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Fully developed turbulence in slugs of pipe flows RORY CERBUS, CHIEN-CHIA LIU, Okinawa Institute of Science and Technology, JUN SAKAKIBARA, Meiji University, GUSTAVO GIOIA, PINAKI CHAKRABORTY, Okinawa Institute of Science and Technology — Despite over a century of research, transition to turbulence in pipe flows remains a mystery. In theory the flow remains laminar for arbitrarily large Reynolds number, Re. In practice, however, the flow transitions to turbulence at a finite Re whose value depends on the disturbance, natural or artificial, in the experimental setup. The flow remains in the transition state for a range of Re $\sim$ 0(1000); for larger Re the flow becomes fully developed. The transition state for Re $>$ 3000 consists of axially segregated regions of laminar and turbulent patches. These turbulent patches, known as slugs, grow as they move downstream. Their lengths span anywhere between a few pipe diameters to the whole length of the pipe. Here we report Stereo Particle Image Velocimetry measurements in the cross-section of the slugs. Notwithstanding the continuous growth of the slugs, we find that the mean velocity and stress profiles in the slugs are indistinguishable from that of statistically-stationary fully-developed turbulent flows. Our results are independent of the length of the slugs. We contrast our results with the well-known work of Wygnanski & Champagne (1973), whose measurements, we argue, are insufficient to draw a clear conclusion regarding fully developed turbulence in slugs.

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