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By-pass mechanism for transition to turbulence in supercritical pipe flow RONALD J. ADRIAN, Arizona State University, XIAOHUA WU, Royal Military College of Canada, PARVIZ MOIN, Center for Turbulence Research, Stanford University, JON R. BALTZER[1], Arizona State University, JEAN-PIERRE HICKEY, Center for Turbulence Research, Stanford University — Direct numerical simulations of 250R long pipe flows evolving spatially at Reynolds number of 6000 and 8000 show that a thin ring of turbulent fluctuations extracted from a fully turbulent simulation superimposed on the linearly stable parabolic profile is capable of causing transition to the self-sustaining turbulent state. The finite amplitude disturbances from the ring create a roughly annular turbulent wake that grows downstream radially inward and outward. Transition is triggered by vortex filaments drawn from the disturbance region, intensified by stretching, and moving towards the wall. Between 30-40R the filaments induce inward radial flows; in turn, they create lambda or hairpin vortices that rapidly form into hairpin packets. Small-scale activity explodes when the packets create turbulent spots and overcomes larger-scale fluctuations from the initial disturbances as it grows and interacts to fill the pipe with turbulence that approaches the fully developed state by about 75R. Following hairpin formation the process is similar to transition in boundary layers. Unlike boundary layers, there is no stage of linear instability in the pipe, and 2-D and 3-D finite amplitude instabilities near the wall do not appear to play a role.

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