

# Gain Aperture for Ubiquitous High Power Lasers

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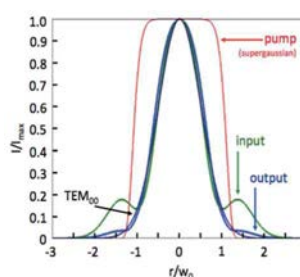
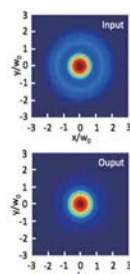
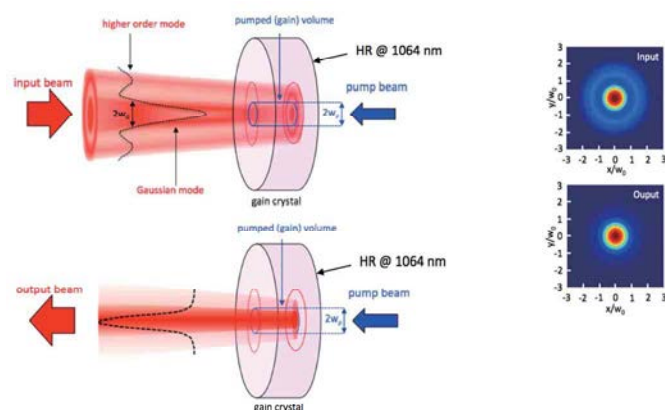
## Introduction

High power high quality compact laser systems are required for various applications such as ignition of spacecraft engines, compact pumping system for high intensity lasers and, in future, for particle acceleration. In the Master-Oscillator Power-Amplifier (MOPA) scheme energy scaling is often get at the cost of system size increase and beam quality degradation. Development of micro-MOPA system thus requires a high-gain compact amplifying medium whose conception mitigates thermal and nonlinear effects, as well as low-footprint beam cleaning elements ensuring a high quality seeder beam.

## Gain aperture

beam can be amplified and cleaned by gain aperture

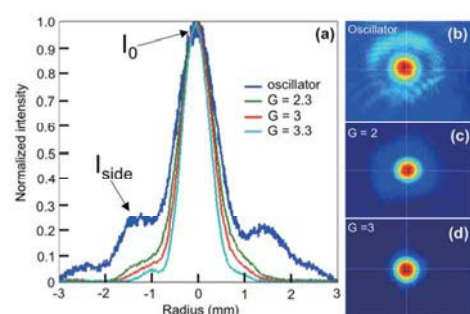
cleaning effect is modeled by radially dependent gain calculation



- higher gain increases efficiency
- gain saturation decreases efficiency

One must work with the highest possible gain such as saturation remains low during 2 pass amplification .

## Results



- Relative reduction of side peak intensity :

$$I_{\text{side}}/I_0 = 0.01$$

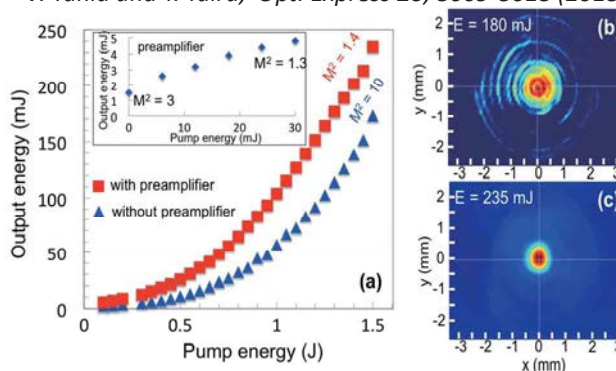
- Energy increased up to 6 mJ : good for amplification

- M<sup>2</sup> reduced from 3.0 to 1.3

## Conclusion

The demand of ultra-compact, high-brightness, high-energy laser sources led us to develop a micro-MOPA system. For maintaining good beam quality at high-energy, it was shown that end-pumping configuration should be used. A compact beam-cleaning element was developed based on the principle of gain aperture, ensuring near-Gaussian beam quality even after amplification.

GA was implemented into a compact high energy MOPA  
 V. Yahia and T. Taira, *Opt. Express* **26**, 8609-8618 (2018)



	Microchip	MOPA without gain aperture	MOPA with gain aperture
Footprint [cm x cm]	5 x 5	30 x 45	30 x 45
Energy [mJ]	2	180	235
M <sup>2</sup>	3	10	1.4
Brightness [PW/sr.cm <sup>2</sup> ]	0.051	0.42	18
		(increase x8)	(increase x353)
Repetition rate [Hz]	100	100	10