The Institute of Hydromechanics, of the National Academy of Sciences of Ukraine, was founded in 1926 as the Ukrainian R&D Institute of Hydrology and Hydraulic Engineering.

**PRIMARY SCIENTIFIC DIRECTIONS**

The institute is involved in fundamental and applied investigations within two scientific fields:

- fluid dynamics related to objects moving in laminar and turbulent flows
- hydromechanics of water flows and hydraulic engineering

The institute is traditionally involved in studies of flow structure around all bridges in Kyiv and of various hydraulic engineering constructions in Ukraine. In parallel, fundamental problems of fluid flows are studied including ideal, viscous and non-Newtonian fluids, heat transfer (basically, with applications to power stations), control of separated and boundary-layer flows, etc. Over the years, scientists at the institute have made major contributions into the development of fundamental fluid dynamics, acoustics, hydro-bionics and boundary layer, stratified and two-phase flows, hydraulics and hydraulic engineering.

**DISTINCTIVE COMPETENCIES**

The Institute has unique experimental infrastructure including a big water channel, aerodynamic facilities, and hydraulic research station in Kyiv. The Institute is a coordination centre for fluid mechanics research and training in Ukraine.

**Research in aerodynamics**

The aerodynamic part of the institute’s research activities is presented by projects and research of Dr. Nina Yurchenko. The goal is the development of advanced flow-control techniques aimed at reduction of fuel consumption and environmental pollution.

These research activities deal with the collaboration and sponsorship of the European Office of Aerospace Research and Development, USA. Figure 1 shows the beginning of these activities as a success story page of the Air Force Office of Scientific Research, Air Force Research Laboratory / International Office (AFOSR / IO). Currently Dr. N. Yurchenko is a Principal Investigator / Manager of seven projects on fundamental research which were funded for more than 15 years by the EOARD through the Science and Technology Center in Ukraine (STCU) and Civilian Research and Development Foundation (CRDF).

Our solution is to offer innovative flow-control technologies to improve aerodynamic performance of a vehicle or any moving/rotating object. Our concept can be expanded to many related applications, e.g. to wind and gas turbines as well as to marine applications and to heat transfer enhancement. Thus our potential customers can be found in other segments of industry, such as wind turbines, propulsion systems (improved turbine blade operation), automotive industry, etc.

The research team combines specialists from the Institute of Hydromechanics, National Space Agency of Ukraine, National Aviation University of Ukraine and Moscow Radio-Technical Institute of Russian Academy of Sci-
ences. It has broad experience in basic fluid dynamics, numerical & experimental aerodynamics and electrodynamics, the latter being applied to develop advanced methods of flow control using microwave (MW) radiation.

**Summary of the flow-control concept. Technological advantage**

The concept of flow control (improvement of aerodynamic performance) is developed that is based on a modification of the near-wall flow structure. Two active flow control methods are realized in the framework of this concept using selective boundary-layer heating with (1) flush-mounted streamwise elements and (2) spanwise arrays of localized plasma discharges. Matched experimental investigations of lift and drag coefficients of an airfoil model and numerical modeling of a fine flow structure show their correlation and open possibilities to manipulate integral flow characteristics. Combinations of parameters are found which can improve the aerodynamic performance (lift-to-drag ratio) of tested models. The developed remote mode of active flow control using MW-initiated plasma arrays is innovative and beneficial due to its greater operational flexibility.

A unique experimental complex for interdisciplinary research is created to measure aerodynamic parameters under conditions of microwave radiation and plasma generation.

**PARTNERING OPPORTUNITIES**

Important areas for collaboration include:

- Estimated net potential fuel burn benefit for subsonic transports due to application of drag reducing technologies is about 5 – 12%; 15% reduction in fuel cost doubles the profit for an airline.
- European Commission has required 50% reduction in fuel consumption (a 50% cut in carbon and 80% cut in nitrogen oxide emissions per passenger kilometer) by 2020. In 2005, 55 billion gallons of the aircraft Jet A-1 fuel was consumed by the US airline industry creating 540 million tons of CO₂.
- Competition in the global aircraft market forces manufacturers to take right decisions today for investments in cost effective technologies for products of tomorrow.

We seek for funding from an interested party to transfer our encouraging fundamental results into an application area, i.e. to perform the research oriented on a specified commercial customer.

---

a) Generation of drag reducing vortices (blue) using flush-mounted heated elements (red)

b) Wind tunnel complex equipped with the microwave/plasma-generation and protection systems

for automated aerodynamic measurements

c) Iso-vorticity lines displaying development of streamwise vortices generated thermally with different $\lambda_z$ scales: Re=$5\cdot10^5$, $\Delta T_z$=35

d) Flow control approach based on MW-generated localized plasma discharges