A.9: Automation of Betatron Tune measurement system of Indus-2

In Indus-2 storage ring, betatron tune measurement is important for optimisation of the machine performance. A particle displaced transversely from its equilibrium orbit exhibits betatron oscillations about the orbit. The number of periods of oscillation in one complete turn around the machine is called betatron tune (Q). Betatron tune of Indus-2 is measured by swept frequency excitation method. The block diagram of betatron tune measurement system for Indus-2 is shown in the Fig. A.9.1. In the earlier version, betatron tune measurement had to be done manually by a skilled person. Now the system has been automated with provision of data logging by Beam Diagnostics Section of Accelerator Controls and Beam Diagnostics Division for continuous measurement of betatron tune.

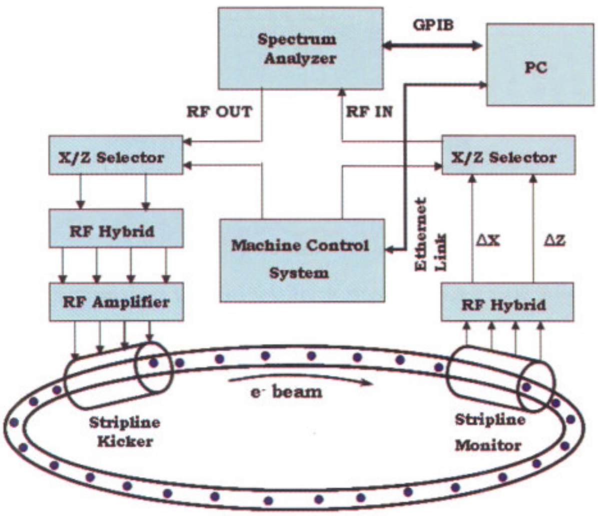

Fig. A.9.1: Betatron tune measurement system of Indus-2

The measurement system employs a spectrum analyzer equipped with a tracking generator. A stripline kicker is used to excite the beam. The tracking generator RF output is given to a remotely controlled horizontal/vertical plane selector (X/Z selector). The output RF signal is then fed to a RF hybrid to produce four output signals with the phase relationship required for exciting the beam in the desired plane. The RF signals are amplified by 50 W RF power amplifiers to drive the stripline kicker located in long straight section LS-1 of the ring. Another stripline located in long straight section LS-2 is used as beam position monitor to observe the betatron oscillation. The four stripline outputs are combined in RF hybrid to produce real-time x and z delta signals. After passing through the X/Z selector, the signal is applied to the RF input of the spectrum analyzer. From the frequency of the betatron sideband peak generated during sweep, fractional betatron tune value is obtained.

For automation of this system, a software has been developed in MATLAB to interface the spectrum analyzer with PC through GPIB bus. The software sets the parameters of spectrum analyzer, selects the plane of excitation, and acquires beam energy and current data. Depending on the beam energy value, software sets the power level of tracking generator output and a frequency sweep is applied to the stripline kicker. The software then acquires the resulting spectrum data from spectrum analyzer, calculates the betatron tune value and displays on the graphical user interface. The screenshot of the developed graphical user interface is shown in Fig. A.9.2. The betatron tune data is logged with beam parameters in a file.

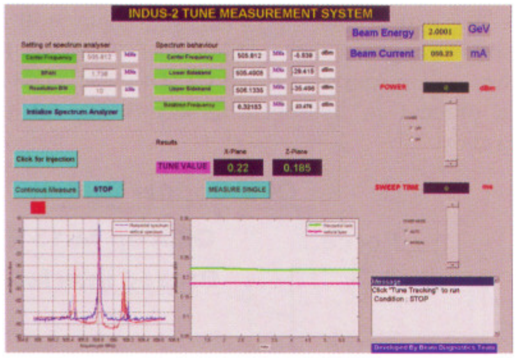

Fig. A.9.2: Screenshot of graphical user interface of betatron tune measurement system

This system is now routinely being used by Indus accelerator operation crew to record the betatron tune value at different beam energies. Fig. A.9.3 shows a typical graph of betatron tune variation with beam energy.

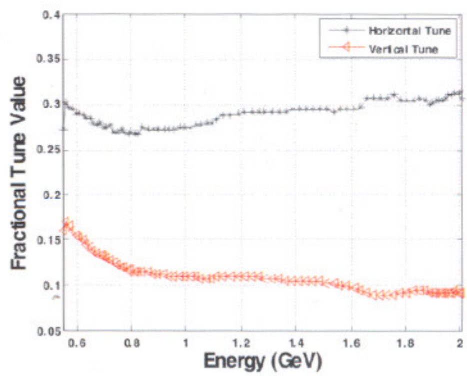

Fig.A.9.3: Betatron tune variation with beam energy

Using this data, tune correction has been applied by accelerator beam physicists to optimise the machine performance.

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