



Finanziato
dall'Unione europea
NextGenerationEU



Ministero
dell'Università
e della Ricerca



Italiadomani
PIANO NAZIONALE
DI RIPRESA E RESILIENZA

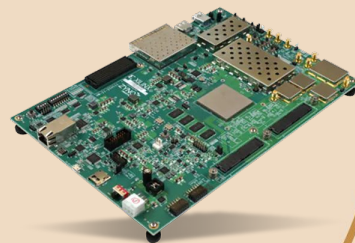
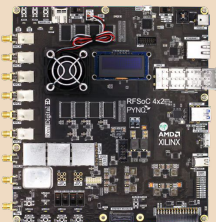
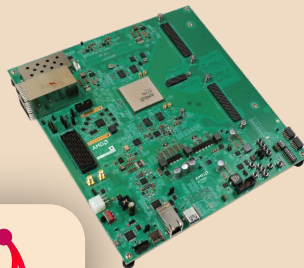


NQSTI
National Quantum Science
and Technology Institute

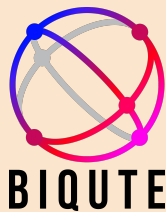
Missione 4 Istruzione e Ricerca

Rodolfo Carobene (UNIMIB)

Development of a Custom Superconducting Qubit Control and Readout System



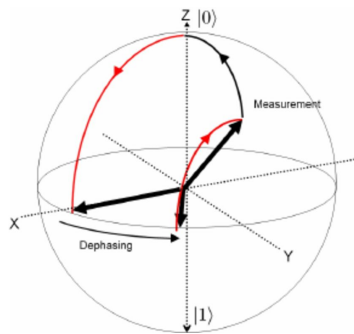
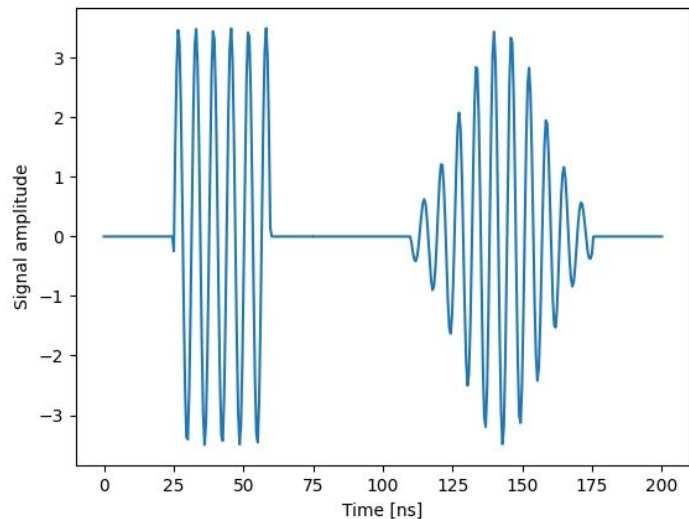
UNIVERSITA' DEGLI STUDI
DI MILANO
BICOCCA





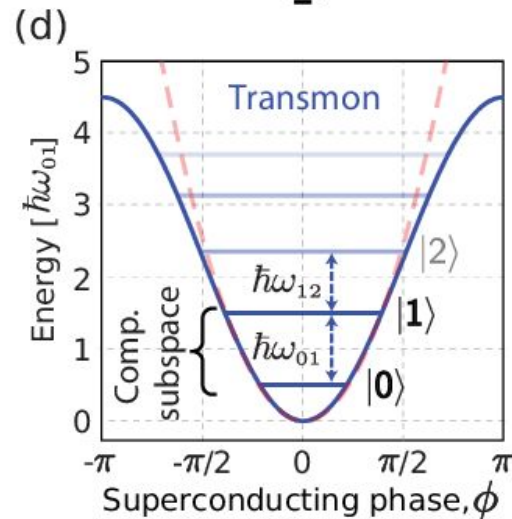
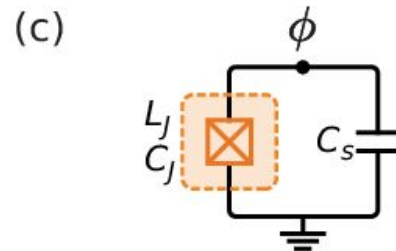
Qubit control: the theory

$$\vec{E} = \vec{E}_0 \cos(\omega_d t + \phi_0)$$

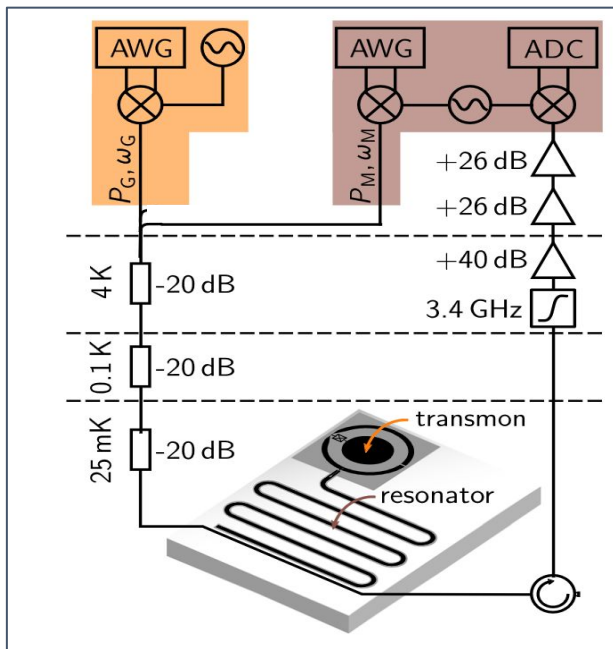


$$P(t)_1 = \frac{A^2}{\Omega^2} \sin^2 \left(\frac{\Omega}{2} t \right)$$

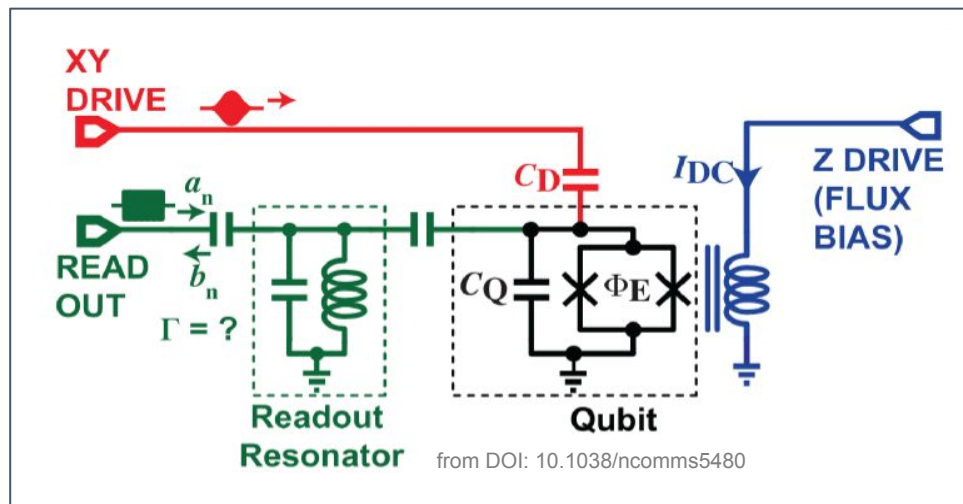
$$\vec{v} = \frac{1}{\Omega} (A \cos \phi, -A \sin \phi, \Delta)$$



Qubit control: the hardware



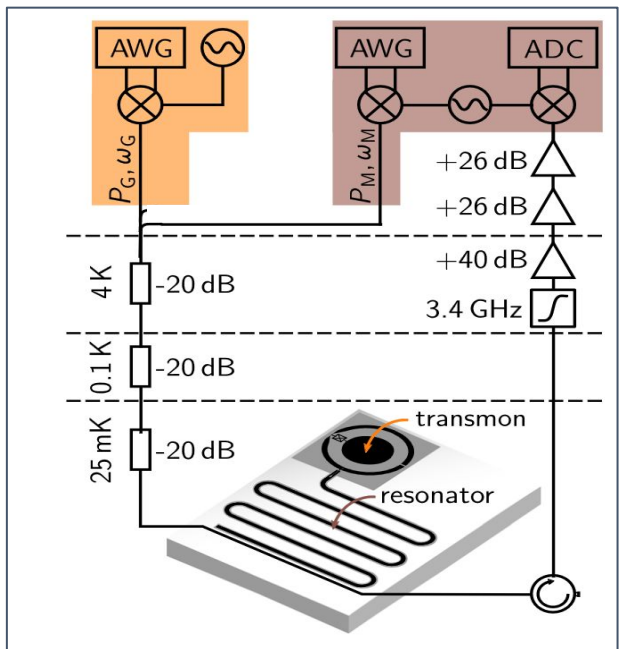
from DOI: 10.1038/s41534-020-00287-w



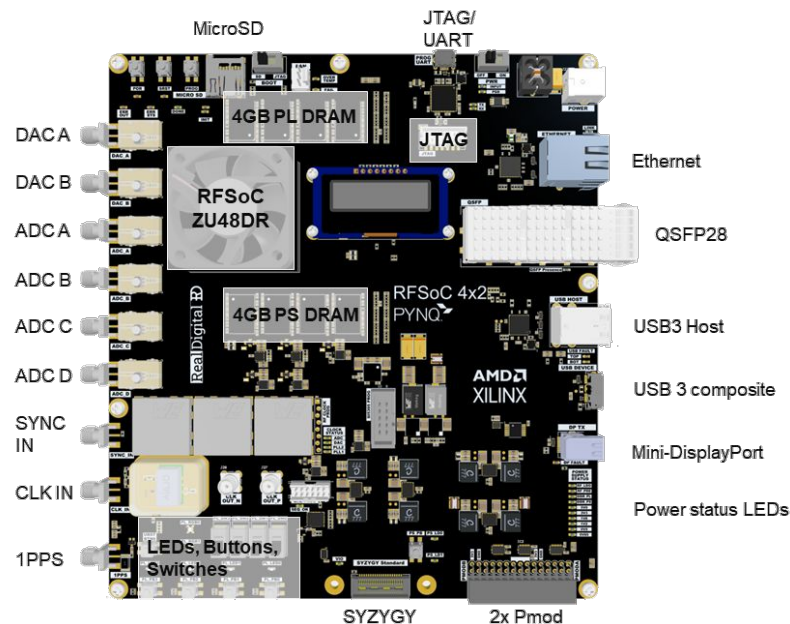
from DOI: 10.1038/ncomms5480



Qubit control: RFSoc (Radio Frequency System on Chip)



from DOI: 10.1038/s41534-020-00287-w





Finanziato
dall'Unione europea
NextGenerationEU



Ministero
dell'Università
e della Ricerca

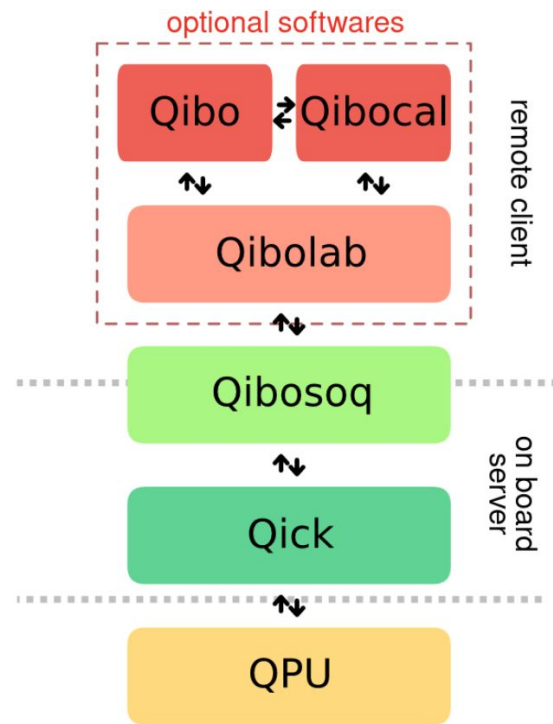
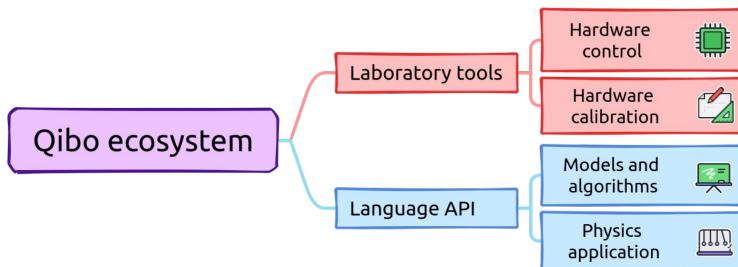
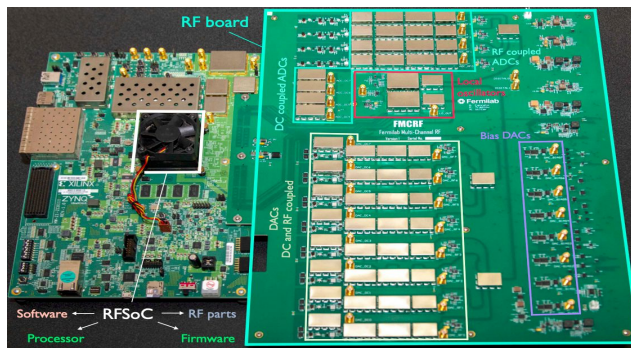


Italiadomani
PIANO NAZIONALE
DI RIPRESA E RESILIENZA



NQSTI
National Quantum Science
and Technology Institute

Presented last year: Qibosoq





Finanziato
dall'Unione europea
NextGenerationEU



Ministero
dell'Università
e della Ricerca

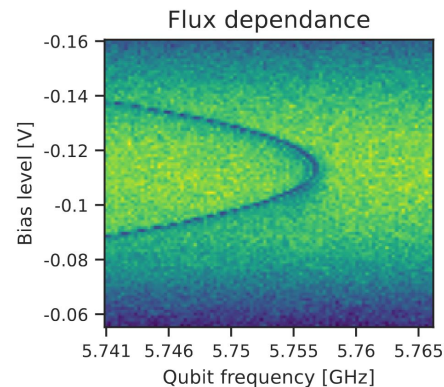
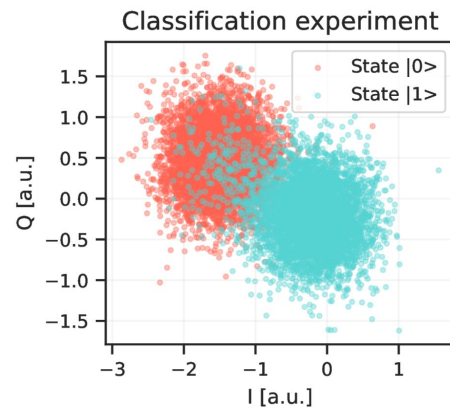
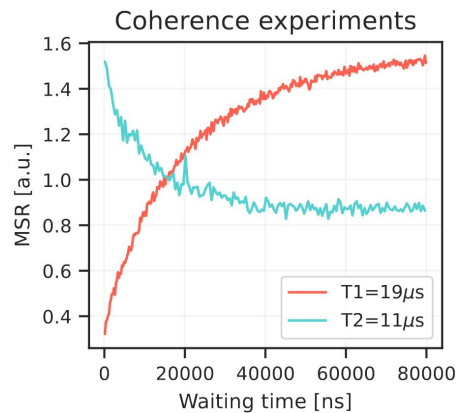
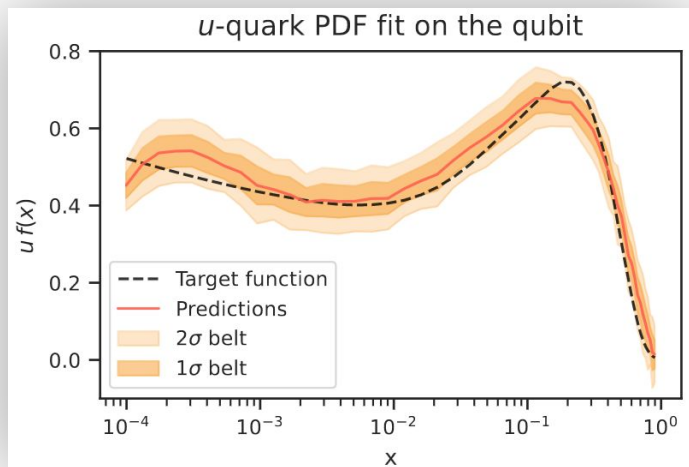


Italiadomani
PIANO NAZIONALE
DI RIPRESA E RESILIENZA



NQSTI
National Quantum Science
and Technology Institute

Presented last year: Qibosoq





Finanziato
dall'Unione europea
NextGenerationEU



Ministero
dell'Università
e della Ricerca



Italiadomani
PIANO NAZIONALE
DI RIPRESA E RESILIENZA

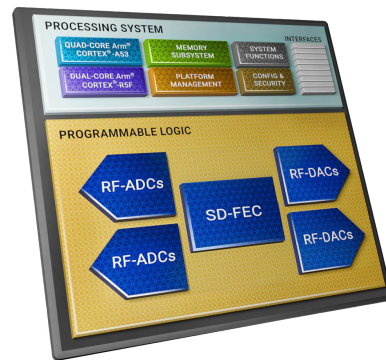
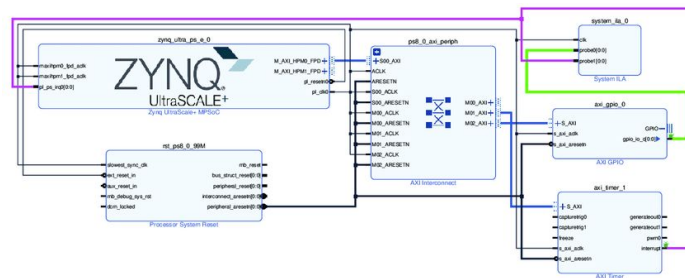


NQSTI
National Quantum Science
and Technology Institute

Test & Usage



Firmware development

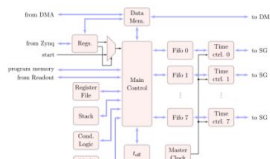
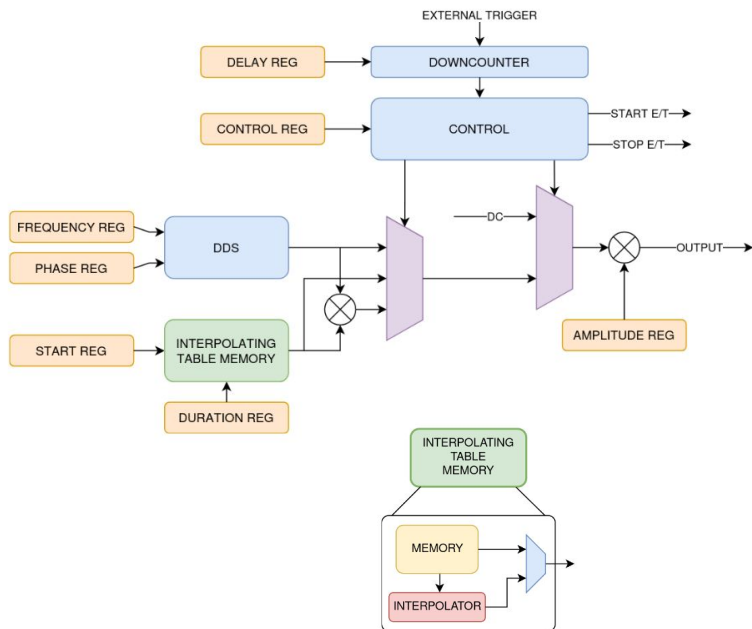




Firmware development: what is missing from QICK?

- Continuous acquisition (required for specific sensing applications)
- Sweep on pulse duration
- Logic and programmability on the FPGA
- Scaling

Firmware development



MicroBlaze:

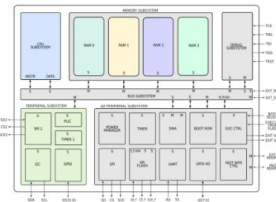
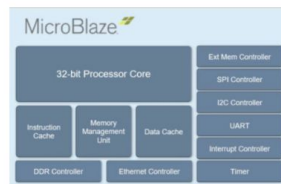
- Custom "Xilinx" ISA;
- 32 bit processor;
- Hard-core dependant;
- High platform maintainance (Vivado IP);
- Fast implementation;
- High performances on ZynqUltrascale+

X-HEEP:

- RISC-V ISA;
- 32 bit processor;
- Hard-core dependant;
- High platform maintainance (maintainers also in the VLSI Lab);
- Easy implementation;
- Highly customizzable;

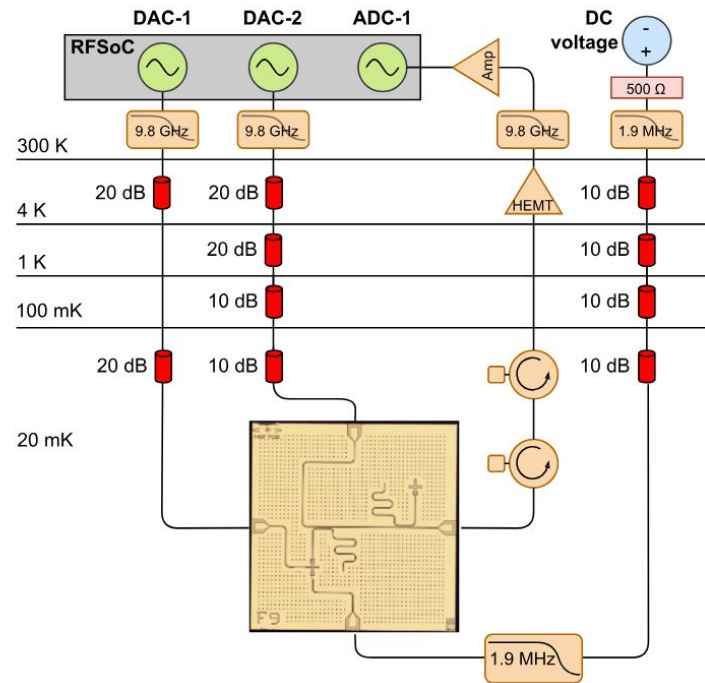
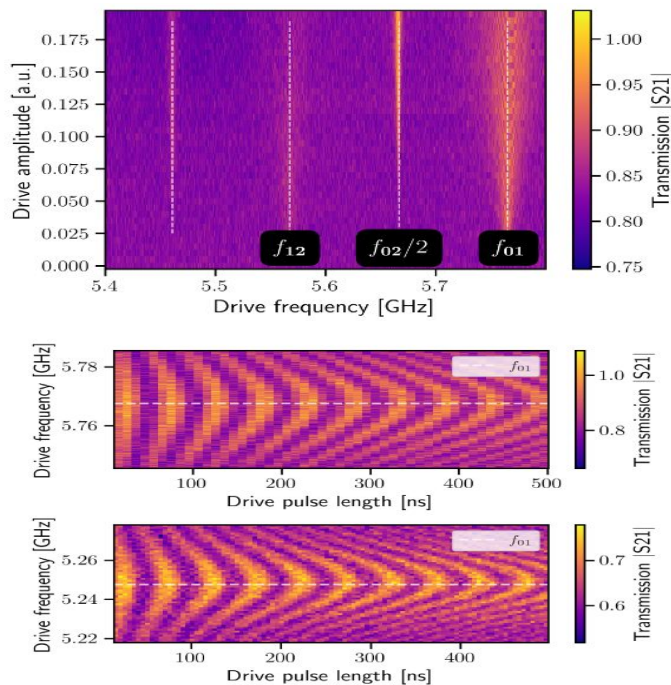
tProcessor:

- Custom "iProc" ISA;
- 32 bit processor;
- Developed by Fermi Institute;
- Hard-core dependant;
- Low platform maintainance (~2 year for a new version);





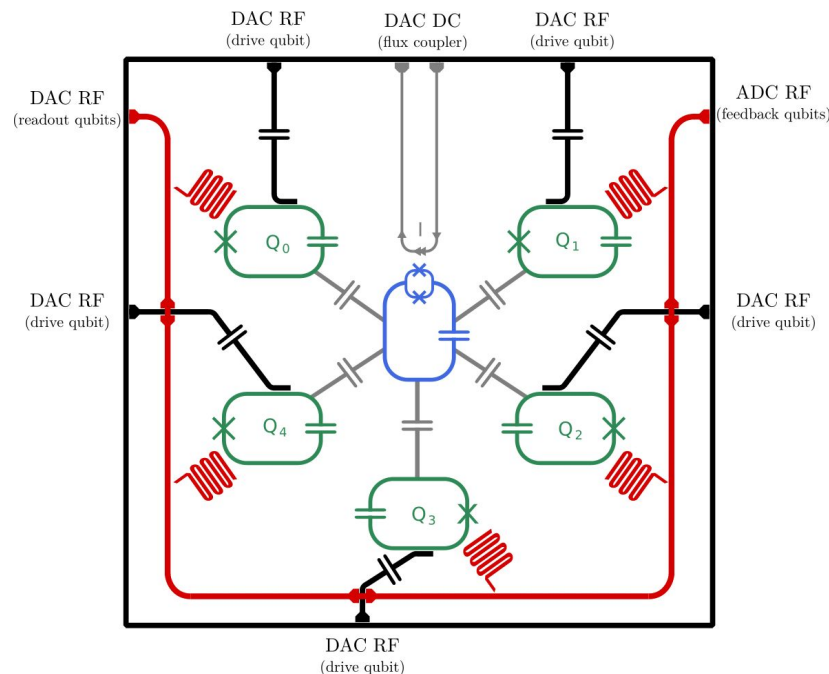
Test measurements at UNIMIB





Next steps

- Complete ongoing firmware updates
- Complete and test continuous acquisition
- Scale up! Control more qubits with new geometries





Finanziato
dall'Unione europea
NextGenerationEU



Ministero
dell'Università
e della Ricerca



Italiadomani
PIANO NAZIONALE
DI RIPRESA E RESILIENZA



NQSTI
National Quantum Science
and Technology Institute

Collaboration

Unimib group

Rodolfo Carobene, Pietro Campana, Marco Gobbo, Danilo Labranca, Roberto Moretti, Luca Origo, Sara Gamba, Alessandro Cattaneo, Hervé Corti, Matteo Borghesi, Marco Faverzani, Elena Ferri, Angelo Nucciotti, Andrea Giachero

LNF group

Matteo Beretta, Pietro Albicocco, Claudio Gatti

PoliTo group

Deborah Volpe, Christian Conti, Andrea De Simone, Giuseppe La Capra, Fabrizio Riente

UNIMI group

Alessandro Candido, Stefano Carrazza



UNIVERSITÀ
DEGLI STUDI
DI MILANO