QDLASER

Compact visible laser modules and NIR DFBs with high speed modulation

October , 2012

QD laser, Inc.

PHOTONEX®
UK'S PREMIER PHOTONICS EVENT
17th & 18th October 2012
Ricoh Arena · Coventry · UK

DC0301-02

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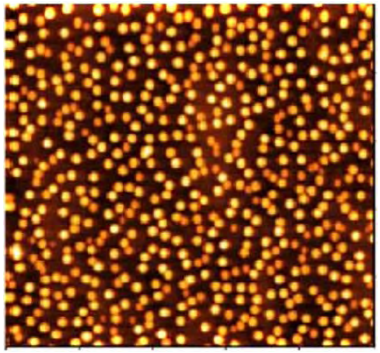
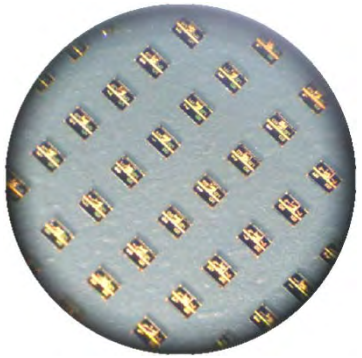
About QD Laser, Inc.

QDLASER

Company

- Founded: April 2006
  - Spin-off from Fujitsu Laboratory
- Headquarter: Kawasaki, Japan
- Employee: 22
- ISO 9001:2008 Certified





Technology

- Quantum dot technology developed by Fujitsu and Univ. of Tokyo collaboration
- Crystal growth technology by our own MBE (Molecular beam epitaxy)
- High-performance semiconductor laser on GaAs substrate
- 532 – 1300nm FP/DFB laser including frequency doubling

Awarded

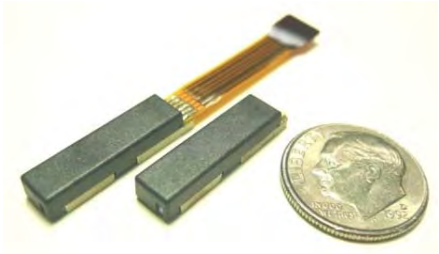
- The Wall Street Journal Technology Runner-up Award 2006
- The Technology Winner selected by the IEEE Spectrum Magazine in 2009
- Green IT Award 2010

Product map

QDLASER

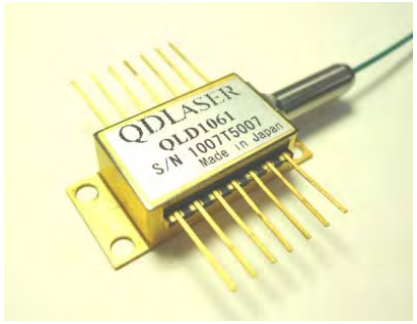
Compact visible lasers

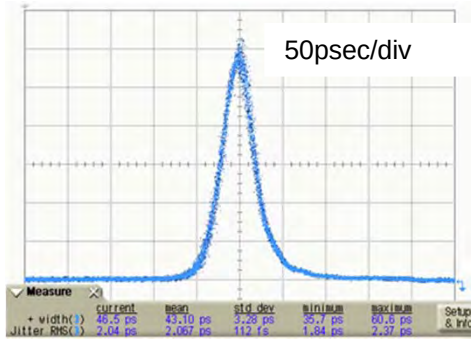
532 nm/5mW, 20mW, 50mW
561 nm, 594 nm
Low power consumption
Spectral single mode
Modulation capability



1030-1180nm DFB lasers

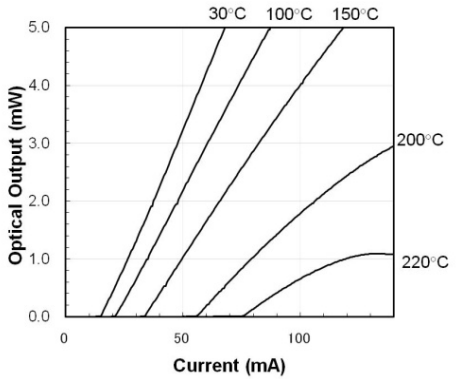
Pulsed/CW DFB lasers
Stable single longitudinal mode
Short pulse including picosecond
14-pin Butterfly, TO56, COAX-pigtail





Quantum dot lasers

1240-1300 nm
FP and DFB lasers
High temperature up to 200˚C
Temperature insensitive

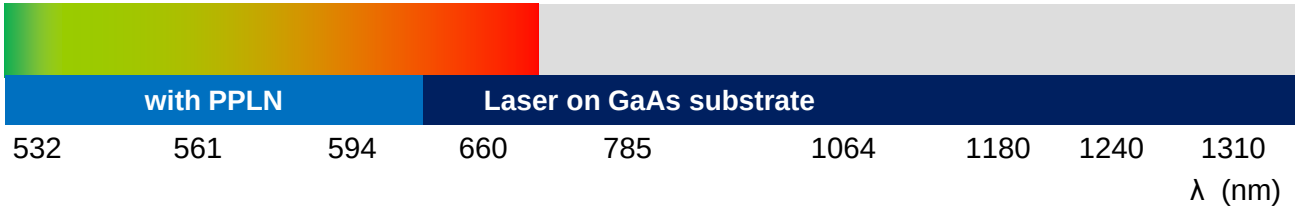


High power FP lasers

640 nm, 30mW
660 nm, 100mW
660 nm, 120mW
785 nm, 100mW
CW and Pulsed operation

Quantum dot/well wafer

High quality Quantum dot/well wafers
Customized epitaxial structure



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NIR DFB laser

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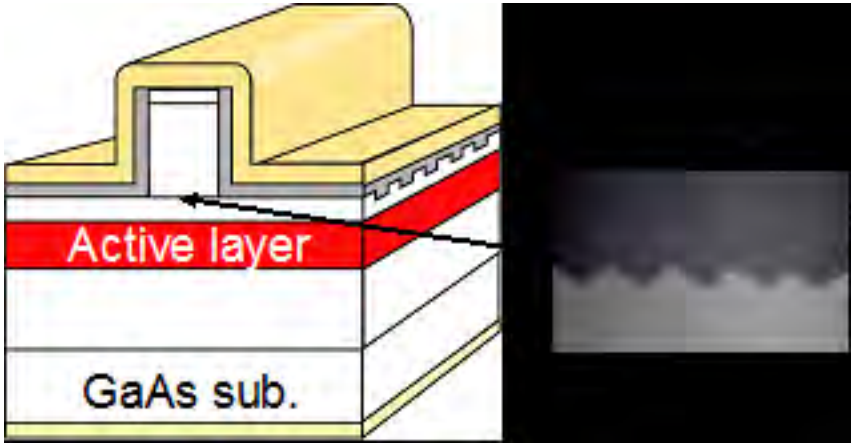
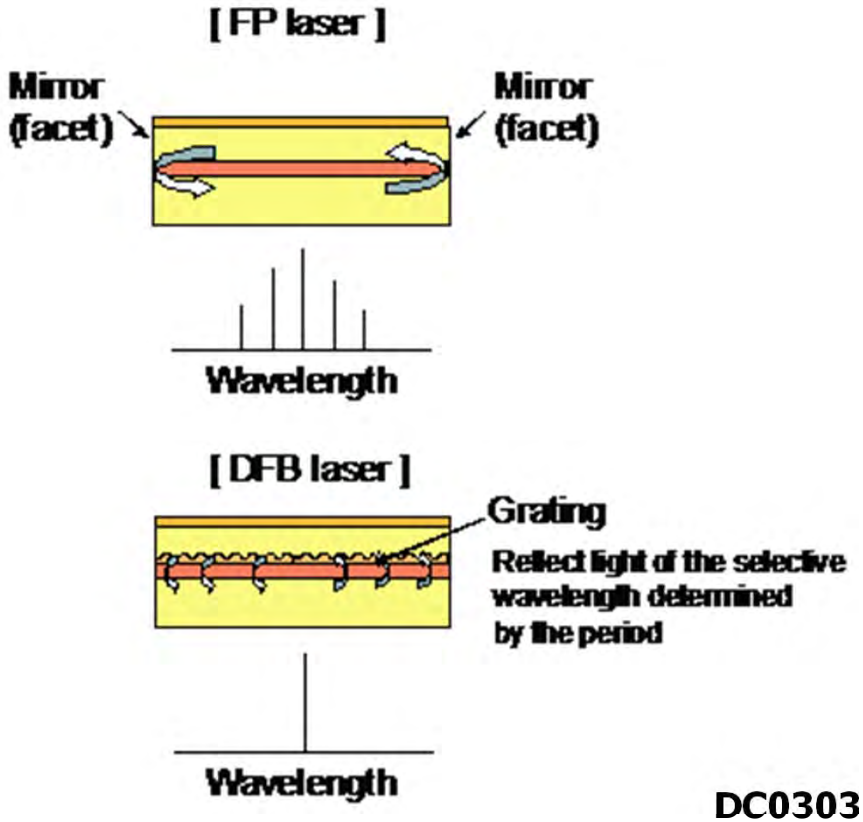
- Distributed feed back laser designed for single mode spectral operation in the 1 um wavelength band
- QDL utilizes index coupling grating on GaAs material system
  - Same structure for optical communication laser on InP system
- Stable single mode operation under various conditions





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NIR DFB laser - Applications

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- Seeder for CW and pulsed fiber lasers
- Pulse source for LIDAR including coherent system
- Sensing applications
- Pico second pulse generation
- Wavelength sweeper for spectral measurement
- Seed source for SHG, SFG, THG…

(*) SHG: Second harmonic generation
SFG: Sum frequency generation
THG: Third harmonic generation
LIDAR: Light detection and ranging

NIR DFB laser – Comparison chart

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Item		Semiconductor laser			Fiber laser
		DFB (QLD1061)	DBR	FP+FBG	FBG+Qsw
Pulse operation	Peak power	>0.1W	0.6W	1W	>100W
	Longitudinal mode stability	Good			
	Pulse width	>50psec	>100psec	>10nsec	>5nsec
	Arbitrary waveform generation	Good			
Wavelength	Spectral width (CW)	1MHz	8MHz	>1GHz	>1GHz
	Continuous tuning range	>1nm	Narrow	N.A.	N.A.
	Wavelength stability (Ta dependence)	<1pm/K	<1pm/K	10pm/K (*1)	10pm/K (*1)
	Wavelength reliability (long term)	Good	(Mode hop)	Good	Good
Other	Isolator integration	Yes	-	No	-

(*1) It could be improved with temperature compensation

NIR DFB laser – CW characteristics

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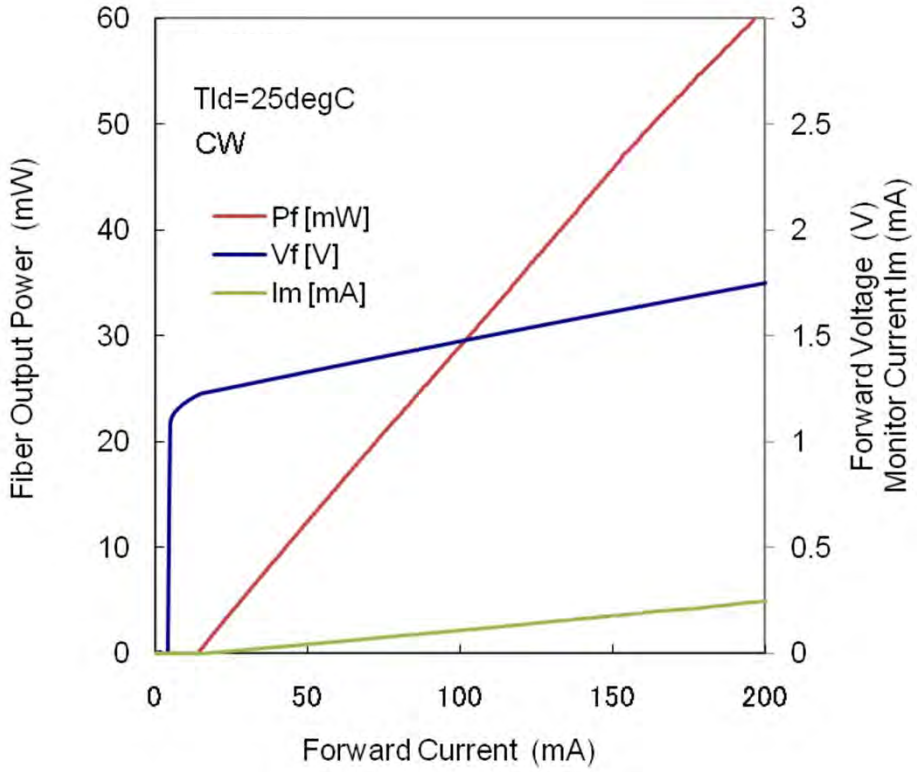
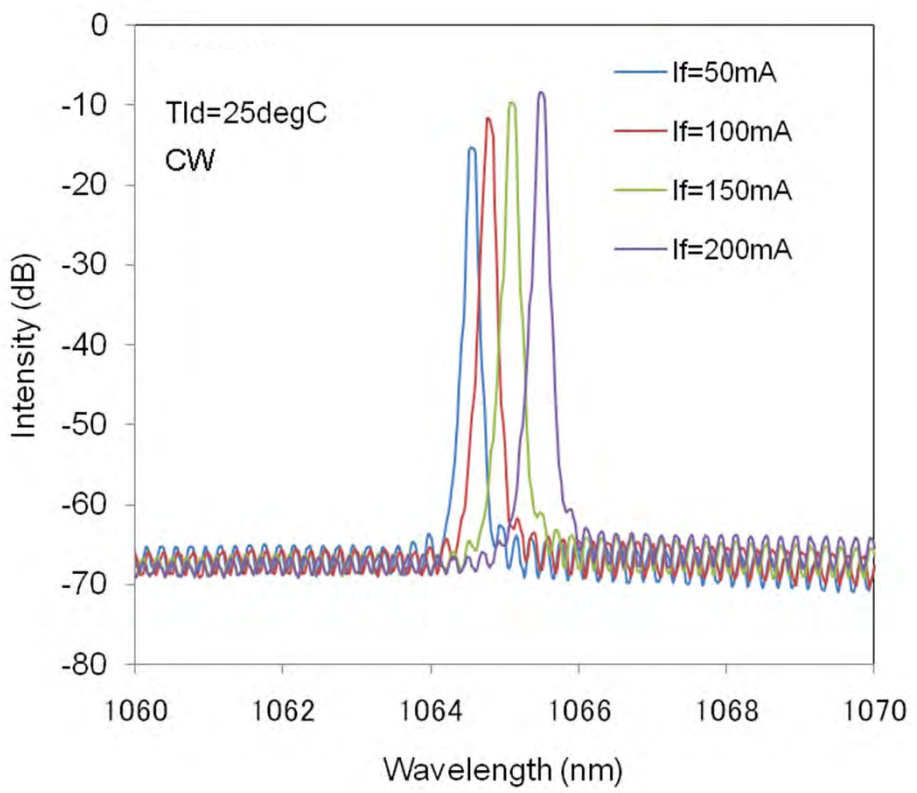
- High output power of >30mW
- Large side-mode suppression ratio (SMSR) of >40dB
- Stable single longitudinal mode emission over entire LD current





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NIR DFB laser – Wavelength sweeping demo

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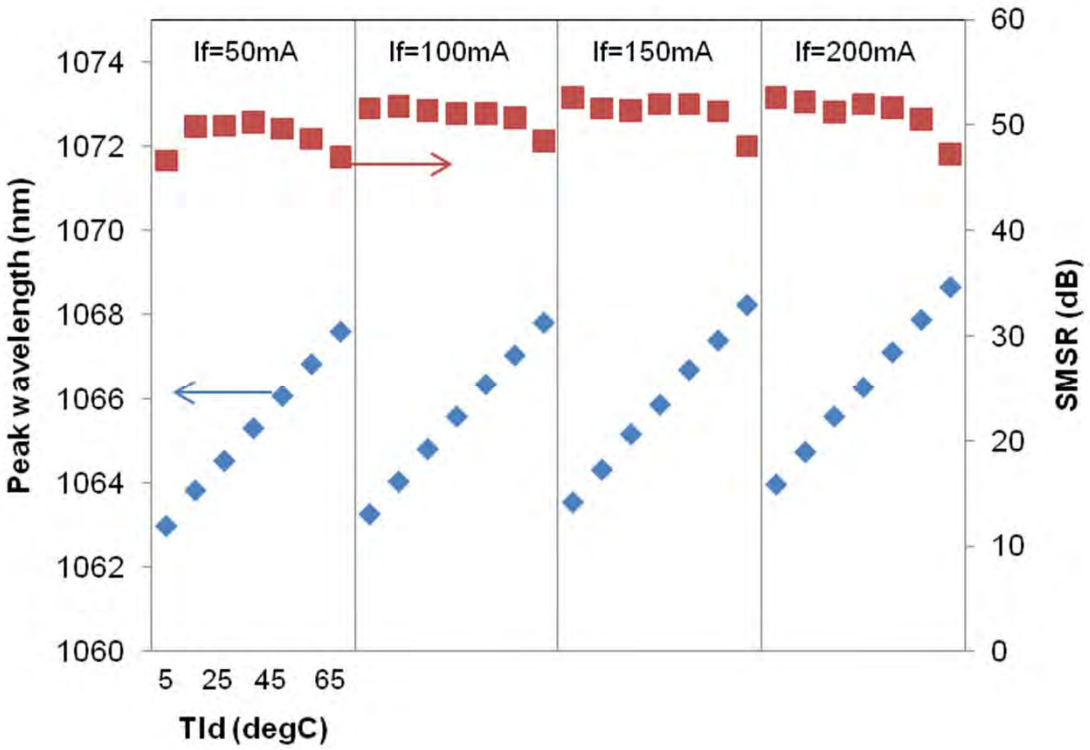
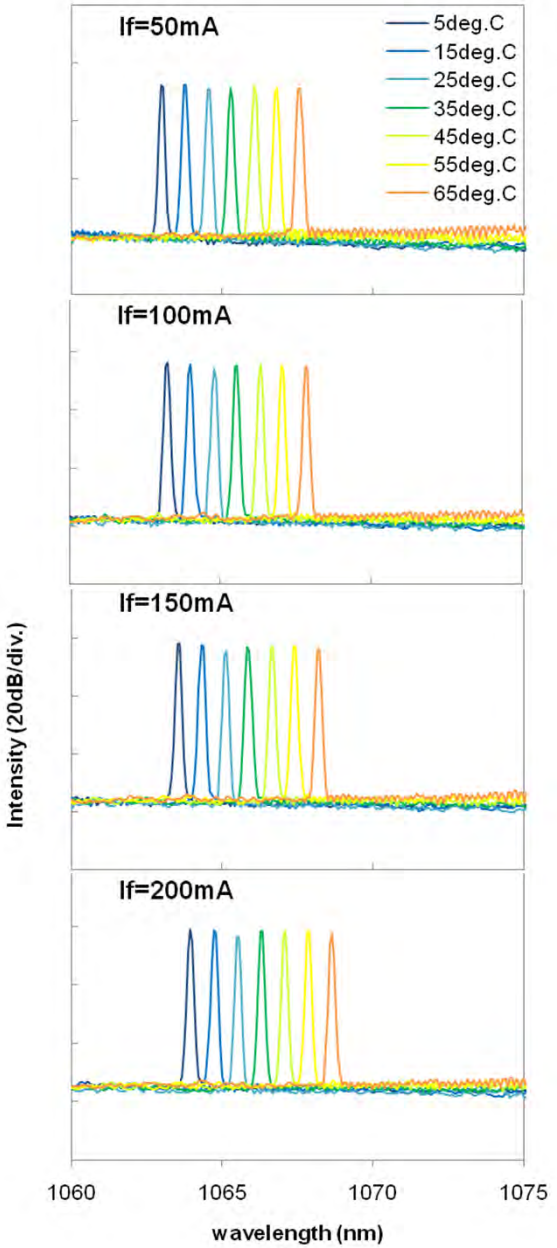
- Continuous λ sweeping of > 5nm with maintaining SMSR of > 40dB





These are the reference data to show the spectral stability. Recommended operating laser temperature is <35deg.C from the view point of reliability.

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NIR DFB laser – Short pulsed operation (1)

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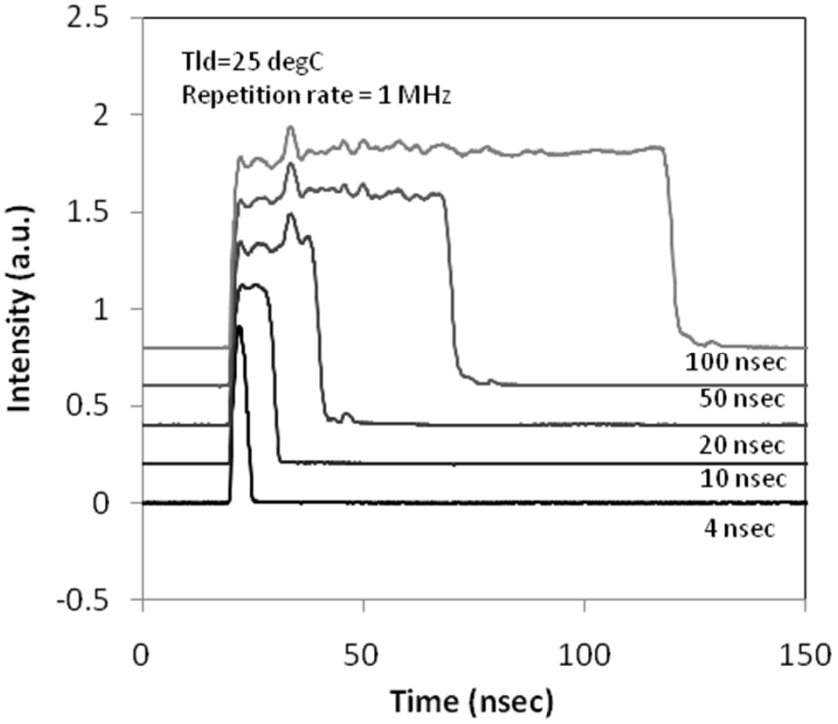
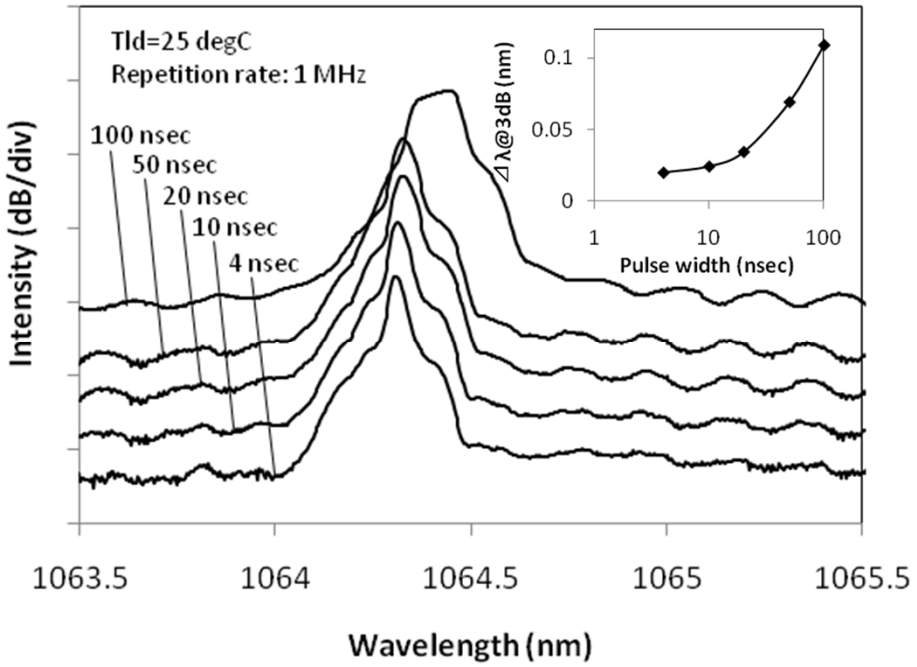
- Narrow spectral width and stable SMSR
- 3dB spectral width of <0.05nm when pulse width of <20nsec
  - Slight spectral broadening comes from thermal chirp





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NIR DFB laser – Short pulsed operation (2)

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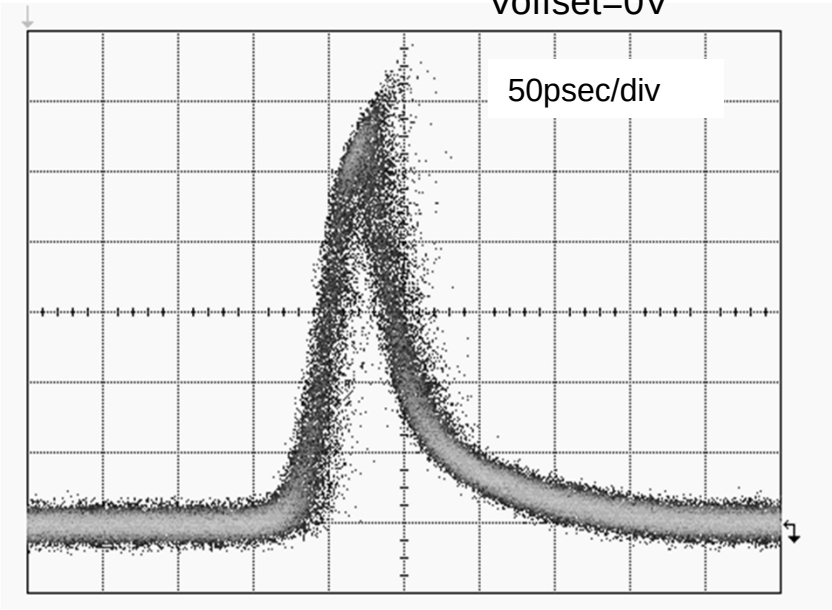
- 50psec gain switched operation

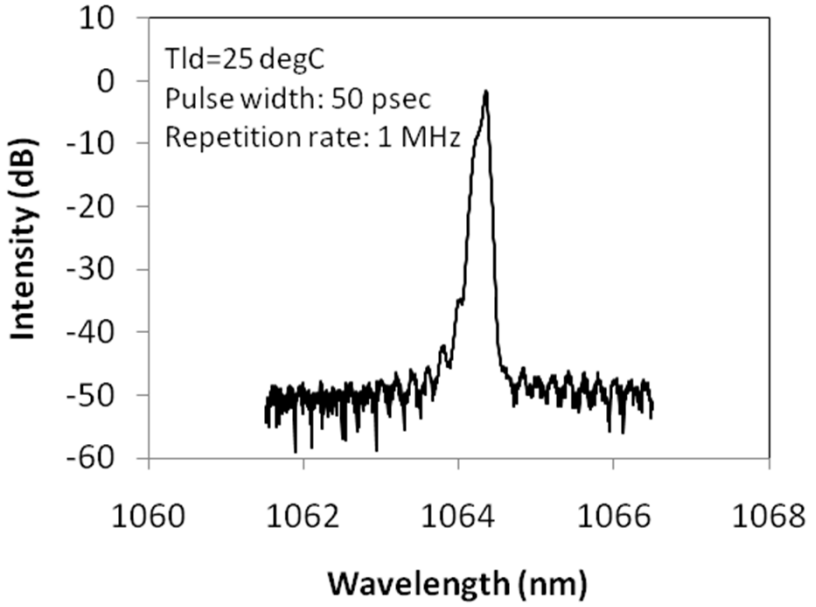
10G PPG

Repetition rate: 1MHz
Input pulse width: 800psec

2.5Vpp
Voffset=0V



Spectral width
0.055 nm@3dB
0.31 nm@20dB



Package options

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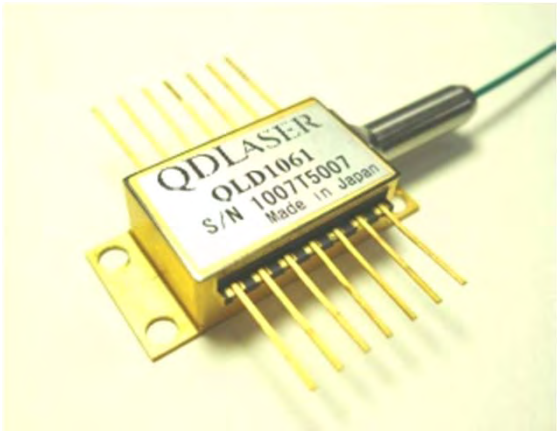
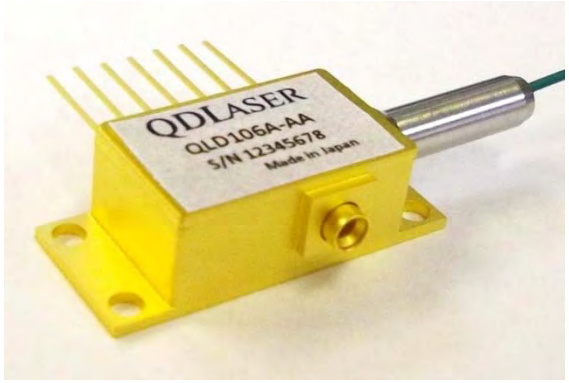
Standard 14-pin Butterfly

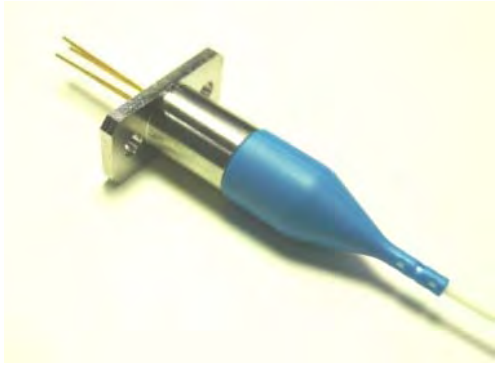


TO-CAN (Φ5.6)

7-pin Butterfly with RF connector



TO-CAN (Φ5.6) with pigtail



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NIR DFB laser – Product lineup

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λ (nm)	LD type	Package type	Product number	Description	Status
1180	DFB	Butterfly PKG with TEC, PMF	QLD1161-8030	30mW fiber output power	TS
1118	DFB		QLD1161	30mW fiber output power	TS
1070	DFB		QLD1061-AE	30mW fiber output power	TS
1064	DFB		QLD1061	30mW fiber output power	CS
1053	DFB		QLD1062	30mW fiber output power	CS
1030	DFB		QLD1061-3030	30mW fiber output power	UD
1064	DFB/SOA		QLA1061-64A0	100mW fiber output power	TS
1118	DFB/SOA		QLA1161-18A0	100mW fiber output power	TS
1064	DFB		QLD106B-6415	Butterfly PKG with SMPM connector for high-speed operation	TS
1064	DFB	TO-CAN (Φ5.6)	QLD103E-6450	50mW, with MPD	ES
			QLD1051-6410	10mW, COAX-pigtail	TS

Custom wavelength available.
Please contact info@qdlaser.com
for more info.

UD: Under development
TS: Test sample
ES: Engineering sample (design fixed)
CS: Commercial sample (qualification finished)

Compact Visible Laser Module

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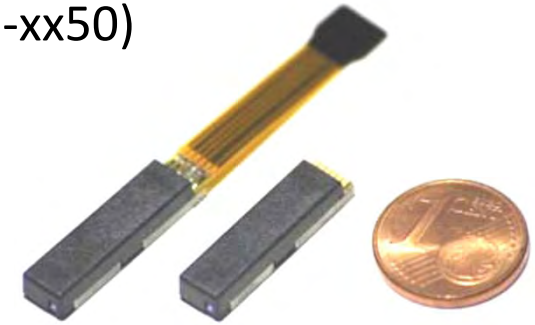
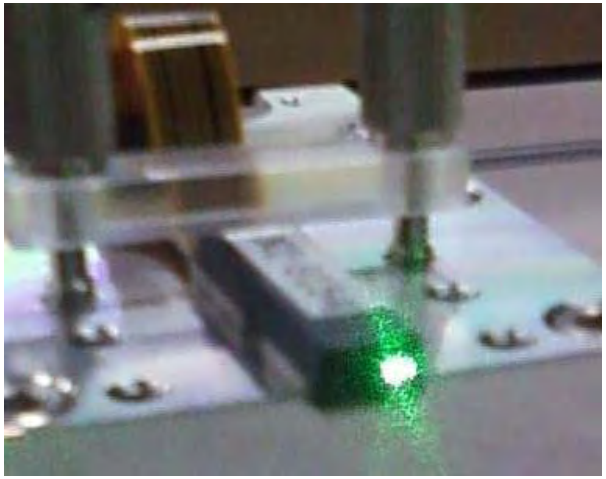
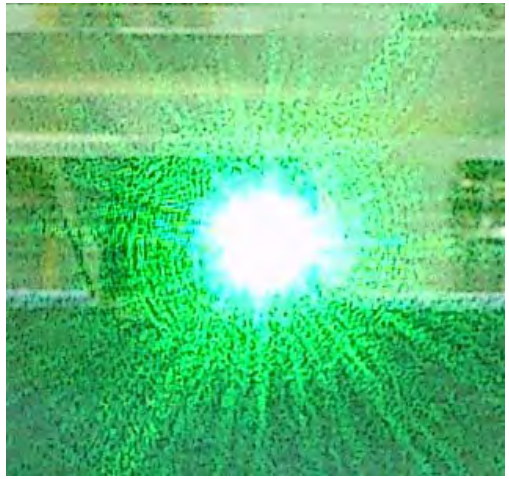
Features

- 532, 561, and 594nm light emission with frequency doubling of NIR DFB output
- Low power consumption
- Output power > 5mW(QLD0593-xx05), >50mW(QLD0593-xx50)
- Low intensity noise <0.1%(RMS)
- Narrow spectral linewidth << 0.1 nm
- Transverse mode: TEM00
- DC~100MHz modulation capable
- Short pulse (<4nsec) with high extinction ratio operation
- Small size <0.5cc (5.6 x 3.8 x 22 mm)







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First Demonstration at SPIE PW2012

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Projected lights from 532, 561 and 594nm compact laser modules and 660 FP laser

Compact visible laser module – Module structure

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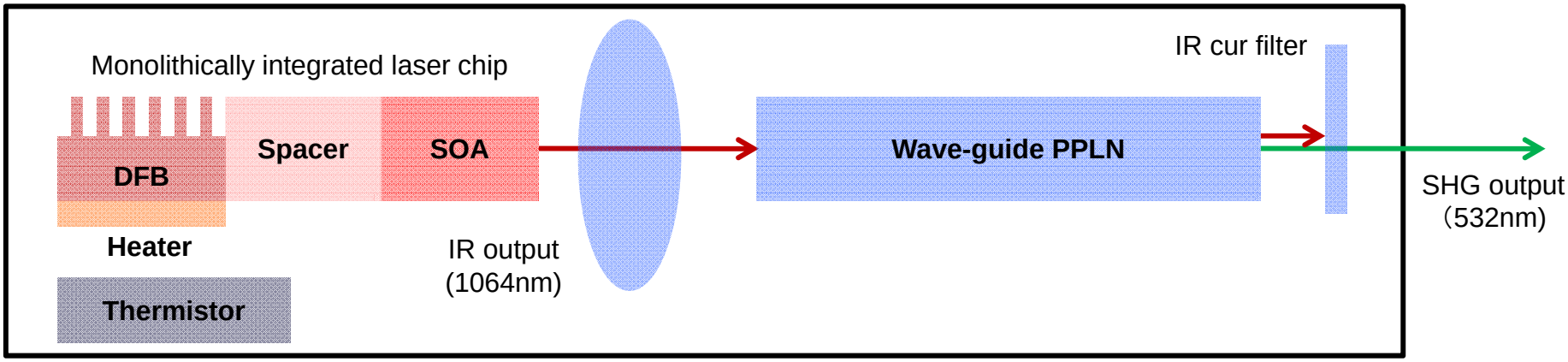
- QD Laser's compact laser module consists of monolithically integrated laser chip (MILC) and waveguide PPLN.
- MILC is designed for independent control of seed power and wavelength.
- SHG output power is controlled by current tuning of each section.

Function block diagram of the module



Target applications

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- Spectroscopy
- Fluorescence microscope
- Flow cytometry
- Time resolved measurement
- Interpherometory, Holography
- Point and line source
- Laser projector

Optical output characteristics

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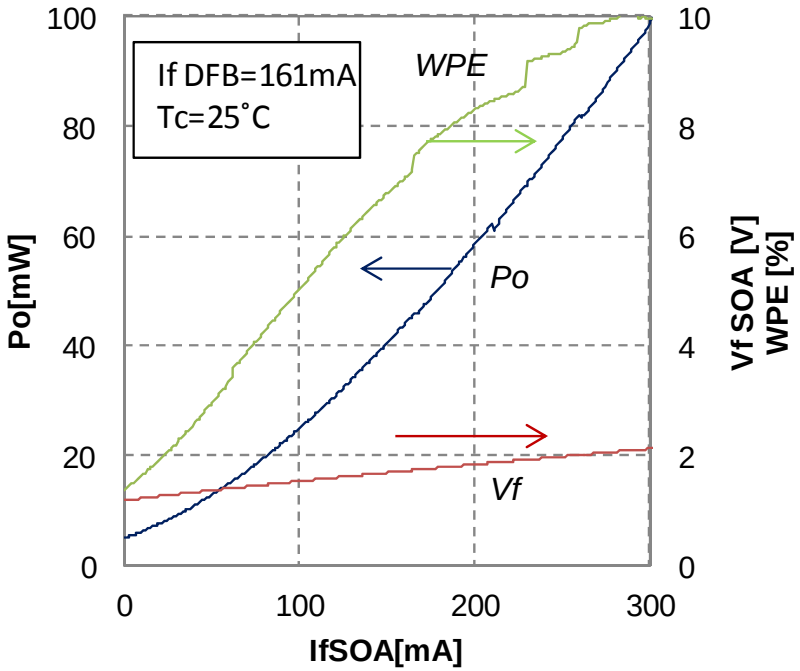

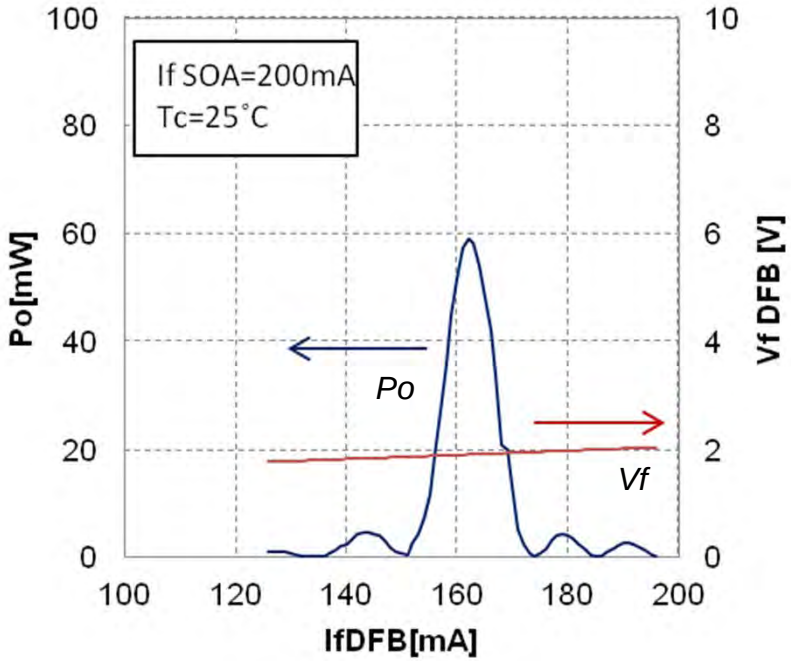

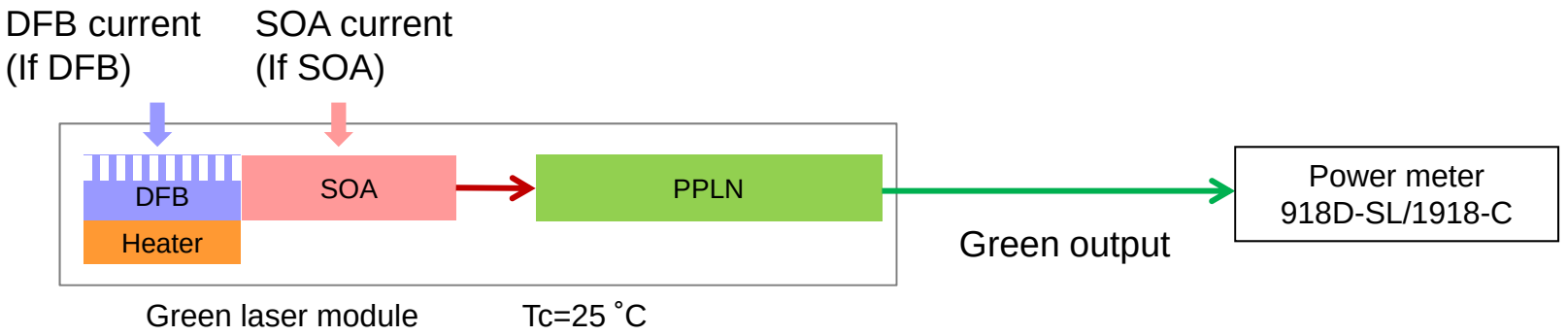

Optical spectral characteristics

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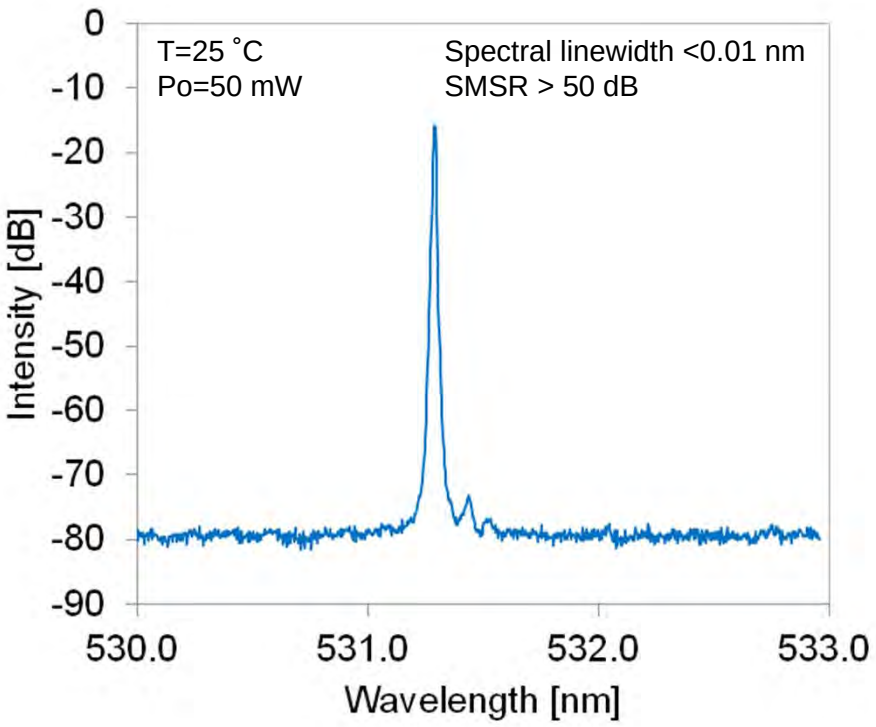

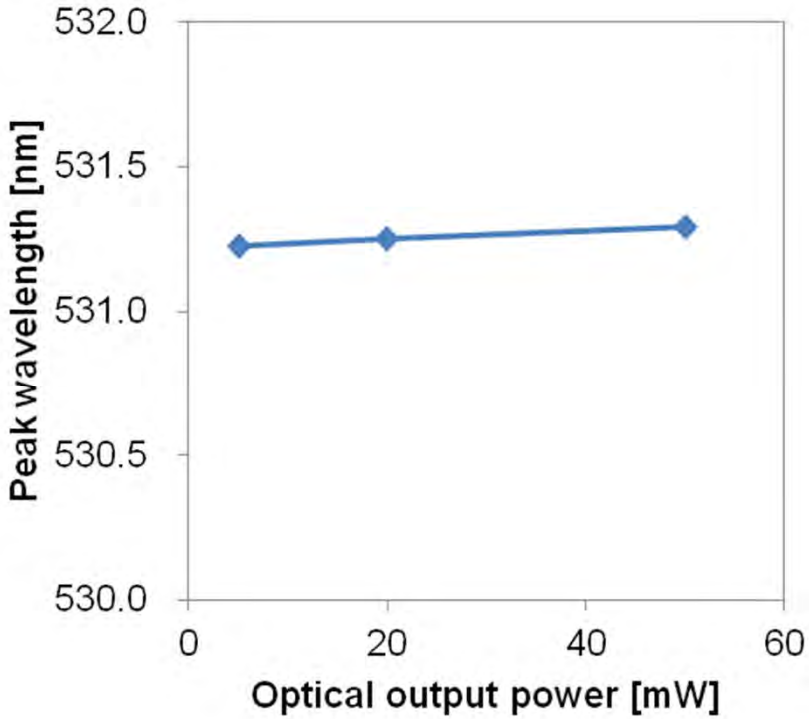

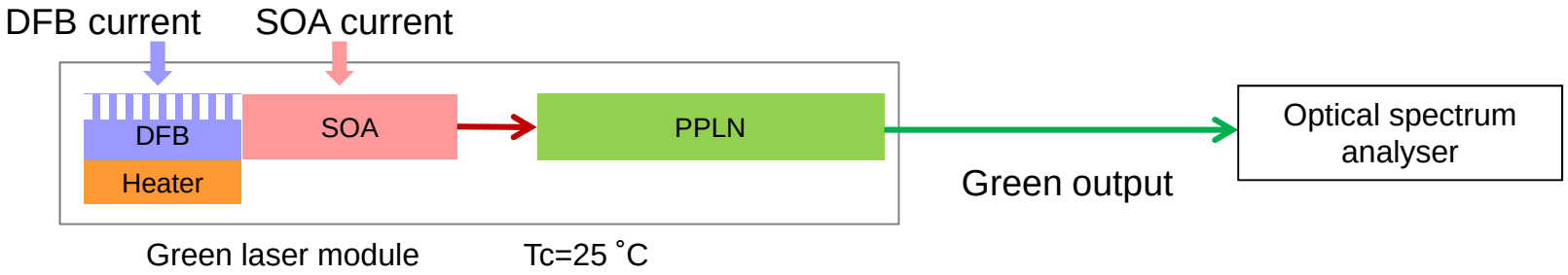

Output beam characteristics

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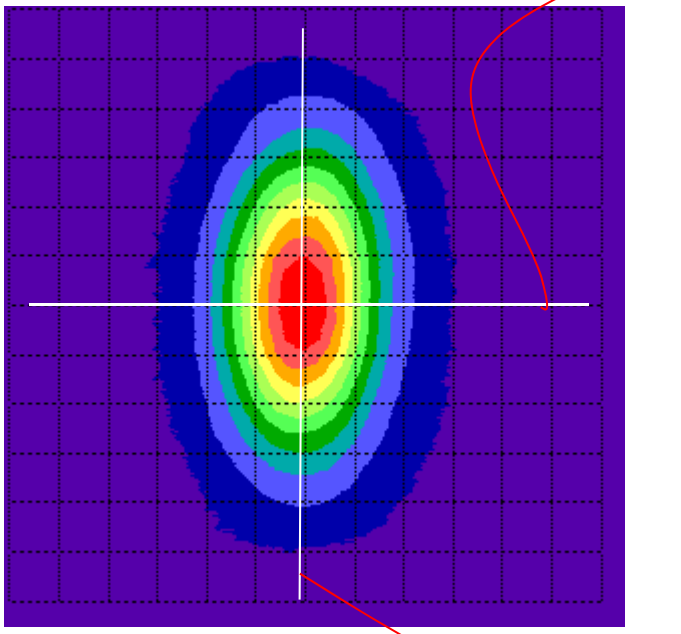
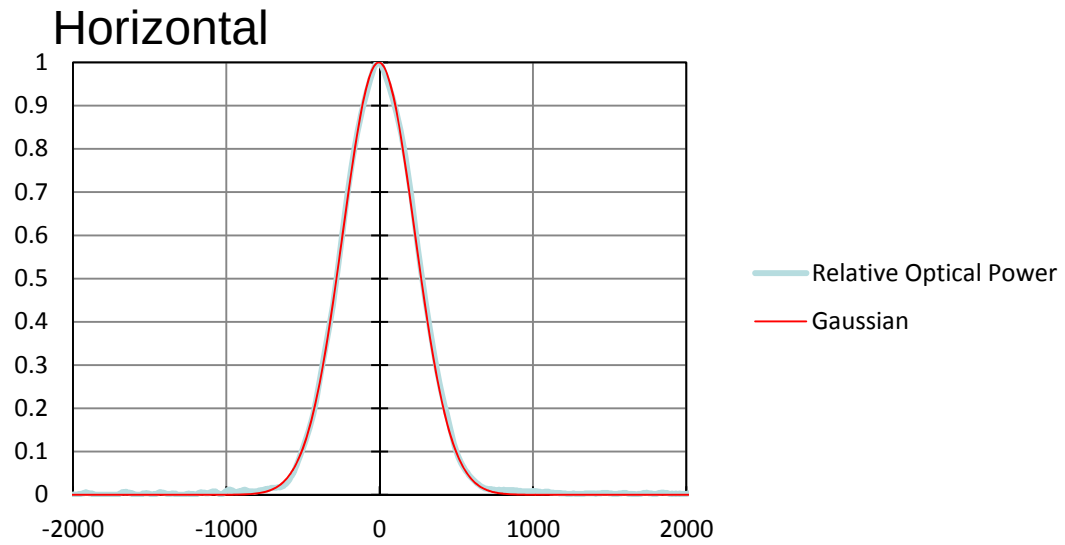
■ Beam divergence (full angle)

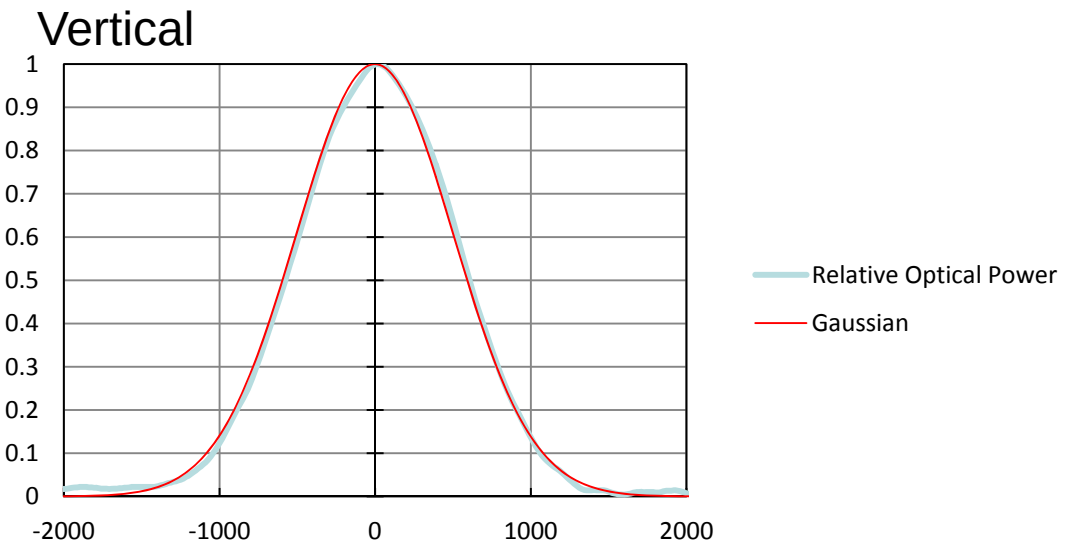
	θ v (deg)	θ h (deg)
1/2	11.1	5.3
1/e^2	18.7	9.0

■ Beam profile

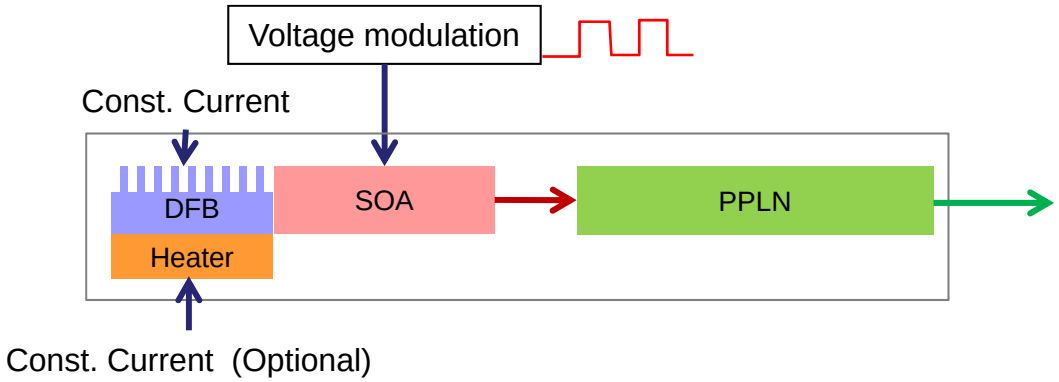


Direction of polarization (Horizontal direction)

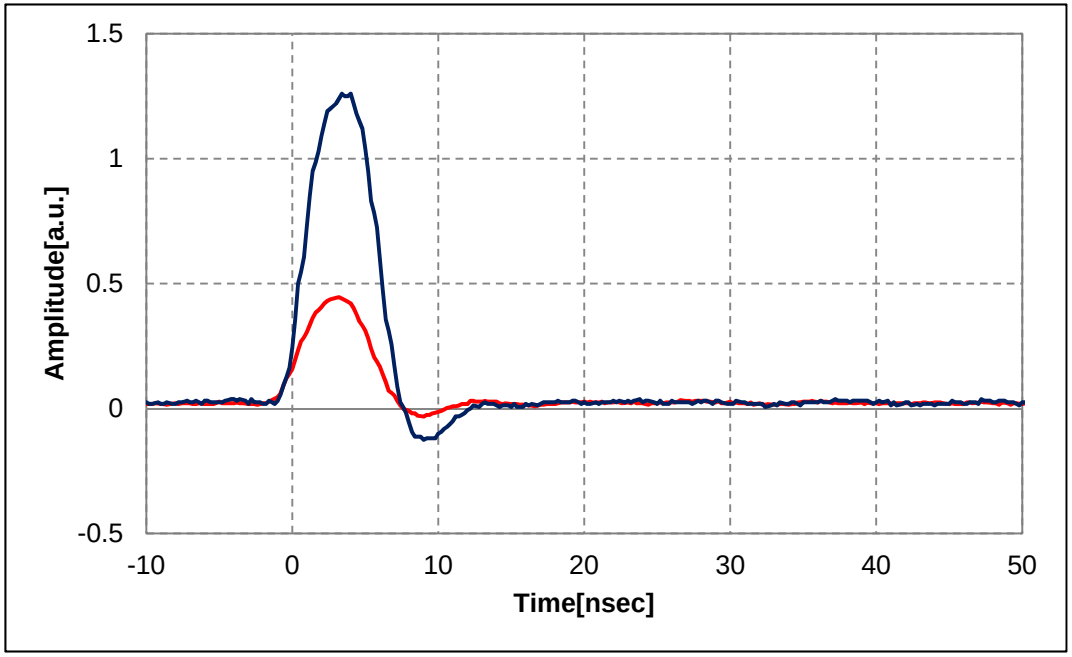




Compact visible laser module – **Nanosecond pulse** QDLASER



5 nsec pulsed operation



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Compact visible laser module – **Picosecond pulse**

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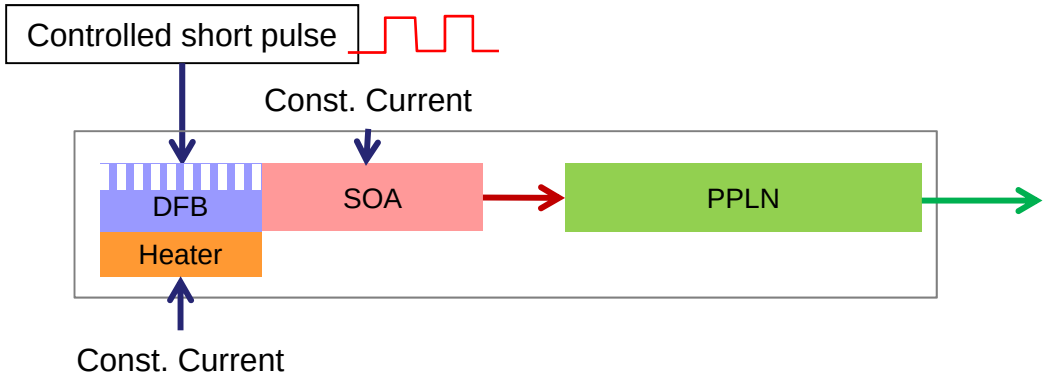
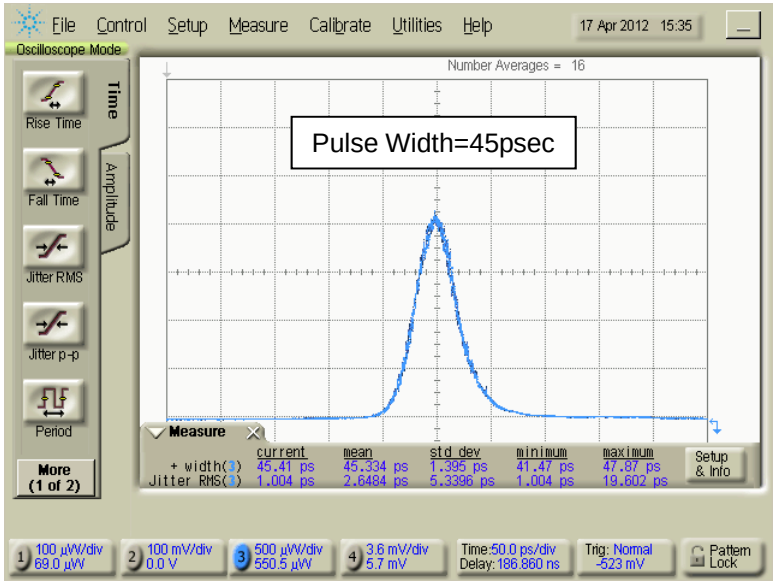
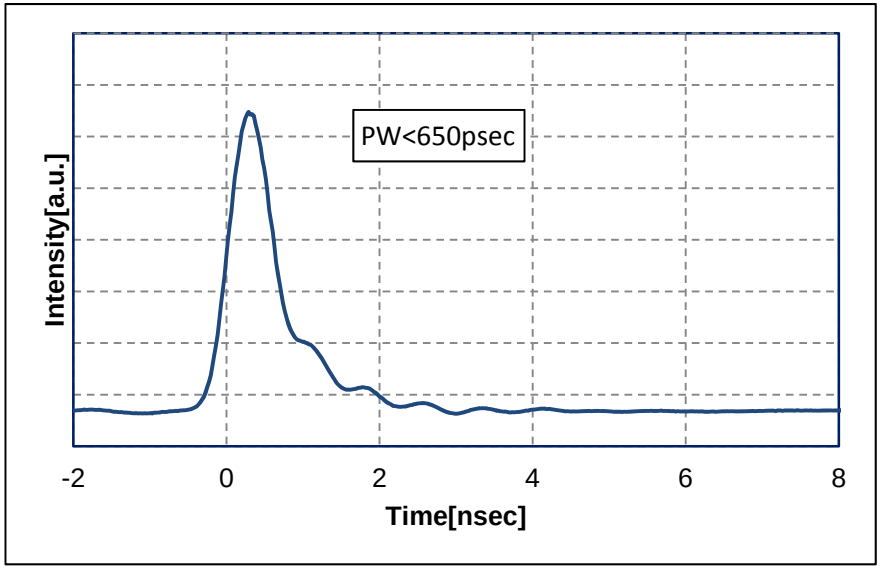


1064nm pulsed waveform

Averaged Waveform



532 pulsed waveform
(PW resolution is restricted by the equipment)



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561 nm laser module latest results

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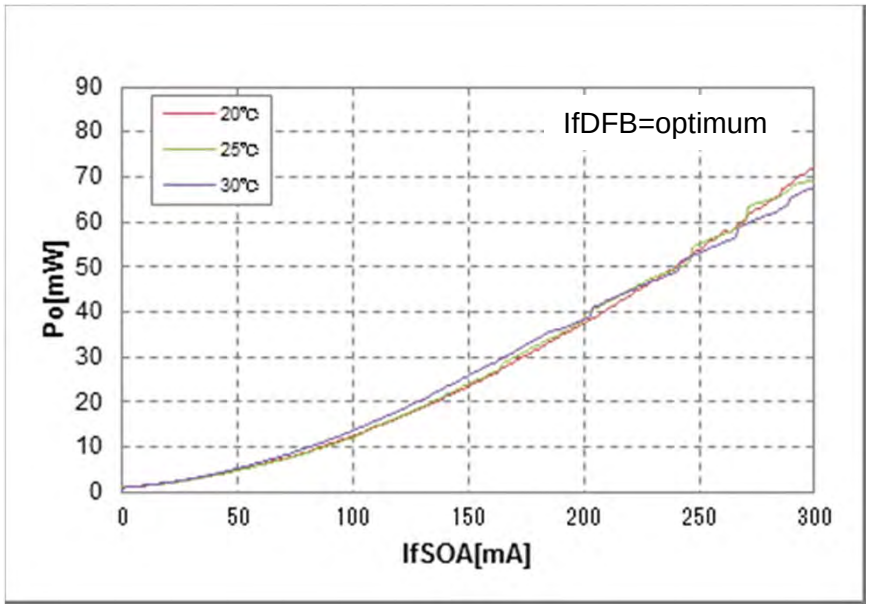

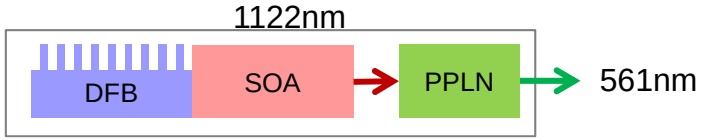

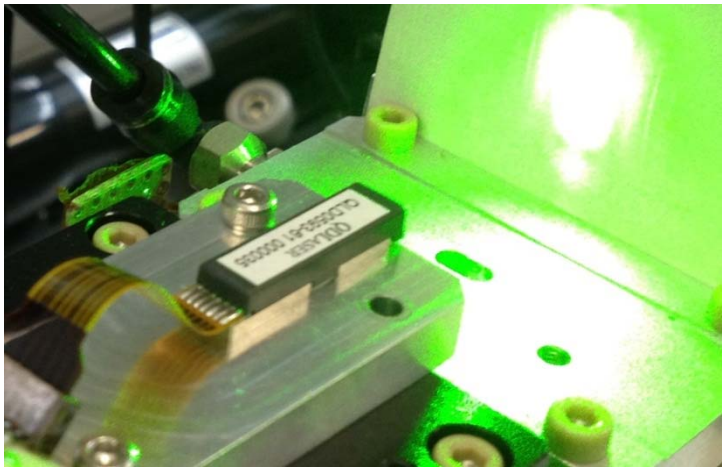

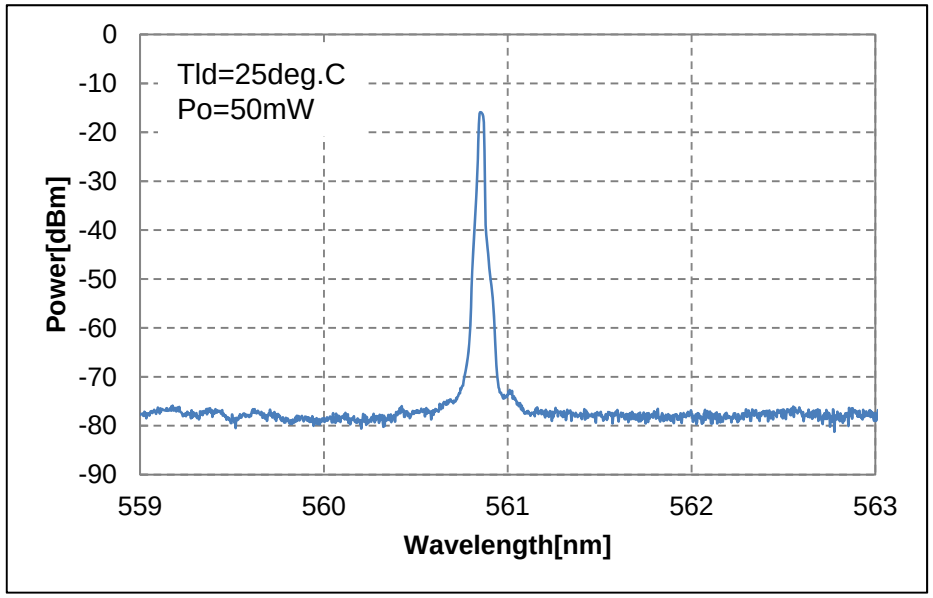

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Summary

QDLASER

- NIR DFB laser
  - Stable spectral characteristics
  - Short puled operation including picosecond pulse
  - Wavelength variety
- Compact visible laser module
  - Frequency doubling from NIR DFB laser
  - High power / High efficient / Compact
  - Short pulsed operation including sub-nanosecond pulse
  - 532, 561 and 594 nm

Thank you!

QDLASER

www.qdlaser.com