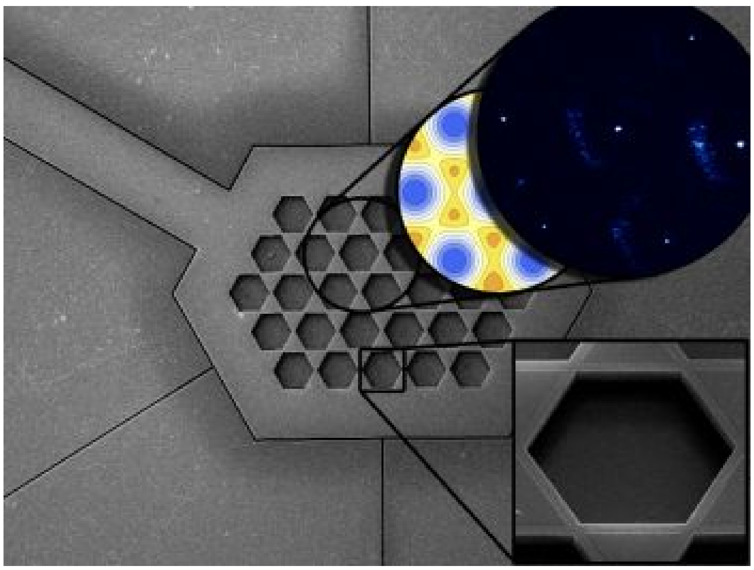
Physicists create lightning in the race to develop quantum technology microchip

April 7 2014, by Jacqui Bealing



Picture of the microchip with a close-up view in the right bottom inset. A two-dimensional chessboard lattice of individual charged atoms levitates just above the surface of the chip (shown in the top right inset).

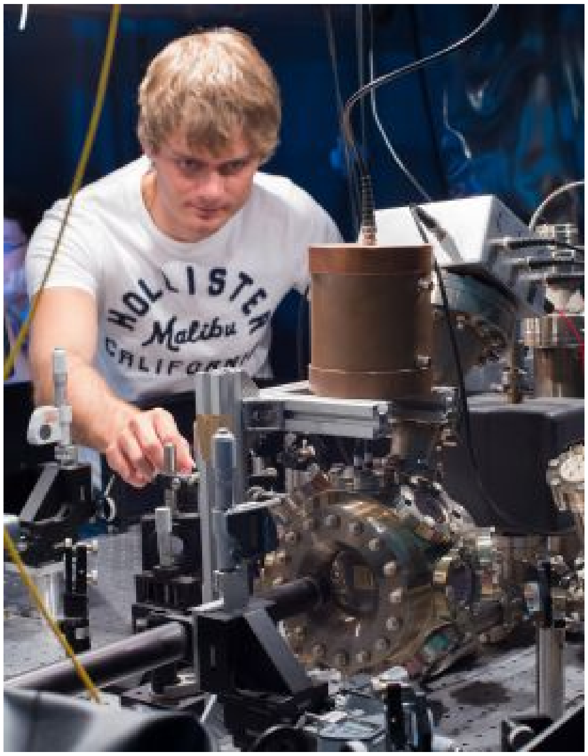
(Phys.org) —Physicists at the University of Sussex have invented a powerful new microchip capable of holding the voltage equivalent to a micronscale bolt of lightning that could be the key for developing next-generation, super-fast quantum computers.

Quantum technology may well revolutionise the way we use technology in a way similar to the emergence of what are now referred to as "classical" computers. Through having immense processing power, super-fast computers could solve, in a matter of minutes, certain mathematical problems that would take the world's current fastest computer 10,000 years to achieve.

But the challenge for researchers has been in how to harness the ions (charged atoms) that can store the immense amount of memory required to build quantum technology devices. And creating microchips powerful enough to provide a backbone for such technologies has been a field of intense research

Now, in a study published online (04 April 2014) in *Nature Communications*, Sussex physicist Dr Winfried Hensinger, together with PhD students Robin Sterling, Seb Weidt, Kim Lake and postdoctoral fellow Simon Webster, who form part of Dr Hensinger's Sussex Ion Quantum Technology Group, have been able to create a new microchip design that is capable of hosting a lattice of individually charged atoms that are held by electric fields emitted from the surface of the microchip . This is the first time that a two-dimensional chessboard lattice of individual ions has been trapped on a microchip.

In order to allow for a solid architecture and to hold individual atoms long enough for practical experiments, researchers had to engineer a microchip that can withstand very large voltages, in excess of 1000V.



PhD student Seb Weidt from the Sussex Ion Quantum Technology Group with the vacuum apparatus that holds the quantum technology microchip. The actual microchip is visible in the centre just behind the window and hosts a two-dimensional chess board lattice.

The researchers created the microchip as part of a collaboration with Prof. Michael Kraft, PhD student Hwanjit Rattanasonti and postdoctoral fellow Dr Prasanna Srinivasan from the University of Southampton.

The ability to create a chess-board lattice of individual atoms is particularly important in the quest to build a quantum simulation machine. Such a device could solve many open problems in science such as energy transport in materials, high-temperature superconductivity and the structure of complex biomolecules.

Dr Hensinger says: "We blew quite a few chips and created a lot of lightning to measure the voltage that can be applied. The results are very exciting. We now have a stable structure to build long term storage devices for single atoms. It's also a big step in building a large-scale ion trap quantum simulator, a very powerful tool to understand many problems in science.

"While this new microchip may be a significant step in the development of quantum technology, this technology may also have applications in the manipulation and sorting of biological samples and chemicals, and other sensor technologies that rely on the storage of individual charged particles for long periods."

More information: "Fabrication and operation of a two-dimensional ion trap lattice on a high-voltage microchip," by R. C. Sterling, H. Rattanasonti, S. Weidt, K. Lake, P. Srinivasan, S. C. Webster, M. Kraft, and W. K. Hensinger, is published in *Nature Communications* on 04 April 2014. www.nature.com/ncomms/2014/140 … full/ncomms4637.html

Provided by University of Sussex