HIGHER ORDER MODES OF THE MAIN RING CAVITY AT FERMILAB

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Abstract

The shunt impedance and frequency of the higher order modes [HOM] of the Main Ring Cavity (h = 1113) at Fermilab were measured using the stretched wire method. The results of the stretched wire measurements and a cavity transmission line model of the modes will be given.

I. SHUNT IMPEDANCE MEASUREMENT

Shunt impedance measurements have been made on a Main Ring Cavity [1], shown in Figure 1, that tunes between 52.812 and 53.104 Mhz with two ferrite tuners. The cavity has a typical gap voltage of 250 kV per cavity at the gap. The stretched wire method is essentially a voltage divider circuit where one part of the divider is a 50 Ω resistor and the other is a fixture (Figure 2) with a wire across the gap of the cavity. The 50 Ω resistor and stretched wire fixture are in series with each other. The frequency drive to the fixture was supplied by an HP 8753C network analyzer. The first voltage measured by the analyzer was across both the fixture and the 50 Ω resistor. The second voltage was measured across just the 50 Ω resistor by a HP 85024A high-frequency probe to the analyzer. The frequency and voltages at each of the resonant modes of the cavity were then recorded. To remove the impedance of the stretched wire fixture, the fixture was placed across only the beam pipe (Figure 2) and the fixture impedance was measured at each frequency of the resonant modes of the cavity. The corresponding impedances of the fixture were then subtracted from each of the cavity modes to give the final shunt impedance.

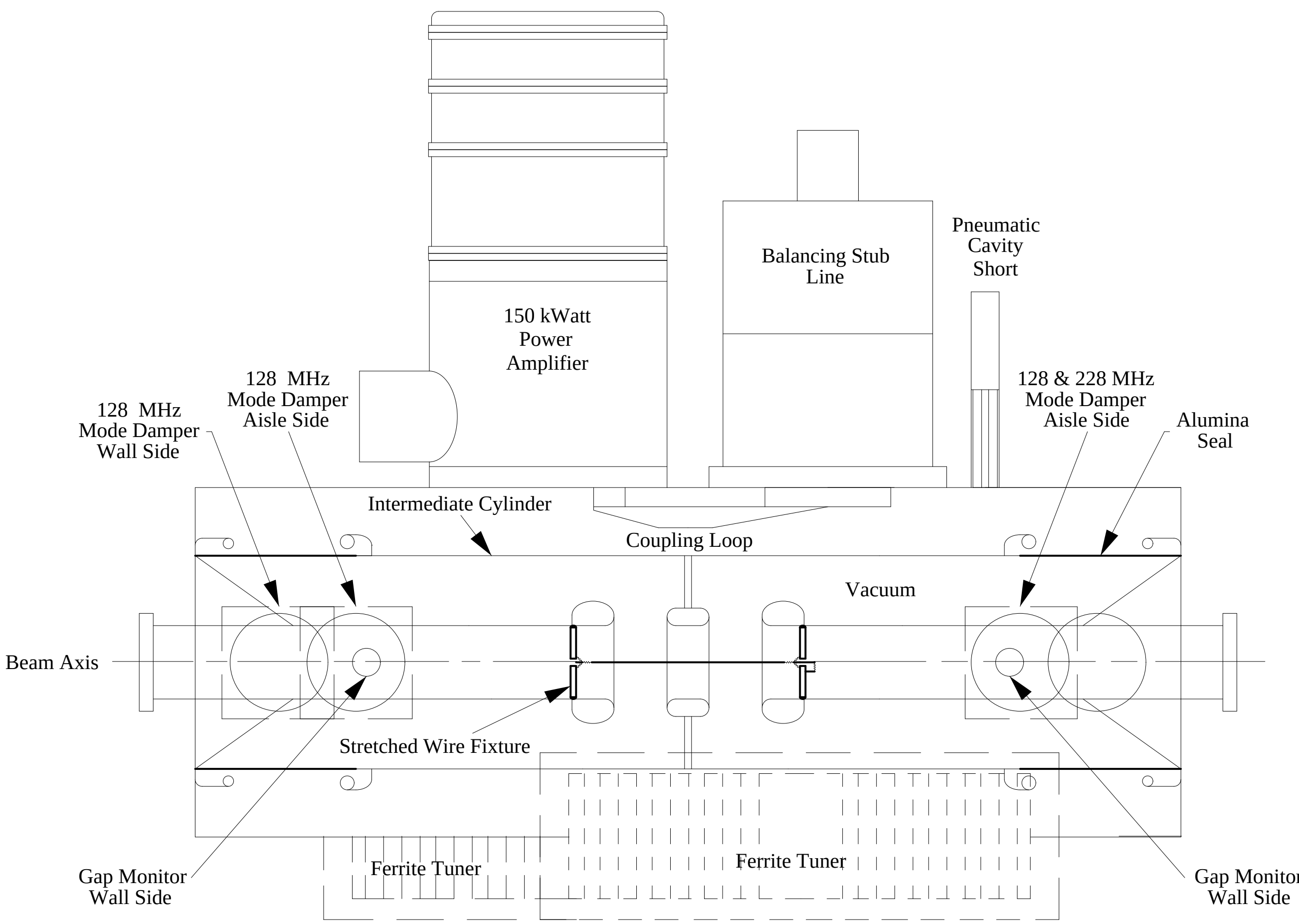

Figure 1: Diagram of Main Ring Cavity (h = 1113).

*Operated by Universities Research Association, Inc. under contract with the U.S. Department of Energy.

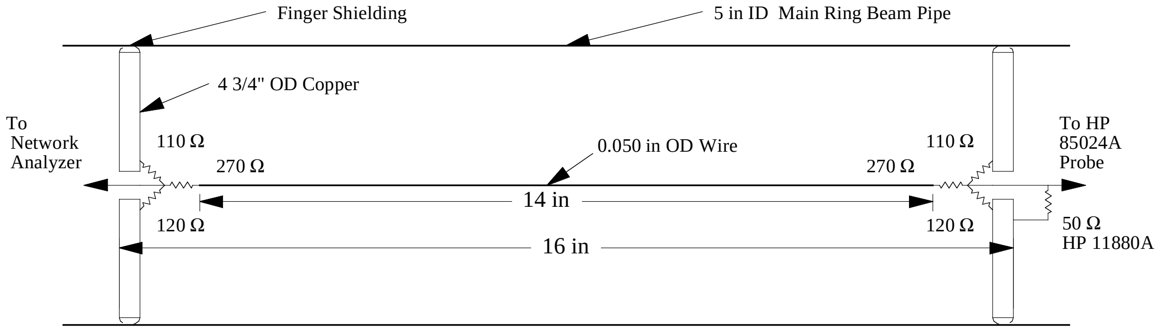

Figure 2: Stretched Wire Fixture.

II. TRANSMISSION LINE MODEL

The circuit in Figure 3 was simulated on RFLab™. The capacitors 1 and 2 represent the gap capacitance of each of the respective cavity gaps. Transmission lines 1 and 2 represent the beam pipe as the inner conductor and the intermedite cylinder as the outer conductor of the line. Transmission lines 3 and 4 represent the folded portion of the cavity. Transmision lines 5 and 6 represent the intermediate cylinder as the inner conductor and the outer shell of the cavity as the outer conductor of the line. Inductor 1 is the inductance of the 1 kV dc bias circuit to the intermediate cylinder. The model predicts (measured) odd modes at 52 (53.191), 131 (127.25), 225 (227.549), and 328 (336.876) Mhz, and even modes at 80 (82.253), 200 (197.776), and 264 (261.996) Mhz when looked at from port 1.

II. HOM OF THE MAIN RING CAVITY

The data presented in Figures 4 and 5 are for the cases where the dc bias current to the ferrite tuners was zero and full bias (2000 A). The data was taken with the cavity mode dampers in place as shown in Figure 1. This is the present state of all the dampers on the eighteen cavities in the Main Ring tunnel.

IV. REFERENCES

[1] "Mode Damping in NAL Main Ring Accelerating Cavities," R.A. Dehn, Q. A. Kerns, and J. E. Griffin, IEEE Trans. on Nucl. Sci., Vol. NS-18, No. 3, June 1971

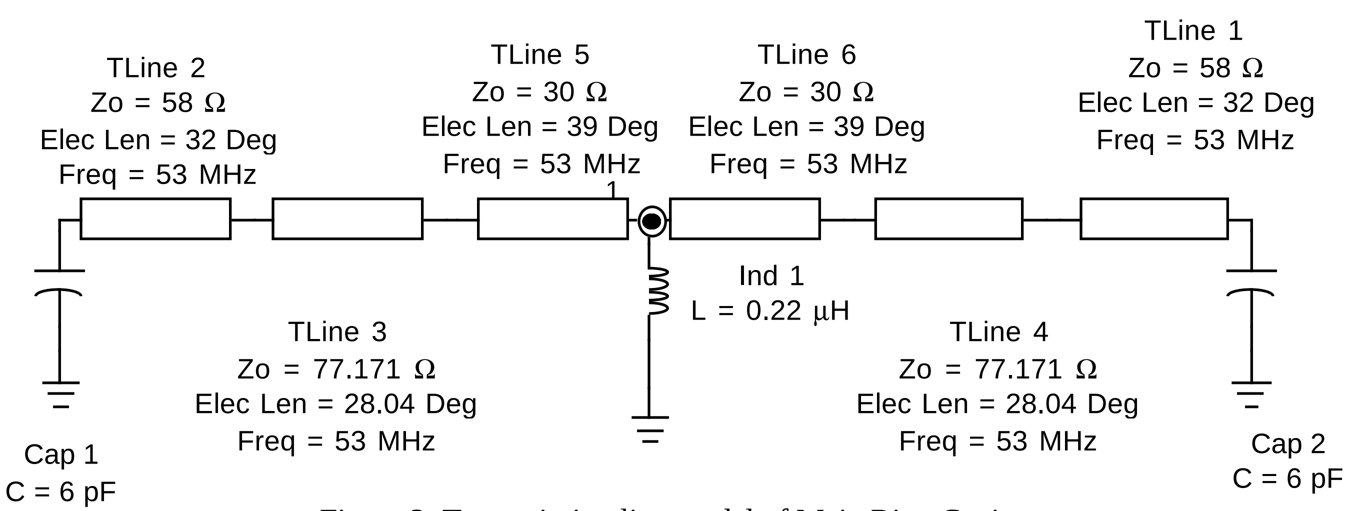

Figure 3: Transmission line model of Main Ring Cavity.

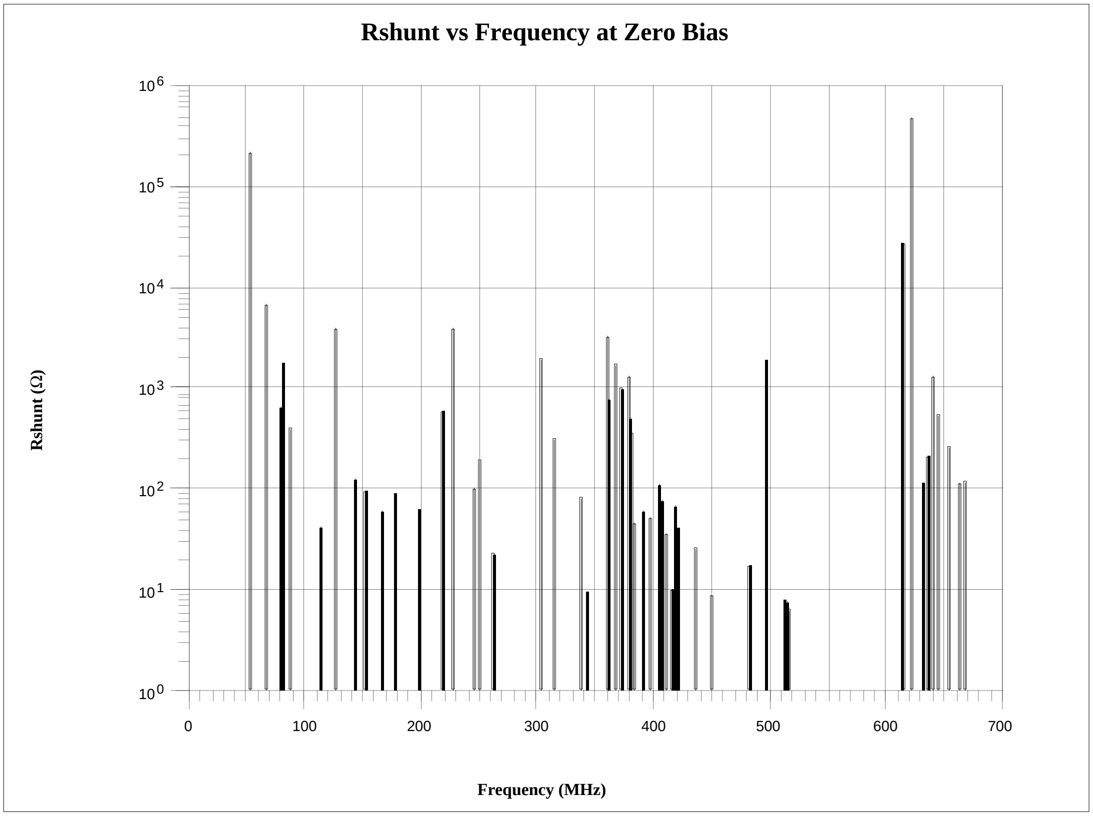

Figure 4: Shunt Impedance at Zero Bias of Main Ring Cavity.

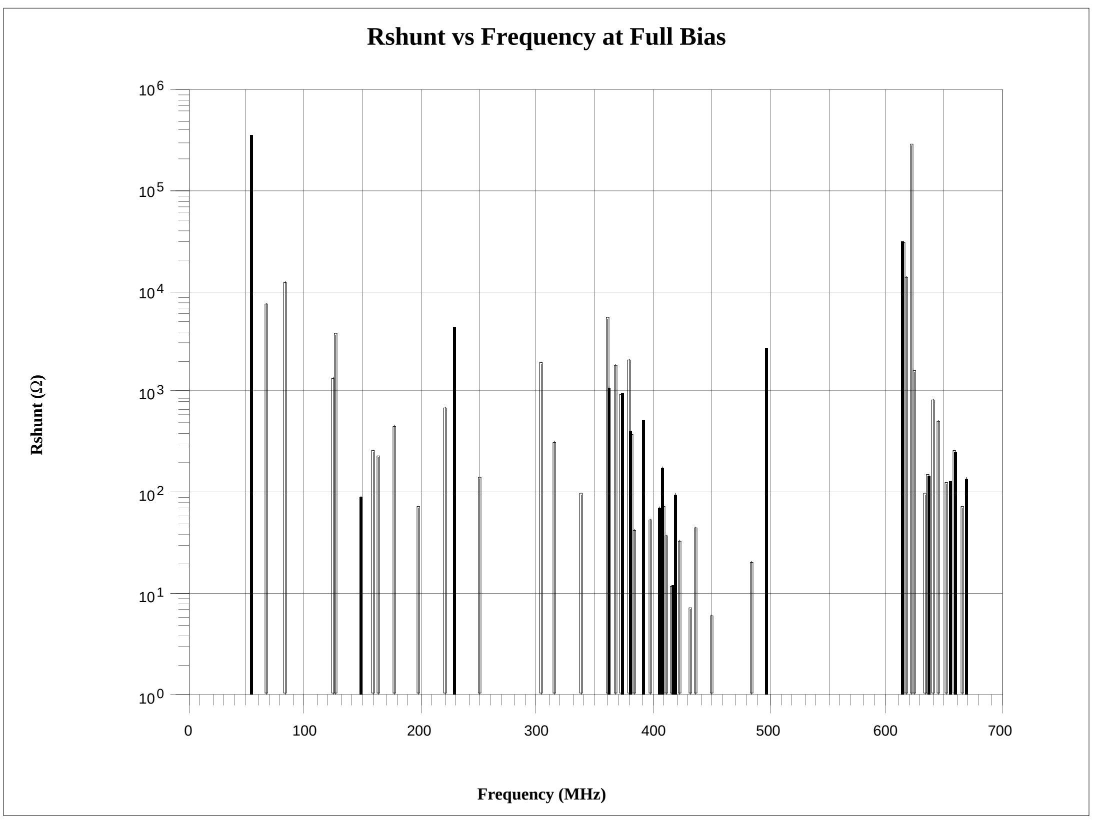

Figure 5: Shunt Impedance at Full Bias of Main Ring Cavity.