POLITECNICO
MILANO 1863

DIPARTIMENTO DI ELETTRONICA
INFORMAZIONE E BIOINGEGNERIA

LOCALIZATION, NAVIGATION AND SMART MOBILITY PROJECT

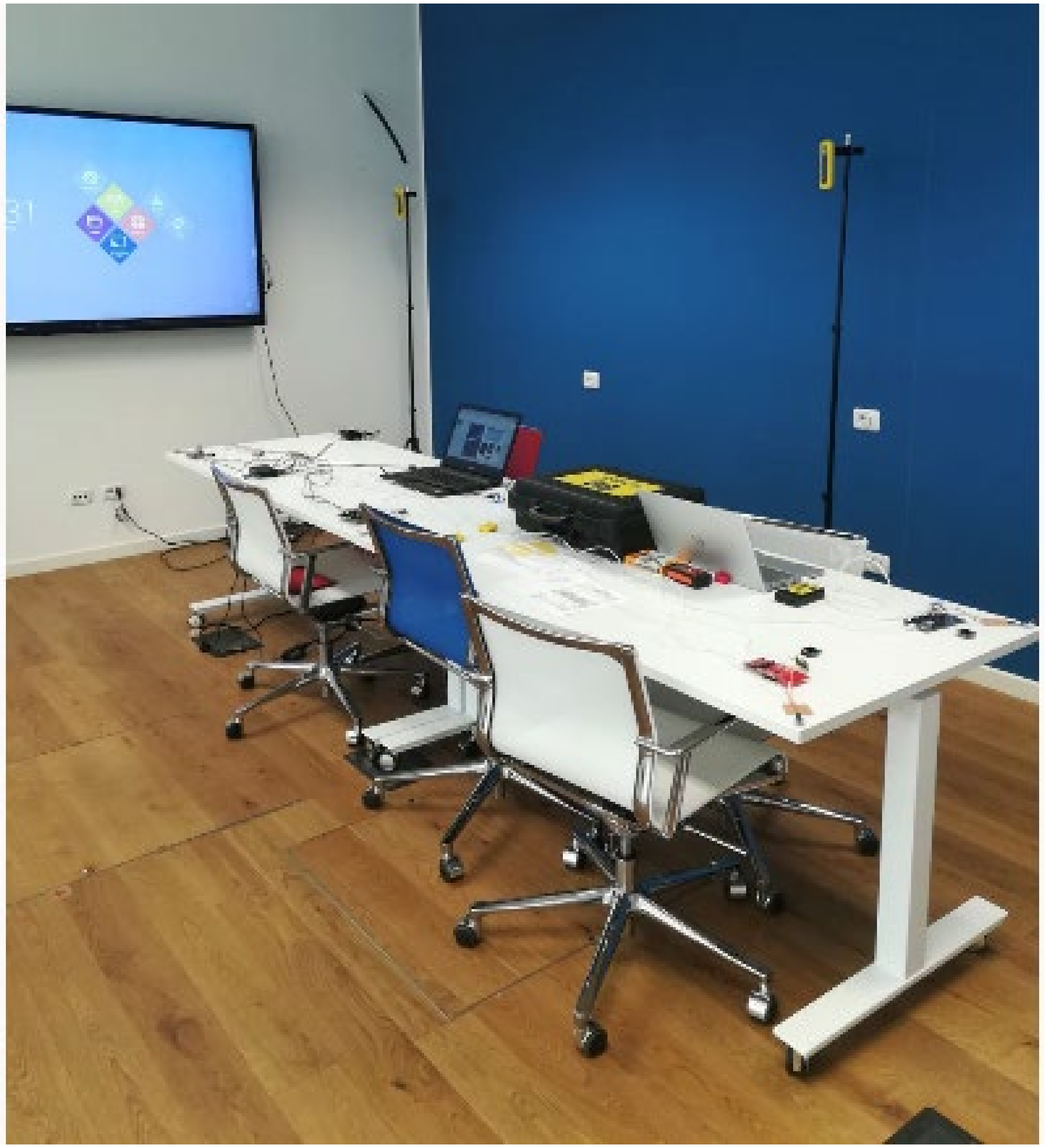
Alessandro De Luca - 10676114

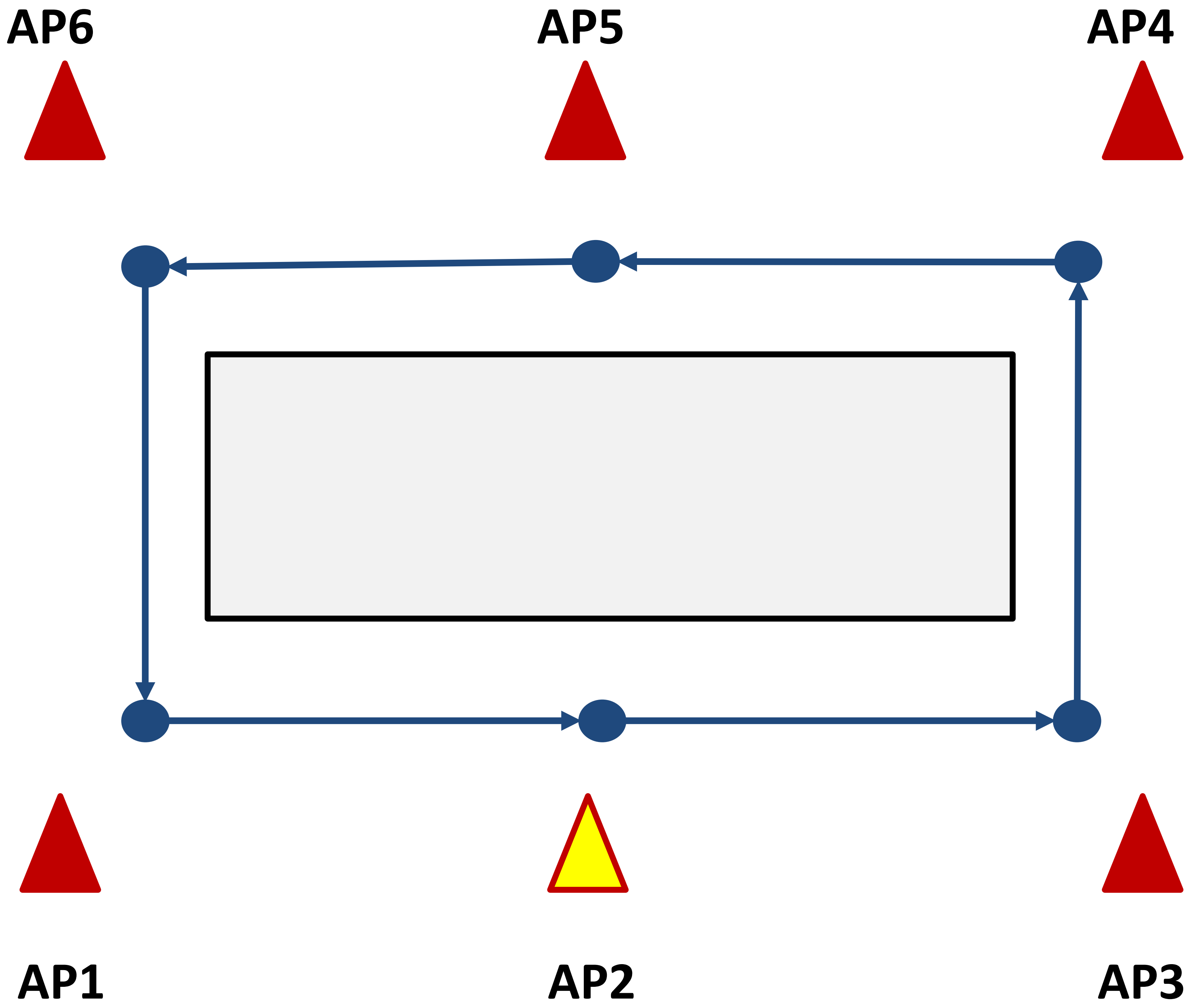
The aim of the project was to implement a localization algorithm and a tracking filter on Time Difference Of Arrival data gathered by an UWB tag

In particular the project was executed in 3 steps:

- **Cleaning of the dataset** to remove noise and outliers
- Implementation of the **Maximum Likelihood localization algorithm**
- Implementation of the **Extended Kalman Filter** and **Particle filter**

Scenario

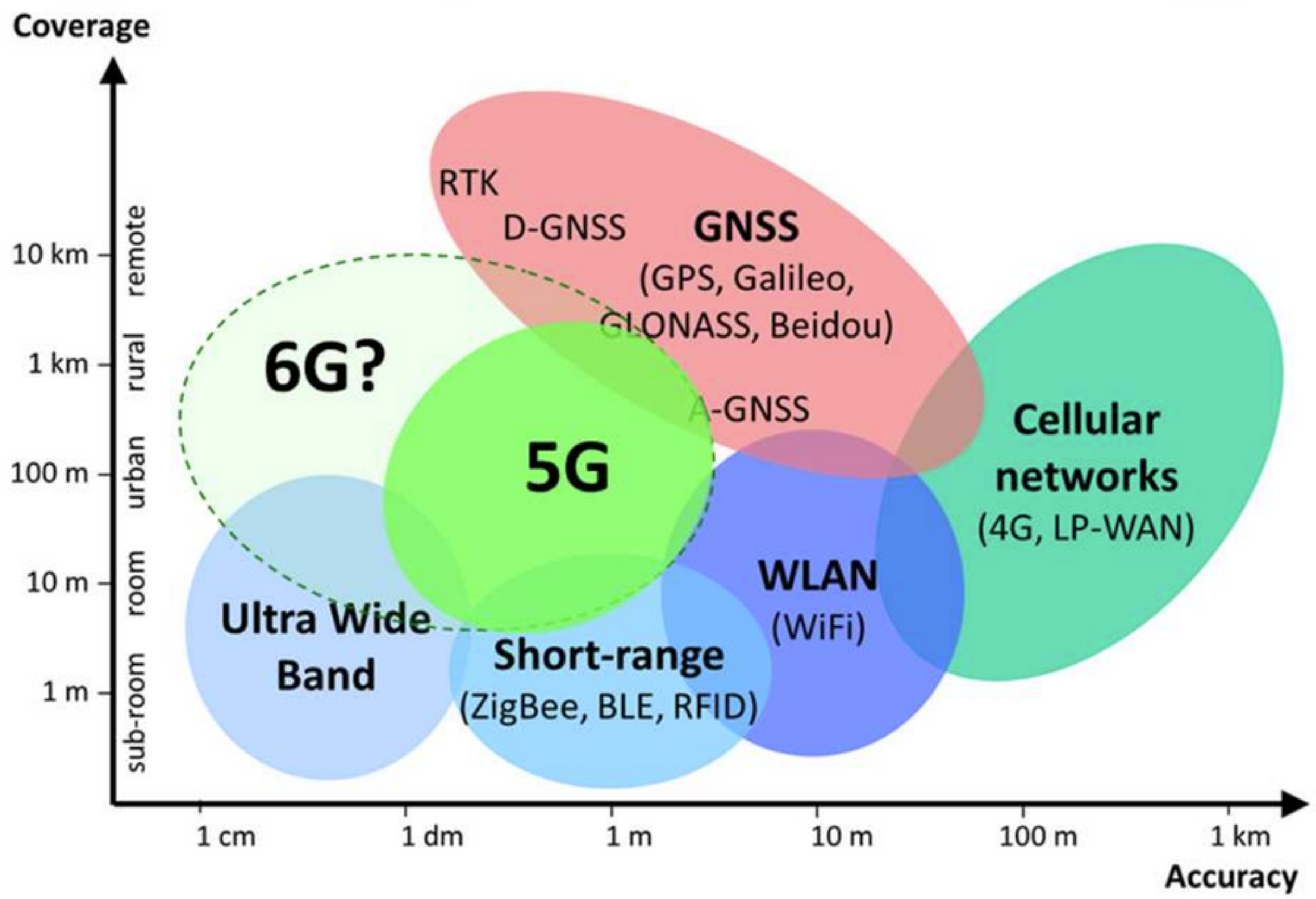




Scenario

The parameters used are:

- x_min = 0 m and x_max = 6 m (from dataset)
- y_min = 0 m and y_max = 3.5 m (from dataset)
- z_min = 0 m and z_max = 2 m (from dataset)
- sigma_TDOA = 0.05 m
    - Choice made due to the fact that Ultra Wide Bandwidth are very precise especially in room and sub room enviromnets



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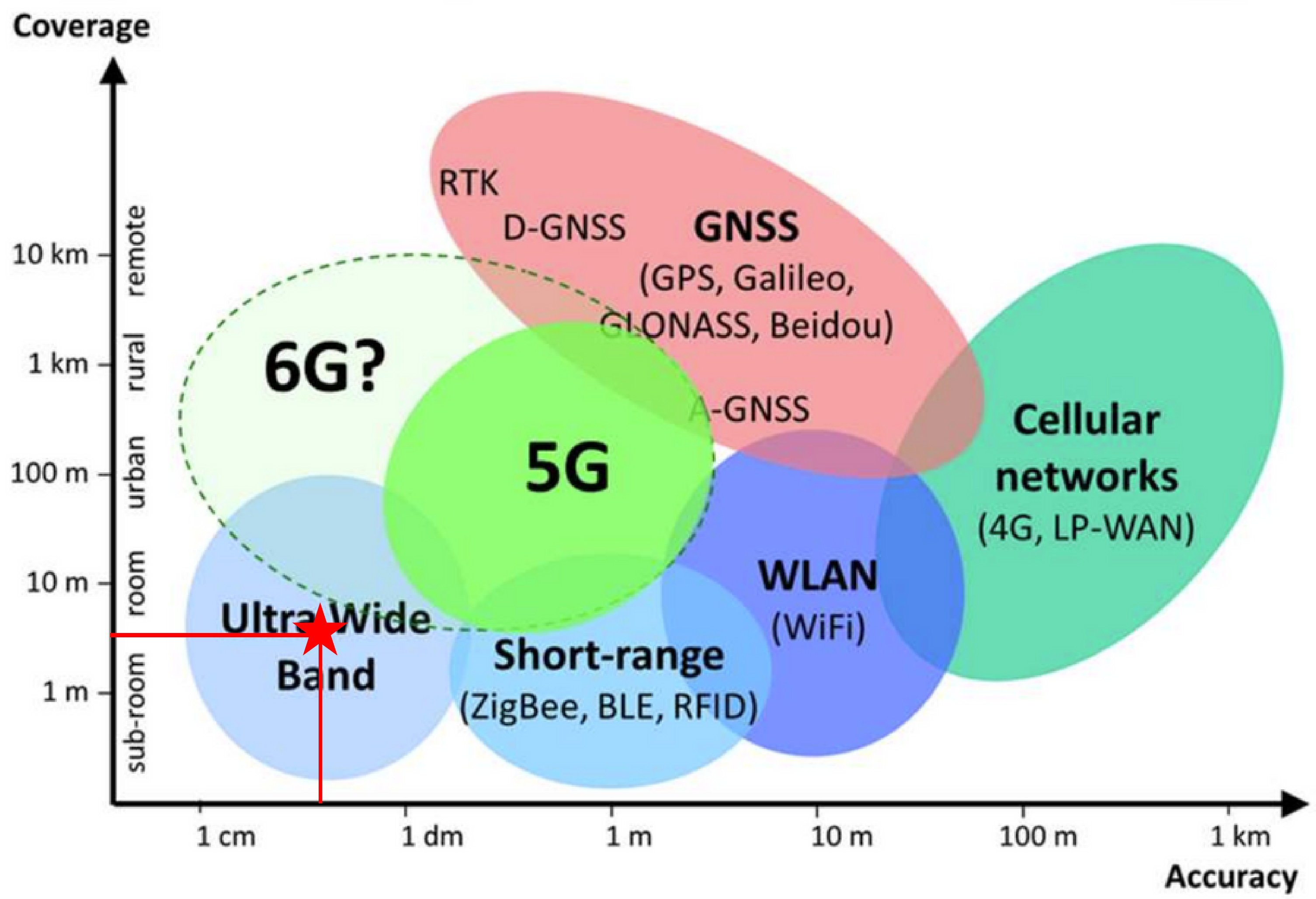
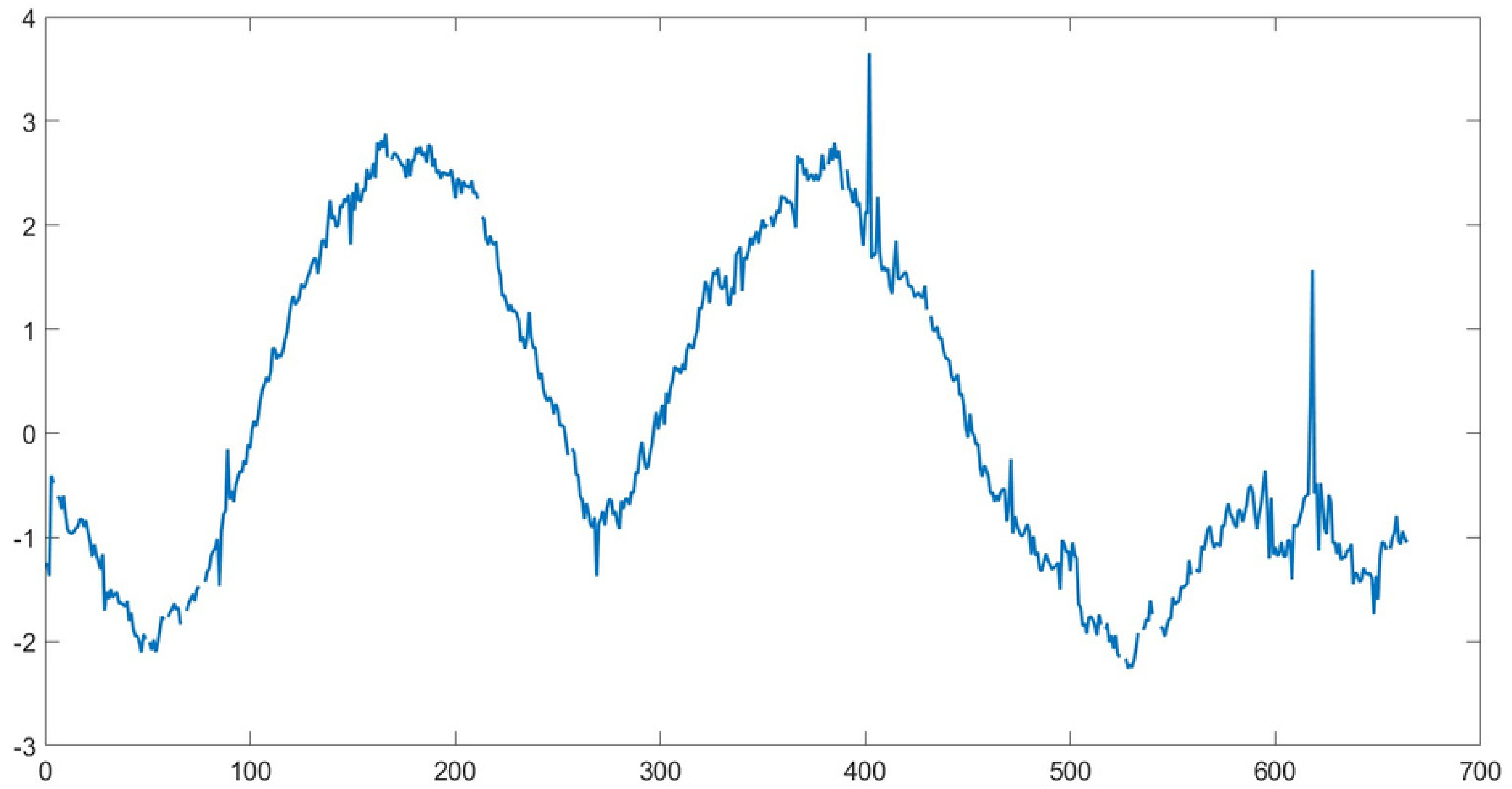


Data Cleaning

The process of Data Cleaning is aimed at filling NaN values from the dataset and then removing noise and outliers. The steps taken were:

1. Fill NaN values by interpolating subsequent samples with fillmissing(dataset, ‘linear’) function



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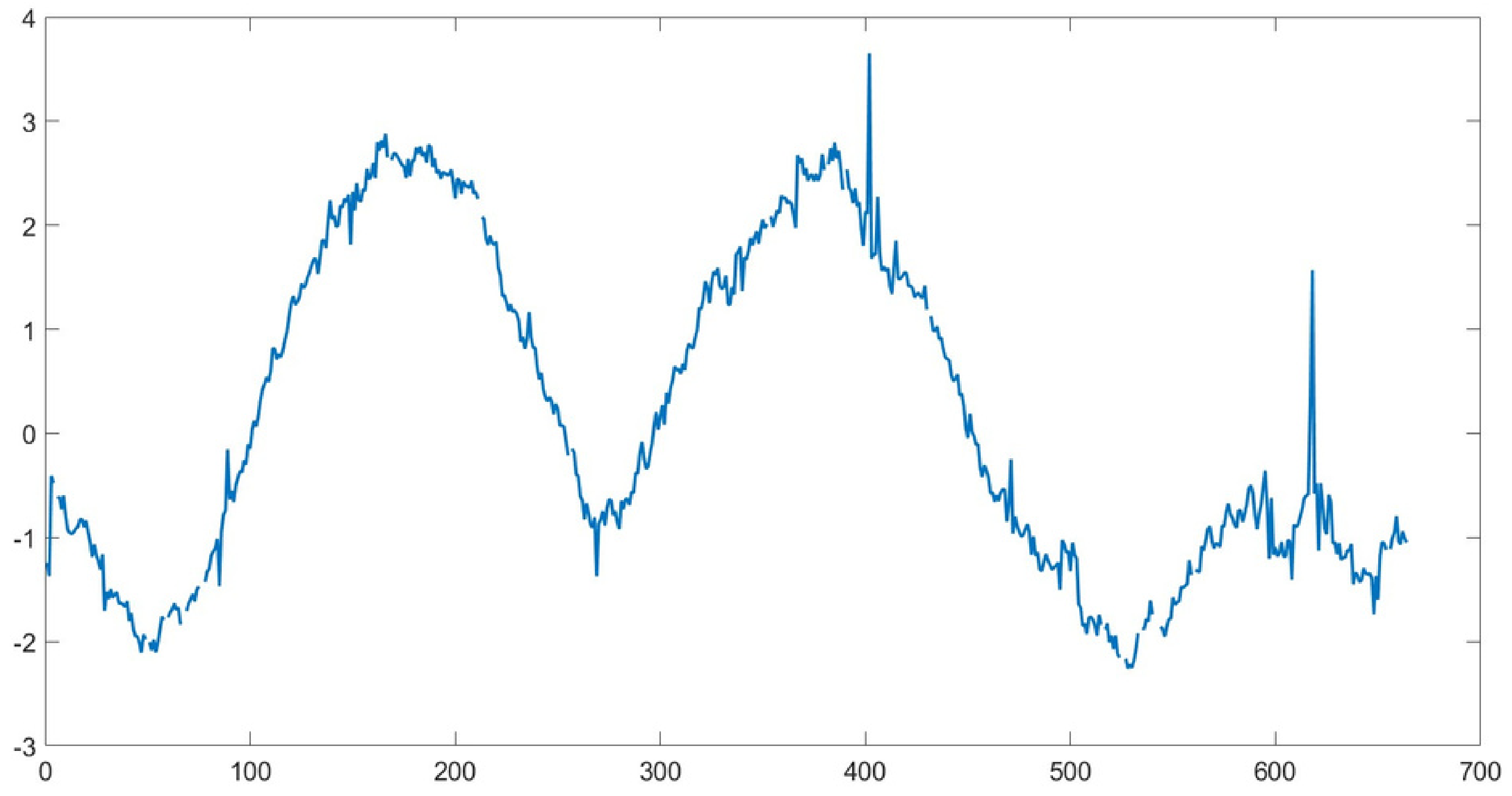

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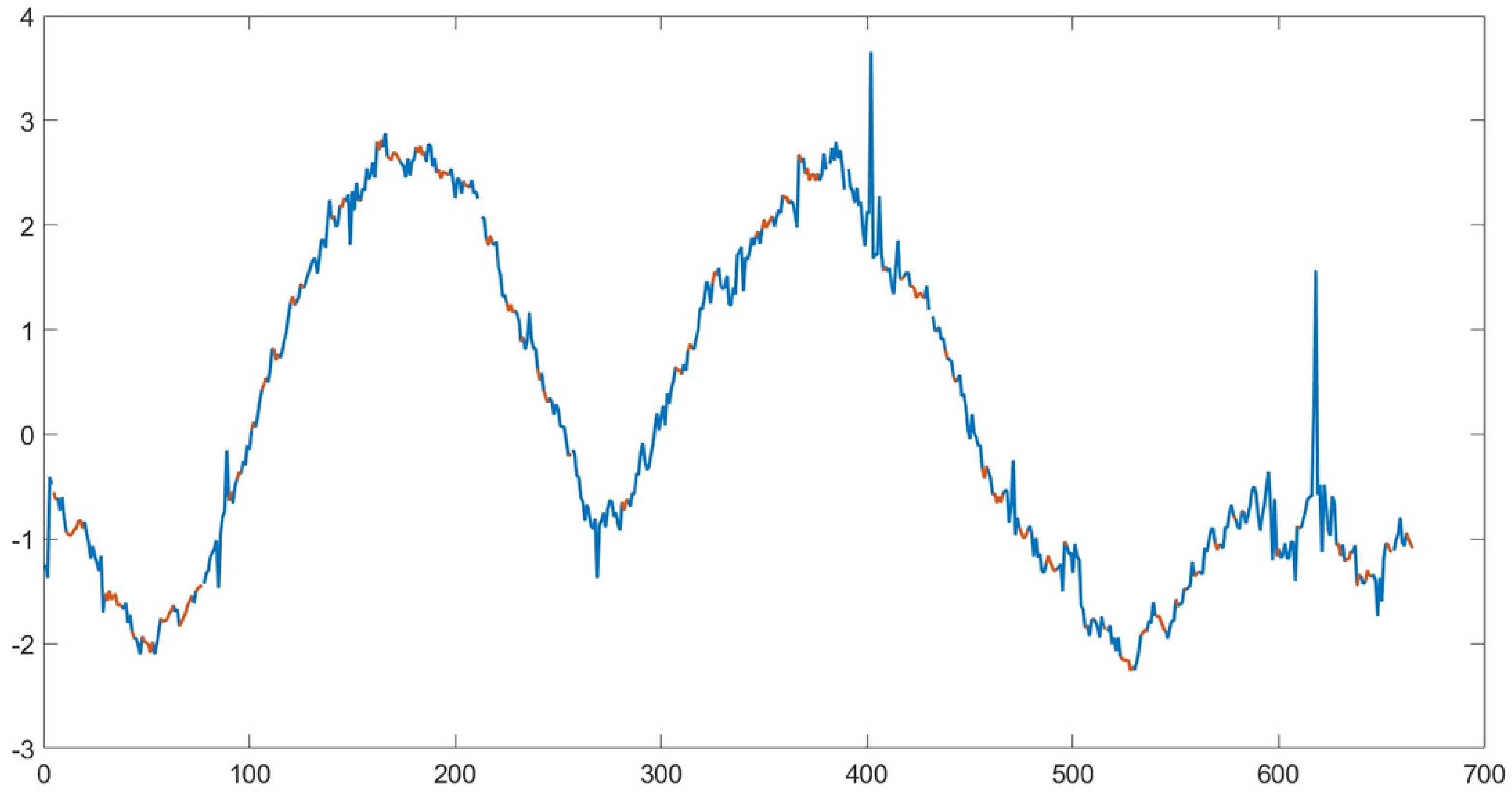

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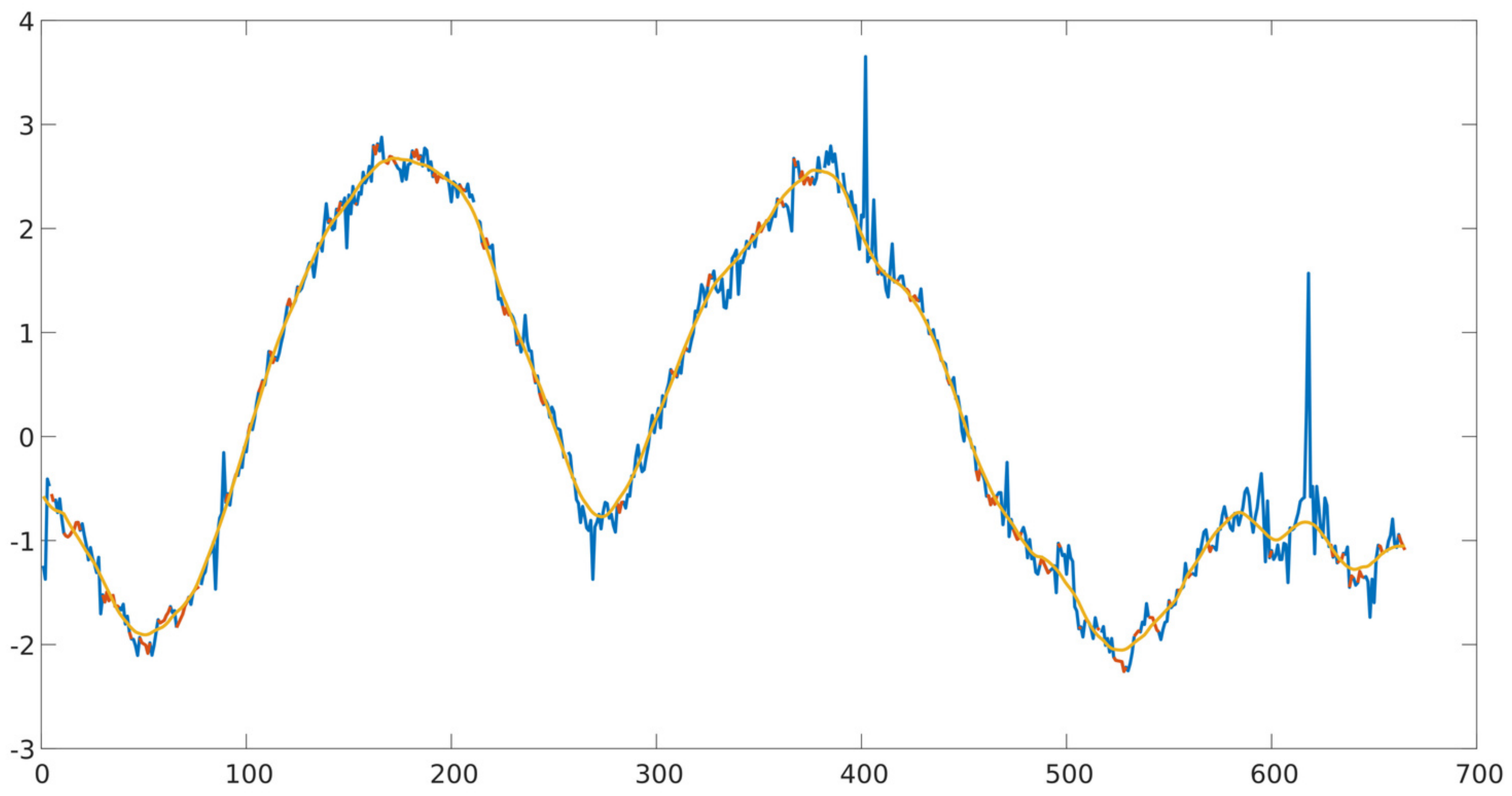
4. Fill missing data with moving avarage of window 20 of the interpolated data

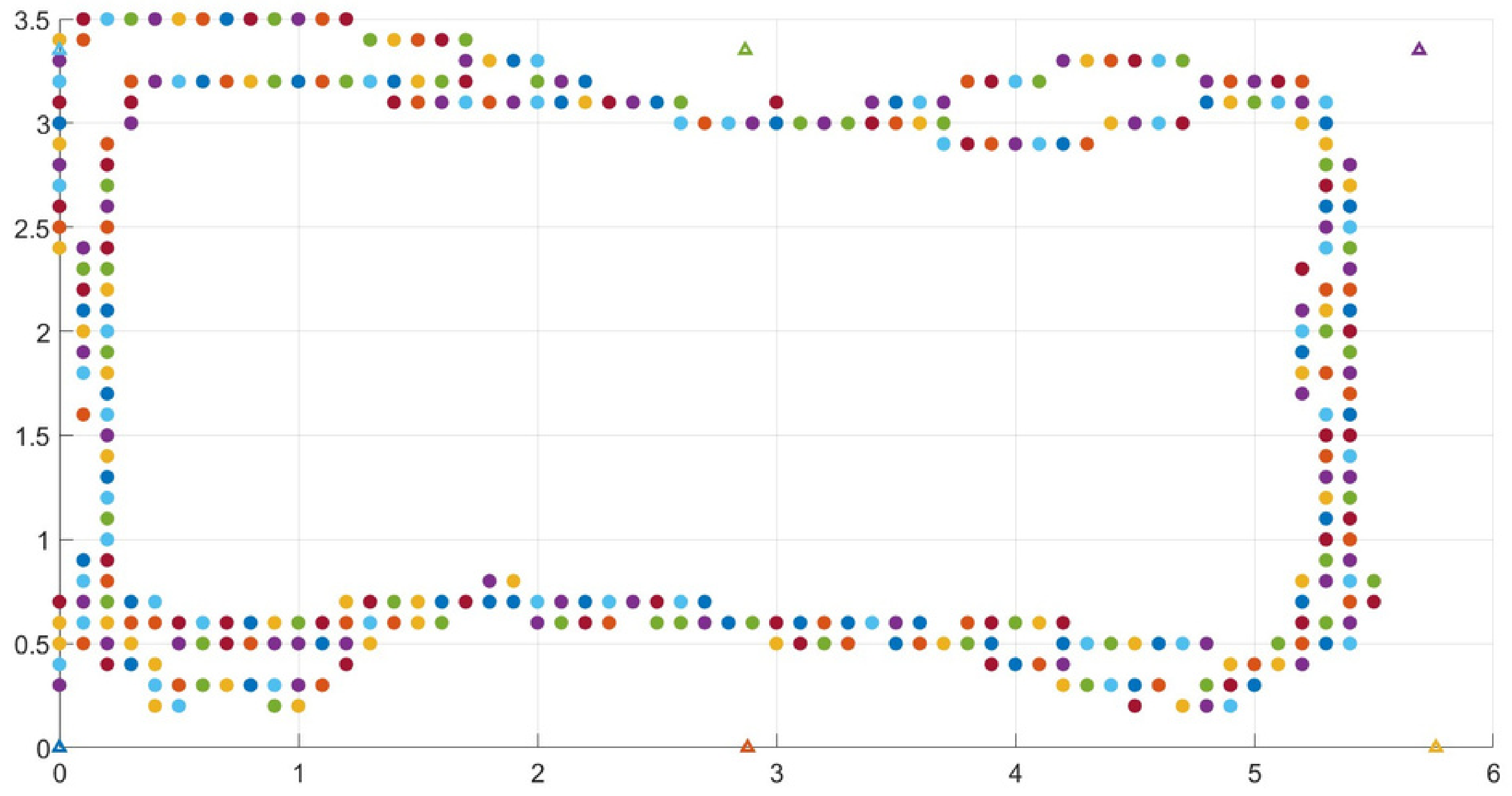


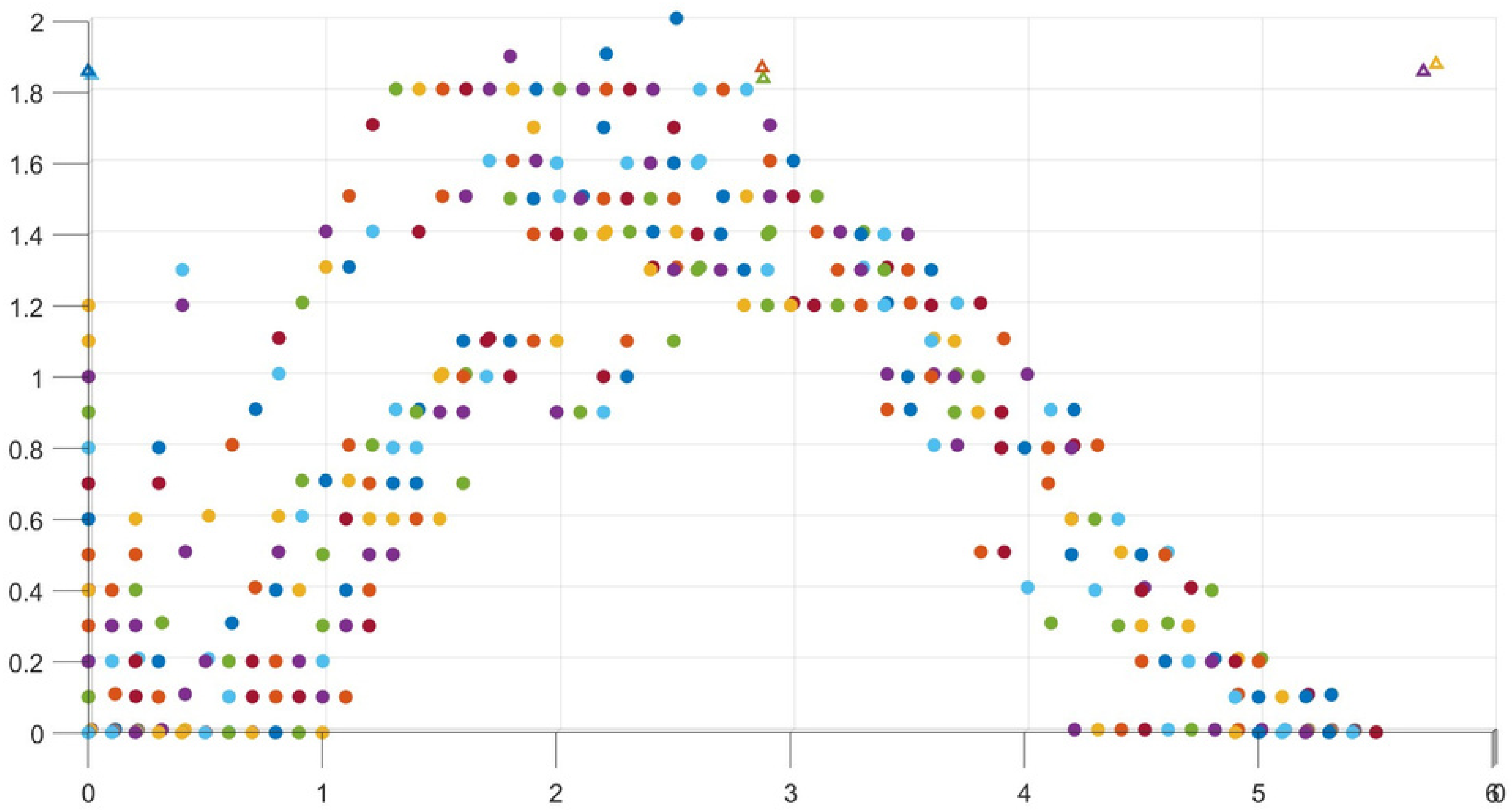
Localization - Mamimum Likelihood

As for the localization with Maximum likelihood I have split 46116 evaluation points each one at 0.1 m from its neighboring evaluation points in a room of dimension:

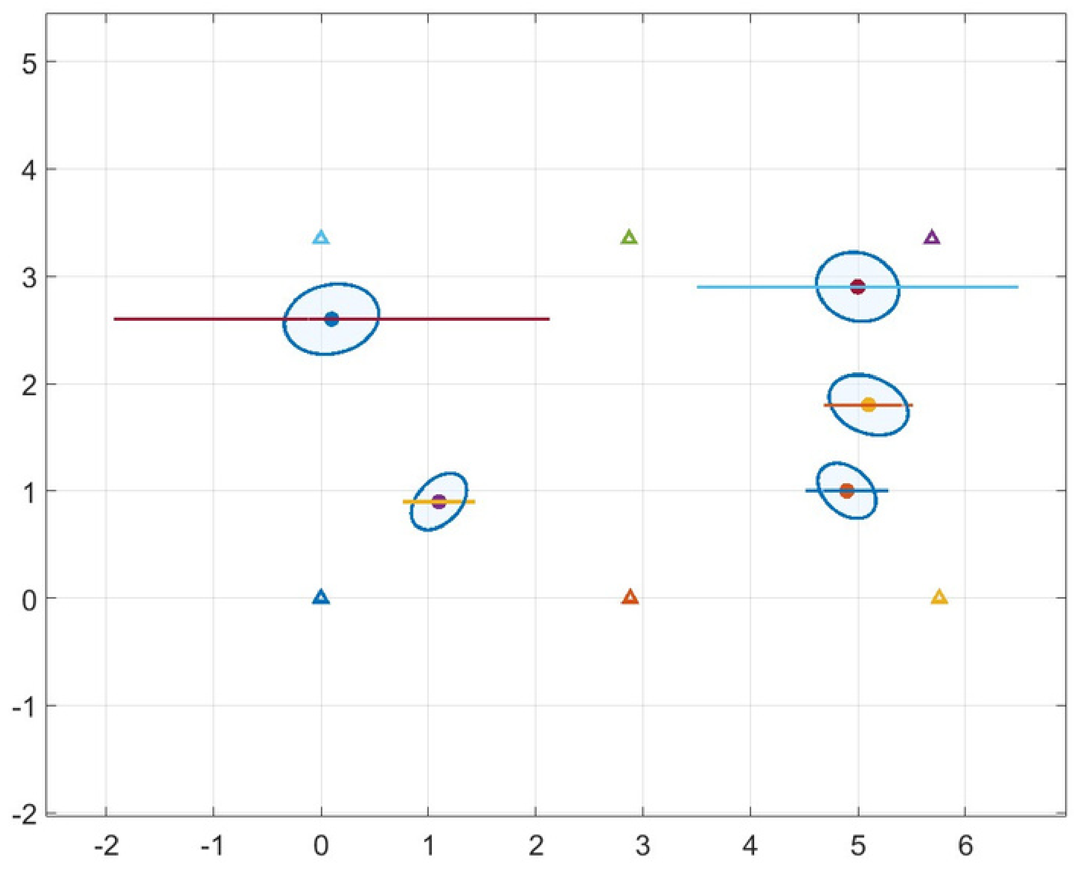
- x = 6 m, thus 61 evaluation values for x;
- y = 3.5 m, thus 36 evaluation values for y;
- z = 2m, thus 21 evaluation values for z;

#_x * #_y * #_z = 46116 evaluation points

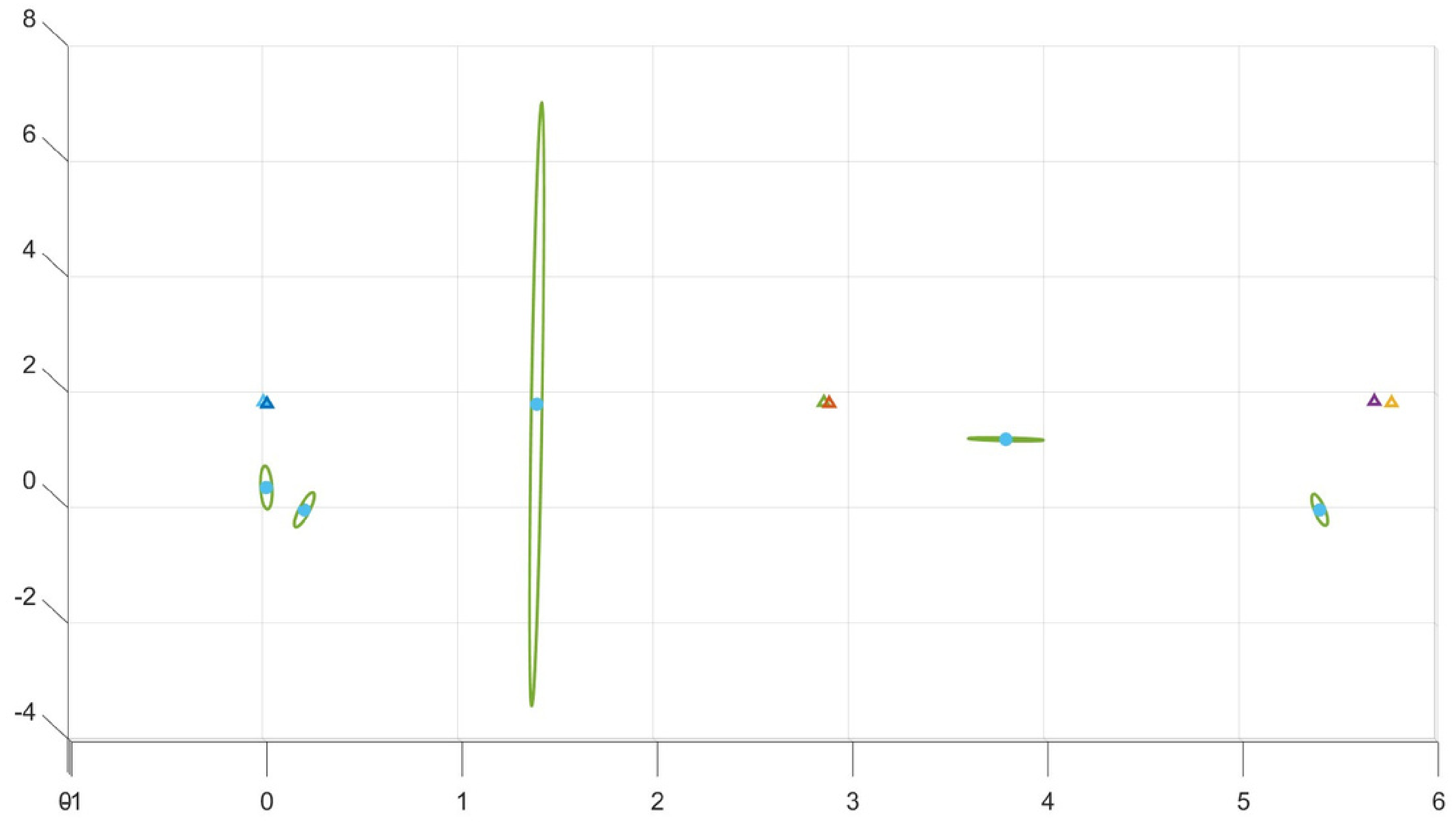




CRB for x-y localization



CRB for x-z localization

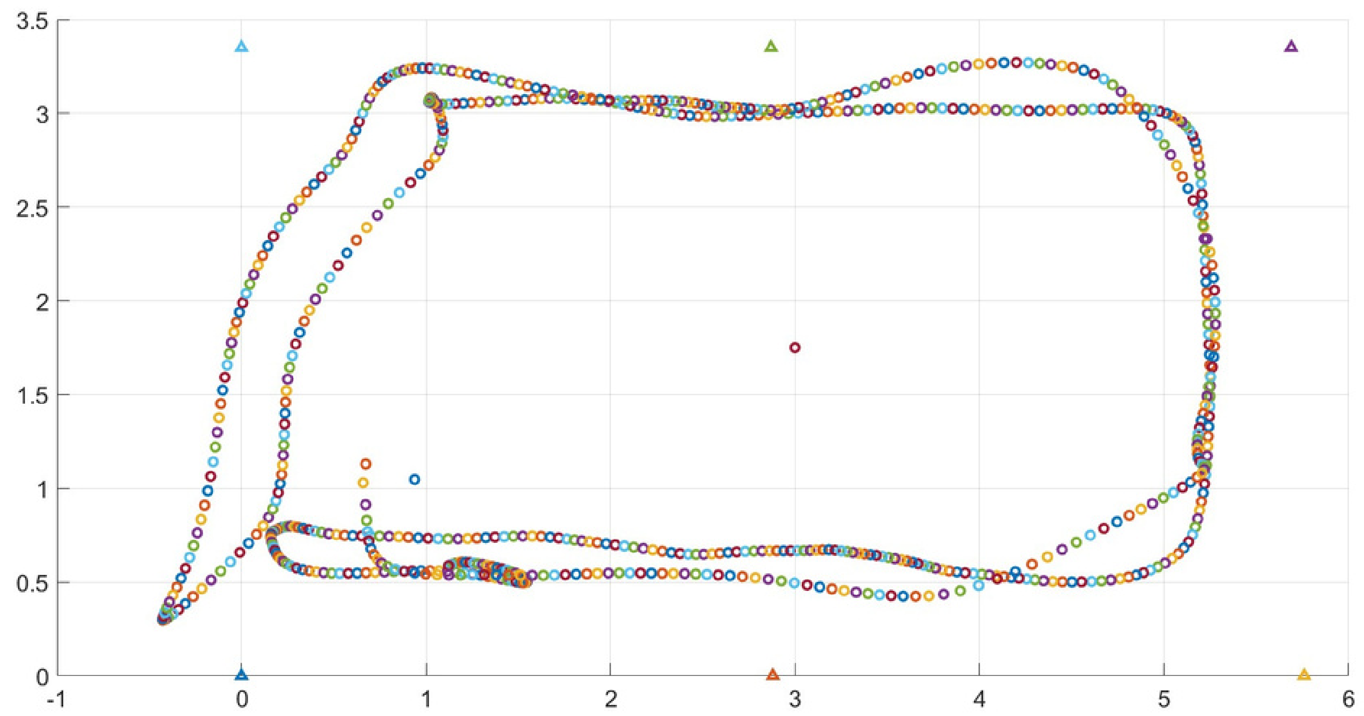


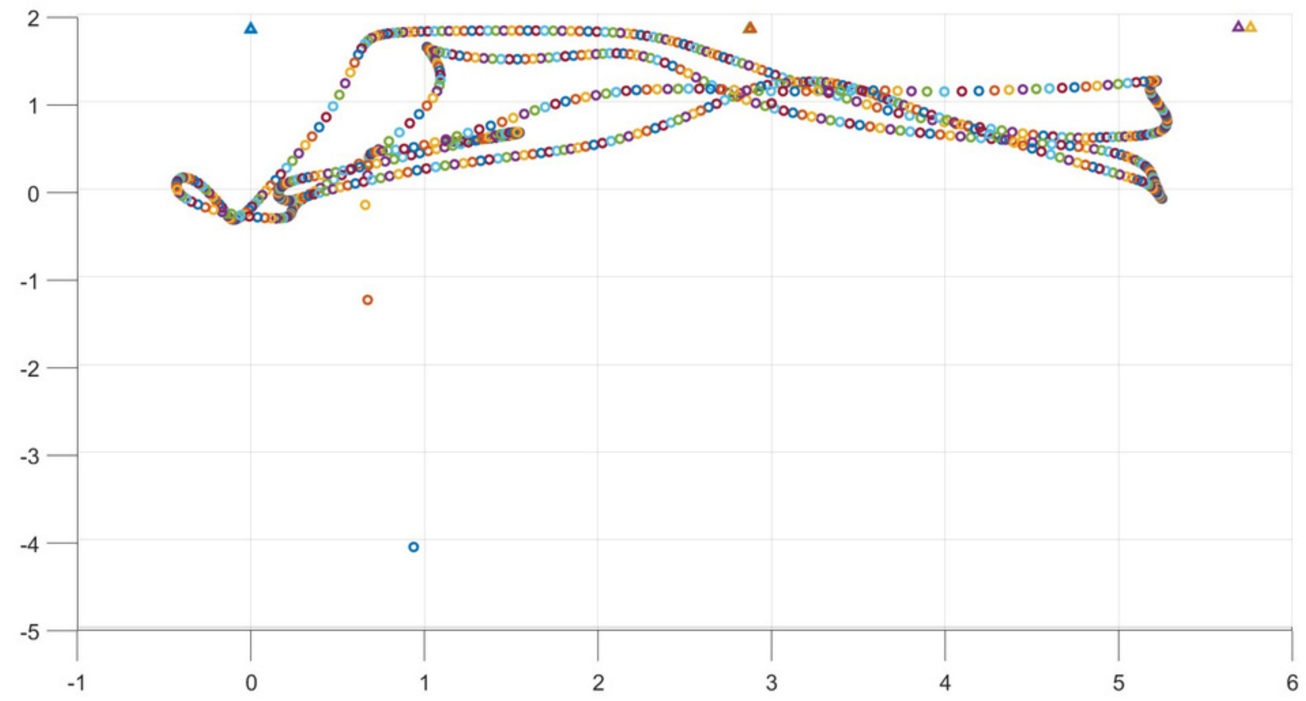
As we can see the error can be much larger in the estimation of the z coordinate

Tracking - Extended Kalman Filter

Parameters of EKF:

- sigma_TDOA = 0.05 m;
- sigma_Driving = 0.1 m/s;
- samplingTime = 0.1 s;
- R = diag(repmat(0.0025 , 1 , 5));
- L = samplingTime * I;
- Q = sigma_Driving^2 * L * L';
- F = I ; (nearly constant veloity model)
- UE_init = [3, 1.75 ,1]; (middle of the room)
- UE_init_COV = diag([10, 10, 10]);





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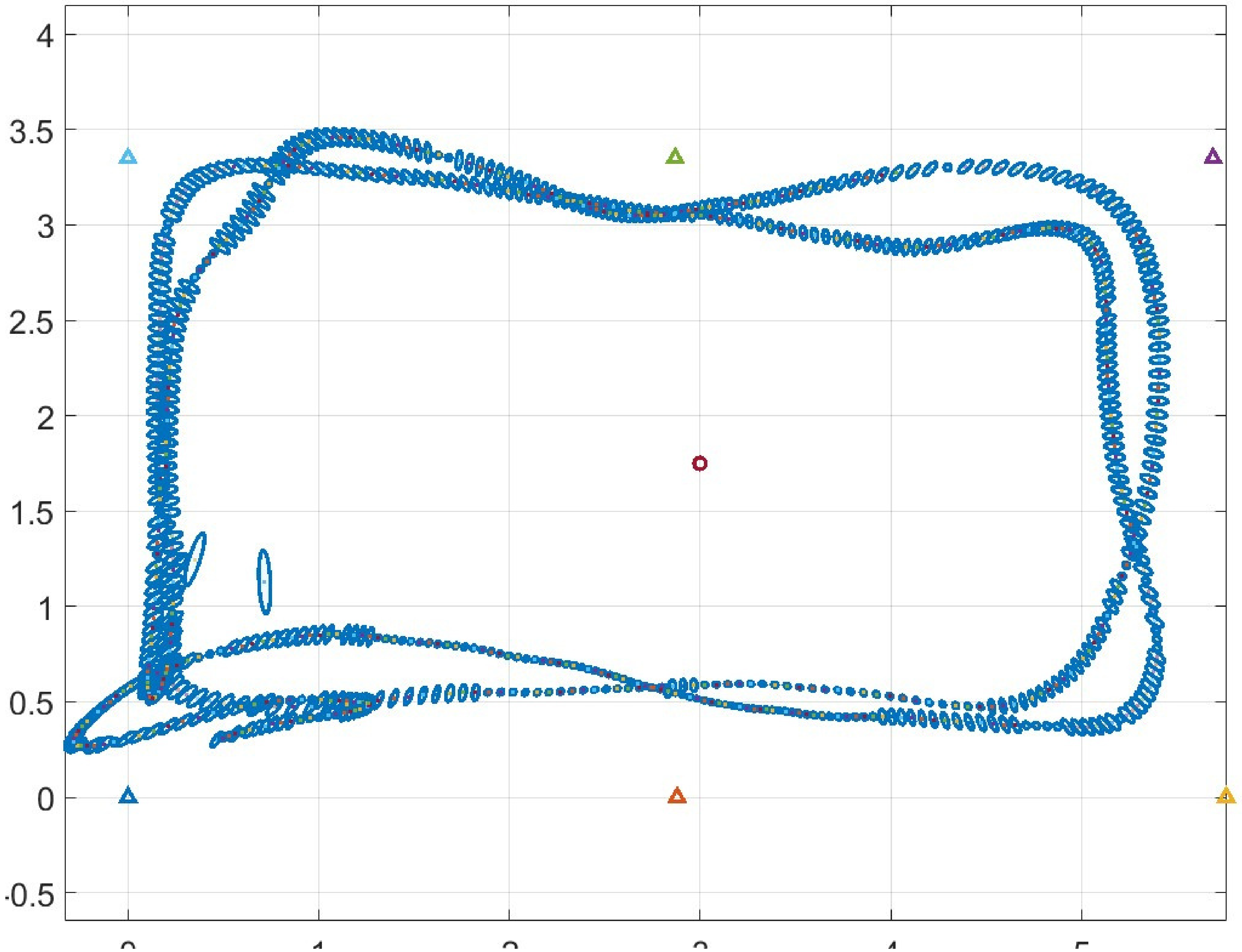
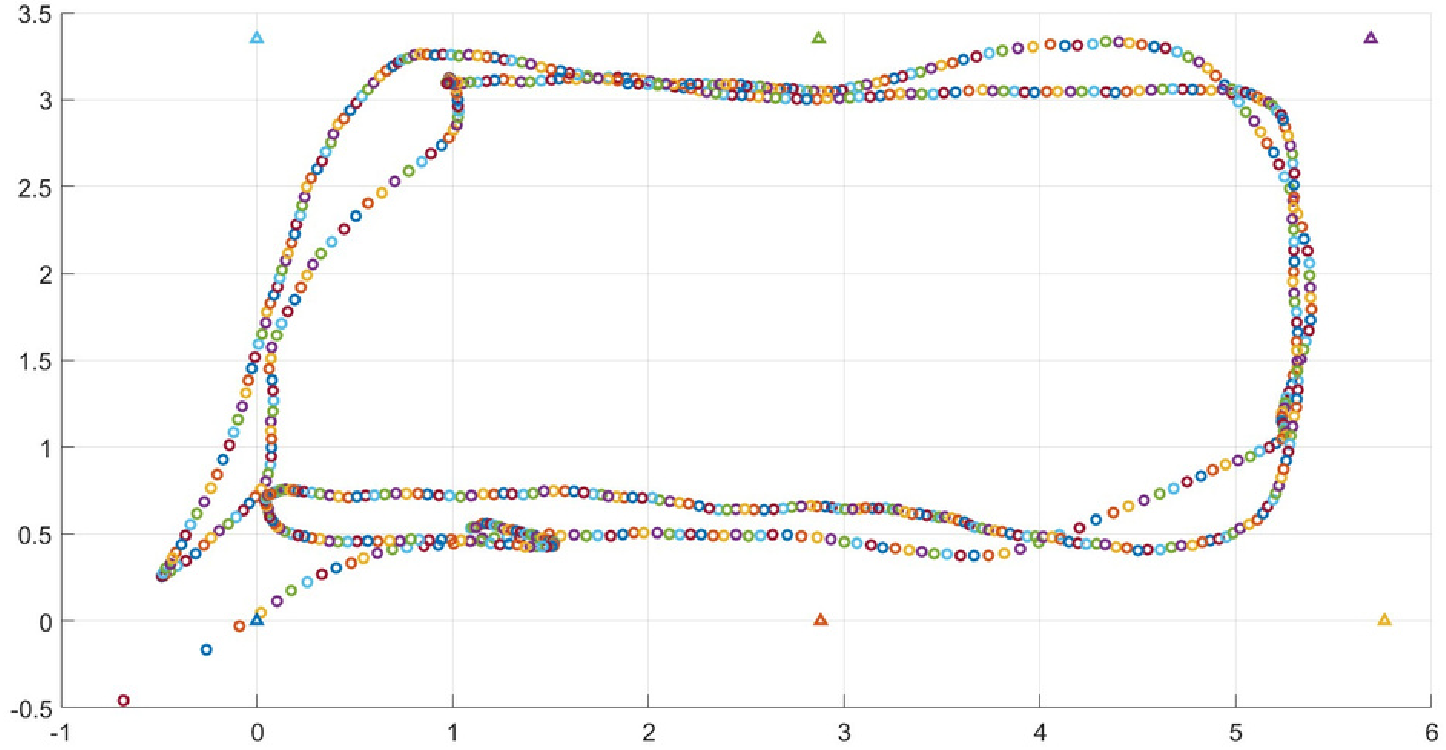
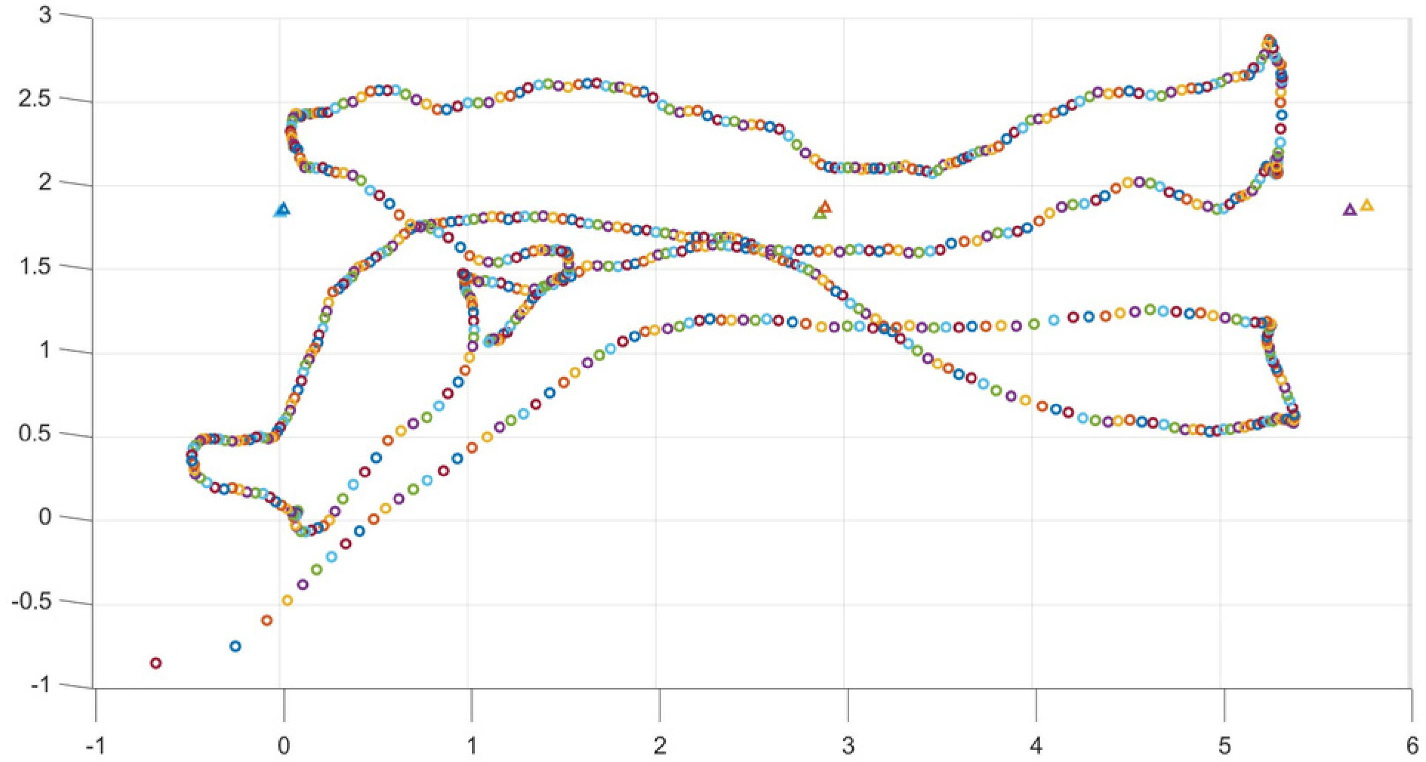


Tracking - Particle Filter

Parameters of PF:

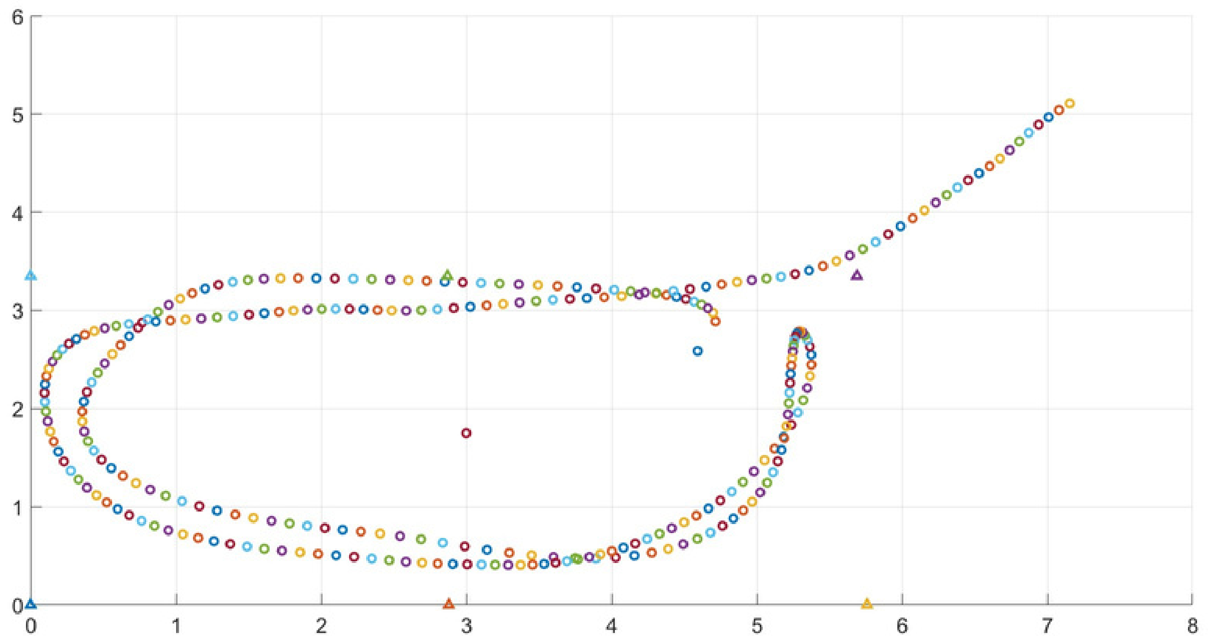
- sigma_TDOA = 0.05 m;
- sigma_Driving = 0.1 m/s;
- samplingTime = 0.1 s;
- number_Of_Particles = 1000;



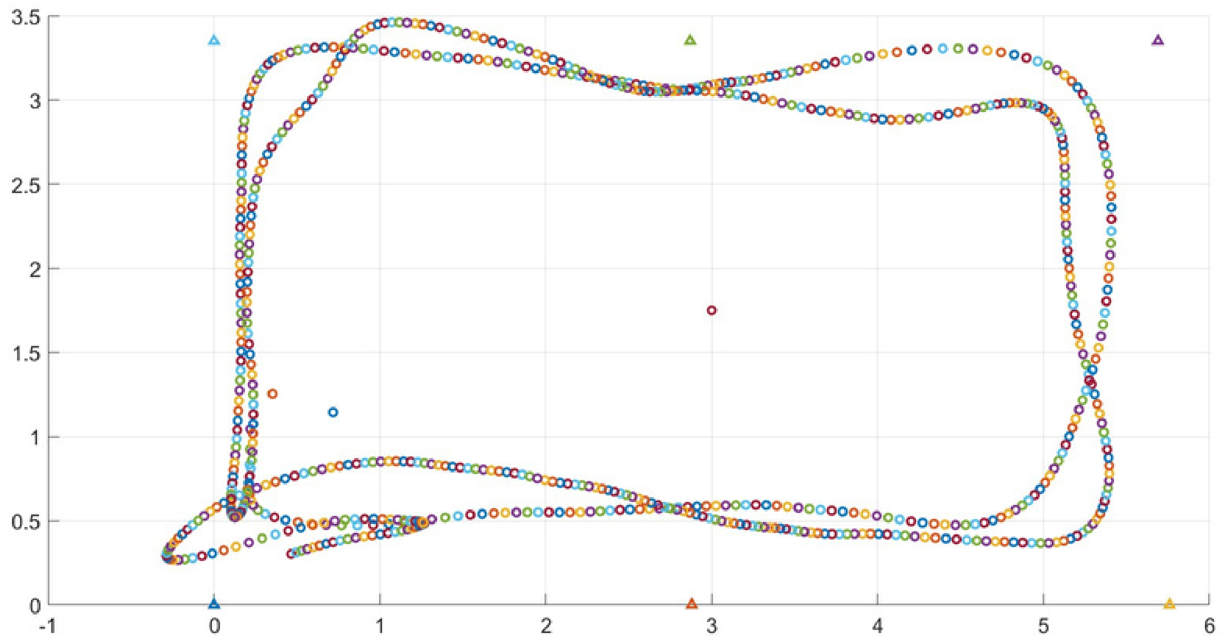


Issues and Conjectures

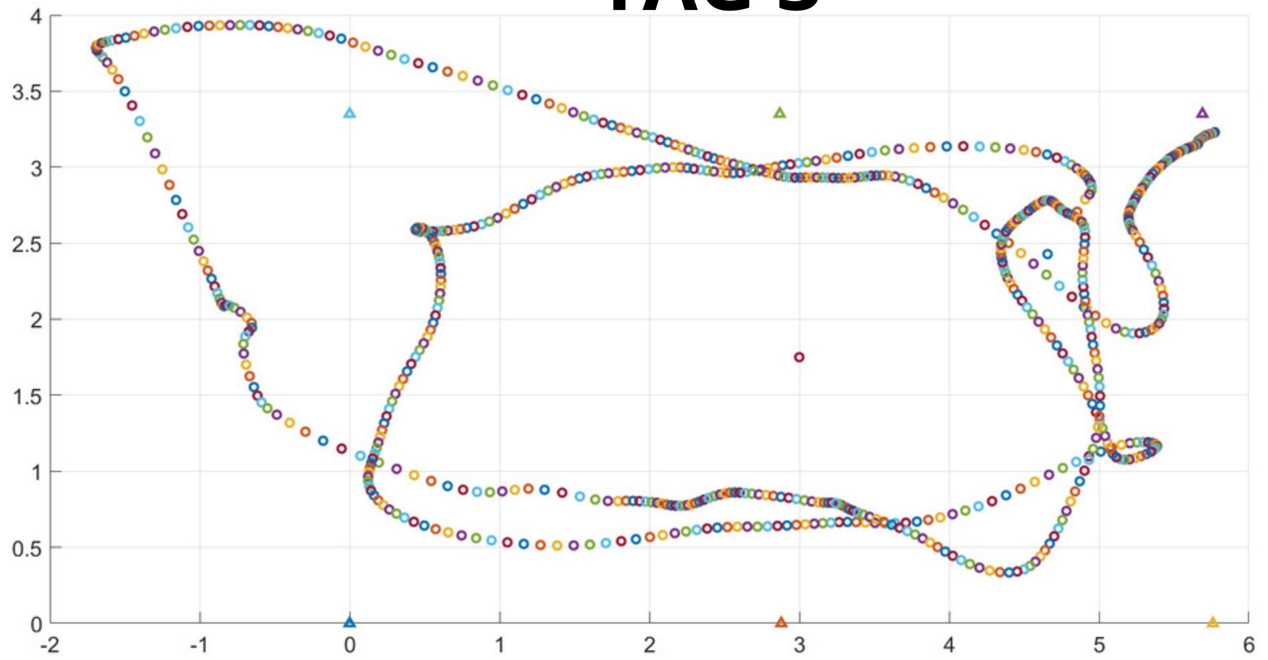
TAG 1



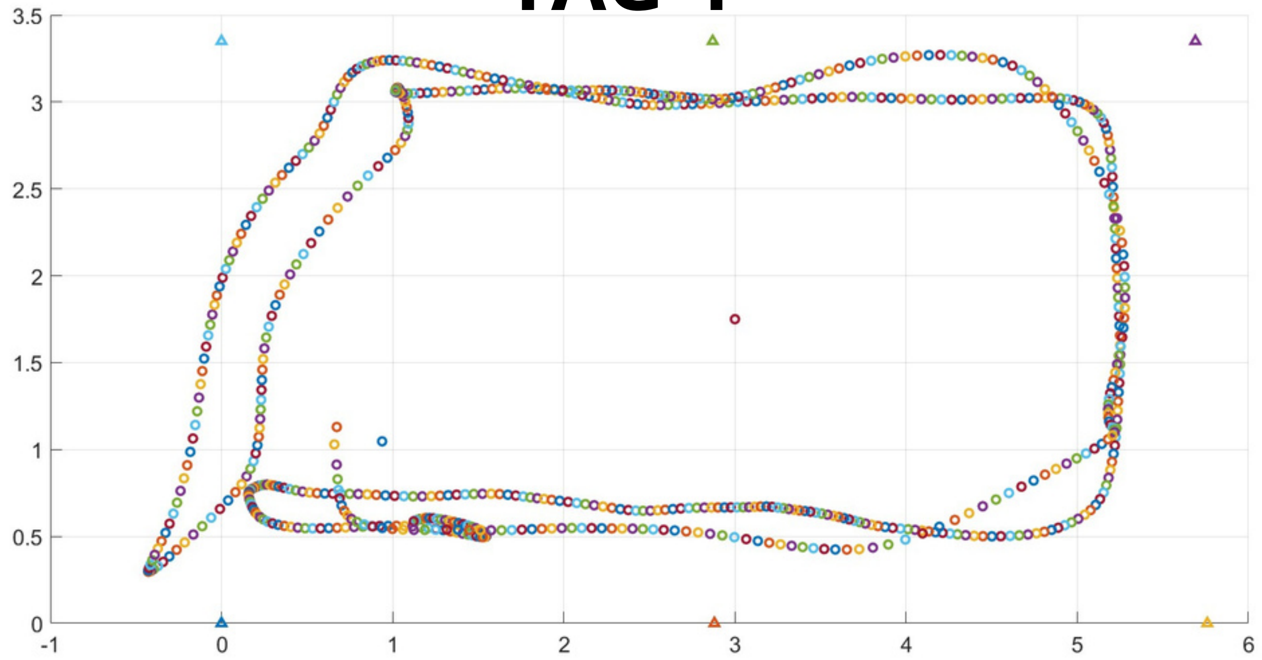
TAG 2



TAG 3



TAG 4



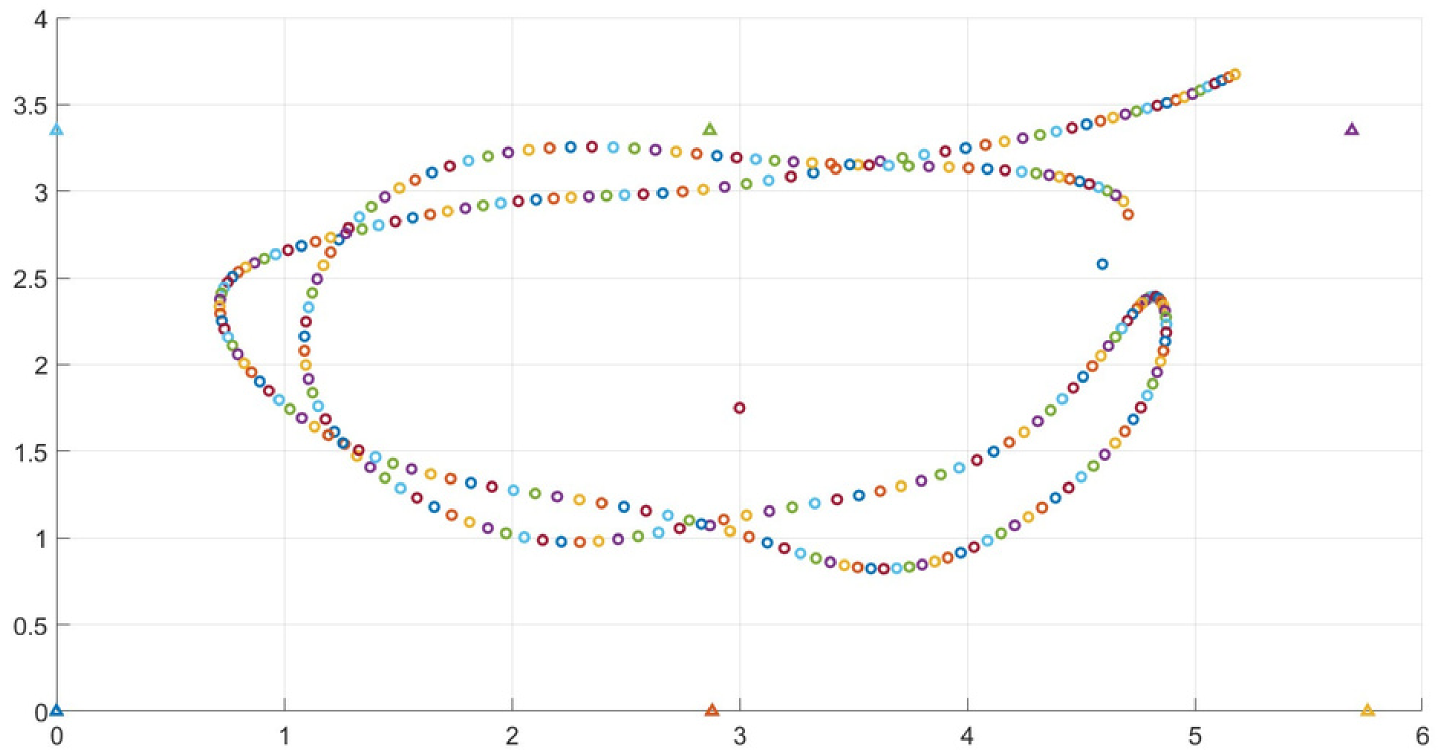
Processes tried that didn’t work:

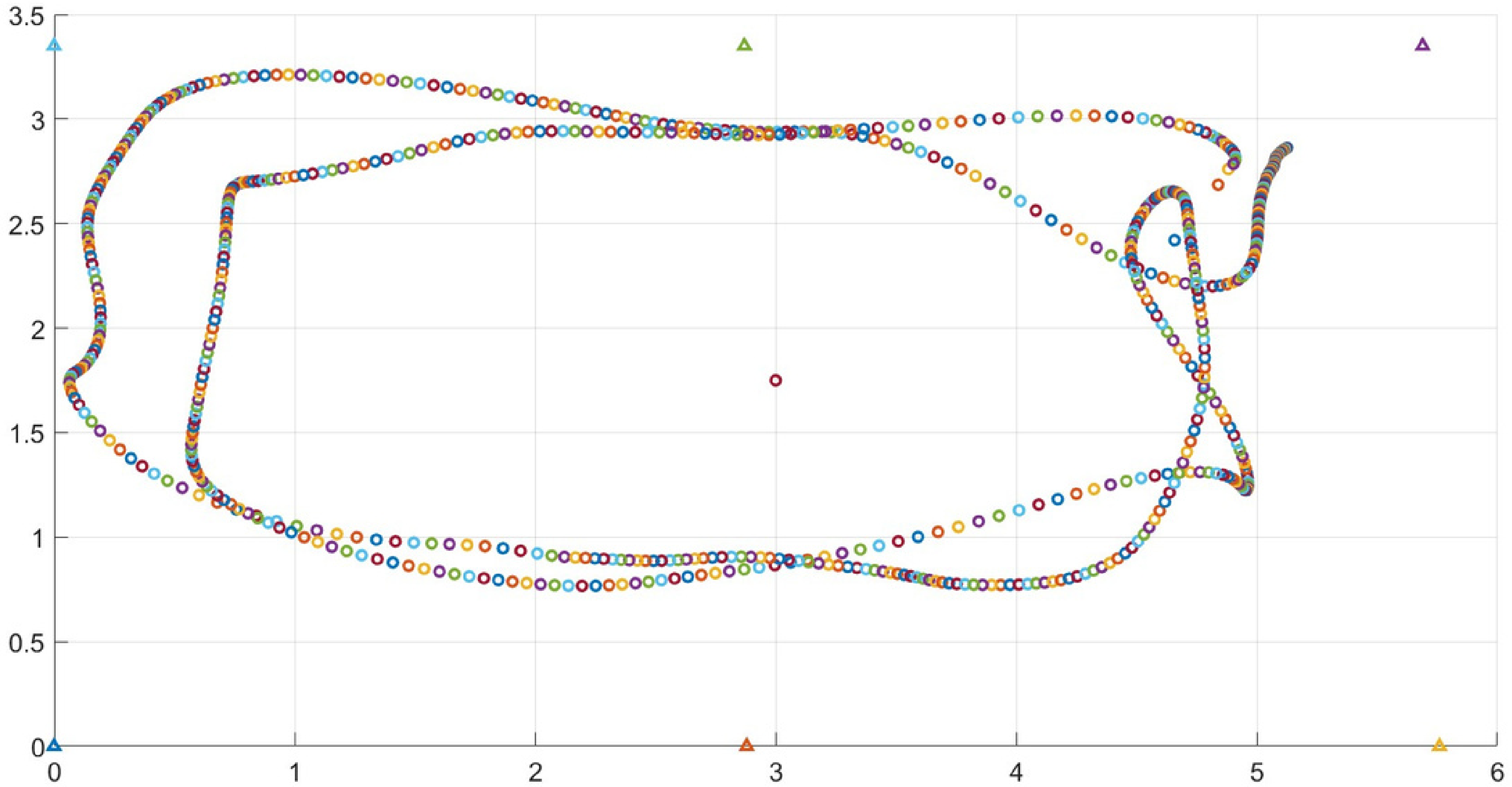
- Changing starting Position
- Changing starting Covariance
- Changing model

Processes tried that did work:

- Changing sigma_Driving

sigma_Driving changed from 0.1 to 0.05





Even though measurements are inside the expected room, an error of 0.05 m/s doesn’t seem reasonable