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Intelligent and Standardized test system for electric propulsion in China

Xi-Ming Zhu[1,2], Yan-Fei Wang[1], Jun-Wei Jia[2]
[1] Harbin Institute of Technology, Heilongjiang, China
[2] Beijing Orient Institute of Measurement and Test, Beijing, China
e-mail (speaker): simon.ximing.zhu@outlook.com

Electric propulsion (EP) devices such as Hall thrusters and ion thrusters are currently used on amounts of spacecrafts, such as communication satellites, LEO internet satellites, and space station. These devices are intensively developing to meet the new demands and challenges for space missions, and they need lots of tests during development, assessment and application.

However, the existing test devices are built by each thruster development unit according to their own needs. Both the test systems and test procedures of each unit have not formed a standard, which brings restrictions to the large-scale application of electric thrusters. Besides, most of these home-made test devices rely on manual operation, and the processing of the original data obtained from the test also needs to be completed manually after the test, so it is difficult to realize online monitoring.

In this presentation, efforts on developing an intelligent and standardized joint test system are presented. Several diagnostic methods for determining electron temperature, ion density, ionization fraction, propellant consumption pathways and rates, neutral density, as well as particle velocities in EP devices are developed, by analyzing optical, electrical, thermal, and dynamic information from tests. Intelligent testing methods based on neural networks are also developed to reducing the influence of experimental measurement noise and theoretical uncertainty and supporting online tests of electric propulsion devices. Methods of mining the deep information on the working state of thrusters, such as the extraction current-voltage function of gridded ion thrusters, are also developed. Demonstrations of these methods are presented.

In addition, a circumferential scanning tomography system is developed, which is capable of reconstructing the 3-D spatial distribution of the plasma spectral radiation. Combined with optical diagnostic methods using the information on radiation spectrum, the 3-D spatial distribution of plasma parameters such as electron temperature and ion density could be addressed. The tomography system is demonstrated on a Hall thruster with power of dozens of Watts.

These research work will help promote the intellectualization and standardization of electric propulsion testing, improve the efficiency of electric propulsion system research and development, reveal the deep physical mechanism of thrusters, and promote the application of thrusters in spacecraft.

References

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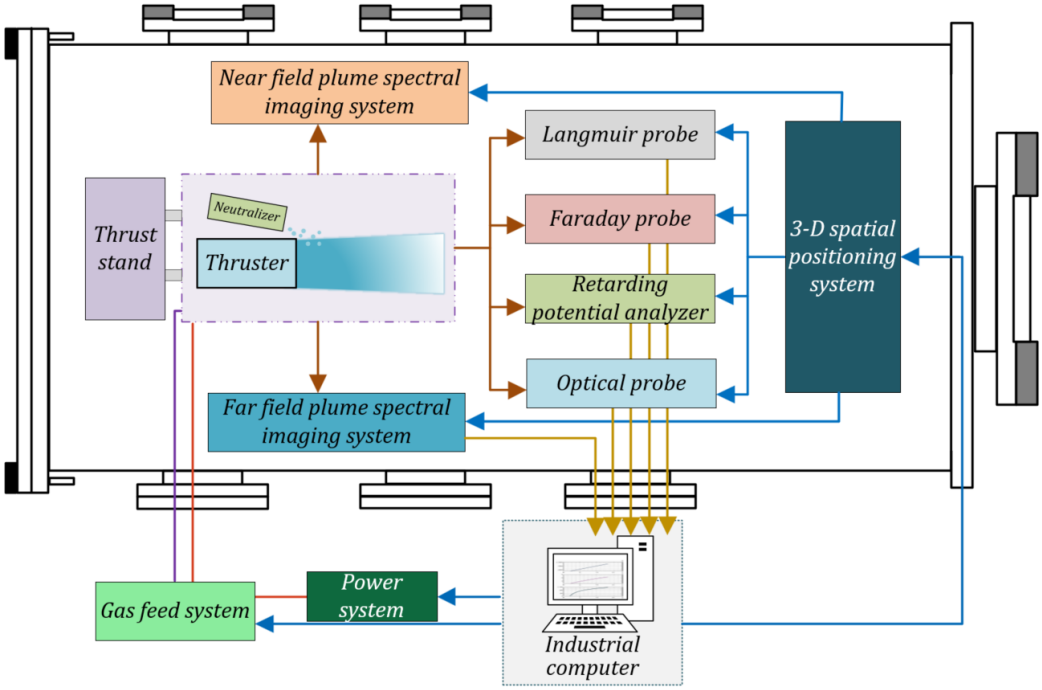

Figure 1. Diagram of the test system for electric propulsion devices