DYNAMICS OF TURBULENT STRUCTURES IN COUETTE-POISEUILLE FLOW

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We carry out experiments in a plane Couette-Poiseuille channel (fig.1). The streaks and rolls are quantified respectively by the streamwise velocity u_x and the spanwise velocity u_z, measured using Particule Image Velocimetry (PIV).

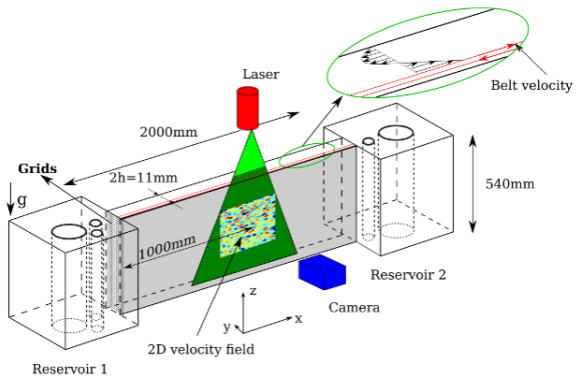

Figure 1. Couette-Poiseuille channel

We study the decay of turbulence using a 'quench' protocol, i.e. an abrupt decrease of the Reynolds number Re from a fully turbulent state to a laminar regime[1].
We show that the rolls decay faster than the streaks. The streaks have two decay stages in the decay process. During the first stage of the decay, the remaining rolls slow down the decay of the streaks. This is consistent with the lift-up effect, i.e. the formation of streaks by linear advection of the rolls.
We also study the effect of the noise, which is the external disturbance generated by the belt driving cylinder, on the transient decay and the permanent regime. The decay dynamics is independent of the noise level. The noise shifts the apparent critical onset of transition. We use the susceptibility of u_z in the permanent regime to quantify the noise intensity.
We present very recent results about the study the waviness of streaks using vortex generators to induce unstable wavy streaks. The evolution of the streaks becoming wavy from a straight state is characterized using stereoscopic PIV. We apply a spatial filter to separate the straight part and the wavy part of the flow (fig.2). Our experimental results show how the appearance of the spanwise velocity and the wall-normal velocity is correlated to the increase of the waviness of the streaks, as expected from self-sustaining models and give quantitative support to this relation.

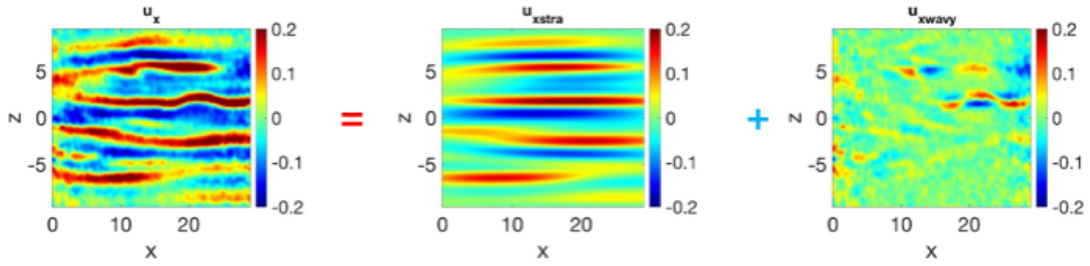

Figure 2. Decomposition of small scale streamwise velocity into straight and wavy components

References

[1] Liu, T., Semin, B., Klotz, L., Godoy-Diana, R., Wesfreid, J. E. and Mullin, T. Decay of streaks and rolls in plane Couette-Poiseuille flow, *J. Fluid Mech.* **915**, A65 (2021).