Tailoring Josephson coupling through superconductivity induced non-equilibrium

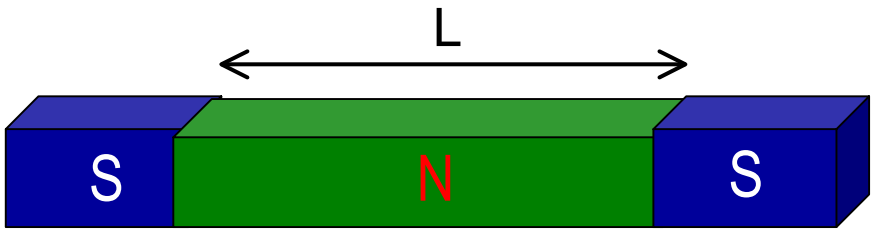
Low Temperature Laboratory, HUT, Finland
A. M. Savin, J. P. Pekola, T. T. Heikkilä, A. Anthore, J. T. Flyktman

NEST-INFM & SNS, Italy
F. Giazotto

Some experiments [1] have proved that electrons in mesoscopic devices can be cooled down to lower temperature than the bath phonon temperature by "evaporation" of hot electrons from the normal part of an SIN junction. Using this controllable temperature opens ways to design new devices. I will present the results of experiments in which the supercurrent intensity in a long Josephson weak link is controlled using an SINIS junction. The obtained situation is richer than the simple consequence of cooling down electrons since out-of-equilibrium distribution functions of electrons should also be achieved [2] and lead to a Pi-state of the Josephson weak link.

[1] M. Nahum, T. M. Eiles, and J. M. Martinis, Appl. Phys. Lett. 65, 3123 (1994).
[2] cond-mat/0312401, to appear in Phys. Rev. Lett.

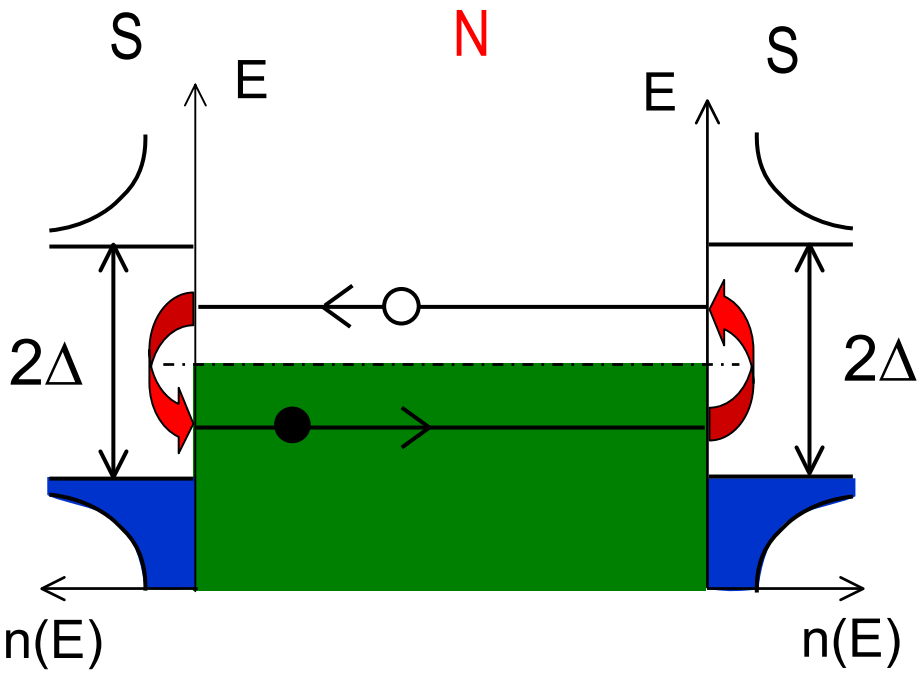
SNS junction and supercurrent



Thouless energy:

$$\varepsilon_C = \frac{\hbar D}{L^2}$$

Coherent Andreev reflections $\Rightarrow$ supercurrent



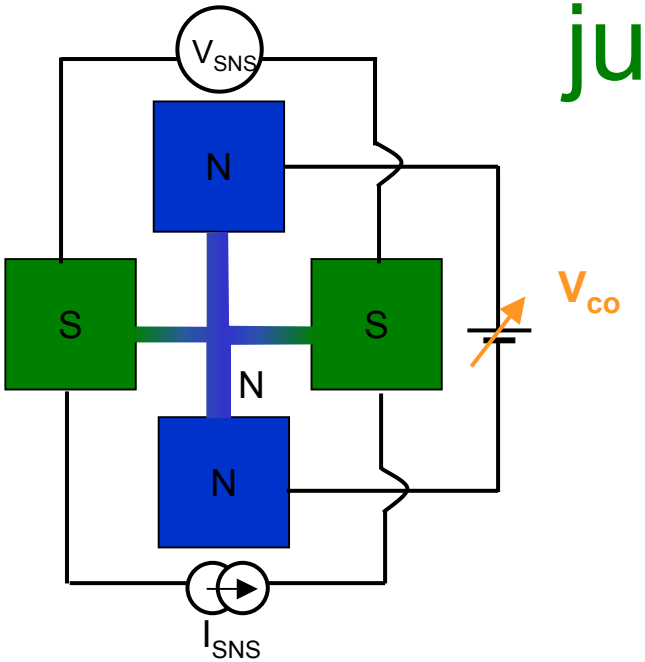
Critical current I_c :

$$\frac{\Delta}{\varepsilon_C} = \infty$$

$$\frac{e R_n I_c}{\varepsilon_c} = 10.8$$

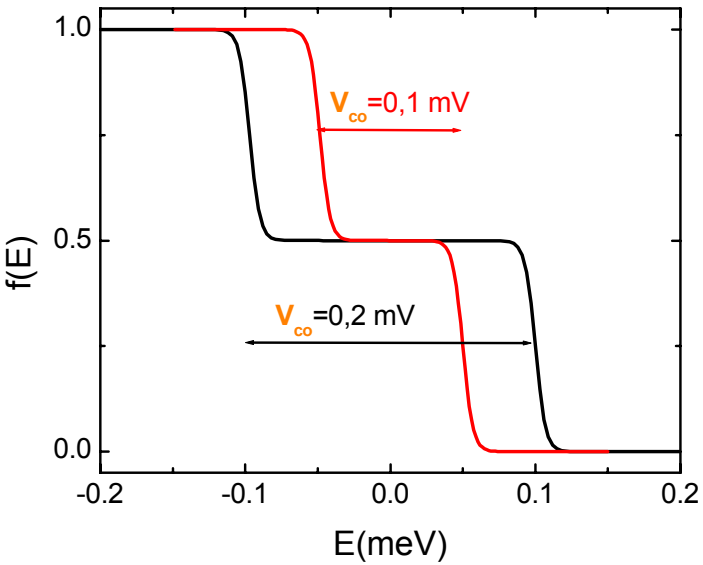
P.Dubos et al., PRB 63, 064502

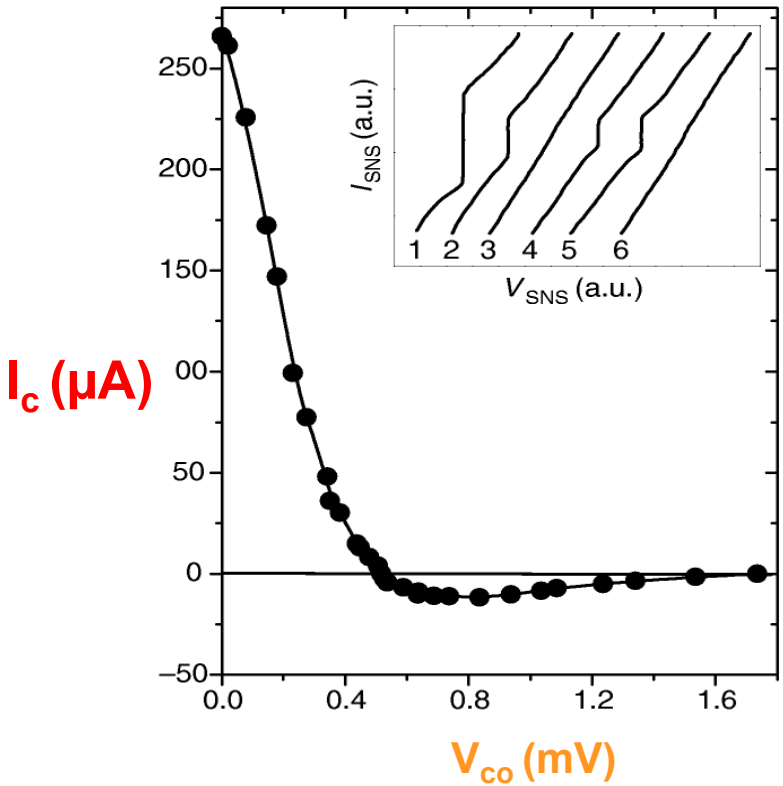
Control of supercurrent in SNS junction (1)



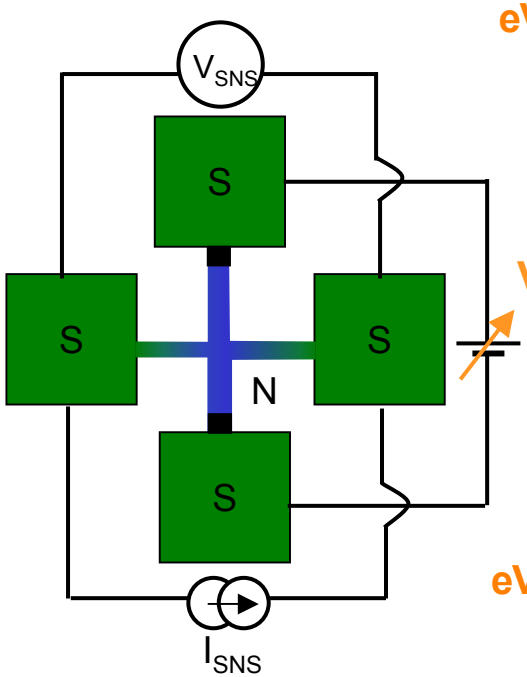
J.J.A. Baselmans *et al.*, Nature 397, 43 (1999).

$$I_J = (1/eR_n)\int (f(-E)-f(E))j_s(E,\varphi)dE$$

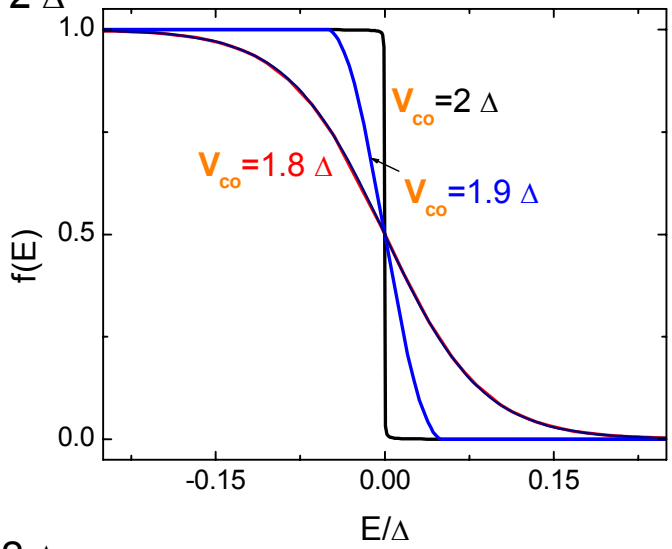




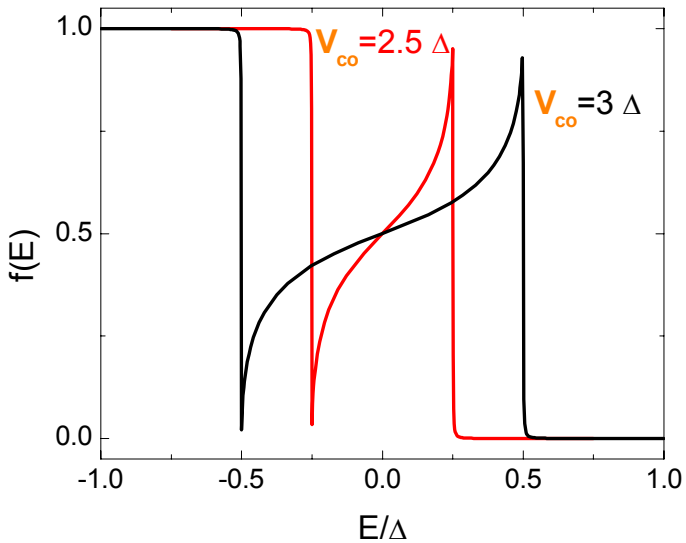
Control of supercurrent in SNS junction (2) : Josephson transistor



$eV_{co} < 2\Delta$

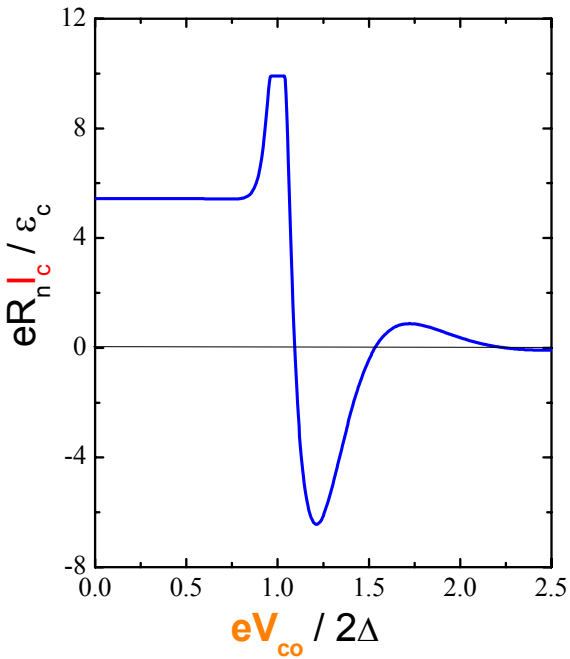


$eV_{co} > 2\Delta$



T_{bath}= 100 mK

$\Delta/\varepsilon_c = 20$



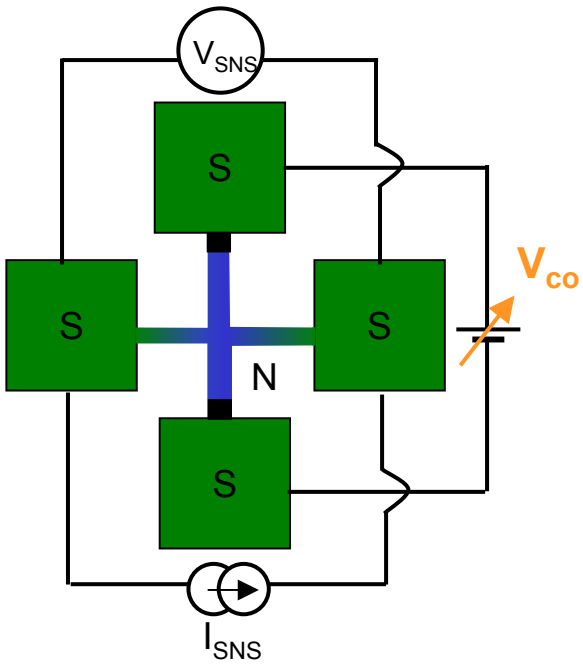
Suggestion and theoretical analysis:

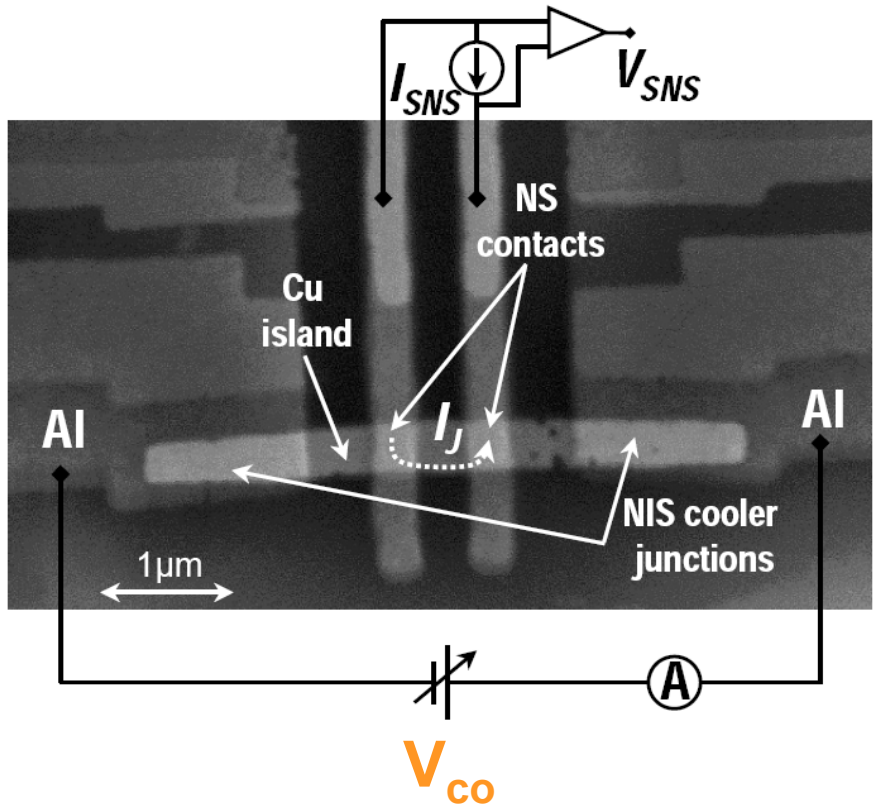
-J. Baselmans, Ph.D. thesis, Univ. of Groningem

-F. Giazotto et al. Appl. Phys. Lett. 83 (2003) 2877.

- F. Giazotto et al., **cond-mat/031138**

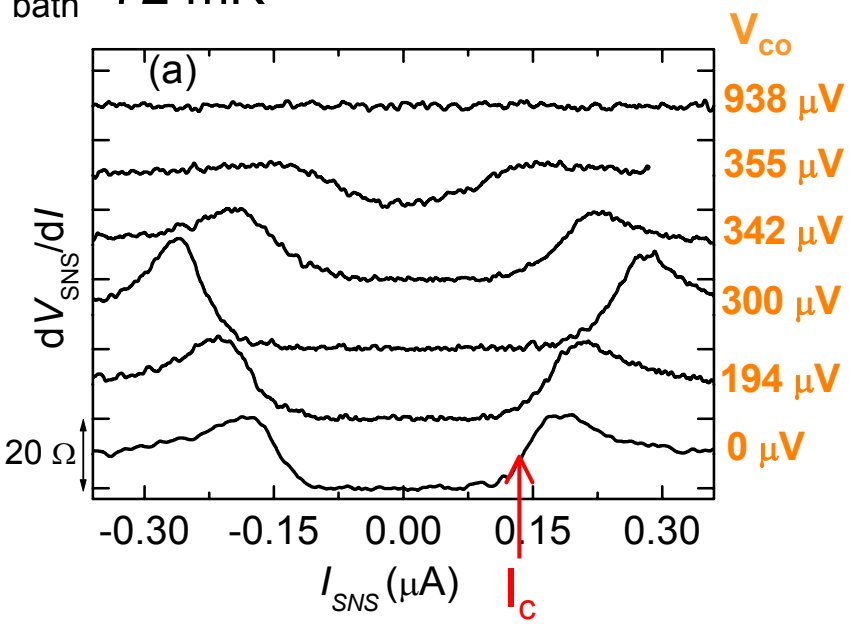
Experimental realization of the Josephson transistor

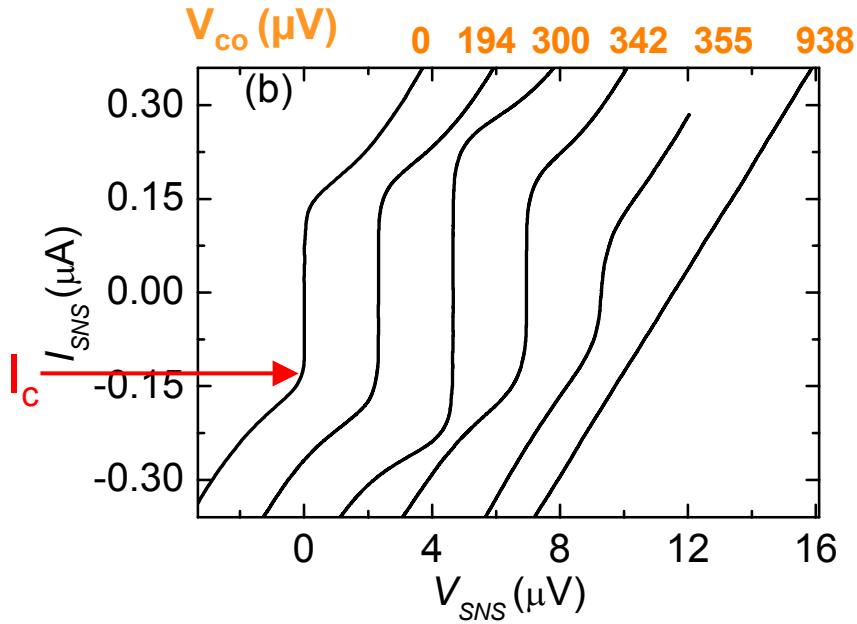


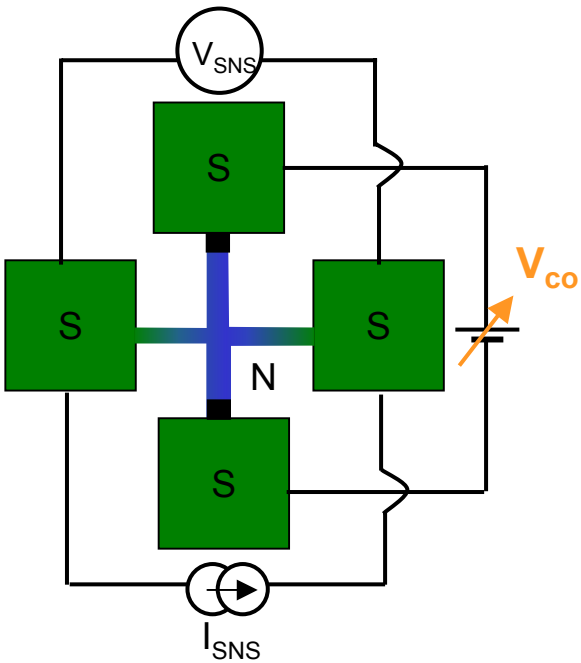


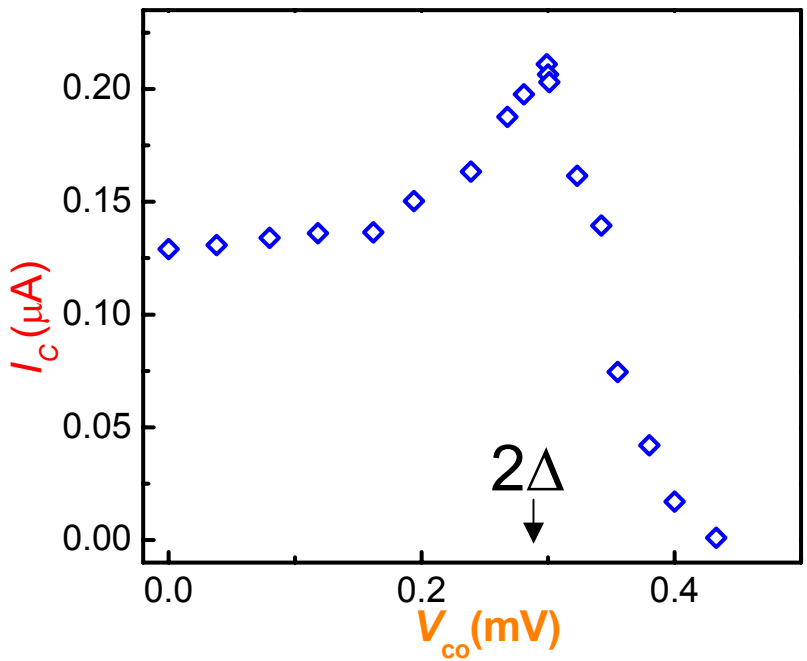
Measurements

T_{bath}=72 mK



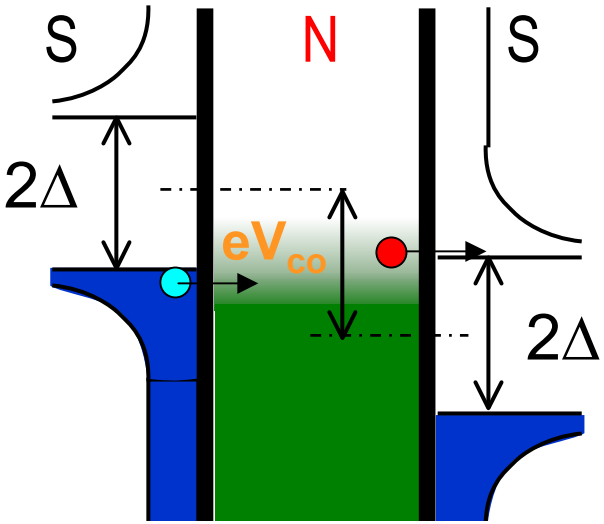




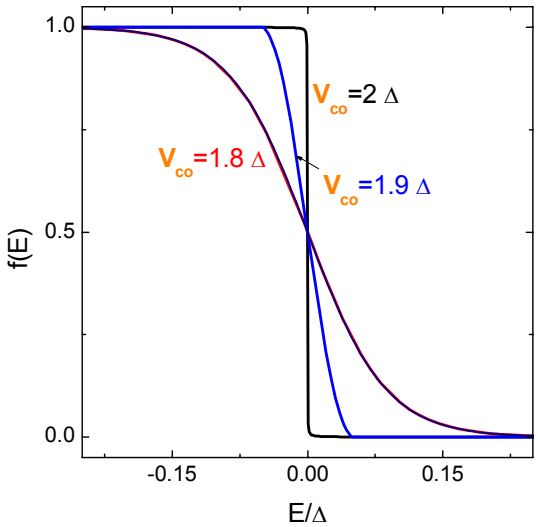


Electronic cooling and heating

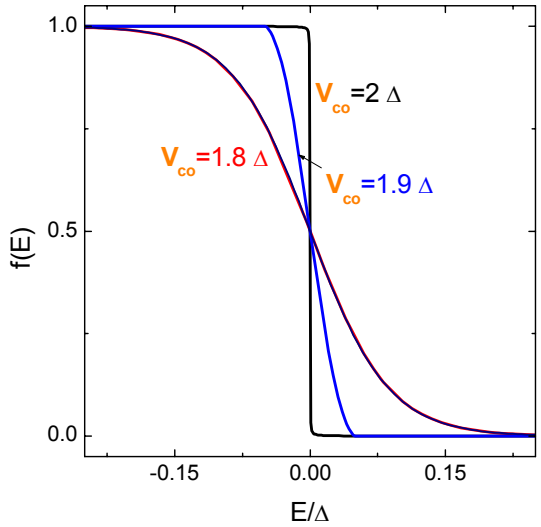
$eV_{co} < 2\Delta$



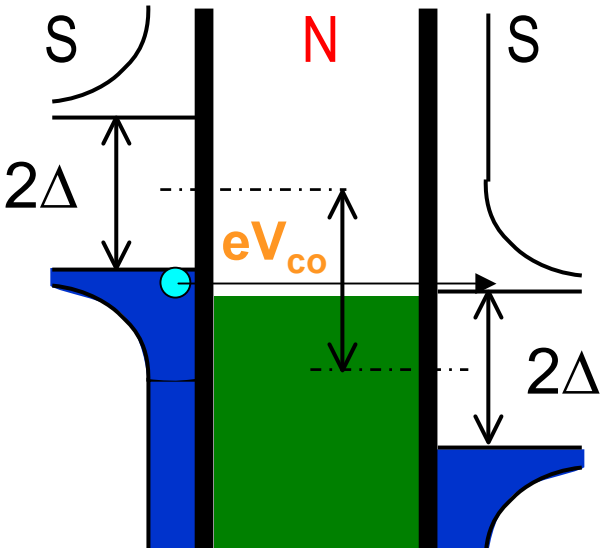
no interactions in N

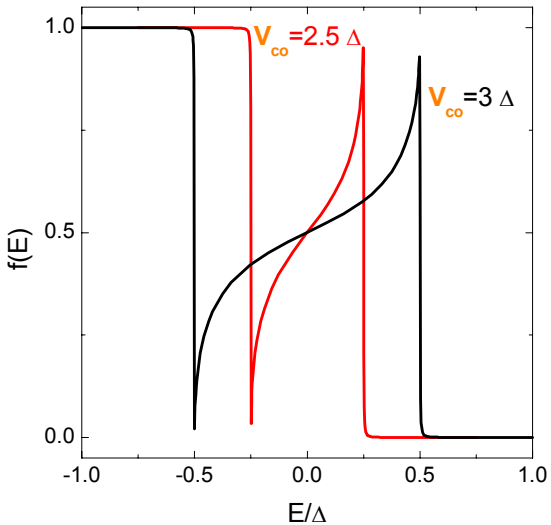


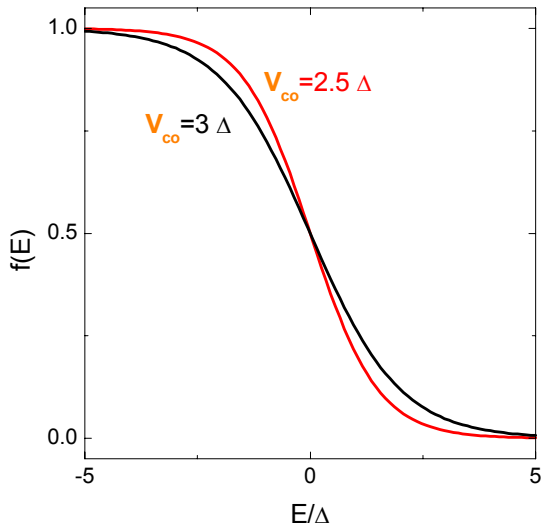
strong interactions in N



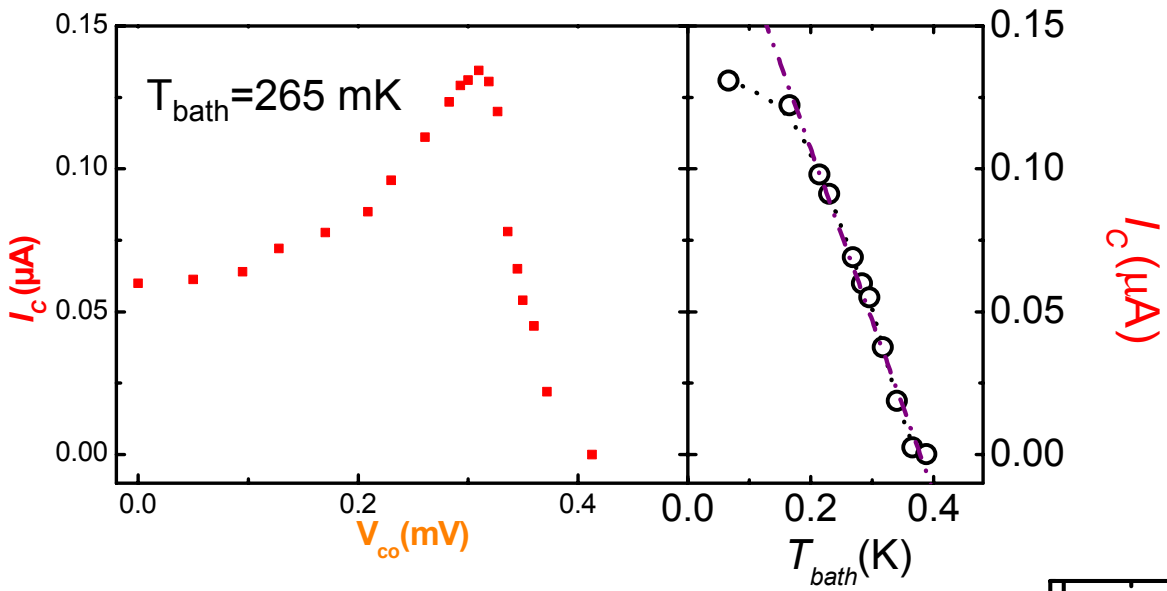
$eV_{co} > 2\Delta$



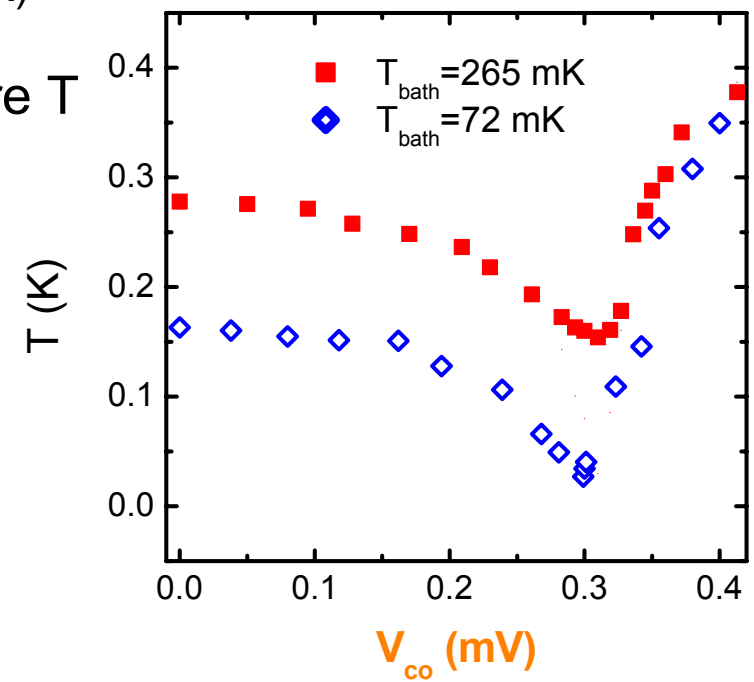




Measurement interpretation

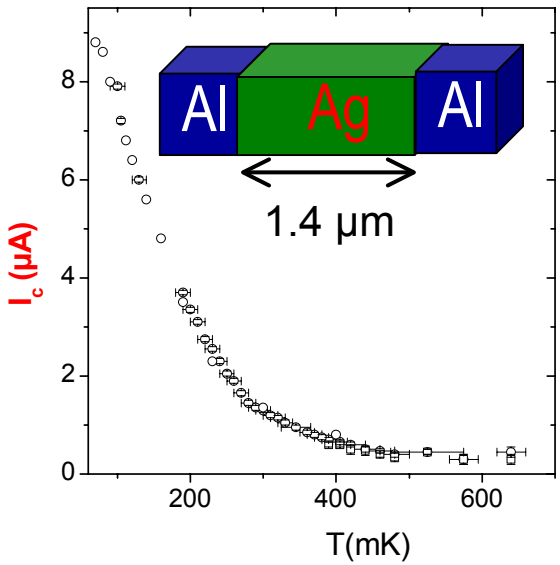


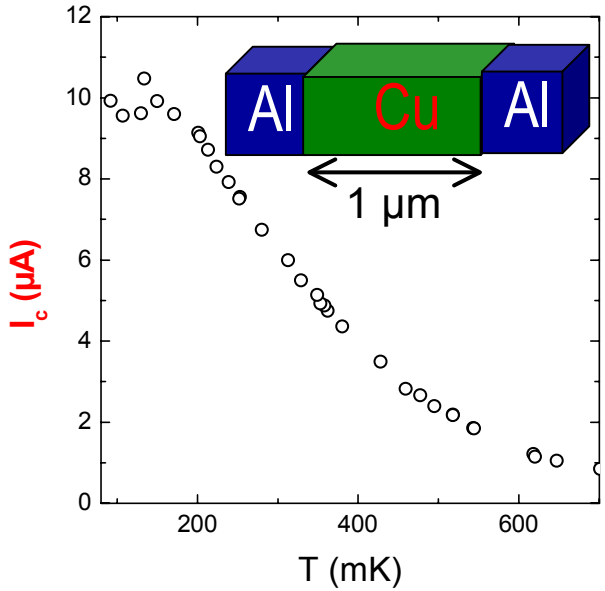
Measurement of the electronic temperature T



Perspective

- Device with higher value of supercurrent





- Less electronic interaction in the normal part to look at out-of equilibrium effects

- Optimization of SINIS parameters

- Effect of the temperature of the superconductors