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Temporal development of hairpin vortex sequences in turbulent puffs[1] KYLE WINTERS, ELLEN LONGMIRE, University of Minnesota, DEPARTMENT OF AEROSPACE ENGINEERING AND MECHANICS TEAM — Puffs are characterized by intermittent swirling structures that develop from sufficient perturbations to pipe flow around $1800 < Re < 2700$. By conducting stereo-PIV on circular cross sections, the authors examined hairpin-shaped vortices near the trailing edge of many puffs. To study the temporal evolution of the hairpins, planar-PIV was conducted on an axial-wall normal plane inside a $44.8mm$ diameter, D, $8.8m$ ($180D$) downstream of a disturbance ring. In certain records, the measurement plane coincided with the plane of symmetry of a hairpin. This allowed for comparison with the stereo-PIV records and examination of the hairpin development. The hairpin heads and associated velocity fluctuations grew in strength as they moved both downstream and away from the wall. Eventually the original hairpin spawned a new hairpin upstream close to the wall at the same azimuthal position. The axial spacing between the two hairpins agreed with that observed in the stereo-PIV records. Further, the spacing grew as they continued to propagate downstream at velocities that generally agree with the propagation of axial fluctuations noted by Shimizu and Kida (2008). The overall development process was similar to that outlined by Jodai and Elsinga (2016) in a turbulent boundary layer.

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Kyle WINTERS
University of Minnesota

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