Optimization of Laser Gain Material

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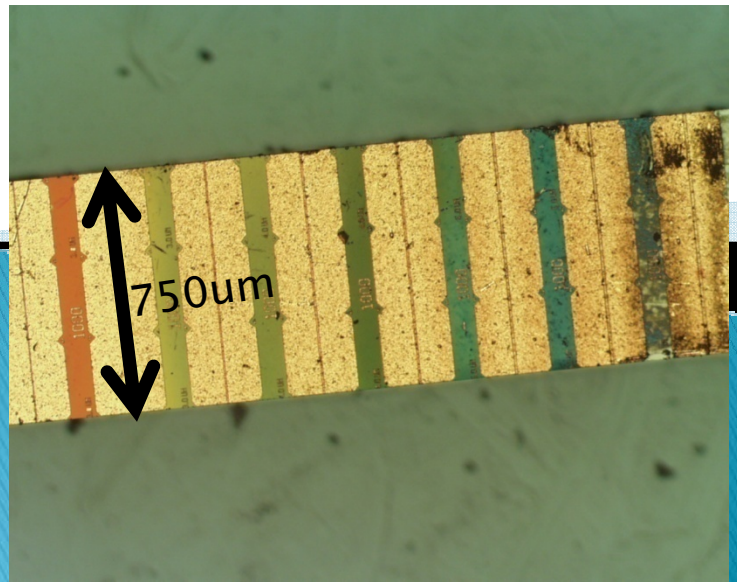
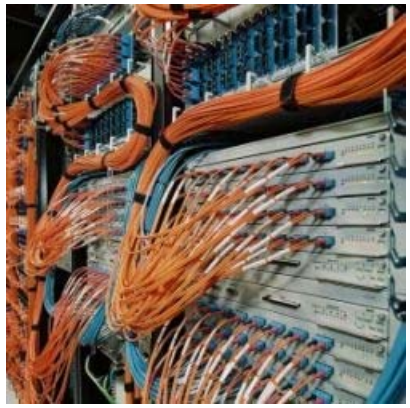


Problems in Servers:

- Shift in electronics to faster computing.
- Problems with Copper:
  - Speed limit: Parasitic loss
  - Bandwidth Limit: Crosstalk
- Pressing problem, servers: Copper cables, too much heat, space, energy and not fast enough.



Possible Solutions:

- Replacing copper interconnects with optical interconnects.

  - Virtually no parasitic losses
  - Virtually unlimited bandwidth
  - No crosstalk
- Current optical interconnects use Vertical Cavity Surface Emitting Lasers (VCSELs).
  - VCSELs have a higher yield.

Research Goals

Determine optimal material compositions and qualities for lasers:

-Strain (% In in InGaAs)

-Doping (Carbon, p-type)

Growth

Processing

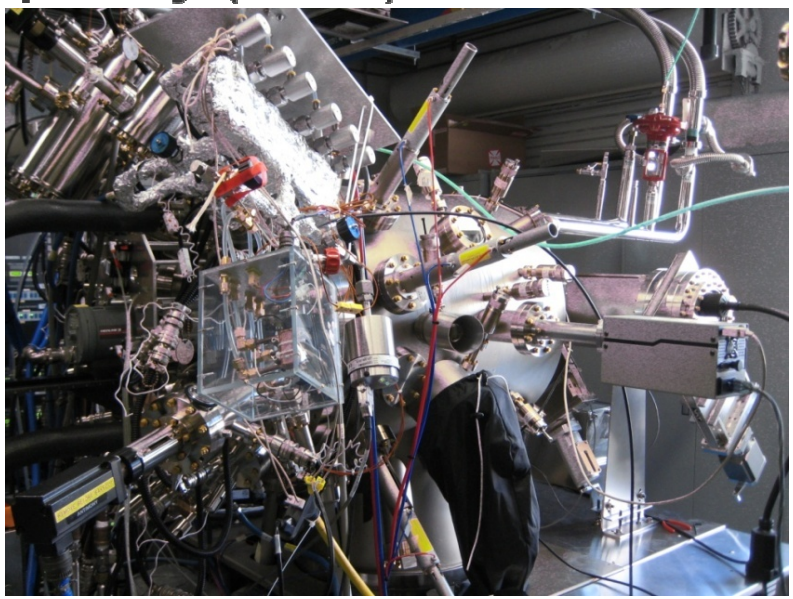
Testing

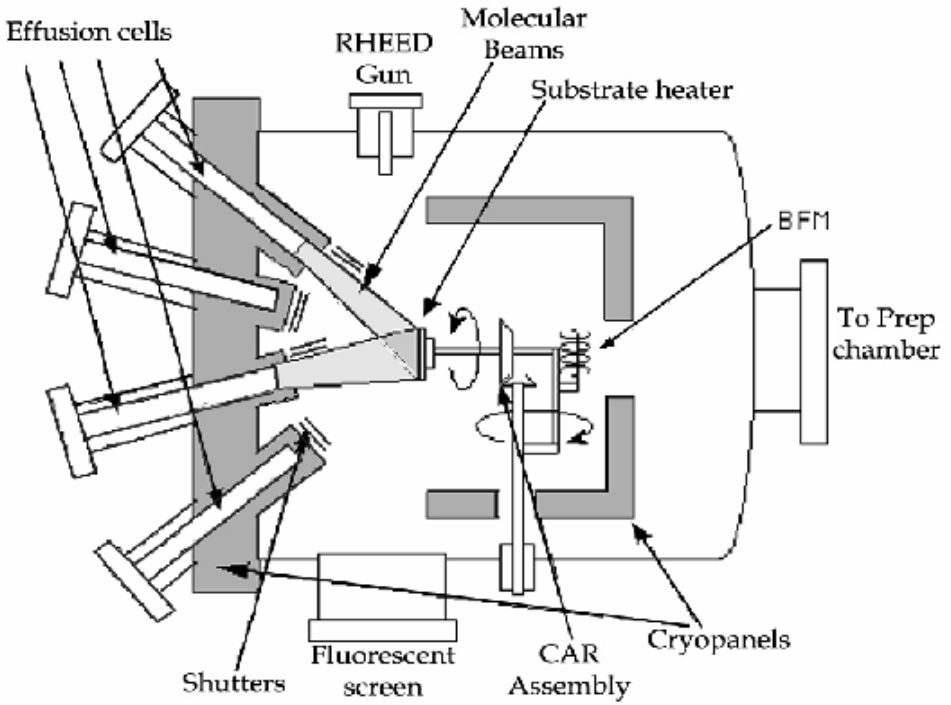
- Light, Current (I), Voltage (LIV) curves.

-Relative Intensity Noise (RIN).

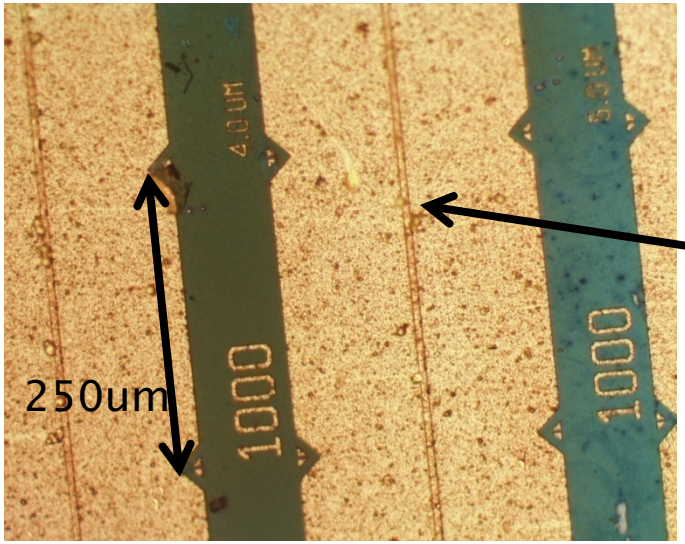
-Assist in compilation and interpretation of data.

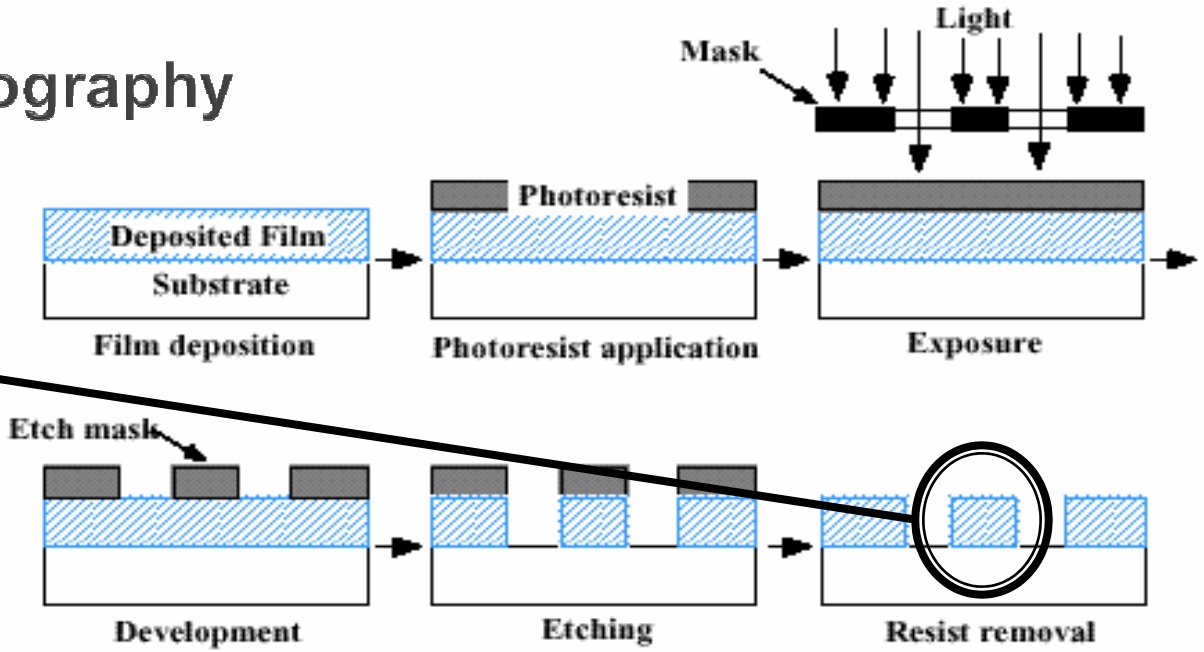
Growth: Molecular Beam Epitaxy (MBE)



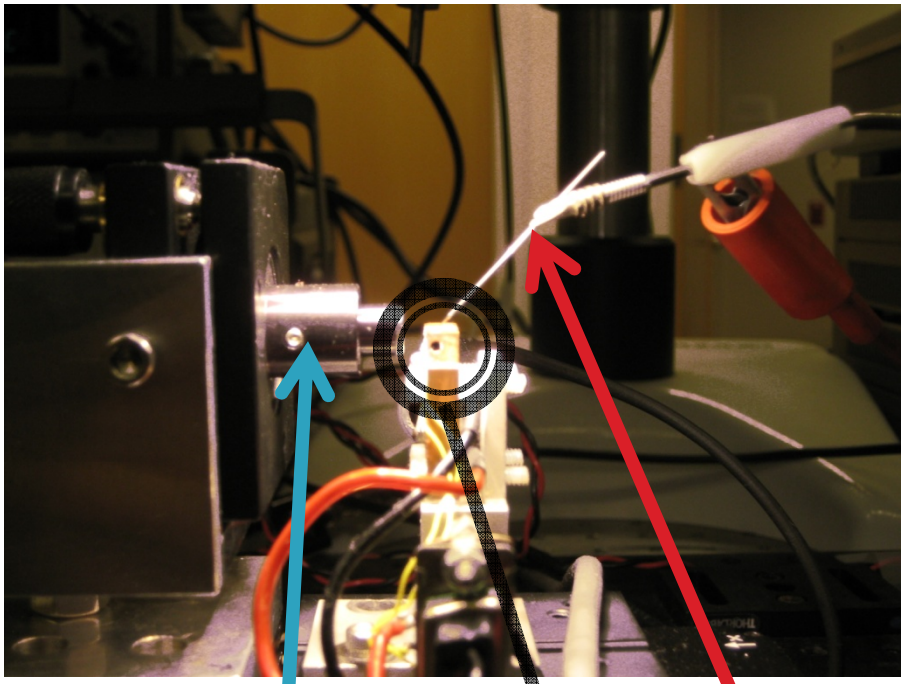


Processing: Photolithography

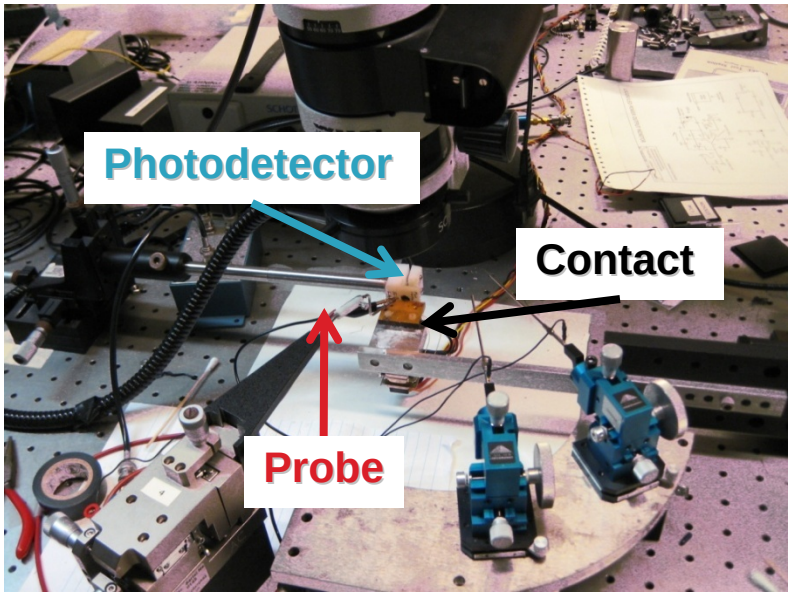




Testing: RIN



LIV



Light, Current (I), Voltage (LIV):

-Use $\frac{dL}{dI}$ and length of laser to obtain gain profile.

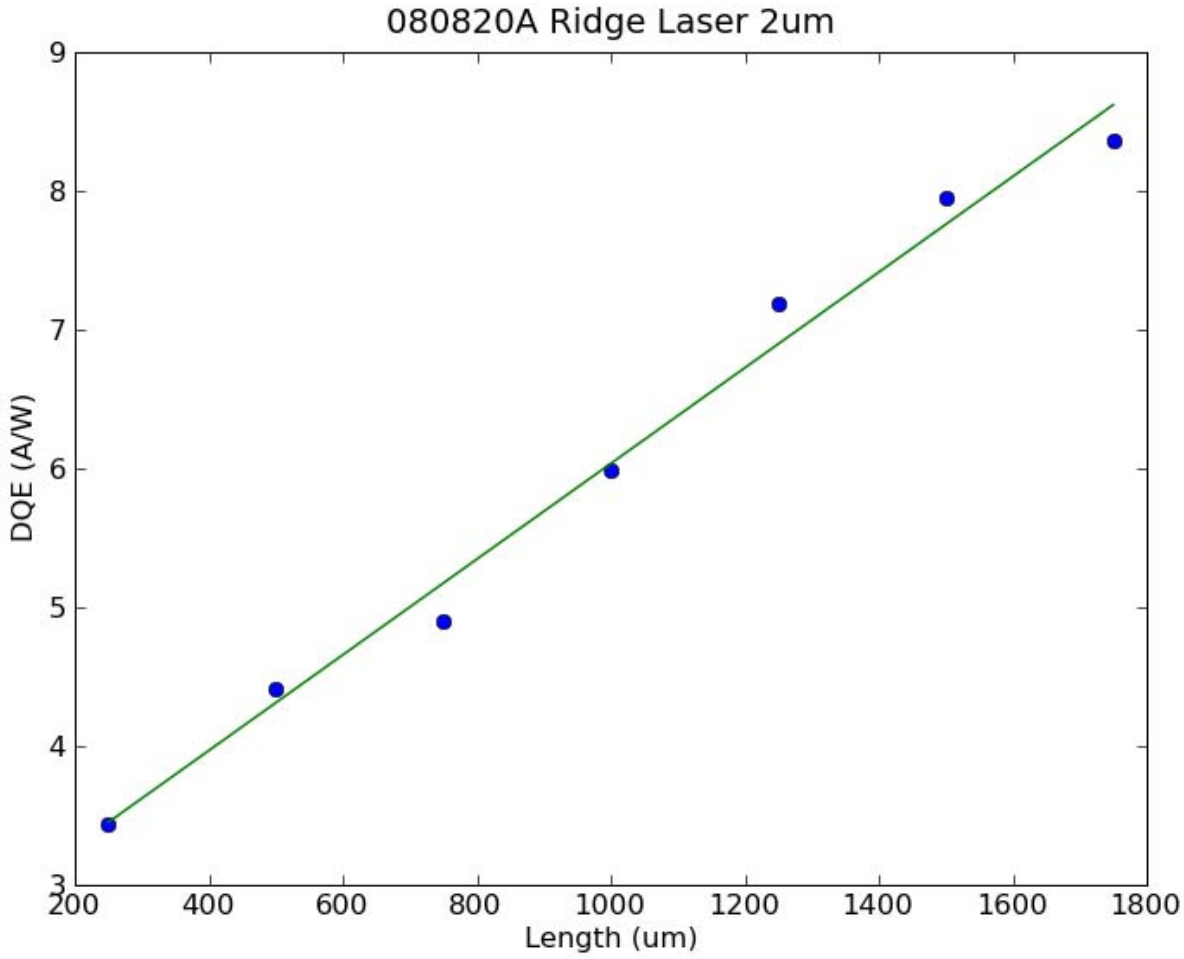
-Threshold current .

Relative Intensity Noise (RIN):

- Magnitude of nonlinear effects.

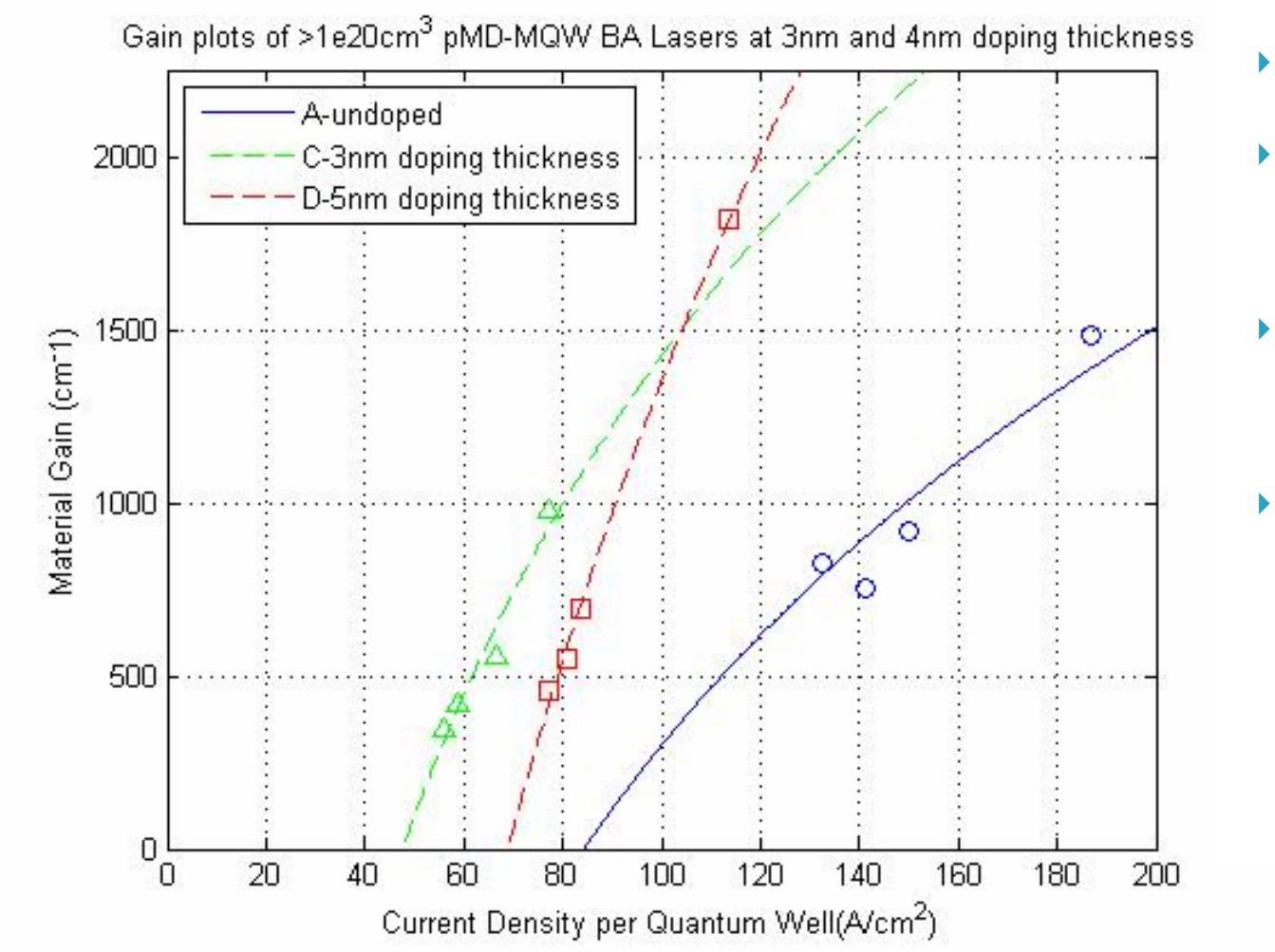
-Relaxation frequency.

Data: Light, Current, Voltage



- Plot inverse slope (Differential Quantum Efficiency- DQE) versus length.
- Extract variables for the gain profile.

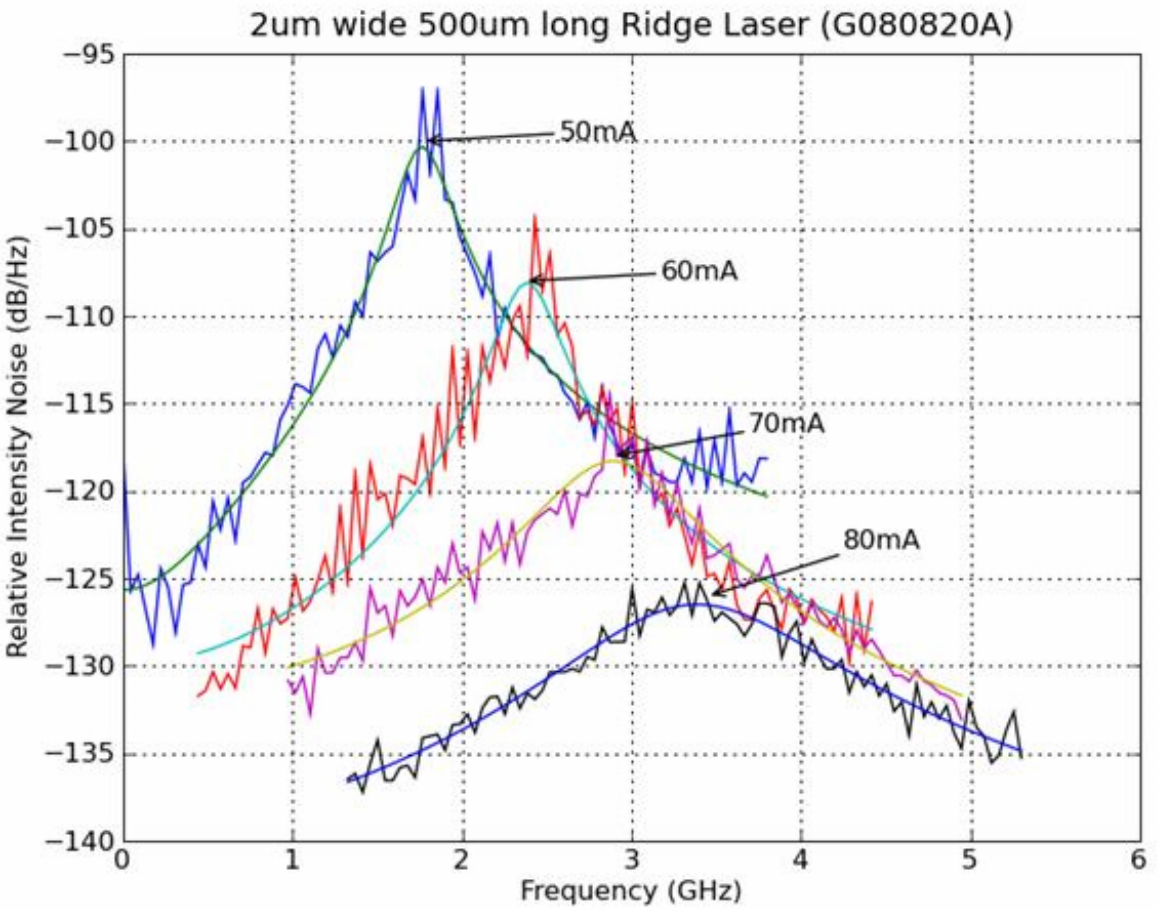
Data: Light, Current, Voltage



Graph Courtesy of Yan Zheng, UCSB

- Gain Profile
- Larger slope = faster laser.
- X intercept = gain transparency.
- Qualitative: comparing one material next to the other.

Data: Relative Intensity Noise (RIN)



Graph Courtesy of Yan Zheng, UCSB

- RIN
- Determine effects that hinder laser performance:
  - Rate of change of "sharpness" of peak wrt current.
  - -minimize
- Determine High speed capabilities of Laser:
  - Shift of peak wrt current.
  - -maximize

Peak
(Resonant Relaxation Frequency)

Conclusions:

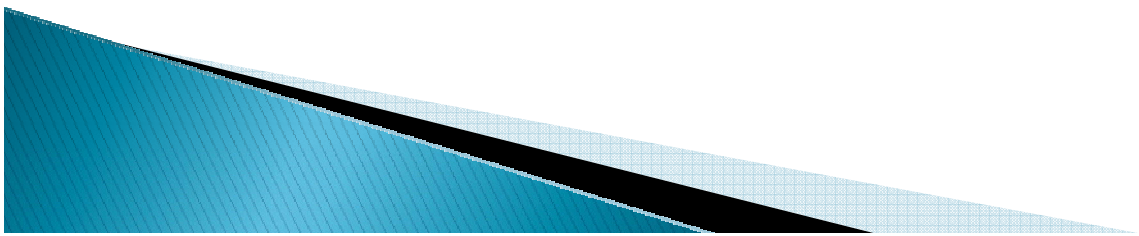
- Baseline LIV and RIN data was obtained.
- GEN III is finally up and running again!

Future Plans:

- Grow new lasers with differing levels of Carbon doping and strain.
- Test and compare data obtained with baseline data.
- Take the best material composition and use it to build a faster Vertical Cavity Surface Emitting Laser (VCSEL).

Summary of Internship Experience:

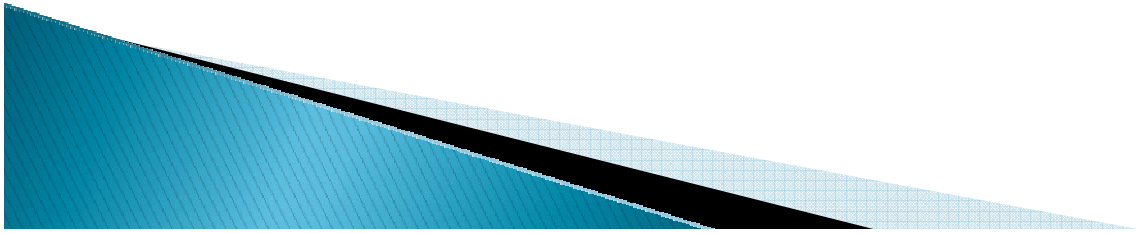
- Learned about laser and solid state physics.
- Observed and assisted in a wide range of research activities, such as:
  - MBE growth
  - Photolithography
  - Laser testing
  - Analyzing data, sitting in on group meetings, etc.
- Got a chance to observe the triumph, the defeat, the joy and the anguish of graduate students.



Acknowledgments:

- Thanks to:
- Yan Zheng, Mentor
- Larry Coldren, Faculty Mentor
- CNSI and INSET
- UCSB, NSF, DARPA
- Fellow interns
- Audience

- Thanks to all, had a blast!



Google Server Far =http://news.softpedia.com/images/news2/Microsoft-and-Google-Server-Farm-Face-Off-2.jpg

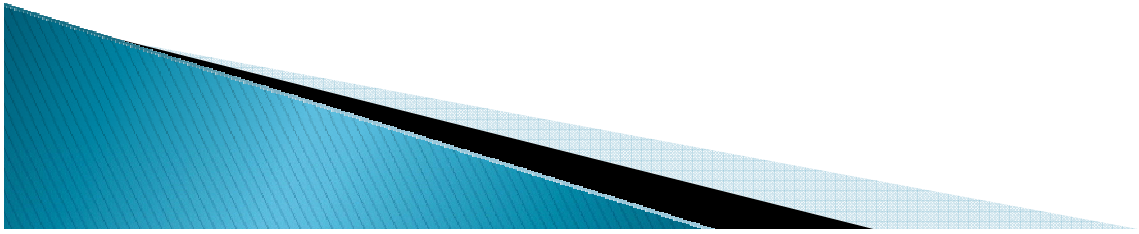
Server Interconnects http://bennett.com/blog/pitchers/remarks_2.jpg

Fiber Optic vs. Copper Cablehttp://www.visuallee.com/weblog/images/copper_fiber_compare.jpg

Optical Active Cable= http://www.hitachi-cable.co.jp/ICSFiles/afieldfile/2009/03/18/oac.jpg

MBE diagram= http://mxp.physics.umn.edu/s07/Projects/S07_Graphene/images/MBE.gif

Photolithography diagram= http://www.hitequest.com/Kiss/photolithography.gif

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