Status of High-Power Laser Development at Stanford

Shally Saraf*, Supriyo Sinha, Arun Kumar Sridharan
and Robert L. Byer
E. L. Ginzton Laboratory, Stanford University

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*saraf@stanford.edu

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Outline

- Review of slab lasers.
- Progress since Livingston LSC.
- 100W demonstration results.
- 200W amplifier design and status.
- (Near) future work.

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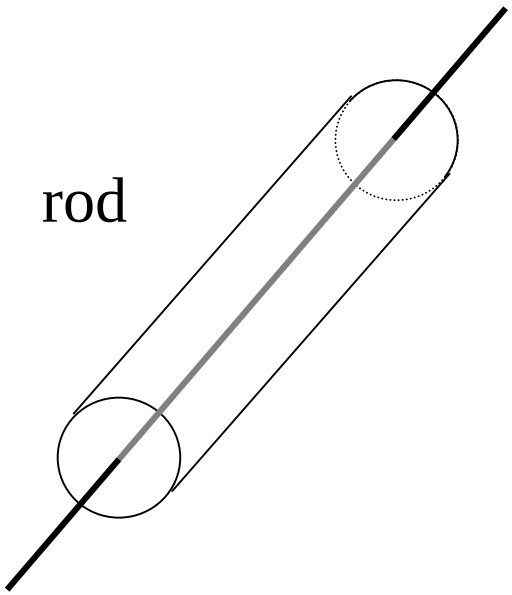
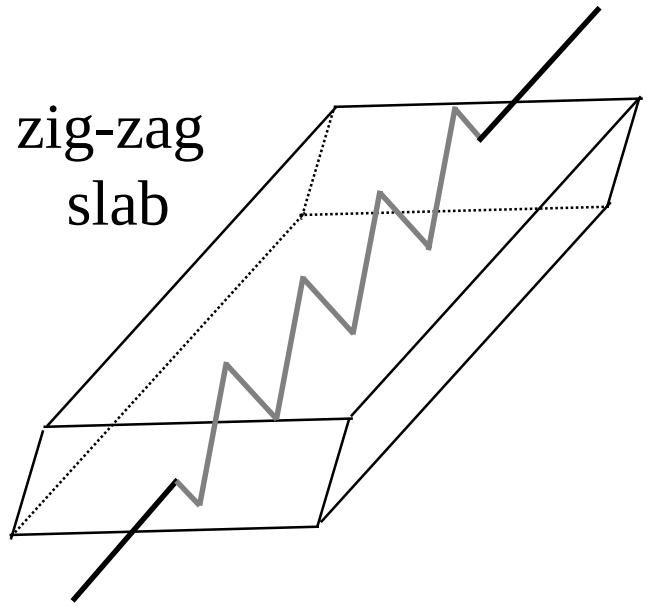
Rod vs Slab

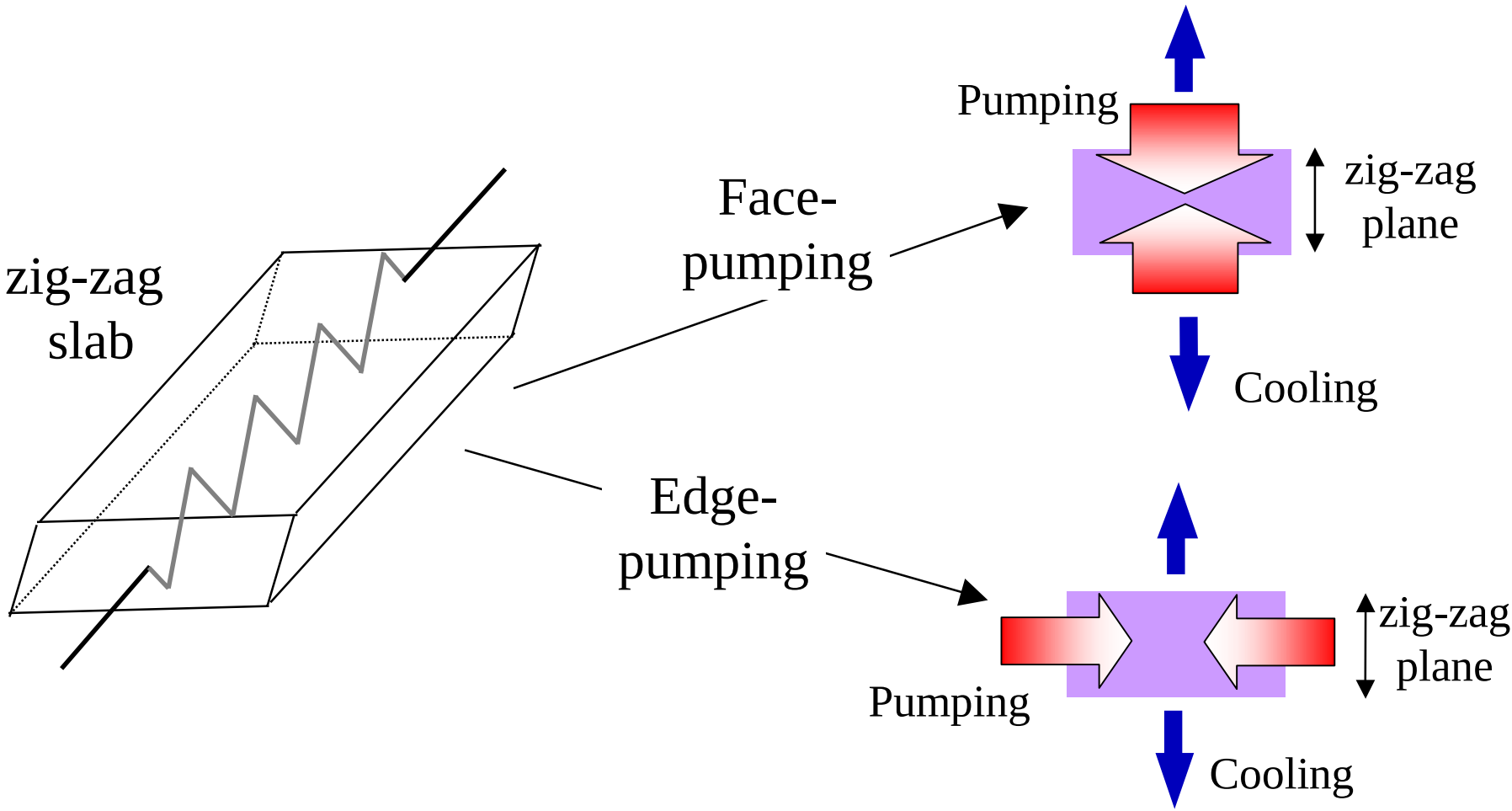




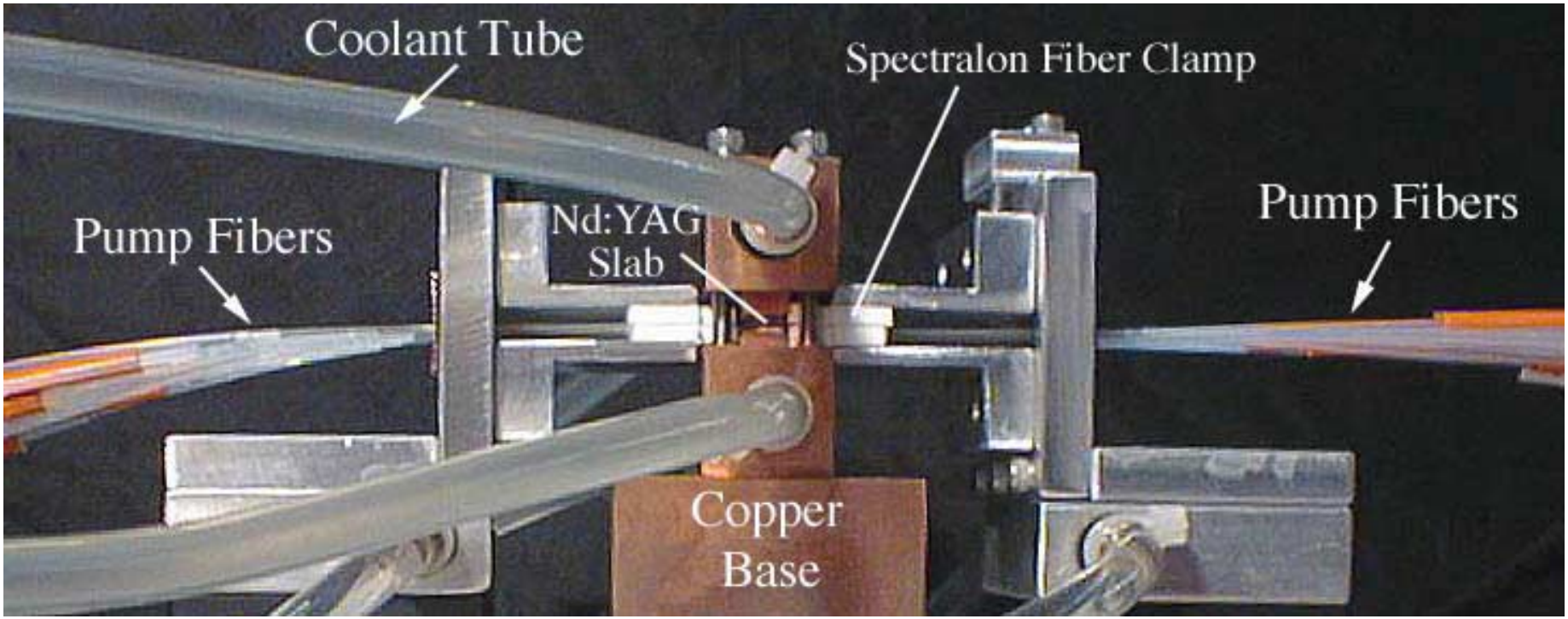
- 1st order thermal lens
- Spatially dependent birefringence (depolarization)

- 2nd order thermal distortions
- Slightly reduced mode-fill

Face-pumping vs Edge-pumping



Nd:YAG Laser Head

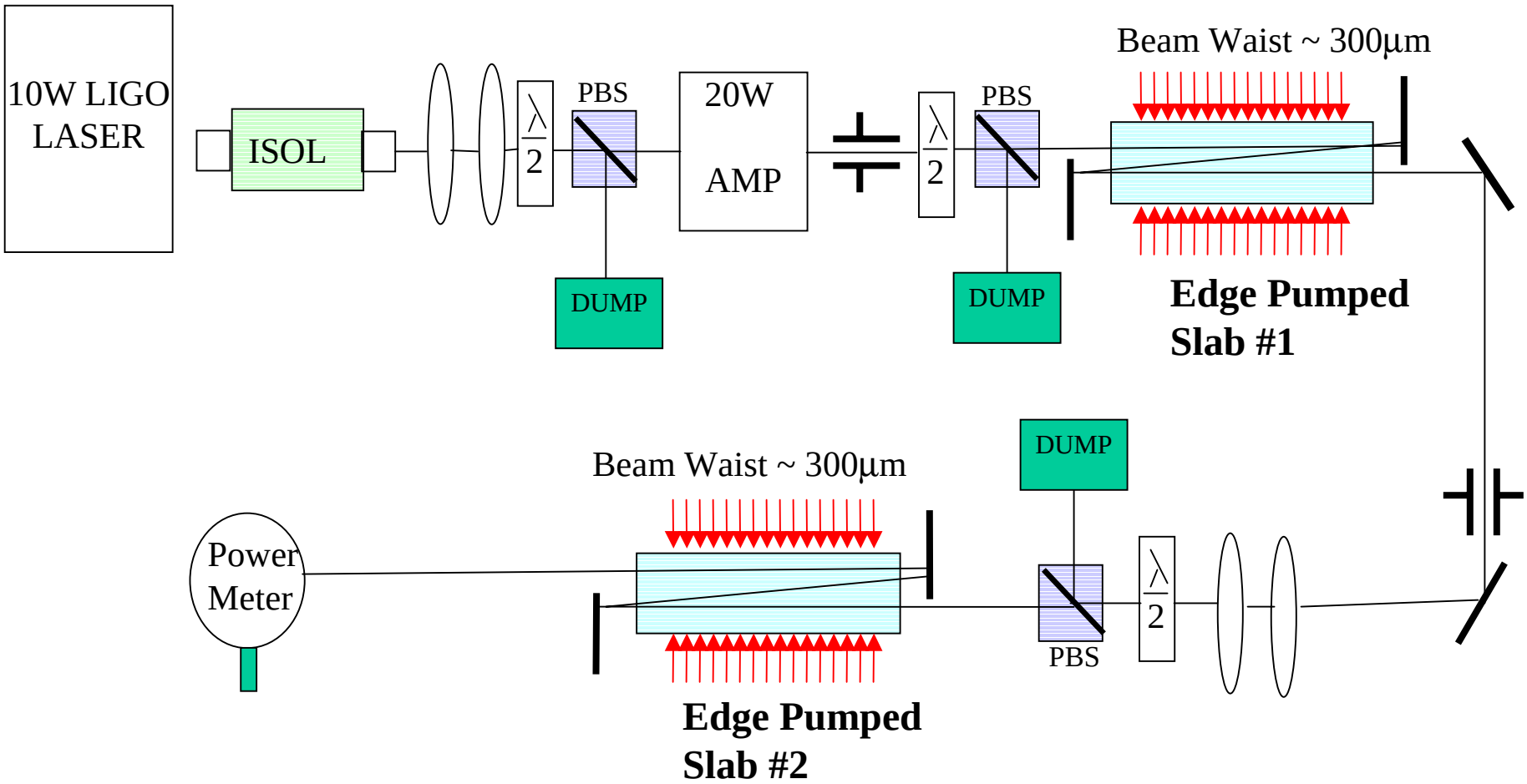


3.8 cm

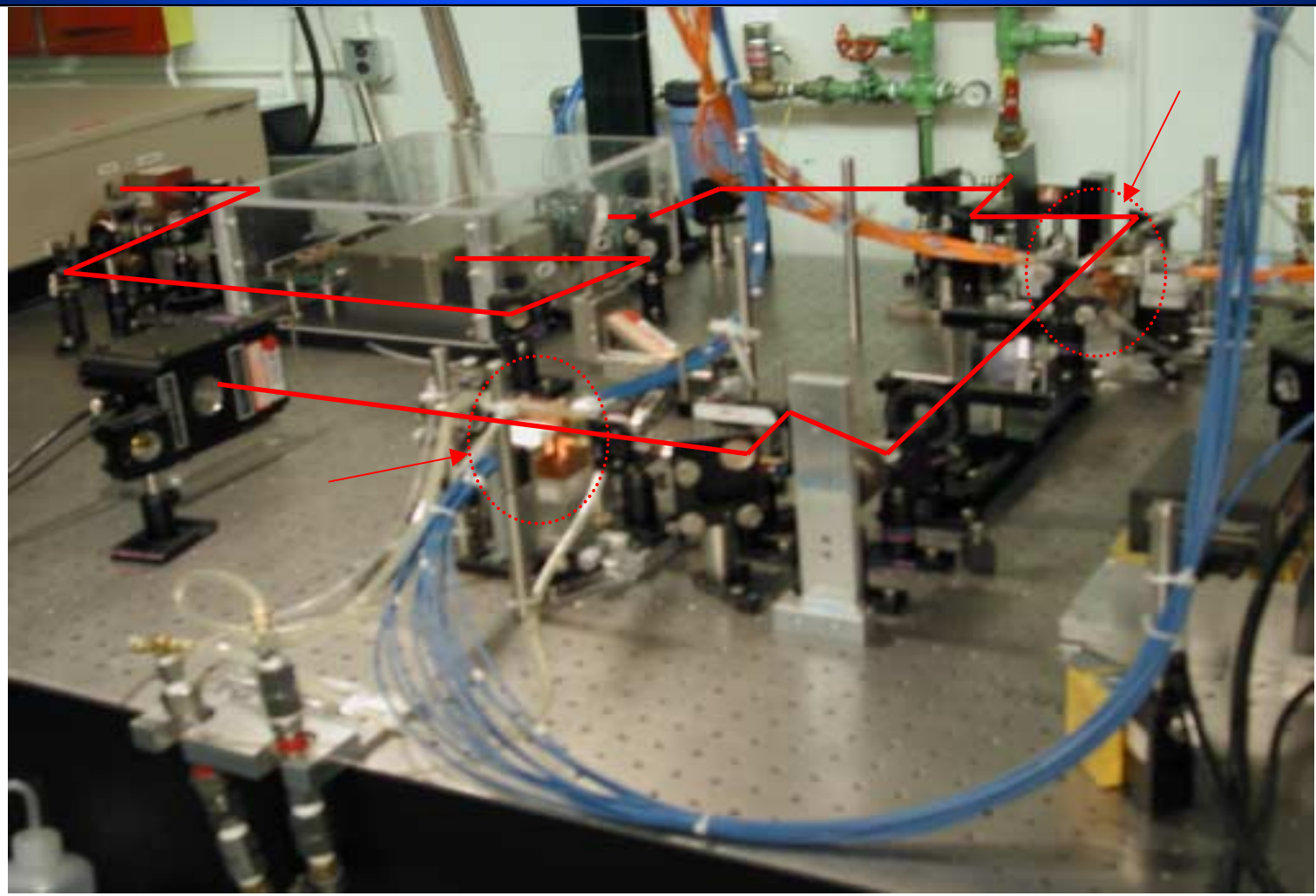
Amplification Goal: 100 W

- Two zig-zag edge-pumped slab amplifiers.
  - Brewster ends.
  - 3:1 aspect ratio (width/thickness).
- About 900 W total pump power.
- 10W LIGO laser followed by an external amplifier provides 20W to drive slab amplifiers.

Experimental Setup for 100W demonstration



100W experimental setup



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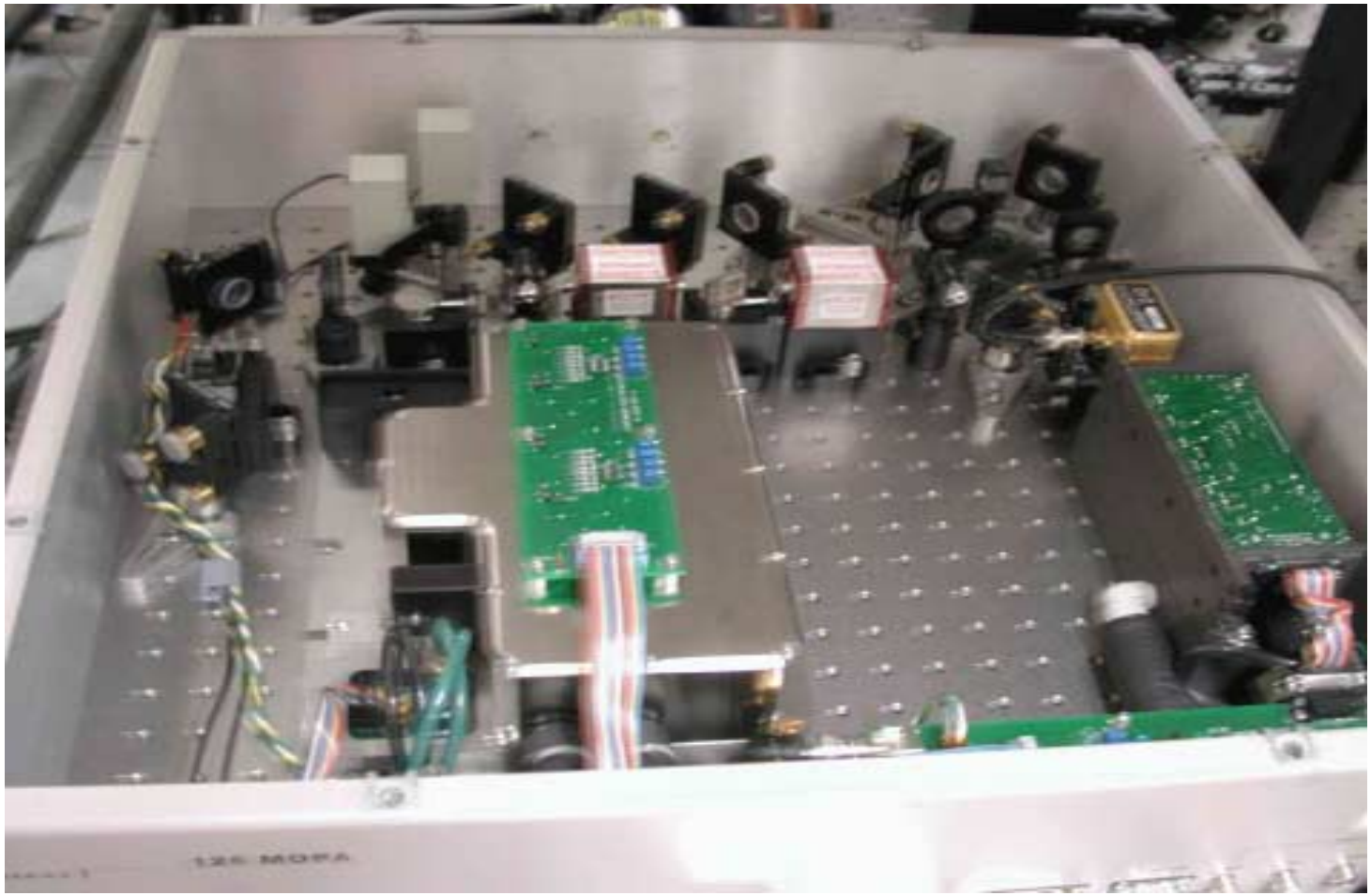
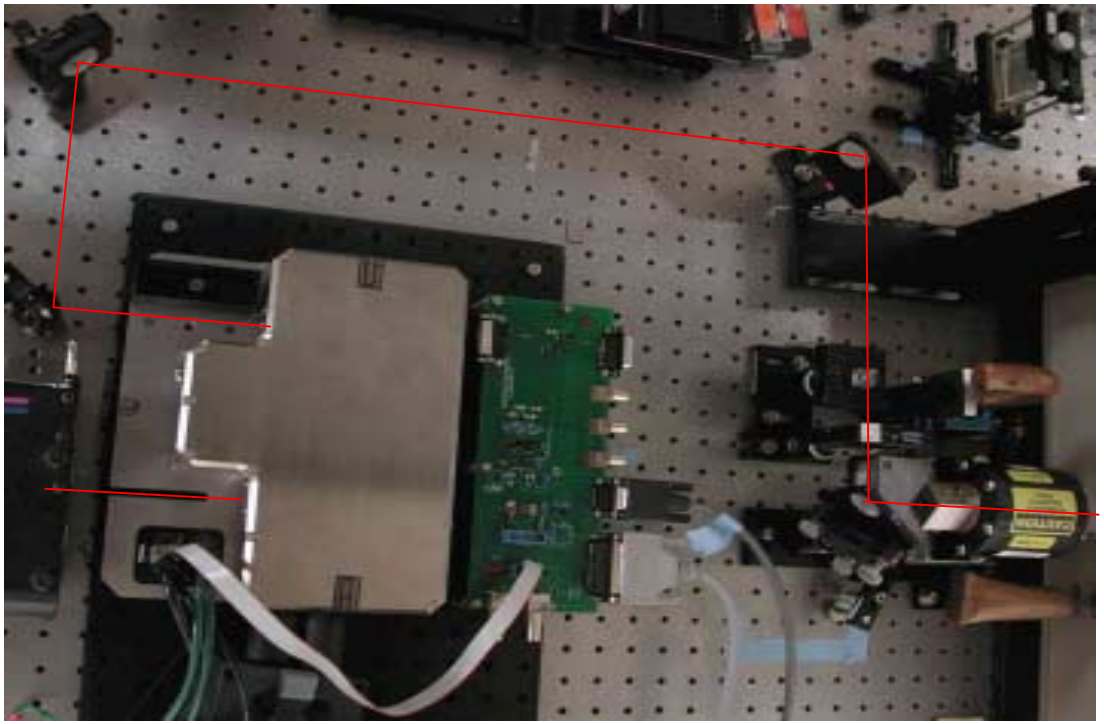
10W Amplifier



10W Amplifier upgrade

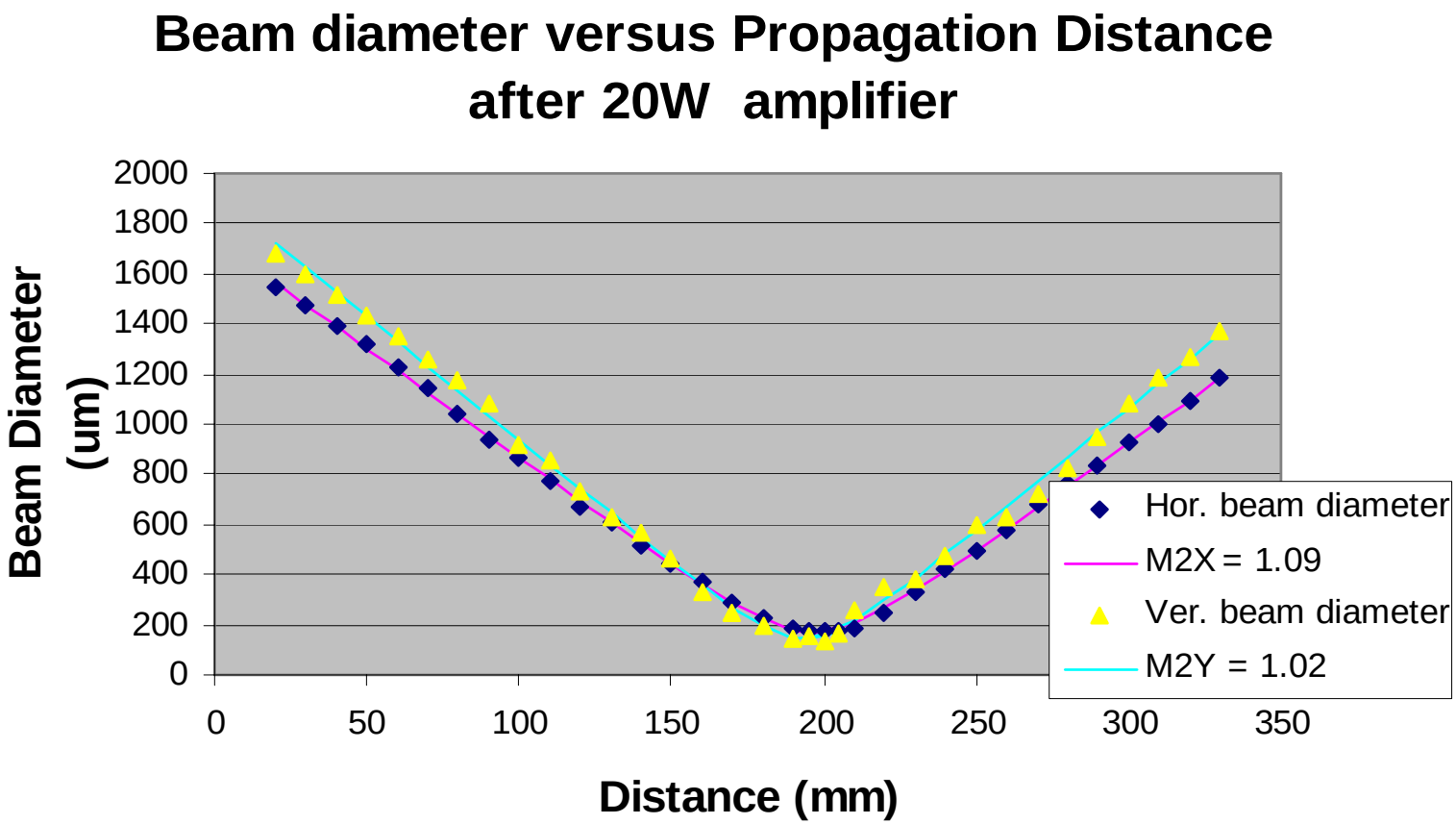
- Increased NPRO power from 235mW to 418mW by turning up drive current from 1.89A to 2.4A.
- Realigned optical train.
- Output power increased to 10.4W back to original specs.
- Set diode temperature to 24.1^{o}C and pump current to 23A for the double passed amplifier.

20W Amplifier



- Replaced Faraday Isolator following 10W LIGO Laser.
- Replaced faulty power supply for external 20W amplifier.
- Mode matched beam into 20W amplifier (waist ~ 245μm)

Beam quality after 20 W amplifier



Measured output power ~ 24.4W.

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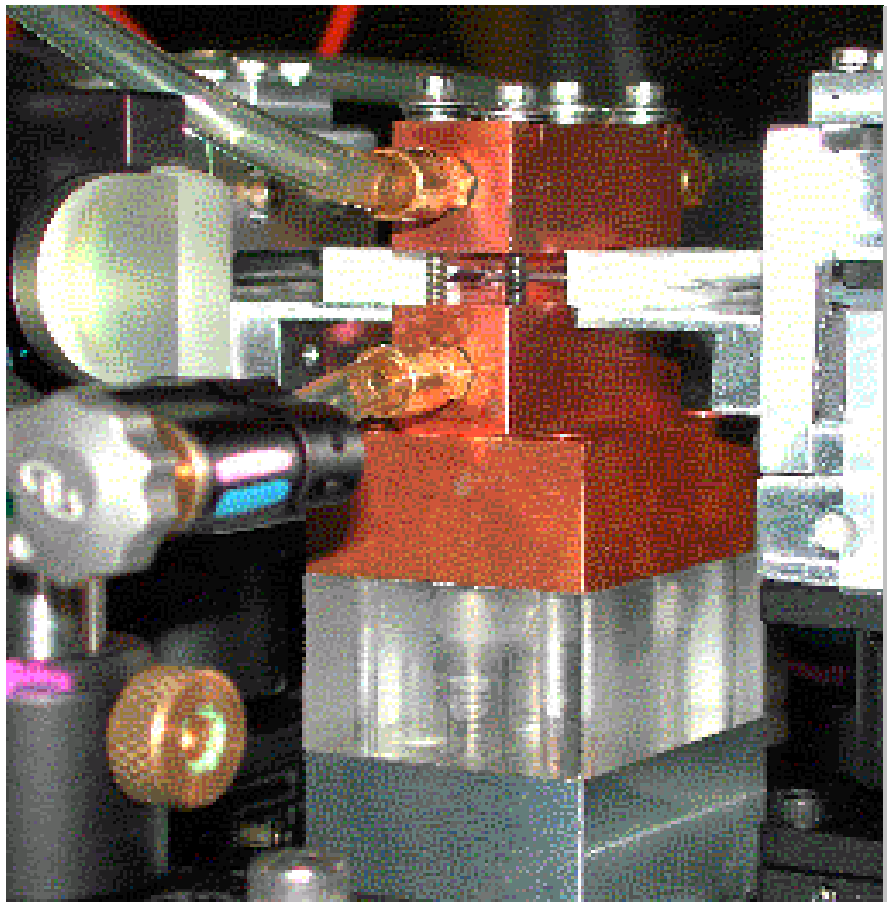
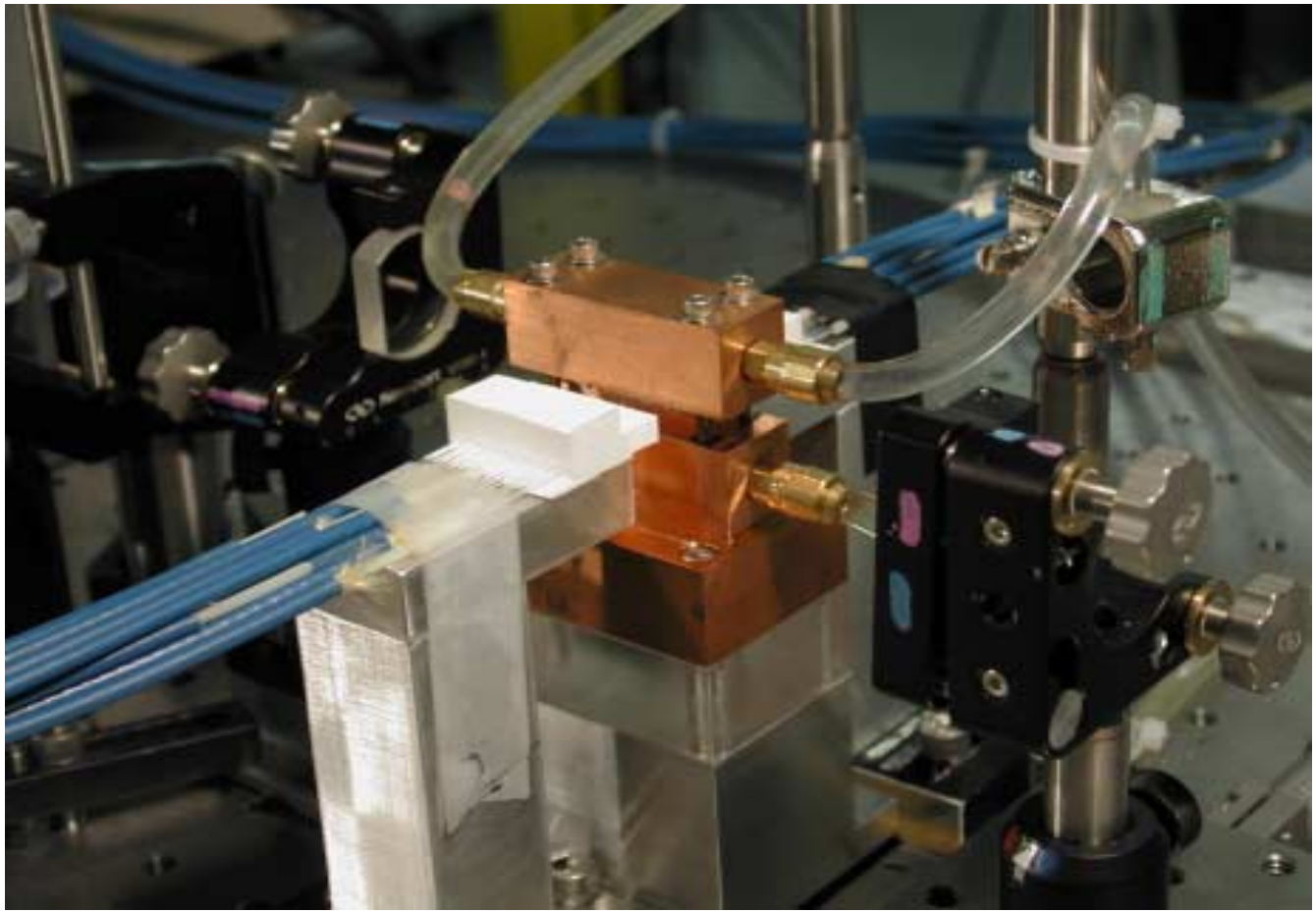
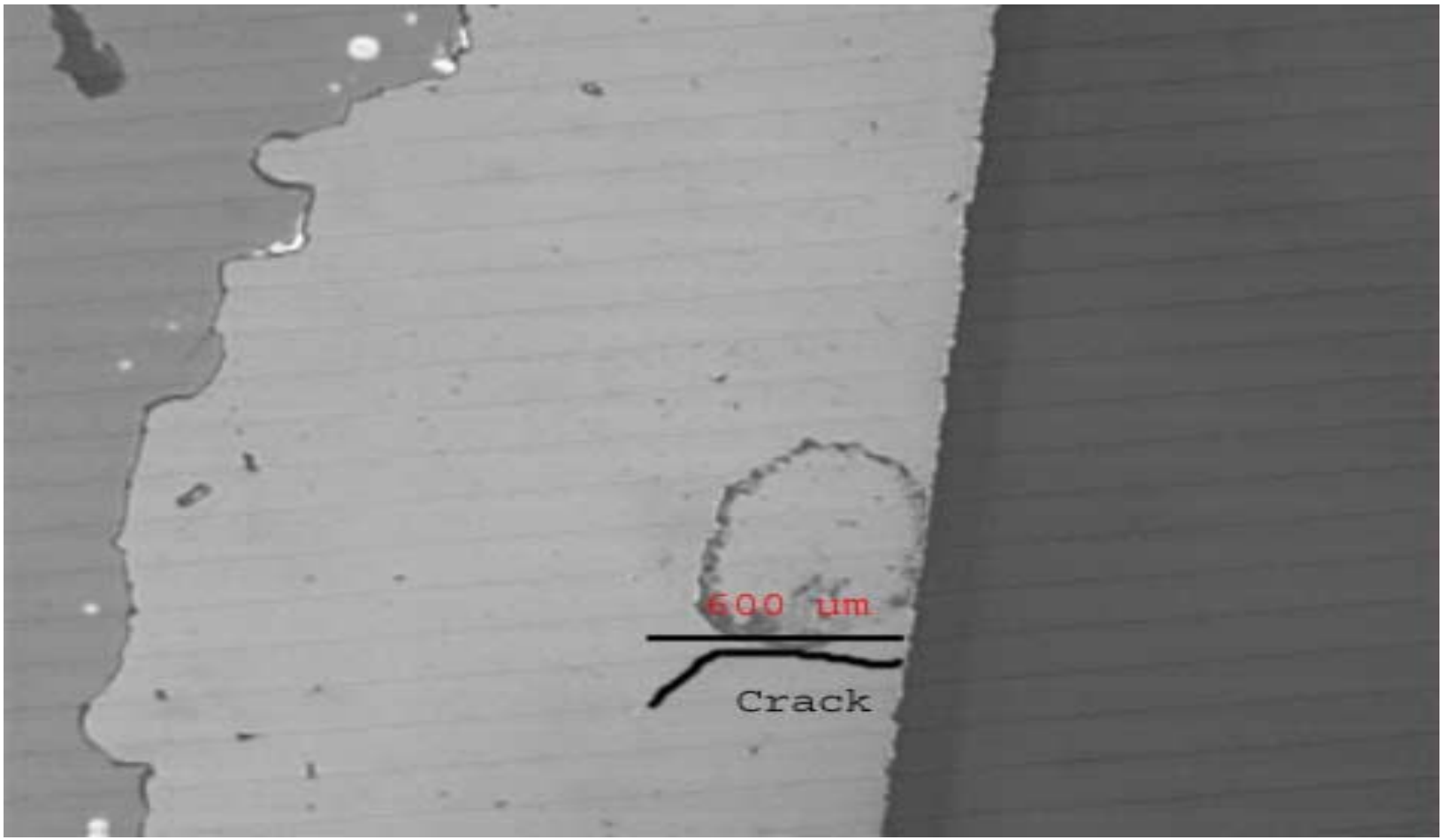
Edge pumped slab head assembly



Slab 2 power amplifier set up



Complication ---- Slab #1 cracked



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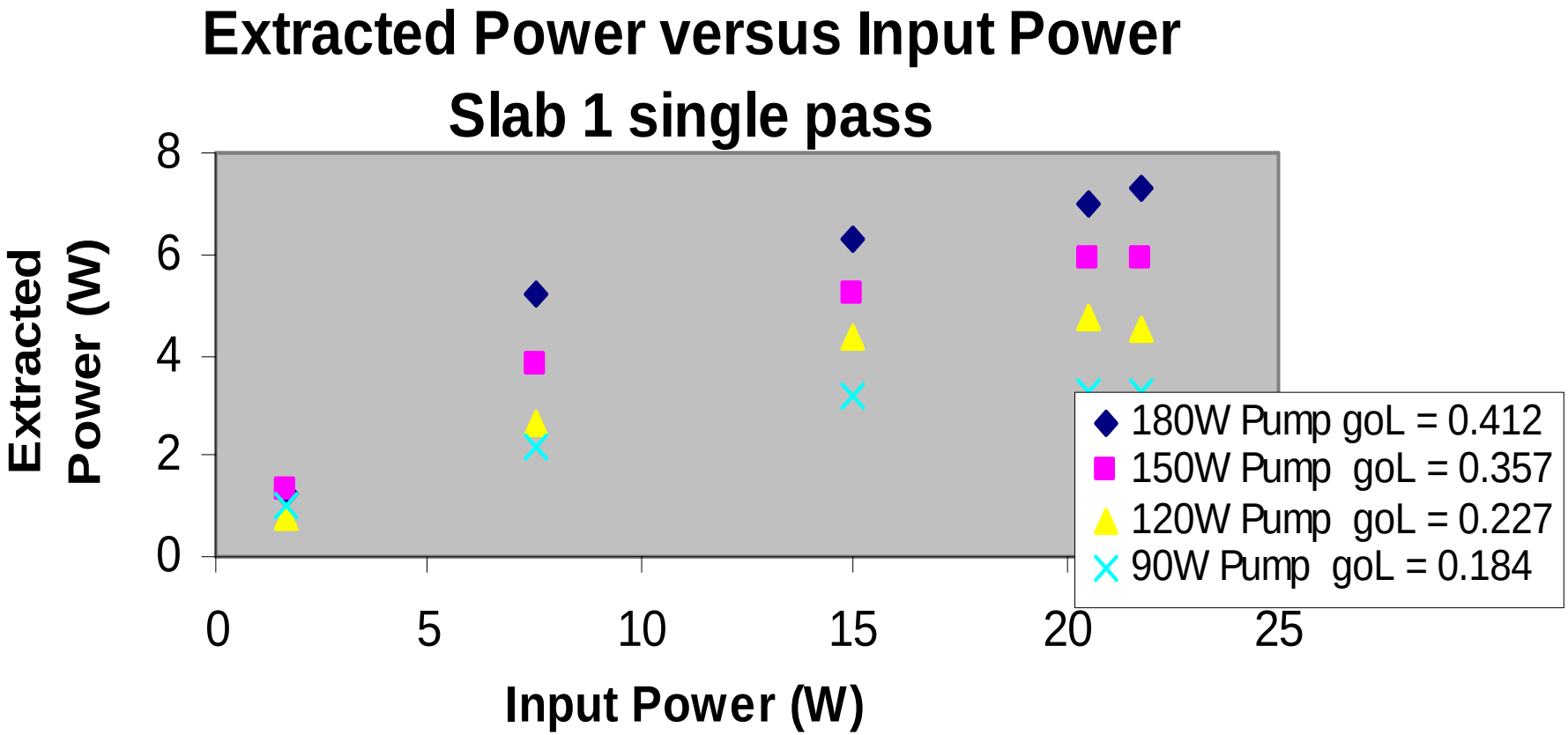
Results for slab amplifier # 1



Output Power = Input Power + Extracted Power

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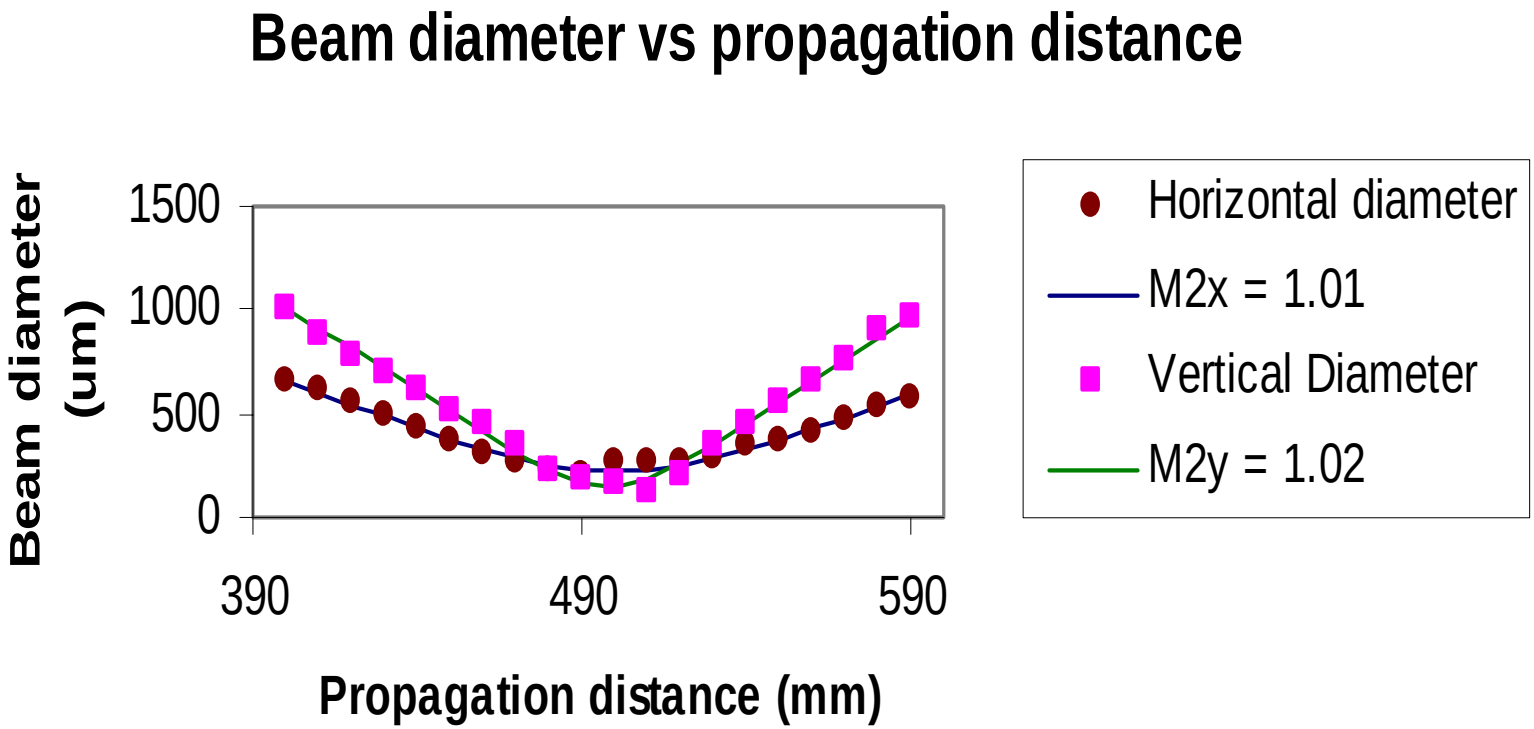
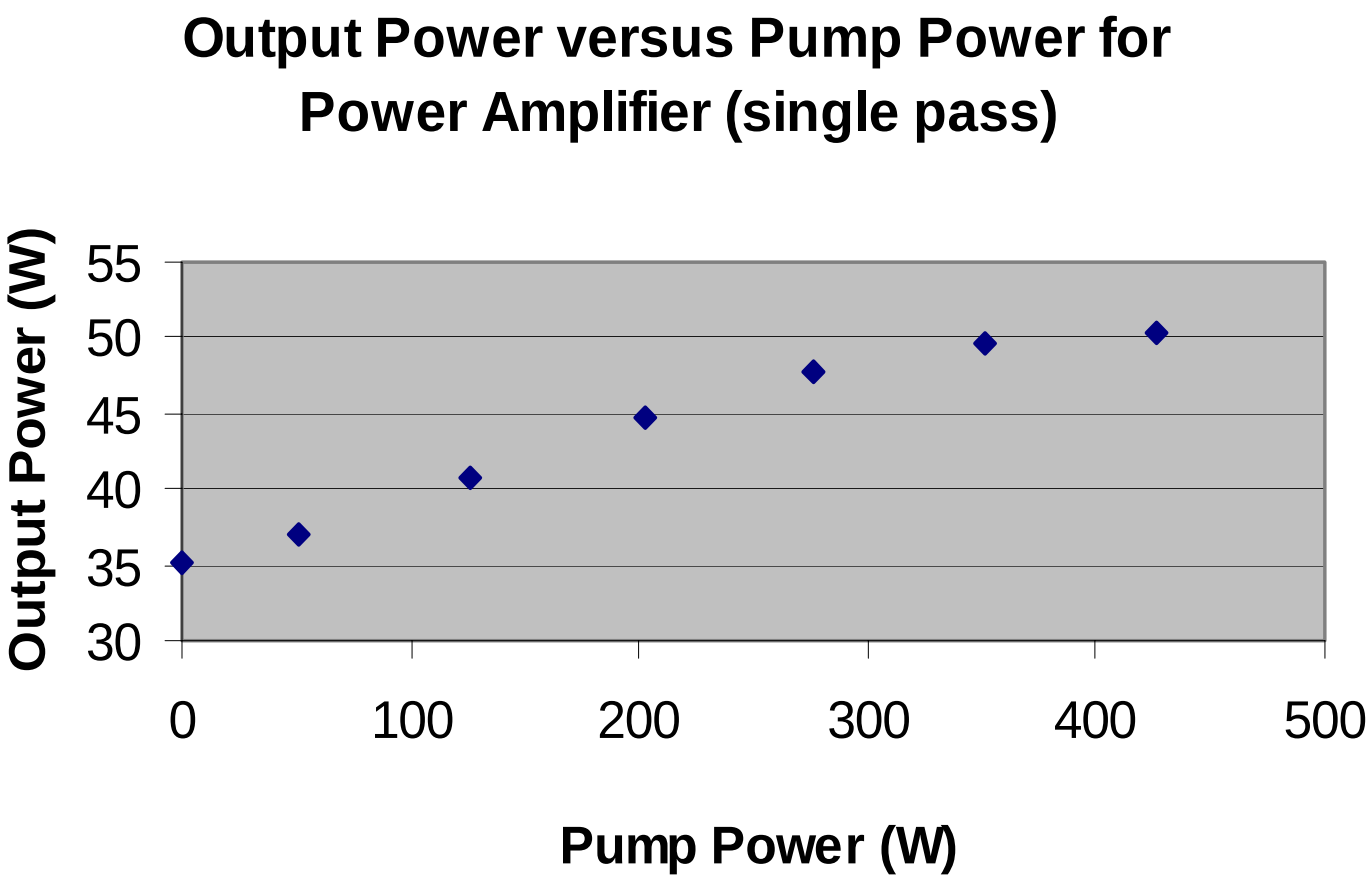
Power and M^2 measurement after slab #1



Output Power from triple passed slab #1 = 39W

Slab #2 single pass power output



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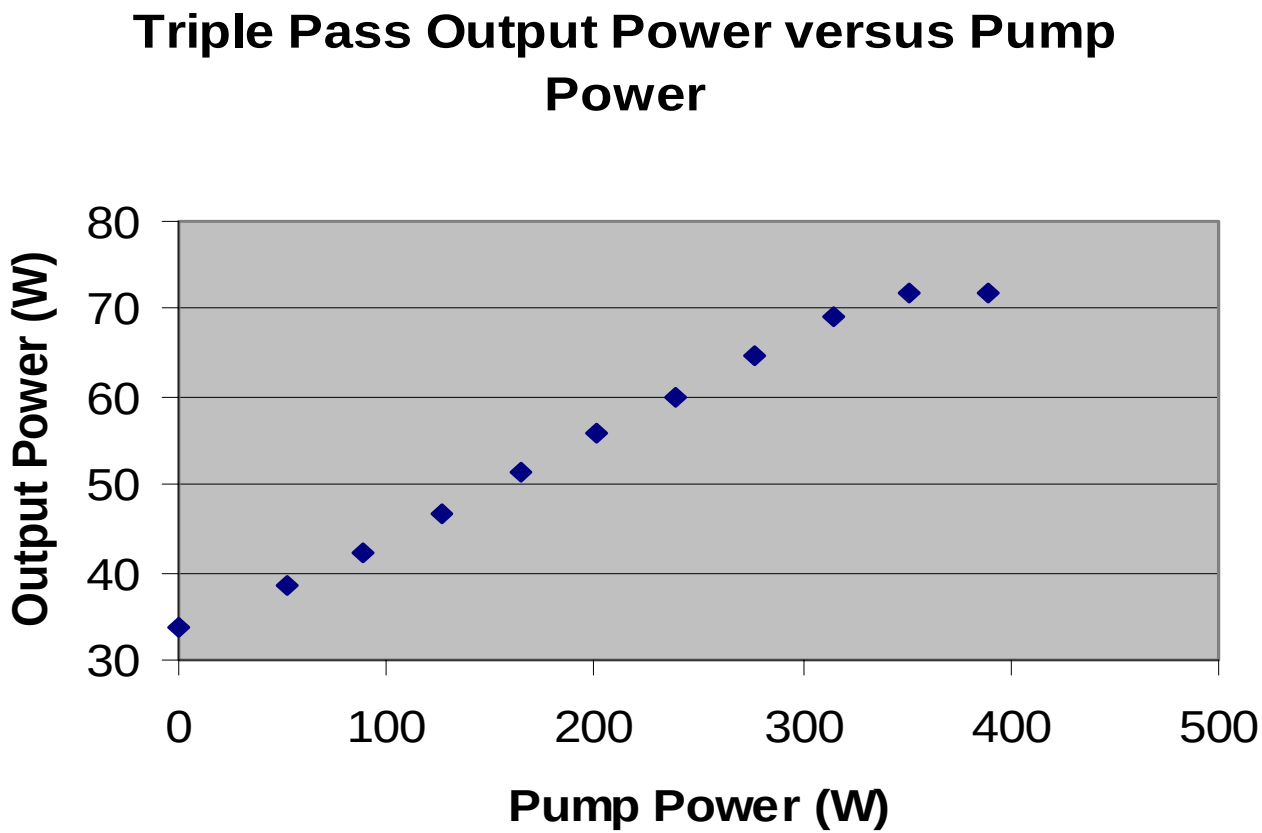
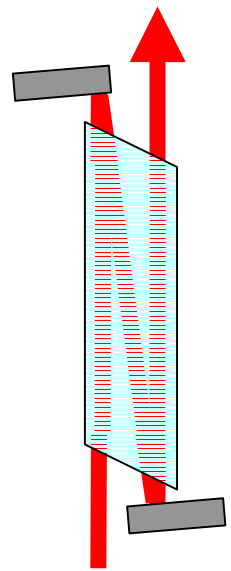
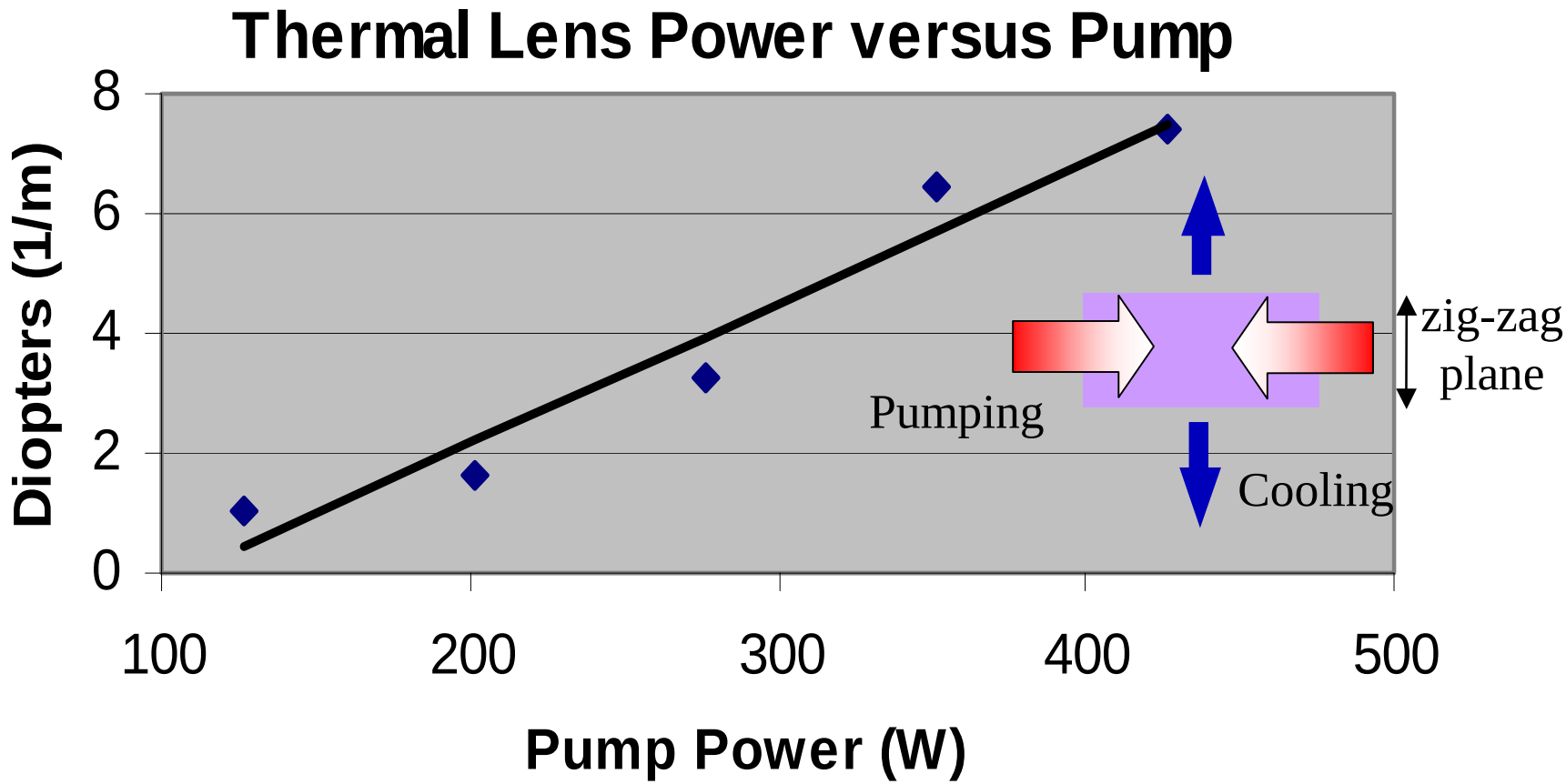
Slab #2 triple pass power output





Power out of MOPA ~ 71.8W

Thermal lens measurements



Future work on 100W MOPA

- Compensate for thermal lens in second slab by using cylindrical lenses in triple pass.

- Faster beam quality measurements using holographic beam sampler to eliminate need for multiple wedges for attenuating power.

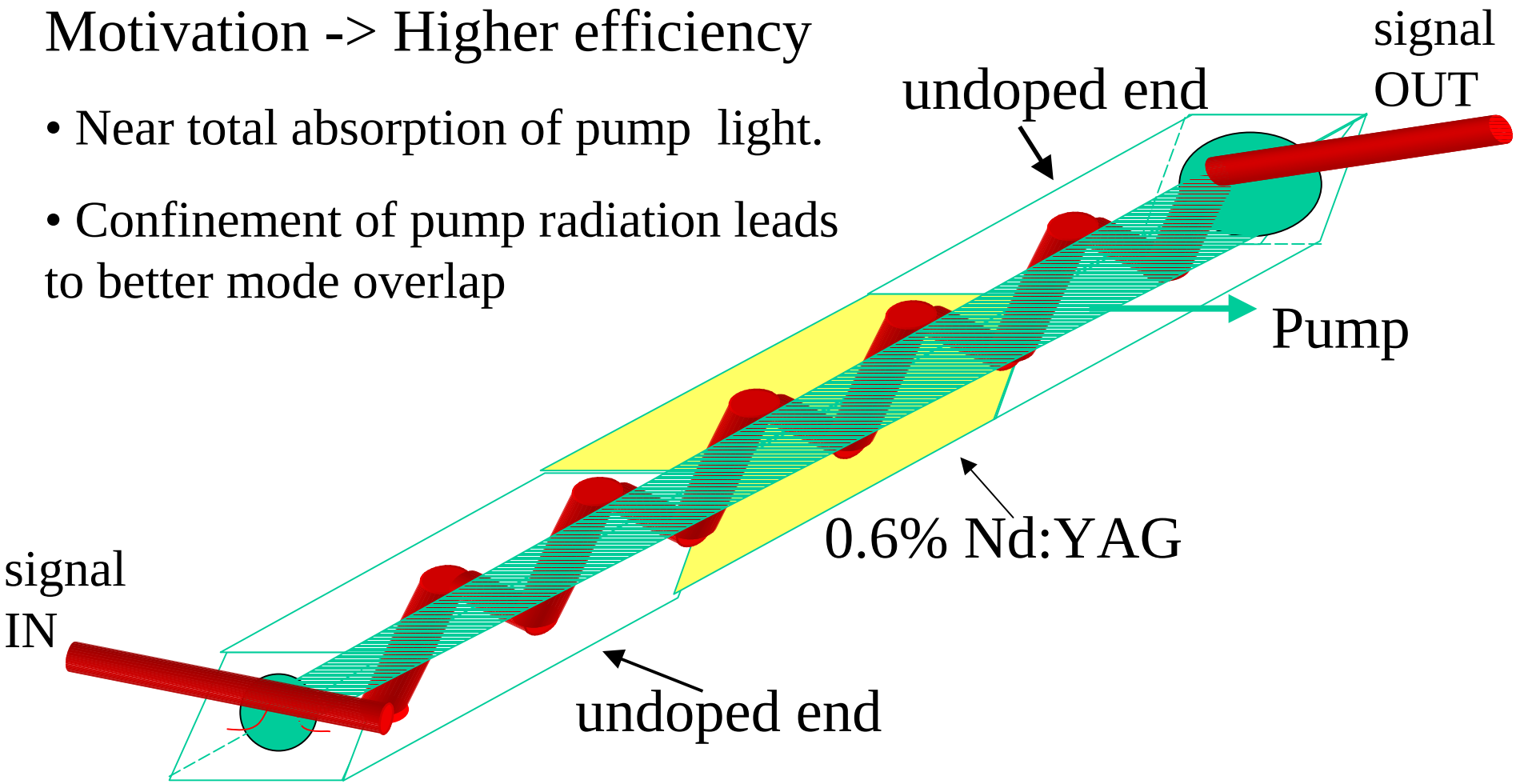
- M^2 measurement of MOPA output.

- Redo theoretical calculation of thermal lens.

End pumping topology for 200W design

Motivation -> Higher efficiency

- Near total absorption of pump light.
- Confinement of pump radiation leads to better mode overlap



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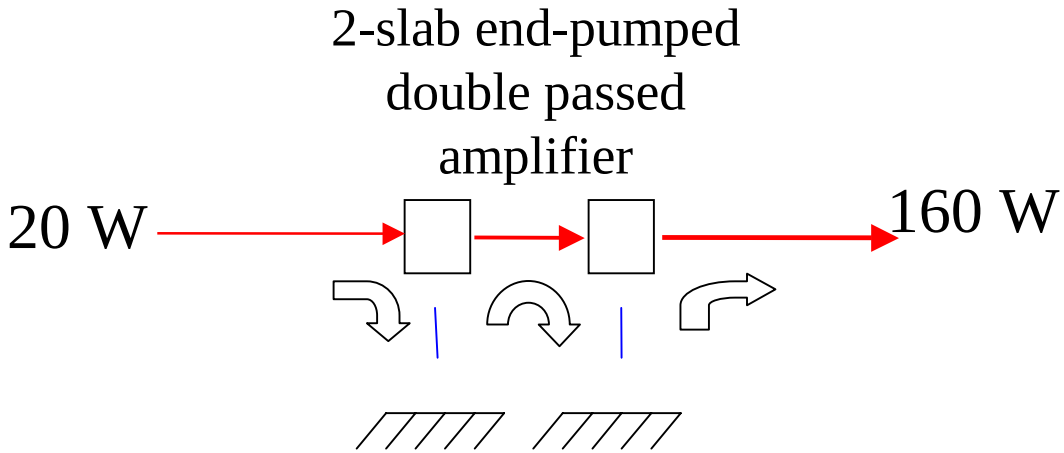
Pre-amplifier Design : End-pumping

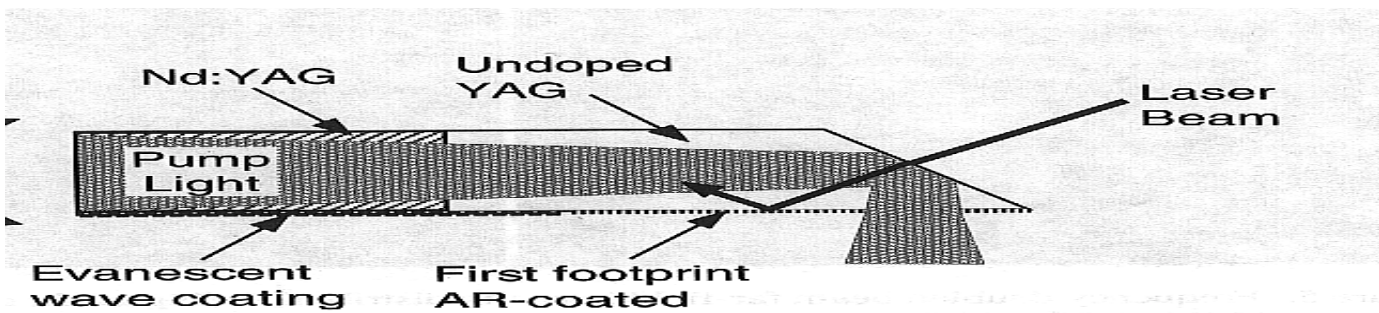


Slab Design Issues

1. Parasitic suppression
2. Pump light coupling and absorption

Crystal Dimensions

Width = 1.11 mm,
Length = 6.6 cm,
Thickness = 0.9 mm



Courtesy, Hagop Injeyan, TRW

Expected MOPA System Performance

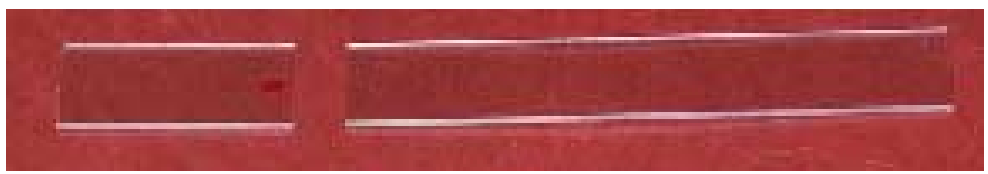
Amplifier	Input Power	Multi-mode Output	Output TEM_{00}
End-pumped (P_{pump} = 130W)	16W	60W	48W
End-pumped (P_{pump} = 435W)	48W	200W	160W
Edge-pumped (P_{pump} = 1400W)	160W	500W	400W

- Edge pumped design chosen for final stage because of heat extraction requirement and simpler engineering design without sacrificing much pump absorption.

Status of 200W design

- Received 8mm x 8mm Nd:YAG composites with undoped ends from Onyx.

- Diced up one composite in the Stanford Crystal shop. On one plate undoped end broke off cleanly from the doped portion. (possibly defective bonding from Onyx?)



Status of 200W design (contd….)

- Second composite being diced up by Crystal River Optics.

Future Work on 200W MOPA

- Get coated plates from MLD, inspect and dice up into slabs with final dimensions.
- Install Laser Line pump diodes with total pump power of 500W.
- Fabricate laser head with microchannel coolers.
- Integrate and start amplifier experiments.