Robustness in control systems expresses a property that the designed control law is insensitive enough to inaccuracies in the controlled process model, its unknown dynamics, fluctuations, disturbance effect of external signals, etc. It means that the control system works well and performs satisfactorily under various conditions. Time-delay systems (TDSs) mean controlled or control systems that include delays or after-effect phenomena, not only in the input-output relation but also in the feedback loops. They can be found in nature as well as in a wide range of human activities, such as biology, medicine, engineering, economy, or epidemiology. They constitute a family of processes, mechanisms, and structures that are difficult to analyze, and their controller design can be arduous in many cases. The model predictive control (MPC) aims to design a controller based on the forecast of the future states, inputs, and outputs by minimizing a specified criterion under a set of given constraints.

This project intends to synergize robustness and MPC control principles to TDSs and to use a beneficiary effect of the delay as a part of the controller so that the controller parameter values are optimized. The delayed feedback is used to suppress oscillations of mechanical systems. This has great potential for practical applications, not only in industry but also in military tasks and everyday life (e.g., transport of cargo suspended from a drone, vibration damping in vehicles, etc.). The optimization goals are to reduce the control system sensitivity, maximize its stability, minimize the controller parameter values, and compensate for delay or distributed parameter effects and non-regular system parts. Most designed and solved tasks represent the area of difficult optimization problems with multiple constraints. Consequently, a non-standard and specially adjusted algorithmic approach is required to obtain solutions of satisfactory quality.

The TBU team, in cooperation with the CTU team, intends to use their knowledge, experience, effort, and experimental equipment to design and investigate control problems of the presented type. These activities will be conducted in synergy with the optimization and machine learning expertise of the AGH team responsible for providing appropriate solution strategies. The construction and execution of these strategies will be based on the AGH HPC infrastructure. The final obtained solutions will be verified experimentally using advanced laboratory models at the CTU.