Triggering and guiding long-gap discharges using fs-TW laser induced ionized filaments

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1. Introduction

A high-power femtosecond laser can produce long-length ionized filaments which are expected for lightning triggering and guiding applications. Discharges guided by filaments have been successively demonstrated over a gap of 2 meters between two plane electrodes[1]. However, the triggering discharges, which can be shown by reducing breakdown voltages, was not demonstrated.

2. Experimental results

We performed triggering and guiding long-gap discharges using fs-TW laser induced ionized filaments[2]. The laser used for the experiments was the Teramobile system[3], a container-integrated mobile fs-TW Ti:Sapphire laser system. During the experiments, it provided 300 mJ and 150 fs (2 TW) laser pulses with 10 Hz repetition rate. A 12 cm diameter sphere was used for the negative high voltage electrode, and a 3 m diameter plane was used for the ground electrode. The laser beam was slightly focused with focal length of 15-20 m. Ionized filaments were produced about 1 m before the high voltage electrode, and continuous up to the ground electrode. The experiments were performed by changing the gap length from 0.5 m to 3.8 m.

Figure 1 shows a photo of breakdown with the laser-induced filaments using 3 m gap and 1.9 MV voltages, and that complete discharge guiding over whole gap was performed. Figure 2 shows breakdown voltage as a function of electrode gap length with and without the laser-induced filaments. U_{50} values are the voltages at which the breakdown probability is 50 % of the tried events. The U_{50} values with laser-induced filaments were reduced to 68 % of those for natural breakdown. These results show the ability of laser triggering discharges for gaps up to 3.8 m.

3. Conclusions

We demonstrated for the first time to our knowledge the triggering and guiding long-gap (up to 3.8 m), high-voltage (up to 1.9 MV) discharges using fs-TW laser induced ionized filaments. The discharges were guided over distances up to 3 m, and triggered for gaps up to 3.8 m reducing breakdown voltages to 68 % of those for natural breakdown.

References

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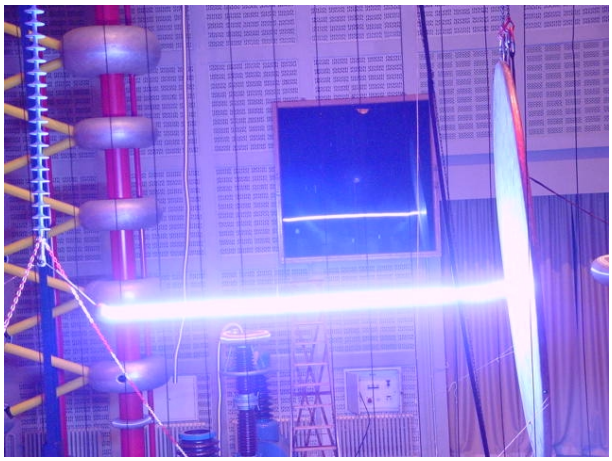

Fig. 1. Discharge guiding with fs-TW laser induced ionized filaments using 3 m gap.

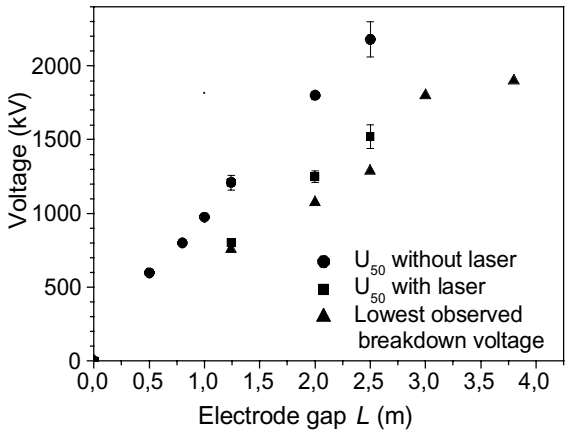

Fig. 2. Breakdown voltage as a function of electrode gap length with and without laser-induced filaments.