

# 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<sup>1</sup>, 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  $100 \mu\text{m}$  in diameter), the intensity reaches  $10^{13}$  -  $10^{14}$  W/cm<sup>2</sup>, sufficient to generate significant self-phase modulation (SPM), yielding a bright white light supercontinuum extending from the UV to the mid-infrared up to  $4 \mu\text{m}^2$ . 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<sup>3</sup>.

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<sup>4</sup> (Figure 1).

<sup>1</sup> D. Strickland, G. Mourou, *Opt. Commun.* **56**, 219 (1985)

<sup>2</sup> J. Kasparian et al., *Opt. Lett.* **25**, 1397-1399 (2000).

<sup>3</sup> H. Wille, et al., *Eur. Phys. J. AP*, to be published.

<sup>4</sup> M. Rodriguez et al., *Opt. Lett.* **27**, pp. 772-774, 2002.

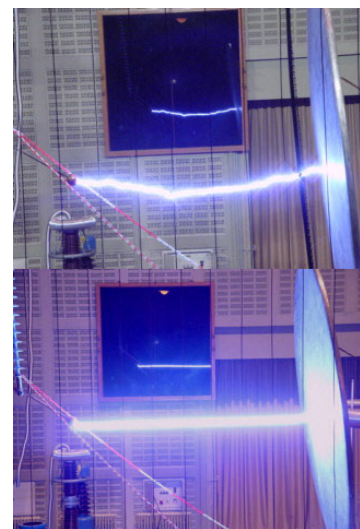


Fig. 1. Unguided (top) and laser-guided (bottom) high-voltage discharge