

Quantum Computation Boosting Novel Superconducting and Hybrid Solutions and the Impact of PNRR in Italy

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Abstract–Italy has supported an ambitious plan on High Performance Computing, Big Data and Quantum Computing with a relevant section on Quantum Computation (ICSC), supported by Piano Nazionale di Ripresa e Resilienza (PNRR). Various hardware platforms have been promoted including the superconducting one. Napoli has a long-standing experience on weak superconductivity and superconducting electronics supported by several international collaborations and has represented the ideal candidate to assemble the superconducting ICSC quantum computer. The initial promise was to build a quantum computer based on a 5-qubits quantum processor by the end of the project (spring 2026) to be available for all partners, which include major Italian Research Centers, Universities and Italian companies. We are currently working on a 24-qubits processor produced by Quantware aiming at a QPU with more than 40-qubits by the end of year. This remarkable effort in hardware solutions in collaboration also with leading companies like SEEQC and Quantware has promoted intensive research for novel quantum components, ranging from an innovative type of qubits based on ferromagnetic Josephson junctions to qubit readout based on Josephson digital phase detector compatible with single-flux-quantum (SFQ) classical circuits. Superconducting quantum technologies have been also supported by another measure of PNRR through the National Quantum Science and Technology Institute (NQSTI). Here targets are mostly single superconducting components useful for applications and fundamental science. The diversity in Josephson junctions opens 'horizons' and much is happening.

Keywords (Index Terms)–Superconducting quantum computer, Josephson junctions, Macroscopic quantum phenomena, Ferrotransmon, qubits, PNRR