Hochschule Wismar
University of Applied Science
Departement of
Electrical Eng. and
Computer Science

Fundamentals of Optical Communications

Referent:
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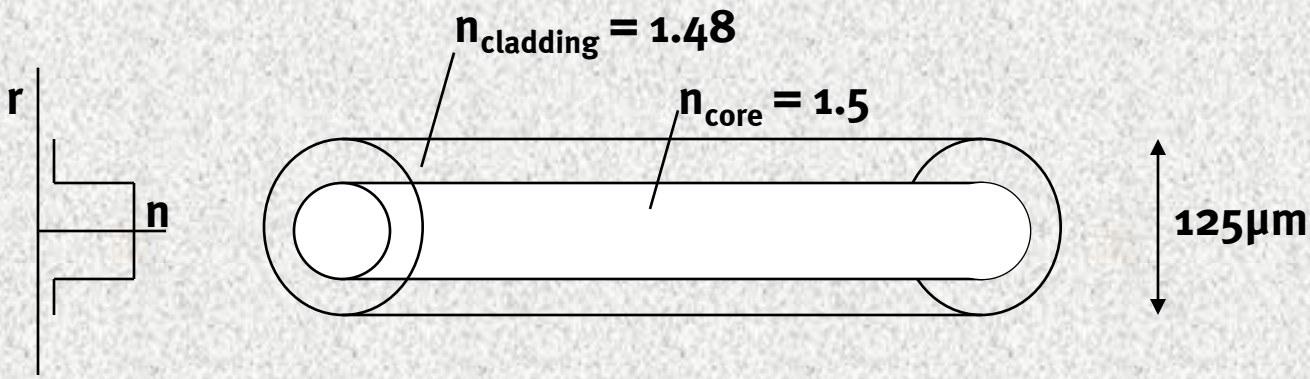
Why Optical Fibres ...

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

Multi-utilization results in high efficiency !

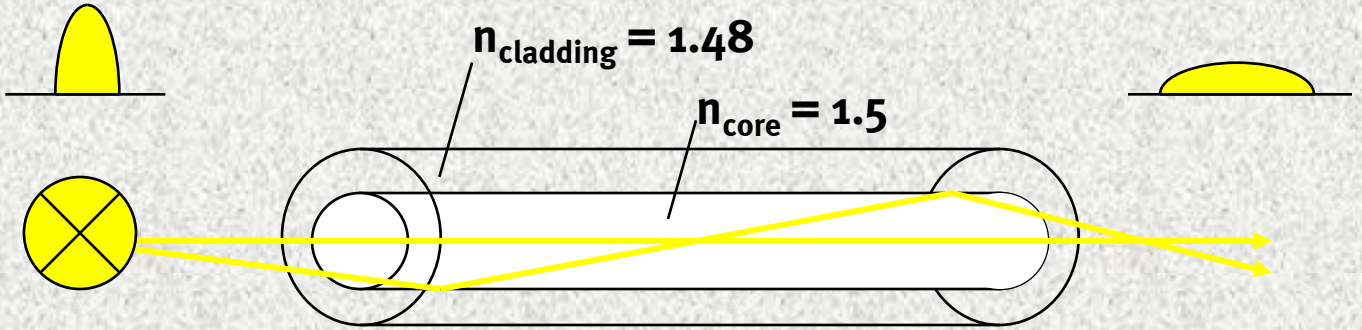
Pinciple

Fiber Structure and Light Guiding Mechanism



Step Index (SI) Fiber

Fiber Structure and Light Guiding Mechanism

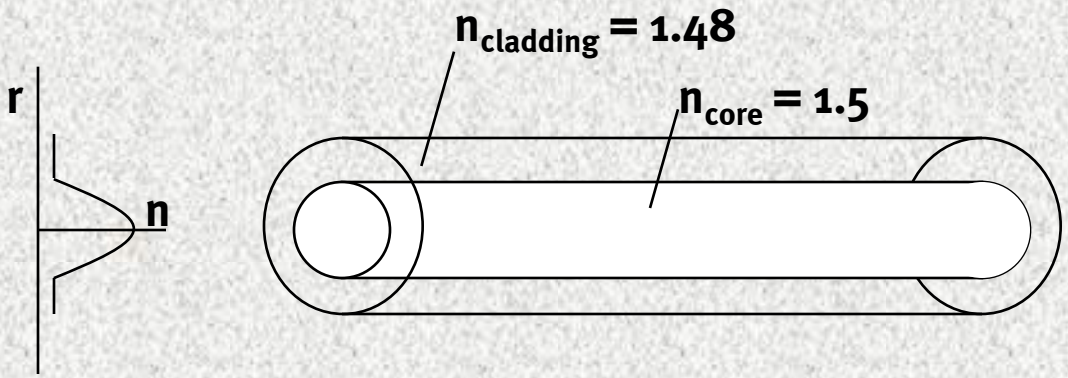


Step Index (SI) Fiber

- high dispersion › 100 ns/km

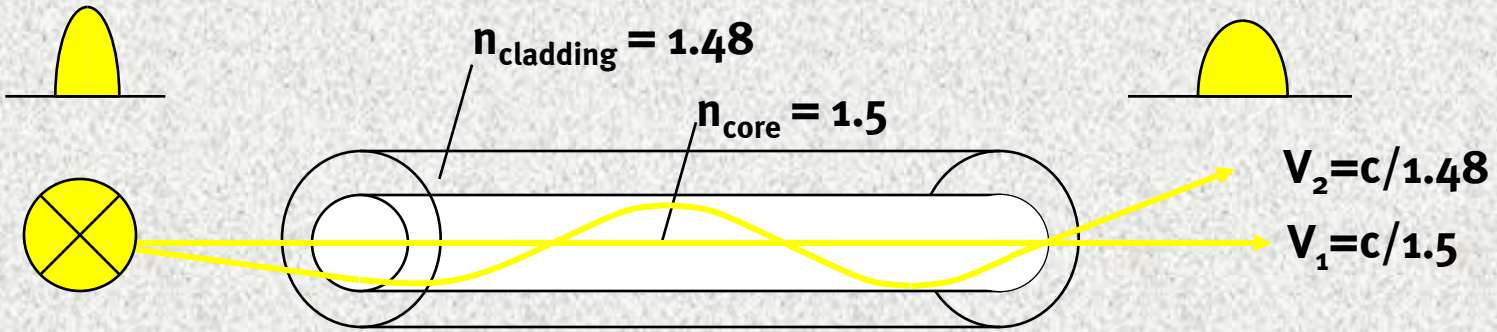
- attenuation ca. 1...15 dB/km

Fiber Structure and Light Guiding Mechanism



Gradient Index (GI) Fiber

Fiber Structure and Light Guiding Mechanism

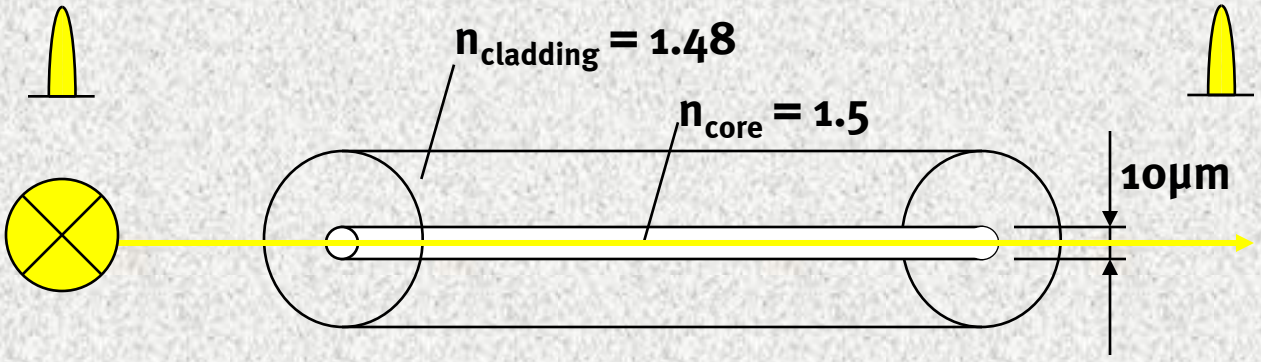


Gradient Index (GI) Fiber

- low dispersion › 2 ns/km

- attenuation ca. 1...3 dB/km

Fiber Structure and Light Guiding Mechanism

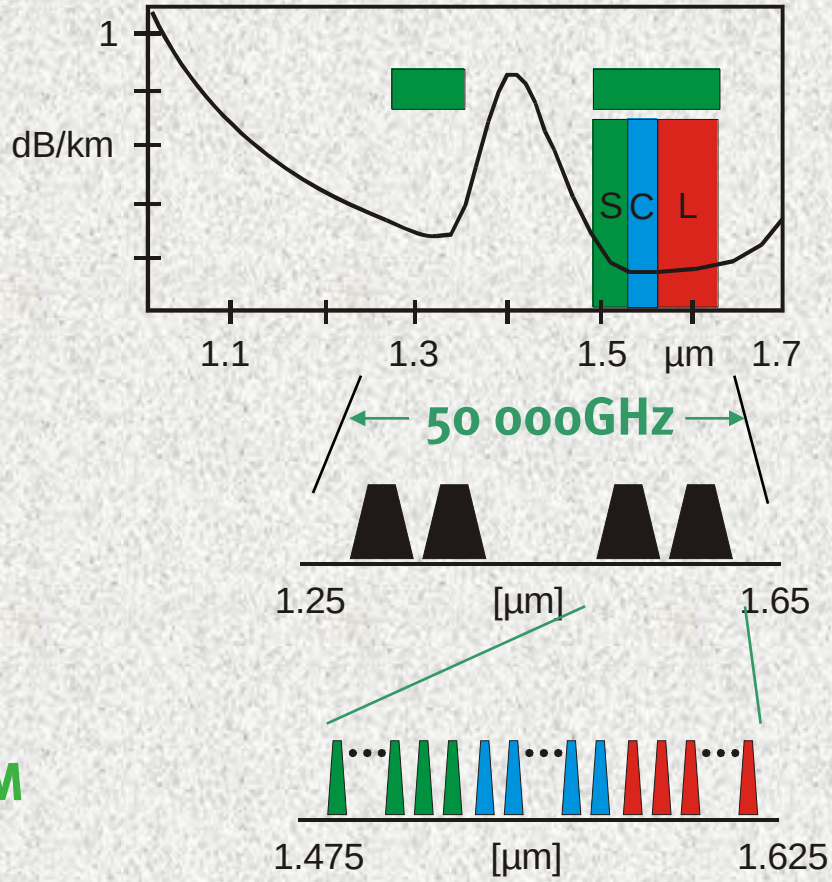


Single Mode (SM) Fiber

- almost no dispersion › 18ps/nm km

- attenuation ca. 0.2 dB/km

Fiber attenuation and optical windows



- WDM
- DWDM

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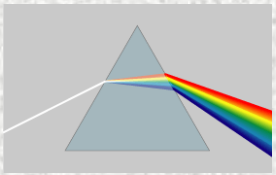
Dispersion:

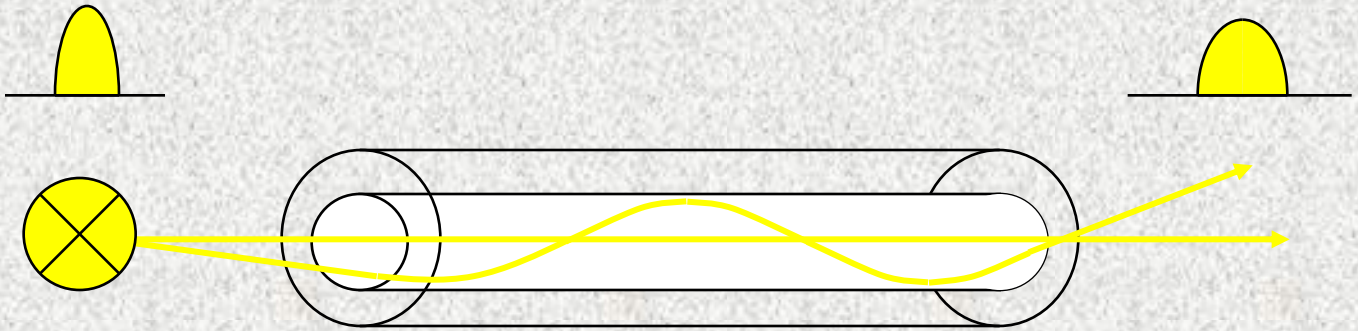
due to:

- **„path differences“** → **modal dispersion (intermodal dispersion)**
  - ↓ **polarisation mode dispersion (PMD)**
- **spectrum of light source** → **chromatic dispersion (intramodal dispersion)**



- ↙ **material dispersion**
- ↓ **waveguide dispersion**

Modal Dispersion:

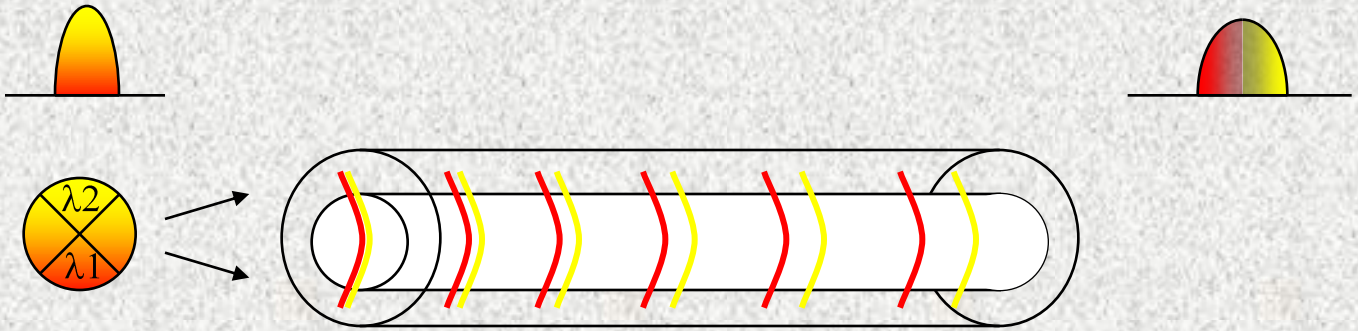


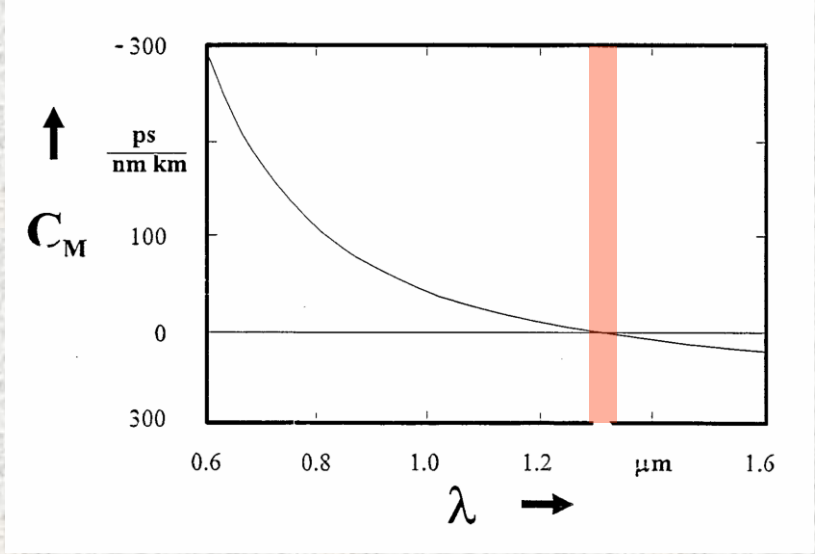
$$C_{modal,SI} \approx \frac{NA^2}{4\sqrt{3} \cdot n_1 \cdot c}$$

$$C_{modal,GI} \approx \frac{NA^4}{80\sqrt{3} \cdot n_1^3 \cdot c}$$

$$with \quad NA = \sqrt{n_1^2 - n_2^2}$$

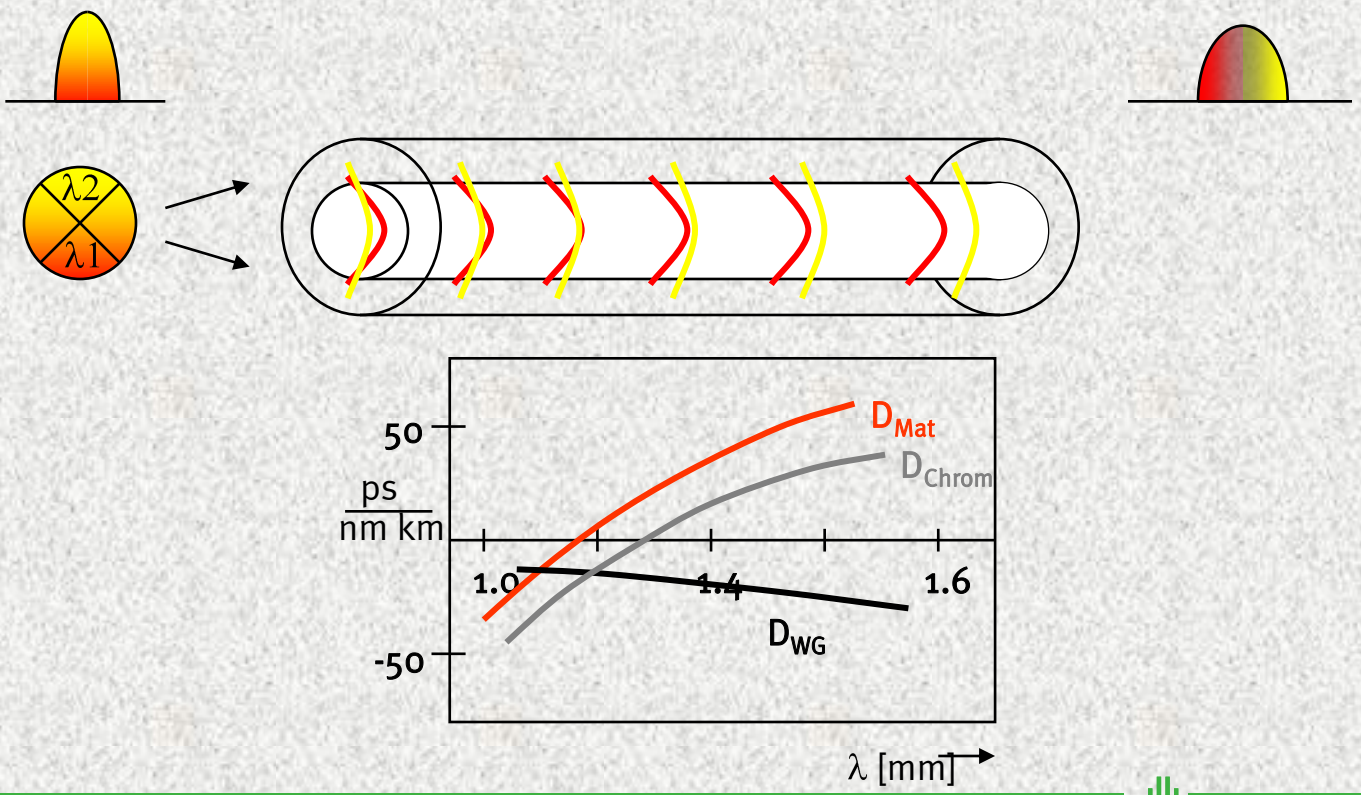
Material Dispersion:





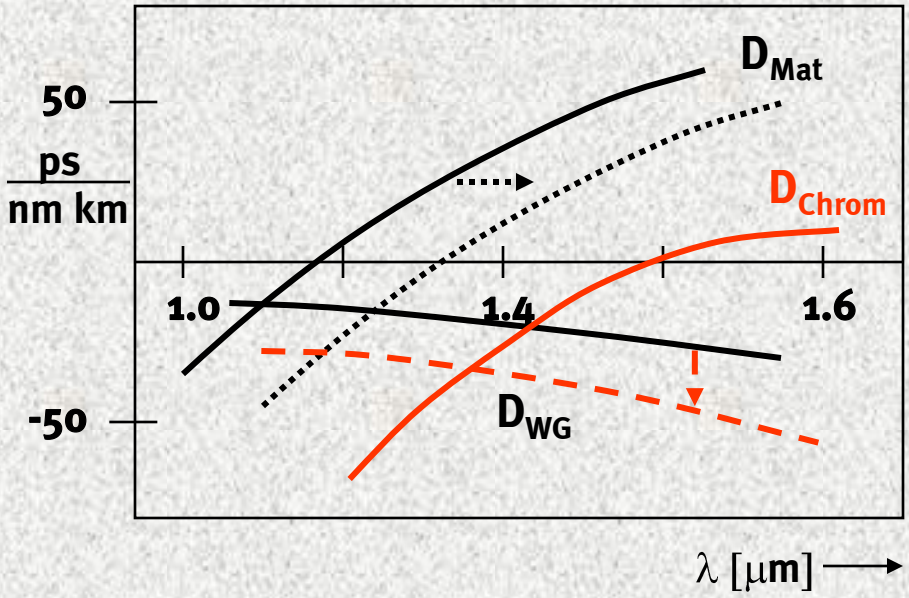
Waveguide Dispersion:

- can be neglected in multimode fibers
- caused by the different extension of LP01 into the cladding b(λ) leading to a wavelength dependent effective refractive index:



Fiber dispersion of DSF

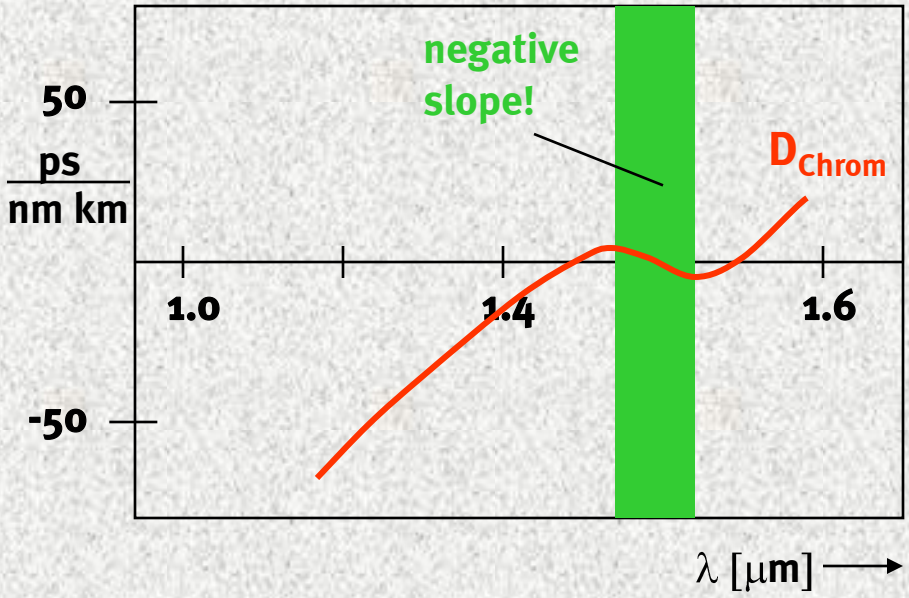
Chromatic dispersion :



Dispersion of a Dispersion Shifted Fiber (DSF)

Fibers for dispersion compensation

Chromatic dispersion :



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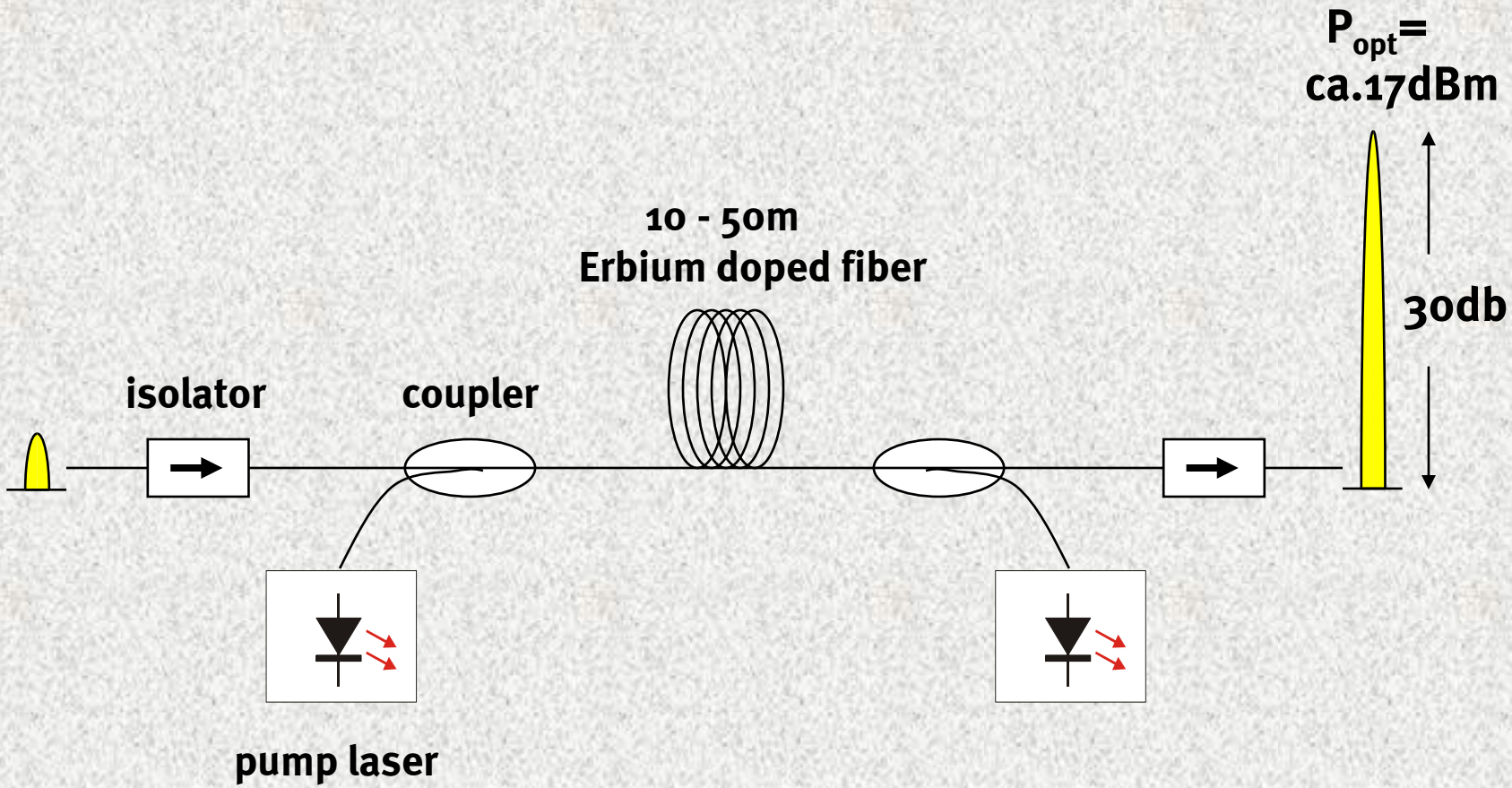
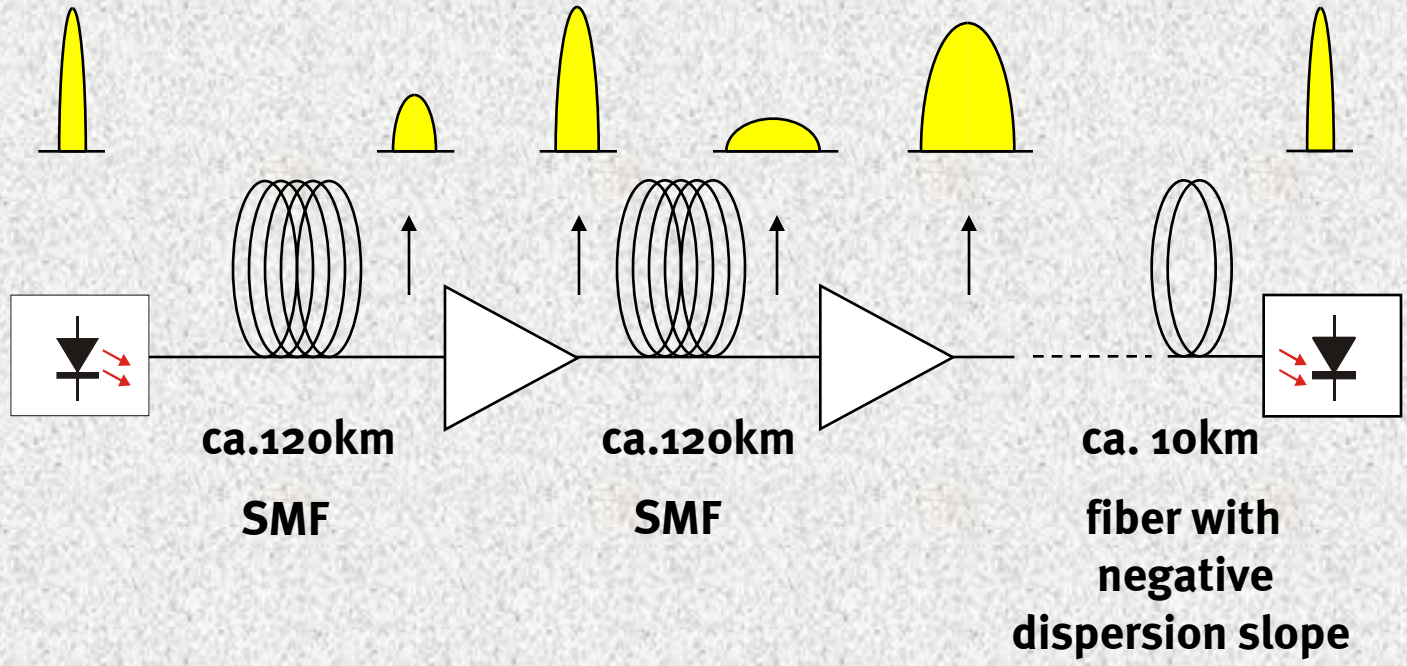
Erbium Doped Fiber Amplifier (EDFA)



Optical pulse reshaping



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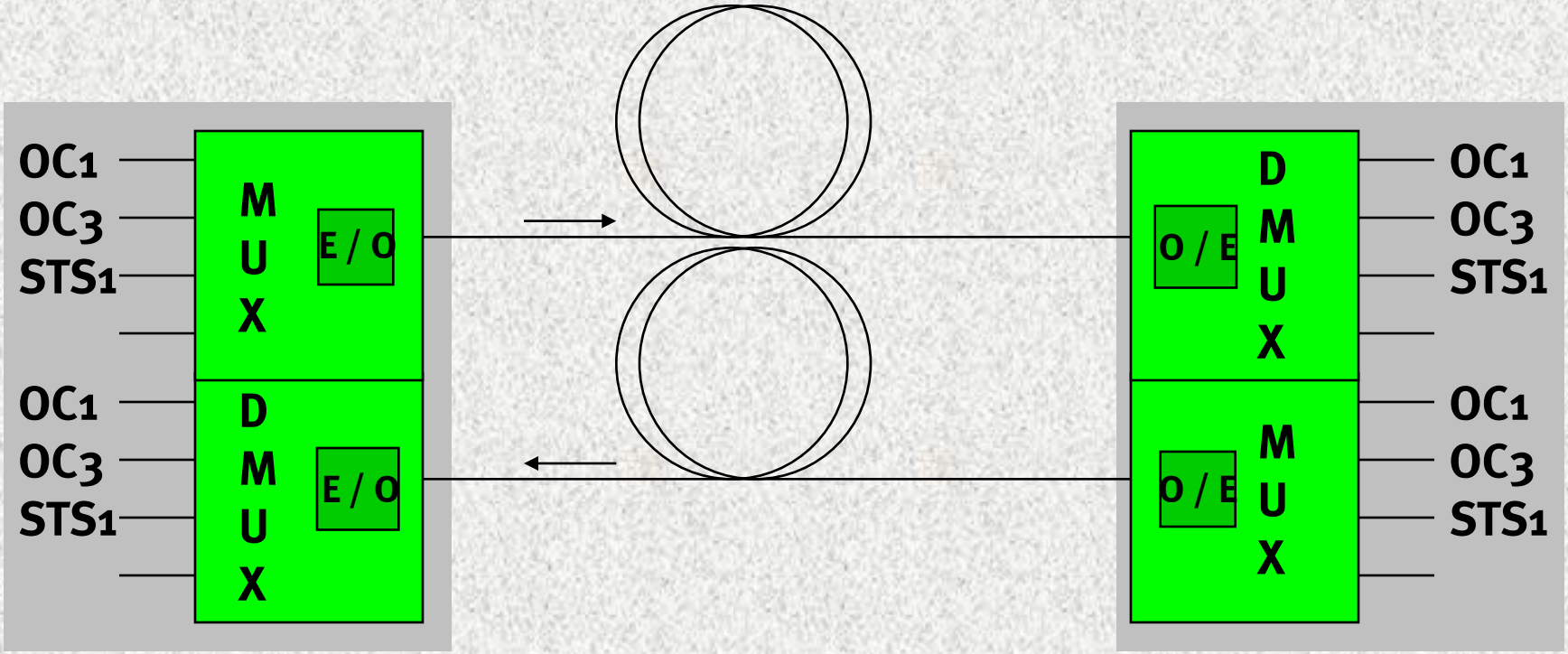
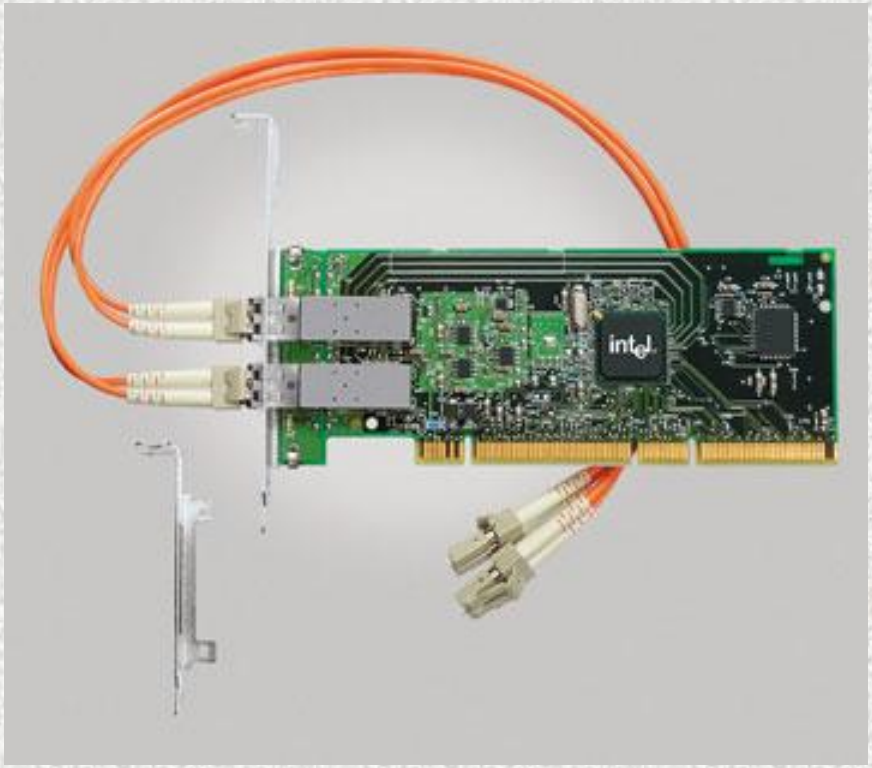
How does it work ?

Point-to-point:



How does it work ?

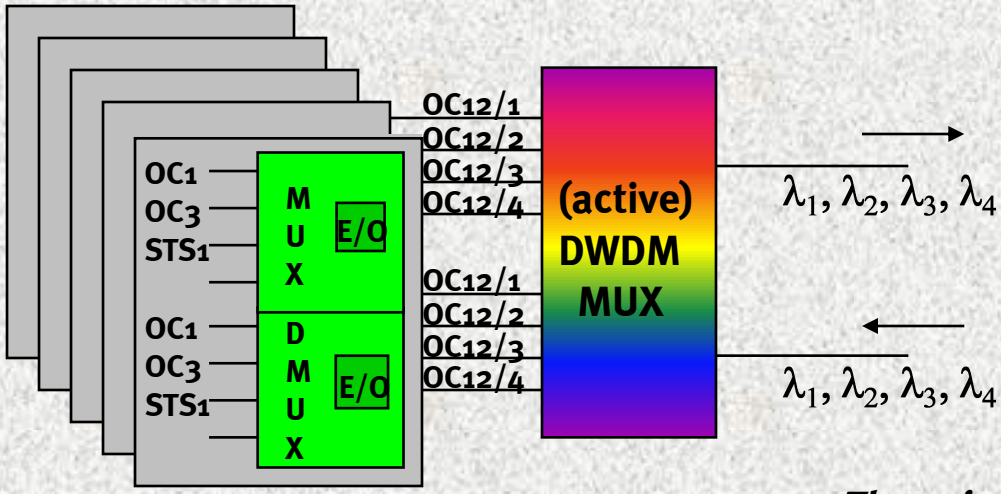
- ***Point-to-point:***



ATM/Ethernet/SDH line board

How does it work ?

- λ – ***MUX, but still point-to-point:***



- ***3 Tbps via 50km (2/1999)***
  10.9 Tbps via 117km (9/2001)

How does it work ?

- λ – ***MUX, but still point-to-point:***

Wave Line EL2:
32channels, 200GHz spacing

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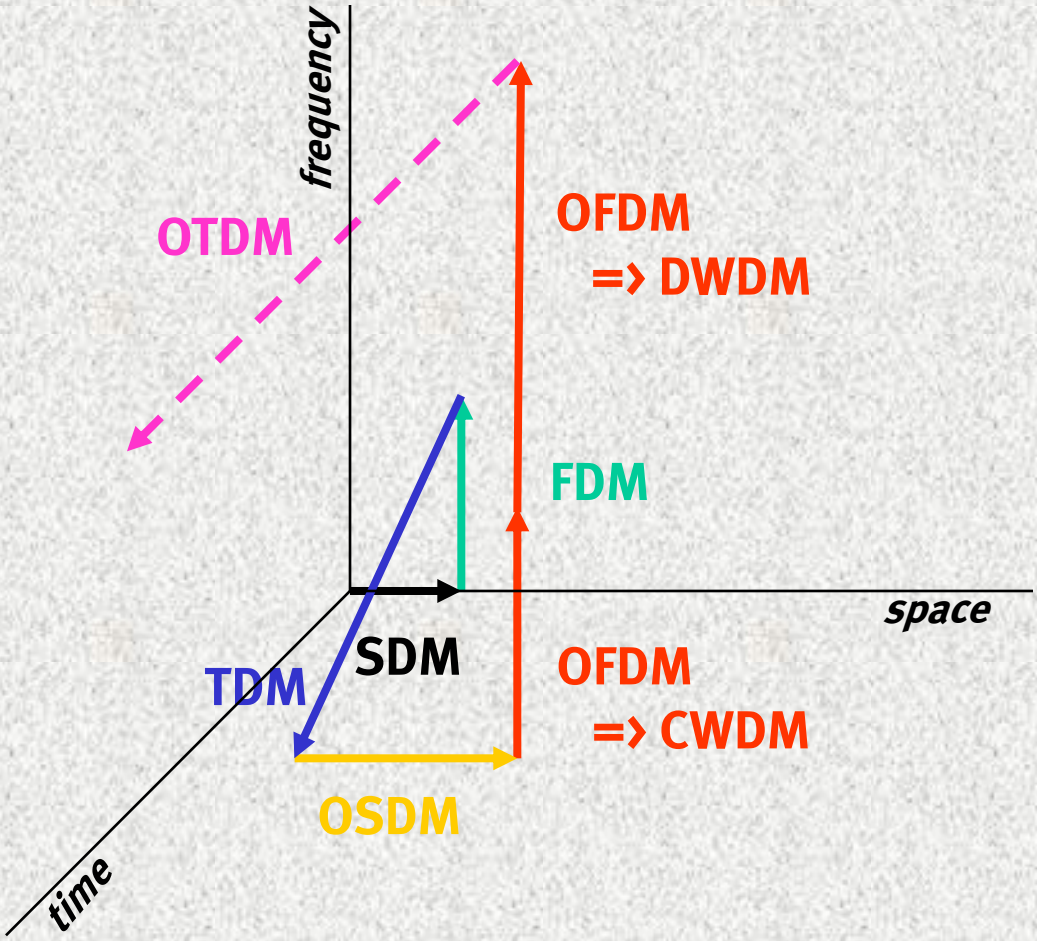
MUX-Generations



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Thank you for listening to

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