

Portable STAMP with thin-plate-based spectral broadening for picosecond single-shot imaging in laser ablation systems

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Ultrafast single-shot imaging techniques, specifically sequentially timed all-optical mapping photography (STAMP) [1], show promise in capturing the poorly reproducible ablation dynamics induced by ultrashort laser pulses. However, the application in diverse ablation visualization is constrained by the system's complexity and the requirement for a wide probe wavelength band. Here, we introduced a compact spectral broadening technique using solid thin plates into the STAMP system, making it portable and readily integrable into conventional pump-probe setups with narrow-band probes.

Figure 1(a) shows the experimental setup to visualize laser ablation with the portable STAMP system. The STAMP system is designed for wavelengths around 514 nm, which corresponds to the second harmonic of Yb-based lasers. It consists of three modules: spectral broadening with a CaF₂ thin plate, pulse stretching, and spectral filtering, each of which is independently portable. We demonstrated the spectral broadening by expanding the bandwidth from 11 nm to 25 nm. A grating pair is used for pulse stretching, with a maximum ~400 ps time window, which can be extended to ~10 ns by installing two parallel mirrors for additional delays [1]. Figure 1(b) shows the sequential images captured by the demonstration using the 800 nm fundamental band of a Ti:sapphire laser for ablation with a fluence of 18 J/cm² and the 514 nm band generated by optical parametric amplification for probing. Filamentation inside the glass and the evolution of the plume into the air were visualized with 24 frames and a 356-ps time window. This portable STAMP system is anticipated to significantly advance our fundamental understanding of laser ablation by visualizing diverse ablation dynamics.

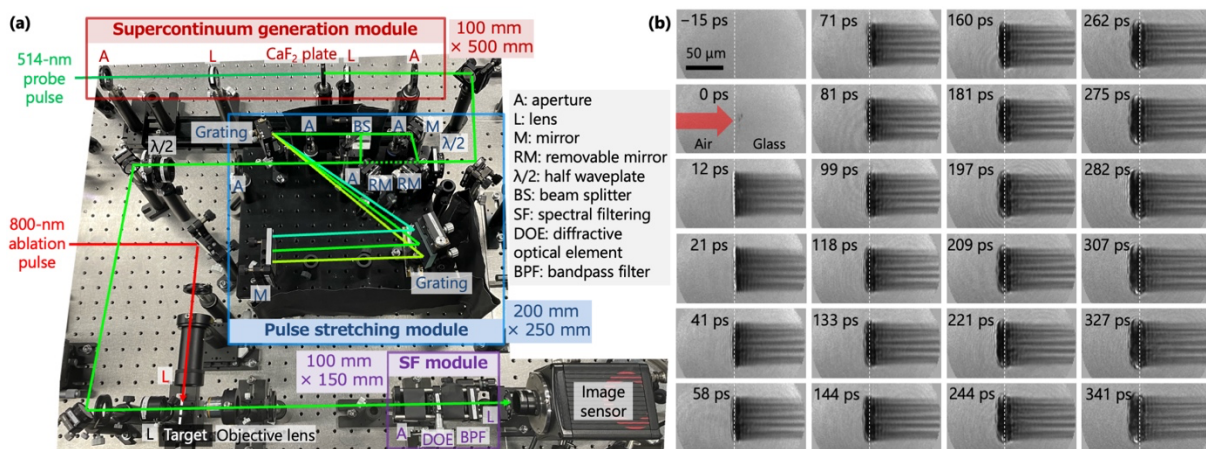


Figure 1: (a) Experimental setup using portable STAMP. (b) Captured images of laser ablation.

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References: [1] K. Shimada, A. Ishijima, T. Saiki, I. Sakuma, Y. Inada, et al.