58th Annual Conference of the SA Institute of Physics
University of Zululand, Richardsbay Campus
8 – 12 July 2013

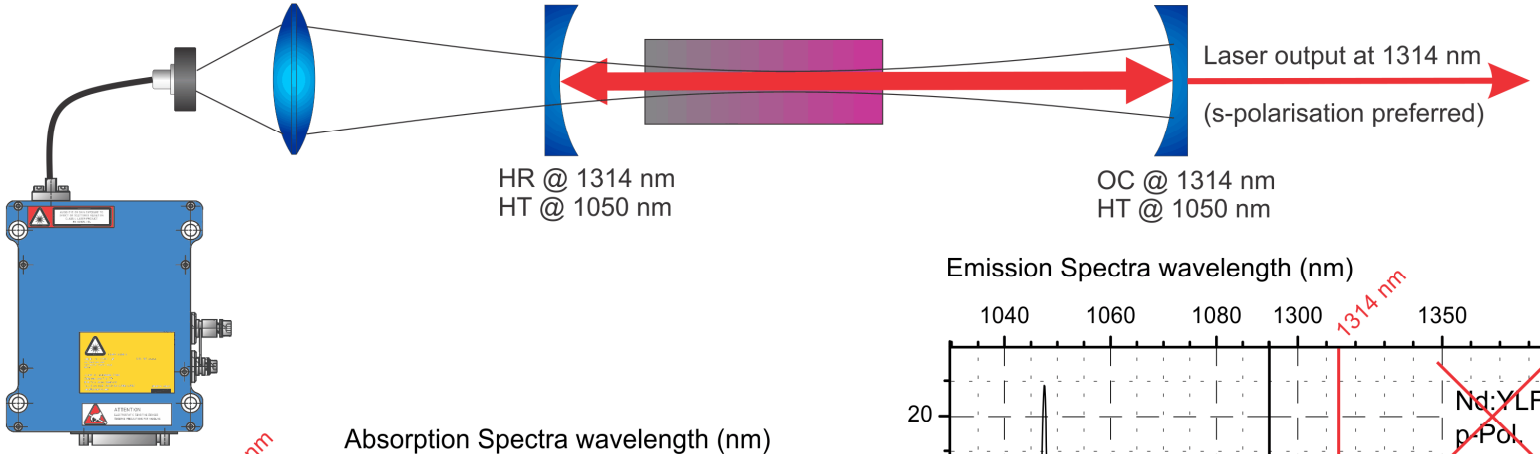
A 2-crystal high-power CW and Q-switched Nd:YLF laser at 1314nm

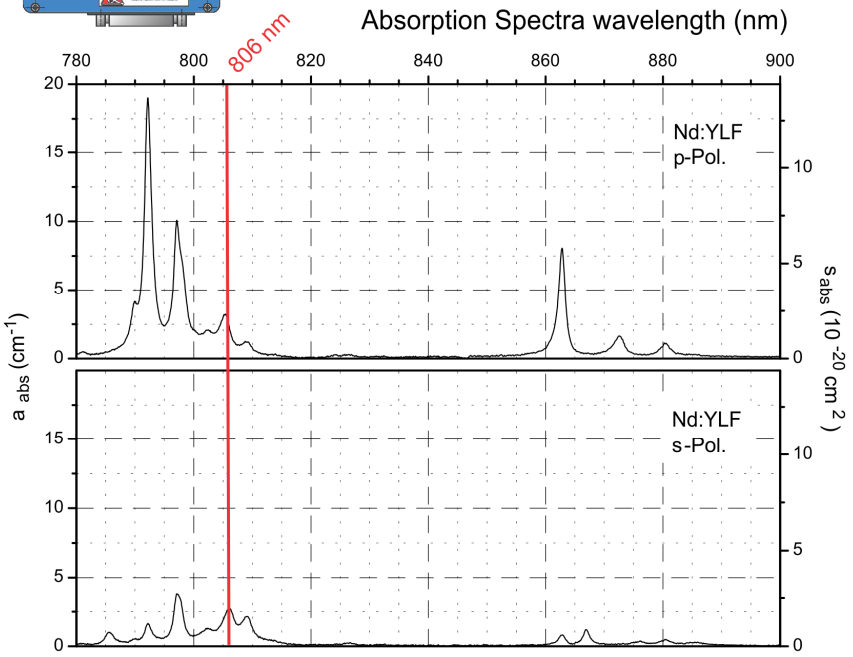
R.C. Botha[1,2,3], H. Strauss[2], W.L. Combrinck[1] , and H. von Bergmann[3]

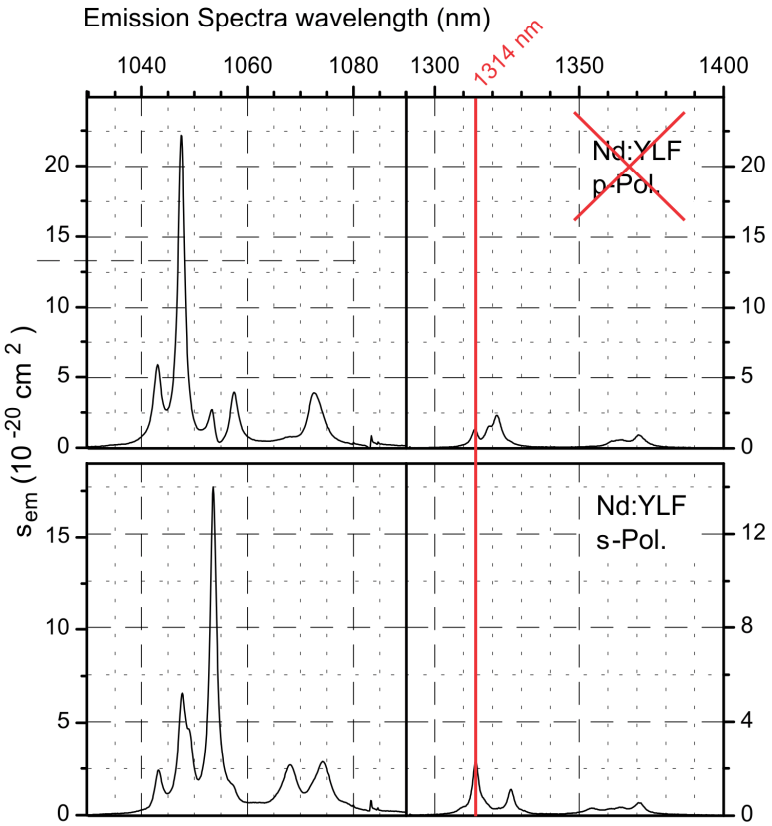
1. Space Geodesy Programme, HartRAO, South Africa, roelf@hartrao.ac.za
2. Laser Sources Group, CSIR National Laser Centre, South Africa
3. Laser Research Institute, Stellenbosch University, South Africa

Corresponding Author:
R. C. Botha
roelf@hartrao.ac.za

Diode end-pumped operation of Nd:YLF at 1314 nm

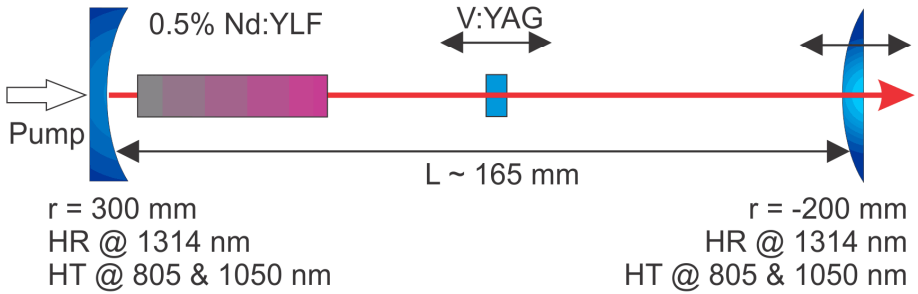


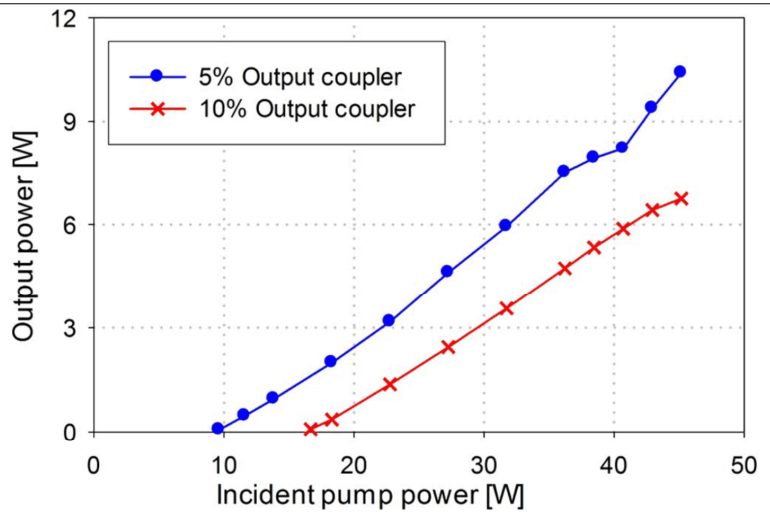


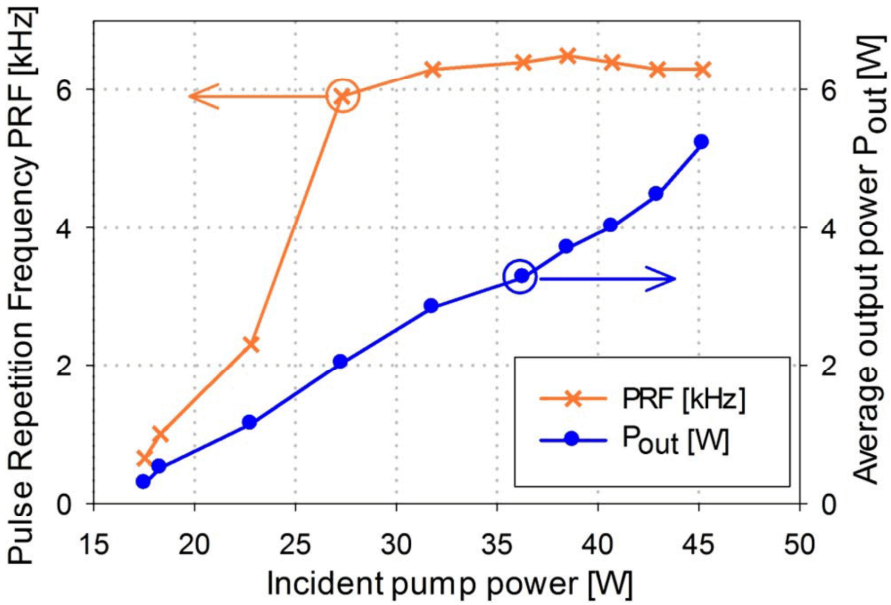


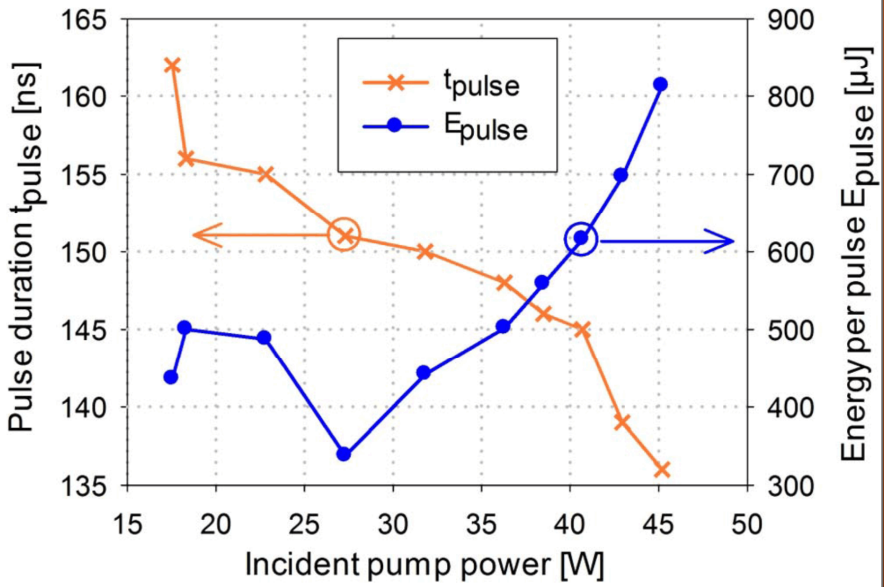
SPECTRA: C. Czeranowsky, "Resonatorinterne Frequenzverdopplung von diodengepumpten Neodym-Lasern mit hohen Ausgangsleistungen im blauen Spektralbereich," PhD, Univ of Hamburg (2002)

Single crystal results



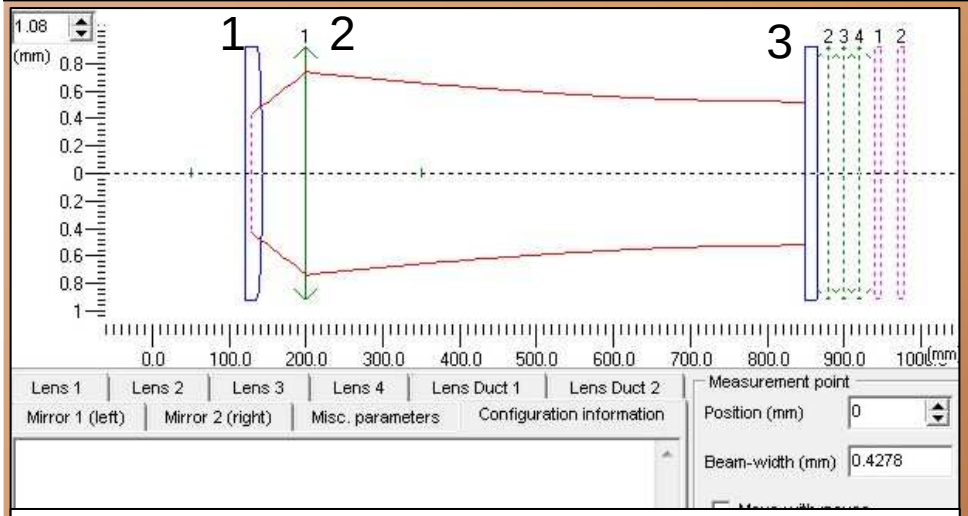


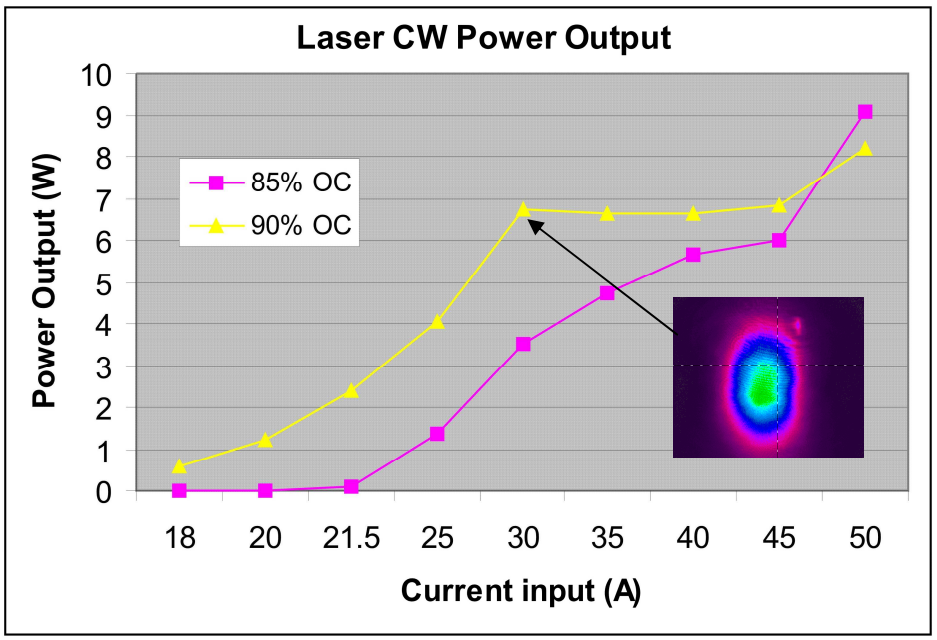




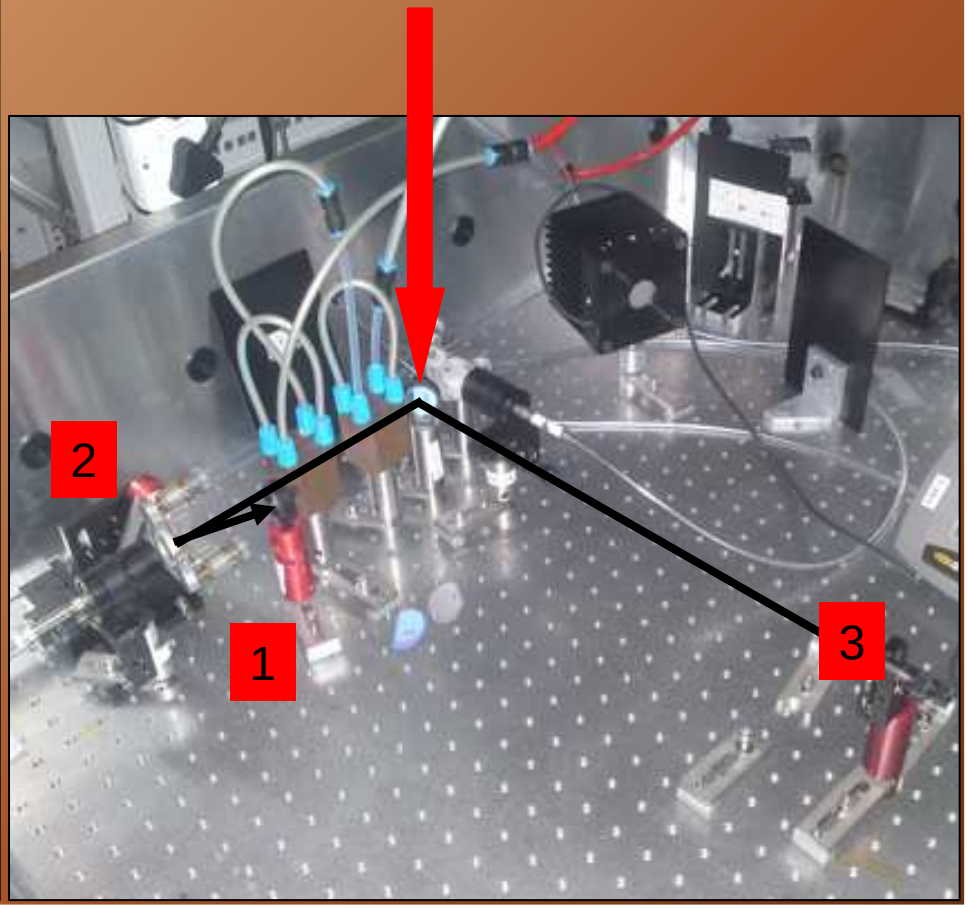
Botha, R.C. et. al. “High average power 1314 nm Nd:YLF laser, passively Q-switched with V:YAG”, Opt. Lett. 38, 980 –982 (2013)

Initial dual crystal setup





Resonator Folding Mirror (flat) is highly reflective @ 1314 nm for s-type waves only: Nd:YLF crystals thus rotated that s-polarisation is vertical.



Include thermal lens in modelling

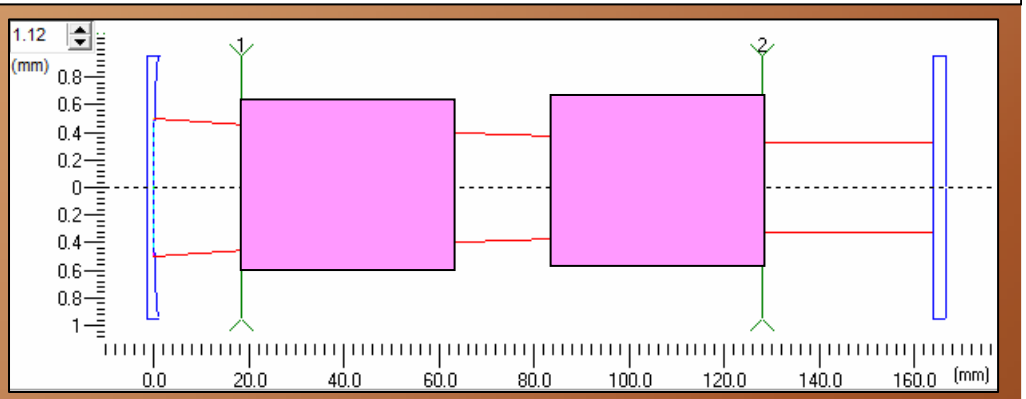
RATIONALE

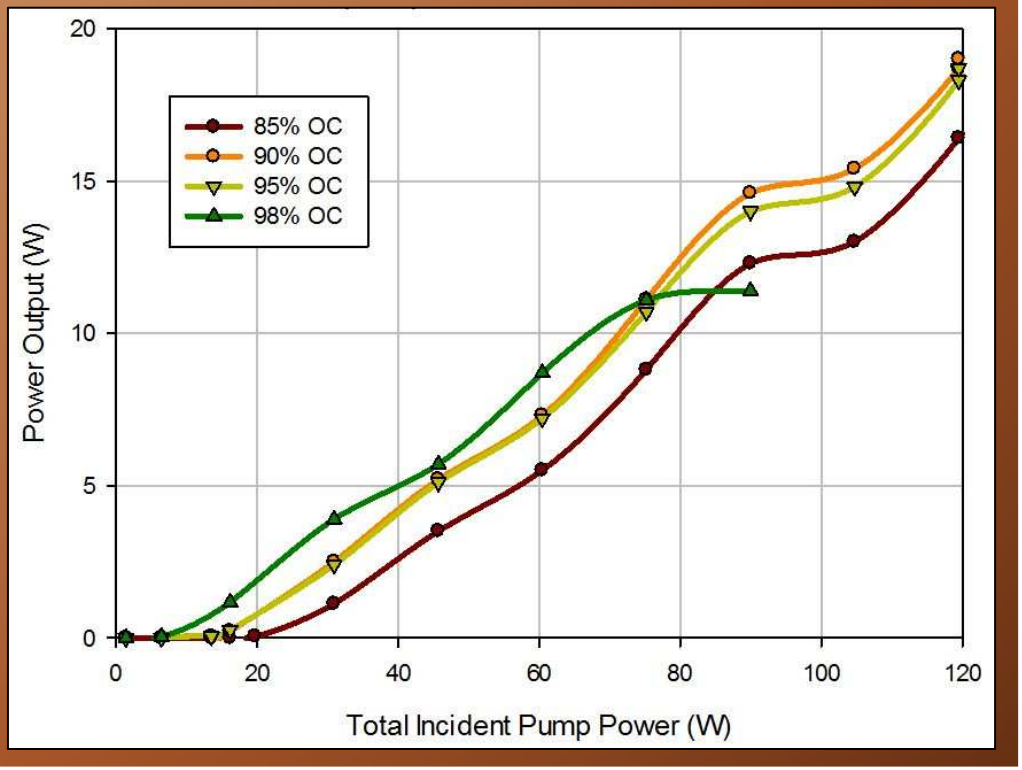
- Used a Curved-flat type resonator
- Pump size 0.5mm at waist
- Unabsorbed pump light to next Nd:YLF crystal
- Modelled for strong (f ~ - 600 mm) thermal lens

RESULTS

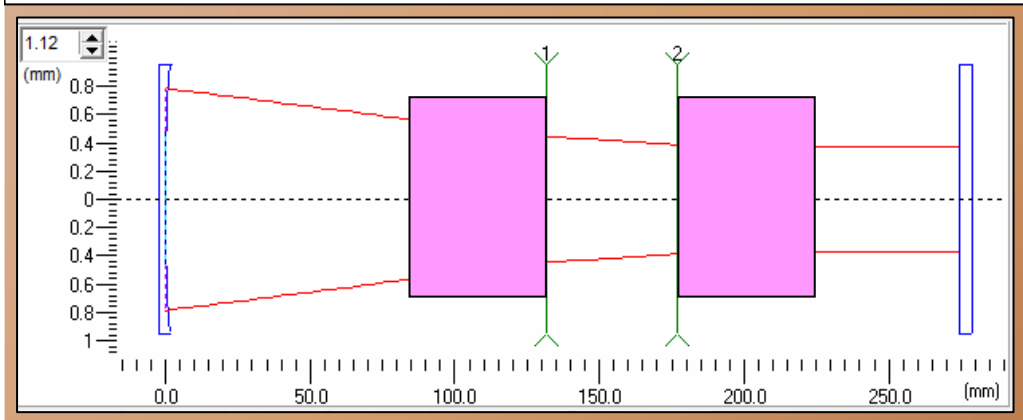
1. Initially stable TEM00 operation
2. Change to multimode
3. Change to unstable
4. Max output power 18 W

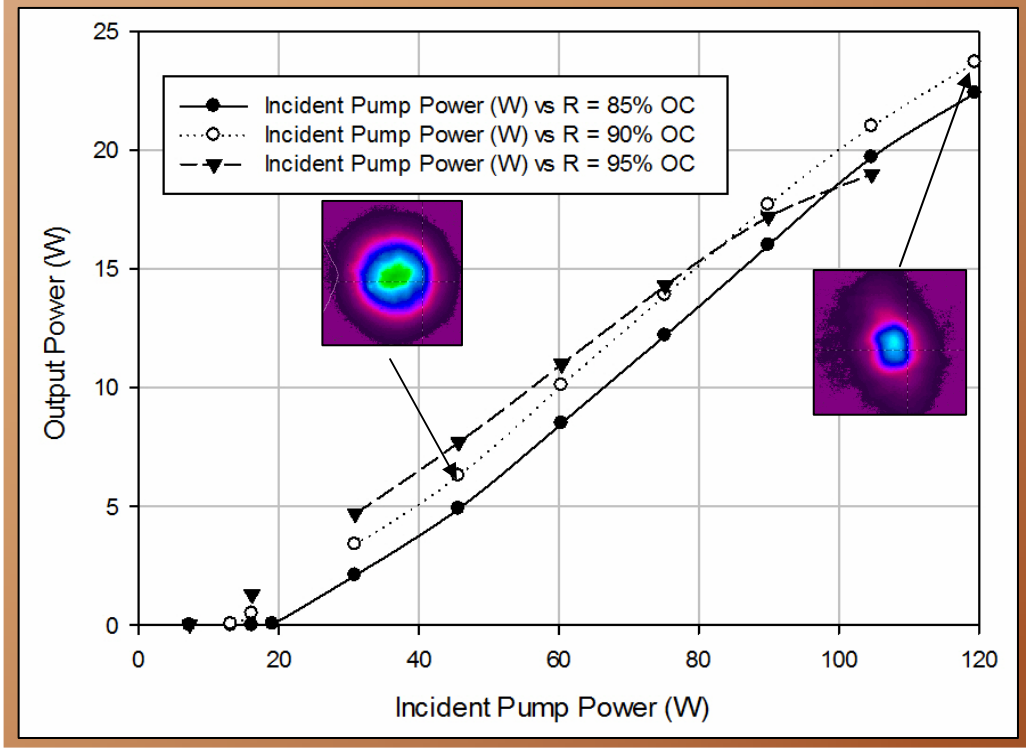
→ Still a thermal lensing problem





Refine thermal lens model





RATIONALE

- Used a Curved-flat type resonator
- Pump size 0.5mm at waist
- Pump through resonator folding mirror
- Modelled for strong (f ~ - 300 mm) thermal lens

RESULTS

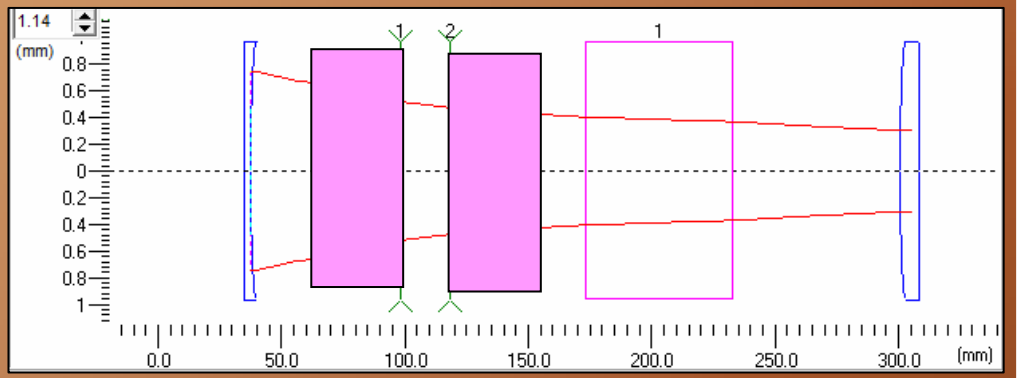
- Initially stable TEM00 operation
- Slight beam degradation at 120 W pump power
- Max output power 23.5 W

→ Slight thermal lensing issue at 120 W of pump power

Verify thermal lens

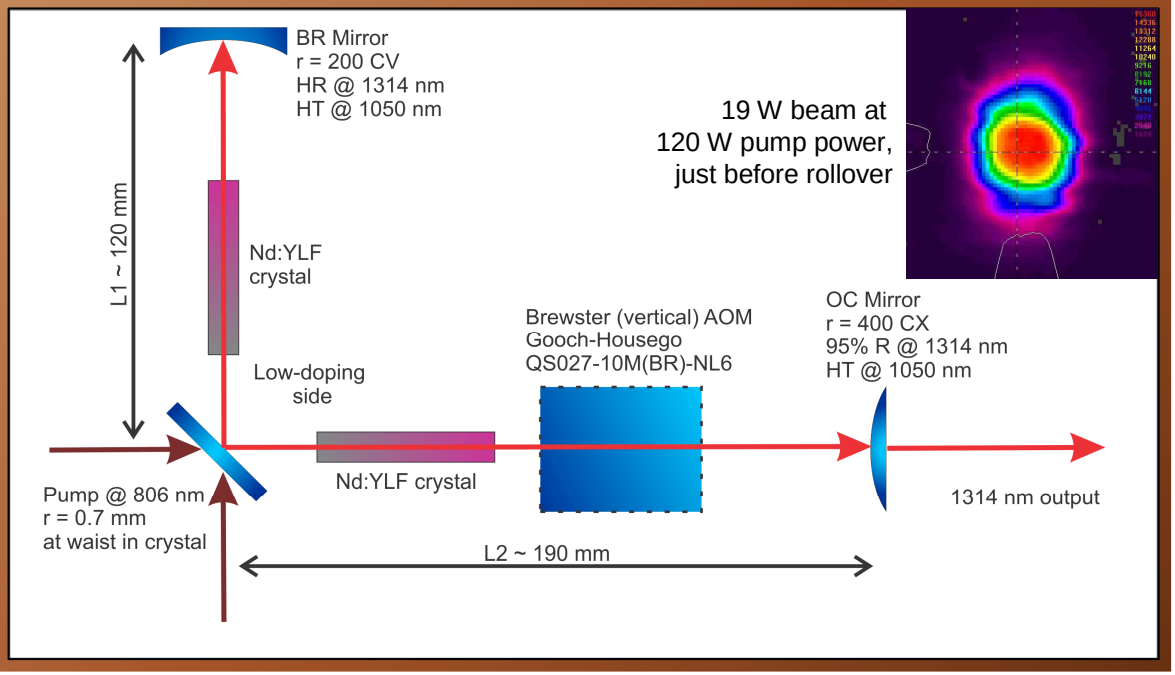
RATIONALE

- Use a curved-curved type resonator
- Pump radius 0.7 mm at waist
- Varying L1, L2 at full power gives rollover effect indication of for better mode-matching
- Modelled for strong (f < - 350 mm) thermal lens at 120 W pump power

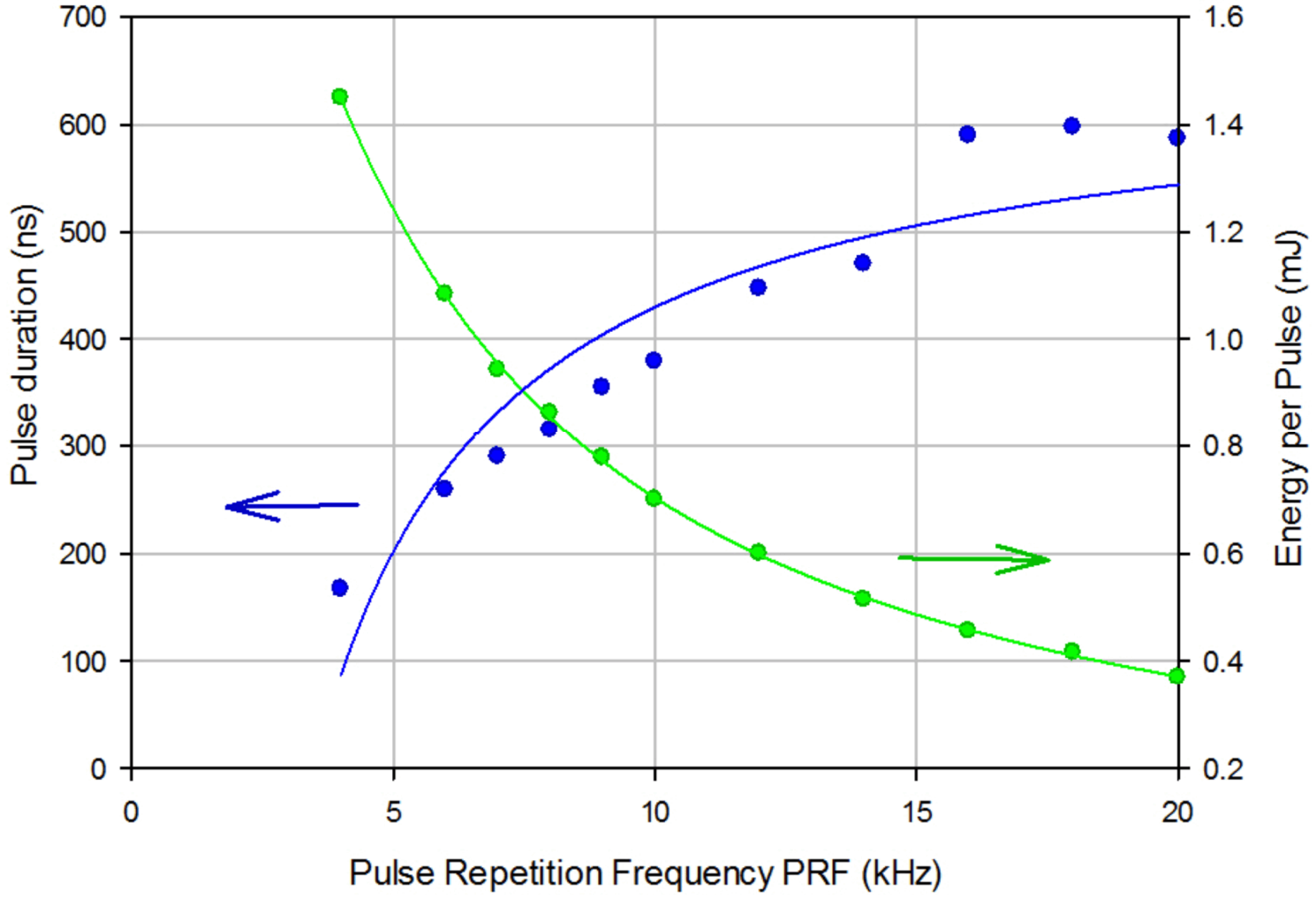


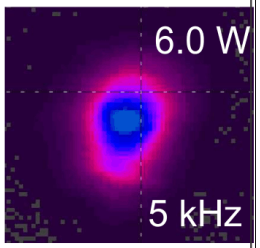
RESULTS

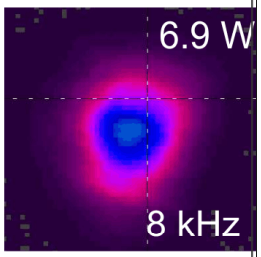
- Rollover effect and PSST model now accurately matches
- Thermal lens at F ~ - 250 mm per crystal, pumped at 60 W per crystal
- Max output power 19 W

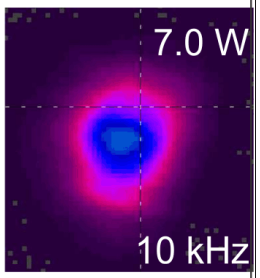


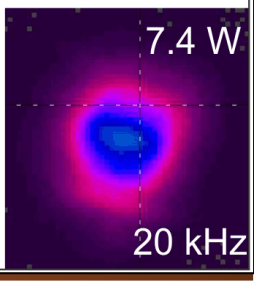
Pulsed with AOM



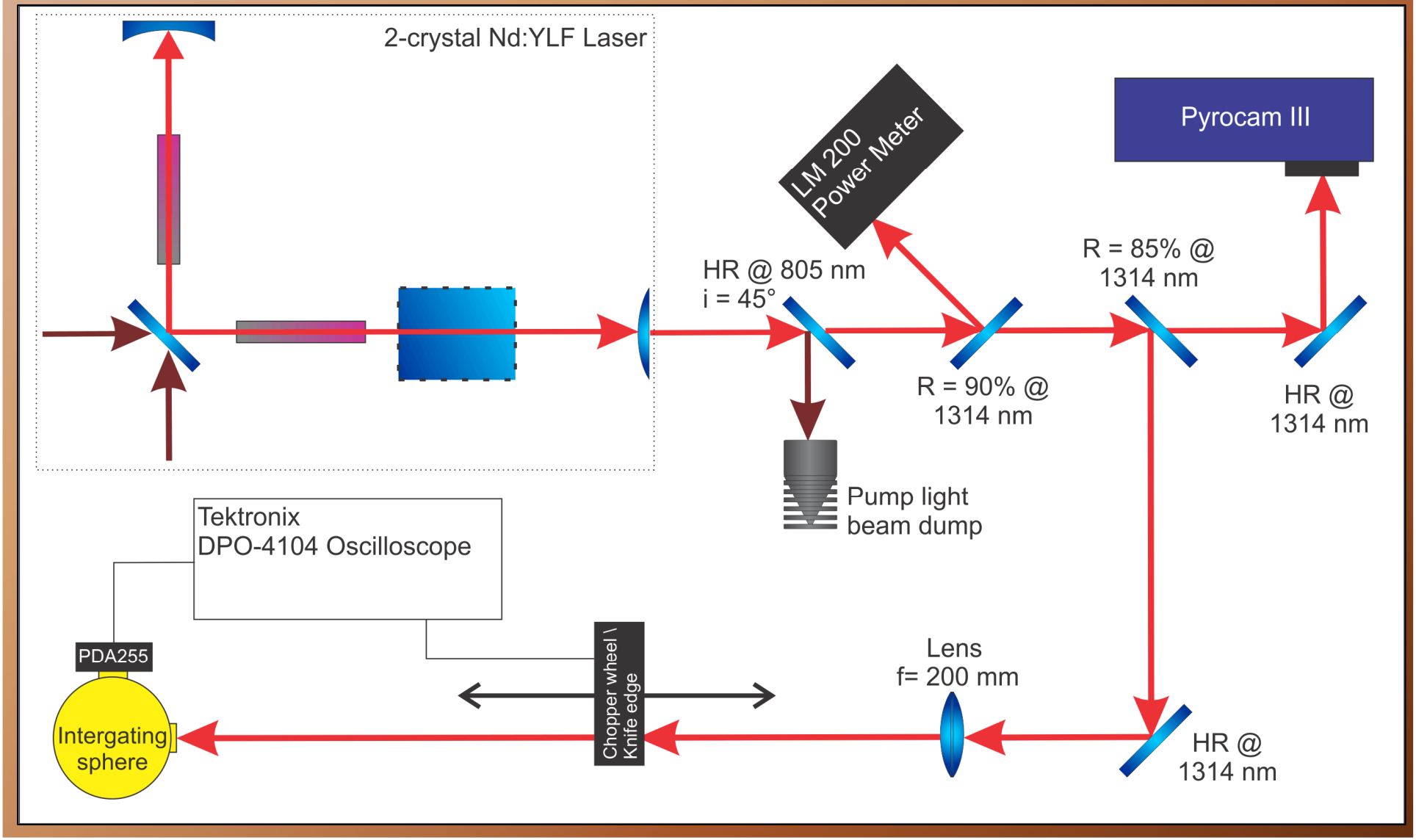




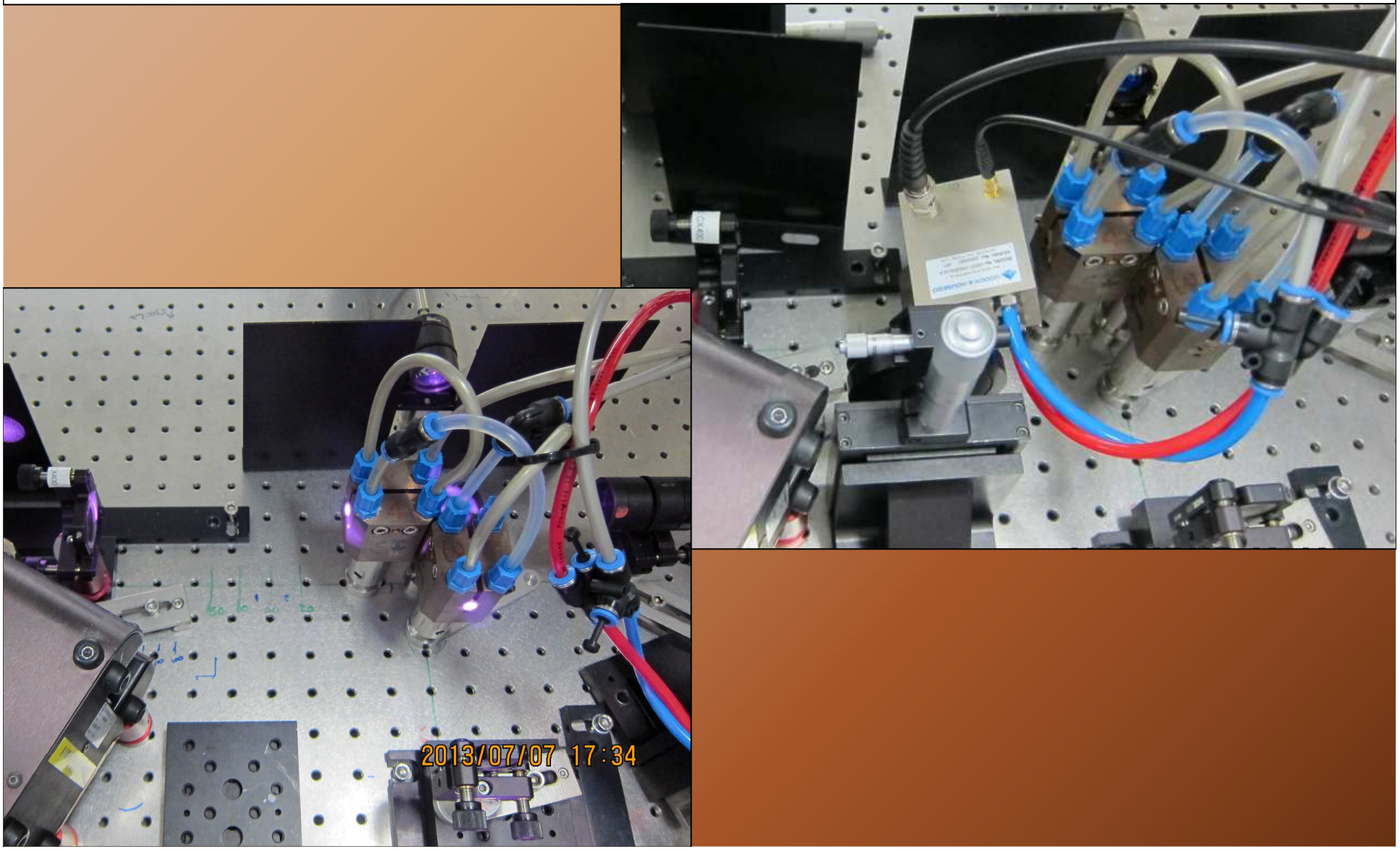




Diagnostic Setup



Resonator layout: CW and Pulsed



Conclusion

Operation of Nd:YLF (0.5% at. doping) at 1314 nm

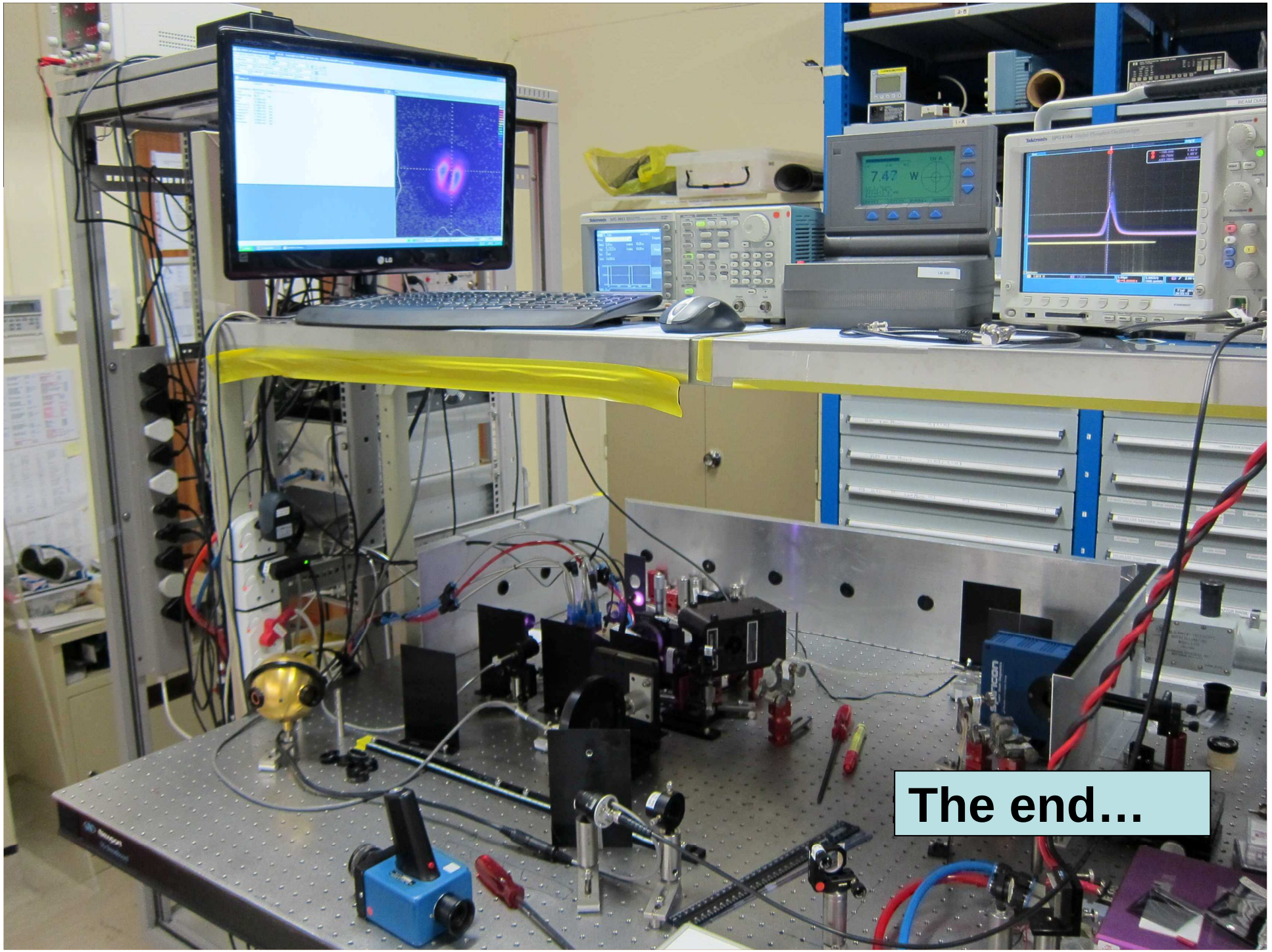
- gives good beam quality at low incident pump powers (< 60 W), but…
- beam quality severely degrades at pump powers > 60 W, due to strong thermal lens behaviour here
- Thermal lens f ~ - 250 mm per crystal at 120 W total pump power
- Expect 25 W @ 1314 nm CW

Future Experimental Work

- Curved flat resonator for thermal lens of – 250 mm
- CW laser full characterisation

- Insert AOM for pulsed laser, optimise resonator length
- 20 kHz PRF and down (< 4 kHz lower limit?)
- Pulsed laser full characterisation

- Increase pump power to 150 W and repeat, IF no fracture occurs


7.47 W
The end…