

YONGSHAN DING

August, 2021

CURRENT POSITION

Assistant Professor of Computer Science, Yale University

Yale University
Computer Science Department
51 Prospect St, New Haven, CT 06511

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RESEARCH AREAS

My research interests are in the areas of **computer architecture** and **algorithms**, particularly in the context of **quantum computing**. My work spans broadly in the theory and application of quantum error correction, efficient and reliable quantum memory management, and optimizations at the quantum hardware/software interface.

EDUCATION

Ph.D., University of Chicago

Department of Computer Science
Thesis: *Architecting Quantum Computing Systems in the Presence of Noise*
Advisor: Frederic T. Chong

Chicago, IL
2016 - 2021

B.Sc., Carnegie Mellon University

Dual degree in Physics and Computer Science
University Honors, MCS and SCS College Honors
Thesis: *Quantum Algorithms on Boolean Matrix Product Verification*
Advisor: Ryan O'Donnell

Pittsburgh, PA
2012 - 2016

PROFESSIONAL EXPERIENCE

Assistant Professor, Yale University, Comp. Sci. Dept. , 2021 - Present	New Haven, CT
Visiting Scientist, Simons Institute for the Theory of Computing , Summer 2021	Berkeley, CA
Visiting Scholar, Massachusetts Institute of Technology, Phys.&Math. Dept. , 2020	Cambridge, MA
PhD Candidate, University of Chicago, Comp. Sci. Dept. , 2016 - 2021	Chicago, IL
Undergraduate Researcher, Carnegie Mellon University, Comp. Sci. Dept. , 2015 - 2016	Pittsburgh, PA
Undergraduate Researcher, Carnegie Mellon University, Phys. Dept. , Summer 2014	Pittsburgh, PA

AWARDS AND HONORS

- IEEE Micro Top Picks in Computer Architecture of 2020, Honorable Mention** 2021
for the paper *Systematic Crosstalk Mitigation for Superconducting Qubits via Frequency-Aware Compilation* with P. Gokhale et al.

2. **IEEE Micro Top Picks in Computer Architecture of 2020, Honorable Mention** 2021
for the paper *SQUARE: Strategic Quantum Ancilla Reuse for Modular Quantum Programs via Cost-Effective Uncomputation* with X.-C. Wu et al.
3. **Siebel Scholarship** (\$35,000) 2020-2021
Thomas and Stacey Siebel Foundation
4. **William Rainey Harper Dissertation Fellowship** (\$4,300) 2020-2021
University of Chicago
5. **QCE Best Paper Award and IBM Q Best Paper Award, First Prize** 2019
for the paper *Minimizing State Preparations in Variational Quantum Eigensolver by Partitioning into Commuting Families* with P. Gokhale et al.
6. **University Honors, SCS College Honors, MCS College Honors** 2016
Carnegie Mellon University
7. **College Dean's List, High Honors** 2012 - 2016
Carnegie Mellon University
8. **Mathematics Competition, Runner Up** 2016
for my undergrad thesis *Quantum Algorithms on Boolean Matrix Product Verification*
9. **Sigma Xi Poster Competition, Second Prize** 2015
for the paper *Analysis of Reconstructed J/ψ Meson Candidates in $p\bar{p}$ Collisions*

TEACHING

- Instructor:** Quantum Computer Systems (CPSC 647) Fall 2021
Computer Science Department, **Yale University**
- Co-Instructor:** Intro to Quantum Computing Systems In Preparation
MOOC at edX.org, **University of Chicago** (with F. T. Chong)
- Guest Lecturer/Teaching Assistant:** Quantum Information Science II (MIT 8.371) Spring 2020
Department of Physics, **Massachusetts Institute of Technology** (with I. Chuang)
- Co-Instructor:** Novel Computing Architectures and Technologies (CMSC 33001-1) Fall 2018
Computer Science Department, **University of Chicago** (with F. T. Chong)
- Teaching Assistant:** Honors Intro to Computer Science II (CMSC 16200) Winter 2019
Computer Science Department, **University of Chicago**
- Teaching Assistant:** Honors Intro to Computer Science II (CMSC 16200) Winter 2018
Computer Science Department, **University of Chicago**
- Teaching Assistant:** Honors Intro to Computer Science II (CMSC 16200) Winter 2017
Computer Science Department, **University of Chicago**
- Head Teaching Assistant:** Parallel and Sequential Data Structures and Algorithms (15-210) Spring 2016
Computer Science Department, **Carnegie Mellon University**
- Head Teaching Assistant:** Parallel and Sequential Data Structures and Algorithms (15-210) Fall 2015
Computer Science Department, **Carnegie Mellon University**

Teaching Assistant: Parallel and Sequential Data Structures and Algorithms (15-210)
Computer Science Department, **Carnegie Mellon University**

Spring 2015

Academic Coach: Level II/Advanced Tutor
Academic Development, **Carnegie Mellon University**

2013 - 2016

PROFESSIONAL SERVICE

Program Committee

- Architectural Support for Programming Languages and Operating Systems (**ASPLOS**) 2022
- IEEE International Symposium on Workload Characterization (**IISWC**) 2021
- IEEE International Conference on Quantum Computing and Engineering (**QCE**) 2021

Journal Refereeing

- Physical Review A (PRA)
- Physical Review X Quantum (PRX Quantum)
- Physical Review Research (PRResearch)
- Nature Partner Journals (NPJ Quantum Information)

PUBLISHED BOOK

Quantum Computer Systems: Research for Noisy Intermediate-Scale Quantum Computers

June 2020

Y. Ding and F. T. Chong

Morgan & Claypool Publishers, DOI: 10.2200/S01014ED1V01Y202005CAC051

This book celebrates the remarkable progress that scientists across disciplines have made in the past decades and reveals what roles computer scientists and engineers can play to enable practical-scale quantum computing.

REFEREED PUBLICATIONS

1. **QuantumNAS: Noise-Adaptive Search for Robust Quantum Circuits** July 2021
H. Wang, Y. Ding, J. Gu, Y. Lin, D. Pan, F. T. Chong, and S. Han
Manuscript

2. **TILT: Achieving Higher Fidelity on a Trapped-Ion Linear-Tape Quantum Computing Architecture** February 2021
X.-C. Wu, D. Debroy, Y. Ding, J. M. Baker, Y. Alexeev, K. R. Brown, and F. T. Chong
In Proceedings of 27th Intl. Symposium on High-Performance Computer Architecture (**HPCA '21**). Acceptance rate: $62/258=24\%$.

2020

3. $O(N^3)$ **Measurement Cost for Variational Quantum Eigensolver on Molecular Hamiltonians** November 2020
P. Gokhale, O. Angiuli, Y. Ding, K. Gui, T. Tomesh, M. Suchara, M. Martonosi, and F. T. Chong
In IEEE Transactions on Quantum Engineering (**TQE '20**)

4. **Systematic Crosstalk Mitigation for Superconducting Qubits via Frequency-Aware Compilation** October 2020
 Y. Ding, P. Gokhale, S. F. Lin, R. Rines, T. Propson, and F. T. Chong
 In Proceedings of 53rd Intl. Symposium on Microarchitecture (**MICRO '20**). Acceptance rate: 82/424=19%.
 Award: **IEEE Micro Top Picks, Honorable Mention**

5. **Minimizing State Preparations in Variational Quantum Eigensolver by Partitioning into Commuting Families** October 2020
 P. Gokhale, O. Angiuli, Y. Ding, K. Gui, T. Tomesh, M. Suchara, M. Martonosi, and F. T. Chong
 In IEEE Intl. Conference on Quantum Computing and Engineering (**QCE '20**)
 Award: **QCE Best Paper Award and IBM Q Best Paper Award, First Prize**

6. **Resource-Efficient Quantum Computing by Breaking Abstractions** June 2020
 Y. Shi, P. Gokhale, P. Murali, J. M. Baker, C. Duckering, Y. Ding, N. C. Brown, C. Chamberland, A. Javadi-Abhari, A. Cross, D. I. Schuster, K. R. Brown, M. Martonosi, and F. T. Chong
 In Proceedings of the IEEE. Invited Paper. (**IEEE '20**)

7. **SQUARE: Strategic Quantum Ancilla Reuse for Modular Quantum Programs via Cost-Effective Uncomputation** May 2020
Y. Ding, X.-C. Wu, A. Holmes, A. Wiseth, D. Franklin, M. Martonosi, and F. T. Chong
 In Proceedings of 47th Intl. Symposium on Computer Architecture (**ISCA '20**). Acceptance rate: 77/421=18%.
 Award: **IEEE Micro Top Picks, Honorable Mention**

8. **NISQ+: Boosting Quantum Computing Power by Approximating Quantum Error Correction** May 2020
 A. Holmes, M. R. Jokar, G. Pasandi, Y. Ding, M. Pedram, and F. T. Chong
 In Proceedings of 47th Intl. Symposium on Computer Architecture (**ISCA '20**). Acceptance rate: 77/421=18%.

- 2019**
9. **Partial Compilation of Variational Algorithms for Noisy Intermediate-Scale Quantum Machines** October 2019
 P. Gokhale, Y. Ding, T. Propson, C. Winkler, N. Leung, Y. Shi, D. I. Schuster, H. Hoffmann, and F. T. Chong
 In Proceedings of 52nd Intl. Symposium on Microarchitecture (**MICRO '19**). Acceptance rate: 80/345=23%.

10. **Resource Optimized Quantum Architectures for Surface Code Implementations of Magic-State Distillation** February 2019
 A. Holmes, Y. Ding, A. Javadi-Abhari, D. Franklin, M. Martonosi, and F. T. Chong
 Microprocessors and Microsystems (**MICPRO '19**)

- 2018**
11. **Magic-State Functional Units: Mapping and Scheduling Multi-Level Distillation Circuits for Fault-Tolerant Quantum Architectures** October 2018
Y. Ding, A. Holmes, A. Javadi-Abhari, D. Franklin, M. Martonosi, and F. T. Chong
 In Proceedings of the 51st Intl. Symposium on Microarchitecture (**MICRO '18**). Acceptance rate: 74/351=21%.

12. **Charm: A Language for Closed-form High-level Architecture Modeling** June 2018
 W. Cui, Y. Ding, D. Dangwal, A. Holmes, J. McMahan, A. Javadi-Abhari, G. Tzimpragos, F. T. Chong, and T. Sherwood
 In Proceedings of the 45th Intl. Symposium on Computer Architecture (**ISCA '18**). Acceptance rate:

DISSERTATION AND OTHER ARTICLES

1. **Architecting Quantum Computer Systems in the Presence of Noise** August 2021
Y. Ding (Advisor: F. T. Chong)
UChicago PhD Dissertation
2. **Putting Qubits to Work – Quantum Memory Management** July 2020
Y. Ding, F. T. Chong
ACM SIGARCH
3. **The Case for Quantum Computing** January 2019
F. T. Chong, K. R. Brown, Y. Ding
ACM SIGARCH
4. **Quantum Algorithms on Boolean Matrix Product Verification** May 2016
Y. Ding (Advisor: R. O'Donnell)
CMU Undergraduate Thesis
Award: **Mathematics Competition, Runner Up**
5. **Analysis of Reconstructed J/ψ Meson Candidates in $p\bar{p}$ Collisions** August 2014
Y. Ding (Advisor: J. Russ)
Award: **Sigma Xi Poster Competition, Second Prize**

INVITED TALKS

1. **Architecting Quantum Computer Systems in the Presence of Noise** Spring 2021
Invited seminar talks, in the reverse chronological order. (Virtual)
 - University of Michigan Host: Ron Dreslinski
 - University of Illinois, Urbana-Champaign Host: Chris Fletcher
 - University of Washington Host: Georg Seelig
 - Yale University Host: Lin Zhong
 - ETH Zürich Host: Kenny Paterson
 - University of Maryland, College Park Host: Xiaodi Wu
 - Stony Brook University Host: C.R. Ramakrishnan
 - University of Pennsylvania Host: Steve Zdancewic
 - North Carolina State University Host: Frank Mueller
 - University of Pittsburgh Host: Xulong Tang
 - University of Notre Dame Host: Peter Kogge
 - Tufts University Host: Peter Love
 - Pennsylvania State University Host: Anand Sivasubramaniam

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| 2. Systematic Crosstalk Mitigation
Invited seminar talk at Quantum Information Science and Engineering Seminar Series, Chicago Quantum Exchange (CQE), Chicago, IL. (Virtual) | November 2020
Host: Gabrielle Roberts |
| 3. Systematic Crosstalk Mitigation
Invited seminar talk at AQT, Lawrence Berkeley National Lab (LBNL), Berkeley, CA. (Virtual) | October 2020
Host: Costin Iancu |
| 4. Systematic Crosstalk Mitigation
Conference Talk at MICRO '20 , Athens, Greece. (Virtual) | October 2020
Host: Yipeng Huang |
| 5. Systematic Crosstalk Mitigation
Invited seminar talk at QIP Club, Chicago Quantum Exchange (CQE), Chicago, IL. (Virtual) | September 2020
Host: Kevin Gui |
| 6. Strategic Quantum Ancilla Reuse
Conference talk at ISCA '20 , Valencia, Spain. (Virtual) | June 2020
Host: Moin Qureshi |
| 7. Magic State Distillation and Arbitrary-Angle Magic States
Invited talk at QIP meeting, MIT , Cambridge, MA. | March 2020
Host: Aram Harrow |
| 8. Architecting Quantum Computing Systems
Invited talk at Quanta meeting, MIT , Cambridge, MA. | January 2020
Host: Isaac Chuang |
| 9. Architecting our way up the quantum ladder: from NISQ to FT quantum computers
Invited seminar talk at NC State , Raleigh, NC. | March 2019
Host: Frank Mueller |
| 10. Magic-state functional units
Conference talk at MICRO '18 , Fukuoka, Japan. | October 2018
Host: Masaaki Kondo |

OTHER TALKS AND PRESENTATIONS

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| 1. ILP-Based Scheduling for Linear-Tape Model Trapped-Ion Quantum Computers
Poster talk at SC '19 conference, Denver, CO. (With X.-C. Wu) | November 2019 |
| 2. Improved Noise Simulation via Clifford+C3 Sampling
Poster talk at QEC 19 conference, London, UK. (With A. Holmes) | July 2019 |
| 3. Significance and Challenges in Quantum Computing Education
Invited as one of the three panelists at WCAE '19 workshop, Phoenix, AZ. (With Ronald Barnes and Aviral Shrivastava) | June 2019 |
| 4. Partial Compilation of Variational Algorithms
Poster talk at MICRO '19 conference, Columbus, OH. (With P. Gokhale) | October 2019 |
| 5. Dynamic Memory Manager for Quantum Programs with Nested Parallelism
Poster talk at STAQ meeting, Durham, NC. | December 2018 |
| 6. Magic-State Functional Units
Talk at EPiQC monthly meeting, Chicago, IL. (With A. Holmes) | October 2018 |
| 7. Resource Optimized Quantum Architectures for Surface Code Error Correction
Master examination at University of Chicago, Chicago, IL. (With A. Holmes) | October 2018 |

8. **Optimizing Rotation Gate Generation on Quantum Machines** April 2018
Poster talk at **GCASR '18**, Chicago, IL. (With M. Fensterstock)
9. **On Quantum Algorithms for Boolean Matrix Product Verification** May 2016
Talk at SCS Honors Undergraduate Thesis Research at Carnegie Mellon University, Pittsburgh, PA
10. **On Quantum Algorithms for Boolean Matrix Product Verification** May 2016
Poster talk at Meeting-of-Minds Research Symposium, Carnegie Mellon University, Pittsburgh, PA
11. **Analysis of Reconstructed J/Psi Meson Candidates in Proton Anti-Proton Collisions** May 2015
Poster talk at Meeting-of-Minds Research Symposium, Carnegie Mellon University, Pittsburgh, PA

PATENT FILED

- **System and Method of Partial Compilation with Variational Algorithms for Quantum Computers**
F. T. Chong, P. Gokhale, Y. Ding and T. Propson Filed 2019

PROFESSIONAL MEMBERSHIPS

- IEEE Member
- ACM Member, ACM SIGARCH
- APS Member, Division of Quantum Information (DQI)

PRESS

1. **Three EPIQC Papers Chosen By IEEE Micro for Annual Top Picks Awards** (Link)
UChicago May 2021
2. **Quantum computer systems interview** (Link)
ODBMS.org November 2020
3. **New textbook advances ‘quantum computer systems design’ to get the most out of quantum hardware** (Link)
ScienceX July 2020
4. **New Book – Quantum Computer Systems** (Link)
ACM SIGARCH July 2020
5. **IBM Quantum Award Winners Announced** (Link)
IBM Research March 2020
6. **Research by University of Chicago PhD Student and EPIQC Wins IBM Q Best Paper** (Link)
HPCWire March 2020
7. **New Compiler Makes Quantum Computers Two Times Faster** (Link)
Phys.org October 2019
8. **UChicago-Developed Compiler Makes Quantum Computers 2x Faster** (Link)
UChicago October 2019

1. **FastSC: Frequency-Aware Synthesis Toolbox for Superconducting Quantum Computers (Link)** August 2020
Y. Ding, P. Gokhale, S. F. Lin, R. Rines, T. Propson, and F. T. Chong
2. **ScaffCC: Scaffold Compiler Collection (Link)** June 2018
A. Javadi-Abhari, A. Holmes, S. Patil, J. Heckey, D. Kudrow, P. Gokhale, D. Noursi, L. Ehudin, Y. Ding, X.-C. Wu, Y. Shi, M. Martonosi, and F. T. Chong
3. **A Scalable Storage Framework with Intermittent Cloud Resources** Autumn 2016
University of Chicago, Intermittent Cloud Computing (CMSC 33001)
4. **VecAndroid: An Android API for SIMD parallelism on ARM processors (Link)** Spring 2016
Y. Ding, and J. Song. Carnegie Mellon University, Parallel Computer Architecture and Programming (15-418)
5. **A Multilevel Classification Approach on CIFAR-10 Data** Fall 2014
Carnegie Mellon University, Introduction to Machine Learning (10-601)
6. **Fulfilly: A Time-Management and Productivity Software** Spring 2013
Carnegie Mellon University, Fundamentals of Programming (15-112)