Characterizing Cyclic Variability in Combustion: Tracking the Centroid and Area of an Ignition Kernel

Student: Susanne Kim

Project Sponsor: Patrick Kirchen

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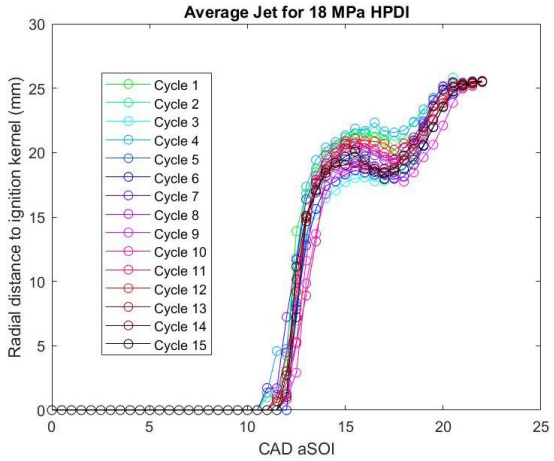

Figure 1: Time series plot of average kernel location for 18 MPa HPDI; minimum cluster size of 30 pixels; threshold 3% of 16-bit

In the field of engines research, quantifying cyclic variability is important in improving engine performance and emissions. Combustion is typically presented in the form of ensemble images averaged over all cycles. This combination results in blurry images which, while providing a visual for combustion behaviour, are not representative of any single cycle. Two metrics to determine combustion behaviour are explored: size of an ignition kernel, and radial distance to the centroid of an ignition kernel. These were determined by splitting the combustion chamber into slices for each fuel jet. The scope of this research focuses on the ignition stage of the combustion process. From the results, several conclusions are drawn. A larger amount of variability was observed for the averaged cycle than the averaged jet. This may indicate that jet to jet variability is more significant than cyclic variability. In addition, jet 9 experienced above average kernel size and distance compared to other jets. This indicates that jet 9 may have been injecting at higher velocities, and a correlation exists between the two metrics of kernel size and distance. In this way, the generated plots are useful in identifying the ``typical'' combustion process in comparison to outlier jets or cycles. Recommendations are made, including exploration into imaging methods such as Proper Orthogonal Decomposition and determining the angular location of the kernel.