Toward non-classical photons emitted by a DC biased Josephson junction

Chloé Rolland[1,2], Marc Westig[1], Iouri Moukharski[1], Denis Vion[1], Philippe Joyez[1], Patrice Roche[1], Daniel Esteve[1] and Fabien Portier[1]

[1]Service de Physique de l'Etat Condensé (CNRS UMR 3680), CEA-Saclay, France
[2]IEMN (CNRS UMR 8520), Villeneuve d'Ascq, France
chloe.rolland@cea.fr

We present preliminary measurements of the time resolved g2 function of the photons emitted by a dc biased Josephson junction embedded in a **high impedance** microwave resonator: the quantum fluctuations of the current through the junction couples to the resonator, so that a dc current flows through the junction when the transfer of a Cooper pair corresponds to the emission of an integer number of photons into the resonator [1]. These photons can then retroact on the transfer of other Cooper pairs via stimulated emission of photons by the junction or dynamical coulomb blockade which results in super bunching or antibunching statistics.

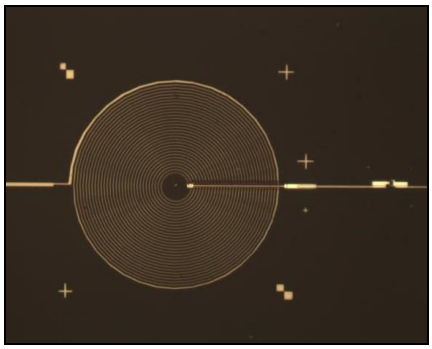

Figure 1: High impedance resonator in series with the Josephson junction

As predicted by theoreticians[2], using high impedance resonator in series with a Josephson junction, we observe a strong coupling which allows us to access strong dynamical coulomb blockade. Our measurements showed first results in this regime, in agreement with P(E) theory. Noise correlation measurements should point out some evidence of non-classical radiation, i.e. antibunched photons.

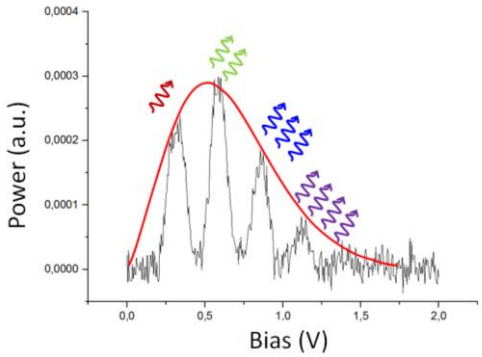

Figure 2: Dynamical coulomb blockage of Copper pair tunneling

In the specific case of two photons emissions, retroaction has been recently predicted to yield to a superbunching of the emitted photons, characterized by a divergence of the Fano factor at a threshold value for the junction's critical current[3], which corresponds to the

classical onset for parametric amplification of the resonator by the ac Josephson current. We probe this prediction by dc biasing a SQUID through a quarterwavelength microwave resonator and measuring the fluctuations of the emitted photon flux in an Hanburry Brown Twiss set up. By varing the flux through the SQUID, we can tune its effective Josephson energy to approach the predicted onset. Our results do show an increase of the Fano factor with increasing critical current.

[1] Hofheinz *et al.*, PRL **106**, 217005 (2011)

[2] V. Gramich *et al*, Phys.Rev.Lett. **111**, 247002, **2013**

[3] Padurariu, Hassler and Nazarov, Phys. Rev. B, (86), 054514 (2012)