Single microwave photon detector with Dark count rate lower than 100 count/S

Léo Balembois
E.Flurin, P.Bertet, E.Billaud, E.Alvertinale, D. Vion, D.Estève

CEA, Orme des merisier, Gif-sur-Yvette, France

leo.balembois@cea.fr

Single photon counters are essential for detecting weak incoherent electromagnetic radiation. In the optical domain, they are widely used to detect spontaneous emission from individual quantum systems, with applications in fluorescence microscopy, and in numerous areas of quantum technologies. In the microwave domain, operational single photon counters have been developed recently using superconducting quantum circuits, offering novel opportunities for detecting spin fluorescence at microwave frequencies [1] or dark matter axions search.

The single microwave photon counter is based on a transmon qubit is irreversibly coupled to the incoming photons [2] The irreversibility of the process is provided by a 4-wave mixing interaction between the qubit, two resonators and a pump tone. The device operates at 6.98 GHz and is frequency tunable on 40 MHz around this point.

Here we demonstrate a record low absolute power sensitivity of $1 * 10^{-22}\ W/\sqrt{Hz}$, corresponding to a dark count rate of less than 100 clicks/s and an efficiency of 0.4.

References

[1] Albertinale, E., Balembois, L., Billaud, E. et al. Detecting spins by their fluorescence with a microwave photon counter. Nature 600, 434–438

[2] Raphaël Lescanne, Samuel Deléglise, Emanuele Albertinale, Ulysse Réglade, Thibault Capelle, Edouard Ivanov, Thibaut Jacqmin, Zaki Leghtas, and Emmanuel Flurin Phys. Rev. X **10**, 021038 – Published 18 May 2020

Figures

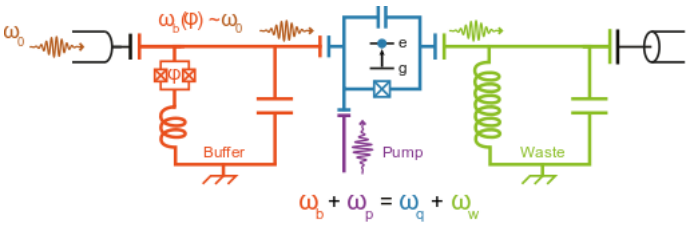

Figure 1: Working principle of the single microwave photon detector. An incident photon at frequency ω_0 is irreversibly converted in a transmon excitation thanks to a four wave mixing process

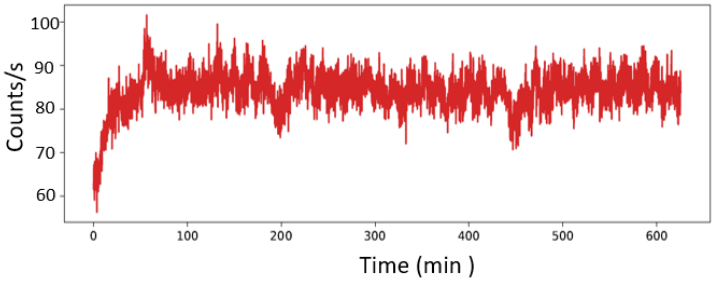

Figure 2: Dark count rate acquired over ~10 hours. After an increasing from 60 count/s to 90 count/s due to the pulses sent to the fridge, the Dark count rate stabilizes around 90 count/s