

Title: Guiding electric discharges in air using femtosecond laser filamentation

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Research Area: Lasers and Plasma Physics, Optics

Methods: High power femtosecond laser system, high voltage generators

PhD track subject:

The propagation of intense ultrashort laser pulses in atmosphere gives rise to a filamentation process, during which the nonlinear effects maintain a high peak intensity over long distances forming a plasma column in the wake of the filamentary pulse [1]. A striking feature of these filaments is their abilities to trigger and guide electric discharges in the atmosphere [2].

In the last 20 years, many applications have been proposed such as the plasma antenna for radiofrequency emission [3], or on a larger scale, the triggering and guiding of natural lightning [4]. In the frame the European project Laser Lightning Rod (LLR) we investigate a new type of lightning protection based on the use of upward lightning discharges initiated through a high-repetition-rate multi-terawatt laser.

The student will participate in various laboratory and outdoor experiments related to the control of electric discharge with laser. The results will be analysed to understand the physical origin of the guiding, especially with high repetition rate lasers.



Photography of 2.5 m long discharge guided by laser filamentation (left one).

References:

[1] J. Kasparian et al. Science 301, 61 (2003)

[2] B. Forestier, et al., "Triggering, guiding and deviation of long air spark discharges with femtosecond laser filament", AIP Advances 2, 012151-13 (2012)

[3] Y. Brelet, et al., Radiofrequency plasma antenna generated by femtosecond laser filaments in air", Applied Physics Letters 101, 264106 (2012)

[4] T. Produit, et al. "The Laser Lightning Rod project," The European Physical Journal 93, 10504 (2021)