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CHARACTERISATION OF A THRUST STAND TO ASSESS MICRO-THRUSTER PERFORMANCE

Abstract

The paper presents two methods to characterise a test-bench pendulum that has been designed, built and calibrated to measure the performance in vacuum of micro-resistojets with a thrust level in the range from 0.1 to 10 mN, all developed by the Department of Space Engineering for CubeSat applications.
The characterisation of this test-bench is one of the main current challenges due to the high influence that external factors have on the performance of the system. In order to limit error sources, in particular the ones caused by the interaction with the propellant lines of the feed system, the entire micro-propulsion system is mounted on the pendulum. A wireless Bluetooth connection has recently been added between a microcontroller controlling the process and a computer collecting data. This allows the control of the system by opening a valve to start the flow of propellant and real time readings from the sensors.
A capacity sensor measures the displacement induced by the thruster on the pendulum and the data is analysed using two methods. The first method compares the data with the ones induced by a known force produced by a coil. The result is a force-displacement characteristic curve that is compared with the displacement measured after thrusting to get the evolution of the thrust with time. The second one is an analysis of the dynamics of the real physical model of the pendulum. The variation of the thrust force with time can be determined using a transfer function and the measured displacement from the second order differential equation that describes the dynamics of the system. Additionally, a comparison between the two methods used to evaluate the thrust is carried out and discussed.
Numerous tests have already been performed and more will follow in the coming months. A successful characterisation will allow to validate the theoretical model of the thrusters' performance comparing the results predicted using simulation models with the experimental data. Another objective of the analysis is to asses the reliability of the model achieving the repeatability of the results. Moreover, different configurations of the system have been selected, especially to gain a deep insight into the parameters that most affect the performance and to define the boundaries within which the model is valid. On a broader level, the space propulsion community is provided with a simple, fast and reliable test-bench to measure the performance of micro-thrusters, accelerating the development of similar technologies.