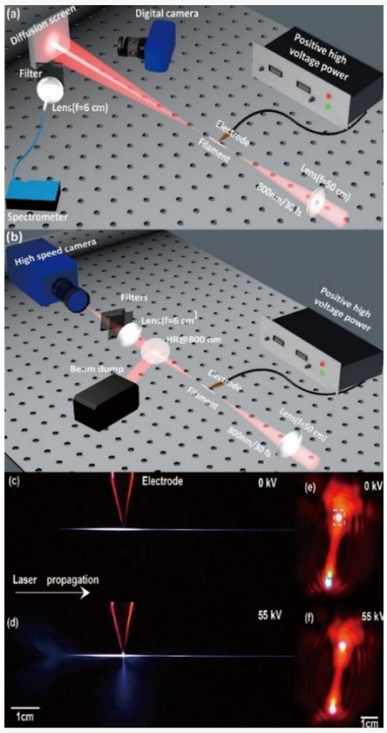
Stable intense supercontinuum light generation from 1kHz femtosecond laser filamentation in air

USA, February 8, 2024 /EINPresswire.com/ -- Supercontinuum (SC) white light generation in gases through ultrafast laser filamentation is in principle immune to damage. However, the bottleneck problem is that the strong jitters from filament induced self-heating at kHz repetition level. Aiming at this problem, scientist in China proposed a method to improve the pointing stability of high-repetition-rate femtosecond filaments and its SC white light sources, successfully generating the stable intense 1 kHz SC white light sources in air.



Schematic of experimental setups.

Supercontinuum (SC) white light (the spectrum stretching from the near ultraviolet to the infrared wavelengths) has advanced ultrafast laser spectroscopy in condensed matter science, biology, physics and chemistry. Compared with the frequently used photonic crystal fibers and bulk materials, femtosecond laser filamentation in gases is damage-immune for SC generation.

However, the milliseconds time scale of thermal diffusion in an air filament leads to air density reduction at the arrival of the next laser pulse for a kHz repetition laser. The thermal self-action effect results in significant beam pointing and intensity jitters of the laser filament, which leads to a challenge for applications using kHz filament and its SC light source.

In a new paper (doi: 10.1038/s41377-023-01364-3) published in Light Science & Application, a team of scientists, led by Professor Tie-Jun Wang from State Key Laboratory of High Field Laser Physics, Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Sciences, China and co-workers have demonstrated a simple method to improve both the beam pointing and

intensity stabilities of the air filament induced SC light. This was accomplished by simply applying an external DC electric field on the filament's plasma channel. With the external electric field, plasma recombination is significantly suppressed resulting in less thermal deposition in the filament zone together with the overwhelmed filament thermal jitter by generating ionic wind from the electrode.

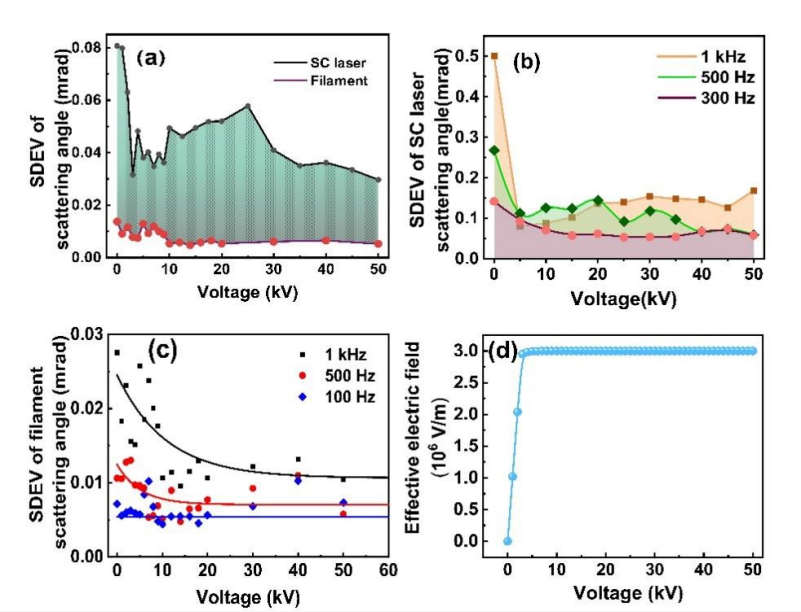


Fig. 2

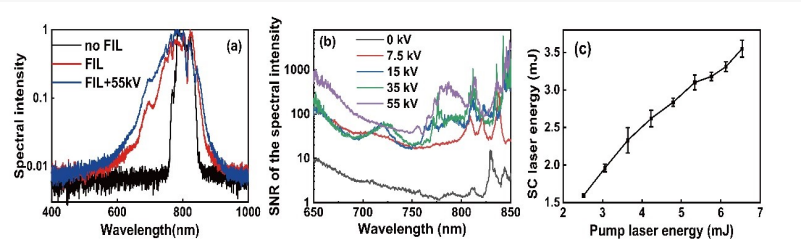


Fig. 3

This is of great significance for the application of supercontinuum white light and is also very important and useful for filament-based other secondary sources, such as, third harmonic generation, THz, air lasing, and filament-based imaging and micromachining of condensed materials.

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