Optoelectronics Research Group

Characterization of
Quantum Cascade Lasers on Silicon

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Mentors: Alexander Spott & Robert Zhang
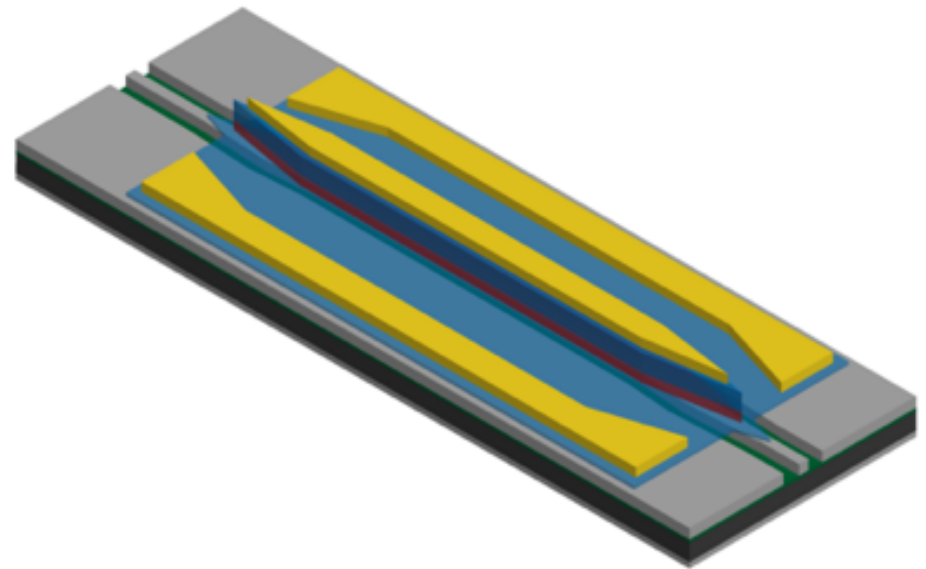
Faculty Advisor: Professor John E. Bowers

Mid-infrared Silicon Photonics

- **Mid-infrared (~2-20 µm) photonics: Sensors and Detectors**

    - Chemical bond spectroscopy

    - Gas sensing

    - Biological sensing

    - Remote sensing

- **Integrated Silicon Platform**

    - Low cost

    - Compact device

    - Broadband

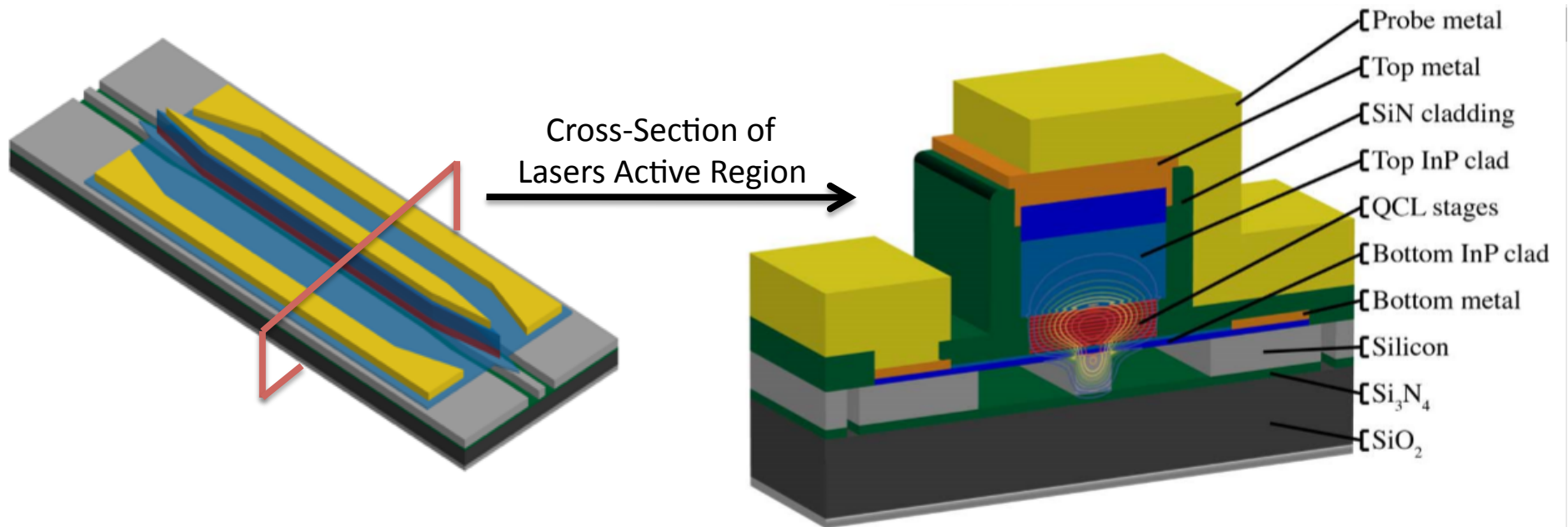   - Low optical losses

    - Multiple applications on one chip

Picture of a 3-D Laser Ridge

Understanding QCL on Silicon
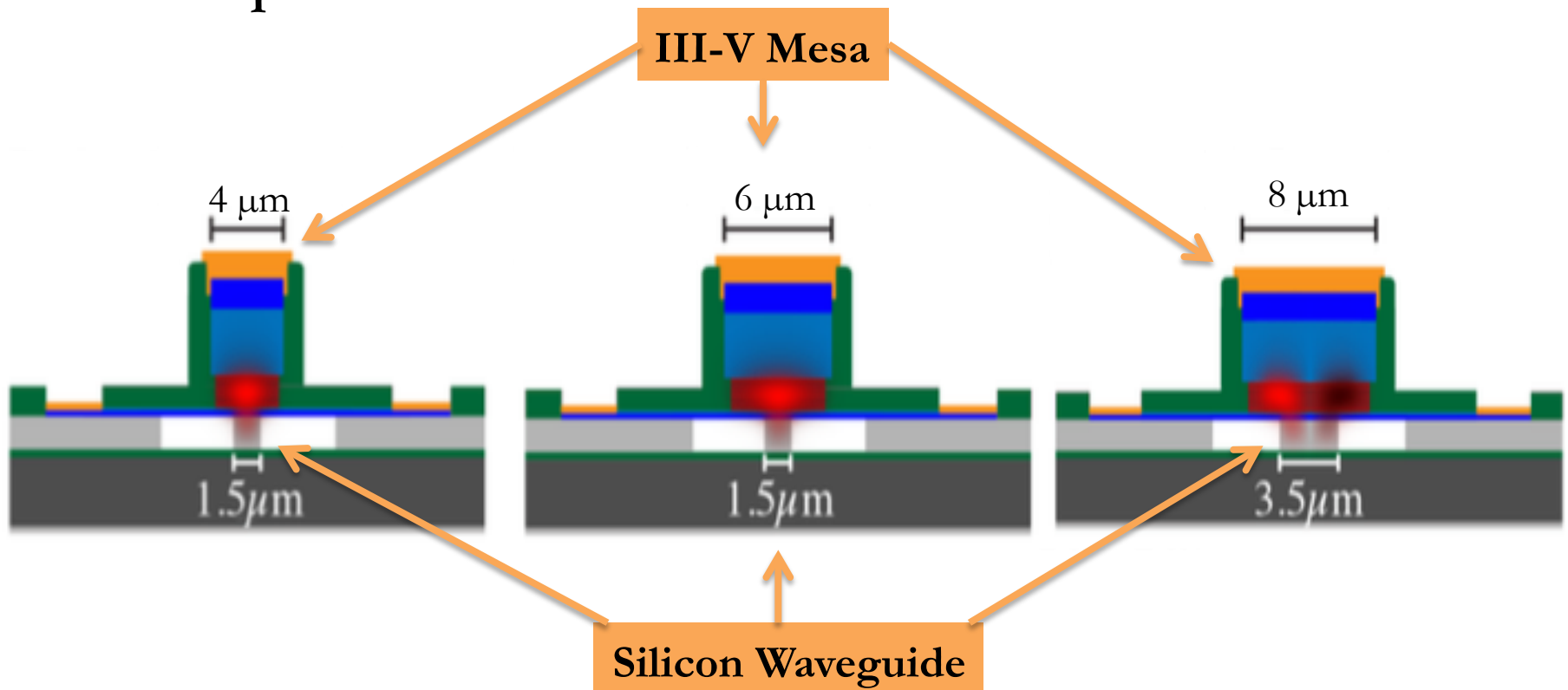
- **Analyzing and Understanding Lasers**
  - Measure lasers with a range of different geometries
  - Matching data collected with laser theory
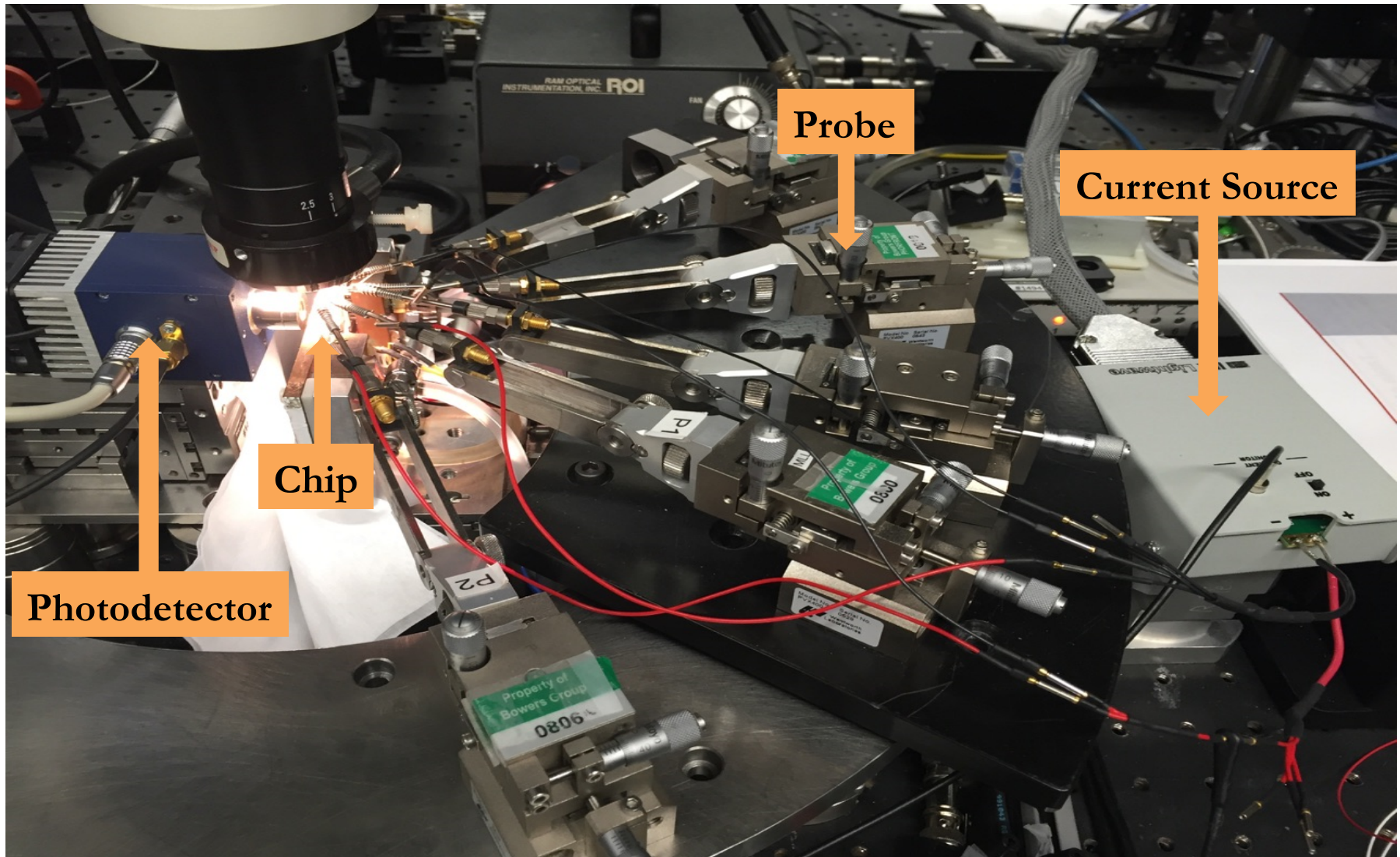 - Understand internal geometry performance to build next generation of lasers

Cross-Section of Lasers Active Region

- Probe metal
- Top metal
- SiN cladding
- Top InP clad
- QCL stages
- Bottom InP clad
- Bottom metal
- Silicon
- Si_3N_4
- SiO_2

Geometry of Lasers

- **Primary design parameters:**
  - III-V mesa width from 4 – 8 µm
  - Silicon waveguide (Si WG) width from 1.5 – 3.5 µm
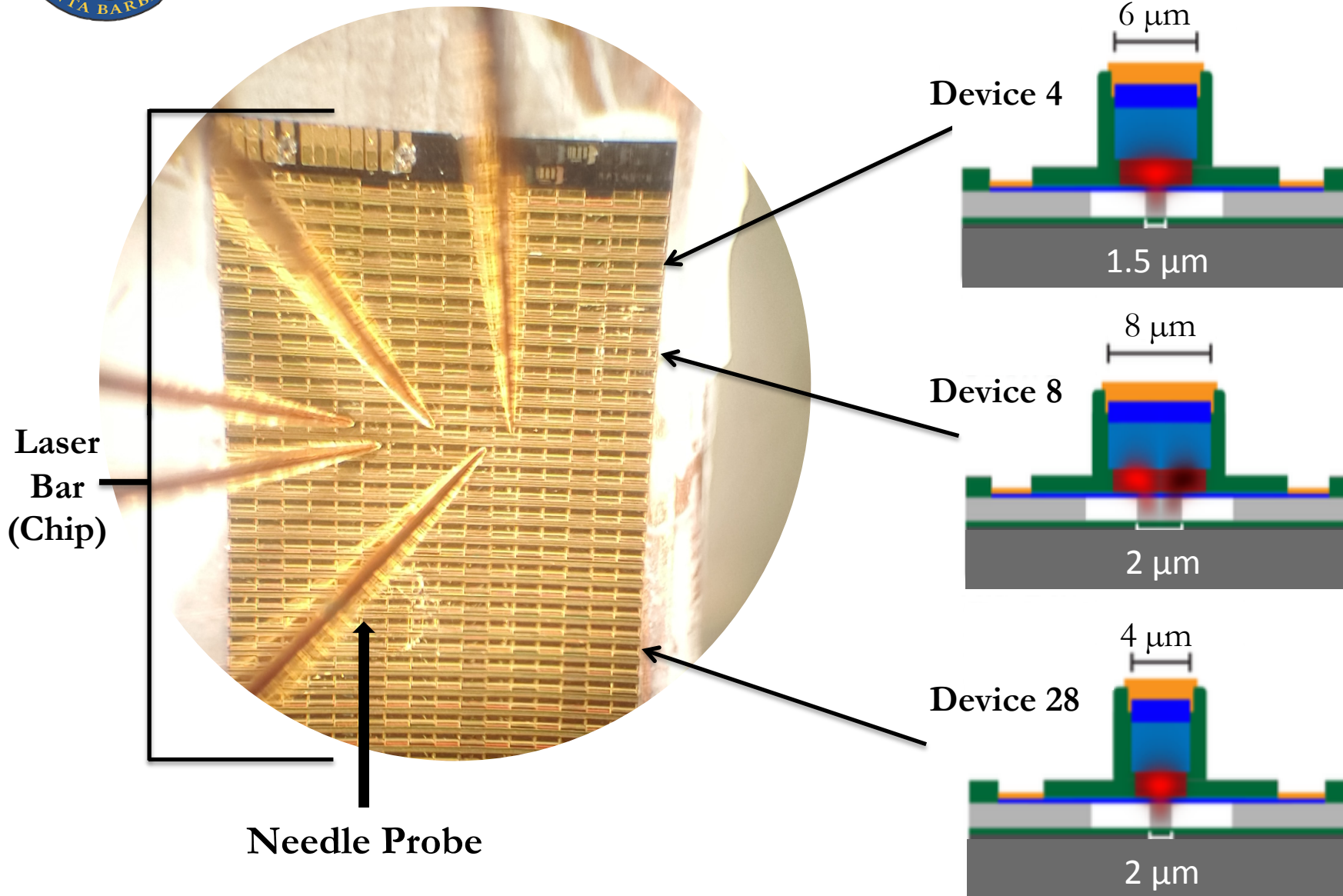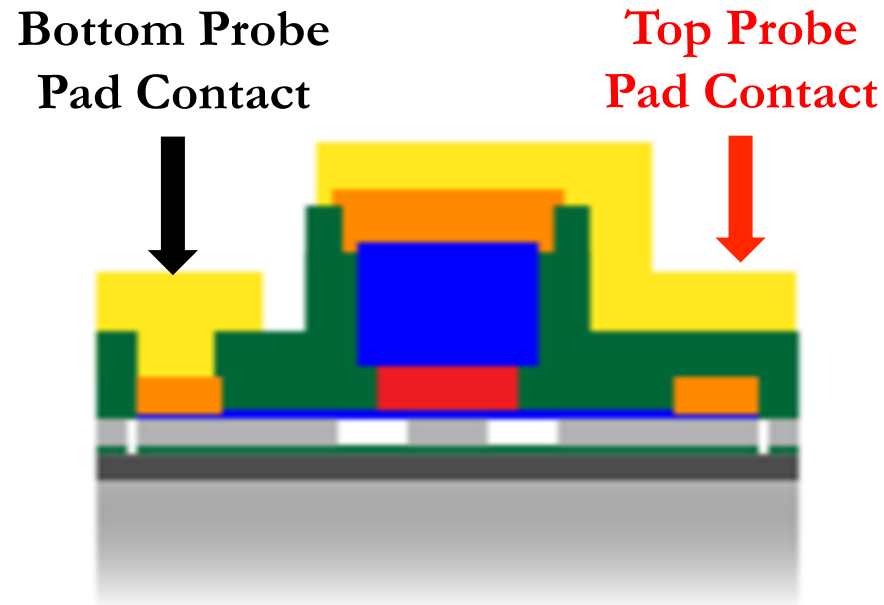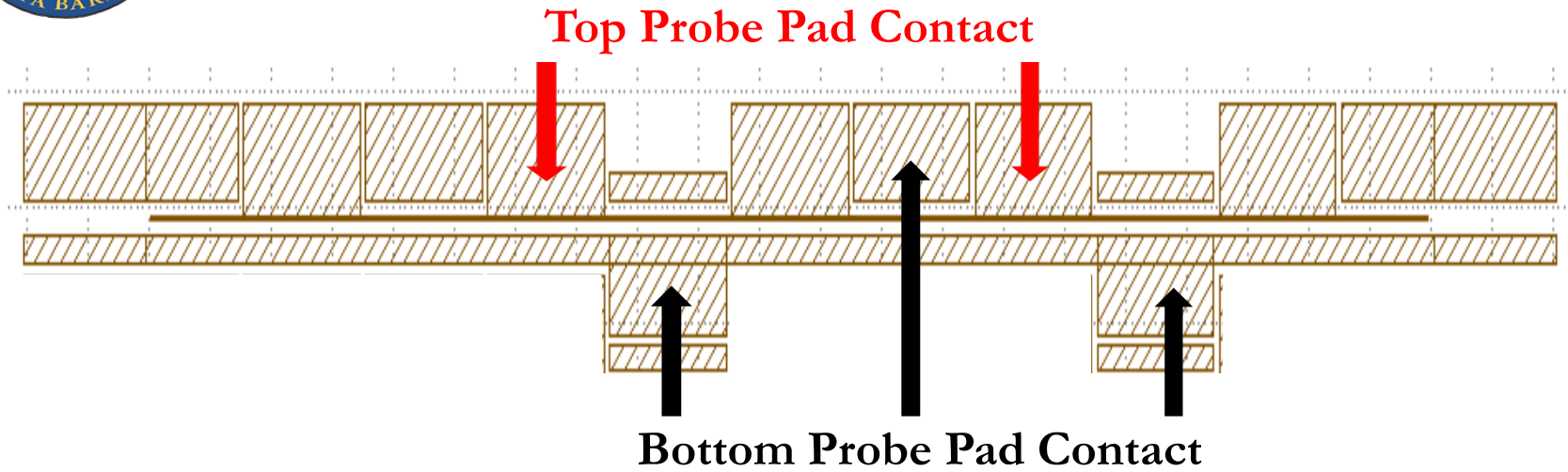
- **What performs better?**

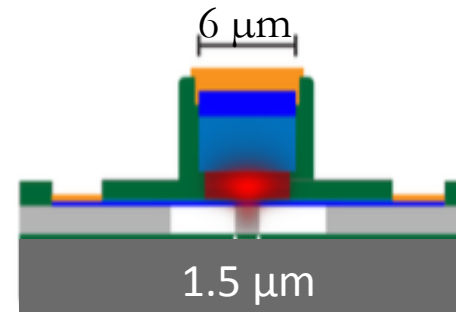# Lab Equipment Set Up

Microscope Close Up of Chip

Laser Bar (Chip)

Needle Probe

Device 4

6 μm

1.5 μm

Device 8

8 μm

2 μm

Device 28

4 μm

2 μm

Needle Probe Contacts

Top Probe Pad Contact
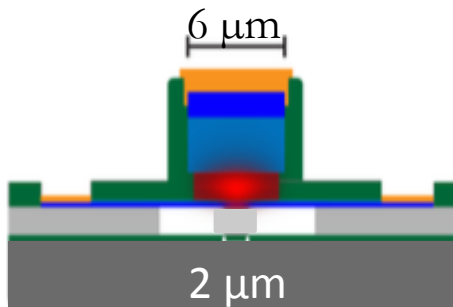
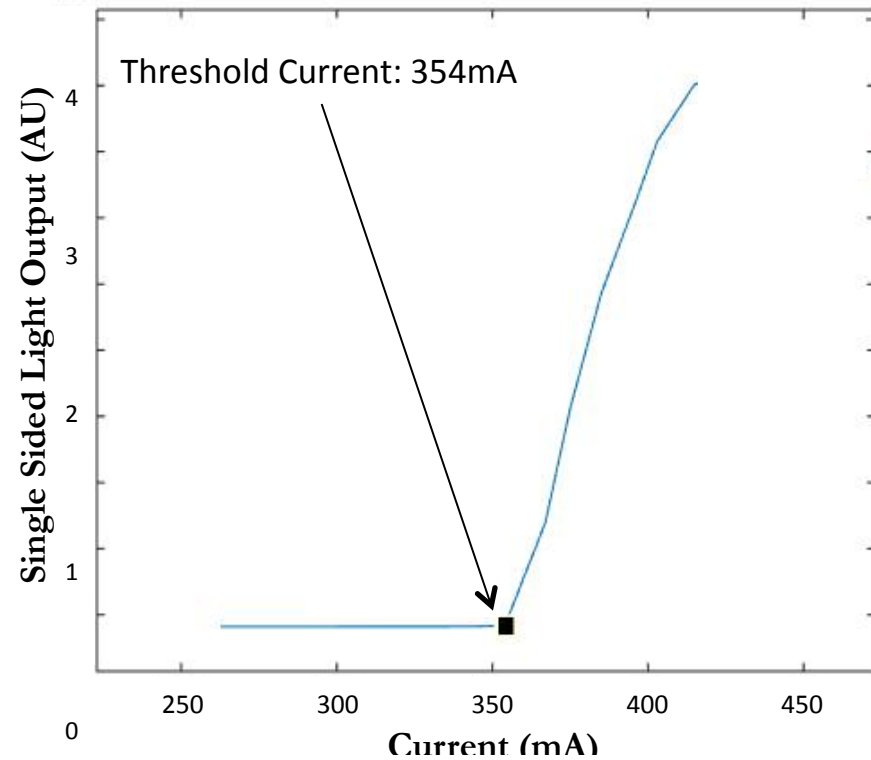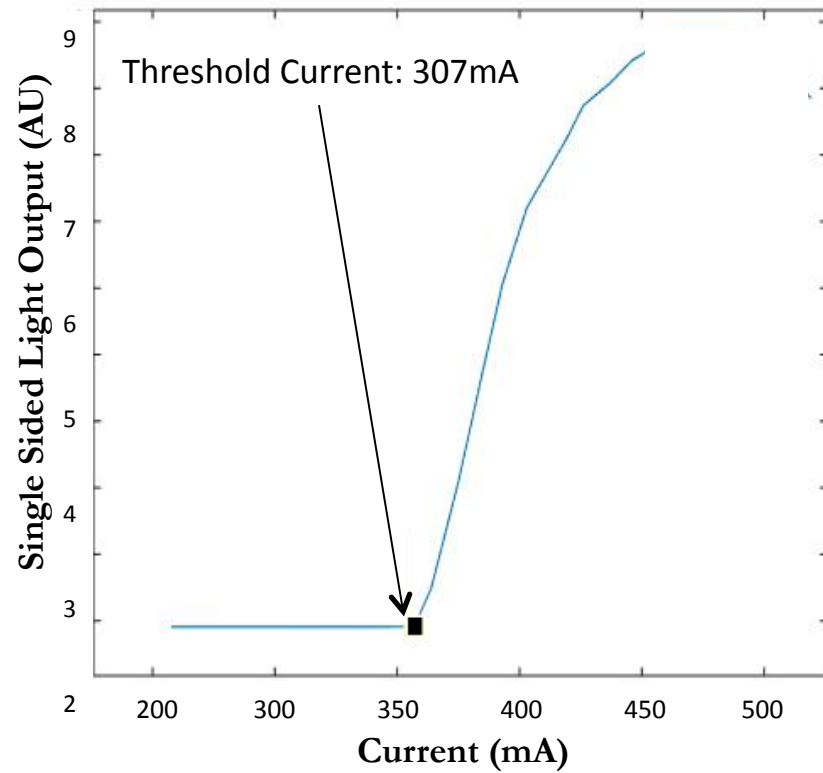Bottom Probe Pad Contact

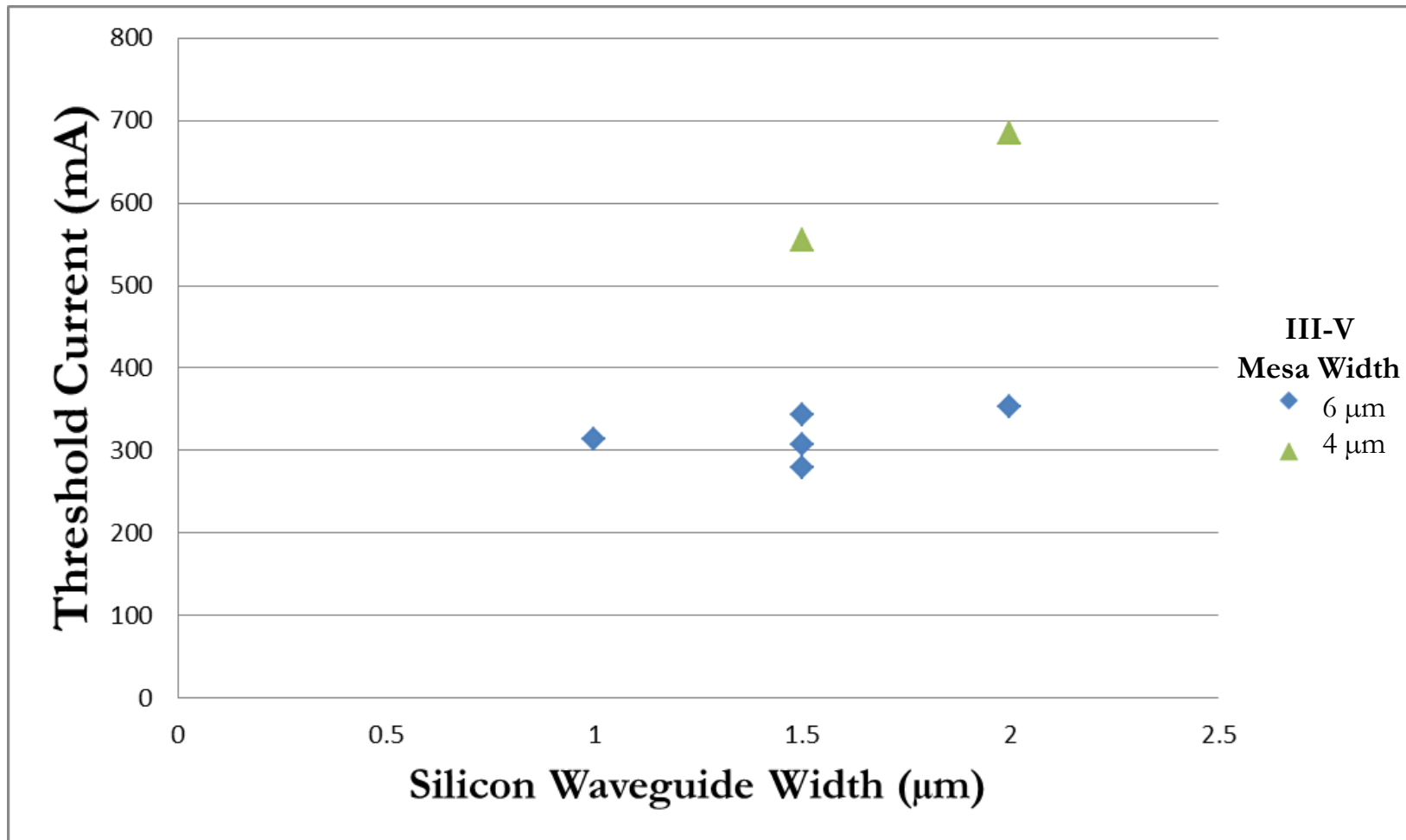Bottom Probe
Pad Contact

Top Probe
Pad Contact

Light Output vs. Current Graph

Data from Chip

Conclusion & Acknowledgements

Conclusion & Future Work

- Continue to get more information from chips
- We hope to build new lasers with optimal internal geometry

Acknowledgements

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