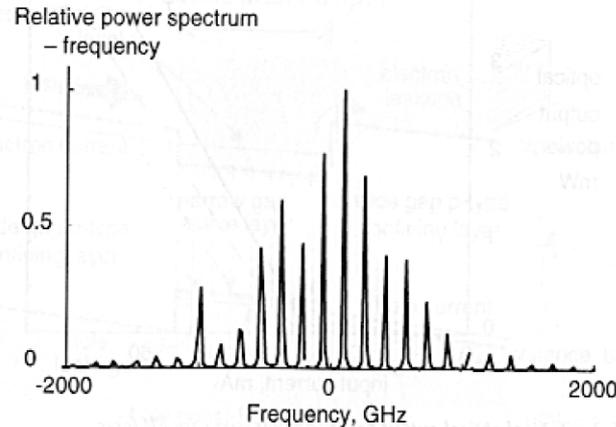
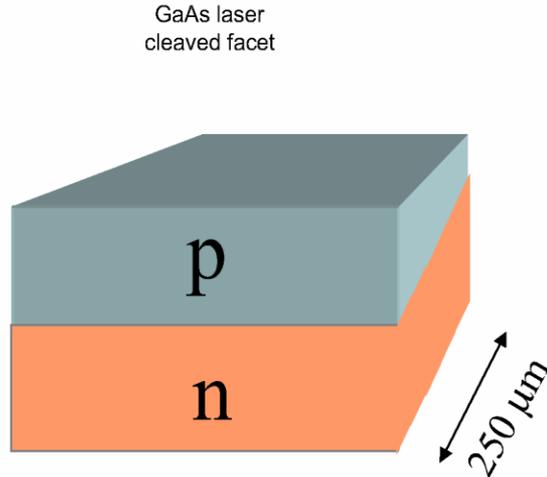


Laser Diodes for optical fiber telecommunication systems

Output spectrum



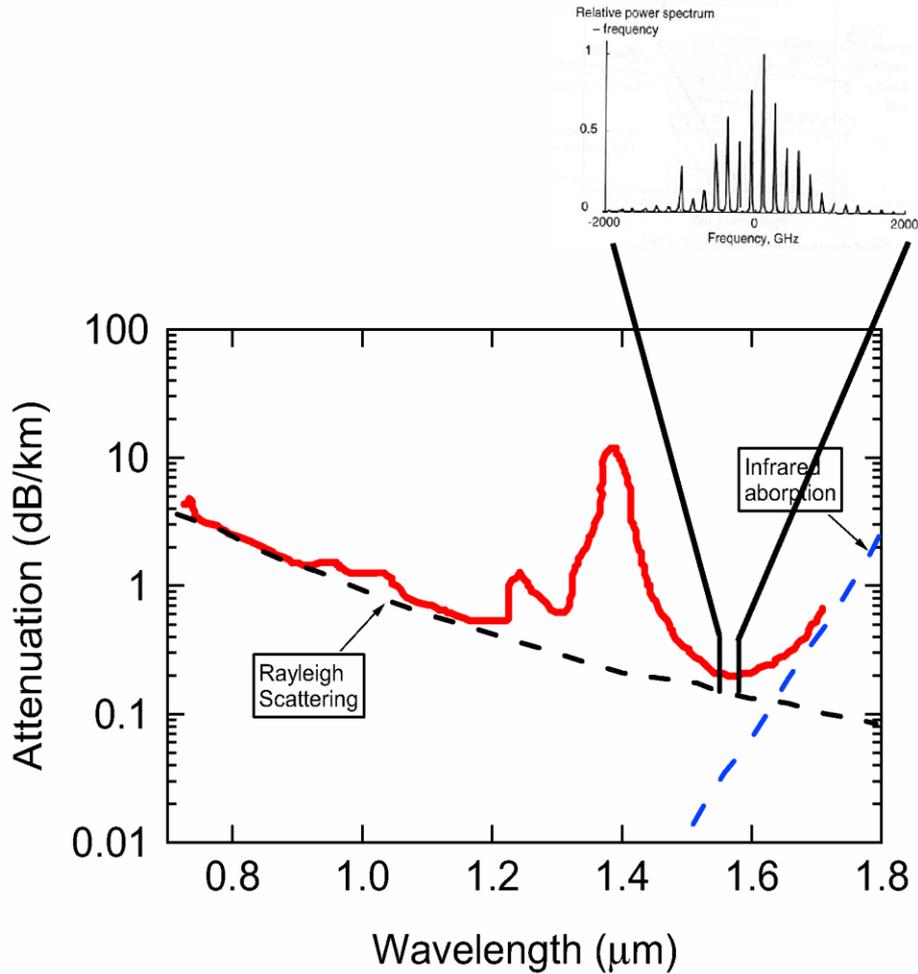
From Carroll, Distributed Feedback Semiconductor Lasers

$$\Delta f = c / 2L = (c_0 / n) / 2L = 170 \text{ GHz}$$

But gain bandwidth \sim applied voltage \sim 10 THz!
 \Rightarrow multi mode oscillation

(Solution is DFB lasers.)

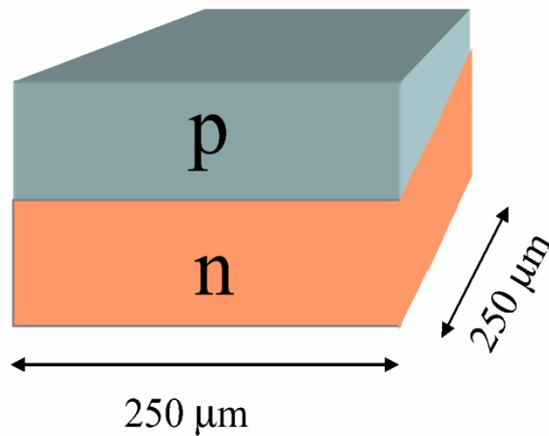
Optical fiber transmission:



(Adapted from Streetman, Solid State Electronic Devices)

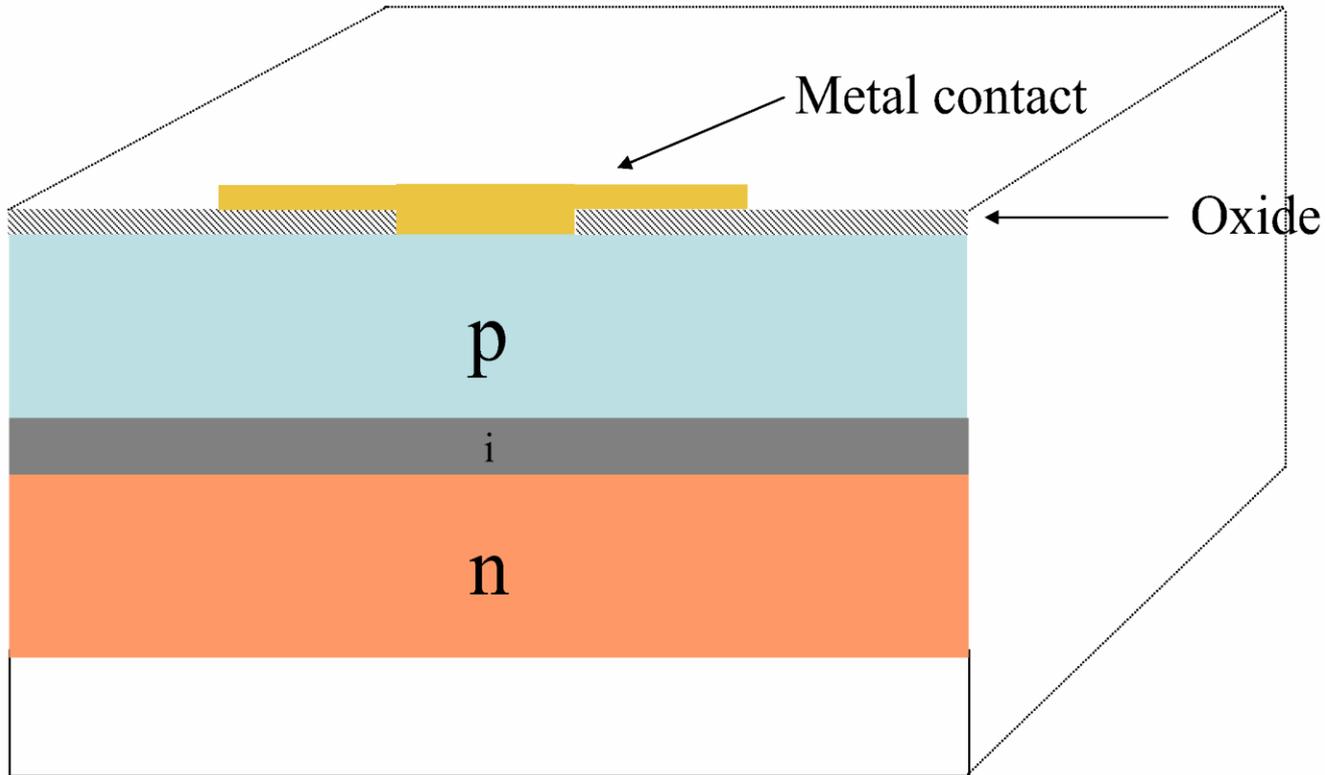
Laser structures

GaAs laser
cleaved facet



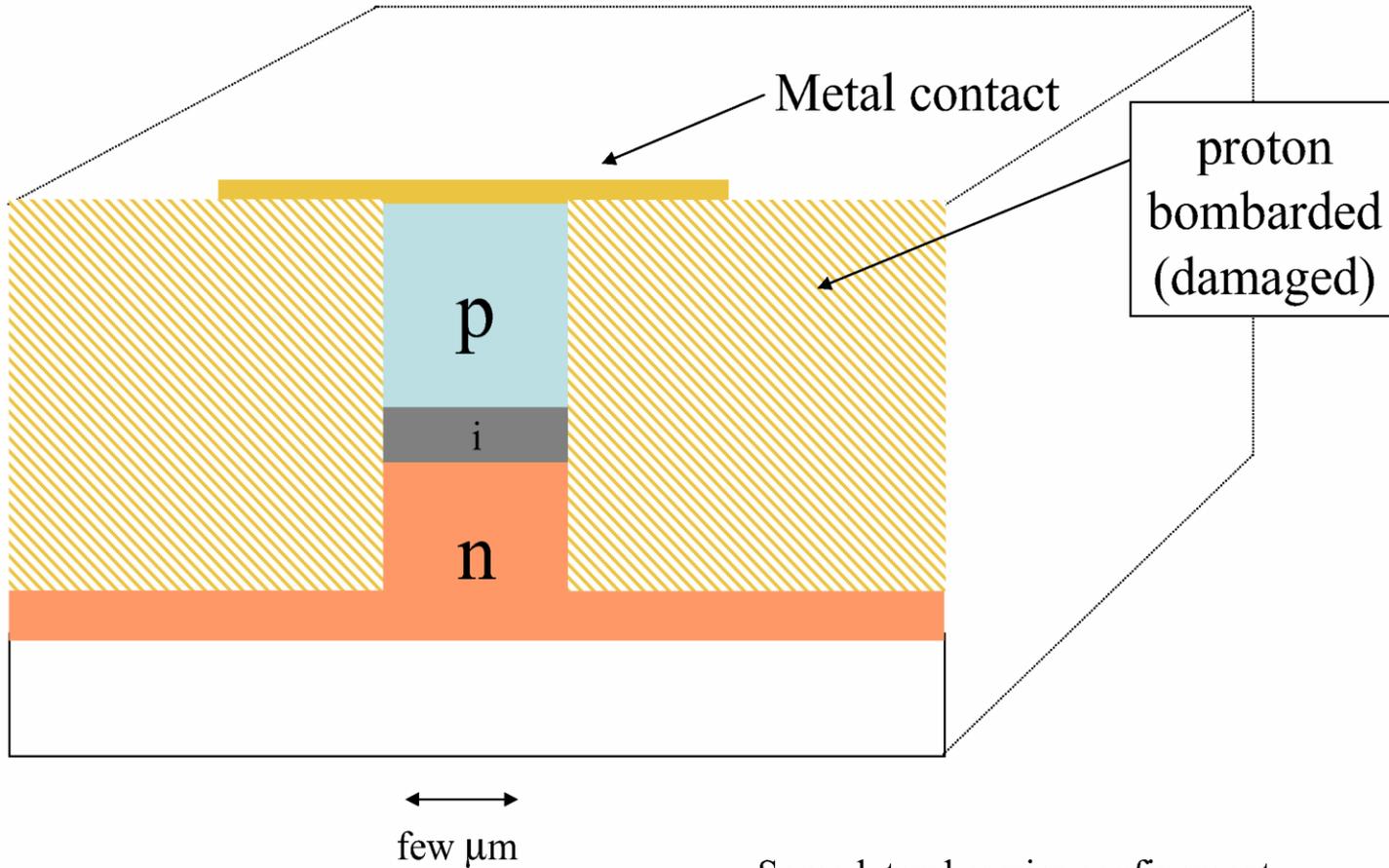
Which direction lases: x or y?

Gain guided structures



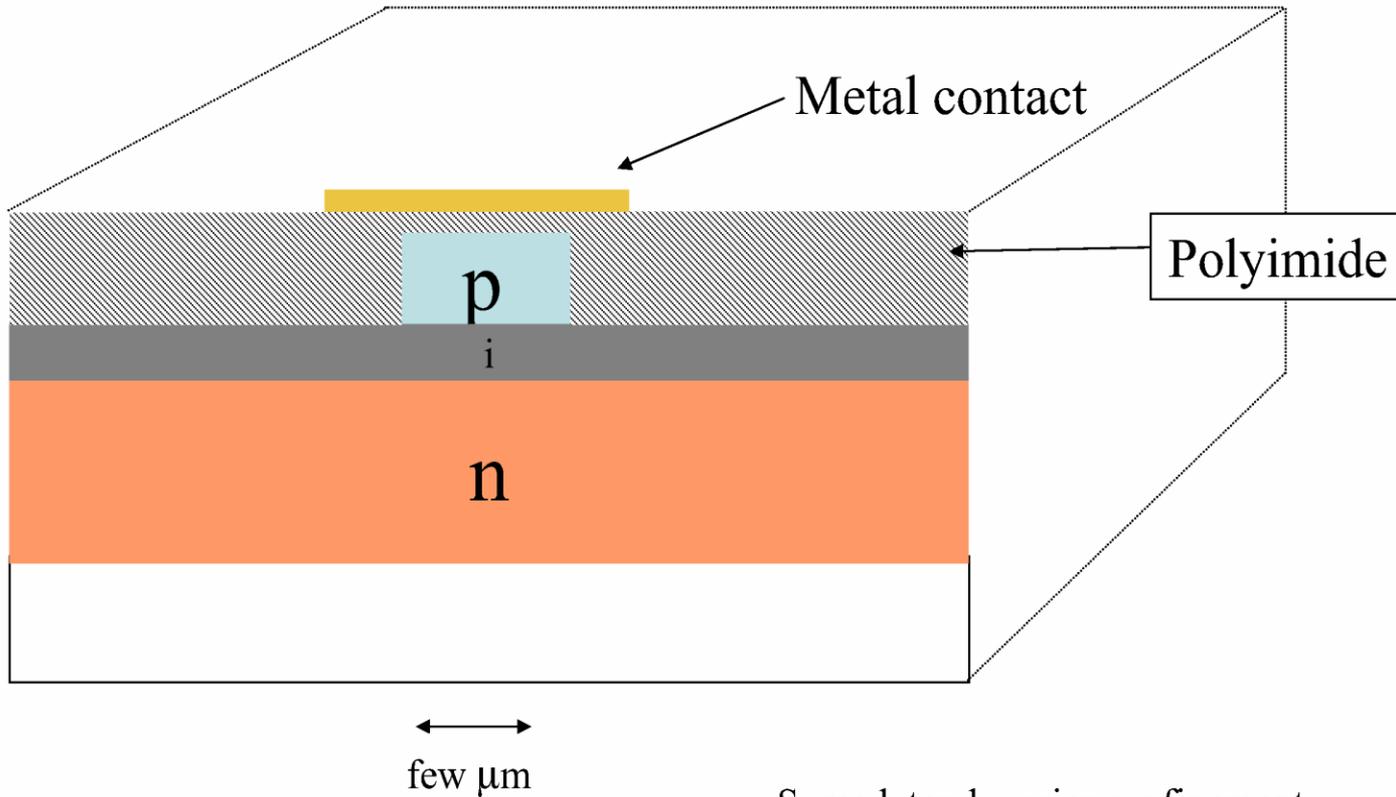
- No lateral carrier confinement
- No lateral light confinement

Gain guided structures



- Some lateral carrier confinement
- No lateral light confinement

Ridge structures

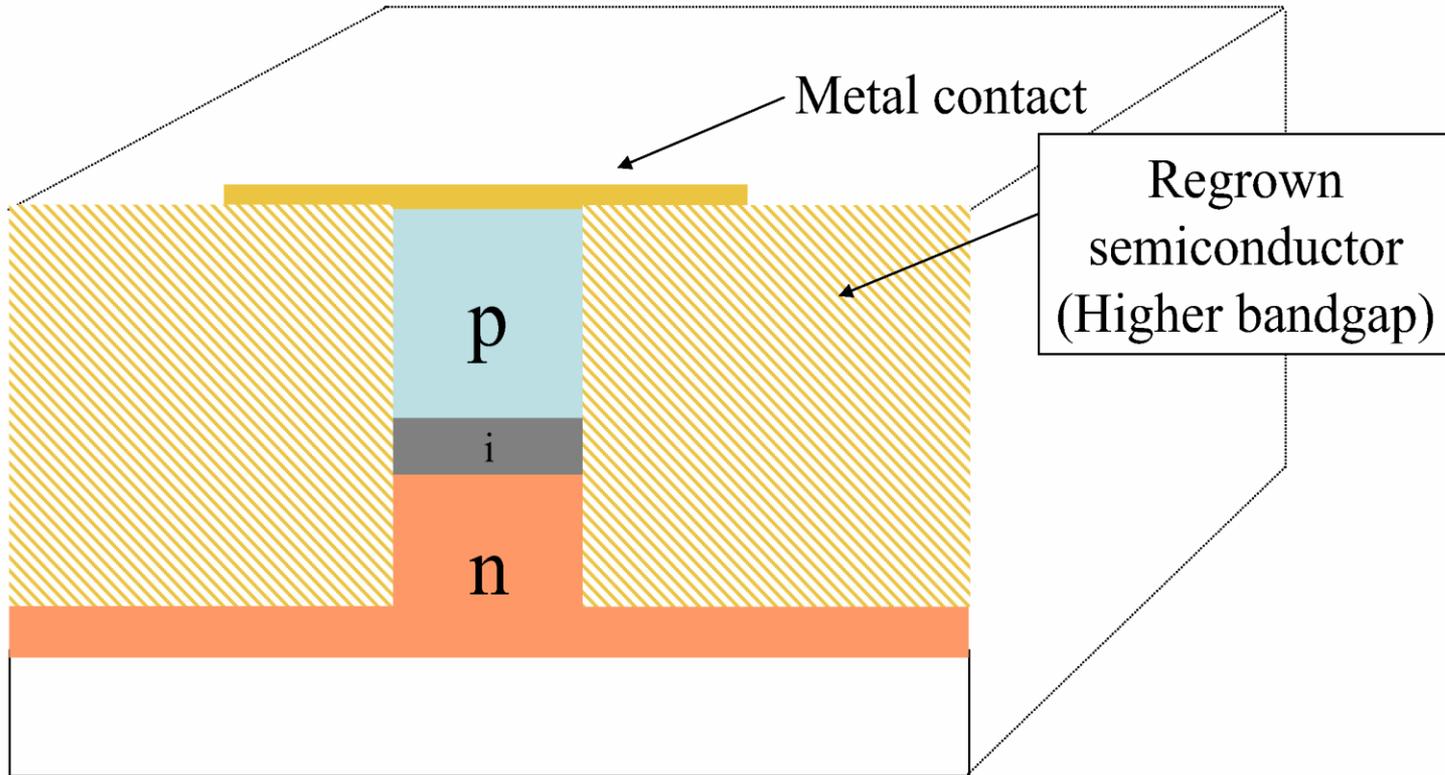


- Some lateral carrier confinement
- Some lateral light confinement

Gain-guided structures

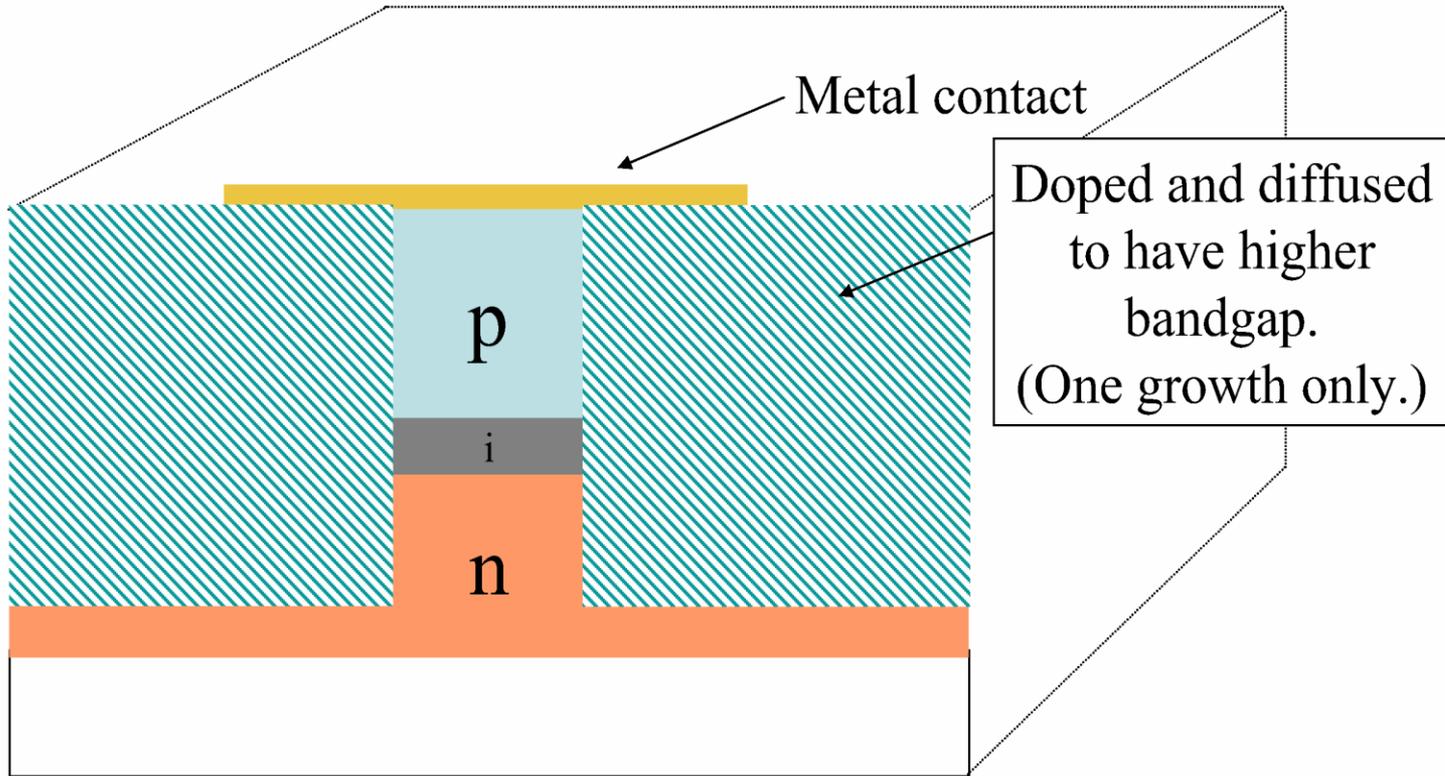
- Easy to fabricate
- Only one MBE growth step needed
- Not very good lateral light confinement
- Not very good lateral carrier confinement
- Threshold current ~ 100 mA
- More than one transverse mode lases

Etched mesa buried heterostructure (EMBH)



- Excellent lateral carrier confinement
- Excellent lateral light confinement

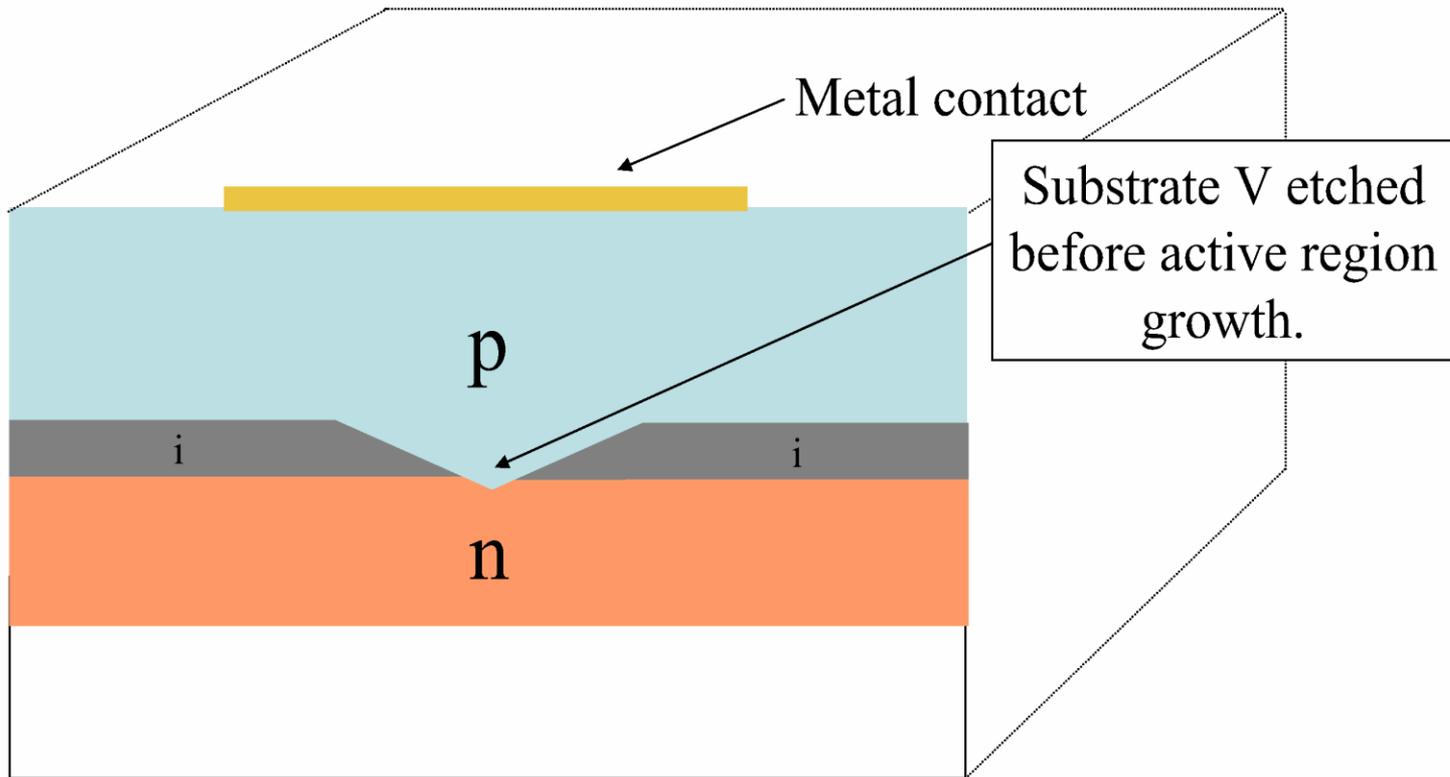
Etched mesa buried heterostructure (EMBH)



↔
few μm

- Excellent lateral carrier confinement
- Excellent lateral light confinement

Channeled substrate BH



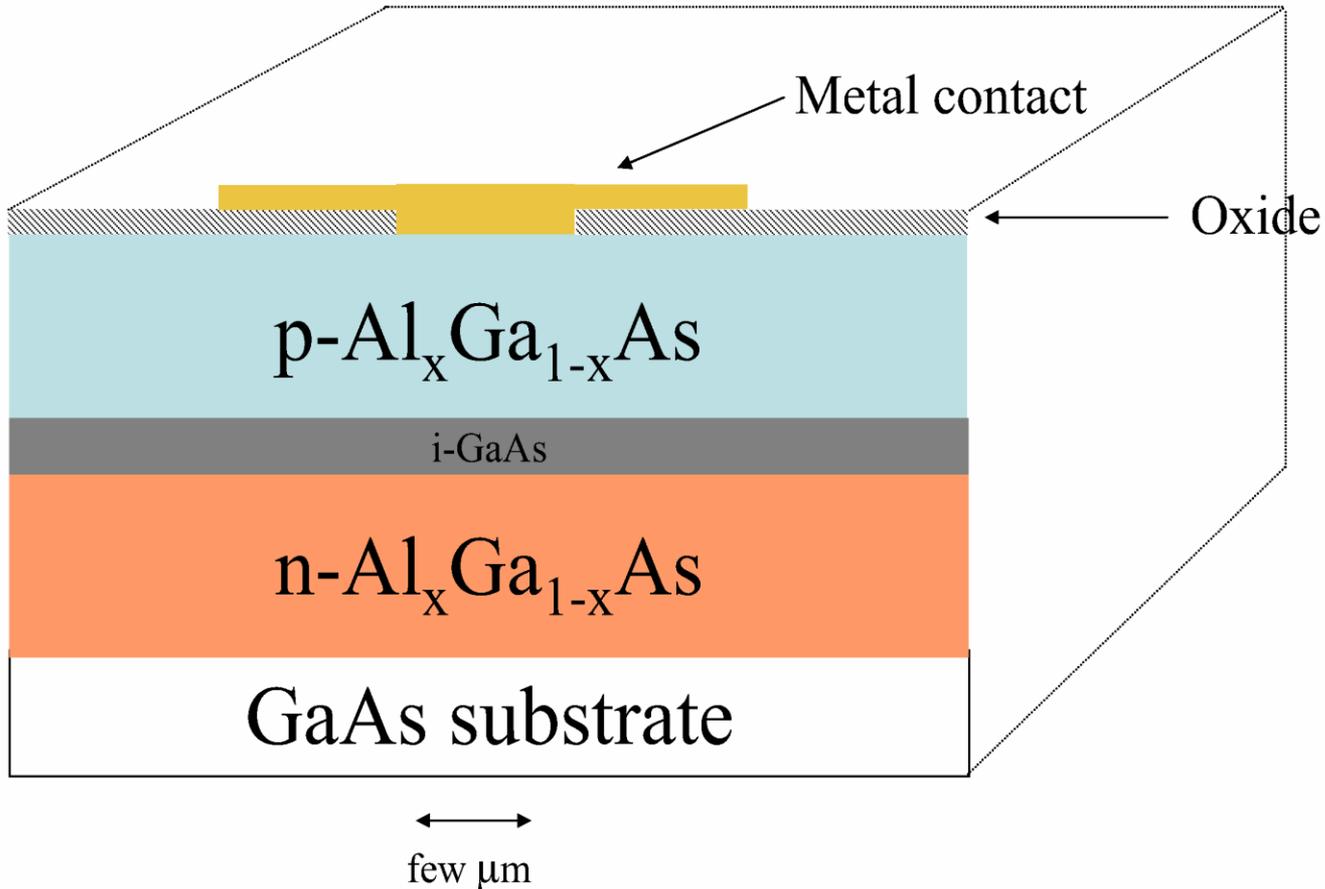
↔
few μm

- Excellent lateral carrier confinement
- Excellent lateral light confinement

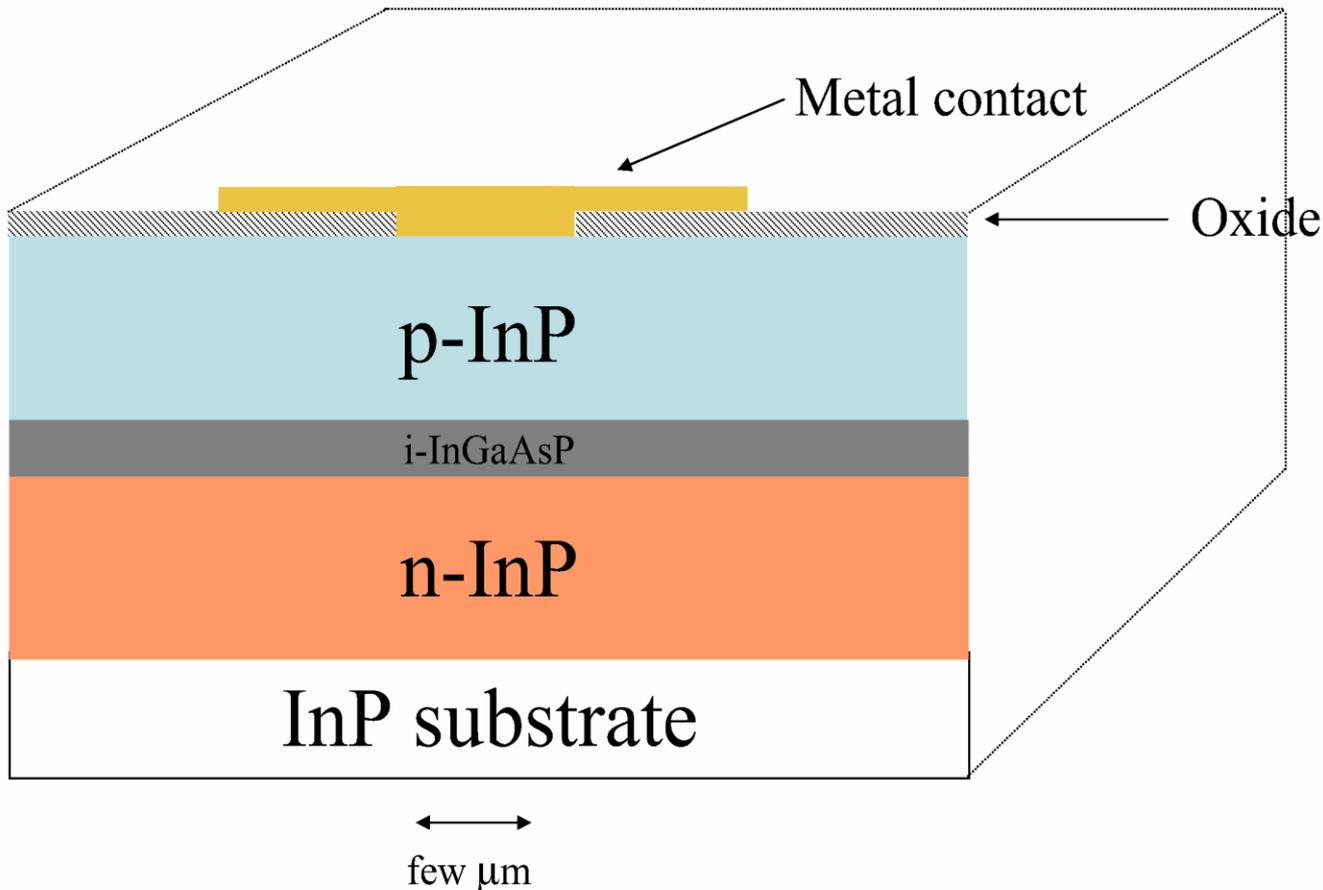
Buried heterostructure lasers

- Harder to fabricate
- Multiple MBE growth steps may be needed
- Very good lateral light confinement
- Very good lateral carrier confinement
- Threshold current ~ 10 mA, much lower than gain-guided structures
- Single transverse mode

GaAs based ($0.9\ \mu\text{m}$)



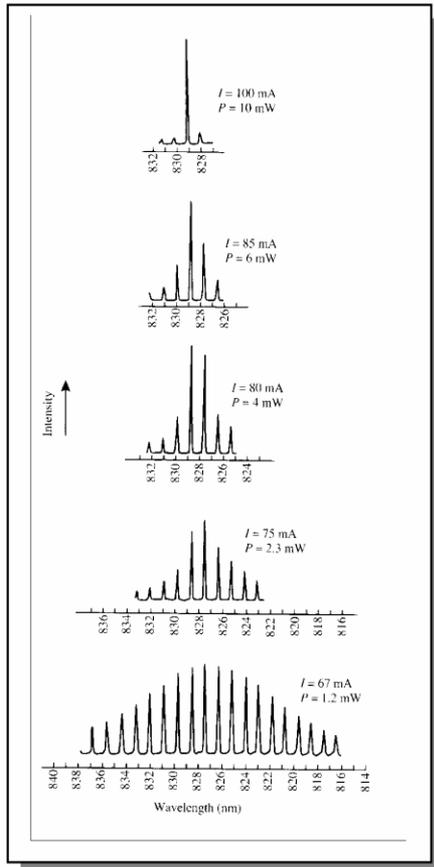
InP based ($1.55 \mu\text{m}$)



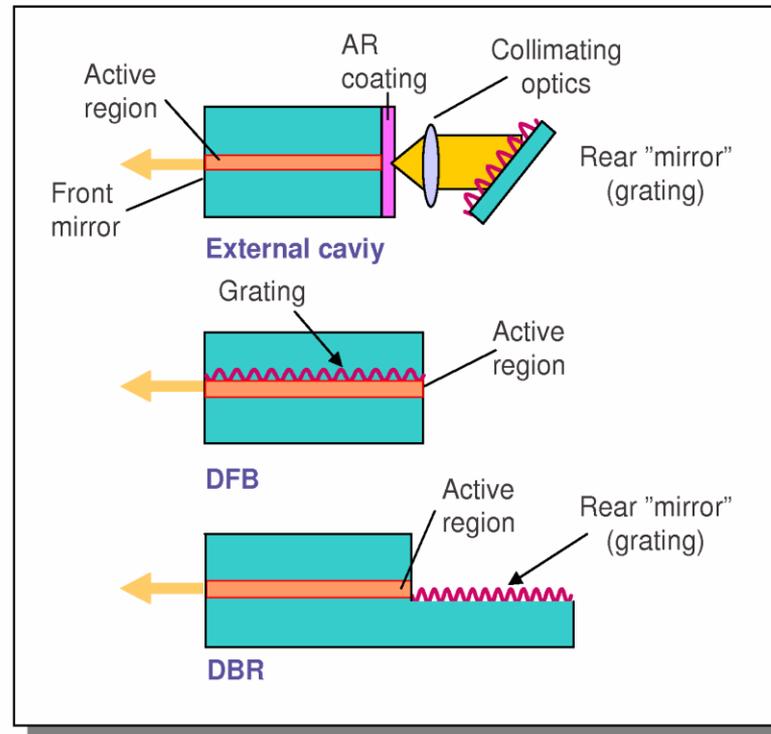
InP also makes fastest transistors (discussed in ECE 217B next quarter)
=> Opportunity for integrated optics, electronics on one chip.

Single-mode diode laser (1 longitudinal mode)

a typical index-guided laser:



Improved performance by adding frequency selectivity in the laser cavity:



DFB – distributed feedback

DBR – distributed Bragg reflector

Technical goals

- Single mode operation
- Gb/s modulation
- Lifetimes of 10^6 - 10^8 hours
- Manufacturability
- Stability