Popular-science abstract.

An interest in round free jet flows has started when the jet engines became a dominant technology in air transport and their growing number and size caused the increasing concern about their environmental impact, in particular the impact of noise generated by these engines. At the same time the research performed by G. Brown and A, Roshko (JFM, 1971) revealed the existence of large – scale structures in free jets, which are shown at Fig. 1a.

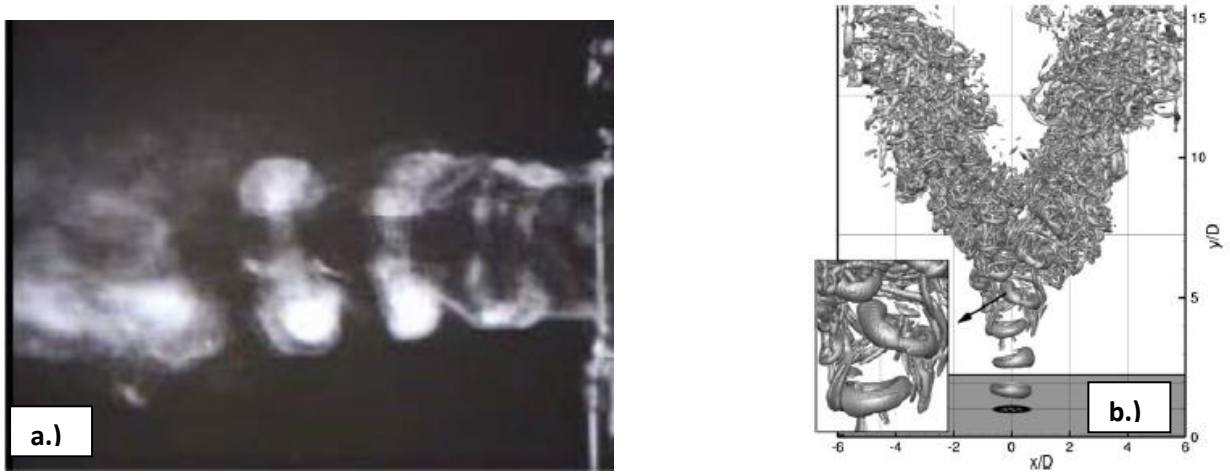

Fig.1.a.) Coherent structures of the round jest (Drobniak S., Klajny R., JoT, 2002);
Fig.1.b.) Bifurcation of round jet (Tyliszczak A., Geurts B., Flow Turbulence Combust, 2014)

As it was soon proved by S. Crow and F. Champagne from Boeing Aircraft, these structures were responsible for the noise generated by the jet and these vortical structures resulted from the loss of jet stability. The above phenomena became known as coherent structures and were intensely investigated during 70' and 80'. This intense research allowed to find out, that there were two main instability types of shear flows i.e. convective and absolute. Convective instability is determined by shear layer characteristics and scales on the shear layer thickness. The absolute instability is characterized by perturbation growth in time and scales on the jet diameter. Recently, the numerical research performed by Bogusławski et al. (J. of Turbulence, 14:4, 25-52, 2013) revealed the new type of instability called self sustained oscillations, that combines features of both processes mentioned above. The new phenomenon was investigated both numerically and experimentally in the period 2012 – 2015 within the NCN 2011/03/B/ST8/06401 grant and the results of numerical investigations confirmed the existence of self-sustained oscillations (Wawrzak K et al, FTAC, vol. 95, 2015) and demonstrated the generation of jet bifurcation under the proper forcing (Tyliszczak A., Geurts B.J., FTAC, v. 93,2014), as shown at Fig. 1.b. The large scale structures and jet bifurcation may be of practical importance since it is beneficial in mixing processes important for jet propulsion, combustion chambers, chemical reactors, injection systems, not to mention a large scale geophysical and astrophysical flows.

The experimental verification of this phenomenon appeared much more difficult than numerical computations, the time consuming modifications were needed in the design of experimental rig, that did not allow to perform all measurements needed for verification of the new type of instability. The project proposed will allow to complete the verification of the new type of instability, which is a subject of the PhD Thesis of Leader of the project proposed. The planned measurements are not simple, since the self sustained oscillations are extremely sensitive to external disturbances, so the CTA measurements must be verified with LDA, which is the non – contact measuring technique. Furthermore, the complete data base is needed to establish scaling laws of self sustained oscillations, that in turn will allow the effective control of the phenomena like jet bifurcation. However, the understanding of the transition mechanisms and vortex dynamics in transitional flows may have a significant impact on many physical and chemical processes important for practical applications.