Homework 7 – Bursting Phenomenon

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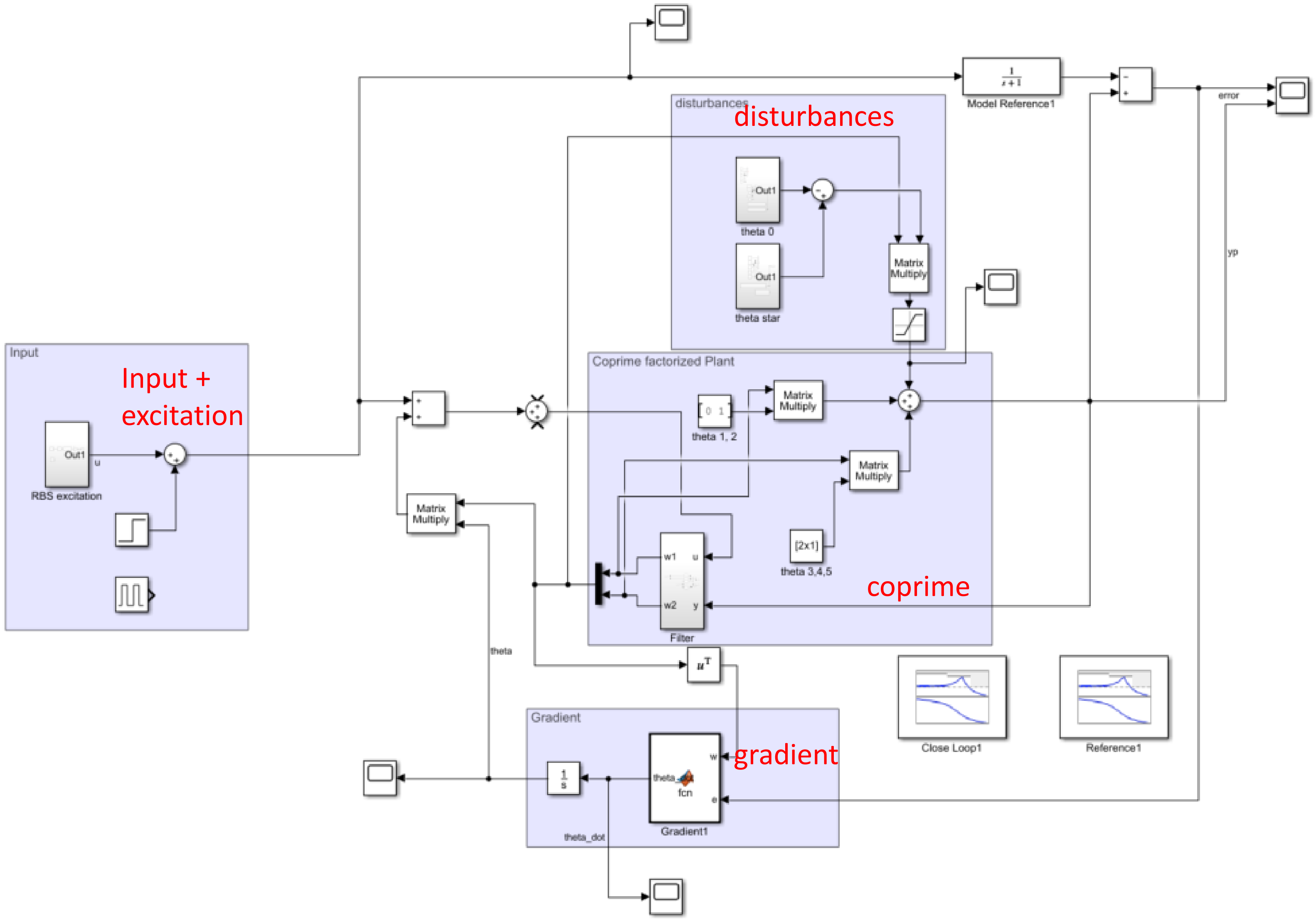
Control Objective

- Given reference signal, design an adaptive controller to track it.
- Simulate bursting phenomenon given disturbances.
- Ensure stability with presence of disturbances

System setup – MRAC with coprime factorization and input disturbances

- Plant: $\frac{1}{s^2+0.2s+0.01}$
- Reference plant: $\frac{1}{s+1}$
- Small excitation signal: Random Number within [-0.1, 0.1]



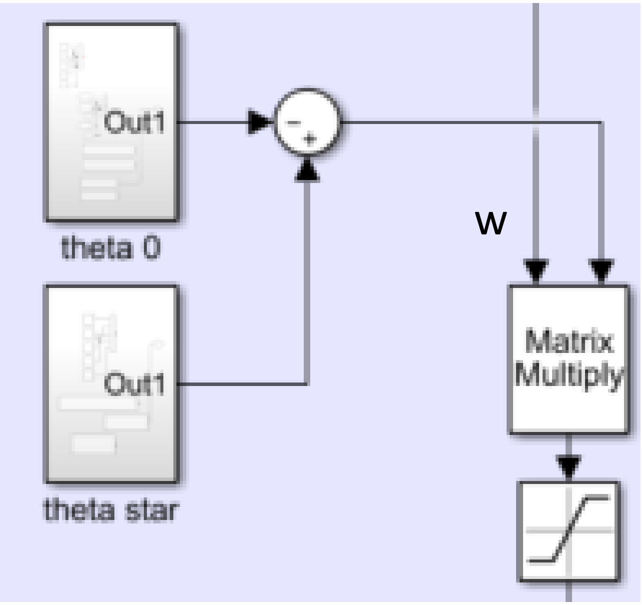
Disturbance design

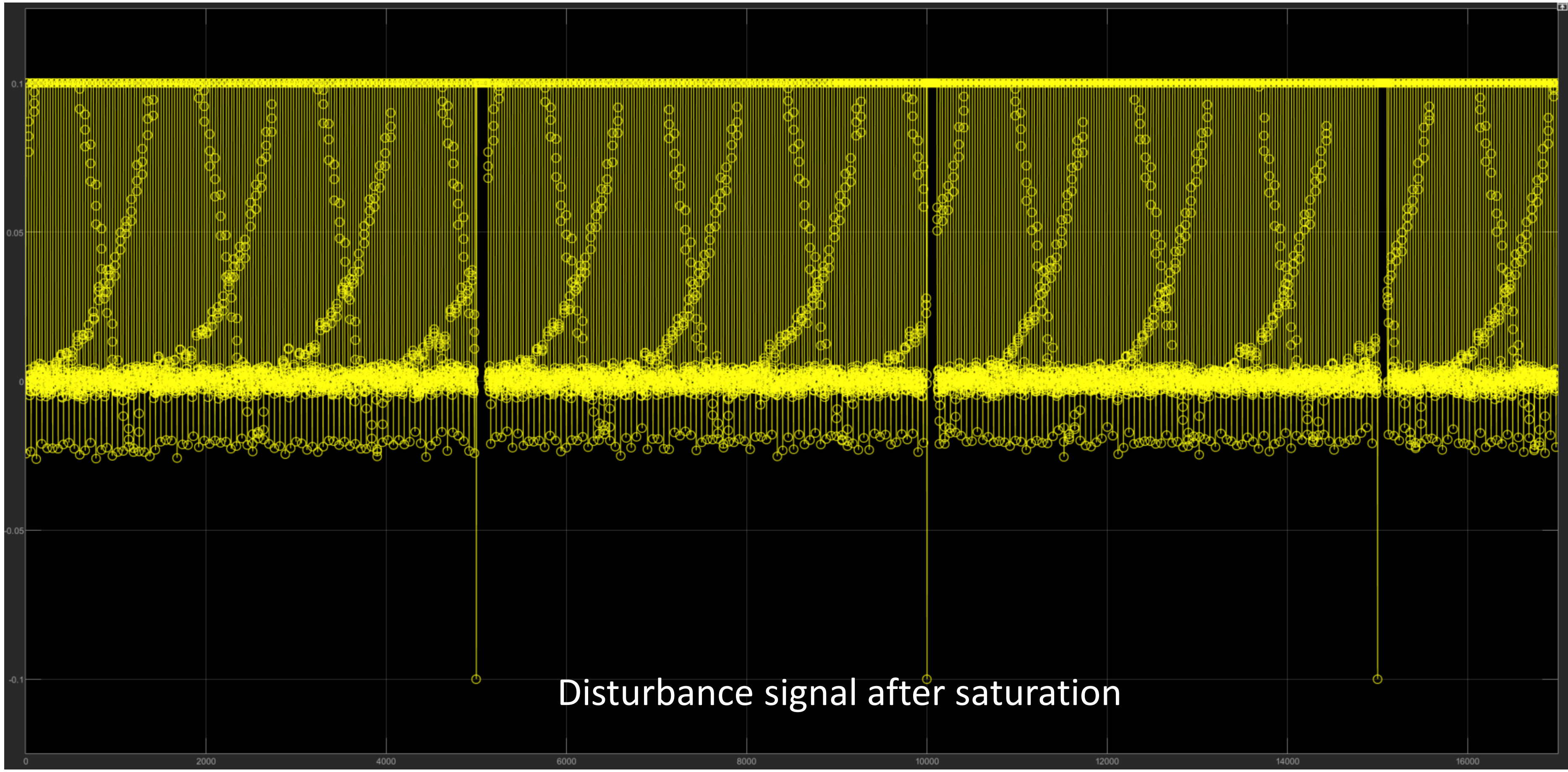
We design the disturbances from the following:

theta_star: [0 1 0.2 0.01]

Theta_0: [0 0.8 0.5 0.01]

Saturation: 0.1





Disturbance signal after saturation

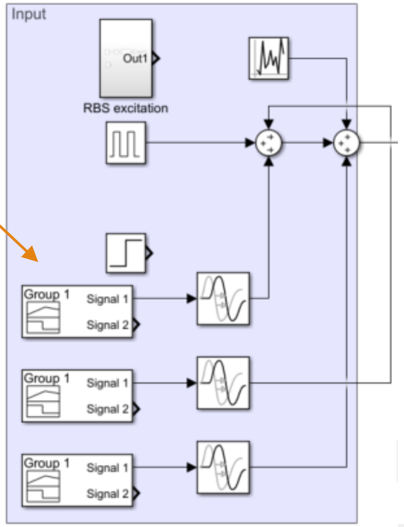
Parameter drifting

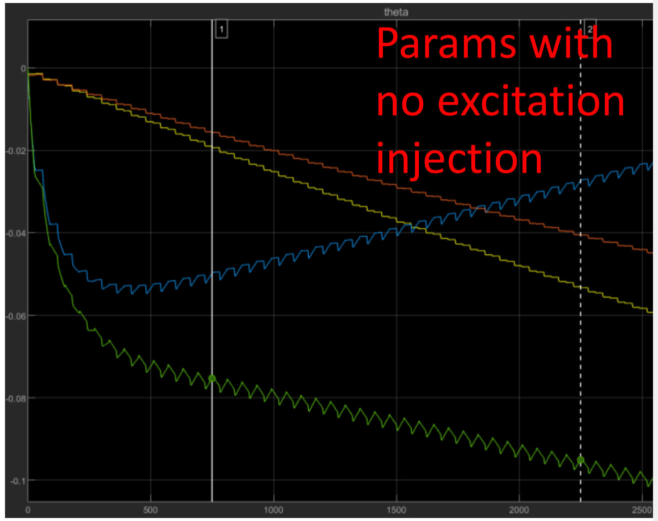
To simulate burst phenomenon, we need the parameters to start drifting

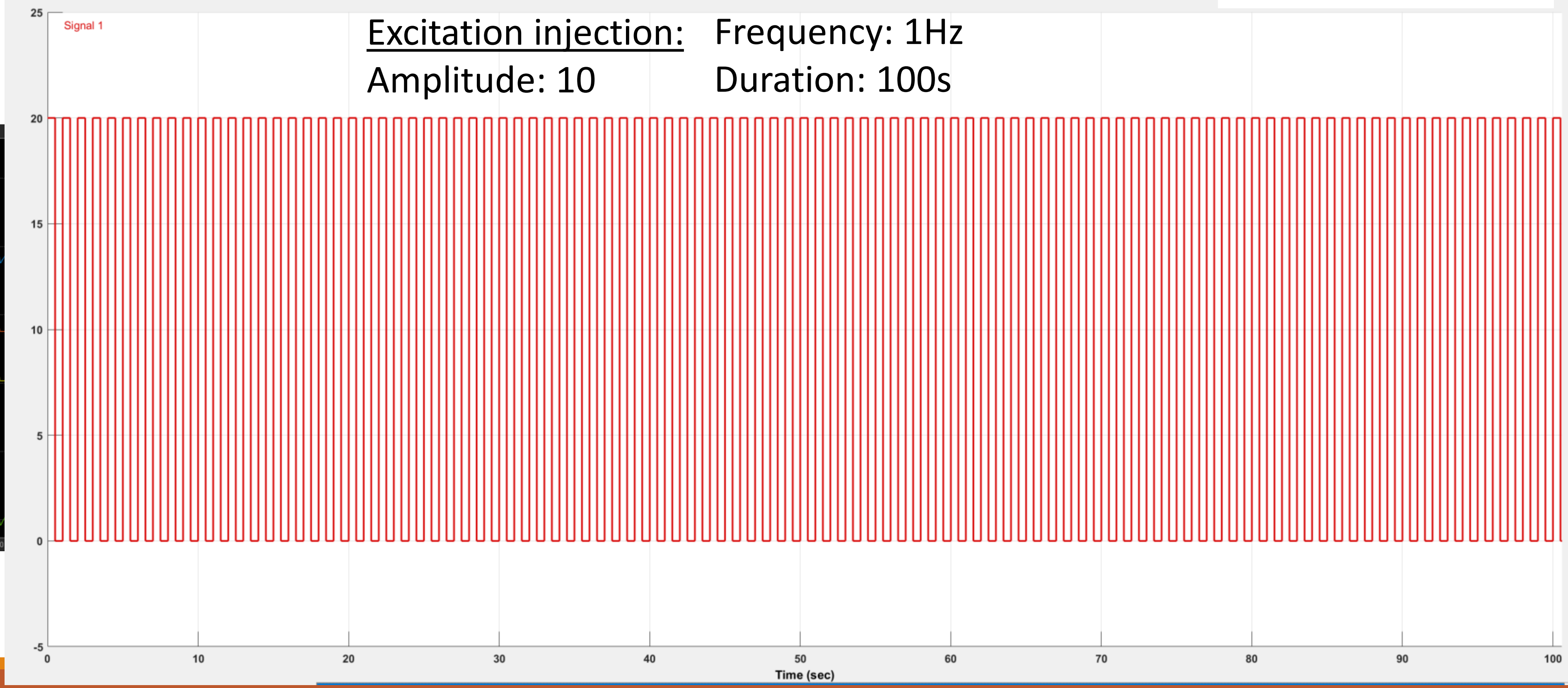
Then we inject higher order excitation than the original one to pull the parameter back

Excitation injection should be in O(1), versus the small excitation in O(δ)

Excitation signals



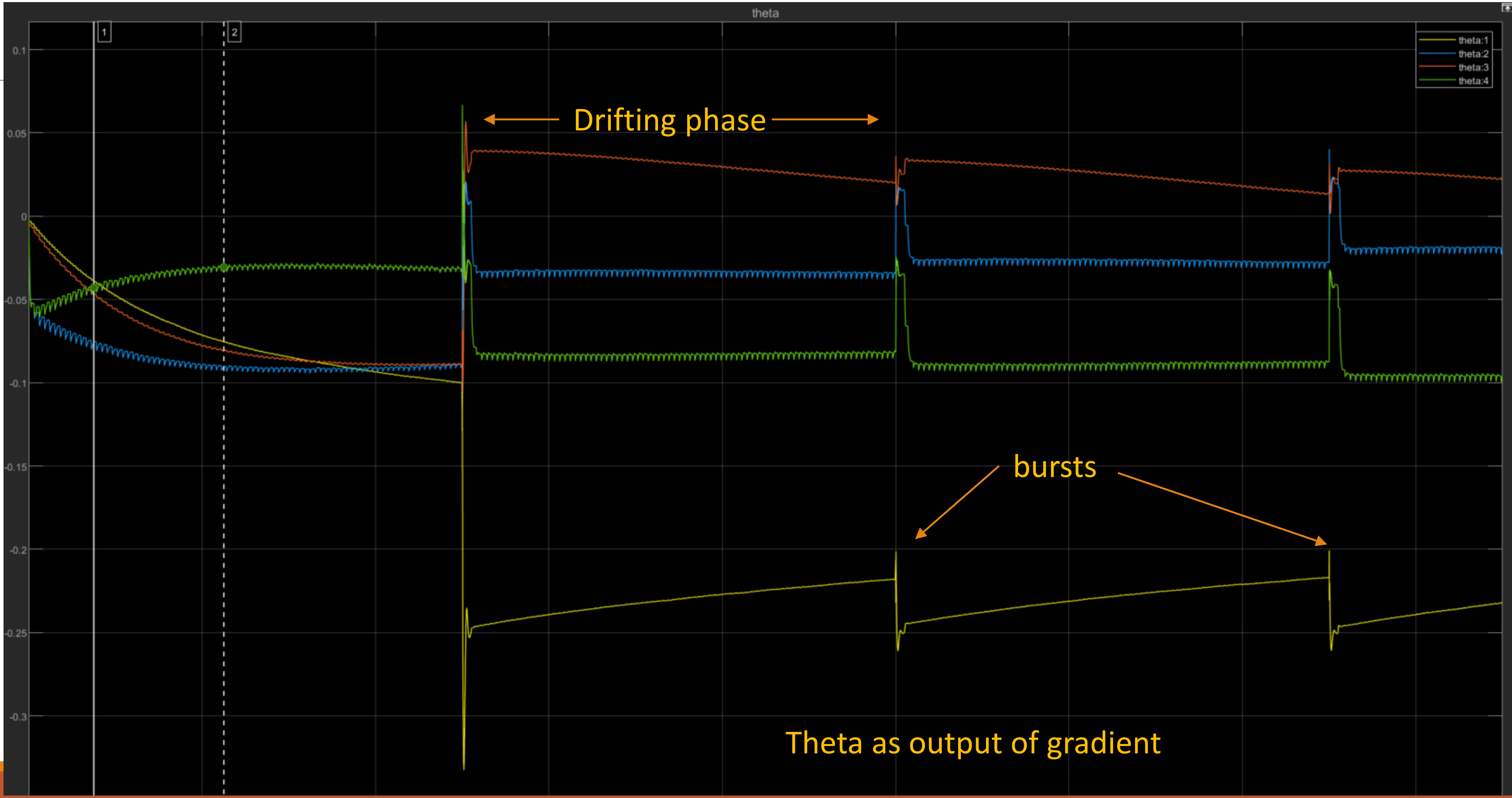




Burst Phenomenon

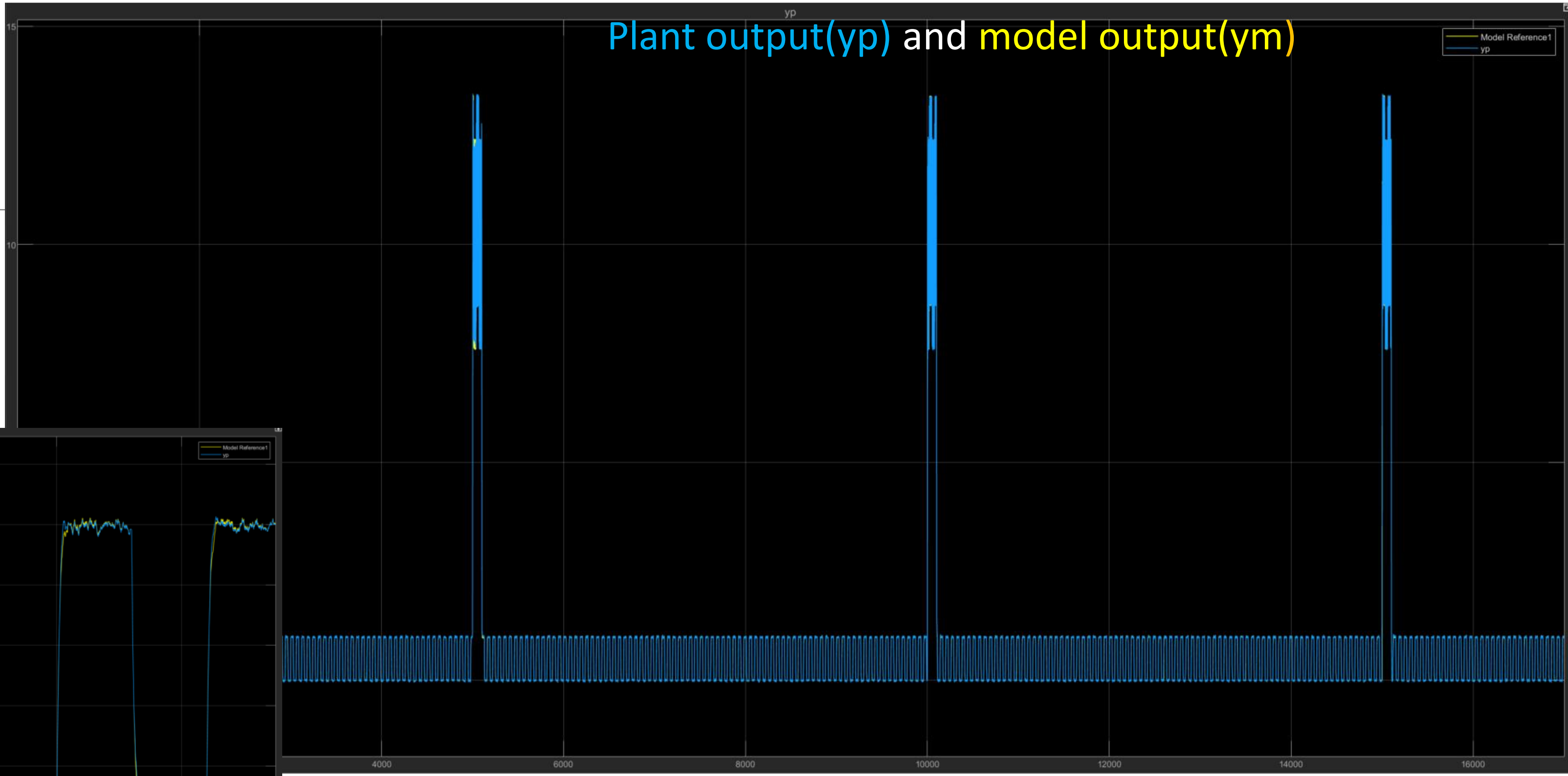
The simulation was ran for 17000 seconds. Excitations were injected around t = 5000, 10000, 15000.

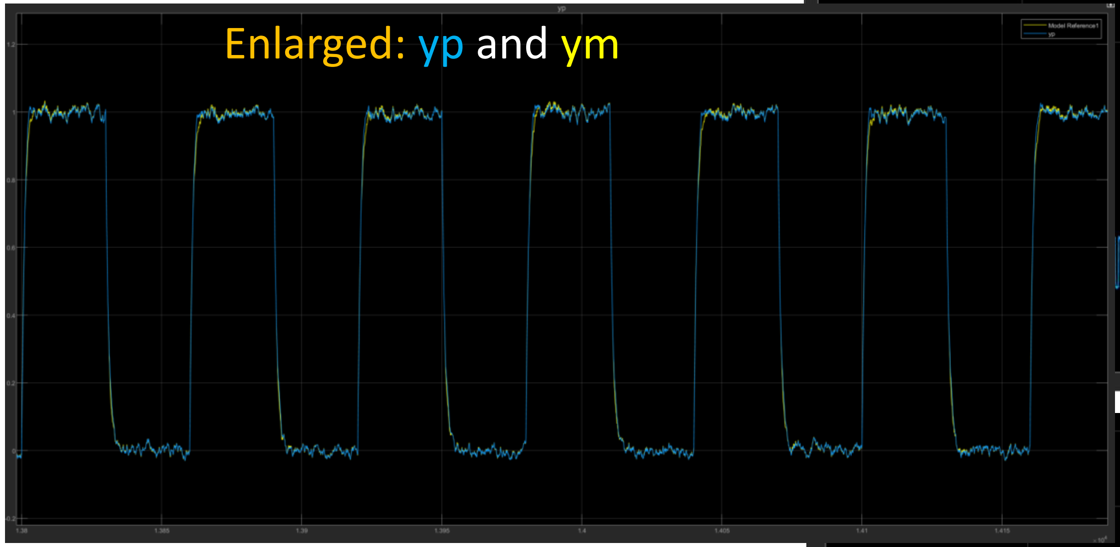
The plot shows that the parameter quickly converge to a value given a large excitation injection.
The parameters were left untouched for the first 5000 seconds to observe its behavior. After that, periodic injections were introduced when parameters reach certain parameters.

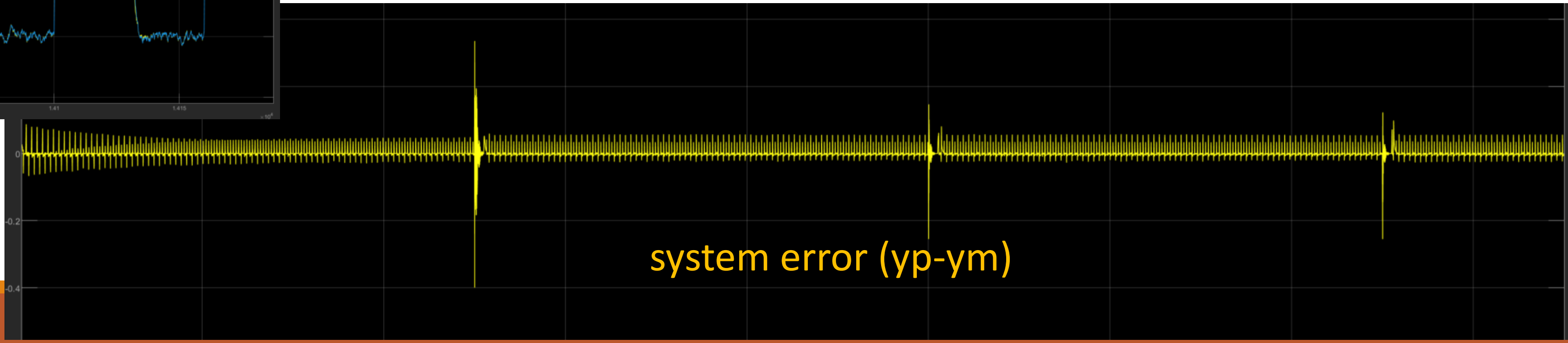


System output

From the graph we can see that the plant output converges to model output with reasonable errors given small excitation. Common sign for bursting phenomenon which is spikes in system error (which should be O($\theta^* - \theta_0$)) is also present as shown.







We can see the error spikes during the bursting phase.

Summary

- To simulate burst phenomenon with less trial and error, coprime factorized plant was implemented to inject disturbances with the source of parameter deviation.
- The parameters quickly converged to a set of parameters when large excitation signals were injected.
- Signs of a bursting phenomenon were captured in the system error