

# Ning Lu

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**Research Interests:** Biomedical Ultrasound, Image-guided Therapy, Imaging Instrumentation, AI-Powered Imaging Algorithms, Parallel Computing, and Wearable Sensors.

## MISSION STATEMENT

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I am an ultrasound researcher specializing in developing integrated systems and computational tools for medical imaging, non-invasive therapy, image-guided intervention, and wearable devices.

## EDUCATION & TRAINING

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**Stanford University, Palo Alto, CA** 08/ 2023 - Present

Postdoctoral Scholar (*PI: Katherine W. Ferrara*)

**University of Michigan, Ann Arbor, MI** 08/ 2018 – 07/ 2023

Ph.D. in Biomedical Engineering & Scientific Computing (*PI: Zhen Xu*) GPA: 4.0/4.0

**Southeast University, Nanjing, China** 08/ 2014 – 06/ 2018

B.E. in Biomedical Engineering (Highest Honor, Chien-Shiung Wu College\*) GPA: 3.6/4.0

\* Only the top 30 engineering undergraduates in Southeast University are selected for this college.

## RESEARCH EXPERIENCE

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### High-resolution Ultrasound Volumetric Imaging

Stanford University, Palo Alto, CA 08/ 2023 – Present

- Developed volumetric spine imaging techniques using a large-aperture array for diagnosis and real-time interventional guidance.
- Developing a high-resolution ultrasound tomography scanner for non-radiant breast cancer screening.
- Developing real-time aberration correction algorithms to improve image quality in 3D anatomical and functional imaging.

### Transcranial MR-guided Histotripsy (TcMRgHt) for Brain Treatment

University of Michigan, Ann Arbor, MI 08/ 2018 – 07/ 2023

*Dissertation committee: Drs. Zhen Xu, Douglas C. Noll, Jeffrey A. Fessler, Timothy L. Hall, Jonathan R. Sukovich, Aditya Pandey*

- Designed and constructed the first human-scale TcMRgHt system, including the phased array, the transmit-and-receive capable electronic driver, and peripheral mechanical structures.
- Developed a two-step aberration correction method to improve treatment efficacy and precision, which uses CT-based raytracing as the first step, followed by a cavitation-based time-reversal approach.
- Developed imaging algorithms for focused ultrasound treatment monitoring, with a spatial-temporal resolution that allows imaging for every cavitation event including the skull surface cavitation.
- Evaluated the feasibility, safety, and outcome of TcMRgHt treatment *ex vivo* and *in vivo*.

### Ultrasound Eye Tracking for AR/VR Devices

Meta (formerly Facebook) Reality Labs, Redmond, WA 05/ 2022 – 09/ 2022

- Developed an acoustic simulation platform to synthesize data for ultrasound eye tracking data as a function of transducer/system design, sensor noise, eye/face occlusion, and headset slippage.
- Achieved end-to-end eye tracking using a machine learning algorithm to jointly estimate gaze and headset slippage.

## High-Speed Photon Counter for Multi-photon Optical Imaging System

Johns Hopkins University, Baltimore, MD

06/ 2017 – 09/ 2017

- Designed a fast signal acquisition pipeline using a high-speed amplifier and digitizer to increase the sensitivity and precision of photon detection for multi-photon imaging systems.
- Achieved a data processing rate of up to 7 GB/s using multi-threading and GPU acceleration.

## High-Performance Cluster Building and Parallel Optimization

National Supercomputer Center, Wuxi, China

01/ 2017 – 04/ 2017

(First Class Award in Asia Student Supercomputer Challenge 2017)

- Implemented parallel optimization for high-resolution surface wave simulations on a supercomputer.
- Designed and built a 6-node server cluster, achieved a LINPACK benchmark score of 4 TFLOPS, and conducted genome assembly simulation and molecular dynamics simulation on the cluster.

## Design, Optimization, and Software Development of 1310 nm SS-OCT System

Southeast University, Nanjing, China

12/ 2017 – 06/ 2018

- Built a 1310 nm SS-OCT system with an imaging depth of 4.8 mm and axial resolution of 25  $\mu\text{m}$  for ex-vivo tissue imaging.

## Multichannel Micro-electrode for in vivo Neural Signal Recording

Southeast University, Nanjing, China

04/ 2015 – 01/ 2017

- Designed a lightweight, highly integrated 256-channel 3D micro-electrode for neural signal recording on freely moving rats.

## HONORS & AWARDS

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IEEE IUS Student Travel Award (\$300)	06/ 2023
ISTU Student Registration Award (\$300)	06/ 2021
Rackham Conference Travel Grant at the University of Michigan (up to \$1,400 annually)	2019 - 2022
Rackham International Student Fellowship (Top 1%, \$10k)	12/ 2019
BME Departmental Fellowship (~ \$40k)	09/ 2018
Best Undergraduate Thesis Award, Southeast University (Top 1%)	06/ 2018

## GRANT EXPERIENCE

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1. Pathway to Independence Award for Outstanding Early-Stage Postdoctoral Researchers (K99/R00)
  - *Funding Sources:* National Institutes of Health (NIH)
  - *My Role:* Principal Investigator - Application in Progress.
2. Quantitative Volumetric Ultrasound and Photoacoustic Tomography (PI: Katherine Ferrara)
  - *Funding Sources:* National Institutes of Health (NCI R01CA258807)
  - *My Role:* Helped the PI draft progress reports.
3. Transcranial Magnetic Resonance-guided Histotripsy (PI: Zhen Xu)
  - *Funding Sources:* National Institutes of Health (NIBIB R01EB028309); Focused Ultrasound Foundation
  - *My Role:* Helped the PI draft grant proposals, progress reports, and grant renewal proposals.

## PUBLICATIONS

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1. N Lu, J Foiret, B Yoon, KW Ferrara. "Improving Ultrasound Spine Imaging with a Large-Aperture Array". Under review, 2024.
2. N Lu, JR Sukovich, TL Hall, Z Xu. "Transcranial Cavitation Imaging Using a Large-Aperture

Transcranial Histotripsy Array”. In preparation, 2024.

3. N Lu, E Yeats, JR Sukovich, TL Hall, Z Xu. “Treatment Envelope of Transcranial Histotripsy: Strategies to Improve the Treatment Efficacy for Targets Near Skull Surface”. *Physics in Medicine & Biology*, 2024. doi: 10.1088/1361-6560/ad8d9f.
4. N Lu, F LaRocca, S Talathi. “Accurate and Robust Eye Tracking with Ultrasound: A Computational Study.” *IEEE International Ultrasonics Symposium (IUS) Proceedings*, 2023. doi: 10.1109/IUS51837.2023.10306398.
5. N Lu, TL Hall, JR Sukovich, SW Choi, J Snell, N McDannold, Z Xu. “Two-step Aberration Correction: Application to Transcranial Histotripsy”. *Physics in Medicine & Biology*, 2022; 67 (12). doi: 10.1088/1361-6560/ac72ed.
6. N Lu, D Gupta, BJ Daou, A Fox, D Choi, JR Sukovich, TL Hall, S Camelo-Piragua, N Chaudhary, J Snell, AS Pandey, DC Noll, Z Xu. “Transcranial MR-guided Histotripsy for Brain Surgery – Pre-clinical Investigation”. *Ultrasound in Medicine & Biology*, 2022; 48 (1). doi: 10.1016/j.ultrasmedbio.2021.09.008.
7. N Lu, TL Hall, D Choi, D Gupta, BJ Daou, JR Sukovich, A Fox, TI Gerhardson, AS Pandey, DC Noll, Z Xu. “Transcranial MR-Guided Histotripsy System.” *IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control*, 2021; 68 (9). doi: 10.1109/TUFFC.2021.3068113.
8. R Wodnicki, J Foiret, B Liu, N Lu, X Sun, J Zhang, H Kang, H Bendjador, L Fu, C Notard, M Legros, Q Zhou, KW Ferrara. “Handheld Large 2D Array with Azimuthal Planewave and Row-Multiplexed Elevation Beamforming Enabled by local ASIC Electronics”. Under review at *IEEE TUFFC*.
9. E Yeats, G Stocker, N Lu, M Komaiha, JR Sukovich, Z Xu, TL Hall. “In Vivo Cavitation-Based Aberration Correction of Histotripsy in Porcine Liver”. *IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control*, 2024; 71(8). doi: 10.1109/TUFFC.2024.3409638.
10. SW Choi, M Komaiha, D Choi, N Lu, TI Gerhardson, A Fox, N Chaudhary, S Camelo-Piragua, TL Hall, AS Pandey, Z Xu, JR Sukovich. “Neuro-navigation-guided Transcranial Histotripsy (NaviTH) System”. *Ultrasound in Medicine & Biology*, 2024. doi:10.1016/j.ultrasmedbio.2024.04.001.
11. S Haskell, N Lu, G Stocker, Z Xu, JR Sukovich. “Monitoring Cavitation Dynamics Evolution in Tissue-mimicking Hydrogels for Repeated Exposures via Acoustic Cavitation Emissions”. *Journal of the Acoustical Society of America*, 2023; 153 (237). doi:10.1121/10.0016849.
12. E Yeats, N Lu, JR Sukovich, Z Xu, TL Hall. “Soft Tissue Aberration Correction for Histotripsy Using Acoustic Emissions from Cavitation Cloud Nucleation and Collapse”. *Ultrasound in Medicine & Biology*, 2022; 49 (5). doi:10.1016/j.ultrasmedbio.2023.01.004.
13. D Gupta, D Choi, N Lu, SP Allen, TL Hall, DC Noll, Z Xu. “MR-thermometry Targeting for MR-guided histotripsy treatments”. *Ultrasound in Medicine & Biology*, 2022; 49 (5). doi: 10.1016/j.ultrasmedbio.2022.12.009.
14. N Lu, D Xing, T Sheng, W Lu. The mechanism and function of hippocampal neural oscillation. *Acta Physiologica Sinica*, 2017, 69(5): 647–656. DOI: 10.13294/j.aps.2017.0052

#### **ACADEMIC PRESENTATIONS (\* = PRESENTER, 1 = TALK, 2 = POSTER)**

1. N Lu\*<sup>1</sup> (Invited) “Transcranial histotripsy for non-invasive brain therapy.” *Academic Seminar on Biomedical and Health Engineering*, Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences.

2. N Lu<sup>\*1</sup>, J Foiret, B Yoon, KW Ferrara. “Real-time volumetric spine imaging for interventional guidance with a large-aperture array”. *IEEE International Ultrasonics Symposium (IUS) 2024*, Taipei.
3. N Lu<sup>\*1</sup>, J Foiret, EY Park, S Poplack, KW Ferrara. “High-resolution large field-of-view volumetric ultrasound scanner for breast imaging.” *IEEE IUS 2024*, Taipei.
4. R Wodnicki, J Foiret, B Liu, N Lu, et al. “2D arrays: Technologies and challenges, a review of past, present, and future.” Invited talk at *IEEE IUS 2024*, Taipei.
5. E Yeats, N Lu, G Stocker, M Komaiha, JR Sukovich, Z Xu, TL Hall. “In Vivo Aberration Correction of Histotripsy Using Acoustic Cavitation Emissions”. *IEEE IUS 2024*, Taipei.
6. N Lu<sup>\*1</sup> (Invited) “High-definition 3D ultrasound imaging and therapy.” *Biomedical Engineering Research Forum 2024*, Nanjing Medical University, China (remote).
7. N Lu<sup>\*1</sup>, F LaRocca, S Talathi. “Accurate and robust eye tracking with ultrasound: a computational study.” *IEEE IUS 2023*, Montreal, Canada.
8. N Lu<sup>\*2</sup>, M Komaiha, JR Sukovich, TL Hall, Z Xu. “Passive cavitation mapping for transcranial histotripsy.” *IEEE IUS 2023*, Montreal, Canada.
9. N Lu<sup>\*2</sup>, JR Sukovich, S Camelo-Piragua, Z Xu, AS Pandey. “Ablation of human brain tumors using histotripsy”. *Congress of Neurological Surgeons (CNS) Annual Meeting 2023*, Washington D.C., USA.
10. N Lu<sup>\*1</sup>, JR Sukovich, TL Hall, Z Xu. “Treatment envelope of transcranial histotripsy: Strategies to improve the treatment efficacy for targets near skull surface.” *International Symposium on Therapeutic Ultrasound (ISTU) 2023*, Lyon, France.
11. N Lu<sup>\*2</sup>, JR Sukovich, TL Hall, Z Xu. “Electronic steering capabilities of aberration correction for transcranial histotripsy.” *IEEE IUS 2022*, Venice, Italy.
12. N Lu<sup>\*1</sup>, TL Hall, JR Sukovich, et al. “Two-step aberration correction: application to transcranial histotripsy”. *ISTU 2022*, Toronto, Canada.
13. N Lu<sup>\*2</sup>, TL Hall, JR Sukovich, Z Xu. “Aberration Correction for Transcranial Histotripsy”. *IEEE IUS 2021*, virtual.
14. N Lu<sup>\*1</sup>, D Gupta, BJ Daou, et al. “Transcranial MR-guided histotripsy for brain surgery - re-clinical investigation”. *ISTU 2021*, virtual (selected as Student Speed Talk Finalist) and *7th International Symposium on Focused Ultrasound, 2020*, virtual.
15. N Lu<sup>\*1</sup>, TI Gerhardson, D Choi, et al. “MR-guided histotripsy system for transcranial therapy.” *IEEE IUS 2020*, virtual.
16. N Lu<sup>\*2</sup>, JR Sukovich, T Gerhardson, et al. “Ablation of human brain tumors using histotripsy”. *IEEE IUS 2019*, Glasgow, UK.
17. J Foiret, EY Park, N Lu, KW Ferrara. “Large aperture imaging, from multi-array prototype to imaging device.” *SPIE Medical Imaging*, 2024, San Diego, USA.
18. D Gupta, T Kaovasia, D Choi, N Lu, SP Allen, TL Hall, Z Xu, and DC Noll, “Evaluating histotripsy treatment dosage in the brain using MRI”. *International Society for Magnetic Resonance in Medicine (ISMRM) Annual Meeting, 2023*, Toronto, Canada.
19. JR Sukovich, TL Hall, M Komaiha, S Haskell, N Lu, et al. “Acoustic cavitation localization during histotripsy using transmit-receive capable arrays”. *Acoustical Society of America (ASA) Meeting 2023*, Chicago, USA.
20. JR Sukovich, N Lu, SW Choi, et al. “High-rate implicit cavitation localization during histotripsy via backwards transmit-delay acoustic cavitation emission (backTRACE) methods”. *IEEE IUS 2022*, Venice, Italy.
21. G Stocker, N Lu, Z Xu, JR Sukovich, TL Hall. “Evaluating cavitation mapping during histotripsy with electronic focal steering”. *ISTU 2022*, Toronto, Canada.

22. SW Choi, JR Sukovich, D Choi, M Komaiha, **N Lu**, et al. "Neuronavigation-guided transcranial histotripsy on human cadavers: a feasibility study". *ISTU 2022*, Toronto, Canada.
23. D Gupta, D Choi, **N Lu**, et al. "MR-Thermometry based targeting for histotripsy treatments in ex-vivo tissues". *ISMRM Annual Meeting, 2022*, London, UK.
24. D Gupta, **N Lu**, A Fox, D Choi, et al. "Technical feasibility and imaging of transcranial MR-guided in-vivo histotripsy treatment." *ISMRM Annual Meeting, 2021, virtual*.
25. D Gupta, **N Lu**, JR Sukovich, et al. "MRI assessment and monitoring of cavitation-based ultrasound therapy (histotripsy) for transcranial brain treatment in vivo". *ISMRM Annual Meeting, 2020, virtual*.
26. TI Gerhardson, JR Sukovich, J Lundt, **N Lu**, et al. "Design of a histotripsy array for the treatment of intracerebral hemorrhage". *ASA meeting 2019*, Louisville, USA.

## **PATENT APPLICATIONS**

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1. **N. Lu**, F. LaRocca, S. Talathi. Provisional patent application under review, 2023.

## **PROFESSIONAL SERVICES**

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Technical Reviewer:

- IEEE Transactions on Biomedical Engineering (TBME), IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control (TUFFC), IEEE International Symposium on Biomedical Imaging (ISBI), Ultrasound in Medicine & Biology, Physics in Medicine & Biology, Journal of Neural Engineering, Medical Engineering & Physics.

Conference Session Chair:

- Brain session at Histotripsy Symposium 2022, Madison, Wisconsin, USA.

Volunteer:

- Deputy Chair of the IEEE UFFC-S Publicity Committee, 2024 – Present.
- Leadership Committee for Women in Molecular Imaging Network (WIMIN), 2024 – 2026.
- President of IEEE UFFC Student Chapter at the University of Michigan, 2020 - 2023.
- Peer mentor for Graduate Rackham International (GRIN), University of Michigan, 2019 – 2021.
- Peer mentor for BME Mentorship Program, University of Michigan, 2019 and 2022.
- Mentor for BME Graduate Application Assistance Program (GAAP), University of Michigan, 2022.

## **TEACHING TRAINING & EXPERIENCE**

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Guest Lecturer: 3D+ Imaging Sensors (EE 119/219) <i>Stanford University</i>	Spring 2024
Mentoring Skills Workshops <i>Teaching &amp; Mentoring Academy, Stanford Medicine</i>	Winter 2024
Guest Lecturer for Ultrasound Lab: Medical Imaging System (BME/EECS 516) <i>University of Michigan</i>	Fall 2019 & 2022

## **TEACHING INTEREST**

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Biomedical Ultrasound, Scientific Computing, Medical Imaging Systems & Labs, Signal & Image Processing, Image-guided Therapy.

## **RESEARCH MENTORING**

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Haeni Lee, Visiting Ph.D. student, Stanford University	2023 – 2024
Tarana Kaovasia, Ph.D. student, University of Michigan	2021 – 2023

Mahmoud Komaiha, Ph.D. student, University of Michigan  
Jeremy Deniega, M.S. student, University of Michigan

2021 –2023  
2019 –2021

## **PROFESSIONAL MEMBERSHIPS**

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- IEEE UFFC
- IEEE Signal Processing Society (SPS)
- IEEE Young Professionals
- Society for Industrial and Applied Mathematics (SIAM)
- ACM Special Interest Group on High-Performance Computing (SIGHPC)
- Women in Molecular Imaging Network (WIMIN)

## **SKILLS**

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**Programming:** Python, C/C++, CUDA, shell scripting, Verilog, R.

**Software:** Matlab, Julia, PyTorch, LaTeX, LabVIEW.

**Technical:** Signal and image processing, circuit design (schematic & PCB layout), ultrasound transducer design and fabrication, parallel optimization, 3D printing, mechanical design, MRI, animal experiments.

## **SELECTED COURSE PROJECTS**

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- *Learning-based Optimization for Under-Sampling MRI*  
Image Processing (EECS 556), Winter 2021 (KLA Runner-up Team Prize)
- *VolumeRend for 3D Lung Nodule Segmentation*  
Advanced Topics in Computer Vision (EECS 542), Fall 2020
- *Point-source Separation for Aberration Correction in Ultrasound Therapy using GAN*  
Advanced Machine Learning for Bioinformatics (BIOINFO 590), Fall 2019