Workshop on Advanced Radiation Detector and Instrumentation in Nuclear and Particle Physics (Online)

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University of Jammu

Book of Abstracts

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Fundamental of the Gas Detectors

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What is your experiment?:

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Comparative study of position resolution and gain map of Single and Double GEM

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Gas Electron Multipliers (GEM) are well known for their excellent position resolution, high rate handling and discharge handling capability among Micro-Pattern gaseous detectors (MPGDs). GEM detectors are used for large scale tracking and imaging application of charge particles like muons. The GEM detectors consist of GEM foil which acts as amplifiers and different combinations of these foils are used depending upon the applications. In the current work, experiments have been conducted to study the position resolution and gain uniformity for different combinations of the GEM detector. The GEM detector consisting of 10 by 10 cm standard GEM foils were used for this purpose with single and double foil configuration. For data collection and processing a Scalable Readout System (SRS) has been used, collecting data from four APV25 front-end boards. The readout has 256 readout strips each in x and y planes which were connected to APV25 front-end boards through 130 pin Panasonic connectors.

For position resolution measurement a Fe-55 soft x-ray source has been attached to AEROTECH PRO165 3-Axis XYZ Linear Stage with 0.5 μm resolutions. The source has been moved with a step of 50 μm in both x and y direction diagonally and the change in position obtained from the detector is used to determine the position resolution. The experiment has been carried out with single and double GEM and comparative studies have been carried out. The gain varies drastically from one configuration to another and similar behavior has been observed in the charge spread data. To obtain position a Center of Gravity method has been used which gives better result once the number of strip hit is high enough for it to work. As a result, the results from double GEM were better than the single GEM. The gain uniformity data was collected by moving the source across the detector and was found to be within ±12% range.

What is your experiment?:

Particle Tracking

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Charging up effect in triple GEM detector

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Micro Pattern Gaseous Detectors (MPGD) are being used in High Energy Nuclear Physics experiments as a tracking device due to its high rate handling capability and good spatial resolution. Gas Electron Multiplier (GEM) detector is one of the advanced members of the MPGD group which is capable of handling high particle rate (~ 1 MHz/mm^2) and has excellent position resolution (~ 100 µm). The standard GEM foil is made up of a thin Kapton of thickness 50 µm with 5 µm copper cladding on both sides of the foil. The presence of di-electric (Kapton) changes the electric field strength of the electric field inside the GEM holes under the influence of external radiation and this phenomenon is referred to as the charging up effect. As a result of the charging up effect, the gain of the chamber increases initially and then asymptotically reaches a constant value.

The charging up effect is investigated for a Single Mask triple GEM detector prototype with Argon-CO_2 gas mixture under continuous irradiation from an X-ray source. The method of measurements and the test results will be presented.

What is your experiment?:

R&D

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Numerical Simulation of Gaseous Detectors using Garfield++

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What is your experiment?:

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Simulations of multi-layer GEM systems from single to quadruple GEMs

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We present comparative simulation results for single, double, and triple layer GEM (Gas Electron Multiplier) GPD (Gas Pixel Detector) systems, along with some preliminary quadruple layer results, using Garfield++ and ANSYS field solver. With a multi-GEM layer structure, of up to 5 layers, a very high effective gain (up to 10^6 in some gases) can be attained with each GEM layer working at an individually much lower gain thus avoiding discharge problems - this is the major advantage of GEM technology. We compare our results with those of published experiments and simulations.

What is your experiment?:

GEM

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Numerical Evaluation of Resistive Plate Chamber

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It is important to be able to correctly estimate the electric field, current, and potential distribution in RPC in order to envisage the working of the device. This is useful in optimizing its design and operation for specific applications. We have performed a calculation of the electric field current and potential distribution of RPC from the first principle using the finite element method on COMSOL Multiphysics platform and compared to results by Ammosov et al [1], which is comparable to our simulated results. It has been then used to study the effect of the electrode and spacer materials on field configuration and dark current. The effect of uniform and non-uniform surface resistivity of the conductive coating on the electric field distribution has also been studied. The time-dependent and transient responses of potential distribution for these two cases have been simulated and used for optimizing the surface resistivity. A few experimental measurements have been carried out to corroborate the simulation results.

References

[1] V. Ammosov, V. Korablev, V. Zaets, Electric field and currents in resistive plate chambers, Nucl. Instr. and Meth. A 401 (1997) 217-228.

What is your experiment?:

Particle Tracking with Gaseous Detectors

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Micro-Pattern Gaseous Detector: Technologies, Developments and Perspectives

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What is your experiment?:

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Sensor Qualification Center (SQC) for Characterizing Silicon Microstrip Detectors, University of Delhi

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Applications of Detectors based on THGEM-like Configurations

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After the development of the Micro Strip Gaseous Chamber (MSGC) based on the semi-conductor technology processes, the genesis of the gaseous detectors has undergone a rapid evolution leading to spatial, temporal and energy resolution, rate capability, radiation hardness etc. This evolution has ushered in a new genre of micro-structured devices, commonly known as Micro-Pattern Gaseous Detectors (MPGDs). Within the broad family of MPGDs, the THick Gaseous Electron Multiplier (THGEM) has been attracting significant attention due to its simplicity and robustness. THGEM-based detectors may be constructed with very large area and their implementation does not require any particular mechanical support. The range of excellent characteristics features and the possibility of industrial production capability of large-area detectors, pave ways towards a broad spectrum of potential applications. These rely on THGEM's single-electron sensitivity, moderate (sub-mm) localization resolution, timing in the 10ns range, high-rate capability, low-temperature and broad pressure-range (mbar to few bar) operation. However, the single THGEM often suffers from occasional discharges which can potentially damage the electrodes affecting detector performance. The Resistive-Plate WELL detector was developed successfully utilizing resistive material to prevent electrical instabilities in the detector. It is a single-sided THGEM coupled to the segmented readout electrode through a sheet of large bulk resistivity. In the last few years, systematic investigations of the RPWELL detector performance and response were conducted. Its performance was characterized both in a generic context and in the context of future digital hadronic calorimeter sampling element. In parallel single- and dual- stage RPWELL-based UV photon detectors exhibit Polya-like spectra at high gains, under stable operation which could make them applicable for single photon imaging in RICH detectors.
In this presentation I will focus on the recent studies aiming to understand the underlying physics processes governing the operation and performance of the new RPWELL detector in the context of the above two applications. Lastly, I will discuss about another new device based on hybrid THGEM Multi-Wire concept which has been considered as a possible candidate for low energy fission studies.

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Gain uniformity of a quad-GEM detector at different gas flowrates

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A systematic study of the absolute gain of a prototype quad-GEM detector at different gas flow rates is carried out. The gain uniformity at the various segment of the detector is also investigated. The active surface area (10 cm x 10 cm) of the detector is divided into 64 zones of equal area (1.25 cm x 1.25 cm), and each zone is irradiated with a collimated Fe^{55} X-ray source. A constant voltage difference of 360 V is maintained across each GEM foil, and the gain is calculated using the measured anode current from the detector. A pre-mixed gas mixture of $Ar:CO_2$ in the ratio of 70:30 is used in the range of 3 - 30 SCCM flow rate for this purpose.

What is your experiment?:

Gain uniformity of a quad-GEM detector at different gas flowrates

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Charging up studies in thick Gas Electron Multipliers

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The time-dependent variation of detector response in MPGDs, especially THGEMs, is one of the challenging problem that has been attributed to the "charging up" and "charging down" processes of insulating materials present in these detector. Experimental studies of stabilization of gain with time due to these phenomena in argon-based mixtures under various experimental conditions have been given in the presentation. Effects of different sources with varying irradiation rates on the gain saturation process have been studied. Low-rate source shows two-step gain stabilization phenomena, one short-term saturated gain, another long-term saturated gain, whereas high-rate source shows just one-step gain saturation. While this two-step stabilization has been attributed to the charging up of the rim by earlier studies, its effect seems to be subdued for high-rate irradiation according to the observations presented here. The final results provide an insight into the transients of gain saturation in THGEMs

What is your experiment?:

Charging up studies in THGEM

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A Simulation of Primary Ionization for Different Gas Mixtures

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The primary ionization is an important part of study in nuclear and particle physics experiments. In high rate experiments [1], the primary ionization is helpful in deep understanding of the discharge formation and charge density studies. The primary ionization was obtained from the simulation of alpha source to estimate discharge probability using single and triple GEM configuration in argon gas mixture [2]. We present and focus here only on the simulation of primary ionization in different argon based gas mixtures [3] to obtain the number of primaries, spatial and energy information.
The simulation tools like geant4 [4] and heed [5] have applications in nuclear, particle, accelerator, medical and space sciences. The geant4 and heed were used to simulate the passage of particles through the matter. The advantage of geant4 toolkit is that it generates the particle information like energy deposition and position co-ordinates after each step. These steps are produced after each interactions that computes the cross-sections of physics processes that were considered for this simulation in a gas volume. The properties of primary ionization, as estimated by geant4 and heed have been compared.
We simulated a collimated beam of alpha particles with and without mylar sheet to compare the range of alpha particles. A bragg peak was obtained because the alpha particles deposit more energy towards the end of the trajectory in the gas volume. The energy loss of charged particles is inversely proportional to the square of their velocity which causes the bragg peak to occur. Thus, the number of primaries appear to be more near the bragg peak. The number of primaries generated with geant4 toolkit has been compared with the heed also. We simulated muons also in a similar manner to study primary ionization, though muons weakly interact with the gas volume for study.
A similar analysis has been done for Fe-55 source which is radioactive in nature. The Fe-55 captures electron and produce primary ionization along with Mn-55, ν e and gamma which are the secondaries in this reaction. The primary ionization have been compared with heed also.
We found that the response of alpha, muons and Fe-55 source in these Ar-based gas mixtures is found to be different due to their different properties.

References:
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[4] S. Agostinelli et al, Geant4 - a simulation toolkit, NIM A 506.3 (2003), p. 250.
[5] I.B. Smirnov; "Interactions of particles with gases"; online at http://cern.ch/heed .

What is your experiment?:

Particle Tracking

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Fundamental of the Resistive Plate Chamber

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Bakelite RPC with and without linseed oil coating

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Resistive Plate Chamber (RPC) detectors are currently used in High Energy Physics (HEP) experiments for triggering and tracking purposes for their low-cost of fabrication, high efficiency (> 90%) and good time resolution ($\sim$ 1-2 ns). RPC is also a potential candidate for high-resolution medical imaging.

Keeping in mind, the requirements of detectors having high-rate handling capability, cost-effectiveness, and large area coverage, to be used in future HEP experiments, commercially available bakelite plates with moderate bulk resistivity are used to build RPC prototypes.

Initially, RPC prototype is fabricated without any oil coating and its characteristics study is done with cosmic ray using 100 % Tetrafluoroethane ($C_2H_2F_4$) gas. In this prototype, only an efficiency $\sim$ 70% is achieved. To improve the performance as a remedial measurement, electrode plates are coated with linseed oil using a new technique. In conventional bakelite RPC, the linseed oil coating is done after making the gas gap. In this particular work, the linseed oil coating is done before making the gas gap. After the linseed oil coating, the plates are cured for several days. The advantage of this procedure is that after linseed oil coating it can be checked visually whether the curing is properly done, or any uncured droplet of linseed oil is present. Standard NIM electronics are used for this study. The detailed method of fabrication, measurement and the test results will be presented.

What is your experiment?:

R&D

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In Search of an Eco-friendly Gas Mixture for Avalanche Mode Operation of RPC

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The standard gas mixture for avalanche mode operation of Resistive Plate Chamber is prepared using a major proportion of R134a along with a small amount of i-C_4H_{10} as a photon quenching component. In addition, a minute amount of SF6 is used for streamer suppression. Both of the R134a and SF_6 gases are known for their large global warming potential which casts harmful effect on the environment. In this work, we have proposed an eco-friendly gas mixture of Ar (5\%): CO_2 (60\%): N_2 (35\%) for operating RPCs in avalanche mode and qualified the mixture with numerical simulation. Using a hydrodynamic model, developed by us, the detector efficiency and streamer probability for the proposed mixture have been simulated to study its suitability. To validate the numerical model,

the simulated results using the standard gas mixture of R134a (95.2\%): i-C_4H_{10} (4.5\%): SF_6 (0.3\%) have been compared with the available experimental data of the same. To show the efficacy of the proposed gas mixture, the simulated efficiency and streamer probability have been compared to that of the standard gas mixture and other eco-friendly hydrofluoro-olefin (HFO1234ze)-based potential replacements. Addition of SF_6 by a small amount and lowering of electronic threshold have been investigated as possible means to reduce the observed streamer probability for the proposed gas mixture.

What is your experiment?:

INO

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Basics Principles of the Silicon Detector

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Charge Collection properties of Double Sided Germanium Strip Detector

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The position sensitivity of a double-sided germanium strip detector has been studied using the coincidence method. The coincidences were demanded between an imaging scanner and a position-sensitive planar segmented germanium detector, comprising 10x10 electrical segmentation in orthogonal directions, using a positron source. The imaging scanner consists of a LYSO scintillation crystal coupled to a position-sensitive photomultiplier tube. The coincidence data have been analyzed by employing the Positron Annihilation Correlation (PSA) principle. The primary objective of this work is to study the charge carrier transportation for gamma-ray interaction inside the germanium detector, which has been studied using the pulse shape analysis procedure. The analysis has been performed to locate the gamma-ray interaction using the rise-time response of the detector for single interaction events along the depth of the germanium detector. The 2-dimensional image generated from the imaging scanner has been used to characterize the planar strip detector. Detailed scanning procedures and analysis of the present work will be presented at the conference.

References

[1] C. Domingo-Pardo et al., Nucl. Instru. Methods in Physics Research, 643 (2011) 79.
[2] J. Sethi, R. Palit, S. Saha, B. Naidu, AIP Conference Proceedings 1524 (2013) 287.

What is your experiment?:

Study response of segmented germanium detector

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Straw Tube Studies and Prototype Assembly for DUNE

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Straw tubes are drift chambers made of a gas-filled conducting cylinder acting as cathode, and a wire stretched along the axis of the cylinder acting as an anode. The Straw Tube Trackers(STTs) are a low mass tracking system with excellent vertex, momentum, angular and time resolution and particle identification. Straw Tube based tracking detector is proposed for one of the Near Detectors in the long baseline neutrino experiment, DUNE (Deep Underground Neutrino Experiment) at Fermilab. The SAND (System for on-Axis Neutrino Detection)detector, one of the Near Detectors, will have the tracking system completely based on Straw Tubes modules. We report on the activity, as part of the DUNE-India-ND collaboration, on the plan to assemble and test the SAND STT modules at Panjab University.One test ST chamber is being operated by the group for setting up the readout and characterization facility. New Straws are being assembled for developing a prototype of 1.8m x 50cm.

What is your experiment?:

DUNE

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Detector Development for INO Experiment

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Virtual lab visit / 94

Resistive Plate Chamber (RPC) Assembly and Muon Coincidence Set-up Demonstration

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Electrical discharges and their mitigation in Thick-GEM based WELL detector

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I will give an overview of the Thick-GEM based WELL detectors and the phenomenon of electrical discharges in them. The effectiveness of using resistive plate in mitigating discharges will be presented next. We developed a tool to produce localized discharges inside the detector to study its effect on the detector performance. I will present the effect of feeble discharges on the performance of Resistive Plate WELL detector.

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Gamma-ray imaging applications of position-sensitive fast scintillators

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We are developing position-sensitive detectors based on Cerium doped Lanthanum Bromide(LaBr3:Ce), Gadolinium Aluminium Gallium Garnet ($Gd_3Al_2Ga_3O_{12}$:Ce, GAGG), and lutetium-yttrium oxyorthosilicate (Lu1.8Y.2SiO5:Ce, LYSO) crystals coupled with the position-sensitive photo-multipliers for the gamma-ray imaging application. Some of these detectors have been tested for energy, timing, and position resolutions for the interaction of the gamma-rays within the detector crystal. The measured results are explained by the GEANT4 simulation results. With a collimated source, the images of irradiation spots in different positions throughout the detector crystal have been obtained. The 2-d images of hexagonal Bismuth Germanate (BGO) crystal and a cylindrical LaBr3(Ce) crystal have been generated using the position sensitive scintillator detectors. The performance for imaging application of the detectors has been investigated by coincidence technique in GEANT4 simulation and compared with the experimental results. The 2-d images of objects with various geometrical shapes have been investigated by Compton back-scattered events of the gamma rays using these detectors in the simulation. These position-sensitive detectors can be used as an absorber of a Compton camera for the image reconstruction of an extended radioactive source. These detectors can have various applications in the fields of nuclear and high-energy physics for scanning of detectors, as well as for the purpose of imaging in the medical and defense sectors. Recent results from these detectors will be presented at the conference.

What is your experiment?:

Gamma-ray imaging

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Development of an air shower array using plastic scintillators

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A cosmic ray air shower array consisting of 7 plastic scintillation detectors is commissioned at an altitude of about 2200 meters above sea
level in the Eastern Himalayas (Darjeeling). The main goal is to study the origin, composition, and direction of primary cosmic rays at high altitudes. The detector array has a structure of the hexagon. Six detectors are kept at the vertices of a hexagon and
one at the center of it. The distance between two consecutive detectors is 8 meters. Each detector element consists of four plastic scintillators of dimension 50 cm $\times$ 50 cm $\times$ 1 cm making the total active area of 1 m $\times$ 1m. These scintillators are fabricated indigenously in the Cosmic Ray Laboratory (CRL), TIFR, Ooty, India. All four scintillators of a detector are coupled with a single Photo Multiplier Tube (PMT) using wavelength shifting (WLS) fibers. A custom-built module with seven inputs is used to generate the multi-fold trigger that detects a shower event. All the plastic scintillators are first characterized and tested in the lab. Continuous measurement of cosmic ray air shower is carried out from the end of January 2018 to April 2019. Details of fabrication of the detectors, experimental setup, techniques of measurement, and results
will be presented.

What is your experiment?:

Cosmic ray

Oral presentations / 55

Investigation on thermal performance of low temperature multilayer insulation technique for ground based rare physics programs.

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Multilayer insulation (MLI) is a robust passive thermal protection system which is widely used as cryogenic thermal insulation technique in high vacuum environments for minimization of radiation heat load to the cryogenic systems. It has it's applications in both, space cryogenics exploration programs as well as on the ground based programs also. There are various heat transfer modes through MLI due to the environmental effects: Thermal radiation, solid conduction and residual gas conduction, in which thermal radiation is the major part of the total produced heat load.

Here, the low temperature application of MLI technique on the ground based rare physics programs is discussed, in which MLI technique is used to reduce the the thermal radiation coming from outer wall to the inner wall of the cryostat. Cryostat is a double walled container filled with cryogenic liquid with the vacuum space between the two walls.
The basic concept of MLI technique is that multiple reflection of incident radiation is obtained by placing the reflective layers to reflect the incident radiation called radiation shields, in between the two walls of the cryostat. Because of it's multilayer structure, with each successive reflective layer reducing the radiation heat load mainly, on the next by a fraction. These reflective layers are formed with thin polyethylene or Mylar sheet, coated with highly reflecting material (Aluminium or Gold) on both the sides. Therefore, low conductivity materials (or insulators) called spacers are placed in between these reflective layers to avoid the thermal contact between them and hence the conduction heat load due to adjacent reflective layers.
The current work is an attempt to find the best materials for MLI system (reflective layer and spacer materials), which is usually asked before designing the insulation system for a cryostat in any experiment. This work discusses the effect of perforated double-Aluminized Mylar (DAM) with Dacron, unperforated DAM with Silk-net and perforated DAM with Glass-tissue on the performance of MLT technique, as the reflective layer as well as spacer materials. After that, we have discussed the effect of layer density and the number of layers on the heat load, by which the optimal layer density is observed for all three combinations. Knowing the key parameters of MLI technique, the heat load generation in spherical as well as cylindrical cryostats is compared and found the effect of layering near the inner and outer wall of the cryostat.

What is your experiment?:

Neutrinoless Double Beta Decay experiment

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Detectors for Nuclear Physics Research

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What is your experiment?:

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Study of neutron response using time of flight technique in ISMRAN detector.

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We present the measurements of the neutron response in **ISMRAN** (Indian Scintillator Matrix for Reactor Anti-Neutrinos) set up consisting of an array of 9×10 Plastic Scintillator Bars at BARC, Mumbai. ISMRAN is an above ground set up at ~13m from **Dhruva** reactor core for the detection of reactor based anti-neutrinos via inverse beta decay process. The ISMRAN setup will be shielded by a 10 cm of Lead and 10 cm of Borated Polyethylene to reduce the reactor related background. The dominant source of reactor related background in the vicinty of the detector are gamma and neutrons. The neutron generated from a Am-Be source are used to study their response using time of flight technique in the ISMRAN. These measurements are useful in context of discriminating fast neutron reactor background from reactor anit-neutrinos in the Dhruva reactor hall. The estimation of proton recoil energy and the neutron capture time in the ISMRAN detector are studied in detail.

What is your experiment?:

Study of neutron response using time of flight technique in plastic scintillator.

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A THGEM based low pressure gas detector for the detection of fission fragments

Authors: Arijit Sen[1]; Purba Bhattacharya[2]; T.K. Ghosh[3]; D Paul[3]; K. Atreya[3]; N. Majumdar[4]; S. Mukhopadhyay[4]; T. Sinha[4]; C Bhattacharya[5]

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A thick gaseous electron multiplier based gas detector, operated at low pressures ~3-4 torrs of isobutane gas is being designed and developed at VECC. The detector shall be used for the detection of highly ionised fission fragments in experimental studies of fusion fission dynamics. The prototype detector consists of three planes, a GEM based anode sandwiched between two wire plane cathodes. The time of arrival of the fission fragments is readout from the anode plane. Future improvements incorporating the position readout (X and Y) of the arrival of fission fragments on the detector, are being planned with simulations being done for the best optimised position of the X and Y readout planes. Details of the prototype detector testing with a 252Cf source and simulation results shall be discussed at the workshop.

What is your experiment?:

Detection of fission fragments

Invited lectures / 25

Silicon Trackers at the Heart of the LHC Experiments

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What is your experiment?:

Oral presentations / 68

FPGA based high speed DAQ systems for high-energy physics experiments: potential challenges

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Nuclear and particle physics experiments at high energies, often referred to as High Energy Physics (HEP) experiments, study the constituents of matter and their fundamental interactions. By colliding proton on proton or heavy-ions, such as, Au on Au or Pb on Pb at relativistic energies; one creates conditions that are prevalent within a microsecond after the birth of our universe. These collisions produce large number of highly energetic particles which are to be recorded by the experiments. This poses great challenges for particle detectors, readout electronics, and data acquisition (DAQ) systems including data storage. In addition, the radiation levels in the proximity of the detectors have also been growing, which demands for radiation tolerant devices. Traditional nuclear physics experiments employ detectors with several tens to few hundred of readout channels using standard electronics and conventional DAQ systems, which handles low data rate (few megabyte per second) and less resilient for data errors against multi-bit upset in radiation zones.
In contrast, the present day HEP experiments, for example at the Large Hadron Collider (LHC) at CERN, FAIR at GSI Darmstadt; operate detectors up to billions of electronics channels, which produce data at the rate of few terabyte (TB) per second. This requires a highly efficient system to cope with the increase in data volume by acquiring data at a high rate and recovery from data error against the multi-bit upsets in radiation environments.

We will present an overview of the new FPGA based high speed DAQ system which is capable of high data rate communication. We will summarize the technical challenges for the development such a DAQ system, points of uncertainties and their probable solutions. The applicability is not limited to particle physics only. It also fits well for industry applications like medical imaging, muon tomography and future HEP experiments.

What is your experiment?:

ALICE at CERN, CBM at GSI

Oral presentations / 60

Designing a front end digital pulse processing chain for FAIR CBM experiment using FPGAs

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The article is about the front end data acquisition chain developed for the MUON detectors in the CBM experiment at FAIR. As a contribution towards the development of CBM experiment, a prototype system for digital pulse processing (DPP) has been designed by me on FPGA development board. A single channel of pulse processing chain for the pulse analysis of detectors has been developed and tested successfully in our lab. The FPGA has been interfaced to the AD9228 ADC board, which is connected to a multichannel mixed signal Front End electronics (FEE) ASIC board named nXYTER. In our design, the ADC interfacing is the challenging part due to its LVDS serial data inputs at the sampling rate of 20 MHz as per the system design requirements. The concurrent and synchronous

nature of FPGA architecture makes it ideal for the testing and development of pulse processing data acquisition chains. The pulses from the ASIC board coming at the rate of 20 MHz are analog inputs, which needs to be sent to FPGA by digitization with AD9228 ADC board. The acquired 12-bit parallel data from ADC board using FPGA is then processed to extract the useful information out of it, which can be then sent to the PC for visualization using various software tools like ROOT, MATLAB etc.

What is your experiment?:

Designing a FPGA based nuclear pulse processing chain

Invited lectures / 24

Development of the Silicon Pixel Technology and Challenges

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Virtual lab visit / 95

Gain, energy resolution measurement using GEM detector and coincidence setup demonstration using cosmic ray

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Young Scientist Talks / 89

From Detector Simulation to Data Analysis in High Energy Physics Experiments

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In Nuclear and Particle Physics Experiments, the combination of more detectors is used to reconstruct the particle trajectories, measure their momentum, and identifying particle species. To optimize the apparatus and understand its performance, indispensable ingredients are Monte-Carlo (MC) Simulations. This talk will give an overview of MC simulation in High Energy Physics (HEP) experiments. There are some general steps of MC simulation namely, generation of particles, their transport in the materials, simulation of the detector response, digitization, hit reconstruction, tracking, and physics analysis. I will illustrate my experience on detector MC simulation (using FAIRROOT and GEANT4) within large HEP experiments.

Oral presentations / 64

Numerical Studies on Primary Ionization in TPC

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The Active-Target Time Project Chamber (AT-TPC) is used in the field of low-energy nuclear physics to study nuclear reactions by tracking the reaction products. The primary ionization produced by charged products along their track in the active gas volume of the TPC can be utilized for track reconstruction. The primary electrons are multiplied in the applied electric field and collected over a 2D array of electrode elements placed at one end of the device for producing 2D position information. The third co-ordinate information can be obtained from the measurement of time of flight of the electrons to reach the collecting electrode. The use of the TPC gas volume simultaneously as a reaction target as well as a tracking medium of ions emitted from the reaction turns out advantageous to conventional detector arrays, especially in probing inverse kinematics where a heavy-ion beam collides with a light-ion target. One of the important factors that govern the tracking capability of the TPC is the homogeneity of the electric field prevailing in the drift volume of the device which is crucially dependent upon the design of the field cage and electrode configuration used in the device. The other factor which can distort the field is space charge effect. It can be substantial in case of low-energy particles which deposit their full energy in the medium and produce a large amount of ionization. Here, we report the spatial information of the primary space charges produced by alpha particles in a TPC filled with Ar:CO2 (70:30) at different gas pressures using Geant4 [1] and Heed [2] simulation packages. We have used Photoabsorption and Ionization Physics Lists in Geant4 for the simulation and compared the results with that of the Heed. The same simulation has been carried out using cosmic muons at atmospheric pressure for validation. These results can be used for finding the distortion of the electric field due to the space charge in the drift region of the TPC which can be helpful for designing an AT-TPC for low-energy nuclear reaction experiments.

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What is your experiment?:

Particle Tracking

Oral presentations / 59

Simulating the response of a liquid scintillation detector to neutrons

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Neutrons are one of the most critical contributors to background signals. Understanding the neutron background is crucial as they can easily mimic the Weakly Interacting Massive Particle (WIMP) signals in dark matter search experiments. Organic liquid scintillation detectors are often used to detect fast neutrons. EJ-301 is a popular liquid scintillator used to detect fast neutrons because of its good pulse shape discrimination property. In this work, we unfold the response of an EJ-301 detector to Am-Be neutron spectra using two unfolding methods: Roo-Unfold and the GRAVEL method. Once the response of the detector is modeled, using the unfolding method, it will be possible to obtain the information of the fast neutron background at different rare event background sites.

A $2'' \times 2''$ cylindrical liquid scintillation detector (EJ-301) has been modeled using the GEANT4 framework. Various properties of the detector like the light output of the scintillator, quantum efficiency of the photocathode, material composition have been defined using values from literature and detector manuals. A photon to electrical signal conversion (Photo-multiplier tube) and digitization method has also been implemented in GEANT4 from which we obtain the response of the detector in terms of integrated electronic charge. Simulated gamma spectra from the detector for different gamma sources like (^{60}Co, ^{22}Na, etc.) show excellent agreement with the experimental gamma measurements providing confidence in the modeling. In the first stage, energy spectra of monoenergetic neutrons are simulated at fixed neutron energy intervals to construct the response matrix. In the second stage, neutrons having energy distribution following the ISO Am-Be continuous neutron energy spectrum are made incident on the detector and the energy spectrum is simulated. The spectrum obtained after the second stage is unfolded using the response matrix generated in the first stage to obtain the actual input ISO Am-Be spectrum. We see that both the methods are able to predict the actual ISO spectrum very well.

What is your experiment?:

R&D of neutron detector for Darkmatter Search Experiment

Oral presentations / 1

Monte Carlo simulations for nuclear physics experiments using NPTool

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In recent times, experiments with rare isotope beams at accelerators around the world have provided several exciting results in nuclear physics and astrophysics. The experiments involve unstable and even unbound nuclei, low beam intensities, highly granular and efficient detectors arrays. Monte

Carlo simulations play a pivotal role in the successful planning as well as data analysis of such experiments. We have used the NPTool (Nuclear Physics Tool) package to carry out the simulations for our experiment at the HIE-ISOLDE radioactive ion beam facility of CERN. The experiment involved a 5 MeV/A ^{7}Be radioactive beam impinging on a CD_2 target. The charged particles emitted from the reaction were detected by an efficient detector array consisting of annular and double sided silicon strip detectors backed by silicon pads covering an angle of $8^\circ - 165^\circ$ in laboratory. NPTool is an open source and freely distributed package for Monte Carlo simulation and data analysis of nuclear physics experiments. It offers a unified framework for designing, preparing and analyzing complex experiments consisting of multiple detectors using GEANT4 and CERN ROOT tool kits. We discuss the NPTool simulations carried out to study scattering and reactions involving the ^{7}Be radioactive beam and its comparison to our experimental data.

What is your experiment?:

Study of nuclear reaction involving 7Be on a CD2 target at HIE-ISOLDE, CERN.

Invited lectures / 35

Roadmap of the MPGD Towards Imaging and Timing Performances

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What is your experiment?:

Oral presentations / 45

Commissioning and testing of real-size triple GEM prototypes for CBM-MuCh in the mCBM experiment at SIS18 facility of GSI

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The Compressed Baryonic Matter (CBM) experiment is one of the core experiments at the Facility for Antiproton and Ion Research (FAIR) in GSI Darmstadt, Germany. The experiment aims to explore the phase diagram of strongly interacting matter at the high net-baryon densities and moderate temperatures. It has been designed to handle unprecedented interaction rates (up to 10 MHz) of Au+Au collisions in an energy range of 2-11 AGeV at SIS100 setup. Muon Chamber (MuCh) system, consisting of alternating layers of instrumented hadron absorbers and triplet of detector stations sandwiched between them, will be used to measure di-muon signals originating from the decay of low mass vector mesons and charmonia. A Gas Electron Multiplier (GEM) based tracking detectors will be used for the first two stations of CBM-MuCh. The detectors will be operated in self-triggered mode. Large area triple GEM detector prototypes of approximately 1900 cm2 in size will be employed for MuCh system. The readout consists of pads with progressively increasing pad sizes from ~4 mm to ~17 mm. A novel opto-coupler based HV biasing to power the 24 segments of each GEM foil has been implemented for the first time. In this contribution, we report the installation, commissioning, and testing of two such modules with nucleus + nucleus collisions at 1-2 AGeV beam energies in the mini-CBM (mCBM) experiment at the SIS18 facility of GSI, which is a part of "FAIR Phase-0" program. Data with the first version of STS/MuCh-XYTER, a dedicated readout chip for GEM-MuCh and STS, has been taken for the first time. The response of large size GEM modules in multiparticle environment have been studied in detail. Event building based on the timestamps of the detector hits has been carried out for the nucleus-nucleus collision data. Optimization of this algorithm and straight-line track fitting using global X-Y coordinates of the hits from all the subsystems will

be reported. The detailed performance of the detectors at different operating conditions will be presented and discussed.

What is your experiment?:

CBM

Oral presentations / 67

Upgradation of CMS Detector at the LHC with GEM Detector

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By the end of the year 2022, the LHC is expected to reach a total integrated luminosity of $300fb^{-1}$ of the data. The high luminosity upgrade of the LHC is foreseen during a third long shutdown to further increase the instantaneous luminosity to $5 \times 10^{-34} cm^{-2} sec^{-1}$. The muon system of CMS detector consists of DTs in barrel, CSCs in the endcaps and RPCs that provide redundant trigger and fine position measurement in both barrel and endcap regions. On the other hand, the forward region of the endcaps is instrumented only with the CSCs. The muon system aims to provide efficient and fast identification of muons, however the possible degradation of CSC performance due to the sustained operation in a high rate environment could drastically affect the entire muon system. In order to improve and maintain the forward muon triggering and muon reconstruction at high luminosity, CMS detector is planned to be equipped with an additional layer of new technology based set of muon detectors, called Gas Electron Multiplier (GEM). In the talk, various activities carried out by Panjab University group in the fabrication and testing of GEM detectors will be discussed.

What is your experiment?:

CMS Experiment

Invited lectures / 33

Fundamental of Silicon Calorimeter

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What is your experiment?:

Oral presentations / 86

Development of silicon detector and readout electronics for the FoCal

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Forward Calorimeter (FoCal) is a proposed silicon-tungsten (Si-W) sampling type electromagnetic calorimeter as a part of the ALICE collaboration's upgrade program at CERN. For the active silicon layers in FoCal, a large area (~ 40 cm2) silicon pad sensor with an individual pad size of ~ 1 cm2 is proposed with challenging requirements like low leakage current and high breakdown voltage. Moreover, Si-W based EM calorimeter involves particle shower formation and dissolution, which put forward the simultaneous requirement of low power, low noise and wide dynamic range FEE (Front End Electronics). A 6x6 array of silicon pad detectors on a 4-inch wafer and two different FEE ASICs, namely ANUSANSKAR and ANUINDRA, are developed and tested towards these goals. ANUSANSKAR, designed initially in 0.7 µm CMOS technology, is a low power, low noise FEE ASIC with a dynamic range of +/- 600 fC. Later, to cater for the still higher dynamic range requirement, a new ASIC, namely ANUINDRA with a dynamic range of ~ 2.6 pC, was designed in 0.35 µm CMOS technology. The silicon pad sensors and the FEE ASICs have been used to build a series of FoCal prototypes, undergone beamline validation, and led to improved readout methodology and better performance. This talk will present the research and development work of the silicon detector, and its readout electronics carried out in India for the proposed FoCal detector.

What is your experiment?:

Forward Calorimeter, ALICE

Oral presentations / 91

Concept and development of the Focussing Aerogel Ring Imaging Cherenkov (FARICH) detector for HMPID-systems

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We present the Focusing Aerogel RICH-detector (FARICH) concept based on 2009-2014 studies of a FARICH prototype detector for the ALICE experiment at CERN. The aim of the project was to develop a prototype detector that would extend the momentum range of charged particle identification: up to 10 GeV/c for pion-kaon separation and up to 14 GeV/c for kaon-proton separation at the ALICE HMPID system [1, 2]. In the frameworks of this project, we proposed the FARICH prototype detector employing a multi-layer silica aerogel as a radiator. In June 2014, we tested a FARICH prototype detector based on Digital Photon Counters (DPC-DSiPM) by Phillips Company at the CERN PS T10 beam line with a particle momentum up to 6 GeV/c [3, 4]. The main performance characteristics of these prototype detectors and a comparison with a Monte Carlo simulation are presented.

In this talk, we also discuss one of the proposed versions of the FARICH concept using an MPGD GEM detector with a photo-conversion film for recording Cherenkov photons.
Proposed FARICH prototypes can be used in the development of HMPID-systems for projected heavy-ion experiments, for example, ALICE3 at CERN.

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What is your experiment?:

Focusing Aerogel Ring Image Cherenkov detector concept

Invited lectures / 34

Fundamental of Readout Electronics and Data Acquisition for Particle Detectors

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Young Scientist Talks / 92

Interaction with calorimeters, triggering and data analysis at the CMS detector

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LHC open an unprecedented window on the weak-scale nature of the universe, providing high-precision measurements of the standard model as well as searches for new physics beyond the standard model. The Electromagnetic Calorimeter (ECAL) of the CMS detector has plays an important role in the physics program of the experiment, delivering outstanding performance throughout data taking. Such precision measurements and searches require information-rich datasets with a statistical power that matches the high-luminosity provided by the LHC. Efficiently collecting those datasets is a challenging task and is performed by two-level triggering system - hardware trigger (Level-1) and software based (high level trigger).

Invited lectures / 29

The Practice of Gamma-ray Spectroscopy: Here & Now

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Oral presentations / 70

Detectors for light charged particles, neutrons and fission fragments produced in low energy nuclear physics experiments

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To understand the strong force that binds all the nucleons together, it is required to perform collision experiments using particle accelerators and detect the reaction products starting from light nuclei like neutron, proton, alpha etc. to very heavy nuclei like fission fragments and evaporation residues. At BARC-TIFR Pelletron-Linac facility, Mumbai, several detector arrays have been setup which are used for the above purposes. For example, the light charged particles are detected using an array of telescopes made of position sensitive silicon strip detectors [1] and many times with small silicon surface barrier detectors, whereas neutrons and gammas are detected using the arrays of plastic and liquid scintillators [2]. On the other hand, heavy nuclei like fission fragments are detected using position sensitive Multiwire Proportional Counters (MWPC) developed in-house [3]. For detecting fission fragments with better timing resolution the micro channel plate (MCP) based detectors for are also being developed at BARC. The details of the characterizations and performances of the above detectors will be presented.

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What is your experiment?:

Experiment using heavy ion accelerator facility

Invited lectures / 39

Experimental Techniques for Dark Matter Search

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What is your experiment?:

Oral presentations / 57

Exploring the Superheated Liquid Detector for Low-Mass Dark Matter Search

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There are ample convincing evidences based on gravitational effects point to the existence of dark matter (DM) though the particle properties of DM is unknown. Many theories suggest that Weakly Interacting Massive Particles (WIMPs) are one of the most promising candidates for DM with masses varies from few MeV to few hundred of TeV. It could be observed directly via direct detection of DM search experiments, which are aimed at detecting the nuclear recoils caused by WIMPs-nucleus elastic scattering. The most challenging part of any DM direct search experiment is identifying and suppressing the backgrounds, therefore the experiments are conducted deep down to minimise the cosmic ray-induced backgrounds. The current most sensitive direct detection experiments are sensitive in the 25−40 GeV WIMP mass range and the null results of these experiments have piqued curiosity in the low WIMP mass region, particularly below 10 GeV. Low threshold energy and a target with low mass nuclei are required for the detector to be sensitive to low WIMP mass.
Here, we have investigated the potentiality of $C_2H_2F_4$ (b.p. -26.3 °C) superheated liquid detector (SLD) (containing low mass nuclei) to probe the low mass WIMPs. SLD provides an excellent rejection to the backgrounds by adjusting the operating temperature and pressure of the liquid such that it can detect heavy ionizing particles (e.g. neutrons) at a certain temperature and pressure range while remaining insensitive to low ionizing radiation (e.g. gamma-rays and muons). Due to the presence of ^{12}C and ^{19}F recoil nuclei, the detector operating at 35.0 °C (gamma-ray insensitive zone) with 100% thermodynamic efficiency can detect WIMPs with masses as low as 2.2 GeV, whereas the ^{1}H recoil nucleus is insensitive in this temperature range. At zero background environment, WIMPs in the few GeV mass range could be explored with a $C_2H_2F_4$ SLD with a WIMP-nucleon spin-independent cross-section sensitivity of about 2.10×10^{-41} cm^2 at WIMP masses as low as 4.0 GeV and a total exposure of 1000 kg.day, assuming a thermodynamic efficiency to be 50% or more. Sensitivity to sub-GeV WIMP masses usually demands sensitivity to the WIMP produced ^{1}H recoil nucleus, which involves the detector working at 50.0 °C temperature and thermodynamic efficiency > 50%. From the calculation, it is found that $C_2H_2F_4$ SLD operating at 60.0 °C temperature (gamma-ray sensitive zone) with 100% thermodynamic efficiency, the bubble nucleation threshold energy of 0.1 keV can be achieved for all three nuclei which is found to be sensitive to 140 MeV, 430 MeV, and 540 MeV WIMP masses due to ^{1}H, ^{12}C, and ^{19}F recoil nuclei, respectively.
The experiment in steps with increasing exposure with $C_2H_2F_4$ SLD has been started at 555m deep Jaduguda Underground Science Laboratory (JUSL), UCIL, Jharkhand, India for the hunt for low mass WIMPs. It is necessary to investigate the noise and background levels at JUSL before run the SLD for WIMPs search. It is observed with a small mass SLD at JUSL that the 20Hz-20 kHz region is dominated by the noises and the background event rate is reduced at underground. The detector with increased active mass is under construction and DAQ and related instrumentation have developed. Signals at higher frequencies will be measured in future to better understand the background induced events as well as the noise with increased active mass and longer run time with a goal to search for the low mass WIMPs.

What is your experiment?:

R & D works for dark matter search

Oral presentations / 65

Characterization of Sapphire detector for CEvNS search at MINER

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Abstract:
The Mitchell Institute Neutrino Experiment at Reactor (MINER) at Texas A&M University, USA is a reactor based neutrino experiment which aims to measure coherent elastic neutrino-nucleus scattering (CEνNS) where a neutrino interacts with a nucleus as a whole creating a nuclear recoil [1, 2]. One of the main challenges for this experiment is to deploy detectors capable of measuring low-recoil energies. A novel sapphire detector made up of Al_2O_3 substrate with dimension 7.62 mm $\times$ 4 mm with mass 73 g has been fabricated and characterized. Particle interactions are detected through phonons and scintillation photons. The phonons are detected through Transition edge sensors (TES) photo-lithographically placed on the surface of the detector. The photons are detected through their interactions with a Si HV [3] detector in coincidence. We will report the characterization and performance of the sapphire detector in reactor and non-reactor environments.

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What is your experiment?:

Mitchell Institute Neutrino Experiment at Reactor (MINER)

Invited lectures / 43

Application to Society: Imaging in Particle Therapy

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What is your experiment?:

Oral presentations / 74

Application of MPGD detector in Medical Imaging and Treatment

Authors: Amandeep Kaur[1]; Anureet Kaur[2]; Jasbir Singh[1]; Sunil Kumar[1]; Meena Meena[1]; Rajat Gupta[1]; Sunil Bansal[1]; Sushil Chauhan[1]; Vipin Bhatnagar[1]

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We will discuss the Micro-Pattern Gas Detector (MPGD) which is a recently developed gas-filled detector in the series of Multi-Wire Proportional Chamber (MWPC) and Resistive Plate Chamber (RPC). MPGD have some characteristics which make it suitable to use in medical diagnosis & prevention techniques. MPGD uses a fine readout electrode structure, so it can obtain much higher spatial resolution compared to that of the conventional gas detector based on the multi-wire proportional chamber. Although MPGD detectors are being used in particle and nuclear physics experiments, the excellent spatial and time resolution make them an invaluable tool for other applications too i.e., radiography and low energy gamma imaging, dosimetry and hadron therapy, X-ray fluorescence.

What is your experiment?:

CMS

Oral presentations / 61

Effect of Continuous Long Term Exposure of Non-ionising Radiation on Human Health

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The Present study is proposed to explore the effect of continuous long term exposure of non ionizing radiations (NIR) on human health. With the population explosion and technology advancement, the requirement of wireless gazettes is also increasing. Consequently, the base transceiver station (BTS) are increasing in the similar way. Therefore, more and more population of humans is being exposed to radiation from them. Evidently, possible biological effects of their radiation become important aspects of current research. Earlier studies had been performed by considering the electromagnetic wavefront spherical, but practically most of the BTS contain vertical rod antenna which transmits cylindrical wavefront. In this study the theoretical calculations for incident electric field, resulting penetration, temperature variation & Specific Absorption Rate (SAR) have been made with the help of computer simulation technology (CST Studio Suite) by considering the cylindrical wavefront using the electrical conductivity, permittivity, permeability and mass density for the respective tissues at a specific higher frequency ranges of NIR. The intensity of these electromagnetic waves are maximum near the BTS and reduces with distance as it is inversely proportional to the square of distances. On the basis of calculation it can be concluded that the continuous and long term exposure of NIR may be harmful for humans at shorter distances from the BTS.

What is your experiment?:

Simulation of Non ionizing Radiations Using Computer Simulation Technology Studio Suite

Oral presentations / 56

Discrimination of neutrons and gamma-rays induced events in Superheated Emulsion Detector

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A liquid which maintains its liquid state above its boiling point is called the superheated liquid. It is a metastable state of the liquid. The superheated state can be reached by slowly increasing the temperature or by slowly reducing the pressure starting from its liquid state. The superheated state moves to a more stable vapour state by a small disturbances as a consequence of thermal motion or temperature fluctuation of the liquid. The transition from the metastable liquid state to the more stable vapour state occurs by forming a nucleus of a new phase known as nucleation. The radiation interaction of ions, charged particles, neutrons, photons etc can nucleate the superheated liquid. In the present study, the Superheated Emulsion Detector (SED) has been fabricated at the laboratory that consists of the droplets of the superheated liquid suspended in a viscous gel. The liquids, CCl2F2 (R12) b.p. -21.6 oC and C2H2F4 (R-134a), b.p. -26.3oC were used as active material in the detector though in the present abstract only the result with R12 is shown. When an energetic particle or radiation falls on the drops, if the energy deposition in the liquid exceeds the critical energy and radius of the nucleus is greater than the critical radius, bubbles are formed inside the drops. The critical energy depends on the temperature and pressure of the liquid and the detector can be made insensitive to specific particles by varying the temperature and pressure of the liquid. Here we have studied neutrons and gamma-rays induced bubble nucleation events by irradiating the SED with 241Am-Be (10 mCi) and 137Cs (5 mCi) as a neutron and gamma rays sources respectively and tried to discriminate the events. The usefulness of the discrimination lies in the WIMPs (Weakly Interacting Massive Particles) dark matter (DM) search experiment using SED as one of the important backgrounds for such experiment is gamma-rays. Therefore efficient discrimination techniques are important for the detection of WIMPs. WIMP and neutron interact similarly and hence the neutron source is used to calibrate the WIMPs detector. The SED is also used as a neutron detector/dosimeter in several applications. The acoustic signals produced from the nucleation of superheated liquid drops have been detected using an acoustic sensor (frequency range - few kHz to 1 MHz) and stored in the LabVIEW. These acoustical signals have been analysed and the frequency corresponding to the maximum power in its FFT spectrum is collected from each signal denoted as the fundamental frequency (FF). It has been observed that the FF of the neutron induced events lies within 80 to 90 kHz but the FF of the gamma-rays induced events lies in the range of 20 to 30 kHz. The high frequency events are produced due to the localised energy deposition of the recoil nuclei originating from the neutrons. The electrons are produced from the gamma-rays inside the liquid and those electrons deposit energy and produce the low frequency events. The range of the electron is larger than the range of the recoil nucleus and it deposits less energy within the critical radius, hence producing the low frequency events. The FF variable discriminates about 83.47 % of the neutrons induced events from that of the gamma-rays. The present study is important in discriminating the background events in WIMPs DM search experiment and also in the neutron detection in a background of gamma-rays.

What is your experiment?:

Experiment with nuclear emulsion detector (SED)

Oral presentations / 85

A Compact and Cost effective Data Acquisition Module (C-DAQ) for Particle physics instrumentation

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Nuclear and particle physics instrumentation often requires lots of NIM based modules and lengthy cables for setting up experiments. Data Acquisition modules with FPGA are used as alternatives. But FPGA modules are expensive and require expertise handling. To address this issue a Cost effective, compact and user friendly Data acquisition module using FPGA was developed. This miniature module consists of a daughter card with 8 input channels which accept negative pulses from a few millivolts to 1 or 2 Volts. This module discriminates analog negative pulses with a common threshold then converts to TTL and sends to FPGA. A low form factor MAX10 FPGA development board was used as a mother board. A user programmable logic with counting of all input pulses up to 100ns resolution and coincidence logic was implemented inside the FPGA. This coincidence output is available in NIM format for triggering purposes. 32bit Counter data of all eight input signals and coincidence counter data are sent to the control PC via USB UART port. Same USB port used for supplying 5V 1A power required by the module. A Simple python script controlled UART protocol is used to receive counter data and send configuration logic. This paper describes architecture and various applications of C-DAQ in detail

What is your experiment?:

India based Neutrino Observatory

Young Scientist Talks / 96

Background Radiation at JUSL and Simulation of Nuclear Recoils in Liquid Xenon Detectors

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Measurements and Simulation of background radiation
at JUSL and Simulation of Nuclear Recoils due to
Supernova Neutrino-induced neutrons in liquid Xenon
detectors
Sayan Ghosh
Abstract
Rare event search experiments require very careful simulations, in addition to accurate measurements
of ambient radiation contribution from radioactive decay and nuclear processes in the surrounding rock
components as well as from charged cosmic rays. A new underground laboratory has been set up at 555 m
(~1.6 km water equivalent) vertical depth, with the vision of undertaking future experiments like direct dark
matter search, neutrino less double-beta decay, etc. I shall present the various measurements and simulation

of background for such underground experiments arising from penetrating charged cosmic rays, radiogenic
and cosmogenic neutrons, in addition to measurement and shielding studies of gamma background, which
in-turn shall serve as the basis of all future rare event search experiments at the underground site. I shall
also discuss about investigating the possibilities of detecting core collapse supernova (CCSN) neutrinos by
large volume liquid Xenon detectors, designed primarily for direct dark matter search. In addition to giving
rise to Coherent Elastic Neutrino Nucleus Scattering (CEνNS) interactions, CCSN neutrinos would undergo
charge current (CC) interactions with the Xenon nuclei and consequently produce neutrons inside the liquid
xenon tank. These neutrons would in turn produce nuclear recoils through multiple elastic scatterings. This
presents an extra-handle, in addition to the CEνNS interactions to detect CCSN neutrinos. I shall discuss
that careful simulation of these interactions, to finally compute the observable S1 and S2 signals, reveals
that this second channel indeed gives a dominant contribution to the total number of detected nuclear
recoil events at the high detector threshold regime. Detection of these second type of events in future large
volume detectors like LZ, DARWIN, etc., may give observational handle on the flavour composition of CCSN
neutrinos, since this second channel shall only be generated by νes while the CEνNS interactions would arise
from all flavours of neutrinos.

Invited lectures / 44

History of Detector Development and Future Perspective in India

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What is your experiment?:

Young Scientist Talks / 90

Background Radiation at JUSL and Simulation of Nuclear Recoils in liquid Xenon Detectors

Corresponding Author: ghoshsayan7@gmail.com

Rare event search experiments require very careful simulations, in addition to accurate measurements
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What is your experiment?: