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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 $\pm 0.016\mu$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 μm 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 μm on each side of the gap, and is consistent with the 0.05 μm 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.