PHOTONICS BRETAGNE

DAVID MÉCHIN, DIRECTOR

PHOTONICS BRETAGNE

Photonics Innovation Hub

afaq ISO 9001 Qualité AFNOR CERTIFICATION

CRÉDIT IMPÔT Agréé CIR RECHERCHE

CRT centre de ressources technologiques

PHOTONICS BRETAGNE

centre de ressources technologiques

A CLUSTER

- Network & Service Hub
- Organization of photonics events
- Custom training of workforce and outreach

A RTO (Research & Technology Organization)

- Development of specialty optical fibres & components
- Biophotonics Engineering
- Technology maturation & industrialization

123 Membres

80 Companies

27 Research Institutes

History of Photonics Bretagne

1960

CNET settling at Lannion
(French« Telecom Valley »)

1995-2005

Telecom technologies spin-off: Startups and
PERFOS creations (PCF Fibers) in 2003

2011

PERFOS becomes

Integrating a
cluster activity

2017

Launching and opening of
the Photonics Park
(New facility)

2018

Photonics Bretagne develops
a **Biophotonics activity**

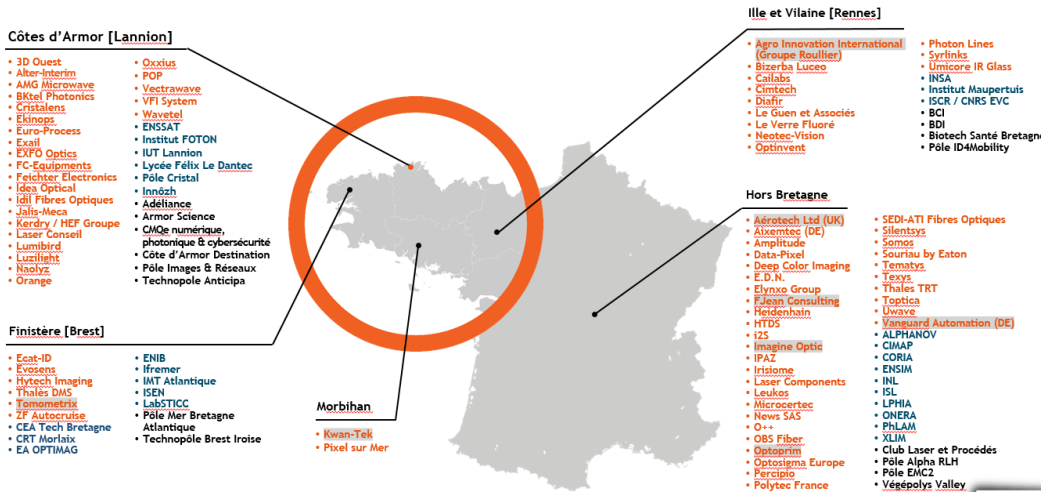
2020

Launching of In-House
Photonics Training for
companies

The Industrial Photonics Ecosystem in Brittany

A Photonics Park In Lannion (>1000 direct jobs in Photonics in Lannion)

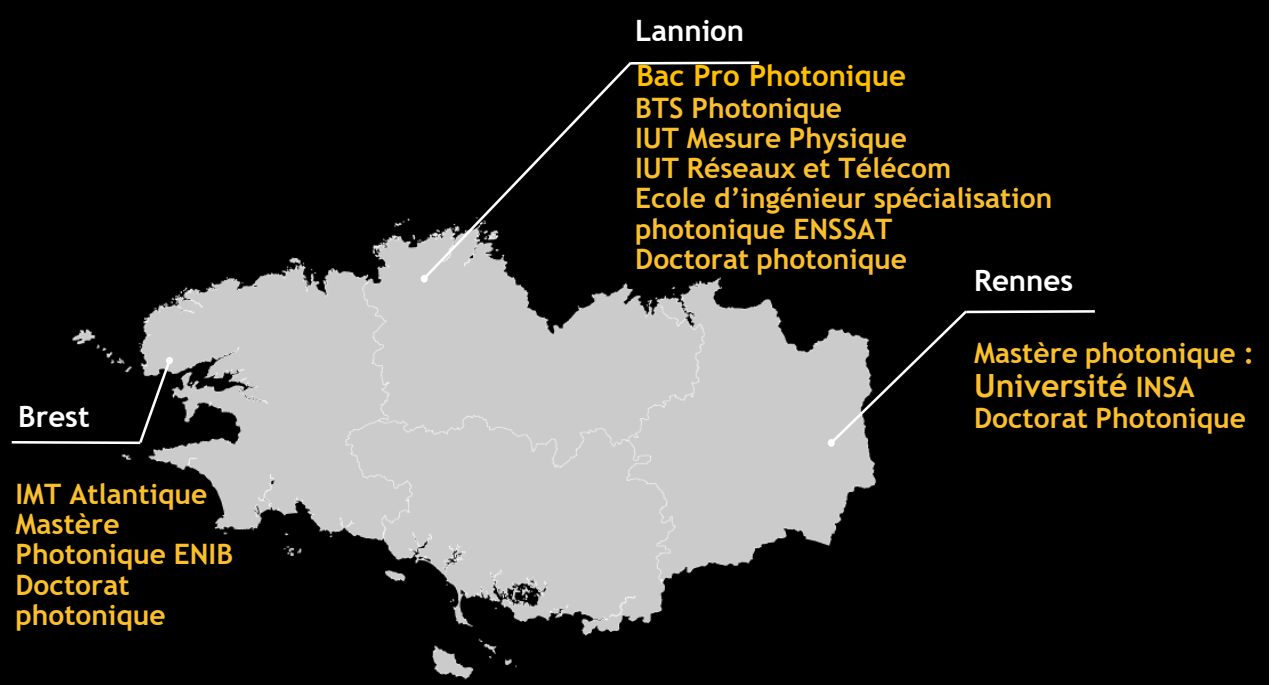
A lot of companies also in Britanny outside the Lannion area!



The strength of a network beyond Brittany: 123 members!

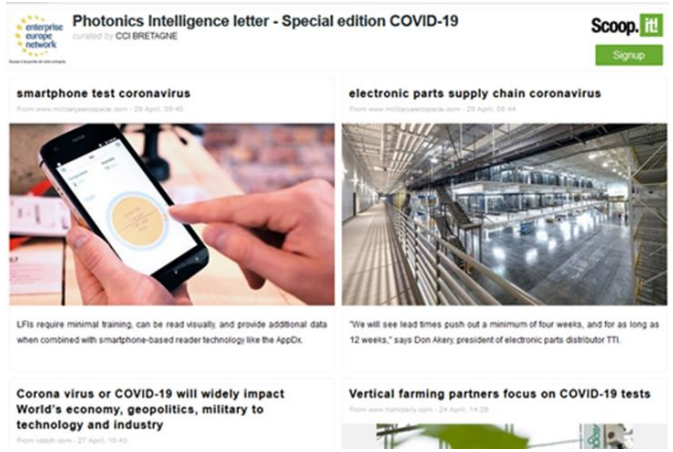
High Level Laboratories and Universities

From Operator to PhD



Highly Specialized R&D Labs

CLUSTER ACTIVITIES



Tech Watch & Consultancy

Regional & EU Lobbying

Events & Networking

Support for Building Collaborative Projects

Communication & Visibility

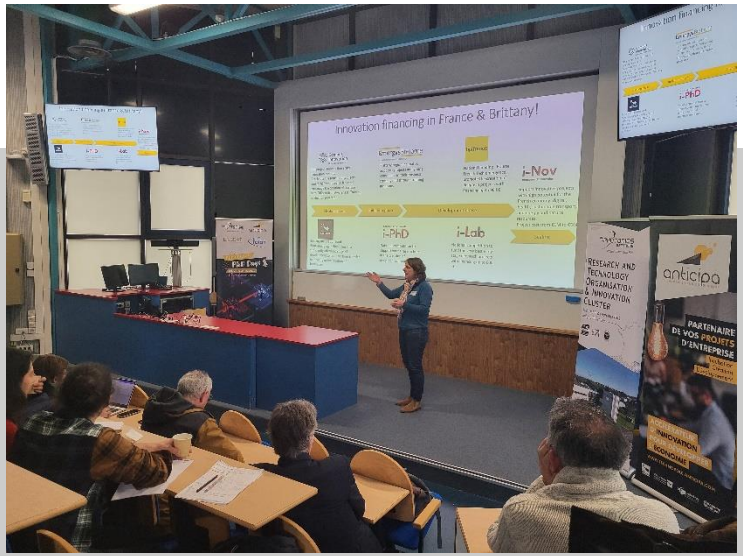
CLUSTER ACTIVITIES

Quantum event co-organised at Orange premises last April!

PHOTONICS PHD DAYS

- One-of-a-kind event in France dedicated to PhD students in photonics working all over Europe
  - break potential mental barriers of young researchers
  - present all the support options available on our territory

- Exploration of career options
  - entrepreneurship through a unique, long workshop in small groups
  - think about a research topic as a potential business case
  - expansion of their professional network through company visits & group work



ADVOCACY: HIGH SCHOOL INTERNSHIPS

- Week-long internships are **compulsory** in France for pupils aged ~14
- New **pooled internships** organised by CMQe Lannion & hosted by Photonics Bretagne
- Avoid the overwhelm of individual requests to companies
- **Objective:** To make photonics as fun and accessible as possible through
  - ✓ interactive workshops
  - ✓ games
  - ✓ company visits
- **First edition wildly successful: ~90 pupils from 10 local schools and enthusiastic feedback**
- **They all pitched their first start-up at the end of the week!!**

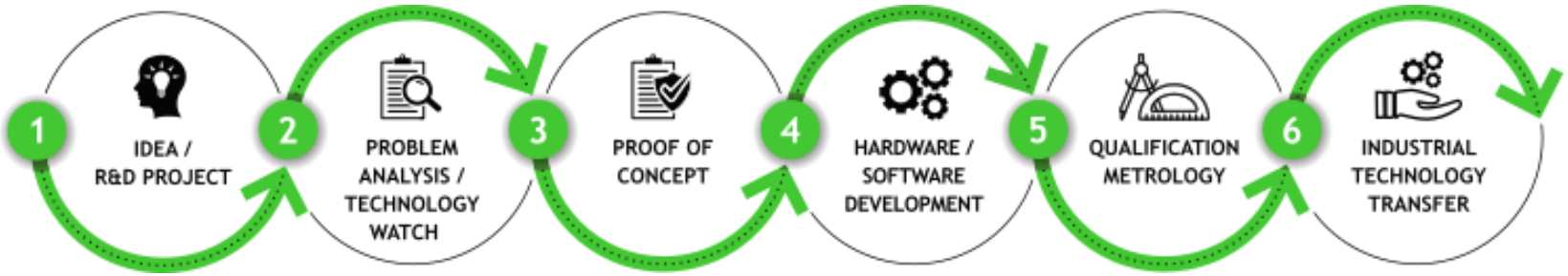
Visite de la tour de fibrage

Professional Training

- **We target and meet companies** who might have needs in upskilling or developing new competences, in Brittany and beyond.
- **We offer tailor-made training in photonics, for all levels, backgrounds, and duration,** theoretical and experimental, in-house or at the company's premises.
- **We act as the link** between education & apprenticeship curricula, students and companies.

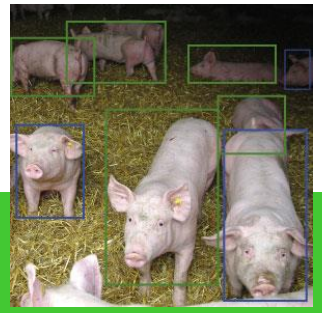
BIOPHOTONICS ENGINEERING

- Promote the development of *in-situ* photonics technologies for life sciences
- Support companies in using photonics technologies



Cultivation

Aquatic ressources



Farming

Agrifood

Biology

Technology Services

Custom Instrumentation

- Optical and mechanical design
- Integration and assembly of devices
- Proof of concept, demonstrators, prototypes

Metrology and Diagnostic Aid

- Measurement and analysis of optical radiation
- Calibration and characterization of systems
- Signal processing and analysis (AI and statistics)

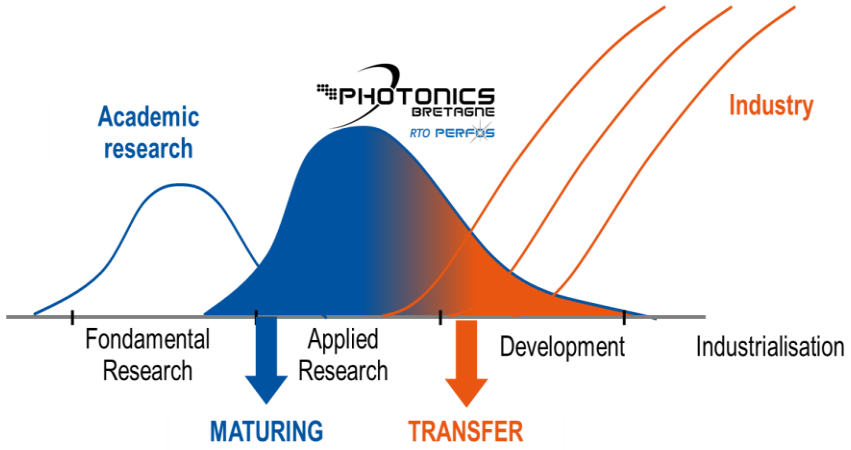
Scientific indoor lab

Outdoor lab

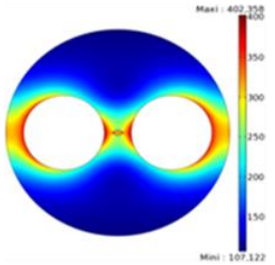
On site (field, factories…)

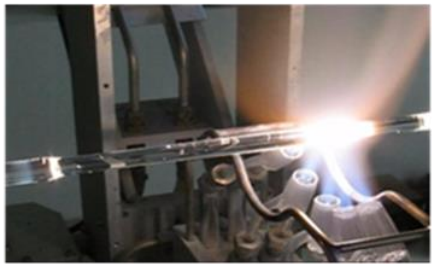
RTO SPECIALISED IN CUSTOM OPTICAL FIBRES!

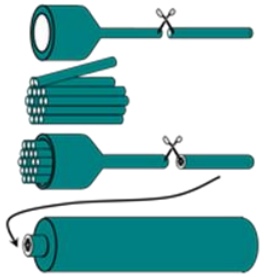
Custom solution from Conception to Integration!

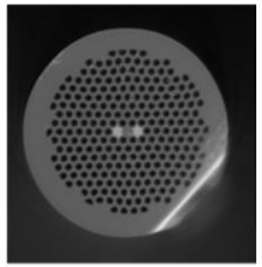


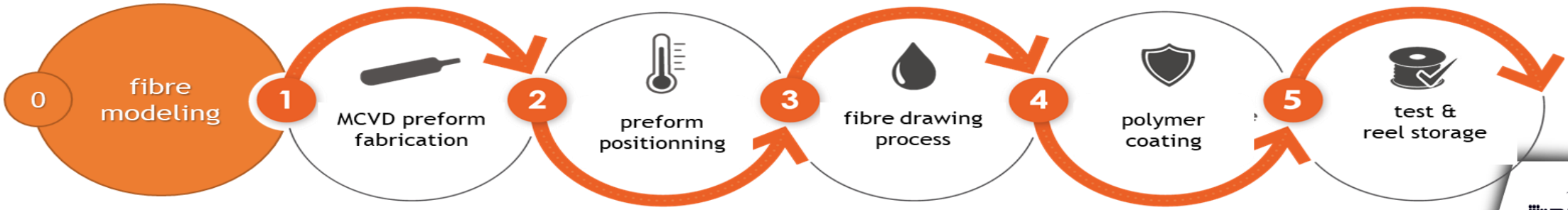
- A focus on **PCF** but also **MCF, Active, custom coating, components…**
- **Active/passive** fibers
- **Different doping** (Yb, Er, Bi, F, B, Ge…), Phase vapor deposition!
- **Draw tower Bragg gratings**
- **Metal coated fibers**
- **Stress rods, Capillaries**
- **Tapers, MFA, Fan In/Out**
- **Simulation, Characterization, Consulting…**



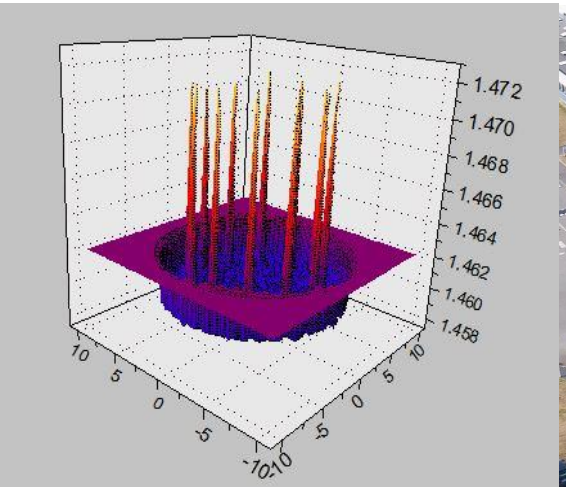


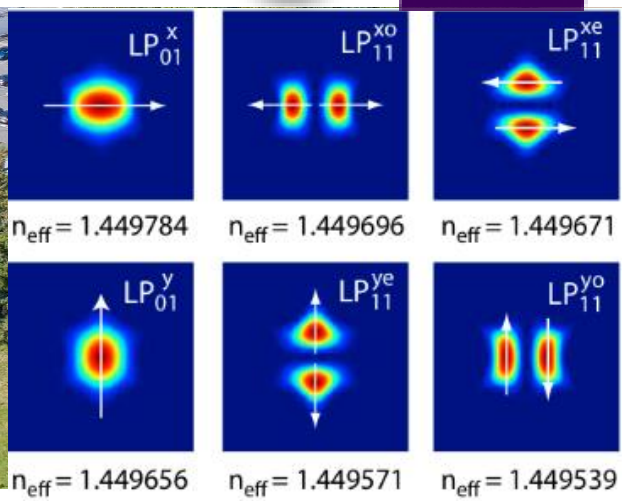




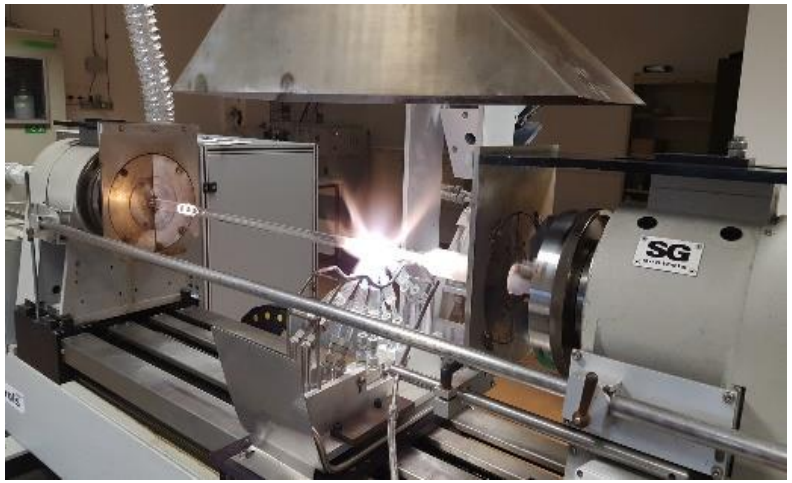


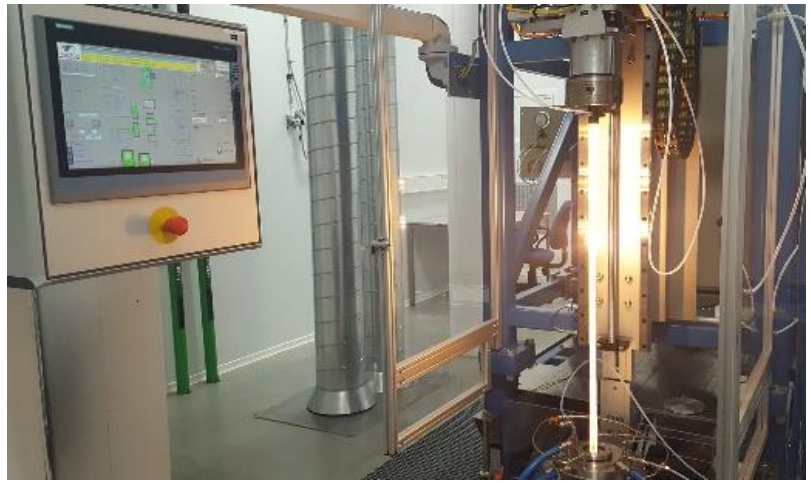
RTO PHOTONICS BRETAGNE: SPECIALTY OPTICAL FIBRES





Custom solution from Conception to Integration!





Technological capacity unique in the world in the field of specialty optical fibre manufacturing !!

RTO Photonics Bretagne: Specialty Optical Fibres

Custom solution from Conception to Integration!

Microstructured Fibres

Solid-Core

Supercontinuum | SUP *

Supercontinuum and nonlinear wavelength conversion

- Optimised for pumping near 780 nm and 1060 nm
- Low background loss
- Small effective area
- High nonlinear coefficient

Endlessly Single-Mode | ESM

White light delivery for life sciences

- Single-mode at all wavelengths
- Wavelength-independent mode-field diameter
- Available in polarisation-maintaining version

Airclad | ACF

Power delivery, spectroscopy

- Multimode
- Ultra-high numerical aperture

** Also plug-and-play modules available on request*

Hollow-Core

Photonic Bandgap | HCF

Gas detection

- Different transmission bands in Near-IR with low background loss
- Ultra-low nonlinearity
- High damage threshold
- >98% of the optical power in the core
- Ultra-low bend loss

Anti-Resonant | ARF

Low latency transmission, power delivery

- Various spectral transmission bands (700-3150 nm) with ultra-low dispersion
- High damage threshold
- ~99% of the optical power in the core
- Nearly single-mode guidance

Cable

Hollow-Core Fibre Optic Cables

Low latency data transmission

- Large bandwidth transmission at 1310 nm, over the full C/L bands and beyond
- Low loss
- Easy integration into existing networks

All Solid Fibres

Very Large Mode Area | VLMA *

Ytterbium Doped Fibre

High power ultra-fast pulsed fibre lasers/amplifiers

PATENTED

- All-solid step-index fibre
- Truly single-mode PM
- Mode area ~750 μm^2
- Photodarkening-free silica matrix
- Cladding absorption >7 dB/m
- Passive version available on request

Multicore | MCF

Sensing, telecom, lasers

- 7 and 12 cores
- Excellent fibre geometry
- Passive, photosensitive, erbium or ytterbium doped cores

Coatings

Metal Coated Fibres

Sensing, amplifiers, lasers

- Multi/single-mode fibres with aluminium or carbon+copper coating
- Wide temperature range and water/hydrogen sealing barrier

Components

Draw Tower Bragg Gratings

Temperature and strain sensors

- Single or multicore fibres
- Weak reflectivity
- Customisable FBG length and spacing

Boron Stress Rods

For polarisation maintaining fibres

- Highly doped
- Various core diameters and lengths

Capillaries

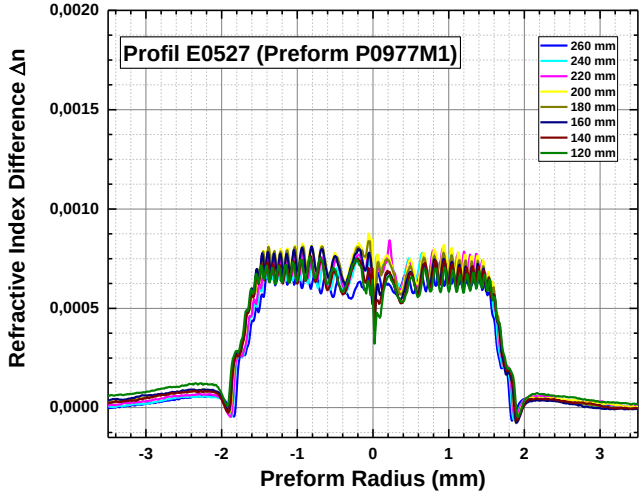
Combiners, biophotonics

- High-precision homogeneous vertical drawing
- Pure or doped (fluorine, boron, germanium...) silica

Product list available on Exail's Eshop! Custom demand/design directly through us! ☺

ACTIVE FIBERS

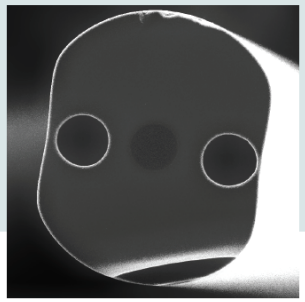
- **Excellent control** of glass composition, fabrication process, refractive index and rare-earth profile!
- **Core diameter up to 6 mm**
- **Yb VLMA (large A_{eff}, single mode, bendable…)**
- **Also custom solution and other dopants (Er, Bi, etc…)!**
- **Module and Passive version available**



PHOTONICS BRETAGNE
Product line PERFOS

ACTIVE FIBRES
VERY LARGE MODE AREA FIBRE
40 µm core diameter

04/2021



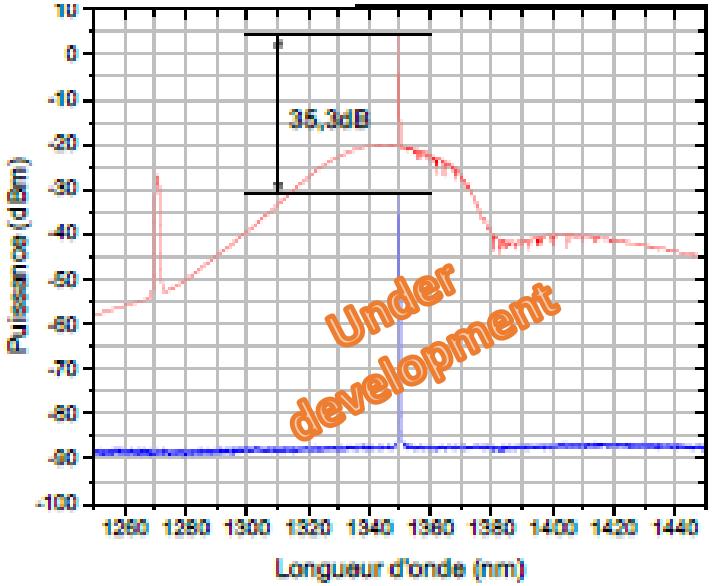
Main characteristics

- Truly single mode polarization maintaining behavior
- All-solid step index based fibre design based on our all-vapor phase delivery process
- Industry standard low index polymer coating providing long term reliability & performance
- Excellent fibre lot uniformity and consistency
- Photodarkening free silica matrix

Applications

High power ultrafast pulsed fiber lasers/amplifiers for material processing, life science, spectroscopy or defense applications.

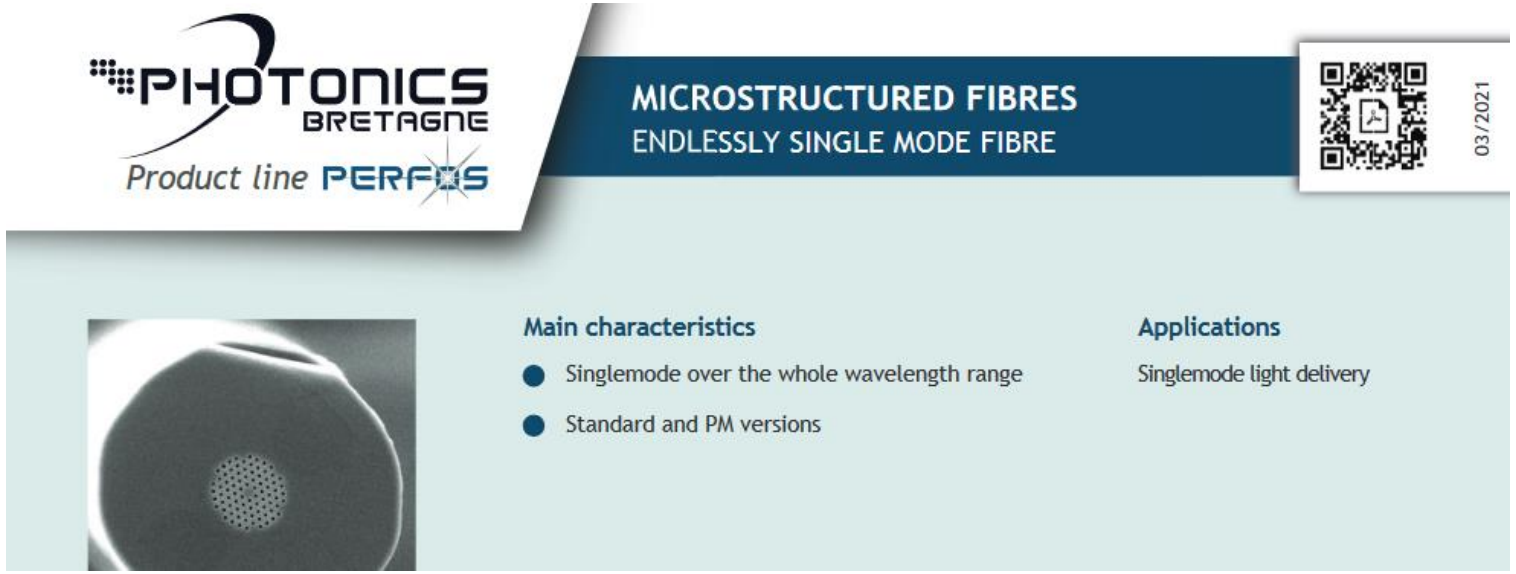
Fibre specifications

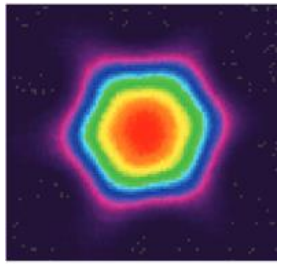


Bi-doped fiber for E-band telecom amplification (1360nm-1460nm)

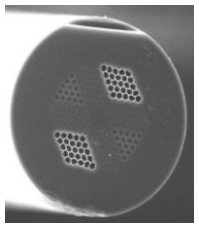
FRANCE RELANCE

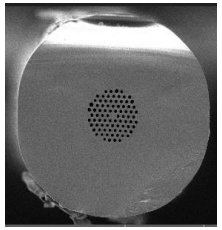
ENDLESSLY SINGLEMODE FIBERS

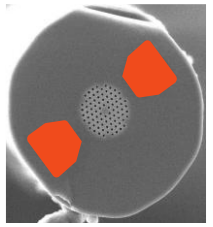


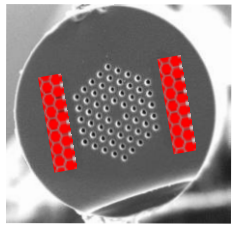


Measured fundamental mode shape of the ESM-5-125-PM @ 532 nm









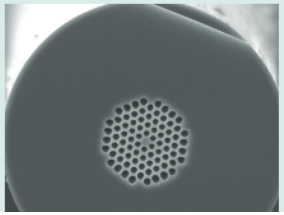
Various design, ESM5, ESM10, PM or not!
ESM20-PM and all-solid ESM on the way! ☺

SUPERCONTINUM FIBERS

PHOTONICS BRETAGNE
Product line PERFOS

MICROSTRUCTURED FIBRES
SUPERCONTINUUM PHOTONIC CRYSTAL FIBRE

01/2024



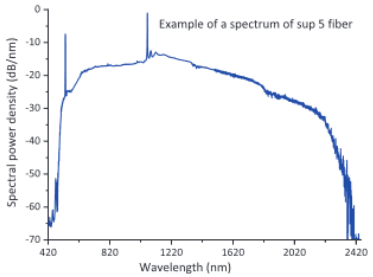
Main characteristics

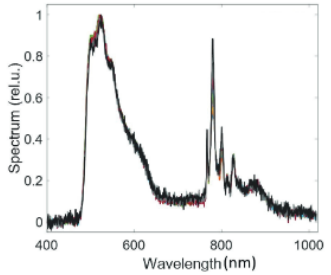
- Pure silica core, low background losses
- Small effective area, high nonlinear coefficient
- Dispersion optimised for pumping near 780 nm & 1060 nm

Applications

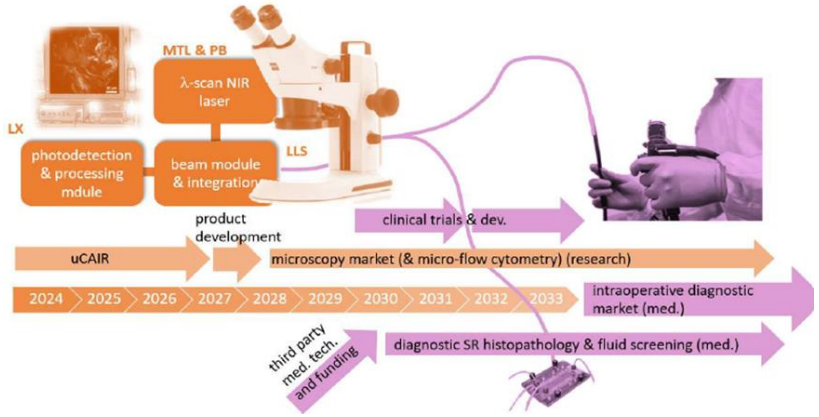
- Supercontinuum generation
- Frequency comb generation

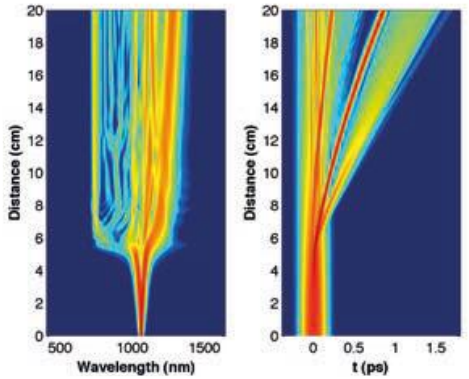
Typical supercontinuum generated in two SUP fibres





Custom simulation and fiber design depending on your pump & desired output spectrum



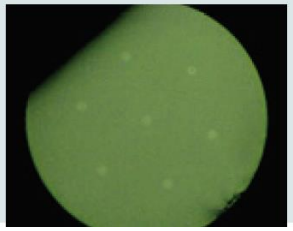


New Horizon Europe project Ucair started early 2024 will help us to develop new **fibers for generating coherent supercontinuum for cancer diagnosis.**

MULTICORE FIBERS

PHOTONICS BRETAGNE
Product line PERFOS

MULTICORE FIBRES
7 CORES



Main characteristics

- Photosensitive core designs for FBG inscription
- Excellent fibre geometry control

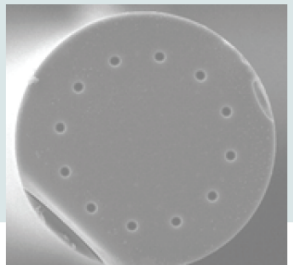
Applications

- Numerous applications in sensing such as structural health monitoring, shape sensing
- Data centers oriented applications in active optical cables and/or silicon photonics technology

PHOTONICS BRETAGNE
Product line PERFOS

MULTICORE FIBRES
12 CORES

12/2020



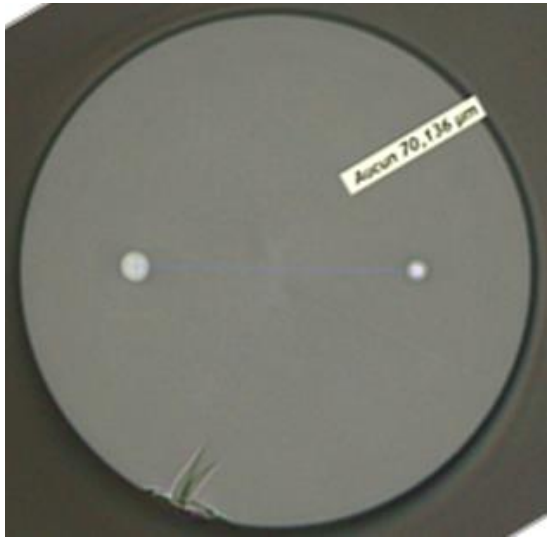
Main characteristics

- Passive/photosensitive or Erbium/Ytterbium doped
- Index difference and dopants superior control and uniformity among all 12 cores for both passive and active fibres
- Excellent fibre geometry (core position and spacing) enables optimal splice losses

Applications

- Sensing
- Telecom
- Laser

Fibre specifications



Custom design MCF available: Passive & Active, integrating similar or different core composition/size, spun (or not), integrating FBG (or not)…

ARF Fibers (and Patchcord/Cable)

PHOTONICS BRETAGNE
Product line PERFOS

MICROSTRUCTURED FIBRES
ANTI-RESONANT HOLLOW CORE FIBRE

04/2021

ARF available from 700nm to 4µm!

Main characteristics

- High damage threshold
- Nearly single mode guidance
- Ultra low dispersion in the transmission bands

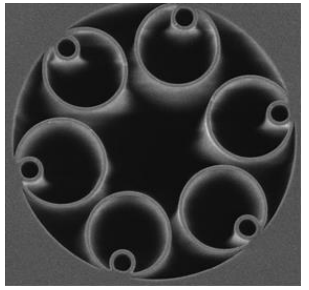
Applications

- Low latency data transmission
- Gas-filled AR hollow core fibre laser
- Molecular tracing, gas detection
- High power delivery for pico- and sub-picoseconds optical pulses

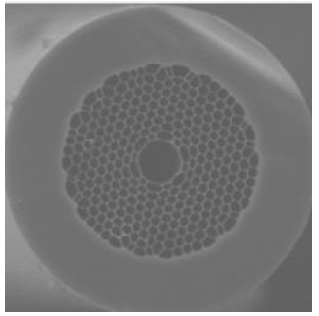
Optical signal in a hollow core anti-resonant fibre propagates in an air core surrounded by single ring of anti-resonant tube elements. Guidance is based on an anti-resonance from the thin glass membranes constituted by the non-touching tubes surrounding the hollow core. The extremely low overlap of guided power with the surrounding silica, less than $2x10^{-5}$, added to the mode effective area, confers to this fibre design record material non-linearity.

Fibre specifications

Fibre type *Optimised for*	ARF-40-240 *750 nm transmission*	ARF-33-160 *1064 nm transmission*	ARF-45-240 *1550 nm transmission*	ARF-40-230 *2 µm transmission*	ARF-120-400 *3 µm transmission*
Optical parameters					
Attenuation (dB/km)	<50 @ 750 nm	< 50 @ 1064 nm	< 35 @ 1550 nm	< 80 @ 2 µm	<70 @ 3µm
Transmission bandwidth (nm) (< 100 dB/km)	700 - 915	1000 - 1350	1450 - 1750	1600 - 2200	2900 - 3150
Mode field diameter (µm)	29 @ 750 nm	26 @ 1064 nm	37 @ 1550 nm	33.5 @ 2 µm	90 @ 3µm
Dispersion (ps/nm/km)	~0.8 @ 750 nm	~ 2 @ 1064 nm	~ 1 @ 1550 nm	~ 2 @ 2 µm	~0.8 @ 3µm
Mode overlap with core			> 99.99 %		
Numerical aperture	~0.02		~ 0.03		
HOM suppression (dB)	N.A.	10 (after 3 m)	10 (after 5 m)	> 25 (after 3 m)	N.A.
3 dB Bend loss radius (cm)	4 +/- 1 @ 750 nm	4 +/- 1 @ 1064 nm	6 +/- 1 @ 1550 nm	8 +/- 1 @ 2 µm	11 +/-1 @ 3µm
Physical/Material parameters					
Fibre material			Air Core		
Core diameter (µm)	38 +/- 2	33 +/- 2	46 +/- 2	40 +/- 2	119 +/- 2
Cladding diameter (µm)	71 +/- 3	66 +/- 3	99 +/- 3	105 +/- 3	233 +/- 3



Also NANF and bandgap Design!



Low latency cable/patchcords available

Collaboration with Idil & Exail!

IDIL
PHOTONICS BRETAGNE
Fiber Optics & Components
Low latency hollow-core cables

▶ INDOOR/OUTDOOR CABLE ASSEMBLY

Low latency hollow-core cables

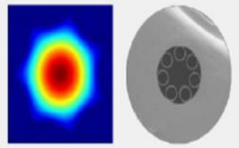
Eye Diagram (Transmission)
10Gb/s NRZ, L=100m

- Low latency data transmission
- Light travels 50% faster than in solid core fibers (+ 1.7µs/km)
- High bandwidth transmission
- Low loss (<10dB/km @1550nm)
- Indoor/outdoor cable and termination
- Inter server distance: from few meters to kms
- Easy to integrate into existing networks
- Operating from -40°C to +60°C
- Traction: 1000N
- Custom lengths, number of fibers, connectors...

ns

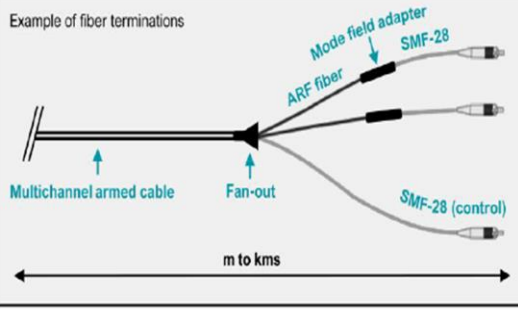
- Telecom networks
- Financial trading
- Data centre
- 5G mobile networks
- Cloud computing
- Quantum com.

ARF : Anti-Resonant Fibers



Optical signal in the fiber propagates in an air core surrounded by single ring of anti-resonant tube elements

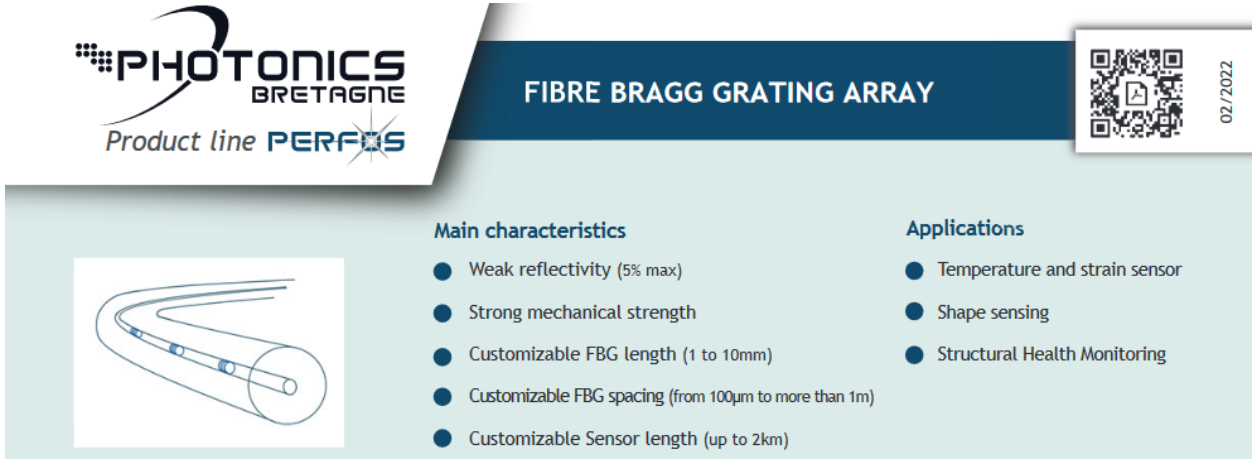
Example of fiber terminations



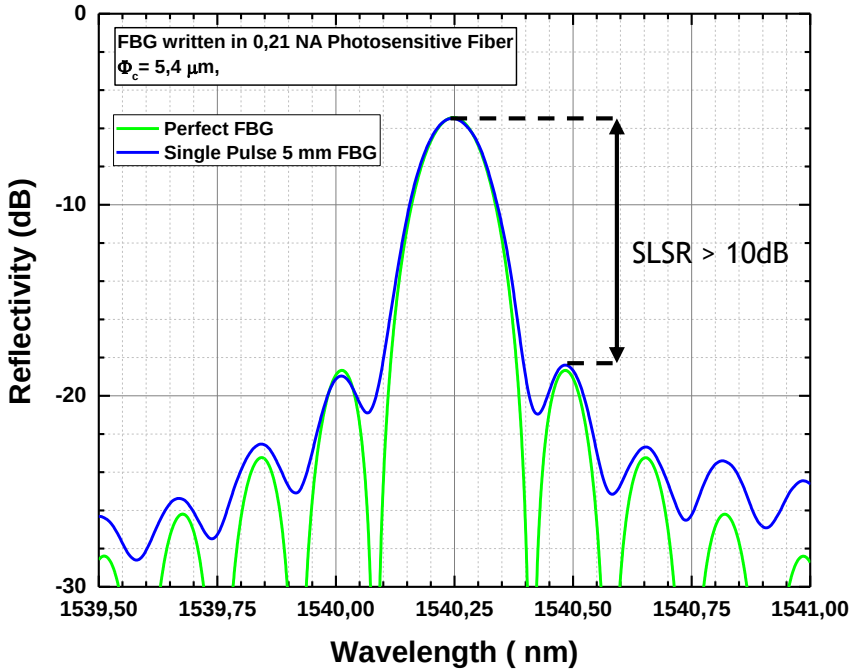
info@idil.fr

Continuously improving the losses of our hollow-core fibers: Currently developing 0.5dB/km loss fiber @ 1.55µm!

FIBER BRAGG GRATING ARRAY (FBGA)



- **Strength:**
  - **No degradation** of intrinsic fiber strength
  - Up to **1000s uninterrupted FBGs on a single fiber draw (DTG)**
  - Accurate positioning of FBGs on fiber, **Gratings on MCF available**
  - **200 µm min gap between FBG** up to 10 cm max error location on 1 km
- **Applications:**
  - **Structural health monitoring:** wind turbines, aircraft wings, bridges
  - FBGs based Distributed **temperature sensing**
  - Non invasive surgery with continuous FBGs based **shape sensing** (MCF)



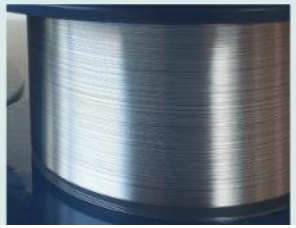
SPECIAL COATING

➢ **Aluminum**

PHOTONICS BRETAGNE
Product line PERFOS

COATINGS
ALUMINUM-COATED FIBRE

01/2024

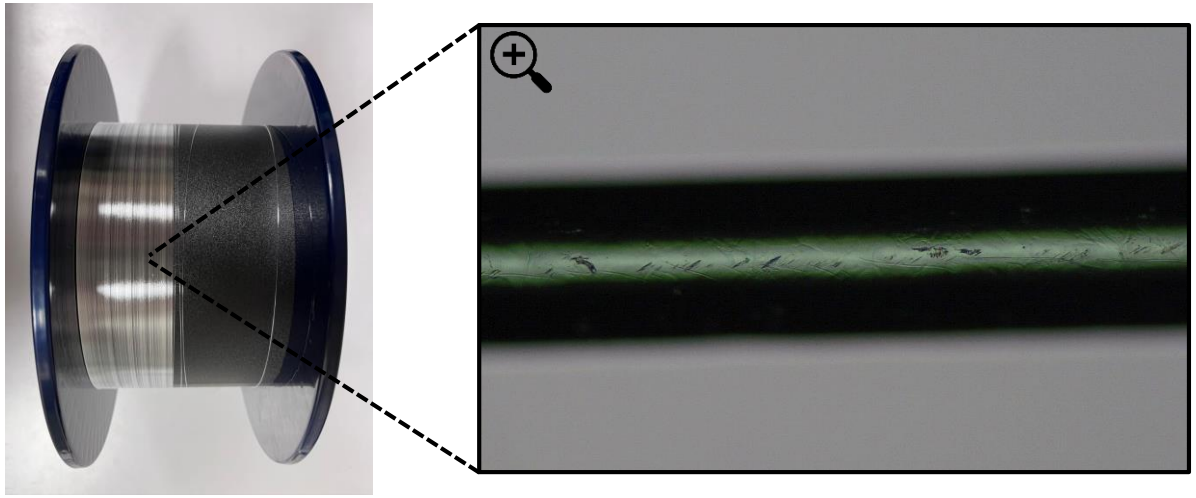


Main characteristics

- Custom multimode or singlemode silica fibres
- Handling wide temperature/radiative ranges
- Water/hydrogen sealing barrier
- Drawing of customer's preform available

Applications

- Signal transmission in harsh environment
- High power active fibre cooling
- Distributive temperature sensing



➢ **State-of-the art** microstructure, mechanical properties and attenuation

➢ **Custom drawing** of your preform

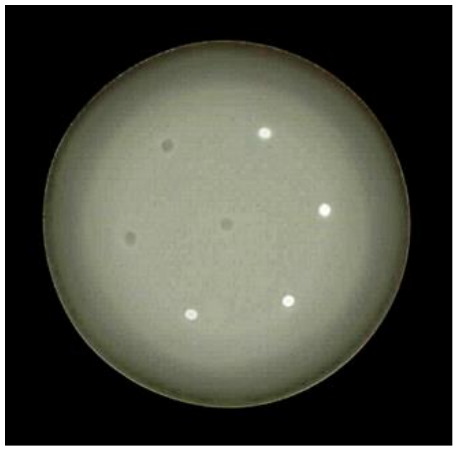
➢ **Already available :** Radiation resistant, SM, MMGI, MMSI

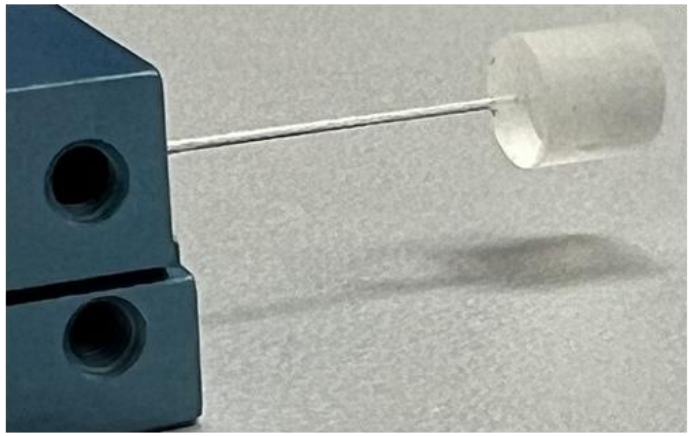
Collaboration with Exail!

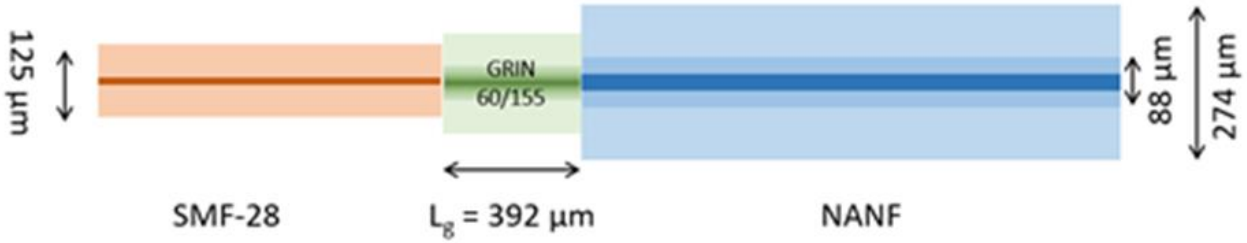
➢ **Under development:** carbon, polyimide and copper

Fiber Component

- Custom Silica Capillaries
- Boron stress rods
- End-Cap
- MCF Fan in/Fan out
- Mode field adapter
- Combiner
- Taper

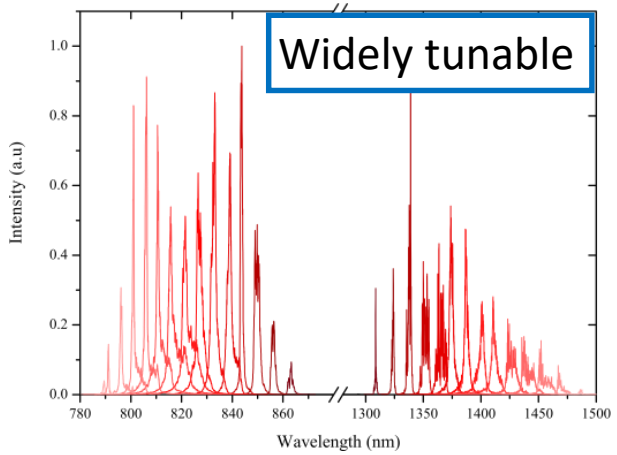


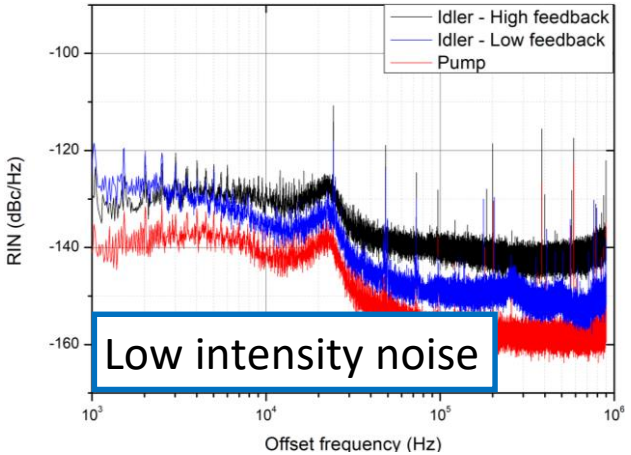


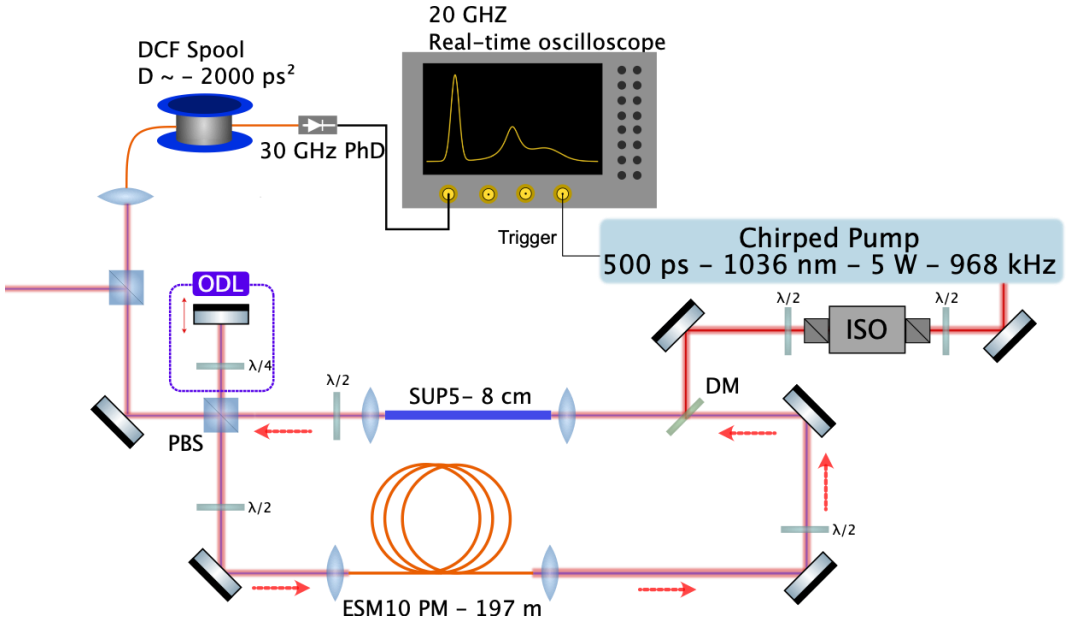


FIBER BASED CHIRPED PULSES OPTICAL PARAMETRIC SOURCES (PHD THESIS)

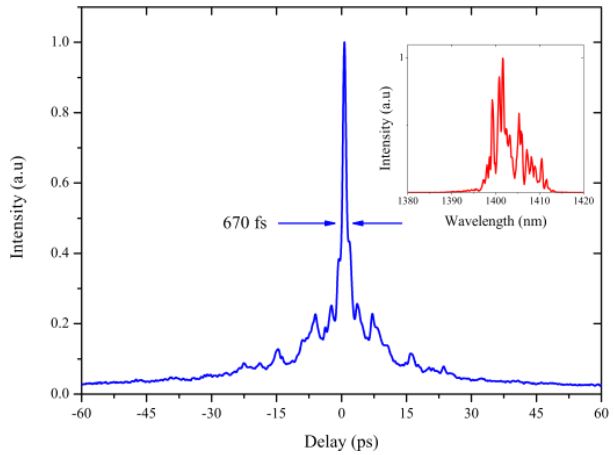
Development of fiber ultrashort multi-wavelength tunable energetic light sources for nonlinear spectroscopy, based on microstructured fibers developed and drawn at Photonic Bretagne facilities







Up to 500 nJ at 820 nm
Up to 300 nJ at 1380 nm



Sub-picosecond pulse durations

CORIA UMR 6614

ACTIVITY AT EUROPEAN LEVEL

Networks

➢Photonics21, EPIC, Opfatec, S3 Platform, Interreg projects…

Conferences & Tradeshows

➢Laser World of Photonics, Photonics West/Europe, OFC, ECOC…

6 International Projects

- 4 Horizon Europe
  - ✓ UCAIR: PCF Fiber for chemical analysis imaging of cancer NEW!!
  - ✓ PHORWARDS21: Advocacy and fostering interregional collaboration in Europe NEW!!
  - ✓ PHOTONHUB: Fostering cross-regional collaboration via vouchers
  - ✓ PHOTONQBOOST: Fostering cross-regional collaboration via vouchers NEW!!
- 2 Biregional Project with Wallonia
  - ✓ CAFCA: Fibre bragg grating array for strain/T° sensing
  - ✓ RIBLETS: VLMA Yb taper for laser manufacturing

and we need more…with you! ☺

Are we unique? Do you know any other organisation in the world manufacturing all the type of specialty fibers we make?

OUR TEAM

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Directeur

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Responsable Administratif & Financier

Agnès MELIN
Responsable QSE & Achats

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Ingénieur Capteurs

Benjamin GAC
Ingénieur Agrophotonique

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Gwenaëlle LEFEUVRE
Responsable Développement

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