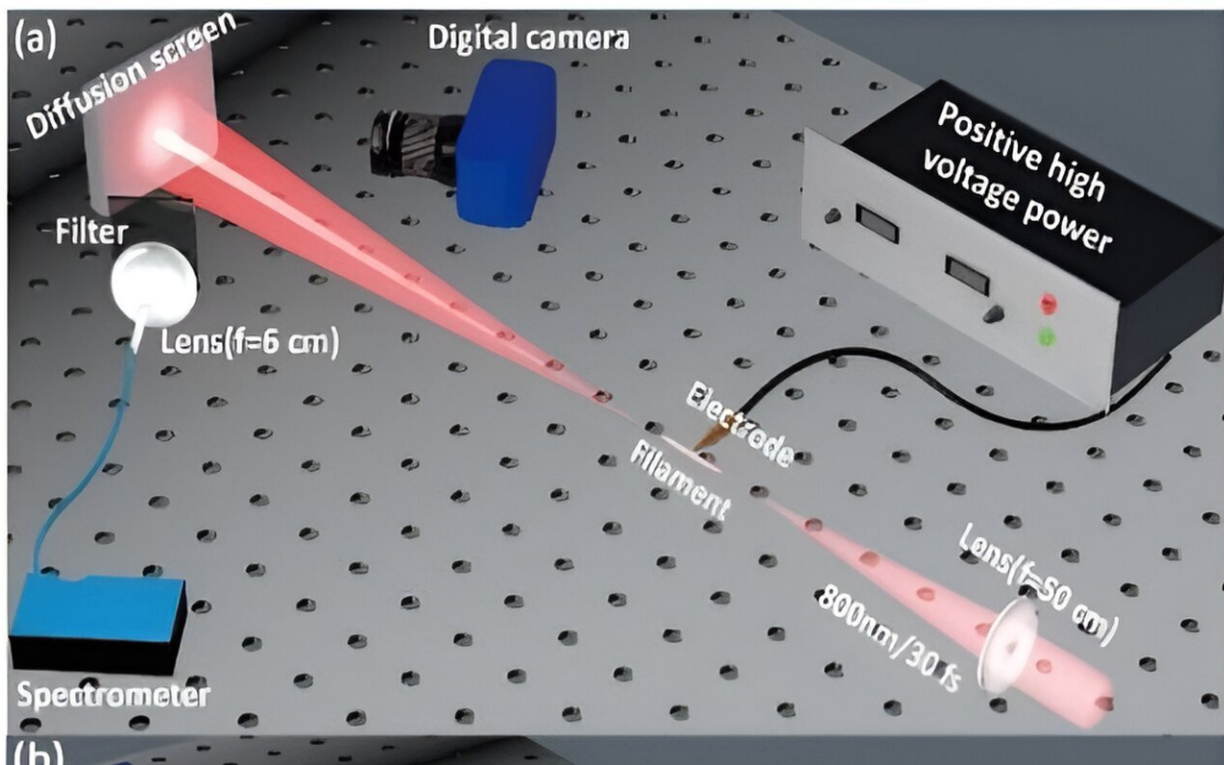


Stable intense supercontinuum light generation from 1kHz femtosecond laser filamentation in air

February 8 2024



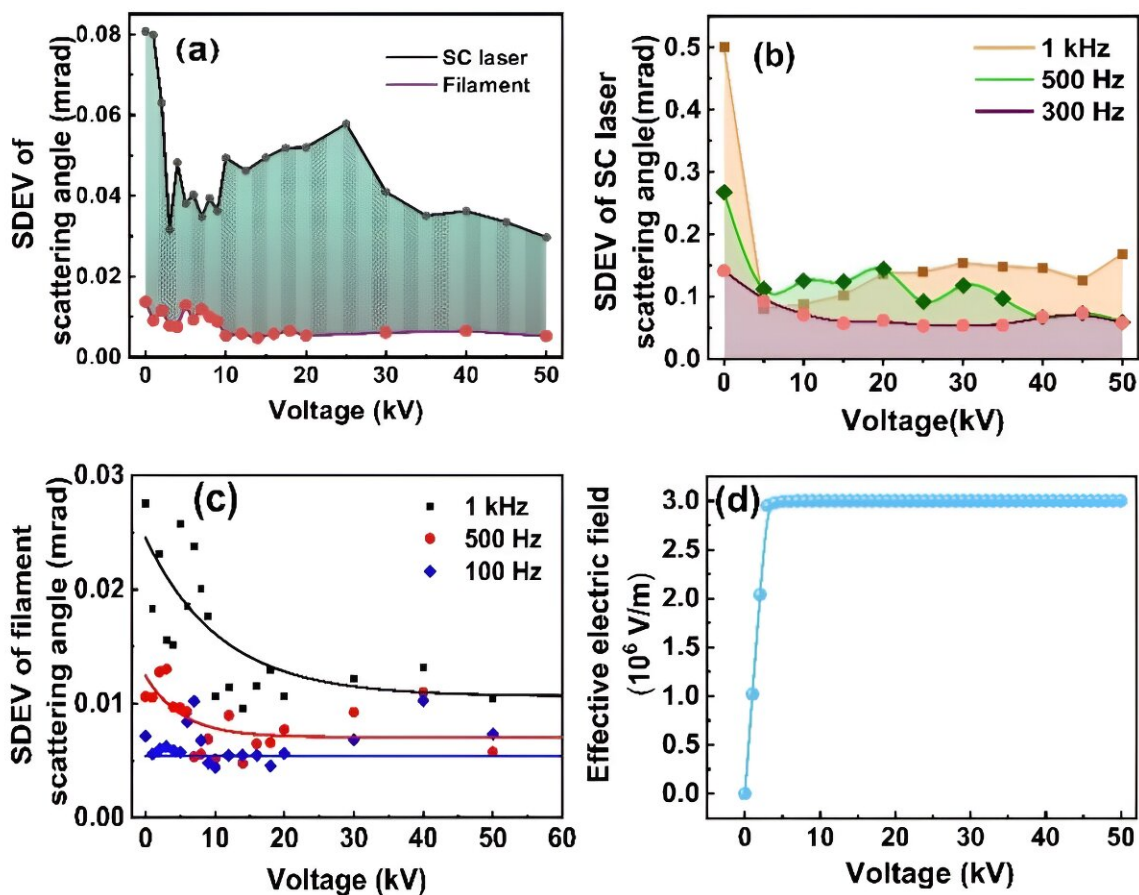
Schematic of experimental setups. (a): Generation and characterization of stable high energy SC light in air at kHz repetition rate. (b): Filament jitter measurement. Real color images of laser filament in air with high voltage off (c) and on (d). The corresponding far-field forward beam patterns on a white screen in real color: (e) high voltage off and (f) high voltage on. Credit: *Light: Science & Applications* (2024). DOI: 10.1038/s41377-023-01364-3

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.

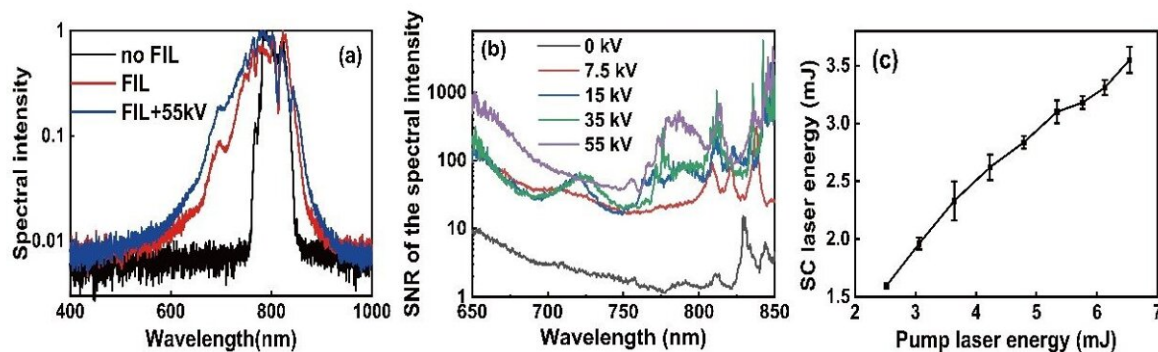
However, the milliseconds time scale of thermal diffusion in an air [filament](#) leads to air density reduction at the arrival of the next laser pulse for a kHz repetition laser. The thermal self-action effect results in significant beam pointing and intensity jitters of the [laser](#) filament, which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

In a new [paper](#) 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.



(a) SDEVs of the forward SC laser and filament pointing angles at 1 kHz as a function of the applied high voltage. SDEVs of the scattering angles of forward SC light (b) and filament (c) under different laser repetition rates. Solid lines in (c) are fits for guiding the eyes. (The distance between the electrode tip and the filament was 1mm) (d) Simulated result of the effective electric field applied on the filament as the voltage increasing. Credit: *Light: Science & Applications* (2024). DOI: 10.1038/s41377-023-01364-3



(a) Typical white light spectra after filamentation with (FIL+55 kV) and without (FIL) external DC electric field together with the initial laser spectrum (no FIL) for comparison. Each spectral distribution was normalized at its maximum. (b) The SNR of the SC spectral intensities when the laser was working at 1 kHz under different polarities (positive and negative) of the DC electric field. (c) The SC laser energy obtained as a function of pump laser energy under 1m focusing condition. Credit: *Light: Science & Applications* (2024). DOI: 10.1038/s41377-023-01364-3

The beam pointing jitters of the 1 kHz air filament induced SC light were reported to be suppressed by more than two-fold. The signal to noise ratio of the SC light was significantly improved as well. The scientists successfully generate a stable high-intensity and high-repetition supercontinuum white light source in air.

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.

More information: Yaoxiang Liu et al, Stable, intense supercontinuum light generation at 1 kHz by electric field assisted

femtosecond laser filamentation in air, *Light: Science & Applications* (2024). [DOI: 10.1038/s41377-023-01364-3](https://doi.org/10.1038/s41377-023-01364-3)

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