Laser ProPULSion: Energy *vs.* Efficiency
Acronym: L-PULSEE

CONTEXT AND OBJECTIVE OF WORK

A national program is piloted by the CNES Launcher Direction for the preparation of the future on Spatial Transport (1.). It aims to apprehend the stakes of tomorrow and future breaks (reusable vehicle). Indeed, space users are becoming aware of the urgent need to put in place real legislation on space activities and satellite traffic to guarantee the long-term sustainability of space. Swirling fragments of past space initiatives are trapped in orbit around Earth and pose a threat to our future in space.

In close cooperation with CNRS teams, a bunch of complementary scientific expertise has been implemented to investigate the Laser Ablation Propulsion (LAP) as a possibility to manage Space Debris problem. It was demonstrated the feasibility of creating a pushing force by laser on an ablative target by creating locally at the target surface a plasma ejected at high speed.

The work intends to the preliminary design of a laser-powered microlighter, by designing demonstrative experiments to be implemented within the frame of European Laser Facilities, HILASE, the laser center of excellence in Czech Republic. LAP development is governed by the determination of coupling coefficient Cm (mechanical impulse *vs.* laser irradiation) measured using the concept of ballistic pendulum especially revisited according to the level of laser energies, and coupled with a Photonic Doppler Velocimetry system and angle measurement using laser deflection (2.,3.,4.). LAP implies repeated ablation on the same spot (infrared laser at 1 kHz, 1030nm, 6ps), which is a complex phenomenon quite different from single pulse. Several cases were considered by changing number of pulses at constant energy per pulse and energy per pulse at a constant number of pulses. in support of Cm definitions, numerical modeling of the Laser Matter Interactions (LMI) provides a physical understanding of the phenomena (5.).

By conceiving experimental and numerical developments, the post-doc will gather advanced data to eliminate existing uncertainties: **i.** primarily in thermal coupling and mass loss on the way to achieving space LAP, and **ii.** to get better understanding of energy *vs.* efficiency. This collection of data will make it possible to define tracks and assist with the preliminary design proposal for a laser-powered micro launcher. It is advisable to propose several concepts, in particular: **I.** materials shapes, designs of systems: to identify most effective LMI, **II.** demonstrators under laser beam: to reproduce different conditions of Space situations (levitation to measure the propulsion length; air cushion table for stability test of vehicle (Scharring 10.117/1.OE.56.1.011007); linear rail support with adjustable compensation force by changing rail angle), **III.** calculation: to identify news advances in thermal effect induced by LMI according to (**I.**), and for the aerodynamic aspects to see which form of the demonstrator will be the most stable/the most controllable according to (**I.**, **II.**).

To advance the several concepts of LAP demonstrators, the project will be supported by Photonic Associates (US) expertise. European collaborative works are planned in particular with the HILASE center of excellence (CZECH REPUBLIC (6.).

1. Bonnal Futura Sci. 2021 ; ***2.*** Phipps 10.1063/1.4997196 ; ***3.*** Phipps 10.1016/j.actaastro.2018.02.018 ; ***4.*** PERLA-B Boyer, www.hilase.cz ; ***5.*** Tahan 10.13009/EUCASS2019 ; ***6.*** www.laserlab-europe.eu

REQUIRED PROFILE AND SKILLS	Space research, laser physics, plasma physics, materials science, mechanical engineering Experimental and numerical fields motivations
KEYWORDS	Space research; Laser-Mater interactions; Spatial Transport & Spatial safety, Numerical modeling
LOCATION	CEMEF CNRS 7635, MINES ParisPSL, SOPHIA ANTIPOLIS (NICE), FRANCE
SUPERVISORS	Séverine A.E. BOYER (CNRS 7635 - MINES Paris PSL, SOPHIA ANTIPOLIS) Michel BOUSTIE (CNRS 3346, ISAE-ENSMA, FUTUROSCOPE) Nathalie GIRARD (CNES, PARIS)
GROSS SALARY	CNES information
DEBUT DE PROJET	Spring/Summer 2022
TYPE DE PROJET / COLLABORATION	CNES (FRANCE) / CNRS (FRANCE) / Photonic Associates (USA)
INVESTIGATION MEANS	Numerical (Python, etc.), Experimental, Microstructures Analysis (MO, SEM, Tomography)
FOR MORE DETAILS, YOU MAY CONTACT	severine.boyer@mines-paristech.fr
CNES INFORMATION	Submit the complete application online (Apply) **before March 31th, 2022 Midnight Paris time, FRANCE** **https://recrutement.cnes.fr/en/annonce/1498347-116-postdoctoral-laser-propulsion-energy-vs-efficiency-acronym-l-pulsee-06560-valbonne**

CEMEF (Centre de Mise en Forme des Matériaux) is a research Laboratory of MINES Paris - PSL University, located in SOPHIA ANTIPOLIS near NICE (South of FRANCE); associated with CNRS (UMR 7635), the French National Foundation for Scientific Research.
https://www.cemef.minesparis.psl.eu/en/homepage/

CNES (**Centre National d'Etudes Spatiales**) is a research center working on the French space program while implementing.
https://cnes.fr/en