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Exercises for Particle Physics I

Winter Semester 2025/26

Exercise 3

To be worked on until January 8, 2026

In this exercise, we will go through several aspects of calorimetry in high energy physics. We will start with the basic concepts related to the interaction of particles with matter and how they are exploited to perform energy measurements. Then, we will use simulated events from the PHENIX experiment to visualize some examples of what we can expect to observe in a real experiment. Each particle typically deposit energy in several channels of a calorimeter, which introduces the problem of how to associate each energy deposit to the correct particle, and how to correctly count how many particles deposited energy in the calorimeter. Clustering algorithms are fundamental tools to fulfill this task: we will introduce the k-means algorithm, a relatively simple and intuitive algorithm to perform clustering. We will guide you through the implementation of the k-mean algorithm, and eventually to compare your own creation with the implementation available in sklearn! Finally, we will briefly introduce a more realistic approach, based on the seeding of clusters.

As you will quickly notice, the notebook has a lot of content: we know this. The hand-in and review will be on the 8th of January 2026, and we will offer one session where you can collect your questions and doubts, on the 27th of November 2025, from 14:00 to 17:00.

To start with the exercise, please login to the jupytermachine, start the standard `Datenanalyse` container and update your `tp1_forstudents` repository, e.g. by navigating to the directory in the file browser on the left and then selecting `Git -> Pull from Remote` from the menu bar. A new subfolder `Exercise03` should appear with a Jupyter notebook `Exercise03.ipynb`. Open the notebook and work though the different tasks that are given inside.