

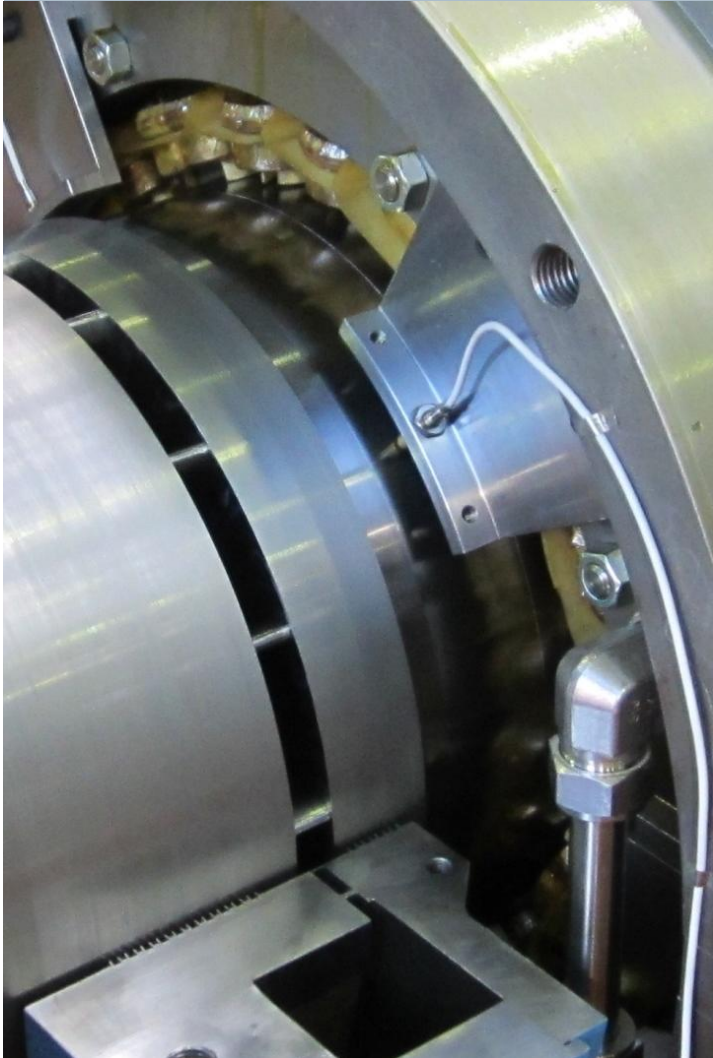


SIEMENS

Christoph Grund, Dr. Detlef Haje

Qualification of Magnetic Bearings for Industrial Turbines

Qualification of Magnetic Bearings for Industrial Steam Turbines



Vision of an oil-free turbine

AMB turbine test bed

Qualification tests

Prototype application

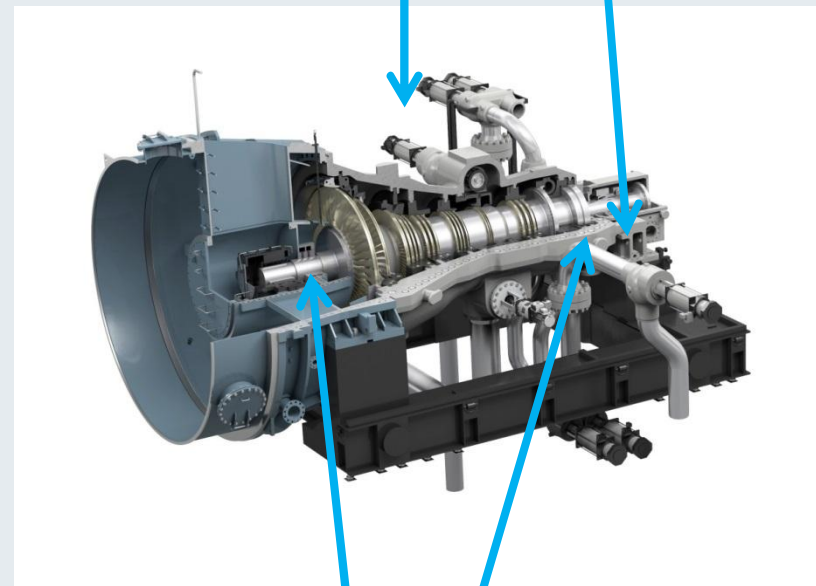
Summary

Vision of an “oil-free turbine”

Advantages for steam turbines:

- Improved turbine efficiency by up to 1% by reduced bearing friction
- Reduced fire hazard by avoiding the lube oil system
- Reduced maintenance scope
- Wear-free bearings
- Online Rotor Monitoring by AMB Controller

Electro mechanic valve actuators instead of oil hydraulic actuators



AMB instead of hydrodynamic bearings

AMB turbine test bed

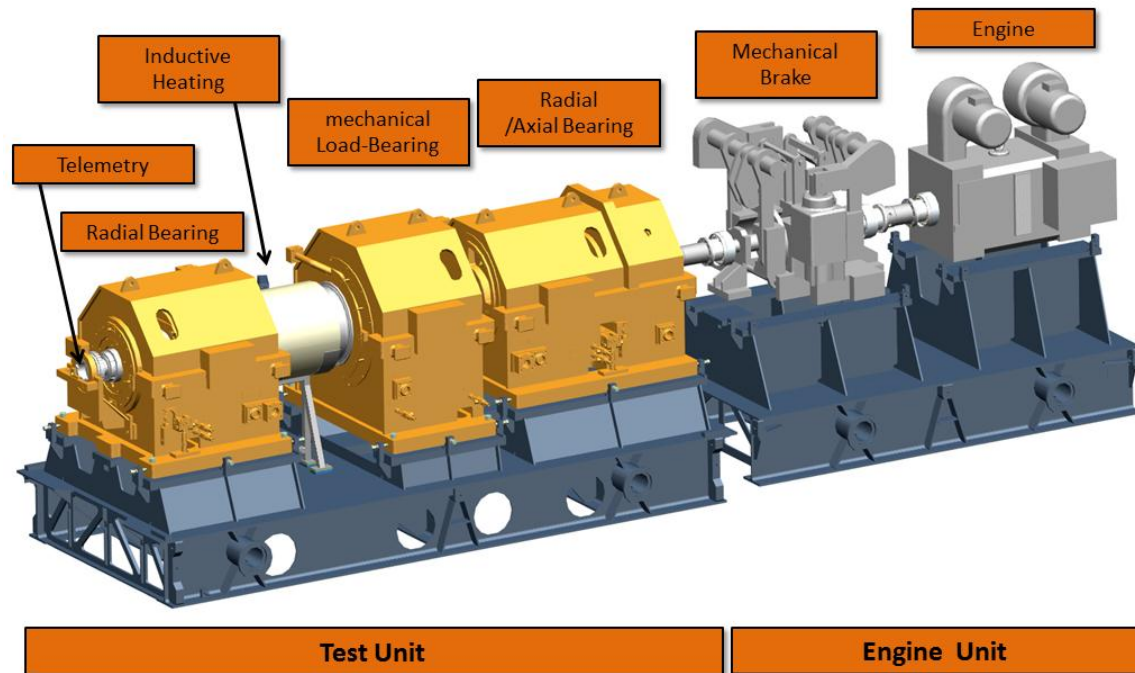
Main development targets for the steam turbine test bed at the University of Applied Sciences Zittau/Görlitz:

1. Steam Temperature simulation to verify the thermal effectiveness of the patented cooling system
2. Verify the handling of simulated steam forces by the AMB
3. Verify the function of auxiliary bearings

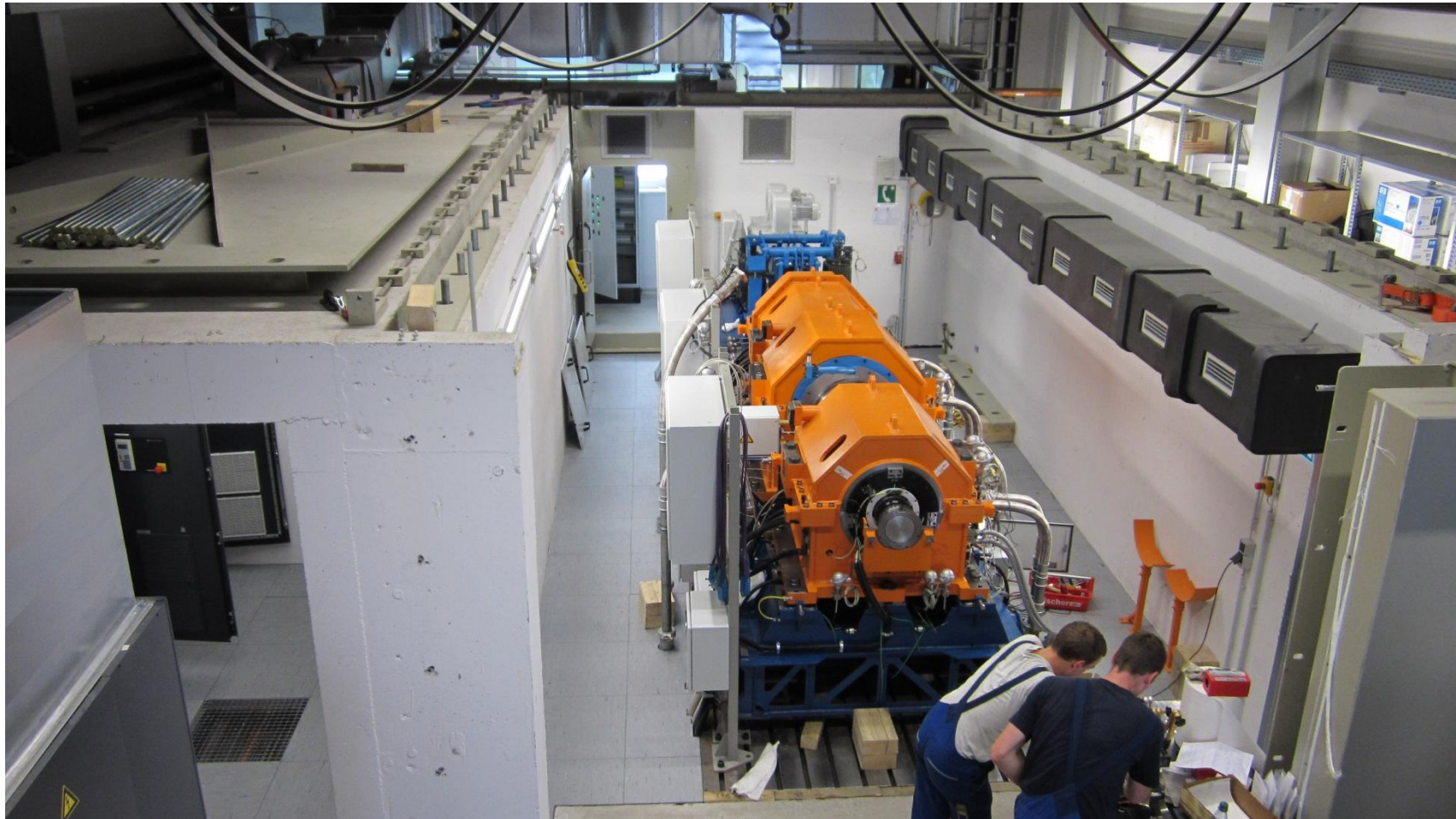
Qualification of the AMB technology for the first application at Industrial Steam Turbines

AMB turbine test bed

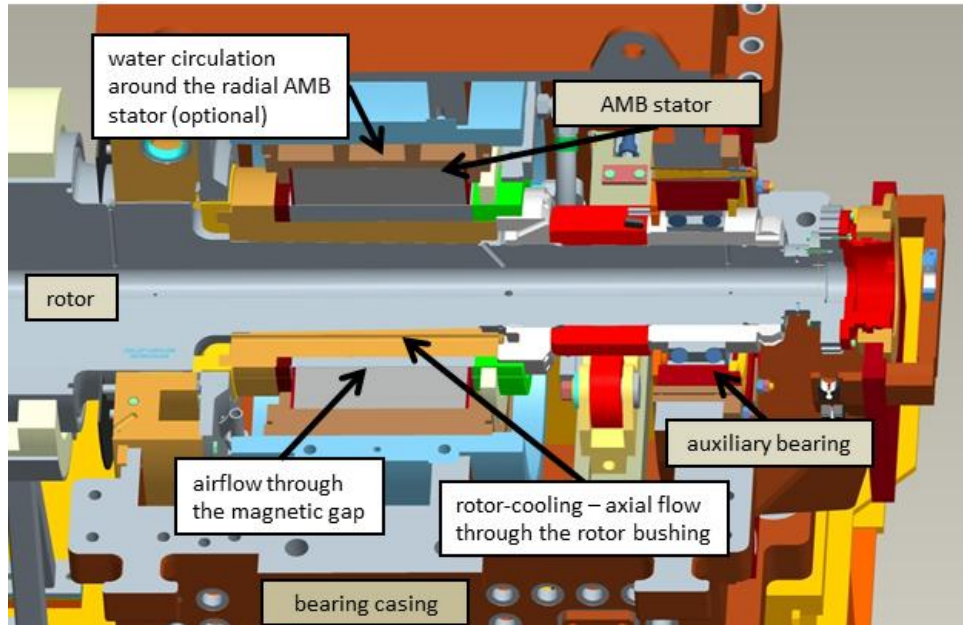
Test bed key parameter		
Speed	5800	rpm
Elect. Power rating Elect. Brake Power	280 640	kW
Loads: Radial AMB Axial AMB Load Bearing	25 25/50 35	kN
Rotor Mass ca. Length ca.	2500 4000	kg mm
Inductive Heating Power	40	kW



AMB turbine test bed



AMB turbine test bed



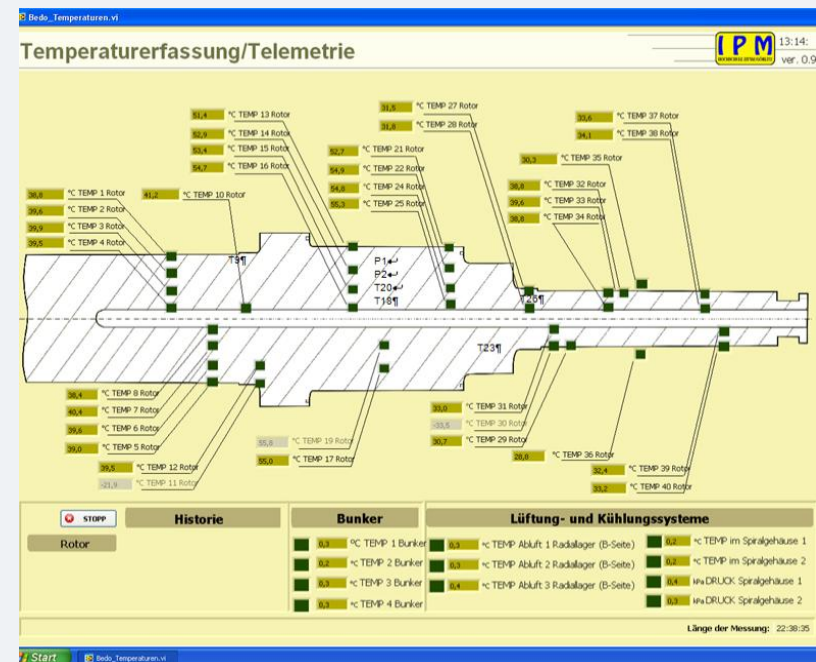
AMB cooling system

Horizontally divided radial AMB



Instrumentation

- Temperature Probes within the rotor (transmitted via telemetry-system)
- Temperature Measurement at the rotor surface with Pyrometers
- Vibration measurement on all bearing casings
- Speed measurement at inner Ring of the auxiliary Bearing
- 6 temperature Probes at the outer Ring of the auxiliary Bearing
- Force Measurement at one auxiliary Bearing
- Condition Monitoring for both auxiliary Bearings
- Volume flow, temperature and pressure measurement for the cooling medias
- AMB Position Sensors



Operation interface screenshot

Qualification tests

Executed Tests

1. Commissioning
2. Flow test AMB rotor cooling
3. Steam temperature tests
4. Auxiliary bearing tests
5. Steam force tests
6. Cooling air parameter optimization

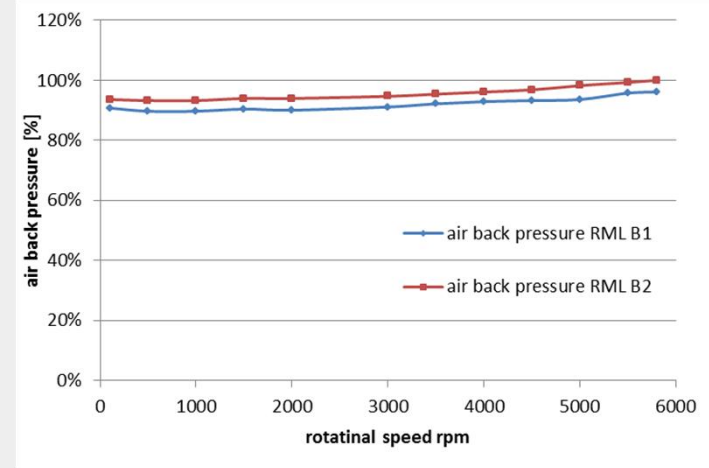
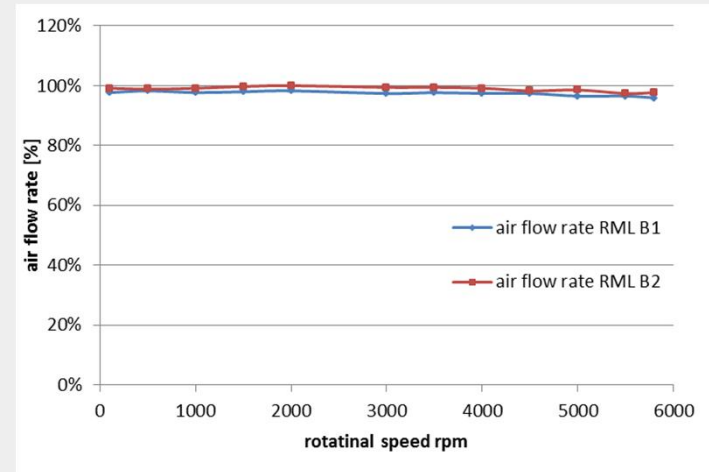
Rotor cooling flow test

Test target:

Verification of cooling air flow for the whole operation range.

Result:

Verification successful. Ram pressure slightly increasing with rotational speed.



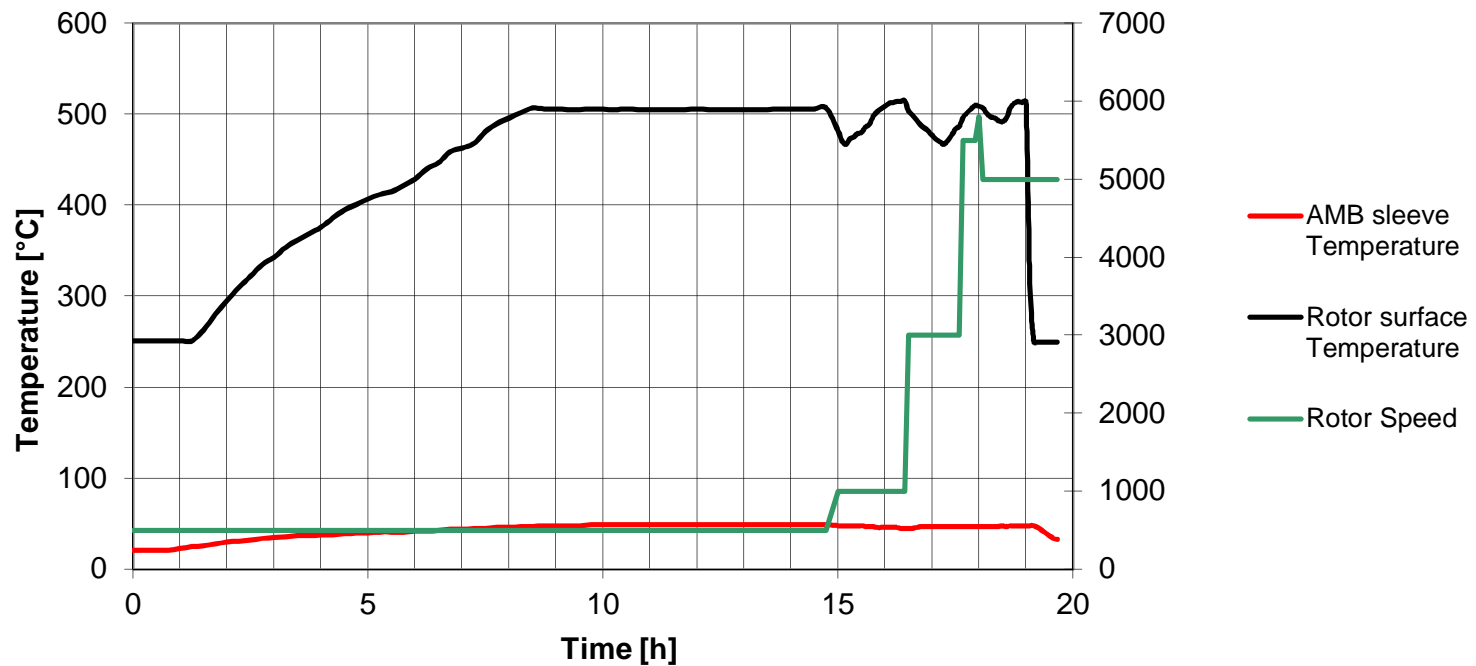
Steam temperature test

Test target:

Verify cooling power to ensure function of AMB

Results:

Stable rotor cooling proven for 510 ° C



Auxiliary bearing test

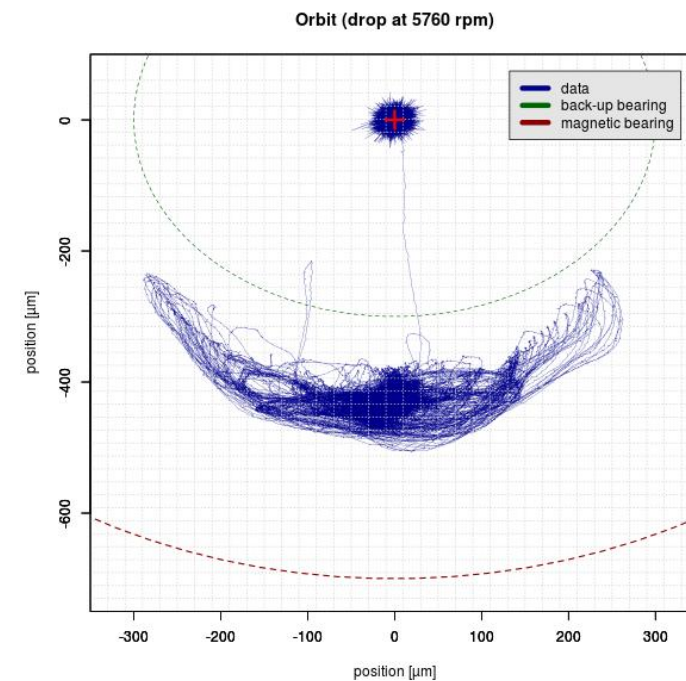
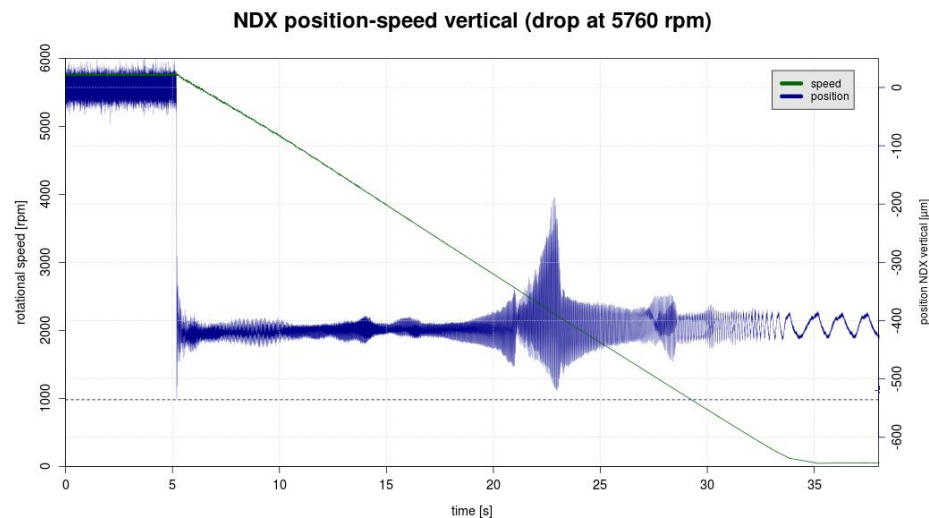
Test target:

Verify function of auxiliary bearing

Result:

Completed test series with full speed drop tests

Auxiliary bearing qualified for application



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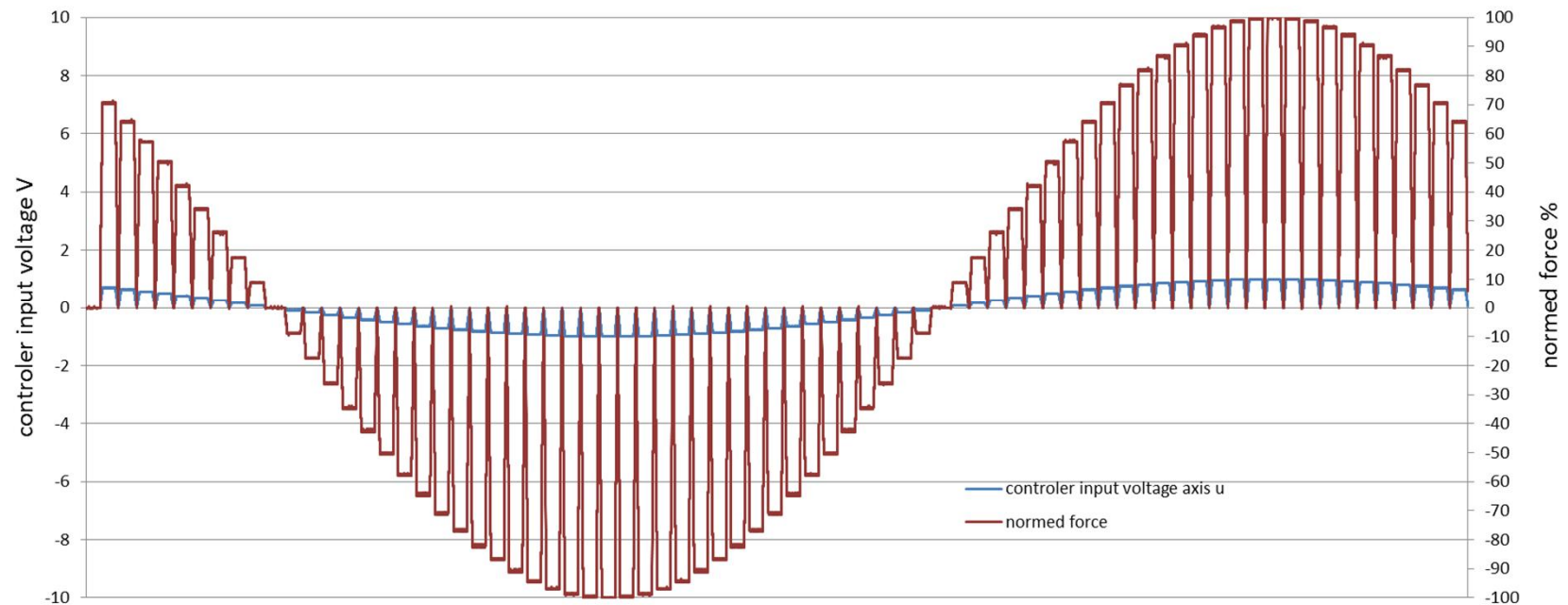
Steam force simulation

Test target:

Verify compensation of a radial process force

Result:

Simulated steam force can be compensated



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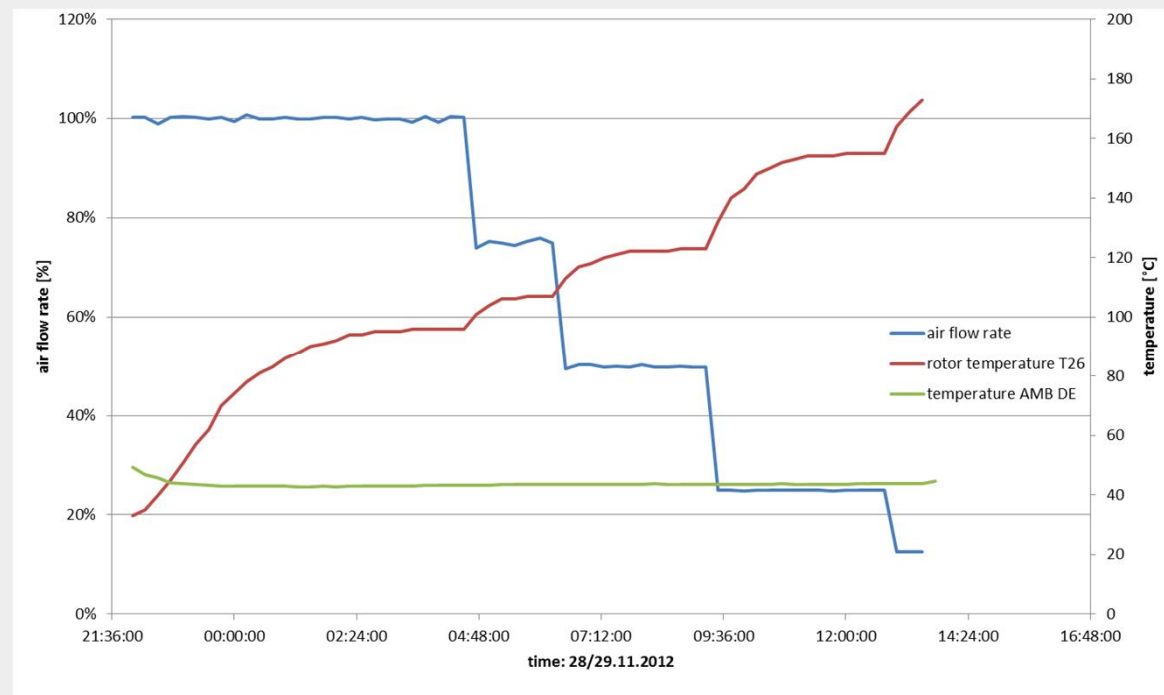
Optimization of cooling air parameter

Test target:

Identification of the influence of the different cooling systems on the rotor temperature

Result:

Optimized air flow rate determined for AMB operation.



Prototype application

Key Data

- Backpressure turbine
- Rotor weight: approx. 2,5 t
- Turbine Power: approx. 10 MW
- Operational speed: 4500-5400 rpm
- Double End Pump Drive
- Turbine Delivery in August 2014
- Siemens Simotics AMB
- Radial AMB horizontal divided
- FAG Auxiliary Bearings



Prototype steam turbine during manufacturing in Goerlitz

Summary

- ✓ Successful operation of the heated rotor in AMB at 5760 rpm
- ✓ Successful test of the AMB cooling System up to maximum speed
- ✓ Successful test of the AMB system under simulated power plant environment
- ✓ Successful test with simulated steam force
- ✓ Successful test of the auxiliary bearings

AMB technology qualified for first Industrial Steam Turbine Prototype

Summary



Thank you for your attention!

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