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High gain Nd:YLF amplifier end-pumped by a beam-shaped broad-stripe diode laser.

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ABSTRACT

The output from a 4W broad-stripe diode, reshaped by a two-mirror beam-shaper, is used to end-pump a Nd:YLF amplifier. In a double-pass configuration a small-signal gain of 240 has been obtained.

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SUMMARY

A two-mirror beam shaping technique, applied to the output of diode bars has produced the near circular beams ideally suited to end pumping[1]. Here we show that the same technique can be successfully applied to a broad-stripe diode, having a much smaller elongation of the emitter region than a diode bar. In fact a typical broad-stripe diode such as the one we have used (4 W cw output, 500 μm x 1 μm emitter) with M^2 values of ~100 and 1 in the junction plane and perpendicular to the plane respectively, has a brightness ~4 times greater than that of a diode bar. So the broad-stripe diode, with its beam shaped to be circular, would be an attractive source for end-pumping, particularly for low gain lasers and also for cladding-pumped fibre lasers.

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High gain Nd:YLF amplifier

We report here the results of beam shaping applied to a broad-stripe diode and, as a demonstration of its effectiveness we describe a Nd:YLF amplifier pumped by the shaped beam. The pumping arrangement, shown in Fig. 1, consists of a 4 W cw broad-stripe diode operating at 797 nm. The first lens, f=6.5 mm collimates the beam in the vertical plane. The role of the f=150 mm and f=12 mm cylindrical lenses is to reduce the vertical plane collimated beam size to ~200 μm $1/e^2$ radius at the beam shaper mirrors. The f=300 mm cylindrical lens collimates the beam in the horizontal plane to ~12 mm $1/e^2$ radius at the beam shaper. After the two-mirror beam shaper a spherical lens, f=38 mm produces a nearly circular spot with $1/e^2$ radius of 50 μm and equal M^2 values, measured to be 14 for both orthogonal planes. With reference to its use for launching into a fibre we note that this corresponds to a 100 μm $1/e^2$ diameter and NA of 0.07. The Nd:YLF amplifier, shown in Fig. 2, uses a simple double-pass geometry and is end-pumped by the reshaped and focused output from the 4W diode. With 3.5 W of available pump power at the focus in the 10 mm long Nd:YLF rod we have measured a cw small signal gain of 50 for a cw input power of 200 μW at 1047 nm. However, by chopping the pump at a low duty cycle we obtained a significantly higher gain of 240. The origin of this reduction in gain for higher average pump power is thought to be thermally-induced broadening of the gain bandwidth and strong thermal lensing causing significant expansion of the signal beam over the double pass through the gain region. For the π-polarisation and in the plane parallel to the c-axis we have measured a thermal lens focal length of stronger than -30 mm. With an appropriate scheme for thermal lens compensation and by increasing the pump power by polarization coupling an additional

diode prior to the beam-shaper, we expect to achieve significantly higher cw gains.

REFERENCES

1. W. A. Clarkson, A. B. Neilson, D. C. Hanna, in Conference on Lasers and Electro-optics,1994 Technical Digest Series, Vol. 8 (Optical Society of America, Washington, D.C .,1994), p.360.

FIGURE CAPTIONS

Fig.1. Broad-stripe diode focusing scheme.

Fig. 2. Broad-stripe diode-pumped Nd:YLF double-pass amplifier.

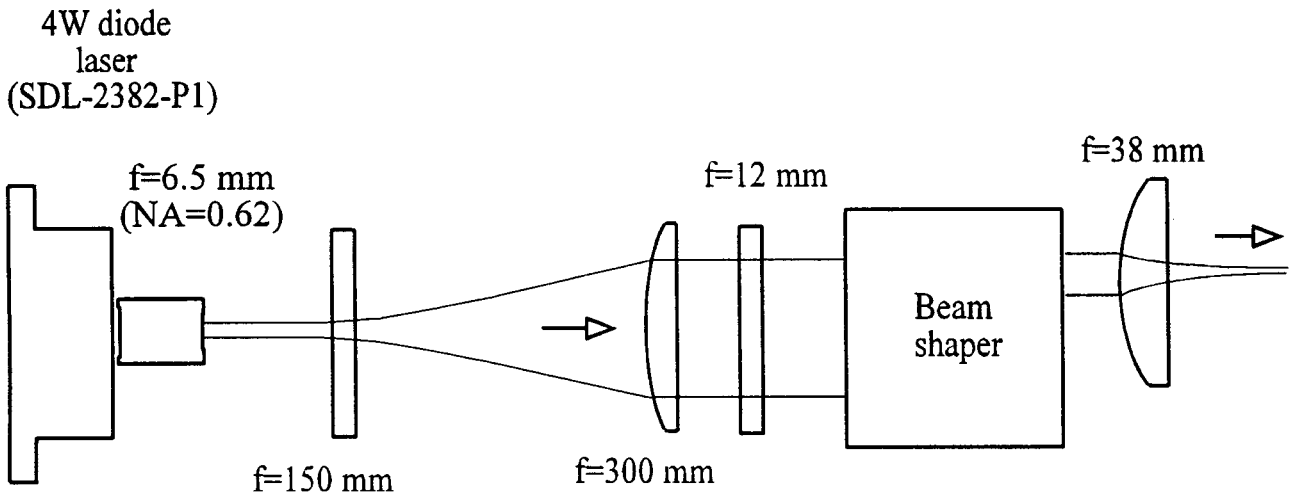
4W diode
laser
(SDL-2382-P1)
f=6.5 mm
(NA=0.62)
f=150 mm
f=300 mm
f=12 mm
Beam
shaper
f=38 mm

Fig. 1

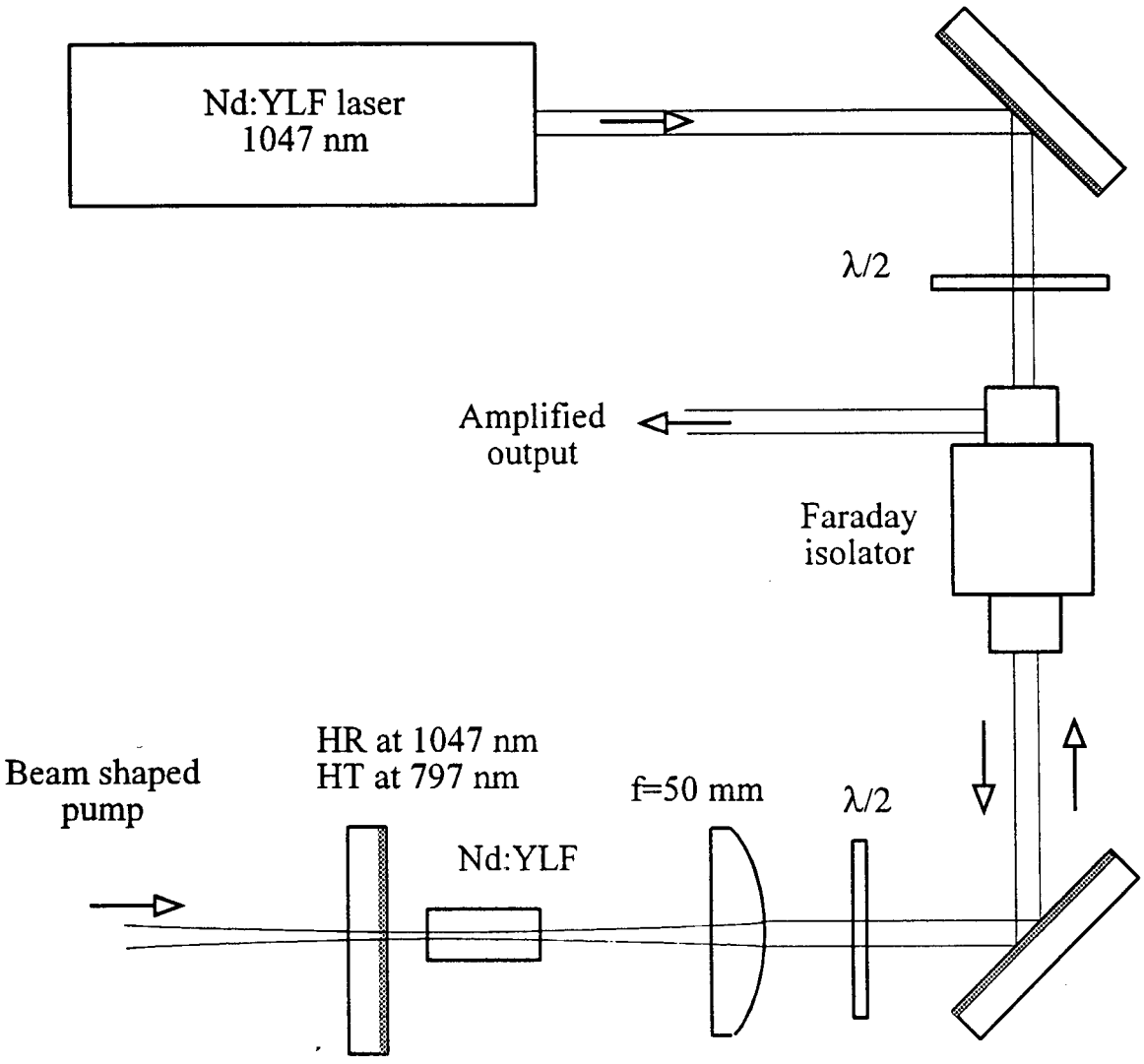
Nd:YLF laser
1047 nm
λ/2
Amplified
output
Faraday
isolator
HR at 1047 nm
HT at 797 nm
Beam shaped
pump
f=50 mm
λ/2
Nd:YLF

Fig. 2