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Project #5. Tracking of a maneuvering vehicle

Team #1:

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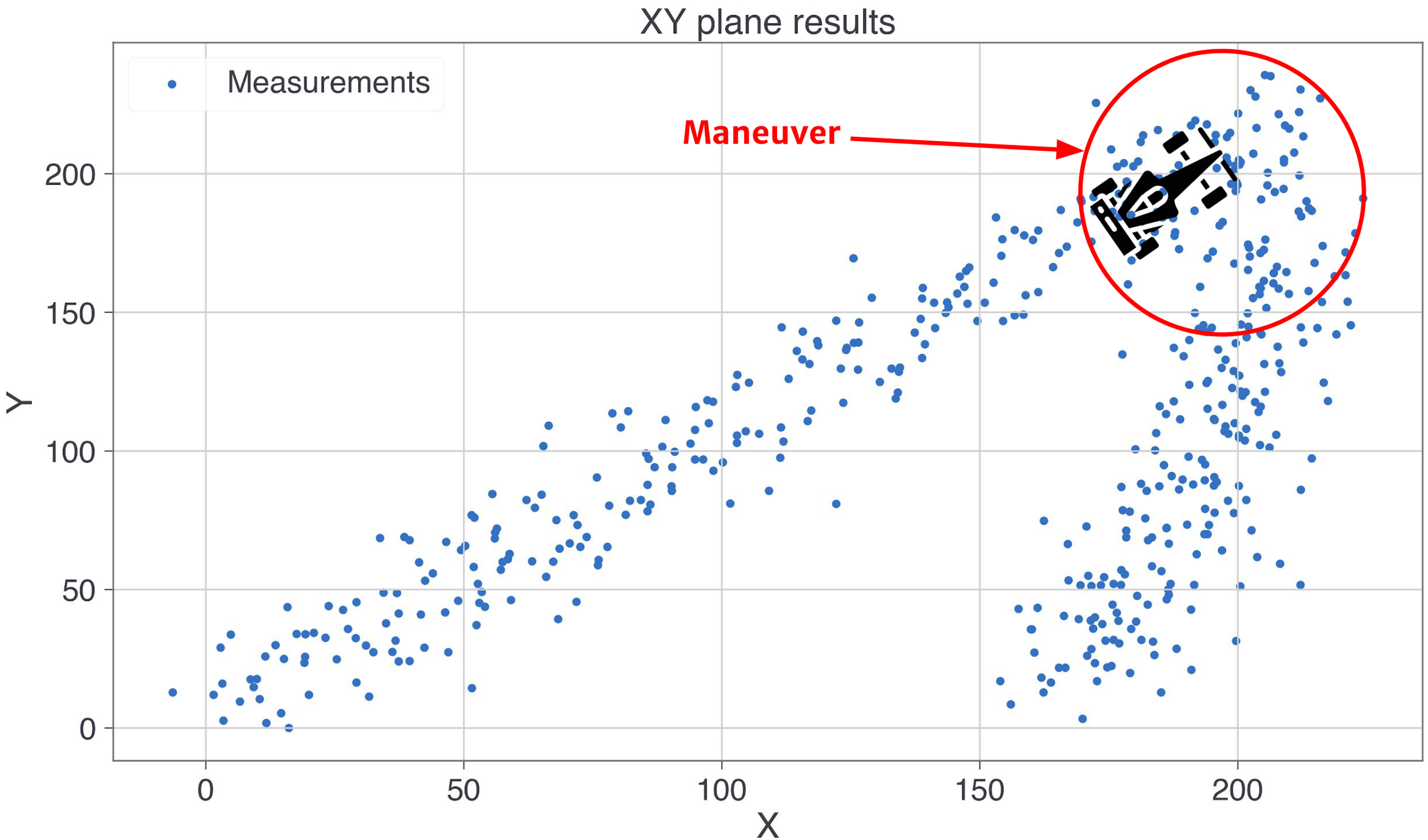
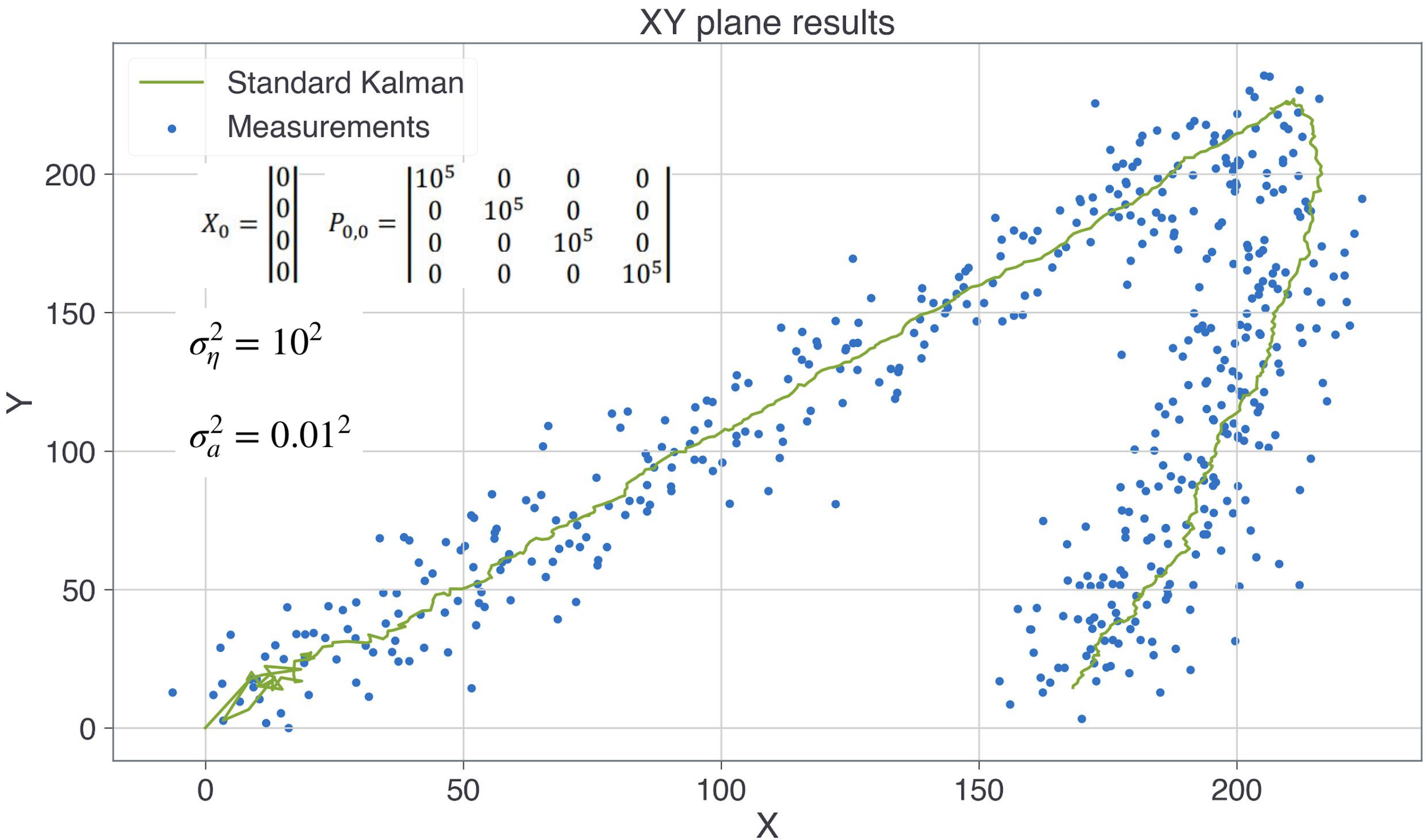
The problem

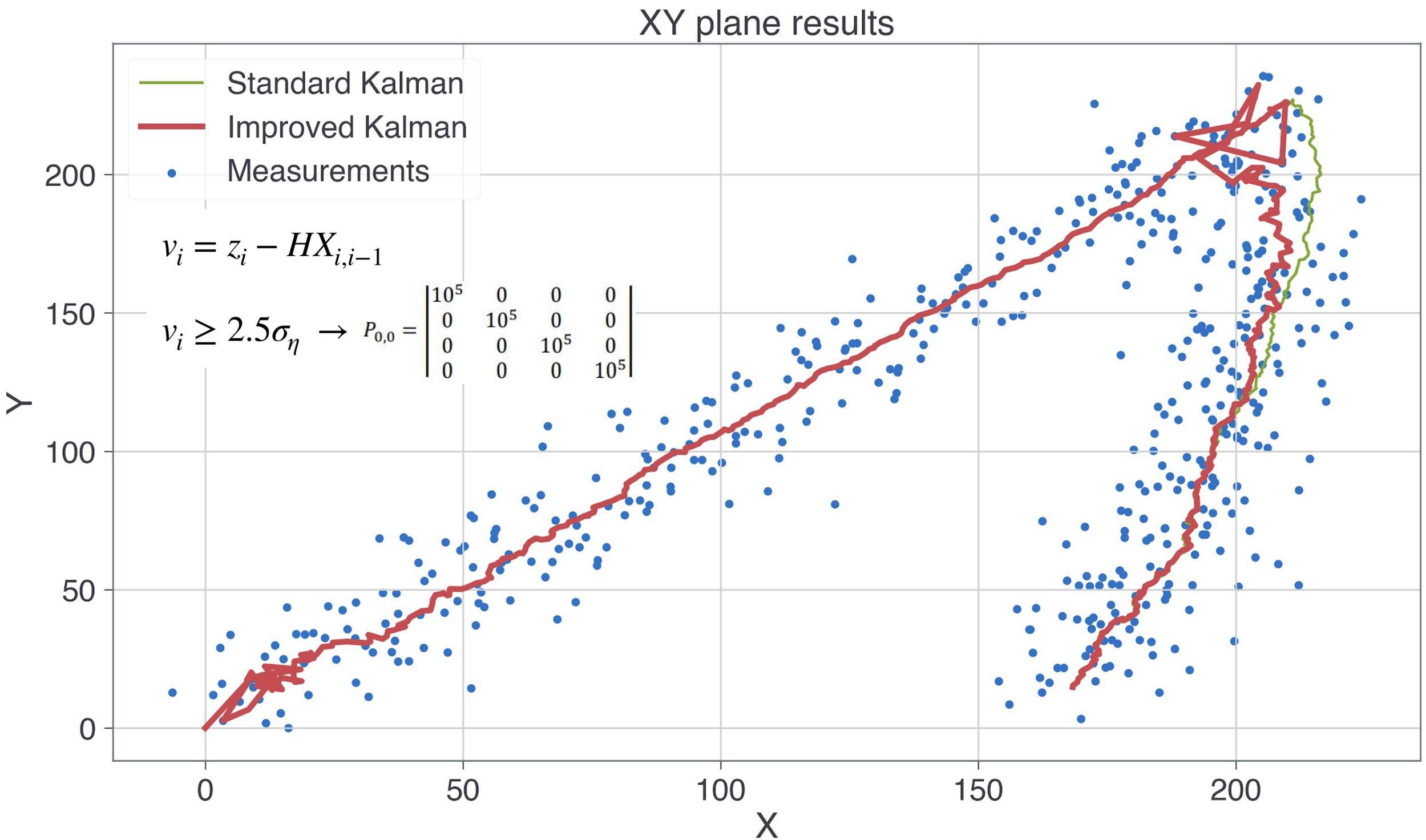
Trajectory measurements



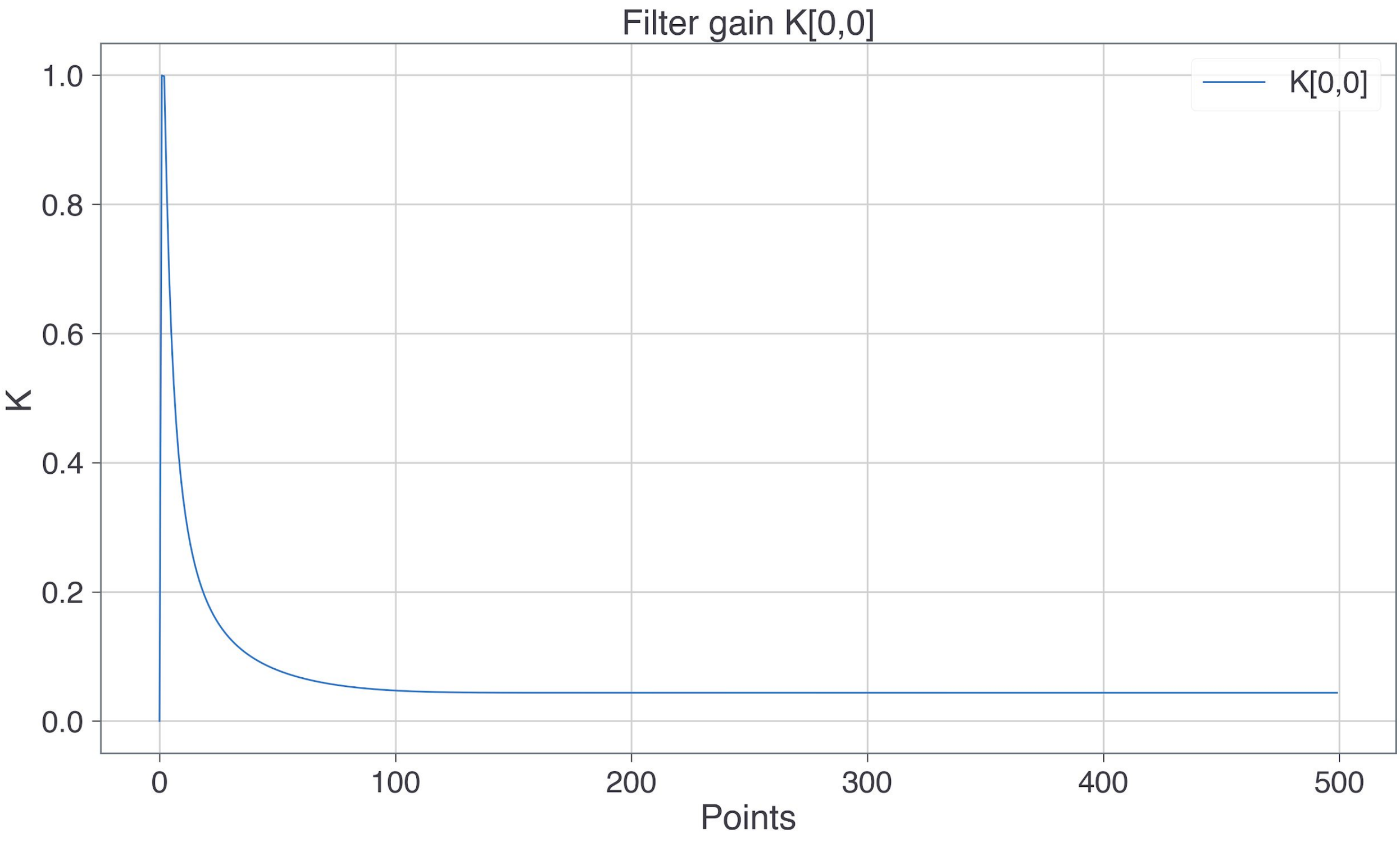
Trajectory measurements



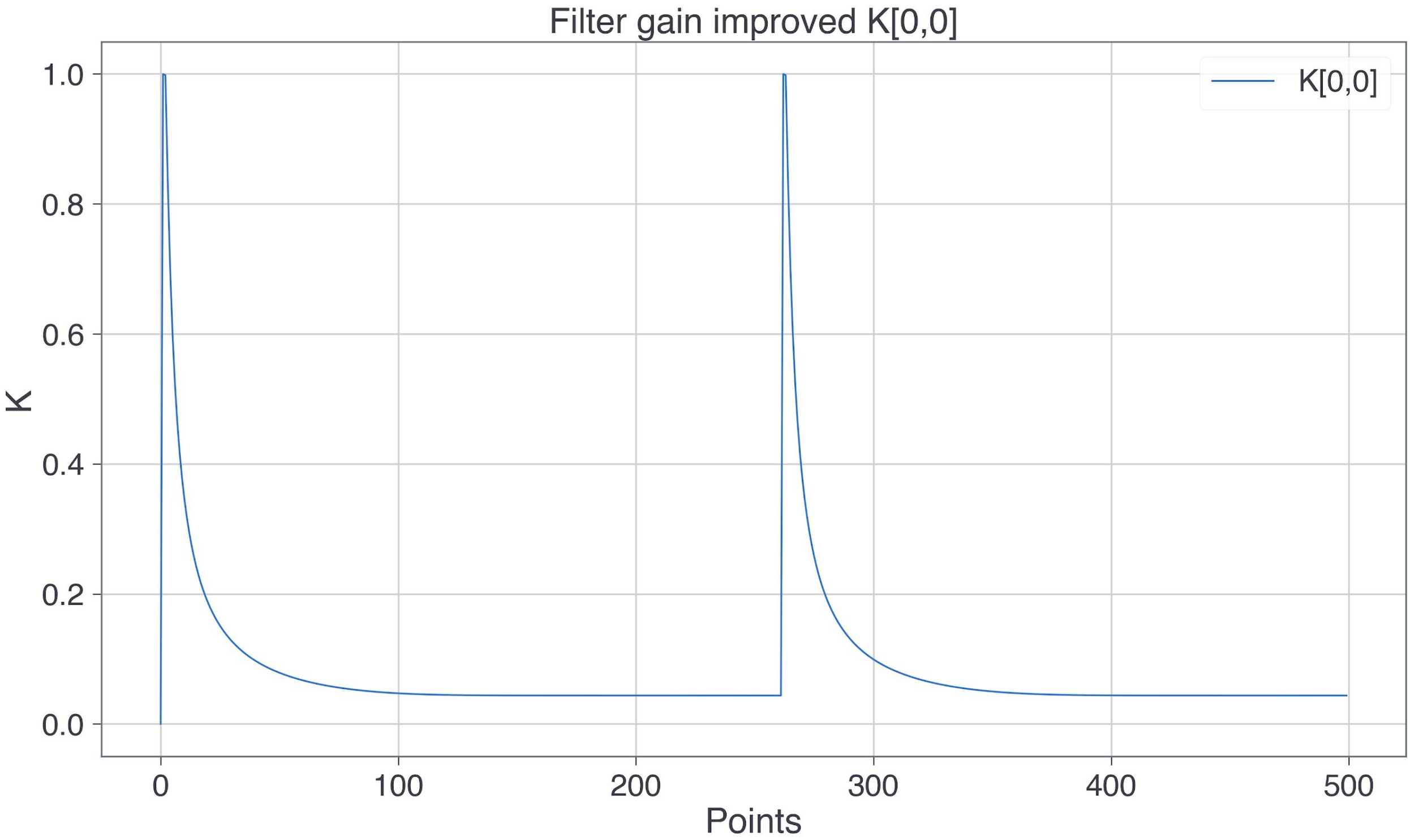
Trajectory measurements



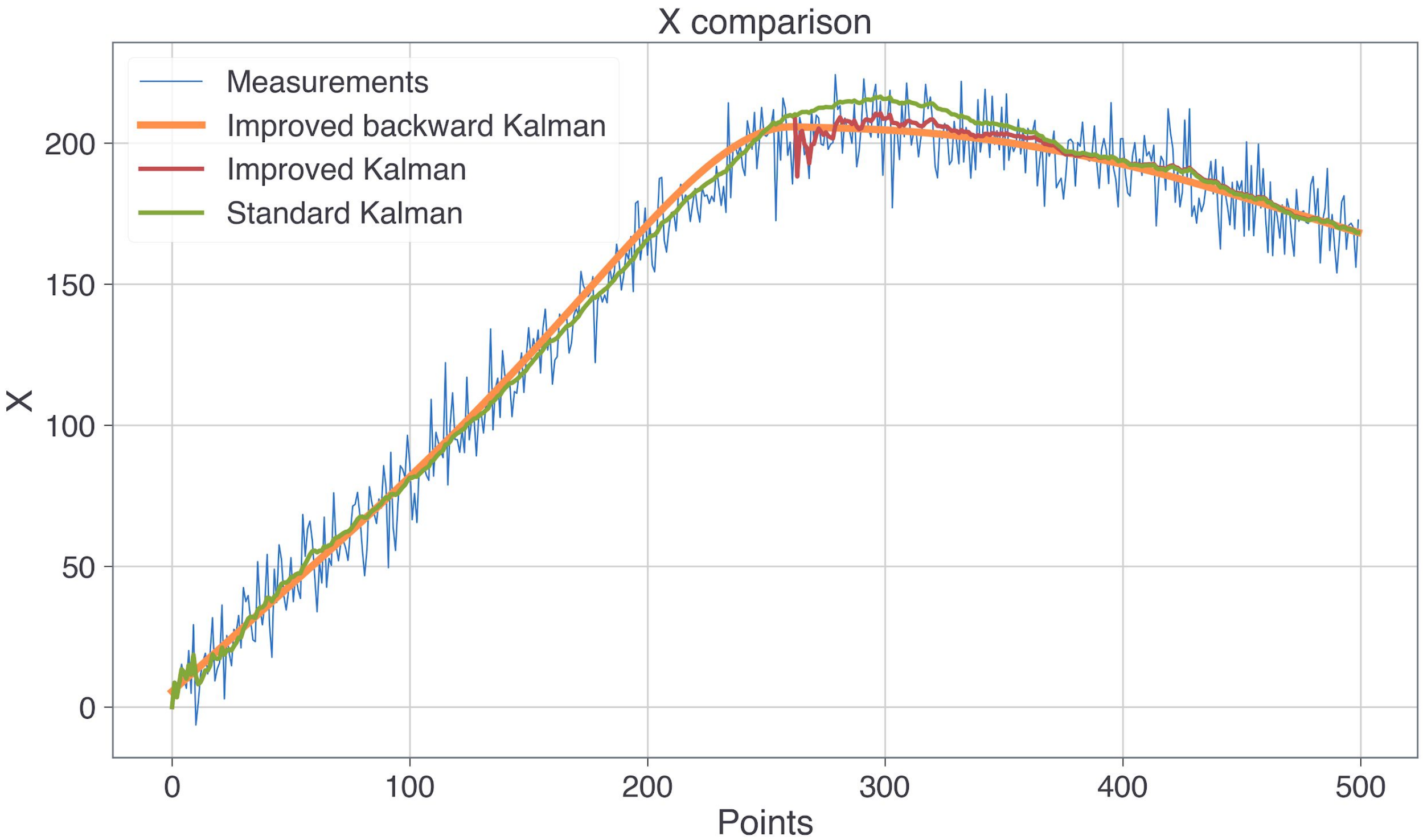
Trajectory measurements



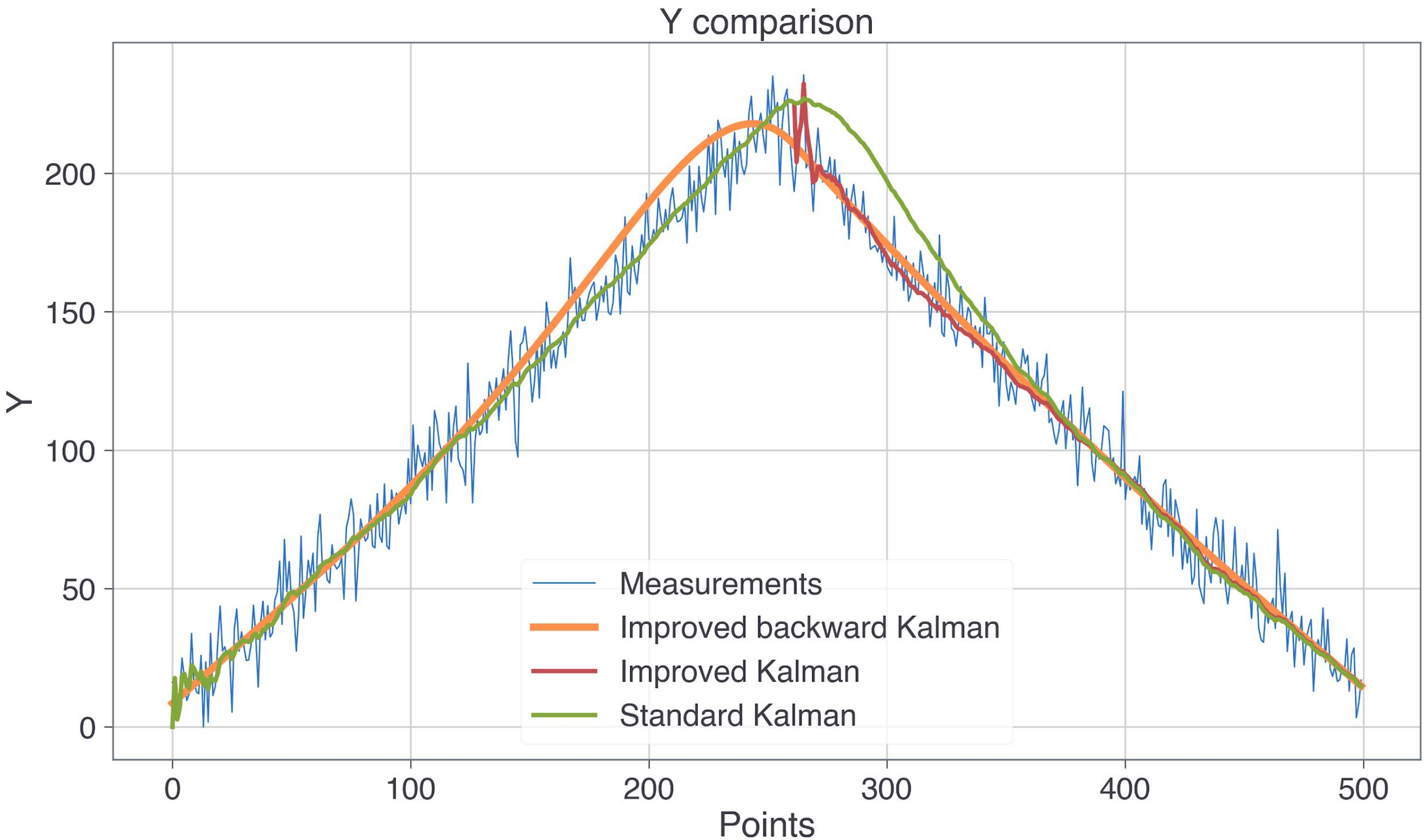
Trajectory measurements



Trajectory measurements



Trajectory measurements



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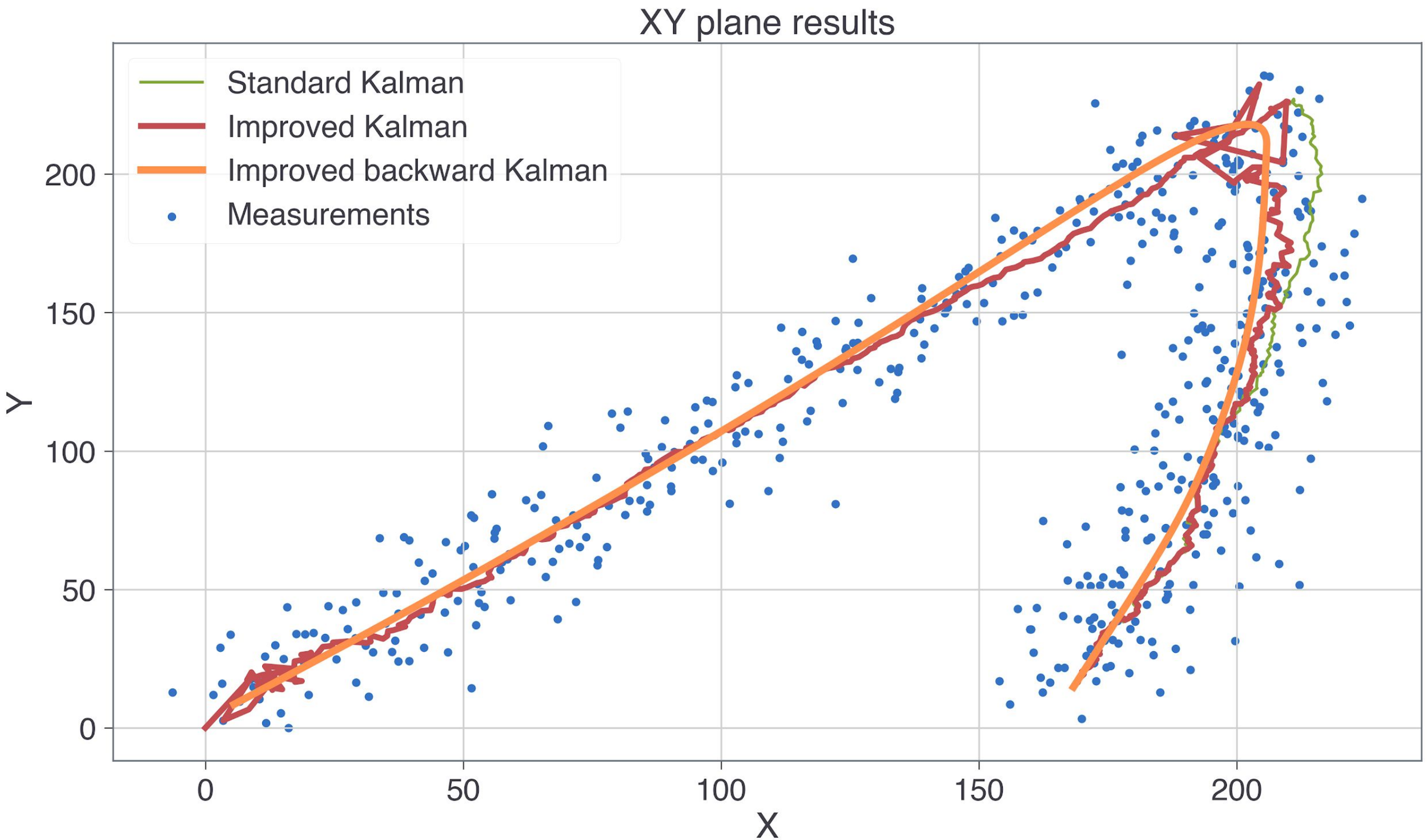
Trajectory measurements



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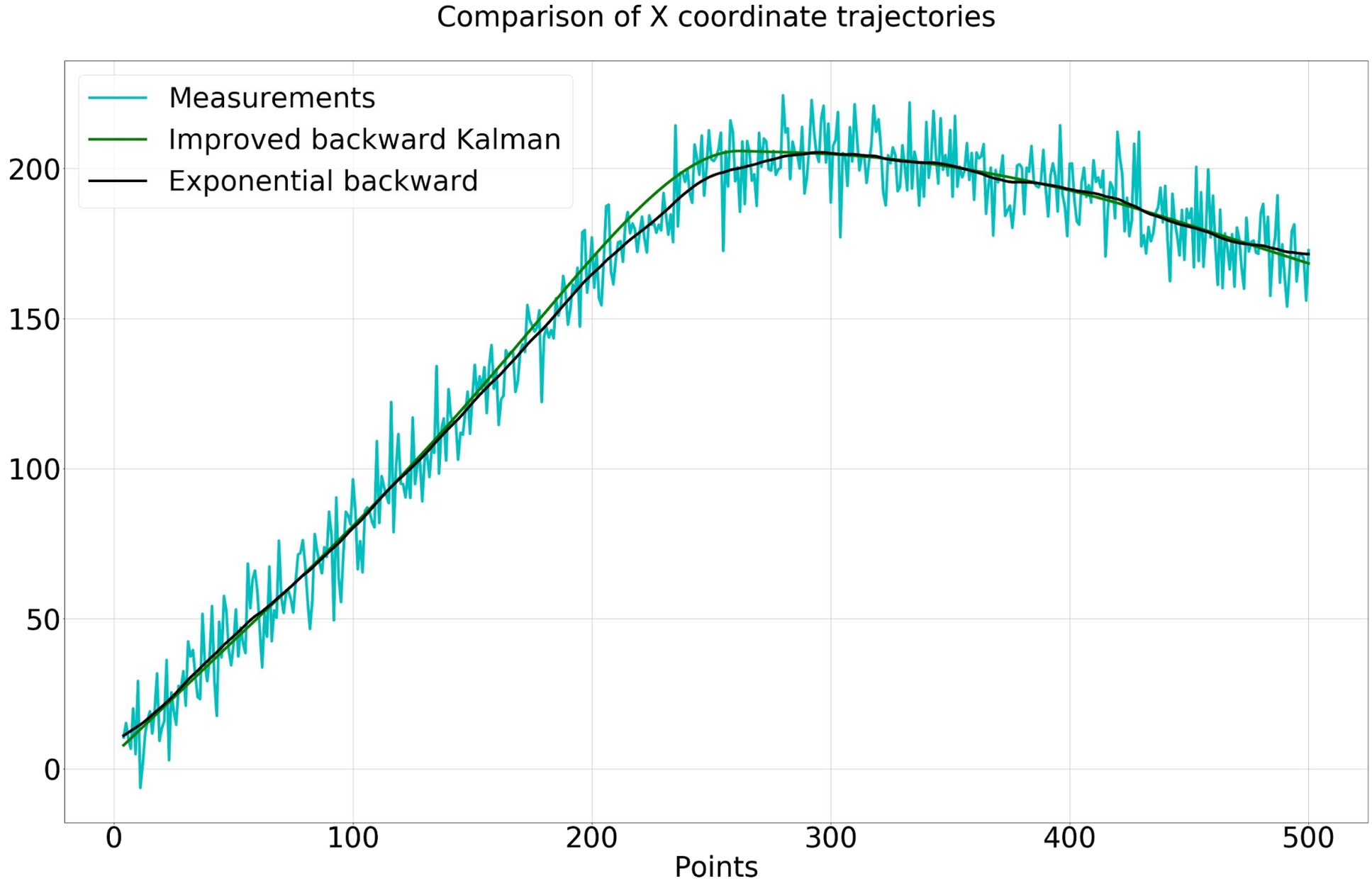
Why the chosen method is the best method

Visual analysis of considered methods



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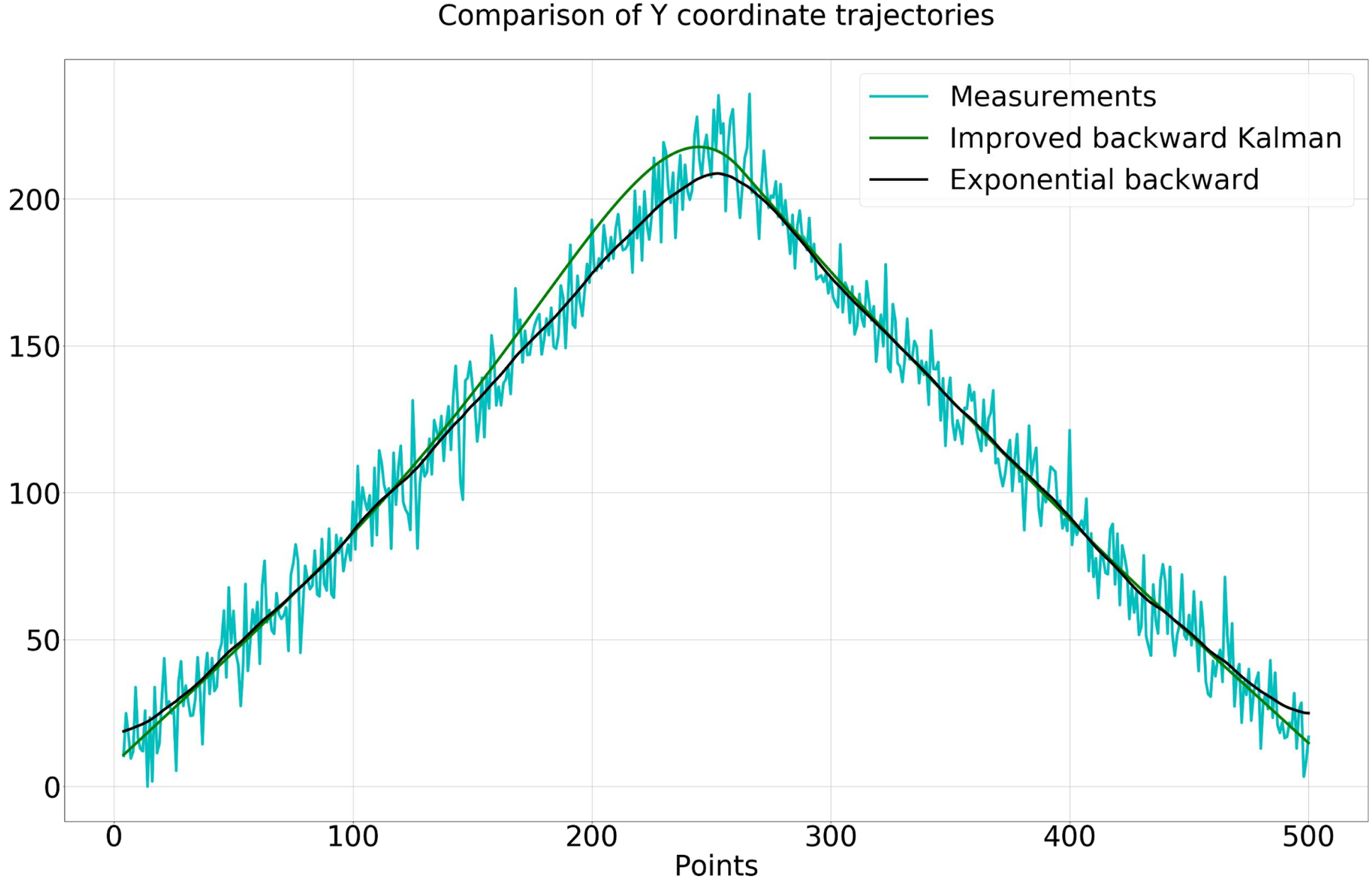

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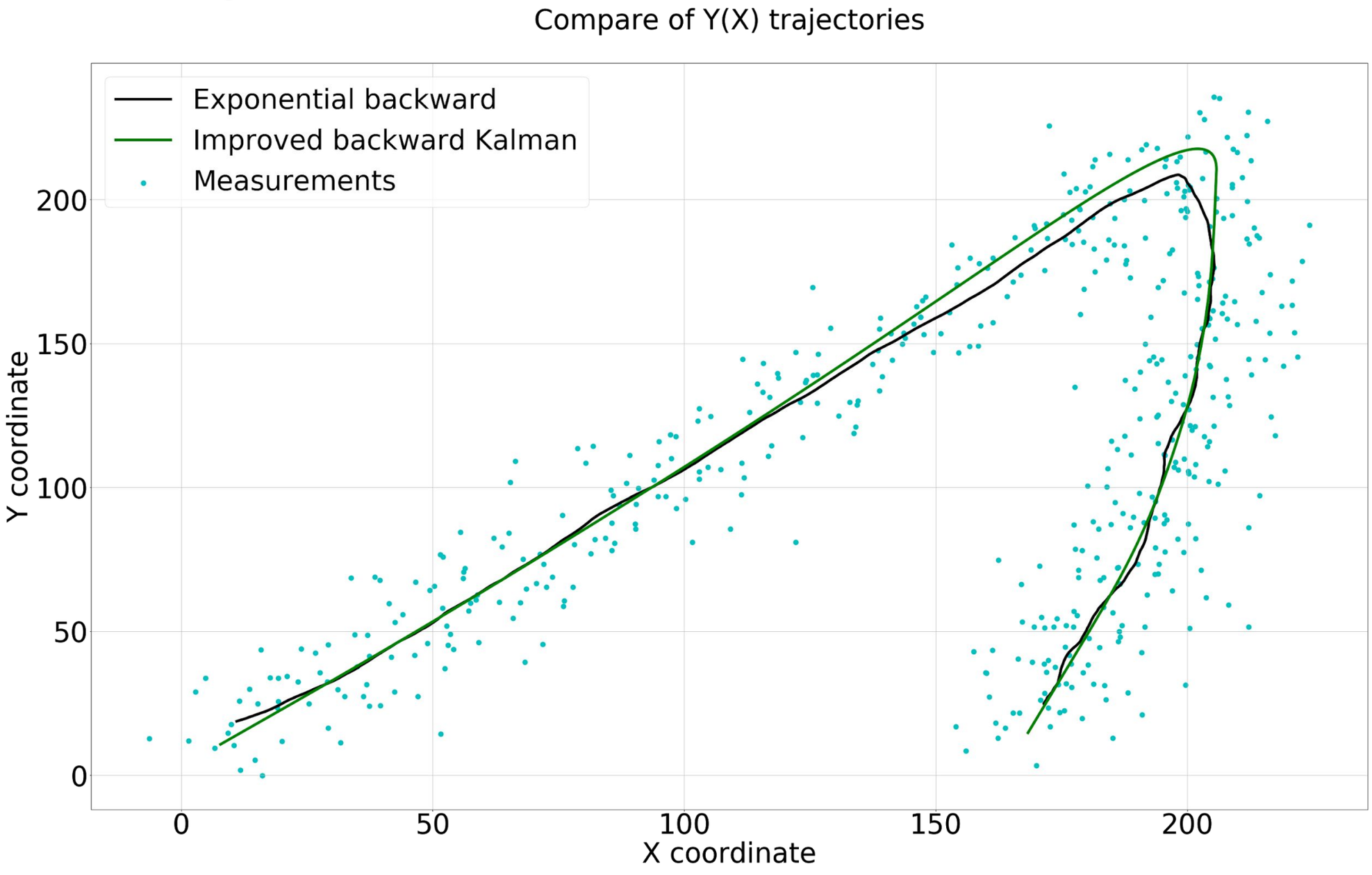
Visual analysis of considered methods



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Why the chosen method is the best method

Simplicity of implementation of the chosen method compared with others

Kalman filter

Extrapolation

Prediction of state vector at time i using i-1 measurements

$$X_{i,i-1} = \Phi_{i,i-1} X_{i-1,i-1}$$

Prediction error covariance matrix

$$P_{i,i-1} = \Phi_{i,i-1} P_{i-1,i-1} \Phi_{i,i-1}^T + Q_i$$

Filtration

Filter gain, weight of residual

$$K_i = P_{i,i-1} H_i^T (H_i P_{i,i-1} H_i^T + R_i)^{-1}$$

Improved estimate by incorporating a new measurement

$$X_{i,i} = X_{i,i-1} + K_i (z_i - H X_{i,i-1})$$

Filtration error covariance matrix

$$P_{i,i} = (I - K_i H_i) P_{i,i-1}$$

Backward smoothing

$$X_{i,N} = X_{i,i} + A_i (X_{i+1,N} - \Phi_{i+1,N} X_{i,i})$$

$$A_i = P_{i,i} \Phi_{i+1,i}^T P_{i+1,i}^{-1}$$

Smoothing error covariance matrix

$$P_{i,N} = P_{i,i} + A_i (P_{i+1,N} - P_{i+1,i}) A_i^T$$

Exponential smoothing

Forward exponential smoothing

$$X_i^f = X_{i-1}^f + \alpha (z_i - X_{i-1}^f), i = 2,...,N$$

Backward exponential smoothing

$$X_i^b = X_{i+1}^b + \alpha (X_i^f - X_{i+1}^b), i = N-1,...,1$$

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The risks of obtained results

- Wrong model for Kalman filtration (sometimes an acceleration can be biased)
- We can only assume kinematics of motion. We don’t know its dynamics, which can provide us a better knowledge of acceleration when a maneuver occurs.
- We have no information about true trajectory so we can’t compare estimated results with it.

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Conclusion

1. We tried quasi-optimal and optimal methods for a motion and compared them
2. More specifically, we can visually estimate an efficiency of our methods, and our chosen method has a quite decent accuracy in comparison with the potential true trajectory described by assumed motion