Delft, July 9th, 2017

To whom this may concern,

I am writing in support of the Stage 2 QuantERA proposal *AZX: A Flexible Intermediate Representation for Quantum Software*. I believe this project will produce tangible gains for quantum technology, both in the theoretical aspects of quantum computation and in the practical aspects of implementing quantum computing with hardware. The central goal of *AZX* is to develop a sophisticated stack of tools for compiling quantum software into low-level instructions for quantum hardware, adding error correction and performing optimizations along the way. This concept of a "compiler stack" has already become indispensable to the operation of classical computers and is crucial to producing scalable quantum computers. Furthermore, with quantum technologies still in their infancy, even small reductions in memory and computational overhead will produce substantial simplifications for physical implementations and experiments.

This proposal has several major strengths. First, it draws on a large body of theory (e.g., the recent textbook *Picturing Quantum Processes*, of Coecke and Kissinger). Second, the consortium has assembled a multidisciplinary team of experts in theoretical computer science, quantum programming languages, quantum error correction, and quantum hardware. For example: Valiron developed and maintains the *Quipper* quantum programming language, Horsman developed the technique of lattice surgery, a leading method for implementing fault-tolerant computation in the surface code, and Benjamin is the "Architectures" work-package leader for the NQIT Quantum Hub, a UK-based project engaged in the implementation of a large-scale quantum computation with trapped ions. Third, the project seems committed to engaging with the broader quantum hardware community, as evidenced by their proposed advisory board, which consists primarily of prominent members of quantum hardware groups throughout Europe. As the principal investigator (PI) of an experimental group implementing quantum computation via superconducting quantum circuits at the QuTech Institute in Delft, I am happy to serve on the advisory board of *AZX*. I look forward to collaborating with Kissinger, the PI for the project's Dutch site, who has visited my group and maintains active communication with several of my group members. I am also delighted to see the specifications of our transmon-based superconducting hardware serving as one of the first two test-case targets for the project's compiler tools.

In summary, I believe this project is timely and important, its consortium is well equipped to handle the challenges it presents, and I look forward to seeing the concrete benefits in the effort to implement effective quantum technologies.

Yours truly,

Dr. Leonardo DiCarlo
Associate Professor
Delft University of Technology

l.dicarlo@tudelft.nl
+31 (0)68 324 7883

DEPARTMENT OF PHYSICS

University of Strathclyde Science

John Anderson Building
University of Strathclyde
Glasgow
G4 0NG
jonathan.pritchard@strath.ac.uk
0141 548 5813
2 July 2017

To Whom It May Concern:

It is my pleasure to support the '*AZX: A Flexible Intermediate Representation for Quantum Software*' proposal for QuantERA and to serve on the advisory board to provide an experimental perspective on relevant strengths and weaknesses of proposed hardware systems to help guide this exciting software driven research effort.

Quantum information processing and computation offers an exciting new frontier in solving classically hard or even intractable problems, and a wide range of architectures have emerged as possible candidates for robust and scalable computing. A significant challenge associated with implementing quantum algorithms on these emerging technologies has been to perform optimized mapping to the strengths and weaknesses of the associated hardware, with software being written that is only able to translate protocols for a single system.

This project offers an important new direction in bridging the gap between high-level software describing quantum algorithms and the technical details of the implementation by creating a platform agnostic representation that can be exploited to optimize the proposed algorithms for the available quantum hardware. This greatly simplifies the development of future quantum algorithms and provides a route to developing open source that can be utilized on any hardware for testing and verification as well as unlocking the potential of these revolutionary new quantum technologies.

In summary, I fully support the QuantERA application and confirm my commitment to the project, which I believe to be of the highest quality and importance for the area of quantum information processing.

Yours sincerely

Jonathan Pritchard
EPSRC Quantum Technology Fellow

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DALHOUSIE UNIVERSITY

Department of Mathematics and Statistics

Peter Selinger
Killam Professor
Tel: 902-494-3311
Fax: 902-494-5130
selinger@mathstat.dal.ca

July 7, 2017

To whom it may concern:

I am writing to provide strong support for the QuantEra proposal "AZX — A Flexible Intermediate Representation for Quantum Software". This proposal aims to fill an important gap in the quantum technology development, namely connecting the wide range of proposed hardware architectures with the broad range of software, and it does this through a single interface, an extended ZX-calculus.

The team is the strongest possible, including the originators of the ZX-calculus, Coecke and Duncan, as well as major contributors to the broader field of high-level methods for quantum computing and quantum programming. They include developers of the quantum programming language Quipper (Valiron) and developers of ZX-interfaces between different computational models (Duncan, Perdrix, Horsman, Kissinger). The close alignment with the NQIT hub also makes the team particularly well-positioned to directly impact the development of quantum technologies.

The project could not have been more timely. A string of new applications of the ZX-calculus has recently emerged, like in quantum error correction and lattice surgery.

I am very happy to confirm my commitment to serve on the Advisory Board of this excellent project.

Sincerely,

Peter Selinger

ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Department of Physics

Prof. Dr. Andreas Wallraff
ETH Zürich
Otto-Stern-Weg 1, HPF D 9
8093 Zurich
Switzerland
Tel. +41 44 633 75 63
Fax +41 44 633 10 72
andreas.wallraff@phys.ethz.ch
www.qudev.ethz.ch

Zurich, June 26, 2017

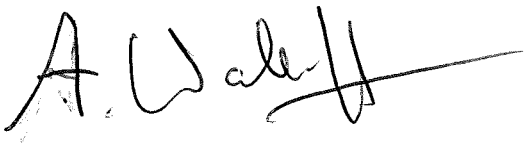
To whom it may concern

I, Andreas Wallraff writing in my capacity as the leader of the Quantum Devices Lab at ETH Zurich to confirm my willingness to serve as a member of the advisory board of the proposed research project AZX.

As well as many years of experience working on quantum information processing with circuit QED and hybrid systems, I also have a leading role in the ETH Zurich Quantum Engineering Initiative which aims at strengthening the ties between science and engineering in the domain of quantum information science. Clearly, software will play a major role in the future development of quantum information processing, and the AZX project proposes a significant step forward for quantum software.
In order to support this very valuable project, either myself or another member of my group will take part in the AZX project meetings as an advisor.

With best regards

Andreas Wallraff



Univ.Prof. DI Dr. Philip Walther
Quantum Information Science & Quantum Computing

Vice-Dean of the Faculty of Physics &
Head of Quantum Optics, Quantum Nanophysics and
Quantum Information Group &
Speaker of the Research Platform TURIS

Faculty of Physics & VCQ
Boltzmanngasse 5
A-1090 Vienna, Austria

Tel: +43 (1) 4277 72560
Email: philip.walther@univie.ac.at
Web: http://walther.quantum.at
http://turis.univie.ac.at

Vienna, July 4th, 2017

To whom it may concern:

I am writing to express my support for the research proposal "AZX" submitted to the ERA-NET QuantERA call.

As Vice-Dean of the Faculty of Physics and Head of Quantum Optics, Quantum Nanophysics and Quantum Information Group at the University of Vienna my research group was dedicated to the development of scalable photonic quantum technology for quantum computing and other quantum information applications.

The aim of the AZX project is to provide software support for a wide variety of quantum computing hardware. This is a valuable goal, and I believe the project is of excellent quality, and should be funded.

A particular challenge facing the project is to ensure that the software can adapt to the characteristics of specific implementations of quantum computation. I am very happy to help the project team with this challenge by serving on the Advisory Board of the project and sharing my experience and that of my group.

Best wishes,

Philip Walther

rigetti
quantum computing

775 Heinz Ave,
Berkeley, CA 94710

July 3, 2017

RE: QuantERA AZX Proposal

To Whom it May Concern:

As quantum information systems start to scale into systems capable of prototype quantum computing, the design of programming tools and intermediate representations is particularly important. The AZX project is a strong proposal will take important steps towards this effort.

I am happy to serve on the board of advisors for this program.

Sincerely,

William Zeng

Director of Engineering
Rigetti Computing