

Optoelectronică

Curs 7->s8

2025/2026

Disciplina 2025/2026

- ▶ 2C/1L Optoelectronică **OPTO**
- ▶ **Minim 7 prezente curs + laborator**
- ▶ Curs – conf. **Radu Damian**
 - an IV μ E
 - Marti 14:00–16:00, P7 \rightarrow **P6**
 - E – 70% din nota (50%+20%)
 - **20% test (VP) la curs**, saptamana **5–7?**
 - probleme + (2p prez. curs)
 - toate materialele permise
- ▶ Laborator – sl. **Catalin Iov**
 - an IV μ E
 - Marti 16–18, I.08
 - Max. 7 prezente
 - L – 30% din nota (+Caiet de laborator +Probleme)

Cuprins

- ▶ **Lumina ca undă electromagnetică*** (ecuațiile lui Maxwell, ecuația undelor, parametri de propagare)
- ▶ **Elemente de fotometrie și radiometrie*** (mărimi energetice/luminoase)
- ▶ **Fibra optică** (realizare, principiu de funcționare, atenuare, dispersie, banda de frecvență)
- ▶ **Cabluri optice** (tehnologie, conectori, lipire – splice)
- ▶ **Proiectare sistemică a legăturii pe fibra optică** (bandă de frecvență, balanța puterilor)
- ▶ **Emitătoare optice** (LED și dioda laser – realizare fizică și funcționare)
- ▶ **Receptoare optice** (dioda PIN, dioda cu avalanșă – realizare fizică și funcționare)
- ▶ **Amplificatoare transimpedanță** (parametri, scheme tipice, TIA în buclă deschisă, cu reacție, diferențiale, control automat al câștigului)
- ▶ **Realizarea circuitelor pentru controlul emițătoarelor optice** (parametri, scheme tipice, controlul puterii, multiplexoare)
- ▶ **Dispozitive de captare a energiei solare** (principiu de funcționare, utilizare, proiectare)

* – VP

Acces

- ▶ Personalizat (parola), Generic (email)



Student profile page showing a photo, personal details, and a table of grades. A red circle highlights the link "Acceseaza ca acest student" and an arrow points to the login page.

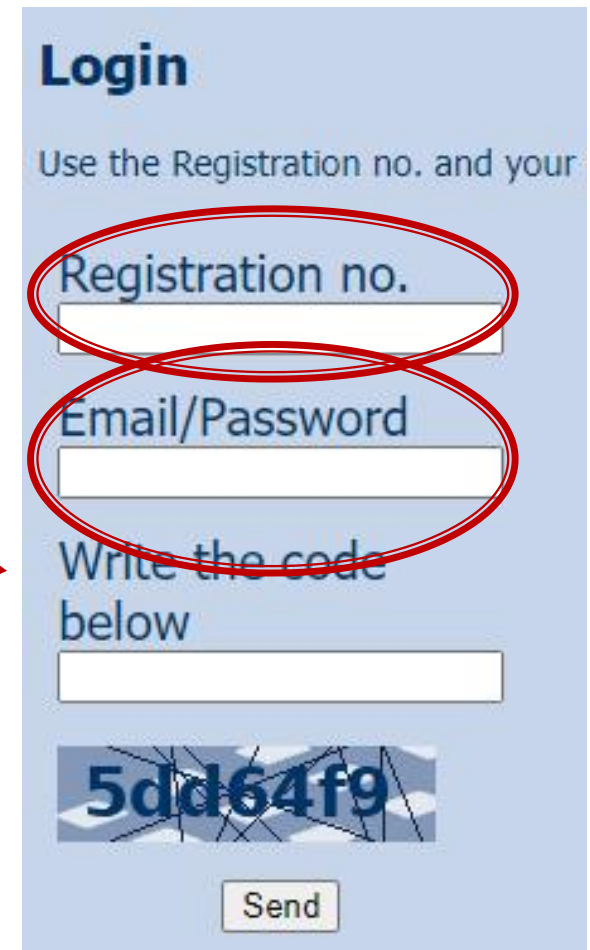
Date:

Grupa	5304 (2015/2016)
Specializarea	Tehnologii si sisteme de telecomunicatii
Marca	5184

[Acceseaza ca acest student](#)

Note obtinute

Disciplina	Tip	Data	Descriere	Nota	Puncte	Obs.
TW			Tehnologii Web			
N		17/01/2014	Nota finala	10	-	
A		17/01/2014	Colocviu Tehnologii Web 2013/2014	10	7.55	
B		17/01/2014	Laborator Tehnologii Web 2013/2014	9	-	
D		17/01/2014	Tema Tehnologii Web 2013/2014	9	-	



Login page with a registration number and password field, a CAPTCHA, and a Send button. Red circles highlight the registration number and email/password fields.

Login

Use the Registration no. and your

Registration no.

Email/Password

Write the code below

5dd64f9

Send

Fibra optică

Capitolul 4

Aplicatii majore

▶ Comunicatii

- Infrarosu (InGaAsP)

▶ Vizibil

- Spectru vizibil (GaAlAs)

▶ Iluminare

- Putere ridicata, lumina alba (GaInN)

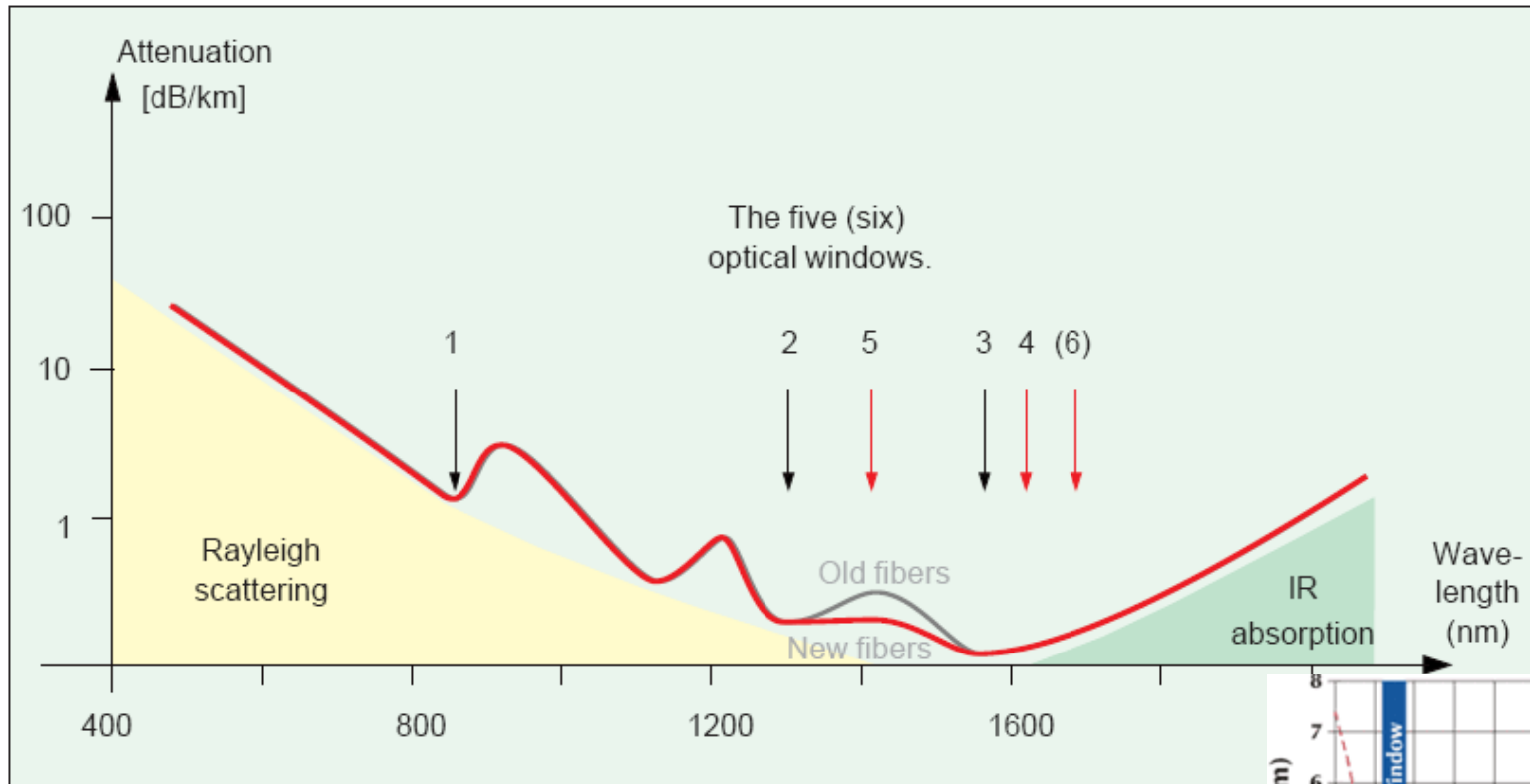
▶ Energie solara

- Efect fotovoltaic (Si)

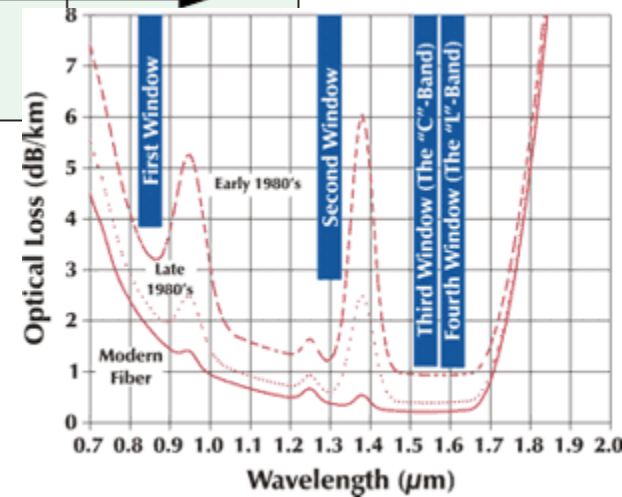
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Atenuarea în fibra optică (SiO₂)

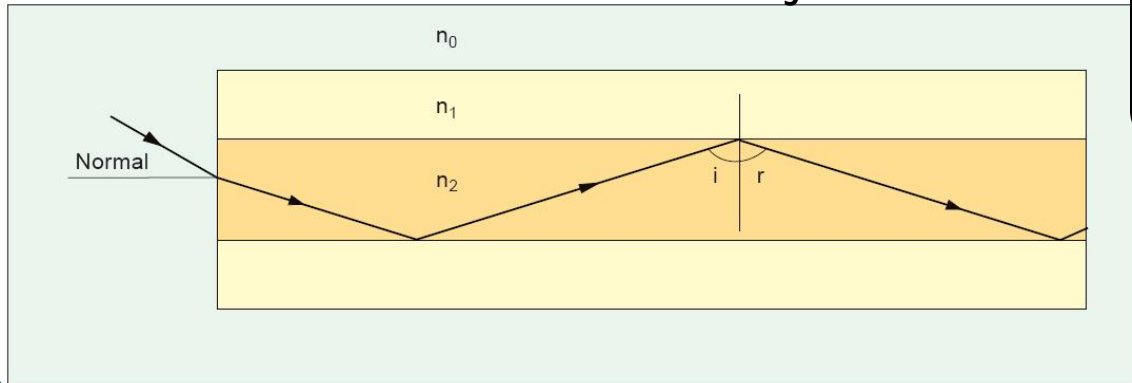
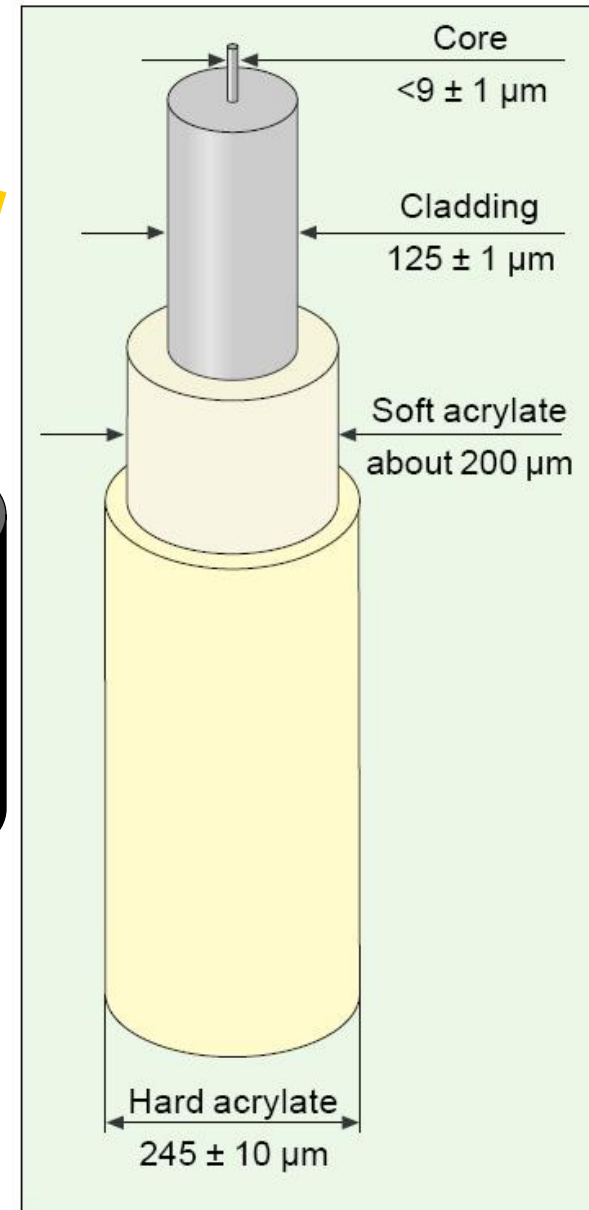
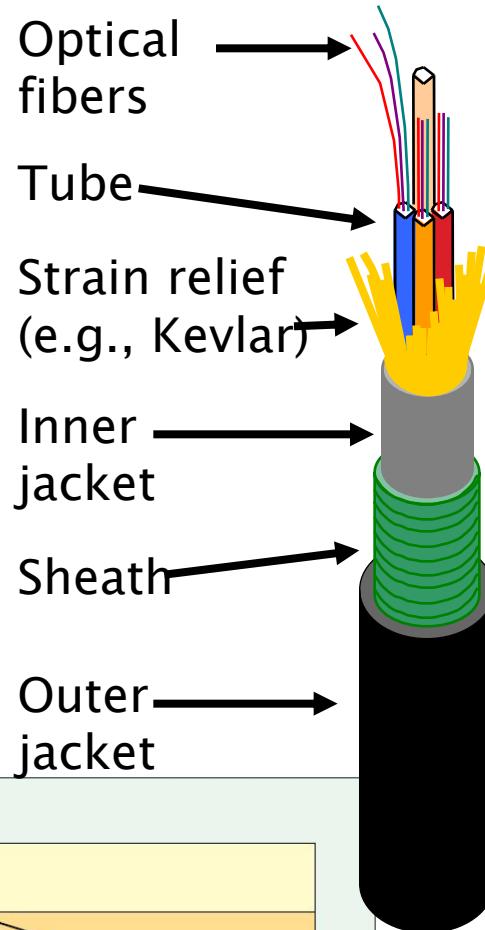


850nm, 1310nm, 1550nm



Fibra optica

- ▶ un ghid de unda dielectric
 - miez
 - teaca

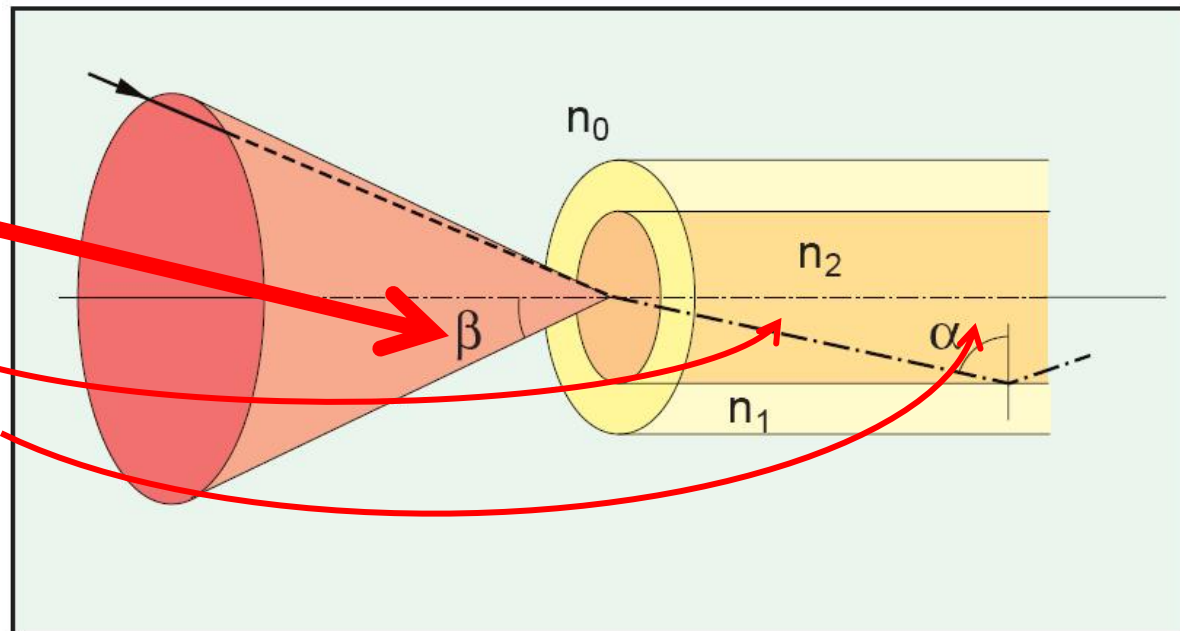


Unghi de acceptanta, apertura numerica

▶ Unghi de acceptanta

$$n_0 \cdot \sin \theta_{ACC} = n_2 \cdot \sin \phi_2$$

$$n_0 \cdot \sin \theta_{ACC} = n_2 \cdot \cos \phi_c$$

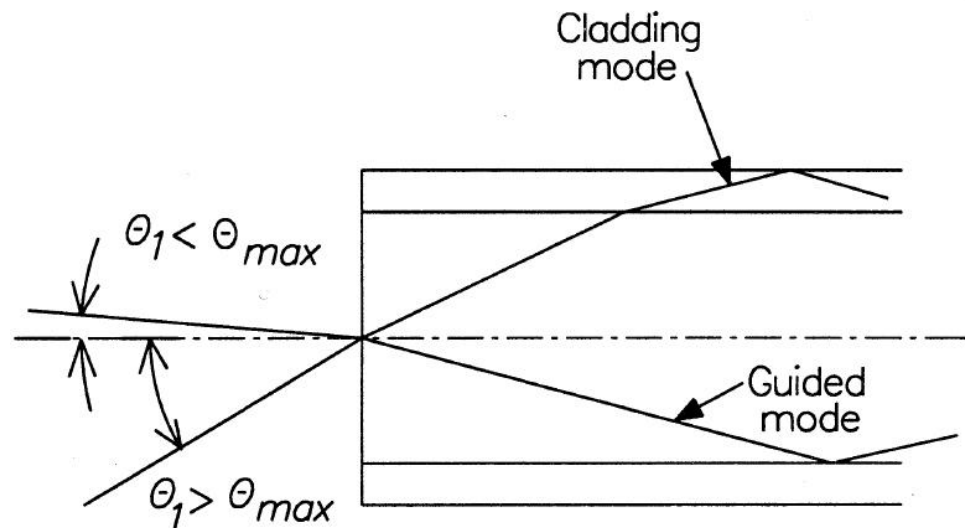


▶ Apertura numerica

$$NA = n_0 \cdot \sin \theta_{ACC}$$

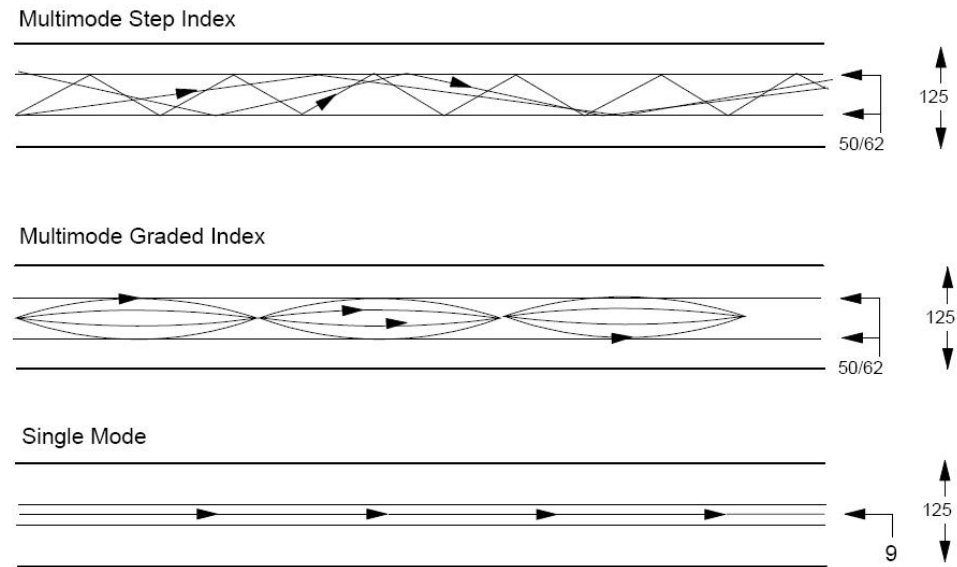
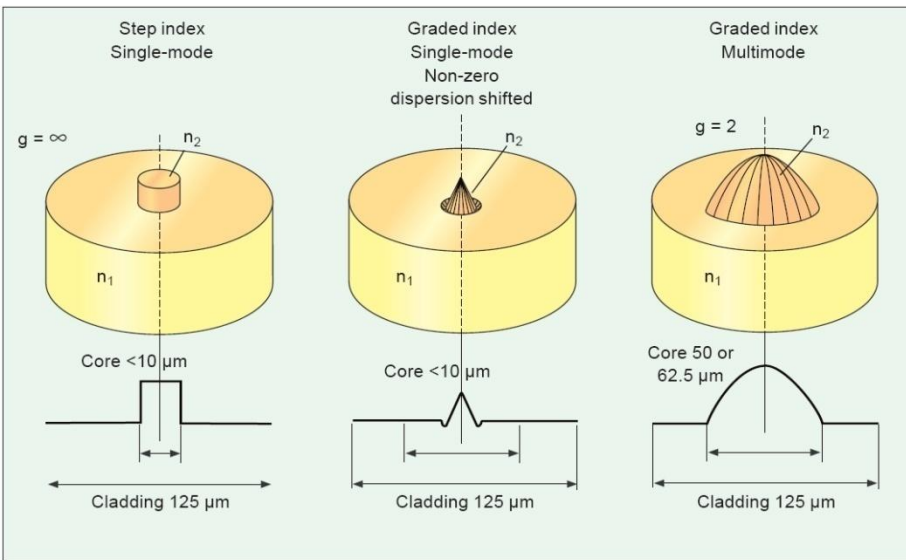
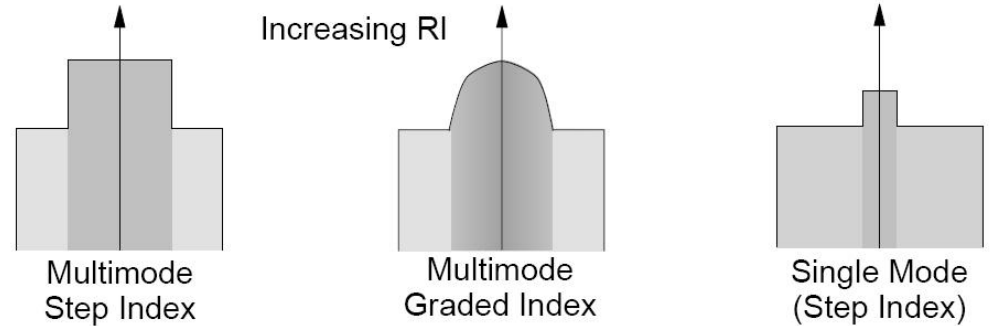
$$NA = n_2 \sqrt{\frac{n_2^2 - n_1^2}{n_2^2}} = \sqrt{n_2^2 - n_1^2}$$

n_2 - miez
 n_1 - teaca
 $n_2 > n_1$!!



Tipuri de fibra

- ▶ Monomod
- ▶ Multimod
 - cu salt de indice
 - cu indice gradat



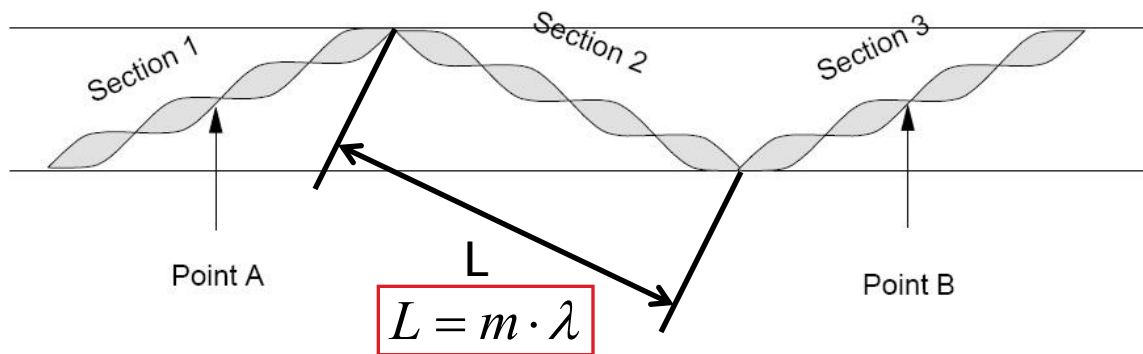
Frecventa normalizata

► Frecventa normalizata

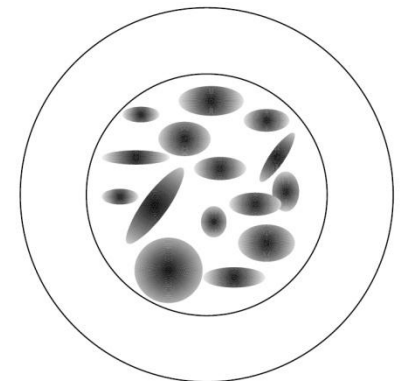
$$V = 2\pi \frac{a}{\lambda} NA = k \cdot a \cdot NA \quad a - \text{raza miezului}$$

$$k = \frac{2\pi}{\lambda}$$

► Numar de moduri

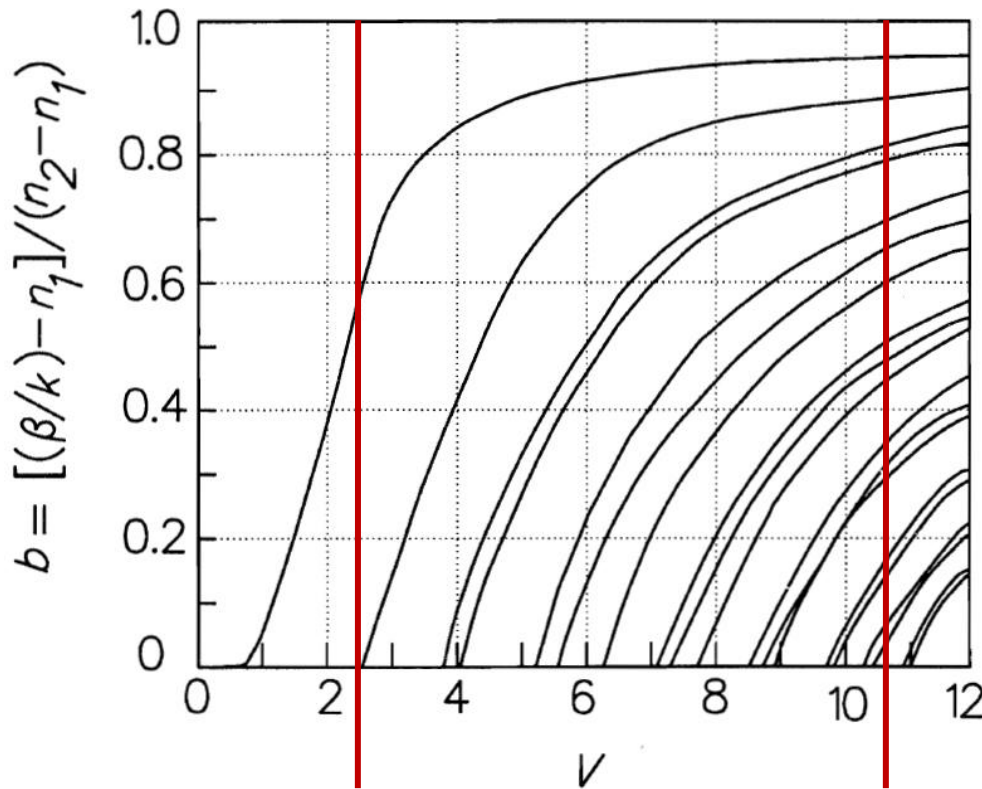


$$N \approx \frac{V^2}{2} \cdot \frac{g}{g+2}$$



Frecventa normalizata – monomod

► Fibre monomod



b – coeficient de propagare modal relativ

$$V \leq V_c = 2.405$$

exista un **singur** mod (solutii fc. Bessel)

$$V = 2\pi \frac{a}{\lambda} NA = k \cdot a \cdot NA$$

$$\lambda \geq \lambda_c = \pi \frac{2a}{V_c} NA = \pi \frac{2a}{2.405} NA$$

Exemplu:

$$2a = 8.5 \mu\text{m}$$

$$NA = 0.11$$

$$\lambda_c = \pi \frac{8.5}{2.405} 0.11 = 1210 \text{nm}$$

Fenomene de interes

- ▶ Cat de departe pot transmite semnalul luminos pe fibra
 - **atenuare**
- ▶ Cat de rapid pot transmite informația
 - dispersie

Atenuare

$$E_y(z_1) = Ct \cdot e^{-\alpha \cdot z_1} \cdot e^{j(\omega t - \beta \cdot z_1)}$$

$$E_y(z_2) = Ct \cdot e^{-\alpha \cdot z_2} \cdot e^{j(\omega t - \beta \cdot z_2)}$$

$$W, P \sim \int E^2$$

$$A = \frac{P_2}{P_1} = \frac{Ct^2 \cdot e^{-2\alpha \cdot z_2}}{Ct^2 \cdot e^{-2\alpha \cdot z_1}} = e^{-2\alpha \cdot (z_2 - z_1)}$$

$$A[dB] = 10 \log_{10} \frac{P_2}{P_1} = 10 \log_{10} \left[e^{-2\alpha \cdot (z_2 - z_1)} \right]$$

$$A[dB] = -20 \cdot \alpha \cdot (z_2 - z_1) \log_{10} e = -8.686 \cdot \alpha \cdot (z_2 - z_1)$$

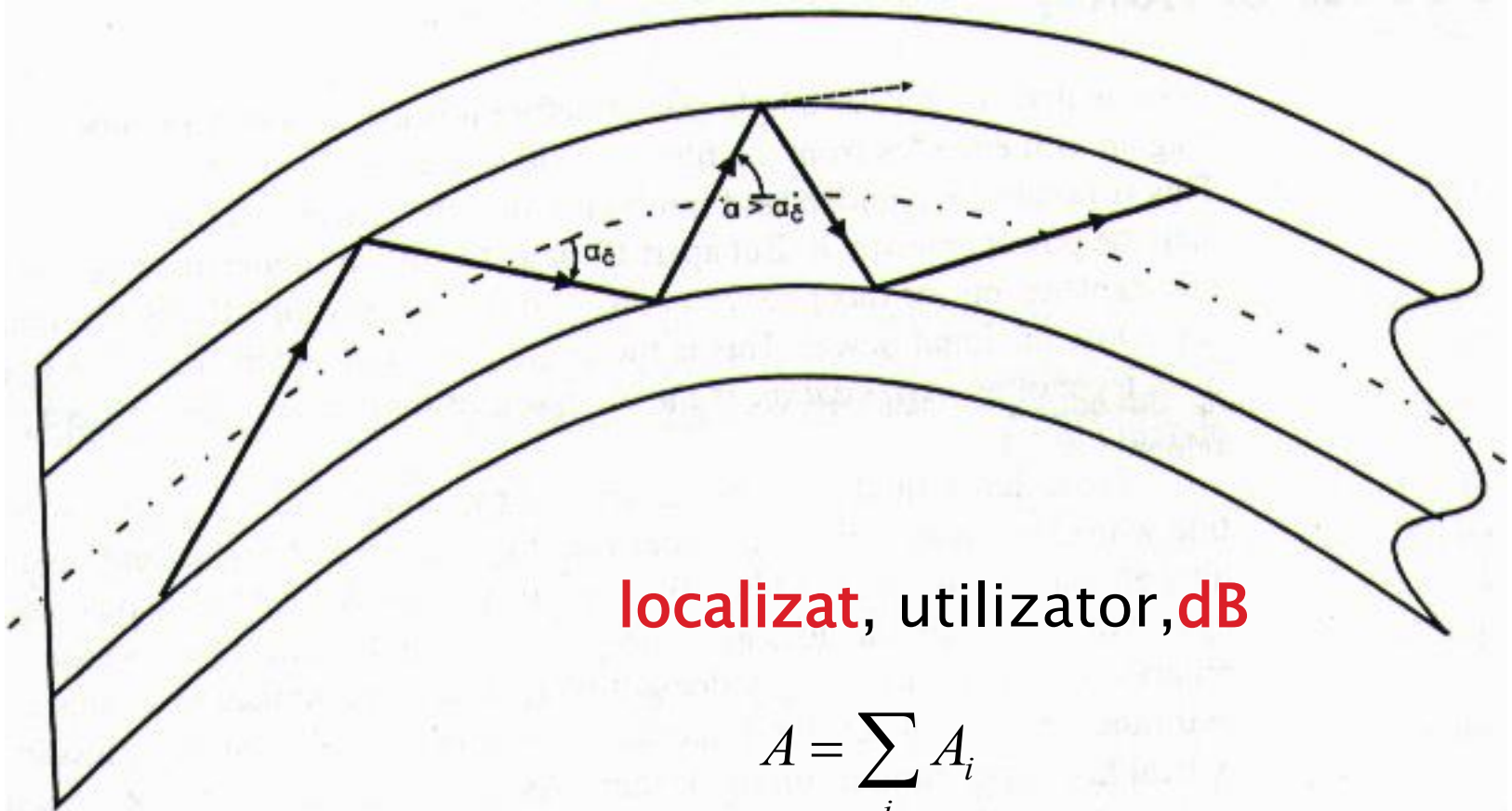
$$A / L [dB / km] = -8.686 \cdot \alpha < 0$$

- ▶ Atenuarea se exprima de obicei in **dB/km**
 - ▶ de obicei valori pozitive
 - ▶ semnul = **implicit**

Atenuare

- ▶ Macrocurburi
 - utilizator, **localizat**, dB
- ▶ Discontinuitate in fibra
 - utilizator, **localizat**, dB
- ▶ Microcurburi
 - **distribuit**, tehnologie, dB/km
- ▶ Imprastiere
 - **distribuit**, tehnologie, dB/km
- ▶ Absorbție
 - **distribuit**, material, dB/km

Macrocurburi



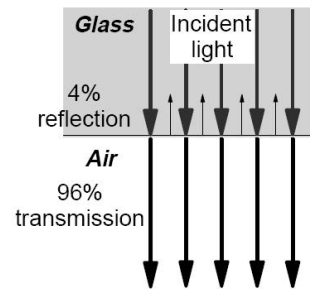
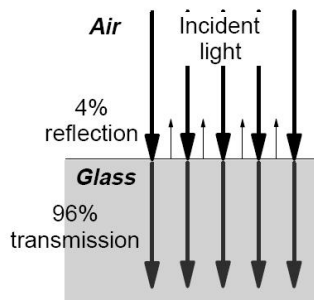
localizat, utilizator, dB

$$A = \sum_i A_i$$

$$A = N \cdot A_i$$

Discontinuitate in fibra

- ▶ Apare cand nu putem considera fibra un singur ghid dielectric
 - defectiuni
 - conectori

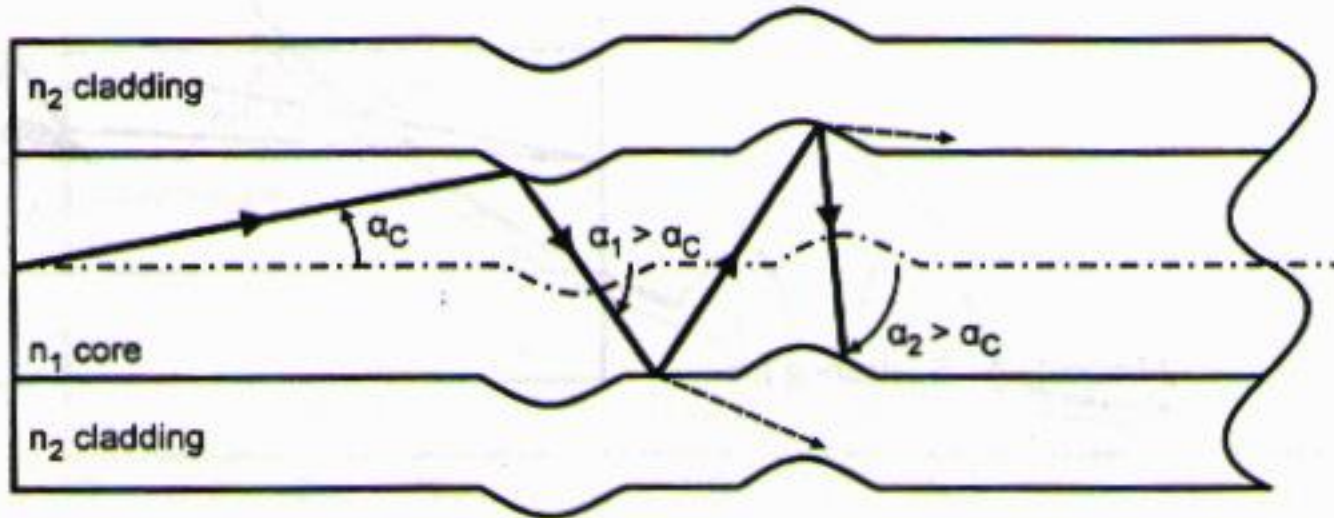


localizat, utilizator, dB

$$A = \sum_i A_i$$

$$A = N \cdot A_i$$

Microcurburi

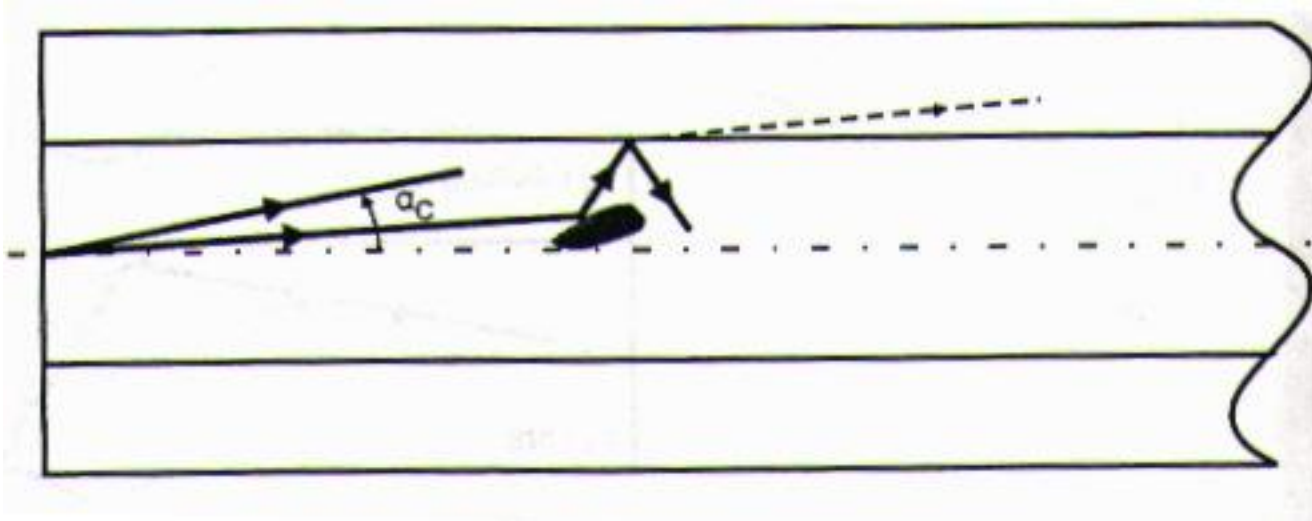


distribuit, tehnologie, **dB/km**

$$A = A_i \cdot L$$

$$A[dB] = A_i[dB / km] \cdot L[km]$$

Imprastiere

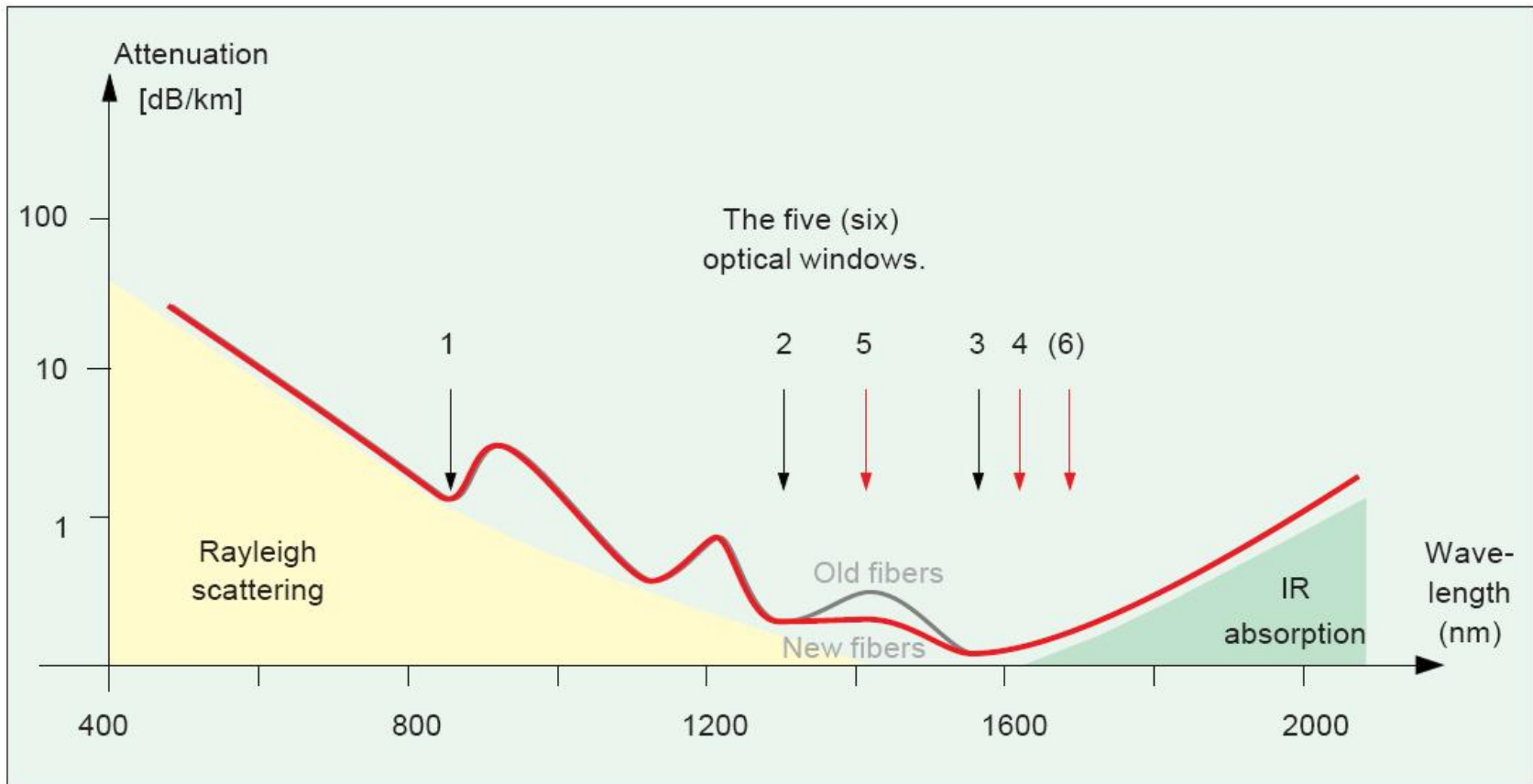


distribuit, tehnologie, **dB/km**

$$A = A_i \cdot L$$

$$A[dB] = A_i[dB / km] \cdot L[km]$$

Absorbtie



distribuit, material, dB/km

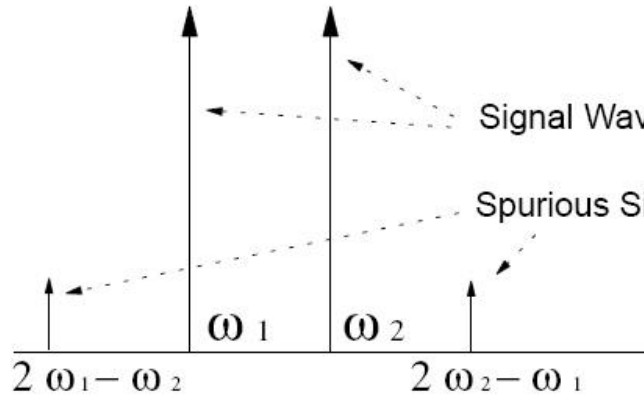
$$A[dB] = A_i[dB / km] \cdot L[km]$$

Efecte neliniare in fibra

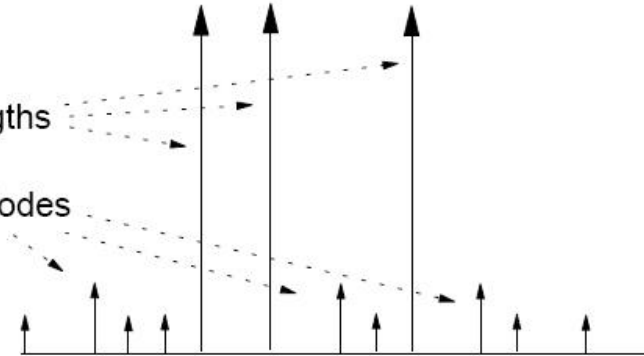
- ▶ **Stimulated Brillouin Scattering, SBC**
 - difractia luminii inspre emitator datorita undelor mecano-acustice generate in fibra
 - 6–10 dBm
- ▶ **Stimulated Raman Scattering, SRS**
 - interactiunea luminii cu vibratiile moleculare
 - 27 dBm (~1W)
- ▶ **Self Phase Modulation, SPM**
 - Frontiera impulsului implica indice de refractie variabil in timp moduland faza impulsului
 - 5 dBm
 - Cross Phase Modulation, CPM
- ▶ **Four-Wave Mixing, FWM**
 - 0 dBm

Four-Wave Mixing, FWM

Two Channels



Three Channels

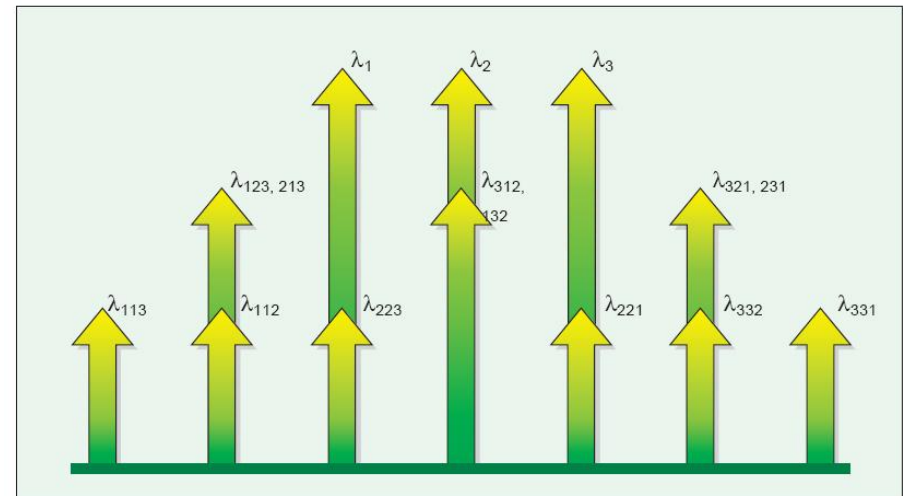


$$NL = \frac{1}{2}(N^3 - N^2)$$

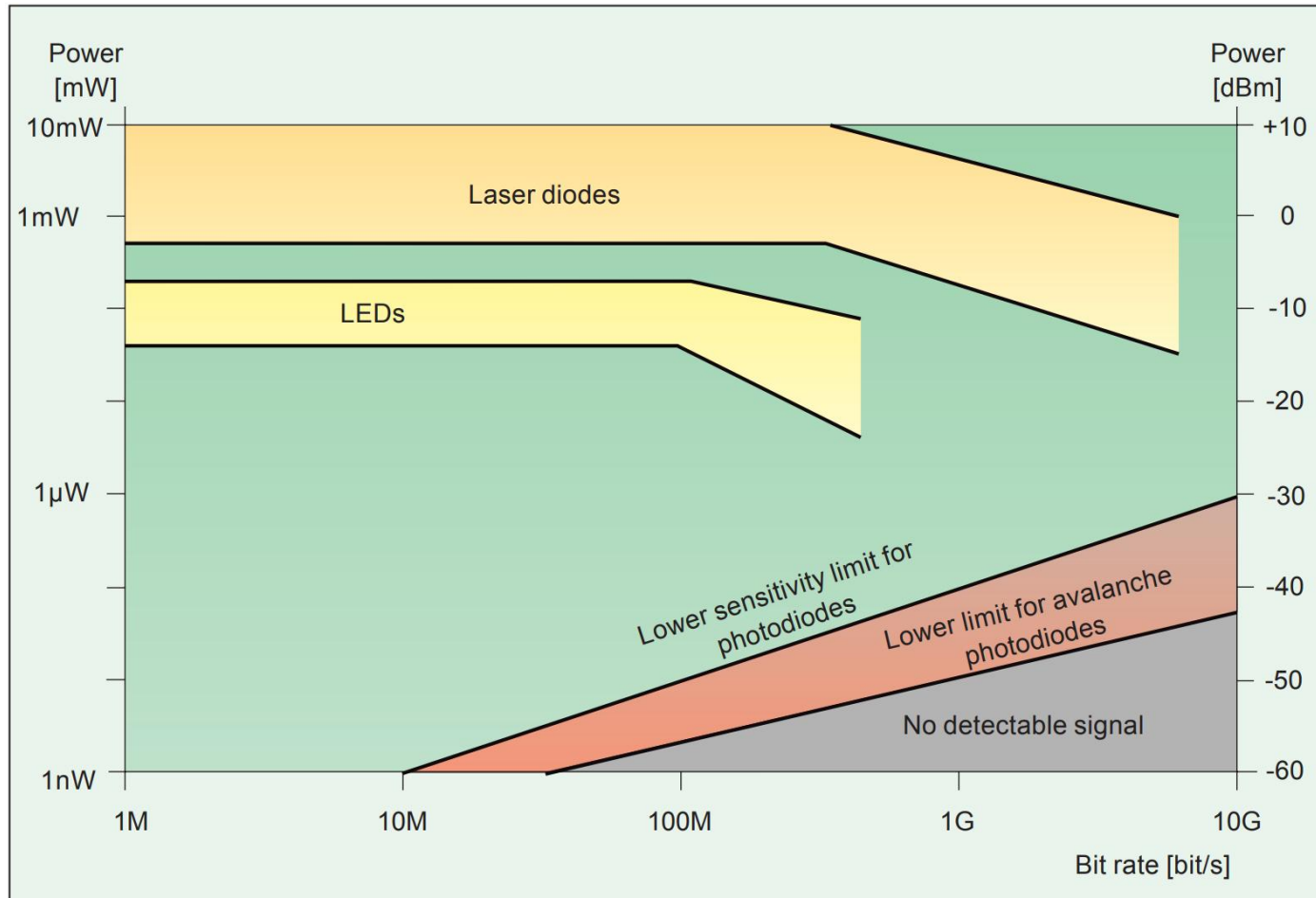
$$N = 2, NL = 4$$

$$N = 3, NL = 9$$

$$N = 16, NL = 1920$$



Limite putere/bandă a dispozitivelor optoelectronice

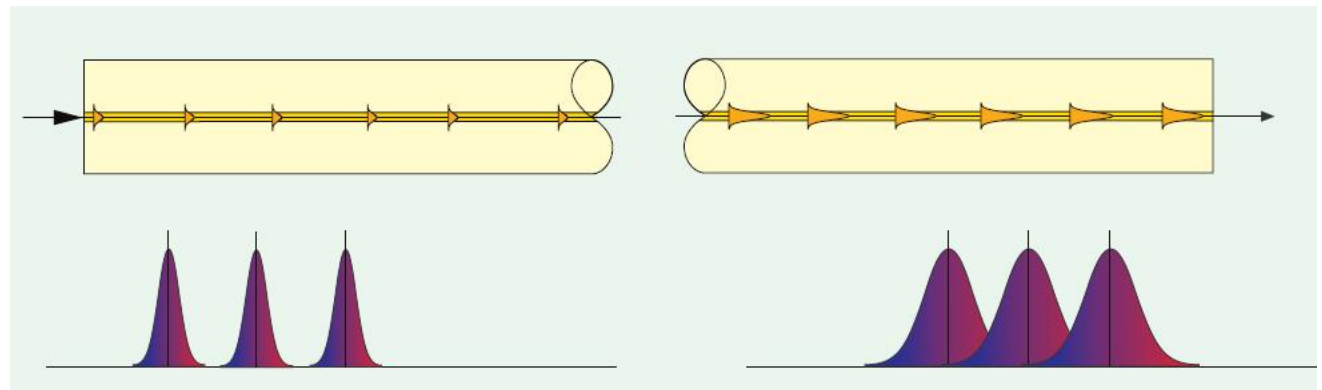


Fenomene de interes

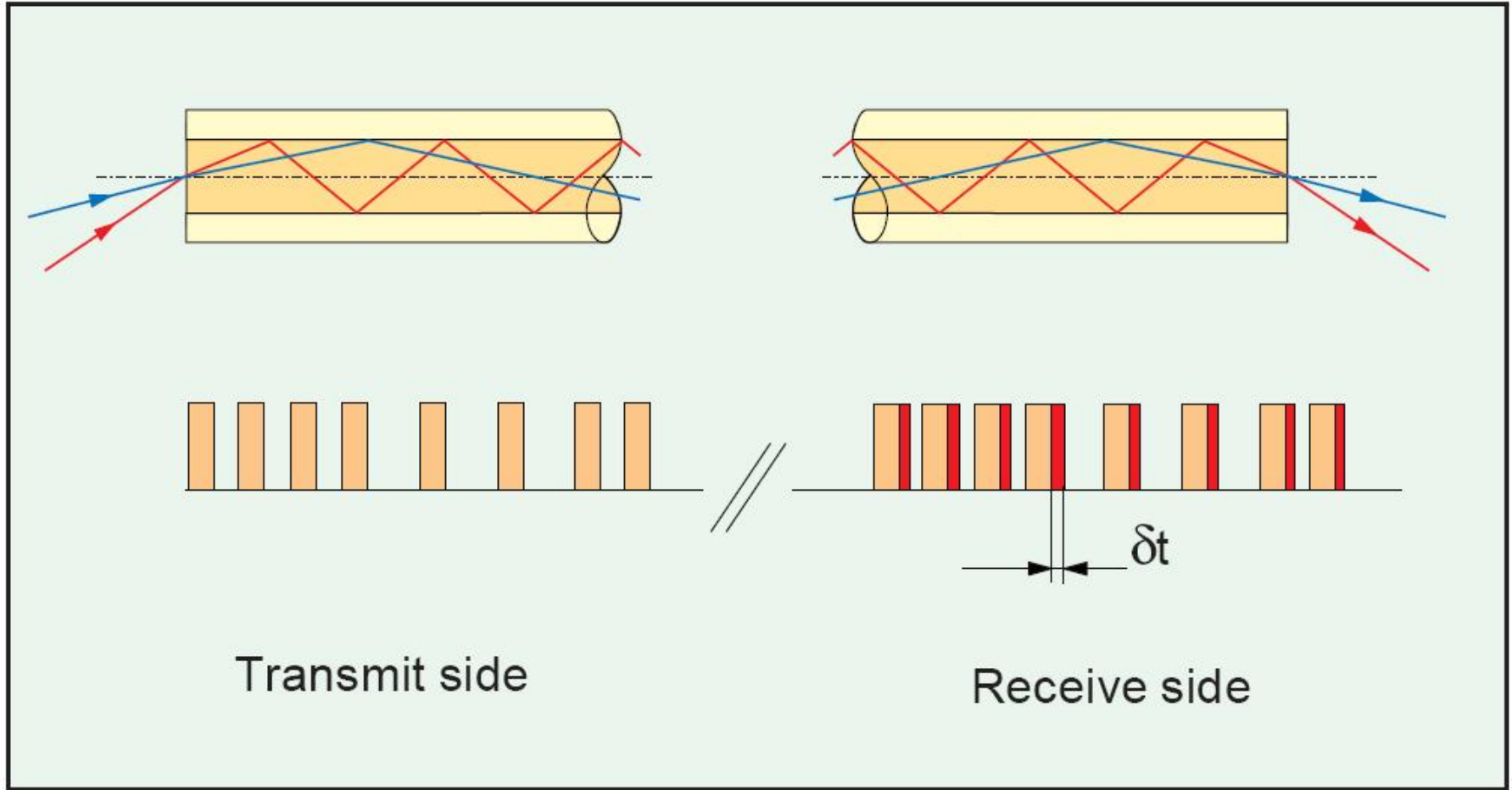
- ▶ Cat de departe pot transmite semnalul luminos pe fibra
 - atenuare
- ▶ Cat de rapid pot transmite informația
 - **dispersie**

Dispersia

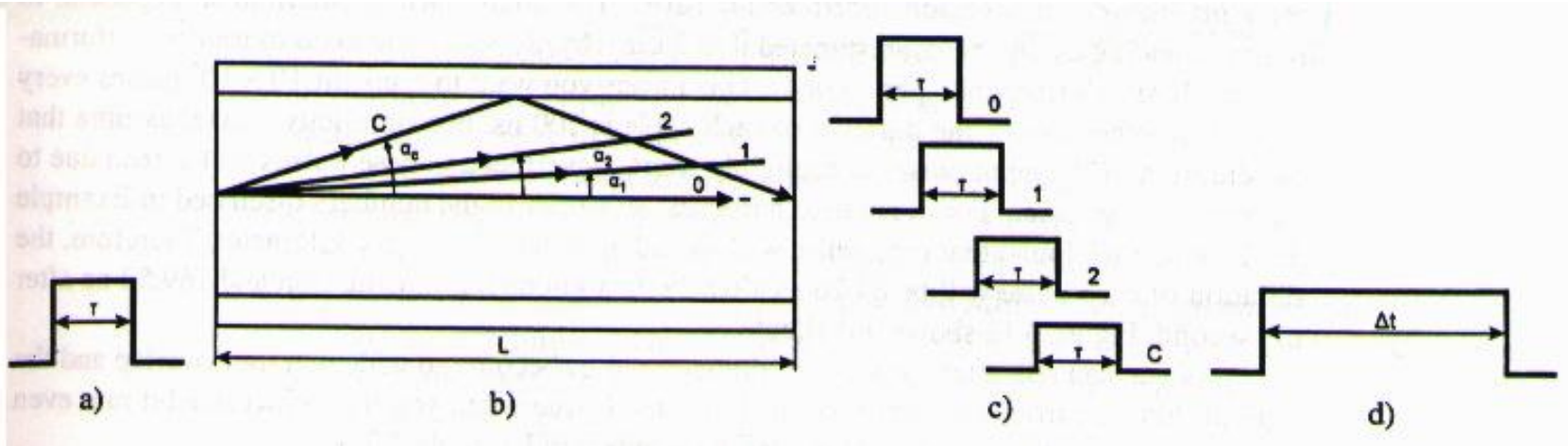
- ▶ Propagarea cu viteze diferite a radiatiilor cu trasee/lungimi de unda diferite
 - intermodala (**modala** – depinde de prezenta modurilor)
 - intramodala (**cromatica** – depinde de lungimea de unda)
 - de material
 - de ghid



Dispersia modala



Dispersia modala



$$t_0 = \frac{L}{v}$$

$$t_C = \frac{L}{v \cdot \cos \alpha_C}$$

$$v = \frac{c}{n_2}$$

$$\cos \alpha_C = NA$$

$$\Delta t_{SI} = t_C - t_0 = \frac{L \cdot n_2}{c} \cdot \left(\frac{n_2 - n_1}{n_2} \right)$$

$$\Delta t_{SI} = t_C - t_0 = \frac{L \cdot n_2}{c} \cdot \Delta$$

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

$$\Delta t_{SI} = t_C - t_0 \approx \frac{L}{2 \cdot c \cdot n_2} \cdot (NA)^2$$

$$\Delta t_{SI} \rightarrow dt$$

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

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

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

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

▶ indice gradat

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

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

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

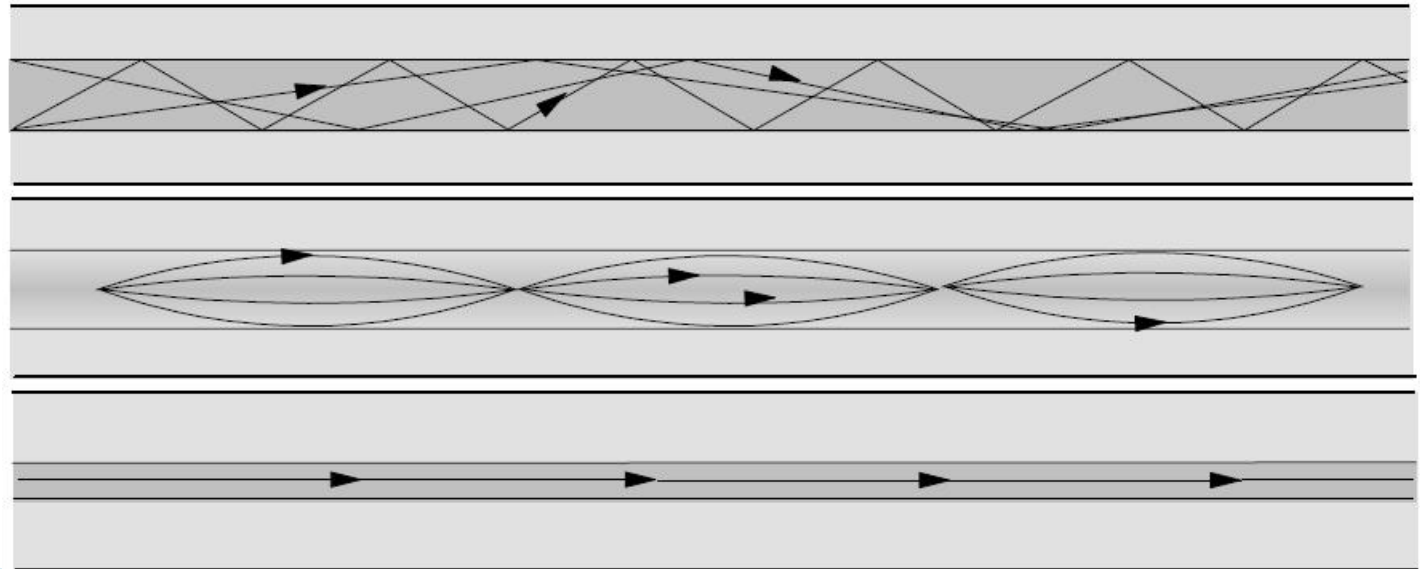
n_2 - miez

n_1 - teaca

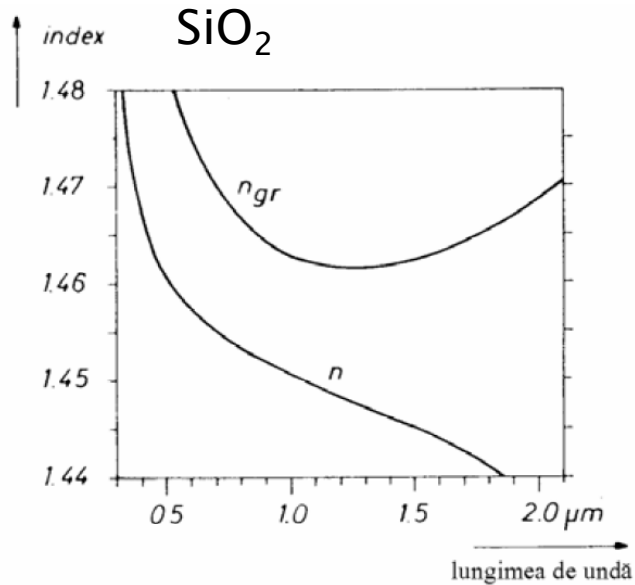
$n_2 > n_1$!!

Dispersia modala

- ▶ Mai mare la fibre multimod cu salt de indice
- ▶ Mai mica la fibre multimod cu indice gradat
 - traseele mai lungi trec prin zone cu indice mai mic
- ▶ **Inexistenta** la fibrele **monomod**

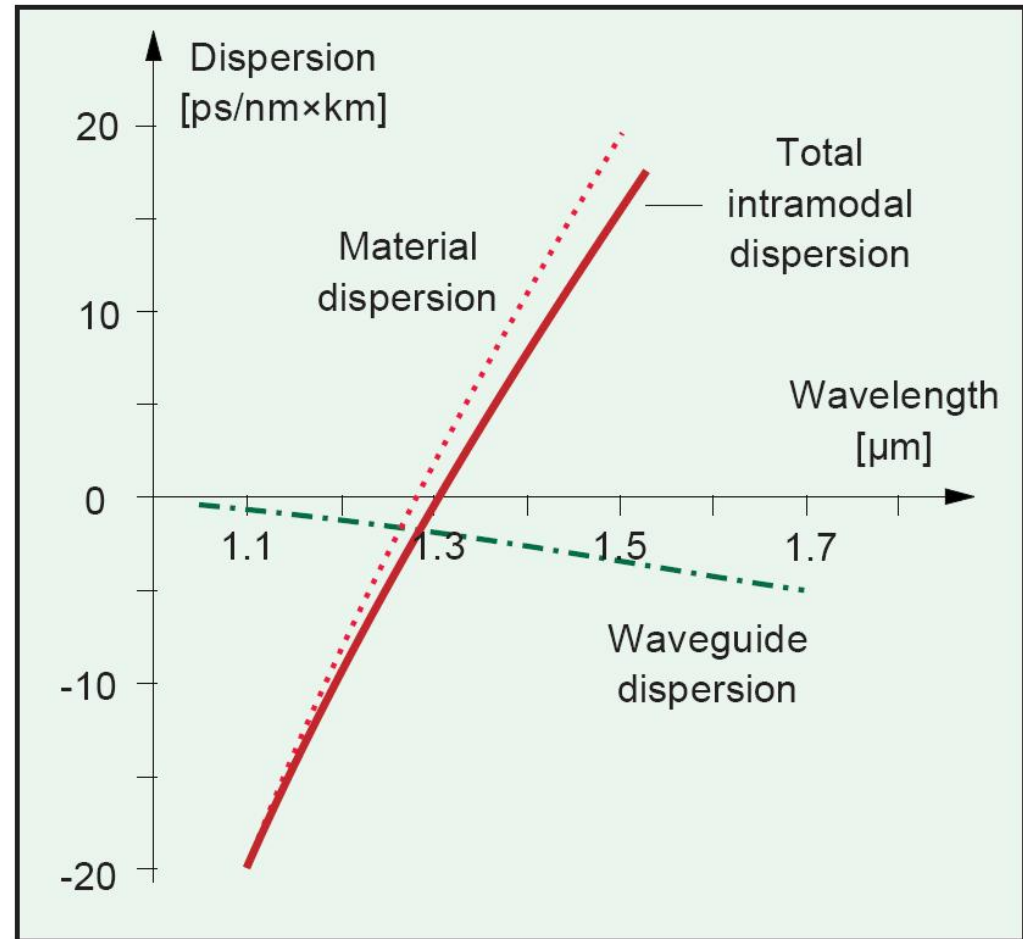


Dispersia de material



$$n_{gr} = n - \lambda \frac{dn}{d\lambda}$$

$$\Delta\tau_{mat} = \frac{L \cdot \lambda \cdot \Delta\lambda}{c} \cdot \frac{d^2n}{d\lambda^2}$$

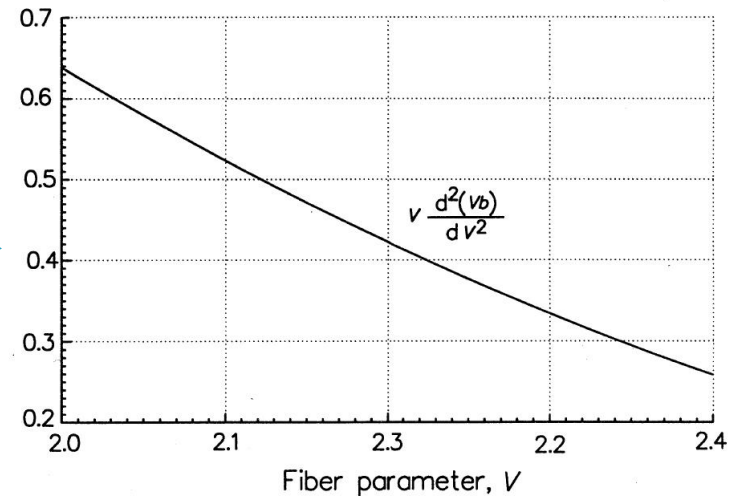
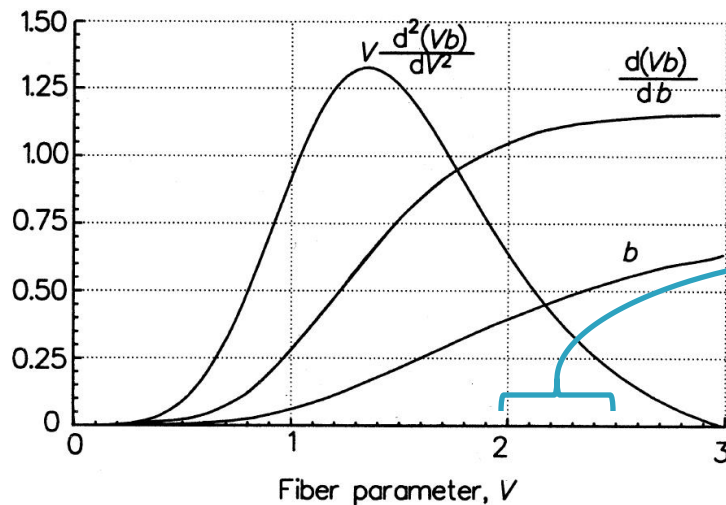


Dispersia de ghid

- ▶ Neglijabila in fibrele multimod fata de dispersia modala

$$\Delta \tau_{gh} = \frac{n \cdot L \cdot \Delta}{c} \cdot \frac{\Delta \lambda}{\lambda} \cdot \left(V \frac{d^2(Vb)}{dV^2} \right)$$

b - constanta de propagare normalizata



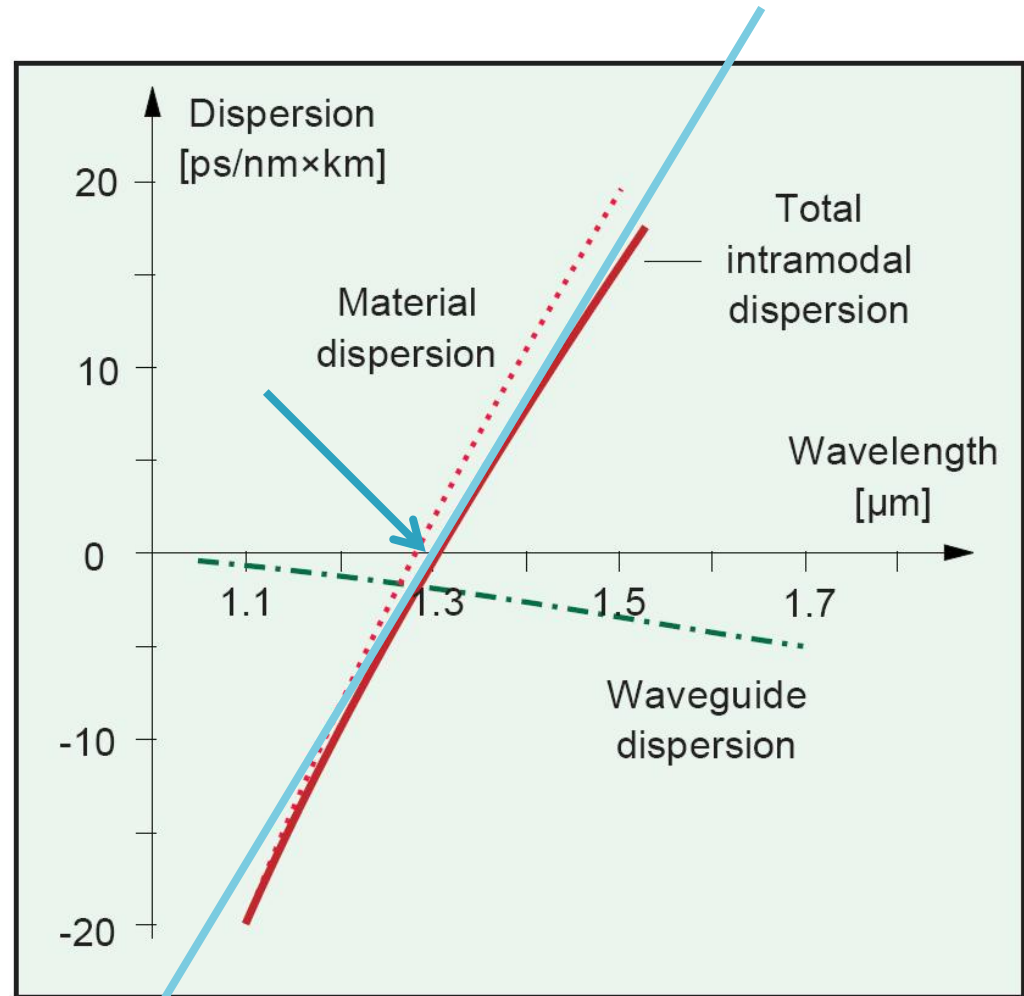
$$V \leq V_C = 2.405$$

Dispersia cromatica (gh+mat)

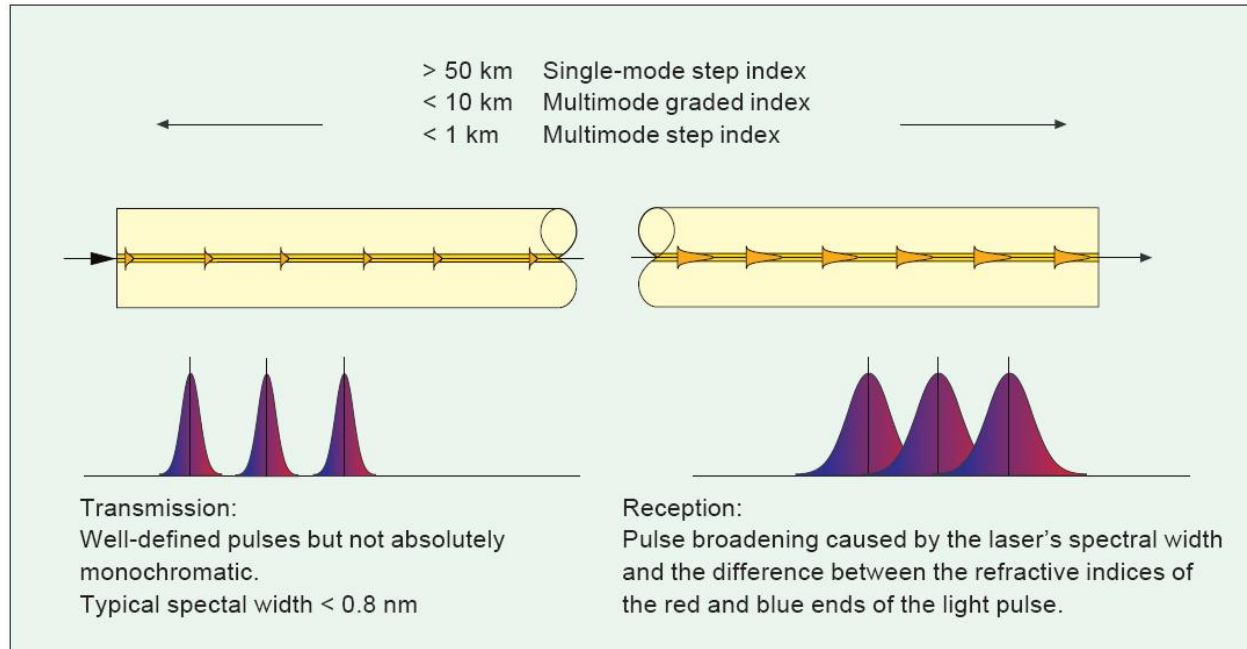
- ▶ Variatie aproximativ liniara
- ▶ Caracterizata de panta si punctul de trecere prin 0

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

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



Dispersia cromatica (gh+mat)



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

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

S_0 panta dispersiei -
ps/nm²/km

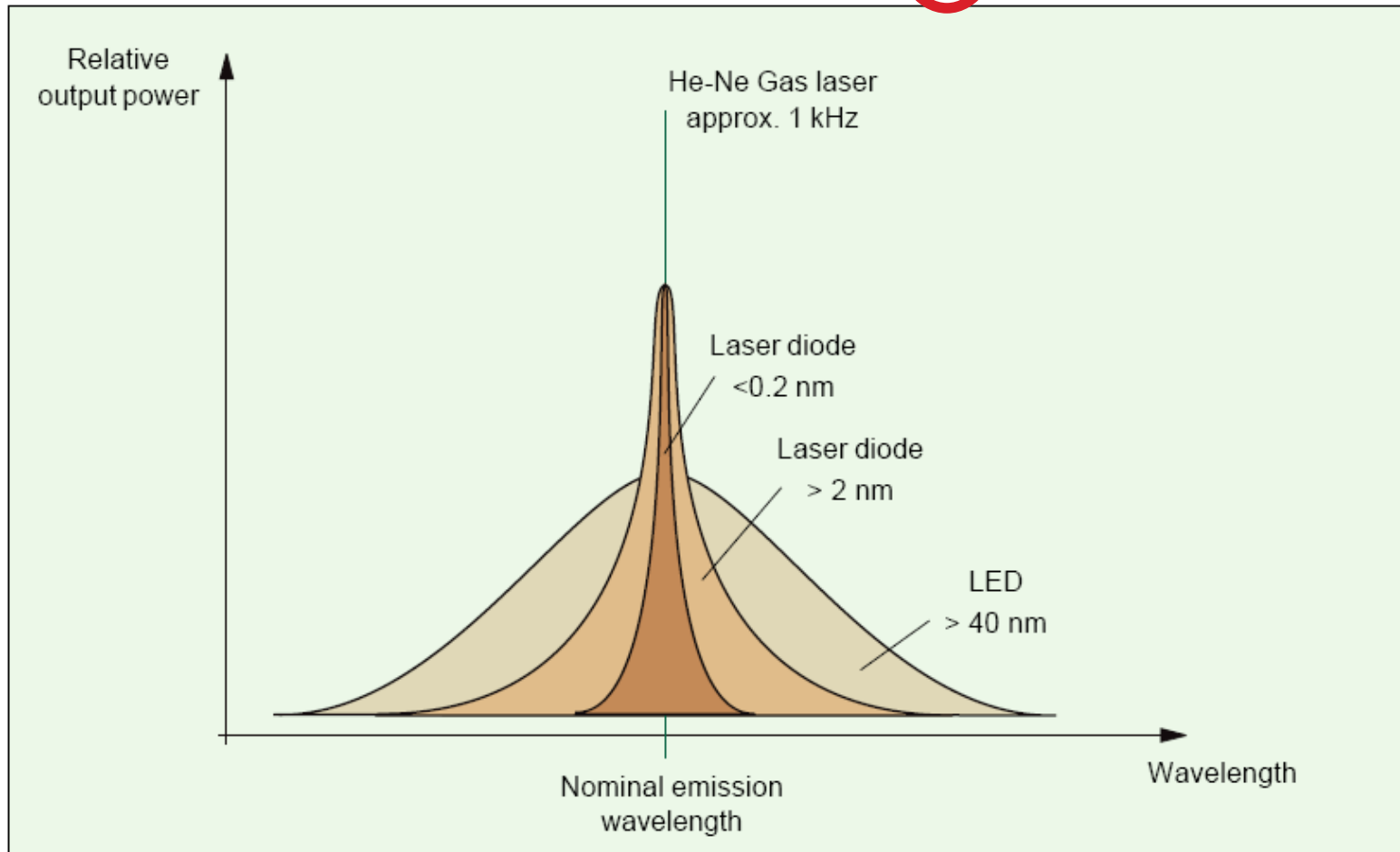
$$D(\lambda_0) = 0$$

- ▶ $D(\lambda) \approx 100 + 0.4 (850 - \lambda)$ [ps/nm/km]
pentru $800 < \lambda < 900$ nm
- ▶ $D(\lambda) \leq 3,5$ ps/nm/km
pentru $1285 < \lambda < 1330$ nm
- ▶ $D(\lambda) \leq 17$ ps/nm/km
pentru $1525 < \lambda < 1575$ nm

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

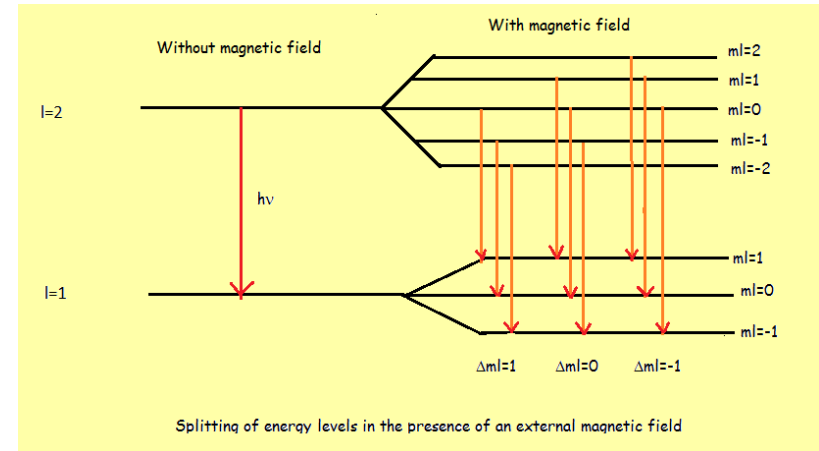
Calitatea spectrală a emițătorilor optici

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

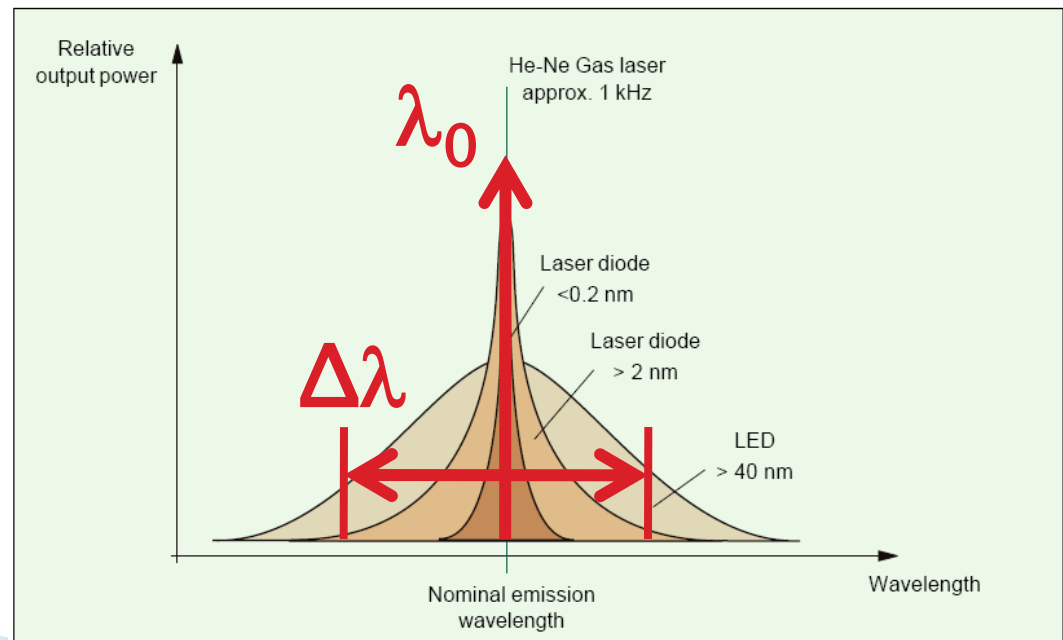


Calitatea spectrală a emițătorilor optici

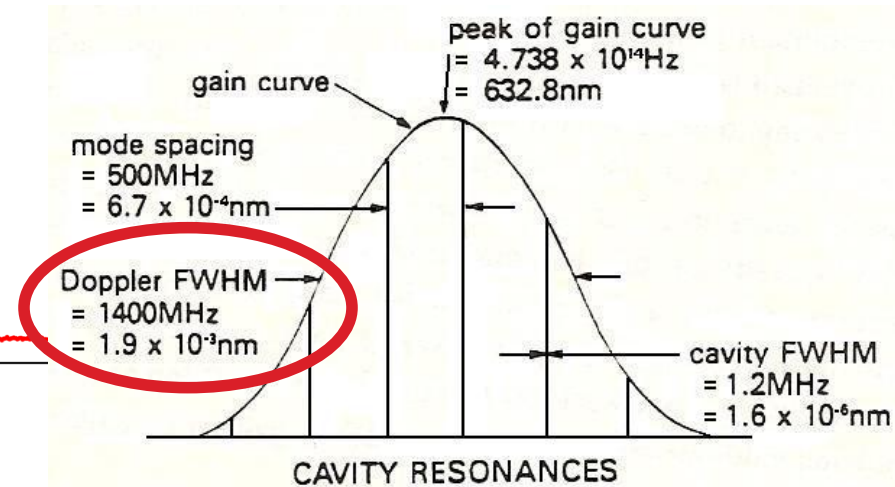
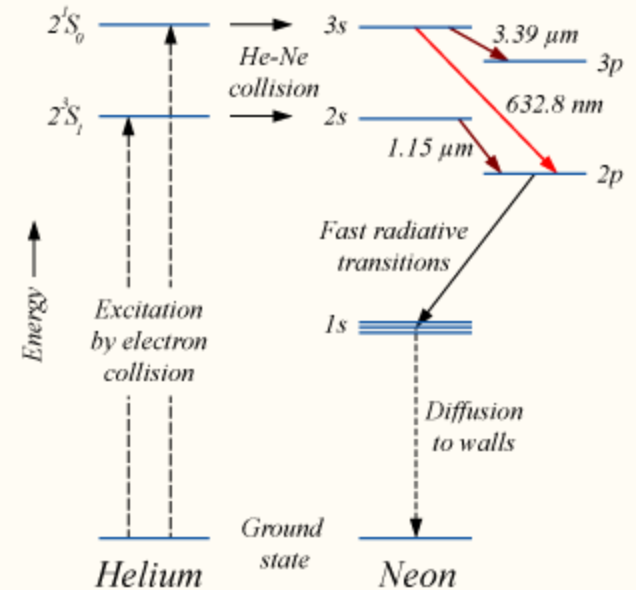
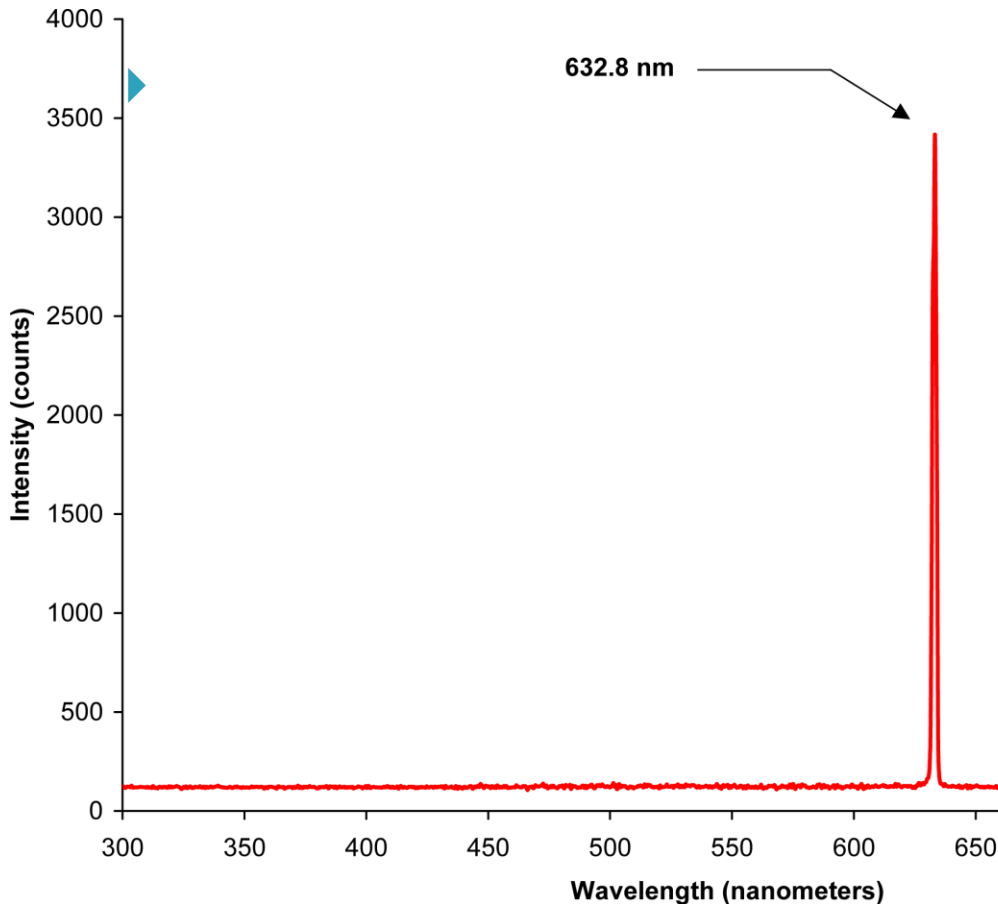
- ▶ degenerarea nivelelor energetice duce la aparitia benzilor energetice
- ▶ Multitudinea de tranzitii posibile intre cate doua nivele situate in benzi energetice diferite duce la largirea caracteristicii spectrale a surselor



$$\lambda_0 \rightarrow \left[\lambda_0 - \frac{\Delta\lambda}{2}, \lambda_0 + \frac{\Delta\lambda}{2} \right]$$



He-Ne Laser



$$\Delta\lambda = 0.002 \text{ nm}$$

Dispersia

▶ Dispersia modala

▶ salt de indice

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

▶ indice gradat

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

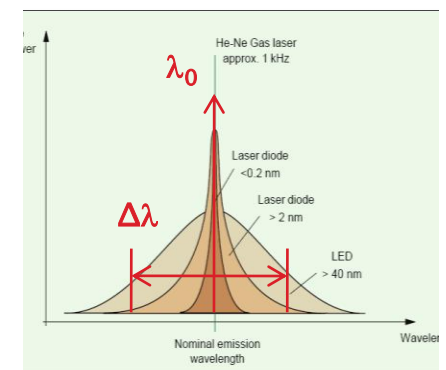
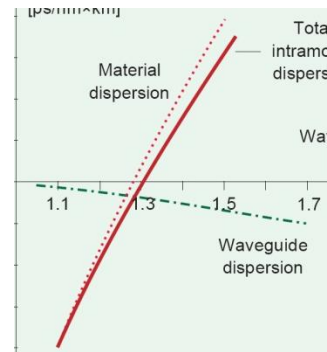
$$\Delta = 0.01 \div 0.02 \ll 1$$

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

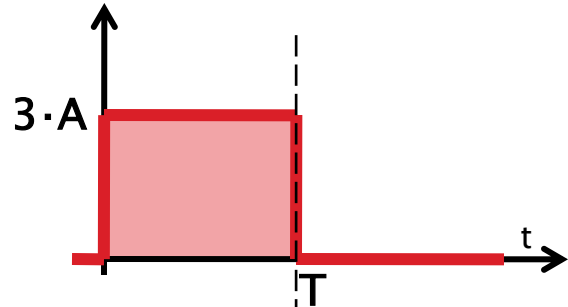
▶ Dispersia cromatica

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

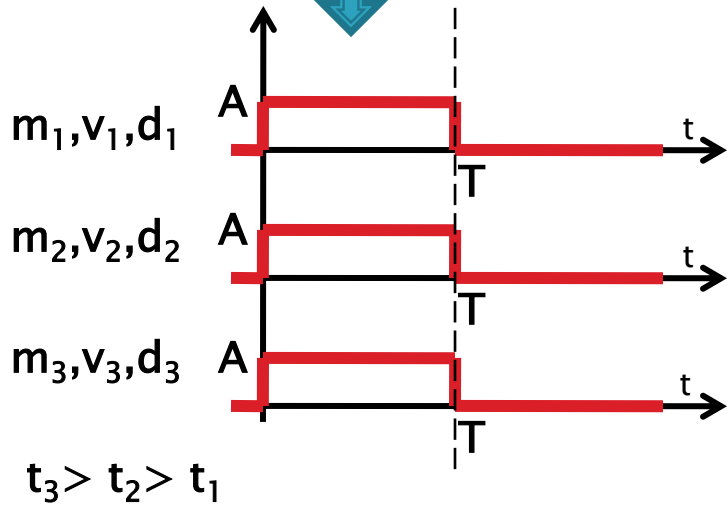
$$D(\lambda) = \frac{S_0}{4} \cdot \left(\lambda - \frac{\lambda_0^4}{\lambda^3} \right)$$



Dispersia modala

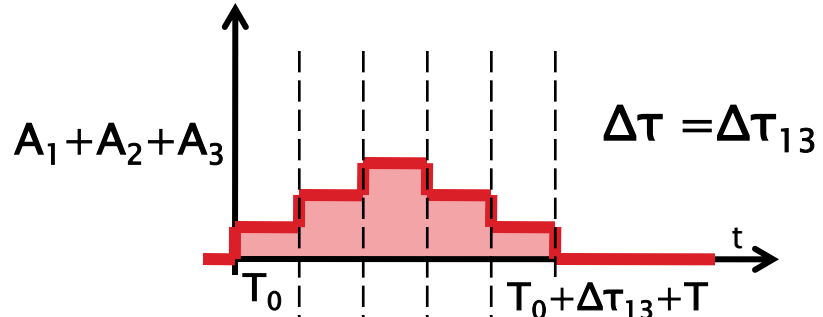


Impartire energie pe moduri

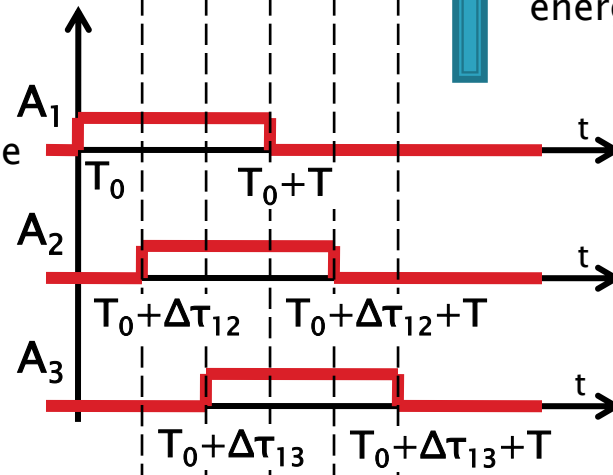


Transmisie cu viteze, distante diferite

$t_3 > t_2 > t_1$

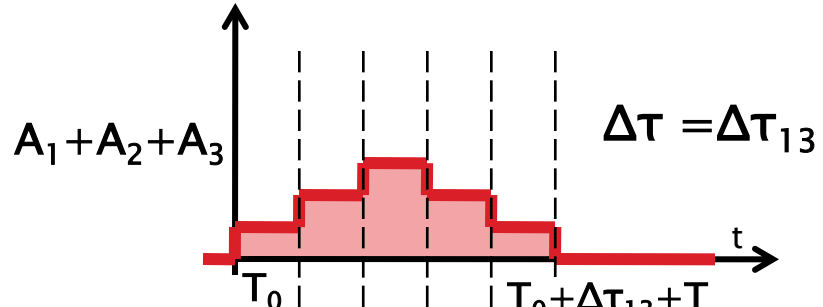
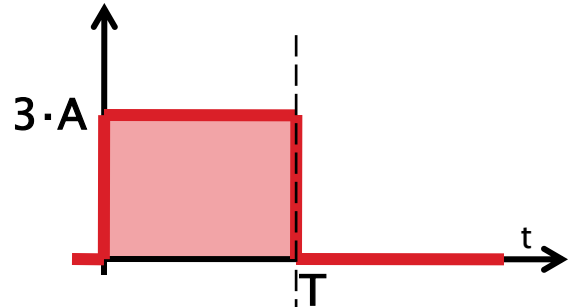


Recombinarea energiei modurilor

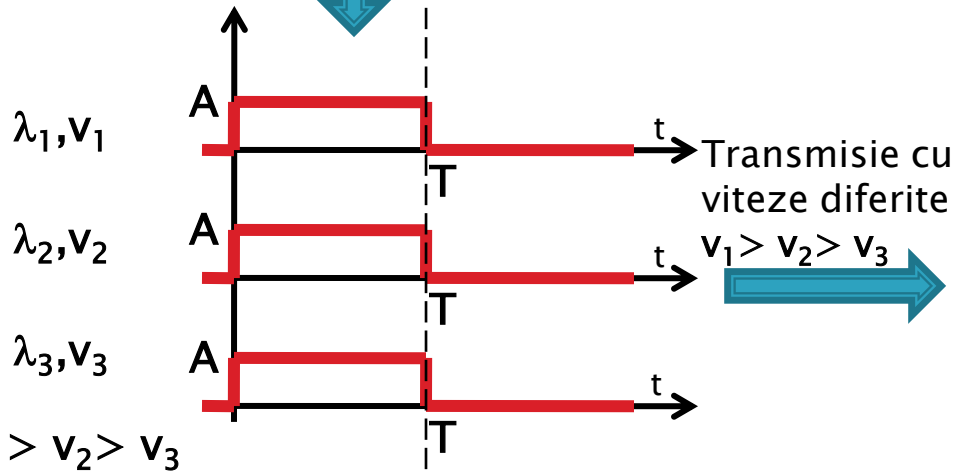


Conceptual $\rightarrow f(t) = \int_{-\infty}^{\infty} g(\omega) \cdot e^{j\omega t} d\omega$

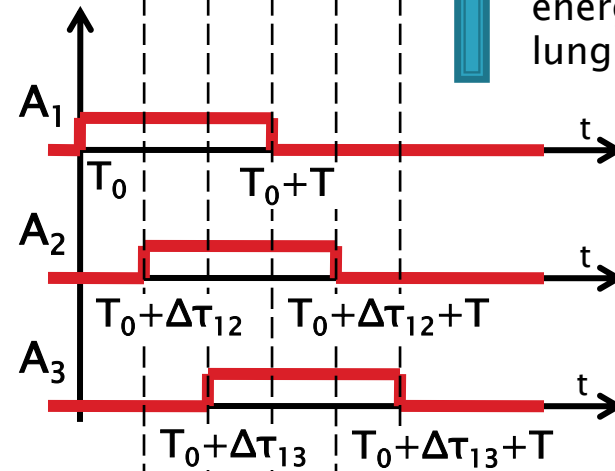
Dispersia cromatica (gh+mat)



Impartire energie pe lungimi de unda



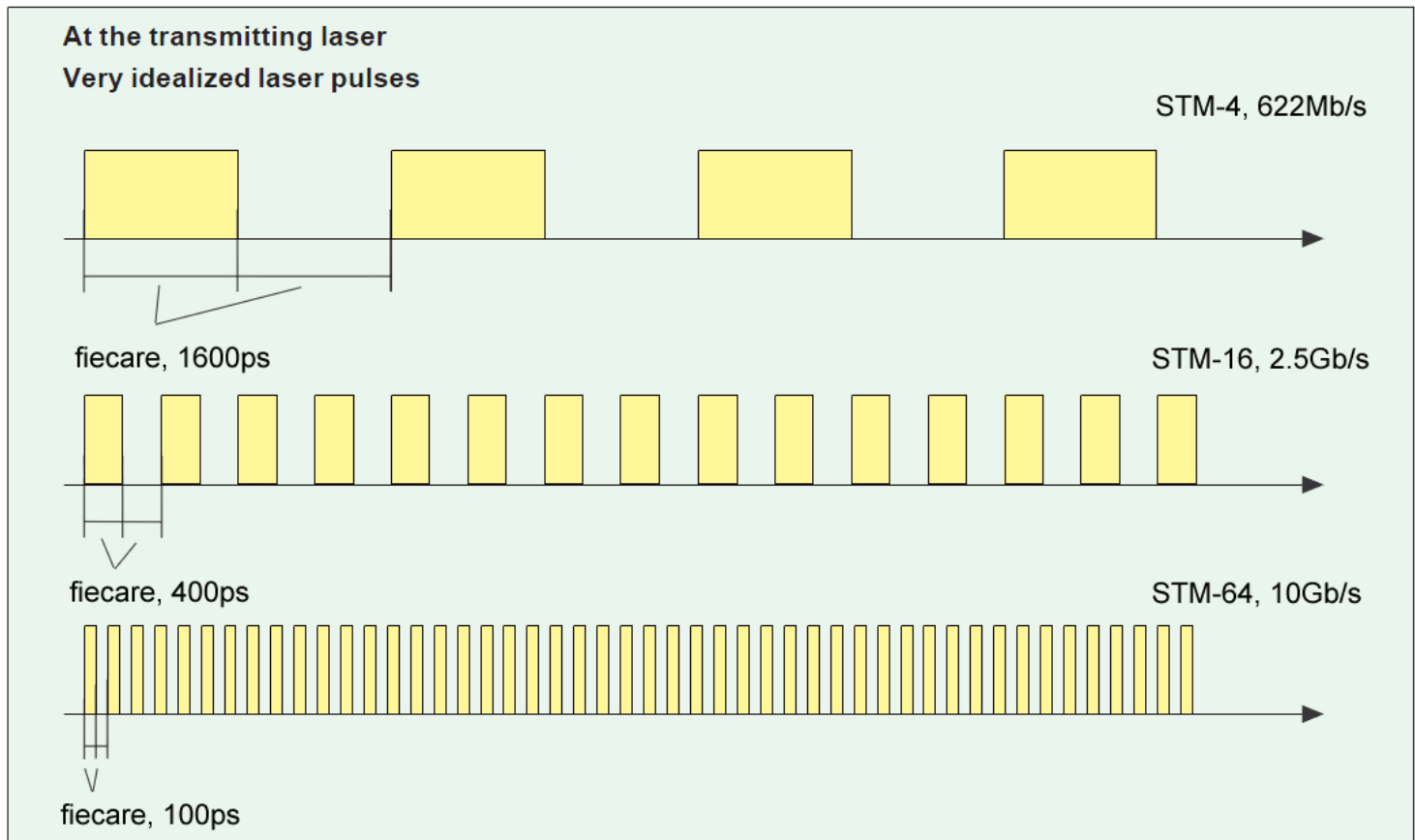
Recombinarea energiei la diferite lungimi de unda



Efectiv $\rightarrow f(t) = \int_{-\infty}^{\infty} g(\omega) \cdot e^{j\omega t} d\omega$

Dispersie exemplu - 1

- ▶ transmisii cu viteze diferite



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

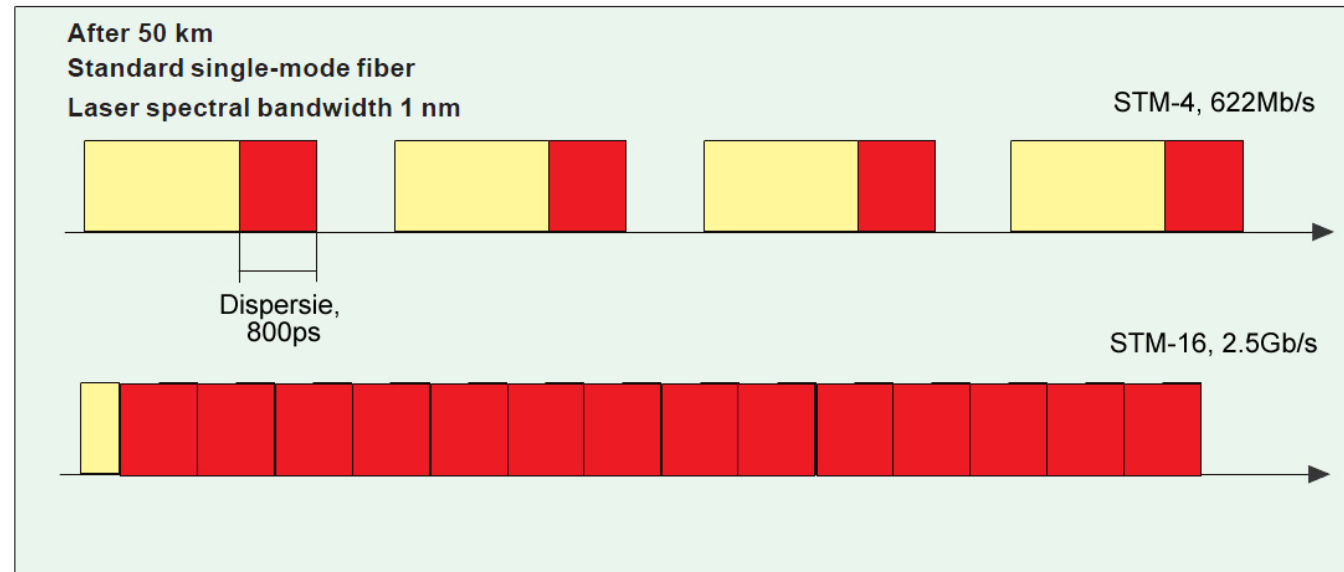
Dispersie exemplu - 2

▶ 1550nm

▶ Efectul sursei

- fibra monomod cu dispersia 16ps/nm/km@1550
- latimea spectrala a sursei $\Delta\lambda=1$ nm
- 50km

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



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

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

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

$$100 < 400 < 800 < 1600$$

Dispersie exemplu – 3

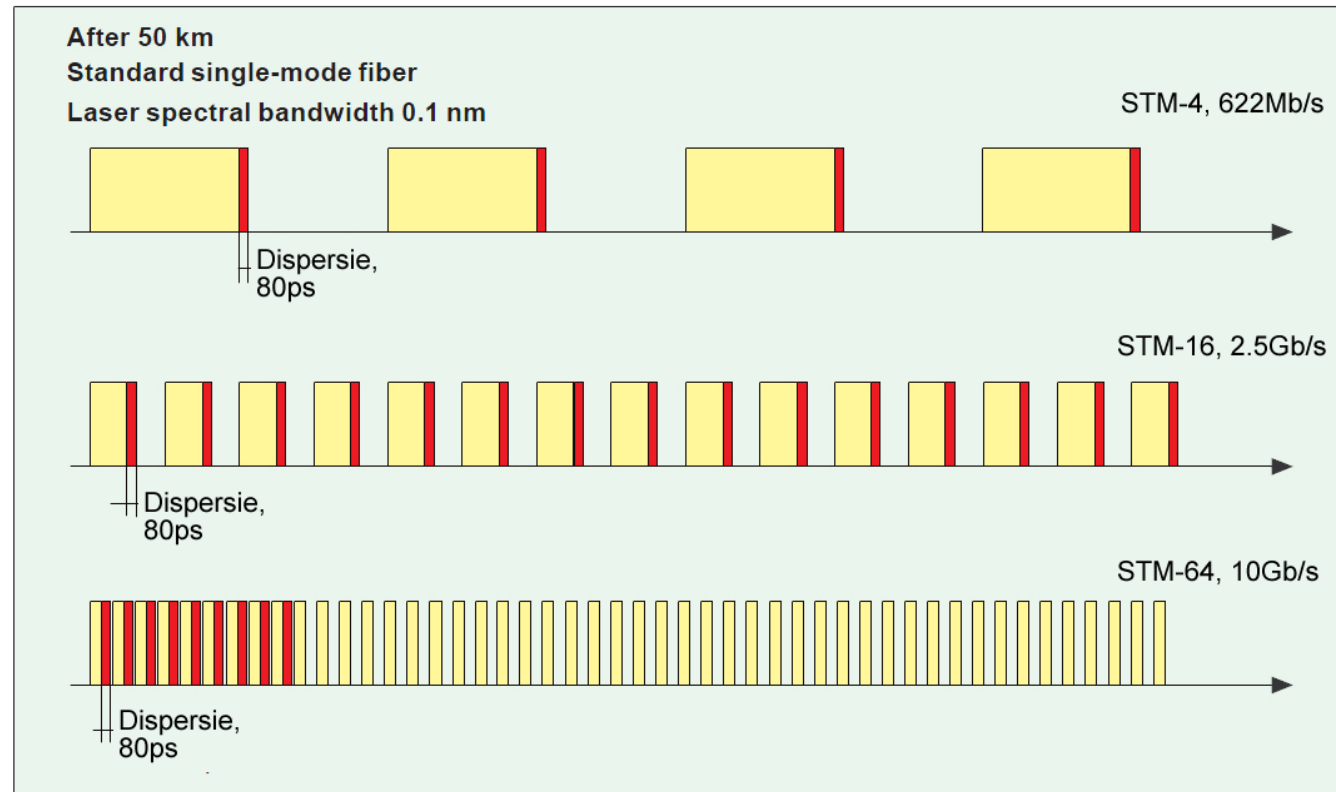
- ▶ 1550nm
- ▶ Efectul sursei
 - fibra monomod cu dispersia 16ps/nm/km@1550
 - latimea spectrala a sursei $\Delta\lambda=0.1\text{ nm}$
 - 50km

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

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

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

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



$$100 \approx 80 < 400 < 1600$$

Dispersie exemplu - 4

▶ Efectul fibrei

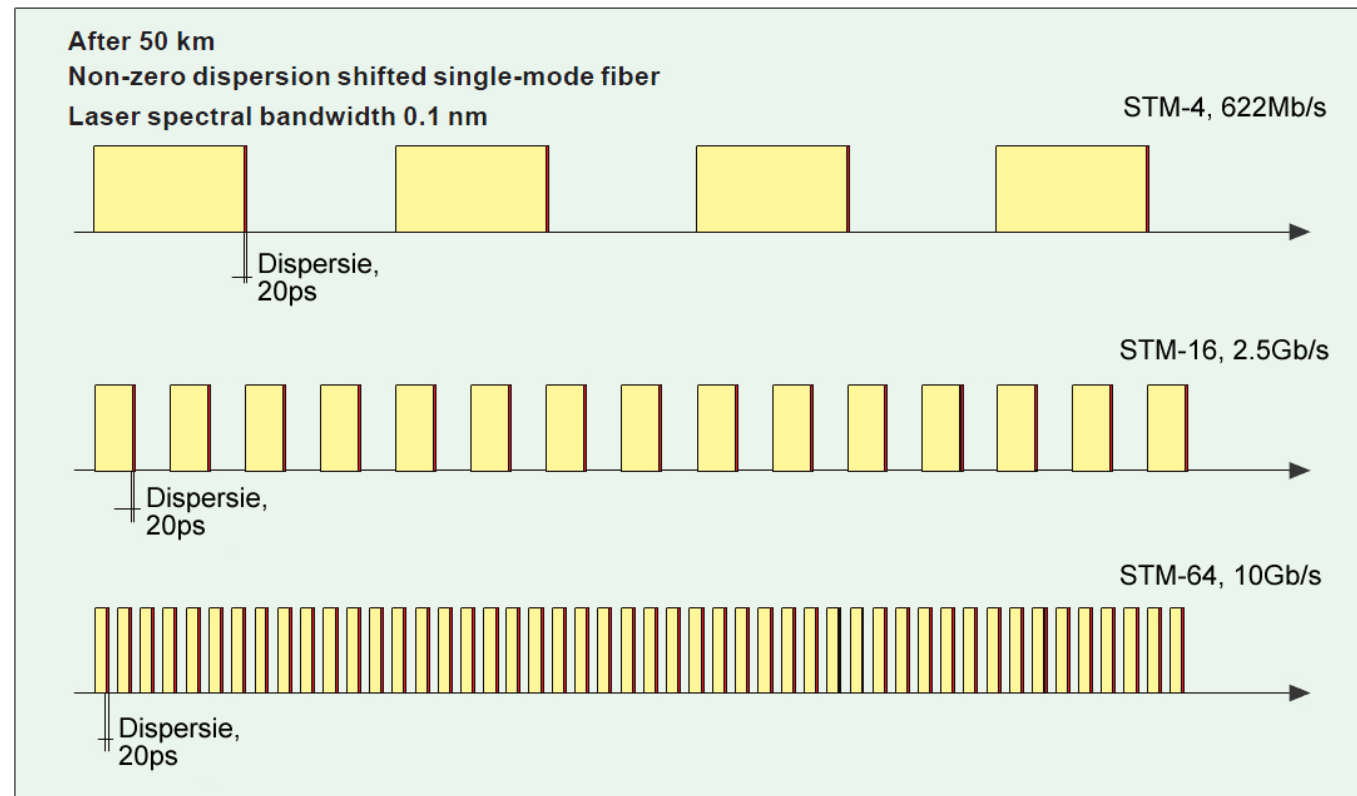
- fibra cu dispersie deplasata: **4ps/nm/km@1550**
- latimea spectrala a sursei $\Delta\lambda=0.1\text{ nm}$
- 50km

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

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

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

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



20 < 100 < 400 < 1600

Dispersie exemplu – 5

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

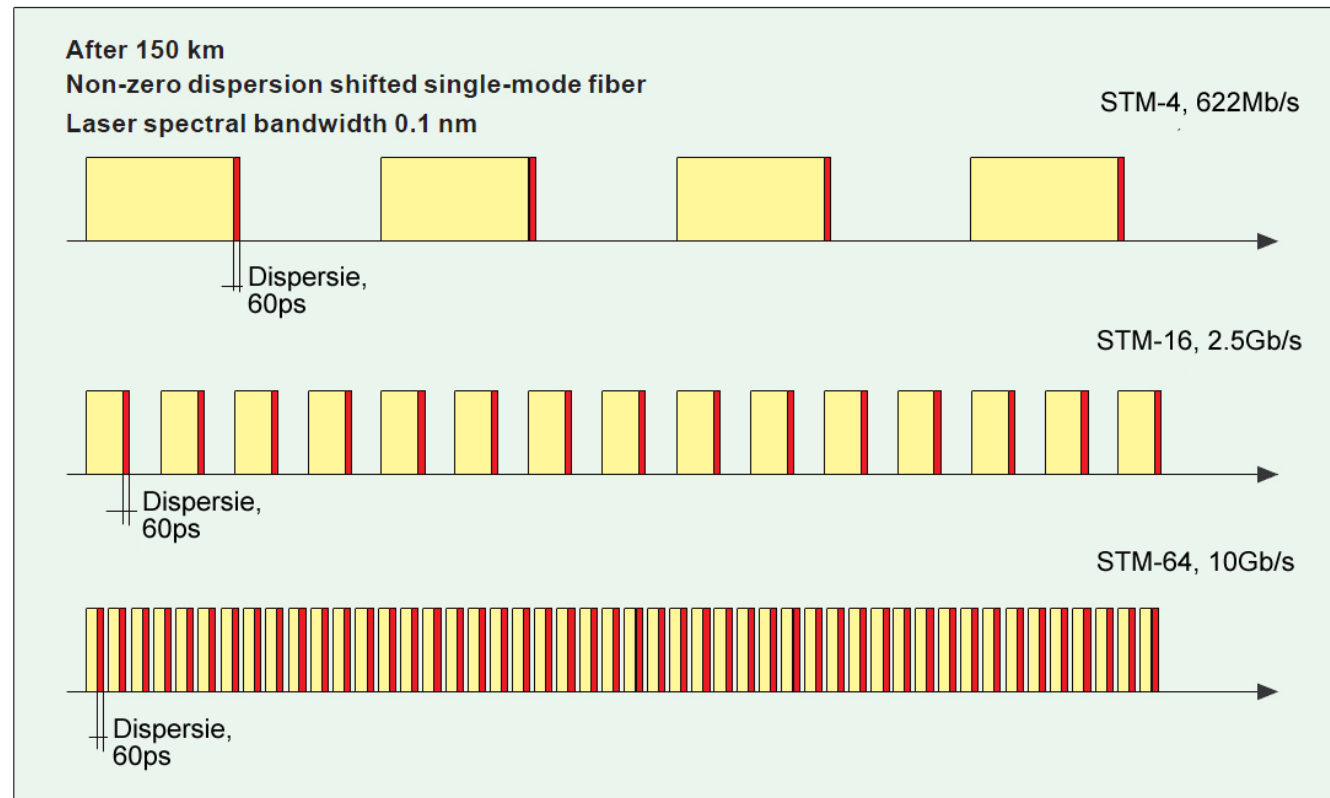
► Efectul fibrei

- fibra cu dispersie deplasata: 4ps/nm/km@1550
- latimea spectrala a sursei $\Delta\lambda=0.1$ nm
- **150km**

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

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

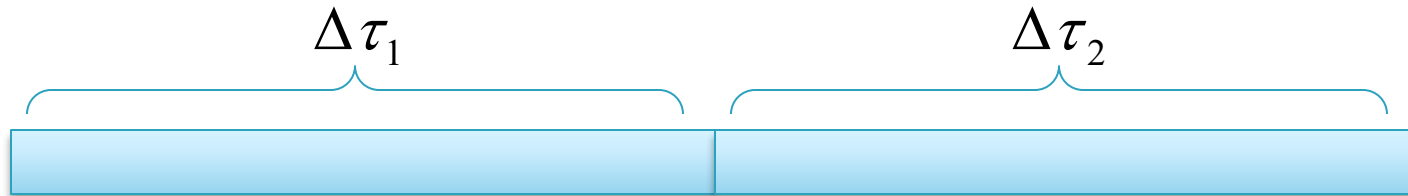
$$[\Delta\tau_{cr}] = \frac{\text{ps}}{\text{nm} \cdot \text{km}} \cdot \text{nm} \cdot \text{km} = \text{ps}$$



$$60 < 100 < 400 < 1600$$

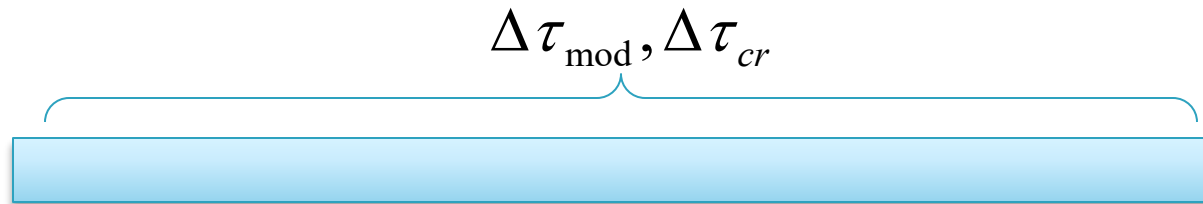
Sumarea efectelor

- ▶ efecte **succesive** se adună liniar



$$\Delta\tau_{tot} = \Delta\tau_1 + \Delta\tau_2$$

- ▶ efecte **simultane** se adună pătratic



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

Dispersia

▶ Dispersia modala

▶ salt de indice

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

▶ indice gradat

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

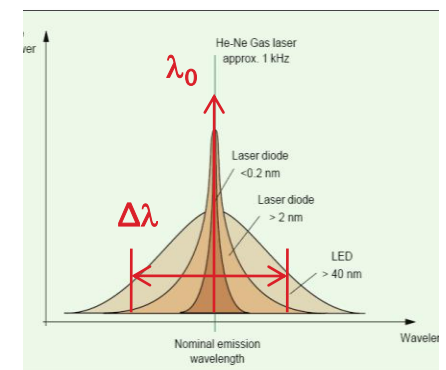
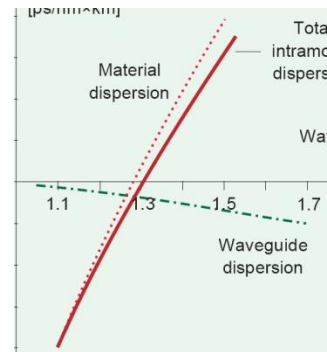
$$\Delta = 0.01 \div 0.02 \ll 1$$

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

▶ Dispersia cromatica

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

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



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

Banda

- ▶ Dispersia totala

$$\Delta\tau_{tot} = \sqrt{\Delta\tau_{cr}^2 + \Delta\tau_{mod}^2} \quad \text{sau} \quad \Delta\tau_{tot} = \Delta\tau_1 + \Delta\tau_2$$

- ▶ Banda

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

- ▶ Banda optica la 3 dB corespunde unei benzi electrice la 6 dB

- $P_{opt} \sim I$; $P_{el} \sim I^2$

$$B_{opt} = \sqrt{2} B_{el}$$

- ▶ Viteza legaturii

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

Produs Banda · Distanta

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

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

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

$$\Delta\tau_{\text{tot}} = \text{const} \cdot L$$

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

$$B_{\text{opt}} = \sqrt{2} B_{\text{el}}$$

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

$$V [\text{Gb/s}] \cong \frac{\text{const}}{L}$$

$$V [\text{Gb/s}] \cdot L [\text{km}] \cong \text{const}$$

Produs Banda · Distanta

$$\Delta\tau_{\text{mod}} \sim L$$

$$\Delta\tau_{\text{cr}} \sim L$$

$$\Delta\tau_{\text{tot}} \sim L$$

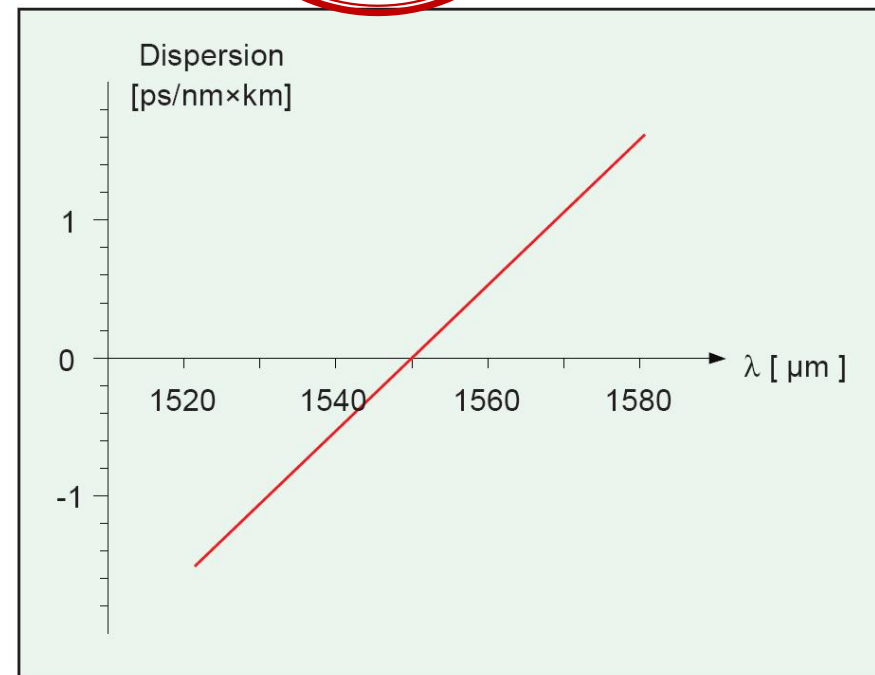
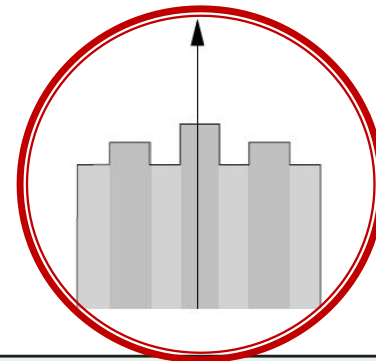
$$V[\text{Gb/s}] \sim B_{\text{el}}[\text{GHz}] \sim \frac{1}{\Delta\tau_{\text{tot}}} \sim \frac{1}{L[\text{km}]}$$

$$V[\text{Gb/s}] \times L[\text{km}] = \text{ct.}$$

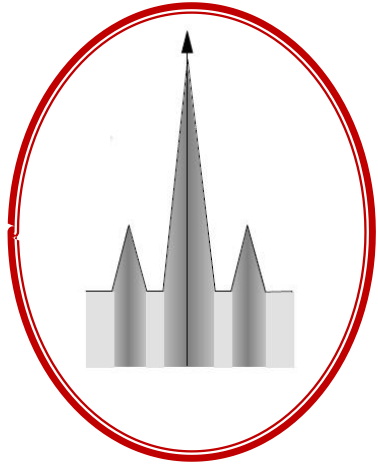
$$B_{\text{el}}[\text{MHz}] \times L[\text{km}] = \text{ct.}$$

Dispersion shifted fibers

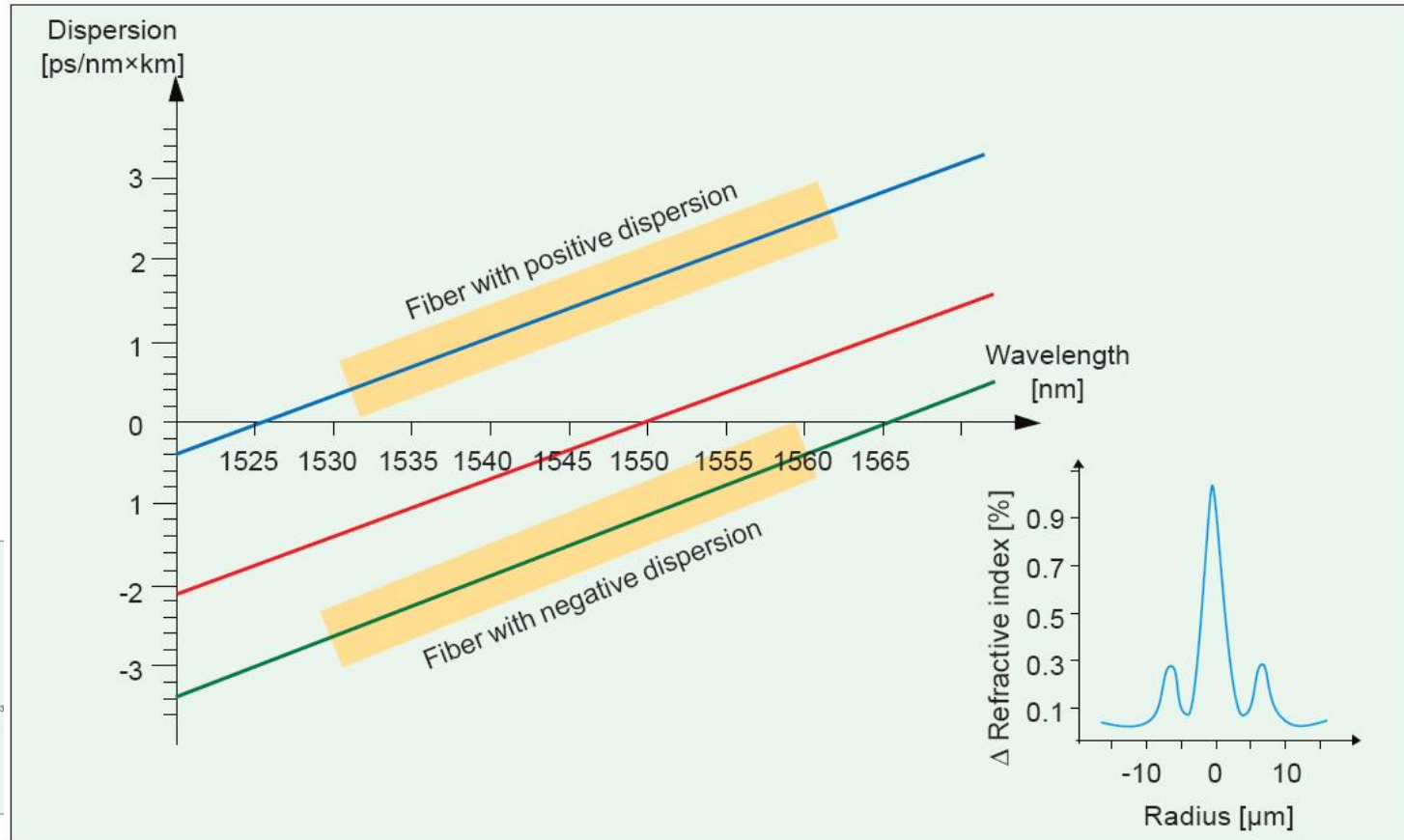
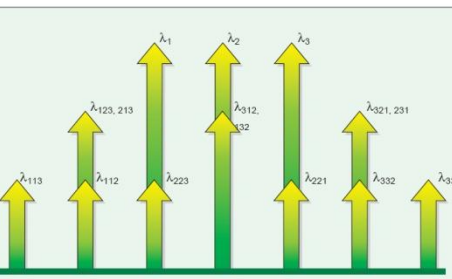
- ▶ Sticla are (nativ) dispersie cromatica 0 la 1310nm
- ▶ Atenuarea e mai mica la 1550 nm
- ▶ EDFA (Erbium doped fibre amplifiers) opereaza in banda 1550nm
- ▶ Sistemele WDM (Wavelength division Multiplexing) necesita banda larga amplificata



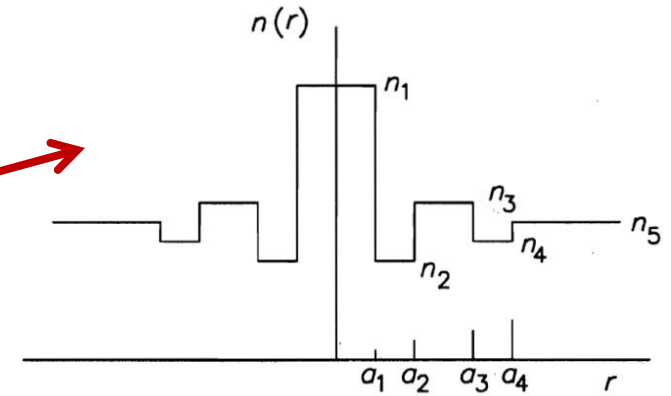
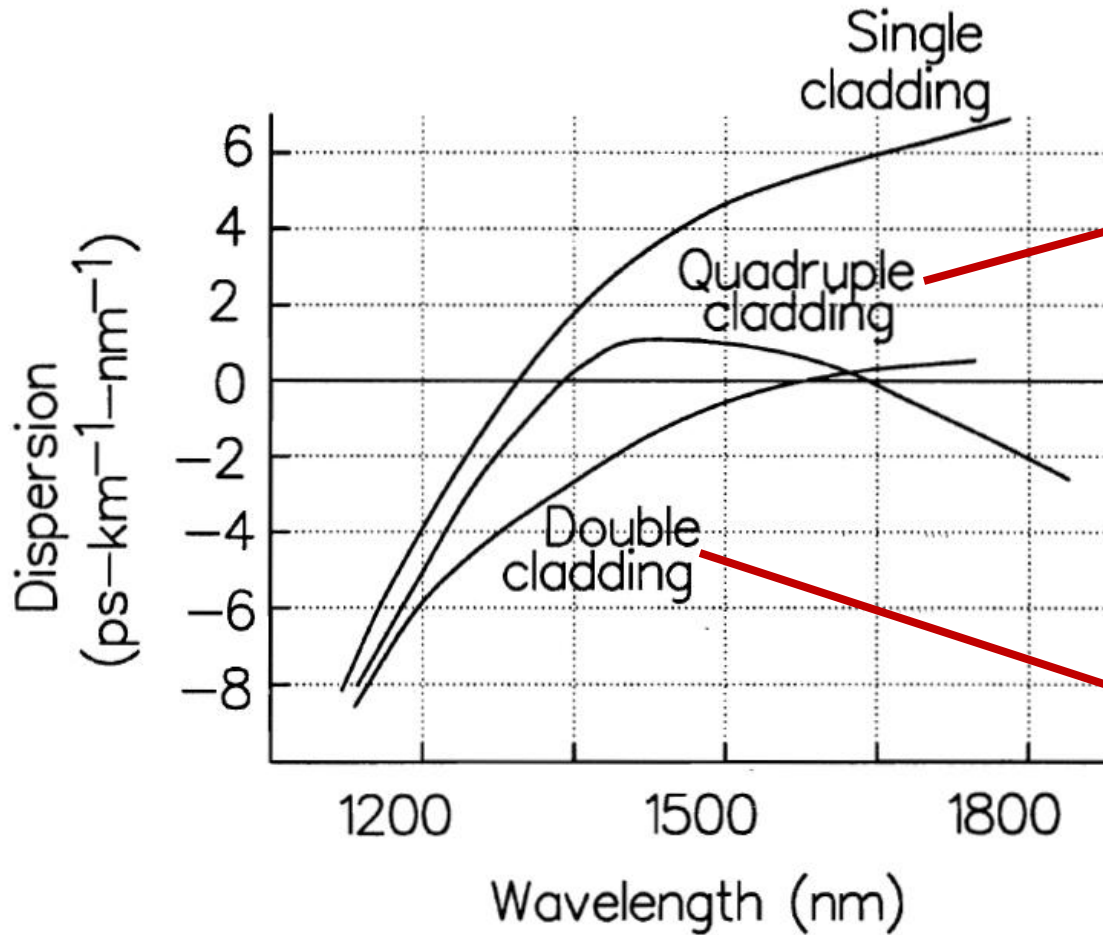
Non-zero Dispersion shifted fibers



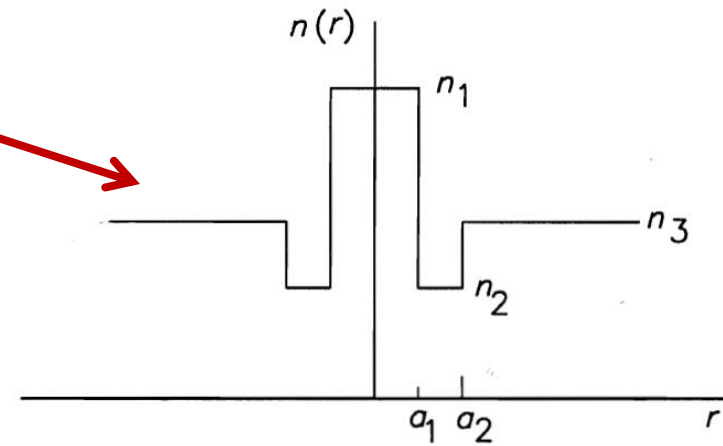
FWM



Dispersion shifted fibers

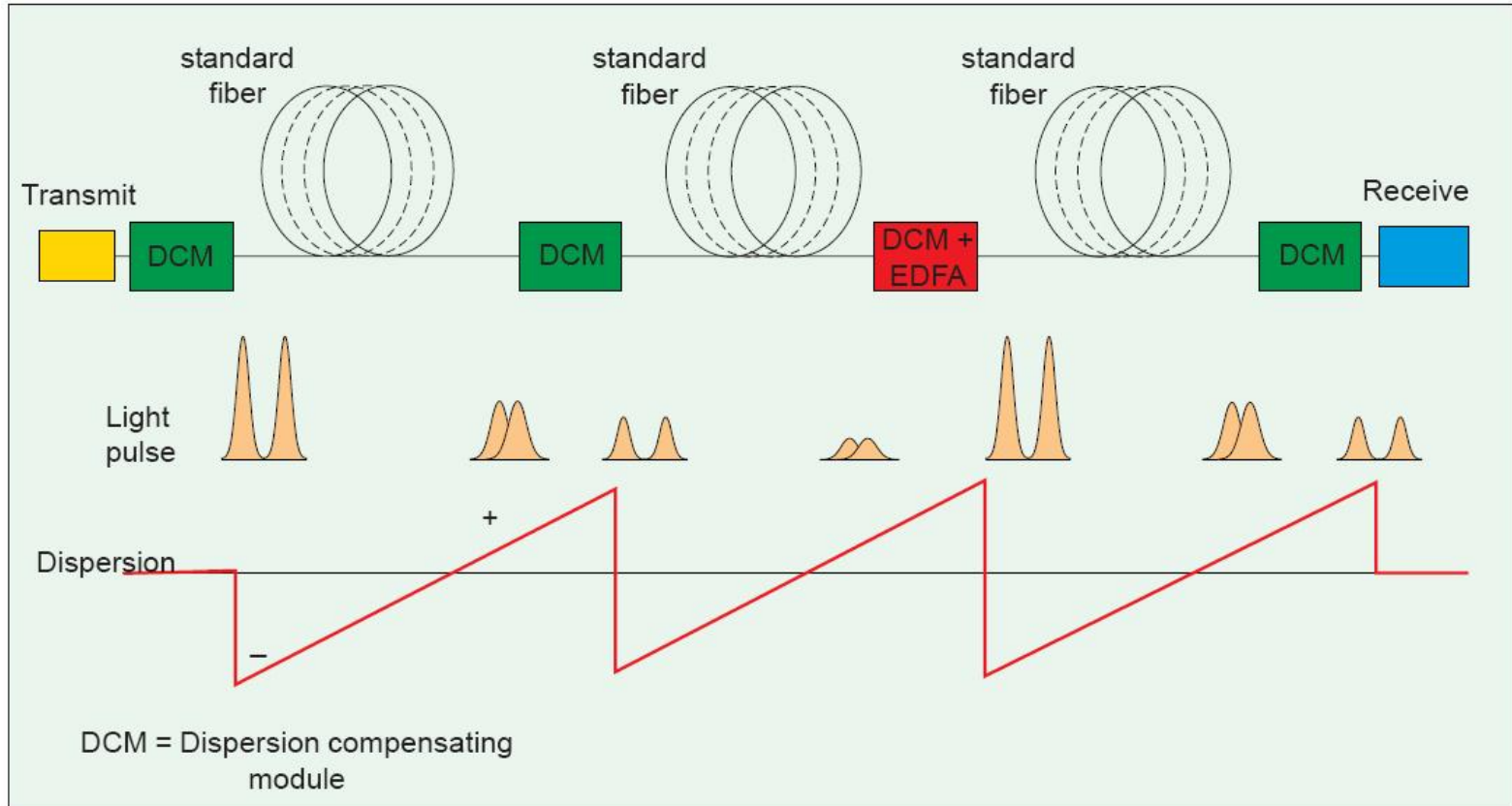


(b)



(a)

Fibra pentru compensarea dispersiei



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

Catalog – monomod

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

How to Order

Contact your sales representative, or call the Optical Fiber Customer Service Department.
 Ph: 607-348-2000 (U.S. and Canada)
 +44-1244-287-437 (Europe)
 Email: opticalfibres@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 spooled lengths available.

Performance Characterizations

Characterized parameters are typical values.

Core Diameter	8.2 μm
Numerical Aperture	0.14 <i>NA is measured as the one percent power level of a one-dimensional intensity profile at 1310 nm.</i>
Zero Dispersion Wavelength (λ_0)	1317 nm
Zero Dispersion Slope (S_0)	0.088 ps/(nm ² ·km)
Effective Group Index at Wavelength (N_e)	1310 nm: 1.4670 1550 nm: 1.4670
Fatigue Resistance Parameter (N_f)	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 ⁰

Notes:
 (1) When characterized with a transmitter specifying 17 dBm SRS threshold over standard single-mode fiber. While absolute SRS 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

$$\text{Dispersion} = D(\lambda) = \frac{S_0}{4} \left[\lambda - \frac{\lambda_0^4}{\lambda^3} \right] \text{ ps/(nm}^2\text{·km)}$$

for 1200 nm \leq λ \leq 1625 nm
 λ = Operating Wavelength

Cladding Non-Circularity

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

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)
 Fax: 800-539-1632 (U.S. and Canada)
 607-786-8344 (International)
 Email: cs@corning.com

Europe
 Ph: 00 800 6620 6621 (U.K., Ireland, France, Germany, The Netherlands, Spain and Sweden)
 +1 607 786 8344 (All Other Countries)
 Fax: 00 44 1244 287 437

Asia Pacific
 Australia
 Ph: 1-800-148-690
 Fax: 1-800-148-568

Indonesia
 Ph: 001-800-015-721-1261
 Fax: 001-800-015-721-1262

Malaysia
 Ph: 1-800-80-3156
 Fax: 1-800-80-3155

Philippines
 Ph: 1-800-1-116-0338
 Fax: 1-800-1-116-0339

Singapore
 Ph: 800-1300-955
 Fax: 800-1300-956

Thailand
 Ph: 001-800-1-3-721-1263
 Fax: 001-800-1-3-721-1264

Latin America
 Brazil
 Ph: 00817-762-4732
 Fax: 00817-762-4996

Mexico
 Ph: 001-800-235-1719
 Fax: 001-800-339-1472

Vietnam
 Ph: 800-1-4418
 Fax: 800-1-4419

Greater China
 Email: GCC@corning.com
 Beijing
 Ph: (86) 10-6505-5066
 Fax: (86) 10-6505-5077

Hong Kong
 Ph: (852) 2807-2722
 Fax: (852) 2807-2152

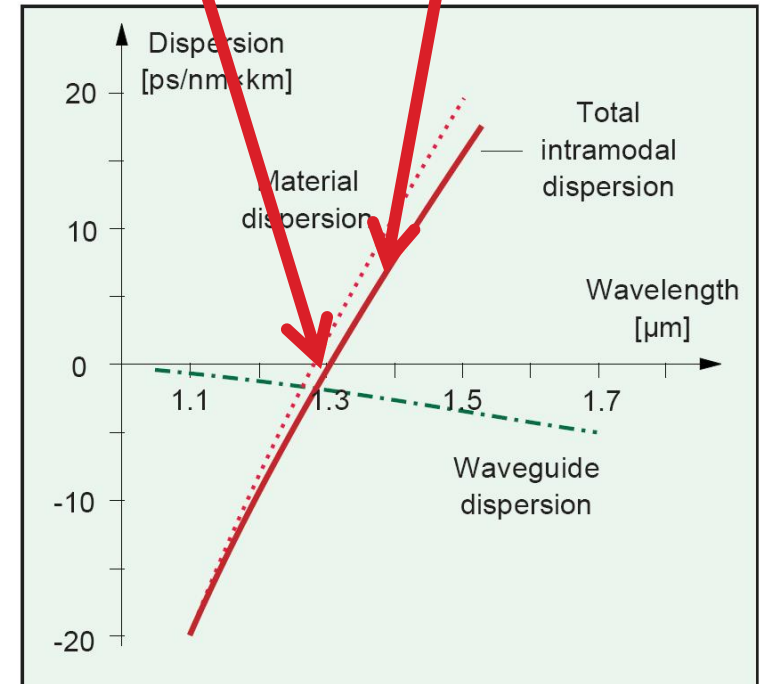
Shanghai
 Ph: (86) 21-3222-4668
 Fax: (86) 21-6288-1575

Taiwan
 Ph: (886) 2-2716-0338
 Fax: (886) 2-2716-0339

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 Any warranty of any nature relating to any Corning optical fiber is only contained in the written agreement between Corning Incorporated and the direct purchaser of such fiber.
 ©2005, Corning Incorporated

jar-jena.com at 1.510 nm.

Zero Dispersion Wavelength (λ_0)	1317 nm
Zero Dispersion Slope (S_0)	0.088 ps/(nm ² ·km)
Effective Group Index	1310 nm: 1.4670



Catalog – multimod

Bandwidth

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

+

Standard Bandwidth Cells	
850/1300 nm (MHz•km)	
	400/400
	400/600
	400/1200
	500/500
	600/600
	600/1000

Other bandwidth cells available upon request.

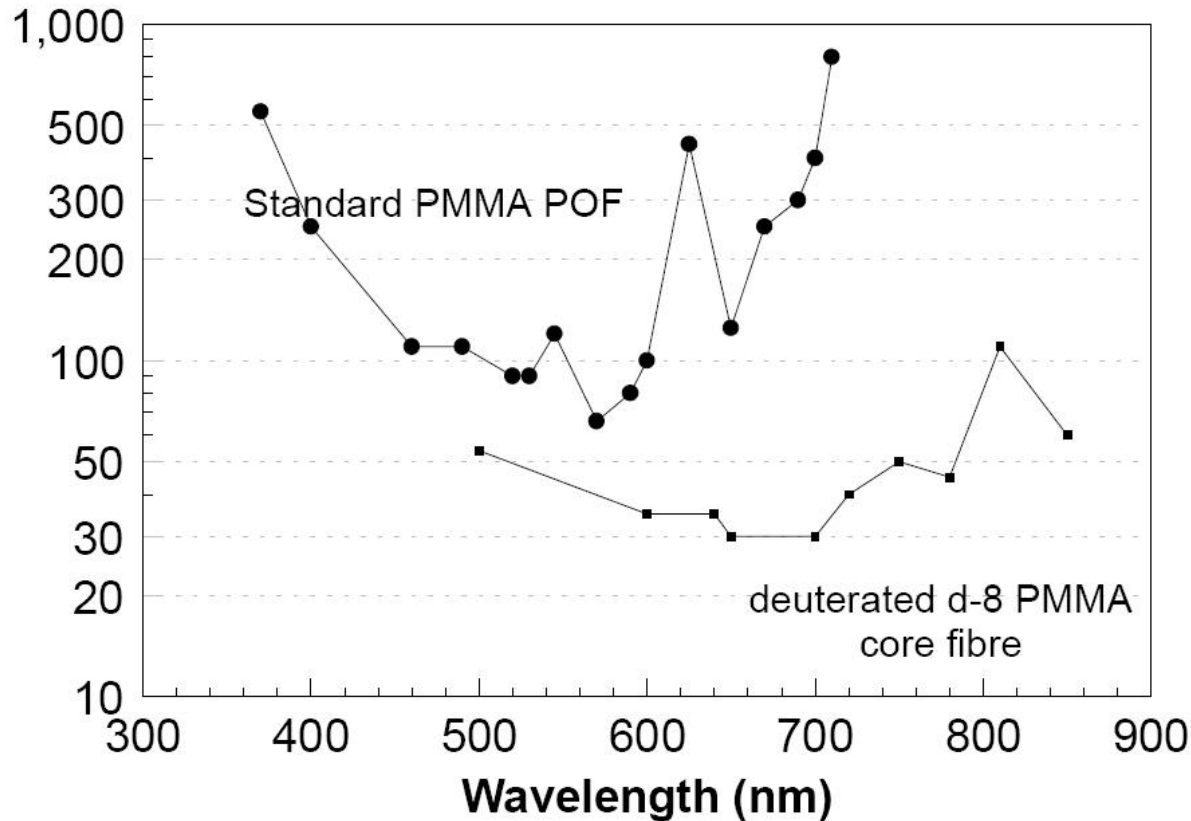
Fibra standard ITU G.652

- ▶ Diametru teaca = 125 μm
- ▶ MFD = 9÷10 μm la 1300 nm
- ▶ $\lambda_C = 1100\div 1280$ 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/nm²/km

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

Fibra optica din plastic (POF)

Attenuation dB/Km



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

Contact

- ▶ Laboratorul de microunde si optoelectronica
- ▶ <http://rf-opto.etti.tuiasi.ro>
- ▶ rdamian@etti.tuiasi.ro