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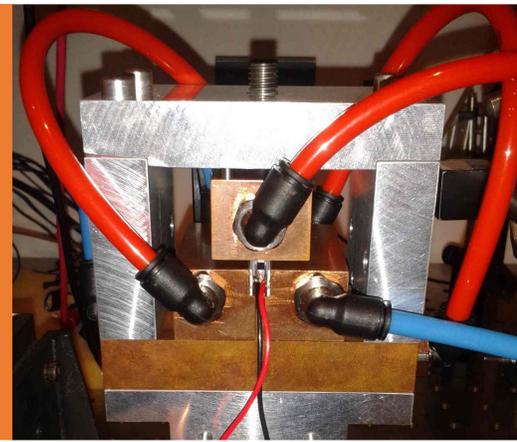
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LED pumped QCW Nd³⁺:YVO₄ laser

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Summary

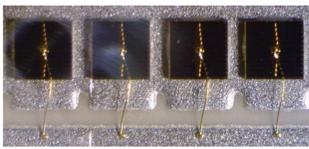
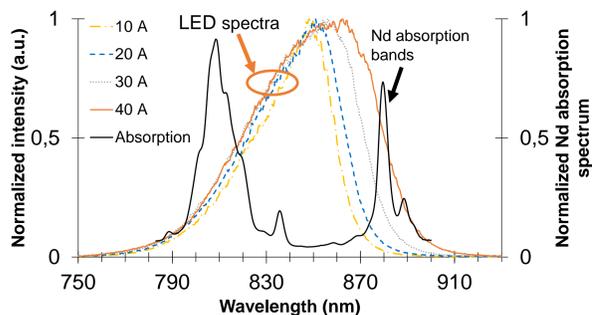
- ✓ Presentation of the **first LED pumped** Nd:YVO₄ laser
- ✓ Side pumping by 850 nm LED arrays
- ✓ At 250 Hz, E_{out} = 40 μJ (at 1064 nm), E_{emitted} = 7.4 mJ, η_{o/o} = 0.5%

Context

- ✓ 60-70's: LED pumping demonstration of Nd, Yb doped lasers [1]
- ✓ 2000's: lighting market → LED performance improved [2] + drop of LED price
- ✓ 2008: LED pumped polymer [3], fiber [4] and semiconductor [5] lasers have been demonstrated BUT bulk crystals not yet revisited

Experiment results

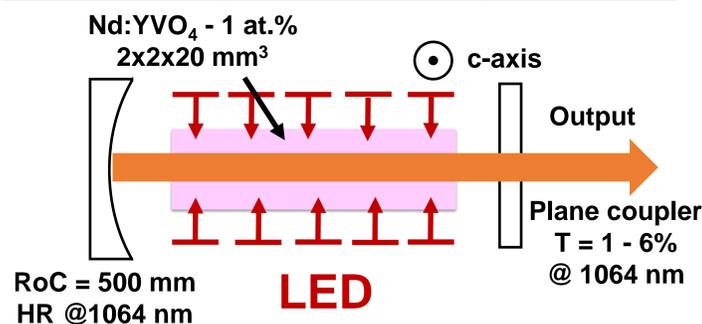
LED's characteristics



LED array :

18 1x1 mm² dices, lambertian emission
Intensity = 25 W/cm² (cw) → 200 W/cm² (pulsed)
100 μs pulses, 250 Hz (damage above 400 Hz)

Experimental setup



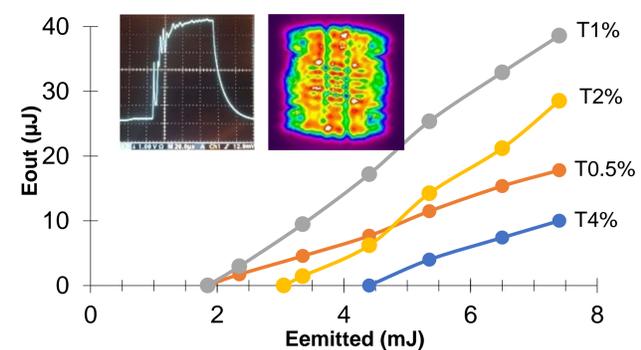
Nd:YVO₄ crystal :

2x2x20 mm³, 1% doped, water cooled
AR coated @1064 nm laser facets
2 transverse faces polished

Laser cavity :

Concave end mirror, R500 mm, HR@1064 nm
Plane coupler, T = 1-6%
L_{cav} = 100 – 500 mm

Laser results



Laser features :

Pulse duration = 65 μs
Beam quality M² = 19
E_{out} = 40 μJ, E_{emitted} by LED = 7.4 mJ → η_{o/o} = 0.5%
E_{absorbed} = 1.5 mJ → η_{o/o} = 2.6%
Repetition rate = 250 Hz

Small signal gain simulation using LightTools

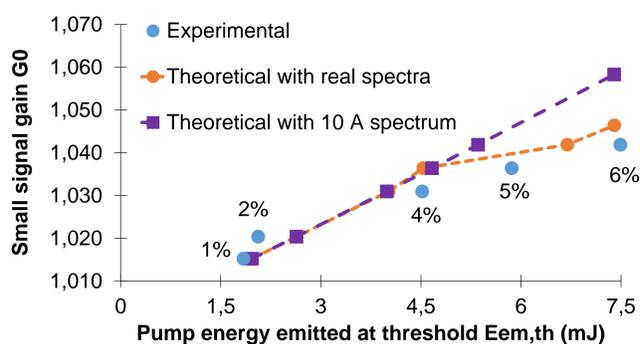
Comparison theory / experiment

Calculations :

$$g = \frac{n_t \sigma_{el} \tau}{hc} \int_{\lambda_{p1}}^{\lambda_{p2}} \sigma_{ap}(\lambda_p) \lambda_p \frac{dI_p}{d\lambda_p} d\lambda_p$$

I_p obtained from LightTools

Spectral broadening with current = key parameter



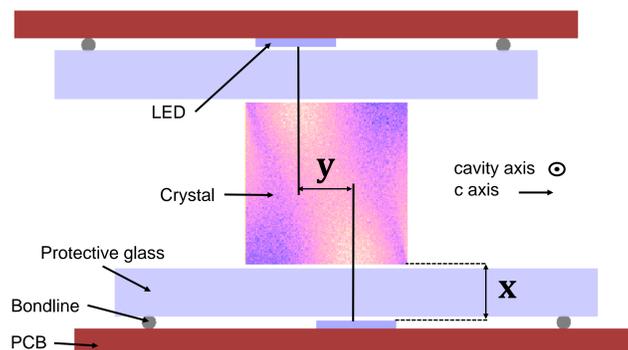
Pumping scheme

Simulation with LightTools :

2 LED arrays : geometry, spectrum, position, power...

Crystal : refractive index, absorption spectrum...

Tens millions of rays → Residual pump intensity I_p



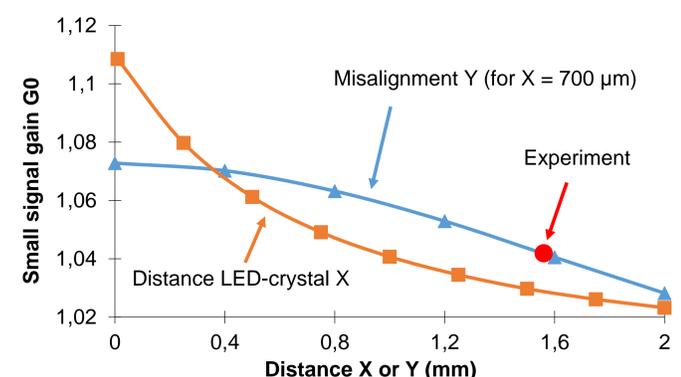
Effect of the misalignment

Two spatial influent parameters :

Misalignment between the two LEDs Y

Distance LED-crystal X (working distance = 700 μm)

→ Strong effect of the distance X



References

1. R. B. Allen & S. J. Scalise, *Appl. Phys. Lett.* **14**, 188 (1969).
 2. Led. Magazine, "Lab record: red LED breaks through the 200 lm/W barrier" (2011).
 3. Y. Yang, G. a. Turnbull, and I. D. W. Samuel, *Appl. Phys. Lett.* **92**, 163306 (2008).
 4. L. Htein, W. Fan, P. R. Watekar, and W.-T. Han, *Opt. Lett.* **37**, 4853 (2012).
 5. X. Liu, G. Zhao, Y. Zhang, and D. G. Deppe, *Appl. Phys. Lett.* **102**, 081116 (2013).
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Perspectives

- ✓ Improve efficiency by using new LEDs (blue chip with phosphor, double stack chip)
- ✓ Tests of other Nd doped crystals (such as Nd:YAG or Nd/Cr:YAG)
- ✓ LED pumping potentially represents a intermediate between DL and flash pumping