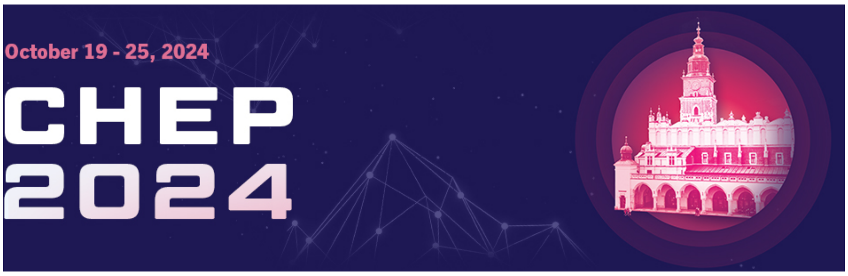

Contribution ID: **277** Type: **Talk**

Storage of nuclear waste suitable for non-invasive monitoring using muon scattering tomography

Monday 21 October 2024 15:00 (18 minutes)

Over the past few decades, there has been a noticeable surge in muon tomography research, also referred to as muography. This method, falling under the umbrella of Non-Destructive Evaluation (NDE), constructs a three-dimensional image of a target object by harnessing the interaction between cosmic ray muons and matter, akin to how radiography utilizes X-rays. Essentially, muography entails scanning a target object by analyzing its interaction with muons, with the interaction mode contingent upon the energy of the incident muon and the characteristics of the medium involved. As cosmic muons interact electromagnetically with atoms within the target medium, their trajectories are likely to deviate prior to reaching the position sensitive detectors placed at suitable locations around the object under study. These deviations serve as a rich source of data that can be used to generate images and infer the material composition of the target.

In this study, a numerical simulation has been conducted using the GEANT4 framework to assess the efficacy of various position sensitive charged particle detectors in muography. The feasibility of detectors with a broad range of position resolutions has been tested, particularly in the context of developing an imaging algorithm to monitor drums containing nuclear waste. The Cosmic Ray Shower Library (CRY) has been employed to simulate muon showers on the detector-target system. The reconstruction of muon tracks, crucial for analyzing muon scattering, has been achieved by collecting hits from all detector layers. Incoming muon tracks have been reconstructed using hits from the upper set of detectors, while outgoing muon tracks have been reconstructed using hits from the lower set. In this presentation, the discussion will center on track reconstruction algorithms, emphasizing the use of efficient single scattering point algorithms like Point of Closest Approach (PoCA) for simplified implementation and fast computation. To enhance material discrimination confidence, a Support Vector Machine (SVM) based algorithm has been applied, utilizing features such as scattering vertices density ([illegible]) and average deviation angle ([illegible]) as inputs. SVM hyperplanes have been generated to segregate various material classes, and corresponding confusion matrices have been obtained. Additionally, for analyzing the shape of materials within nuclear waste drums, an algorithm based on Pattern Recognition Method (PRM) has been employed. This presentation will delve into studies of track reconstruction algorithms applied to GEANT4 data for particle detectors with varying position resolutions, followed by shape and image analysis based on the PRM with the motivation of optimizing storage of nuclear waste that can be efficiently monitored by techniques such as muography.

Primary author: Dr BHATTACHARYA, Purba (Adamas University, Kolkata, India)

Co-authors: Ms MUKHERJEE, Indira (Adamas University, Kolkata, India); Prof. MAJUMDAR, Nayana (Saha Institute of Nuclear Physics, Kolkata, India and A CI of Homi Bhabha National Institute, Kolkata, India); Mr PALLAV, Piyush (Adamas University, Kolkata, India); Dr ROY, Promita (Virginia Polytechnic Institute & State University, United States); Dr TRIPATHY, Sridhar (University of California, Davis, United States); Dr DAS, Subhendu (Applied Nuclear Physics Division, Saha Institute of Nuclear Physics, A CI of Homi Bhabha National Institute, Kolkata, India); Prof. MUKHOPADHYAY, Supratik (Applied Nuclear Physics Division, Saha Institute of Nuclear Physics, A CI of Homi Bhabha National Institute, Kolkata, India)

Presenter: Dr BHATTACHARYA, Purba (Adamas University, Kolkata, India)

Session Classification: Parallel (Track 5)

Track Classification: Track 5 - Simulation and analysis tools