April 20, 1980

Note 48

Beam-Pipe Fields at SPEAR--II

Last fall measurements made in the east pit at SPEAR indicated that the electromagnetic fields caused by the beam and its image charge in the beam pipe did not show the characteristics expected from a simple picture of shielding by a continuous, conducting beam pipe. (See Note 24) There was far too much energy at frequencies (~ 400 MHz) that should have been completely shielded out by many skin depths, and the magnitude of the field outside the pipe was substantial: an amount that would be induced by a current of at least 10% of the beam current. All the results were consistent with substantial currents flowing on the outside of the pipe and on other conducting structures, presumably because of reflections at discontinuities. It seemed reasonable that there would be little to gain from using a thick beam pipe and much, possibly, to loose if free quarks are produced, but have a large interaction cross-section. However, because there was no access at that time to a thin section, there was no firm evidence.

Since the west pit is now free, I asked Joe Jurow to have the 0.006" thick Mark II pipe reinstalled, and a direct comparison is now available. Figure 1 shows the general setup. Four regions along the beam pipe were

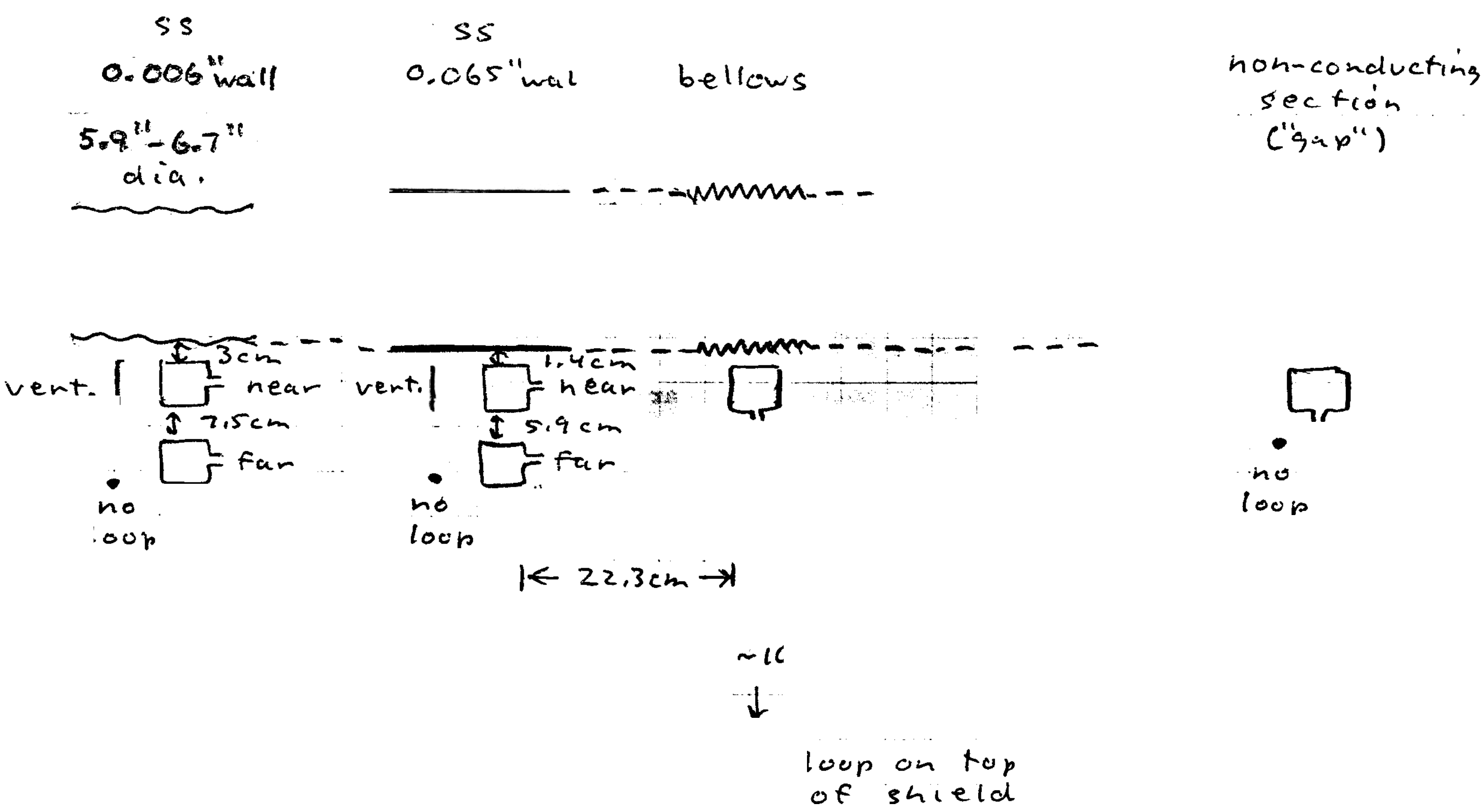

Figure 1

instrumented with 10 cm x10 cm single turn pickup loops connected directly to 50 Ω cables. (As discussed in Note 24, single turn loops were used to maximize the frequency response.) Since the objective was simply to compare relative field magnitudes, no proportional chambers or electric field pickup electrodes were used. The thin and thick sections each had two horizontal loops in the beam plane, one vertical loop in the plane perpendicular to the beam, and one cable with no loop to check for possible cable pickup. (No significant signal should be picked up by the vertical loops if the only currents are the beam and parallel ones in the beam pipe.) In addition, horizontal loops were placed near a bellows, on top of the concrete shield about 10' from the beam pipe, and near the insulating section of the vacuum pipe about ¼ of the way to the east pit, going clockwise. Because of the extra length of cable needed to reach there and the expected large fields in its vicinity, we also added a parallel cable with no loop for background subtraction.

Figure 2 shows the signal from the horizontal coils closest to the thick and thin sections for e^+e^- and e^+ only. For both types of beam, the fields are about 10 times larger outside the <u>thick</u> beam pipe. From the no-loop pictures, it can be seen that at most a few percent of the signal comes from the cable run to 226. Figures 3 and 4 show signals from the remaining cables. The signal height decreases with distance from the beam pipe as might be expected, but substantial signals are seen in the vertical loops. By far the largest signal is seen near the gap in the conducting beam pipe. However the timing of the other signals does not correspond to what would be expected if they originated only from the gap at the times of beam traversals.

Figures 5 and 6 use mixed trace speeds to show high frequency detail. Figure 7 can be used to determine the cable delay so relative times can be established between the various loop signals.

From the data in these two notes, no clear electrical reason can be seen for using the thick aluminum beam pipe. Its use doubles the number of interaction lengths to the 5th thin chamber.

S. Parker