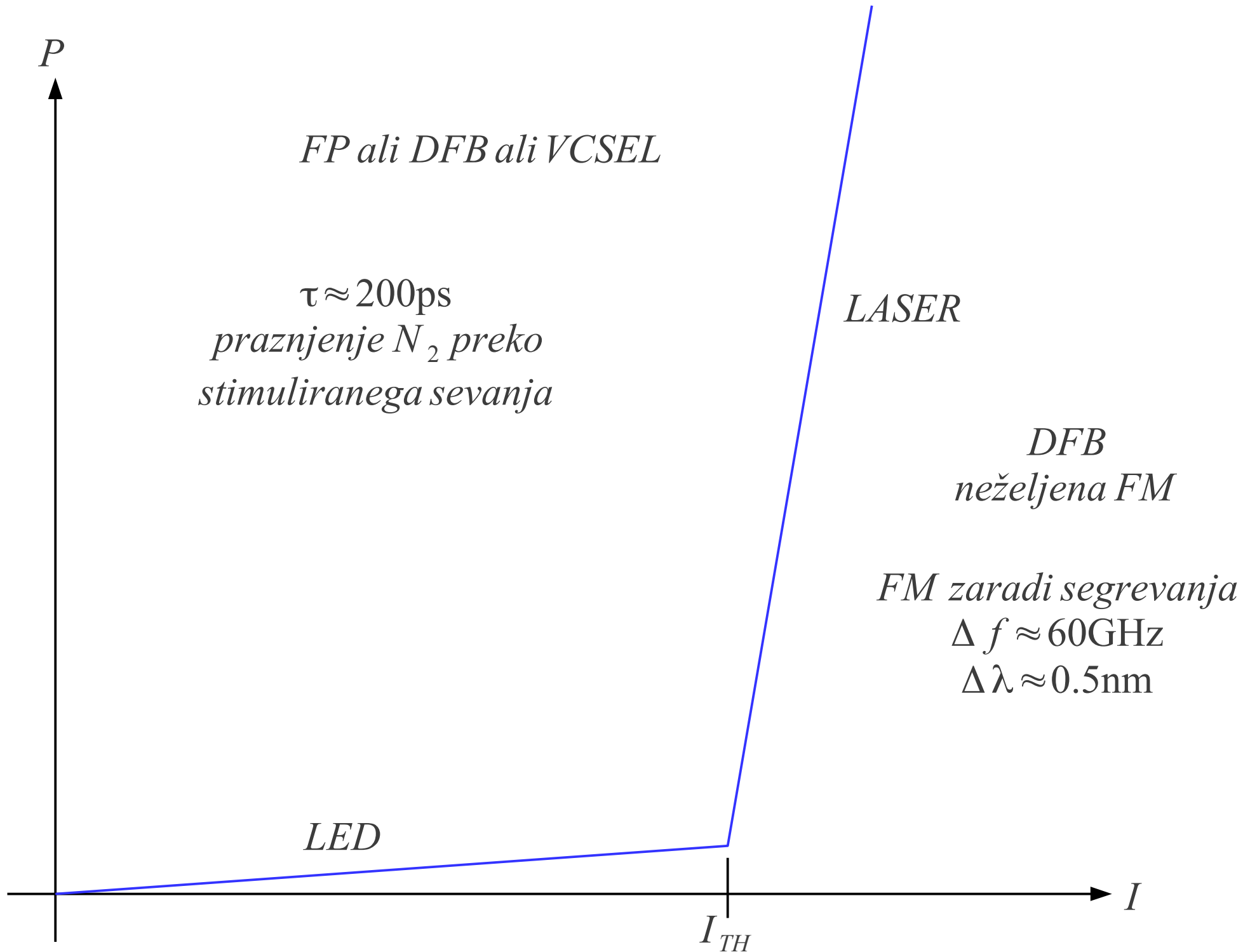
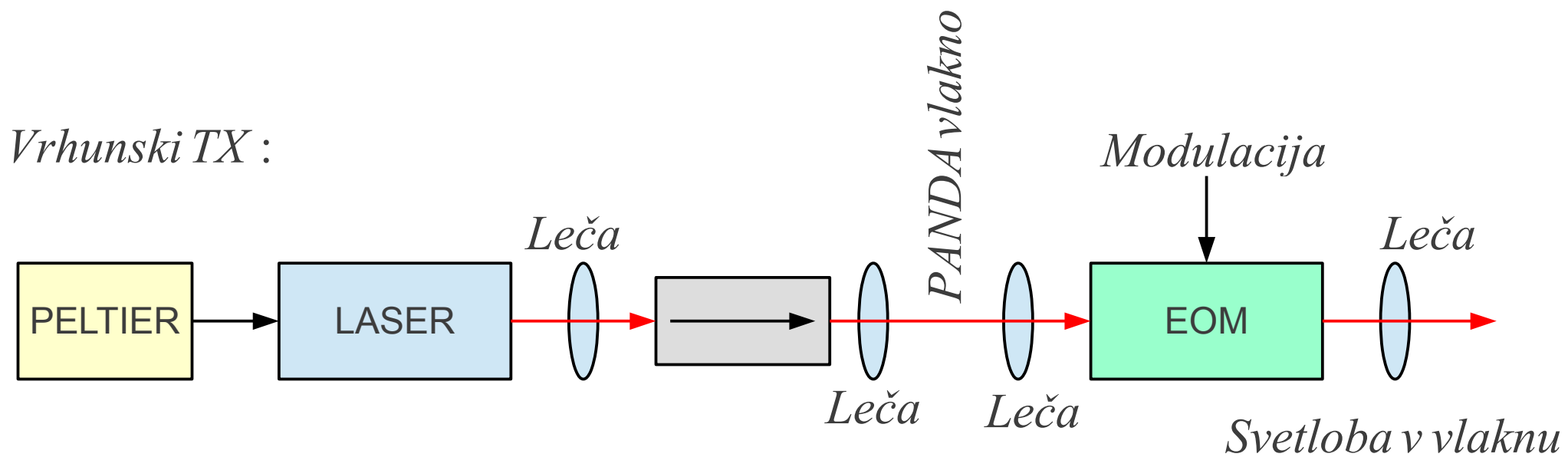
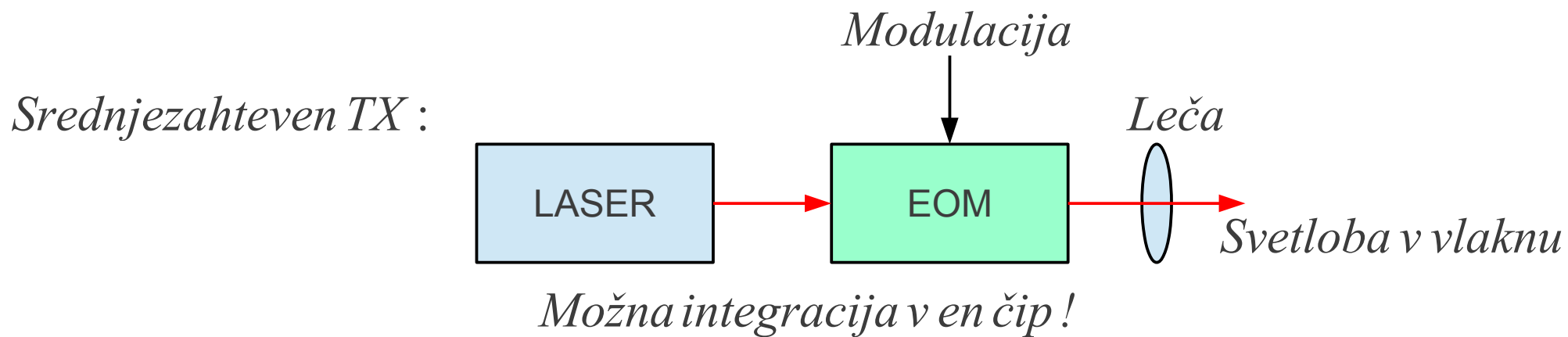
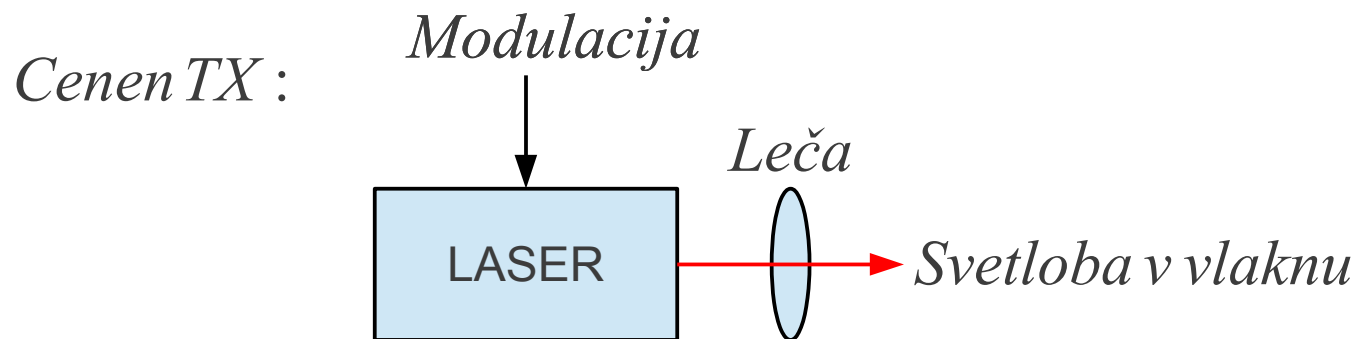


# Optične komunikacije

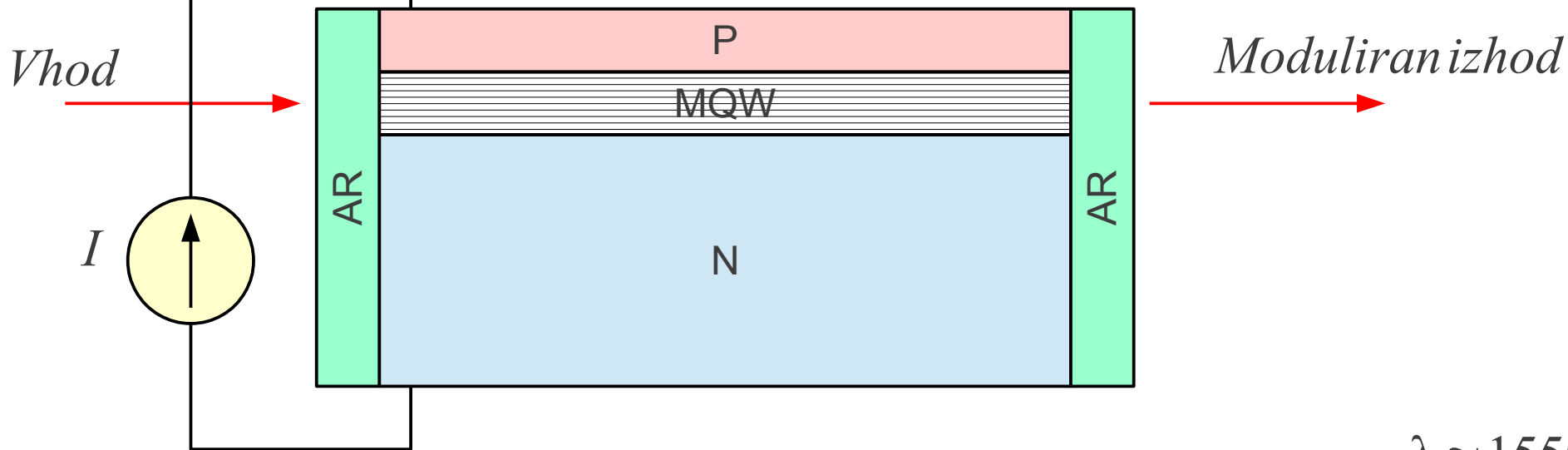
## Predavanje 12:

### Zunanji modulatorji svetlobe



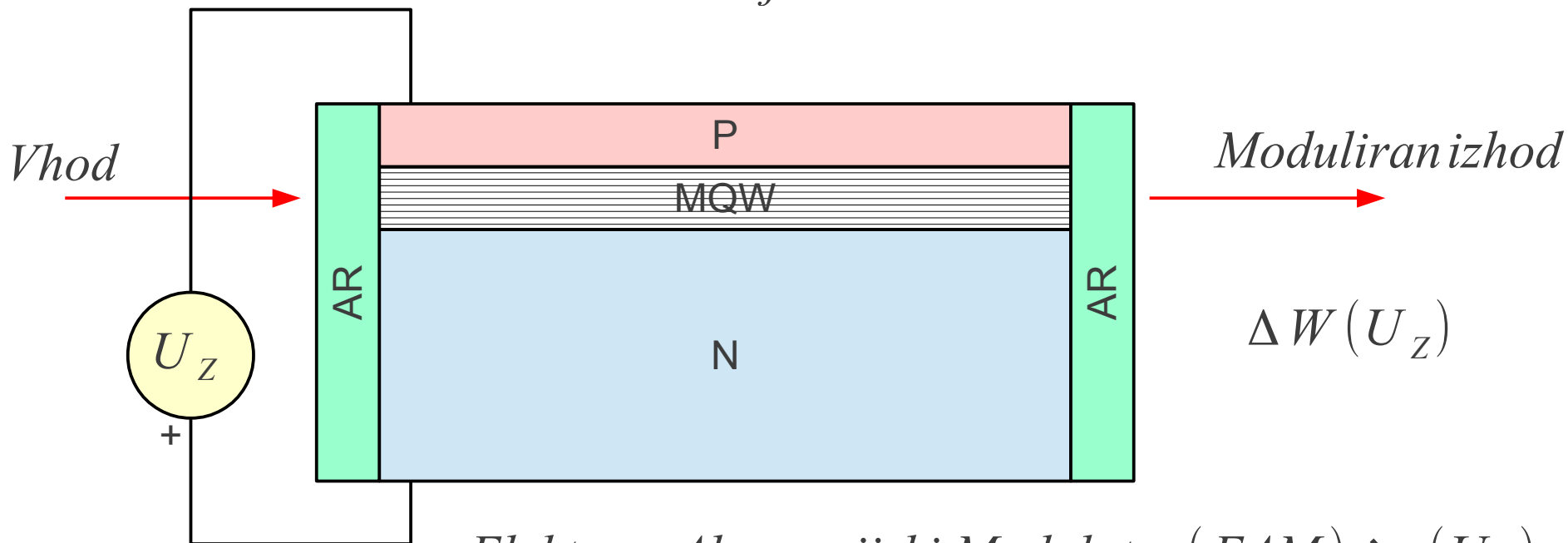


*Polprevodniški ojačevalnik (SOA)  $\rightarrow G(I)$*



$\lambda \approx 1550\text{nm}$   
osnova InP

*Polarizacijsko odvisen ali neodvisen*



*Elektro – Absorpcijski Modulator (EAM)  $\rightarrow a(U_Z)$*

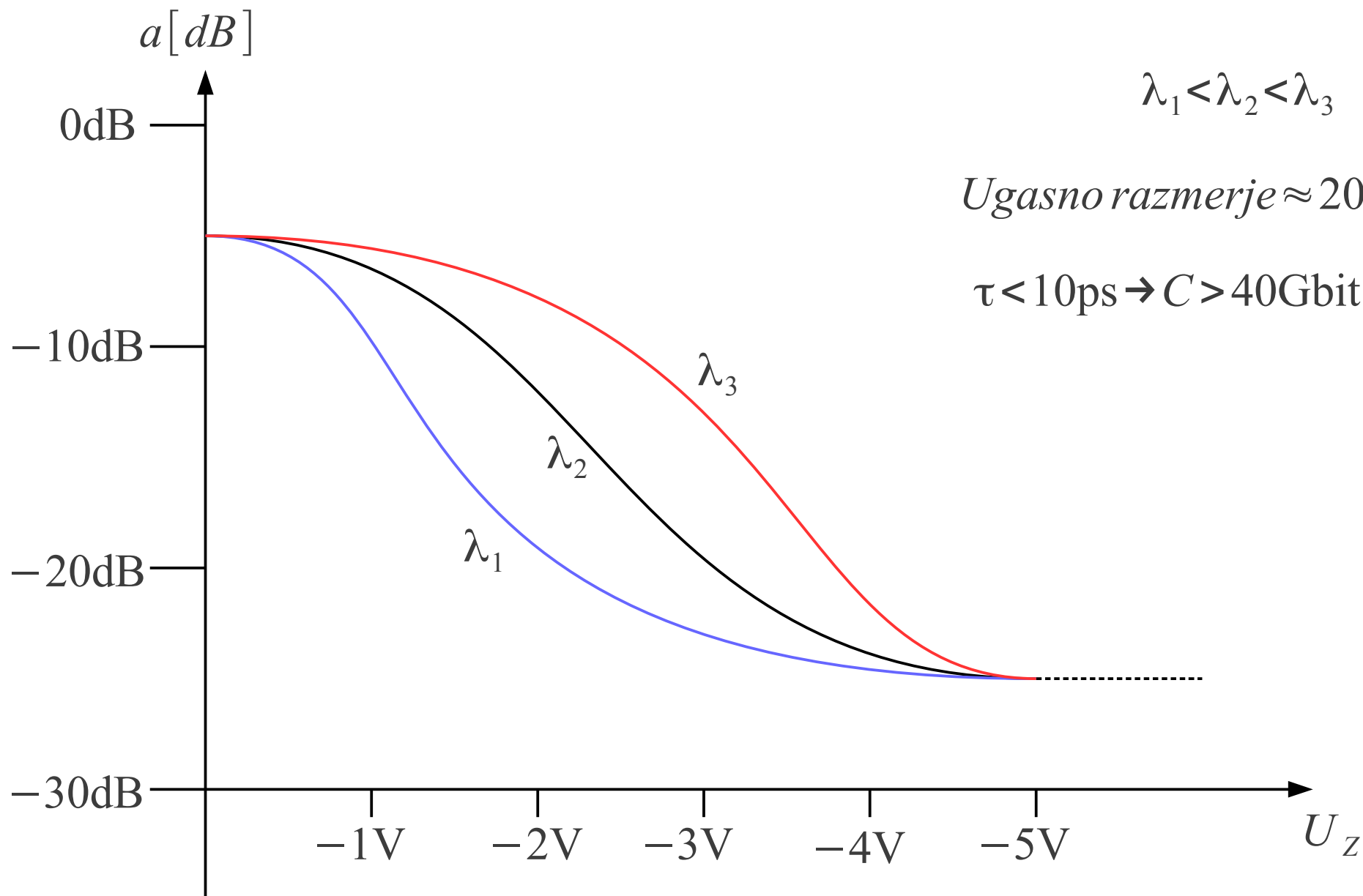
*Elektro – Absorpcijski Modulator (EAM)  $\rightarrow a(U_Z)$*

$\Delta W(U_Z)$

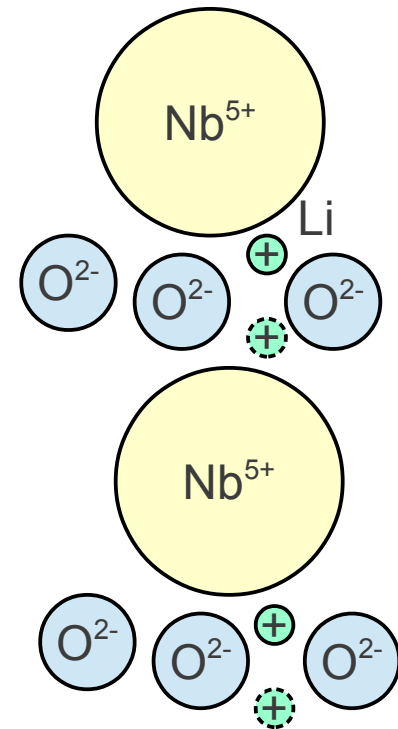
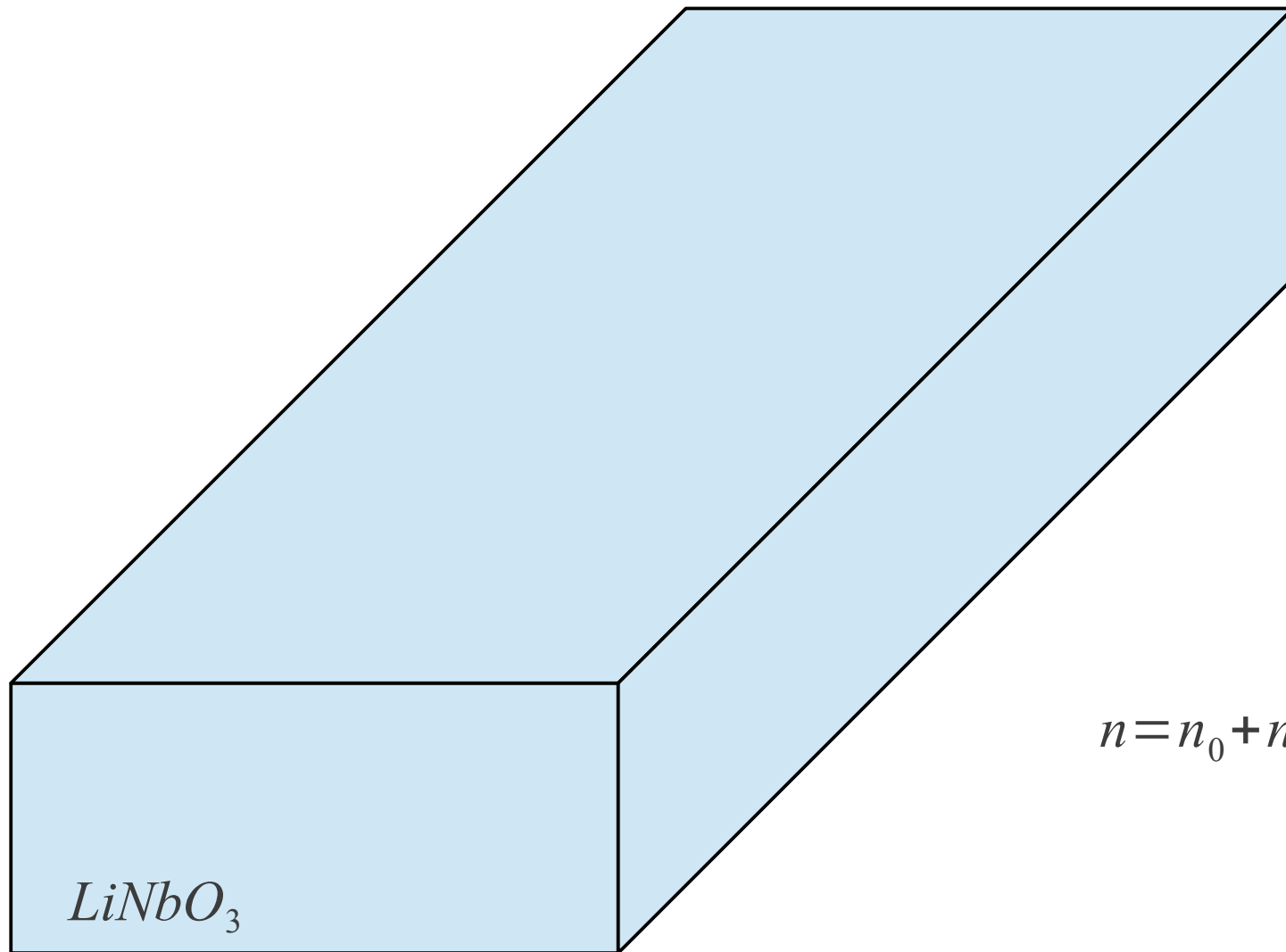
$\lambda_1 < \lambda_2 < \lambda_3$

*Ugasno razmerje  $\approx 20\text{dB}$*

$\tau < 10\text{ps} \rightarrow C > 40\text{Gbit/s}$



*Podlaga InP  $\rightarrow$  ne potrebuje potujočega vala*



$$n = n_0 + n_1 \cdot E + n_2 \cdot E^2 + \dots$$

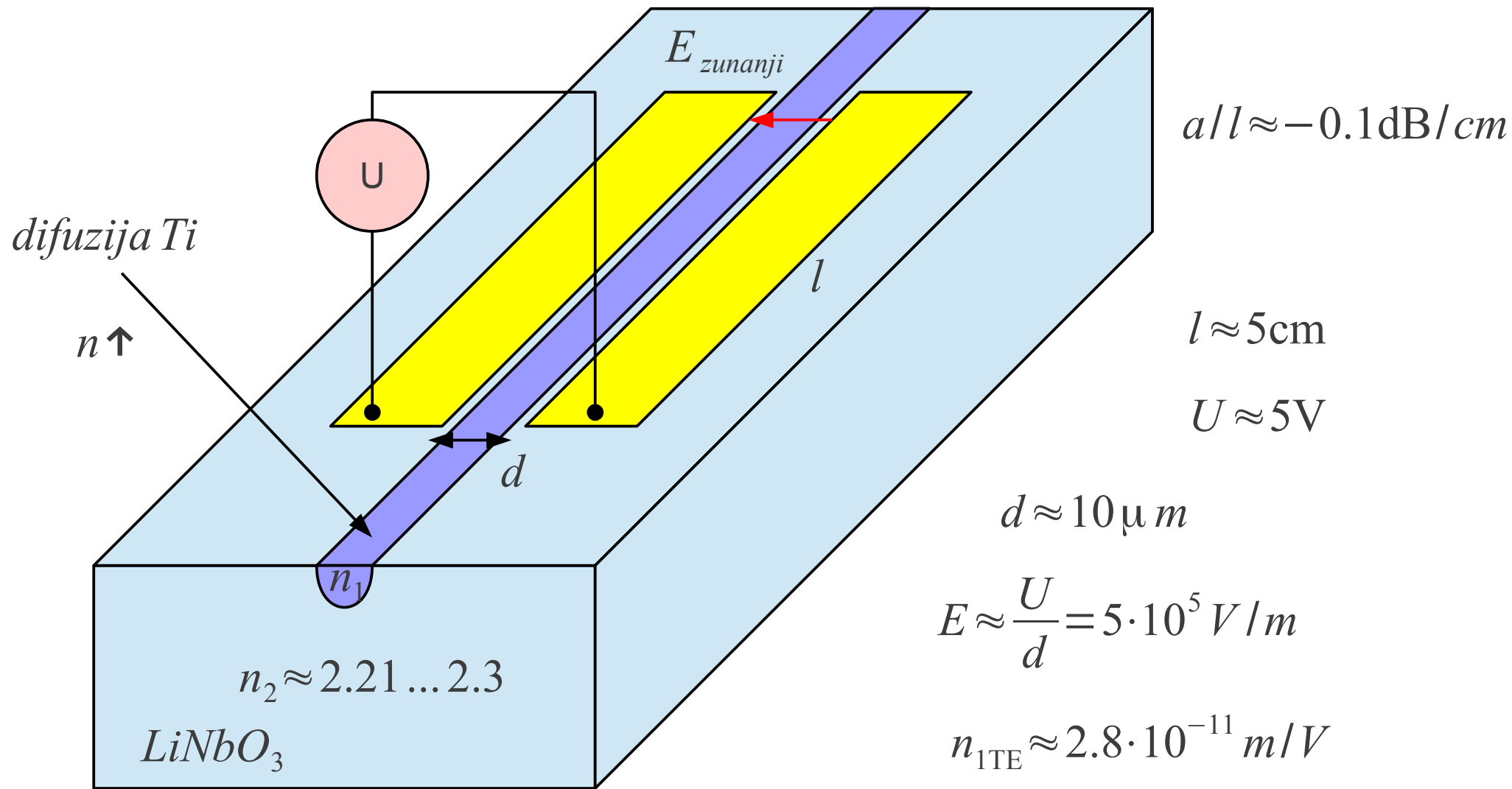
*Kerr*

*Pockels*

$$E = E_{\text{vgrajeni}} + E_{\text{zunanji}}$$

$$E^2 = E_{\text{vgrajeni}}^2 + E_{\text{zunanji}}^2 + 2 E_{\text{vgrajeni}} E_{\text{zunanji}}$$

$$n_1 \approx 1 \cdot 10^{-11} \dots 2.8 \cdot 10^{-11} \text{ m/V}$$

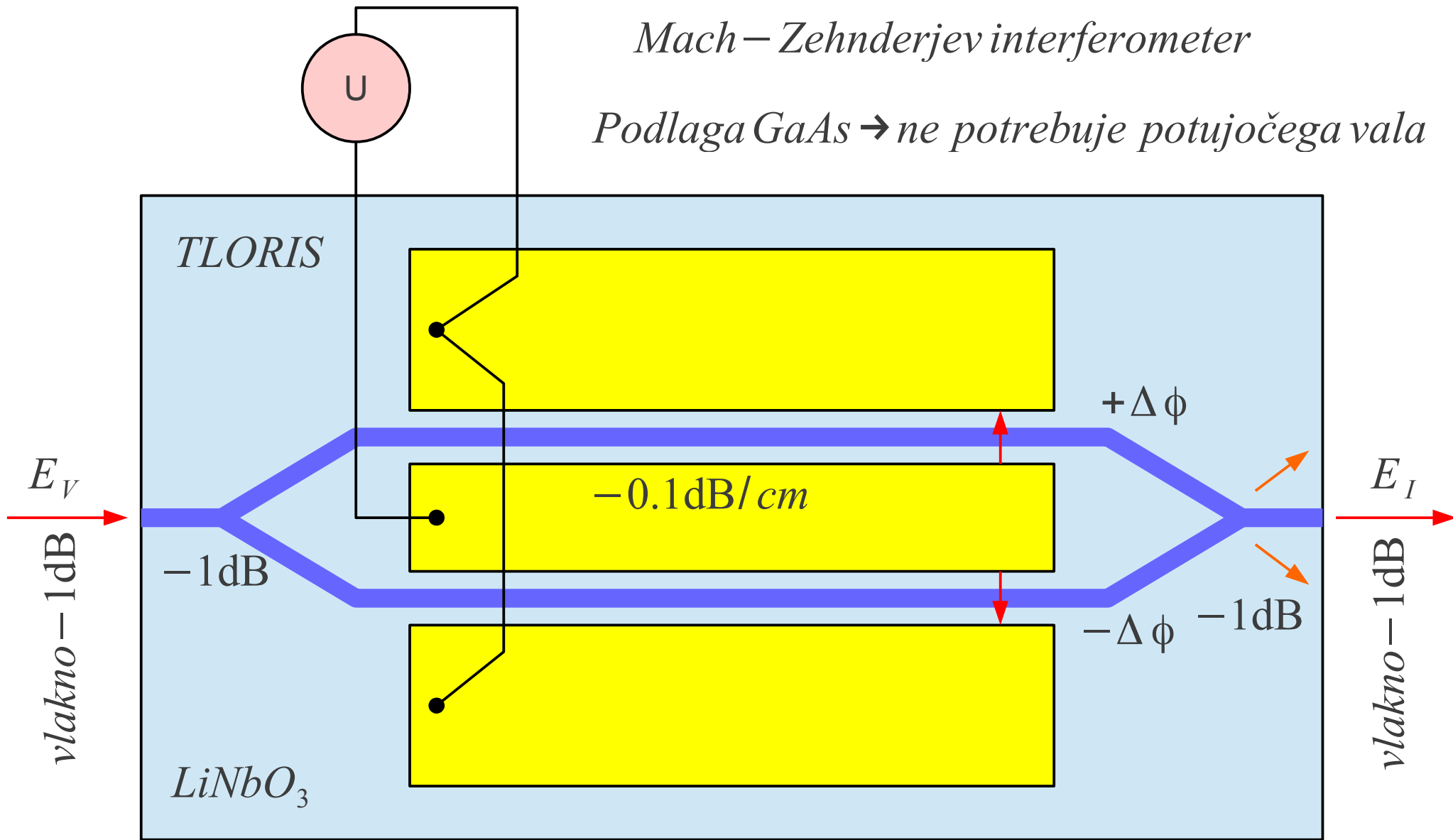


$$\Delta \phi = \Delta n \cdot k_0 \cdot l \approx 2.84 \text{rd} \rightarrow \text{fazni modulator}$$

$$k_0 = \frac{2\pi}{\lambda_0} \quad \lambda_0 = 1.55 \mu\text{m}$$

# Mach-Zehnderjev interferometer

Podlaga GaAs → ne potrebuje potujočega vala



Ugasno razmerje  $\approx 20\text{dB}$  (polarizacija?)

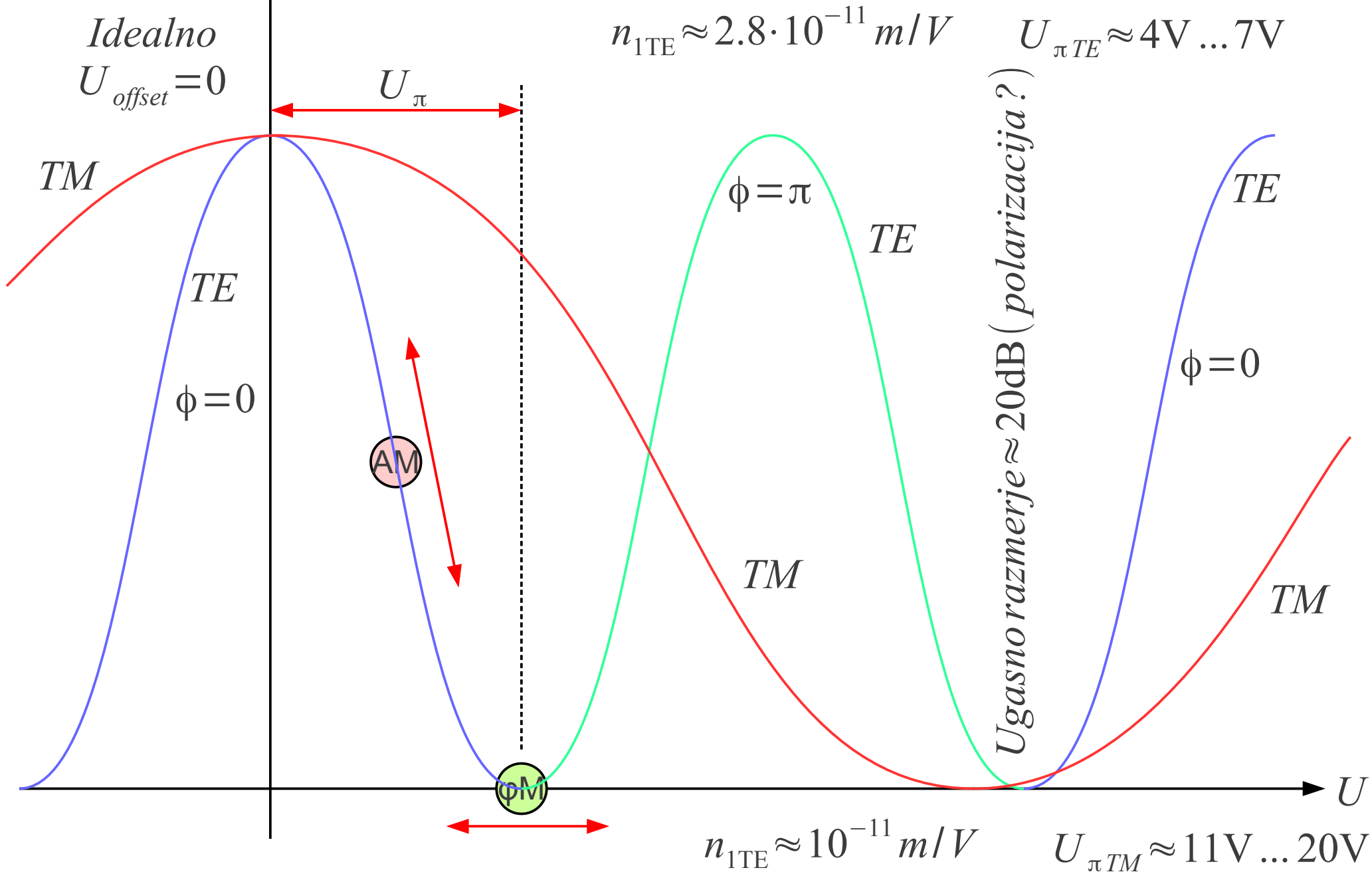
$$\alpha^2 \approx -5\text{dB}$$

$$E_I = \alpha \frac{E_V}{2} (e^{j\Delta\phi} + e^{-j\Delta\phi}) = \alpha E_V \cos \Delta\phi$$

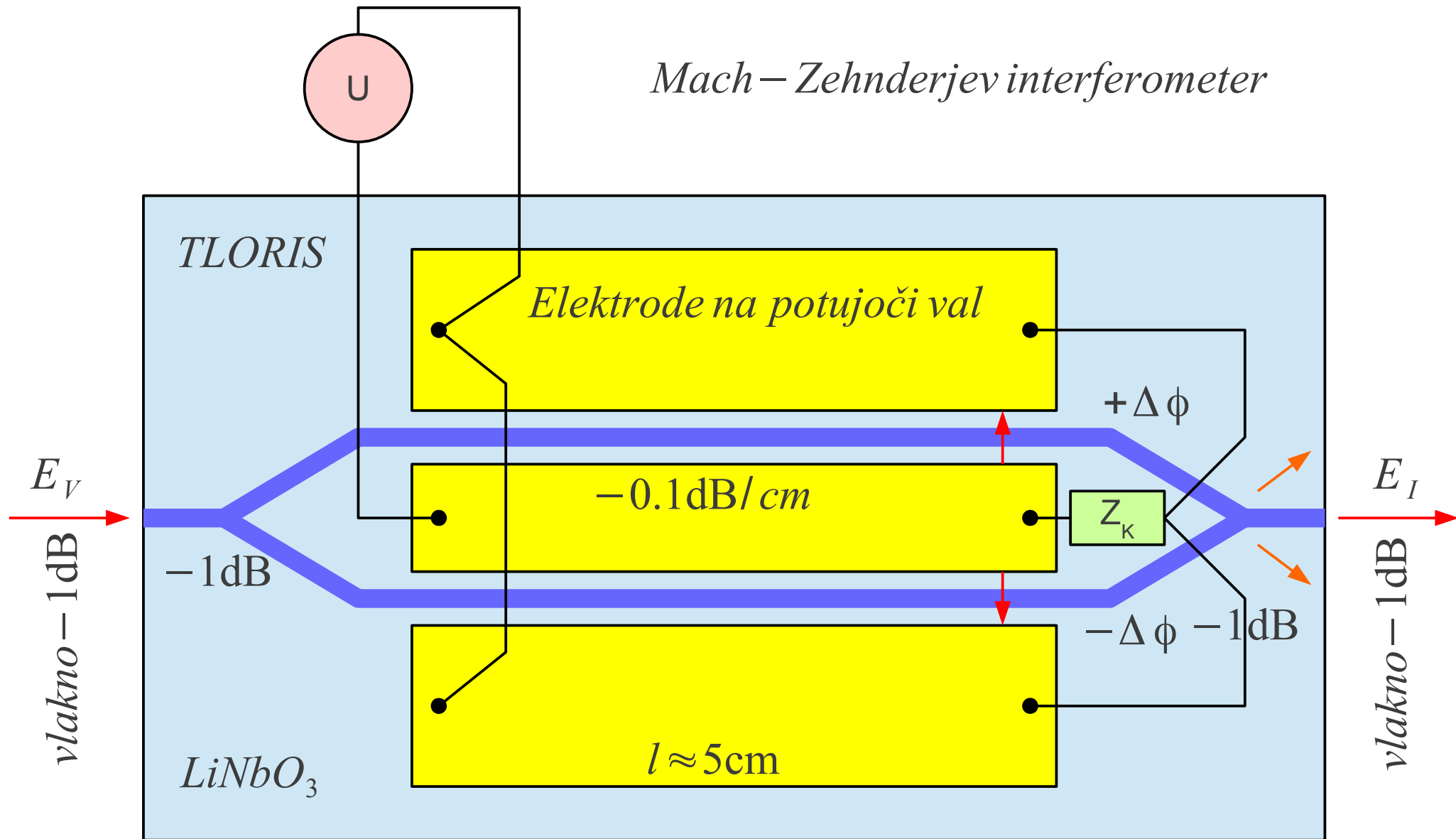
$$P_I = \alpha^2 P_V \left( \frac{1}{2} + \frac{1}{2} \cos 2\Delta\phi \right)$$



$$P_I = \alpha^2 P_V \left( \frac{1}{2} + \frac{1}{2} \cos 2 \Delta \phi \right) = \alpha^2 P_V \left( \frac{1}{2} + \frac{1}{2} \cos \pi \frac{U}{U_\pi} \right)$$



# Mach – Zehnderjev interferometer



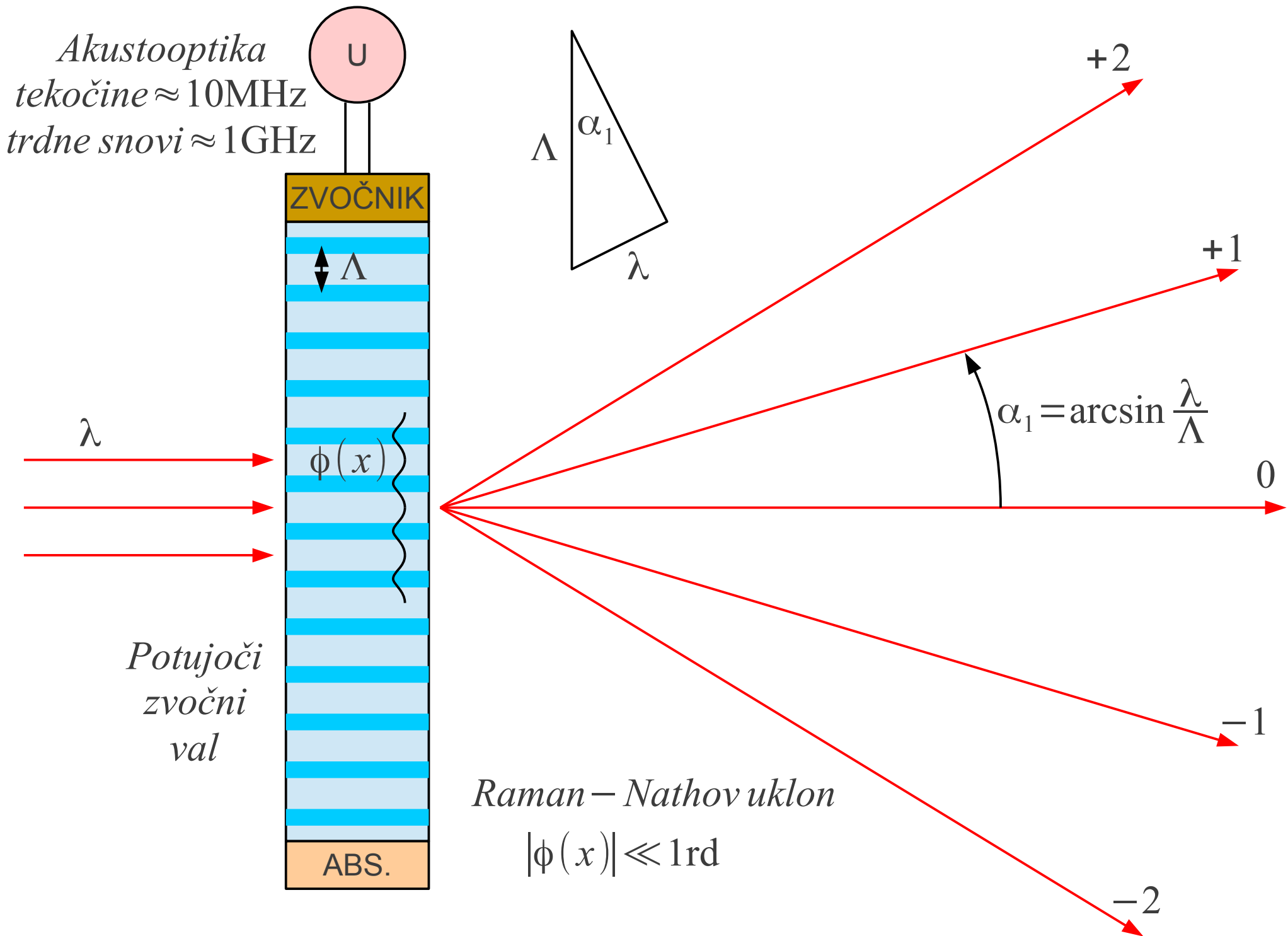
$$n_{\text{optični}} \approx 2.21 \dots 2.3$$

Neskladje hitrosti

$$B \approx 10 \dots 40 \text{ GHz}$$

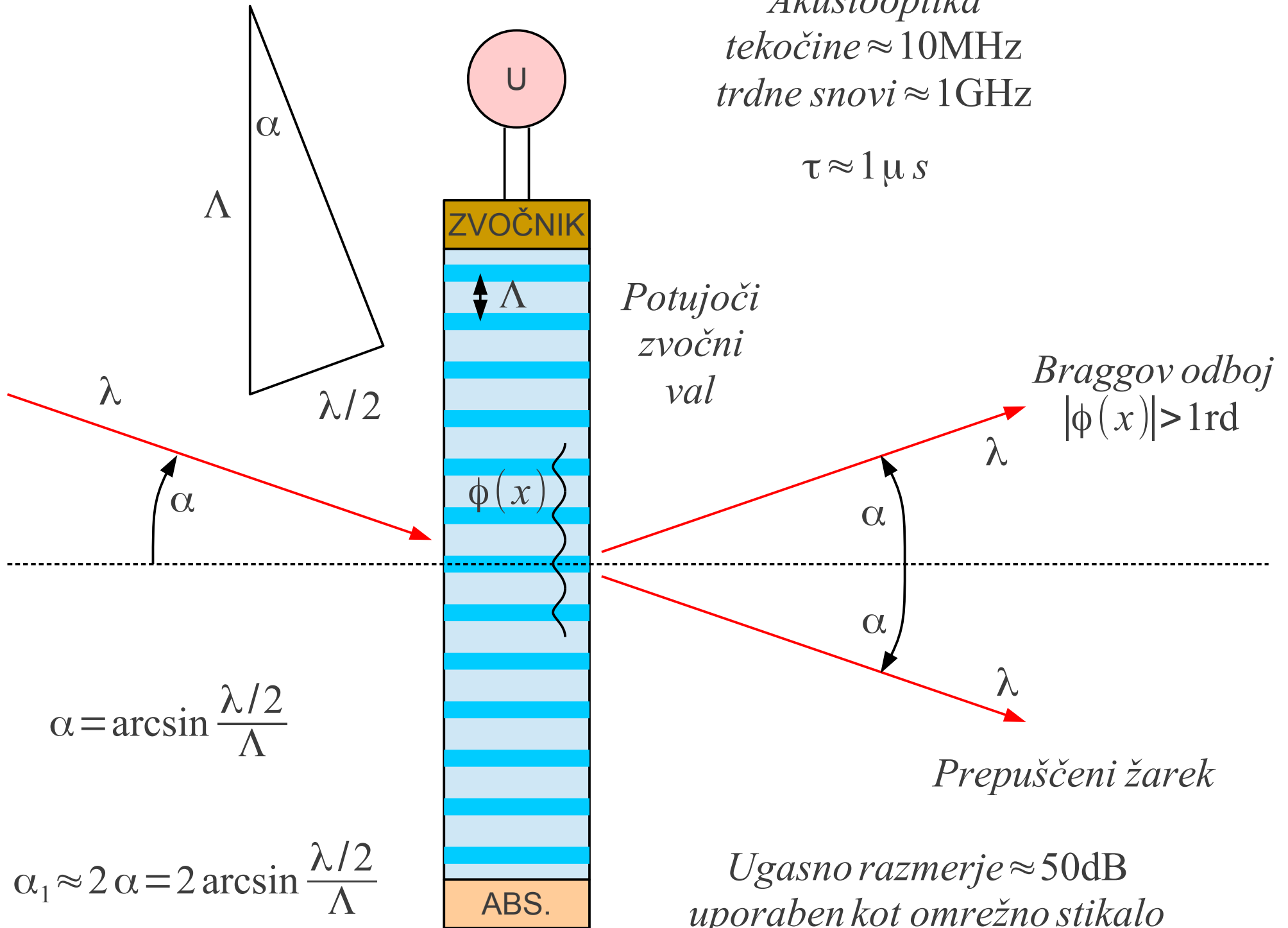
$$n_{\text{električni}} \approx 5 \dots 10$$

$$P_I = \alpha^2 P_V \left( \frac{1}{2} + \frac{1}{2} \cos \pi \frac{U - U_{\text{offset}}}{U_\pi} \right)$$



*Akustooptika*  
*tekočine*  $\approx 10\text{MHz}$   
*trdne snovi*  $\approx 1\text{GHz}$

$$\tau \approx 1\mu s$$



$$\alpha = \arcsin \frac{\lambda/2}{\Lambda}$$

$$\alpha_1 \approx 2\alpha = 2 \arcsin \frac{\lambda/2}{\Lambda}$$

*Potujoči*  
*zvočni*  
*val*

*Braggov odboj*  
 $|\phi(x)| > 1\text{rd}$

*Prepuščeni žarek*

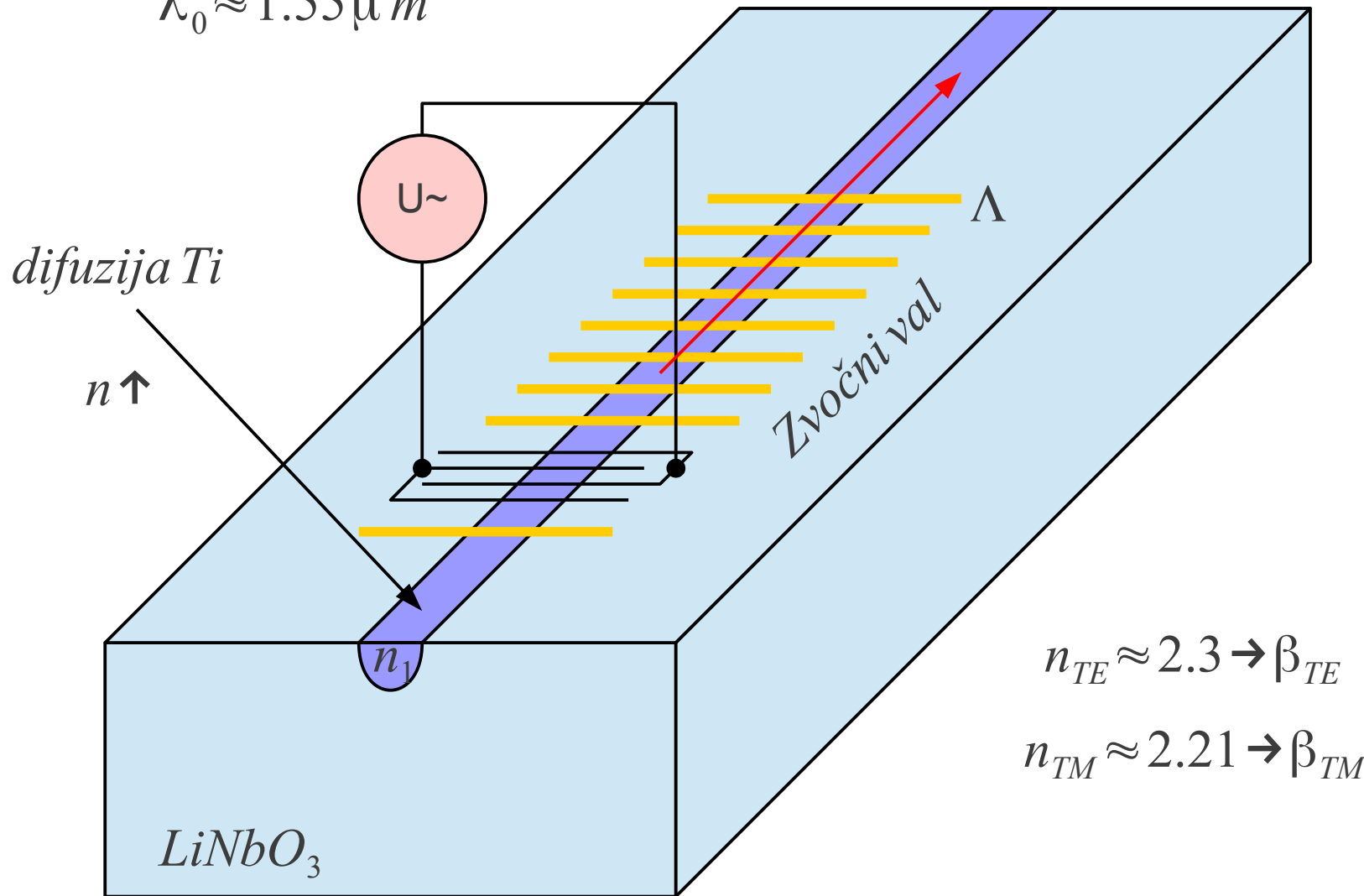
*Ugasno razmerje*  $\approx 50\text{dB}$   
*uporaben kot omrežno stikalo*

Valvnodolžinsko sito iz  $\text{LiNbO}_3$

$$\frac{2\pi}{\Lambda} = \Delta\beta \rightarrow \text{sklop } TE \leftrightarrow TM$$

$$f \approx 175\text{MHz}$$

$$\lambda_0 \approx 1.55\mu\text{m}$$



$$n_{TE} \approx 2.3 \rightarrow \beta_{TE}$$

$$n_{TM} \approx 2.21 \rightarrow \beta_{TM}$$