

VECC NEWSLETTER

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ACCELERATOR

OPERATIONAL ACTIVITIES OF K130 ROOM TEMPERATURE CYCLOTRON

The K130 variable energy cyclotron has been running in continuous round-the-clock shifts. It has been providing stable accelerated beams of light ions such as protons, alpha particles and deuterons, along with heavy ion beams. These beams are utilized for experiments in nuclear physics, radiation damage studies, material science, isotope production and other research programs throughout the year. From July to December 2025, proton and alpha beams were widely utilized by the user community. Along with regular operation, several maintenance and system upgradation activities were completed to enhance the overall performance of the cyclotron. For example, the PIG ion source gate valve and Wilson seal were replaced and thorough MSLD was carried out to improve the RT tank pressure level. In addition, new fire alarm detectors were installed in the RTC control room, vault and PIT area to replace the old fire alarm system and ensure better fire safety. User’s target and beam dump area in beam transport line of channel-3 is modified and alignment has been done. During this period, low-level RF tests, comprising open-loop and closed-loop performance of the digital Dee voltage regulator near full operating Dee voltages, were carried out.

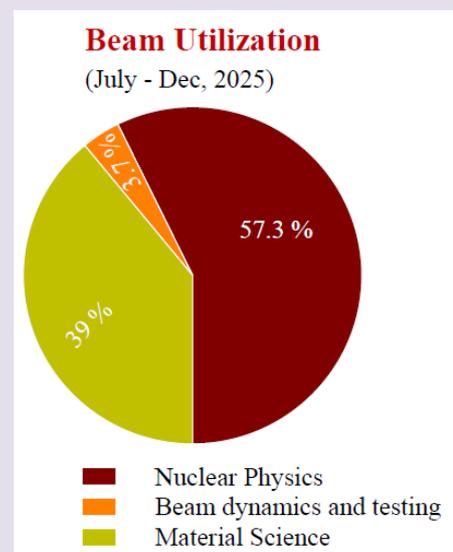
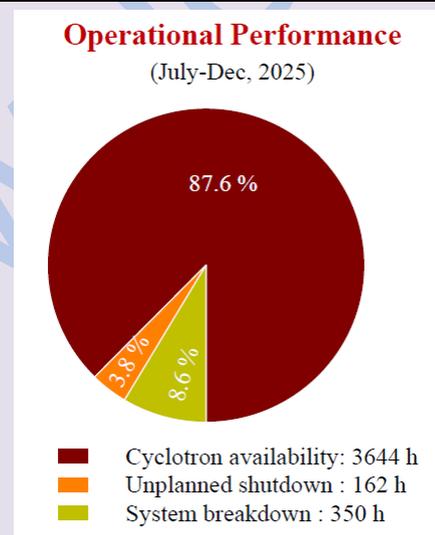
The K130 cyclotron has delivered alpha beams at the energies listed in Table 1. The beam current on target was maintained in the range of approximately 200 nA to 500 nA in Channel #1, 1 nA to 9 nA in Channel #2, and 1 nA to 5 nA in Channel #3, as per user requirements. In addition, proton beams at the energies given in Table 1 were successfully provided with beam currents on target of approximately 25 nA to 4.2 μA in Channel #1, 3 nA to 5 nA in Channel #2, 1 nA to 4 nA in Channel #3, and about 1.2 μA in Channel #4.

The facility has been extensively utilized by experimentalists from VECC, SINP, Diamond

Harbour Women’s University and other institutes. The beam utilization chart of the K130 cyclotron (2921 hours of beam on target) and its overall performance during this period are shown below.

Table 1

Projectile	Beam Energy (MeV)
Proton	6.5-15
Alpha	26-53



For further details, please contact Dr. Animesh Goswami (animesh@vecc.gov.in), Head, Cyclotron Operation Section/ APG.

CHARACTERIZATION OF PIG ION SOURCE AT K130 ROOM TEMPERATURE CYCLOTRON

The experimental performance of a PIG ion source is determined by the plasma properties. The plasma resistivity (η) is defined as

$$\eta = \frac{m_e v_e}{e^2 n_e} \quad (1)$$

where m_e is the electron mass, n_e is the electron density and v_e is the Maxwellian-averaged electron-ion collision frequency of binary collisions that depends on ion density and temperature. The ion source operation requires the presence of a magnetic field parallel to the chimney axis. Electrons emitted from either cathode are accelerated by the potential difference between the cathode and the anode. Their movement is along the expanding helical orbit crossing the hollow anode and they proceed toward the opposite cathode due to the axial magnetic force. The neutral gas injected is ionized, generating a plasma which is confined by the magnetic field. Characterization of the internal PIG type ion source in K130 cyclotron i.e the observation of ion source ARC voltage with respect to ARC current, gas flow, main magnet current with RF voltage ON and OFF condition for both proton and alpha ion has been done. It is observed that ARC voltage is in increasing trend with ARC current as shown in the figure 1. If we increase the H₂ gas flow rate then plasma production occurs more and subsequently plasma resistivity decreases, which reduces ARC voltage for the gas flow range and the specific anode geometry of PIG ion source for K130 cyclotron as shown in the figure 2. The magnetic field is other parameter to consider because it modifies the trajectory of the charged particles in the plasma and consequently, it affects the averaged electron-ion collision frequency. However, their influence is of less relevance as volume of the plasma is small and the internal pressure is high. Thus, the plasma conditions remain almost unchanged against variations of the magnetic

field as long as it reaches certain value that evinces the stability of the plasma as shown in the figure 3.

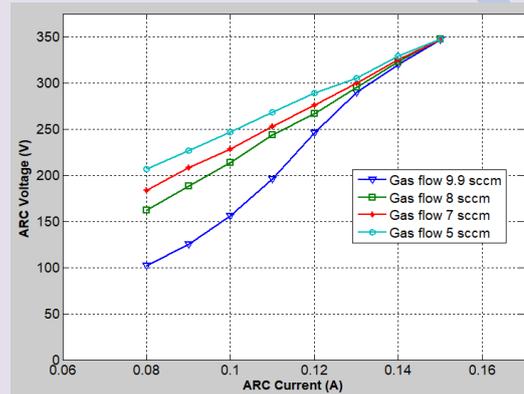


Figure 1: Variation of ARC voltage with ARC Current for different gas flow rate, $I_{mag} \sim 369.4$ A,

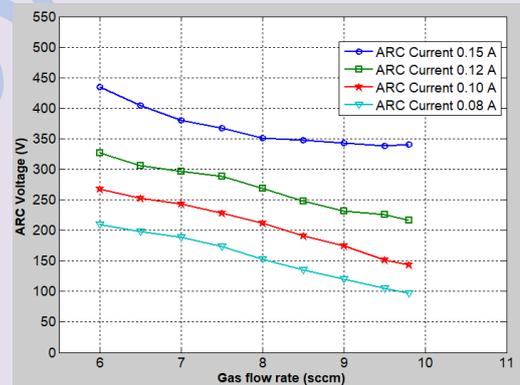


Figure 2: Variation of ARC voltage with gas flow rate for different ARC Current, $I_{mag} \sim 369.4$ A, RF: ON

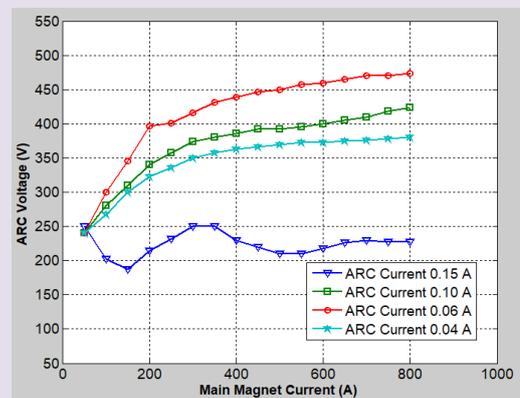


Figure 3: Variation of ARC voltage with Magnet Current for different ARC Current, gas flow~8.9 sccm, RF: ON

For further details, please contact Debasis Sinhamahapatra (debasis.sm@vecc.gov.in), Cyclotron Operation Section, APG

K500 SUPERCONDUCTING CYCLOTRON

The K500 Superconducting Cyclotron (SCC) at the Variable Energy Cyclotron Centre (VECC) is currently delivering a range of heavy-ion beams for user experiments. During the period from July 2025 to December 2025, the facility primarily provided 40Ar ion beams with energies ranging from 190 to 340 MeV and 84Kr ion beams with energies ranging from 416 MeV to 610 MeV, with the cyclotron operating in the second harmonic mode. These beams were utilized for nuclear physics experiments to study the effect of iso-spin, nuclear structure and alpha clustering in the emission of light charged particles (LCPs).

In addition to fundamental nuclear physics studies, a dedicated experiment was conducted using 198 MeV 40Ar^{6+} beam towards the development of a national Single-Event Effects (SEE) testing facility, compliant with MIL and ASTM standards. Scattered beams

from thin Gold (Au) and Rhodium (Rh) targets were used to produce tunable linear energy transfer (LET) values in the range of 14–20 MeV·cm²/mg. The tests were carried out under vacuum conditions with a controlled $\pm 30^\circ$ beam–device geometry, achieving a uniform flux of approximately 10^3 ions/cm²/s and a total fluence of $\sim 10^6$ ions/cm² per LET point. Successful evaluation of Single Event Upset (SEU) and Single Event Latch-up (SEL) effects was performed on mixed-signal CMOS devices (HDSRAMs, ADCs, DACs), developed at Semiconductor Laboratory (SCL), Mohali. These results demonstrate the readiness of the facility for high-reliability electronics qualification.

Apart from routine beam delivery to users, 86Kr^{14+} ion beam was developed and successfully accelerated up to the extraction radius of the cyclotron.

OPERATIONAL ACTIVITIES OF MEDICAL CYCLOTRON FACILITY AT CHAKGARIA

The Medical Cyclotron facility houses the MC-30, a specialized medical cyclotron operating with a fixed 0.9 Tesla magnetic field. The system utilizes a radio frequency of 65.5 MHz to drive negative hydrogen ions (H⁻) through dual "Dee" cavities. By employing oscillating electric fields to increase velocity, the ions spiral outward until they intercept a carbon stripping foil. This component strips electrons from the anions, converting the stream into a high-intensity proton beam ready for distribution.

The Medical Cyclotron-30 (MC-30) has established a strong and reliable record in the routine production of the PET radioisotope ^{18}F -FDG, which is vital for

cancer diagnosis and therapeutic monitoring. Under standard operating conditions, the cyclotron delivers an 18 MeV proton beam at an average beam current of approximately 37 μA for about 90 minutes each morning. Over a total of 91 production days during July to December 2025, the facility produced nearly 100 Ci of ^{18}F -FDG, corresponding to an overall Beam On Time (B.O.T.) of around 150 hours and a cumulative integrated current of approximately 5305 μA -hours. Production activities experienced limited interruptions, including a twelve-day shut down for maintenance of the liquid target and HOT cells by BRIT, as well as a further twenty two-day pause for RF system and stripper maintenance. Despite these

brief operational halts, the MC-30 consistently demonstrated high efficiency and dependable performance, successfully meeting the routine demand for ¹⁸F-FDG.

Parallel to these production of radioisotopes, the facility verified its research capabilities by successfully transporting a 30 MeV proton beam to the second Faraday cup, achieving a stable 10 μA current with a transmission efficiency of 75% along the ADSS line.

For further details please contact Shri. Aditya Mandal (aditya@vecc.gov.in), Head, Medical Cyclotron Facility Section/ATG



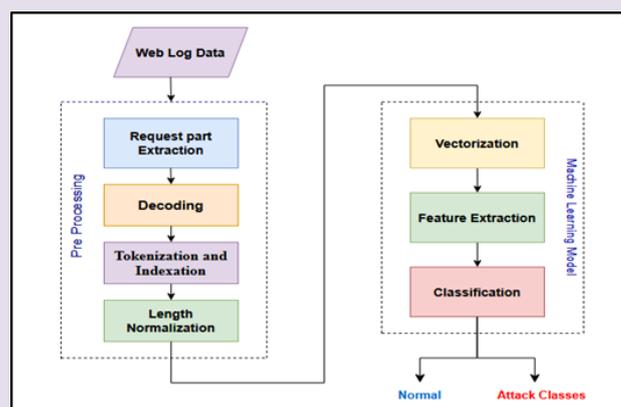
TECHNOLOGY DEVELOPMENT

AI-BASED FRAMEWORK FOR DETECTION OF WEB ATTACKS THROUGH WEB LOG ANALYSIS

As web applications become integral to daily life, they have emerged as prime targets for cyber-attacks. Web-based attacks—typically executed via malicious HTTP requests—represent the most common and diverse security threats. While Web Application Firewalls (WAFs) are the traditional defences, their reliance on static rules and heuristics approaches often leave them ineffective against sophisticated or unknown exploits.

To address these limitations, an AI-based system has been developed for classification of various web-based attacks analysing web server log data. This system collects logs from multiple web servers and parses them to extract relevant request fields which are then processed by *Natural Language Processing (NLP)* techniques such as tokenization, indexation, and embedding to convert textual information into numerical representations

suitable for machine learning models. Subsequently, feature extraction is carried out followed by classification of web attacks using neural network based machine learning techniques. A Linux-based application (*Anu Raksha*) is developed with the trained model and deployed in a live operational environment. This application enables online processing, analysis, and classification of incoming web logs from VECC web servers, with results displayed through an



interactive dashboard, demonstrating the system’s effectiveness and practical applicability.

Figure 1: Application architecture



Figure 2: Dashboard for displaying identified web attacks

For further details, please contact Shri Soham Kundu (soham.k@vecc.gov.in), HPC&ITSS, Computer Division, C&I Group, VECC.

CENTRALISED HOST-BASED INTRUSION DETECTION SYSTEM (HIDS) FOR CRITICAL SERVERS

A centralized Host-Based Intrusion Detection System (HIDS) has been developed and deployed for real-time host monitoring, detection of suspected intrusion attempt and alert generation for security events. This system, developed in-house using open-source software stack *Wazhu-Open Search-Kibana*, consists of five functional components namely *End-Point Hosts* (Servers/Virtual Machines which run a lightweight *Wazhu* agent), *Manager* (*Wazhu* - receives data from agents, analyzes it, and generates security alerts), *Indexer* (*Open Search* - stores and indexes the data to enable fast and efficient searching), *Dashboard* (*Kibana* - visualizes the data using graphs and charts, making it easier to understand the overall security posture) and *Users* (security teams and administrators who access alerts and reports through the dashboard).

This system offers a unified framework for comprehensive security monitoring by continuously collecting and analyzing system and application logs from multiple hosts. Its File Integrity Monitoring (FIM) detects unauthorized changes to critical files, while process and service monitoring identifies abnormal or malicious activity. The system also tracks user logins, logouts, and privilege escalation attempts to detect compromised accounts, insider threats, and policy violations in real time. Additionally, it identifies system misconfigurations and software vulnerabilities by assessing hosts against a defined security baseline. A centralized HIDS dashboard provides actionable insights through consolidated visualization of security data from all monitored hosts.

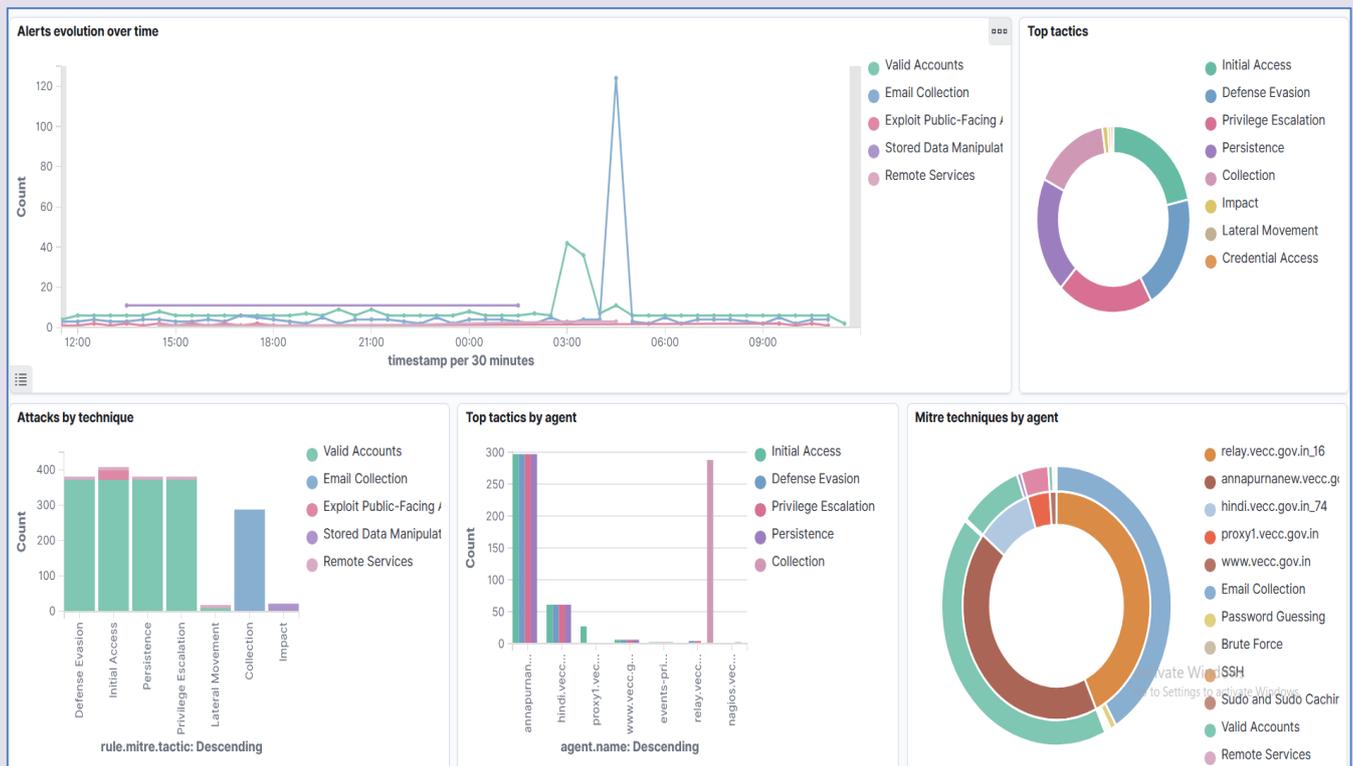


Figure 1: A Frame of HIDS Dashboard

For further details, please contact Shri Kaushik Datta (kaushikdatta@vecc.gov.in), HPC&ITSS, Computer Division, C&I Group, VECC.

DEVELOPMENT OF A LOW-COST LIQUID NITROGEN BASED OPEN-CYCLE CRYOSTAT FOR CRYOGENIC TESTING OF ELECTRONIC AND MATERIAL SAMPLES

A compact liquid nitrogen (LN₂) based open-cycle cryostat has been developed for the characterisation of cryogenic electronics and material samples enabling controlled cooling of devices from room temperature down to approximately 120 K as shown in Fig 1. This provides a cost-effective and experimentally flexible alternative to closed-cycle cryostats for device-level measurements.

The cryostat operates on heat-exchanger mechanism in which LN₂ flows through a copper tube brazed to a copper base plate. A mechanically fastened copper block mounted on this plate serves as the sample stage, ensuring good thermal uniformity at the DUT. The assembly is enclosed

within a vacuum chamber to minimize moisture and frosting during low-temperature operation. Temperature monitoring is performed using PT-100 sensors, while controlled heating is achieved through a cartridge heater, allowing stabilization at predefined temperature set-points. A Graphical User Interface (GUI) was developed to monitor the temperature and to set the desired temperature using serial communication with computer. A 26 watts of heating through the cartridge heater was applied and the lower plate's temperature was maintained within 20-30 Kelvin below the set temperature. The desired temperature was successfully achieved with an average stability of ±2 Kelvin at the sample as shown in Fig 2. This is a very cost effective solution for the testing of any

devices / sample in the cryogenic temperature down to 120K.

A tuned amplifier has been designed, developed, and experimentally characterized for Penning trap operating at cryogenic temperatures. The amplifier

is based on a GaAs pseudomorphic high electron mobility transistor (pHEMT) and DC characteristics could be systematically evaluated at different low-temperature regime. A typical measurement data is shown in Fig 3.



Figure 1: (a) The open-cycle cryostat, (b) Schematic arrangement of the lower plate, upper block, and device under test (DUT).

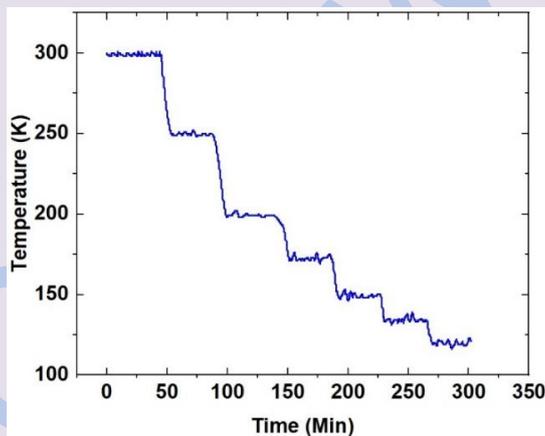


Figure 2: Measured temperature variation at the device under test during stabilised operation.

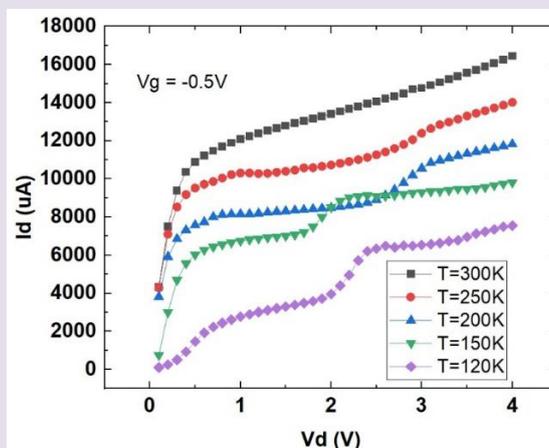


Figure 3: I-V characteristics of GaAs based pHEMT at different temperatures

FACILITIES

TRANSFORMER AND MAGNET COIL WINDING FACILITY REPORT

The PE&MCD Section plays a significant role in facilitating the production of transformers, inductors and magnet coils for various sections of the Centre over the years. These include design, development as well as providing assistance to winding facilities for various coils for diverse applications, mostly at VECC. The facility continues to develop several types of coil systems for DC power supplies and magnets and for power line frequency and high frequency applications.

During July to December 2025, the facility was put to use for producing 20 1- ϕ transformers, 2 magnet coils and 3 inductors. Transformer production, during the said period, amounted to 10541.35 VA while total production of coils disbursed for a stored energy of 1.00 J.

Figure 2 gives the production summary during the period with a graphical comparison with that of 2024

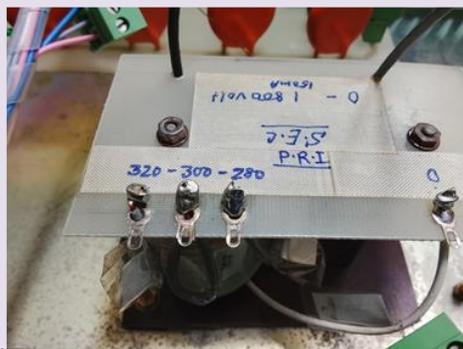


Figure 1: A 1.8 kV / 24 VA transformer

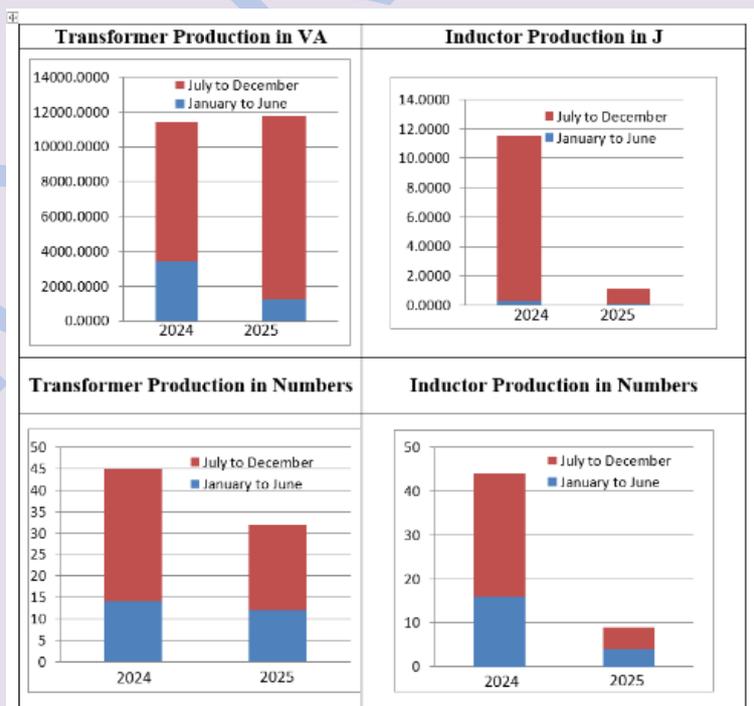


Figure 2: Production from January, 2024 to December, 2025

For further details, please contact Dr. Anirban De (ade@vecc.gov.in), PE&MCDS/PED/ATG

COLLABORATION

SUCCESSFUL TEST OF FOCAL PADS IN TEST BEAM EXPERIMENT AT CERN

VECC is actively engaged in R&D on p-type silicon pad sensors for the Forward Calorimeter (FoCal) upgrade of the ALICE experiment at the CERN Large Hadron Collider (LHC). The sensor arrays, designed by VECC and BARC, were fabricated at Bharat Electronics Limited (BEL), Bengaluru. Beam tests were conducted at the H2 beamline of the CERN Super Proton Synchrotron (SPS), which provides secondary beams of electron and pion with energies ranging from 20 GeV to 200 GeV. The test-beam program was planned for two main objectives: (i) detection of minimum ionizing particle (MIP) response using a 100 GeV pion beam, and (ii) measurement of electromagnetic showers initiated by electrons with variable absorber thickness

upstream of the detector. Tungsten plates served as absorbers, and electron-induced showers were recorded across several incident energies and absorber configurations.

A clear separation between pedestal and MIP signals was seen for almost all pads with the pion beam. The preliminary results from both the MIP and shower measurements are robust, and a detailed analysis of the high-quality shower dataset is underway. As this p-type design with HGCROC-ASIC-based readout is a new effort for both VECC and BEL, the successful tests and characterizations represent a significant technological milestone and a major step towards the FoCal design physics goals.

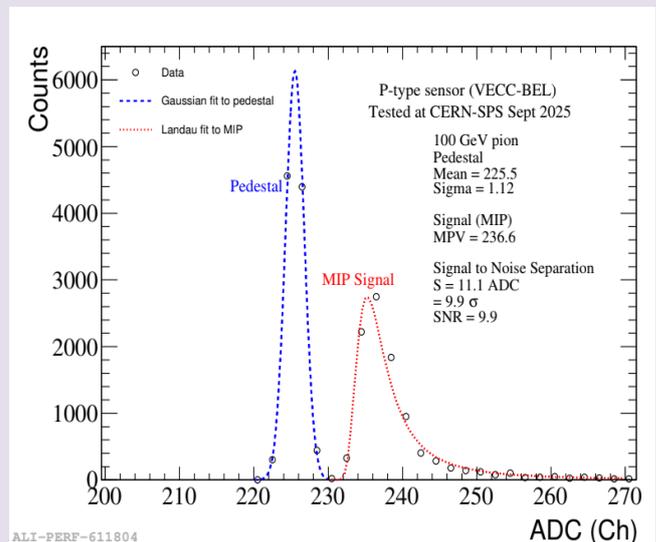


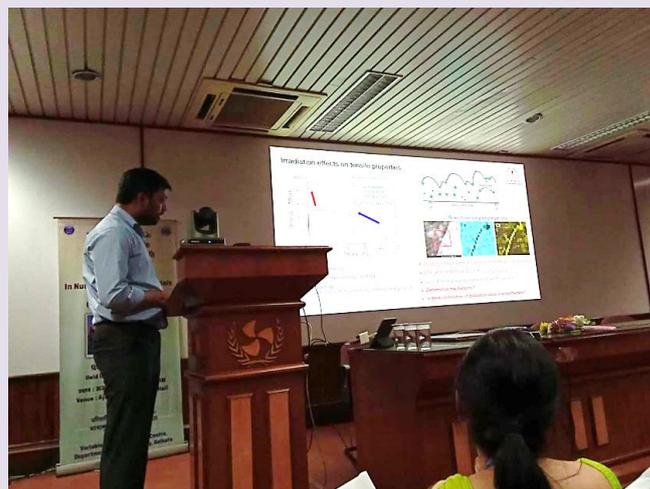
Figure: (left panel) Dr. Sumit Som, Director VECC (2nd from left) with scientists of Experimental High Energy Physics Division, VECC, at the CERN SPS beamline during the testing of FoCal sensors developed by VECC. (right panel) FoCal pad response to minimum ionizing particle (MIP) at the CERN SPS beamline. The clear separation between the Gaussian pedestal and the Landau signal from 100 GeV pion can be seen.

EVENTS

THEME MEETING ON RADIATION DAMAGE IN NUCLEAR STRUCTURAL MATERIALS USING ACCELERATORS (RADNUMAT@VECC25)

Radiation damage in structural materials remains a critical challenge for the safe operation and long service life of nuclear reactors. With the Department of Atomic Energy (DAE) actively pursuing advanced and next-generation reactor systems, research on radiation effects in new materials has gained increasing importance. Focussing on these aspects, VECC organized a theme meeting, **RaDnuMaT@VECC25**, on 29th October 2025, bringing together researchers working in radiation damage, materials science, and nuclear technology. The meeting featured nine invited talks covering key topics such as advanced materials for present

and future reactors, ion irradiation facilities and experimental methodologies, radiation-induced microstructural evolution and its impact on mechanical properties, characterization techniques, and modelling and simulation of radiation effects. The discussions provided an effective platform for interaction among experimentalists, simulation experts, and materials scientists, highlighting recent progress in India's nuclear materials programme. The meeting strengthened collaborative efforts and reinforced VECC's role as a leading centre for radiation damage studies, contributing to the development of safer, more reliable, and long-lasting nuclear reactor materials.



VECC ORGANIZED THE 12TH INDIA CERN TASK FORCE MEETING

The 12th India CERN Task Force meeting was organized at VECC, during 21st - 22nd August, 2025. Around 20 senior scientists and delegates from both DAE and DST institutes participated in the meeting. The delegates were

welcomed by Dr. Sumit Som, director of VECC. Prof. D. K. Kanjilal, the chairperson of the Task Force, thanked VECC director for successful organization of the meeting.



Figure1: Delegates of the CERN India Task Force and scientists from VECC during the meeting.

VECC ORGANIZED THE INDIA-ALICE-STAR COLLABORATION MEETING

The India-ALICE-STAR Collaboration meeting was held in VECC during July 1-4, 2025.

Research fellows, postdoctoral fellows and faculties collaborating in the ALICE experiment at LHC and STAR experiment at RHIC from different Indian research institutes and universities along with the members of the Experimental High Energy Physics Division, VECC working in these experiments, participated in the meeting. The meeting started with the welcome addresses by Dr. Sumit Som, Director, VECC and Dr. Arup Bandyopadhyay, the then head of Experimental

High Energy Physics & Applications (EHEP&A) Group, VECC. This was followed by the address of Dr. Zubayer Ahammed, Spokesperson of the India-ALICE-STAR Collaboration. The brief inaugural session was followed by extensive presentation on various scientific and technical aspects related to the analysis and physics interpretation of the recorded data by both the experimental facilities as well exhaustive discussion on the design, simulation and hardware developments for the upcoming Forward Calorimeter (FoCal) detector, where India has a major contribution.



Figure 1: Participants of the INDIA-ALICE-STAR Collaboration meeting at VECC

CELEBRATION OF NATIONAL CYBER SECURITY AWARENESS MONTH OCTOBER 2025 AT VECC

The month of October is observed every year as National Cyber Security Awareness Month.

This annual observance is aimed at raising awareness of Cyber Hygiene and Cyber Security best practices in the country to achieve “**Cyber Jagrit Bharat**”. In view of celebrating this occasion in October, 2025, VECC undertook several initiatives to promote better understanding and awareness in cyber security practices among VECC officials.

On 17th October, a colloquium lecture was organized for VECC employees on “Cyber Crime & Prevention” delivered by Shri Sandeep Sengupta, Director at "Indian School of Anti Hacking (ISOAH)", Kolkata who enlightened audience with his profound knowledge on modern

day’s cybercrimes and their mitigation techniques. A half-day programme was conducted on 24th October by Computer Division, VECC with an aim to enhancing cyber security awareness among VECC officials. The event featured a keynote address on cyber security awareness delivered by the CISO, VECC, along with activities such as quiz and slogan competitions on cyber security, live demonstrations of cyber-attacks, and a phishing email campaign. Several flexes and banners on cyber security were displayed in various places of VECC premises during the entire month. Officials were also notified through announcement mail about common tricks used by scammer. Officials of VECC actively participated in the above programs to a great extent.



VECC Newsletter



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Feedback may be sent to

newsletter@vecc.gov.in

Variable Energy Cyclotron Centre

1/AF, Bidhan Nagar, Kolkata 700064, India