

DEVELOPMENT OF THE TRANSVERSE BEAM PROFILE MONITORS FOR THE PAL-XFEL*

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Abstract

The PAL-XFEL is an X-ray free electron laser under construction at the Pohang Accelerator Laboratory (PAL), Korea. In the PAL-XFEL, the electron beam can make coherent optical transition radiation (COTR) due to the microbunching instability in the compressed electron beam. In order to obtain transverse beam profiles without the COTR problem, we are developing scintillating screen monitors (with the geometric suppress method) and wire scanners. In this paper, we report test results at the test facility and progress in the development of the screen monitor and the wire scanner for the PAL-XFEL.

INTRODUCTION

Transverse beam profile diagnostics in electron linacs is widely based on optical transition radiation (OTR) as standard technique which is observed in backward direction when a charged particle cross the boundary between two media with different electrical properties. Unfortunately, microbunching instabilities in high-brightness electron beam of modern linac-driven free-electron lasers (FELs) can lead to coherent effects in the emission of OTR. Because of this reason it is not possible to obtain a direct image of the particle beam. In order to allow the beam profile measurements in the presence of microbunching instabilities, there are solutions has been studied. First is to use scintillation screens instead of transition radiation and another is wire scanner [1, 2].

To successful commissioning, the transverse beam profile monitors which is not affected by COTR effect are necessary. In this reason we are studying scintillating beam profile monitors and wire scanners.

In this article, we report test results with transverse profile monitor installed at the injection test facility (ITF) and the new profile monitors design for PAL-XFEL.

MEASUREMENTS

The screen monitors and wire scanner which is used to acquire beam profile installed at the ITF. The screen monitor is operating for beam diagnostics. The Fig. 1 shows screen monitor and wire scanner installed at the end of beamline.

ITF Screen Monitor

The RadiaBeam Technologies's Integrated Beam Imaging System II (IBIS-II) was installed at the ITF. This screen target is 100 μm thick YAG:Ce scintillator which is installed normal to the beam direction and 200 nm aluminized silicon

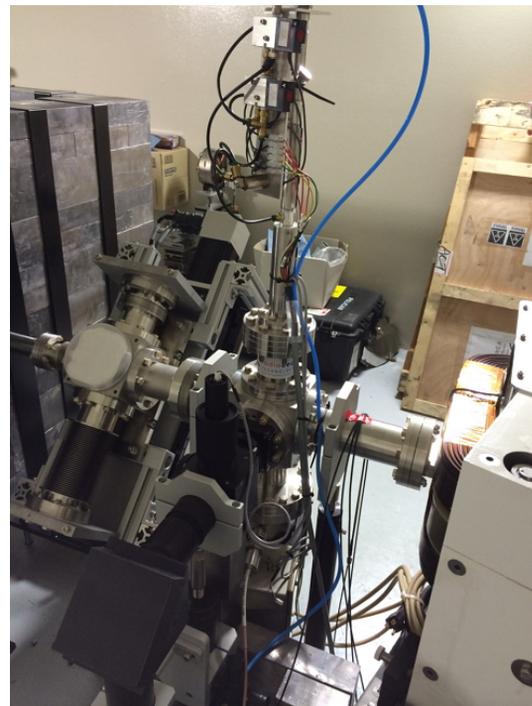


Figure 1: The wire scanner (Left) and screen monitor (Right) station.

wafer for mirror was installed 45 deg with respect to the beam axis. The BAUMER GigE cameras with 5M pixels and a 2/3 inch CCD sensor are used to obtain electron beam image. The electron beam image with this screen is shown in Fig. 2. The beam size was obtained with $\sigma_x = 0.57 \pm 0.03$ mm and $\sigma_y = 1.00 \pm 0.05$ mm.

ITF Wire Scanner

A wire scanner measures the average, projected beam profile in one plane over several successive beam pulses. The wire scanner was installed at the diagnostic section which was manufactured by RadiaBeam Technologies. This is consist of a wire card with three 25 μm thick tungsten wires and a ball-screw linear stage [3]. And the radiation intensity of the beam at a wire position determined by silica optical fiber with Photomultiplier (PMT). The schematic layout of measurement system are shown in Fig 3. The electron beam loss signal (shown Fig. 4) is pulse width is about 5 μsec .

Beam profile measurement and analysis were performed. Because of the motor controller is not yet integrated with timing system, it takes a few minutes to get a set of beam profile. The electron beam operation condition which is

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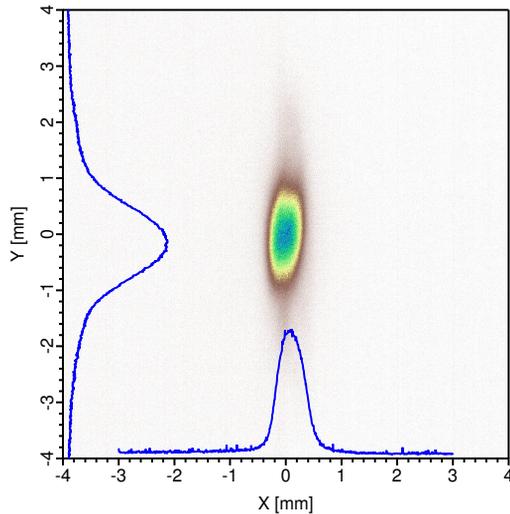


Figure 2: The Beam image with YAG:Ce scintillator and projected profile.

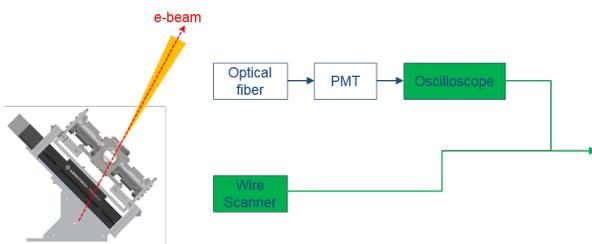


Figure 3: The wire scanner measurements diagram.

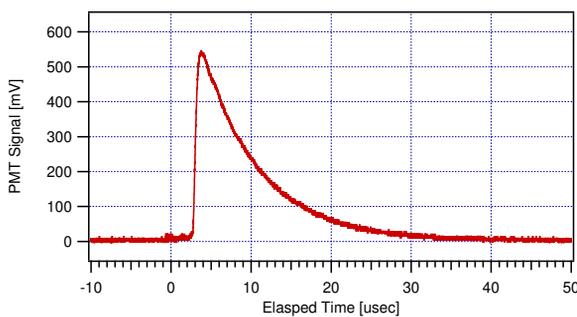


Figure 4: The beam loss signal.

obtained beam profile with wire scanner (shows in Fig. 5) is the same with beam image of Fig. 2. The beam size was obtained with $\sigma_x = 0.63 \pm 0.09$ mm and $\sigma_y = 0.92 \pm 0.02$ mm with wire scanner. The measurement value with wire scanner was good agreement with the value of beam image.

XFEL SCREEN MONITOR

The Screen monitor for PAL-XFEL will be consisted of scintillator target and vacuum mirror for imaging without COTR effect. The YAG:Ce scintillator has been used to electron beam imaging which is will be saturated for high energy and high flux beam current [4]. And the LYSO:Ce was not saturated and very good linearity depend on beam

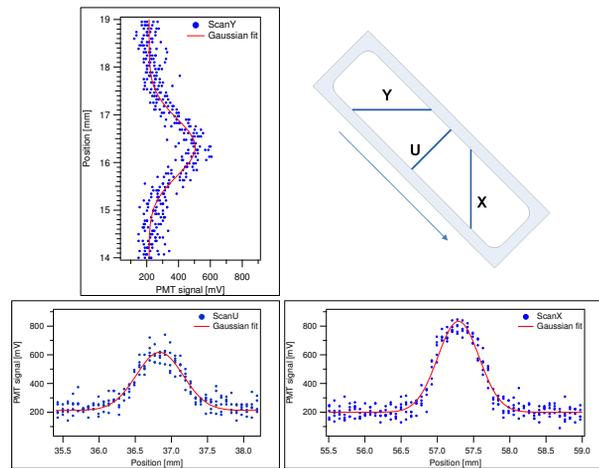


Figure 5: The wire scanner measurements.

charge [5]. Because of this reason we choose LYSO:Ce for scintillator and also will be adapted the RF shield to minimize the wake field due to the structure of chamber. And we have limited space for installation because of this reason we apply mirror in vacuum for guide the scintillation light to CCD camera. In order to minimize depth-of-focus effects, we will apply the Scheimpflug principle. Fig. 6 shows the geometric scheme for screen monitor between ITF screen and XFEL screen.

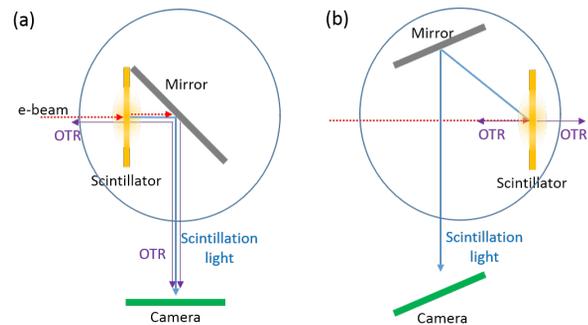


Figure 6: The geometric scheme for screen monitor. (a) ITF Screen Monitor and (b) XFEL Screen Monitor.

XFEL WIRE SCANNER

The wire scanner for XFEL is on going design with Linear servo motor to minimize the vibration from the step motor stage [2].

SUMMARY

The screen monitor and wire scanner will be updated for PAL-XFEL facility.

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