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BEAM POSITION DEPENDENCE OF A WALL-CURRENT MONITOR

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Abstract

It was pointed out [illegible] that there exists an appreciable beam position dependence in the wall current monitor widely used [illegible] accelerator. Detailed study [illegible] performed [illegible] bench varying the pulse width and [illegible] input signal simulating the beam. The results of experiments show that when the pulse width becomes shorter more appreciable becomes the dependence, and it approaches to that [illegible] calculated from the method of images. A unified analysis is under way.

Introduction

A wall current monitor is one of the monitors [illegible] widely used [illegible] to measure the beam current and its waveform, and most suited for short pulse [illegible].

However, it was [illegible] recently that there is significant beam position [illegible] detailed study was then made to make clear the characteristics and performance of this monitor. One of the results of the study is that the output signal is not proportional to the input signal in magnitude but precisely proportional in area. These results are reported elsewhere [illegible].

This paper describes a study about the beam position dependence of this detector [illegible] experiment [illegible] to clarify the property of this dependence.

Experimental method

The operational principle of the monitor is well known; across the register [illegible] the beam [illegible] voltage difference is produced [illegible] wall current [illegible]

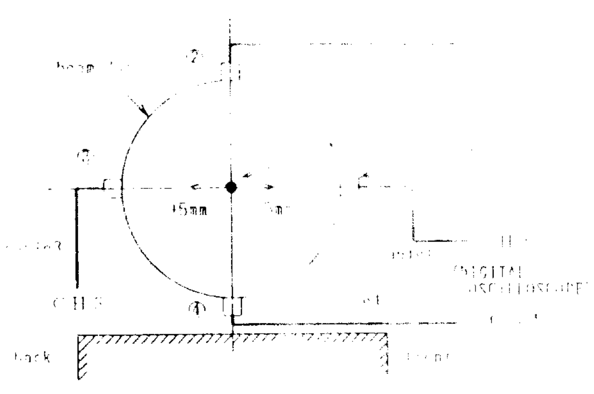

Fig 1 Schematic drawing of the monitor cross section

through it, and the current flow is csused by the beam. A schematic drawing of the monitor cross-section is shown in Fig.1, the monitor has four output ports to make clear the current distribution around the register.

The layout of the experimental apparatus is shown in Fig 2. The beam duct has an insulator in its middle around which the monitor is installed. The beam is simulated by a current passing through a wire set in the center of the beam duct. The current is supplied by a [illegible] pulse from a pulse generator (HP8131A).

[illegible] dependence of the monitor signal on the beam position, the beam duct [illegible] varied with a stepping motor [illegible] position. It is varied by a step of [illegible] up to [illegible] mm in the horizontal plane as shown in Fig 1. [illegible] signal from [illegible] oscilloscope [illegible]

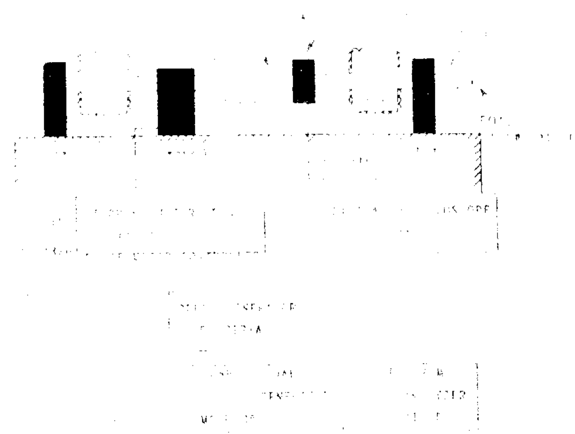

Fig 2 Schematic representation of the test bench

Two kinds of experiment are performed in studying the beam position dependence of the monitor. One is the experiment in which the width is varied of the input signal, the other is that the frequency is varied for the sinusoidal waveform used as an input signal. Although the beam does not have a sinusoidal waveform, the frequency dependence of the cause to produce the position dependence may probably be shown more directly by using the sinusoidal input.

The attenuation of the signal in the cable and the voltage gain of the oscilloscope depend on the pulse width or the frequency of the signal, and both are measured and corrected for each measurement.

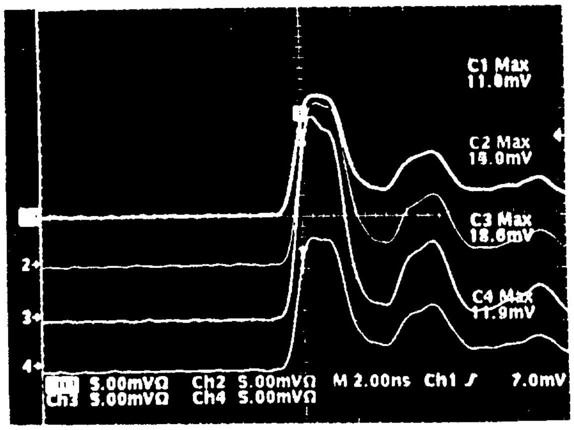

Fig.3 Waveforms of the monitor outputs from ch.1 to 4 for 1 ns input

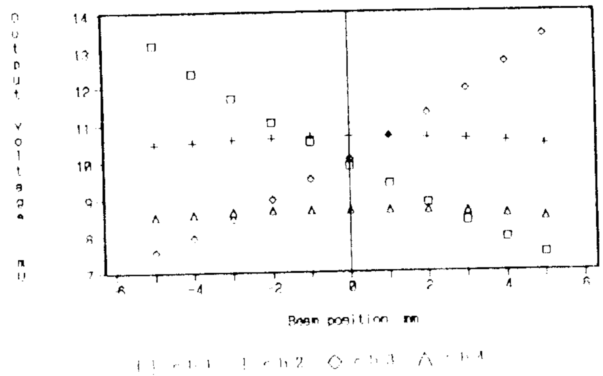

Fig.4 Output voltage vs. beam position for ch.1 to 4

Results and disscussions

Typical output waveforms are shown in Fig.3. The pulse width is 1 nsec, and the beam position is +5 mm. The channel number of each signal from the top to the bottom is 1 to 4, respectively, and corresponds to the output port indicated in Fig.1. An appreciable reflection of the signal is observed, however its influence may be mostly avoided in reading the magnitude by selecting an appropriate time point.

A result of the measurements is shown in Fig.4, in which the output signals from four channels are plotted as a function of the beam position. The pulse width is 1 nsec in all measurements. As is shown in the figure, four curves give different behaviours which are characteristic for the output positions relative to the beam position deviation from the center.

Figure 5 shows a summery of the measurements for channel 1, where the output vs. the beam position is shown and the parameter is the pulse width varied from 750 ps to 50 ns.

When the pulse width is 50 nsec long, the output secarcely depends on the beam position. However, when the width becomes shorter, more apreciable becomes the dependence, and when it comes near or less than a few nanoseconds, the outputs seem to approach gradually to a solid curve shown in the Fig.5. This curve is obtained by the method of images, and given by [5]

$$i = \frac{r^2 - \delta^2}{r^2 + \delta^2 - 2r\delta\cos(\theta - \phi)} \qquad (1)$$

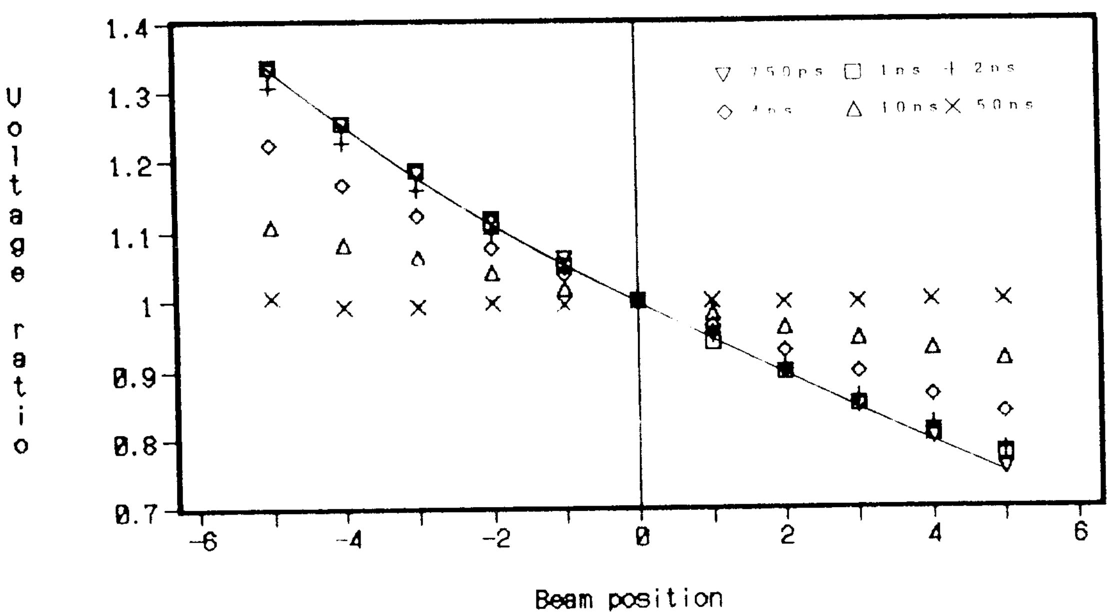

Fig.5 Output voltage vs beam position; the parameter is the pulse width

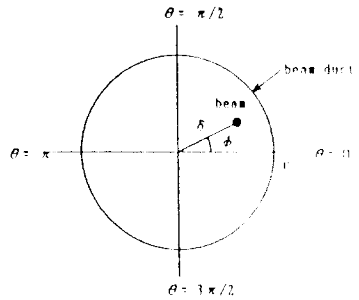

Fig.6 Beam position in the beam duct

where the quantities used are those given in Fig.6. In the calculation the value of r is required and is assumed to be 35.25 mm which is about the average value of the solid register.

The result fo r channel 3 of the monitor output is very similar to the channel 1 described above. As shown in Fig.1, the channel 2 and 3 are much less sensitive to the beam position displacement as is also expected from Eq.(1).

Figure 7 represents the output waveforms for the channel 1 to 4 when the sinusoidal input is supplied. The frequency is 300 MHz and the beam position + 5 mm. The results of the measurements for channel 1 is shown in Fig.8 where the frequency of the input is varied. The parameter is the frequency varied from 10 MHz to 300 MHz, and at 10 MHz the output does not seem to depend on the beam position. However,the frequency becomes higher,more appreciably depends the output on the beam position. This is very similar to the previous experiment where the pulse width is varied. The solid curve is the one calculatrd by Eq.(1). At 300 MHz the experimental data show more appreciable beam position dependence than the calculated. Detailed examination of these data is under way. The reason to cause such beam position dependence is suggested to be due to the rxistance of an impedance along the beam duct in azimuthal direction [1], [2], and this impedance is shown most likely to be an inductance [3]. However, unified quantitative analysis of this monitor is required on various characteristics, and now in progress.

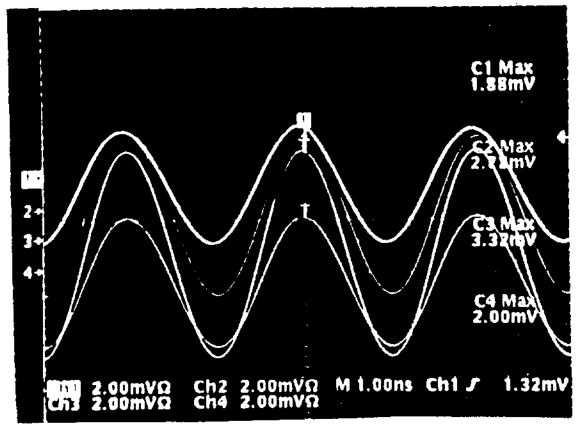

Fig.7 Waveforms of the monitor outputs from ch.1 to 4 for 300 MHz input

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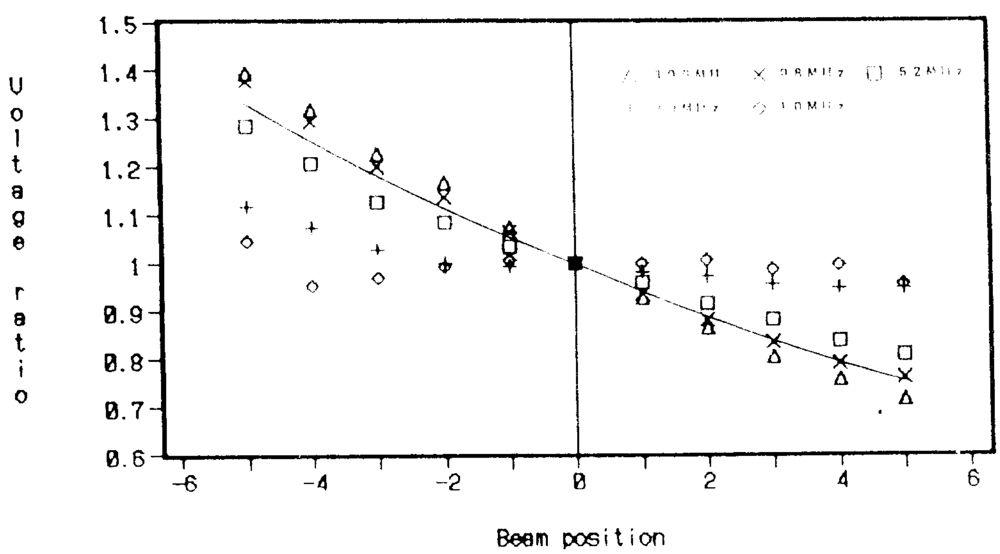

Fig.8 Output signals vs beam position; the parameter is the frequency