Verification of Control Sequences within OpenBuildingControl

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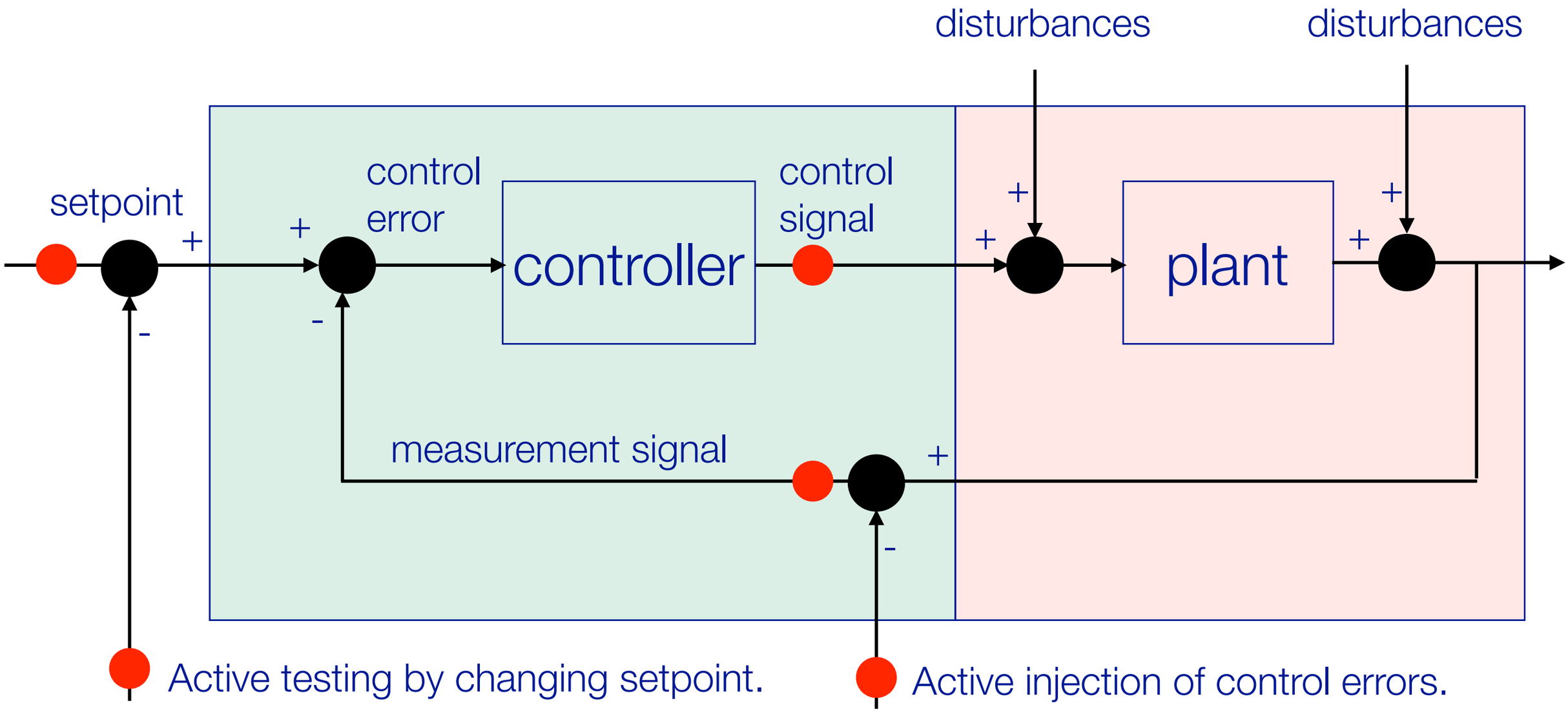
What do we verify?

How should we verify?

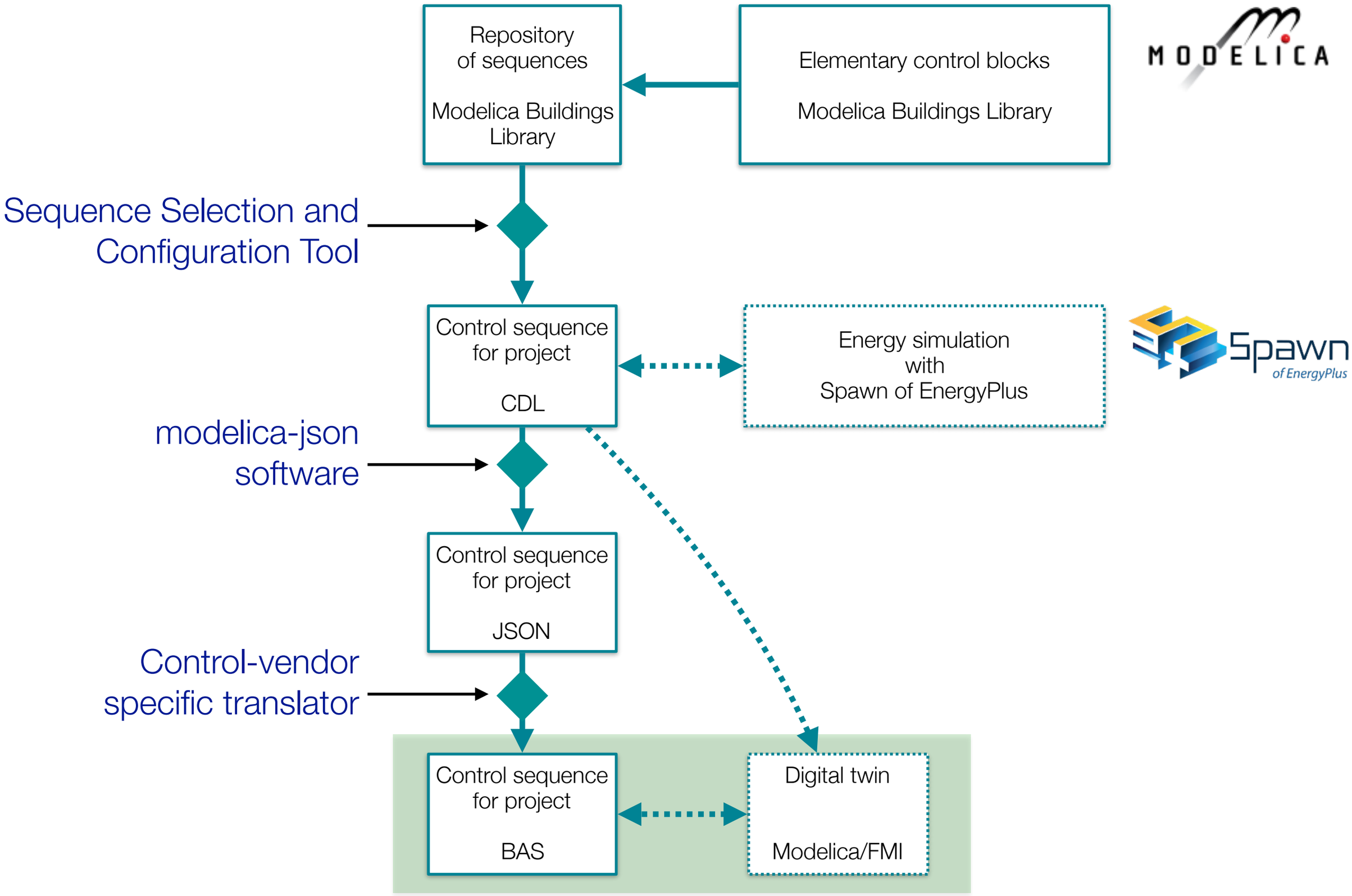


Active testing by changing setpoint.

Active injection of control errors.

- Red points indicate which signals to verify against a CDL generated response.

Reuse of control sequence to verify correct implementation



How do we verify?

Requirements

From http://obc.lbl.gov/specification/requirements.html#commissioning-and-functional-verification-tool:

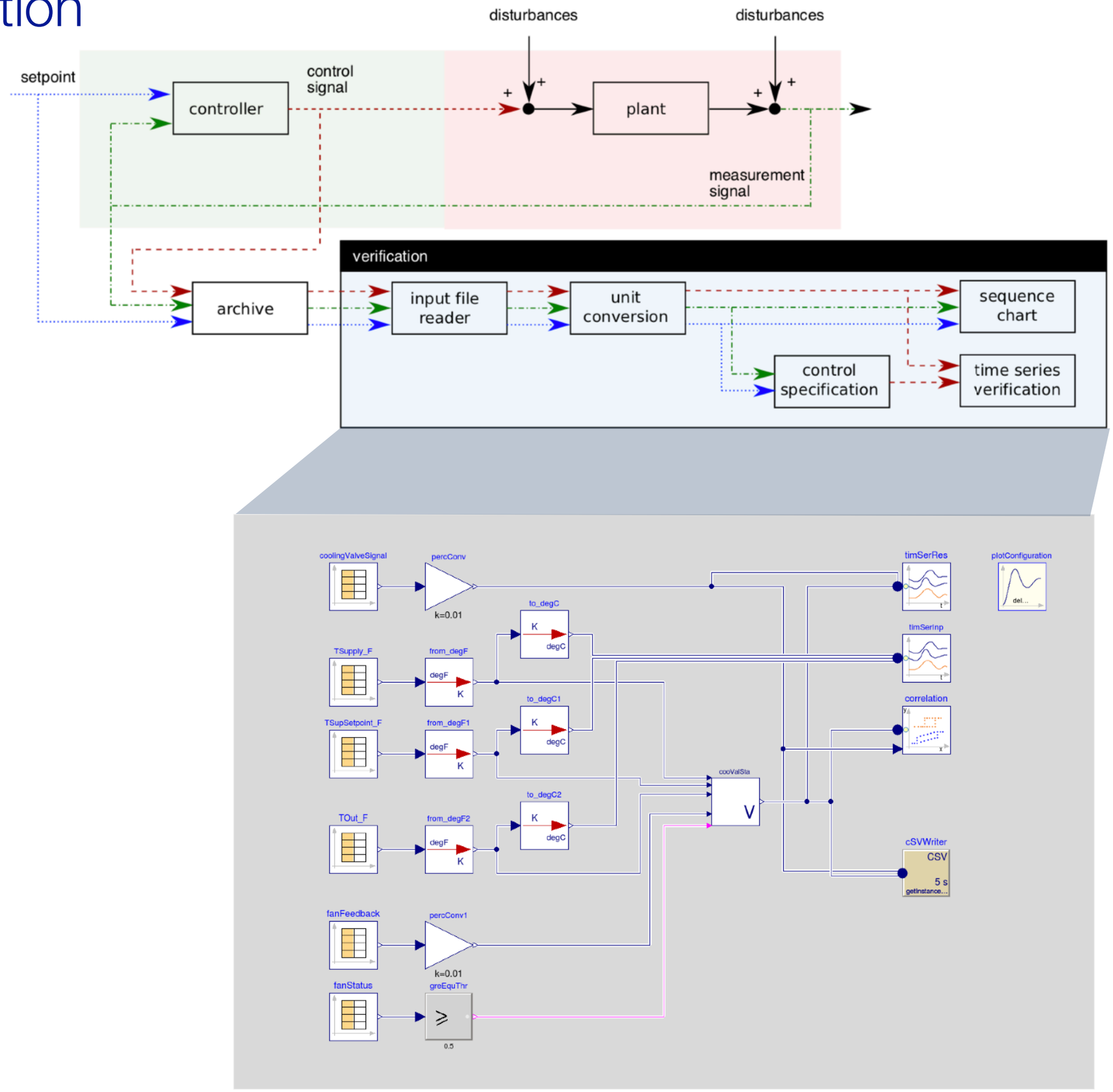
1. The CDL tool shall import verification tests expressed in CDL, and a list of control points that are used for monitoring and active functional testing.

2. The commissioning and functional verification tool shall be able to read data from, and send data to, BACnet, possibly using a middleware such as VOLTTRON or the BCVTB, or read archived data.

3. It shall be possible to run the tool in batch mode as part of a real-time application that continuously monitors the functional verification tests.

4. The commissioning and functional verification tool shall work on Windows, Linux Ubuntu and Mac OS X.

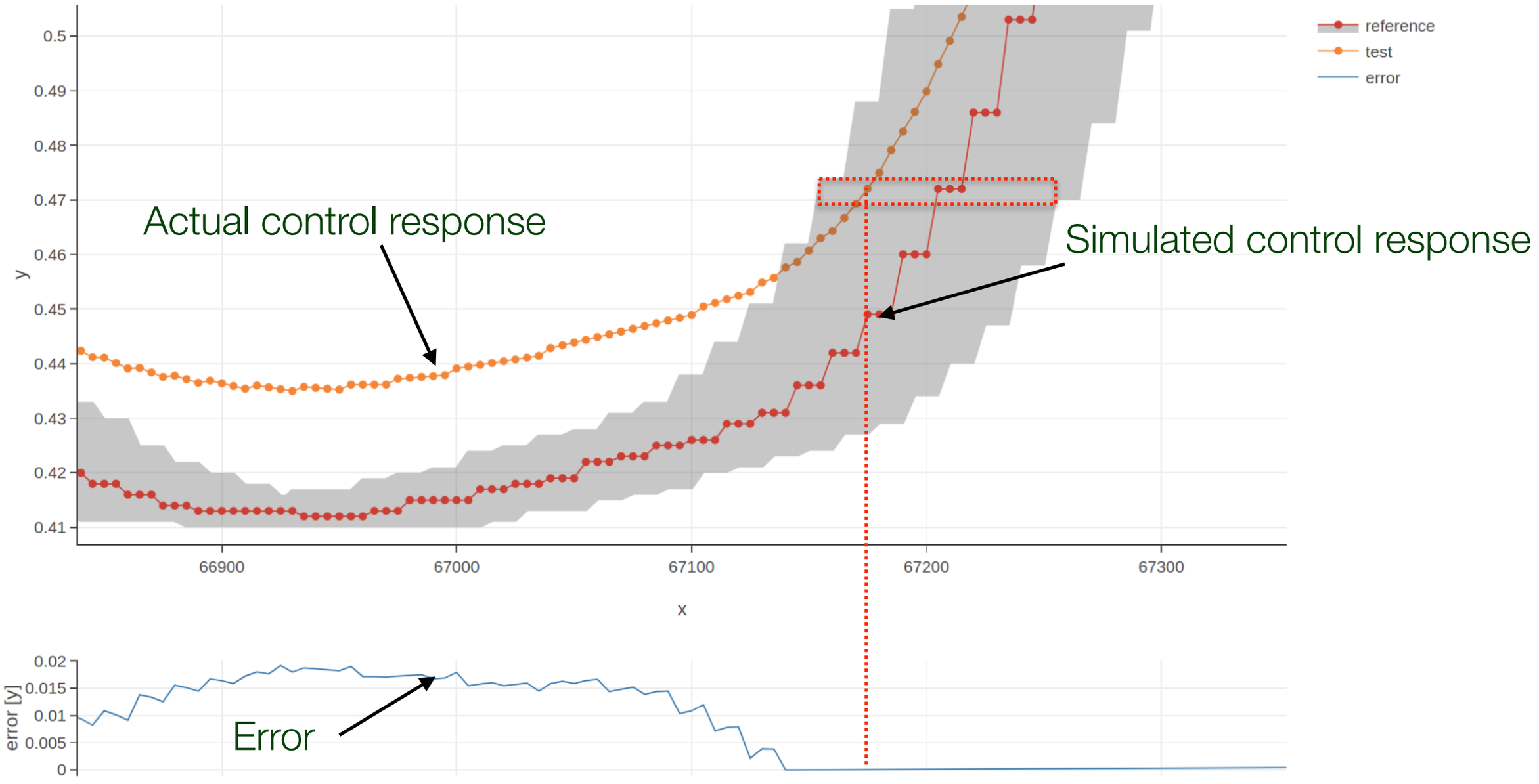
Implementation



Are time series between simulated and implemented control within a certain error band?

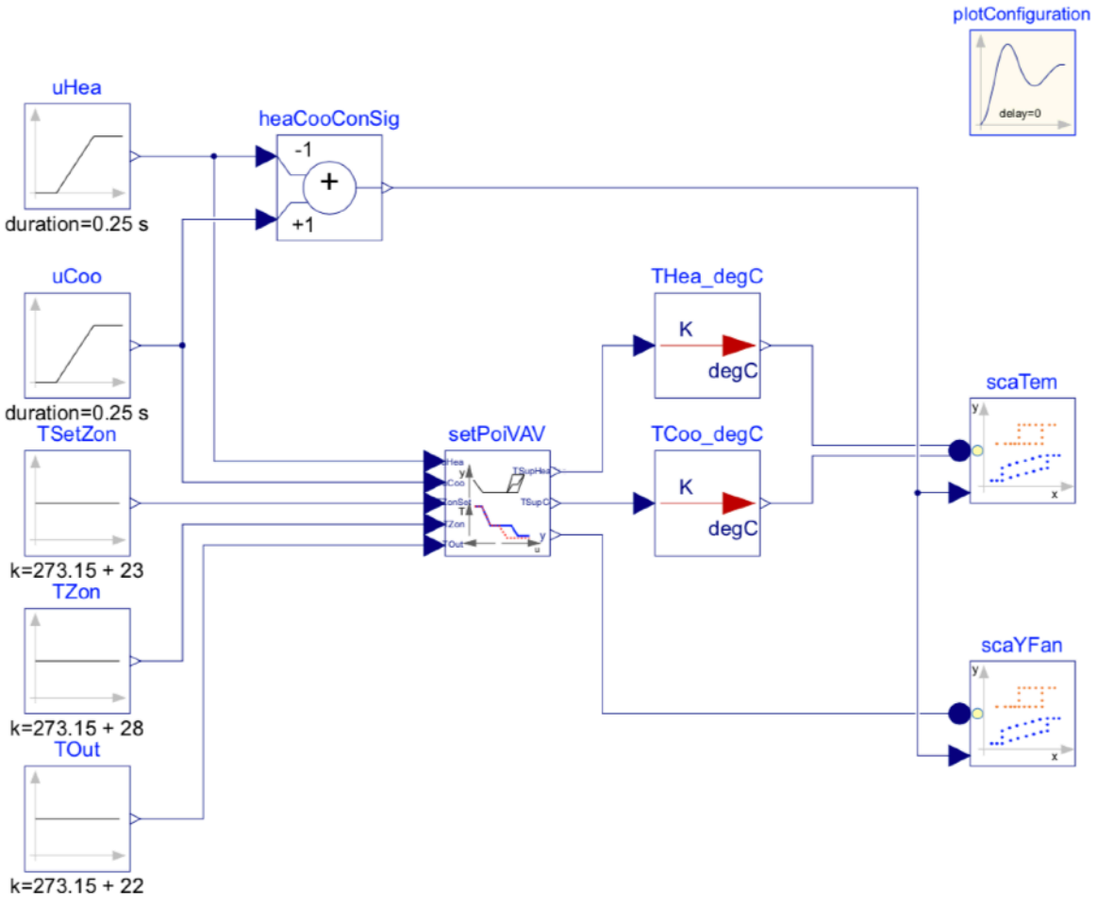
Detailed principles

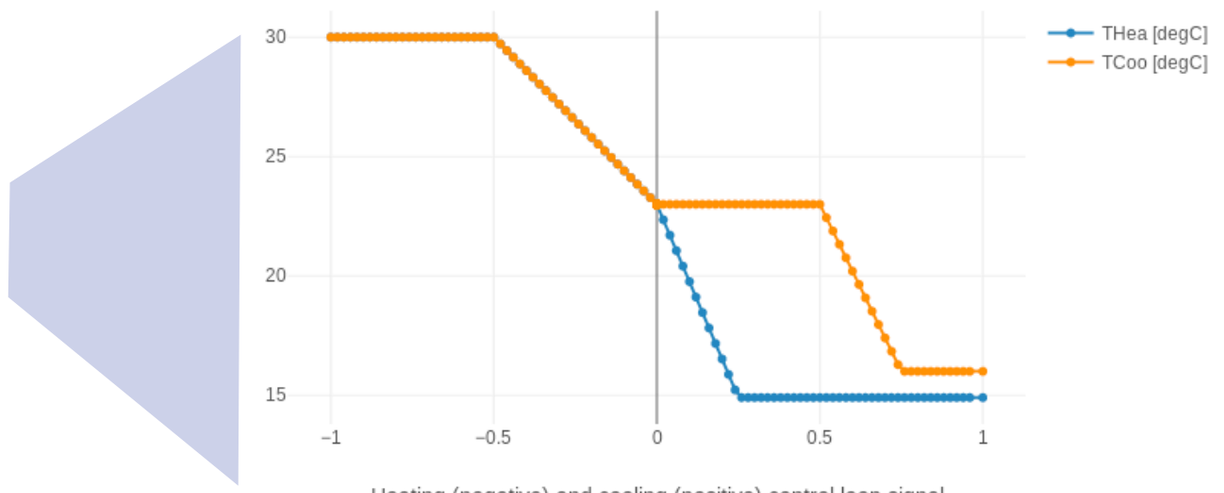
- L1-norm based comparison
- Trajectory comparison (as opposed to point-to-point): handles time events & different time scales

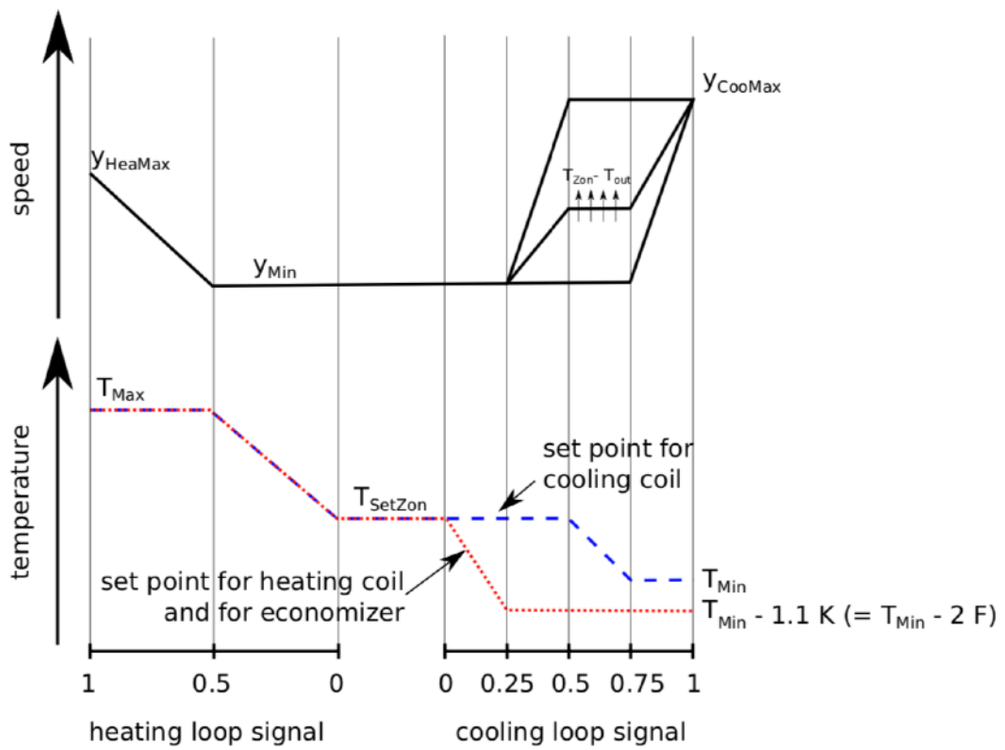


Example output generated using funnel *software, https://github.com/lbl-srg/funnel*

Optional: Generate sequence charts



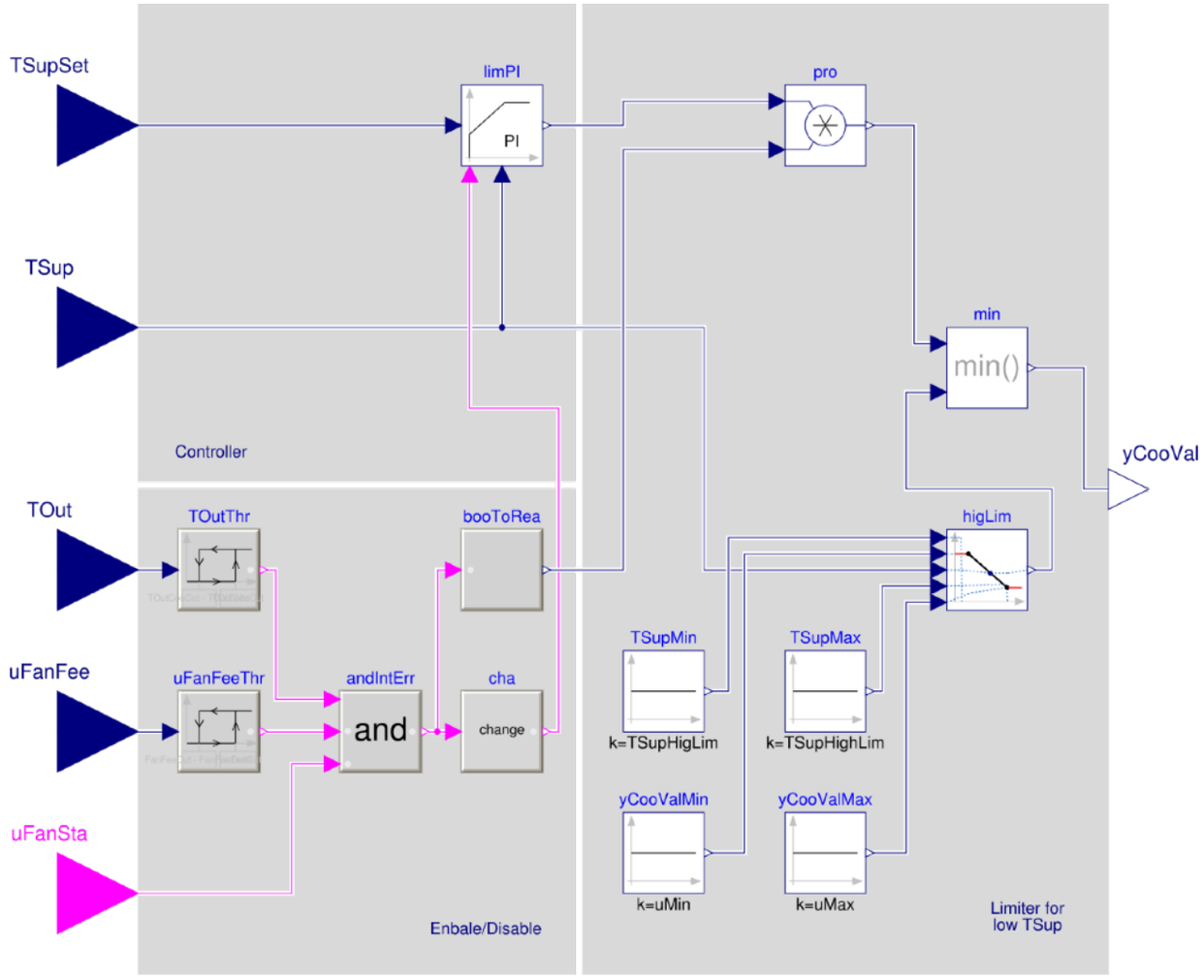




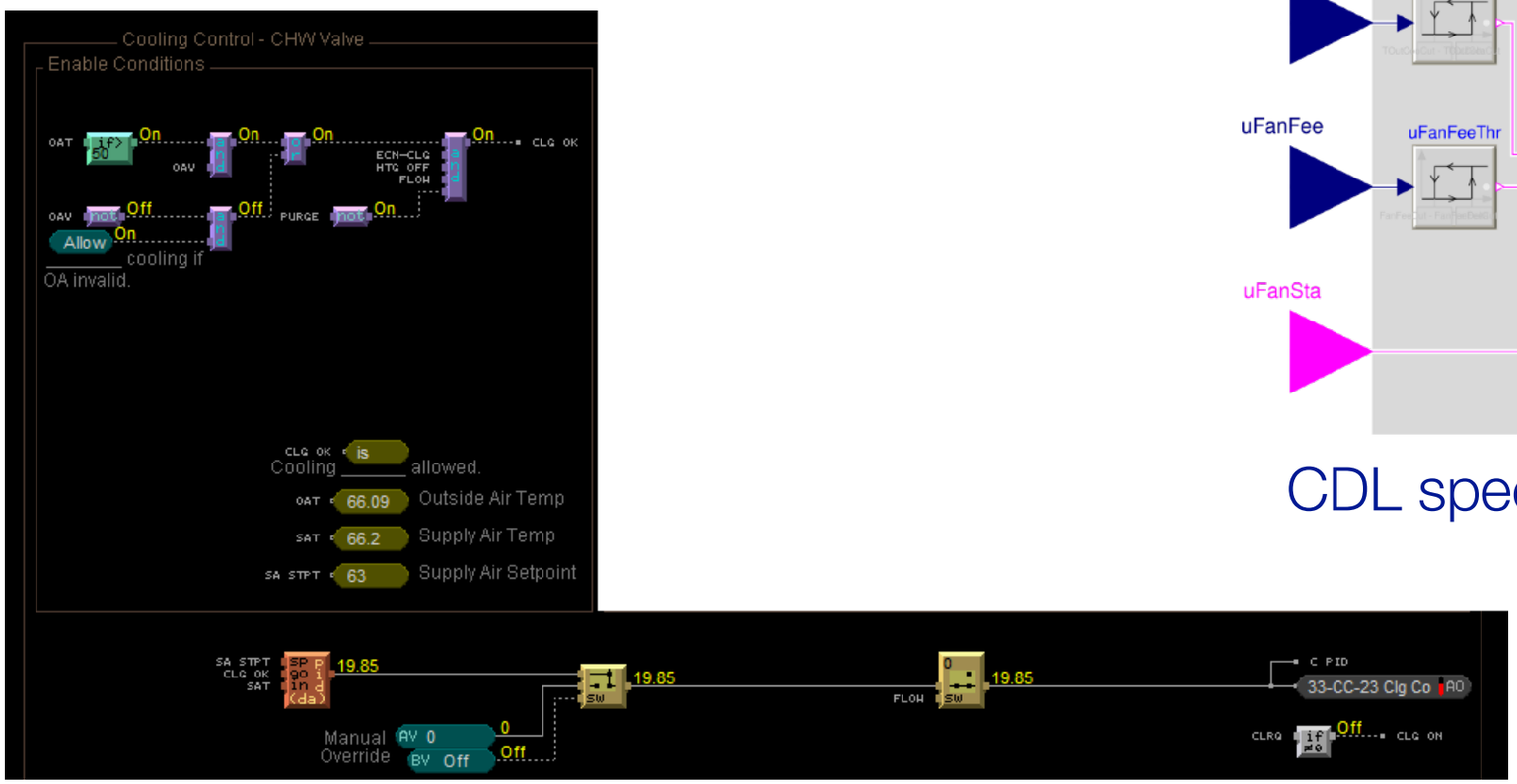
Verification test with a measured control response - Sequence specification

We validated a **trended output** of a control sequence that defines the **cooling coil valve** position.

The cooling coil valve sequence is a part of the ALC EIKON control logic implemented in building 33 at LBNL.

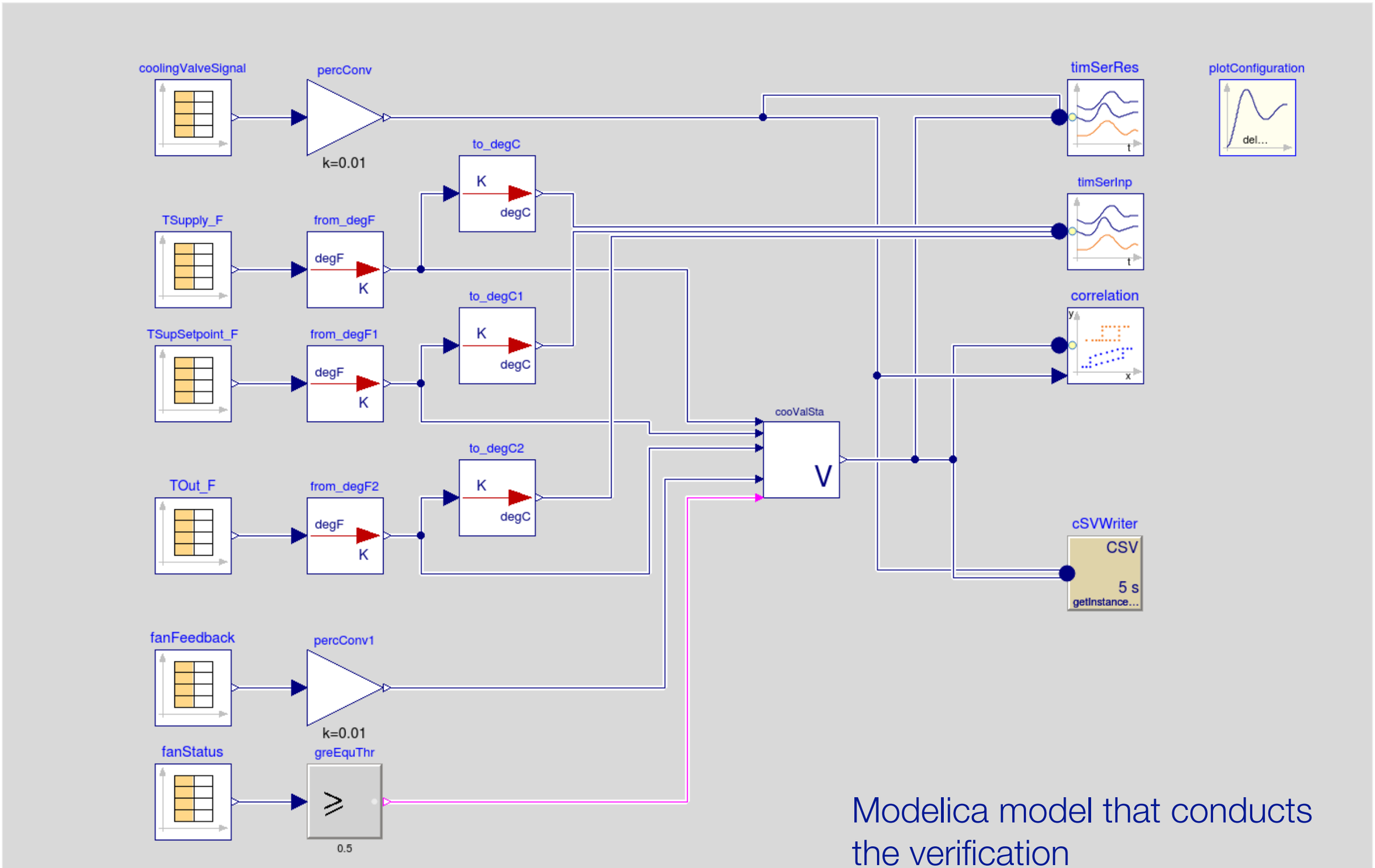


CDL specification



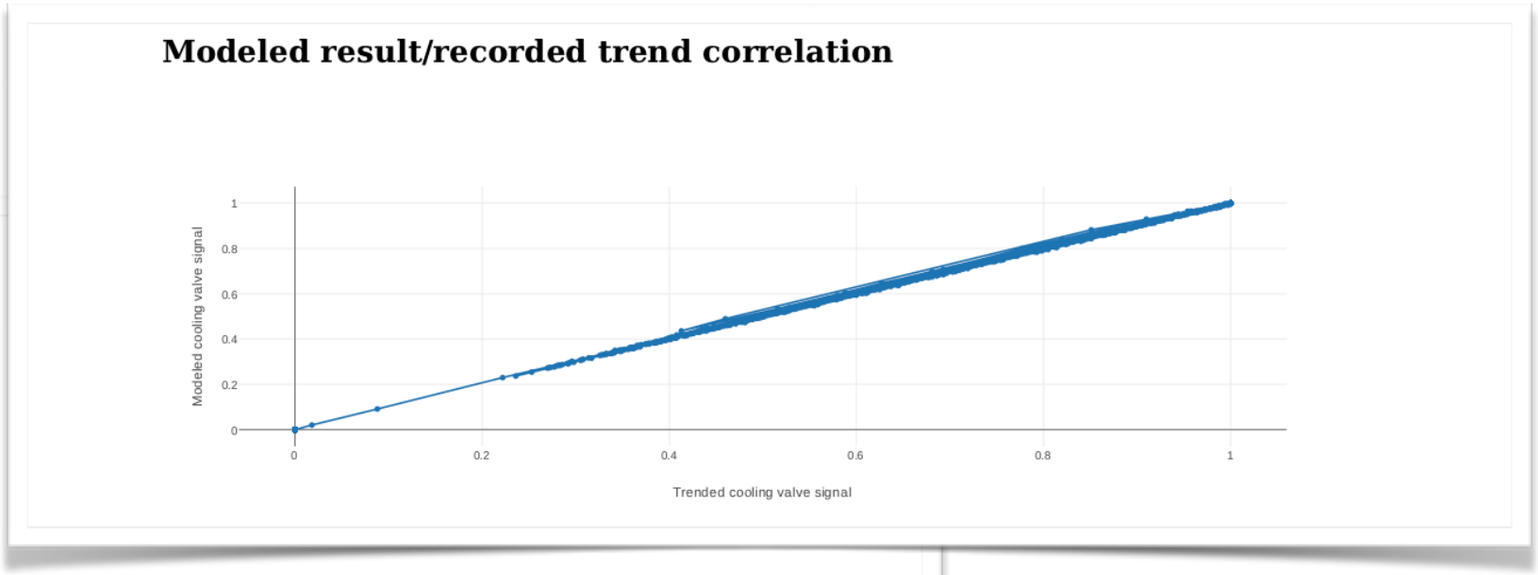
ALC EIKON specification

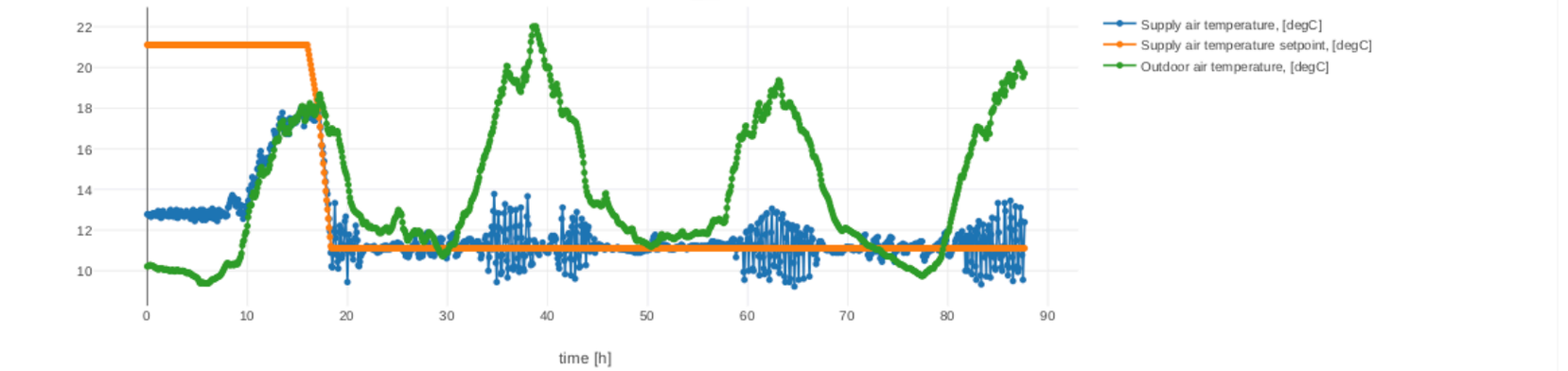
Verification test with a measured control response - Conducting the verification

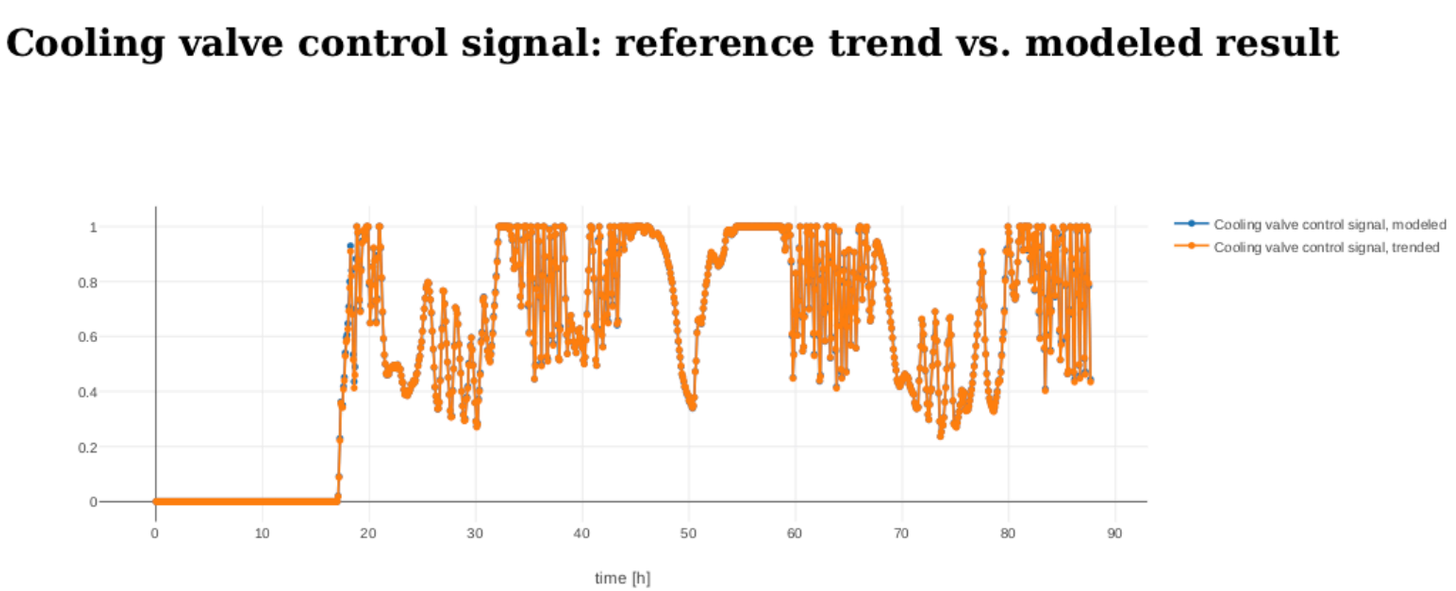


Modelica model that conducts the verification

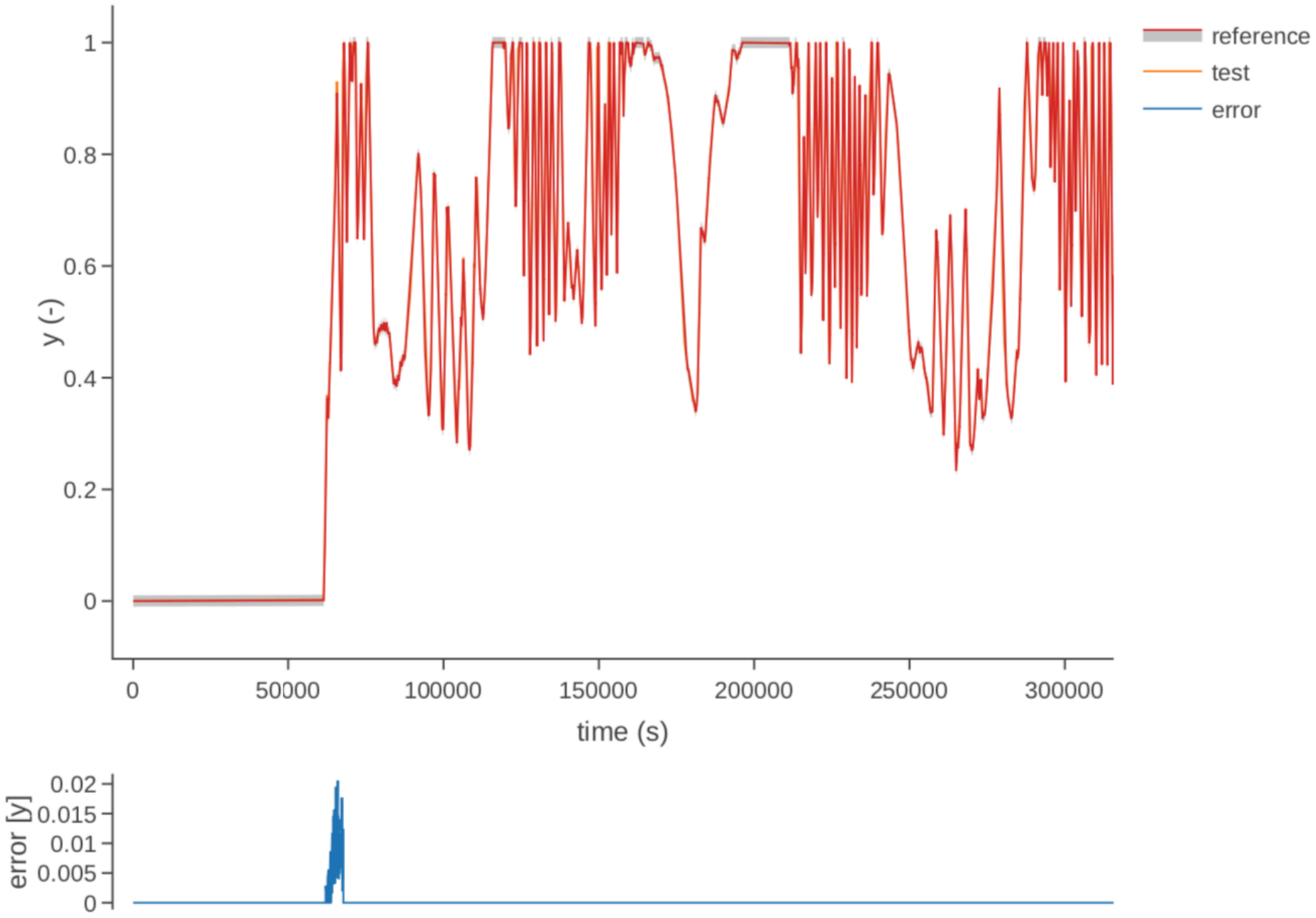
Verification test with a measured control response - verification results







Verification test with a measured control response - using *funnel* software to compare cooling valve control signal y



https://github.com/lbl-srg/funnel

What is next?

- Determine how close tolerance should be based on larger control sequence.
- Facilitate mapping of actual, trended control sequences with model to reduce setup time.

Further information and discussions

Further information at

- https://obc.lbl.gov
- Michael Wetter, Antoine Gautier, Milica Grahovac, Jianjun Hu.
  Verification of Control Sequences within OpenBuildingControl.
  Proc. of the 14th IBPSA Conference, Rome, Italy, September 2019.

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