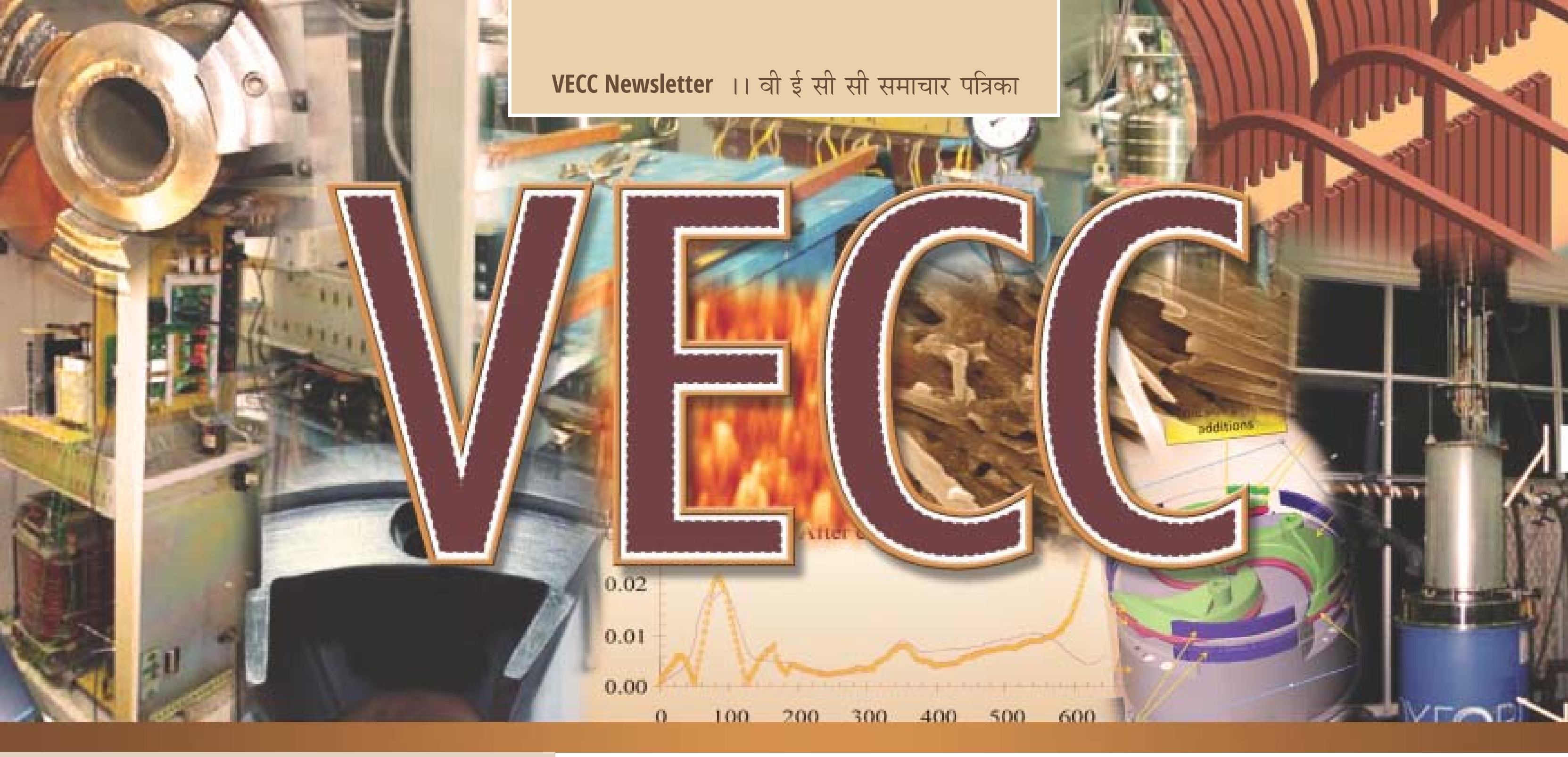
VECC Newsletter ।। वी ई सी सी समाचार पत्रिका



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Contents

Director's Message

Before sharing the news about the major developments at our centre with you, let me wish you and your family all the best for 2015.

The magnetic field of the Superconducting Cyclotron has been remapped in order to identify and correct its existing aberration. It was measured by using a search coil based magnetic field mapping system. The search coil was calibrated by using NMR (Nuclear Magnetic Resonance) based techniques. The deviation of the average field in the central region was compensated by redesigning the associated iron geometry which has resulted in a considerable improvement in the field profile.

The room temperature cyclotron (RTC) is now working better than ever. To maintain the high quality of the beam that is being delivered by RTC maintenance and up-gradation of its various subsystems is essential. In view of this, the control of the beam transport system of RTC has recently been successfully rejuvenated. The excellent performance of the RTC is reflected in the high quality publications that have been achieved recently by using beam from RTC. One such recent example is the investigation of the critical behaviour in the evolution of Giant Dipole Resonance (GDR) width at very low temperature in A ~ 100 region. VECC scientists have observed, for the first time, a plateau in the temperature variation of the GDR width in the low temperature domain. A phenomenological model has been developed by the same group at VECC to explain this result.

Recently, important results on the irradiation of the reactor cladding material have been obtained with the help of beam from RTC which may help in understanding the issues related to the demands for reactors with extended life time. Moreover, the development of the Gadolinium nano-tube by electrochemical technique, formation of nano-structure on Ni film by irradiation method, development of the dynamic voltage restorer using superconducting magnetic energy storage system, etc., are also some of the other important developments reported in this issue.

I am happy to note that in addition to these scientific and technological developments, the current bulletin also communicates several important events like the Summer School on Nuclear Fission to mark the 75 years of the discovery of nuclear fission, INO collaboration meeting, ALICE-India collaboration meeting, etc., at VECC.

Dinesh Kumar Srivastava
(Director)

ACCELERATOR

Magnetic field measurement and correction in superconducting cyclotron

The internal beam in Superconducting Cyclotron at VECC showed large off-centeredness before reaching the extraction radius (~670 mm). This could not be sufficiently corrected by using harmonic coils. Since this beam behavior is a signature of magnetic field aberration, it was felt necessary to remap the magnetic field in order to correct or compensate this aberration to the acceptable limits.

Accordingly, magnetic field distribution in the median plane of the superconducting cyclotron was measured using a search coil based magnetic field mapping system. The magnetic field data was taken in 360 degree azimuth at 2 degree step and up to 668 mm radius at 2.54 mm step. Thus at each scan 180x263 data points were stored. The search coil was initially calibrated using an absolute magnetic field measuring probe based on nuclear magnetic resonance (NMR) principle, and later on search coil's velocity was optimized by minimizing the relative deviation in magnetic field from ten repetitive radial scans. After calibration and tuning of the magnetic field mapping apparatus, actual measurement data was taken for different main coil currents, with central magnetic field in the range of 29 to 39 KG. Each data was analyzed to check the presence of any error induced due to the mapping system and subsequently corrections were made. After 1st set of measurement, the average magnetic field in the central region, was found to be significantly deviated compared to the previous measurement carried out in the year 2006. Simultaneously, a large 1st harmonic magnetic field of 45 Gauss peaking at 650 mm was observed. To reduce the 1st harmonic magnetic filed towards extraction radius, extra iron shims were added on inner wall of the cryostat. The locations of the various shims in the inner walls of the cryostat are shown schematically in figure 3.

To compensate the average field deviation in the central region up to 120 mm, the associated iron geometry was redesigned and modifications were incorporated. Figure 4 shows the central plug region with the modified hill regions added. The modifications are shown separately in figure 5. To confirm the effectiveness of the corrections made, magnetic fields were measured again. Deviation in average magnetic field and 1st harmonic peaking component were found to be reduced.

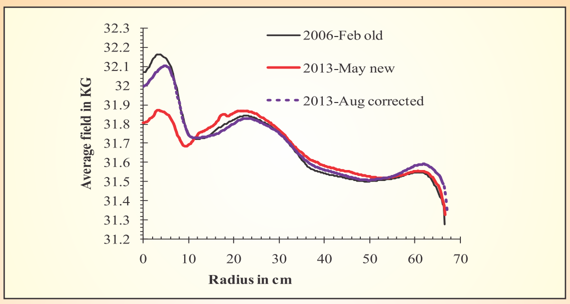

Figure 1: Deviation in magnetic field before and after correction. In the figure black line indicates previous measurement (in the year 2006); red line indicates present measurement before correction. Violet dotted line represents the field mapping after correction.

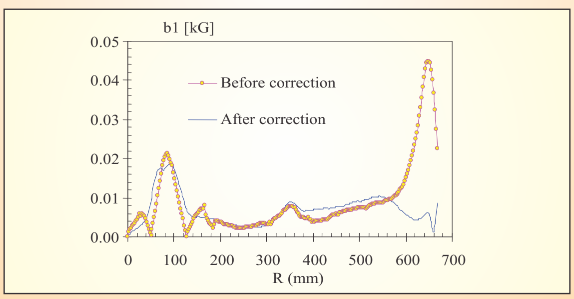

Figure 2: 1st harmonic field amplitude before and after correction.

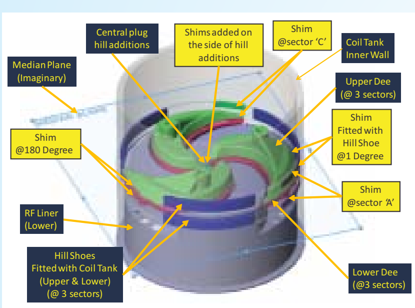

Figure 3: Shim locations (on inner wall of cryostat)

Figure 4: Central Plug with the modified hill addition

Figure 5: Modified hill addition

Successful upgradation of BTS vacuum control system for K130 cyclotron

Recently, vacuum control for the beam transport system (BTS) in K130 cyclotron was upgraded. The BTS vacuum system of K-130 Room Temperature Cyclotron is comprised of many high vacuum pumps, valves, beam line gate valves and several vacuum gauges distributed over cyclotron vault and caves. This system is indispensible towards maintaining high quality vacuum in BTS. It ensures the quality of the accelerated beam while transporting it from the cyclotron to the experimental target. The implementation of state-of-the-art PLC based control system replacing the relay based system enhances the operational reliability and maintainability and facilitates computerized distributed control and monitoring.

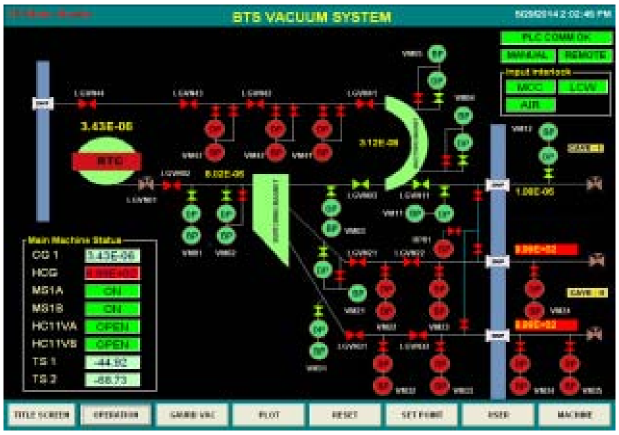

Figure 1: Remote operator interface of BTS vacuum system

The operational logic of this system is designed to incorporate the necessary interlocks for safe operation of the field components and hence ensures the overall vacuum quality of the BTS system. Since the operation of the cyclotron depends on main machine vacuum and BTS vacuum, few crucial parameters of the main machine are also used in the operational interlocks of this system. An optimally designed integrated local control panel is provided for in-situ module-wise monitoring and control of all the vacuum components distributed among several channels of BTS vacuum system during commissioning and periodic maintenance of the system. The in-house developed EPICS (Experimental Physics & Industrial Control System) based supervisory control of the main machine vacuum system is upgraded to incorporate the BTS system 'mimic', as shown in Figure 1, for computerized remote monitoring and operation of the system. This PC based supervisory system also provides facilities e.g. on-line trending, audio-visual alarms, user-authentication based operation etc.

The PLC based control system is designed to cater the future requirement of fourth beam line to be used for RIB system. The installation, testing and commissioning of the system is completed successfully within stipulated period.

PHYSICS

Probing the critical behavior in the evolution of GDR width at very low temperatures in A~100 mass region

Recently, Physics Group, VECC has proposed a new phenomenological model called the Critical Temperature included Fluctuation Model (CTFM). It is proposed that the experimental GDR widths should remain constant at the ground state values until a critical temperature (T_c) and the effect of the thermal fluctuations on the experimental GDR width (i.e. increase of the apparent GDR width) should appear only above T_c. In order to probe the critical behaviour in A ~ 100 mass region, an extensive experiment was performed by bombarding ^{93}Nb target using ^{4}He beams at 28, 35, 42 and 50 MeV from the K-130 Cyclotron. The high energy photon spectra at 42 MeV beam energy is shown in Fig 1 along with the linearised GDR spectra for different angular momenta. Interestingly, these are the first data points both above and below the critical point in A ~ 100

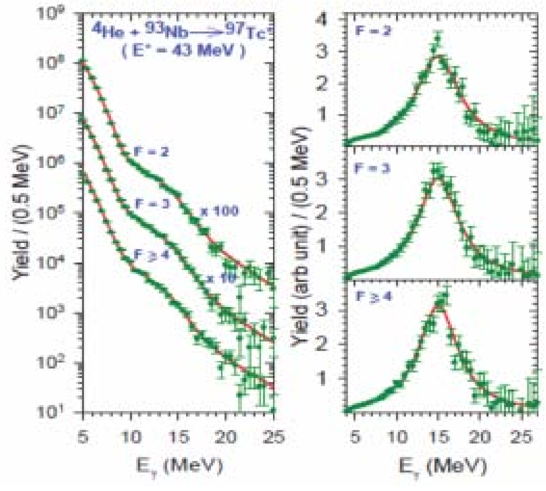

Figure 1: Experimental γ-energy spectrum along with CASCADE prediction (Left panel). Linearized GDR strength function (Right panel).

mass region. The data have been compared with Thermal Shape Fluctuation Model (TSFM) and CTFM in Fig 2. As can be seen, the temperature dependence of the GDR width determined from this experiment differs substantially from the commonly accepted adiabatic TSFM. On the other hand, the CTFM better explains the trend of the data at this low temperature range pointing towards the universality of the CTFM in explaining the temperature and angular momentum dependence of the GDR width. The results were published in Phys. Lett. B 731 (2014) 92.

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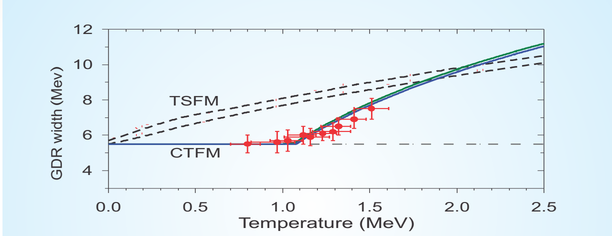

Figure 2: The GDR widths as a function of T for ^{97}Tc. The red filled circles are the data from this work. The dashed lines (no shell correction) and dotted lines (shell correction) correspond to the TSFM calculations at two angular momenta J = 0$\hbar$ (lower) and J=30 $\hbar$ (upper) while the continuous lines are the results of the newly developed CTFM calculations at two angular momenta J=10 $\hbar$ (lower) and J=20 $\hbar$ (upper) selecting the extreme angular momenta involving the experimental data.

New framework to yield the statistics of dislocation pinning at defects

Introduction

Irradiation of materials by energetic particles generates nano-size defects at the atomic scale, and their subsequent evolution with other defects affect mechanical behaviour of materials at the macroscopic scale significantly. For example, the phenomena like hardening and creep are highly influenced by pinning of dislocations by nano-size defects like voids, precipitates and bubbles. The basic mechanism of dislocation-defect interactions are widely studied in last few decades through numerous experiments, computer simulations and analytical modelling. However, a statistical framework is still awaited to incorporate complete size-distribution of the defects along with dislocation density to yield the detailed statistics of dislocation pinning by defects affecting long term behaviour of materials.

Mathematical framework

In this approach, we take into account spatially homogeneous, three dimensional distributions of dislocation lines and pinning defects, which can be modelled as spherical in shape. With the help of geometrical arguments and few justified assumptions along with the minimal set of material parameters as input, we derive a simple closed form expression for the statistics of dislocation pinning at localized nano-size defects of arbitrary size-distribution as,

$$\frac{dN_{\perp o}}{dr} = \frac{1.03\eta_0 \rho_\perp f_0(r)}{\int_{r_{\min}}^{r_{\max}} r^3 f_0(r)\,dr}$$

where $\rho_\perp$ is the dislocation density, $f_o(r)$ is the size-distribution of defects with radius *r*, the is volume fraction of defects and η_o is the number of pinning sites. Calculations are done for a given size-distribution $f_o(r)$ with η_o as starting number density of defects.

Application of the model

Application of this model has been illustrated by calculating the pinning statistics for experimental data of nanovoid distributions in type 316-stainless steel, which has been irradiated (6×10^{22} neutrons/cm^2) at different temperatures (data taken from D. Olander, *Fundamental Aspects of Nuclear Reactor Fuel Elements*, Technical Information Center, U.S. Dept.of Energy,VA,1976). An interesting phenomenon of transition from rare pinning to multiple pinning regime is revealed with increasing irradiation temperature (refer Figure 1). For dislocation density $\rho_\perp$, the mean distance between two adjacent dislocation lines can be approximated as $\rho_\perp^{-1/2}$. When a nanovoid diameter exceeds this mean distance, it would pin multiple segments simultaneously. We observe that the crossover radii for 763K and 803K lie close to $\rho_\perp^{-1/2}/2$ thereby validating the consistency of the above derived equation. With more intrinsic parameters at hand, this model can be further modified and refined to provide helpful results of physical significance for radiation damage studies.

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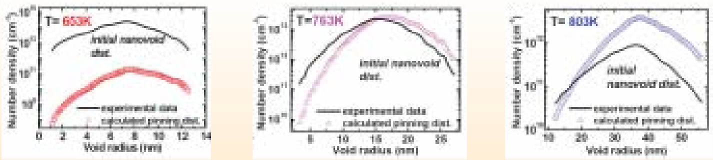

Figure 1: Calculated distribution of pinning at nanovoids are plotted with initial nanovoid data for three temperatures

Radiation damage studies on reactor cladding material

Zirconium based alloys find extensive use as structural materials in nuclear power plants. These alloys exhibit a combination of good corrosion resistance, superior high temperature mechanical properties, and resistance to irradiation induced dimensional changes. The urge for meeting the demands of extended reactor life, high burn up of fuels, higher coolant temperature and partial boiling inside coolant channel have led to a worldwide drive in development of new zirconium alloys with improved properties. Over the years, binary Zr-1 wt.% Nb alloy has drawn considerable interest owing to its prominent application as cladding material, particularly in Russian Pressurized Water Reactor (PWR) of VVER type.

This study has been done in collaboration with Material Science Division (MSD), BARC. In this work, an attempt has been made using both wide angle X-ray diffraction and synchrotron grazing incidence X-ray diffraction (GIXRD) to characterize the microstructural parameters like domain size and microstrain within the domains of Zr-1Nb alloy as a function of proton-irradiation dose. The main aim of this work has been to investigate the variation of statistically averaged microstructure in the irradiated region from surface to bulk as a function of damage energy deposition. The X-ray diffraction line profile analysis (XRDLPA) has been used to characterize the microstructural parameters in a statistical manner averaged over a volume of 10^9 μm^3 for wide angle XRD and 10^6 μm^3 for GIXRD. Hence, the bulk damage and near surface damage could be assessed by this analysis.

For proton irradiation experiments the electropolished samples were mounted on an aluminum flange and then irradiated by 5 MeV proton beam from Variable Energy Cyclotron (Variable Energy Cyclotron Centre, India) using aluminium degrader. The current on the target was 2μA. The irradiation doses were 5×10^{16} protons/cm^2 and 7×10^{17} protons/cm^2. The flange used for irradiation was cooled by a continuous flow of water. During irradiation, sample temperature did not rise above 40°C as monitored by a thermocouple placed in close proximity of the sample. The range of protons in Zr-1Nb, and the damage profiles were obtained by Monte-Carlo simulation technique using the code SRIM 2000. Maximum depth of penetration of the ions was estimated to be 120±3μm.

Characterization of the inhomogeneous damage profile using
•Grazing Incidence XRD – using SYNCHROTRON - RRCAT λ = 0.709Å
•Wide-angle XRD – VECC λ = 1.54 Å

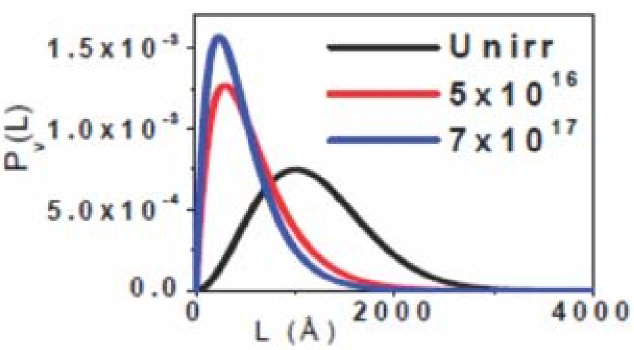

Fig1 : Size distribution of domain ($P_v(L)$) with coherent length (L)

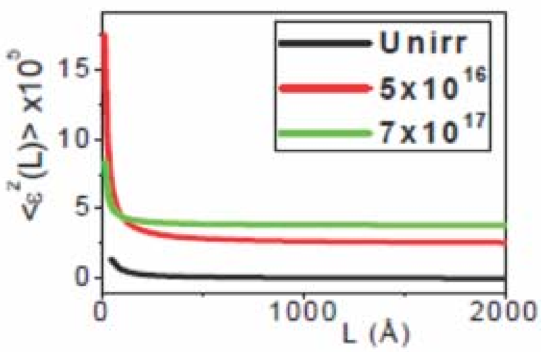

Fig 2 : Change in average microstrain $\langle\varepsilon^2(L)\rangle$ with coherent length (L)

The microstructural parameters particularly the domain size and the microstrain within the domains have been estimated as a function of irradiation dose and depth by line profile analysis of wide angle XRD and GIXRD data. Model-based approaches of XRDLPA like Simplified Breadth Method, Williamson–Hall Technique, Double Voigt Analysis, all relying on single peak analysis, and modified Rietveld technique, based on whole powder pattern fitting, have been used to analyze the microstructural parameters. The distributions of domain size and average microstrain have been plotted in Fig.1 and Fig 2 respectively as a function of coherent length.

It is interesting to note that the analyses of wide angle XRD data, in comparison to the GIXRD data at low incidence angles, resulted in an estimation of higher average volume weighted domain size. Assuming the average depth of penetration of CuK_α in Zr to be ~ 35–40μm, the wide angle X-ray diffraction is expected to probe a volume almost three times than that of GIXRD at low angle of incidence. Since the peak damage region is characterized by the presence of rich concentrations of vacancies and interstitials, there will be a flow of vacancies away from the peak damage region down the concentration gradient. As a result, the mutual recombination process will become dominant as compared to clustering of defects at a depth of ~ 35–40 μm. Consequently, the size of the coherent domains is expected to be higher in these regions, as aptly observed in the present study by wide angle X-ray diffraction.

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Multiplicity distributions in Au + Au collissions at RHIC

The Experimental High Energy Physics and Applications group at VECC has a major participation in the STAR experiment at the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory. RHIC has embarked on a beam energy scan (BES) program since the year 2010 to map the QCD phase diagram and to search for the QCD critical point. The BES program was initiated by scientists at VECC, who have made a major contribution to the critical point search.

Lattice QCD calculations indicate that at vanishing baryonic chemical potentials the transition from the QGP to a hadron gas is a smooth crossover, while at large chemical potentials, the phase transition is of first order. Therefore, a critical point in the QCD phase diagram is expected at finite chemical potential at the end of the first order transition. The aim of the beam energy scan program is to map the QCD phase by varying the center-of-mass energy of the colliding ions, thereby scanning a large window in baryonic chemical potential and temperature.

One of the characteristic signatures of the QCD critical point is the non-monotonic behavior in the fluctuations of globally conserved quantities, such as net-baryon, net-charge, and net-strangeness number as a function of beam energy. At the critical point, thermodynamic susceptibilities and the correlation length of the system are expected to diverge for large samples in equilibrium. The products of the moments of the net-charge, net-proton, and net-kaon are expected to go through rapid change near the critical point. In addition, the products of the moments can be effectively used to determine the freeze-out points on the QCD phase diagram by comparing directly with first-principle lattice QCD calculations. The higher moments of net-proton distributions have already been reported earlier in two publications (Physical Review Letters 105 (2010) 022302 andPhysical Review Letters 112 (2014) 3, 032302).

In a recent publication, the moments of net-charge distributions have been reported for Au-Au collisions at c.m. energies of 7.7, 11.5, 19.6, 27, 39, 62.4, and 200 GeV, corresponding to baryonic chemical potentials from 410 to 20 MeV. Within the statistical and systematic uncertainties, no non-monotonic behavior has been observed in the products of moments as a function of collision energy. Calculations of freeze-out parameters based on these data have been obtained from the latest lattice and HRG analyses. The extracted freeze-out temperatures range from 135 to 151 MeV and chemical potentials range from 326 to 23 MeV. These measured moments, for the first time, have provided unique information about the freeze-out parameters by directly comparing with theoretical model calculations. Future measurements with high statistics data will be needed for precise determination of freeze- out conditions and to make definitive conclusions regarding the critical point. This is the major goal of the second phase of beam energy scan program (BES-II) at RHIC. This work constituted the thesis topic of Dr. Nihar Ranjan Sahoo, HBNI scholar at VECC, who is presently at Texas A&M University. For further details, refer to Physical Review Letters 113 (2014) 092301.

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Lifetime measurement and decayspectros copy of neutron-rich ^{132}I

The structure of nuclei around the doubly magic neutron rich ^{132}Sn (Z=50 and N=82) is of special importance that gives insight about the evolution of nuclear shell structure of neutron-rich nuclei. The odd-odd nuclei in this mass region are of particular interest to understand the proton-neutron residual interaction in the single particle orbits. Recently, Physics Group, VECC has taken up a program to study the neutron-rich nuclei around ^{132}Sn from fission fragment decay spectroscopy. Fission processes are known to be the most efficient routes for the production of neutron rich nuclei in this region. With the recent advancement of novel techniques of chemical separation and identification, it is now possible to obtain precise information related to a particular nucleus without any contamination. In the present work, the neutron-rich Iodine and Tellurium isotopes have been produced by alpha-induced fission of ^{235}U. Alpha beam of 40 MeV was obtained from K-130 cyclotron at VECC, Kolkata and incident on a stack of ^{235}U electro-deposited targets separated by Aluminium catcher foils, in which fission products were collected. Radiochemical separation was carried out to separate the element of interest. The radioactive solutions of fission products before and after the radiochemical separation were counted with High Purity Gemanium (HPGe) detector to ensure the clean separation of respective isotopes.

The low lying level structure of ^{132}I has been derived by the beta decay of ^{132}Te and a high spin isomer decay in ^{132}I. The lifetime of first excited state of ^{132}I has been precisely measured using new generation $LaBr_3$(Ce) scintillators for the first time, by populating the state from beta decay of ^{132}Te. The energy spectrum of $LaBr_3$(Ce) detector for a separated Tellurium sample is shown in Fig.1 and time spectrum between the transitions feeding in (228 keV) and feeding out (49 keV) of the first excited state of ^{132}I, populated from beta decay of ^{132}Te, is shown in Fig.2. The decay measurement from both the high-spin isomer and the ground state in ^{132}I were performed using a high resolution Low Energy Photon Spectrometer (LEPS) of four-fold segmented planer HPGe detector and a Clover HPGe detector. The corresponding LEPS and Clover Ge spectra are shown in Fig.3 and Fig.4 respectively. The 97 keV γ-ray has been identified as decaying out from the isomer in ^{132}I and the half-life of the isomer has been obtained as 89.4±4.7 min. The γ rays of other neutron-rich Xenon isotopes, populated from the beta decay of various neutron-rich Iodine isotopes are also identified in the spectra.

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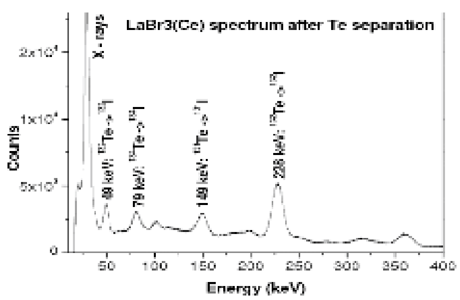

Figure 1: The spectrum of $LaBr_3$(Ce) detector for sample counted after the radiochemical separation of Te.

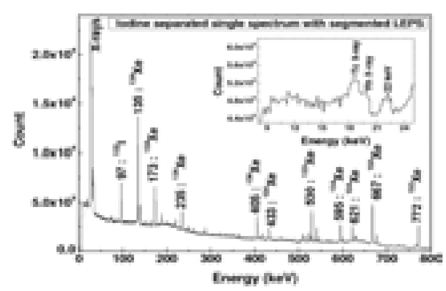

Figure 3: LEPS spectrum of Iodine sample, the lower energy part of the spectrum is shown in the inset.

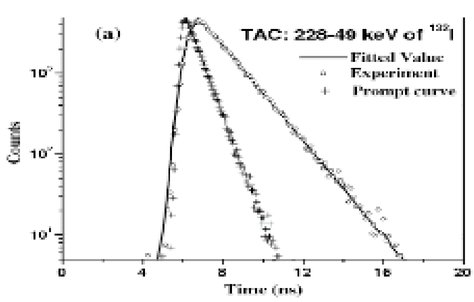

Figure 2: The decay (TAC) spectrum of 228-49 keV cascade corresponding to first excited state of 132I

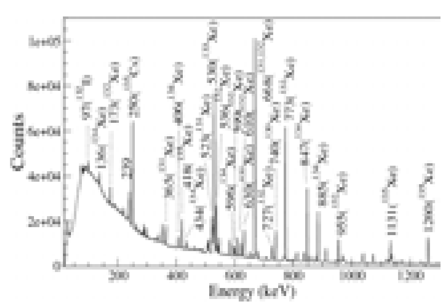

Figure 4: The γ spectrum of Iodine sample obtained with Clover HPGe detector showing all decay products.

MATERIAL SCIENCE

Nanostructure formation on Ni film by ion irradiation

The growth of nanostructure like nanowire, nanotube, nanoripple etc. provides a new dimension to functional materials. Enhancement of properties in a particular direction can be achieved. Out of various techniques, low energy ion irradiation is a unique one to grow a wide variety of nanostructures. With this end in view, Ni thin films of thickness around 90nm grown on optically polished Si were subjected to irradiation at VECC with 10keV Ar ion up to a fluence of $7x10^{16}$ions/cm^2 at oblique angles of incidence. There are signs of growth of nanopillar type structure. Fig. 1 shows AFM pattern for one typical position of a film irradiated with $5x10^{16}$ions/cm^2 at an angle of 80^0 to normal, i.e. almost grazing incidence of 10^0. There are signatures of nanopillar formation. Magnetic studies are being carried out in both in-plane and out of plane direction to ascertain anisotropy due to the formation of nanopillar.

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Development of Gadolinium nanotube by electrochemical technique

Present situation of global warming demands the environmental friendly technology for replacing the conventional hazardous gas compression refrigeration technique employed worldwide in our day-to-day life. In this regard, materials with large Magnetocaloric effect (MCE) can be considered as a potential candidate for environmental friendly magnetic refrigeration application. Array of aligned Gadolinium (Gd) nanotubes having length in the micrometer range, average diameter ~ 200 nm and wall thickness ~ 27 nm have been developed electrochemically at VECC. The study of magnetocaloric entropy change is under progress.

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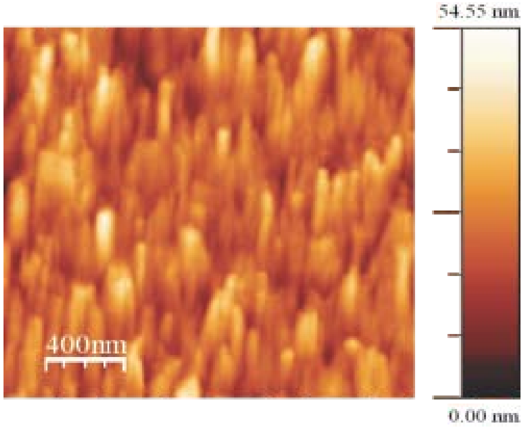

Figure 1: AFM picture of position 1 bombarded at 80^0 to normal with 8keV Ar^+ fluence of $5x10^{16}$ ions/cm^2

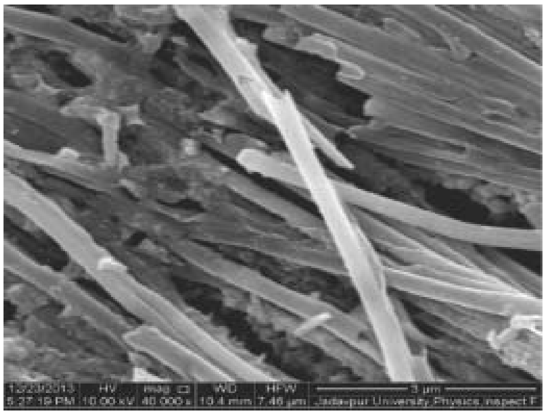

Figure 2: FE-SEM of Gd nanotube developed by electrochemical technique

TECHNOLOGY DEVELOPMENT

Dynamic voltage restorer using superconducting magnetic energy storage system

The Power Quality is one of the most important issues in power distribution system. The problems generally appear in the form of three broad categories that are voltage sags, transients and harmonics. Many critical machines or industrial processes, especially controlled by computers are sensitive to any voltage sag or short interruptions in

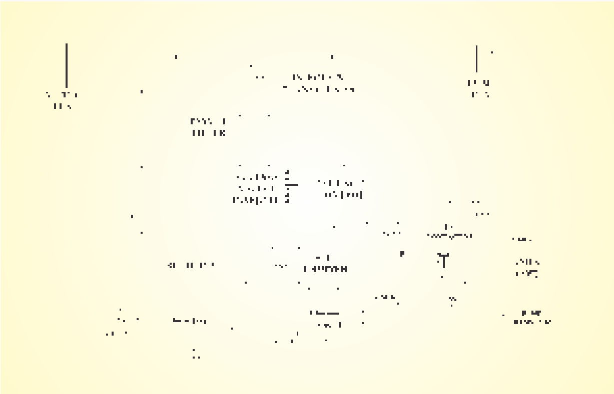

Figure 1: Schematic of DVR using SMES coil

supplying. These disturbances in supply can increase the down time of the machine and hence the cost of production. Accelerator laboratories also suffer from sudden voltage dip that leads to sub-system trips resulting in shutdown of the entire machine. VECC has undertaken the development of Superconducting Magnetic Energy Storage (SMES) system based Dynamic Voltage Restorer (DVR) to address this issue that may find application in particle accelerator facilities, R&D laboratories and industries in the country.

DVR (Fig. 1) is one of the most effective and efficient compensating type power electronic controller used in the distribution network to get rid of or to mitigate the most severe power quality problem caused by voltage sags, especially for sensitive loads. Its major components, designed and developed at VECC includes

1. **SMES Coil** (Fig. 2a): The cryostable superconducting magnet was constructed using NbTi based superconductor and vapour cooled current leads to carry DC current of 800A (max), thus storing 0.6MJ of energy. The coil assembly was being housed inside a Standard Magnet Dewar (SMD) with all related instrumentations and coil protection system comprising of a quench detection circuit and dump resistor (20 m-ohm, 5kW) placed externally.
2. **2-Quadrant DC-DC Chopper** (Fig. 2b): A high current IGBT based DC- DC chopper was designed and developed for charging the superconducting coil to its constant current of 400A (max) for energy storage and to discharge the stored energy to a constant DC-link capacitor voltage of ~80V as required by the VSI. A novel topology of "Hysteresis Band Controller" was adopted for proper functioning of the chopper in two-quadrant in order to match the power flow demand of the DVR system.
3. **3-ϕ Voltage Source Inverter (VSI) with DSP based control** (Fig. 2c): A 10kVA 3- ϕ VSI was designed and developed that compensates for the voltage sag in the utility mains so as to keep the load voltage constant, deriving power from the chopper controlled constant DC bus. A 12-bit multi-channel 12.5 MSPS ADC and 3- ϕ PT based instrumentation samples the input mains and feeds to a DSP based controller that ultimately generates the switching signals to the IGBT bridge of the VSI, employing pre-sag compensation technique.

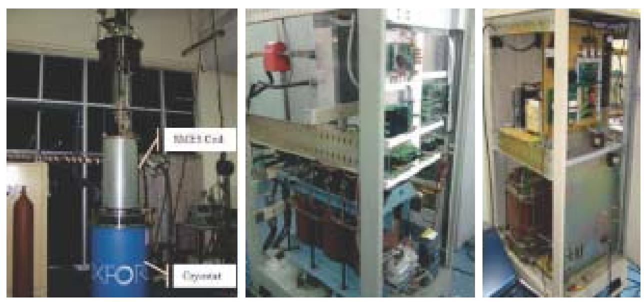

Figure 2: (from left) a). SMES coil, b). DC-DC chopper, c). VSI

Integration and Functionality test of SMES based DVR

Following integration of the four sub-systems, the trial for demonstration was done on 8th August 2014. The superconducting coil with 800kg of cold mass and inductance 1.86H underwent rigorous cryogenic tests (Fig. 3) and thereafter cooled down to approximately 4.2K by liquid Helium with pool boiling mode of heat transfer.

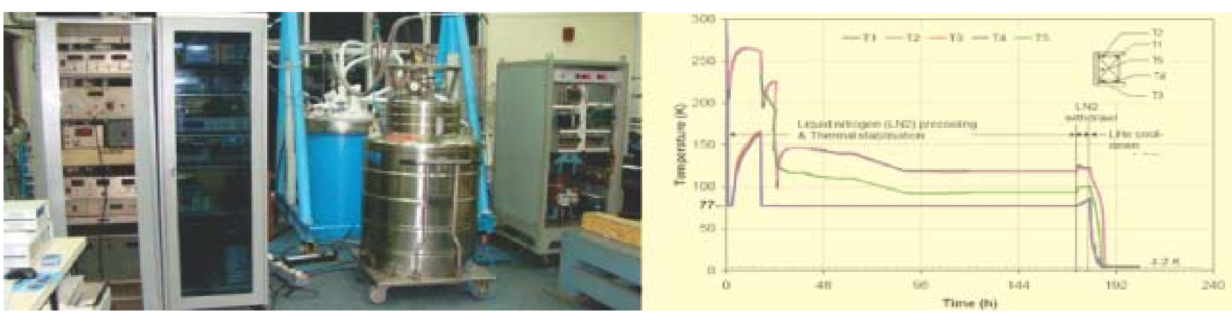

Figure 3 : (from left) a). Test set-up and b). cool down characteristics of coil

VECC

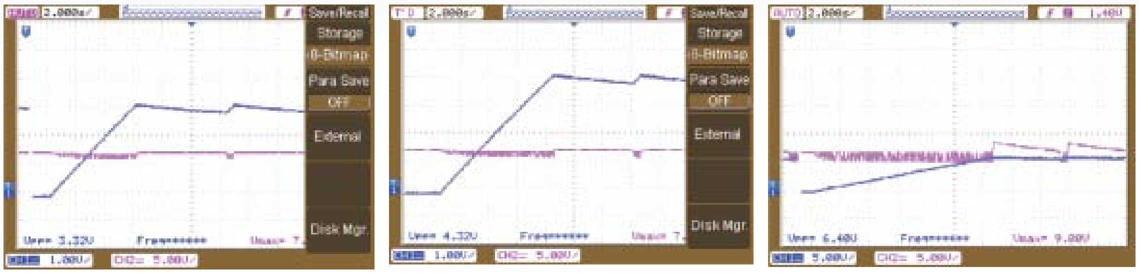

Figure 4: Current ramp up (blue) up-to 150A (extreme left) up-to 200A (middle),up-to 300A (right), keeping DC-bus voltage (pink) constant ~ 55V during charging

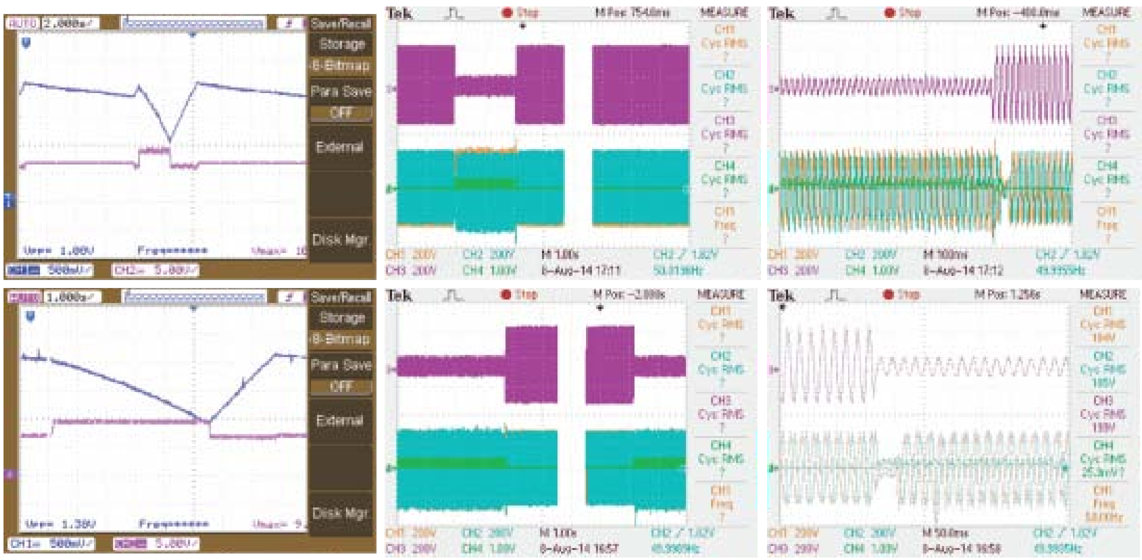

Figure 5: (top & bottom extreme left) coil current (blue) & DC-bus voltage boost (pink) of ~80V to meet VSI requirement during sag, (top & bottom middle) mains voltage (pink), load voltages (blue, yellow), sag compensation actuating signal to VSI bridge (green) showing response when sag occurs, (right) same magnified to show the transient response

A programmable power source (California Instruments make 3- ϕ 300Vac, 16-819Hz, 45kVA power converter) was utilized to function as the utility input mains. The source was started with normal mains that configured the system to charging mode and energized the SMES coil. Fig. 4 shows the current ramp profiles and the steady state conditions, controlled by the DC-DC chopper. Thereafter several voltage sags were generated by the source and the final results recorded. Controller switching to discharge mode during sag and then reverting back to normal mode was observed (Fig. 5) as were the locking and synchronising of the DVR injection voltage with the mains.

Academic Spin-offs

The SMES based development project at VECC has been the subject of several journal and conference publications and has been taken up as the theme of two doctoral (under HBNI) thesis by the project team members.

For further details please contact: Shri Subimal Saha (ssaha@vecc.gov.in), Accelerator Technology Group

Report on development of brazing joint for water cooled copper conductors for coils of INO prototype magnet

First set of coils have been assembled for the prototype magnet of India-based Neutrino Observatory (INO) at VECC. The scale down magnet of dimension 8 m(L) x 8 m(W) x 7.5 m(H) will require 2400 Ton Iron and the coil will have total 76 turns of water cooled OHFC grade Copper conductor having cross section of 30 mm x 30 mm with 17 mm bore having oxygen content less than 8 ppm, suitable for brazing joint.

The brazing procedure was simulated with 5 conductors placed at 12 mm gaps, same as would be during actual fabrication of coil (as shown in Fig-1). After the machining of conductors is done, these conductors were placed side by side and mounted on a MS structure maintaining turn to turn gap of less than 12mm and then brazing of the joints were successfully done by oxy-acetylene torch with brazing filler material RUPATUM-43as shown in figure-2. The tests that have been performed are (i) Resistance measurement Test (ii) Radiography Test of all 5 brazed joint (iii) Leak Test with Air (Pneumatic Test) (iv) Leak Test with water (Hydraulic Test) , as shown in fig-3 and Fig-4.

All the test results are found to be satisfactory and there is no sign of air void found in Radiography test. Thus the brazing procedures are validated and on-line measurement will be done during the actual fabrication of the prototype coil of INO magnet.

For further detail please contact thakur@vecc.gov.in

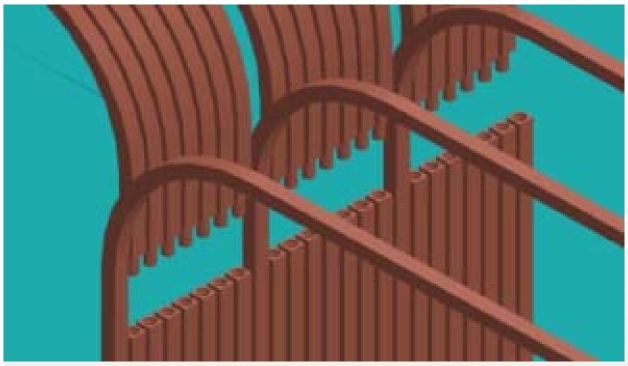

Figure 1: Top assembly of coils which will have total 152 brazing joints to be done in-situ and required for finalising QAP.

Figure 2: Brazing joint of conductors being done with 12mm gap keeping similar to actual situation.

Figure 3: Pneumatic Test bench for joint leak-testing at 6.5 bar.

Figure 4: Hydraulic Test bench for joint leak-testing at 13.5 bar.

EVENTS

VECC hosts INO collaboration meeting

VECC hosted the India-based Neutrino Observatory (INO) collaboration meeting during April 3-5, 2014. About 100 participants from different institutions of the country attended this meeting which had 4 parallel sessions on the first day and plenary sessions on second and third days.

A group photograph of all the participants in the meeting

FAIR news

Tri-party agreement on power converter: ECIL-Hyderabad, Bose Institute-Kolkata and FAIR-GmBH Germany have signed an agreement to produce first set of power converters for the FAIR accelerator ring. VECC has built up a prototype power converter which will be produced in large scale at ECIL-Hyderabad. This is first major production agreement (in-kind) on FAIR items from India.

Agreement on beam stopper for FAIR: An agreement has been signed between Bose Institute (BI) and CMERI-Durgapur for designing the beam-stopper, an advanced equipment, which will be supplied by India to FAIR. The beam stopper will work in a very high radiation environment. This is to be used for stopping the primary and unwanted secondaries for letting the beams of particular species to pass through. The design work is the first phase of the project and will involve thermal and thermo-mechanical calculations.

A meeting of the FAIR experiment evaluation committee took place for evaluating the proposals received for performing experiment at FAIR. VECC have submitted proposals on NUSTAR and CBM experiments.

Summer school on "Nuclear Fission and Related Phenomena"

VECC organized a summer school on "Nuclear Fission and Related Phenomena" during May 13-23, 2014 to celebrate the 75th year of the discovery of nuclear fission. Fifteen faculty members from various institutions across India and abroad delivered lectures on the frontier areas of nuclear fission research. The school was attended by 38 research students.

A group photograph of all the participants in the summer school

VECC hosts ALICE-India collaboration meeting

VECC hosted the ALICE-India collaboration meeting during 11-13 August 2014. Faculties, scientists, and research scholars of most of the collaborating Institutes and Universities from India attended the meeting. Some of the collaborators who could not be present in person were connected via the Video facility.

About 30 presentations were made, mostly by Ph.D. research scholars working on the data analysis and data interpretation. At the Large Hadron Collider (LHC) of CERN, the ALICE collaboration has collected a large amount of data for proton-proton collisions at 0.9, 2.76, 7.0, and 8.0 TeV, proton-lead collisions at 5.02 TeV, and lead-lead collisions at 2.76 TeV. Most of the data analyses have been carried out by using the Tier-2 and Tier-3 GRID computing facilities at VECC and other collaborating institutes. In addition, special sessions were organized on the PMD installation and commissioning for upcoming run, and future upgradation projects on ALICE TPC and Common Readout Units (CRU).

Dr. Dinesh Kumar Srivastava, Director, VECC gave a special lecture on “Great teams achieve excellence”. The lecture was quite motivating for all the audiences, especially to the young researchers.

हिन्दी कार्यशाला का आयोजन

दिनांक 22 जुलाई 2014 को अजय दिवेतिया व्याख्यान कक्ष में सुरक्षा संबंधी विषय पर एक हिन्दी कार्यशाला का आयोजन किया गया। इस अवसर पर केन्द्र के उप मुख्य सुरक्षा अधिकारी श्री विवेक सुधाकर गुप्ते को वक्ता के रुप में आमंत्रित किया गया था। विषय था ‘आन्तरिक खतरों के विरुद्ध निरोधात्मक तथा सुरक्षात्मक उपाय’। वी. ई. सी. सी. के वरिष्ठ अधिकारियों एवं कर्मचारियों की उपस्थिति में उन्होंने सुरक्षा संबंधी मामलों पर विस्तृत रुप से प्रकाश डालते हुए उन्हें इन सुरक्षात्मक तथ्यों से अवगत कराया। साथ ही साथ, केन्द्र के सभी अधिकारियों/कर्मचारियों से यह भी आग्रह किया कि वे भी केन्द्र में लागू सभी प्रकार के सुरक्षा नियमों का सही रुप से अनुपालन करें तथा इसमें अपना पूर्ण सहयोग दें। इस कार्यशाला का संचालन श्री भास्करानंद झा, सहायक निदेशक - (रा.भा) - ने किया।

Awards & Honours

YPC-2014 award

Dr. Deepak Pandit

Dr. Deepak Pandit (Experimental Nuclear Physics Division) has been selected as the 2nd best speaker in the Young Physicists Colloquium (YPC 2014) held at Saha Institute of Nuclear Physics during 21-22 August, 2014. Young Physicist Colloquium (YPC) is a well known yearly event, organized by the Indian Physical Society. 23 young physicists (of age less than 35 years) were selected from the country to present their research work. A board of judges selected the best three presentations.

Dr. Pandit's research work deals with the probing of different nuclear shapes via the decay of Giant Dipole Resonances (GDR) in hot rotating nuclei. Giant dipole resonance (GDR) occurs in nuclei due to the out of phase oscillations of protons and neutrons. This is an excellent probe to study the deformation of nuclei. Deepak and his group members have developed an efficient detector array (Large Area Modular BaF_2 Detector Array, abbreviated as LAMBDA -) to detect these GDR gamma rays. From the experiments carried out with beams from K-130 cyclotron at VECC, he has shown that Jacobi shape transition, which occurs in gravitating rotating stars, also takes place in atomic nucleus using GDR as a probe.

Photo courtesy : Shri Tanmoy Das

bloom up-close... courtesy: Parks & Garden Section, VECC

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