Optoelectronică, structuri şi tehnologii

Curs 6
2014/2015

Fotografii

Studentii care au trimis fotografiile

Grupa: 5402

Nr.	Nume
1	APETRII MARIA

Grupa: 5403

Nr.	Nume
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Grupa: 5404

Nr.	Nume
1	APERGHIS MIHAI-ALIN

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Studentii care inca nu au trimis fotografiile

Grupa: 5304

Nr.	Nume

Grupa: 5402

Nr.	Nume

Grupa: 5403

Nr.	Nume

Grupa: 5404

Nr.	Nume

Reprezentare logaritmică

dB = $10 \cdot \log_{10} (P_2 / P_1)$

dBm = $10 \cdot \log_{10} (P / 1\ mW)$

0 dB	= 1	0 dBm	= 1 mW
+ 0.1 dB	= 1.023 (+2.3%)	3 dBm	= 2 mW
+ 3 dB	= 2	5 dBm	= 3 mW
+ 5 dB	= 3	10 dBm	= 10 mW
+ 10 dB	= 10	20 dBm	= 100 mW
−3 dB	= 0.5	−3 dBm	= 0.5 mW
−10 dB	= 0.1	−10 dBm	= 100 μW
−20 dB	= 0.01	−30 dBm	= 1 μW
−30 dB	= 0.001	−60 dBm	= 1 nW

[dBm] + [dB] = [dBm]

[dBm/Hz] + [dB] = [dBm/Hz]

[x] + [dB] = [x]

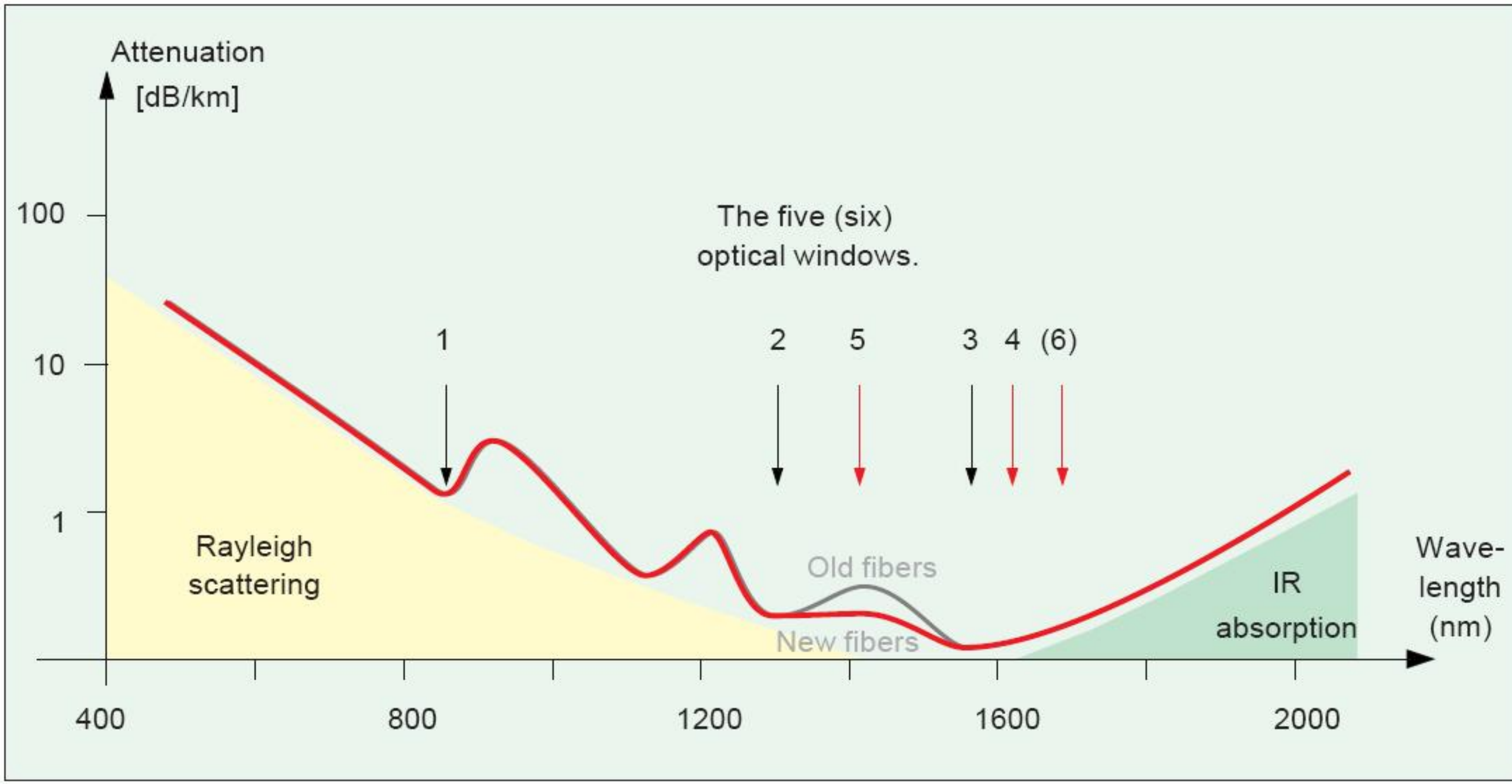
Fibra optică

Capitolul 5

ATENUAREA

- Macrocurburi
- Microcurburi
- Imprastiere
- Absorbtie

Absorbtie



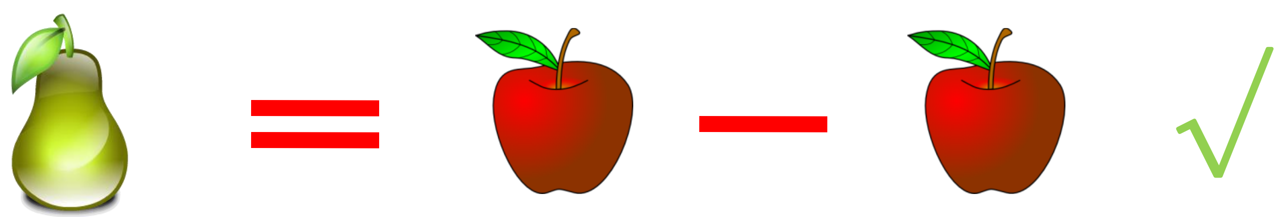
Attenuation
[dB/km]
100
10
1
The five (six)
optical windows.
1
2
5
3
4
(6)
Rayleigh
scattering
Old fibers
New fibers
IR
absorption
Wave-
length
(nm)
400
800
1200
1600
2000

Calculul atenuarii

$$\text{Pierderi} = \frac{P_{out}}{P_{in}}$$

$$\text{Pierderi}[\text{dB}] = [-]10 \cdot \log_{10}\left(\frac{P_{out}}{P_{in}}\right)$$

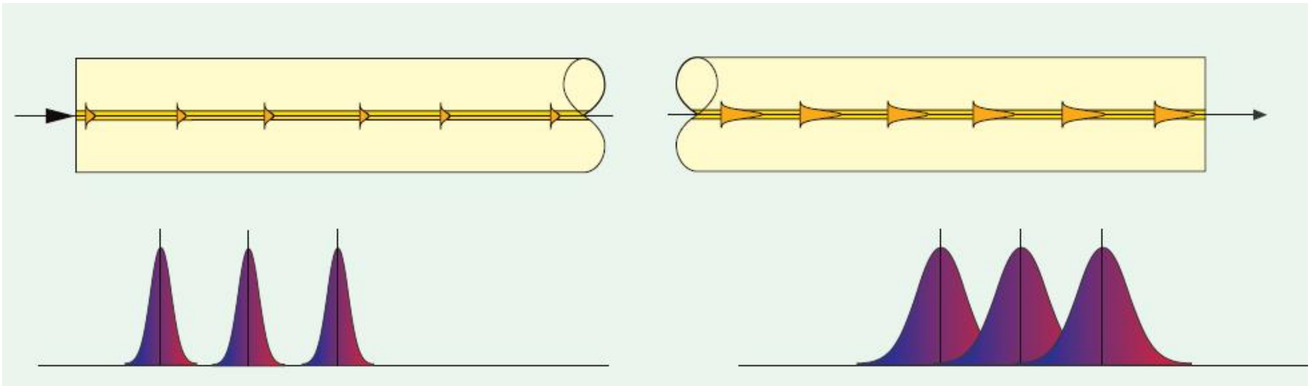
$$\text{Pierderi}[\text{dB}] = [-]\left(P_{out}[\text{dBm}] - P_{in}[\text{dBm}]\right)$$



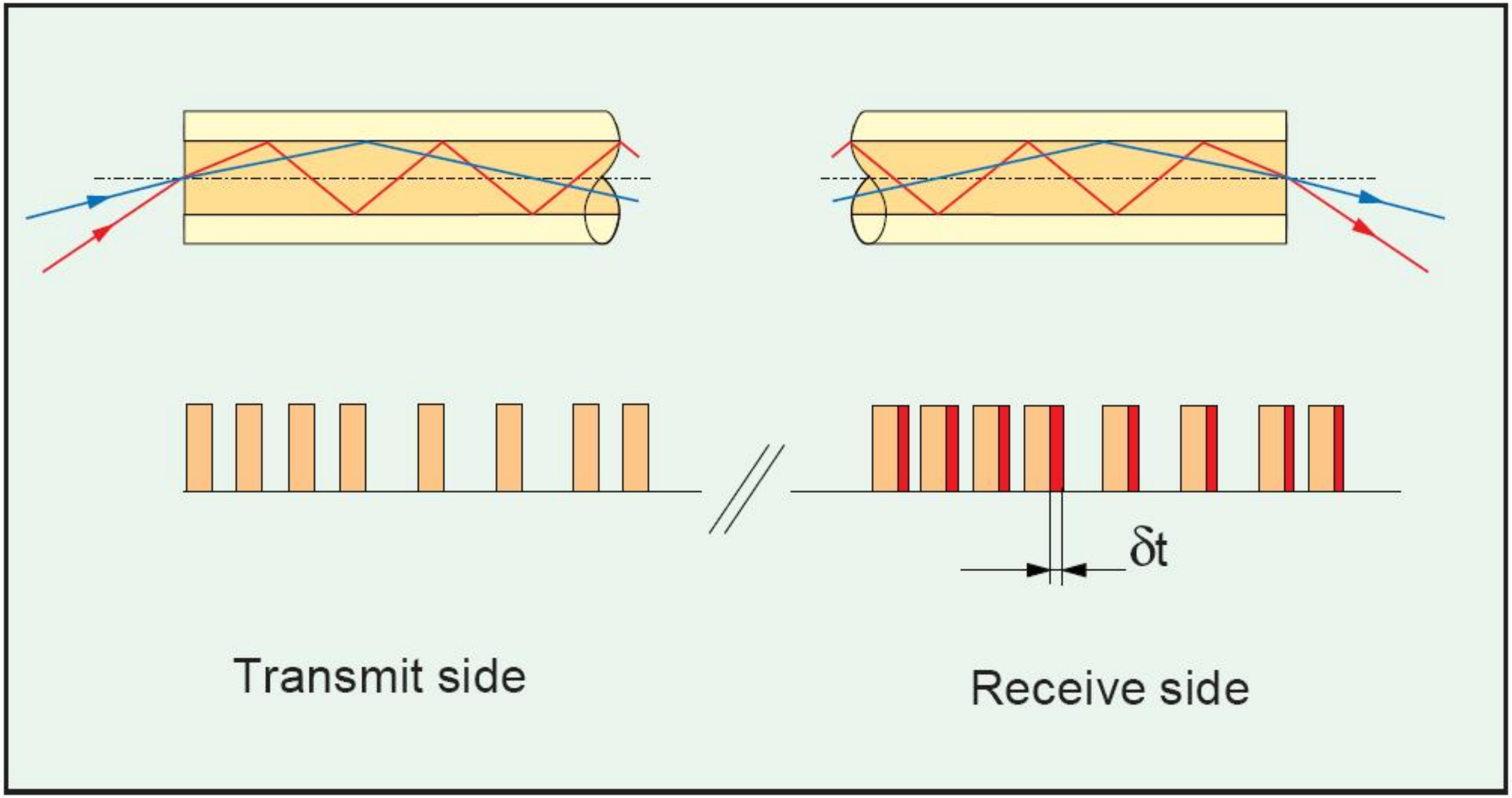
$$\text{Atenuare}[\text{dB/km}] = \frac{\text{Pierderi}[\text{dB}]}{\text{lungime}[\text{km}]}$$

Dispersia

- Propagarea cu viteze diferite a radiatiilor cu lungimi de unda diferite
  - intermodala (modala – depinde de prezenta modurilor)
  - intramodala (cromatica – depinde de lungimea de unda)
    - de material
    - de ghid



Dispersia modala



Dispersia modala

- salt de indice

$$dt = \frac{L \cdot n_2^2}{c \cdot n_1}\left(\frac{n_2 - n_1}{n_2}\right) \approx \frac{L \cdot NA^2}{2 \cdot c \cdot n_2}$$

intarzierea intre moduri cand

$$\Delta = \frac{n_2 - n_1}{n_2} << 1$$

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

$$NA \cong n_2 \cdot \sqrt{2 \cdot \Delta}$$

$$\Delta\tau_{\mathrm{mod}}^2 = \frac{1}{3}\left(\frac{dt}{2}\right)^2$$

$$\Delta\tau_{\mathrm{mod}} \cong \frac{L \cdot n_2 \cdot \Delta}{2\sqrt{3} \cdot c} \approx \frac{L \cdot NA^2}{4\sqrt{3} \cdot c \cdot n_2}$$

- indice gradat

$$dt = \frac{L \cdot n_2 \cdot \Delta^2}{2c} \approx \frac{L \cdot NA^4}{8 \cdot c \cdot n_2^3}$$

$$\Delta\tau_{\mathrm{mod}} \cong \frac{L \cdot n_2 \cdot \Delta^2}{4\sqrt{3} \cdot c} \cong \frac{L \cdot NA^4}{16\sqrt{3} \cdot c \cdot n_2^3}$$

$$\Delta = 0.01 \div 0.02 << 1$$

$$NA = 0.1 \div 0.2 < 1$$

n_2 – miez

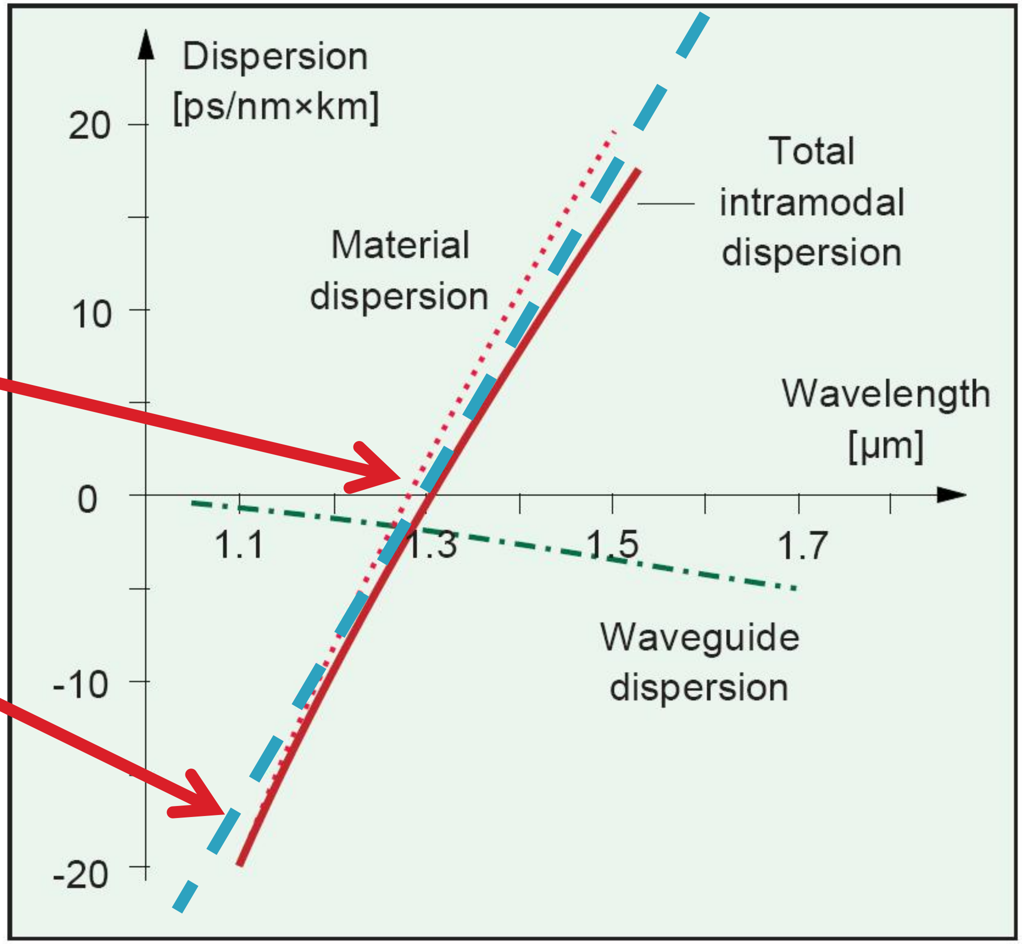
n_1 – teaca

$n_2 > n_1$!!

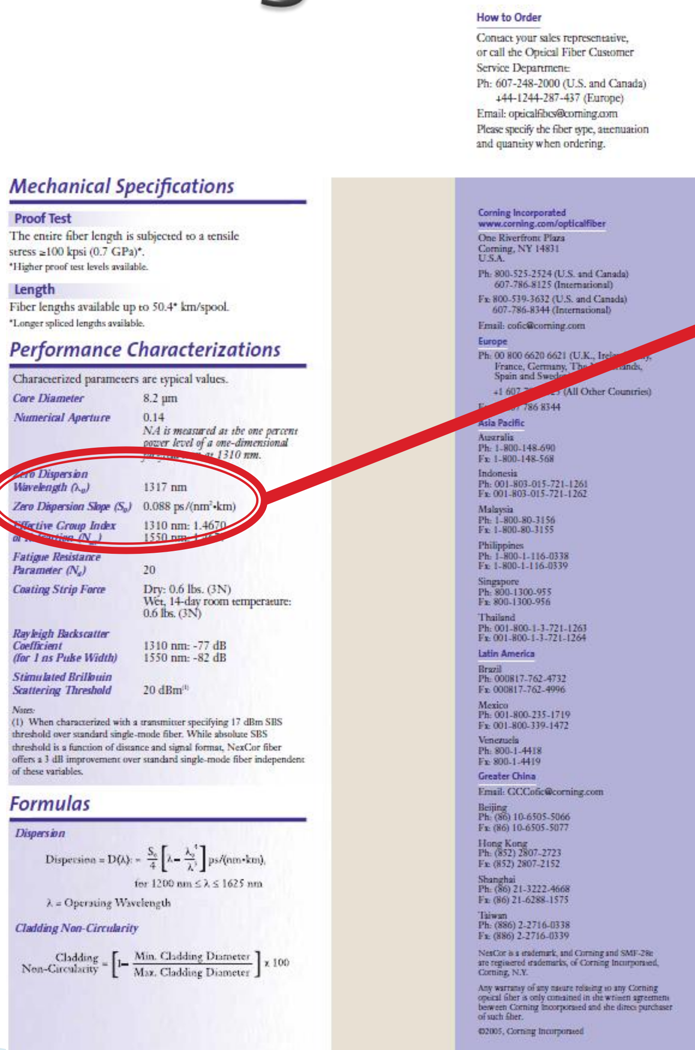
Dispersia de material (λ)

$$\Delta\tau_{cr} = D(\lambda)\cdot\Delta\lambda\cdot L$$

$$D(\lambda) = \frac{S_0}{4}\cdot\left(\lambda - \frac{\lambda_0^4}{\lambda^3}\right)$$



Catalog



How to Order

Contact your sales representative, or call the Optical Fiber Customer Service Department:
Ph: 607-248-2000 (U.S. and Canada)
+44-1244-287-437 (Europe)
Email: opticalfiber@corning.com
Please specify the fiber type, attenuation and quantity when ordering.

Mechanical Specifications

Proof Test

The entire fiber length is subjected to a tensile stress ≥100 kpsi (0.7 GPa)*.
*Higher proof test levels available.

Length

Fiber lengths available up to 50.4* km/spool.
*Longer spliced lengths available.

Performance Characterizations

Characterized parameters are typical values.

Core Diameter	8.2 µm
Numerical Aperture	0.14 *NA is measured at the one percent power level of a one-dimensional [illegible] at 1310 nm.*
[illegible]ero Dispersion Wavelength (λ_0)	1317 nm
Zero Dispersion Slope (S_0)	0.088 ps/(nm²•km)
[illegible]ffective Group Index [illegible] (N_{eff})	1310 nm: 1.4670 1550 nm: [illegible]
Fatigue Resistance Parameter (N_d)	20
Coating Strip Force	Dry: 0.6 lbs. (3N) Wet, 14-day room temperature: 0.6 lbs. (3N)
Rayleigh Backscatter Coefficient (for 1 ns Pulse Width)	1310 nm: -77 dB 1550 nm: -82 dB
Stimulated Brillouin Scattering Threshold	20 dBm(1)

Notes:
(1) When characterized with a transmitter specifying 17 dBm SBS threshold over standard single-mode fiber. While absolute SBS threshold is a function of distance and signal format, NexCor fiber offers a 3 dB improvement over standard single-mode fiber independent of these variables.

Formulas

Dispersion

$$\text{Dispersion} = D(\lambda) := \frac{S_0}{4}\left[\lambda - \frac{\lambda_0^4}{\lambda^3}\right] \text{ps/(nm•km)},$$

for 1200 nm ≤ λ ≤ 1625 nm

λ = Operating Wavelength

Cladding Non-Circularity

$$\text{Cladding Non-Circularity} = \left[1 - \frac{\text{Min. Cladding Diameter}}{\text{Max. Cladding Diameter}}\right] \times 100$$

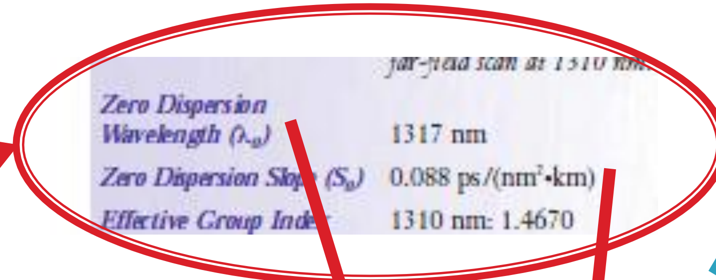
Corning Incorporated
www.corning.com/opticalfiber
One Riverfront Plaza
Corning, NY 14831
U.S.A.
Ph: 800-525-2524 (U.S. and Canada)
607-786-8125 (International)
Fx: 800-539-3632 (U.S. and Canada)
607-786-8344 (International)
Email: cofic@corning.com

Europe
Ph: 00 800 6620 6621 (U.K., Irel[illegible], France, Germany, The [illegible]ands, Spain and Swed[illegible])
+1 607 [illegible] (All Other Countries)
F[illegible] 786 8344

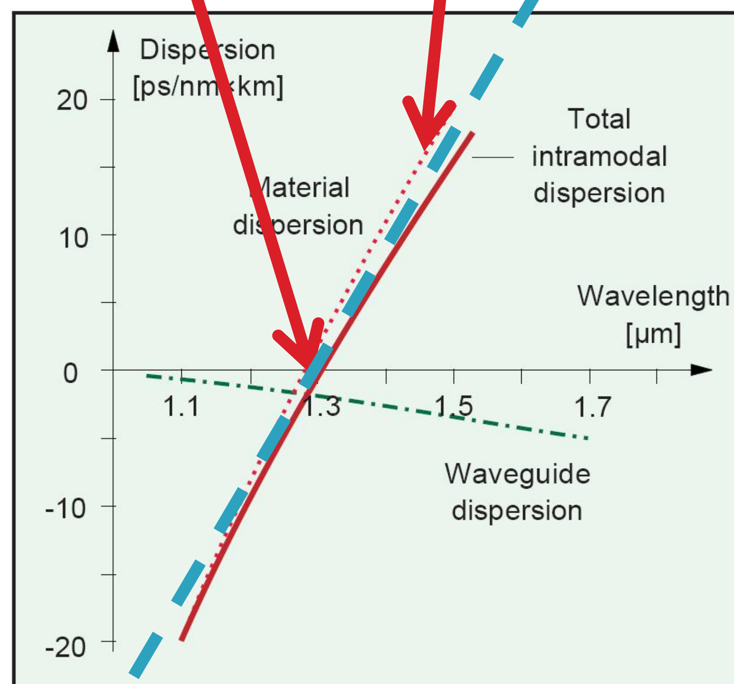
Asia Pacific
Australia
Ph: 1-800-148-690
Fx: 1-800-148-568
Indonesia
Ph: 001-803-015-721-1261
Fx: 001-803-015-721-1262
Malaysia
Ph: 1-800-80-3156
Fx: 1-800-80-3155
Philippines
Ph: 1-800-1-116-0338
Fx: 1-800-1-116-0339
Singapore
Ph: 800-1300-955
Fx: 800-1300-956
Thailand
Ph: 001-800-1-3-721-1263
Fx: 001-800-1-3-721-1264

Latin America
Brazil
Ph: 000817-762-4732
Fx: 000817-762-4996
Mexico
Ph: 001-800-235-1719
Fx: 001-800-339-1472
Venezuela
Ph: 800-1-4418
Fx: 800-1-4419

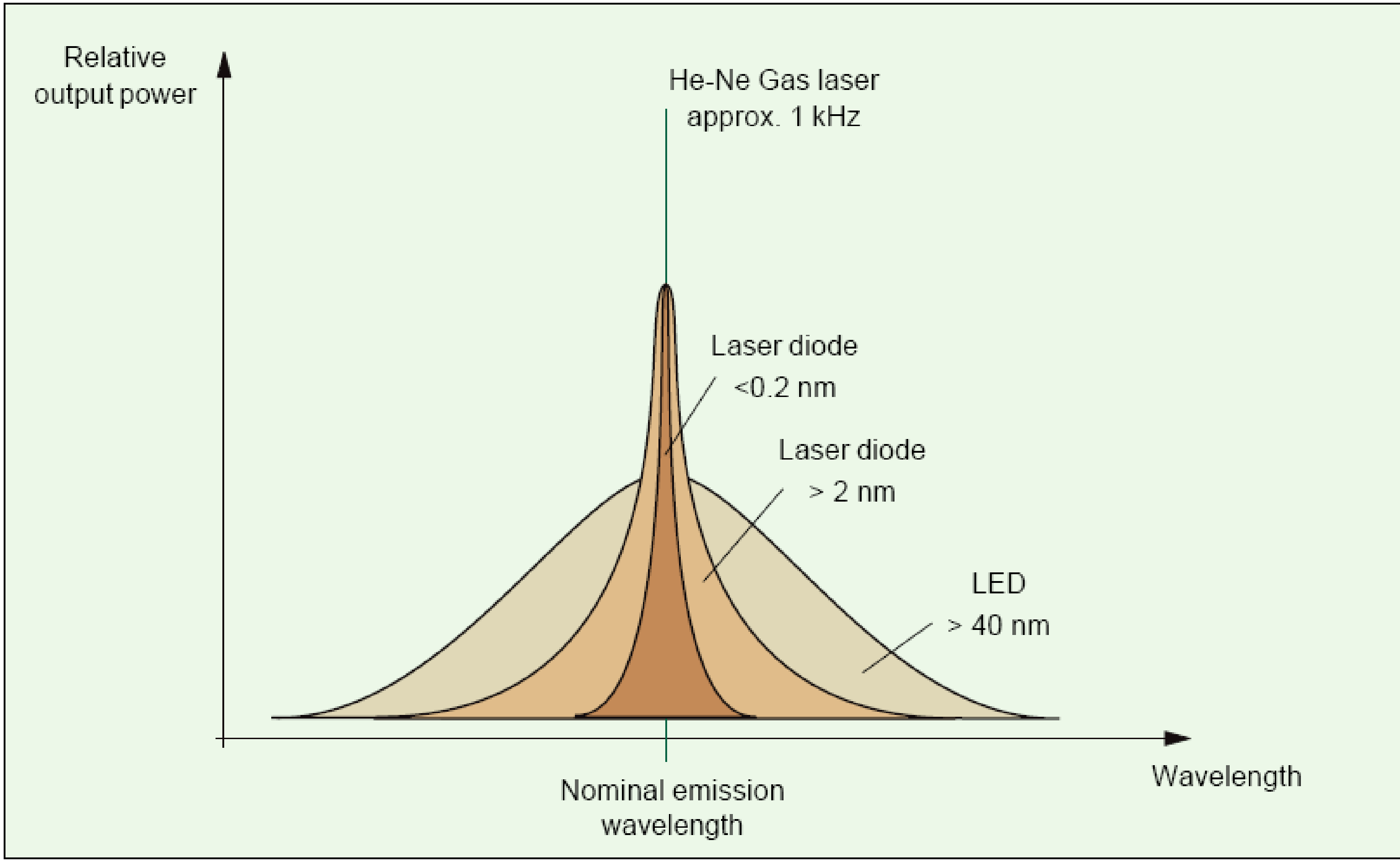
Greater China
Email: GCCofic@corning.com
Beijing
Ph: (86) 10-6505-5066
Fx: (86) 10-6505-5077
Hong Kong
Ph: (852) 2807-2723
Fx: (852) 2807-2152
Shanghai
Ph: (86) 21-3222-4668
Fx: (86) 21-6288-1575
Taiwan
Ph: (886) 2-2716-0338
Fx: (886) 2-2716-0339



Zero Dispersion Wavelength (λ_0)	1317 nm
Zero Dispersion Slo[illegible] (S_0)	0.088 ps/(nm²•km)
Effective Group Inde[illegible]	1310 nm: 1.4670



Calitatea spectrală a emiţătorilor optici



Banda

- Dispersia totala

$$\Delta\tau_{tot} = \sqrt{\Delta\tau_{cr}^2 + \Delta\tau_{\text{mod}}^2}$$

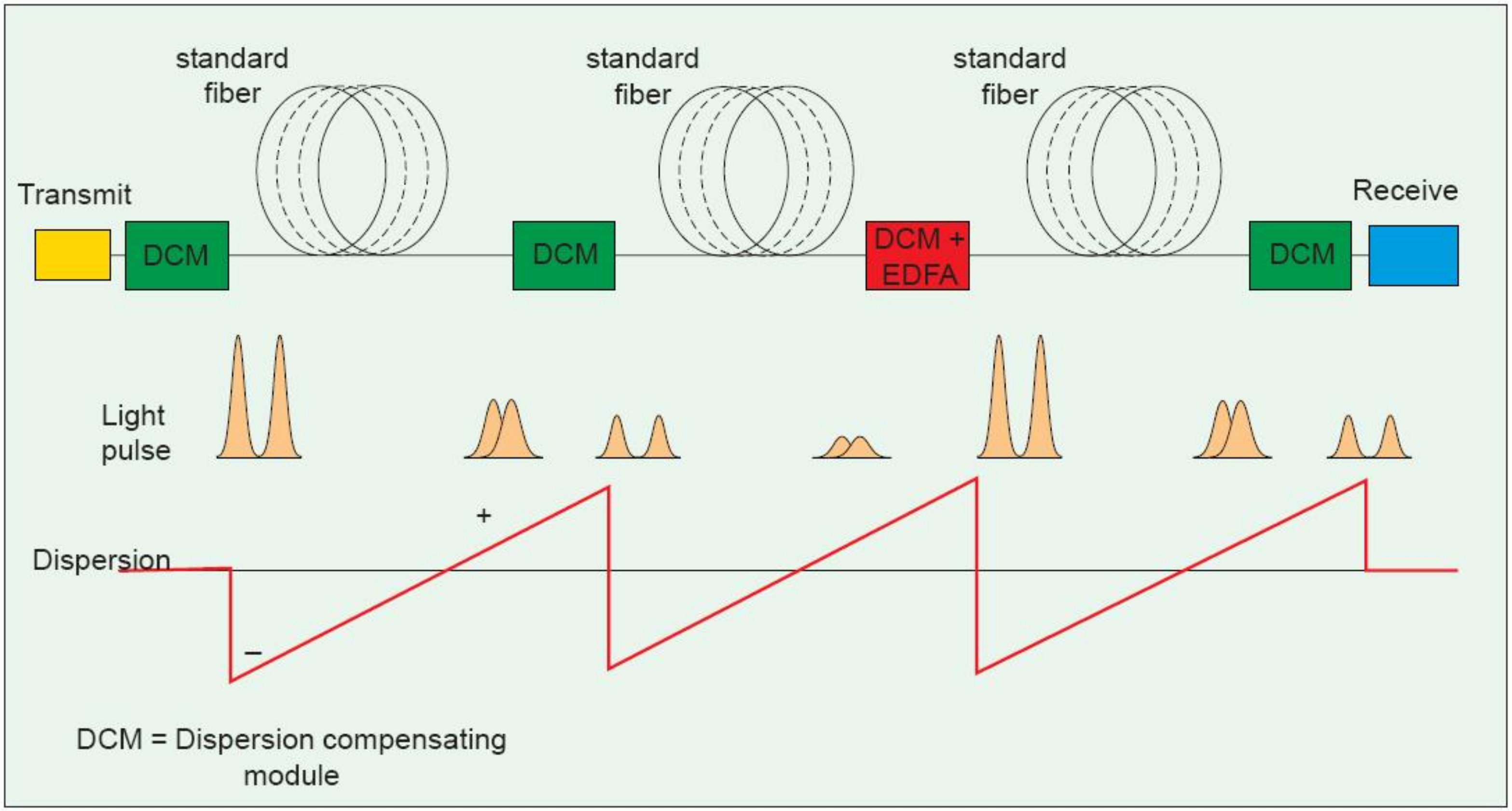
- Banda

$$B_{opt} = \frac{0.44}{\Delta\tau_{tot}[ns]} \quad [GHz]$$

- Banda optica la 3 dB corespunde unei benzi electrice la 6 dB
  - $P_{opt} \sim I; \quad P_{el} \sim I^2$ $\qquad B_{opt} = \sqrt{2} B_{el}$
- Viteza legaturii

$$V[Gb/s] \cong 2 \cdot B_{el}[GHz]$$

Fibra pentru compensarea dispersiei

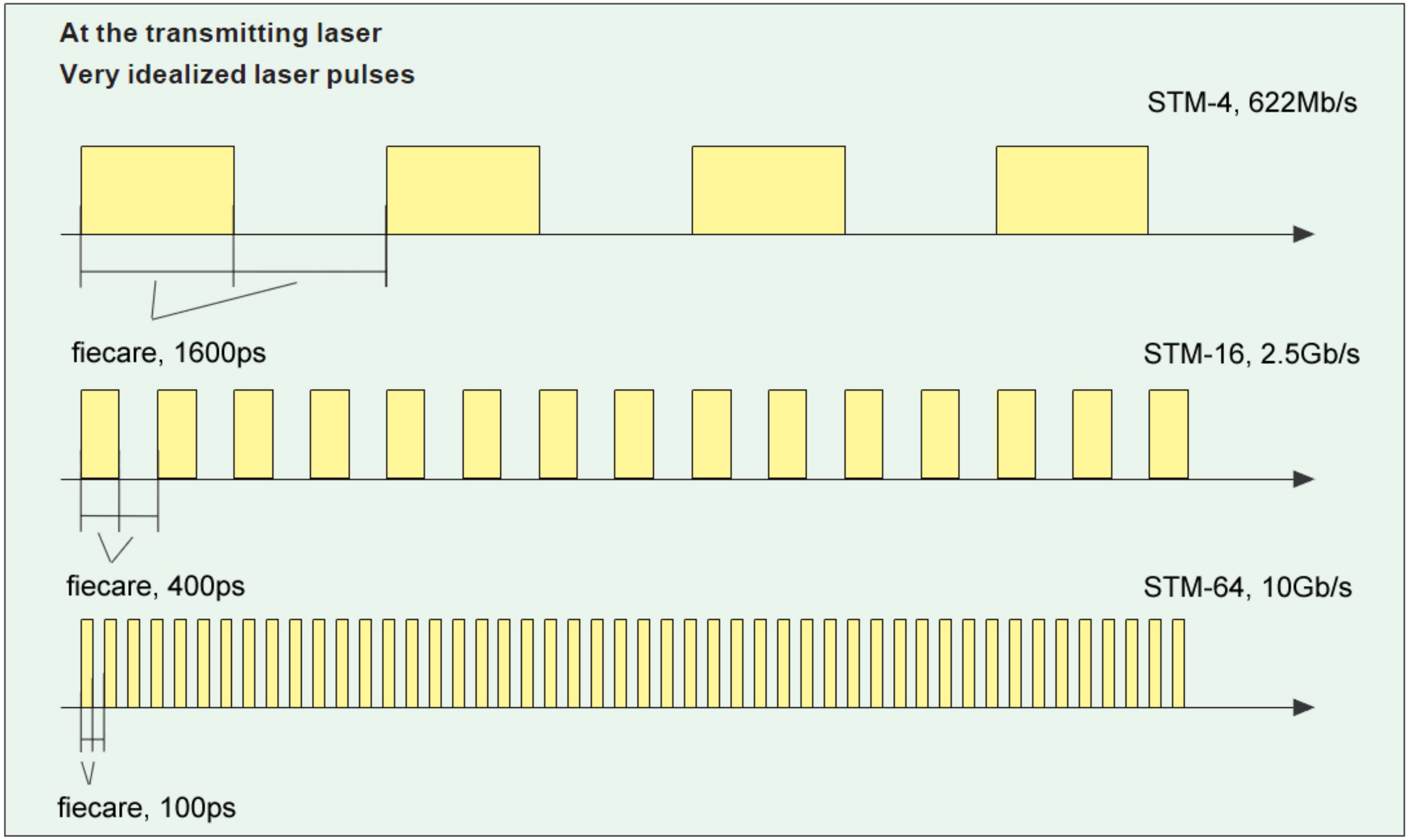


- Dispersie: -100 ps/nm/km
- Atenuare 0.5 dB/km

Dispersie exemplu – 1

- transmisii cu viteze diferite

$$\Delta\tau_{cr} = D(\lambda)\cdot\Delta\lambda\cdot L$$



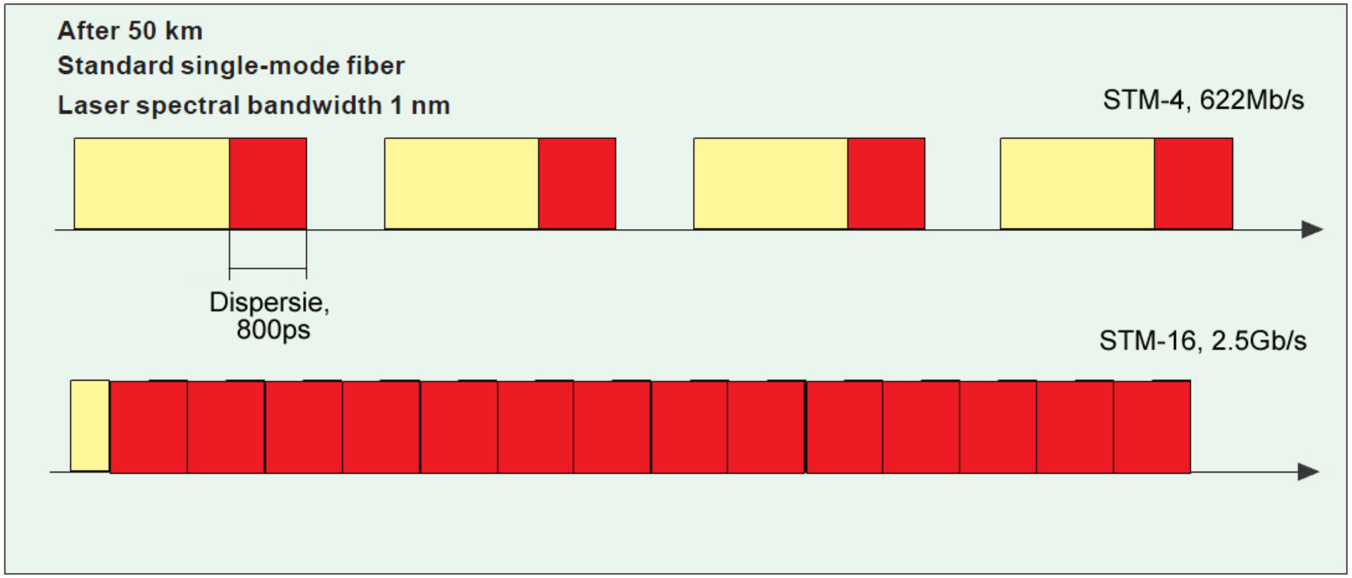
Dispersie exemplu – 2

- 1550nm
- Efectul **sursei**
  - fibra monomod cu dispersia 16ps/nm/km@1550
  - latimea spectrala a sursei Δλ=1nm
  - 50km

$$\Delta\tau_{cr} = D(\lambda)\cdot\Delta\lambda\cdot L$$

$$\Delta\tau_{cr} = 16\cdot 1\cdot 50\, ps = 800\, ps$$

$$[\Delta\tau_{cr}] = \frac{ps}{nm\cdot km}\cdot nm\cdot km = ps$$



100<400<800<1600

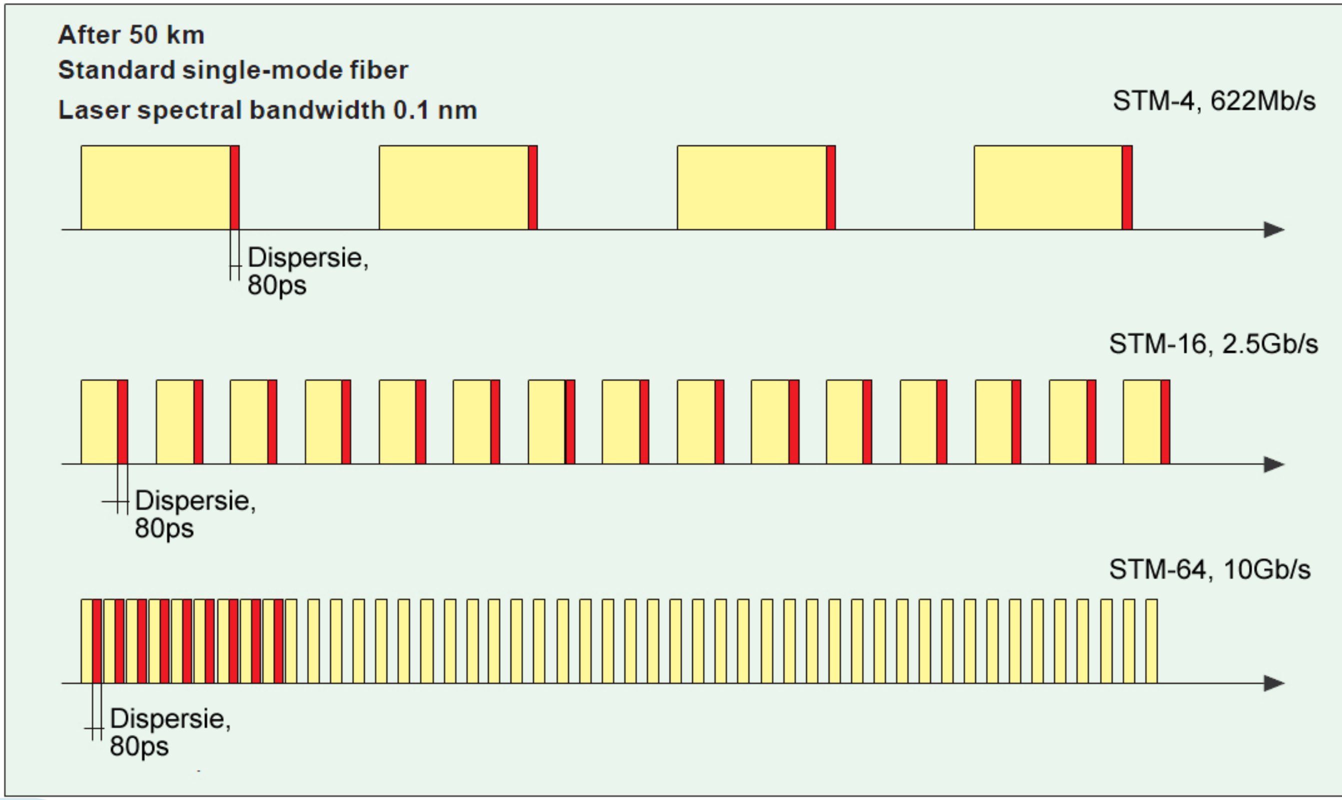
Dispersie exemplu – 3

- 1550nm
- Efectul **sursei**
  - fibra monomod cu dispersia 16ps/nm/km@1550
  - latimea spectrala a sursei $\Delta\lambda = 0.1$nm
  - 50km

$$\Delta\tau_{cr} = D(\lambda)\cdot\Delta\lambda\cdot L$$

$$\Delta\tau_{cr} = 16\cdot 0.1\cdot 50\,ps = 80\,ps$$

$$[\Delta\tau_{cr}] = \frac{ps}{nm\cdot km}\cdot nm\cdot km = ps$$



100≈80<400<1600

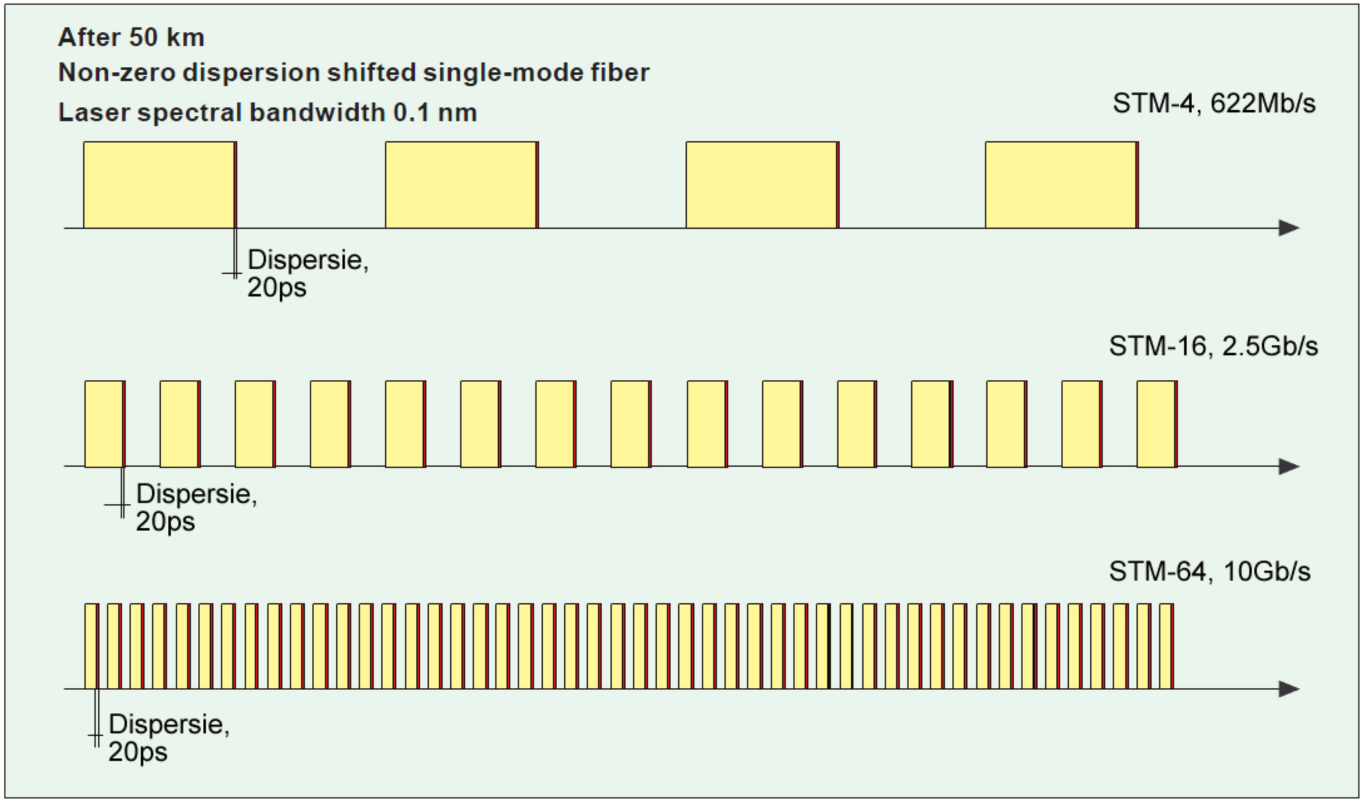
Dispersie exemplu – 4

- Efectul **fibrei**
  - fibra cu dipersie deplasata: 4ps/nm/km@1550
  - latimea spectrala a sursei Δλ=0.1nm
  - 50km

$$\Delta\tau_{cr} = D(\lambda)\cdot\Delta\lambda\cdot L$$

$$\Delta\tau_{cr} = 4\cdot 0.1\cdot 50\,ps = 20\,ps$$

$$[\Delta\tau_{cr}] = \frac{ps}{nm\cdot km}\cdot nm\cdot km = ps$$



20<100<400<1600

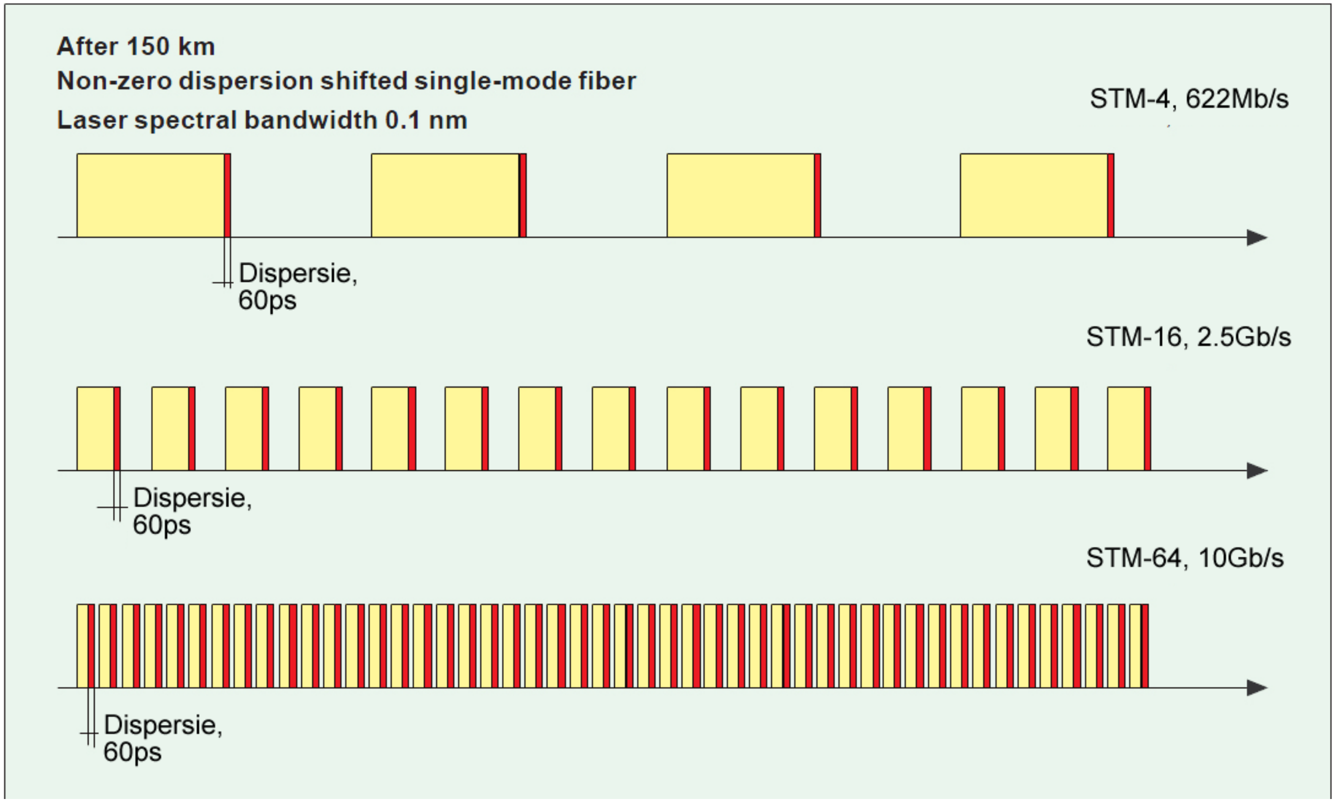
Dispersie exemplu – 5

- Efectul **fibrei**
  - fibra cu dipersie deplasata: 4ps/nm/km@1550
  - latimea spectrala a sursei Δλ=0.1nm
  - 150km

$$\Delta\tau_{cr} = D(\lambda)\cdot\Delta\lambda\cdot L$$

$$\Delta\tau_{cr} = 4\cdot 0.1\cdot 150\,ps = 60\,ps$$

$$[\Delta\tau_{cr}] = \frac{ps}{nm\cdot km}\cdot nm\cdot km = ps$$



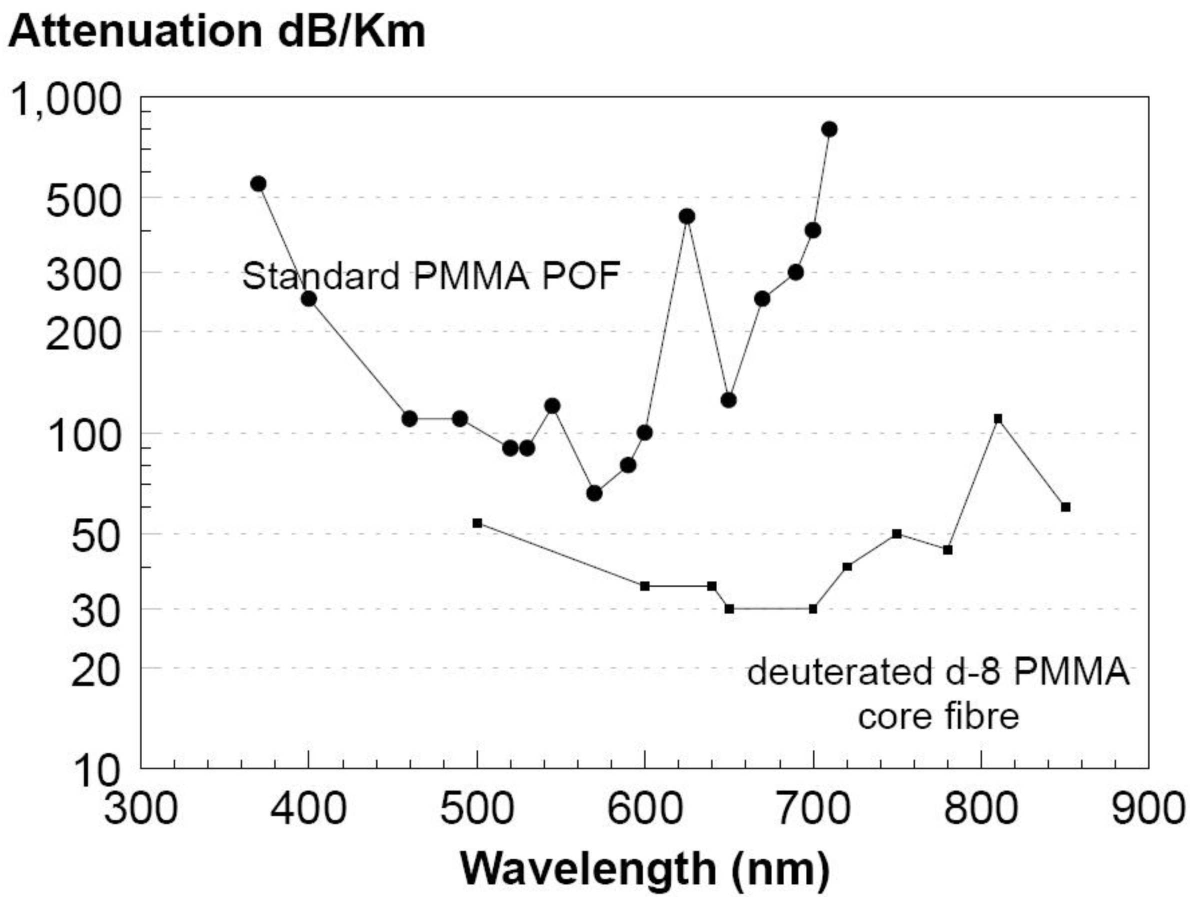
60<100<400<1600

Fibra standard ITU G.652

- Diametru teaca = 125 µm
- MFD = 9÷10 µm la 1300 nm
- λ_C = 1100÷1280 nm
- Pierderi de curbura (la 1550 nm) mai mici de 1 dB pentru 100 spire de fibra rulata pe un mosor cu 7.5 cm diametru
- Dispersia in banda 1300 nm (1285-1330 nm) mai mica de 3.5 ps/nm/km. La 1550 nm dispersia trebuie sa fie mai mica de 20 ps/nm/km
- Viteza de variatie a dispersiei (panta dispersiei S_0) mai mica de 0.095 ps/nm^2/km

ITU (International Telecommunication Union) is the United Nations specialized agency for information and communication technologies - ICTs

Fibra optica din plastic (POF)



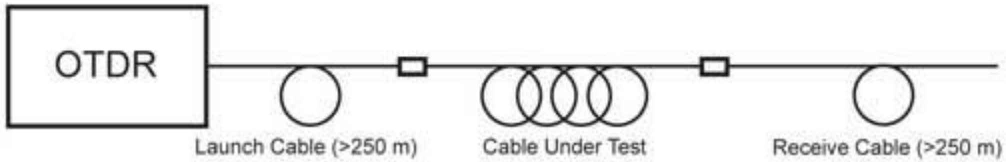
- Atenuare 180 dB/km
- NA = 0.3
- Diametru 1 mm
- Banda 125MHz (100m)

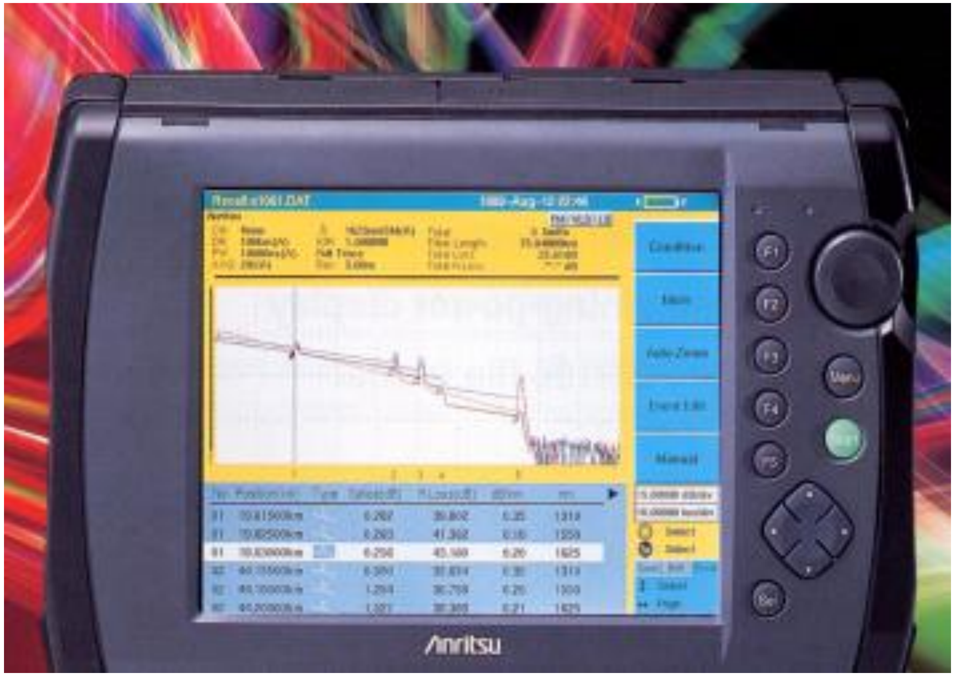
Fibra optică – Tehnologie

Capitolul 6

OTDR

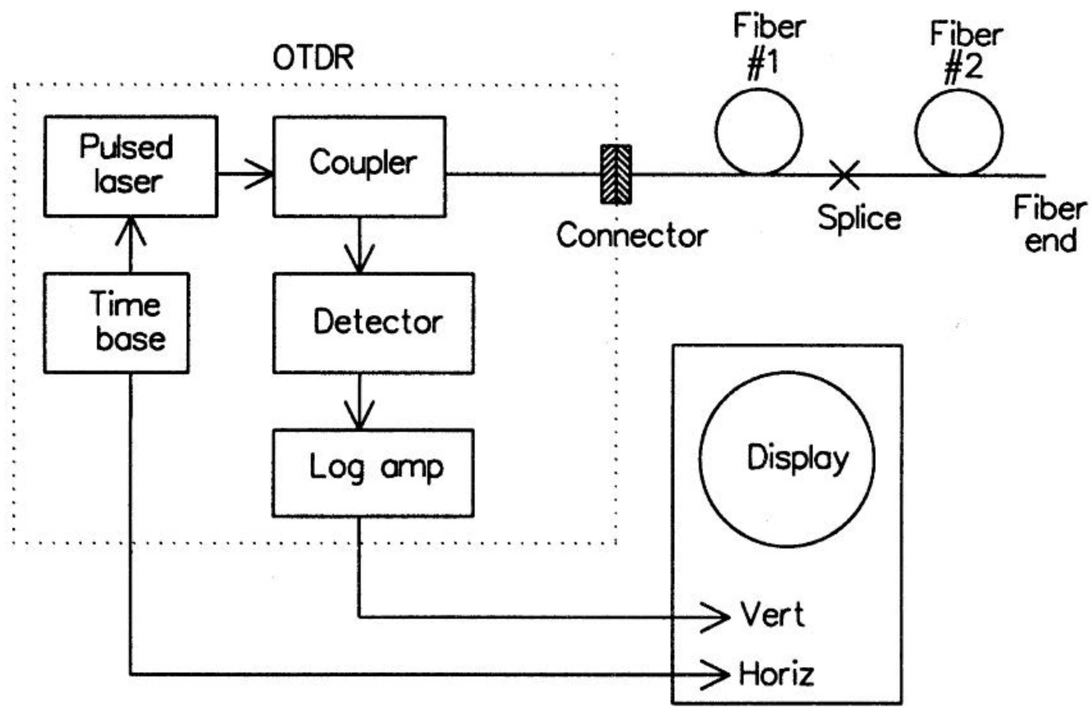
- Optical time-domain reflectometer
- Localizarea defectelor



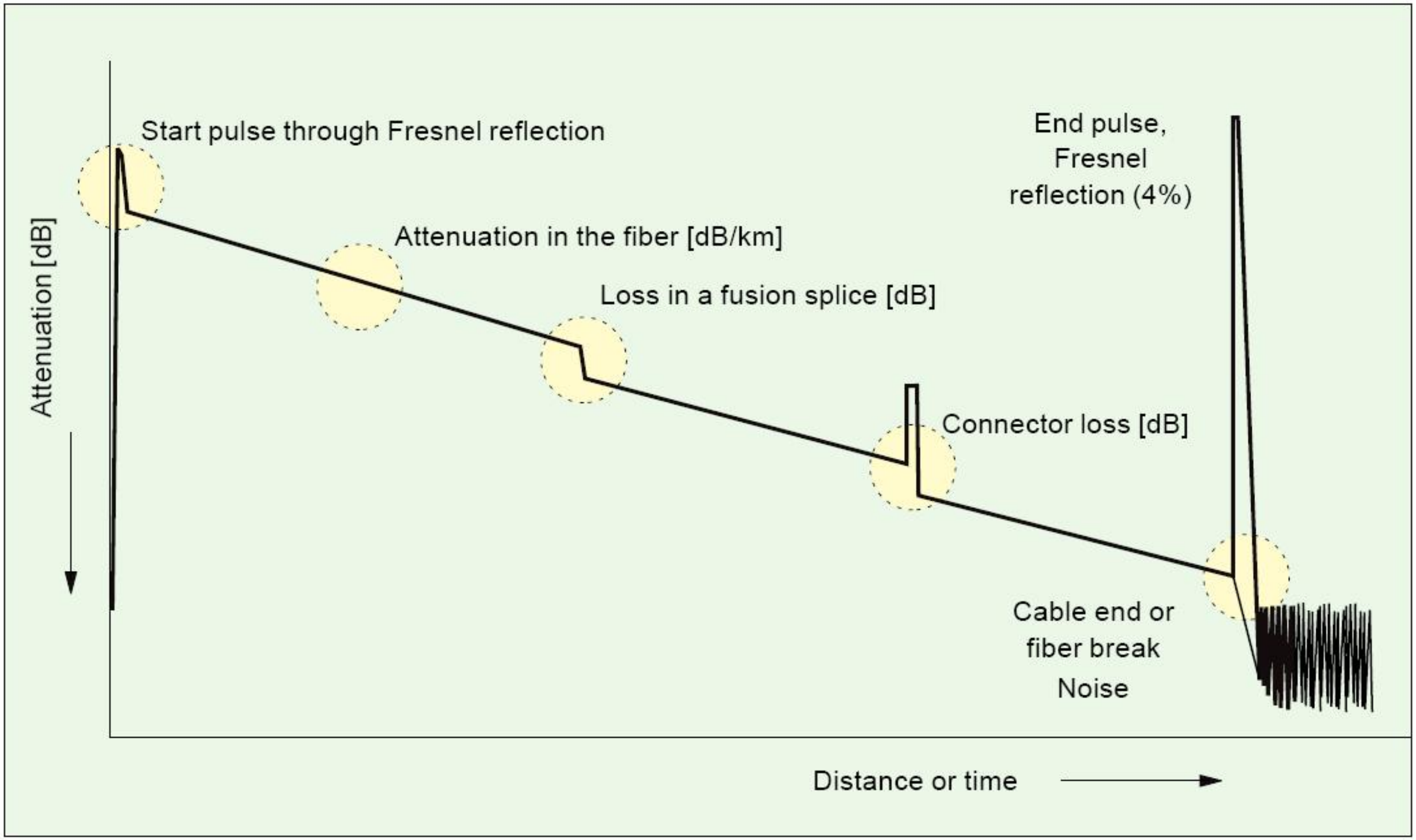


OTDR

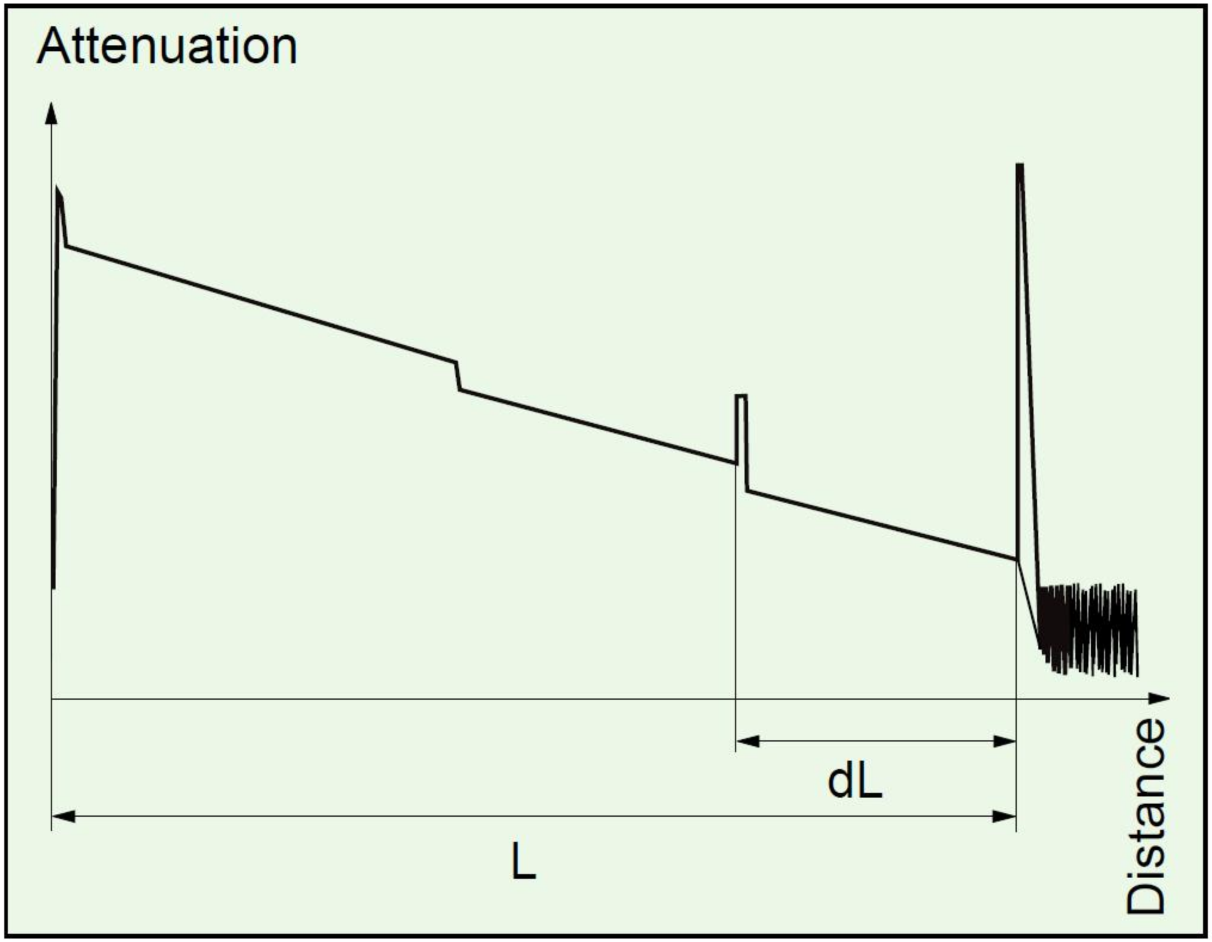
- Optical time-domain reflectometer
- Localizarea defectelor



Rezultat grafic al OTDR



Efecte vizibile OTDR



$$2 \cdot L = c \cdot t$$

$$L = \frac{c_0}{n} \cdot \frac{t}{2}$$

Efecte vizibile OTDR

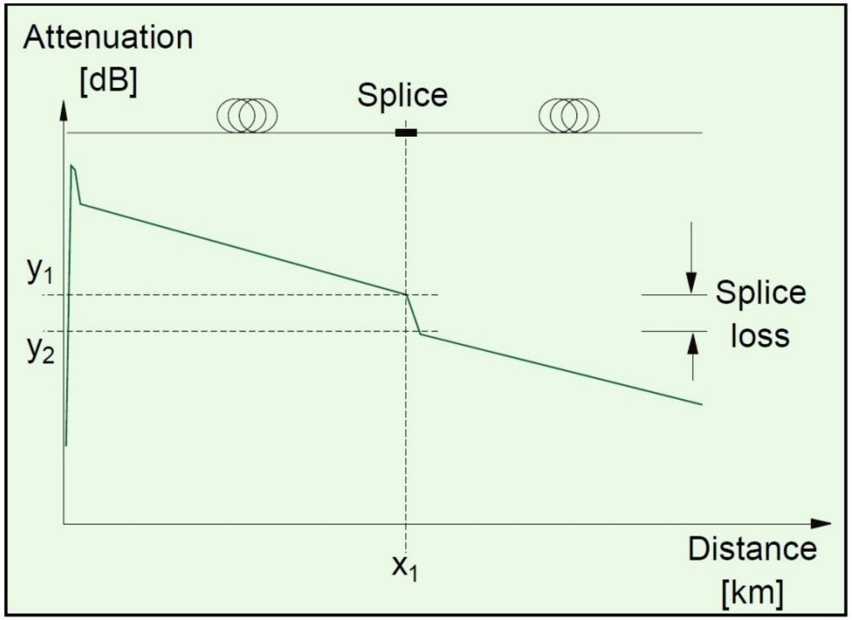
$$A[dB] = \frac{P_1 - P_2}{2}$$

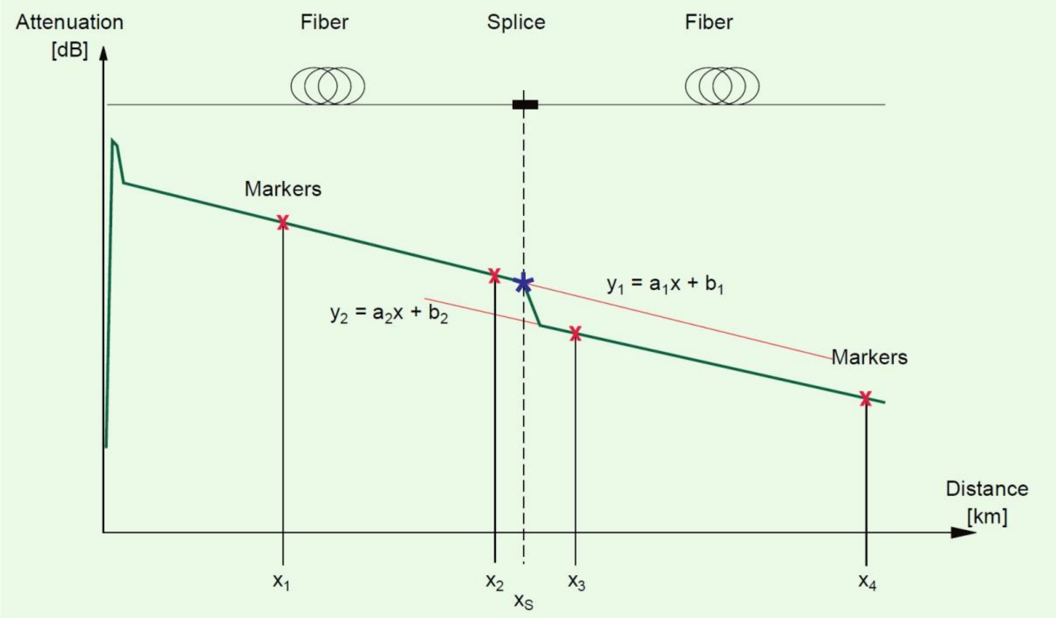
$$A[dB] = \frac{P_1 - P_2}{2 \cdot L}$$

panta curbei

Efecte vizibile OTDR – Splice

- splice loss – A(s)

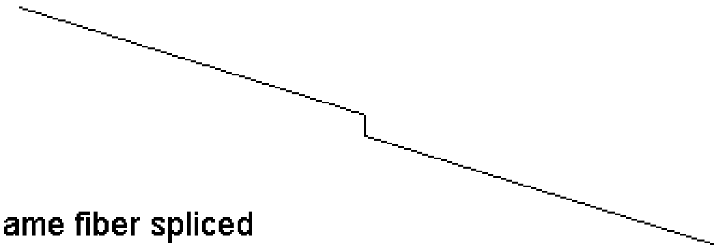




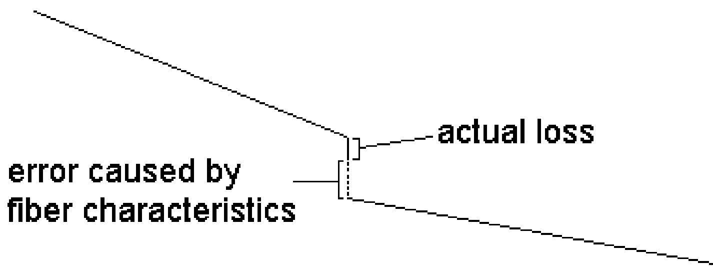
$$A(s) = y_1 - y_2$$

$$A(s) = y_1 - y_2 = x_s \cdot (a_1 - a_2) + (b_1 - b_2)$$

Efecte vizibile OTDR – Splice

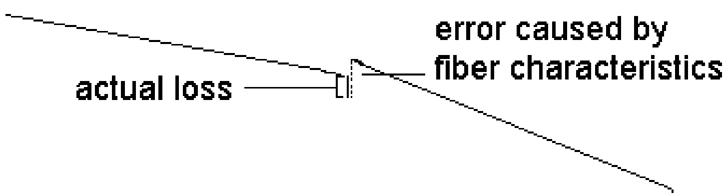


a. same fiber spliced



b. high loss fiber spliced to low loss fiber

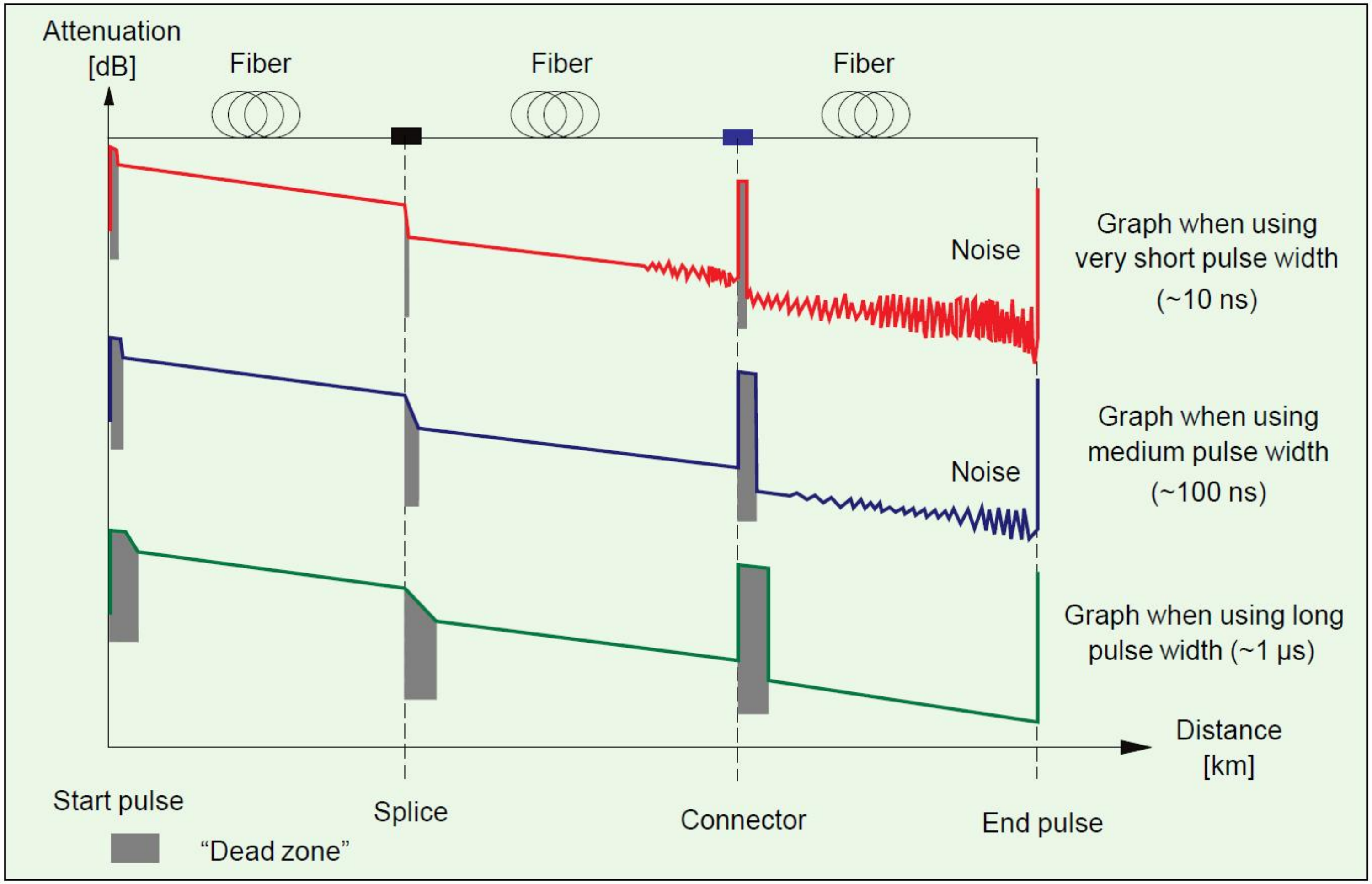
$$A(s) = \frac{A(s)_{A \to B} + A(s)_{B \to A}}{2}$$



c. low loss fiber spliced to high loss fiber
can cause an apparent gain at a splice

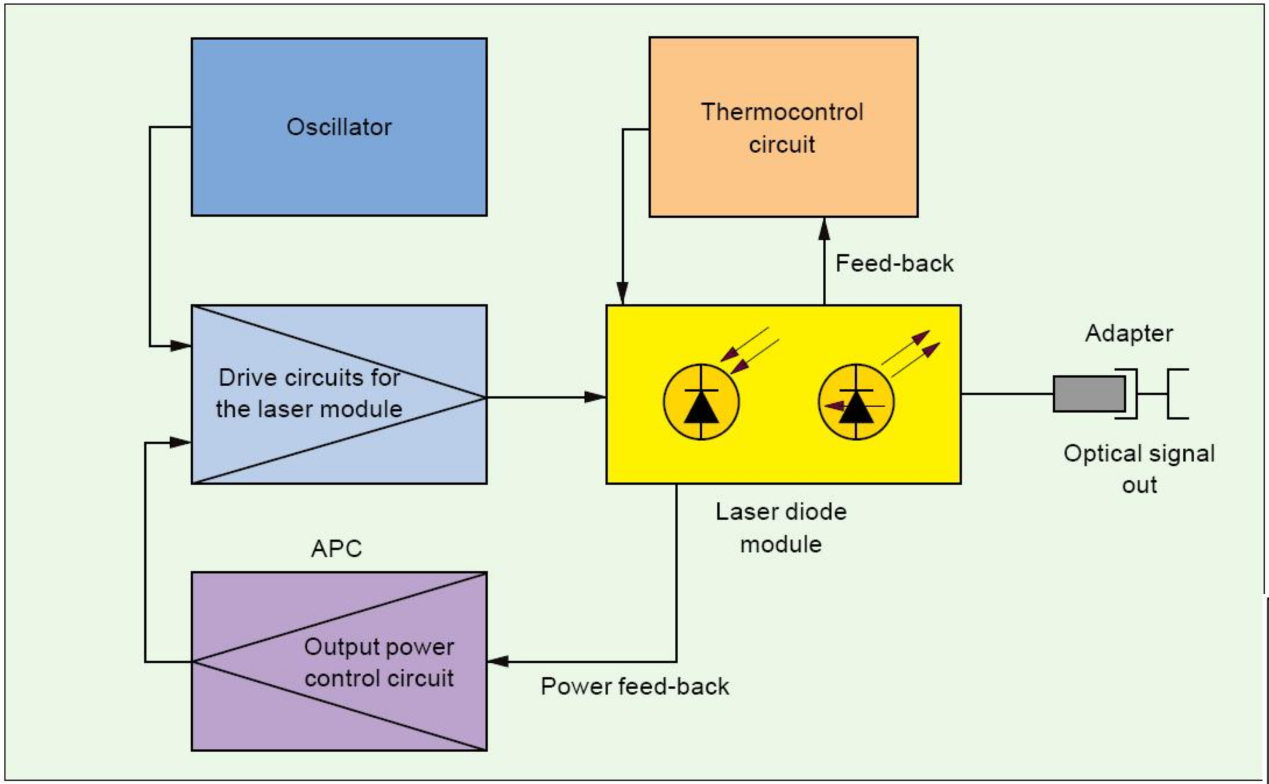
Rezultat grafic al OTDR

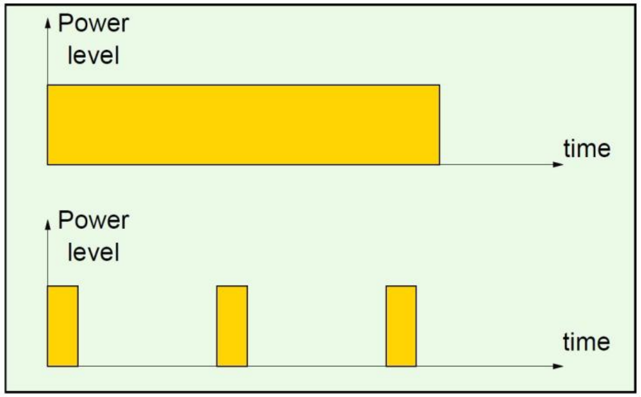
- latimea pulsurilor luminoase



Stabilized light source
Optical power meter

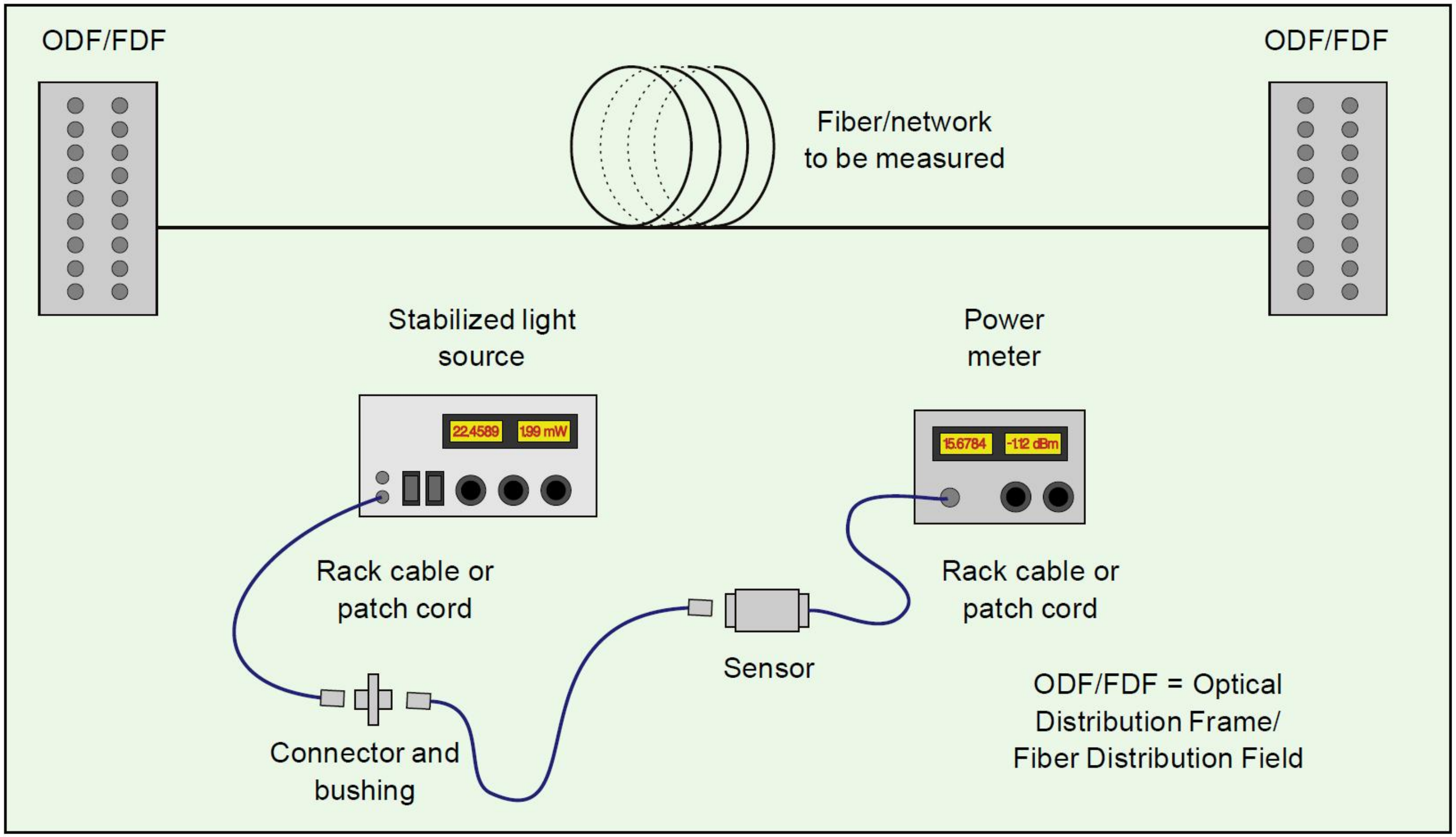
- Masurarea puterii si atenuarii





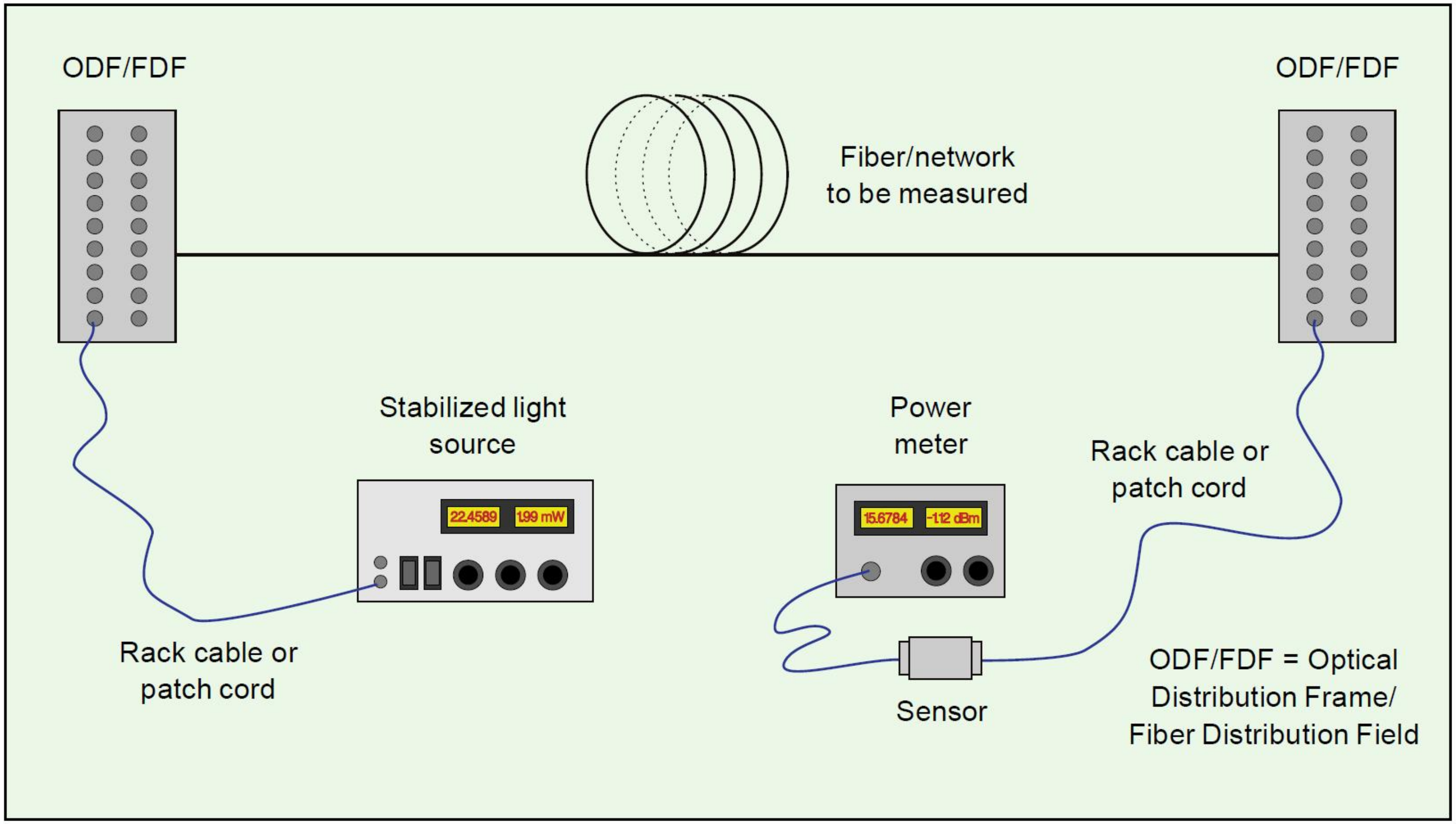
Masurarea puterii si atenuarii

- Masuratoare referinta



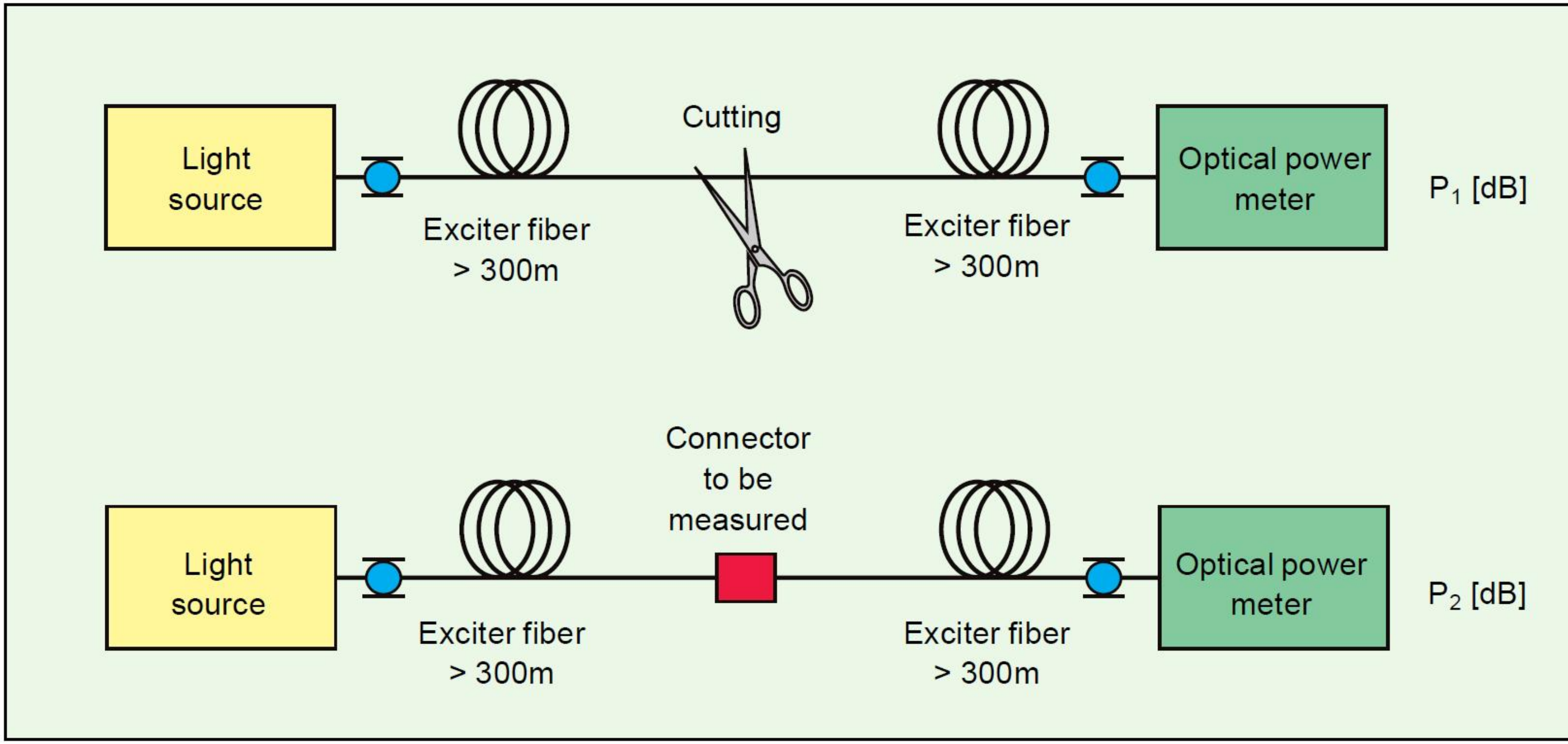
Masurarea puterii si atenuarii

- Masuratoare instalatie



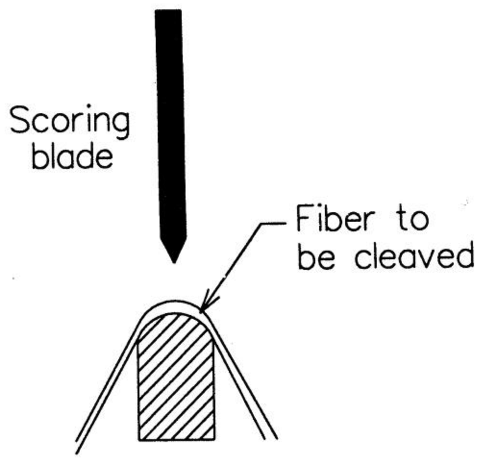
Masurare conectori si splice

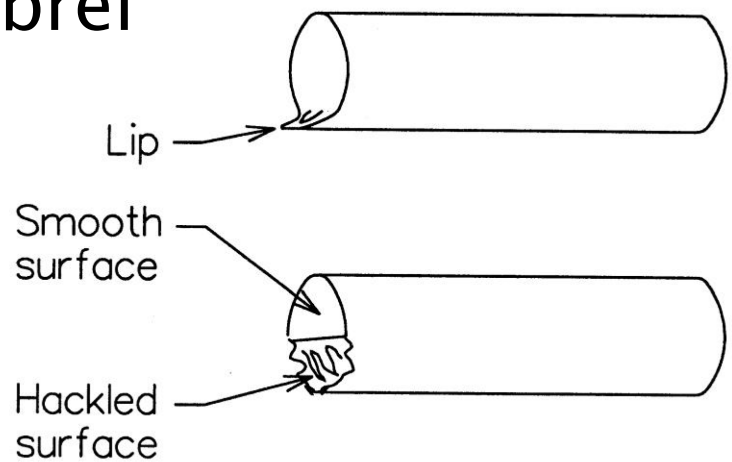
- Se elimina efectele fibrei



Taiere – Cleaving

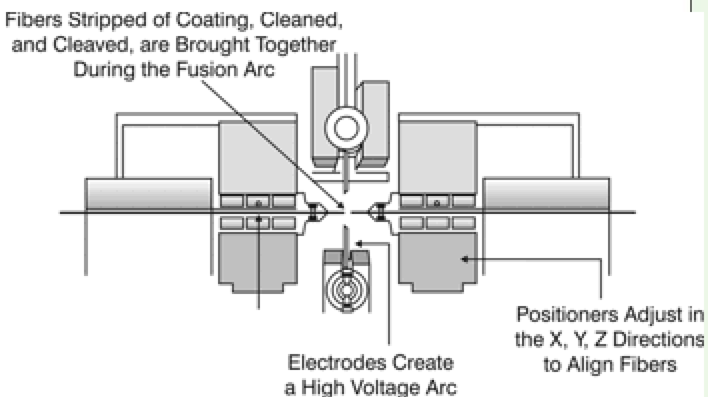
- Tehnici necesare pentru a asigura o taiere perpendiculara pe axa fibrei

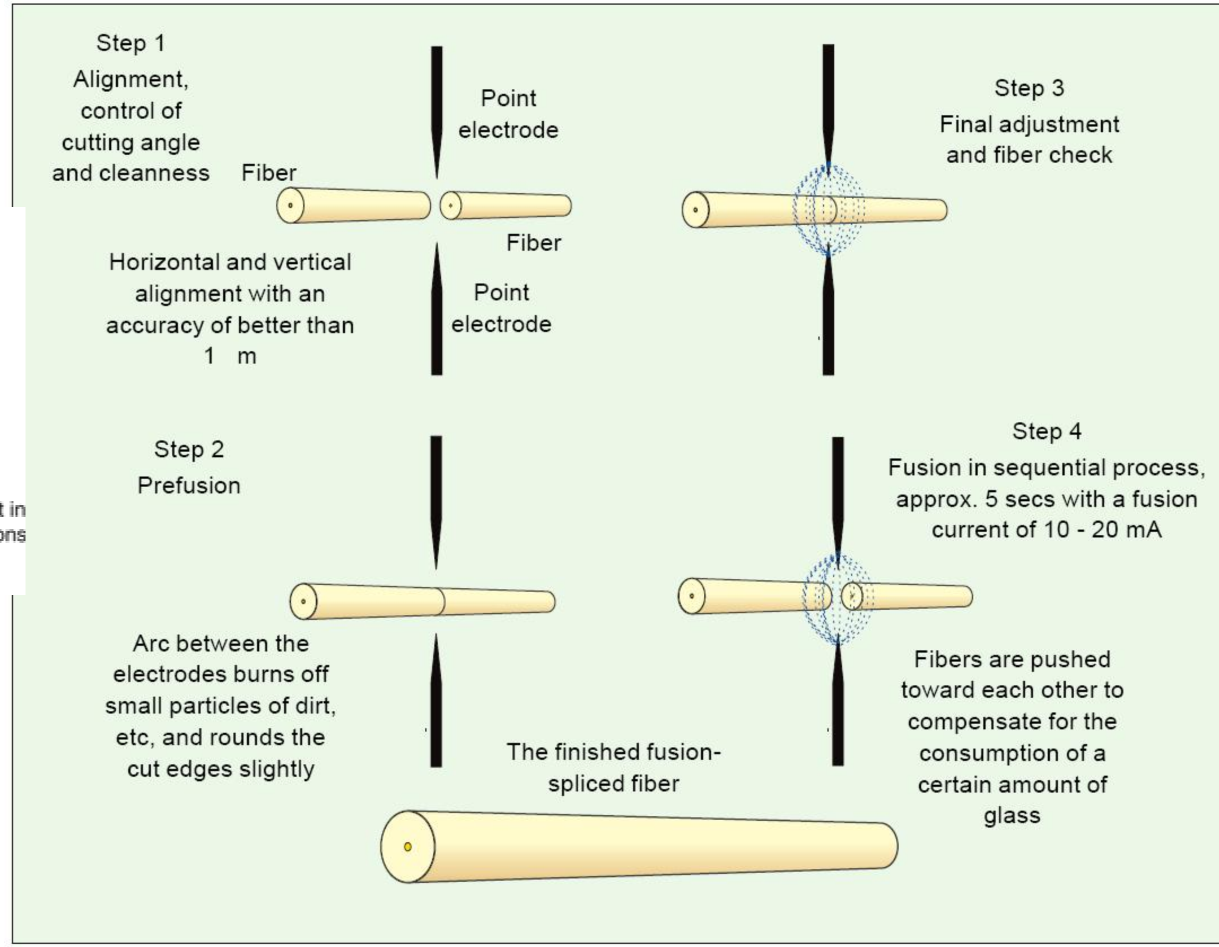




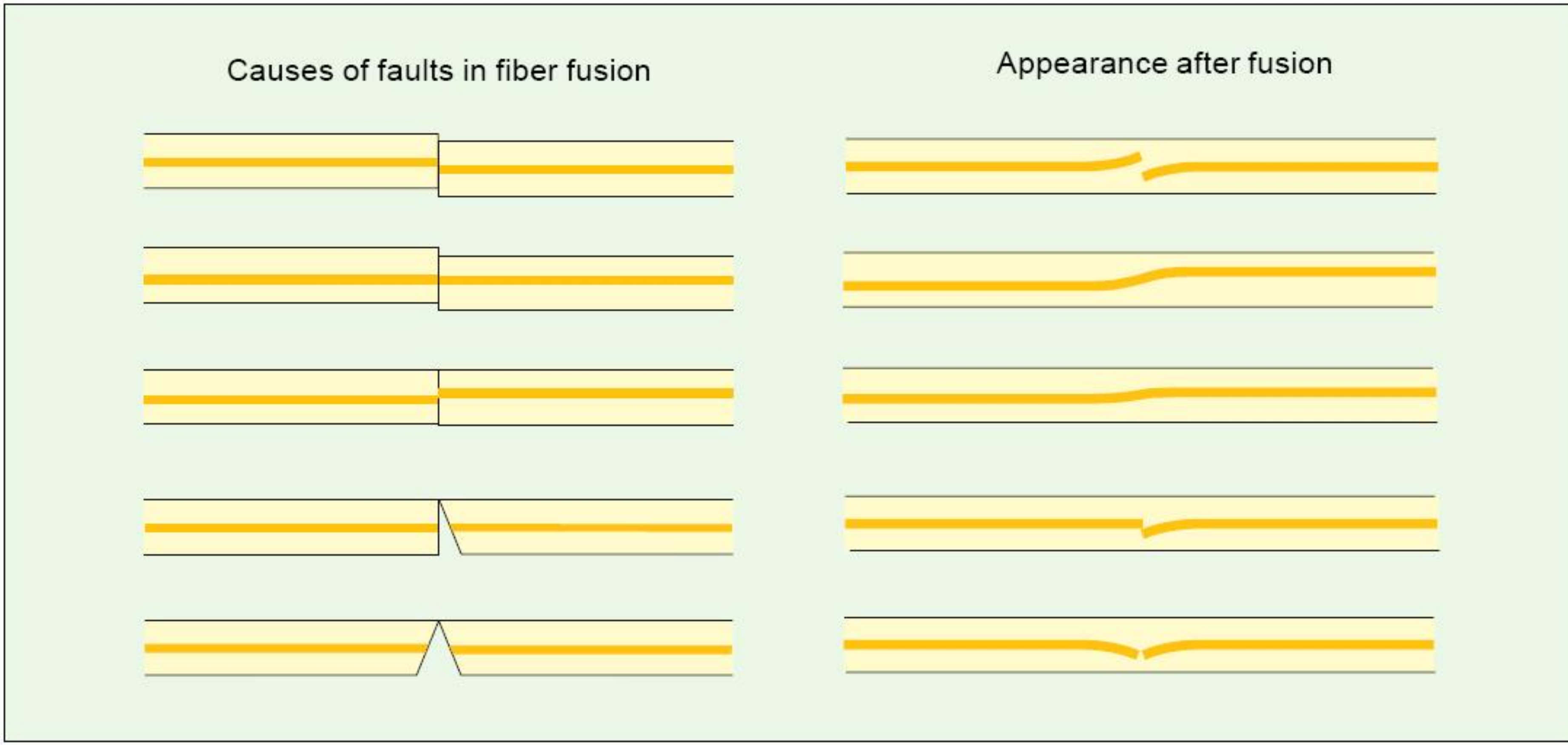
Lipire prin fuziune

Splice prin fuziune

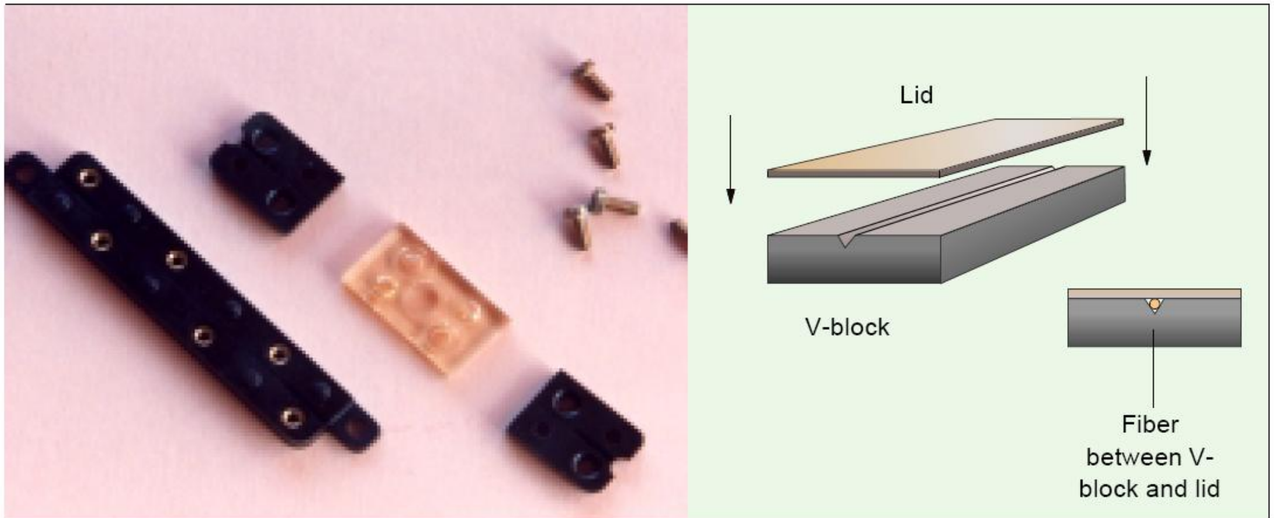


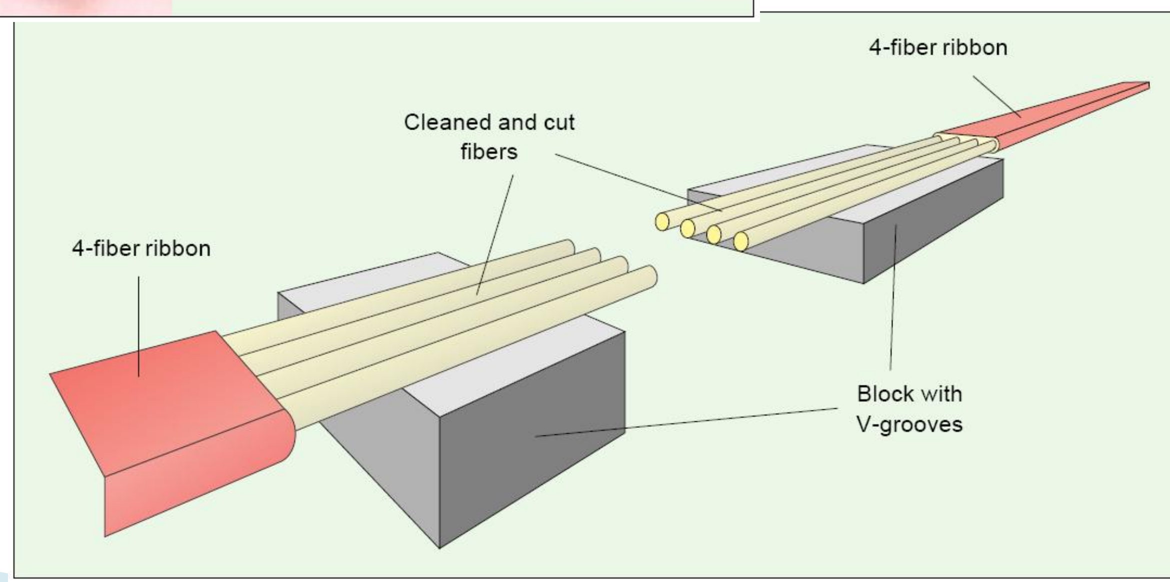


Splice prin fuziune

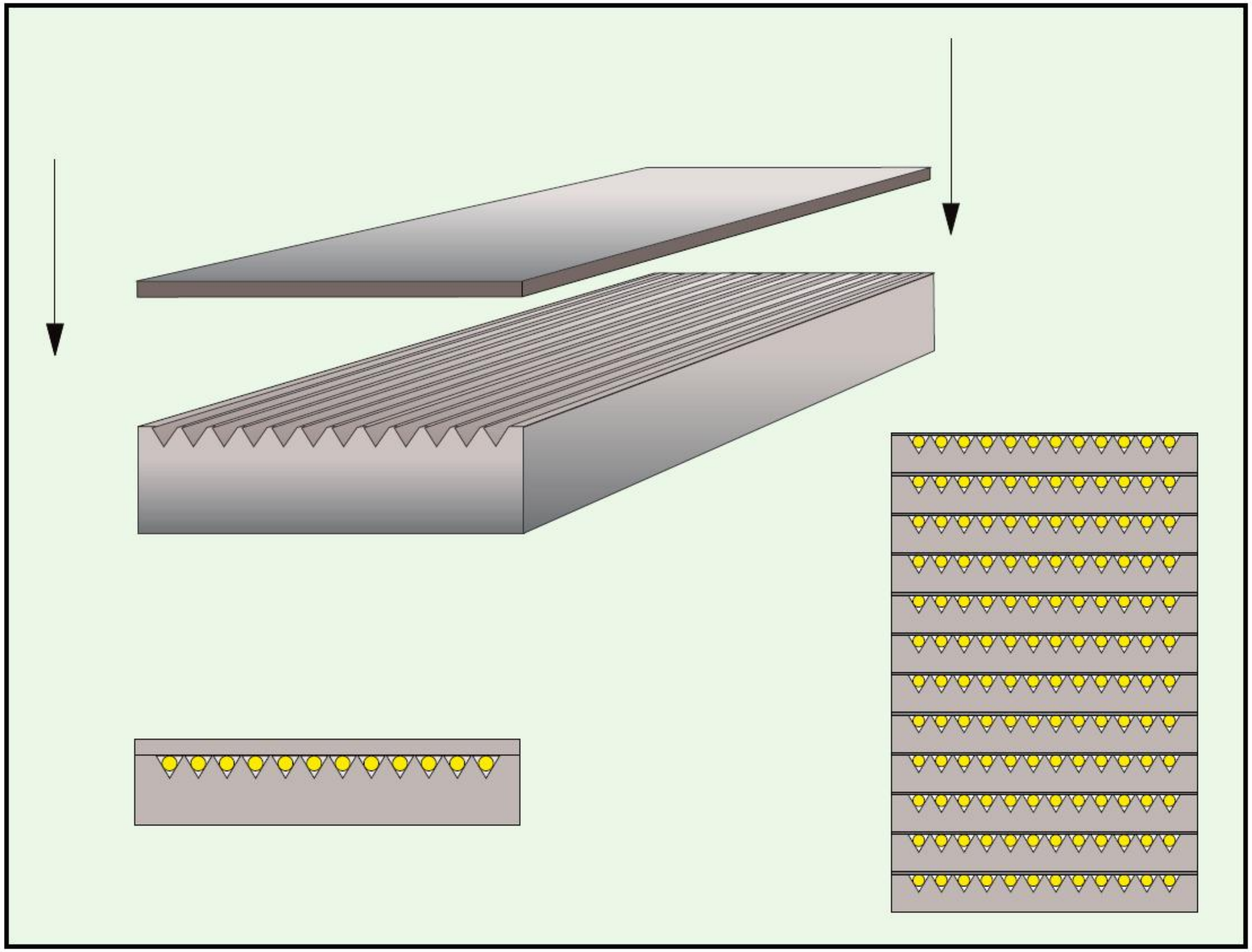


Splice mecanic – bloc V

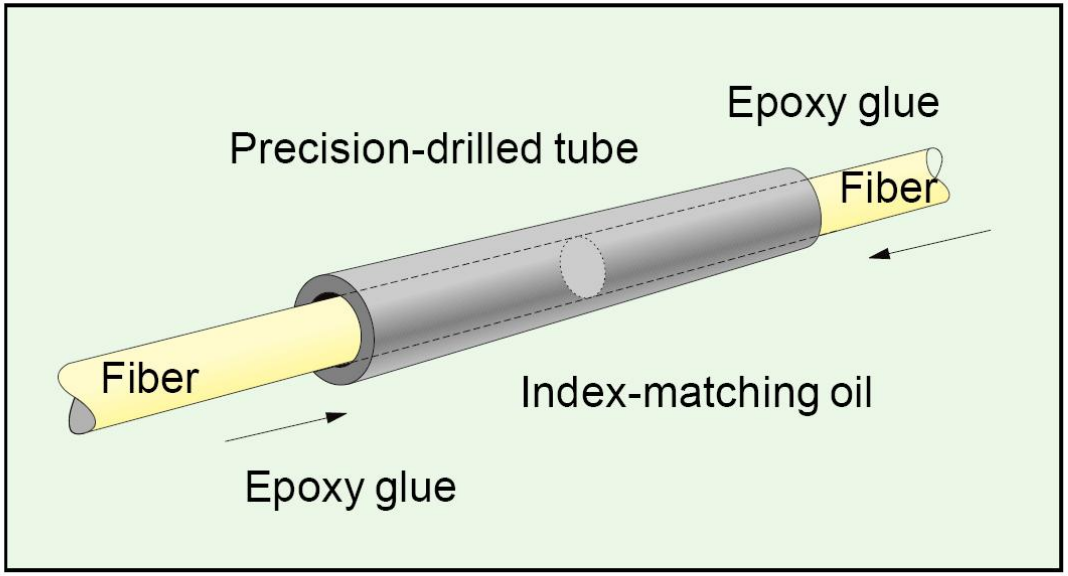


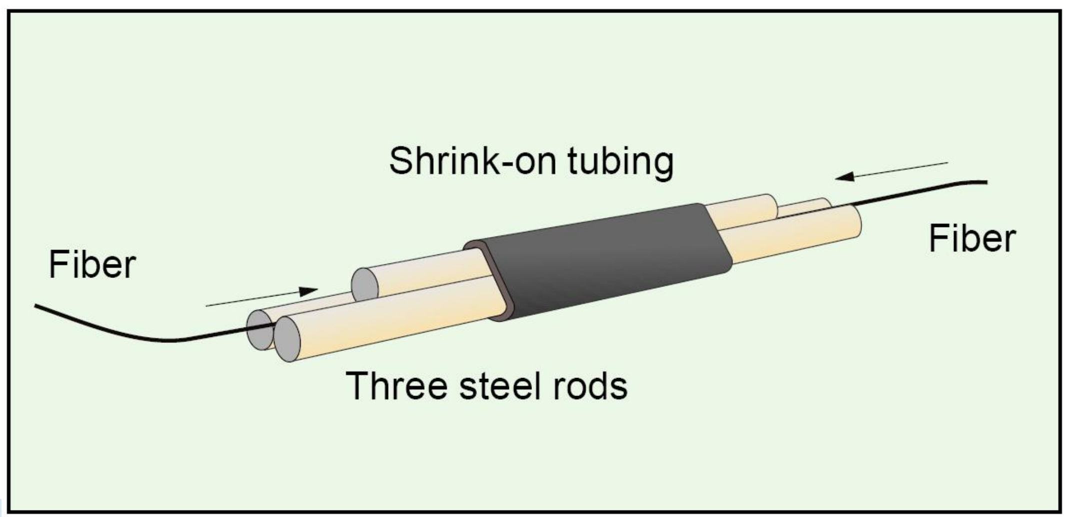


Splice mecanic – bloc V



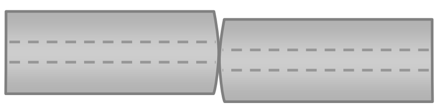
Splice mecanic



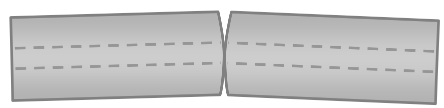


Probleme Fibre/Conectori

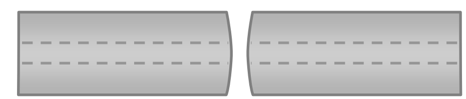
Offset



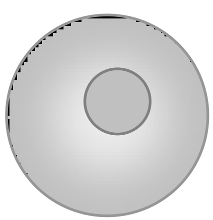
Angular Misalignment



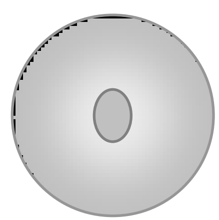
Separation



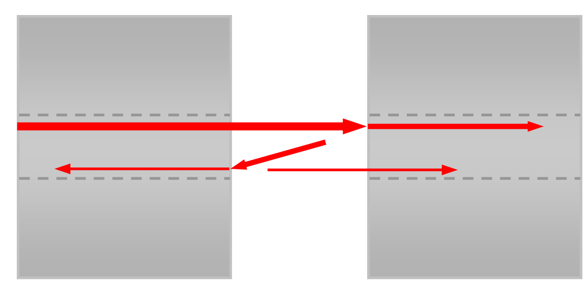
Core Eccentricity



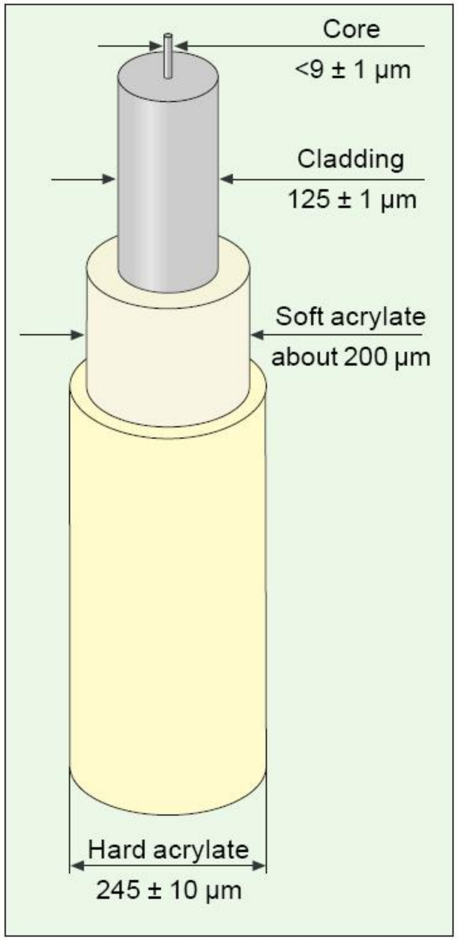
Core Ellipticity

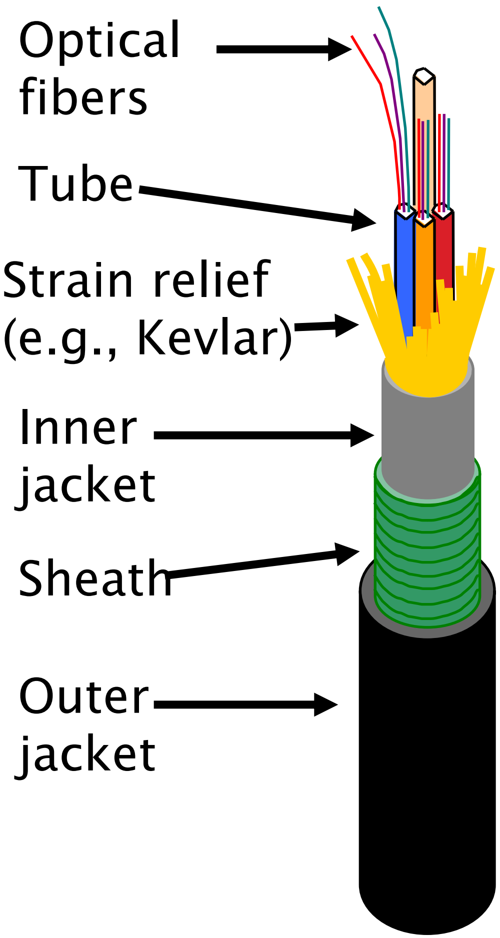


Reflections & Interference

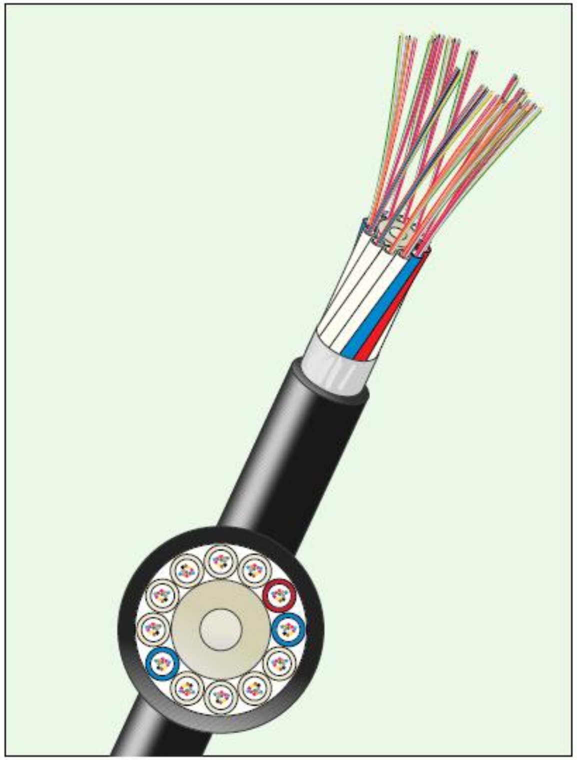


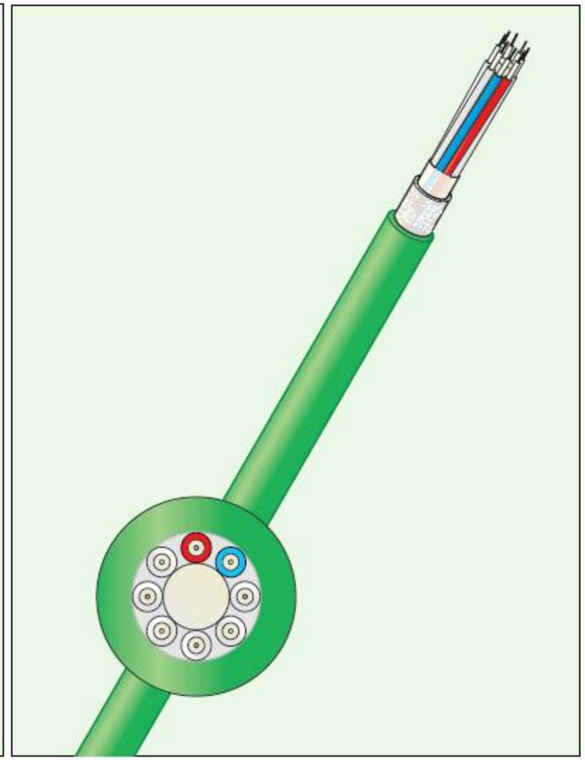
Cabluri

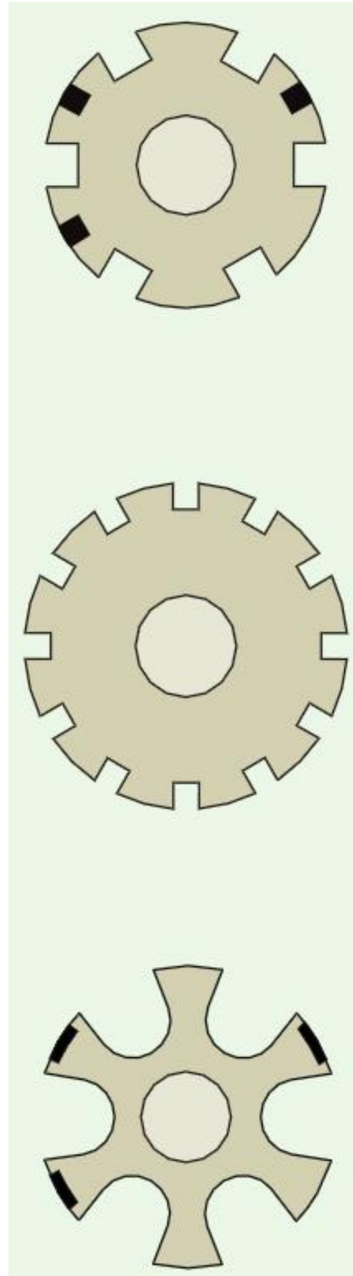

Core
<9 ± 1 µm
Cladding
125 ± 1 µm
Soft acrylate
about 200 µm
Hard acrylate
245 ± 10 µm


Optical fibers
Tube
Strain relief (e.g., Kevlar)
Inner jacket
Sheath
Outer jacket

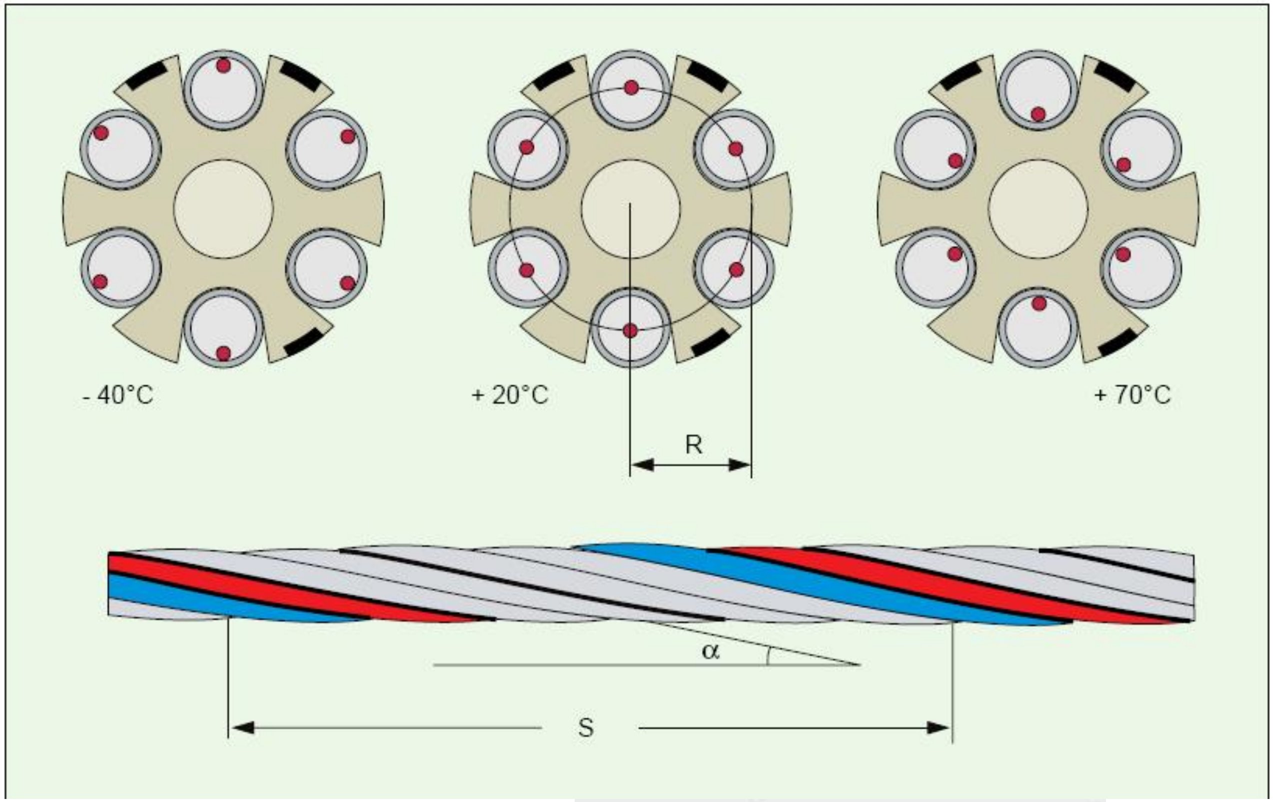
Cabluri



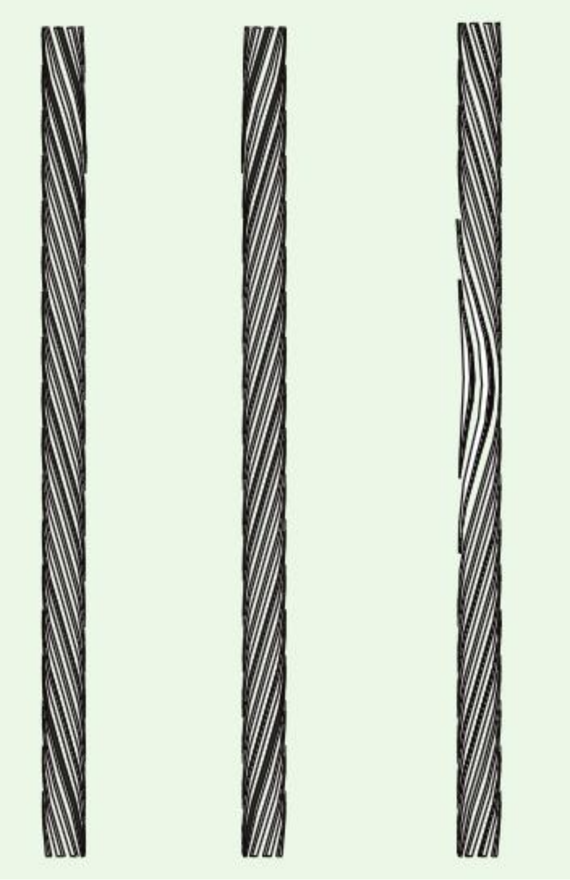




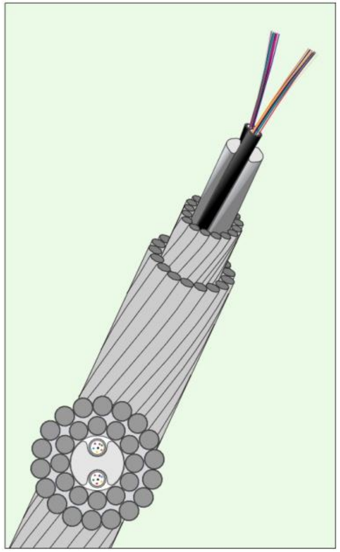
Cabluri

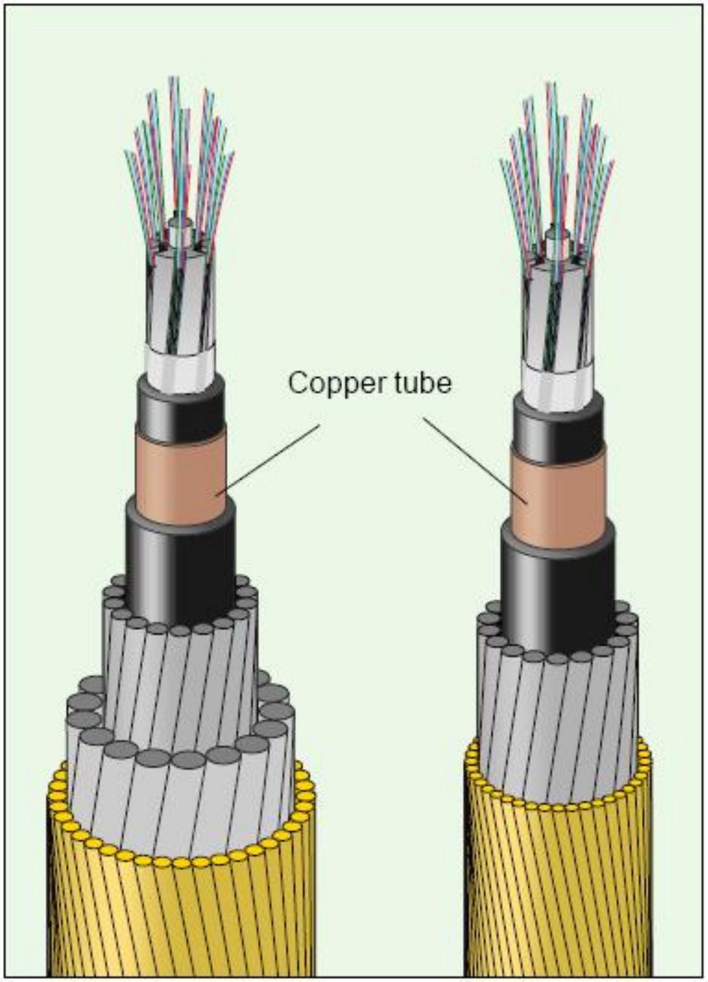


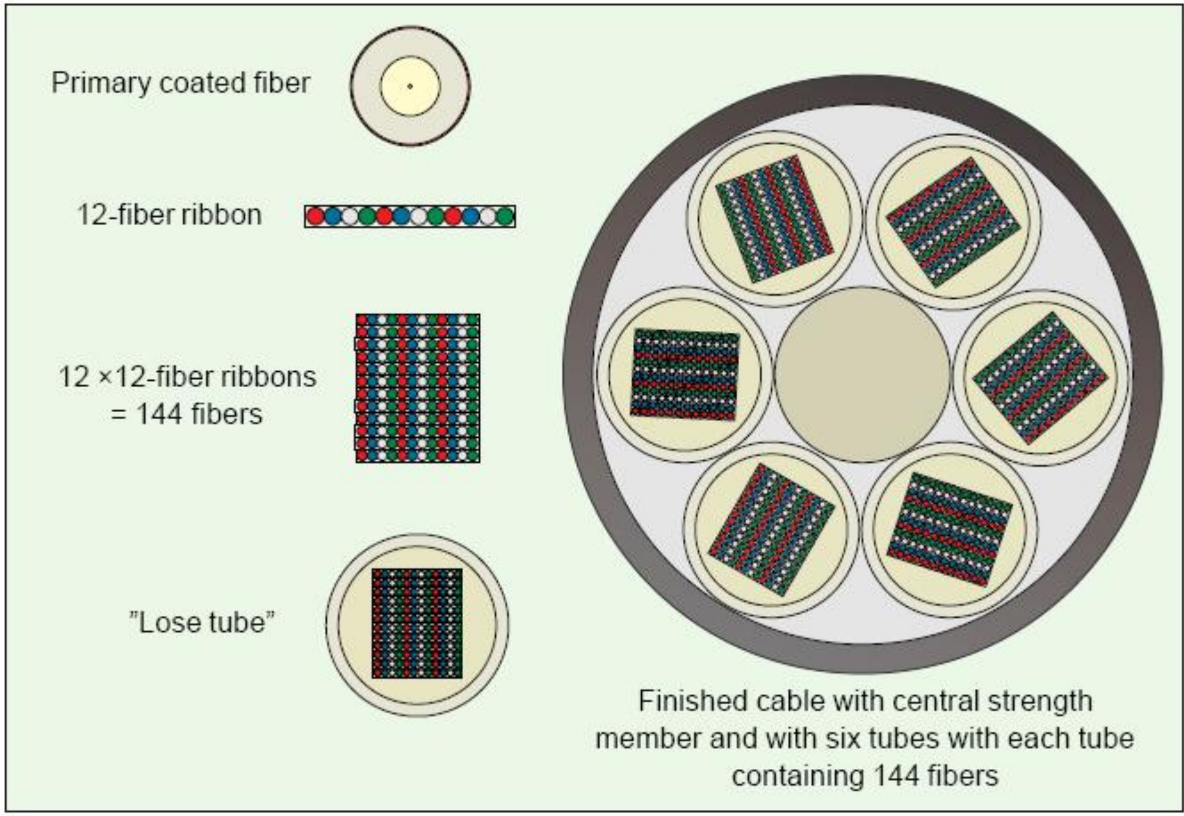
$$L = S\sqrt{1+\left(\frac{2\pi R}{S}\right)^2}$$



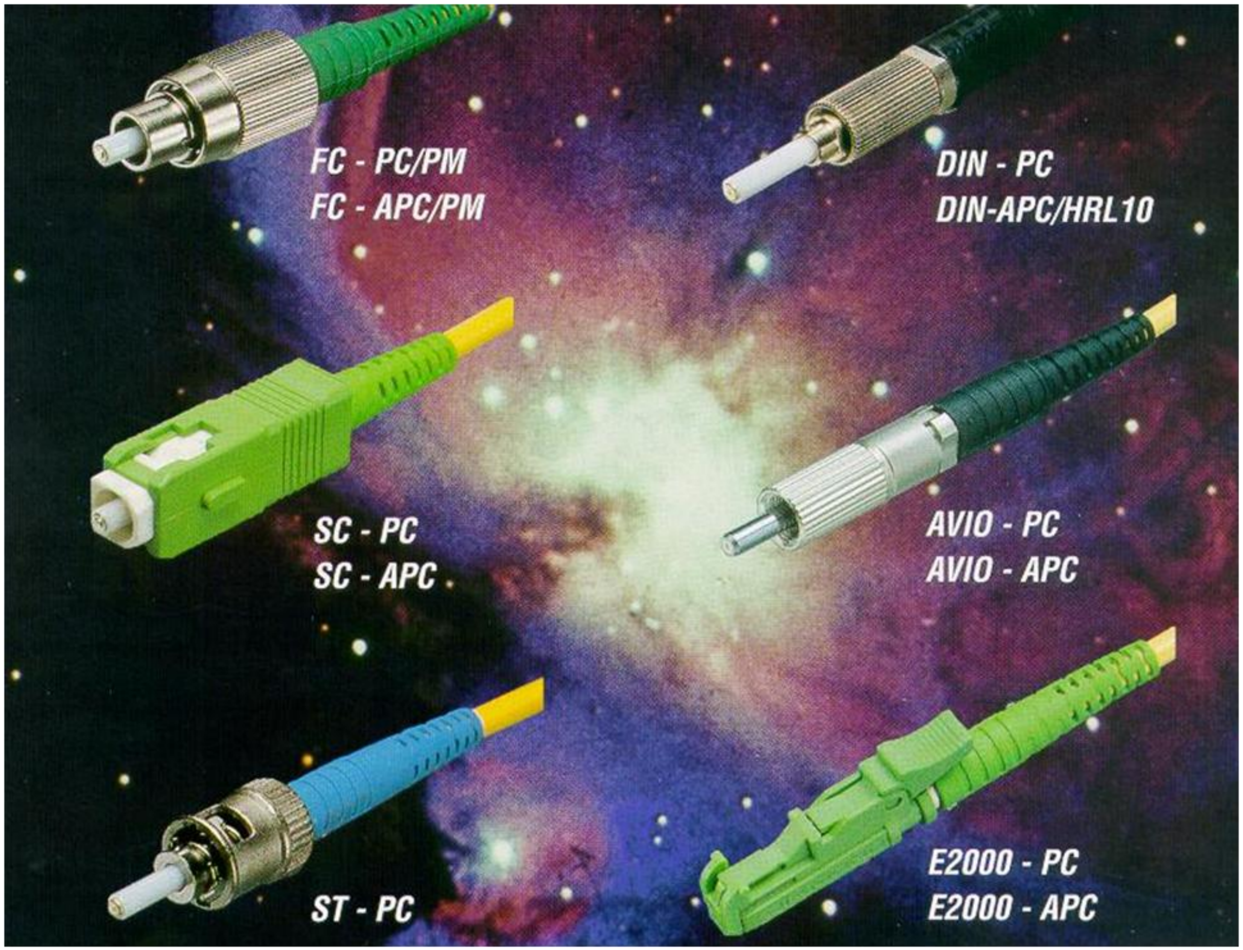
Cabluri




Copper tube

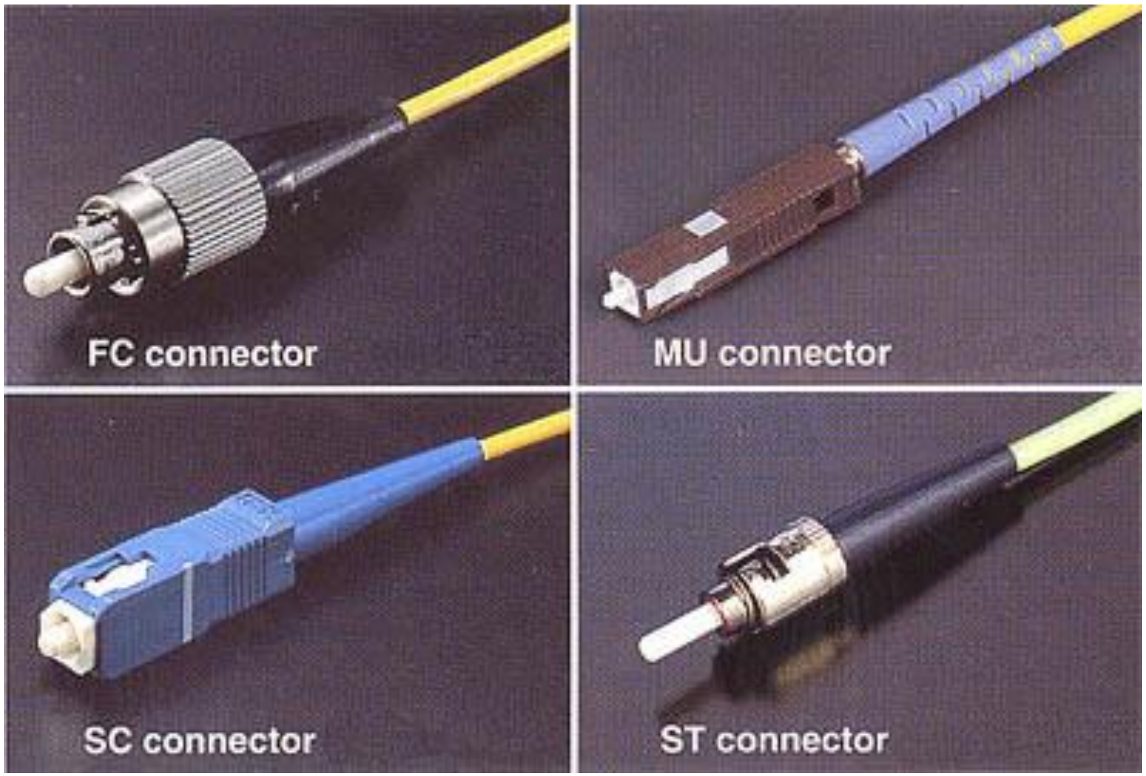

Primary coated fiber
12-fiber ribbon
12 ×12-fiber ribbons
= 144 fibers
"Lose tube"
Finished cable with central strength member and with six tubes with each tube containing 144 fibers

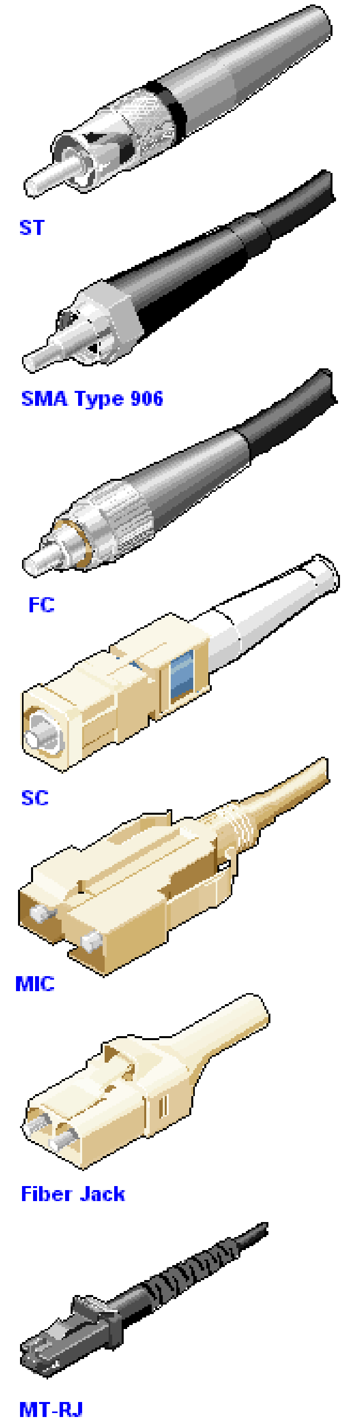
Conectori



FC - PC/PM
FC - APC/PM
DIN - PC
DIN-APC/HRL10
SC - PC
SC - APC
AVIO - PC
AVIO - APC
ST - PC
E2000 - PC
E2000 - APC

Conectori





All fiber-optic connectors use ferrules to hold the ends of the fiber and keep them properly aligned.

The ST connector uses a half-twist bayonet type of lock, while SMA and FC use threaded connections.

The SC uses a push-pull connector similar to common audio and video plugs and sockets.

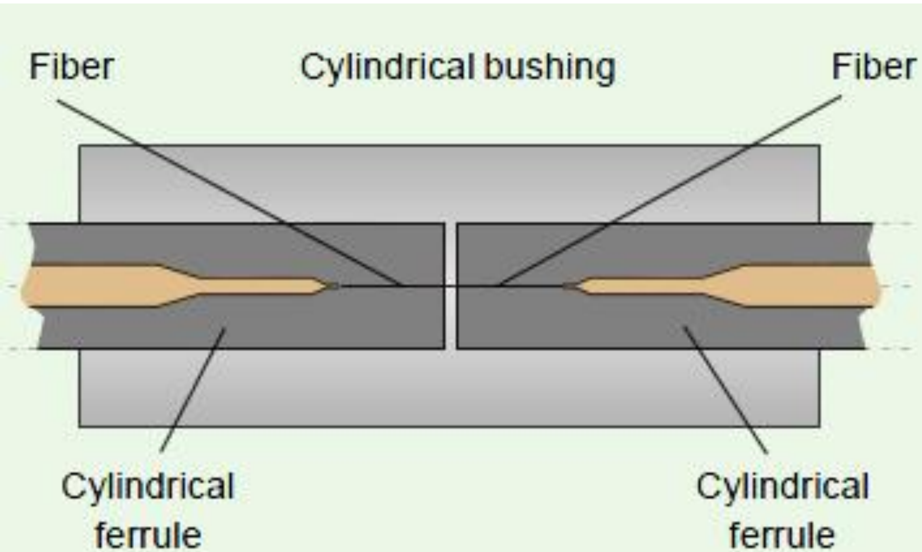
The MIC is the standard FDDI connector.

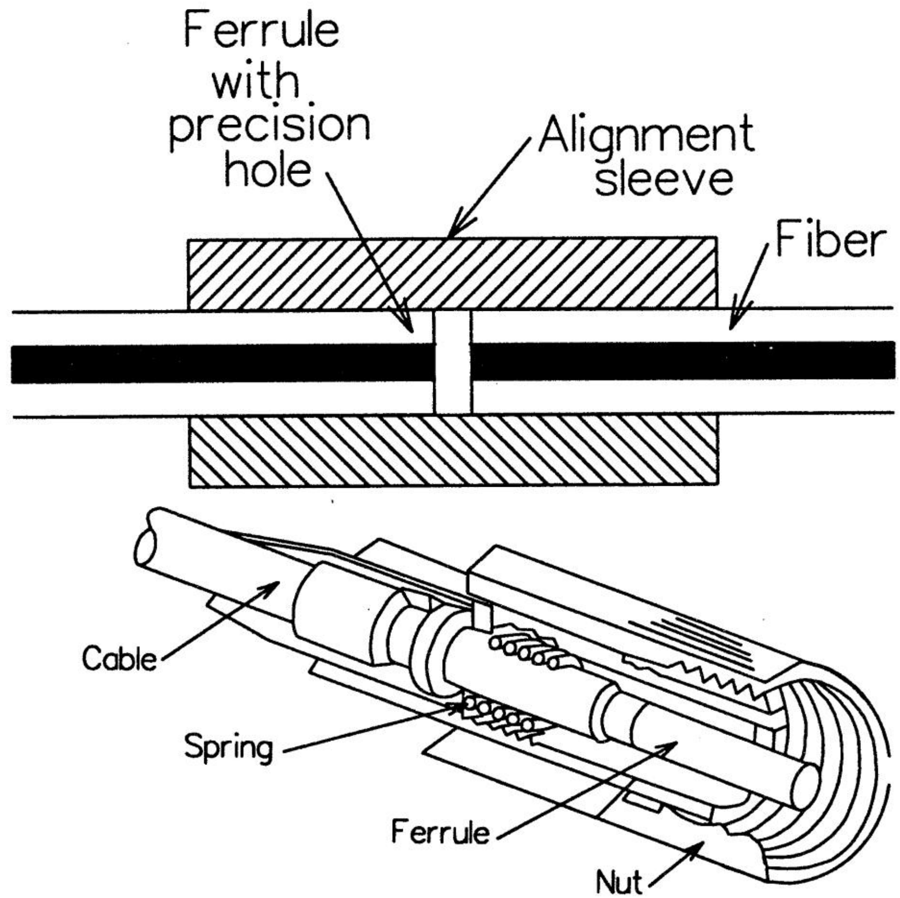
The Fiber Jack connector attaches two fibers in a snap lock connector similar in size and ease of use as an RJ-45 connector.

MT-RJ is a popular connector for two fibers in a very small form factor.

Conectori

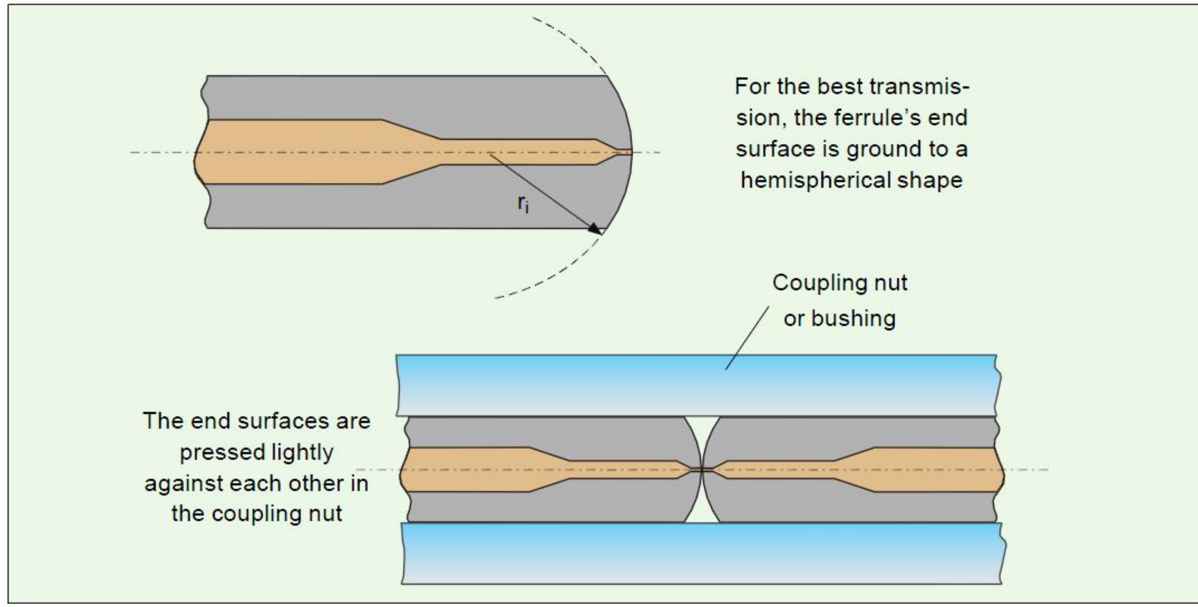
- Verificati http://rf-opto.etc.tuiasi.ro





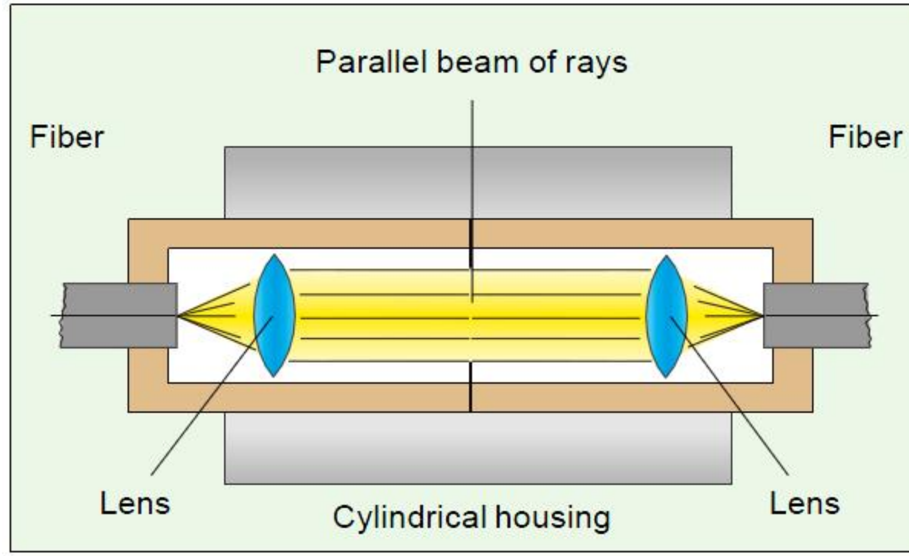
Conectori

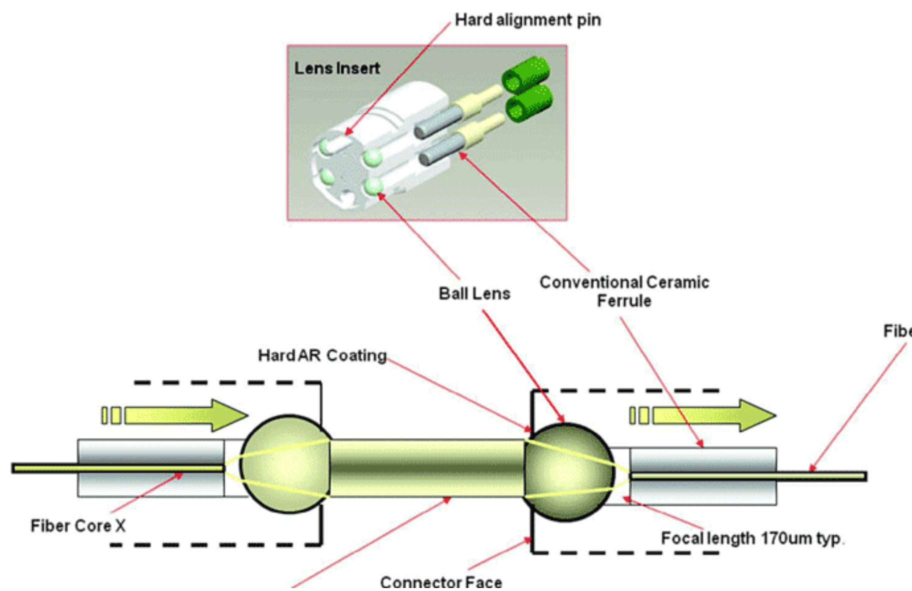
- Ferula semisferica
  - 20mm
  - 60mm



- Conectori multifibra

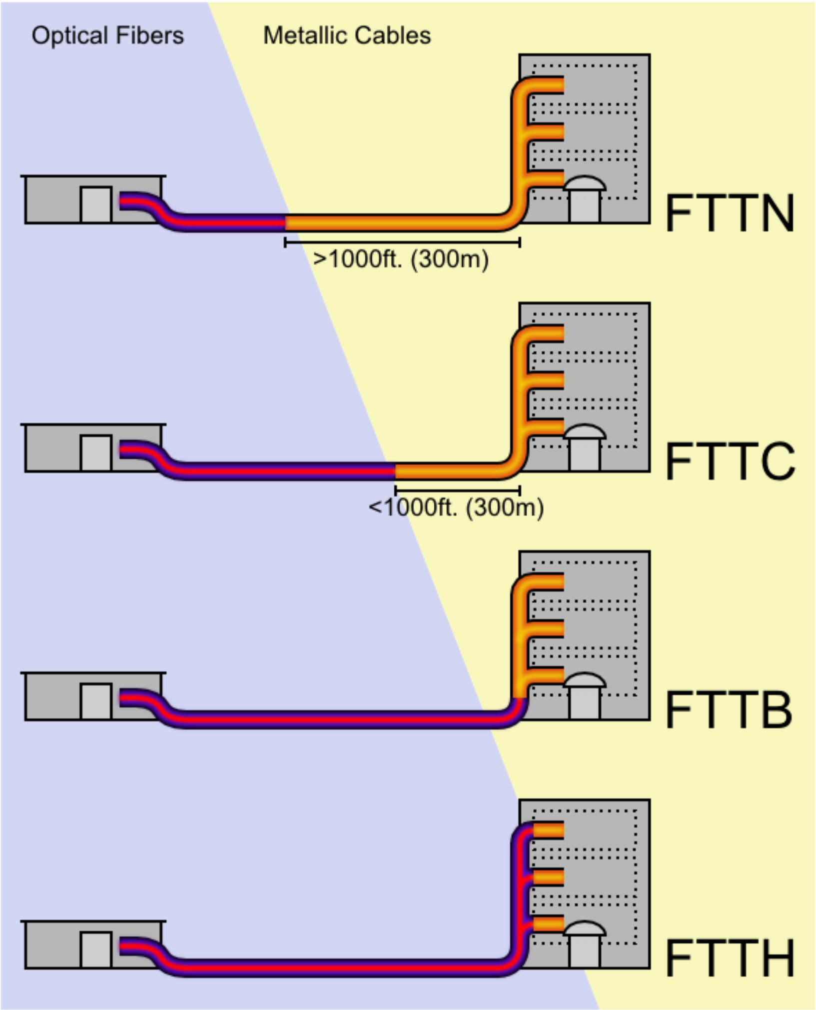
Expanded beam connector





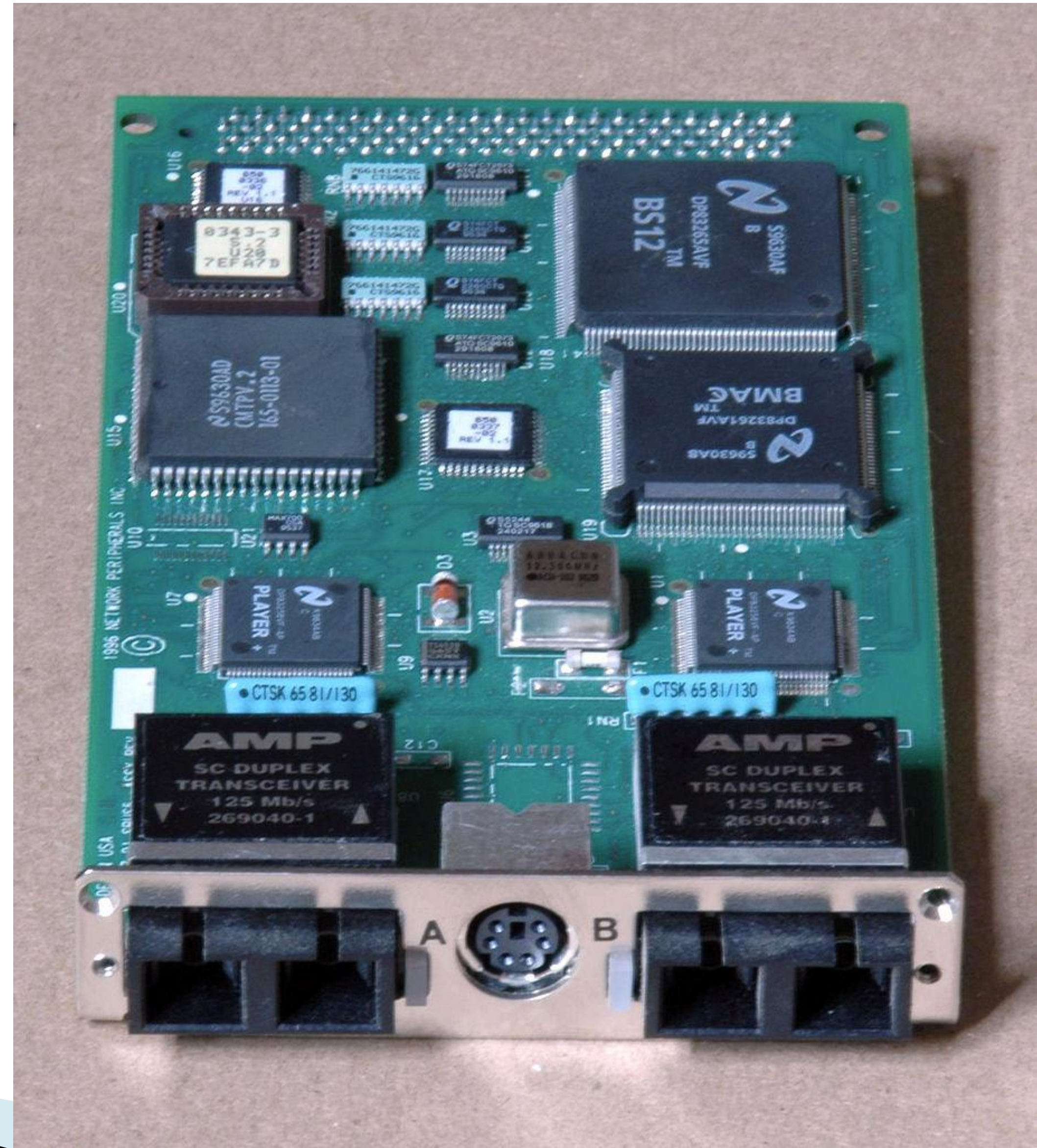
FTTH

- FTTN: Fiber to the node, neighborhood
- FTTC: Fiber to the curb
- FTTB: Fiber to the building
- FTTH: Fiber to the home



FDDI

- Fiber Distributed Data Interface



Contact

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