Recent progress of adaptive beam cleanup of solid-state slab lasers in Institute of Optics and Electronics, Chinese Academy of Sciences

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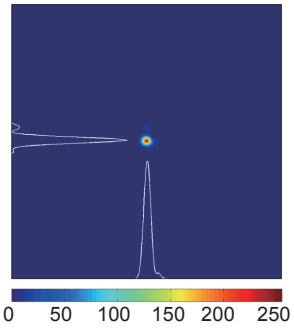

Far-field intensity distribution of the 5 J/6.6 ns/200 Hz solid-state slab laser system after corrected by the hybrid adaptive optics system

Overview: The solid-state slab laser is a promising architecture for power scaling. However, the beam qualities of high power solid-state slab lasers are severely limited by many factors such as thermal effects of the gain medium. Simultaneously achieving high beam quality and high average output power remains a fundamental problem in the development of high power solid-state slab lasers. Adaptive optics systems are able to significantly improve beam qualities by compensating for both static and dynamic phase distortions of the beams. Compared to adaptive optics systems for other types of laser systems, solid-state slab lasers specifically demand large-amplitude low-order aberration compensations of laser beams with high aspect ratio, advanced manipulations of large local phase gradients, and extra flexible real-time wavefront controllers. In recent years, Institute of Optics and Electronics, Chinese Academy of Sciences has successfully developed low-order aberration compensators based on geometric optics, weighted least-square wavefront reconstruction algorithms, and generic real-time wavefront processors implemented with x86 CPUs and real-time operating systems. Based on these state of the art techniques and components, we have developed several types of hybrid adaptive optical system for solid-state slab laser systems, which contains low-order aberration compensators based on several cylindrical and spherical lenses mounted on a motorized rail, and uncooled piezo electric deformable mirror adaptive optical systems. We have offered an adaptive optics system to a 5 J/6.6 ns/200 Hz Nd:YAG solid-state slab laser system developed by Academy of Opto-electronics, Chinese Academy of Sciences, and achieved beam quality of β=1.64 after correction. We have also developed adaptive optics systems for a continuous wave Nd:YAG conduction-cooled, end-pumped slab laser systems of the No.11 Institute, China Electronics Technology Group Corporation. After Correction, the beam quality was improved to β=2.0. To guarantee high beam quality of the quasi-continuous wave Nd:YAG direct liquid cooled slab laser, we integrated an adaptive optics system into the laser system, and beam quality of β=1.7 was achieved. Besides, we have also developed adaptive optics systems for many different solid-state slab laser systems, and significant beam quality improvements were obtained. In the past decade, Institute of Optics and Electronics, Chinese Academy of Sciences have delivered over two dozens of adaptive optics systems for beam cleanup. With effective operations of these adaptive optics systems, the beam qualities of the laser systems have all been well improved. We will continue to develop adaptive optics for various types of laser systems in the future.

Citation: Dong L Z, Xu B, Yang P, *et al.* Recent progress of adaptive beam cleanup of solid-state slab lasers in Institute of Optics and Electronics, Chinese Academy of Sciences[J]. *Opto-Electronic Engineering*, 2018, **45**(3): 170539

Supported by National Key Scientific Equipment Development Project of China (ZDYZ2013-2), National Natural Science Foundation of China (11704382) and Youth Innovation Promotion Association of Chinese Academy of Sciences
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