PROPAGATION OF TW LASER PULSES IN AIR AND APPLICATIONS TO LIGHTNING CONTROL

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While propagating in air, ultrashort laser pulses undergo filamentation which results from a dynamic balance between Kerr lens focusing and defocusing on laser-induced micro plasma. Such equilibrium leads to a self-guided ionized channel, or filament, with a diameter on the order of 100 µm, extending over long distances up to several hundreds of meters. Using the Teramobile laser system [1] providing 250 mJ pulses of 100 fs duration, centered at 800 nm, we have shown that the beam propagation for multi-TW pulses is driven by the interplay between random nucleation of small-scale cells and relaxation to long waveguides. After a first chaotic step where amplitude and location vary a lot, some filaments emerge and are confined into distinct clusters called "optical pillars". We compare experimental results with simulations. Also, a white-light supercontinuum is generated by self-phase modulation, and mixing with the generated Third Harmonic Generation (THG) extends the spectrum down to 230 nm in the infrared, providing a promising light source for multiparameter remote sensing by Lidar.

We show that filaments can propagate even under perturbed conditions such as rain, surviving their interaction with droplets as large as its own diameter. This effect, due to the contribution of the photon bath, is highly favourable for lightning control application (laser lightning rod), since the rain usually associated with thunderstorms should not jeopardize the laser effect. We investigated the triggering and guiding of high-voltage (MV) under artificial rain in laboratory experiments at the meter-scale (1.2 m gap, tip-plane configuration), using a Marx shock generator providing high-voltage pulses with a rise time of 1.2 µs rise time. Compared with dry air, the discharge probability is reduced by only 30 % in a heavy artificial rain (1.4 mm/min, extinction coefficient 0.14 m^{-1}). However, guiding of the discharges is little affected, as shown in Fig. 1 [2].

These results, combined with recently proposed multi-pulse strategies to enhance the plasma lifetime within the filaments, provide a new perspective towards the 30 years old idea of controlling lightning using lasers.

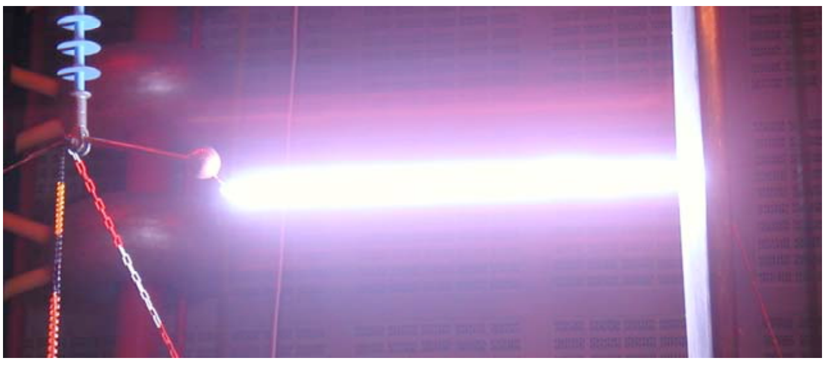

Fig. 1. Guided discharge in artificial rain

1 J. Kasparian *et al.*, Science **301**, 61 (2003)
2 R. Ackermann *et al.*, Applied Physics Letters **85**, 5781 (2004)