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Transition to Turbulence in Oscillatory Flow for Pulse Tube Cryocoolers MEGHAN MCNULTY, Department of Mechanical Engineering, Virginia Tech, Blacksburg, VA, BENJAMIN JEWELL, THOMAS FRASER, Air Force Research Laboratory / RVSS, Kirtland AFB, NM — Pure (zero-mean) oscillatory flows are less studied than the pulsatile flows found in biology, yet they are frequently used in low-temperature cooling systems, like the pulse tube cryocooler (PTC). PTCs have high potential for extended lifespans and reductions in size, weight, and power compared to other cryocoolers, but advancements of the technology have been hampered by the lack of knowledge of the working fluid's behavior. While design guides assume laminar flow in the pulse tube, an evaluation of PTCs in literature using the Womersley parameter $\alpha=a(\omega/\nu)^{1/2}$ and the oscillatory Reynolds number $Re_\delta=U(2/\omega\nu)^{1/2}$ indicates the probability of transitional or turbulent flow. Because PTC operation relies on thermal stratification of the oscillating internal gas, turbulent mixing will significantly reduce performance. We quantify the fluid flow within a PTC under near-operational conditions using planar particle image velocimetry (PIV) and calculate the first full-field velocity measurements that provide insight to the presence of transitional or turbulent flow and the physics that underlie experimentally observed "streaming effects."

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