



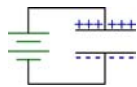
Quantum Computing and the Cooper-pair Box

Konrad Lehnert, Lafe Spietz and Prof. Rob Schoelkopf
 Department of Applied Physics, Yale University



Introduction: Quantum Computing

Classical bit



values 0 or 1

Quantum bit (or "qubit")



Information as state of a two-level quantum system

values $|0\rangle$, $|1\rangle$ or
 superposition: $\alpha|0\rangle + \beta|1\rangle$

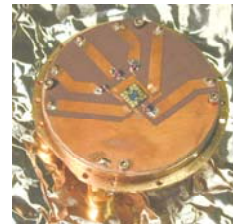
Prediction: a quantum computer can perform computations that no conventional computer ever could.

Small, Fast and Cold



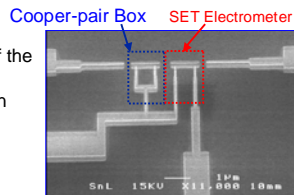
Created by a beam of focused electrons our qubits are 1000 times smaller than thickness of human hair

Qubits change state quickly. To study them, we use the same microwave technology that makes modern cellular phones work.



The Cooper-pair Box Measured by a Single Electron Transistor: A Qubit and its Readout

The picture is a scanning electron microscope image of the Cooper-pair box. The box is situated near a single electron transistor (SET).



Our implementation of a qubit is called the Cooper-pair box. It is an electrical circuit which is the same size and made with the same techniques as the transistors in a Pentium processor. The nearby SET provides the worlds most sensitive measurement of electrical charge. Using the SET, we can study the Cooper-pair box qubit



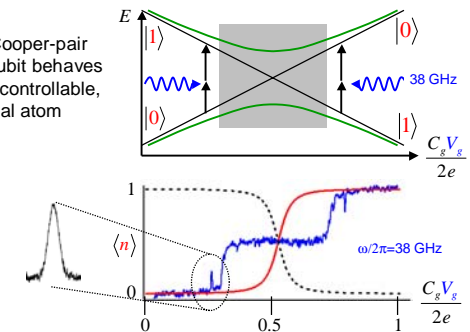
Temperature causes random, erratic changes in the qubits state. To reduce these errors, we cool the qubit to a temperature 1/100 of degree above absolute zero.

The photo to the left shows a dilution refrigerator, the machine which makes these low temperatures.

Research done in collaboration with Kevin Bladh, David Gunnarson, and Prof. Per Delsing of Chalmers University of Technology
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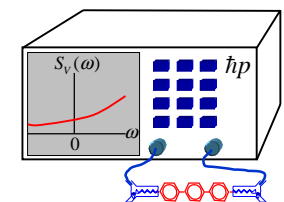
Cooper-Pair Resonance Spectroscopy

The Cooper-pair box qubit behaves like a controllable, artificial atom



The Quantum Spectrum Analyzer

Measures all Noise
 Classical
 Quantum



The Cooper-pair box is capable of measuring the fluctuations of objects a few nanometers away. This will provide a new tool for nanotechnology.