Control circuit for future supercomputer to be produced in Finland

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The circuit will improve the computational accuracy and efficiency of quantum computers operating at extremely low temperatures. Quantum computers require an ambient temperature of approximately -273 degrees centigrade to function properly. The Technical Research Centre of Finland (VTT) is **to build a control circuit for such a superconducting computer that will function at very low temperatures**. Future quantum computers will be able to crack IT encryption codes and perform searches of enormous databases, which are currently impossible. The memory bits of a quantum computer may have several states simultaneously. This feature has enabled the few existing quantum computers, which although still primitive may yet achieve super efficiency in the future.

The high efficiency of a quantum computer facilitates computing far beyond the capacity of present-day equipment. For example, where current computers perform 1,000,000 searches in an unorganised database, quantum computers will perform approximately 1,000 searches, thus reducing the number by 1,000-fold. In the future the most extensive and complicated computing tasks can only be resolved with a quantum computer.

The cryogenic control circuit to be constructed at VTT will bring us one step closer to the speed and accuracy required of a quantum computer. The control circuits operate at just 0.02 degrees centigrade above absolute zero (- 273.15 degrees centigrade). Thus far quantum computers have been controlled at room temperature, which has

prevented the full use of their incredible speed. In addition, unlike quantum computers, the memory bits of modern computers only have two alternative states.

The EU-funded project carried out by VTT and the Helsinki University of Technology (HUT) involves the design of an integrated circuit comprising a quantum computer prototype and its control - the first one to operate in a cold environment. This enables accurate and fast control, which is less vulnerable to disturbances than the present-day 'room temperature' control. VTT will also build the integrated circuit, while the quantum bits will be constructed using nanotechnology (a millionth of a millimetre) techniques by the other top research teams involved in the project, including the CEA nuclear energy institute in France, the Chalmers University of Technology in Sweden and the IPHT Institute in Jena, Germany.

In connection with low-temperature quantum technology, VTT and HUT have developed a wholly new kind of charge pump. In theory, the pump has a capacity up to 1,000-fold (one nanoampere) higher than that of currently used pumps (one picoampere) without compromising accuracy. The pump developed at VTT may essentially facilitate the definition of the electro-technical current normal (current standard), in the international SI system of units, which in turn will facilitate the functional testing of industrial current meters. In addition, the new current standard is one of the three fundamental quantities in electrical engineering, and it may revolutionise the electro-technical foundation of the entire SI system.

The new pump and controlled control of the quantum computer are connected with the Doctoral dissertation of Antti Niskanen (26). The dissertation of the young VTT Research Scientist was examined at HUT on 26 November. Construction of the new control circuit at VTT is a continuation of Niskanen's work. In 2005 Niskanen will join the

quantum technology top research unit NEC in Japan as Visiting Researcher.

Source: Technical Research Centre of Finland