UNIVERSITY OF Southampton
Optoelectronics Research Centre
UCL

Record High Capacity (6.8 Tbit/s) WDM Coherent Transmission in Hollow-Core Antiresonant Fiber

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EPSRC Engineering and Physical Sciences Research Council
Photonic Hyperhighway
UNIQUE

Guide light in air rather than solid material

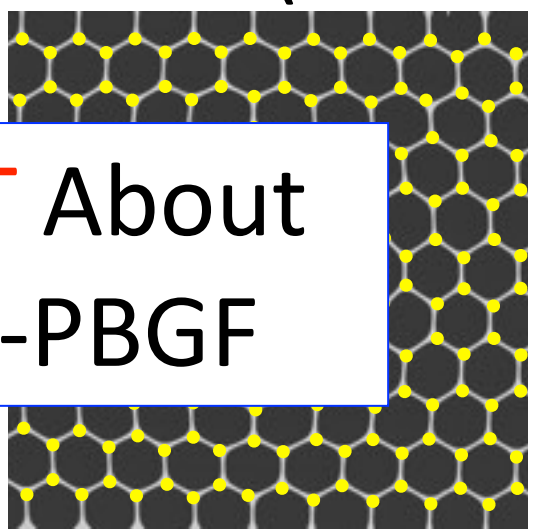
- Ultimately low latency (50% faster than silica fiber)
- Ultra-low nonlinearity (1000 times smaller than SMF-28)
- High damage threshold (handle up to Giga Watt)
- Low temperature sensitivity (>100 times lower than SMF-28)

Hollow-core Photonic Bandgap Fiber (HC-PBGF)

Highest data rate:
73.7 Tb/s
[V.A.J.M. S
32(4), 201

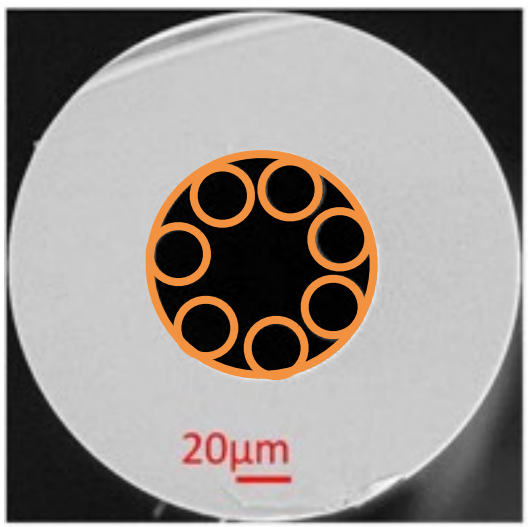
Longest
74.
[M. Kuscherov, et al., ECOC, 2015]

NOT About HC-PBGF



Lattice Pitch
decides performance

Hollow-core Antiresonant Fiber (HC-ARF)



Highest data rate:
10 Gb/s

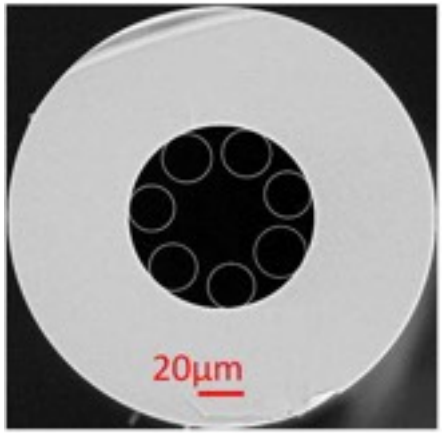
Longest Distance:
100 meters

[J. Hayes, et al., JLT, 35, 2017]

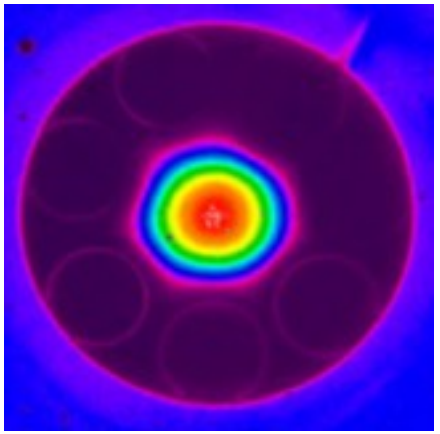
Thickness of the thin wall
decides performance

Hollow-Core Antiresonant Fiber (HC-ARF)

Fiber Structure



Mode field image
(high mode purity)



Special features can only get from HC-ARF

- **High mode purity with large core**
- **Broadband guidance (over 1100 nm)**
- **Low dispersion (±2ps across entire band)**
- **Simple structure (easy fabrication)**
- **Potential low loss (0.1dB/km) with nested structure**

F. Poletti, Opt Express **22**, 23807 (2014)

State-of-the-art

Length: **100 meters**
[J.R. Hayes et al., JLT, **35,** 2017.]

Data transmission: **10 Gb/s OOK**
[J.R. Hayes et al., JLT, **35,** 2017.]

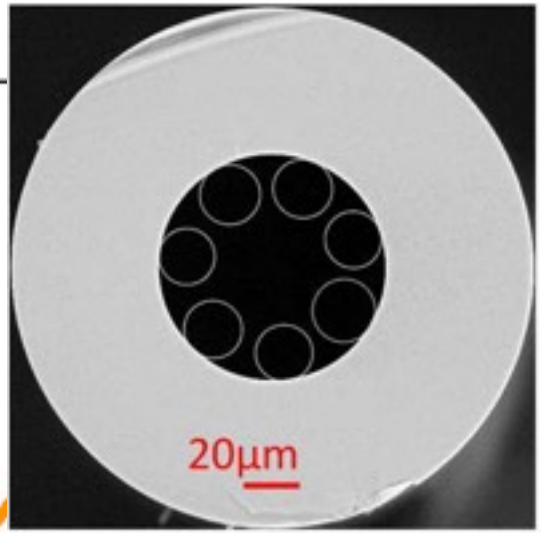
Loss: **7.7 dB/km (at 750 nm)**
[B. Debord, et al., Optica, **4**, 2017.]

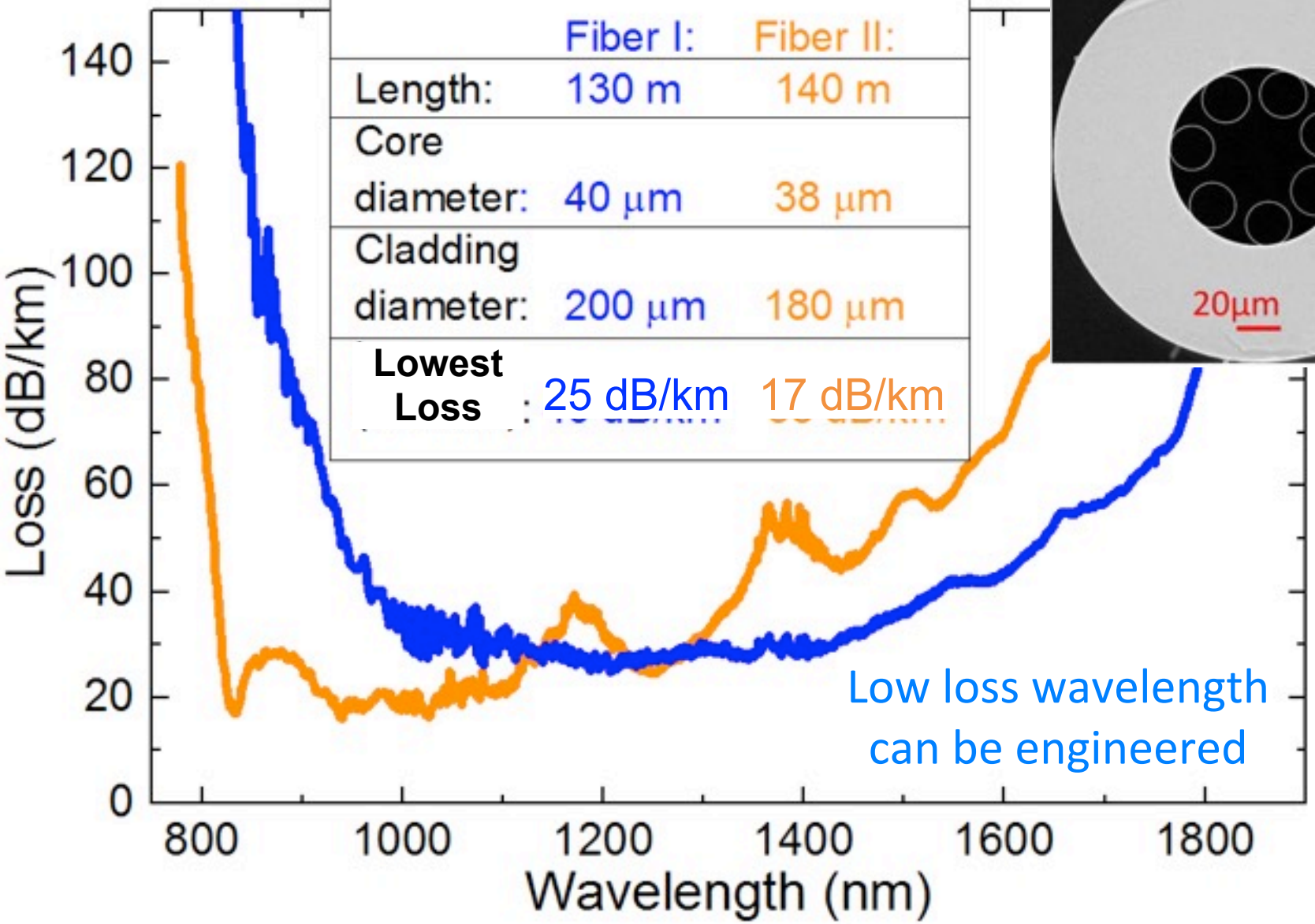
We show:

- Dual-polarization high-order formats transmission
- WDM transmission
- Comparison with SMF-28 in nonlinearity penalty

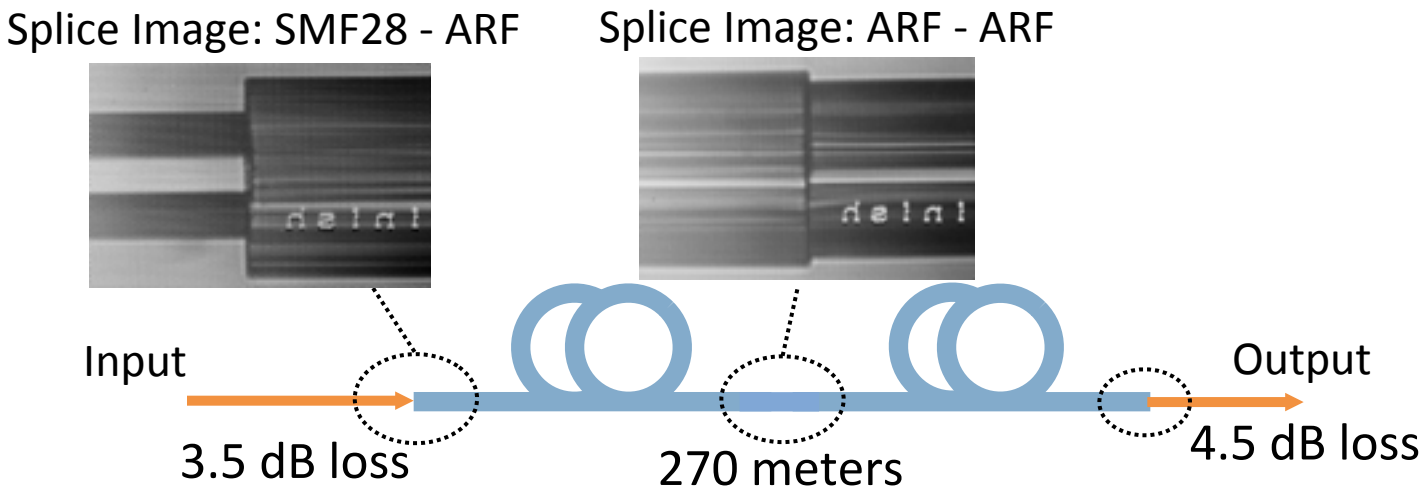
Fiber Used in This Experiment

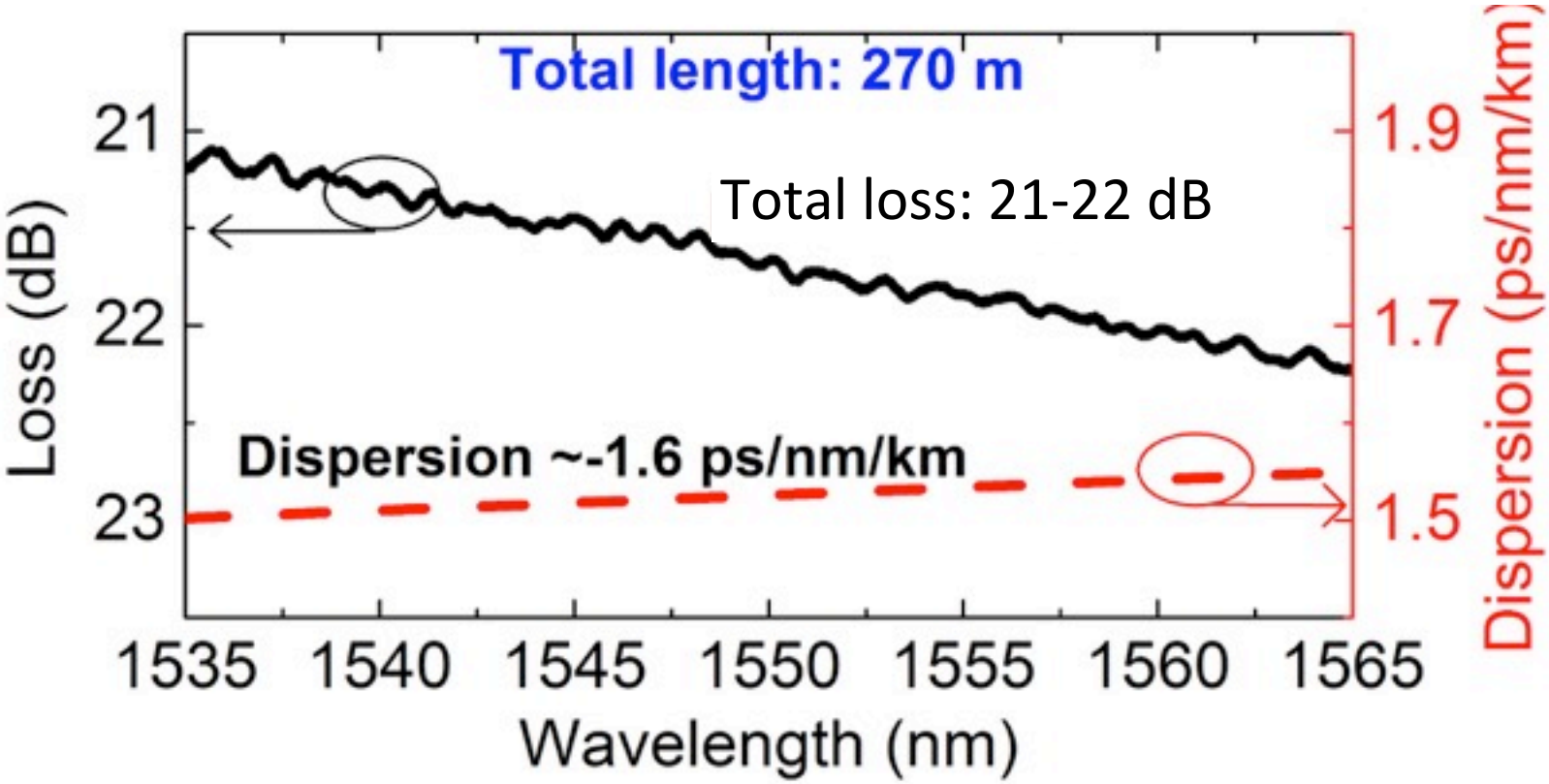
	Fiber I:	Fiber II:
Length:	130 m	140 m
Core diameter:	40 μm	38 μm
Cladding diameter:	200 μm	180 μm
Lowest Loss :	25 dB/km	17 dB/km



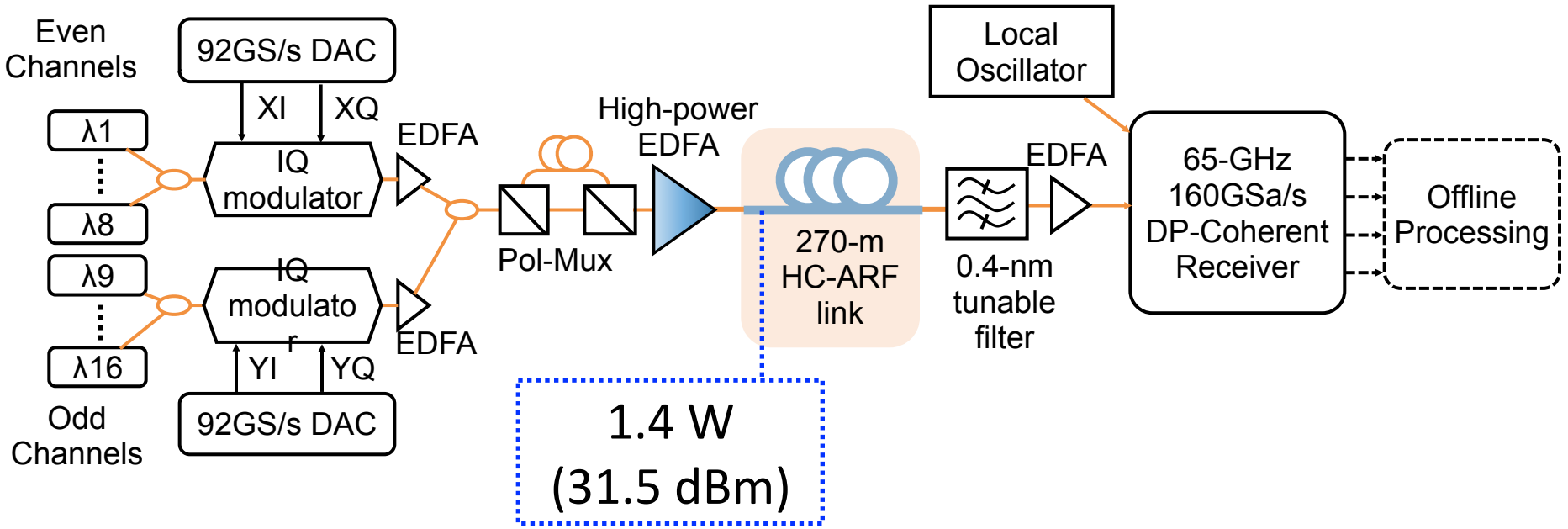


The HC-ARF Fiber Link



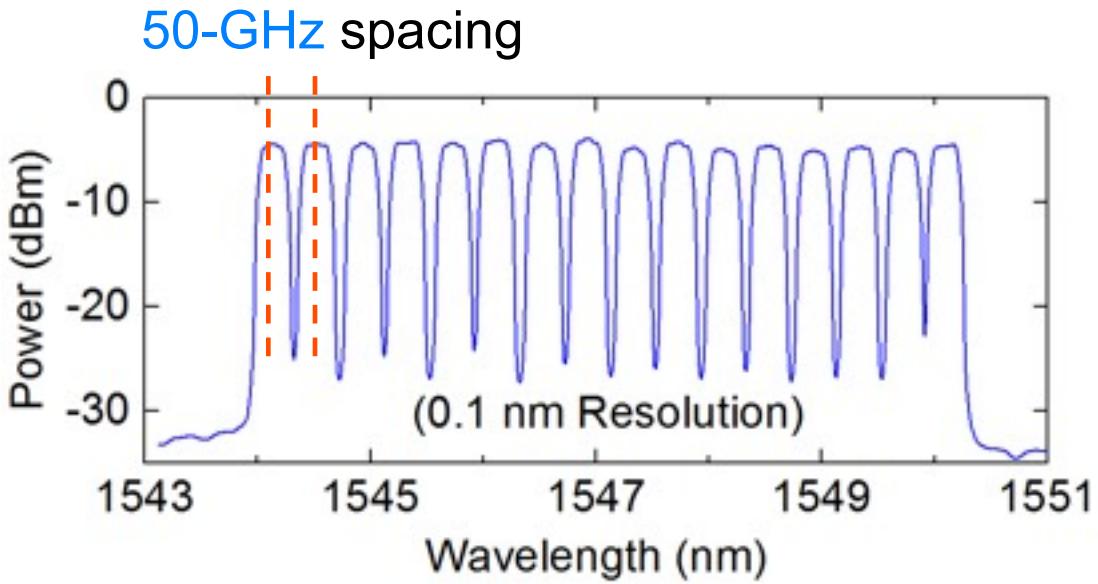


Transmission Experiment: Transmitter

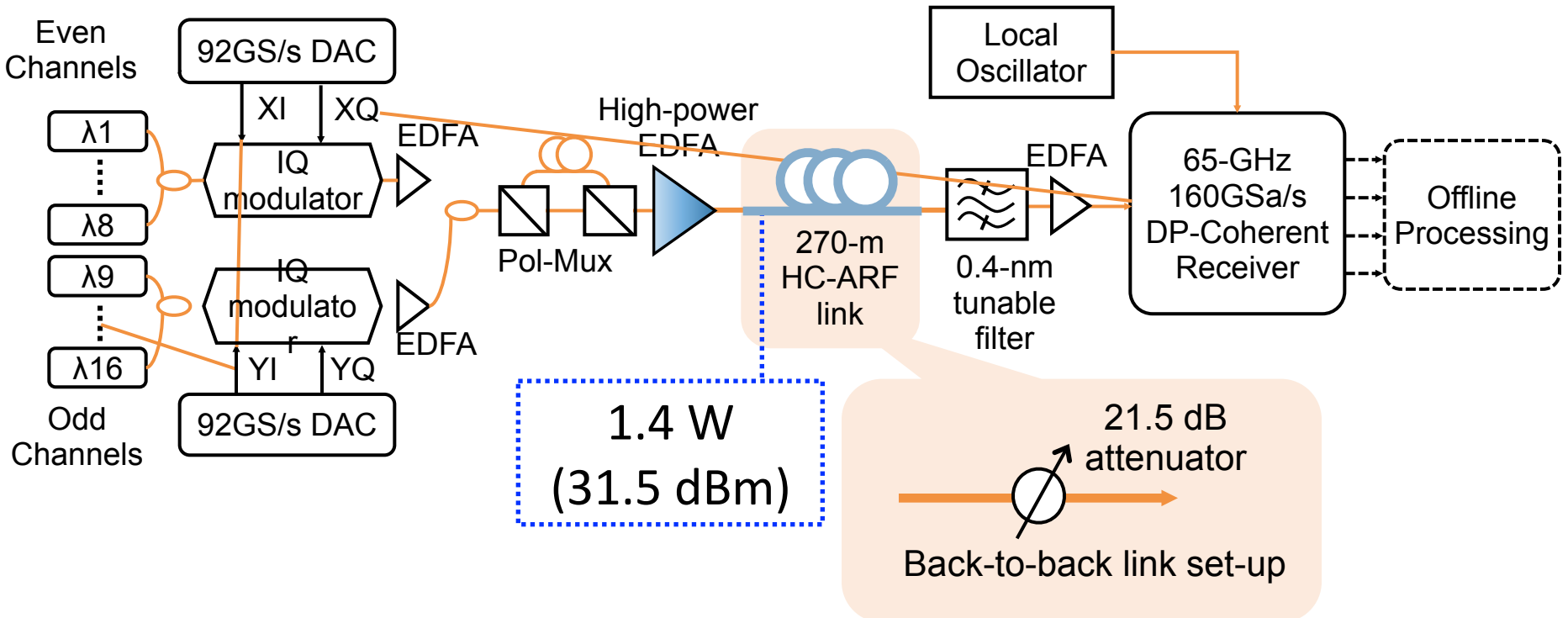


Transmitter

- 32 GBd
- 256 QAM
- EDFA output : 3.2 W (35 dBm)



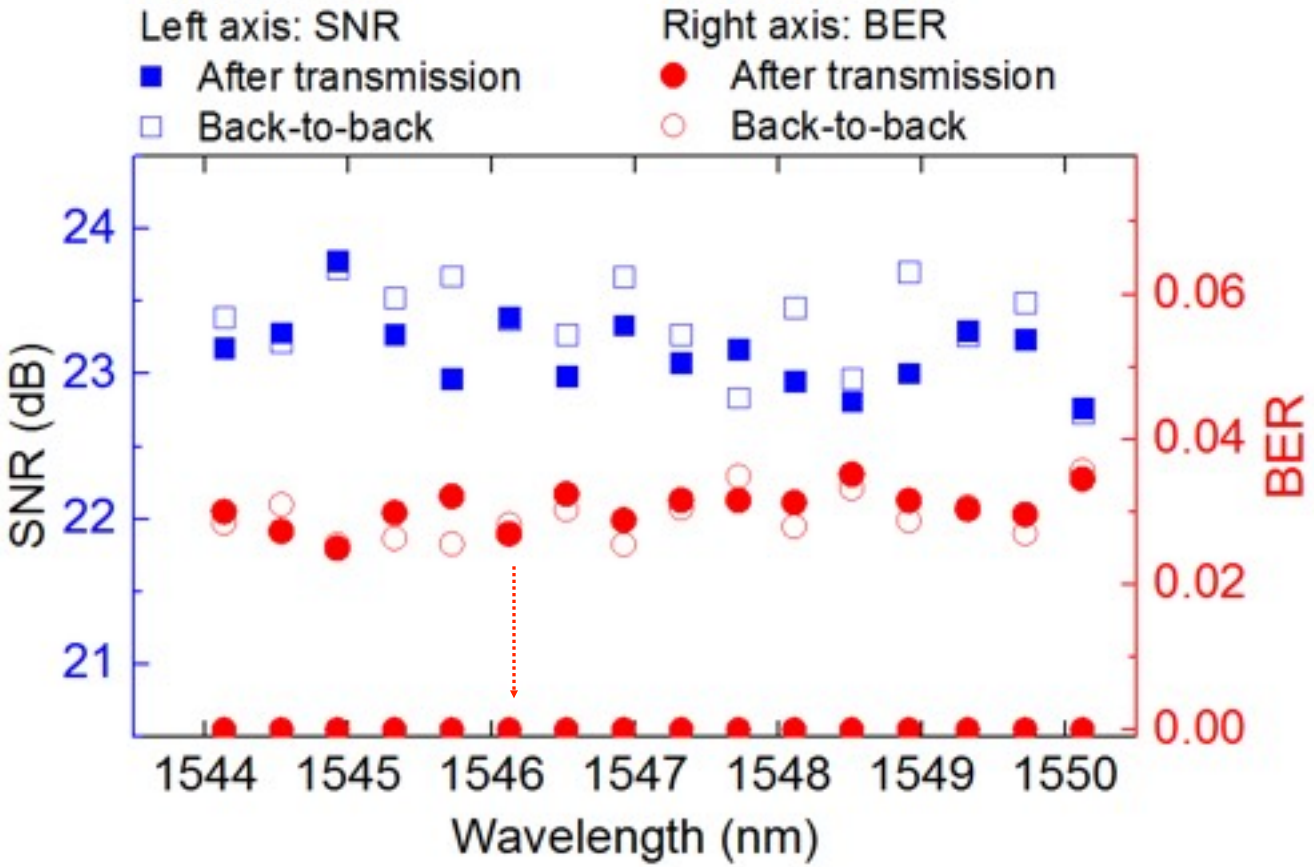
Transmission Experiment: Receiver



Receiver

- Standard algorithms for signal demodulation
- No static dispersion compensation due to short fiber
- Small dispersion (<1.6 ps/(nm·km)) allows reduce the taps numbers by 90%

WDM Transmission Results: 16-Channel 256QAM



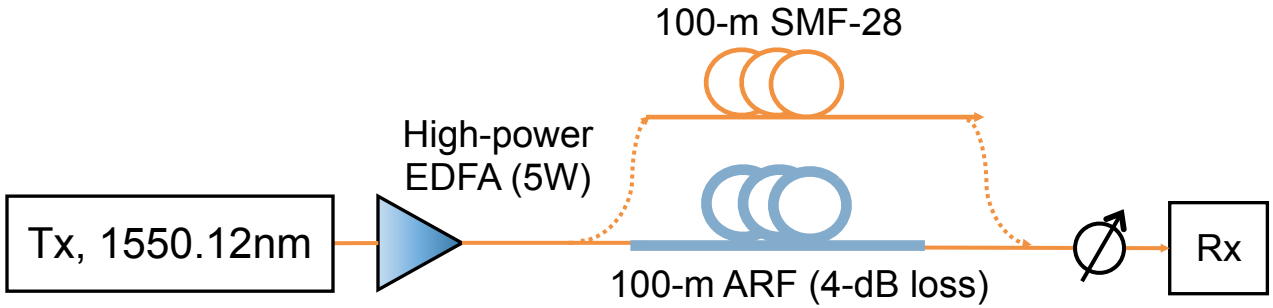
SNR: 22.8 – 23.7dB

BER: $2.7\times10^{-2} – 3.5\times10^{-2}$

Error free after soft-decoding
(17% overhead IRA-LDPC)

Net rate: **6.8 Tbit/s**

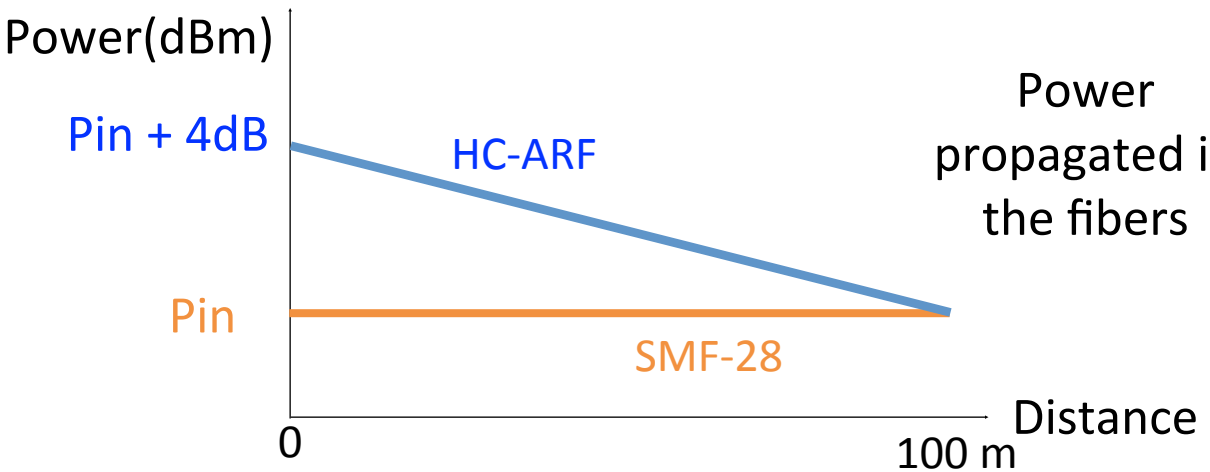
Single-channel Nonlinearity Tolerance



To make a comparison as fair as possible, we did:

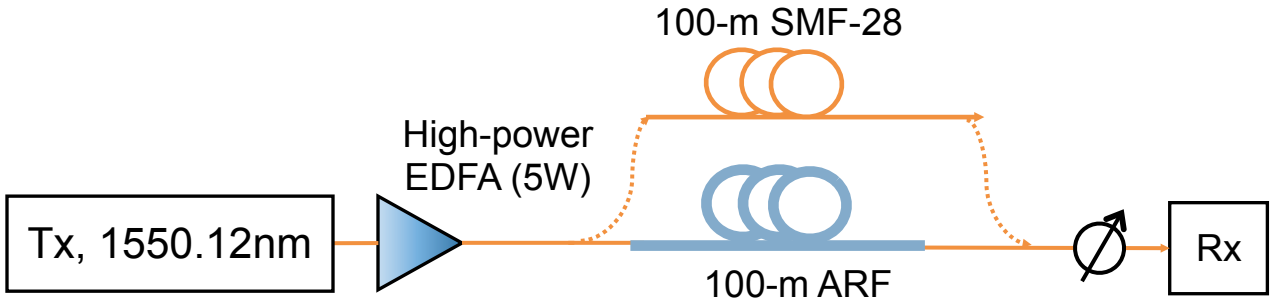
1. Use lowest loss and short sample;
2. Compare power after transmission:

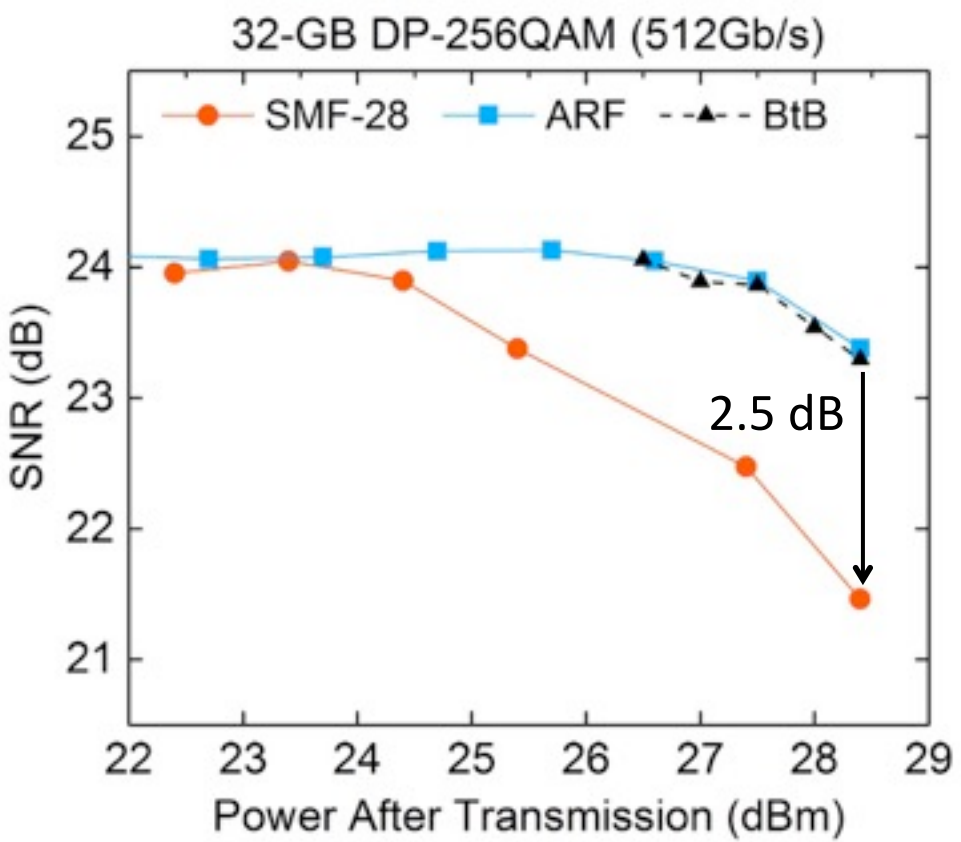
half the difference between input and output powers



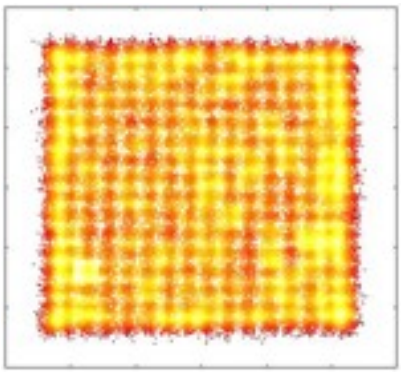
(power launched in to the hollow core fiber is 4 dB higher than to SMF-28)

Single-channel Nonlinearity Tolerance: 256QAM

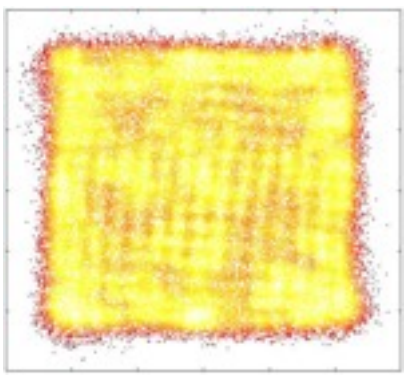


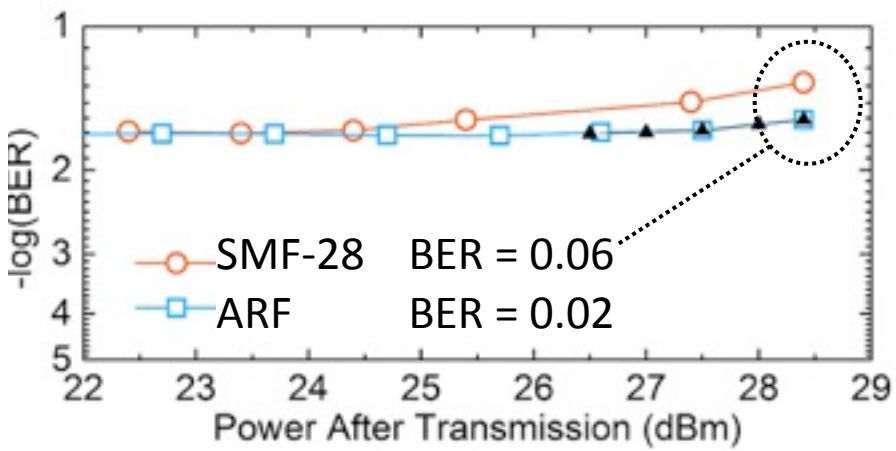


After ARF

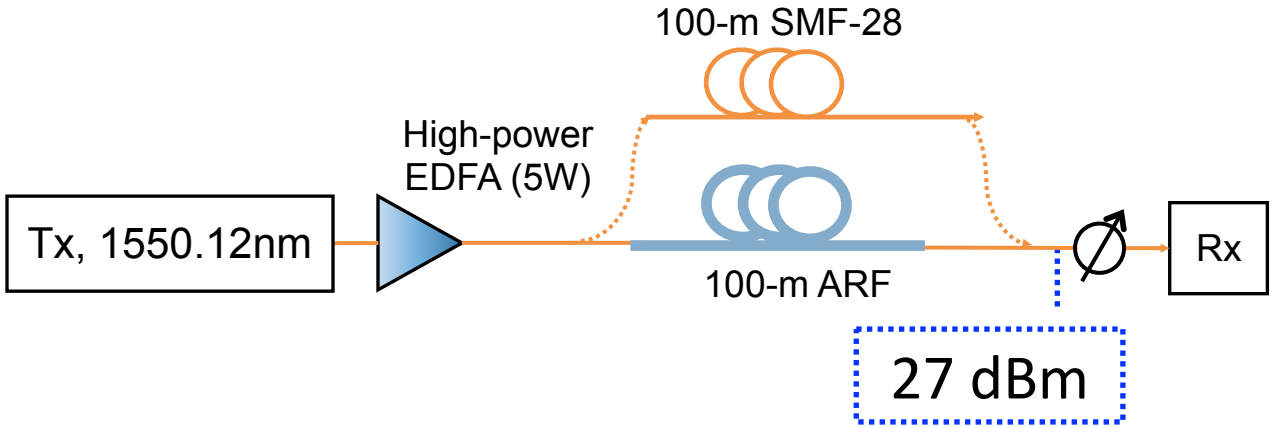


After SMF-28

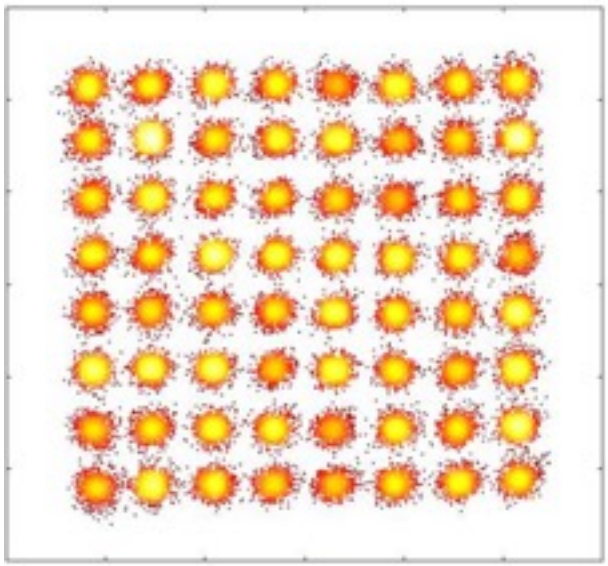




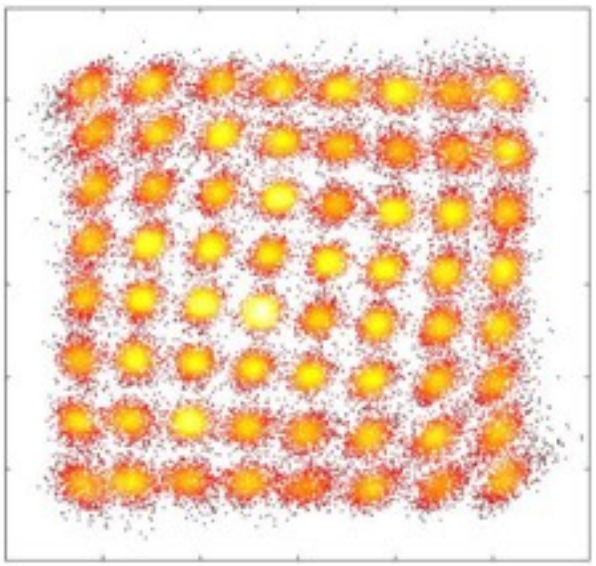
Single-channel Nonlinearity Tolerance: 64QAM



After ARF



After SMF-28



Summary

Using Antiresonant Fiber, we demonstrate:

- Longest transmission over HC-ARF (270 m);
- First dual-polarization coherent signal transmission;
- First WDM transmission using high-order format (256QAM);
- First comparison of signal nonlinearity penalty between SMF-28 and hollow-core fiber.

Take away message:

Low latency, low NL, HC-ARF has immediate application in inter/intra-DC links.