

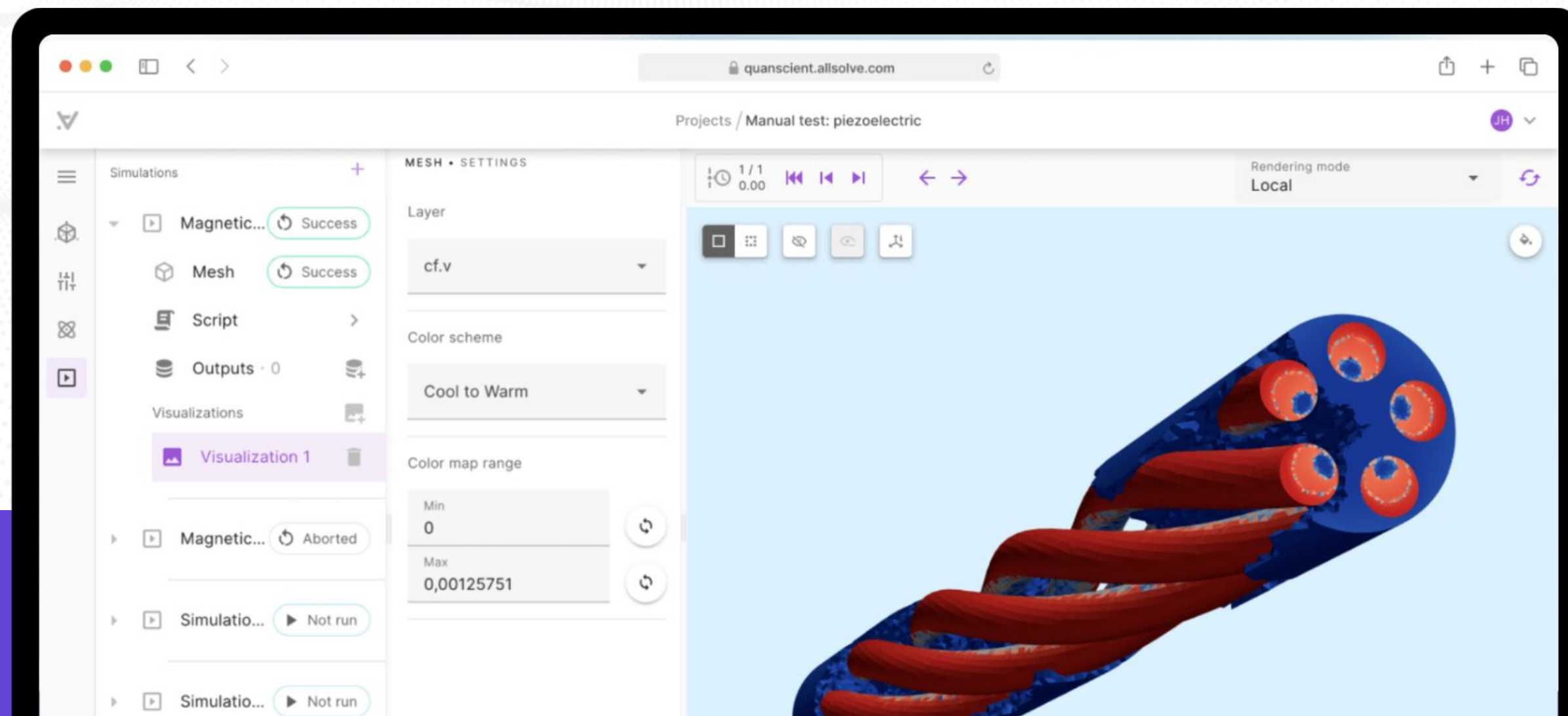
24 January 2025,  
Quantum Software Day,  
University of Helsinki,  
Helsinki, Finland

Dr. Valtteri Lahtinen  
Chief Scientist & Co-founder

QUANSCIENT

# Physics simulations with quantum computers

Quantum-native multiphysics



# Agenda

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**1.**

Quanscient Overview

**2.**

Quantum algorithms  
for multiphysics

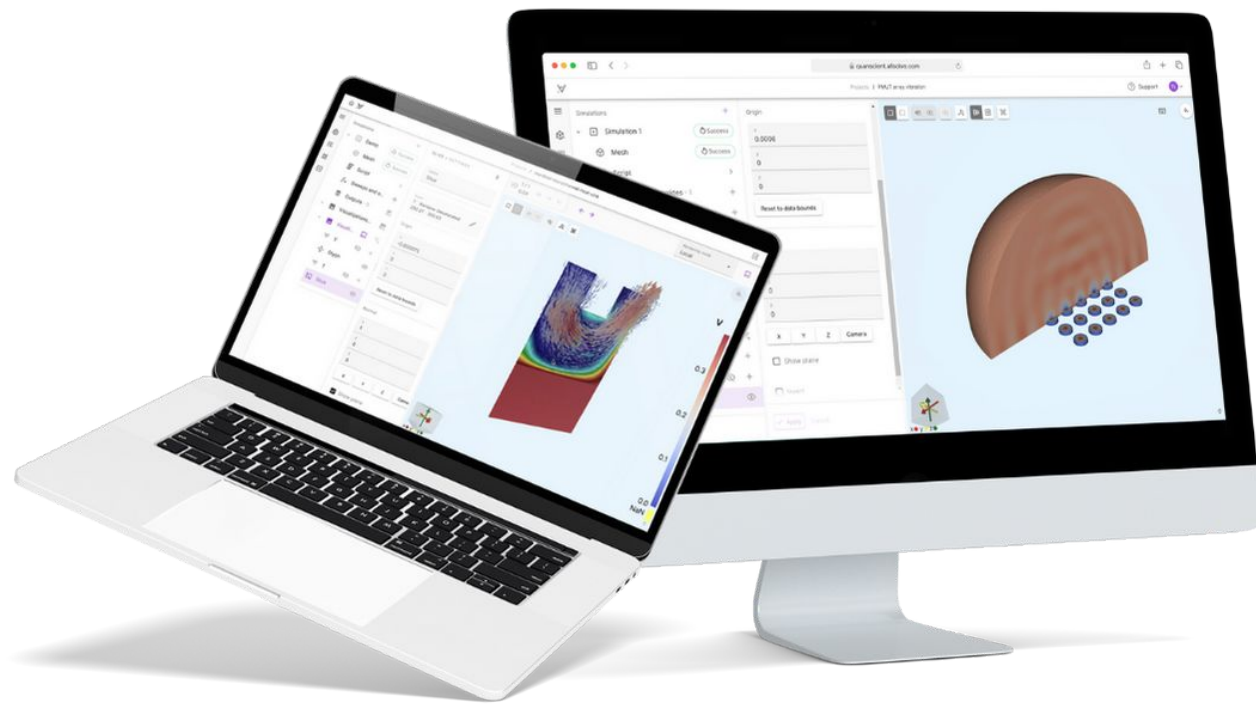
**3.**

Quantum-native  
algorithms

**4.**

Final notes and conclusions

# About Quanscient



Founded

2021

HQ in Tampere, Finland



Funding raised

10M+

Different nationalities

15

Companies using the product

+100

Employees

~40

Trusted in both industry  
and academia

QUANSIENT



# We have partnered with the key companies in cloud & quantum



- Our infrastructure is built on AWS.
- We are engaged in technical partnership discussions and exploring co-selling opportunities.



- They have released a small quantum chip. We have been running things on their simulator through Intel Quantum SDK.
- Possibility to access the chip.
- Important for PR value.

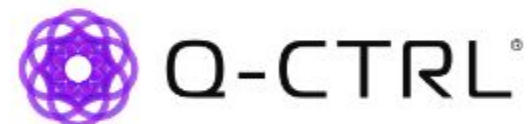


- We are in their Quantum Startup Ecosystem.
- We are eligible for \$120k credits to their devices through their Hyper Protect program.



- We are in the NVIDIA Inception program.
- GPU credits for running their quantum simulator.
- Collaboration with NVIDIA Modulus Physics informed ML.

Many other quantum HW manufacturer partnerships:



# Quanscient Allsolve **reduces time, costs and risks** for R&D with cloud & quantum powered simulations

WHAT IS POSSIBLE ALREADY?

IN THE FUTURE



## > 1000x speedups

Increase complexity and runtime from days to coffee breaks.

## Enable automated workflows

Workflows with APIs to automate simulation processes and connect to AI similar to NVidia Modulus.

## More experiments, less prototypes

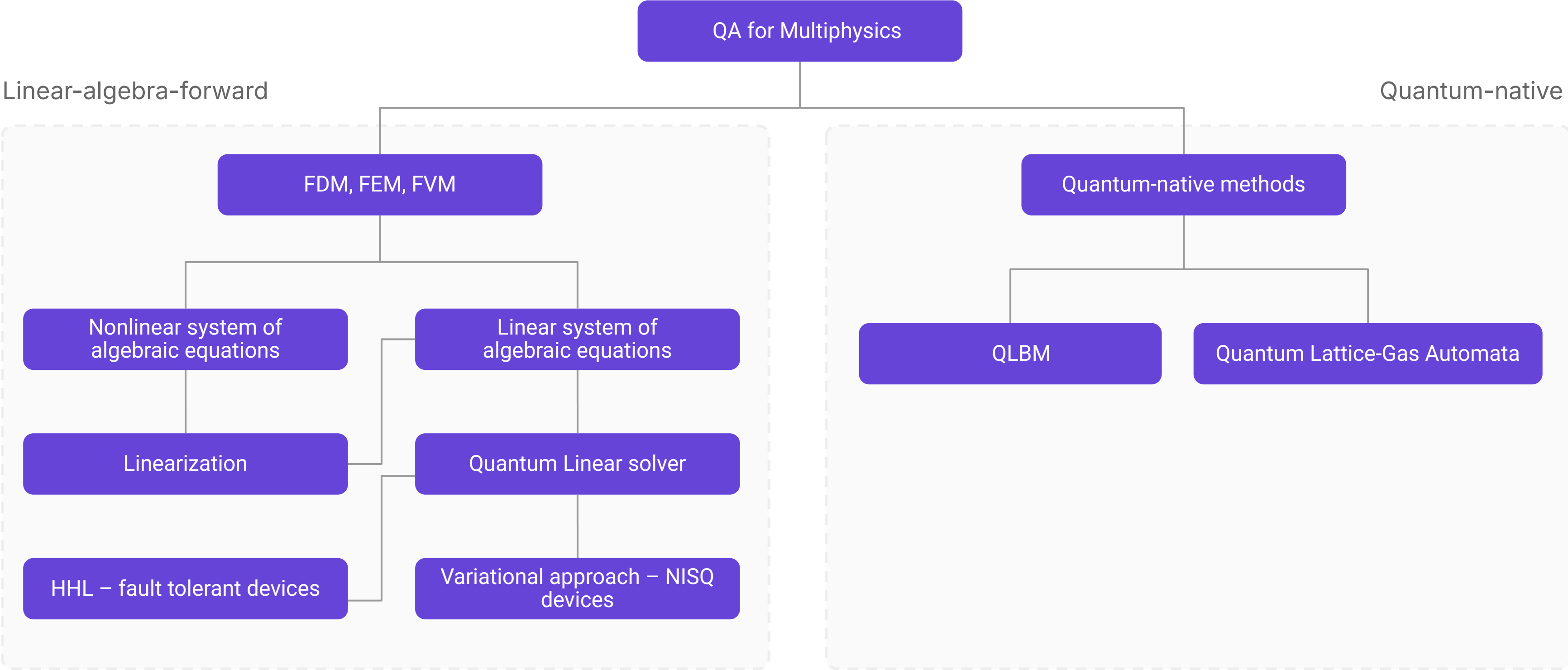
Optimization tasks, Monte Carlo simulations, and ML based surrogate models.

## Make the impossible possible with Quantum

Exponential speedups with quantum advantage make the impossible possible in simulations.

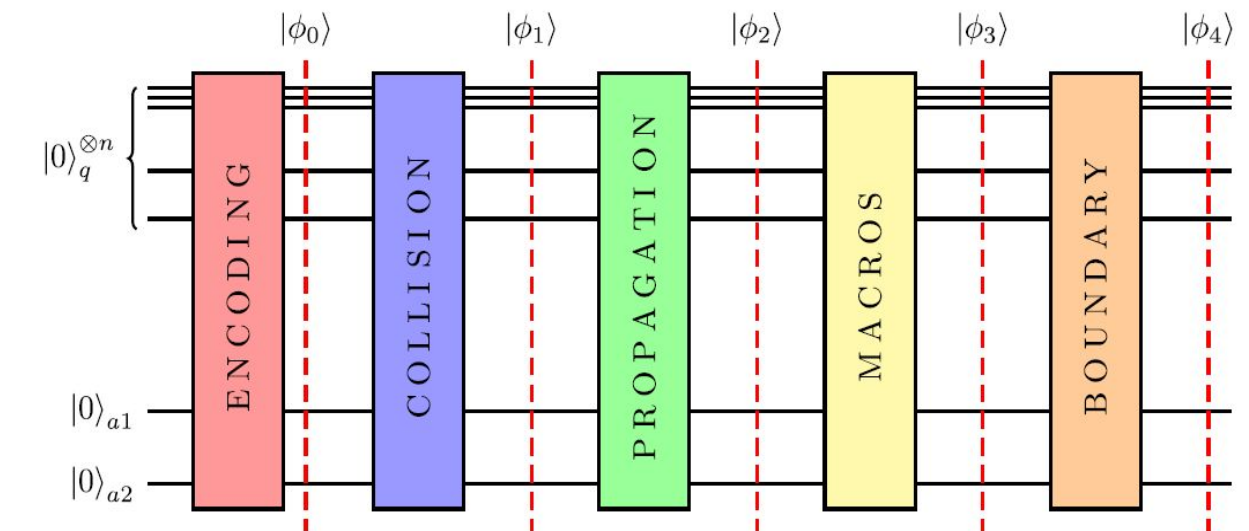
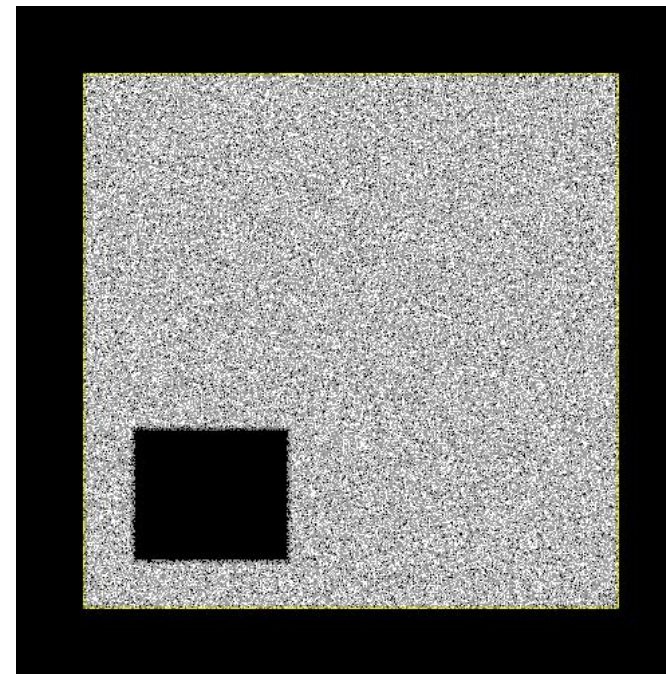
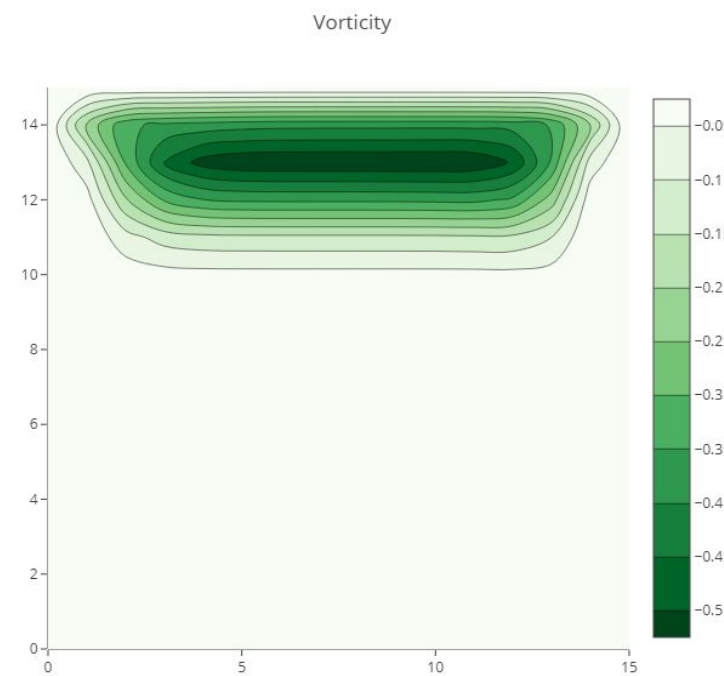
Quantum-native multiphysics algorithms  
Quanscient Quantum Labs'  
quantum-native® approach

# Quantum algorithms for multiphysics



# Quantum-native lattice-based physics simulations

Exponential problem size, logarithmic scaling.  
Validated against classical counterparts & analytical solutions.



## Quantum Lattice-Boltzmann

Evolution of mesoscopic probability distributions of particles on a lattice

Macroscopically generates PDE solutions

Each step is solved efficiently on a quantum computer

Already demonstrated accurate results in 1D and 2D on real hardware

## Quantum Lattice-Gas Automata

Evolution of particles on a lattice

Simple collision and propagation of microscopic particles → Nonlinear macroscopic phenomena

Noise-resilience: statistical averaging can mitigate noise

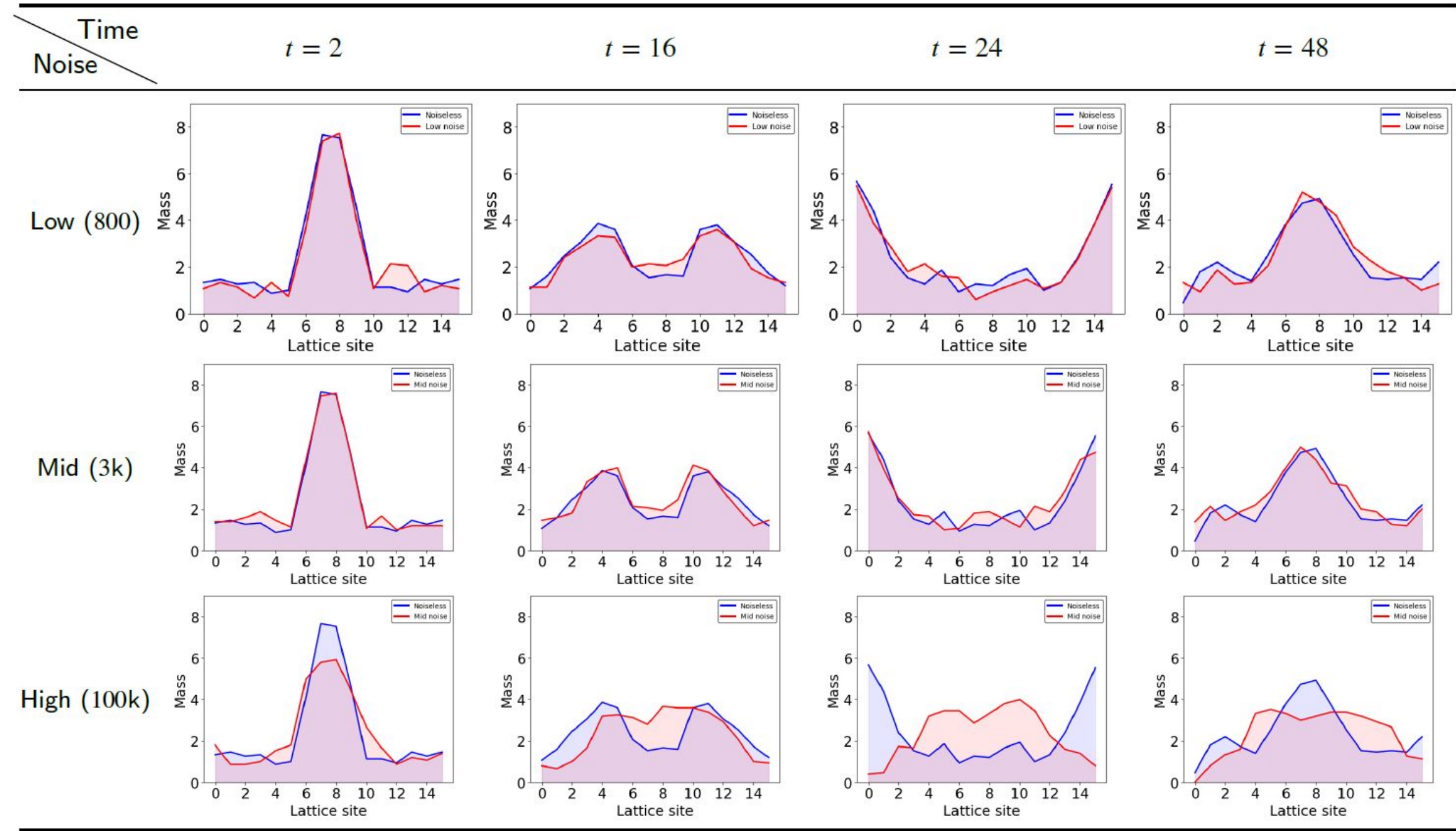
# PoCs by Quansient Quantum Labs

## Concrete use cases & industry projects



# D1Q3 HPP Quantum Lattice Gas Automaton

Noise Level	Single Qubit Error Rate	2-Qubit Error Rate	Readout Error Rate
Low	$10^{-5}$	$10^{-4}$	$10^{-4}$
Mid (similar to Quantinuum H2)	$3 \times 10^{-5}$	$2 \times 10^{-3}$	$2 \times 10^{-3}$
High (similar to early IBM devices)	$6 \times 10^{-3}$	$2 \times 10^{-2}$	$2 \times 10^{-2}$

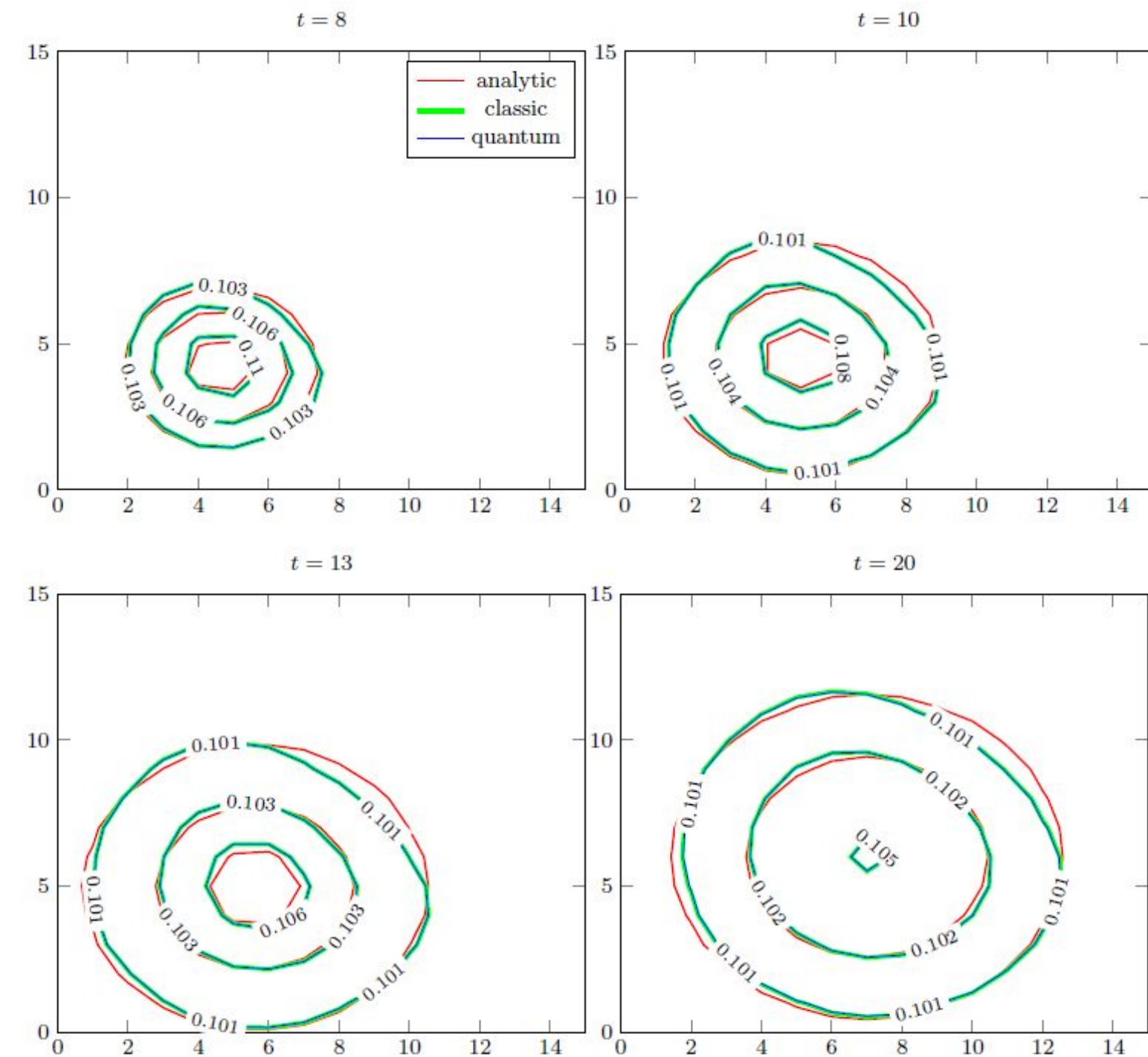
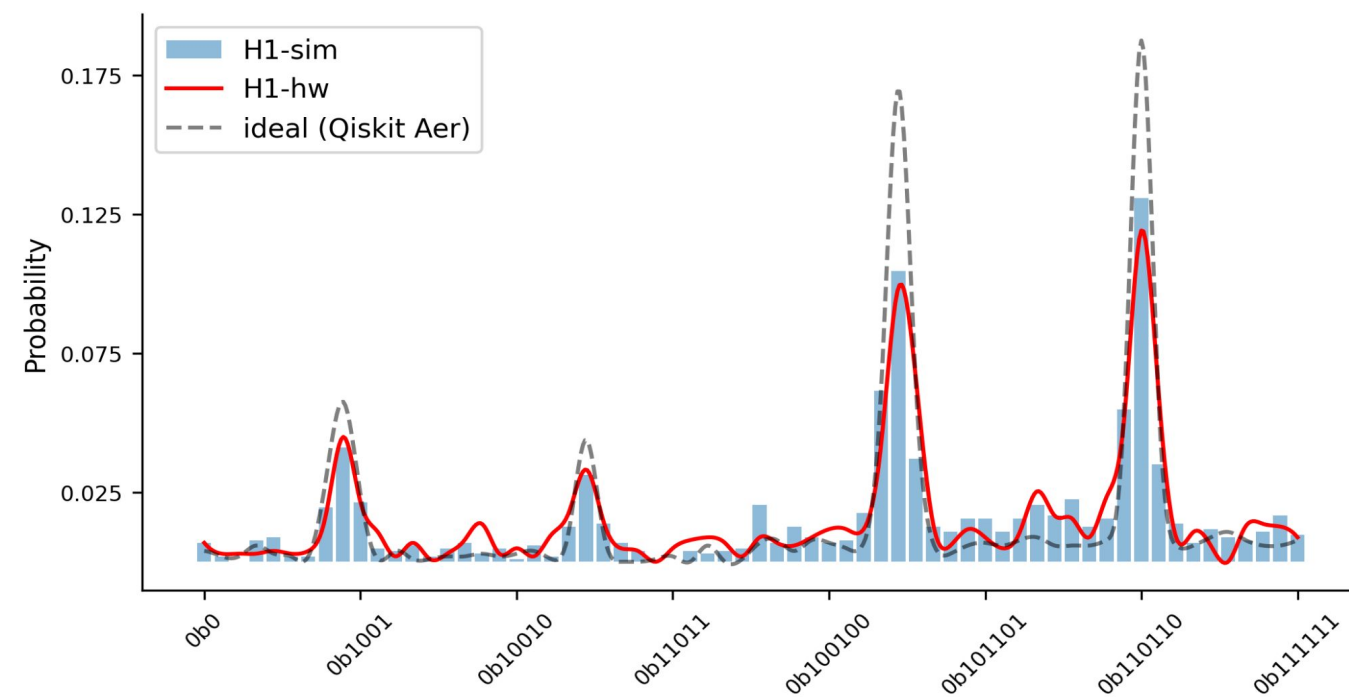
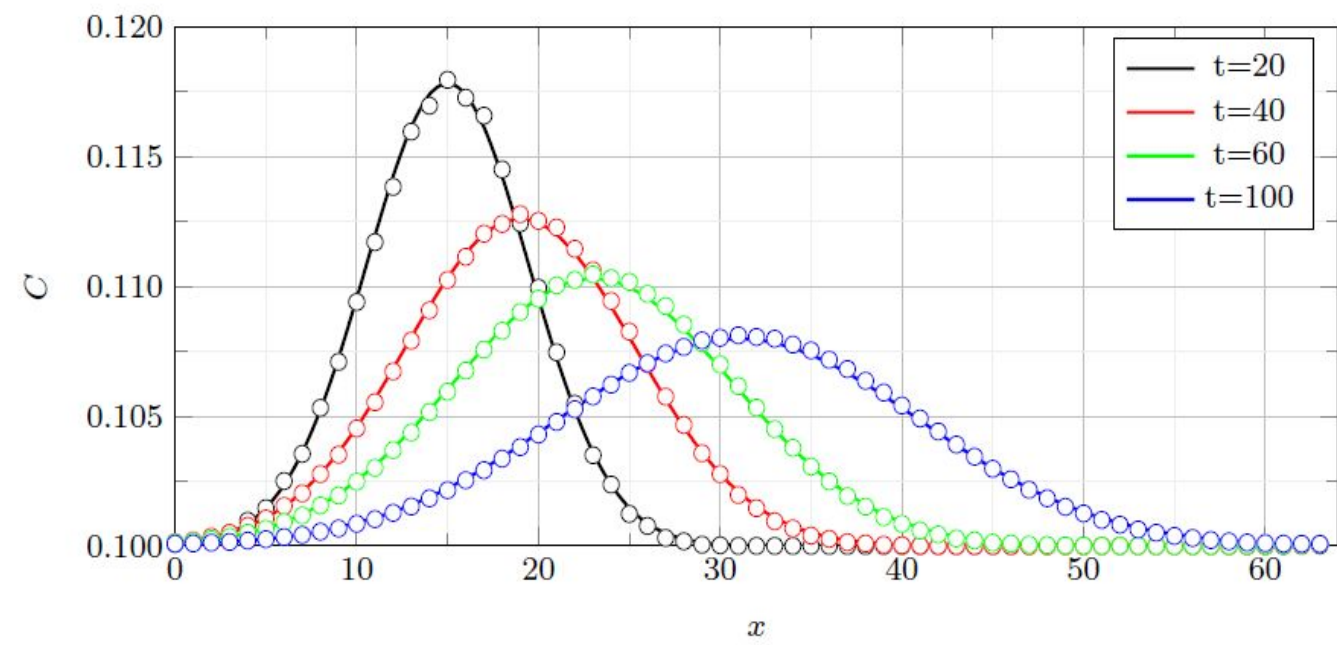


QLGA with different noise levels. The number of shots used appears in parentheses

# Quantum LBM Benchmark

## Motion of 1D and 2D Gaussian hills

Validation against classical simulation and analytical solution

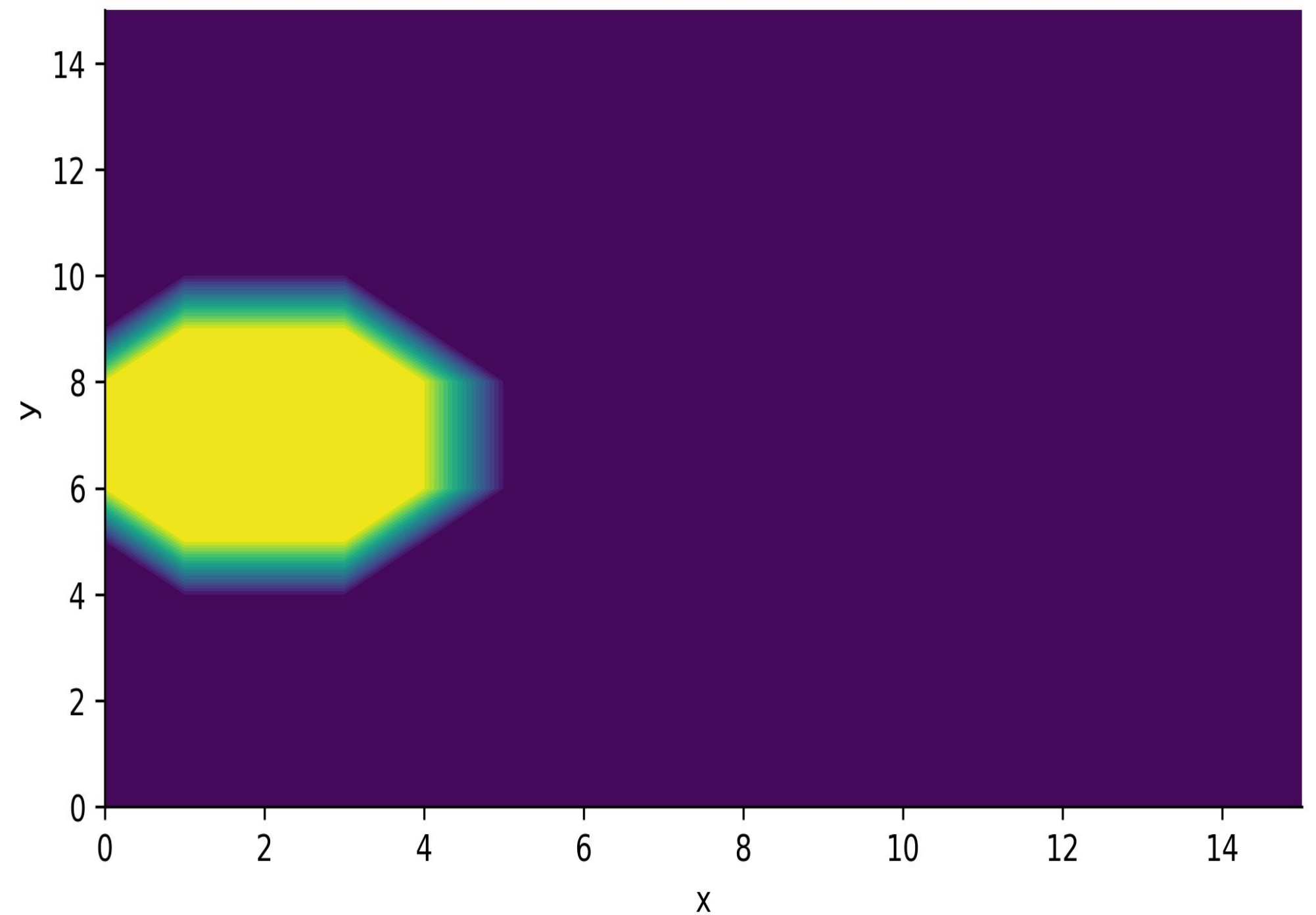
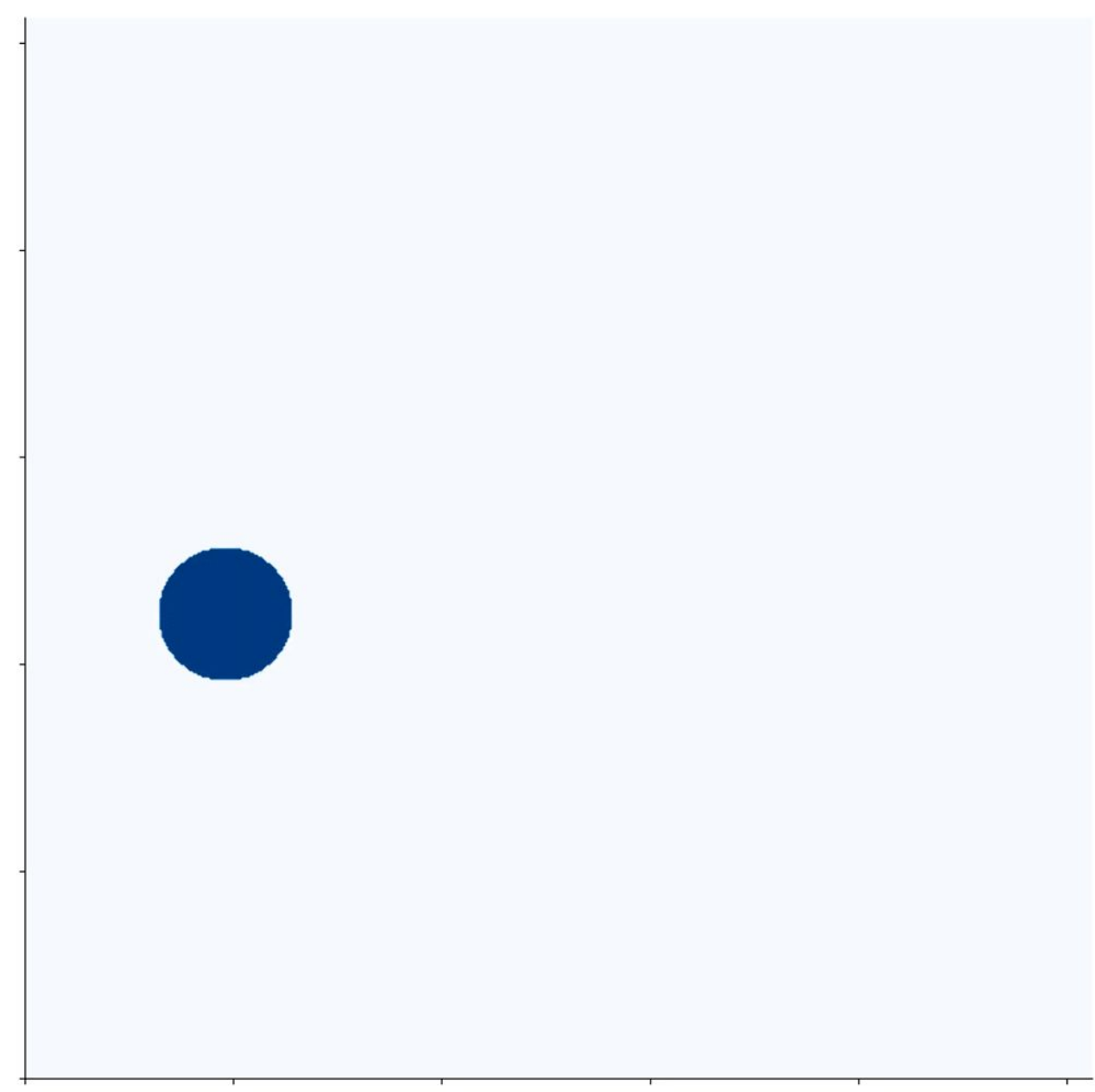


# Quantum LBM

## Spread of aerosols benchmark

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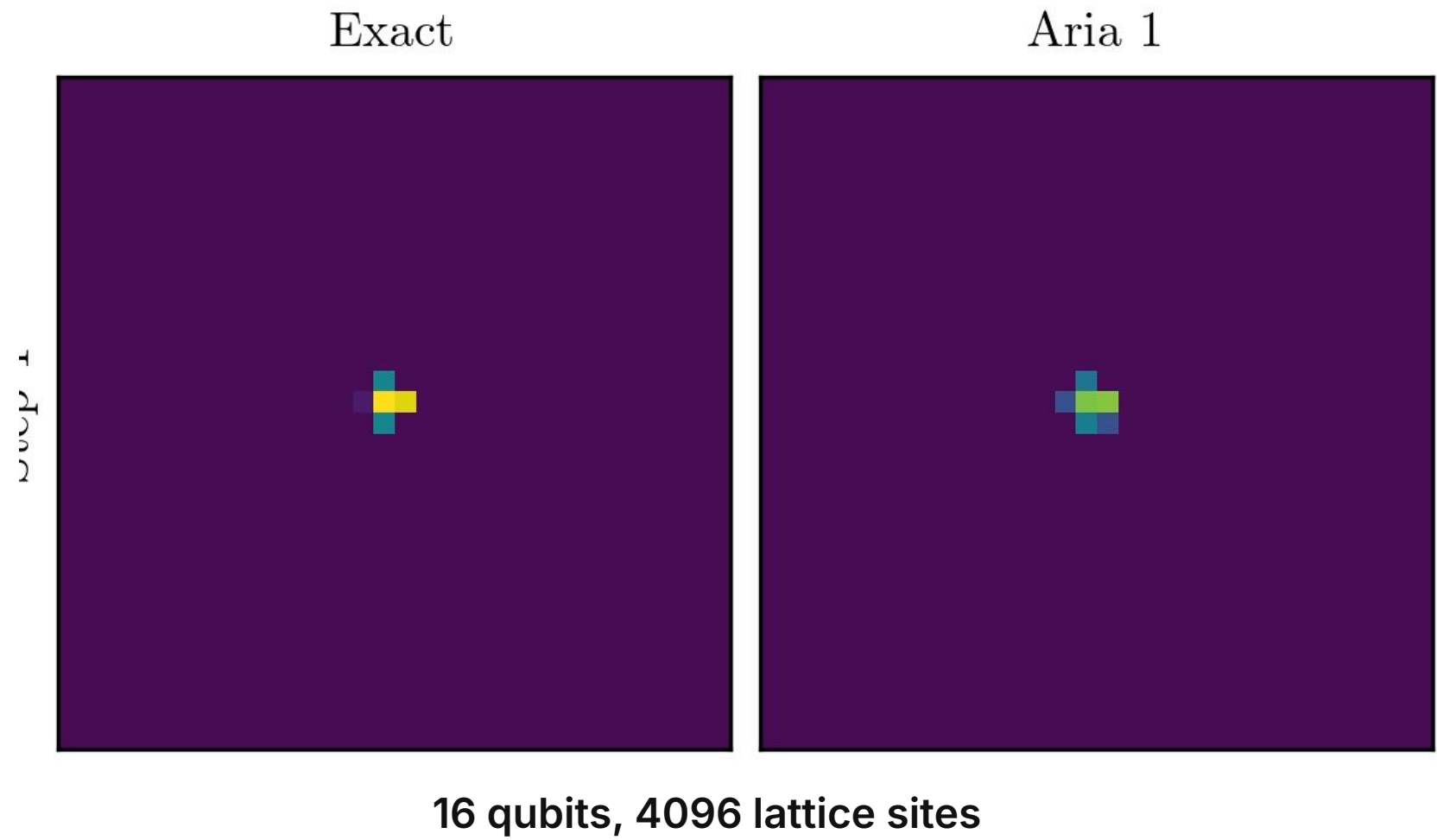
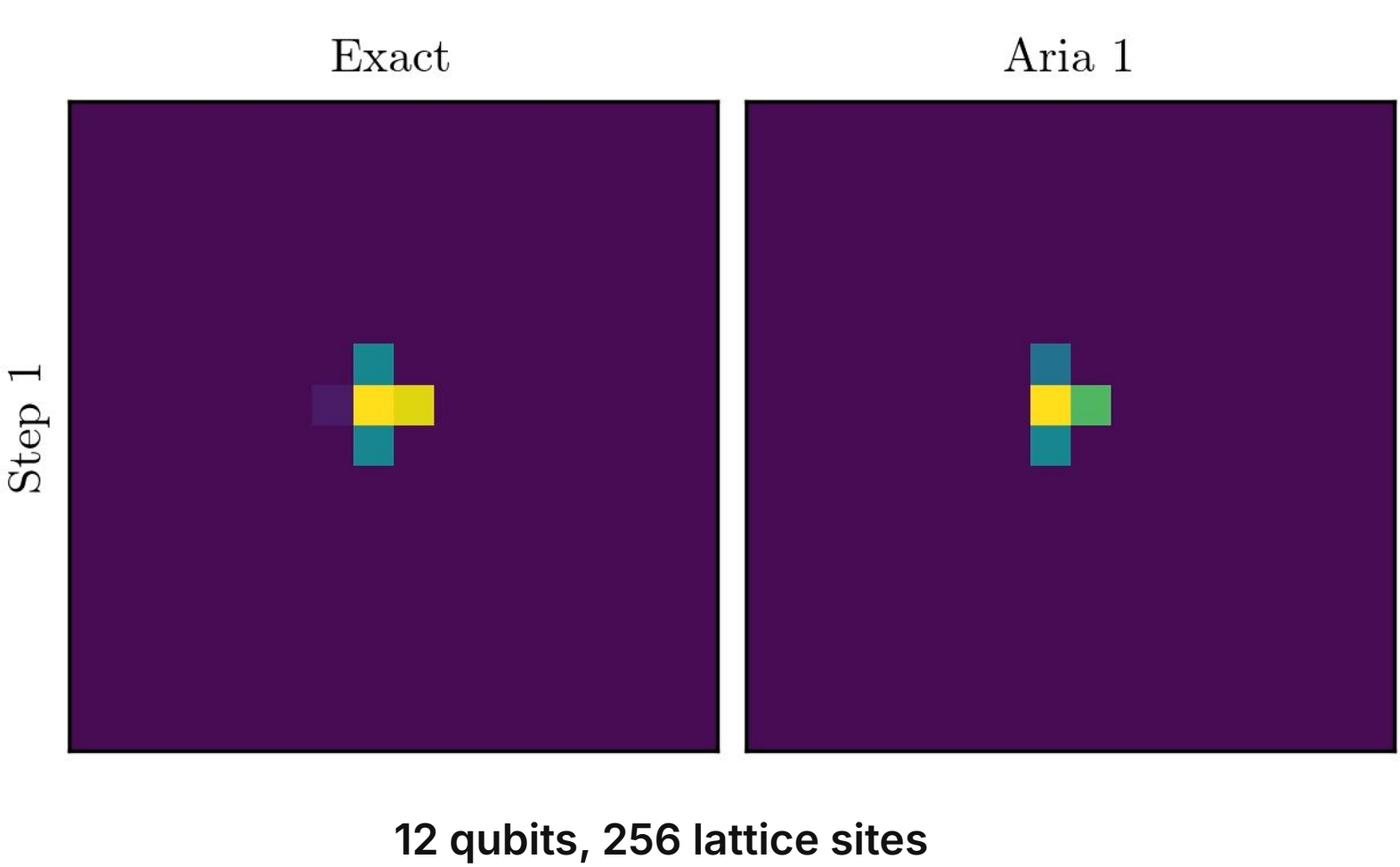
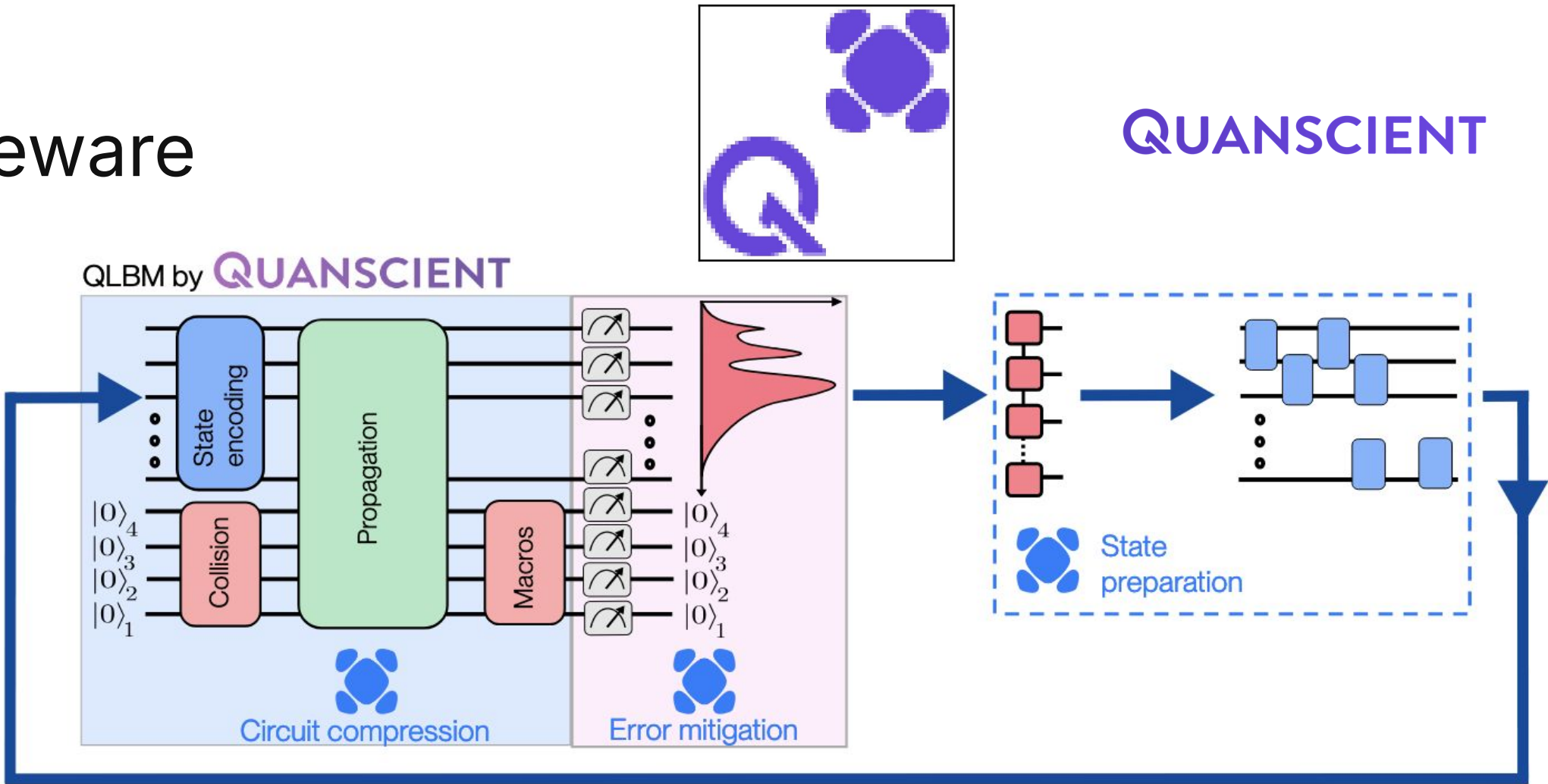
Simulations on CSC Lumi validated in collaboration with VTT Technical Research Centre of Finland



# Quanscient QLBM + Haiqu middleware

Advection diffusion equation simulated on IonQ  
Aria

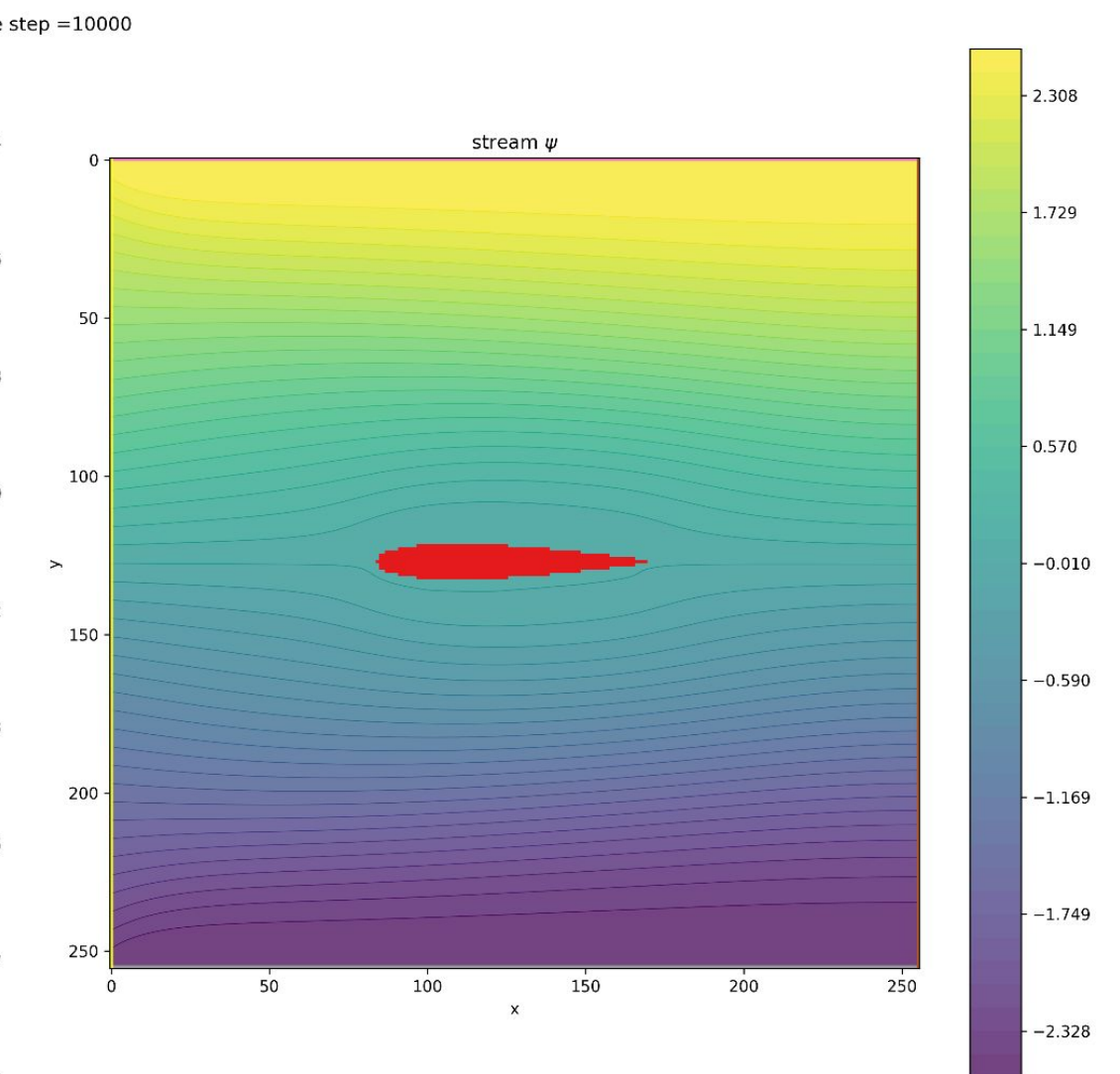
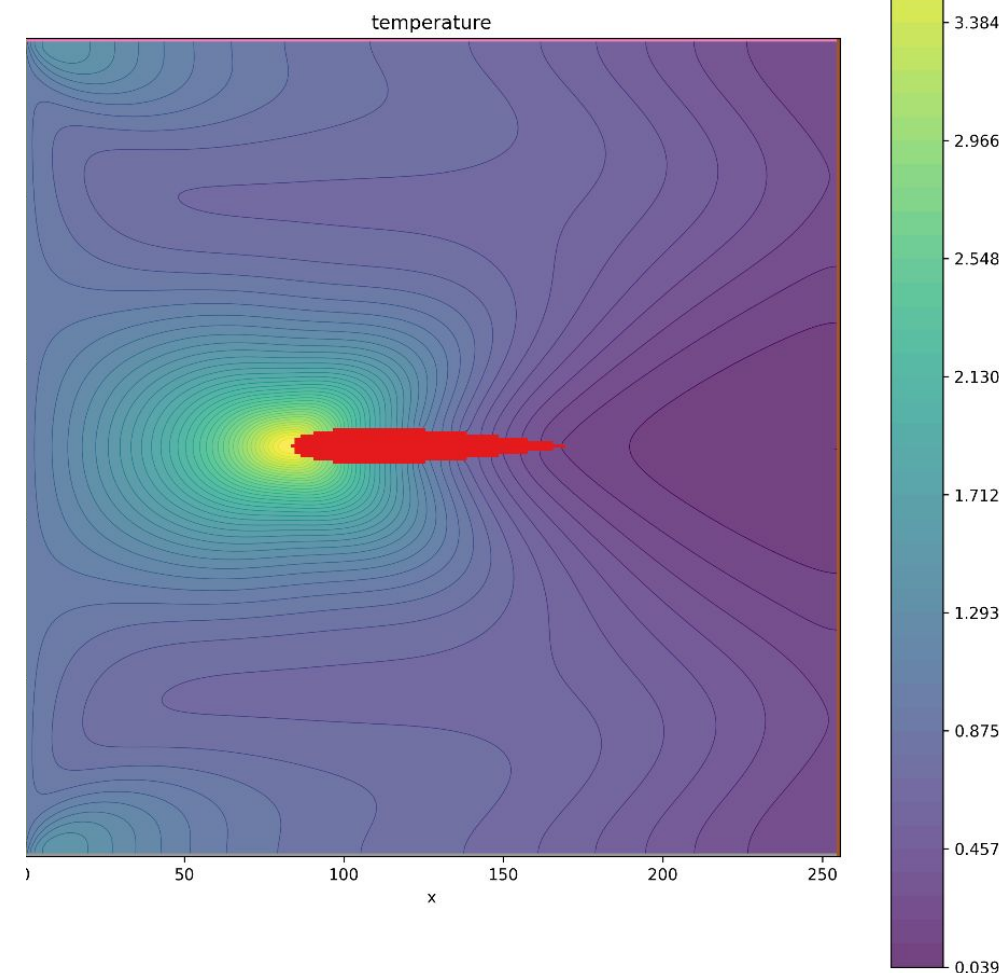
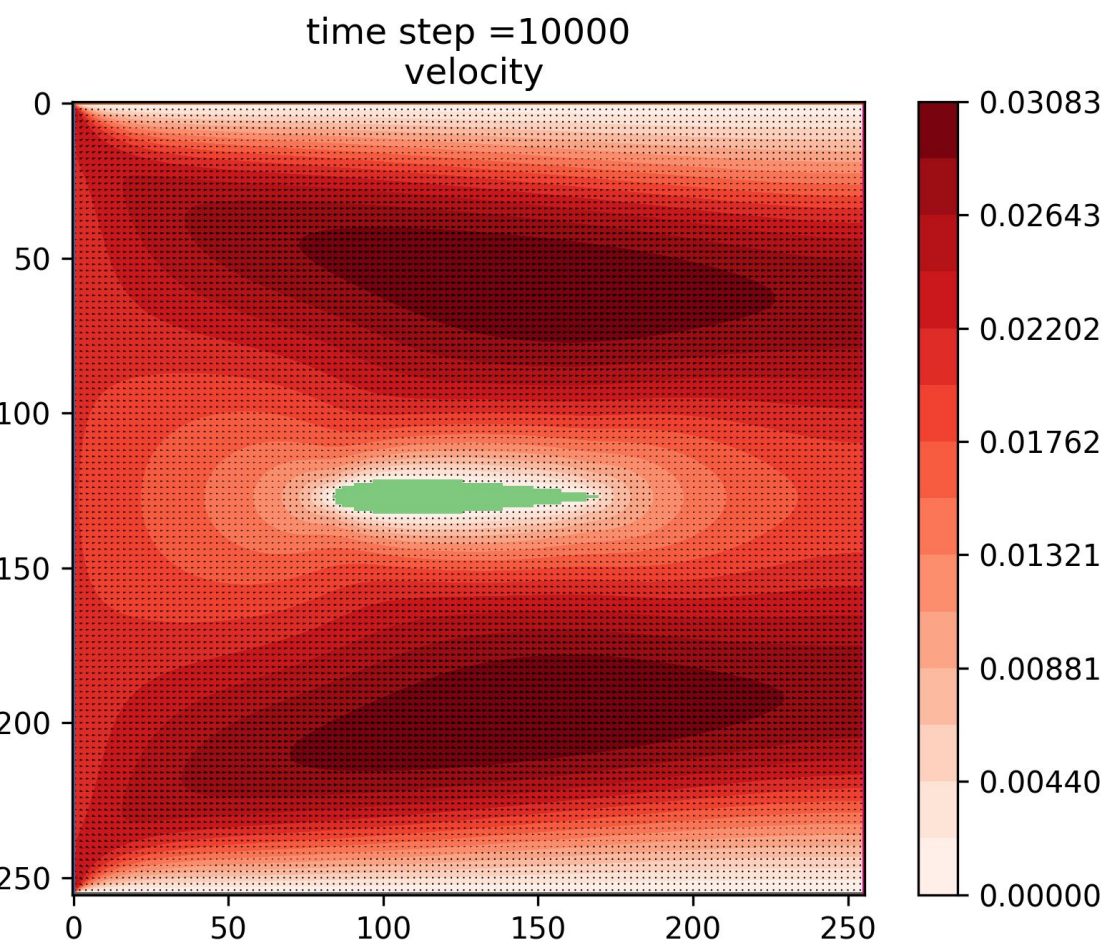
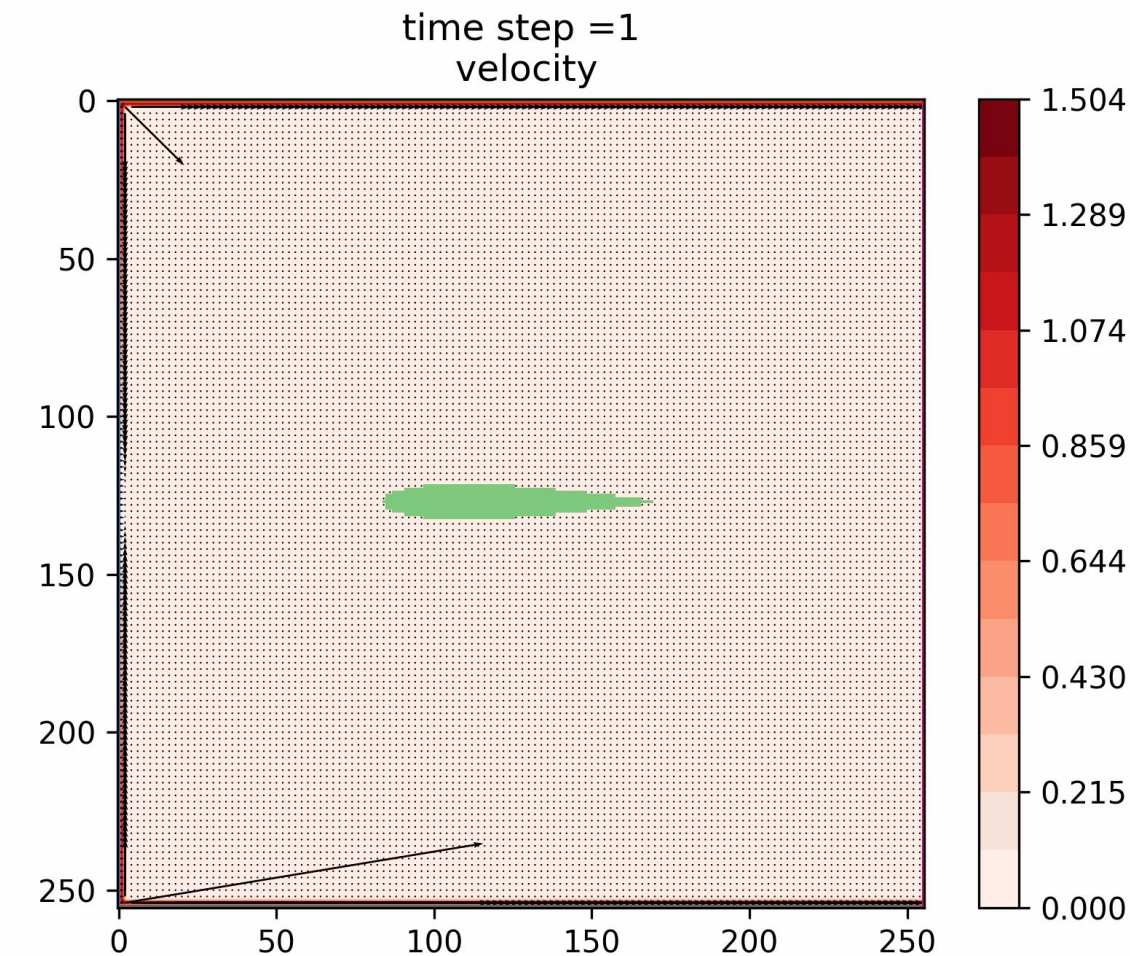
- First end-to-end execution of multiple 2D QLBM steps on quantum hardware
- This underscores the potential of quantum computing to address realistic CFD applications
- Emphasis on improving higher-level algorithms and practical quantum middleware engineering



# Airfoil flow + temperature simulations with QLBM

## Several LBM equations solved in superposition

- Flow coupled with the transport of a constituent with minimal extra computational cost. Flow around an airfoil with transport of temperature field.
- This simulation consists of three coupled Lattice-Boltzmann equations in superposition.
- Validated against classical simulation.
- 23 qubits, 66000 lattice points





## Partnership between Quanscient, Airbus & Oxford Ionics

- Using mid-circuit measurements to run CFD simulations from start to end entirely on a quantum computer
- Research the implementation on ion-trap hardware
- Quantum CFD use case input from Airbus

## Oxford Ionics And Quanscient Partner With Airbus To Develop Quantum Computing Applications For Fluid Dynamics Modeling

Quantum Computing Business

Matt Swayne • December 6, 2024



**The Quantum Insider:**

<https://thequantuminsider.com/2024/12/06/oxford-ionics-and-quanscient-partner-with-airbus-to-develop-quantum-computing-applications-for-fluid-dynamics-modeling/>

# Our quantum roadmap

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# Key takeaways

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1.

Quanscient Allsolve:  
fast, accurate, and scalable  
multiphysics simulations on the  
cloud.

2.

Quantum-native algorithms for  
CFD & multiphysics.

3.

Gearing up for quantum  
advantage. Willing to collaborate!

Thank you!  
Get in touch to learn more!

QUANSCIENT

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