COMPUTING

Quantum physicists think big

Blueprint outlines ambitious plan to build computer bigger than a football pitch.

BY ELIZABETH GIBNEY

Physicists have sketched a blueprint for a quantum computer that could be built using existing technology and would be powerful enough to crack important and currently unsolvable problems, such as factoring enormous numbers. Such a machine would need to be larger than a football pitch and would cost at least £100 million (US$126 million) to make, its designers say.

"Yes it will be big, yes it will be expensive — but it absolutely can be built right now," says quantum physicist Winfried Hensinger of the University of Sussex in Brighton, UK, who leads the team that published the blueprint on 1 February (B. Lekitsch *et al. Sci. Adv.* **3,** e1601540; 2017). "While this proposal is incredibly challenging, I wish more in the quantum community would think big like this," says Christopher Monroe, a physicist at the University of Maryland in College Park.

Quantum computers promise to exploit the remarkable properties of quantum particles to carry out some calculations exponentially faster than their classical counterparts. Teams around the world are competing to build them, but most designs so far target a few dozen quantum bits, or qubits. Many thousands of qubits are probably needed to do useful calculations, such as finding the prime factors of large numbers, a crucial problem in encryption.

Hensinger's team suggests using ions trapped by magnetic fields to create its qubits — an approach that physicists have been working on for more than 20 years. Most of the components necessary to build a trapped-ion quantum computer have already been demonstrated, says Monroe. "Our community needs a systems-engineering push to simply build it."

In Hensinger's blueprint, thousands of hand-sized silicon-based modules could be yoked together to produce — in theory — a quantum computer of any size. In each module, around 2,500 trapped-ion qubits would be suspended in magnetic fields, protected from interference that would affect their delicate quantum states. To perform operations, ions interact with their neighbours by shuttling around an x-shaped grid. Rather than using individual lasers to control each trapped ion, the team suggests sending a field of microwave radiation through the whole computer, and applying a local voltage to tune individual qubits in and out of interaction with the wider field. To find the prime factors of a 2,048-bit (or 617-digit-long) number — something no classical computer can do today — the computer would need 2 billion qubit ions.

Huge technical challenges stand in the way of any team aspiring to build such a computer, but Hensinger and his team are working on a prototype. "Building that thing will be an extraordinary engineering challenge, but one that's worth pursuing," says Andrea Morello, a quantum physicist at the University of New South Wales in Sydney, Australia. ■

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