Effective Pumping Scheme for Nd:YAG Lasers

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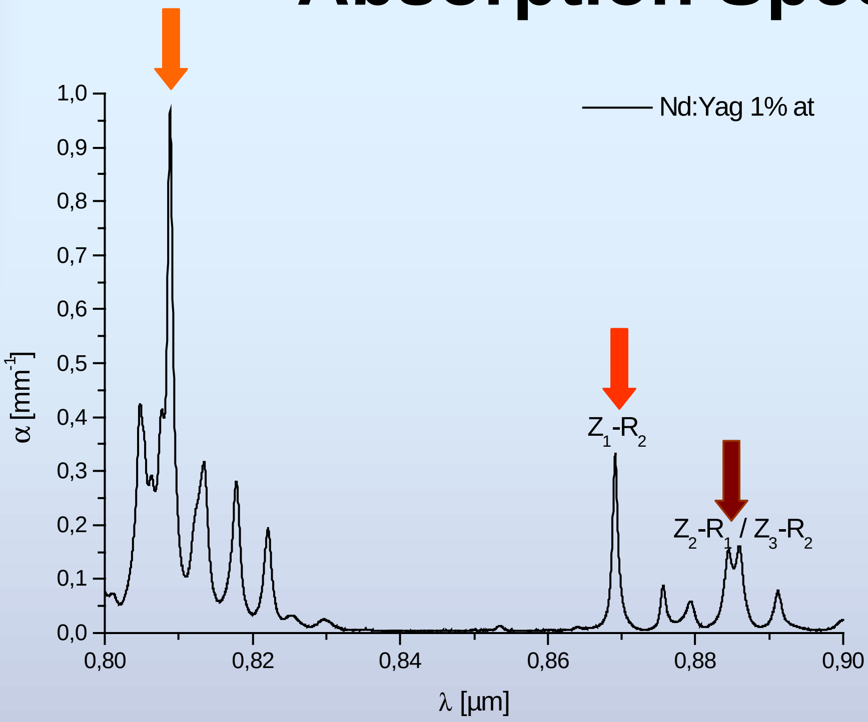
Introduction

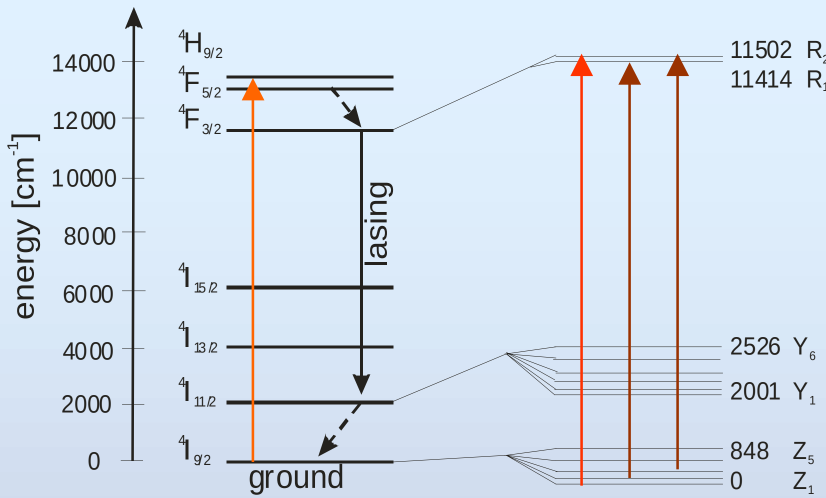
- reduction of thermal effects is one of the main assignments also by diode pumped laser systems
- first intention for high power laser design must be the reduction of heat generation
- prevent thermal load before compensation is necessary

- one possibility is an efficient pumping scheme
  - minimize Stokes factor loss
  - maximize quantum efficiency

➜ direct pumping to the upper lasing level

Absorption Spectrum of Nd:YAG





pumping at 0.885 µm

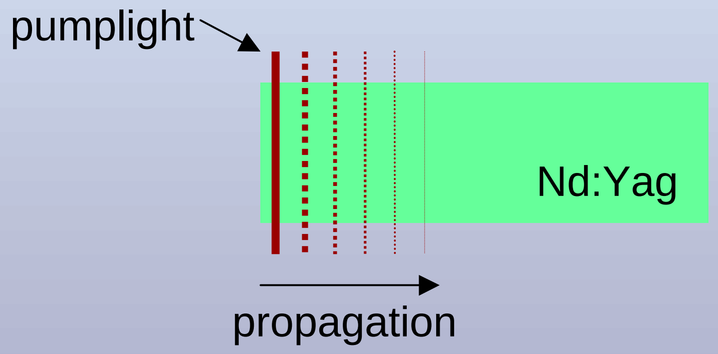
➜ 30% less Stokes shift

➜ higher quantum efficiency [1]

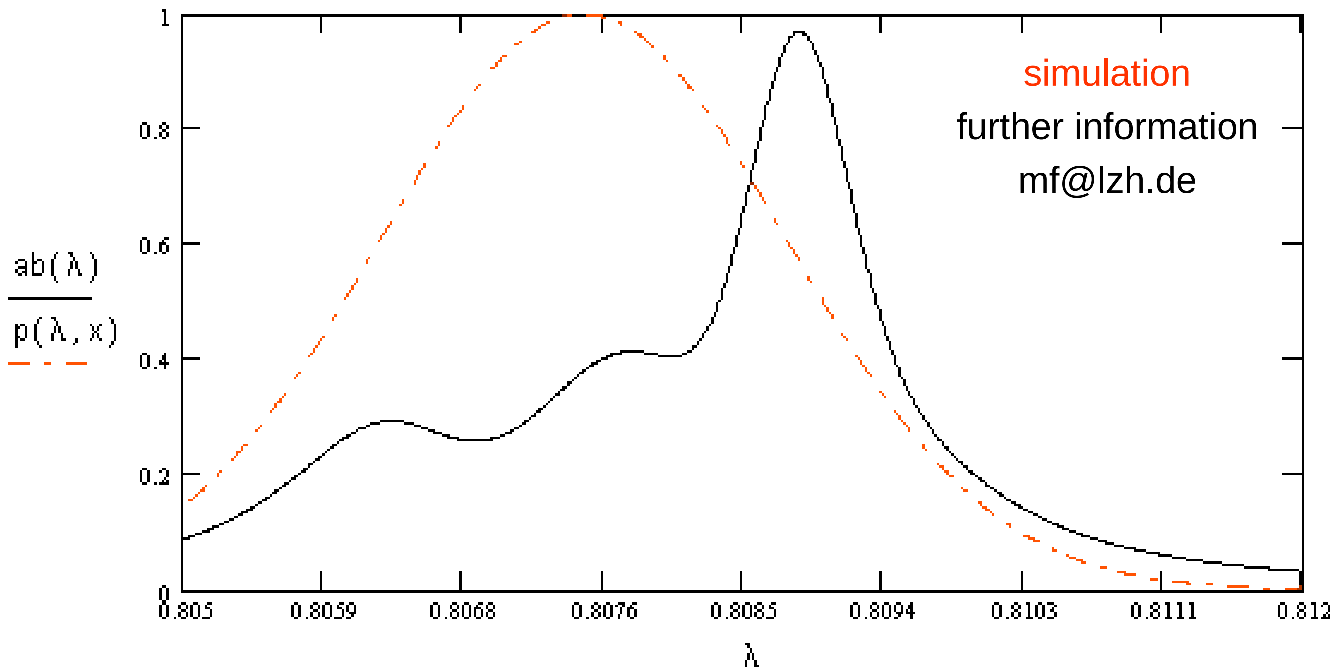
[1] R.Lavi,S.Jackel,Y.Tzuk "Enhanced performance of Nd:YAG by direct pumping from thermally exited ground state levels directly to the upper lasing level."

Effective Absorption by Laser Diode Pumping

- pump light is not monochromatic
- in consideration of the spectral width from the pump diodes the absorption must be a function of these width
- simulating pump light propagation through the laser crystal shows the absorption change



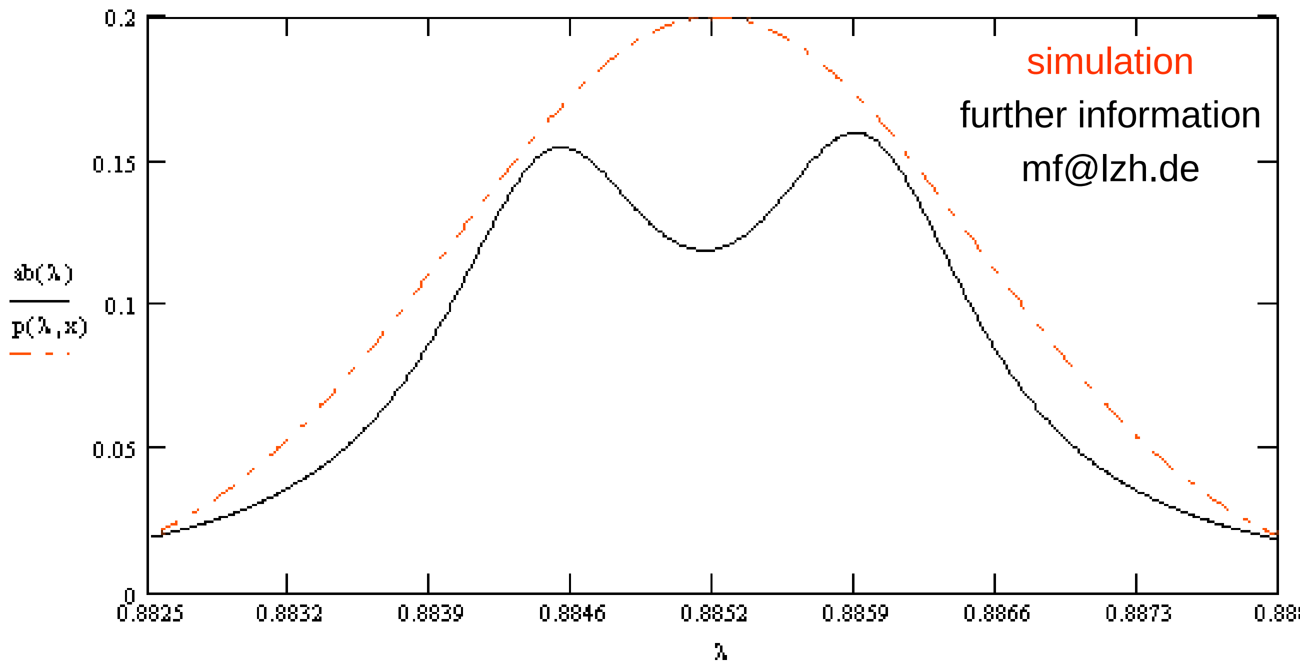
Effective Absorption at 0.807 µm Pumping



effective absorption abeff(x) = 0.404 absorptionlength = 0

absorption coefficients ab(0.8088) = 0.962

Effective Absorption at 0.885 µm Pumping

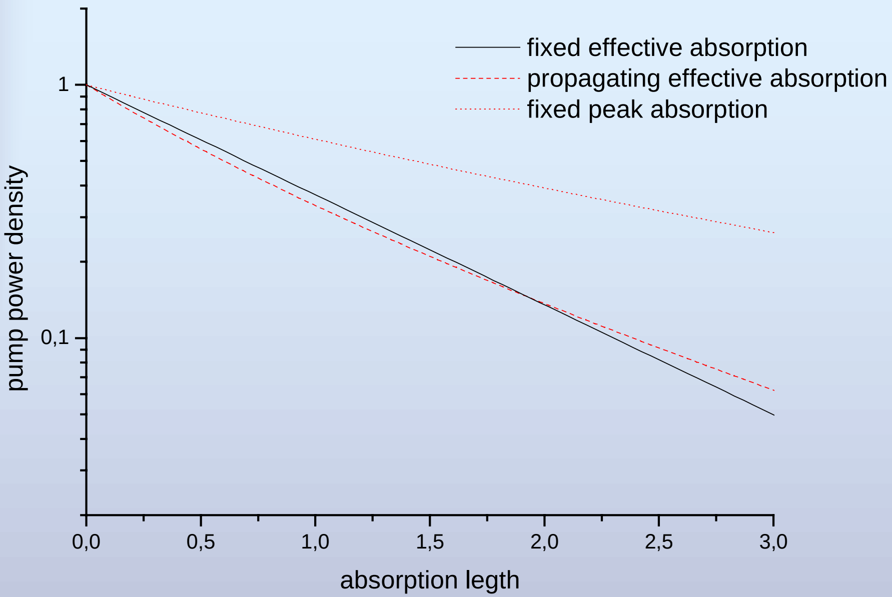


effective absorption abeff(x) = 0.112 absorptionlength = 0

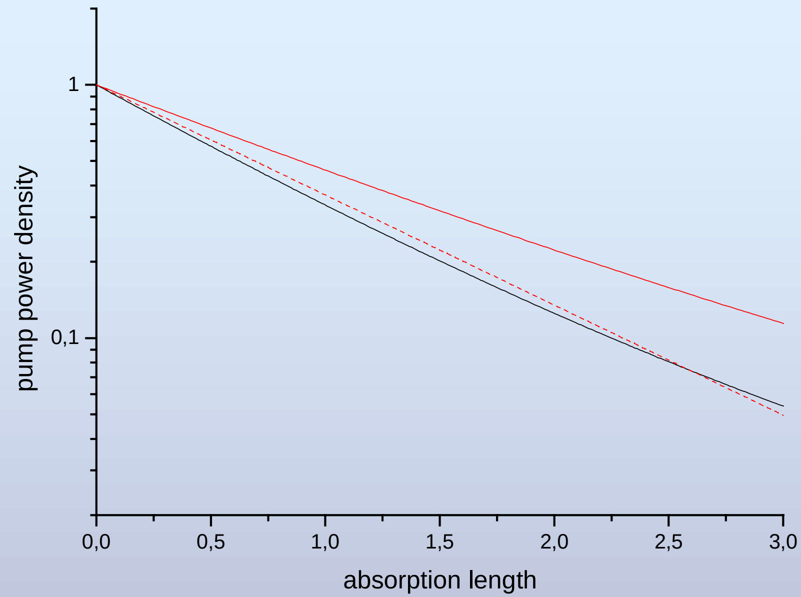
absorption coefficients ab(0.885) = 0.125

Absorbed Pump Power Density

0.807 µm



0.885 µm



➜ calculation with effective absorption is necessary

➜ dependence between fixed and changing absorption is negligible

Availability

- 885 nm pump sources are available from:
  - Coherent — released product
  - Dilas — expected in near future
  - Opto Power — expected in near future
  - Jenoptik — expected in near future

- high doped laser crystals (2% at) to compensate the lower absorption are available from:
  - FEE

Experiments

- fluorescence experiments with a Ti:Sa source shows identically fluorescence spectrum from Nd:YAG at diverent pump wavelength
- the first laser experiments shows maximum laser power at pumping with 885 nm

➜ to investigate if 885 nm pumping is scalable to high power a 885 nm pumping Nd:YAG laser system will be build up

conclusion

- 0.885 µm is a real alternative to traditional 0.808 µm pumping
- a heating reduction of nearly 40% can be achieved
- laser diodes at 0.885 µm are available
- high doped laser crystals to compensate the lower absorption are available

➜ pumping to the upper lasing level can be a real possibility
to scale Nd:Yag laser systems to higher power