HBSTM Awards

for excellence in nuclear science and technology

Mr. Alok Prakash

Developmental work in

Design & Development of Compact Nuclear Steam Generators

Mr. Alok Prakash, a Mechanical Engineer, graduated from the OCES 55th Batch of BARC Training School; and a recipient of Homi Bhabha Award. He joined Reactor Projects Group in 2012 as a Scientific Officer. He has been involved in design, development and fabrication of compact steam generators (SGs) for RPG projects.

The Homi Bhabha Science & Technology Maanpatra - 2024 was conferred on him for his contributions towards **Design & Development of Compact Nuclear Steam Generators.**

Shri Prakash designed and developed a first-of-its-kind 50 MW compact once-through type steam generator having novel features such as pluggability of individual leaky tubes and replaceable tube bundles. His ingenious design integrated multiple tube bundles within the same shell housing to facilitate emergency heat removal by natural circulation in addition to the normal transfer duty. His design, utilising indigenously developed titanium material, was completely amenable to manufacturing ease and stringent quality control requirements. He accomplished the challenging task of developing the process for end bends formation of the tube bundle using a custom-built CNC machine and qualification of the tube-to-tube sheet joints using micro-focal radiography technique meeting tight dimensional tolerances. He designed and realised a test facility, where the testing was performed on a scaled-down model of the equipment and validated the design from the point of view of flow induced vibrations. He also developed multiple scaled-down models to experimentally study overall equipment performance and flow instabilities associated with boiling flows in parallel channels. He effectively utilised his overall expertise to develop this novel steam generator with several innovative and advanced design features.

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Advancements in Radiation & Cancer Biology and Drug Delivery Systems

Dr. Amit Kunwar

Dr. Amit Kunwar, Scientific Officer, Chemistry Group, was conferred with the prestigious 'Homi Bhabha Science & Technology Maanpatra (HBSTM)' by DAE for his outstanding contribution in the field of **"Radiation & Cancer Biology and Drug Delivery System"**.

Dr. Amit Kunwar joined BARC in 2005 through 48th batch of Training School (Bioscience) after completing his MSc (Biotechnology) from TNAU Coimbatore. He received his PhD (Chemical sciences) from HBNI and subsequently carried out postdoctoral research at Meakins Christie Laboratories, McGill University, Canada under prestigious "Richard and Edith Strauss Fellowship". His research interest includes understanding the redox biology of synthetic organoselenium compounds with an intent to explore such compounds as therapeutic agents against cancer. Additionally, he implies his multidisciplinary research experience to design protein-based drug delivery systems to improve the safety and specificity of existing chemotherapeutic drugs.

Briefly, there is a dire need for easily administrable oral radioprotectors and/or chemotherapeutics for use in clinics to prevent the radiotherapy/chemotherapy side effects and to improve the quality of life of cancer patients. His decade long research has led to the identification of DSePA as a very potent agent for management of radiation pneumonitis and lung cancer. The preclinical studies have been completed and currently, clinical studies (Phase I) of DSePA as a radiotherapy adjuvant drug is under progress at ACTREC/TMC.

The fundamental studies by Dr. Kunwar on the anti-cancer mechanisms of DSePA and other related organodiselenides have established that such compounds follow a novel mechanism of reductive stress. Till date, only a few research groups have reported the importance of reductive stress as one of the mechanisms of anticancer drugs. The findings of Dr. Kunwar research work has resulted in 2 USA patents and has also opened a new area of understanding the anticancer effect of organoselenium compounds. Recently, Dr. Kunwar's group in BARC also demonstrated the utility of deuterated DSePA as a considerably safer derivative for therapeutic application.

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Dr. Kunwar has also contributed significantly to the antioxidant and anticancer research of "Curcumin" an active ingredient from turmeric. His group has designed albumin and gelatin based novel delivery systems for improving the cellular uptake of curcumin. The knowledge gained from these investigations has facilitated development of different nutraceutical formulation/technologies for general health benefits, translating into TWO technology transfers to the industry.

Dr. Kunwar is a recognized faculty of Homi Bhabha National Institute, has guided three PhD students, published 135 research articles (peer reviewed journals), 7 book chapters and 9 articles in BARC Newsletter, delivered 35 invited lectures and authored nearly 70 papers in national and international conferences.

He is also the recipient of several prestigious awards such as "Young Scientist Award" from Indian Academy of Biomedical Sciences (IABS), "DAE Group Achievement Award", "DAE Young Scientist Award", "HBNI Outstanding PhD Thesis Award" and "Young Scientist Award" from OCC, USA. Dr. Kunwar is the elected "Fellow of Maharashtra Academy Sciences", elected member of IABS, visiting faculty member to UM-DAE, CEBS & ACTREC/TMC.

Advancements in Establishing Core Regulators of Abiotic Stress Tolerance in Crops

Dr. Ashish Kumar Srivastava

Dr. Ashish Kumar Srivastava, Bio Science Group, is a recipient of Homi Bhabha Science and Technology Maanpatra Award. His research has established redox-state homeostasis, as one of the **core regulators of abiotic stress tolerance in crops**. He has successfully converted his research findings into innovative field-applicable technologies.

Notably, supplementation of thiourea (a non-physiological thiol) reduced arsenic accumulation within rice grains in naturally arsenic-contaminated fields of Nadia district, West-Bengal, India. Thiourea decreased arsenic accumulation by suppressing the expression of various arsenic transporters, which in turn improved the root-system architecture. Furthermore, the stress-ameliorating potential of thiourea was demonstrated in diverse crops such as mustard, rice, and soybean. Thiourea application was demonstrated to enhance seed yield by 14.92% at the national-level. Presently, the use of thiourea, has been recommended by All India Coordinated Research Project (AICRP) as a package-of-practice, for soybean cultivation in India.

He has developed another crop yield-enhancing technology "Anu-Chaitanya", that employs gamma-irradiated chitosan. As, chitosan is a major waste product from sea-food industry, this application has contributed immensely to "wealth-from-waste" and "peaceful application of radiation" programs.

Using radiation-induced mutagenesis approach, a salt-tolerant sugarcane mutant "M4209" with significantly higher yield under saline field conditions was developed. Active transcriptional reprogramming of genes coupled with enhanced photosynthetic efficiency was responsible for the salt-tolerance in M4209. Recently, the mechanistic basis of halophytic adaptation was delineated in Sesuvium portulacastrum (L.), which grows naturally under high-saline environments. An open-access database named "SesuviumKB" (https://cb.imsc.res.in/sesuviumkb)has been established to facilitate wide-scale gene function studies in S. portulacastrum. Dr. Srivastava has also elucidated the critical role played by volatile and non-volatile metabolites in orchestrating the herbicidal and plant-growth promotion activities of Trichoderma virens.

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Dr. Srivastava has more than 90 research and review articles and book chapters to his credit. He has been awarded with Fulbright-Nehru Professional and Excellence Fellowship in 2024; Young Scientist Award by National Academy of Sciences, India (NASI), Allahabad in 2018; Young Scientist Medal from Indian National Science Academy (INSA) in 2014 and Young Scientist Award from Department of Atomic Energy (DAE) in 2014. He has also received the Newton-Bhabha International Grant from DBT-BBSRC in 2018, President International Fellowship from Chinese Academy of Sciences, China in 2016 and EMBO Short-Term Fellowship in 2011. He has edited three books for reputed publishers (Wiley, Springer and CRC Press).

Dr. Gattu Suneel

Developmental work in Nuclear Waste Management

Dr. Gattu Suneel, Nuclear Recycle Board, is a recipient of Homi Bhabha Science & Technology Maanpatra Award - 2024. Dr. Suneel made notable **contributions to the management of radioactive waste** from nuclear power reactors and in the indigenous development of vitrification technology and its implementation on industrial scale for the fixation of High-Level Radioactive Liquid Waste (HLW).

He developed a multi-physics-based finite element model for its analysis by coupling the system's thermos-physical properties with electrical, heat transfer, fluid flow, and reaction kinetics phenomena. The model was validated with experimental data and used for troubleshooting plant-scale operations besides being deployed as a reliable, predictive, and diagnostic tool. He played a key role in the deployment of the Cold Crucible Induction Melter (CCIM), a next-generation vitrification technology, on an industrial scale.

Dr. Suneel also developed process flow sheets for selective removal of radioactive constituents from nuclear waste streams. He was instrumental in synthesis of novel ion-exchange resins and associated processes for selective removal of specific radionuclides from HLW.

Dr. Suneel has significantly contributed for reducing the volume as well as radiotoxicity of waste forms requiring long-term storage and surveillance.

These flow sheets enable recovery of fission products and minor actinides, thereby reducing the radiotoxicity of HLW.

He has also commissioned the Uranium Oxide Facility (UOF) and Vitrified Waste Storage Facility (VWSF). Under his supervision, the Fluidized Bed Thermal Denitration Plant was successfully commissioned, for management of Ammonical effluents. Furthermore, he oversaw the construction, commissioning, and operation of the facilities for the storage of heavy metals and solid wastes disposal.

Through his extensive work in nuclear waste management, Dr. Gattu Suneel has significantly contributed for reducing the volume as well as radiotoxicity of waste forms requiring long-term storage and surveillance.

Dr. Mohit Tyagi

Advancements in Growth & Characterization of Single Crystals for Nuclear Radiation Detection

Dr. Mohit Tyagi, Scientific Officer, Physics Group, made significant contributions towards the development of advanced scintillating materials, aligning with department's mandate towards an 'Aatmanirbhar Bharat' (self-reliant India). His work on **growth and characterization of single crystals for nuclear radiation detection** applications has garnered national and international recognition. His systematic and comprehensive investigations into unresolved issues in scintillating crystals have been acknowledged by leading research groups worldwide. His integrated approach, combining experimental and theoretical studies, led to many novel discoveries in scintillators, some of which are reported first time and have been adopted by other researchers.

In India, he has pioneered development of advanced single crystal scintillators and devices. Through a deep understanding of various scintillating materials, he has developed high-performance devices in close collaboration with various end-users. These devices are now deployed across various departmental units. His work includes creation of compact and portable detectors for charged particles, gamma rays, neutrons, X-rays, and electrons. The single crystals of Ce doped Gd3Ga3Al2O12 (GGAG), grown at about 1900oC has shown the most versatile single crystal scintillator, reported so far. Its performance has been evaluated, in details, to detect various radiations like X-rays for beam profile monitor at RRCAT and flash X-rays at APPD, gamma at higher count rate at IRAD, alpha and beta discrimination at NRG, and thermal neutrons at FF and NISER etc.

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A novel phoswich detector consisting of two single crystals, GGAG:Ce,B and CsI:Tl was also developed with excellent performance characteristics and a US patent was also granted to the DAE for this innovation. This detector has been also shown to detect and discriminate various radiations like alpha-beta, low energy gamma in presence of high energy gamma, thermal neutron-gamma etc. in mixed radiation fields with the highest figure of merit reported so far. Dr. Mohit Tyagi has also played an active role in the incubation of a portable radiation detector based on single crystal scintillator, which is one of the first completed incubation under Atal Incubation Centre of BARC. His current research is to develop novel radiation detection devices as per the end users' requirements for the departmental program.

Advancements in Nuclear Level Density and Nuclear Reaction Mechanisms

Dr. P. C. Rout

Dr. P. C. Rout, Scientific Officer, joined Physics Group after graduating from the 46th batch of OCES (Physics) of the BARC Training School and earned his Ph.D. in Nuclear Physics from HBNI, Mumbai. He was awarded the Best Graduate Student Award and University Gold Medals in both B.Sc. and M.Sc. for securing first rank before joining the department. For his notable contributions to STEM, he has received several prestigious recognitions, including the INSA Medal for Young Scientists (2014) by the Indian National Science Academy, New Delhi; the Young Physicist Colloquium Award (2014) by the Indian Physical Society, Kolkata; the DAE-Young Scientist Award (2014); and the DAE-Science and Technology Excellence Award (2019) by the Department of Atomic Energy. He has completed a five-year tenure as a selected Member of the Indian National Young Academy of Sciences (INYAS), New Delhi, and was selected as a Member of NASI in 2024.

Dr. Prakash Chandra Rout is an accomplished experimental nuclear physicist, recognized for **his extensive work on nuclear level density and nuclear reaction mechanisms** using the BARC-TIFR Pelletron and Linac facilities. He has also made significant contributions to the development of radiation detector systems for experimental nuclear physics.

Dr. Rout has investigated the collective enhancement of nuclear level density and its fade-out with excitation energy in deformed nuclei (^{161}Dy and ^{171}Yb) through exclusive measurements of neutron evaporation spectra using arrays of liquid scintillation detectors and Si-strip detectors. The significantly large collective enhancement inferred for the first time highlighted its importance in predicting radiative neutron capture cross sections of astrophysical interest. He was responsible for developing ancillary detectors, such as the CsI(Tl) detector array for light charged particle measurements by pulse-shape discrimination, and augmenting the BGO detector array for the study of radiative capture reactions. His research also extends to alpha-clustered nuclei, unraveling reaction mechanisms with weakly bound stable nuclei, understanding fusion–fission dynamics in both actinide and sub-lead regions, neutron multiplicity measurements to probe fission dynamics, and generating high-precision nuclear data relevant to both fundamental research and nuclear energy. Additionally, he has contributed to the indigenous development and characterization of deuterated liquid scintillation detectors for neutron and neutrino measurements in nuclear and high-energy experiments.

Dr. Rout's contributions encompass indigenous development and characterization of deuterated liquid scintillation detectors for neutron and neutrino measurements in nuclear and high-energy experiments.

Dr. V. Nafees Ahmed

Developmental work in Iodine-Sulfur Thermochemical Process for Production of Hydrogen

Dr. V. Nafees Ahmed, Scientific Officer, Chemical Technology Group was conferred with the Homi Bhabha Science & Technology Maanpatra, for his outstanding contribution towards the "**development of Iodine-Sulfur (I-S) thermochemical process for the production of hydrogen by splitting water**". He was instrumental in obtaining kinetic rate parameters for non-ideal, hazardous gas-liquid Bunsen reaction system. He has led the team to carry out all reactions & concentration steps of I-S process together to achieve closed loop operation to produce hydrogen at 150 Nlph with water & heat as input. According to the documented information available in the scholarly literature, India is the first country to carry out hydrogen production at this scale in a closed loop in industrial materials with all engineering features. His role in demonstration of closed loop I-S process has been remarkable.

The scaled up version (3Nm^3/hr) of the I-S process developed at BARC is being setup in collaboration with Heavy Water Board. He was involved in design of scaled up process plant with electrical heat. In this, he has actively contributed in development of process flow sheet, P&ID, process equipment design, technical specifications preparation, system & plant layout, along with detailed safety analysis and documentation.

The modified I-S process is envisaged to co-generate hydrogen & sulphuric acid in industries such as sulfuric acid, Zinc & Copper. He was involved in working out feasibility of this concept. Through Atal Incubation route, an MoU was inked with a domestic vendor for design & deployment of scaled up hydrogen plant using this process. In this, he was involved in finalization of process flow diagram, P&ID, heat recuperation studies & process equipment design. He was involved in design of a novel Bunsen reactor using lean and very lean SO_2 from the sulphur burner.

Dr. Ahmed spearheaded the team to carry out all reactions & concentration steps of Iodine-Sulphur process together to achieve closed loop operation to produce hydrogen at 150 Nlph with water & heat as input.

In refineries, sufficient amount of hydrogen sulphide (H_2S) is generated which is converted to sulfur, water & heat through Claus Process. Instead, when H_2 is extracted from H_2S & re-used in refinery, lot of methane combustion which is used for process heating is reduced, resulting in drastic reduction of CO_2 emissions. He has studied the reaction to extract H_2 from H_2S. The reaction of iodine & concentrated H_2S has been studied in detail along with development of novel reactor to produce hydroiodic acid & sulphur both in aqueous and organic phases. He was involved in development of a process for purification of sulphur from the I-H_2S reactor. He has developed process flow diagram to demonstrate I-H_2S process in closed cycle. He was involved in obtaining reaction kinetic parameters of iodine-H_2S reaction.

Developmental work in Fabrication of Advanced Nuclear Fuels for Research Reactor Applications

Dr. V.P. Sinha

Dr. Ved Prakash Sinha has joined Nuclear Fuels Group of BARC in the year 2002, through 45th batch of OCES programme in BARC Training School. Since then he has been actively engaged and participated in **various advanced fuel development programmes** for important departmental applications. Amongst them, one of the major accomplishment, where a team under his able leadership has overcome the challenges related to fabrication of fuel for Apsara-U reactor and have successfully implemented innovative upgrades to the process parameters for superior performance *(Apsara-U fuel has achieved average assembly & average plate burnup of 54,635 and 62,556 MWD/t respectively)* and enhanced acceptance rate was. He has also played a central and pivotal role in indigenous development & qualification of fuel fabrication process flow sheet for Apsara-U reactor including an innovative P/M (Powder Metallurgy) route for the synthesis of U3Si2 compound. Dr. Sinha has made valuable and indispensable contributions to ensure uninterrupted operation of dedicated radiological facilities engaged in the accomplishment of mandates related to very important departmental programmes, in compliance with stringent safety requirements and has ensured processing of record quantities of fissile material for nuclear fuel fabrication.

He has played a key role in setting-up and establishment of a state-of-the-art dedicated Special Plate Facility (SPF) for industrial scale manufacture of LEU (Low Enriched Uranium) based target elements for the Fission Moly programme. He has successfully developed, qualified and validated a complex process for indigenous manufacturing of LEU based target elements conforming to international quality standards. The process has been implemented at SPF for regular production of fission Mo targets facilitating domestic supply of the vital medical isotope, reducing our dependence on imports and positioning our country among a handful of nations possessing this capability. His sustained and committed efforts have allowed complete indigenization of sophisticated closely guarded technical capabilities in this field. Dr. Sinha is also playing a lead role in the ongoing departmental efforts for the development and qualification of advanced fuel options including ceramic, dispersion and metallic fuels, for upcoming research and test reactors being planned for future applications.

Dr. Sinha has made valuable and indispensable contributions to ensure uninterrupted delivery of fuel for Apsara-U and Fission Moly programme and is also playing a lead role in the ongoing departmental efforts for the development and qualification of advanced fuel for upcoming departmental programmes of research and test reactor.

Mr. S. K. Vadali

Developmental work in Nuclear Fuel Fabrication

Mr. S.K. Vadali, Scientific Officer, Nuclear Fuels Group has made significant contributions in the field of **nuclear fuel fabrication**. He specializes in the field of fabrication of dispersion fuels for use in research as well as other types of nuclear reactors. He has "developed and optimised several metallurgical and mechanical processes used in the fabrication of dispersion fuels". He was instrumental in setting up of new process lines for fabrication of dispersion fuel at Integrated Fuel Fabrication Facility, Nuclear Fuels Group, BARC.

Mr. Vadali was instrumental in setting up of new process lines for fabrication of dispersion fuel at a key integrated facility in BARC.