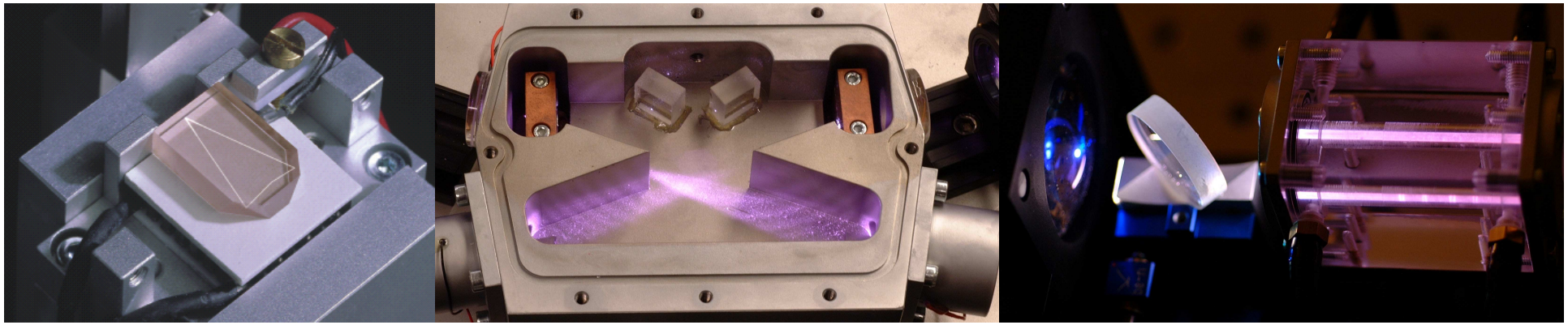

AdvLIGO Laser Status

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LSC March 06
G060112-00Z

Outline

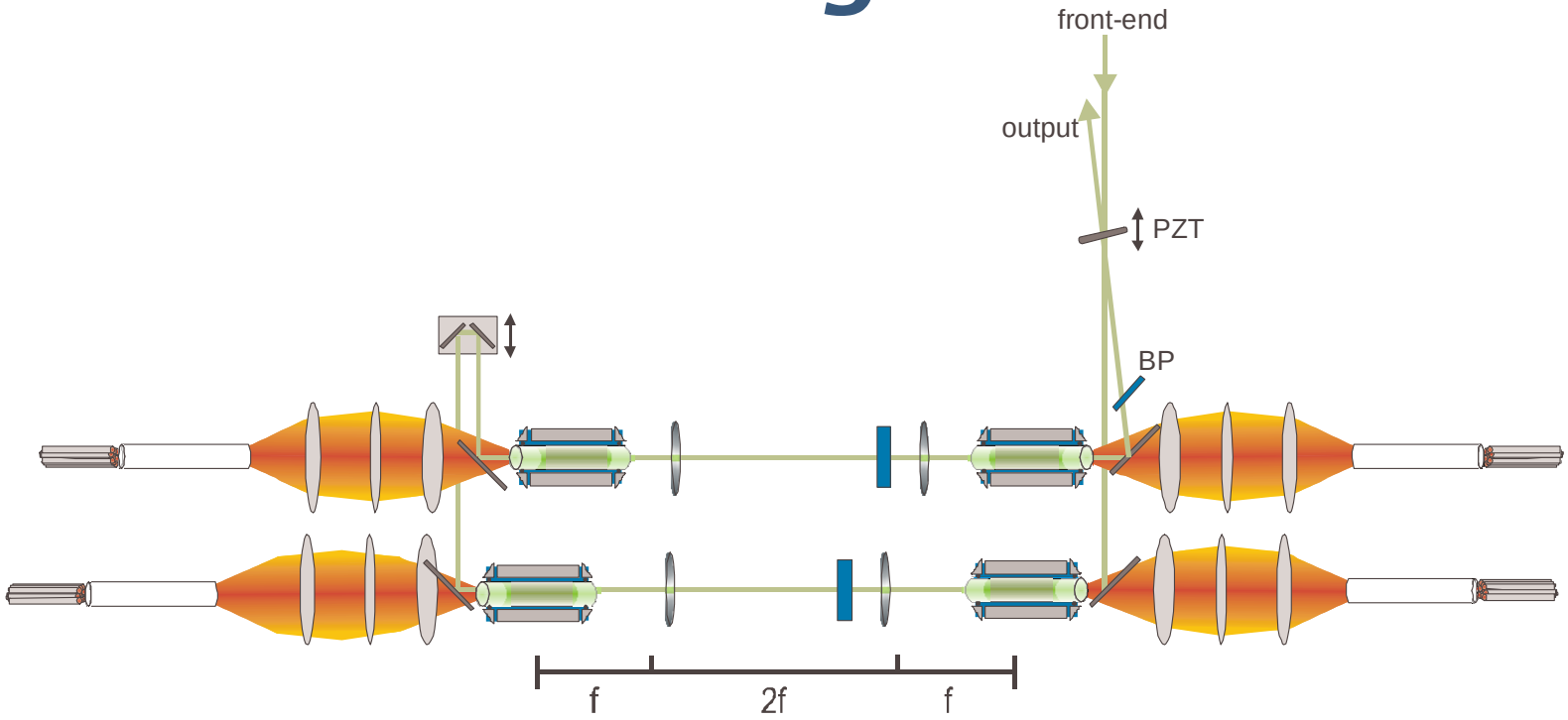
- Optimization History of the advLIGO laser
  - New laser design approach
  - Component related complications
  - Quality inspection measures for new components
  - Final results of new approach

History

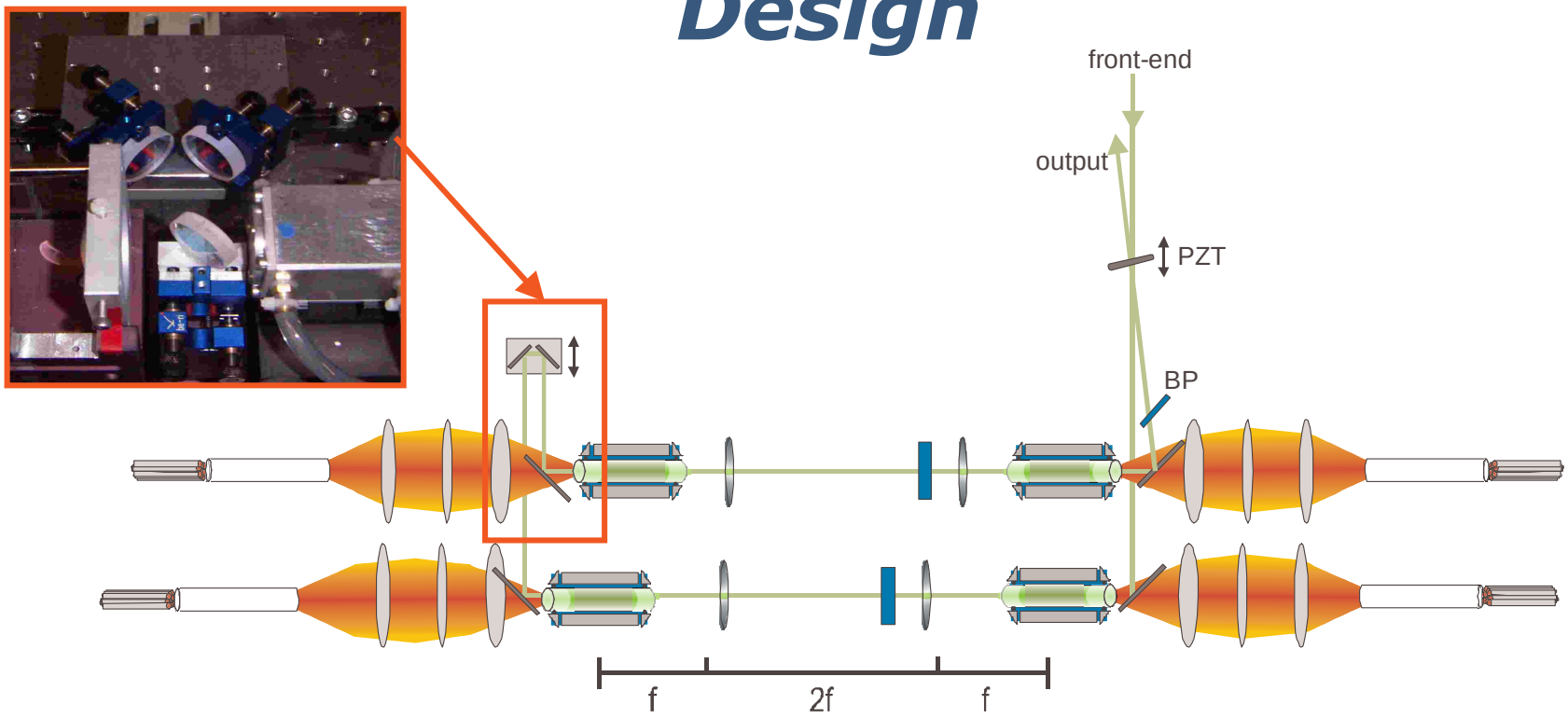
New resonator design to improve beam profile / mode control

- Asymmetric resonator design

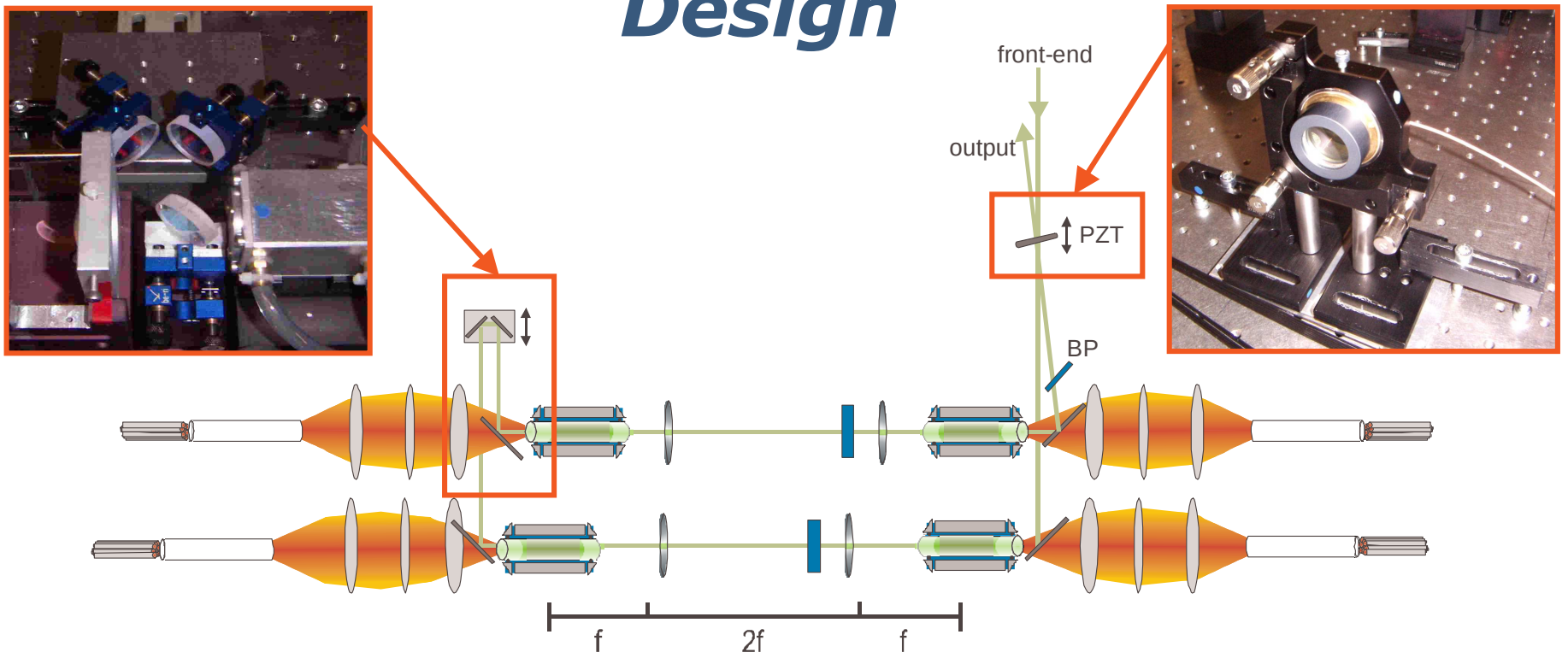
New Resonator Design



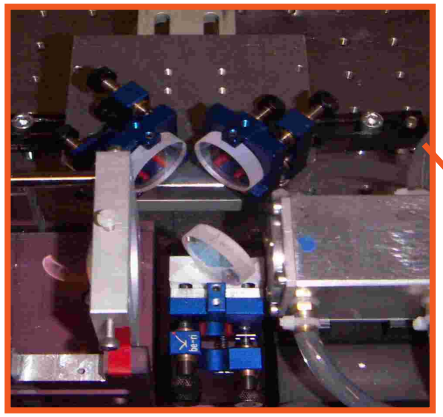
New Resonator Design

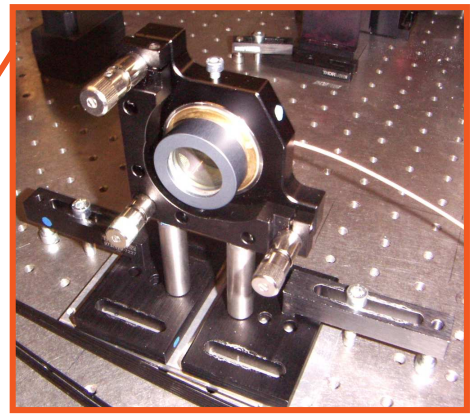


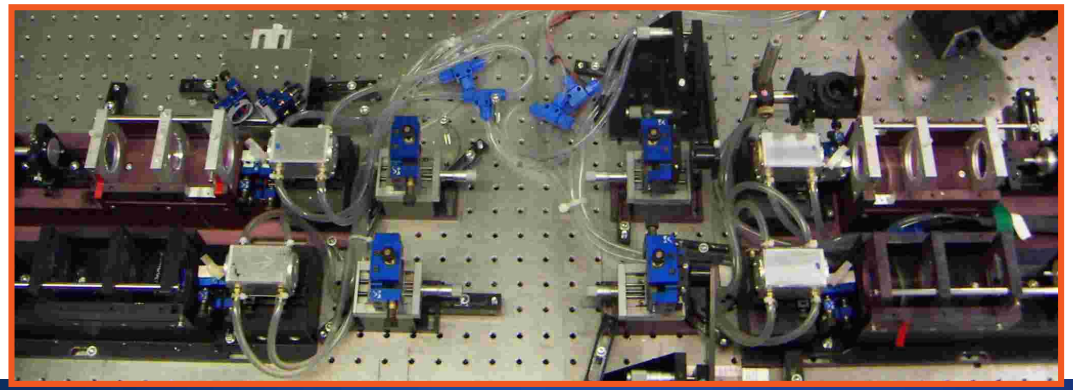
New Resonator Design



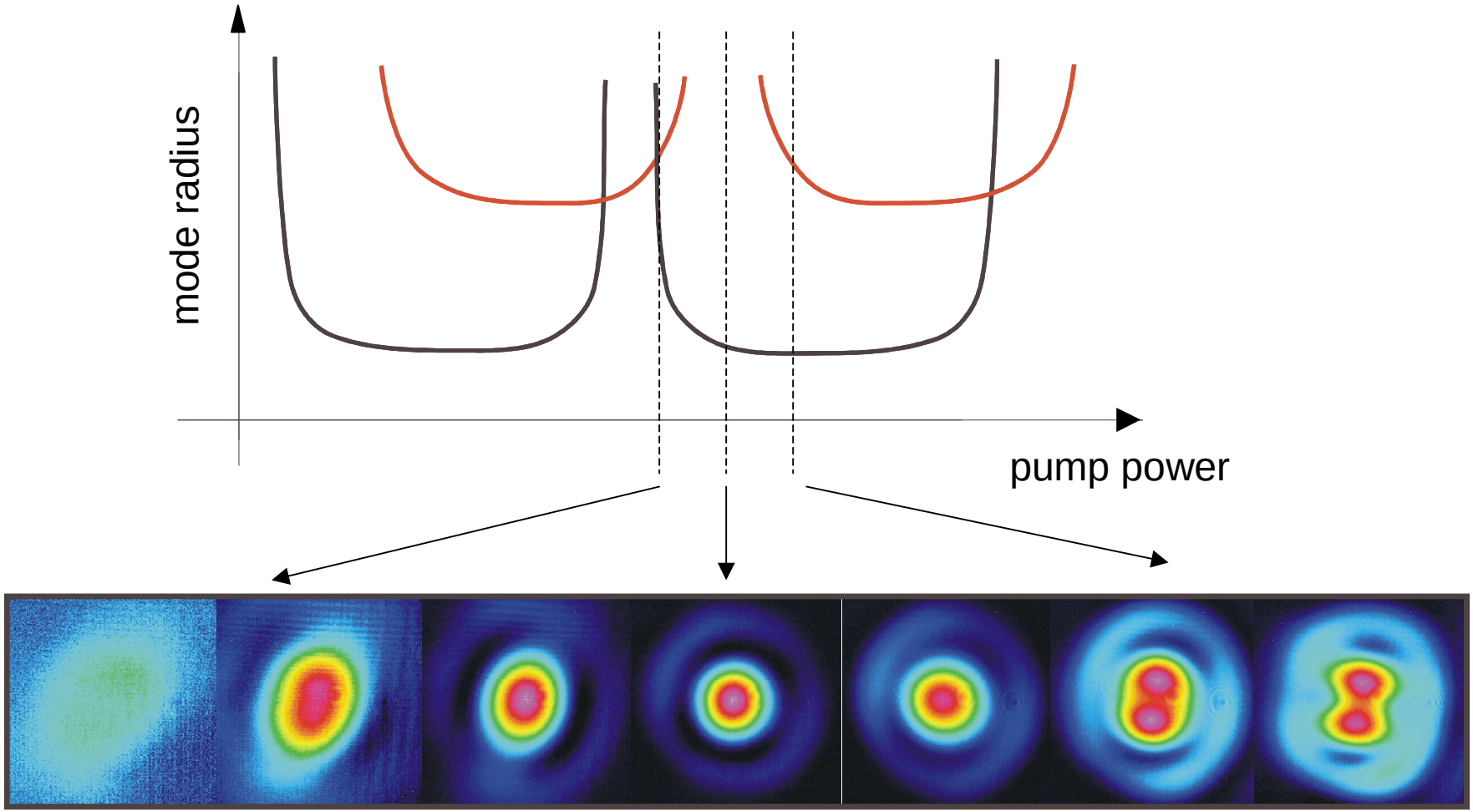
New Resonator Design







Better mode control



History

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  - Asymmetric resonator design => output power ≈ ***115 W***
- Difficulties with low damage threshold of 45° mirr or coatings
  - Mirrors changed to high power IPG coated ones

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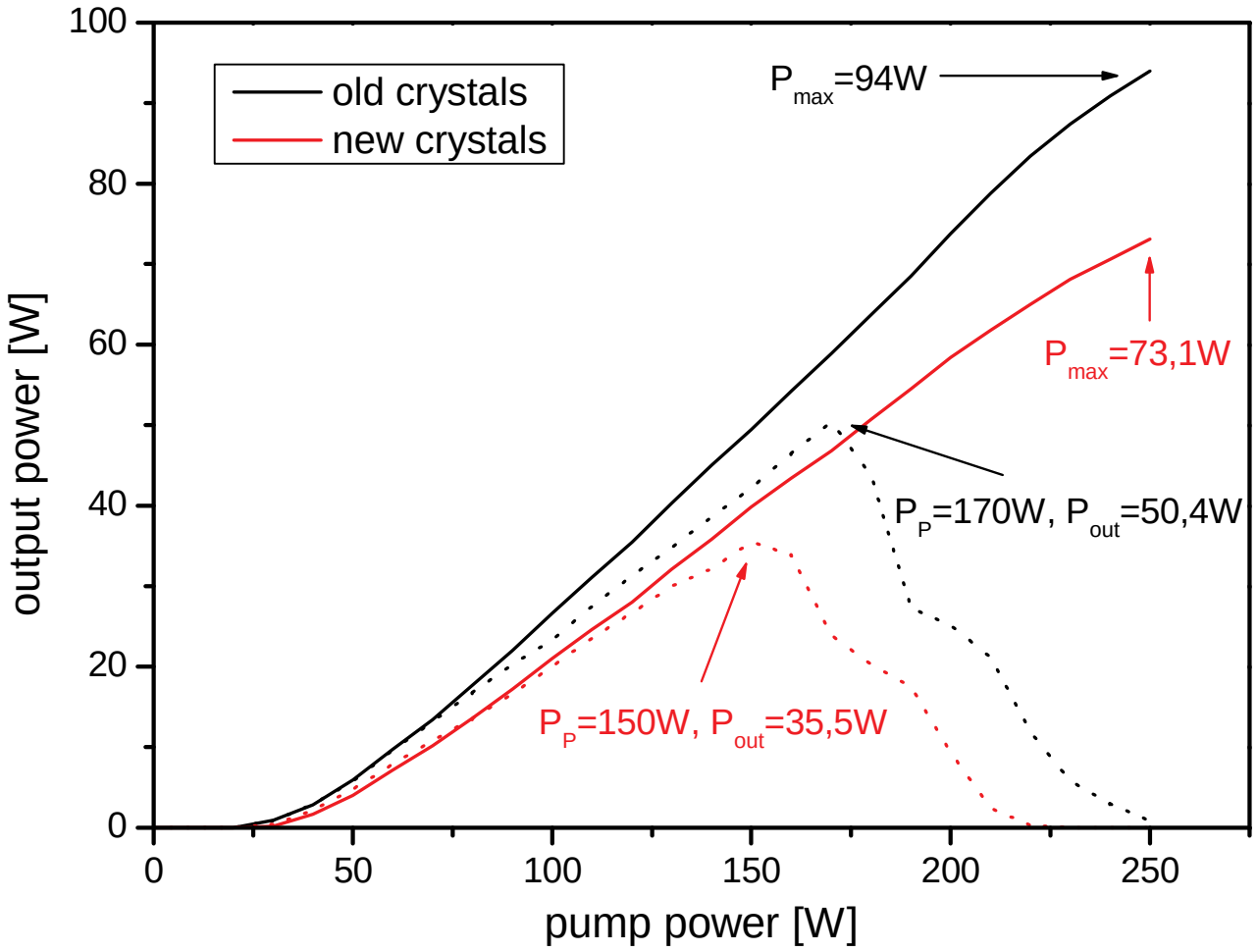
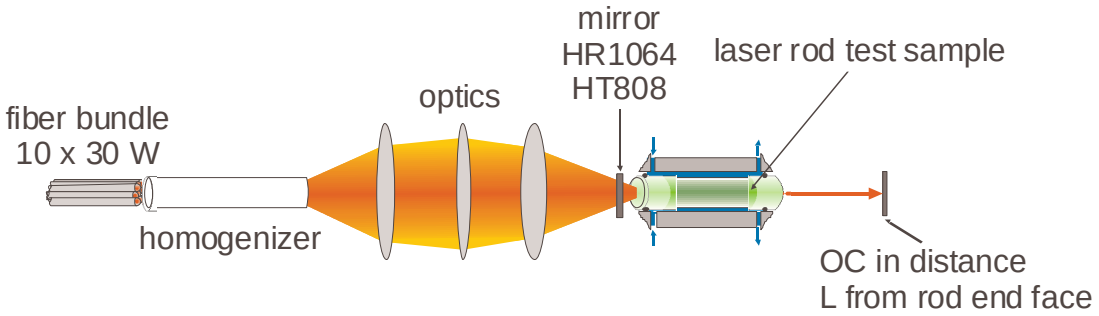
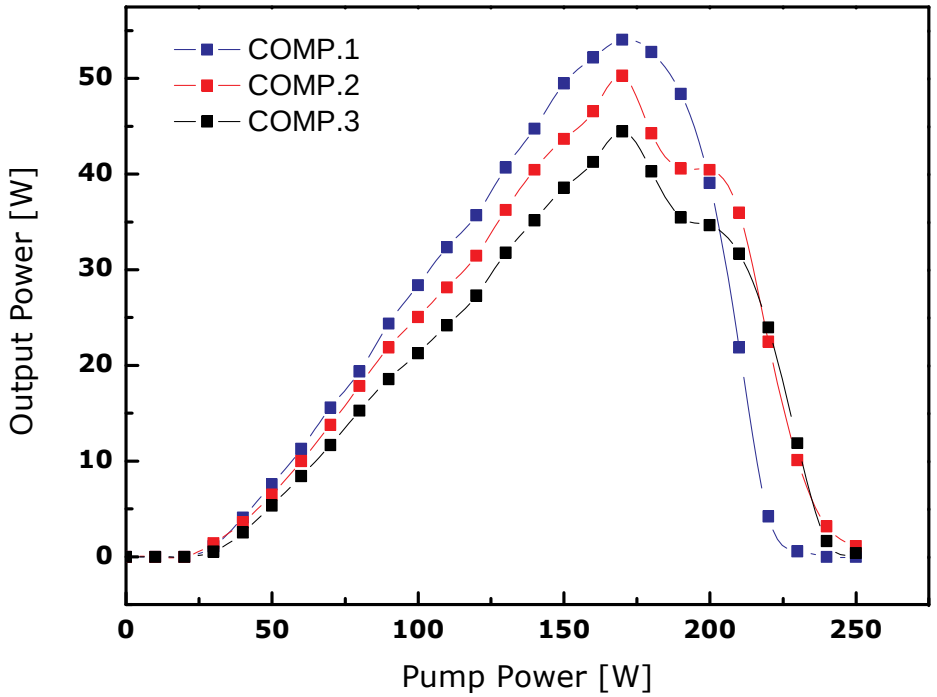
- Power-loss due to impurities in laser crystal material
  - minimal Er/Yb contamination in crystal material
  - decrease in output power by unknown absorption effects
  - higher thermal-lensing

Comparison of laser crystals old and new

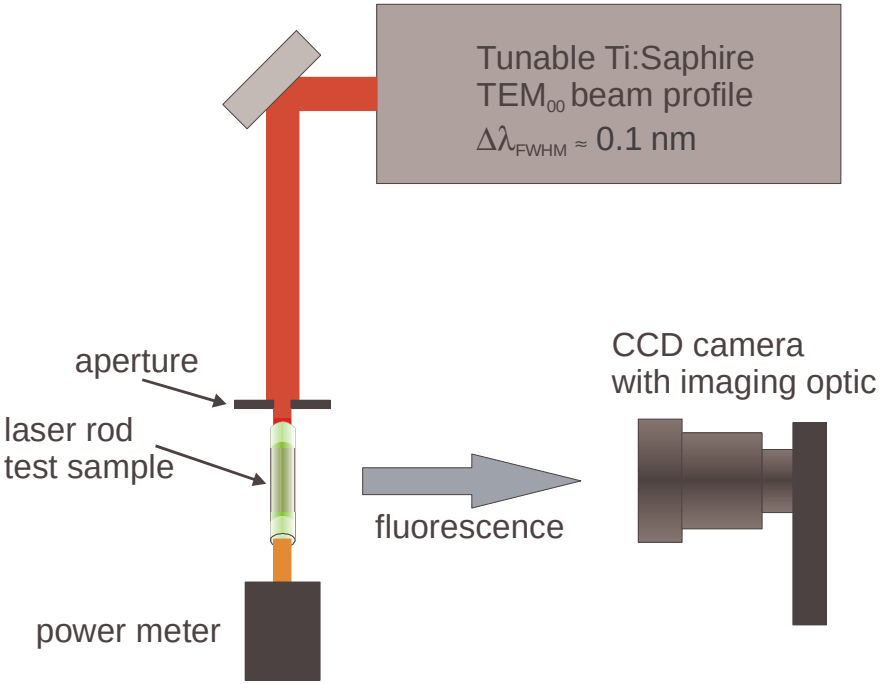


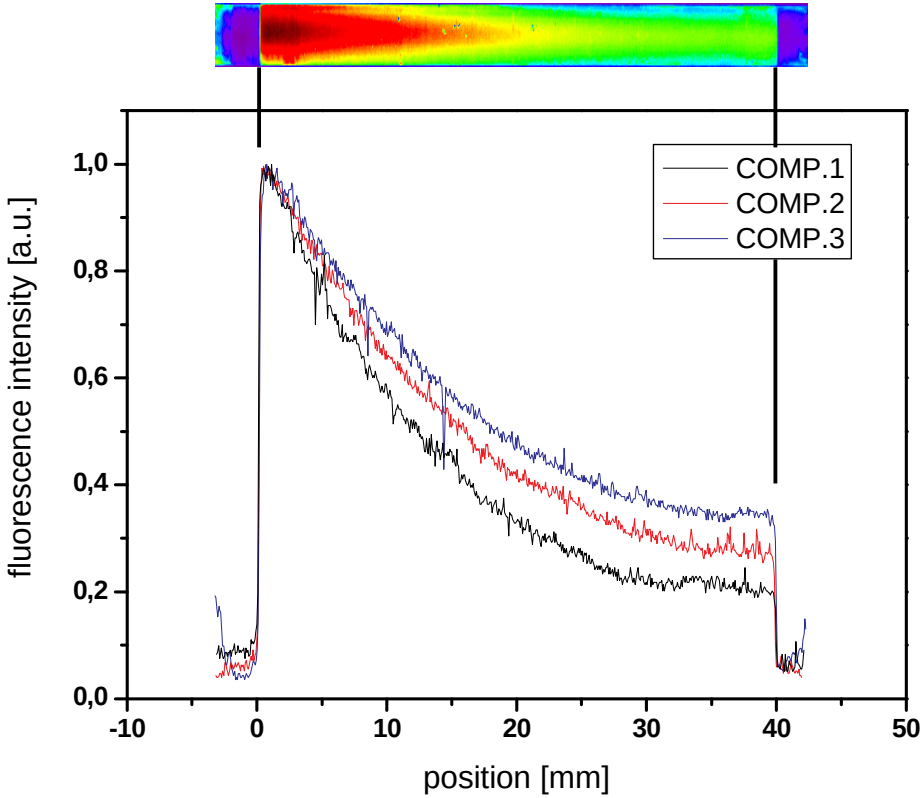
Quality inspection measures for new components: laser crystals





Quality inspection measures for new components: laser crystals





Variation of up to +/-10% in doping concentration for rods from different vendors

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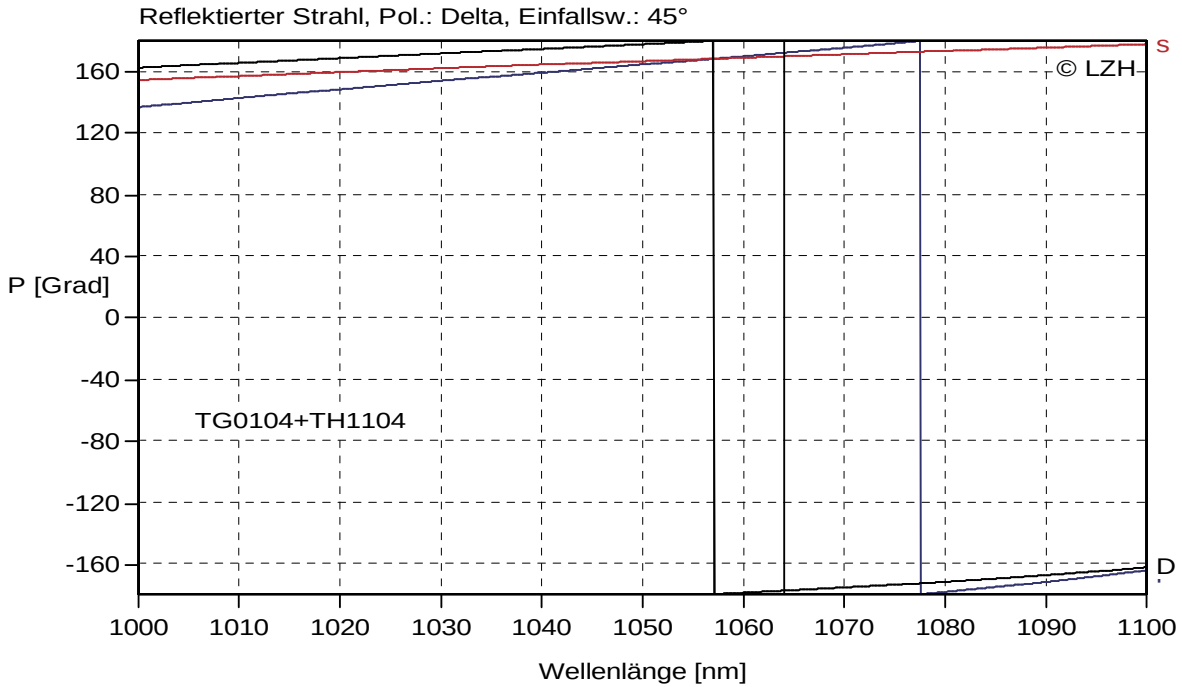
- Limitation of output power due to depolarization effects
  - 45° HR1064nm / HT808nm => phase shift difference f or p- and s-polarization up to ***30°***
  - mirrors act as λ/x-waveplates
  - additional depolarization losses

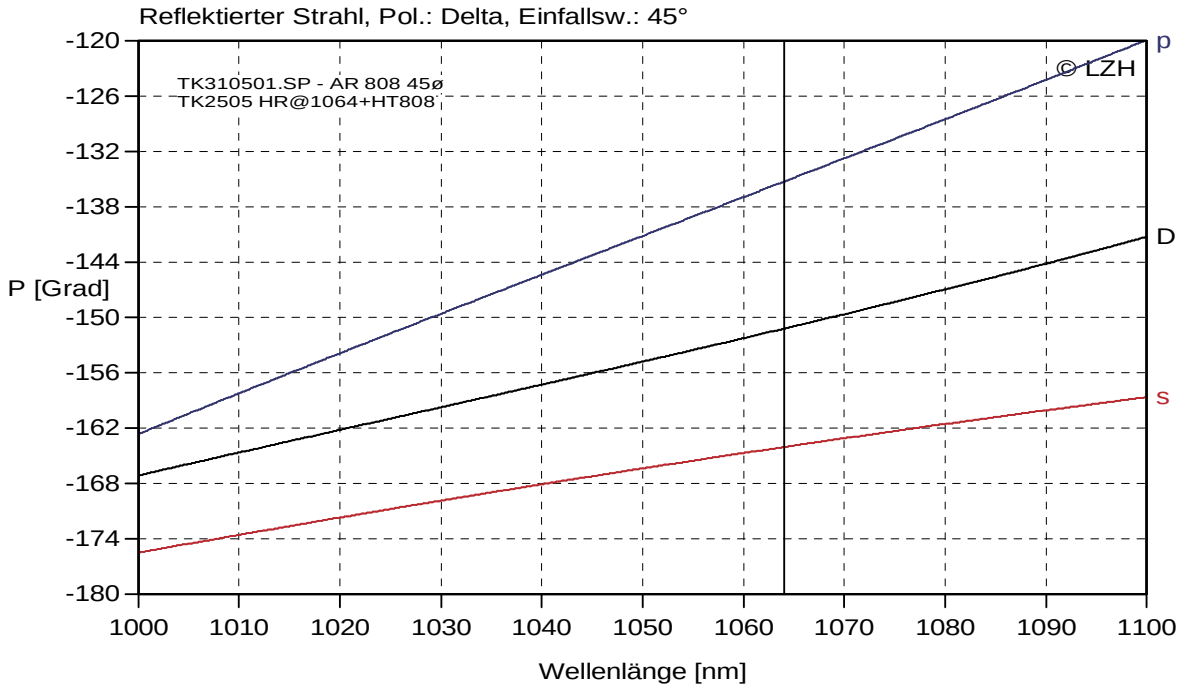
Mirrors

Old mirror with low damage threshold: phase difference 3° for s- and p-polarization



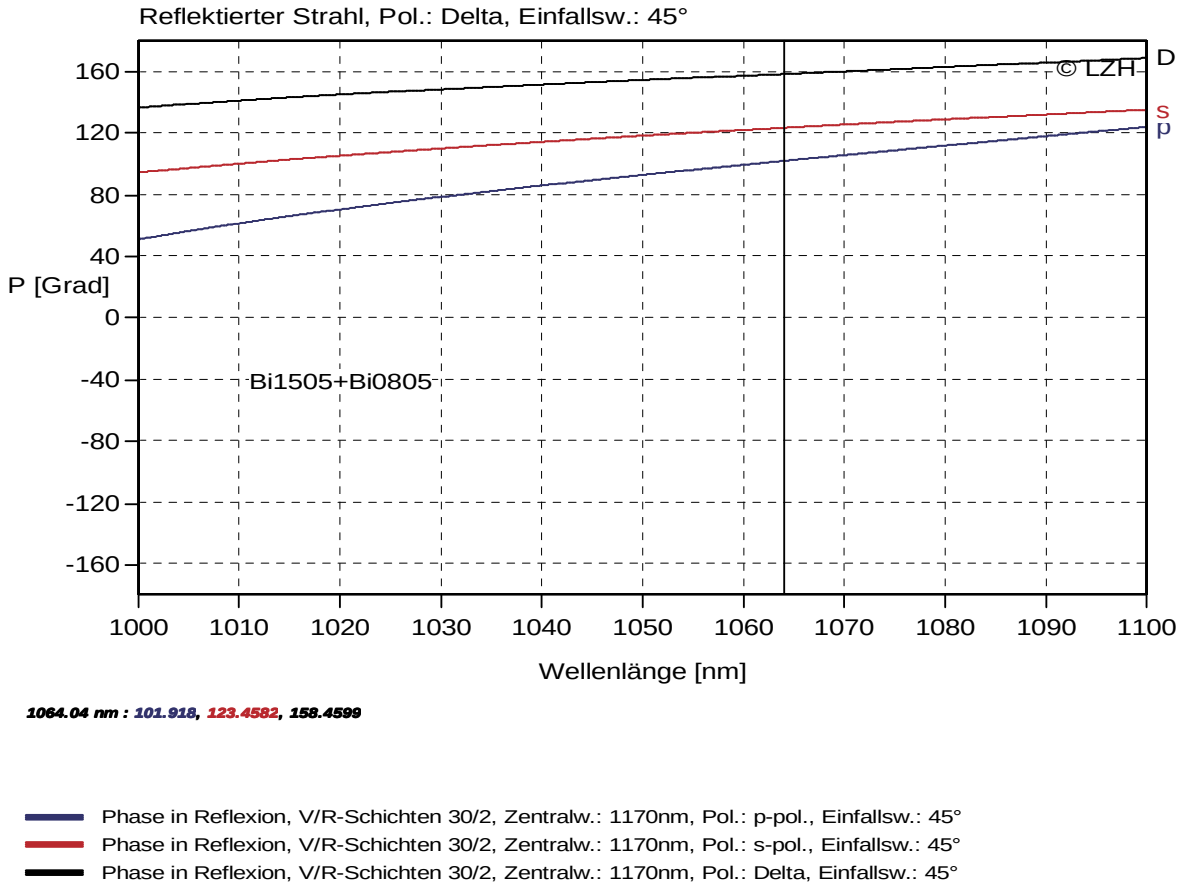
Mirrors

New high power mirror with IPG coating:
phase difference 30° for s- and p-polarization



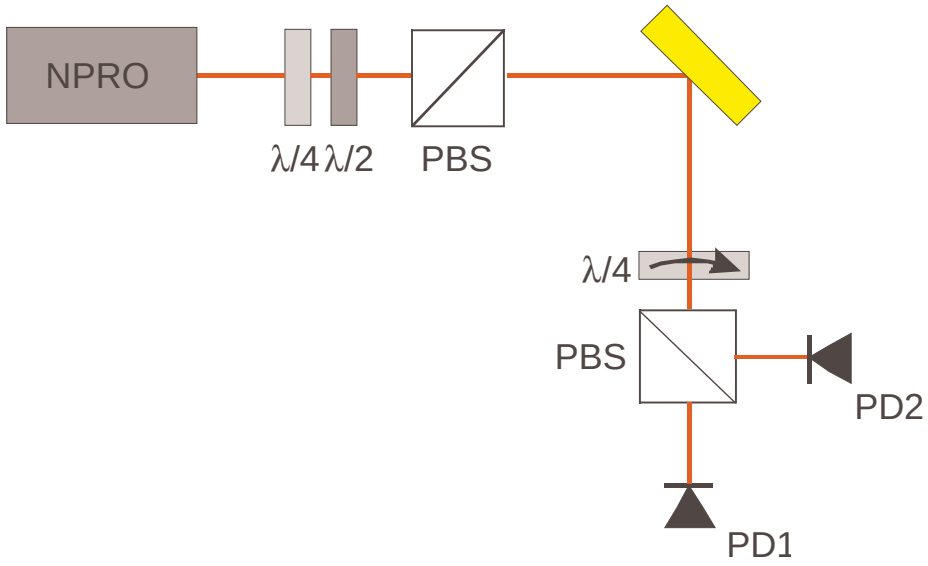
Mirrors

Mirrors actually used:
phase difference 20° for s- and p-polarization

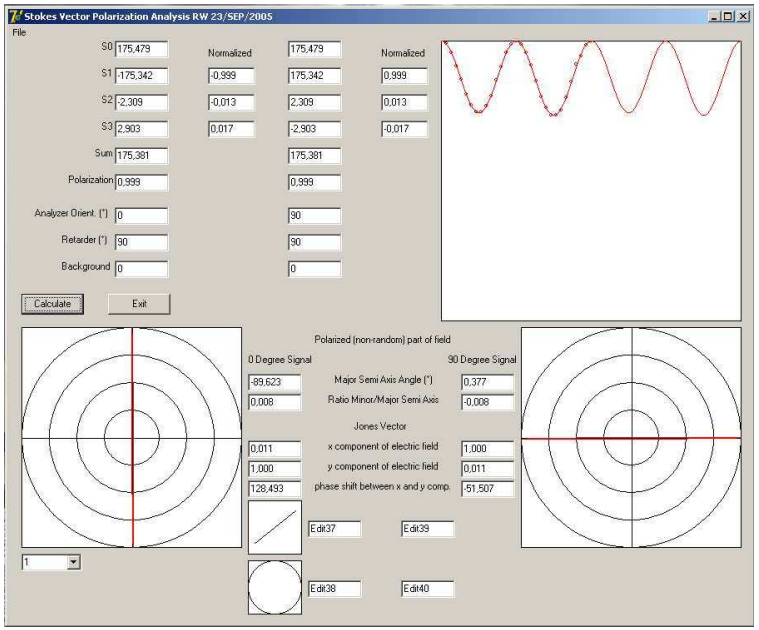


Quality inspection measures for new components: mirror's

automated polarimeter



polarization analysis software



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  - Increased output power by use of mirrors with 20° phase shift to ≈ ***150 W***

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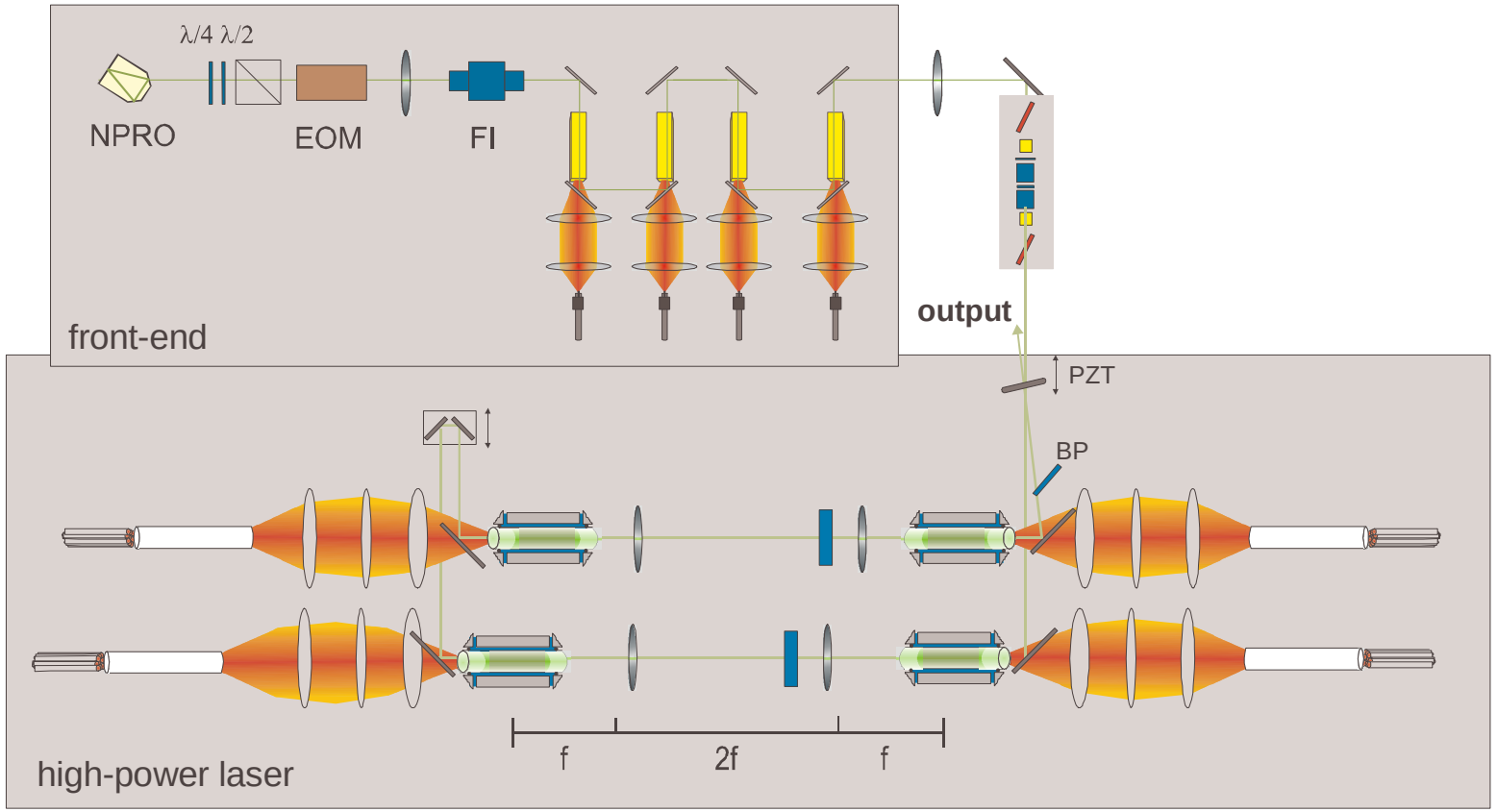
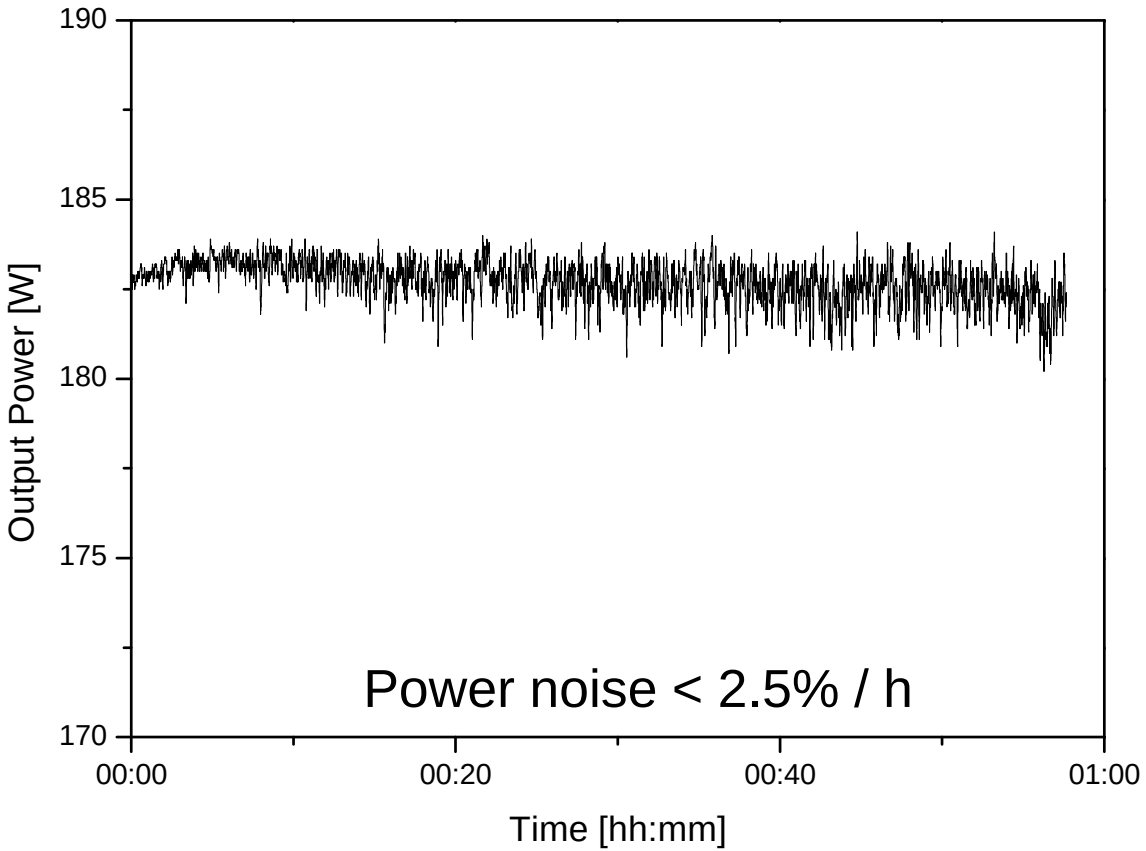
- Limitation of output power due to depolarization effects
  - Increased output power by use of mirrors with 20° phase shift to ≈ ***150 W***
- Improvement of locking range
  - Replaced front-end by 35 W Nd:YVO_4 amplifier

New Laser Design

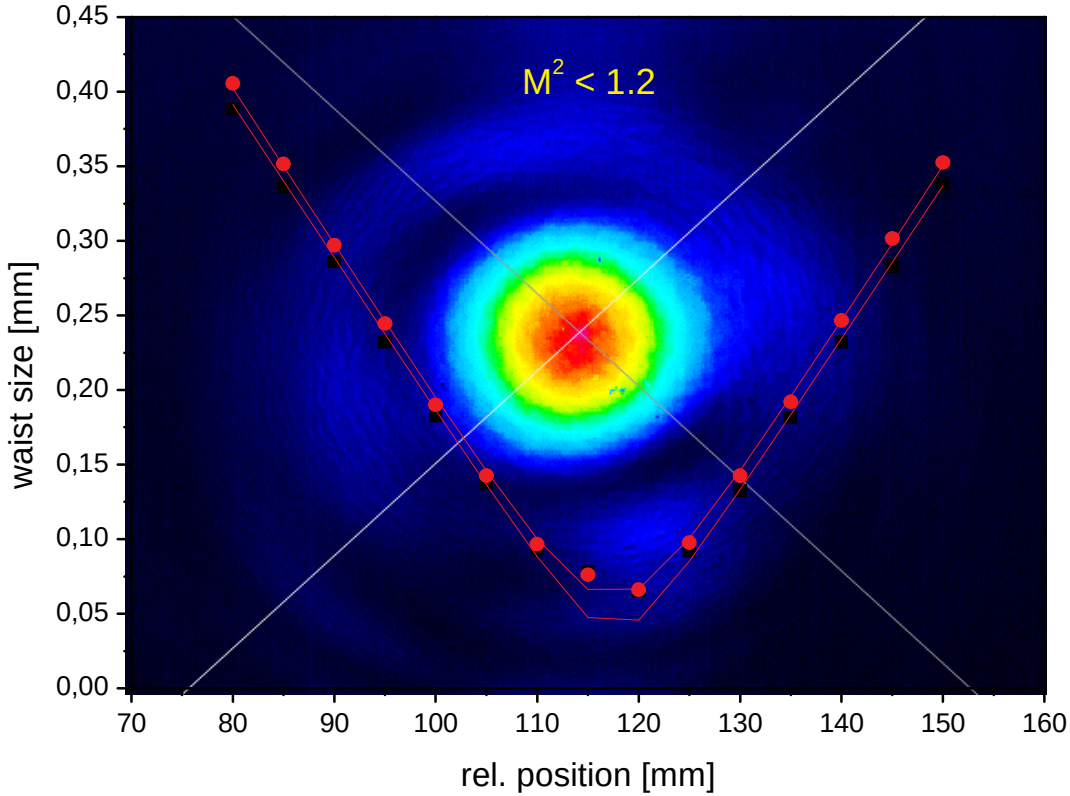


Injection-Locked Single Frequency Output-Power



Single-frequency TEM_{00} output power 183 W

Beam Quality



Optimization of front-end to HPL mode-matching:
Further improvements in output power and beam quality possible

Summary and Outlook

- 35 W front-end implemented
- 183 W linearly polarized output power
  (>200 W expected due to new mirrors)
- Beam quality $M^2 < 1.2$ (has to be optimized)

- Quality inspection measures for incoming components
- Further investigation on PET mirror resonance
- More accurate mode-matching of front-end and HPL