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High Power Vanadate lasers

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Aims

1) To develop new *techniques to mount* laser crystals,

2) compare the *lasing properties* (like thermal lens) of two equally doped, high power *Nd:*YVO_4 and *Nd:*$GdVO_4$ lasers,

3) build a 1 μm vanadate laser with average output power exceeding 100W,

4) build a 1.3 μm vanadate laser with average output power of around 30 to 50 W.

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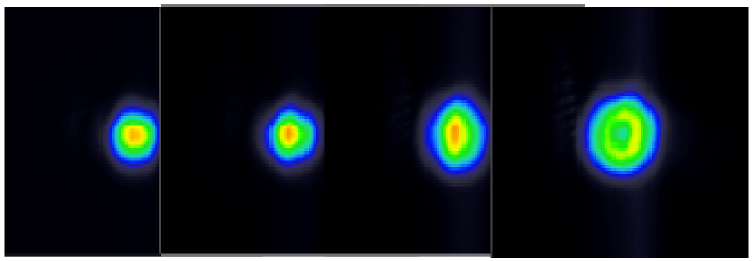
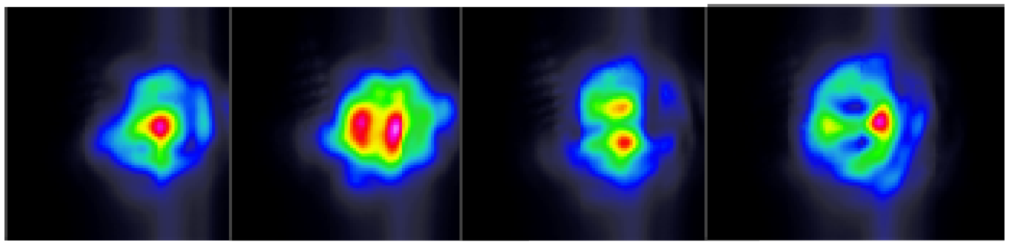
Motivation

1) Poor thermal contact between crystal and mount →
   stronger thermal lenses and thermal stress →
   bad beams and / or crystal damage.

2) $Nd{:}GdVO_4$ spectrally very close to $Nd{:}YVO_4$.
   Much uncertainty about the thermal properties →
   Directly comparing two equally doped crystals
   under lasing conditions will contribute to this debate.





3) No end-pumped vanadate the 100W range.

4) There is a strong interest in this for numerous applications in industry and the medical field. End-pumped vanadate lasers are a good candidate, especially for Q-switched lasers.

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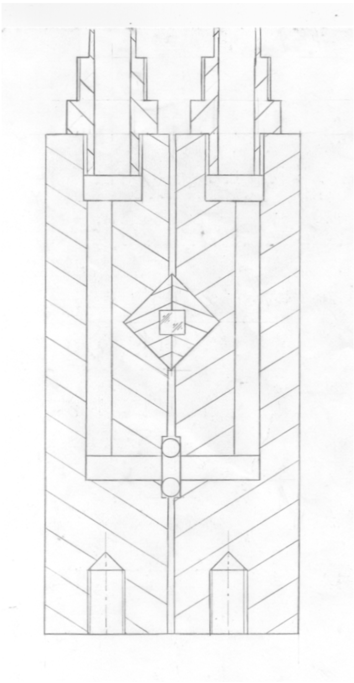
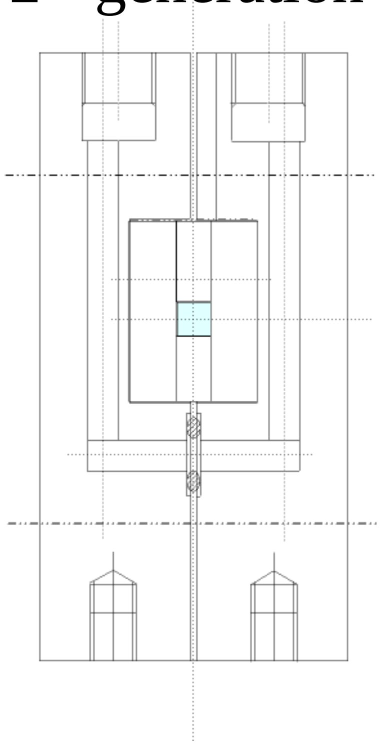
Mounts

1st generation



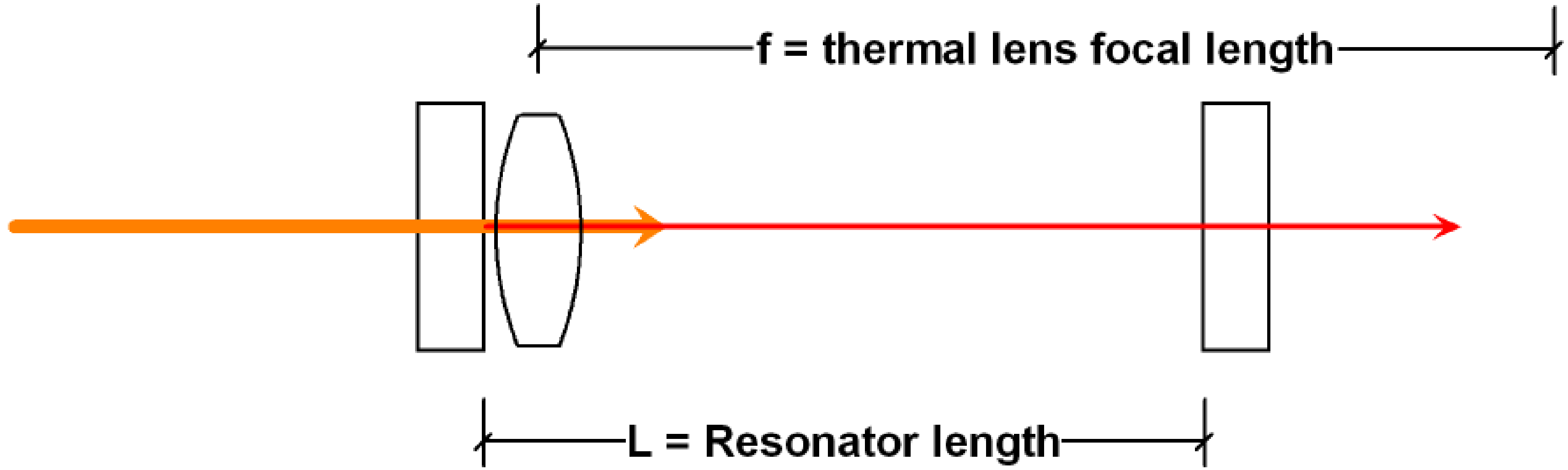
2nd generation



- Low temp. solder (~ 93ºC)
- Silver thermal epoxy (~ 80ºC)

- Indium between mounts
- Silver thermal epoxy in crystal mount

Thermal lens measurements



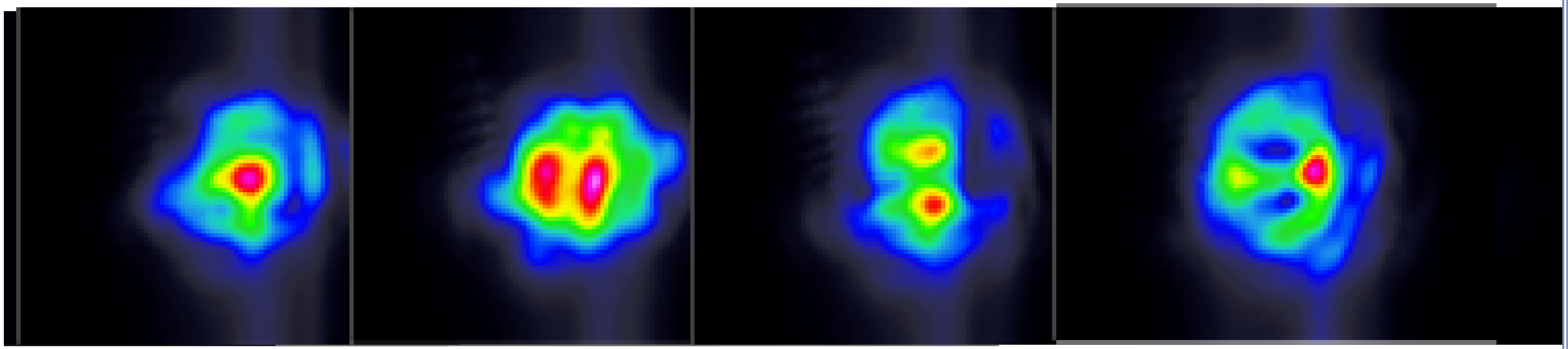
•Resonator unstable if f = L

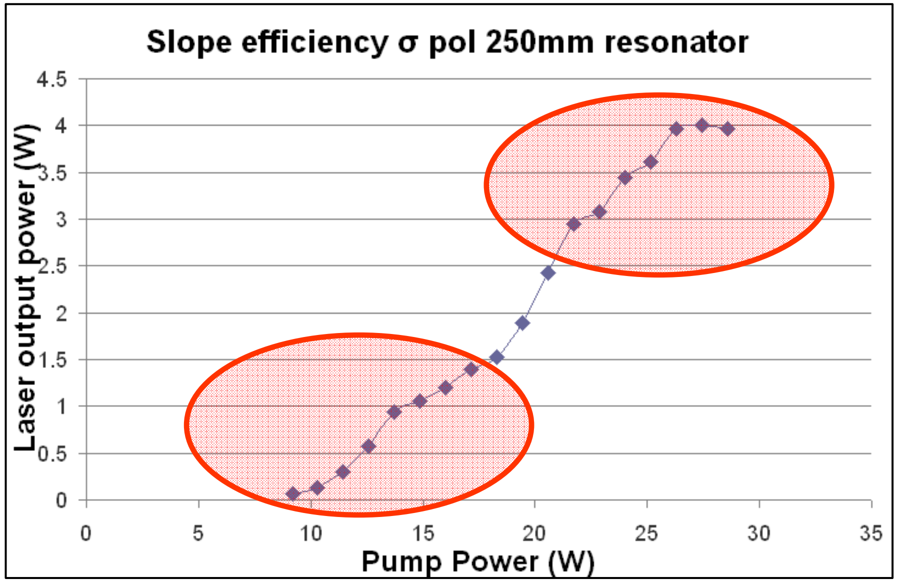
•Can determine the thermal lens focal length at various pump power levels by varying the resonator length

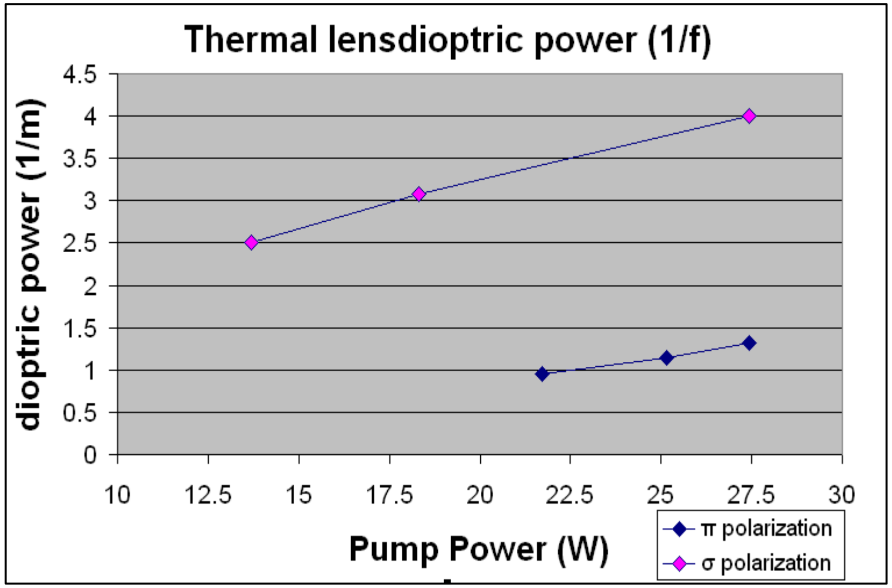
•Take slope efficiencies and monitor the exit beam with camera*

*M.J. Daniel Esser et al.

Current Results: Output beam thermal lens







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High Power vanadate laser

1) Pump two laser crystals from both sides using a 140W diode pump (2 beams) and two 75W pumps.

2) Mount crystals perpendicular to each other.

3) The crystals have to be very close because of their large thermal lenses, to keep the beam diameter roughly equal in both.

4) High Average Power at 1 and 1.3 μm and is expected to exceed 100W and 40W respectively

6) The laser can be also pulsed by using an Acousto-Optic Modulator (AOM) to produce high energy pulses.

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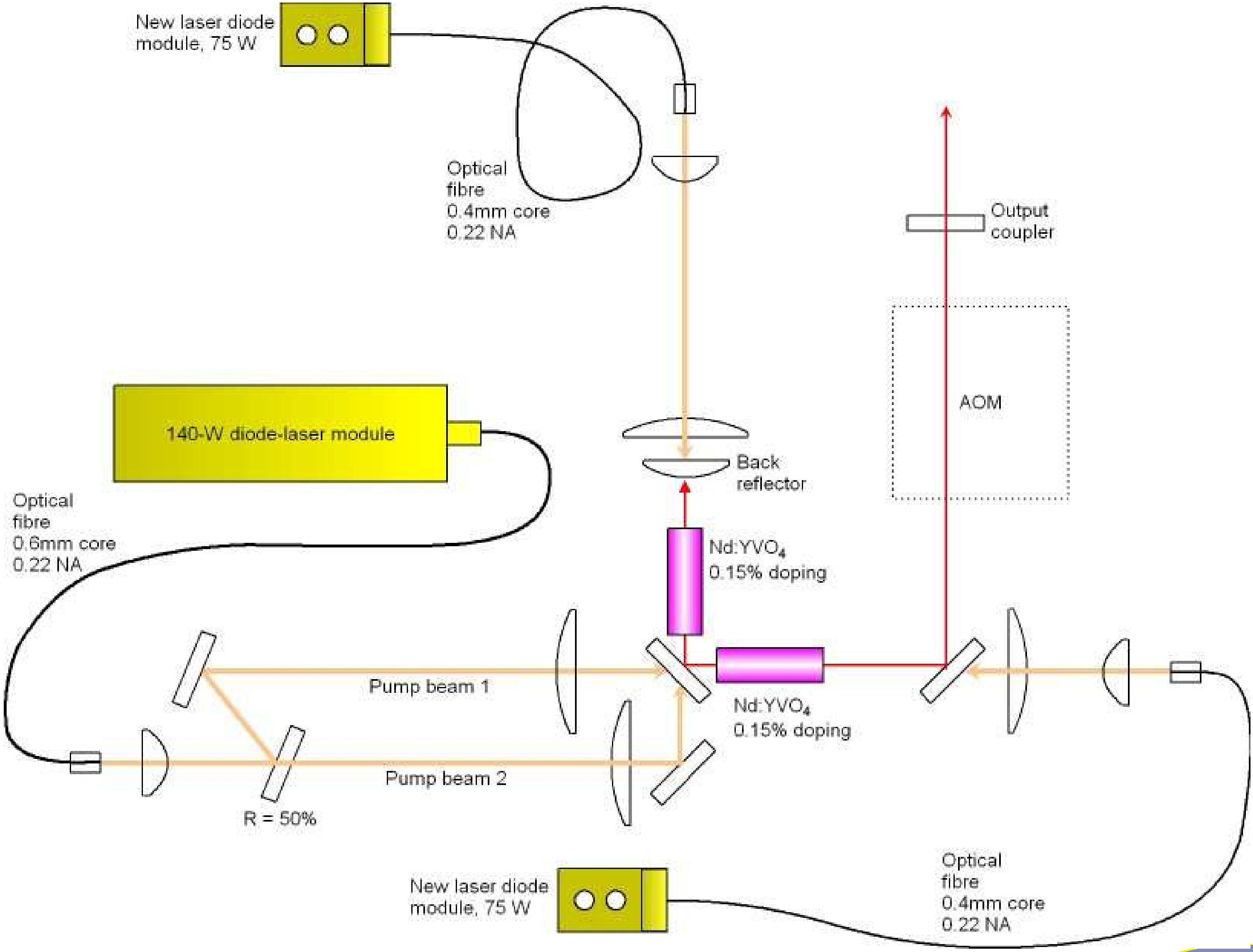
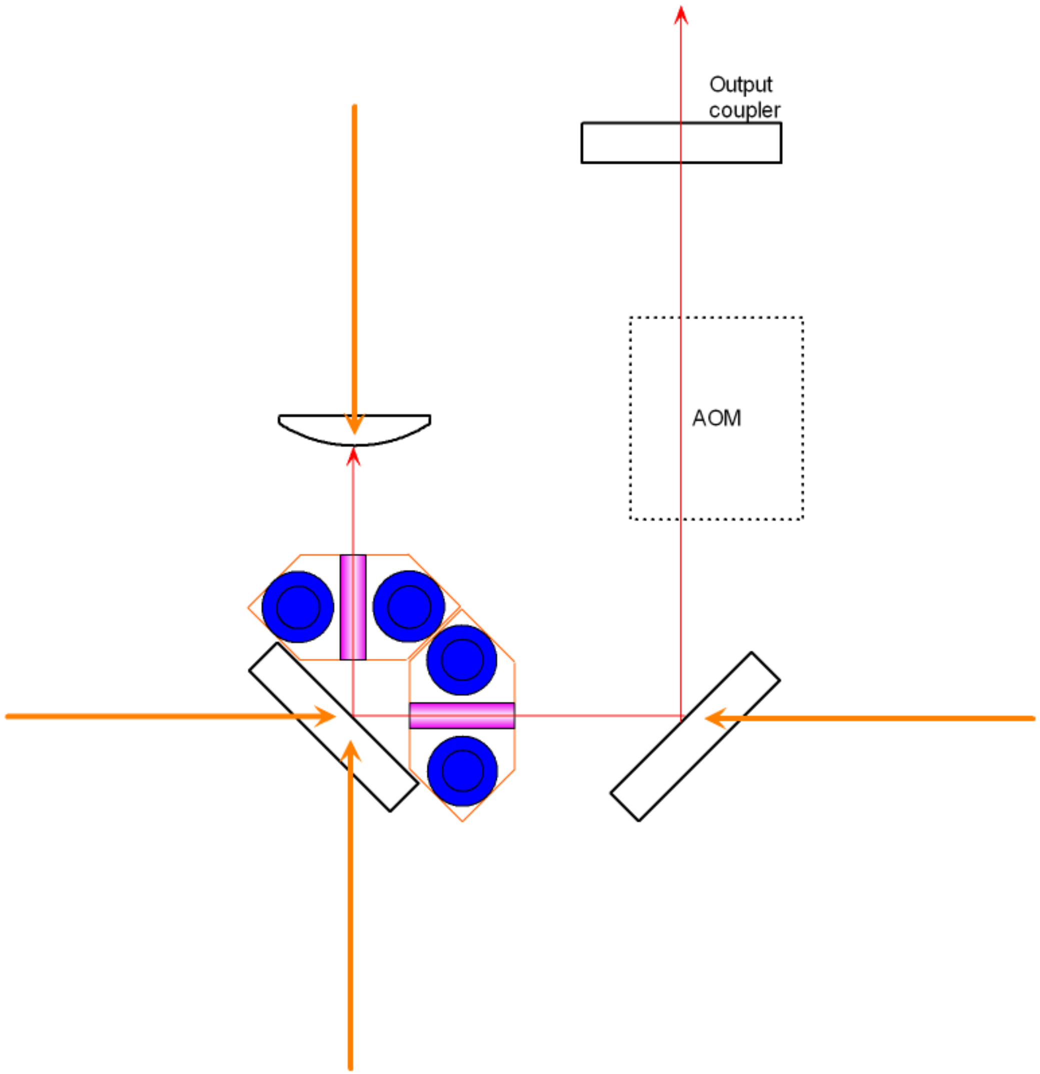
Layout for the High Power vanadate laser



Mount positions in resonator



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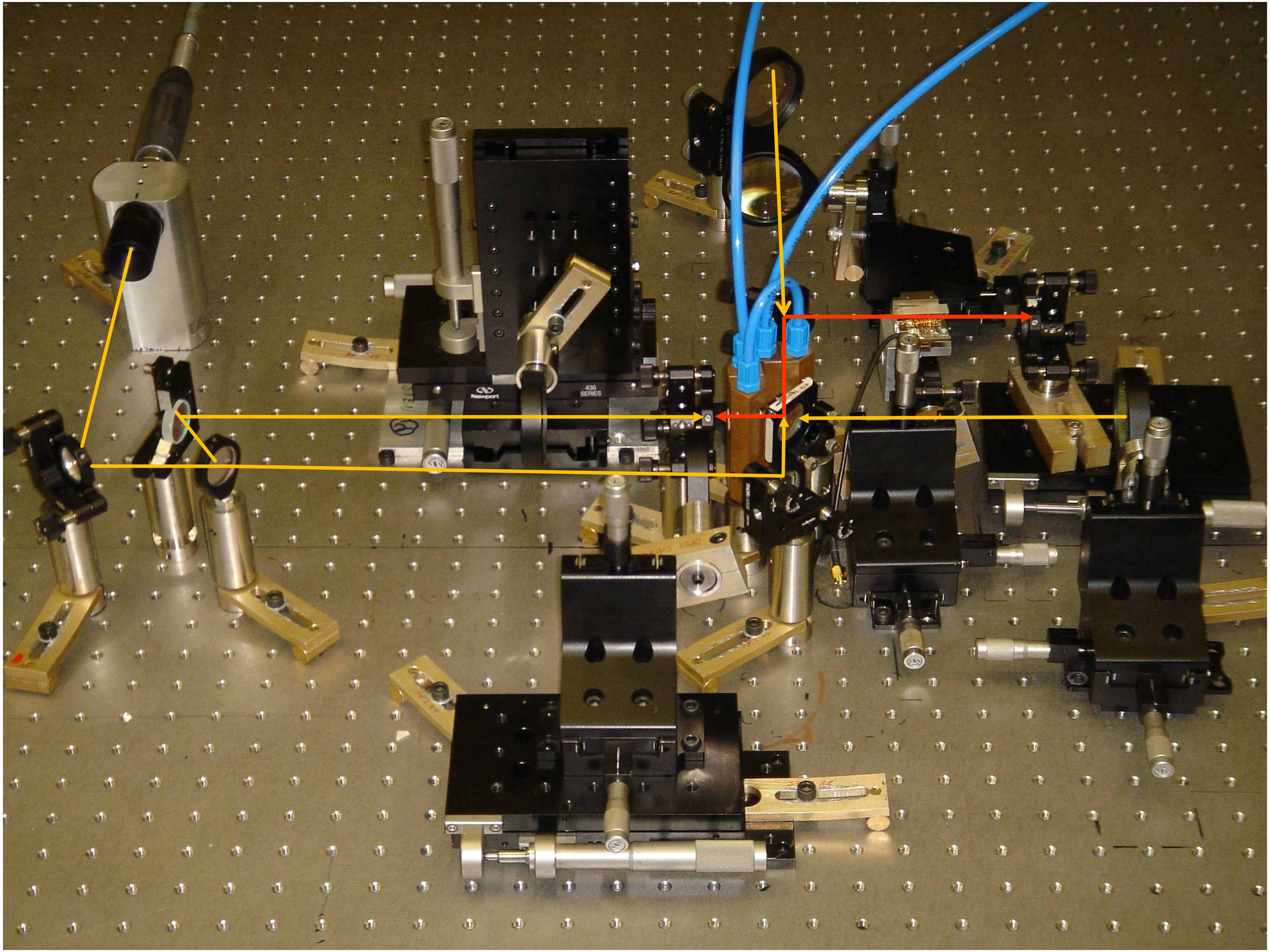
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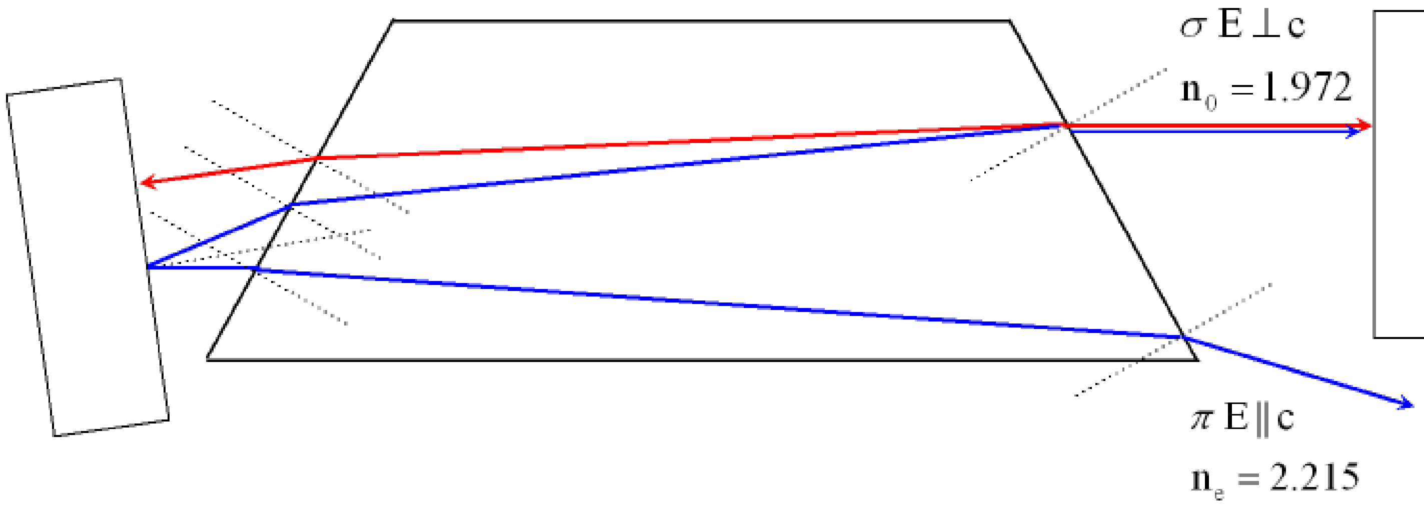
Polarization line selection of vanadate crystals

If a birefringent laser crystal has a wedge and is cut correctly the two polarizations can be spatially separated.

Only one polarization can therefore be aligned in the resonator



Conclusions

1) New mounting techniques have been developed for square crystals.

2) Thermal lens measurements- a direct comparison between $Nd:YVO_4$ and $Nd:GdVO_4$'s thermal properties during lasing can be made at two important wavelengths.

3) Pi-polarisation → Weakest thermal lens → Ideal for high output power levels

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Future Work

- Determine the thermal lens focal lengths over a wider range of pump powers and for 1 and 1.3 μm and better method: beam scanner
- Compare the thermal lens behavior of $Nd:GdVO_4$ and $Nd:YVO_4$ at both polarizations.
- Build high average power and high energy vanadate lasers
- Waiting for: 2nd generation crystal mounts
power supplies for 75W diode pumps

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Acknowledgements

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