Exercise 6: Superconducting niobium cavity

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| Group | Student 1 |
|  | Student 2 |
| Date | Assistant |

Staple the graphs, which you base your analysis on, to the answer form.

The level of detail of a complete answer is such that the answer fits in the box if typed in average handwriting.

Instead of typing in the boxes below, you may write on separate sheets.

The numbering of the questions below refers to the corresponding labels in the instructions. Notice that not all the latter questions will be considered in this *lomake* assignment.

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| 1. Use Eq. (19) and the measured dimensions of the cavity to predict the mode frequency, and compare it to the stated value. |
| 2. Convert the thermometer reading voltages into temperature according to the diode data sheet, or the ready-made Matlab function ``TempCal.m'' provided in the exercise material. |
| 3. Fit (inverted) Lorentzian functions to the measured resonance dips in order to find int, according to Eq. (18). Use a fixed value for ext as provided above. Be cautious whether you are using decibels, power, or voltage! |
| 4. Plot the internal loss rate int as a function of temperature (in the temperature range from 4.2 K up to clearly above *T*C, e.g. 20 K). Show the vertical axis in logarithmic scale, because the values vary quite a lot. |
| 5. Fit temperature dependence of int to theory, that is, Eqs. (21,22). Use as fitting parameters the constant , superconducting gap , and the residual resistance *R*0. Plot the fitted curve together with the data. |
| 6. Based on the result from step 5, recover the critical temperature of the cavity material, and compare to a literature value. |
| (b) Derive equation (12). Start from Kirchhoff laws used in the circuit segment in Fig. 2, and combine the results to obtain Eq. (12). From the result, write down expression for the speed *C* of the wave in terms of the given wire parameters, evaluate the value using the given parameter values, and compare to the corresponding quantity in free space. |
| (d) Present any graphs used in the data analysis. |
| (e) Attach all the analyzed resonance curves, complete with fit functions plotted on top of the data, as an appendix. |