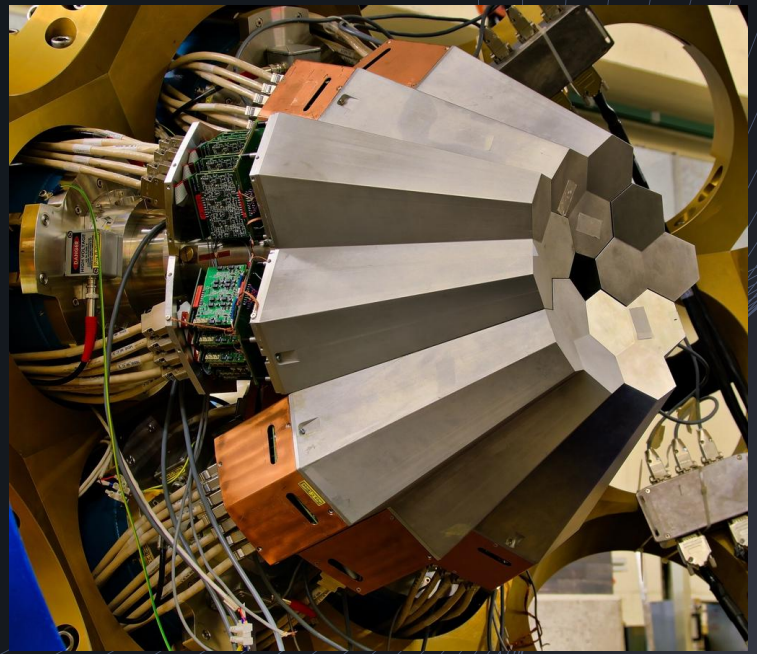
Gamma-ray tracking with AGATA using Machine Learning

Ivan Kovalenko
Supervised by Joa Ljungvall

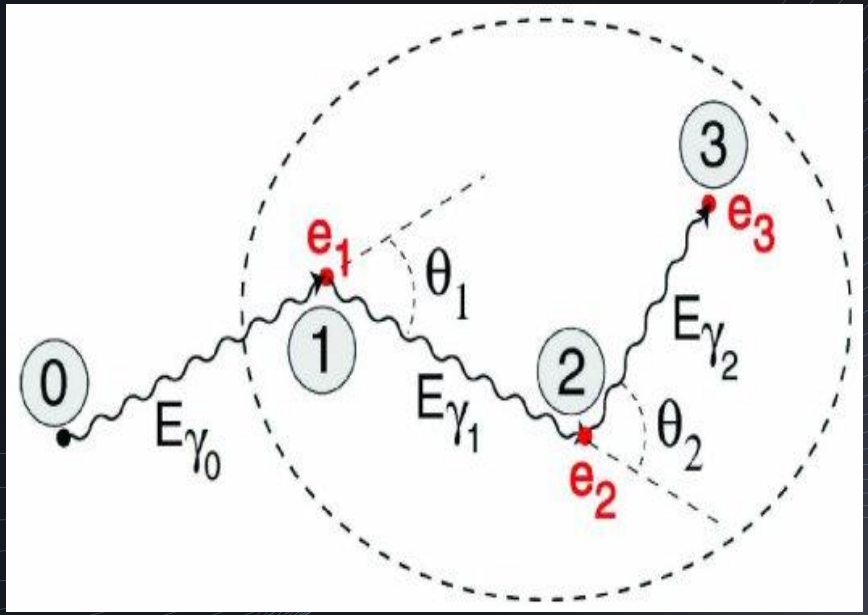
AGATA

AGATA (Advanced Gamma Tracking Array) is a European research project with the aim of developing and building a 4pi gamma-ray spectrometer of the next generation. It will be used in experiments utilising both intense stable and radioactive ion beams, to study the structure of atomic nuclei as a function of angular momentum, isospin, and temperature at the limits of their stability.

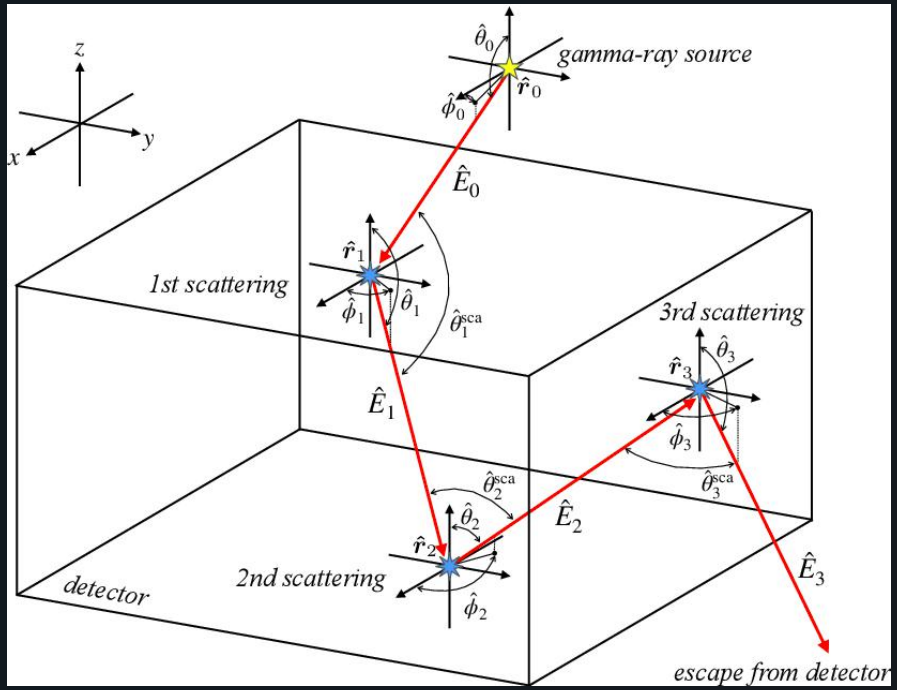


Gamma-ray tracking

The basic idea is to group the interactions we get after pulse-shape analysis and classify them as fully or incompletely absorbed gamma-rays. This must be done to obtain the total energy and direction of the emitted photon.



Algorithms currently in use



Forward-tracking algorithm

This algorithm clusterise the interaction points according to their relative angular distance. It starts from first interaction of a gamma ray.

Back-tracking algorithm

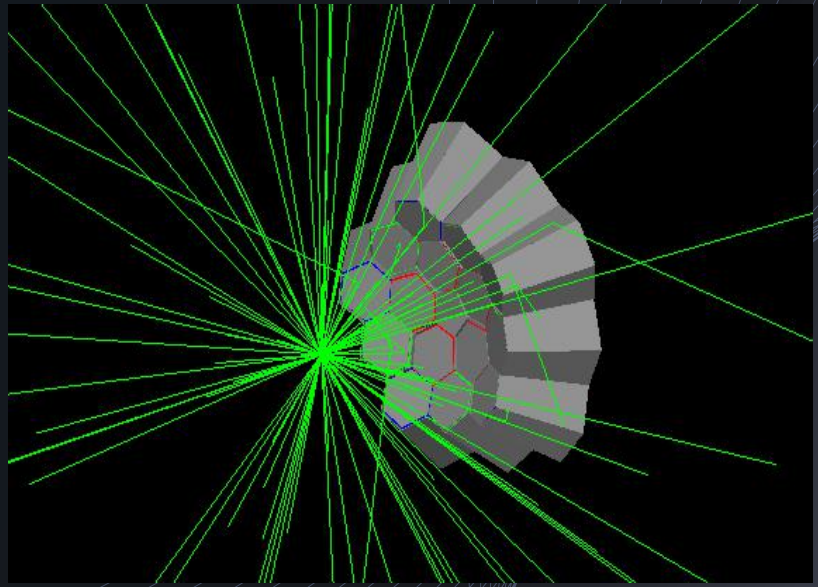
The starting point is the assumed photoelectric interaction point. Then step by step, using Compton's formula, it goes through the gamma track.

Stages of this work

1. **Simulating data sets using AGATA GEANT4 code**
2. **Corruption data**
3. **Implemetning ML technologies to track gamma rays**

Simulating data sets

Data sets are simulated from 1π AGATA geometry with 1 MeV gamma-ray and multiplicity 1 or 30.



Corruption

The positions and energies of the AGATA code correspond to the ideal situation, where all the interaction points are detected with infinite position and energy resolution. In order to make the data more realistic one has to include many experimental uncertainties.

Packing

This process consists of packing several simulated interactions into one if the distance between them is less than 5 mm.

Smearing

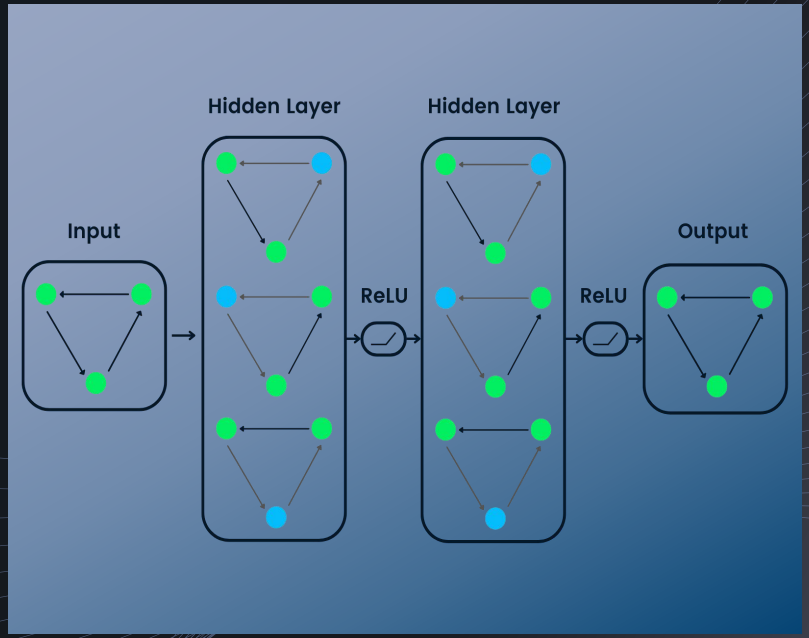
This process consists in smearing points and energies of interactions along the Gaussian distribution.

Implemetning ML technologies

I have not reached this stage yet, but I plan to use a graph neural network, because it is suitable for representing a set of interactions as a graph.

Python3 and Tensorlow (a Python library for ML) are going to be used as tools.

A similar problem has already been solved by MIKAEL ANDERSSON (“Gamma-ray tracking using graph neural networks”).



Thanks!