Abstract Submitted
for the DFD08 Meeting of
The American Physical Society

Harmonically forced enclosed swirling flow J.M. LOPEZ, ASU, F. MARQUES, UPC, T.T. LIM, Y.D. CUI, NUS — The response of steady state flows in a cylinder driven by a harmonically modulated rotating endwall is investigated experimentally and numerically. Three dynamic regimes are identified. For very low forcing frequency, the synchronous flow approaches quasi-static adjustment, and for very large forcing frequencies the oscillations are localized in the boundary layers on the cylinder. These localized wall oscillations drive the synchronous flow in the interior to the underlying axisymmetric steady basic state. The third regime occurs for forcing frequencies in the range of the most dangerous axisymmetric Hopf eigenfrequencies, with the 1:1 resonances leading to greatly enhanced oscillation amplitudes localized in the axis region where the flow manifests vortex breakdown recirculation zones. By comparing the spatio-temporal structure of the junction vortices produced by the modulations in this range of frequencies with the vorticity eigenfunctions responsible for the self-sustained oscillations in the unmodulated problem, we have identified the mechanism responsible for the large amplitude pulsations of the vortex breakdown recirculations on the axis at mean rotation rates well below critical for the self-sustained vortex breakdown oscillations. An important consequence of this study is that to achieve a strong resonant effect, it is not sufficient to only consider the temporal characteristics of the flow state, but that the imposed forcing must also match the spatial characteristics.

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Date submitted: 04 Aug 2008 Electronic form version 1.4