EURISOL DESIGN STUDY
SC Cavity Development Group

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Summary of the experimental results on the Eurisol β 0.35 spoke cavity tests at 4.2 K

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Experiment from 21 to 24 January :

21st January Experiment preparation:

Cable attenuation at cold temperature:

- AttPi = 29.515 dB
- AttPr = 31.545 dB
- AttPt = 24.565 dB

Calibration point :

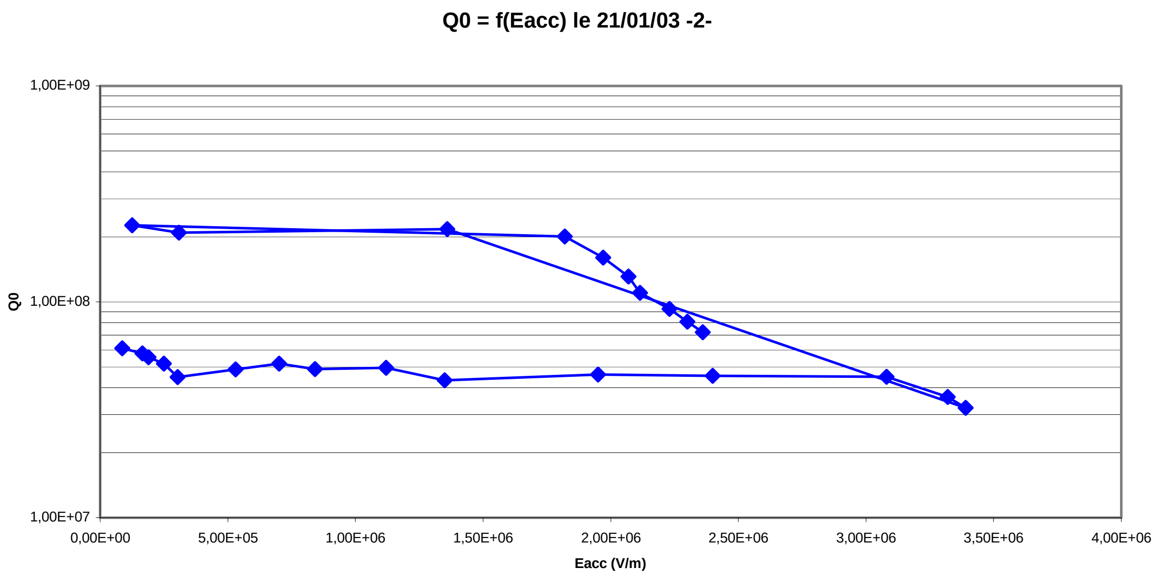
- Pi = -10.12 dBm (87 mW)
- Pr = -34.6 dBm (0.495 mW)
- Pt = -37.59 dBm (49.83 μW)
- $Q_0 = 2.176\ 10^9$ for Eacc = 1.02 MV/m

} i.e. 86.46 mW in the cavity

- $\beta_t = 5.76\ 10^{-4}$, $\beta_i = 0.86$

Cavity results are the following :

Measured frequency is 359.234 MHz. Q_0 curve as a function of Eacc is the following:



On the 22/01, after an RF configuration modification, cable attenuation at cold temperature are measured again:

- AttPi = 49.78 dB
- AttPr = 51.52 dB
- AttPt = 16.72 dB

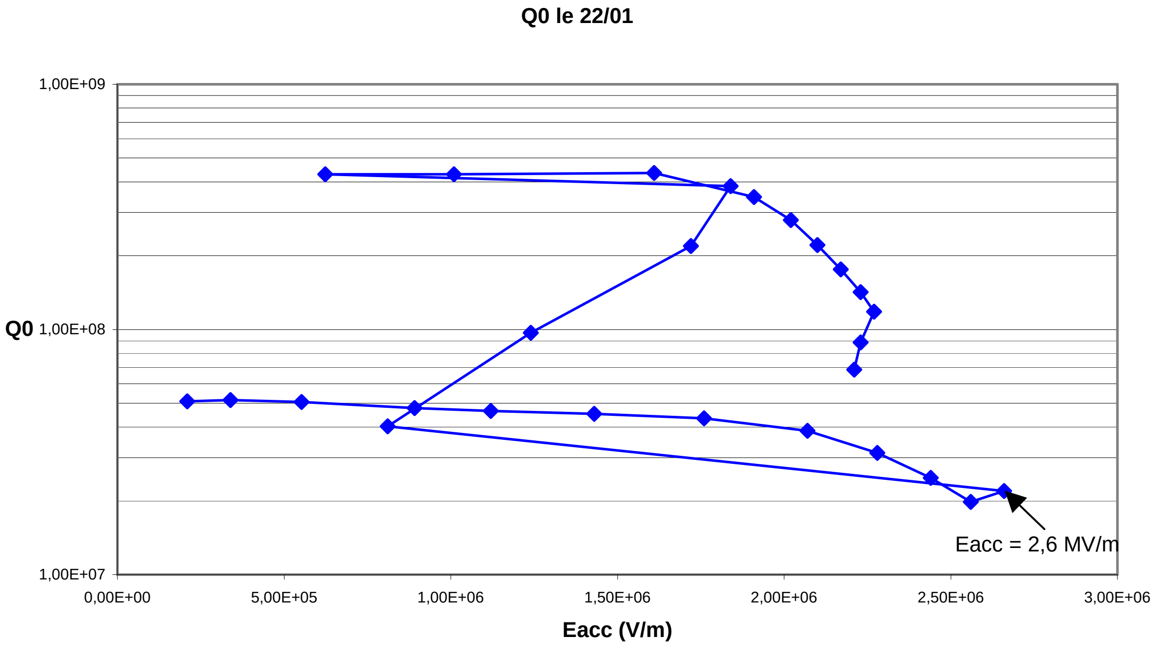
And the calibration point is :

- Pi = -22.32 dBm (0.56 mW)
- Pr = -27.85 dBm (0.23 mW)
- Pt = -16.75 dBm (99 μW)

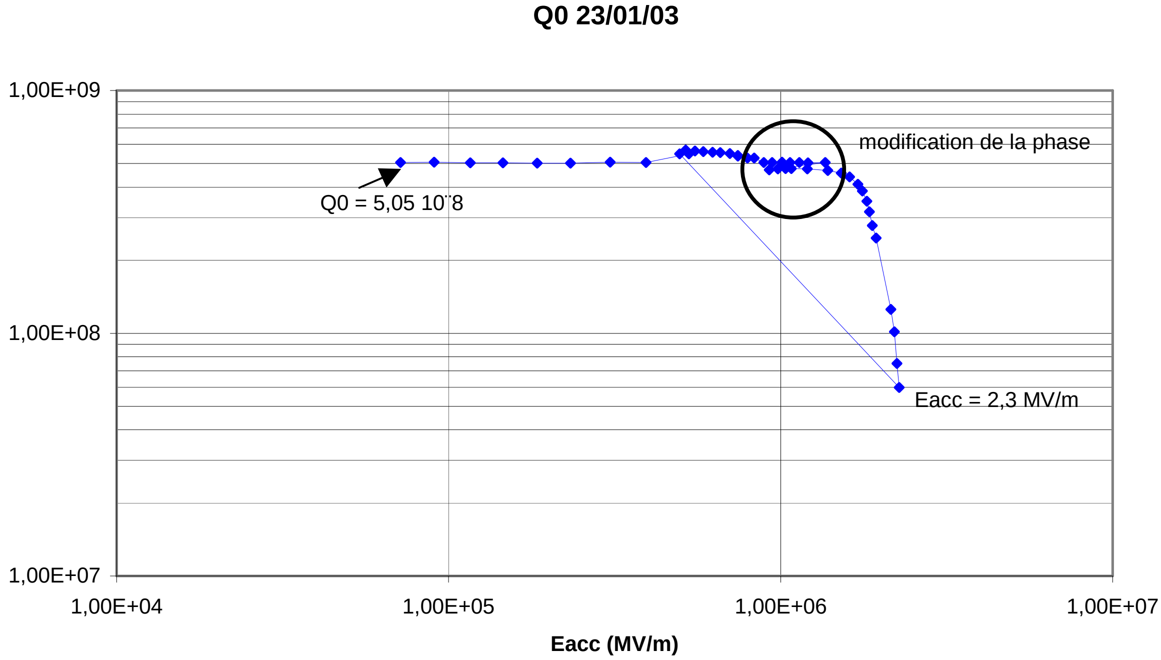
} i.e. 0.32 mW dissipated in the cavity

- $Q_0 = 5.32\ 10^8$ for Eacc = $2.77\ 10^5$
- $Q_i = 2.48\ 10^9$, $Q_t = 1.74\ 10^{11}$, $Q_l = 4.27\ 10^8$, $\beta_t = 0.003$, $\beta_i = 0.21$, $\rho = -0.65$

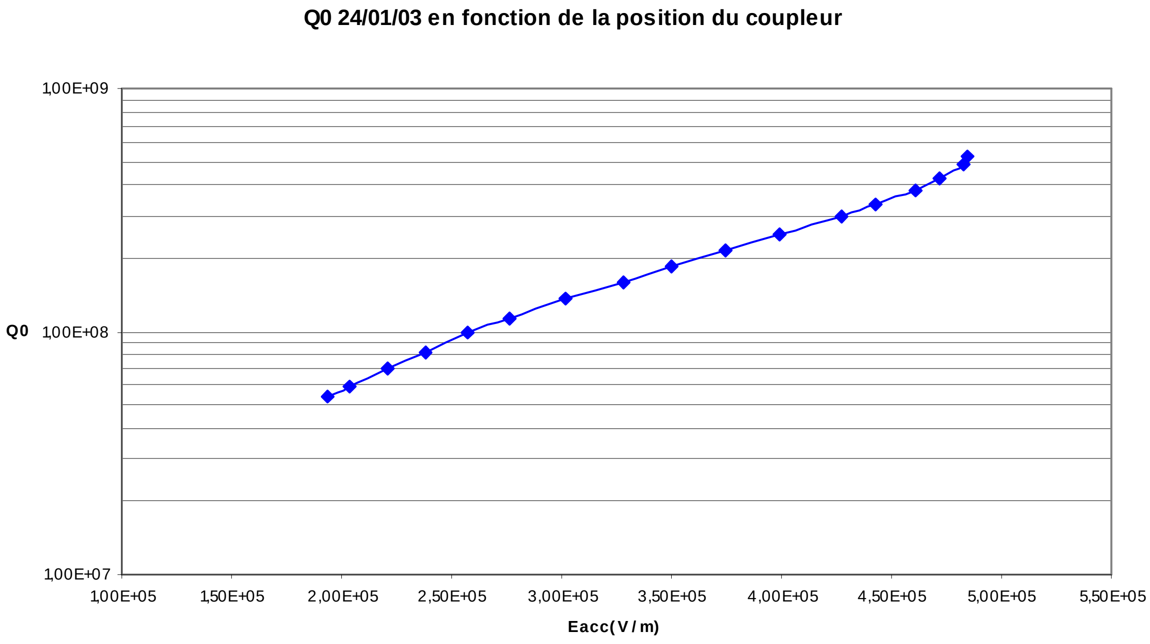
Decreasing time τ calculation gives 190 ms.
Maximum gradient Eacc is 2.6 MV/m.



On the 23/01, a new measurement in CW mode has been performed:



The impact of the incident coupler displacement on the Qo has been also checked on the 24/01

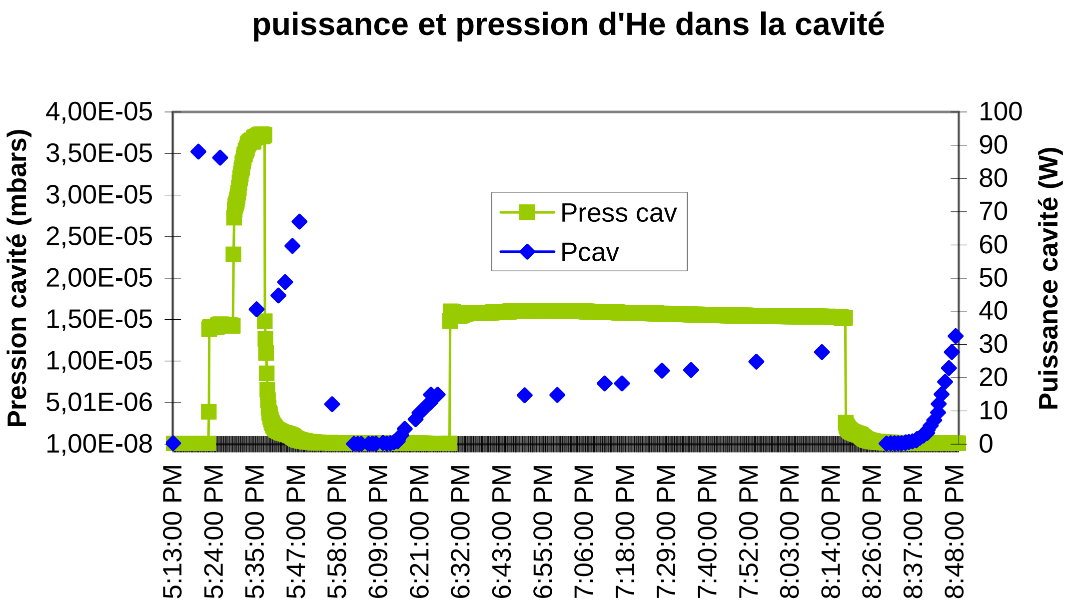


It has not been possible to increase the gradient to a very high value, the maximum has been 2.6 MV/m. The highest Qo also was quite low, around $Q_{0\ max} \approx 5.10^8$. The cavity is producing a lot of field emission awaited consequence of the absence of high pressure water rinsing treatment with a dose rate of 50µSv/h with RF power pulsed to HF 25% of duty cycle. The impossibility to increase the accelerating field might be due to high losses on the RF antenna. This one is located in a cavity area where the magnetic field is not equal to zero, thus leading to RF losses. This assumption is confirmed by the Qo variation with the antenna displacement. One has to notice the very good operation of the vertical cryostat and the low level RF system.

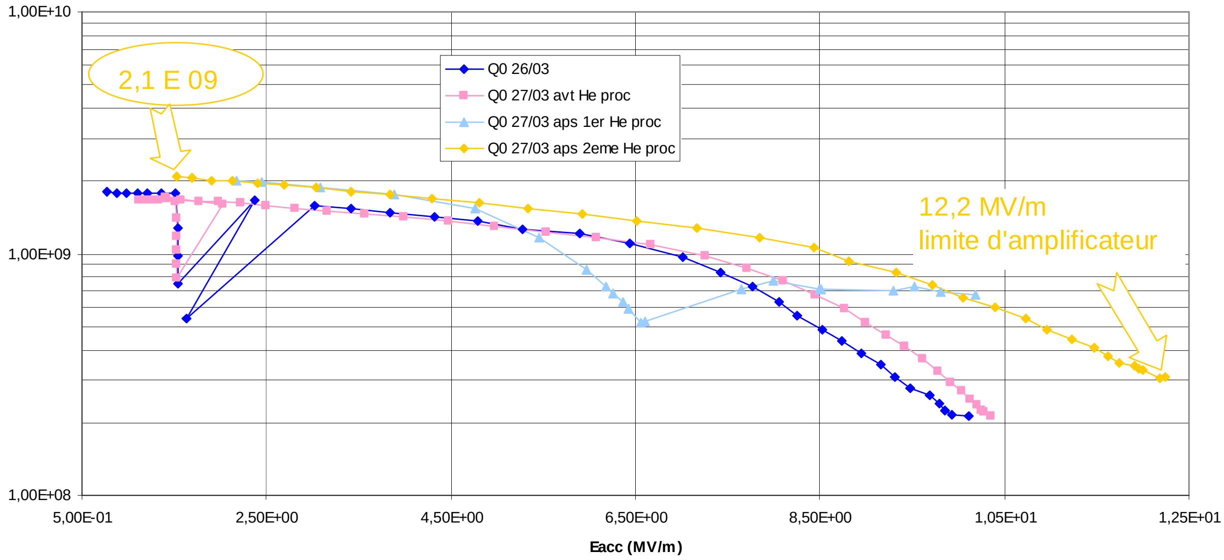
Experiment from the 26 to the 27 march :

The main modification with respect to the previous experiment is the high pressure rinsing treatment of the cavity and the coupling by the beam port instead of the side power coupler port.
During this experiment, 2 helium processing has been performed (between 1 10^{-5} and 4 10^{-5} mbar), which allowed to very high gain on the maximum achievable accelerating field.

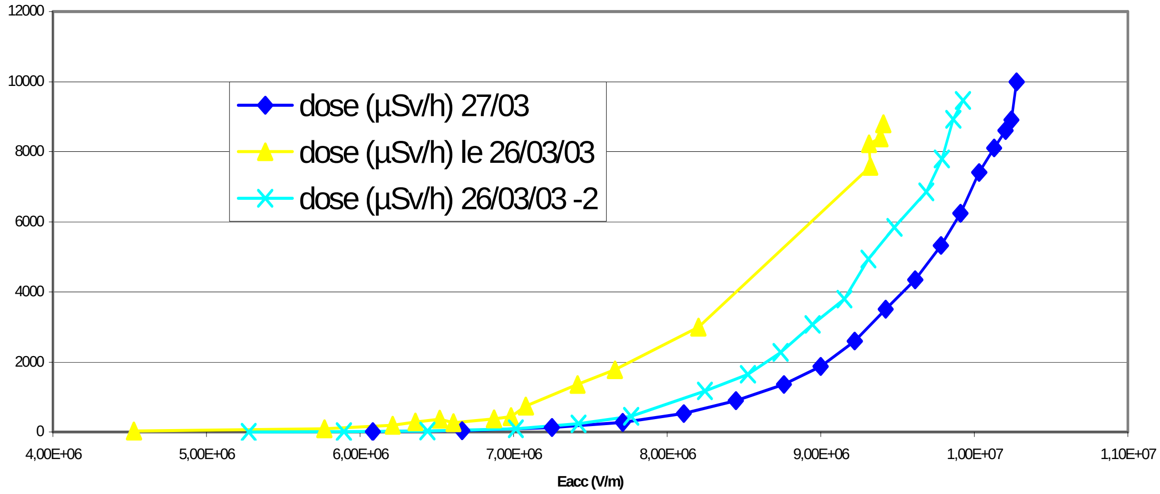
He processing :



Q_0 evolution :

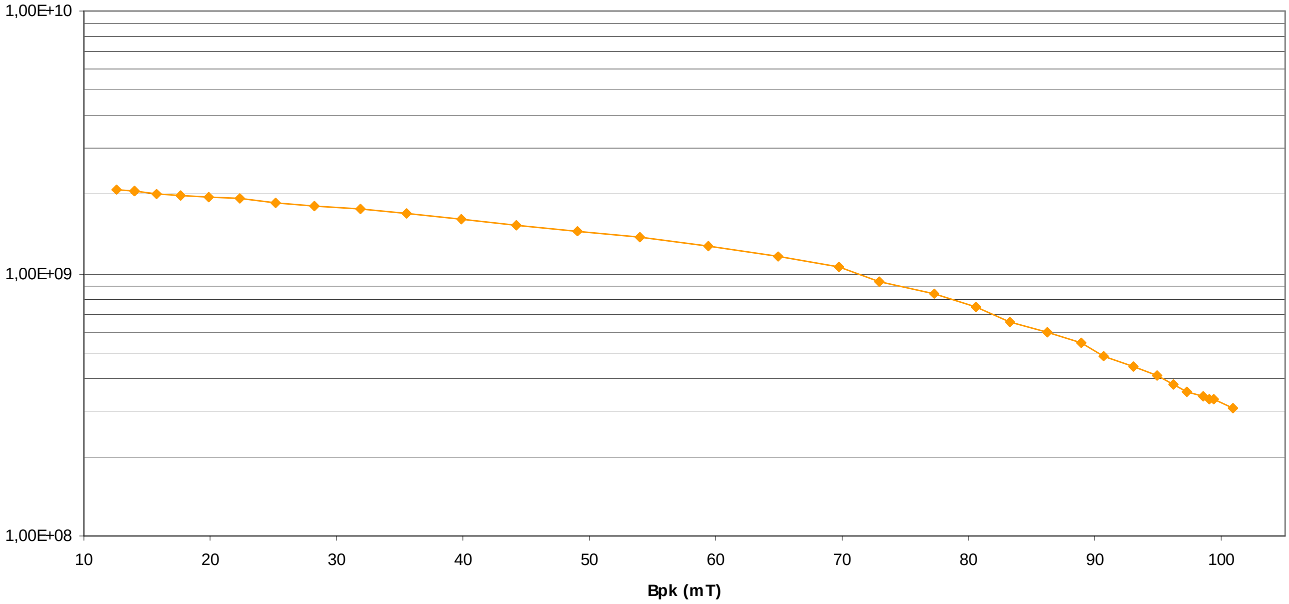


The helium processing has allowed to decrease the field emission level and the measured dose rate for the same accelerating field.



The maximum achievable surface fields have been : Epk = 37.5 MV/m and Bpk = 100 mT.

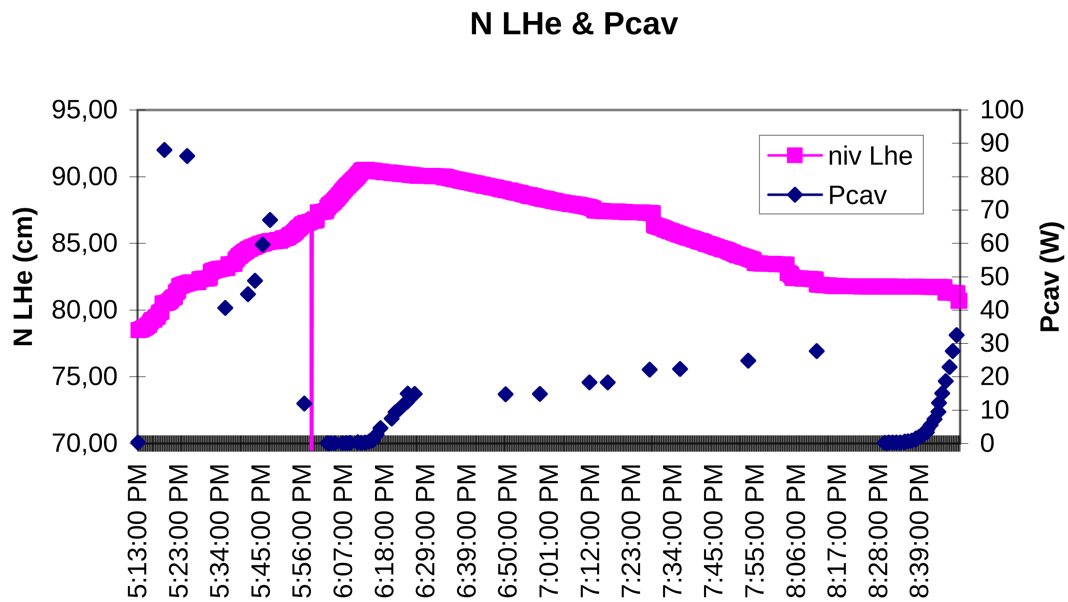
The experimental Q_0 = f(Bpk) measured curve:



With the measure of the liquid helium inside the cryostat, the dissipated power P_{He} in the bath could be measured

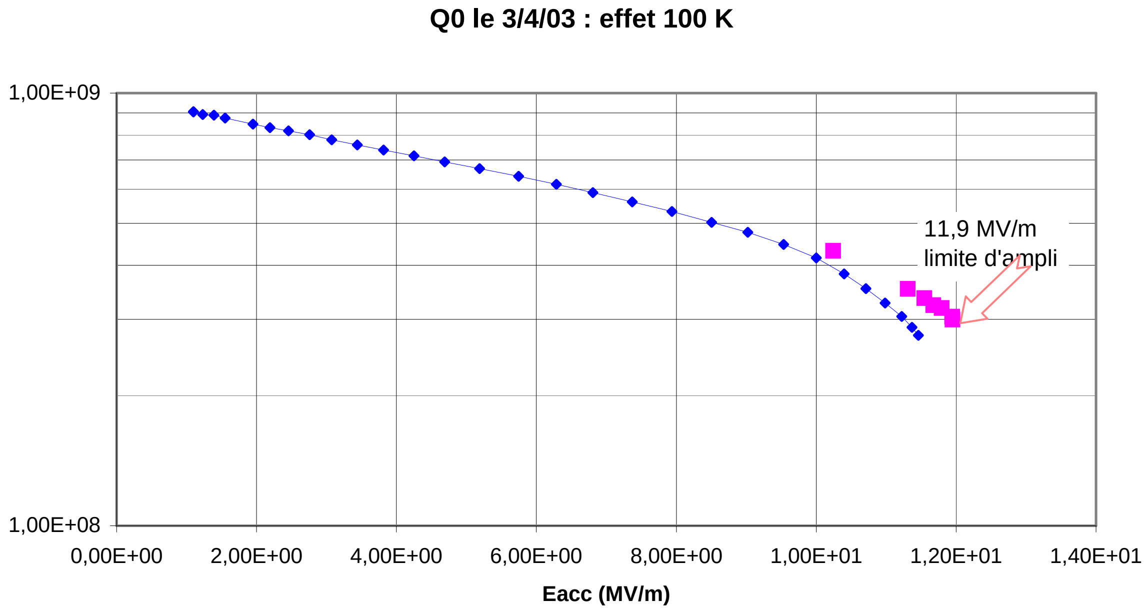
$$P_{He}.t_{HF} = \rho_{LHe}.N^{i}_{LHe}.S_{LHe}.\left(T^{f} - T^{i}\right) + \Delta H^{vap}_{LHe}.\rho_{LHe}.S_{LHe}.\left(N^{i}_{LHe} - N^{f}_{LHe}\right)$$

With: t_{HF} : the overall time with RF power on, ρ_{Lhe} : the liquid helium density at 4.2 K (124.8 kg/m^3), N_{Lhe} : the liquid helium level in the cryostat, S_{Lhe} : the helium free surface (0.507 m^2), T the bath temperature and ΔH^{vap} the liquid helium vaporization latent (20.71 J/g).
Between 18h34 and 19h12 the level varied from 89.93 cm to 87.62 cm, corresponding to 13.2 W dissipated in the helium bath, in good agreement with the 14.8 W dissipated in the cavity and measured by the RF system.
Between 19h29 and 19h55, le the level varied from 86.4 cm to 83.76 cm, corresponding to a dissipated power of 22.2 W in the bath, corresponding to a dissipated power in the cavity of 22.3W.

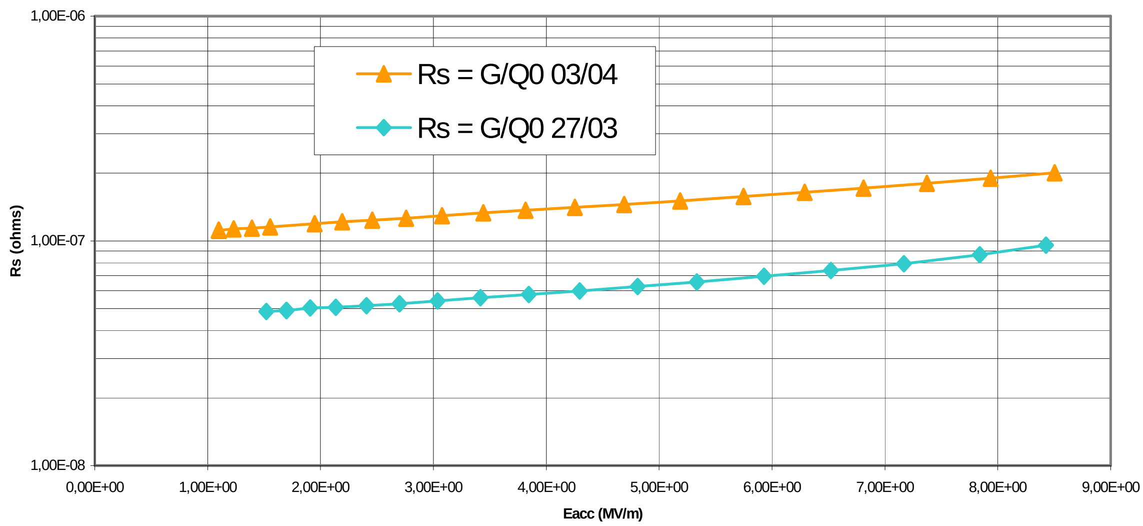


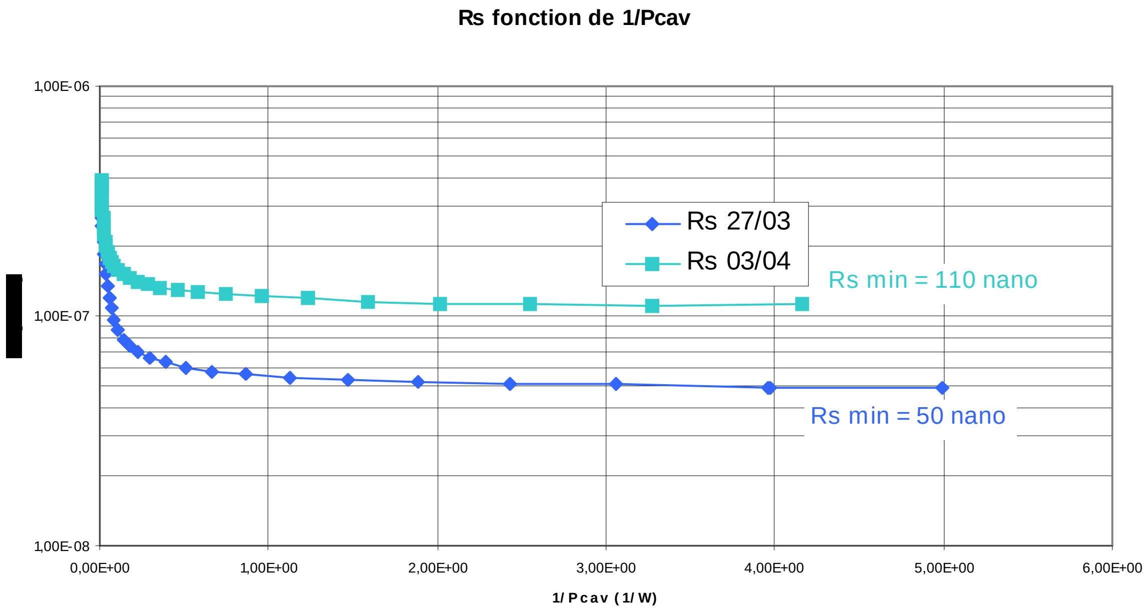
Experiment on the 03/04: 100K effect study

After spending around 67 hours between 90 K and 120 K, the dangerous temperature zone known to produce the 100 K effect in superconducting cavities, the measured Qo became the following:

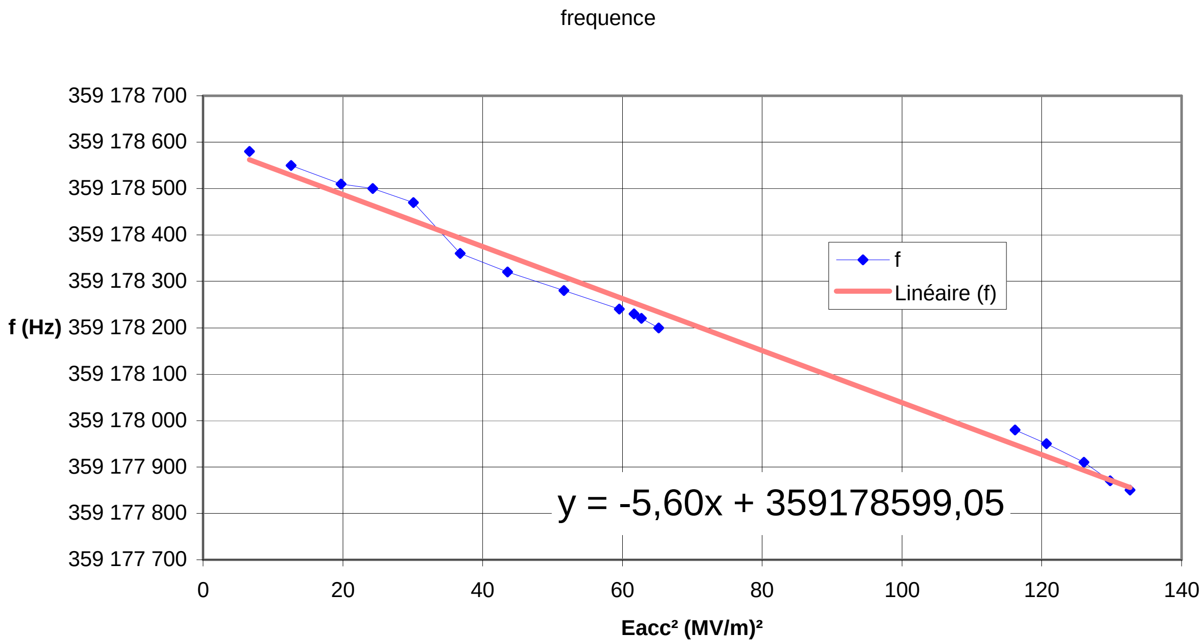


The consequence of the 100 K effect on the surface resistance (Rs) is clearly visible on the following experimental curve :





The Lorentz detuning parameter K has also been measured : K = 5.6 Hz/(MV/m)²



Finally, the cavity performances could be summarized with the following curve: