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The HITL Faraday Cup Amplifier

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Technical Note

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BACKGROUND

The Heavy Ion Transfer Line (HITL) will connect the Tandem Van de Graaf (TVDG) to the Alternating Gradient Synchrotron (AGS). This 2100 foot beam line will consist of a series of 200-foot long cells containing a quadrupole doublet and small steering dipoles, and several large dipole magnets to provide the required bends. Proper beam monitoring is necessary to achieve the required high efficiency transport for such a long line at low energy.

One of the primary measurements will be of the beam intensity. Faraday cups have been provided at 17 locations in the beam line (Fig. 1). While a Faraday cup is destructive to the beam, it provides a measurement of both DC and pulsed beams and can operate over a very wide dynamic range. These will be used to successively tune each section of line for maximum transmission during set-up.

The amplifiers for the Faraday cup signal have been designed to match the two modes of TVDG operation, Pulse and DC, and to provide 2 gain settings in each. Thus not only does the gain change by a factor of 1000 between the 2 modes, but the bandwidth is also reduced greatly for DC, to limit the noise. For the Pulse mode the actual beam current (electrical) in the line is expected to be about 250 uA for oxygen and 10 uA for sulfur. For the DC mode the microAmps become nanoAmps and the minimum current might be as low as several hundred pA during turn on.

The Faraday cup amplifier is designed to cover this range while providing a risetime of less than 20 usec in the pulse mode and 1 msec in the DC mode. The electronics will be located near the cup (within 3 to 4 meters) and be able to provide a signal of 10 V into 50 Ohms. Careful grounding of the shield of the input signal coax at the amplifier end only, will prevent ground loops and 60 Hz pickup. Tests of a prototype unit in the TVDG indicated that the noise was +/- 1 mV on the 100 uA/V scale when viewed in the control room. Figure 2 shows the amplifier output observed in the TVDG control room for a 100 uA negative beam, with - 200 V on the bias electrode. The DC mode was not tested at that time. Figure 3 shows the amplifier output for a 2.5 uA signal from the low current source test circuit [1] at the 100 uA/V gain. The scope trace was taken at 5 mV/div and 20 usec/div.

THE CIRCUIT DESIGN

The amplifier circuit schematic is shown in Figure 4. The

REFERENCES

1. Zhen-Guo Li and R. L. Witkover, "A Pulsed Low Current Test Source", Accel. Div. Tech. Note No. 221, Oct. 2, 1985. BNL, Upton NY, 11973

2. Precision Monolithic Incorporated 1982 Catalog, 1500 Space Park Drive, Santa Clara, CA, 95050, pp 5-47

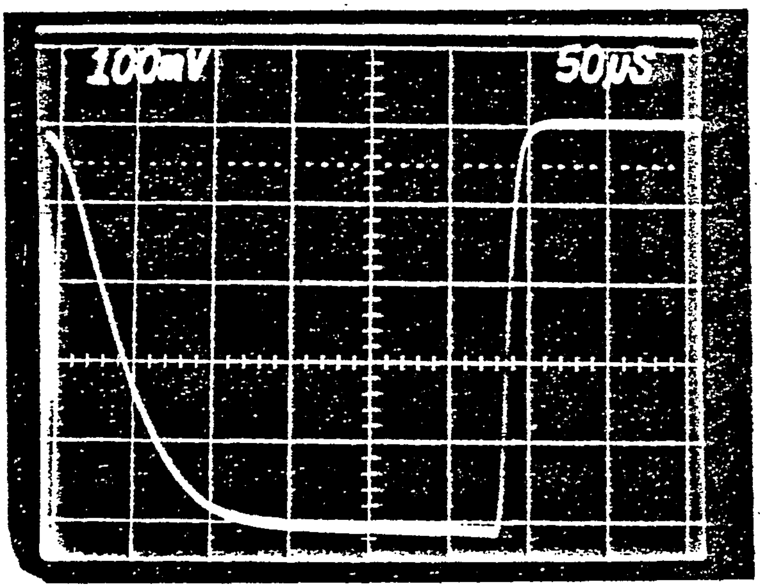

FIG. 2. 20μA / DIV NEGATIVE OXYGEN BEAM

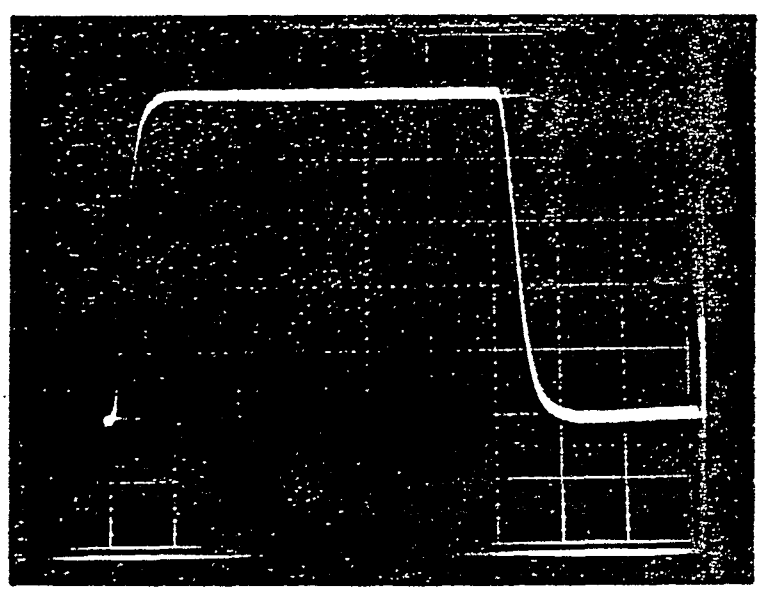

FIG. 3. 2.5μA TEST CURRENT PULSE. 5 mV/DIV, 20μS/DIV