

Design and Construction of a Diode-pumped High Power Laser as a front-end for LIGO II

Martina Brendel

Carsten Fallnich, Maik Frede, Ralf Wilhelm, Ivo Zawischa, Prof. Herbert Welling
Laser Zentrum Hannover e.V.

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Introduction

Front-end

- scheme of a diode-pumped 12W slave laser
- the master laser
- optical output data
- actual mechanical design

Industrial Laser Design

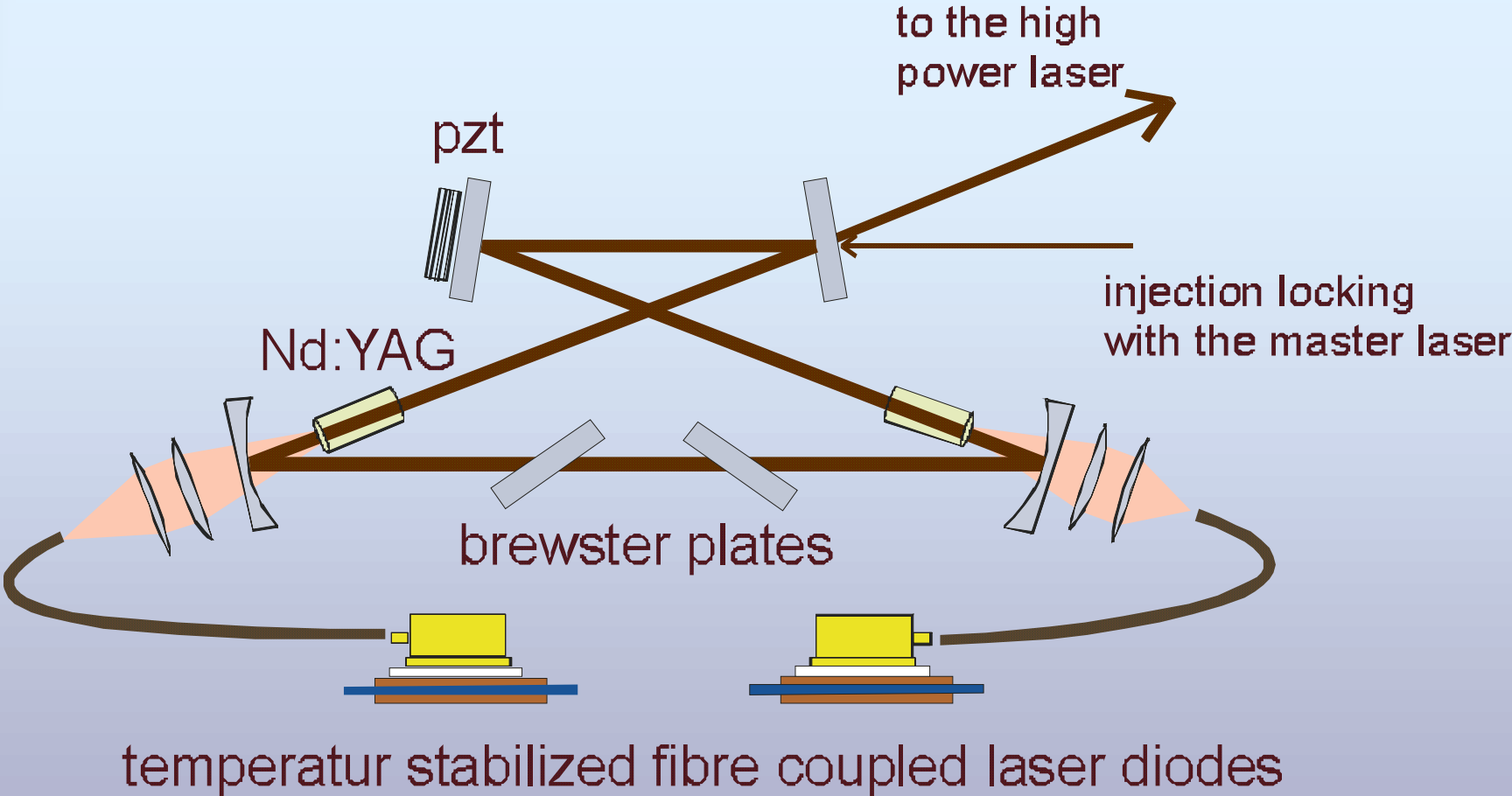
- injection locked system
- integrated laser system

Powerscaling

- by using Nd:YVO
- of the Nd:YAG laser

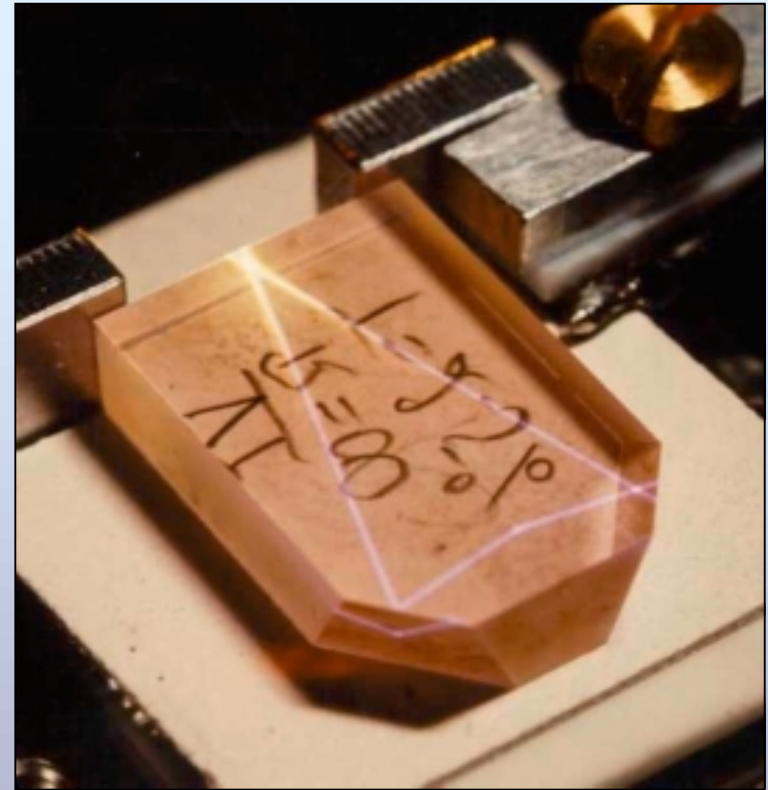
Summary and Outlook

Scheme of a Diode-pumped 12W Slave Laser



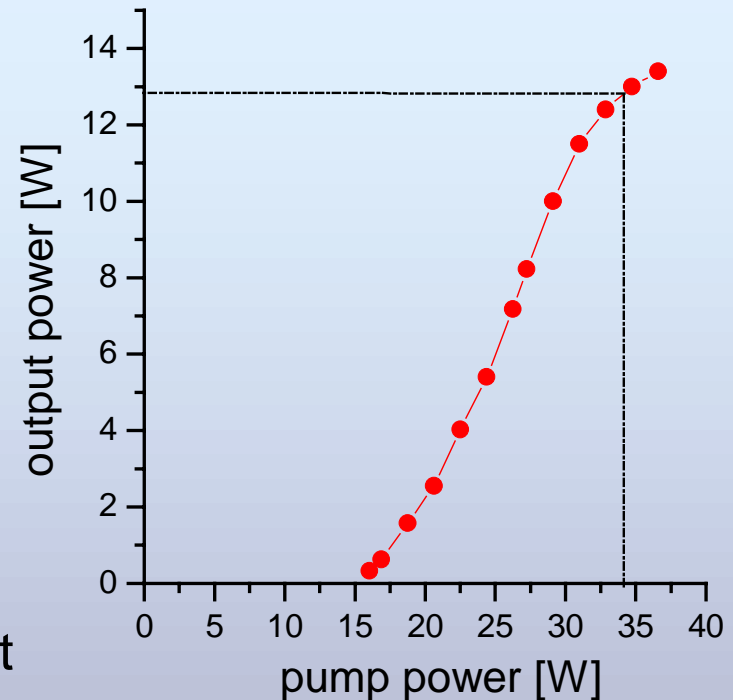
The Master Laser

monolithic Nd:YAG NPRO



Optical Output Data

- Nd:YAG
- TEM₀₀
- > 12 W output power
- single frequency
- > 35 % optical efficiency
- $M^2 < 1.1$
- 300 μm +/- 30 μm output beam waist



Actual Mechanical Design

quasimonolithic

- mechanical stable
- acoustically insensitive

invar steel

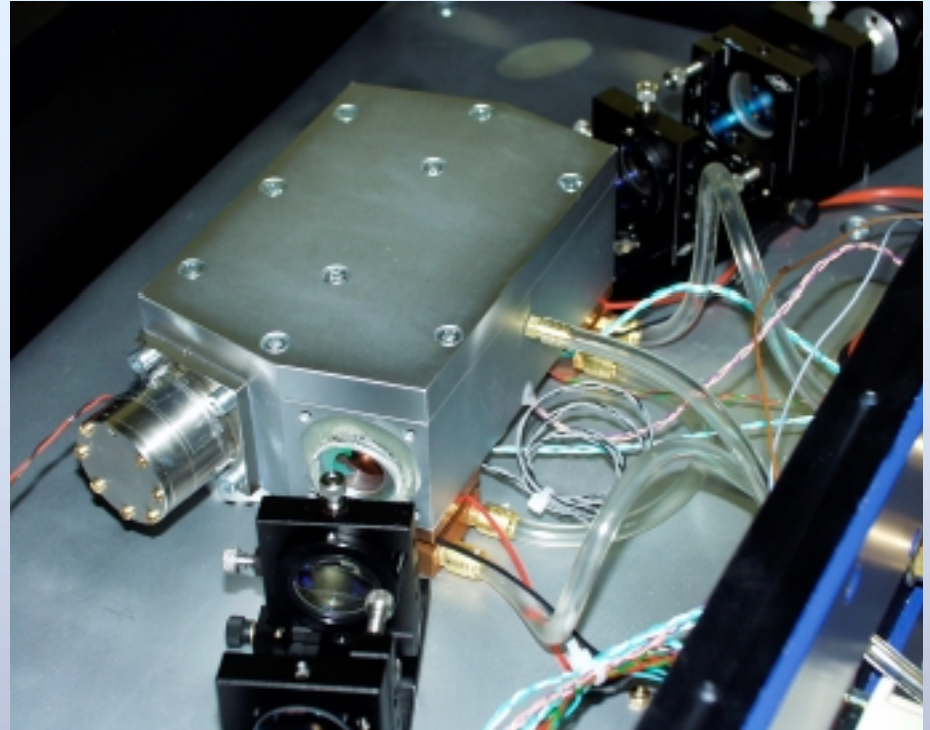
- invar: $\alpha = 8 \times 10^{-7}/K$

piezos

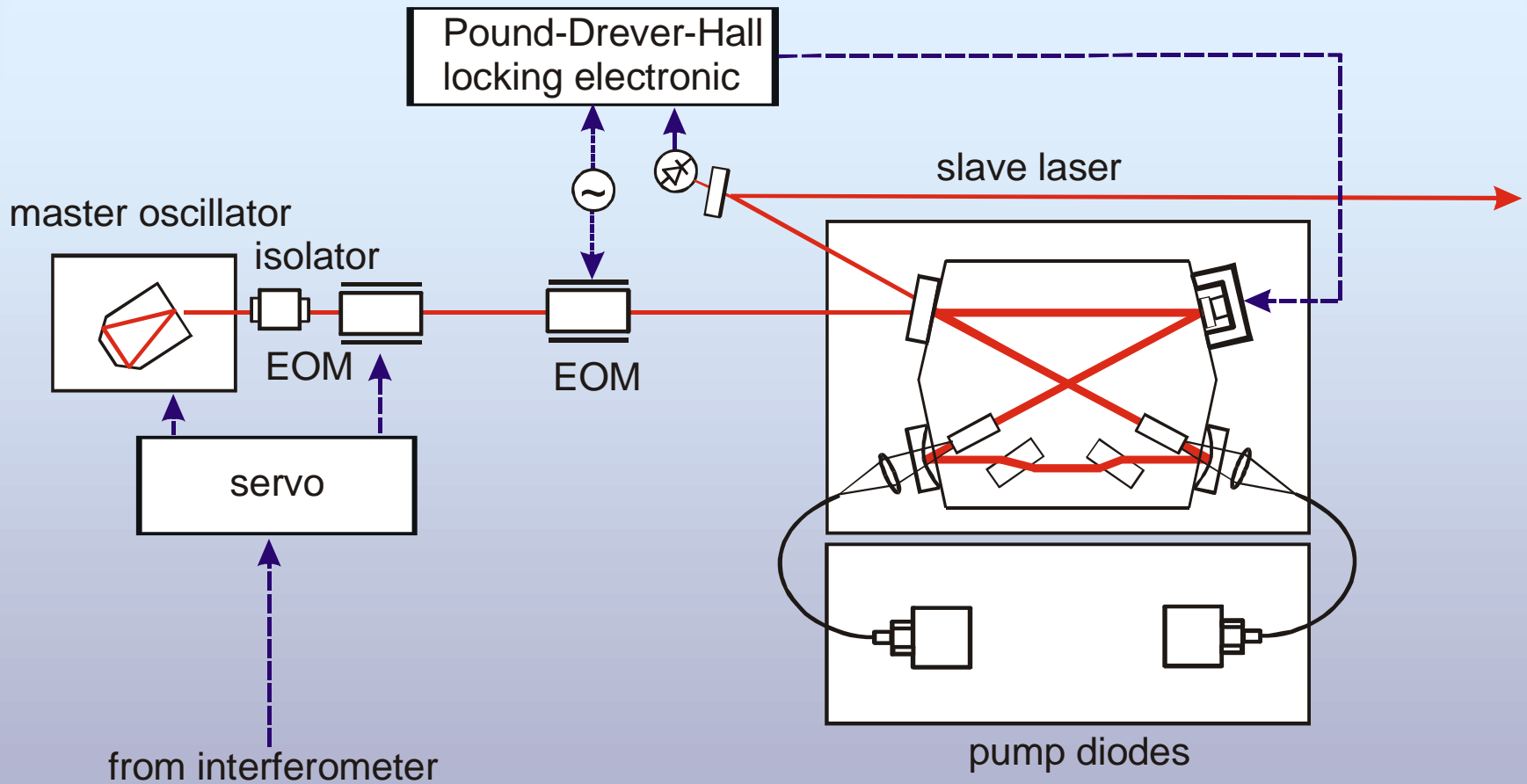
- fast piezo: 0.2 nm / V (VIRGO)
resonances > 300 kHz
- slow piezo: 8 μm / -30 V to 150 V

airtight resonator

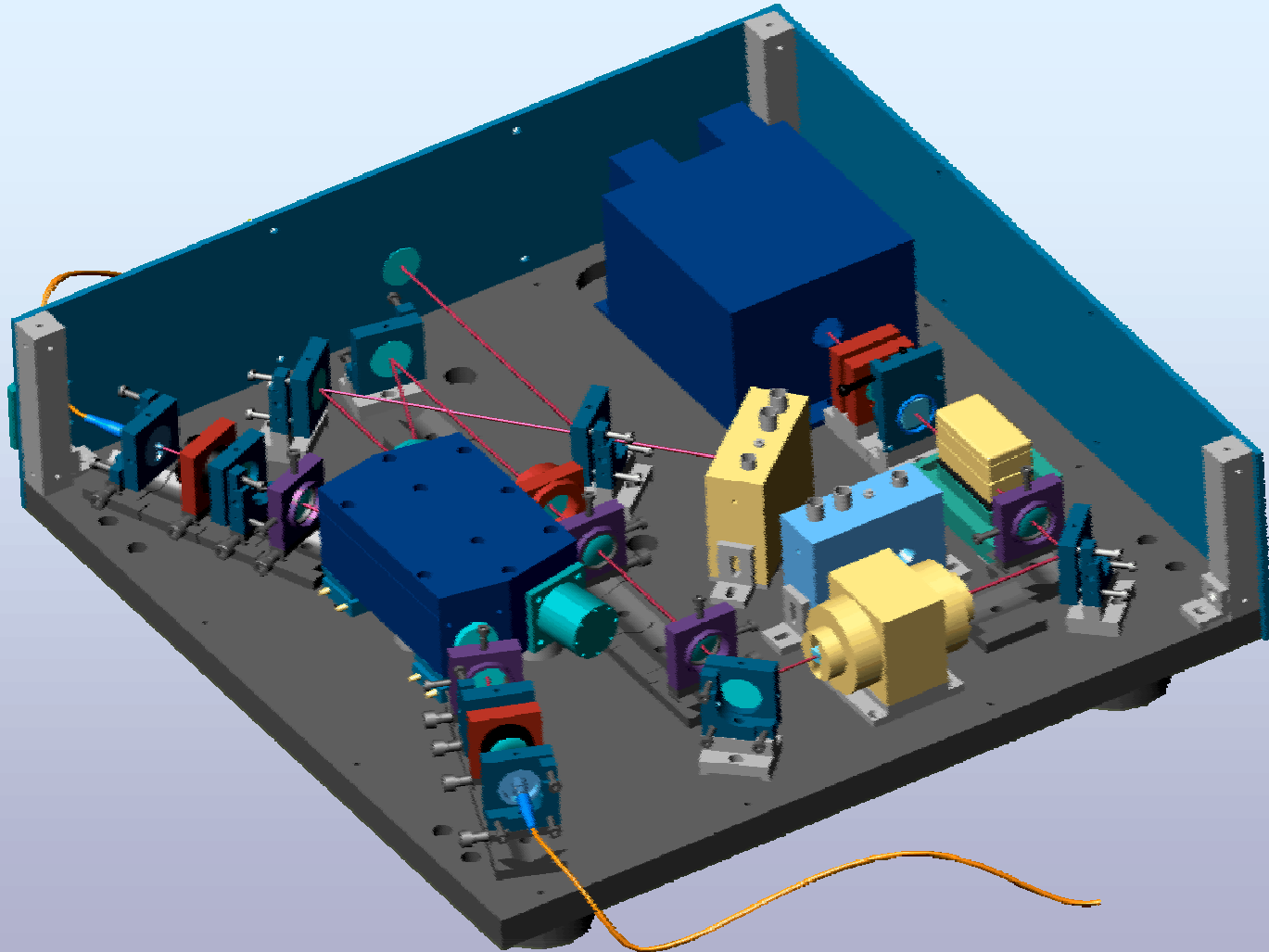
- fixed internal gas density
 - the optical length is determined by the mechanical length of the resonator
- controlled pressure
 - 4 GHz / 50 mbar



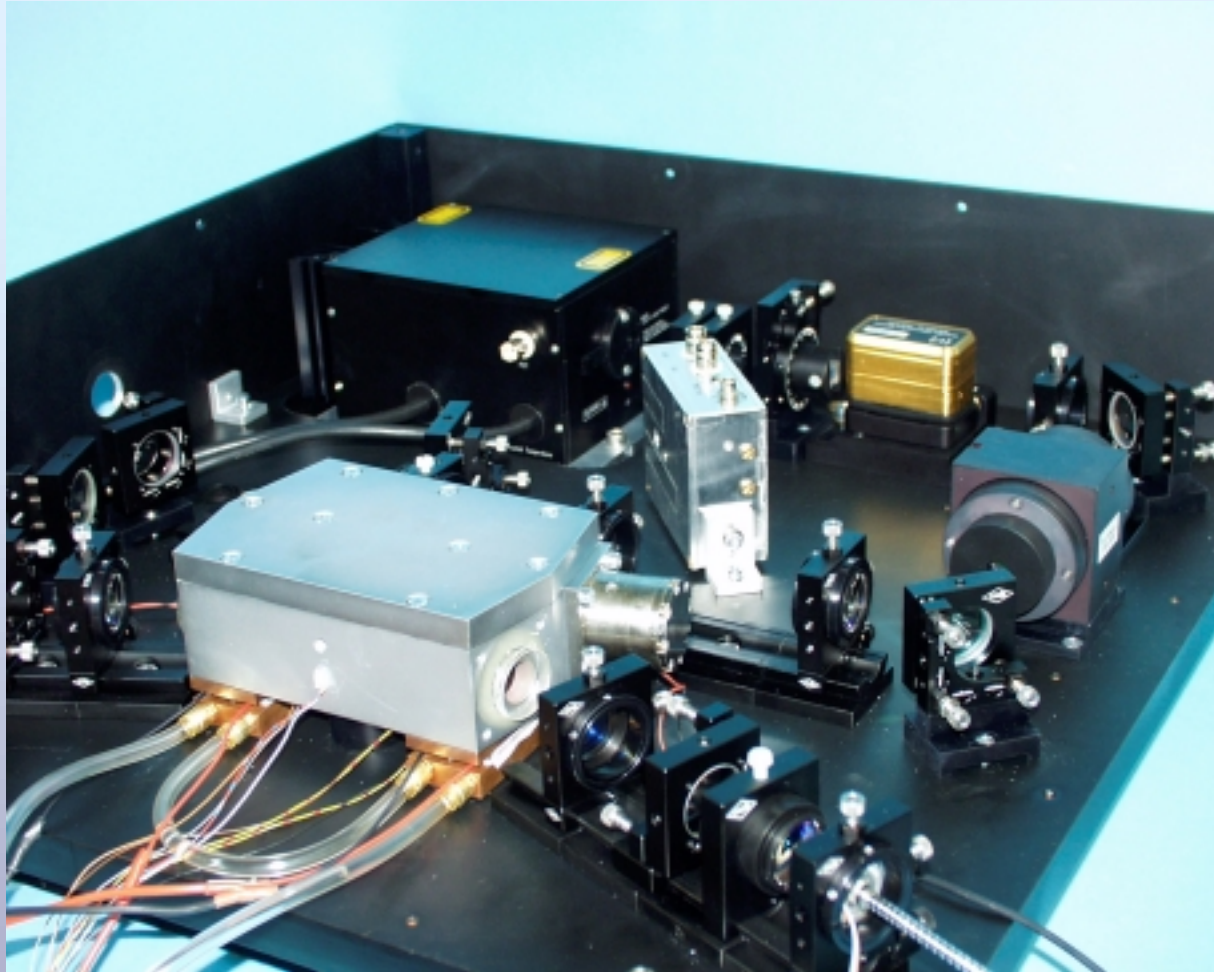
Injection Locked System



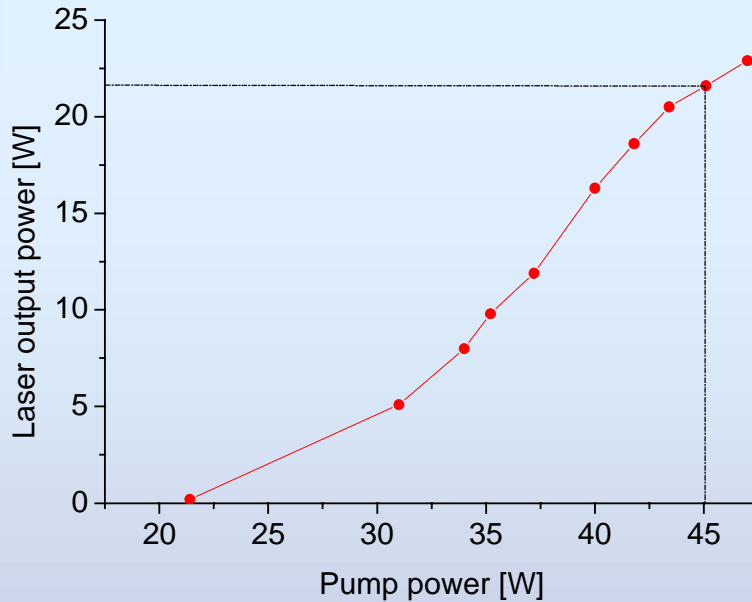
Integrated Laser System



Integrated Laser System



Powerscaling by Using Nd:YVO



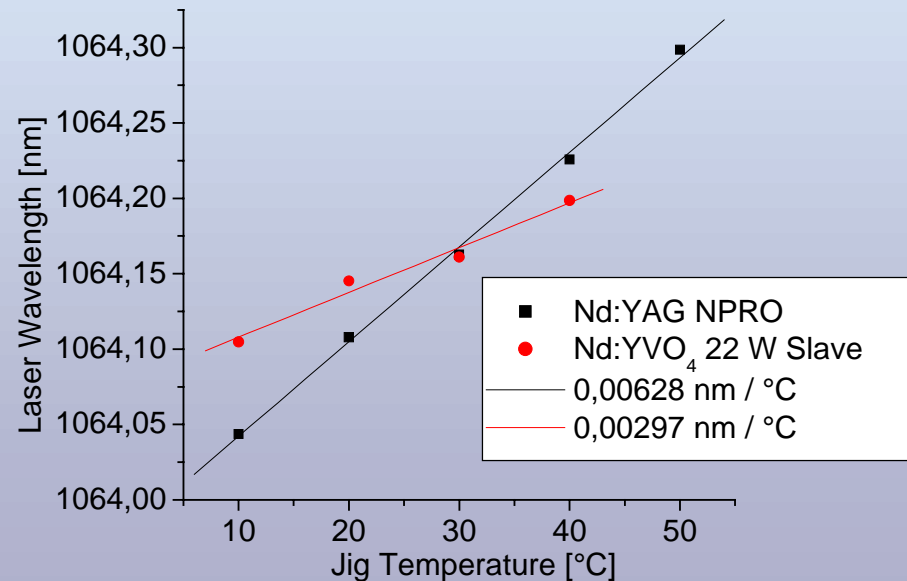
- > 22 W
- single frequency
- 50 % optical efficiency
- $M^2 \approx 1.1$

advantages of Nd:YVO₄

- no depolarization
- broad pump-absorption at 808.5 nm
- high gain

disadvantage of Nd:YVO₄

- small thermal conductivity



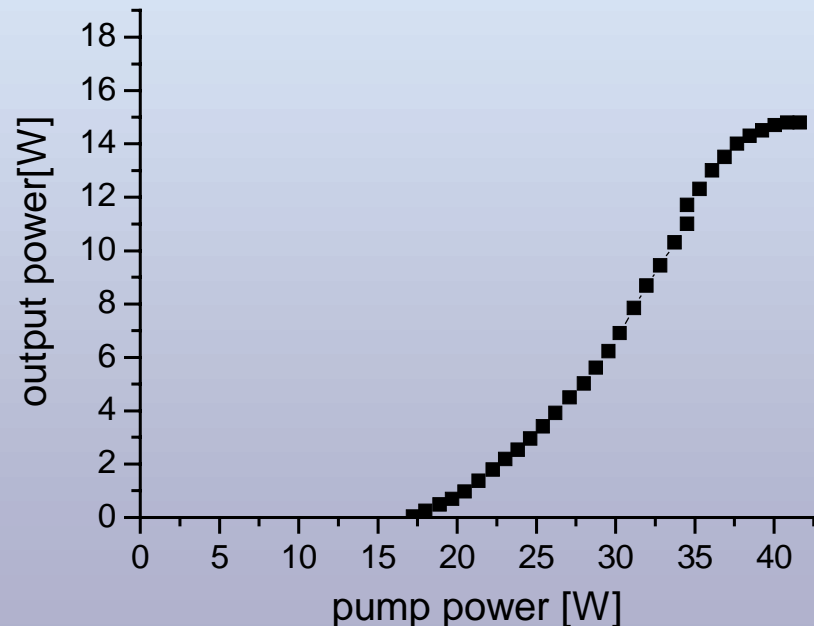
Powerscaling of the Nd:YAG Laser

- bonded Nd:YAG laser rods with undoped end caps
 - about 35 % reduction of the maximum temperature
 - weaker thermal lens

Data from R: Weber et al. IEEE Journal of Quantum Electronics, Vol. 34 (1998)

- resonator redesign

GEO slave with Nd:YAG rods with undoped encaps



Summary and Outlook

- seven laser systems near an industrial design
(2 Prototypes, 3 GEO, 1 VIRGO, 1 industrial customer)
- 22 W Nd:YVO slave laser injection locked to a Nd:YAG master laser
- next step is to design a Nd:YAG slave laser of about 20 W