Investigating the Prospects of Quantum Computing in Particle Physics

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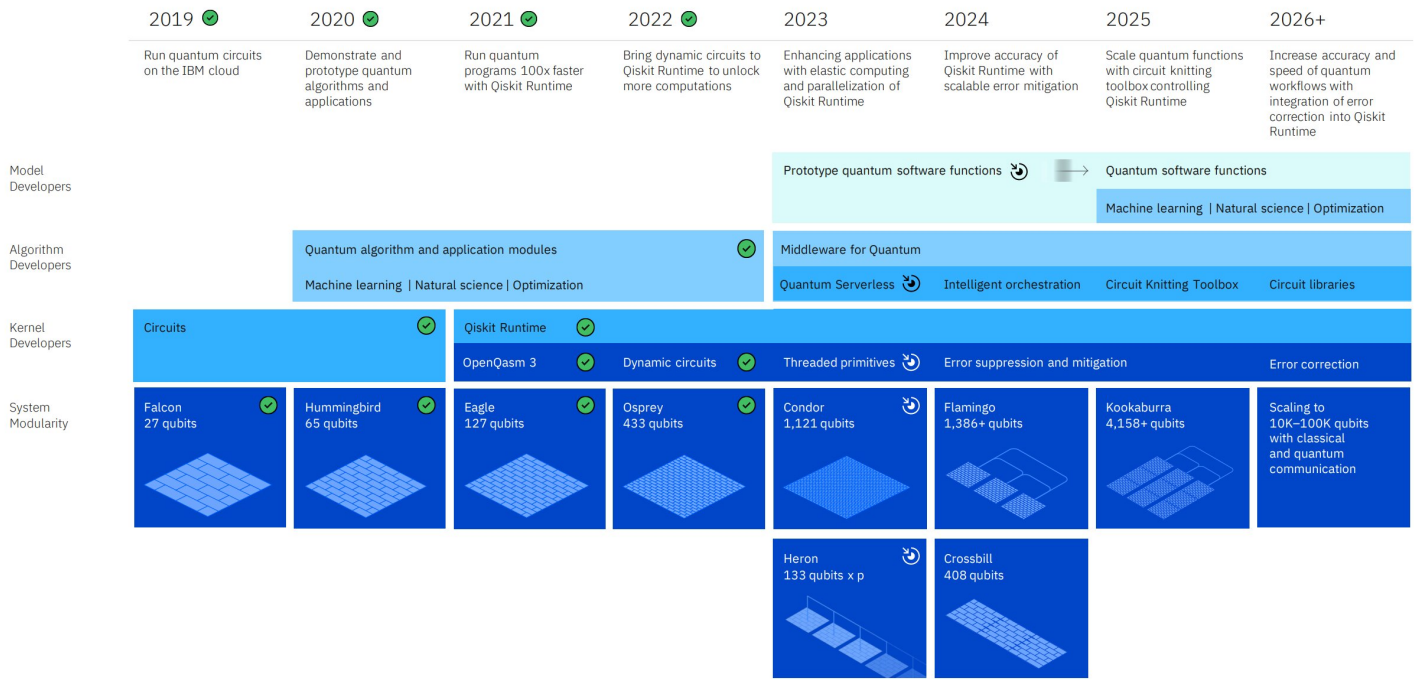

IBM's roadmap for upcoming quantum computers, updated 2022. Credit: arXiv (2023). DOI: 10.48550/arxiv.2307.03236

Leading experts from prestigious organizations like CERN, DESY, and IBM Quantum have collaboratively published a groundbreaking white paper that identifies the potential applications of quantum computing technologies in the field of particle physics. This important paper, now accessible as a preprint on arXiv, presents a roadmap for utilizing quantum computing to tackle complex computing challenges associated with various particle physics experiments, including the ambitious upgrade program of the Large Hadron Collider.

The white paper is the result of the efforts of a dedicated working group formed during the pioneering QT4HEP conference, held at CERN in November. Over the past eight months, the 46 members of the working group have meticulously analyzed particle physics activities and mapped them to specific "problem formulations" in quantum computing. This comprehensive

analysis ensures that the particle physics community can maximize the potential of upcoming quantum computers when they become available.

Alberto Di Meglio, head of the CERN Quantum Technology Initiative (CERN QTI), emphasizes the importance of identifying the most suitable areas for quantum computing within particle physics. While quantum computing holds great promise, not all problems in particle physics can be effectively solved using this approach. Di Meglio, along with Karl Jansen from DESY and Ivano Tavernelli from IBM Quantum, spearheads this forward-thinking paper, providing invaluable insights into areas such as quantum dynamics, lattice-gauge theory, neutrino oscillations, and more.

The white paper also focuses on the experimental side of particle physics, highlighting areas like jet and track reconstruction, extraction of rare signals, and problems related to the Standard Model. The applications identified within these areas include classification, regression, optimization, and generation problems. By ensuring a strong collaboration between particle physics and quantum computing, the authors aim to leverage the 100×100 Challenge initiated by IBM Quantum. This challenge will provide a tool capable of calculating unbiased observables of circuits with 100 qubits and depth-100 gate operations in 2024, enabling the exploration of promising use cases from various research fields.

More information: Alberto Di Meglio et al, Quantum Computing for High-Energy Physics: State of the Art and Challenges. Summary of the QC4HEP Working Group, arXiv (2023). DOI: 10.48550/arxiv.2307.03236

Journal information: arXiv