Coherent beam combining-an alternative scheme for delivering high average power femtosecond laser at 2.0 μm

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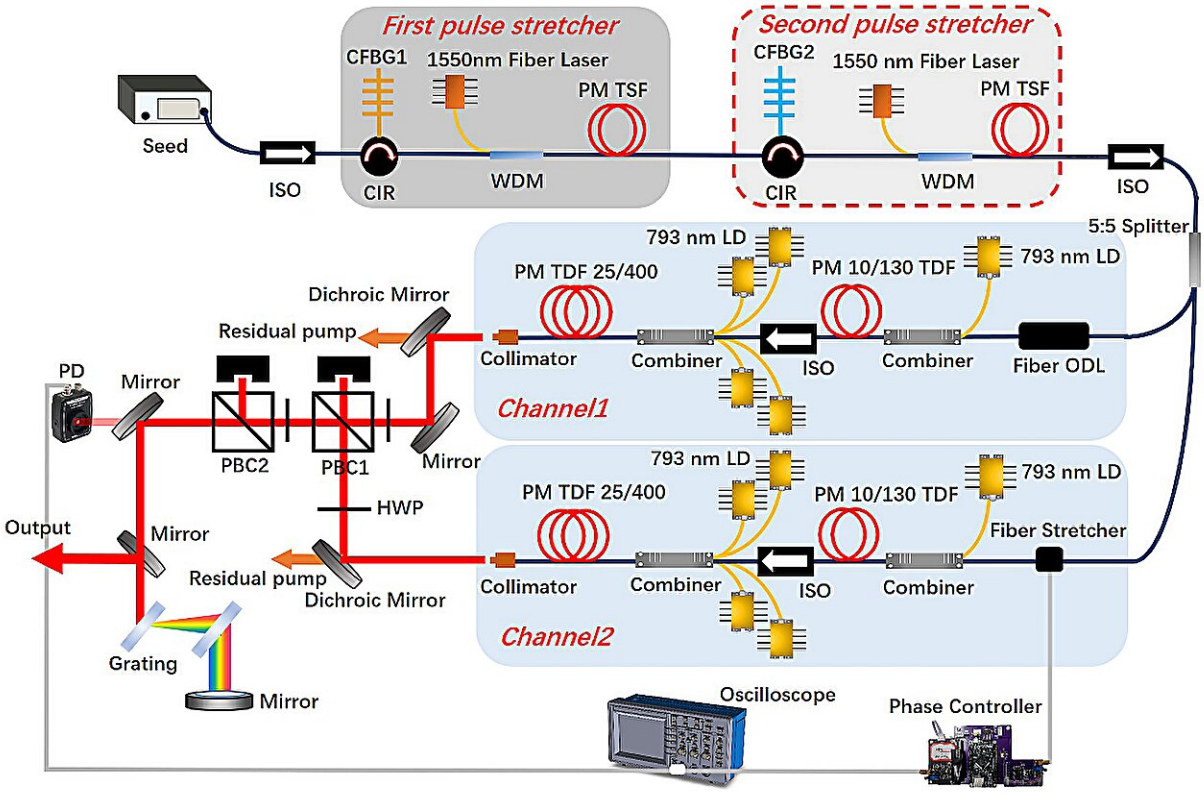

Experimental Setup of the CBC system based on two channels of all-PM TDF-CPA. Credit: *Frontiers of Optoelectronics* (2024). DOI: 10.1007/s12200-024-00117-3

High-power ultrafast laser with an operation wavelength extending to the 2.0 μm range has been attracting increasing research interest, mostly driven by its applications in various fields such as remote sensing, material processing, medical care, and mid-infrared broadband supercontinuum generation.

Thulium-doped fiber (TDF) chirped pulse amplifier (CPA) has been recognized as a promising candidate for generating high average power ultrafast lasers at 2.0 μm, thanks to the merits of fiber lasers in terms of high conversion efficiency, efficient heat dissipation and excellent beam quality.

To further enhance the laser power, an alternative scheme is the coherent beam combining (CBC), which partitions the laser signal into multiple parallel amplification channels and subsequently coherently combines them into a single output beam with a power scaling factor being nearly the number of channels employed, thereby effectively mitigating the impact of nonlinearities and thermal effects of a single fiber amplifier.

Nevertheless, the employment of free-space coupled amplification channels in most of the current CBC system demonstrations renders the system fragile and cumbersome, as well as difficult to extend the combining channels. More compact CBC of ultrafast lasers at 2.0 μm based on the all-fiber amplification channels has not yet been reported.

Researchers led by Prof. Pu Zhou and A./Prof. Can Li at National University of Defense Technology (NUDT), China, are interested in high power/energy ultrafast fiber laser technologies. Their article, "Coherent beam combining of two all-PM thulium-doped fiber chirped pulse amplifiers," is published in *Frontiers of Optoelectronics*.

Based on two-channels all-PM TDF-CPAs, by actively controlling the relative phase with a fiber stretcher based on the SPGD algorithm, the

coherent combining efficiency was ~81% with an estimated residual phase error of λ/17 at the maximum output power of 265 W, which represents the highest average power generated from the CBC system based on all-PM TDF-CPA.

After being compressed by a pair of diffraction gratings, the duration of the combined laser pulse was measured to be 690 fs, corresponding to a peak power of 4 MW.

More information: Bo Ren et al, Coherent beam combining of two all-PM thulium-doped fiber chirped pulse amplifiers, *Frontiers of Optoelectronics* (2024). DOI: 10.1007/s12200-024-00117-3

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