DeSyT-2025 (International workshop on Detection Systems and Techniques for fundamental and applied physics)

Monday, 24 February 2025 - Wednesday, 26 February 2025

Book of Abstracts

Contents

Day 2 - Session 2 / 1

Study of neutron-rich systems 6H, 7H and 4n in 8He+d interactions at ACCULINNA-2

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An experiment at the ACCULINNA-2 fragment separator was conducted using a 8He beam and a deuterium target to study neutron-rich systems 6H, 7H, and 4n [1, 2, 3]. This work provided comprehensive insights into their decay modes and interaction mechanisms. For 7H, we report the first experimental evidence of five-body decay. For 6H, sequential decay through 5H g.s.was established [4]. The 4n system was studied as a product of two independent transfer reactions, with low-lying structures observed at 3.5 MeV above the decay threshold. These findings align with the results of work [5].

The experiment relied on an efficient use of ultra-thin silicon strip detectors (20 μm) for precise detection of ⍰=1,2,3 isotopes across a wide energy range. The approach enabled detailed analysis despite the setup's limited neutron detection efficiency. This methodological framework is discussed in [5-9], including studies of 6H,7H, and other isotopes, along with the optimization of charged particle detection at ACCULINNA-2.

Recognizing the experiment's limitations, simulations within the ExpertRoot framework [10] were performed to enhance the detection efficiency of reaction products. The results demonstrate that detector modifications can improve statistics for the studied systems by a factor of ~2.5 under identical beam parameters.

The presentation will detail experimental techniques, including the use of ultra-thin detectors, methods for particle reconstruction, and the impact of simulation-based optimizations. Key results and future perspectives for extending studies of neutron-rich systems will also be presented.

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Day 3 - Session 3 / 2

ROVERLAB: design and development of a ground drone for environmental radioactivity monitoring and field data acquisition

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This research focuses on the design, development, and deployment of an innovative ground drone, RoverLab, designed for monitoring environmental radioactivity with a particular emphasis on detecting hotspots and radiometric anomalies. The RoverLab system was conceived to improve the safety and accuracy of radiometric control procedures conducted by the Regional Agency for Environmental Protection of Calabria (ARPACAL), particularly in high-risk environments such as landfills, waste treatment and management facilities, and former or active industrial sites where the illegal disposal of radioactive waste or orphan sources is suspected.
The RoverLab system integrates:
• advanced radiometric sensors, adhering to geometric efficiency principles, utilizing a polystyrene plastic scintillator with dimensions of 15 cm × 25 cm × 2 cm;
• environmental monitoring sensors, capable of measuring temperature, pressure, and humidity;
• real-time video transmission capability, through an integrated camera that facilitates site inspection and remote navigation of the rover;
• georeferenced mapping technology, enabling precise localization of measurement points;
• a centralized control unit, which manages data acquisition and provides an operational interface through a dedicated software platform.
The project involved the development of a control and management software suite that integrates advanced signal analysis, mapping, environmental sensors, and AI, creating a unified system to support decision-making and activity management.
For practitioners in the field of radiometric monitoring, RoverLab offers a novel, cost-effective and efficient radiation monitoring solution, making it ideal for radiometric monitoring in critical, real-world scenarios.

Day 1 - Session 4 / 3

Conceptual design of the DIRC detector for EicC experiment

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The Electron-Ion Collider in China (EicC) has been proposed as a future high-intensity heavy-ion and electron accelerator experiment. It aims at the precise measurement of nucleon structure in the sea quark region, including the 3D tomography of nucleon, the partonic structure of nuclei, parton interactions with the nuclear environment, and investigation of exotic states, particularly those containing heavy flavor quarks. Furthermore, issues fundamental to understanding the origin of mass could be addressed by measurements of heavy quarkonia near-threshold production at EicC. To achieve these physics goals, a hermetic particle identification (PID) detector system with high resolution and large momentum coverage is essential.

One major challenge associated with the EicC spectrometer is to achieve precise hadron identification with a large momentum coverage within the limited space of high luminosity accelerator. In the barrel region of EicC, a compact DIRC (Detection of Internally Reflected Cherenkov lights) detector referring to PANDA and EIC schemes is designed at a radius around 70cm, with a inner layer of LGAD (Low Gain Avalanche Detector) close to it. The LGAD can measure the incident particles'hit position and time as ToF detector, which will effectively enhance the Cherenkov angular reconstruction capability of DIRC. The GEANT4 simulation shows that DIRC can achieve 3σ π/K separation up to 6GeV/c with the angular resolution ≤ 1mrad. The detailed conceptual design and simulation of DIRC detector will be presented in the paper.

Day 3 - Session 2 / 4

ALICE ITS3: new bent, large-scale sensors for Run 4

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During Long Shutdown 3 (LS3, scheduled 2026-2029) a new Inner Tracking System (ITS) will be installed in ALICE for the future Run 4 data taking. At present, the ALICE ITS is at its second version, ITS2, formed by 7 layers of silicon CMOS Monolithic Active Pixel Sensors (MAPS). The 3 innermost layers are collectively referred to as Inner Barrel (IB), while the outermost ones form the Outer Barrel (OB). Each layer is then divided along the azimuthal direction into staves of ALPIDE (ALICE PIxel DEtectors) chips, and cooled by a water system.
The future ITS upgrade to ITS3, after LS3, will see a dramatic change in the IB structure, through a replacement of the ITS2 layers with innovative bent large-scale stitched sensors, produced with the TPSCo 65 nm technology. Each of the ITS2 IB layers will be replaced by 2 of these sensors, bent into truly half-cylindrical shapes. Sensor bending allows to reduce the need for mechanical frame support: this innovation, in addition to the replacement of water cooling with air cooling, is expected to thin out the material budget down from an average 0.36% X_0 to 0.09% X_0 per layer. The upgrade will also see a reduction of minimum radial distance from the beam axis from 23 to 19 mm, an improved granularity of $20\times22.5\ \mu m^2$ and a wider pseudo-rapidity range, up to $|\eta| \leq 2.5$ for the innermost layer. Compared to ITS2, the new ITS3 will also have to withstand larger radiation loads, a maximum limit of which has been estimated at 10^{13} 1 MeV $n_{eq}cm^{-2}$ NIEL and 10 kGy TID.
This contribution will present an overview of the ALICE ITS3 upgrade project goals and innovations, as well as the R&D process results and achievements: TPSCo 65 nm technology has been validated by testing the first Multi-Layer Reticle 1 (MLR1) small test devices, both in laboratory and under test beam, even at larger NIEL levels than the ITS3 goal. For the yield and stitching assessment part of ITS3 R&D, current test results of ITS3 stitched devices from Engineering Run 1 (ER1) will also be shown. Finally, we will give a hint to the design of MOSAIX, the latest ITS3 stitched sensor prototypes, currently awaiting submission.

Day 2 - Session 4 / 5

Diamond detectors for life-time measurements of exotic nuclei (the LISA project)

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The measurement of the lifetime of exotic nuclei requires high-resolution gamma energy detection and precise Doppler correction of the energy spectrum.
According to the Doppler shift relation, the uncertainty in the reconstructed energy is influenced by the velocity (β) and emission angle (α). While thin targets can reduce the uncertainties in both these quantities, thick targets are required to achieve higher luminosity in experiments with exotic nuclei

at relativistic energies. However, in the case of thick targets, the energy spread and the uncertainty in the reaction vertex location become dominant contributors to the overall uncertainty (i.e. resolution), thereby reducing sensitivity to lifetime measurements.
The LISA project (LIfetime measurement with Solid Active targets) addresses these challenges by replacing conventional thick targets with pixelated layers of active targets. This allows for the measurement of energy loss in each layer and precise identification of the reaction vertex. Single-crystal CVD diamonds are identified as optimal candidates for these active layers because of their exceptional energy resolution, which supports event-by-event Z identification in each layer. Each layer is made of a 5x5 matrix of diamonds (4.5 x 4.5 mm^2, 500 µm thick), with a total active area of approximately 4.2 cm^2 per layer.
The first LISA prototype (2 layer of a 2x2 matrix –Figure 1) was tested at the GSI facility (Darmstadt, Germany) and the HIMAC facility (Tokyo, Japan) using heavy ion beams in the energy range of 200 AMeV to 1 AGeV. In-beam tests showed excellent energy resolution, approximately 1% at 1 GeV energy deposit. Such high resolution allowed for the discrimination of individual fission products by atomic number from a uranium cocktail beam, even using only a single diamond detector.
Further tests allowed for the calibration of the deposited energy and the comparison with ionization chambers enabled Z-discrimination within each layer and reaction identification between layers.
This presentation will provide an overview of the LISA array's current status, the results from experimental tests conducted in 2024, and plans for commissioning the final setup in 2025.

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Day 2 - Session 2 / 6

AZIMUTH: a new generation telescope array for EoS experiments

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The nuclear Equation of State (EoS) community is converging towards experiments with exotic inline fragmentation beams, at energies above 100 MeV/u. Many groups are now interested in the recently upgraded FRIB facility, at the Michigan State University (USA). In the beam energy region there available, the study of dense nuclear matter at supra-saturation density is possible and it allows to constrain the symmetry energy behavior. The INFN NUCL_EX collaboration, together with many other groups, presented a letter of intents to the FRIB PAC, collecting many physics cases and suggesting new detector setups for measuring them.
In this context, I am going to submit an application for an ERC Consolidator Grant, proposing a new generation telescope array. The project, called AZIMUTH (A and Z Identification, Modular, Universal, Tracking Hodoscope), will focus on a Si-Si-CsI module, combining two SSSSD layers for a precise position determination, followed by CsI cubes. The aforementioned modules may be stacked one after the other, enabling tracking capabilities of most energetic particles punching through the various CsI layers. By means of machine learning we plan to classify the possible paths of light charged particles (H and He isotopes) in the CsI layers in order to identify also the ions which scatter or make a nuclear reaction inside the crystals. In such a way we should maximize the detection efficiency of the telescope. Thanks to the first two solid state layers we should be able to discriminate in charge and mass also the least energetic intermediate mass fragments, making the apparatus almost "universal". Finally, we propose a streaming readout paradigm to reduce the amount of electronics needed to operate the detector.
In this contribution I'd like to illustrate the submitted project and other possible alternatives which can be used to study the EoS at FRIB and in future European laboratories (FAIR, FRAISE, Spiral2, etc…).

Day 2 - Session 4 / 7

The EPSI R&D: Development of a X-Ray detector for the detection of synchrotron radiation in space

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The direct measurements of the antimatter components in cosmic rays provide a crucial information on the mechanisms responsible for their acceleration/propagation and represent a powerful tool for the indirect search of dark matter. At present, charge sign discrimination has been performed by the use of magnetic spectrometers, which are not suited to extend the current measurements at higher energies in a relatively short time scale. Since most of present and future experiments in space dedicated to the high energy frontier are based on large size calorimeters, it would be important to develop an alternative charge sign discrimination technique that can be integrated with them.
Investigating this technique is the main goal of the Electron Positron Space Instrument (EPSI) project, an R&D that has been approved and financed in Italy as a PRIN (Research projects of relevant national interest), whose activity started in September 2023. To this end, we plan to exploit a principle that has been suggested long time ago, based on the synchrotron radiation emitted by charged particles as they travel into the geomagnetic field. The simultaneous detection of a electron/positron with an electromagnetic calorimeter and synchrotron photons with a X-ray detector is enough to discriminate among the two leptons at the event level. The main challenge is to develop a X-ray detection array with very large active area, high X-ray detection efficiency, low energy detection threshold and compliant with space applications.
In order to achieve the required specifications while keeping the cost sufficiently low to equip a large area, we investigate the feasibility to develop a single detection cell based on a small scintillator, a large area SiPM and a thin aluminum layer deposition. Different solutions for the components and the geometry of the detection cell are currently under test both with laboratory measurements and detailed simulations. In this contribution, we will discuss the current status of the
R&D and next steps for the fulfillment of the project goals.

Day 1 - Session 2 / 8

Measurements of nuclear fragmentation cross sections with the FOOT experiment

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Nuclear fragmentation processes significantly impact particle therapy and space radiation protection, where accurate cross section measurements are needed for refining treatment planning and shielding strategies. Despite extensive research efforts in recent years, experimental data remain limited for double-differential cross sections, particularly in the energy range of 100–1000 MeV/nucleon. This gap affects the optimization of treatment plans, where nuclear interactions alter dose distributions, and the development of spacecraft shielding, since fragmentation processes are a critical source of radiation exposure for astronauts.
The main goal of the FOOT (FragmentatiOn Of Target) experiment is to tackle these needs by providing measurements of double differential fragmentation cross sections of light elements ($Z \leq 10$) in the energy range of interests in medical and space applications.
Two different setups were designed for this scope and data have already been carried out in several

campaigns.
An overview of the state of the art of the apparatus is described, focusing on features and performances of the tracking detectors. Finally, the preliminary results of cross section measurements obtained with a ^{16}O beam at the GSI facility are shown.

Day 2 - Session 1 / 9

Design and performance of the prototype of the new Particle Identification system for the MAGNEX spectrometer within the NUMEN project

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The MAGNEX large acceptance magnetic spectrometer, which consists of a large aperture vertically focusing quadrupole and a horizontally bending dipole magnet, is installed at the Laboratori Nazionali del Sud of the Istituto Nazionale di Fisica Nucleare (INFN-LNS) in Catania.
During MAGNEX data taking, the experimental campaigns were performed using ion beams up to 1010 pps provided by the Superconducting Cyclotron (SC) at INFN-LNS. Nevertheless, in the context of the NUMEN project, which aims to get accurate values of the tiny Double Charge Exchange (DCE) cross-sections and to perform a systematic study of a large number of nuclei of interest for the neutrinoless double beta decay (0⊠⊠⊠), the SC is being fully refurbished featuring ion beams with energies from 15 up to 70 MeV/u and intensities up to 10^{13} pps. The high rate of incident particles demands a complete upgrade of the MAGNEX Focal Plane detector, which will consist of a new Particle Identification (PID) system and a new gas tracker detector along with a γ-calorimeter. The PID system is equipped with a large number (720) of ΔE-E telescopes of 110 μm thin SiC detectors and 5 mm thick CsI(Tl) crystals arranged in 36 towers that will work in a neutron-rich environment. For this reason, the radiation hardness of the SiC has been tested, as well as the performance in detecting ions and the border profile with a proton-microbeam. A prototype of the PID wall has been built and studied thanks to an experimental test with an 18O beam at 272 MeV incident energy and ^{197}Au and ^{12}C targets performed at INFN-Laboratori Nazionali di Legnaro, Italy. This contribution will present the design of the new PID system, SiC characterizations, and the prototype's performances.

Day 3 - Session 2 / 10

Recent progress of aerogel production for Cherenkov detectors in Novosibirsk

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We produce high transparent aerogel tiles with a thickness of 20, 30 and 40 mm and n = 1.05 and aerogel tiles with a thickness of 40 or 50 mm and n = 1.03. The new procedure of thermal annealing of aerogel allows us to produce several new aerogel samples with recordable lateral sizes in 2022-2023.

In a multilayer aerogel, the refractive index and layer thicknesses are chosen so that the images of Cherenkov rings from different layers coincide in the photon detector plane. In 2023, we produced several samples of four-layer focusing aerogel measuring 230×230×35 mm with the correct parameters for refractive index and transparency.
Single photon Cherenkov angle resolution is investigated with relativistic electrons at BINP beam test facilities "Extracted beams of VEPP-4M complex".
Expected powers of particle separation with such aerogels and photon detector with pixel size 3x3 mm are following:
• for μ/π–separation up to 1.7 GeV/c;
• for π/K–separation up to 8.5 GeV/c;
• for μ/π–separation up to 14 GeV/c.

Day 3 - Session 1 / 11

Transition Edge Sensors for Antiprotonic Atom X-ray Spectroscopy

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The advent of quantum sensing x-ray microcalorimeters such as Transition Edge Sensors (TESs) 1 has created exciting new opportunities to push the limits of precision physics in the x-ray domain. Thanks to the factor of 50 improvement in energy resolution offered by TESs over high-purity germanium [2, 3], and their high efficiency compared to crystal spectrometers [4], anti-protonic atom x-ray spectroscopy has entered a new era compared to the previous generation of experiments. The PAX project (anti-Protonic Atom X-ray spectroscopy) will employ a next-generation TES detector for spectroscopy of Rydberg transitions in antiprotonic atoms to establish new benchmarks for bound-state QED with a precision of 10^{-5} at field strengths well beyond the Schwinger limit [5]. Details of the PAX experiment at the CERN's ELENA facility [6], current status of detector development, and first results from test beam including unique challenges for detector development related to annihilation and electromagnetic background will be discussed.

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Day 3 - Session 3 / 12

Picosecond resolution time resolved photoelectron emission detection system

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The lifetime of hot carriers in materials following photoexcitation is a critical factor influencing their potential for various applications, including solar energy conversion, surface chemistry, optoelectronic devices, etc. We have developed a time-resolved photoelectron emission detection system to experimentally study hot carriers in diverse materials. This system employs an advanced Radio Frequency Timing (RFT) technique, where RF-synchronized ~258 nm photons are directed at the sample target. The emitted photoelectrons are accelerated to ~2.5 kV, scanned using a dedicated circular scanning deflector operating at 500–1000 MHz, and subsequently focused and detected by a position-sensitive detector composed of dual chevron microchannel plates and a delay-line anode. By converting the time of arrival of incident electrons into a hit position on a circle, the system achieves ~10-picosecond temporal resolution for single electrons. Experimental results for gold and graphene are presented: no delayed electrons were observed from gold, whereas graphene exhibited delayed electrons clearly detectable up to the nanosecond range. Current efforts focus on achieving sub-10-picosecond resolution.

Day 3 - Session 2 / 13

Options of RICH detectors based on silica aerogels for high momenta range

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Nowadays several projects of future colliding beam experiments are considered in the world. Among them are CEPC (Circular Electron Positron Collider) in China and FCC (Future Circular Collider) at CERN (Switzerland). To perform experiments on flavour physics at energy range of the projects an excellent particle identification up to momenta of 30 GeV/c is required. Several concepts of RICH detectors were considered and evaluated with help of GEANT4 simulation: FARICH (Focusing Aerogel RICH) based on multilayer aerogel with maximal refractive index 1.008, RICH with Fresnel lens based on aerogel with refractive index 1.008, RICH based on transparent aerogel fibres with refractive index 1.008. Results of simulation are presented. Some results of beam tests at the BINP performed to validate GEANT4 simulation are shown. Requirements to position-sensitive photon detectors are formulated and some technical solutions and availabilities are discussed as well.

Day 1 - Session 3 / 14

Hardware-software solutions for beam diagnostics in the LINAC-200 linear electron accelerator

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The linear accelerator LINAC-200 at DLPN JINR is a new facility, constructed to provide electron test beams to carry out particle detectors R&D, to perform studies of advanced methods of electron beam diagnostics, and for applied research in the field of materials science, radiobiology and radiochemistry. One of the most important systems of the accelerator is the beam diagnostics system. The report will focus on beam current transformers and RF travelling wave beam monitors (which allow to monitor both beam current and its position relatively to accelerator axes). The design of the data acquisition system from these sensors including both hardware and software solutions will be presented.

Day 3 - Session 2 / 15

ASHIPH option for PID on future colliding beam experiments

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Now the ASHIPH (Aerogel, SHifter, PHotomultiplier) Cherenkov counters are considered as a particle identification system for the detector on various future colliding beam experiments. Cherenkov light from particle in aerogel is collected by wavelength shifter (WLS) placed in the middle of the counter and re-emitted transported by WLS like a lightguide to photomultiplier (PMT). Today it is possible to use more efficient silicon photomultipliers (SiPMs) as photon detectors (PDE~40%).

We have developed prototypes of ASHIPH-SiPMs counters of small (260x80x36 мм^3) and large (500x200x60 мм^3) sizes. Aerogels with refractive indexes of 1.05 and 1.03 were used inside the prototypes, which can allows separation of pions and kaons up to 2.5 GeV with high quality. The both prototypes of the ASHIPH-SiPM counters were investigated on a test electron beam. The results of measuring average number of photoelectrons per relativistic particle, inhomogeneity of the light collection in counter and the quality of particle separation will be presented.

Day 2 - Session 4 / 16

Scintillation detector array GADAST for the investigation of proton radioactivity reactions

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<p>Scintillation detectors based on CsI(Tl) crystals are widely used in nuclear physics, especially in the field of gamma-ray spectrometry and/or fast light charged particles. Large CsI(Tl) crystals like ours with a volume of 370 cm³, are used in many collaborations [1-3].</p>

<p>GADAST (GAmma-ray Detector Around the Secondary Target) is a compact detector array, that is a part of the EXPERT setup [3]. It is intended to be used in experiments with radioactive beams and positioned in the middle focal plane of the Super-conducting FRagment Separator (Super-FRS) facility [4], within FAIR. The array consists of 128 CsI(Tl) and 32 LaBr₃ scintillators coupled with photomultipliers. The principal task of the GADAST detector in the context of the EXPERT physics program is to disentangle measurements of (few-)proton radioactivity by tagging the gamma-ray de-excitation of the heavy fragment in the excited state(s). In addition, due to its thickness, it is suitable to be used as the detector of charged particles.</p>

<p>The proton radioactivity processes are of significant interest due to the limited understanding of their formation mechanisms. Furthermore, many isotopes exhibiting this phenomenon are either insufficiently studied or not discovered at all. For example, the properties and potential proton radioactivity of exotic isotopes such as ¹⁷N, ³⁰Ar, etc. can be studied in radioactive beam experiments, which employ GADAST.</p>

<p>In this work, the gamma-ray source measurements of 32 CsI(Tl)-based modules, which are an in-kind contribution from the Czech Republic to FAIR, are presented. Main properties of CsI(Tl)-based detectors were investigated, specifically, energy resolution, non-uniformity of the light output and efficiency.</p>

<p>The ExpertRoot package [3], based on the FairRoot framework, was used to produce a robust simulation of the experiment. Various algorithms were developed to account for pile-ups, light output non-uniformity and activities of the gamma-ray sources. Signal overlaps were observed in the experiment due to the high intensity of the gamma-ray sources. The need to consider the non-uniformity of the light output stems from the large size of the CsI(Tl) crystals.</p>

<p>The simulation and experiment are found to be in good agreement; the pile-ups were fully reproduced.</p>

<p>In the future, we will use the pulse pile-up algorithm, when GADAST modules are located near the target, bombarded by a high-intensity heavy ion beam.</p>

Day 3 - Session 1 / 17

The DUNE PhotoDetection System: Components and key goals

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The Deep Underground Neutrino Experiment (DUNE) is a international flagship project in particle physics and one of the most ambitious neutrino beam experiments ever conceived, hosted by the United States Department of Energy national laboratory, Fermilab. This experiment will use the Liquid Argon Time Projection Chamber (LArTPC) technology, proposed by C. Rubbia in 1977.
DUNE will consist a far detector with four modules and a near detector complex exposed to the world's most intense neutrino beam that will be originated at the Long Base Neutrino Facility (LBNF). When the neutrino beam interacts in liquid argon, charged particles are produced, which in turn will ionize and excite the argon atoms.
The free electrons, obtained from the ionization, begin to move with the drift velocity towards the anode; while the de-exitation of the argon atoms produces scintillation light that will be detected by the photon detector system (PDS). The PDS is an independent system that will provide valuable time information for the reconstruction of the event. The PDS of the first two far detectors modules will be composed of photon detection devices, named X-ARAPUCAs. In this talk I will present the PDS with an emphasis on the design, features and status of the X-ARAPUCA technology.

Day 2 - Session 3 / 18

Low-pressure TPC with GEM readout for experiments with low energy ion beams

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At Accelerator-based Mass Spectrometer (AMS) in Novosibirsk, there is a problem to separate isobar ions of different chemical elements that have the same atomic mass. The typical example is radioactive isotopes 10Be and 10B that are used to date geological objects at a time scale of a few million years.
To solve this problem we have developed and successfully tested a low-pressure Time Projection Chamber (TPC) with Gas Electron Multiplier (GEM). The idea behind this development is to measure the length of the ion's track until it comes to a stop and the energy it releases in the chamber volume. The TPC was successfully manufactured and its characteristics were studied in iso-butane at low pressures using alpha particles of different energies. Using results of the TPC tests and the SRIM code simulation, it was shown that it is possible to efficiently separate isobaric boron and beryllium ions at a nominal pressure of 50 Torr. The chamber was then installed on the AMS and successfully tested on 14C beam.
Based on this technology, a TPC with the optical readout, using the highly sensitive video camera.
The latest results f this work will be presented in my presentation.

Day 1 - Session 2 / 19

Study of radiation damage of SiPMs at the BNCT facility (BINP)

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A stand to study of radiation damage of SiPMs at BINP (Novosibirsk, Russia) was developed. The stand is based on BNCT (Boron Neutron Capture Therapy) facility. The facility has option to produce fast neutrons with an energy up to 15 MeV. These neutrons are used to irradiation and are formed in the process of nuclear reactions during the interaction of deuteron beam with thin layer of lithium: $d +^7 Li \rightarrow^8 Be + n + 15.028\ MeV$ and $d +^7 Li \rightarrow 2^4 He + n + 15.122\ MeV$. Integral dose at the level of $10^{14} neq/cm^2$ can be obtained. In December 2024 first irradiation of SiPMs was performed, results and further plans will be presented.

Day 3 - Session 3 / 20

Advanced Radwaste Monitoring By Means Of Flexible Scintillating Fibers And Compact Neutron Detectors

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The monitoring of radioactive waste (radwaste) is a critical aspect of nuclear waste management, ensuring environmental safety and compliance with regulatory standards. Among the advanced technologies explored for this purpose, scintillating fibers (SciFi) and Silicon-Lithium-Fluoride (SiLiF) detectors have emerged as promising tools for real-time radiation monitoring and data acquisition. Research conducted at the LNS-INFN in Catania has demonstrated the feasibility of SciFi-based systems for detecting gamma radiation and SiLiF sensors for neutron monitoring in radioactive environments.
The SciFi sensors operate by converting ionizing radiation into light signals through scintillation, which are then transmitted via optical fibers to SiPM (Silicon Photo Multiplier). This approach offers several advantages, including good energy resolution, high counting rates, and scalability for large-scale monitoring applications. Experimental campaigns have validated the performance of SciFi-based detection systems through laboratory tests and pilot-scale field deployments. Specific results include improved detection sensitivity by over 30% through optimized fiber configurations and readout electronics. These advancements have enabled more precise radiation mapping, enhancing waste characterization accuracy. Key developments include the integration of advanced data processing algorithms for real-time analysis.
Neutron detection capabilities have been significantly studied by using SiLiF sensors. These detectors exploit neutron capture reactions to produce detectable charged particles, enabling efficient neutron monitoring in mixed radiation fields. Measurement campaigns demonstrated discrete neutron detection with good background discrimination even in medium level activity environment. Results included successful field trials with mixed neutron and gamma sources, confirming neutrons counting and stability over extended operational periods.
Additionally, innovative data fusion techniques have been implemented, combining signals from multiple sensor arrays to reduce measurement uncertainty and increase the statistics. Tests involving mixed radioactive sources demonstrated reliable discrimination between isotopes based on gamma energy spectra. Long-term operational stability tests have confirmed negligible performance

degradation over extended monitoring periods.
Further technological enhancements include the development of standalone, battery-powered electronics with wireless connectivity, enabling remote monitoring and data transmission in hard-to-access environments. Field deployments have shown that these systems can operate autonomously for extended periods, simplifying maintenance and reducing operational costs.
The adoption of integrated gamma and neutron detection systems with advanced electronics represents a significant advancement in radwaste monitoring. Their implementation could lead to more efficient, accurate, and sustainable management strategies, contributing to the long-term safety and security of radwaste storage facilities.

Day 2 - Session 3 / 21

Stilbene-based neutron TOF-spectrometer

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Modular neutron spectrometer (MONES) in ACCULINNA-2 based on stilbene crystals in combination with 3-inch fast ET-Enterprise 9822B photomultipliers, was developed in accordance with the requirements of our recent research in studying the low-energy spectra of several unbound nuclear systems 10Li, 5–7H, 7,9He populated in transfer reactions [1–3]. Since the correlation between the incident neutron energy and the amplitude scintillator response is unsettled, the time of flight (TOF) method is routinely applied for neutron energy measurements. The neutron energy is obtained from the measured neutron flight time using the nonrelativistic kinetic energy equation and its accuracy is entirely determined by the time resolution of scintillation detector. This work is devoted to the characterization of neutron TOF spectrometer, in terms of amplitude and time resolution, neutron/gamma separation performance and detection efficiency in the detector. The detector response to gamma-rays and neutrons were performed using Monte Carlo Geant4 simulations and compared with measured data. The first derivative of measured response by the use of gamma sources was to locate the Compton Edge position for amplitude calibration. The portable generator of "tagged"neutrons with energies of 14.1 MeV [4] was utilized for reconstruction the light out response to heavy ions (protons and alpha particles) and determining the neutron registration efficiency.

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Day 3 - Session 3 / 22

Radwaste reconditioning: a new approach through a gamma scanner/imaging system.

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In the context of the "Grand Challenges", special attention is paid to the reconditioning of radioactive waste (radwaste) generated by energy and non-energy activities. Institutions such as the Nuclear Decommissioning Authority (NDA) promote projects that aim to develop new, safe, affordable, and accessible technologies for better protection of both people and the environment. Effective waste management is critical to the success of nuclear decommissioning missions. Nuclear decommissioning generates several types of waste, including Low-Level Waste (LLW) and Intermediate-Level Waste (ILW), which represent most of the radwaste. These spoiled materials are typically stored in specialized drums at near-surface disposal sites. Delaying operations can reduce ILW and increase LLW, which may be exempt from regulatory control. Decommissioning strategies include keeping the facility in safe confinement mode or dismantling, conditioning the waste, and storing it temporarily until it decays to levels that allow for standard disposal. According to the International Atomic Energy Agency (IAEA), storage is critical for isolation, environmental protection, and the possibility of future recovery if necessary. Waste sorting and segregation are key steps in this process.
In this context, the PI3SO project (Proximity Imaging System for Sort and Segregate Operations) was developed as a gamma radiation spectroscopic scanner/imager tool for radioactive waste. The primary goal of PI3SO is to accelerate the waste management cycle while minimizing human intervention. The system provides detailed information via proximity imaging and spectral analysis, enabling the identification of "hot-spots" in activated materials. The system consists of a table equipped with two linear arrays of scintillators, installed on a motorized bridge that slides along the table to scan the radwaste from above and below. It employs two linear arrays of 64 CsI(Tl) scintillators and each of them is coupled to a SiPMs to perform a scan with precision down to 1 cm2. Preliminary promising results form the basis for further optimization of the prototype and sensor technology.
The PI3SO system has undergone successful testing with radioactive sources, achieving a minimum detectable activity of a few hundred Bq and showing an interesting 5-6% energy resolution at the 662 keV peak of 137Cs. Real-world tests on decommissioned accelerator parts at INFN-LNS further demonstrated the system's ability to detect radioactive isotopes, including 44Ti, 44Sc, 22Na, 60Co, and 133Ba. The PI3SO system promises to improve safety by reducing direct human exposure to radioactive materials, minimizing operational errors, and offering a faster, more efficient waste management process. This innovative approach holds promising potential for enhancing the sorting, segregation, and storage of ILW and LLW during nuclear facilities decommissioning, thus reducing costs and facilitating the release of storage space.

Day 2 - Session 1 / 23

Advancements in the characterization of SiC devices within the SAMOTHRACE ecosystem

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This contribution highlights recent results obtained in the characterization of new-generation Silicon Carbide (SiC) devices. Due to their peculiar features, SiC detectors are recognized as an excellent choice for charged particles detection, for both medical applications and nuclear physics studies [1-6]. Specifically, within the SAMOTHRACE ecosystem [7], a SiC detector array is under development for the detection of Radioactive Ion Beams (RIBs), which currently represent a new frontier for both medical and nuclear physics fields. This array, coupled with a fast electronics front-end [8-9], is designed to be compact, versatile, and capable of providing detailed information on RIBs. A key feature of this detection system is its high timing performance, which offers significant advantages in experimental studies involving RIBs. The reported results, obtained using radioactive α sources as well as accelerated proton and α beams, focus on evaluating the SiC detectors energy resolution and timing performance. In the latter case, a novel method based on crossing time and signal-sharing analysis has been employed to assess the time resolution of SiC detectors. A comparison of the timing resolution achieved using a micro-channel plate detector will also be discussed.

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Day 1 - Session 1 / **24**

Silicon carbide detectors for particle therapy within the SAMOTHRACE ecosystem

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Silicon carbide detectors for particle therapy within the SAMOTHRACE ecosystem

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The cancer treatment using different methods and with high profile clinical approach is an important challenge in the current era. Several methods are used to treat cancer, among which the well knows X-rays. However, while X-rays inevitably damage healthy tissue during the irradiation for tumor cells killing, it was shown that the irradiation with charged particles (such as protons, alphas, carbon ions) allows a more precise definition of the deposited energy in the tumor cells, saving the healthy tissues 1. Even more, recently, radioactive ion beams, as the Carbon-11, are indicated as promising ions to be used in such a field: Carbon-11 particles, in fact, have the advantage of being used both in hadron therapy and medical imaging. In this context, SiC detectors are being characterized within the SAMOTHRACE ecosystem for their employment as dosimeter, micro-dosimeter and tagging for RIBs such as the Carbon-11 [2, 3, 4]. In this contribution the characterization of two Silicon Carbide devices, will be discussed. In particular, a detector with a surface of 1 cm2 and 10 um thick, intended to be used as a dosimeter and micro-dosimeter, has been characterized with a radioactive source. A second detector, with the same surface area and 100 um thick, has been characterized with radioactive sources and a comparison with a Silicon detector of similar capacity has been performed.

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Day 1 - Session 4 / 25

The GEM-μRWELL for ePIC Endcap Tracking

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The ePIC detector will be the first detector at the upcoming Electron-Ion Collider (EIC)1 at Brookhaven National Lab. The design of the detector is determined by the various physics goals of the EIC program, which include addressing the origin of the nucleon spin, the three-dimensional structure of the nucleon, the study of saturation effects, and the study of hadronisation. This ambitious scientific program imposes stringent requirements on the tracking system needed for the measurement of the scattered electron and charged particles produced in the collisions at the EIC.

The ePIC tracking system combines Silicon trackers with Micro Pattern Gaseous Detectors (MPGDs). The Endcap Trackers are designed to cover the pseudo-rapidity region $|\eta| > 2$, one positioned in the leptonic region and the other in the hadronic region. Each of them is composed of a pairs of GEMμ-RWELL[2,3], a hybrid detector capable of very stable operation at gas gain larger than 2×10^4. This is accomplished through the coupling of a single GEM pre-amplification layer and a standard μ-RWELL. The R&D has been introduced in collaboration with the INFN-LNF group, which is studying its timing performance for the LHCb Phase II upgrade.

As tracker, each disk is engineered to meet stringent performance requirements, including a time resolution of 10 ns, a material budget of approximately 1% X_0, and most of all a spatial resolution of 150 μm, and a single detector efficiency of 96–97%, corresponding to a combined efficiency for the two layer of 92–94%. The addition to the GEM pre-amplification is necessary as a solution for the typical high gain required for satisfying such performance for angular tracks.

As part of this effort, a recent test beam campaign was conducted in November 2024 at the PS-T10 East Area at CERN. This test aimed to evaluate the spatial resolution and detection efficiency under varying angles between the incident beam and the detector surface, ensuring compatibility with ePIC's operational requirements.

In this talk, I will provide an overview of the EPIC detector, with a focus on the Endcap Trackers and their integration into the broader tracking system. I will then delve into the GEMμ-RWELL technology and the key results obtained.

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Day 1 - Session 4 / 26

Recent Advancements in Resistive MPGD: from μ-RWELL technology to high performance Hybrid Layouts

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The challenges posed by forthcoming high-energy physics experiments necessitate the development of particle detection technologies with very high tracking and timing performance, as well as robustness in harsh environments.
In this contribution, we present a summary of the R&D on the μ-RWELL technology, a single-amplification-stage resistive MPGD. The highlights of various tests performed with X-rays and particle beams at the CERN PS-SPS complex facility will be presented, providing a comprehensive characterization of this detector. The typical performance of the μ-RWELL can be summarized as follows: maximum gas gain on the order of 2×10^4, 1D spatial resolution of 100 μm over a wide range of incidence angles (0–45 degrees), and time resolution as low as 5 ns.
To address the stringent requirements of the LHCb experiment's muon system upgrade, which demands unprecedented time resolution and operational stability, we explored innovative detector layouts beyond the conventional μ-RWELL design. A recently proposed solution is based on a hybrid technology, in which a GEM-based pre-amplification stage is combined with the classic μ-RWELL. This new hybrid layout, referred to for brevity as G-RWELL, was recently characterized using X-rays and muon/pion beams at the PS-T10 CERN facility. It demonstrated exceptional performance, achieving a maximum gas gain of up to 10^5 and a time resolution as low as 3.8 ns (single gap), setting a new benchmark among classical MPGDs.
The G-RWELL layout has been proposed to address the issue of fine 2D tracking for non-orthogonal particle tracks, which typically require gas gains greater than 104. This latest R&D effort, aimed at studying tracking detectors for the EPIC experiment at the future Electron-Ion Collider facility at Brookhaven National Laboratory (USA), has been conducted in collaboration with the Roma Tor Vergata University group. Preliminary results indicate a spatial resolution well below 100 μm for perpendicular tracks, while the performance for incident particles is still under evaluation.
The G-RWELL appears to be a very promising and groundbreaking technology with extremely high reliability and achieving some of the highest gains in the field of MPGDs and delivering truly remarkable performance.

Day 1 - Session 3 / 27

Advancements in Silicon Carbide-Based Detectors for High-Performance Radiation Dosimetry and Beam Monitoring: from simulations to test phase

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Advancements in Silicon Carbide-Based Detectors for High-Performance Radiation Dosimetry and Beam Monitoring: from simulations to test phase

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Silicon Carbide (SiC) based detectors have been appointed as possible candidates for new-generation detectors for both radiation and charged particles. SiC is in fact a material characterized by a high radiation hardness, a strong mechanical resistance and thermal stability. Also, its high breakdown field and saturation velocity could allow a fast charge collection [1,2]. In consideration of such properties and the biocompatibility and insensitivity to light [3], SiC detectors can be used as high-performing and easy-to-use biomedical sensors and dosimeters.
In this contribution, some of the activities related to the study of the Silicon Carbide device as dosimeter or real time beam monitor, in the framework of Samothrace ecosystem [4], are presented.
Specifically, proton beams and radioactive sources were used to analyze the performance of a SiC device with segmented geometry. Investigations were conducted on the effects of interactions between different pads, as well as the cross-talk, the interaction between electric fields of different pads, the inter-pad contribution and the edge effects.
Focus of this contribution is the development of accurate simulations, conducted with Geant4 tools.

The signals expected for a 10 µm and a 100 µm SiC detectors, with a 2x2 padded configuration, were reproduced when irradiated by alpha radioactive sources of 3-4 AMeV. The performed simulation takes into account the different possible configurations and manufacture of the detector, and represented a crucial tool to understand the electric field of the inter-pad regions, and to get a proper identification of lost events. Also, a thorough evaluation of electric field effects, performed using different simulations tools, is ongoing.

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Day 1 - Session 2 / 28

Cellular irradiation with proton beams at the CIRCE tandem accelerator: a dosimetric and radiobiological investigation for BNCT applications

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Boron Neutron Capture Therapy (BNCT) is a radiotherapy (RT) technique based on targeting tumors with a ^{10}B-labelled drug and on irradiating them with neutrons. It exploits the ^{10}B(n,α)^{7}Li capture reaction, whose short-ranged high-LET products enable a localized and enhanced therapeutic effect compared to photon-based RT. Products of other neutron reactions also contribute to the overall absorbed dose imparted to the patient, each with a potentially different radiobiological effectiveness. The ^{14}N(n,p)^{14}C reaction is among the most frequent ones, and produces 583 keV protons. The aim of this study was irradiating U87 cells, from an aggressive and radioresistant glioblastoma cell line, with 583 keV protons, in order to start investigating their radiobiological effectiveness.
Irradiations were conducted at the CIRCE (Center forIsotopic Research on Cultural and Environmental Heritage) Laboratory of University of Campania "Luigi Vanvitelli", using its Pelletron tandem accelerator to produce the proton beam and a dedicated beamline for radiobiological experiments, consisting in a scattering chamber with several radial channels and a movable target holder 1. In particular, a gold target and the 15° and 60° channels were employed. Preliminary irradiations with Silicon Surface Barrier Detectors (SSBD) placed at the two angles are conducted for counting calibration, employed for subsequent real-time beam dosimetry. Then, the 15° SSBD is replaced with CR39 nuclear track detectors for dose/fluence verification. Finally, the U87 MG cells, seeded on the mylar basis of cylindrical sample holders in layers of 10 µm nominal thickness, are irradiated at different nominal dose values. The initial beam energy set to have average incident proton energy of 583 keV on the cells was calculated taking into account the energy losses in the gold target and in the mylar

layer, by using SRIM/TRIM and GATE/GEANT4 Monte Carlo (MC) simulations. The same simulation toolkits were employed to calculate the average absorbed doses to the cells and compare them with the real-time dosimetry, which follows a LET-based analytical approach 1. After irradiation, a clonogenic assay of the cells was carried out, estimating the survival fractions (SFs) at the different dose values and deducing the respective survival curve by fitting the data with the linear-quadratic model.
The results of etching and trace counting on CR39 are in good agreement with the theoretical expected fluences. The cellular dosimetric estimates from MC simulations show some discrepancies with respect to the analytical ones, suggesting a possible integration of MC in the the real-time dosimetry workflow for proton beams of the energies employed in this study. The obtained SFs for 583 keV protons, when compared with the ones obtained on the same cell line with 250 kVp x-rays, show higher radiobiological effectiveness. The lack of radiobiological data in literature for protons of such energies warrant further studies, for accurately estimating new survival curves of high interest for BNCT.

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Day 2 - Session 3 / 29

Neutral particles discrimination with BGO in then BGOOD experiment

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The BGOOD experiment at the ELSA facility has been designed to investigate hadron structure through the study of non-strange and strange meson photoproduction on the nucleon. The setup uniquely combines a BGO crystal calorimeter with a large aperture forward magnetic spectrometer providing excellent detection of both neutral and charged particles.
To accurately reconstruct the final state and minimize particle misidentification, the optimization of photon-neutron discrimination criteria in the BGO calorimeter is continuously evolving.
The different processes underlying detection of high-energy photons and neutrons in the BGO calorimeter, are responsible for differences in the main features of signal clusters associated to these two particles in the detector.
In this contribution I will describe the photon-neutron discrimination criteria that we have developed on the base of this features and present a comparison with simulation.

Day 3 - Session 2 / 30

Latest results of meson photoproduction on deuterium at GRAAL

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The latest results of data from the GRAAL experiment for coherent π π and ηπ coherent photoproduction channels on deuterium are presented. A complete kinematical reconstruction was made

with the deuterons identified by the forward part of the GRAAL set-up and the π0 and η reconstructed by two photons detected by the central part of the apparatus. The results of the GRAAL data are compared with the results of the BGOOD data. Further, an overview of the GRAAL setup is shown.

Day 2 - Session 1 / 31

First characterization of the gas tracker of the new focal plane detector of the MAGNEX spectrometer for the NUMEN project

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The realization of a new focal plane detector for the MAGNEX large acceptance magnetic spectrometer (@INFN-LNS) is one of the current focuses of the R&D activities within the NUMEN project. The project aims to provide data-driven evaluation of the neutrinoless double beta (0νββ)-decay Nuclear Matrix Elements by measuring the extremely low Heavy-Ion induced Double Charge Exchange reaction cross sections (tens of nb). In this scenario, the ongoing upgrade of the INFN-LNS infrastructure toward unprecedented high fluencies of ions (10^13 ions/cm^2 integrated in the 10 years prospected duration of the project) is of fundamental importance, encouraging the application of innovative technologies for the new detection system. The new focal plane detector consists of a low pressure gas-filled tracker based on micro-pattern gas detector (i.e. Multiple-THGEM) and a telescope array of SiC-CsI(Tl) for particle identification (PID-Wall).
The structure of the gas tracker involves three main regions: the drift, the multiplication, and the induction regions, from the bottom to the top, respectively. Systematic studies on the electrical configurations return a maximum achievable gain of the order of 10^5 and an Ion Backflow down to 10-20% in our working conditions. Moreover, the first characterization of the gas tracker in coincidence with a single SiC-detector points out a good reconstruction quality of the tracks left by α particles. A new in-beam test (IRRAD4) was performed at the University of São Paulo, employing 7Li and 12C beams at different energies and at different rates of incident particles. The analysis of the data is ongoing.
This contribution will introduce the detector and its working principle, reporting the main results obtained during the tests.

Day 1 - Session 3 / 32

J-PET tomograph as a multidisciplinary detection system for medical imaging and fundamental studies

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The Jagiellonian Positron Emission Tomograph (J-PET) is the first modular and portable multi-photon PET scanner, which is a multidisciplinary detection system used in medical imaging as well as in fundamental research including discrete symmetry tests in positronium decays [1,2]. In addition to standard PET imaging, the J-PET scanner allows the positronium lifetime imaging in the human body [3,4,5]. The first ever in-vivo image of positronium in the human brain recently obtained using a J-PET scanner [5] shows the huge potential of this new diagnostic method in the future.

I am going to present research performed with the J-PET facility regarding both fundamental studies and medical imaging.

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Day 1 - Session 1 / 33

Internal dosimetry for paediatric patients: a GATE Monte Carlo study on UF/NCI phantoms

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Internal dosimetry has an increasing and crucial role in nuclear medicine. Though radiation detection through tomographic imaging permits to reconstruct patient's morphology via CT scans and the biodistribution of radionuclide inside the body via PET or SPECT scans, directly detecting the distribution of deposited energy inside the body is not feasible. Consequently, dedicated calculation methods are necessary to estimate the radiation absorbed dose internally imparted to organs and tissues by radionuclides. Internal dosimetry enables to potentially optimize the injected activity for safer diagnostic acquisitions and effective therapeutic treatments, maximizing the damage to lesions while minimizing complications to healthy tissues. Particular care is required in nuclear medicine practice and related dosimetry for paediatric patients, constituting a radiosensitive cohort 1.
The standard model-based approach for internal dosimetry is the MIRD organ S-factors formalism, widely applied to various adult computational phantoms, such as the ICRP110 ones, for different emitted particles and energies. Instead, to date there is still lack of studies on paediatric phantoms. The aim of this work was to perform a dosimetric study on the UF/NCI voxelized paediatric phantoms [2] through GATE Monte Carlo simulations. The Specific Absorbed Fractions (SAF) due to photons and electrons at different energies were estimated for pairs of organs of major interest for clinical practice.
The geometries and organ compositions of the whole UF/NCI series, which includes phantoms for newborn, 1, 5, 10, 15 and 35 years old of age, were reproduced on the GATE simulation environment, and a set of organs, including thyroid, liver and brain among others, were each set as a homogeneous source of emitted particles. A wide set of monoenergetic values of energy, from 5 keV to 10 MeV, was simulated, scoring for each combination of phantom, particle, energy and source organ the average absorbed dose in all the organ volumes of the phantoms; the respective SAFs were then calculated.
The simulations were carried out on the Marconi 100 CINECA HPC cluster, within the INFN MIRACLE project, exploiting a parallelization into 62 runs per node, thus strongly reducing the overall simulation time. 10^7 primary events were run for each simulation, requiring a further parallelization on multiple runs for high-energy electrons. These specifics guaranteed the selection of photon SAFs with statistical uncertainties below 5% for most of the organ pairs examined. Instead, for the electrons, given their short range, we focused on auto-SAFs (i.e., source = target), which showed uncertainties below 1%.
The obtained SAFs exhibit trends depending on the emitted particle energy, on the organs'size and reciprocal distances and in some cases on phantoms'age. Photon SAFs decrease in the source organ

and in the nearby target organs as the energy increases; the same behaviour is found for electron auto-SAFs. SAFs for the same organ pairs show a decreasing trend for increasing age of the phantoms, evidence justified by the increase of body size, and consequently of the organ volumes and of the reciprocal distances, causing a lower relative energy deposition than for younger ages. Comparing the results for phantoms of the same age but different sex, the differences are way lower than for adult phantoms, and not significant for ages below 10 years; this reflects the more similar body dimensions and proportions between male and female newborns and children with respect to adults. Future perspectives foresee the extension of the dosimetric analysis to additional pair of organs, and the comparison of the SAFs obtained with different Monte Carlo codes.

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Day 2 - Session 2 / 34

The Cross-talk problem for a neutron correlator: preliminary results on the CROSSTEST@LNL experiment for NArCoS

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The advent of new facilities for radioactive ion beams mainly rich in neutrons, SPES @ LNL, FRAISE @ LNS and FAIR @ GSI only to give some examples, imposes the joint detection and discrimination of neutrons and charged particles in Heavy radioactive Ion collisions, with high angular and energy resolution. The construction of novel detection systems suitable for this experimental task is both a scientific and a technological challenge.
The contribution will illustrate the results of recent tests performed on a recently introduced plastic scintillator material, the EJ276, both in the "green-shifted" and in the base version, coupled with SiPMs. The contribution will also present preliminary results on the CROSSTEST experiment performed at LNL-INFN in November 2023. The goal of the experiment was the study of the crosstalk among the elementary cells of NArCoS (Neutron Array for Correlation Studies), a novel detector for neutrons and charged particles with high energy and angular resolution, based on a 3D cluster of the EJ276 scintillation units. This project is also funded by the Italian PRIN ANCHISE Project (2020H8YFRE) and the CHIRONE experiment of the INFN.

Day 2 - Session 2 / 35

A scintillator veto detector prototype for low energy charged beam particles

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A preliminary study for a novel detector development, designed for integration as a fast veto system in the ACTAR TPC chamber 1,
will be presented. The primary goal of this study is to optimize the detection of low-energy charged beam particles while
ensuring minimal interference by positioning the sensor as far as possible from the TPC's active region.
The detector consists of a fast thin plastic scintillator coupled to a silicon photomultiplier (SiPM) via a light guide. To
improve sensitivity to low-energy particles, minimizing their energy losses, a very thin platinum layer (34 nm thickness)
has been deposited on the scintillator surface, by using the DC Magnetron sputtering source at the DFA of Catania University.
This layer serves as a light-tight window, ensuring optimal functionality.
We will present the results of the prototype functional testing, emphasizing its performance and its suitability for
this specific application.

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Day 1 - Session 1 / 36

A new diagnostic system based on SiC technology for proton beam range detection

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Monitoring the Percentage Depth-Dose (PDD) distribution is a fundamental step in beam quality control programs with clinical proton beams, due to its correlation with the beam range, which is closely involved in the patient's treatment plan definition. The uncertainties related to the estimation of the proton range in the biological tissue lead to the extension of the treatment volume, with a consequent increase in the total absorbed dose. In this context, we will present the work done within

the PRAGUE (Proton Range Measurement Using Silicon Carbide) project, funded by the H2020 and Fyzikální ústav AV ČR v.v.i. under the MSCA-IF IV framework, and by the INFN through a young researcher grant. The main goal of PRAGUE was the realisation and characterisation of a SiC (Silicon Carbide) multilayer detector able to measure online the PDD distribution of 30-150 MeV proton beams with both conventional (10^7 pps) and high (10^{14} pps) intensity. The electronic readout, based on the chip TERA08 (commercialised by the DE.TEC.TOR company), can manage up to 64 input channels, converting the incoming charge into counts with a wide range of sensitivity. It was designed to avoid loss of collection efficiency also under high-intensity irradiation conditions. A detector prototype was already realised and tested with 30 MeV and 70 MeV conventional proton beams to study the feasibility of using a multilayer SiC-based system to resolve the PDD distribution of proton beams. A new generation of 80 SiC devices (10 μm active layer, $15x15$ mm^2 sensitive area) was adopted and characterised using X-ray and alpha particle sources as part of the final PRAGUE detector. The results indicate that SiC devices suit relative dosimetry with charged particles. The detectors show a stable and reproducible response, and outstanding behaviour in terms of linearity with absorbed dose was found. The negligible dependence of SiC response against energy and dose rate and the high radiation hardness represent advantageous features compared to commercial solid-state detectors for ion beam dosimetry.

Day 2 - Session 1 / 37

Study of the time characteristic of NArCoS detection system

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The NarCoS (Neutron Array for Correlation Studies) array is designed for simultaneous detection of neutrons and charged particles, particularly in the context of heavy ion collisions involving neutron-rich nuclei. This type of detection plays a crucial role in studying reaction mechanisms and exploring the spectroscopy of nuclear states where neutron emission is a key characteristic. NarCoS is a compact, modular, and segmented apparatus constructed with EJ276G plastic scintillators, proved for their exceptional neutron detection capabilities. Its design consists of elementary detection cells measuring 3 cm x 3 cm x 3 cm, which are optically coupled with Silicon PhotoMultipliers (SiPMs). The array provides a high neutron detection efficiency along with precise angular and energy resolution. Energy measurements are derived from the time of flight, making excellent timing performance and resolution essential. In this contribution, we present a comprehensive study of the timing characteristics of both the detection cells and the associated electronics.

Day 1 - Session 3 / 38

Advancing Proton Therapy with Prompt Gamma-Based Monitoring Methods

Day 2 - Session 3 / 39

Silicon Strip Detectors: more than 20 years achieving worth knowledge regarding weakly bound and exotic nuclei

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Starting the present century, we found in the silicon strip detectors a unique opportunity to reach relevant results regarding the structure and dynamics of weakly bound nuclei and exotic nuclei, particularly, those called halos, where valence neutrons or protons are tremendously separated from a central core.
The common difficulties to produce exotic nuclei in different accelerators and using different methods lay in low beam current productions. Thus, it can be considered as normal, to measure currents of tens and hundreds of exotic particles, interacting with a target. The measure of scattering and reactions in this regime is a challenge, requiring systems with the capability to cover the biggest part of the processes that are occurring. At the same time, the angular discrimination is also important, considering the reaction kinematics.
The silicon strip detectors have been, without place to doubt, the best alternative to cover a large solid angle, and at the same time, solve the scattering angle. Their large active area and its segmentation makes possible to cover a bigger solid angle sections with the same device, permitting simultaneously have every time information about the position either the scattered particle or the particle produced by a reaction.
Single-Side and Double-Sided silicon strip detectors, can be used interchangeably and according to what information is required. One of the advantages of Double-Sided is the possibility to form pixels, increasing potentially the granularity of the active area. Combining strip detectors among them, with PAD's or CsI(Tl) crystals, open a wide window of possibilities building "telescopes". Nevertheless, not everything is bright with strip detectors: the analysis is always a difficult task, considering common problems as channeling, charge sharing, cross talk, dead-layers, complicated mounting, fragile package, and of course, the usual expensive price.
In the present talk, the good advantages and common problems to face up when silicon strip detectors are in action, will be detailed by using good examples of successful arrays, such as DINEX, GLORIA, FARCOS, SIMAS, and some derivations from them.

Day 3 - Session 1 / 40

Overview of Silicon Carbide Detectors: from material properties to radiation hardness

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In this talk an overview of the advantage of silicon carbide detectors will be presented in terms of leakage current, signal resolution and radiation hardness. To obtain high performance in the detectors for different applications, a new growth process of the epitaxial layers has been developed and the characteristics of the epitaxial layers have been obtained by electrical measurements. Furthermore, these detectors with different structures have been used in different applications (neutrons, high energy particles, UV, X-Ray, ⋯) and the main results of these detectors will be reported in this overview. Finally, a specific study on the radiation hardness of these detectors for high energy particles and of the effect of high temperature in the detection of neutrons will be presented.

Day 3 - Session 3 / 41

Sensor systems for radwaste monitoring and nuclear decommissioning: experience from the Euratom projects MICADO, PREDIS, CLEANDEM

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In the framework of the three Euratom H2020 projects MICADO, PREDIS and CLEANDEM several devices and systems were developed suitable for radioactive waste drums monitoring in store and possibly during transportation. The radiological gamma and neutron data, collected in real time, represent a useful tool both for safety and security and are also suitably stored in databases.
Two miniature low cost sensors for gamma and neutrons, constituting the so called MiniRadMeter device, were integrated inside a small box and installed on top of a robotic vehicle for a quick dose rate mapping in radiologically hostile environments in case of nuclear decommissioning or accident remediation.
These systems were installed and tested in several real or realistic nuclear environments and the outcome was absolutely promising. The test missions and the corresponding results will be illustrated during the presentation.

Day 1 - Session 1 / 42

Advanced Detector Technologies for Dosimetry in Conventional and FLASH Radiotherapy

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Dosimetry for conventional and ultra-high dose rate (FLASH) beams involves fundamentally different challenges and requirements, directly influencing the choice and design of detectors. Conventional beam dosimetry typically operates at dose rates of 1-10 Gy/min, allowing for the use of detectors with different properties as moderate temporal, spatial and energetic resolution combined with a well-established calibration protocol. In contrast, FLASH radiotherapy delivers doses at rates exceeding 40 Gy/s, necessitating detectors with ultra-fast temporal resolution, high saturation limits, and resistance to dose rate-induced artifacts. These differing requirements underscore the critical role of advanced detector technologies in ensuring precise and reliable dosimetry for both modalities.
A variety of detector technologies are currently employed to meet these demands. Silicon detectors, widely used for conventional beam dosimetry, o>er high sensitivity and mature fabrication techniques but face limitations in radiation hardness under high-dose exposure. Silicon carbide detectors, known for their exceptional radiation tolerance and fast response, have proven effective for both conventional and FLASH applications. Ionization chambers, the gold standard in clinical dosimetry, provide high precision and stability, though their temporal resolution may fall short for FLASH therapy. Scintillators, valued for their ability to provide real-time measurements, and diamond detectors, with their superior charge carrier mobility and radiation hardness, further expand the toolkit for dosimetry.
Emerging materials, such as perovskites and organic-inorganic hybrids, offer exciting opportunities to address the limitations of existing systems. However, challenges related to stability, reproducibility, and scalability remain critical hurdles to overcome.
This work integrates an overview of the challenges in dosimetry for conventional and FLASH beams with a review of current detector technologies, highlighting their strengths, limitations, and potential for future development. By advancing these technologies, we aim to enable more precise and effective radiation therapies, particularly in the rapidly evolving field of FLASH radiotherapy.

Day 3 - Session 1 / 43

Statistical Insights into Time Resolution of Resistive Plate Chambers

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The pursuit of the best possible time resolution remains one of the most critical areas of ongoing research on Resistive Plate Chambers (RPCs). Achieving top-tier time resolution is vital for numerous applications, ranging from high-energy physics experiments to medical imaging technologies. Various technological solutions are being proposed, each aiming to improve RPC performance, but their effectiveness must be validated through experimentation.
Yet, in addition to technological progress, there are fundamental statistical factors inherent in the signal formation process within RPCs that impose theoretical limits on the time resolution that can be achieved. These limits arise from the random nature of particle interactions and signal generation in the chamber. A clear understanding of these statistical constraints is essential for setting realistic goals and guiding the development of new technologies.
This talk will focus on these statistical limitations, providing an overview of how they affect RPC time resolution. We will examine the key factors contributing to these limits, as well as explore potential solutions and strategies to enhance time resolution within these statistical boundaries.

Day 2 - Session 1 / 48

Nuclear physics applications of SiC detectors: results of the SiCILIA project and perspectives

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Silicon carbide (SiC) is a wide-bandgap semiconductor extensively investigated over the past decades as a potential solution for radiation detection in harsh environments, such as those with high radiation fluences or high temperatures. SiC is characterized by a good radiation hardness, insensitivity to visible light, and suitability to high-temperature operation - unattainable use performances for silicon detectors. These properties make SiC highly attractive for next-generation nuclear physics experiments and applications. However, SiC devices with the required characteristics in terms of active area, thickness and purity are not commercially available.
In recent years, the SiCILIA project, a collaborative effort of INFN-CSN5 and CNR-IMM, has carried out R&D activities aimed at developing new advanced production technologies for manufacturing state-of-the-art thick, large area, p/n junction SiC detector devices.
This contribution will present an overview of the SiCILIA project, reviewing the performances of the SiC detectors developed within this framework. These detectors have been successfully tested in various application fields, and the excellent results demonstrate their significant potential for an extensive use of SiC in both fundamental and applied nuclear physics. Additionally, some of the envisioned applications in innovative detection systems will be discussed.

Day 3 - Session 3 / 50

High-Temperature Performance and Radiation Resistance of 4H-SiC pn Diode Detector for Neutron Detection

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Tritium is crucial for fueling fusion reactions in tokamaks, and its production occurs through neutron-lithium interactions in the Breeding Blanket (BB). Developing and validating BB designs is challenging due to the lack of neutron sources with fluences similar to those in tokamaks. Fast neutron detectors are critical for measuring tritium production and validating neutron multiplication rates. While diamond detectors have been used in past and planned tokamak projects, they face performance issues at high temperatures. Silicon Carbide (SiC) detectors are emerging as promising alternatives for neutron detection in tokamak environments due to their better high-temperature performance. The radiation resistance of 4H-SiC p-n diode detectors was studied under deuterium-tritium fusion neutron irradiation at 14.1 MeV, across temperature range of 25–500 ℃. These detectors, with an active thickness of 250 µm and an active area of 25 mm², A p+ layer 0.3 µm thick with a doping concentration of 1018 cm-3 has been performed though ion implantation. Despite performance degradation due to increased dark current and defect formation, the detectors remained functional. Neutron-induced lattice damage, traps, and compensating centers reduced free carrier concentrations, built-in voltage, and capacitance. The effects worsened at higher temperatures up to 250 ℃, as traps altered charge distribution and increased resistivity. Defects like silicon and carbon vacancies captured carriers, reducing the electric field and dopant activation. Electrical measurements (I-V and C-V) confirmed these impacts, showing reduced donor and acceptor concentrations and changes in dopant uniformity. In addition, neutron-induced defects in the epitaxial layer were identified and quantified using a deep-level transient spectroscopy measurement system.

Day 3 - Session 3 / 51

Numerical simulations for neutron detector optimization

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In this work, the aim of simulations is to optimize a Silicon Carbide detector (SiC) for neutrons with energy = 14.1 MeV. The device has an active thickness obtained by epitaxial growth and an active area
of 25 mm2
. In the first step of the Fluka simulations, we compare SiC detector performance to Diamond
and Silicon detectors, with the same geometric features. In the second step of the simulations, we have
found the best solution to improve the response of the detector for a fixed epitaxial layer thickness using an overlayer of aniline (C6H7N). Furthermore, a saturation of the alfa-particles at SiC thickness of
around 200 microns have been observed by Fluka. Finally, the Synopsis numerical simulations have been used to optimize the SiC detector edge structure.

Day 2 - Session 4 / 52

Compact and Scalable Electronics for Sub-10 ps Timing in Particle Physics and Medical Imaging

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High-precision time measurements are crucial for both high-energy physics experiments and advanced medical imaging applications, such as Positron Emission Tomography (PET). Future detector systems require readout electronics that combine sub-10 ps timing resolution with scalability, compactness, and efficient multi-channel integration.

The CAEN A5203 module, part of the FERS 5200 system, integrates the high-performance picoTDC ASIC from CERN, enabling precise Time of Arrival (ToA) and Time over Threshold (ToT) measurements. The unit features 3.125 ps LSB precision over 64 channels and can be coupled with a leading-edge discriminator stage. In this configuration, it achieves ~7 ps RMS timing resolution for constant-amplitude signals and ~20 ps RMS for variable-amplitude signals. The walk effect is corrected via ToT, which also enables signal amplitude reconstruction and background noise suppression.

Successfully deployed in a high-resolution PET imaging system, the A5203 has demonstrated its capability for large-scale applications, supporting continuous, dead-time-free acquisition from thousands of channels. In high-energy physics, the FERS architecture, combined with the picoTDC's performance, is well-suited for integration with advanced front-end electronics, such as Weeroc's Radioroc and Psiroc ASICs, enabling precise energy and time measurements with Silicon-based detectors. These features make the FERS system a powerful and flexible solution for next-generation applications in both fundamental research and applied physics.