About Omics Group

OMICS Group International through its Open Access Initiative is committed to make genuine and reliable contributions to the scientific community. OMICS Group hosts over 400 leading-edge peer reviewed Open Access Journals and organize over 300 International Conferences annually all over the world. OMICS Publishing Group journals have over 3 million readers and the fame and success of the same can be attributed to the strong editorial board which contains over 30000 eminent personalities that ensure a rapid, quality and quick review process.

About Omics Group conferences

- OMICS Group signed an agreement with more than 1000 International Societies to make healthcare information Open Access. OMICS Group Conferences make the perfect platform for global networking as it brings together renowned speakers and scientists across the globe to a most exciting and memorable scientific event filled with much enlightening interactive sessions, world class exhibitions and poster presentations
- Omics group has organised 500 conferences, workshops and national symposium across the major cities including SanFrancisco,Omaha,Orlado,Rayleigh,SantaClara,Chicago,Philadelphia,Unitedkingdom,Baltimore,SanAntanio,Dubai,Hyderabad,Bangaluru and Mumbai.

Manufacturing and performance of quantum cascade lasers for industrial applications

Mariano Troccoli
Director, Product Development
AdTech Optics Inc.

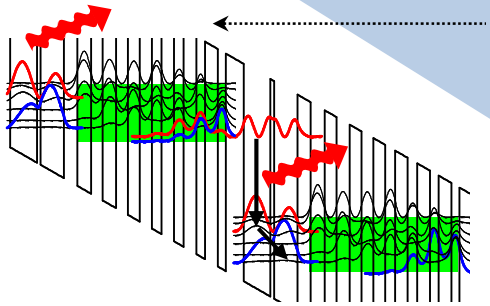
AdTech optics
advancing photonics / shaping an industry

In-house capabilities at ATO

FROM CONCEPT

Laser Design

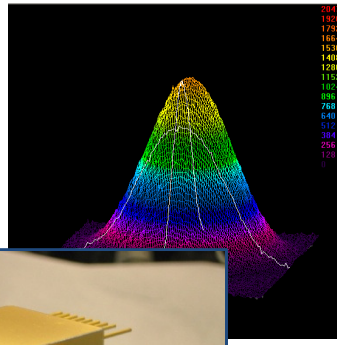
full modeling of QCL devices
with proprietary software



12 YRS in business
25 PPL on QCLs
11,000 SQFT
ITAR compliant

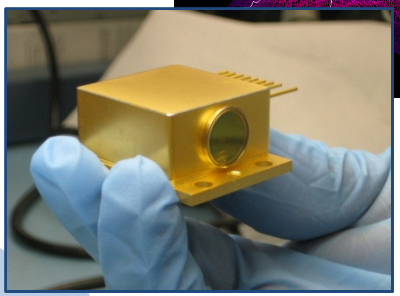
MOCVD Growth

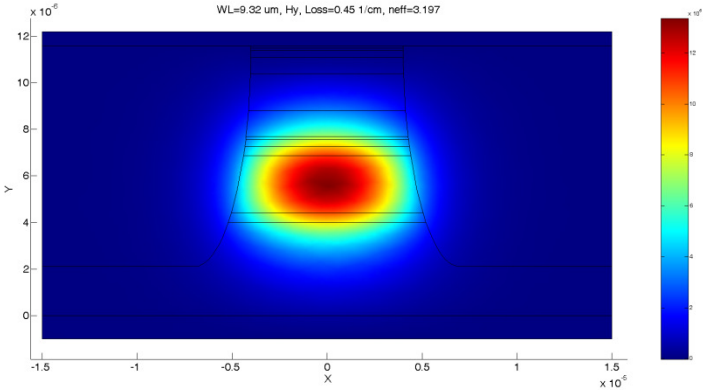
2 reactors dedicated
to QCLs production

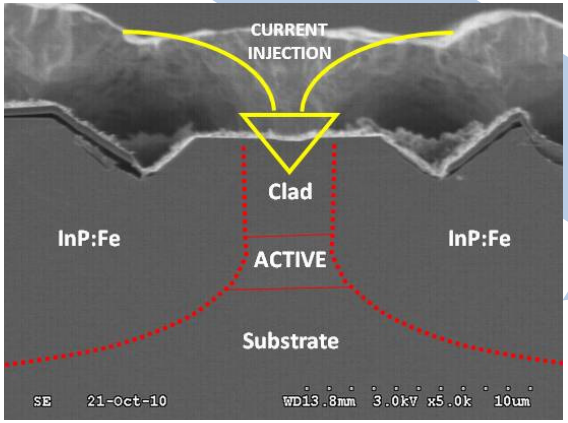


Device Fabrication

buried-het process
for RT CW operation







Test and Mounting

C or CS open-mount, TO-3, HHL

TO PRODUCTION

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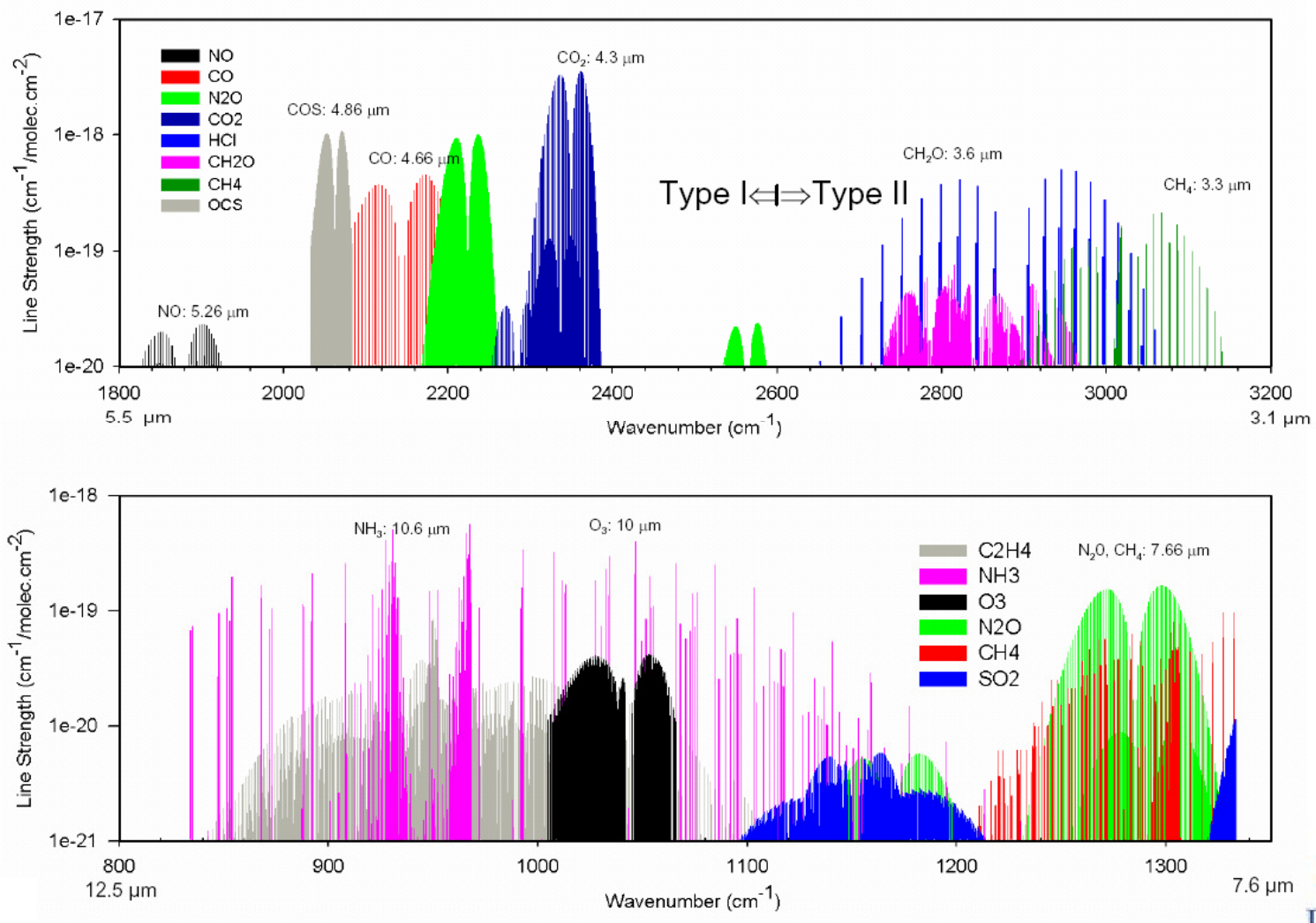
Mid-IR “molecular fingerprints”



RICE

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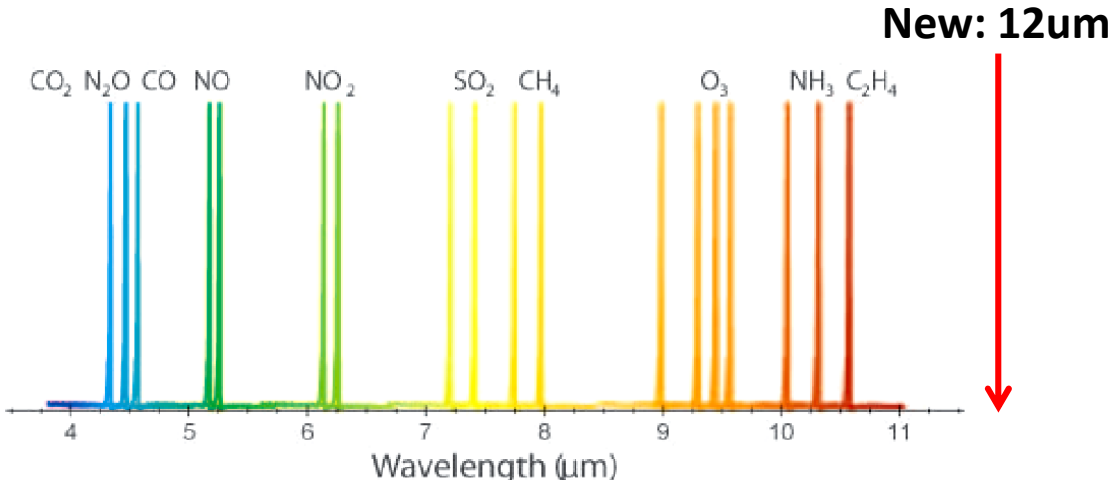
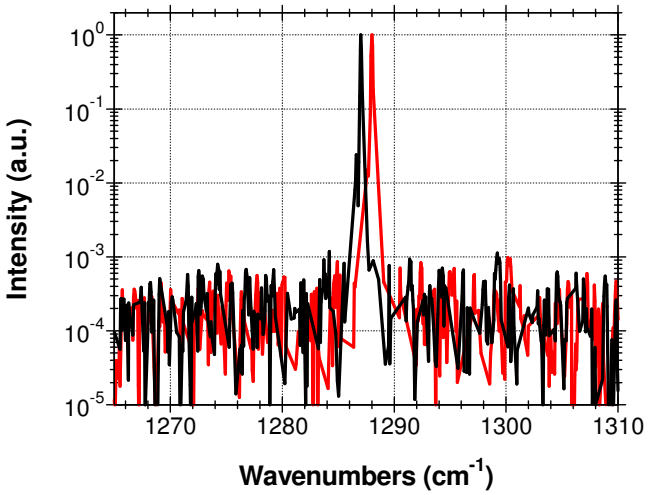
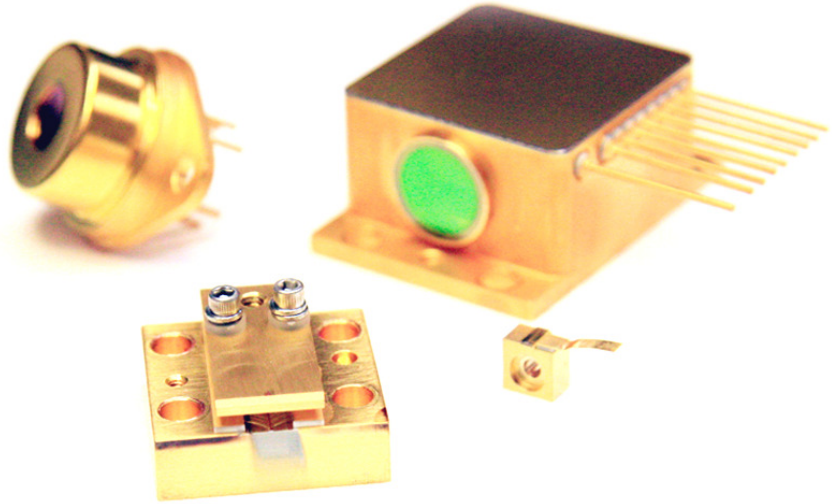
CW DFB QC Lasers: wide range coverage of the mid-IR

- 30dB SMSR
- CW, RT Operation
- 3-4 cm^{-1} tunability
- Broad coverage of mid-IR
- Scalable technology for affordable, portable sensors







Full list of DFB wavelengths is available at www.atoptics.com/laser_specs.html

Applications of Mid-IR spectroscopy

Analytical

Hyper-spectral imaging
Microscopy
Analysis of food, water, fluids, etc.

Environmental

Emissions & pollutant monitoring
Power generation & catalytic processes
Combustion processes

Defense & Security

IRCM
IED detection
Stand-off haz-mat detection

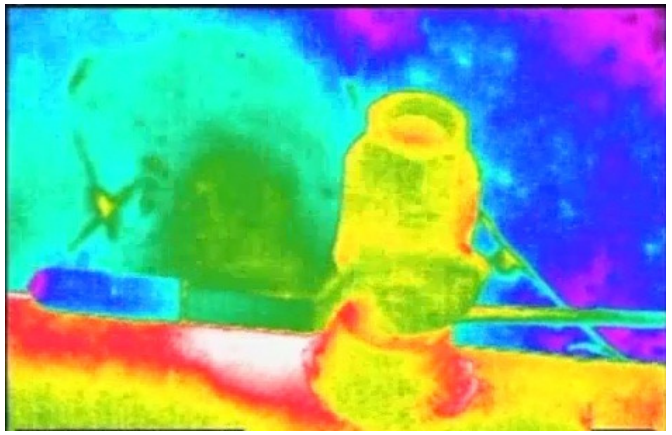
Industrial

Process monitoring and optimization
Leak detection
Quality control

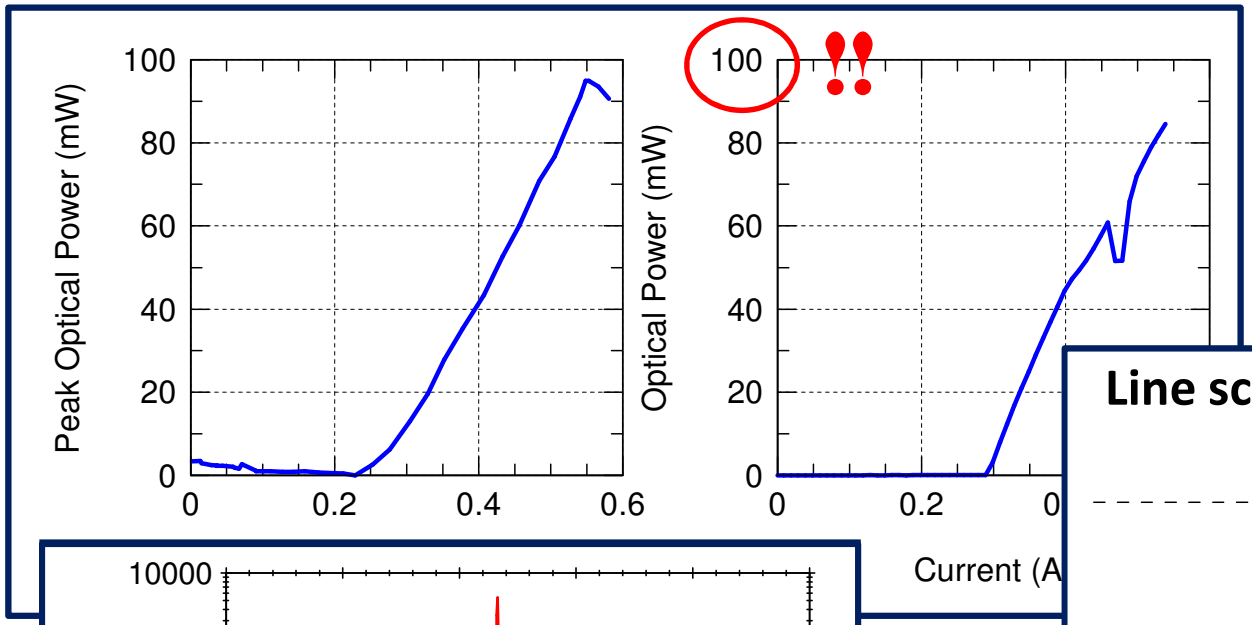
Bio-medical

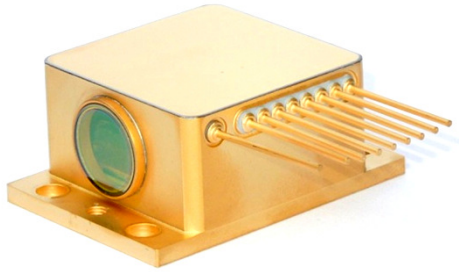
Advantages of Optical Detection:

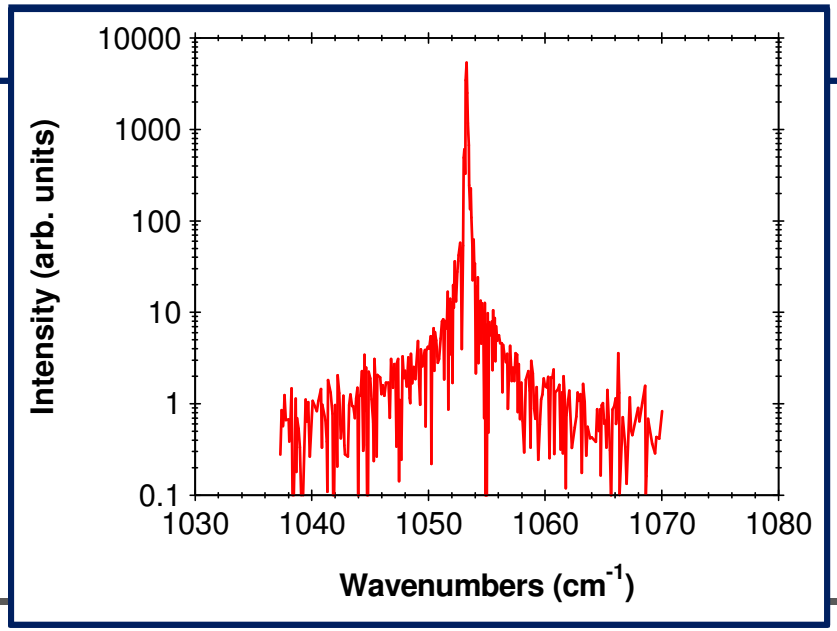
Non-invasive
Highly Selective
Highly Sensitive
In-situ or stand-off
Clean



Direct Absorption measurements with a DFB QCL: detector saturation issues







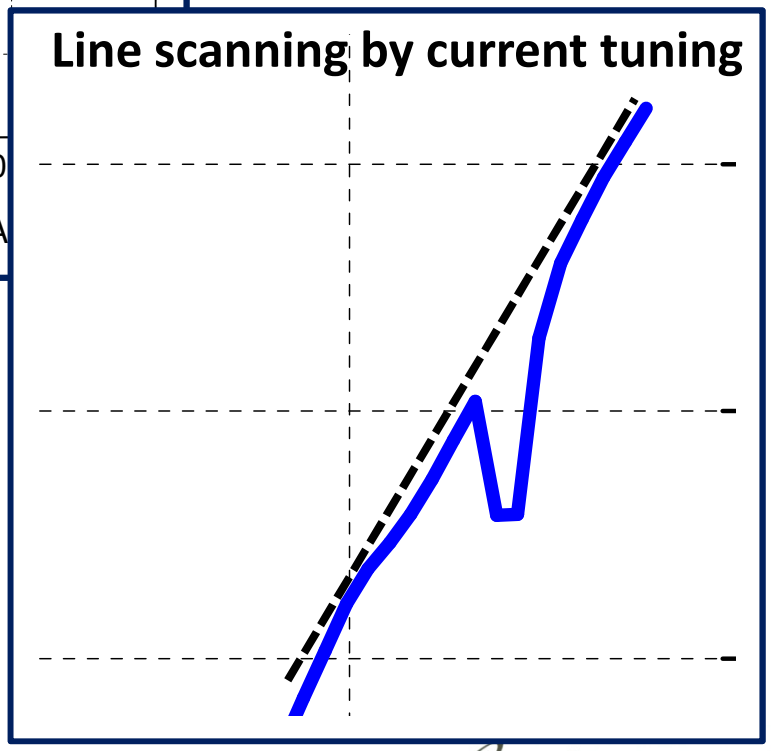


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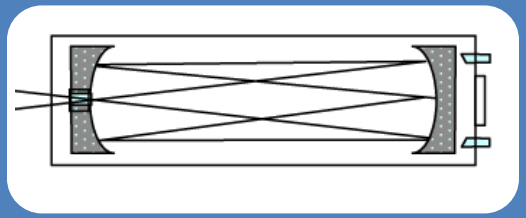
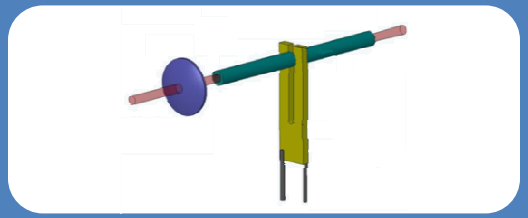
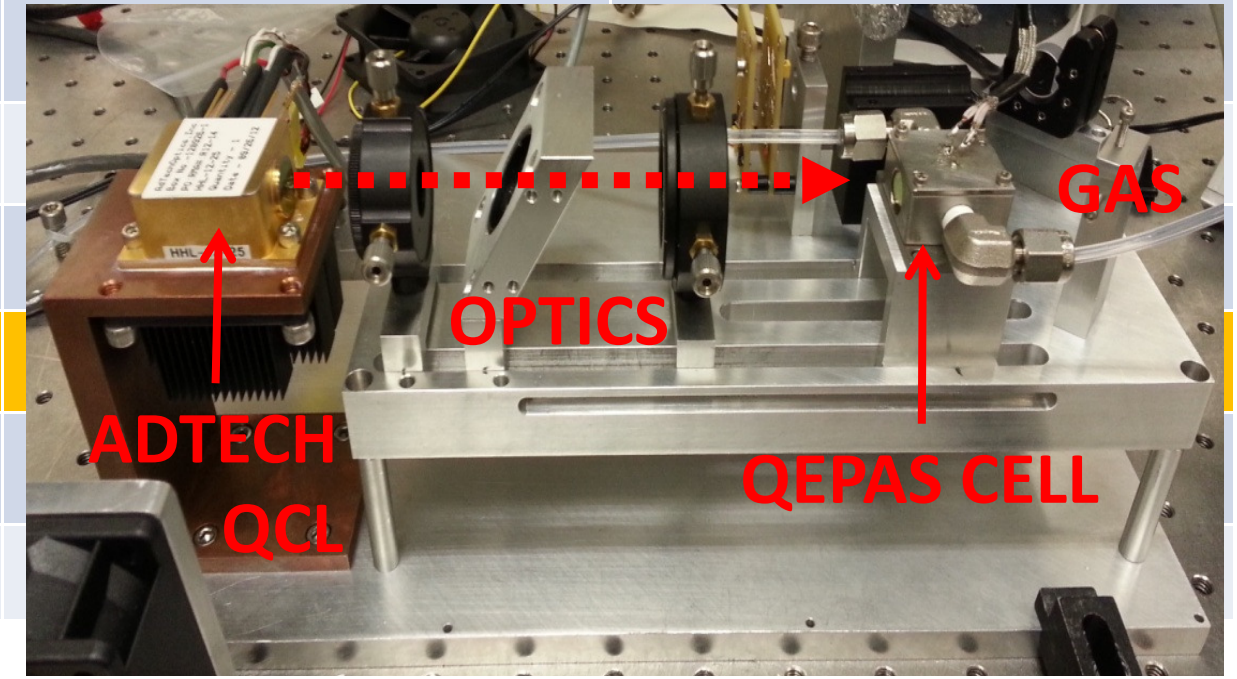
Photo-Acoustic Sensing systems benefit from Hi Power QCLs

Sensor system	 Multipass system	 QEPAS system
Cell volume		
Response τ		
Optical path		
Laser power		
BG noise		
MDC (1s)		



RICE

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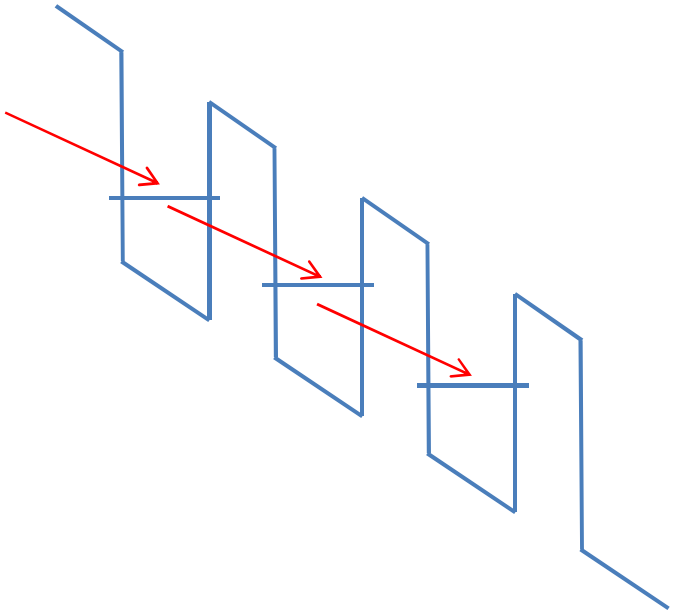
The challenges of low-power QCLs

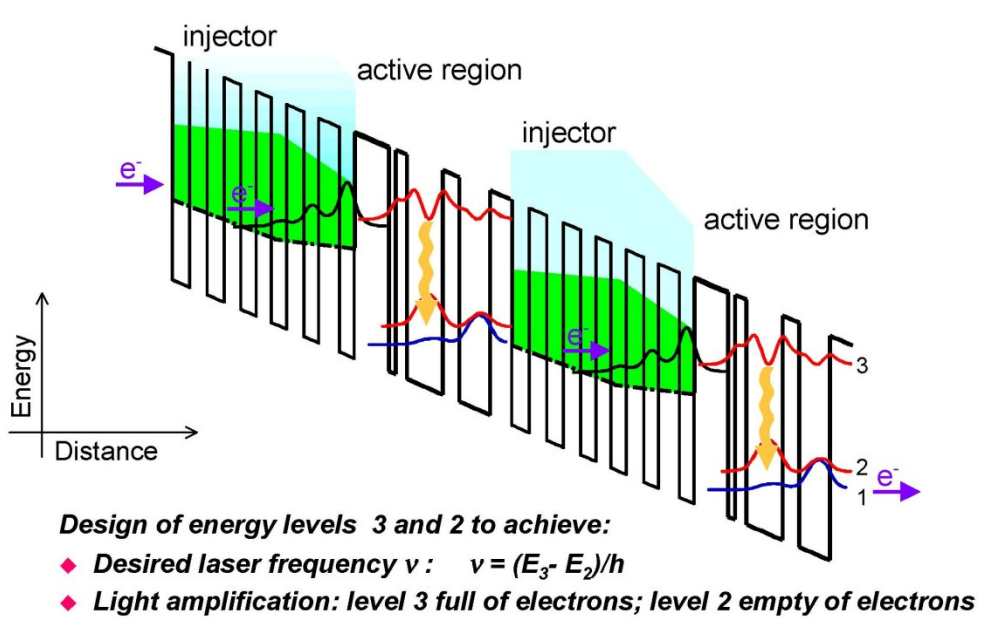
Fundamental limits:
QCL intrinsically a high current device
Short intraband lifetimes
Unipolar device
2-electrode configuration

Material-related:
Optimizing injection & conversion efficiency
Minimizing losses / reducing operating current
Minimizing voltage “defect”
Reducing voltage drop on contacts / claddings
Optimizing mode confinement

Fabrication-related:
Reducing device size
Optimizing fabrication
Optimizing coatings
Optimizing mounting and heat transfer

QCL band structure





$$V_{tot} \cong N \times h\nu$$

$$V_{tot} \cong N \times h\nu \times V_{def} + V_c$$

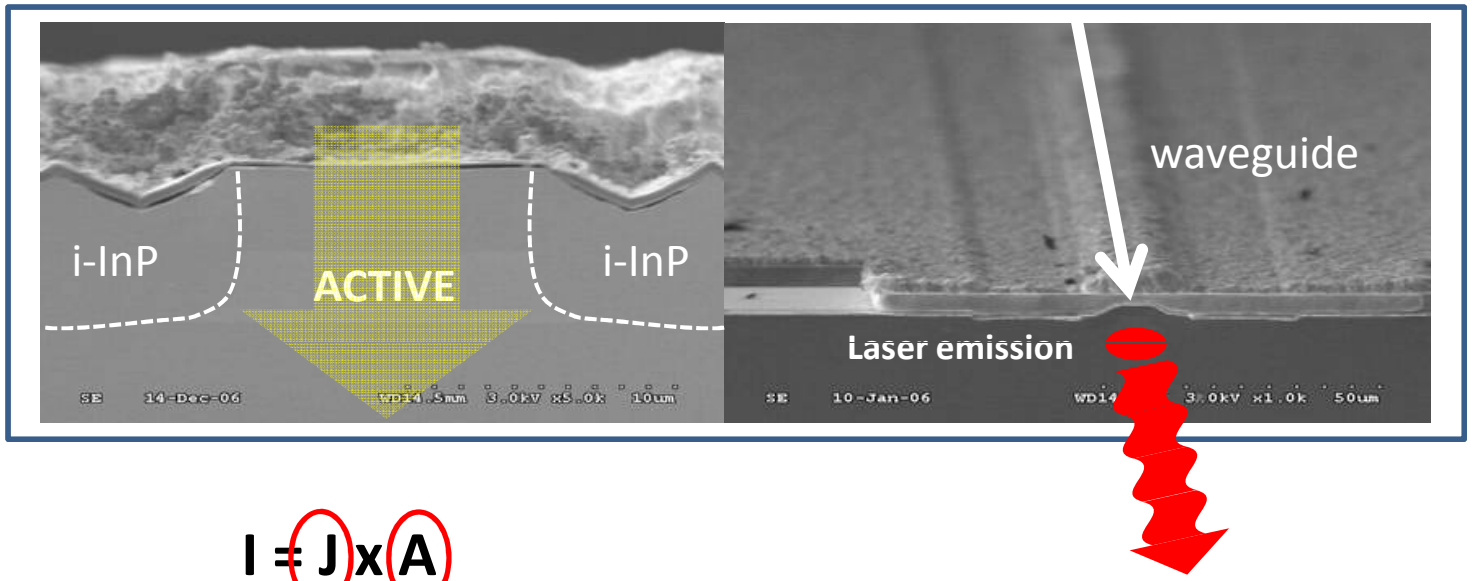
Gain / overlap

Wavelength

Backfilling

Contact res.

BH process: fabrication challenges for low-Power QCLs



$$I = J \times A$$

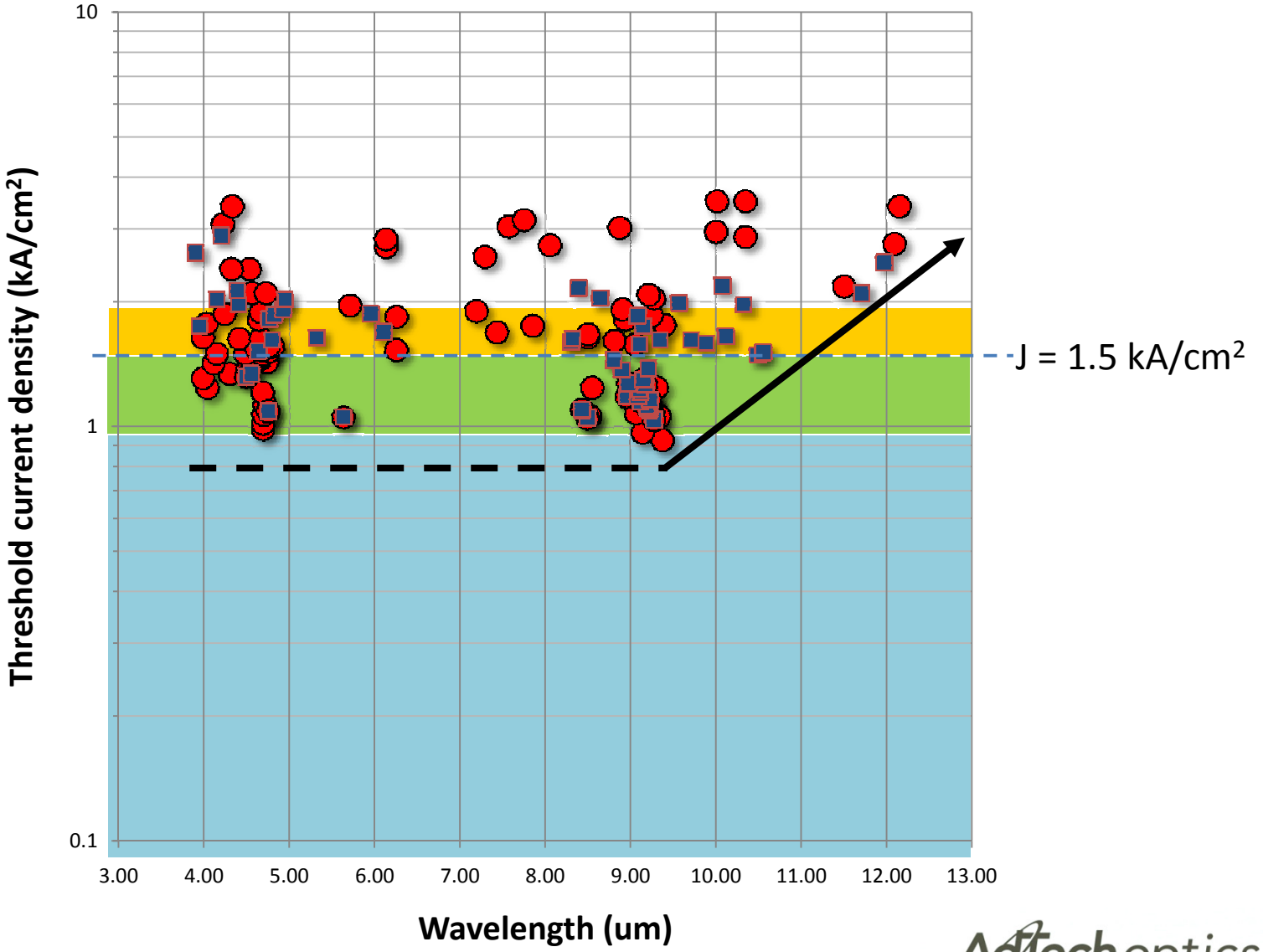
Material:
- Losses
- Coatings

Geometry:
- Emitter width
- Cavity

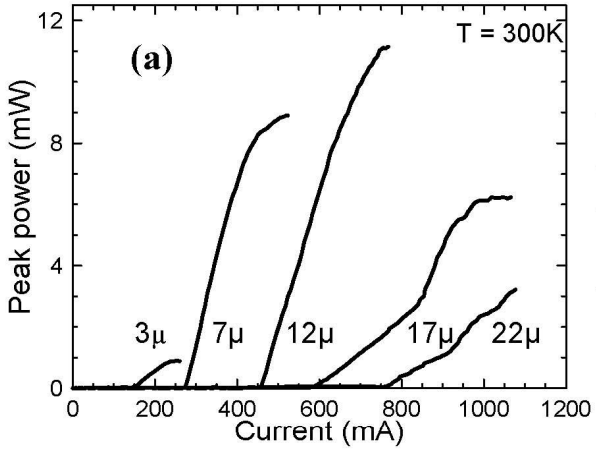
Narrow device fabrication:

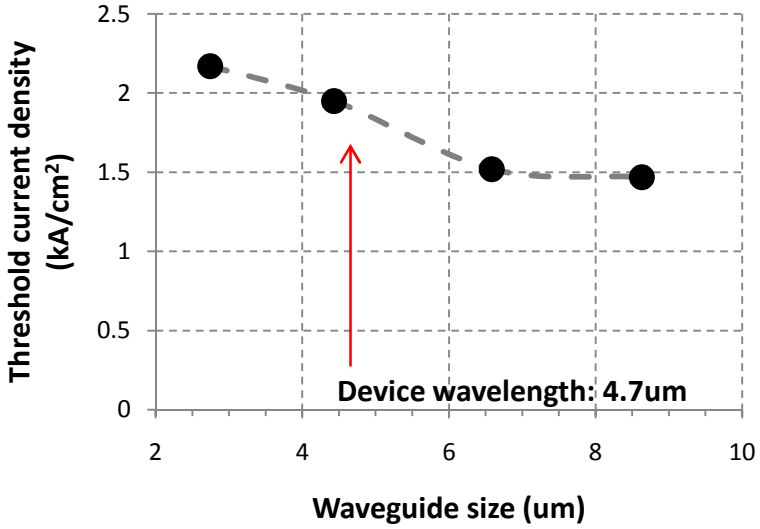
Etching (aspect ratio, intf. smoothness, …)
Doping optimization
Re-growth quality / background impurities

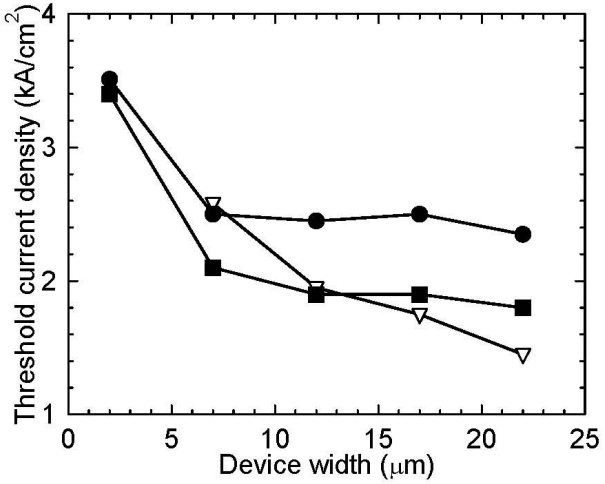
Threshold density vs. wavelength

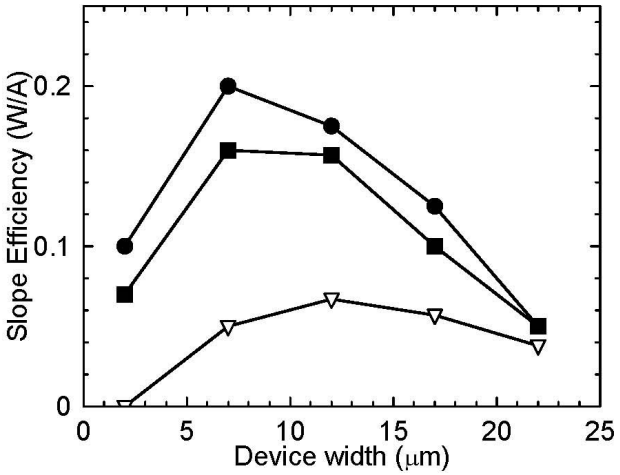


J_{th} vs. device width



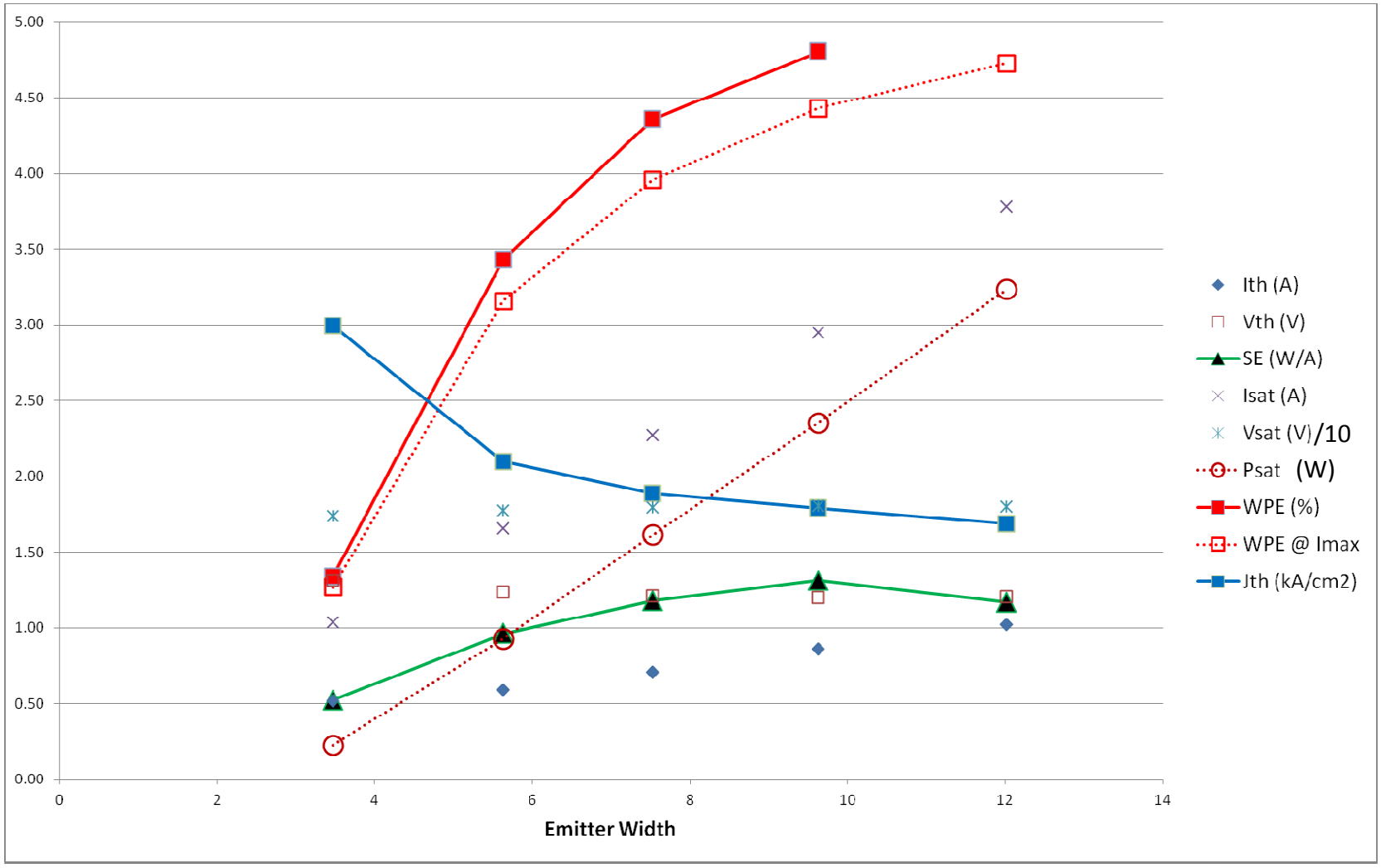




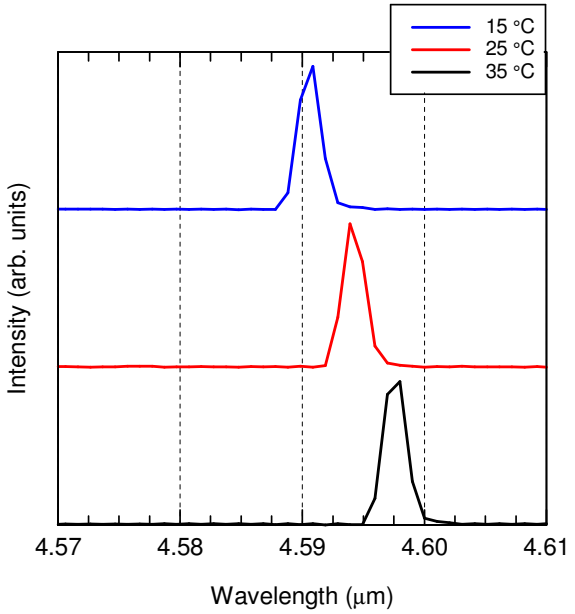


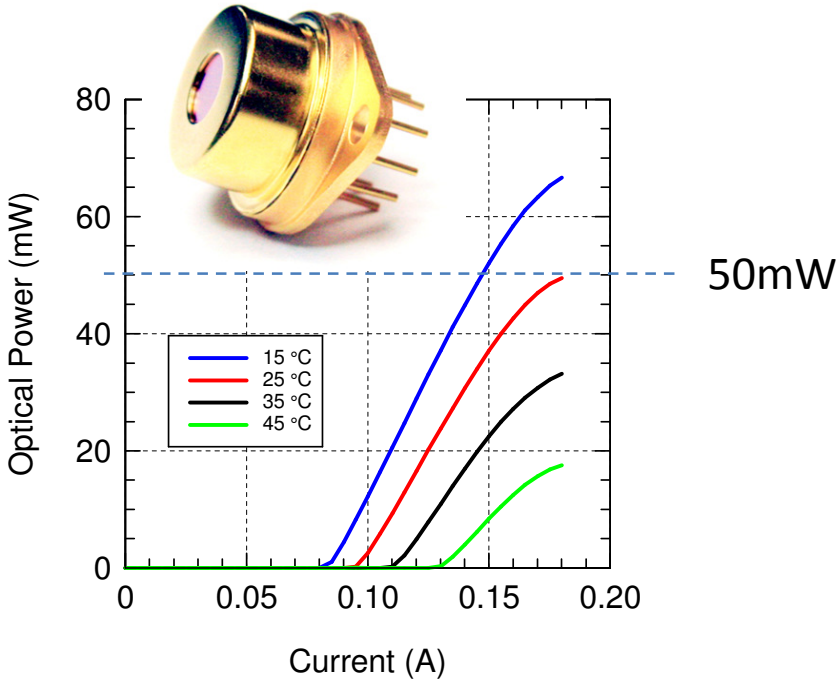
Narrow BH devices @ 5um

(pulsed operation, RT, no heat sinking)



Low-Consumption DFB QCL

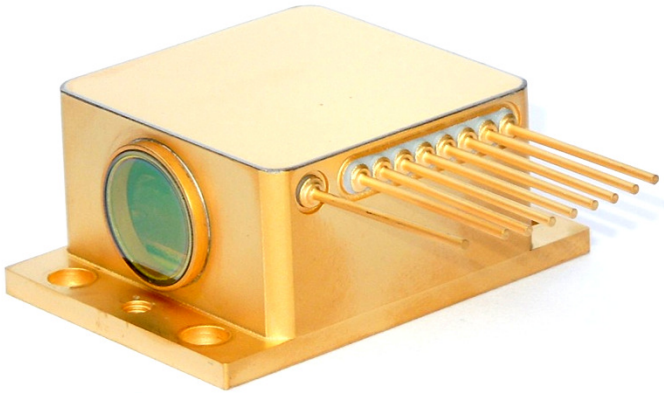


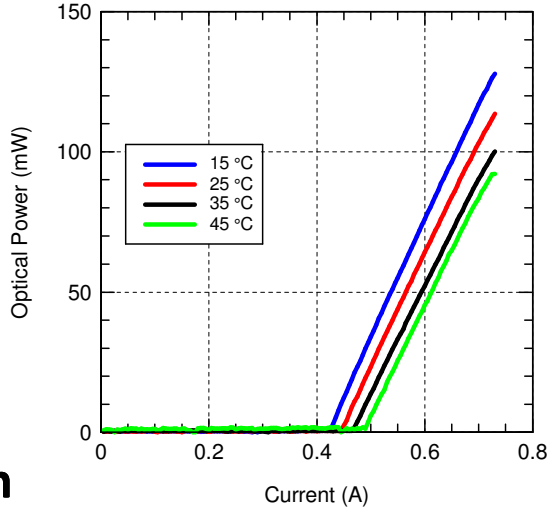


λ= 4.5um ; Emitter Width= 3.7um

P^{E}_{th} = 0.8W ; P^{E}(50mW) = 1.9W

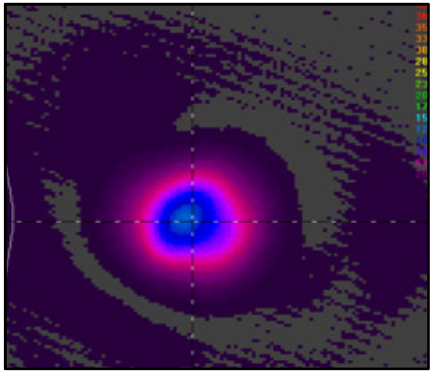
LWIR narrow device results

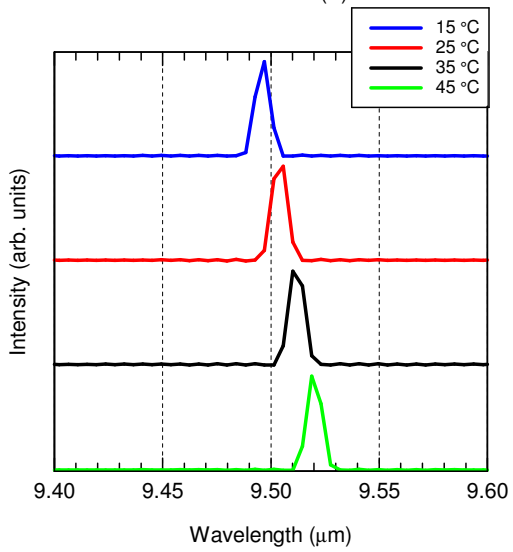




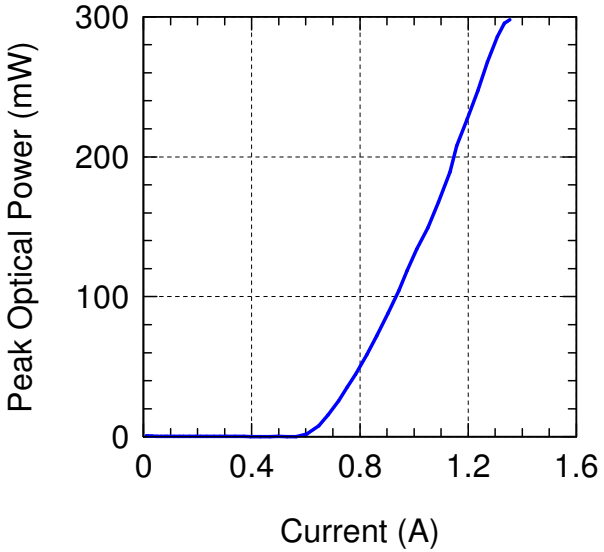
λ=9.5um ; Emitter Width= 7um

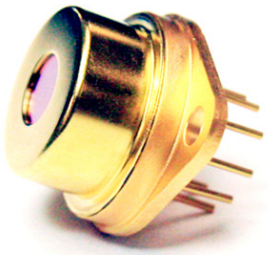
P^{E}_{th} = 3.3W ; P^{E}(50mW) = 4.7W

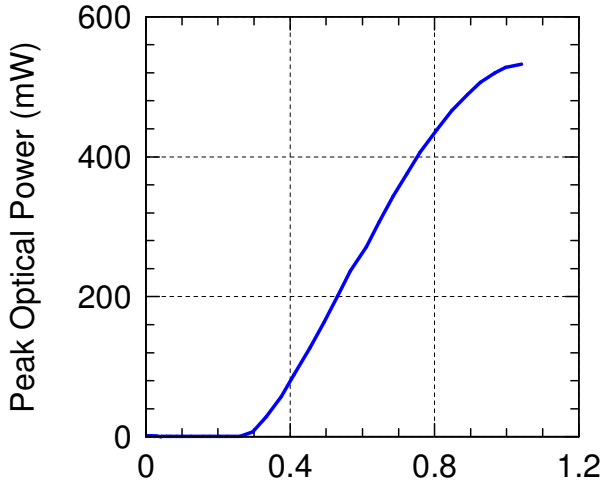


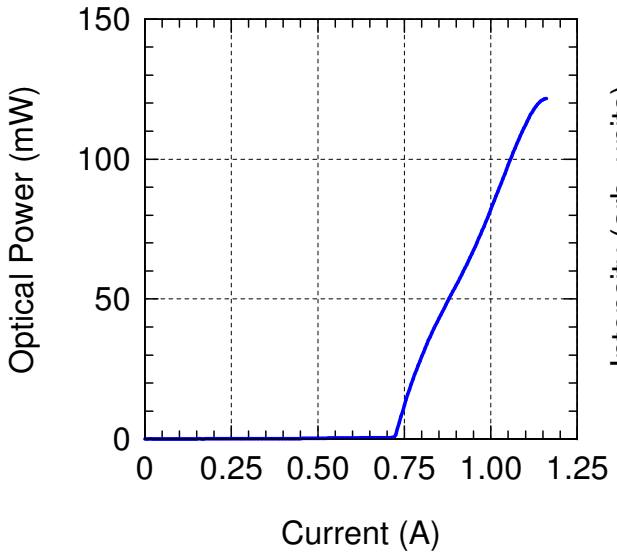


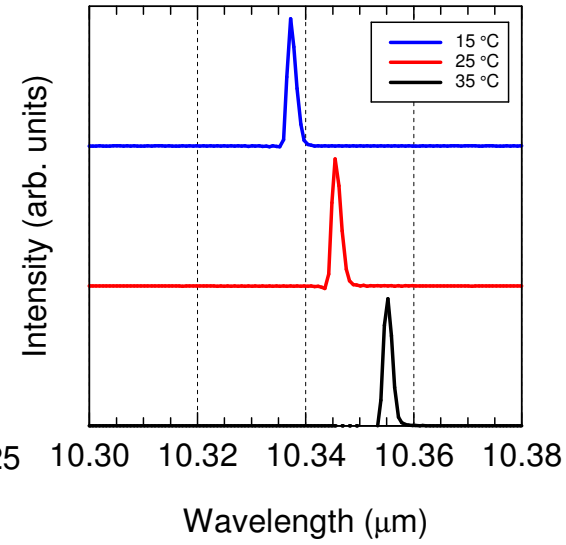
TO-3 DFBs for NH_3 and CO_2

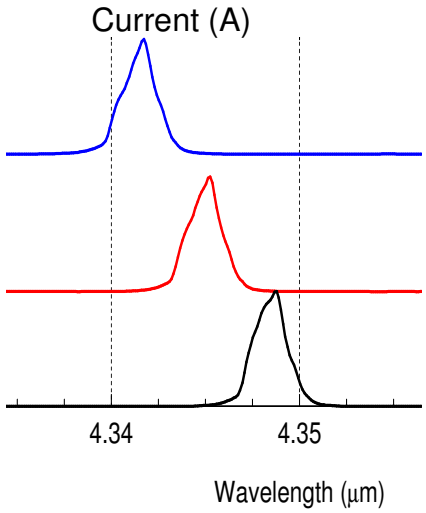




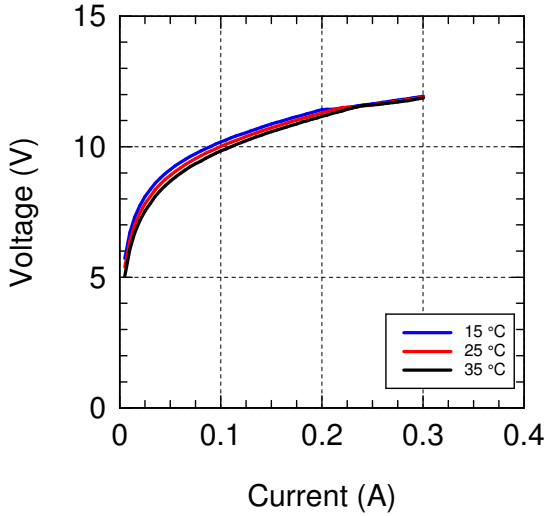


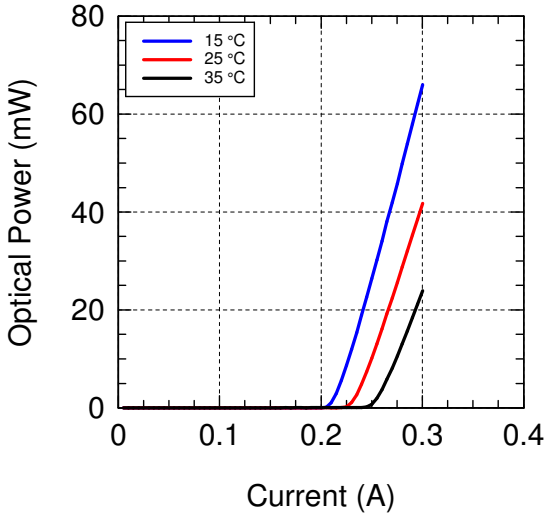


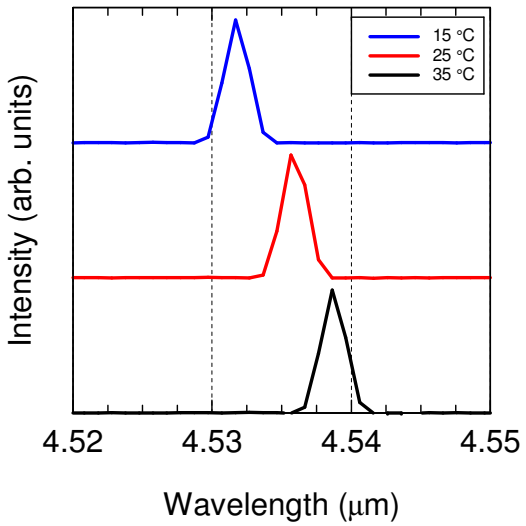


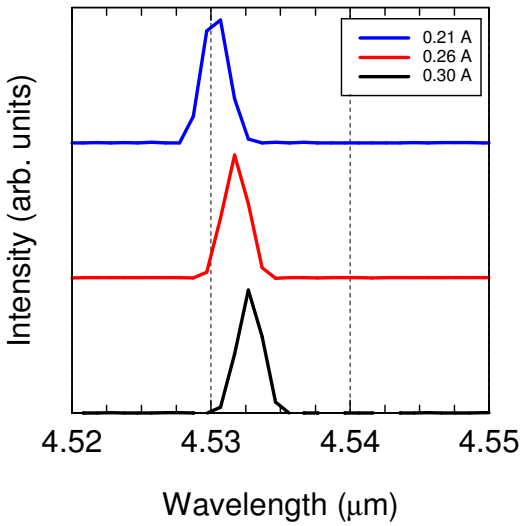


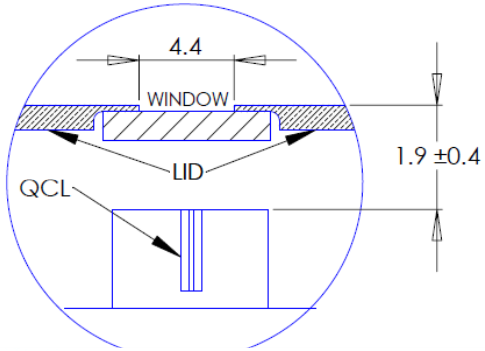
VHL DFBs: 5.26 and 4.53um

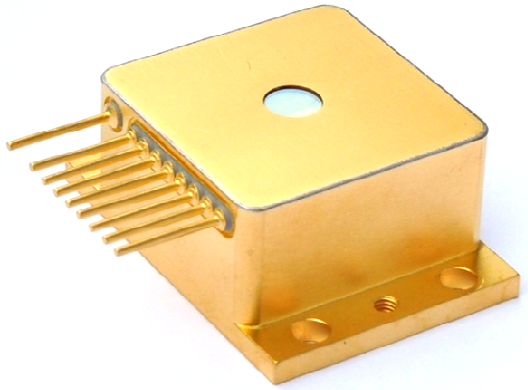












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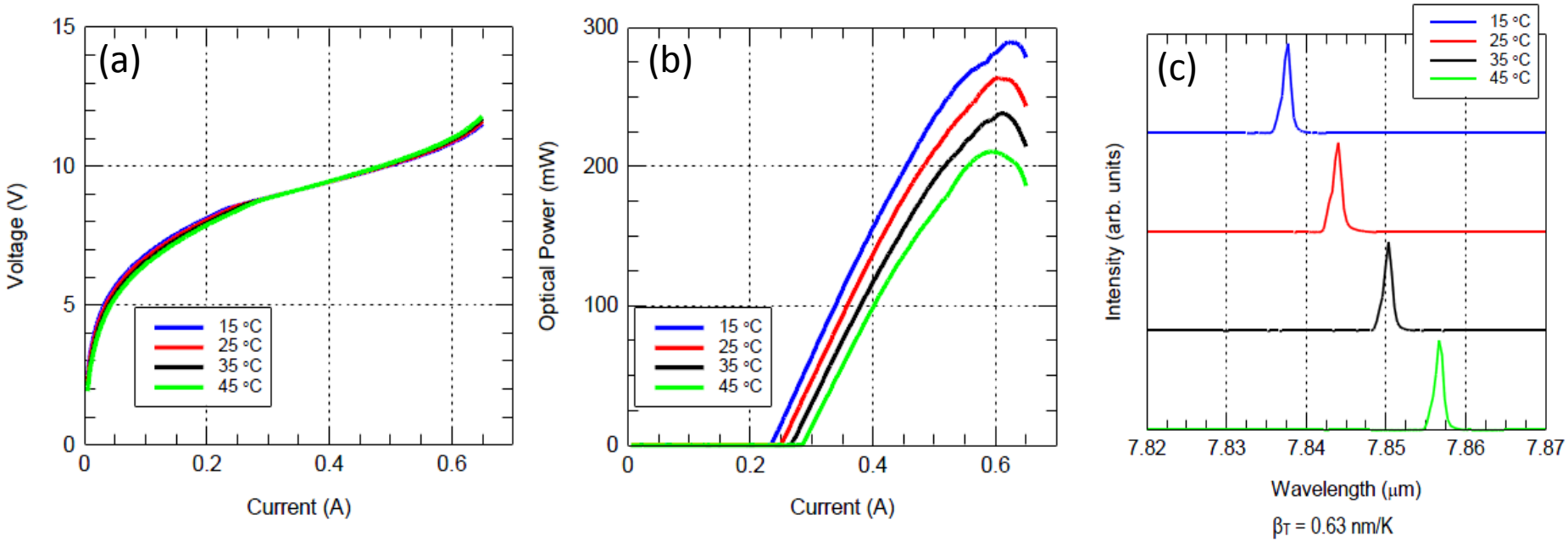
High power DFBs



$$\eta_{max} = P_{out}/P^{E} = 250mW/5W = 5\%$$

Conclusions & Perspectives

QCLs are becoming a mature technology and becoming production/manufacturing ready :

- laser performances are being tuned to the application requirements
- product development is steadily moving forward
- field testing of QCLs is successful and integration is following
- customers need industry-wide standards and reliable suppliers

AdTech has the manufacturing capabilities, technical expertise and financial stability to pursue the full development of QCL-based products. We are committed to support the scientific community and our customers throughout this process.

Acknowledgements

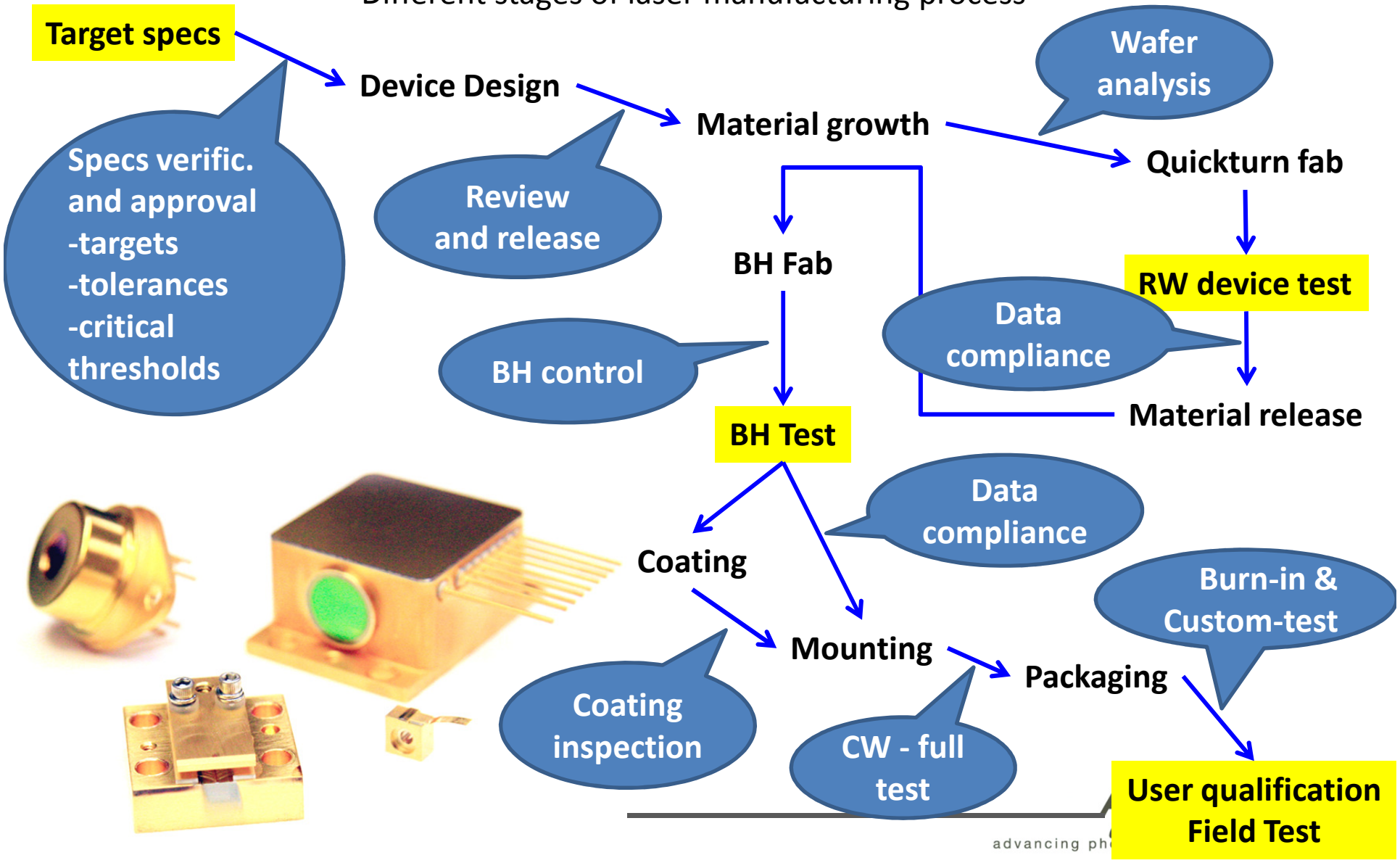
AdTech Optics Team

Jenyu Fan (fab operations)
Xiaojun Wang (material development)
Rommel Ceballos (processing)
Hien Quach (testing)
Ulisses Gamboa (packaging)
Gene Lin (coating)
Charles Luu (tech sales)
Ed Ho (Finance)
Mary Fong (CEO)

Support from DARPA, ONR, MDA

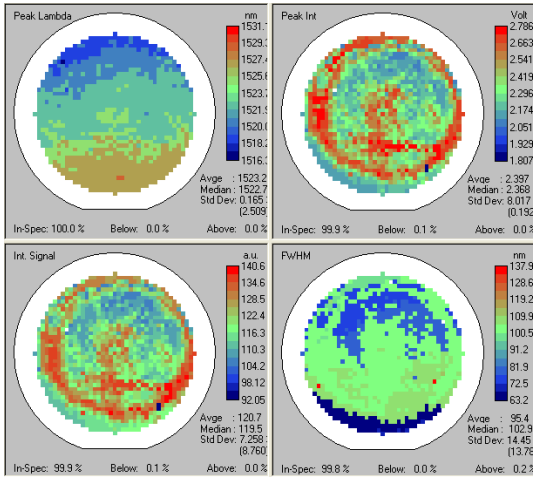
QCL Manufacturing

Different stages of laser manufacturing process

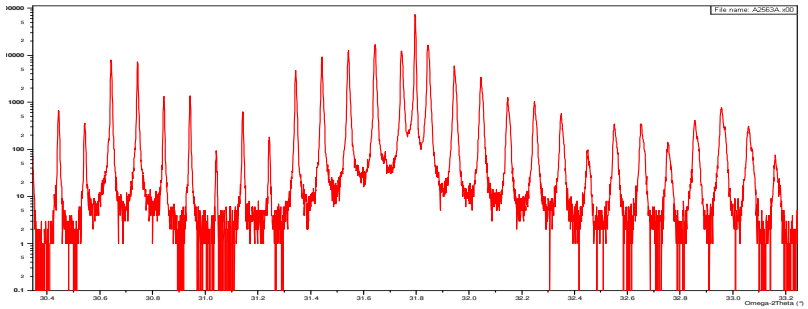


QCL Manufacturing – quality control

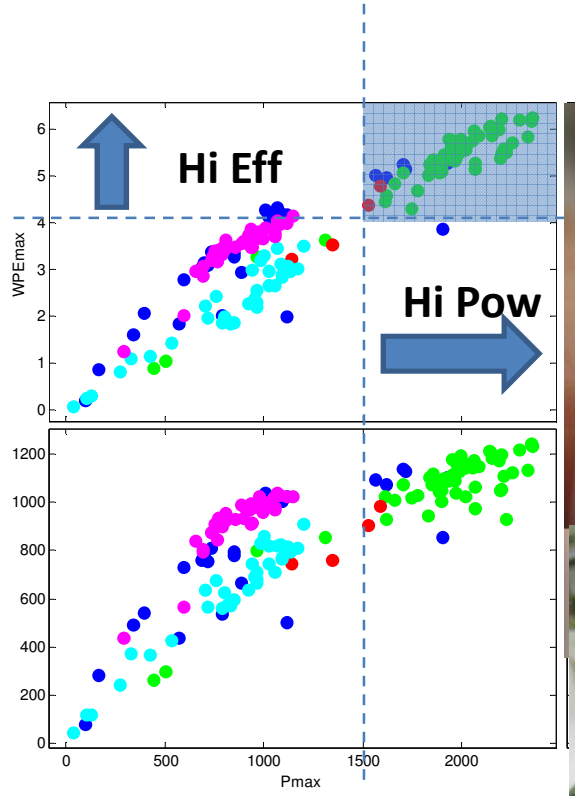
Measurements and technologies for manufacturing control and repeatability



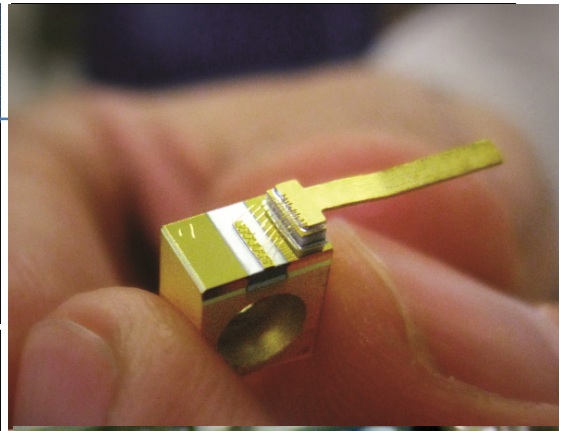
Luminescence mapping



Xray-scattering mapping



Yields across processes



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