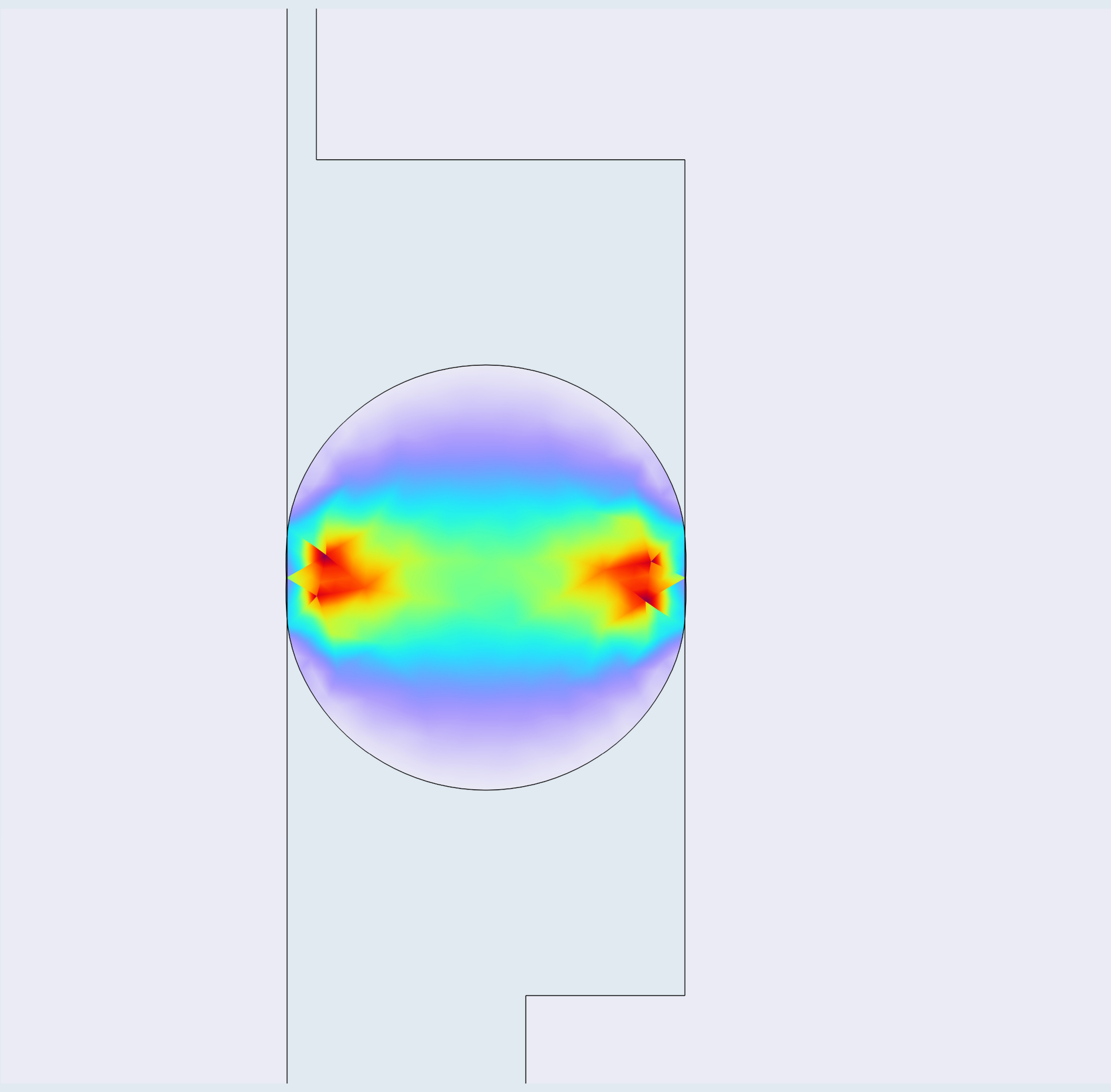

Dynamic Characterization of Elastomeric Rings

Since the behavior of elastomeric components depends on many factors. The use of a hybrid identification procedure can be a cost and time-saving method for their dynamic characterization.

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Introduction and Goals

Gas bearings are currently used to support rotors in micro-turbomachinery and ultra precision machine tools [1]. The success of these applications requires a careful evaluation of the rotor-bearing dynamics. Here, the main goal is enhancing the system stability. One of the most effective methods to increase damping of rotor-bearing systems is the use of elastomeric O-rings as external dampers. However, the availability of practical and effective elastomer damper designs is and hard task since their behaviour depends on many factors: geometry, preload (stretch and squeeze), temperature, frequency and amplitude of excitation and manufacturing errors [2].

This work is aimed to implement a hybrid identification procedure that makes it possible to dynamically characterize elastomeric O-rings employing a COMSOL model and the master curve of the employed material.

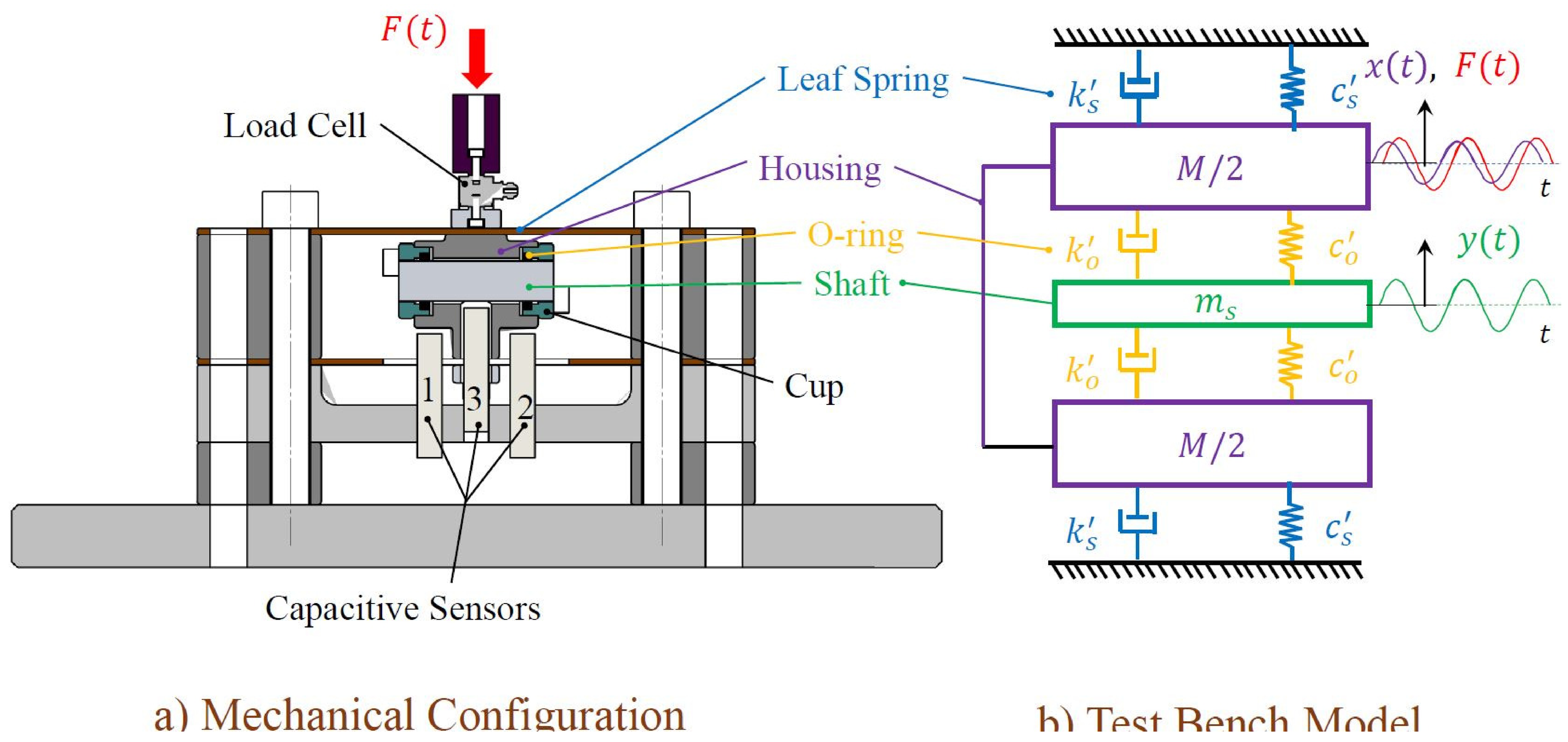

Figure 1: Mechanical configuration and model parameters model of the proposed test bench.

Metodology

Figure 1 shows the mechanical configuration and the lumped parameter model of the proposed test bench. It consists in a housing that is suspended by means of two leaf springs mounted in parallel and a floating shaft that is inserted into the housing through a couple of O-rings and cups. Once measured the amplitude A and the phase φ of the transfer function $\mathcal{F}\{y(t)/x(t)\}$, the stiffness k_o and damping c_o parameters of the O-ring can be evaluated through the mass-resonance method. The COMSOL model consists in a simplified version of test bench that considers only one O-ring whose material properties were experimentally measured through a Dynamic Mechanical Analysis (DMA) machine.

Results

Figure 2 shows the results obtained under temperature conditions of 25, 40, 80 and 120 °C mounting the O-rings in the presence of a squeeze δ=20% and a stretch of ε=0.77%. O-ring stiffness and damping are largely influence by the environmental temperature since they significantly decrease with the temperature and they exhibit opposite trends with respect to the excitation frequency f: stiffness increases whereas, damping reduces. It is worth mentioning that the estimations computed when the phase φ was outside the range of [15°-165°] were discarded (on a grey background), since it was found that they are very sensitive to errors of measure. The comparison between numerical and experimental results will be presented later as the implementation of the numerical model is still ongoing.

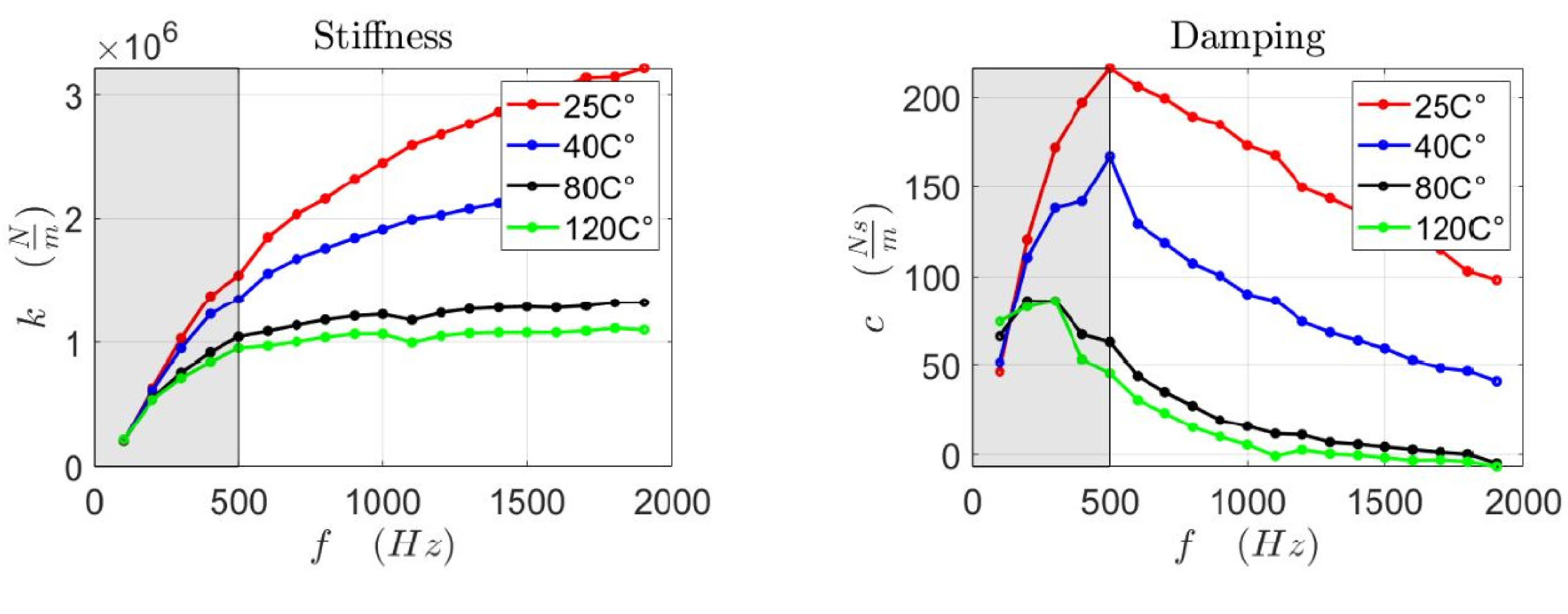

Figure 2: Stiffness and damping estimation at different environmental temperature.

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