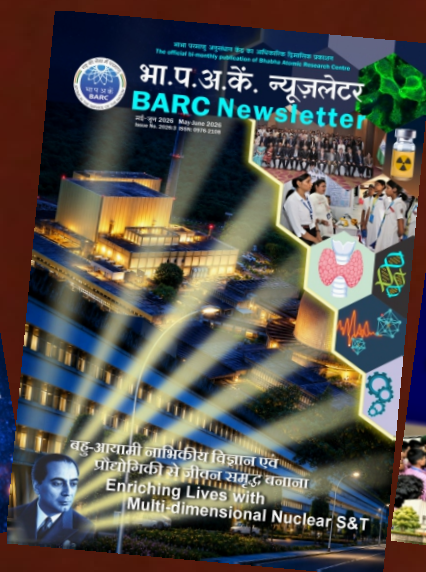
Homi Bhabha As Artist: A Selection of His Paintings, Drawings and Sketches presents the artistic side of Homi Jehangir Bhabha, renowned Indian nuclear physicist. The book showcases his paintings, drawings, and sketches, highlighting his creativity, aesthetic sensibility, and appreciation of visual arts beyond his scientific achievements and contributions to modern India.



The Life & Times of Visionary Dr. Homi J. Bhabha

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