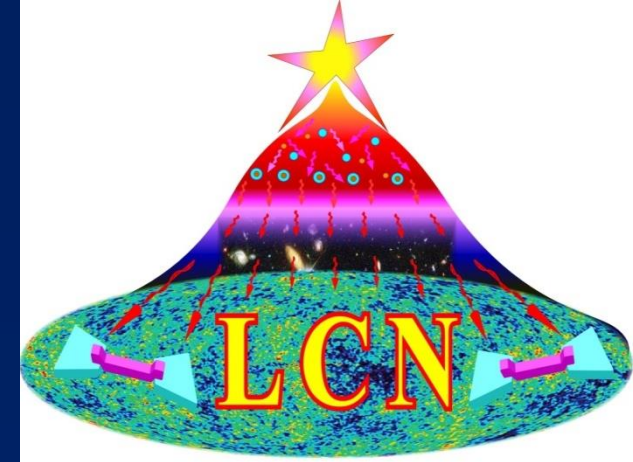




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# Observation of Thermal Photons from the 14 GHz Cavity by a Single-Photon Counter within the QUAX

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# The need for a Single Microwave Photon Counter:

Quantum-noise-limited amplifier Single Photon Counter (SPC)

S.K. Lamoreaux, PRD (2013)

$$P_{lin} = hf\sqrt{(\Delta f_a/t)} - \text{SQL}$$

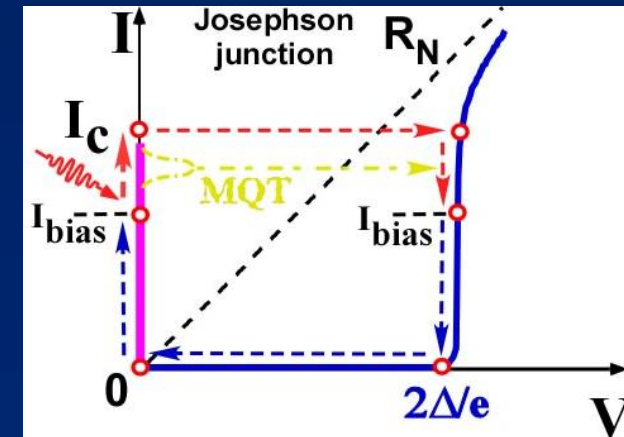
$$\Delta f_a = 7.2 \text{ kHz}$$

SQL - the standard quantum limit about 700 mK at 14 GHz.

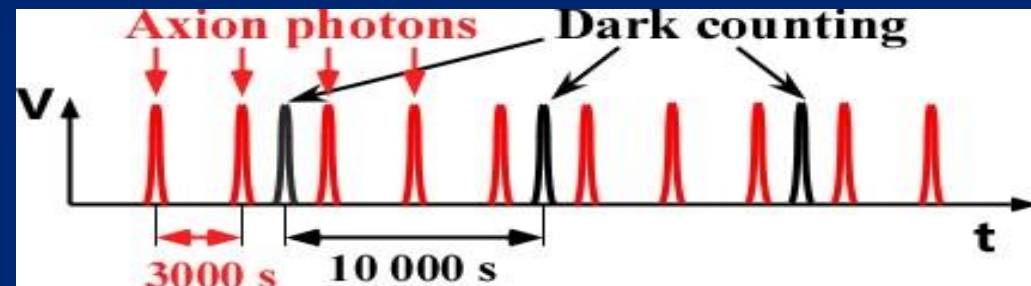
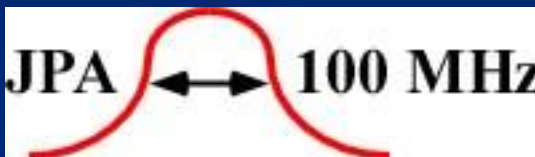
$$P_{SP} = hf\sqrt{(f_{DC}/t)}$$

$$f_{DC} = 1/10000 \text{ sec} = 0.1 \text{ mHz}$$

$$\frac{P_l}{P_{sp}} = \frac{\bar{n} + 1}{\sqrt{\bar{n}}} \sqrt{\frac{\Delta\nu_a}{\eta\Gamma}}$$

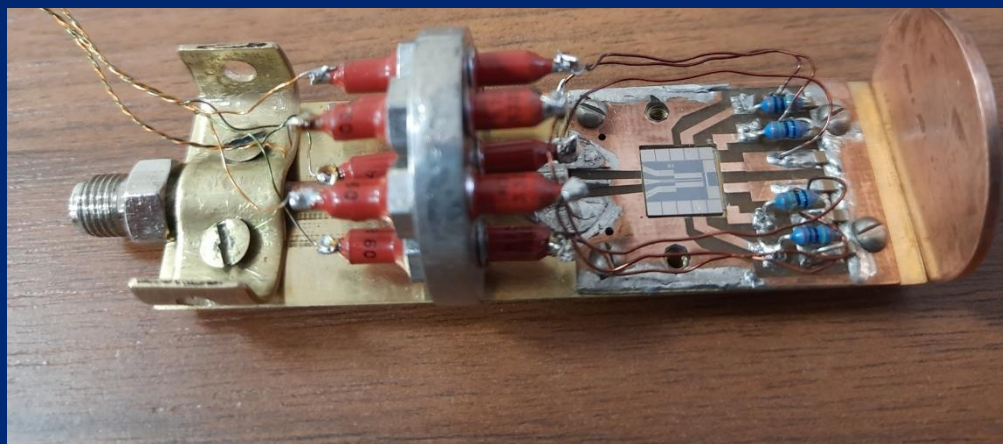
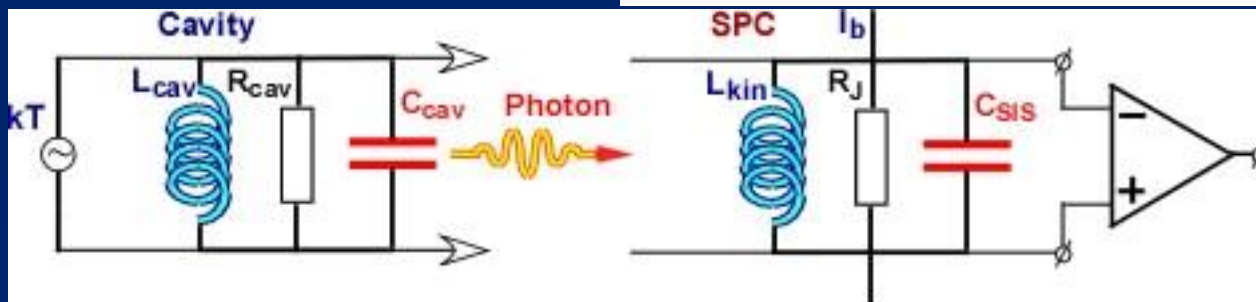
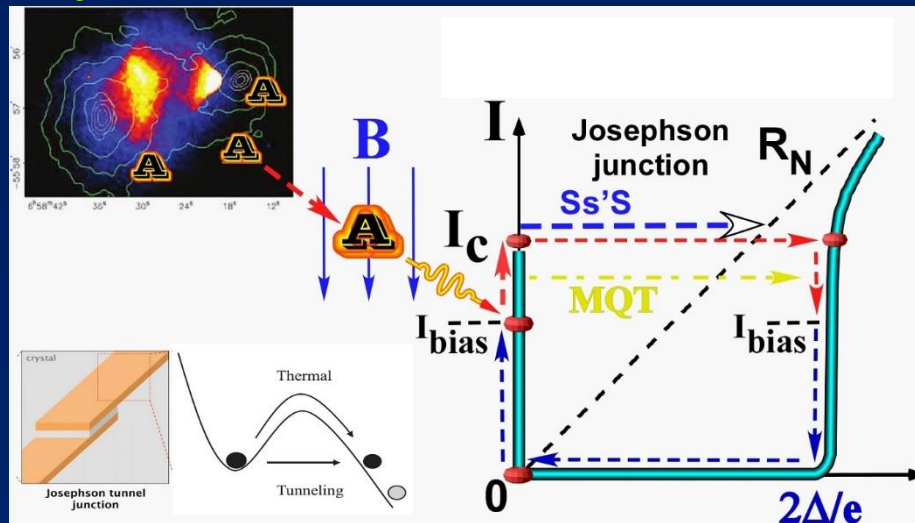
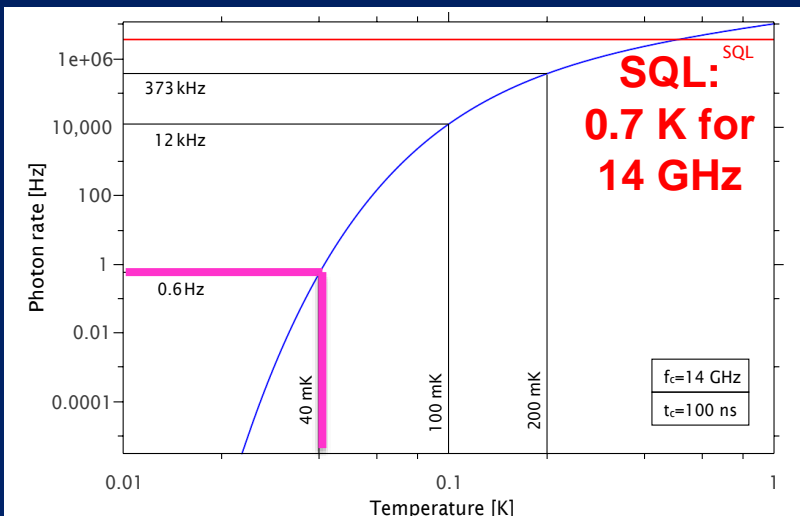


$\Gamma = 0.1 \text{ mHz} !$



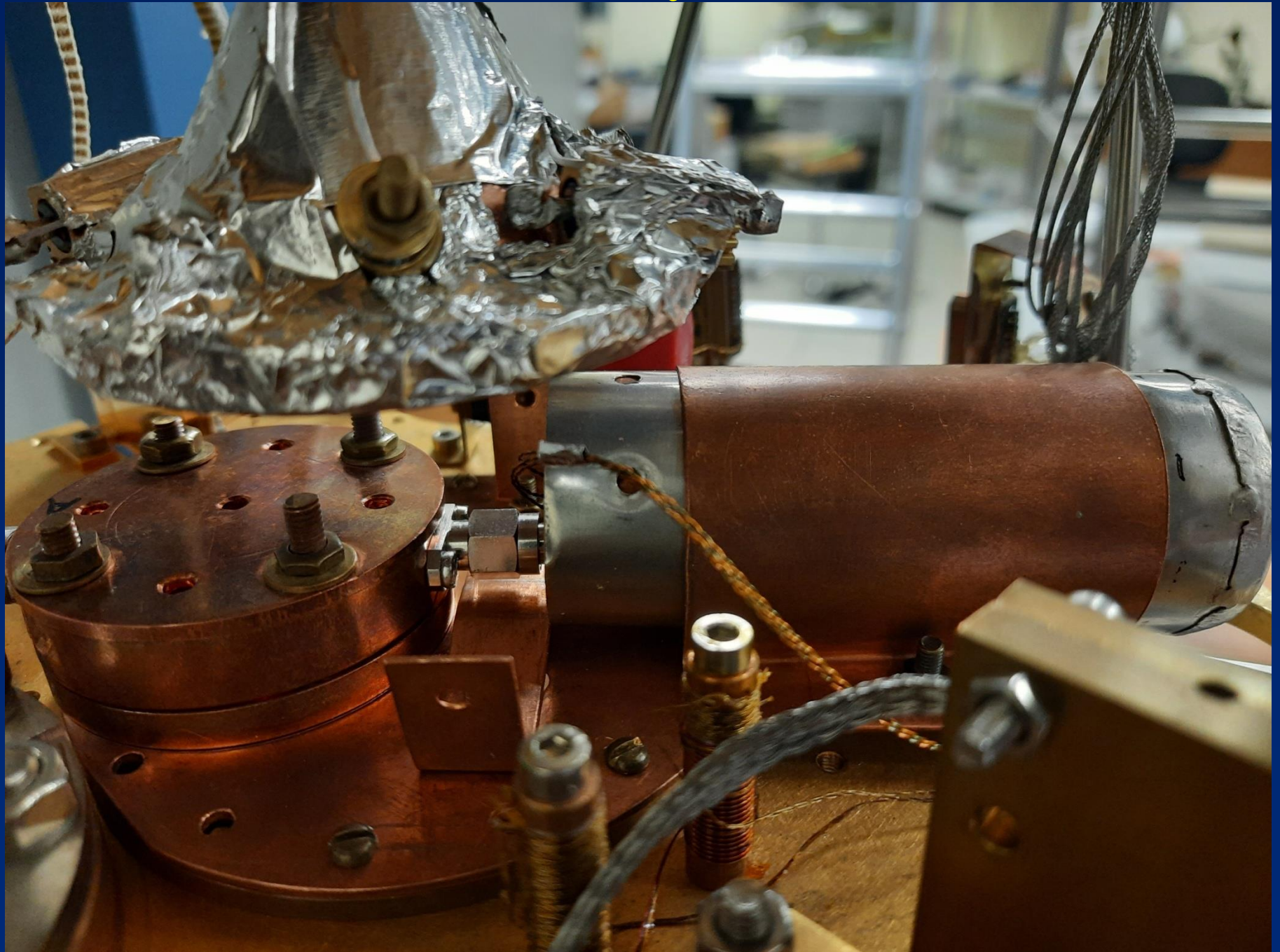
$$\frac{P_l}{P_{sp}} > 30\,000 \text{ for } T = 20 \text{ mK}$$

# 14 GHz Cavity with SPC



Made by Nicolo Crescini, INFN

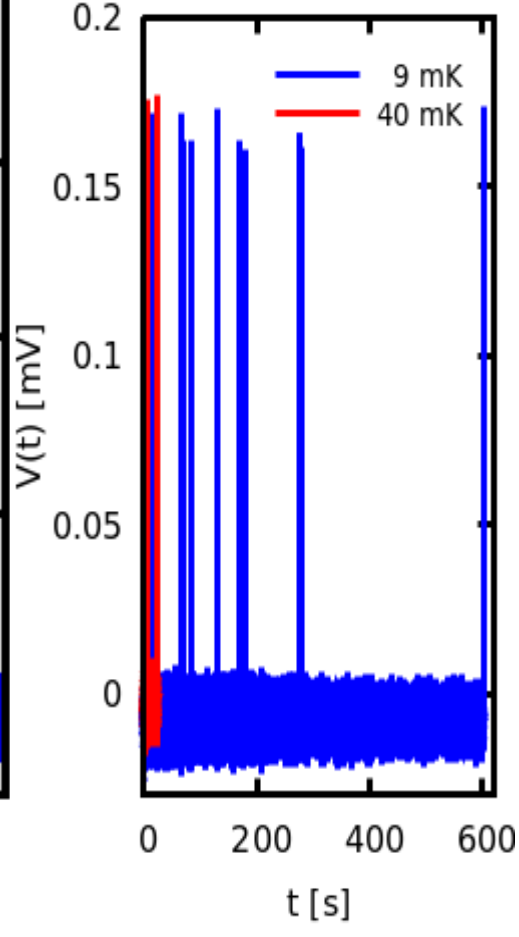
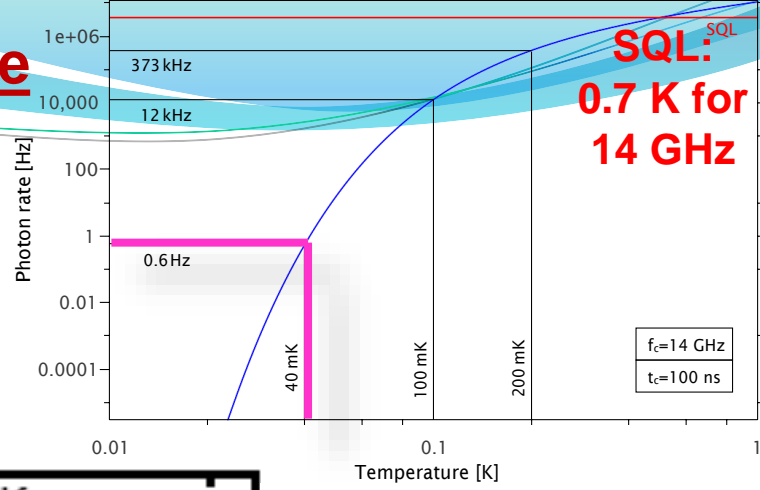
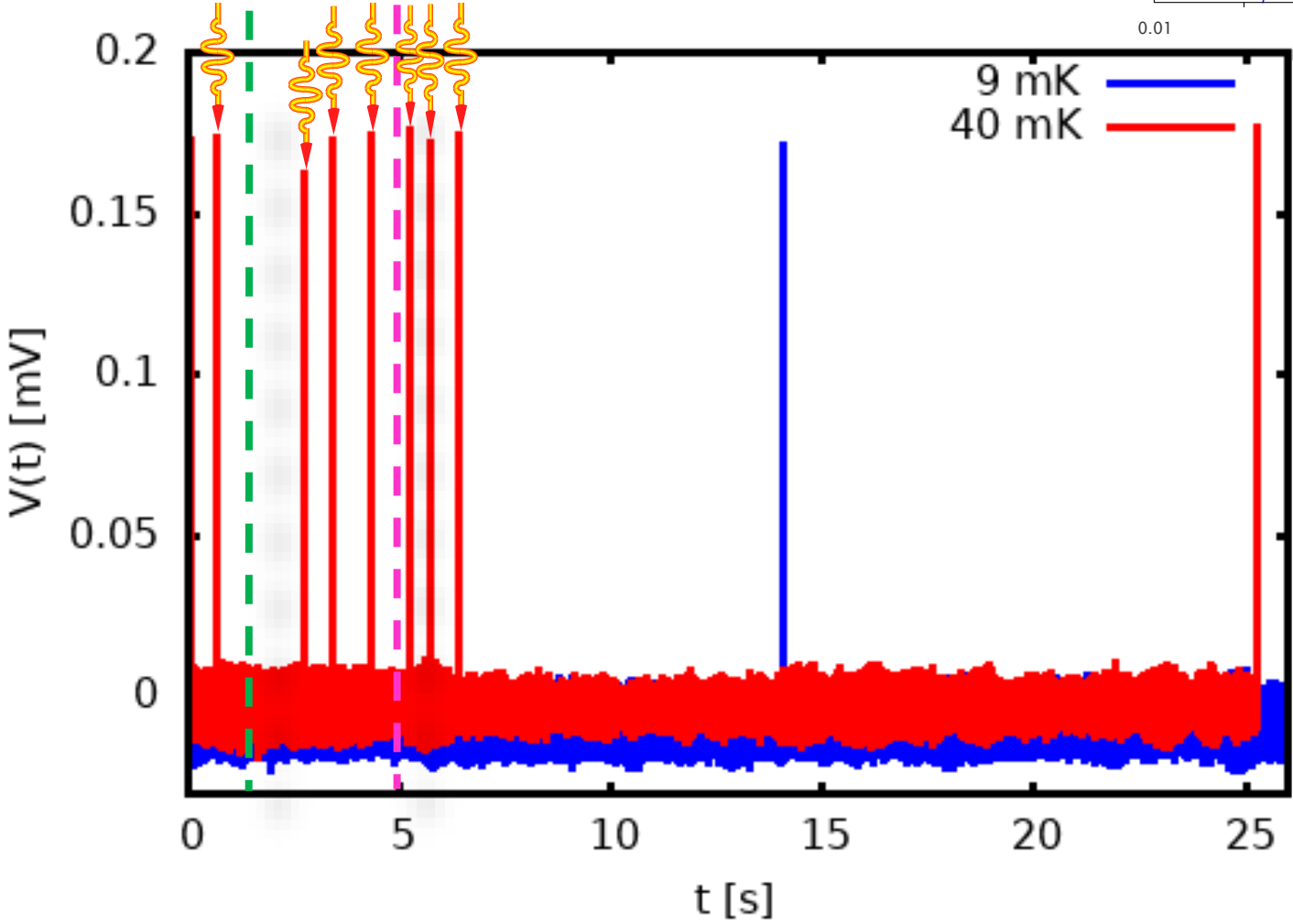
# 14 GHz Cavity with SPC



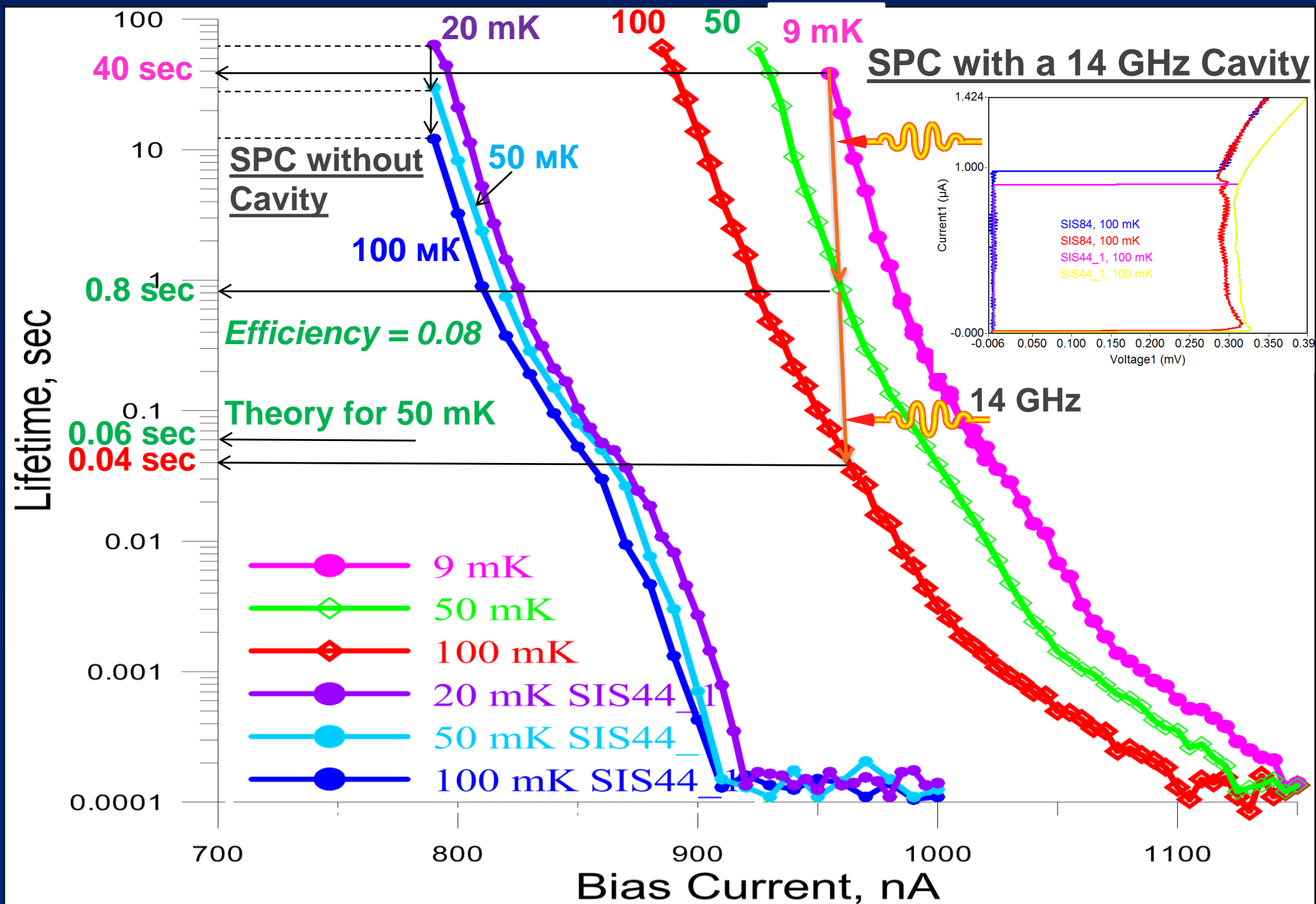
# Observation of Thermal Photons from the 14 GHz Cavity by an SPC in real time

## *Efficiency = 0.33*

Theory Experiment  
for 40 mK at 40 mK



# SPC Lifetime with and without Cavity irradiation



## Conclusions

- Observation of thermal photons from the 14 GHz cavity by a Single Photon Counter in real time.
- **SPC Efficiency = 0.33 !**  
*for rate of photons = 0.6 Hz at 40 mK.*
- **JPA noise / SPC noise = 10 000**  
**@40 mK**  
*(due to the standard quantum noise limit)*