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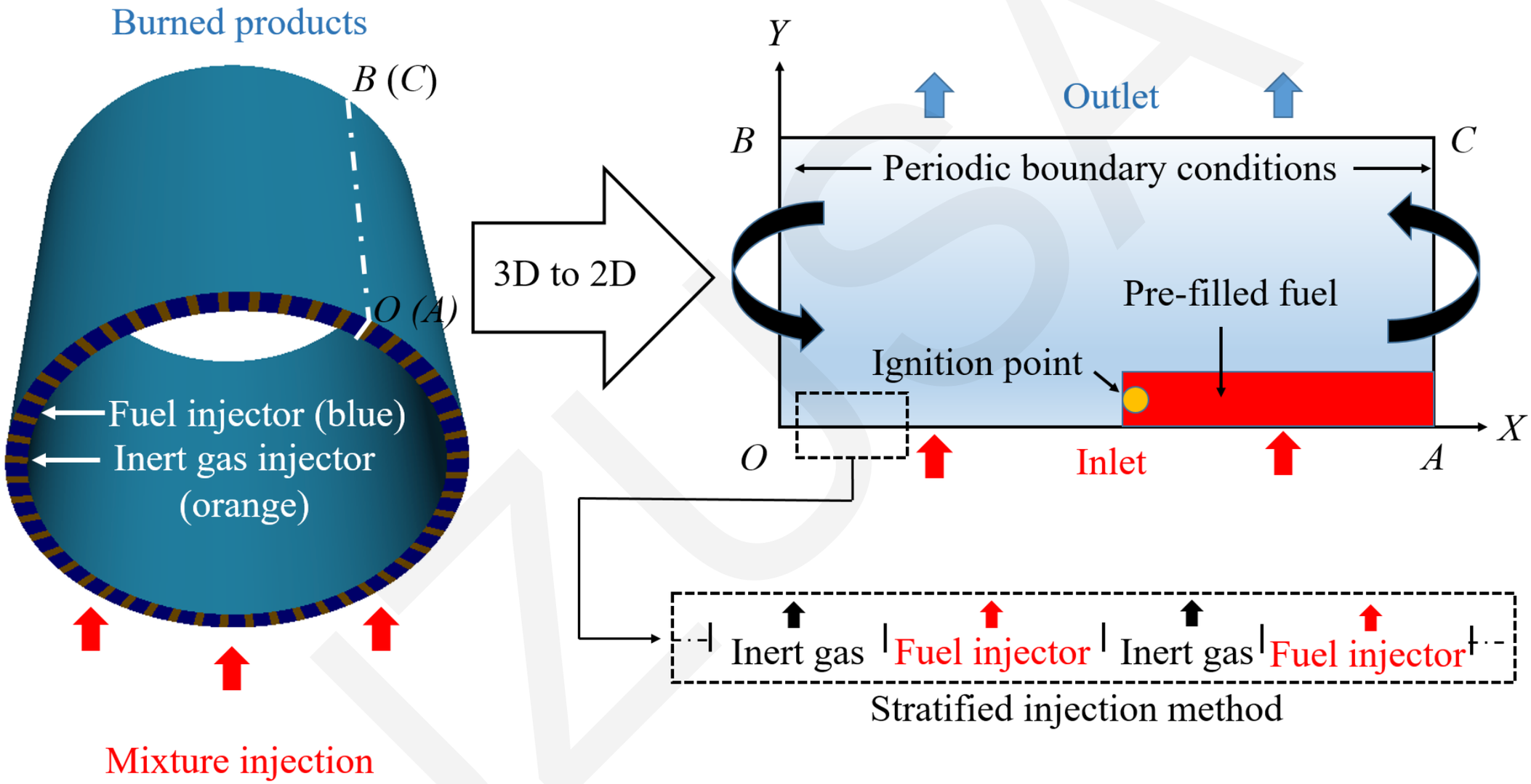
Performance of rotating detonation engine with stratified injection

Key words:

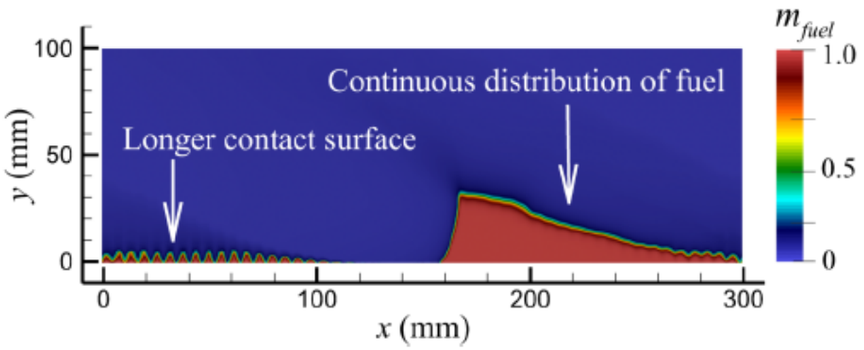
Rotating detonation engine; Injection pattern;
Propulsion performance; Instability

The realization of stratified injection

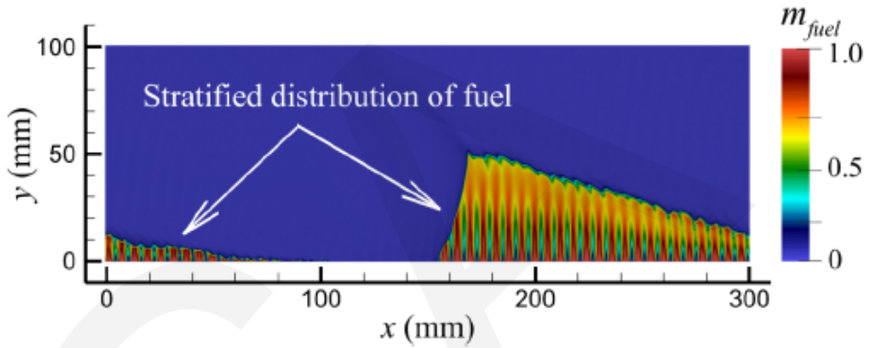


Schematic of the combustion chamber, computational domain, and injector

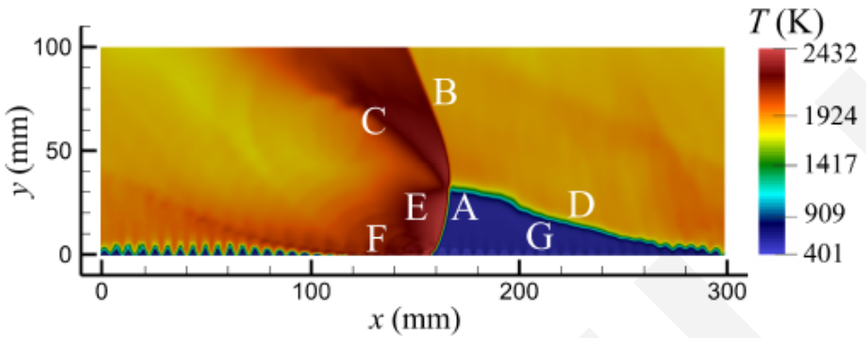
Flow fields with different injection pattern



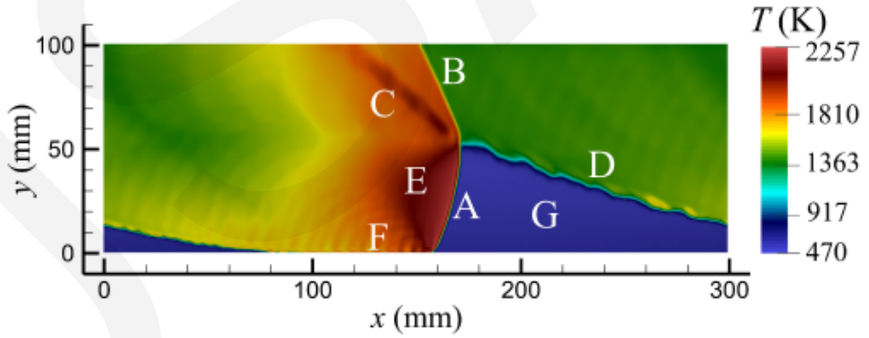
(a) Hydrogen distribution of interval injection



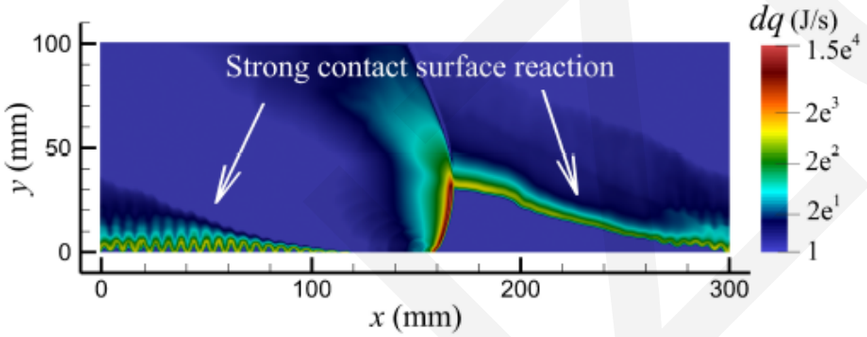
(b) Hydrogen distribution of stratified injection



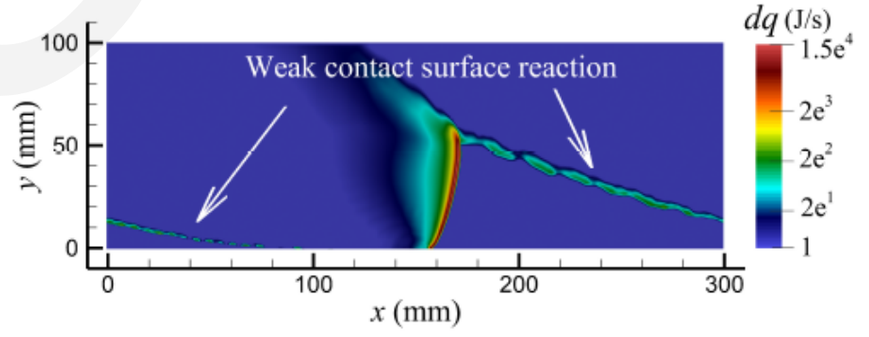
(c) Temperature field of interval injection



(d) Temperature field of stratified injection



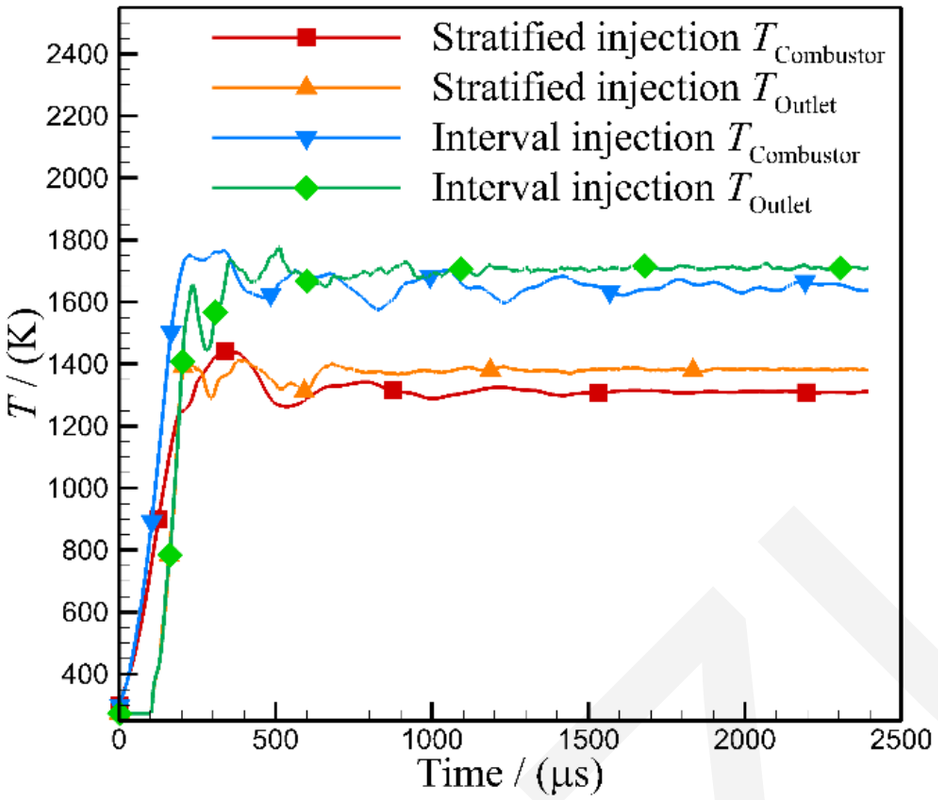
(e) Heat release energy of interval injection



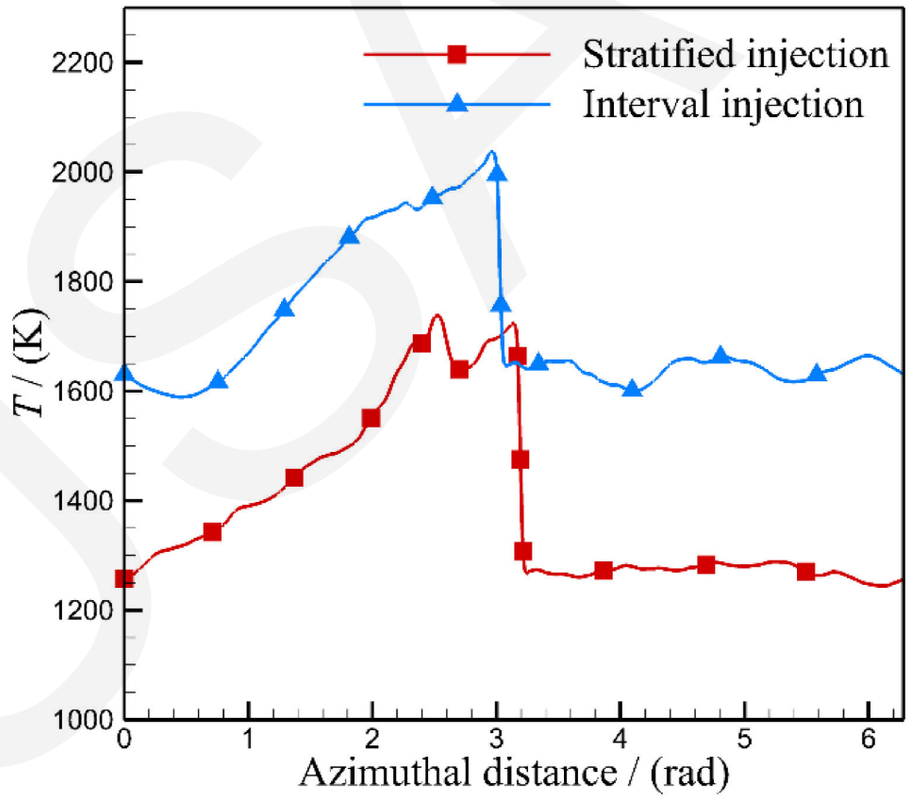
(f) Heat release energy of stratified injection

The distribution of hydrogen is continuous in most areas when interval injection is applied. This is due to the newly injected fresh mixture which expands and fills all the space around the inlet plane gradually. The distribution of hydrogen with stratified injection is shown in Fig. b, where the existence of extra inert gas squeezes the expansion area for hydrogen, thus, the hydrogen is less expanded and its distribution stratified.

Comparison of flow field temperature



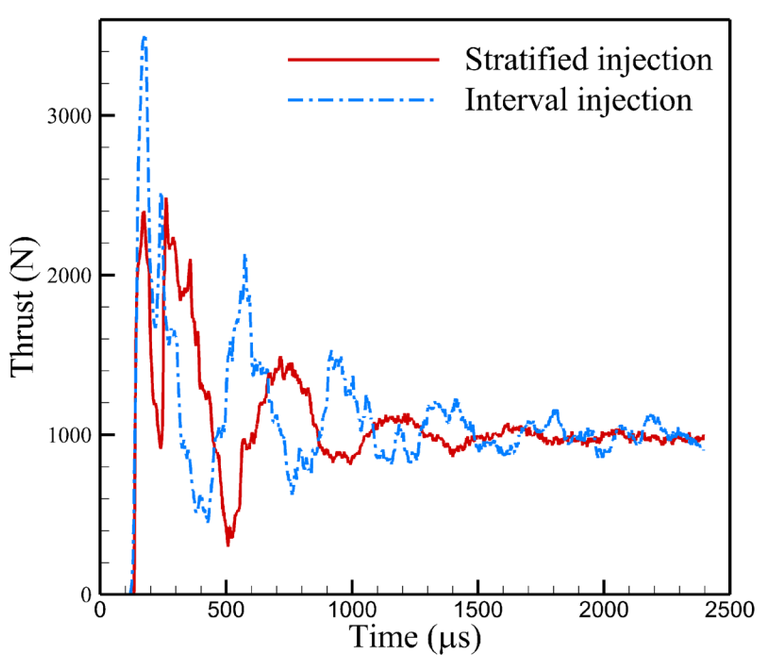
Average temperature-time profile

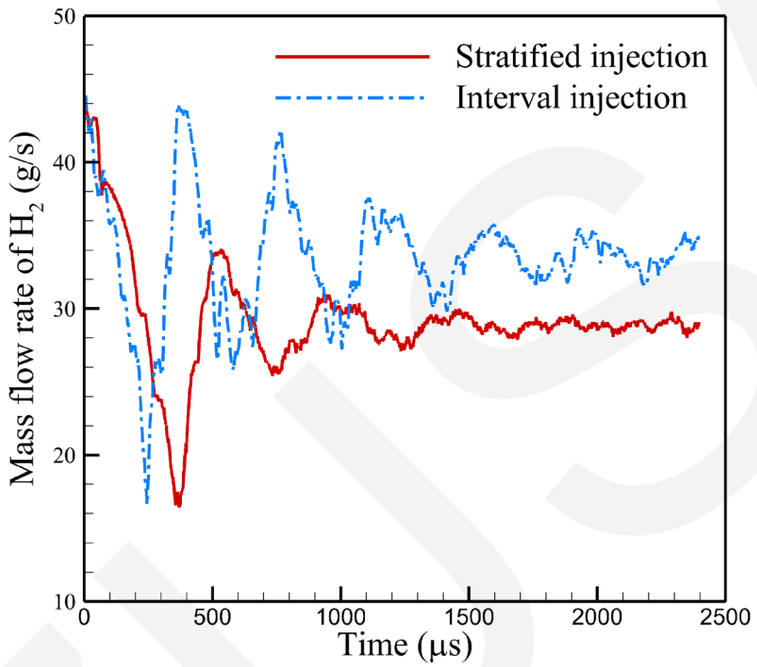


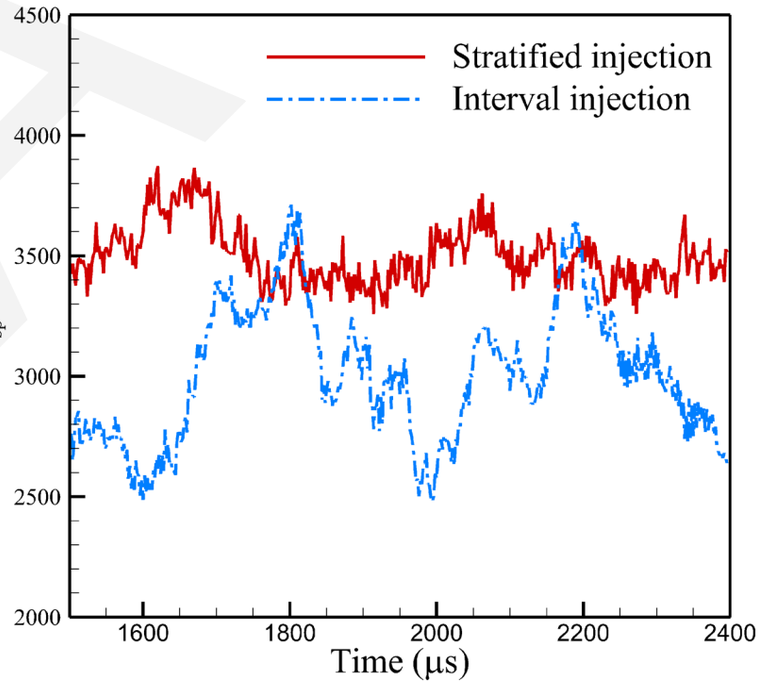
Temperature distribution along x axis at outlets

By applying the stratified injection method, the outlet temperature of the engine is reduced by 327.4K, which is 19.1% lower than the engine with the traditional interval injection method.

Comparison of propulsion performance

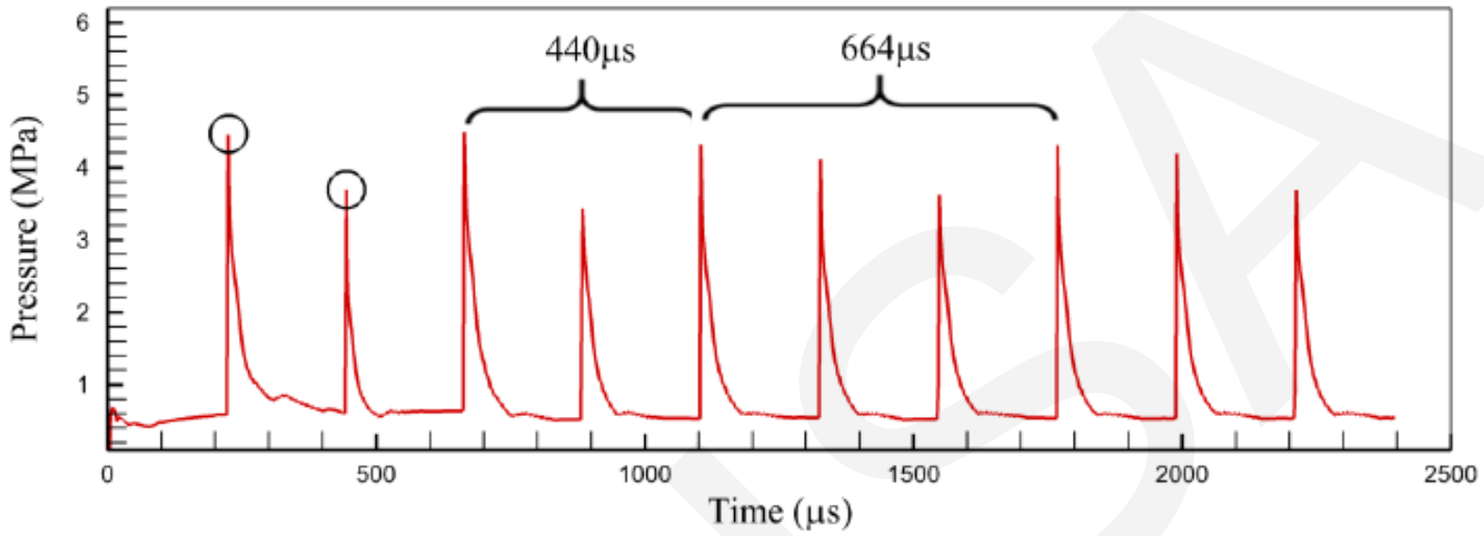


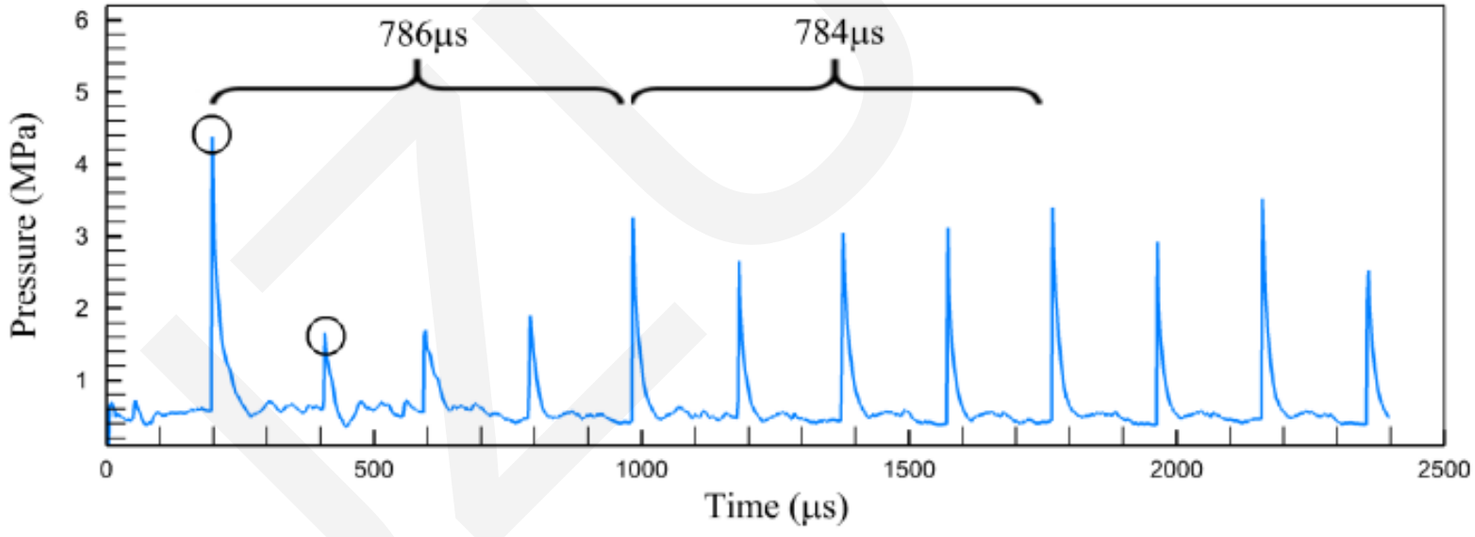




The engines create almost identical thrust with both injection patterns. But the specific impulse of the engine with stratified injection is improved by 16.3%. After deducting the effect of additional argon injection, the improvement of specific impulse is 4.5%. Moreover, the results of the study indicate that the fluctuations amplitude thrust and specific impulse are reduced, which implies that the stability of the engine is enhanced.

Comparison of pressure fluctuations





As the contact surface chemical reaction is highly suppressed under stratified injection condition, the oscillation magnitude caused by unsteady heat release will be well controlled. The magnitude of oscillation under stratified injection is considerably lower in comparison to the interval injection