The Re-scaling of the propagation speed of turbulent fronts in pipe flow

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The scaling of the propagation speed of turbulent fronts with the Reynolds number in pipe flow has been a long-standing problem since the work by Lindgren and Wygnanski and co-authors[1]. Our previous study[2] reported power-law scalings of the front speeds based on measurements in a wide range of Reynolds number. Here, we explain the mechanism underlying the scaling of the upstream front. The key finding is that the average wall-normal position of low-speed streaks at the tip of the upstream front appears to be approximately constant in local wall units throughout the Reynolds number range investigated. It has been established that the local transition at the front tip is caused by the local streak instability. By assuming that the axial propagation speed of the velocity disturbances resulting from the streak instability is dominated by the local mean flow at the front tip, a power-law scaling of the front speed can be deduced where the power is very close to the fitted power based on direct speed measurements. This mechanism also offers a way to obtain an approximation of the front speed based on a single snapshot of the velocity field without having to measure the front speed by actually tracking the front.

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[2] Chen, Xu and Song *J. Fluid Mech.* **935**, A11 (2022).