

# Experimental Verification of Thrust Bearing Models in Automotive Turbochargers



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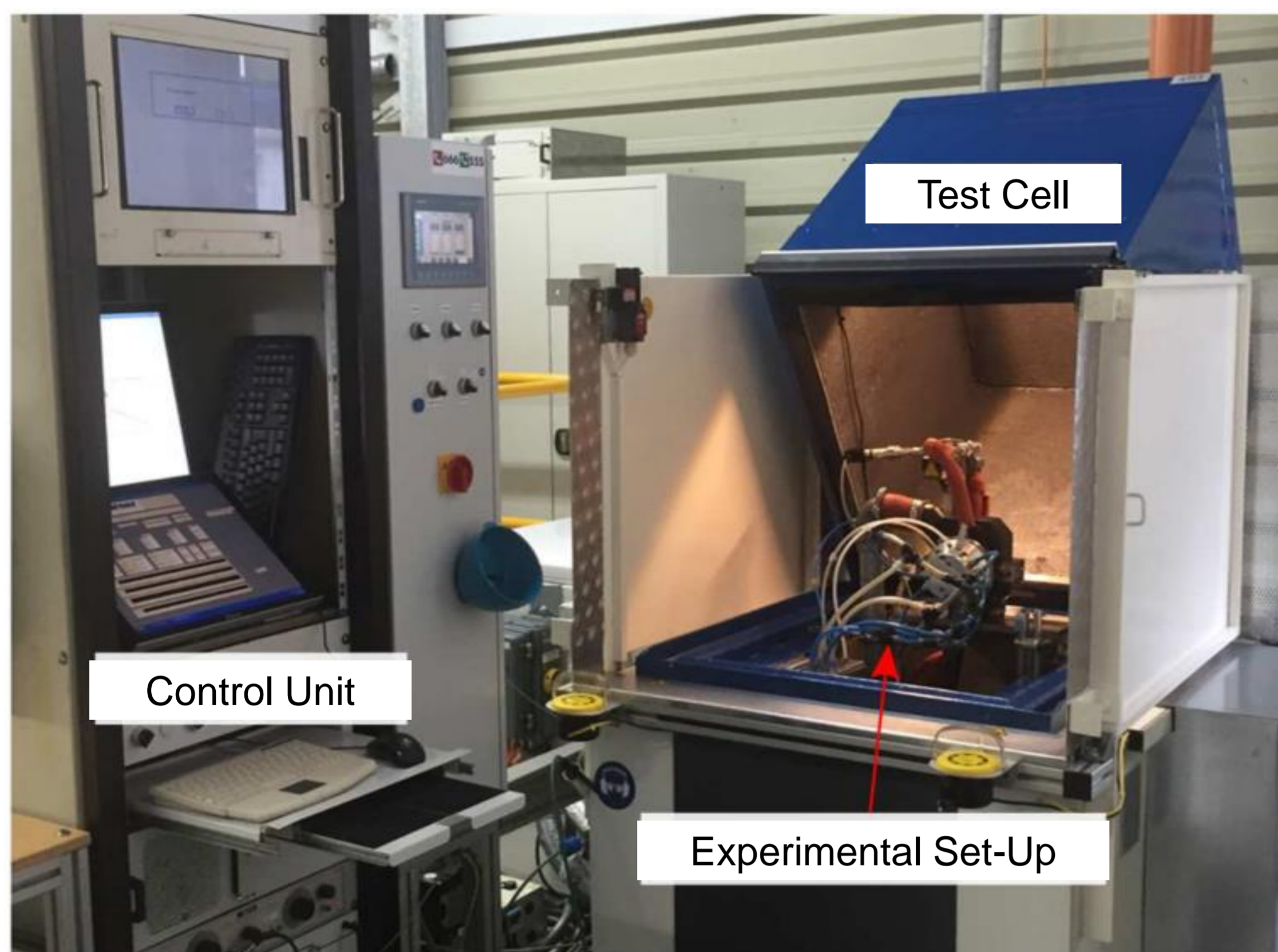
1. Institute of Applied Dynamics, Technical University of Darmstadt

2. BorgWarner Turbo Systems Engineering GmbH

Motivation

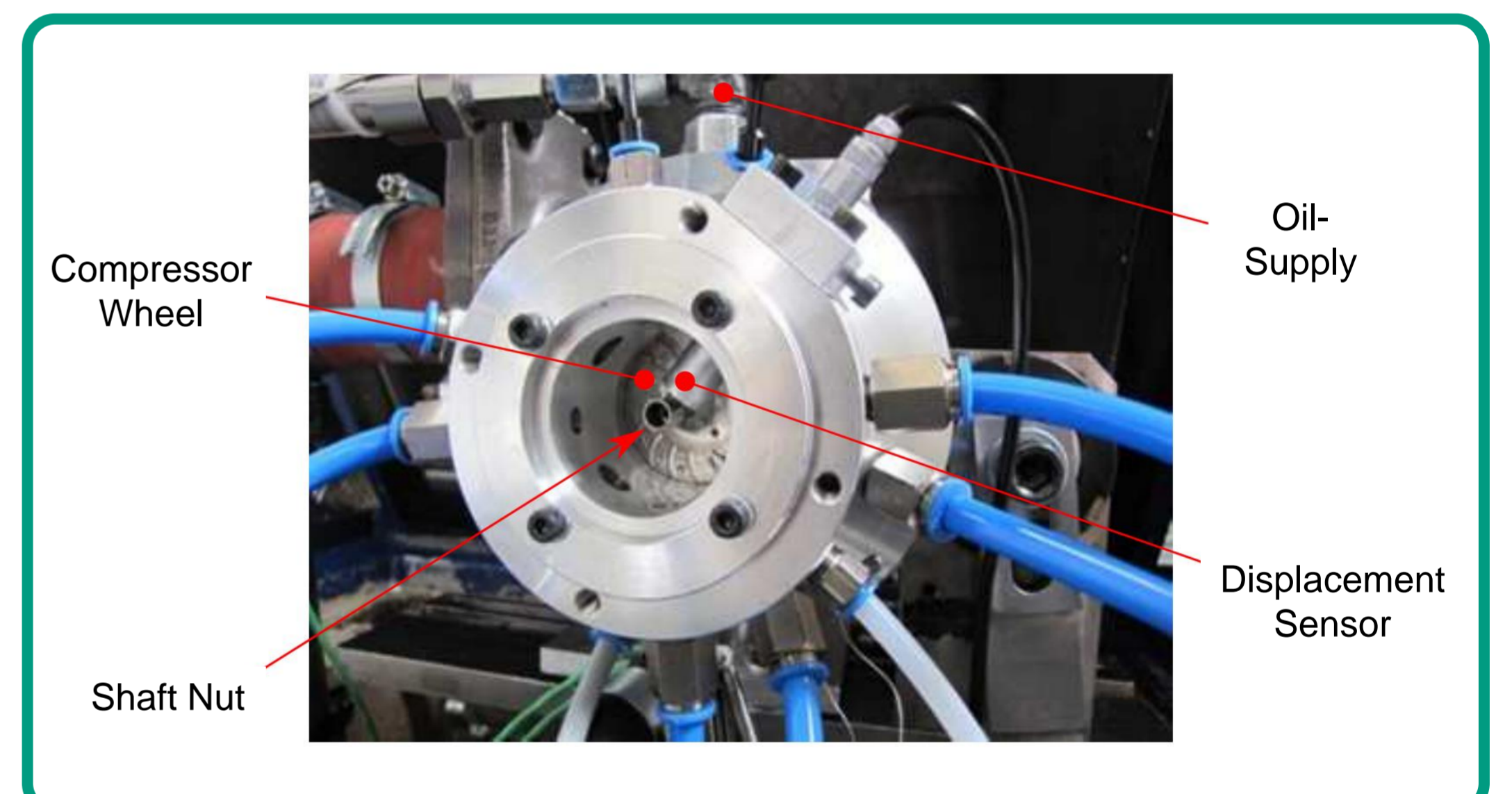
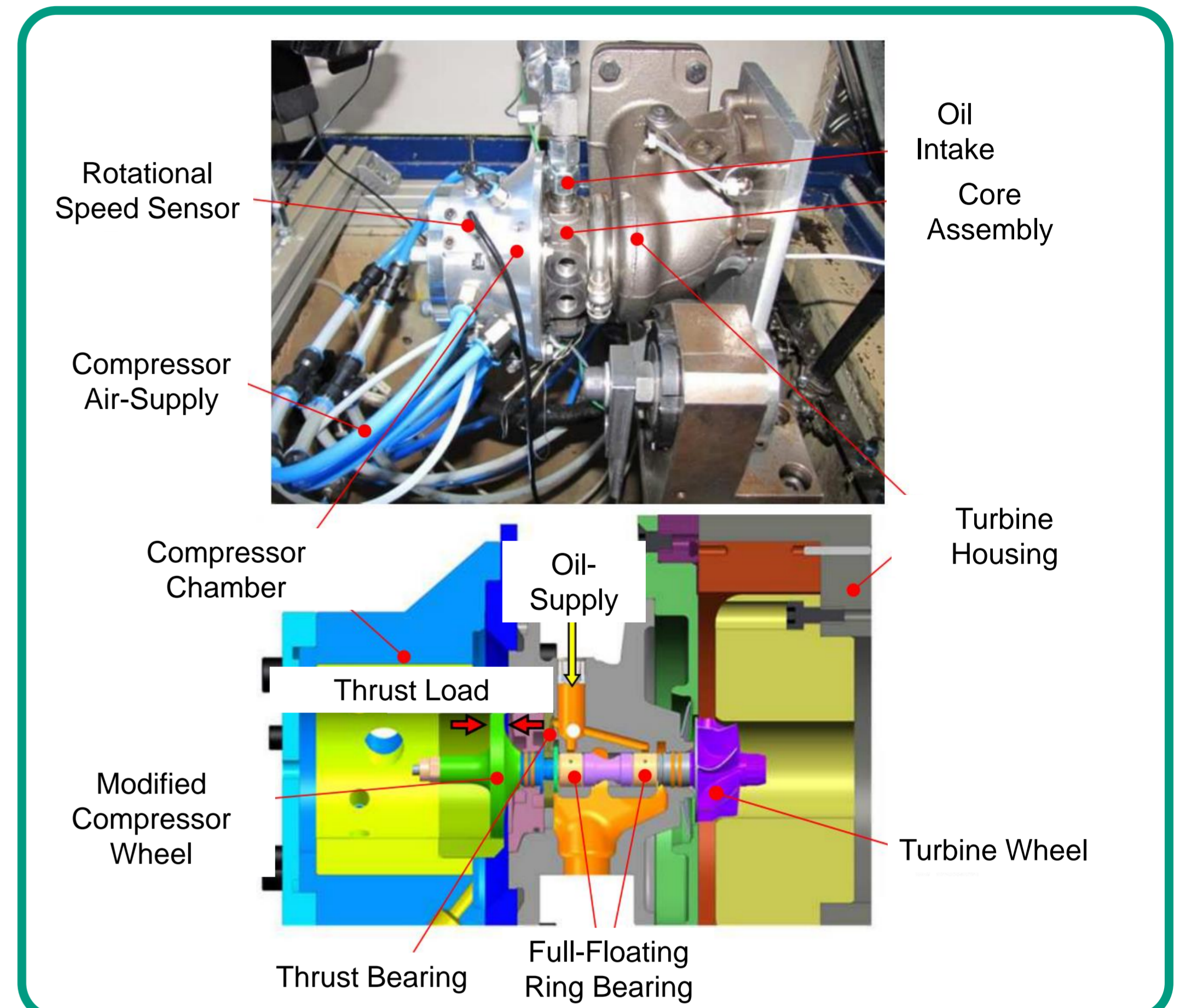
- Experimental validation for the influence of thrust bearings both on the frequency and on the amplitude of the subsynchronous vibrations is provided.
- Detailed comparison between measurement and simulation.

Experimental Device



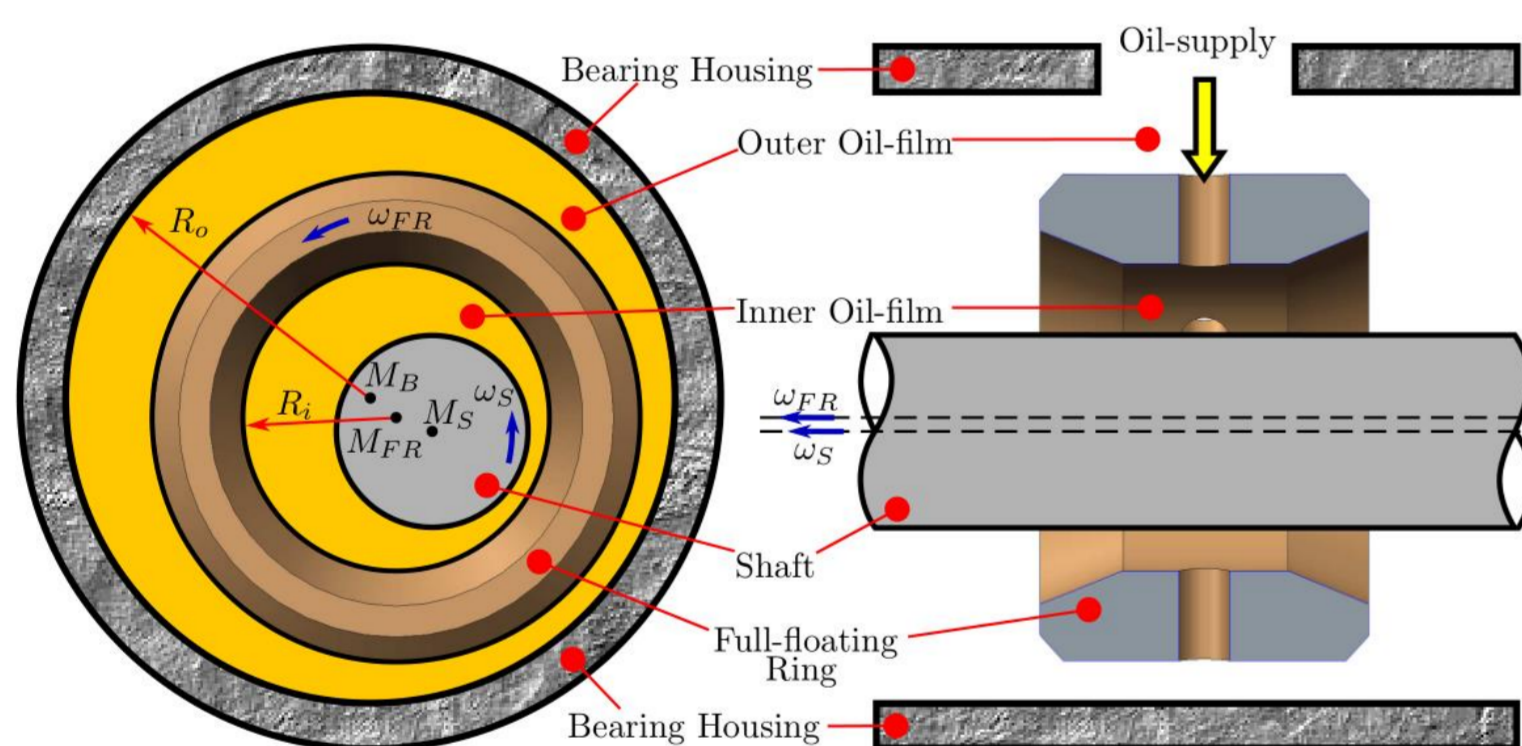
- The turbocharger is placed in the Test Cell for measurements of: (a) acceleration on housing, (b) shaft motion, (c) axial displacement.
- Specially designed compressor housing for allowing two sided thrust loads.
- Specially designed compressor wheel for controlling the axial motion.

## Experimental Set-Up:

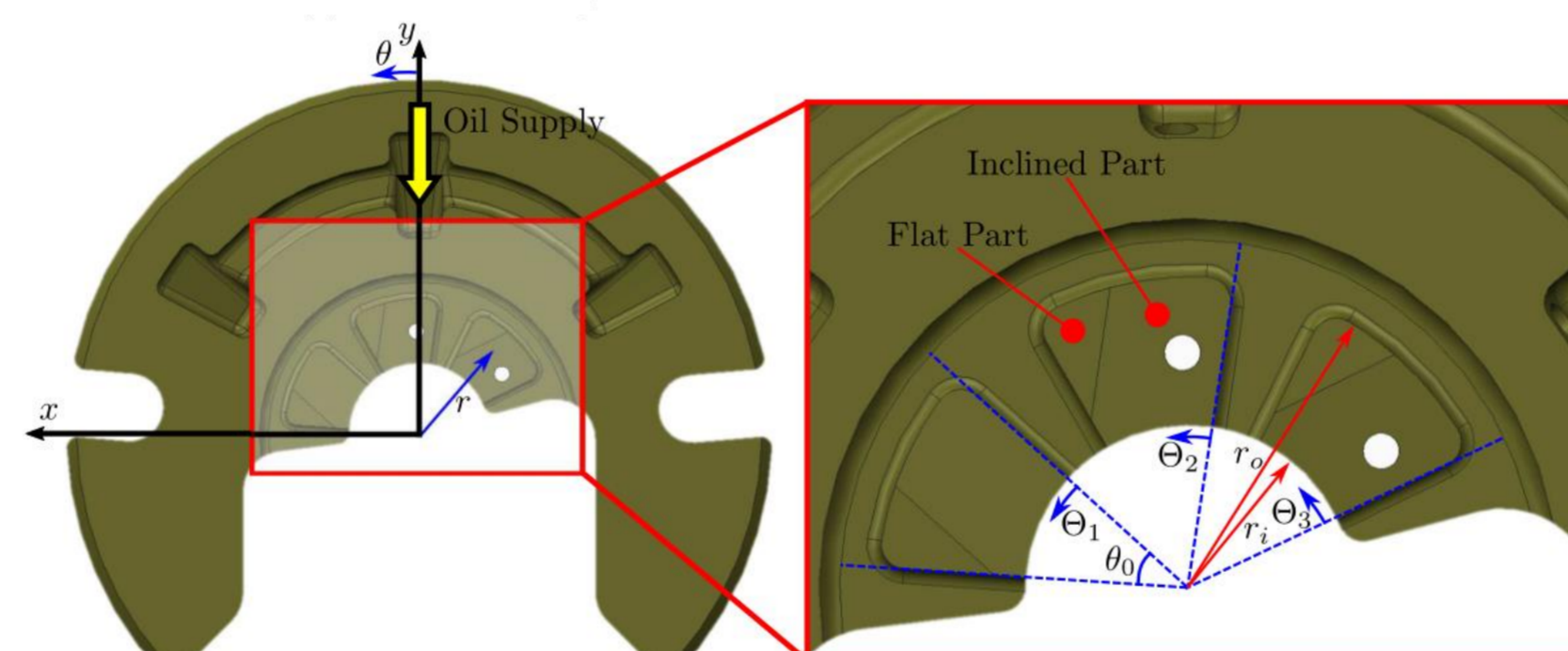


Radial and Thrust Bearings

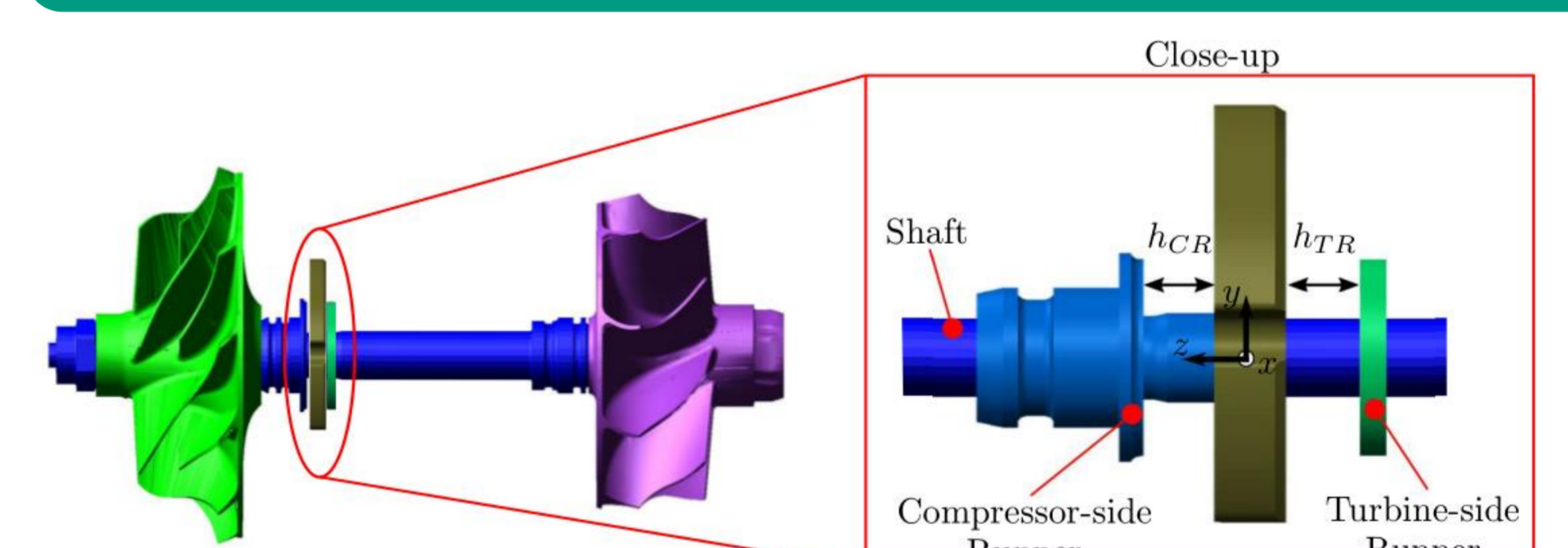
## Full-floating Ring Bearing



## Thrust Bearing with 3 Pads

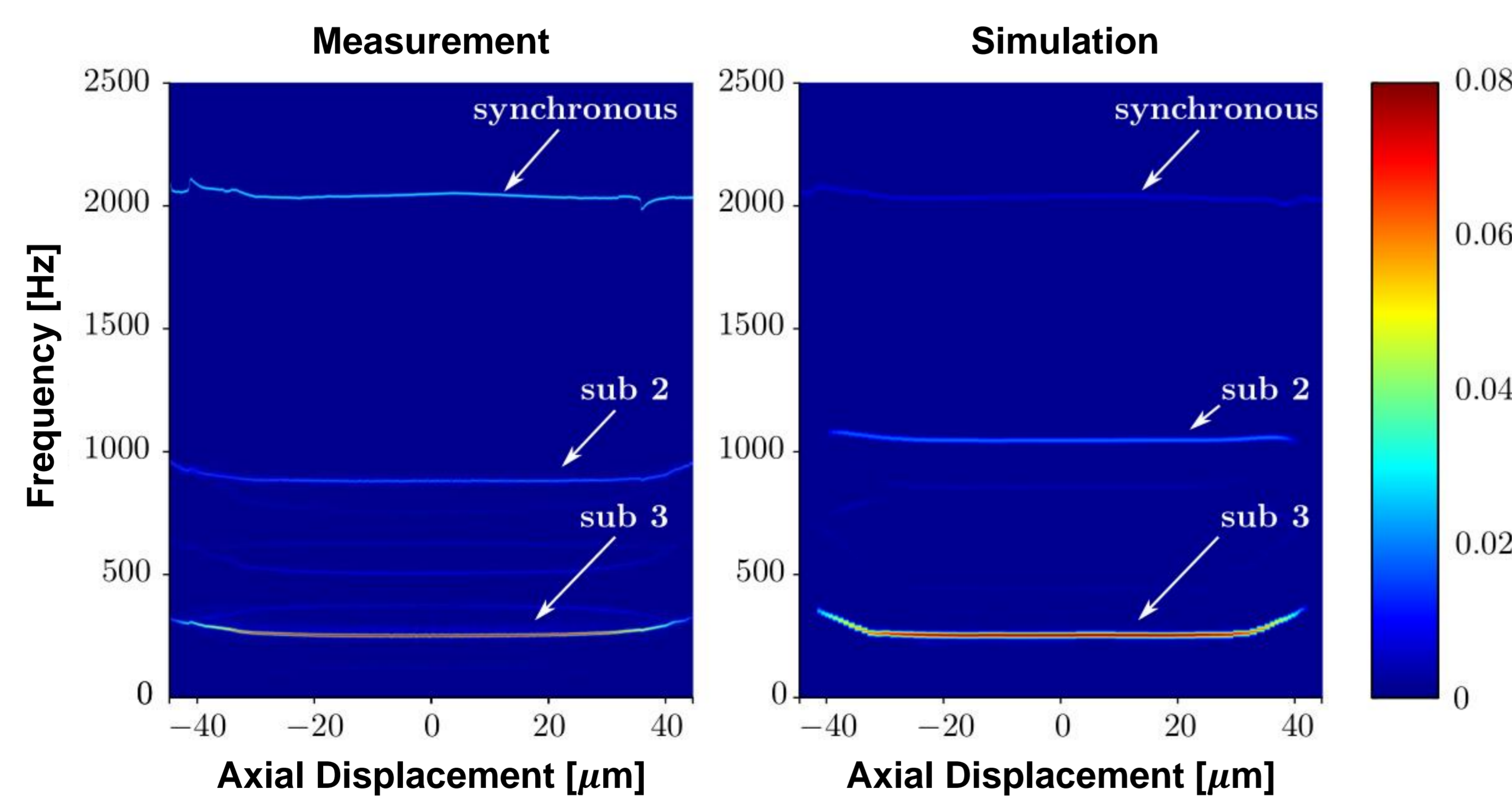


The radial bearings are modeled using a novel semi-analytical Galerkin<sup>1</sup> approach and the thrust bearing is modeled using a Finite Difference approach<sup>2</sup> for the solution of the Reynolds equation.



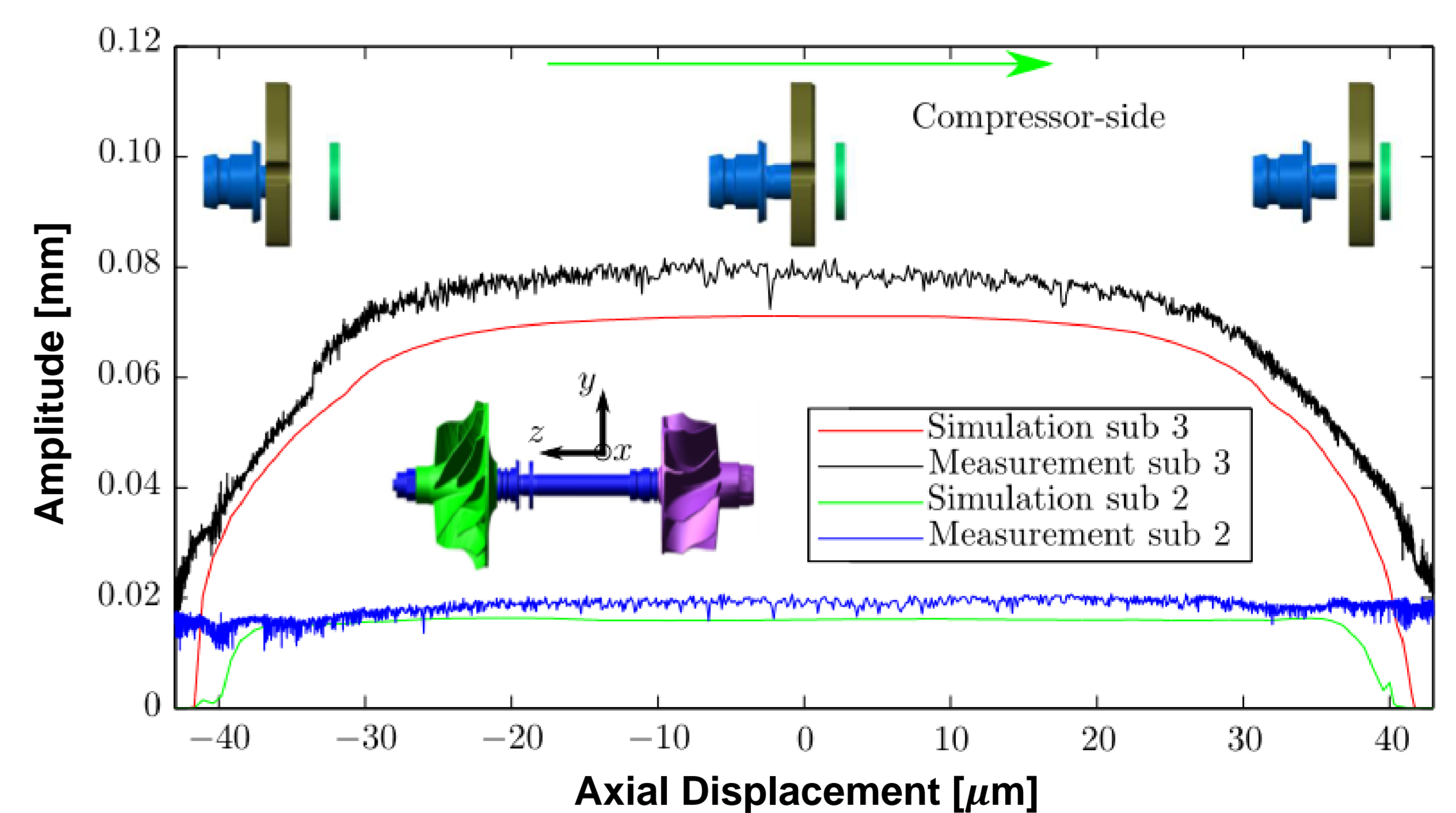
Experimental Validation

## Short-Time Fourier Transform



- Good agreement between simulations and experimental results.
- The thrust bearing affects the subsynchronous vibrations, both their amplitudes as well as their frequencies.

## Subsynchronous Vibrations



[1] I. Chatzisavvas, G. Nowald, P. Koutsovasilis, B. Schweizer.: "Experimental And Numerical Investigations Of Turbocharger Rotors On Full-floating Ring Bearings With Circumferential", ASME Turbo Expo, 2017.

[2] I. Chatzisavvas, A. Boyaci, P. Koutsovasilis, B. Schweizer.: "Influence Of Hydrodynamic Thrust Bearings On The Nonlinear Oscillations Of High-speed Rotors", Journal of Sound and Vibration 380, 224-241, 2016.