Current global trends show that one of the main directions in increasing the level of ergonomics at work is their miniaturization. This principle also applies to heat exchangers. Solutions are sought that make the high value of heat flux transferred through a small heat exchange surface. For this purpose, various methods are used to intensify heat transfer processes. One of such methods, proposed in the project, is the mechanical disturbance of the fluid layer (thermal boundary layer) located in a close proximity to the heat exchange surface, which allows one to obtain even a 10-fold increase in the heat flux. Due to the small dimensions of the thermal boundary layer and the use of movable disturbance blades, the exact energy transport mechanism responsible for the intensification of heat transfer is still unknown. Based on the theoretical results obtained by our group (Fig. 1), we hypothesized that the intensification of heat exchange is caused by the appearance of microvortices between the end of the moving blade and the wall.

The main goal of the project is to experimentally verify the hypothesis about the local formation of vortex flow in gaps up to 700 µm wide. For this purpose, a special measuring technique called µ-PIV will be used. It allows the observation of micro-flows (width of 80 µm) thanks to the use of a microscope. PIV stands for Particle Image Velocimetry and is a unique method of measuring velocity fields in fluids. It consists in illuminating the fluid with a laser beam of sufficiently high energy (65 mJ). Inside the fluid there are microscopic particles (1-5 µm in diameter), the so-called seeding, reflecting a specific laser wavelength. The light reflected from the particles passes through the microscope and is recorded in a plane perpendicular to the laser beam by a high-speed camera every 1 µs. By analyzing many of these images, it is possible to determine the position of microparticles at specific intervals using dedicated software. In this way, it is possible to get an "image" of the flow in very small spaces. The diagram of the designed test stand is shown in Fig. 2.

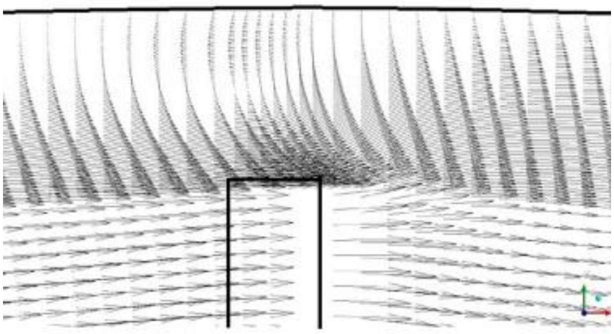

Fig. 1. Theoretical results of velocity vectors in a 140 µm wide gap

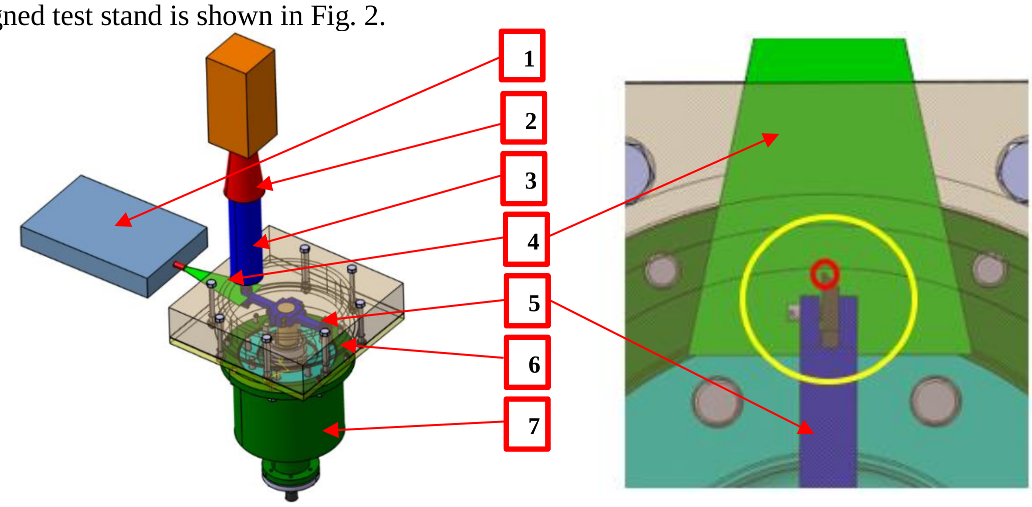

Fig. 2. Scheme of the test stand for observing microvortices: 1) laser, 2) CCD camera, 3) microscope, 4) laser beam ("light knife"), 5) scraping blade, 6) transparent cylinder, 7) engine

The motivation for undertaking this research topic is the fact that the phenomenon of mechanical removal of the thermal boundary layer is closely related to the fundamental issues of turbulence and the transition from laminar to turbulent (vortex) flow. The proposed way of visualizing the flow will make a significant contribution to the development of knowledge about these phenomena. It is a unique research method that has not yet been used in research analyzes on this type of devices by anyone in the world.