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Title
Injection characterization of multi-injector rocket combustion chambers

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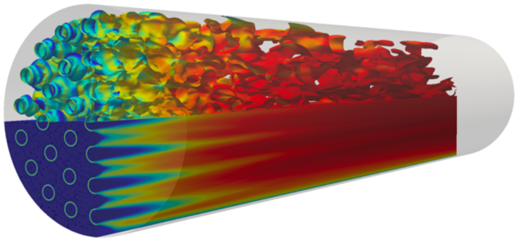
Abstract
Liquid Rocket Engines are a widespread technology for space transportation systems, being characterized by ever-increasing complexity in terms of both configuration and operating conditions. Thermal characterization is in this context a key aspect of the design process, directly impacting the engine performance and operating life, and can be efficiently tackled by simulations significantly reducing the development time and costs. While the most thermally stressed parts of the combustion chambers (e.g. nozzle and lateral walls) have been largely investigated, only a small portion of the recent literature has dealt with the injection zone. In particular, the effect of the injector layout on the thermal load has been assessed in a recent work through the collection of a database of 2D-simulations with a parametric variation of the combustion chamber lateral dimension [1]. In the present contribution, the thermal analysis of two multi-injector configurations simulated in a 3D setting is presented, with particular attention to the heat flux pattern over the injection faceplates. The two configurations are based on the layout of a 7-injectors lab-scale chamber [2] and are obtained from each other via a parametric variation of injectors density. The trends obtained in [1] in a 2D setting will be compared with their 3D counterpart, the latter being characterized by inherently 3D phenomena such as the recirculations between injectors. The 2D database of [1] will be also used to develop and test a data-driven model for thermal load estimation in 3D complex geometries. To mitigate the computational cost of the simulations, an unsteady RANS solver will be used [3], coupled with a flamelet-based approach for turbulent combustion modeling and accounting for non-equilibrium and non-adiabatic effects and enforcing a wall-modeled description for the boundary layer stiffness reduction [3].



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