1-kW, All-Glass Tm:fiber Laser

SPIE Photonics West 2010: LASE

Fiber Lasers VII: Technology, Systems, and Applications, Conference 7580

Session 16: Late-Breaking News

January 28, 2010

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Nufern, Inc.

Glen Rines and Peter Moulton

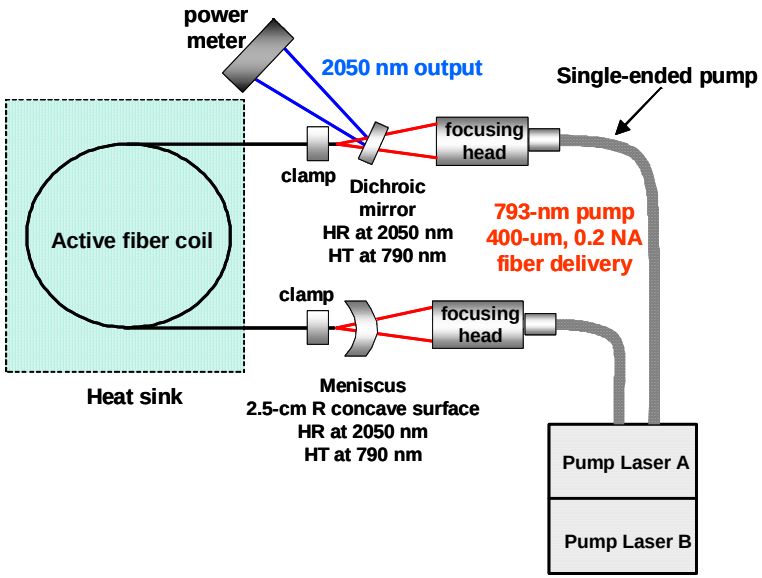
Q-Peak, Inc.

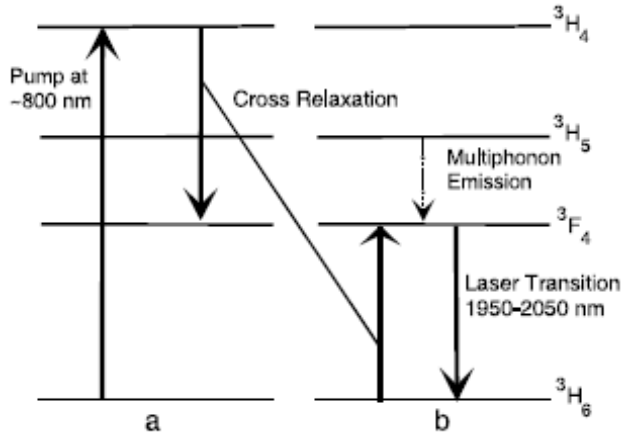
Outline

- Review of prior results
- Components
- Laser results
- Summary

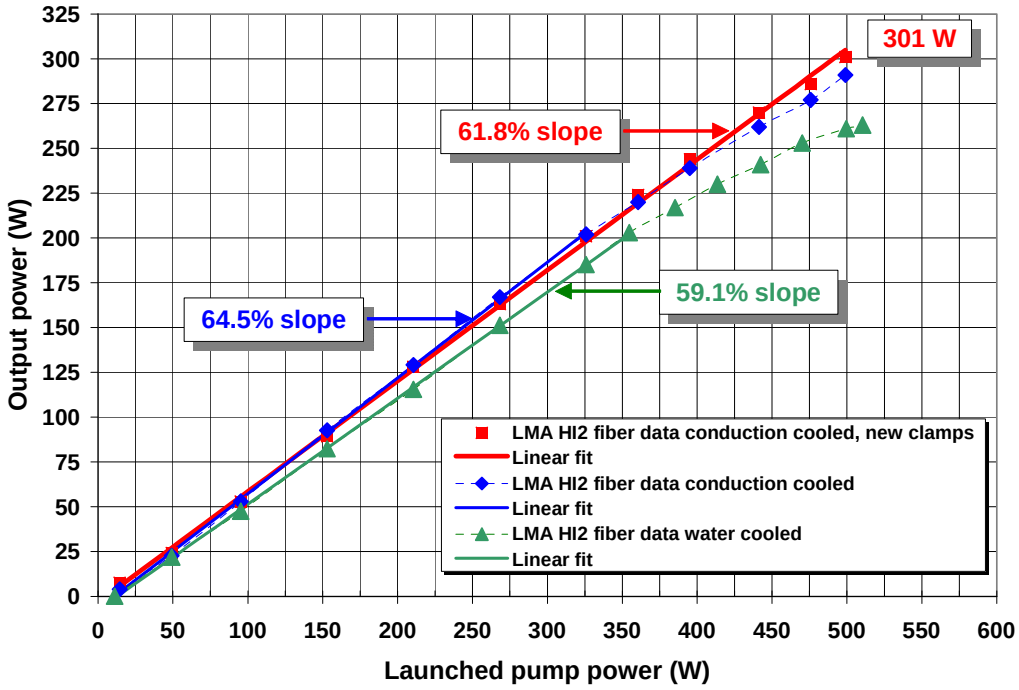
Support: HEL/JTO
Contract Number: FA9451-08-D-0199/0002

Early Q-Peak results scaling to 300 W, single-mode

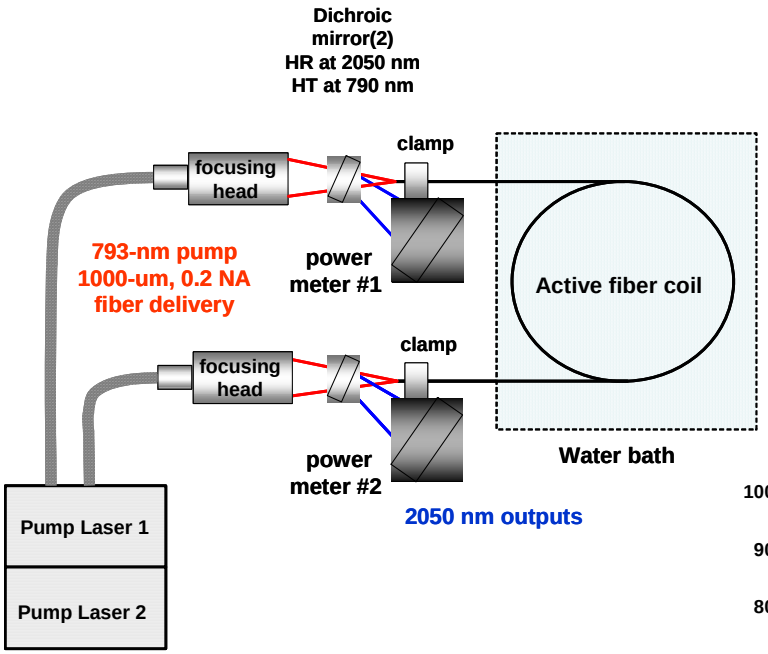


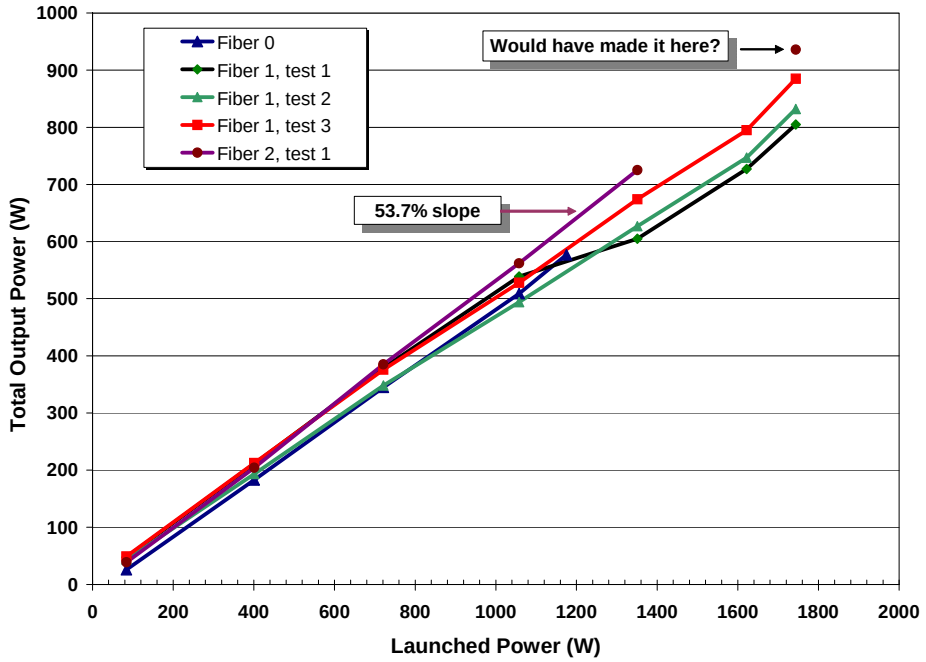


Gain fiber: 5-m long, 3-m undoped ends (2)
Core: 25 μm in diameter, NA: 0.08.
Pump cladding: 400-μm in diameter

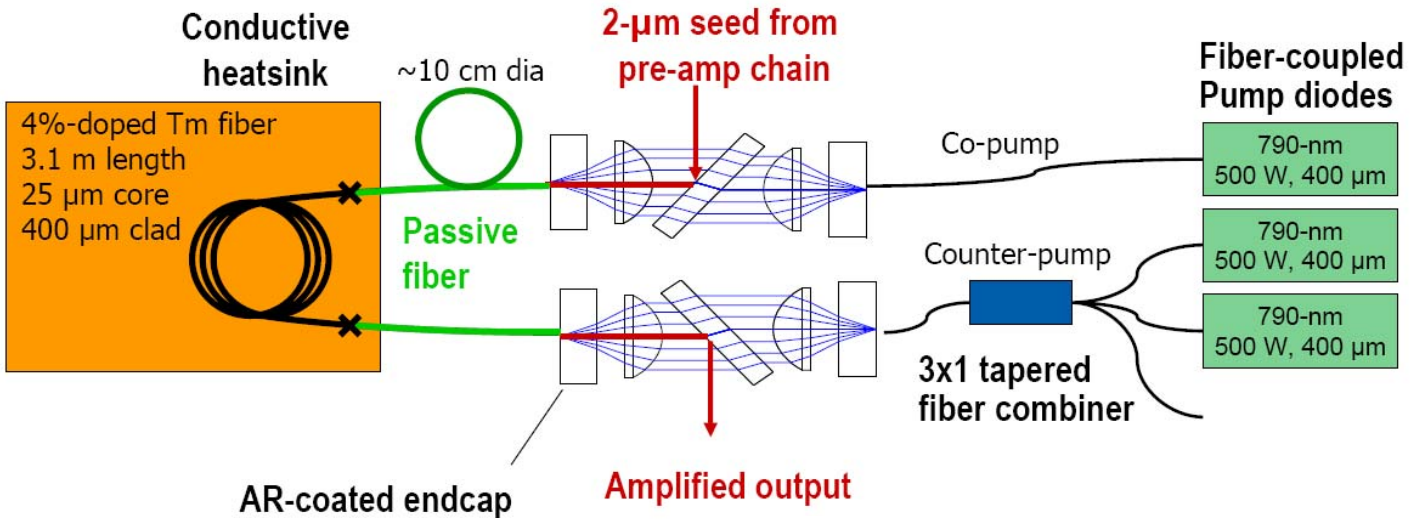


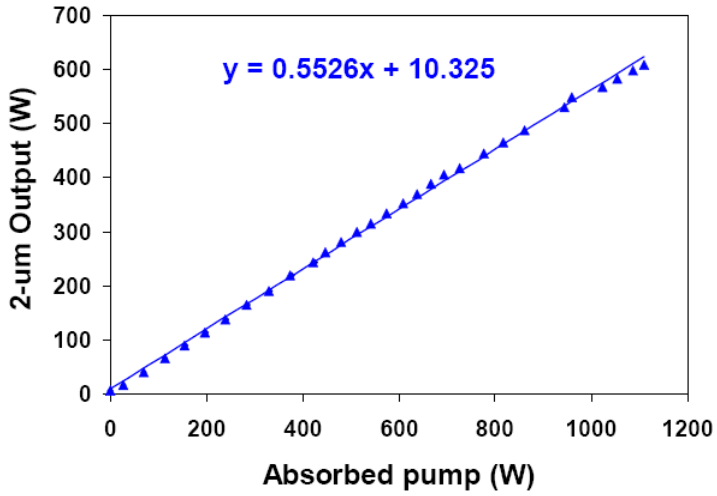
Record powers (885 W) with bigger pumps and spectacular damage

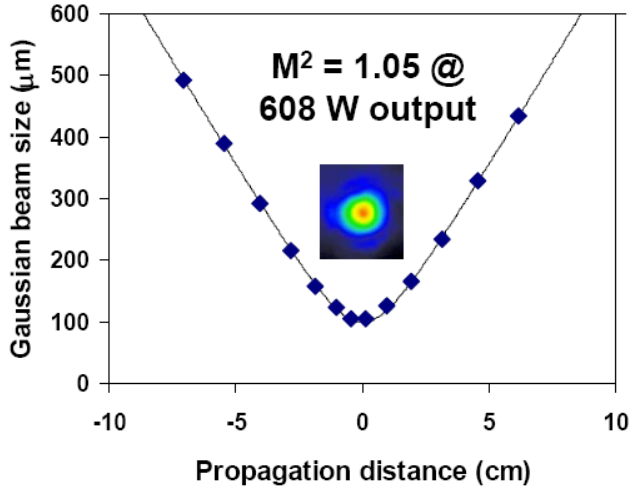




NGAS 600-W Single-frequency MOPA (PW 2009)



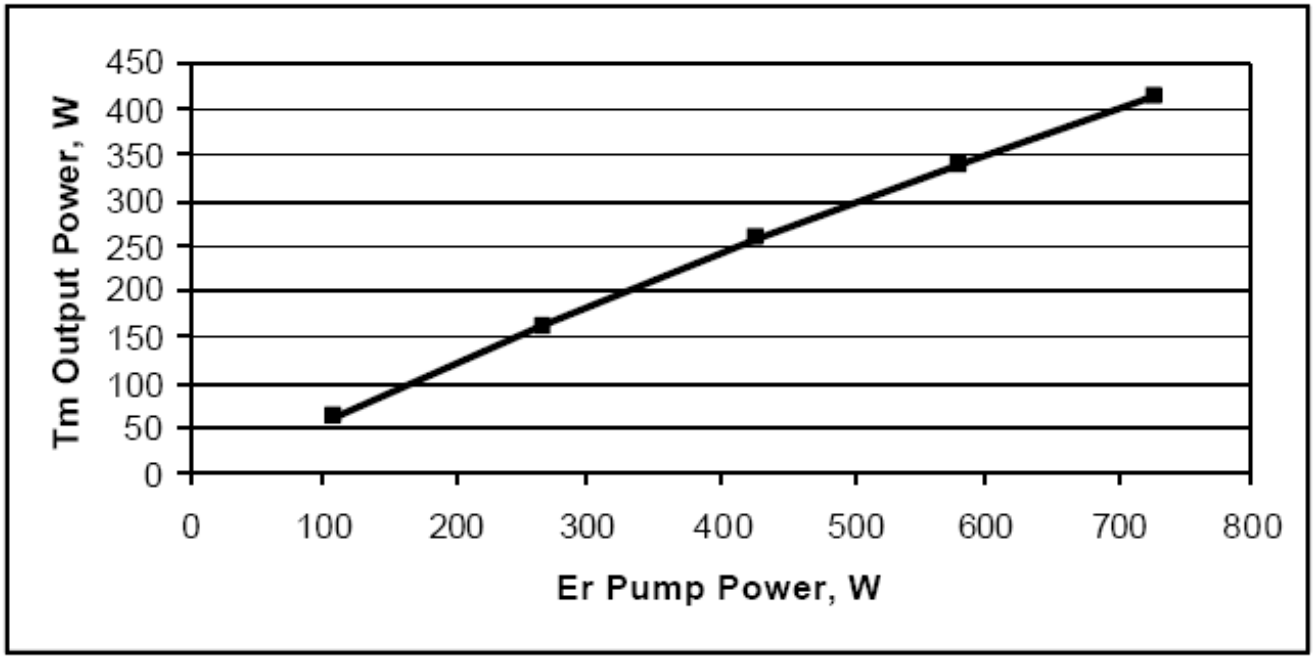




Gregory D. Goodno, Lewis D. Book, and Joshua E. Rothenberg

IPG 415-W all-glass result (CLEO Europe 2007)

The laser setup was consist of an 8 meters of low concentration Tm-doped fiber with core diameter of ~20 mm and a pair of fiber Bragg gratings (FBG), fusion spliced with an active fiber, forming a laser cavity. The output of the Tm fiber laser was terminated by a single-mode fiber with mode field diameter (MFD) of LP01 mode and wavelength of the cutoff of LP11 equal to 14 mm and 1450 nm respectively. The reflectivity of output FBG was ~1dB. The double clad Tm fiber was end-pumped to the cladding through the strong FBG by pump fiber assembly consisting of 18 40W CW Er fiber lasers at 1567nm. The total in-fiber power of this pump assembly output more than 720W CW. The 1567nm pumping of Tm fibers compare to 793nm pumping advantage in no up-conversion processes that leads to fiber degradation due to photodarkening.



M. Meleshkevich, N. Platonov, D. Gapontsev, A. Drozhzhin, V.Sergeev, V.Gapontsev

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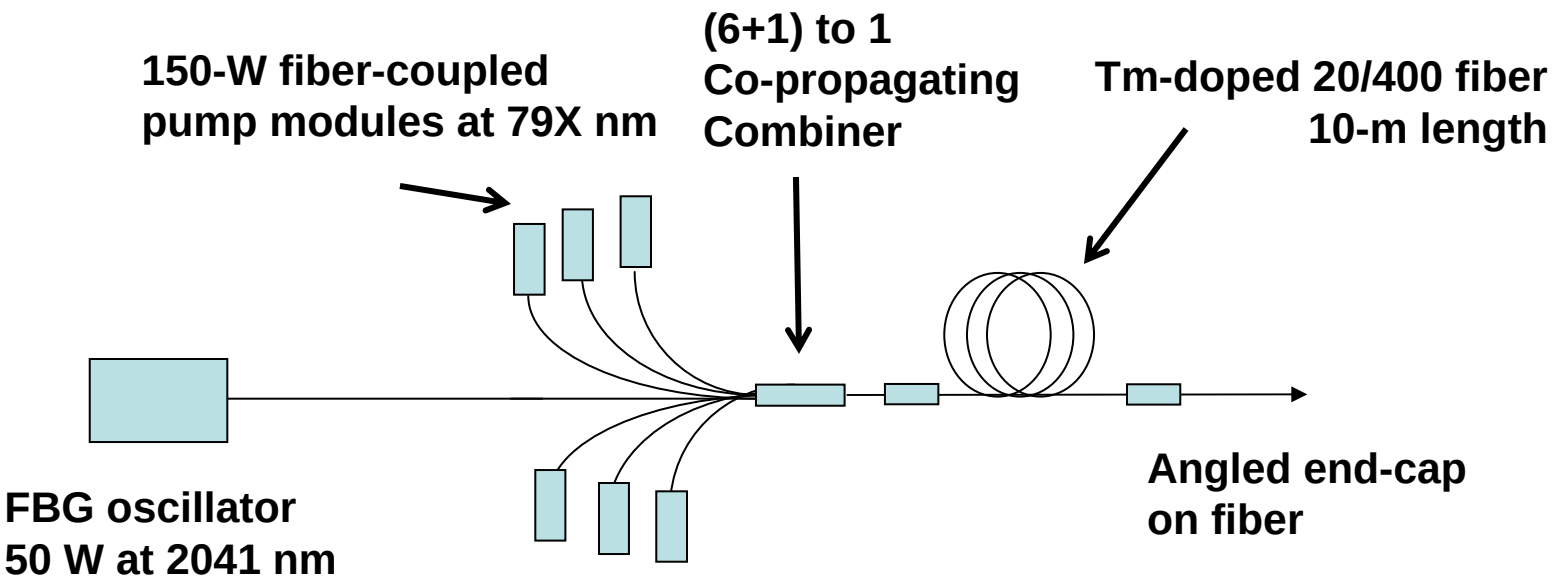
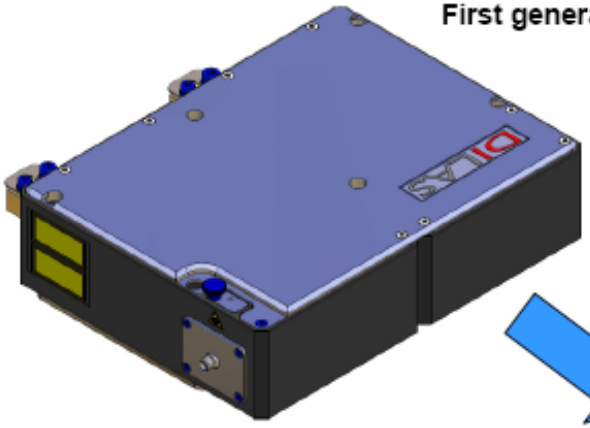
Components for all-glass laser – single stage



Using DILAS “second generation” fiber-coupled diodes

First generation MMF 4x1 module



240 x 180 x 55 mm^3

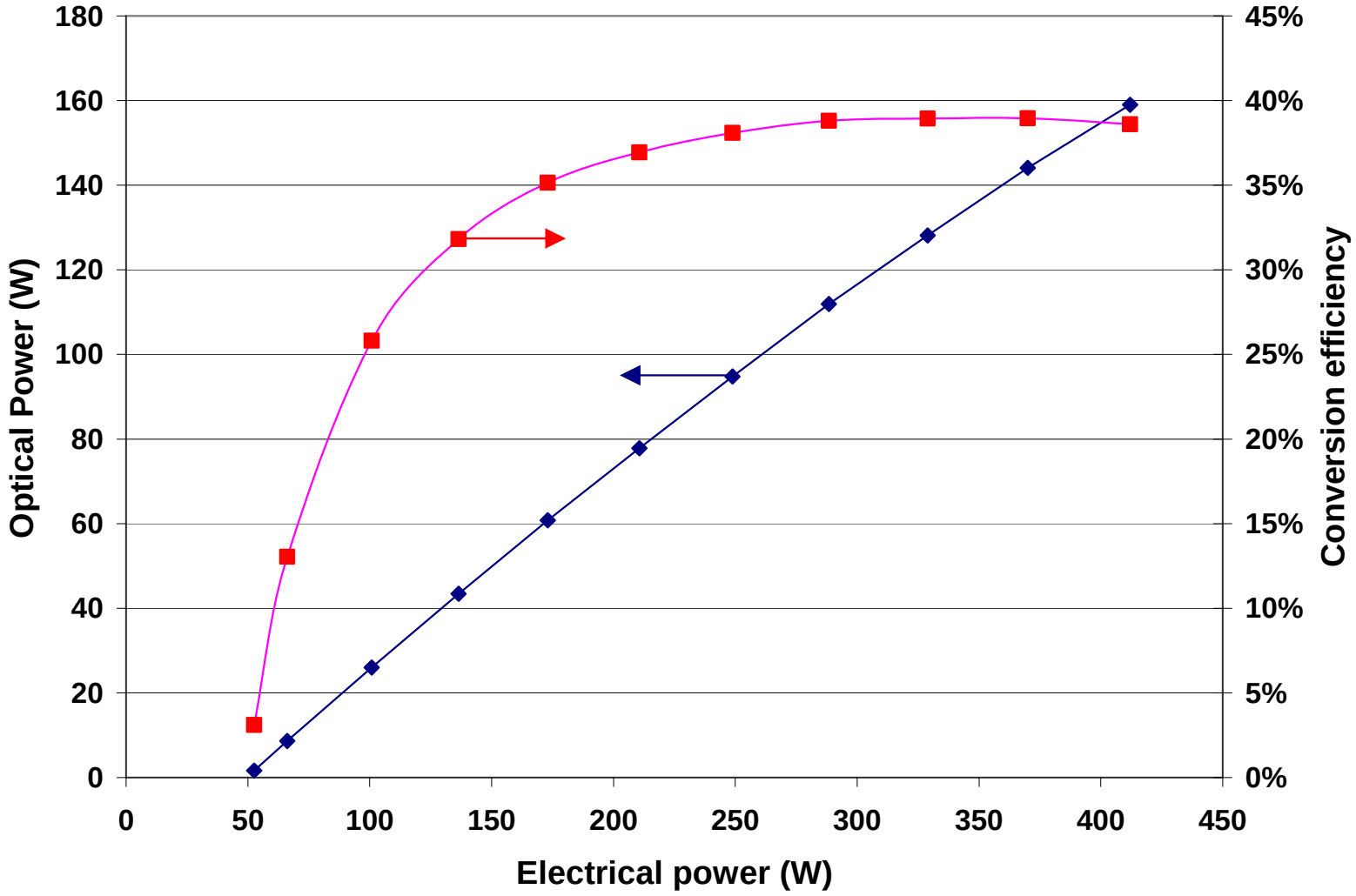
Compact MMF 4x1 Module
IS 5.4

175 x 115 x 37 mm^3

DCB T-Bar Module

140 x 75 x 26 mm^3

DILAS modules have nearly 40% electrical-optical conversion



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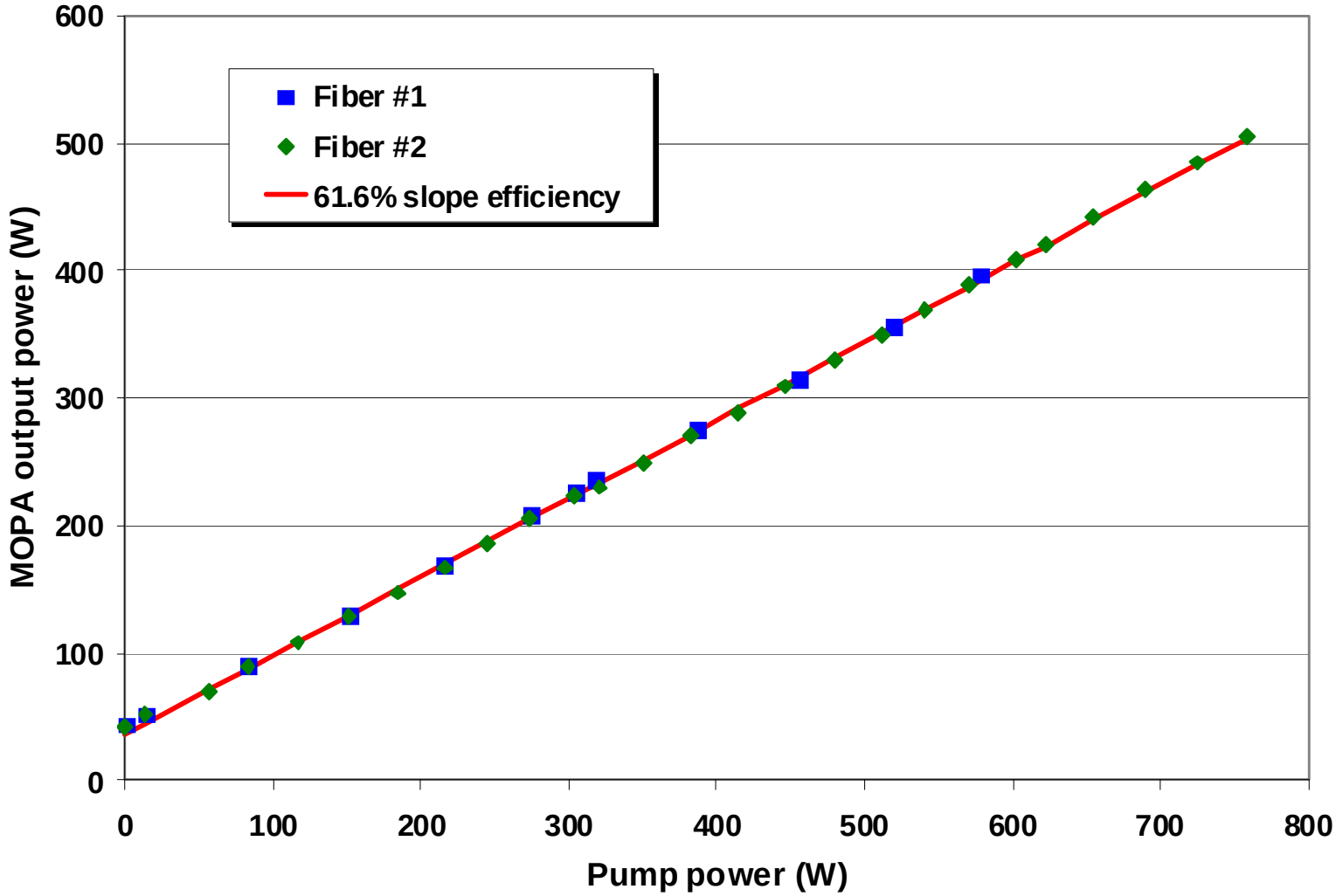
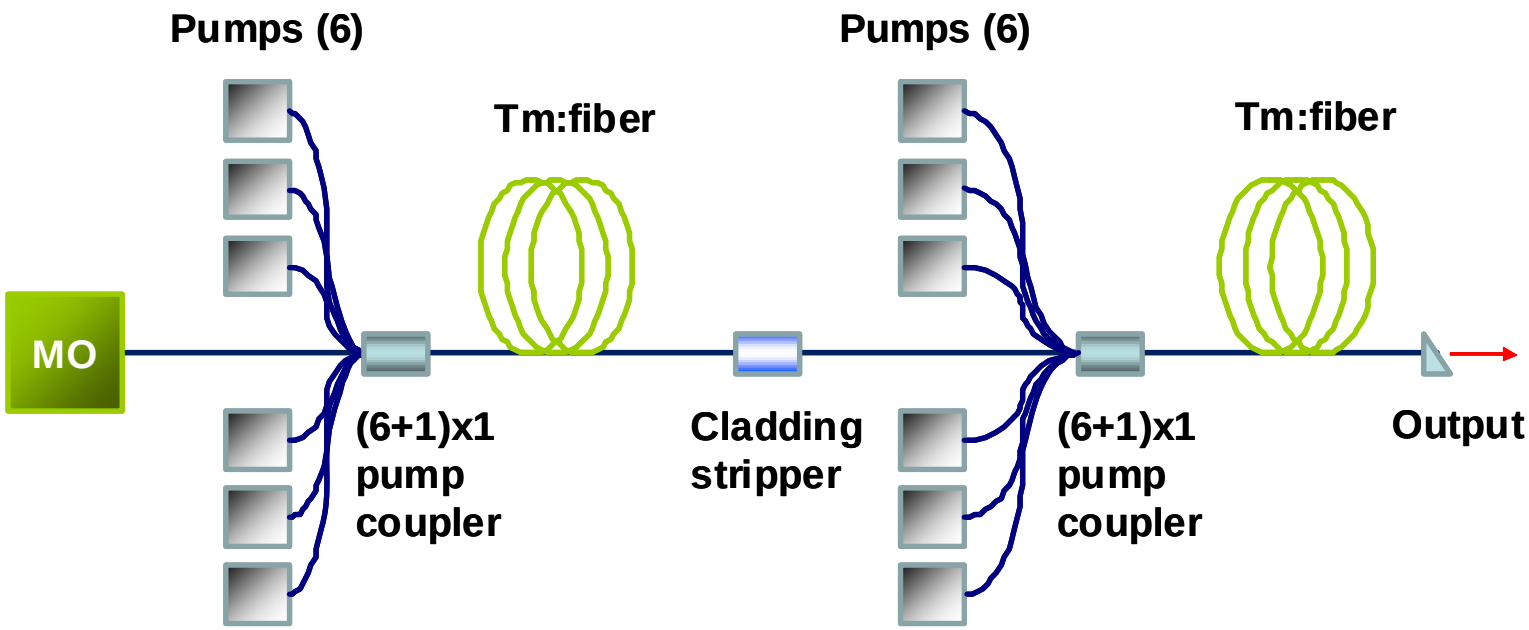
Results from single stage: >500 W



Two-stage power amplifier



MO

50 Watts at 2045-nm

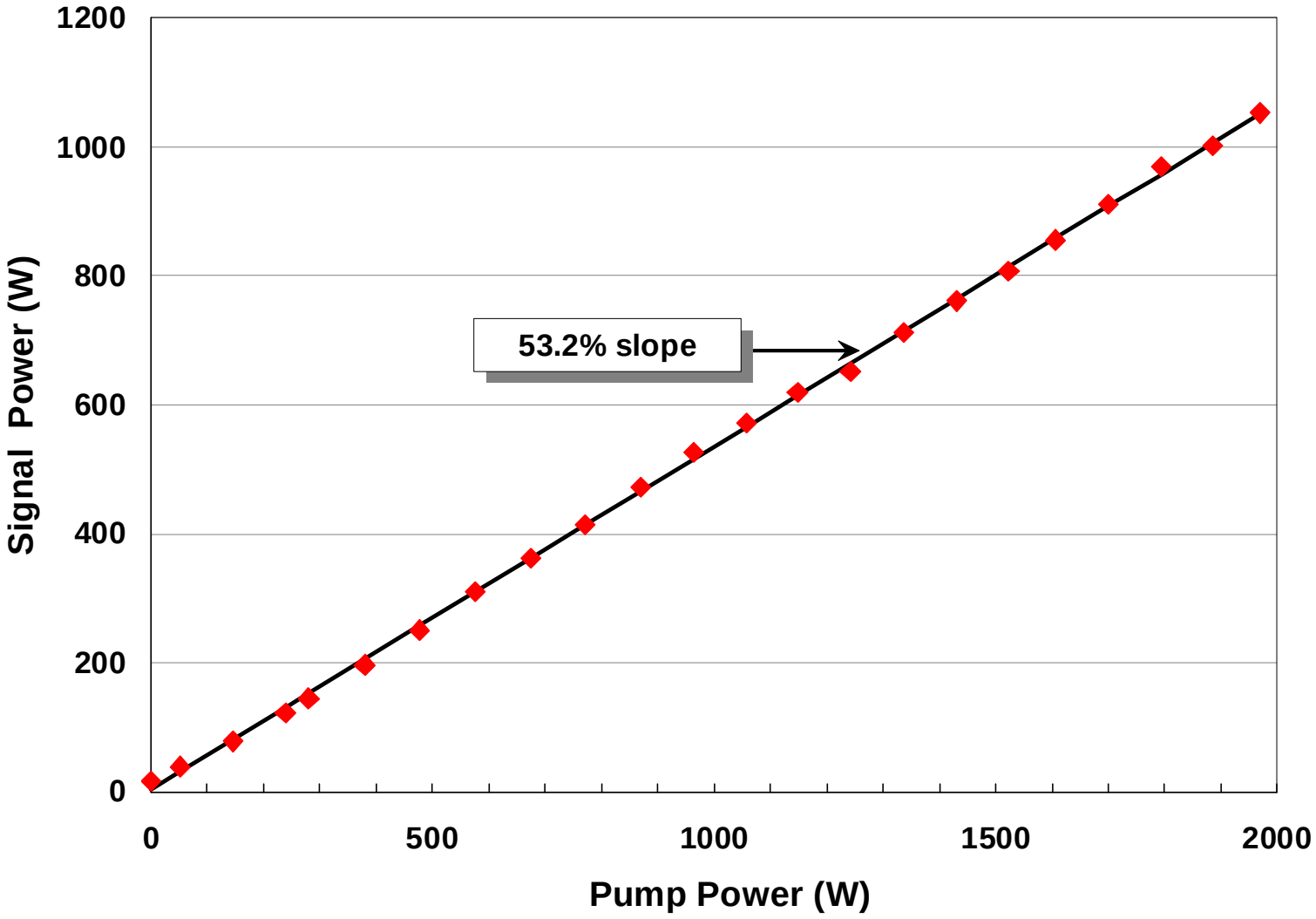
1st Stage

12m LMA-TDF-20/400 active fiber

2nd Stage

12m LMA-TDF-20/400 active fiber

> 1 kW of power output at 2045 nm



Summary

- High-power, “all-glass” operation of a 79X-nm pumped Tm:fiber laser has been made possible by development of:
  - High-brightness, fiber-coupled pump lasers
  - Fiber-based, (6+1):1 pump-coupling optics
- To date, power levels achieved are:
  - > 500 W with six pump lasers
  - > 1 kW with twelve pump lasers
- Based on the fibers used, the results represent single-mode operation at 2045 nm and the highest cw power level (to our knowledge) ever generated in this wavelength range
- Improvements are possible in all of the components, leading to higher powers and efficiencies
- Substantial further scaling of this approach will rely on development of higher-brightness pump lasers