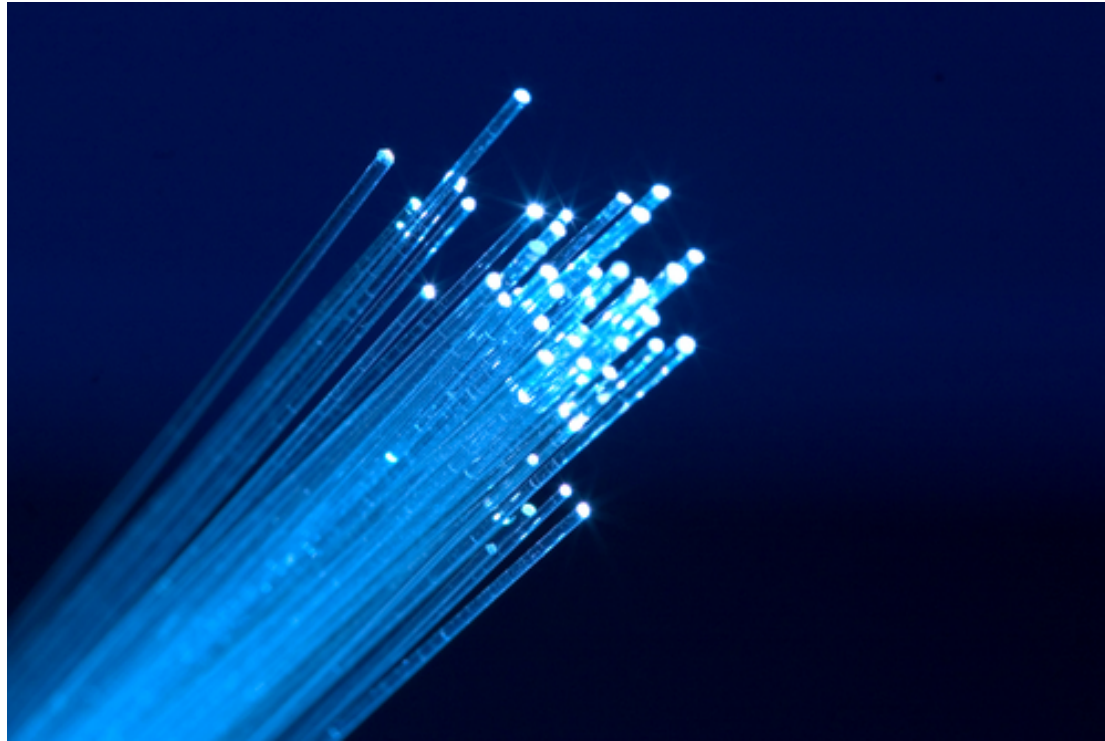


Fiber Optics Communication

A “brief” overview...



Bertrand Zauhar, VE2ZAZ

January 2013

Today's Presentation

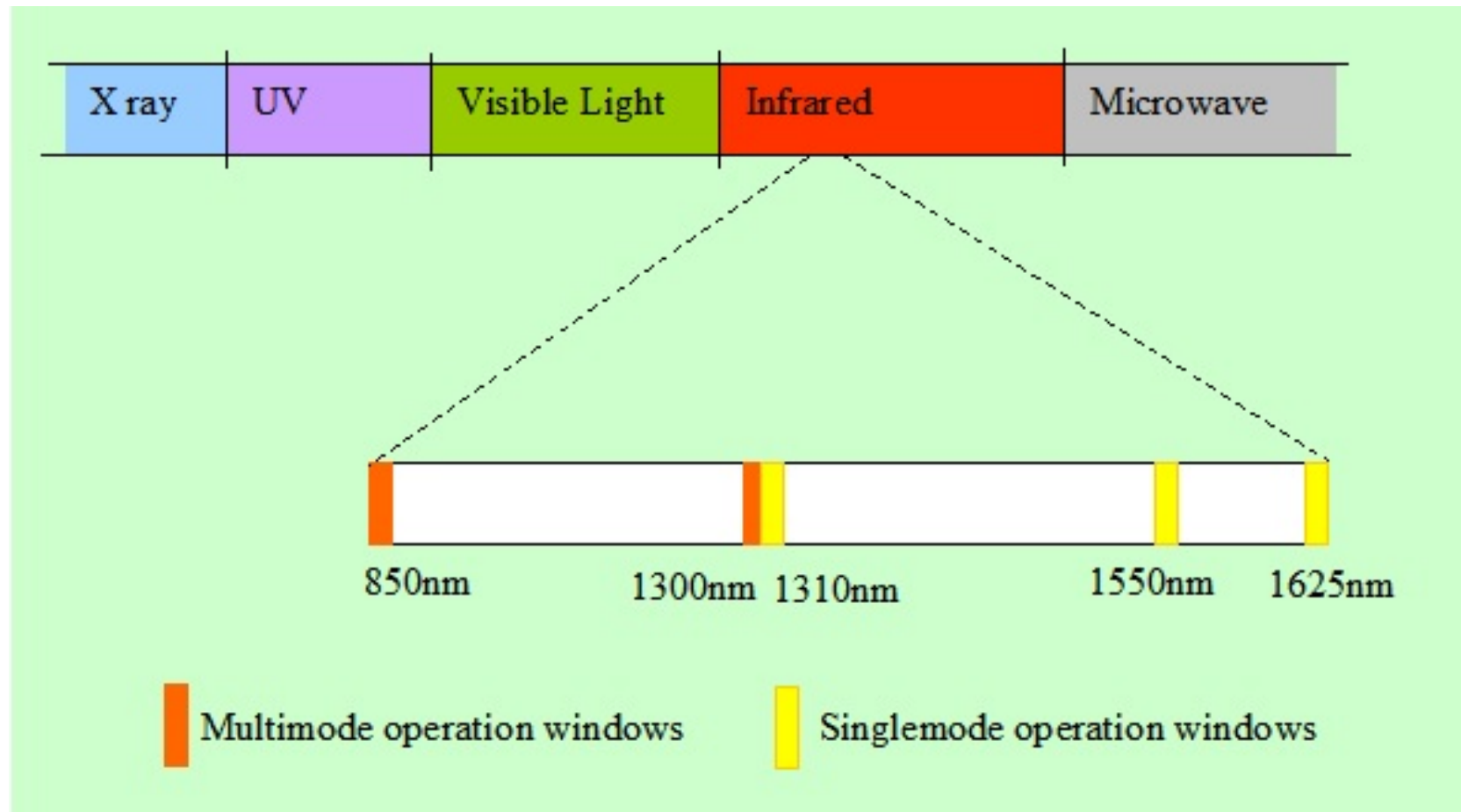
- Why fiber optics,
- Where in the spectrum,
- Fiber optics physics,
- Transmission impairments,
- Fiber splicing,
- Tx, Modulation, Rx,
- Communication Systems, topologies, reach...

Why Optical Fiber ...

(Optical Fiber, Fibre, Fiber Optics....)

- Low Signal Attenuation,
- Huge Bandwidth,
- No EMI,
- Proof against Short-circuiting, Earthing and Fire
- Offers Data Security
- Components with low Weight and Volume

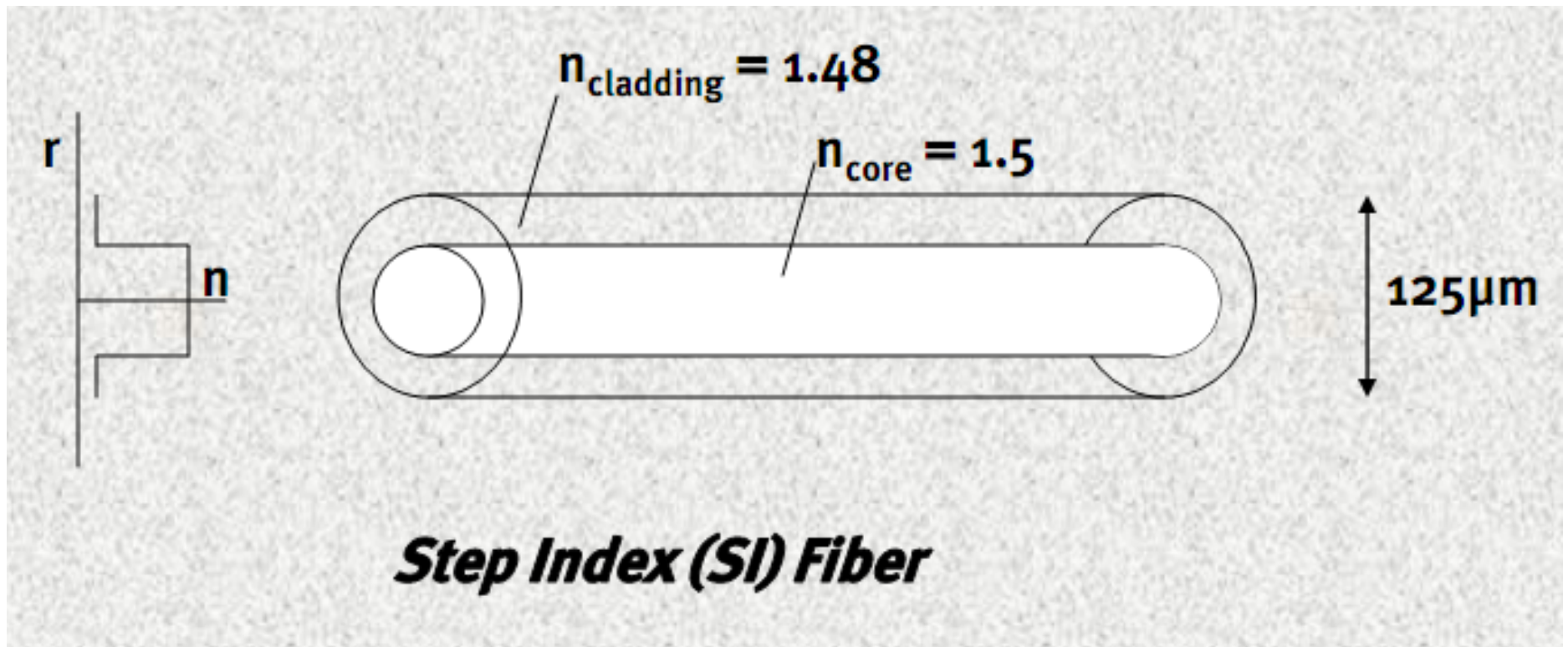
Where are we Playing...



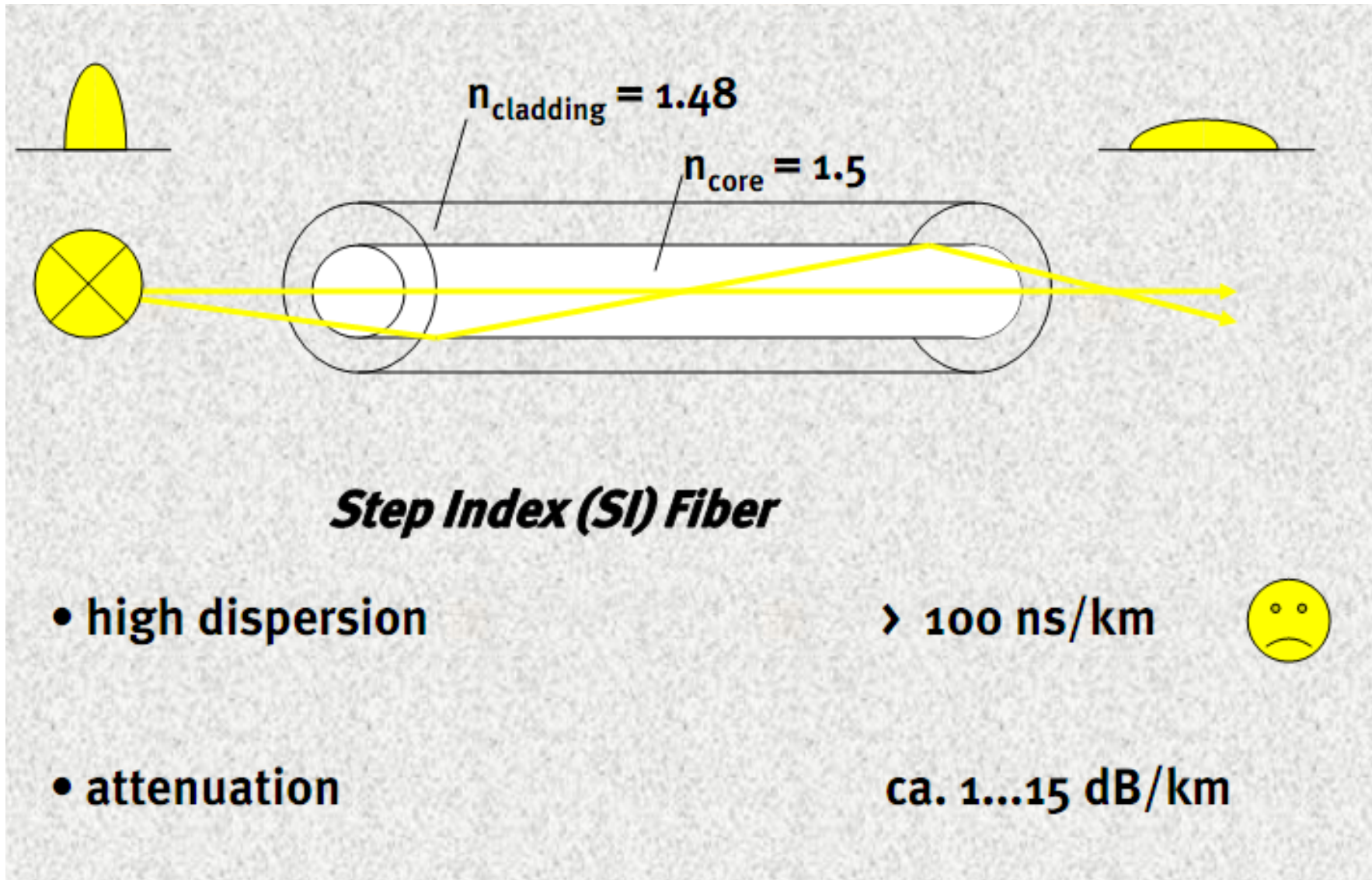
Fiber Structure and Light Guiding Mechanism

Optical Communication Fiber made of:

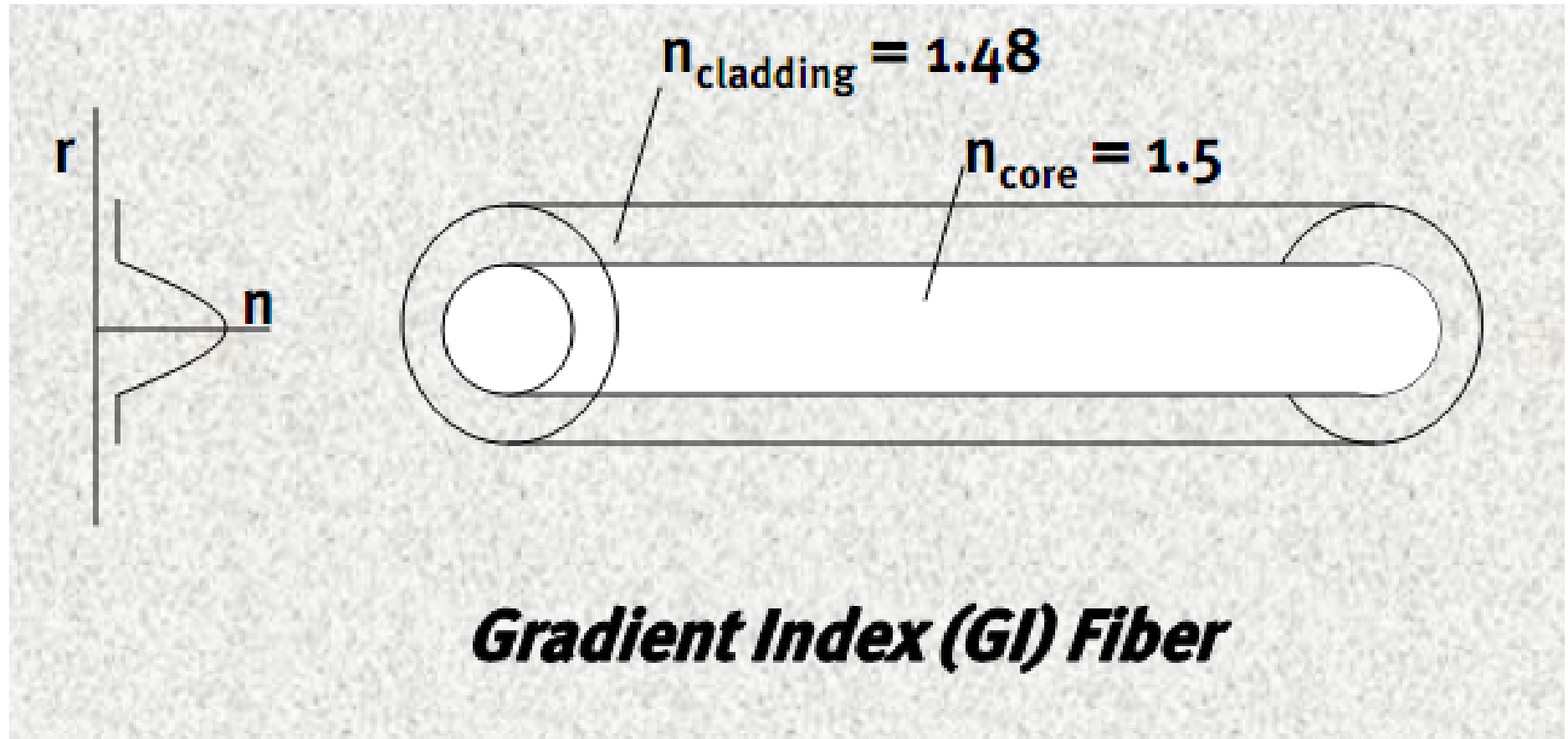
- High purity glass,
- Plastics (for very short links).



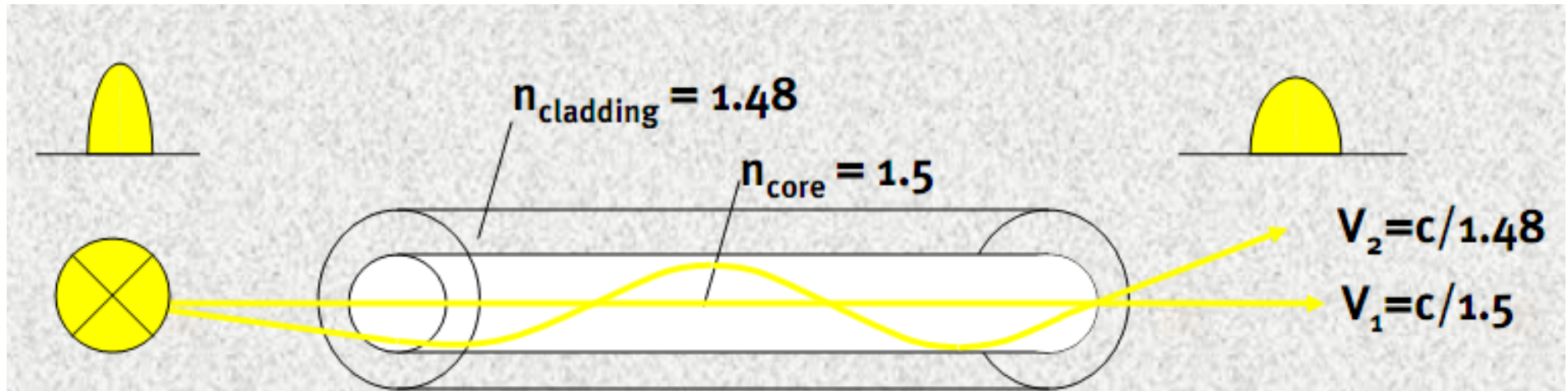
Fiber Structure and Light Guiding Mechanism



Fiber Structure and Light Guiding Mechanism



Fiber Structure and Light Guiding Mechanism



Gradient Index (GI) Fiber

- low dispersion

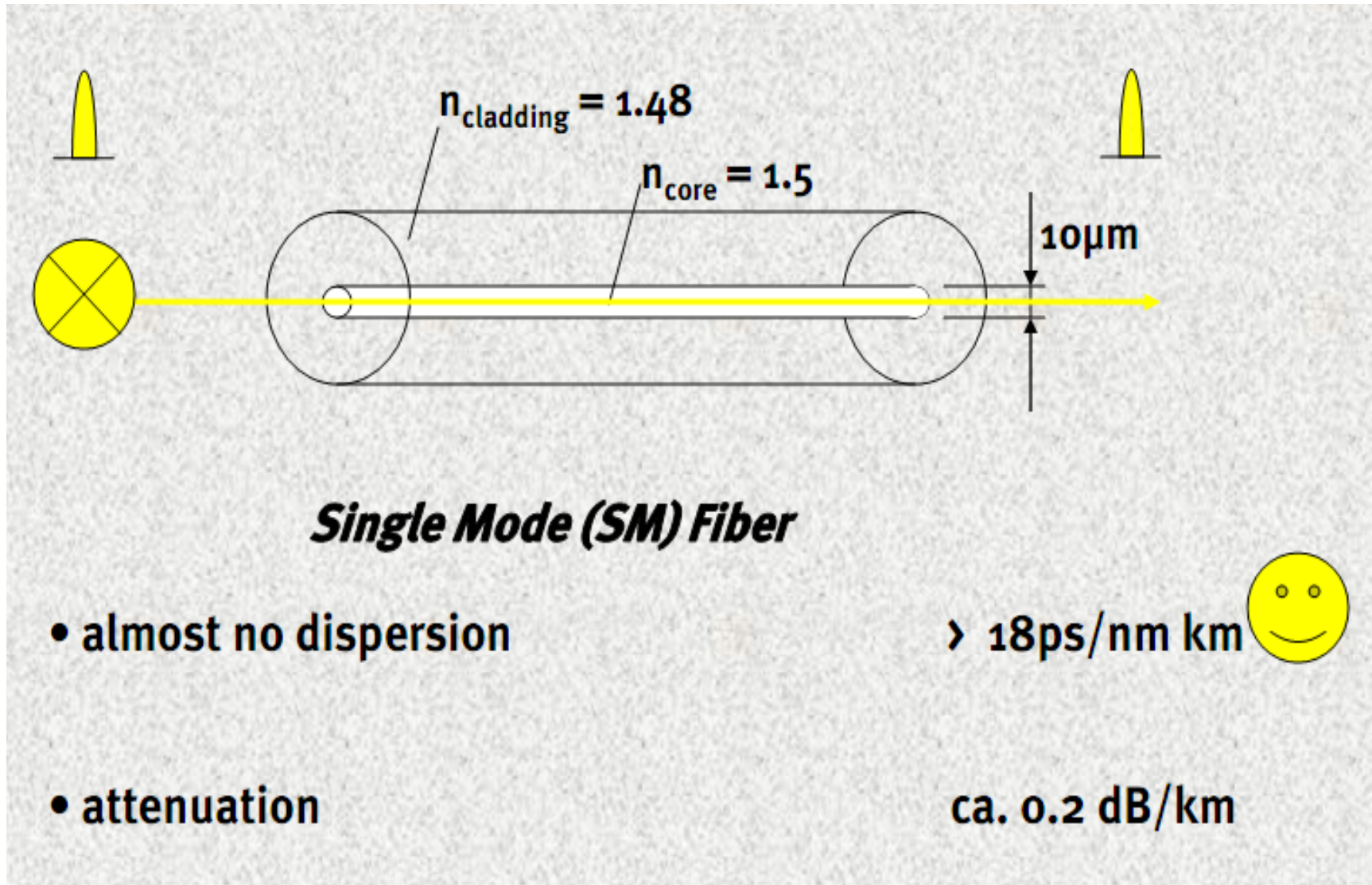
> 2 ns/km



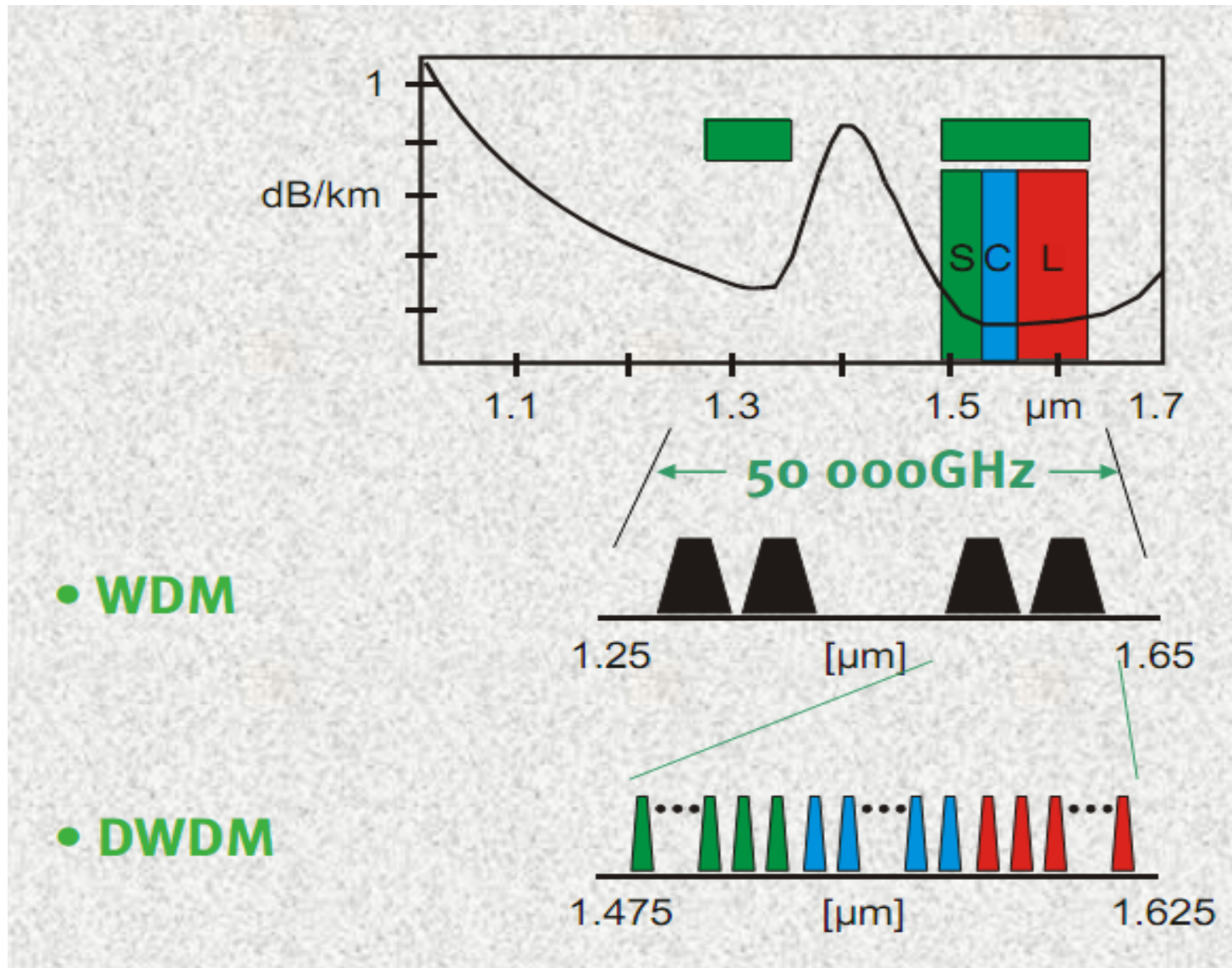
- attenuation

ca. 1...3 dB/km

Fiber Structure and Light Guiding Mechanism



Fiber Attenuation and Optical Windows



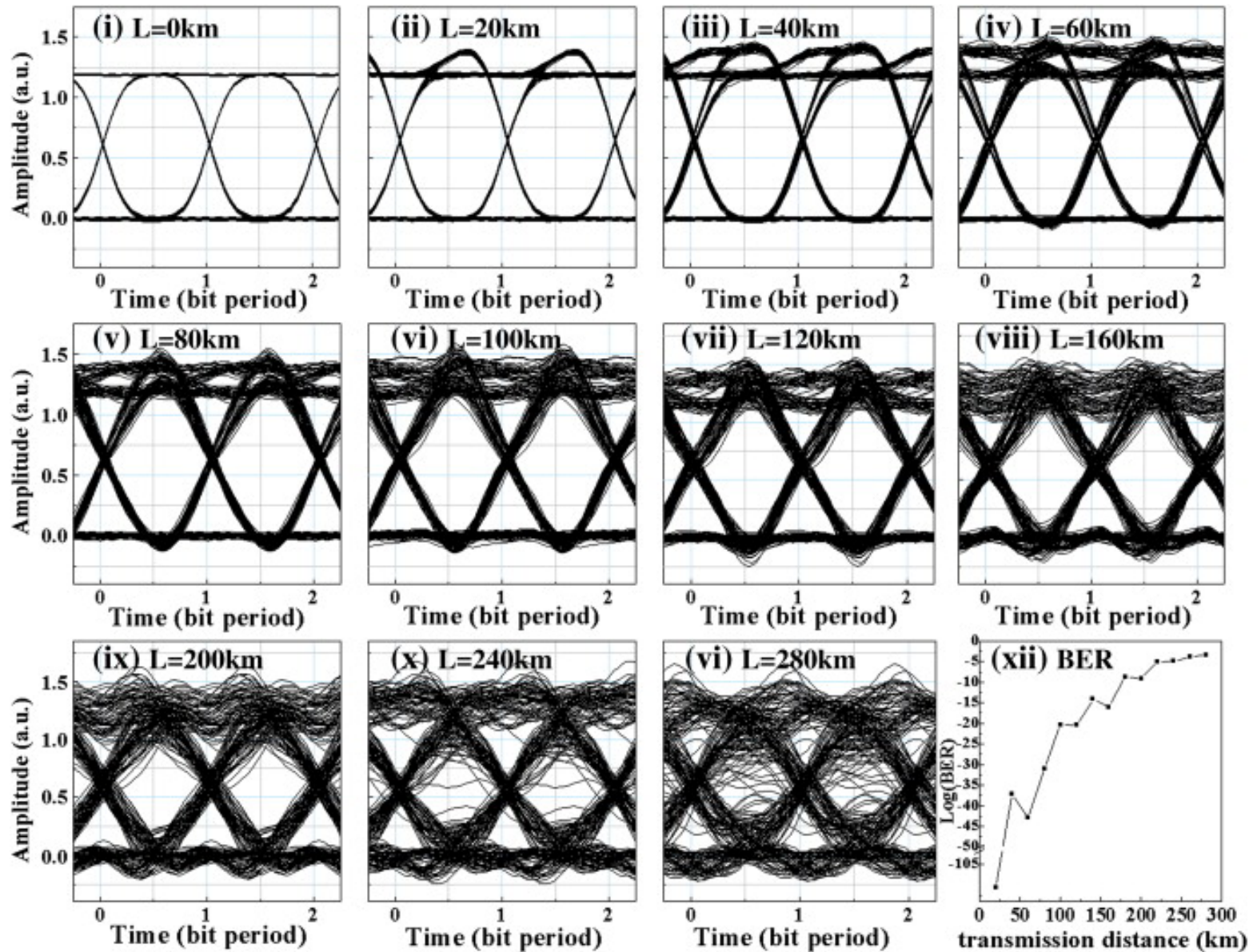
16 Ch.

100+ Ch.

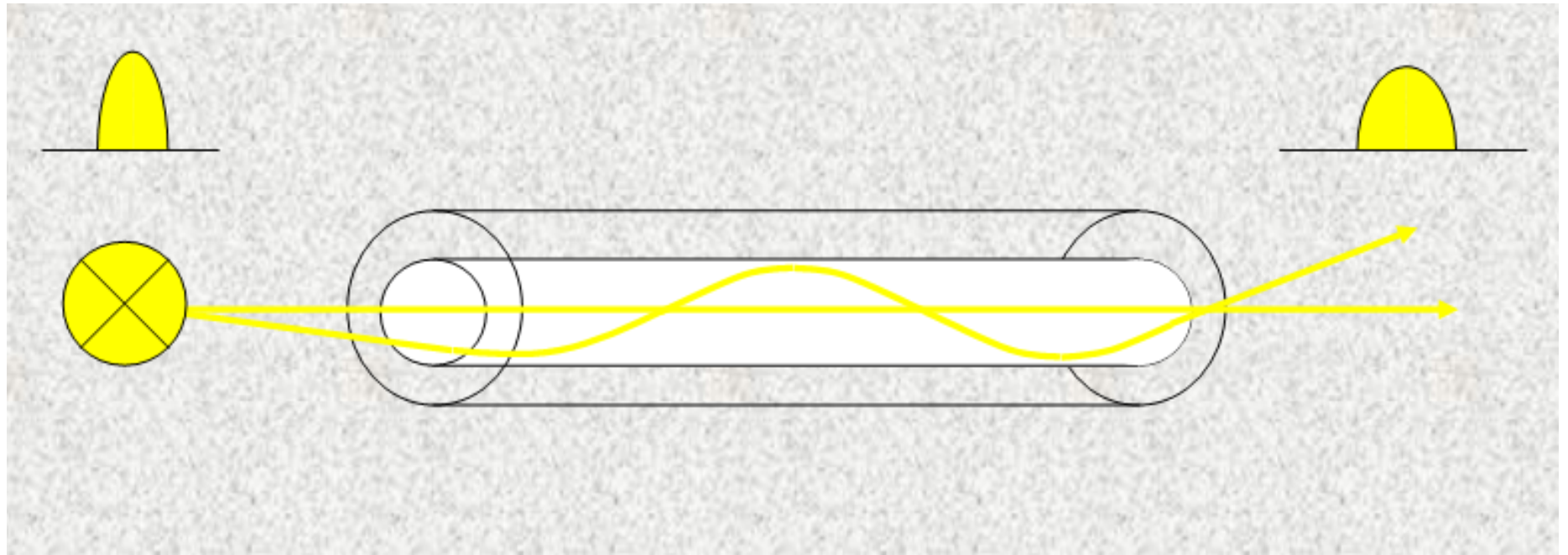
Dispersion

- Broadening of the light pulses caused by
 - Path differences
 - modal dispersion
 - polarisation mode dispersion (PMD)
 - Spectrum of light source
 - chromatic dispersion
 - material dispersion
 - waveguide dispersion

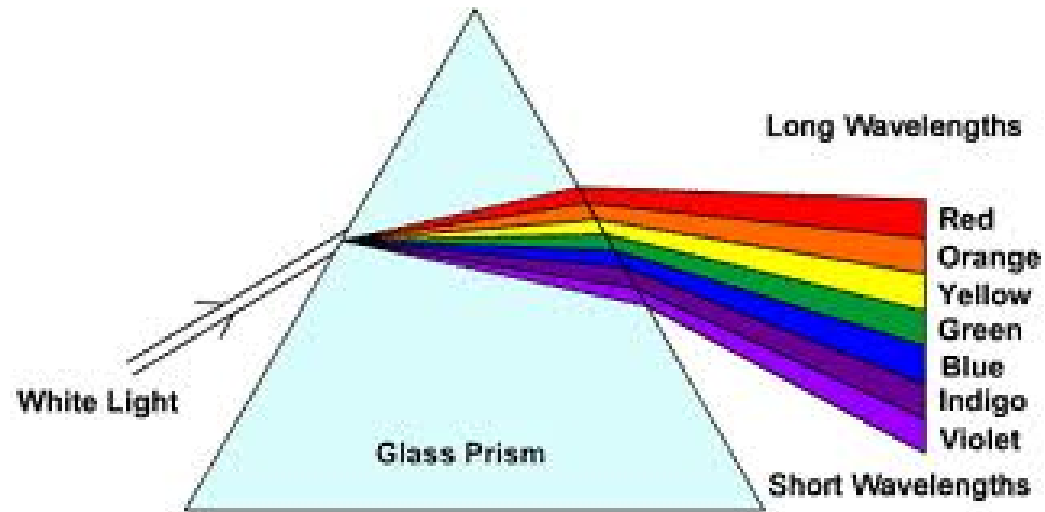
Impact of Dispersion



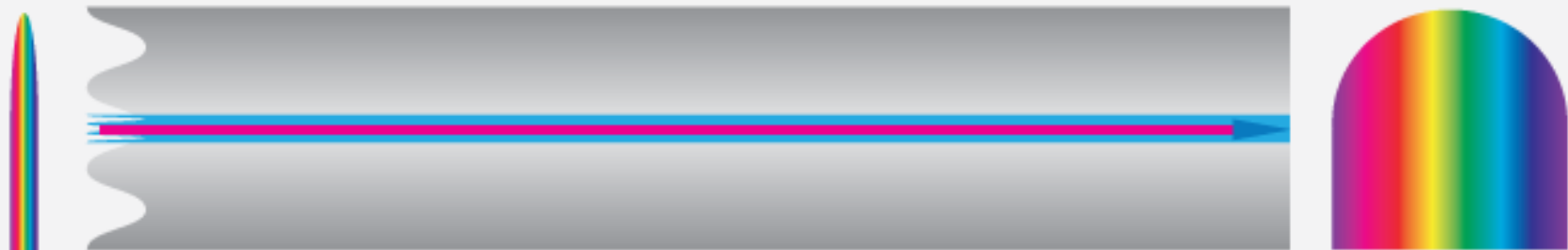
Modal Dispersion



Chromatic dispersion

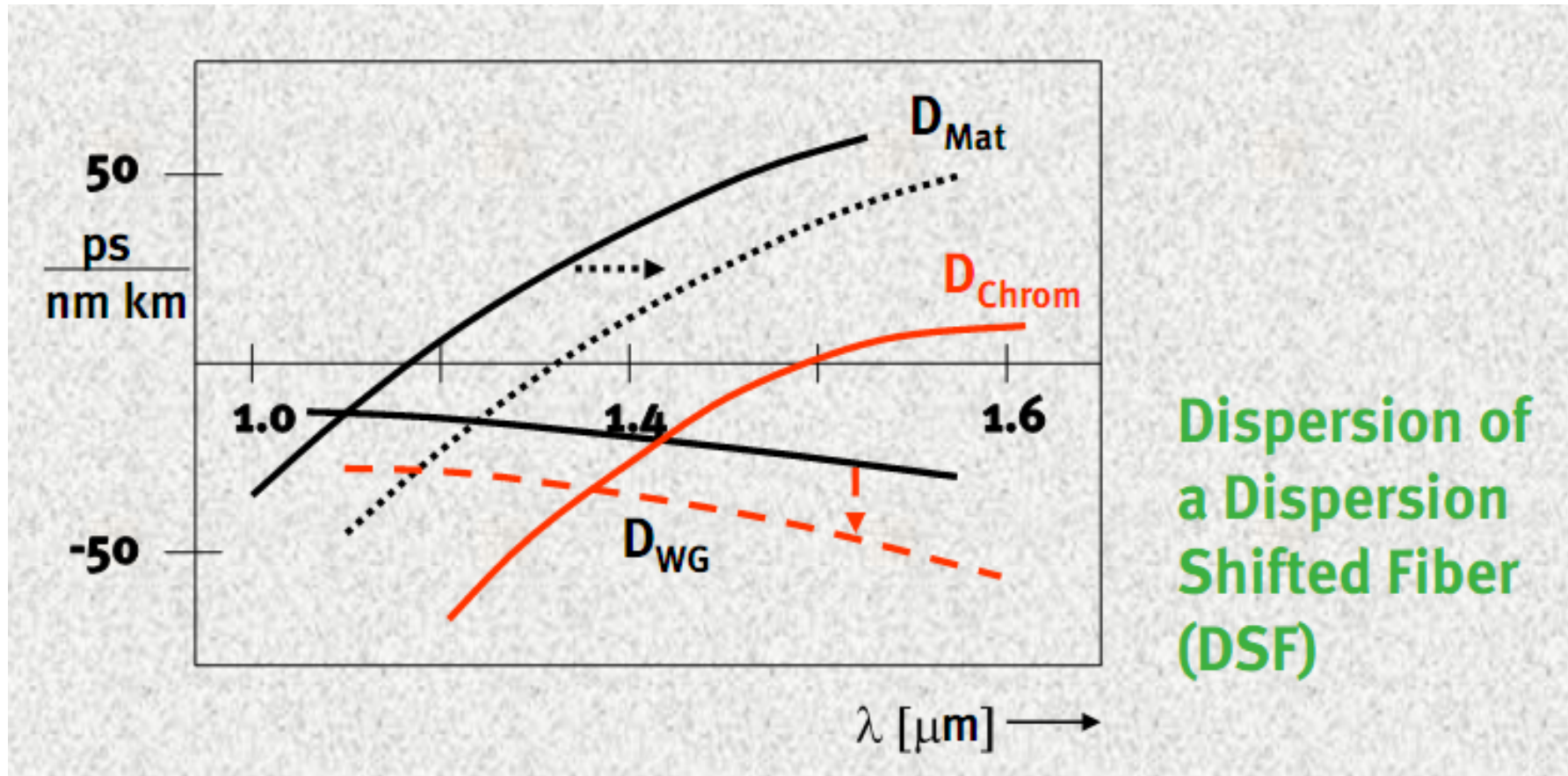


PULSE BROADENING EFFECT DUE TO CHROMATIC DISPERSION



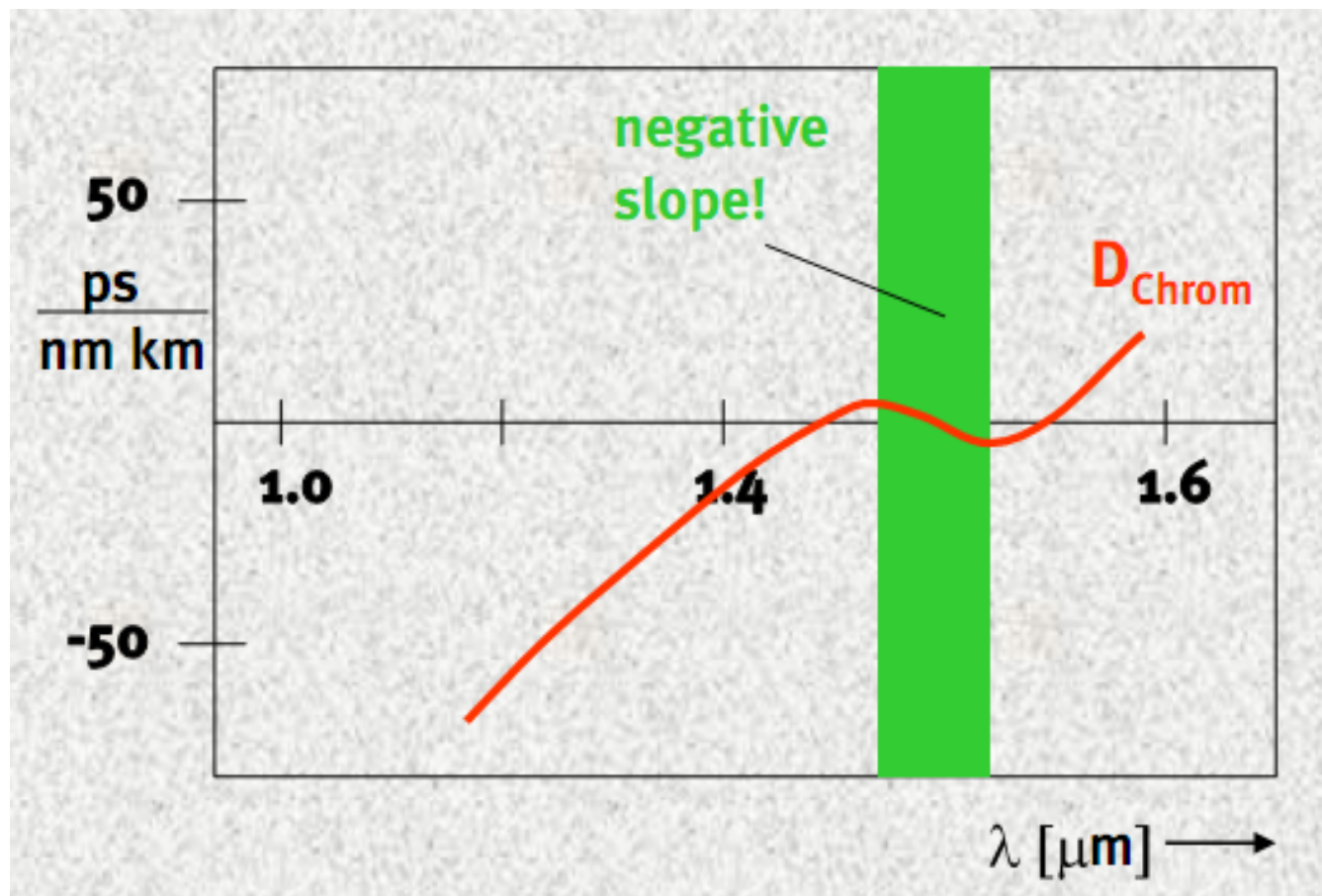
Longer Wavelengths travel faster

Playing with Chromatic Dispersion

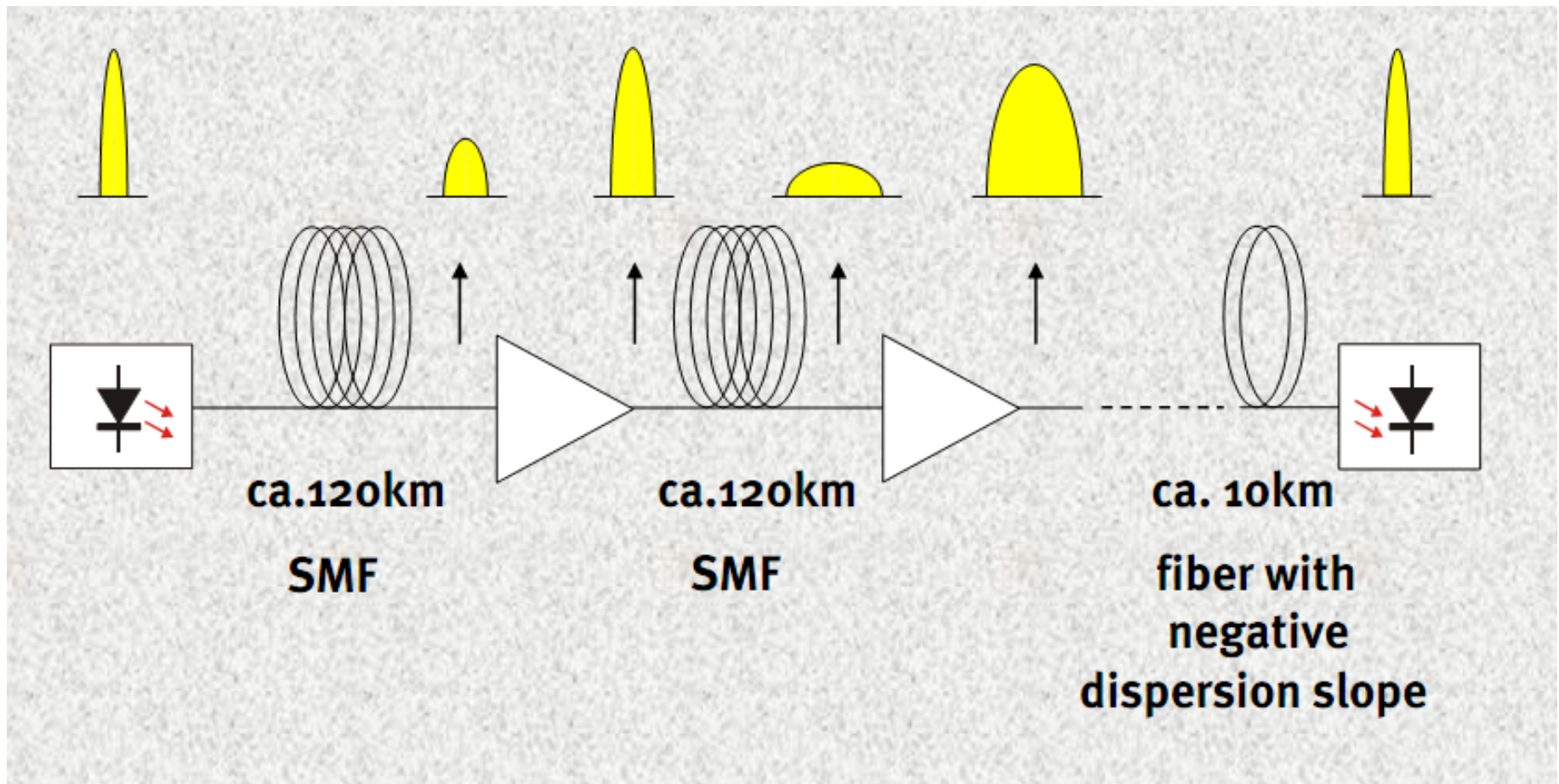


Fibers for Dispersion Compensation

- Negative Chromatic dispersion

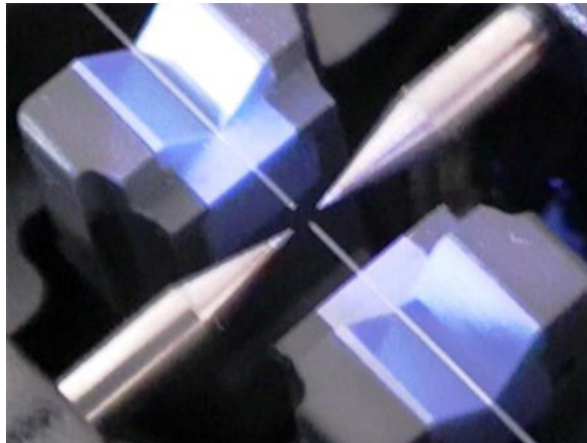


Optical Pulse Reshaping

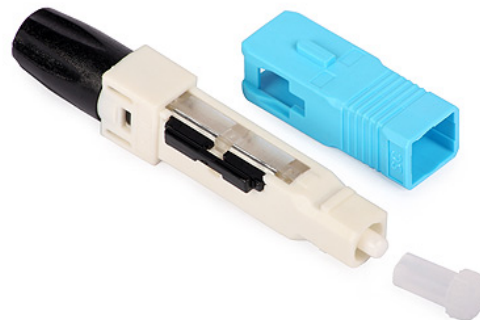


Fiber Splicing

- Fusion splicing



- Mechanical Splicing

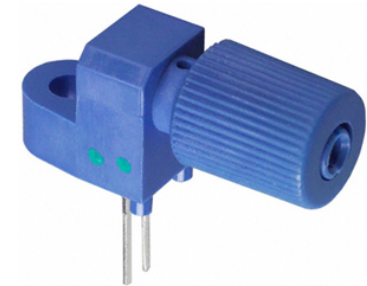


Fiber Communication TX

- Two light source classes

- LEDs

- Lower power, short reach, wider spectrum, multi-mode, WAN, LAN, cheap.
 - GaAs, GaAsP



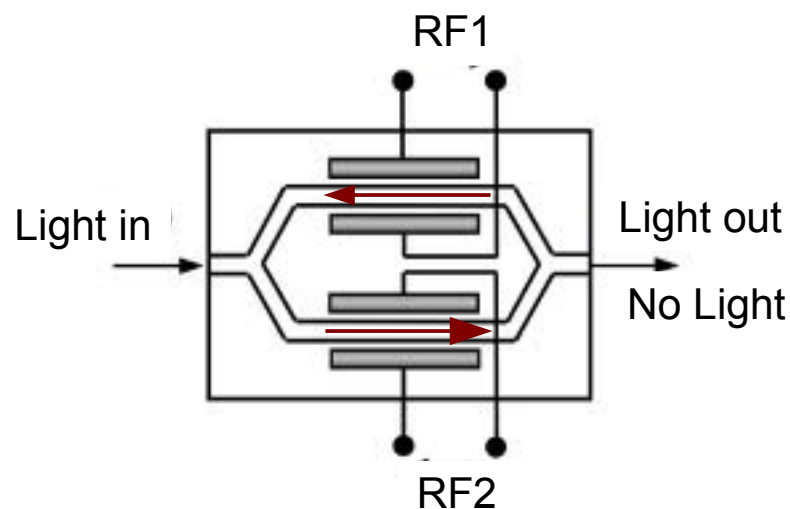
- Lasers

- Higher power, tunable, narrow spectrum, longer reach, single-mode, more costly.
 - VCSEL, DFB, F-P, etc...



Fiber Communication TX

- Modulation
 - Direct (CW on-off of light source)
 - Chirp/stability, speed issues
 - Using external Mach-Zender modulator
 - Also called optical interferometer
 - Laser always on, phase shifting to cancel out light.



Fiber Communication Rx

- Photodetectors
 - Semiconductor-based photodiode
 - PIN, Avalanche
 - Broadband by nature.
 - Coupled to a Trans-impedance Amplifier with large gain-bandwidth

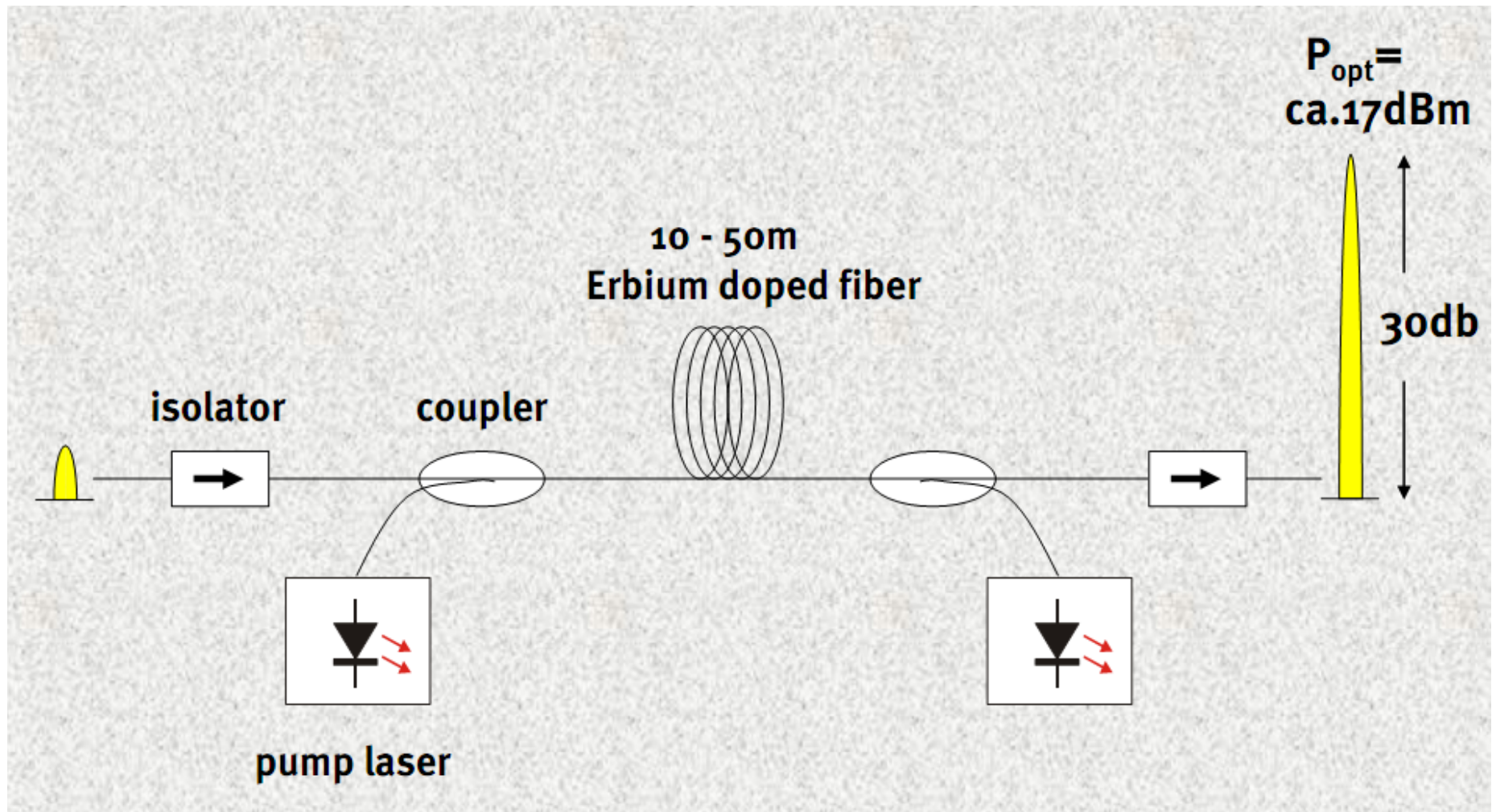


Transceivers

- Pluggable, standardized



Erbium-Doped Fiber Amplifier (EDFA)

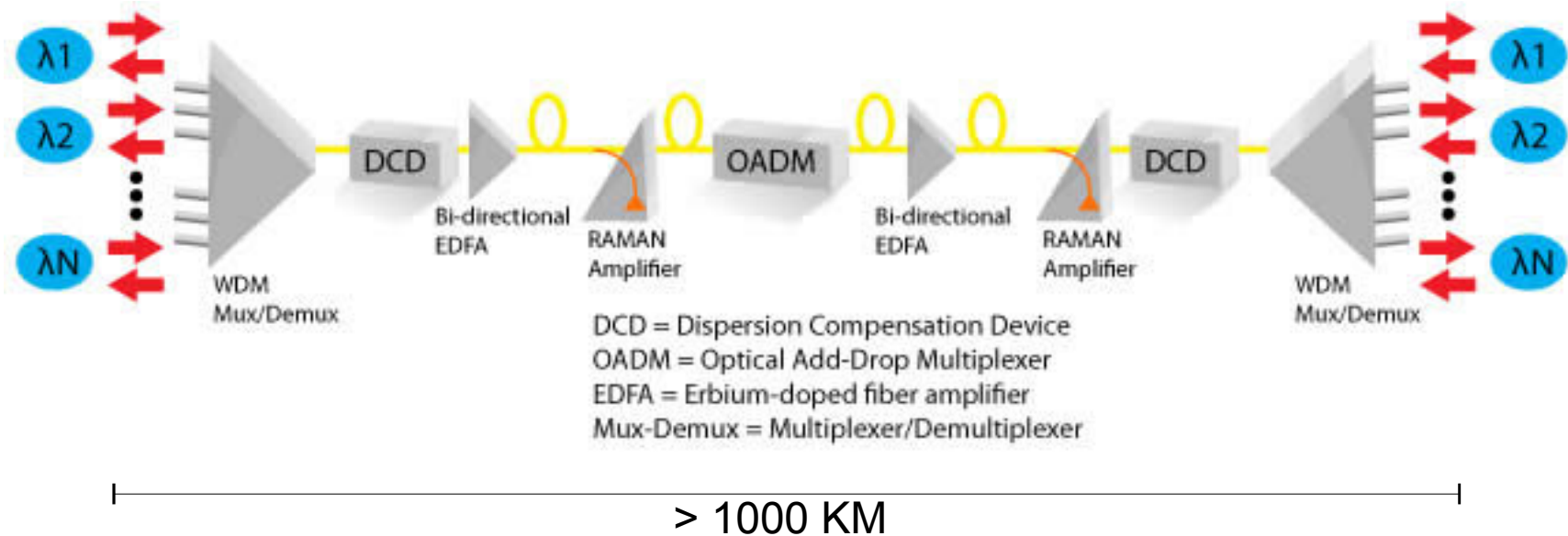


A Typical Terminal Shelf

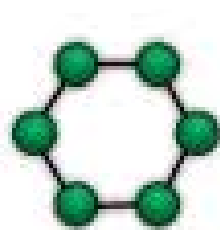


Communication Systems

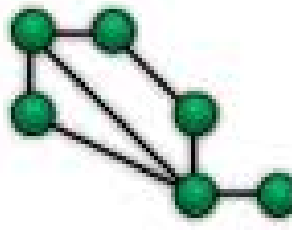
- Typical optical link



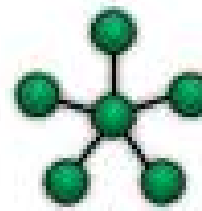
Network topologies



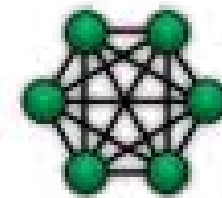
Ring



Mesh



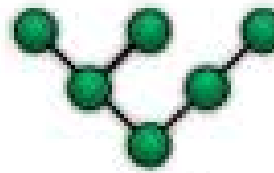
Star



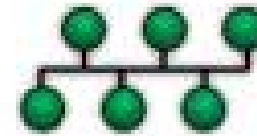
Fully Connected



Line



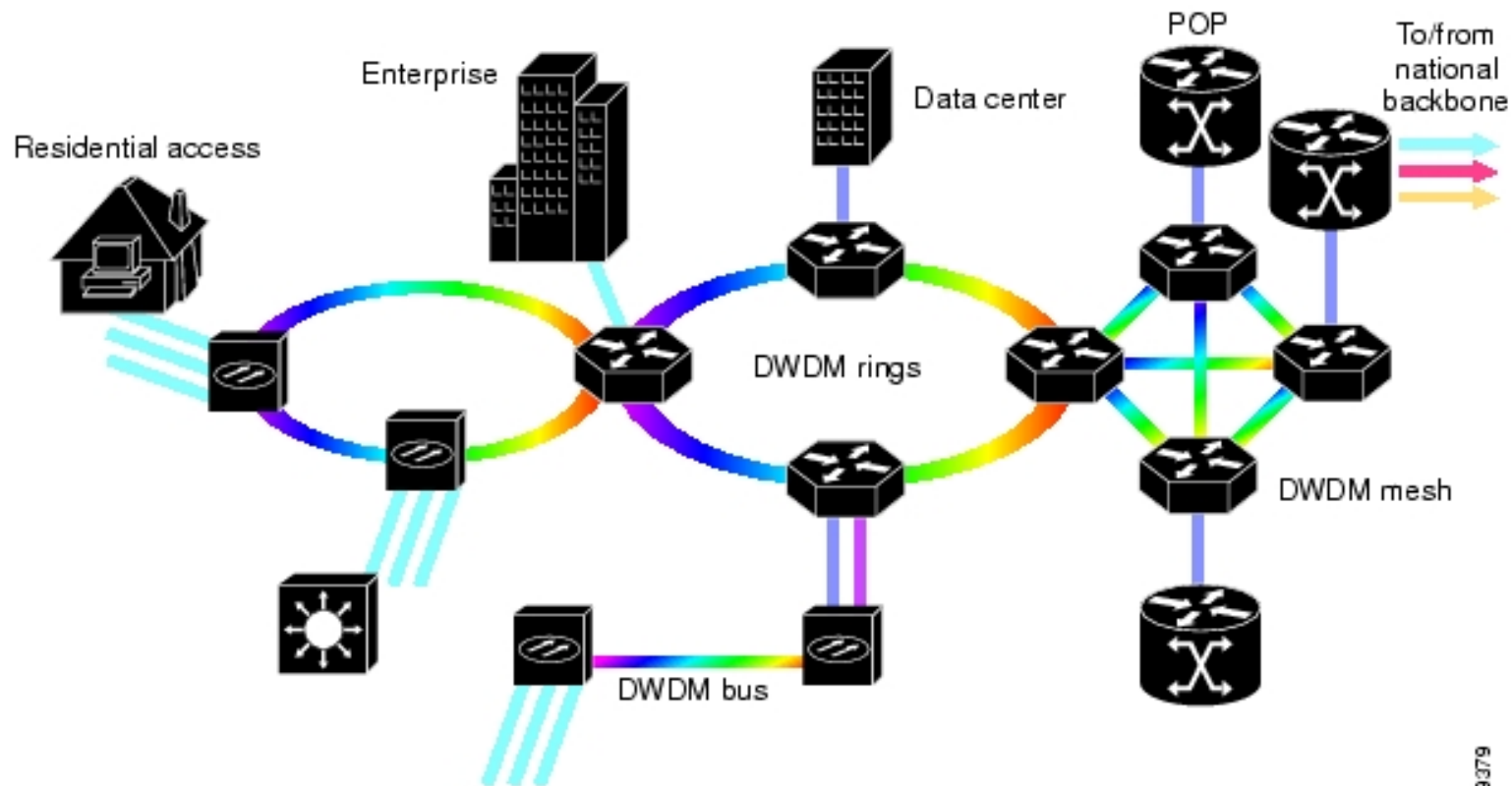
Tree



Bus

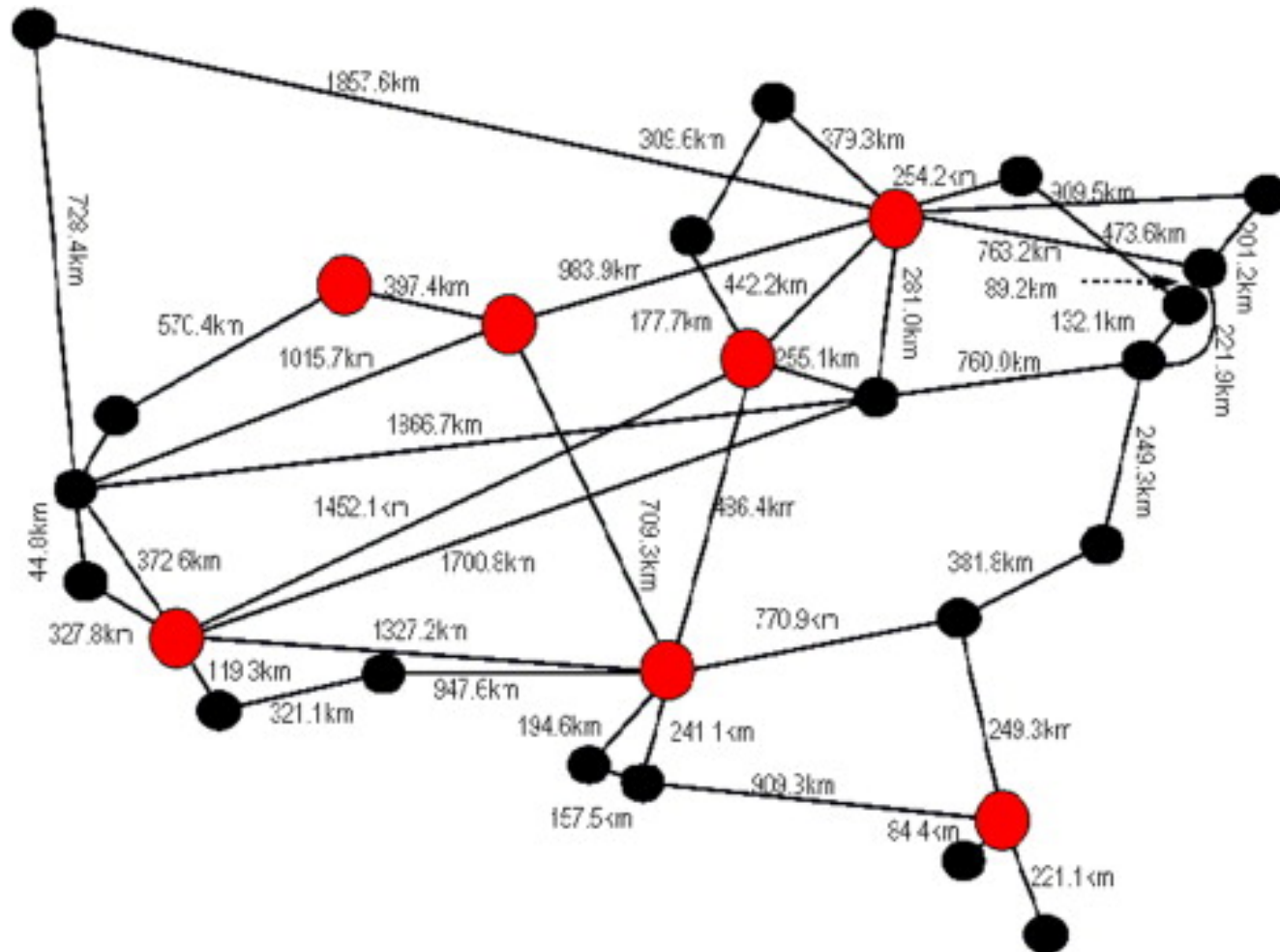
Network Classes

- Metropolitan



Network Classes

- Long Haul



Network Classes

- Submarine (Ultra-Long-Haul)

