Karlsruhe Institute of Technology

KIT-Campus Alpin
IMK-IFU: Atmospheric Environmental Research

Design of a Powerful Transversely Pumped Ti:Sapphire Laser for Near-Infrared Lidar Application

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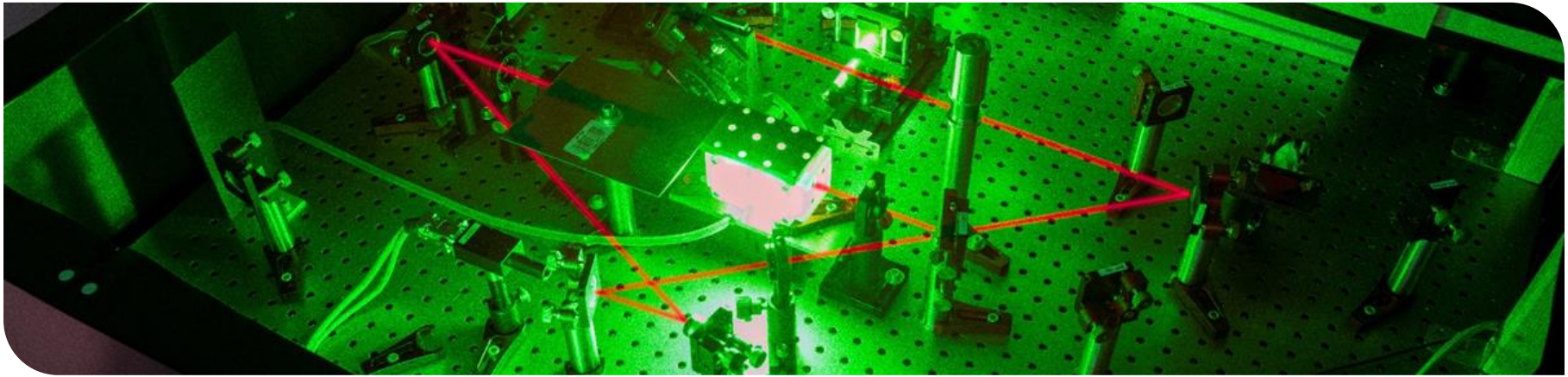


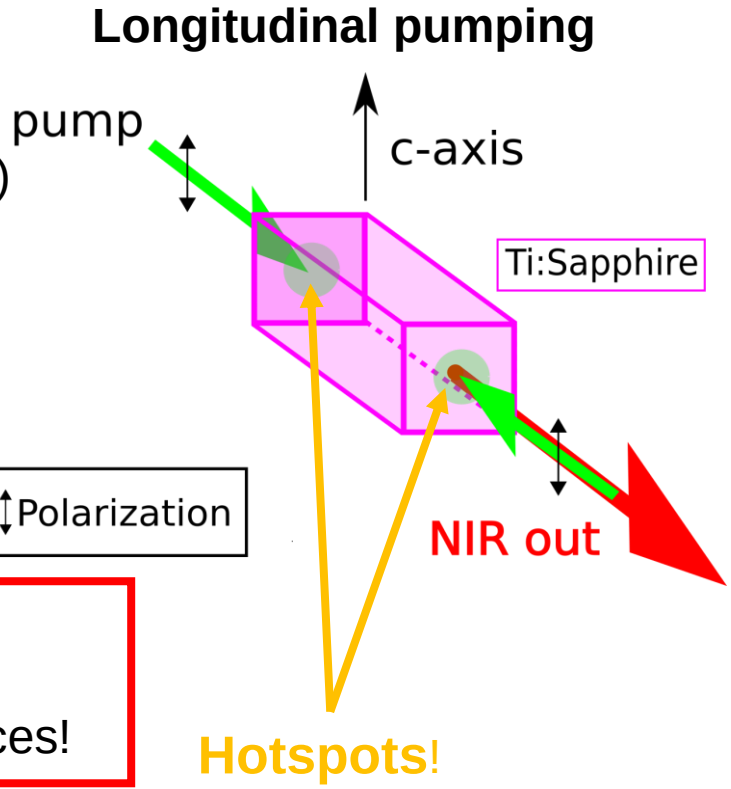
The dilemma

Differential Absorption Lidar (DIAL) measurements depend on:

- High pulse energies (good signal-to-noise ratio)
- Tunable lasers to match absorption lines
- Reliable spectral purity

Common solution:
Ti:Sapphire lasers, longitudinally pumped by Nd:YAG @532nm

But:
Maximum energy storage by longitudinally pumped Ti:Sa is limited: Burning at the crystal faces!



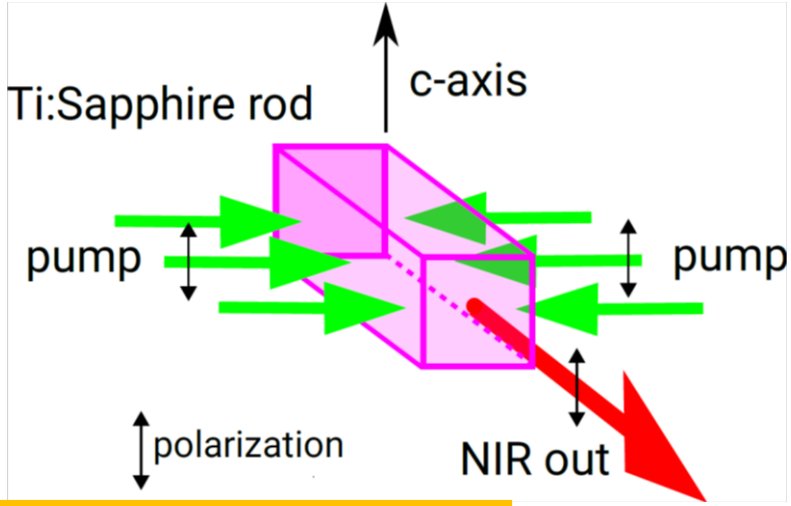
The idea

Permanent increase of commercially available pump laser energies

Therefore: Transversal pumping!

- Thermal energy is not concentrated on one single spot.
- Crystal burning is avoided by widening the pump beam.
- If pump energy further increases: Burning is avoided by longer crystal rods.

Transversal pumping

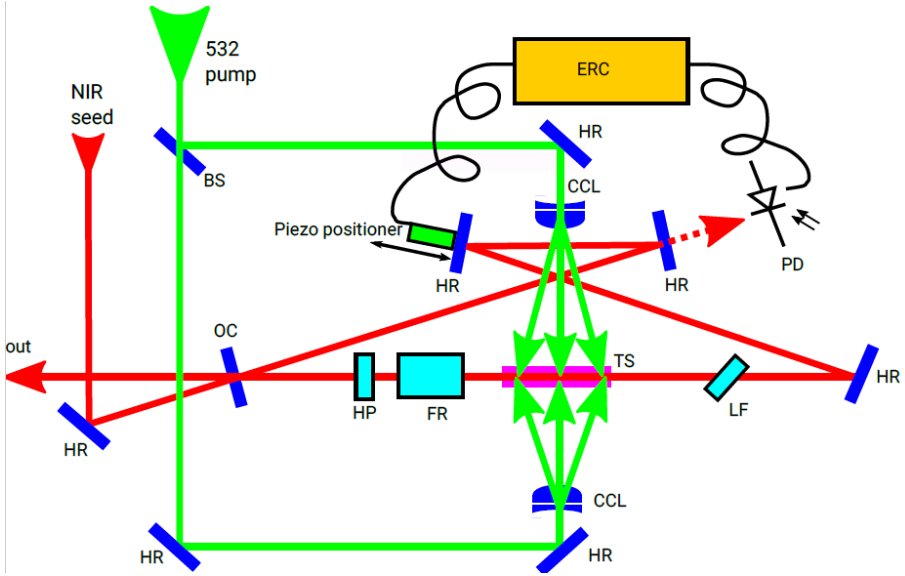


➡ Higher pump energies and longer rods increase the total amount of stored energy.

➡ Emission energies can be maximized!

The implementation

- Transverse pumping of a 7x7x50mm Ti:Sa (TS) crystal in folded x-ring resonator
- Horizontal widening and vertical focusing of pump beam through lens pairs (CCL)
- Emission frequency constrained by birefringent filter (LF), unidirectional emission by polarization changes (HP/FR)
- Injection seeding by two external cavity diode lasers ($\lambda_{on}/\lambda_{off}$)
- Adjusted resonator length to λ_{on} with mirror on piezo positioner, λ_{off} adapts to resonator length



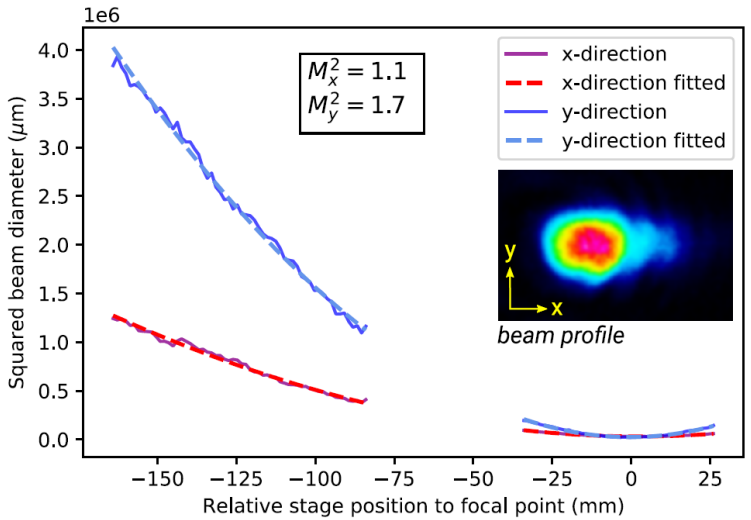
* Installed inside the ATMONSYS lidar

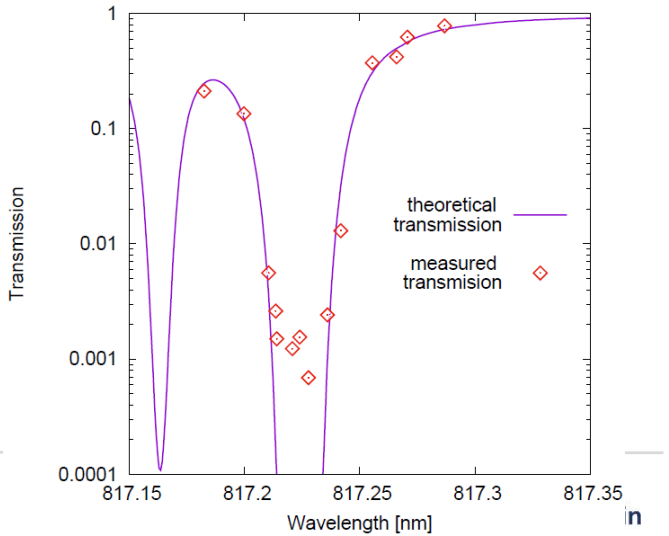
➡ Resonator setup is mechanically stable and reliable.

The implementation

Specifications (not fully exhausted)	
P_{pump} (@532nm)	25W
Frequency	100Hz
P_{IR} (Output; @817nm)	3W
Frequency	100Hz
Pulse duration (FWHM)	50ns
M^2	1.1 (M^2_x) / 1.7 (M^2_y)
Divergence	0.5mrad / 0.8mrad
Pointing stability	~0.1mrad
Spectral purity	>99.8%
Spectral bandwidth	~7.5Mhz

➡ Further improvement definitely possible!





The conclusion

- Transverse pumping…
  - is **mechanically stable.**
  - shows already **high pulse energies.**
  - promises scope for a lot of **further improvement.**
- Prototype is **installed** within the mobile **ATMONSYS boundary layer lidar** 💪 🎉
- Future **deployment** of transversely pumped Ti:Sa on **Mount Zugspitze**

➡ Findings currently under review (Vogelmann et al., *Appl. Optics*)

➡ For details on the ATMONSYS lidar: **visit poster *Wednesday_09_P17***