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Filled-aperture coherent combination of ns pulse laser beams (公財) レーザー技術総合研究所¹, ALPROT², 大阪大学レーザーエネルギー学研究センター³ ⁰ハイク コスロービアン^{1,2}, 谷口誠治^{1,2}, 藤田雅之^{1,2,3}, 椿本幸治³, 吉田英次³, 宮永憲明³, 井澤靖和^{1,3}

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Introduction

Powerful lasers with high brightness and good beam quality are increasingly required for many material processing applications. Within a "Highpower laser development for efficient material processing applications" project (NEDO), we are developing single mode, 400 ps ~ 10 ns adjustable pulse duration, high repetition rate (500 kHz - 1 MHz), tunable (1040 nm - 1060 nm) high average power (150 W - 200 W) laser amplifier units based on Yb-doped LMA (large mode area) PCFs (photonic crystal fibers). For final design of a desired laser system with 1.5 kW average output power, beam combining concept seems to be one of the viable choices. In our previous report [1], we have introduced a single-detector, filled-aperture (FA) CBC geometry based on half mirrors design and use of SPGD (stochastic parallel gradient descent) algorithms for phase locking in CW regime. Here we will present experimental results of the same technique for pulse laser beams (~3 ns, 1 MHz). As a proof of a principle, it is demonstrated for four beams.

Experimental results and discussion

Laser beam from a master oscillator (~1040 nm) is split into four channels and aligned again in FA design (Fig. 1). The signal captured by PD is maximized by a feedback loop to piezo-modulators (PM) located on the paths of the beams using simple "climbing hill" algorithms. As a result, the output formed by four beams behaves as single FA coherent beam. Fig. 2 shows main results for four beams. The efficiency drop caused by power imbalance, divergence, pointing overlap mismatch,



Fig. 1 Single detector CBC setup for four pulse-beams.

wavefront distortions and degree of coherence between individual beams will be discussed.



Fig. 2 Intensity distribution profiles on a (x, 0) horizontal axis for; (a) Single pulse beam, (b) Coherent combination of four pulse beams.

Currently work is underway to combine high power, high repetition rate nanosecond-pulse laser beams. Some results of these developments will be presented as well.

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