# Ti:Sapphire Laser and new Garnet Lasers for $H_2O$-LIDAR at 935 and 942nm

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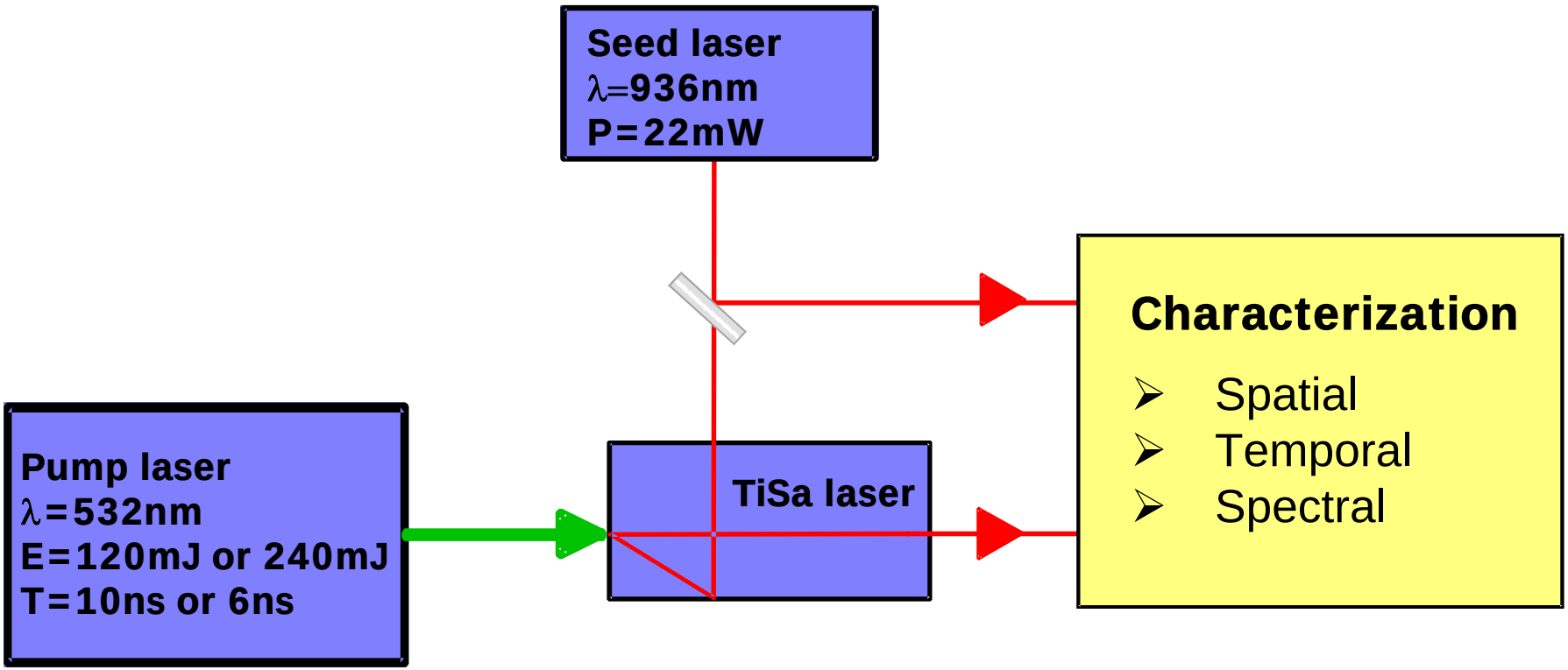
**TiSa-ring laser: injection seeding and spectral characterization**

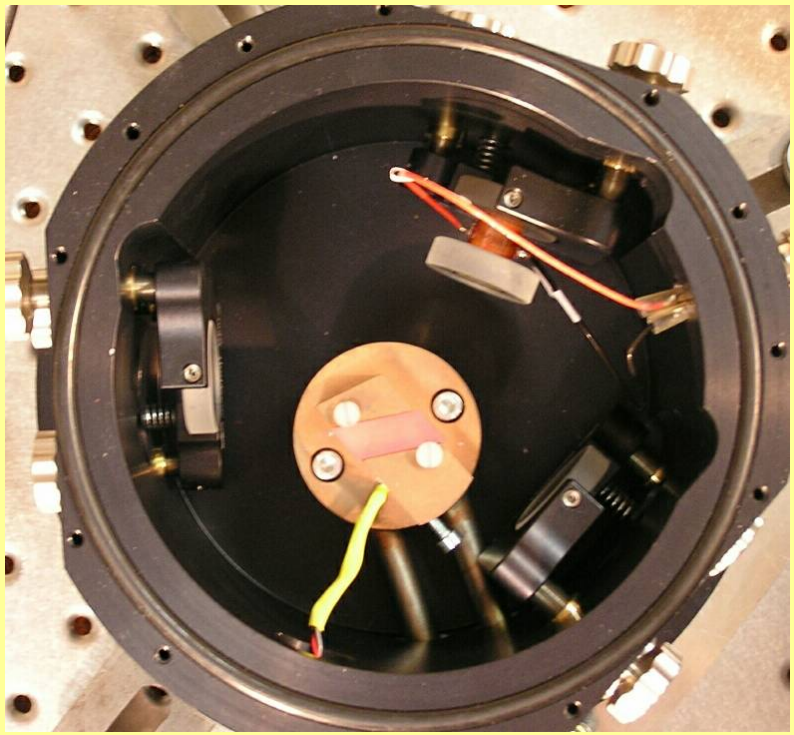
**TiSa-laser with linear resonator: energy scaling**

**Nd:YGG and Nd:GSAG-laser with direct diode pumping**

# Experimental Setup: Overview



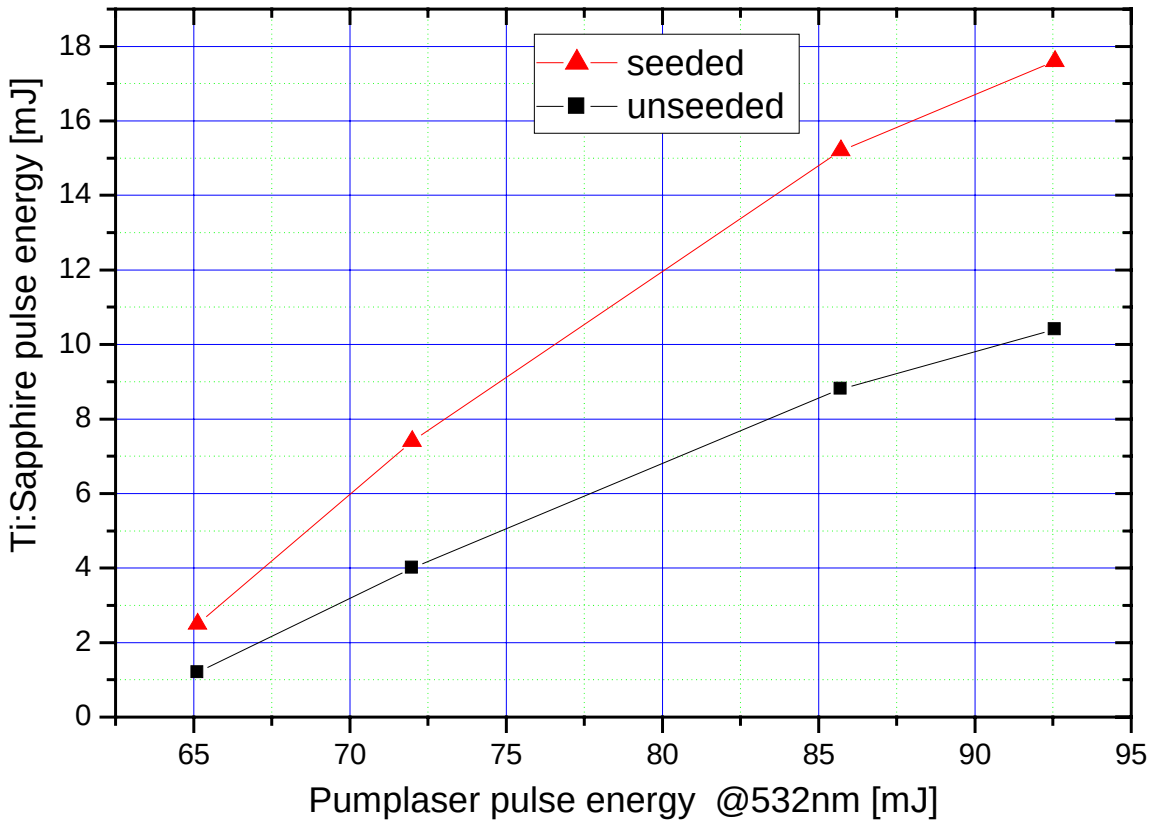
# Ti:Sapphire laser set-up



Constructed by Poberaj et al in DLR

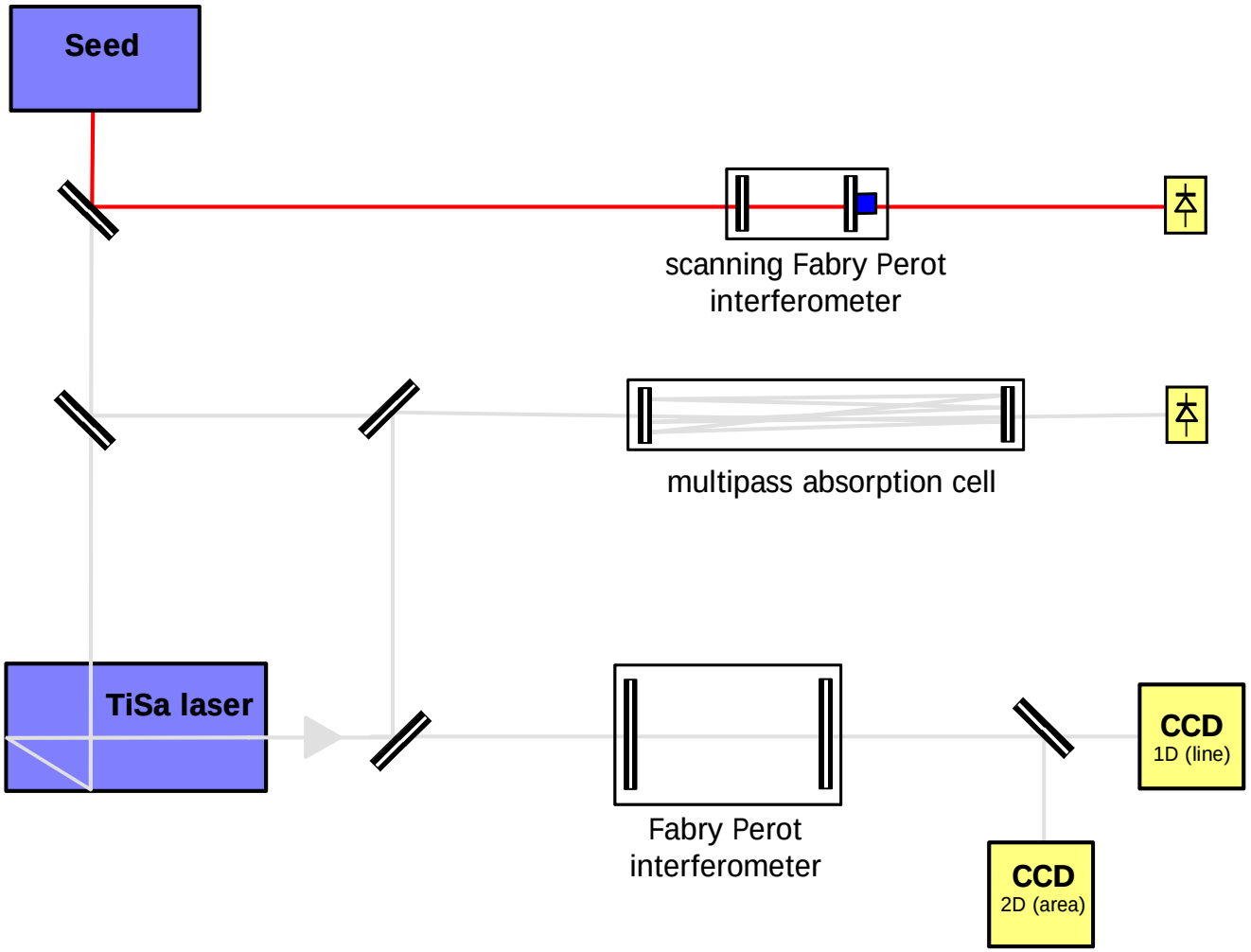
- Three-mirror-set-up: 45°-90°-45°
- Output coupler reflectivity ~80% at 936nm
- Pulse-Energy in seeded mode: 20mJ

# Ti:Sapphire ring laser pulse energies




**Ti:Sapphire pulse energies in direction selected by injection seeding, single sided pumped with $M^2$=3.5 (beam quality of pump laser)**

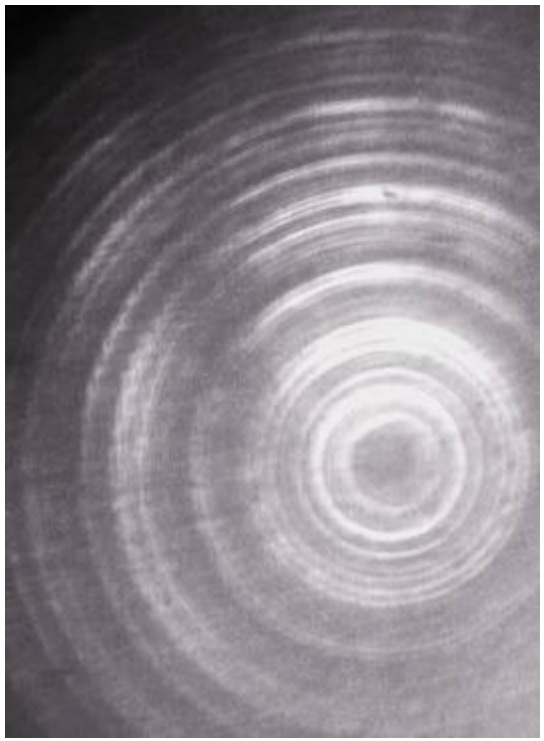
# Characterization Setup : Overview



# Seed laser: External cavity diode laser

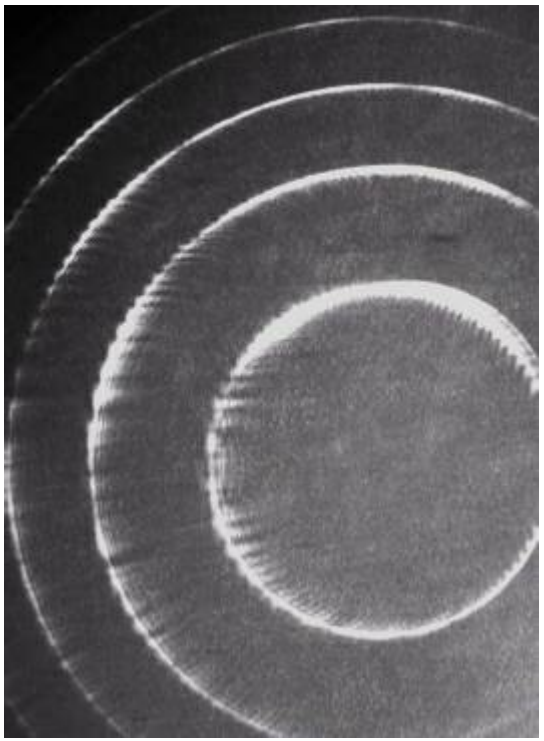
- **Commercial device: TOptica DL100 in Littrow configuration**
- **Specification of manufacturer:**
  - Output power >40mW
  - Linewidth 1-2 MHz when not locked to cavity
  - Sideband suppression ratio >45dB
  - Frequency drift ~300MHz/12h
  - Significant linewidth reduction when locked to cavity
- **Test measurements performed**
  - Scanning Fabry Perot Interferometer
  - Fixed distance FPI
  - Measurement of the filter characteristic of the absorption cell

# Seed laser: FPI fringes on 2D CCD camera



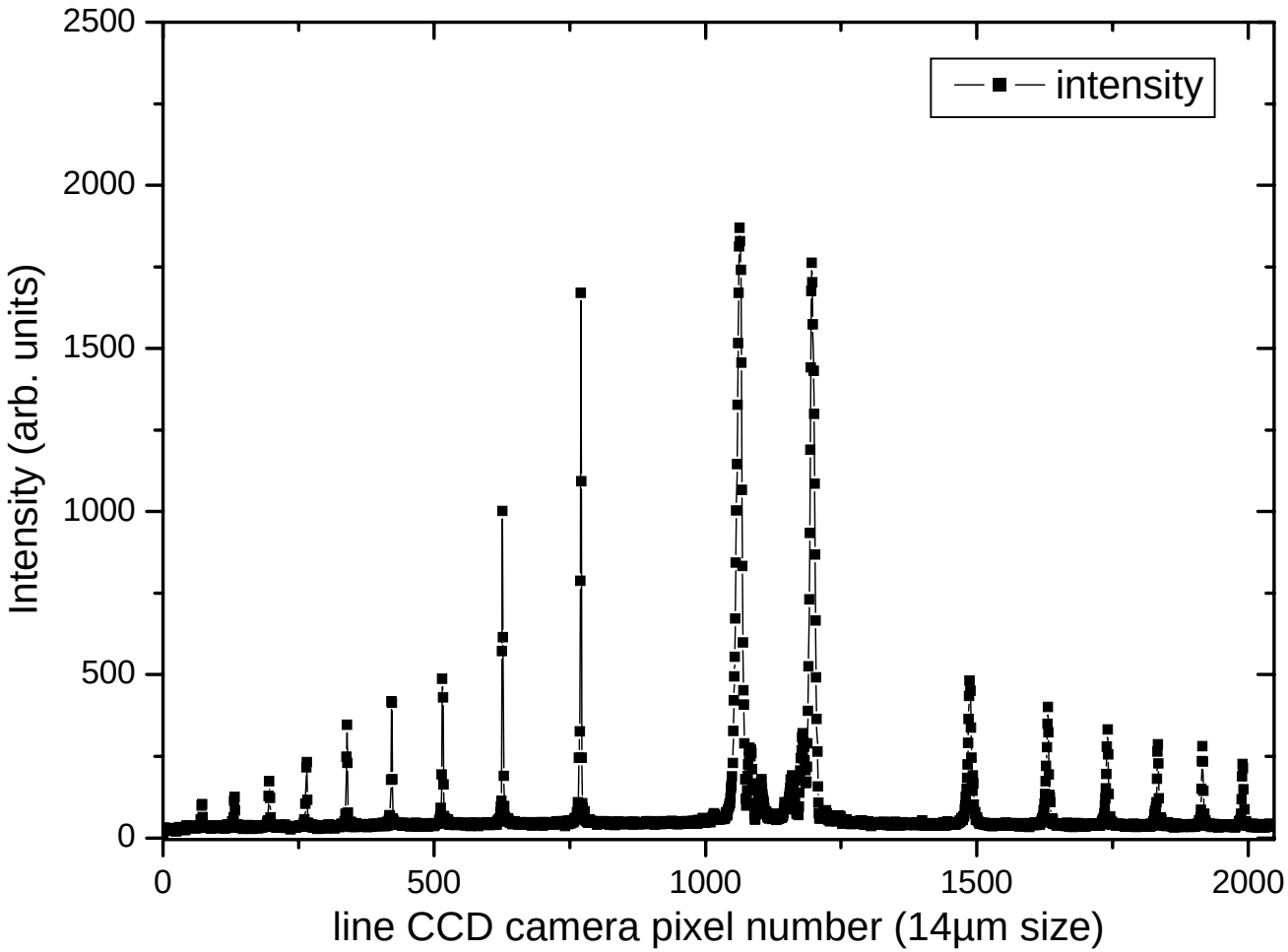
multi-mode

three modes



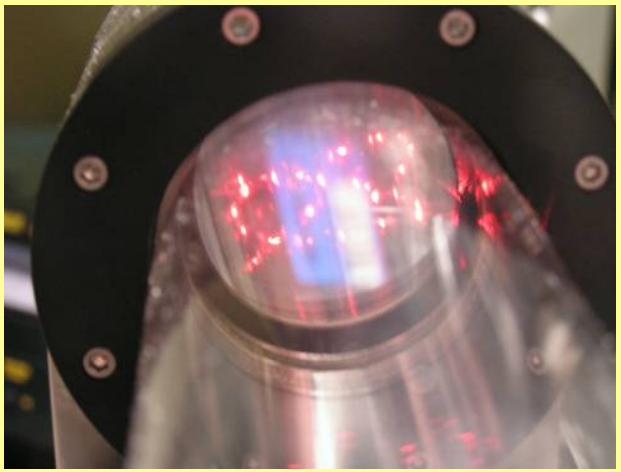
single mode

# Seed laser: FPI fringes on 12bit line CCD camera




- Single mode operation can be easily verified (choice of optimum current)
- Resolution limitations due to optical noise
- Measured side mode suppression of > 25 dB

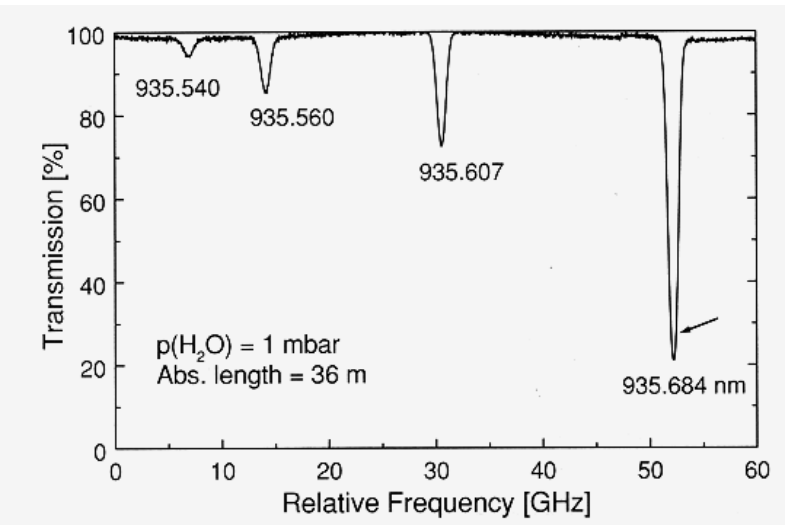
# Seed laser: multipass cell measurement (I)



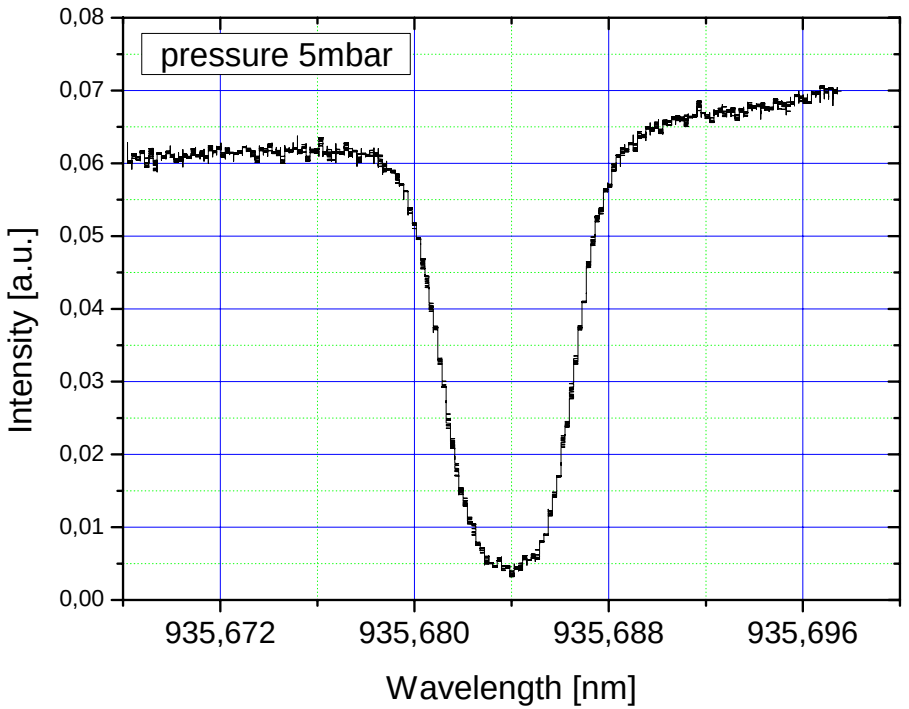
Spot pattern of HeNe Laser used for alignment

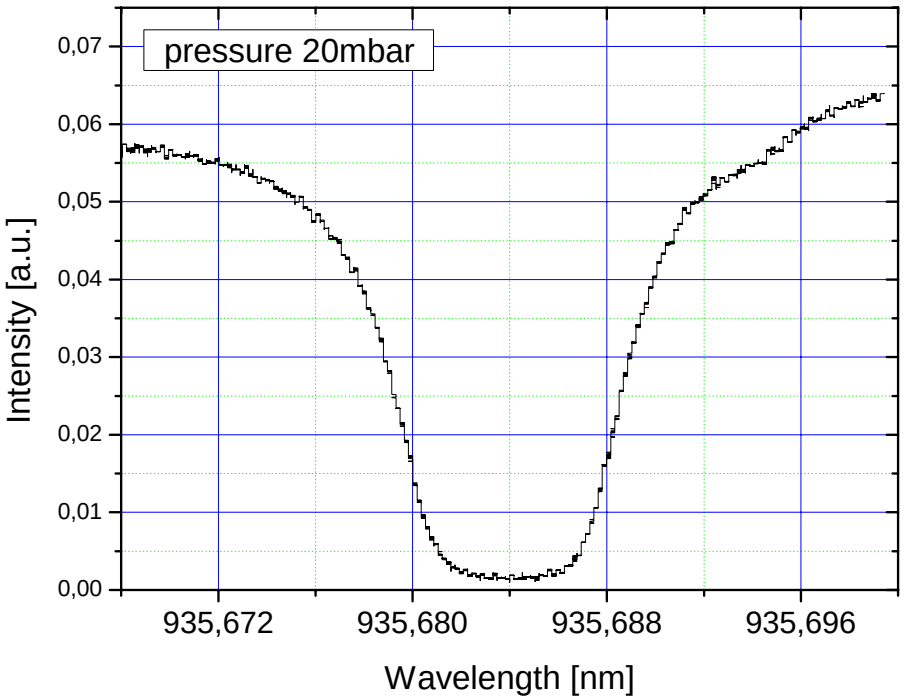
Absorption length in 182 pass configuration: 36m

- Scan range of 12 GHz
- Determination of absolute wavelength using wavemeter



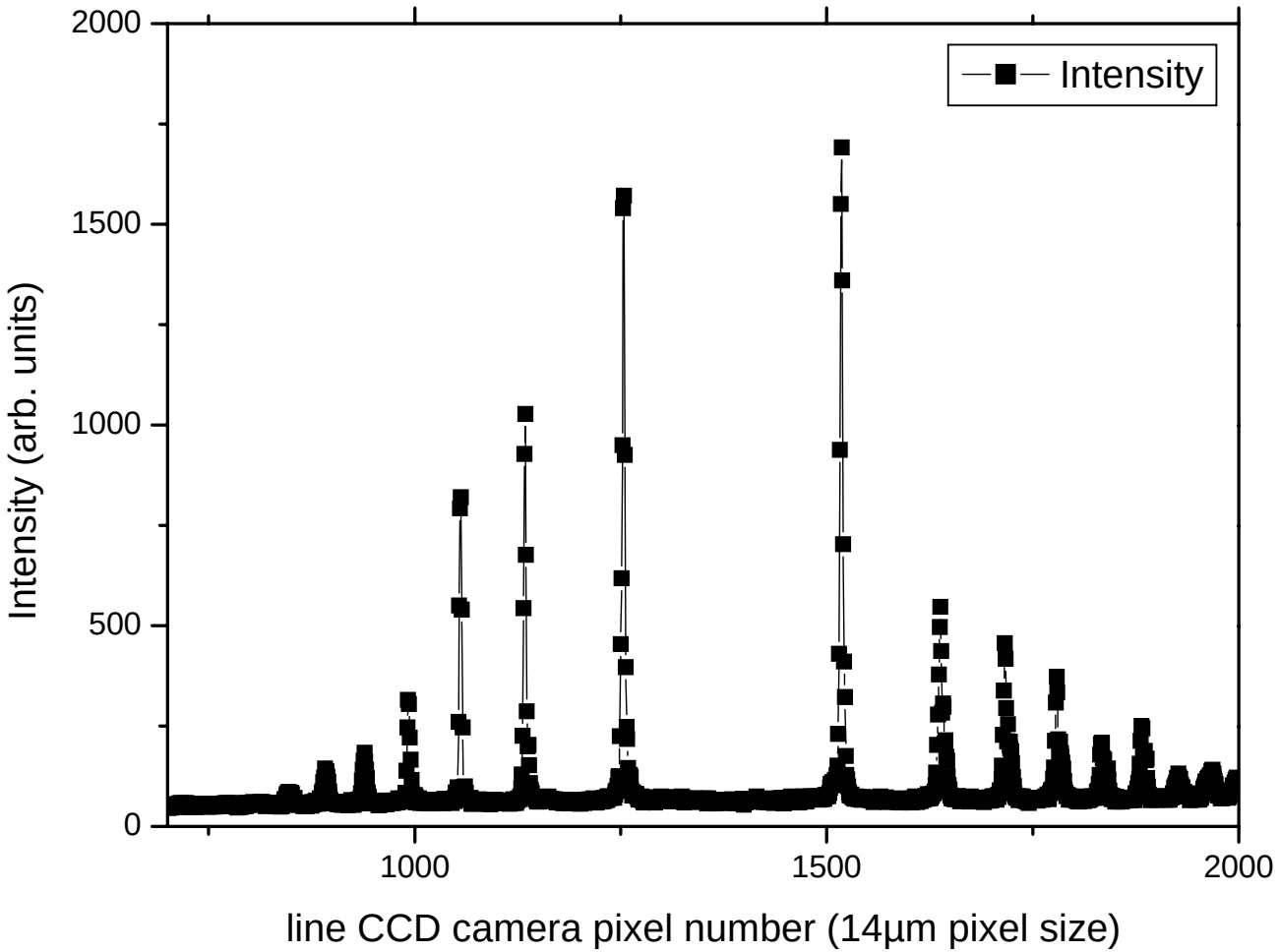
# Seed laser: multipass cell measurement (II)



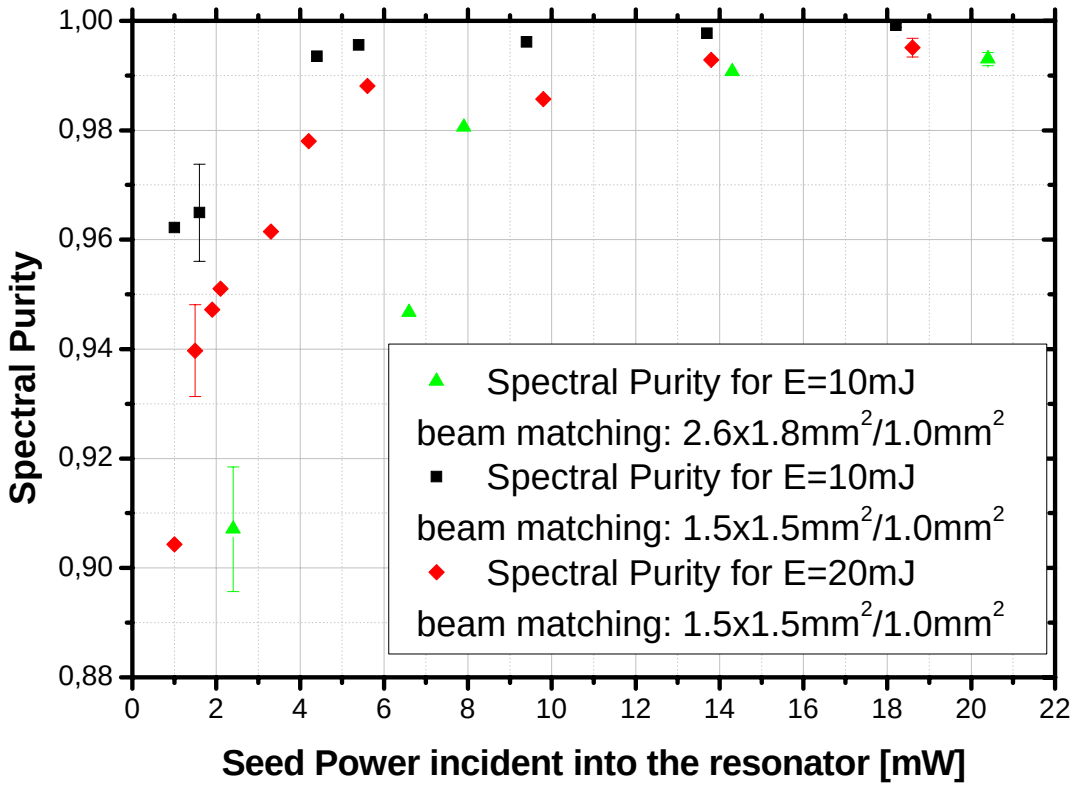

Water vapour absorption of seed laser diode measured using multi pass cell for different pressure values (left:~5mbar, right:~20mbar).

# FPI fringes on 12bit line CCD of injection seeded Ti:Sa laser



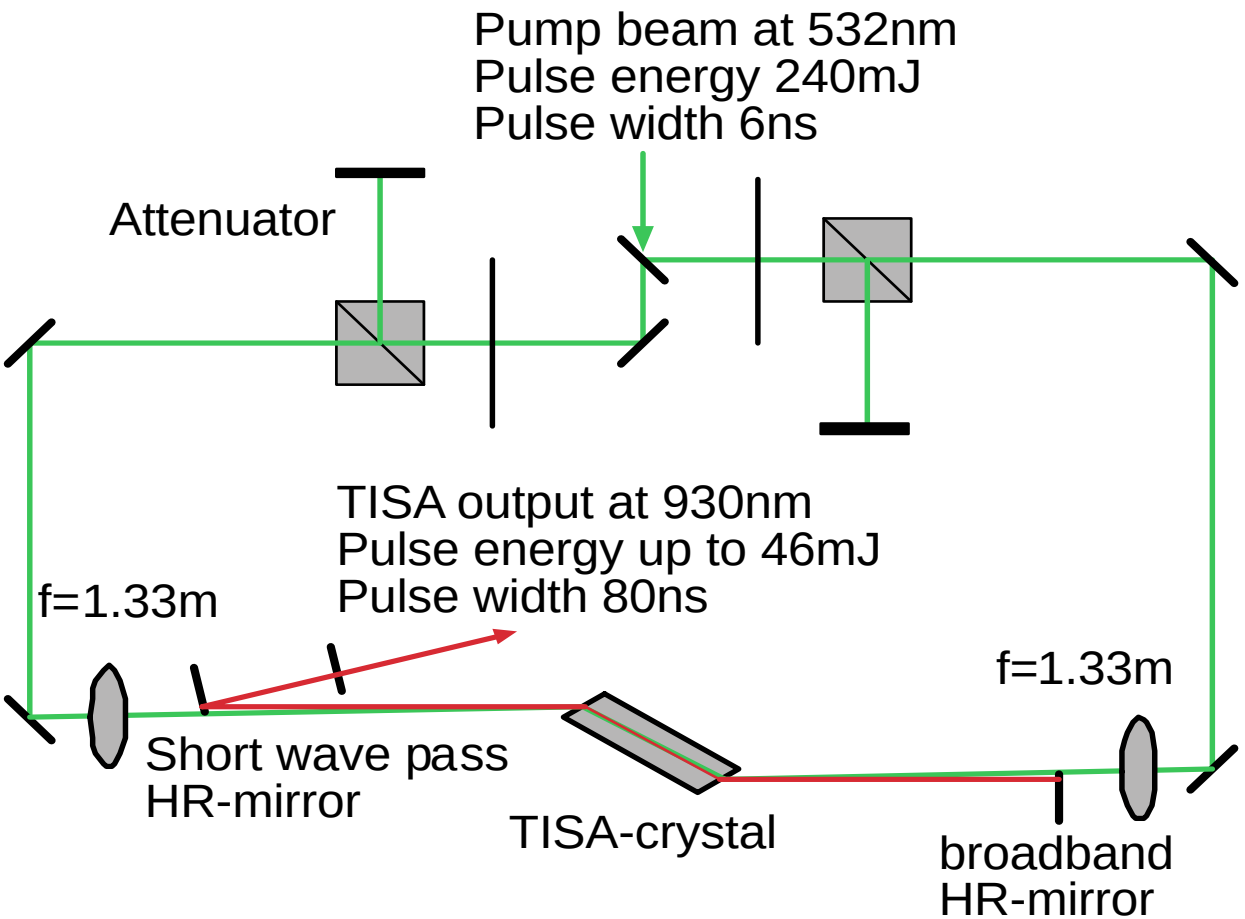

- Measured line width < 150 MHz
- Resolution limitations due to low finesse
- Improvement of the finesse with optimised mirrors

# Ti:Sapphire laser: Spectral purity

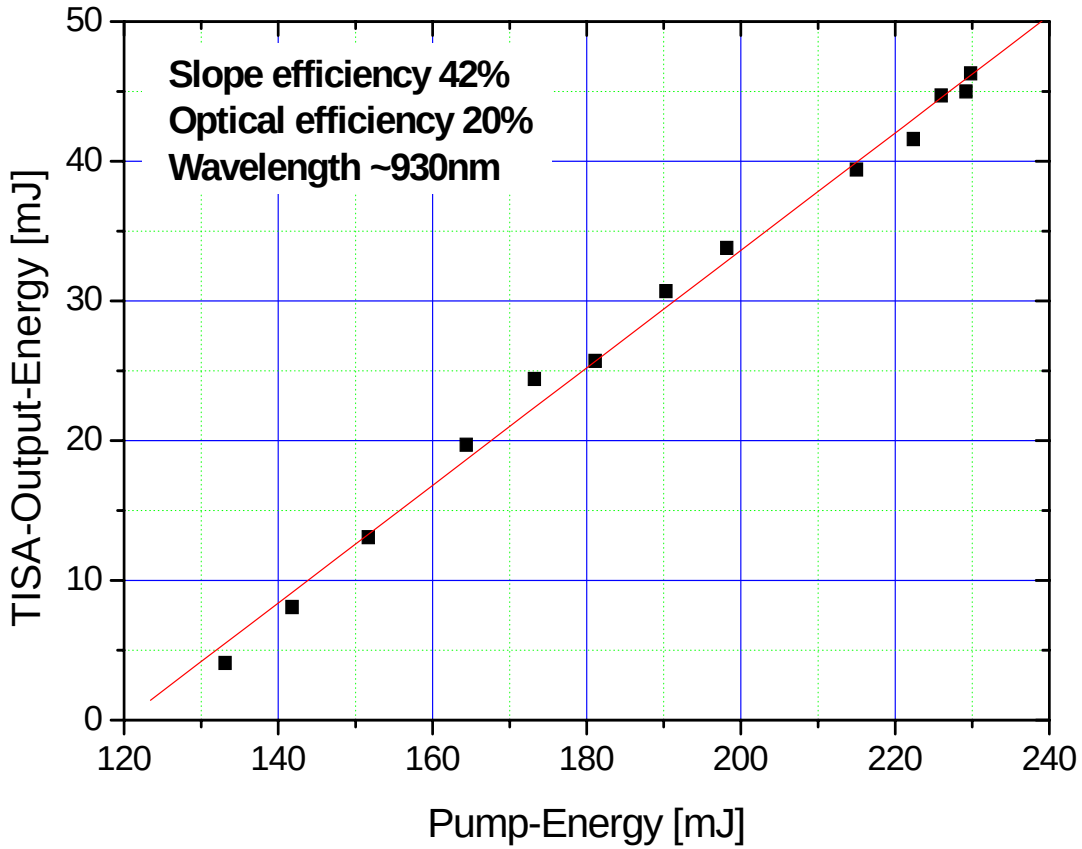



Dependence of spectral purity of Ti:Sapphire laser on seed laser power and beam matching between TISA and seed laser beam cross section.

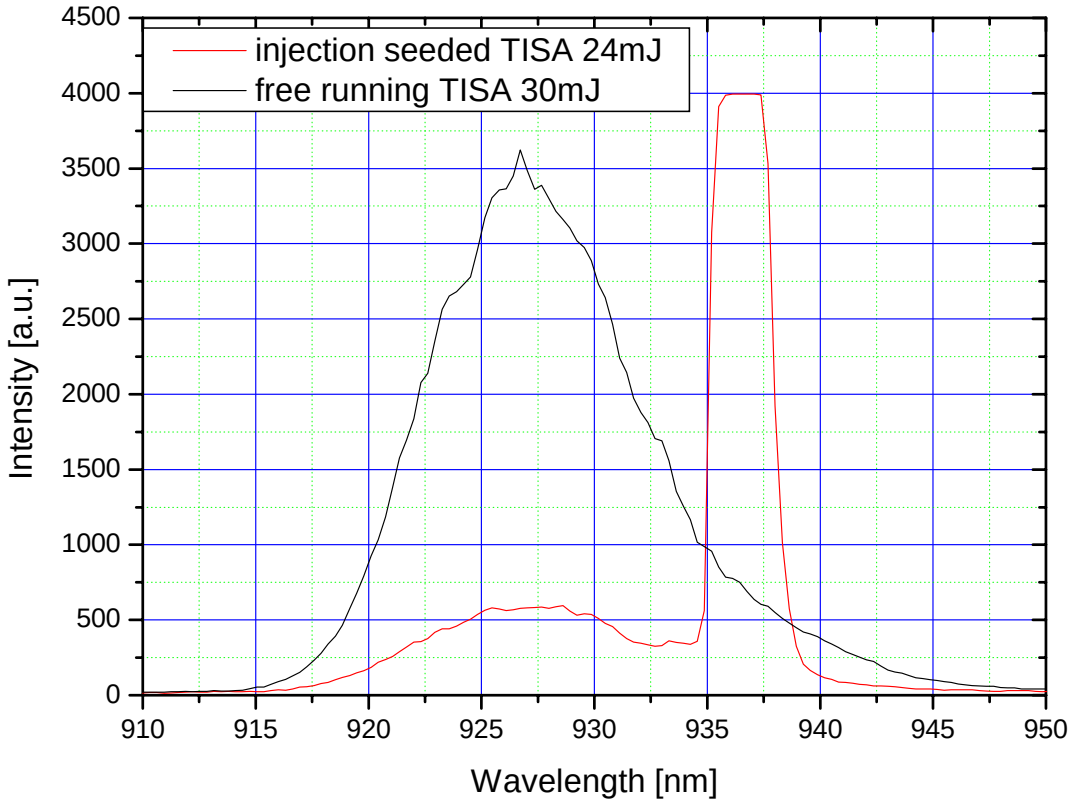
# Set-up of linear TISA resonator



# Pulse energy of linear Ti:Sapphire laser

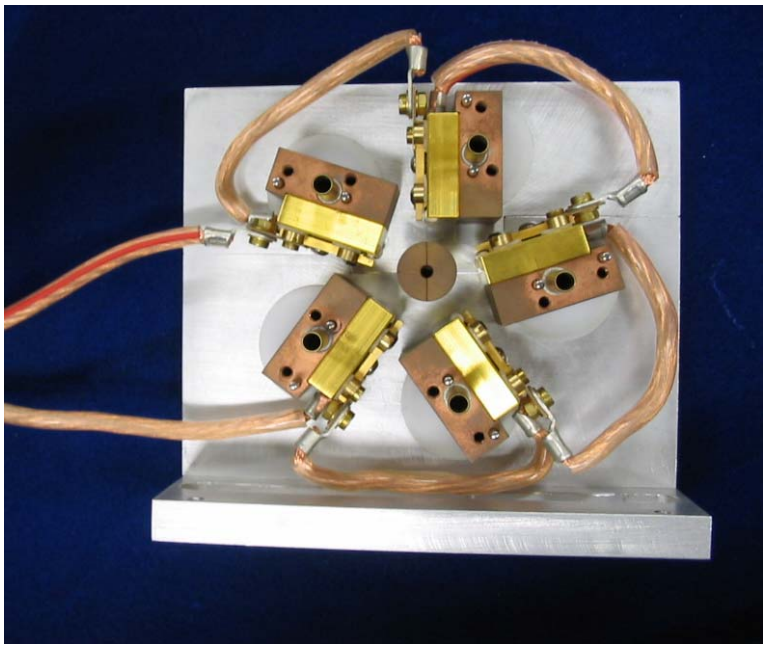


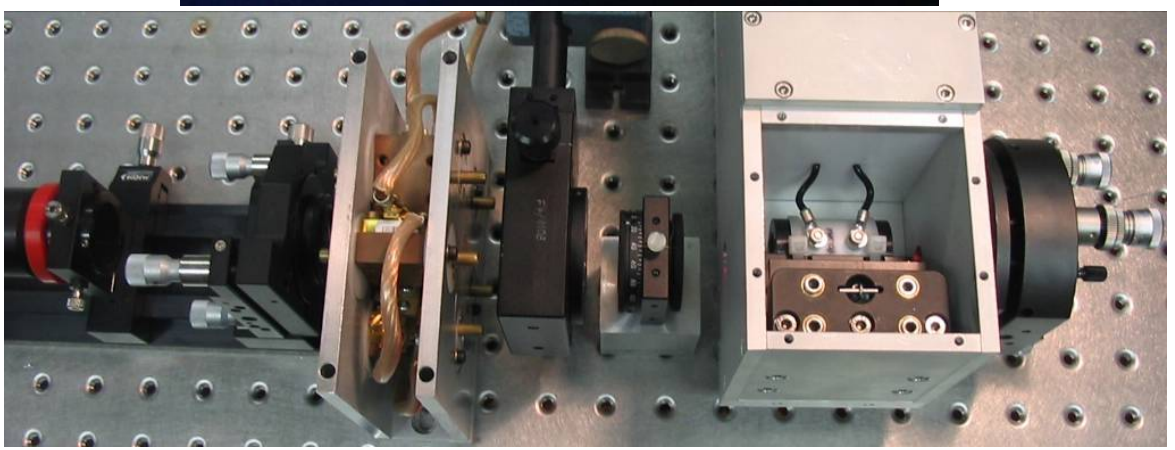
# Injection seeding of linear Ti:Sapphire resonator



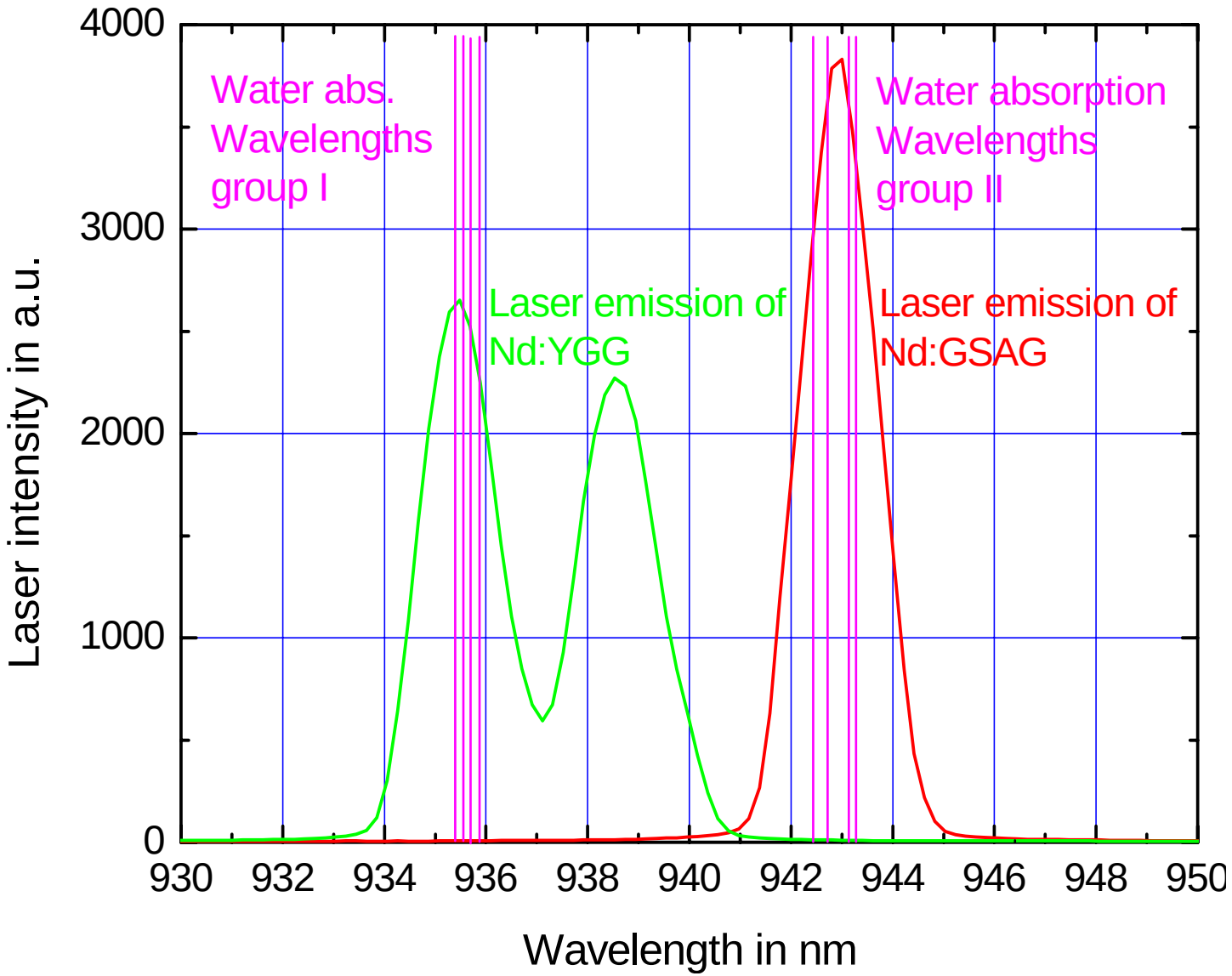

With injection seeding with 18mW seed power 83% of TISA output energy is emitted at the seed wavelength (~936 nm). To improve this ratio more seed power is necessary.

# Nd:GSAG and Nd:YGG lasers

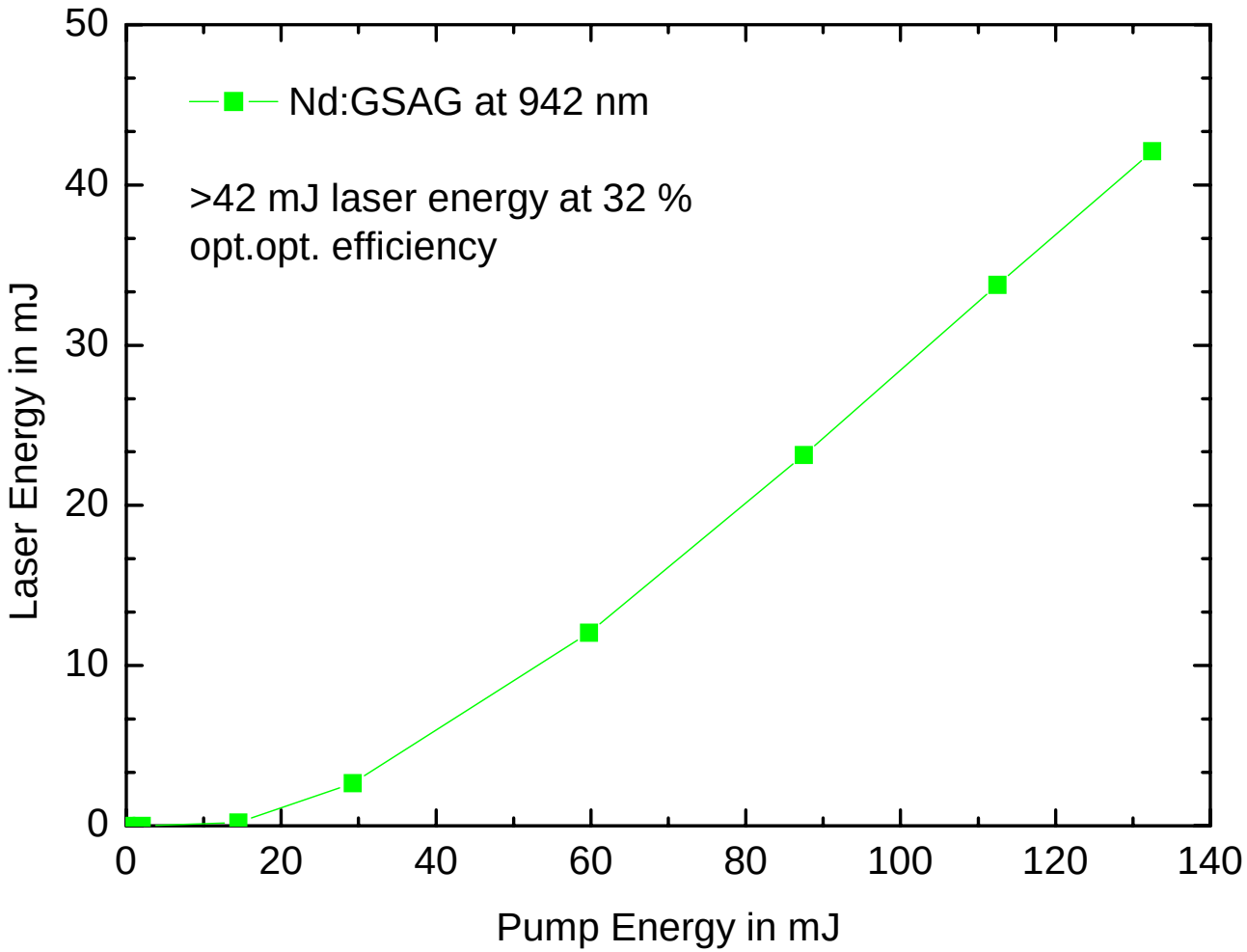




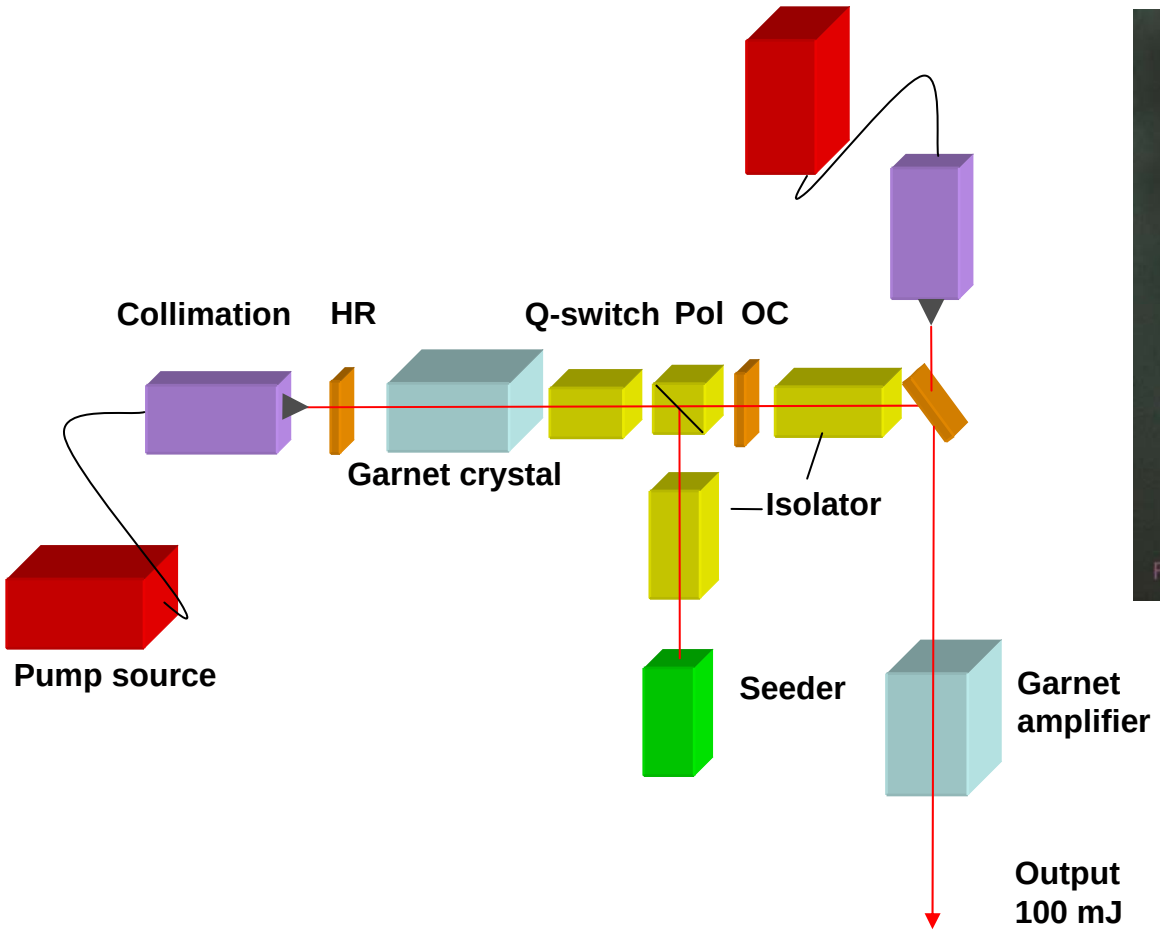
# Spectral properties of YGG and GSAG Lasers



# Mixed Garnet Laser Energy



# Proposal: 100 mJ seeded MOPA system





**Nd:GSAG boule drawn by FEE**
**Previous boules by University of Hamburg**

# Summary

**Ti:Sapphire laser for 936 nm generation**

- *ring resonator:* 20 mJ laser energy with 15 ns pulse width and spectral purity of 99.6% was achieved using 100 mJ pump energy from a frequency doubled Nd:YAG laser.
- A spectral purity of 99.9% was achieved operating the TISA at 10 mJ .
- *linear resonator:* 46 mJ laser energy with 70 ns pulse width at about 930 nm was achieved using 230 mJ pump energy.

**Nd:GSAG Garnet laser**

- direct diode pumped emission at 942 and 936 nm with optical efficiency of > 30 %
- Pulse widths 30 to 100 ns in Q-switched operation
- 42 mJ pulse energy at 942 nm demonstrated