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Control of large electric spark through laser filamentation in air

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Controlling lightning is a long time dream of mankind. As a part of the Laser Lightning Rod (LLR) project, we investigate the feasibility of a new type of lightning protection based on the use of upward lightning discharge initiated through a high-repetition-rate multi-terawatt femtosecond laser [1].
When such high intensity laser pulse propagates in the atmosphere, a process called filamentation happens. The laser pulse undergoes Kerr self-focusing until creating a long column of weakly ionized plasma. Energy deposition through photoionization will result in a low density channel over a microsecond timescale [2]. This channel acts as a preferential path for discharge propagation, providing a way to trigger and guide electric discharge [3].
To prepare for the real scale experiment on lightning, we study the impact of the laser parameters over the discharge control by analyzing the propagation of a laser guided meter scale electric discharge from a compact Tesla coil (output voltage: 360 kV) using a fast camera. Furthermore, we characterize by means of transverse interferometry the spatial and temporal evolutions of the underdense channel, with a particular attention to the hydrodynamics effects appearing with high-repetition-rate laser.

[1] http://llr-fet.eu/
[2] G. Point, et al., “Generation of long-lived underdense channels using femtosecond filamentation in air,”J. Phys. B 48, 094009 (2015).
[3] B. Forestier et al., ”Triggering, guiding and deviation of long air spark discharges with femtosecond laser filament,”AIP Advances 2, 012151 (2012).

Author: Mr WALCH, Pierre (Laboratoire d’Optique Appliquée, ENSTA ParisTech, Ecole Polytechnique, CNRS, Institut Polytechnique de Paris, 91128 Palaiseau, France)

Co-authors: Mr MAHIEU, Benoit (Laboratoire d’Optique Appliquée, ENSTA ParisTech, Ecole Polytechnique, CNRS, Institut Polytechnique de Paris, 91128 Palaiseau, France); Mr ARANTCHOUK, Leonid (Laboratoire d’Optique Appliquée, ENSTA ParisTech, Ecole Polytechnique, CNRS, Institut Polytechnique de Paris, 91128 Palaiseau, France); Mr MYSYROWICZ, André (André Mysyrowicz Consultants, 6 Rue Gabriel, 78000 Versailles, France); Mr HOUARD, Aurélien (Laboratoire d’Optique Appliquée, ENSTA ParisTech, Ecole Polytechnique, CNRS, Institut Polytechnique de Paris, 91128 Palaiseau, France)

Presenter: Mr WALCH, Pierre (Laboratoire d’Optique Appliquée, ENSTA ParisTech, Ecole Polytechnique, CNRS, Institut Polytechnique de Paris, 91128 Palaiseau, France)

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