Weighting Coupling Strength of Superconducting CPW Resonators Characteristics

María Benito-Gomes [1,2]
Gemma Rius [1]

[1] *Instituto de Microelectrónica de Barcelona (IMB-CNM), CSIC. Carrer dels Til.lers s/n, Cerdanyola del Vallès, 08193, Spain*
[2] *Departament de Física, Universitat Autònoma de Barcelona, Bellaterra 08193, Spain*

maria.benito@imb-cnm.csic.es,
gemma.rius@csic.es

Superconducting Coplanar Waveguide (CPW) resonators are microwave (MW) resonators consisting in a conductive strip separated by a gap of a dielectric substrate from surrounding ground planes. They are operated within the superconductive phase of a given material. CPWs have become important for quantum information processing, such as qubit readout, quantum memories…), but also as elements for filters and detectors (MKIDs, SNSPD…).
Their ultimate performance can only be obtained if they are properly designed, so that low-loss signal propagation and strong electromagnetic confinement can eventually be ruling. Practically, for CPW readout, a MW input source is applied through a feedline to which one or several CPWs are coupled. The output signal contains a contribution depending on the resonator itself (internal loss), and another that depends on the coupling strength to the feedline (external loss).
The internal loss can be tuned by adjusting the geometry of the CPW structure itself. For example, for a given central width-to-gap value (constant ratio), decreasing the central conductor width would increase the CPW Surface Participation Ratio (SPR), concentrating the electromagnetic field at the edges of the resonator, yielding higher intrinsic losses. [1] Distinctively, the external loss depends mainly on the coupling distance between the CPW and the feedline. Positioning too far decreases the coupling capacitance, leads to weak or under coupling, which increases the relative weight of external loss. Ideally, *critical coupling* is desired, that is, internal and external losses are equal and so that the total loss is optimized for maximum energy transfer.
Here, I will present experimental evidences of some significant, unexpected frequency shifts in certain *Aluminium Superconducting Resonators*, which can be explained only if combined effects of the total/nominal CPW length and also the coupling distance to the feedline are, both, considered. By analysing and comparing different geometries systematically designed for specific frequencies and quality factors (Inset, Figure 1), we have aimed to provide an advanced model that accurately allows some mapping of the theoretical projections with the experimental outcomes (Figure 1).

References

[1] Gao, J. (2008)
[2] Göppl, *et al.* (2008)

Figures

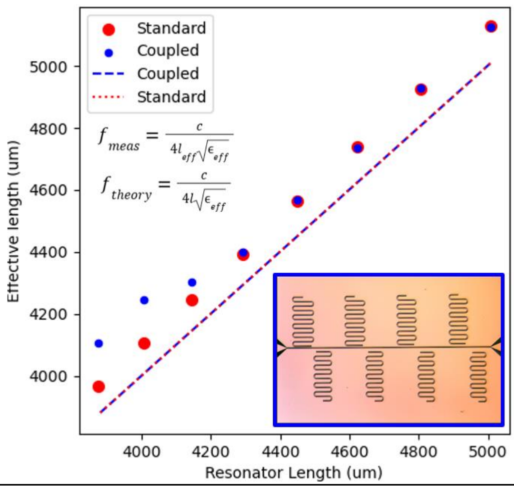

Fig. 1: Effective vs Nominal Length for Al resonators on 4H-SiC substrate, according to embedded formulae. Coupled design (inset, blue) shows coupling separation from 10 to 80 µm in steps of 10 µm. A constant offset of f_{meas} accounts for some common coupling capacitance and kinetic inductance, not considered in the theoretical prediction.