

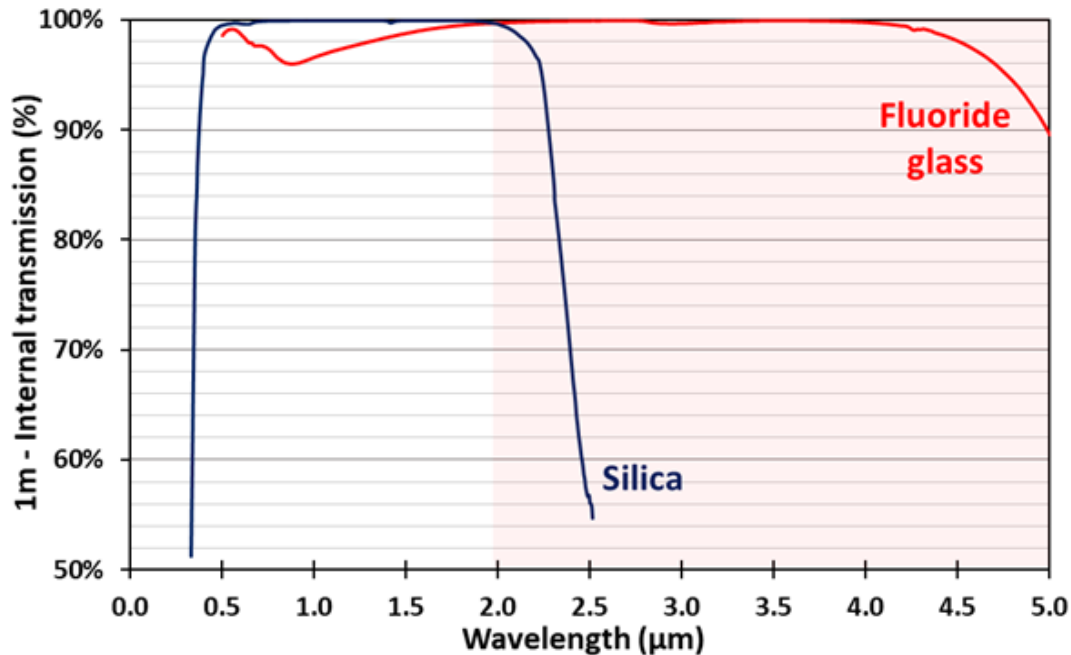


אגודת זכוכית ישראל

# Fluoride glass technology for XXIst century's challenges

# Interests of the technology

## High transparency from UV to mid-IR (300 nm – 5500 nm)



Fluoride glass fibers exhibit the best transparency among all technologies in the 2000 nm – 5000 nm range

**Many rare-earth transitions** for visible and mid-IR lasers and amplifiers allow a new generation of fiber lasers and amplifiers :

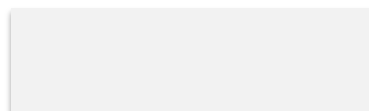
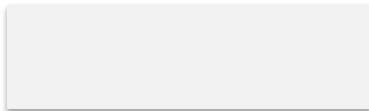
- Multiwatts visible (red, green, yellow, blue) single mode fiber lasers,
- Multiwatts mid-IR fiber lasers,
- Telecom amplifiers (O-band and E-band)

# Building an ecosystem

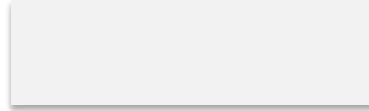
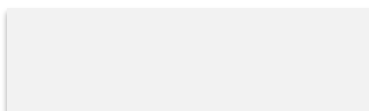
## 4 official partnerships



## 4 non official partnerships



Your company ?



# INDUSTRY & ECOLOGY

## **Oil & gas NIR spectroscopy (1000 nm – 2400 nm)**

- Fiber patch cables and flow cell

## **Industrial process monitoring**

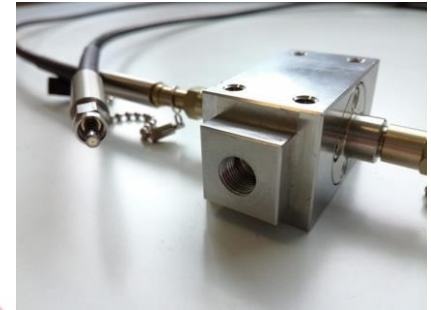
## **Aircraft exhaust gas monitoring**

## **Smart agriculture monitoring**

## **Water quality and wastewater monitoring**

## **Urban pollution monitoring**

- ICL/QCL pigtailed, coupling and amplification
- 2.5  $\mu\text{m}$ -10  $\mu\text{m}$  supercontinuum



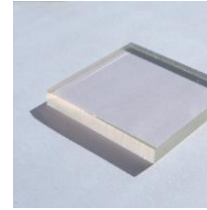
# MEDICAL

Er-YAG laser pigtailed : multimode ZBLAN fiber with endcaps

DNA sequencing :

Rare earth doped glass pieces

Multiwatts red and green fiber lasers



Super-resolution microscopy : Multiwatts visible fiber lasers

Cytometry : Multiwatts visible fiber lasers

Surgery : CW and pulsed 2.9  $\mu\text{m}$  fiber laser

Ophthalmology :

Multiwatts yellow laser

CW 2.9  $\mu\text{m}$  fiber laser

Cancer detection : multimode ZBLAN fibers,

2.5  $\mu\text{m}$  – 10  $\mu\text{m}$  supercontinuum

3D living cells bio printing (including vascularization) :

High power 2.8  $\mu\text{m}$  pulsed fiber laser



# TELECOM

O-Band (1260nm-1360nm) and S-band (1460 nm – 1530 nm) telecom amplifiers

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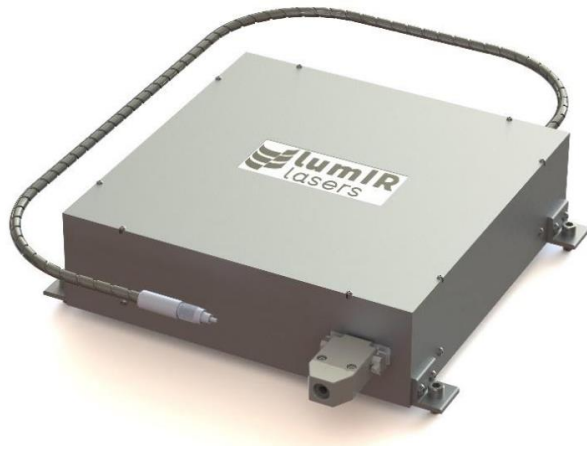
3.9  $\mu\text{m}$  ground and ground to space communication.

High bite rate LIFI communication : R G B pulsed fiber lasers



# 2.8 $\mu\text{m}$ fiber laser (up to 10W CW)

LumIR lasers is a canadian company (Québec) which is a spinoff of University of Laval (Québec), world leader in mid-IR fiber lasers



Main applications :

- Treatment of glaucoma
- Skin defects erasing
- Surgery

Next products :

- 2.8  $\mu\text{m}$  pulsed fiber lasers
- 3.2  $\mu\text{m}$  CW fiber lasers,
- 3.5  $\mu\text{m}$  CW fiber lasers



המכון הלאומי למחקר ופיתוח

# VISIBLE FIBER LASERS



# History of visible fiber lasers

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ZBLAN glasses offer several rare-earth transitions in the visible range :

Cyan (485 nm – 495 nm )	: Praseodymium
Green (525 nm – 535 nm)	: Praseodymium
Green (540 nm – 555 nm)	: Thulium
Yellow-green (555 nm – 565 nm)	: Holmium
Yellow (569 nm – 582 nm)	: Dysprosium
Red (630 nm – 640 nm)	: Praseodymium

During the 90's, many visible fiber lasers have been developed using upconversion (pumping at 850 nm and 980 nm).

In 2015, 1st publication of Pr doped fiber laser pumped by blue laser diode

Since 2019, > 100 W GaN diodes are commercially available.

# LVF development of visible fiber lasers

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In 2019, LVF has made 450 mW 635 nm fiber laser using 2.2W GaN diode.

LVF has received funding (580 k€ in 3 years) to develop 4 CW fiber lasers pumped by GaN diode :

0.5 W CW Cyan (485 nm – 495 nm ),

2 W CW Green (525 nm – 535 nm),

1 W CW Yellow-green (555 nm – 565 nm),

5 W CW Red (630 nm – 640 nm).

This development will involve 3 companies and 1 laboratory.

Interests of the technology :

- Compact,
- Reliable (> 5000 hours)
- Cost effective (< 10 k\$)
- Low electrical consumption (~20W).

