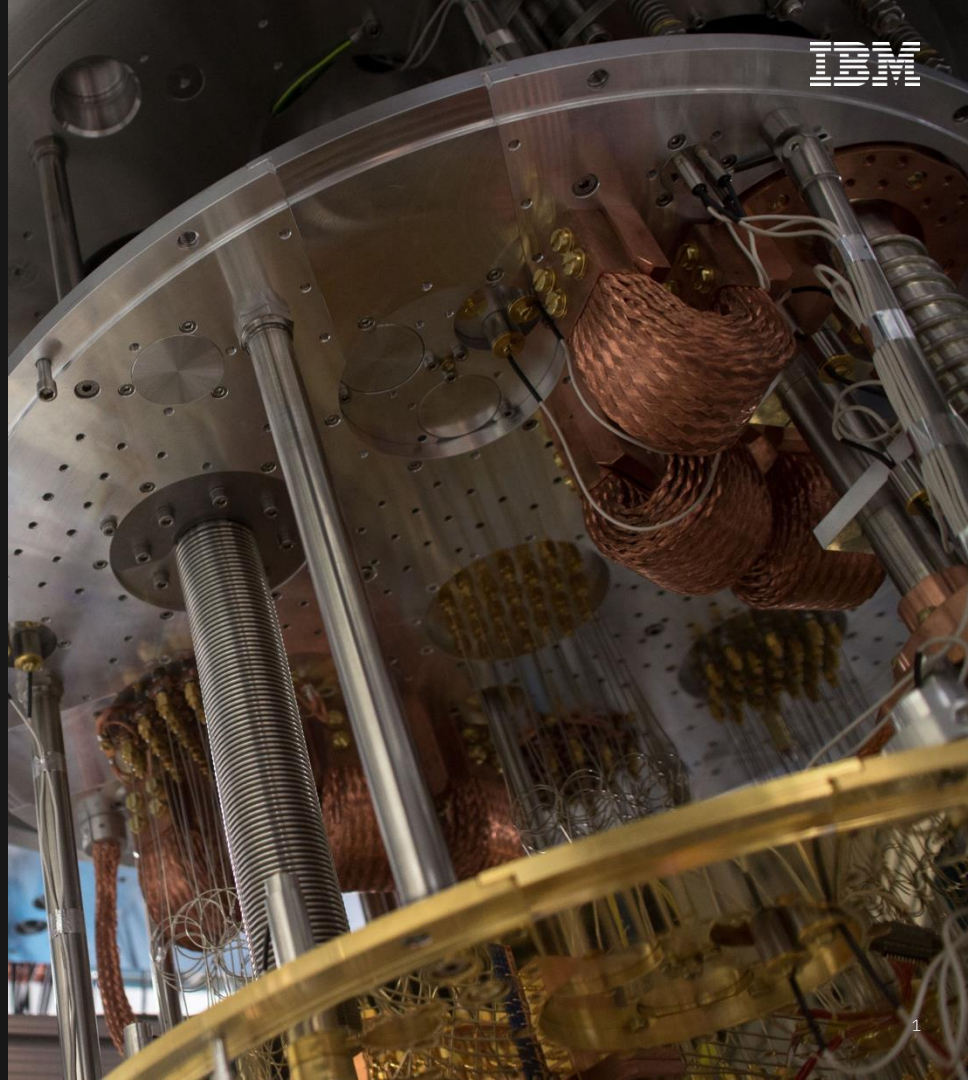
IBM Research

Quantum Computing Opportunities and Challenges

Dr Peter Waggett
Director of Research IBM UK Ltd



IBM Q

 #IBMQ

About Me

Dr Peter Waggett

PhD in Rocket Science

Failed Astronaut

Over 25 years IT Research Experience

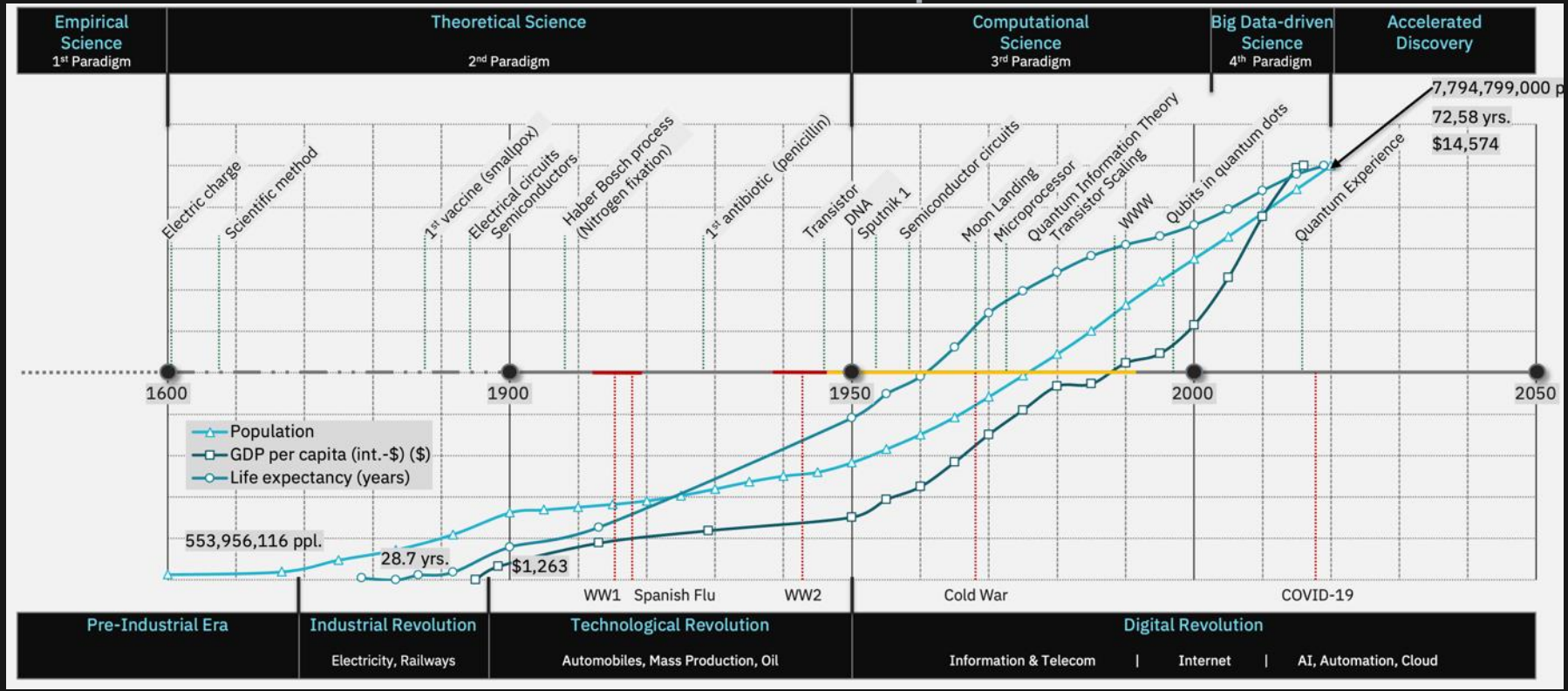
Director of Research – IBM UK

Research Emphasis on Emerging and Disruptive Technologies

The urgency of science has never been stronger than it is now.

The scientific method has been humanity's best model for discovery.

Science has solved some of the world's most difficult problems



… and it has evolved over time and we are now entering a new paradigm of discovery.

1st Paradigm

Empirical Science

Observations
Experimentation

Pre-Renaissance

2nd Paradigm

Theoretical Science

Scientific laws
Physics
Biology
Chemistry

~1600s

3rd Paradigm

Computational Science

Simulations Molecular dynamics Mechanistic models

~1950

4th Paradigm

Big data-driven Science

Big data
Machine learning
Patterns
Anomalies
Visualization

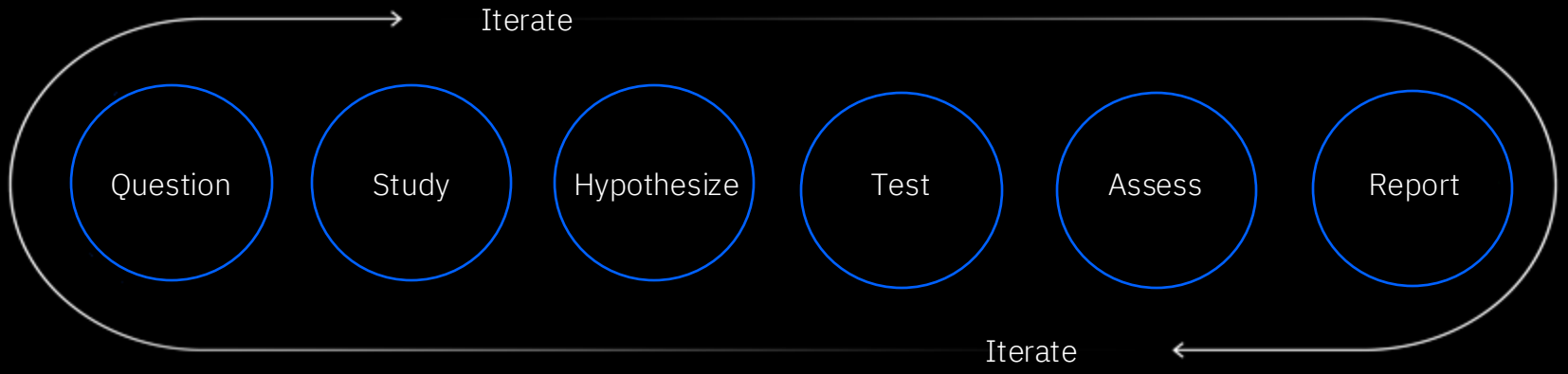
~2000

Accelerated Discovery

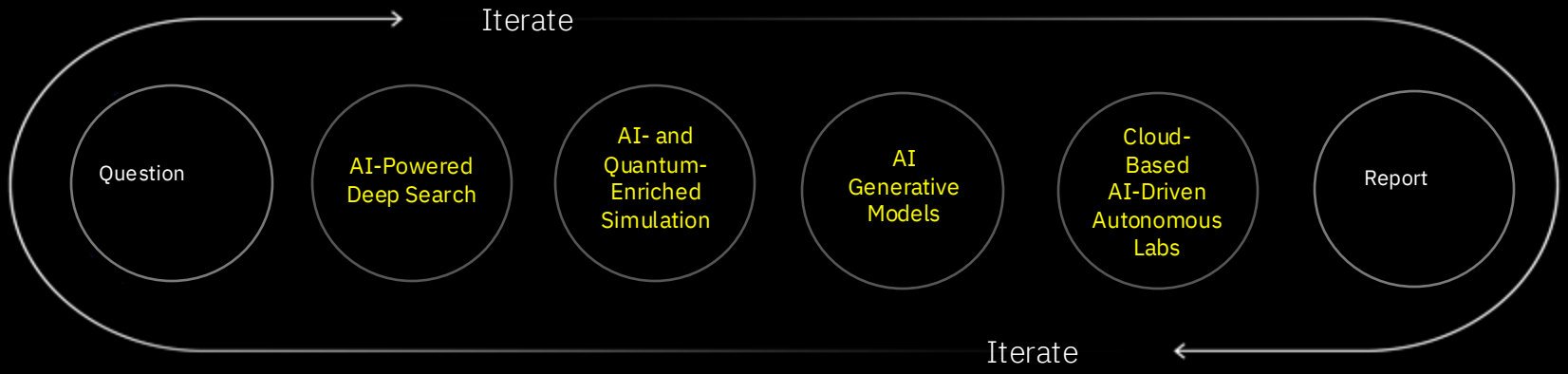
Scientific knowledge at scale
AI generated hypotheses
Autonomous testing

2020

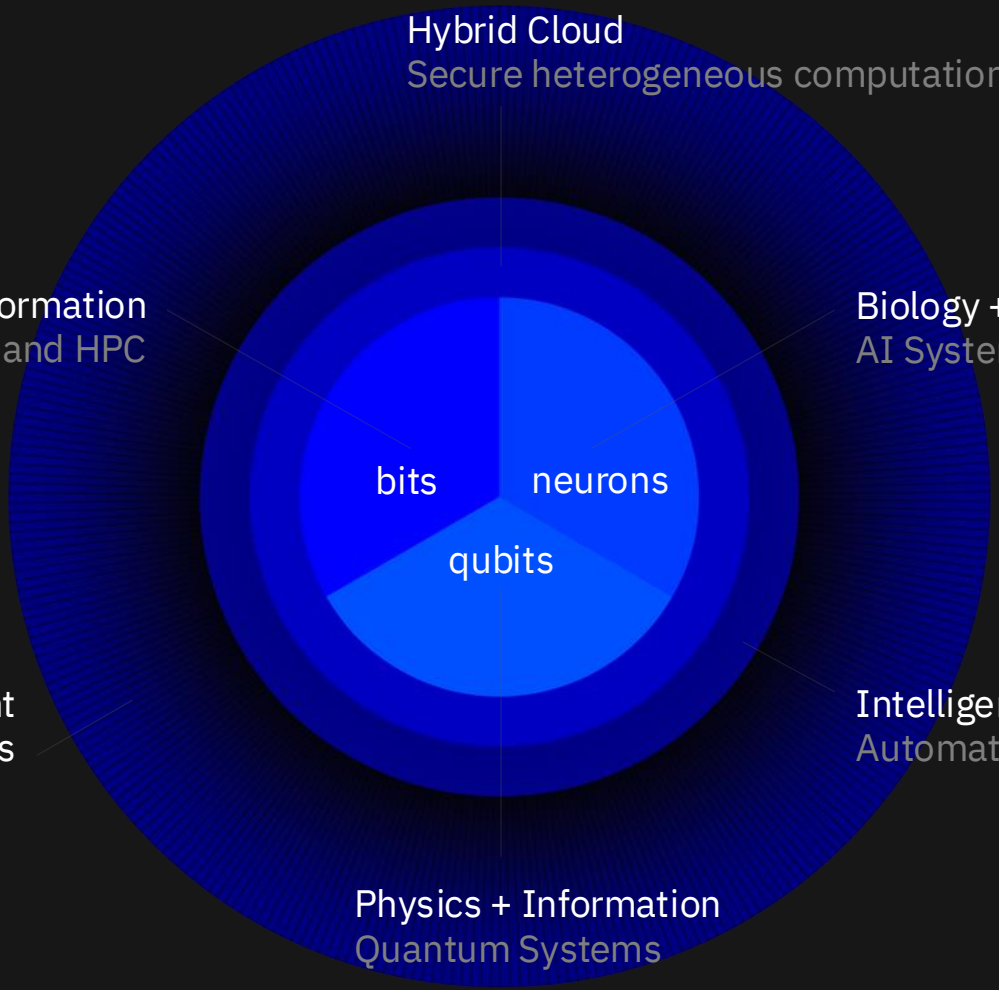
We supercharge the scientific method …



… to create the components of an accelerated discovery workflow.



The future of computing



“I’m not happy with all the analyses that go with just the classical theory, because nature isn’t classical, dammit, and if you want to make a simulation of nature, you’d better make it quantum mechanical …”

Richard P. Feynman
Department of Physics,
California Institute of Technology

International Journal of Theoretical Physics,
Vol 21, Nos. 6/7, 1982

Opportunities with Quantum Computing

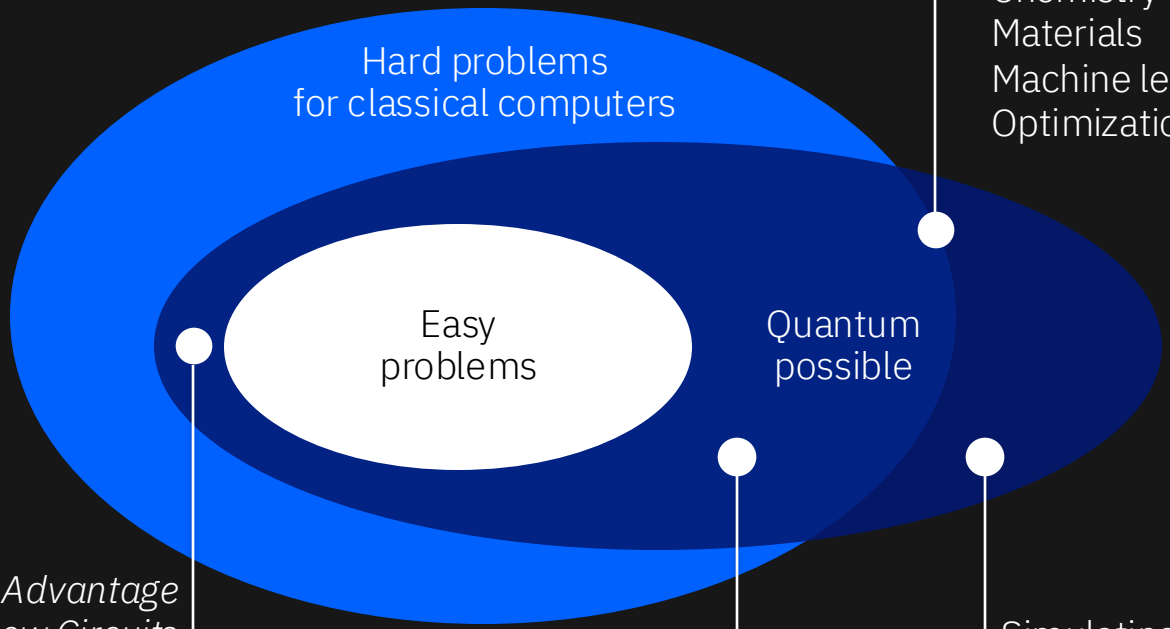
Qbits

New Operations
- Superposition
- Entanglement
- Decoherence
- Interference

New Use Cases
- Chemistry/Materials
- Pharmaceuticals
- Machine learning

Hard versus easy problems

Quantum computing may provide a new path to solve some of the hardest or most memory intensive problems in business and science.



 #IBMQ

HARTREE NATIONAL CENTRE FOR DIGITAL INNOVATION

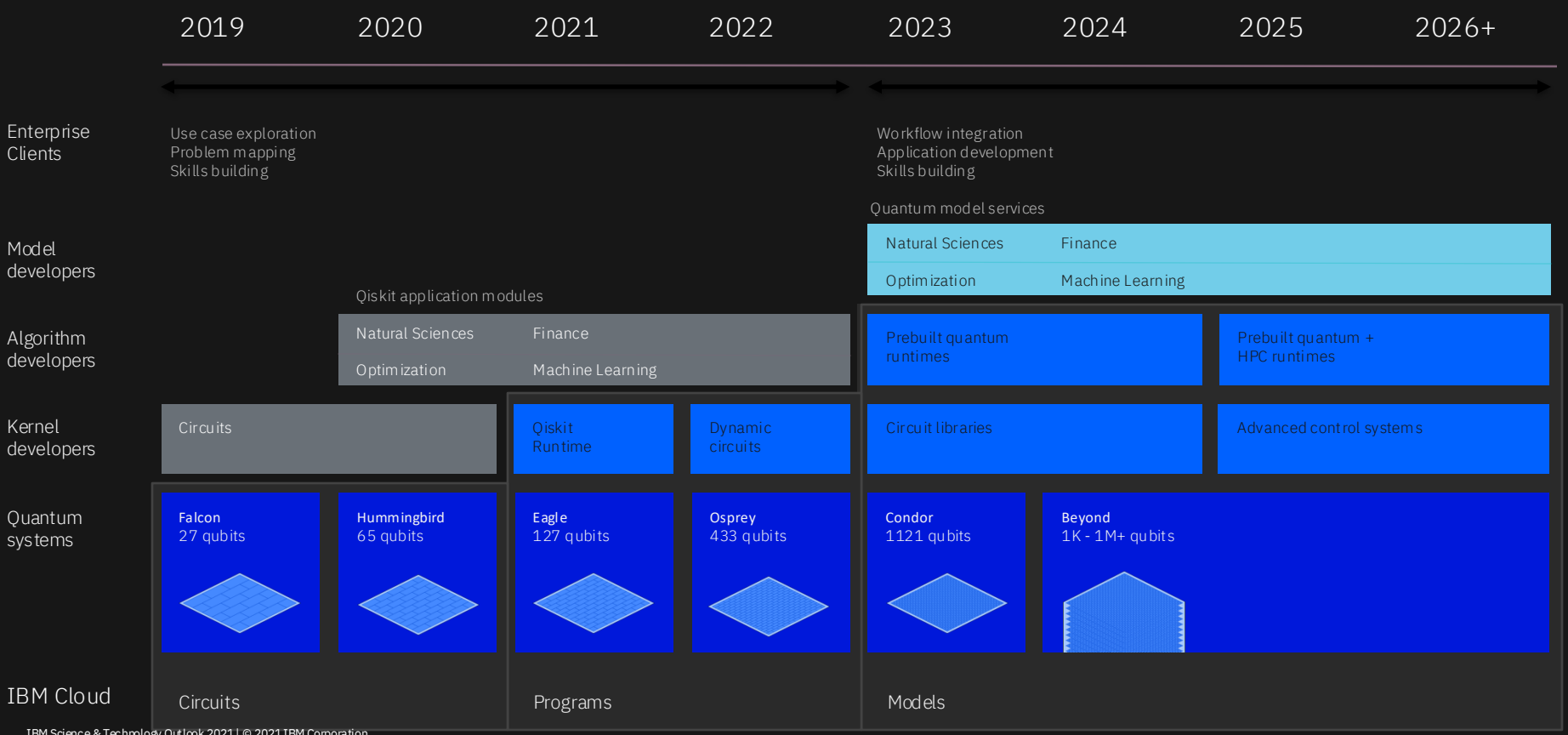
UKRI Science and Technology Facilities Council

Hartree Centre

IBM

Development Roadmap

IBM **Quantum**



Quantum Volume

Qbits x Error Rate

Quantum Errors

Sources
- Cosmic Rays
- Thermal Instabilities
- Etc .....!

Quantum Error Mitigation and Correction

Environments Like Boulby?

Error Mitigation

Error Correction


IBMQ

Thank you

Dr Peter Waggett
Director of Research IBM UK Ltd

Peter_Waggett@uk.ibm.com
+44 7711537378
ibm.com

 #IBMQ