Note on Vertical Test Results of Cavity TE1AES004

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2/10/09

Cavity TE1AES004, a single-cell Tesla-shape cavity manufactured by AES Corporation, was tested at the Fermilab VCTF on several previous occasions. During these earlier tests, the cavity was limited by FE loading, never exceeding a gradient of about 33MV/m. Prior to the first tests at FNAL, the cavity was electro-polished (EP) at ANL then high-pressure rinsed (HPR) at the A0 facility at FNAL. For the second test cycle, the cavity was only HPR'd at A0. After these test cycles, the cavity was optically inspected at FNAL using the KEK/Kyoto-supplied imaging system. This inspection revealed a rather large (~1mm diameter) "pit" located near the equator. After this inspection and prior to this test, the cavity was HPR'd and assembled/evacuated exclusively at the ANL/FNAL facility using procedures recently developed. It was then transported back to FNAL, to the VCTF at IB1, where it was mounted on the test stand, connected to the pumping system, and instrumented with the prototype single-cell diode thermometry system

The cavity was cooled down from 4K to 2K, and some Q_0 vs T measurements were performed in the temperature region just above the λ-point transition. Once at 2.00K, CW measurements of Q_0 vs E were performed. The cavity exhibited several soft multipacting barriers at 20, 21 and 24MV/m which were breached without great difficulty.

Field emission was not observed initially until a gradient of about 31 MV/m was reached, in contrast to earlier tests of this cavity which indicated field emission onset at about 21-22 MV/m. The field emission activity was fairly low, remaining below 0.06mR/hr, and the emitter appeared to have processed away once the cavity reached maximum gradient (39.2 MV/m) and stayed at that field for a few minutes (see Figure 1). On the subsequent Q_0 vs E run, no field emission was observed, though the overall Q_0 had been decreased slightly (see Figure 2). Overall the cavity performed exceedingly well, reaching a maximum gradient of 39.2MV/m with a Q_0 of 6 x 10^9 there, and was limited by quench at this maximum field. The cavity exceeded the ILC performance specification with a Q_0 of 8 x 10^9 at a gradient of 35MV/m.

After performing the Q_0 vs E run at 2K, the cavity was further cooled down to 1.58K while Q_0 measurements were made. From these measurements, we find the cavity had a residual surface resistance of about 9.4nΩ (see Figure 3). This is somewhat higher than the last measured value for R_s for this cavity of 6nΩ. These measurements were also much "noisier", and hence there is a larger uncertainty in this value (0.6nΩ). This scatter in Q_0 values is most pronounced in the data taken above the λ-point of He, perhaps reflecting the poorer cooling of normal helium; yet there is still substantial scatter below the l-point, greater than that seen in previous measurement runs (i.e., cavity NR-1, or previous tests of TE1AES004). It is not clear why this should be the case.

Diode thermometry was mounted to this cavity and scans were performed at various times during Q_0 vs E runs at 2K. The thermometry system did reveal the appearance of “hot spots” that may be correlated to initial FE or (after FE processing) to normal-conducting defects or oxides. Further analysis of the data is required. If at high fields (near quench) an observed hot spot can be correlated with the location of the known “pit”, suggesting it is the cause of the quench, it may be useful to attempt the recently proposed “laser melting” repair process on this pit, and see if an improvement in quench field can be obtained during a subsequent test.

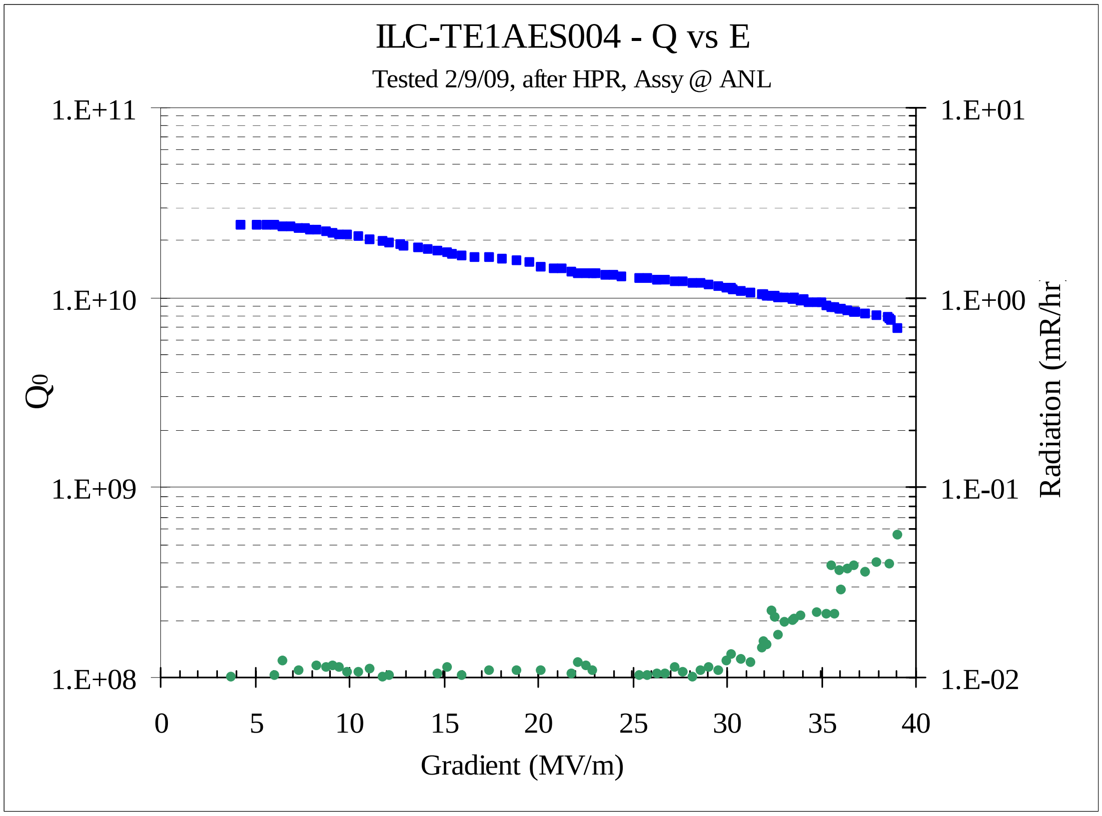

Figure 1.) Initial Q_0 vs E run at 2K

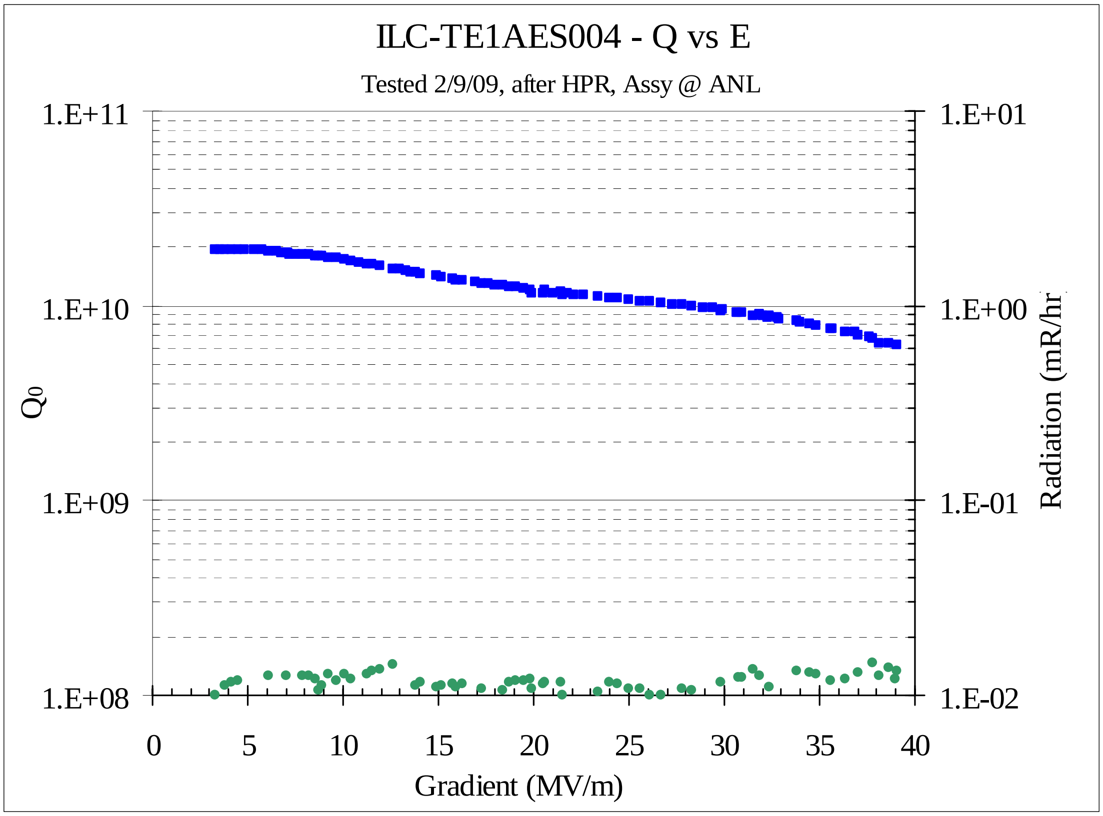

Figure 2.) Final Q_0 vs E run at 2K, after FE processed away (leading to somewhat reduced values of Q_0 when compared to the initial run).

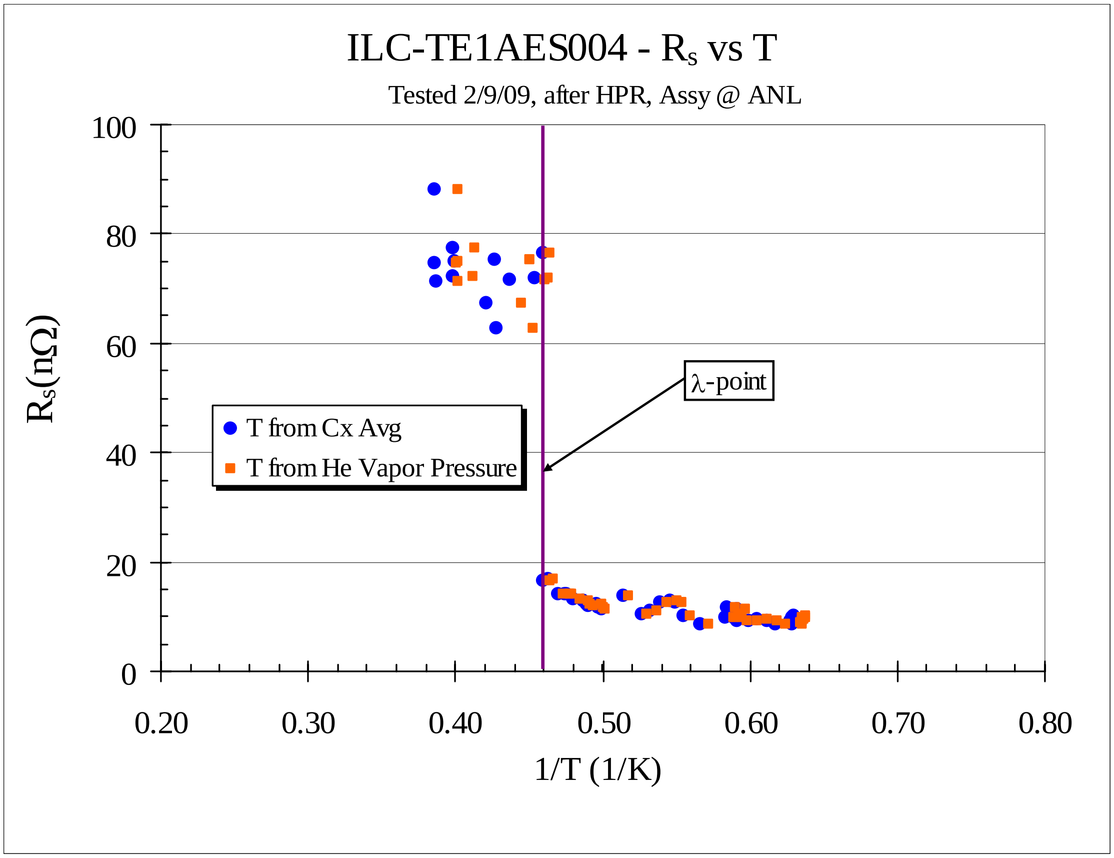

Figure 3.) R_s vs 1/T.