AKL ´12 EU Innovation Forum

High-brilliance Fiber Laser Sources with new NIR Wavelengths

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IPG PHOTONICS®

High Power Fiber Lasers and Amplifiers

The Power to Transform™

Overview

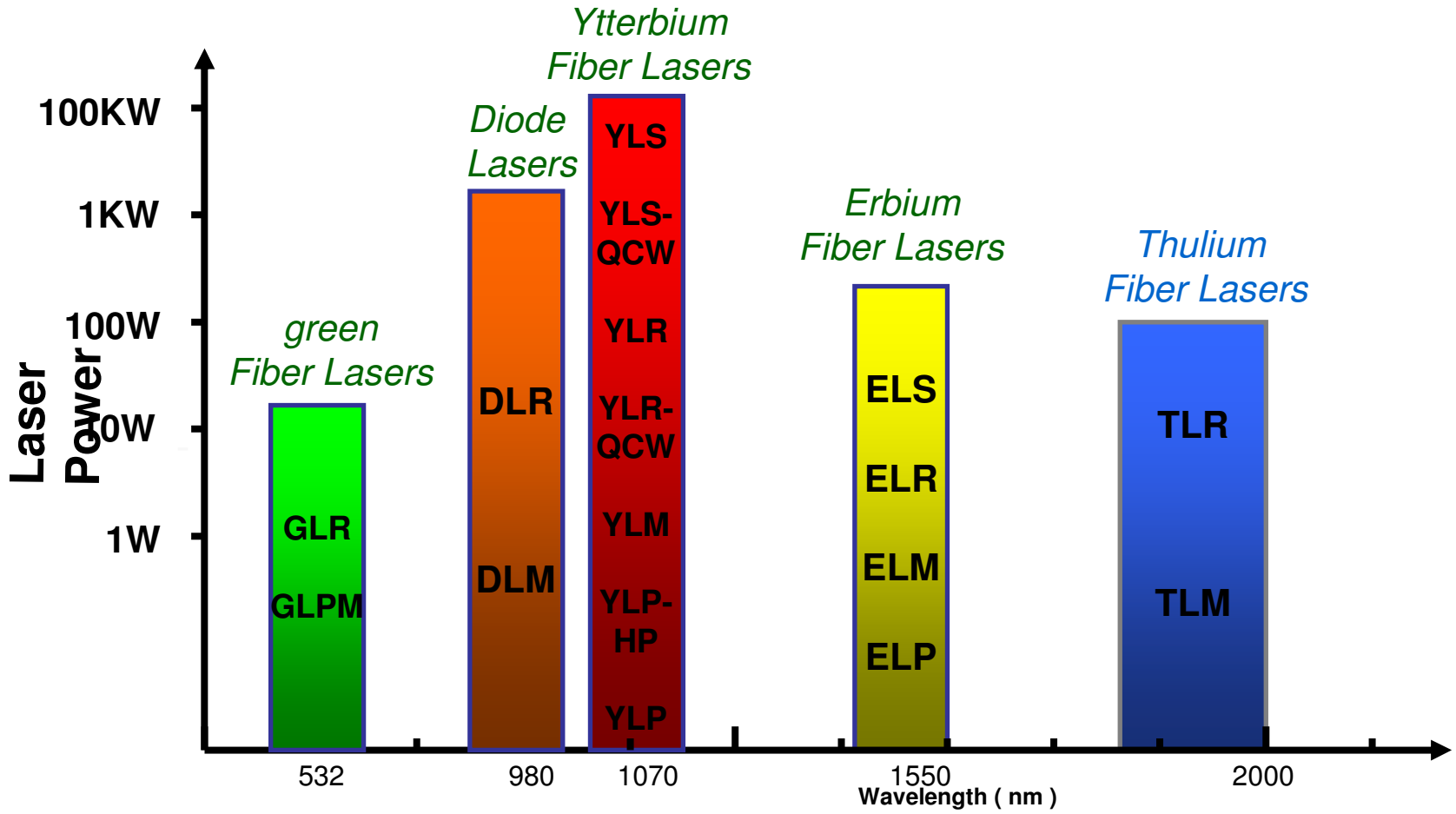
1. Overview of IPG´s different Fiber Laser types

2. Setup of Erbium doped Fiber Lasers (1.567 nm wavelength)
   - 2.1. Single Mode
   - 2.2. Multi Mode

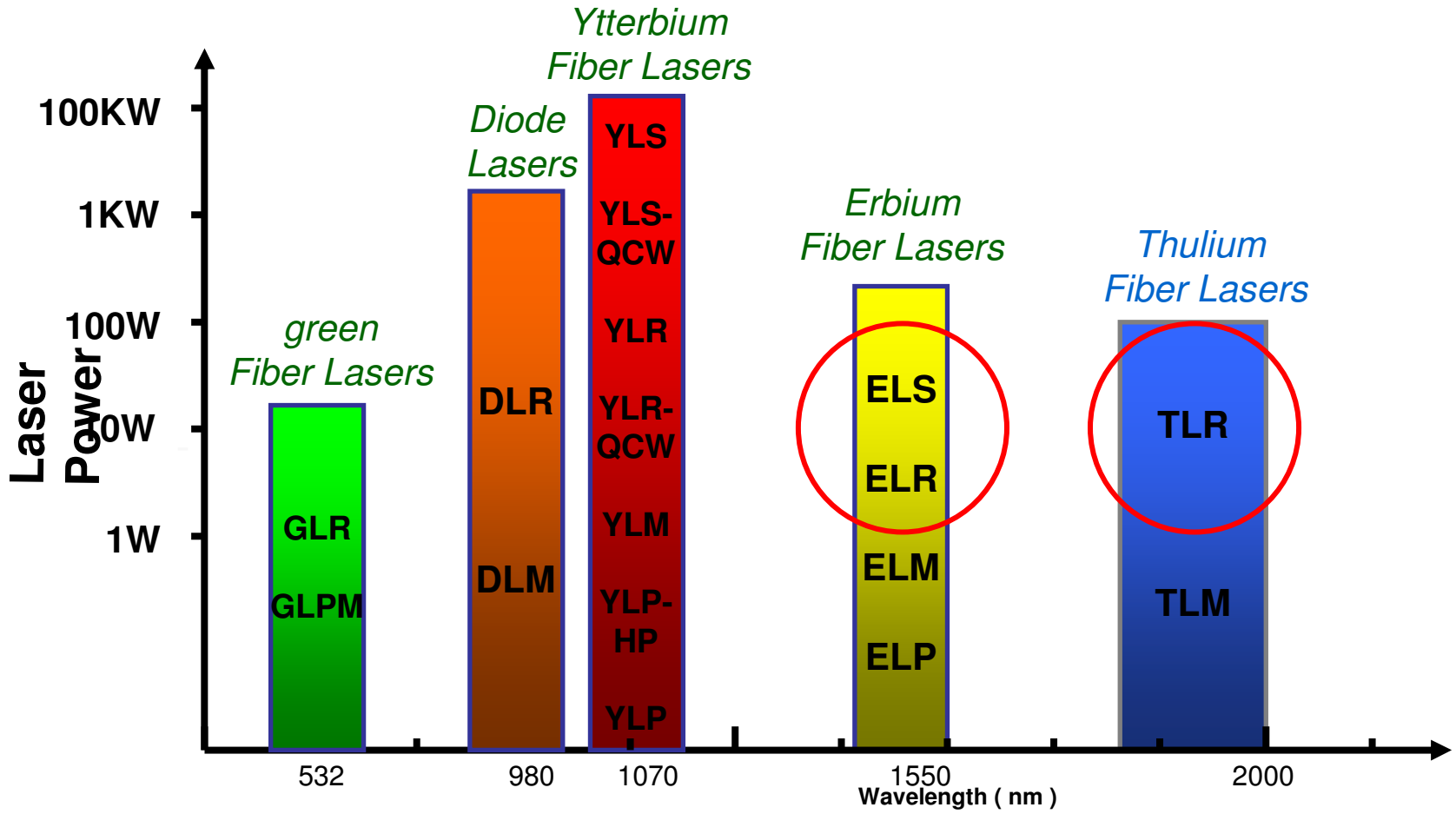
3. Setup of Thulium doped Fiber Lasers (1.940 nm wavelength)

4. Summary

Overview of IPG´s fiber laser families



Overview of IPG´s fiber laser families



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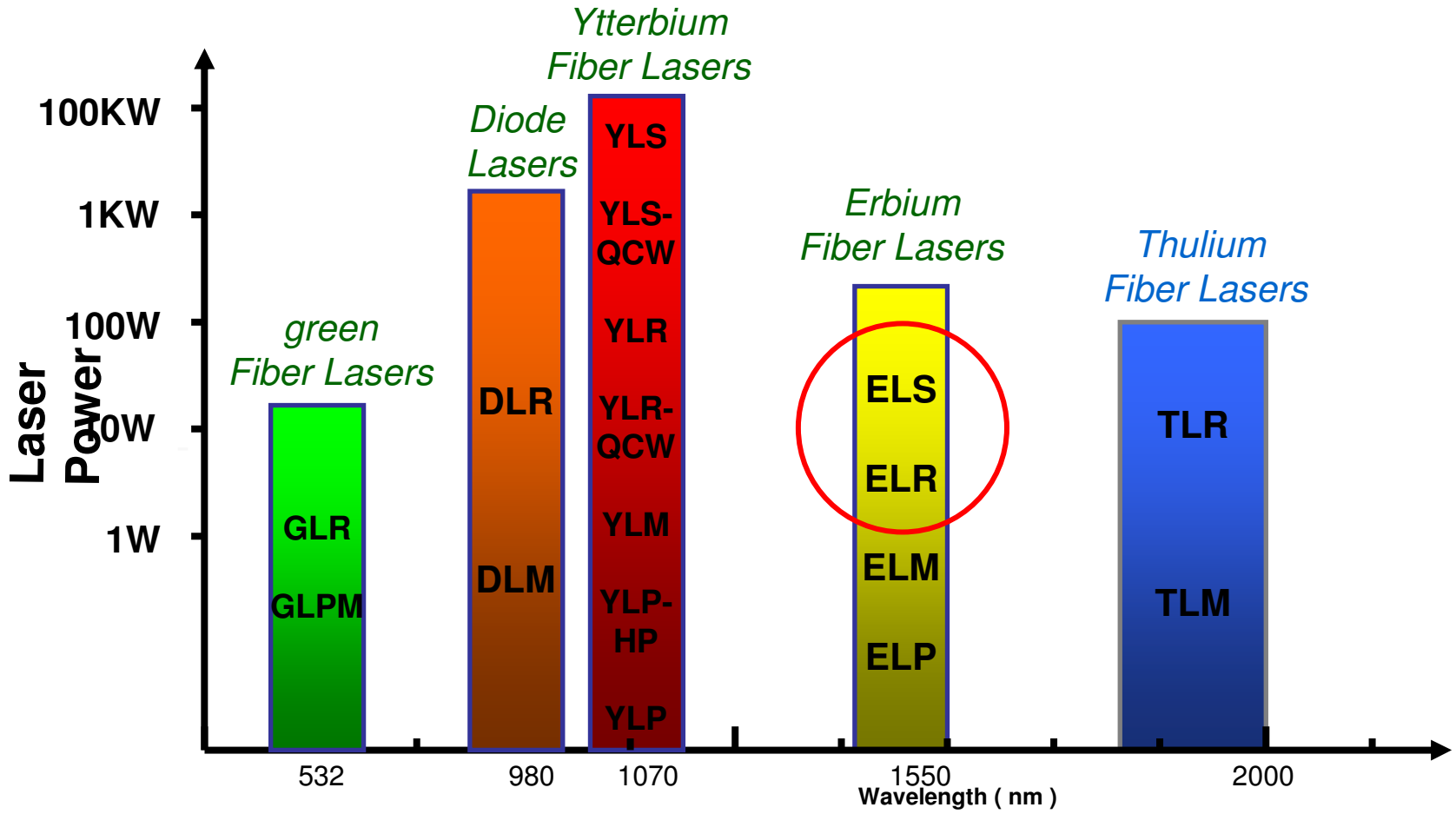
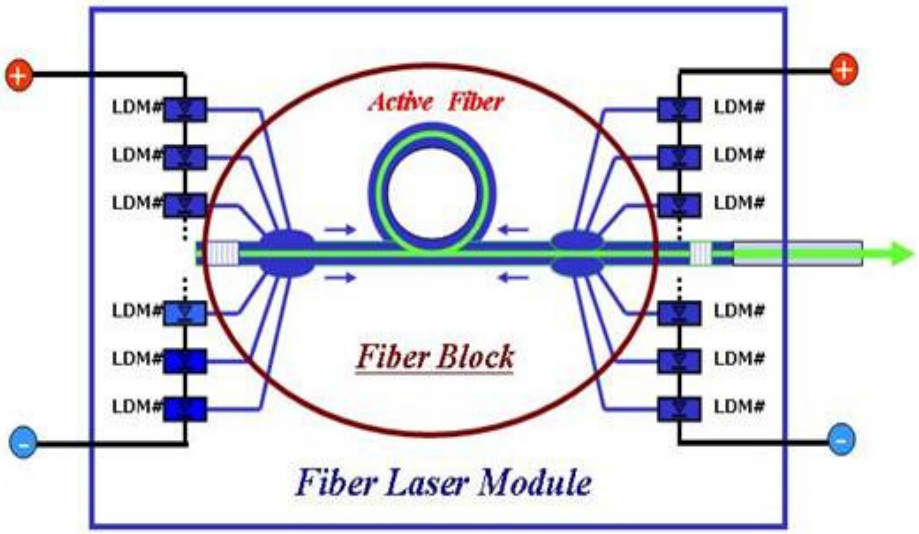


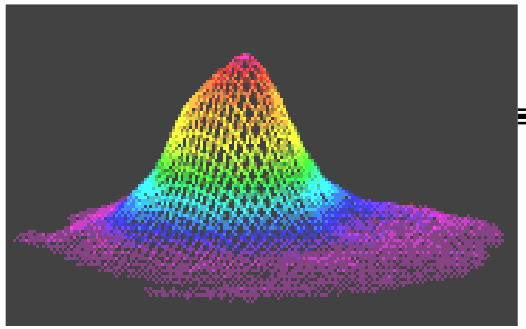
Concept of Erbium doped fiber lasers (1.5 µm wavelength)

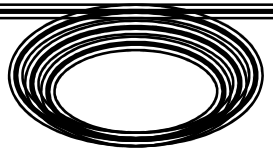


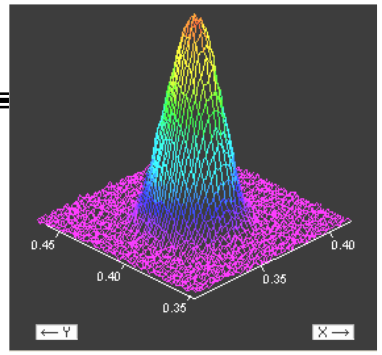
- Compact and monolithic Design
- Parallel adjustment of LDM
- Monomode-Beam quality
- $M^2 < 1.05$
- Robust mechanical setup
- Thermal non-sensitive
- no adjustment / maintenance

Conversion of Brightness

Low Beam Quality → High Beam Quality

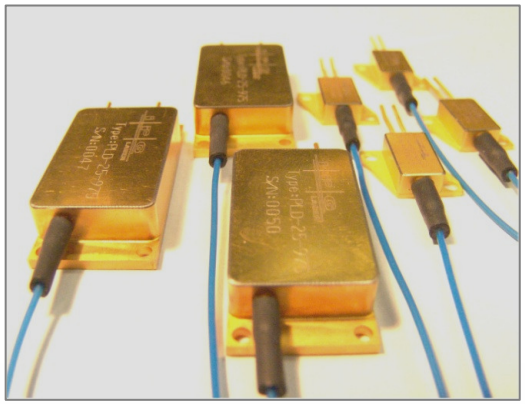


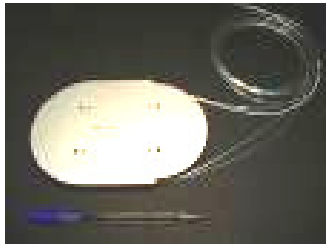




Multimode, Broadband Pumpdiode 975nm,
NA 0.12, M^2 >20

Fiber Laser 1 / 1,5µm, NA 0.06, M^2 = 1





Needed Components for Fiber Laser Production

Fab Operations

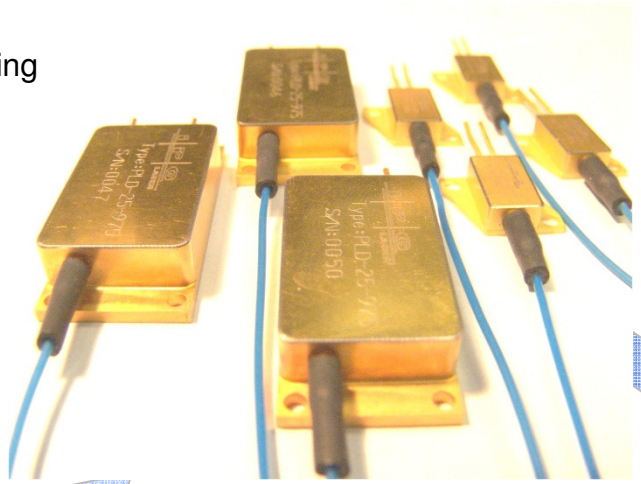
Semiconductor Wafer Growth

Diode Processing

Chip Mounting

Burn-In

Laser diode Packaging



Optical Preform

Silica based glass

MCVD method

Dope with rare earth ions

Final Assembly

Coupling

Final burn in

Shipment

Fiber Draw

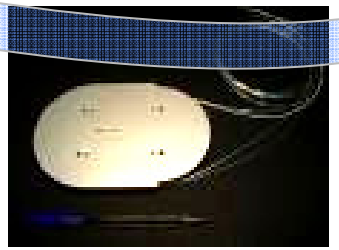
Draw towers

Active fibers only

>200 different fibers

Modules

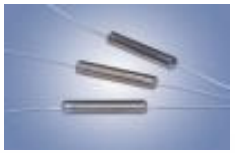
Up to 800-1000 Watts (1070 nm)



Fiber Block

Pod of active fibers

Components



Bragg Gratings, Isolators

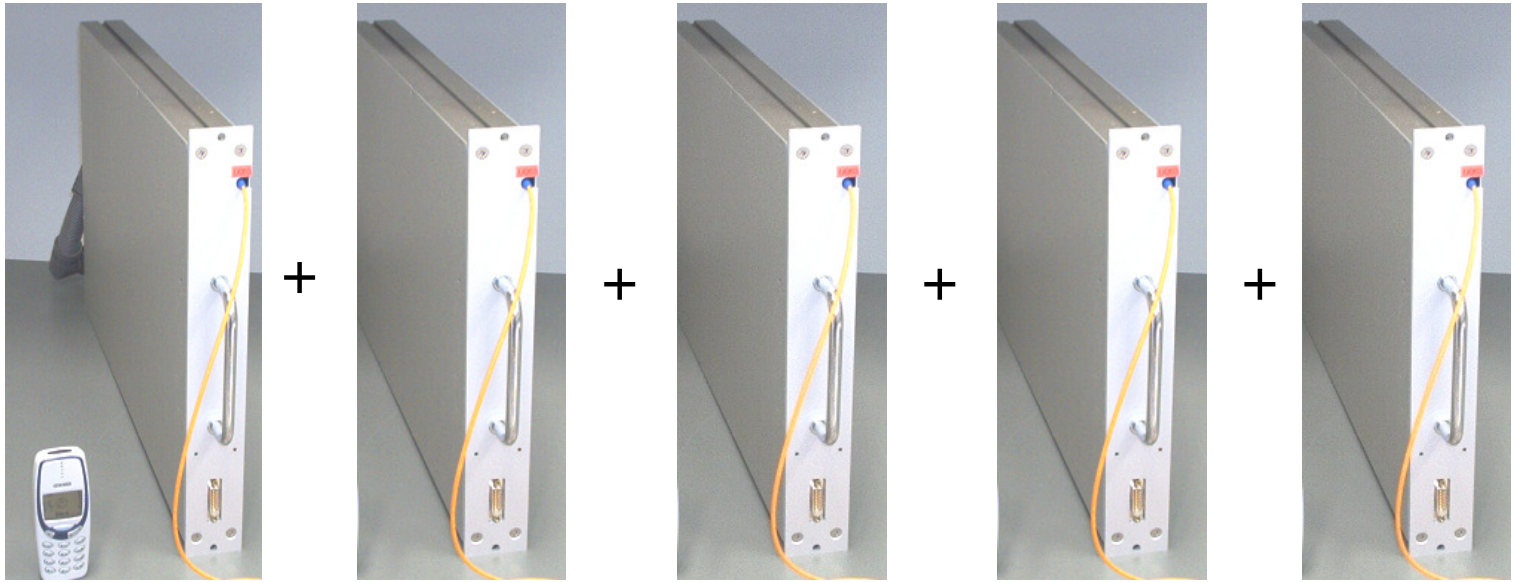
Couplers

Single Mode Fiber Laser Rack / Module

3U Housing of 120 W Erbium doped Fiber Laser

Collimator output of TLR-120 and ELR-120

IPG Fiber Laser
Modul Combination



+ + + + = XL
XXL
XXXL

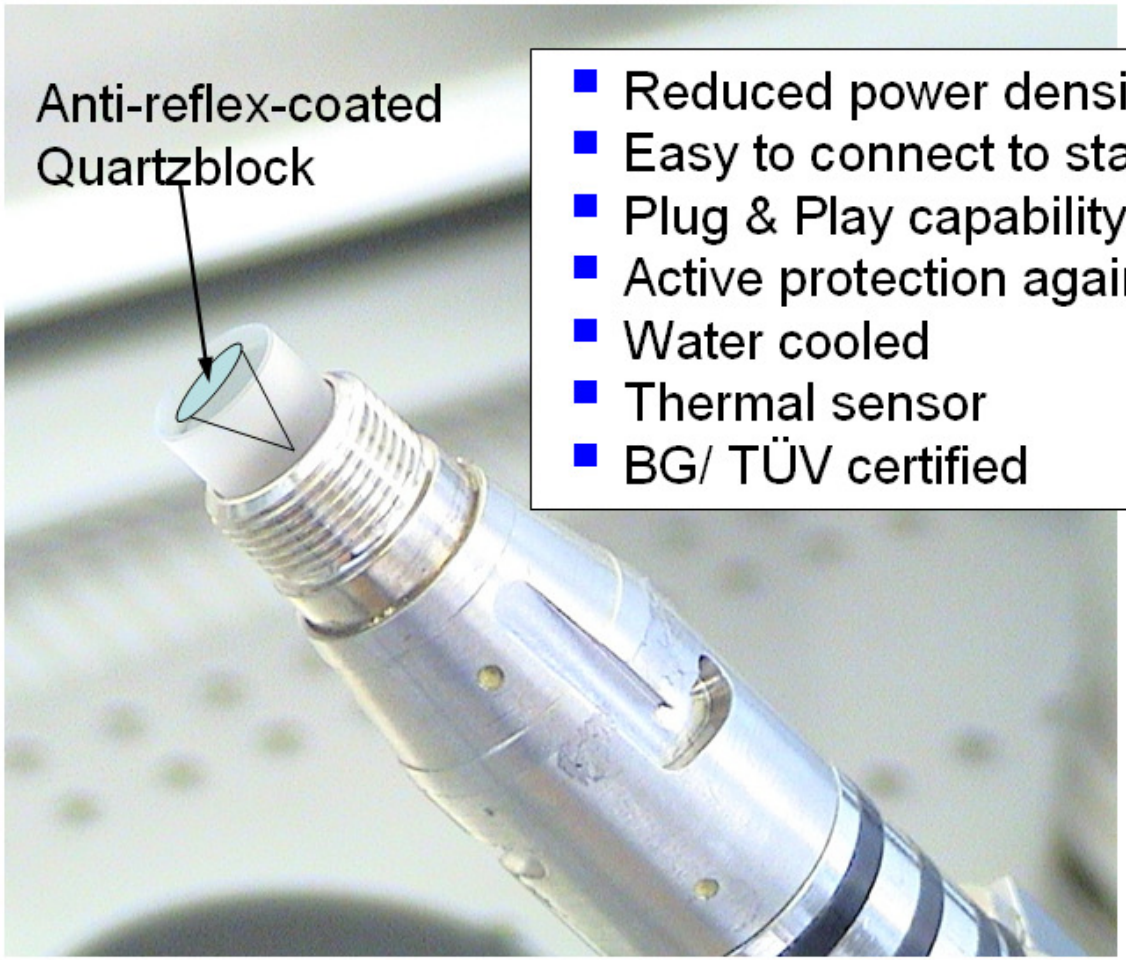
Modules are combined according to the requested Power = scaleable and upgradeable Power → **custom design**

First Multimode Fiberlaser @ 1.5 µm wavelength with 500 W Output power

ELS-500 shipped to ILT beginning of 2012

1567 nm, 500 W, Multimode Fiber Output

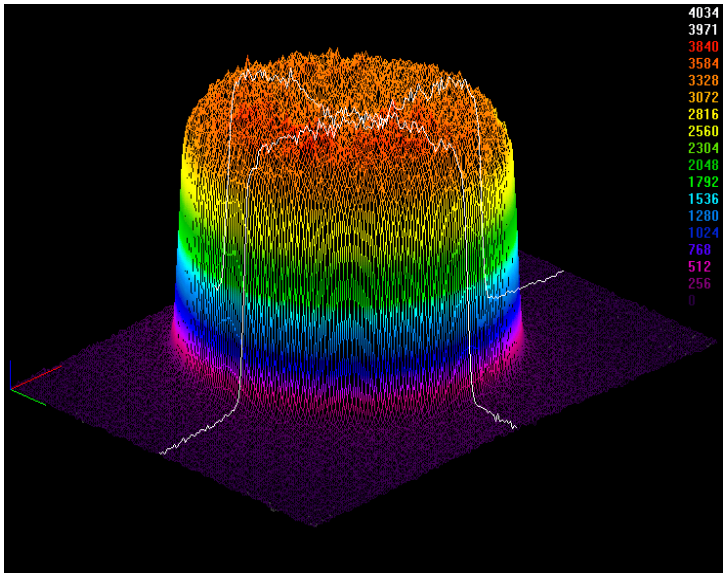
Fiber connector in QBH design

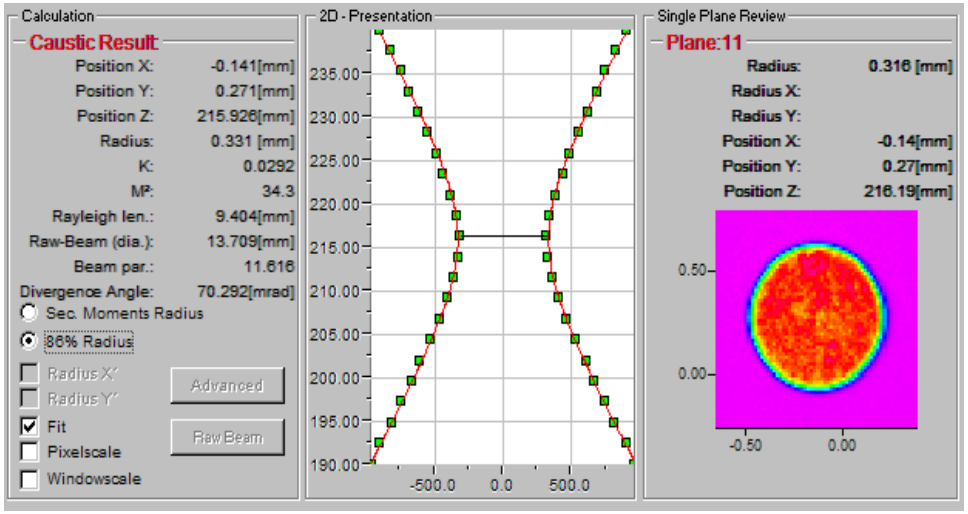


- Reduced power density @ power exit
- Easy to connect to standard optics
- Plug & Play capability
- Active protection against back reflection
- Water cooled
- Thermal sensor
- BG/ TÜV certified

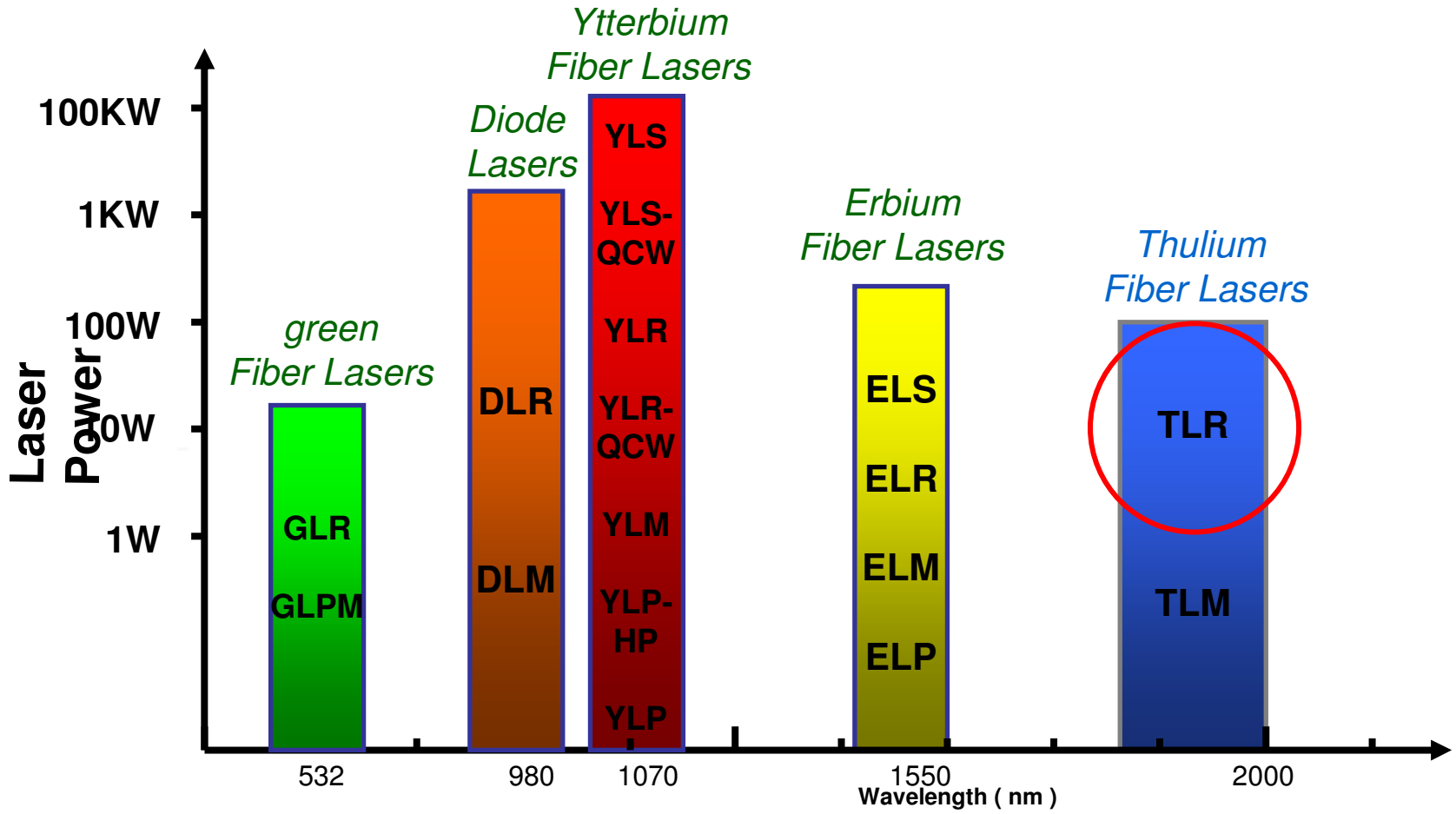
Top Hat Beam Profile

- Realized with 200 µm Multimode Feeding Fiber of ELS 500

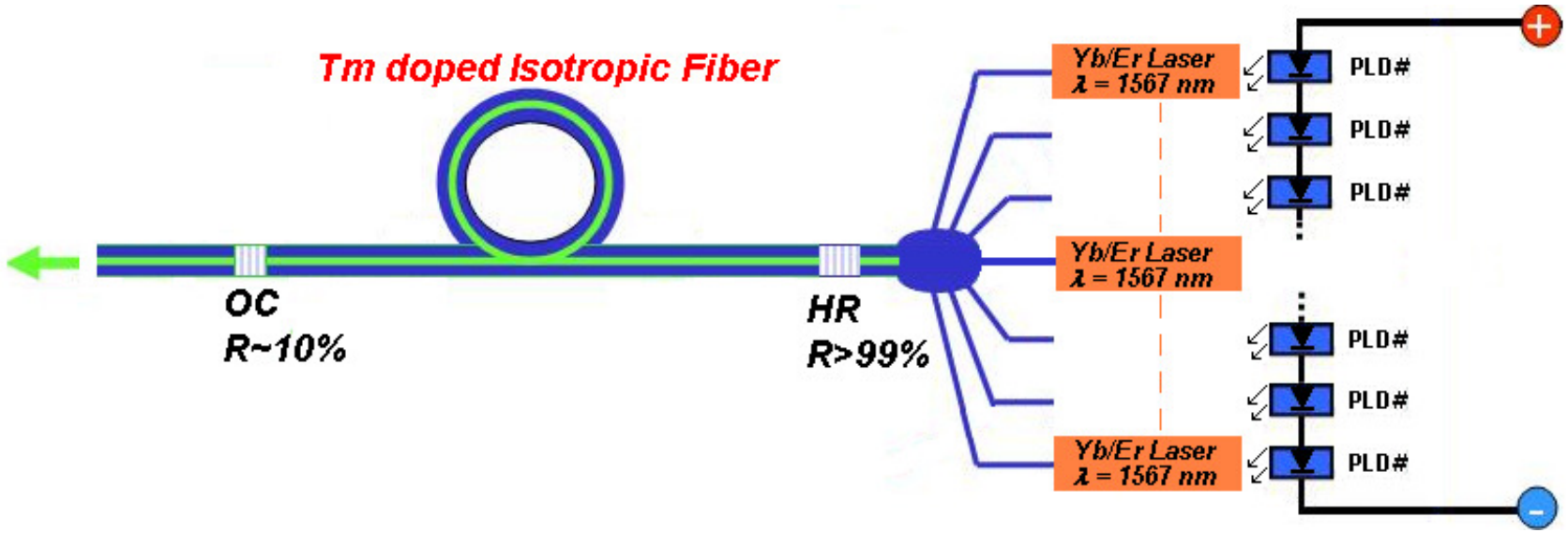




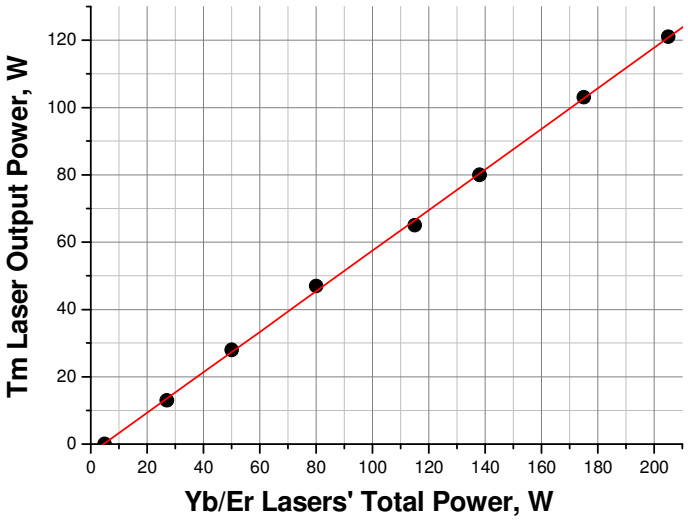
Overview of IPG´s fiber laser families

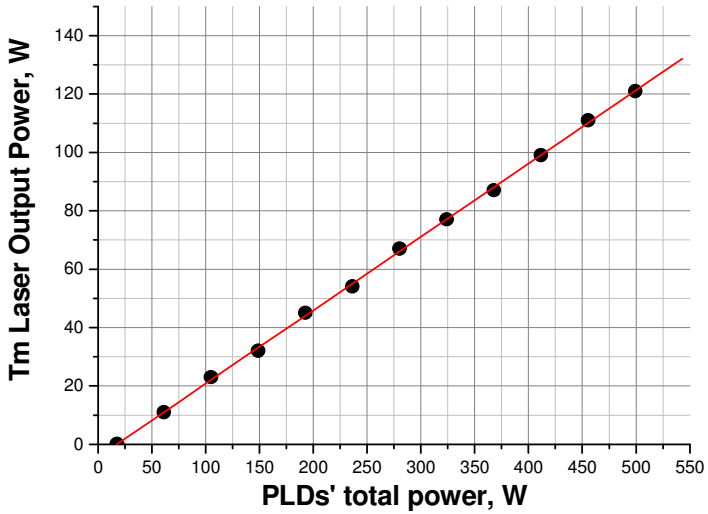


General Setup of Thulium doped Fiber Lasers



Output Power and Efficiency

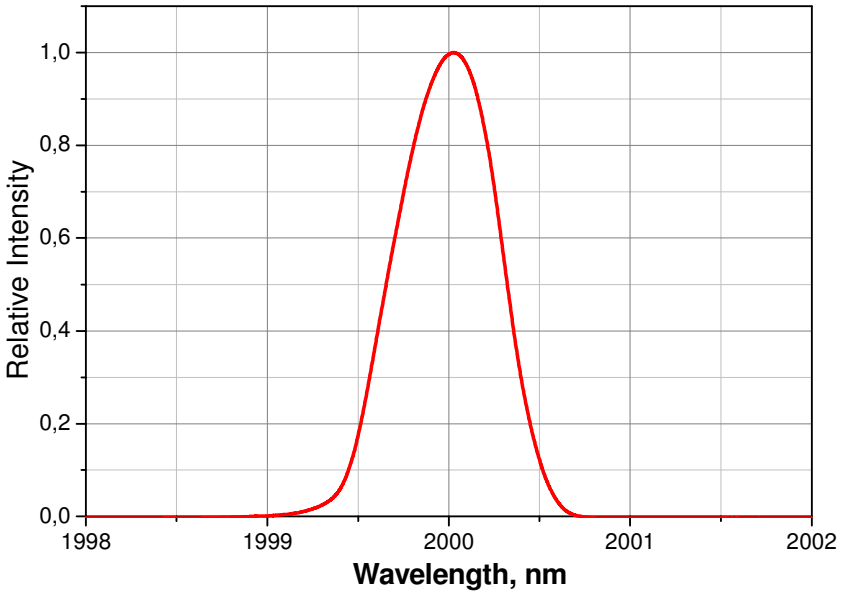




Up to 120 W Output Power @ 1.9 µm wavelength

Wall plug efficiency > 10 %

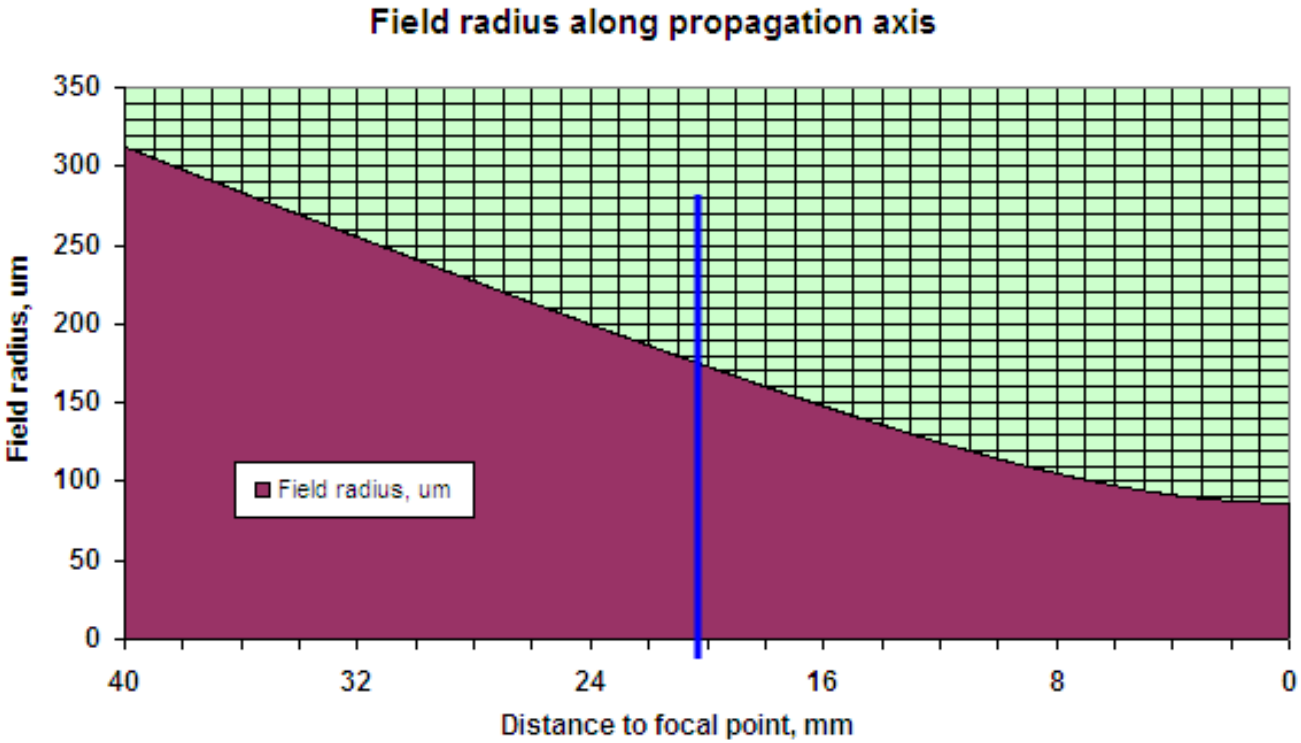
Spectral Properties



- ***Extremely broad spectral range: 1850 – 2050 nm***
- ***Narrow linewidth – less than 1 nm***

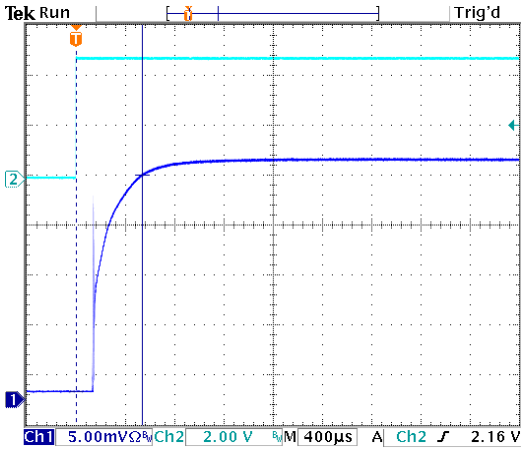
Beam Profil at 300 mm focal length

Distance, mm	Field radius, um	Waist diameter, um	Chart zone from focus, mm	M2 parameter	Wavelength, nm	Focal distance, mm	Beam diameter, mm	Calculations adequacy condition		
40	312,202227	172,91	40	1,05	1940	300	4,5	67500	>>	345,503954

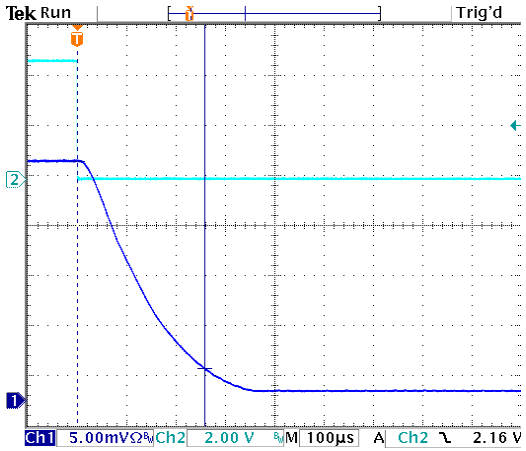


Transient Characteristics

Switching On Time 550 µs



Switching Off Time 250 µs



Modulation with PRR = 3 kHz

Direct modulation of semiconductor emitter diodes' (PLDs) current

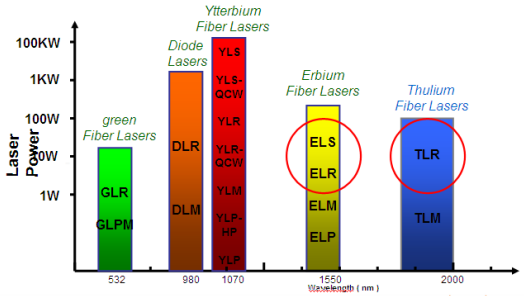
- ✓ **Fast switching ON/OFF**
- ✓ **Relatively high modulation frequencies**

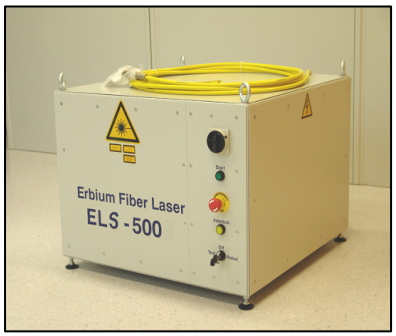
IPG PHOTONICS

Summary

Erbium and Thulium doped Fiber Lasers

- Power up to 120 W single mode (Tm doped @ 1.940 nm)
- Power up to 500 W multi mode (Er doped @ 1567 nm)
- Robust concept for industrial usage
- Long term tests: Thousands of hours without power decreasing
- Fast modulation by direct switching of PLDs
- ELS-500 Multimode: Top hat beam profil by usage of multi mode fiber





Thank you for your attention!