Breakdown and quasi-DC phase of a nanosecond discharge

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A nanosecond Atmospheric Pressure Plasma Jet (ns-APPJ) is studied by picosecond Electric-Field Induced Second Harmonic generation (E-FISH) and spatially/temporally resolved Optical Emission Spectroscopy (OES). Two distinct phases of the discharge are identified: fast breakdown at high electric fields is followed by a quasi-DC phase at lower permanent electric field and high electron density. Spatial structure of the discharge after the breakdown is found to be similar to a glow discharge, while the bulk electric field in the quasi-DC phase is independent of the amplitude of the high voltage used to feed the high voltage switch and, consequently, the electric field strength during breakdown. It is also shown that the discharge voltage and current waveforms and its morphology weakly depend on the gas mixture. The experimental results are compared with the results of PIC/MCC simulations and an analytical model. Good agreement is found throughout.