Development of CPP devices : tunnel structures

(from February -> now)

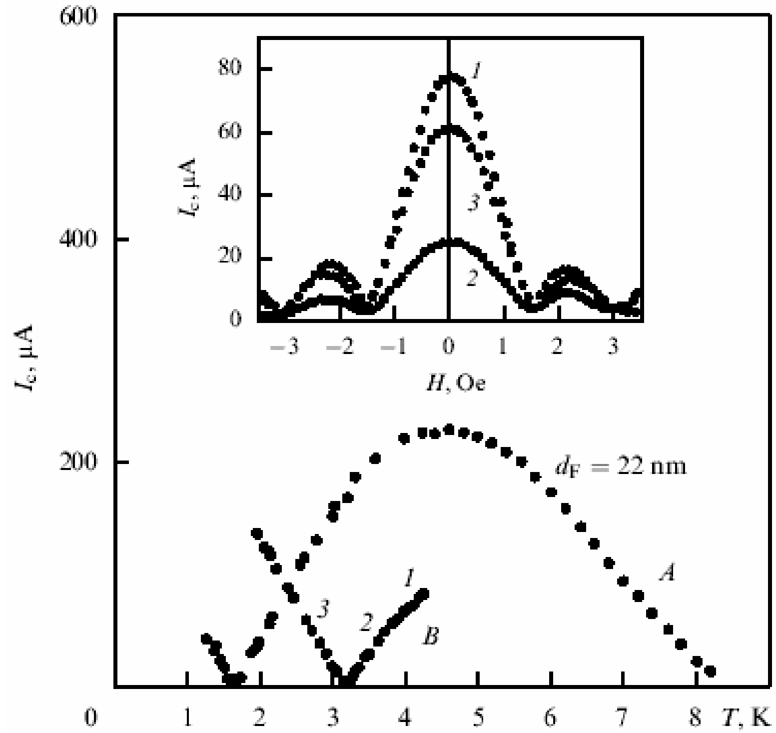
chris *et al*

Motivation

CPP junctions:

Josephson junctions with F barriers: π-junctions

Crossover from 0-π state as a function of T



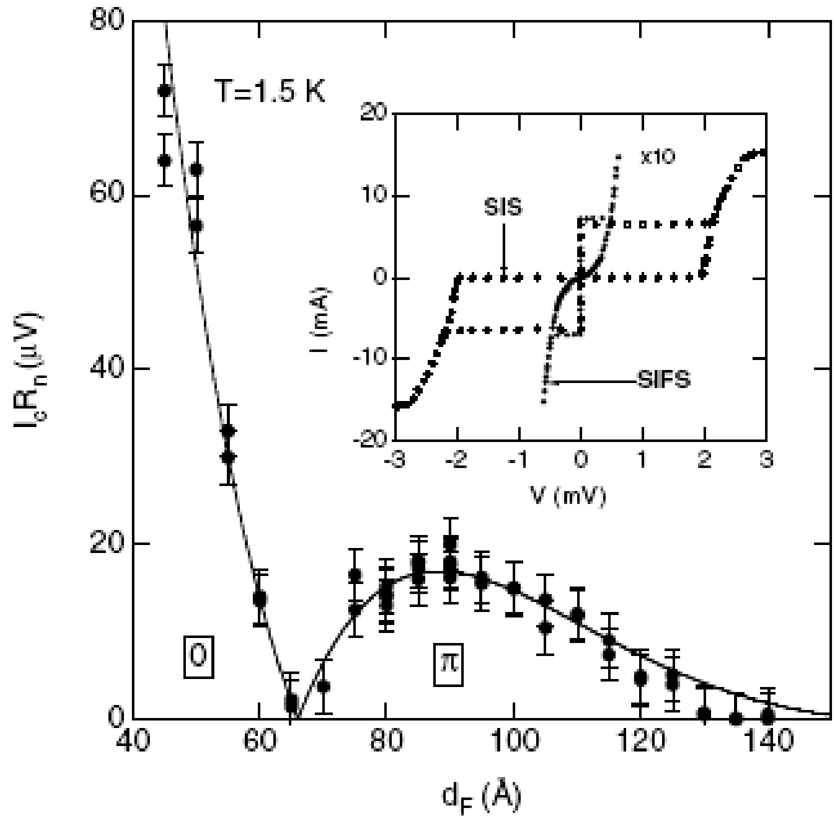
Ryazanov et al : S/F/S: Nb/CuNi/Nb, 50 X 50 μm^2 junctions

$R_N \sim 10^{-5}\ \Omega$ giving $I_C R_N \sim 1$ nV for sensible critical currents

Not easy to measure! (need SQUID picovoltmeter)

Motivation

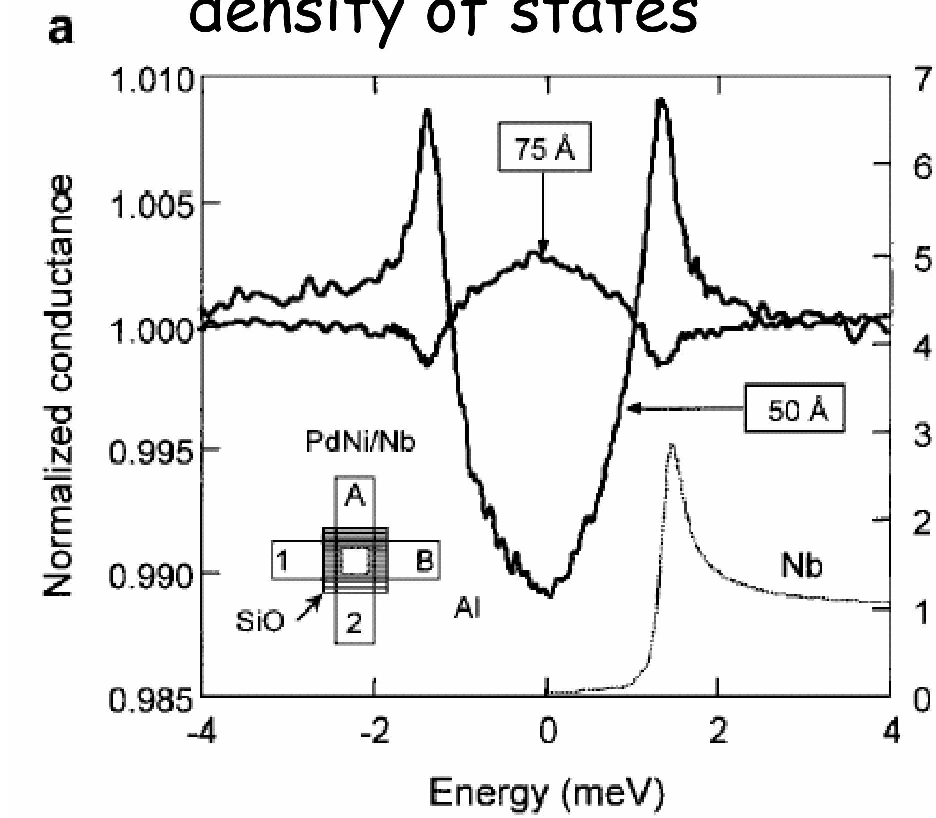
Either: make the devices smaller to raise R_N, (and use thinner barriers to keep I_C high)
Or: add an I layer



Nb/PdNi/AlO$_x$/Nb junctions
0-π crossover vs F thickness

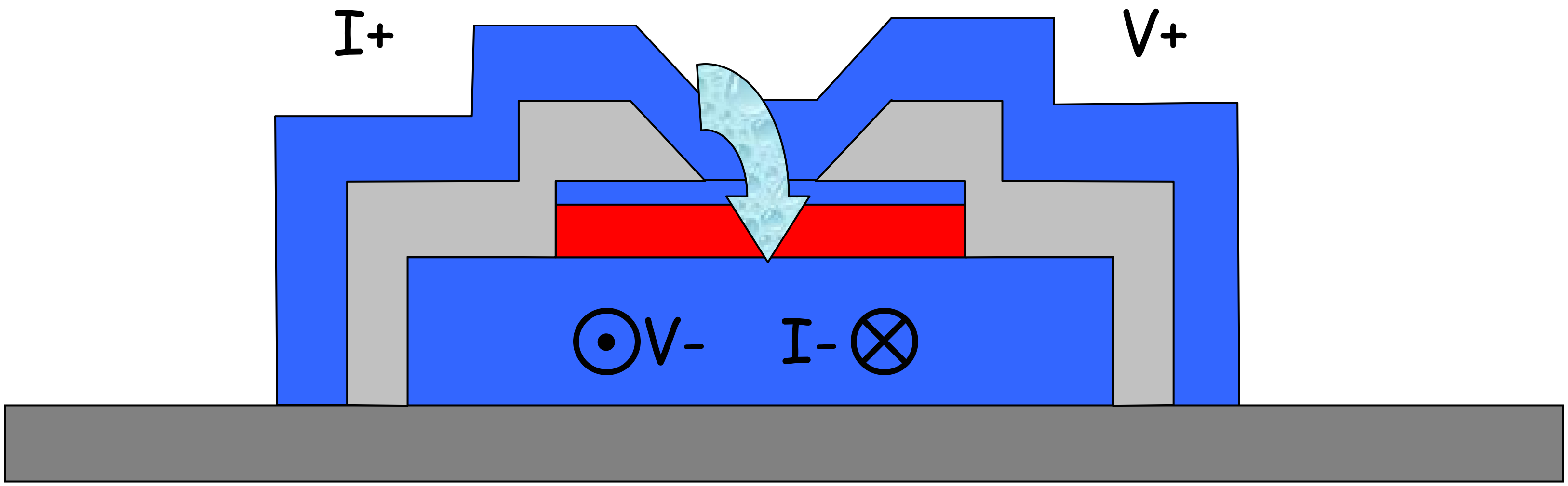
ALSO: S/F/I/N

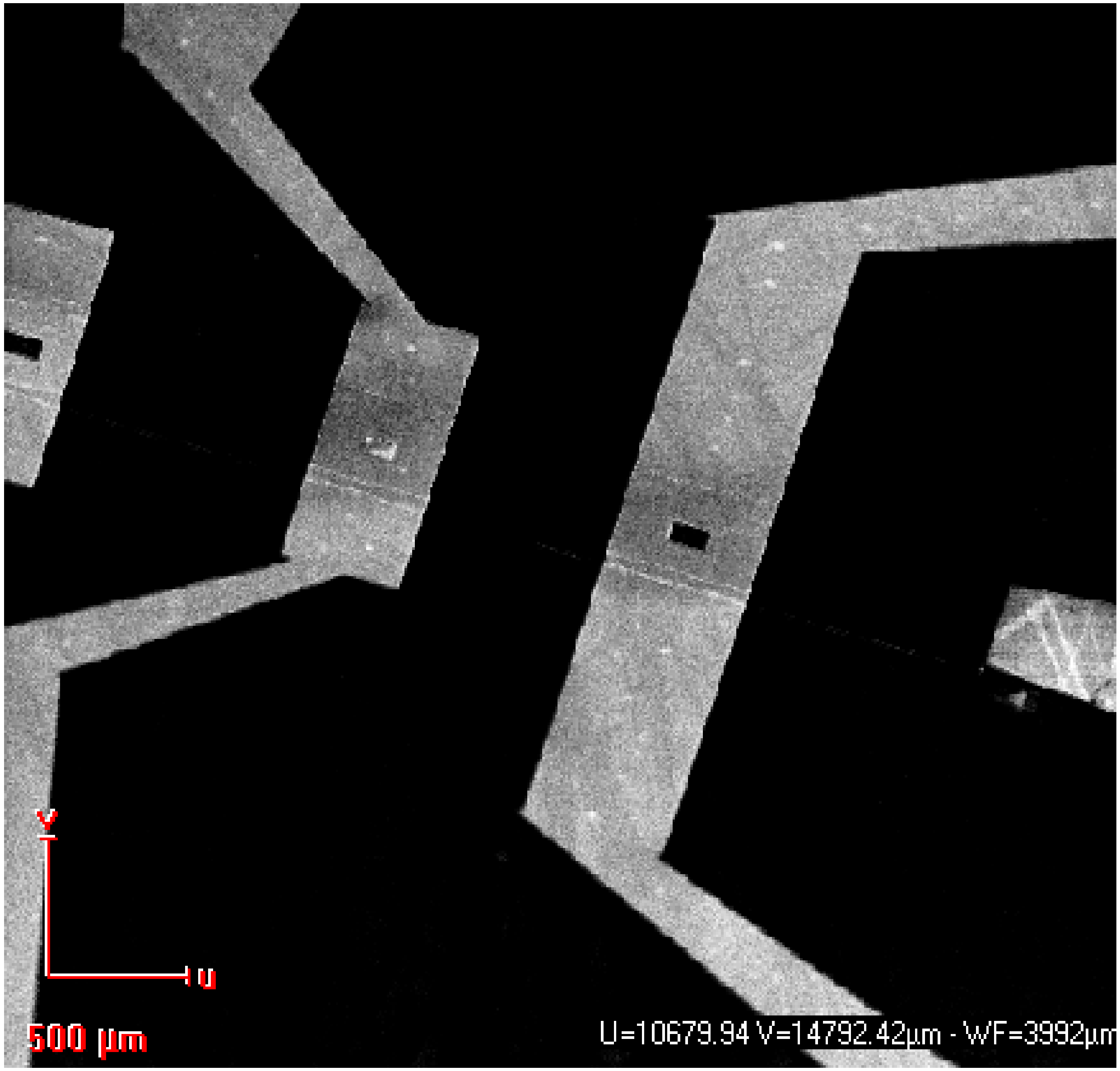
Now you measure the (inversion) of the density of states



Kontos et al

Mesa structure

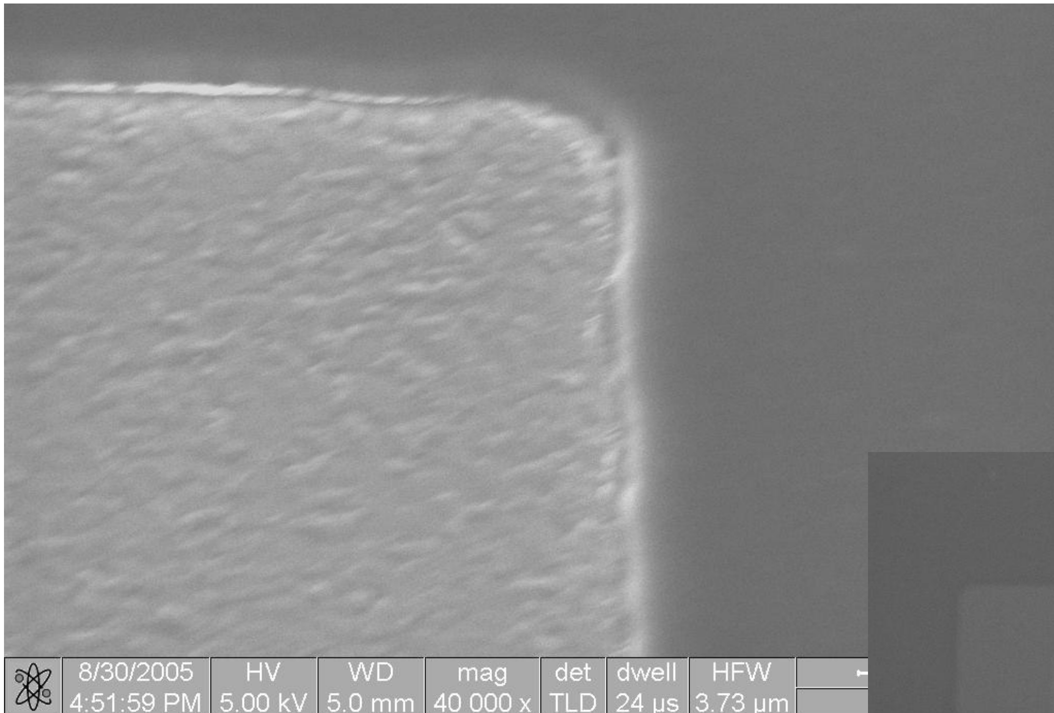


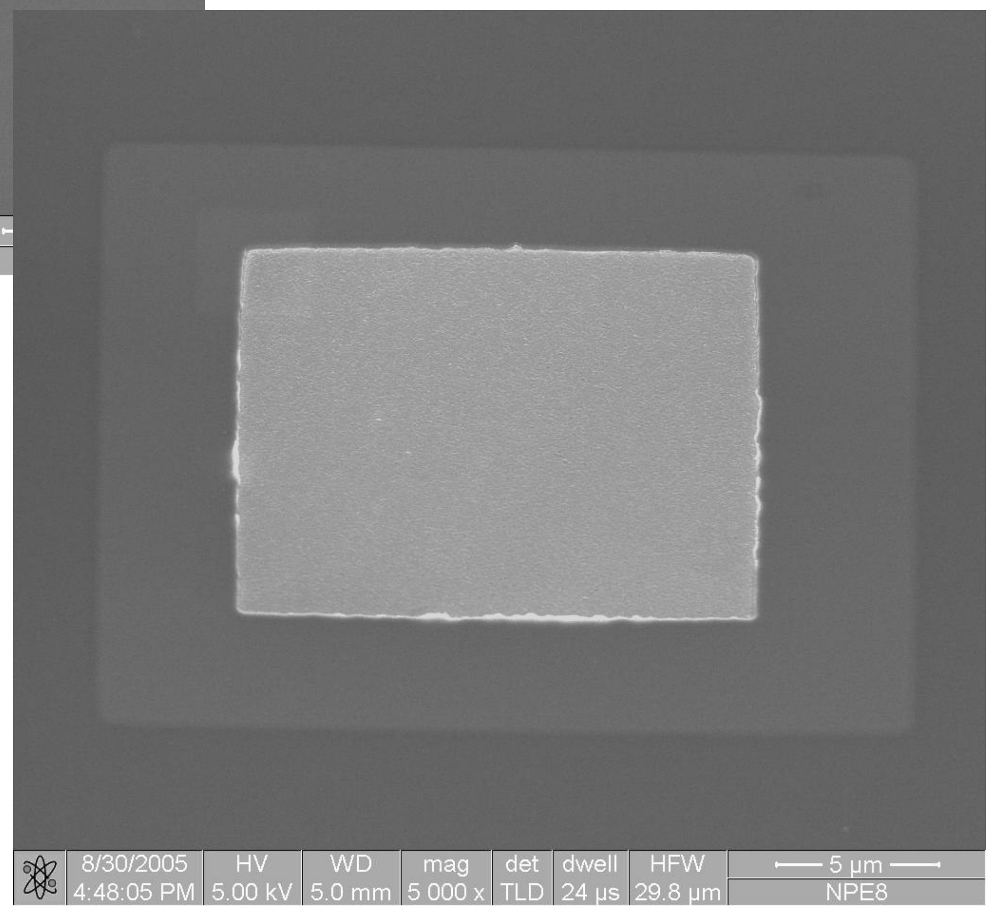


Charging means that the lift-off of the SiO layer was not done properly: PMMA
Remains above the mesa which means you can’t make a good contact

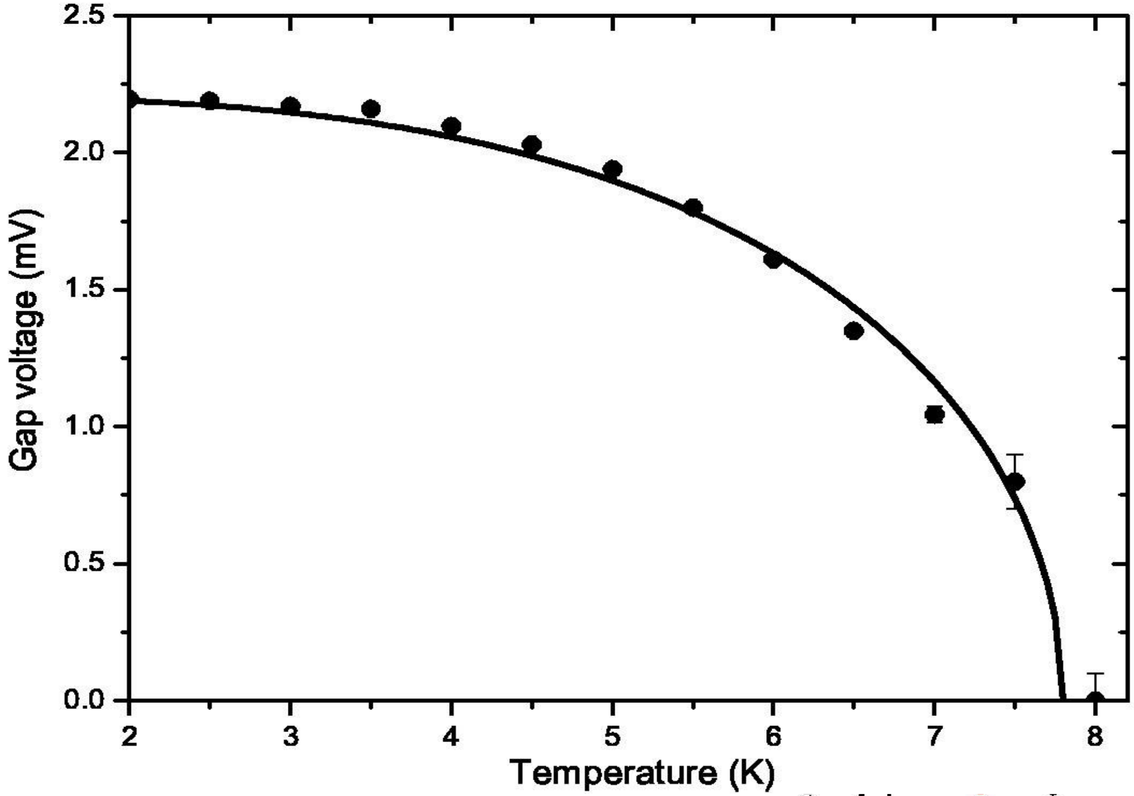
Better this time after ultrasounding thoroughly.

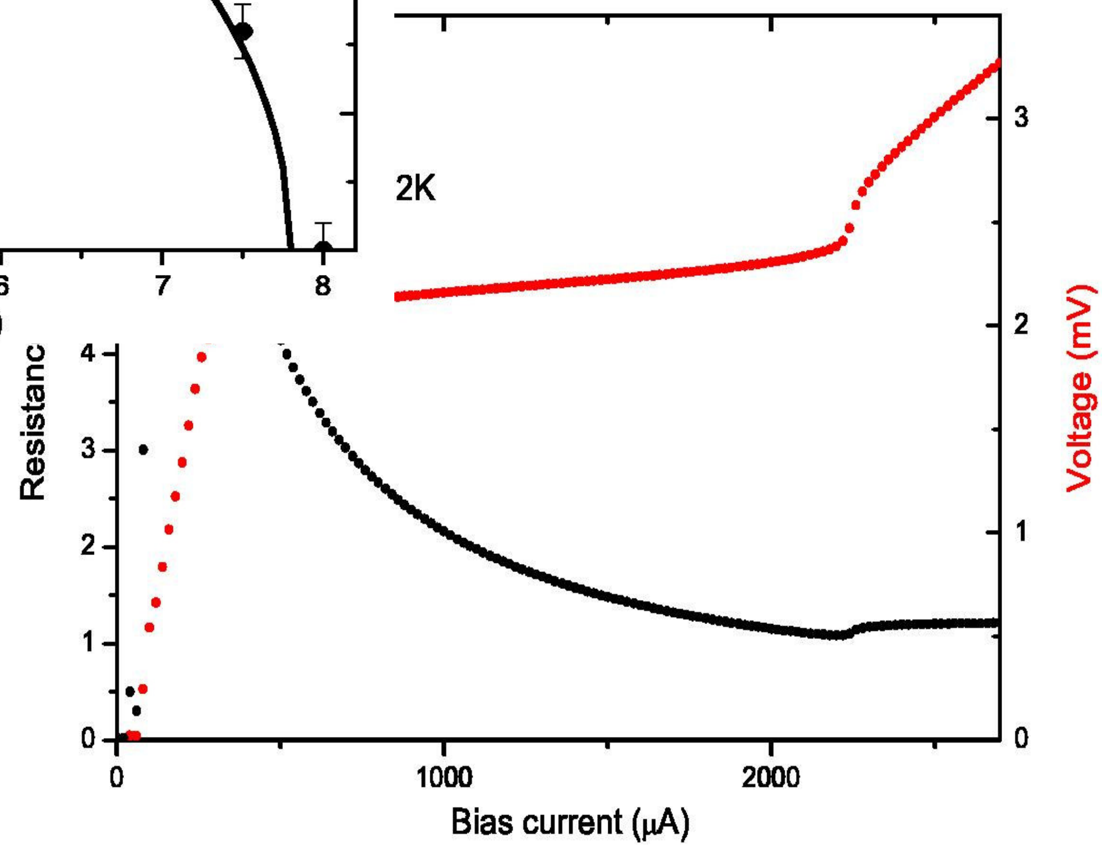
Left image tilted: no ears: smooth slope from SiO to Nb



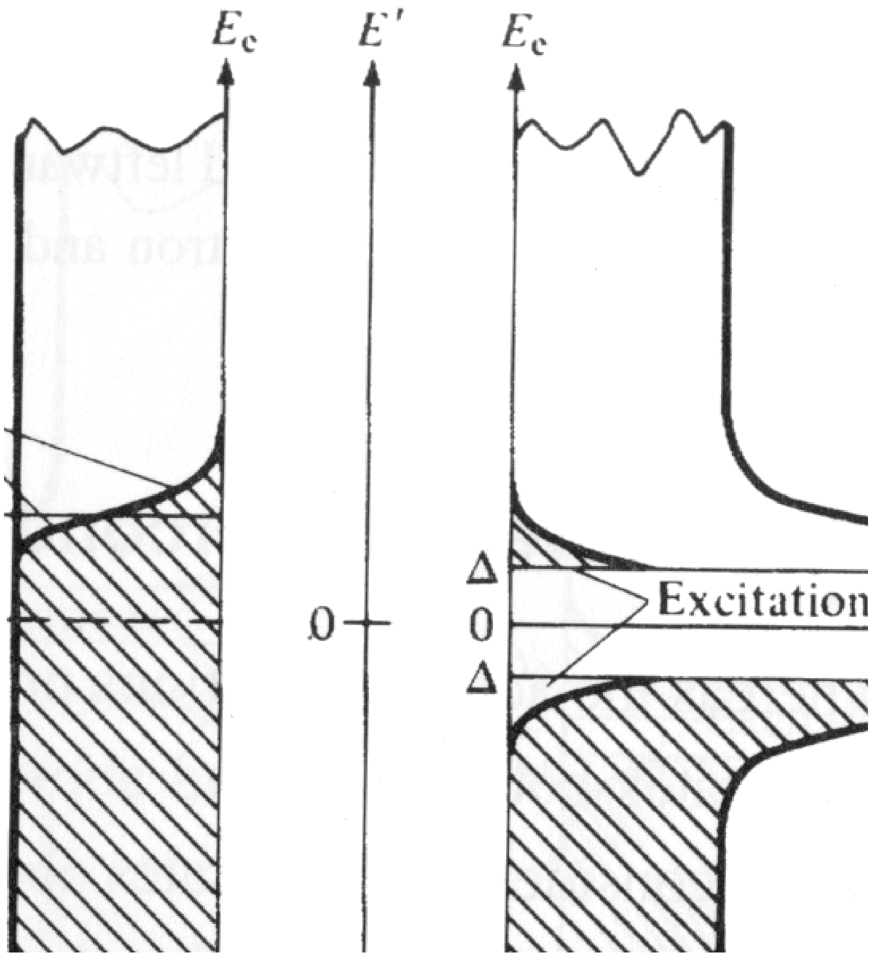


First tests : S/I/S

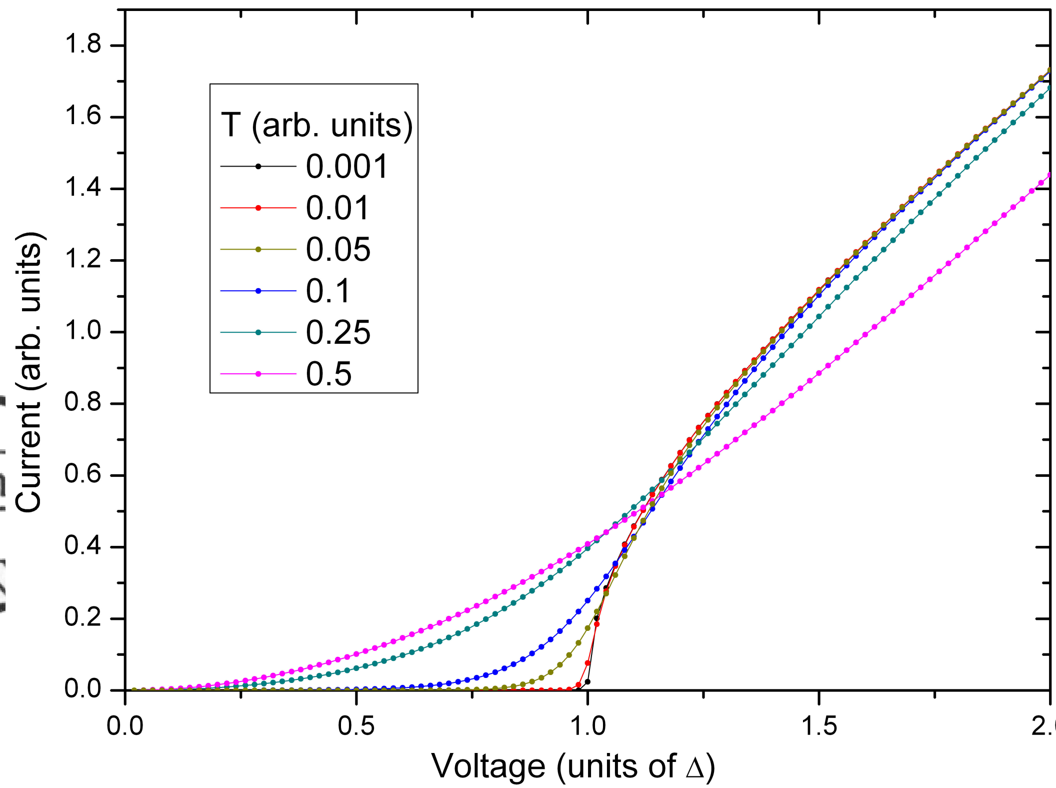




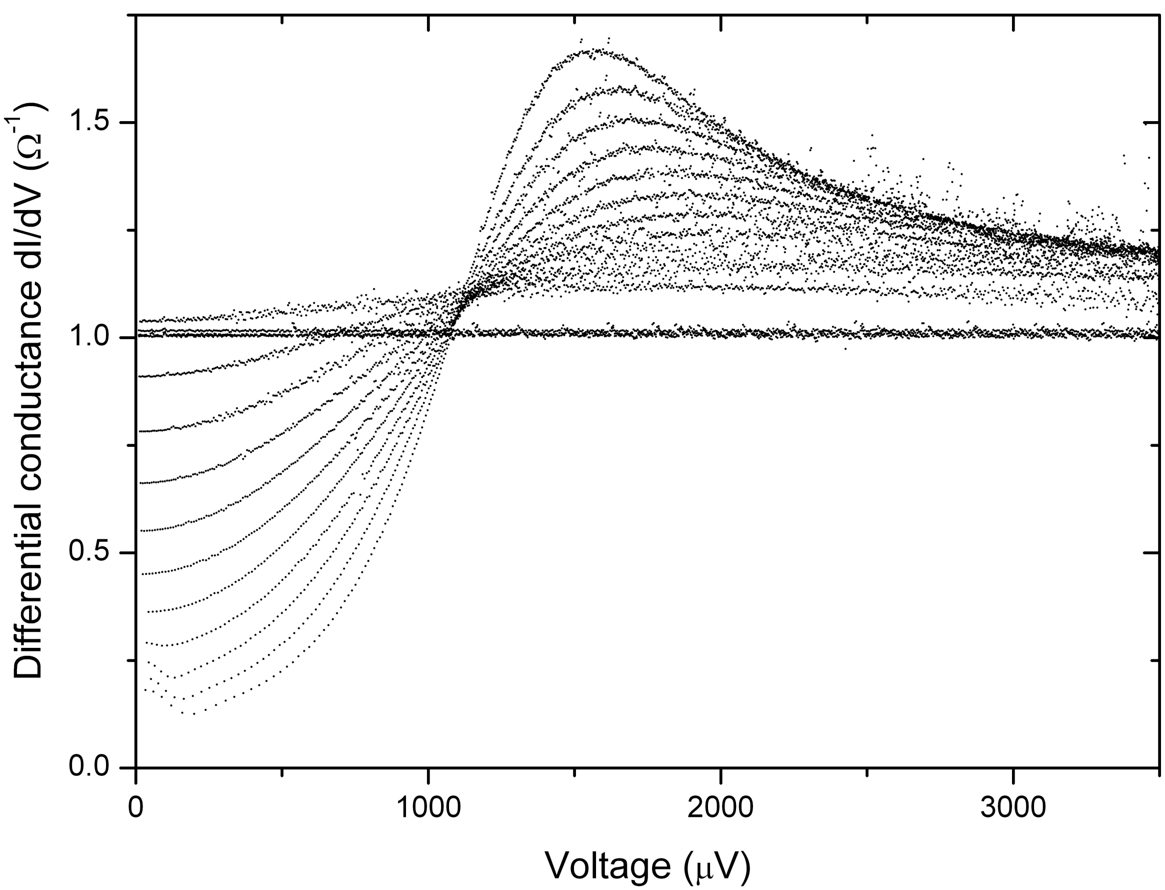
S/I/N



E_e
E'
E_e
0
Δ
0
Δ
Excitation

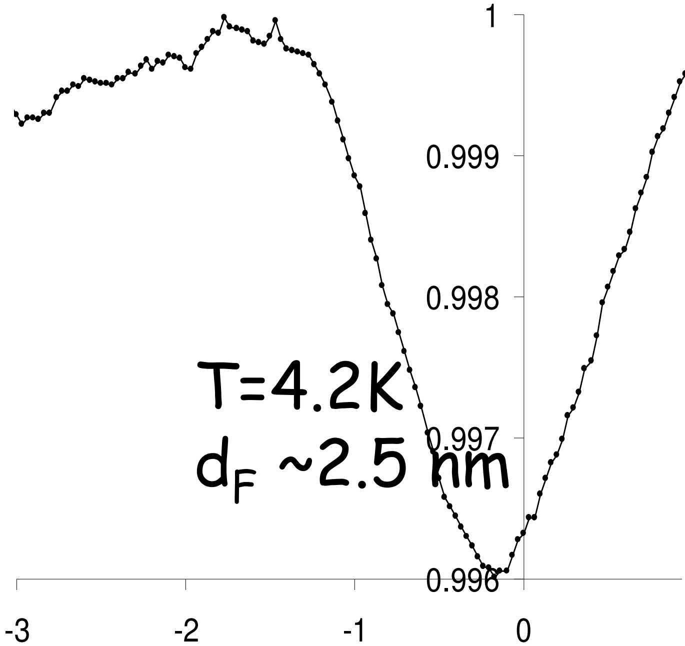


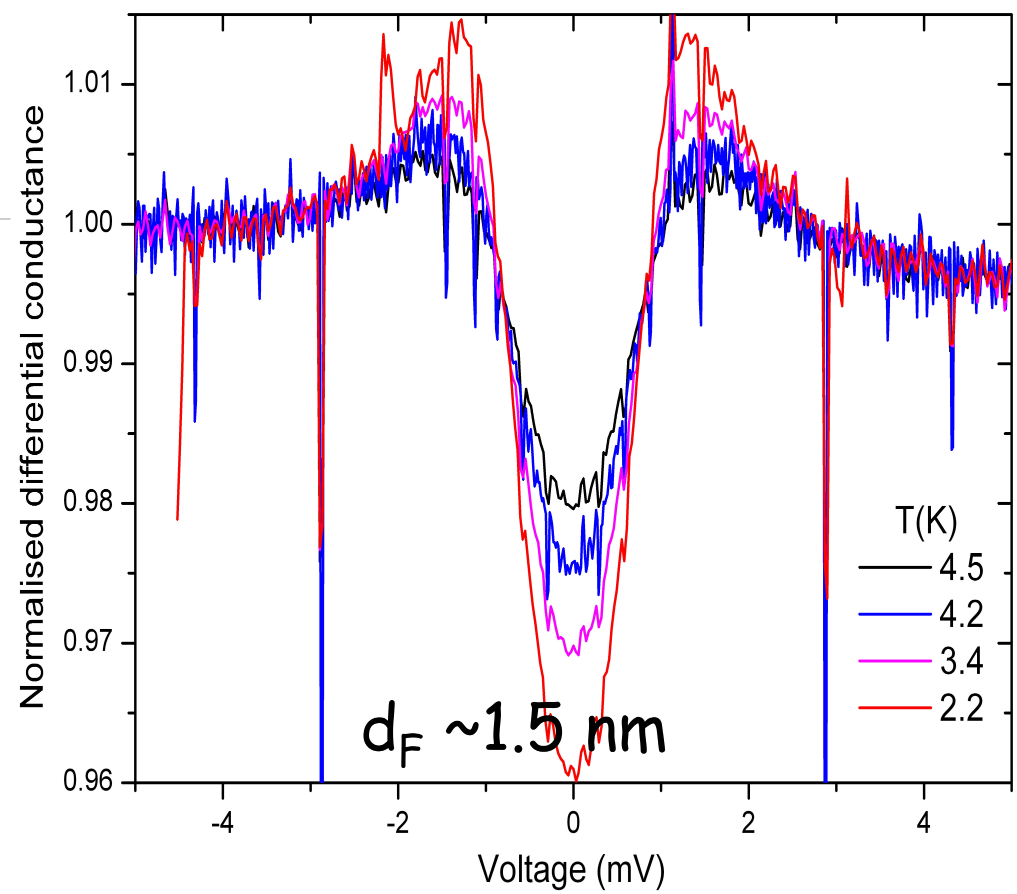
T (arb. units)
0.001
0.01
0.05
0.1
0.25
0.5
Current (arb. units)
Voltage (units of Δ)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
0.0
0.5
1.0
1.5



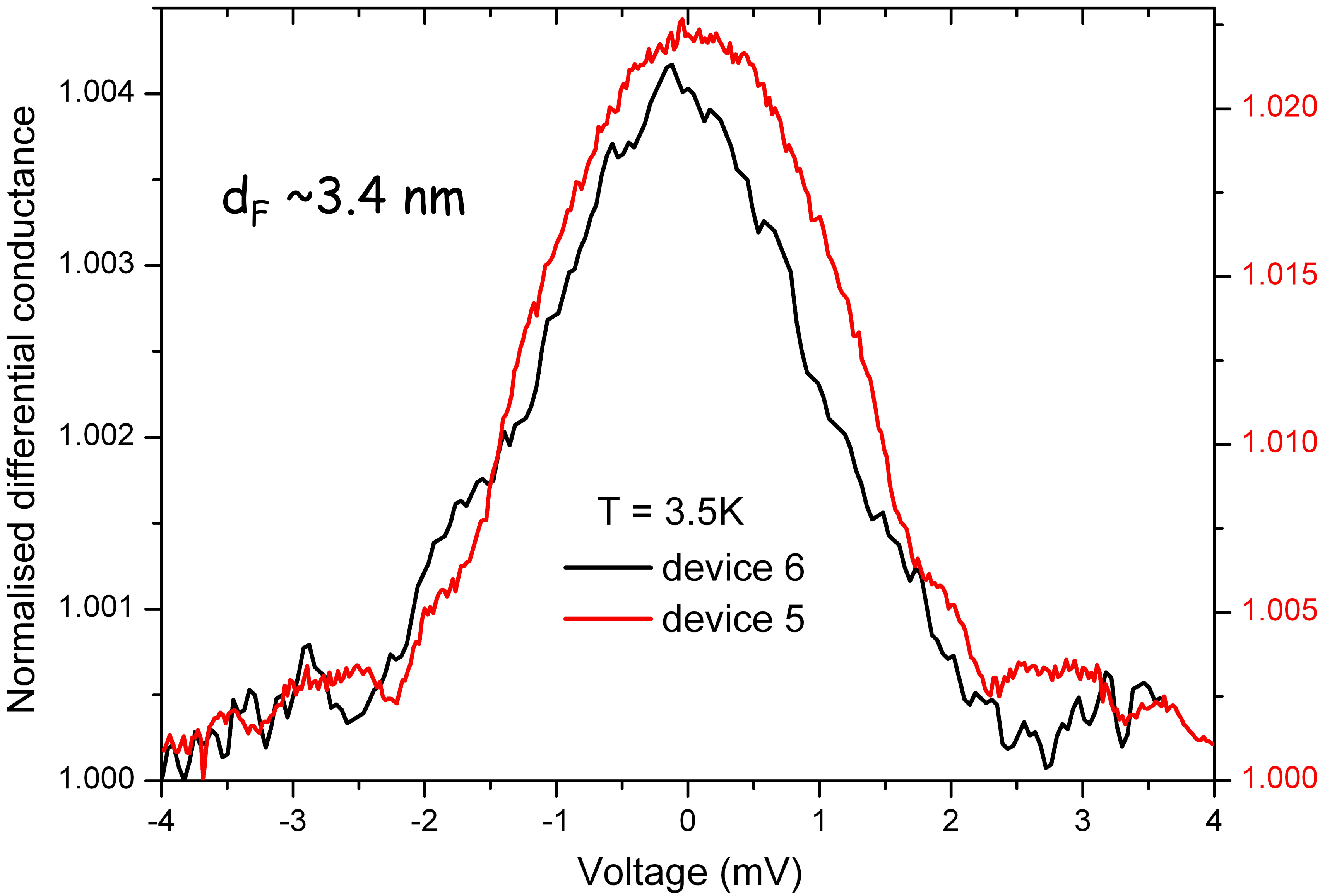
Differential conductance dI/dV (Ω⁻¹)
0.0
0.5
1.0
1.5
0
1000
2000
3000
Voltage (μV)

S/F/I/N





Signals very small, so need a lockin amplifier to measure diff. resistance directly (top)



Same chip – big difference in size of conductance change.
Is the inverted DoS real??

Future: experiments

- Get better processing!!
- For thickness with N(0) ~ 0 see if we can see 0-π crossover with T
- Try same things with Py instead of PdNi (show that strong F can make π junctions, and see what happens with domains: field tune a crossover??) & Josephson junctions
- Replace everything by amorphous things: MoGe / GdNi
- Follow up with STM if possible