

The HITL Faraday Cup Amplifier

R. L. Witkover

November 1985

Collider Accelerator Department
Brookhaven National Laboratory

U.S. Department of Energy

USDOE Office of Science (SC)

Notice: This technical note has been authored by employees of Brookhaven Science Associates, LLC under Contract No. DE-AC02-76CH00016 with the U.S. Department of Energy. The publisher by accepting the technical note for publication acknowledges that the United States Government retains a non-exclusive, paid-up, irrevocable, world-wide license to publish or reproduce the published form of this technical note, or allow others to do so, for United States Government purposes.

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or any third party's use or the results of such use of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

Accelerator Division
Alternating Gradient Synchrotron Department
BROOKHAVEN NATIONAL LABORATORY
Associated Universities, Inc.
Upton, New York 11973

Accelerator Division
Technical Note

No. 224

The HITL Faraday Cup Amplifier

R.J. Witkover and Z-G Li

November 8, 1985

The HITL Faraday Cup Amplifier

Richard L. Witkover and Zhen-Guo Li

November 8, 1985

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

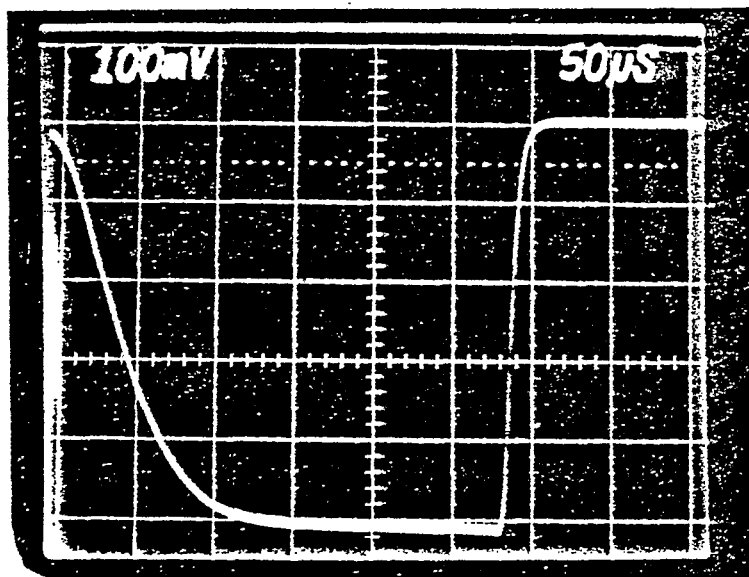


FIG.2. $20\mu\text{A}/\text{DIV}$ NEGATIVE OXYGEN
BEAM

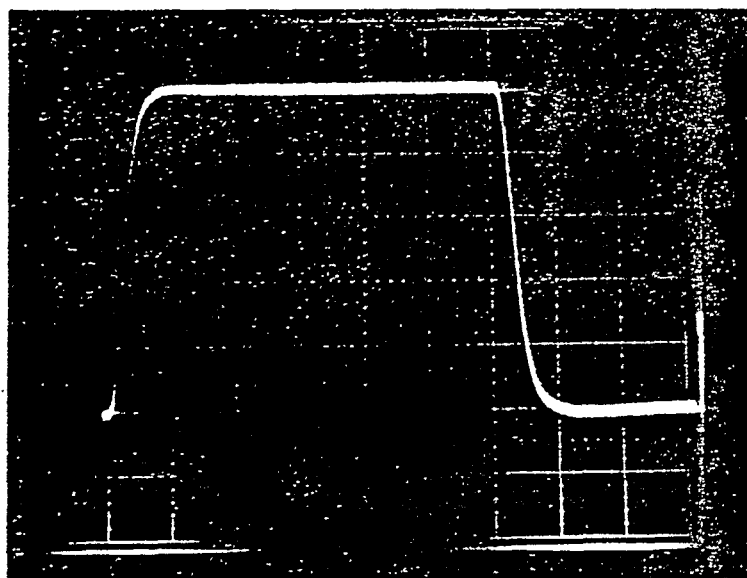


FIG.3. $2.5\mu\text{A}$ TEST CURRENT
PULSE. $5\text{mV}/\text{DIV}$, $20\mu\text{s}/\text{DIV}$