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Three-dimensional vortex analysis and aeroacoustic source characterization of jet core breakdown DANIELE VIOLATO, FULVIO SCARANO, TUDelft — The 3D patterns of jet core breakdown are investigated in a jet at Re=5,000 by time-resolved tomographic particle image velocimetry in the range between 0 and 10 jet diameters. The characteristic pulsatile motion of vortex ring shedding and pairing culminates with the growth of primary in-plane and out-of-plane azimuthal waves and leads to the formation of streamwise vortices. Vortex ring humps are tilted and ejected along the axial direction as they are subjected to higher axial velocities. By the end of the potential core, this process causes the breakdown of the vortex ring regime and the onset of streamwise filaments oriented at 30-45 degrees to the jet axis. A three dimensional modal analysis of velocity and vorticity fields is conducted by proper orthogonal decomposition within the first 10 modes. The decomposed velocity fluctuations describe helical motion in the region of the jet core-breakdown and, further downstream, jet axis flapping and precession motions. By the end of the potential core, vorticity modes show travelling waves of radial and axial vorticity with a characteristic 40 degree inclination to the jet axis. Following Powell's aeroacoustic analogy, the instantaneous spatial distribution of the acoustic source term is mapped. Far-field acoustic predictions are given based on the direct evaluation of Powell's analogy with the tomographic data.

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