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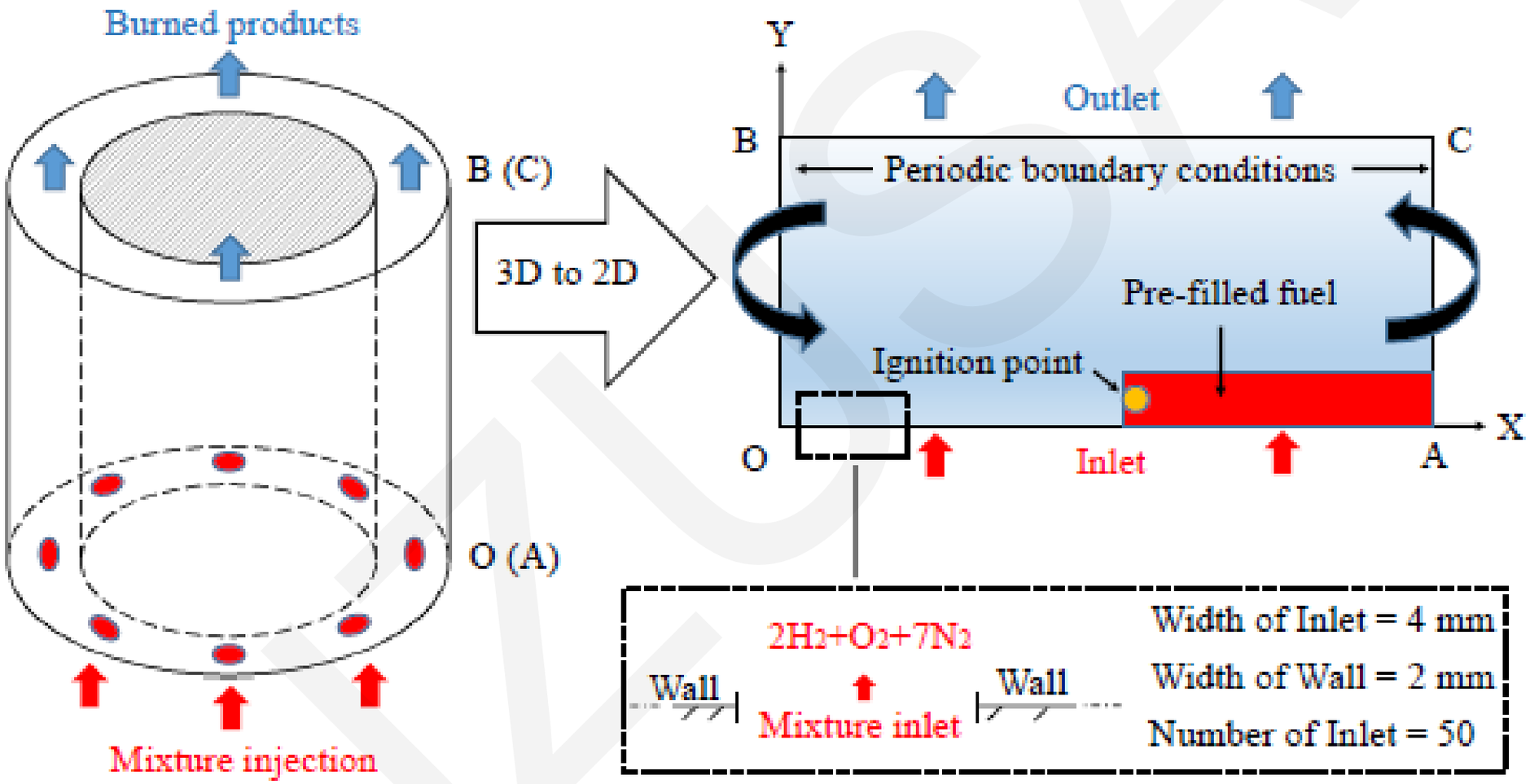
Operational mode transition in a rotating detonation engine

Key words:

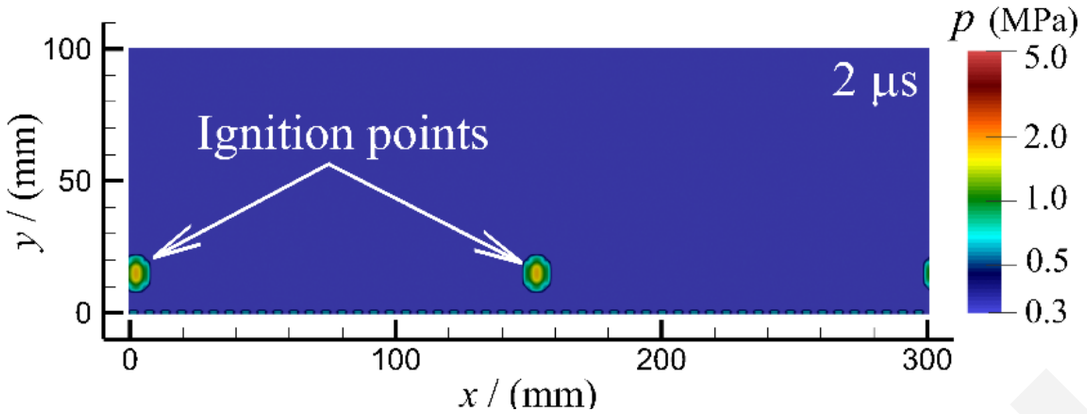
Rotating detonation engine; Detailed chemical reaction; Multiple detonation waves; Stability

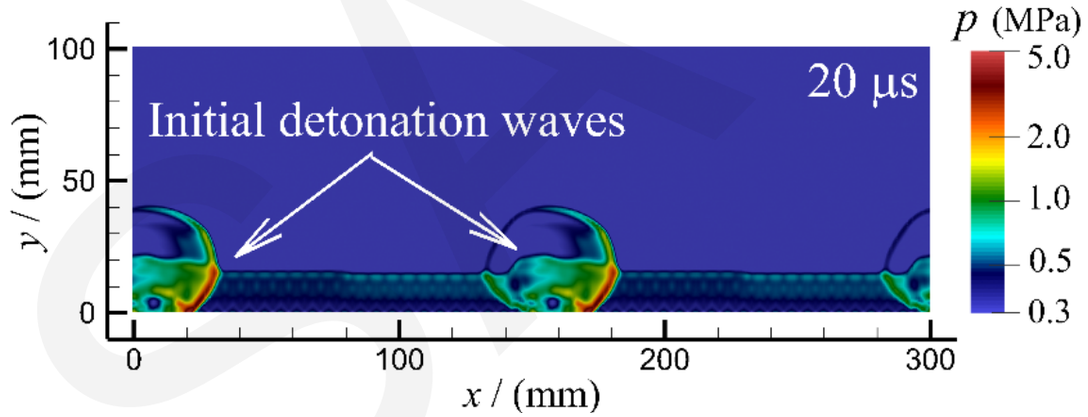
Physical model and computational domain

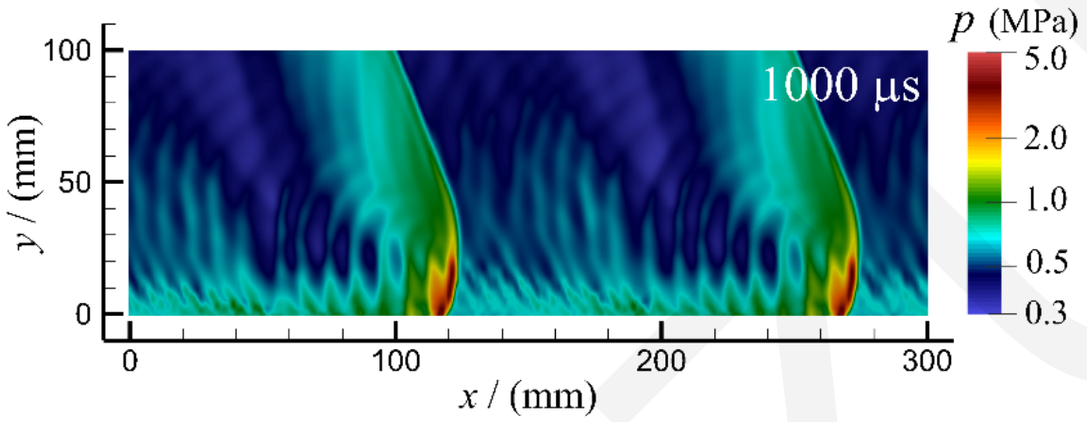


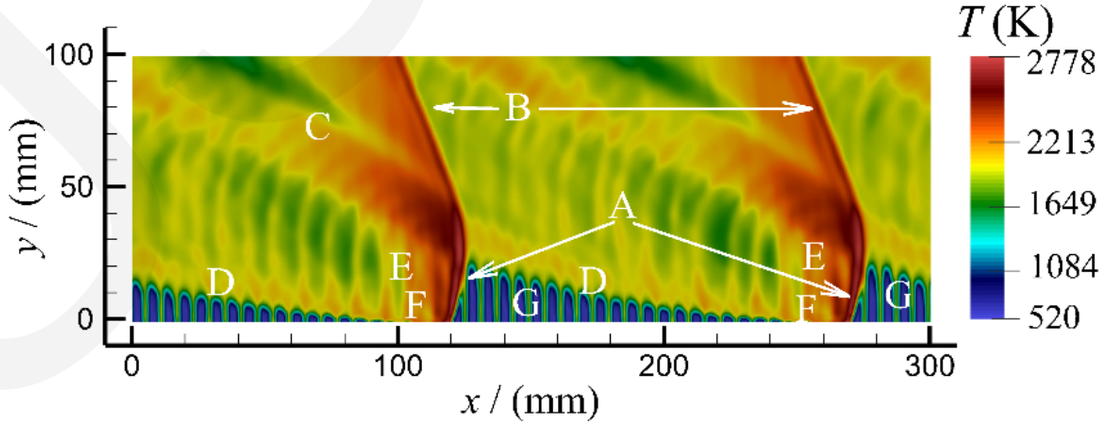
Schematic of the combustion chamber, computational domain, and injector

Quasi-steady evolution of detonation waves



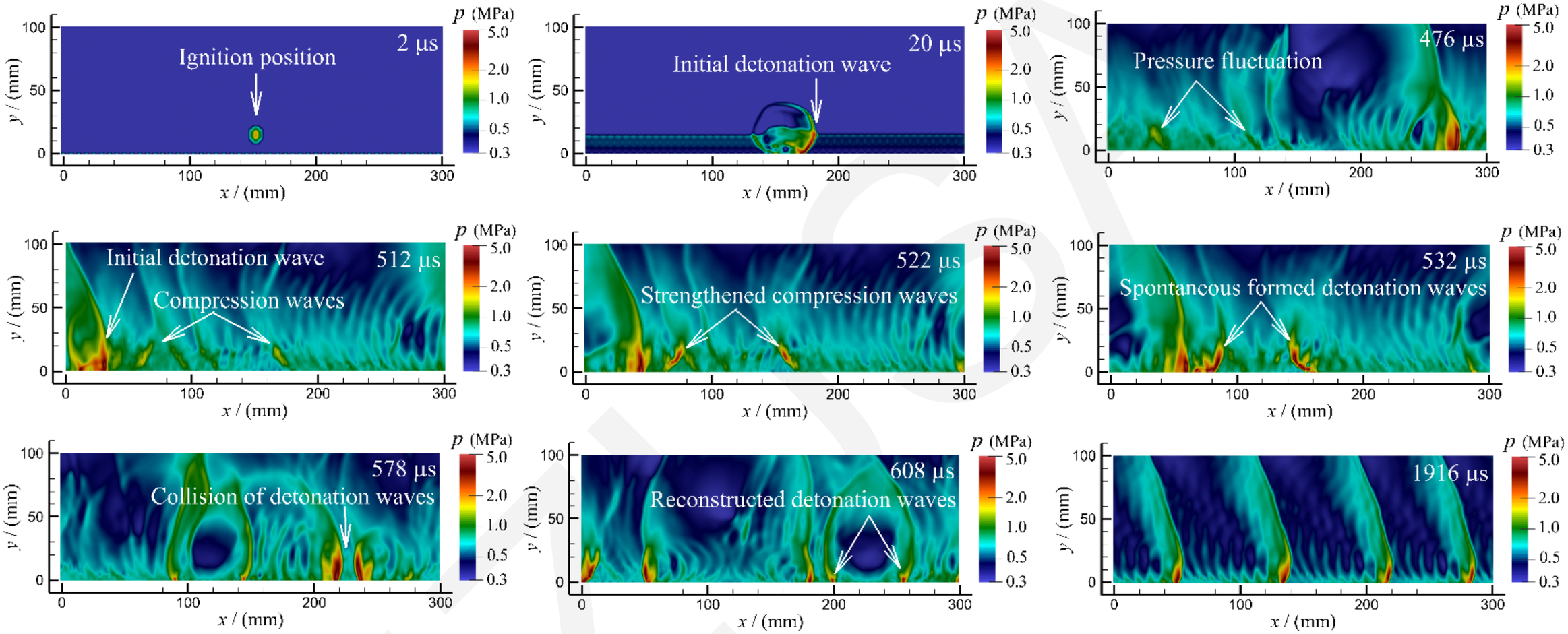






In quasi-steady evolution, all initial detonation waves propagate stably and the chemical reactions on the contact surface cannot trigger new detonation waves. The fully developed detonation flow contains the same number of detonation waves as that in the initial condition.

Unstable evolution of detonation waves



Unstable evolution is characterized by the formation of new detonation waves, collisions between detonation waves, and the detonation waves quenching during the stabilization process.

The derivation of N_L

Parameters and results of the simulations

Pst/(MPa)	T/(K)	N_2%	$N_{initial}$	N_{final}
1	600	70%	1	4
1	600	70%	2	2
1	600	70%	3	3

The necessary conditions for the stable propagation of a single detonation wave:

$$t_w \le t_T \le t_L$$

Necessary conditions for stable propagation of N detonation waves:

$$t_w \le \frac{L}{u_{DW} N} \le t_L$$

Give a definition of $N_{\mathrm{L}} = \dfrac{L}{u_{DW} t_{\mathrm{L}}}$, $N_{\mathrm{W}} = \dfrac{L}{u_{DW} t_w}$ $\qquad N_{\mathrm{L}} \le N \le N_{\mathrm{W}}$

By calculating the N_{L} value of the engine and selecting a reasonable number of ignition positions, the desired multi-wave propagation mode can be obtained without transforming the operational modes in the detonation flow field.