DyNaLab Test Bench

WIND ASSURING CONFIDENCE
THROUGH COMPETENCE

Torben Jersch

3rd Annual International Workshop on
GRID SIMULATOR TESTING
OF
ENERGY SYSTEMS AND WIND TURBINE POWERTRAINS

November 5-6, 2015 - Tallahassee, Florida, USA

QUALITY SYSTEM CERTIFICATION
DNV·GL
ISO 9001

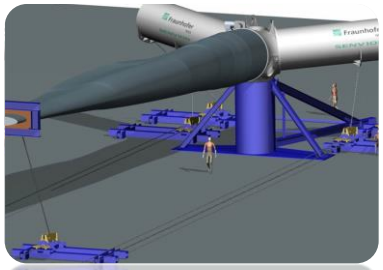
Fraunhofer
IWES

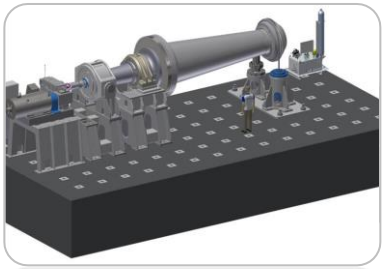
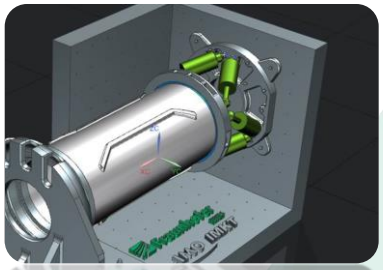



Short profile of Fraunhofer IWES North-West

Managing Director:	Prof. Dr.-Ing. Andreas Reuter
Research spectrum:	Wind energy from material development to grid connection
Operational budget 2014:	around 13,2 million €
Staff:	150 employees
Previous investments in the establishment of the institute:	€ 60 million

Strategic Association with ForWind and the German Aerospace Center (DLR)



Short profile of Division Wind Turbine and System Technology

Division Manager:	Prof. Dr.-Ing. Jan Wenske
Research spectrum:	Structural durability, mechatronics, power electronics and control in the area of entire wind turbines Large scale test benches for mechanics, electronics and Power mechatronics
Staff:	30 employees
Division locations:	Bremerhaven – Hannover



Planning in 2013

Wind Load Simulation 6-DOF:

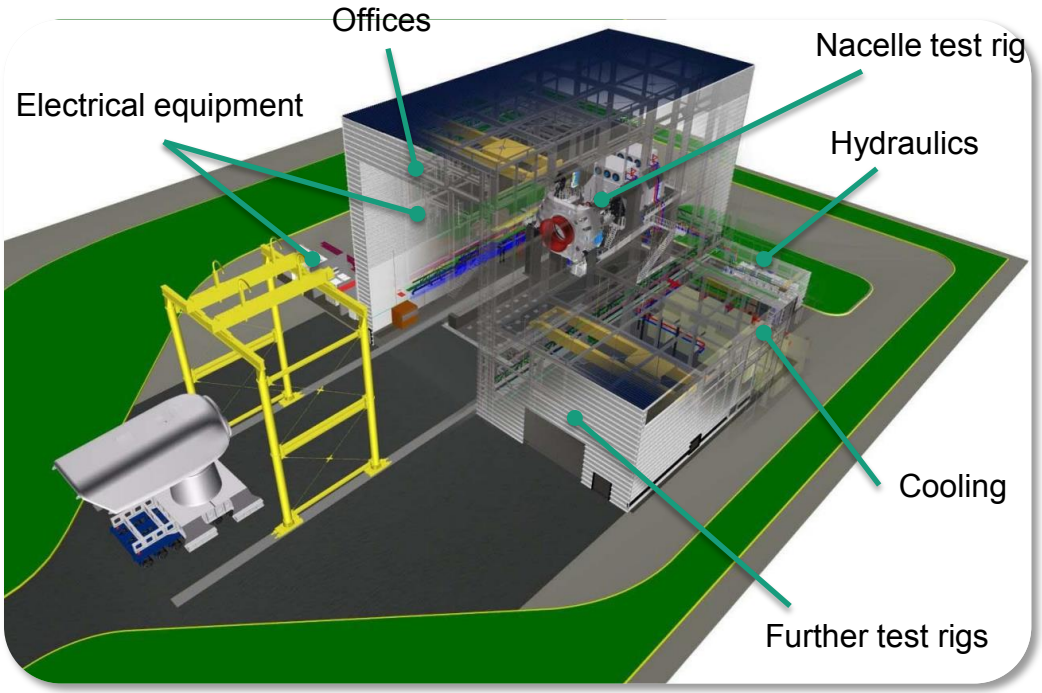
- Bending: ± 20000 kNm
- Torque: 8600 kNm
- Motor speed: ± 25 rpm

Grid load simulation:

- LVRT & HVRT
- Low THD level (< 2%)

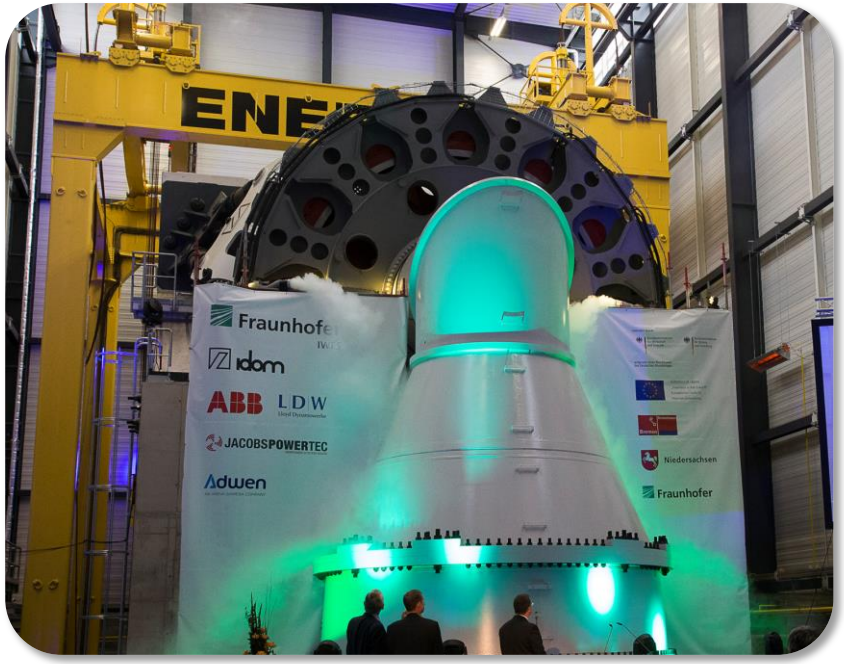
Auxiliaries:

- Offices for 24 researchers / technicians
- 1.5 MW installed hydraulic power
- 3.5 MW installed cooling power
- 9.0 MVA grid connection @ 20 kV






10MW Full Nacelle Test bench



Design – two ESM on one Shaft - Nominal Power of 10 MW @ 11rpm:

- Civil and building construction 01/14 – 04/15
- Test bench construction 12/14 - 06/15
- Commissioning 05/15 – 09/15
- Transfer of ownership 10/15

JPT Testing:

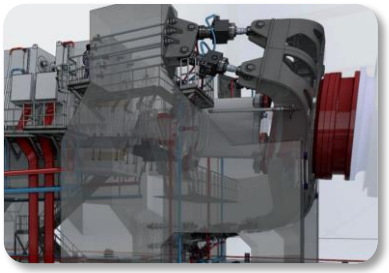
- Installation of electrical equipment 07/15
- Installation of DUT 08/15

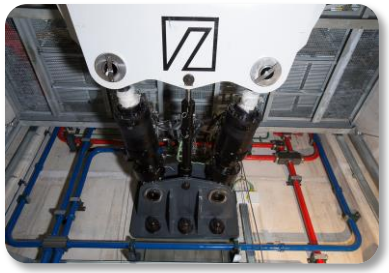
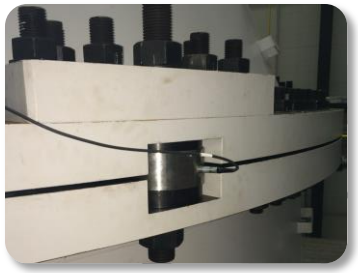
Opening ceremony 10/15

Invest:

- 32 mio €

Fraunhofer IWES



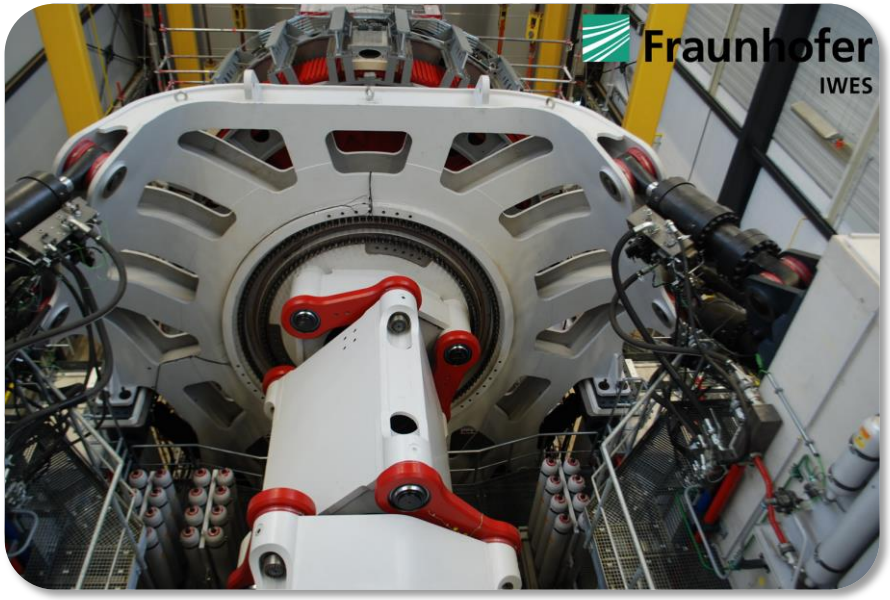
Load Application System

Design – three nominal voltage level

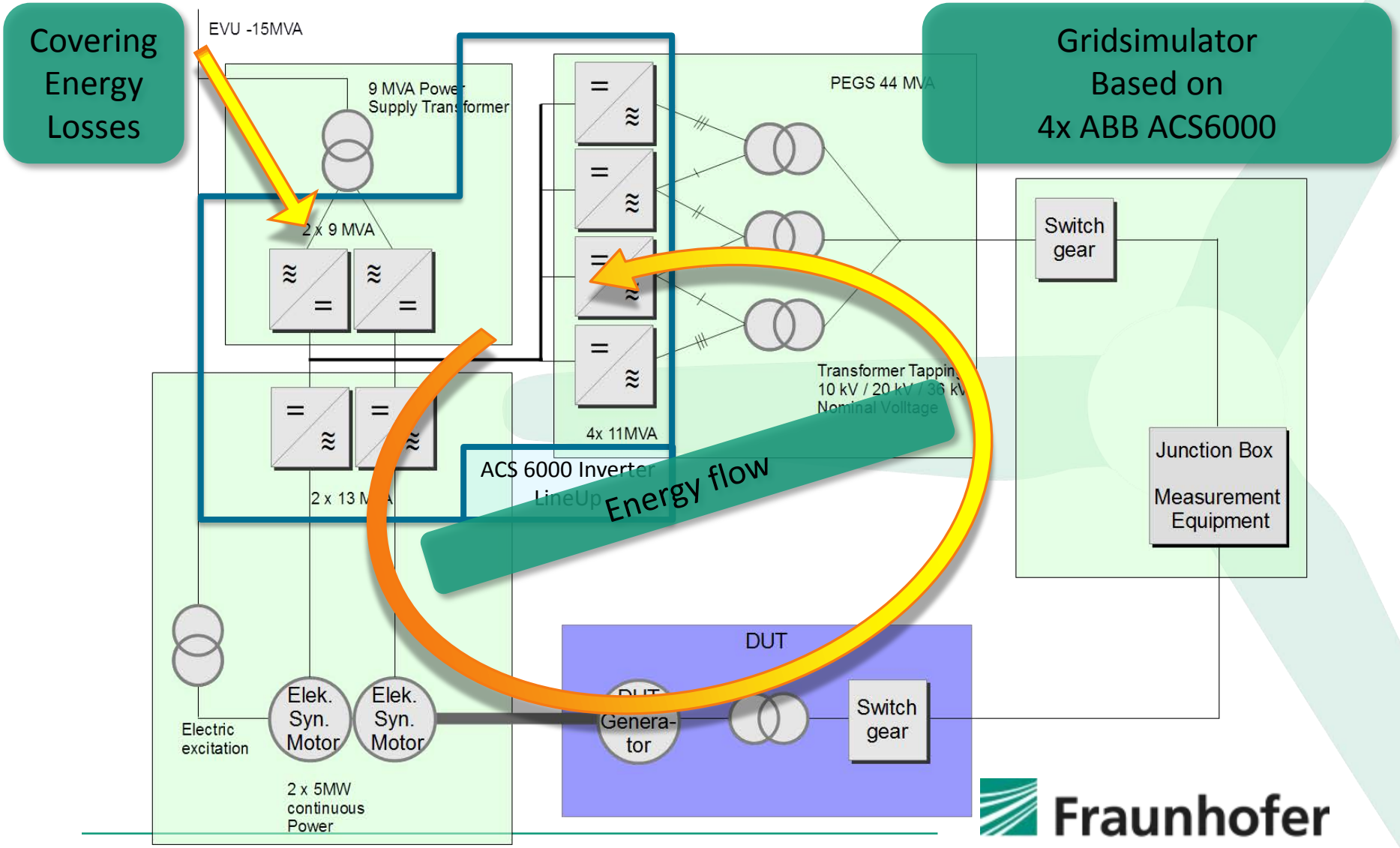
- 5 DOF
- Bending moments up to 20MNm
- Dynamic 0-2 Hz
- 0-G Kit + Blocking cylinders
- 1.2 MW Hydraulic power
- Applying realistic load time series

Commissioning:

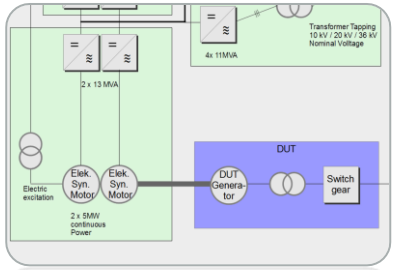
- Running in position and force Mode
- Running against blocking cylinders
- Calibration of Load application unit by using load cells

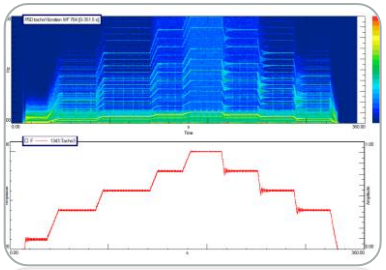


Overview – Inverters and MV-System



Fraunhofer IWES





Drivetrain

Design – two ESM on one Shaft - Nominal Power of 10 MW @ 11rpm

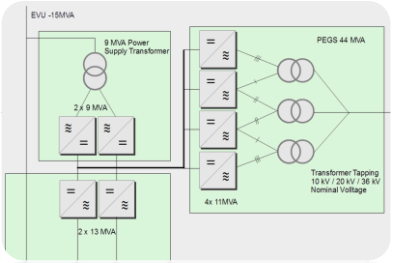
- Torque: S1 8600 kNm – S6 13000 kNm
- Motor speed: ± 25 rpm
- Inverters: 2 x 13 MVA

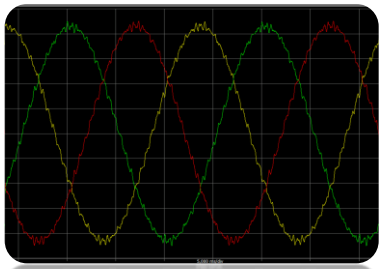
Commissioning:

- Back-to-Back test at nominal design loads
- Heating test
- Dynamic behavior

Auxiliaries:

- Real-time control Interface
- Adjustable safety clutch





Gridsimulator

Design – three nominal voltage level

- Nominal tapping: 10 kV – 20 kV – 36 kV
- HVRT tapping: 13 kV – 26 kV – 46.8 kV
- LVRT capability: to 0V

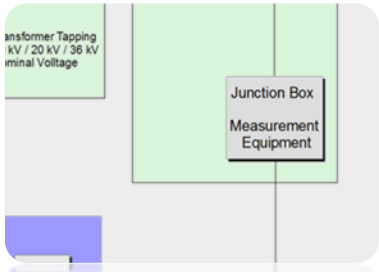
Commissioning:

- Improvement of PEGS for faster slopes

Further work:

- Voltage feedback
- Commissioning of ABB <> Opal-RT high speed interface
- Reduction of high harmonics

Fraunhofer IWES



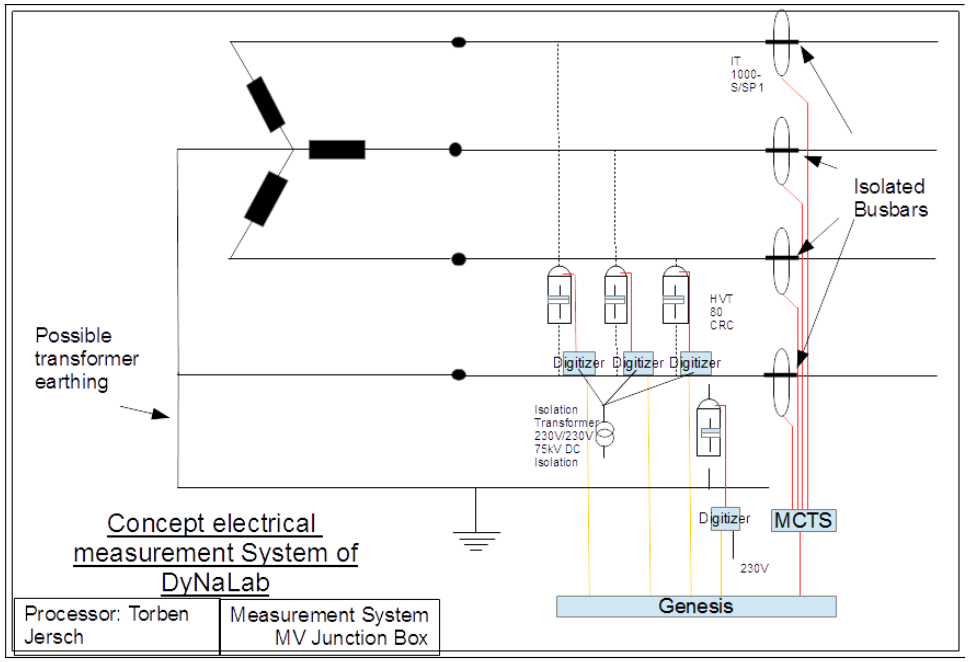
Electrical Metrology

Electrical metrology

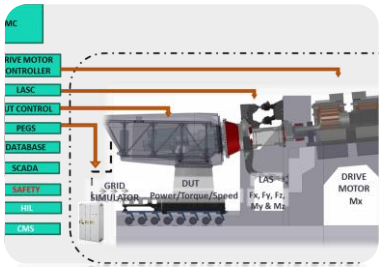
- Synchronized measurements of 50 channels
- Visualization in control rooms
- 4 TByte storage capability
- By GPS clock synchronized measurements
- EtherCat Interface

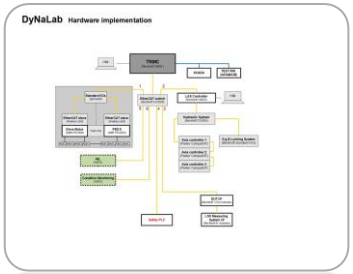
Design – MV-Measurements

- Designed for in IT-Grid
- Isolated voltage up to 75 kV
- Ultra precise measurements of voltages and currents
- Bandwidth up to 1 MHz

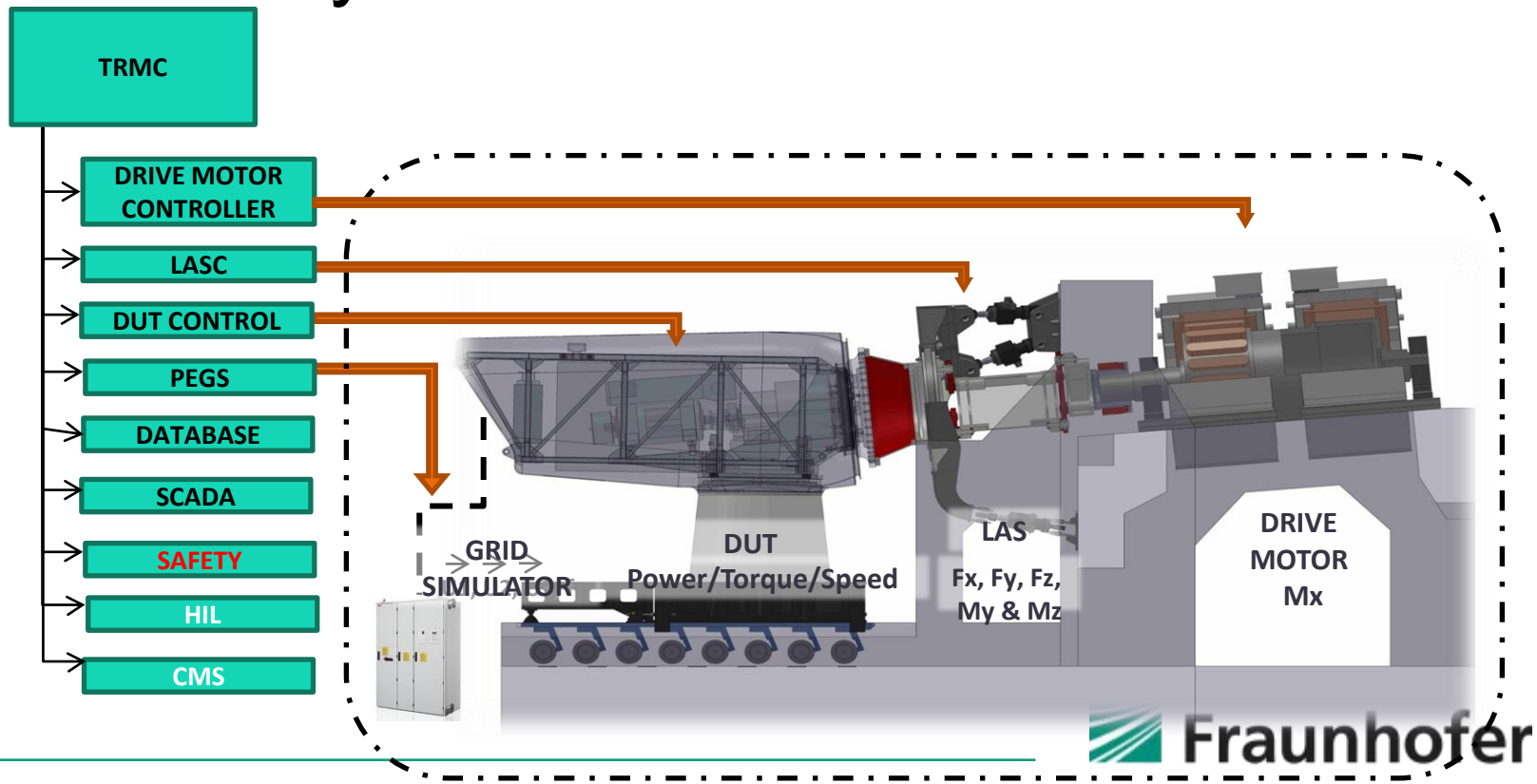


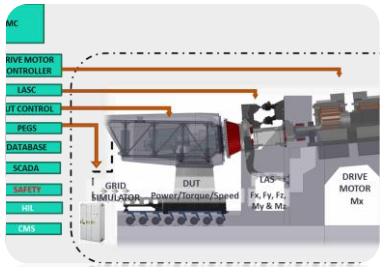
Fraunhofer IWES

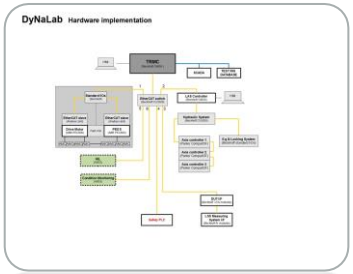




Control - System







Control - System

Real-Time Control

- Real-Time EtherCat Fieldbus
- 2ms – 1ms Cycle time for controlling the main actuators
- Real-time simulation platform for WEC-models (Beckhoff) - grid and power electronics models (Opal-RT) with EtherCat interface
- Time synchronization of all components over distributed clock functionality

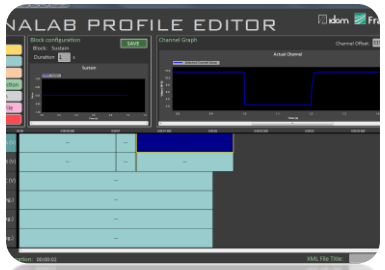
ABB - Control

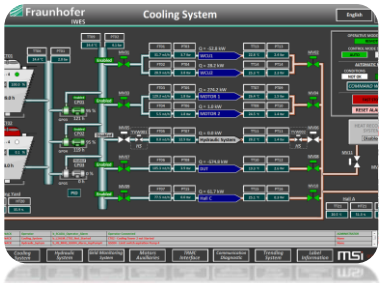
- EtherCat interface to ABB
- Advanced control on ABB-Inverters

Safety System

- Programmable Safety interface
- Safety over EtherCat

Fraunhofer IWES





HMI – Graphical User Interface

Profile Editor

- Defining profiles of set points of LASC, Motor, PEGS

SCADA

- Control of auxiliaries, Cooling, Hydraulic pumps, Switchgears, Fans
- Supervision of Power consumption, Grid

HMI – TRMC

- Operating the Test bench

Communication

- Beckhoff to Labview communication via ADS Interface

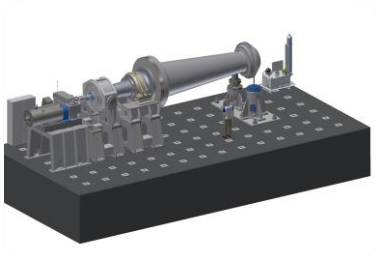
Fraunhofer IWES

Actual Projects and Outline

JACOBSPOWERTEC
VENPOWER-SYSTEM INSIDE

Adwen
AN AREVA GAMESA COMPANY

Fraunhofer IWES



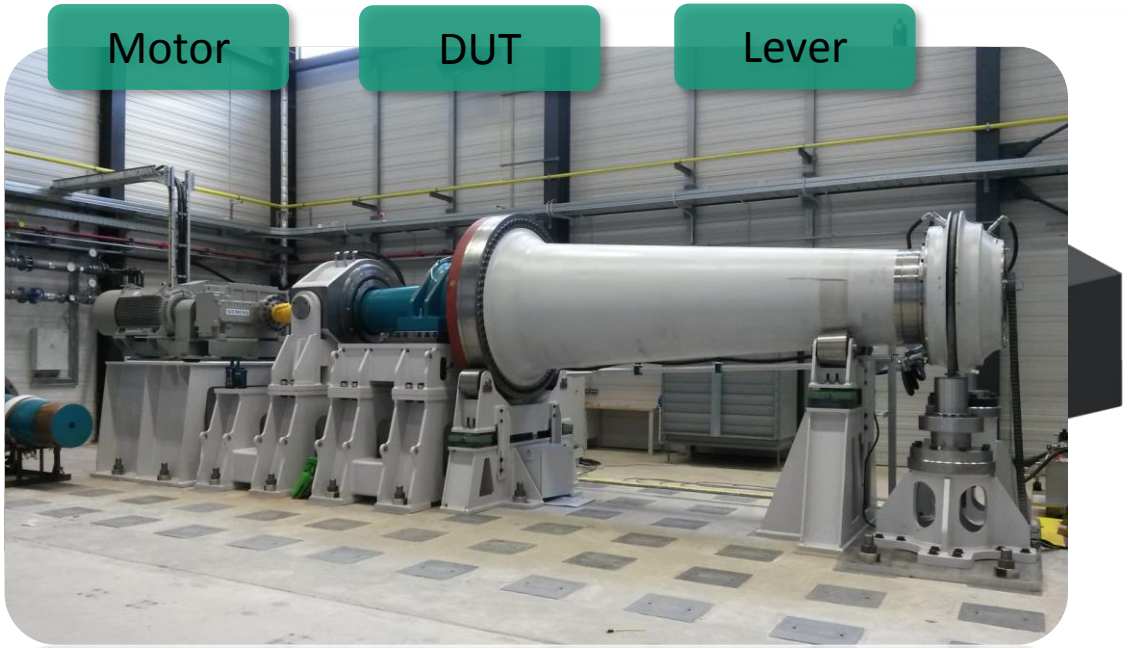

BeBen XXL – Main shaft testing

Key points

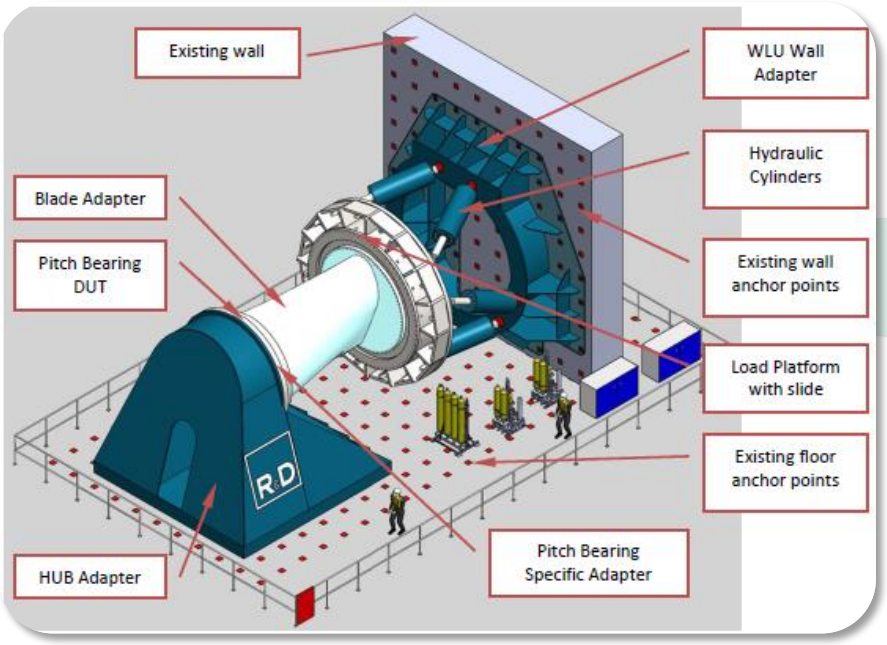
- Max bending moment 15 MNm
- 350 kW drive unit
- Modular adapter
- 7x15m clamping field

Possible tests

- Accelerated lifetime test
- Model validation
- Functional testing



Outline
HAPT (**H**ighly **Accelerated P**itch bearing **T**est)



Motivation

- Currently no method for pitch bearing lifetime prediction
- Current test rigs exclude interaction with hub and blade Current test rigs exclude interaction with hub and blade

Goal

- Development of suitable test rig and test method

Capabilities

- Dynamic generation of bending moments, axial and radial forces
- Emulation of blade and hub stiffness
- Continuous pitching under load possible
- Pitch bearing diameter of 4 – 4,5 m (~ 10 MW turbine)
- Turbine service life in 6 month test time

THANK YOU FOR YOUR ATTENTION

Any questions?

Torben.jersch@iwes.fraunhofer.de

Fraunhofer IWES

Acknowledgements

Fraunhofer IWES North-West is funded by the:

Federal State of Bremen

- Senator für Umwelt, Bau, Verkehr und Europa
- Senator für Wirtschaft und Häfen
- Senatorin für Bildung und Wissenschaft
- Bremerhavener Gesellschaft für Investitions-Förderung und Stadtentwicklung GmbH

Federal State of Lower Saxony

Federal Republic of Germany:
BMWi Federal Ministry for Economic Affairs and Energy
BMBF Federal Ministry of Education and Research

with support of the European Regional Development Fund (EFRE)

Bremerhaven
Bremen

Niedersachsen
Lower Saxony

Supported by:
Federal Ministry for Economic Affairs and Energy
Federal Ministry of Education and Research
on the basis of a decision by the German Bundestag

EUROPEAN UNION:
Investing in your future
European Regional Development Fund

Fraunhofer IWES

