

2023 IEEE International Conference on Quantum Software (QSW 2023)

**Chicago, Illinois, USA
2-8 July 2023**



**IEEE Catalog Number: CFP23BY1-POD
ISBN: 979-8-3503-0480-0**

**Copyright © 2023 by the Institute of Electrical and Electronics Engineers, Inc.
All Rights Reserved**

Copyright and Reprint Permissions: Abstracting is permitted with credit to the source. Libraries are permitted to photocopy beyond the limit of U.S. copyright law for private use of patrons those articles in this volume that carry a code at the bottom of the first page, provided the per-copy fee indicated in the code is paid through Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923.

For other copying, reprint or republication permission, write to IEEE Copyrights Manager, IEEE Service Center, 445 Hoes Lane, Piscataway, NJ 08854. All rights reserved.

****** This is a print representation of what appears in the IEEE Digital Library. Some format issues inherent in the e-media version may also appear in this print version.***

IEEE Catalog Number:	CFP23BY1-POD
ISBN (Print-On-Demand):	979-8-3503-0480-0
ISBN (Online):	979-8-3503-0479-4

Additional Copies of This Publication Are Available From:

Curran Associates, Inc
57 Morehouse Lane
Red Hook, NY 12571 USA
Phone: (845) 758-0400
Fax: (845) 758-2633
E-mail: curran@proceedings.com
Web: www.proceedings.com

CURRAN ASSOCIATES INC.
proceedings
.com

2023 IEEE International Conference on Quantum Software (QSW) **QSW 2023**

Table of Contents

Steering Committee Chair Message	ix
Congress General Chairs Message	x
Congress Program Chairs Message	xi
TCSVC Chair Message	xii
QSW 2023 Chairs Message	xiii
QSW 2023 Committees	xiv

QSW Conference Papers

Quantum Software Development (QSW1)

Middleware for Quantum: An Orchestration of Hybrid Quantum-Classical Systems	1
<i>Ismael Faro (IBM Quantum), Iskandar Sitdikov (IBM Quantum; IBM T.J. Watson Research Center, USA), David Garcia Valiñas (IBM Quantum; IBM T.J. Watson Research Center, USA), Francisco Jose Martin Fernandez (IBM Quantum; IBM T.J. Watson Research Center, USA), Christopher Codella (IBM Quantum; IBM T.J. Watson Research Center, USA), and Jennifer Glick (IBM Quantum; IBM T.J. Watson Research Center, USA)</i>	
Agile Practices for Quantum Software Development: Practitioners' Perspectives	9
<i>Arif Ali Khan (University of Oulu, Finland), Muhammad Azeem Akbar (LUT University, Finland), Aakash Ahmad (Lancaster University Leipzig, Germany), Mahdi Fahmideh (School of Business at University of Southern Queensland, Australia), Mohammad Shameem (Department of CSE, Koneru Lakshmaiah Education Foundation, India), Valtteri Lahtinen (Quanscient Oy, Finland), Muhammad Waseem (University of Jyväskylä, Finland), and Tommi Mikkonen (University of Jyväskylä, Finland)</i>	
iQuantum: A Case for Modeling and Simulation of Quantum Computing Environments	21
<i>Hoa T. Nguyen (The University of Melbourne, Australia), Muhammad Usman (The University of Melbourne; Data61, CSIRO, Australia), and Rajkumar Buyya (The University of Melbourne, Australia)</i>	

Quantum Software Analysis (QSW2)

Effects of Imperfections on Quantum Algorithms: A Software Engineering Perspective	31
<i>Felix Greive (Technical University of Applied Sciences Regensburg, Germany), Tom Krüger (Technical University of Applied Sciences Regensburg, Germany), and Wolfgang Mauerer (Technical University of Applied Sciences Regensburg; Siemens AG, Technology, Germany)</i>	
Predicting Good Quantum Circuit Compilation Options	43
<i>Nils Quetschlich (Technical University of Munich, Germany), Lukas Burgholzer (Johannes Kepler University Linz, Austria), and Robert Wille (Technical University of Munich, Germany; Software Competence Center Hagenberg GmbH (SCCH), Austria)</i>	
A Testing Pipeline for Quantum Computing Applications	54
<i>Colin Kai-Uwe Becker (Fraunhofer Institute for Open Communication Systems (FOKUS)), Ilie-Daniel Gheorghe-Pop (Fraunhofer Institute for Open Communication Systems (FOKUS)), and Nikolay Tcholtchev (Fraunhofer Institute for Open Communication Systems (FOKUS))</i>	
Recommending Solution Paths for Solving Optimization Problems with Quantum Computing	60
<i>Benedikt Poggel (Fraunhofer Institute for Cognitive Systems IKS, Germany), Nils Quetschlich (Technical University of Munich, Germany), Lukas Burgholzer (Institute for Integrated Circuits, Johannes Kepler University Linz, Austria), Robert Wille (Technical University Munich, Germany; Software Competence Center Hagenberg GmbH (SCC), Austria), and Jeanette Miriam Lorenz (Fraunhofer Institute for Cognitive Systems IKS, Germany)</i>	

Quantum Machine Learning (QSW3)

An Empirical Study of Bugs in Quantum Machine Learning Frameworks	68
<i>Pengzhan Zhao (Kyushu University, Japan), Xiongfei Wu (Kyushu University, Japan), Junjie Luo (Kyushu University, Japan), Zhuo Li (Kyushu University, Japan), and Jianjun Zhao (Kyushu University, Japan)</i>	
LAWS: Look Around and Warm-Start Natural Gradient Descent for Quantum Neural Networks	76
<i>Zeyi Tao (William and Mary), Jindi Wu (William and Mary), and Qun Li (William and Mary)</i>	
Reinforcement Learning for Continuous Control: A Quantum Normalized Advantage Function Approach	83
<i>Yaofu Liu (Hong Kong University of Science and Technology, China), Chang Xu (Hong Kong University of Science and Technology, China), and Siyuan Jin (Hong Kong University of Science and Technology, China)</i>	

Architecture of Quantum Software (QSW4)

Architectural Vision for Quantum Computing in the Edge-Cloud Continuum	88
<i>Alireza Furutanpey (TU Vienna), Johanna Barzen (University of Stuttgart), Marvin Bechtold (University of Stuttgart), Schahram Dustdar (TU Vienna), Frank Leymann (University of Stuttgart), Philipp Raith (TU Vienna), and Felix Truger (University of Stuttgart)</i>	

Influence of HW-SW-Co-Design on Quantum Computing Scalability	104
<i>Hila Safi (Siemens AG, Technology; Technical University of Applied Sciences Regensburg, Germany), Karen Wintersperger (Siemens AG, Technology, Germany), and Wolfgang Mauerer (Technical University of Applied Sciences Regensburg; Siemens AG, Technology, Germany)</i>	
A Conceptual Architecture for a Quantum-HPC Middleware	116
<i>Nishant Saurabh (Utrecht University), Shantenu Jha (Rutgers University; Brookhaven National Lab, US), and Andre Luckow (Ludwig Maximilian University Munich; BMW Group, Germany)</i>	

Optimizing Quantum Algorithms (QSW5)

ScaffML: A Quantum Behavioral Interface Specification Language for Scaffold	128
<i>Tiancheng Jin (Kyushu University, Japan) and Jianjun Zhao (Kyushu University, Japan)</i>	
TRIM: Crosstalk-awaRe qubit Mapping for Multiprogrammed Quantum Systems	138
<i>Soheil Khadirsharbiyani (Pennsylvania State University, USA), Movahhed Sadeghi (Pennsylvania State University, USA), Mostafa Eghbali Zarch (NC State University, USA), Jagadish Kotra (AMD, USA), and Mahmut Taylan Kandemir (Pennsylvania State University, USA)</i>	
Parallelizing Quantum Simulation with Decision Diagrams	149
<i>Shaowen Li (The University of Tokyo, Japan), Yusuke Kimura (Fujitsu Limited, Japan), Hiroyuki Sato (The University of Tokyo, Japan), Junwei Yu (The University of Tokyo, Japan), and Masahiro Fujita (The University of Tokyo, Japan)</i>	
Compression of Qubit Circuits: Mapping to Mixed-Dimensional Quantum Systems	155
<i>Kevin Mato (Technical University of Munich, Germany), Stefan Hillmich (Software Competence Center Hagenberg (SCCH) GmbH; Johannes Kepler University Linz, Austria), and Robert Wille (Technical University of Munich, Germany; Software Competence Center Hagenberg (SCCH) GmbH, Austria)</i>	

Usage of Quantum Algorithms (QSW6)

Quantum Utility – Definition and Assessment of a Practical Quantum Advantage	162
<i>Nils Herrmann (Quantum Brilliance GmbH, Germany), Daanish Arya (Quantum Brilliance GmbH, Germany), Marcus W. Doherty (Quantum Brilliance Pty Ltd, Australia), Angus Mingare (Quantum Brilliance Pty Ltd, Australia), Jason C. Pillay (Quantum Brilliance Pty Ltd, Australia), Florian Preis (Quantum Brilliance GmbH, Germany), and Stefan Prestel (Quantum Brilliance GmbH, Germany)</i>	
QIn: Enabling Formal Methods to Deal with Quantum Circuits	175
<i>Jonas Klamroth (FZI Research Center for Information Technology, Germany), Bernhard Beckert (Karlsruhe Institute of Technology, Germany), Max Scheerer (FZI Research Center for Information Technology, Germany), and Oliver Denninger (FZI Research Center for Information Technology, Germany)</i>	

Distributing Quantum Circuits Using Teleportations	186
<i>Ranjani G. Sundaram (Stony Brook University) and Himanshu Gupta (Stony Brook University)</i>	
Real-Time Hybrid Quantum-Classical Computations for Trapped ions with Python Control-Flow .	193
<i>Tobias Schmale (Institut für Theoretische Physik, Leibniz Universität Hannover, Germany), Bence Temesi (Institut für Theoretische Physik, Leibniz Universität Hannover, Germany), Niko Trittschanke (Institut für Theoretische Physik, Leibniz Universität Hannover, Germany), Nicolas Pulido-Mateo (Institut für Quantenoptik, Leibniz Universität Hannover; Physikalisch-Technische Bundesanstalt, Germany), Ilya Elenskiy (Institut für Elektrische Messtechnik und Grundlagen der Elektrotechnik, Technische Universität Braunschweig, Germany), Ludwig Krinner (Institut für Quantenoptik, Leibniz Universität Hannover; Physikalisch-Technische Bundesanstalt, Germany), Timko Dubielzig (Institut für Quantenoptik, Leibniz Universität Hannover, Germany), Christian Ospelkaus (Institut für Quantenoptik, Leibniz Universität Hannover; Physikalisch-Technische Bundesanstalt, Germany), Hendrik Weimer (Institut für Theoretische Physik, Leibniz Universität Hannover; Institut für Theoretische Physik, Technische Universität Berlin, Germany), and Daniel Borchering (Institut für Theoretische Physik, Leibniz Universität Hannover, Germany)</i>	
Author Index	201