A.6: Development of longitudinal coupled bunch mode measurement system for Indus-2

The design beam current of Indus-2 is 300 mA @ 2.5 GeV beam energy. At high beam current, longitudinal and transverse coupled bunch instabilities may get excited by the interaction of electron beam with surrounding elements. Longitudinal coupled bunch instability limits the high current operation in accelerator and results in the degradation of luminosity performance. 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 the measurement of longitudinal coupled bunch modes (CBM) using a spectrum analyzer is presented. This development has been carried out by Beam Diagnostics Section of Accelerator Control and Beam Diagnostics Division.

The longitudinal oscillation of beam creates phase modulation in the beam intensity signal. The modulating frequency is decided by the longitudinal mode of oscillation. In Indus-2 ring, 291 possible coupled bunch modes may get excited. The developed system scans the beam spectrum in the frequency range of 505.808 MHz to 758.7 MHz with a resolution of 1 kHz.

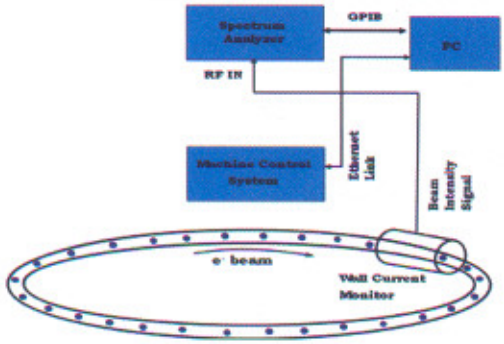

Fig. A.6.1 : Block diagram of longitudinal coupled bunch mode measurement scheme

The block diagram of longitudinal coupled bunch measurement system is shown in Fig. A.6.1. For observation of longitudinal CBM, the wall current monitor (WCM) of Indus-2 ring is used to pick up the beam intensity signal. The pickup signal of WCM is fed to a spectrum analyzer for producing the beam spectrum. The spectrum analyzer is chosen for this purpose since the dynamic range required for measurement is more than 50 dB. A GPIB interface is used for acquiring the beam spectrum data from spectrum analyzer to a PC for extracting the information about CBM.

For automation of this system, software has been developed in MATLAB to interface the spectrum analyzer with PC through GPIB bus. The software sets the parameters of spectrum analyzer, acquires spectrum data, and processes spectrum data to evaluate the excitation level of different modes. This software also acquires beam energy and current data from MATLAB server of accelerator control system. The measured excitation levels of user selected modes are displayed in the form of a table and logged with beam parameters in a file. A typical screenshot of the developed graphical user interface is shown in Fig. A.6.2.

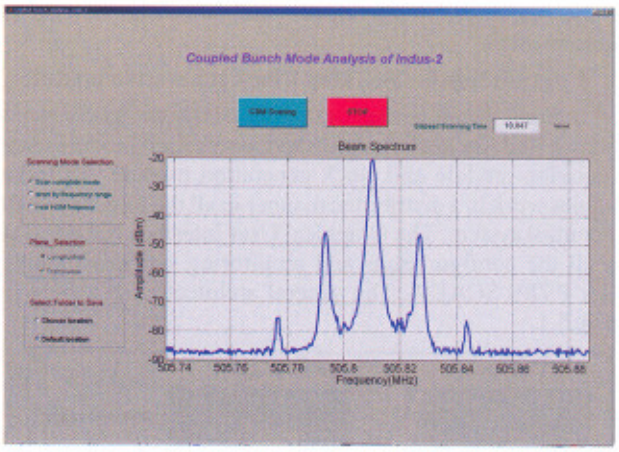

Fig. A.6.2 : Screenshot of graphical user interface of longitudinal coupled bunch mode measurement system

This system is now routinely being used to measure the level of excitation at different beam energies during machine operation. This system is also used during the machine experiments. In an experiment to understand the partial beam loss phenomenon during beam accumulation and beam energy ramping, it was observed that CBM around L1 (~950 MHz) mode was excited during the ramping. Similar observation was also made by RF system experts, who optimized the HOM plunger position to suppress the L1 mode excitation. The variation in the excitation level of CBM around L1 mode at different beam energies is shown in Fig. A.6.3.

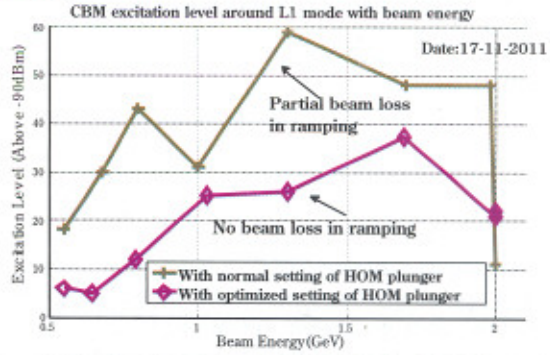

Fig. A.6.3 : Variation in excitation level of CBM near L1 mode at different beam energies

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