Ballistic Imaging of Sprays at Diesel Relevant Conditions

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Abstract

Diesel engines are an important aspect of our transportation infrastructure, whose performance is greatly affected by the characteristics of the spray from their injectors. Characterization of the injector's spray is therefore tantamount to clean-running efficient diesel motors. In this study, a ~15 ps pulsed Leopard D-10 laser is used along with an optical Kerr Cell to realize ballistic images of high-delivery-pressure dodecane sprays injected into a quiescent air environment at elevated temperature and pressure. Using CS_2 as the Kerr switching media and by optimizing the overlap of the gate and imaging beams, an effective high speed shuttering effect is obtained. This effort resulted in the first usage of a ballistic imaging technique to successfully capture the spray behavior of dodecane injected at pressures of 100 MPa or greater, via a single 160 micron hole injector, into pre-combustion environmental conditions typical of diesel engines. Control of the imaging beam arrival time after the start of injection allowed for the capture of images from separate experiments that indicate the spray's development over time. The resulting images demonstrate significant differences in spray behavior over a range of chamber temperatures and pressures. Specifically, at low pressure and temperature, some smooth wave structure is apparent, but at high chamber pressure, sprays show significant signs of violent mass shedding from the spray periphery.