VECC NEWSLETTER

June 2025 Volume 27 Number 1 VECC-NL-2706

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ACCELERATOR

OPERATIONAL ACTIVITIES OF K130 ROOM TEMPERATURE CYCLOTRON

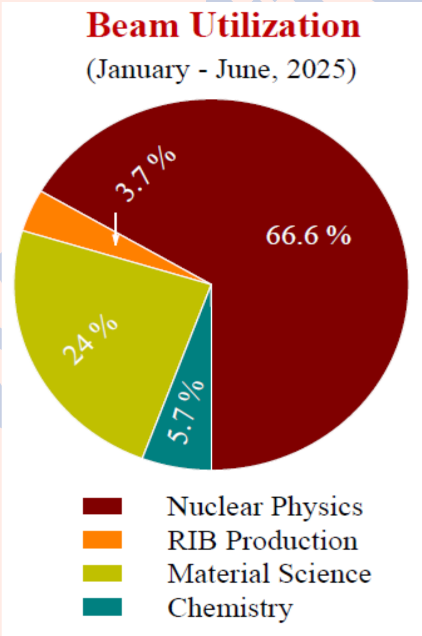
The K130 variable energy cyclotron has been operating on a round the clock shift basis and has been delivering stable accelerated light ions beams like alpha, proton, deuteron and heavy ion beams for nuclear physics, radiation damage, material sciences, isotope production and other experimental research programs throughout the year. Light ion beams (proton and alpha) have been extensively used by the users during the period “January to June, 2025”. Apart from round the clock operation, several maintenance and upgradation work has been carried out to improve the performance of the cyclotron. The old analog alarm annunciator system, to display the interlock status of various system, has been replaced with a new modular, digital alarm annunciator system. A new interlock based status (dot matrix LED based) display system has been installed for the cyclotron. The control system K130 cyclotron has been upgraded with the integration of Control System Studio (CS-Studio), which supports both Linux and Windows. A detailed analysis of the beam optics has been carried out to improve the beam transmission in four experimental beam lines.

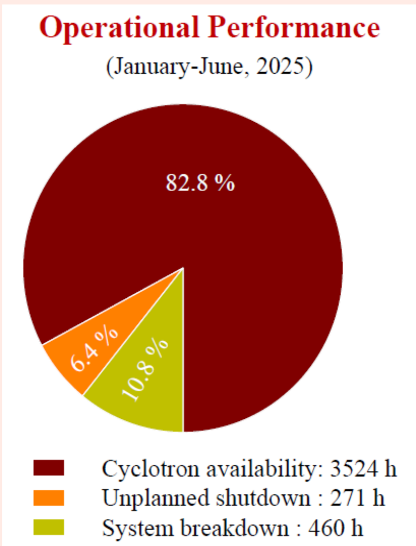
The K130 has delivered alpha beams of energies shown below in Table 1, and the beam current on target being @ 1 nA - 5 nA in channel # 3 and 100 - 600 nA in channel # 1 as per user requirement. Proton beam of following energies (Table 1) and beam current on target @ 500 nA – 3.5 µA in channel # 1 have been delivered.

Table 1

Projectile	Beam Energy (MeV)
Proton	6.5-14
Alpha	26-45

The facility has been utilized by the experimentalists of VECC, SINP, VECC/HPU, RCD/BARC Visva-Bharati University, ACD/BARC, Diamond Harbour Women's University etc. The beam utilization chart (2851 hrs beam on target) of K130 cyclotron and its overall performance during this period are shown below.





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

K500 Superconducting Cyclotron (SCC)

The K500 Superconducting Cyclotron (SCC) at the Variable Energy Cyclotron Centre (VECC) is currently providing a range of heavy ion beams to users. From January to June 2025, the facility primarily delivered nitrogen, neon and oxygen ion beams. These beams were employed to study fission-like phenomena in heavy nuclei, focusing on non-equilibrium processes in reactions involving pre-actinide and actinide targets.

In addition to in-house users, researchers from Guwahati University conducted experiments using the Segmented Horizontal Axis Reaction Chamber (SHARC) beam line. These experiments utilized large-area Multi-Wire Proportional Counters, developed indigenously at VECC. Nitrogen beams with energies between 252 MeV and 398 MeV, Neon beam of 424 MeV and Oxygen beams ranging from 330 MeV to 362 MeV, were used in these scientific studies. VECC users also carried out irradiation experiments using Terbium (Tb), Aluminium (Al) and Rhodium (Rh) as targets with thicknesses between 10 and 25 microns. These were irradiated with 252 MeV Nitrogen beam at beam currents of approximately 50 nA for cross-section measurements using gamma spectroscopic technique.

Operational Activities Of Medical Cyclotron Facility At Chakgaria

The Medical Cyclotron-30 (MC-30) is a high-performance cyclotron facility designed to generate proton beams across a range of energies for applications in medical diagnostics and materials research. It operates with a fixed magnetic field of 0.9 Tesla and a radio frequency (RF) of 65.5 MHz, which accelerates negative hydrogen ions (H^-) via two RF cavities known as "Dees." As the ions gain energy through oscillating electric fields and spiral outward, they are stripped of electrons using a carbon foil to produce protons, which are then directed toward one of five specialized beam lines. The facility runs from Monday to Friday, from 6 a.m. to 7 p.m., offering consistent uptime. One beam line is exclusively dedicated to produce ^{18}F-FDG, a short-lived radiotracer essential for PET imaging, especially in oncology. Two additional beam lines are used for the production of SPECT radioisotopes via solid target irradiation, supporting diagnostic imaging in cardiology, neurology and cancer care. Beyond clinical use, the MC-30 also supports advanced research. One beam line is focused on radiation damage studies in nuclear structural materials, enabling investigations into material degradation mechanisms like embrittlement and swelling, which are vital for improving the safety and longevity of components used in nuclear reactors and aerospace. The fifth beam line supports window studies for Lead-Bismuth target assemblies, aiming to enhance efficiency, durability and safety of these systems by testing materials under intense thermal and radiation stress. Overall, the MC-30 stands as a versatile and essential facility that bridges medical technology and nuclear science, enabling both reliable isotope production and cutting-edge research to support current and future advancements in healthcare and high-radiation environments.

Period: 1st January 2025 to 30th June 2025:

The Medical Cyclotron-30 (MC-30) has demonstrated a robust and reliable track record in producing the PET radioisotope ^{18}F-FDG, essential for cancer diagnosis and monitoring. Typically, the cyclotron generates an 18 MeV proton beam with beam currents ~38 µA for about 90 minutes each morning. Over 99 production days, the facility has produced approximately ~180 Ci of ^{18}F-FDG, with a total Beam On Time (B.O.T.) of roughly ~160 hours and a cumulative integrated current of around ~5600 µA-hours. Production was interrupted for 3 days due to maintenance of the liquid target and HOT cells by BRIT and for an additional 17 days for RF and stripper maintenance. Despite these brief pauses, the MC-30 remains a highly efficient and dependable source of ^{18}F-FDG, consistently fulfilling the demand for this critical radioisotope.

In addition to its routine production of ^{18}F-FDG, the Medical Cyclotron-30 (MC-30) has also successfully delivered a 28 MeV proton beam to the solid target beam line for the production of ^{67}Ga radiopharmaceuticals.

This beam line was operated for 9 days, with a Beam On Time (B.O.T.) of approximately 45 hours and a cumulative integrated current of ~4300 µA-hours. The Medical Cyclotron-30 (MC-30) has also been utilized for irradiation studies on Ni-based alloys, delivering a 16 MeV proton beam through the 4th research beam line. This beam line was operated over a period of 13 days, with a total Beam On Time (B.O.T.) of ~60 hours and an integrated current of ~580 µA-hours. These studies contribute to understanding the radiation-induced effects in structural materials, supporting research in nuclear materials science and enhancing the development of radiation-resistant alloys for advanced reactor systems and other high-radiation environments.

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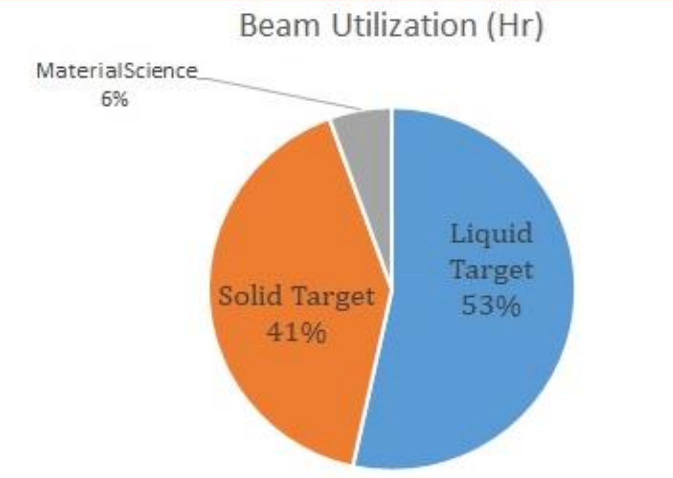

PHYSICS

RESULTS ON SYMMETRY ENERGY FROM FIRST PHYSICS EXPERIMENT USING K500 CYCLOTRON BEAM, VECC

The K500 cyclotron at VECC has recently begun delivering high-energy beams suitable for nuclear physics experiments. Using nitrogen and neon beams with energies ranging from 18 to 30 MeV per nucleon, measurements of nuclear symmetry energy have been successfully carried out.

The symmetry energy is a concept in nuclear physics that describes how the energy of nuclear matter changes when there is an imbalance between the number of neutrons and protons. The symmetry energy is crucially important in both nuclear physics and astrophysics. It plays a central role in how we understand the structure, stability, and behavior of atomic nuclei and extremely dense astrophysical objects like neutron stars.

In this study, we have measured the symmetry energy by studying isoscaling behavior of isotopic compositions of the intermediate mass fragments (IMFs) emitted in heavy ion reactions and measuring the temperature of their source. Isoscaling refers to a scaling law that describes how the ratios of isotope yields, $Y_2(N, Z)/Y_1(N, Z)$, from two similar nuclear reactions depend exponentially on the neutron number (N) and proton number (Z) of the fragments. Here, $Y_2(N, Z)$ and $Y_1(N, Z)$, are the yields of the isotope from the neutron rich and neutron deficient system, respectively. Mathematically, $\frac{Y_2(N,Z)}{Y_1(N.Z)} = C \times \exp(\alpha N + \beta Z)$ where C is the normalization constant, α and β are the isoscaling parameters. We have measured the isotopic yields of IMFs (Z = 3 - 7) emitted in the reactions ^{20}Ne, ^{14}N + ^{112}Sn, ^{116}Sn, ^{124}Sn, using silicon strip ΔE - E charged particle telescopes. It was observed that isoscaling property is well respected in all reactions across the excitation energy range studied. The double isotope ratio method was used to measure the temperature from the ratio of yields of the isotopes, ^{6,7}Li/^{11,12}C.

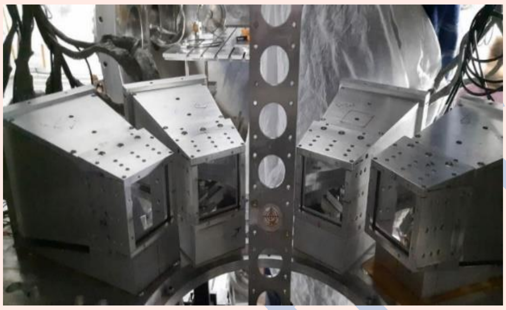

Fig 1: Experimental setup.

The values of coefficient (C_{sym}) of the symmetry energy term of nuclear equation of state were extracted using isoscaling parameters and measured temperatures. The result shows a variation of C_{sym} from approximately 24–17 MeV, for excitation energy 2.1–2.8 MeV/nucleon. Based on this trend, C_{sym} would be expected to exceed 24 MeV at energies below 2.1 MeV/nucleon. Instead, it drops to around 20 MeV at 1.8 MeV/nucleon. Theoretical calculations have been performed using an isospin-dependent hybrid model for nuclear multifrag-mentation. The theoretical results align well with the experimental data for the range of excitation energies per nucleon (2.1–2.8 MeV), but do not appear to match for the lowest excitation (E^*/A = 1.8 MeV), indicating that multifrag-mentation is not the dominant mechanism at lower energies. The result has been published in Physical Review C 112, 024614 (2025).

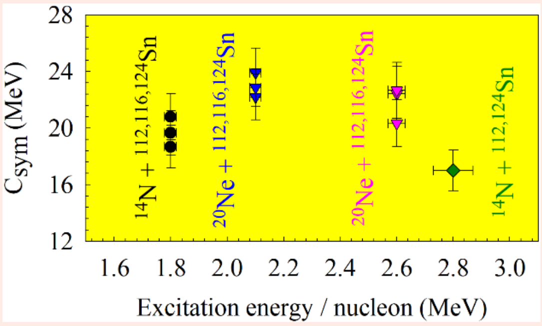

Figure 1: The experimentally measured values of C_{sym} at various excitation energies.

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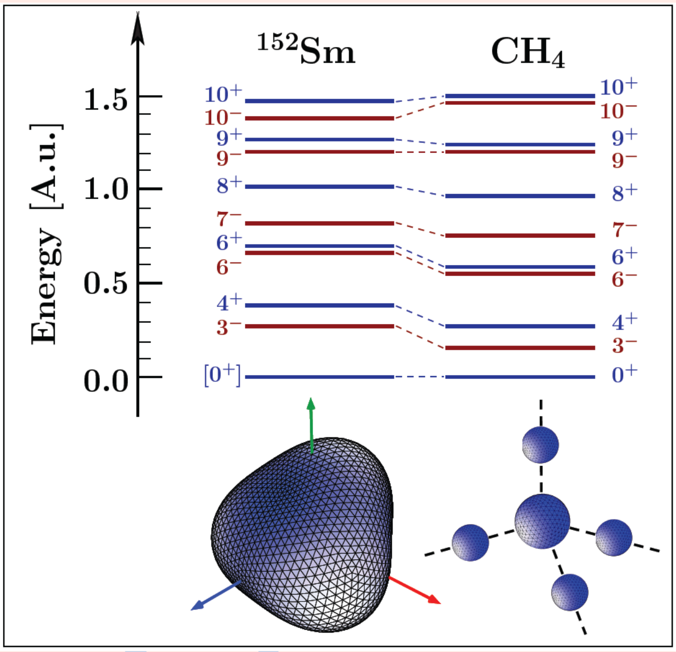
EXPERIMENTAL OBSERVATION OF TETRAHEDRAL SHAPE IN ATOMIC NUCLEUS ^{152}SM

The surprising similarity between rotational spectra of two incomparable quantum objects with same symmetry (tetrahedral symmetry atomic nuclei and molecules) were revealed in an experiment performed at VECC, Kolkata. The illustration shows this comparison of an atomic nucleus composed of tightly packed nucleons interacting with one another via nuclear forces, the most complex known in the universe and a molecule composed of a few distant atoms.

Theory predicts that nuclei like ^{152}Sm can manifest tetrahedral symmetry. It is known that even-even nuclei with ellipsoidal symmetry form rotational spectra with energy (E) vs angular momentum (I) sequences (bands), composed of even spins $I^{\pi} = 0^+$, 2^+, 4^+, etc., and thousands of such cases are known. Whereas tetrahedral symmetry generates totally different bands $I^{\pi} = 0^+, 3^-, 4^+, 6^{\pm}, 7^-, 8^+, 9^{\pm}, 10^{\pm}$ …mixing odd and even spins, both parities, certain states totally missing (I=1,2,5,…) and some appearing in degenerate parity doublets ($6^{\pm}, 9^{\pm}, 10^{\pm}$, …).. This property was experimentally identified in the world-first dedicated experiment run at VECC, Kolkata using ^{4}He beam from K-130 cyclotron and an array of twelve Clover HPGe detectors, showing that more laboratories can push forward exotic symmetry research. The work has been recently published in Phys. Rev. C, **111**, 034319 (2025).



Illustrated: Tetrahedral CH_4 methane molecule produces up to scaling factor the same spectrum (energies in arbitrary units). As a byproduct we formulated new observations about competing tetrahedral and octahedral symmetries and manifestations of spontaneous symmetry breaking.

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NON-DESTRUCTIVE DETECTION OF STORED ELECTRONS IN VECC PENNING TRAP USING MULTI-CHANNEL PLATE

An open-ended, five-electrode cylindrical Penning trap was employed to confine a cloud of electrons. The trapped electrons collided with background gas molecules, leading to ion production. These ions were accelerated by the trapping potential itself and subsequently detected destructively using a Multi-Channel Plate (MCP). This method provides an indirect but non-destructive means of obtaining information about the stored electrons inside the trap. The trap operated under a magnetic field of approximately 0.18 T and a quadrupolar electrostatic potential of about 350 V. Electrons were generated within the trap by bombardment from a high-energy (~300 eV) electron beam.

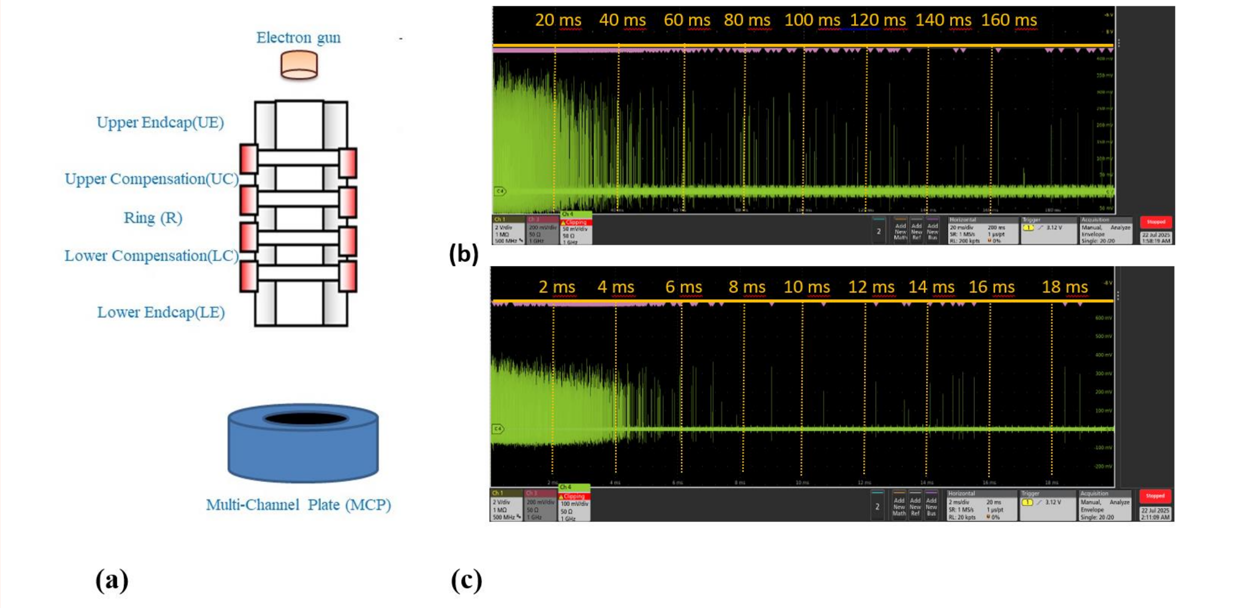

Figure 1 (a): Schematic diagram of Penning trap assembly with electron gun and MCP, (b, c) Oscilloscope image showing the ion stream striking the MCP for trapping of electron cloud at ambient pressure of 1x10^{-7} mbar & 1x10^{-6} mbar respectively.

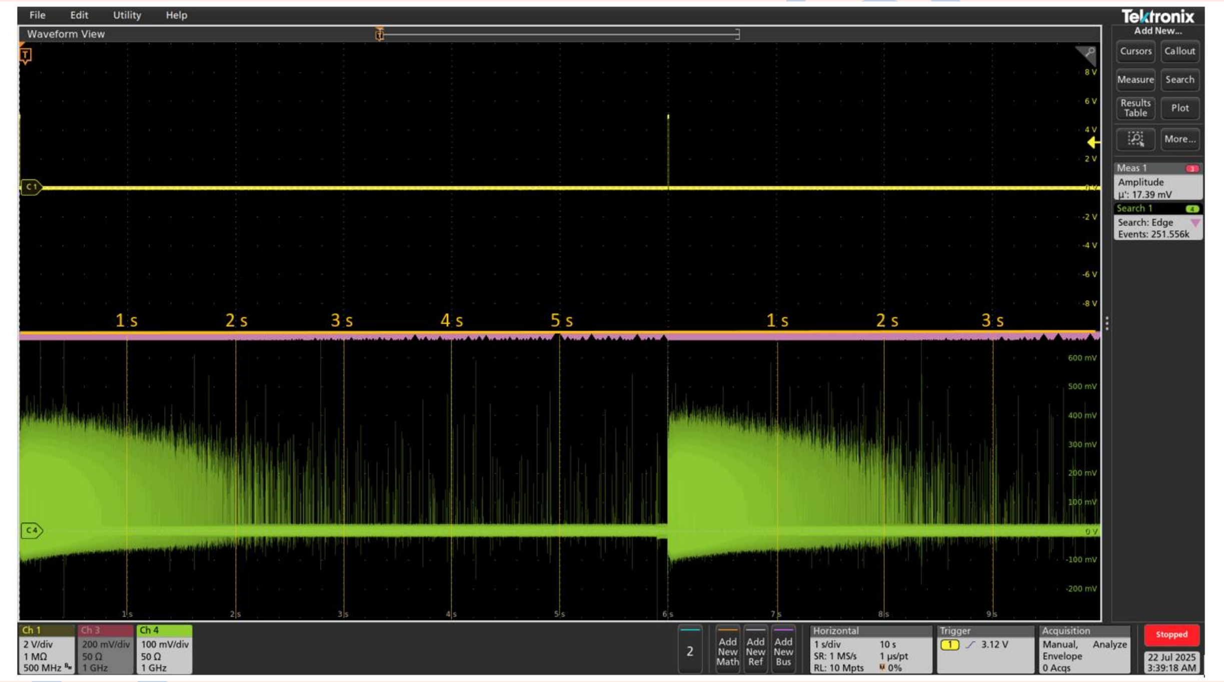

Figure 2: Oscilloscope image showing two cycles where the ion stream are striking the MCP for trapping of 300 eV electron cloud at ambient pressure of 1x10^{-7} mbar. The produced ions kept on striking MCP over the entire trapping time of ~2 sec.

The schematic diagram of Penning trap assembly with electron gun and MCP is shown in Fig. 1(a).

A high-energy electron beam was passed through the trap for 100 µs. Its interaction with residual gas molecules led to the creation of secondary electrons with energies ~ 20 eV. A potential well for storing the secondary electrons was established by applying +350 V to the ring and compensation electrodes, while keeping the end-cap electrodes grounded. The stored electrons collided with the background gases and produced ions which get accelerated to MCP detector. The trapped electron cloud continuously loses energy through collisions with background gas molecules. Although the electrons remain confined for several seconds at the operating pressure of 1x10^{-7} mbar, they eventually lose sufficient energy such that ionization no longer occurs. These ions signal was found to be constant initially and then it decreased exponentially with a decay constant of 20 ms as shown in Fig. 1 (b). It was observed that increasing the background pressure to 1×10^{-6} mbar reduced the exponential decay constant of ion production from 20 ms to 5 ms, as shown in Fig. 1(c).

However, by tailoring the trapping potential in a synchronous fashion, the high-energy (~300 eV) electrons coming directly from the field emitter was confined in the trap. This highly energetic electrons had sufficient energy to undergo multiple collisions and the ion production persisted throughout the entire trapping time of ~2 s as shown in Fig. 2. This behaviour provides a direct technique for measuring the trapping time at a given operating pressure.

Furthermore, if the trapping time exceeds the characteristic time for the high-energy electron cloud to lose all its energy and fall below the ionization threshold, the observed ion signal can be directly correlated with the electron energy. Hence, this technique can be used to determine the kinetic energy of stored electron clouds, provided the cloud loses its entire energy and drops below the ionization limit within the storage time.

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MEASUREMENT OF WEAK BRANCHING RATIO OF ^{159}DY WITH LOWEST Q VALUE

The ground-state to ground-state electron-capture Q-value of ^{159}Dy ($3/2^-$) has been reported as 364.73(19) keV by the JYFLTRAP group. For the allowed Gamow–Teller transition from the $5/2^-$state to ground state with an excitation energy of 363.5449(14) keV, the corresponding Q-value was found to be 1.18(19) keV, which is among the lowest known electron-capture Q-values. This particular decay branch provides a promising candidate for probing the electron-neutrino mass in the sub-eV range through precision studies of electron-capture decay.

However, the branching ratio of this decay branch has not been determined with high accuracy. To address this, we produced ^{159}Dy by bombarding a stack of six ^{159}Tb foils (each of 25 µm thickness) with a 10.5 MeV proton beam from the Room Temperature Cyclotron at VECC. The target was irradiated for 41.5 hours with an average beam current of 2.45 µA. The irradiated target was then placed between two BGO-suppressed Clover detectors. Copper plates were used on both sides of the source to attenuate the high-intensity X-rays, and proper lead shielding was arranged around the setup to reduce ambient gamma background. Data were collected over a period of 100 hours, and the resulting add-back spectrum for one of the Clover detector is shown in Fig. 1.

After applying the dead-time correction and background subtraction, the branching ratio for the $5/2^- \rightarrow 3/2^-$ transition was determined to be $(3.5\pm0.7)\times10^{-4}$ %. This value is about an order of magnitude higher than the previously reported value of 5.5×10^{-5} %.

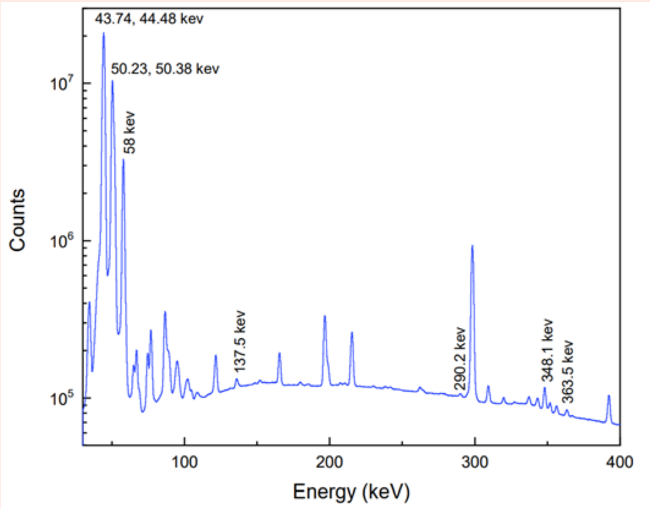

Figure 1: The addback spectrum from one of the Clover detectors for the ^{159}Dy source, collected over a period of 100 hours.

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DEVELOPMENT OF SUPERCONDUCTING TOROIDAL COIL QUARTER WAVE RESONATOR

The realization of high-Q resonators is vital for precision measurements in Penning traps, where the detection of charged particle motion depends on highly sensitive resonant circuits. Conventional copper resonators exhibit a pronounced reduction in quality factor at low frequencies, thereby limiting their applicability in ion trapping experiments. To overcome this limitation, superconducting materials such as NbTi are employed, as they drastically reduce resistive losses and ensure stable operation under cryogenic conditions. Configuring the coil in a toroidal geometry further improves field confinement and minimizes coupling with the surrounding shield, making such resonators particularly effective for high-sensitivity applications in the sub-MHz frequency regime. Insights gained from COMSOL simulations on higher-frequency resonators have shown that employing NbTi exclusively in the coil leads to a substantial enhancement of the quality factor, whereas its use in the shield offers little improvement. Consequently, the present design incorporates NbTi only in the coil while retaining copper for the shield, striking an optimal balance between performance, cost efficiency, and magnetic field homogeneity required for trapping experiment.

A 66.5 m long, 75 µm diameter NbTi filament with Teflon insulation (M/S GVL Cryo-engineering, Make: GVLZ086) was carefully wound on a specially designed Teflon toroidal dielectric core. The wound coil was then placed centrally inside the resonator cavity using a mechanical fixture. This central placement, however, made the cooling of the coil particularly challenging. To address this issue, the coil was wrapped with Teflon tape until it touched the cylindrical wall of the outer copper shield. Although Teflon has a much lower thermal conductivity than copper, it still provides a limited conduction path. Cryogenic trials revealed that without this wrapping, the coil relied solely on radiation cooling, leading to a large thermal gradient (with the shield at 4 K, the coil remained at ~60 K). After the Teflon wrapping was introduced, the thermal resistance was significantly reduced, and the coil temperature reached 6.2 K, well below the superconducting transition temperature of NbTi (9.3K). The resonator was integrated with two SMA connectors on the top plate of the cylindrical cavity, one serving as the excitation port and the other as the receiving port. Cooling was achieved using a cryocooler-based setup. The measured resonance frequency of the resonator was 849.7 kHz with a quality factor of 8092. To the best of our knowledge, this is the first experimental demonstration of a superconducting quarter wave resonator in India achieving a quality factor above 8000.

Figure 1: (a) Teflon dielectric core in toroidal shape, (b) 75 µm diameter NbTi filament wound on the core, (c) Teflon tape wrapped around the core for thermal link maintaining the resonating structure, (d) Assembled toroidal superconducting resonator.

For further details contact j.nandi@vecc.gov.in, (Joydip Nandi, Cryogenic Trap & Nuclear Spectroscopy Section, Physics Group, VECC)

Effect of Length of Wire on the Resonance Frequency of a Helical Resonator

A simulation-based characterization of helical resonators for Penning trap applications has been carried out using COMSOL Multiphysics, with emphasis on the dependence of resonance frequency on wire length under varying geometrical and dielectric conditions. A schematic of the resonator geometry is shown in Figure 1(a), where the total wire length is determined by the number of turns, the winding pitch, and the coil position inside the shield. The simulations reveal a clear linear relationship as shown in Figure 1(b) between the quarter-wavelength and the coil wire length, with the slope influenced by the dielectric medium present in the resonating region. The introduction of dielectric fillers such as Teflon—often required for cryogenic operation—lowers the resonance frequency due to the additional capacitive loading.

Comparing the slope for different dielectric materials in Figure 1(b) the relationship between the quarter wavelength and the length of wire with filler material dielectric constant (ε_r) can be written as

$$\frac{\lambda}{4} = \sqrt{\frac{\varepsilon_r + 0.49}{2.05}} \times Length\ of\ wire$$

For verification of the above equation, previously reported data were considered where the number of turns was N=400, the helix diameter was 31 mm, and the measured resonance frequency was 1.6 MHz. From these parameters, the wire length was calculated as 38,936 mm. Substituting these values into the equation gives a resonance frequency of 1.7 MHz, showing excellent agreement with the reported result. In this case, the wire length is nearly 43 times greater than that used in the simulation regime, yet the equation still predicts the resonance frequency accurately. This relation is particularly significant in the low-frequency (sub-MHz) domain, where no other empirical or analytical expression exists for determining the resonance frequency.

For further details contact j.nandi@vecc.gov.in, (Joydip Nandi, Cryogenic Trap & Nuclear Spectroscopy Section, Physics Group, VECC)

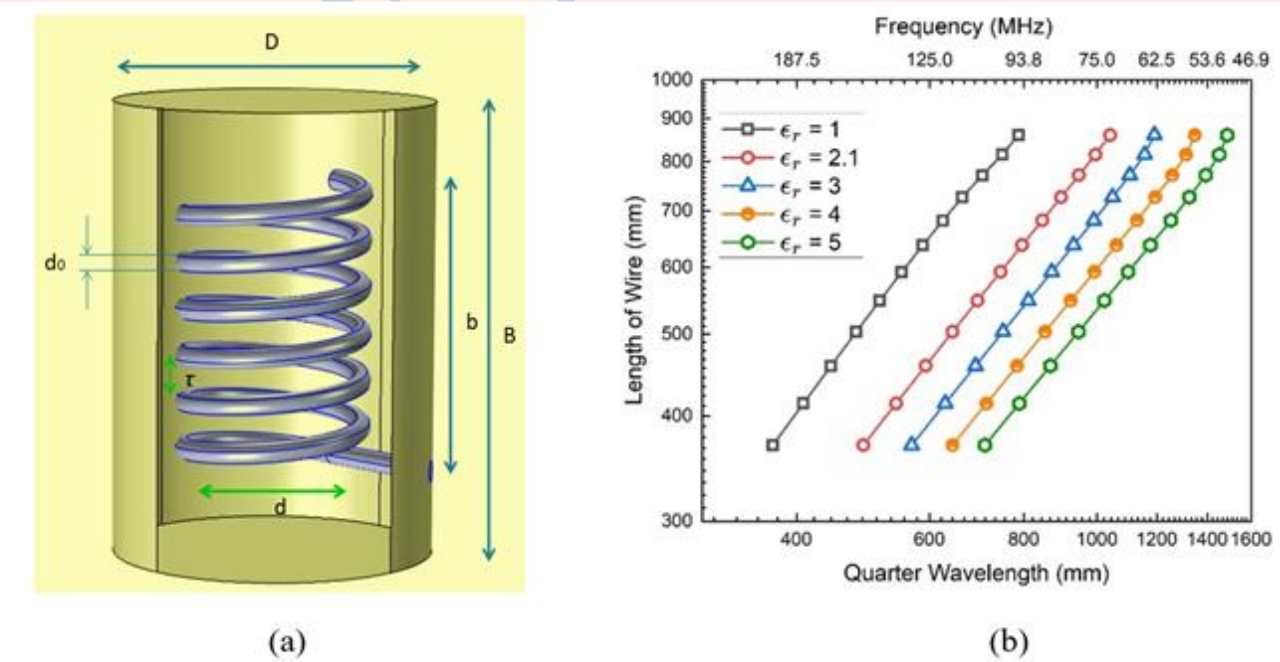

Figure 1: (a) Schematic of helical resonator showing different geometrical parameter, (b) Plot of the Length of the wire with the quarter wavelength is shown for different dielectric filler material.

LANGEVIN DYNAMICAL CODE FOR FISSION VECLAN1D DEVELOPED AT VECC

Although nuclear fission has been discovered almost 85 years ago, it is still an active field of research mainly due to the lack of knowledge on the inter nucleonic interactions. Also, fission is crucial in multifaceted applications ranging from basic sciences to nuclear engineering. Particularly, in basic research, the astrophysical nucleosynthesis process and the production of superheavy elements depend critically on fission decay. Hence, we have renewed the interests in fission research and associated nuclear reaction studies

Different dynamical effects such as nuclear dissipation, deformation-dependent shell correction and level densities, etc. are essential while studying the heavy-ion induced reactions. We have developed a one-dimensional Langevin dynamical code (VECLAN1D) for fission in order to simulate the dynamical evolution of excited compound nuclei starting from the compact ground-state configuration till the time when either the cold fission-fragments or evaporation residues are formed. Three major advantages of the present code with respect to the open-source statistical model codes are: (i) it includes all the relevant dynamical features, (ii) different decay channels can be adopted flexibly depending on the users' requirement, (iii) different time distributions can be generated as the code can follow the real-time dynamics even up to a very large time reaching the upper limit for the fission decay process. Apart from these, the technical advantage is that the code can be run in parallel mode using MPI based parallelization, which substantially reduces the computational time. A concise flowchart of the code is shown in the figure 1.

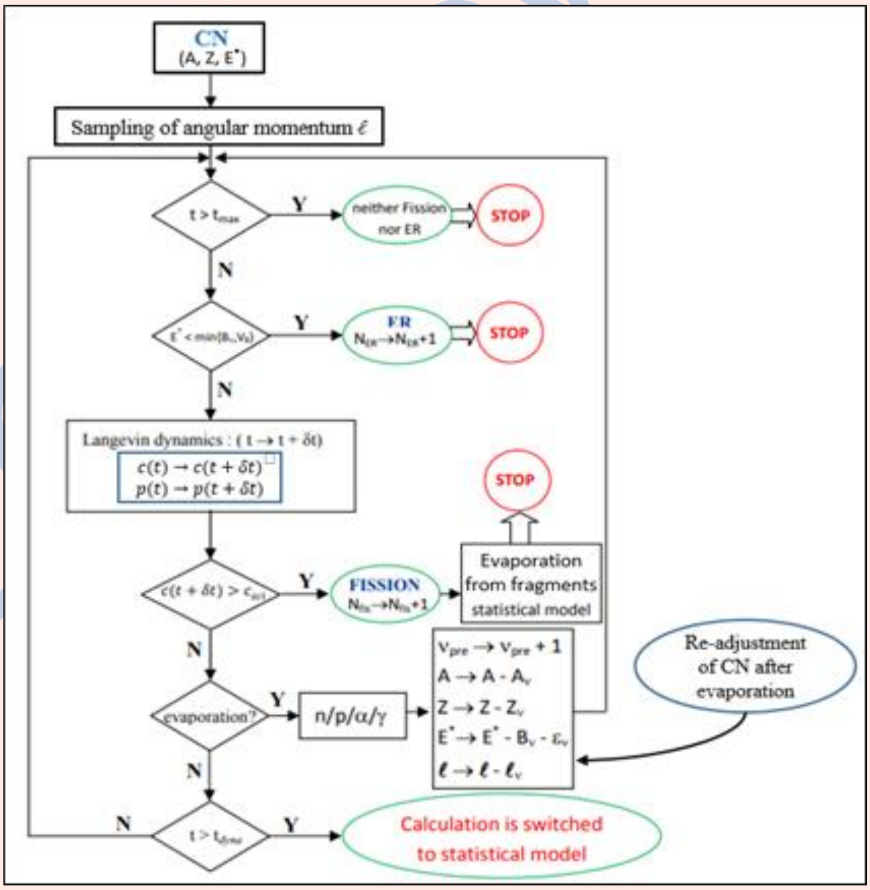

Figure 1: Langevin dynamical decay algorithm for compound nuclear decay

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HESS J1731-347: Unraveling the Mystery of its Composition

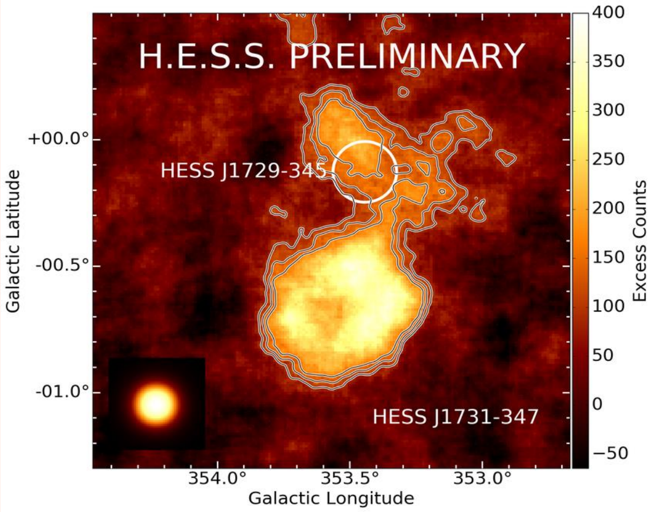

Figure. 1: γ-ray excess count map of HESS J1731-347

HESS J1731-347 is a supernova remnant containing ultralight and very small compact object at its centre. It has mass 0.77 $M_\odot$ and radius 10.4 km. which makes it as one of the lightest and smallest compact objects ever detected. The small size of HESS J1731-347 requires its composition must correspond to soft Equation of State (EOS), while massive stars like PSR J0740+6620 demand a stiff one, creating a tension that motivates exotic models. Our study explores the possibility that HESS J1731-347 is a hybrid star, potentially containing dark matter admixed quark core or a normal quark core.

Dark Matter Admixture in Hybrid Stars

We proposed that HESS J1731-347 could be a dark matter admixed hybrid star (DMAHS). Our study extensively investigates how the density and mass of dark matter particles influence observable properties of DMAHSs, such as their mass, radius, and tidal deformability. We found that stars are more likely to match HESS J1731-347's observed properties if they contain more massive and denser dark matter particles Fig. 2. This suggests that dark matter could be the reason for this compact object's unusually light and small nature. The dimensionless tidal deformability ($\Lambda_{1.4}$), a parameter constrained by gravitational wave observations such as GW170817, also suggests

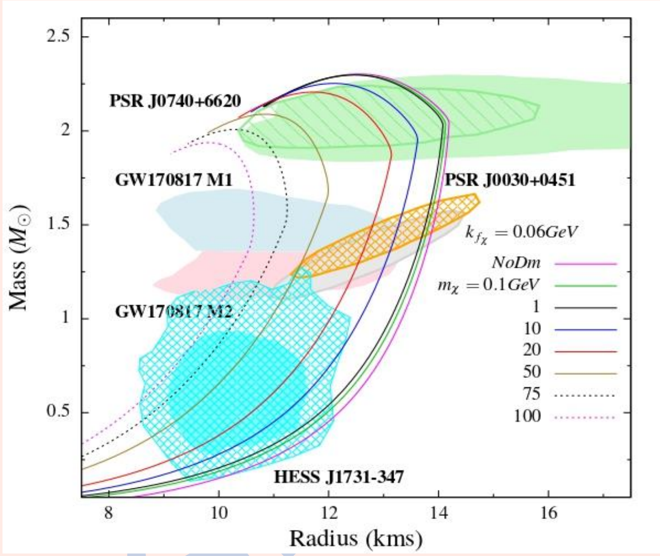

Figure 2: Mass-Radius diagram corresponding to different DM particle mass m_χ with fixed Fermi momentum $k_{f\chi}$ =0.06 GeV.

the same. Interestingly, the speed of sound inside such a star is largely unaffected by the dark matter, because the dark matter kinetic energy is more important than its pressure contribution. In essence, the dark matter admixed hybrid star model offers a plausible explanation for HESS J1731-347, particularly favoring scenarios with more massive and higher Fermi momentum dark matter particles to match its observed properties.

Hybrid Star with a Quark Core

A complementary and equally detailed investigation of ours explores HESS J1731-347 as a hybrid star primarily featuring a quark core, using the Constant Speed of Sound (CSS) model to describe the quark matter. The CSS model is characterized by three key parameters governing the hadron-quark phase transition: transition density (ρ_{tr}), energy jump ($\Delta\varepsilon$) and speed of sound squared (C_s^2) in the quark phase. The energy gap ($\Delta\varepsilon$) was found to be very important, with larger energy jumps making the star more compatible with HESS J1731-347 constraints and facilitating the formation of "twin stars." Low transition densities (e.g. ρ_{tr}=0.25 fm^{-3}) allow hybrid star models to reproduce the HESS J1731-347 data for a wide range of energy gaps. An intermediate value (ρ_{tr}=0.3 fm^{-3}) is particularly favorable, since with gaps of 250–750 MeV/fm^{-3} (Fig. 3) it can simultaneously explain both the light HESS J1731-347 and the massive PSR J0740+6620, offering a unified description. At higher ρ_{tr}, the HESS J1731-347 constraints cannot be matched within a stable hybrid branch. The results are only weakly sensitive to the quark matter speed of sound, though larger C_s^2 supports higher maximum masses. This model strongly supports the idea of "twin star", where a pure nuclear matter star and a smaller, denser hybrid star with a quark core can have the same gravitational mass. HESS J1731-347's (Fig. 3) small size fits well with the hybrid star component of such a twin system. This object, unlike heavier compact stars that probe higher densities, offers unique insights into matter at lower nuclear saturation densities (1-2 times nuclear saturation density).

Both studies offer valuable theoretical frameworks for understanding HESS J1731-347's mysterious composition. They both aim to connect its unusual features with broader observations, including massive neutron stars and gravitational wave events. HESS J1731-347 is a unique cosmic laboratory, pushing the boundaries of what we know about matter in extreme conditions. Future observations are expected to provide more clues, helping us distinguish between these and other proposed explanations.

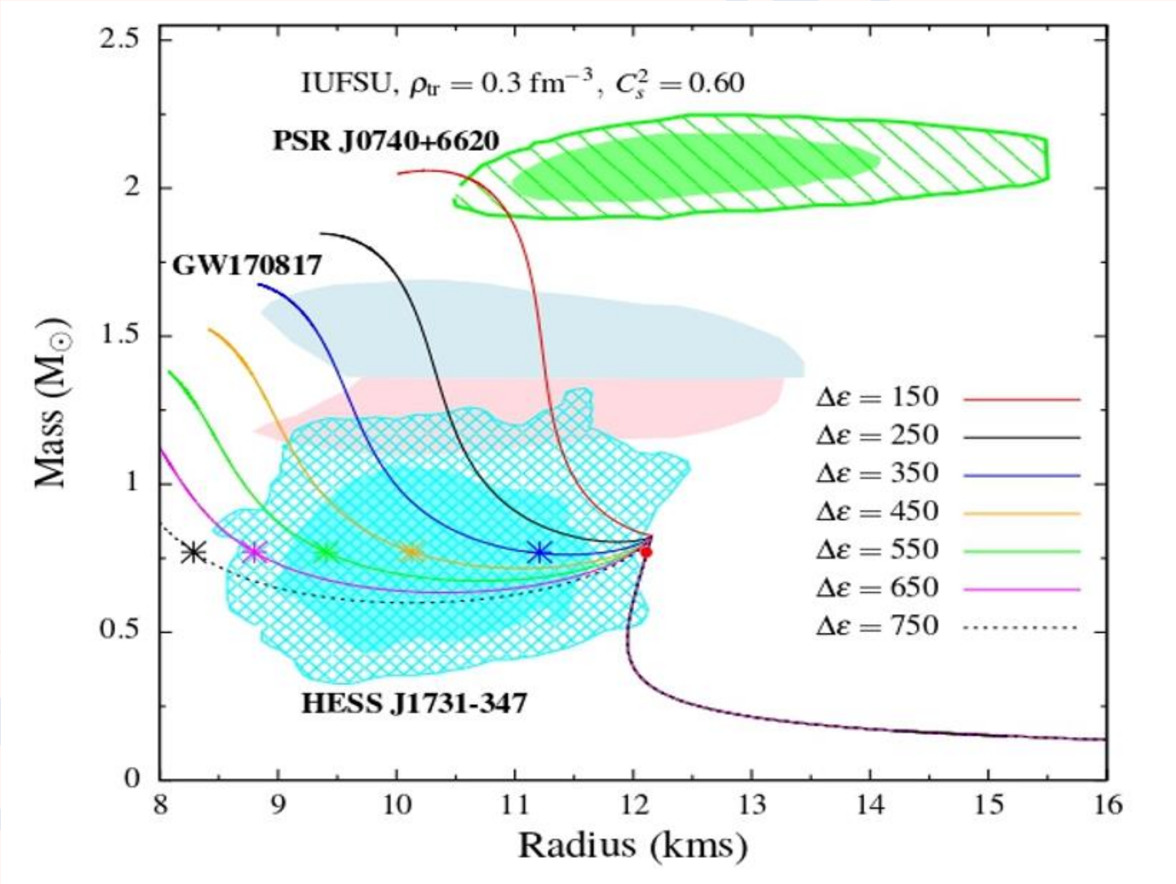

Figure. 3: Mass-Radius diagram for different energy gap (Δε) with fixed ρ_{tr}=0.3 fm^{-3} and C_s^2 = 0.6. '' shows twin star configuarations.*

TECHNOLOGY DEVELOPMENT

INSTALLATION, TESTING AND COMMISSIONING OF HELIUM AND NITROGEN GAS MANIFOLD SYSTEM AT BRIT, MCF, VECC

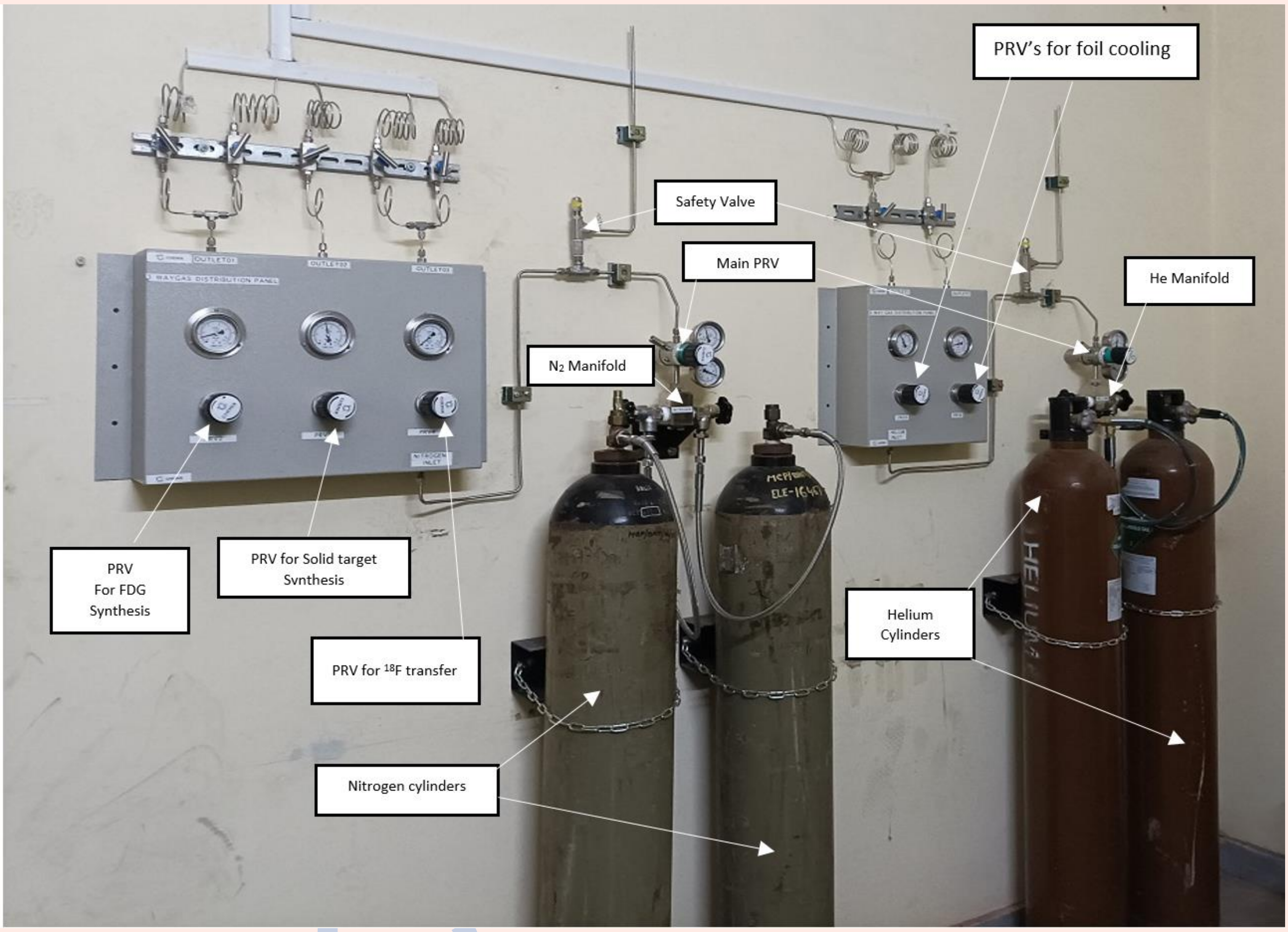

Figure 1. Nitrogen and Helium gas manifold system.

BRIT, RC Kolkata is producing PET and SPECT radiopharmaceutical using Cyclone-30 at MCF, Chakgaria campus. ^{18}F is produced in liquid target by proton irradiation of $H_2{}^{18}O$ by $^{18}O(p, n)^{18}F$ reaction mechanism. During irradiation helium gas (99.999% purity) is recirculated for the cooling of target foils (both Havar and Titanium), with the flow rate of ~ 40 lpm and working pressure ~ 450 mbar.

Nitrogen gas of purity 99.995% is also required for transfer of ^{18}F from the target chamber to synthesizing hot cell, at a required pressure of ~ 2 bar and for transfer of chemical reactants during synthesis of radiopharmaceuticals at various pressures.

For these, two separate manifold systems were developed and installed, one each for He and N_2 gas system, to selectively direct the gas flows to required chambers at varying pressures.

The manifold systems consist of SS tubes (1/8 inch), needle valves and Pressure Relief Valves (PRV) for fine tuning pressure of individual circuits for PET and SPECT modules. The entire system was leak tested at a pressure of 7 bar while installing.

For each gas transfer circuit, there is a dedicated safety valve, which has a crack pressure of 7 bar that ensured venting to atmosphere in case of malfunctioning of the main PRV for the specific system.

Each PRV is fitted with a bourdon tube based pressure gauge, which monitors pressure of the corresponding line in the range of 0-2 bar for helium gas and 0-10 bar for nitrogen gas.
The chief design aspects of the system are summarised as below.

- The manifold provides regulated the pressure to different circuits simultaneously with different required pressure.
- Entire circuit is designed with SS tubings and nut ferule arrangements that provide leak proof, low pressure drop facility and are selected so that these can last over a long period.
- The safety valve in each manifold protects the entire downstream system from damage due to sudden high pressure thrust.
- Each downstream tube consists of one individual PRV besides the main PRV to fine tune pressure in the specific system.
- Manifold system of two cylinder provides the benefit of online cylinder changeover in case of one of the cylinders gets exhausted.

Cylinder brackets and clamps are used to provide effective support to cylinders for safety against fall and accidents

For further details, please contact Shri Arup Kumar Hudait (ak.hudait@vecc.gov.in), RC BRIT, Kolkata

FACILITIES

TRANSFORMER AND MAGNET COIL WINDING FACILITY

The PE&MCD Section, ATG has played 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 has developed several types of coil systems during the years and is still being utilized for the purpose in DC, power line frequency and high frequency applications.

The winding facility has been put to use specifically during January to June 2025 for producing 11 nos 1-ϕ transformers, 1 no 3-ϕ transformer and 4 inductors. The superconducting inductor shown in Fig. 1, is one of the notable products during the period that was wound at the facility for research in Penning Ion Trap, with superconducting wire of diameter 500 μm.

Fig. 2 gives the production summary during the period with a graphical comparison with that of 2024. Transformer production reached a total of 57 transformers to supply 12606.58 VA while coils and inductors totalled 48 that amounted to stored energy of 11.64 J for the magnet coils.

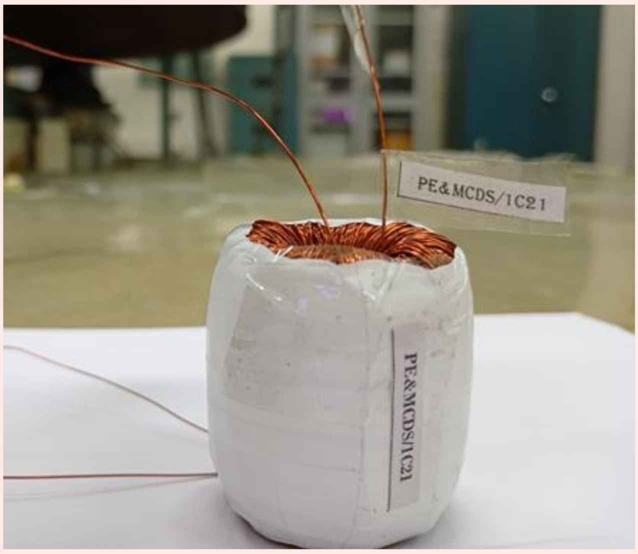

Figure 1: Superconducting inductor for Penning Ion Trap

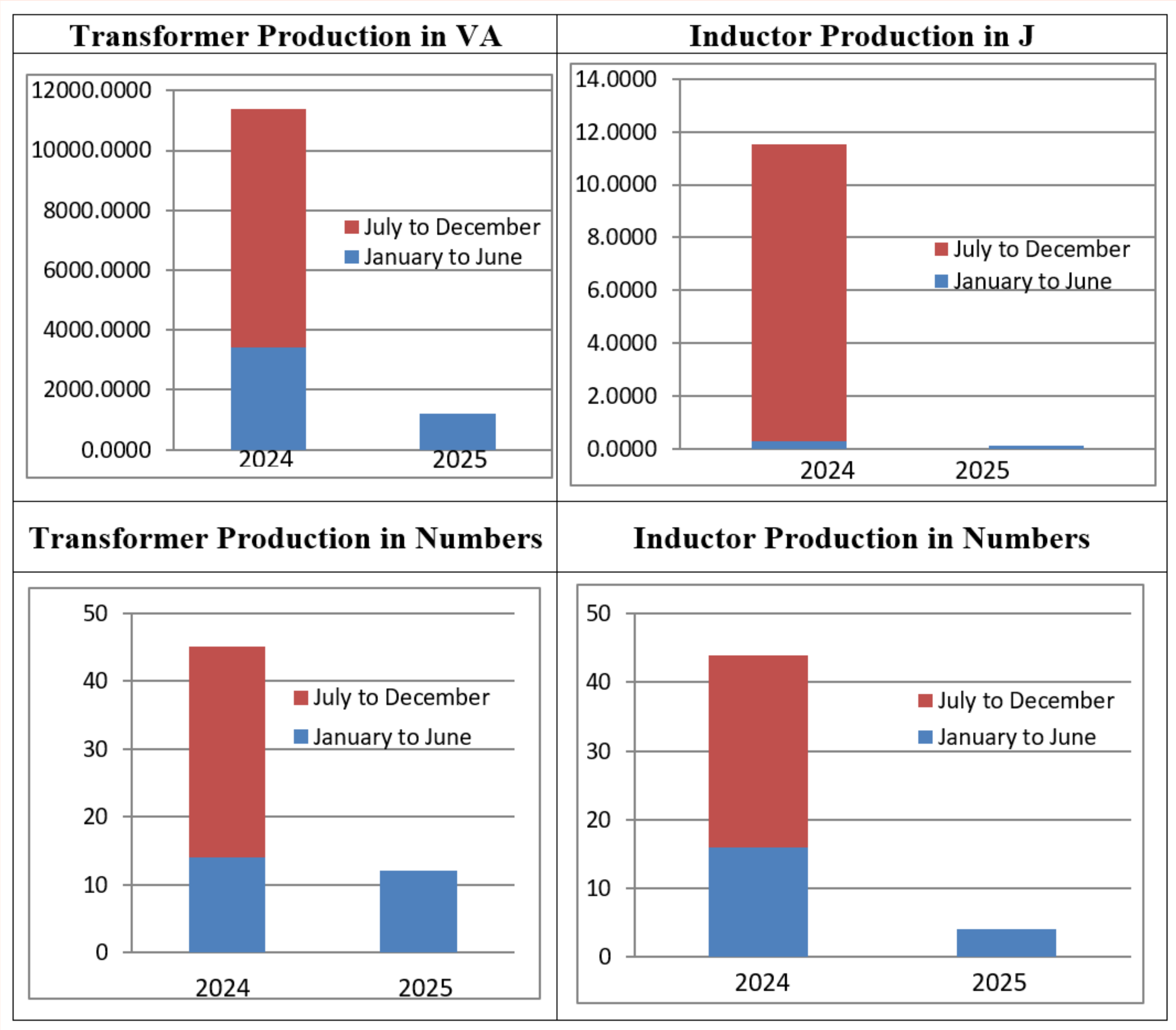

Figure 2: Production from 2024 to June, 2025

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

PUBLIC AWARNESS CELL

VECC OPEN HOUSE VISIT

Public Awareness Cell, VECC organized an 'Open House Visit' on 21st May, 2025, to commemorate National Technology Day. On this occasion, visits to the cyclotron facilities and various laboratories at the VECC Bidhannagar campus were arranged for the general public. The visit included individuals spanning a wide range of ages, from 14 to 65 years.

The visit was organized in two sessions, with 58 participants attending in the morning and 69 participants in the afternoon. A short film highlighting the R&D facilities at VECC was screened for the participants. Following this, they visited the Room Temperature Cyclotron, the Health Physics Unit, the Superconducting Cyclotron, and the Radioactive Ion Beam facilities of VECC in four batches.

The event concluded with participants expressing visible enthusiasm and a sense of inspiration.

AWARDS & HONOURS

BEST POSTER AWARD

Mrs Sumita Chattopadhyay, RC BRIT, Kolkata was awarded the first prize in Poster presentation in 24th National Symposium on Radiation Physics (NSRP-24) for the research work titled **"**Exploring Tungsten alloys as a shielding material for transporting of high activity PET radiopharmaceuticals" organized by ISRP in association with BARC & BRNS held at DAE convention Centre, Anushaktinagar, Mumbai, India during March 27-29, 2025.

Feedback may be sent to
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