TS-SSC 90-099

Wayne Koska

December 4, 1990

Azimuthal 40 mm Long Coil Size Variations

This note summarizes a quick analysis of the data from the azimuthal coil size measurements of 4 long 40 mm inner coils (coil numbers 1010,1012, 1008,and 1011R, used in magnets DC0303 and DC0304 respectively) and 2 long 40 mm outer coils (coil numbers 2011 and 2012, used in magnet DC0303). So that this analysis might be useful for those working on the relation between coil size and tooling variations, this data is displayed as a function of longitudinal position along the coil in the forms devised by Dick Sims to accentuate vertical or horizontal displacements of the tooling. That is, the sum or difference (divided by two) of the size for the two sides of a coil normalized to the average sum or difference for the overall coil is shown. In equation form:

$$S_i=(a_{1i}-Ave(a_i))+(a_{2i}-Ave(a_i))/2$$

and

$$D_i=(a_{1i}-Ave(a_i))-(a_{2i}-Ave(a_i))/2=a_{1i}-a_{2i}$$

where a_{1i} and a_{2i} are azimuthal measurements of the coil directly across from each other (i.e. the left and right side of the coil) for the i_{th} coil. Variations in the quantity S show fluctuations which are correlated in both sides of the coil, and therefore represent vertical variations of the tooling, while variations in the quantity D show fluctuations which are anticorrelated between the two sides and indicate horizontal fluctuations in the tooling. In figures 1) and 2) averages of S_i and D_i over the i coils are shown for both the inner and outer coils, with error bars which represent the standard deviation of the S_i and D_i. Due to various systematic errors in the measurement of these coils, the alignment between measurements from side to side in a coil is probably not better than 1.5 inches and that between coils is probably not better than 3 inches. Even with these possible misalignments, it is obvious that the coils share some common features. The most noticeable is the dip in S of about 3.5 mils in the inner coils which is seen in figure 1a) at position 107, corresponding to the center of the coils. There are also dips at positions 53 and 160, which correspond to 1/4 and 3/4 the length of the coils. These latter two dips also show up strongly in S in the outer coils (figure 2a)) however a dip at the center of the outer coils is barely discernable. There are also several other features which can be picked out. These include a bump in S in the inner coils of about 2.5 mils at position 125 and a bump in D in the inner coils at position 145. There is also a wide bump in D centered near position 103 which may be correlated with the bump in S centered near position 107. Systematic variations in S of about 0.5 mils which seem to come in 4 to 5 foot segments can also be seen. As a final comment, it should be pointed out that the dip in S of about 3.5 mils near the center of the coils, when coupled with the bump in S of 2.5 mils near position 125 means the variation in prestress in a magnet would be about 6 kpsi, assuming the rule of thumb that 1 mil variation in coil size represents 1 kpsi in prestress.

Figure 1a

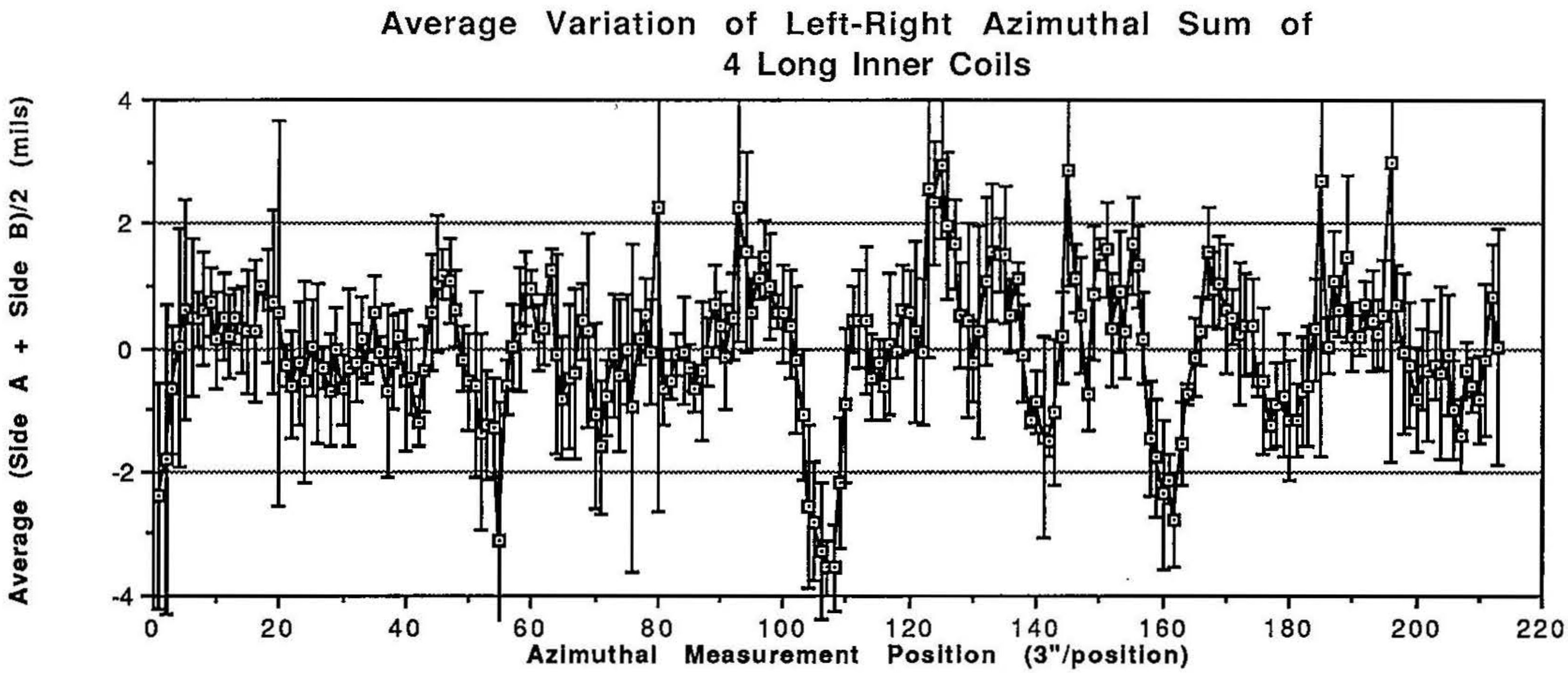


Figure 1b

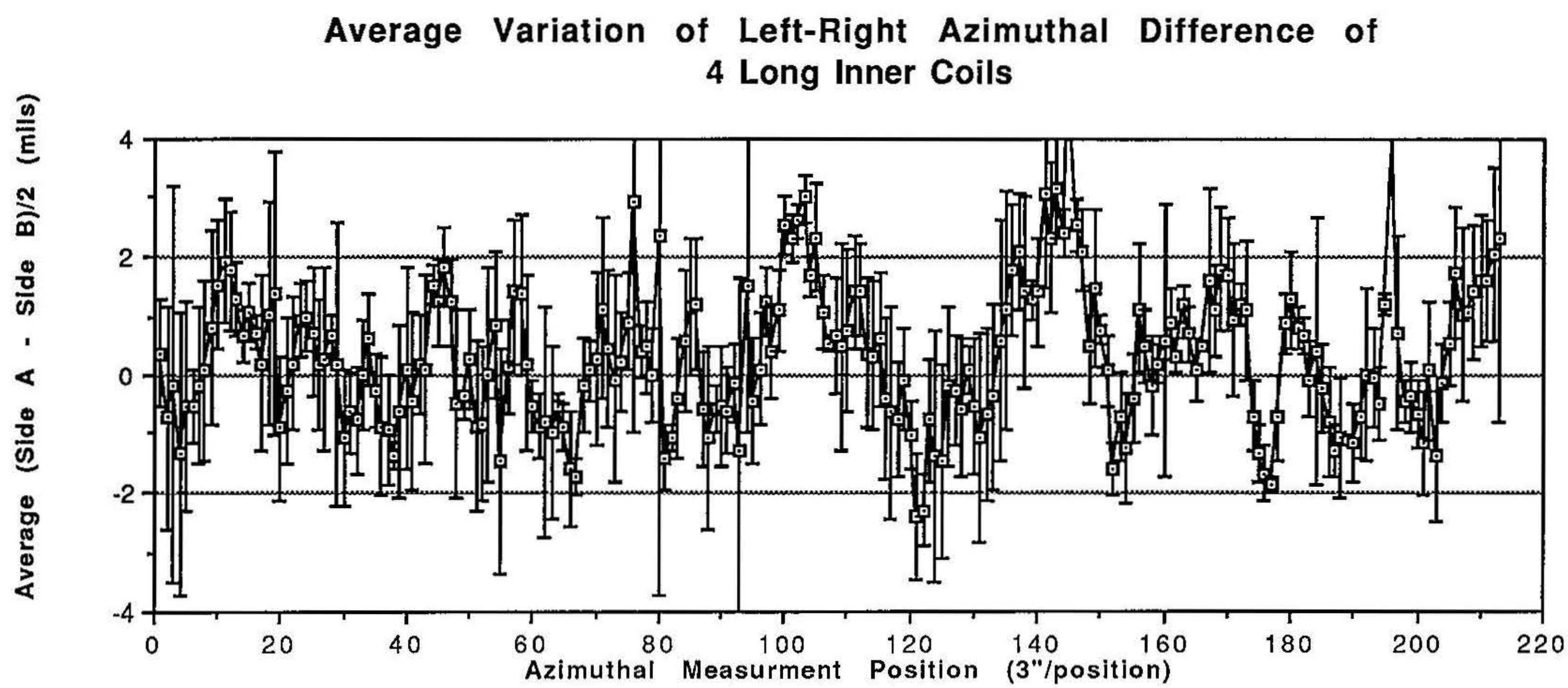


Figure 2a

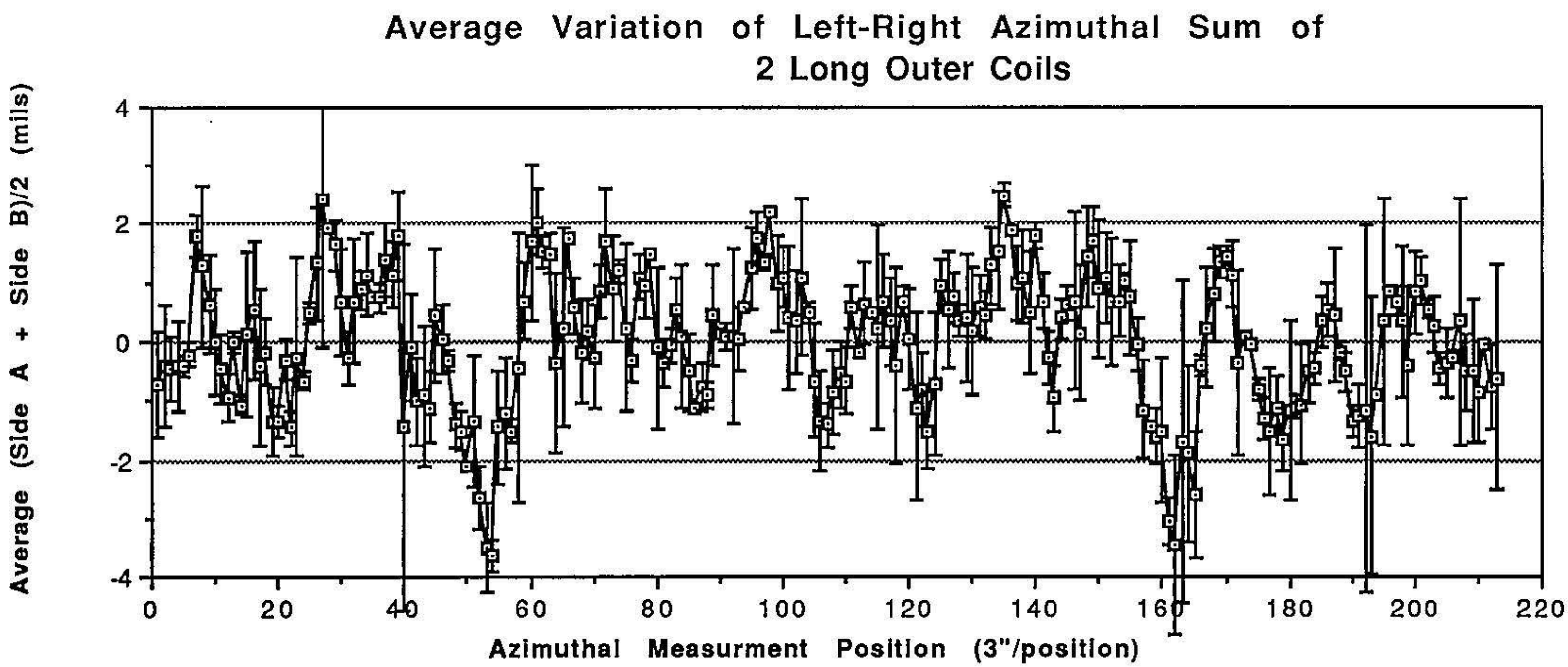
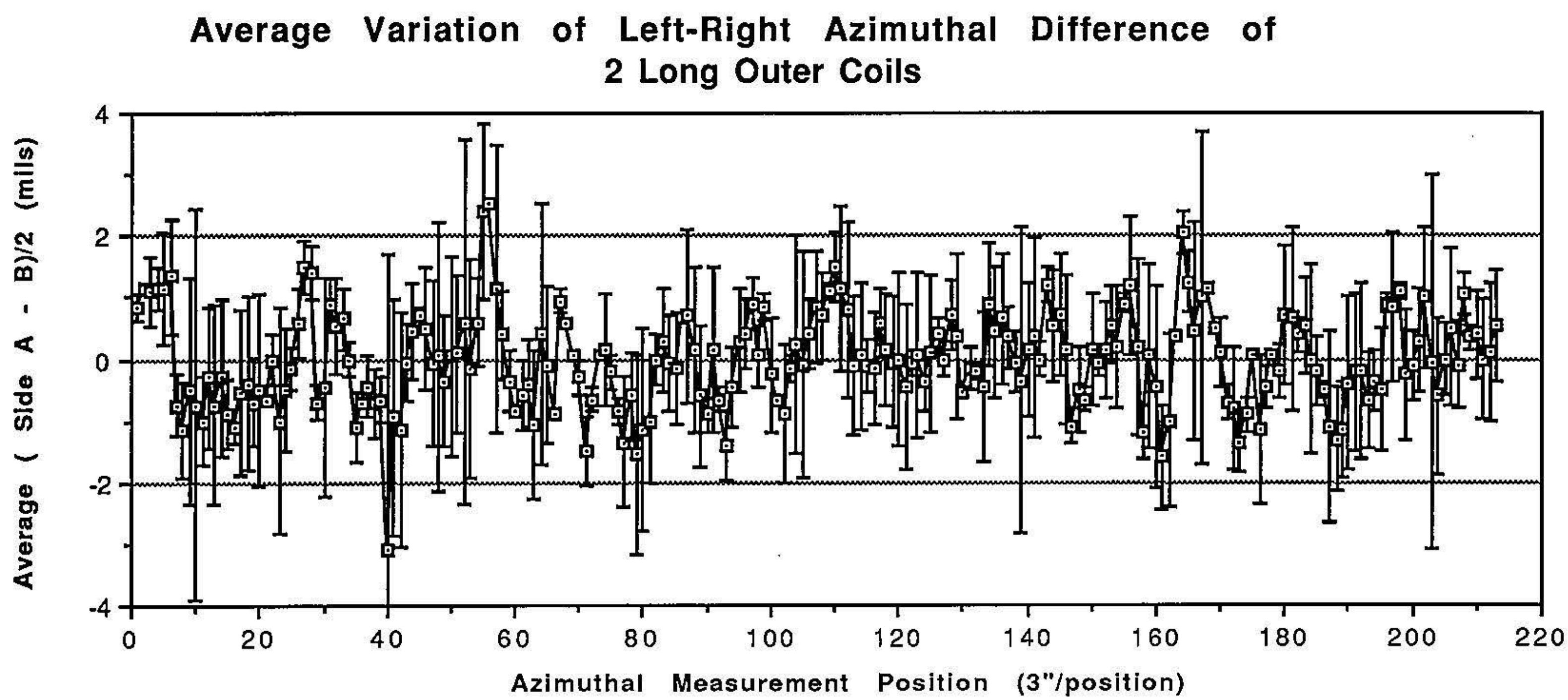


Figure 2b



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**Experiment Utilizing AC Magnetic
Field Pick-up Coil to Probe
Short Faulted DCO302**

TS-SSC90-100
December 5, 1990
Richard E. Sims

After yoking coil DCO302, a short appeared between the upper and lower coil sections. Based on the hypothesis that any shorts in the total coil assembly could distort the vertically oriented B Field so that it would have some horizontal B Field components, an experimental probe coil was designed to search for the short locations.

The first attempt was made with a 50 turn coil wound on a 1 3/16" diameter wooden bobbin. The coil was approximately 7/8 inch in diameter and approximately 1/2 inch wide. The ends of the coil were attached to a standard BNC female connector which was screwed into the center hole of the wooden bobbin. A 50 ohm cable which was marked every foot was used to pull the bobbin from the "return end" of the coil toward the lead end. A signal generator set to 1 kHz was connected to DSC302 with the coil connected in the normal manner to produce a vertical field. Approximately 13 volts rms thru 50 ohms was applied to the leads.

The output of the probe coil was connected to a Tektronix 7603 oscilloscope with a 7A22 vertical amplifier section. As the probe coil was pulled through the DCO302 coil, several peaks and valleys were noted on the oscilloscope; however, it was also noted that rotating the probe by twisting the cable also produced large variations in pick-up voltage. This was thought to be caused by the loop formed by the start and finish leads of the probe coil as they were routed to the BNC connector.

A new probe was built which was only 3/16 inch wide and the start and finish leads were routed with very short leads to the BNC connector.

This 50 turn coil was again pulled through DCO302 while attached to the same oscilloscope set-up. Although the effect was reduced, the probe was still very sensitive to rotation inside the coil. The scan of the coil was performed despite the rotational sensitivity but every effort was made to pull the probe through without twisting or rotating the probe cable. The results are shown in Figure 1. Note the "W" shaped dip between 27 feet and 39 feet as measured from the mouth of the lead-end beam tube.

The 303 coil was probed using the same probe coil and equipment; however, since 303 was not yoked at the time of this test, there was a much larger output with large (50 to 200 microvolt) swings in amplitude (see Figure 2). The periodicity of this waveform is 6 to 8 feet and is unexplained at this time.

Conclusions:

It was later found that coil 302 was heavily shorted at a single small spot between upper and lower inner coils and upper and lower outer coils at a location very close to the lead end (approximately 18" from turn-around). The difference between the 302 scan and the 303 scan shows 302 decreasing rapidly in the first foot of measurement and 303 increasing rapidly in the same area. Because there were only two sample coils and 303 was not yoked at the time, no conclusions are drawn. A future scan of 303 is planned after it is yoked to better compare a known shorted coil to a known good coil (303), while both are in the yoked stage.

The "W" pattern in 302 may be from the slightly magnetic stainless steel shim material that was used in the strain gauge pack at 36 feet. The same is probably true of the smaller dip at 18 feet.

In the future, it may be possible to improve the probe coil by placing the coil bobbin inside a high permeability metal tube about 3" long so that only horizontal magnetic lines are picked up by the coil. Grounding this tube would also reduce electrostatic pick-up.

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HORIZONTAL MAGNETIC FIELD INSIDE BEAM TUBE OF LONG COIL WITH 1KHZ APPLIED TO TOTAL COIL

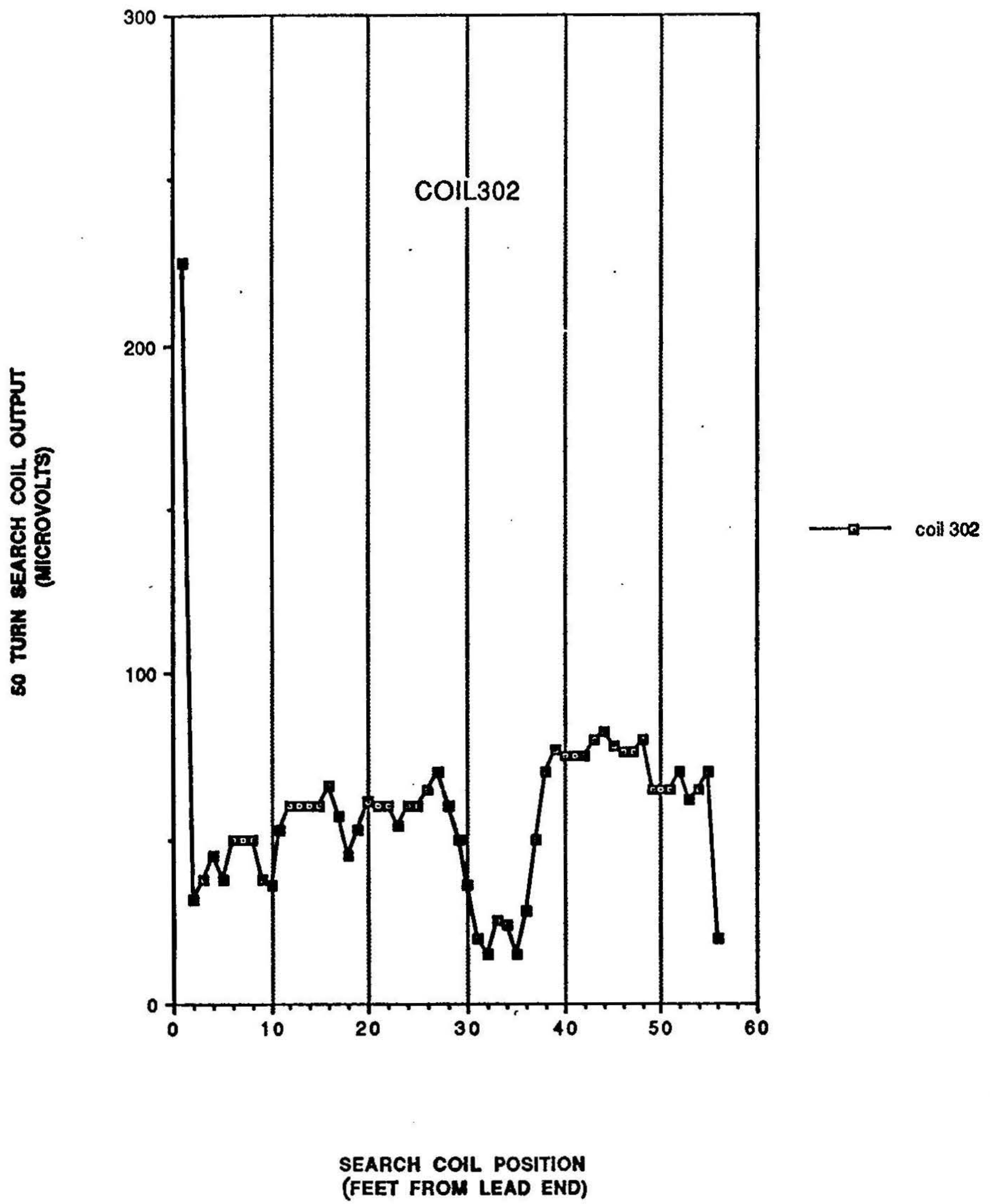

FIGURE 1

HORIZONTAL MAGNETIC FIELD INSIDE
BEAM TUBE OF LONG COIL WITH 1KHZ
APPLIED TO TOTAL COIL

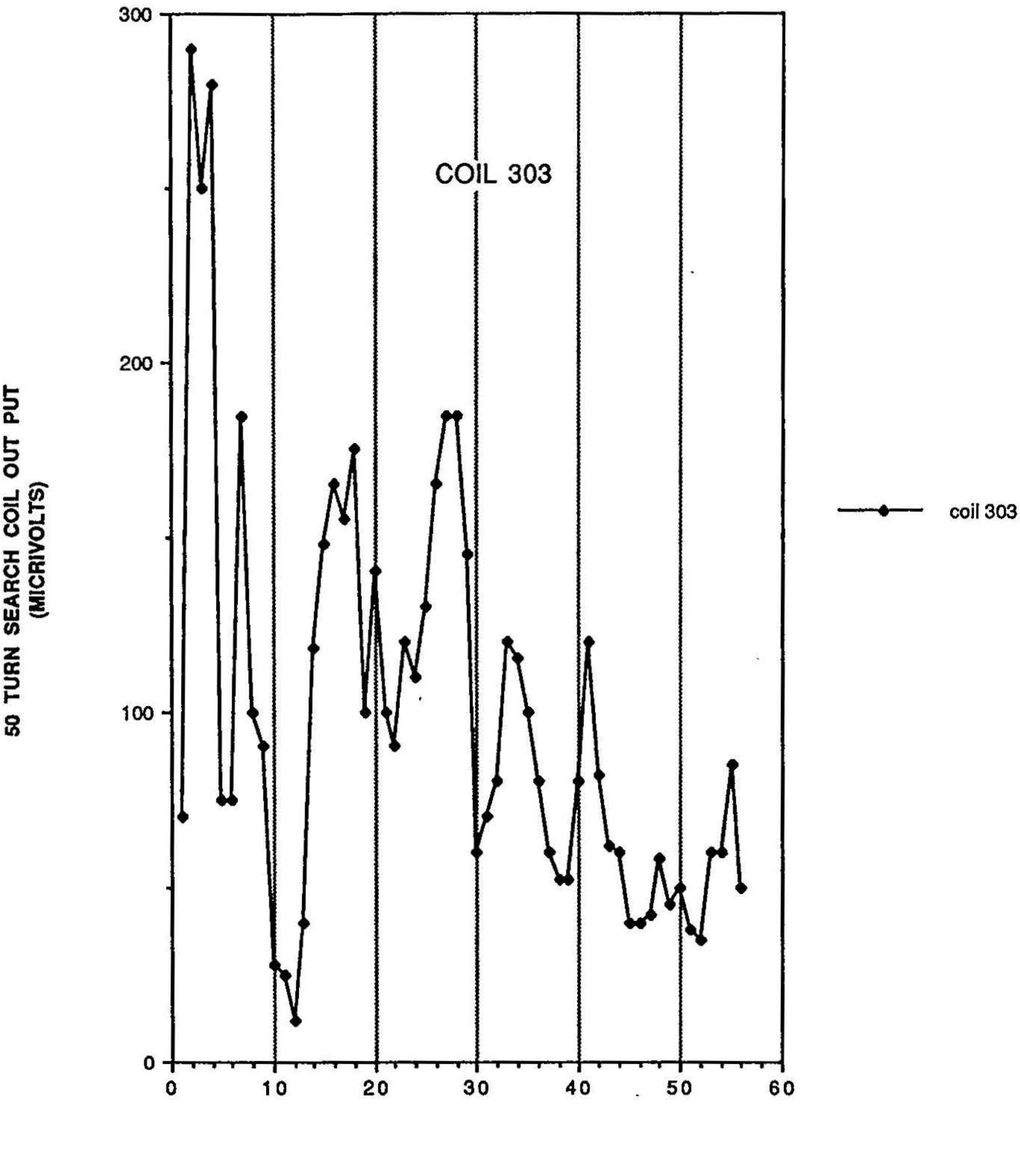

FIGURE 2