

A.2: Online Measurement of Electron Beam Parameters by Image Processing

The basic image acquisition software, which was developed earlier [Y.Tyagi, et al., Proceedings of DAE-BRNS InPAC 2009, RRCAT (2009)] has been recently upgraded to support online measurement of beam centroid, beam height and beam width from the diagnostic devices namely fluorescent screen beam profile monitors and beam slit monitor installed in Transport Line-1(TL-1) at Indus Accelerator Complex. The development and upgradation of image acquisition and analysis software was carried out by Beam Diagnostics Section of Accelerator Control and Beam Diagnostics Division. Online measurements of beam centroid, beam height and beam width are regularly required to optimise transport of electron beam through TL-1. Measurement of these parameters is also required whenever some operating parameter of Microton is changed or some modifications/upgradations are carried out in some sub-systems in Microton. Online measurement of these electron beam parameters has helped the Indus operation team to take necessary corrective action if required before injection of the electron beam into booster synchrotron. Many new software modules have been developed or rewritten to support these measurements. The new software modules support automatic and manual mode of image analysis. In the automatic mode, user intervention is minimal and software automatically configures the hardware parameters like gain control, acquisition window size, etc., of frame grabber card.

The measurement of beam centroid, beam height and beam width is initiated with the acquisition of image, which can be acquired in live mode, triggered single shot or triggered continuous mode. The trigger signal from Microton control system is used to synchronize image acquisition with the arrival of electron beam in triggered mode of image acquisition. The electron beam from Microton is available at a repetition rate of 1 Hz. To find beam centroid, beam height and beam width, software first locates the beam in the image by scanning the image from top to bottom and left to right and finding line of highest intensity (by summing all pixels values in a line). Once lines of highest intensity are found, software draws a rectangular region of interest on the image and background image is subtracted from this image. Since the focal length of lens used in the cameras, grid spacing on the screens and the illumination arrangement of screen in each device is different but fixed, the background images of each screen is captured and stored in a file at the time of installation of the device itself. These background images are used in subsequent analysis. Software locates the beam spot in the

image by creating a rectangular region in an iterative manner. The rectangular region is reduced in each iteration until it encompasses the beam spot closely. Software finally locates the beam centroid in this rectangular region.

Once centroid is located, the software computes this position with respect to predefined reference point and converts into mm by applying calibration information. The software has facility to define and set reference point. For calibration (conversion from pixels to mm) the image of grid lines marked on the fluorescent screen was taken and number of pixels were computed between edges of grid and saved in a file. Software automatically loads the calibration information based on the device selected, which is used for computation of beam centroid, beam height and beam width. For height and width calculation software first segments the image by thresholding it and then median filter is used to remove the noise without affecting the clean pixels. Finally, edges of beam spot are detected by using an edge detection function available in National Instruments (NI) Vision Development Module and beam height, width are computed and saved in a file along with date and time.

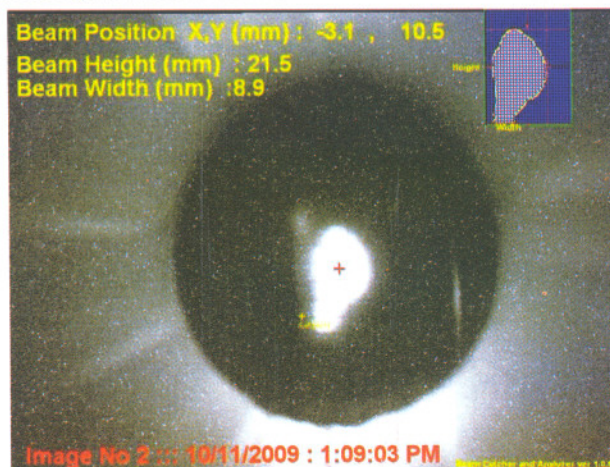


Fig. A.2.1: Captured beam spot on beam slit monitor

Fig. A.2.1 shows the image of the beam captured on beam slit monitor installed in TL-1. Beam centroid can also be located manually by defining the region of interest in image and software computes this with respect to pre-defined reference point. This feature is useful when beam shape is irregular or of very odd shape. This upgraded image acquisition and analysis software is now routinely being used by Indus accelerator operation crew for finding beam centroid, beam height and beam width in TL-1.

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