TWO-MIRRORS BEAM SHAPER DEVICE

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Abstract

We have developed a two-mirrors beam shaper in order to improve the spatial overlapping between the pumping and the signal beam in a dye laser amplifier transversally pumped by a copper vapor laser. This device uses a closely spaced mirror pair for reshaping and homogenizing the pumping beam. In this work we show and discus the results obtained with the investigation of the operation characteristic of this device. Chiefly we will show how the many reflections orders contribute to construct an image having the shape and homogenization desired, as well as how far we can go from the image plane without change significantly the intensity uniformity.

Introduction

Transversely pumping of the dye laser amplifier by copper vapor laser demands modification of the copper beam shape. In this system the pump beam shape and size must matched dye signal beam for efficient amplification and low amplified spontaneous emission (ASE). Generally, this is done by focusing the pump beam at the dye cell amplifier through a cylindrical lens [1 - 4]. However, the “soft” edges of the focused beam may mean that a significant fraction of the pump light is poorly converted to amplified signal, or it generates ASE, or the pump intensity at the focus is too strongly peaked to produce the desired intensity uniformity in the amplified signal beam. Efficient utilization of the copper vapor laser pump with low ASE also requires the shape and size of the pump beam well matched to that of the dye beam in the generally rectangular overlap volume [2].

We have, therefore, built a device using two closely spaced, nearly parallel mirrors that, by multiple reflections, can reshape and homogenize the beam at the output gap between the mirrors [2, 4, 5]. The various orders exiting impinge on an optical device that forms an image of the output gap in the plane image. The resulting image has a generally rectangular shape defined by the edges of the output gap of the mirror-pair along the long dimensions and by the profile of the incoming laser beam [2, 4, 5].

In this work we show and discus the results obtained with the investigation of the operation characteristic of this device. Chiefly we will show how the many reflections orders contribute to construct an image having the shape and homogenization desired, as well as how far we can go from the image plane without change significantly the intensity uniformity.

Experimental Setup

The diagram of our experimental apparatus is shown in Figure 1. The HeNe laser beam was expanded by plane-convex lens L1 and L2, with focal length 20 mm and 200 mm, respectively, to obtain a 10 mm beam diameter. Two aluminum mirrors having 100 x 20 mm dimension was used as a closely spaced mirror pair for reshaping and homogenizing lasers beam. The various orders reflections beam impinge an optical image system, built by L3 and L4 lens, and has 75 mm focal length. This system images the two-mirrors output gap on a Waltec CCD camera model M-39244. A Spiricon Advanced Laser Beam Analyzer, Model LBA-100A, analyzes the CCD signal.

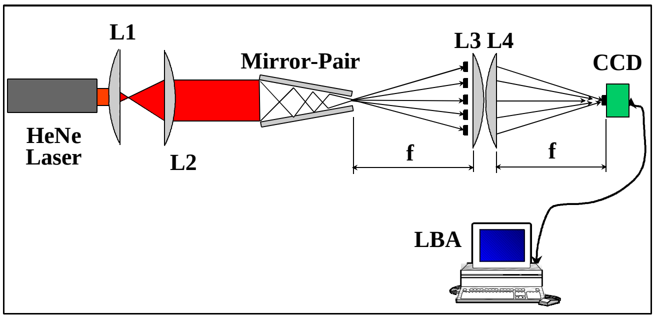


Figure 1: Experimental apparatus: L1 and L2 are the beam expander lenses; L3 and L4 are the optical image lenses; CCD is the CCD camera and LBA is the laser beam analyzer.

Results and Discussions

The Figure 2 summarizes how each reflections order contribute to construct an image having the shape and homogenization desired.

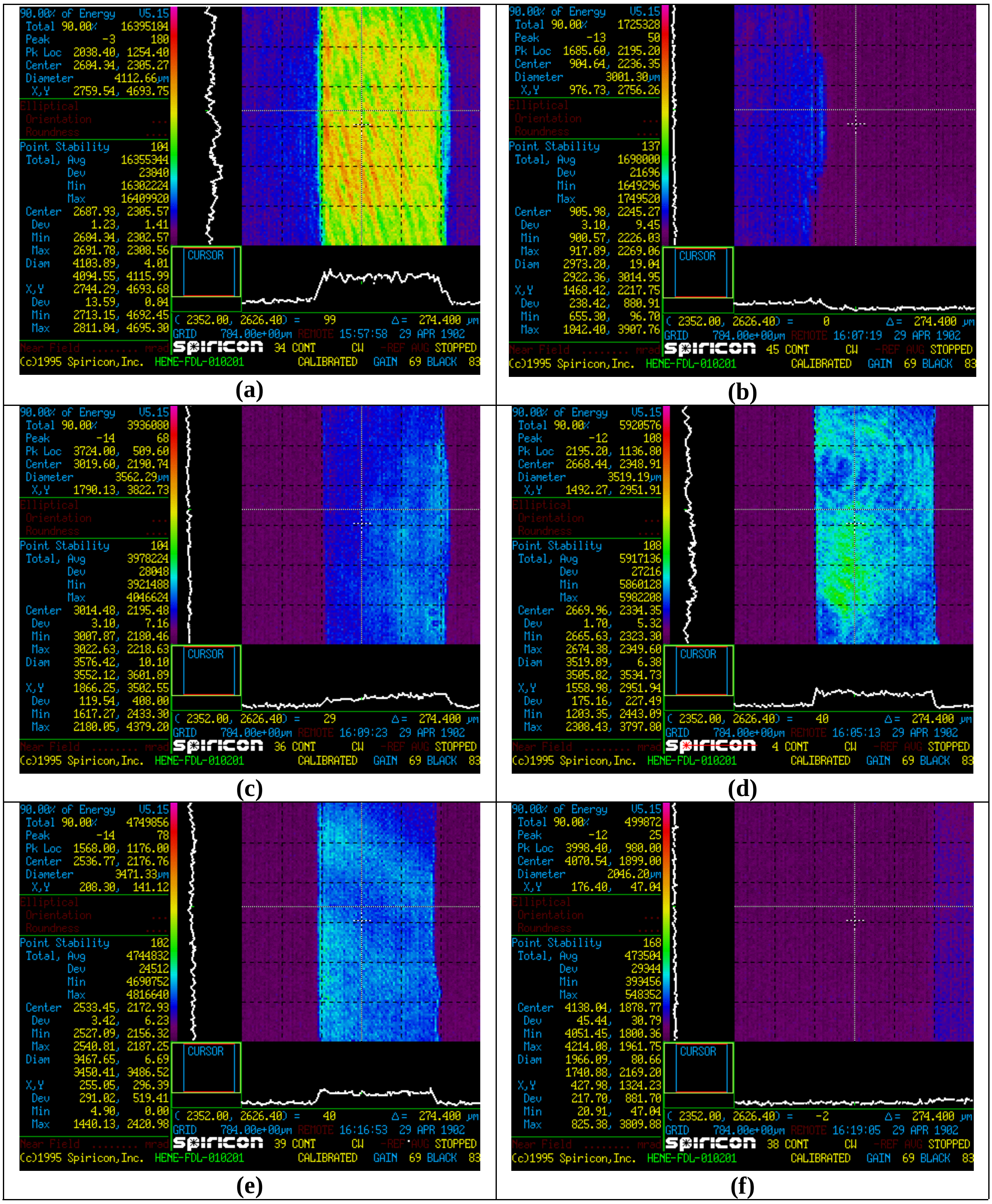
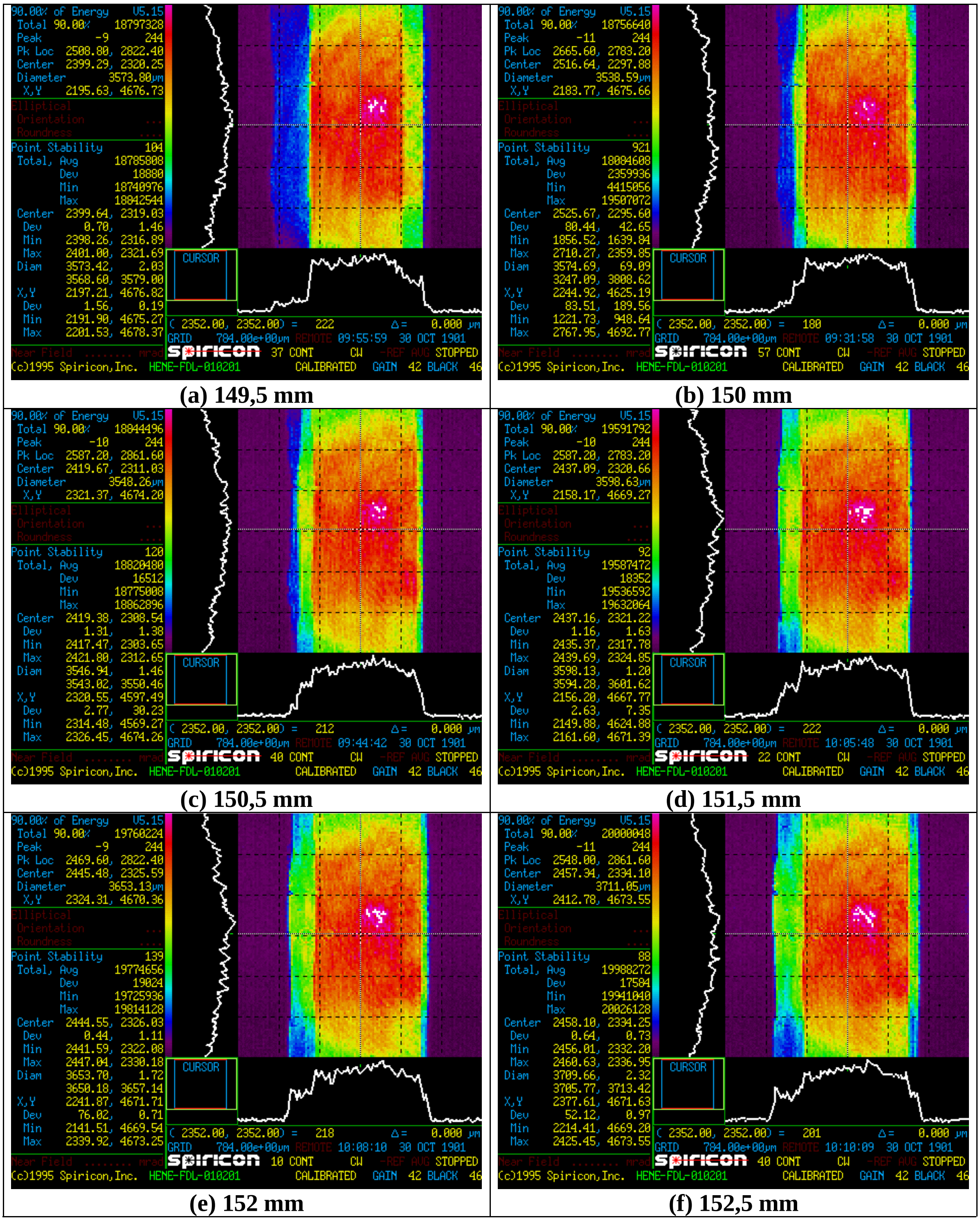


Figure 2: Contribution of five refection order into the image plane of beam shaper having its output slit width of 1,4 mm; mirrors inclination β ≈ 3,8°, in relation to optical axis, and put the optical image system far 120 mm from output slit and a beam with 10,6 mm diameter impinging into the entrance. **(a)** Total image due the five reflections order superposition; **(b)** right second order reflection contribution; **(c)** right first order reflection contribution; **(d)** center order contribution; **(e)** left first order reflection contribution; **(f)** left second order reflection contribution.

The Figure 3 summarizes the intensity distribution profile changes when the CCD camera is positioned out of the image plane.



(a) 149,5 mm **(b) 150 mm** **(c) 150,5 mm** **(d) 151,5 mm** **(e) 152 mm** **(f) 152,5 mm**

Figure 3: Intensity distribution profile changes when the CCD camera is positioned out of the image plane. These profile were obtained with the beam shaper having its output slit width of 2,4 mm; mirrors inclination $\beta \approx 3,8^{o}$, in relation to optical axis, and put the optical image system far 150 mm from output slit and a beam with 10,6 mm diameter impinging into the entrance. The values below each figure are the distance from CCD camera to optical image system. Note that in this configuration the image plane is located at 150 mm form the optical image system.

From the Figure 2 one can observe that the intensity distribution has a nearly rectangular profile. So the beam shaper allows a good intensity profile homogenization. Furthermore, the optical image system used presents loss of external reflections order. This contributes to image degradation due aberration effects and reduce the energy efficiency extraction of beam shaper, when a collimated beam impinges its entrance aperture. However, in spite of this a good homogenization was obtained. Figure 3 analyzes shows that this intensity profile change can be neglected if the position of CCD camera is shifted up to 2 mm from image plane.

Conclusions

We have obtained experimental results from a beam shaper device that uses a closely spaced mirror pair for reshaping and homogenizing laser beams. Multiple reflections of the laser beam inside of the mirror pair homogenize the beam in the output gap and several orders were observed. Imaging the output gap on a plane image produces a nearly rectangular distribution intensity profile. Furthermore, the intensity profile no change significantly if the observation position is shifted up to 2 mm from the image plane These experimental results indicate that this beam shaper device is appropriate to reshape and homogenize the laser beam at the output gap between the mirrors.

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