FURUKAWA ELECTRIC

3rd June, 2022

FURUKAWA ELECTRIC GROUP

iPOP 2022 Exhibition

# R&D of novel optical links using Hollow Core Fibers (HCFs)

Furukawa Electric Co., Ltd.

# Innovative optical properties of Hollow Core Fibers

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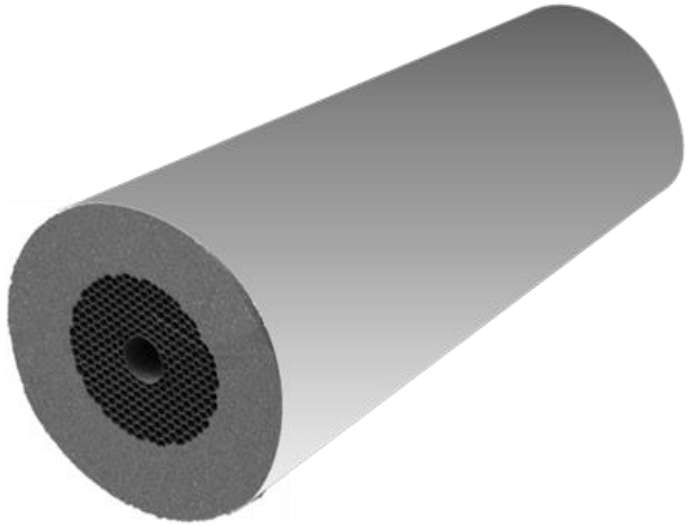
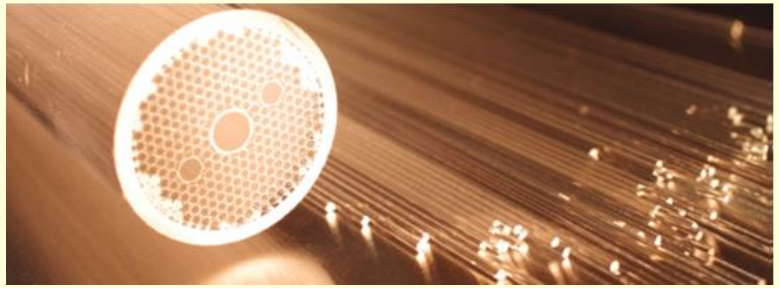
◈ Hollow core fibers (HCFs) have unique properties, which is difficult to achieve with conventional glass core fibers.



| Unique characteristics of the hollow core fibers | Innovative optical properties |
|---|---|
| **Light is confined not in the glass core but in the air core.**  | Ultra-low latency characteristics |
| | Ultra-low loss potential |
| | Ultra-low nonlinearity |
| | Super high reliability / Resistance to severe environment |
| | Interaction with a gas in the core |
| **Light confinement is based on a principle different from the conventional total internal reflection theory.** | Ultimate low bending loss characteristics |
| | Unique dispersion / polarization characteristics |

https://www.furukawa.co.jp/en/rd/review/fr052/fr52_09.pdf

# Improve optical properties of Hollow Core Fiber (1)

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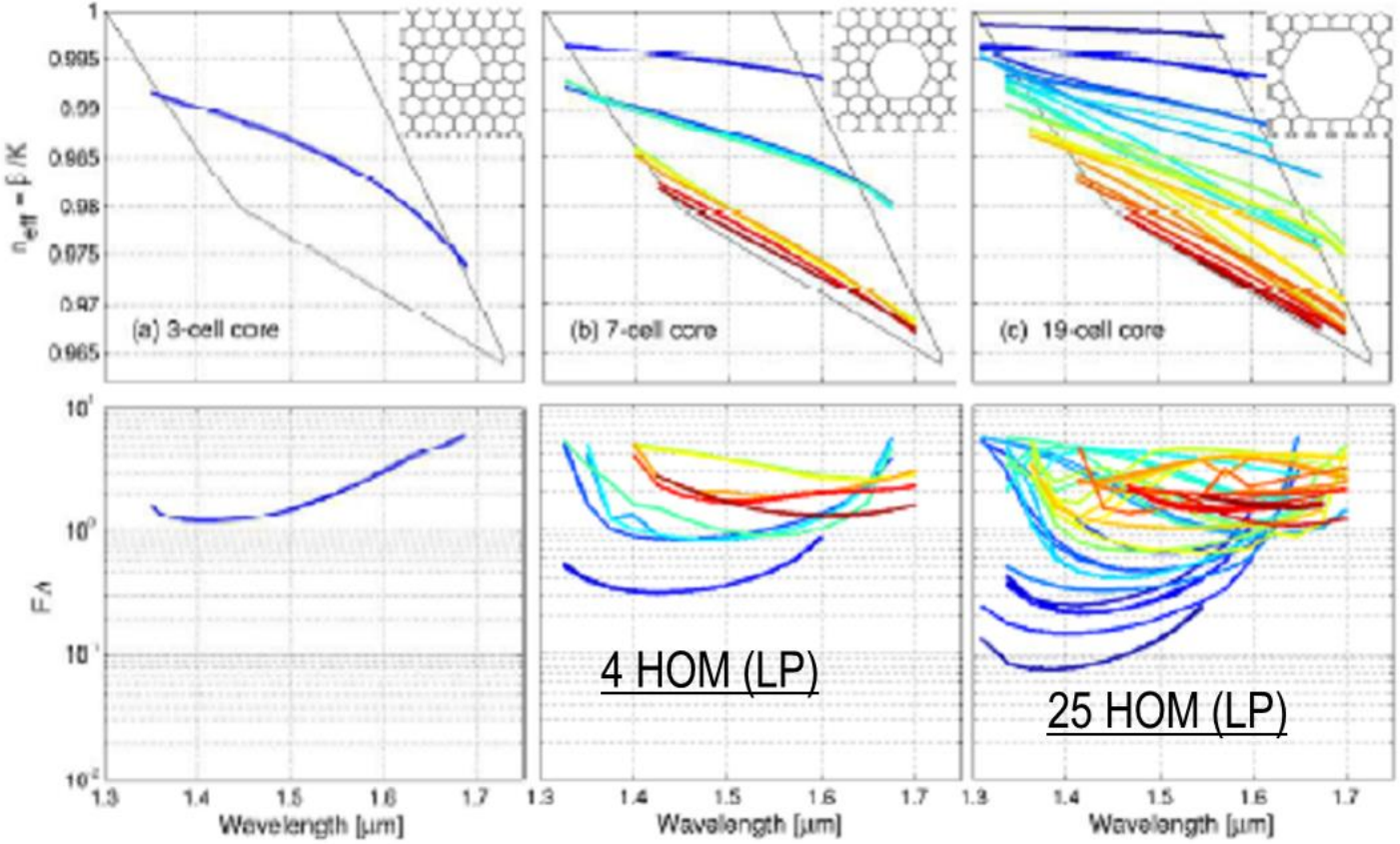
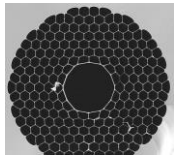
## Disadvantages of the hollow core fibers (HCFs)




From; http://eprints.soton.ac.uk/50698/1/3926.pdf



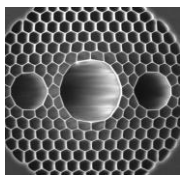
**Larger core diameter**

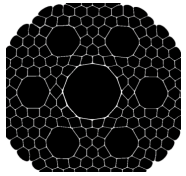
**is advantageous in terms of lower attenuation loss.**

But

**is disadvantageous in terms of increasing number of transmission mode (multi moded transmission).**

## We have solved this problem by the novel structure HCFs.





# Improve optical properties of Hollow Core Fiber (1)

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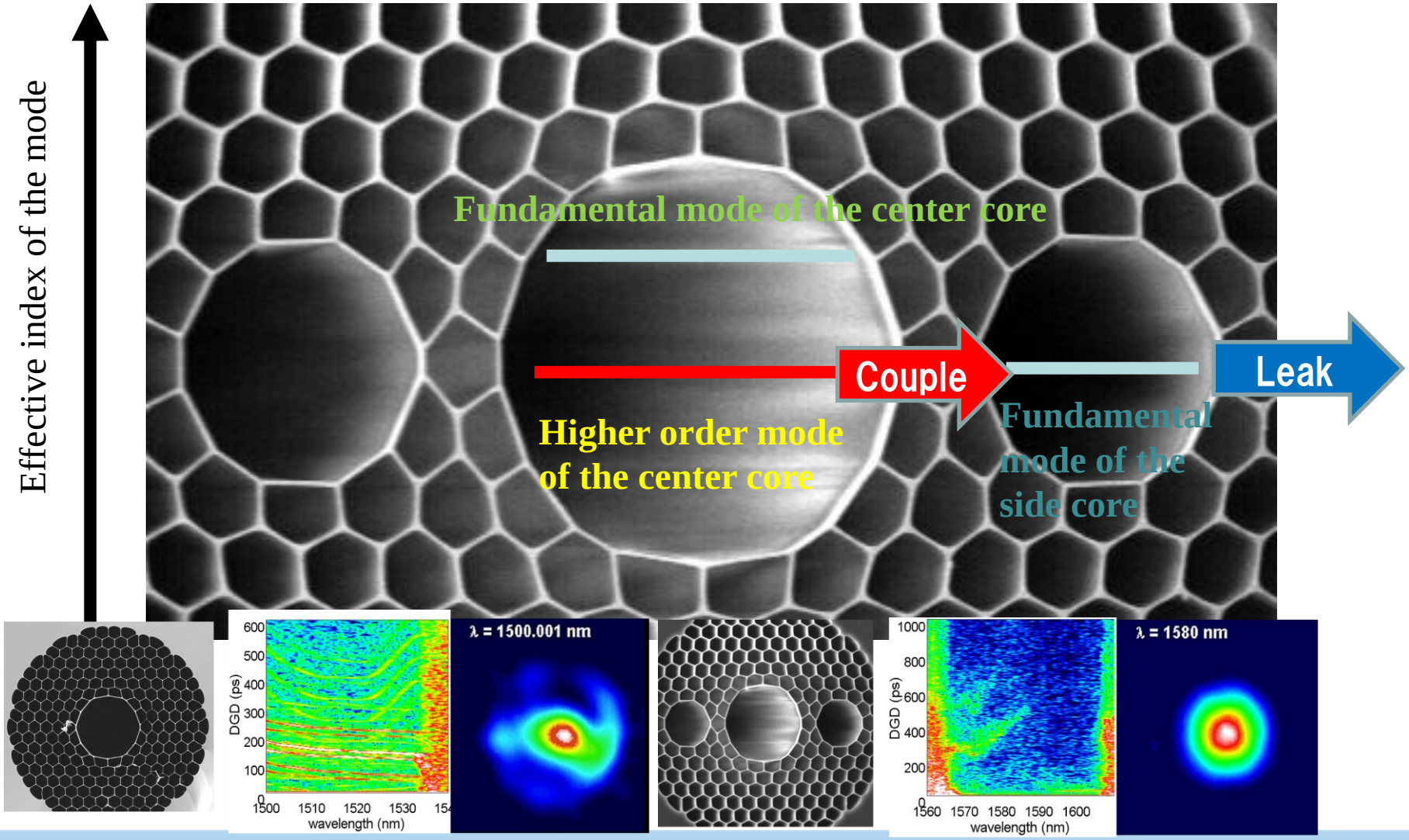
**We have solved this by perturbed resonance for increase single modeness (PRISM) structure.**




- We placed side core (shunt core) at the side of center core.
- High order mode in the center core coupled to the fundamental mode of the side core.
- The coupled high order mode light is leaky and leak out.
- Practical SM property is realized.

# Improve optical properties of Hollow Core Fiber (1)

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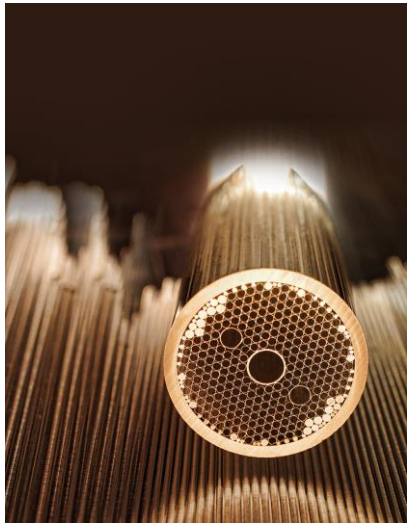
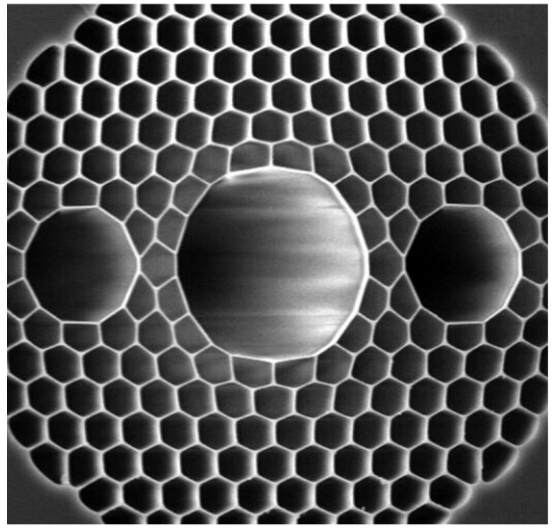
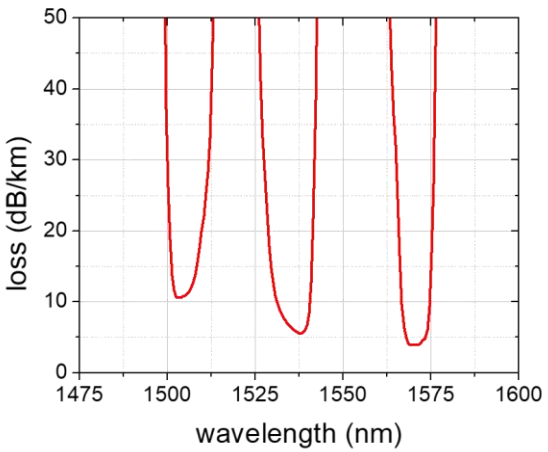
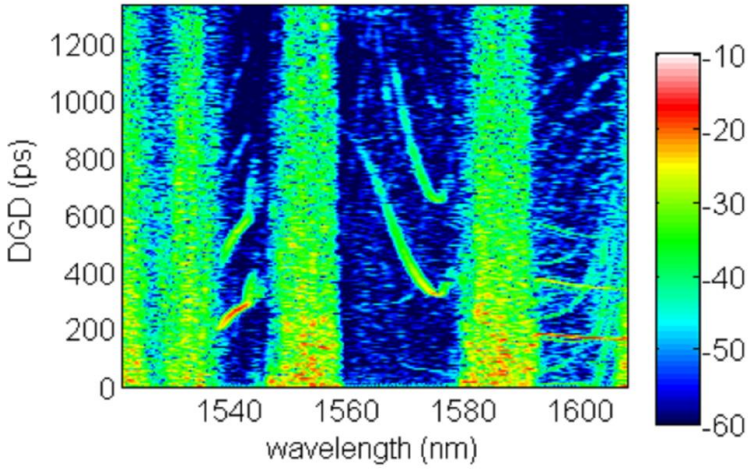
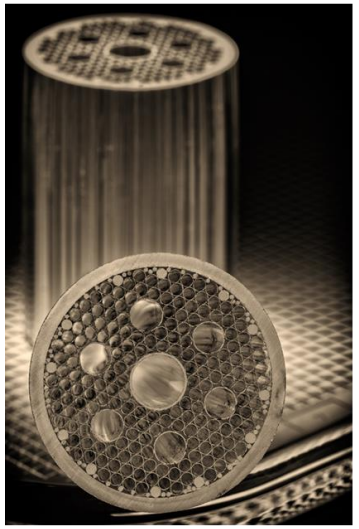
◆ Further improvement of single modeness ➔ was demonstrated by 6 shunt (side) core fibers.

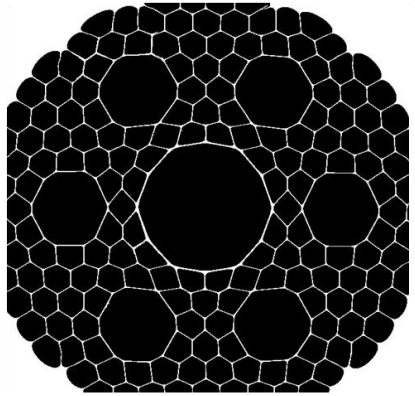


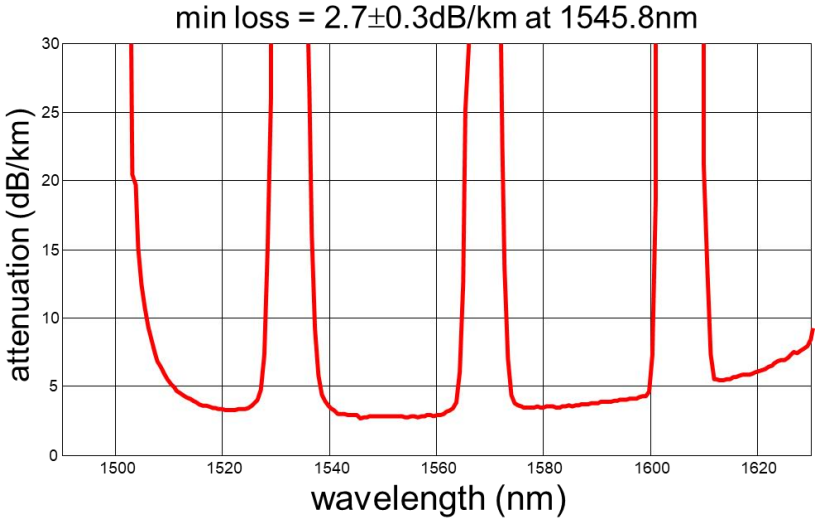


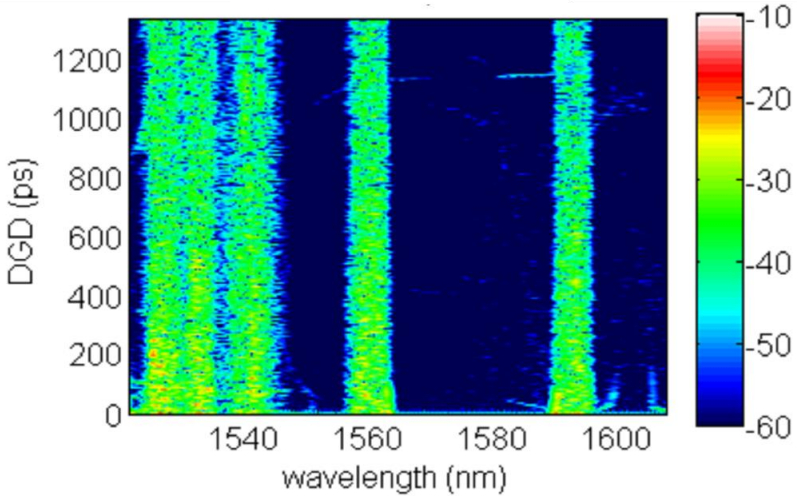






# Improve optical properties of Hollow Core Fiber (2)

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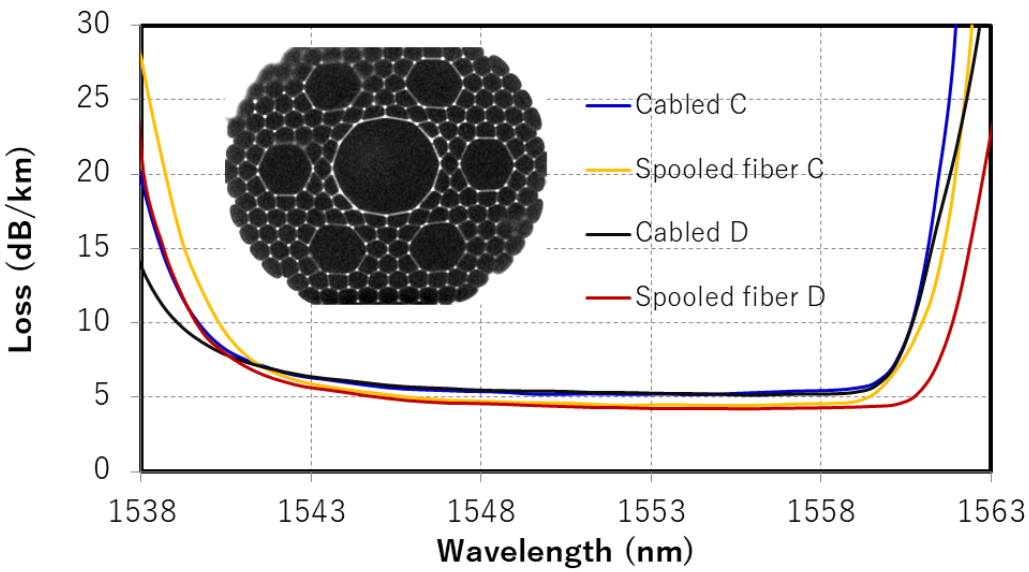
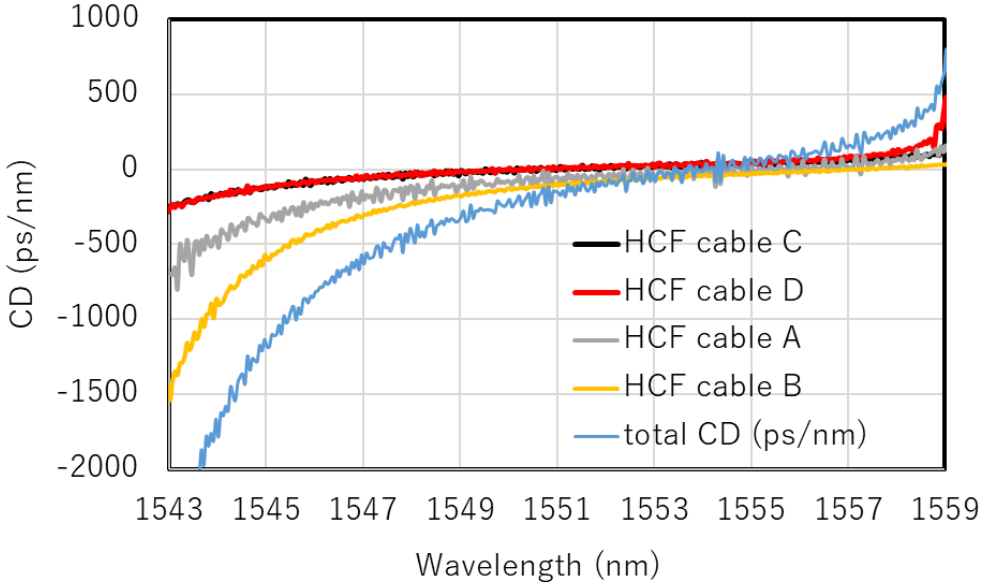
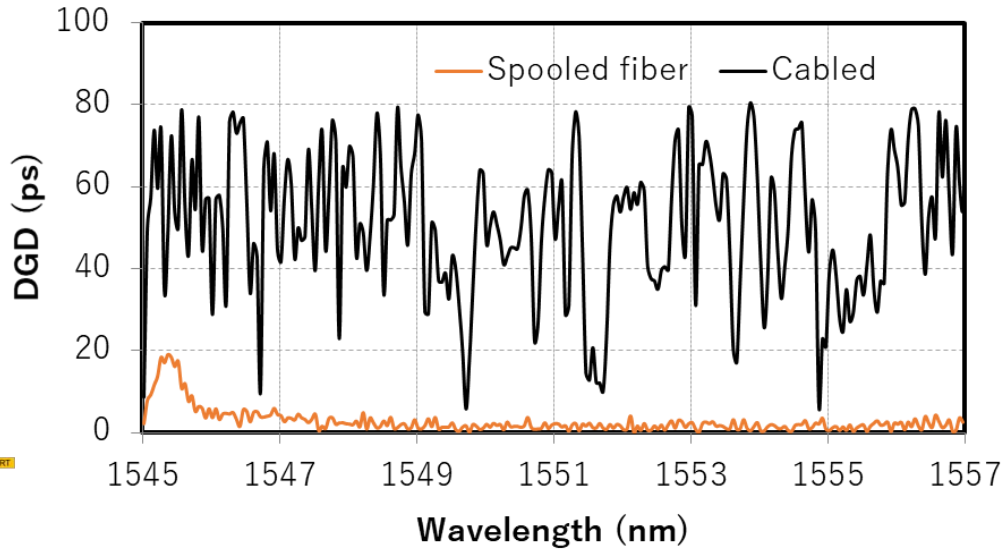
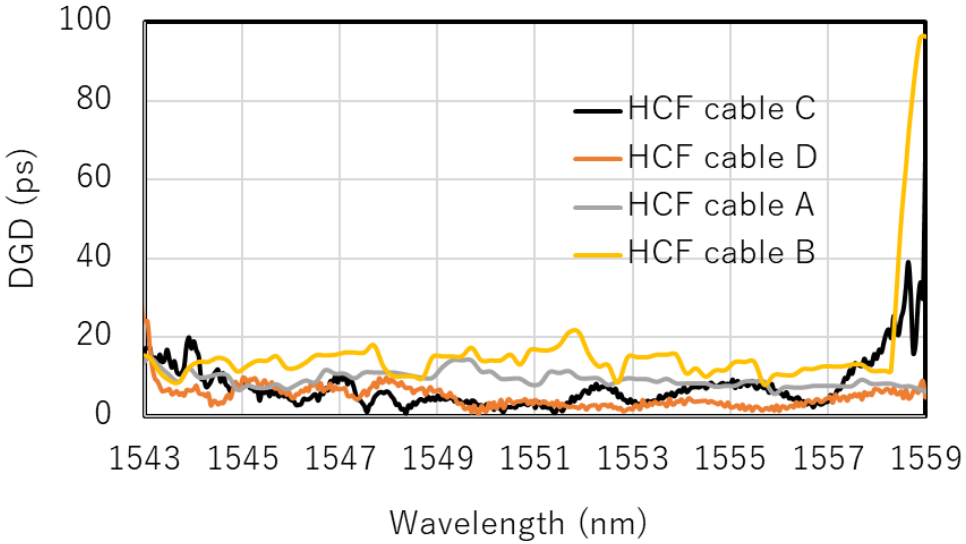
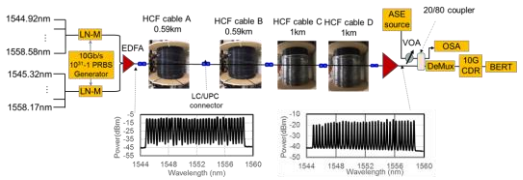
- Reduce loss, dispersion, PMD not only for fiber spool but also after cabling.
- Optimized terminations for cabling as well.



# Project of Ministry of Internal Affairs and Communications (Soumu-syou)

◆R&D of Cutting-edge transmission technologies to realize green society

Project I. 10Tb/s-class Transmission technologies

Project II. High-capacity and high branch number access systems

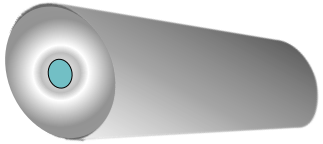
◆Project II High-capacity and high branch number access systems

Project II-A High-capacity access transmission technologies

Project II-B High-multiplexing access transmission basic technologies

- To realize high number brunch systems, optimizing optical link is one of the key points.
- High input resistance is one key point.

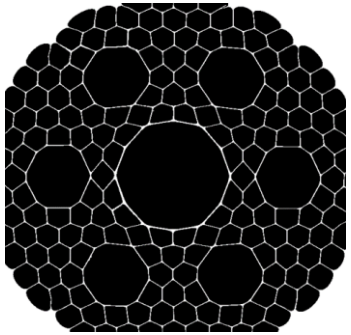
☆Expected issues of conventional fibers for high power input



- Non-linear phenomena
- Fiber fuse

☆One way to solve those problems

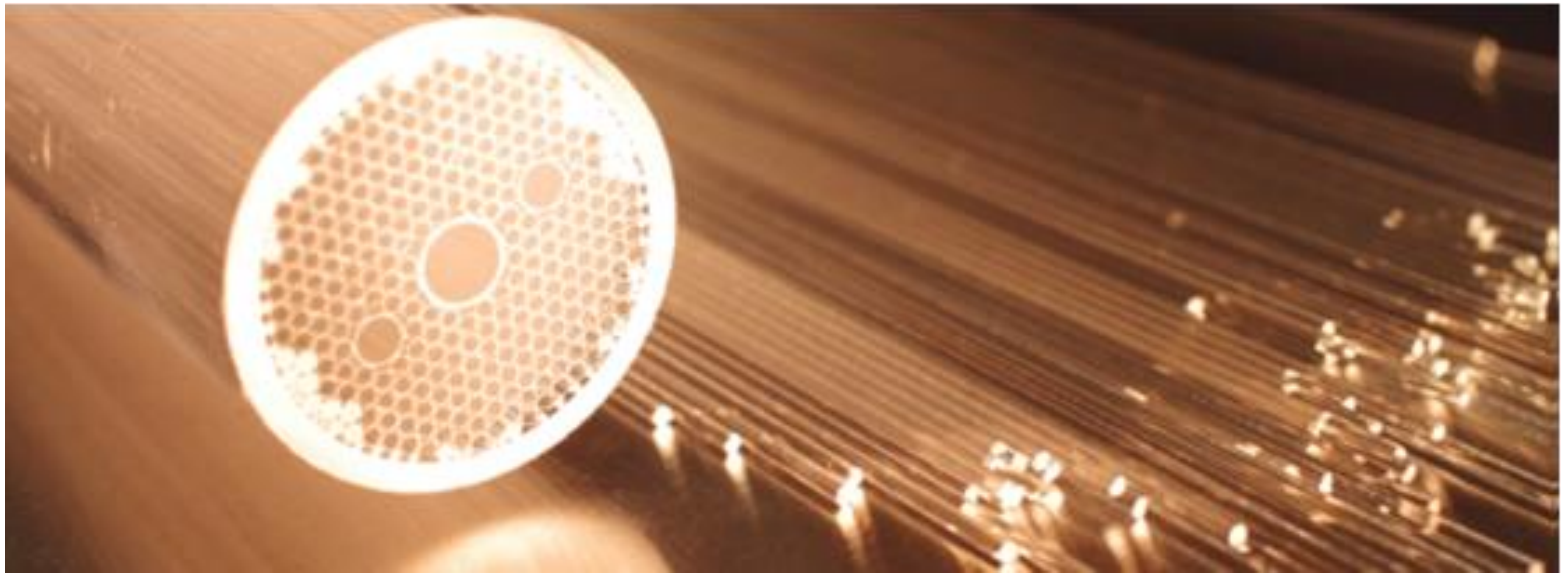
Novel transmission link using



Hollow core fiber

>3-digit higher power resistance than conventional fibers

# With this new project of Ministry of internal affair and communications.



**Thank you !**