Optical Properties of a Wedged Thin-Disk Amplifier

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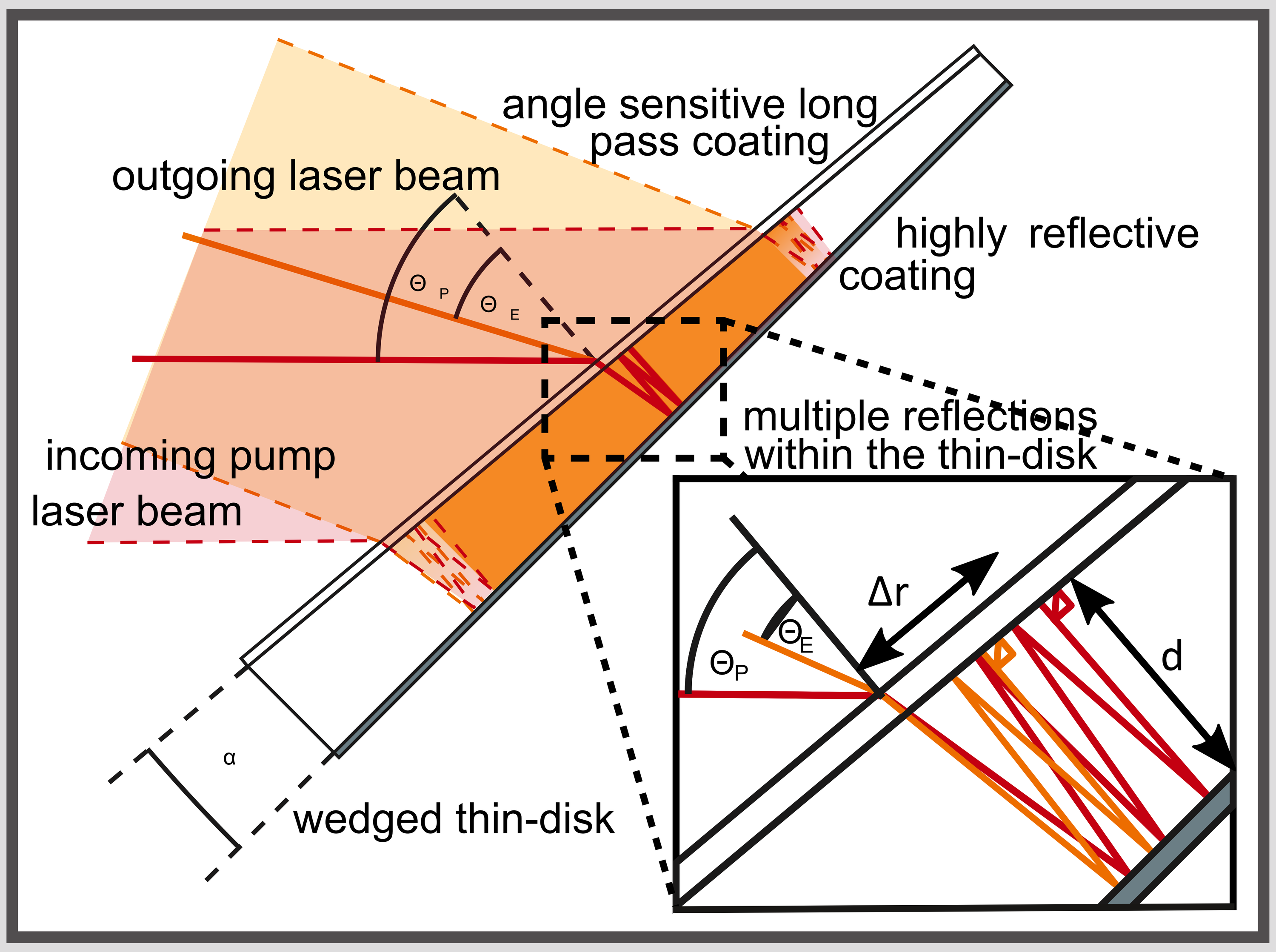
The task

Thin-disk lasers are able to achieve state of the art levels in power and brightness. Nevertheless, these achievements come at a cost. Due to the low absorption per pass and especially the low amplification per pass, thin-disk laser systems are limited in compactness which prevents small and lightweight laser designs.

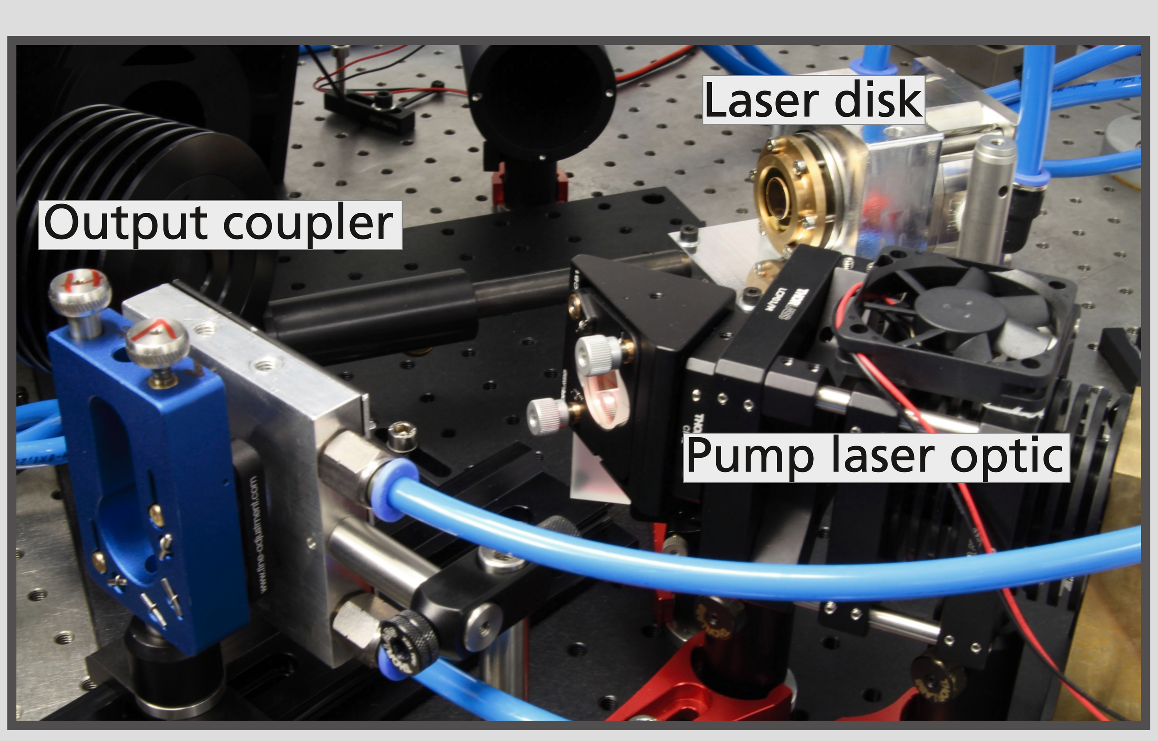
The concept

Recently, we developed a technique for folding laser beams in place [1], temporarily trapping them between a highly reflective (HR) mirror and a long-pass (LP) interference filter. We are now able to apply this method directly to wedged thin-disks [2].



The setup

The test setup consists of the wedged thin-disk laser crystal, which is pumped by a wavelength stabilized fiber coupled (1 mm core diameter, NA = 0.2, M² > 300) diode laser at 969 nm. An I-resonator and an amplifier configuration are used to investigate optical-to-optical conversion efficiency, power scaling and beam quality. In addition, a master oscillator is used to measure the gain and beam quality of the thin-disk in an amplifier configuration.

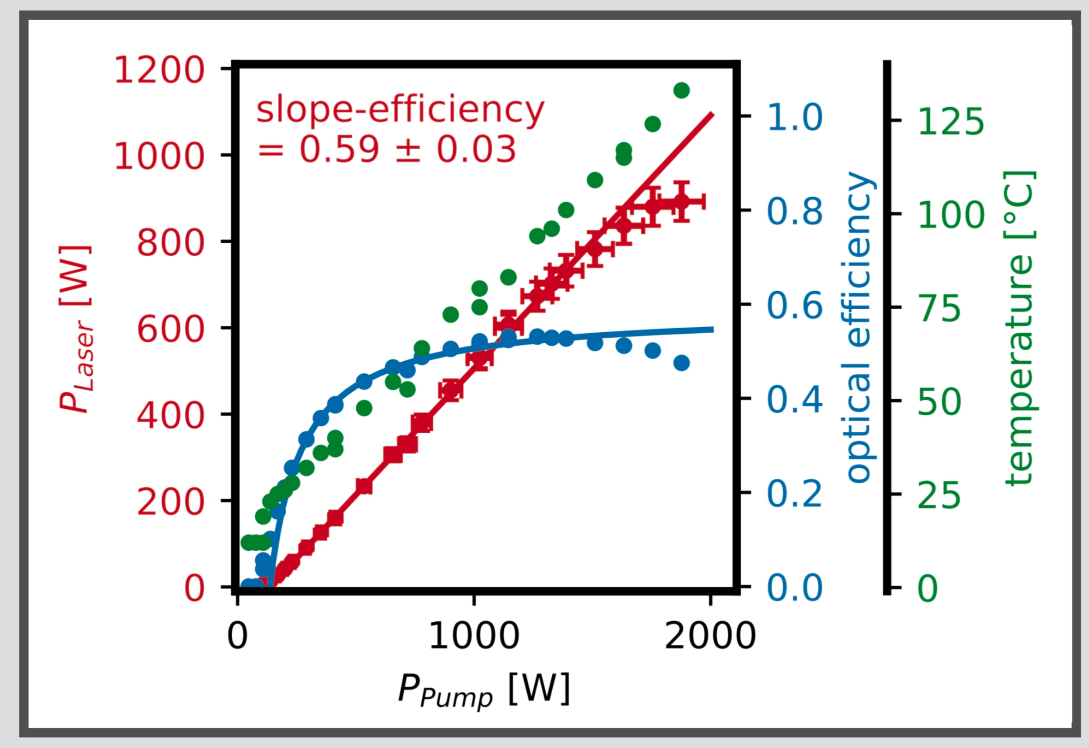


Picture of the test setup

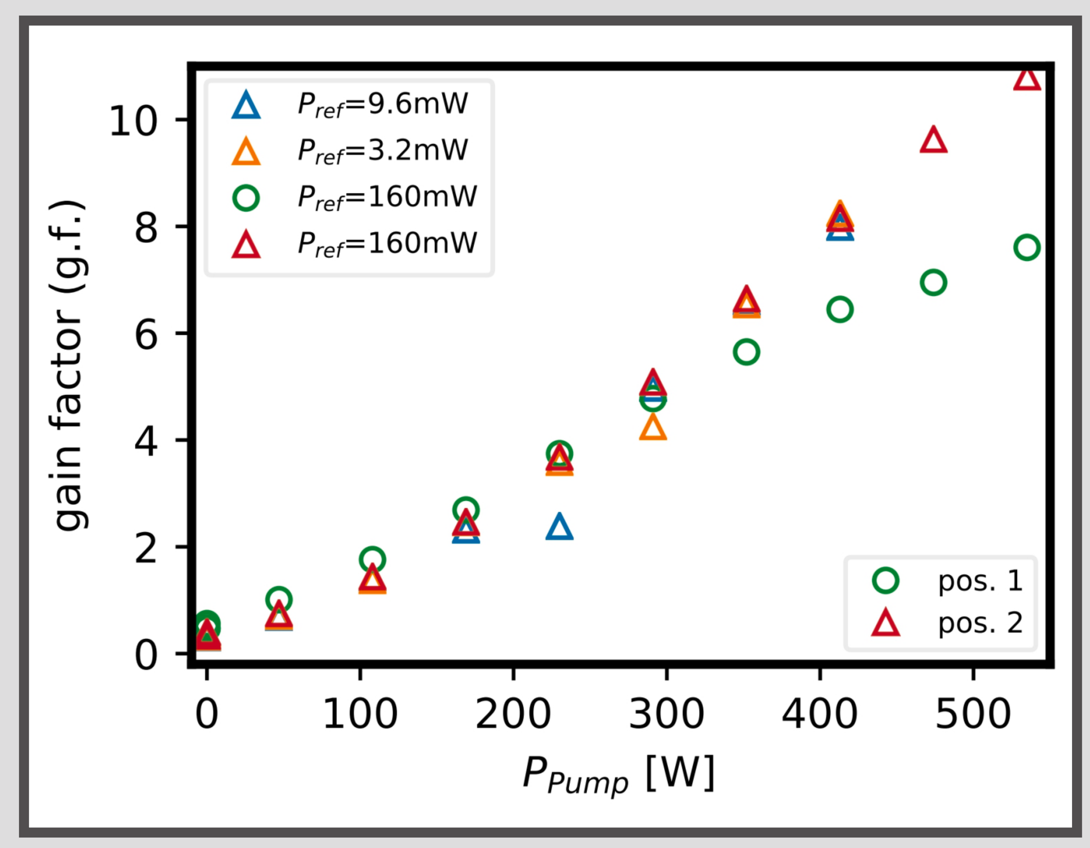
Pump spot on wedged laser disk

Results

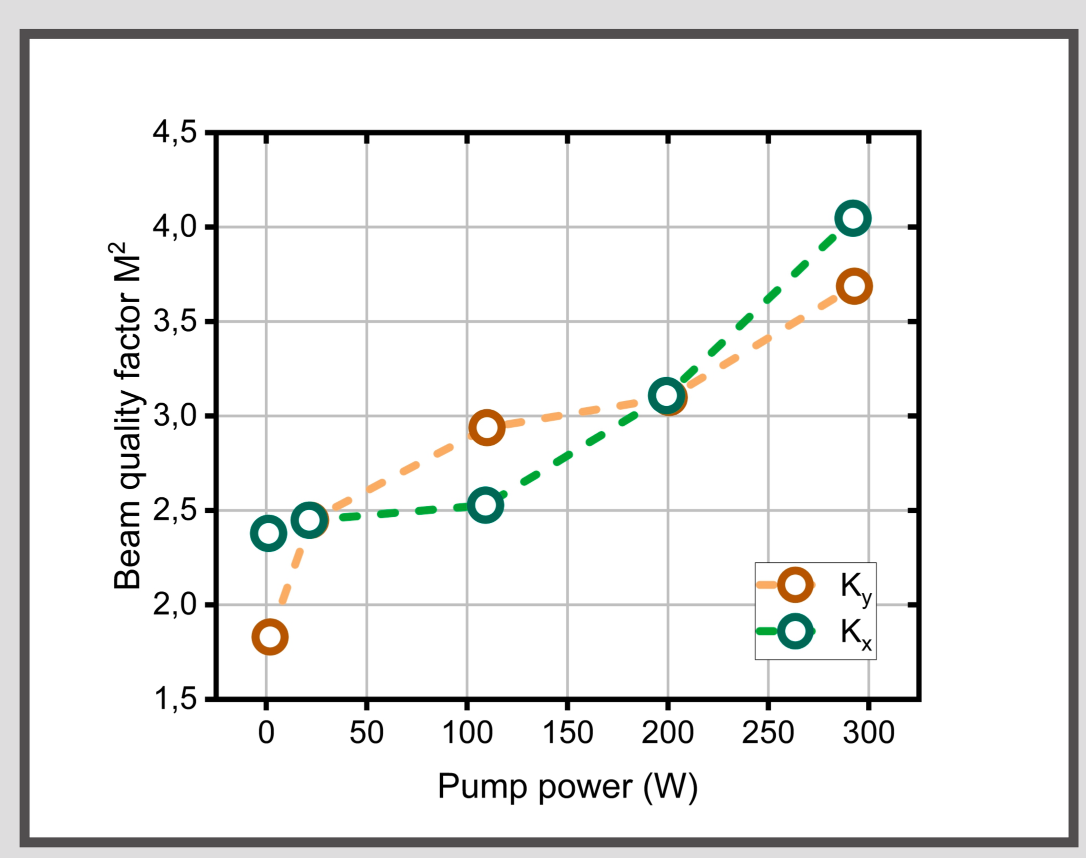
With our system we were able to demonstrate lasing up to a power of 900 W at an optical-to-optical efficiency of over 50%. This was tested in a simple I-resonator configuration.



The beam quality was measured at different optical pump powers. As can be seen the beam quality decreases (increasing M²) with increasing pump power.



In amplifier configuration we obtained a gain factor of up to 10. The optical output power of the master oscillator was between 3.2 mW and160 mW. Higher optical power, as well as a ps-master oscillator will be tested in the future.



Outlook

- Improving beam quality with a Spatial Light Modulator
- ps-Laser-puls amplification
- Increasing output power by improving the cooling efficiency

[1] B. Ewers and R. Lorbeer, "Interference filter based beam confinement for increased mechanical phase modulation," OSA Continuum 2, 1502-1509 (2019).
[2] R.-. Lorbeer, B. Ewers, C. Santek, D. Beisecker, J. Speiser, and T. Dekorsy, "Monolithic thin-disk laser and amplifier concept," Optica 7, 1409-1414 (2020)

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