Introduction

In our project we are dealing with charged kaons (*K*+) which decay exponentially into charged and neutral pions (*\_*+ and *\_*0). To simplify the calculations, we neglect the decay of the pions. The aim of this simulation is to determine the distance between a kaon source and a detector which maximizes the acceptance of the detector. The detectors are set up as follows:

Figure 1: Experimental setup

As shown in figure 1 the initial beam of kaons is measured by detector 1 and the resulting pions are measured by detector 2. The second detector is a circular disc with a radius of 2 meters. Depending on

1. the location of the decay and
2. the decay angle (in the K+ rest frame)

the pions might miss the pion detector. Thus, the closer the second detector is to the first, the bigger the probability that the pions are detected. However, if the detector is too close to the first one, the kaons might decay after they have already passed the detector and will therefore not be detected. Given these two constraints, there is a unique optimal distance between the first and the second detector, which we compute with the following simulation.

In the first part of this project, the average decay length of a K+ is estimated based on a dataset containing the decay lengths of a mix of kaons and pions. Using the result of the first part we can simulate the location of the decay using a Monte-Carlo simulation for an exponential distribution. Further, some impulse vectors (which are distributed isotropically in the K+ rest frame) are generated, supplemented with an energy to form a four-vector and boosted into the laboratory frame. Finally, the percentage of decayed kaons that are detected (called ‘acceptance of the downstream detector’) can be determined.

The whole simulation is conducted twice, once assuming that the particle beam is parallel to the z-axis and once including a Gaussian distributed deviation from the z-axis of the particle beam.