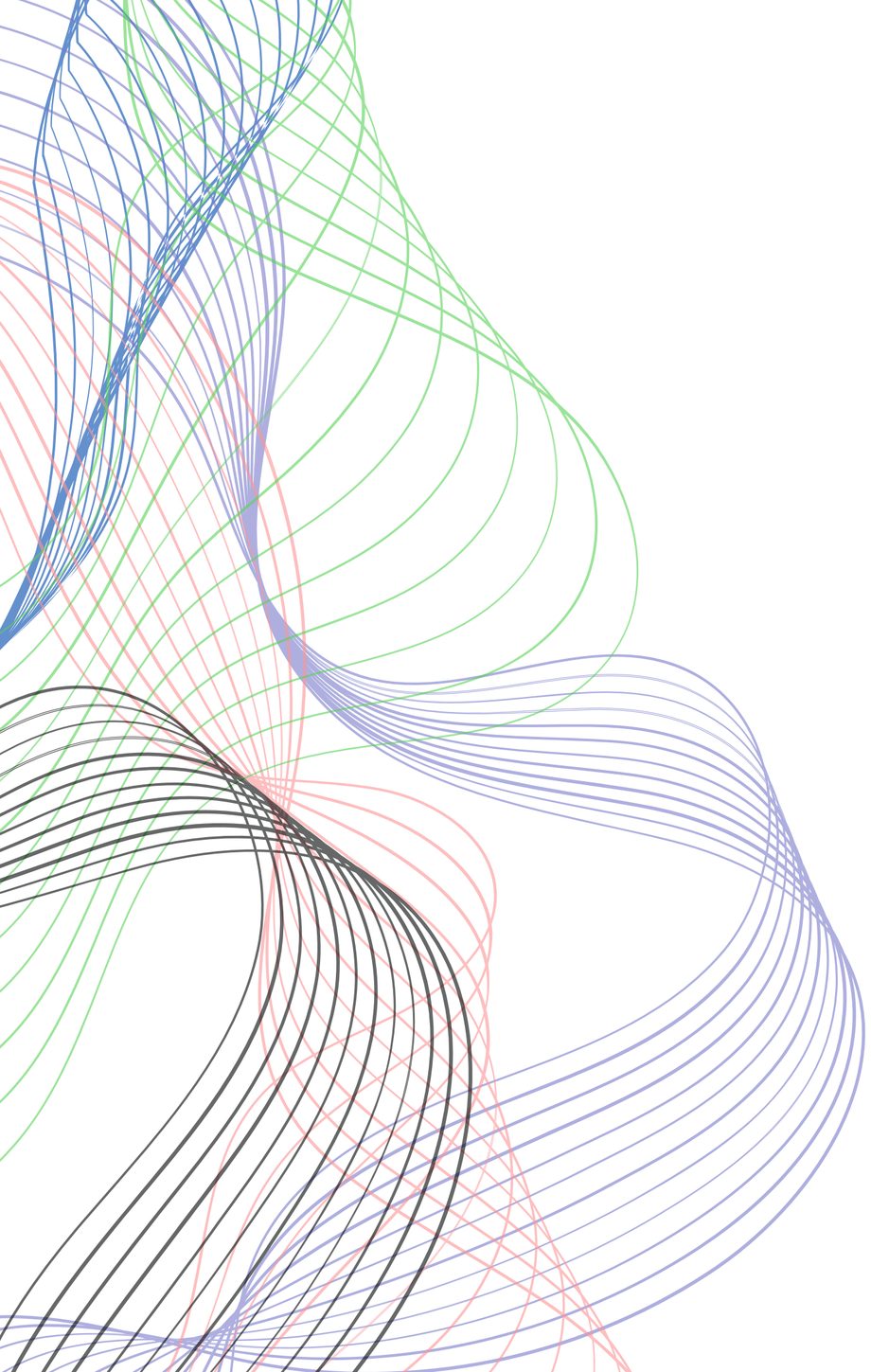
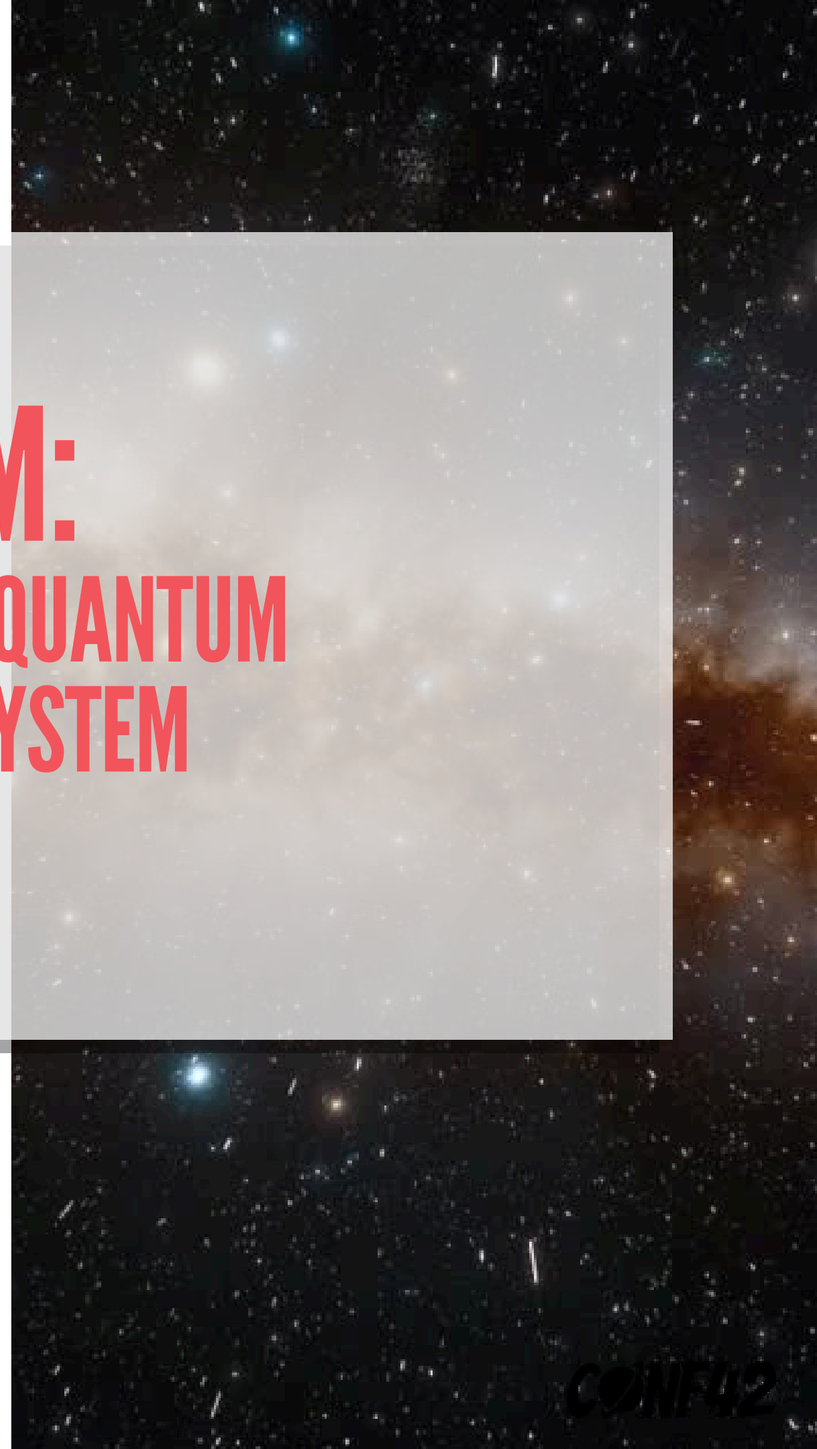


PRINCIPIUM:
DIVING INTO THE QUANTUM HARDWARE ECOSYSTEM

Presented By

Archit Srivastava



“

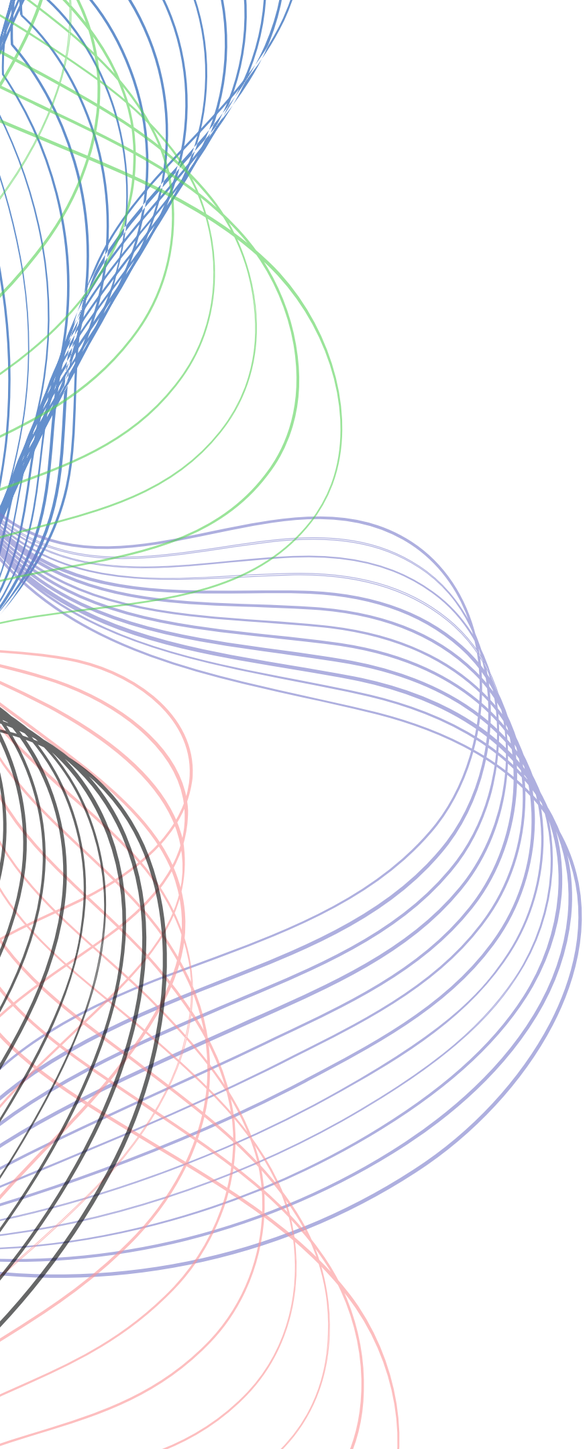
ABOUT

”

CONF42

- Founder ofAiQyaM, a Quantum Hardware Community
- Founder of CIRQuIT Quantum Research at RVCE & Quantum Hardware Learning Circle in QCI
- Quantum Computing Intern at BosonQ Psi Pvt. Ltd.
- Quantum Evangelist at Innogress working on GKQCTP
- Senior Technical Consultant at o9 Solutions, Bengaluru, Karnataka, India.

AiQyaM



MOTIVATION

- There's a lack of knowledge about the quantum hardware ecosystem and the need for growth in the domain.

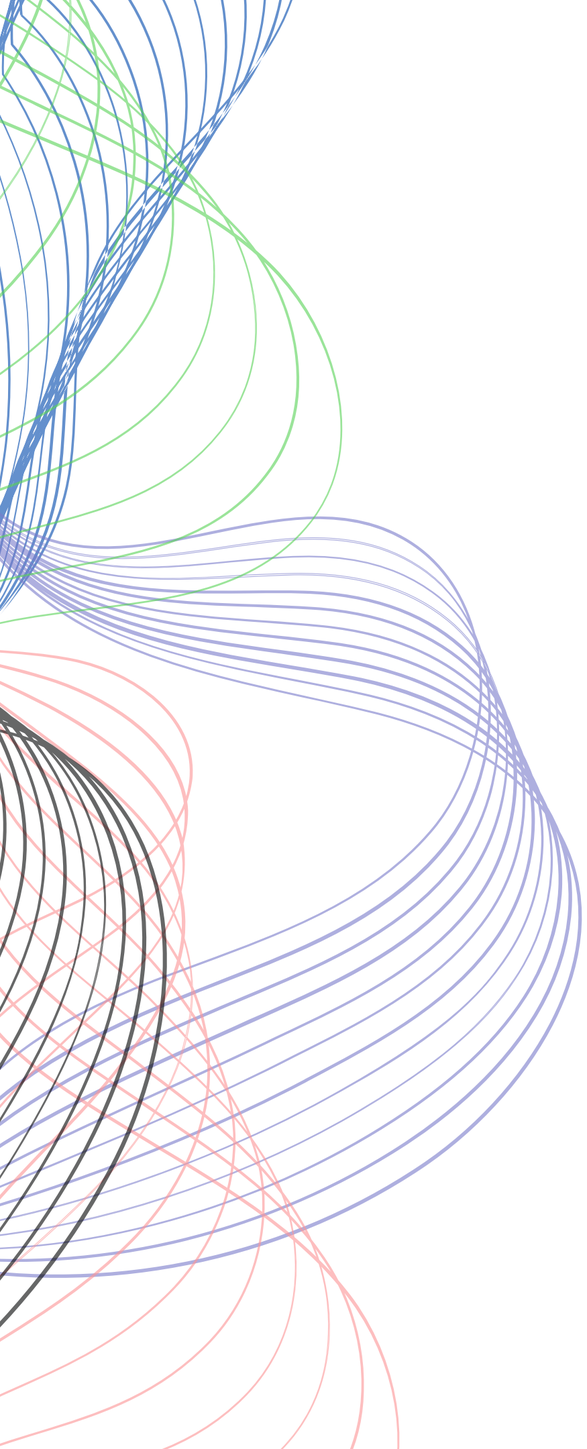
- Increase in the need to spread awareness about various topics related to quantum computing hardware.

- The immediate need for people to indulge in the development of quantum hardware to realize effective quantum computing solutions in the future

“

CONTENT

”

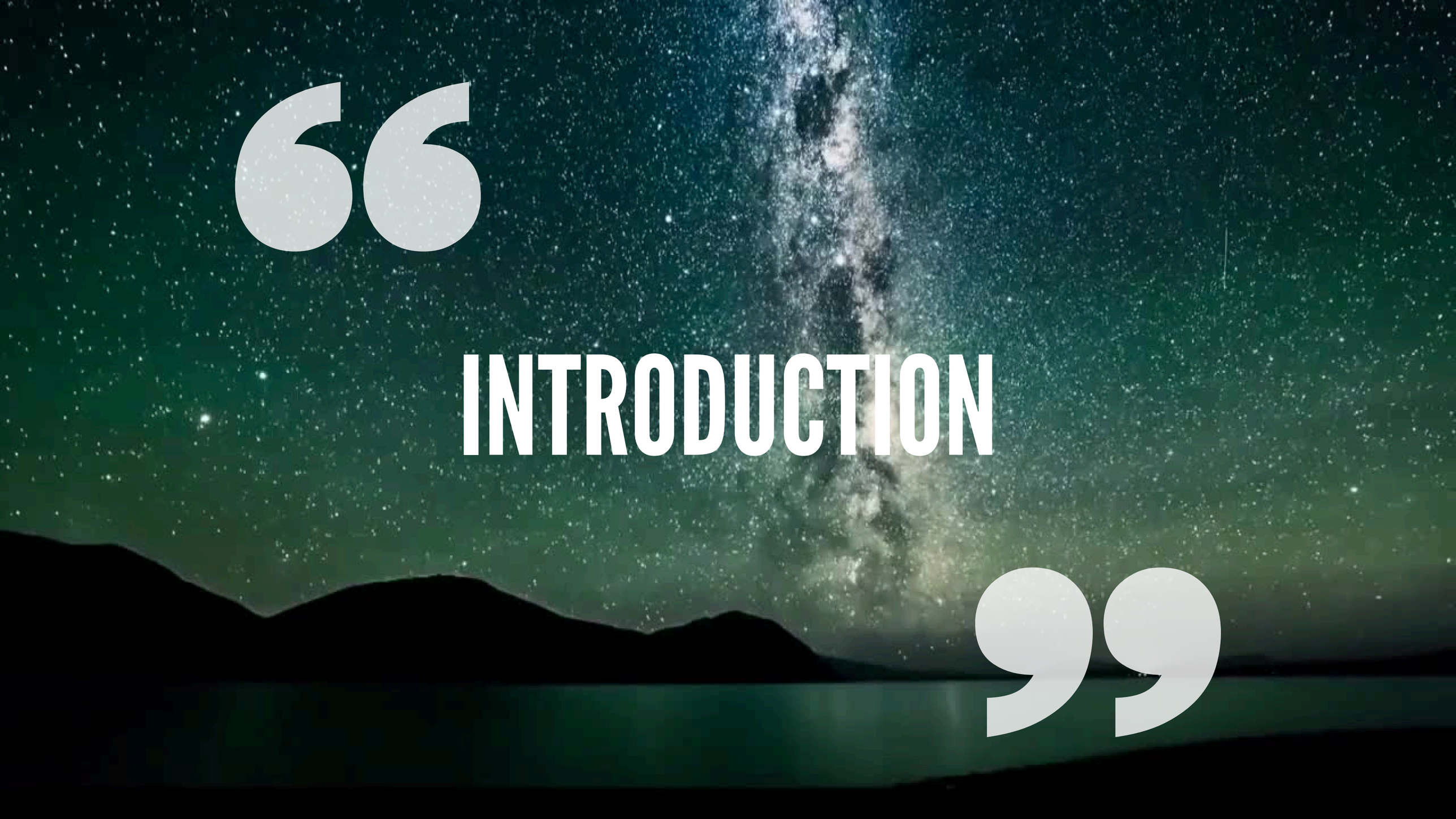


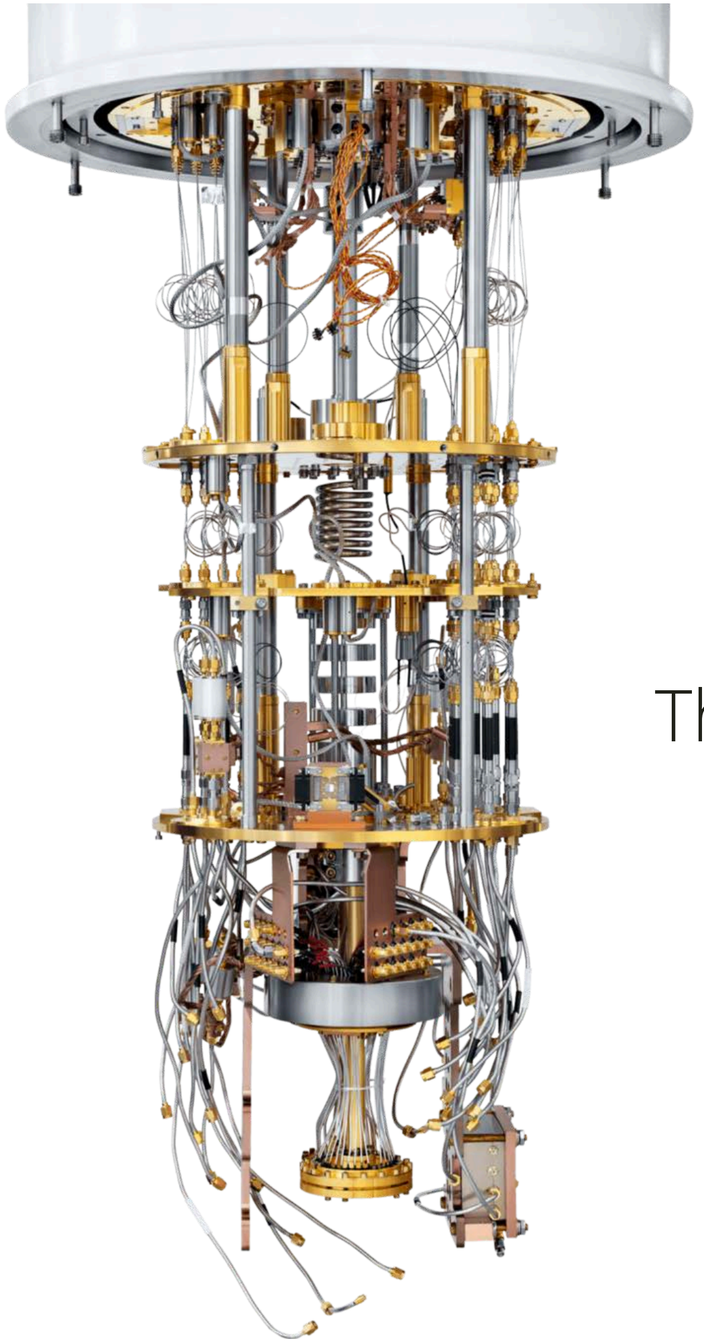
INTRODUCTION

THE GLOBAL PICTURE

THE INDIAN LANDSCAPE

USE CASES


“
INTRODUCTION
”



This is a Quantum Computer :-)

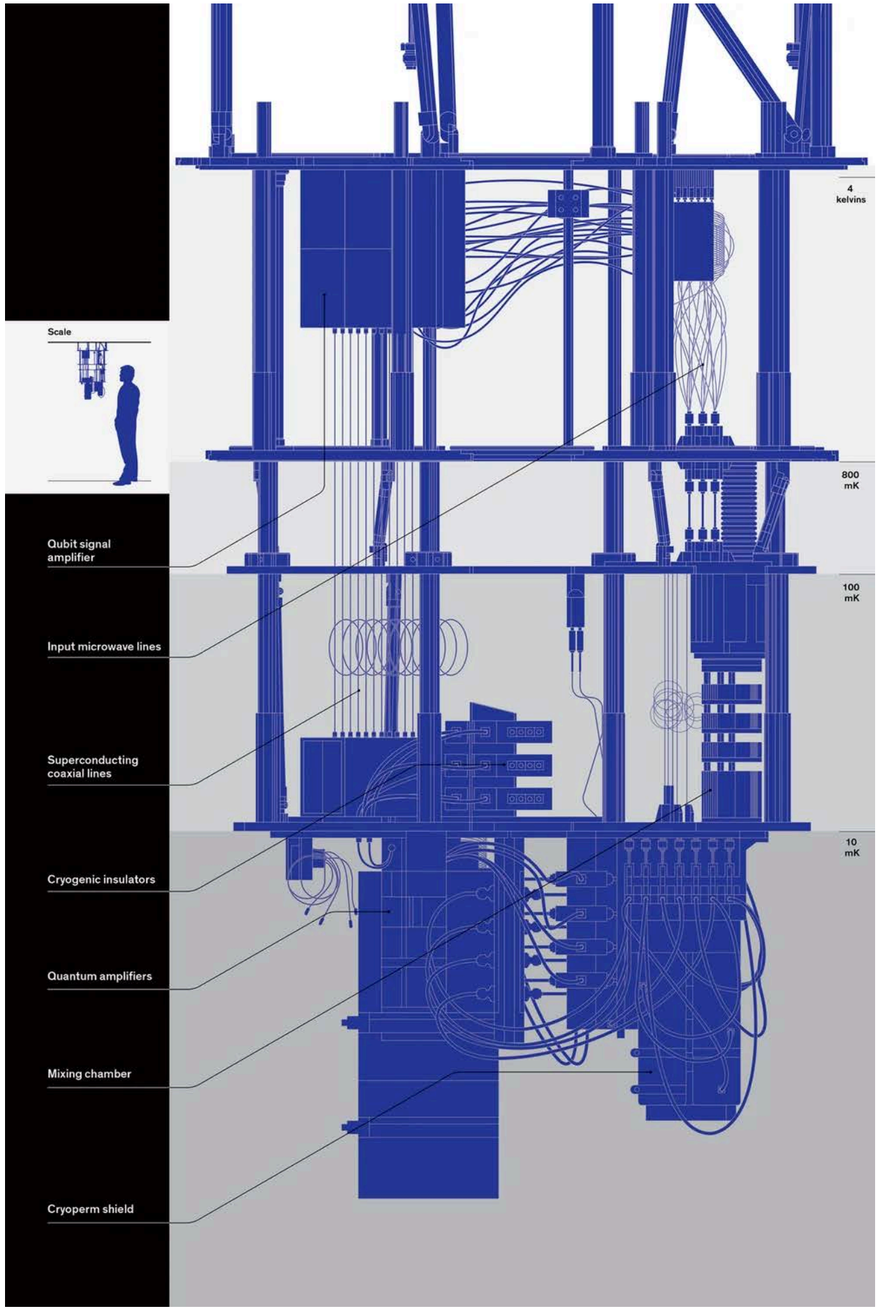
(Well not Actually)

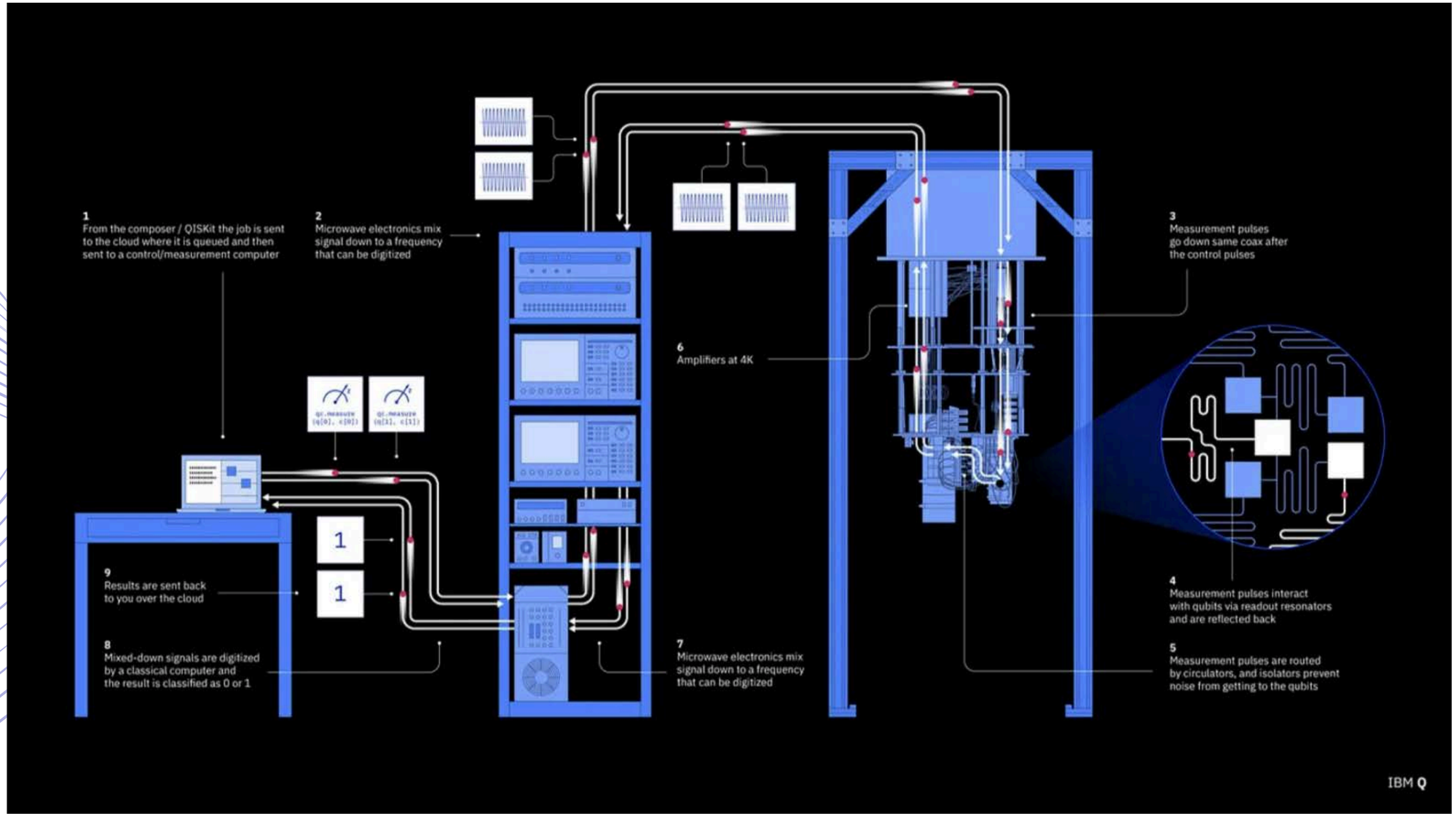
A

bigger

picture

:-)



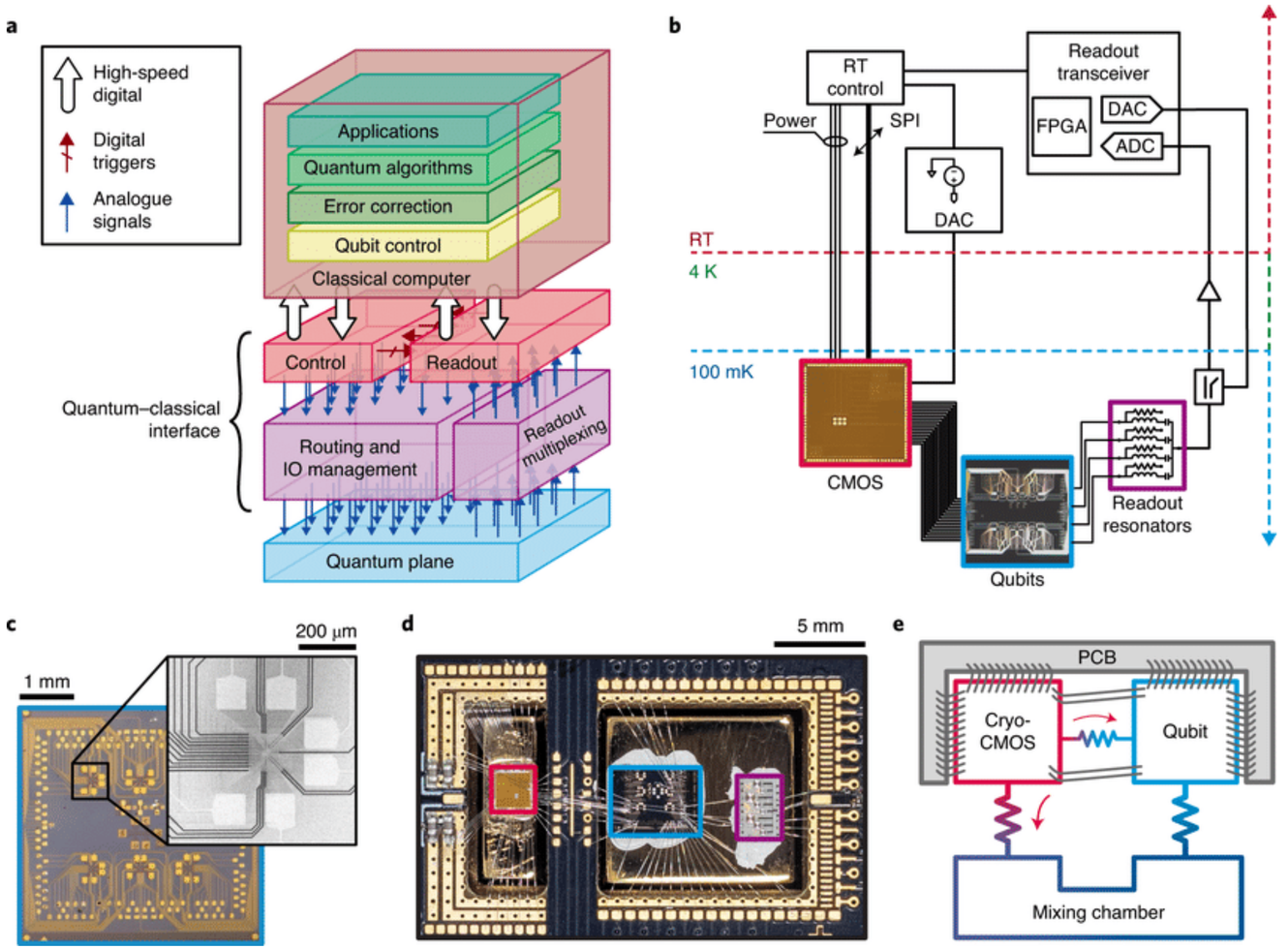

1
From the composer / QISKit the job is sent to the cloud where it is queued and then sent to a control/measurement computer
2
Microwave electronics mix signal down to a frequency that can be digitized
3
Measurement pulses go down same coax after the control pulses
6
Amplifiers at 4K
4
Measurement pulses interact with qubits via readout resonators and are reflected back
5
Measurement pulses are routed by circulators, and isolators prevent noise from getting to the qubits
7
Microwave electronics mix signal down to a frequency that can be digitized
8
Mixed-down signals are digitized by a classical computer and the result is classified as 0 or 1
9
Results are sent back to you over the cloud
1
1
IBM Q

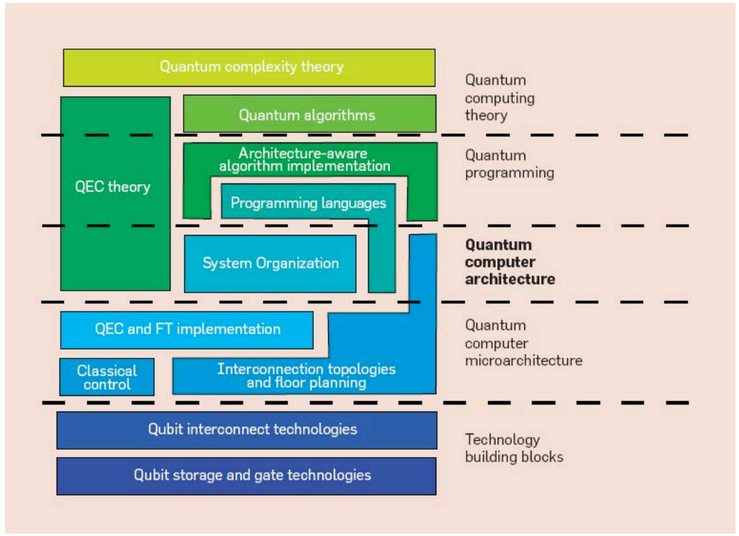
CONF42

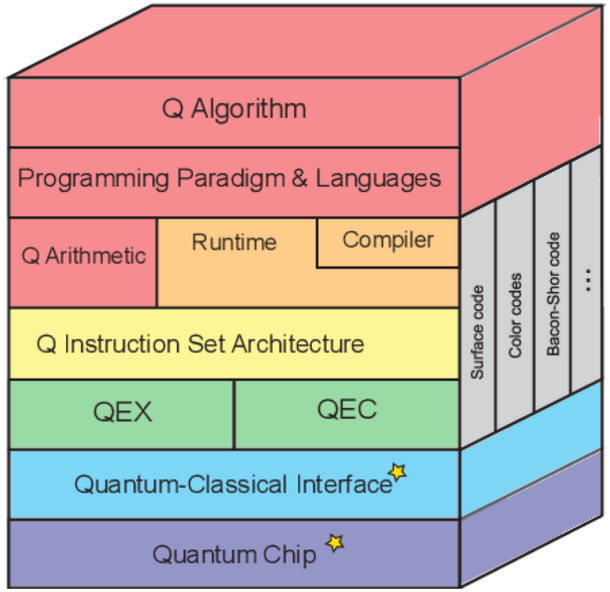
What' under the hood of a quantum computer?[1]

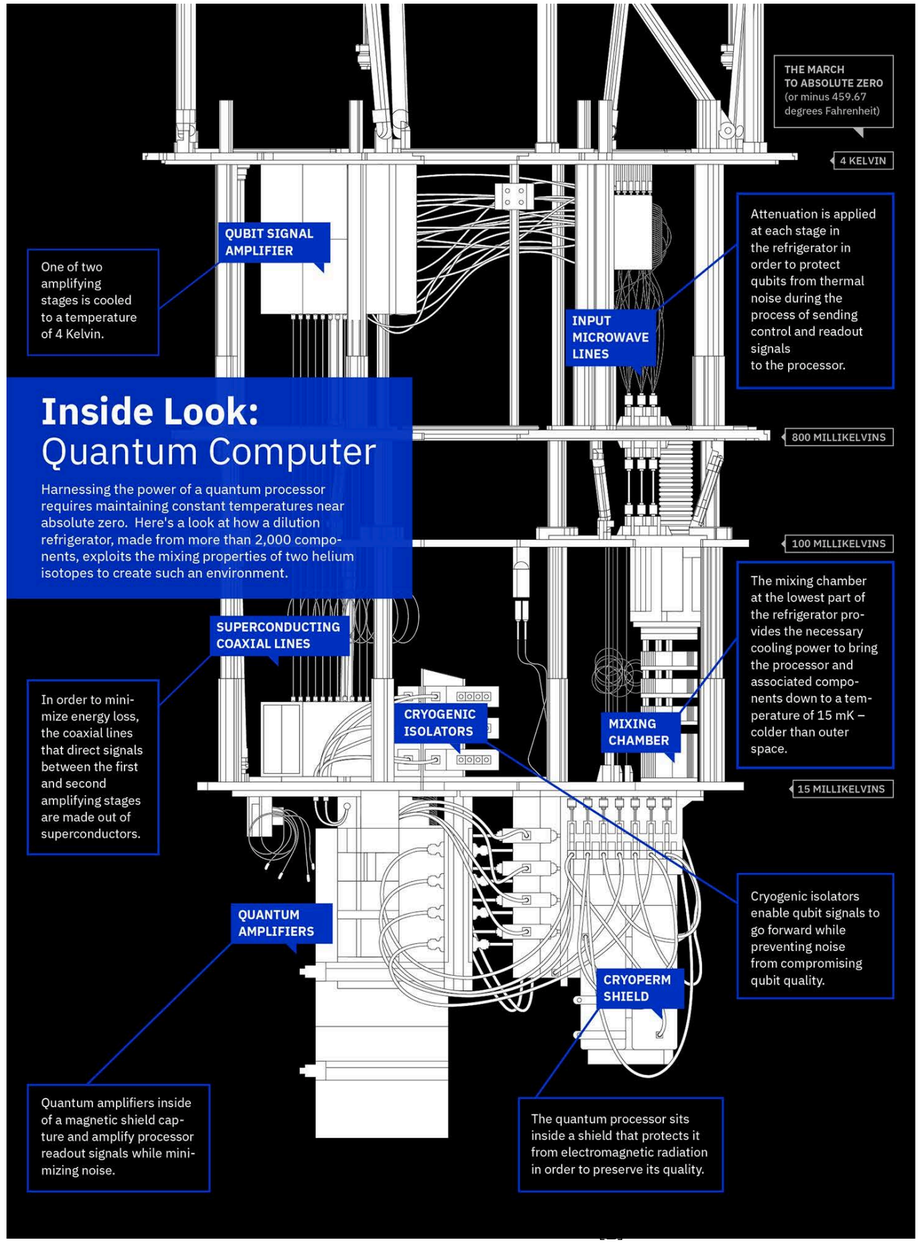
A generic quantum-classical interface of a Quantum Computer

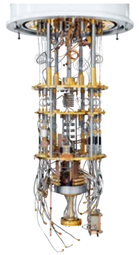
[2]



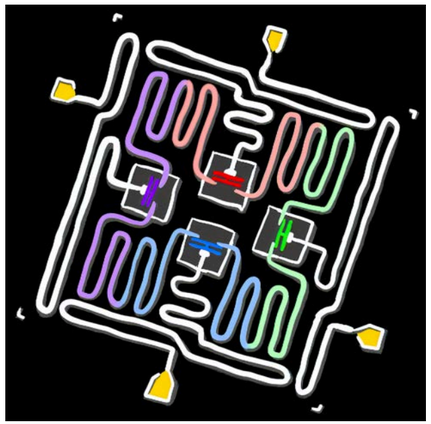

Quantum complexity theory
Quantum algorithms
Architecture-aware algorithm implementation
Programming languages
QEC theory
System Organization
QEC and FT implementation
Classical control
Interconnection topologies and floor planning
Qubit interconnect technologies
Qubit storage and gate technologies
Quantum computing theory
Quantum programming
Quantum computer architecture
Quantum computer microarchitecture
Technology building blocks


Q Algorithm
Programming Paradigm & Languages
Q Arithmetic
Runtime
Compiler
Q Instruction Set Architecture
QEX
QEC
Quantum-Classical Interface
Quantum Chip
Surface code
Color codes
Bacon-Shor code
...

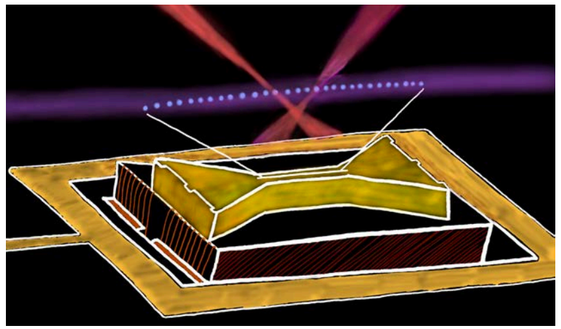

Inside Look:
Quantum Computer
Harnessing the power of a quantum processor requires maintaining constant temperatures near absolute zero. Here's a look at how a dilution refrigerator, made from more than 2,000 components, exploits the mixing properties of two helium isotopes to create such an environment.
THE MARCH TO ABSOLUTE ZERO (or minus 459.67 degrees Fahrenheit)
4 KELVIN
QUBIT SIGNAL AMPLIFIER
One of two amplifying stages is cooled to a temperature of 4 Kelvin.
INPUT MICROWAVE LINES
Attenuation is applied at each stage in the refrigerator in order to protect qubits from thermal noise during the process of sending control and readout signals to the processor.
800 MILLIKELVINS
100 MILLIKELVINS
SUPERCONDUCTING COAXIAL LINES
In order to minimize energy loss, the coaxial lines that direct signals between the first and second amplifying stages are made out of superconductors.
CRYOGENIC ISOLATORS
MIXING CHAMBER
The mixing chamber at the lowest part of the refrigerator provides the necessary cooling power to bring the processor and associated components down to a temperature of 15 mK – colder than outer space.
15 MILLIKELVINS
Cryogenic isolators enable qubit signals to go forward while preventing noise from compromising qubit quality.
QUANTUM AMPLIFIERS
CRYOPERM SHIELD
Quantum amplifiers inside of a magnetic shield capture and amplify processor readout signals while minimizing noise.
The quantum processor sits inside a shield that protects it from electromagnetic radiation in order to preserve its quality.



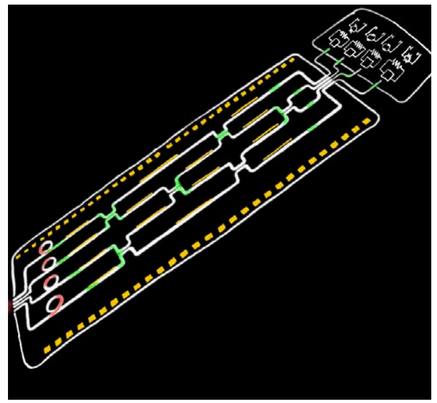
Superconducting



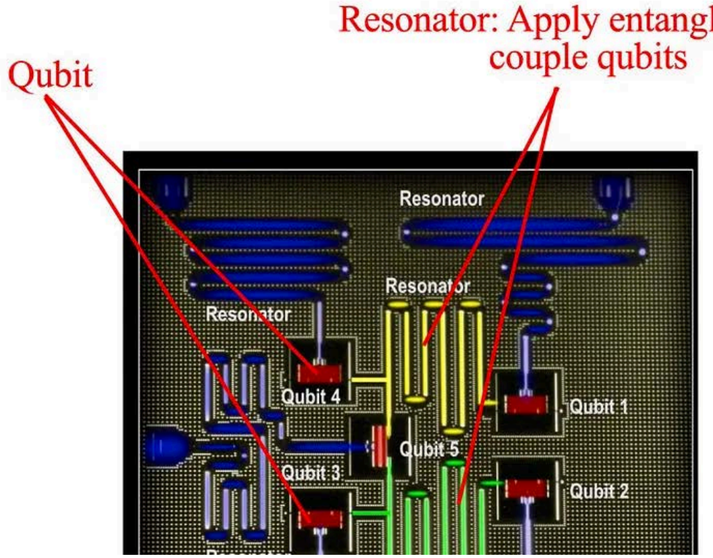
Trapped-Ions

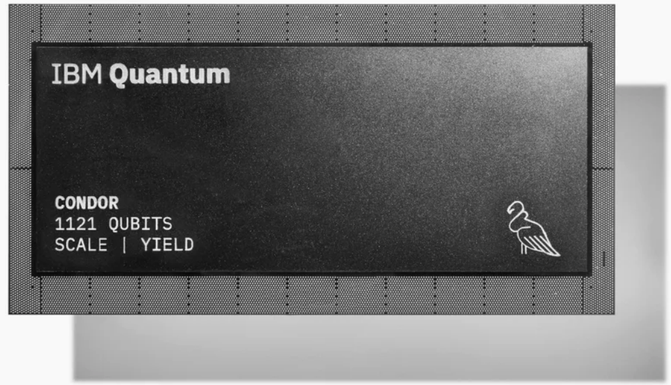


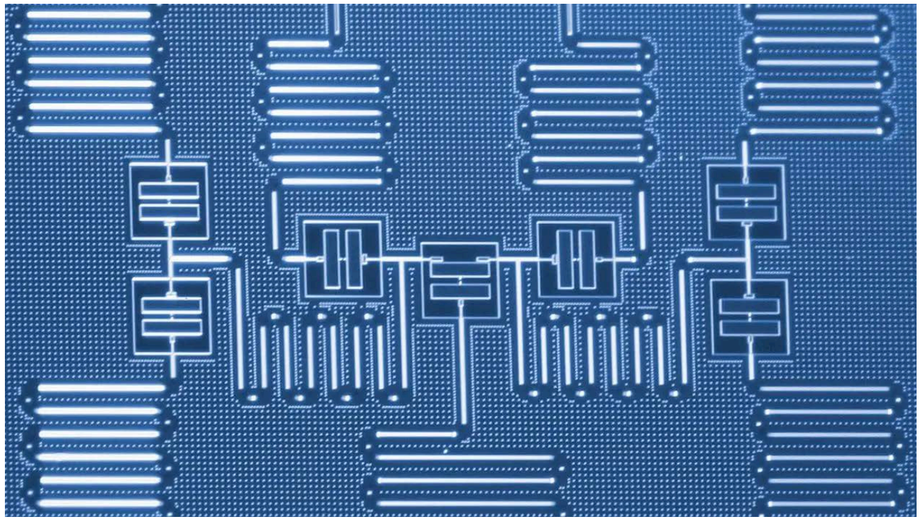
Photonics



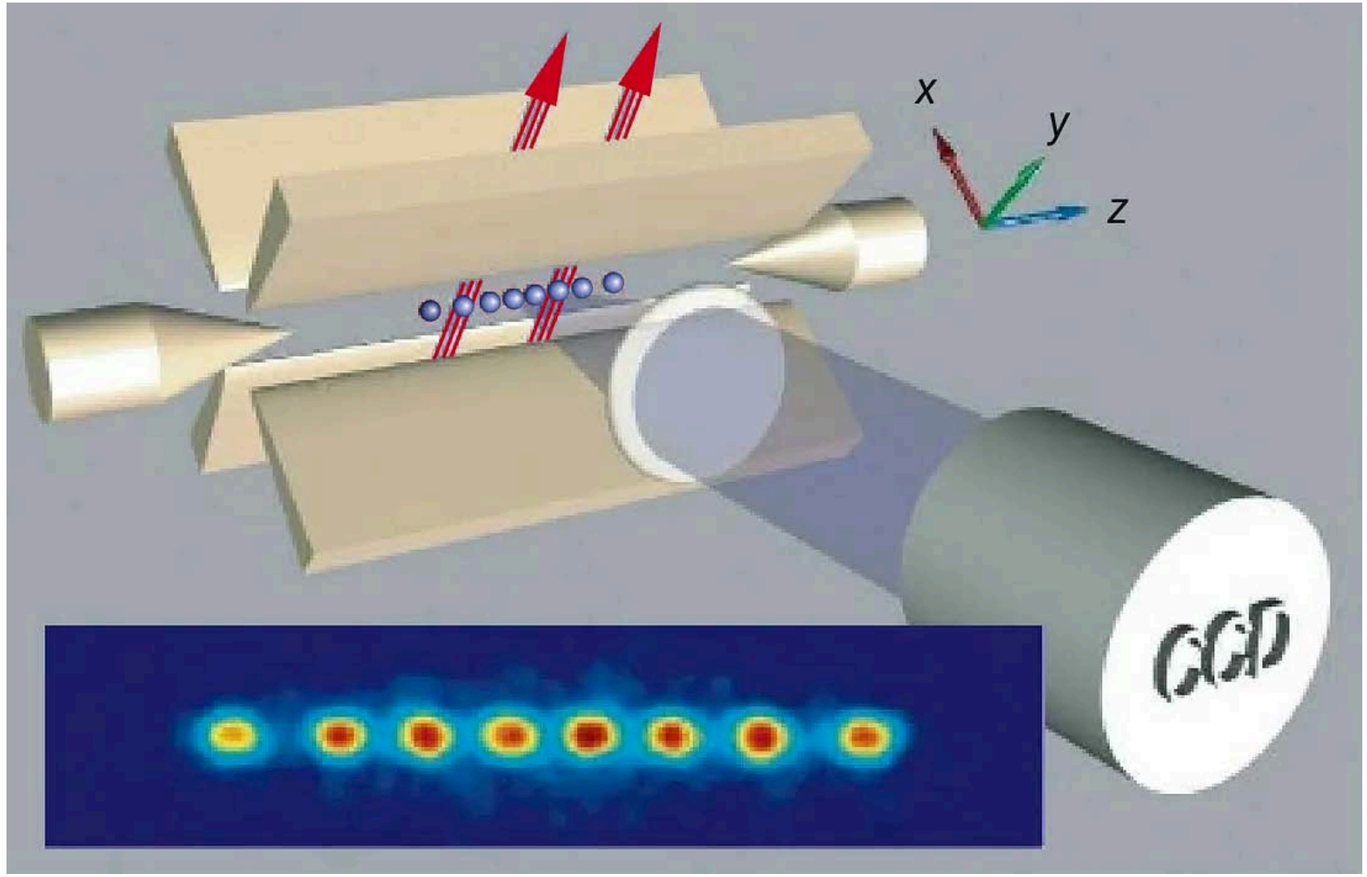
and more...



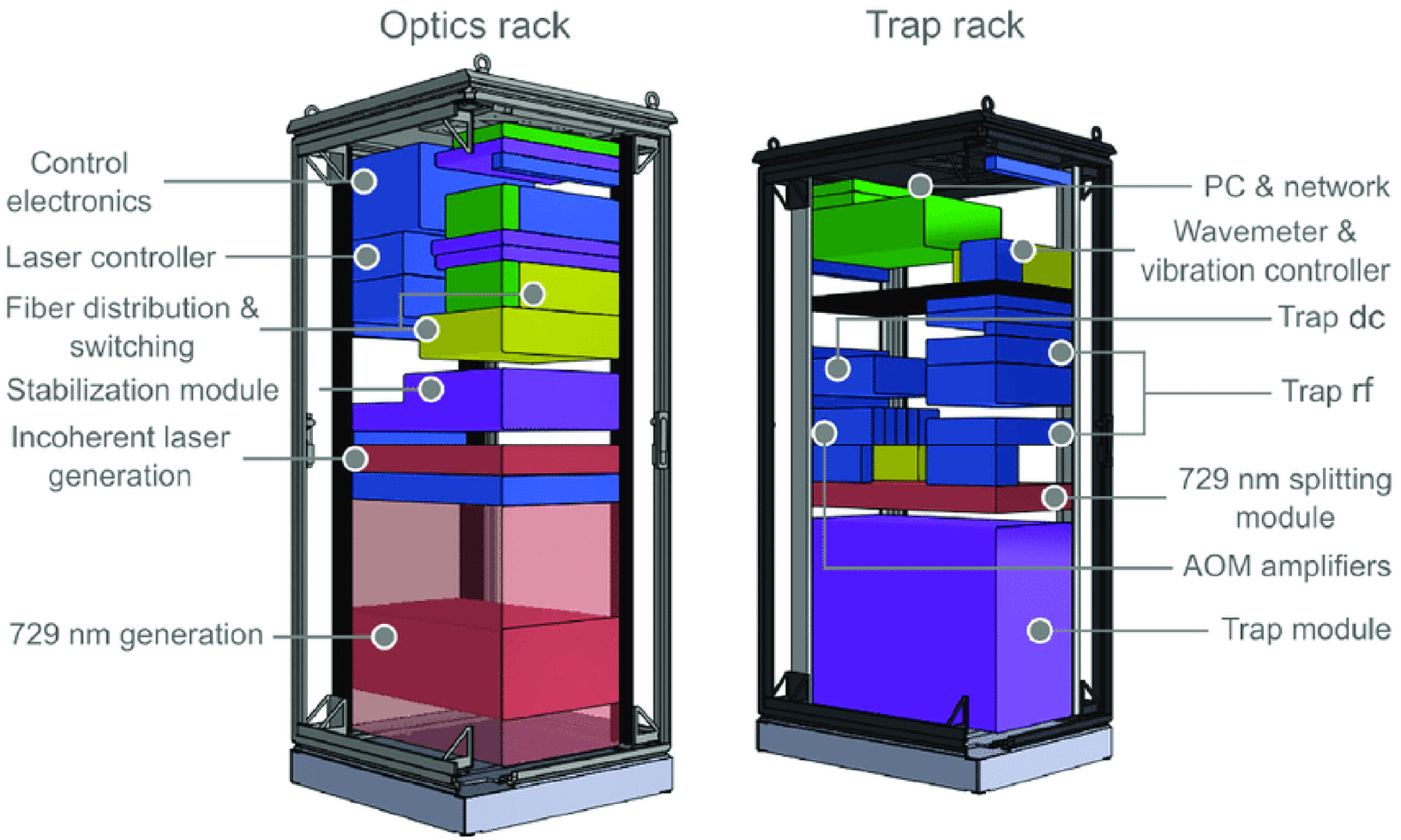




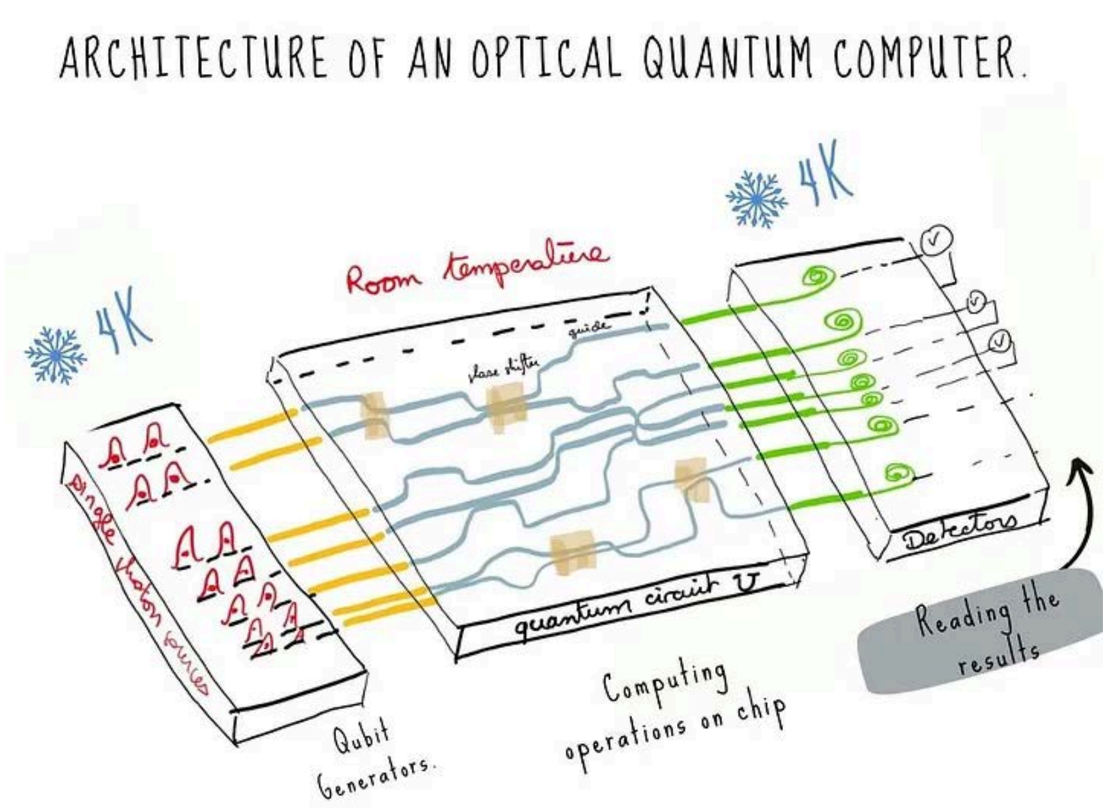
Superconducting Qubit

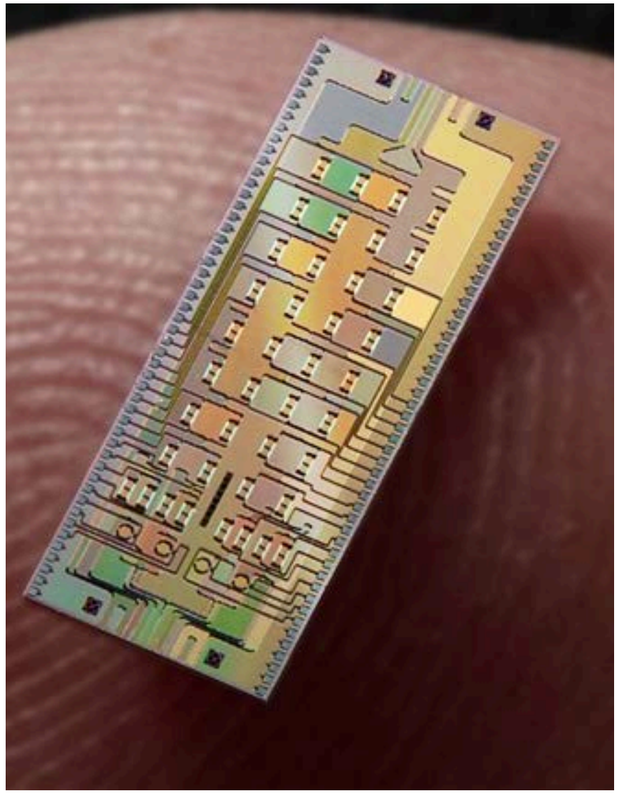


Ion Trap Qubit



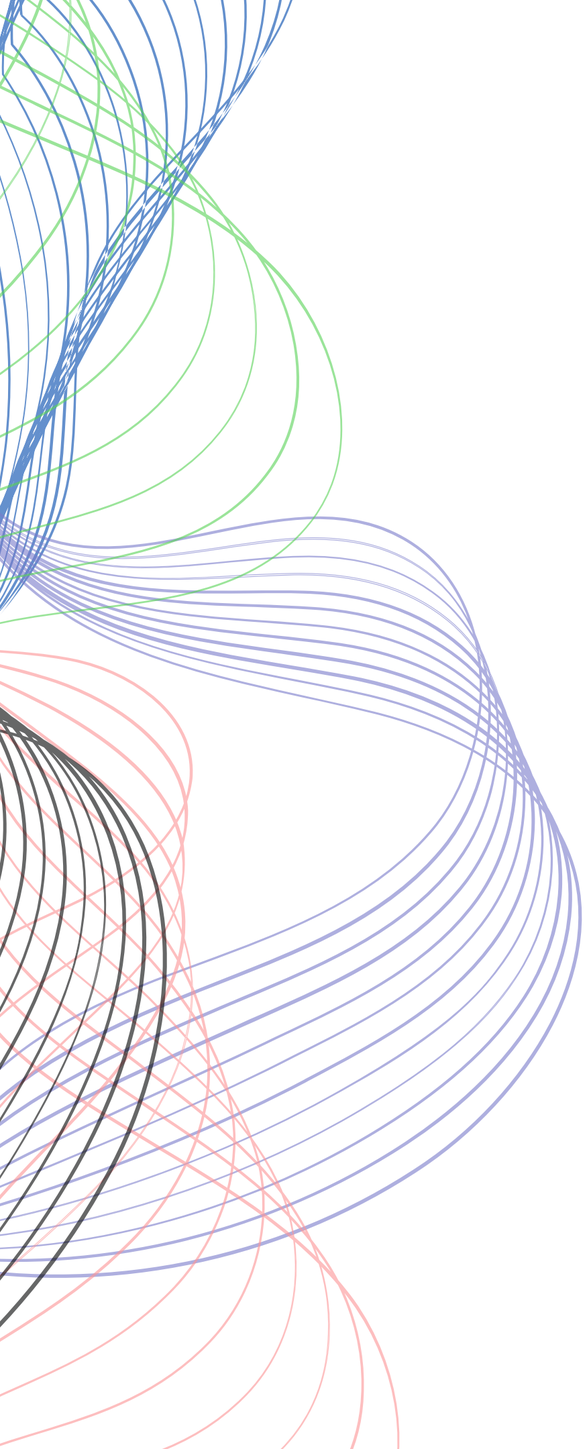
[1]
Compact Ion Trap Quantum Computer demonstrator





Photonic Qubit

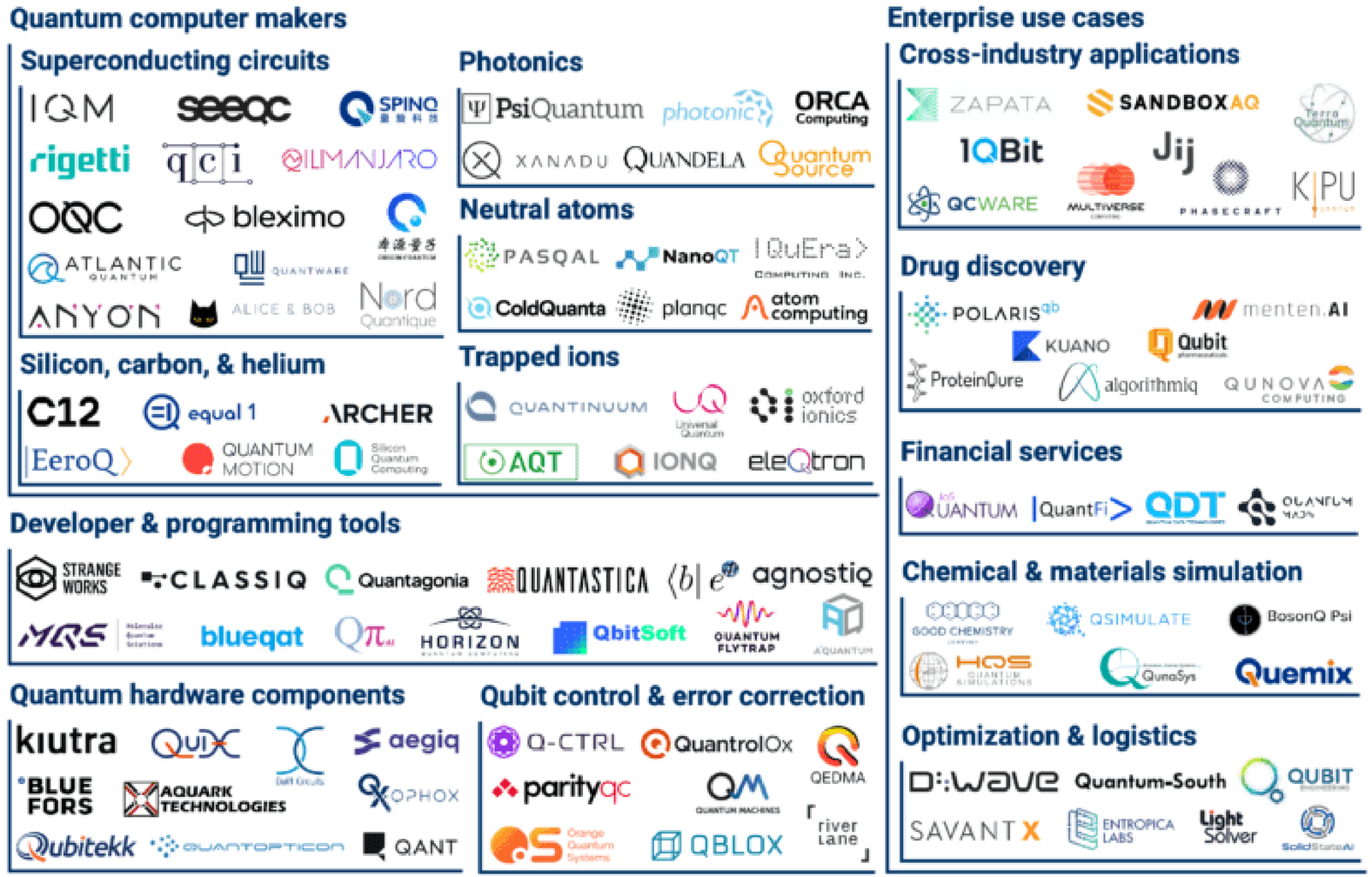

“
THE GLOBAL PICTURE
”



CURRENT GLOBAL PICTURE

- The global quantum computing market was valued at approximately $500 million in 2021.
- Expected to reach $1.76 billion by 2026, with a CAGR of 30.2%.
- Major investments from tech giants like IBM, Google, and Microsoft.
- Significant government funding and private sector investments worldwide.
- Rapidly growing interest from sectors like finance, healthcare, and logistics.

102 companies shaping the quantum computing landscape

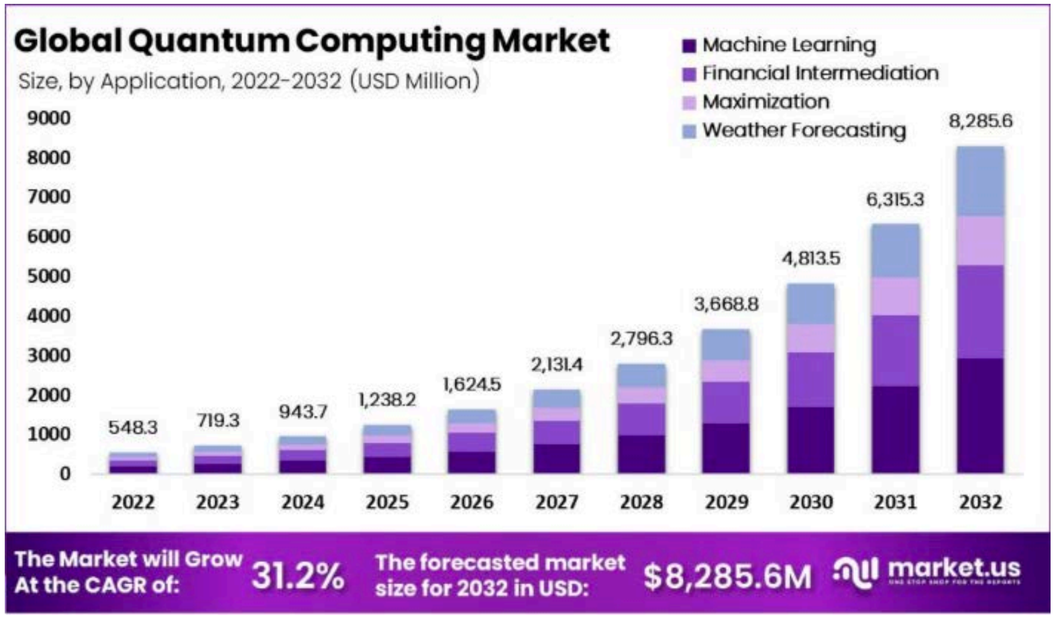


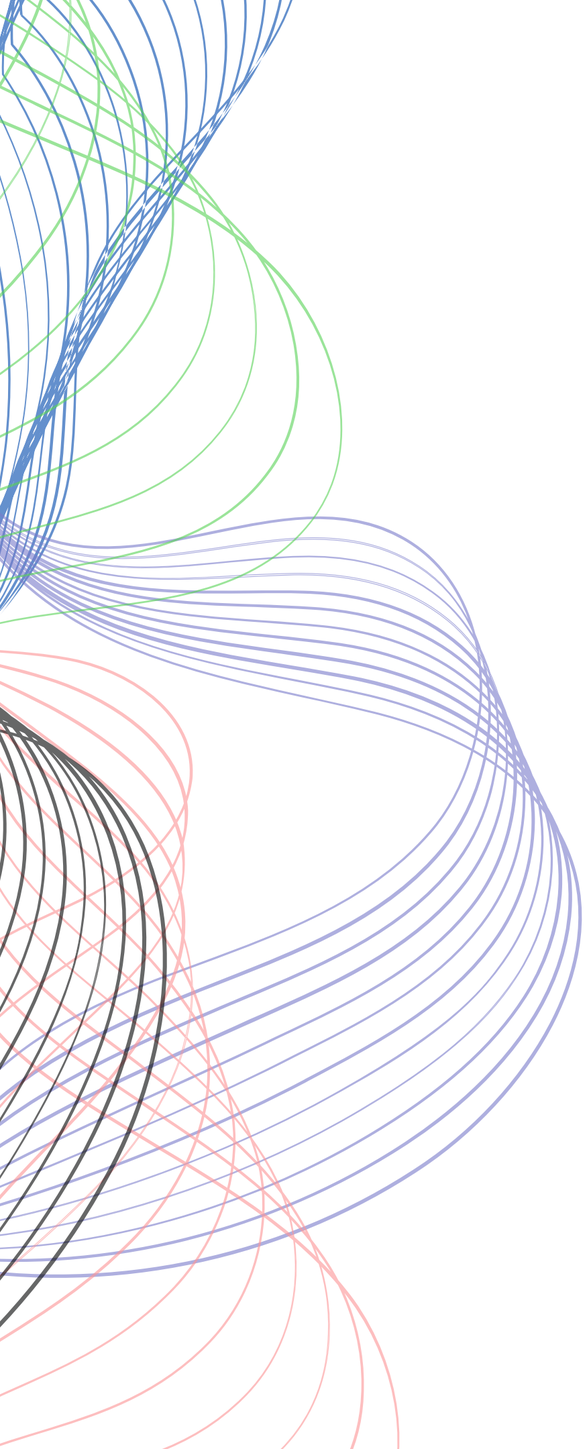
Created by You. Powered by CBINSIGHTS

CONF42

GLOBAL MARKET FOR QUANTUM HARDWARE COMPANIES?

- Quantum hardware market valued at $300 million in 2021.
- Projected to grow to $1.3 billion by 2027.
- Dominated by companies like IBM, D-Wave, Rigetti, and IonQ.
- Increasing competition from startups and new entrants.





LONG TERM BENEFITS?

- Enhanced computational power drives technological innovation and economic growth.
- Accelerates advancements in AI, cryptography, and material science.
- Attracts high-tech investments and talent, boosting GDP.
- Strengthens national security through advanced encryption and defense capabilities.
- Promotes leadership in the global tech landscape and international collaborations.

HOW DOES THE FUTURE LOOK?

- Expected market size of $2.5 billion by 2030.
- Continued exponential growth in R&D investments.
- Increased partnerships between academia, industry, and governments.
- Rapid improvements in qubit stability and scalability.
- Broadening application areas, including healthcare, finance, and climate modeling.

CONF42


“
THE INDIAN LANDSCAPE
”
CONF42

CURRENT INDIAN PICTURE

- India emerging as a key player with strategic investments.
- Initiatives like the National Mission on Quantum Technologies & Applications.
- Growing ecosystem of startups, research institutions, and collaborations.
- Focus on quantum cryptography, simulations, and AI applications.
- Government support driving R&D and skill development in quantum technologies.


Quantum
Computing
India


BosonQ Psi


AiQyaM


CIRQuIT


INNO
GRESS


Q→NU
Proactively
Quantum™


Qπ
AI

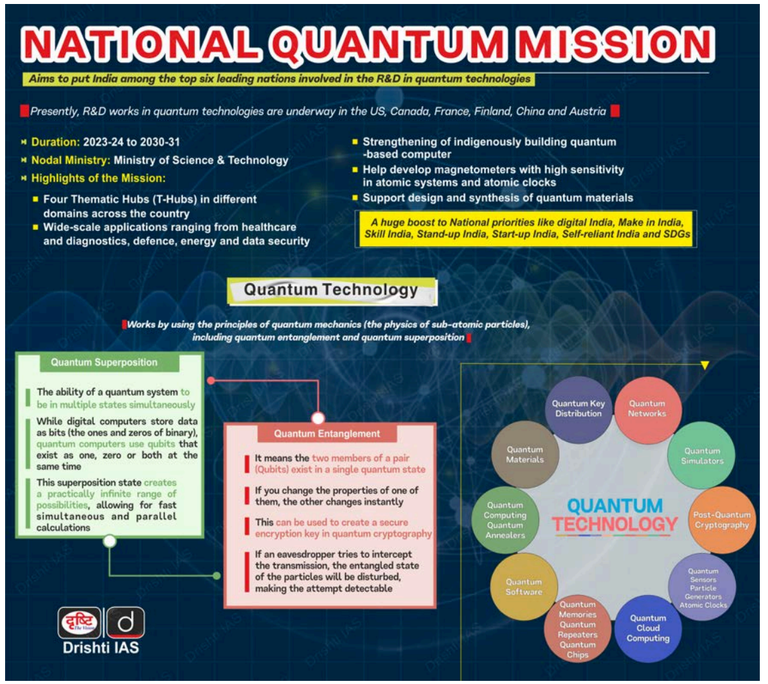

INDIAN INSTITUTE OF SCIENCE
भारतीय विज्ञान संस्थान

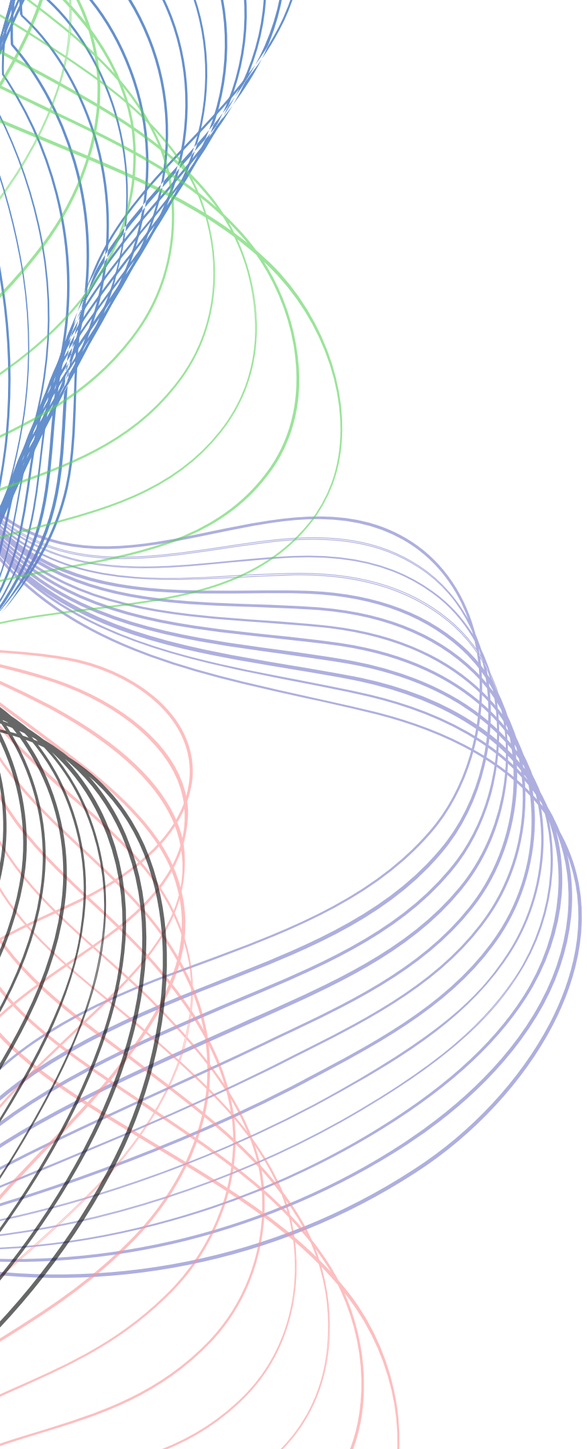

INDIAN INSTITUTE OF TECHNOLOGY MADRAS
सिद्धिर्भवति कर्मजा


tifr

NATIONAL QUANTUM MISSION

- Invest approximately INR 8,000 crores over 5 years.
- Foster research, development, and deployment of quantum technologies.
- Focus on quantum computing, communication, and sensing applications.
- Develop skilled manpower and establish quantum labs and testbeds.
- Position India as a global hub for quantum technology innovation.





FUTURE OF INDIA

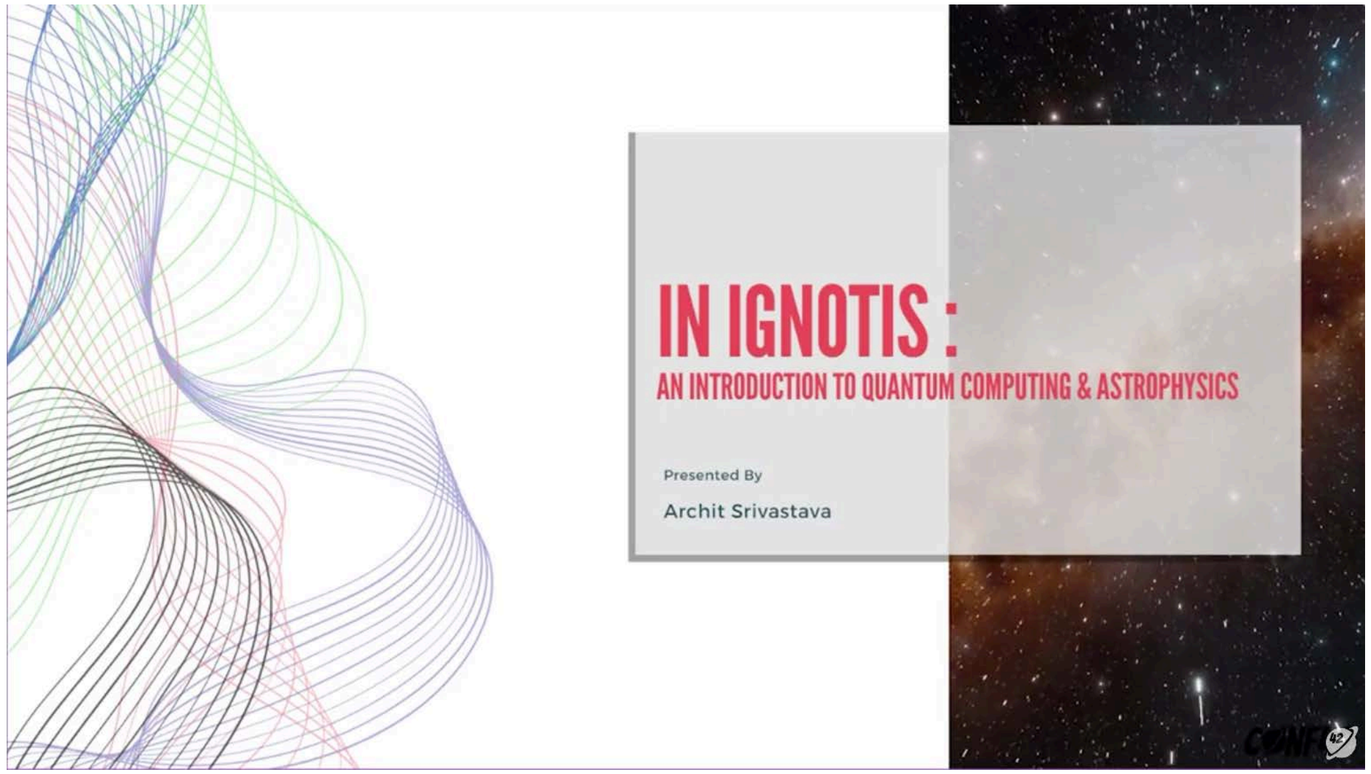
- Indian government's investment of approximately INR 8,000 crores in the National Mission on Quantum Technologies & Applications.
- Strategic partnerships with academic institutions and international quantum research centers.
- Emerging startups focusing on quantum hardware development.
- Expected growth in quantum computing market share in Asia-Pacific region.
- Anticipated contributions to global quantum technology advancements by 2030.
- Focus on applications in sectors like cybersecurity, healthcare, and finance.
- Aim to establish India as a significant player in the global quantum computing landscape

“USE CASES”

BlueQubit

Quantum Computing Use Cases

- Artificial Intelligence and Machine Learning
- Cryptography and Data Security
- Drug Discovery and Development
- Disease Risk Predictions
- Financial Modeling and Portfolio Optimization
- Traffic Optimization and Smart Cities
- Weather Forecasting and Climate Modeling
- Grid Optimization
- Material Science and Design
- Protein Folding
- Quantum Chemistry
- Design Optimization
- Quantum in Space
- Supply Chain and Inventory Optimization


IN IGNOTIS :
AN INTRODUCTION TO QUANTUM COMPUTING & ASTROPHYSICS
Presented By
Archit Srivastava
CONF42


“
THANK YOU
”