DARTWARS

Detector Array Readout with Traveling Wave AmplifieRS

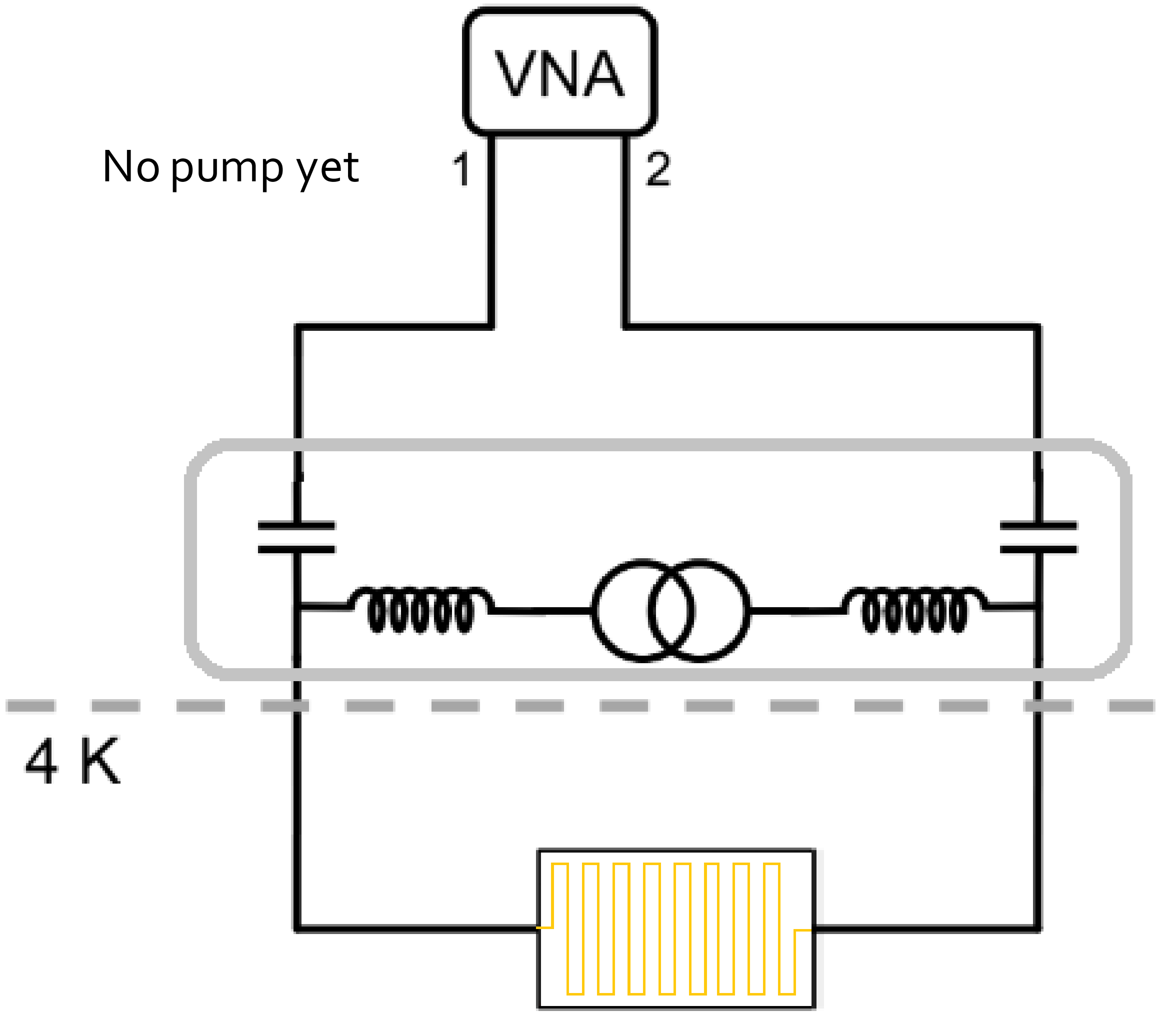
Update report on experimental activity in Milano-Bicocca

by Andrea Celotto

a.celotto1@campus.unimib.it

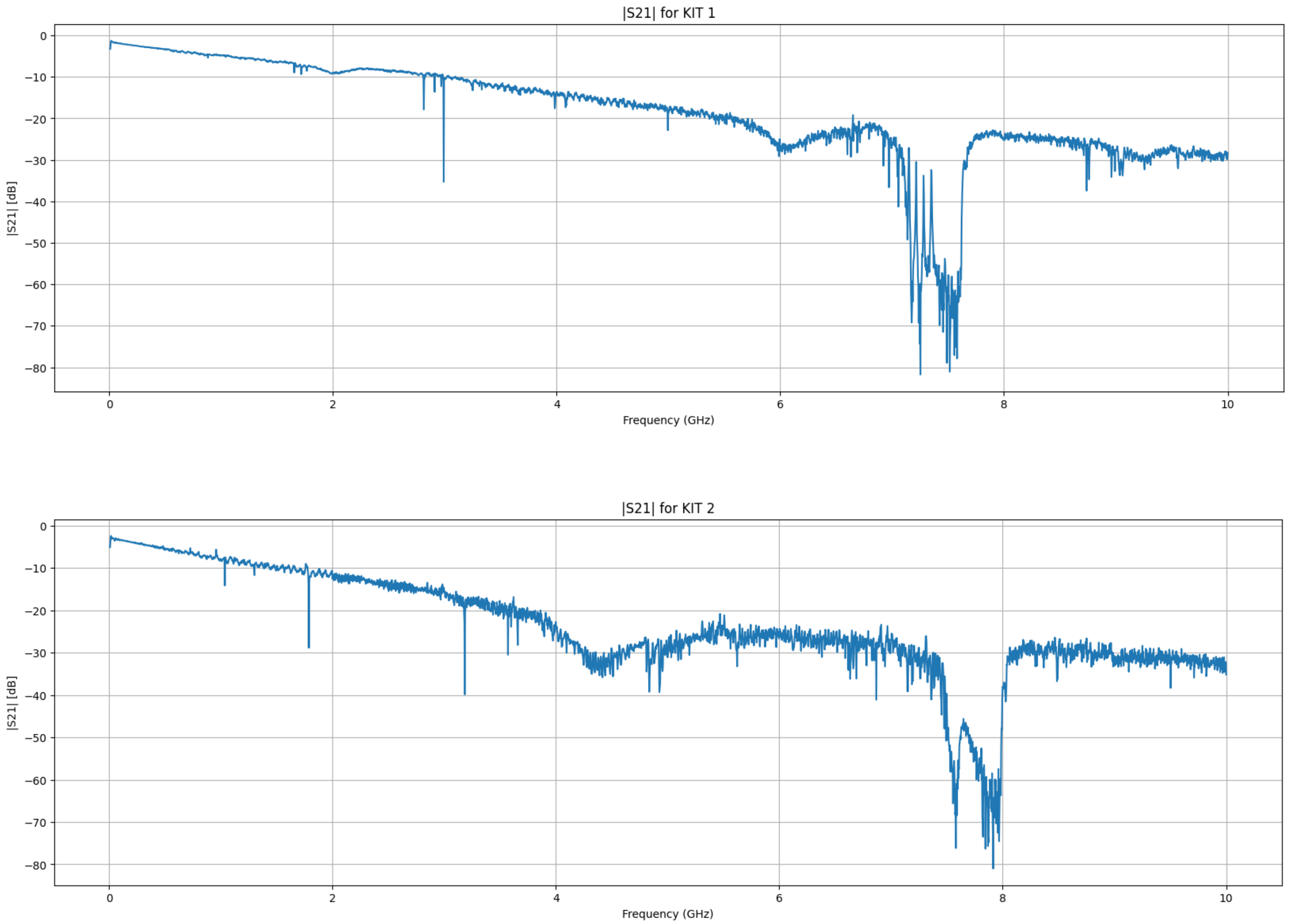
Experimental setup

- I can place two devices at 4 K



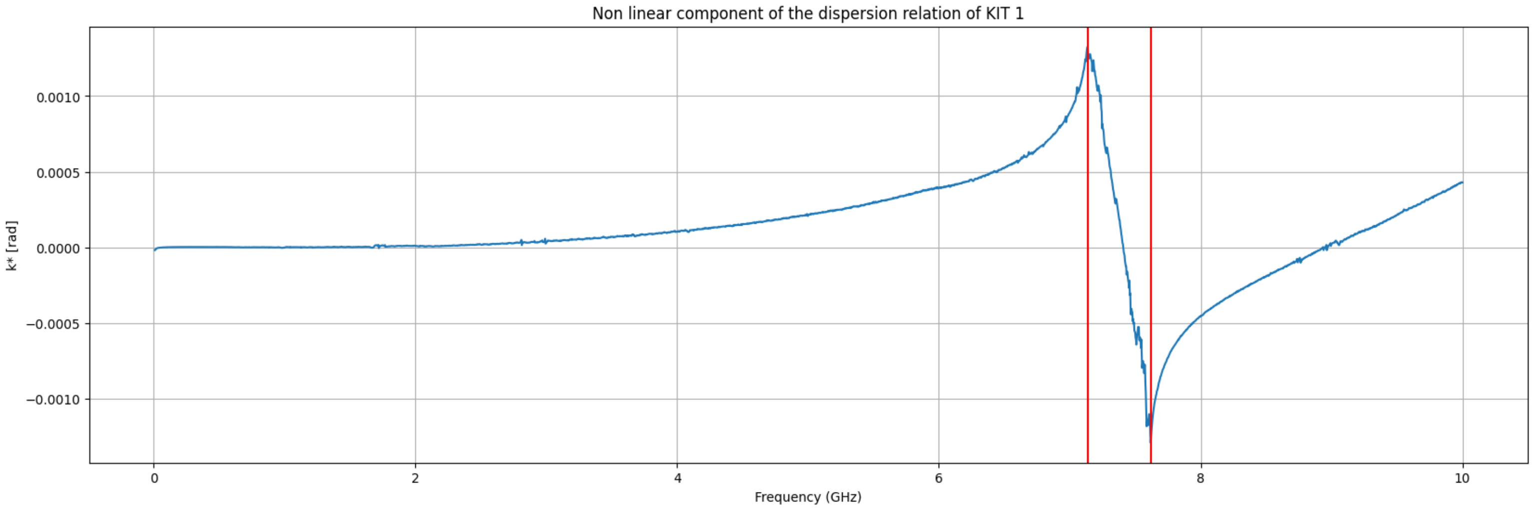
First look at |S21| traces

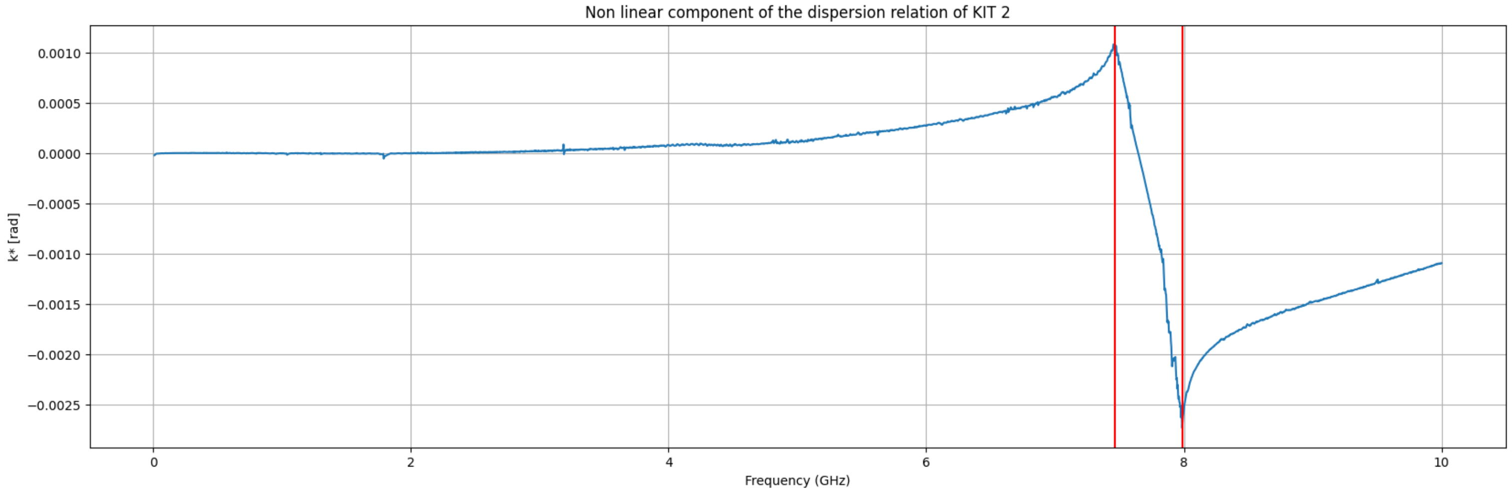
- Measurements w/o the bias tee.
- The bandgap is showing



First look at arg(S21)

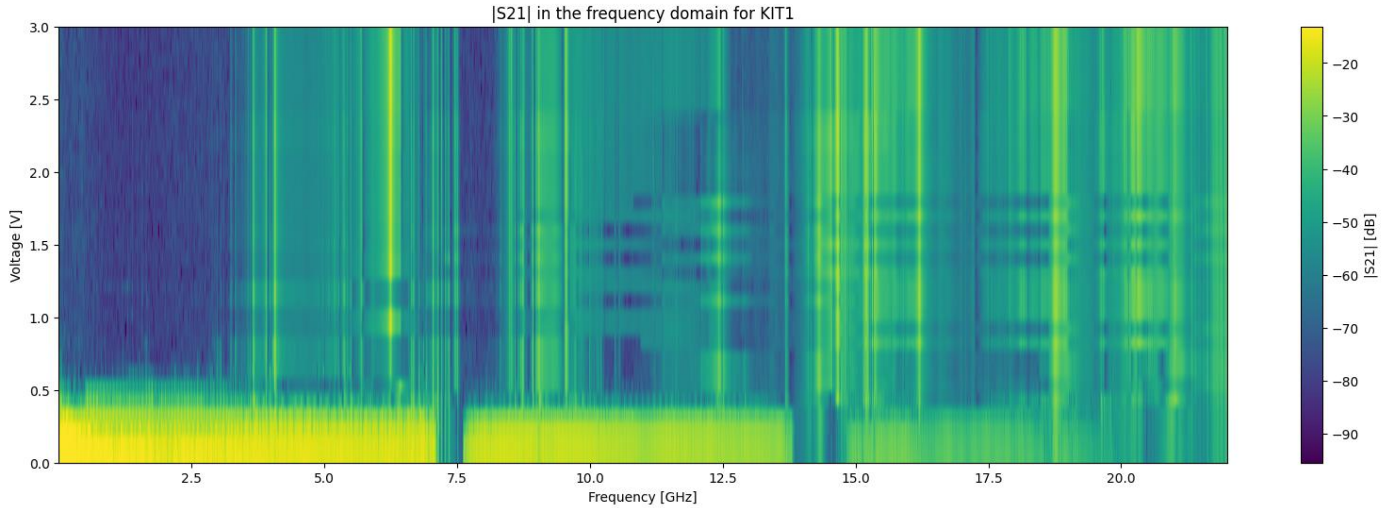
- If I isolate the non-linear component I can assess the stopband location
- KIT 1: (7.137 - 7.618) GHz
- KIT 2: (7.462 - 7.983) GHz

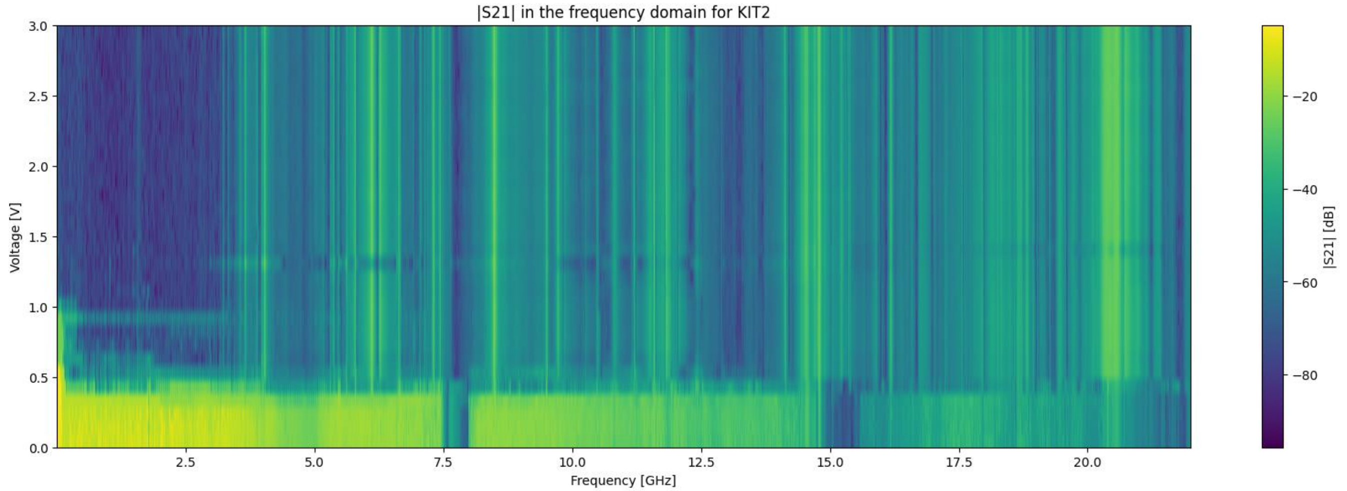




Biasing breaks superconductivity

- At small bias the stopband is clearly visible
- Increasing the bias over 0.7 mA superconductivity seems to breaks.
- Regardless of the reasons, a transition is evident

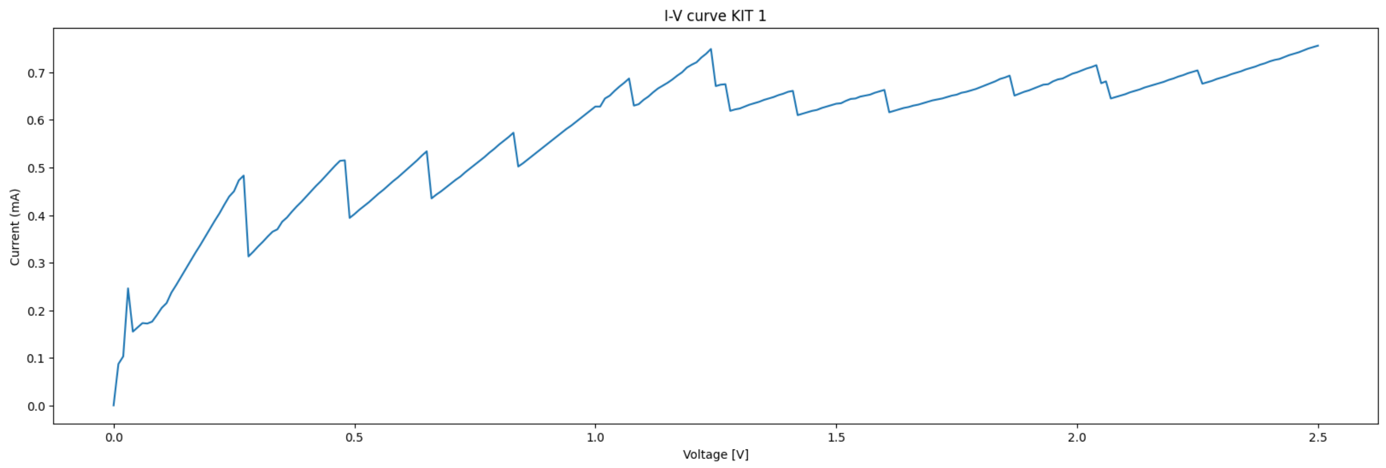


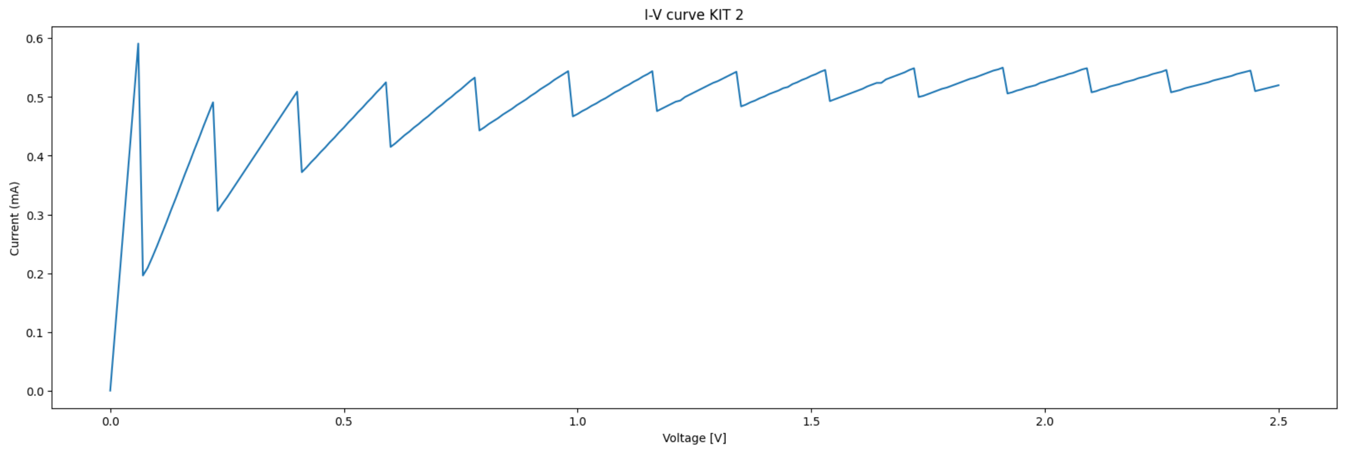


Resistive measurements

Strange I-V curves

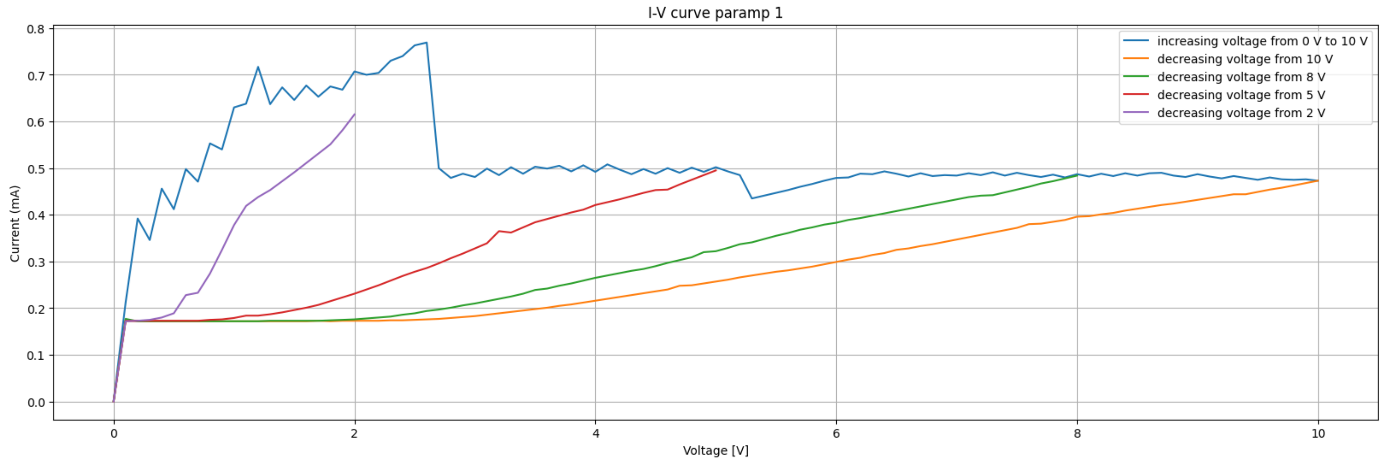
- Measurments w/o any resistance in series
- Between 0 and 3 V
- The current doesn't seem to go above a certain critical value
- A strange jagged I-V curve appears

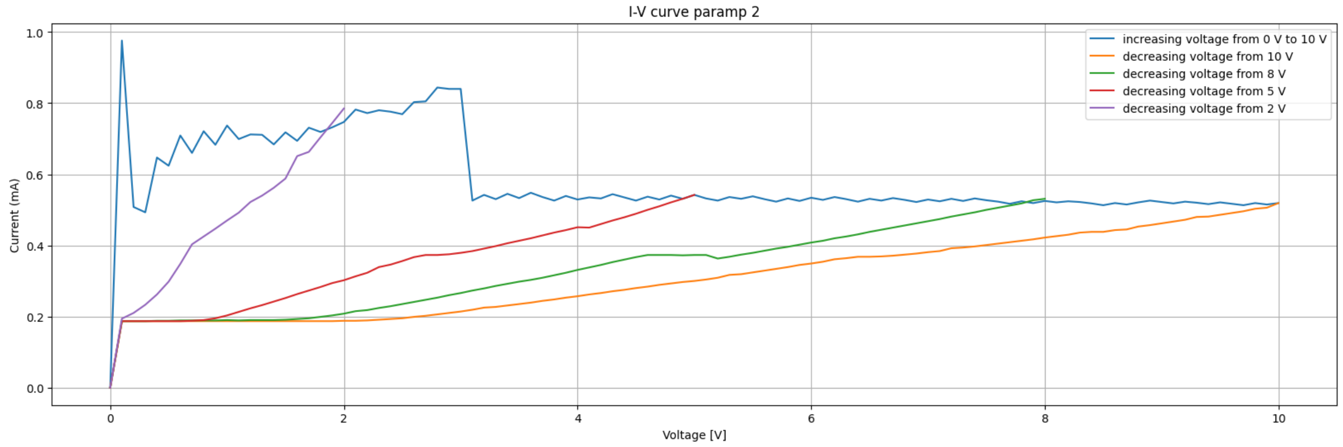




Hysteretic behaviour

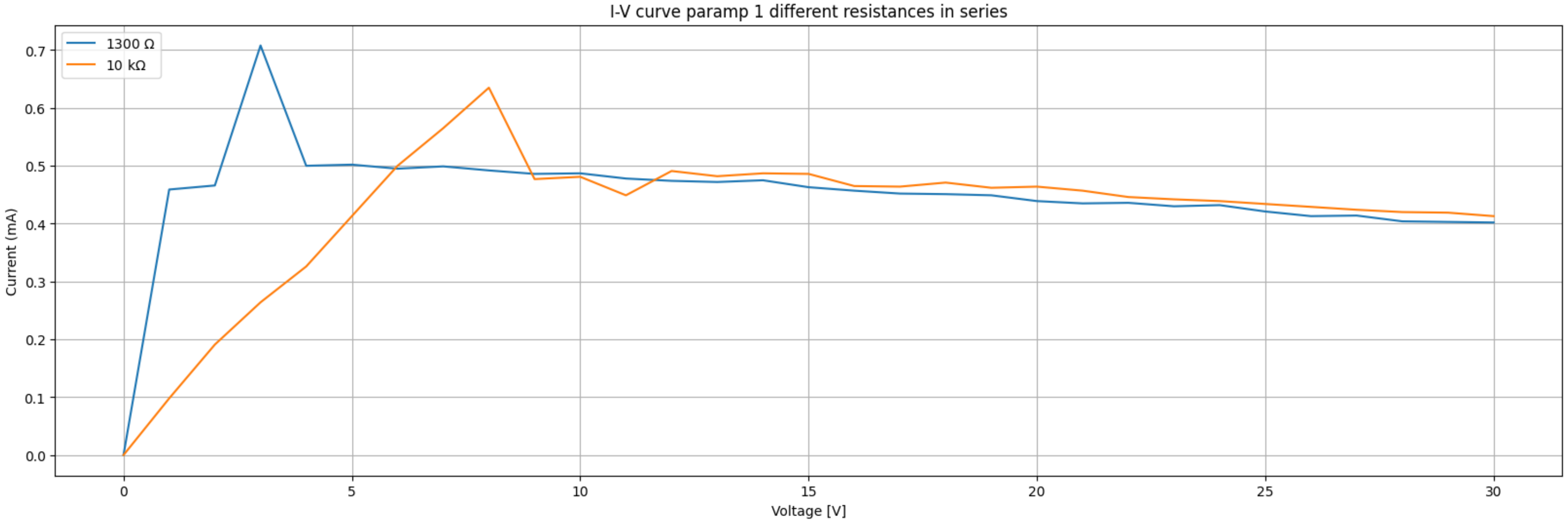
- Measurments w/o any resistors in series
- Sweeping upwards from 0 V to 10 V gives a jagged increase, until the current drops and stabilizes.
- Sweeping down from different voltages yields different curves





With resistors in series

- Putting a resistor in series with the bias line revelas that before the critical current the behavior is ohmic!
- The critical current is roughly the same



Likely shorts to ground

- The resistance at the ends of the line looks fine
- The resistance to ground should be in order of MΩ, I'm likely having shorts.

	bias tee on port 1 - bias tee on port 2	bias tee - ground
KIT 1	0.9 Ω	444 Ω
KIT 2	1.5 Ω	1.76 kΩ

Experimenting with TDR measurements

The state of the cryostate

- At this point I was sure about having malfunctioning chips:
- The one with 444 Ω towards ground was removed, and I measured the S parameters of its line at 4 K for later de-embedding
- The other one was kept in the cryostate, to make some experience with TDR measurements
- I am using an Agilent PNA Series Network Analyzer, that can simulate TDR measurements computing the IFFT of the S parameters, it doesn't perform reals Time Domain measurements

TDR of the first section

- Phase velocity inferred with stopband position:

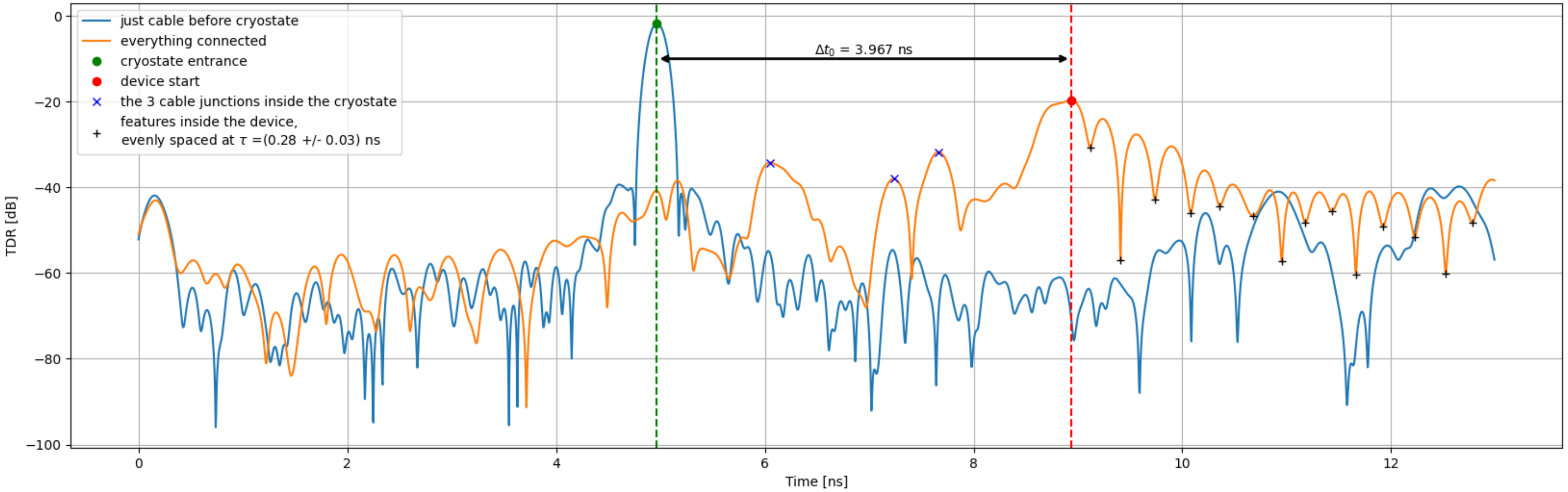
  $v_{ph} = f_{stop} \bullet (N_u + N_l) =$ 7.137 GHz • 66 cells = 471.042 cell/ns

- τ = 3.967 ns corresponds to

  Δn = 471.042 cell/ns • (0.28 ± 0.03) ns = (132 ± 14) cells = 2 • (66 ± 7) cells $\simeq$ 2 • $(N_u + N_l)$

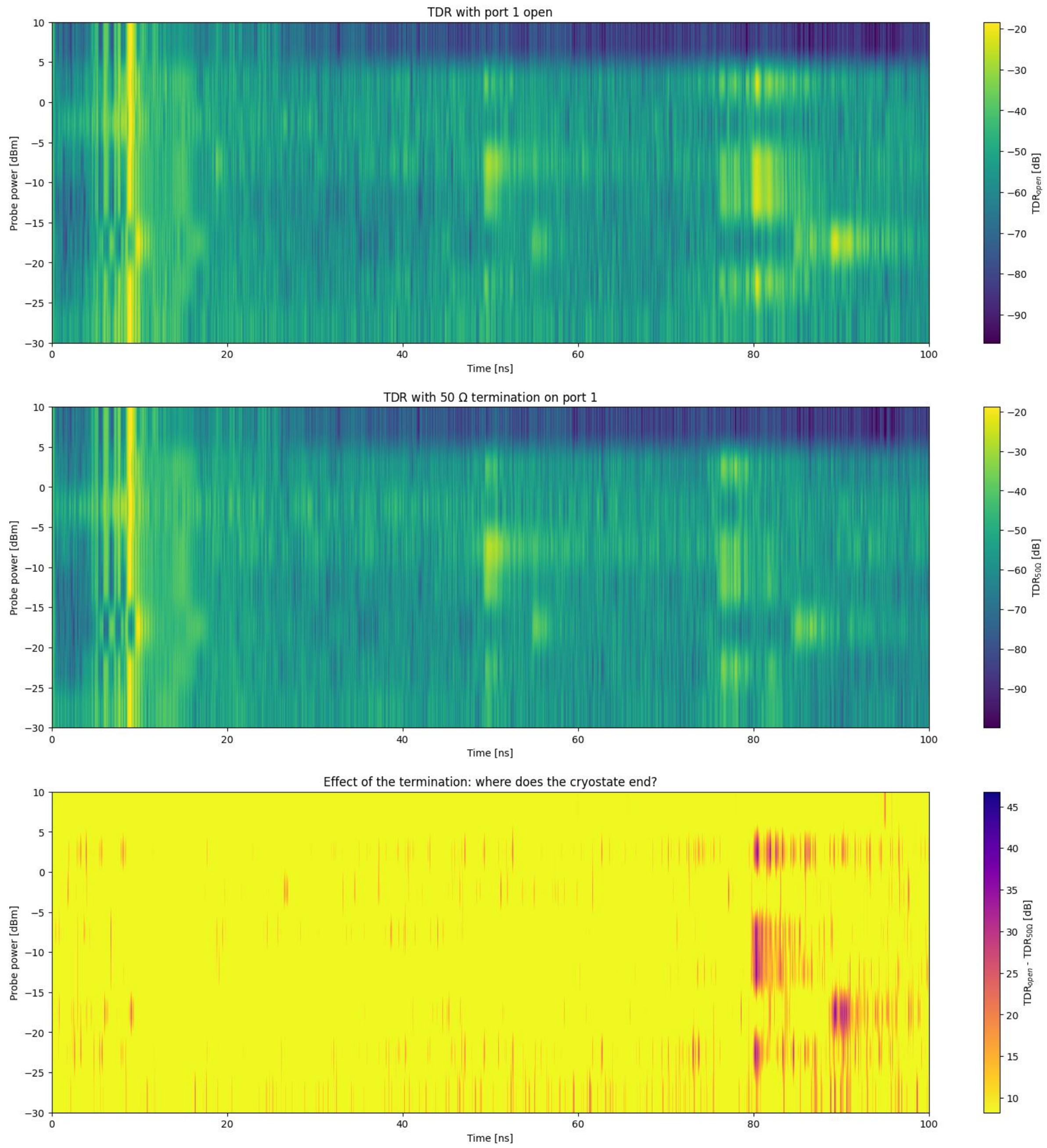
- That means that I am seeing the periodic 80 Ω loadings!

- The line has 34518 cells in total, this means that we should see the edges of the device separated by ΔT = 34518 cells / (471.042 cell/ns) = 73.280 ns



TDR for different probe powers

- I sweep the probe power and aquire the TDR trace for port 1 with an open and with a 50 Ω termination
- The device start is clearly visible (yellow strip on the left)
- The difference between the two tells me where the cryostate ends
- The device end is obtained subtracting Δt_o = 3.967 ns



Final results for TDR

- I convert the power level from dBm to mA, knowing that Z = 1.5 Ω
- I plot the traverse times for different probe current amplitudes, as well as the corresponding phase velocities
- The values are in the same order of those estimated with the bandgap position (red)
- The fit with the theoretical law is useless