Towards a More Compact Laser: Yb:Glass CPA Laser System

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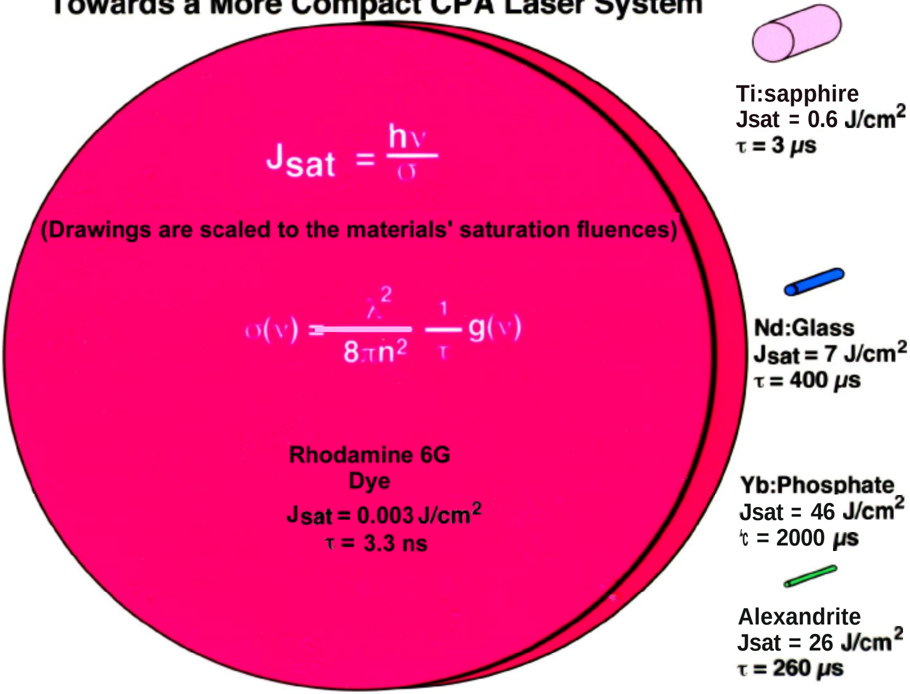
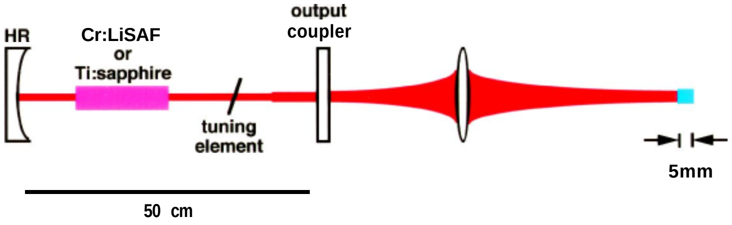


Yb:glass: Easy to Pump and Store a High Energy Density



Free - Running Pump Laser

Long pulse width (10 - 1000 μs)

High energy per pulse (10 - 100 J)

Directly Diode Pumpable

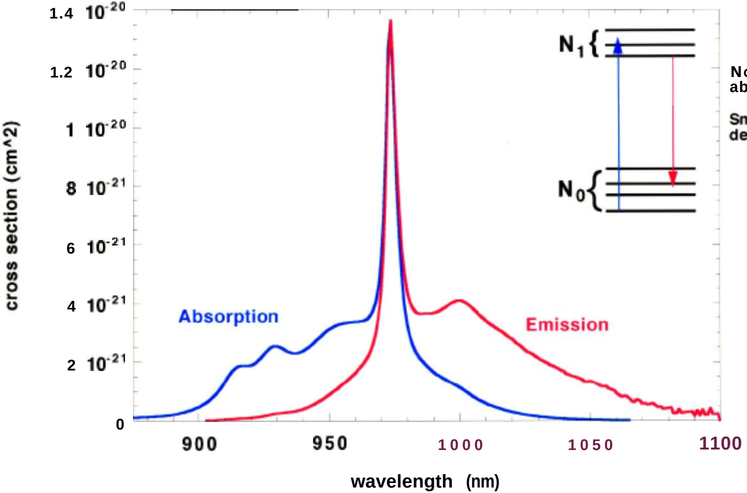
Yb:Glass

Long upper state lifetime (2 ms)

High energy storage (>100 J/cm^3)

High doping concentration (>10^21/cm^3)

Spectral Characteristics of Yb:Phosphate Glass: A Quasi-4-Level Laser



No excited state absorption

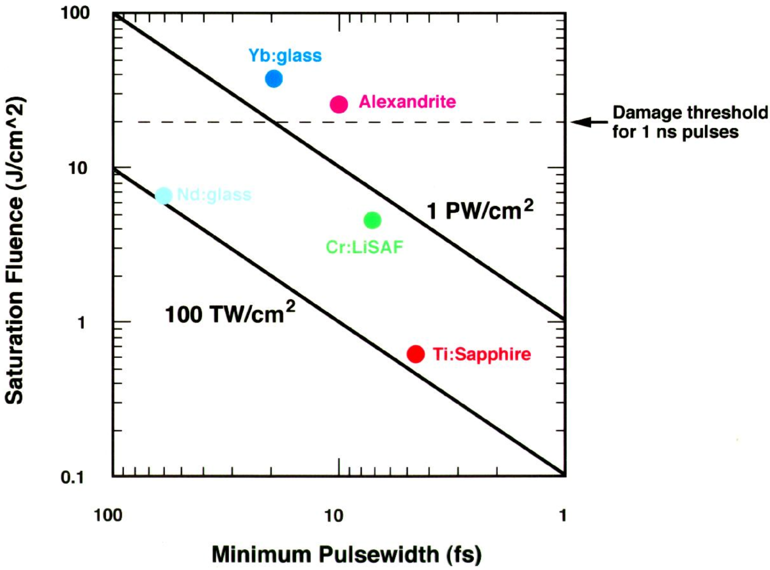
Small quantum defect

Reciprocity Relationship

$$\sigma_e(\nu) = \sigma_a(\nu)\exp[h(\nu_{10} - \nu)/kT]$$

Theoretical Peak Power per cm ^{2}

$$\frac{h\nu}{\sigma\Delta\tau_{min}}$$



Advantages of Yb:glass

- Long upper-state lifetime (1 - 2 ms)

  Directly pumpable by free-running solid-state lasers

  Directly pumpable by diodes (InGaAs)

- Excellent stored energy density capability (> 100 J/cm^3)

- Broad gain bandwidth (< 30 fs)

- Small quantum defect (7 - 9%)

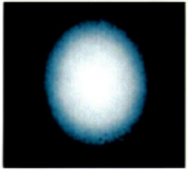
- No losses due to excited state absorption

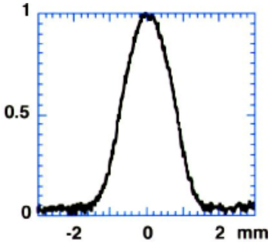
- Low cost

- Compact

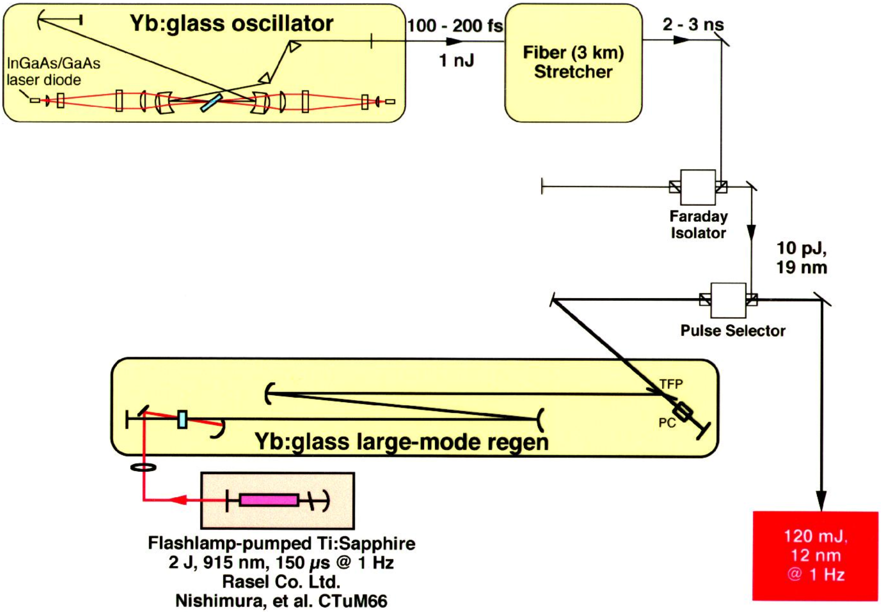
Advantages of a Large-Mode Regenerative Amplifier

- Efficient energy extraction below saturation fluence
- Compact system size (one amplifier stage to get to > 100 mJ)
- Simple spectral shaping
- Excellent spatial mode quality





Yb:glass Chirped Pulse Amplification Laser System



Flashlamp-pumped Ti:Sapphire
2 J, 915 nm, 150 μs @ 1 Hz
Rasel Co. Ltd.
Nishimura, et al. CTuM66

Conclusions

Highest energy regenerative chirped-pulse amplifier (120 mJ) with 10^{10} net amplification

Compact system size (One amplifier stage to reach > 100 mJ; seeded by a directly-diode-pumped oscillator)

Future Plans

Increase mode-size to improve efficiency and energy

Tune injection bandwidth to optimize amplified spectrum

Obtain 1 J from a single amplifier stage, producing 10 TW potentially