

Optoelectronică, structuri și tehnologii

Curs 9

Dioda Laser

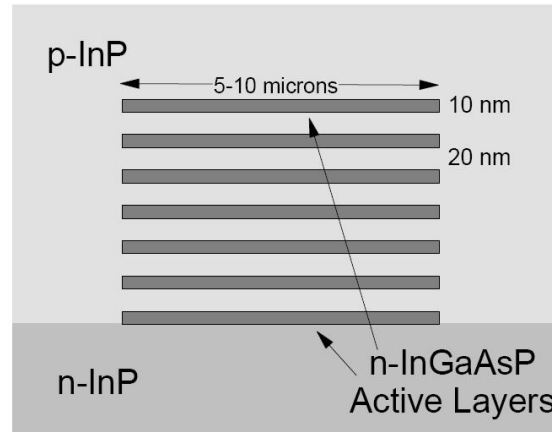
Partea a II-a

Quantum Well Laser

- ▶ Cand lumina e pastrata in cavitati mai mici decat lungimea de unda nu mai poate fi modelata prin unda, modelul devine cuantic
- ▶ Daca inaltimea zonei active scade la 5–20 nm comportarea diodei laser se schimba
 - energia necesara pentru inversarea de populatie se reduce, deci curentul de prag scade
 - dimensiunea redusa a zonei active duce la scaderea puterii maxime
- ▶ multiple straturi subtiri suprapuse – Multiple

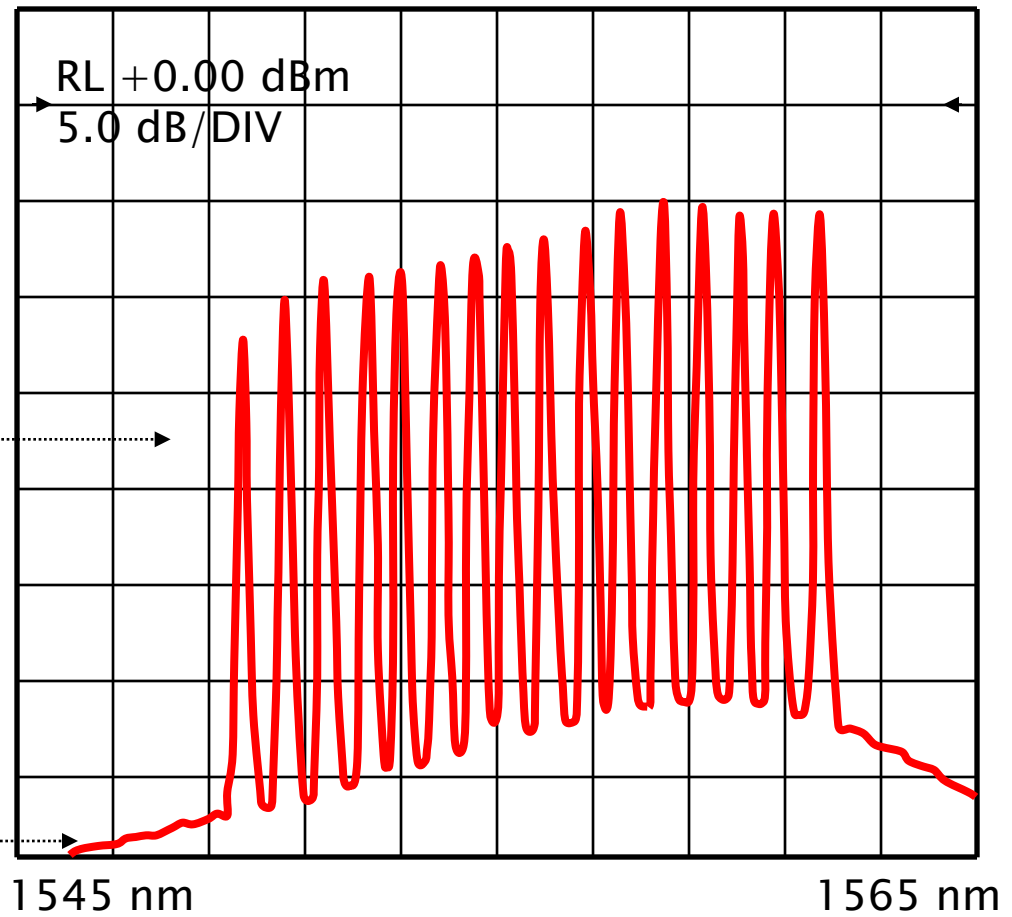
Quantum Well Laser

- ▶ multiple straturi subtiri suprapuse – Multiple Quantum Well



- ▶ Avantaje
 - curent de prag redus
 - stabilitate crescuta a frecventei la functionarea in impuls
 - latime mica a liniilor spectrale
 - zgomot redus

Spectrul WDM – Wavelength Division Multiplexing



Canale: 16
Spațiere: 0.8 nm

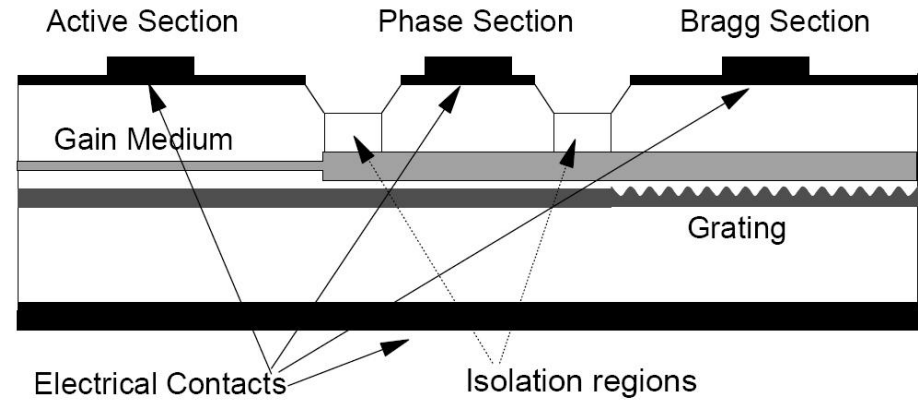
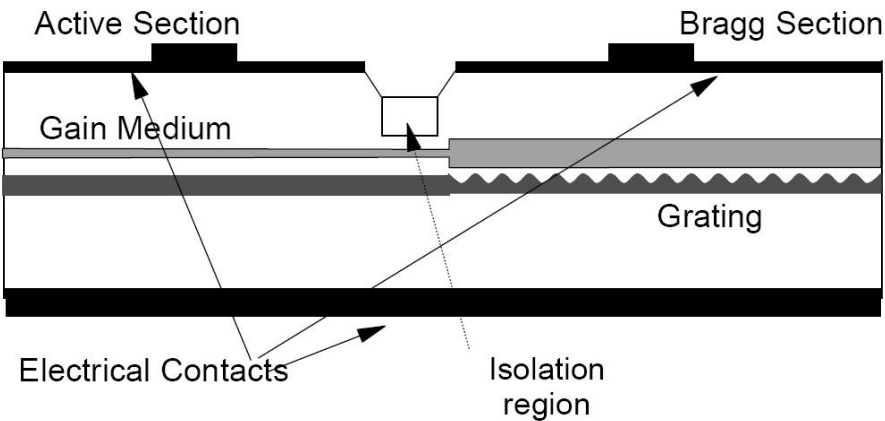
Emisie spontană
Amplificată (ASE)

Diode laser reglabile

▶ Necesitate

- In sistemele WDM exista necesitatea (in propuneri pentru arhitecturi viitoare de retele) pentru reglaj foarte rapid al lungimii de unda pe un anume canal – zeci de ns
- In aceleasi sisteme intervine necesitatea rutarii prin lungime de unda – timp de reglaj necesar de ordinul secundelor)
- realizarea cererilor de date – timp de reglaj de ordinul sute de μ s
- reglarea emitatorilor individuali in sistemele WDM
 - lipsa necesitatii controlului strict la productia diodelor
 - degradarea lungimii de unda in timp

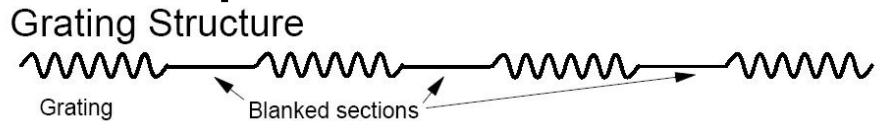
Diode laser reglabile



- ▶ Curentul trece prin zona activa ducand la amplificarea luminii
- ▶ curentul ce parcurge zona corespunzatoare reflectorului Bragg modifica indicele de refractie al acestei zone deci lungimea de unda
- ▶ zona centrala suplimentara permite reglaj fin suplimentar in jurul valorii impuse de reflectorul Bragg

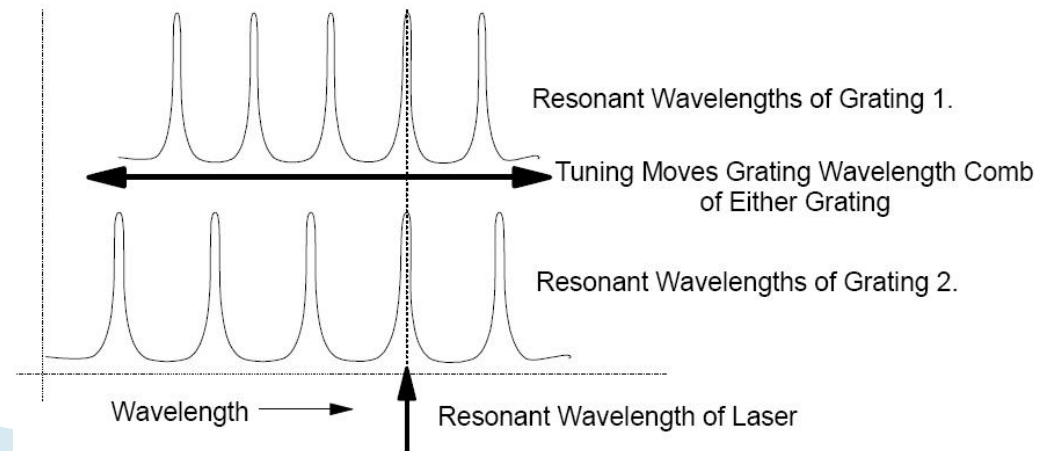
Diode laser reglabile

- ▶ Dezavantajul metodelor anterioare e dat de limita redusa a reglajului ($\sim 10\text{nm}$)
- ▶ Reflectorul Bragg esantionat (periodic) produce spectru de filtrare discret

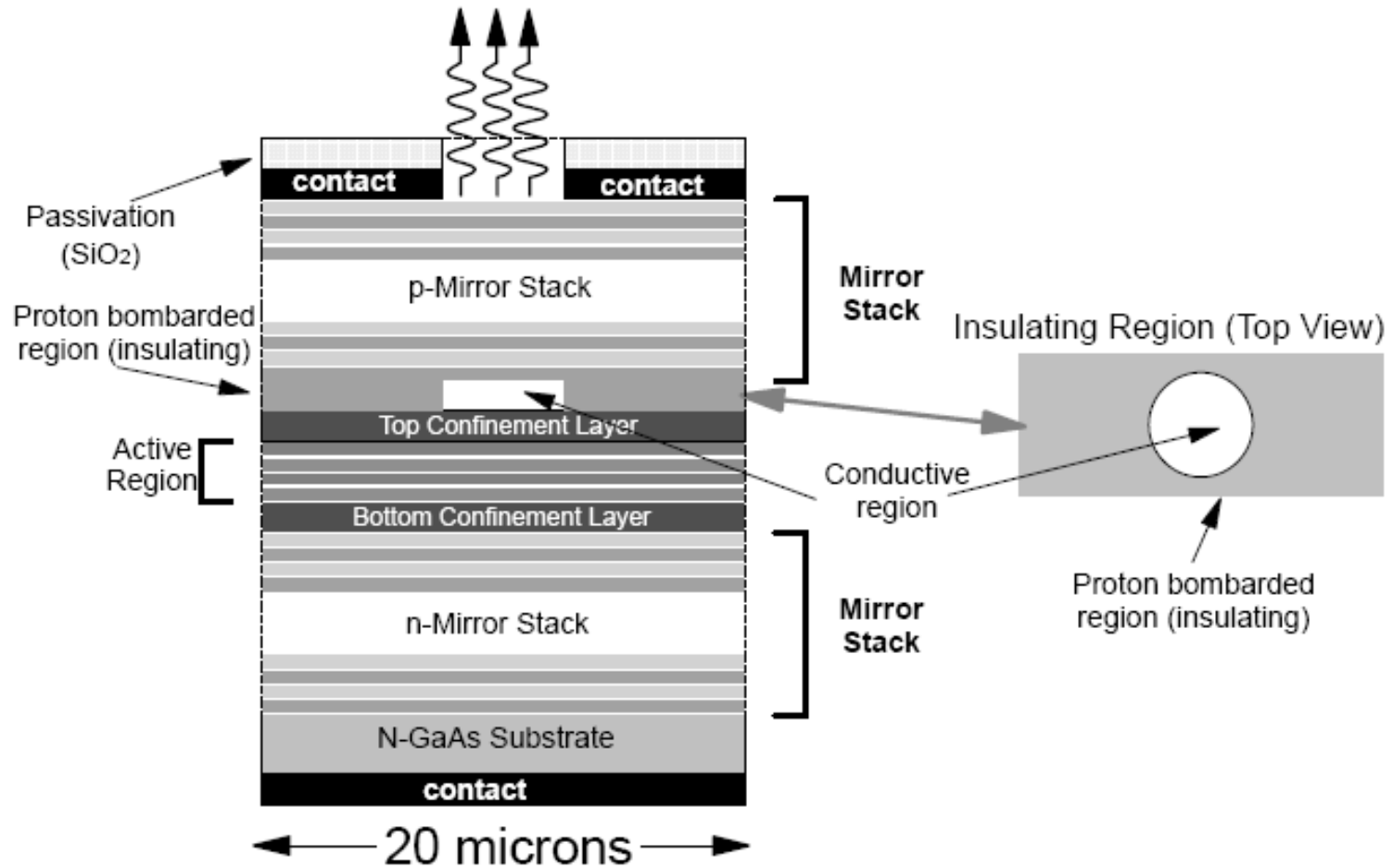


- ▶ Regland unul din reflectori se obtine rezonanta la suprapunerea celor doua spectre

Dezavantaj :
reglajul e discret

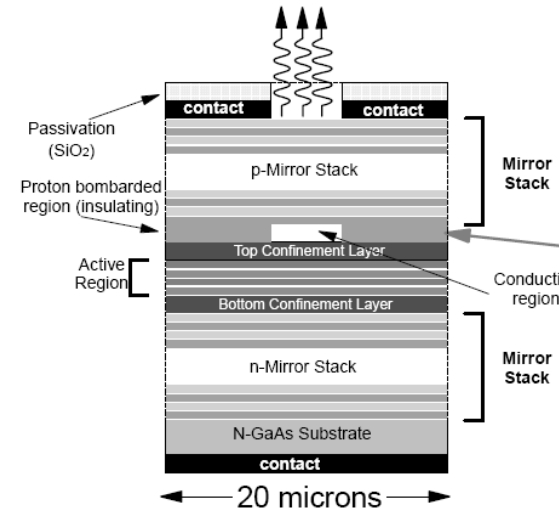


Vertical Cavity Surface Emitting Lasers (VCSEL)



VCSEL

- ▶ Oglinzile pot fi realizate din straturi succesive din semiconductori cu indici de refractie diferiti – reflector Bragg
- ▶ Prelucrarea laterala se rezuma la taierea materialului
- ▶ Numarul total de straturi poate ajunge la 500
- ▶ Caracteristici
 - ▶ puteri de ordinul 1 mW
 - ▶ lungimi de unda 850 si 980 nm
 - ▶ radiatie de iesire circulara cu divergenta redusa



VCSEL

▶ Caracteristici

- puteri de ordinul 1 mW
- lungimi de unda 850 si 980 nm
- radiatie de iesire circulara cu divergenta redusa
- VCSEL produce mai multe moduri transversale
 - insensibila la pierderile selective la mod din fibrele multimod (principala limitare in utilizarea diodelor laser in fibrele multimod)
- Curenti de prag foarte mici (5mA) si putere disipata redusa
 - circuite de control speciale nu sunt necesare
- Banda de modulatie mare (2.4GHz)
- Stabilitate mare cu temperatura si durata de viata

Dependenta de temperatura

- ▶ Dependenta de temperatura a curentului de prag este exponentiala

- ▶
$$I_{th} = I_0 \cdot e^{T/T_0}$$

- ▶ I_0 e o constanta determinata la temperatura de referinta

Material	Lungime de unda	T_0
InGaAsP	1300 nm	60÷70 K
InGaAsP	1500 nm	50÷70 K
GaAlAs	850 nm	110÷140 K

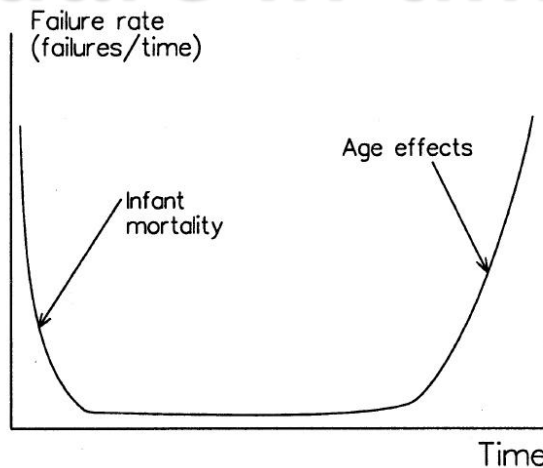
Degradare in timp

- ▶ Puterea scade in timp exponential

$$P(t) = P_0 \cdot e^{-t/\tau_m}$$

- ▶ τ_m – timpul de viata
- ▶ Diodele laser sunt supuse la conditii extreme de lucru
 - densitati de curent in zona activa $2000 \div 5000 \text{ A/cm}^2$
 - densitati de putere optica: $10^5 \div 10^6 \text{ W/cm}^2$
- ▶ Diverse definitii ale timpului de viata fac comparatiile dificile

Degradare in timp



- ▶ Cresterea curentului duce la scaderea duratei de viata

$$\tau_m \sim J^{-n}$$

- ▶ $n = 1.5 \div 2$ (empiric)
- ▶ Cresterea temperaturii duce de asemenea la scaderea duratei de viata

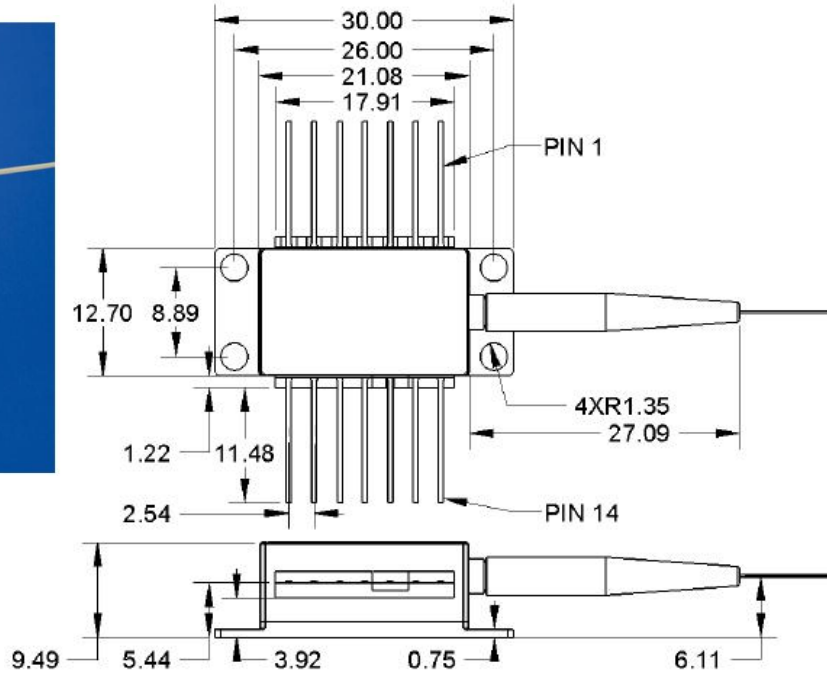
$$\tau_m \sim e^{E/kT}$$

- ▶ $E = 0.3 \div 0.95 \text{ eV}$ (valoarea tipica in teste 0.7 eV)

1550nm DFB Laser

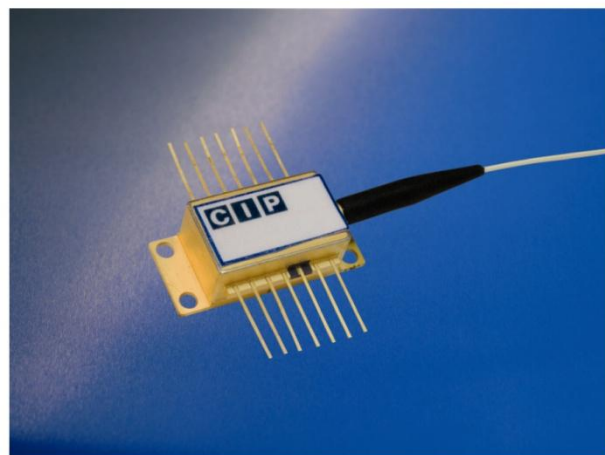
Mechanical Drawing

All units in mm

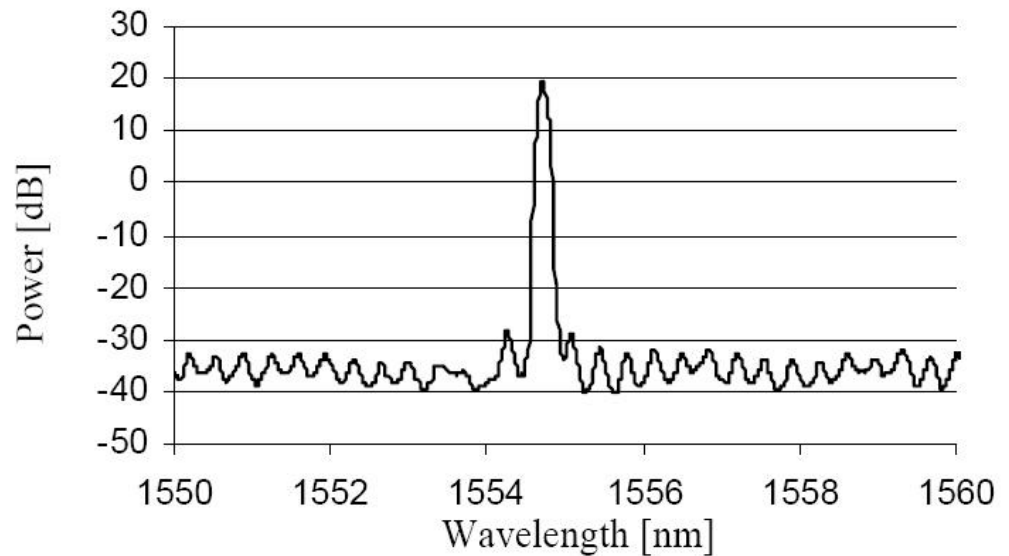
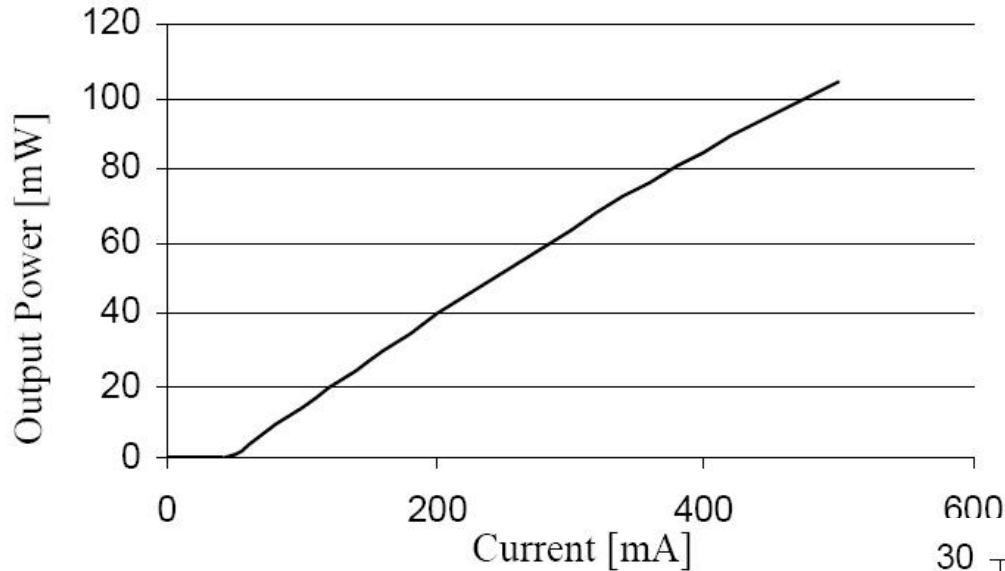


Pin out

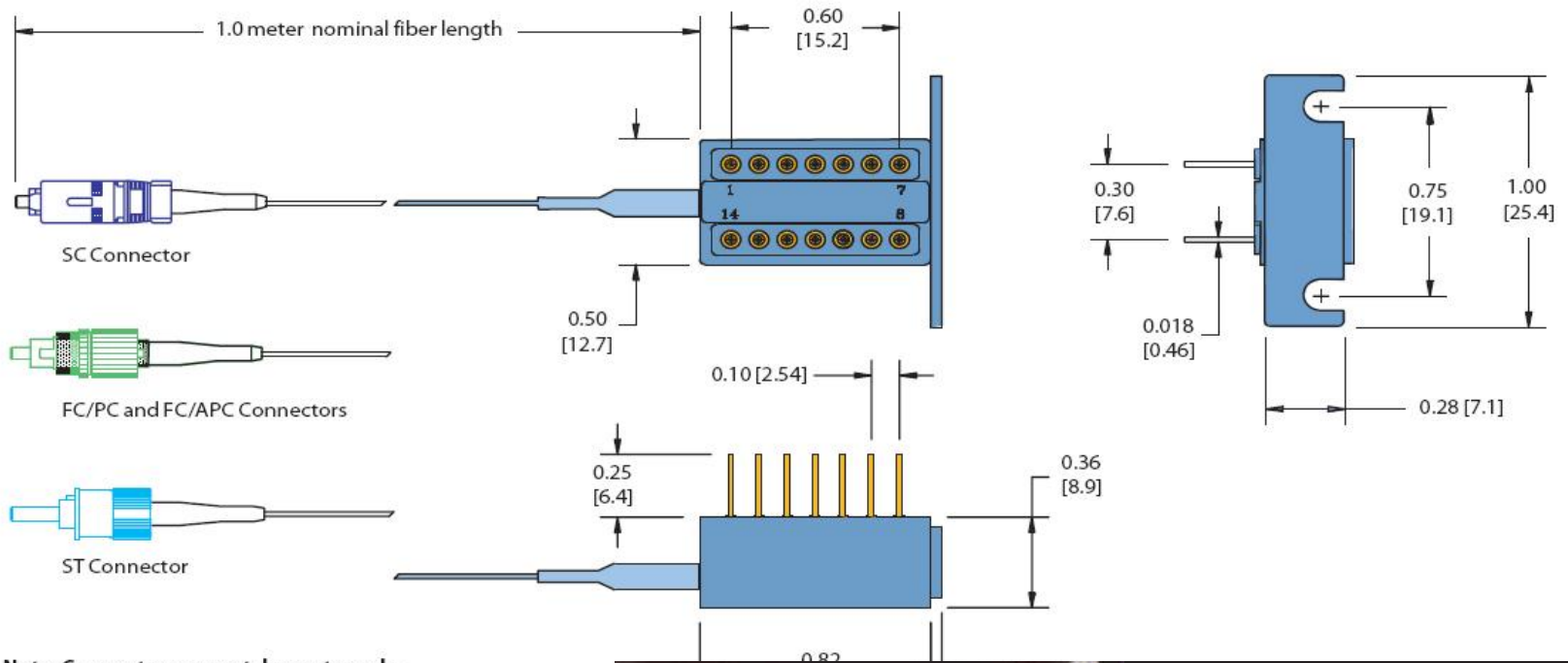
Pin	Description
1	Thermistor
2	Thermistor
3	Laser Cathode (Bias)
4	Monitor PD Anode
5	Monitor PD Cathode
6	TEC +
7	TEC -
8	Case GND, Laser Anode
9	Case GND, Laser Anode
10	Case GND, Laser Anode
11	Case GND, Laser Anode
12	Laser Cathode (modulation)
13	Case GND, Laser Anode
14	Case GND, Laser Anode



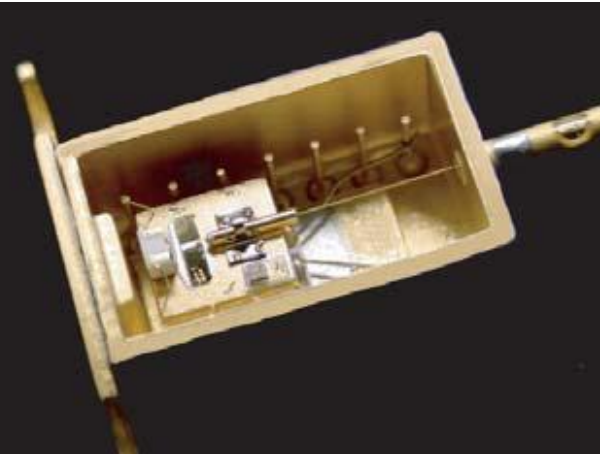
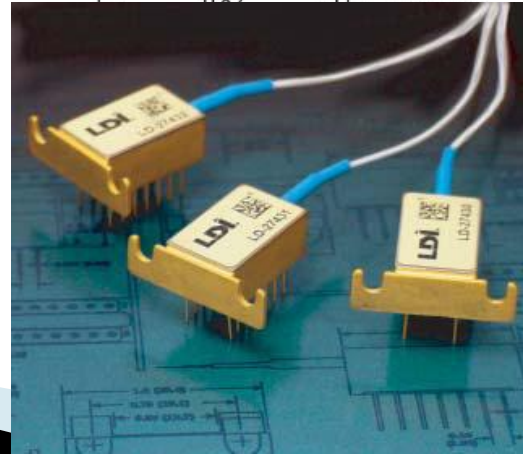
1550nm DFB Laser



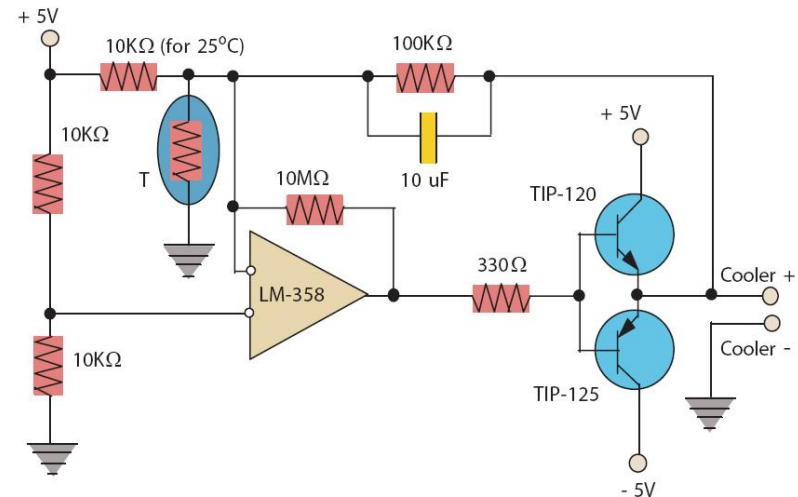
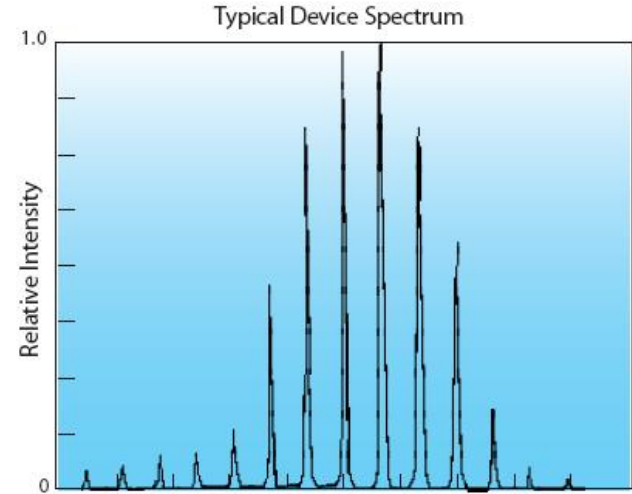
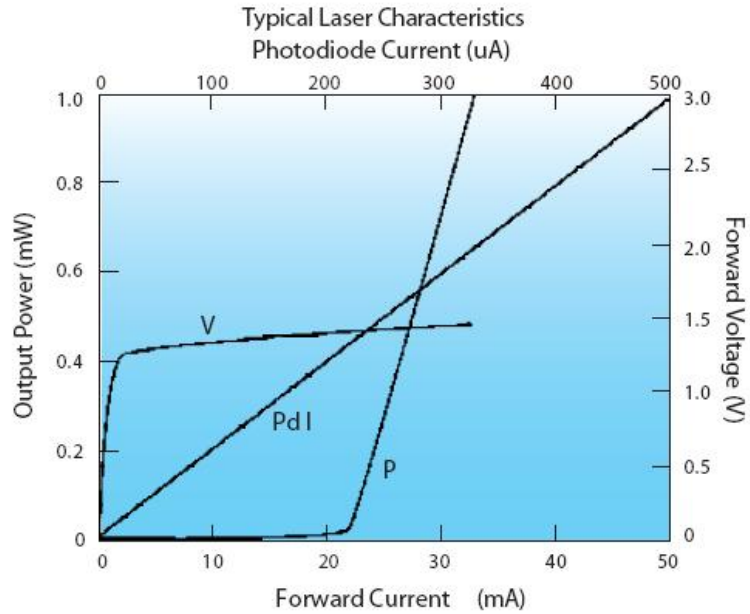
1550nm MQW Laser



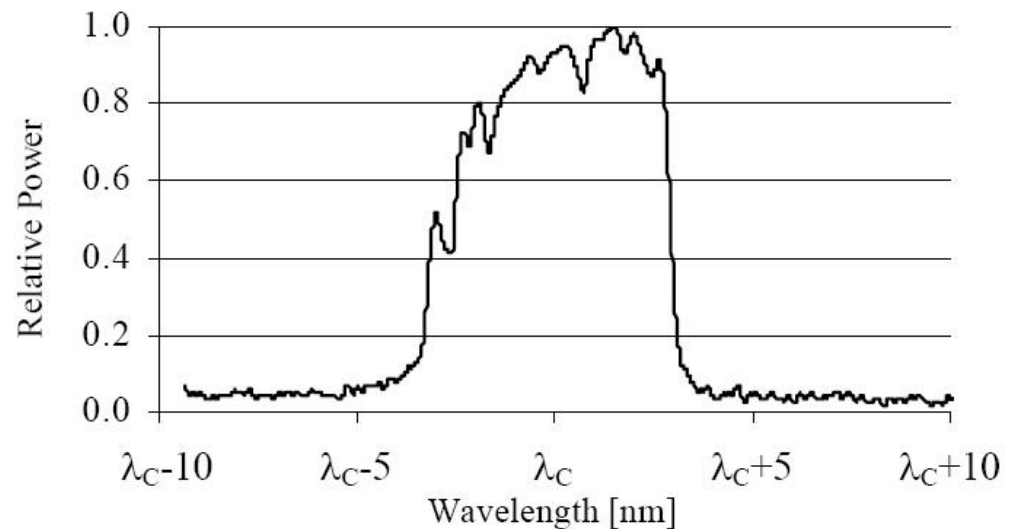
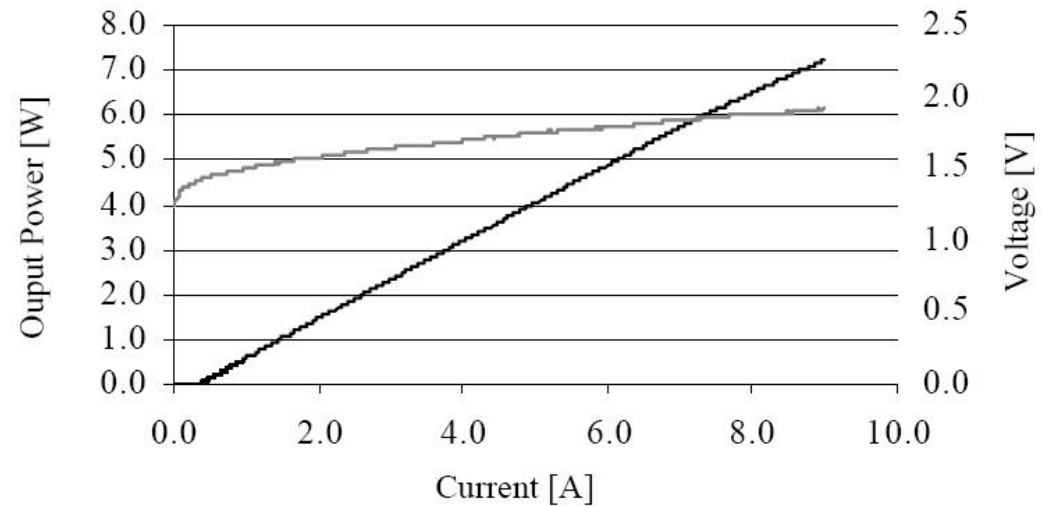
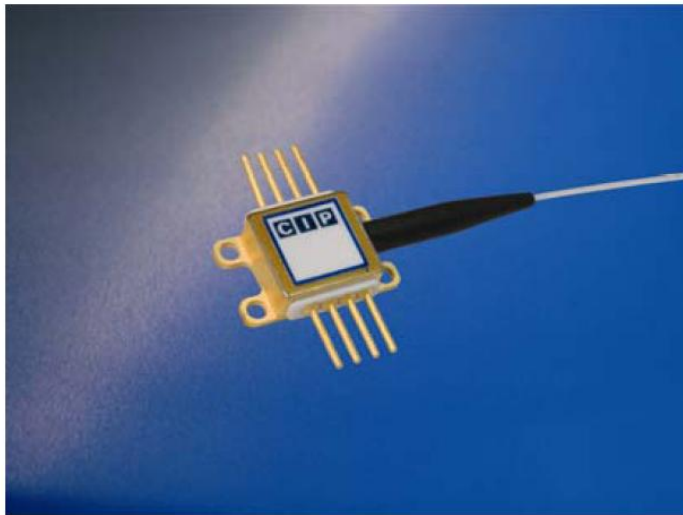
Note: Connectors are not drawn to scale.



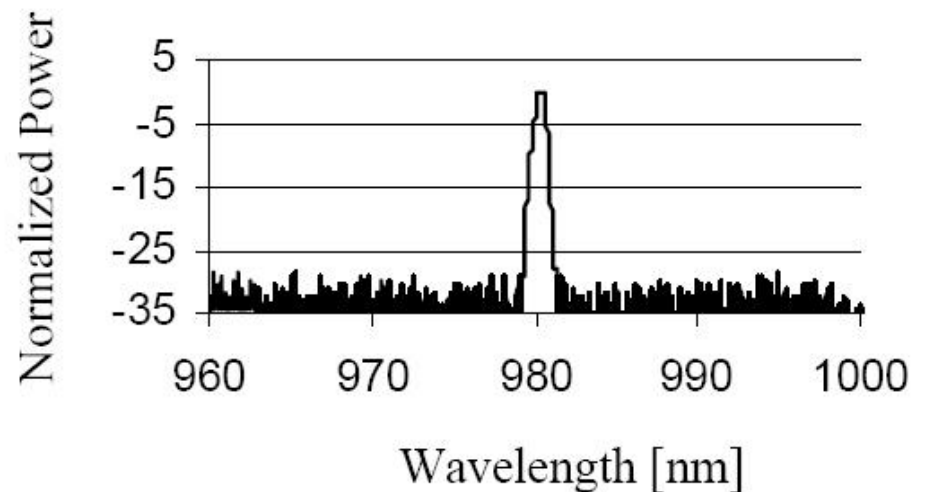
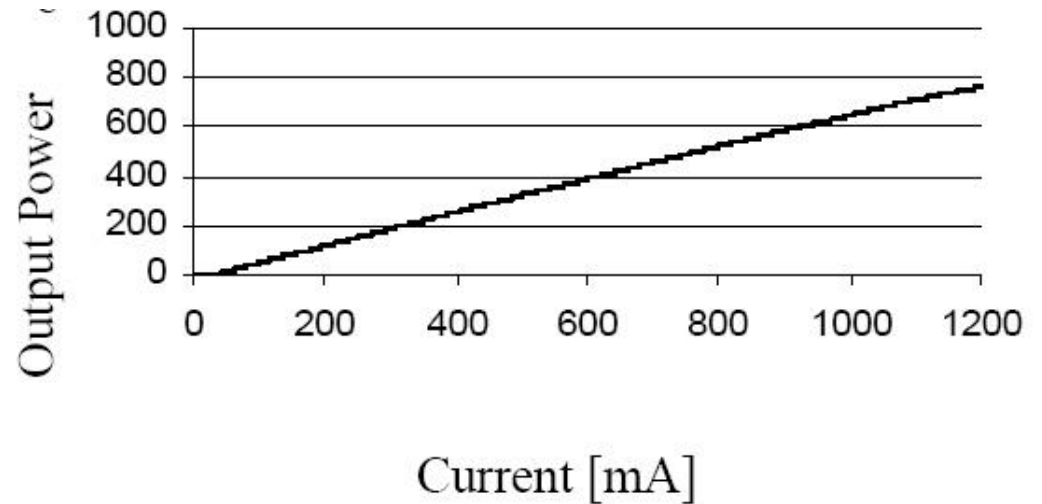
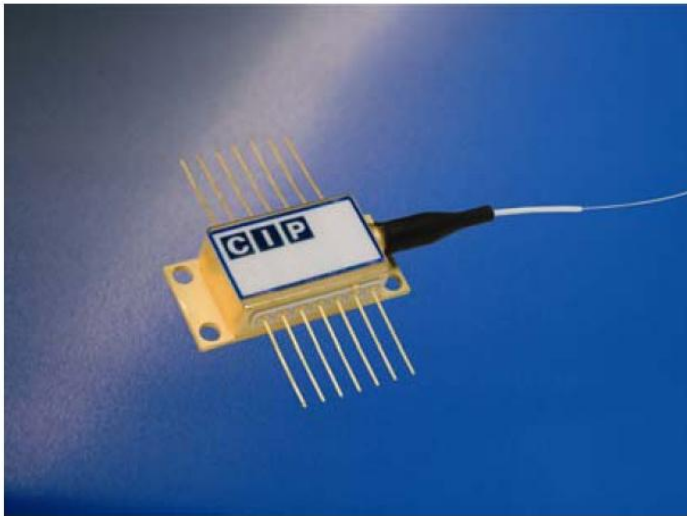
1550nm MQW Laser



7W 980 nm Multimode Pump Laser

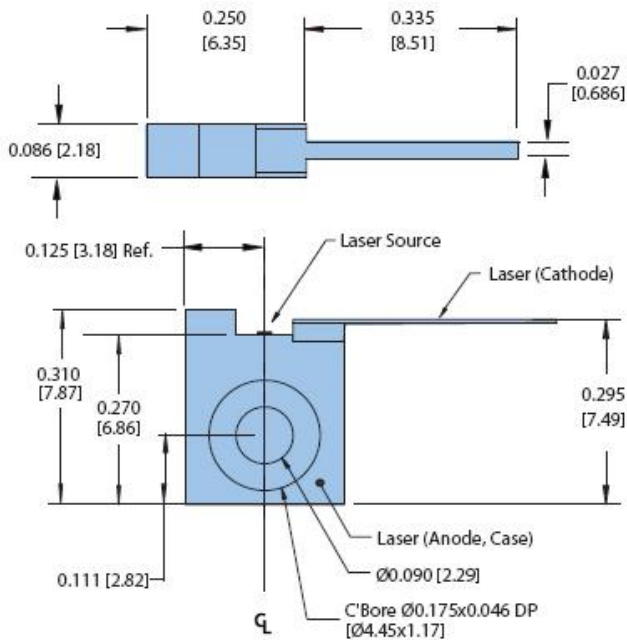


600mW 980 nm Singlemode Pump Laser

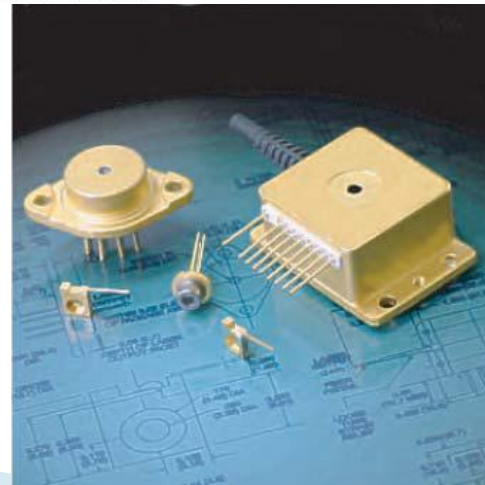
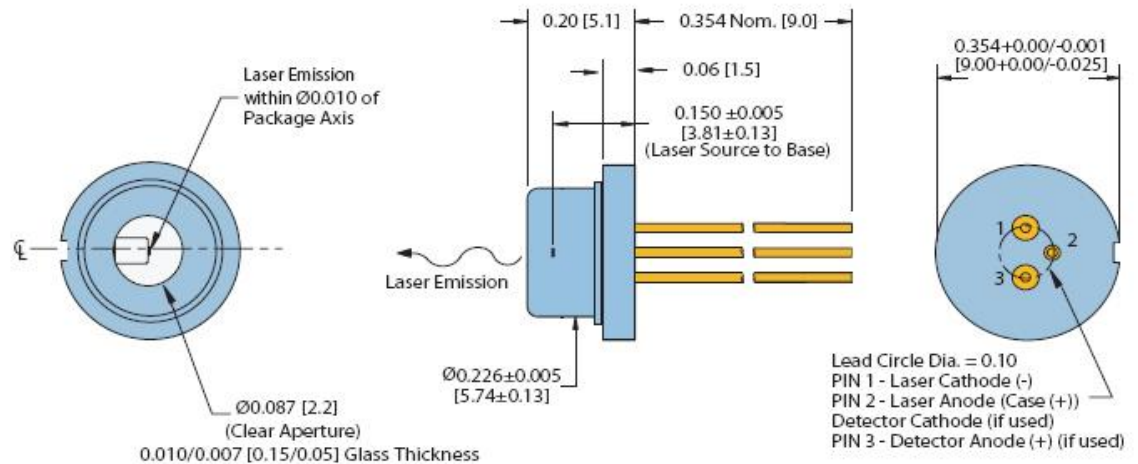


6 W, CW, 800nm

C-Mount Package

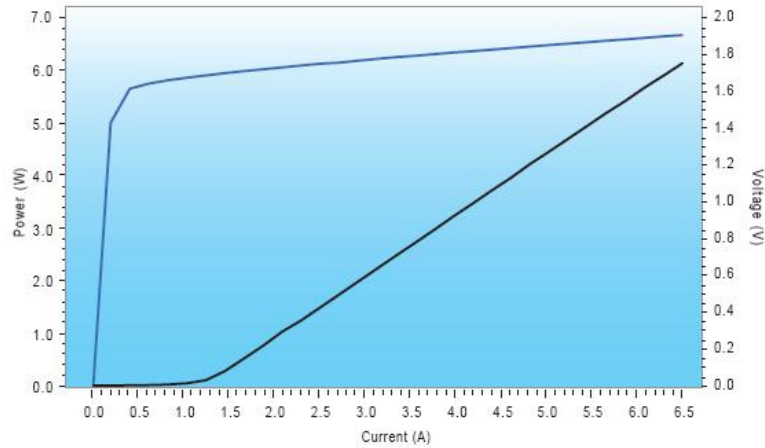


9mm Package

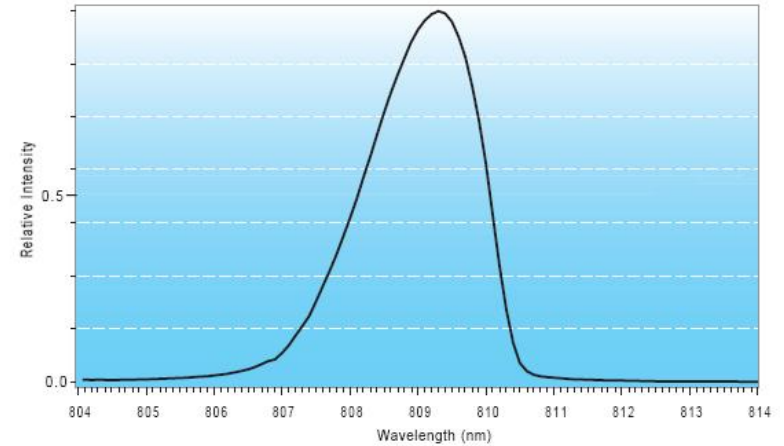


6 W, CW, 800nm

Typical L/I, V/I Graph

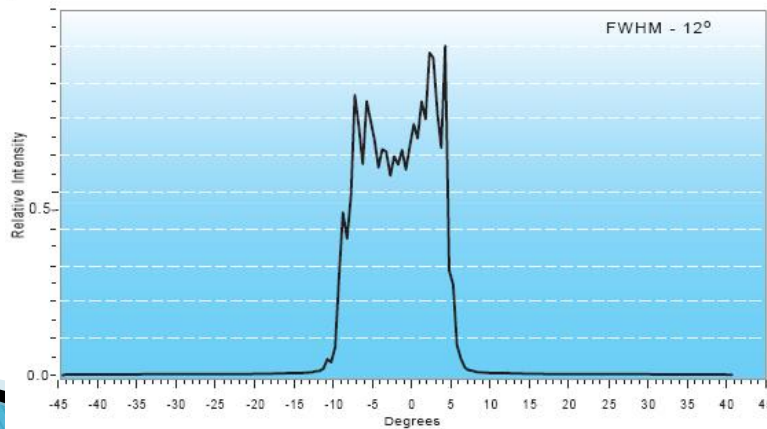


Wavelength Distribution



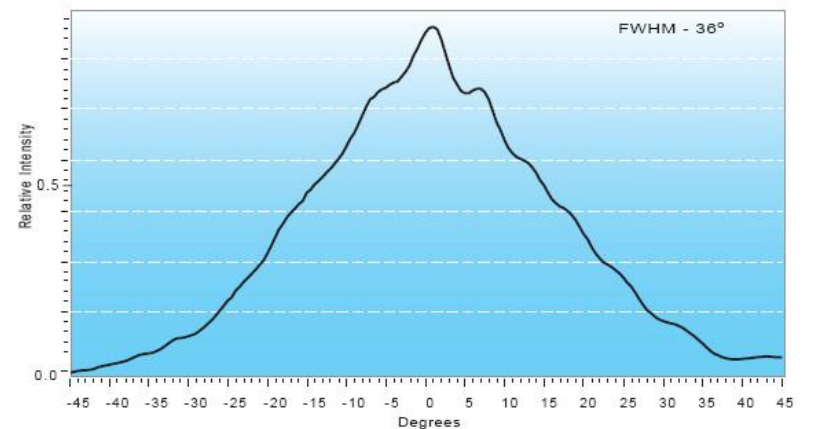
Typical Beam Divergence

Parallel

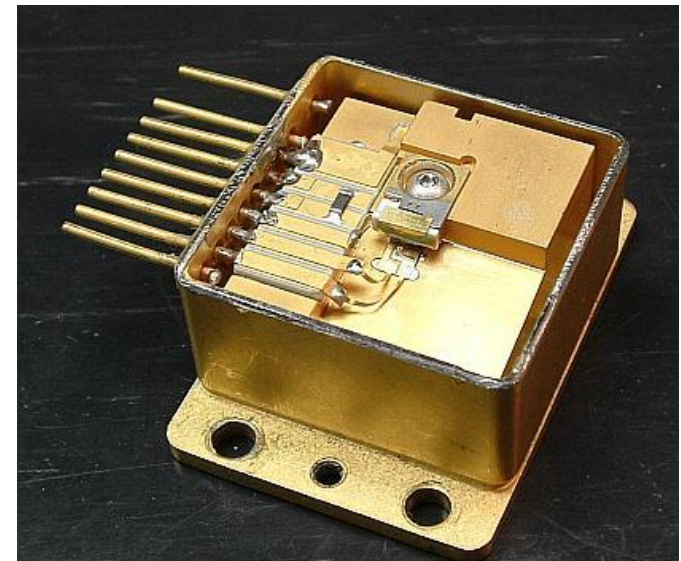
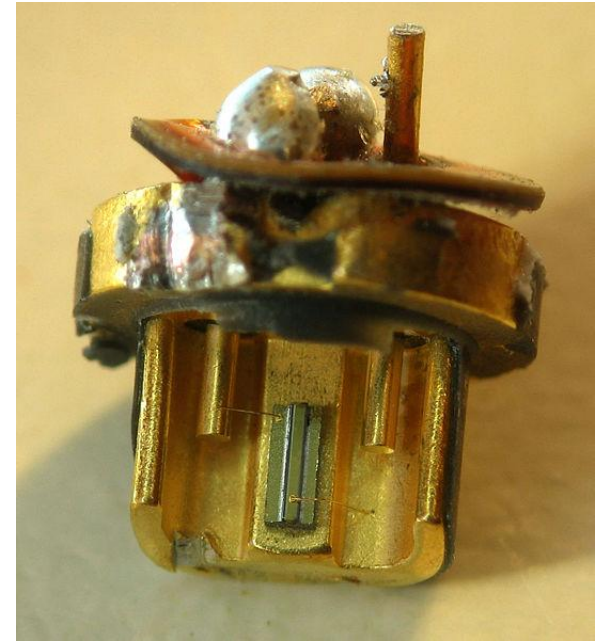
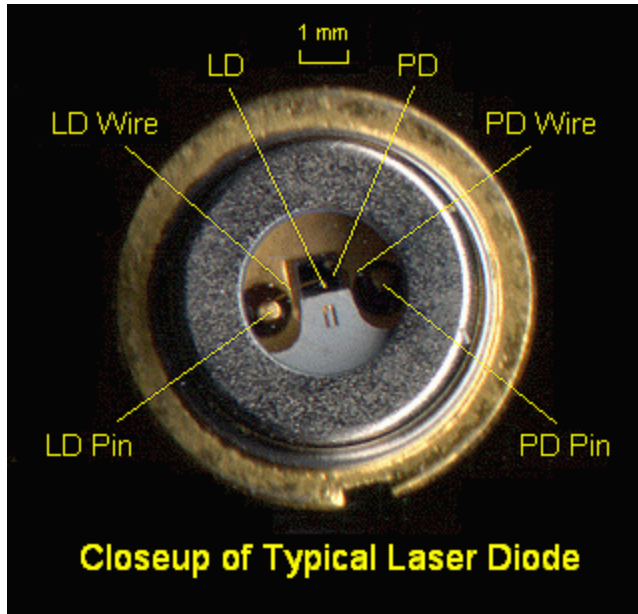


Typical Beam Divergence

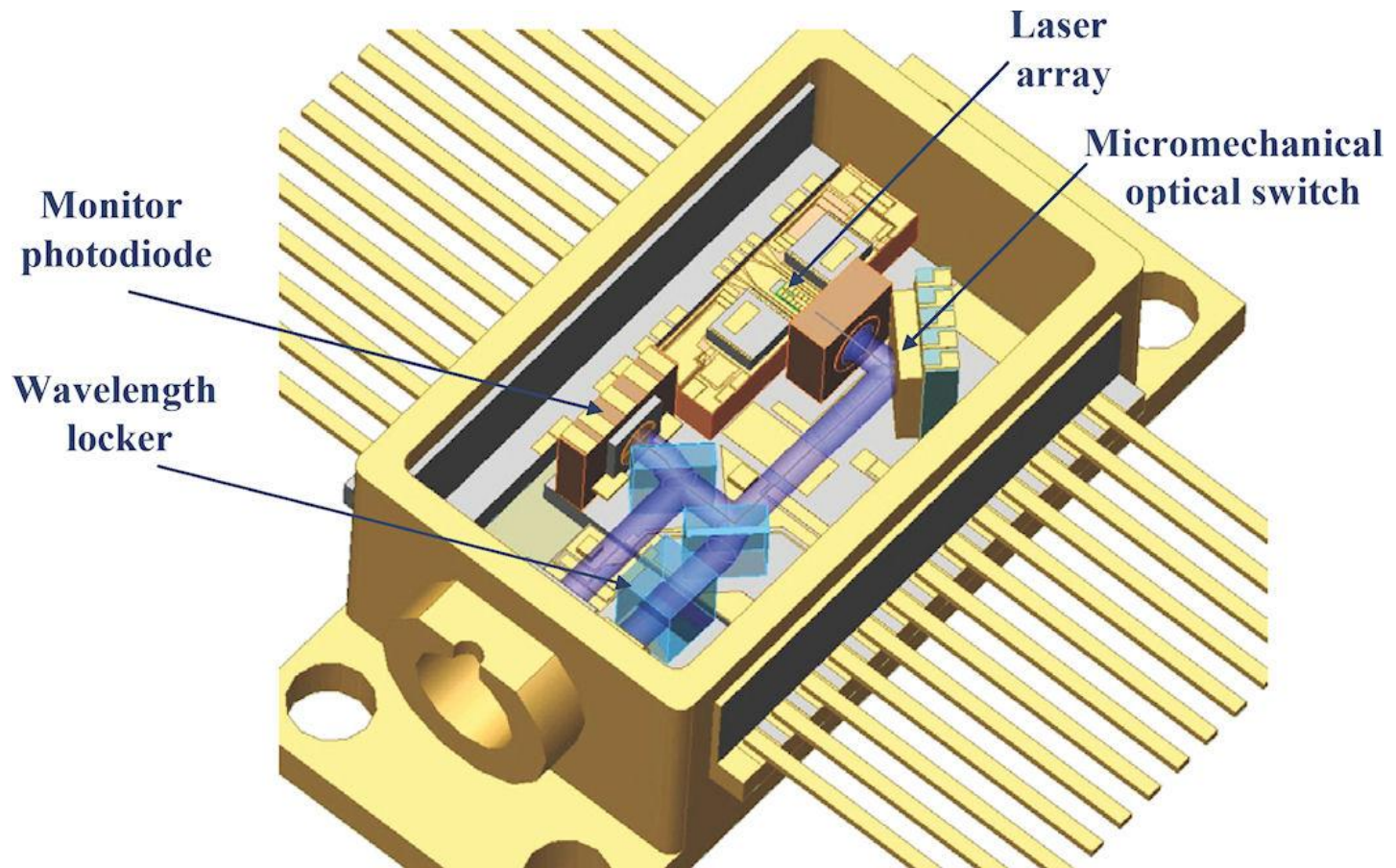
Perpendicular



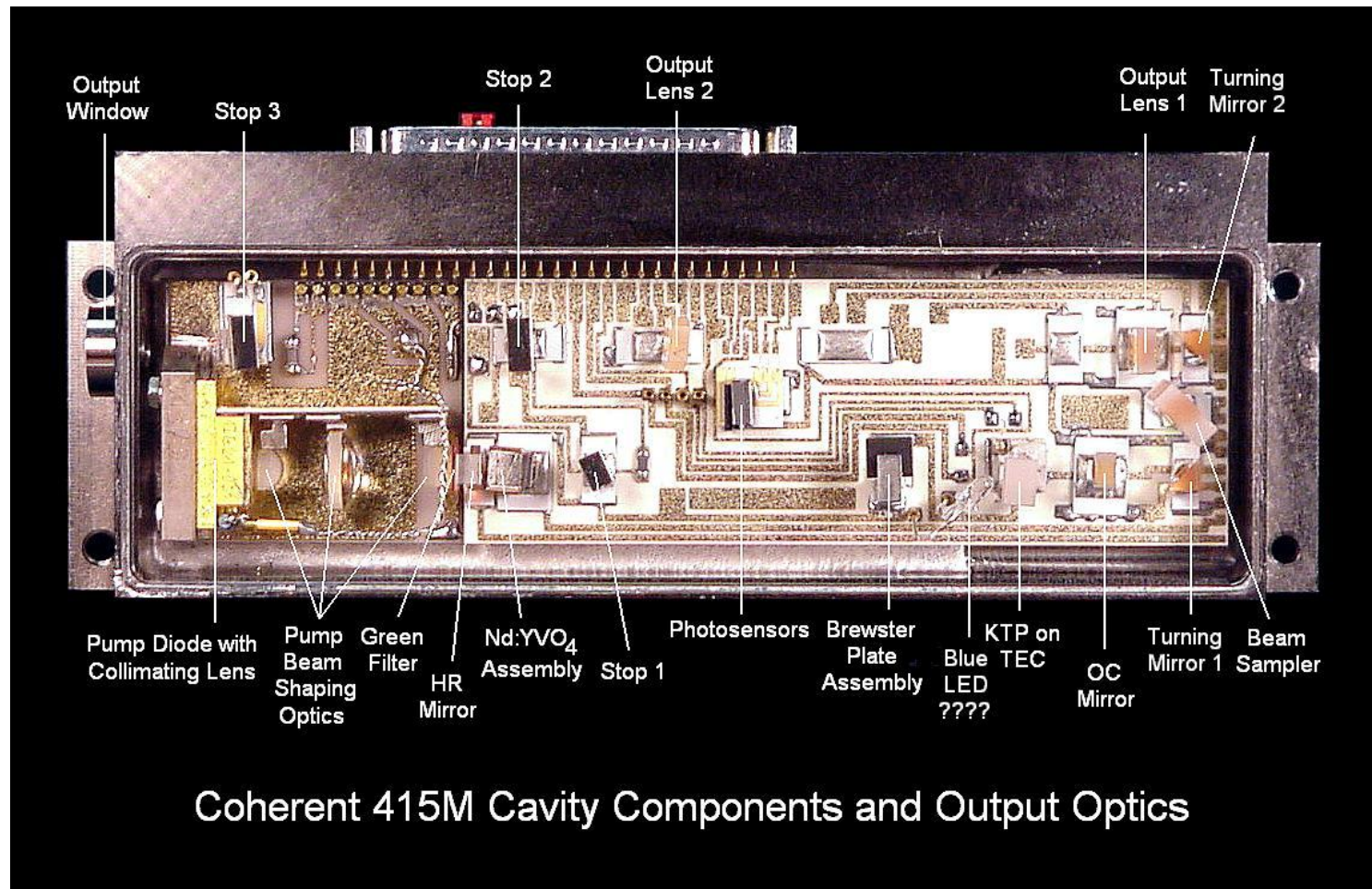
CW Laser, 650 nm



Tunable Laser Diode Chip



Dispositive optice integrate



Dispositive optice integrate

