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Ignition Prediction in a Hydrogen Jet in Turbulent Crossflow by a Laser-Induced Breakdown PAVEL POPOV, DAVID BUCHTA, MICHAEL ANDERSON, JONATHAN FREUND, University of Illinois at Urbana-Champaign — We use large-scale simulation to predict the ignition (or not) of a hydrogen jet in turbulent air crossflow. The round jet issues from the wall of a low-speed wind tunnel into a turbulent boundary layer; an upstream laser-induced optical breakdown (LIB) is used to ignite it. The LIB hotspot also introduces a locally elevated oxygen radical concentration. A detailed hydrogen chemical mechanism is used to model the radicals. Additionally, ignition is augmented via actuation with a dielectric-barrier discharge that generates body forces and additional radicals. Comparison is made with corresponding experiments. We focus particularly in the ignition process. Traditional ignition identification involves a lengthy simulation run, until either the hotspot dissipates (unsuccessful ignition) or a sustained high temperature is observed (successful ignition). To avoid the computational cost in mapping the sustained-ignition threshold, a short-time criterion is developed based on detailed observations. It evaluates key radicals near the stoichiometric surface a short time after the LIB. This criterion allows for low-cost estimation of the approximate ignition boundary location, which can then be further refined via the traditional process.

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