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The Development of Novel Pulse Shape Analysis Algorithms for the Advanced Gamma Tracking Array (AGATA)

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I. INTRODUCTION

Standing at the forefront of Gamma-Ray Spectroscopy, the Advanced GAmma Tracking Array (AGATA) provides insight into a wide variety of Nuclear Physics, by employing Gamma-Ray Tracking (GRT) AGATA provides significant improvements to efficiency, doppler correction and position resolution.

As all tracked photons occur solely within the germanium volume without the need of additional ancillaries a critical component of GRT the field of Pulse Shape Analysis (PSA) is required. PSA uses characteristics of the measured signals from the segmented electrodes of each crystal to directly infer the positions of the gamma-ray interactions.

II. DEVELOPMENT OF NEW PSA TECHNIQUES

The use of Convolutional Neural Networks for regression was investigated and offers a viable solution on experimental data offering reasonable prediction accuracy and operating at 3kHz.

Utilising graph accelerated k-Nearest Neighbour algorithms for Fold-1 interaction prediction combined with Manifold-Learning assisted dimensionality reduction has allowed for a significant improvement in processing rate with little loss to prediction accuracy. In particular the algorithms, FAISS, HNSWLIB, MKS and Nanoflann were profiled on various embeddedings.

Adaptions were made to extend these methods to work on High-Fold data utilising hierachical restrictive geometry. Precomputation of these scenarios into hyper-efficient hierarchical structures provides a robust, dynamic and efficient approach to High-Fold PSA.

III. EXPERIMENTAL CHARACTERISATION

In order to profile the performance of these algorithms the algorithms were assessed blindly using experimental data collected at Liverpool and IPHC Strasbourg. Data from ^{137}Cs, ^{241}Am & ^{152}Eu sources was used to evaluate PSA performance. The full position and energy dependence of these PSA methods is evaluated and compared against the industry standard.

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