

CLAIMS

1. An arrangement for reading out states of a plurality of qubits in a quantum computing system, wherein each of said qubits is capable of exhibiting a coherent superposition of two quantum states, and wherein reading out the state of any of said qubits collapses the respective superposition into one of said two quantum states, **characterized** in that the arrangement comprises:
- 10 - a plurality of threshold detectors, each of said threshold detectors having an input and an output, of which said input is controllably couplable to a respective one of said plurality of qubits,
 - a superconductive parallel to serial converter having a plurality of parallel inputs and a serial output, of which each of said parallel inputs is coupled to the output of a respective one of said threshold detectors, and
 - 15 - a transmitter coupled to said serial output of the superconductive parallel to serial converter, said transmitter being configured to transmit a signal obtained at said serial output across a boundary of a cryogenically cooled environment in which said qubits, said threshold detectors, said superconductive parallel to serial converter, and said transmitter are located.
2. An arrangement according to claim 1, wherein:
- said qubits are transmon qubits, the states of which are represented by the momentary amounts of energy stored in the respective transmon qubit, and
 - 30 - said threshold detectors are pulsed microwave photon counters configured to give one of two possible values at their output, indicative of whether the respective transmon qubit was in its ground state or first excited state.
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3. An arrangement according to claim 2, wherein said plurality of pulsed microwave photon counters are Josephson junction based single photon detectors.

5 4. An arrangement according to claim 2, wherein said plurality of pulsed microwave photon counters are bolometers.

5. An arrangement according to any of claims 2 to 4, wherein:

- 10 - each of said plurality of pulsed microwave photon counters comprises a control input for receiving a control signal, and
- each of said plurality of pulsed microwave photon counters is responsive to control signal received
15 through its control input by enabling the controllable coupling between it and the respective one of the plurality of qubits.

6. An arrangement according to any of the preceding claims, wherein there are as many of said
20 threshold detectors as there are said qubits.

7. An arrangement according to any of claims 1 to 5, wherein:

- for at least one of said threshold detectors, there is a group of N of said qubits, where N is an integer,
25 and
- the arrangement comprises readout control means configured to controllably couple such at least one of said threshold detectors with a selected one of the corresponding group of qubits.

30 8. An arrangement according to claim 7, wherein N is equal to or smaller than 5, preferably equal to 2.

9. An arrangement according to any of claims 2 to 5, wherein said superconductive parallel to serial converter comprises single flux quantum (later SFQ) based classical logic.

5 10. An arrangement according to claim 9, wherein said superconductive parallel to serial converter comprises a chain of logic cells coupled in series, each logic cell in said chain of logic cells being configured to temporarily store a piece of digital
10 information obtained from a respective one of said plurality of threshold detectors.

11. An arrangement according to claim 10, wherein each logic cell in said chain of logic cells comprises:

15 - a data input coupled to the output of a respective one of said pulsed microwave photon counters,
 - a transfer input and a transfer output,
 - a register element coupled to said data input, said transfer input, and said transfer output, and
20 - a control input,
and wherein each logic cell in said chain of logic cells is configured to temporarily store in said register element a value obtained either from said data input or from said transfer input, depending on a control
25 value received at said control input.

12. An arrangement according to any of the preceding claims, wherein said transmitter comprises a microwave transducer configured to transmit said signal obtained at said serial output into a vacuum tube
30 waveguide.

13. An arrangement according to any of claims 1 to 11, wherein said transmitter comprises an optical transmitter configured to transmit said signal ob-

tained at said serial output into an optical fibre connection.

14. A quantum computing system, comprising:
- a cryostat for establishing a cryogenically cooled environment, and
 - an arrangement according to any of claims 1 to 13, located inside said cryostat within said cryogenically cooled environment.

15. A method for reading out states of a plurality of qubits in a quantum computing system, wherein said reading out involves collapsing a coherent superposition of two quantum states exhibited by the respective qubit into one of said two quantum states, the method comprising:
- controllably establishing readout couplings between said plurality of qubits and a plurality of threshold detectors simultaneously, thus making each of said plurality of threshold detectors assume one of two possible output values indicative of whether reading out the respective qubit made it collapse into a first one or a second one of said two quantum states, and
 - subsequently transferring the values assumed by said plurality of threshold detectors out of said plurality of threshold detectors as a digital string, and transmitting said digital string out of the cryogenically cooled environment that contains said qubits and said threshold detectors.

16. A method according to claim 15, wherein said establishing of readout couplings is performed by controllably setting each of a plurality of pulsed microwave photon counters into resonance with a respective one of said plurality of qubits.

17. A method according to any of claims 15 or 16, wherein said transferring out of the values as-

sumed by the plurality of threshold detectors involves storing said values into a shift register and reading them out of said shift register in serial form that constitutes said digital string.

5 18. A method according to any of claims 15 to 17, wherein said transmitting of said digital string out of the cryogenically cooled environment is done using electromagnetic waves that propagate through a vacuum tube waveguide.

10 19. A method according to any of claims 15 to 17, wherein said transmitting of said digital string out of the cryogenically cooled environment is done using optical pulses that propagate through an optical fibre connection.