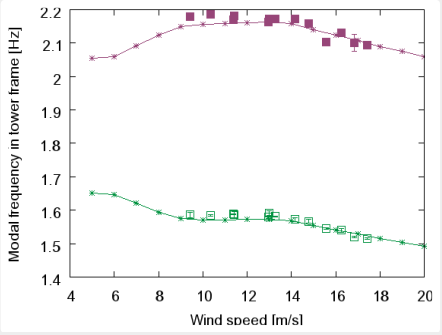
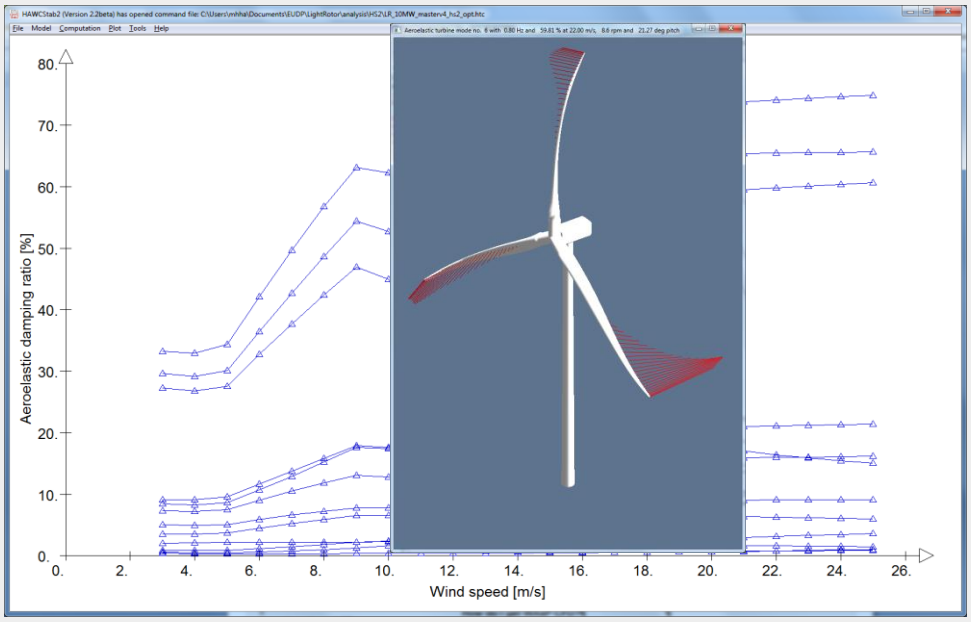
HAWCStab2 – Aeroservoelastic modal analysis

Aero-servo-elastic modal analysis
Vibrations of large flexible wind turbines are highly dependent on its modal properties: frequencies, damping ratios, and mode shapes. HAWCStab2 is a tool for computing and analyzing these modal properties of a wind turbine with or without the unsteady aerodynamic forces and in open- or closed-loop operation. The inclusion of the aerodynamic forces and the controller actions enables aero-servo-elastic stability analysis for predicting negative damped turbine modes.

Aero-servo-elastic design
HAWCStab2 is a powerful tool for aero-servo-elastic design and tuning of controllers: Dominating modes in the simulated aeroelastic response of a turbine can be easily identified and visualized, resonance issues can be predicted to avoid coincidence of modal frequencies with multiples of the rotational speed, both open- and closed-loop aero-servo-elastic stability analyses can be used to predict instabilities due to negatively damped operational turbine modes without and with the influence of the controller, and reduced order aero-servo-elastic models can be derived and parameterized for model-based controllers.



A comparison between HAWCStab2 predicted and measured frequencies of the edgewise rotor whirling modes of a 2750 kW turbine during operation.



The graphical user interface of HAWCStab2 shows a calculation of aeroelastic damping for a wind turbine versus operational wind speed. A click on a point in this diagram starts an animation of the corresponding mode shape including unsteady aerodynamic forces.

Member of the HAWC2 package
HAWCStab2 is a member of the software platform developed by DTU Wind Energy that includes the validated aeroelastic code HAWC2. The aeroelastic model in HAWCStab2 is similar to the model in HAWC2, and their inputs are the same. An existing HAWC2 model of a turbine can therefore be directly used for open- and closed-loop aero-servo-elastic modal and stability analysis in HAWCStab2 and compared directly to the simulated aeroelastic response.

Further development
The software platform from DTU Wind Energy is under constant development. Advanced new tools for design analysis and optimization are and will be implemented in HAWCStab2, and comments from users are used to make it an even more effective tool for aero-servo-elastic wind turbine design.

Facts about HAWCStab2

- *Linear aero-servo-elastic model for open- and closed-loop eigenvalue and frequency-domain analysis of wind turbines.*
- *Kinematics based on co-rotational finite element method. Unsteady aerodynamics based on Beddoes-Leishman.*
- *State space model of the controller can be defined by the user for closed-loop analysis.*
- *HAWCstab2 is constantly being developed at DTU Wind Energy.*
- *HAWCStab2 is today used in both academia and industry.*

Contact & Information:
Scientist Lars C. Henriksen
Phone +45 4677 4026
Email: larh@dtu.dk