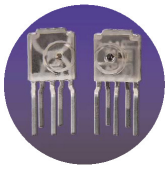
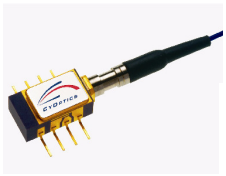
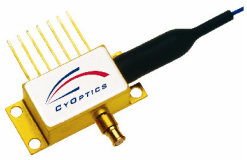
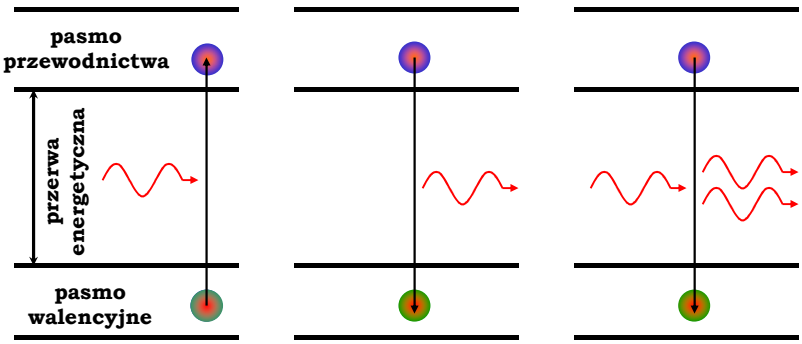
Lasery półprzewodnikowe



Podstawowe procesy fotoniczne



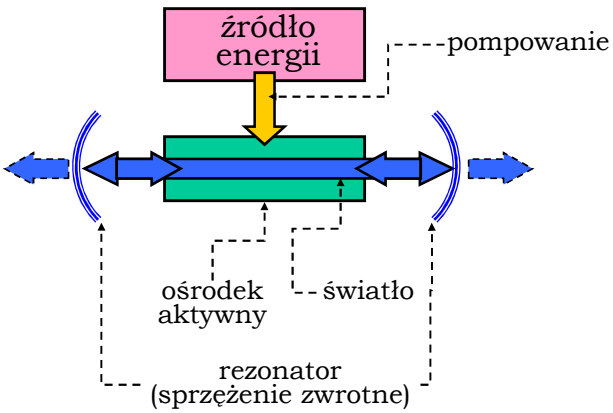
absorpcja | emisja spontaniczna | emisja wymuszona

rekombinacja niepromienista

Na czym polega „akcja laserowa”?

podejście Einsteina

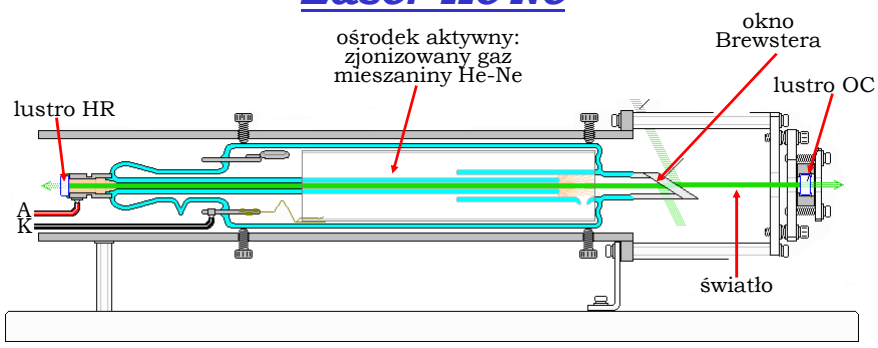
Schemat ideowy lasera



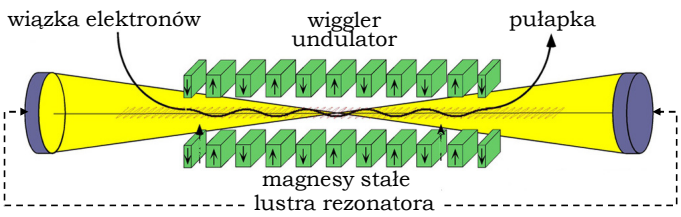
Rodzaje laserów

- ciała stałego (rubinowe, Nd-YAG, Ti-Sp, Er...)
- gazowe (He-Ne, Co_2, Ar, Kr,...)
- półprzewodnikowe (te lubimy najbardziej bo są małe...)
- chemiczne
- FEL (Free Electron Laser)
- ....

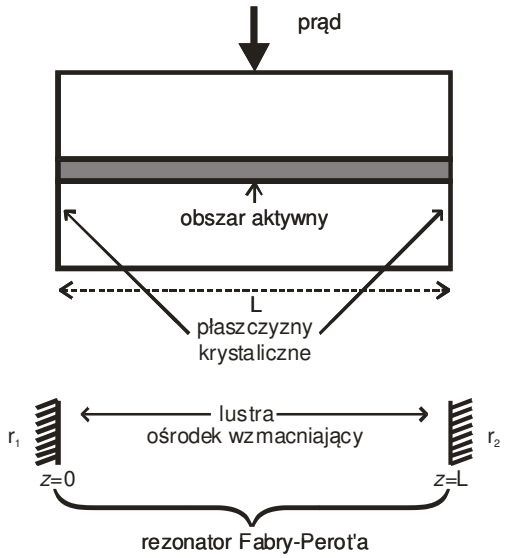
Laser He-Ne



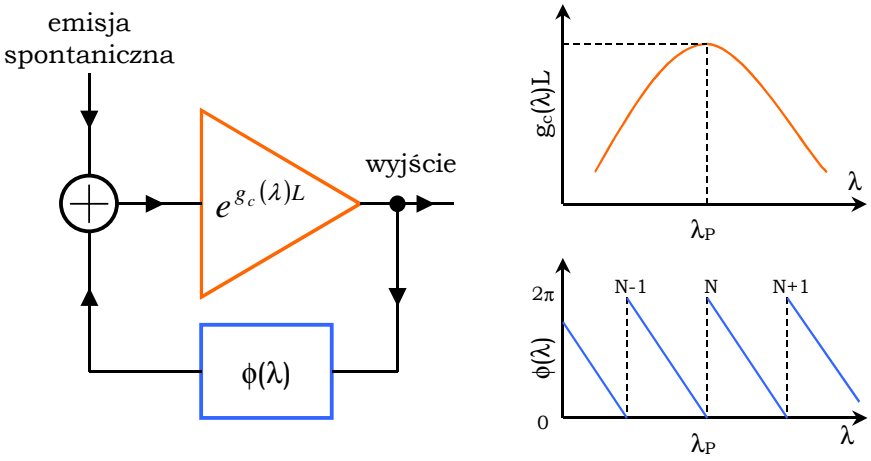
Free Electron Laser



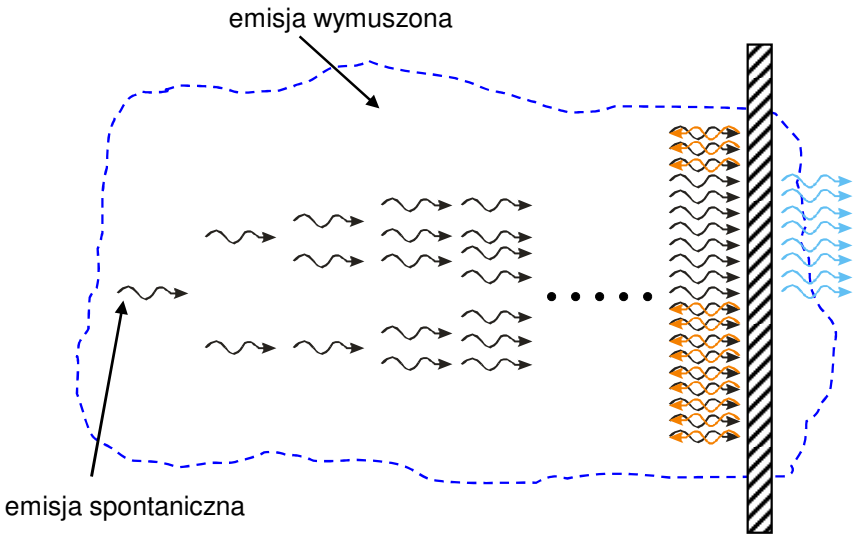
Laser półprzewodnikowy Fabry-Perot



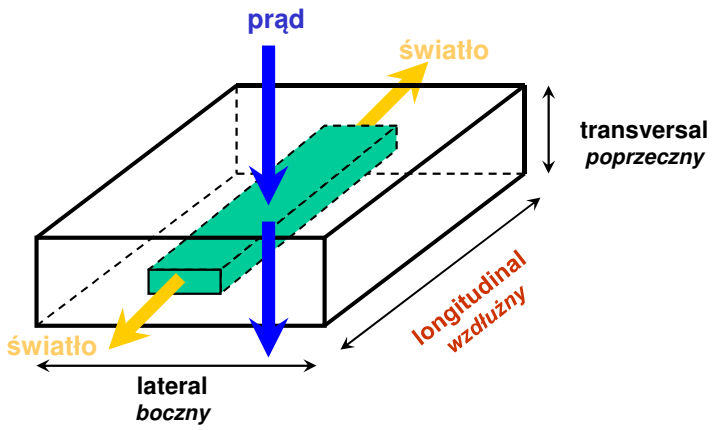
Zasada działania lasera



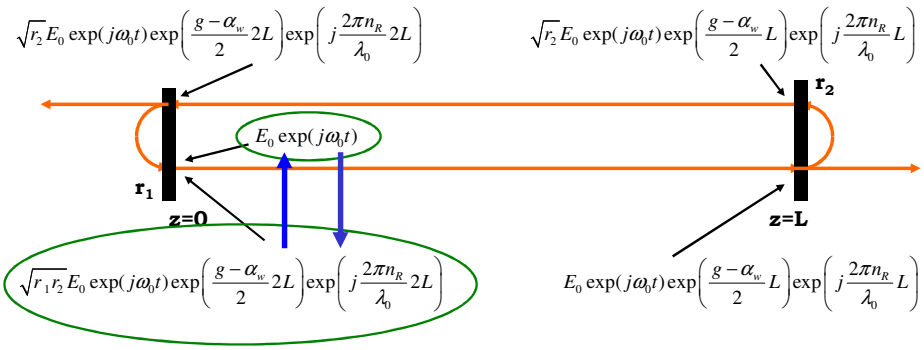
Na czym polega wzmocnienie w obszarze aktywnym lasera?



Obszar aktywny lasera półprzewodnikowego



Warunki akcji laserowej



$$\sqrt{r_1 r_2}\exp((g-\alpha_w)L)\exp\left(j\frac{2\pi n_R\cdot 2L}{\lambda_0}\right)=1+j0$$

Warunki akcji laserowej

$$\sqrt{r_1 r_2}\exp((g-\alpha_w)L)\exp\left(j\frac{2\pi n_R\cdot 2L}{\lambda_0}\right)=1+j0$$

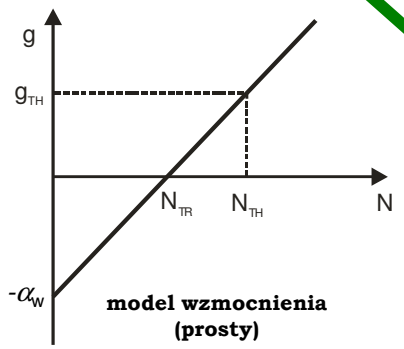
I. Warunek amplitudowy

$$\sqrt{r_1 r_2}\exp((g-\alpha_w)L)=1 \;\Rightarrow\; g_{th}=\alpha_w-\frac{1}{2L}\ln(r_1 r_2)$$

Prąd progowy lasera

$$g_{th} = \alpha_w - \frac{1}{2L}\ln(r_1 r_2)$$

$$g_{th} = \alpha_w \left(\frac{N_{th}}{N_{TR}} - 1 \right)$$



model wzmocnienia (prosty)

$$N_{TR} < N_{th} \Rightarrow \frac{dN}{dt} = \eta \frac{I}{qV} - \frac{N}{\tau_e}$$

(brak emisji wymuszonej)

stan ustalony $\Rightarrow \frac{dN}{dt} = 0$

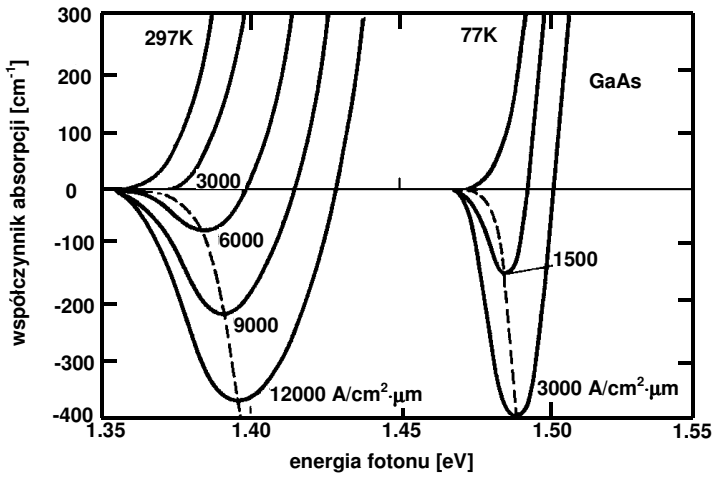
$$I = N \frac{q}{\eta} \frac{V}{\tau_e}$$

$$N_{th} = N_{TR}\left(1 + \frac{g_{th}}{\alpha_w}\right)$$

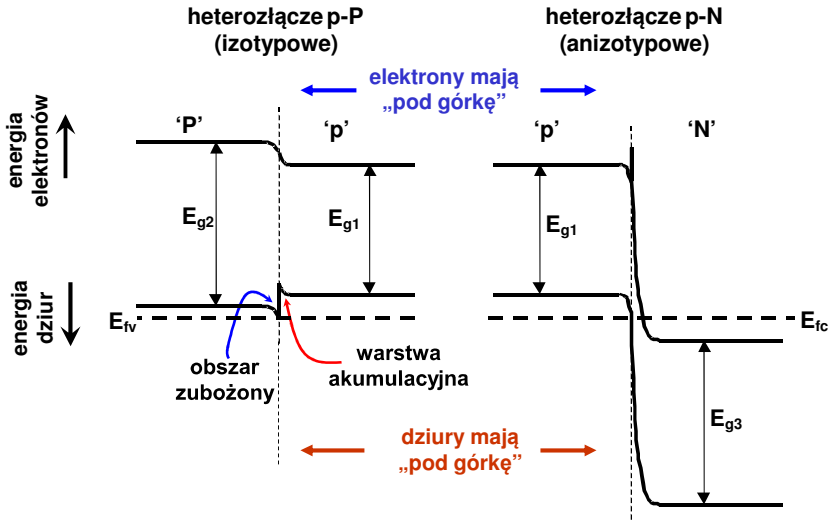
$$I_{th} = N_{TR}\left(1 + \frac{g_{th}}{\alpha_w}\right)\frac{qV}{\eta\tau_e}$$

Wzmocnienie w obszarze aktywnym

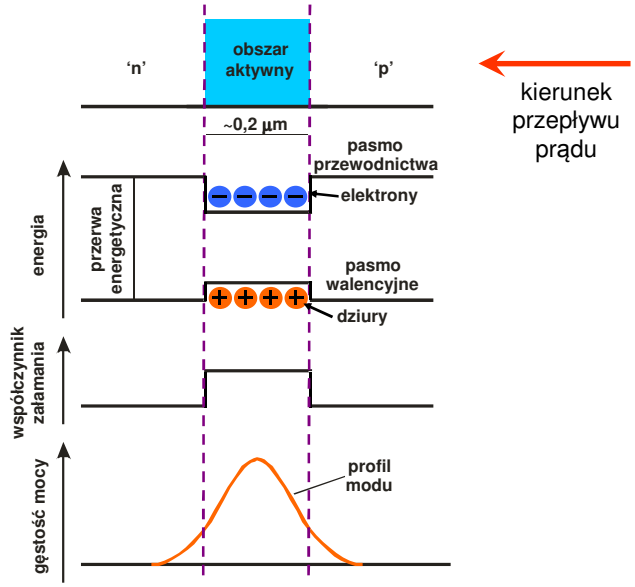
(profil wzmocnienia)



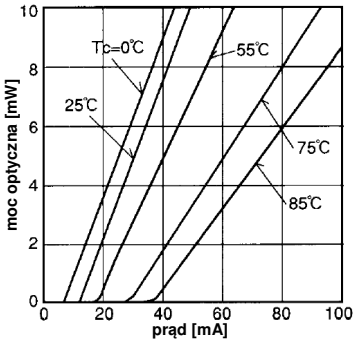
Budowa lasera *(transversal confinement)*



Laser biheterozłączowy *(transversal confinement)*



Prąd progowy lasera



laser QW
(quantum well)

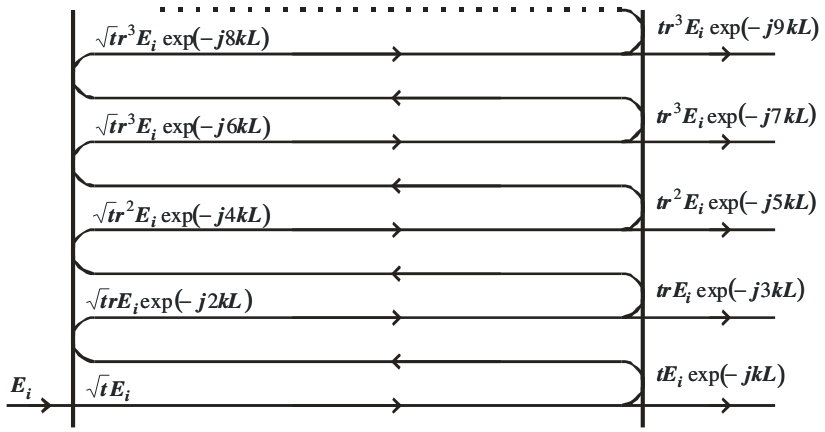
Warunki akcji laserowej

$$\sqrt{r_1 r_2}\,\exp((g-\alpha_w)L)\exp\left(j\frac{2\pi n_R \cdot 2L}{\lambda_0}\right)=1+j0$$

II. Warunek fazowy

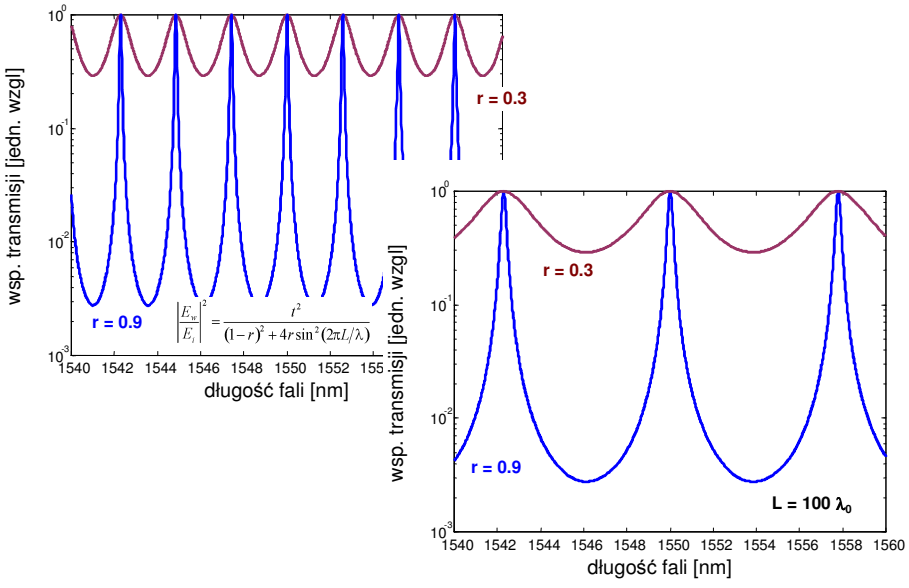
$$\frac{2\pi \cdot n_R \cdot 2L}{\lambda_0}=2\pi \cdot m \Rightarrow \begin{array}{l}\lambda_0=\dfrac{2L\cdot n_R}{m}\\ L=m\dfrac{1}{2}\dfrac{\lambda_0}{n_R}\end{array}$$

Rezonator Fabry-Perot *(longitudinal confinement)*

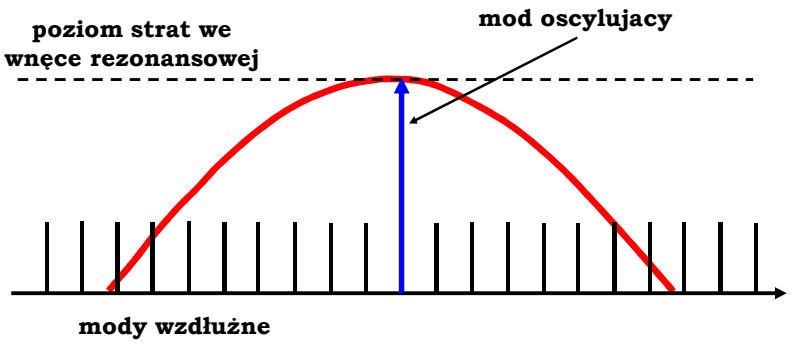


***t, r* - zdefiniowane dla MOCY**

Charakterystyka rezonatora Fabry-Perot



Wzbudzenie akcji laserowej

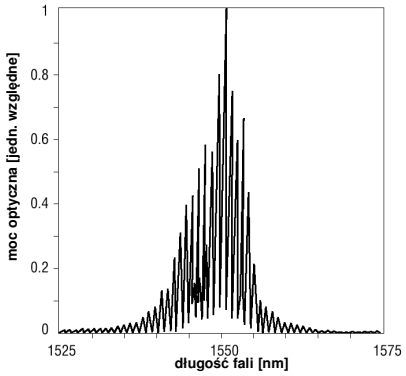


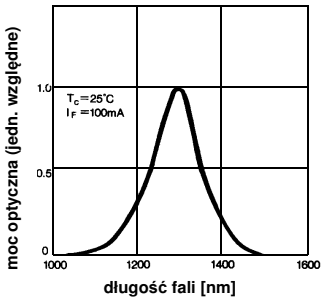
Odległość między modami

Odległość między modami

Lasery FP

charakterystyka spektralna

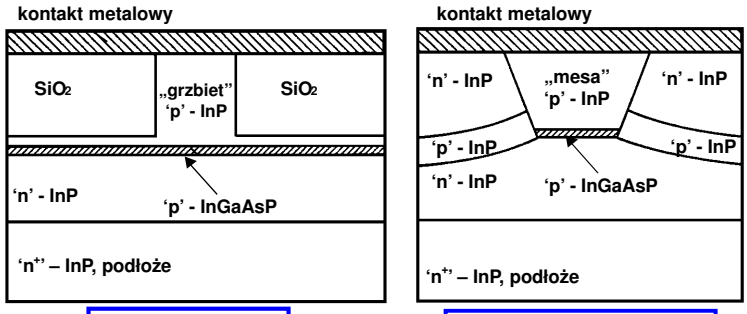




50 nm

600 nm

Laser biheterozłączowy *(lateral confinement)*



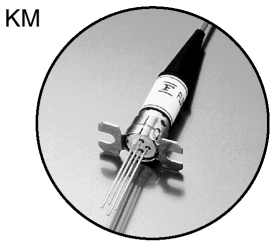
„ridge waveguide”
Δn ~0.01
weak guiding

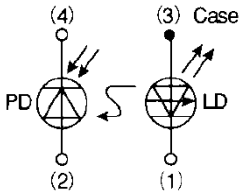
„burried heterostructure”
Δn ~0.1
strong guiding

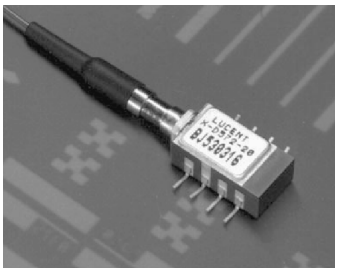
lasery „index guided”

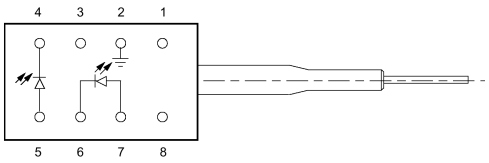
obszar świecący ~0.1×1μm
mało zależny od prądu sterującego laser

Co można znaleźć w obudowie lasera?

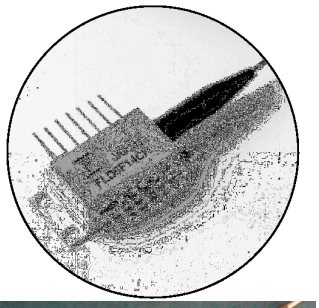


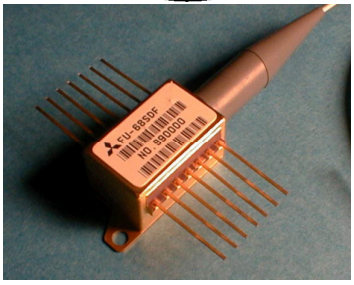


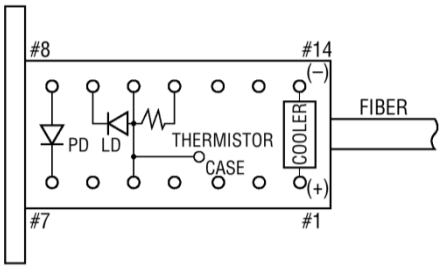




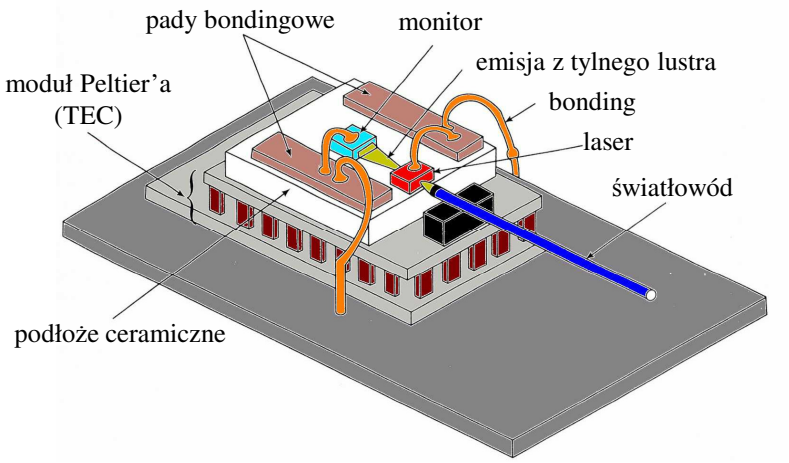
Co można znaleźć w obudowie lasera? ...



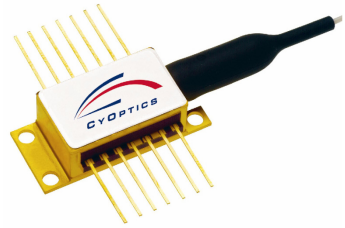


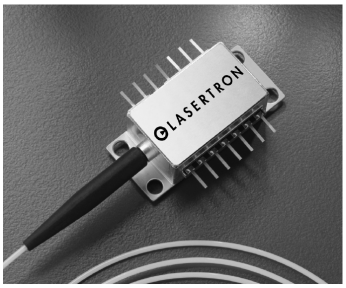


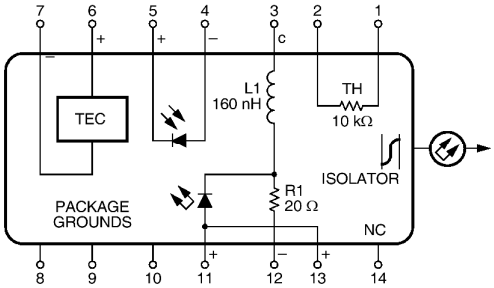
Konstrukcja modułu laserowego



Co można znaleźć w obudowie lasera? ...







Moduły:
GBIC – Gigabit Interface Converter
SFP – Small Form-factor Plugable