



f/Q vs Temp measurement at KEK

TTC high-Q/high-G WG

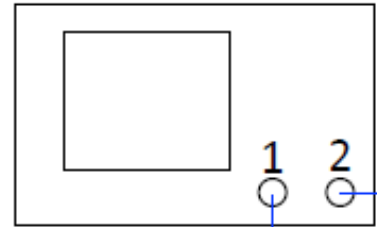
2022/12/14

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(Most of works have been done by Araki-san and Ito-san)

Normal measurement setup at VT

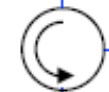


Network Analyzer



Amp is used to amplify the signal.

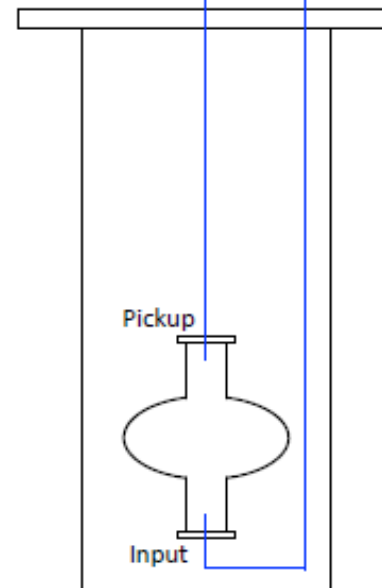
AMP.
Up to 17 dB



Attenuator

20 dB

Termination



- Measure the temperature dependence of resonant frequency and Q value during warm up
- Monitor the S12 signal of the Network analyzer

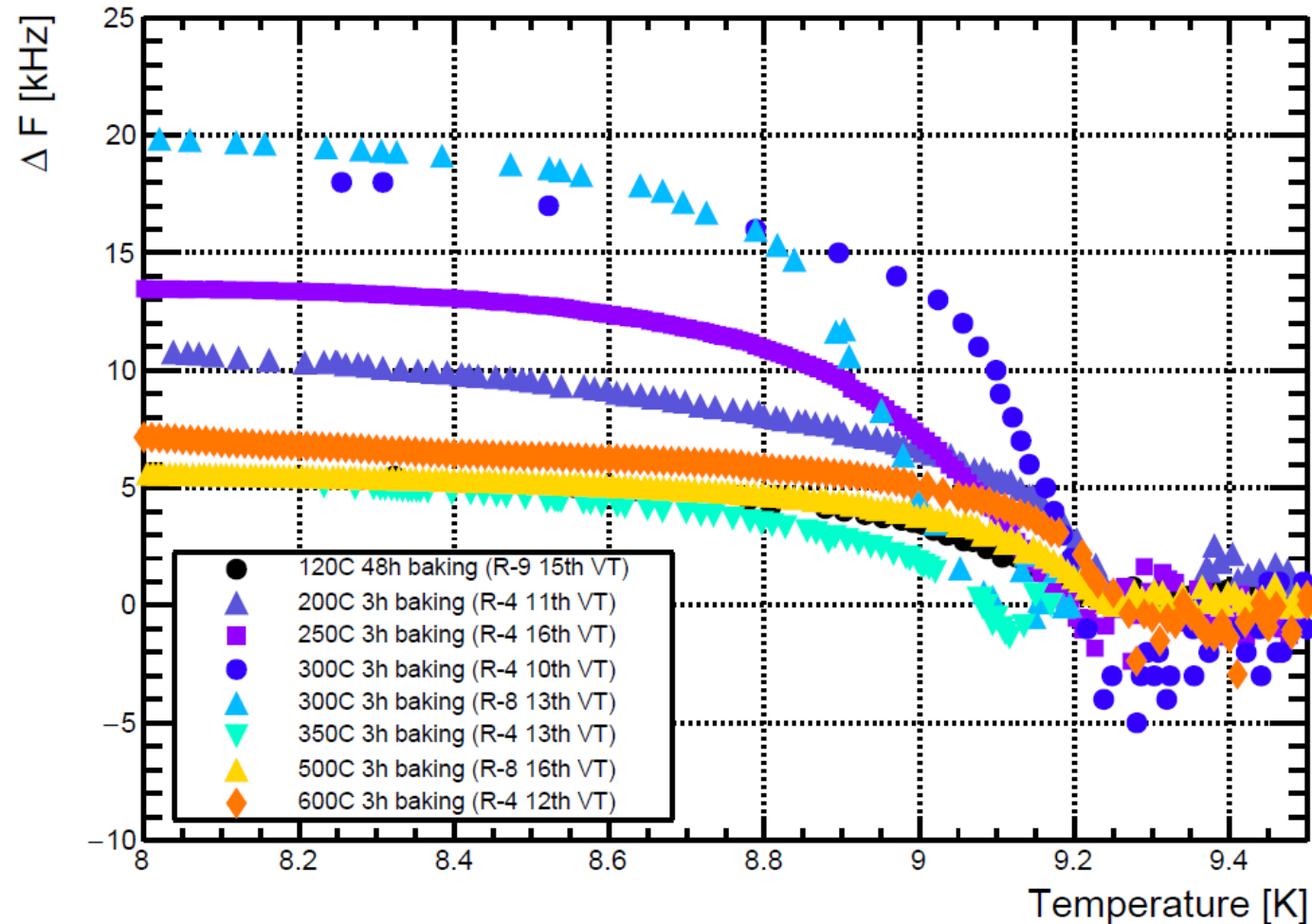
$Q_t > 1e11$

$Q_{in}(\text{variable})$

$\sim 5e8 - 5e10$

(Fix to max. coupling for f/Q measurement.)

Δf vs Temperature for furnace baked cavity

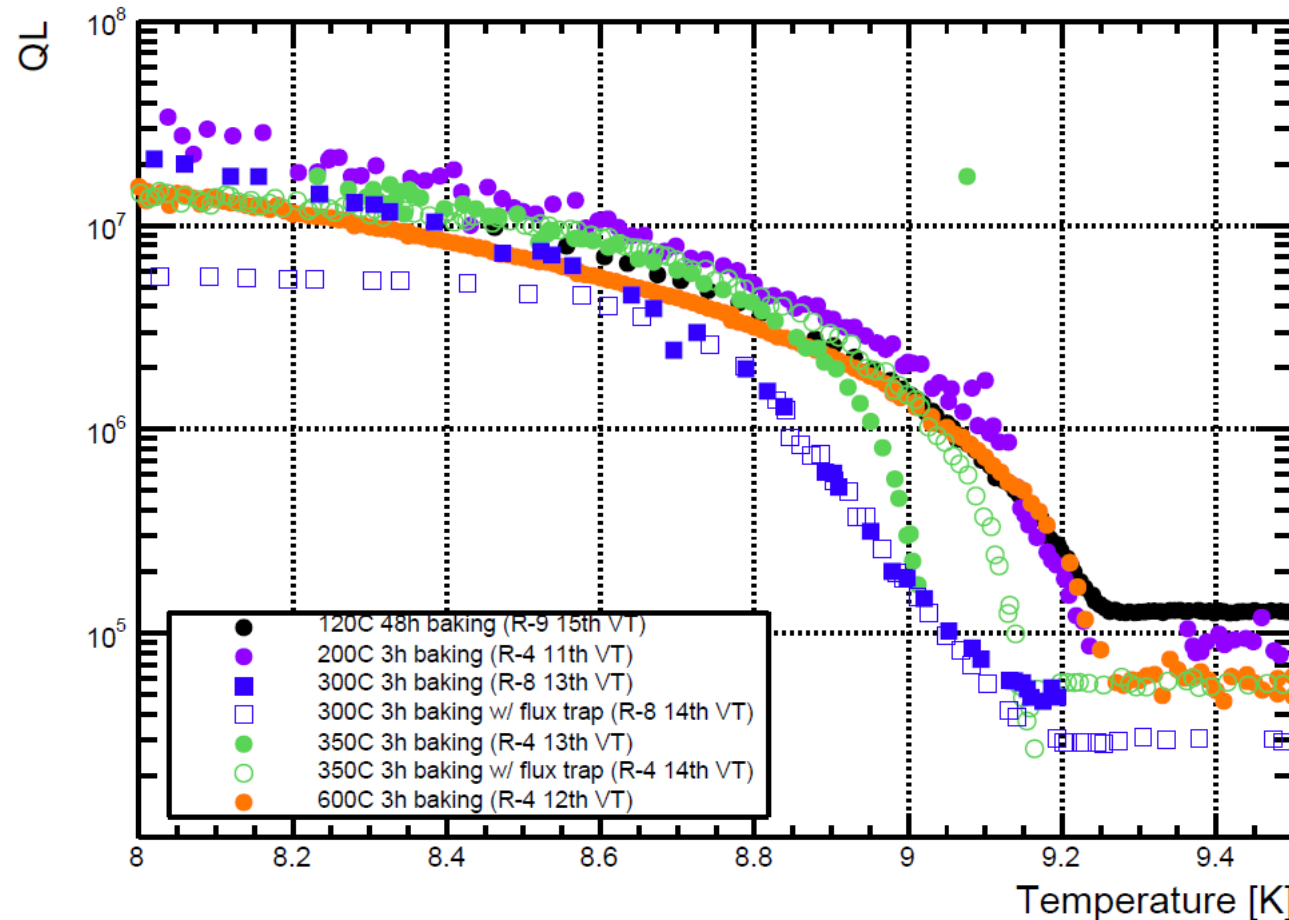


- Difference of Δf depending on the treatment procedure is clearly seen.
- Some procedure seem to show dip of frequency.
⇒ But not so clear.

QL vs Temperature for furnace baked cavity



Note: This plot is for QL, not Qo.

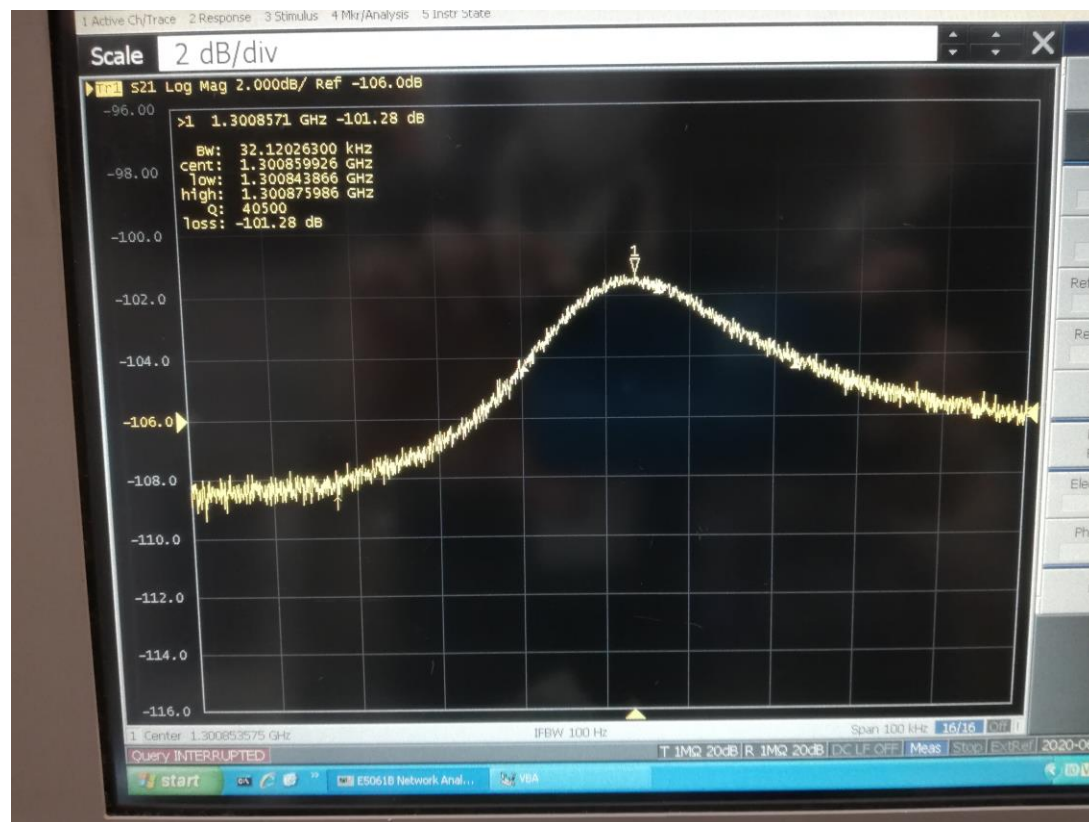


- Qo (QL) vs Temp is also measured.
- Again, the measurement around Tc is difficult, due to small signal.

Some example of VNA spectrum difficulty after transition to RT



This is just typical example.



Difficulty on f/Q vs Temp measurement



- General feature can be observed.
- Clear difference is also seen between treatment procedures.
- Data just around T_c is not so clear.
- Because of the drastic change of QL and relatively small coupling of the system, S_{21} spectrum around T_c is rather unstable.
- Shape of S_{21} baseline also somewhat change around T_c . \Rightarrow Possible to affect as fake frequency shift

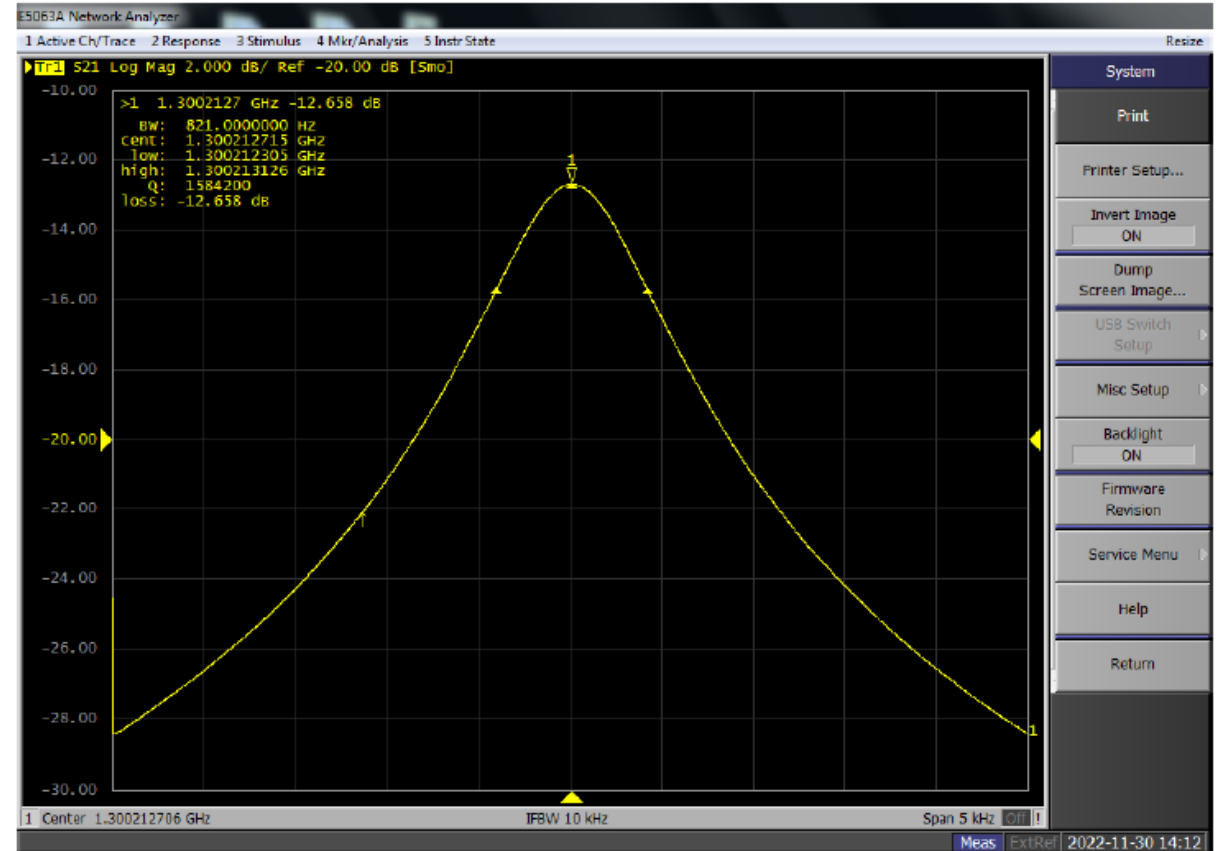
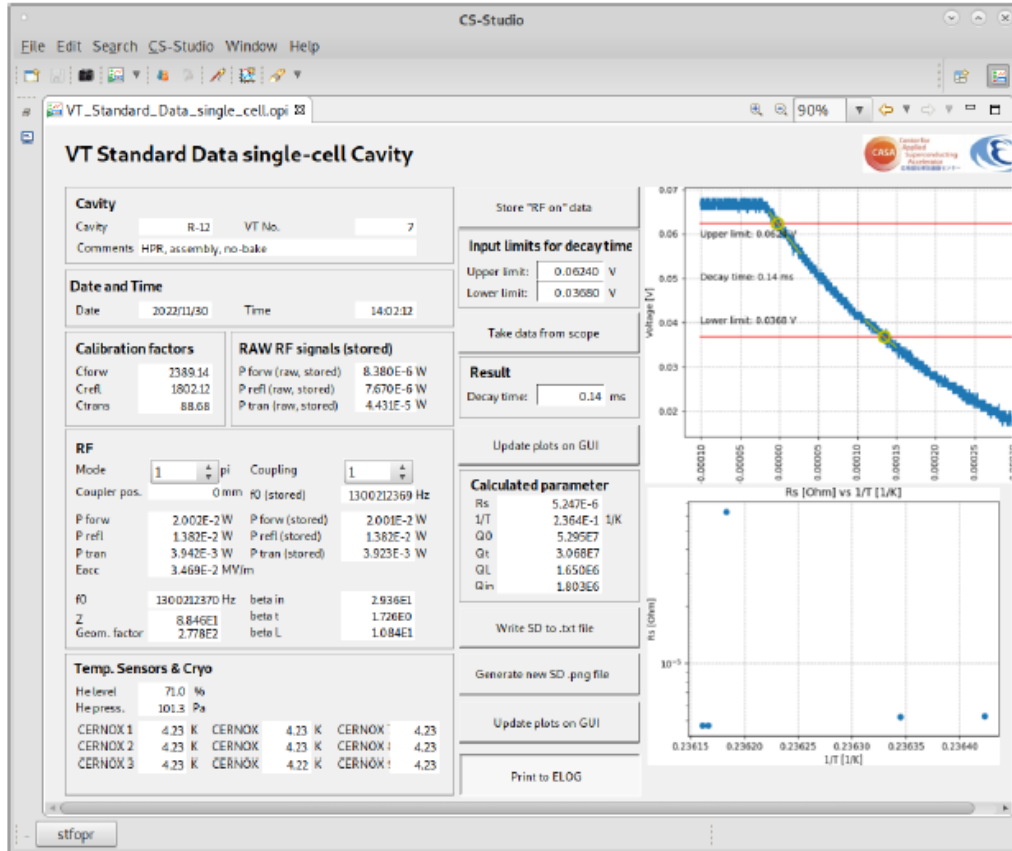
Special run for f/Q vs Temp measurement



- Used long input & pickup antenna for f/Q measurements. (No-high power test was performed.)
 - $Q_{in} \sim 4e6$
 - $Q_t \sim 6e7$
- Focused on to measure f/Q around T_c correctly.
 - Measurement 1: Network analyzer (S21)
 - Measurement 2: Decay measurement using LLRF
- 120C, 48h baked cavity used for this study (following plots)

Decay (LLRF) measurement at 4K

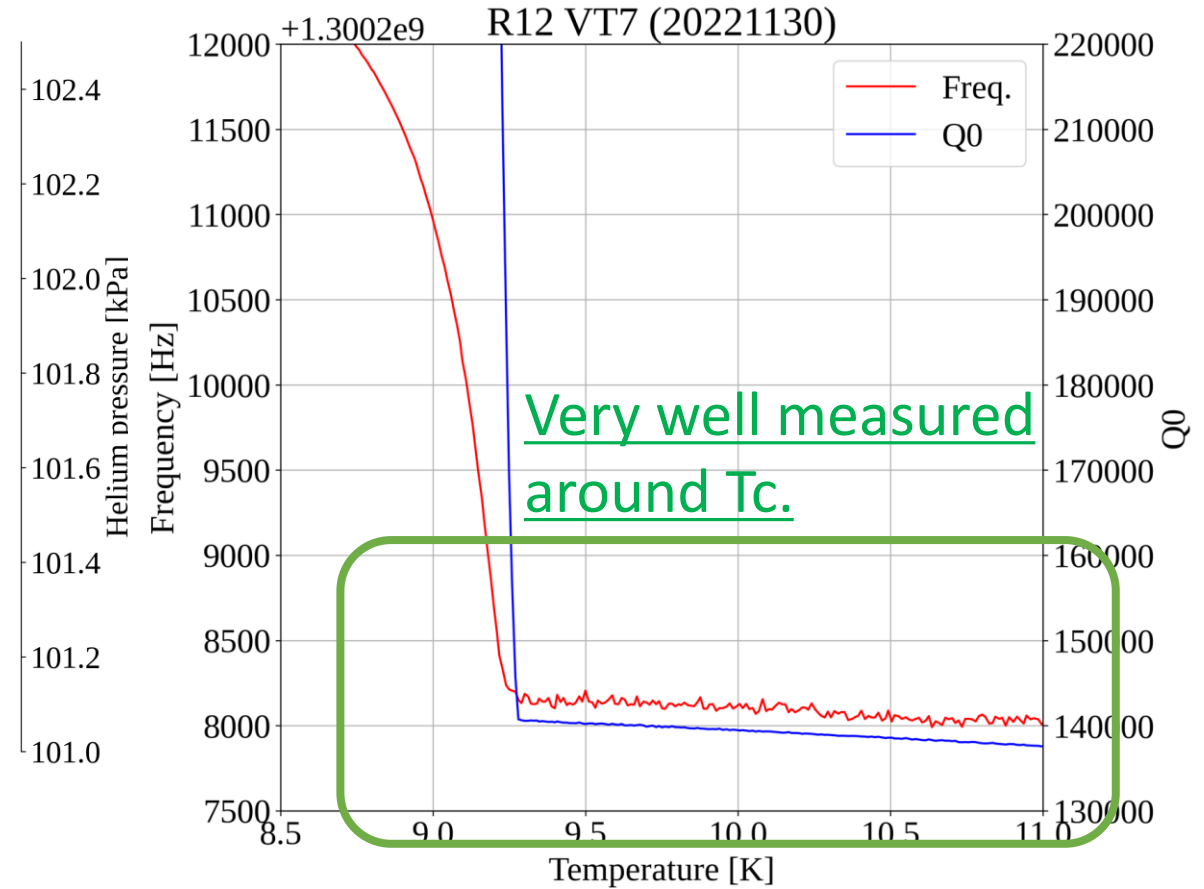
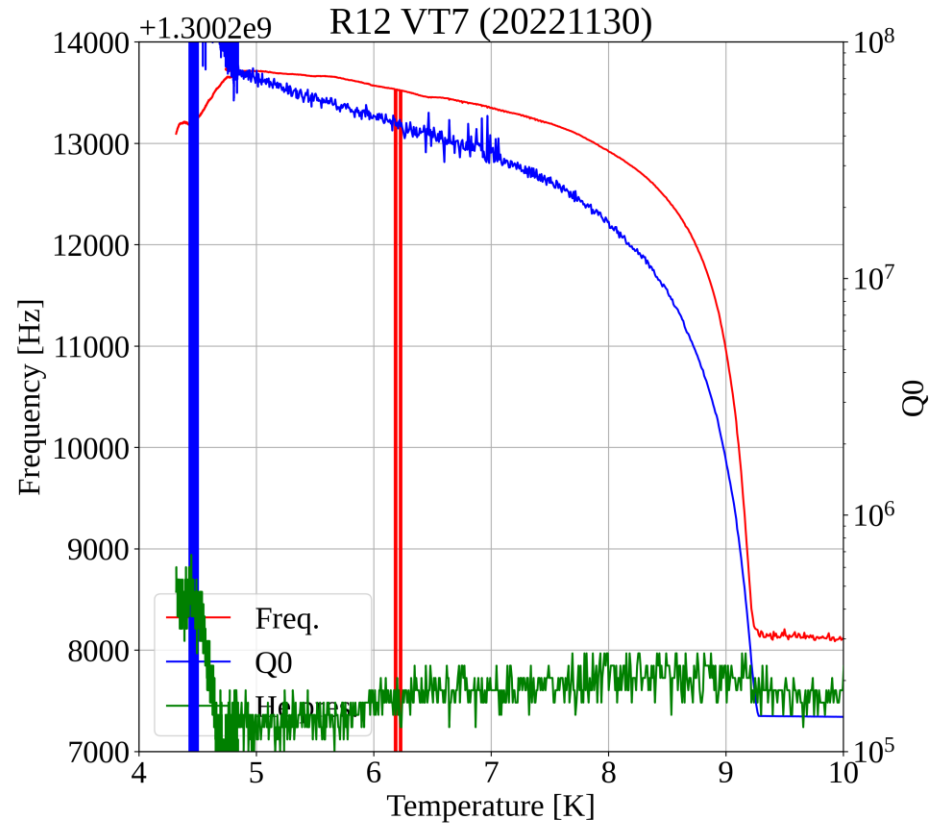
S21 (NA) measurement at 4K



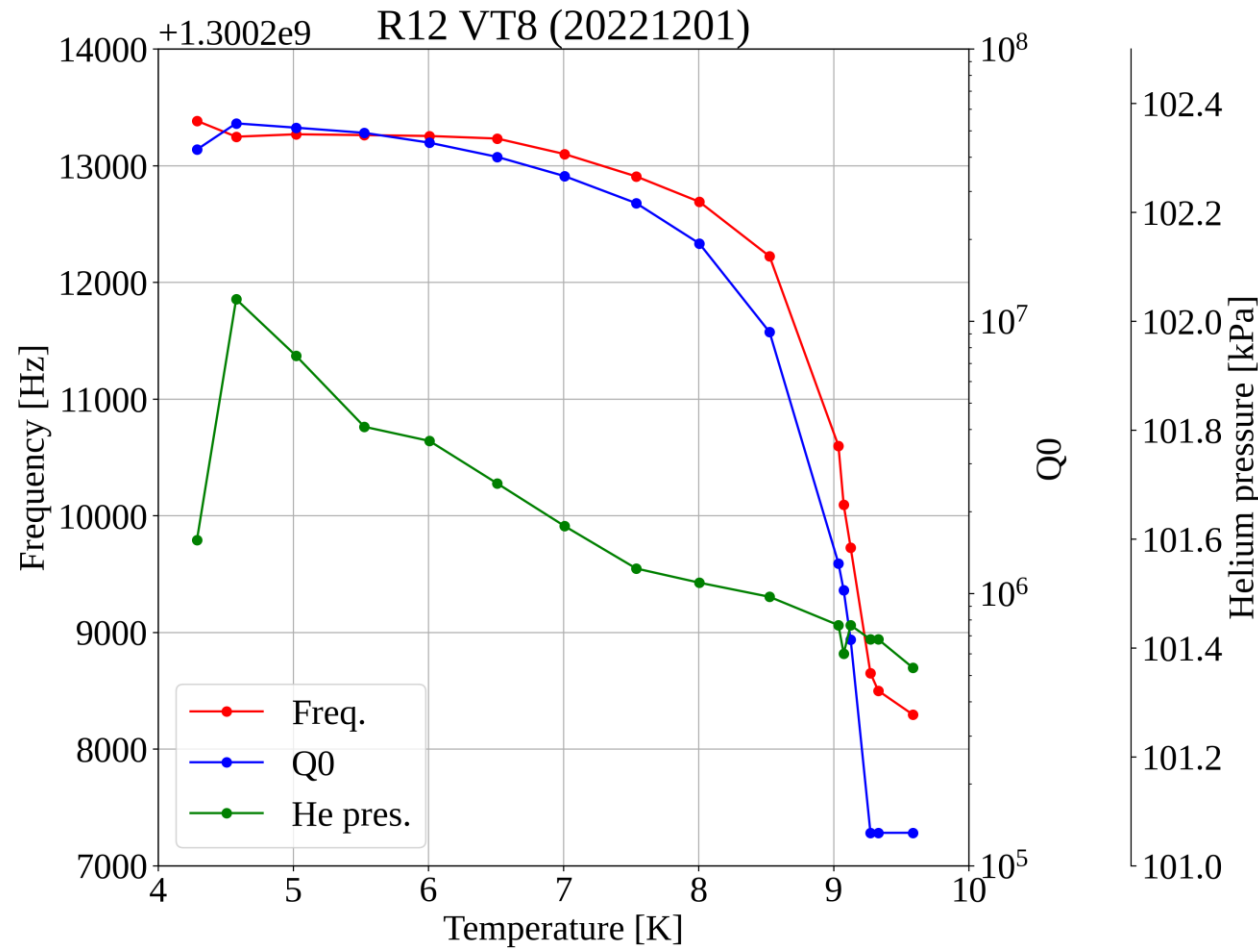
	Decay	NA
Frequency	1 300. 212 369	1 300. 212 7
Q_L	1.650E6	1.584E6

Similar results for both.

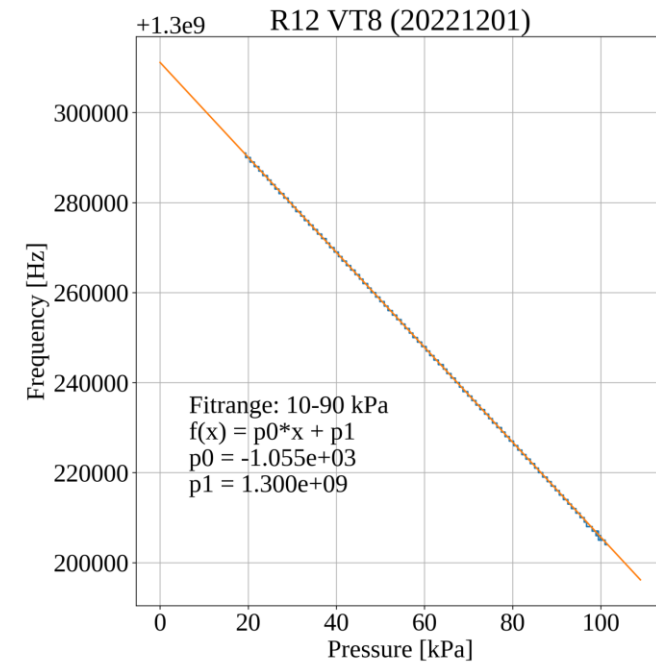
Measurement1: S21(NA)



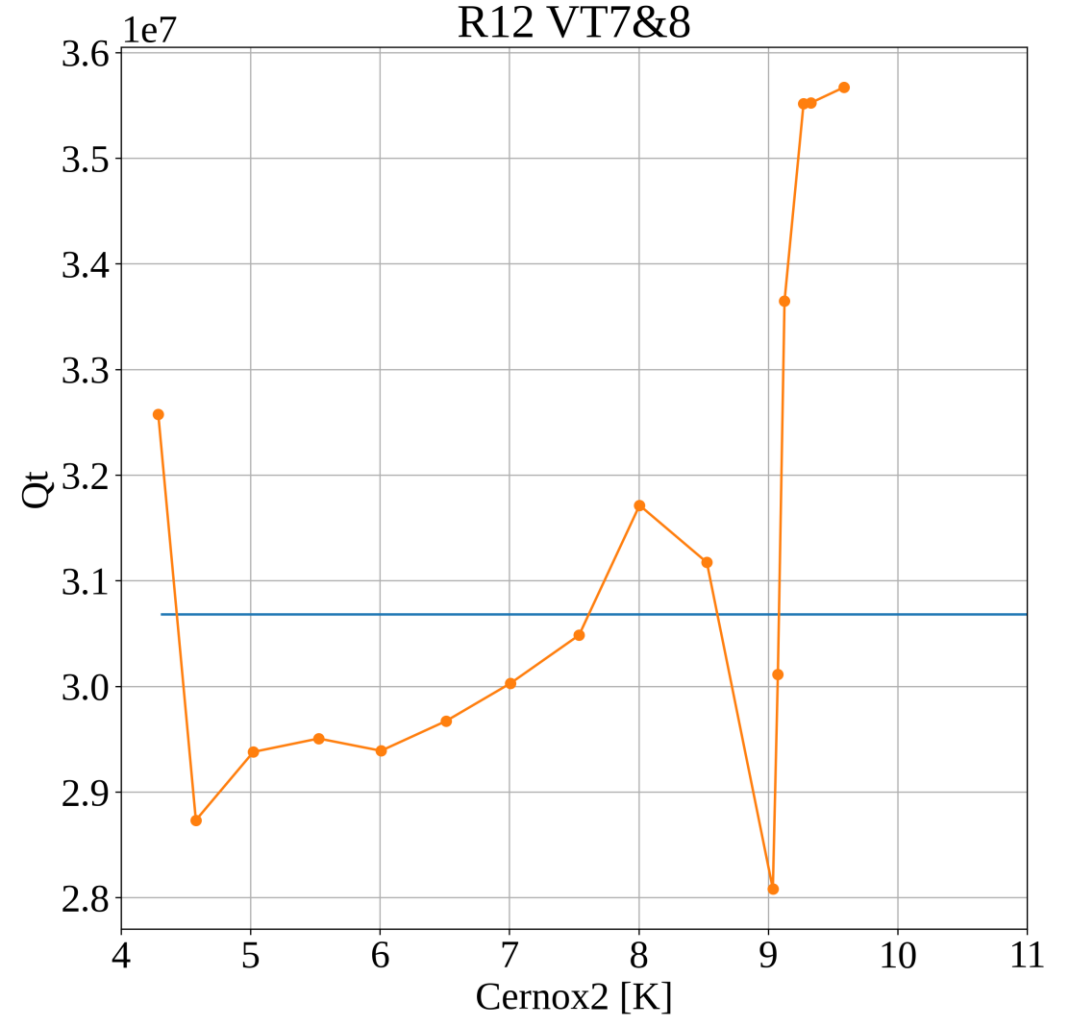
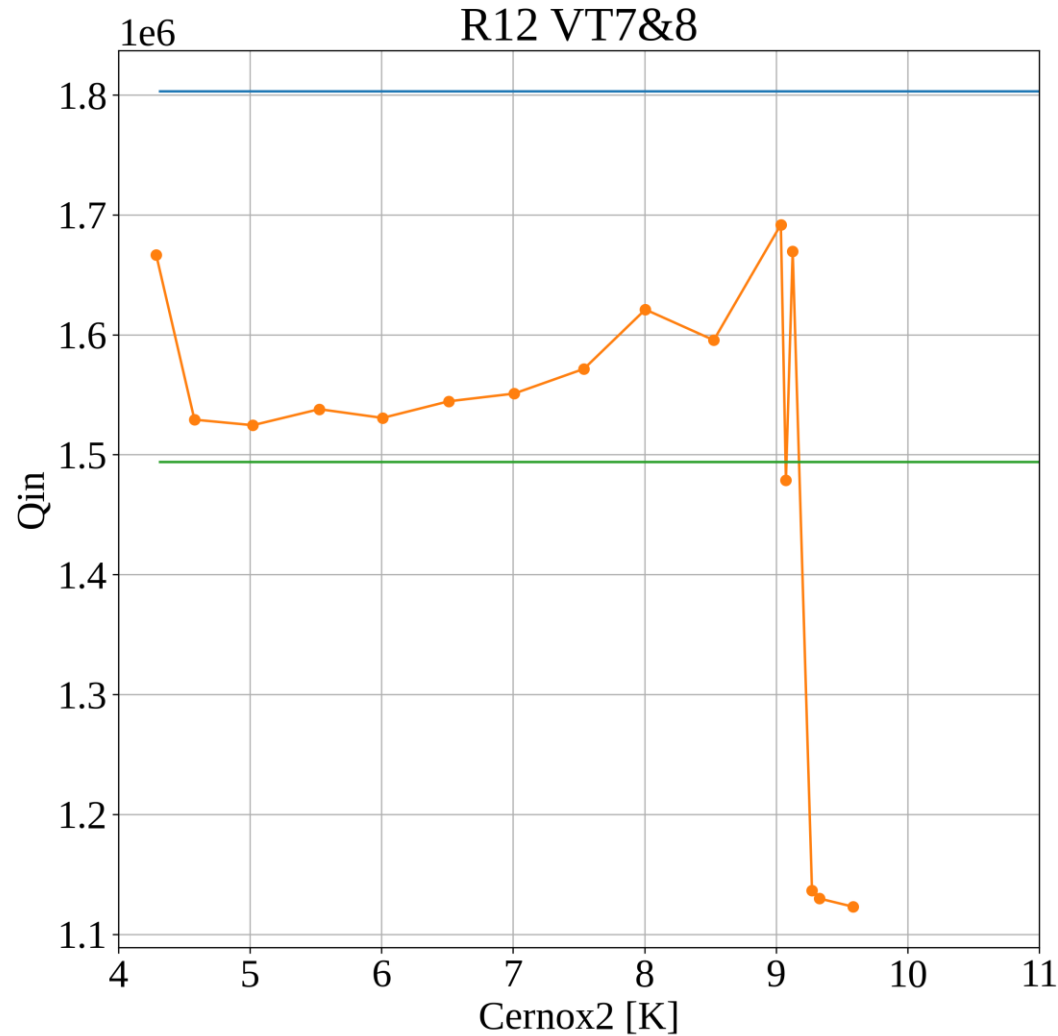
Measurement2: Decay(LLRF)



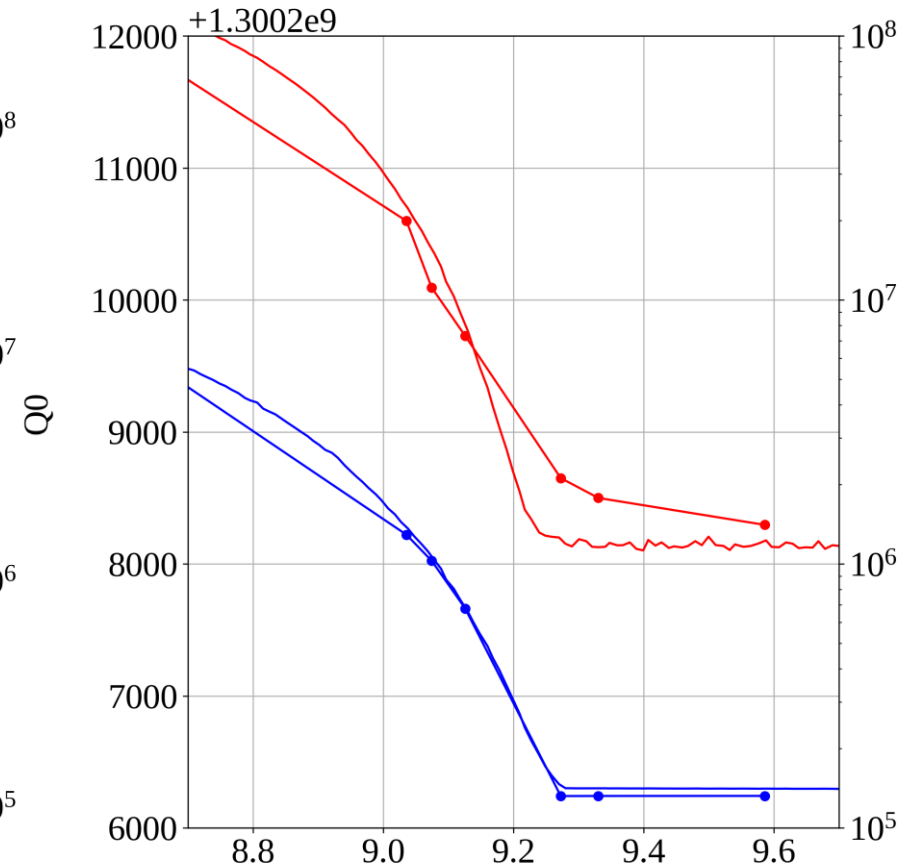
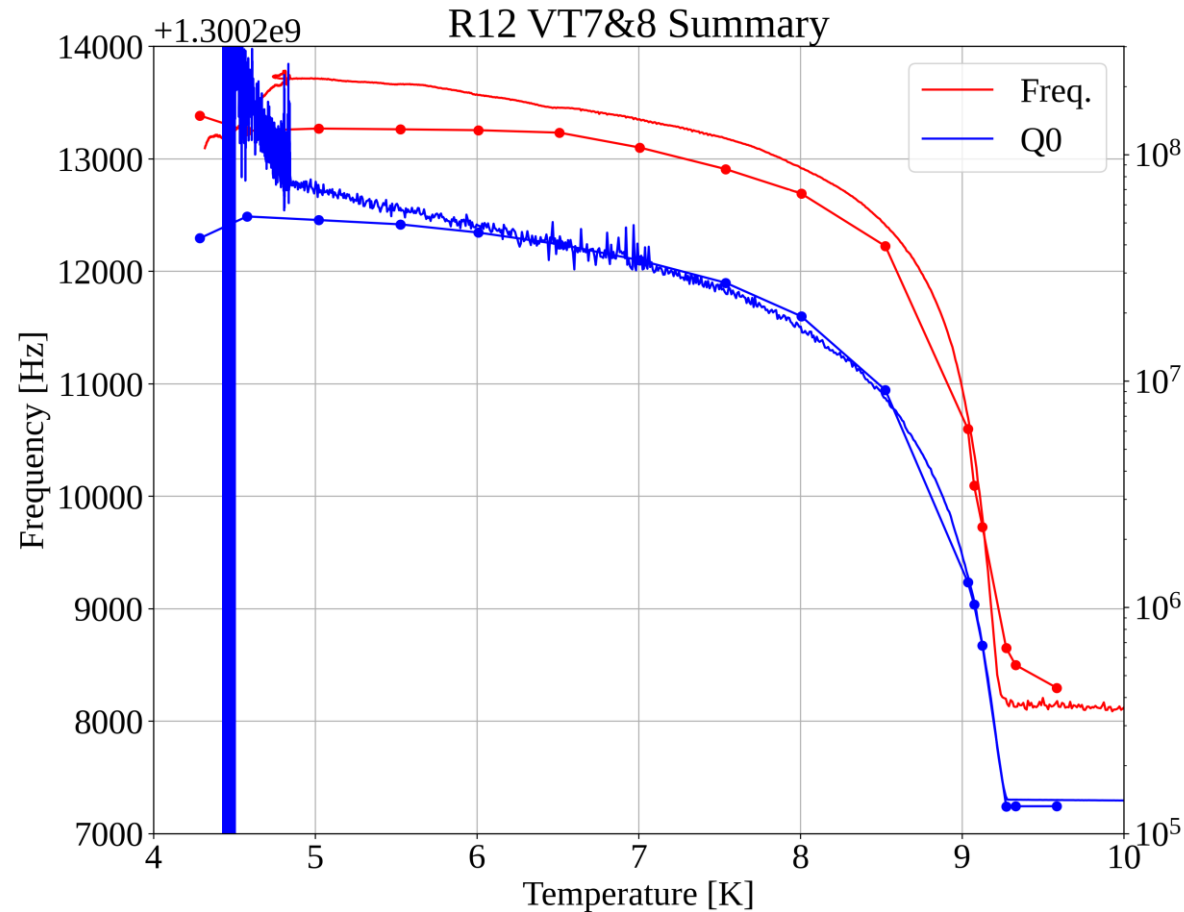
He pressure dependence was corrected.



Some ambiguity on Q_{in} , Q_t



Comparison of 2 measurements



Both measurement shows relatively good agreement.

Some trial... (very preliminary)

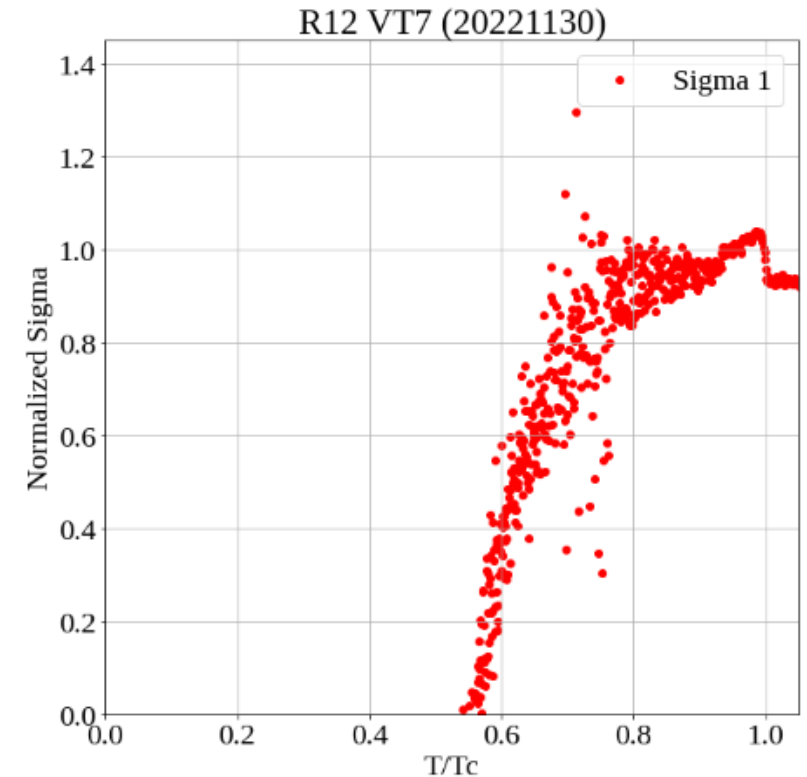
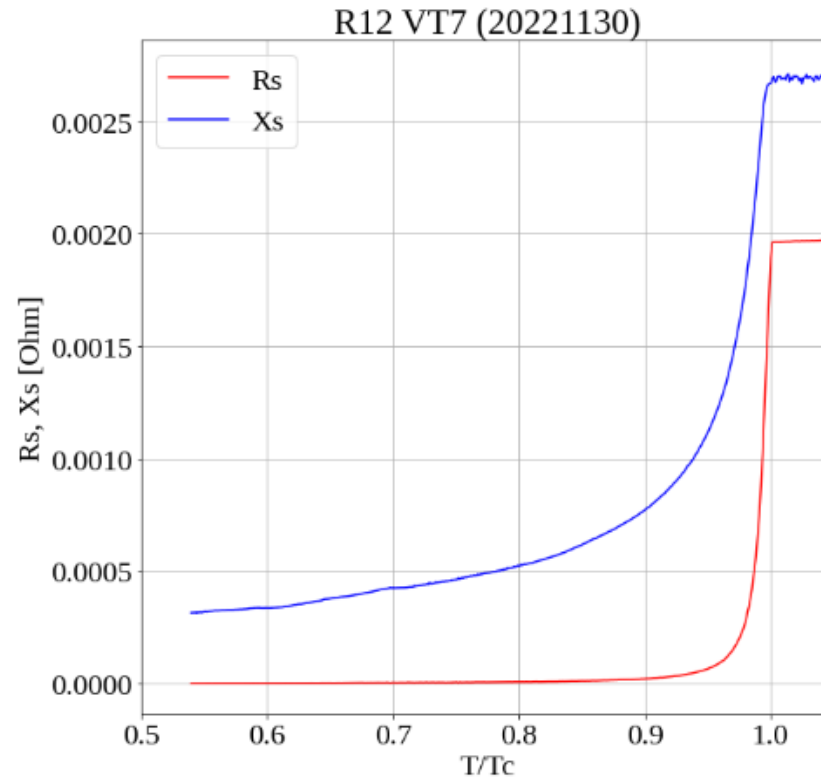


Should modify this number, considering anomalous skin effect.
For the case for following plots, 1.37 was used.

$$R_s(T) = \frac{G}{Q(T)}, \quad X_s(T) = G \left(\frac{1}{Q(T_c)} - 2 \frac{\Delta f(T)}{f} \right)$$

(Q1)
Which number should be used?

(Q2)
Large experimental error?



Summary



- KEK have taken f/Q vs Temperature data for many cavities and for many treatment procedures.
- General characteristics was well observed, but precision around T_c was suspicious.
- KEK tried special cooldown focused on f/Q vs T measurements, using strong coupling antenna for both of input and transmit line.
- Signal around T_c was clearly seen.
- We had been trying to analyze our data.
- But, there are some ambiguous parameter and also fitting is not so reliable.
- We hope some of you help us for analyzing our data.