PERFORMANCE OF THE ADVANCED PHOTON SOURCE (APS) LINAC BEAM POSITION MONITORS (BPMs) WITH LOGARITHMIC AMPLIFIER ELECTRONICS*

R. E. Fuja and M. White
Argonne National Laboratory, 9700 S. Cass Avenue, Argonne, IL 60439 USA

Abstract

This paper discusses the performance of the logarithmic amplifier electronics system used with stripline BPMs to measure electron and positron beam positions at the APS linac. The 2856-MHz, S-band linac accelerates 30-nsec pulses of 1.7 A of electrons to 200 MeV, and focuses them onto a positron conversion target. The resulting 8 mA of positrons are further accelerated to 450 MeV by the positron linac. Beam position resolutions of 50 μm are easily obtainable in both the electron and positron linacs. The resolution of the 12-bit A/D converters limits the ultimate beam positron resolution to between 20 and 30 μm at this time.

I. INTRODUCTION

The APS linac BPM system, in operation for over a year, has been used in the commissioning of both the 200-MeV electron and the 450-MeV positron beams. It consists of stripline pickups and signal processing electronics using logarithmic amplifiers. The system has proven very reliable with only one problem occurring in an A/D section. System stability has not been a problem, and beam can be transported to the end of the linac a few minutes after being turned on.

II. EXPERIMENT

The following data were taken to determine the resolution of the linac BPM system in the presence of pulsed power supply noise. Background on the detectors and the processing electronics is provided.

A. Detectors

Stripline-type BPMs [1], were chosen because they provide -5 dBm of peak signal from the 8-mA positron beam. The BPMs are cylindrical in geometry, and the four striplines are mounted 90 degrees apart. The striplines are 1 inch long and subtend an arc of 1 radian. Their geometry is such that they form 50-Ohm pickups. The measured electrical length of the striplines is 0.21 wavelengths at 2.856 GHz. The average detector sensitivity is 1.73 dB/mm ± 0.1 dB. Signals from the striplines are transported via 1/4-inch heliax cable to electronics located an average of 85 feet away in the klystron gallery. About 10 dB of signal is lost over this distance.

Five BPMs are installed in the electron linac, one downstream of each accelerating structure, and seven BPMs are installed in the positron linac, one downstream of each of the last seven accelerating structures. There are no BPMs downstream of the first two accelerating structures after the target in the positron linac.

B. Electronics

The electronics [2], can be subdivided into two sections, a downconverter section and a logarithmic amplifier section. The downconverter section consists of a 2.856-GHz to 70-MHz downconverter followed by a 70-MHz bandpass filter and amplifier. The bandpass filter stretches the 30-nsec pulse to around 200 nsec and reduces its amplitude by some 13 dB. The overall gain of the downconverter is around 6.2 dB and it has a noise figure of around 7.5 dB. This 70-MHz signal is used as the input to a cascaded chain of logarithmic amplifiers consisting of two Analog Devices AD640s with their video bandwidths set to 7 MHz. The input power to the logarithmic amplifiers is adjusted to -10 dBm for the two different beam intensities in the electron and positron linacs. The sensitivity of the logarithmic amplifier chain is 53 mV/dB ± 1 mV. The calibration shown in Figure 1 is typical of all logarithmic amplifier sections.

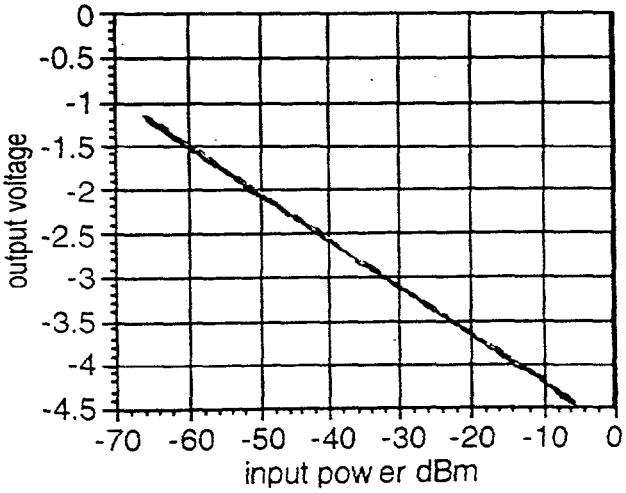

Figure 1: Dynamic ranges of eight different logarithmic amplifier channels. The slope is -54.26 ± 0.6 mV/dBm, and the intercept is at -4.756 ± 0.02 V.

* Work supported by U.S. Department of Energy, Office of Basic Energy Sciences, under Contract No. W-31-109-ENG-38.