

# Jonathan Rodolfo Silva, PhD FAHA

Professor

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## Positions

Department of Biomedical Engineering  
Washington University in St. Louis

Professor	2023 - present
Dennis & Barbara Kessler Career Development Associate Professor	2021 - 2023
Associate Professor	2018 - 2023
Assistant Professor	2012 - 2018

Department Director of Diversity 2020 – present

Department of Computer Science and Engineering, Adjunct 2020 - present

SentiAR, Inc.

Founder, Director and Chief Technology Officer 2017 – present

Excera, Inc.

Founder, Director and Chief Technology Officer 2021 – present

## Education

**Washington University in St. Louis**, St. Louis, MO

PhD in Biomedical Engineering. 2008

**Case Western Reserve University**, Cleveland, OH

MS in Biomedical Engineering. 2004

**The Johns Hopkins University**, Baltimore, MD

BS in Biomedical Engineering. 2000

## Pre- and Postdoctoral Research

**Washington University in St. Louis**, St. Louis, MO

Postdoctoral training. Department of Cell Biology. Colin Nichols, PhD. 2011 to 2012

Measured and modeled physiological effects of K<sub>ATP</sub> heterogeneity in the heart and the pancreas.

**University of Chicago**, Chicago, IL

Postdoctoral training. Department of Pediatrics. Steven AN Goldstein MD PhD. 2008 to 2011

Probed Na<sup>+</sup> channel slow inactivation using simultaneous cut-open oocyte recording and fluorescence.

**Washington University in St. Louis**, St. Louis, MO

Doctoral program, Department of Biomedical Engineering. Yoram Rudy, PhD 2004 to 2008

Dissertation: Linking Ion-Channel Molecular Dynamics to the Action Potential: Cardiac I<sub>Ks</sub> Simulations.

**Case Western Reserve University**, Cleveland, OH

MS program, Department of Biomedical Engineering. Yoram Rudy, PhD 2000 to 2004

Thesis: Subunit interaction determines I<sub>Ks</sub> Participation in Cardiac Repolarization and Repolarization Reserve.

## Honors and Awards

- 2022. American Heart Association Established Investigator Award
- 2018. Fellow American Heart Association
- 2011. Burroughs Wellcome Fund Career Award at the Scientific Interface
- 2007. AAAS/Science Sponsored Membership
- 2005. Cardiac Arrhythmias Gordon Conference: Best Poster
- 2003. Housing and Residence Life Distinguished Service Award, Case Western Reserve University
- 2002. Graduate Dean's Award for Instructional Excellence, Case Western Reserve University
- 1999. Biomedical Engineering Honor Society (Alpha Eta Mu Beta), The Johns Hopkins University
- 1996. National Merit Scholar

### Honors to students:

- 2019. Kathryn Mangold, Best Graduate Poster, Cardiovascular Research Day
- 2019. Kuo Chan Weng, Best Postdoctoral Poster, Cardiovascular Research Day
- 2018. Emily Wagner, Best Poster, CIMED Research Day
- 2018. Wandu Zhu, Washington University Biomedical Engineering Research Award
- 2018. Wandu Zhu, Philip Needleman Pharmacology Prize
- 2018. Wandu Zhu, Biophysical Society Student Research Achievement Award
- 2017. Wandu Zhu, Best Presentation, Gordon Research Seminar
- 2016. Caroline Dong, LMI Aerospace Award for Excellence in Research
- 2015. Wandu Zhu, Best Poster, Cardiovascular Research Day
- 2015. Wandu Zhu, Best Translational Poster, Bo Koster Memorial Symposium
- 2015. Bianca Yu, LMI Aerospace Award for Excellence in Research
- 2014. Eric Hsu, Barry M. Goldwater Scholar
- 2014. Ruben Garcia, Best Pre-College Poster AGMUS Research Symposium

## Fellowships

- 2011. Burroughs Wellcome Fund, Career Award at the Scientific Interface
- 2011. NIH Cardiovascular Biology Training Grant  
Washington University School of Medicine
- 2008. NIH Cardiovascular Pathophysiology and Biochemistry Training Grant  
University of Chicago
- 2001. NIH NRSA Pre-doctoral Fellowship
- 2000. Case Prime Fellowship  
Case Western Reserve University
- 1999. Provost's Award for Undergraduate Research  
The Johns Hopkins University
- 1998. Research Experience for Undergraduates (REU) Fellowship  
University of California, San Diego/San Diego Supercomputing Center
- 1997. Ford Foundation Award for Minority Research  
The Johns Hopkins University

## Research Funding

### *Current as PI or MPI*

American Heart Association Established Investigator Award \$400,000 7/1/22-6/30/27  
Precision Antiarrhythmic Medicine: Using Biophysical Insight to Improve Therapy  
Developing molecules that target the cardiac Na<sup>+</sup> channel voltage sensing domains to improve efficacy of class I antiarrhythmics and assess the role of amiodarone metabolites in determining efficacy.

NIH-NHLBI, R01HL150637 \$2,292,835 7/1/20-6/30/24  
Post-Transcriptional Regulation of Myocardial Sodium Channels  
Collaborative project to understand how molecular level regulation of Nav channels by intracellular fibroblast growth factors determines myocyte electrophysiology.

NIH-NHLBI, R01HL148803 \$3,169,663 4/1/20-3/31/25  
Personalizing Class I anti-Arrhythmic Drug Therapy  
Goal is to leverage biophysical insight to predict whether patients with ventricular tachycardia or fibrillation will respond to class I anti-arrhythmic molecules.

NIH-NHLBI, R01HL142301 \$2,149,137 4/1/19-3/31/23 (NCE)  
Mechanism of BK Channel Gating  
Goal is to delineate mechanisms of the dual regulation of BK channels by membrane potential and intracellular Ca<sup>2+</sup>.

NIH-NHLBI, 1R01HL136553 \$1,906,250 4/1/17-3/31/23 (NCE)  
Modulation of Cardiac NaV Channel Function and Electrophysiology by Interacting Molecules  
Combines advanced molecular imaging modalities with multi-scale modeling to understand how molecules that interact with cardiac NaV channels affect arrhythmia susceptibility.

### *Current as Co-I or Preceptor*

NIH-NIDDK, T32 DK108742 06/2016-05/2021  
Imaging, Modeling and Engineering of Diabetic Tissues  
Designed to prepare trainees with engineering backgrounds for research focused on fundamental mechanisms and translational possibilities for diabetes and metabolic diseases.  
Role: Preceptor

NIH-NHLBI, T32 HL134635 7/1/17-6/30/22  
Training in Integrative and Systems Biology of Cardiovascular Disease  
Provide research opportunities; fundamental education and basic training in cardiovascular physiology.  
Role: Preceptor

### *Previous as PI or MPI*

NIH-NHLBI, 1R44HL140896 \$2,221,372 2/1/18-7/31/21  
Using Augmented Reality to Make Cardiac Ablation Procedures Simpler and Safer  
SBIR FastTrack grant is to SentiAR, Inc., a WashU spinout, whose goal is to commercialize an augmented reality platform that was developed in the Silva lab for use in the cardiac catheterization laboratory.

Institute of Clinical and Translational Sciences, 733 \$3,990 10/7/20-10/6/21  
Post-translational Mechanisms in the Coordinated Regulation of Cardiac Rhythms  
Create mouse models of FGF regulation of Nav channels

Children's Discovery Institute, CH- II-2017-575	\$450,000	2/1/17-1/31/21
Improving Outcomes In The Pediatric Cardiac Catheterization Lab Using Augmented Reality Using mixed reality to guide cardiac ablation (year 1) and catheterization (year 2&3) procedures.		
NIH-NHLBI, R01NS092570	\$333,594	3/1/20 - 2/28/21
KCNQ Channels: Gating and Subunits Modulation Goal is to understand how intracellular and transmembrane subunits regulate KCNQ channel gating.		
NIH, UG3 TR002170-01		7/1/17-4/30/20
A 3D In-Vitro Disease Model of Atrial Conduction Aim is to create a compact system to test new therapies for atrial fibrillation using adenoviral delivery. Role: Co-I		
Skandalaris Center LEAP Inventor Challenge	\$50,000	1/1/19-12/31/19
Using Merged Reality to Improve Cochlear Implant Outcomes Leveraging our experience in creating augmented reality solutions for cardiac ablation to improve cochlear implant outcomes.		
CIMED Center Pilot Grant	\$25,000	1/1/18-12/31/18
Effects of Mechanical Forces on Cardiac Excitability in Heart Disease Pilot grant in collaboration with Michael Greenberg and Jonathan Moreno developing technology to simultaneously assess excitability and contraction in iPSC-derived cardiomyocytes.		
American Heart Association, 16GRNT31200025	\$154,000	7/1/16-6/30/18
Molecular Pathology of Brugada Syndrome Mutations Goal is to use molecular imaging methods to discover the molecular basis for arrhythmia.		
School of Engineering Collaboration Initiation Grant	\$25,000	4/25/17-3/24/18
Applying Mixed Reality to Otolaryngology Procedures Using an augmented reality display to assist surgeons who are performing otolaryngology procedures.		
Bear Cub Grant	\$55,000	6/1/16-5/31/17
Improving Transcatheter Ablation Outcomes with Virtual Reality Goal is to used mixed reality to enhance visualization during catheter ablation procedures.		
Burroughs Wellcome Fund, 1010299	\$500,000	7/1/11-6/30/17
Applying molecular spectroscopy to derive multi-scale cardiac bioelectricity models Goal is to obtain experimental data regarding the molecular motions of the cardiac Na <sup>+</sup> channel.		
Institute for Clinical and Translational Sciences, JIT410	\$5,000	7/11/16-7/10/17
The Nav Channel Beta Subunit Role in Chamber-Specific Heart Pharmacology Editing iPSC-derived myocytes to test beta subunits alter Class 1b drug pharmacology.		
CIMED Center Pilot Grant	\$25,000	1/1/14-12/31/14
Fluorescent Unnatural Amino Acid Tracking of Membrane Protein Conformation Develop protocols to use fluorescent un-natural amino acids for voltage-clamp.		
CIMED Center Pilot Grant	\$25,000	1/1/14-12/31/14
ATP binding to the cytosolic domain of KCNQ1 channel proteins Goal is to assess mechanisms of ATP binding to KCNQ1 ion channels.		

### Grants to Trainees

NIH F31 to Lucy Woodbury Investigating the interactions of auxillary subunits with the Nav1.5 channel	\$270,516	9/1/23-8/30/26
NIH F30 to Druv Bhagavan Connecting Subcellular Electrophysiology to Patient Arrhythmia: A Case Study of Amiodarone	\$268,838	4/1/22-3/31/25
American Heart Association Fellowship to Druv Bhagavan Connecting Molecular Electrophysiology to Patient Arrhythmia: A Case Study of Amiodarone	\$64,072	7/1/15-6/30/17
NIH K08 to Jonathan D. Moreno MD PhD 3-Dimensional virtual ventricles to design precision therapies in hypertrophic cardiomyopathy	\$745,988	7/1/21-6/30/26
American Heart Association Fellowship to Wandu Zhu Discovering molecular mechanisms of how $\beta$ -subunits regulate cardiac Na <sup>+</sup> Channels	\$52,000	7/1/15-6/30/17
CBSE Center Scholarship to Wandu Zhu	\$10,000	7/1/15-6/30/16
American Heart Association Fellowship to Bicong Li	\$4,000	7/1/16-9/1/16
HHMI Summer Research Fellowship (x5) Student(s): Chen Zhao, Eric Hsu, Linxuan Yang, Namit Sambare, Sushruth Manchineella	\$15,000	Summer 2013-22
American Heart Association Scholarship to Alex Goldberg	\$2000	Summer 2016

## Publications

### Peer Reviewed Publications

1. Lesage A, Lorenzini M, Burel S, Sarlandie M, Bibault F, Lindskog C, Maloney D, **Silva JR**, Townsend RR, Nerbonne JM, Marionneau C. Determinants of iFGF13-mediated regulation of myocardial voltage-gated sodium (Nav) channels in mouse. *Journal of General Physiology*. 2023 Sep 4;155(9). [PMID: 37516919]
2. Bloom D, Catherall D, Miller N, Southworth MK, Glatz AC, **Silva JR\***, Silva JN\*. Use of a Mixed Reality System for Navigational Mapping During Cardiac Electrophysiology Testing Does Not Prolong Case Duration: A Sub-analysis from the Cardiac Augmented Reality Study. *Cardiovascular Digital Health Journal*. 2023 Jun 14. [PMID: 37600447] \*co-corresponding author
3. Angsutararux P, Dutta AK, Marras M, Abella C, Mellor RL, Shi J, Nerbonne JM\*, **Silva JR\***. Differential regulation of cardiac sodium channels by intracellular fibroblast growth factors. *Journal of General Physiology*. 2023 Mar 21;155(5):e202213300. [PMID: 36944081] \*co-corresponding author
4. Hanson A, McClenaghan C, Weng KC, Colijn S, Stratman AN, Halabi CM, Grange DK, **Silva JR**, Nichols CG. Electrophysiology of human iPSC-derived vascular smooth muscle cells and cell autonomous consequences of Cantu Syndrome mutations. *bioRxiv*. 2023:2023-06. [PMID: 37425756]
5. Moreno JD, **Silva JR**, Emerging methods to model cardiac ion channel and myocyte electrophysiology. *Biophys Rev (Melville)*. 2023 Mar;4(1):011315 [PMID: 37034130]
6. Hernandez B, Roberts B, Jamro-Comer E, Kodidhi A, Roelle L, Miller N, Littell L, Ybarra A, **Silva JR**, Silva JNA, Orr W. Validity Study Comparing Polar Ignite's® Estimated VO2max to Traditional

- Cardiopulmonary Exercise Testing in Normal Cardiac Anatomy & Fontan Pediatric Patients. *American Journal of Pediatrics*. 2023;9(2):79-84. [PMID: Pending]
7. Kang PW, Woodbury L, Angsutararux P, Sambare N, Shi J, Marras M, Abella C, Bedi A, Zinn D, Cui J, **Silva JR**. Arrhythmia-associated Calmodulin Variants Interact with KCNQ1 to Confer Aberrant Membrane Trafficking and Function. *bioRxiv*. 2023:2023-01.
  8. Zhang G, Xu X, Jia Z, Geng Y, Liang H, Shi J, Marras M, Abella C, Magleby KL, **Silva JR\***, Chen J\*, Zou X\*, Cui J\*. An allosteric modulator activates BK channels by perturbing coupling between Ca<sup>2+</sup> binding and pore opening. *Nature Communications*. 2022 Nov 9;13(1):6784. [PMID: 36351900] \*co-corresponding author
  9. Bloom D, Colombo JN, Miller N, Southworth MK, Andrews C, Henry A, Orr WB, **Silva JR\***, Silva JN\*. Early preclinical experience of a mixed reality ultrasound system with active GUIDance for NEedle-based interventions: The GUIDE study. *Cardiovascular Digital Health Journal*. 2022 Oct 1;3(5):232-40. [PMID: 36310686] \*co-corresponding author
  10. Oguntuyo K, Schuftan D, Guo J, Simmons D, Bhagavan D, Moreno JD, Kang PW, Miller E, **Silva JR**, Huebsch N. Robust, Automated Analysis of Electrophysiology in iPSC-Derived Micro-Heart Muscle for Drug Toxicity. *Tissue Engineering Part C*. 2022 Jun 7 (online). [PMID: 35925789]
  11. Mangold KE, Zhou Z, Schoening M, Moreno JD, **Silva JR**. Creating Ion Channel Kinetic Models Using Cloud Computing. *Current Protocols*. 2022 Feb;2(2):e374. [PMID: 35175690]
  12. Ransdell JL, Bhagavan D, **Silva JR**, Nerbonne JM. Intrinsic mechanisms in the gating of resurgent Na<sup>+</sup> currents. *eLife*. 2022 Jan 25;11:e70173. [PMID: 35076394]
  13. Moreno JD, Bhagavan D, Li A, Gerstner NC, Miller EW, Huebsch N, Cresci S, **Silva JR**. Pulsus Alternans in Cardiogenic Shock Recapitulated in Single Cell Fluorescence Imaging of a Patient's Cardiomyocyte. *Circulation: Heart Failure*. 2021 Dec 10. [PMID: 34886677]
  14. Angsutararux P, Zhu W, Voelker T, **Silva JR**. Molecular pathology of sodium channel beta-subunit variants. *Frontiers in Pharmacology*. 2021 Nov 19:3220. [PMID: 34867379]
  15. Jung C, Wolff G, Wernly B, Bruno R, Franz M, Schulze PC, Silva JNA, **Silva JR**, Bhqatt D, Kelm M, "Virtual and augmented reality in cardiovascular care: State of the art and future perspectives", *JACC: Cardiovascular Imaging*, 2021 Mar;15(3):519-532. [PMID: 34656478]
  16. Mangold KE, Wang W, Johnson EK, Bhagavan D, Moreno JD, Nerbonne JM, **Silva JR**. "Identification of Structures for Ion Channel Kinetic Models". *PLoS Computational Biology*. 2021 Aug 17. [PMID: 34398881]
  17. Zhu W, Wang W, Angsutararux P, Mellor RL, Isom LL, Nerbonne JM, **Silva JR**. "Modulation of the effects of Class-Ib antiarrhythmics on cardiac NaV1.5-encoded channels by accessory NaVβ subunits", *Journal of Clinical Investigation: Insight*. 2021 Jun 22. [PMID: 34156986]
  18. Gholami Derami H, Gupta P, Weng KC, Seth A, Gupta R, **Silva JR**, Raman B, Singamaneni S. "Reversible Photothermal Modulation of Electrical Activity of Excitable Cells using Polydopamine Nanoparticles". *Advanced Materials*. 2021 Jul 3:2008809. [PMID: 34216406]
  19. Angsutararux P, Kang PW, Zhu W, **Silva JR**. "Conformations of voltage-sensing domain III differentially define NaV channel closed-and open-state inactivation." *Journal of General Physiology*. 2021 Aug 4;153(9):e202112891. [PMID: 34347027]
  20. Prakosa A, Southworth MK, Silva JN, **Silva JR**, Trayanova NA. "Impact of augmented-reality improvement in ablation catheter navigation as assessed by virtual-heart simulations of ventricular tachycardia ablation." *Computers in Biology and Medicine*. 2021 Jun 1; 133:104366. [PMID: 33836448]

21. Silva JN, Southworth MK, Andrews CM, Privitera MB, Henry AB, **Silva JR**. “Design Considerations for Interacting and Navigating with 2 Dimensional and 3 Dimensional Medical Images in Virtual, Augmented and Mixed Reality Medical Applications.” In *International Conference on Human-Computer Interaction 2021* Jul 24 (pp. 117-133). Springer, Cham. [PMID: 35079751]
22. Lorenzini M, Burel S, Lesage A, Wagner E, Charrière C, Chevillard M, Evrard B, Maloney D, Ruff K, Pappu R, Wagner S, Nerbonne J, **Silva JR**, Townsend RR, Maier LS, Marionneau C, “Proteomic and functional mapping of cardiac Nav1.5 channel phosphorylation”, *Journal of General Physiology*, 2021 153 (2): e202012646. [PMID: 33410863]
23. Andrews CM, Henry AB, Soriano IM, Southworth MK, **Silva JR**, “Registration Techniques for Clinical applications of 3-Dimensional Augmented Reality Devices”, *IEEE Journal of Translational Engineering in Health and Medicine*, 2020 Dec 17. [PMID: 33489483]
24. Kang PW, Westerlund AM, Shi J, White KM, Dou AK, Cui AH, **Silva JR**, Delemotte L, Cui J, “Calmodulin acts as a state-dependent switch to control a cardiac potassium channel opening”, *Science Advances*, 2020 Dec 11; 6(50):eabd6798. [PMID: 33310856]
25. Southworth MK, Silva JNA, Blume W, Van Hare GF, Dalal AS, **Silva JR**, Performance Evaluation of Mixed Reality Display for Guidance during Transcatheter Cardiac Mapping and Ablation, *IEEE Journal of Translational Engineering in Health and Medicine*, 2020 Jul 3. [PMID: 32742821]
26. Zhu W, Li T, **Silva JR**, Chen J. Conservation and divergence in NaChBac and Nav1.7 pharmacology reveals novel drug interaction mechanisms. *Scientific Reports*. 2020 Jul 1;10(1):1-1. [PMID: 32612253]
27. Silva JN, Southworth MK, Blume WM, Andrews C, Van Hare GF, Dalal AS, Miller N, Sodhi SS, **Silva JR**. First-In-Human Use of a Mixed Reality Display During Cardiac Ablation Procedures. *Journal of the American College of Cardiology: Clinical Electrophysiology*. 2020 Jul 8. [PMID: 32819517]
28. Silva JN, Privitera MB, Southworth MK, **Silva JR**. Development and Human Factors Considerations for Extended Reality Applications in Medicine: The Enhanced Electrophysiology Visualization and Interaction System (ÉLVIS). *International Conference on Human-Computer Interaction 2020* Jul 19 (pp. 341-356). Springer, Cham. [PMID: 34327520]
29. Salvage SC, Zhu W, Habib ZF, Hwang SS, Irons JR, Huang CL\*, **Silva JR\***, Jackson AP\*. Gating control of the cardiac sodium channel Nav1. 5 by its  $\beta$ 3-subunit involves distinct roles for a transmembrane glutamic acid and the extracellular domain. *Journal of Biological Chemistry*. 2019 Dec 20;294(51):19752-63. \*Co-corresponding authors. [PMID: 31659116]
30. Moreno JD, Zhu W, Mangold K, Chung W, **Silva JR**. A molecularly detailed Nav1. 5 model reveals a new class I antiarrhythmic target. *Journal of the American College of Cardiology: Basic to Translational Science*. 2019 Oct 28;4(6):736-51. [PMID: 31709321]
31. Southworth, MK, **Silva JR\***, Silva JNA\*. Use of Extended Realities in Cardiology. *Trends in Cardiovascular Medicine*. Apr. 2020. \*Co-corresponding authors. [PMID: 31076168]
32. Andrews C, Southworth MK, Silva JNA\*, **Silva JR\***. Extended Reality In Medical Practice. *Current Treatment Options in Cardiovascular Medicine*. 2019 Apr 1;21(4):18 . \*Co-corresponding authors [PMID: 30929093]
33. Zhu W, Mazzanti A, Voelker T, Hou P, Moreno JD, Angsutararux P, Naegle KM, Priori SG, **Silva JR**, Predicting Patient Response to the Antiarrhythmic Mexiletine Based on Genetic Variation: Personalized Medicine for Long QT Syndrome. *Circulation Research* 2019;124:539:552. [PMID: 30566038]
34. Silva JNA, Southworth M, Raptis C, **Silva JR**, “Emergence of Virtual and Augmented Reality in Cardiology”, *Journal of the American College of Cardiology: Basic to Translational Science*, 3(3),420-430, 2018. [PMID: 30062228]

35. McJunkin JL, Jiramongkolchai P, Chung W, Southworth M, Durakovic N, Buchman CA, **Silva JR**. Development of a Mixed Reality Platform for Lateral Skull Base Anatomy. *Otology & Neurotology*. Dec 1;39(10):e1137-42, 2018. [PMID: 30239435]
36. **Silva JR** "How to Connect Cardiac Excitation to the Atomic Interactions of ion channels", *Biophysical Journal*, 114(2),259-266, 2018. [PMID: 29401425]
37. Peters CH, Yu A, Zhu W, **Silva JR**, Ruben PC, "Depolarization of the Conductance-Voltage Relationship in the Na<sub>v</sub>1.5 Mixed Syndrome Mutant, E1784K, Caused by Modified Fast Inactivation", *PLoS One*, 12(9):e0184605, 2017 [PMID: 28898267]
38. Zhu W, Voelker TL, Varga Z, Schubert AR, Nerbonne JM, **Silva JR** "Mechanisms of non-Covalent  $\beta$  Subunit Regulation of Nav Channel Gating", *J of General Physiology*, August; 149(8), 2017. [PMID: 28720590]
39. Mangold K, Brumback B, Angsutararux P, Zhu W, **Silva JR** "Mechanisms and Models of Cardiac Na<sup>+</sup> Channel Inactivation", *Channels*, 2017. [PMID: 28837385]
40. Hsu EJ, Zhu W, Schubert AR, Voelker T, Varga Z, **Silva JR** "Regulation of Na<sup>+</sup> Channel Inactivation by the DIII and DIV Voltage-Sensing Domains", *J of General Physiology*, March; 149(3):389, 2017. [PMID: 28232510]
41. Teed ZR, **Silva JR** "A Computationally Efficient Algorithm for Fitting Ion Channel Gating Parameters", *MethodsX*, 3, 577-588, 2016. [PMID: 27924282]
42. Zhu W, Varga Z, Silva JR. Molecular motions that shape the cardiac action potential: Insights from voltage clamp fluorometry. *Progress in biophysics and molecular biology*. 2016 Jan 1;120(1-3):3-17. [PMID: 26724572]
43. Wang HG, Zhu W, Kanter RJ, **Silva JR**, Honeywell C, Gow RM, Pitt GS "A Novel NaV1.5 Voltage Sensor Mutation Associated with Severe Atrial and Ventricular Arrhythmias", *Journal of Molecular and Cellular Cardiology*, March; 92:52-62, 2016. [PMID: 26801742]
44. Brettmann J, Urusova D, Tonelli M, **Silva JR**, Henzler-Wildman K. "Role of Protein Dynamics in Ion Selectivity and Allosteric Coupling in the NaK Channel", *Proceedings of the National Academy of Science*, 112(50):15366-15371, 2015. [PMID: 26621745]
45. Varga, Z, Zhu W, Schubert AR, Pardieck JL, Hsu EJ, Zaydman MA, Cui J, **Silva JR**. "Direct Measurement of Cardiac Na<sup>+</sup> Channel Conformations Reveals Molecular Pathologies of Inherited Mutations." *Circulation: Arrhythmia and Electrophysiology*, 8:1228-1239, 2015. [PMID: 26283144]
46. Rudokas MW, Varga Z, Asaro AB, Schubert AR, **Silva JR**. "The *Xenopus* Oocyte Cut-Open Vaseline Gap Voltage-Clamp Technique with Fluorometry" *J of Visualized Exp*, e51040-e51040, 2014. [PMID: 24637712]
47. **Silva JR**, Cooper P, Nichols CG, "Modeling K,ATP-dependent Excitability in Pancreatic Islets" *Biophysical Journal*. 107(9), 2016-2026, 2014. [PMID: 25418087]
48. **Silva JR**. "Slow inactivation of Na<sup>+</sup> channels. Voltage Gated Sodium Channels". *Handbook of Experimental Pharmacology*. Feb. 2014 vol. 221, 33-49.
49. Zaydman MA, **Silva JR**, Delaloye K, Larsson HP, Cui J. "Kv7. 1 ion channels require a lipid to couple voltage sensing to pore opening" *Proceedings of the National Academy of Science*, August;110(32):13180-13185, 2013. [PMID: 23151230]
50. [Zhang HX\*, **Silva JR\***], Lin YW, Verbsky JW, Lee US, Kanter EM, Yamada KA, Schuessler RB, Nichols CG. "The Heterogeneity and Function of KATP Channels in Canine Hearts" *Heart Rhythm*, \*Both authors contributed equally, October; 10(10):1576-1583, 2013. [PMID: 23871704]



51. **Silva JR** and Goldstein SAN. "Voltage Sensor Movements Describe Slow Inactivation of Na<sub>v</sub> Channels I: Wild Type" *Journal of General Physiology*. March; 141:309-321, 2013. [PMID: 23401571]
52. **Silva JR** and Goldstein SAN. "Voltage Sensor Movements Describe Slow Inactivation of Na<sub>v</sub> Channels II: L689I Mutants" *Journal of General Physiology*. March; 141:323-334, 2013. [PMID: 23401572]
53. Zaydman MA, **Silva JR**, Cui J. "Ion Channel Associated Diseases: Overview of Molecular Mechanisms" *Chemical Reviews*. November; 112(12):6319-6333, 2012. [PMID: 23151230]
54. Silva JNA and **Silva JR**. "Updates on the inherited cardiac ion channelopathies: from cell to clinical" *Current Treatment Options in Cardiovascular Medicine* – October; 14(5):473-489, 2012. [PMID: 22865245]
55. **Silva JR** and Rudy Y. "Multi-scale Electrophysiology Modeling: From Atom to Organ" *Journal of General Physiology*. May; 135:575-581, 2010. [PMID: 20513759]
56. **Silva JR**, Pan H, Wu D, Nekouzadeh A, Decker K, Cui J, Baker N, Sept D, Rudy Y. "A Multiscale Model Linking Ion-Channel Molecular Dynamics and Electrostatics to the Cardiac Action Potential" *Proceedings of the National Academy of Science*. June; 106 (27):11102-11106, 2009. [PMID: 19549851]
57. Decker K, Heijman J, **Silva JR**, Hund T, Rudy Y. "Properties and Ionic Mechanisms of Action Potential Adaptation, Restitution and Accommodation in Canine Epicardium" *Am J Physiol: Heart* 2009 Jan; 296:1017-1026, 2009. [PMID: 19168720]
58. Nekouzadeh A, **Silva JR**, Rudy Y. "Modeling subunit cooperativity in opening of tetrameric ion channels", *Biophysical Journal*. 2008 October;95(7):3510-20. [PMID: 18621838]
59. Rudy Y and **Silva JR**. "Computational biology in the study of cardiac ion channels and cell electrophysiology." *Quarterly Reviews in Biophysics*. 2006 Feb;39(1):57-116. [PMID: 16848931]
60. Faber G, **Silva JR**, Livshitz L, Rudy Y. "Kinetic properties of the cardiac L-type Ca<sup>2+</sup> channel and its role in myocyte electrophysiology: a theoretical investigation." *Biophysical Journal*. 2007 Mar;92(5):1522-43. [PMID: 17158566]
61. **Silva JR** and Rudy Y. "Subunit Interaction Determines I<sub>Ks</sub> Participation in Cardiac Repolarization and Repolarization Reserve", *Circulation*. 2005;112:1384-1391.
62. **Silva JR** and Rudy Y. "Mechanism of pacemaking in I(K1)-downregulated myocytes." *Circulation Research*. 2003 Feb 21;92(3):261-3.

## **Chapters**

1. Mangold K, **Silva JR**, "Modeling the Molecular Details of Ion Channels", *Modeling and Simulating Cardiac Electrical Activity*, Ed. Krogh-Madsen, T and Christini, D, 2022.
2. Moreno JD, Kang PW, **Silva JR**, "Connecting Cardiac Excitation to the Atomic Interactions of Ion Channels", *Cardiac Electrophysiology: From Cell to Bedside 8<sup>th</sup> ed.* Eds Zipes, Jalife, Stevenson, 2021.
3. Cox K, Privitera MB, Alden T, **Silva JR**, Avari Silva JN. "Augmented Reality in Medical Devices". *Applied Human Factors in Medical Device Design*. Academic Press, pp. 327-337, 2019.
4. **Silva JR**. "Slow inactivation of Na<sup>+</sup> channel", *Voltage Gated Na<sup>+</sup> Channels*, Ed. Peter Ruben, Springer, Berlin Heidelberg, 2014.
5. Zhang HX, **Silva JR** and Nichols C. "Cardiac K<sub>ATP</sub> Channels in Health and Diseases", *Electrical Diseases of the Heart, 2nd edition*. pp 259-279, Ed. Ihor Gussak et al., Springer London, 2013.
6. **Silva JR** and Rudy Y. "Voltage-Gated Channels and the Heart", *Molecular Machines*. Ed. B. Roux. World Scientific 2011.

7. **Silva JR** and Rudy Y. “Ionic Mechanisms of Ventricular Action Potential Excitation” *Cardiac Electrophysiology: From Cell to Bedside, 5th edition*, Eds. D.P. Zipes and J. Jalife. Elsevier Science, 2008.

## Patents and Licenses

1. Silva JNA, **Silva JR**, Southworth MK, Soriano I, Dagley M, Andrews CM, Razzaque S, Hougard I, Tas B, Two-way Communication Between Head-Mounted Display and Electroanatomic System, US Patent App 63/333,900 – Provisional.
2. Southworth MK, Andrews CM, Soriano I, Henry AB, **Silva JR**, Silva JN, inventors; Excera Inc, assignee. Multiscale ultrasound tracking and display. United States patent application US 17/740,191. 2022 Nov 10.
  - a. Pending in Europe, Japan, Canada, China
3. **Silva JR**, Andrews C, Silva JNAS, Iqbal Z, inventors; Washington University in St Louis WUSTL, assignee. System and method for augmented reality data interaction for ultrasound imaging. United States patent application US 17/799,826. 2023 Mar 2. – Licensed to SentiAR/Excera Inc.
  - a. Pending in Korea, Europe, India, Australia
4. Southworth MK, Blume W, Silva JN, **Silva JR**, inventors; SentiAR Inc, assignee. Disposable sticker within augmented reality environment. United States patent US 10,733,960. 2020 Aug 4.
  - a. Continuation – United States patent US 10,964,291. 2021 Mar 30.
  - b. Issued in Japan (7105996), Pending in Hong Kong, Europe, Canada, Australia
5. Blume W, Southworth MK, Silva JN, **Silva JR**. Gaze based interface for augmented reality environment. United States patent US 11,199,898. 2021 Dec 14.
  - a. Continuation - US Patent App. 17/524,981, 2022
  - b. Issued in Japan (7213899), Pending in Korea, Israel, Europe, Canada, Australia.
6. Blume W, Southworth MK, **Silva JR**, Silva JN, Soriano I, inventors; SentiAR Inc, assignee. Electrogram Annotation System. United States patent application US 17/078,889. 2021 Apr 29.
  - a. Continuation – US Patent App. 17/940,564, 2022 – Allowed on 3/16/2023
  - b. Pending in Australia, Canada, Europe, Hong Kong, Israel
7. **Silva JR**, Silva JNA. System and method for virtual reality data integration and visualization for 3D imaging and instrument position data. United States patent US 10,258,426. 2019 Apr 16. – Licensed to SentiAR, Inc.,
  - a. Divisional US Patent Application, 16/386,156
  - b. Issued in Hong Kong (HK1263061) and China (CN105395252A), Pending in Europe, Canada
8. **Silva JR**, Zhu W, Priori S, Mazzanti A, Naegle K “Predicting response to sodium channel blockers”, US Patent App 16/708,312, Provisional.

## Invited Lectures

1. University of California - Davis, Davis, CA, 2024
2. The Johns Hopkins University, Baltimore, MD, 2024
3. WWNav-conference, Grindelwald, Switzerland, 2024
4. 2023-24 Pioneers in Biomedical Research Seminar Program, Virginia Tech, Roanoke, VA, 2023
5. Nanion Webinar talk, 2023
6. 8<sup>th</sup> World Congress of Pediatric Cardiology and Cardiac Surgery, Washington DC, 2023

7. Heart Rhythm Society Annual Meeting, New Orleans, LA 2023
8. Cardiac Electrophysiology Society, New Orleans, LA, 2023
9. Nanion User Meeting, Boston, MA, 2023
10. Center for Engineering MechanoBiology Colloquium, St. Louis, 2022
11. SPECTRA Conference, St. Louis, 2022
12. Northwestern University, Department of Pharmacology, Chicago 2022
13. FASEB SRC Ion Channel Regulation, Halifax, Nova Scotia, Canada 2022
14. Heart Rhythm Society Annual Meeting, San Francisco, CA 2022
15. Society for Mathematical Biology, 2021
16. American Heart Association Scientific Sessions, 2021
17. Washington University Biomedical Engineering Seminar, St. Louis MO 2021
18. Cardiology Grand Rounds, Washington University School of Medicine, St. Louis MO 2020
19. Venture Café, St. Louis MO 2020
20. UC Davis Cardiovascular Symposium, Davis, CA2020
21. Channelopathy 2020, Quebec City, (conference postponed)
22. Ohio State University, Department of Biomedical Engineering 2019
23. Skandalaris Center for Interdisciplinary Innovation and Entrepreneurship, 2019
24. Department of Biochemistry and Molecular Biophysics, Washington Univ School of Medicine, 2019
25. University of Michigan, Ann Arbor, Michigan, 2018
26. CECAM Multiscale Modeling Workshop, Lugano, Switzerland, 2018
27. St. Louis University Biomedical Engineering Society, St. Louis, USA, 2018
28. Center for Cardiovascular Research, Washington University School of Medicine, St. Louis USA, 2018
29. Cardiac Arrhythmia Mechanisms Gordon Research Conference, Ventura, California, USA, 2017
30. Experimental Biology Meeting, Chicago, IL, USA, 2017
31. Biomedical Engineering Seminar, Washington University in St. Louis, St. Louis, MO, USA, 2016
32. Cardiac Bioelectricity and Arrhythmia Center 10<sup>th</sup> Anniversary Symposium, Washington University in St. Louis, St. Louis, MO, USA, 2015
33. Center for Cardiovascular Research, Cardiovascular Research Day, Junior Faculty Presentation, Washington University in St. Louis, St. Louis, MO, USA, 2014
34. Biochemistry and Molecular Biophysics Chalk Talk, Washington University in St. Louis, St. Louis, MO, USA, 2014
35. Medical Scientist Training Program MAP Talk, Washington University in St. Louis, St. Louis, MO, USA, 2014
36. Cardiac Bioelectricity and Arrhythmia Center Seminar, Washington University in St. Louis, St. Louis, MO, USA, 2014
37. Université de Montréal (GEPROM), Montréal, Québec, Canada, 2013
38. Biophysical Evenings, Washington University in St. Louis, St. Louis, MO, USA, 2013
39. University of British Columbia, Vancouver, British Columbia, Canada, 2012
40. Simon Fraser University, Vancouver, British Columbia, Canada, 2012

## Teaching

BME 440 Introductory Python with Biomedical Applications

Role: Co-Instructor

Year Taught: 2021, 2022,2023

Avg. Enrolled Students: 40 undergrad

BME 301 Quantitative Physiology

Role: Course Master (bi-annual)

Year(s) Taught: 2018, 2019, 2020, 2021, 2022, 2023

Avg. Enrolled Students: 65 undergrad

BME 401 Senior Design

Role: Team taught (3)

Years taught: 2013, 2014, 2015, 2016

Avg. Enrolled Students: 77 undergrad

BME 450/550 Numerical Methods for Computational Modeling in Biomedicine (Tier 1 Class)

Role: Developed, Instructor

Years taught: 2014, 2015, 2016, 2017, 2018

Avg. Enrolled Students: 19 (25% grad, 75% undergrad)

BME 5901 Integrative Cardiac Electrophysiology

Role: Team-taught (3)

Years taught: 2014, 2016, 2018

Avg. Enrolled Students: 4

## Trainees

### *Graduate*

#### *Current PhD:*

Martina Marras (2021-)

Thesis Topic: Novel Approaches for Class I Anti-arrhythmic Therapies

Current status: Transitioning from MS program to PhD

Chang Hi Lee (2020-)

Thesis Topic: Using Machine Learning Algorithms to Improve Anti-arrhythmic Therapy

Current status: Transitioning from MS program to PhD

Druv Bhagavan (2020-)

Thesis Topic: Algorithms to connect micro-heart muscle phenotype to patient arrhythmia

Anticipated Graduation: 2023

Lucy Woodbury (2020-)

Thesis Topic: Regulation of Nav1.5 by intracellular fibroblast growth factors

Anticipated graduation: 2024

Emily Wagner (2017 - )

Thesis Topic : Disordered protein regulation of Nav1.5

Anticipated graduation: 2022

#### *Past PhD:*

Wandi Zhu (2013 - 2018)

Thesis topic: Modulation of Cardiac Na<sup>+</sup> Channel Gating by Interacting Molecules

Currently a postdoctoral fellow at Harvard Medical School

Kathryn Mangold (2016 – 2021)

Thesis topic: Computational modeling of cardiac Na<sup>+</sup> channel gating

Currently a post-doctoral trainee at Mayo Clinic

Po Wei Kang (2019 -2021)

Thesis Topic: Calmodulin regulation of cardiac ion channels.

Currently completing medical school.

Paweorn Angsutararux (2017 - 2022)

Thesis topic: Novel methods to monitor ion channel gating in myocytes

Planning to start postdoctoral training at UC Davis

*Past MS:*

Nicholas Bach (2020 - 2021)

Thesis topic: Tracking algorithm for otolaryngology procedures

Currently working in the lab.

**Post-graduate**

*Current:*

Heather Struckman, PhD, (2023- )

*Past:*

Jonathan Moreno MD, PhD (2017 - 2021), Assistant Professor, Washington University

Khrystyna Sukanova, PhD (2021 - 2022), Research Scientist, Washington University

Christopher Andrews, PhD (2018-2020), Sr. Systems Engineer, SentiAR Inc.

Divya Kernik, PhD (2019 -2020), Medical Writer, Ashfield MedComms

Kuo-Chan Weng, PhD (2017 - 2020), Director iPSC Core, Washington University

Zoltan Varga, PhD (2013-2014), Asst. Professor, Debrecen Medical School, Hungary

Darya Urusova, PhD (2014-2015), Staff Scientist, Washington University School of Medicine

Arie Krumholz, PhD (2014-2015), Data Scientist,

**Undergraduate (>6 months)**

*Past:*

Irene Zhou (2021-2022), Graduate Student at Boston University

Anish Bedi (2019-2022), Applying to Medical School

Namit Sambare (2020-2022), Applying to Medical School

Andrew Whitaker (2019-2020), Graduate Student, Washington University

Michael Rudokas (2012-2013), Postdoctoral Fellow, Yale University

Bicong Li (2015-2017), Medical Student

Eric Hsu (2013-2015), MD/ PhD Candidate UT Southwestern

Zach Teed (2014-2017) – PhD Candidate, Princeton University

Chen Zhao (2013-2014) – PhD Candidate, The Johns Hopkins University

**Professional Associations**

**Member**

2018 – Present. American Heart Association

2016 – Present. Biomedical Engineering Society

2015 – Present. Society of Hispanic Professional Engineers

2015 – Present. Society of General Physiologists.

2011 – Present. Heart Rhythm Society

2010 – Present. American Heart Association

2009 – Present. Biophysical Society

2007 – Present. AAAS/Science

# University and Professional Leadership

## **Department**

Director of Diversity (2020-)  
Undergraduate Studies Committee (2013-2014, 2017-2020)  
Graduate Studies Committee (2014-2016, Cardiovascular Engineering Program Leader)  
Faculty Search Committee (2014, 2016, 2019, 2021)  
Masters Studies Committee (2016-2019)

## **School**

Advancing Data Science for Racial Equity Faculty Recruiting Committee  
Faculty Advisor, Society of Hispanic Professional Engineers, Undergraduate Chapter  
Representative to Society for the Advancement of Chicanos/Hispanics and Native Americans in Science  
Member, Engineering Space Committee  
Panel, Society of Hispanic Professional Engineers, Q&A  
Panel, Graduate School Forum  
Panel, Engineering Visit Day

## **University**

Member, Race and Ethnicity Hiring Initiative, 2020-present  
Member, University Public Safety Committee, 2020-2021  
Member, Conflicts of Interest Committee, 2018-present  
Oversight sub-committee  
Member, Danforth COVID-19 Re-opening Committee, 2020  
Member, HHMI Gilliam Fellowship Nomination Review Committee, 2019-2020  
Member, Ethnicity Cluster Hire Review Committee, 2020  
Reviewer, SURF Undergraduate Research Fellowship  
Participant, Libraries Data Curation Pilot  
Participant, StemFIT Program

## **External**

### *Grant Review*

National Institutes of Health, MPPB Study Section, Standing Member (2021-2026)  
National Institutes of Health, ESTA Study Section, Standing Member (2020-2021)  
American Heart Association, Career Development Award (2020)  
American Heart Association, Strategically Focused Research Network, Sudden Cardiac Death (2019)  
National Institutes of Health, ESTA Study Section, Ad Hoc (2018)  
American Heart Association, Transformational Project Award (2018-2019)  
American Heart Association, Strategically Focused Research Network, Atrial Fibrillation (2018)  
American Heart Association, Electrophysiology 1, permanent member (2015 - 2017)  
American Heart Association, Biomedical Engineering Basic Science 3, ad hoc reviewer (2x)  
FWO, Belgian Research Foundation, Ad hoc reviewer (4x)  
Isaac Newton Trust, Ad hoc Reviewer  
Israel Science Foundation, Ad hoc Reviewer  
Arch Grants Pitch Competition

### *Oversight*

American Heart Association, SFRN: Atrial Fibrillation Oversight Committee (2018 -)  
Heart Rhythm Society Journal Subcommittee

## *Outreach & Diversity*

Brightpath Middle School Outreach Program Host Lab  
Council of Diversity for Biomedical Engineering  
Aim High St. Louis Career Day  
Mentor, Sister Thea Bowman School, Under-represented 8<sup>th</sup> Grade Students  
Invited Speaker, Forsyth School 2<sup>nd</sup> Grade, Topic: Biomedical Engineering (2016 - 2020)  
Coach, Lego League, Forsyth School  
Judge, Honors Science Fair, St. Louis

## **Journal Affiliations**

### **Editorial Board:**

Frontiers in Neuroscience

### **Reviewer:**

PLoS ONE

American Physical Society

Chaos

MethodsX

Journal of General Physiology

American Journal of Physiology

Scientific Reports

Circulation Research

Circulation: Arrhythmia and

Electrophysiology

Heart Rhythm Journal

Journal of the American Heart Association

Biophysical Journal

Physical Biology

Journal of Medical and Biological  
Engineering

Journal of Biomechanical Engineering

Journal of Molecular and Cellular  
Cardiology

Journal of Neuroscience

Cardiovascular Research

Europace

Progress in Biophysics

eLife

## **Center Affiliations**

Center for Cardiovascular Research (CCR)

Center for Science and Engineering of Living Systems (CELS)

Cardiac Bioelectricity and Arrhythmia Center (CBAC)

Center for the Investigation of Membrane Excitability Diseases (CIMED)

Diabetes Research Center (DRC)