A.3: Operation of Indus-2 at 100 mA, 2.5 GeV with undulator U1

Indus-2 machine is designed for installation of 5 insertion devices (ID) to provide Synchrotron Radiation (SR) beam to users. Out of these, three insertion devices (U1, U2 and U3) have been installed in the Indus-2 ring. For facilitating operation of insertion devices at electron beam current of ~100 mA, the integrated testing of U1 with the machine was taken up. This experiment required the integrated testing of different system parts like ID control software, hardware and software interlocks, qualifying the beam position trip interlock limits of beam position indicators (BPI) in ID sections (IDBPI), verification of the electron reference orbit inside ID, characterizing the effect of ID jaw closure action on the electron beam orbit, characterization of Slow Orbit Feedback (SOFB) for minimizing these ID induced disturbances, qualifying the complete system through proper temperature and vacuum condition monitoring at required locations in the ring and at beam dump. The experiment provides the U1 operation data that is important for machine and beam line and their operation. It also qualifies the machine, U1 interlocks and the related developments for the operation of U1 at high current.

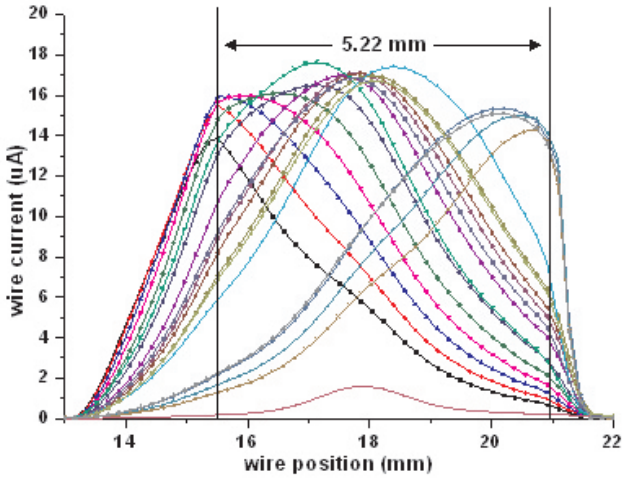

Fig. A.3.1: Plot of wire scanner current for different electron beam orbits showing the measured effective vertical dipole chamber aperture at 0° port with 25mm ID pole gap.

For this, first the available effective dipole chamber aperture at U1 was found experimentally from the wire scanner data taken for different orbits at low beam current (3mA) while the electron beam was steered using SOFB to different beam positions and angles in Indus-2 ring. Effective vertical aperture at 0° port of dipole chamber was found to be 5.22 mm as shown in Fig. A.3.1. Beam position readings of BPI-9 and BPI-10 were taken as reference positions for verifying the repeatability of the electron beam position in the ID chamber. Measured aperture data was used to calculate the reference beam positions at BPI-9 and BPI-10 for defining the beam orbit inside the U1.

The repeatability of the reference trajectory by the SOFB system was validated experimentally. The formulated reference orbit serves the purpose of practically identifying the safe operational values for the electron beam positions inside the ID chamber. The closing of ID gap from full open (250 mm) to fully closed (25 mm) perturbs the electron beam path in the ring. The effectiveness of the SOFB system to suppress these perturbations was verified, and the limits for the safe beam operation in the ID chamber were calculated as ±120μm at ID input (BPI-9) and ID exit (BPI-10) locations. The BPI position interlocks were validated and configured as per the calculated limits.

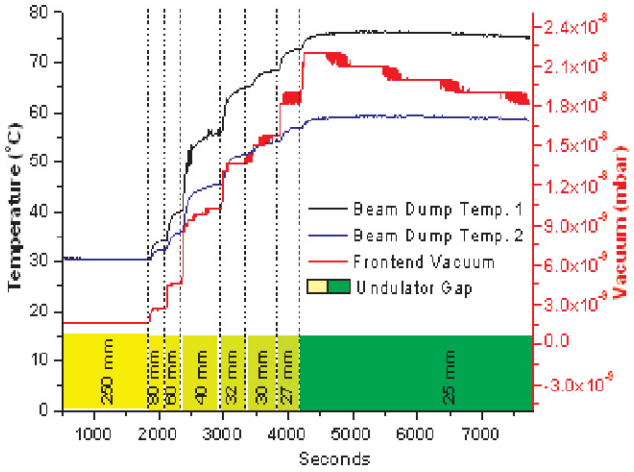

Fig. A.3.2: Plot of FE vacuum and beam dump temperature for different ID gap values with beam at 2.5 GeV at 100 mA.

ID operation trials were performed at 2.5GeV at 100mA and the successful operation of the complete system was qualified from the beam dump temperature and beamline front end vacuum reading values (see Fig. A.3.2). The temperatures labelled Beam Dump Temp.1 and Beam Dump Temp.2 are measured at two different locations at the beam dump, with two sensors. The figure shows the increase in the beam dump temperature for different ID gap positions. It can be seen that as the ID gap is reduced from 250 mm to 25mm in steps, the beam dump temperature increases from ~31 °C to ~ 60 °C in sensor -2, and simultaneously the beam line front end vacuum changes from ~ 2.0E-9 to 2.0E-8 mbar; however, after some time of operation, the vacuum starts improving.

The success of this experiment has led us to ID operation qualification method in Indus-2 machine. This will be useful for qualification of the upcoming insertion devices in Indus-2.

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