

VLBA ACQUISITION MEMO #243

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TO : VLBA Data Acquisition Group
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SUBJECT : Capacitance of Gapped Bars

Since the glass in the gap is silicon dioxide, an insulator with a known dielectric constant, it is possible to measure the gap length by measuring the capacitance across the gap. To this end, two gapped bars were measured at a frequencies between 10 and 500 KHz. Since the resistivity of the ferrite is fairly high and would introduce a series resistance that would dominate the capacitance measurement, small wires were bonded to the edges of the bar with conductive paint, which can be washed off with acetone. I found that the gaps were shunted with a DC resistance as low as 720 ohms, a shunt probably caused by ferrite in the gap, or smeared across the surface of the gap.

The results of some of these measurements are shown in the table, where a dielectric constant of 4 has been used to calculate the gap length from the measured capacitance. A frequency of 100 KHz was chosen to ensure that the capacitive reactance is less than the shunt resistance, and still much greater than the series resistance of a few ohms. In fact, the capacitance changes by less than 10 percent between 10 and 400 KHz.

Bar	DC Resistance ohms	100 KHz		
		Resistance ohms	Capacitance nf	Gap Length μm
1	4750	3460	4.580	.200
2	720	662	4.683	.196

The uncertainty in the calculation of gap length is about 8 percent, or $\pm 0.016\mu\text{m}$, primarily because of uncertainty in the gap area within the mechanical tolerances of the bar. This gap length agrees with preliminary scanning electron microscope measurements, but disagrees with the $.25\mu\text{m}$ calculated from the gap null in VLBA Acquisition Memo #184. This difference between the mechanical and magnetic gap length could be the result of a dead layer in the ferrite of $0.025\mu\text{m}$ on each side of the gap, and is consistent with the $0.05\mu\text{m}$ dead layer reported in VLBA Acquisition Memo #207. If there is such a dead layer, we should be careful about changing the method of measuring the gap length, since head performance is determined by the effective magnetic gap length.