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Abstract #XXX *(to be filled by the organizers)*
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Title

Repetitive Femtosecond Laser Energy deposition for Supersonic Flow Control

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Abstract

Laser energy deposition has been considered as an appealing method to perform off-body energy deposition in supersonic flow [1]. When the laser power exceeds a threshold depending on the incoming flow properties (nature of the gas, density, etc.), the gas breakdown leads to the formation of a plasma. When the laser pulse duration is in the nanosecond range, the plasma kernel consists in a small volume of a few cubic millimeters. When the pulse duration is in the femtosecond range, lasers can form long plasma filaments over distances ranging from several centimeters to several meters [2]. Depending on the pulse energy, the filament can induces a significant heating of the gas [3] which can be used advantageously for high speed flow control, in particular for drag reduction. This idea has been recently demonstrated experimentally using a femtosecond laser in single pulse mode [4], [5]. While the effect of single pulse has been shown to lead to a transient drag reduction above 40%, a repetitive action is needed to induce quasi-steady effect on the flow. LOA, ONERA and Phasics are engaged in a research project to examine experimentally whether repetitive femtosecond laser energy deposition could enable a quasi-steady drag reduction. In addition, the effect of off-axis repetitive energy deposition will be considered.

The test campaign, scheduled for July 2023, will use a state-of-the-art femtosecond laser (repetition rate in the kHz range) [6]. This paper will detail the main steps of this project. It will present the main challenges of the experimental arrangement, in particular the adaptation of the ONERA R1Ch wind-tunnel and the design of a 6-component balance to specially designed to measure the effect of the new LOA femtosecond laser. A first modelling of the laser energy deposition will be discussed, which will serve as the basis for the modelling effort that will accompany the experiments. In particular, the gas heating phase and will be investigated at different pressure, comparing neutral gas density measurements with results of ONERA's CEDRE/TARANIS.

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