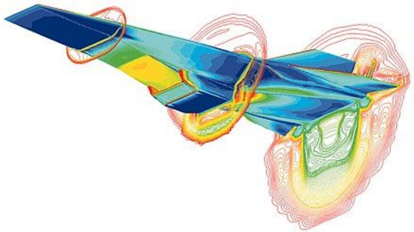
QuaSi

Quantum AI for CFD Simulations

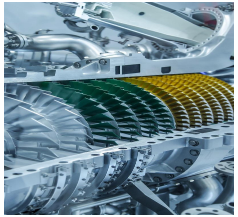
BERLIN QUANTUM PIONEER

BERLIN QUANTUM Pioneer is collaboration

Computational Fluid Dynamics



Modeling to analyse fluid flows, heat transfers, and multi-physics phenomena



AEROSPACE & **DEFENSE** INDUSTRIES

AUTOMOTIVE INDUSTRY

CHEMICAL & **INDUSTRIAL** COMPANIES

HEALTHCARE INDUSTRY

Navier-Stokes Equation

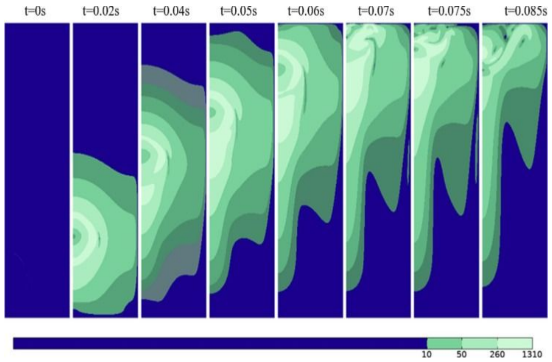
$$\rho\left(\frac{\partial v}{\partial t} + v.\nabla v\right) = -\nabla p + \nabla.T + f$$

Biomedical CFD

Problem

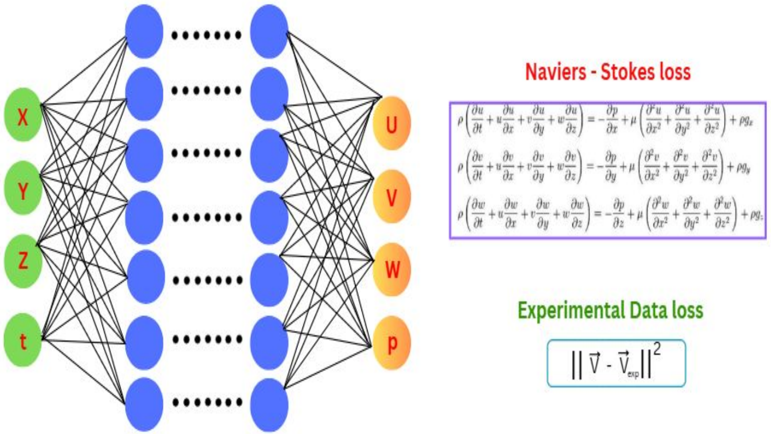
Challenges for CFD Simulations

- **High Computational Cost for Turbulent Flows**
- **Inaccuracies in Predicting Nonlinearities**
- **Expensive High fidelity simulations**



Solution

Combining Quantum with Physics-Informed Neural Networks
Neural Operators, Geometry Aware Operator Transformers



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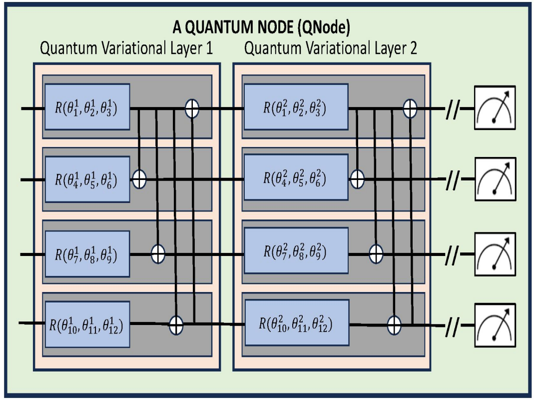
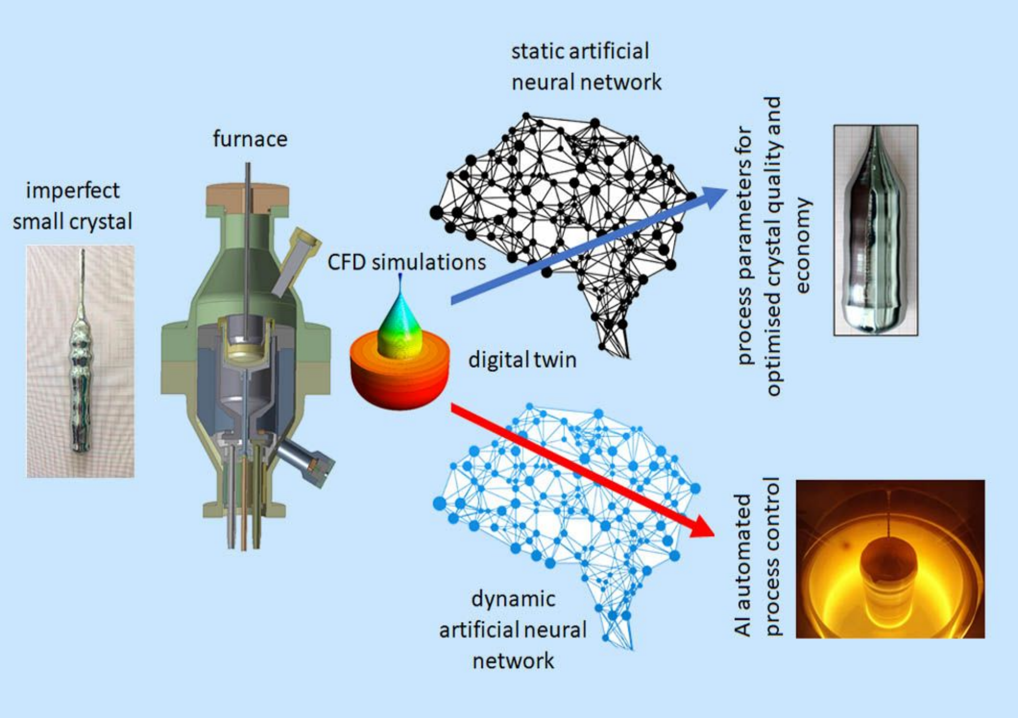
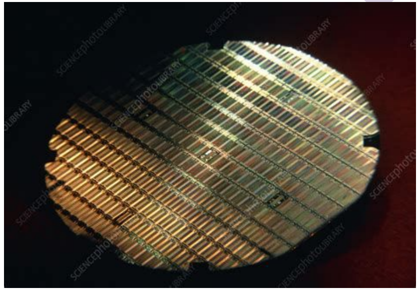


Bringing Quantum Advantage through AI
(Hybrid Approaches on QPU/GPUs Hardware)

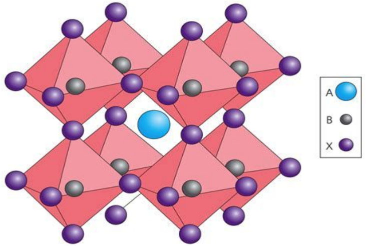
Use Case (PoC)

Single-Crystal Growth Simulations





Silicon Wafers

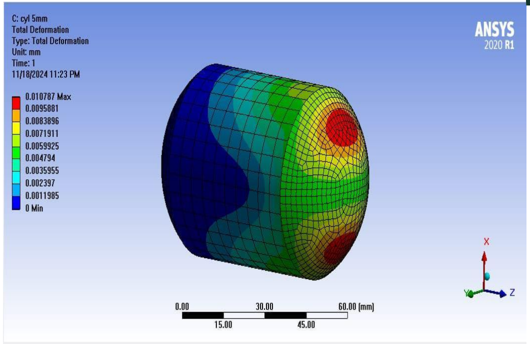


Perovskites

Accelerating CFD for Faster Chips Production

Designing Cryogenic Vessels

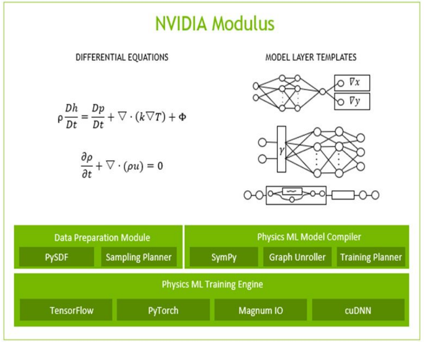
Accelerating CFD Reduces Design to Production Time

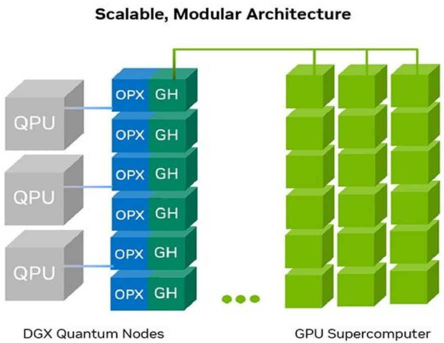


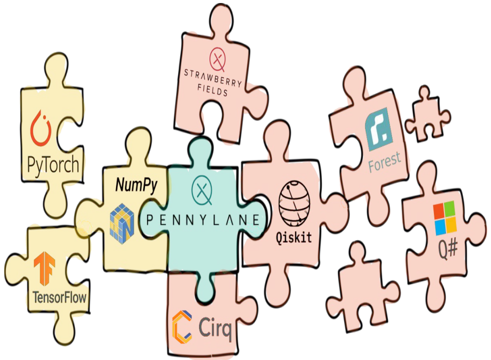
Green Hydrogen Economy

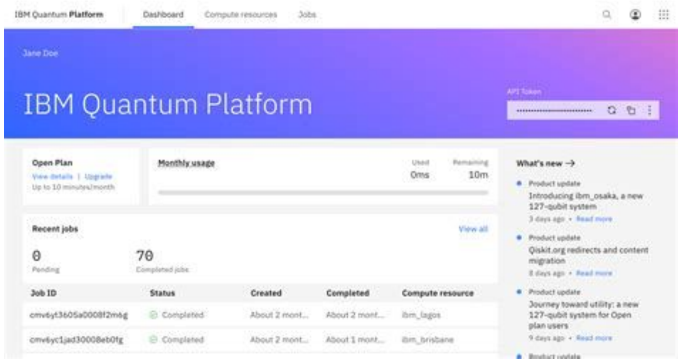
Collaboration with Indo-Australian Startup

Frameworks & Resources









Pennylane, Nvidia Modulus, DGX Quantum, IBM Quantum Credits

https://pennylane.ai/ developer.nvidia.com https://quantum.ibm.com/

Business Model

Ecosystem Integration

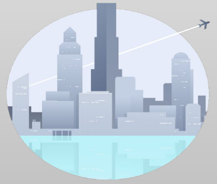
Integrate workflows

QuantME

Simulations as a Service

Domain Specific

QFaaS

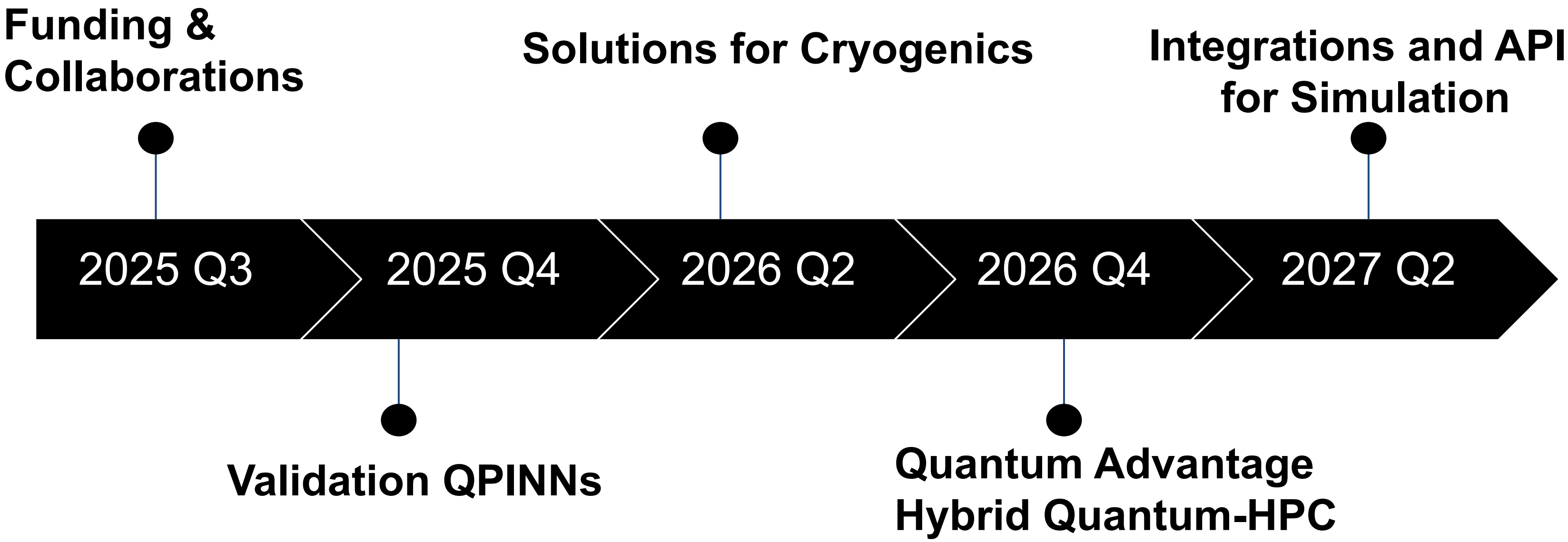


Synthetic Data Generation

Licensing

Reselling

Timeline & Milestones



Team

Strong background in Quantum AI, Simulations and Business Development

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ICFO The Institute of Photonic Sciences

Thank You

Collaborations & Partnerships

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https://adytiaa.github.io/quasi.ai/

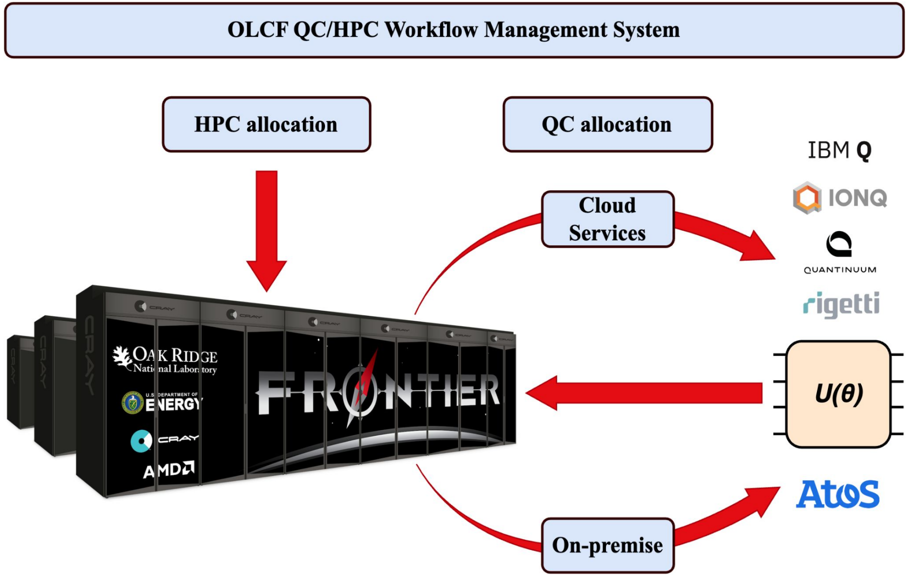
Classical Benchmarks

PINNs, Neural Operators, NeuralDEM, Universal Physics Transformer Models

	ShapeNet-Car		AhmedML			DrivAerML			Neural field	Mesh independent
	p_s	u	p_s	u	ω	p_s	u	ω		
PointNet	12.01	3.05	8.51	5.43	67.29	23.26	28.12	880.0	✗	✗
GRAPH U-NET	10.33	2.48	6.42	4.14	53.53	16.13	17.98	330.0	✗	✗
GINO	13.27	2.52	7.90	6.23	71.80	13.03	40.58	98.5	✓	✓
LNO	9.05	2.29	12.91	7.56	72.04	20.51	23.27	173.0	✓	✓
UPT	6.41	1.49	4.25	2.73	15.03	7.44	8.74	90.2	✓	✓
OFormer	7.05	1.60	3.55	2.22	7.78	4.48	6.64	60.4	✓	✓
Transolver	6.46	1.62	3.45	2.05	8.22	4.81	6.78	38.4	✗	✗
Transformer	4.86	1.17	3.41	2.09	6.76	4.35	6.21	47.9	✗	✗
AB-UPT	**4.81**	**1.16**	**3.01**	**1.90**	**6.52**	**3.82**	**5.93**	**35.1**	✓	✓

Source: https://arxiv.org/pdf/2502.09692

QC-HPC integration



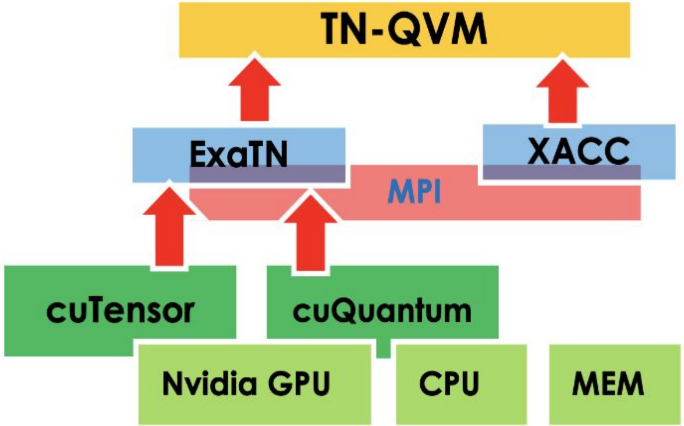


Figure 3: Schematic showing how the TN-QVM, an ORNL-developed tensor-network based accelerator, integrates with various other software packages to form a powerful tool for simulating large circuits and algorithms on HPC platforms.

Source: https://arxiv.org/html/2408.16159v1

Hybrid Benchmarks

Quantum PINNs/Neural Operators/Tensor Networks

Model	Harmonic		Non-harmonic		Number of trainable parameters
	Accuracy	Trainability	Accuracy	Trainability	
Classical	Medium	High	High	High	High
Quantum	High	Low	Low	Low	Low
Hybrid	Medium–High	Medium–High	Medium	Varies	Medium–High

Table 4: Qualitative assessment of PINN models in the present study.

Qubits: 4–12 qubits for initial benchmarks

Source: https://arxiv.org/pdf/2502.09692