Quantum Computing

CERN, IBM Collaborate on Quantum Computing

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CERN, the European laboratory for particle physics, is home to the world's largest particle accelerator, the Large Hadron Collider. Experiments built on this machine enable physicists like me to study the fundamental building blocks of our universe.

CERN has an ambitious upgrade programme for the accelerator and experiments over the coming years. This will lead to formidable computing requirements. By 2026, computing requirements — under conservative assumptions based on the evolution of hardware, software and techniques — are estimated to be around 50-100 times higher than today!

To meet this challenge and provide adequate Information and Communication Technologies (ICT) resources for the manipulation and analysis of data, CERN openlab is working with the worldwide research community to explore innovative computing solutions. CERN openlab is a public-private partnership through which CERN works with leading ICT companies to help drive innovation. IBM is one of the latest members to join this collaboration.

Quantum computing is one emerging technology that holds promise in terms of providing a major breakthrough in computing power. CERN openlab has launched a number of projects in this field in close collaboration with major vendors and advanced users.

IBM is one of the major players in this field. For some time now, the company has made a five qubit quantum machine available for public use, along with a rich, open-source software suite. CERN openlab and IBM have already been working on the development of quantum applications for particle physics. Extending this collaboration to include work on IBM Q — the first integrated quantum computing system for commercial use — is a major step forward in our already successful collaboration.

Particle physics involves very diverse computational workloads, thus presenting a whole range of opportunities to evaluate the applicability — and potential — of quantum computing. One very exciting field of research will be the direct simulation of quantum mechanics processes on quantum machines. At the other end of the application spectrum, the use of quantum computing combined with artificial intelligence and deep neural networks could open a whole range of new possibilities for the analysis of the data. This may play an important part in the discovery of new physics phenomena, allowing us to further verify — and possibly move beyond — our current best models of the universe.

Another important field will be the application of quantum computing to data classification. We expect that quantum computing will also find application in Monte Carlo simulation, thanks to the capability to both directly reproduce quantum processes and to generate "true" random numbers (instead of "pseudo-random" ones).

However, all of these possibilities are only those that we can see at the moment, before having really acquired substantial experience with the system. As more advanced users join this initiative — and also thanks to the privileged collaborations CERN has through CERN openlab — we will certainly discover new and more advanced usages for this developing technology.

A new era is dawning for computing. Particle physics is gearing up to explore and assess all the new, exciting possibilities offered, thus helping researchers to continue probing the unsolved mysteries of the universe.

Federico Carminati
Chief Innovation Officer, CERN openlab