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On decoupling dark and luminous phases of nanosecond discharges developing in liquid water.[1] MILAN SIMEK, PETR HOFFER, VACLAV PRUKNER, JIRI SCHMIDT, Institute of Plasma Physics, Czech Academy of Sciences — There is no clear experimental evidence of the underlying microscopic mechanisms of micro-discharges produced by high-voltage pulses of nanosecond duration in liquid water. In this work, we examine shadowgraph images and plasma-induced emission (PIE) to decouple nearly simultaneously developing dark and luminous phases of nanosecond discharges in deionized water. We applied diagnostics with extremely high temporal and spatial resolutions to capture tiny dark filaments together with the formation of luminous discharge structures. Following the main objective of disentangling two closely coupled dark and luminous phases, we accurately determined their onsets with respect to the driving high-voltage pulse. We establish that the initial dark filaments start occurring within ∼3-4 ns after the onset of the high-voltage pulse, and subsequently expand at a constant velocity of ∼$1{\cdot}10^5$-$2{\cdot}10^5$ m/s, depending on the high-voltage amplitude and anode curvature. A systematic analysis of the PIE waveforms together with the associated shadowgraph images reveals that the onset of the luminous discharge phase is delayed by ∼600-800 ps with respect to the onset of the initial dark filaments.

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Milan Simek
Institute of Plasma Physics, Czech Academy of Sciences

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