

# ZHENGQI, GAO

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## EDUCATION

### Massachusetts Institute of Technology

Cambridge, USA

*Ph.D. in Electrical Engineering and Computer Science*

Sep 2021 – Feb 2026 (Expected)

- GPA: 5.00/5.00 (Rank: N/A); supervised by Prof. Duane S. Boning
- Research interests:
  - Design automation for electronic & photonic integrated circuits
  - AI/ML algorithms, and AI/ML for hardware design

### Fudan University

Shanghai, China

*M.S. in Microelectronics and Solid State Electronics*

Sep 2018 – Jun 2021

- GPA: 3.82/4.00 (Rank: N/A); worked with Prof. Jun Tao and Prof. Xin Li (Duke University)
- Research interests: electronic design automation (EDA), and Bayesian methods

*B.E. in Microelectronic Science and Engineering*

Sep 2014 – Jun 2018

- GPA: 3.84/4.00 (Rank: 4/71); selected to Elite Engineering Program (top 5%)

## PUBLICATIONS

### Machine Learning

1. K. Zha\*, **Z. Gao\***, M. Shen, Z.-W. Hong, D. S. Boning, and D. Katabi, “RL Tango: Reinforcing Generator and Verifier Together for Language Reasoning,” *Conference on Neural Information Processing Systems (NeurIPS)*, 2025. [\[PDF\]](#)[\[Code\]](#) (\*Equal Contribution)
2. H. Ye, **Z. Gao**, M. Ma, Q. Wang, Y. Fu, M.-Y. Chung, Y. Lin, Z. Liu, J. Zhang, D. Zhuo, and Y. Chen, “Training-free Online KV-cache Communication for Efficient LLM-based Multi-agent System,” *Conference on Neural Information Processing Systems (NeurIPS)*, 2025.
3. **Z. Gao**, K. Zha, T. Zhang, Z. Xue, and D. S. Boning, “REG: Rectified Gradient Guidance for Conditional Diffusion Models,” *International Conference on Machine Learning (ICML)*, 2025. [\[PDF\]](#)[\[Code\]](#)
4. S. Zheng\*, **Z. Gao\***, F.-K. Sun, D. S. Boning, B. Yu, and M. Wong, “Improving Neural ODE Training with Temporal Adaptive Batch Normalization,” *Conference on Neural Information Processing Systems (NeurIPS)*, 2024. [\[PDF\]](#)[\[Code\]](#) (\*Equal Contribution)
5. H. Lin, C. Liu, C. Xu, **Z. Gao**, Y. Fu, and Y. Yao, “On the Theory of Cross-Modality Distillation with Contrastive Learning,” *International Conference on Learning Representations BGPT workshop*, 2024. [\[PDF\]](#)
6. C.-Y. Lai, F.-K. Sun, **Z. Gao**, J. Lang, and D. S. Boning, “Nominality Score Conditioned Time Series Anomaly Detection by Point/Sequential Reconstruction,” *Conference on Neural Information Processing Systems (NeurIPS)*, 2023. [\[PDF\]](#)[\[Code\]](#)
7. Z. Xue\*, **Z. Gao\***, S. Ren\*, and H. Zhao, “The Modality Focusing Hypothesis: Towards Understanding Crossmodal Knowledge Distillation,” *International Conference on Learning Representations (ICLR)*, 2023. [\[PDF\]](#) [\[Code\]](#) (\*Equal Contribution, **ICLR Spotlight**)
8. **Z. Gao**, F. Sun, M. Yang, S. Ren, Z. Xiong, M. Engeler, A. Burazer, L. Wildling, L. Daniel, and D. S. Boning, “Learning from Multiple Annotator Noisy Labels via Sample-wise Label Fusion,” *European Conference on Computer Vision (ECCV)*, 2022. [\[PDF\]](#) [\[Code\]](#)
9. J. Gu, **Z. Gao**, C. Feng, H. Zhu, R. T. Chen, D. S. Boning, and D. Z. Pan, “NeurOLight: A Physics-Agnostic Neural Operator Enabling Parametric Photonic Device Simulation,” *Conference on Neural Information Processing Systems (NeurIPS)*, 2022. [\[PDF\]](#) [\[Code\]](#)
10. S. Ren, H. Wang, **Z. Gao**, S. He, A. Yuille, Y. Zhou, and C. Xie, “A Simple Data Mixing Prior for Improving Self-Supervised Learning,” *IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR)*, 2022. [\[PDF\]](#) [\[Code\]](#)
11. S. Ren, **Z. Gao**, T. Hua, Z. Xue, Y. Tian, S. He, and H. Zhao, “Co-Advise: Cross Inductive Bias Distillation,”

- IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR)*, 2022. [\[PDF\]](#) [\[Code\]](#)
12. Z. Xue, S. Ren, **Z. Gao**, and H. Zhao, "Multimodal Knowledge Expansion," *IEEE International Conference on Computer Vision (ICCV)*, 2021. [\[PDF\]](#) [\[Code\]](#)

## Design Automation for Electronic & Photonic Integrated Circuits

1. P. Ma, Z. Yin, Q. Jing, **Z. Gao**, N. Gangi, B. Zhang, T.-W. Huang, Z. Huang, D. S. Boning, Y. Yao, and J. Gu, "SP<sup>2</sup>RINT: Spatially-Decoupled Physics-Inspired Progressive Inverse Optimization for Scalable, PDE-Constrained Meta-Optical Neural Network Training," *Arxiv Preprint*, 2025. [\[PDF\]](#)
2. **Z. Gao**, J. Gu, L. Daniel, R. Rohrer, and D. S. Boning, "SPIPE: Differentiable SPICE-Level Co-Simulation Program for Integrated Photonics and Electronics," *IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems (IEEE TCAD)*, 2025. [\[PDF\]](#)
3. P. Ma, **Z. Gao**, M. Zhang, H. Yang, M. Ren, R. Huang, D. S. Boning, and J. Gu, "MAPS: Multi-Fidelity AI-Augmented Photonic Simulation and Inverse Design Infrastructure," *Design, Automation & Test in Europe Conference (DATE)*, 2025. [\[PDF\]](#)
4. P. Ma, **Z. Gao**, A. Begovic, M. Zhang, H. Yang, M. Ren, R. Huang, D. S. Boning, and J. Gu, "BOSON<sup>-1</sup>: Understanding and Enabling Physically-Robust Photonic Inverse Design with Adaptive Variation-Aware Subspace Optimization," *Design, Automation & Test in Europe Conference (DATE)*, 2025. [\[PDF\]](#)
5. P. Ma, H. Yang, **Z. Gao**, J. Gu, and D. S. Boning, "PIC<sup>2</sup>O-Sim: A Physics-Inspired Causality-Aware Dynamic Convolutional Neural Operator for Ultra-Fast Photonic Device Time-Domain Simulation," *APL Photonics*, 2025. [\[PDF\]](#)
6. **Z. Gao**, Z. Zhang, Z. He, J. Gu, D. Z. Pan, and D. S. Boning, "Selecting Robust Silicon Photonic Designs after Bayesian Optimization without Extra Simulations," *Optica Express (OE)*, 2024. [\[PDF\]](#) (Editor's Pick)
7. **Z. Gao**, F. Sun, R. Rohrer, and D. S. Boning, "KirchhoffNet: A Scalable Ultra Fast Analog Neural Network," *IEEE/ACM International Conference on Computer-Aided Design (ICCAD)*, 2024 [\[PDF\]](#)[\[Code\]](#) (ML and System Rising Star 2024)
8. **Z. Gao**, X. Chen, Z. Zhang, U. Chakraborty, W. Bogaerts, and D. S. Boning, "Gradient-Based Power Efficient Functional Synthesis for Programmable Photonic Circuits," *IEEE Journal of Lightwave Technology (IEEE JLT)*, 2024. [\[PDF\]](#)
9. **Z. Gao**, D. Zhang, L. Daniel, and D. S. Boning, "NOFIS: Normalizing Flow for Rare Circuit Failure Analysis," *Design Automation Conference (DAC)*, 2024. [\[PDF\]](#)[\[Code\]](#) (MIT MARC 2024 Best Pitch Award)
10. **Z. Gao**, X. Chen, Z. Zhang, C. Y. Lai, U Chakraborty, W. Bogaerts, and D. S. Boning, "Provable Routing Analysis of Programmable Photonics," *IEEE Journal of Lightwave Technology (IEEE JLT)*, 2024. [\[PDF\]](#)
11. **Z. Gao**, Z. Zhang, and D. S. Boning, "Few-Shot Bayesian Performance Modeling for Silicon Photonic Devices Under Process Variation," *IEEE Journal of Lightwave Technology (IEEE JLT)*, 2023. [\[PDF\]](#)
12. J. Li\*, D. Ahsanullah\*, **Z. Gao\***, and R. Rohrer, "Circuit Theory of Time Domain Adjoint Sensitivity," *IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems (IEEE TCAD)*, 2023. [\[PDF\]](#) (\*Equal Contribution)
13. Z. Zhang, M. Notaros, **Z. Gao**, U. Chakraborty, J. Notaros, and D. S. Boning, "Impact of Process Variations on Splitter-Tree-based Integrated Optical Phased Arrays," *Optica Express (OE)*, 2023. [\[PDF\]](#)
14. **Z. Gao**, X. Chen, Z. Zhang, U. Chakraborty, W. Bogaerts, and D. S. Boning, "Automatic Synthesis of Light Processing Functions for Programmable Photonics: Theory and Realization," *Photonics Research*, 2023. [\[PDF\]](#) [\[Code\]](#) (Editor's Pick)
15. C. Li, C. An, **Z. Gao**, F. Yang, Y. Su, and X. Zeng, "Unleashing the Power of Graph Spectral Sparsification for Power Grid Analysis via Incomplete Cholesky Factorization," *IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems (IEEE TCAD)*, 2023. [\[PDF\]](#)
16. **Z. Gao**, X. Chen, Z. Zhang, U. Chakraborty, W. Bogaerts, and D. S. Boning, "Automatic Synthesis of Light Processing Functions for Programmable Photonics," *IEEE Photonics Conference (IEEE IPC)*, 2022. [\[PDF\]](#)
17. **Z. Gao**, Z. Zhang, and D. S. Boning, "Automatic Synthesis of Broadband Silicon Photonic Devices via Bayesian Optimization," *IEEE Journal of Lightwave Technology (IEEE JLT)*, 2022. [\[PDF\]](#)[\[Code\]](#)
18. **Z. Gao**, Z. Zhang, and D. S. Boning, "Automatic Design of a Broadband Directional Coupler via Bayesian

- Optimization,” *Conference on Lasers and Electro-Optics (CLEO)*, 2022. [\[PDF\]](#)
19. Z. Liang, H. Wang, J. Cheng, Y. Ding, H. Ren, **Z. Gao**, Z. Hu, D. S. Boning, X. Qian, S. Han, W. Jiang, and Y. Shi, “Variational Quantum Pulse Learning,” *IEEE International Conference on Quantum Computing and Engineering (IEEE QCE)*, 2022. [\[PDF\]](#)
  20. **Z. Gao** and R. Rohrer, “Efficient Non-Monte-Carlo Yield Estimation,” *IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems (IEEE TCAD)*, 2021. [\[PDF\]](#)
  21. **Z. Gao**, J. Tao, Y. Su, D. Zhou, X. Zeng, and X. Li, “Fast Statistical Analysis of Rare Failure Events with Truncated Normal Distribution in High-Dimensional Variation Space,” *IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems (IEEE TCAD)*, 2021. [\[PDF\]](#)
  22. **Z. Gao**, Z. Chen, J. Tao, Y. Sun, D. Zhou, and X. Zeng, “Bayesian Inference on Introduced General Region: An Efficient Parametric Yield Estimation Method for Integrated Circuits,” *ACM/IEEE Asia and South Pacific Design Automation Conference (ASPDAC)*, 2021. [\[PDF\]](#)
  23. **Z. Gao**, J. Tao, D. Zhou, X. Zeng, and X. Li, “Efficient Rare Failure Analysis over Multiple Corners via Correlated Bayesian Inference,” *IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems (IEEE TCAD)*, 2020. [\[PDF\]](#) [\[Code\]](#)
  24. **Z. Gao**, J. Tao, D. Zhou, and X. Zeng, “Efficient Parametric Yield Estimation over Multiple Process Corners via Bayesian Inference Based on Bernoulli Distribution,” *IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems (IEEE TCAD)*, 2020. [\[PDF\]](#) [\[Code\]](#)
  25. Y. Li, X. Zeng, **Z. Gao**, L. Lin, J. Tao, J. Han, X. Cheng, M. Tahoori, and X. Zeng, “Exploring A Bayesian Optimization Framework Compatible with Digital Standard Flow for Soft-Error-Tolerant Circuit,” *IEEE/ACM Design Automation Conference (DAC)*, 2020. [\[PDF\]](#)
  26. **Z. Gao**, J. Tao, F. Yang, Y. Su, D. Zhou, and X. Zeng, “Efficient Performance Trade-Off Modeling for Analog Circuit Based on Bayesian Neural Network,” *IEEE/ACM International Conference on Computer Aided Design (ICCAD)*, 2019. [\[PDF\]](#)

## PROFESSIONAL EXPERIENCE

### Massachusetts Institute of Technology

Cambridge, USA

Research Assistant --- Supervisor: Prof. Duane S. Boning

Sep 2021 – Feb 2026 (expected)

- Created SPIPE, the first differentiable simulator for electronic–photonic integrated circuits.
- Developed automatic synthesis for programmable photonic circuits, highlighted by Photonic Research 2023.
- Applied Bayesian optimization and neural operators to optimize and model silicon photonic devices under fabrication variations, highlighted by Optica Express 2024.
- Co-designed and prototyped KirchhoffNet, a hardware accelerator for ODE-based generative models, demonstrating low latency and high energy efficiency, awarded MLSys rising star 2024.

### Apple Inc.

Sunnyvale, USA

AR/VR Hardware Engineering Intern --- Mentor: Dr. Luya Zhang

May 2025 – Aug 2025

- Co-designed hardware and an autoencoder to mitigate VisionPro display artifacts.
- Compressed the model by 15× and reduced runtime to 10% of the original without performance loss, enabling efficient on-device execution; deployed in the next-generation VisionPro.
- Developed an LLM-based automated test case generation pipeline for display algorithms, reducing manual inspection effort by 10× and improving bug detection efficiency.

### Nvidia Corporation

Austin, USA

Research Intern --- Manager: Dr. Mark H. Ren

Jun 2023 – Sep 2023

- Developed deep neural network model for semiconductor lithography.
- Produced a large-scale image translation model (> 1B) based on Pixel2Pixel and model compression technique.
- Achieved <0.02% MSE error on Nvidia proprietary chip layout dataset containing over 3M images.

### Shanghai Qizhi AI Institute

Shanghai, China

Research Intern --- Mentor: Prof. Hang Zhao (Tsinghua Univ.)

Mar 2021 – Jun 2021

- Exploited multimodal learning and knowledge distillation.
- Developed the modality focusing hypothesis (MFH), spotlighted at ICLR’23.

### Southern Methodist University

Remotely

Research Assistant --- Supervisor: Prof. Ron Rohrer

May 2020 – Sep 2021

- Proposed a novel circuit theory to re-explain the time-domain adjoint method.
- Analyzed parametric yield based on the adjoint method, achieving  $>10\times$  efficiency over MC approach.

#### **Baidu Inc.**

*Quality Assurance (QA) Engineering Intern*

Shanghai, China  
Jun 2017 – Sep 2017

- Measured the robustness of programs and took charge of the FEEDS project.

#### **Fudan University (State Key Laboratory of ASIC & System)**

*Research Assistant --- Supervisor: Prof. Jun Tao and Prof. Xin Li (Duke University)*

Shanghai, China  
Sep 2016 – Jul 2021

- Improved post-silicon yield estimation with domain adaptation technique.
- Estimated multi-corner failure rate and yield with Bayesian inference.
- Performed multi-objective optimization of analog circuits based on a Bayesian neural network.
- Optimized a time variant analog filter by hierarchical clustering (bachelor thesis).
- Developed an SRAM failure-rate estimation tool in collaboration with Prof. Xuan Zhang (WUSTL). [[see here](#)]

### **TEACHING EXPERIENCE**

#### **Massachusetts Institute of Technology**

*Teaching Assistant --- Head Instructor: Prof. Shen Shen*

Cambridge, USA  
Feb 2025 – May 2025

- Performed TA duties for 6.3900 Introduction to Machine Learning (~400 students).
- Led the Transformer module and contributed extensively to the course lecture notes on Github, ranking as the second-largest contributor as of August 2025.

#### **Fudan University**

*Teaching Assistant --- Instructor: Prof. Jun Xu*

Shanghai, China  
Sep 2019 – Jan 2020

- Performed TA duties for Design of Analog Integrated Circuits.

#### **Duke Kunshan University**

*Teaching Assistant --- Instructor: Prof. Dennis Quan (Duke Univ.)*

Kunshan, China  
Jan 2020 – Mar 2020

- Performed TA duties for Introduction to Programming & Data Structure at DKU.

### **MENTORING EXPERIENCE**

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|--|---------------------|
| • Ziang Chen, Fudan University B.E., now Ph.D. student at Fudan University | Sep 2019 – Jun 2021 |
| • Nanlin Guo, Fudan University B.E., now Ph.D. student at Fudan University | Sep 2019 – Jun 2021 |
| • Jiahe Shi, Fudan University B.E., now Ph.D. student at MIT EECS          | Sep 2019 – Jun 2021 |
| • Su Zheng, CUHK Ph.D. student   | Sep 2023 – Present  |
| • Michael Vogit, MIT B.S. student  | Mar 2024 – Aug 2024 |
| • Mohit Dighamber, MIT B.S., now at Google                                 | Sep 2024 – Present  |
| • Ferre Vanden Kerchove, Visiting Ph.D. student from IMEC                  | Dec 2024 – Present  |
| • Ziqin Li, University of Connecticut Ph.D. student                        | Mar 2025 – Present  |
| • Hancheng Ye, Duke University   | Mar 2025 – Present  |

### **SELECTED AWARDS AND HONORS**

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|---|------|
| • 1 <sup>st</sup> place, ACM/IEEE DAC Phd Forum   | 2025 |
| • Editor's highlight, Optica Express  | 2024 |
| • ML and Systems Rising Star, MLCommons   | 2024 |
| • Best Pitch Award, MIT Microsystem Annual Research Conference  | 2024 |
| • Oral (Spotlight) paper, International Conference on Learning Representations (top 5%)                 | 2023 |
| • Editor's highlight, Optica Photonics Research   | 2023 |
| • 2 <sup>nd</sup> place, CVPR'23 Ego4d TTM challenge  | 2023 |
| • DAC young fellowship  | 2023 |
| • Outstanding Graduates of Shanghai (top 5%)  | 2021 |
| • Biren Scholarship (3 awardees nationwide)   | 2020 |
| • The Integrated Circuits Scholarship, Chinese Institute of Electronics (44 awardees nationwide)        | 2020 |
| • National Scholarship, Fudan University (top 1%)   | 2020 |
| • Rising Star of Academic, Fudan University (awarded to 11 graduate students majoring in Sci. & Engi.)  | 2020 |
| • Pacemaker to Merit Student, Fudan University (awarded to 15 graduate students)                        | 2019 |
| • First Prize Scholarship, Fudan University (top 5%)  | 2019 |
| • National Gold Award, China "Internet+" College Student Innovation & Entrepreneur Competition (top 5%) | 2018 |

- National 2<sup>nd</sup> Prize, China Post-Graduate Mathematical Contest in Modeling (top 15%) 2018
- Outstanding Undergraduates of Shanghai (top 5%) 2018
- Meritorious Winner, American Mathematical Contest in Modeling (top 13%) 2017
- Top 11%, 2017 IEEE Xtreme Global Programming Competition (out of 3,350 teams worldwide) 2017
- First Prize Scholarship, Fudan University (top 5%) 2015, 2016, 2017
- National 2<sup>nd</sup> prize, China Mathematical Contest in Modeling (top 15%) 2016

## REPRESENTATIVE EXTRACURRICULAR PROJECTS

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**PRML Solution Manual (GitHub ~1k Stars)** Shanghai, China  
*An Original Solution Manual for Pattern Recognition and Machine Learning (PRML)* Sep 2017 – Present

- Solved nearly all exercises in *PRML*; used as references by instructors and students globally. [[see here](#)]

**Auto-Grading System** Kunshan, China  
*An Auto-Grading System Developed at DKU* Jan 2020 – Mar 2020

- Led a small TA group to develop an auto-grading system based on the source code of Submittify.

**“Dr. Stanley’s House” (Puzzle Video Game) Written in Haskell** Shanghai, China  
*Final Project for Introduction to Functional Programming: From C/C++ to Haskell* Sep 2018 – Jan 2019

- Implemented the game with a complete plot via Haskell. [[see here](#)]
- Organized the program structure, sorted the logic, and set the schedule as the team leader.
- Exploited Haskell libraries (e.g., SDL2, SDL2-ttf, and SDL2-mixer) to add music and animation.

## ADDITIONAL INFORMATION

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### Professional Services

- Reviewers: IEEE TCAD, ACM TODAES, ICCV, CVPR, NeurIPS, ICML, etc.,
- Organizers:
  - [Optical/Photonics Computing System Seminar Series](#) (2023 – present), with Jiaqi Gu
  - DAC 2023 tutorial on optical computing, with Jiaqi Gu, Ulf Schlichtmann, Cunxi Yu
  - DAC 2025 workshop on AI and circuit, with Zhou Jin, Mark Ren, Yiran Chen, Ron Rohrer
  - MIT MIMO Symposium Student Research Forum (2022), with Fan-keng Sun and others
- Selected invited talks:
  - Conference presentation: ICCAD’19 & 24, ECCV’22, DAC’23, ICLR’23, ICML’25, etc.,
  - ‘Programmable Photonic Synthesis’, at DAC 2023 tutorial on optical computing
  - ‘Bayesian Optimization for Photonic Devices,’ with Ansys Lumerical, 2022 (host: Jens Niegemann)
  - ‘Bayes Elegance in Semiconductor Manufacturing’, in Lam Research webinar, 2023 (host: Joe Lu)
  - ‘KirchhoffNet’, at Duke Mini-Workshop on ML for Analog Circuit Design, 2025 (host: Yiran Chen)

### Miscellaneous

- Programming languages & software: C/C++, MATLAB, Python, HSPICE, SPECTRE, Lumerical, Verilog, etc.,
- Languages: Mandarin Chinese (native), English (proficient)
- Volunteer teaching in a rural area of Henan Province, China (Jun – Jul 2015)
- Graduate housing officer, Ashdown House, MIT (Mar 2022 – Sep 2024)

## REFERENCES

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Duane S. Boning, Ph.D., IEEE Fellow (Advisor)  
 Clarence J. LeBel Professor in EECS, MIT  
 MIT Vice Provost  
[boning@mtl.mit.edu](mailto:boning@mtl.mit.edu)

Luca Daniel, Ph.D., IEEE Fellow  
 Professor of EECS, MIT  
[dluca@mit.edu](mailto:dluca@mit.edu)

Yiran Chen, Ph.D., AAAS, ACM, IEEE, and NAI Fellow  
 John Cocke Distinguished Professor  
 Department of ECE, Duke University  
[yiran.chen@duke.edu](mailto:yiran.chen@duke.edu)

Ron Rohrer, Ph.D., IEEE Life Fellow, NAE Member  
 Professor Emeritus of ECE, CMU  
 Associate Director CHES, UT Dallas  
[rr1j@andrew.cmu.edu](mailto:rr1j@andrew.cmu.edu)

Dirk Englund, Ph.D., IEEE and OPTICA Fellow  
 Professor of EECS, MIT  
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David Z. Pan, Ph.D., ACM, IEEE, and SPIE Fellow  
 Silicon Laboratories Endowed Chair Professor  
 Department of ECE, UT Austin  
[dpan@ece.utexas.edu](mailto:dpan@ece.utexas.edu)