VECC NEWSLETTER

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ACCELERATOR

OPERATIONAL ACTIVITIES OF K130 ROOM TEMPERATURE CYCLOTRON

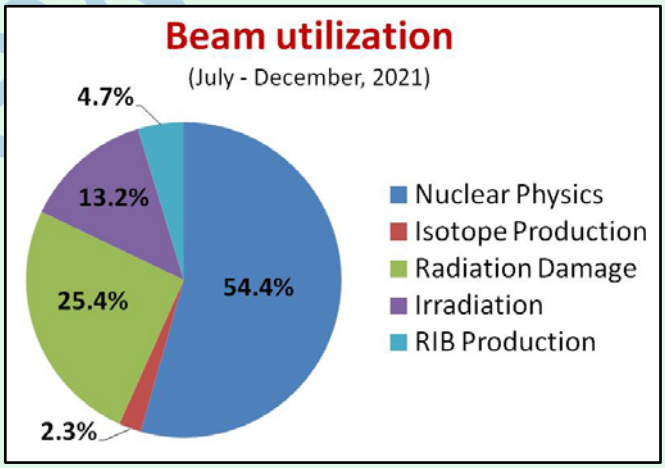
The *K*130 room temperature cyclotron has been operating round the clock and delivering ion beams for various research programs during the period "July to December, 2021". During this period light beams have been used for the production of isotopes, radiation damage study, material science and nuclear physics experiments etc. The light ions like alpha and proton are produced from the internal PIG ion source.

Cyclotron operation was suspended in the month of August, September and October due to unplanned shutdown. This was due to water leaks in Dee stem lower skin and RF panels, which consumes about 30 (thirty) days altogether. Planned shutdown have been taken in the month of October for 4 (four) days and December 2 (two) days during which air handling unit (AHU), duct work and dee probe rectification work etc. have been carried out. Apart from this, cyclotron operation was also interrupted due to problems in magnet power supplies, power dips and trips, diagnostics probe work, beam line alignment, electrical shutdown, cooling tower maintenance, cave shield door movement problem, electrical change over, safety interlock checking etc.

During the above period, *K*130 cyclotron has delivered alpha beam of the following beam energies @ 1.0 nA to 8 nA in channel# 2 and 3 and 125-400 nA in channel#1 as per user requirement. Proton beam of following energies @ 1.0 nA in channel#2 and 500 nA – 3.8 µA in channel#1 have been delivered.

Projectile	Beam Energy (MeV)
Alpha	26, 28, 30, 31, 32, 33, 34, 35, 36, 37 40, 42, 42.7, 45, 46, 48, 50, 52.4
Proton	7, 7.5, 8, 10, 10.7, 11.37, 14

The facility has been utilized by the experimentalists of VECC, SINP, VECC/HPU, RCD/BARC, ACD/BARC, BHU-Varanasi, Viswa Bharati University-Santiniketan and Calicut University etc. The beam utilization chart for doing experiments (2130.5 hrs) of *K*130 cyclotron is shown below.



For further details please contact Shri P S Chakraborty (prodyut@vecc.gov.in), Head, Cyclotron Operation Section/APG.

DEVELOPMENT OF HIGH VOLTAGE POWER SUPPLY FOR ION SOURCE PULLER OF MC18

Power Electronics & Magnet Coil Development Section has developed the required power supplies and facilitated the installation for prototype testing of the VECC developed Ion Source of MC18. The Ion source was tested with the installed system (Fig. 1) with proper interlocks i.e. water flow, safety door-close interlock etc. in place. After several beam trials a requirement of higher rating for the puller supply had come up.

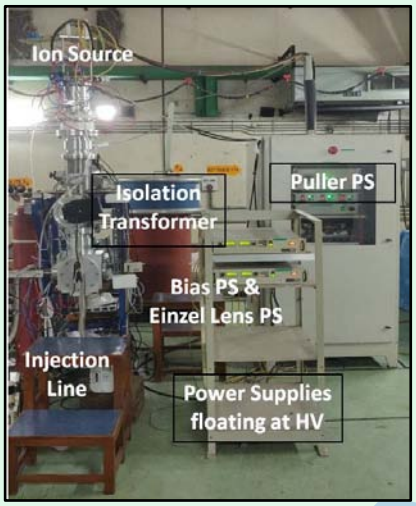


Figure 1: Power supplies during testing with Ion Source

A 10kV, 100mA SPMS (Switch Mode Power Supply) with high voltage DC regulated output voltage was developed (Fig. 2 and 3). The basic schematic of the power converter circuit which is based on a Full Bridge converter topology followed by a Cockcroft-Walton two stage voltage multiplier circuit is shown in Fig. 4. All the internal sub-components including high frequency transformer, inductor, voltage–multiplier PCB, controller PCB etc. were designed and developed indigenously in VECC. The power supply incorporates overvoltage and overcurrent protection. Initially it was tested with a dummy load and was finally integrated with existing VECC developed H- Ion Source test stand where it is operated while floating at -30kV with respect to ground. Testing and optimization of Ion source is going on and -200µA beam has successfully been extracted so far at the end of the injection beamline with the new Puller Power Supply.

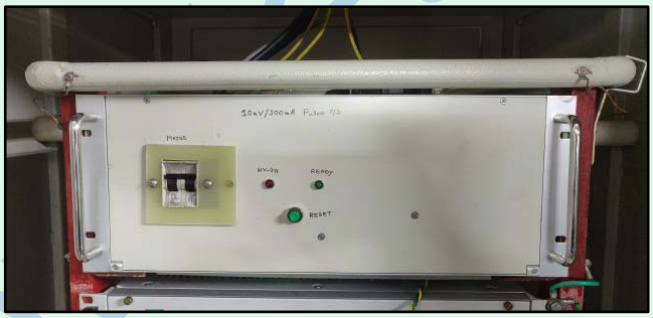


Figure 2: Puller power supply after final assembly

Figure 3: Internal view of puller power supply

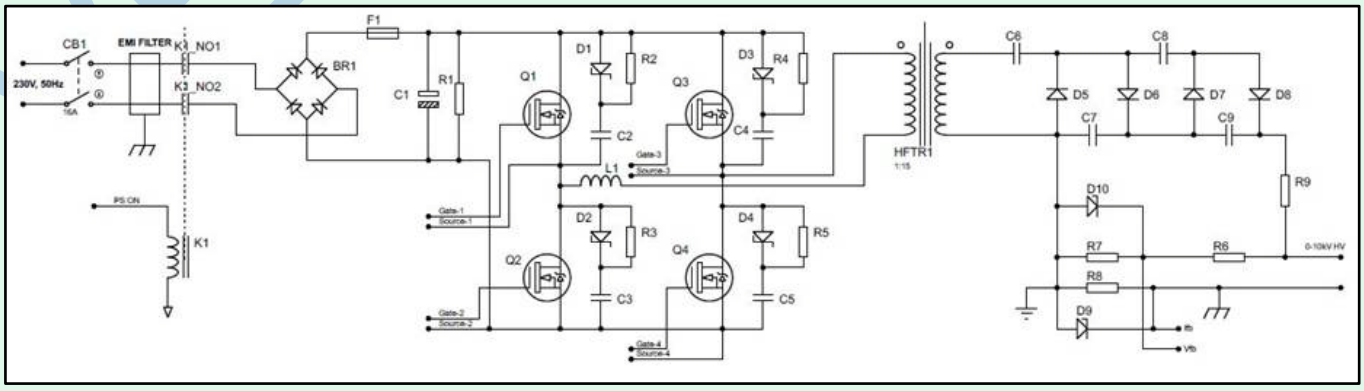


Figure 4; Basic schematic of high voltage power converter

For further details, please contact S Pathak (spathak@vecc.gov.in), Power Electronics & Magnet Coil Development Section/APG

DEVELOPMENT OF 1.5KV, 2A VOLTAGE REGULATED POWER SUPPLY FOR RF SCREEN OF K130 ROOM TEMPERATURE CYCLOTRON

The RF System of K130 Room Temperature Cyclotron VECC consists of tetrode (Eimac 4CW150000E) based high power RF amplifier which operates in the range of 5.5MHz – 16.5MHz. Four numbers of power supplies are required to operate this amplifier – Filament power supply, Control Grid power supply, Screen power supply and Anode power supply. The existing power supply is a 1500V/ 1A linear regulated power supply with low ripple typically 0.1% from M/s Sairush Electronics Systems (model No. SVH01K5001). For ease maintenance, Power Electronics & Magnet Coil Section has indigenously developed the screen power supply rated at 1.5kV/ 2A.

Figure 1: Initial stage of development & testing of the power supply

Figure 2: Power supply components assembled within 19inch cabinet

This is a voltage regulated power supply incorporating four numbers of MOSFETs connected in parallel as series pass element in series with rectified and filtered output from a 3-Ø step-up transformer. Input 3-Ø mains is controlled using three triacs to keep the voltage across the MOSFETs fixed at 50V to limit the losses in the series pass element. Protection for output over-current, over-temperature, MOSFET over-voltage, phase failure and soft-start features are provided in the power supply. The power supply was assembled inside a 19inch rack as shown in Figure 3 and tested with 1.5 A dummy load and 1V peak to peak voltage ripple and 0.05% regulation are achieved. Power Supply has the capability to be operated remotely.

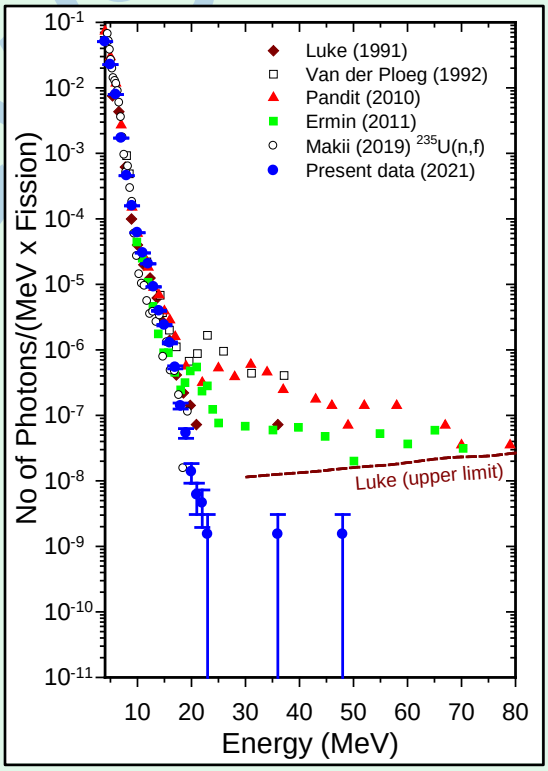
Figure 3: Final assembled power supply inside rack

For further details, please contact S Pathak (spathak@vecc.gov.in), Power Electronics & Magnet Coil Development Section/APG

PHYSICS

SEARCH FOR COHERENT BREMSSTRAHLUNG FROM ^{252}Cf AT JADUGUDA UNDERGROUND LABORATORY

The discovery of nuclear fission (1938) and its utilization (e.g; production of power in reactors or nuclear weapons) has fascinated science as well as the history of mankind! Experiments carried out in the last three decades claimed to observe high energy (more than 25 MeV) gamma-rays in the spontaneous fission of Californium. This is intriguing as no fission theory can explain the emission of high energy gamma ray and puts a question mark on our understanding of the fission process itself after comprehensive research of more than 80 years in this field. To verify indeed if high energy gamma rays are emitted in the fission process, scientists of VECC went to the newly built 555-meter-deep underground laboratory at the UCIL complex in Jaduguda. The reason that the scientists went to carry the experiment in the underground laboratory is that the cosmic muons background (which gives gamma like signal in scintillator detectors) will be drastically less (24,000 times smaller compared to the surface laboratory). The spectrum of high-energy γ-rays accompanying spontaneous fission of ^{252}Cf has been measured in γ-γ coincidence mode. A total of 25 billion fission events were recorded employing the LAMBDA spectrometer developed at VECC, high-energy γ-rays > 25 MeV were not observed at the level as reported in the previous experiments at surface level suggesting that the observed high energy yields in the previous measurements were due to inefficient rejection of cosmic rays. The sensitivity of the present experiment was highly augmented by the measurement at the underground laboratory which naturally reduces the cosmic ray background and no complicated setup was necessary for cosmic rejection. The measurement provides a new upper limit at 95% confidence level of 5×10^{-11} photons/(fission × MeV) for γ-ray emission from the nucleus-nucleus coherent bremsstrahlung in 25-180 MeV energy region, which is two orders of magnitude lower than the previous value. The measured spectrum is shown in the figure along with the previous measurements. The results have been published in **Physics Letters B 823 (2021) 136760.**



For further details, please contact Dr Deepak Pandit (deepak.pandit@vecc.gov.in), PG

TECHNOLOGY DEVELOPMENT

IMPLEMENTATION OF A PORTAL FOR MEETING ROOM BOOKING

With the upsurge in the number of web meetings, webinars and video conferences, particularly in the aftermath of the COVID-19 pandemic, there is a substantial increase in the demand from users for accessing the facilities for holding such meetings and conferences. A few rooms at VECC premises have been equipped with the necessary facilities to hold such meetings. To streamline the arrangement of concurrent meetings at different rooms by different users, a meeting room booking portal has been implemented based on open source software. By using the portal, users can make advance reservation of a meeting room of their choice for a given time slot. Once, the user makes a reservation, the room administrator is informed of it by an automated email. Users can easily find out the booking status of the meeting rooms on a particular day by looking at the room-reservation matrix for the particular day (Figure 1).

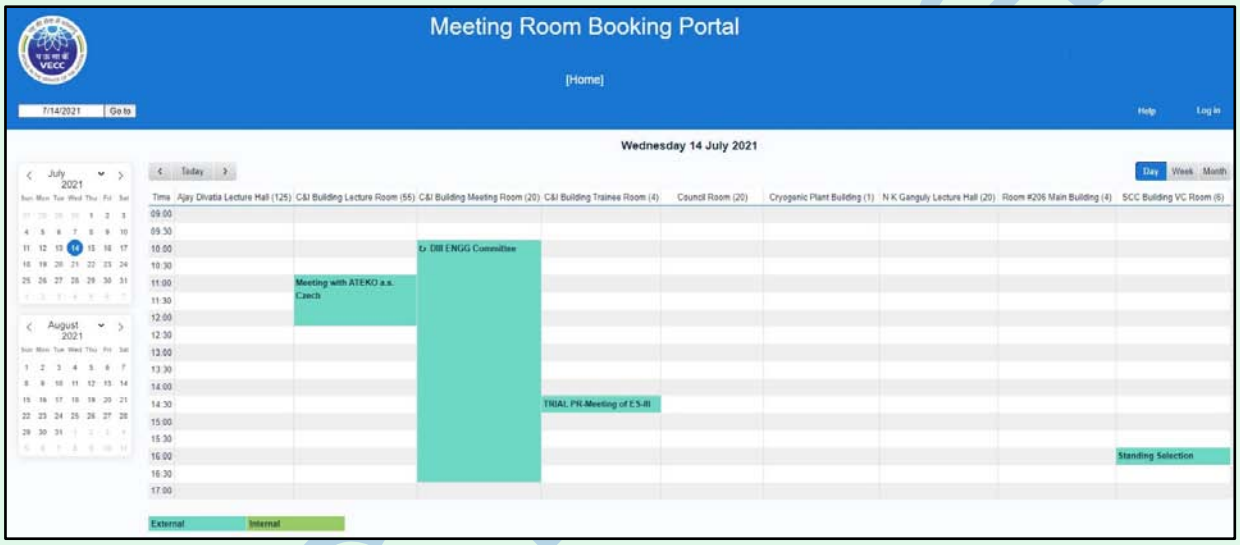


Figure 1: Meeting room booking portal

IMPLEMENTATION OF NETWORK INTRUSION DETECTION AND TRAFFIC MONITORING SYSTEM

Security risk assessment of any IT infrastructure involves risk identification and risk analysis. In view of these, two systems have been implemented and deployed for assessing the potential security risk on VECC cyber space.

A Network Intrusion Detection System (NIDS) has been implemented using open-source software *SNORT*. The system has been deployed outside VECC perimeter to inspect entire incoming and outgoing network traffic of VECC and generate alert against any malicious event based on the defined rule sets. The alert logs from the IDS are analysed with *ELK (Elasticsearch-Logtash-Kibana)* based log analyser and salient information such as Top Attack Name, Top Attack Source IP list, Top Target IP list etc. are graphically displayed in a dashboard (Figure 1) for better understanding of intrusion attempts in VECC network.

Another system to monitor and analyse overall network traffic of VECC has also been implemented using open-source software tools *ntopng* and *ELK*. *Ntopng* is a high-performance web-based network traffic flow collector and analyser tool which is deployed to capture all the inbound and outbound packets of VECC network and analyse them from packet header and payload information using deep

packet inspection technique (nDPI). *ELK* has also been used to analyse the raw packets captured by *ntopng* in order to provide statistical representation of various traffic data (Figure 2) as required by the administrator.

These two systems have greatly enhanced the capability of security risk evaluation and subsequently risk reduction in VECC IT infrastructure.

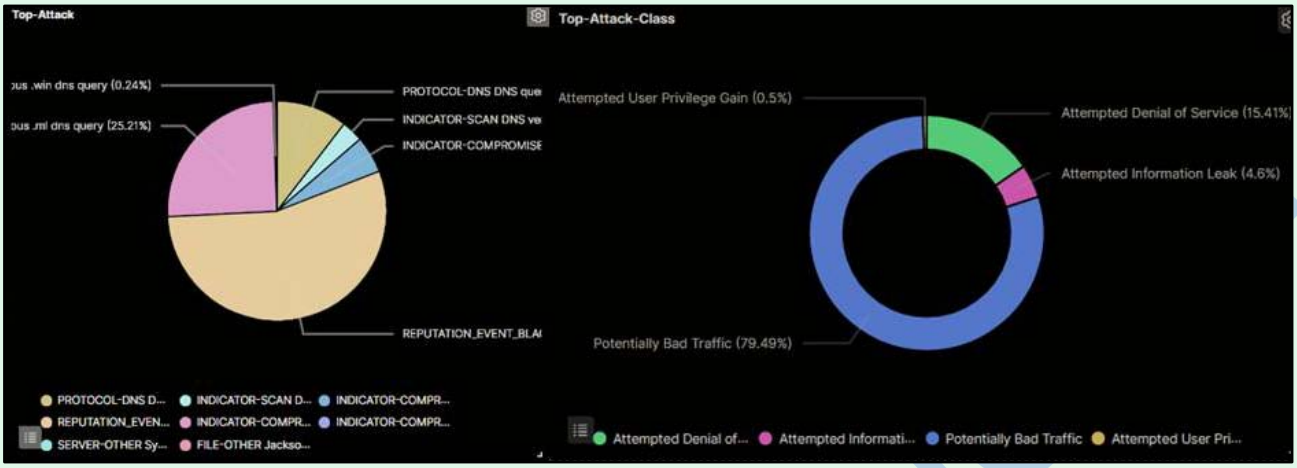


Figure 1: Top Attacks and Top Attack Classes as detected by SNORT are graphically displayed in ELK dashboard.

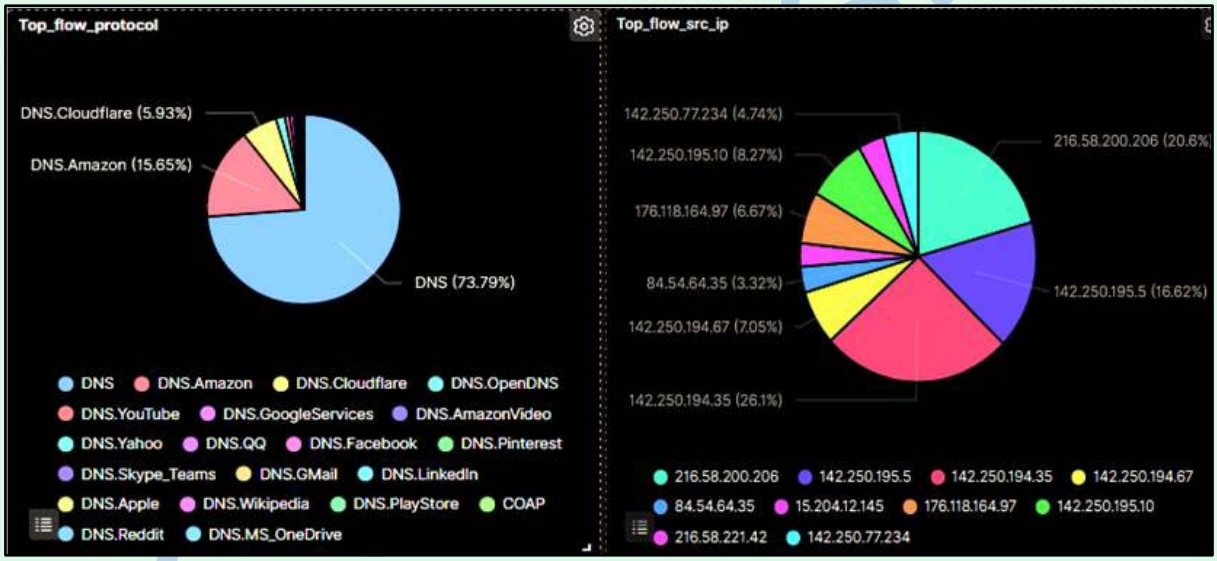


Figure 2: Top Flow Protocol and Source IPs of Top Traffic Flow as captured by ntopng are graphically displayed in ELK dashboard.

OPERATION OF CRYOGENIC PENNING ION TRAP AT VECC

Cryogenic Penning trap is a technologically challenging instrument where all the components of the setup should be operational at liquid Helium temperature. The cryogenic Penning trap has been tested successfully at 4K in VECC by confining a cloud of electrons in a closed-ended, 5-electrode, cylindrical Penning trap. A magnetic field ~ 0.1 T and quadrupolar electrostatic potential ~ 10 V was applied for its operation. The image current induced by the trapped electrons on the Penning trap electrode was detected using resonant technique. The schematic of Penning trap assembly shown in Fig. 1(a) along with its detection electronics was enclosed in a vacuum chamber. The vacuum chamber was evacuated, pinched off and then immersed in liquid Helium. The Penning trap operation thus required components like feedthrough as shown in Fig. 1(d), helical resonator as shown in Fig. 1(c) and low noise amplifier operational at 4K. The trap electrode assembly and detection circuits indigenously built at VECC operated successfully at 4K. A ramp voltage was applied to the electrodes of the trap and it changed the axial oscillation frequency of trapped electron cloud. When the axial

oscillation frequency matched with the resonance frequency of LCR circuit connected for signal detection, a transfer of energy took place. This is observed as a beat signal when the power variation at the resonance frequency of the detection circuit was measured as shown in Fig. 1(b).

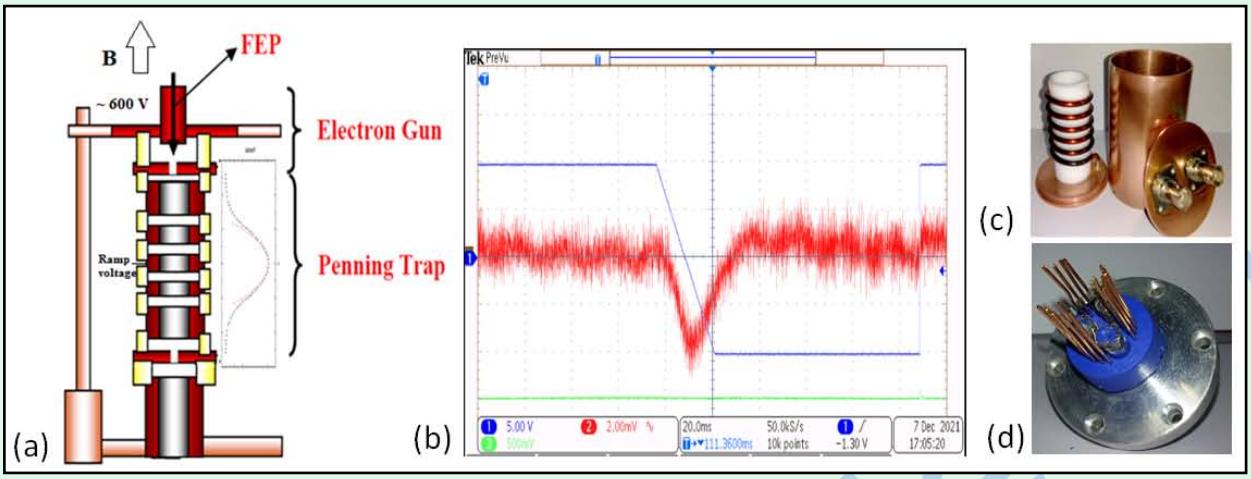


Figure 1: (a) Penning trap setup with electron gun. The potential profile along z axis is shown, (b) A typical dip signal of trapped electron cloud, (c) Indigenously built helical resonator and (d) Indigenously developed cryogenic, coaxial vacuum feedthrough which maintained vacuum leak tightness under repeated thermal cycling from room temperature to 4K.

INDIGENOUSLY DEVELOPED NEUTRON FLUX MONITOR WITH A FOCUS ON 'ATMANIRBHAR BHARAT'

Neutron Flux Monitor (NFM) is an indispensable instrument in any nuclear installations. VECC uses plenty of NFM for area radiation monitoring and safety in and around its cyclotron facilities where neutron flux needs to be measured from high gamma background. The available commercial monitors being used presently uses BF_3 proportional counter and the electronics are vulnerable to power surges and often fails to detect low charge yield in order of femto-coulomb. With this motivation, an ASIC, VECC-003, a charge-sensitive preamplifier and shaper has been designed and developed indigenously at VECC using SCL PDK. The chip has been fabricated at SCL Chandigarh, using 180 nm CMOS technology. It has a dynamic range of 500fC and a sensitivity of 2 V/pC with a resolution of 1-2 fC. A Charge-Sensitive Pulse Converter (CSPC) module is developed using the ASIC along with a state-of-the-art controller module, powered by a PSoC 5LP board with integration of modern touch screen display. The CSPC module along with complete NFM is shown in the figure below. The advantage of using such CSPC module using self-designed ASIC are many as it can be altered or modified according to the user's requirement and other factors at any point of time. For example, ^{3}He proportional counter is widely used for neutron measurement owing to its high neutron detection efficiency and availability, however, BF_3 proportional counters are preferred around cyclotron installations as gamma-ray signal cannot be precisely eliminated and neutrons and gamma rays become indistinguishable in high gamma-ray field with ^{3}He proportional counter. The present CSPC module can easily discriminate with a simple addition of n/γ discriminator circuit and ^{3}He proportional counter may be utilized as detector. The monitor has been tested in the laboratory environment with a 30 mCi Am-Be source and long term stability is ensured and deployed in its working environment successfully.

CSPC module with 28 Pin DIP VECC003 ASIC and NFM monitor with touch-panel display

For further details please contact Dr. Susanta Kumar Pal (sushant@vecc.gov.in), Head, Applied Electronics Division/C&IG

HEALTHCARE

RADIATION APPLICATION IN HEALTHCARE

In the 75th year of Azadi ka Amrit Mahotsav (AKAM), Regional Centre, Board of Radiation & Isotope Technology (RC-BRIT), Kolkata has launched the radiopharmaceutical Thallium-201 chloride (Tl-201) for cardiac imaging studies towards early diagnosis of heart ailments. The RC-BRIT jointly with VECC, Kolkata, produced Tl- 201 for the first time in India from the CYCLONE-30 by irradiating Tl-203 enriched target undergoing the nuclear reaction $^{203}Tl(p,3n)^{201}Pb \longrightarrow {}^{201}Tl$. Tl-201 chloride has been approved for use in cardiac imaging by Radiopharmaceutical Committee, DAE. The Tl-201 patient doses were supplied to NH Rabindranath Tagore International Institute of Cardiac Sciences, Kolkata. Excellent feedback has been received from the hospital on the SPECT imaging performed in two patients for ischemia evaluation and viability assessment respectively. The Tl-201 Chloride produced by RC, BRIT Kolkata reportedly showed good biodistribution with good cardiac uptake due to which excellent quality images could be obtained. Uptake of Tl-201 in the liver and soft tissues was low as compared to that of ^{99m}Tc-MIBI in the same patients. With this mammoth achievement, BRIT, Kolkata has once again reiterated its commitment towards bringing out more and more useful radiopharmaceuticals at economical costs for the benefit of the patients in the country.

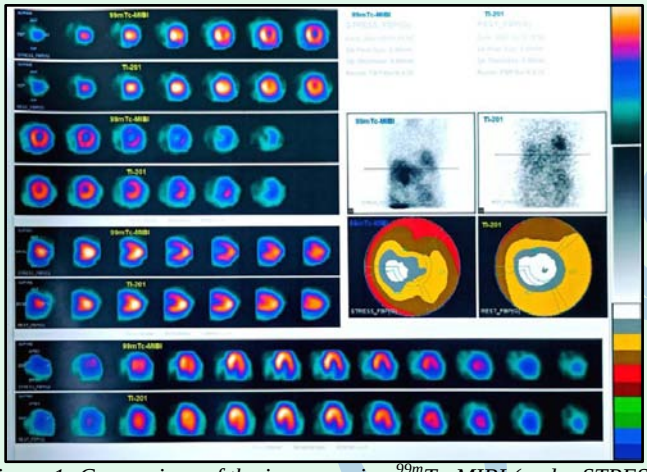


Figure 1: Comparison of the images using ^{99m}Tc-MIBI (under STRESS) and Tl-201 (REST)

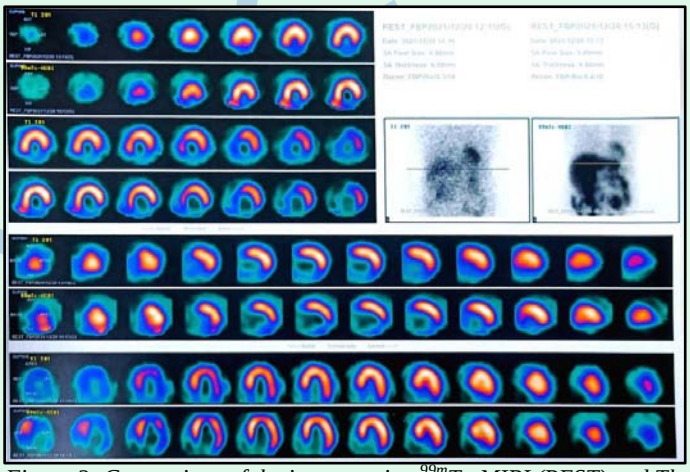
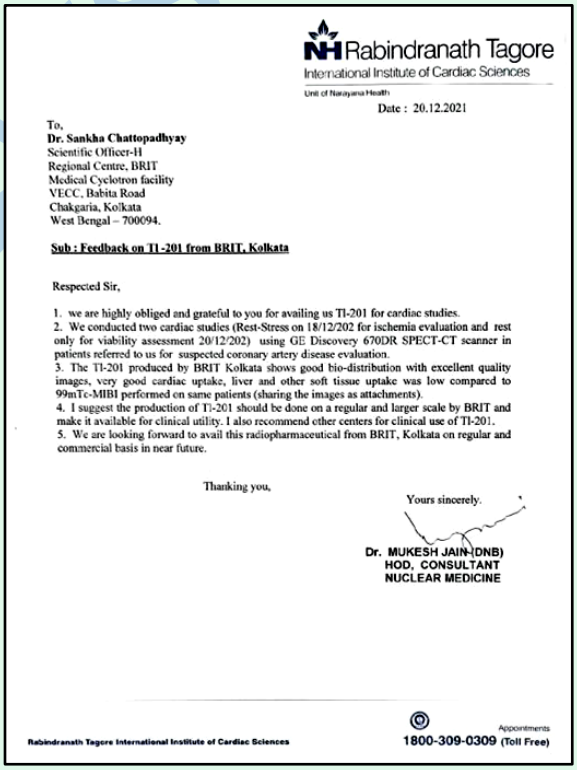


Figure 2: Comparison of the images using ^{99m}Tc-MIBI (REST) and Tl-201 (REST)



NH Rabindranath Tagore
International Institute of Cardiac Sciences
Unit of Narayana Health

Date : 20.12.2021

To,
Dr. Sankha Chattopadhyay
Scientific Officer-H
Regional Centre, BRIT
Medical Cyclotron facility
VECC, Babita Road
Chakgaria, Kolkata
West Bengal – 700094.

Sub : Feedback on Tl-201 from BRIT, Kolkata

Respected Sir,

1. we are highly obliged and grateful to you for availing us Tl-201 for cardiac studies.
2. We conducted two cardiac studies (Rest-Stress on 18/12/202 for ischemia evaluation and rest only for viability assessment 20/12/202) using GE Discovery 670DR SPECT-CT scanner in patients referred to us for suspected coronary artery disease evaluation.
3. The Tl-201 produced by BRIT Kolkata shows good bio-distribution with excellent quality images, very good cardiac uptake, liver and other soft tissue uptake was low compared to 99mTc-MIBI performed on same patients (sharing the images as attachments).
4. I suggest the production of Tl-201 should be done on a regular and larger scale by BRIT and make it available for clinical utility. I also recommend other centers for clinical use of Tl-201.
5. We are looking forward to avail this radiopharmaceutical from BRIT, Kolkata on regular and commercial basis in near future.

Thanking you,

Yours sincerely.

Dr. MUKESH JAIN (DNB)
HOD, CONSULTANT
NUCLEAR MEDICINE

Rabindranath Tagore International Institute of Cardiac Sciences

Appointments
1800-309-0309 (Toll Free)

Figure 3: The letter of appreciation received from NH Rabindranath Tagore International Institute of Cardiac Sciences, Kolkata

AWARDS & HONOURS

BEST POSTER AWARD

Ms. Shefali Basak, SRF, HBNI, VECC received the 'Best Poster Award' in "65th DAE-BRNS symposium on Nuclear Physics", held at BARC, DAE, Mumbai during 1st-5th December, 2021.

In the poster, entitled "Spectroscopy of ^{152}Sm", Shefali presented the study of nuclear shape in N = 90 ^{152}Sm. The experiment was performed by setting up an array of twelve Clover HPGe detectors at Channel-III beamline of K-130 cyclotron, VECC, augmenting one existing structure of SINP, Kolkata. The Clover array along with a digital data acquisition facility was setup in collaboration with SINP, and UGC-DAE-CSR, Kolkata.

New negative parity band structures were observed with findings on nuclear shape coexistence that is of contemporary interest. With the analysis of high resolution gamma-gamma coincidence data, the development of an octupole structure on a gamma vibrational band in this nucleus was unfolded.

Feedback may be sent to
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1/AF, Bidhan Nagar, Kolkata 700064, India