

Experimental Evaluation on the Starting Process of the Opposed-piston Free-piston Linear Generator

Zhifeng TANG, Huihua FENG and Yao WANG

School of Mechanical Engineering, Beijing Institute of Technology, Beijing, China. Mail: 2120170489@bit.edu.cn

www.applied-energy.org/mitab2020

Paper ID: APEN-MAT-2020 159

OPFPLG CONFIGURATION

The prototype of opposed-piston free-piston linear generator(OPFPLG) has a pair of opposed pistons sharing the same combustion chamber.

To improve the self-balance, the prototype adopts:

- Synchronization Mechanism
- Connecting Pipeline
- Check Valves

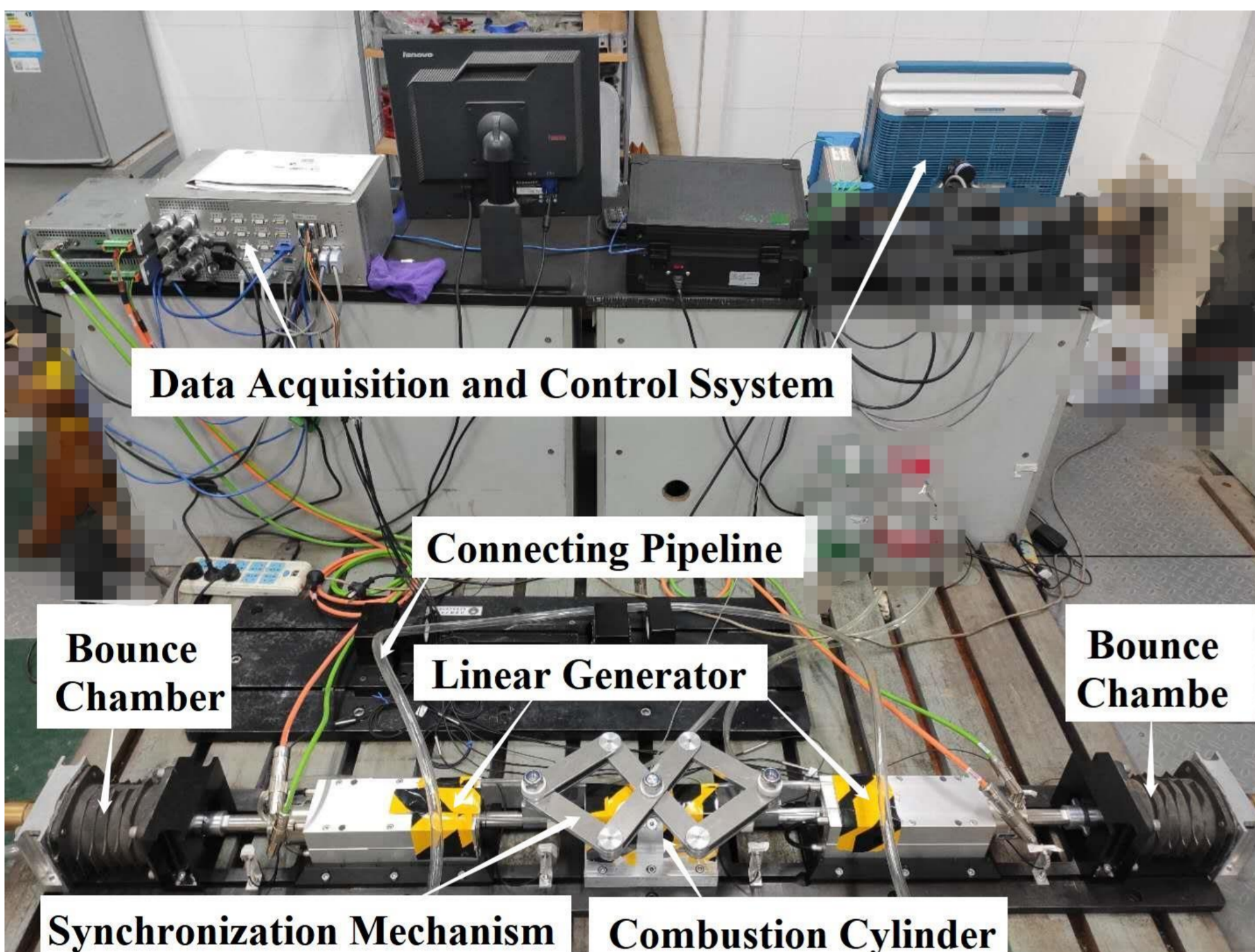


Fig.1. Opposed-piston Free-piston Linear Generator Prototype

STARTING METHOD

Aim of the Starting Process:

- Achieve the required condition for ignition.
- Ensure the Synchronous motions of the twin pistons.

Control Strategies:

- Mechanical Resonance Method
- Synchronization Control Methods
 - Master-Slave Mode
 - Dual Current Mode

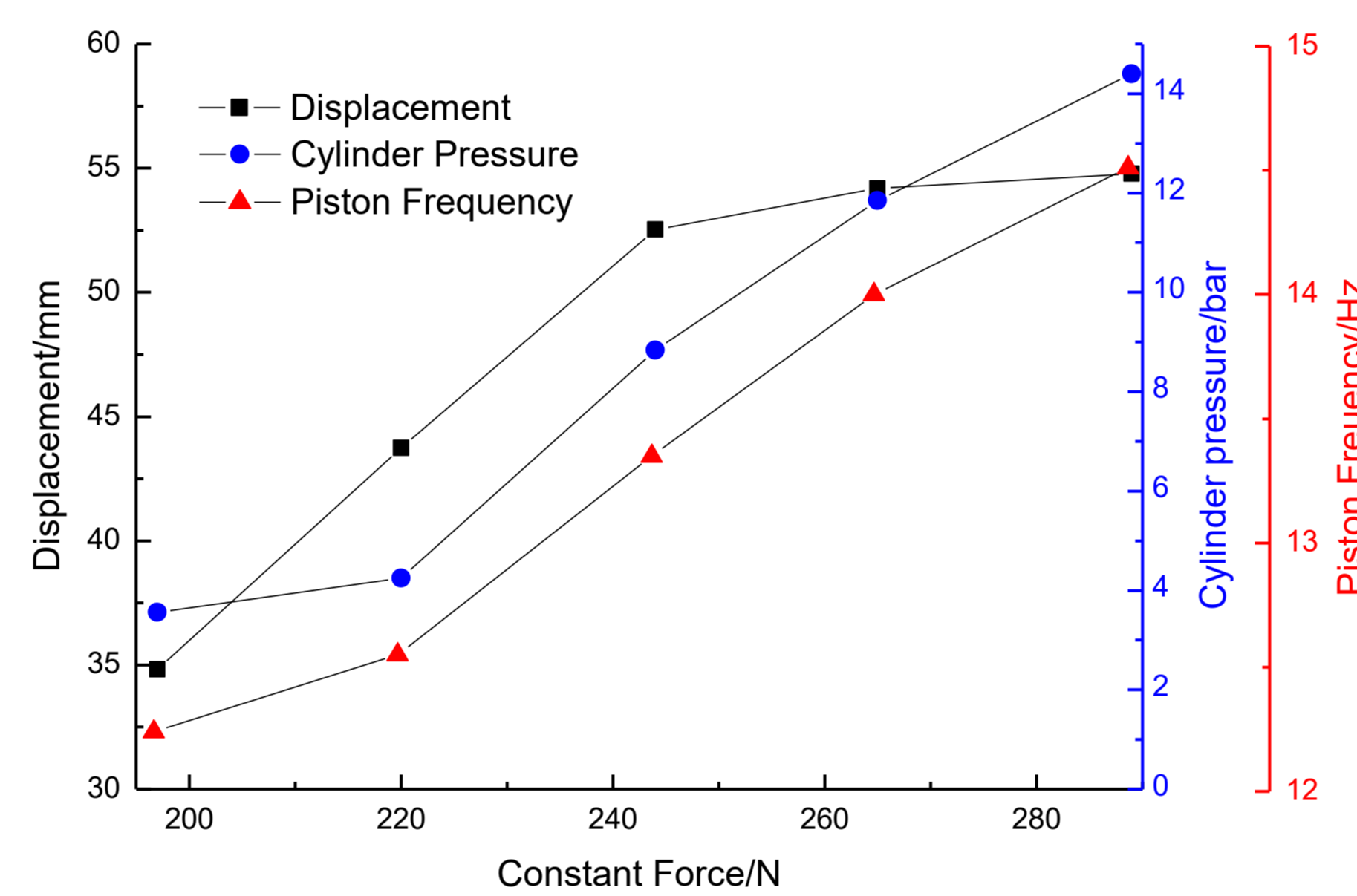


Fig.2. Piston displacement and frequency, cylinder pressure for various constant force

STARTING STATE

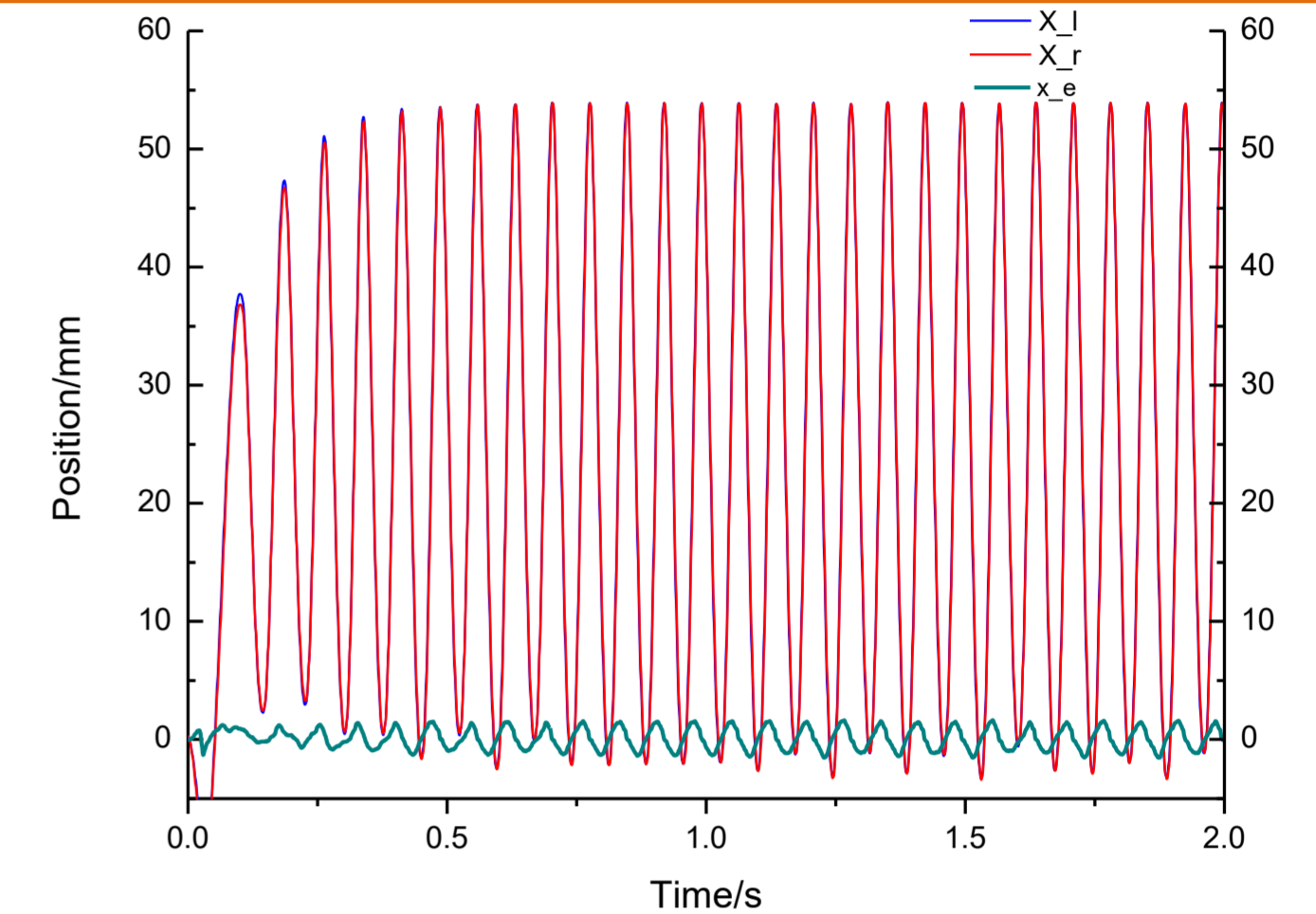


Fig.3. Positon and syn error of the opposed piston

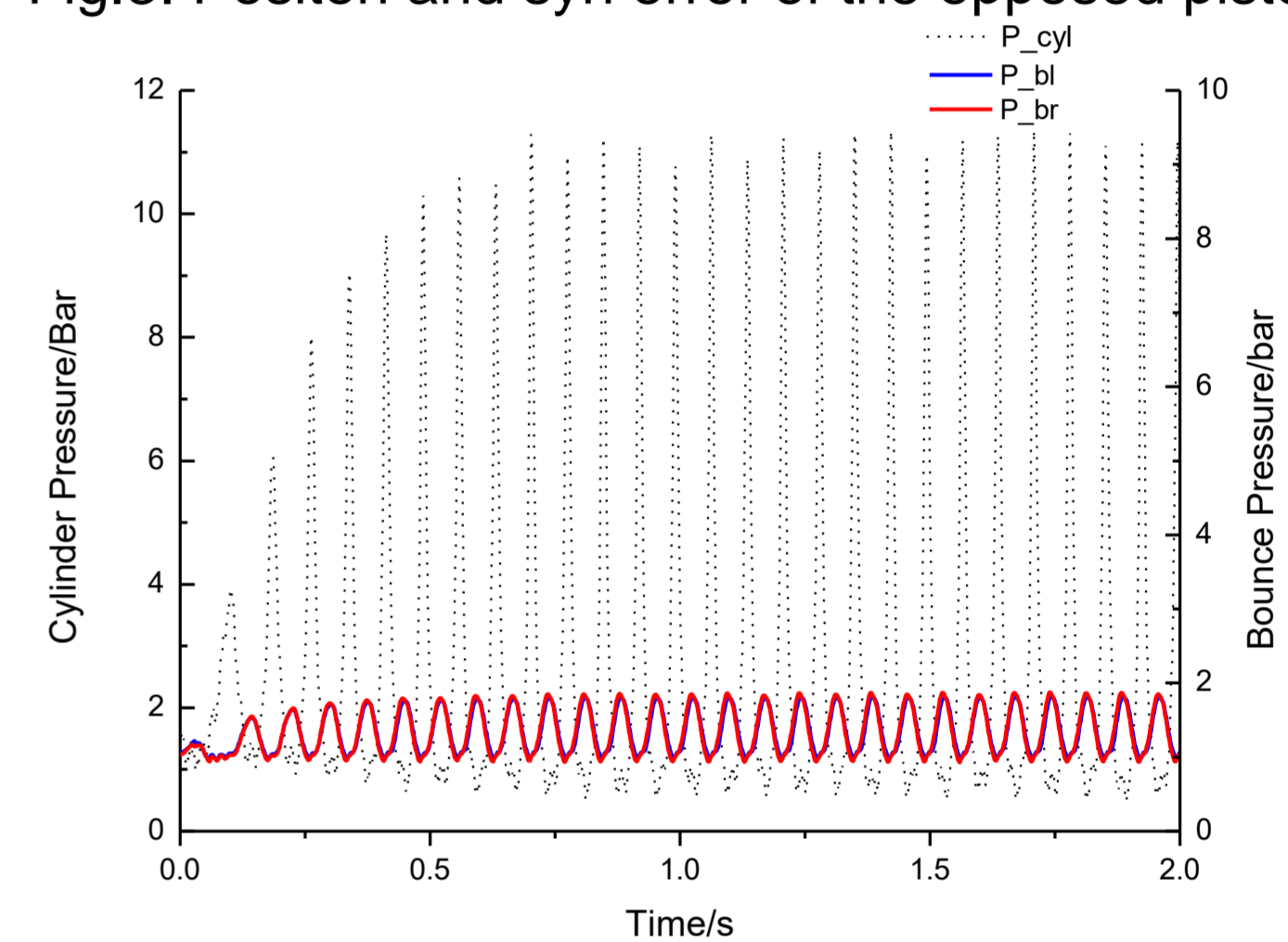


Fig.4. Pressure of combustion and bounce chamber

TABLE I Starting state of applying Mechanical Resonance

Starting Parameters	Value	Starting Parameters	Value
Starting Force/N	260	P _{cyl} /bar	11.8
Stroke/mm	56	P _b /bar	1.7
Frequency/Hz	14	Compression Ratio	12:1

SYNCHRONOUS MOTIONS UNDER DIFFERENCE CONTROL MODES

A. Synchronization Error Analysis

- The synchronization mechanism improves the balance of system and eliminates the external disturbances to reduce the syn error.

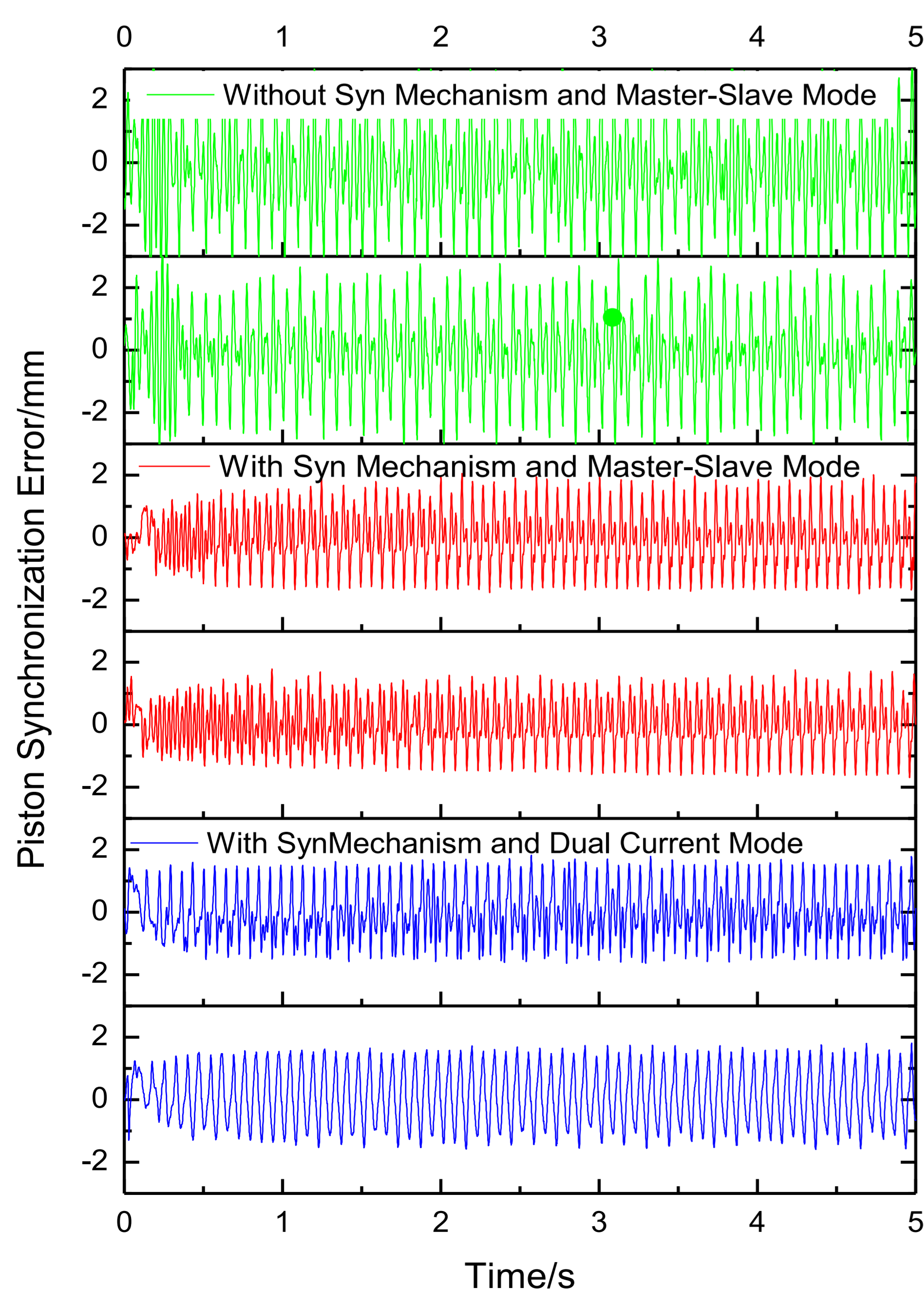


Fig.5. Positon synchronization error under difference control strategies

A. Synchronization Error Analysis

- The syn error relates to the piston velocity.
- Zero error at the inner dead center and outer dead center.

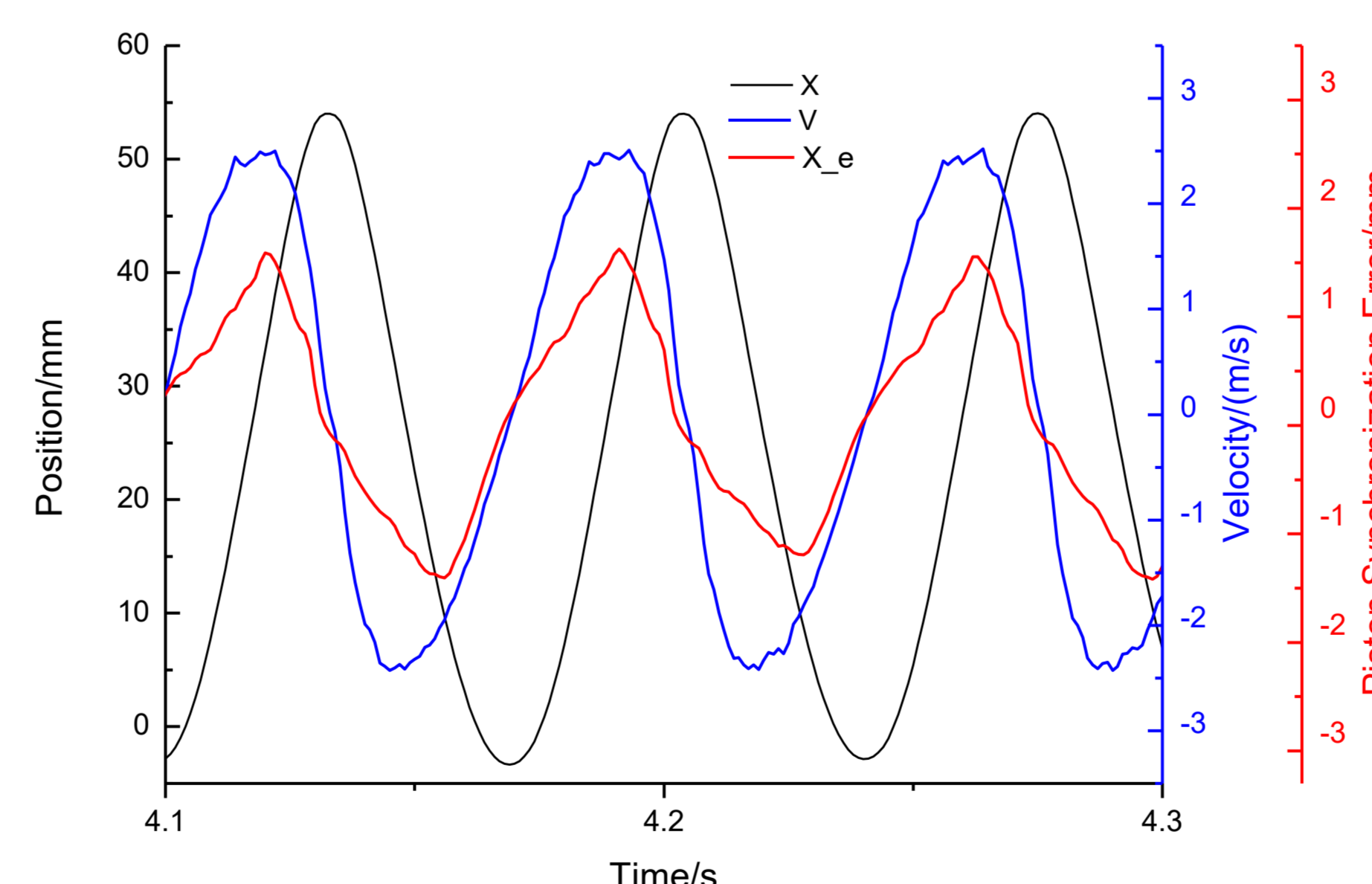


Fig.6. Piston synchronization error along with position and velocity

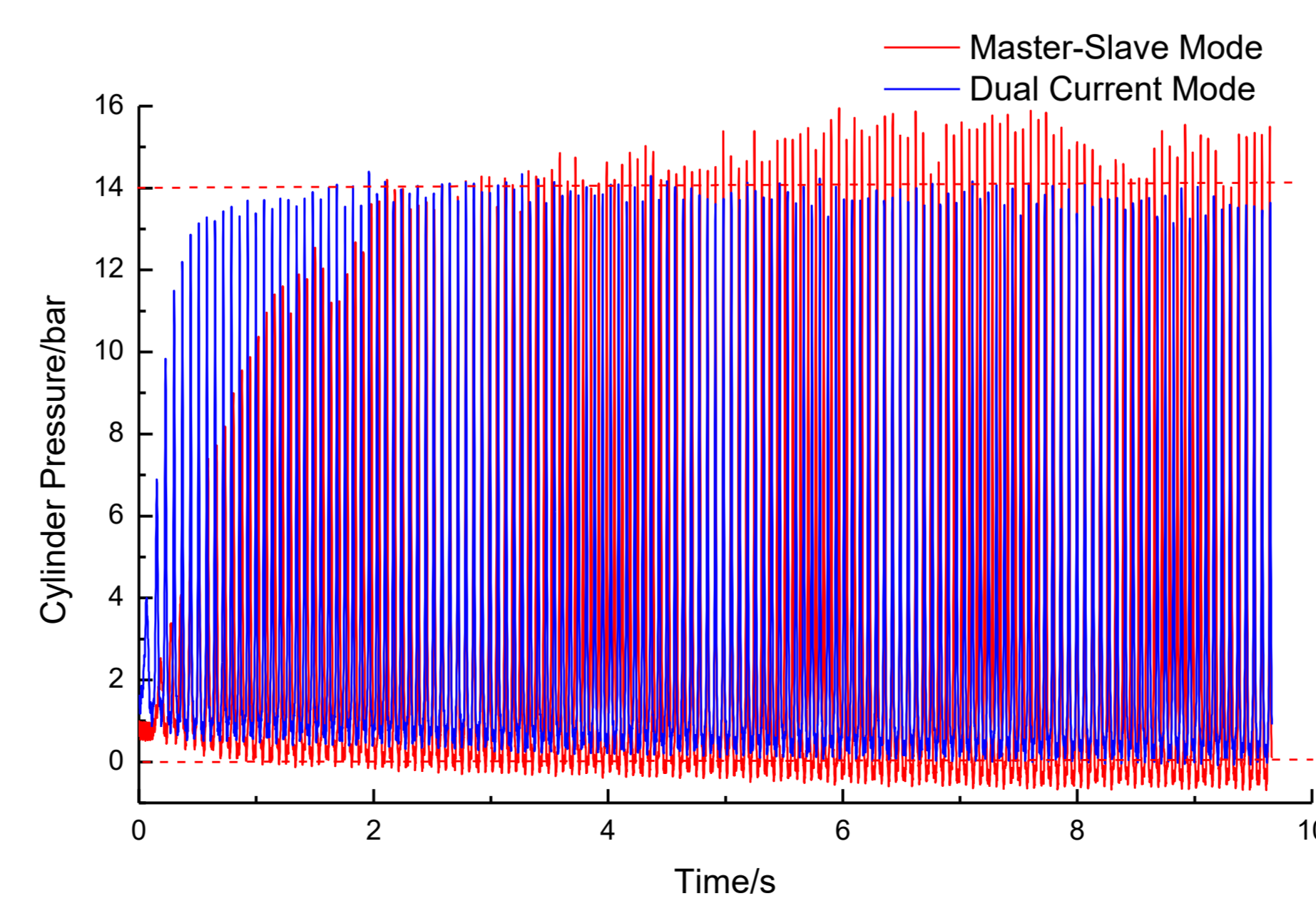


Fig.7 Cylinder pressure of various control method

B. Cycle fluctuation of in-cylinder pressure

- In dual current mode, the increases quickly and hold steady.
- In Master-Slave mode, a delay between the two motors causes the larger cyclical fluctuation in long term continuous operation.

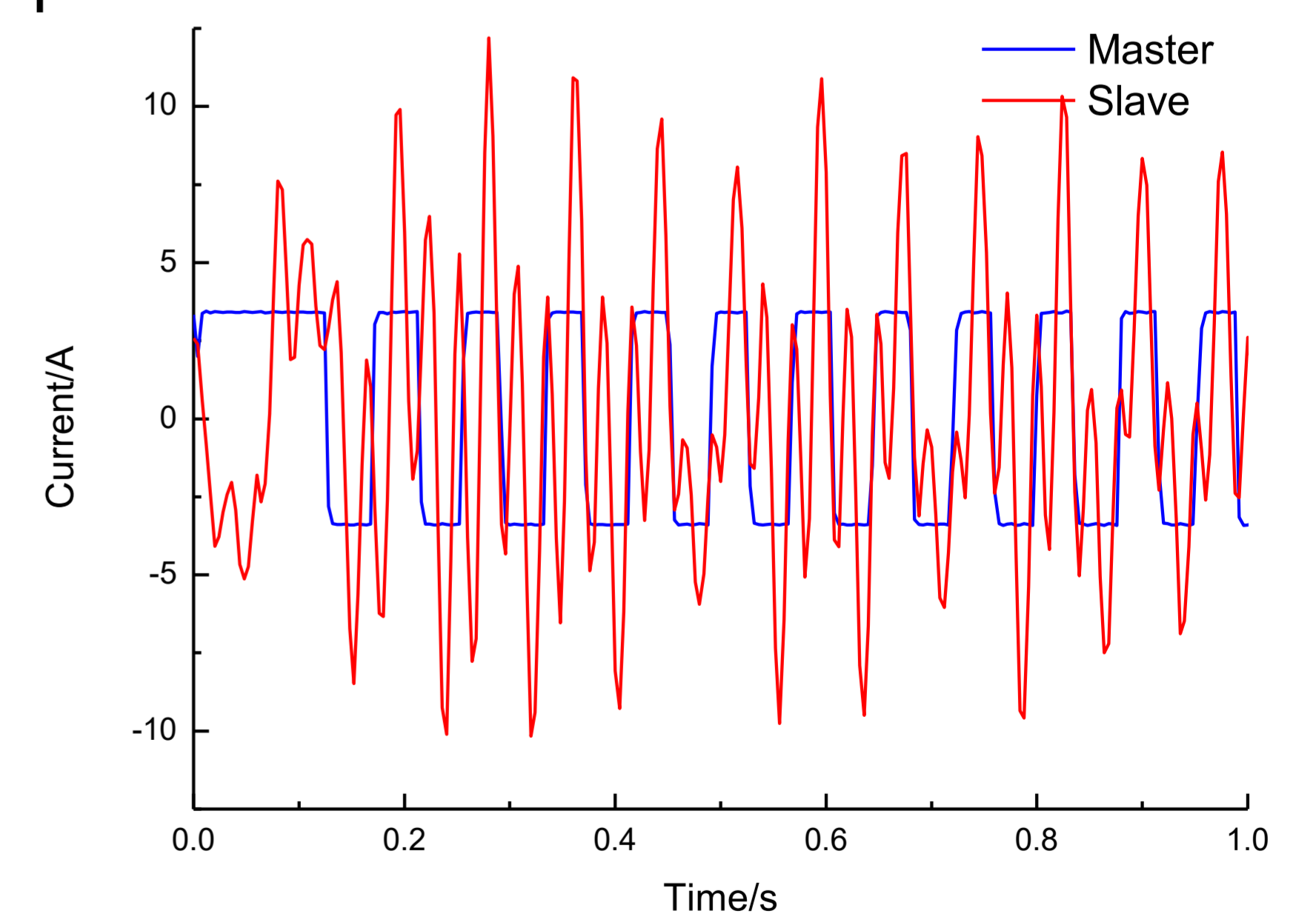


Fig.8 Target current of the mater and slave motor

SUMMARY AND CONCLUSION

- Synchronization mechanism and pipeline improve the self-balance of the system.
- The mechanical resonance method can gradually accelerate the piston to complete the startup process.
- The larger the piston velocity, the larger the synchronization error.
- The dual current mode does better in eliminates the syn error and cycle fluctation