Numerical Study of Cyclic Variation in a Large Bore 2-Stroke Natural Gas Engine

– Timothy Jacobs, et al.

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Objective

- Cyclic variation (CV), may lead to increased or unexpected (and thus difficult to control for) emissions
- CFD simulations can help diagnose the CV problem inherent in 2-stroke engines
  - Fluid flow characteristics and development have been shown to influence the combustion performance
  - Factors local to the spark plug, such as turbulent kinetic energy, and local equivalence ratio can affect the development of the initial flame kernel into a fully developed flame front

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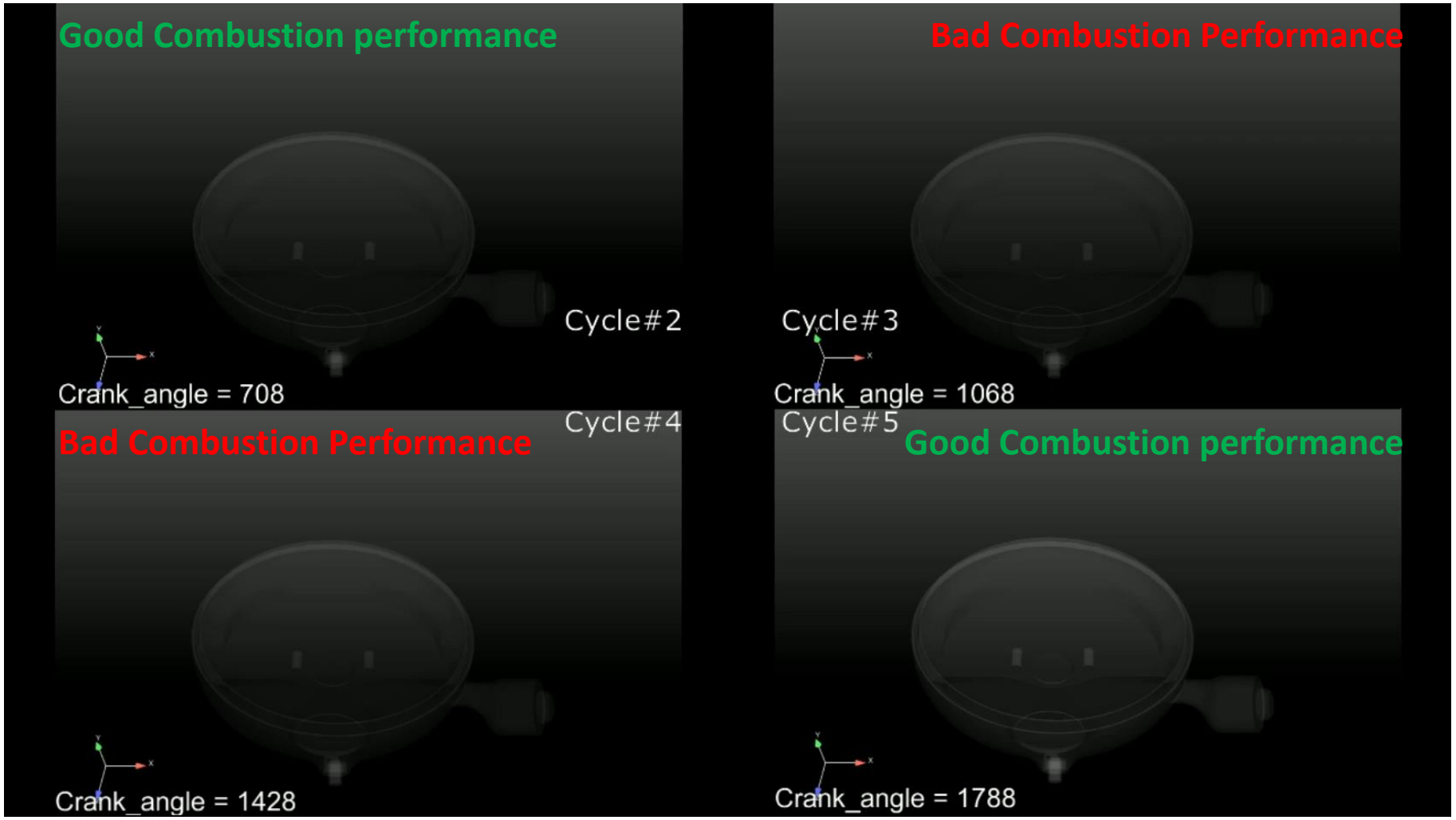
Gas Machinery Research Conference, 2016

Numerical Simulation: Cyclic Variation Study



- The animations show the development of the flame front.
- The difference in shape of the flame front and speed of its growth is obvious comparing the good and bad cycles.

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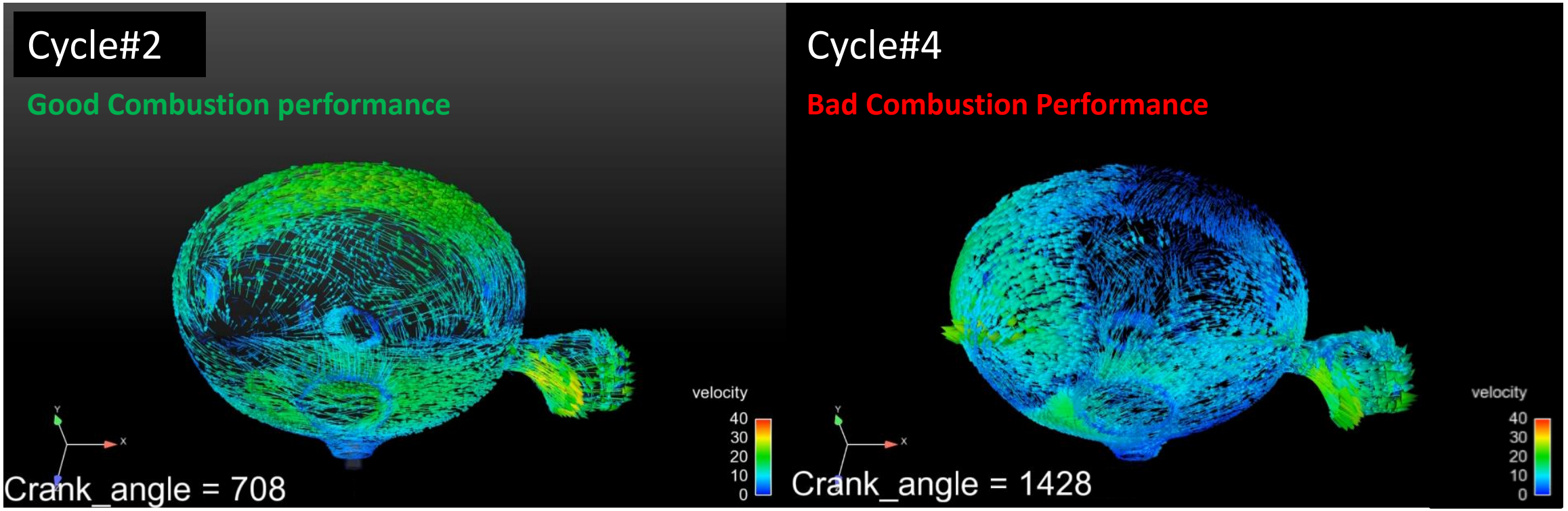

- The difference in fluid flow characteristics in the combustion chamber for a good and bad cycle can be observed in this animation
  - This difference in flow development can be one of the reasons for having cyclic variation

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Conclusion

- Based on our simulation results, the flow development is the main culprit for the observed cyclic variation
- These results can be later used to modify the design of relevant parts, in order to maintain the combustion performance from cycle to cycle (reduce cyclic variation)

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Numerical Tools

- Software used: CONVERGE CFD
- Cluster used: ADA
- Typical job size
  - #cores: 2 nodes = 40 cores
  - Memory: 10GB/core
  - Walltime: 150 hours for one cycle of the engine!
    - To get useful information to study the cyclic variation we need at least 8-9 cycles of the engine ≈ 1400 hours ≈ 2 months!

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Advanced Engine Research Lab (AERL)

- PI: Dr. Timothy Jacobs
- Students:
  - 3 PhD students
  - 5 MSc students
  - 3 BSc students
- Research topics:
  - In-cylinder combustion processes
  - The coupling to advanced concepts
  - The use of alternative fuels
  - The integration of exhaust after treatment systems
- Website: http://aerl.tamu.edu/