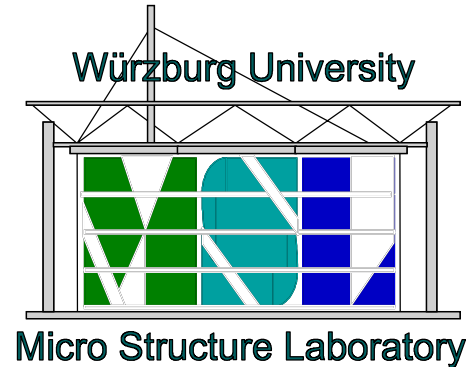


QDots Lasers

Presented by: Johann Peter Reithmaier⁽¹⁾
Organisation name: University of Würzburg
Co-workers: St. Deubert, W. Kaiser, R. Debusmann

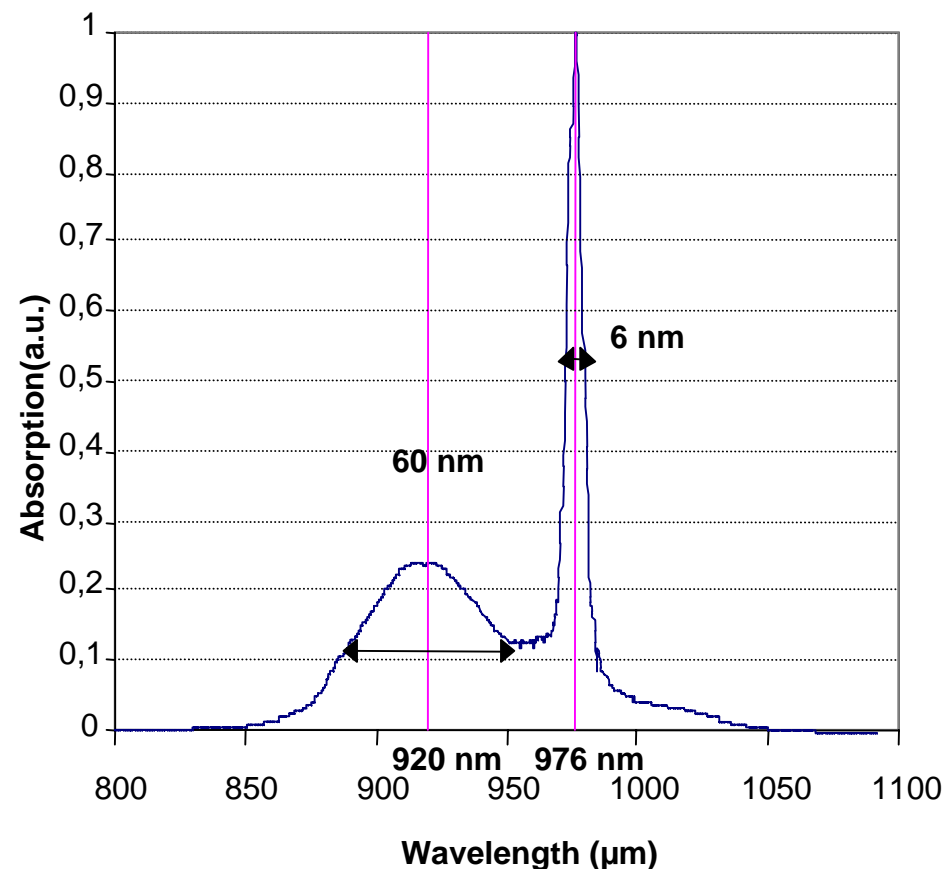


⁽¹⁾Present address: University of Kassel,
Institute of Nanostructure Technologies and Analytics

Demand for Uncooled Pump Lasers

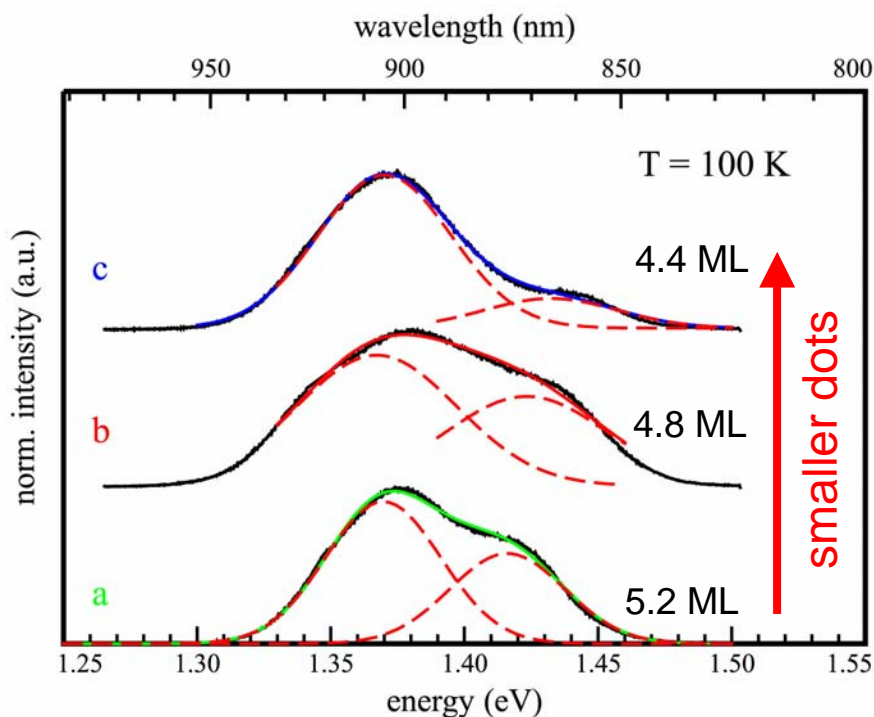
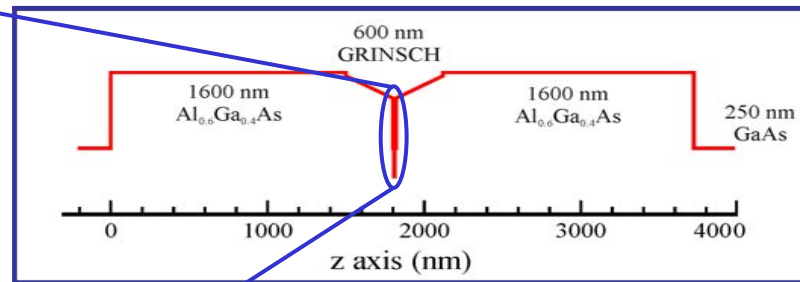
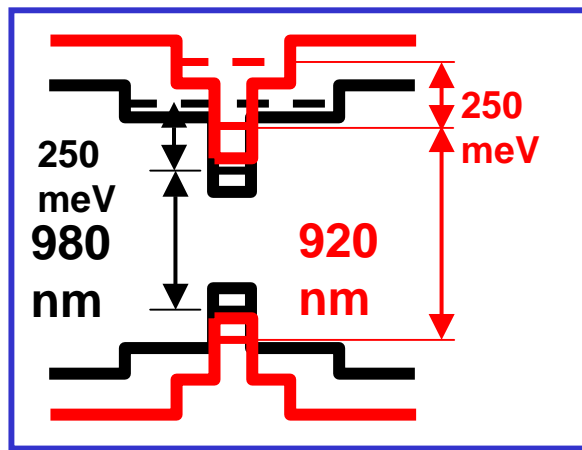
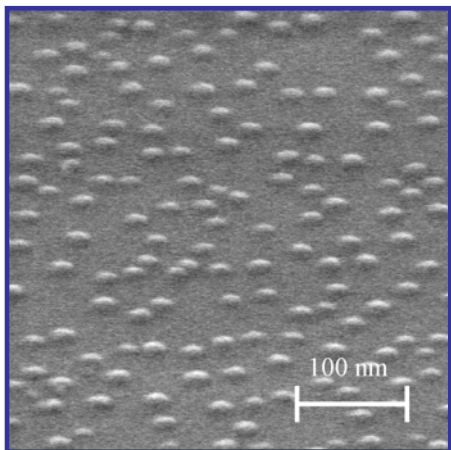
- Major costs in high power pump modules: **Peltier cooler**
- External wall plug efficiency of pump module dominated by Peltier cooler consumption.
- **Strong cost reduction possible by passive cooling**
- Passive cooling with QW laser impossible due to wavelength shift (> 20 nm between $0 - 65$ °C)
- 920 nm favourable due to broader absorption band
- **High power 920 nm QD laser with temperature shift < 10 nm possible**

Absorption spectrum of Yb fibre

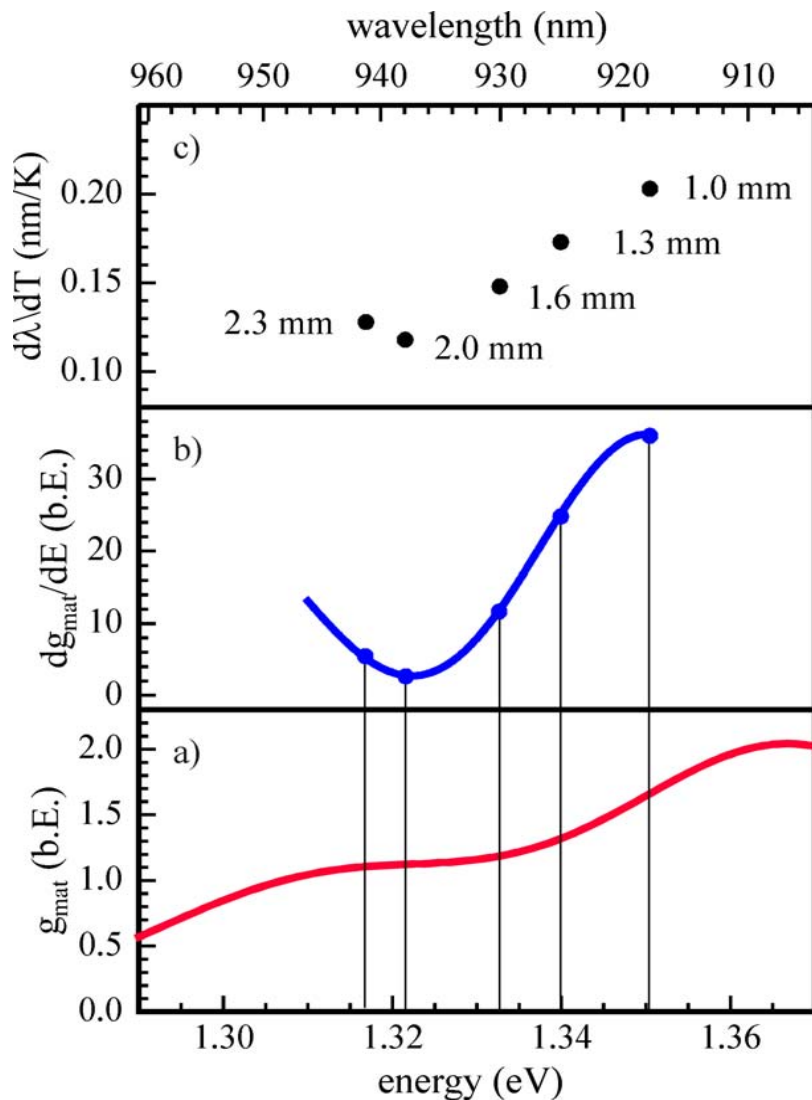


- Development of 920 nm temperature stable quantum dots material for uncooled laser pump modules
- Realisation of high power single mode QDots tapered lasers with lateral feedback gratings

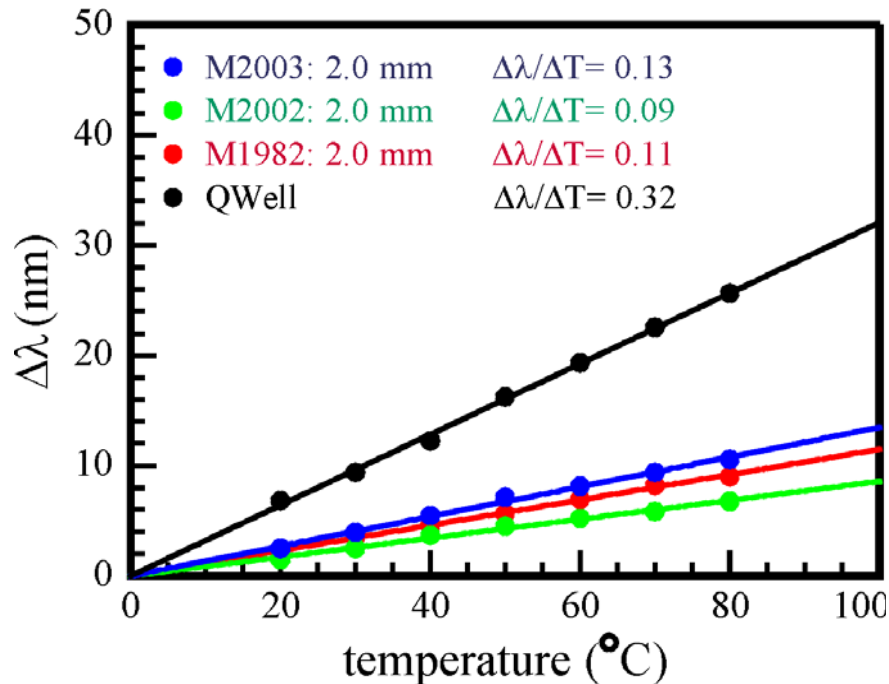
Optimisation of Quantum Dots Material for 920 nm



- 920 nm quantum dots need new layer design
- Carrier confinement should be constant (250 meV) to keep temperature stability
- Barrier height increased to 40%, cladding to 60% Al content
- Reduced In content for short wavelength
- Smaller QDs for larger level splitting

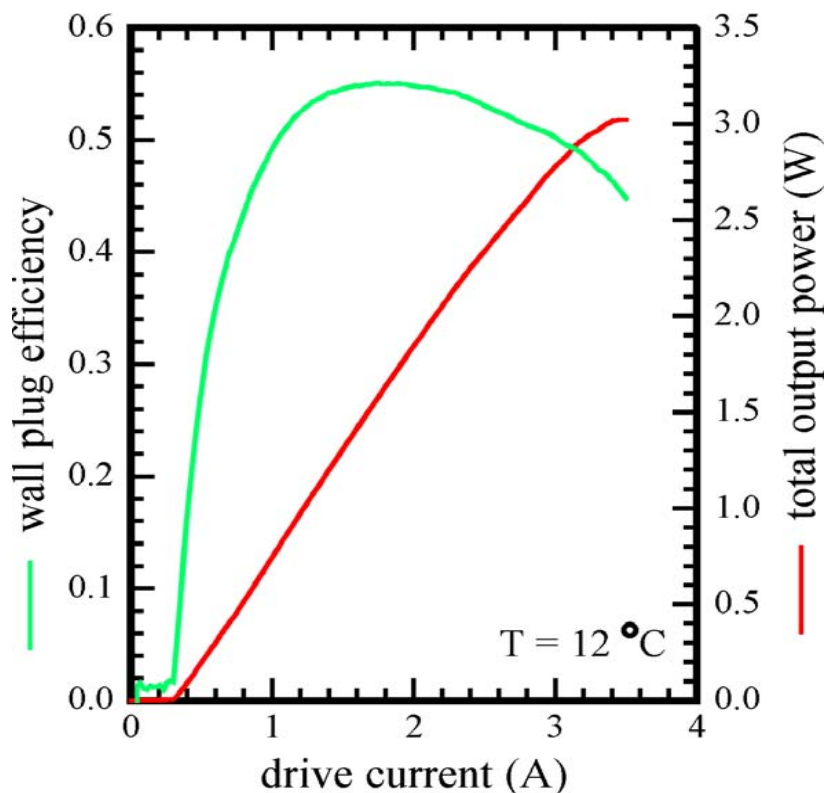


Temperature stability of wavelength shift

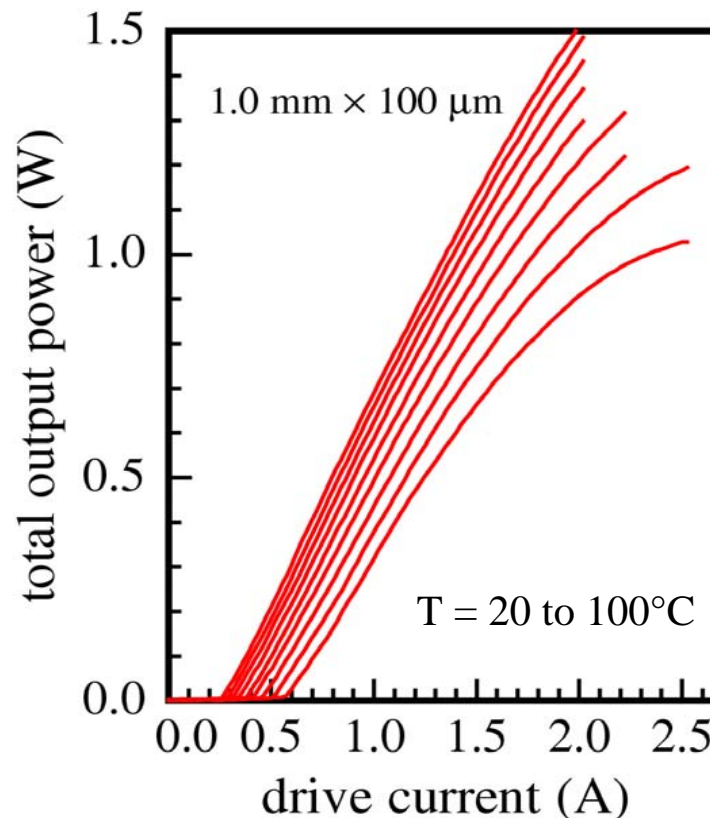


- Flat gain profile similar to 980 nm lasers
- Very low temperature dependence of emission wavelength (0.09 nm/K)

BA lasers (100 μm x 1 mm)

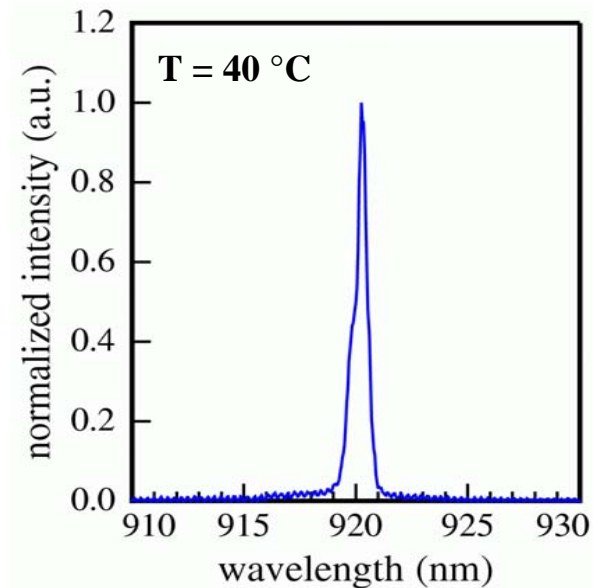
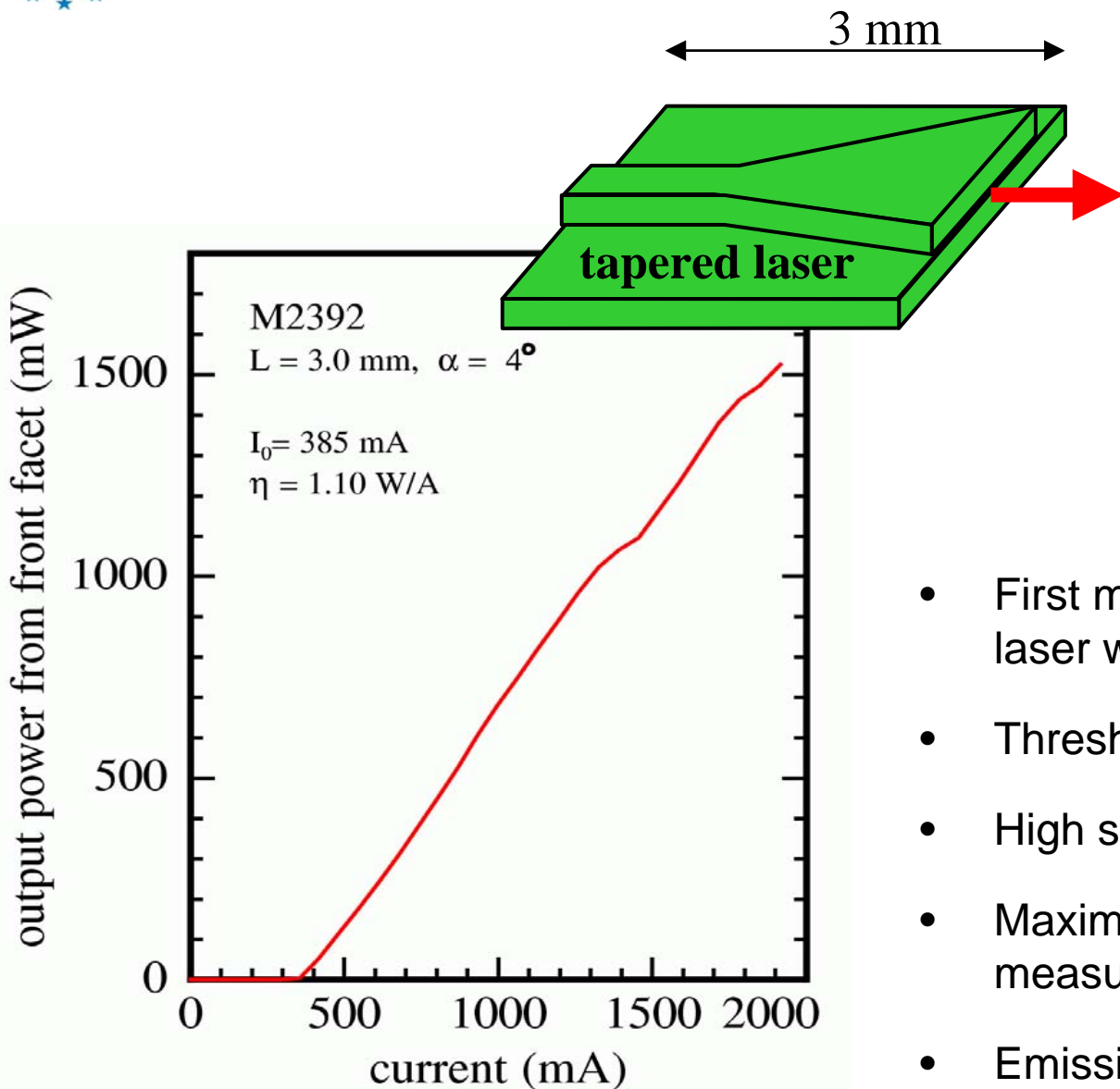


- wall-plug efficiency up to 55 % at 1.5 W
- max. output power of 3 W at 3.2 A



- high temperature stability of threshold and efficiency ($T_0 > 150$ K)
- $P_{\text{out}} > 1$ W at 100°C

Tapered Laser with 920 nm Quantum Dots



- First measurement of 3 mm long tapered laser with 4° angle
- Threshold current of 385 mA
- High slope-efficiency of 1.1 W/A
- Maximum power of 1.2 W limited by measurement setup in pulsed mode
- Emission wavelength of 920 nm at 40 °C

- 920 nm QDots laser material developed with stabilized emission wavelength (QD: $d\lambda/dT = 0.09 \text{ nm/K}$, QW: $d\lambda/dT = 0.35 \text{ nm/K}$)
- BA QDots lasers with high device performance ($\eta_{\text{ext}} > 1.1 \text{ W/A}$, $\eta_{\text{w.p.}} = 55\%$, $P_{\text{out}} > 1 \text{ W cw}$ at $100 \text{ }^\circ\text{C}$)
- Tapered lasers with nearly preserved device data ($\eta_{\text{ext}} = 1.1 \text{ W/A}$, $P_{\text{out}} > 1.5 \text{ W}$)
- Single mode tapered lasers with lateral feedback gratings ($\eta_{\text{ext}} = 0.88 \text{ W/A}$, $P_{\text{out}} > 0.5 \text{ W}$)