Active stoppers for decay experiments

Report of Contributions

Contribution ID : **29** Type : **not specified**

Advanced Implantation Detector Array (AIDA)

Monday, 24 March 2025 15:00 (30)

On behalf of the AIDA collaboration

The Advanced Implantation Detector Array (AIDA) is a state-of-the-art detector system for the measurement of the decay properties of exotic nuclei at fragmentation/fission facilities. Using highly segmented, large area double-sided silicon strip detectors the positions, energies and times of high energy implants and their subsequent low energy decays can be correlated at high implantation rates. To process signals from the large number of strips application specific integrated circuits provide low and high gain signal processing per strip with high dynamic range. We will discuss operation at RIBF (RIKEN), FRS (GSI) and CRYRING (GSI).

Presenter(s) : DAVINSON, Thomas (University of Edinburgh)

Session Classification : Session 1

Contribution ID : **30** Type : **not specified**

Beta counting systems at RIBF: requirements and options

Monday, 24 March 2025 15:30 (30)

The beta-counting system has various requirements that depend on the conditions of radioactive isotope beams and the specific physics cases. We conducted decay experiments using double-sided silicon strips and plastic scintillation detectors. In my talk, I will report on the performance of the beta-counting systems used at RIBF and discuss the challenges involved in overcoming their associated problems.

Presenter(s) : NISHIMURA, Shunji (RIKEN)

Session Classification : Session 1

Contribution ID : **31** Type : **not specified**

The FRIB Decay Station initiator and its Active Stoppers

Monday, 24 March 2025 16:00 (30)

The Facility for Rare Isotope Beams (FRIB) will provide access to roughly 80% of the exotic isotopes predicted to exist up to uranium (Z = 92). The FRIB Decay Station (FDS) — an efficient, granular, and modular multi-detector system designed under a common infrastructure — will be a key discovery instrument for FRIB, focused on nuclear structure, nuclear astrophysics, fundamental symmetries, and isotopes of importance to applications. The FRIB Decay Station Initiator (FDSi), led by the FDSi Coordination Committee and supported by the FDSi Group and Working Groups, is the initial stage of the FRIB Decay Station (FDS). The FDSi is primarily an assembly of the best detectors currently available in the community within an integrated infrastructure. An overview of the FDSi and its active gas, silicon, and scintillator implant detectors will be given, including their performance over the first two years of FRIB operations.

*This material is based upon work supported by the U.S. Department of Energy, Office of Science, Office of Nuclear Physics.

Presenter(s) : ALLMOND, James M. (ORNL)

Session Classification : Session 1

Contribution ID : **33** Type : **not specified**

Scintillators for Fast Charged Particle Decay Experiments

Monday, 24 March 2025 17:30 (30)

For proton-rich nuclei, charged particle emission competes with beta decay and electron capture. One notable region of this competition is the nuclei northeast of 100Sn, where alpha-decay becomes prominent, and the proton drip line competes with proton emitters; see the cases of as 109I and 108I [1,2]. With decreasing half-lives close to the drip line, scintillators become optimal for measuring sequential decay signals [3,4]. This work will discuss the methods of identifying pileup in scintillator signals, techniques for separating pileup signals, the current limitations of fast decay measurements, and correction techniques for scintillators implemented to measure charged particles. Specifically, this work will discuss the alpha-decaying nuclei near 100Sn, such as the decay chain of 109Xe along with the individual decays of 105Te and 108I from a recent experiment at RIBF RIKEN. The advantages and drawbacks of using scintillators to measure these nuclei will be discussed.

[1] C. Mazzocchi et al. Phys. Rev. Lett. 98, 212501 (2007)
[2] K. Auranen et al. Phys. Lett. B 792, 187-192 (2019)
[3] Y. Xiao et al. Phys. Rev. C 100, 034315 (2019)
[4] R. Yokoyama et al. NIM A 937, 93-97 (2019)

Presenter(s) : COX, Ian (University of Tennessee, Knoxville)

Session Classification : Session 2

Contribution ID : **34** Type : **not specified**

A novel active stopper based on hetero-structured BGO scintillators functionalized with 2D-perovskites and chalcogenide semiconductors

Monday, 24 March 2025 18:00 (30)

Scintillator-based detection systems are in wide use since many years and in many applications ranging from nuclear and particle physics experiments to medical imaging and security. Their physical properties like density, light yield, linearity of the detector response and operational speed, but also their resistance to harsh radiation load, their insensitivity to small changes in operational parameters and the widely available production capabilities, make them one of the most popular devices for the detection and the energy measurement of charged and neutral particles interacting with material structures.
The timing resolution of scintillators is to first order proportional to the square root of the photon density (number of produced photons per time interval), which can itself be expressed as the ratio of the emission decay time and the light yield of the scintillator. Therefore, to minimise timing resolution, scintillator development aims at achieving a maximum light yield with the shortest possible decay times.
Conventional commonly used scintillators produce an amount of light proportional to the energy deposited by charged or neutral particles. The energy transfer from initial ionisation in the bulk material to the luminescence centres is complex and leads to an intrinsic time-resolution limit in photoproduction due to the stochastic relaxation processes of the hot electron-hole pairs produced by the impact of radiation on the crystal material. To go below this intrinsic limitation,
various ways of exploiting faster photon production mechanisms have been investigated, among which the development of semiconductor nanomaterials represents a promising route towards fast timing. In direct-band-gap-engineered semiconductor nanostructures, one effect of quantum confinement consists of a significant enhancement of Coulomb interactions between charge carriers of electron-hole pairs, coherent and multiexciton states. This plays a significant role in enhancing the transition dipole moment of absorption and emission and can thus increase the rate of fast radiative transitions resulting in scintillation decay times below 1 ns.
Several types of scintillating nanomaterials with different levels of confinement (nanoplatelet, quantum wire, quantum dots) have been studied over many years, reaching a fast photon emission with characteristic radiative decay times in the range of nanosecond or sub-nanosecond. The very short decay times of such nanocrystals together with the possibility to tune their emission spectra open new prospects for timing detectors for particle physics experiments, such as precision timing layers for time tagging of collision tracks or scintillators for the energy measurement of particles in combination with high time resolution.
Hetero-structured scintillations obtained by the growth of new fast scintillators, e.g., nanoparticle 2D perovskites over a heavy scintillator component, like Bismuth Germanate ($Bi_4Ge_3O_{12}$) BGO, will allow to use the system as an active stopper for decay experiments of rare isotopes. This system allows to stop and detect at the same time beta-decaying exotic radioactive nuclei, measuring electrons, neutrons (through ^6Li film converter) and gamma rays in the same detector, having good electron-detection efficiency, gamma capture (stopping power) and scintillation performance (ultra-fast and high light yield emission).
In this talk, first results based on $BaZrO_3$ perovskites will be presented, together with prospects for using further materials as A_4SnX_4 chalcogenide family compounds with optical properties very

similar to GaAs.

Presenter(s) : KURTUKIAN NIETO, Teresa (CSIC-IEM)

Session Classification : Session 2

Contribution ID : **35** Type : **not specified**

Upgrade of the Belle II vertex detector with CMOS pixel technology

Monday, 24 March 2025 17:00 (30)

The Belle II experiment currently records data at the SuperKEKB e+e- collider, which holds the world luminosity record of 5.1x10^34 cm-2.s-1 and plans to push up to 6x10^35 cm-2 s-1. In such luminosity range for e+e- collisions, the inner detection layers should both cope with a hit rate dominated by beam-induced parasitic particles and provide tracking precision. A R&D program has been established to develop a new pixelated vertex detector (VTX), based on the most recent CMOS pixel detection technologies. The VTX design matches the current vertex detector radial acceptance, from 14 mm up to 140 mm. It includes 5 layers for an overall material budget lower than 3 % of X0. All layers are equipped with the same depleted monolithic active pixel sensors, OBELIX, adapted from the TJ-Monopix2 sensor originally developed for the ATLAS experiment. This contribution will review the latest results on chip design and characterization and on the detection modules early prototyping.

Presenter(s) : MARINAS, Carlos (IFIC)

Session Classification : Session 2

Contribution ID : **36** Type : **not specified**

Active stopper concepts employing scintillators

Tuesday, 25 March 2025 09:00 (30)

Besides active stoppers with segmented Si detectors, plastic scintillator based approaches are followed within the DESPEC collaboration for experiments at the fragmentation facilities at GSI and FAIR. The main advantage is the excellent fast timing properties of plastic scintillators and the relative simplicity and robustness of the signal generation and processing.
Two distinct projects are currently pursued, bPlast and FIMP. The bPlast detector consists of 3 mm thick plastic sheets with SiPM readout along the edges. It can detect implanted ions and beta or alpha particles from subsequent decays. bPlast has a position sensitivity in the order of cm and a sub ns time resolution. FIMP consists of orthogonal layers of scintillating fibers, pushing the position resolution to the mm range.
The concepts, current achievements, challenges and limitations will be discussed.

Presenter(s) : GERL, Juergen (GSI/FAIR)

Session Classification : Session 3

Contribution ID : **37** Type : **not specified**

The DESPEC Fiber IMPlanter

Tuesday, 25 March 2025 09:30 (30)

DESPEC experiments aim at a detailed study of the decay mechanisms in the most exotic nuclear species at reach at GSI/FAIR, with the measurements of decay half-lives, competing decay modes, and isomeric state identification. For the DESPEC experimental program, ions will be stopped in an active implanter and their subsequent decays will be measured. The active implanter's role is to stop the nuclides produced by the FRS/Super-FRS, provide their respective implantation times and positions, detect the times and positions of subsequent β or α decays, and provide rough energy information to distinguish the decay processes. Particularly for fast-timing experiments, an implantation detector is needed with a time resolution better than 1ns and the capability to detect and distinguish between ion implantations and subsequent decays. The fundamental idea of Fibre IMPlanter (FIMP) is to replace the DSSSD-s array with scintillating fibres. Such fibres made from polystyrene-based scintillation materials in thin PMMA cladding are available and can be read out by SiPMs. The FIMP consists of layers of orthogonally running fibre mats. The design is based on the assumption that β and α particles and the associated secondary electrons will hit at least one fibre in each of two consecutive layers so that complete position information is available. The first small-scale FIMP prototype with custom front-end readout electronics and a mechanical construction paradigm suitable for scaling up to the planned full size has been constructed and recently tested in beam in GSI. The preliminary results as well as future plans and outlook will be presented.

Presenter(s) : VESIC, Jelena (Jozef Stefan Institute, Ljubljana, Slovenia)

Session Classification : Session 3

Contribution ID : **38** Type : **not specified**

βPlast, a plastic scintillator for fast timing and decay spectroscopy

Tuesday, 25 March 2025 10:00 (30)

DEcay SPECtroscopy (DESPEC) experiments [1] are part of the NUSTAR collaboration, one of the four scientific pillars of the FAIR/GSI facility. Those experiments aim at studing the properties of exotic nuclei using high- resolution decay spectroscopy. They are currently performed at the FRagment Separator (FRS) and will be, in the future, at the Super-FRS facility at FAIR, at GSI. The DESPEC setup comprises a series of state-of-the-art detection systems tailored to the experimental goals. The heavy ion implantation stack is the core of this setup: a so-called 'snout' wherein exotic ions are implanted in detectors. This stack comprises usually 1 to 3 layers of highly- segmented AIDA double-sided silicon strip detectors [2] which are sandwiched between two "βPlast" plastic scintillator detectors for beta-particles, placed upstream and downstream. Implanted ions emit gamma-rays that can then be measured by different systems such as the FATIMA array of LaBr3(Ce) detectors [3], DEGAS HPGe detectors [4] or the DTAS Total Absorption Spectrometer, which enables fast-timing, high-precision or high-efficiency measurements, respectively.
The βPlast detectors are of paramount importance. They are indeed able to provide excellent timing resolution for β particles emitted by the exotic ions of interest to enable β-⊠ timing-measurements as well as a veto for punchthrough events, for example. Several configurations of those detectors have been used in recent years
during FAIR Phase-0 experiments. The last one is composed of a 247.50.3 cm3 rectangular monolithic plastic sheet coupled at edges by an optical silicon pad with arrays of 3*3 mm2 aligned silicon PhotoMultipliers (SiPMs).
Each long and short side contains respectively 48 and 16 aligned SiPMs, with adjacent pairs of SiPMs gathered to form, in total, 64 channels per detector. Those are connected to the TAMEX multi-channel TDCs, developed in-house at GSI, in order to exploit the fast-timing characteristics of the βPlast.
This presentation will focus on the technical details of the detectors and on its characterisation. It will then describe the recent development that aimed at improving detector performance and accessing the position of a particle by creating a lookup table using time-differences between the SiPMs. Finally, it will give an overview of future development work and redesign.

[1] A.K. Mistry et al., The DESPEC setup for GSI and FAIR, Nucl. Instrum. Methods in phys. Res. A 1033, 166662 (2022)
[2] O. Hall et al., The Advanced Implantation Detector Array, Nucl. Instrum. Methods in phys. Res. A 1050, 168166 (2023)
[3] M. Rudigier et al., FATIMA – Fast TIMing Array for DESPEC at FAIR, Nucl. Instrum. Methods in phys. Res. A 969, 163967 (2020)
[4] G.S. Li et al., Characteristics of the DEGAS-FATIMA Hybrid setup for the DESPEC program at NUSTAR, Nucl. Instrum. Methods in phys. Res. A 987, 164806 (2021)

Presenter(s) : CHATEL, Carole (Institut für Kernphysik, Technische Universität Darmstadt, Schlossgartenstrasse 9, 64289, Darmstadt, Germany)

Session Classification : Session 3

Contribution ID : **39** Type : **not specified**

Modeling of Light Production in Inorganic Scintillators

Tuesday, 25 March 2025 10:30 (30)

The detection of heavy ions and light particles in inorganic scintillators has been recently implemented in fragmentation facilities for measurements of beta decay and charged particle emission. One of the challenges of using scintillators in these experiments is the need to simultaneously detect energetic ions, which deposit GeV energy, and subsequent decays, which can deposit less than 1 MeV. Detection of signals with such a wide dynamic range in scintillator material is only possible due to light quenching, which drastically reduces the scintillator's light output for heavy ions. This effect has been studied experimentally, and a parametrization of this effect based on the models of Birks [1,2] and others [3] was proposed. Following these approaches, we developed a method to predict light quenching for various combinations of heavy ions and scintillator materials based on recent experimental measurement. This method can be used to plan fragmentation experiments in different energy regimes. I will present the findings from our model and compare them with the experimental results.

[1] J. Birks. Proc. Phys. Soc. A 64, 874 (1951)
[2] Y. Koba et al. Progress in Nuclear Science and Technology 1, 218 (2011)
[3] A. Meyer and R. Murray. Phys. Rev. 128, 98 (1962)

Presenter(s) : KREIDER, Ben (University of Tennessee, Knoxville)

Session Classification : Session 3

Contribution ID : **40** Type : **not specified**

Proton decay studies with ACTAR TPC

Tuesday, 25 March 2025 11:30 (30)

The ACTAR TPC [1,2] detector has been designed as a versatile device for reaction and decay studies in nuclear physics. It is a gas detector working as a time projection chamber (TPC), than can be used either in "active target" mode where the gas is used as a target for the nuclear reaction or as an active stopper for implantation-decay experiments. The first experimental campaigns took place at GANIL, where two experiments performed at the LISE3 separator demonstrated that the detector is a powerful instrument to measure the exotic decay modes involving proton emissions. The first experiment aimed at measuring the proton radioactivity of 54mNi isomer (10+), with a very short half-life (155 ns) in order to determine its complete decay scheme [3-5]. In addition, the beam time also allowed elucidating the decay of the first observed proton radioactivity, from the isomeric state (19/2−) of 53mCo [6], involving high angular momentum protons with $\ell = 7$ and 9. The second experiment was dedicated to the study of the 2-proton radioactivity of 48Ni [7], in the context of the recent development of a new theoretical framework (Gamow Coupled Channels calculation) to describe this exotic decay mode at the proton drip-line. During this experiment, many other nuclei in the region of 48Ni where implanted in the active volume of the detector. Despite the device settings were not optimized for this, the beta-delayed emission of 1, 2 or 3 protons from these nuclei can be studied, opening large opportunities for this type of decays. Ideally, the association of a gamma detection to ACTAR TPC, as already foreseen, would significantly benefit to such studies.
The decay experiments performed with ACTAR TPC, from realization to analysis, cover all topics suggested for the workshop.

[1] B. Mauss et al., Nuclear Inst. and Methods in Physics Research, A 940 (2019) 498–504
[2] J. Giovinazzo et al., Nuclear Inst. and Methods in Physics Research, A 953 (2020) 163184
[3] J. Giovinazzo et al., Nature Comm. 12, 4805 (2021), doi.org/10.1038/s41467-021-24920-0
[4] D. Rudolph et al., Physics Letters B, 2022, 830, 137144
[5] J. Giovinazzo et al., Nuclear Inst. and Methods in Physics Research, A 953 (2022) 167447
[6] L.G. Sarmiento, T. Roger et al., Nature Comm., 14, 5961 (2023), doi.org/10.1038/s41467-023-39389-2
[7] A. Ortega Moral, PhD thesis (2023), University of Bordeaux

Presenter(s) : GIOVINAZZO, Jérôme (LP2iB / CNRS-IN2P3 / Univ. Bordeaux)

Session Classification : Session 4

Contribution ID : **41** Type : **not specified**

Recoil-decay correlations with beta particles at the MARA focal plane

Tuesday, 25 March 2025 12:00 (30)

The recoil-decay correlation technique is a powerful tool to perform spectroscopic studies of exotic nuclei produced with very low cross sections. The characteristic alpha or proton decays (or decay chains) observed at the focal plane of a recoil separator provide a straightforward way to identify the produced nuclei and allows to "tag" the prompt or delayed gamma-rays emitted by the nucleus of interest. However, nuclei around the N=Z line in the A=50-80 mass region are beta+ emitters, which make the spectroscopic studies of these systems particularly challenging when employing the recoil-decay correlation technique. The complications arise for example from the continuous energy distributions, longish decay half-lives, and extended ranges of beta particles in the detector material.

In this presentation, the recent experimental advances in the instrumentation and methodologies, achieved at the Accelerator Laboratory of the University of Jyväskylä, to enable the spectroscopic studies of beta-decaying N≈Z nuclei will be discussed together with some examples of fresh spectroscopic data, e.g., on 62Ge, 66As and 78Zr nuclei.

Presenter(s) : Dr. RUOTSALAINEN, Panu (Uni. Jyväskylä)

Session Classification : Session 4

Contribution ID : **42** Type : **not specified**

Application of silicon strip and pixel detectors in nuclear physics experiments

Tuesday, 25 March 2025 12:30 (30)

In the past few decades, nuclear physics research has seen tremendous progress as several radioactive-ion beam facilities with unprecedented beam intensities are coming online around the world. These facilities open up the way to access and
study the most exotic nuclei ever produced on earth, bringing us closer to the elusive nuclear systems that play a crucial role in astrophysical sites such as supernovas and neutron stars. The advent of this new era has also been driven by the new, dedicated apparatuses and in particular the new, state-of-the-art detection systems that employ the latest technological advances in ionizing detection technology, data acquisition and data processing. Silicon detectors, strip and pixel, play a particularly important role in these apparatuses.
Application of these detectors within the R3B and EXPERT setups at GSI are discussed.

Presenter(s) : KISELEV, Oleg (GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt, Germany)

Session Classification : Session 4

Contribution ID : **43** Type : **not specified**

Status of DINTESPEC project at GSI-FAIR

Tuesday, 25 March 2025 14:30 (30)

The HISPEC-DESPEC collaboration has an extended experimental program in the FAIR Phase-0 campaign focused on decay studies. Such studies are based on active implantation detectors surrounded by a gamma array, allowing to determine large sets of experimental quantities: α and/or β decay half-lives, internal de-excitation schemes, lifetimes of nuclear states, full β-strength and Pn measurements, exploiting ad-hoc developed techniques.
The goal of the DINTESPEC project consists in the development of a new concept for implantation and decay detectors to improve the DESPEC setup performances in decay studies, which are presently suffering of high levels of noise. To overcome this, a first prototype of commercially available BB7 DSSD layer from Micron was developed and tested at GSI. The first tests were carried out with analogue electronics in the lab as well as in-beam.
The present status of the project as well as future plans will be reported on.

Presenter(s) : POLETTINI, Marta (GSI Helmholtzzentrum für Schwerionenforschung)

Session Classification : Session 5

Contribution ID : **44** Type : **not specified**

Advances in integrated front-end circuits for semiconductor detectors

Tuesday, 25 March 2025 15:00 (30)

In this talk the latest advances in integrated pre-amplifiers for semiconductor detectors will be explored. In particular, an innovative device will be described that allows to perform simultaneously high-energy and low energy, high resolution spectroscopy. This device also minimizes the dead-time in case of saturation and configures itself as the ideal readout solution to detect both heavy ion implantation and the following decay. This integrated pre-amplifier is particularly suitable for high-density multichannel solution, being characterized also by extremely low power consumption. Integration of this preamp with existing DAQ systems will also be also discussed.

Presenter(s) : CAPRA, Stefano (University of Milano)

Session Classification : Session 5

Contribution ID : **45** Type : **not specified**

Digital DAQ System at RIBF for Beta-Decay Studies

Tuesday, 25 March 2025 15:30 (30)

Advancing beta-decay experiments at RIBF (RIKEN Nishina Center) requires a robust and efficient data acquisition (DAQ) system capable of handling high-rate conditions while capturing rare decay events with minimum deadtime. This presentation introduces the development and implementation of a digital DAQ system based on fast digitizers and a customized version of the RCDAQ framework [1].
The DAQ system processes, reads out, and monitors online a large number of detector inputs in parallel. These include a wide variety of detectors: BigRIPS beamline detectors, the silicon detector array WAS3ABi, the segmented plastic detector GARi [2], neutron and gamma-ray detector arrays, and the MCP-silicon active stopper of the ZDMRTOF setup [3]. Its deployment has been pivotal in several beta-decay experiments conducted at RIKEN RIBF [4, 5, 6].
In this talk, I will present the system's architecture, emphasizing its scalability, data-handling capabilities, and the seamless integration of diverse detector types. I will also highlight experimental results that demonstrate the successful implementation of the DAQ system for the active stopper WAS3ABi, GARi and MCP-Si.

[1] M. L. Purschke, 2012 18th IEEE-NPSS Real Time Conference, Berkeley, CA, USA, (IEEE, 2012).
[2] S. Nishimura, PTEP 2012, 03C006 (2012).
[3] M. Rosenbusch et al., NIMA 1047, 167824 (2023).
[4] R. Yokoyama et al., Phys. Rev. C 108, 064307 (2023).
[5] T. T. Yeung et al., Phys. Rev. Lett. 133, 072501 (2024).
[6] V. H. Phong et al., RIKEN Accel. Prog. Rep. 56 (2023).

Presenter(s) : VI, Phong (RIKEN)

Session Classification : Session 5

Contribution ID : **46** Type : **not specified**

Correlation Analysis of Low-Energy Beta Decay and Conversion Electron Signals with an Implantation Detector

Tuesday, 25 March 2025 16:50 (20)

Decay spectroscopy of the most exotic neutron-deficient nuclei can be effectively performed using a recoil separator coupled with a highly segmented silicon implantation detector positioned at its focal plane to study weakly produced products resulting from fusion-evaporation reactions. Sufficient pixelation enables the correlation of implantation events with their subsequent decay chains. Spatial and temporal correlation analysis is well-suited for decay chains involving alpha, proton or isomeric gamma-ray emissions due to their characteristic energies. Extending this method to include states that decay by beta emission is more challenging because of the resultant continuous energy distribution and the substantial range of the emitted beta particles within the silicon detector. Similarly, correlating with conversion electrons presents similar challenges due to their low energy. Results from recent studies at the Accelerator Laboratory of University of Jyväsklyä on experiments focusing on the measurement of low-energy beta and conversion electron signals in decay chains involving 156W [1], 155Lu [2] and 156Ta [3] will be presented. The MARA recoil separator [4] and its advanced array of detectors [5] was deployed and provided new nuclear structure insights, including beta decay half-lives, beta-decay feeding, branching ratios and state multipolarities.

The application of this method to other suitable advanced implantation detectors systems with the aid of simulations will be discussed for future prospective decay spectroscopy experiments.

[1] A. D. Briscoe et al., Phys. Lett. B 847 (2023)
[2] R. J. Carroll, et al., Phys. Rev. C 94, 064311 (2016).
[3] I. G. Darby et al., Phys. Rev. C 83, 064320 (2011)
[4] J. Uusitalo, et al., Acta Phys. Pol. B 50, 319 (2019).
[5] J. Sarén, J. Uusitalo, H. Joukainen, Nucl. Instrum. Methods Phys. Res. B 541, 33–36 (2023).

Presenter(s) : BRISCOE, Andy (The University of Liverpool)

Session Classification : Session 6

Contribution ID : **47** Type : **not specified**

Development and testing of the DESPEC FIMP implanter

Tuesday, 25 March 2025 17:30 (20)

Decay spectroscopy experiments aim at a detailed study of the decay mechanisms in the most exotic nuclear species at reach at FAIR, with the measurements of decay half-lives, competing decay modes, and isomeric state identification. For the experimental program conducted by the DESPEC collaboration, nuclides isolated by the FRS are stopped in the AIDA active implanter which is based on Si DSSSD detectors. Its role is to provide temporal and positional information on the implantations as well as the subsequent decays (α or β), while providing rough energy deposition information to distinguish between the decay processes. Its drawback is a limited time resolution of over 1 μs. For fast timing measurements and neutron detection, however, a time resolution better than 1 ns and the capability to detect and distinguish between ion implantations and subsequent decays are desired. To fulfill these requirements, a new Fibre IMPlanter (FIMP) was envisioned. The fundamental idea is to replace the DSSSD array with fibres made of a polystyrene-based scintillation material in thin PMMA cladding. The fibres are assembled in layers of orthogonally running mats, forming a fibre block. This design is based upon the assumption that β and α particles will hit at least one fibre in two consecutive layers so that complete position information is available. The mean β particle energy in the anticipated experiments will be in the order of 1 MeV, while the maximum deposited energy may go up to 10 MeV. For α particles the stopping power is larger, so they can be easily distinguished from β particles by their energy deposition in each fibre. Implanted ions produce traces through the fibre layers ending with a Bragg peak at the implantation position. For very heavy ions, the thickness required to stop all interesting species is just under 1 cm. A small-scale FIMP prototype with custom front-end readout electronics and a mechanical construction paradigm suitable for scaling up to the planned full size has been constructed. The fibres of a 12 mm thick
block are read out by 192 SiPMs arranged in lines of 16, which cover the side faces of the block and form three rings at different implantation depths. The resulting high granularity allows FIMP to sustain a high count rate, making it feasible to study several species at the same time. The SiPMs, their corresponding preamplifiers, and the fibre block itself are mounted inside a light-tight 3D-printed plastic enclosure which enables their precise relative positioning. The electronics make use of a resistive multiplexing matrix to reduce the required number of readout channels. Time and energy information is extracted from the analog SiPM signals using discrete implementations of constant fraction discriminators and time over threshold circuits, respectively. These produce differential signals that are subsequently sampled and processed by the ClockTDC system, and are constructed in a modular fashion in conjunction with a system control board, allowing for further detector developments. The detector system has recently been tested in combination with gammaray detectors for β-delayed γ correlations using a 100Mo beam at the GSI/FAIR facility, showing good performance. The design and preliminary results will be presented.

Presenter(s) : ŽAGAR, Klemen (Institut "Jožef Stefan")

Session Classification : Session 6

Contribution ID : **48** Type : **not specified**

Slowing down exotic beams from the FRS: the FRS Ion Catcher experience

Tuesday, 25 March 2025 16:30 (20)

For a successful experiment with slowed down exotic beams at a fragmentation facility, certain common steps have to be followed including identification, separation and an accurate set of their energy to match the range into the detector to be used. At GSI, primary beams are accelerated to relativistic energies to impinge in a production target at the entrance of the Fragment Separator (FRS) where exotic nuclei are produced via projectile fission or fragmentation. The FRS has the capabilities of identification, separation and selection of the exotic species of interest and setting their energy by means of degraders to match their range to match the experimental needs: active stopper, ion catcher, ancillary detector…etc. In this contribution we will share the experiences gathered by slowing down exotic nuclei in an ion catcher, the FRS Ion Catcher, showing some aspects and learned lessons which might be of interest to other experiments.

Presenter(s) : AYET SAN ANDRÉS, Samuel (Instituto de Física Corpuscular - CSIC UV)

Session Classification : Session 6

Contribution ID : **49** Type : **not specified**

Investigation of nuclei beyond N = 126 shell closure region at the DESPEC Phase-0 campaign

Tuesday, 25 March 2025 17:10 (20)

In this contribution, the preliminary results obtained from implantation in Active Stopper during an experiment scheduled in June 2024 will be presented . This experiment is a part of the DESPEC collaboration at the GSI-FAIR Phase-0 campaign.The experiment focuses on exploring the region beyond N = 126 shell closure, which is relevant to the modeling of the r-process as most nuclei in this region are formed by this process.
In the experiment, a 238U beam accelerated to 1 GeV/nucleon is directed on a 9Be target to produce heavy neutron rich nuclei by cold fragmentation reaction.The Fragment Separator (FRS) is used to separate the exotic nuclei by in-flight technique. These separated ions are then implanted in AIDA active stopper which consists of two triple-wafer DSSDs. The AIDA setup is placed between two plastic scintillators to measure the timing of the implanted ions. A DINTESPEC detector consisting of three DSSDs is positioned behind AIDA. The hybrid FATIMA + DEGAS array, consisting of 36 LaBr3 and 27 HPGe detectors has been used to extract γ decay and lifetime information.
We have observed α decays from implants in the Active Stopper during our experiment and conducted some preliminary studies to characterize these decays. α spectra for the X strips in DSSD0 have been obtained with α energy aligned according to the ground-state α decay of 215Po. Using an α-γ correlation analysis within a prompt time-coincidence window of approximately 4 µs, we can successfully identify some peaks in the α spectra. Additionally, an α-tagged β delayed γ spectroscopy study was performed to investigate the α decays with very short half-lives. The findings of these studies, including the identification of specific α decays through this methodology will be presented in this contribution.

Presenter(s) : KUNDU, Mallicka

Session Classification : Session 6

Contribution ID : **50** Type : **not specified**

Test of the segmented plastic implantation detector with RI beam at the RIBF

Tuesday, 25 March 2025 18:10 (20)

The decay experiment was conducted by recycling the secondary beam transported after the interaction cross-section and mass measurements at the RIBF. In this experiment, the performance of the segmented plastic implantation detector "GARi" was tested. The position reconstructions of ion and beta events were investigated, which were used to determine the beta-decay half-lives of implanted ions. Some nanosecond-scale half-lives of low-lying states were also measured through beta-gamma correlations.

Presenter(s) : ZENG, Quanbo (IMP,CAS)

Session Classification : Session 6

Contribution ID : **51** Type : **not specified**

Exploring Perovskite Scintillators: Potential and Properties for Radiation Detection

Tuesday, 25 March 2025 17:50 (20)

Perovskite materials possess a unique crystal structure and show great promise in applications such as solar cells, LEDs, lasers, and photodetectors. Recently, they have gained attention as efficient X-ray detectors, particularly lead halide perovskites (HPs), which are known for their excellent luminescence, high mobility-lifetime product (μτ), and sensitivity to X-rays [1]. Their adjustable band gap and low cost enable the production of thick films over large areas, making them attractive alternatives to commercial products such as thallium-doped cesium iodide (CsI:Tl) and amorphous silicon (Si) [2].
Additionally, studies on the scintillation properties of $CsCu_2X_3$ and $Cs_3Cu_2X_5$ (where X: Cl^-, Br^-, I^-), which are based on halide perovskite structures, have revealed their luminescence induced by charged particles and a simple, cost-effective deposition method that does not require external dopants. These materials have also been investigated as hybrid detectors to enhance their efficiency [3].
The search for new materials in this area has led to the identification of the radioluminescent properties of barium zirconate perovskite ($BaZrO_3$), discovered by Moreira and collaborators through crystal growth via the microwave-assisted hydrothermal method [4]. $BaZrO_3$, a material with a wide band gap, offers unique advantages, demonstrating increased luminescent emission proportional to the growth time. Additionally, it exhibits structural stability under high doses of irradiation and has been investigated as a UV detector [5,6].
Building on these advances, this work aims to explore $BaZrO_3$ as an innovative material for ionizing radiation detection that is free of lead. Pure $BaZrO_3$ and rare-earth-doped $BaZrO_3$ materials were grown using the microwave-assisted hydrothermal method and characterized through diffuse reflectance and radioluminescence spectroscopic analyses. These characterizations identified an experimental band gap of approximately 5 eV and a radioluminescent emission peak in the 450 nm range, allowing for variations in emission with modifications in growth and doping parameters.
Through the deposition of thin films on polystyrene substrates via the doctor blade method, their timing capabilities are being investigated in comparison to standard detectors, such as commercial LYSO and CsI scintillators coupled with photodetectors (SiPMs). By combining adjustable properties, a wide band gap, and enhanced performance, the investigation of new perovskites presents a strong candidate for redefining radiation detection paradigms, contributing to the development of more effective and accessible systems.

[1] Materials Today, 2022, 55, 110–136.
[2] RSC Adv., 2024, 14, 6656.
[3] Adv. Funct. Mater., 2022, 2206645.
[4] Scripta Mater., 2011, 64, 118–121.
[5] Radiat. Phys. Chem., 2017, 139, 152–155.
[6] Inorg. Chem., 2024, 63, 5865–5871.

Presenter(s) : GONÇALVES MESQUITA, Daniele (CSIC & UFPel)

Session Classification : Session 6

Contribution ID : **52** Type : **not specified**

Tracking arrays and the development of imaging capabilities

Wednesday, 26 March 2025 09:00 (30)

New developments on detection systems are have been going on since the mid 90's order to build arrays with improved sensitivity by increasing peak to total (P/T) and efficiency. The adopted solution is the use of large volume GeHP detector with position sensitivity based on segmented contacts and Pulse Shape Analysis (PSA). In these new arrays the target can be surrounded by hundreds of position sensitive GeHP detectors, in a 4pi solid angle geometry, in such a way that up to about the 80% of the solid angle is covered, thus increasing the detection efficiency dramatically. Using digital sampling electronics and PSA it is possible to determine energy, position and time of each gamma-ray interaction and,
subsequently, applying tracking algorithms it is possible to reconstruct the scattering paths of incident gamma-rays inside the detector [1].

A further improvement would be to use detectors with higher position resolution, e.g. planar GeHP DSSD detectors, as implanters or first scatterers, which will provide the array with imaging capabilities [2].

In this contribution we will show the conceptual ideas and the R&D on detector technologies performed by our collaboration.

[1]S. Akkoyun et al., AGATA — Advanced Gamma Tracking Array, Nucl. Instrum. Meth. A 668 (2012) 26
[2]M. Doncel et al. "Conceptual design of a high resolution Ge array with tracking and imaging capabilities for the DESPEC (FAIR) experiment." Journal of Instrumentation 10.06 (2015) P06010.

Presenter(s) : GADEA RAGA, Andres (IFIC CSIC-University of Valencia)

Session Classification : Session 7

Contribution ID : **53** Type : **not specified**

A novel 139La-GPS scintillator for β-implantation detectors in decay spectroscopy at fragmentation facilities

Wednesday, 26 March 2025 09:30 (30)

The study of β-decays far from stability is essential to understand the evolution of nuclear structure and nucleosynthesis processes. β-decay experiments with such exotic nuclei involve intense cocktail beams from fragmentation facilities. The role of an implantation detector in these experiments is to measure the energy and the positions of both heavy ion implantation and β-ray emission to correlate the identified ion with β-decay events.
Due to the lack of time resolution of conventional Silicon strip detectors, we have previously developed a new implantation detector using a segmented YSO (Yttrium Orthosilicate) scintillator array for time-of-flight spectroscopy of the β-delayed neutron emission [1]. The new detector was implemented in β-delayed neutron measurement experiments at RIKEN RI Beam Factory, and it was confirmed that the YSO detector correlates β and implant events better due to its higher effective atomic number Z~35.
The success of the YSO detector motivated us to develop a new detector using heavier scintillator material. We will report on the design and some test results of the new detector using (Gd,139La)2Si2O7:Ce (A=139 enriched La-GPS [2, 3]) crystal which has a much higher effective atomic number (Z~51) and is expected to have better β-implant efficiency with a lower background.

[1] R. Yokoyama et al., NIM A 937, 93-97 (2019)
[2] S. Kurosawa et al., NIM A 744, 30-34 (2014)
[3] S. Kurosawa et al., IEEE TNS 65, 2136-2139 (2018)

Presenter(s) : YOKOYAMA, Rin (Center for Nuclear Study, University of Tokyo, 2-1 Hirosawa, Wako, Saitama 351-0198, Japan)

Session Classification : Session 7

Contribution ID : **54** Type : **not specified**

The Silicon PIe DEtectoR for low-energy Coulomb-excitation

Wednesday, 26 March 2025 10:00 (30)

The low-energy Coulomb-excitation technique is capable of providing unique information on static electromagnetic moments of short-lived excited nuclear states, including non-yrast states. The process selectively populates low-lying collective states and is ideally suited to study phenomena such as shape coexistence and the development of exotic deformation (triaxial or octupole shapes) in stable and radioactive nuclei.

In this talk, I will present the SPIDER detector, an array of segmented silicon detectors for low-energy Coulomb-excitation experiments designed as an ancillary device for modern gamma-ray spectrometers, and currently used at the INFN Legnaro National Laboratories (LNL). Also, I will talk about some highlight of the past experimental campaigns and discuss some features and capabilities of the detector.

Presenter(s) : ROCCHINI, Marco (INFN Firenze)

Session Classification : Session 7

Contribution ID : **55** Type : **not specified**

Evolution and Applications of Silicon Detectors in Nuclear Physics and Astrophysics

Wednesday, 26 March 2025 10:30 (30)

Silicon detectors are widely used in various fields of physics, including nuclear physics and astrophysics. Over time, several generations of detectors have succeeded one another, becoming increasingly performant in terms of precision and accuracy of observables, as well as in their number and type. In this contribution, I will discuss different types of detectors, from EUCLIDES to GRIT, including methods for their characterization and evaluation of their performance.

Presenter(s) : MENGONI, Daniele (University and INFN - Padova)

Session Classification : Session 7

Contribution ID : **56** Type : **not specified**

Analysis techniques and results from AIDA at DESPEC at GSI

Wednesday, 26 March 2025 12:00 (30)

AIDA (The Advanced Implantation Detector Array) has been employed at the DESPEC (DEcay SPECtroscopy) experiments at GSI since 2019 as the key detector and active stopper, measuring both the implants (ca. 1-10 GeV) and the subsequent decays (ca. 200-1000 keV), exploiting advanced electronics to cover the high dynamic range, and high pixilation to allow implantation rates of approximately 1 kHz to measure half-lives of seconds. New DAQ and analysis techniques have been developed to analyse the complex triggerless data from AIDA and to combine it with other DESPEC detectors (such as gamma-ray detectors) and the FRS (FRagment Seperator) which provides the secondary beams, using the White Rabbit timing system to correlate data. Likewise techniques for correlating the implants to their subsequent decays (over many seconds and thousands of events later). This talk will discuss the techniques development and some of the results so far.

Presenter(s) : HUBBARD, Nicolas (GSI)

Session Classification : Session 8

Contribution ID : **57** Type : **not specified**

Waveform analysis with WAS3ABi for measurements of ion implantation and charged-particle decays

Wednesday, 26 March 2025 12:30 (30)

With the increasing popularity of modern digitizers, it is becoming more common for signal waveform to be recorded in addition to energy and time information in experiments. The waveform was typically used for better signal timing and pulse shape discrimination. In this talk, we will focus on WAS3ABi, an active stopper made of four layers of double-sided silicon strip detectors. In an experiment using WAS3ABi, there were multiple challenges in the analysis due to limitations of the experimental setup. We will demonstrate how waveform analysis overcomes these obstacles and improves measurements of ion implantation and charged-particle decays.

Presenter(s) : YEUNG, Tik Tsun (The University of Tokyo)

Session Classification : Session 8

Contribution ID : **58** Type : **not specified**

Machine Learning techniques for background noise identification in ATLAS

Wednesday, 26 March 2025 11:30 (30)

The ATLAS experiment at the LHC presents a very complex data scenario, with tens of protons colliding in the same bunch interaction every 25ns at high energies of 13 TeV. Together with the SM processes generated in the collisions, data analyses have to deal with other sources of noise like detector effects of beam-induced backgrounds. In this talk we'll review different machine-learning techniques to identify these kinds of background in unconventional searches like those looking for potential new long-lived particles, whose signatures in the detector resemble those of the background noise and cannot easily be discriminated from them.

Presenter(s) : TORRÓ PASTOR, Emma (IFIC)

Session Classification : Session 8

Contribution ID : **59** Type : **not specified**

Round table

Wednesday, 26 March 2025 14:30 (75)

Session Classification : Session 9

Contribution ID : **60** Type : **not specified**

Overview and Closing

Wednesday, 26 March 2025 15:45 (15)

Session Classification : Session 9