A.4: Development of online transverse coupled bunch mode measurement system for Indus-2

In a storage ring like Indus-2, at high beam currents, the interaction of electron beam with surrounding elements may excite longitudinal and transverse coupled bunch instabilities. Transverse coupled bunch instability limits the high current operation in accelerator and may cause partial or complete beam loss. Presently, Indus-2 is routinely operated at 100 mA beam current and 2.5 GeV beam energy. To achieve the design beam current in Indus-2, coupled bunch instability measurement and correction is required. In this report, development of software in MATLAB for online measurement of transverse coupled bunch modes (CBM) using a real time spectrum analyzer is presented. Beam Diagnostics Section of Accelerator Control and Beam Diagnostics Division has carried out this development.

The transverse oscillation of beam creates amplitude modulation in the beam position monitor pickup signal. The modulating frequency is decided by the transverse mode of oscillation. In Indus-2 ring, 291 possible CBM may get excited. The developed system scans the beam spectrum in the frequency range of 505.808 MHz to 758.7 MHz with resolution of ~2.5 kHz in horizontal and vertical plane separately. The measurement rate of the system is ~0.1 Hz.

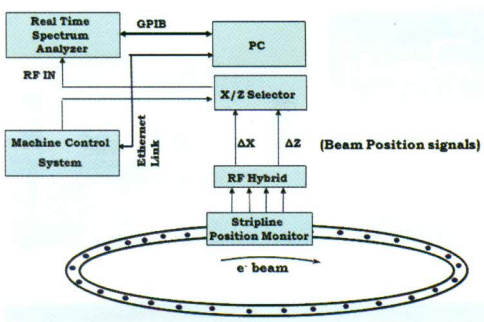

Fig. A.4.1: Block diagram of transverse coupled bunch mode measurement scheme

The block diagram of transverse coupled bunch measurement system is shown in Fig.A.4.1. For observation of transverse coupled bunch modes, one of the stripline monitors in Indus-2 is used to generate the position dependent beam signal. The output signals of stripline are fed into a RF hybrid, which generates the real time horizontal (X) and vertical (Z) position signals. The X and Z signals are passed through the RF switch, which switches the X or Z position signal at its output depending on the control signal. The output of RF switch is fed to a real time spectrum analyzer for spectrum generation.

For automation of this system, software has been developed in MATLAB to interface the spectrum analyzer over GPIB, to control X/Z selector and interface with MATLAB server of control room over Ethernet. The software switches the X and Z plane sequentially for horizontal and vertical CBM measurement respectively. The complete frequency range of ~252.8 MHz needs to be acquired in three parts of 85 MHz each to achieve the desired frequency resolution. For particular plane selection, software sets the required parameters of spectrum analyzer for all three scanning ranges of CBMs one by one, acquires the spectrum data from spectrum analyzer into PC, processes spectrum data to evaluate the excitation levels and peak to average ratio (PAR). This software also acquires beam energy and current data from MATLAB server of accelerator control system. The measured excitation levels are displayed on graphical user interface (GUI) and logged with beam parameters in a file. The screenshot of the developed GUI is shown in Fig. A.4.2.

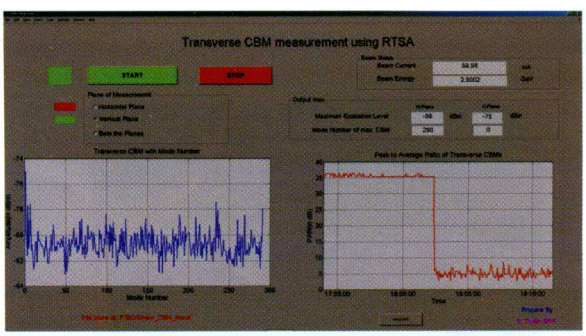

Fig. A.4.2: Screenshot of graphical user interface of transverse coupled bunch mode measurement system

This system is being regularly used to get the status of beam stability in transverse plane. Typical graphs of CBM measurements are shown in Fig. A.4.3.

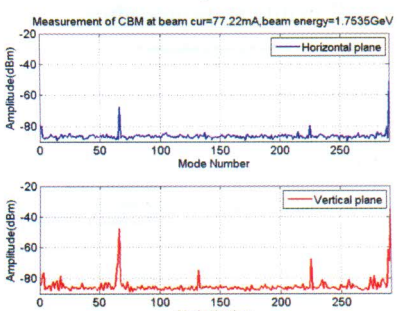

Fig.A.4.3: Typical CBM measurement results

This data of excitation level of different modes helps in optimization of the machine performance.

Reported by:
S. Yadav (syadav@rrcat.gov.in)