Spatial evolution of the turbulent/turbulent interface geometry and turbulent momentum entrainment

J. G. Chen*, Oliver R. H. Buxton†

We examine the spatial evolution of the geometrical and dynamical features of the turbulent/turbulent interface (TTI) in a turbulent cylinder wake, from near to far field where the energy-content of the coherent motions diminishes. The turbulent wake was marked with a high-Schmidt-number scalar and a planar laser induced fluorescence (PLIF) experiment was carried out to capture the TTI between the wake and the ambient flow from $x/d = 5$ to 40 where x is the streamwise coordinate from the centre of the cylinder and d is the cylinder's diameter (Fig 1). The cylinder is placed at various downstream distances from various grids which are used to generate the background turbulence, such that the parameter space (turbulence intensity TI, integral length scale L_{12}) was explored as widely as possible. Measurements were carried out for seven cases of (TI, L_{12}). We found that all the TTI cases have a larger mean value of mean interface position $\overline{y_I}$ than the TNTI case at almost all x/d positions. A transition region of the interfaces' spreading rate towards the ambient flow is found at $x/d \approx 15$, beyond which the interfaces propagate at a slower rate than upstream and the interface-position scales with the local wake half-width L_ϕ. We found that turbulence intensity induces a higher fractal dimension of the interface in the far wake, while the effect of the integral length scale is more appreciable in the near-wake region. The evolution of the entrainment of mass and momentum across the various TTIs is also examined in a separate experiment of combined PIV & PLIF measurement and will be discussed in the meeting's presentation.

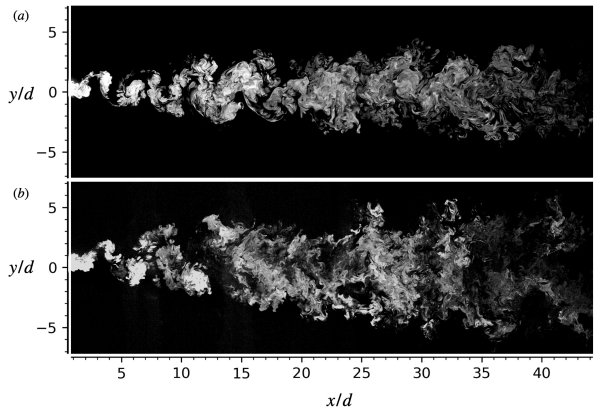

Figure 1: Visualisation of the wake (a) without and (b) with turbulence present in the background flow.

*Department of Aeronautics, Imperial College London, South Kensington Campus, London SW7 2AZ, UK

†Department of Aeronautics, Imperial College London, South Kensington Campus, London SW7 2AZ, UK