Improving accuracy of interceptive current measurement for use in IFMIF/EVEDA accelerator

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ACCT/DCCTs are used as a non-interceptive means of beam current measurement in the IFMIF/EVEDA accelerator. Current measurement using ACCTs for long pulses with 100 ms or longer suffers such problems as drooping due to the fact that this measurement is based on the current induction through transformers. The electrical circuits connected to ACCT have been improved in order to reduce the drooping and to obtain a waveform as close as to the waveform of the original beam current.

In this presentation we propose a method for measuring the beam currents derived from the waveform of ACCT output signals. Since the ACCT and associated electrical circuits can be considered as a linear system, there must be a unique transfer function connecting the input and the output of the ACCT, etc. This transfer function and the backward transfer function can be obtained numerically from simple experiments. The conversion from the output waveform to the input waveform is "ideal"since they are free from restrictions of real circuits.

This method has several advantages: (1) no detail information about the ACCT and the electronics is necessary; (2) the transfer function is easy to obtain from simple experiments with a function generator and an oscilloscope other than the ACCT system; (3) effects of stray capacitance and inductance are inherently reflected in the transfer function; (4) the use of FFT speeds up the calculation for obtaining the transfer function. On the other hand, it does not allow a real-time beam monitoring since retrieving the accurate input waveform requires the whole waveform of the ACCT output.

For verification of this method, we conducted a set of simple measurements using a function generator, an ACCT and an amplifier to determine the transfer function numerically. Applying this transfer function to the ACCT output, the waveform of the original beam current was retrieved. In order to reduce the noise in obtaining the transfer function, a set of waveforms were carefully chosen so that the FFT window is not an integer multiple of the input pulse length.

For an FFT window of 3 seconds, five waveforms with pulse lengths between 0.7 –1.3 seconds were used to determine the transfer function. The backward transfer function so obtained was applied to ACCT outputs with pulse lengths of 0.1 - 1.3 seconds. The retrieved waveforms show a very good agreement with the original square inputs without any drooping observed, showing the validity of this retrieval method.

In the presentation, we will show the theory and the procedure of retrieval as well as several results for waveforms with different kinds of shapes and lengths. We will also discuss potential problems and limitations of this method. Approaches to making this close to real-time current monitoring and implementation for use in the accelerator will be also discussed.

Eligible for student paper award?

No

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