A.1: Commissioning of low emittance electron beam optics in Indus-2

Currently Indus-2 is being routinely operated for the beam users. Certain users require tightly collimated x-ray beams radiated from bending magnets and are more concerned with the brightness of the source. These users benefit greatly from the reduced beam emittance. To accomplish this in Indus-2 storage ring, horizontal emittance was reduced to 40 nm-rad from 82 nm-rad.

Indus-2 was commissioned with the moderate optics having beam emittance of 82 nm-rad. In this optics, sensitivity towards linear and nonlinear imperfections was lower due to the weak focussing of electron beam. This results in easy beam circulation and beam energy ramping.

The natural horizontal emittance originates from equilibrium between radiation damping and quantum exciation. The quantum excitation gives rise to the growth of oscillation amplitude. On decreasing the quantum excitation by properly shaping the dispersion function the beam emittance can be reduced. For reducing the quantum excitation, a procedure has been evolved and implemented to shift the beam emittance of stored beam at final energy. At this beam energy, the properties of the ring lattice are changed by varying the strengths of the four quadrupole families in such a way that dispersion function at the location of bending magnet was reduced. Procedure has been evolved considering the following constraints :

1. Transverse betatron tunes in both horizontal and vertical planes should remain constant, so that betatron tunes kept far away from the dangerous resonances lines to avoid beam loss.
2. In the vertical plane, changes in lattice function should be as small as possible.
3. The error sensitivities of the lattice are kept within acceptable limit.
4. The strengths of the sextupoles for chromaticity correction are adjusted as per requirements of stable beam optics.

The lattice functions of moderate optics and the low emittance optics are plotted in Figs. A.1.1 and A. 1.12.

In the emittance switching processes, a look up table for the magnet currents was generated and fed to the hardware by using the existing ramp software. Using this, emittance transfer process was executed by synchronously changing the field strengths of quadrupole and sextupole magnet families.

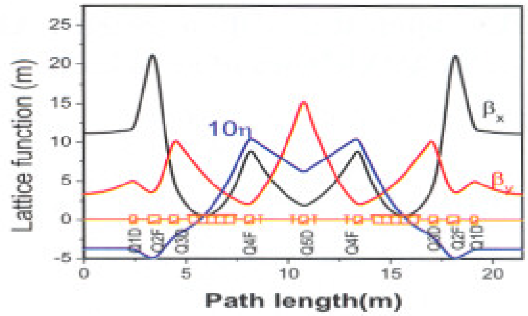

Fig. A.1.1: Moderate optics

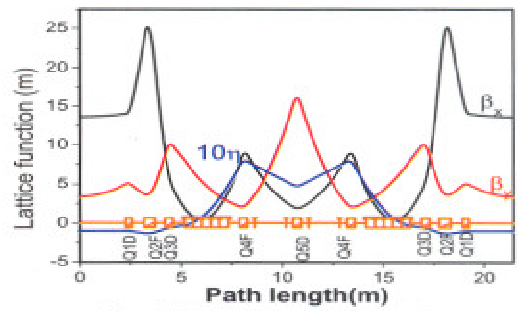

Fig. A.1.2: Low emittance optics

With this procedure, the beam emittance of stored beam was successfully shifted to the lower value, without any beam loss. The time taken for the emittance transfer is 1-2 minutes. The tunes in both plane were measured and found to be same as that of moderate optics. In the above experiment, electron beam lifetime was found to be smaller as compared to the regular operation and is shown in Fig. A.1.3. This may be due to the smaller dynamic aperture of the lattice in the low emittance mode. This exercise was carried out at the beam energy of 2 GeV.

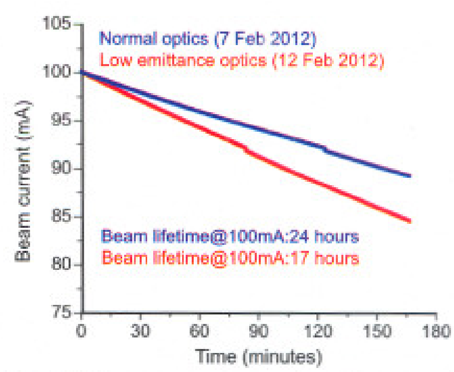

Fig. A.1.3: Lifetime comparison of moderate-optics and low-emittance-optics

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