EXPERIMENTAL STUDY OF AN UNFORCED AND FORCED SUBSONIC FREE JET FOR AERO-ACOUSTICAL APPLICATIONS

Alfonso González Gozalbo, Spain
Supervisors: J. Anthoine & C. Schram

The subject of this project is the investigation of the aerodynamic properties of an isothermal free jet discharging into a quiescent medium, at low Mach numbers (M< 0.1). The results of this investigation will be the benchmark for further investigations, namely the noise radiated by the jet (due to pairing of coherent structures). Recent improvements of the facility make it necessary to re-assess the quality of the flow and to evaluate the intrinsic acoustic properties of the set-up.

Hot wire and flow visualisation campaigns were carried out with and without acoustical excitation. Profiles of velocity, turbulence intensity and video recordings were obtained from these experiments. The acoustical response of the set-up has been predicted by means of simplified analytical models and compares well to field measurements.

It has been shown that the modifications undertaken on the set-up have significantly enhanced the quality of the flow. This translates into mean velocity profiles with a more defined top-hat shape and a reduction of turbulence level of 50%, in the potential core length, with respect to data from previous work. Furthermore, the jet profile appears to be symmetrical within the accuracy of our velocity measurements (2%).

The predicted acoustic response is in good agreement with the measurements. From these, the most resonant frequency (114 Hz) was identified and selected as the reference excitation frequency for the subsequent flow visualisation campaign. The cut-off frequency of the set-up (700 Hz) was predicted and measured with very good agreement.

Flow visualisation experiments show asymmetric jet oscillations at frequencies higher than the cut-off frequency. A preliminary study of the dependence of the flow on the amplitude of acoustical excitation revealed unsteady flow separation within the nozzle walls for velocity amplitude modulations above 2% at Strouhal numbers, based on the nozzle diameter, of O(1). These experiments also revealed linear relation between velocity fluctuations and amplitude of excitation. Location of vortex pairing is inversely proportional to amplitude of excitation, shifting upstream.

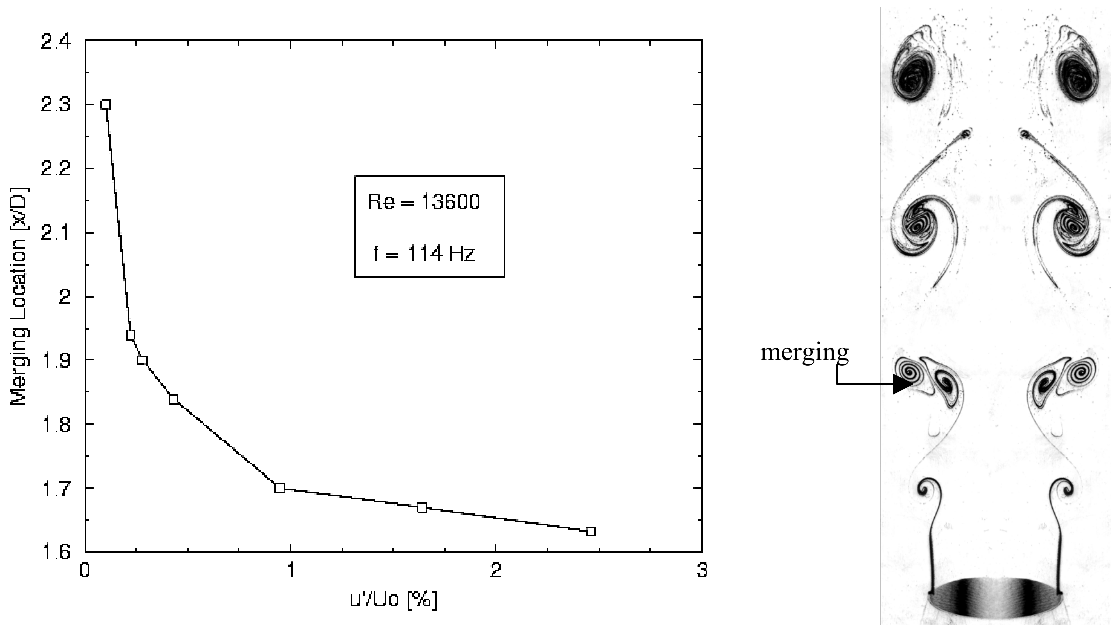

Figure 1: Pairing location as a function of loudspeaker signal amplitude (left) and image of excited jet with typical pairing (right)