

Call 2021
Final Evaluation



STAQS

Shortcuts to Adiabaticity for
Quantum Computation and Simulation

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COLLABORATION | 6 partners across 5 countries

6 partners

5 countries

1 widening country



Widening country: Poland



University of Innsbruck

Austria



University of Luxembourg

Luxembourg



BAdW / WMI

Germany



University of Naples Federico II

Italy



CNR — National Research Council

Italy



Jagiellonian University

Poland

A geographically compact consortium with complementary expertise.

COLLABORATION | complementary expertise, shared methods

STA & quantum control

UNI.LU · UNINA



Quantum computation & optimization

UIBK



Many-body simulation & tensor networks

JU



Experimental platforms & hardware

CNR ultracold atoms · WMI superconducting-circuit expertise



HOW WE WORKED TOGETHER

- Joint theory → numerics → experiment workflows across work packages
- Shared software and methods
- Regular online meetings, mobility and conference interaction

Complementarity was functional: methods moved from theory to algorithms and from algorithms to experimental validation.



SUCCESS STORY | from adiabatic bottlenecks to faster controlled dynamics

CHALLENGE

Adiabatic protocols can become prohibitively slow near small gaps; long runtimes compete directly with finite coherence times.

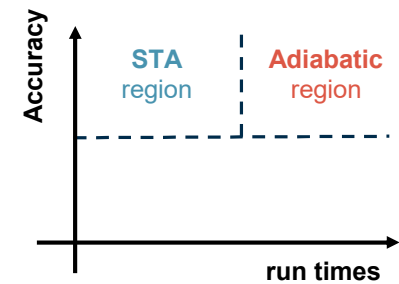
STRATEGY

Use approximate counterdiabatic driving, optimal control and hardware-aware compilation to reach useful target states faster.

BUILDING BLOCKS

- Krylov-space STA
- digitized counterdiabatic driving
- parity compilation / twines
- tensor-network simulation

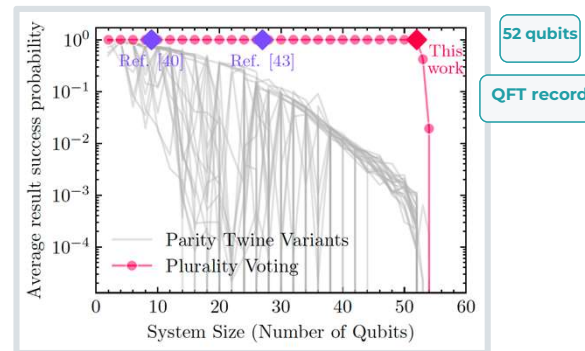
Goal: shorter runtime without sacrificing accuracy



SUCCESS STORY | two flagship hardware demonstrations

Core methods: counterdiabatic control + hardware-aware parity compilation

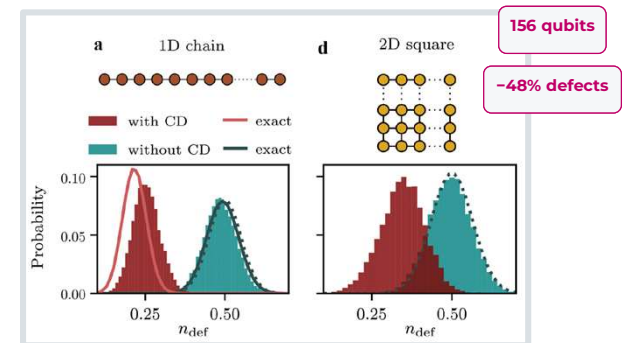
Enhanced quantum computation



Aumann et al. (2026)

QFT demonstrated up to 52 qubits with high average result success probability, establishing a new scale record

Enhanced quantum simulation



Visuri et al., npj Quantum Information (2026)

Digitized counterdiabatic driving on IBM processors up to 156 qubits reduced defect formation by up to 48%.

SCIENTIFIC OUTPUTS | high-impact publications, training and experiments

70+

STAQS-linked publications (2022–2026)

9

PhD theses

5

Master's theses

SELECTED HIGH-IMPACT PUBLICATIONS

Nature Physics · 2024

False vacuum decay via bubble formation in ferromagnetic superfluids

Physical Review X · 2024

Shortcuts to Adiabaticity in Krylov Space

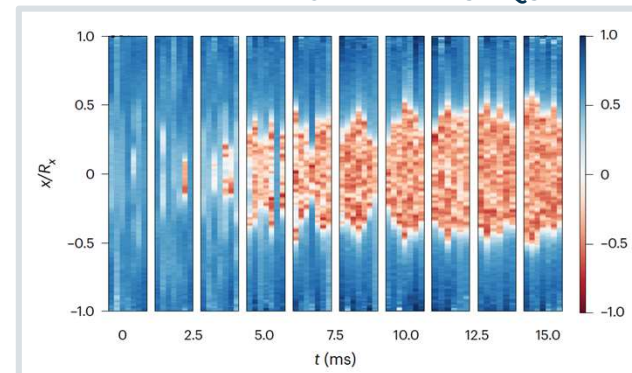
PRX Quantum · 2026

Fighting Exponentially Small Gaps by Counterdiabatic Driving

+ publications in PRL, PRX Quantum, PRA, PR Research, QST, ...

Open / reusable outputs: YASTN · parity-floquet · error-mitigation code

EXPERIMENTAL WORK WITHIN STAQS



False-vacuum bubble nucleation in coherently coupled atomic superfluids

Zenesini et al., Nature Physics 20, 558–563 (2024)

IMPACT | from project results to users and commercial relevance

APPLICATIONS



- Quantum optimization & state preparation
- Many-body quantum simulation & benchmarking

END USERS



- Quantum processor and software vendors
- Cloud quantum-computing providers

INDUSTRY LINKS



- ParityQC — active route for transfer of parity-based methods
- IBM Quantum — hardware validation of QFT and STA protocols

IMPACT | Responsible Research & Innovation (RRI)

OPEN SCIENCE



- Peer-reviewed publications and preprints
- open-source software packages

GENDER BALANCE



- One female PI
- Employed 5 female PhDs and PostDocs

DISSEMINATION



- Journals, conferences, talks
- Workshop: Mathematics and Physics Day (Innsbruck, 2023)





WHAT'S NEXT | from project results to a lasting toolbox

1

HARDWARE-NATIVE STA

Translate counterdiabatic and optimal-control ideas into pulse- and device-compatible protocols for superconducting and neutral-atom processors.

2

EXPAND EXPERIMENTAL VALIDATION

Build on the ultracold-atom and IBM-cloud demonstrations to test more ambitious many-body and optimization protocols.

3

SCALE PARITY METHODS

Extend parity-flow / parity-twine compilation and optimization benchmarks to larger systems and newer hardware generations.

4

SUSTAIN THE ECOSYSTEM

Continue cross-consortium collaboration, open-source development and transfer to industrial partners such as ParityQC.





Thank you

Questions

Glen Bigan Mbeng · University of Innsbruck



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