TEST OF A WIRE SCANNER IN THE DIAGNOSTIC SECTION OF PITZ*

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Abstract

The Photo Injector Test facility at Zeuthen (PITZ) has been established to produce and optimize electron beams of high brilliance. One wire scanner station, developed and used in the undulator section of the FLASH at DESY [1] [2] , has been installed in the diagnostic section of PITZ. Measurements of beam-profile and beam-position were performed to test the usability of such type of wire scanner at PITZ. The test has shown that wire scanners of this type can be well used as complementary measurement device at PITZ. In the final state of the extension of PITZ, two wire scanners are foreseen as standard diagnostic tools for beam-profile and beam-position measurements.

INTRODUCTION

Wire-scanners are important diagnostic tools for particle accelerators in order to tune the beam-line and to measure the beam-profile. Various types of wire-scanners have been developed for different particle accelerators [3][4][5]. In PITZ the beam-electrons will undergo scattering processes when hitting the wire. Once scattered the electron will hit the beam pipe and create a shower of electrons and photons. The shower signal of electrons and gammas can be observed by means of scintillator counters placed nearby the beam pipe. The measured correlation between the wire position and scintillator signal gives information about the beam-position and the beam-profile.

SETUP AND MEASUREMENT

The configuration of PITZ in the year 2005 (PITZ1.5) with the wire scanner station is shown in Figure 1. A wire scanner station consists of two independent scanners for the vertical- and horizontal-direction, respectively. Each scanner is equipped with two tungsten wires of 30 µm diameter in a distance of 10 mm.The whole set up is combined with a scintillation counter. The counter detects secondary particles which are created when the wire interacts with the electron beam. The light of the scintillation counter is read out by wavelength shifter bars and guided via clear fibers to the photomultiplier H6780-4. The gain of the photomultiplier is steered by a reference voltage $v_{ref.}$ and ranges from $10^2 – 10^6$. For this measurement a gain of ~ 500 is mostly used. The photomultiplier signal is read out and digitized by a Tektronics TDS 5104 oscilloscope. Together with the photomultiplier signal the position of the wire is stored and analyzed afterwards. Vertical and horizontal scans provide vertical resp. horizontal measurements of beam-profile and beam-position with µm resolution. The system allows scanning speeds from 5 µm/sec up to 1 m/sec. Absolute position determination in the range of 50 µm is achieved by calibrating the wires. The wire scanner is integrated in the coordinate system of PITZ.

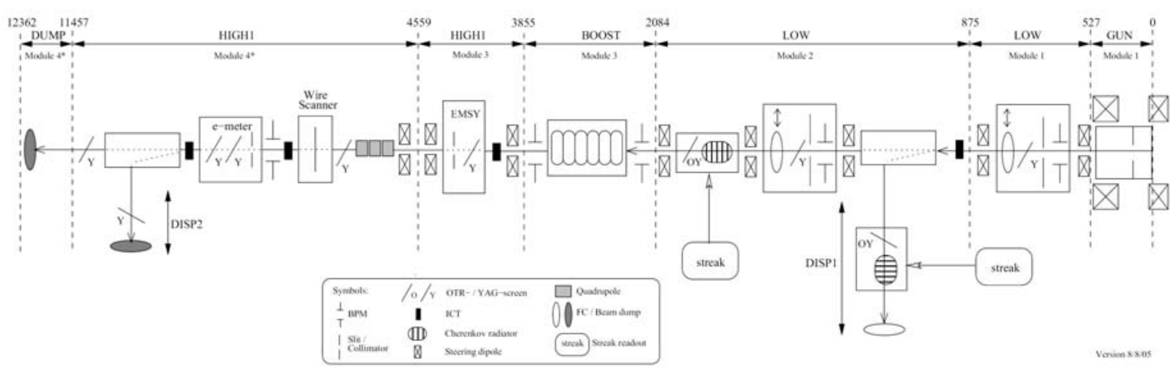

Figure 1: Configuration of PITZ .

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Thee parameter settings for this measurement were:

Beam charge	0.5 nC
Beam momentum	12 MeV/c
Bunches/Train	10
Rep.Rate	2 Hz
Focus Point (Screen)	5.74 m from cathode
Wire scanner Position	6.28 m from cathode

Figure 2: Wire scanner station

Figure 2 shows the wire scanner station mounted at PITZ. The different scanner modules for horizontal- and vertical scans respectively, can be seen.

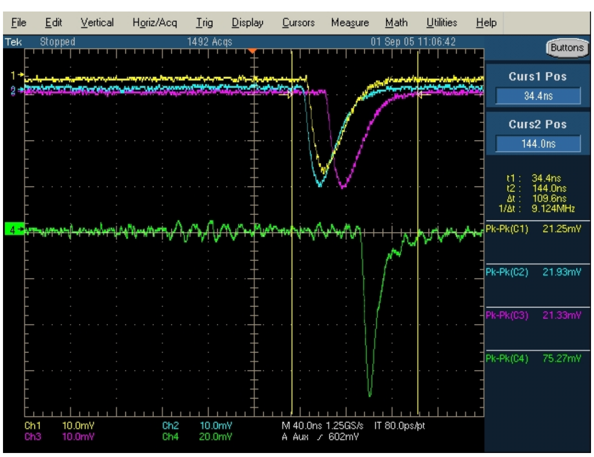

Figure 3: Screen shot of the wire scanner signal

In Figure 3 a typical photomultiplier signal on the oscilloscope (green) is shown together with the signals from the 3 Integrating Current Transformers (ICTs, yellow, blue and magenta), which represent the beam charge before and after the wire scanner. The signal exceeds 0.7 mV when the wire is in the centre of the beam. If the wire is outside the beam a background signal of 0.2 mV is observed. This gives a S/N ration of about 3.5.

RESULTS

To exploit the possibilities of the wire scanner different measurements have been performed. Scans with different step sizes, variation of the gain ($v_{ref.}$ and variation of the beam-size. In Figures 4 and 5 scans of the beam with different step sizes are shown.

The obtained RMS values are $X_{RMS} = 1.27$ mm and $Y_{RMS} = 1.79$ mm.

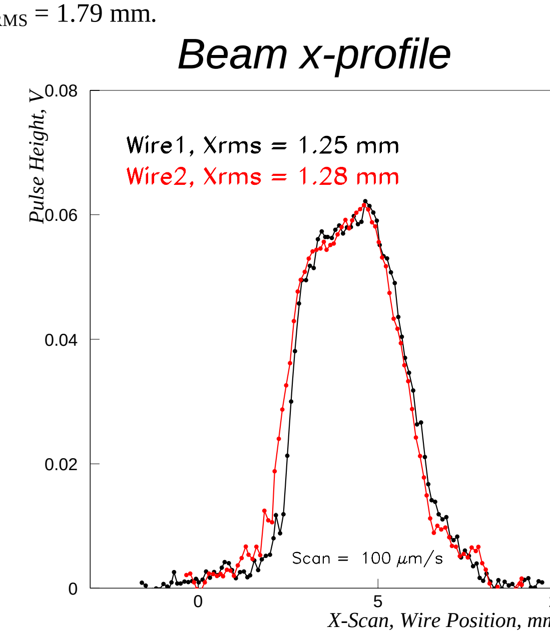

Figure 4: Scan in horizontal direction (the second wire is shifted by 10 mm with respect to the position of the first)

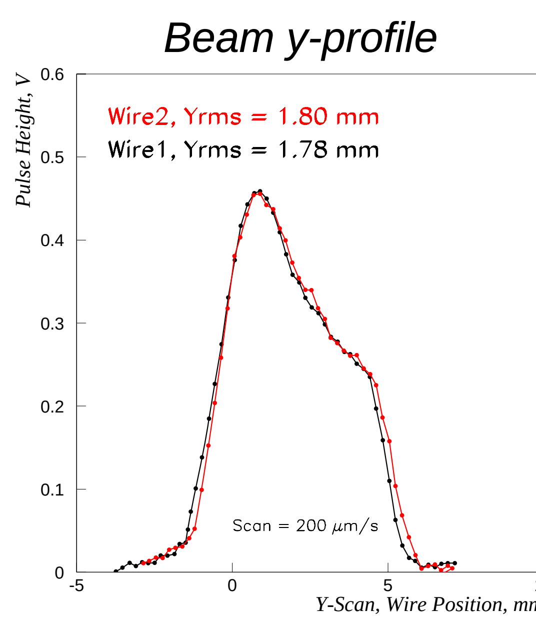

Figure 5: Scan in vertical direction (the second wire is shifted by 10 mm with respect to the position of the first)

The overall measurement error is estimated of about 10 % , the small differencies between the red and black curves in Figure 4 and 5 (wire1 and wire2) may be caused by fluctuations in the electron beam.

To check the capability to measure very small charges with the wire scanner a 50 µm slit [1] was inserted into the beam 199 cm upstream of the wire scanner position. Figure 6 shows this beamlet on a YAG-Screen 54 cm before the wire scanner position.

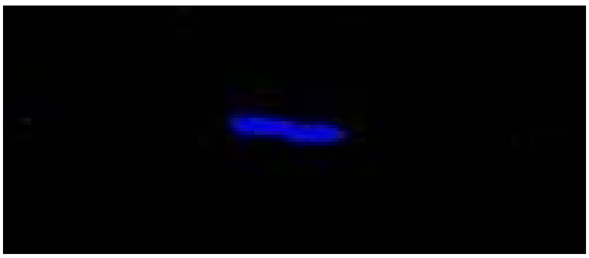

Figure 6: Beamlet from a 50 µm slit

The beamlet was scanned with a step-size of 50 µm/sec in vertical direction. The result of this scan is shown in Figure 7. The beamlet is well resolved. The average RMS value of the measurement is 250 µm, the distance between the wires is measured by 10.10 mm which is 100 µm lager than expected.

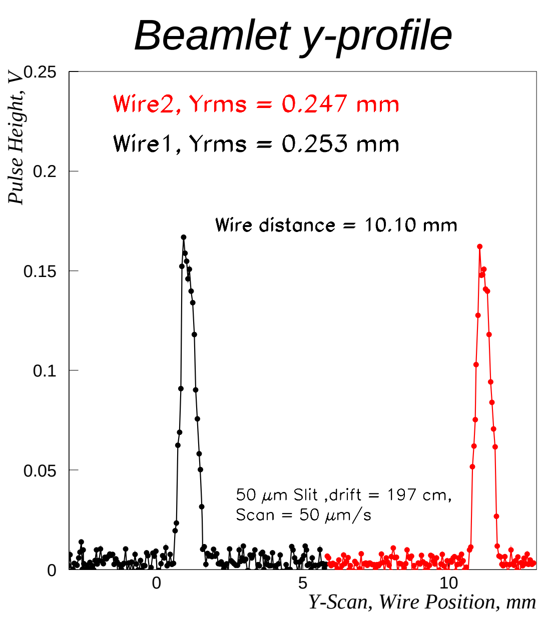

Figure 7: Scan of the beamlet from a 50 µm slit

From simple geometrical considerations one can estimate that the charge of the beamlet must be the order of a few tens of pC.

[1] Tungsten slits are used in PITZ to measure the local divergence

CONCLUSION

Beam-profiles and beam-position could be measured at PITZ with a new type of wire scanner developed for FLASH at DESY. The capability to measure beams of small sizes and charge was also demonstrated. In the final state of the extension of PITZ, two wire scanners are foreseen as standard diagnostic tools for beam-profile and beam-position measurements.

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