

# GLOphotonics

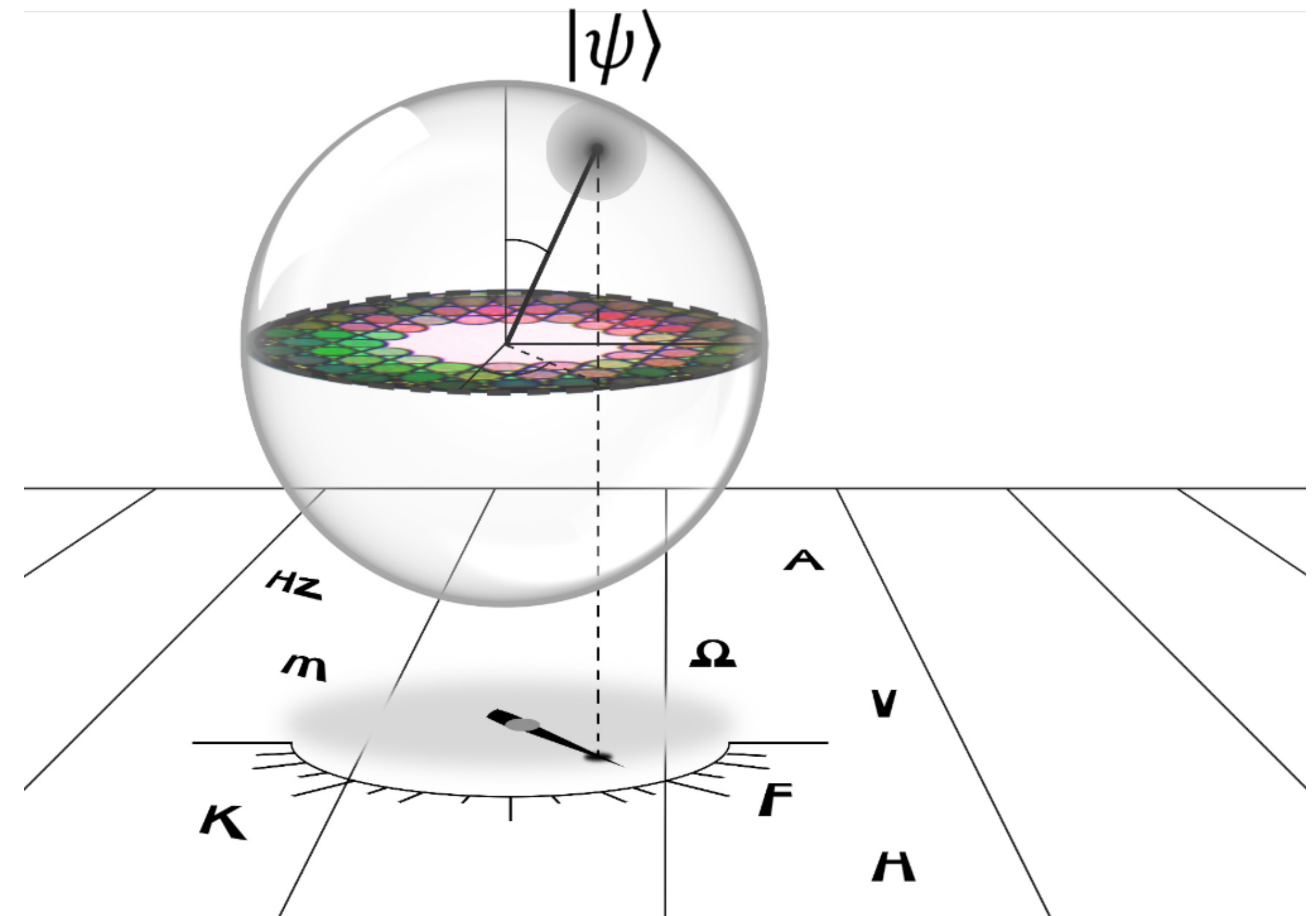
The Hollow-Core PCF & Photonic MicroCell™ company

## Quantum Sensing in the Palm of Your Hand

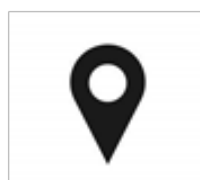
Devang Naik, Lead scientist, BTU QuTech

### Table of Contents

- Company
- Platform & Key Enabling Technology
- Business model & Operational structure
- QuTech Business & Technology unit (BTU)
  - Frequency references & miniature atomic clocks
  - Quantum photon sources
  - Quantum magnetometers



 **The company**



A French start-up based in Limoges. Incubation in Bath (**2008**). Transfer to and re-incubation in Limoges (**July 2011**). Trading activities in **2013**



~20 employees. 80% in R&D, 12 PhD+



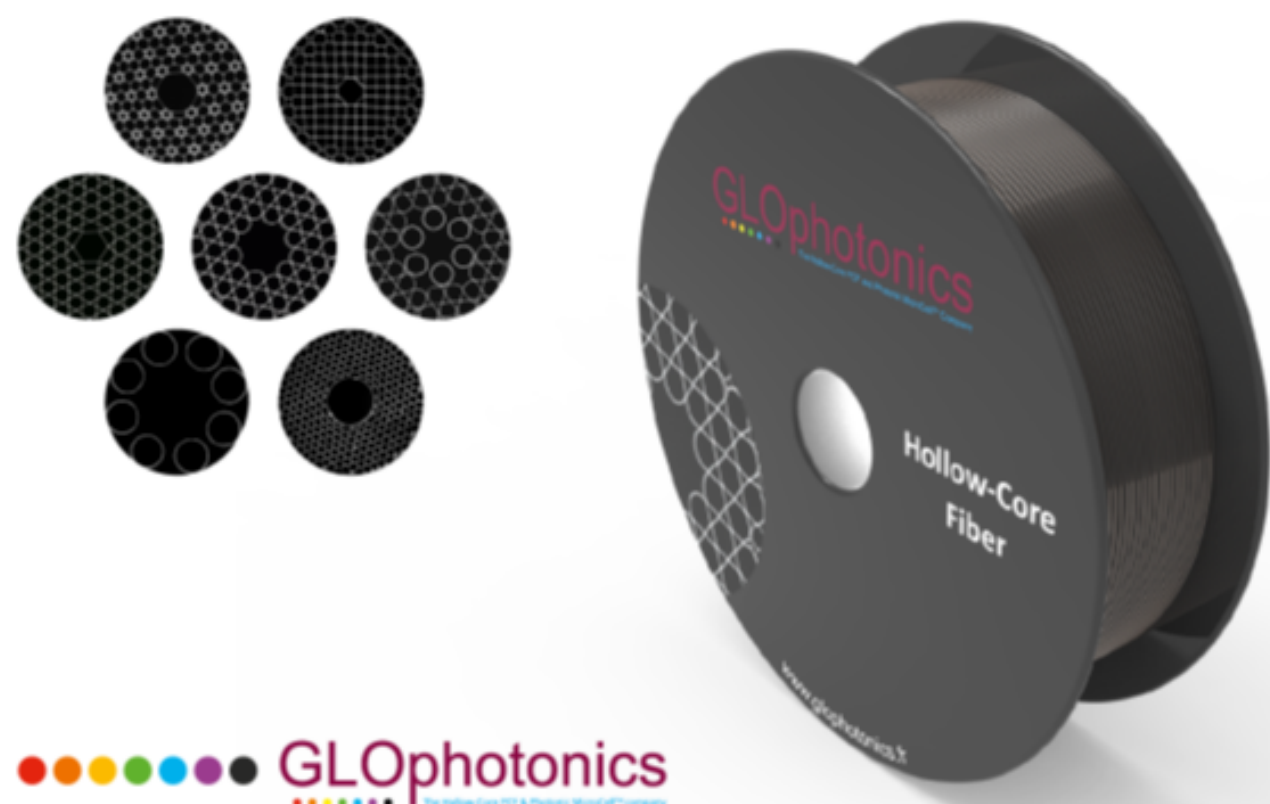
150 m<sup>2</sup> clean room (ISO-07)  
2 drawing fiber towers



Strategic partnership with XLIM / GPPMM



Development & supply of photonic components, modules and/or systems based on a proprietary Technology\*.










 **GLOphotonics**

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The Hollow-Core PCF & Photonic MicroCell™ company

# MULTISECTORIAL PRODUCT MIX

GLOphotonics HCPCF and PMC technology is equally a platform key-enabling technology.

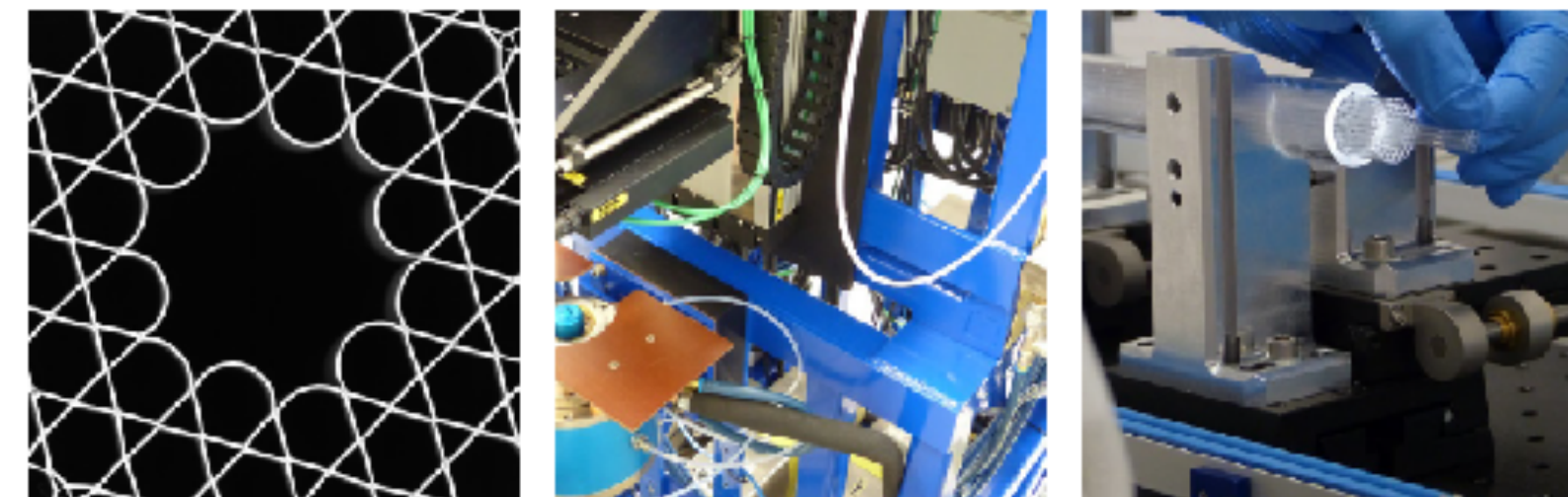
A feature, reflected in GLO photonics products, service and offer

-  **HOLLOW CORE PHOTONICS CRYSTAL FIBER & PHOTONIC MICROCELL**
-  **BEAM DELIVERY**
-  **PULSE COMPRESSION**
-  **FREQUENCY CONVERSION & LASERS**
-  **Quantum technologies**
-  **LOW LATENCY DATACOM**
-  **TECHNOLOGY SOLUTIONS**

 TECHNOLOGY

## HCPCF

Hollow Core Photonic Crystal Fiber



### What it is

HCPCF outstands by guiding light in a hollow channel surrounded by a microstructured cladding.  
GLO is a pioneering industrial player in this field by offering its partners varied and bespoke HCPCF.

### How it is made

HCPCF are produced using a set of special techniques in making its preform and in its drawing process.  
GLO enjoys fiber drawing infrastructure purposely design for HCPCF requirements.

## PMC™

Photonic Micro-Cell



### What it is

A Photonic Micro-Cell (PMC) is a length of HCPCF filled with a gas in a controllable fashion and hermetically sealed.  
PMC offers highly strong gas-light interaction

### How it is made

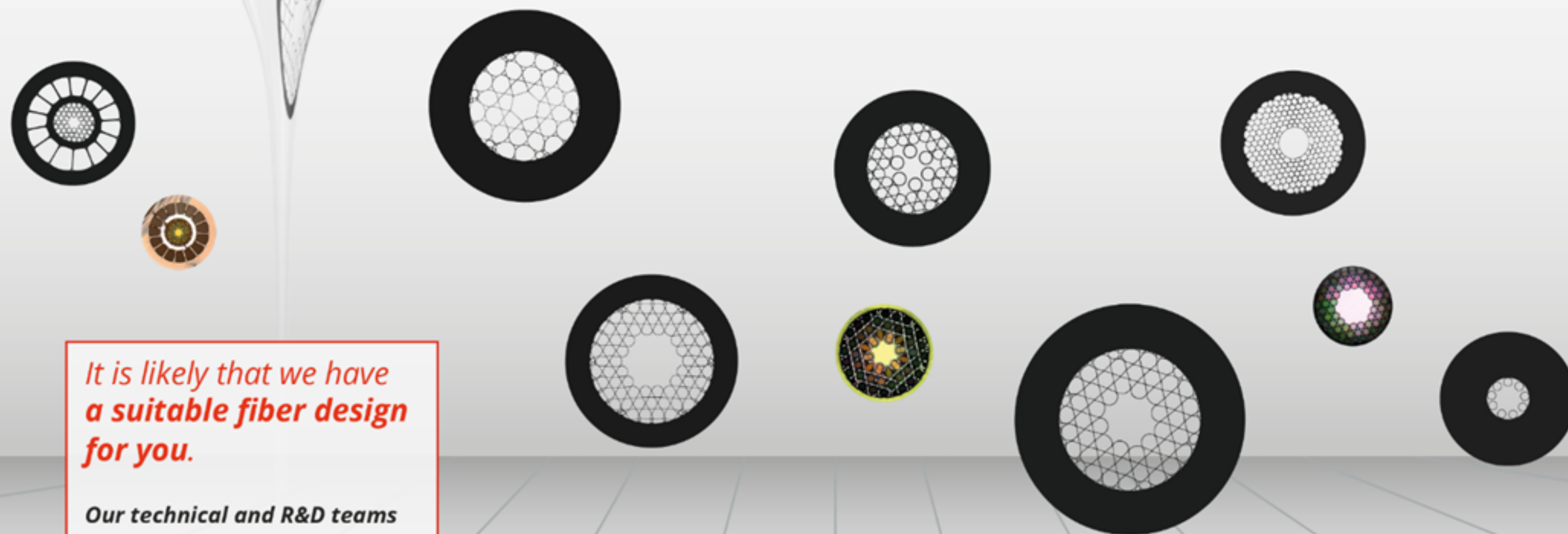
GLO enjoys a large number of processes in evacuating its HCPCF or filling it with a variety of gases and at different pressures.  
The PMC technology relies on glass post-processing, such as splicing, fusing, engraving, end-capping,  
The PMC termination are designed and shaped to accommodate specific applications or required standards.  
In some specific applications, we even coat the PMC inner core with smart coatings.



# Unique expertise in design & fabrication of HCPCF



## FIBER ON DEMAND



*It is likely that we have  
a suitable fiber design  
for you.*

*Our technical and R&D teams  
have already demonstrated:*

- > Wavelength range UV to IR
- > Loss as low as 1 dB/km
- > Truly single mode fibers
- > PER as large as 30 dB
- > Fiber core range 5 to 200 um



***Gives us your requirement, we give you your fiber!***

Don't be *inhibited* in asking and sharing with us your needs and dreams.  
Our R&D team is made of highly qualified scientists and engineers,  
capable of designing and fabricating the most **demanding** HCPCF.



**HOLLOW CORE PHOTONICS**  
**CRYSTAL FIBER & PHOTONIC MICROCELL™**

# Unique expertise in design & fabrication of HCPCF



**BEAM DELIVERY**



**PULSE COMPRESSION**



**FREQUENCY  
CONVERSION & LASERS**



**Quantum tech**



**LOW LATENCY DATACOM**



**TECHNOLOGY SOLUTIONS**

## Standardized Fibers

Optimized for representative lasers

Market push

Continuous extension to other wavelength

## Bespoke Fibers

Customer requirements

Market pull

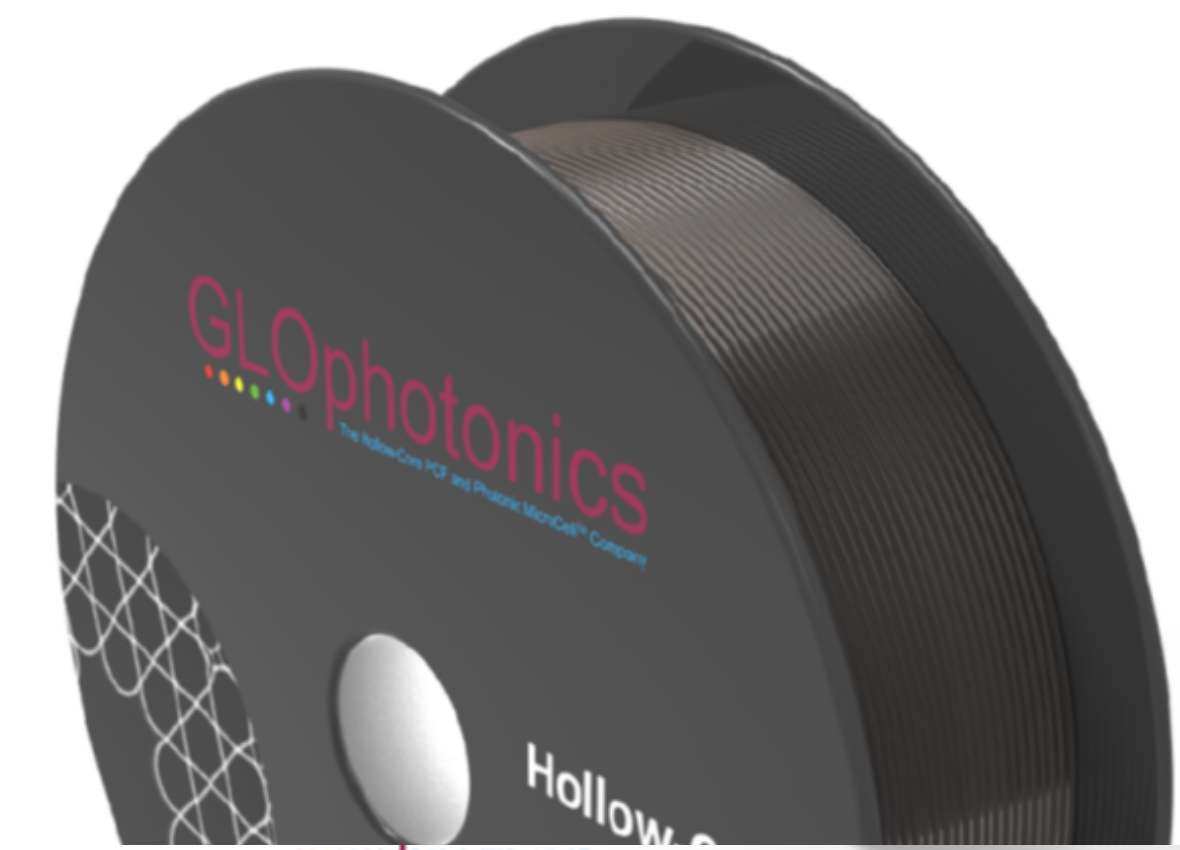
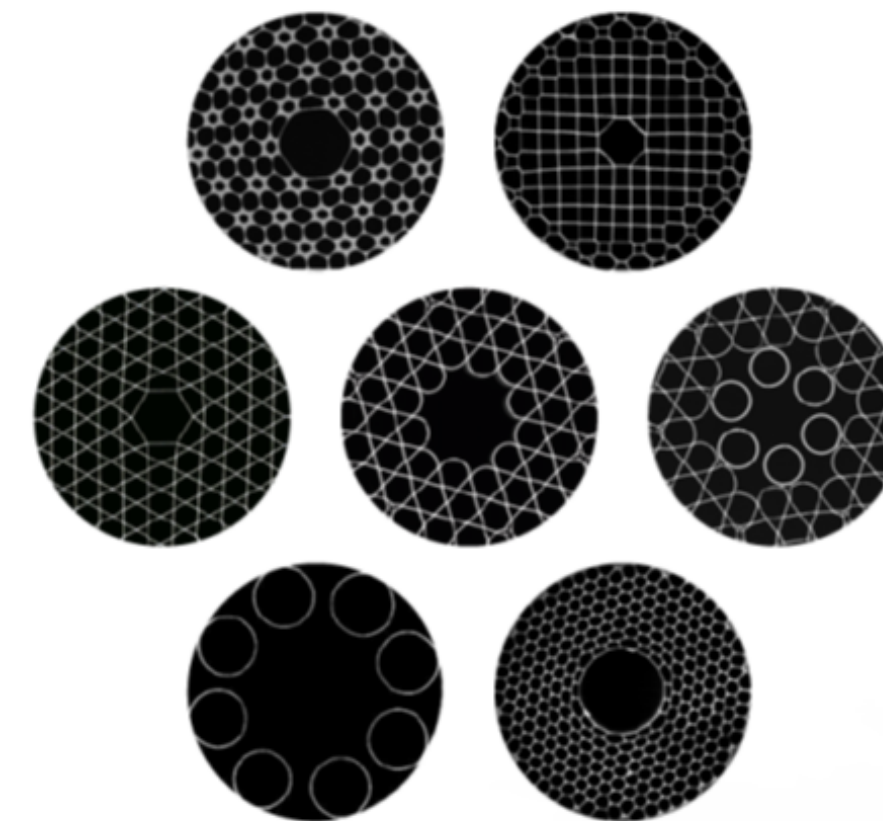
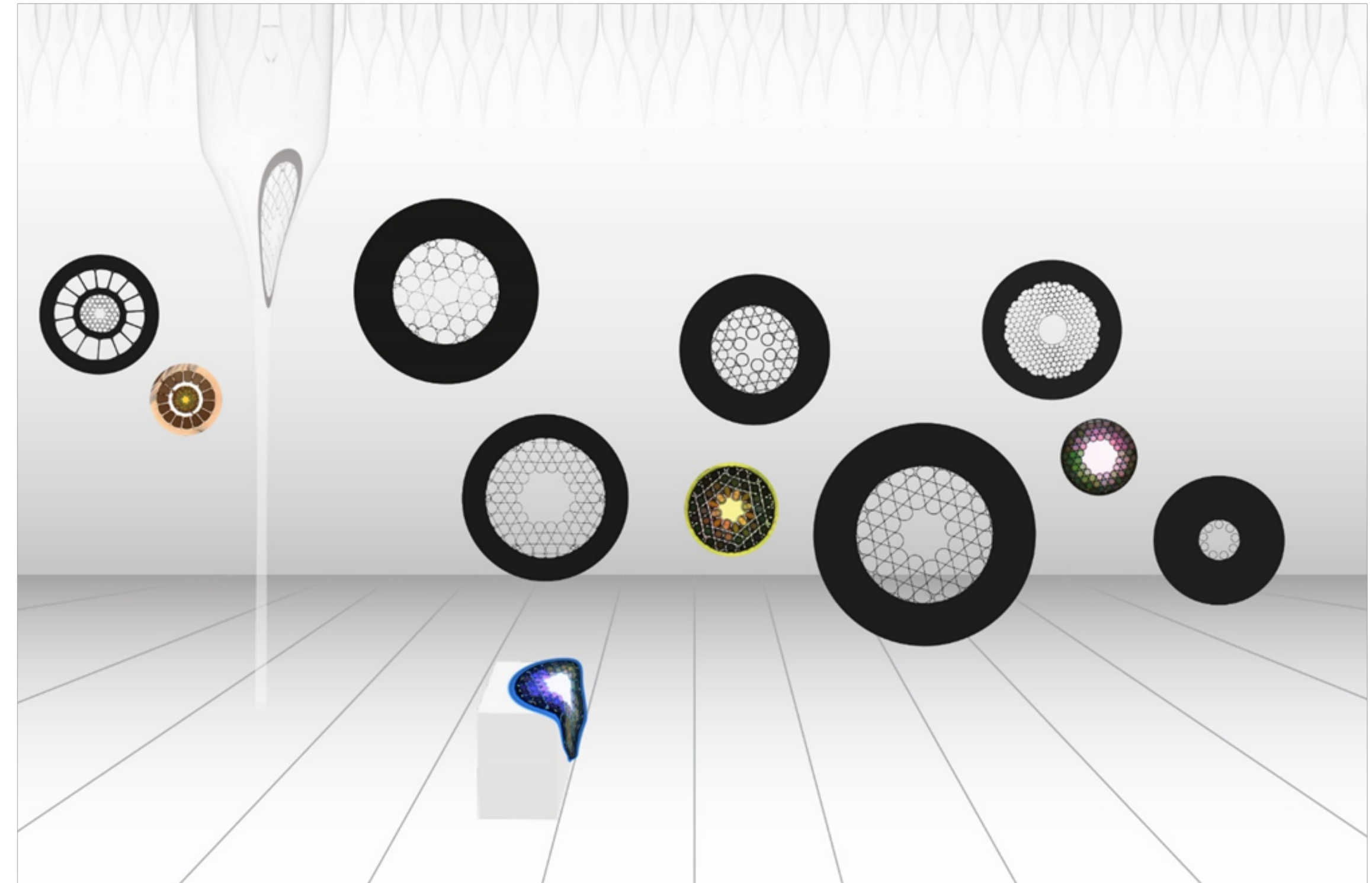
Continuous process/design innovation

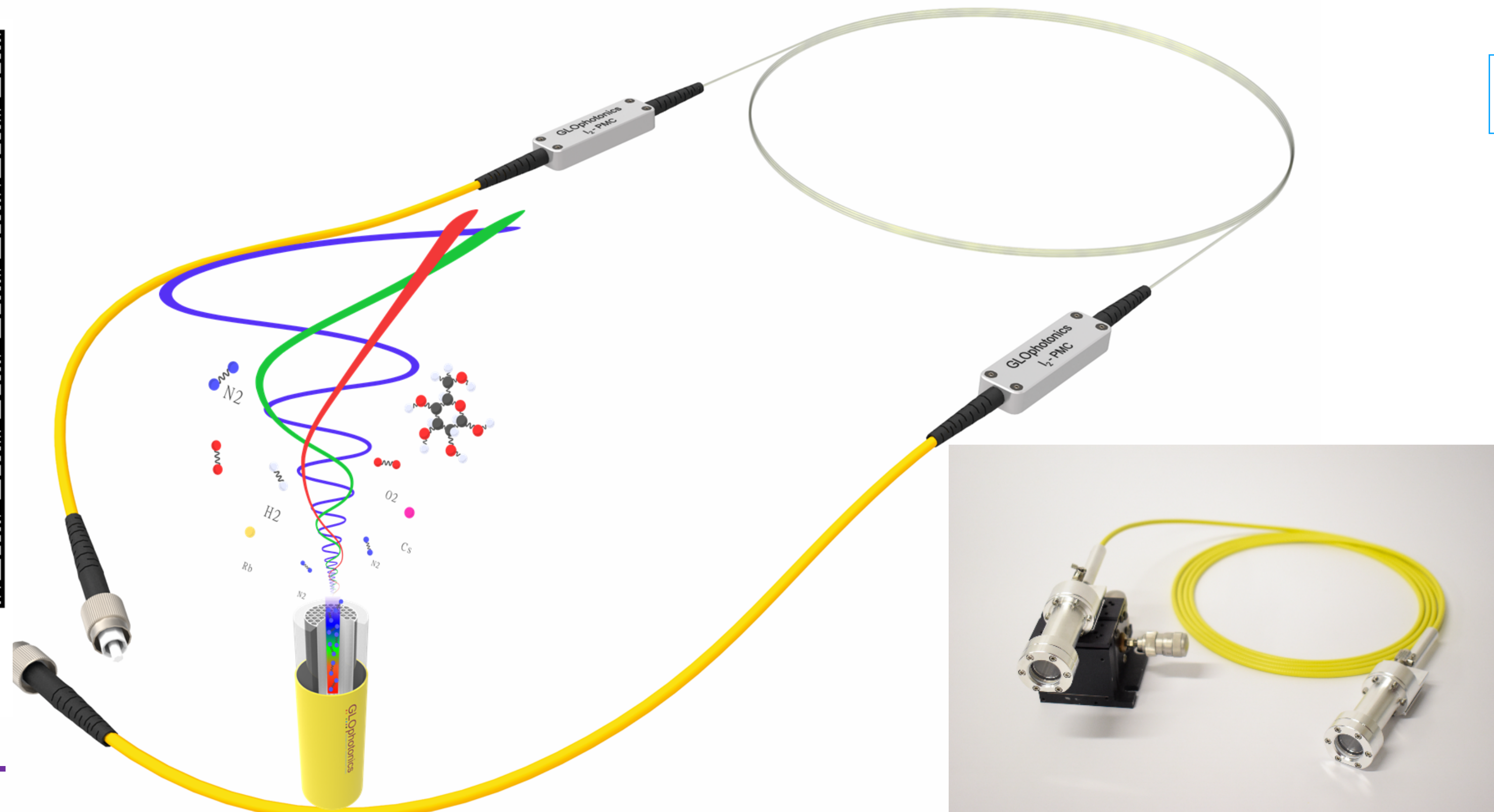
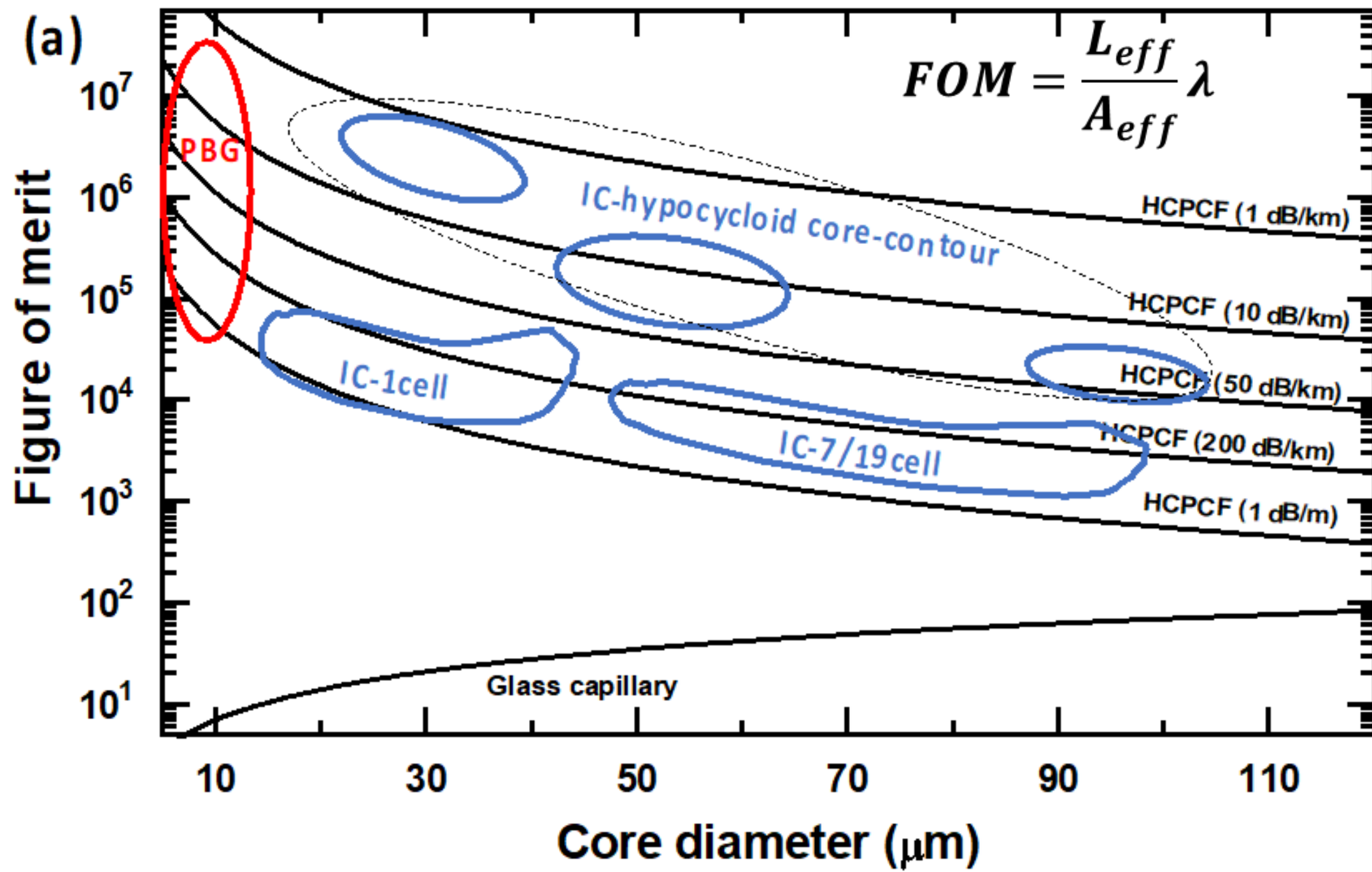
## Innovative Fibers

Improved specifications

Volume scaling

Higher market drive





**OVER MILLION-FOLD ENHANCEMENT IN GAS-**

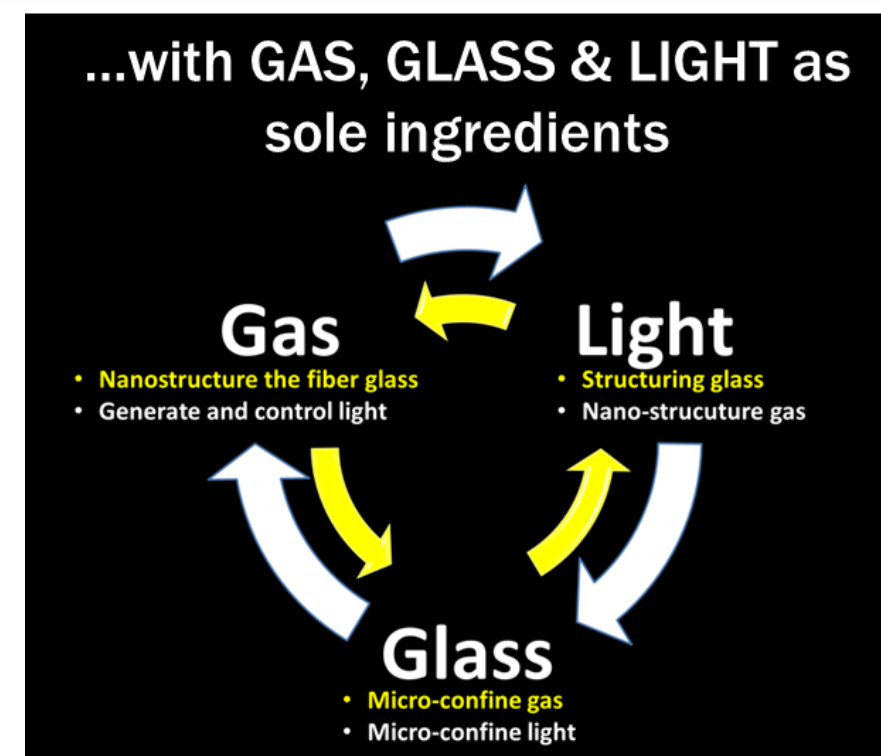
**LASER INTERACTION**

**NONLINEAR OPTICS**

**LASERS**

**SPECTROSCOPY**

**QUANTUM SENSING**





## Features

First Gas-photonics component<sup>(1)</sup>


Million-fold enhancement in Gas-Light interaction

Unique microconfinement of gas and atom vapours in optica fiber


Shapable footprint

Platform technology

## They tested & loved it

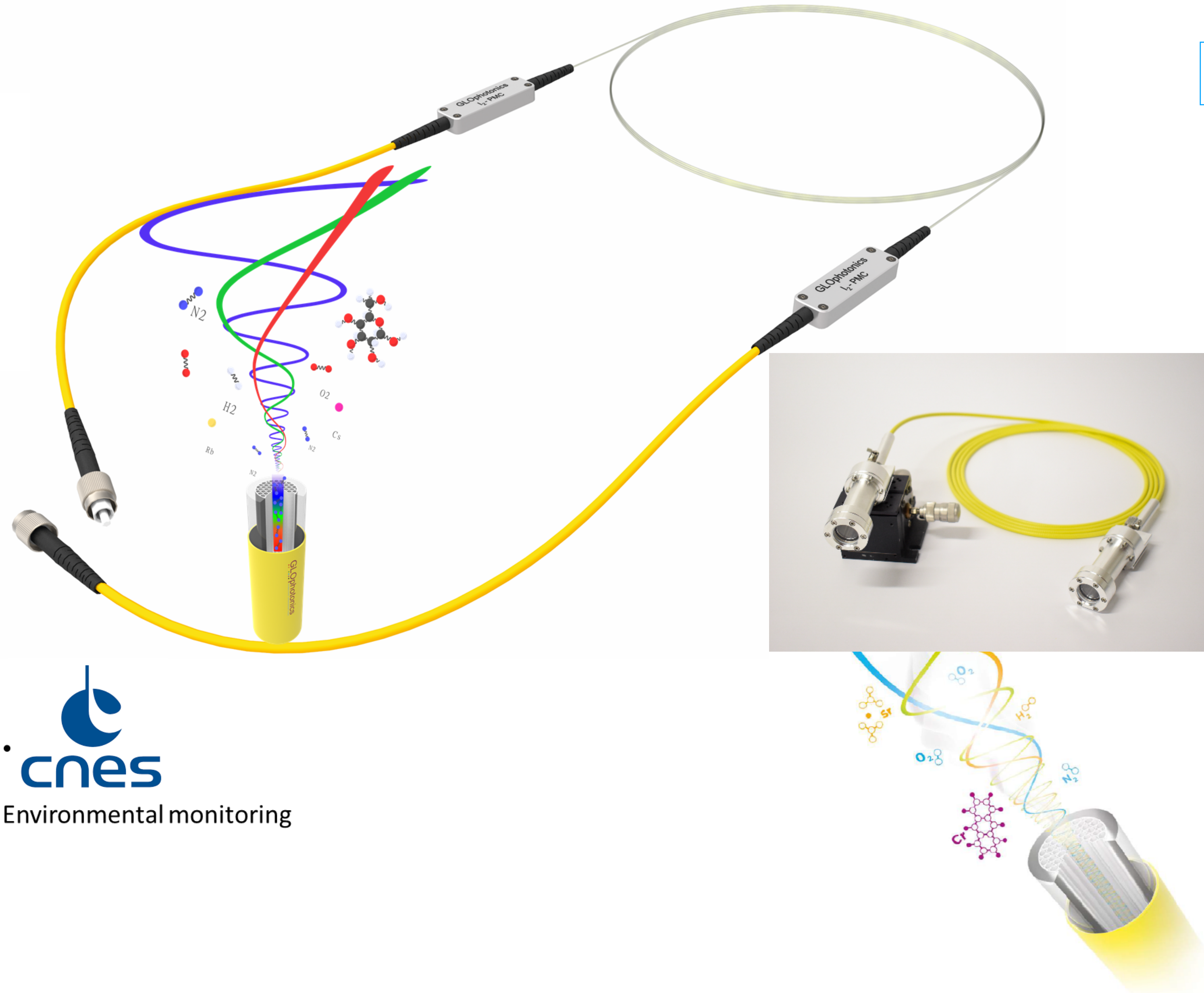
• **NASA**   
Environnemental monitoring

• **LOCKHEED MARTIN**   
Defence

• **ESA**   
Quantum metrology

• **Northrop Grumman**   
Space technology

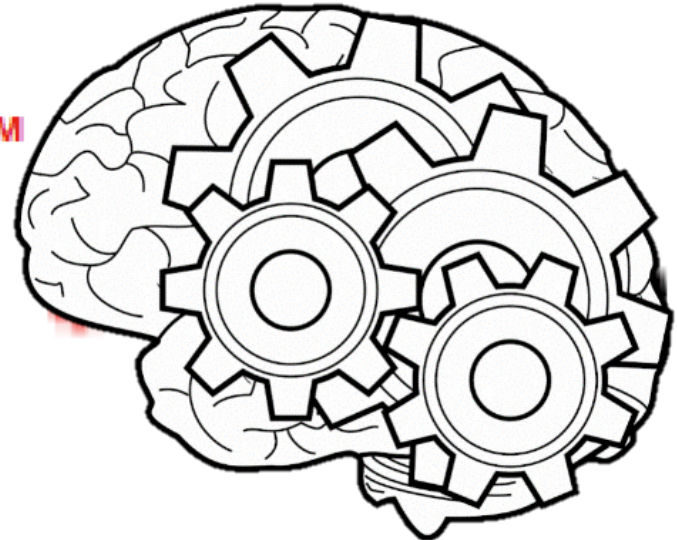
• **cnes**   
Environmental monitoring



<sup>(1)</sup> Nature 434 (7032), 488-491



**HOLLOW CORE PHOTONICS  
CRYSTAL FIBER & PHOTONIC MICROCELL™**



# Business Model & Operational structure



**BEAM DELIVERY**



**PULSE COMPRESSION**



**FREQUENCY  
CONVERSION & LASERS**



**Quantum tech**



**LOW LATENCY DATACOM**



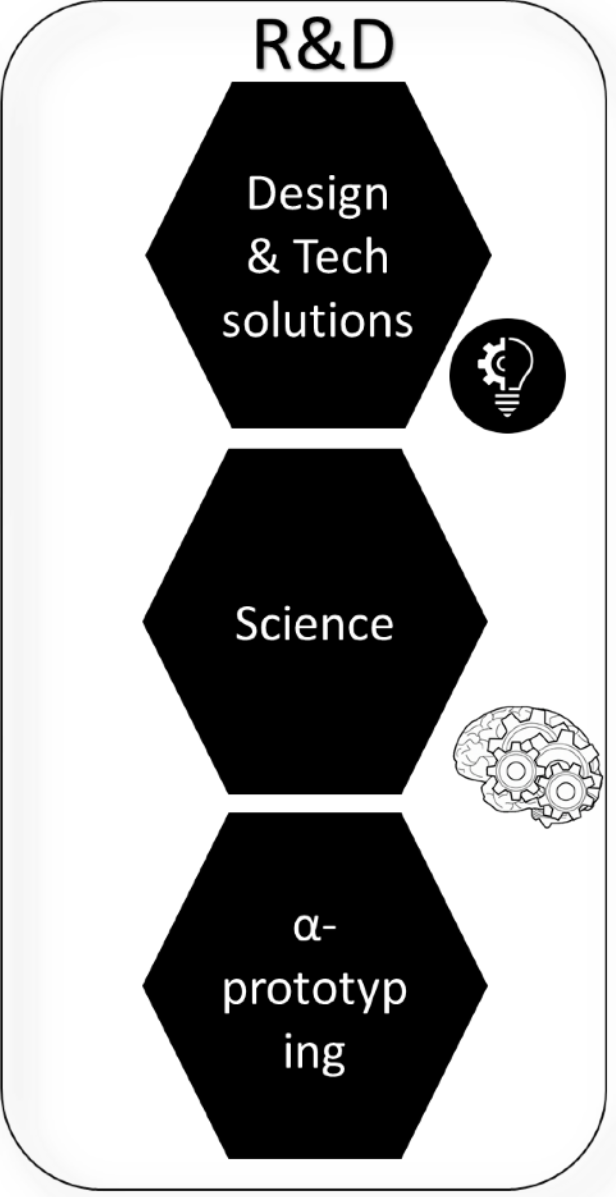
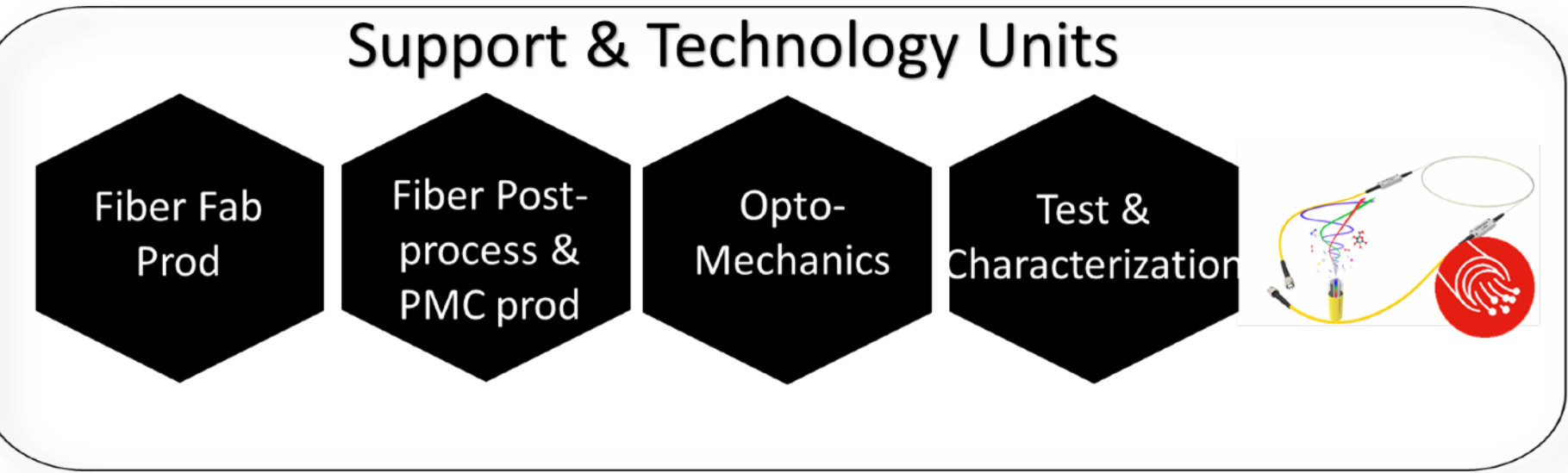
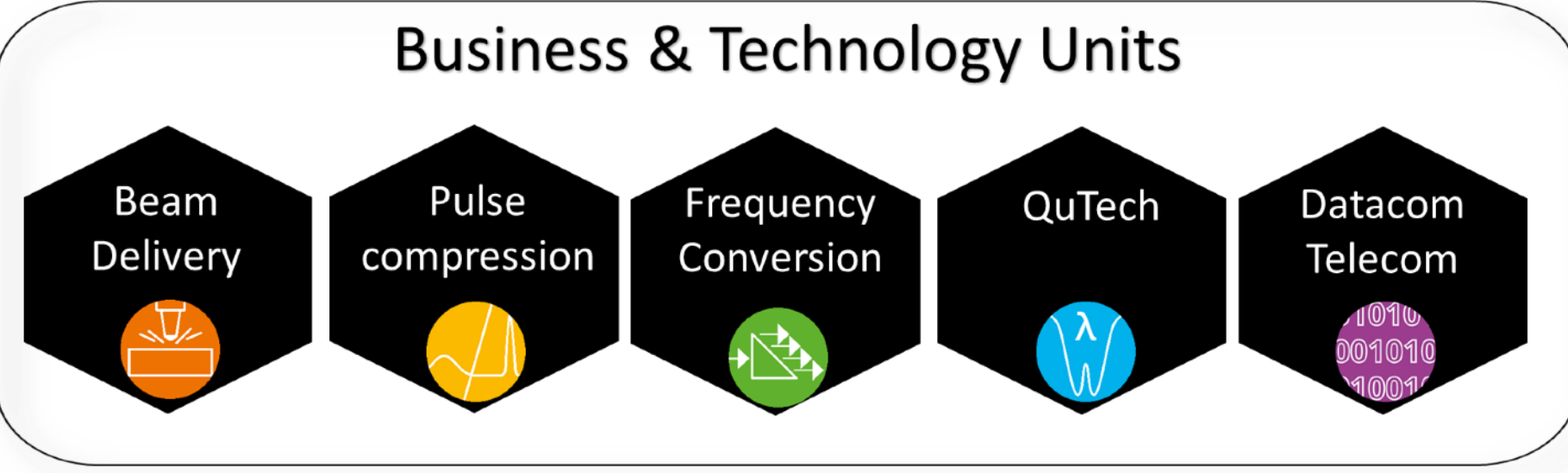
**TECHNOLOGY SOLUTIONS**

## OFFERING AND PRODUCT



- Key enabling technology  
Technology differentiator
- Platform technology  
One technology for several products
- Performance & Uniqueness  
Conditions to win loyalty

## Three-Pillar Operational Structure





# QuTech products & offering



HOLLOW CORE PHOTONICS  
CRYSTAL FIBER & PHOTONIC MICROCELL™



BEAM DELIVERY



PULSE COMPRESSION



FREQUENCY  
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**Quantum tech**



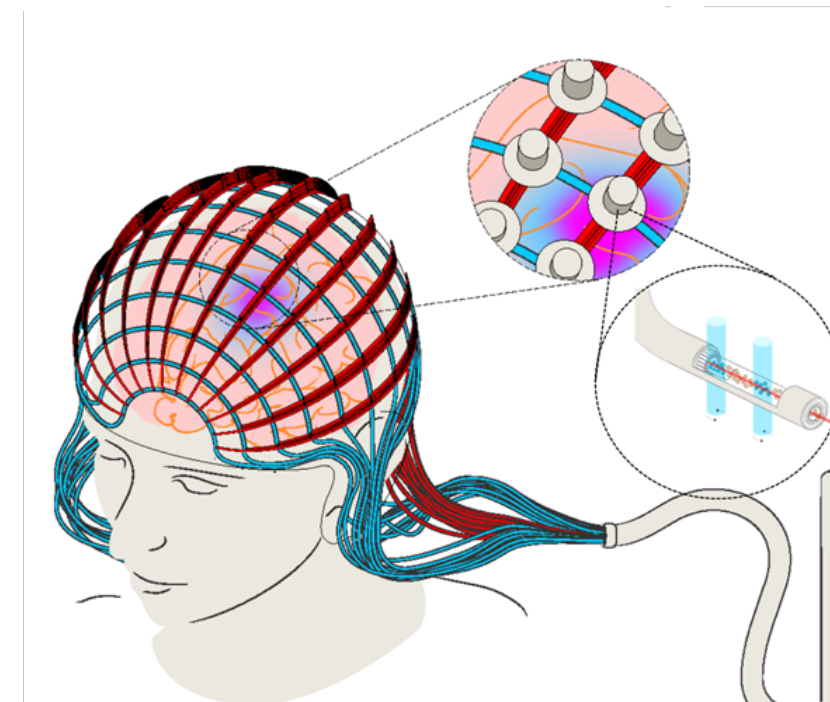
LOW LATENCY DATACOM



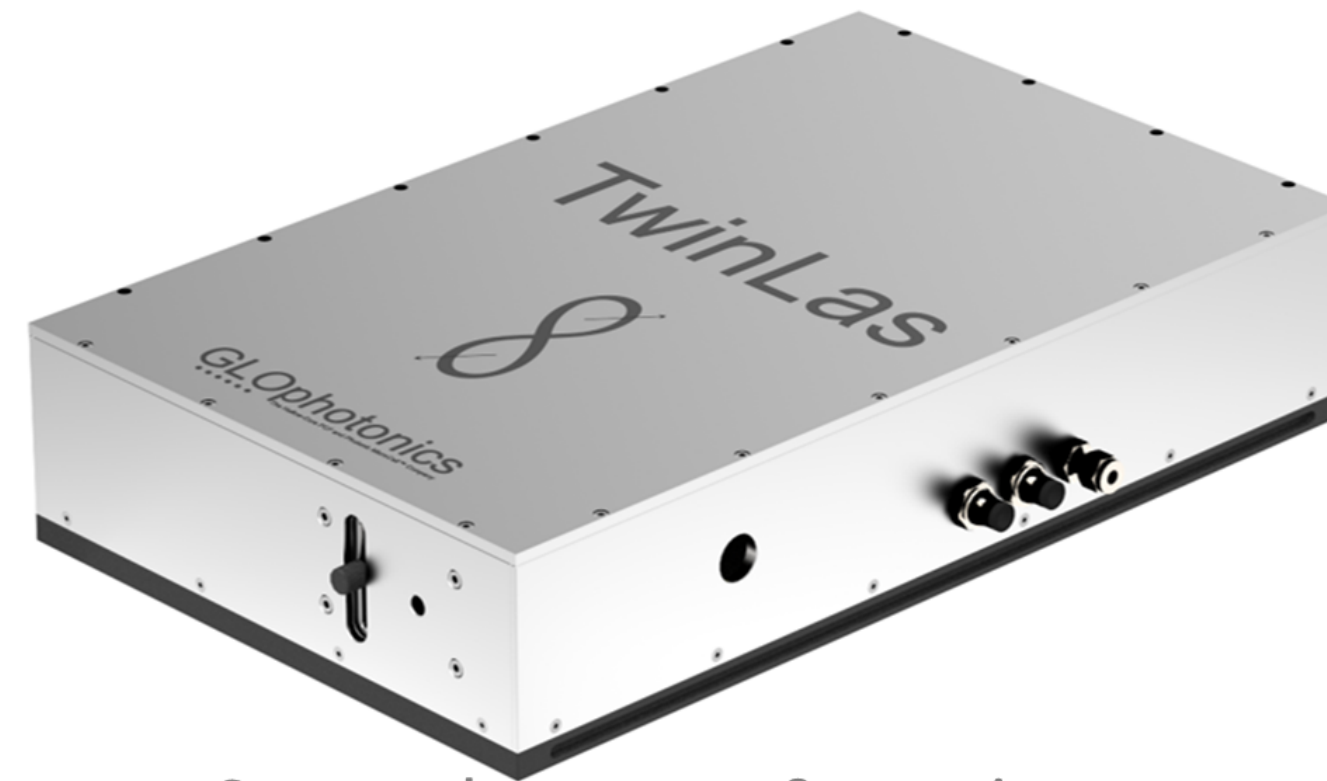
TECHNOLOGY SOLUTIONS



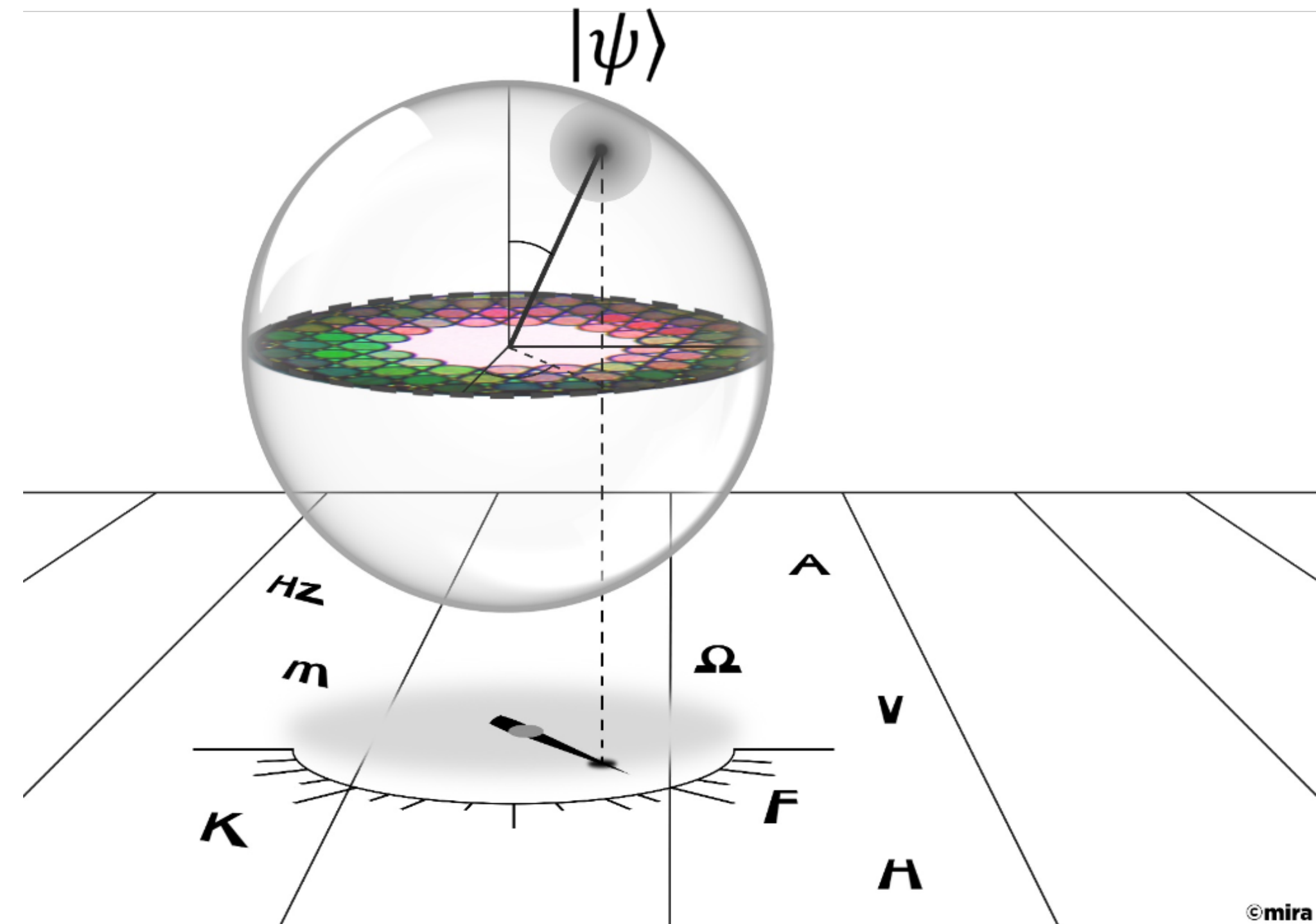
Miniature atomic clocks & frequency reference



Magnometry & brain imaging solutions



Quantum photon sources & memories

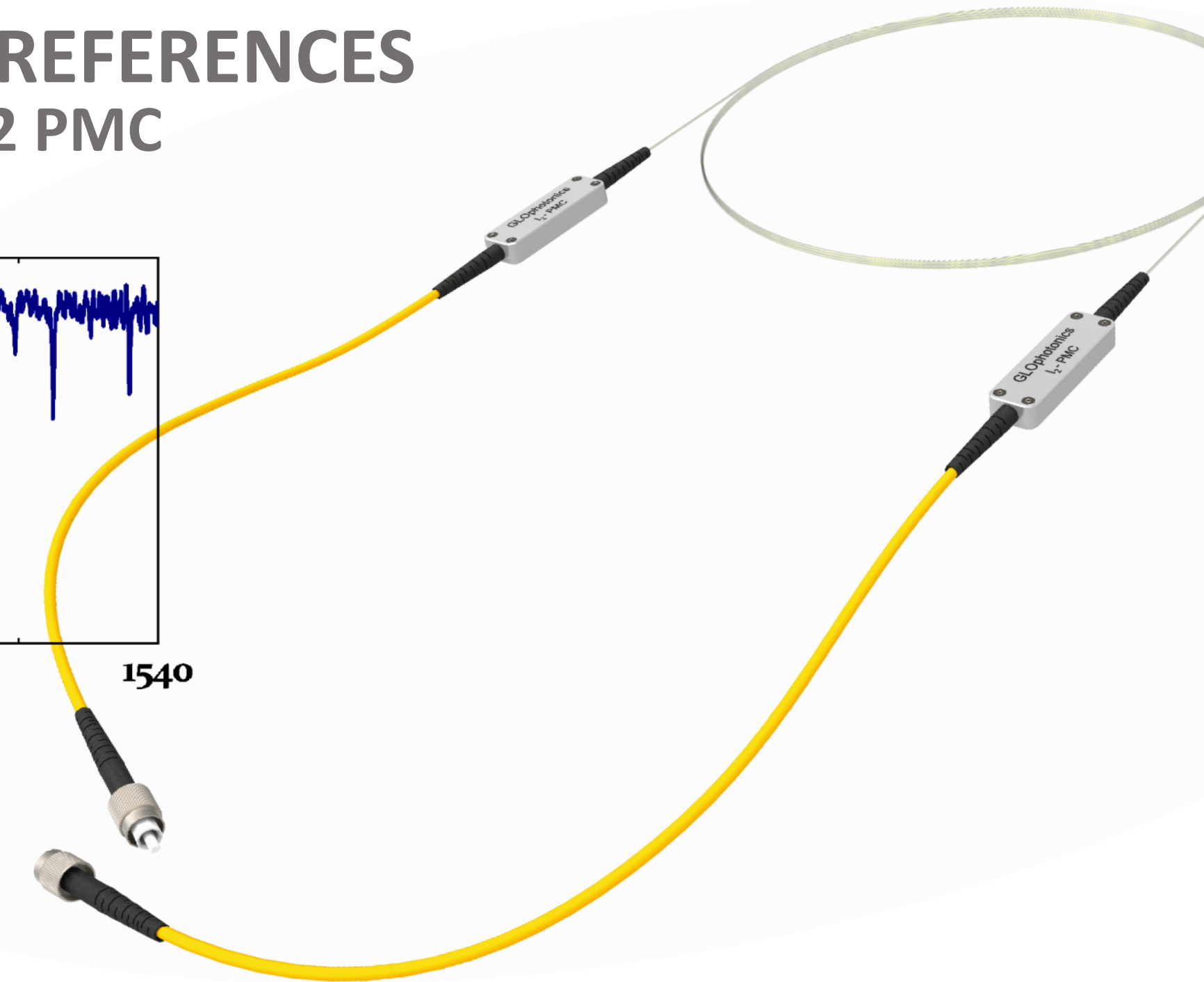
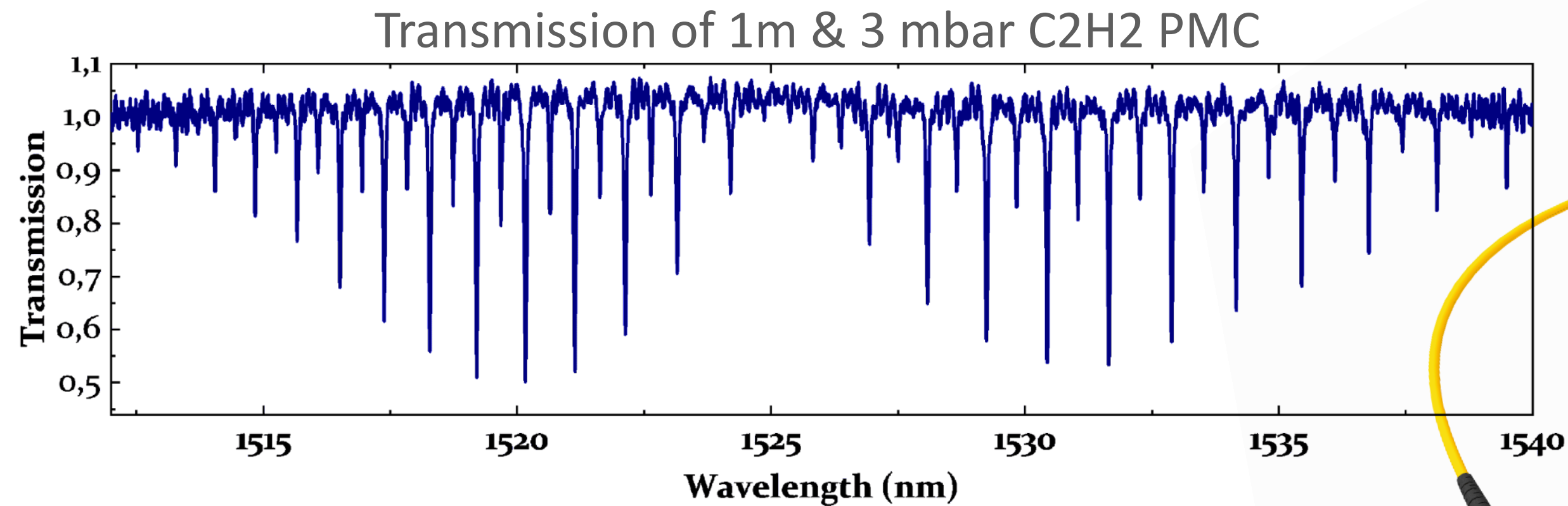


©mira

\*

# QuTech products & offering

## FREQUENCY REFERENCES C2H2 PMC



### TYPICAL SPECIFICATIONS

Gas	C2H2*
HCPCF Type	PBG or IC
Fiber connection	FC, FC/PC, SMA
Fiber length	3m*
Insertion loss	<4 dB
Contrast	>90%*
Wavelength range	1512-1540 nm
Frequency stability	10 <sup>-11</sup> @1s-1000s
Frequency accuracy	<10 kHz

\*Other molecular gases, fiber length and absorption contrast can be achieved upon request

### Market/applications

Frequency references/precision timing, instrumentation calibration, environment sensing, quantum sources...



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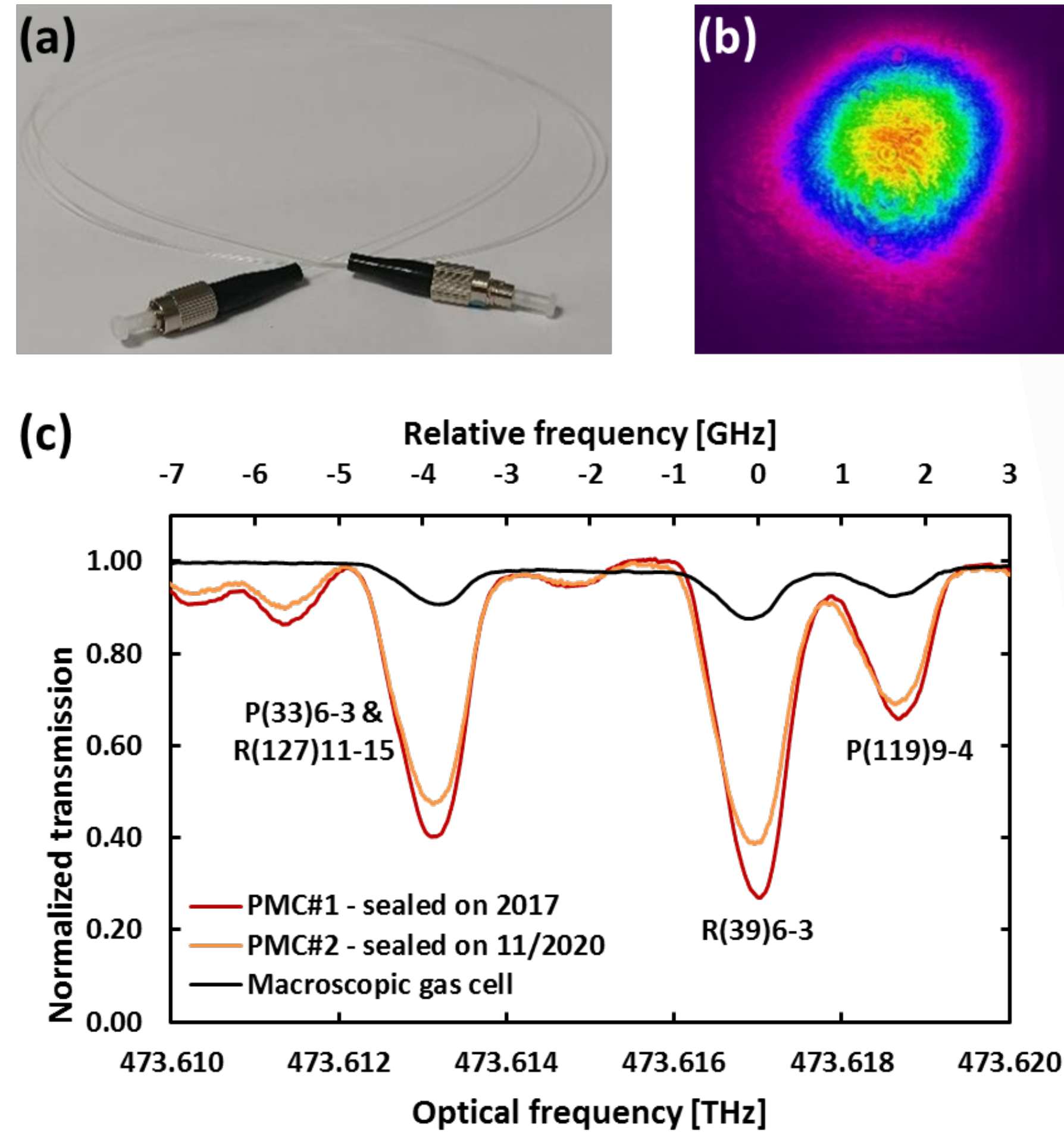
LOW LATENCY DATACOM



TECHNOLOGY SOLUTIONS

# QuTech products & offering

## FREQUENCY REFERENCES I2 PMC



### Market/applications

Frequency references/precision timing, instrumentation calibration, environment sensing, quantum sources...



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Quantum tech



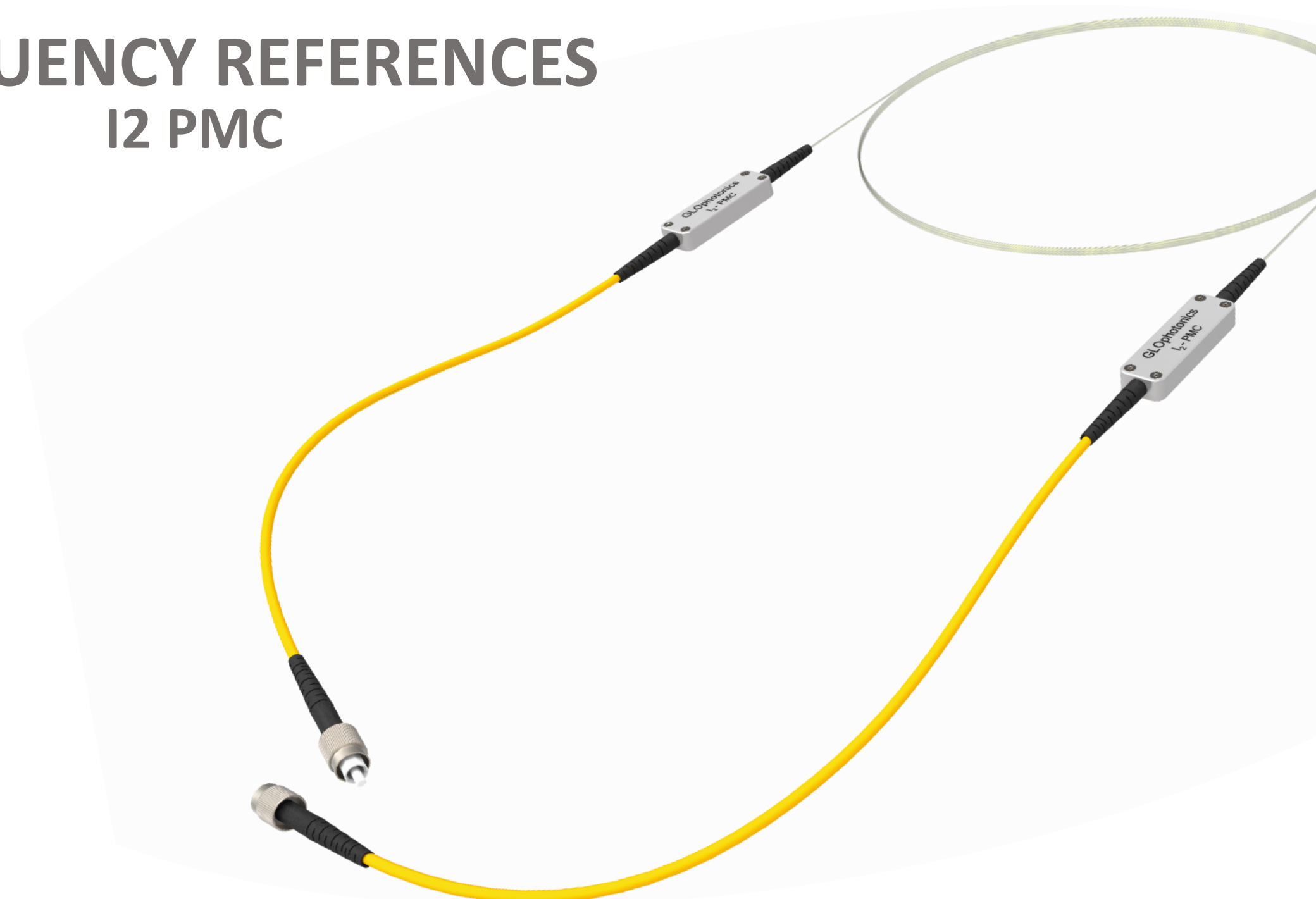
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TECHNOLOGY SOLUTIONS

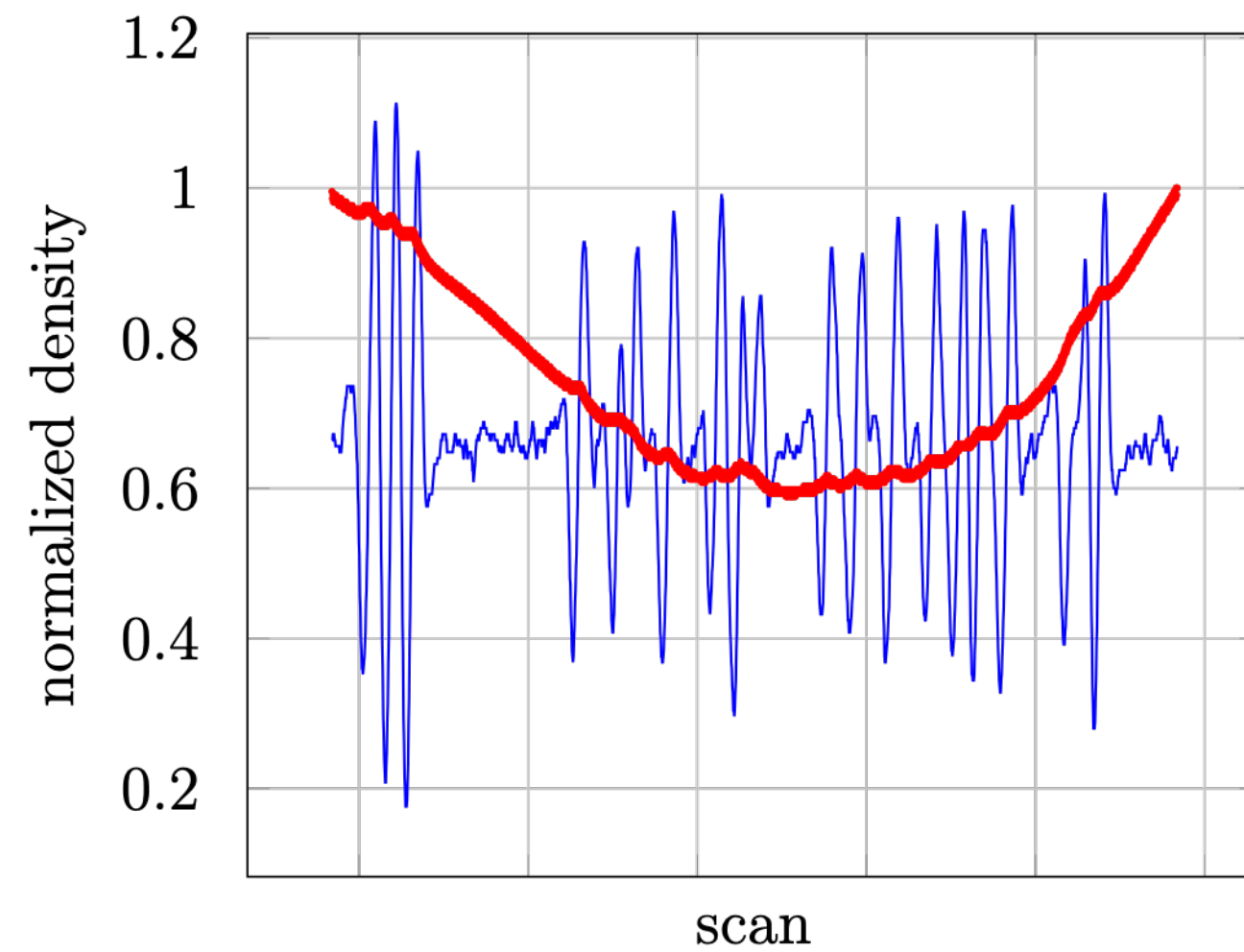
# QuTech products & offering

## FREQUENCY REFERENCES I2 PMC



### Unique Features

- Room temperature operation
- Fiber connection
- Outstanding contrast
- Ideal for astronomy applications



**Large Lock Signal at Room Temperature!!!**

### Market/applications

Frequency references/precision timing, instrumentation calibration, environment sensing, quantum sources...



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**Quantum tech**



LOW LATENCY DATACOM



TECHNOLOGY SOLUTIONS

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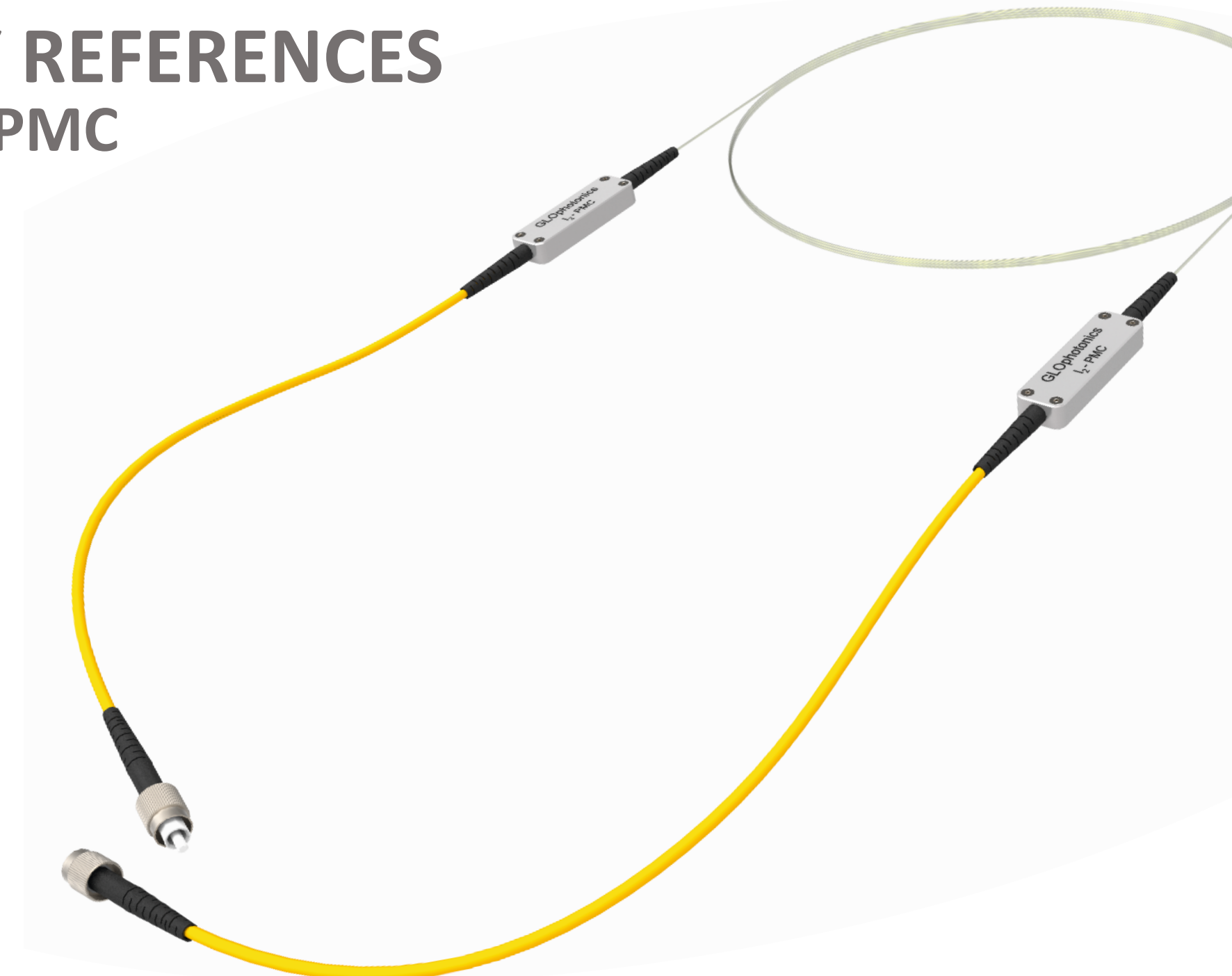
**Large Lock Signal at Room Temperature!!!**

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# QuTech products & offering

## FREQUENCY REFERENCES

Rb PMC



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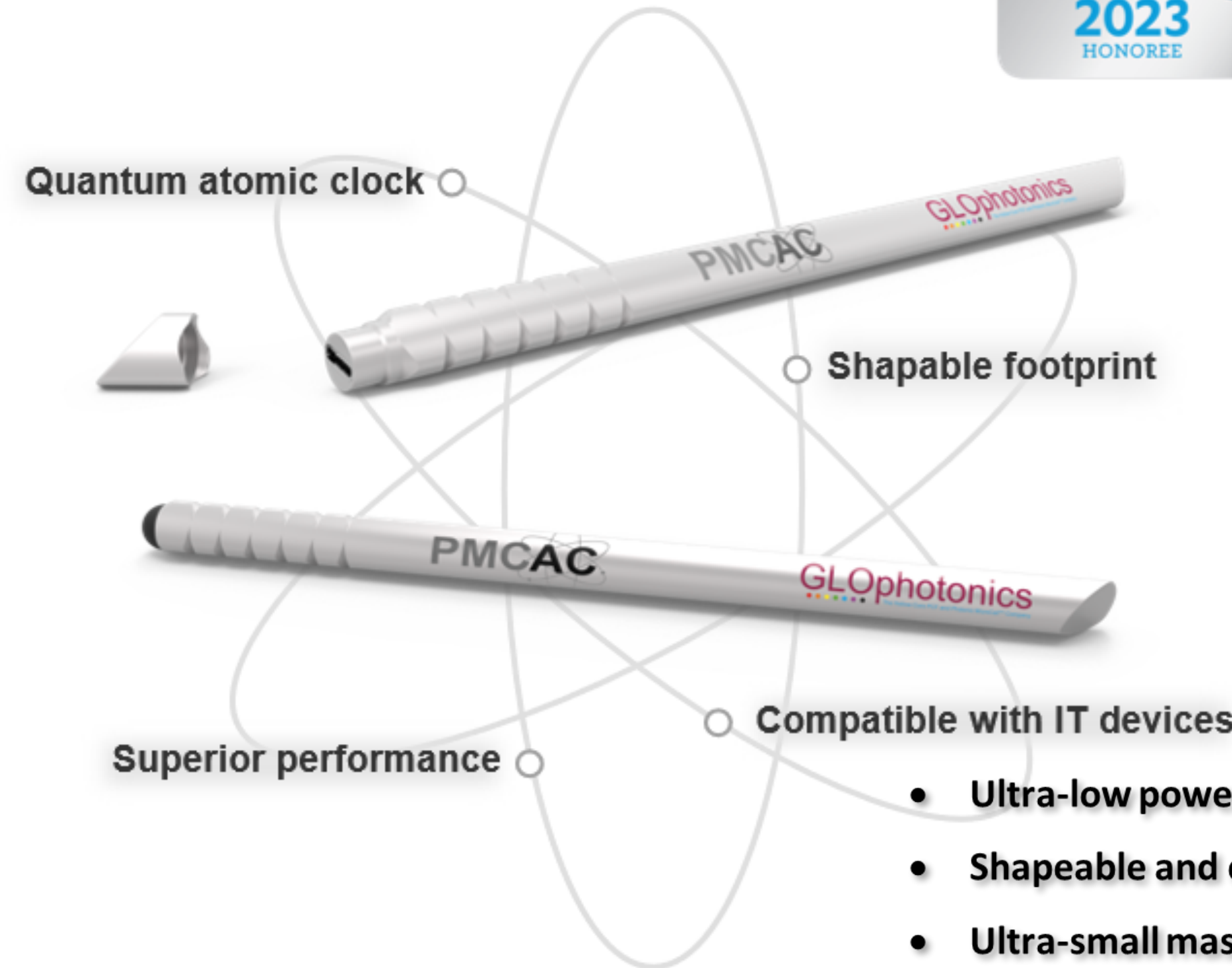


TECHNOLOGY SOLUTIONS

# GL Ophotonics

The Hollow-Core PCF & Photonic MicroCell™ company

## PHOTONIC MICROCELL ATOMIC CLOCK



Quantum atomic clock ○

○ Shapable footprint

○ Compatible with IT devices

Superior performance ○

## Key Features

- Ultra-low power consumption (<100 mW)
- Shapeable and compact footprint (typical: pen-shaped with a volume of 10x1x1mm<sup>3</sup>)
- Ultra-small mass (<<50 grs)
- Short term stability 10<sup>-11</sup>-10<sup>-13</sup> at integration time of 1000s.
- Low long term drift.
- Long operating temperature range and harsh environment resistant.

Large Lock Signal at Room Temperature!!!

# GL Ophotonics

The Hollow-Core PCF & Photonic MicroCell™ company

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# QuTech products & offering

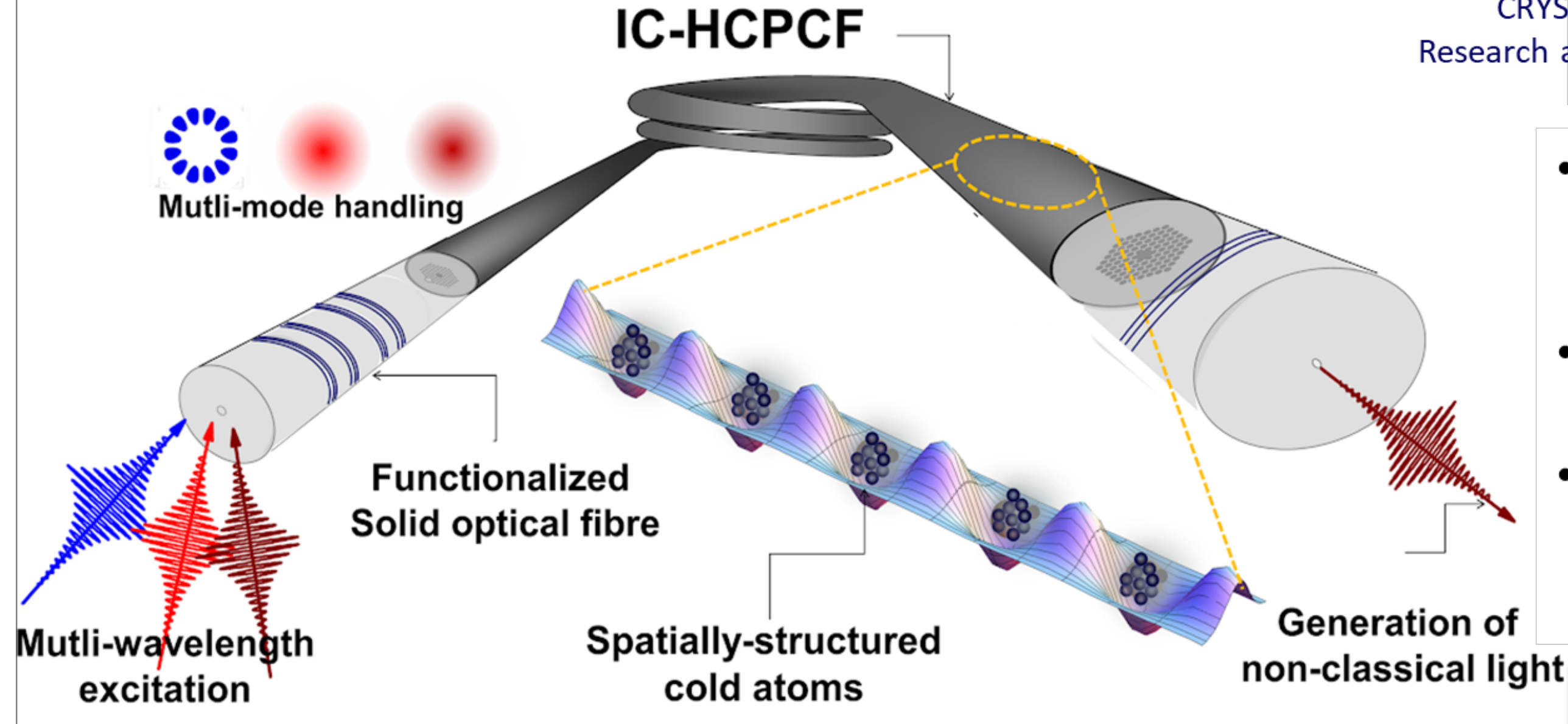
Active partner in several projects on quantum technology innovation

Quantum sources

Quantum sensors

Quantum brain imaging system

## Paving the way for Cold-Atom-Core PCF



 **CRYST<sup>3</sup>**  
 CRYST<sup>3</sup> European Union's Horizon 2020  
 Research and Innovation programme under Grant  
 Agreement No 964531

- GLO designs and provides tailored fibers
- Explore Rb-PMC market
- Scale-up study of Rb-PMC for quantum technology market



HOLLOW CORE PHOTONICS  
 CRYSTAL FIBER & PHOTONIC MICROCELL™



BEAM DELIVERY



PULSE COMPRESSION



FREQUENCY  
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**Quantum tech**



LOW LATENCY DATACOM



TECHNOLOGY SOLUTIONS

# QuTech products & offering

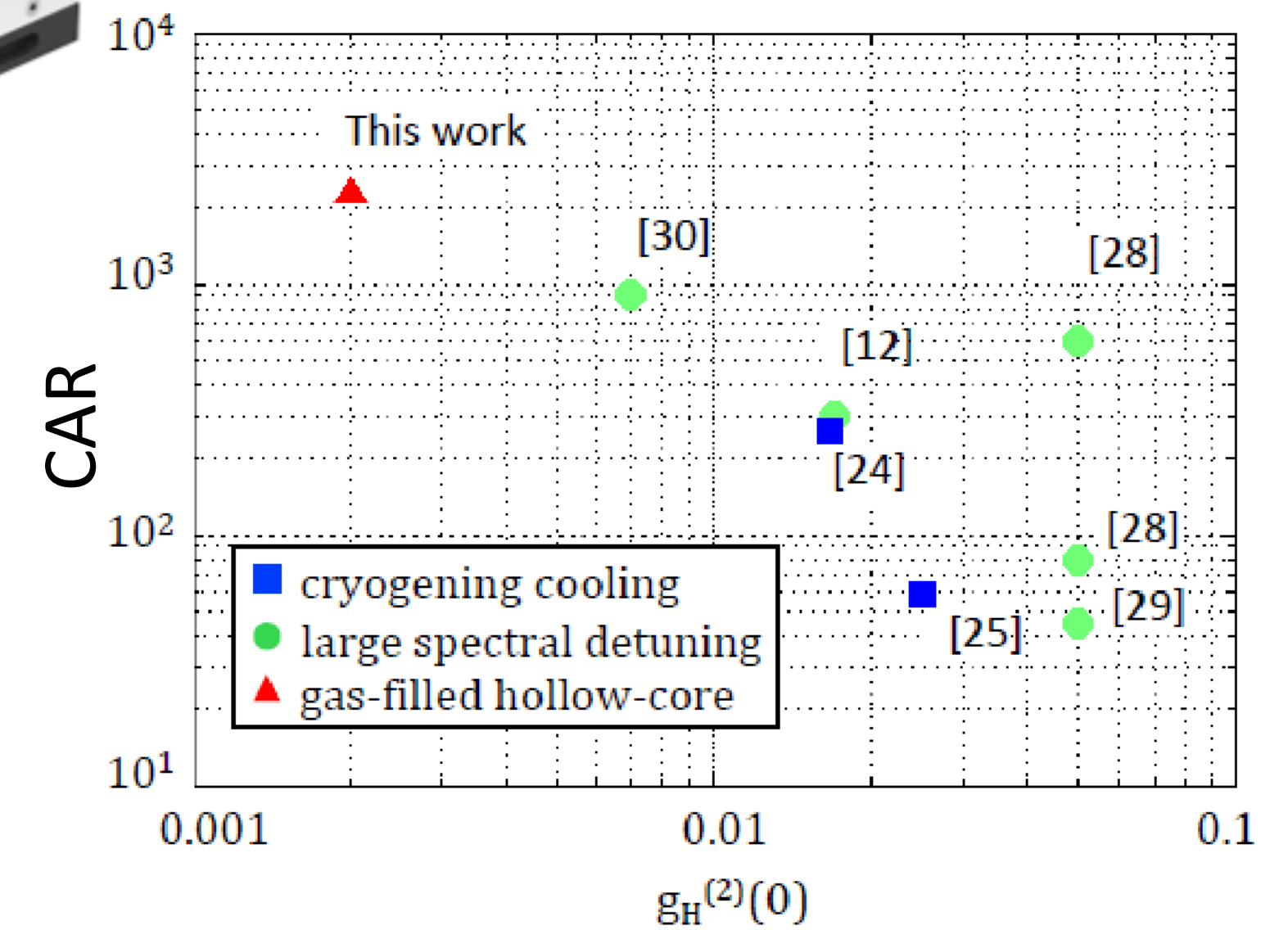
Quantum sources

## Key Features

- Scalable in Wavelength
- Photon pair at  $\sim 780$  nm & Telecom range
- Noise free (no SRS)
- High purity



Product launch planned for PW 2024



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BEAM DELIVERY



PULSE COMPRESSION



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Quantum tech



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TECHNOLOGY SOLUTIONS

# QuTech products & offering

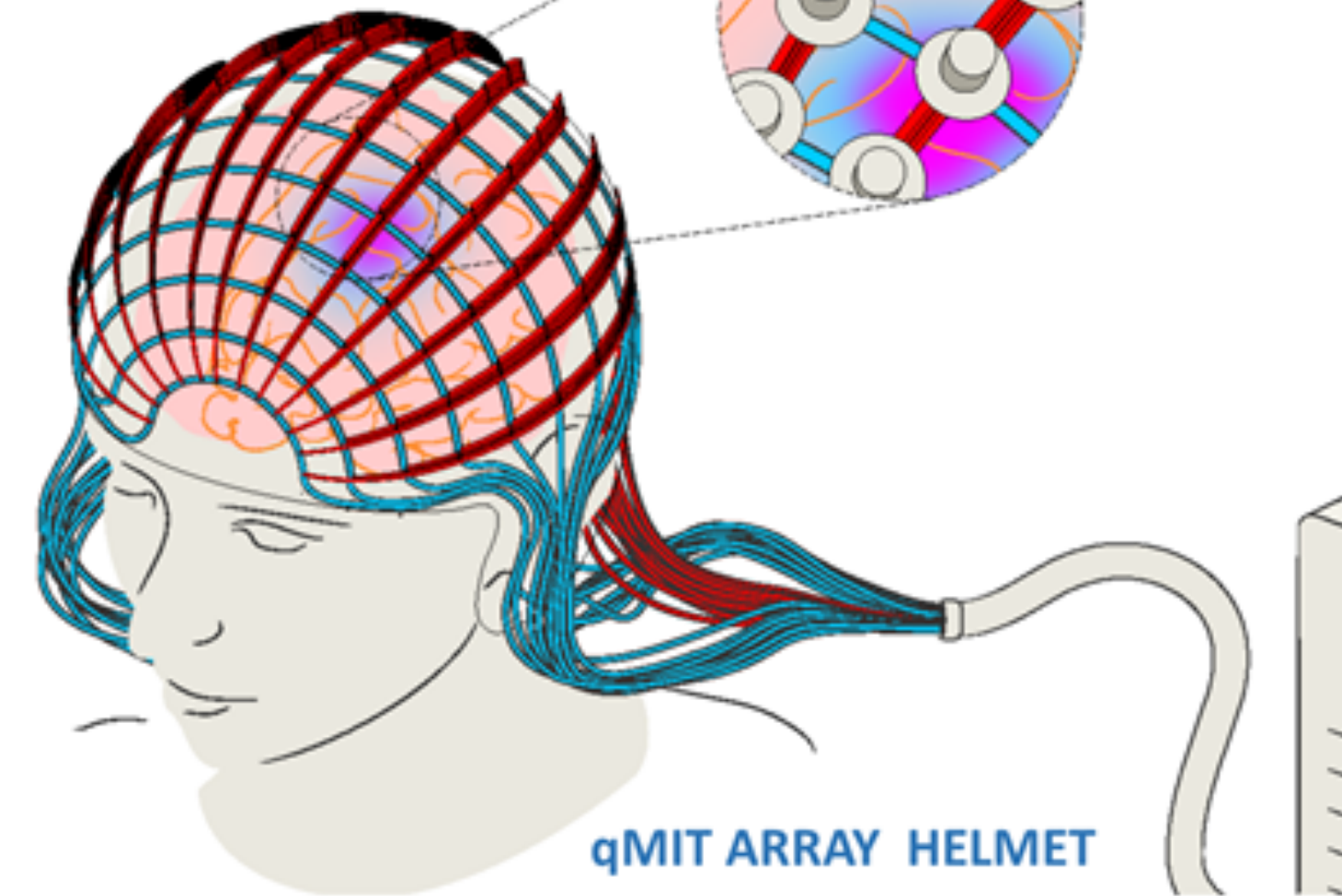
brain imaging system



MEG

MRI

Towards wearable and 'affordable' brain imaging



Q-MIT

**GLO Q-MITHelmet is the next revolution of MIR with unprecedented sensitivity with the size of hat and an estimated cost of an house.**

## Impact

- Radical Transformation in health practice
- Easing the access to medical imaging
- Unlocking the too much lasted neuro-degenerative deseases
- A machine for medicine nobel prize



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THANK YOU

