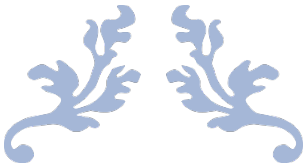

FINAL PROJECT

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The main goal of project part 1:

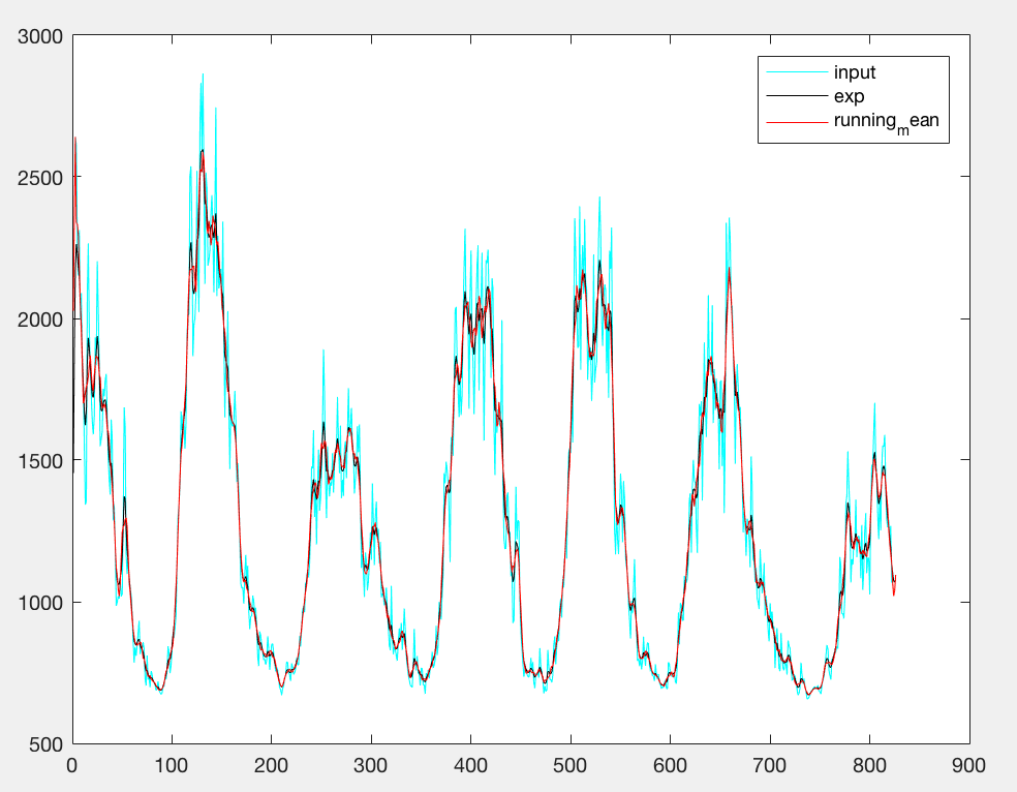
We need to choose best approximation method of given experimental data to reconstruct the dynamics of process. We apply such quasi-optimal estimation methods as running mean and forward-backward exponential smoothing compare them by deviation and variability indicator.

PART 1 Best approximation method:

First step is to find good parameters for our methods.
The best result according to indicators show such parameters:
Running mean:
7 points window.
var_indicator_mean = 1.2699e+06
dev_indicator_mean = 1.1493e+07

Exponential smoothing:
alpha = 0.45
var_indicator_exp = 1.0209e+06
dev_indicator_exp = 7.8541e+06

According to these indicators, we can consider that in our case Running mean shows probably better result. And running mean is very easy to implement.
Let's look at graphs



Both methods show good smoothing. And it is hard to choose the best by graphs.

After smoothing We can see quite stable fluctuating with approximate period 100 months

What is about risks?

We suppose, there is very low chance to make something wrong. First of all, methods are quite basic, and they are stable. So, We think if we use a couple of quasi-optimal estimation methods, it will be quite safety.

Part 2 Tracking and forecasting in conditions of measurement gaps:

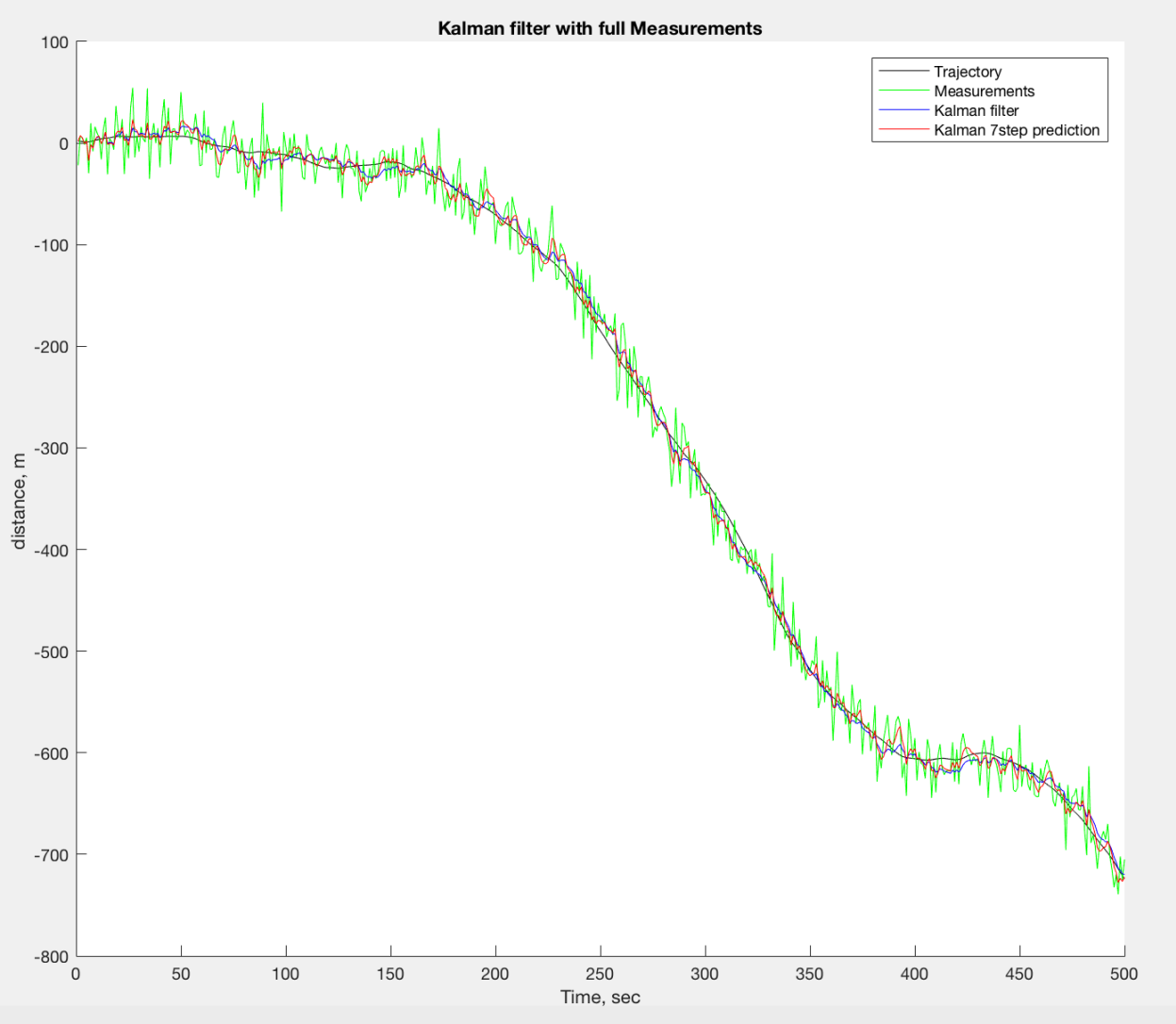
The trajectory of a moving object is disturbed by normally distributed unbiased random acceleration a_i with variance $\sigma_a^2 = 0.2^2$. In general measurements of coordinate x_i are performed every second with variance of measurement noise $\sigma_\eta^2 = 20^2$. Observation interval is 200 seconds. However, there are measurement gaps. Probability of measurement gaps is $P = 0.2$

Task 1: Develop Kalman filter to track moving object under this conditions.

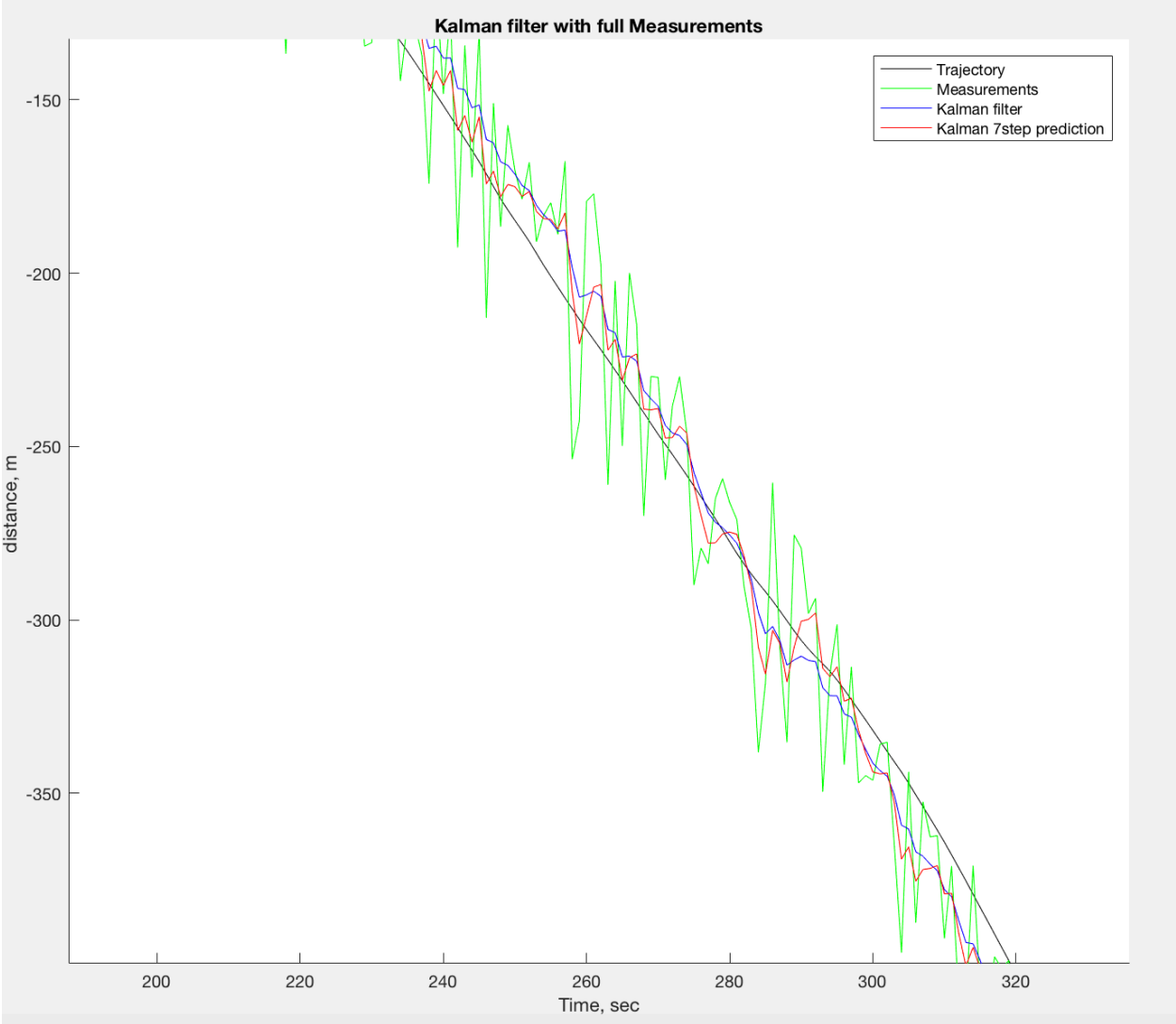
Task 2: Determine filtered and extrapolated errors of estimation (1 step and 7 steps ahead) over 500 runs of filter. Compare them with true estimation errors.
Task 3. Analyze the decrease of estimation accuracy in conditions of measurement gaps. Compare results when measurements are obtained without gaps.

We implemented everything together.

Firsltly lets look at graphs withou gaps at all.

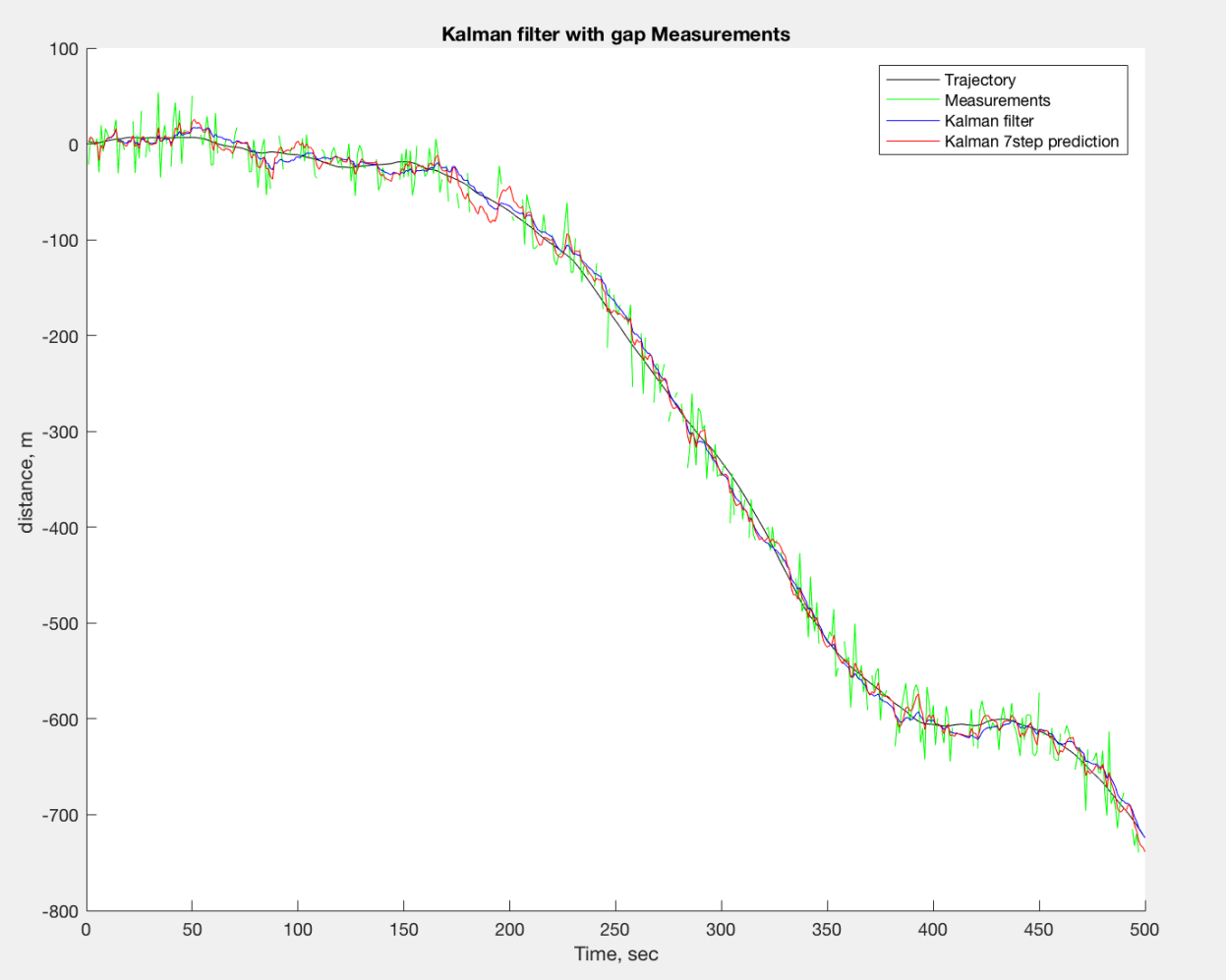


Zoom version:



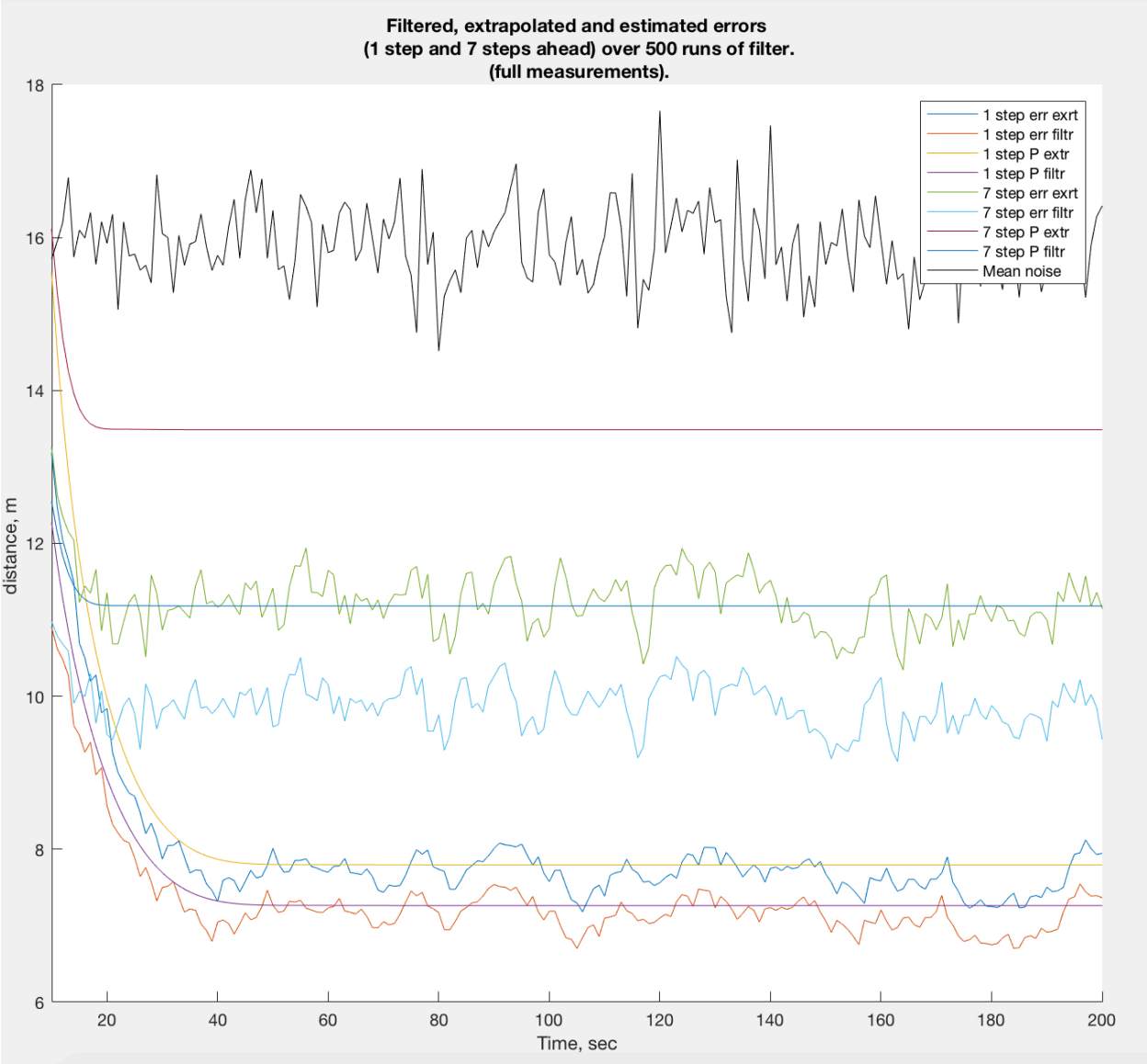
To be honest, It seems that 1 step filter shows better results according to graps.

Now look at graphs with gaps:



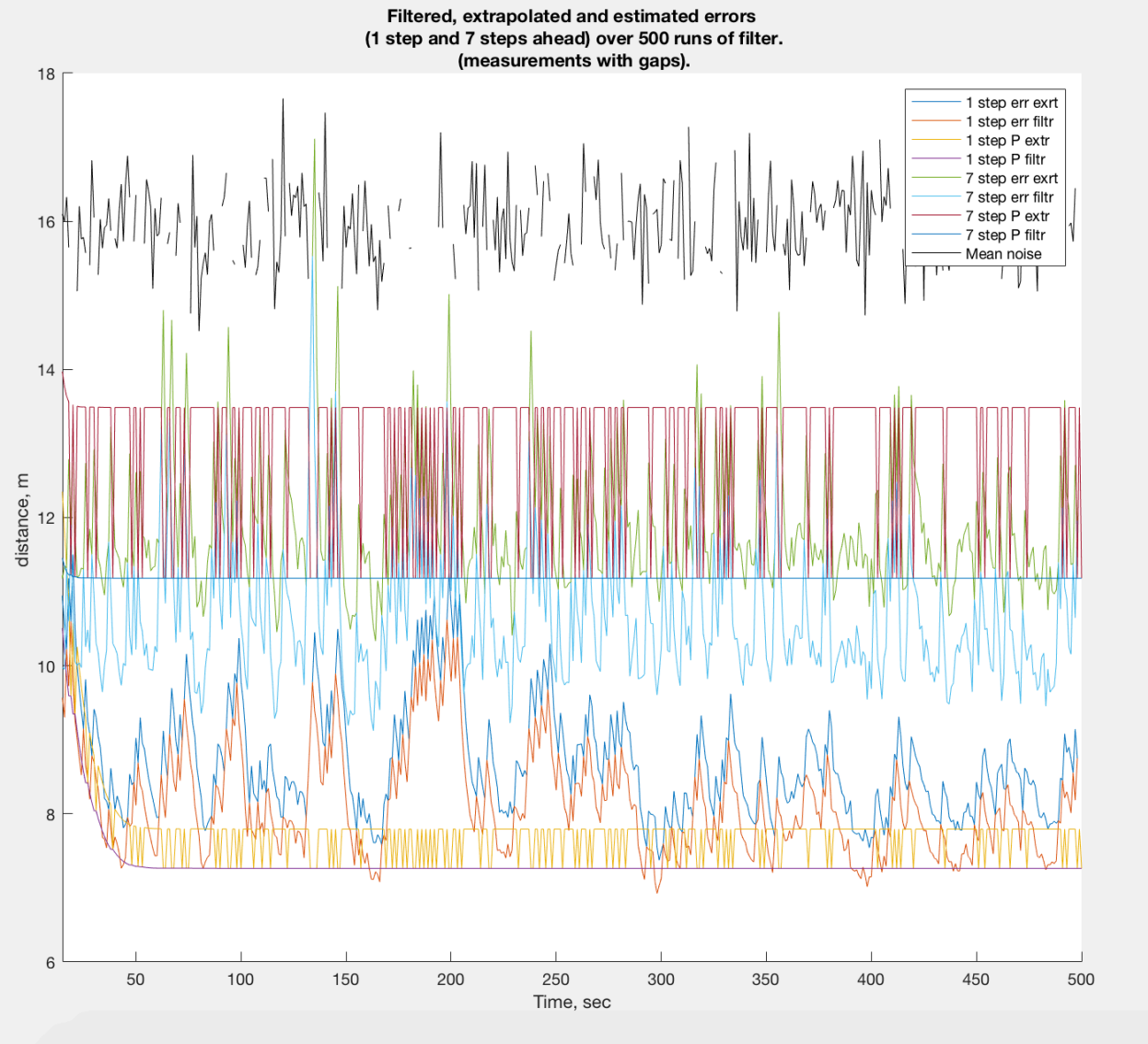
Gaps don’t affect on Kalman filter estimations a lot. We still see quite good estimations.

The next step is to calculate measurements errors



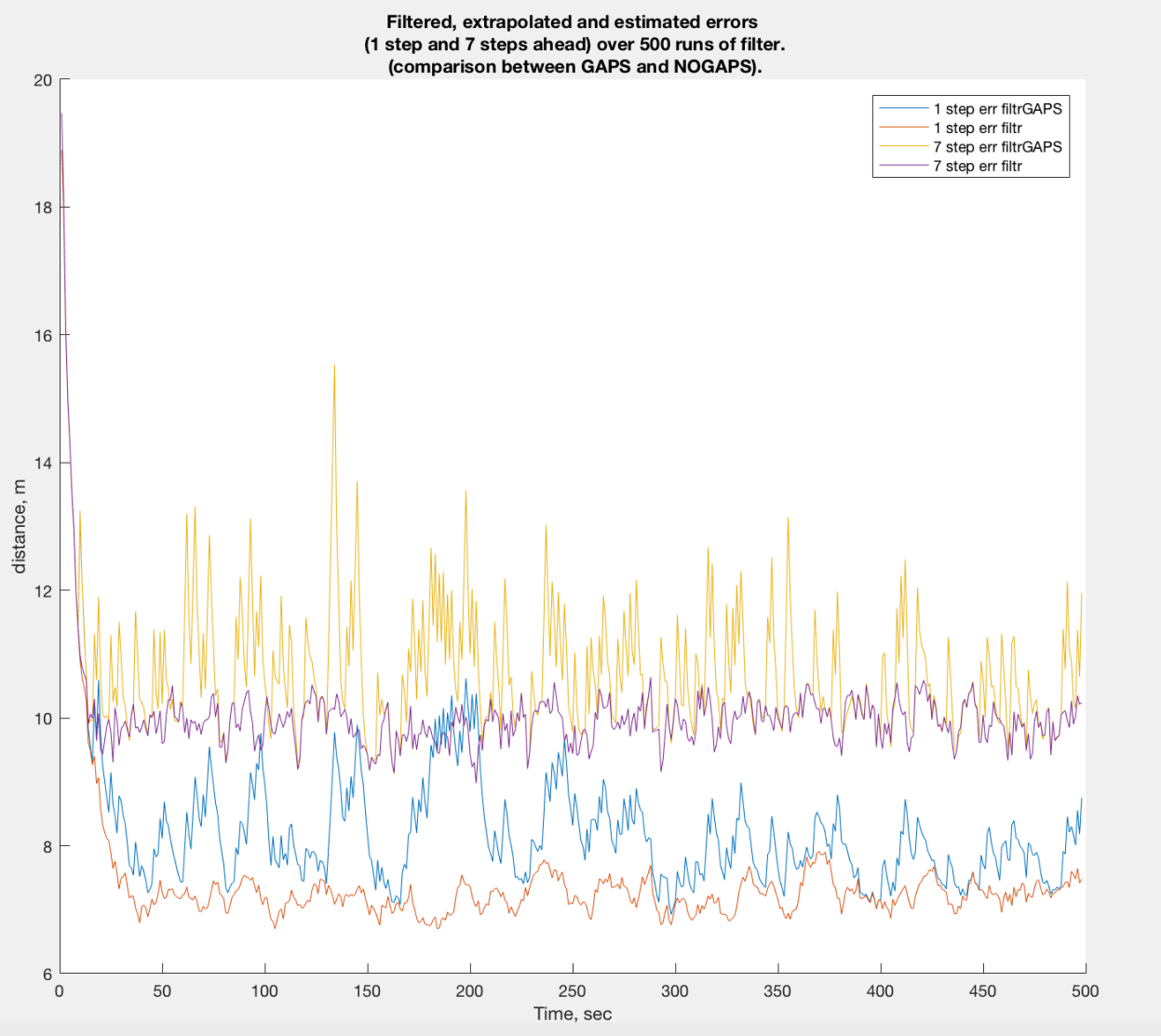
We can notice that mean noise is much higher than other errors. And one step shows nice results!

Now look at the same graphs with gaps:



Errors of all methods are more fluctuating than without gaps.

The last picture.



The last picture clearly provides conclusion to our work:

1) One step is better than 7 steps.
2) Gaps makes filtrating worse.
3) Gaps significantly increase fluctuating of error.

Our code you can find at https://github.com/Bandd-k/FinalProjectSpaceData/ourFinal.mlx