Both increasing consumer demands and global competitiveness encourage manufacturers of machines and technical systems to maintain continuous product improvement. Amongst many trends in the market, it can be seen that the consumer attention is focused on the following aspects: enhanced operational conditions, reduction of energy consumption and miniaturization. However, demand for higher power and efficiency for the systems of reduced overall size leads to necessity of applications of higher operational speeds. This fact is also observed for rotating machines. Their shafts achieve higher and higher rotating speeds. Hence, the necessity of development and application novel technologies regarding bearings for high-speed rotating machinery is observed.

**In the project, the methods for analysis of high-speed radial gas foil bearings will be developed.** Foil bearings are categorized as a type of journal bearings. In foil bearings the region of clearance between the journal and the bushing is filled with a gaseous film. The functionality of the structural part of the supporting layer is obtained by a set of two special foils placed between the journal and the bushing – top and bump foils. An exemplary structure of a foil bearing is presented in Fig. 1.


Fig. 1. Construction of a typical radial gas foil bearing (content from the applicants' reports): (a) example of its structure, (b) prototype - the bump foil is visible inside the bushing, (c) numerical model of a modular bump foil.

Significance of foil bearings originates from a wide range of their applications, taking into account the applications not available for other types of bearings: other types of journal bearings, rolling and magnetic bearings. Uniqueness of foil bearings results from a series of advantageous features, mainly originating from a high tolerance of both the shaft misalignment and the effects of thermal expansion in the relatively wide range of temperature. Foil bearings may operate at high speeds (of order of hundreds of thousand revolutions per minute), and they are characterized by a high durability, very low friction during their operation as well as high resistance to impact loads.

Despite many confirmed significant advantages of foil bearings, there is one major inconvenience that prevents from common applications. Maintaining a required thickness of the gaseous film to assure a stable operation of such bearings is problematic. The thickness of the gaseous film depends on the temperature distribution on the top foil. **The increase (within given limits) of the average temperature of the bearing itself does not have a detrimental effect, however an improper temperature spatial distribution, especially within the top foil, may inevitably lead to a stability loss for the conditions required to maintain the gaseous film, and, eventually, to a bearing damage. The stability loss phenomenon proceeds very rapidly without any earlier symptoms.** This behaviour of a foil bearing may have catastrophic effects, especially in case of turbocharges.

The proposed solution for the problem of foil bearings' stability loss assumes measurements of temperature and strain distributions directly on the top foil and an identification of thermomechanical couplings during bearing operation. A novel approach for the measurements of temperature (recently successfully tested by the applicants) will be applied; it makes use of thermocouples integrated into the construction of the bearing itself. The strain distribution measurements will be conducted using strain gauges. Novelty in the project deals with: (1) elaboration of an experimentally validated multiphysics model of a foil bearing, considering the phenomena occurring in the region of the gaseous film and the nonlinear supporting structure so as to determine conditions that have to be met in order to maintain the stable operation of a foil bearing, (2) application of the nonlocally formulated finite difference method and peridynamics in numerical simulations.

**The knowledge gained from the project's basic research will allow for a future elaboration of guidelines for new methods of analysis of the operating conditions for newly designed foil bearings, especially in terms of thermal stability, which is now not available due to lack of appropriate numerical and experimental tools.**