Contribution ID : **95** Type : **presentation (QT PhD program student)**

Digital qubit readout with a flux-switchable superconducting circuit

martedì 30 agosto 2022 18:00 (20)

Quantum computing platforms based on superconducting qubits have emerged as one of the most promising candidates in the race to build a large scale quantum computer [1]. Controllability, standard chips fabrication techniques combined with the possibility of exploring unconventional hybrid systems [2] are well established advantages of superconducting qubits architectures as quantum processors. However, while the performance of small superconducting quantum processors has advanced the threshold necessary for fault tolerance, the current technique to control and readout the qubit state imposes severe system scaling challenges [3]. Within this framework, digital control based on cryogenic energy-efficient superconducting Single Flux Quantum (SFQ) logic is being adapted to perform qubit control and readout for scalable quantum 3D-architectures [4]. This is leading to the development of innovative concepts for quantum processor control and benchmarking in this integrated digital-quantum hybrid system.

Here, we propose an SFQ-compatible approach to accomplish diabatic readout of superconducting qubits based on a Josephson Digital Phase Detector (JDPD). When properly excited by flux bias pulse, the JDPD is able to quickly switch from a single-minima to a double-minima potential and, consequently, relax in one of the two stable configurations discriminating between two phase values of a coherent input tone at GHz frequency. The basic concepts behind this new readout scheme have been experimentally verified with a preliminary version of the JDPD. The capability to work as a phase detector has been demonstrated up to 100kHz tone with a remarkable agreement between the experimental outcomes and simulations [5].

By choosing design parameters, the JDPD will be sensitive at frequency in the range of GHz, the typical frequency of superconducting qubits. These characteristics make the JDPD suitable for the implementation of a high speed platform integrated with superconducting digital electronics for both control and readout the qubit's state directly at 20 mK, providing a solid solution for highly scalable superconducting quantum processors.

[1] J. M. C. J. M. Gambetta and M. Steffen, "Superconducting quantum bits", NPJ Quantum Inf 2, 1 (2017). [2] H. G. Ahmad et al., "Hybrid ferromagnetic transmon qubit: Circuit design, feasibility, and detection protocols for magnetic fluctuations" Phys. Rev. B, 2022 [3] O. Mukhanov et al., "Scalable Quantum Computing Infrastructure Based on Superconducting Electronics" IEEE International Electron Devices Meeting (IEDM), 2019, [4] R. McDermott et al., "Quantum–classical interface based on single flux quantum digital logic", Quantum Science and technology 3 (2018). [5] Di Palma et al., "Discriminating the phase of a weak coherent tone with a flux-switchable superconducting circuit", in prep.

Primary author(s) : DI PALMA, LUIGI (Università Federico II Napoli)

Co-author(s) : Dr. MIANO, Alessandro (Department of Applied Physics, Yale University, New Haven, Connecticut 06520, USA); Mr. MASTROVITO, Pasquale (University of Naples Federico II); MASSAROTTI, Davide (Dipartimento di Ingegneria Elettrica e delle Tecnologie dell'Informazione, Università degli Studi di Napoli Federico II); Dr. ARZEO, Marco (SeeQC); AHMAD, HALIMA GIOVANNA (Department of Physics "Ettore Pancini", University of Naples "Federico II", CNR-SPIN, Naples and Seeqc); MONTEMURRO, DOMENICO; PEPE, GIOVANNI

PIERO (University of Napoli Federico II); TAFURI, Francesco (Università di Napoli Federico II); Dr. MUKHANOV, Oleg (SeeQC)

Presenter(s) : DI PALMA, LUIGI (Università Federico II Napoli)

Session Classification : Students Talks 2