SELF-STABILIZATION OF MICROWAVE CURRENT IN A SUPERCONDUCTING RESONATOR FOR PHOTON DETECTION

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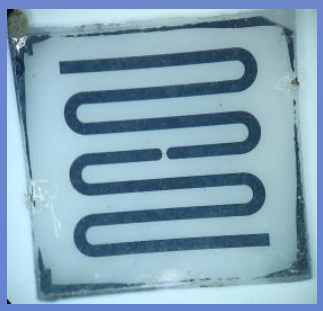
Types of Superconducting Photon Detectors

Feature	MKIDs	Bolometric Nanowire Detectors
Detection mechanism	Change in kinetic inductance	Destruction of superconductivity (hotspot)
Multiplexing	**Excellent (thousands pixels per line)**	Poor (individual readout per pixel)
Efficiency	Moderate	**Very high**
Time resolution	Microseconds	**Tens of picoseconds**
Energy resolution	Moderate	**High (in some variants)**
Scalability	**High**	Limited
Operating temperature	< 0.3 K	**< 4 K**

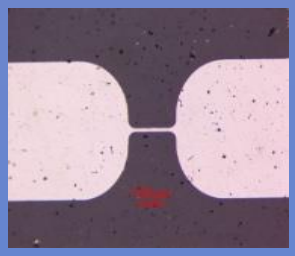
We propose combining the multiplexing capabilities of MKIDs with the high efficiency of bolometric nanowire detectors.

Nb microstrip superconducting resonator with constriction

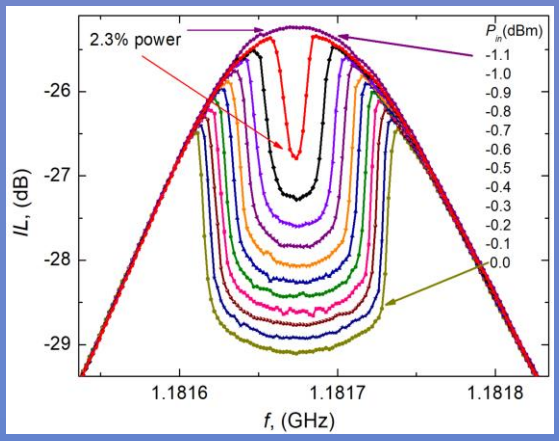
100 nm niobium films resonators on polycrystalline Al_2O_3 0.5 mm thick substrates. Resonators size is 8x8 mm and a wide line width 500μm. Constriction microstrip line length 140 μm and a width of 12 μm.



microstrip superconducting resonator

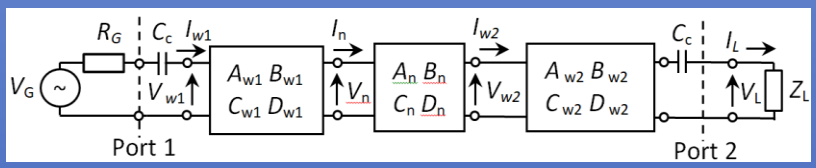


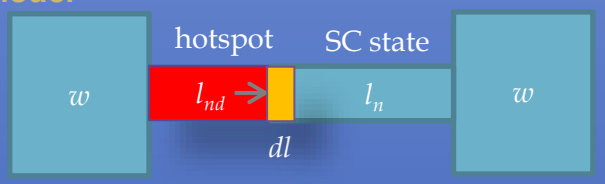
constriction



Nonlinear frequency response

ABCD Matrix Model





$$\begin{vmatrix} A & B \\ C & D \end{vmatrix} = \begin{vmatrix} A_c & B_c \\ C_c & D_c \end{vmatrix} \times \begin{vmatrix} A_{w1} & B_{w1} \\ C_{w1} & D_{w1} \end{vmatrix} \times \begin{vmatrix} A_n & B_n \\ C_n & D_n \end{vmatrix} \times \begin{vmatrix} A_{w2} & B_{w2} \\ C_{w2} & D_{w2} \end{vmatrix} \times \begin{vmatrix} A_c & B_c \\ C_c & D_c \end{vmatrix}$$

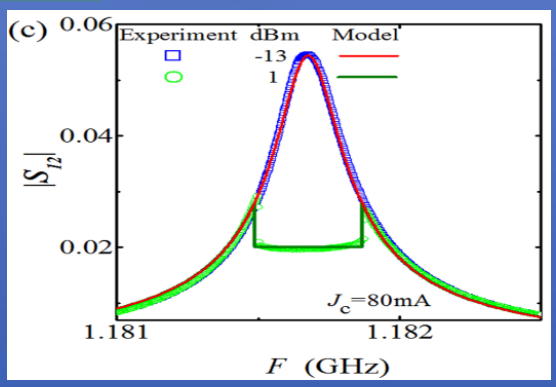
capacitive-wide line-constriction line-wide line-capacitive

Conditions:

1. A hotspot resistive domain appears when the microwave current density in constriction reaches the critical value: $J=J_c$.

2. The hotspot has a minimal size l_{min}.

3. The microwave current cannot exceed the critical value. Any attempt to increase it further expands the domain size, maintaining $J=J_c$.



The possibility of creating a hotspot in the constriction of a superconducting microstrip resonator by adjusting the amplitude of the microwave current has been demonstrated. A self-regulation effect of the hotspot size has been observed in the constriction, ensuring that the microwave current does not exceed its critical value.

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