

Kiryl D. Piatkevich, PhD
Molecular Bioengineering Group Leader

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Twitter: <https://twitter.com/PiatkevichL>

Summary:

Development of novel methods of neural interfacing using synthetic biology; development of scalable and multiplexed nanoscale imaging of large biological samples (expansion microscopy); synthetic biology, neuroimaging, and neuroengineering, high-throughput robotic cell screening systems; molecular and cellular determinants of Alzheimer's disease phenotypes.

EDUCATION:

Albert Einstein College of Medicine Bronx, New York
Lomonosov Moscow State University Moscow, Russia
Ph.D. in Biotechnology and Biochemistry October, 2007 – February, 2011

Lomonosov Moscow State University Moscow, Russia
M.S. in Chemistry (summa cum laude) August, 2002 - June, 2007

Belarusian State University Minsk, Belarus
Certificate of the Lyceum in Chemistry August, 2000 - June, 2002

WORK EXPERIENCE:

Westlake University Hangzhou, China
Assistant Professor October 2019 - *present*
Leader, Molecular BioEngineering group, School of Life Sciences

Massachusetts Institute of Technology Cambridge, Massachusetts
Research scientist (advisor Prof. Edward S. Boyden) June 2018 – September 2019
Project title/responsibilities: conceiving and supervising projects on development of new scalable tools for brain interfacing; development of multiplexed nanoscale imaging of large biological samples (expansion microscopy); cell type specific analysis to understand mechanisms underlying Alzheimer's disease phenotypes.

Massachusetts Institute of Technology Cambridge, Massachusetts
Postdoctoral associate (advisor Prof. Edward S. Boyden) July 2013 – May 2018
Project title: Development of novel methods of neural interfacing using synthetic biology; development of scalable and multiplexed nanoscale imaging of large biological samples (expansion microscopy).

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Albert Einstein College of Medicine

Postdoctoral associate (advisor Prof. Vladislav V. Verkhusa)

Project title: Development of advanced near-infrared fluorescent proteins for *in vivo* applications.

Bronx, New York

April 2011 – June 2013

Lomonosov Moscow State University

Albert Einstein College of Medicine

PhD student (advisor Prof. Vladislav V. Verkhusa)

Project title: Development of fluorescent proteins for multicolor intravital two-photon imaging.

Moscow, Russia

Bronx, New York

October 2007 – February 2011

Zhejiang University

Visiting Scientist (advisor Prof. Yin Shen)

Project title: Development of genetically encoded ratiometric chloride/pH sensors with enhanced sensitivity and temporal resolution for neuroimaging.

Hangzhou, China

November 2010 – February 2011

PUBLICATIONS:

Scholar Google link: <https://scholar.google.com/citations?user=V3YNjNEAAAAJ&hl=en>

Semantic Scholar link: <https://www.semanticscholar.org/author/Kiryl-D-Piatkevich/6440263>

Research articles:

- Qian Y., Cosio D. M. O., **Piatkevich K. D.**, Aufmkolk S., Su W.-C., Celiker O. T., Schohl A., Murdock M. H., Aggarwal A., Chang Y.-F., Wiseman P. W., Ruthazer E. S., Boyden E. S., Campbell R. E. Improved Genetically Encoded Near-Infrared Fluorescent Calcium Ion Indicators for in Vivo Imaging. *PLOS Biol.* 2020, 18 (11), e3000965.
- Linghu C., Johnson S.L., Valdes P.A., Shemesh O.A., Park W.M., Park D., **Piatkevich K.D.**, Wassie A.T., Liu Y., An B., Barnes S.A., Celiker O.T, Yao C.-C., Yu C.C., Wang R., Adamala K.P., Bear M.F., Keating A.E., Boyden E.S. Spatial Multiplexing of Fluorescent Reporters for Imaging Signaling Network Dynamics, *Cell* 2020, 183(6), 1682-1698.e24.
- O.A. Shemesh*, C. Linghu*, **K.D. Piatkevich***, D. Goodwin, O.T. Celiker, H.J. Gritton, M.F. Romano, R. Gao, C.-C. Yu, H.A. Tseng, S. Bensussen, S. Narayan, C.-T. Yang, L. Freifeld, C.A. Siciliano, I. Gupta, J. Wang, N. Pak, Y.-G. Yoon, J.F.P. Ullmann, B. Guner-Ataman, H. Noamany, Z.R. Sheinkopf, W.M. Park, S. Asano, A.E. Keating, J.S. Trimmer, J. Reimer, A. Tolias, M.F. Bear, K.M. Tye, X. Han, M.B. Ahrens, E.S. Boyden. Precision calcium imaging of dense neural populations via a cell body-targeted calcium indicator. *Neurons*, 2020 107 (3), 470-486. e11 (*equal contribution).
- L.Z. Fan, S. Kheifets, U.L. Böhm, H. Wu, **K.D. Piatkevich**, M.E. Xie, V. Parot, Y. Ha, K.E. Evans, E.S. Boyden, A.E. Takesian, A.E. Cohen. All-optical electrophysiology reveals the role of lateral inhibition in sensory processing in cortical layer 1. *Cell* 2020, 180 (3), 521-535.
- O.M. Subach, V.P. Sotskov, V.V. Plusnin, A.M. Gruzdeva, N.V. Barykina, O.I. Ivashkina, K.V. Anokhin, A.Y. Nikolaeva, D.A. Korzhenevskiy, A.V. Vlaskina, V.A. Lazarenko, K.M. Boyko, T.V. Rakitina, A.M. Varizhuk, G.E. Pozmogova, O.V. Podgorny, **K.D. Piatkevich**, E.S. Boyden, F.V. Subach. Novel Genetically Encoded Bright Positive Calcium Indicator

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NCaMP7 Based on the mNeonGreen Fluorescent Protein. *International Journal of Molecular Sciences*, 2020 21 (5), 1644.

- **K.D. Piatkevich***, S. Bensussen*, H. Tseng*, S.N. Shroff, V.G. Lopez-Huerta, D. Park, E.E. Jung, O.A. Shemesh, C. Straub, H.J. Gritton, M.F. Romano, E. Costa, B.L. Sabatini, Z.Fu, E.S. Boyden, X. Han. Population imaging of neural activity in awake behaving mice. *Nature*, 2019 574 (7778), 413-417 (*equal contribution).
- Y. Qian*, **K.D. Piatkevich***, B. McLarney*, A.S. Abdelfattah, S. Mehta, S. Gottschalk, R.S. Molina, W. Zhang M. Drobizhev, T.E. Hughes, J. Zhang, E.R. Schreiter, S. Shoham, D. Razansky, E.S. Boyden, and R.E. Campbell. A Genetically-Encoded Near-Infrared Fluorescent Calcium Ion Indicator. *Nature Methods*, 2019 16 (2), 171-174 (*equal contribution).
- O.M. Subach, N.V. Barykina, K.V. Anokhin, **K.D. Piatkevich**, F.V. Subach. Near-infrared genetically encoded positive calcium indicator based on GAF-FP bacterial phytochrome. *International Journal of Molecular Sciences*, 2019 20 (14), 3488
- O.M. Subach, T.A. Kunitsyna, O.A. Mineyeva, A.A. Lazutkin, D.V. Bezryadnov, N.V. Barykina, **K.D. Piatkevich**, Y.G. Ermakova, D.S. Bilan, V.V. Belousov, K.V. Anokhin, G.N. Enikolopov, F. V. Subach. Slowly reducible genetically encoded green fluorescent indicator for in vivo and ex vivo visualization of hydrogen peroxide. *International Journal of Molecular Sciences*, 2019, 20 (13), 3138.
- N.V. Barykina, D.A. Doronin, O.M. Subach, V.P.Sotskov, V.V. Plusnin, O.A. Ivleva, A.M. Gruzdeva, T.A. Kunitsyna, O.I. Ivashkina, A.A. Lazutkin, A.Y. Malyshev, I.V. Smirnov, A.M. Varizhuk, G.E. Pozmogova, **K.D. Piatkevich**, K.V. Anokhin, G.N. Enikolopov, F.V. Subach. NTnC-like genetically encoded calcium indicator with a positive and enhanced response and fast kinetics. *Scientific Reports*, 2018 8 (1), 15233.
- **Piatkevich K.D.***, Jung E.E.*, Straub C., Linghu C., Park D., Suk H.J., Hochbaum D.R., Goodwin D., Pnevmatikakis E., Pak N., Kawashima T., Yang C.-T., Rhoades J.L., Shemesh O., Asano S., Yoon Y.-G., Freifeld L., Saulnier J., Riegler C., Engert F., Hughes T., Drobizhev M., Szabo B., Ahrens M.B., Flavell S.W., Sabatini B.L., E.S. Boyden. Robotic multidimensional directed evolution of proteins: development and application to fluorescent voltage reporters. *Nature Chemical Biology*, 2018. 14 (4), 352. (*equal contribution).
- Doronin D., Barykina N., Subach O., Isaakova E., Varizhuk A., Pozmogova G., **Piatkevich K.**, Anokhin K., Enikolopov G., Subach F. Genetically encoded calcium indicator with NTnC-like design and enhanced fluorescence contrast. *BMC Biotechnology*, 2018. 18 (1), 10.
- Shemesh O.A., Tanese D., Zampini V., Linghu C., **Piatkevich K.**, Ronzitti E., Papagiakoumou E., Boyden E.S., Emiliani V. Temporally precise single-cell resolution optogenetics. *Nature Neuroscience*. 2017. 20(12), 1796-1806.
- **Piatkevich K.D.**, Suk H.J., Suhasa B.K., Yoshida F., DeGennaro E.M., Drobizhev M., Hughes T.E., Desimone R., Boyden E.S., Verkhusha V.V. Near-infrared fluorescence proteins engineered from bacterial phytochromes in neuroimaging. *Biophys. J.* 2017. 113(10), 2299-2309.
- Barykina N.V., Subach O.M., **Piatkevich K.D.**, Jung E.E., Malyshev A.Y., Smirnov I.V., Bogorodskiy A.O., Borshchevskiy V.I., Varizhuk A.M., Pozmogova G.E., Boyden E.S.,

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- Anokhin K.V., Enikolopov G.N., Subach F.V. Green fluorescent genetically encoded calcium indicator based on calmodulin/M13-peptide from fungi. *PLoS One*. 2017; 12(8):e0183757.
- Rowlands C.J., Park D., Bruns O.T., **Piatkevich K.D.**, Fukumura D., Jain R.K., Bawendi M.G., Boyden E.S., So P.T.C. Wide-field three-photon excitation in biological samples. *Light: Science & Applications*. 2017, 6, e16255;
 - Barykina N.V., Subach O.M., Doronin D.A., Sotskov V.P., Roshchina M.A., Kunitsyna T.A., Malyshev A.Y., Smirnov I.V., Azieva A.M., Sokolov I.S., **Piatkevich K.D.**, Burtsev M.S., Varizhuk A.M., Pozmogova G.E., Anokhin K.V., Subach F.V., Enikolopov G.N. A new design for a green calcium indicator with a smaller size and a reduced number of calcium-binding sites. *Scientific Reports*. 2016, 6:34447.
 - Konold P.E., Yoon E., Lee J., Allen S.L., Chapagain P.P., Gerstman B.S., Regmi C.K., **Piatkevich K.D.**, Verkhusha V.V., Joo T., Jimenez R. Fluorescence from multiple chromophore hydrogen-bonding states in the far-red protein TagRFP675. *J. Phys. Chem. Lett.*, 2016. 7, 3046-3051
 - Tillberg P.W., Chen F., **Piatkevich K.D.**, Zhao Y., Yu C.C., English B.P., Gao L., Martorell A., Suk H.J., Yoshida F., DeGennaro E.M., Roossien D.H., Gong G., Seneviratne U., Tannenbaum S.R., Desimone R., Cai D., Boyden E.S. Protein-retention expansion microscopy of cells and tissues labeled using standard fluorescent proteins and antibodies. *Nat Biotech*. 2016. 34 (9), 987-992.
 - Randino C., Gelabert R., Moreno M., Lluch J.M., **Piatkevich K.D.** Molecular modelling of the pH influence in the geometry and the absorbance spectrum of near-infrared TagRFP675 fluorescent protein. *Phys Chem Chem Phys*. 2015. 17:29363.
 - **Piatkevich K.D.**, English B.P., Malashkevich V.N., Xiao H., Almo S.C., Singer R.H., Verkhusha V.V. Photoswitchable red fluorescent protein with a large Stokes shift. *Chem Biol*. 2014. 21:1402.
 - **Piatkevich K.D.**, Subach F.V., Verkhusha V.V. Far-red light photoactivatable near-infrared fluorescent proteins engineered from a bacterial phytochrome. *Nat Commun*. 2013. 4: 2153.
 - **Piatkevich K.D.**, Malashkevich V.N., Morozova K.S., Nemkovich N.A., Almo S.C. and Verkhusha V.V. An extended Stokes shift in fluorescent proteins: chromophore-protein interactions in the near-infrared TagRFP675 variant. *Sci Rep*. 2013. 3: 1847.
 - **Piatkevich K.D.**, Hult J., Subach O.M., Wu B., Abdulla A., Segall J.E., Verkhusha V.V. Monomeric red fluorescent proteins with a large Stokes shift. *Proc Natl Acad Sci USA* 2010. 107: 5369-5374.
 - **Piatkevich K.D.**, Malashkevich V.N., Almo S.C., Verkhusha V.V. Engineering ESPT pathways based on structural analysis of LSSmKate red fluorescent proteins with large Stokes shift. *J Am Chem Soc*. 2010. 132: 10762-10770.
 - Filonov G.S., **Piatkevich K.D.**, Ting L.M., Zhang J., Kim K., Verkhusha V.V. Bright and stable near-infrared fluorescent protein for in vivo imaging. *Nat Biotechnol*. 2011 29: 757-61.

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- Morozova K.S., **Piatkevich, K.D.**, Gould T.J., Zhang J., Bewersdorf J. and Verkhusha V.V. Far-red fluorescent protein excitable with red lasers for flow cytometry and superresolution STED nanoscopy. *Biophys. J.* 2010. 99: 13-15.
- Subach F.V., Subach O.M., Gundorov I.S., Morozova K.S., **Piatkevich K.D.**, Cuervo A.M., Verkhusha V.V. Monomeric fluorescent timers that change color from blue to red report on cellular trafficking. *Nat Chem Biol.* 2009. 5, 118-126.
- Subach O.M., Malashkevich V.N., Zencheck W.D., Morozova K.S., **Piatkevich K.D.**, Almo S.C., and Verkhusha V.V. Structural characterization of acylimine-containing blue and red chromophores in mTagBFP and TagRFP fluorescent proteins. *Chem. Biol. (Cell press)* 2010. 17: 333-341.

Manuscripts in preparation:

- **Piatkevich K.D.**, Jung E.E., Boyden E.S. Rapid directed molecular evolution of fluorescent proteins in mammalian cells.
- **Piatkevich K.D.**, Apkhazava D., Shen Y. Simultaneous imaging of intracellular chloride concentration and pH with high temporal resolution in neurons in vivo.
- **Piatkevich K.D.**, Estandian D., Boyden E.S. Comprehensive guide to optogenetics. *Invited review.*

Review Articles and Chapters in Books:

- **Piatkevich K.D.***, Murdock M.H., Subach F.V.* Advances in engineering and application of optogenetic indicators for neuroscience. *Appl. Sci.* 2019, 9(3), 562. (*co-corresponding).
- **Piatkevich K.D.**, Subach F.V., Verkhusha V.V. Engineering of bacterial phytochromes for near-infrared imaging, sensing, and light-control in mammals. *Chemical Society Reviews.* 2013. 42(8):3441-52.
- Wu B.*, **Piatkevich K.D.***, Lionnet T., Singer R.H., Verkhusha V.V. Modern fluorescent proteins and imaging technologies to study gene expression, nuclear localization, and dynamics. *Curr. Opin. Cell Biol.* 2011. 23:310-317. (*equal contribution).
- Subach F.V.*, **Piatkevich K.D.***, Verkhusha V.V. Directed molecular evolution to design advanced red fluorescent proteins. *Nat Methods* 2011, 8:1019-26. (*equal contribution).
- **Piatkevich K.D.**, Verkhusha V.V. Guide to red fluorescent proteins and biosensors for flow cytometry. *Methods in Cell Biology.* 2011. 102:431-461.
- **Piatkevich, K.D.**, Verkhusha, V.V. Advances in engineering of fluorescent proteins and photoactivatable protein with red emission. *Curr. Opin. Chem. Biol.* 2010. 14: 23-29.
- **Piatkevich, K.D.**, Efremenko, E.N., Verkhusha, V.V., and Varfolomeev, S.D. Red fluorescent proteins and their properties. *Russ. Chem. Reviews.* 2010. 79: 243-258.

PATENTS:

- Xu G., Boyden E., **Piatkevich K.D.**, Adamala K. Spatial multiplexing for multisignal cellular imaging. 2016, US, 15/099,232.

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- **Piatkevich K.D.**, Jung. E.E., Boyden E. Genetically red fluorescent voltage sensors enabling millivolt-resolution and high-speed neural voltage imaging. 2018. US, 16/026,551.
- Apkhazava D., **Paitkevich K.D.** Simultaneous measurement of halide ion concentration and pH. *Pending*.
- **Piatkevich K.D.**, Jung E.E., Boyden E.S. Directed molecular evolution of fluorescent proteins via robotic cell picking. *In preparation*.

INVITED TALKS AND SEMINARS:

24. **Piatkevich K.D.**, Engineering Scalable Tools of Mapping Brain Computations, *PKU-JNC Joint Neurotechnology & Discovery Series*, September 2020.
23. **Piatkevich K.D.**, Reverse Engineering the Brain, *Tencent Collaboration meeting*, Westlake University, China, July 2020.
22. **Piatkevich K.D.**, Solving the Brain – Engineering the Future, *FLADY Sorority meeting*, Westlake University, China, July 2020.
21. **Piatkevich K.D.**, Development of advanced fluorescent probes for structural and functional imaging of biological systems, *Interdisciplinary PI Lunch Seminar*, Westlake University, China, March 2020.
20. **Piatkevich K.D.**, Engineering tools for mapping brain computations, *Invited Lecture*, Imperial College London, UK, December 2019.
19. **Piatkevich K.D.**, Engineering scalable tools for mapping brain computations, *Invited Lecture*, Zhejiang University, China, November 2019.
18. **Piatkevich K.D.**, Engineering scalable tools for mapping brain computations, *Invited Lecture*, HUST – Suzhou Institute for Brainmatics, China, November 2019.
17. **Piatkevich K.D.**, Solving the Brain – Engineering the Future, *Keynote Speaker*, Westlake University Forum, China, October 2019.
16. **Piatkevich K.D.**, Genetically encoded indicators of neuronal activity, *Invited Lecture*, University of Minnesota, USA, September 2019.
15. **Piatkevich K.D.**, Engineering scalable tools for mapping brain computations, *Multiphoton Workshop*, Montana State University, USA, August 2019.
14. **Piatkevich K.D.**, Engineering scalable tools for mapping brain computations, *Invited Special Seminar*, Westlake University, China, March 2019.
13. **Piatkevich K.D.**, Engineering scalable tools for mapping brain computations, *Invited Special Seminar*, Center for Brain Sciences, RIKEN, Japan, February 2019.
12. **Piatkevich K.D.**, Mapping neuronal computation in zebrafish brain, *Imaging Structure and Function of the Zebrafish Brain*, Brighton, UK, December 2018.
11. **Piatkevich K.D.**, Population voltage imaging in vivo. *45+1th Merocyanine 540*, Woods Hole, USA, August 2018.
10. **Piatkevich K.D.**, Voltage imaging and associated signal processing. *Invited talk*, Toshiba Collaboration meeting, Boston, USA, October 2018.

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9. **Piatkevich K.D.**, Genetically encoded near-infrared fluorescent probes for in vivo imaging. *256th ACS National Meeting*, Boston, USA, August 2018.
8. **Piatkevich K.D.**, Engineering scalable tools for solving the brain. *Invited Special Seminar*, University of California Riverside, USA, February 2018.
7. **Piatkevich K.D.**, Population voltage imaging with single-cell millivolt resolution. *Brain and Cognitive Sciences Retreat*, Newport, USA, June 2017.
6. **Piatkevich K.D.**, Voltage imaging with subcellular and subthreshold resolution using novel genetically encoded voltage reporters, *MIT Plastic lunch*, USA, October 2016.
5. **Piatkevich K.D.**, Engineering tools for mapping brain computations. *Junior Scientists workshop on "Protein Engineering: Making and Using Tools for Neuroscience and Other Biological Problems"*, Janelia Research Campus, USA, March 2016.
4. **Piatkevich K.D.**, Development and application of advanced fluorescent proteins. *Invited Seminar*, Harvard Medical School, USA, February 2013.
3. **Piatkevich K.D.**, Development and application of novel monomeric fluorescent proteins. *Invited Seminar*, Massachusetts Institute of Technology, USA, April 2012.
2. **Piatkevich K.D.**, Photoactivatable near-infrared fluorescent protein designed from a bacterial phytochrome for in vivo imaging. *Work in Progress Seminar*, Albert Einstein College of Medicine, USA, February 2012.
1. **Piatkevich K.D.**, Recent advances in engineering and application of GFP-like red fluorescence proteins. *Invited Seminar*, Lomonosov Moscow State University, Russia, March 2011.

TEACHING:

Teaching "Neurobiology" course for graduate students at Westlake University.

Trained and supervised multiple undergraduate and graduate students from MIT (2013-2019).

Developed and taught course "Chemistry of black and white photography" at SigmaCamp for middle and high school students (2012-2014).

Teaching Assistant for Protein and Gene Engineering class at MSU; taught 15-student section (2010).

PROFESSION SERVICE:

- Topic Editor at International Journal of Molecular Sciences (https://www.mdpi.com/journal/ijms/special_issues/Advanced_fluorescent_probes)
- The Editorial Board of Dataset Papers in Biology, Biophysics section (<http://mts.datasets.com/>);
- Currently reviewing the manuscripts for The Journal of Physical Chemistry, Journal of Neurochemistry, and Applied Microbiology and Biotechnology

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AWARDS:

- Young Investigator of Brain and Behavior Research Foundation, 2020
- I.V. Berezin scholarship for graduate students, 2010
- Best presentation award at International Lomonosov Conference, Chemistry section, Biochemistry subsection, Moscow, 2007
- Special fund for talented pupil and students social support of President of Republic of Belarus laureate, Belarus, 2003
- Special fund for talented pupil and students social support of President of Republic of Belarus laureate, Belarus, 2002
- Bronze Medal, 33rd International Chemistry Olympiad, India, Mumbai, 2001
- Silver Medal, 34th International Chemistry Olympiad, Netherlands, Groningen, 2002
- Silver Medal, 36th Mendeleev International Chemistry Olympiad, Russia, Moscow 2001
- Silver Medal, 37th Mendeleev International Chemistry Olympiad, Kazakhstan, Alma-Ata 2002
- Third prize, National Chemistry Olympiad, Belarus, Vitebsk, 1999
- First prize, National Chemistry Olympiad, Belarus, Mogilev, 2000
- First prize, National Chemistry Olympiad, Belarus, Vitebsk, 2001
- First prize, National Chemistry Olympiad, Belarus, Grodno, 2002
- Diploma of Honor, International Soros Chemistry Olympiad, 1998
- Third prize, International Soros Chemistry Olympiad, Belarus, Minsk, 1999
- Second prize, International Soros Chemistry Olympiad, Belarus, Minsk, 2000