Breaking through the limits of a single fiber laser amplifier: Coherent beam combination

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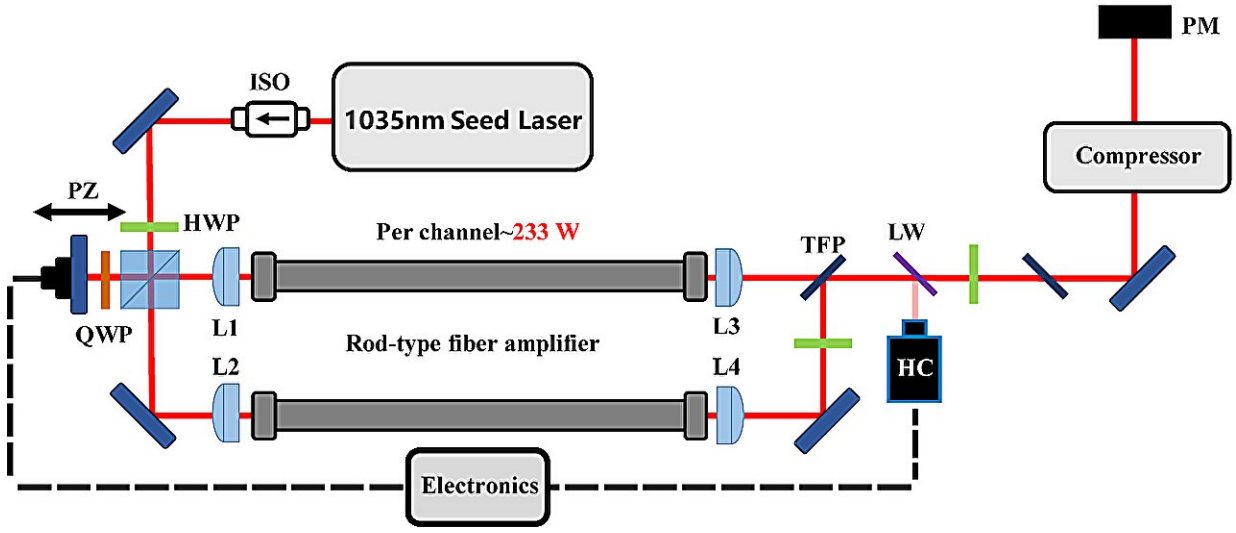

Diagram of coherent beam combining experimental setup. Credit: Shuangxi Peng, Zhihao Wang, Feilong Hu, Zhengyan Li, Qingbin Zhang, Peixiang Lu

High-power, high-energy ultrafast fiber lasers are indispensable tools in various fields, from basic and applied science research to industrial processing. However, due to thermal effects, nonlinear effects, there is always a limit to the power/energy expansion of a single fiber laser amplifier.

Coherent beam combination (CBC) technology is an effective strategy to break through the limits of a single fiber laser amplifier and further

achieve power/energy scaling.

Under the conditions of mutual coherence and stable phase relationship, multiple laser beams can be superimposed and mutually interfere with each other. This approach allows for an improvement in average power and pulse energy by a factor almost equal to the total number of combined channels. However, with the increase of beam combining channels, the complexity of CBC systems also increases, bringing negative impacts such as decreased beam combining efficiency, degraded beam quality, and increased operational difficulty to the system.

Researchers from Huazhong University of Science and Technology reported the use of filled aperture coherent beam combining technology to achieve an ultrafast fiber laser system with an average power output of 403 W, 0.5 mJ pulse energy, and 260 fs. Excellent beam quality (M^2