TERAMOBILE : FEMTOSECOND LIDAR AND OTHER ATMOSPHERIC APPLICATIONS OF ULTRASHORT LASERS

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The interest in nonlinear laser pulse propagation has been significantly renewed since 1985, when the development of the chirped pulse amplification (CPA) technique[1], permitted to produce ultra-short laser pulses, which now reach powers in excess of 10^{14} W. At those power levels, nonlinear phenomena dominate pulse propagation in air. One of the most spectacular processes under such conditions is filamentation, in which a dynamical equilibrium between Kerr-lens self-focusing and defocusing due to plasma production results in a self-trapping of the beam for distances of at least several hundreds of meters. In those thin filaments (around 100 μm in diameter), the intensity reaches 10^{13} - 10^{14} W/cm^2, sufficient to generate significant self-phase modulation (SPM), yielding a bright white light supercontinuum extending from the UV to the mid-infrared up to 4 μm[2]. This range covers the absorption bands of many important pollutants, such as volatile organic compounds (VOCs), opening the way to Lidar remote sensing of the atmospheric composition based on white-light-continuum.

The main advantages of white-light Lidar is to combine the range resolution of classical Lidar with a full spectral information, allowing the simultaneous measurement of multiple species, as well as a reduction of interferences between species with overlapping spectra, such as Volatile Organic Compounds (VOCs). In that purpose, we developed the first mobile femtosecond-terawatt Lidar: the Teramobile[3].

Besides multicomponent Lidar, fs-TW lasers are useful for aerosol remote sensing, based on non-linear effects generated in-situ in the microparticles. These non-linear effects include harmonic generation, multiphoton-excited fluorescence or microcavity lasing, leading to signatures characteristic of the aerosol particle shape, size and compositions.

Furthermore, since the self-guided filaments are ionized, they are suitable candidates for laser-triggered and guided lightning. Recently, we demonstrated the guiding and triggering of MV discharges by laser-generated filaments over several meters[4] (Figure 1).

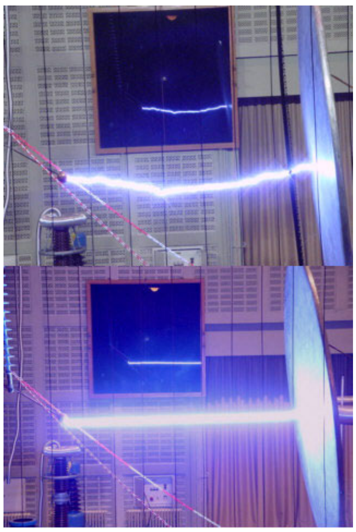

Fig. 1. Unguided (top) and laser-guided (bottom) high-voltage discharge

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