CURRICULUM VITAE

Arkadiy Lyakh

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Career Brief

-Over 15 years of experience in semiconductor laser field with specialty in Quantum Cascade Lasers (QCLs). Expertise in areas ranging from basic research through product development and manufacturing both as individual contributor and manager.

-Leading technical role in development of first multiwatt continuous wave room temperature QCLs in MWIR and LWIR spectral regions. A number of world records in QCL optical power and wallplug efficiency. Commercialization of first high power QCLs. Development of QCL-based systems with industry leading characteristics.

-Demonstration of ultra-fast, broadly tunable QCLs with switching time between arbitrary wavelengths under 1μs, demonstration of first substrate-emitting QCLs and CW QCL tree-arrays for next generation high power QCL systems

-Proven record in writing winning proposals for external funding, experience in managing collaboration between research groups and leading large budget R&D efforts

-Taught graduate level electrical engineering courses at UCLA and University of Florida

-10 patent applications (4 granted, 6 pending), 2 book chapters, over 20 scientific publications cited over 700 times (per google scholar)

Education

Ph.D. - Electrical Engineering **May 2007**
UNIVERSITY OF FLORIDA, GAINESVILLE, FL
Advisor: Prof. Peter Zory

M.S. - Applied Physics and Mathematics **July 2003**
MOSCOW INSTITUTE OF PHYSICS AND TECHNOLOGY

B.S. - Applied Physics and Mathematics **June 2001**
MOSCOW INSTITUTE OF PHYSICS AND TECHNOLOGY

Employment History

Assistant Professor (tenure track) **September 2015 to present**
NanoScience Technology Center (NSTC)
CREOL
University of Central Florida

Director - High Performance QCLs **June 2011 to August 2015**
Pranalytica Inc. (CEO – Dr. C. Kumar N. Patel)

Responsibilities: -Head of QCL laboratory. Directing all activities related to QCL R&D and QCL component production

Results:

-Within an STTR U.S. Army program on broadly tunable QCLs developed a novel external cavity configuration with an ultra-rapid scanning time (full wavelength sweep ~10μs). Scanning speed is critical for standoff detection and combustion diagnostics. Commercialized the new platform.

-Leading a U.S. SOCOM program ($1.6M) focused on QCL development. Exploring numerous new ideas ranging from fundamental laser design to high power coating development to studying laser degradation mechanisms. Transition to high yield, large throughput manufacturing for field applications.

-Within an STTR U.S. Army program on QCL development demonstrated world-best QCL performance in MWIR and LWIR spectral regions. Results were covered in Laser Focus World News Section. A "success story" describing the results was published in the Army Commercialization Brochure 2013.

-Within DARPA beam combining program demonstrated first CW operation of QCL tree arrays with diffraction limited beam quality. Laser configuration promising optical power over 10W, threshold power level required for a number of critical defense applications

-Responsible for development of novel QCL-based products and commercial deliveries of products with industry leading performance.

Example (laser part):
http://www.laserfocusworld.com/articles/2013/01/ng-pranalytica-ircm-advance.html

Lecturer **September 2014 to January 2015**

University of California at Los Angeles
(EE270; graduate class on Applied Quantum Mechanics)

Responsibilities:

-Course content
-Lectures
-Office hours
-Grading exams and home works

Lecturer **September 2012 to January 2013**

University of California at Los Angeles

Senior Scientist **May 2007 to June 2011**

Pranalytica Inc. (CEO – Dr. C. Kumar N. Patel)

Responsibilities:

-R&D in high power QCLs
-Manufacturing of high power QCLs

Results:

-Leading laser designer in a DARPA program with overall $10M budget targeting fundamental improvement in 4.6μm laser power and efficiency. Demonstrated tenfold improvement in optical power and fourfold improvement in laser efficiency, setting several world records.

-Developed two new QCL design methods that allow optimization of several design parameters in a single structure. All Pranalytica QCL products with industry leading characteristics have been designed using these proprietary methods.

-Developed a new intracavity QCL modulation scheme with suppressed thermal chirp. Suppressed thermal chirp results in a much narrower laser emission linewidth that is critical for spectroscopy

-Developed a new CTE-matched composite submounts with high thermal conductivity. New submounts improved laser performance by 20%. Currently used in all Pranalytica products.

Graduate Research Assistant **August 2003 to May 2007**
Semiconductor Research Laboratory
University of Florida (Adviser – Prof. Peter Zory)

Responsibilities: -Design, processing, and testing of semiconductor lasers

Results: -Demonstrated the first-of-its-kind substrate-emitting DFB QCLs. This configuration is now used by several groups for low-divergence beam delivery and compact on-wafer QCL arrays

-Demonstrated low-ridge QCLs with record-high optical power. Published comprehensive model.

-Demonstrated pulsed high-power three-stage diode laser. Designed used to develop a commercial product

Graduate/Undergraduate Research Assistant **August 2000 to June 2003**
Injection Lasers Laboratory
Lebedev Physics Institute, Moscow, Russia

Responsibilities: -Diode laser characterization

Results: - Measured temperature and current dependence of differential gain, one of the key parameters in determining the speed of semiconductor lasers

- Far-field measurements of novel leaky-mode semiconductor lasers

Teaching Activities

-Lecturer - graduate class on applied quantum mechanics at UCLA (EE270), fall 2014

-Lecturer - graduate class on applied quantum mechanics at UCLA (EE270), fall 2012

-Substitute lecturer - graduate course on semiconductor lasers at the University of Florida; spring 2006

Honors and Awards

-University of Florida Certificate of Outstanding Academic Achievements 2007, 2006, 2005, 2004

-Honorable mention for a poster titled: "*Design and Realization of MOCVD-grown GaAs based Intersubband Light Emitting Devices Emitting at 4.8μm*", Annual Joint Symposium of the Florida Chapters of the American Vacuum Society Science and Technology Society and the Florida Microscopy Society, March 2005

-University of Florida Alumni Fellowship for a period August 2003 – August 2007

-Basov Prize for researcher below 35 years old for a work titled: "*Peculiarities of Radiation Pattern of InGaAs/AlGaAs/GaAs Heterolaser with Quantum Well Active Region*", Lebedev Physical Institute, December 2001

Current and Past Externally Funded Projects

1. A. Lyakh (PI) *Mid-wave Infrared (MWIR) Illuminator for Ground and Small Unmanned Aircraft System (SUAS) Targeting* Air Force SBIR; proposal for Phase II was selected for award ($750k)

2. A. Lyakh (PI) *High-Power Mid-Infrared Quantum Cascade Laser Array with Continuous-Wave Output Power Exceeding 100W*, Navy SBIR N68936-14-C-0079

3. A. Lyakh (PI) *Tunable High-Power Infrared Lasers for Standoff Detection Applications,* Army STTR TW911SR-14-C-0067

4. A. Lyakh (PI) *Mid-wave Infrared (MWIR) Illuminator for Ground and Small Unmanned Aircraft System (SUAS) Targeting* Air Force SBIR AF141-129

5. A. Lyakh (PI) *Multi-Function Mid-Wave/Long Wave Infrared Laser* NAVY SBIR Topic N131-042 Pranalytica (2013)
   Selected for award (http://www.dodsbir.net/selections/abs2013-1/navyabs131.htm)

6. (overall technical lead) U.S. SOCOM Contract H92222-13-C-0050 (2013); $1.6M

Program that Dr. Lyakh fully controlled, i.e. wrote proposal, managed program, and led R&D efforts, but was not eligible to be PI when it started (before Dr. Lyakh became U.S. permanent resident)

1. *High Performance Quantum Cascade Lasers* ARMY STTR W911NF-11-C-0073 (2011); Phase II, $750k

2. *High Performance Quantum Cascade Lasers* ARMY STTR Contract W911NF-09-C-0147 (2009); Phase I, $100k

Programs in which Dr. Lyakh participated (technical contribution 30-50%)

1. *Coherent Beam Combining of Mid-Infrared Lasers* ARMY STTR W911NF-11-C-0011 (2010); Phase I, $100K

2. *Beam Combining for High Power Quantum Cascade Laser Arrays* DARPA SBIR W91CRB-11-C-0007 (2010); Phase II, $750K

3. *Beam Combining for High Power Quantum Cascade Laser Arrays* DARPA SBIR W31P4Q-09-C-0242 (2009); Phase I, $100K

4. *Efficient Mid-Infrared Laser Program* DARPA BAA06-20 (2006); >$10M

Patents

1. A. Lyakh, "Power Scaling for high power Quntum Cascade Lasers", filed February 2016
2. C. K. N. Patel, A. Lyakh, and B. Tadjikov, "Novel Tunable Quantum Cascade Laser Configuration", Filed March, 2014
3. A. Lyakh and C. K. N. Patel, "Novel Coating for Quantum Cascade Lasers", Filed December, 2013
4. R. Maulini, A. Lyakh, A. Tsekoun, C. K. N. Patel, "Quantum Cascade Lasers with Buried Facets", Filed October, 2013
5. A. Lyakh, R. Maulini, A. Tsekoun, C. K. N. Patel, "Multi-Sectional Quantum Cascade Lasers", Filed May, 2013
6. R. Maulini, A. Lyakh, A. Tsekoun, C. Kumar N. Patel, "Tapered waveguide quantum cascade lasers", U.S. Pat. 9077153, Issued July 2015
7. A. Lyakh, R. Maulini, A. Tsekoun, C. K. N. Patel, "Quantum Cascade Lasers Based on High Strain Composition", Filed September 9, 2012
8. R. Maulini, A. Lyakh, A. Tsekoun, C. K. N. Patel, "Quantum Cascade Lasers with Optimized Voltage Defect", Application number US20130010823 A1, Filed July, 2012
9. A. Lyakh, R. Maulini, A. Tsekoun, C. K. N. Patel, "Quantum Cascade Laser: Bias Neutral Design Approach", US Pat. 8121164 B1; Filed Dec. 22, 2010; Issued Feb. 21, 2012
10. A. Lyakh, R. Maulini, A. Tsekoun, C. K. N. Patel, C. Pflügl, L. Diehl, Q. Wang, F. Capasso, "Quantum Cascade Laser", US Pat. 8014430; Filed Feb 27, 2009; Issued Sep 6, 2011 (corrected author order)
11. C. K. N. Patel, A. Lyakh, R. Maulini, A. Tsekoun, "Submounts for Semiconductor Lasers", US Pat. 8068524; Filed Dec. 27, 2010; Issued Nov. 29, 2011

Book Chapters

1. A. Lyakh, R. Maulini, A. Tsekoun, B. Tadjikov, C. Kumar N. Patel, "*Advances in High-Power Quantum Cascade Lasers and Applications*", Book Chapter in *The Wonder of Nanotechnology: Quantum Optoelectronic Devices and Applications* Editors: M. Razeghi. L. Esaki, and K. von Klitzing, pp. 209-233, SPIE Press 2013
2. D. Botez, M. D'Souza, G. Tsvid, A. Khandekar, D. Xu, J.C. Shin, T. Kuech, A. Lyakh and P. Zory, "*Intersubband quantum-box lasers: An update*", Book Chapter in *Future Trends in Microelectronics : Up the Nano Creek*, Wiley IEEE Press 2007

Publications

1. A. Lyakh, R. Barron-Jimenez, I. Dunayevskiy, R. Go, C. Kumar N. Patel, "*Continuous wave operation of quantum cascade lasers with frequency shifted feedback*", AIP Advances 6, 015312 (2016)

2. C. Kumar N. Patel and A. Lyakh, *"High power quantum cascade lasers for infrared countermeasures, targeting and illumination, beacons and standoff detection of explosives and CWAs"*, Proc. SPIE 9467, May 2015

3. A. Lyakh, R. Barron-Jimenez, I. Dunayevskiy, R. Go, C. Kumar N. Patel, "*External cavity quantum cascade lasers with ultra rapid acousto-optic tuning"*, Applied Physics Letters 106, 141101, February 2015

4. A. Lyakh, R. Maulini, A. Tsekoun, R. Go, and C. K. N. Patel, "*Continuous wave operation of buried heterostructure 4.6μm quantum cascade laser Y-junctions and tree arrays*", Optics Express 22, 1203, January 2014

5. M. Troccoli, A. Lyakh, J. Fan, X. Wang, R. Maulini, A. Tsekoun, R. Go, and C. K. N. Patel, "*Long-wave IR Quantum Cascade Lasers for emission in the λ=8-12μm spectral region*", Optical Materials Express 9, 1546, August 2013

6. A. Lyakh, R. Maulini, A. Tsekoun, R. Go, and C. K. N. Patel, "*Multiwatt long wavelength quantum cascade lasers based on high strain composition with 70% injection efficiency*", Optics Express 22, 24272, October 2012

7. A. Lyakh, R. Maulini, A. Tsekoun, R. Go, and C. K. N. Patel, "*Tapered 4.7μm quantum cascade lasers with highly strained active region composition delivering over 4.5 watts of continuous wave optical power*", Optics Express 20, 4382, February 2012

8. R. Maulini, A. Lyakh, A. Tsekoun, R. Go, and C. K. N. Patel, "*λ~7.1μm Quantum Cascade Lasers with 19% wall-plug efficiency at room temperature*", Optics Express 19, 17203, August 2011

9. R. Maulini, A. Lyakh, A. Tsekoun, R. Go, and C. K. N. Patel, "*High average power uncooled mid-wave infrared quantum cascade lasers"*, Electronics Letters 47, p. 395, March 2011

10. A. Lyakh, R. Maulini, A. Tsekoun, R. Go, and C. Kumar N. Patel, "*Multi-watt level short wavelength quantum cascade lasers*", Proceedings of SPIE 7953, March 2011

11. A. Lyakh, R. Maulini, A. Tsekoun, and C. K. N. Patel, "*Progress in high-performance quantum cascade lasers*", Optical Engineering, vol. 49, p. 111105, November 2010 (*Review Paper*)

12. A. Lyakh, R. Maulini, A. Tsekoun, R. Go, S. Von Der Porten, C. Pflugl, L. Diehl, F. Capasso, and C. K. N. Patel, "*High-performance continuous-wave room temperature 4.0-μm quantum cascade lasers with single-facet optical emission exceeding 2 W*", Proceedings of the National Academy of Sciences, vol. 107, p. 18799, November 2010

13. R. Maulini, A. Lyakh, A. Tsekoun, and C. K. N. Patel, "*QCLs take the leap from toys to tools"*, Compound Semiconductor vol. 16, p. 22, April 2010

14. A. Lyakh, R. Maulini, A. Tsekoun, and C. K. N. Patel, "*QUANTUM CASCADE LASERS: Advances push QC lasers into the mainstream*", Laser Focus World Vol: 46, p. 30, February 2010

15. C. Pflugl, L. Diehl, A. Lyakh, Q. Wang, R. Maulini, A. Tsekoun, C. K. N. Patel, X. Wang, and F. Capasso, "*Activation energy study of electron transport in high performance short wavelength quantum cascade lasers*", Optics Express vol. 18, p. 746, January 2010

16. R. Maulini, A. Lyakh, A. Tsekoun, R. Go, C. Pflügl, L. Diehl, F. Capasso, and C. K. N. Patel, *"High power thermoelectrically cooled and uncooled quantum cascade lasers with optimized reflectivity facet coatings"*, Applied Physics Letters vol. 95, p. 151112, October 2009

17. A. Lyakh, R. Maulini, A. Tsekoun, R. Go, C. Pflügl, L. Diehl, Q. Wang, F. Capasso, and C. K. N. Patel, *"3 W continuous-wave room temperature single-facet emission from quantum cascade lasers based on non-resonant extraction design approach"*, Applied Physics Letters vol. 95, p. 141113, October 2009

18. A. Lyakh, R. Maulini, R. Go, A. Tsekoun, and C. Kumar N. Patel, "*New midwave infrared laser sources for defense and security needs*", Proceedings of SPIE 7434, August 2009

19. A. Tsekoun; I. Dunayevskiy; R. Maulini; R. Barron-Jimenez; A. Lyakh; C. Kumar N. Patel, "*Compact, rapid, and rugged detector for military and improvised explosives based on external grating cavity quantum cascade lasers*", Proceedings of SPIE 7434, August 2009

20. A. Tsekoun, A. Lyakh, R. Maulini, M. Lane, T. Macdonald, R. Go, C. Kumar N. Patel, "*High power and efficiency quantum cascade laser systems for defense and security applications*", Proceedings of SPIE 7325, May 2009

21. R. Maulini, I. Dunayevskiy, A. Lyakh, A. Tsekoun, L. Diehl, C. Pllugl, Federico Capasso, "*Widely tunable high-power external cavity quantum cascade laser operating in continuous-wave at room temperature*", Electronic Letters, vol. 45, p. 107, January 2009

22. A. Lyakh, R. Maulini, A. Tsekoun, R. Go, and C. K. N. Patel, *"Intersubband absorption of quantum cascade laser structures and its applications to laser modulation"*, Applied Physics Letters vol. 92, p. 211108, May 2008

23. A. Lyakh, R. Maulini, A. Tsekoun, R. Go, and C. K. N. Patel, "*Intracavity amplitude modulation of quantum-cascade lasers using intersubband absorption in the active region under reverse bias*", Proceedings of SPIE 6909, p. 690910 (2008)

24. A. Lyakh, C. Pflügl, L. Diehl, Q. Wang, F. Capasso, X. Wang, J. Fan, T. Tanbun-Ek, R. Maulini, A. Tsekoun, R. Go, and C. K. N. Patel, *"1.6 Watt, high wall plug efficiency, continuous-wave room temperature quantum cascade laser emitting at 4.6 μm"*, Applied Physics Letters vol. 92, p. 111110, March 2008

25. A. Lyakh, P. Zory, M. D'Souza, D. Botez, D. Bour, *"Substrate-emitting, distributed feedback quantum cascade lasers"*, Applied Physics Letters, Vol. 91, p. 181116, October 2007

26. A. Lyakh, P. Zory, D. Wasserman, G. Shu, C. Gmachl, M. D'Souza, D. Botez, and D. Bour, "*Narrow Stripe-Width, Low-Ridge Configuration for High Power Quantum Cascade Lasers*", Applied Physics Letters, Vol. 90, p. 141107, April 2007

27. A. Lyakh and P. Zory, "*Gallium-Arsenide based Bipolar Cascade Lasers with Deep Quantum-Well Tunnel Junctions*", Photonics Technology Letters, Vol.18, #24, pp. 2656-2658, December 2006

28. D. P. Xu, A. Mirabedini, M. D'Souza, S. Li, D. Botez, A. Lyakh, Y.-J. Shen, P. Zory and C. Gmachl, "*Room-temperature, Mid-infrared (lambda=4.7μm) Electroluminescence from Single-Stage Intersubband GaAs-based Edge Emitters*", Applied Physics Letters, Vol.85, pp. 4573-4575, November 2004

29. Bogatov, A. Drakin, A. Lyakh, A. Stratonnikov, "*Dependence of the Radiation Pattern of a Leaky-Mode, Quantum-Well Heterolaser on the Pump Current"*, Quantum Electronics, Vol. 31, #10, pp. 847-852, 2001

Presentations and seminars

1. (invited) A. Lyakh, "Power scaling for high power Quantum Cascade Lasers", AFRL, Kirtland AFB, February 2016
2. (invited) A.Lyakh, "Quantum cascade lasers: from bandgap engineering to practical devices", Northrop Grumman, Redondo Beach, January 2016
3. (invited) A. Lyakh, "*Quantum Cascade Lasers: from Band-gap Engineering to Practical Devices*", Energy, Materials, Nanotechnology Meeting, Bangkok, November 2015
4. A. Lyakh, "*Band engineering and its applications to quantum cascade laser design", NanoScience Technology Center*", University of Central Florida, April 2015
5. (invited) A. Lyakh, R. Maulini, A. Tsekoun, R. Go, and C. Kumar N. Patel, "*Advances in High-Power Quantum Cascade Lasers and Applications*", 20 Years Quantum Cascade Laser Anniversary Workshop, Zurich, January 2014
6. A. Lyakh, R. Maulini, A. Tsekoun, R. Go, and C. Kumar N. Patel, "*Multiwatt long wavelength quantum cascade lasers based on high strain composition with 70% injection efficiency*", Photonics West, February 2013
7. A. Lyakh, R. Maulini, A. Tsekoun, R. Go, and C. Kumar N. Patel, "*4.0μm quantum cascade laser with single-facet optical emission exceeding 2 W*", Photonics West, January 2011
8. R. Maulini, A. Lyakh, A. G. Tsekoun, R. Go, M. Lane, T. Macdonald, C. Kumar N. Patel, "*High power, high efficiency quantum cascade laser systems for directional infrared countermeasures and other defense and security applications*", SPIE Europe Security and Defense, Berlin, August 2009
9. A. Lyakh, R. Maulini, R. Go, A. Tsekoun and C. Kumar N. Patel, "*New midwave infrared laser sources for defense and security needs"*, Conference on Optical Technologies for Arming, Safing, Fusing, and Firing, August 2009
10. Tsekoun, I. Dunayevskiy, R. Maulini, R. Barron-Jimenez, A. Lyakh, and C. Kumar N. Patel, "*Compact, rapid, and rugged detector of military and improvised explosives based on external grating cavity quantum cascade lasers*", Conference on Optical Technologies for Arming, Safing, Fusing, and Firing, August 2009
11. Tsekoun, A. Lyakh, R. Maulini, M. Lane, T. Macdonald, R. Go, and C. Kumar N. Patel, *"High power and efficiency quantum cascade laser systems for defense and security applications"*, SPIE Defense, Security and Sensing Conference, Orlando, April 2009
12. C. Pflugl, L. Diehl, Q. J. Wang, F. Capasso, A. Lyakh, R. Maulini, A. Tsekoun, R. Go, and C. Kumar N. Patel, *"High power continuous-wave quantum cascade lasers"*, Photonics West 2009, San Jose, January 2009
13. C. Pflugl, A. Lyakh, L. Diehl, Q. J. Wang, F. Capasso, R. Maulini, A. Tsekoun, R. Go, and C. Kumar N. Patel, *"High Power (1.6W) Continuous Wave Room Temperature Quantum Cascade Lasers"*, International Quantum Cascade Lasers School & Workshop, Monte Verita, Switzerland, September 2008
14. R. Maulini, A. Lyakh, A. Tsekoun, I. Dunayevskiy, R. Go, C. Pflügl, L. Diehl, Q. J. Wang, F. Capasso, X. J. Wang, J. Y. Fan, T. Tanbun-Ek, and C. K. N. Patel, *"High Power, High Wallplug Efficiency Room Temperature Continuous Wave Quantum Cascade Lasers"*, International Quantum Cascade Lasers School & Workshop, Monte Verita, Switzerland, September 2008
15. A. Lyakh, C. Pflügl, L. Diehl, Q. Wang, F. Capasso, X. Wang, J. Fan, T. Tanbun-Ek, R. Maulini, A. Tsekoun, R. Go, and C. K. N. Patel, *"1.3 W Quantum Cascade Lasers with Design Optimized for*

Continuous Wave Operation at Room Temperature", Conference on Lasers and Electro Optics, San Jose, May 2008

16. R. Maulini, A. Lyakh, A. Tsekoun, R. Go, and C. K. N. Patel, *"Intersubband absorption of quantum cascade laser structures in the high differential resistance voltage range and its applications to laser modulation"*, Photonics West, San Jose, January 2008

17. A. Lyakh, M. D' Souza, D. Botez, D. Bour, and P. Zory, "*Substrate-Emitting Distributed Feedback Quantum Cascade Laser*", Lasers and Electro Optics Society Conference, Lake Buena Vista, October 2007

18. A. Lyakh, D. Wasserman, G. Shu, C. Gmachl, M. D' Souza, D. Botez, D. Bour, and P. Zory *"Narrow Stripe-Width, Low-Ridge Configuration for High Power Quantum Cascade Lasers"*, Conference on Lasers and Electro Optics, Baltimore, May 2007

19. A. Lyakh and P. Zory, "*GaAs - based Bipolar Cascade Lasers with Deep Quantum Well Tunnel Junction"*, Lester Eastman Conference on High Performance Devices, Cornell University, August 2006

20. A. Lyakh and P. Zory, "*Design and Realization of MOCVD-grown GaAs based Intersubband Light Emitting Devices Emitting at 4.8μm*", Annual Joint Symposium of the Florida Chapters of the American Vacuum Society Science and Technology Society and the Florida Microscopy Society, March 2005

Service

1. Session Chair "2D Materials", Energy, Materials, Nanotechnology Meeting, Bangkok, November 2015.
2. Frequent reviewer for Applied Physics Letters, Photonics Technology Letters, and Photonics