DESIGN STUDY FOR AN UNDULATOR PHOTON BEAM POSITION AND PROFILE MONITOR

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Abstract

This paper we presented part of the design study for building a semi-nondestructive undulator photon beam position and profile monitor. It is a mesh wire monitor. However, in order to be classified as a semi-nondestructive monitor, the destruction to the undulator photon beam have to be minimized under the constrains of the required position resolution. The destruction considered should include the flux reduction and the beam size blowup due to diffraction (the later part are not presented in this paper). The variation parameters are the wire diameter and the wire spacing. The resolutions of the position and the profile measurements as function of the variation parameters are simulated.

1 INTRODUCTION

The photon beam line having an extremely high resolution is one of the primary characteristics of a third generation synchrotron radiation light source. Such characteristic has caused the photon beam lines' optical systems to become quite sensitive to their photon sources' position and angle, i.e. the electron beam orbit. A fundamental issue of all of these light sources, the photon beam line's flux fluctuates due to instabilities of the electron beam position and angle. To resolve this problem, at the first, the sources of the orbit instabilities have to find out and remove as clear as we can. The second step will be to build all kinds of the orbit stabilization feedback loops.

For the purpose of stabilizing a certain beam line, the local orbit feedback loop are usually applied. To stabilize a beam up to a few micrometers range, the resolution of the detecting system of the loop has to be no worse than a few micrometers. To accomplish this requirement, photon monitors are used for their high resolution character. However, the feedback system for the undulator beam line has an extra complication. Because, the synchrotron radiation from up-stream and down-stream bending magnets will unavoidable add to the photon monitor of the undulator light, this will confuse the beam position signal when adjusting the gap of the undualtor.[1] In most of application of undulator light, gap adjusting is a necessary while doing the experiment. This difficulty force people to think other monitor system, e.g. high resolution electronics BPM.

This paper we proposed and presented part of the design study for building a semi-nondestructive undulator photon beam position and profile monitor. It is a mesh wire monitor. However, in order to be classified as a semi-nondestructive monitor, the destruction to the undulator photon beam have to be minimized under the constrains of the required position resolution. The destruction considered should include the flux reduction and the beam size blowup due to diffraction (the latter part are not presented in this paper). The variation parameters are the wire diameter and the wire spacing. The resolutions of the position and the profile measurements as function of the variation parameters are simulated. Later, the estimated measurement and electronics errors should be included.

One of the advantage of this method is that by fitting the measurement results to the known photon beam profile functions, we can subtract the light contribution from the up-stream and the down-stream bending magnets. Thus, over come the difficulty, we mentioned earlier in this section. Also, besides knowing the beam position, we have the beam profile information.

2 SIMULATIONS

We first used a gaussian beam to simulate the undulator light. That just for simplicity. Later, we should used the known photon beam profiles (both the undulator light and the bending synchrotron light). By using gaussian beam, we can also experimentally exam our simulation results in bench and using handy Laser beam.

Figure 1 depicts the photon beam and wires parameters used in the simulations.

0-7803-4376-X/98/$10.00

Where **S**: the photon beam size (±2 sigma), **M**: the center wire spacing, **a**: normal (beside center) wire spacing, and **da**: the wire diameter.

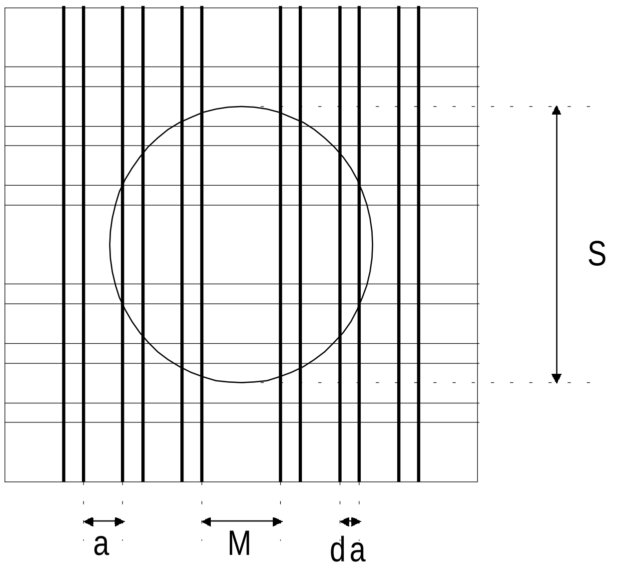

Fig. 1 The photon beam and wires parameters used in the simulations

Figure 2 shows the relative photon flux for different wire number and different wire diameter with the same beam size and the same center spacing.

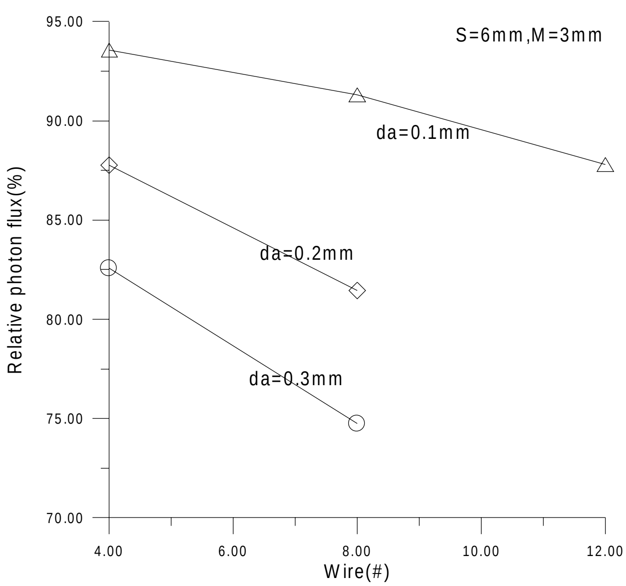

Figure 2 shows the relative photon flux for different wire number and different wire diameter

For different wire diameter, we will gain different photon electrons and thus different measurement uncertainties. For different wire number (wire spacing), we will get different amount of information and thus different fitting errors. Figure 3 shown a 6 mm (±2 sigma) gaussian beam measured by different wire spacing and added the measurement uncertainties, then fitted by gaussian function. We can see that for wire spacing larger than 0.6 mm the fitting error become very large.

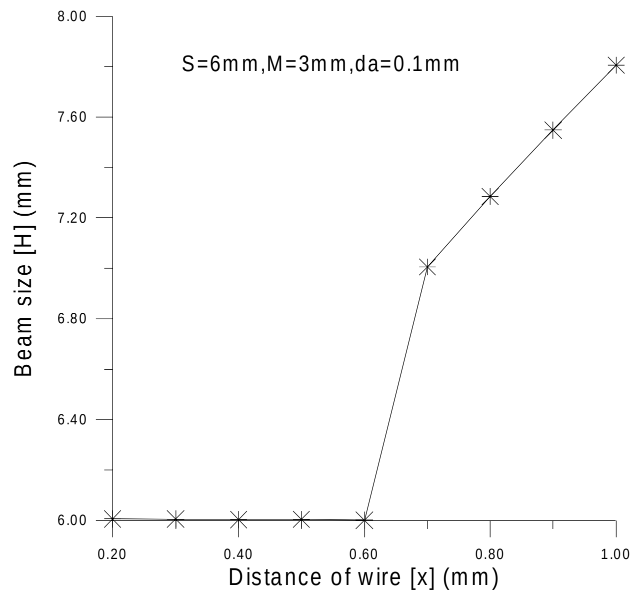

Fig. 3 A 6 mm (±2 sigma) gaussian beam measured by different wire spacing and added the measurement uncertainties, then fitted by gaussian function

3 DISCUSSIONS

This very preliminary study shown that the error analysis can play an important role for designing the mesh wire photon monitor. Lots of further studies have to be carry on.

ACKNOWLEDGEMENTS

This work was supported by the NSC of Taiwan, under contract NSC 85-2112-M-007-019.

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