Introducing flux-tunability in high-Q superconducting cavity devices

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Three-dimensional (3D) superconducting microwave cavities have been shown to exhibit long lifetimes of up to several milliseconds, making them promising candidates for storing continuous-variable quantum information. Effective control of these cavities requires non-linear auxiliary circuits. Incorporating flux-tunable elements such as SQUID or SNAIL [1] devices is highly desirable as they can potentially enable fast operations without imparting unwanted dynamics on the cavity modes. However, this integration is non-trivial due to the need to apply external magnetic bias in a 3D superconducting enclosure. Consequently, the implementations demonstrated so far are limited to only either DC [2] or fixed-frequency AC bias [3]. In this work, we realise a device that uses a μ-metal magnetic hose [4] to provide fast adiabatic bias to a SQUID circuit coupled to a cavity. The architecture is compact and has the potential to provide effective biasing of the SQUID element without compromising the coherence times of the cavity. Furthermore, we investigate the possibility of using this device to enact fast resonant control of individual sideband transitions [5] of the cavity. This highlights the value of our architecture in achieving robust operations on 3D superconducting for continuous-variable quantum information processing.

References

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Figures

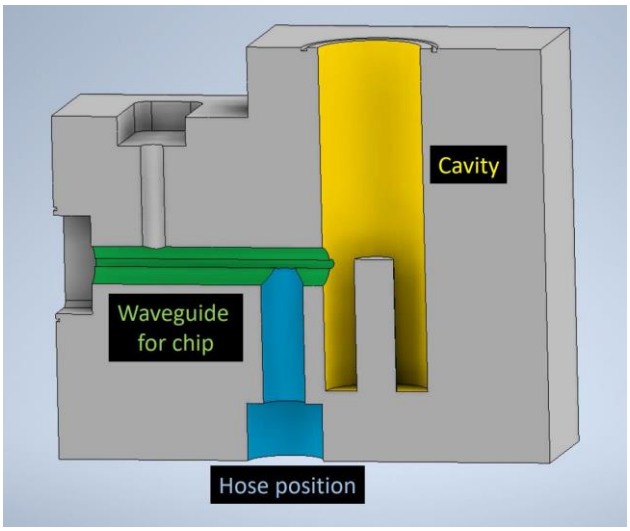

Figure 1: cQED hardware schematic showing: waveguide for a auxiliary circuit chip, slot for μ-metal magnetic hose and storage cavity.