Qubit-0.0.1 - Activity Report - 06/04/2022
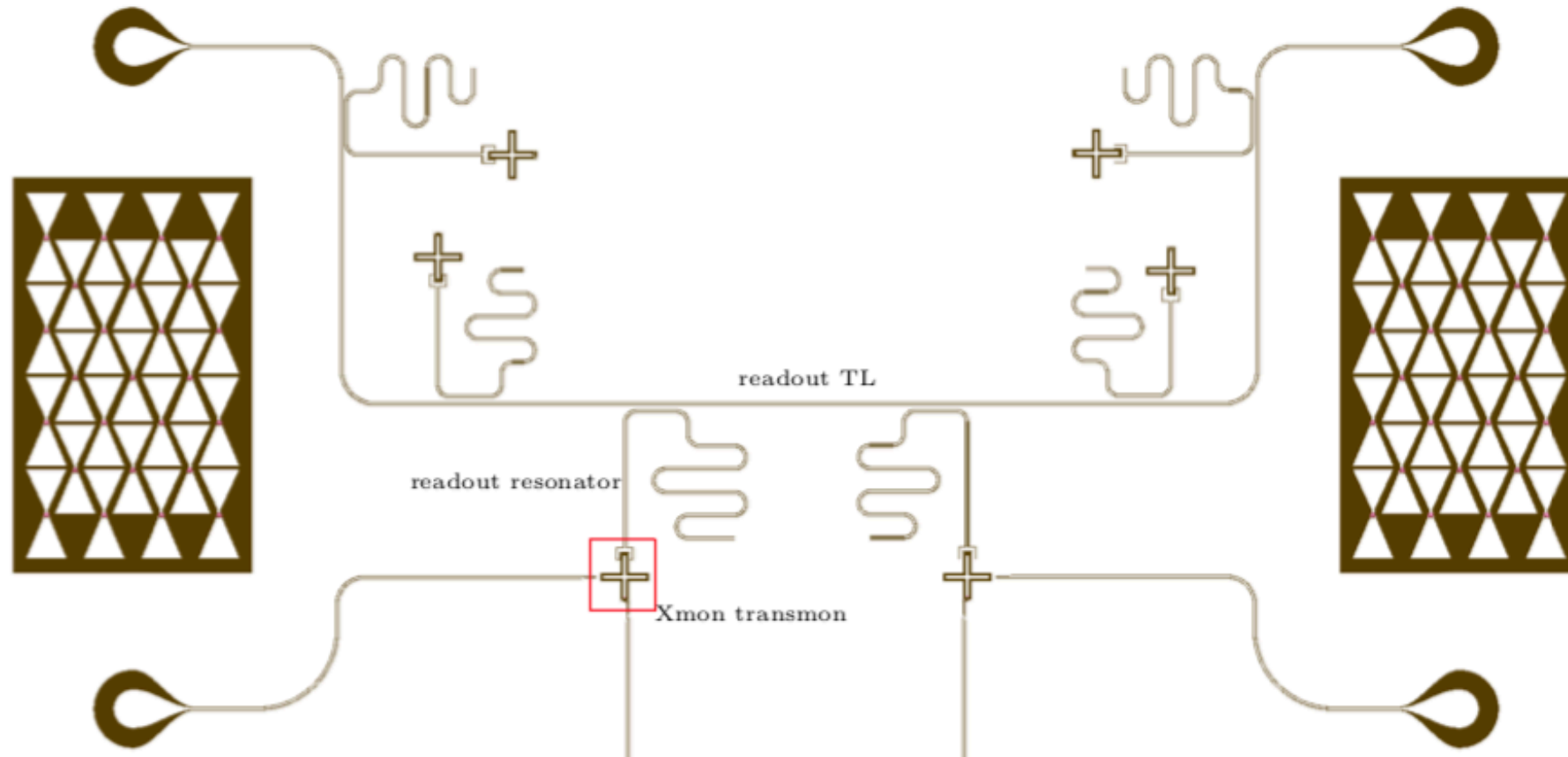
Danilo Labranca, University of Milano Bicocca - Hervè Atsè Corti, University of Pisa

Introduction


readout TL

readout resonator

Xmon transmon

Extensible Architecture for Superconducting Quantum Computing - Thomas G. McConkey https://uwspace.uwaterloo.ca/handle/10012/13464

Design Goals

- Test device comprised of four qubits capacitively coupled to a readout resonator.

- Feedline with $Z_0 = 50\ \Omega$

- Two readout resonators capacitively coupled to the feedline

- Two readout resonators inductively coupled to the feedline

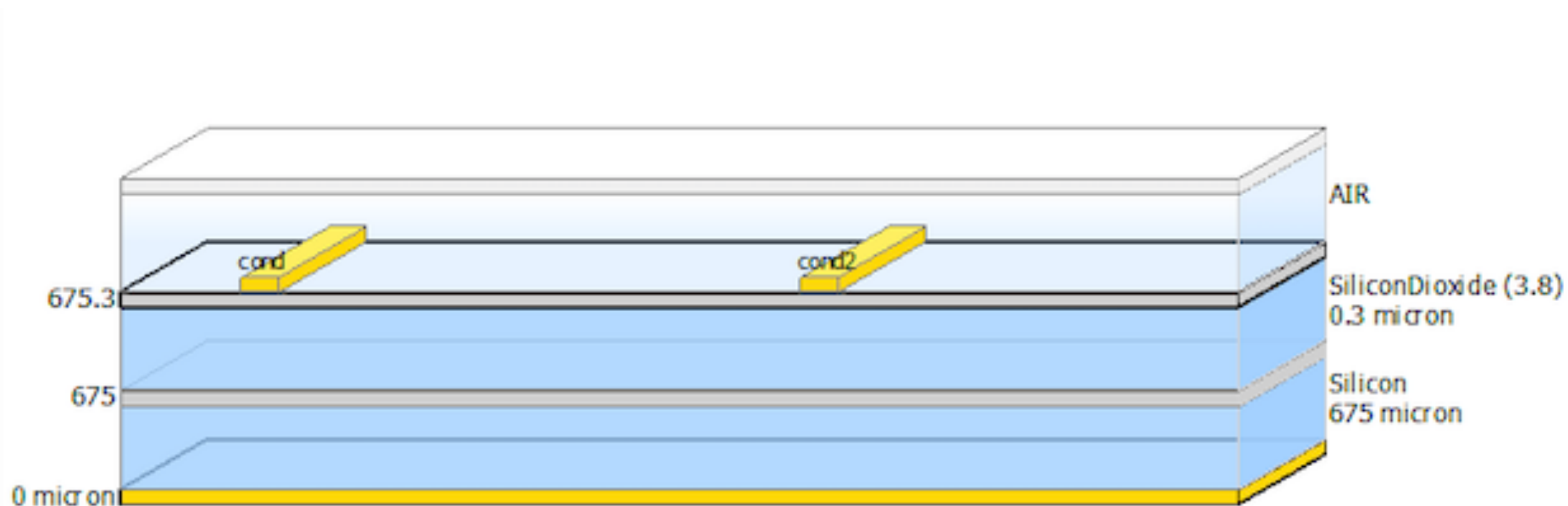- Two qubits tunable via a dedicated control line
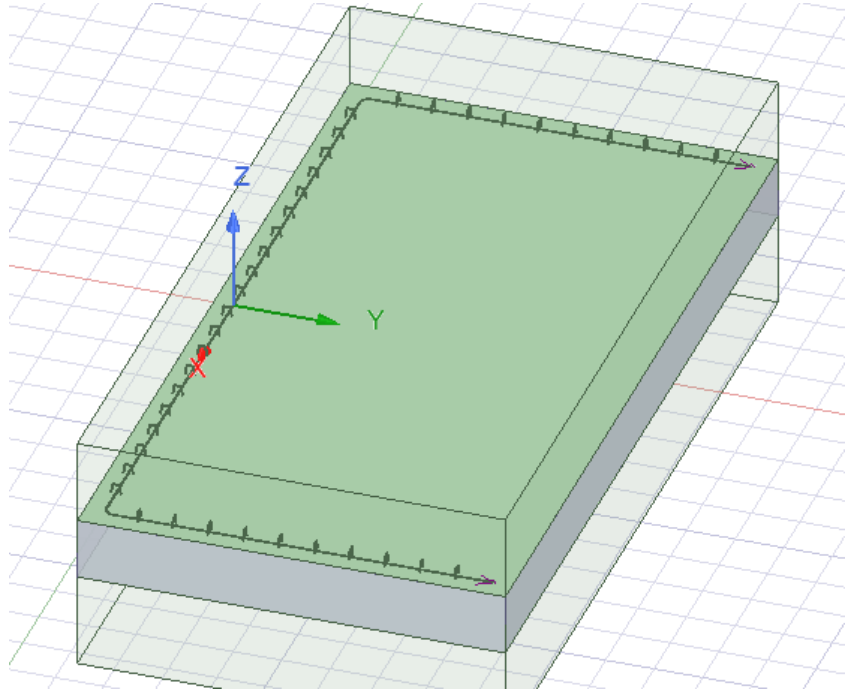
Design Snapshot
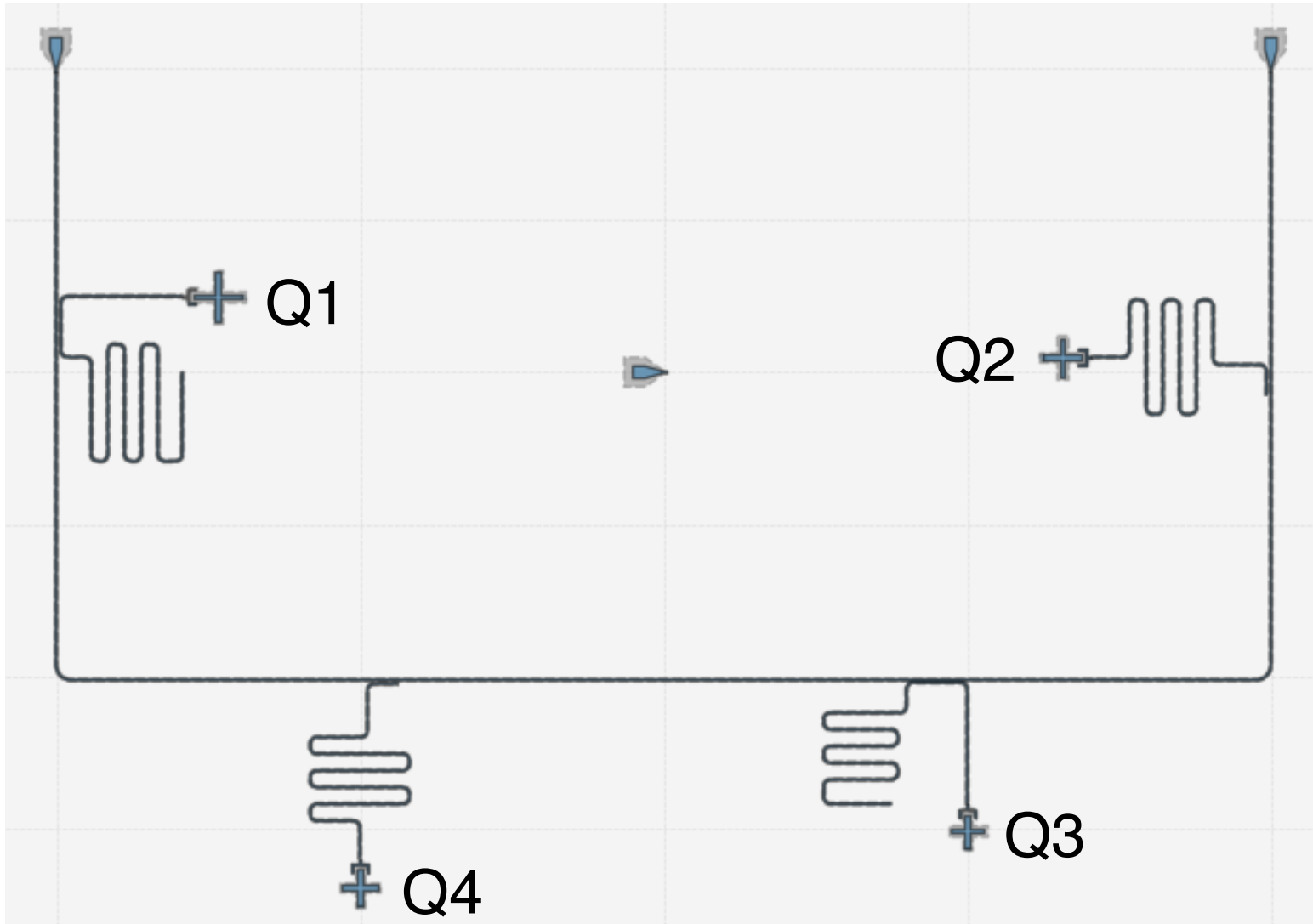
Note

- Four qubits on the same chip

- No tuning control lines for qubit Q3 and Q4 at the moment

- Qiskit Metal hack to simulate the substrate (the wirebond pad at the center is a side-effect)
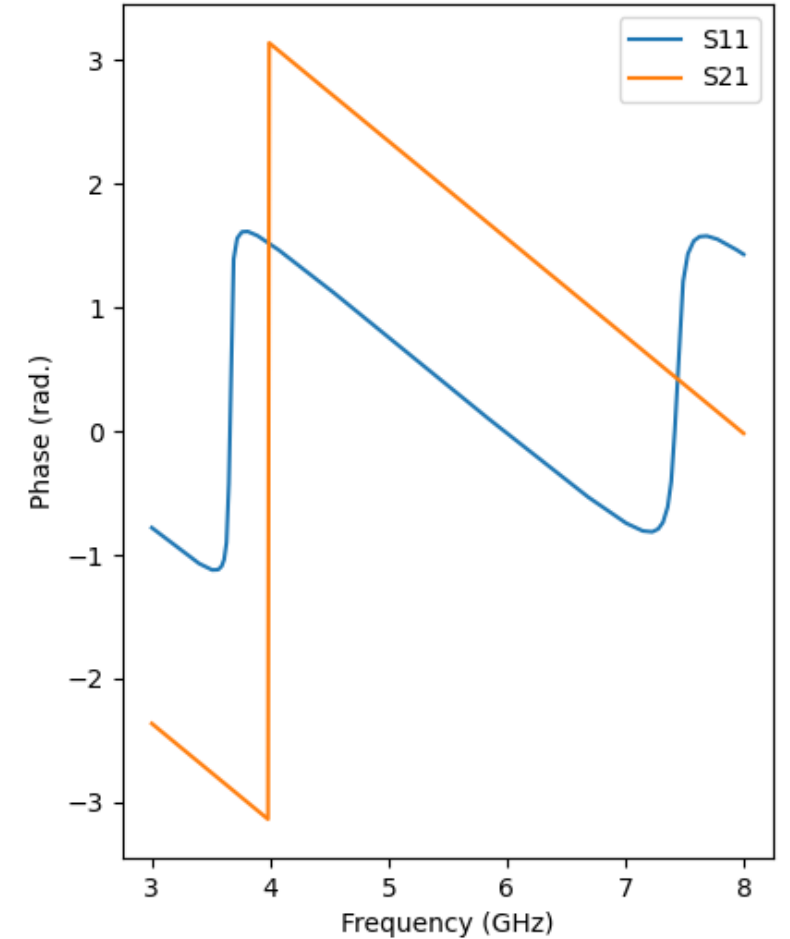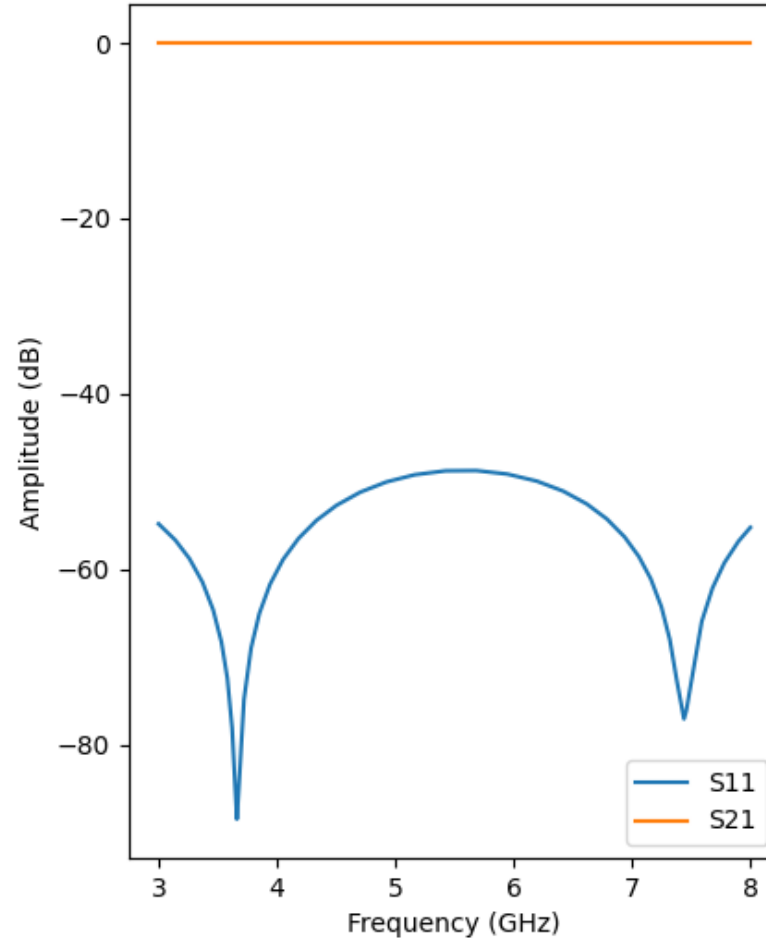
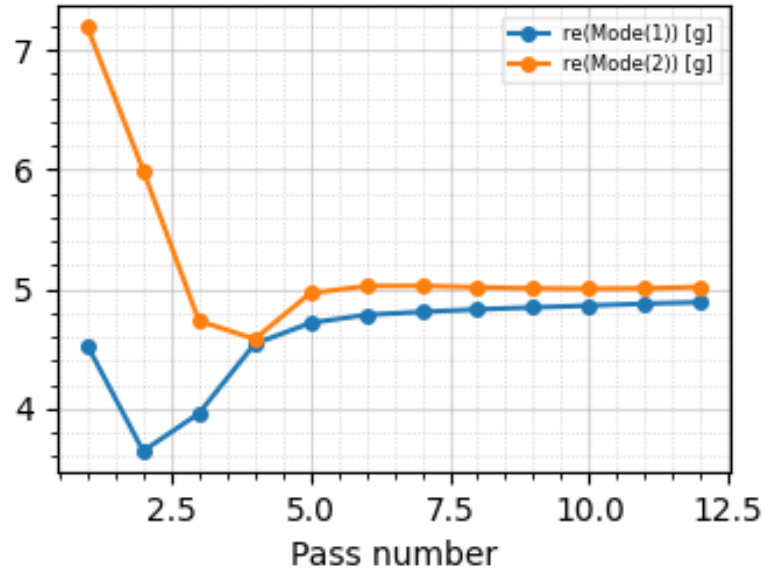# FBK Substrate

Feedline Impedance Matching
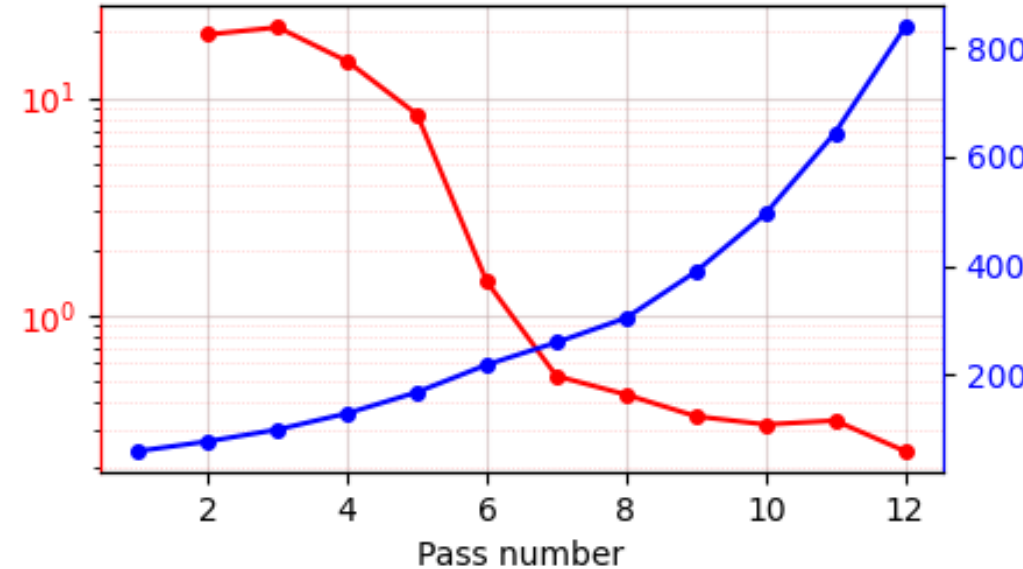

Note

10 convergent passes
(current matching)

Design Analysis 1/3
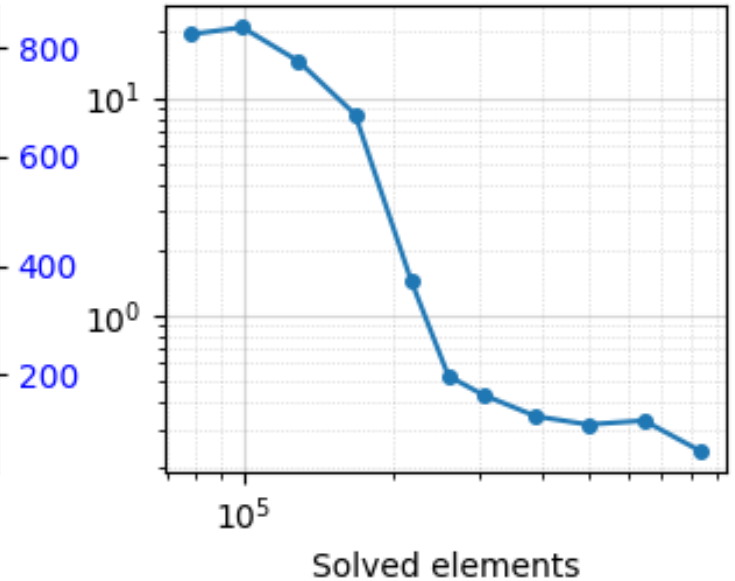
The analysis are based on the EPR (Energy Participation Ratio)

Energy-participation quantization of Josephson circuits - Zlatko Minev

https://arxiv.org/abs/2010.00620

Design Analysis 2/3

Qubit	Frequency (GHz)	α (MHz)	χ (MHz)
Q1	4.70	216.78	0.95
Q2	5.34	288.29	0.66
Q3	5.92	165.52	2.54
Q4	5.69	150.05	0.65

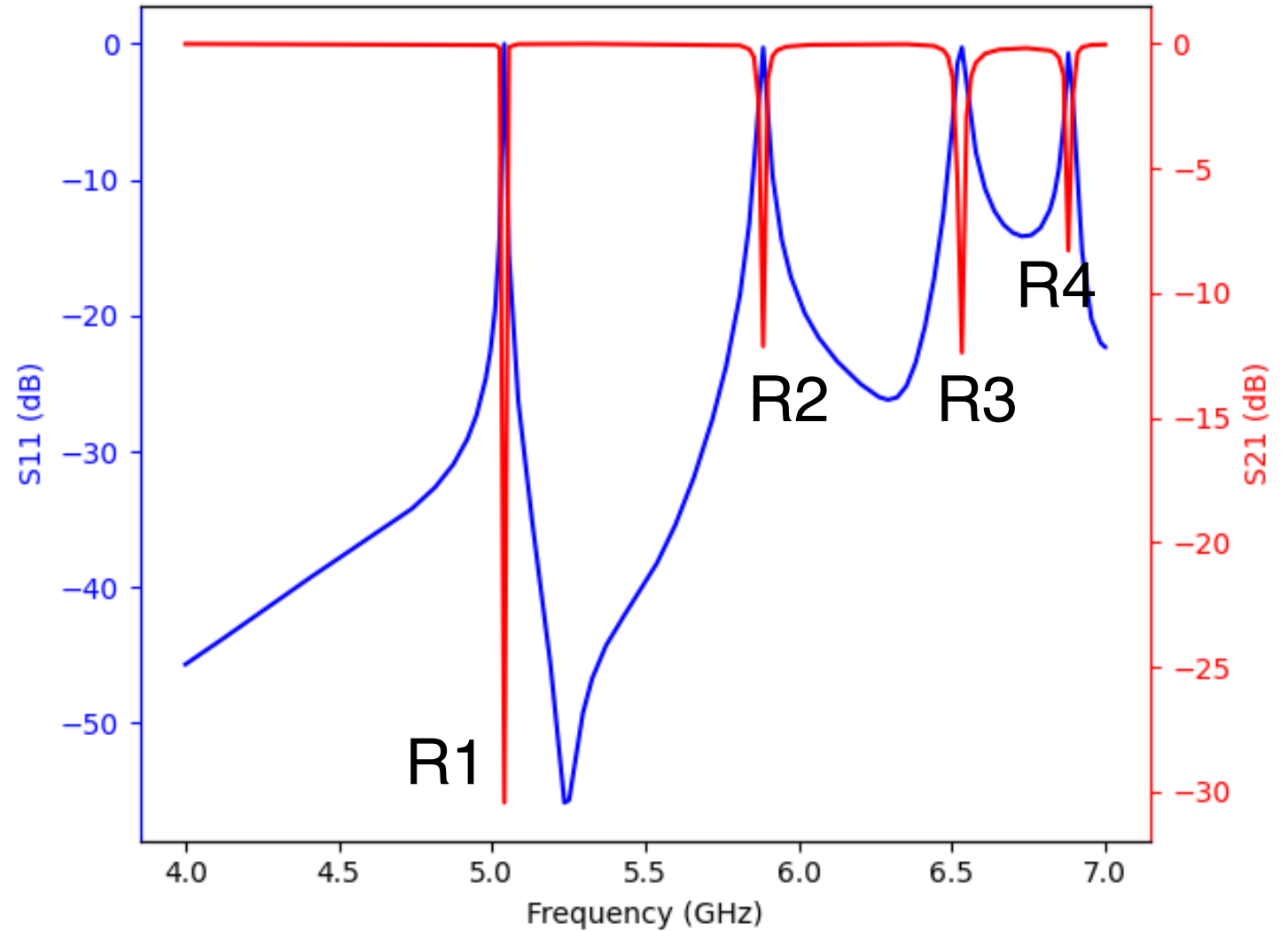| Readout Resonato	Frequency (GHz)
R1	5.01
R2	6.16
R3	6.45
R4	6.84

Note

- At the moment we don't have T1 since its analysis has a severe bug on Qiskit Metal

Design Analysis 3/3

Simulation of the whole chip (i.e. qubits, resonators, feedline)

Note

4 convergent passes

Manufacturing Constraints

- Is it important to consider the SiO2 layer in our simulations?

- Are there any constraints on the JJ inductances?

- How much variance does have the manufactured JJ inductances?

- Can we design qubits with different JJ inductances on the same chip?

- Are there any constraints on the aluminum metallisation (e.g. qubits, resonators, feedline, gaps)?

- Does FBK already have a document with the specs to design 50 ohm feedlines?

- Which are the desired values of χ, α, frequencies, and qubit detunings?

- Which is the qubit minimum shunt capacitance that allows to neglect the JJ parasitic capacitance?

Thanks for your attention!