Method to identify insufficient sub-models in simulation models of wind turbine drivetrains

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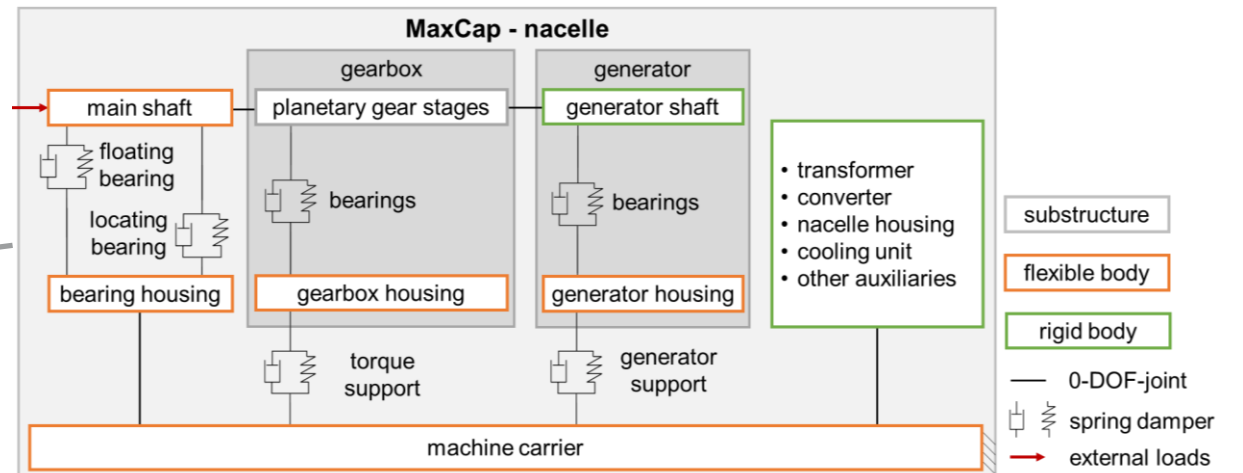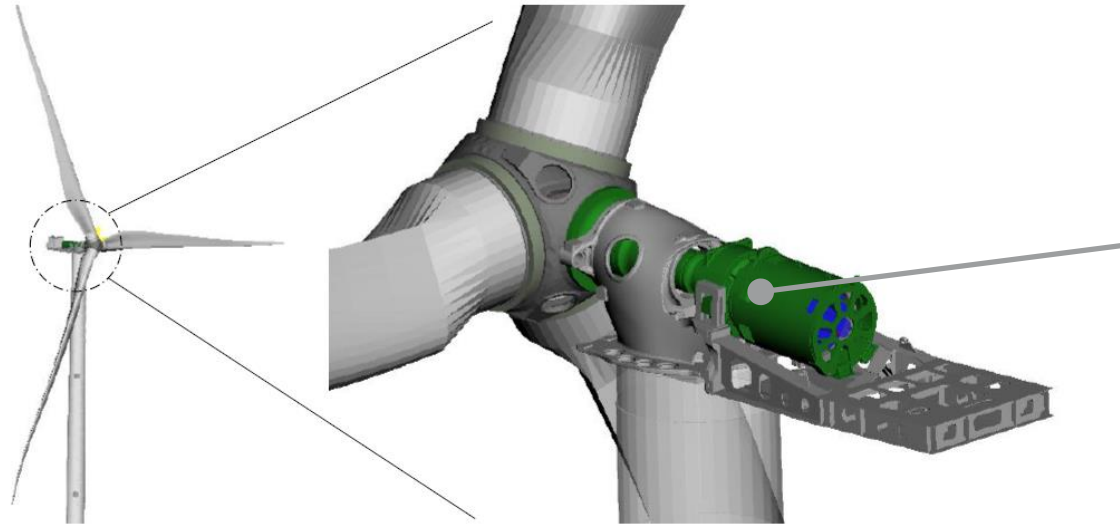EERA DeepWind '22 | Poster Session | 19 January 2022

Motivation & Objective

- Trend towards higher power and torque densities of wind turbine drivetrains
  - Drivetrains become more complex and have stronger interactions between the individual components
  - Future design of wind turbines will rely more on sophisticated simulation models

- Mechanical tests are carried out to validate the prototypes
  - Measurement data can also be used for the validation and improvement of the simulation models

- A new method is needed to quantify the quality of the simulation models and their sub-models
  - The modelling quality parameter (MQP) quantifies the model quality and allows to identify insufficient sub-models
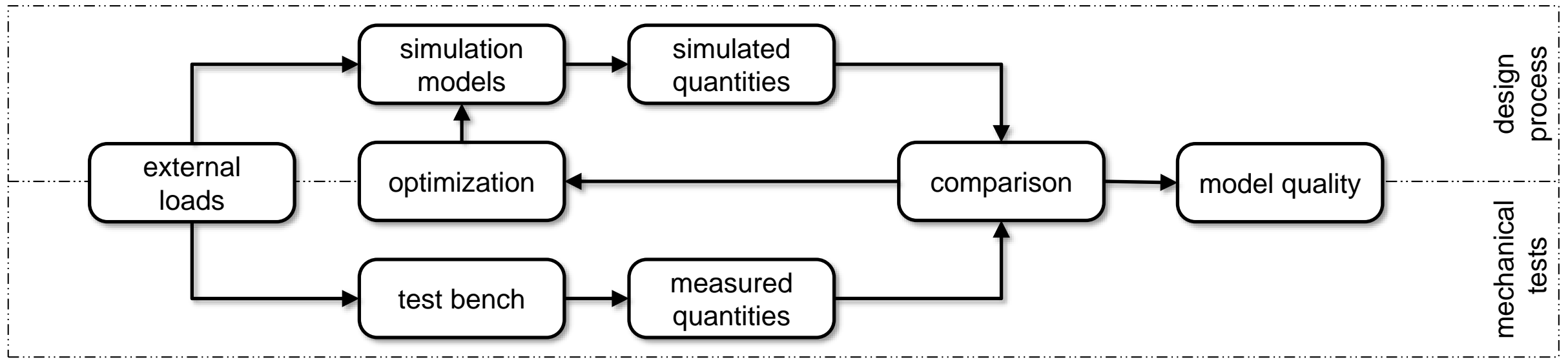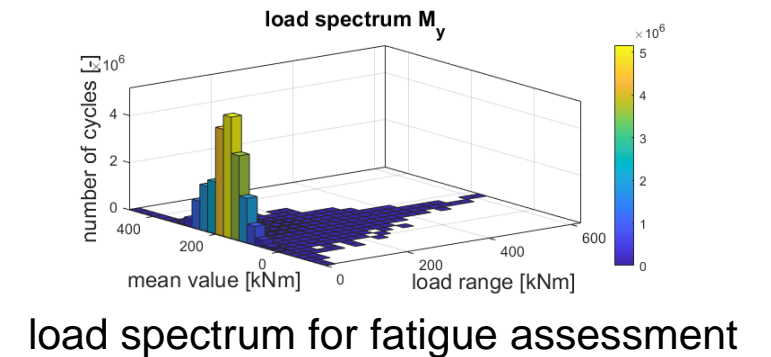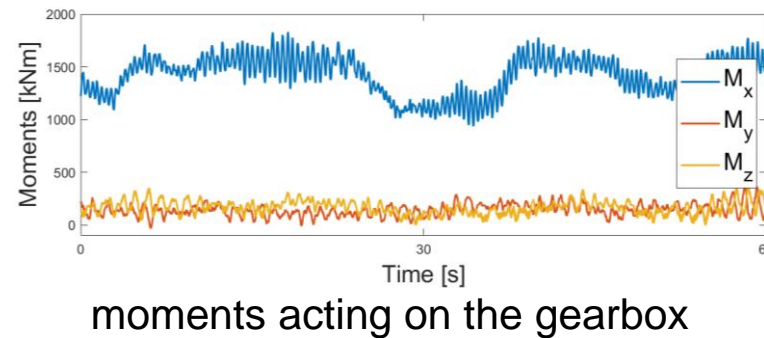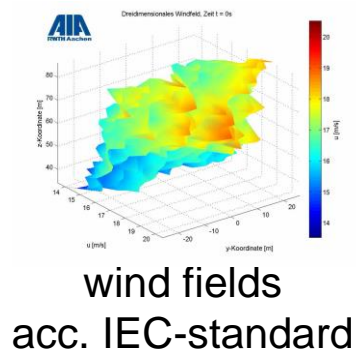
Simulations the design process

Multibody simulation model of the MaxCap compact drive wind turbine

multi body simulation model of the drivetrain

Example Input and Results

wind fields
acc. IEC-standard

moments acting on the gearbox

load spectrum for fatigue assessment

Mechanical tests of the MaxCap compact drive wind turbine on the 4-MW test bench at CWD

The prototype of the compact drive wind turbine is equipped with various sensors
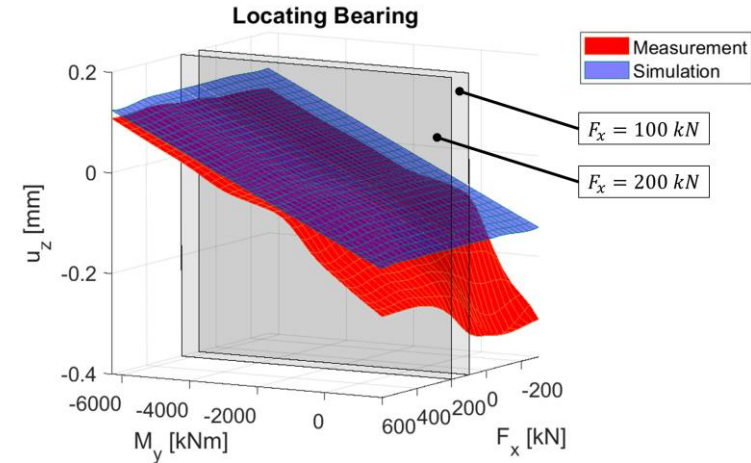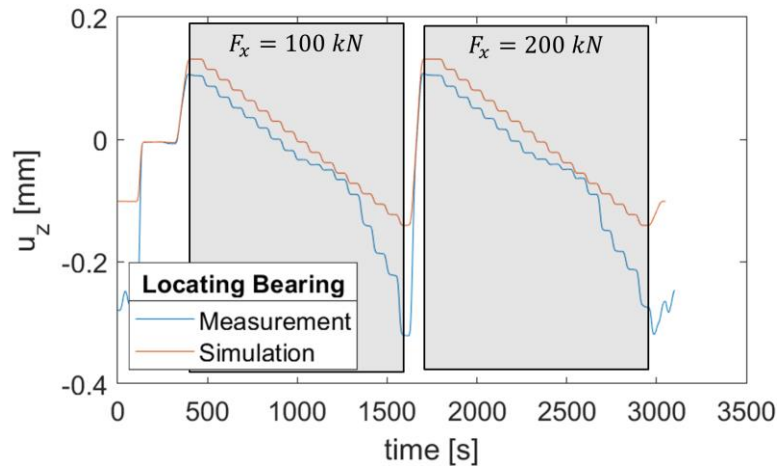
test bench motor

non torque load unit

MaxCap - prototype
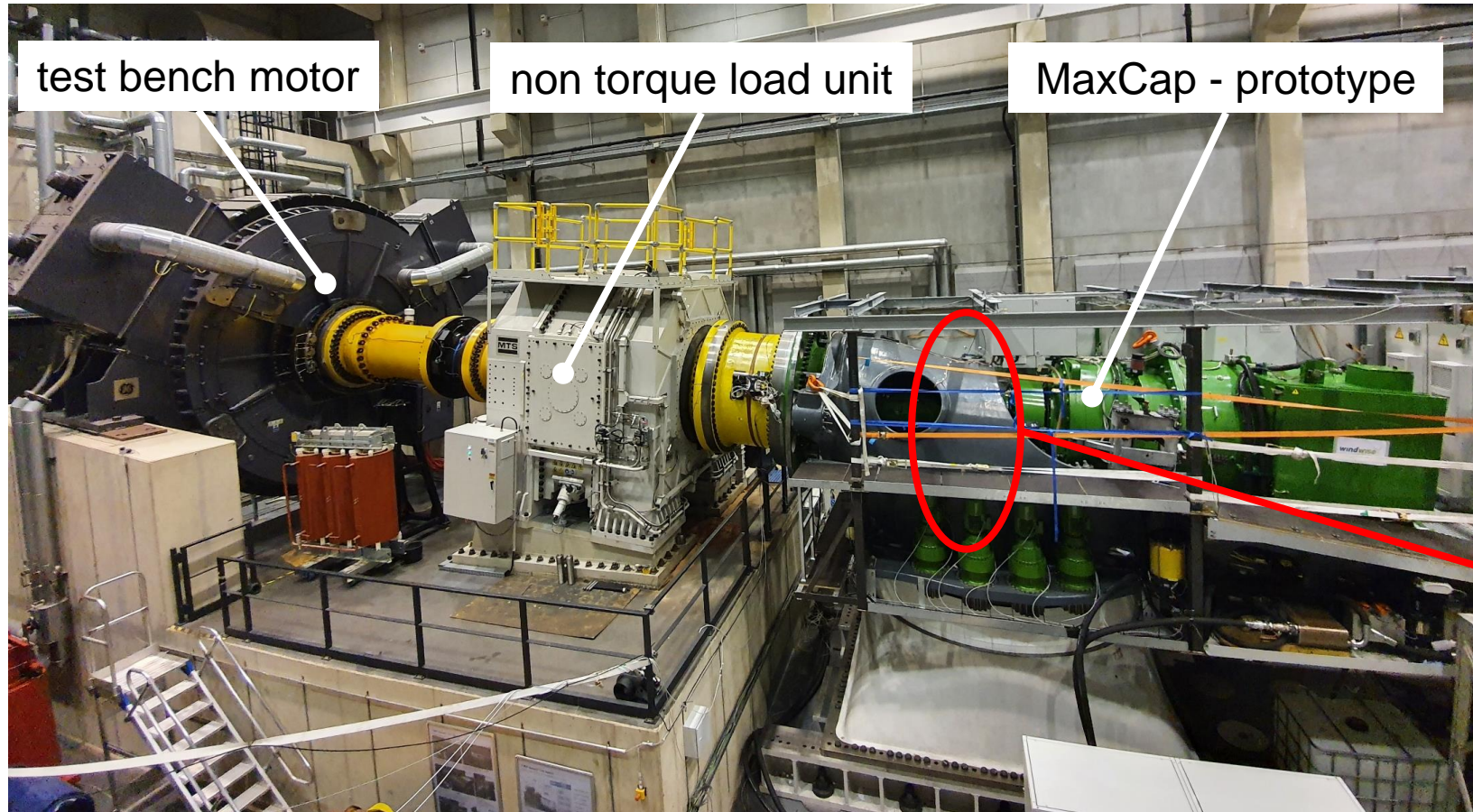
- e.g. radial and axial measurement of the displacement at the locating bearing with eddy current sensor

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Comparison of simulated and measured data

⚙ Measured and simulated vertical displacement of the locating bearing:
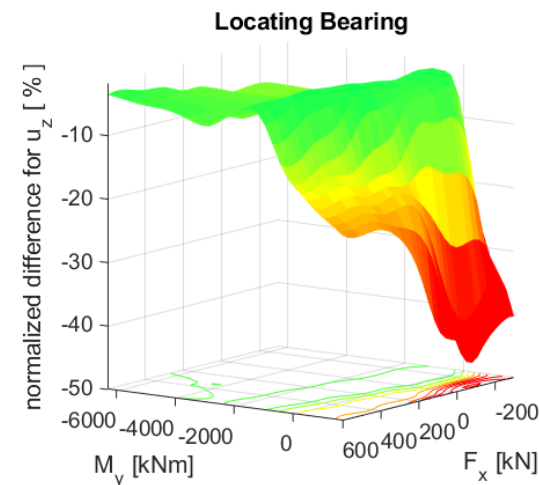

⚖ Comparison with normalized difference:

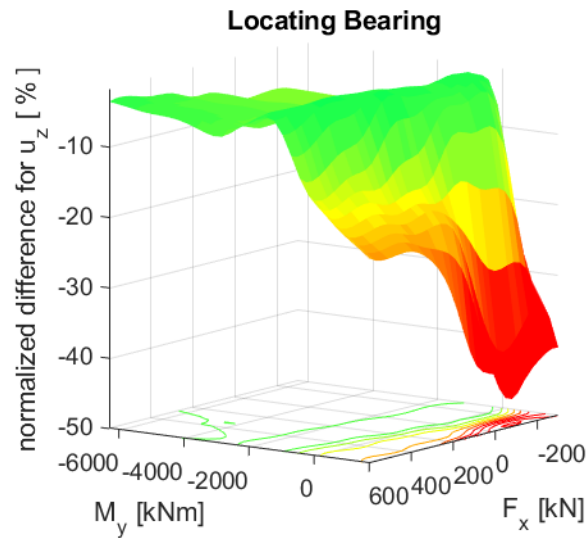$$d_i = \frac{Z_M - Z_S}{max(Z_M) - min(Z_M)}$$

Z_M measurement value
Z_S simulation output

- difficult to interpret
- no objective evaluation possible
➢ new quality parameter needed

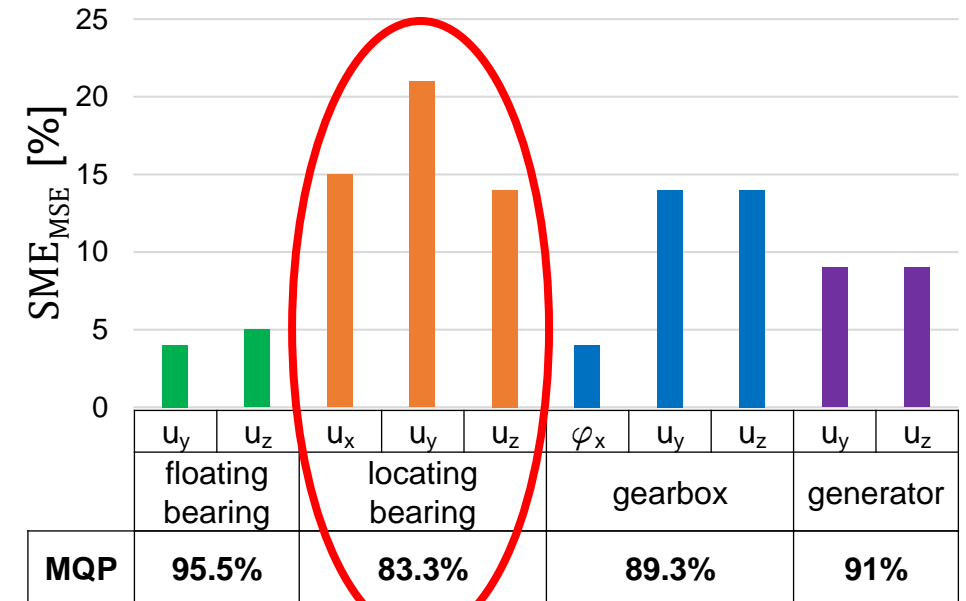# Quantification of the quality of the simulation models and their sub-models

The MQP defined by the sub model error $\mathrm{SME_i}$, quantifies the model quality and identifies insufficient sub-models

$$\mathrm{SME_{MSE}} = \frac{1}{n}\sqrt{\sum_{i=1}^{n} d_i^2}$$

SME: Sub model error

$$MQP = 1 - \frac{1}{n}\sum_{i=1}^{n} \mathrm{SME}_i$$

Advantages of the method
- objective evaluation and easy interpretation of the model quality

➤ **easy identification of insufficient sub-models**