SOFTWARE DEVELOPMENT FOR INDUS-1 BUNCH FILLING PATTERN MESUREMENT

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Abstract

Indus-1 is a 450 MeV synchrotron radiation source operational at RRCAT Indore. In Indus-1 storage ring, electrons are stored in two bunches. The distribution of beam current in these two bunches is termed as bunch filling pattern. In Indus-1, it is desirable to have symmetric bunch filling pattern for its optimum performance. This paper describes the development of software for bunch filling pattern measurement of Indus-1. This software measures the current distribution of the electron bunches circulating in the storage ring. To measure bunch currents wall current monitor (WCM) installed in the Indus-1 storage ring is used. Using a 500 MHz digital storage oscilloscope as a high-speed digitizer and online data processing by the developed software, measurement of online bunch filling pattern was achieved. This software has helped Indus operation crew to achieve desired bunch current symmetry in the Indus-1 storage ring. The software has the provision to store the online bunch current symmetry into a Microsoft-excel file which can be used for further analysis. Using this software, up to 99% bunch filling symmetry has been achieved by Indus operation crew.

INTRODUCTION

The bunch filling pattern of a storage ring drastically affects its operation performance. Measurement of bunch filling pattern in the synchrotron light source is possible with various techniques. Digital storage oscilloscope (DSO) or fast digitizer with sampling rate much larger than the bunch repetition frequency can be used to observe signal from fast current transformer, sum signal of pickups, wall current monitor (WCM) pickup or photo-detector of synchrotron light[1]. A most simple and reliable approach with adequate dynamic range is to observe the WCM signal. The signal captured by the oscilloscope is further analyzed to obtain the bunch current of each individual electron bunch. Accuracy is adequate for most of the applications.

To achieve bunch symmetry in Indus-1, injection timing parameters needs to be adjusted. Online measurement of the filling pattern is therefore essential during operation of storage ring. A bunch filling pattern measurement system has been developed and implemented for online measurement of current of individual bunches and hence the ratio of currents in the two bunches.

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SYSTEM SETUP

The system block diagram is given in the figure 1. This system uses pickup signal of Wall Current Monitor[2] installed in Indus-1 storage ring. The WCM is resistive pickup device which measures the wall current produced by the bunched electron beam. For relativistic electron bunch, image current is a replica of bunch current. The output of WCM gives the longitudinal distribution and position of electron bunches. The pickup signal of Indus-1 WCM has two pulses corresponding to two bunches circulating in the storage ring. These two pulses are separated by ~31.6 ns. The height of the pulses depends on the distribution of electron in bunches. The pickup signal of WCM is fed to a digital storage oscilloscope (DSO) kept in the control room. The digitized signal from DSO is transferred on GPIB bus to a PC for calculation of individual bunch current.

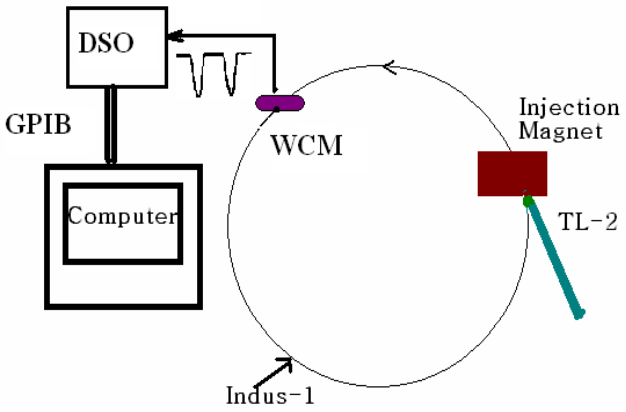


Figure 1: Block diagram of Indus-1 bunch filling pattern measurement system

SOFTWARE DEVELOPMENT

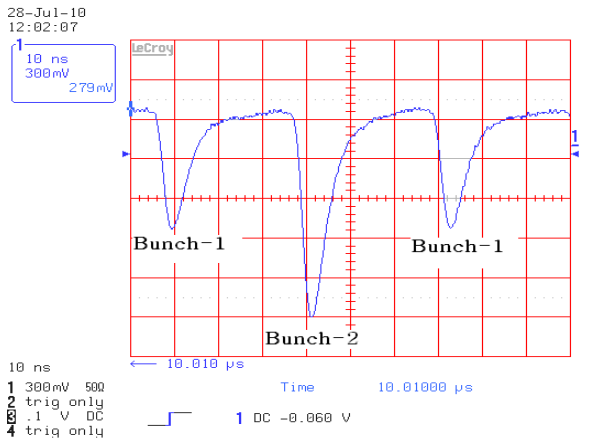
MATLAB based software has been developed to interface with DSO for data acquisition and data processing to provide information of measurement results on graphical user interface. The software uses GPIB object to communicate with DSO. The required settings of DSO are automatically done by the software during initialization. During measurement, software automatically changes the volt/div setting of DSO according the input signal level to improve the resolution.

Software processes the acquired data to calculate bunch current from the height of pulses. The bunch current, bunch current ratio and total beam current are displayed online and also stored in a Microsoft excel file for later analysis.

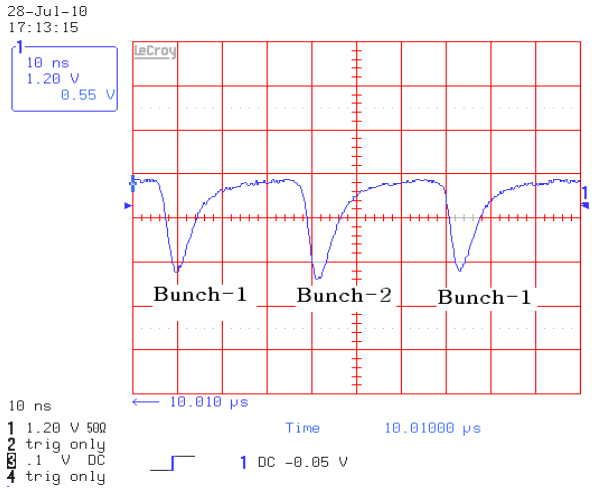
The system was calibrated with DC current transformer (DCCT) installed in Indus-1 ring to get calibration factor for measurement of absolute bunch current. DCCT gives the average current of the storage ring. To calculate the calibration factor, a linear fitting was done between sum of individual pulse heights and average current measured by DCCT. The calibration accuracy is better than 1 %.

RESULTS

The bunch symmetry is indicated by ratio of the two bunches. Figure 3 shows typical traces of WCM signal on digital storage oscilloscope for the case of 60 % and 92 % bunch symmetry.



(a)



(b)

Figure 3 **:** Typical WCM signal traces captured on DSO for a) 60% and b) 92% bunch current ratio

Figure 4 shows a screen shot of GUI showing typical results of online measurement of individual bunch currents and the bunch current ratio. It also shows plot of bunch currents during decay of store beam in Indus-1. Beam life time of individual bunches can be studied using the logged data.

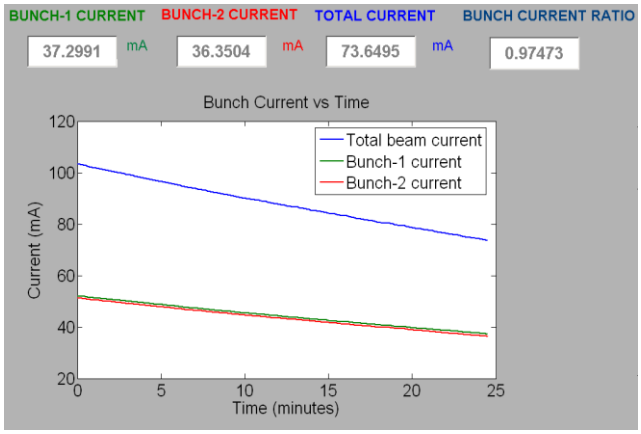


Figure 4 : Screen shot showing plot of bunch currents and total beam current in Indus-1

The accuracy of this measurement system is better than 2% in the range of 0 -100 mA

CONCLUSION

A bunch filling measurement system has been developed and implemented in Indus control room. This system is now routinely being used by Indus accelerator operation crew for adjusting the injection timings to achieve symmetric filling and recording bunch symmetry for beam related studies. Using this software up to 99% bunch filling symmetry has been achieved.

ACKNOWLEDGEMENT

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