INFN Workshop on future detectors 2022

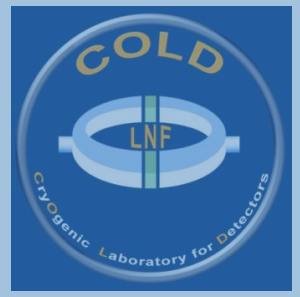
Bari 17-19/10/2022

Toward single-photon detector based on Josephson effect for dark matter search

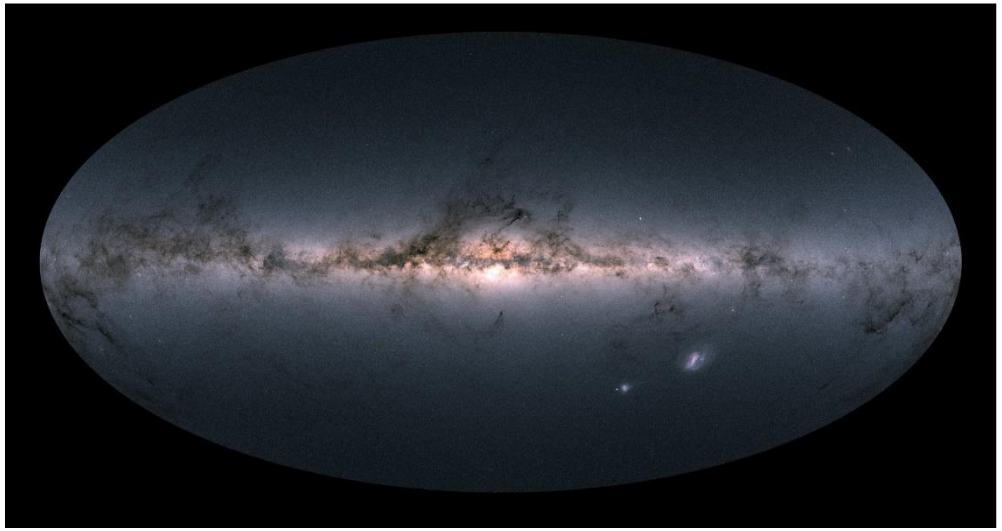
Alessandro D'Elia, Ph.D.

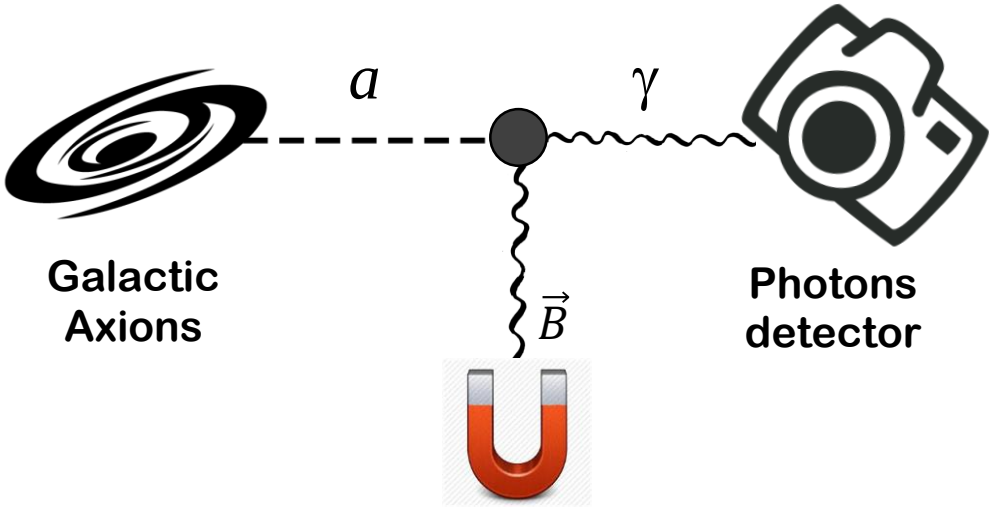
INFN-LNF

alessandro.delia@lnf.infn.it

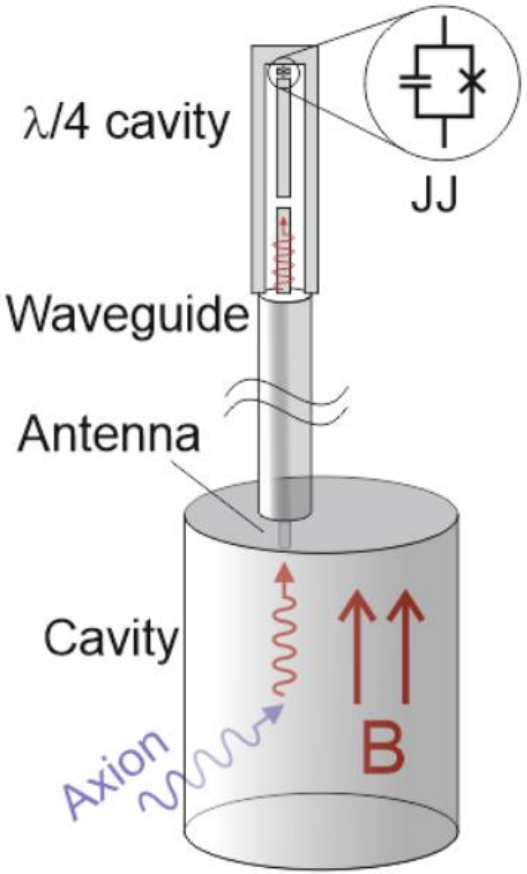


Dark matter search





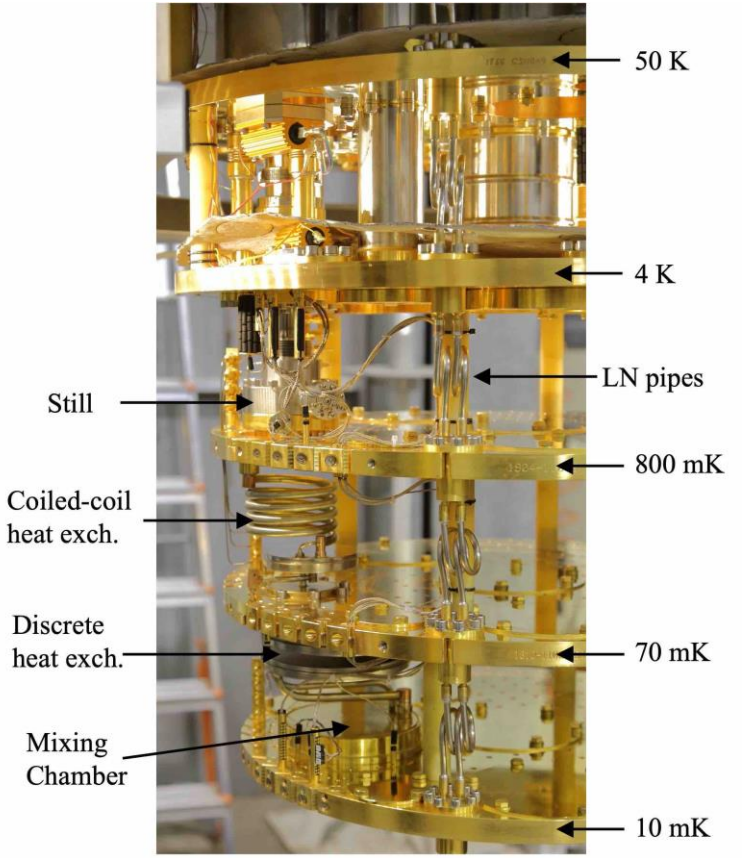
We need for a single photon detector with ultra low noise



COLD laboratory cryostat

LEIDEN CRYOGENICS

$$T_{base} = 8\ mK$$



Magnet 9 T

SUPERGALAX

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 863313. Grant amount 2 456 232.50 Euro.

SUPERGALAX →

Study the changes induced in a Transmission line when a Coherent array of Qubits "sees" a photon

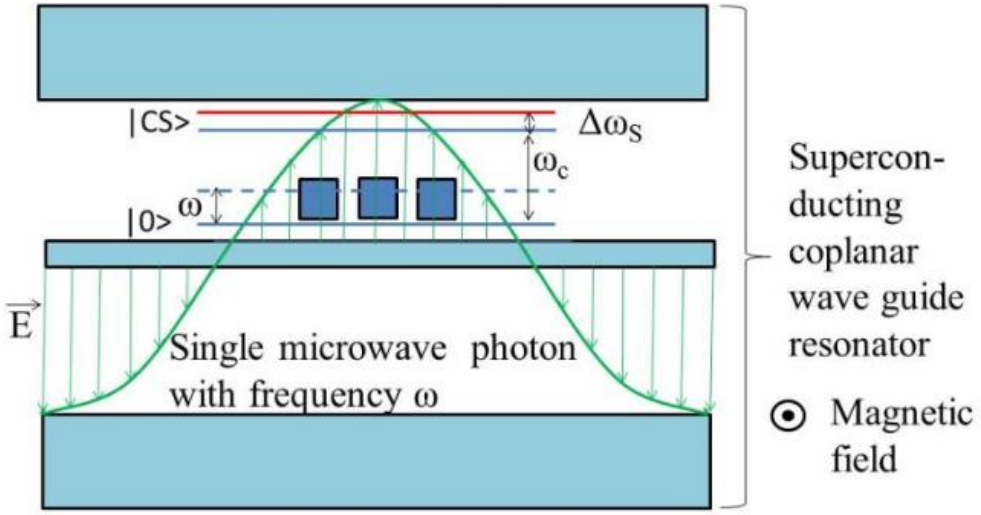
↓

Exploit AC Stark effect to shift the qubit array collective mode

↓

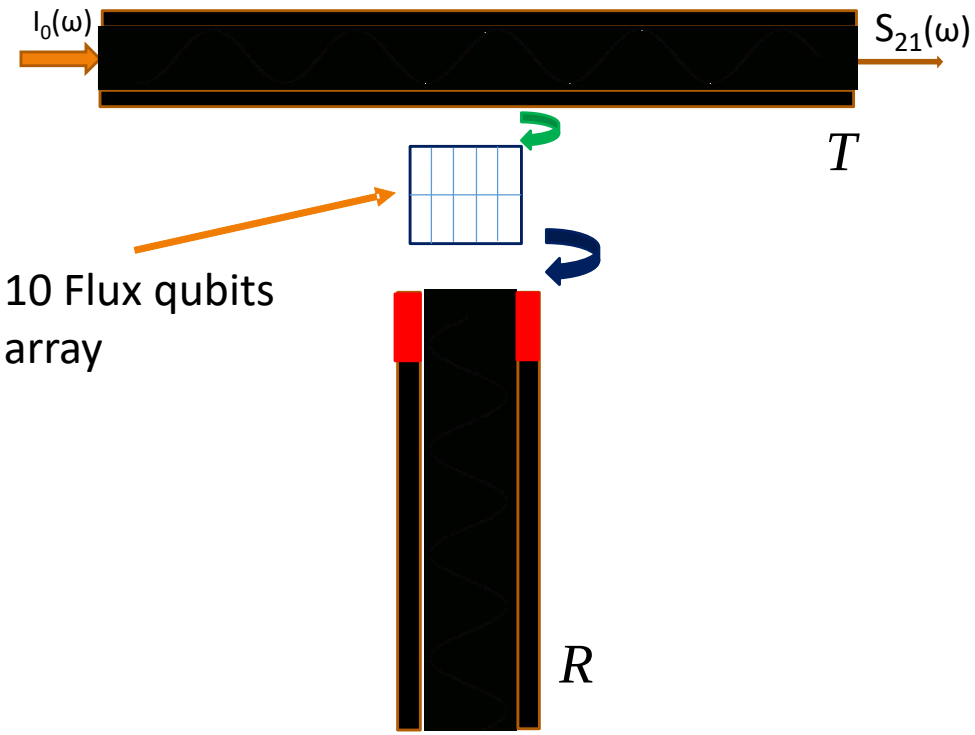
We try to detect this small $\Delta\omega_s$

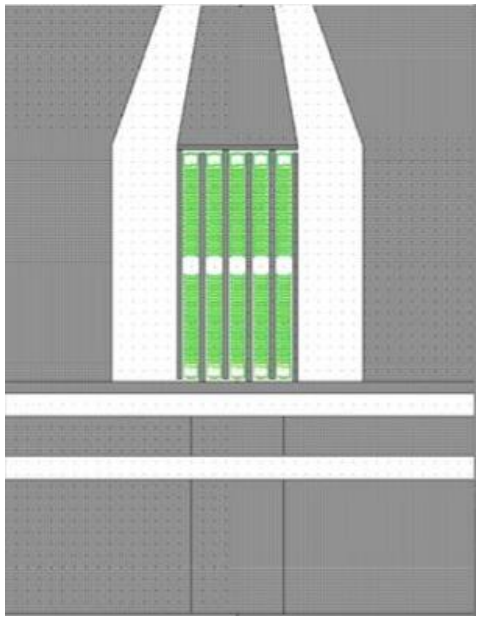
Using a Qubits array th predicted scaling of the signal to noise ratio goes as N instead of $\sqrt{N}$

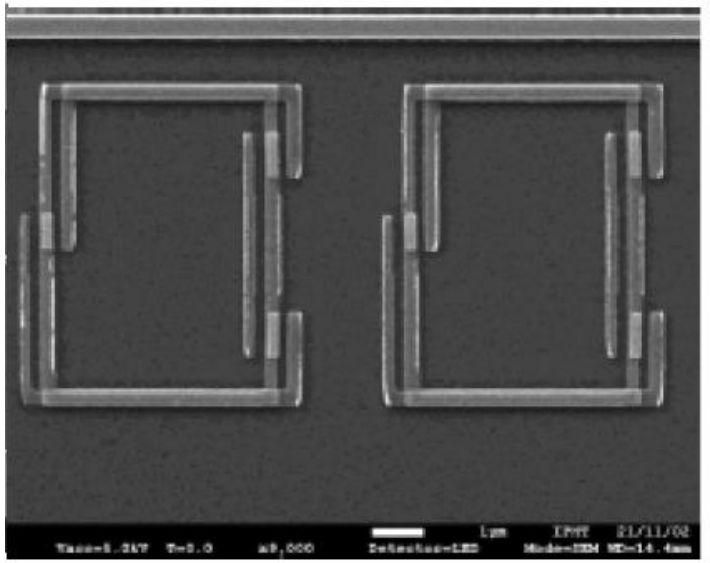


SUPERGALAX outline

Two uncoupled resonators at the same resonant frequency both coupled to an array of qubits





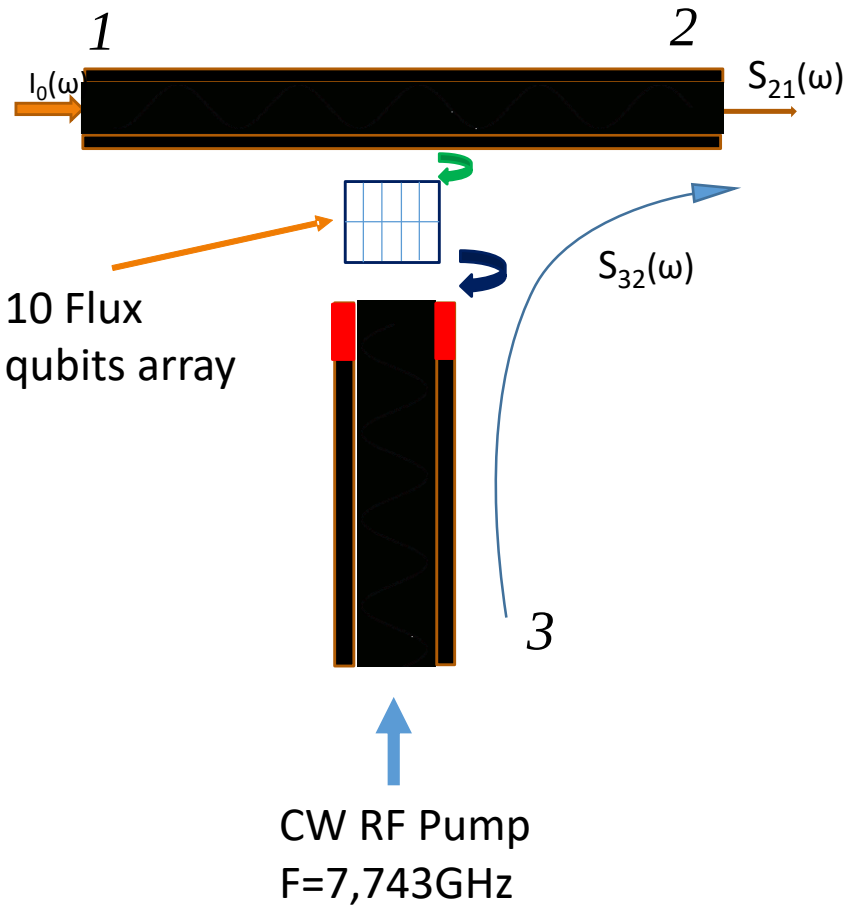


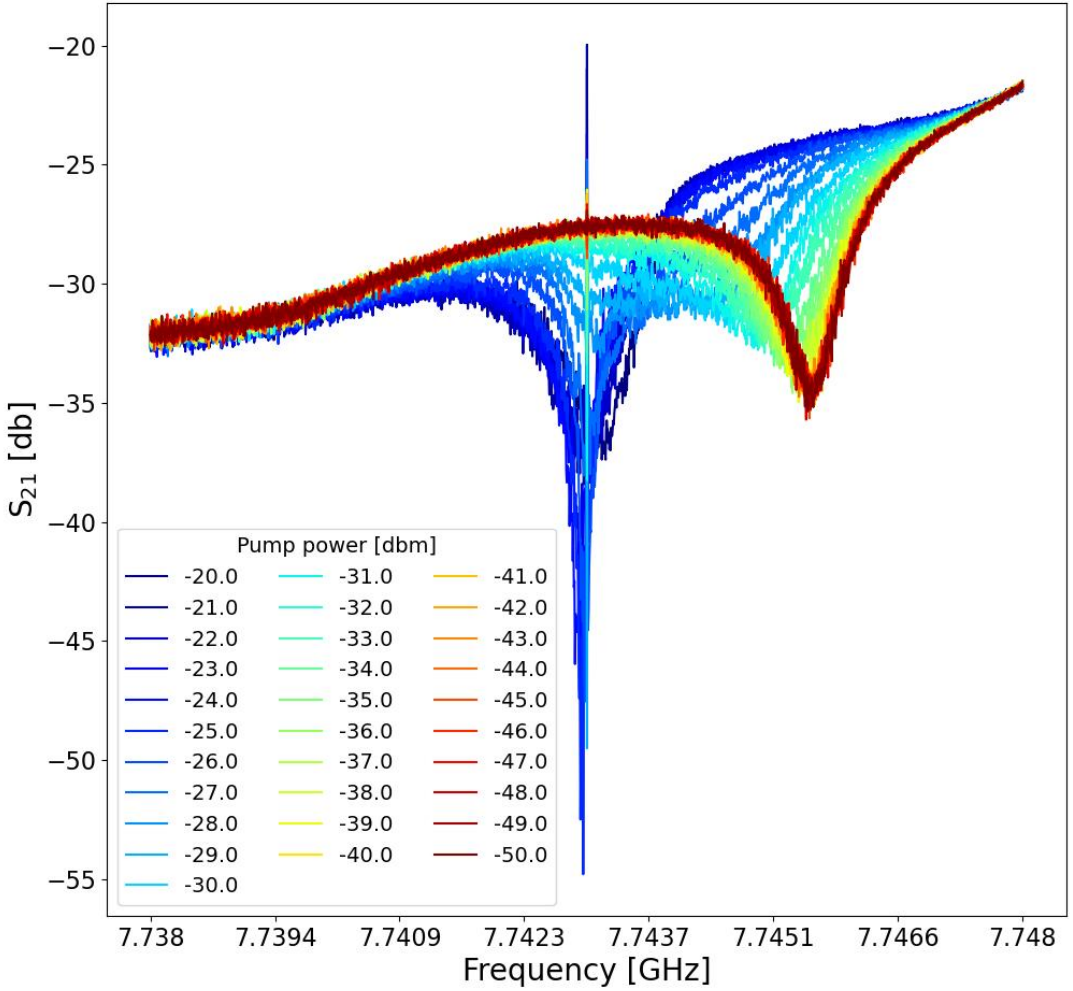
Study the change in S_{21} transmission when sending photons trough resonator R

Application of magnetic field to tune the Qubits array not yet possible!

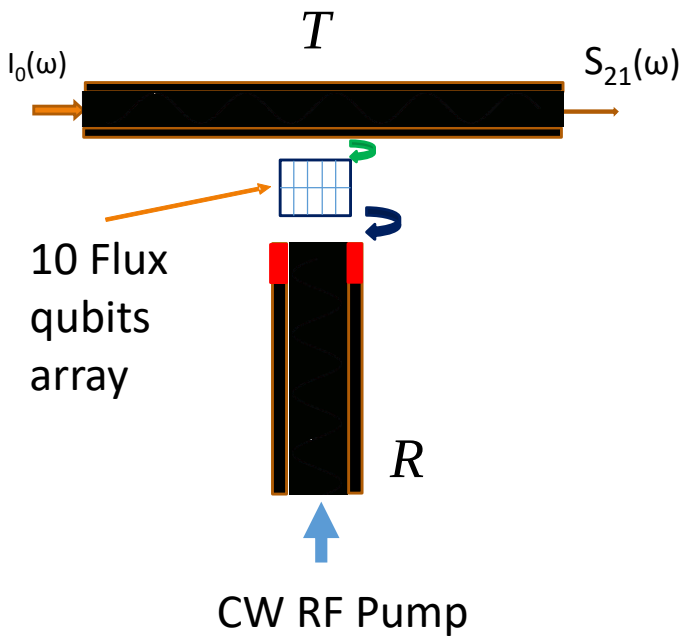
Leibniz-Institut fuer Photonische Technologien

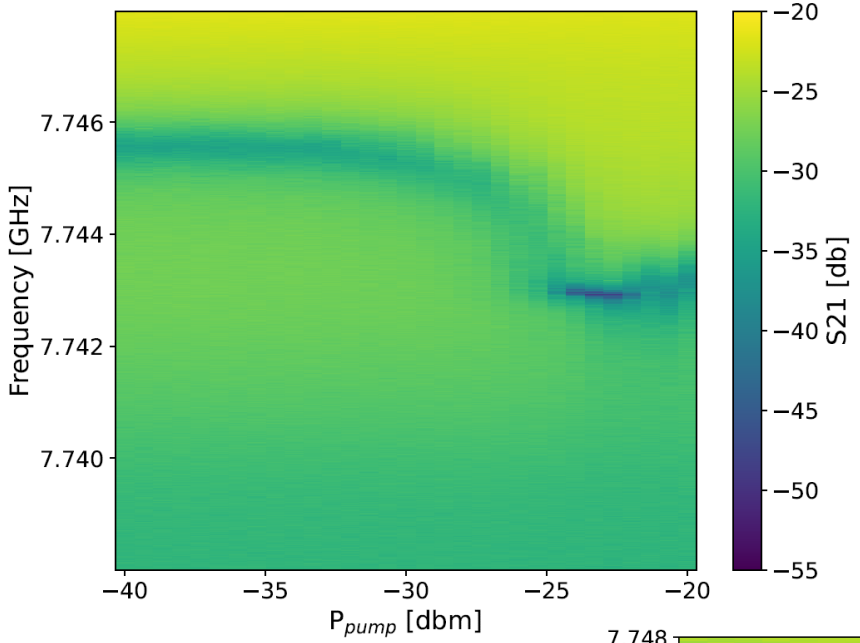
SUPERGALAX preliminary results

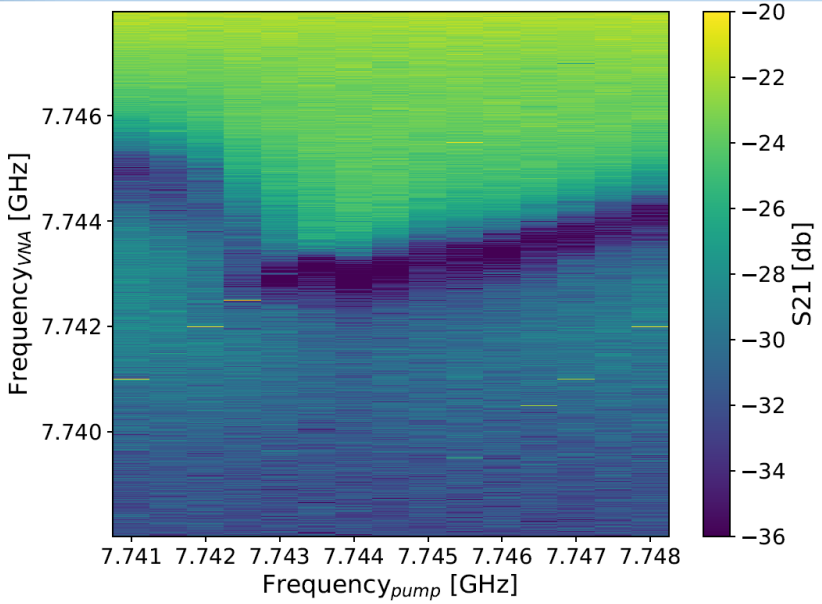


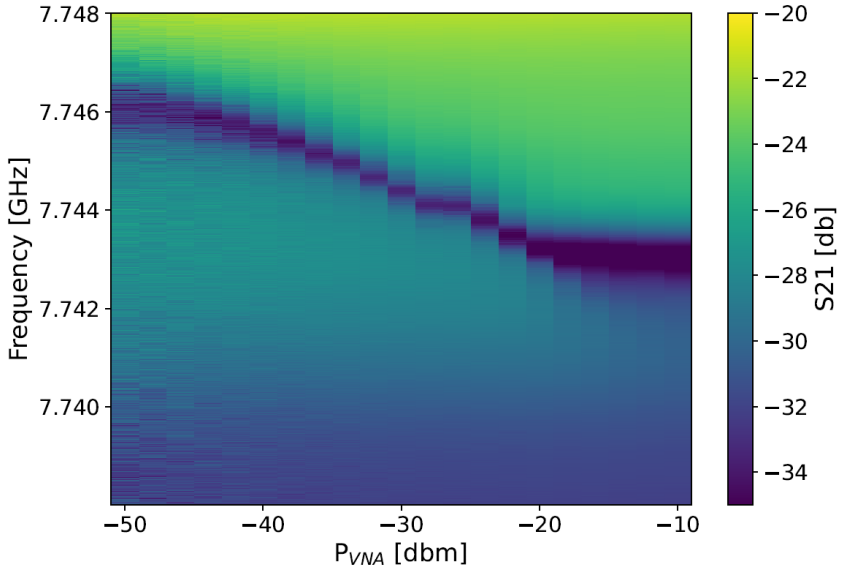


SUPERGALAX preliminary results









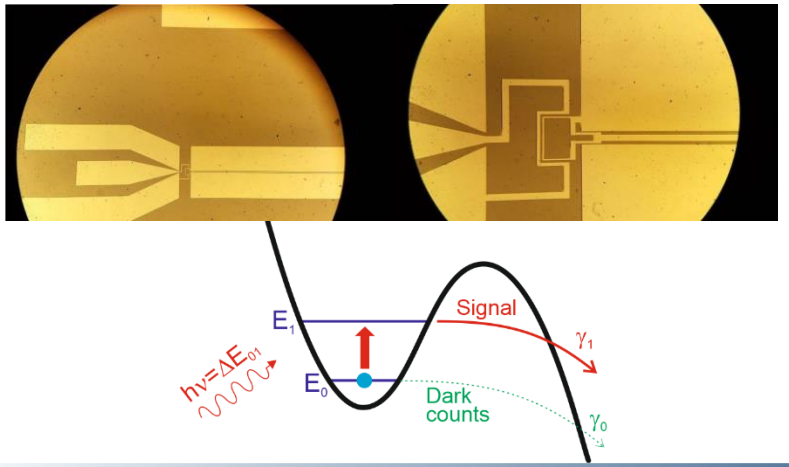
The transmission on the upper branch (S21) is modified of ~ 4 MHz when RF is injected in the R resonator

Conclusions and contacts

We demonstrated that the S_{21} of a transmission line is modulated up to ~ 4 MHz by pumping RF into a third line, coupled to a qubit array, and arranged in a «transistor-like» geometry.

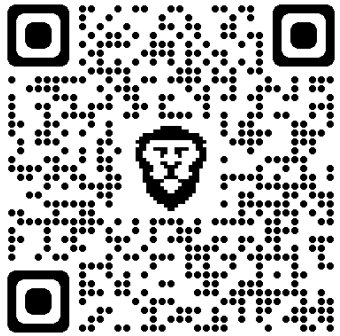
Work in progress

Single photon detector with one Josephson junction terminated on a transmission line



Magnetic field resistant Josephson junction using van der Waals materials

Contacts



Acknowledgment

THANK YOU FOR YOUR ATTENTION!