ベルヌーイアルゴリズムを用いたタイルアパーチャ多ビームコヒーレント結合

Tiled Aperture Coherent Combining of Multiple Beams using Bernoulli Algorithm

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Introduction

Powerful lasers with high brightness and good beam quality are increasingly required for many applications in material processing, environment monitoring, etc. To reach higher intensities, one needs to increase the output power of the laser beam and at the same time keep or improve the beam quality. For this purpose, beam combining concept seems to be one of the viable choices. Several CBC techniques for multiple laser beams using a single PD have been already proposed and implemented [1]. In this contribution, we will present and discuss a method where a single PD is employed for active phase control and locking of multiple tiled-aperture laser beams using an algorithm based on Bernoulli discrete probability distribution. It is demonstrated for coherent combination of four beams. We note that the laser beam profile was not good and one purpose of these experiments was to evaluate the applicability of the used combination method on CBC of imperfect beams.

Experimental results and discussion

A laser beam from a master oscillator with ca. 2 mm in diameter is split into four equal parallel beam channels with ~ 4 mm distance between them. All four beams imitate “amplified” beams to be combined coherently. To compensate and lock the phases of the beams, a signal from the center of the far-field pattern was picked-up by a fast photodiode and used it as a feedback control signal to piezo-actuators located on the paths of the beams. The control algorithm is based on Bernoulli probability distribution and is implemented on a FPGA board to keep the phase locking bandwidth as broad as possible when using slow phase modulators like piezo-shifters in our case. Fig. 1 (a) shows far-field (FF) patterns of the combined beams when the CBC system is **off** and **on**, respectively. Fig. 1 (b) shows corresponding horizontal beam profiles.

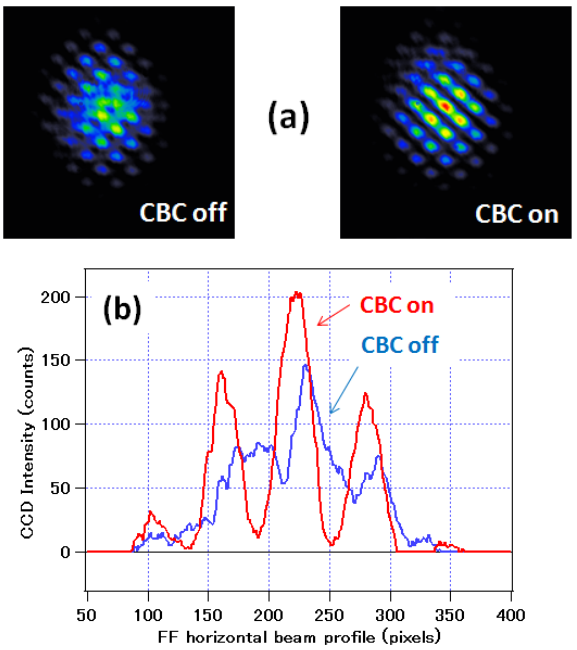

Fig. 1 (a) Snapshots of CCD FF images of four combined beams when the CBC system was **off** (random phase) and **on** (in-phase combination); **(b)** corresponding intensity distributions on a horizontal axis for in-phase and random-phase combinations.

In conclusion, the CBC technique based on single detector and Bernoulli discrete distribution probability algorithm was able to combine four imperfect beams satisfactorily. Details of the combining accuracy, bandwidth, *rms* error, etc. will be discussed at the conference as well.

[1] A. Brignon (Ed.), Coherent Laser Beam Combining, Wiley–VCH, ISBN: 978-3-527-41150-4, 498pp. (2013).