
iXblue

Narrow Linewidth Single Frequency Fiber Laser

IXC-CLFO-LN-BT

iXblue

iXblue DFB-FL at 1.5µm: IXC-CLFO-LN-BT solution

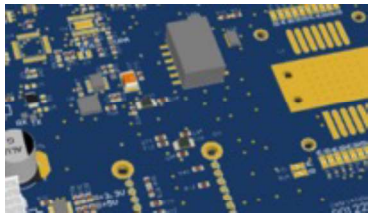
A single frequency laser for which applications?

- Coherent LIDAR
- Cold atoms
- Laser seeder
- Sensing
- Hydrophone
- Interferometry

iXblue

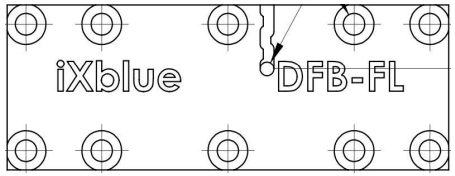
iXblue DFB-FL at 1.5µm: IXC-CLFO-LN-BT solution

Integrated iXblue technologies



Electronic (PCB)

→ Laser and TEC drivers, feedback loop



Distributed FeedBack Fiber Laser (DFB-FL)

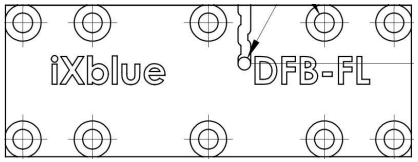
→ Bragg grating on active fiber

iXblue specialty fibers

→ Erbium, matched passive fibers and polarization maintaining (PM)

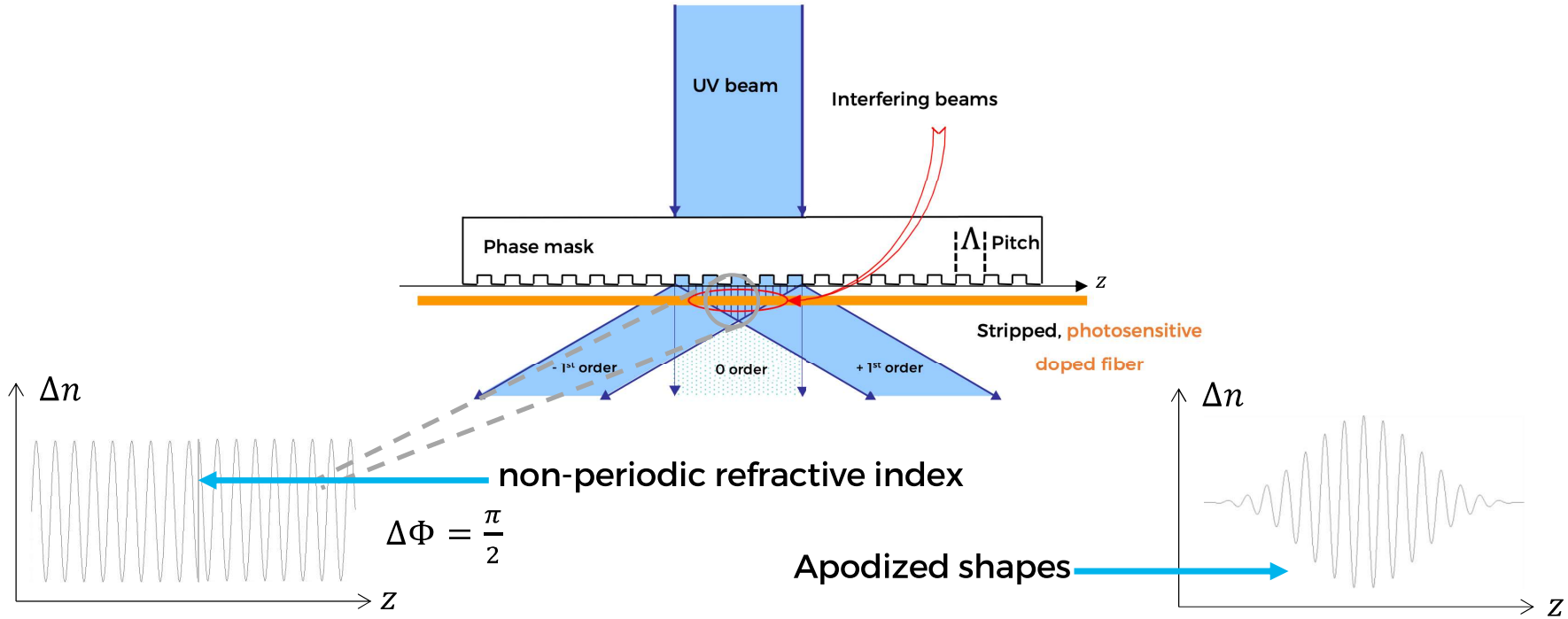
iXblue

iXblue DFB-FL at 1.5µm: IXC-CLFO-LN-BT solution



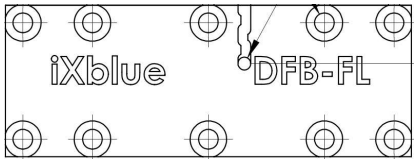
Focus on the DFB-FL sub-system → Fiber Bragg Grating (FBG)

- The DFB consist in a Fiber Bragg Grating written in a photosensitive doped fiber



iXblue

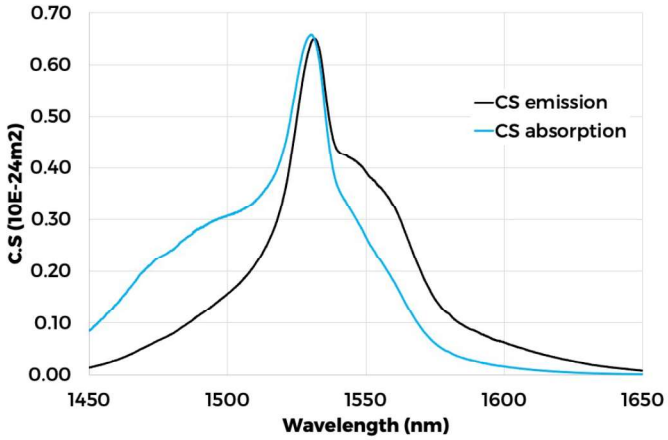
iXblue DFB-FL at 1.5µm: IXC-CLFO-LN-BT solution



Focus on the DFB-FL sub-system → specialty optical fibers

- Optimized doped fiber and tailored composition suitable for UV-photosensitivity
- Matched passive fibers
- Polarization-Maintaining (PM) fiber

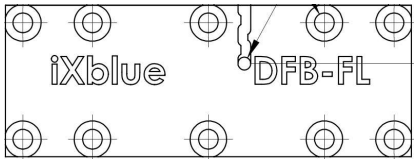
+ + + FBG = in-house solution!



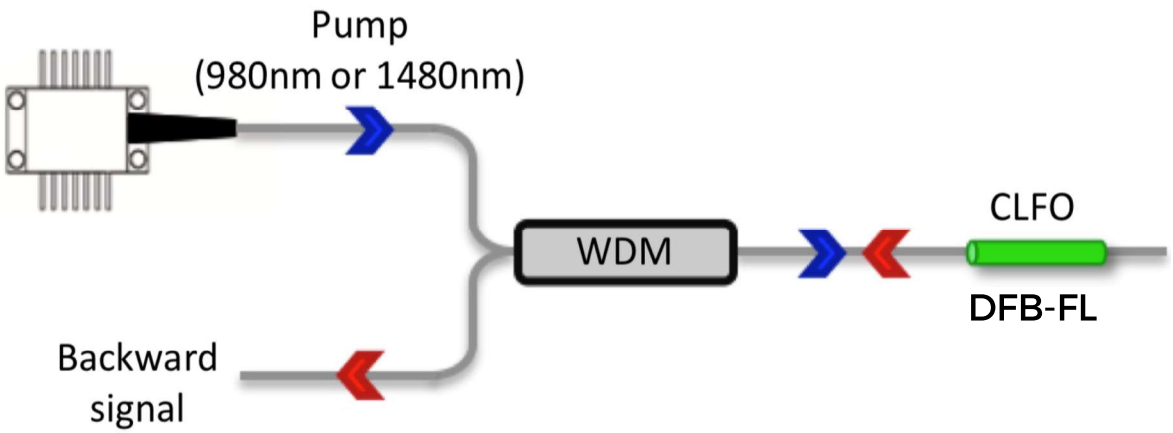
Typical Erbium cross-section

iXblue

iXblue DFB-FL at 1.5µm: IXC-CLFO-LN-BT solution



Focus on the DFB-FL sub-system → principle and …

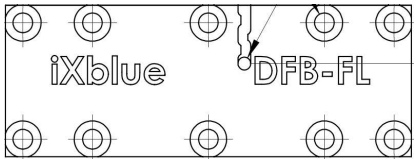


DFB-FL pump configuration: backward

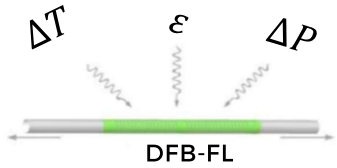
- Laser emission activated by SC-pump
- Bi-directional laser emission
- In this configuration, Laser emission in C-band
- Few tens of µW backward output power

iXblue

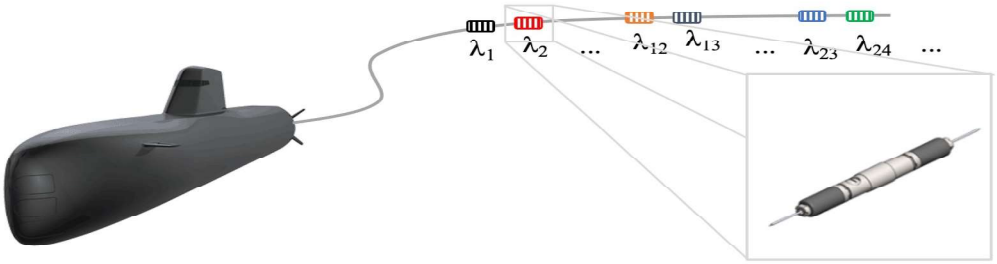
iXblue DFB-FL at 1.5µm: IXC-CLFO-LN-BT solution



Focus on the DFB-FL sub-system → principle and … caution!



- The active part, (= DFB-FL) → very sensitive to the Temperature, Strain and Pression
- DFB-FL commonly used as a sensor → hydrophone for ex. in array configuration (see below)

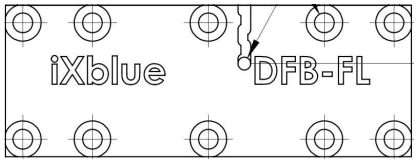


- Laser wavelength depends on:

$$\frac{\Delta\lambda_B}{\lambda_B} = \boldsymbol{a}\Delta T + \boldsymbol{b}\varepsilon + \boldsymbol{c}\Delta P$$

iXblue

iXblue DFB-FL at 1.5µm: IXC-CLFO-LN-BT solution



Focus on the DFB-FL sub-system → principle and … caution!

- First integration step → iXblue packaging
- Thermal management → wavelength stability + tunability easy to reach
- Tuning range approximatively, 1 nm (eq. to 125 GHz @ 1550 nm) at ~ 1 GHz/sec

DFB-FL packaging
62 x 12 x 3 mm

iXblue

iXblue DFB-FL at 1.5µm: IXC-CLFO-LN-BT solution

Focus on the DFB-FL system → fully integrated solution

- The DFB-FL is packaged and integrated in turn-key benchtop solution → IXC-CLFO-LN-BT

FEATURES

- Narrow linewidth < 0,1 kHz
- Low intrinsic phase noise
- Single longitudinal mode
- Output power up to 40 mW

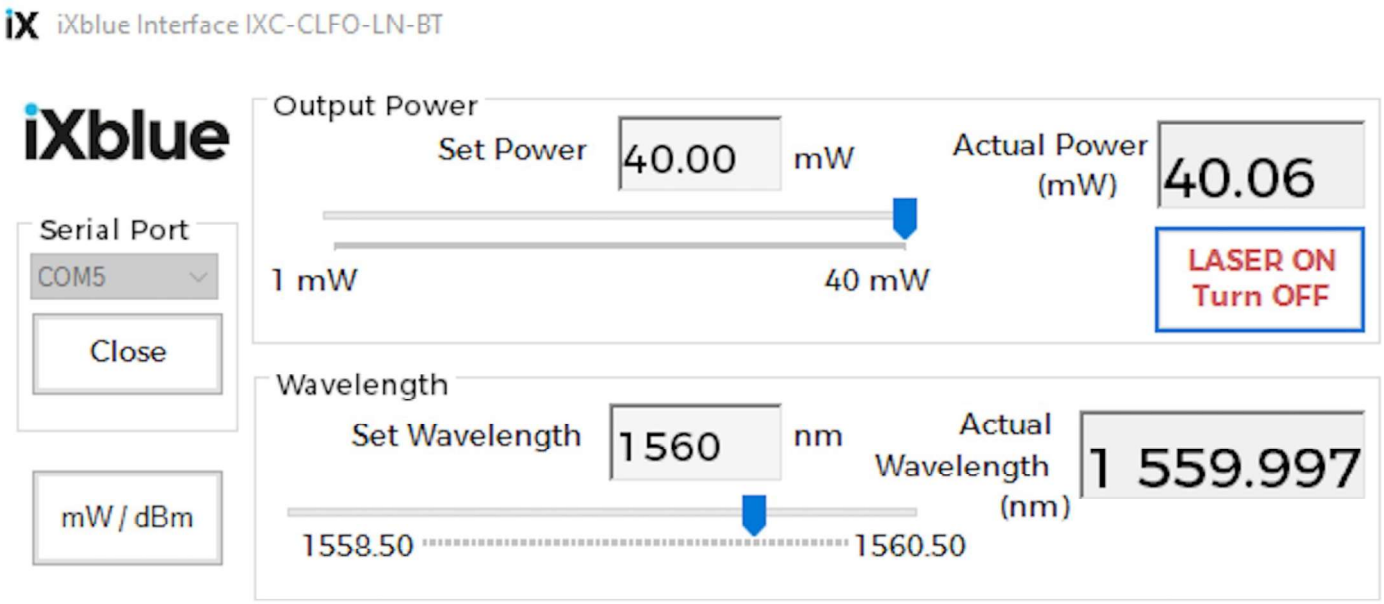
BENEFITS

- Linear polarization
- Mode-hop-free
- 1 nm range tunability

iXblue DFB-FL at 1.5µm: IXC-CLFO-LN-BT solution

Focus on the DFB-FL system → fully integrated solution

- The DFB-FL is packaged and integrated in turn-key benchtop solution → IXC-CLFO-LN-BT



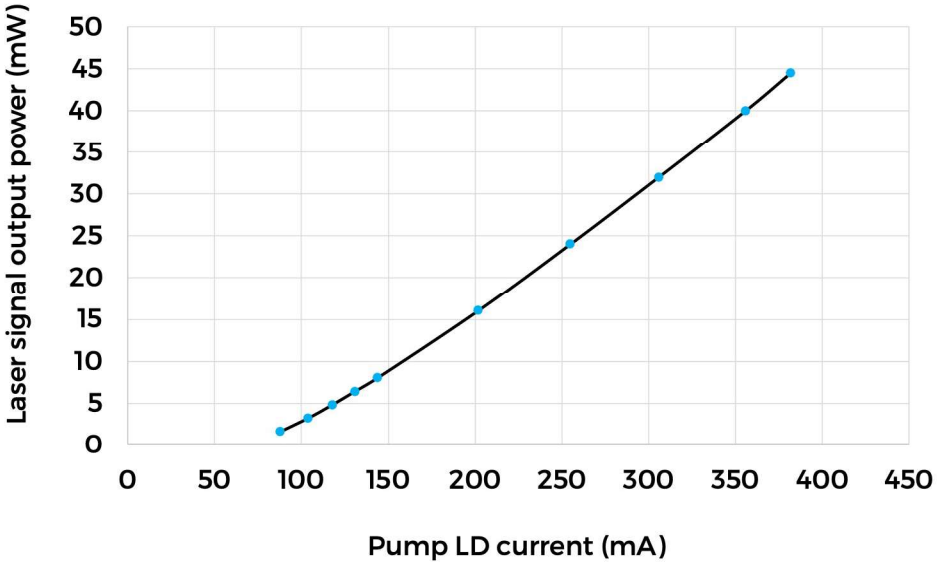
User-friendly interface to monitor the output laser power and wavelength

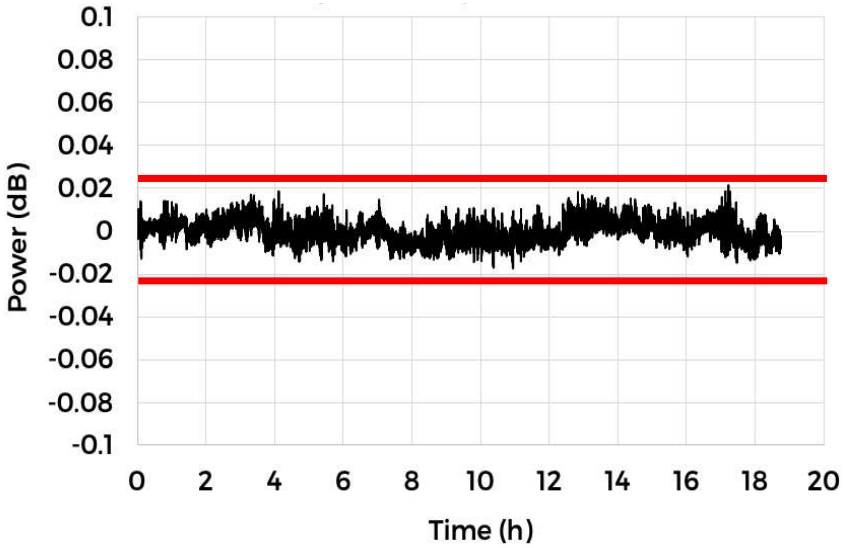
iXblue

iXblue DFB-FL at 1.5µm: IXC-CLFO-LN-BT solution

Focus on the DFB-FL system → fully integrated solution

- Polarization maintaining laser output power tunable with high stability





0.9 % power stability

Laser output power tunability up to 40 mW

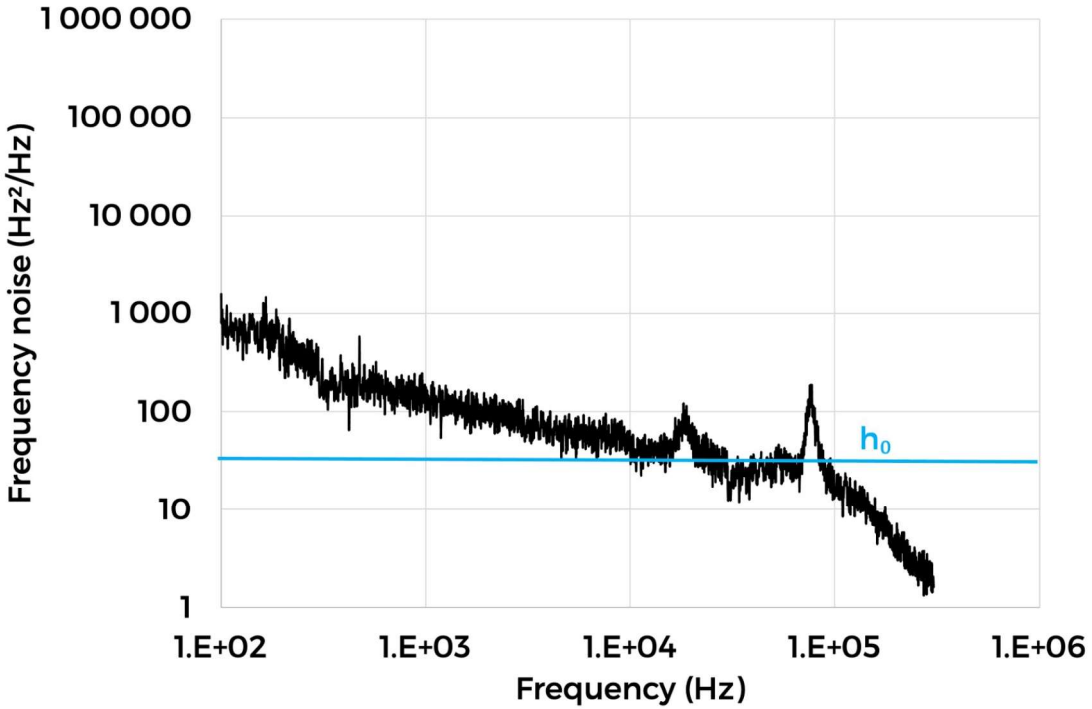
Laser output stability < 1 % (at room temperature)

iXblue

iXblue DFB-FL at 1.5µm: IXC-CLFO-LN-BT solution

Focus on the DFB-FL system → fully integrated solution

- Low frequency noise



- ultra narrow linewidth fiber laser
- Intrinsic linewidth $\Delta\nu = \pi h_0 \cong$ **0.1 kHz**

- Frequency noise level related to:
  - optical fiber properties
  - FBG cavity design
  - rare-earth lifetime

iXblue

iXblue DFB-FL at 1.5µm: IXC-CLFO-LN-BT

Apr 20, 2022 – Magazines

Photonics 2022 Special Edition

iXblue know-how in specialty optical fibers led to the development of single-frequency fiber lasers based on UV Bragg grating technology written into active rare-earth photosensitive fibers. Short cavity length and phase-shifted design permit an ultra-narrow linewidth, robust mode-hop-free and single longitudinal mode laser operation.

Such single-frequency fiber lasers, also called "Narrow Linewidth Fiber Laser" or "Distributed Feedback Fiber Lasers" (DFB-FL) are ideal for various emerging applications including LIDAR and cold atoms. Due to the extremely narrow linewidth, low noise and compactness, these fiber lasers can be used in applications such as interferometric sensing, in seismology for example. Several millimeters in length as a sensing element, lead to a robust single mode operation, without mode hop even when thermal and vibration environment are uncontrolled. That is why, these fiber lasers can also be used as hydrophones. One of their key advantages lies in the very low intrinsic noise, suitable for level with "Deep Sea State Zero" which means, the capabilities of an acoustic signal detection as low as the level of the acoustic noise floor of a quiet ocean. Finally, these fiber lasers are also useful for scientific research (i.e spectroscopy), or as continuous / pulse laser seeders.

Reaching a measurement with very low noise is possible when both FBGs and optical fibers design and manufacture are mastered. Based on its expertise in optical fibers and in photo-writing, iXblue is able to design matched active and passive fibers dedicated to such solutions. Armed with several years' experiences in the Fiber Bragg Grating (FBG) technology, iXblue shapes continuously FBGs and therefore improves fiber laser performances.

Today narrow linewidth fiber lasers can be applied to a variety of applications at several frequency or wavelength ranges: coherent pulse laser source for LIDARs, continuous laser for cold atoms, etc. They can replace semiconductor lasers having output powers of only few mW, with linewidths not suitable for coherent lightwave systems.

A new compact and integrated solution

With the aim to develop a fully integrated system, iXblue is adding to its portfolio a new compact solution integrating the narrow linewidth laser, the IXC-CLFO-LN-BT at 1.5 ×m. It houses the 1.5×m iXblue single-frequency fiber laser (FBG on active doped fiber) and an iXblue pump driver, but also an optical amplification stage. The output laser is a continuous polarization maintaining laser signal up to 40 mW, 1kHz linewidth range and a tunability over 1nm. In this turn-key benchtop solution, iXblue guarantees the power amplification, the high stability and the quality of the narrow linewidth fiber laser. The DFB fiber laser sub-component is also available by itself, for 1.5×m. Thanks to its know-how at 1.5×m, iXblue opens new emerging applications, with its fiber laser at 2×m, based on the specialty Thulium doped fibers ■

The compact turn-key benchtop solution housing the 1.5µm DFB with 40 mW output power released at Laser World of Photonics 2022.

IXC-CLFO-LN-BT

NARROW LINEWIDTH SINGLE FREQUENCY FIBER LASER

FEATURES & BENEFITS

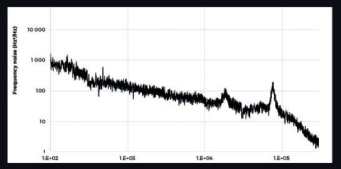
- Narrow linewidth < 0.1 kHz
- Low intrinsic phase noise
- Single longitudinal mode
- Output power up to 40 mW
- Linear polarization
- Mode-hop-free
- 1 nm range tunability

APPLICATIONS

- Sensing
- Coherent LIDAR
- Hydrophone
- Cold atoms
- Laser seeder
- Interferometry
- Spectroscopy

Wavelength	1560 nm Other wavelengths available in C band
Wavelength tuning range	1 nm
Laser output power tunability	1 to 40 mW
Output power stability [1]	< 1 %
Linewidth [2]	< 0.1 kHz
Frequency noise @ 100 Hz	750 Hz²/Hz
Frequency noise @ 1 kHz	130 Hz²/Hz
RIN peak range	75 kHz
RIN @ peak frequency	<-80 dBc/Hz
Rin @ 10MHz	<-130 dBc/Hz
Output fiber type	Panda PM1550
PER	> 23 dB
Operating temperature range	18-35 °C
Power supply	110 - 220 VAC
Com. interface	RS232 over USB
Dimensions	27 x 27 x 59 mm
Weight	5 Kg

1 : over 12 h, 40 mW output power, 23°C room temperature
2 : intrinsic linewidth



iXnews | 25

iXblue

iXblue DFB-FL at 1.5µm: IXC-CLFO-LN-BT solution

- Other development in progress → DFB-FL sub-assembly already explored at 2 µm

2-m Narrow Linewidth All-Fiber DFB Fiber Bragg Grating Lasers for Ho- and Tm-Doped Fiber-Amplifier Applications

Article May 2021 · Journal of Lightwave Technology

Wiktor Walasik · Daniya Traore · Alexandre Amavigan · [...] · Emmanuel Pinsard

Add full-text | Add to project | Add supplementary resources

2051 nm Narrow Linewidth All-Fibre DFB Laser for Holmium-Doped Fibre-Amplifier Applications

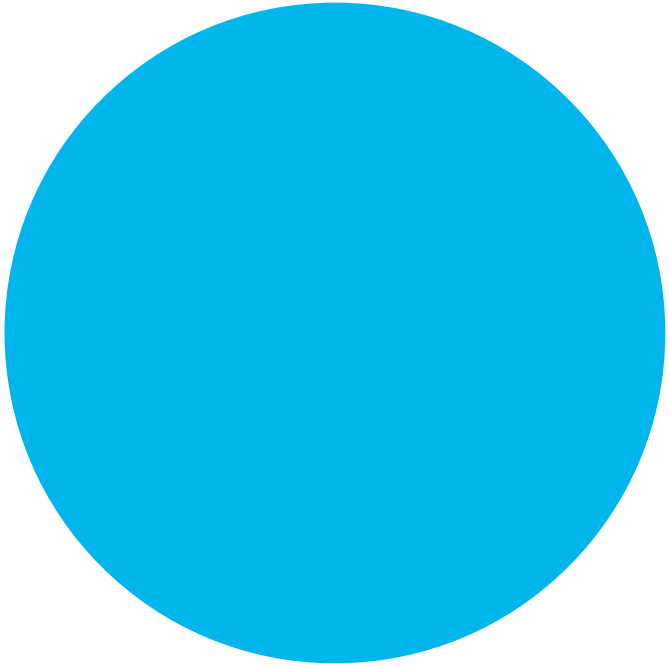
Conference Paper December 2020 · 2020 European Conference on Optical Communications (ECOC)

Daniya Traore · Wiktor Walasik · Alexandre Amavigan · [...] · Emmanuel Pinsard

Add full-text | Add to project | Add supplementary resources

- The DFB fiber laser sub-component remains available by itself (at 1.5 µm and 2 µm)

iXblue



Emmanuel Pinsard

Product Line Manager Fiber Optic Components
iXblue Photonics

Rue Paul Sabatier
22300 Lannion
France
www.photonics.iXblue.com

emmanuel.pinsard@ixblue.com