

Increasing the load-cycling capability of large coal-fired steam generators using online coal dust measurement and state controller

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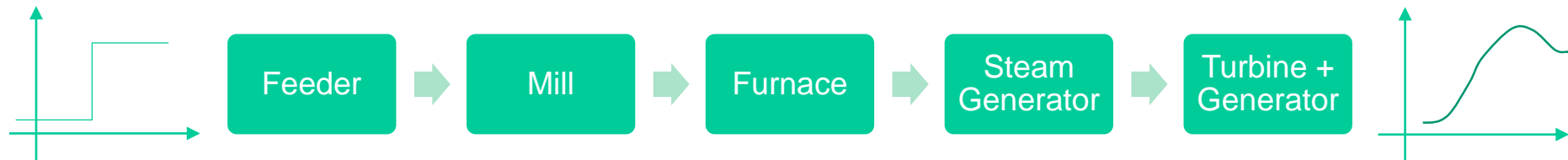
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Introduction

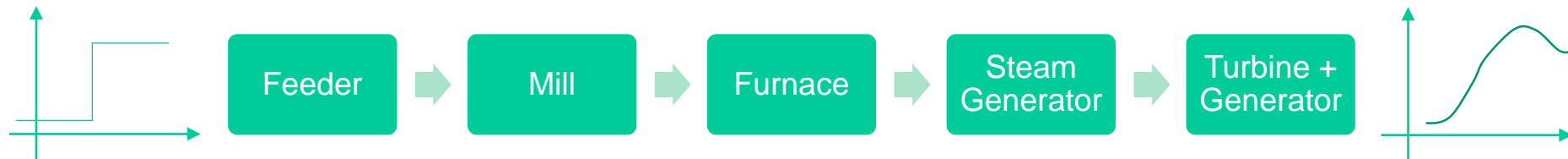
- In Germany the intermittency in the electrical grid is mainly compensated for by coal fired power plants.
- That increases the requirements for primary and **secondary control reserve** in these plants.
- This presentation shows how that was accomplished at the Uniper coal fired power plant in Wilhelmshaven.

Model of a Coal Fired Power Plant



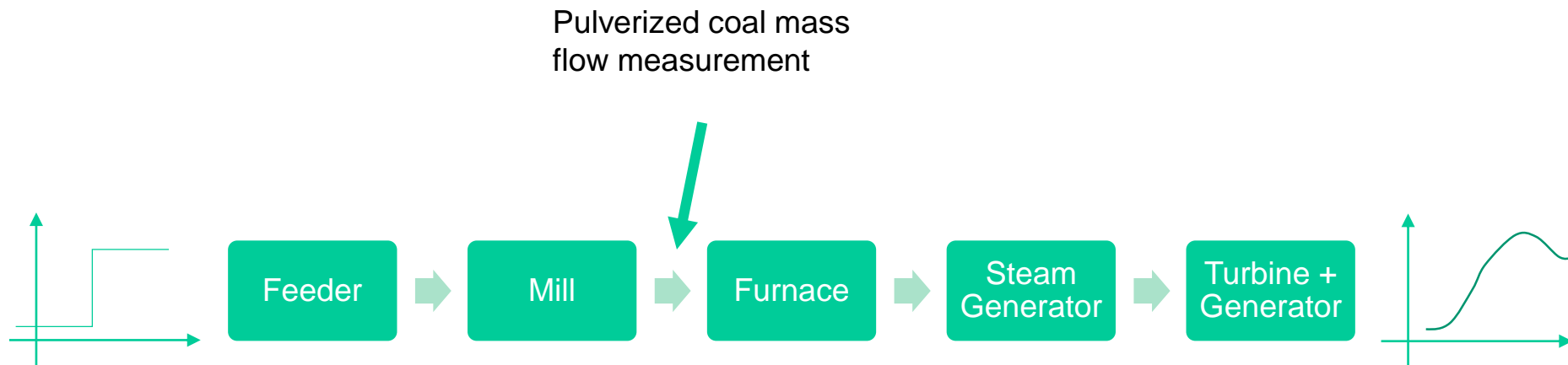
- Traditionally PI power correction controllers with feedforward are used.
- Here a state controller approach was applied to mitigate the time variance.

Model of a Coal Fired Power Plant



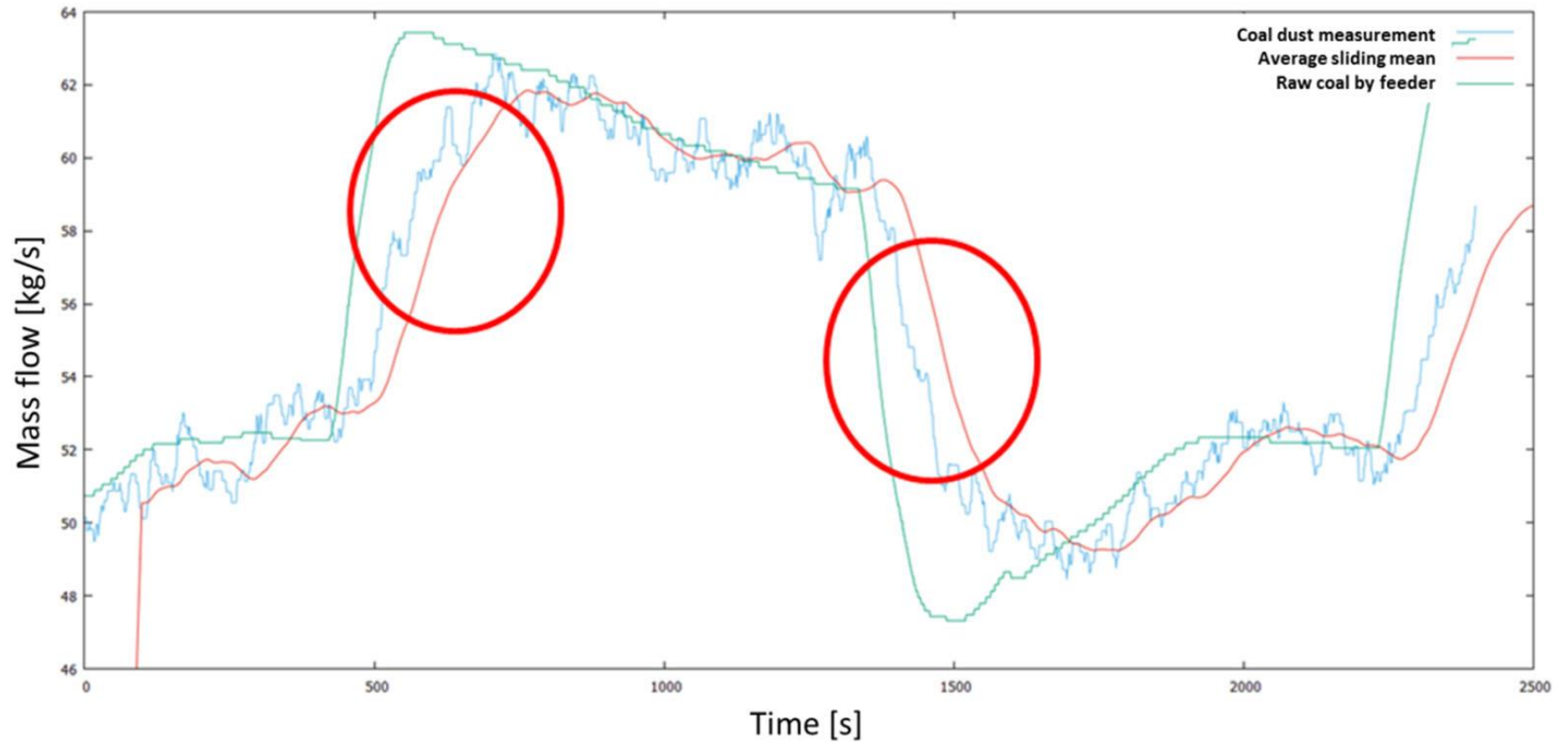
- Long time delay between input signal at the feeder and output at the generator, degrading the quality of the observer.
- Introducing an additional state variable midstream would improve the situation.

Model of a Coal Fired Power Plant

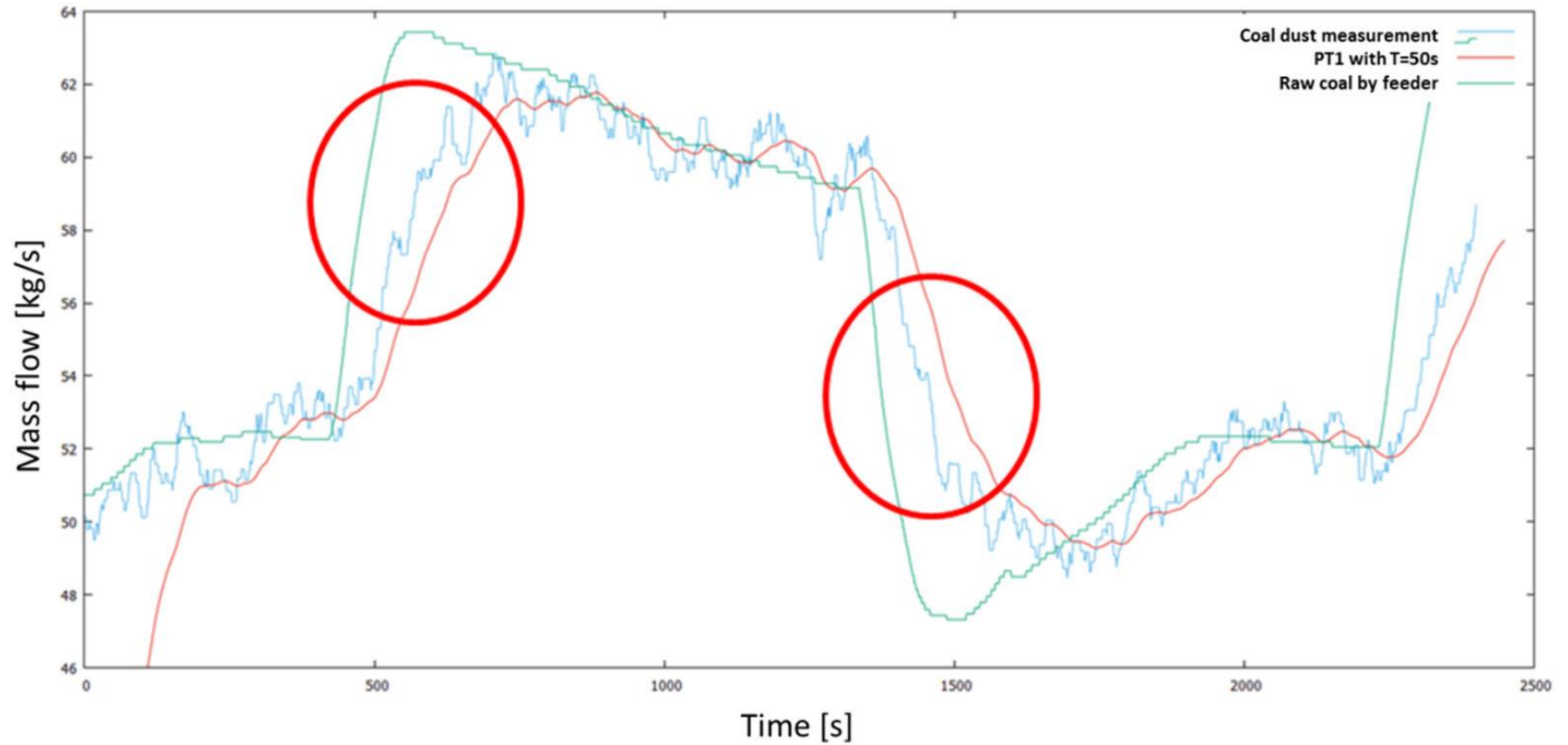


- Mass flow measurement of the pulverized coal flow is an ideal variable since the power output is directly related to the coal (and air) input!

Rolling average filter



First order filter



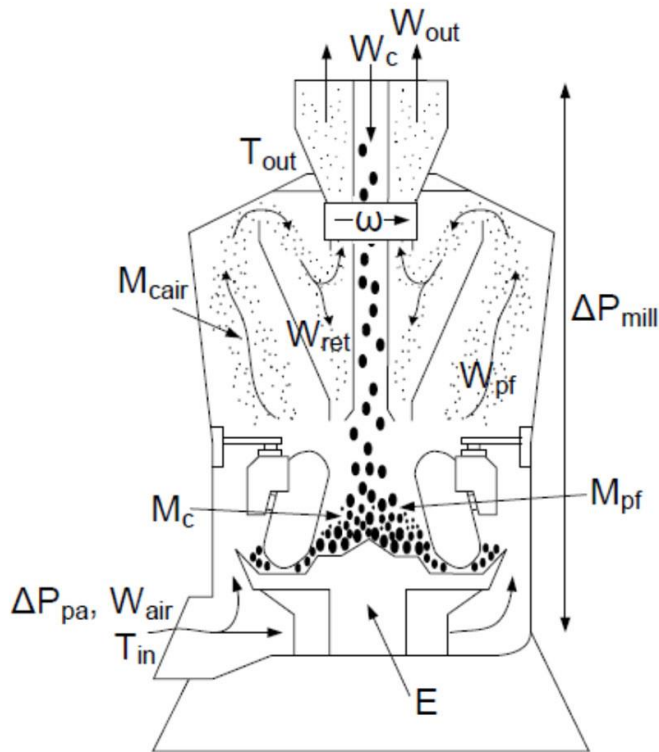
Kalman Filter

- Combines noise reduction with „smart“ prediction capabilities
- Uses a model of the mill

Model of the coal mill

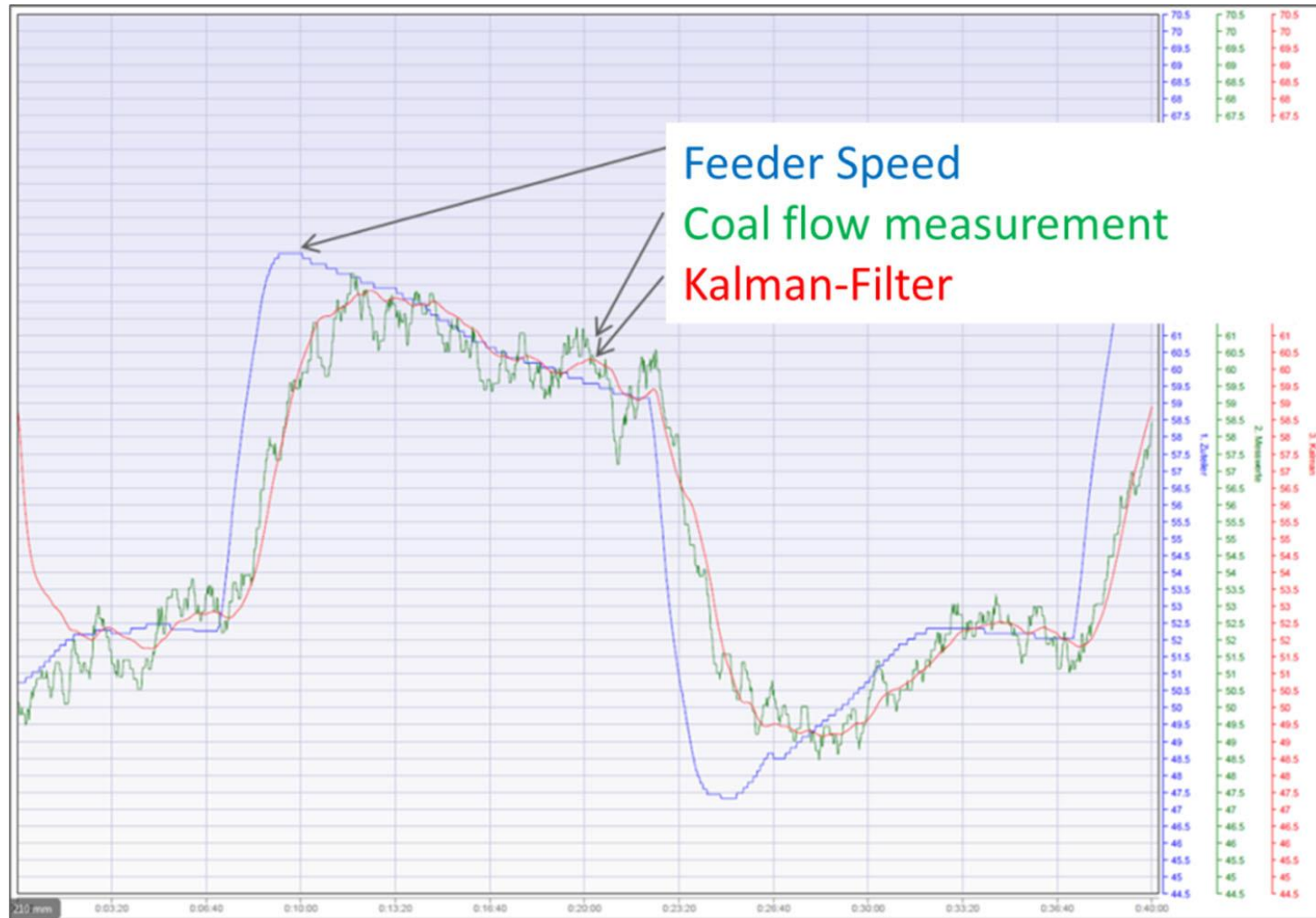
- Raw coal flow
- Primary air flow
- Grinding speed

- Kalman filter constantly adjusts for variations over time in coal type, wear and tear on the balls etc.

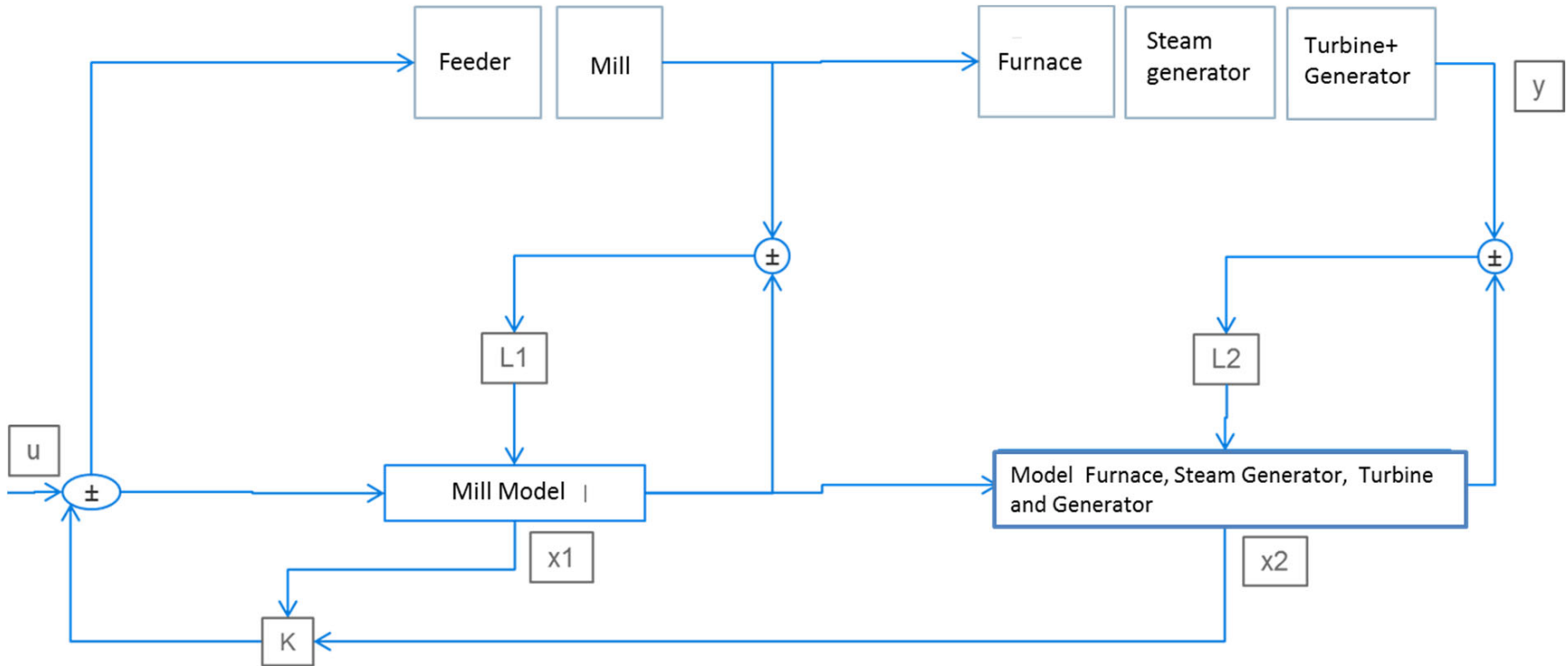


Piotr Niemczyk, Palle Andersen, Jan Dimon Bendtsen, Tom Søndergaard Pedersen, Anders Peter Ravn;
 Derivation and validation of a coal mill model for control; Department of Electronic Systems, Aalborg University

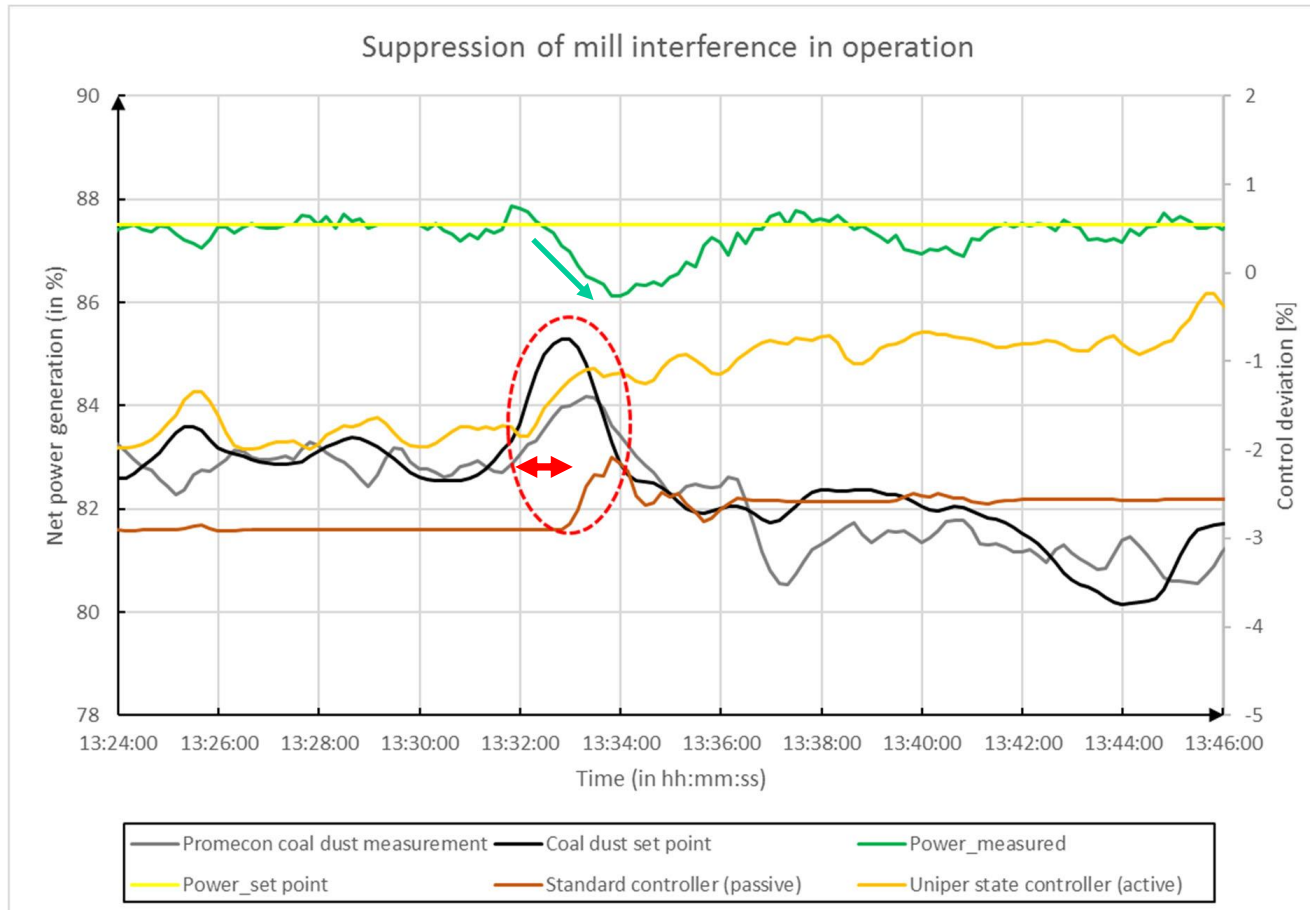
Kalman Filter



Power correction controller (simplified)



Suppression of mill interference



Summary

- Control reaction time is reduced
- Disturbances in the mill are compensated faster
- Load following behavior is improved
- Higher step load changes for secondary control response made possible without sacrificing stability

Thank You!