Digital Twin Platform project (VTT):

Model-based operational digital twin

Project demo scope:

- A practical approach in digital engineering and operational condition monitoring application field towards the Digital Twin concept
- Feedback from realized operation to maintenance and engineering design by connecting physics based and data driven models
- Operational load identification and response prediction for predictive maintenance as well as feedback to engineering design

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A Digital Twin demo test environment

Torsional vibration demo environment of a driveline

- Technically corresponds e.g. propulsion system of a ship

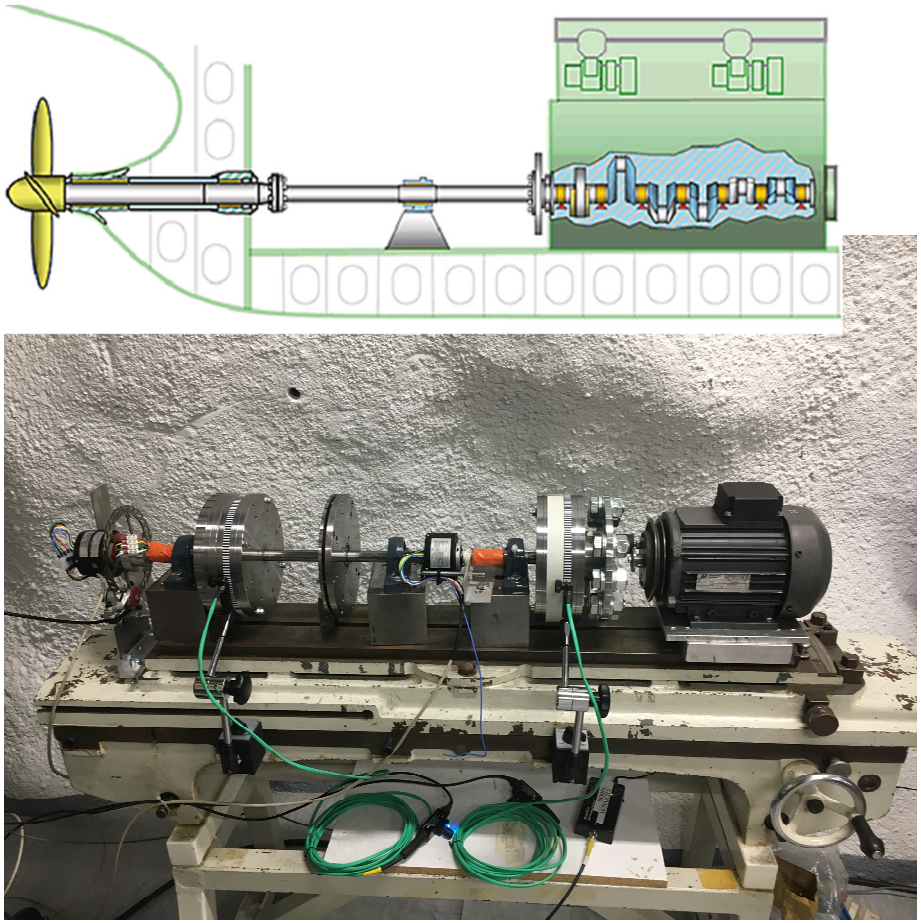
Scope of the demo:

- **Virtual sensing**: Identification of operational loads and stresses by hybrid modelling; combining physics based model and indirect measurements, e.g. tachometer signals
- Online Remaining Useful Lifetime (RUL) monitoring of selected critical components

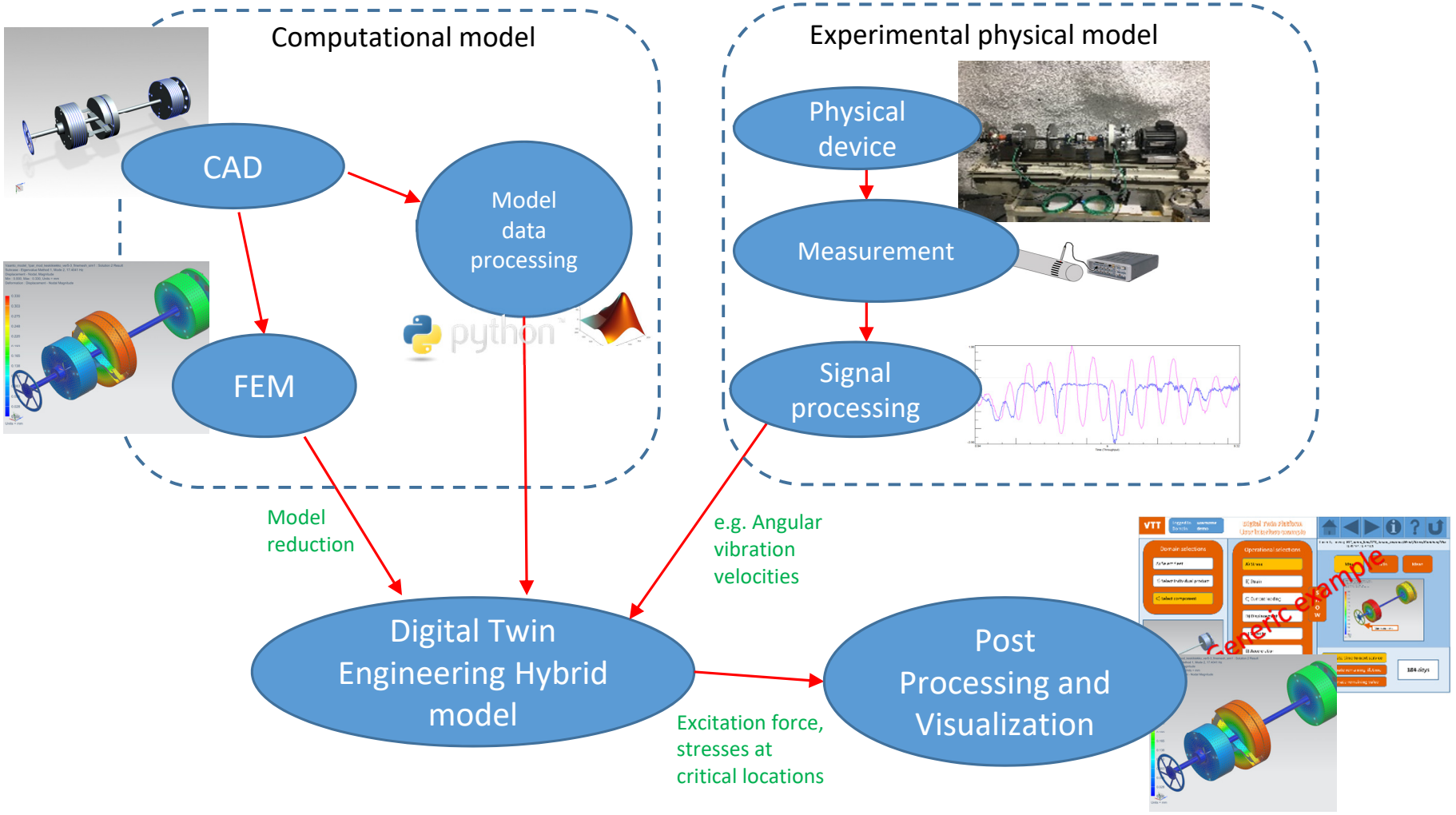
Benefits:

- Opens new opportunities for measurement data exploitation and allows measuring previously unmeasurable quantities
- Operational excitation force is typically unknown and uncertain factor in simulation and design processes; usually difficult, expensive or even impossible in some cases to measure directly in practice
  - Measuring rotating speed fluctuation is easy compared with strain gage measurements from the rotating shaft

DNV GL® 2018, Available: https://www.dnvgl.com/news/increased-risk-of-shaft-fatigue-due-to-long-time-for-passing-barred-speed-range-bsr--126545.

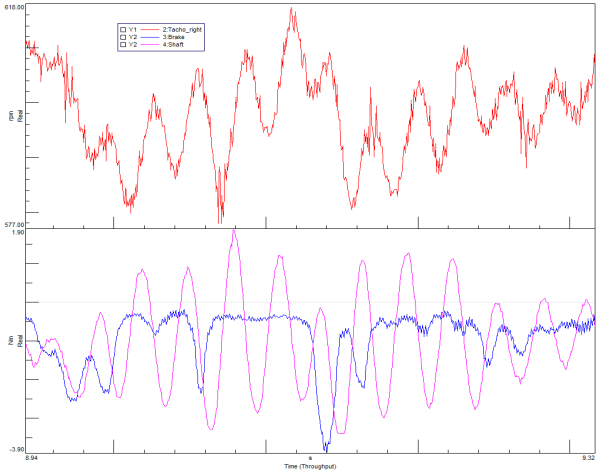


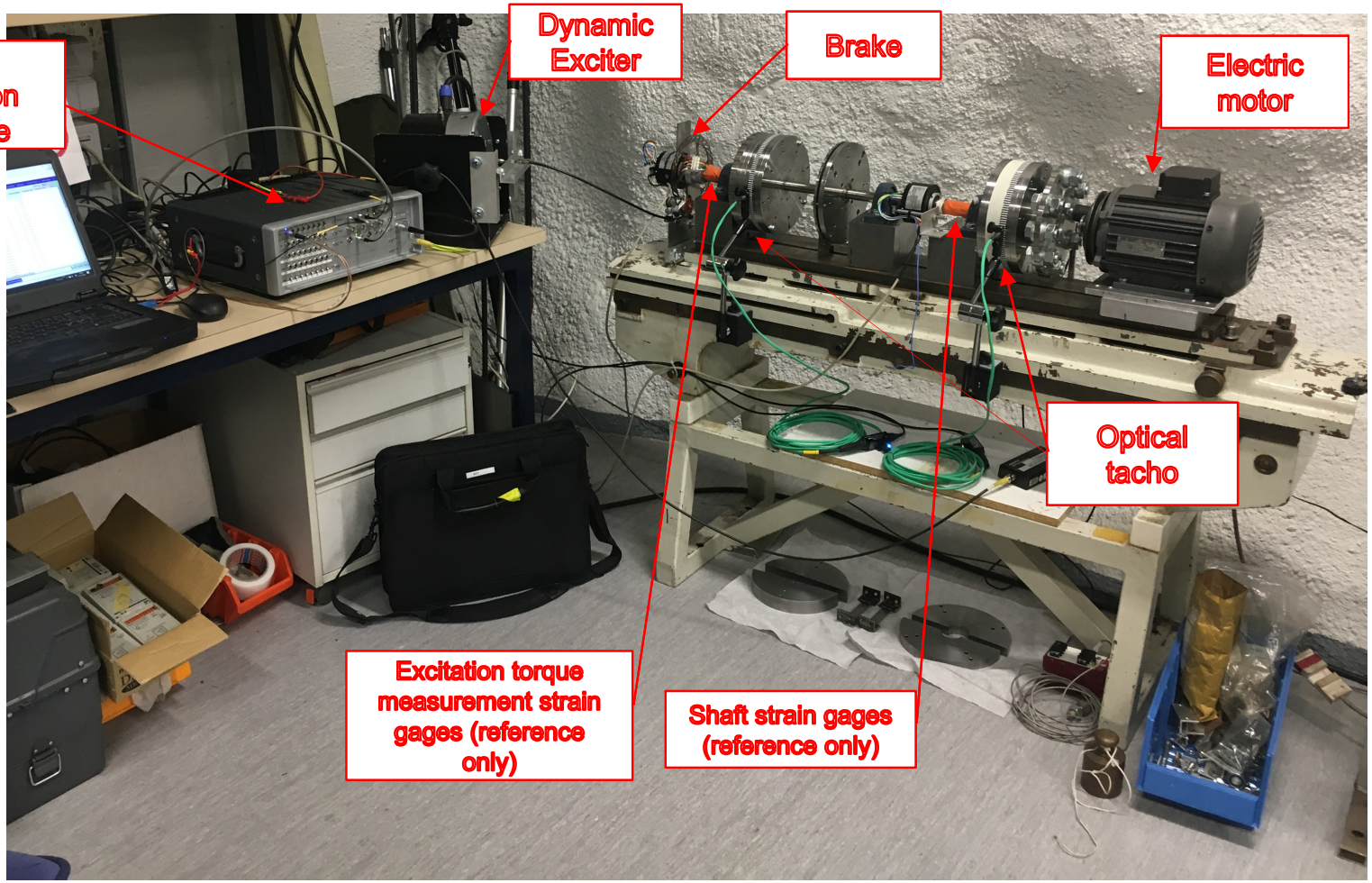
General Model-based Digital Twin realization scheme



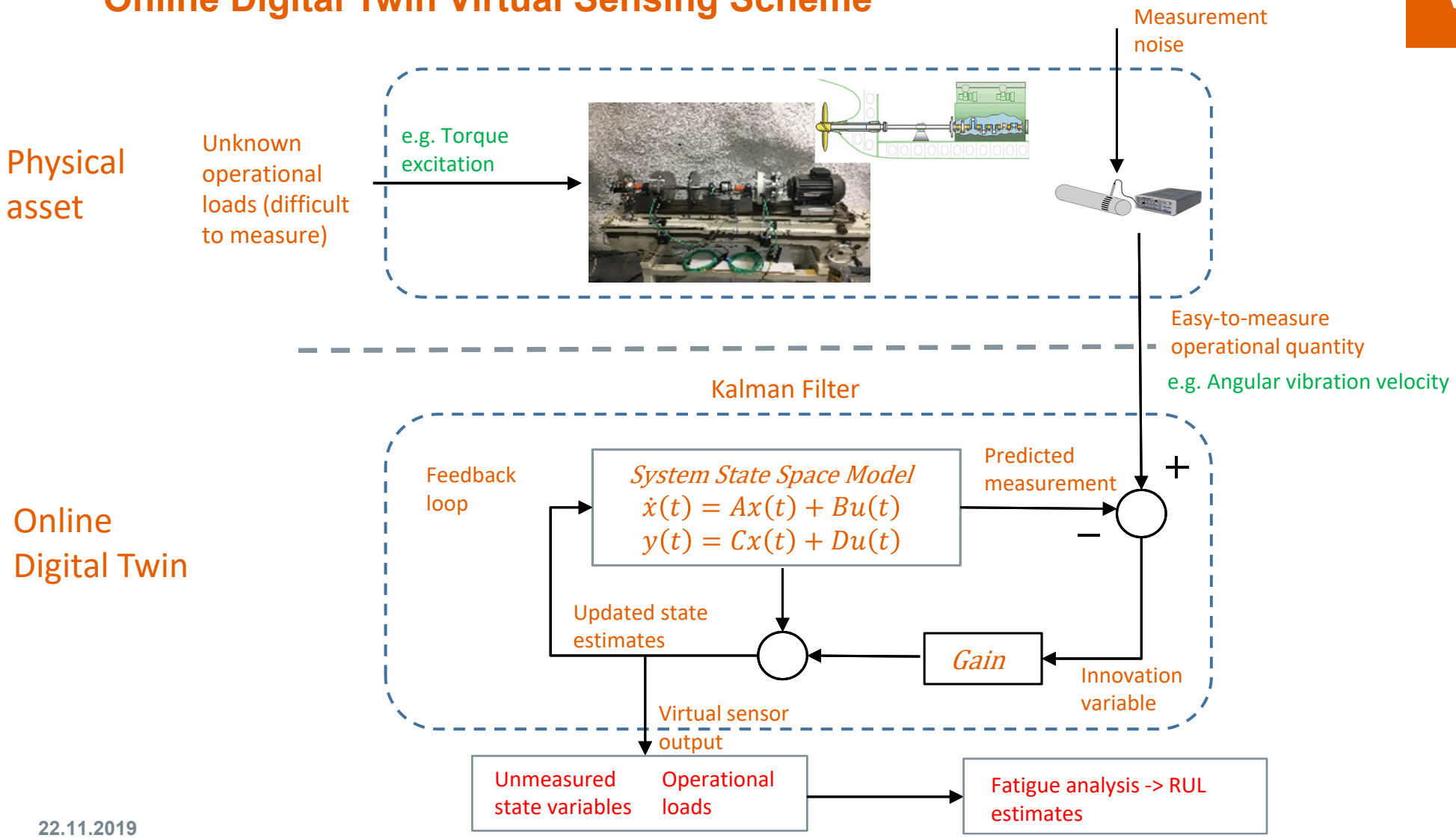
Torsional vibration test environment: measurement data acquisition setup

Tacho rpm
Brake excitation (reference)
Shaft torque (reference)





Online Digital Twin Virtual Sensing Scheme

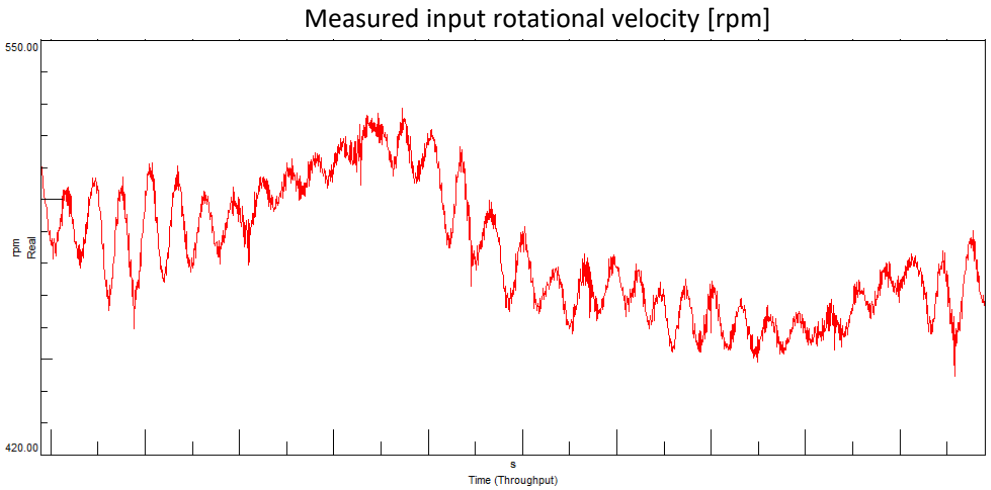


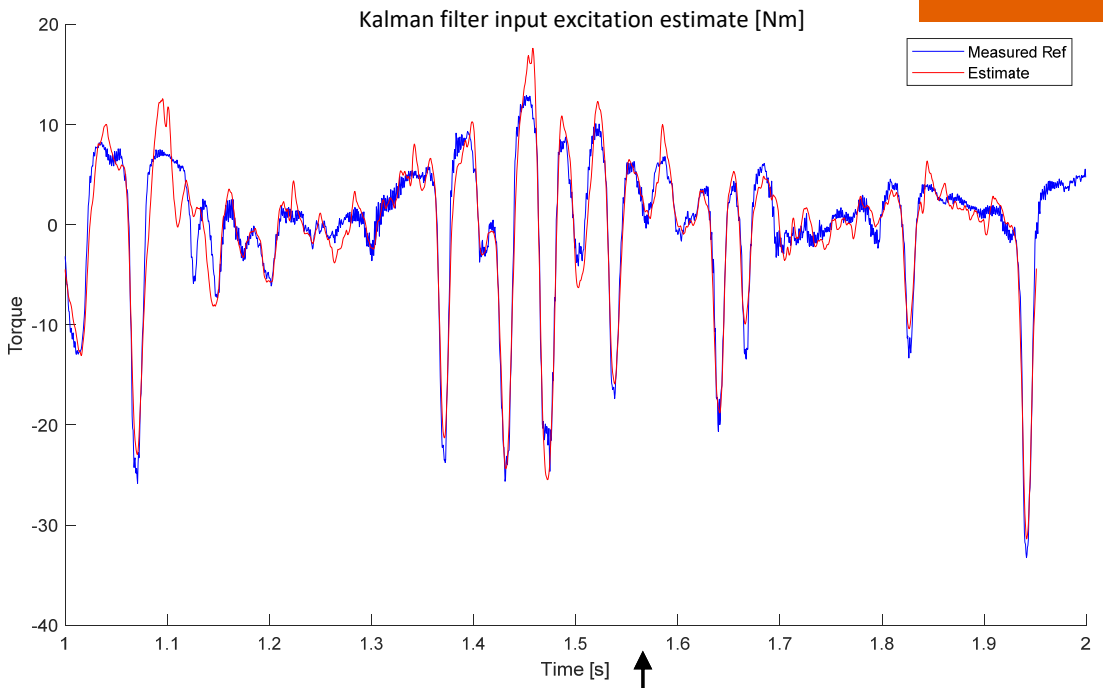
Kalman Filter based virtual sensing

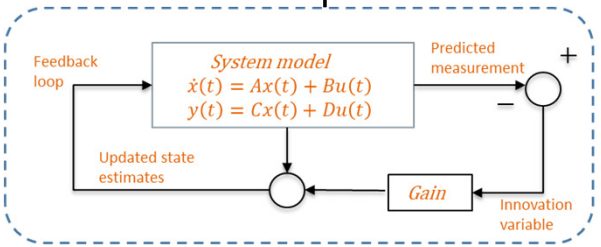
- Input measurement: Angular velocity
- Output: Excitation torque

- Only response measurements has been used for the input torque identification
- Kalman filter estimation was used
- First measurements and analyses, estimates could be improved

- Next step: Integrate the model-based digital twin process to one online hybrid environment







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