Vertex reconstruction

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Setup

Three-plane setup

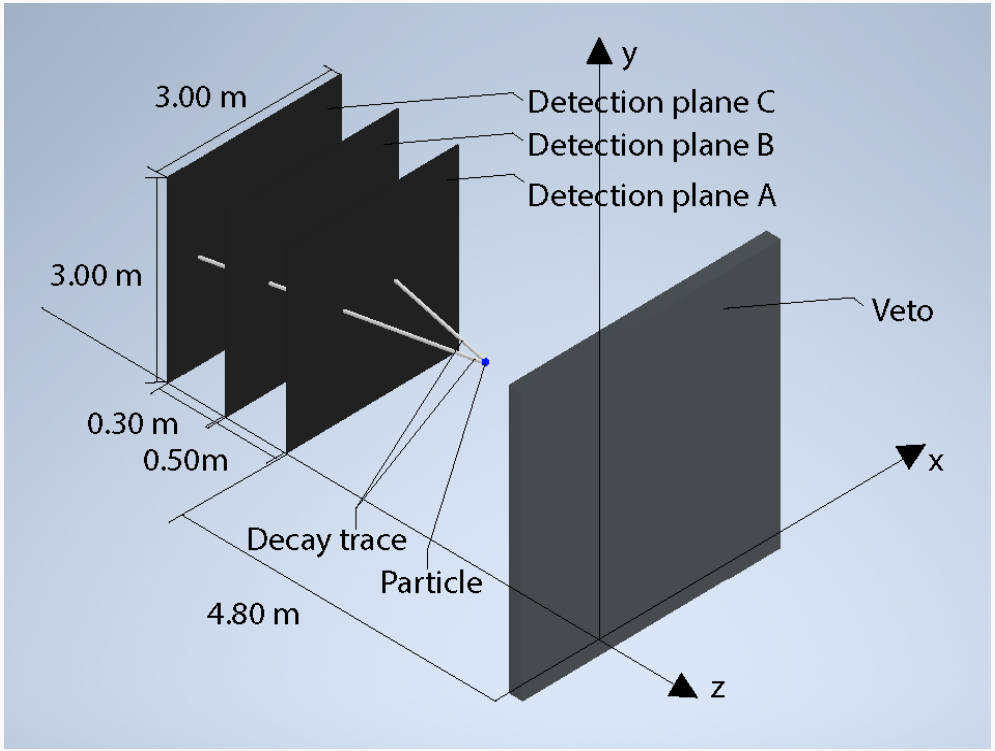

Figure 1: Three-plane setup.

Moving the first detection plane around does not change the simulation results significantly (assuming the decay occurs exactly at the center of the decay zone, between the veto and the first detection plane).

Scintillator overlapping

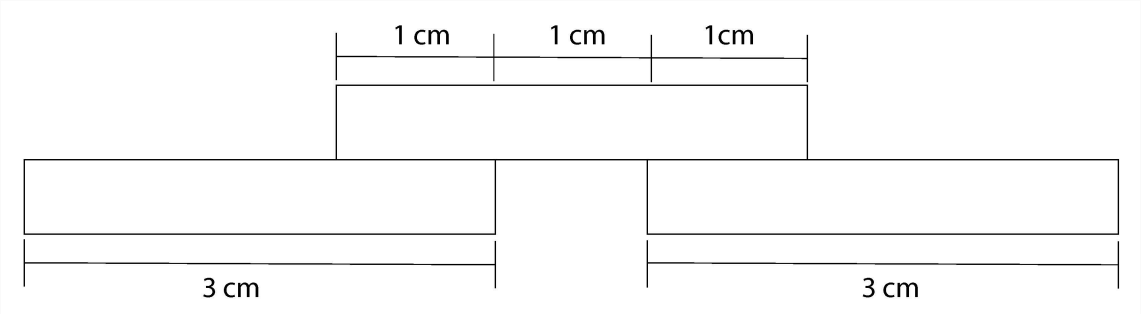

Figure 2: Scintillator overlapping as seen from their ends.

The detection planes are made of overlapping scintillator bars. Overlap is of 1 cm.

Effective detection grid

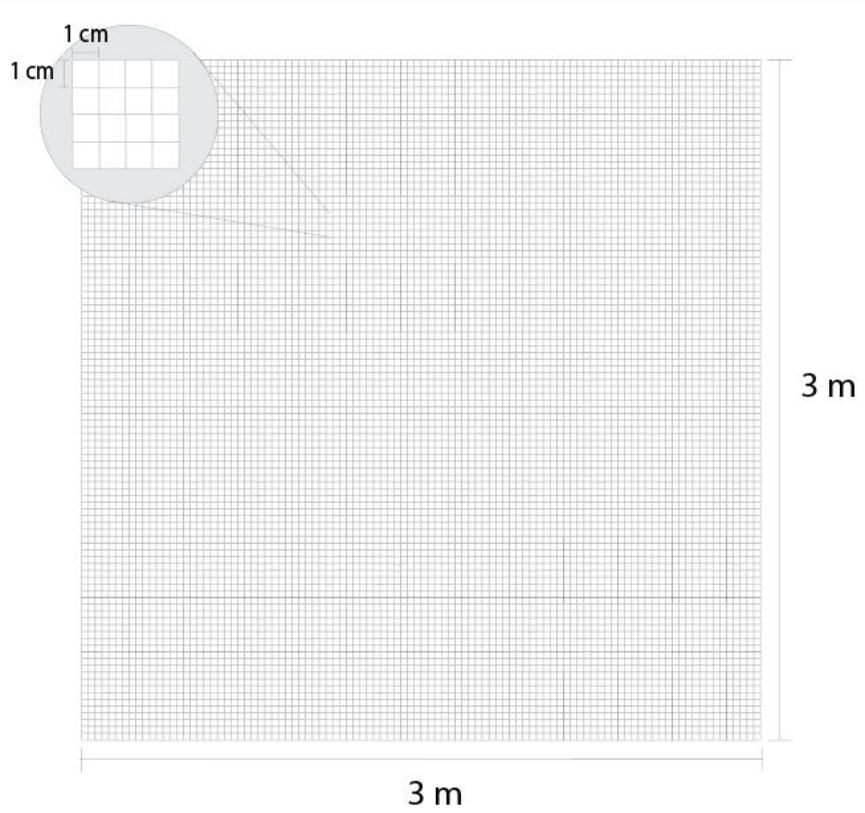

Figure 3: Effective detection grid on each detection plane as a result of scintillator bars overlapping.

Simulation

Simulation of real life detections

The blue dots simulate the real hits from the particles are each plane, with their respective blue tracks. The red dots simulate the observation of those hits in the laboratory. The red tracks are the reconstruction of the traces of the real hits based on the observation in the laboratory.

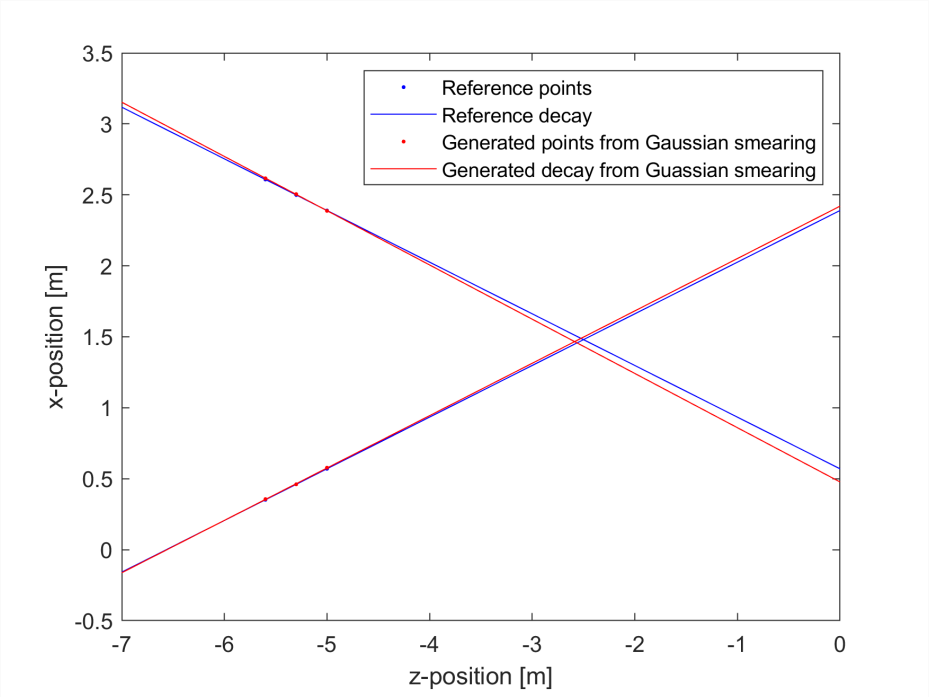

Figure 4: Detection simulation in 2 dimensions.

Simulation of real life detections (continued)

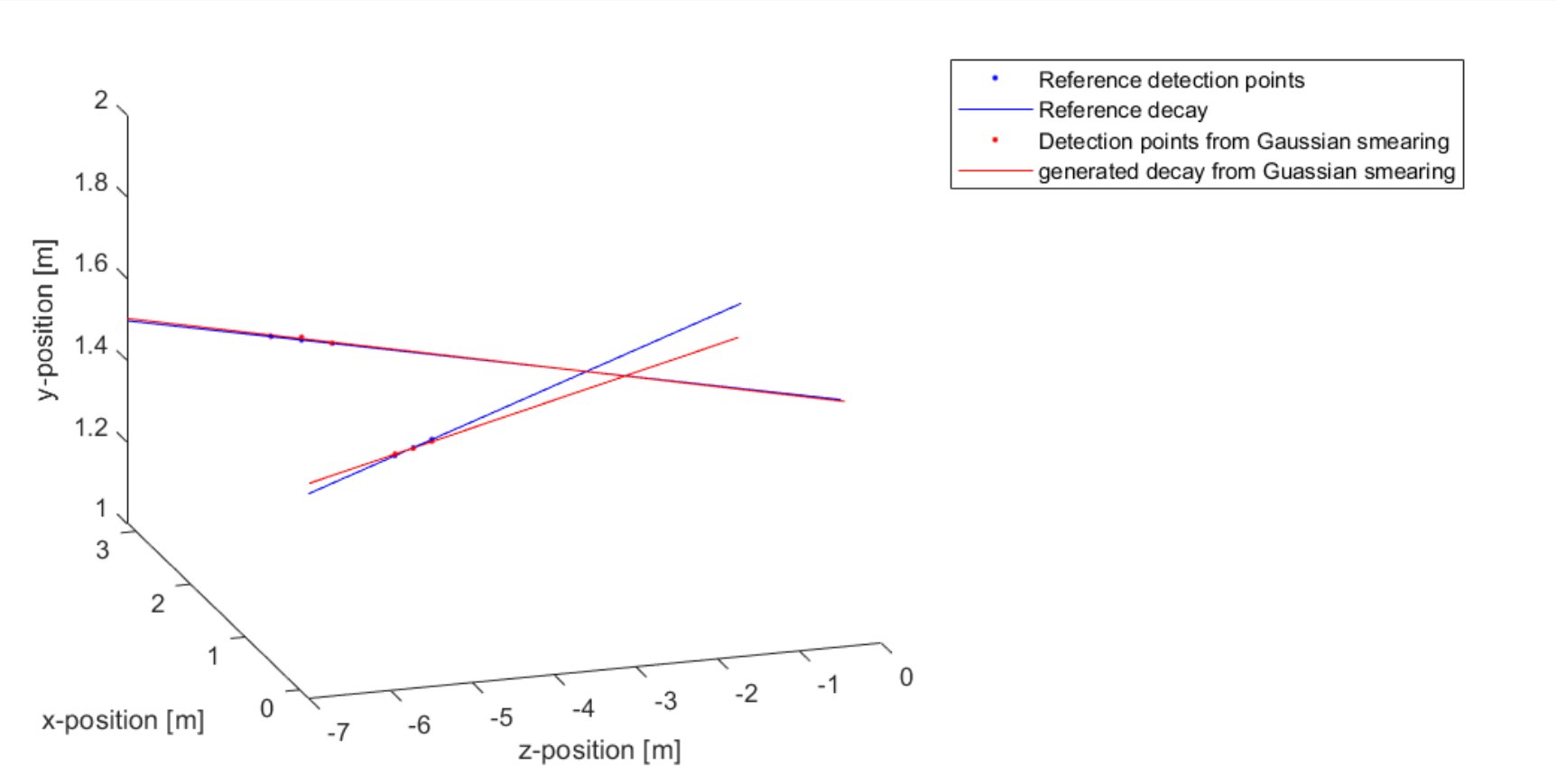

Figure 5: Detection simulation in 3 dimensions.

Vertex reconstruction resolution

Vertex-to-vertex distance

We look at the distance between the vertex were the real decay occurred and the vertex generated from a linear fit based on the observation in the laboratory. The analysis is done for different opening angles of the decay.

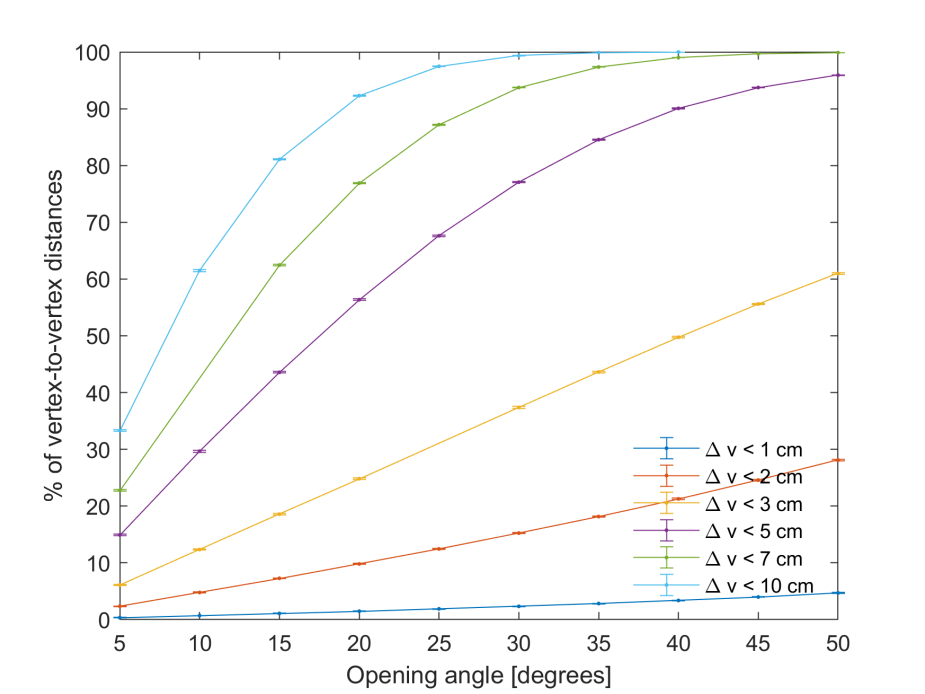

Figure 6: Vertex resolution.

Vertex-to-vertex distance by coordinate

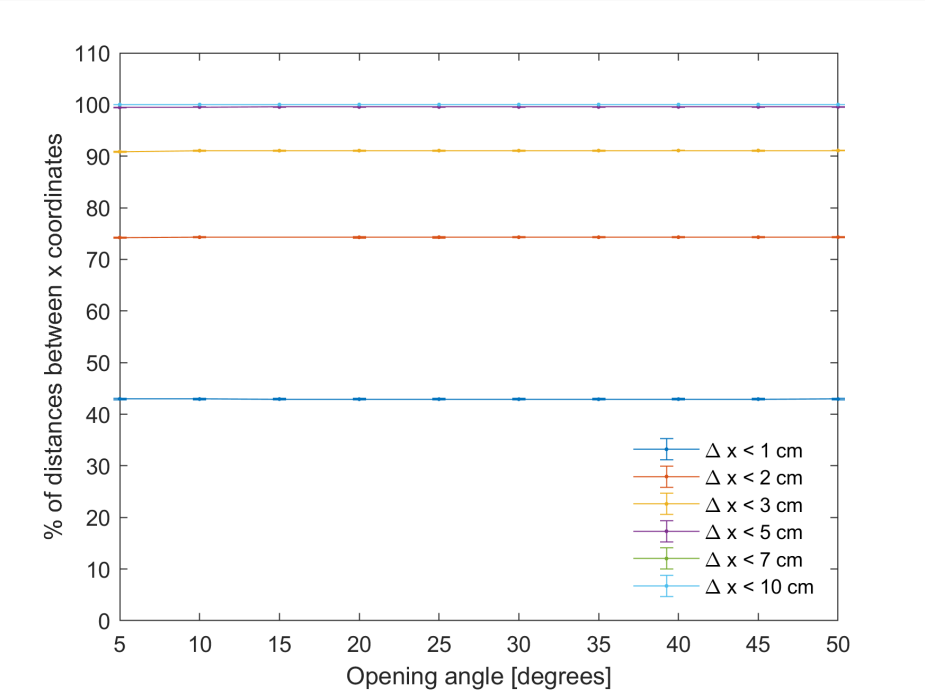

Figure 7: Vertex resolution in the x-coordiante.

Vertex-to-vertex distance by coordinate (continued)

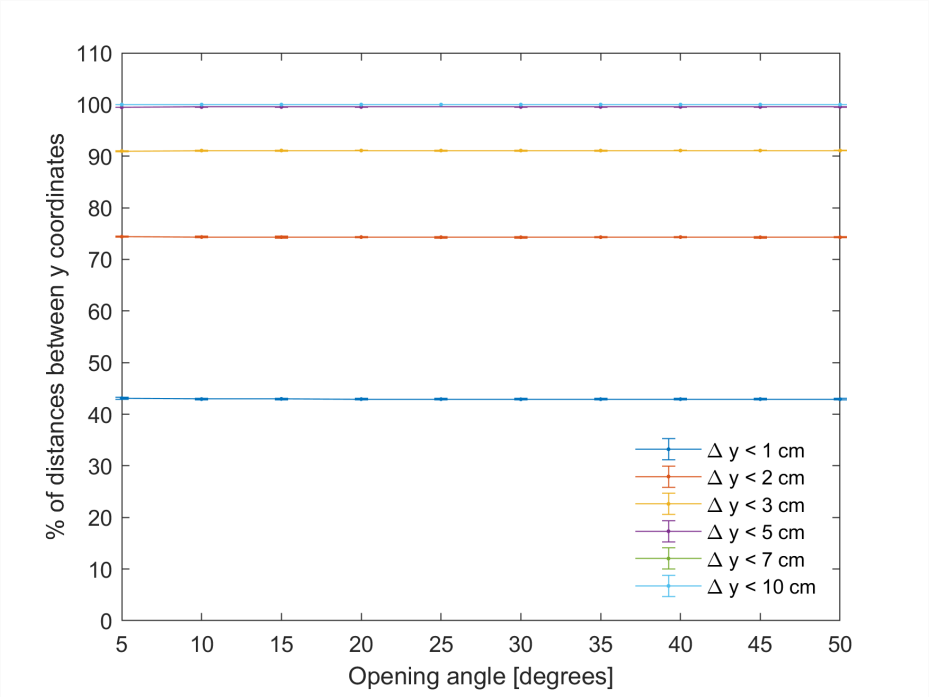

Figure 8: Vertex resolution in the y-coordiante.

Vertex-to-vertex distance by coordinate (continued)

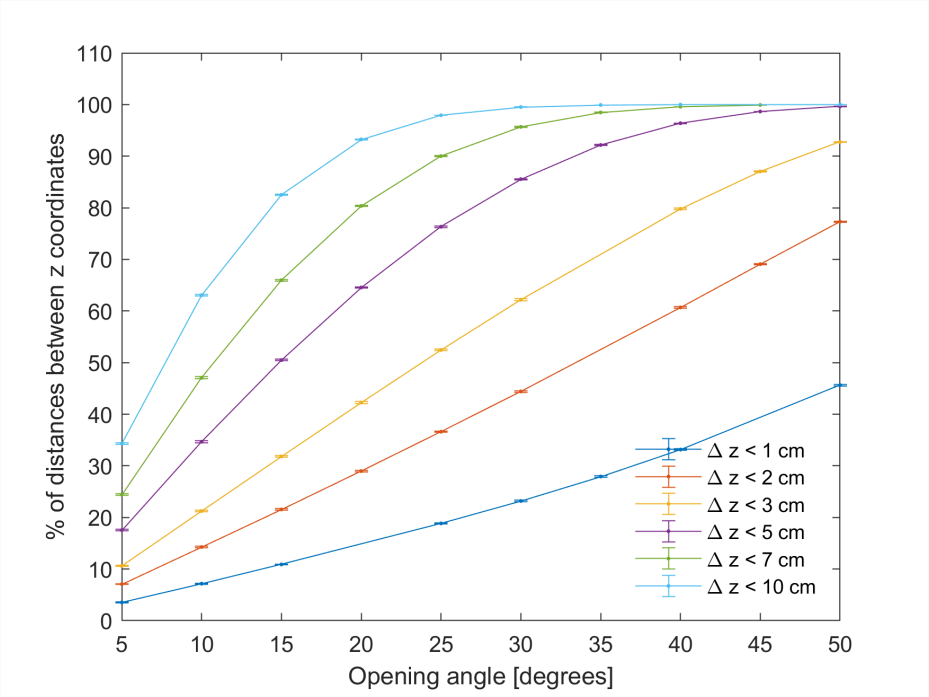

Figure 9: Vertex resolution in the z-coordiante.

Simulation with added noise

Simulation with added noise

As before, the blue dots simulate the real hits from the particles are each plane, with their respective blue tracks. The red dots simulate the observation of those hits in the laboratory. The red tracks are the reconstruction of the tracks of the real hits based on the observation in the laboratory without taking into account the added noise. The green dots are noise, and the green tracks are the reconstruction of the tracks of the real hits based on the observation in the laboratory taking into account the added noise.

Simulation with added noise (continued)

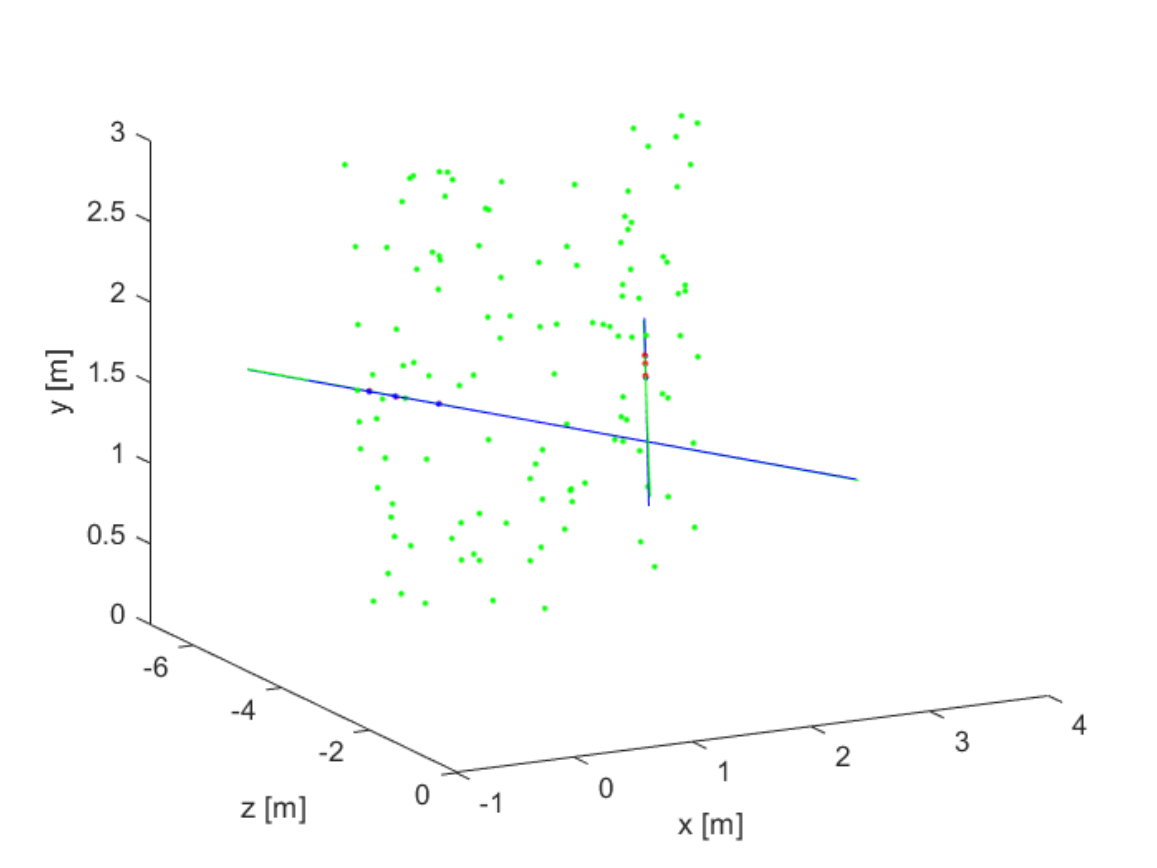

Figure 10: Simulation with added noise. 40 noise points per plane.

Simulation with added noise (continued)

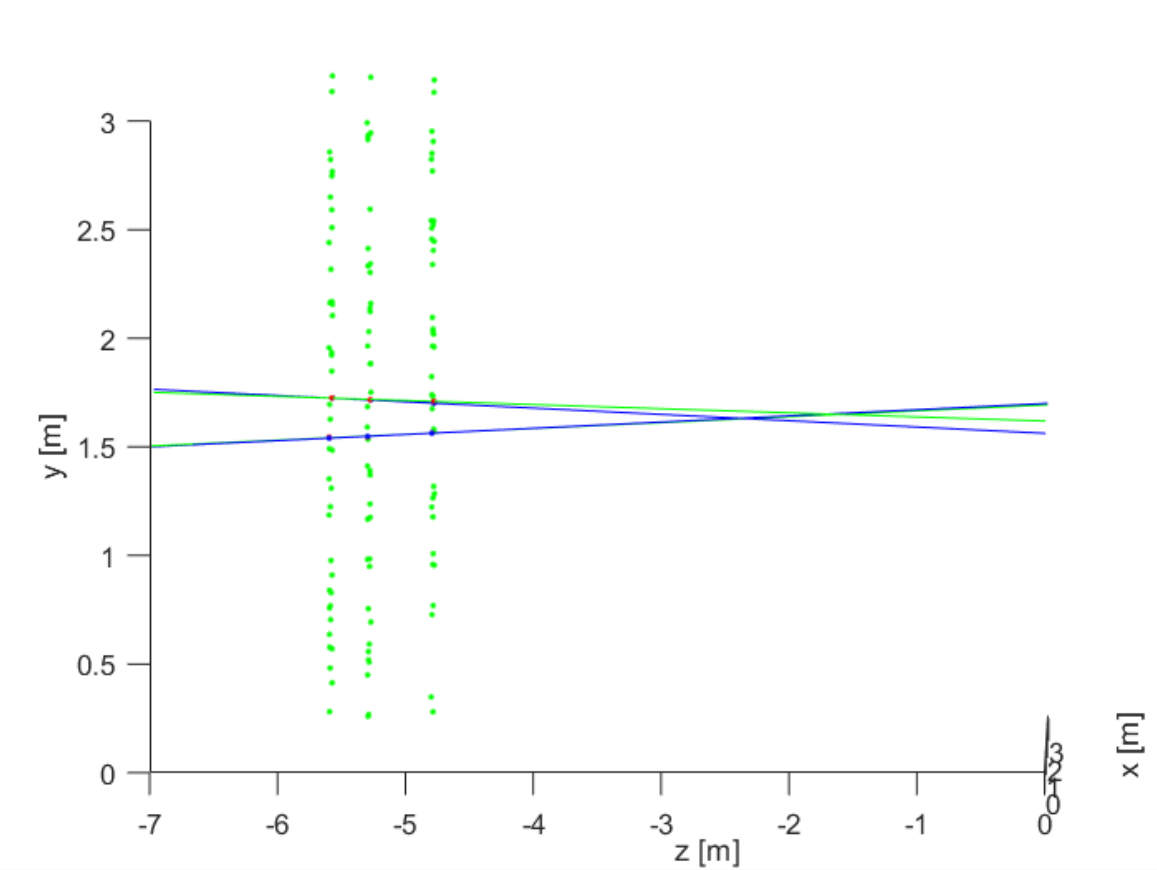

Figure 11: Simulation with added noise. 40 noise points per plane.

Noise cleaning

Method 1: procedure

The analysis is made for an opening angle of 40 degrees and a decay occurring in the xz-plane.

Step 1: noise cleaning is based on a (1) chi-squared analysis and (2) a look at the distance between the line generated by linear fit and the points used to generated that linear fit. This is for all the linear fits possible for the all the possible combinations of points in the detection planes. The results of the two methods are compared and their are matched. The best linear fits for each method that match the other's method are selected.

Step 2: the reconstructed tracks intersect each other in the xz-plane, but not in the yz-plane. Among the best linear fits, one looks at the tracks that intersect in the xz-plane inside the decay zone. Then one looks at the mismatch of the intersection in the y-axis and chooses the tracks that give the smallest mismatch value.

Method 1: results

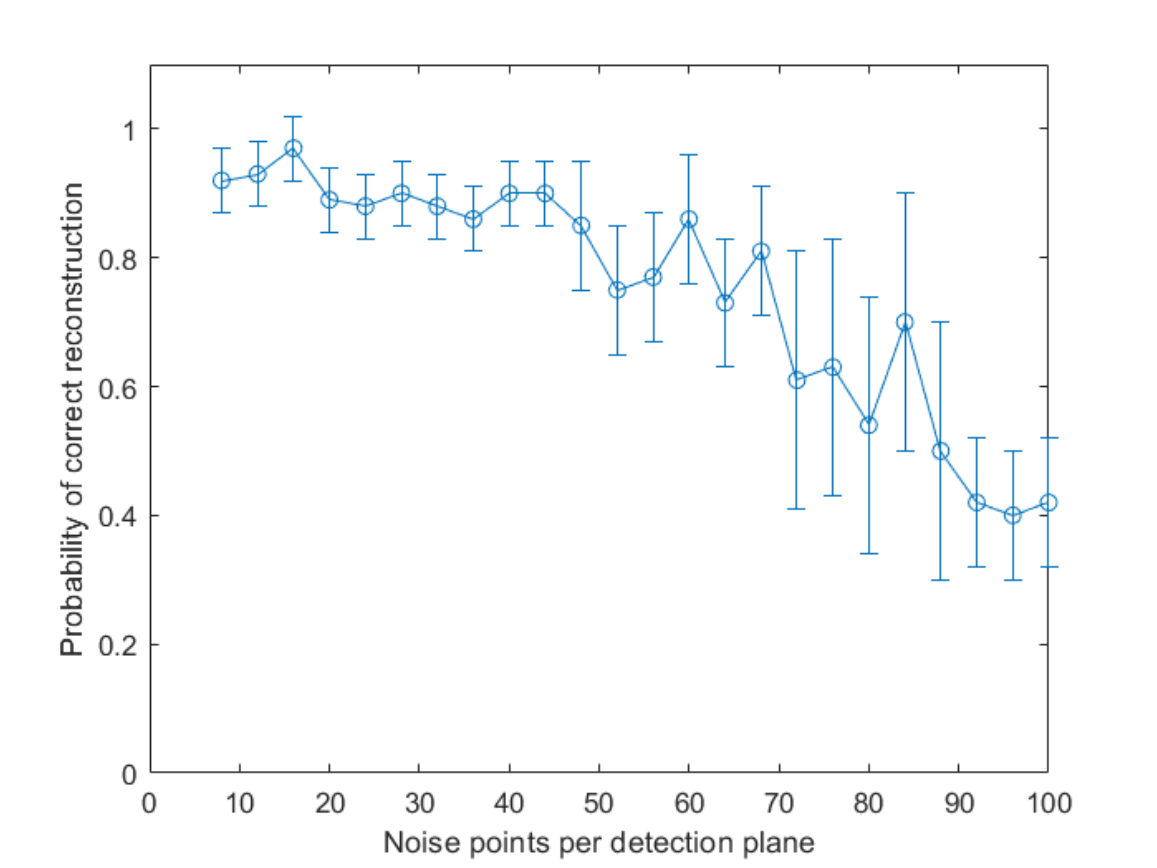

Figure 12: Results from noise cleaning, Method 1. Error bars are estimates only.

Method 2: procedure

This method looks at the y-axis mismatch of correct vertex reconstructions first (no noise present). The results give a range $\Delta y \approx [0, 0.14)$:

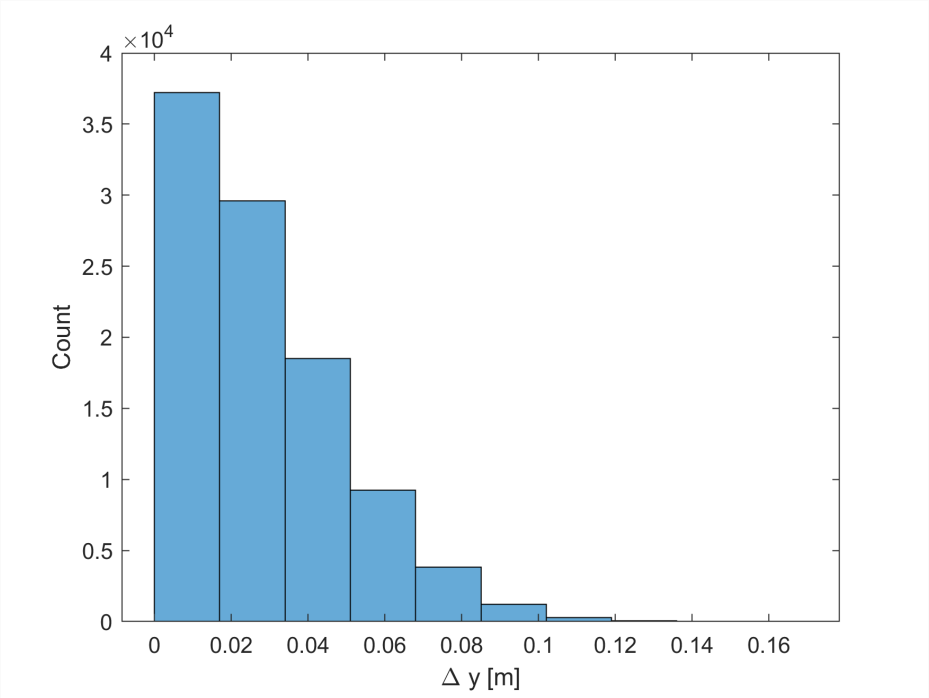

Figure 13: y-axis mismatch for a 40 degrees opening angle decay.

Method 2: next steps

The next steps to take is generated linear fits with noise included in the simulation. The linear fits that give a value of $\Delta y < 0.14$ [m] will be selected and the criteria of Method 1 with other criteria to be determined will be applied. This is expected to make the code run faster and improve the noise cleaning process.

Candidates:

- Opening angle filter (possible range: [35, 45])