High fidelity qubit readout using a V-shaped transmon in a 3D cavity

R. Dassonneville, L. Planat, J. Puertas, S. Leger, K. Bharadwaj, F. Foroughi, C. Naud, W. Guichard, N. Roch, O. Buisson[a,b]

[a]University Grenoble Alpes, Institut Néel, F-38000 Grenoble, France.
[b]CNRS, Institut Néel, F-38000 Grenoble, France.

* olivier.buisson@neel.cnrs.fr / nicolas.roch@neel.cnrs.fr

Using the transverse dispersive coupling between a qubit and a microwave cavity is the most common read-out technique in circuit-QED. However, despite important progresses, implementing a fast high fidelity readout remains a major challenge. Indeed, inferring the qubit state is limited by the trade-off between speed and accuracy due to Purcell effect and unwanted transitions induced by readout photons in the cavity. To overcome this, we introduce a circuit with a V-shaped energy spectrum coupled to a 3D-cavity [1,2]. This circuit presents one transmon qubit with a large intrinsic longitudinal coupling to an anharmonic mode, called ancilla mode. This ancilla mode results from the hybridization between the microwave cavity and the V-shape circuit. Longitudinal coupling is a key point to our readout scheme since such a coupling is immune to Purcell effect. We will present qubit readout performance using this 3D V-shaped transmon inserted in a cavity with fidelity as high as 97%. We will also discuss the quantum non-demolition properties of this novel readout as function of the readout photons number.

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[1] É. Dumur, et al, Phys. Rev. B 92, 020515(R) (2015).
[2] É. Dumur, et al, IEEE Trans. On Appl. Supercond. 26, 1700304 (2016).

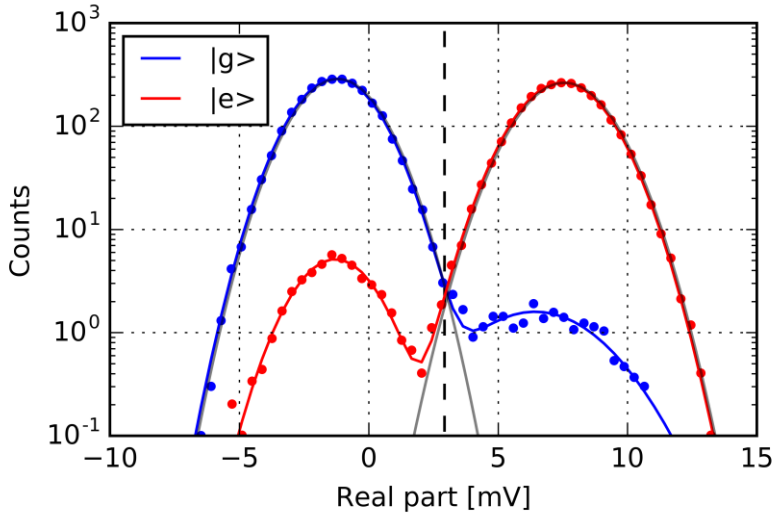

Figure 1: Histograms of single shot readout signal measured during 500ns when the qubit is prepared in the ground (blue) or excited state (red). Here the fidelity of this readout is about 97%.