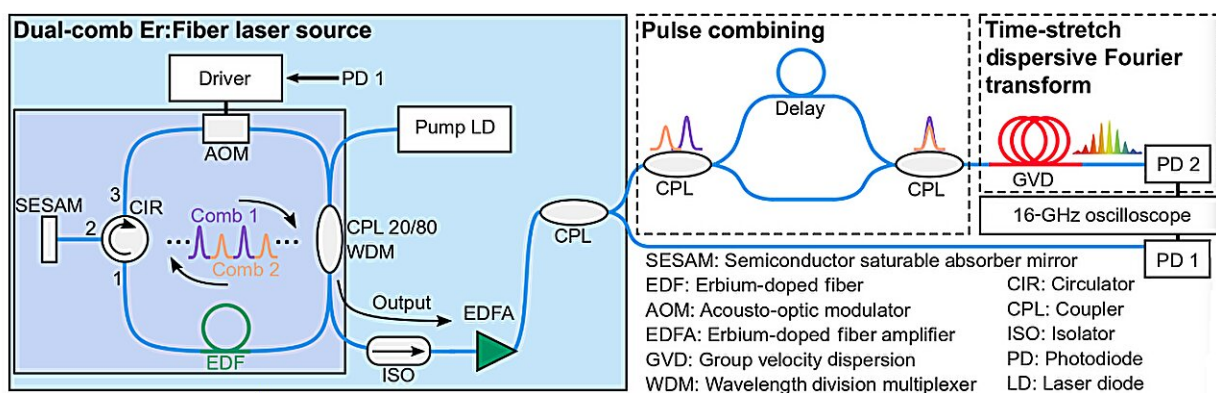


Ultra-short laser flashes on demand: Controllable light pulse pairs from a single-fiber laser

January 11 2024, by Jennifer Opel



Setup of the dual-comb fiber laser oscillator, external pulse combination, and real-time detection. Credit: *Science Advances* (2024). DOI: 10.1126/sciadv.adk2290

In an innovative approach to controlling ultrashort laser flashes, researchers from the Universities of Bayreuth and Konstanz are using soliton physics and two pulse combs within a single laser. The method has the potential to drastically speed up and simplify laser applications.

Traditionally, the [pulse](#) spacing of lasers is set by splitting each pulse into two pulses and delaying them over different, mechanically tunable distances. Alternatively, two [laser](#) sources with slightly different orbital

periods ("dual combs") are used to generate fast traveling delays from the superposition of the two pulse combs.

The purely optical method demonstrated by Prof Dr. Georg Herink, head of the group "Experimental Physics VIII–Ultrafast Dynamics" at the University of Bayreuth and his doctoral student Julia A. Lang in cooperation with Prof Dr. Alfred Leitenstorfer and Sarah R. Hutter from the University of Konstanz is based on two pulse combs within a single laser. It enables extremely fast and flexibly adjustable pulse sequences.

At the same time, this can be implemented in very compact, glass fiber-based light sources. By temporally merging the two pulse combs outside the laser, the researchers obtain pulse patterns that can be set with arbitrary delays as required.

The researchers use a trick: Instead of the usual single light pulse, two pulses circulate in the laser. "There is just enough time between the two pulses to apply a single 'disturbance' using a fast optical switch inside the laser," explains Lang, first author of the study. "Utilizing laser physics, this 'intracavity modulation' causes a change in the speed of the pulses and thus shifts the two pulses against each other in time."

The glass fiber-based laser source was built by Hutter and Leitenstorfer from the University of Konstanz. Thanks to a special real-time measurement method, the researchers in Bayreuth can now precisely observe how the short light pulses—known as solitons—move when external influences act on them. This [real-time](#) spectral interferometry allows the precise measurement of the distance between each pair of pulses—more than 10 million times per second.

"We show that we can adjust the timing extremely quickly over a wide range and achieve freely programmable forms of movement," explains Herink. [The research](#) now presented in *Science Advances* presents an

innovative approach to controlling solitons and, in addition to new insights into soliton physics, opens up possibilities for particularly fast and efficient applications of ultrashort laser pulses.

More information: Julia A. Lang et al, Controlling intracavity dual-comb soliton motion in a single-fiber laser, *Science Advances* (2024).
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Provided by Bayreuth University

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