

Keep-in-Touch meeting (January 18, 2021)

ESTHER qualification campaign and first experimental results

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Space exploration is one of Humanity longest dreams, yet it is one full of challenges. One of the key engineering issues is the planetary atmospheric entry of a spacecraft. In the typical hypersonic flight regime (~ 5 - 12 km/s or higher) a bow shockwave enhances dissociation and ionization reactions for the flow, leading to the formation of a so-called entry plasma. The thermal heat fluxes from such plasma has to be carefully managed to properly tailor the spacecraft Thermal Protection System (TPS). The optimization of these TPS systems is carried out through a combination of numerical (CFD) and experimental validation in ground test facilities, namely shock-tubes, which are used to faithfully reproduce the entry conditions and study the plasma flow and its radiation.

IPFN (Instituto de Plasmas e Fusão Nuclear) is the leader of the ESA (European Space Agency) consortium building the new European Shock-tube, ESTHER. Inaugurated in 2019 it is now in the qualification campaign phase. This first part is composed of combustion tests in the Driver section, a 50L combustion chamber. A series of experimental shots were performed to evaluate the combustion performance and the influence of several parameters in the overall process. The results are compared to numerical data from both the in-house SPARK (Software Platform for Aerothermodynamics, Radiation and Kinetics) and STAGG (Shock Tube and Gas Gun) codes solutions.

This presentation will focus on the ESTHER qualification activities that have been carried over the last 6 months, namely mechanical design, the laser ignition system and the first experimental shots in the isochoric combustion chamber. The shots are analysed and compared to the test scale combustion chamber “Bombe”. A Fourier Transform analysis of the pressure signal is carried out to infer on the acoustic pressure waves and sound speed inside the chamber. Furthermore, a qualitative analysis of the influence different combustion parameters is presented as well as a discussion on the upcoming test campaign.