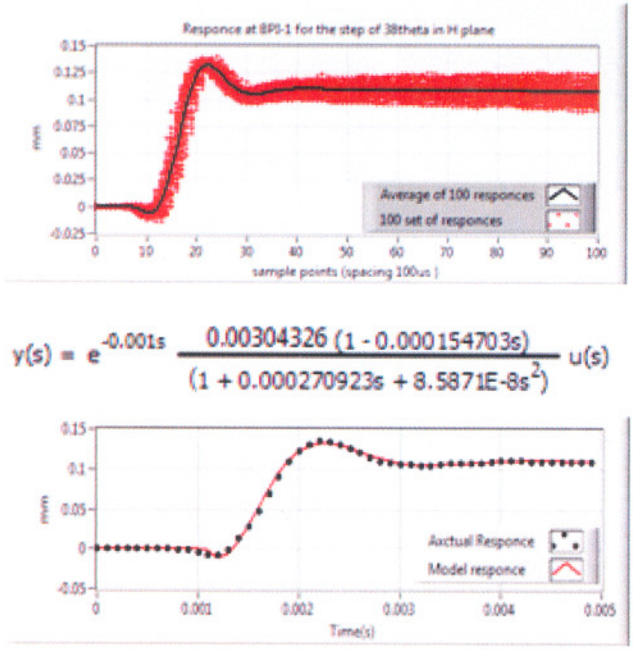
A.7: Local Fast Orbit Feedback Control System for Indus-2

In the presence of different noise sources such as ground vibrations, noise in magnet power supplies and mechanical vibrations introduced by nearby machines such as vacuum pumps and AC fans, the apparent size of electron beam in synchrotron radiation sources increases. In order to stabilize the electron orbit at local X-ray beamline for angle and displacement in both the planes (Vertical and Horizontal) the Local Fast Orbit Feedback (LFOFB) Control System is developed and demonstrated for BL-8 in Indus-2.

For this system, module for data collection at 10KHz rate from Digital BPIs in Libera grouping configuration is developed. FPGA module for handling the power supply interface is developed on the PXI side using LabVIEW FPGA development tools. The LabVIEW real-time codes were developed for implementing the 'eight input four output' feedback control system with 5KHz loop rate for horizontal plane and vertical plane. These codes are optimized to achieve the loop rate of 10KHz. The GUI for controlling the overall LFOFB application is developed in LabVIEW and the overall integrated system is tested in steps and qualified for functioning.



$$y(s) = e^{-0.001s} \frac{0.00304326\,(1 - 0.000154703s)}{(1 + 0.000270923s + 8.5871E\text{-}8s^{2})}\,u(s)$$

Fig. A.7.1 Measured step response and the derived transfer functions in horizontal plane.

On this base system the supervisory codes are developed for performing the system identification experiments and logging of data. The sinusoidal stimulus is produced using the model derived closed bump coefficients for the 'four corrector closed bump scheme' and the bump closure condition is evaluated for both the planes. The experiments are performed to capture the system's open loop response in vertical and horizontal plane (using step stimulus). From the experimental data, two sets of 100 different measurements were made for system identification and validation respectively for each plane. Figure A.7.1 shows the measured step response, derived Transfer Functions (TF) and model validation for horizontal plane. Using this TF, the initial PID controller values are calculated and then fine tuned online for getting good disturbance rejection in noise.

The system is characterized for disturbance rejection by injecting the sinusoidal disturbance (at 12 different frequencies between 1Hz to 200Hz range) in beam using a separate corrector downstream the correction point. Figure A.7.2 shows the measured systems noise sensitivity in horizontal plane.

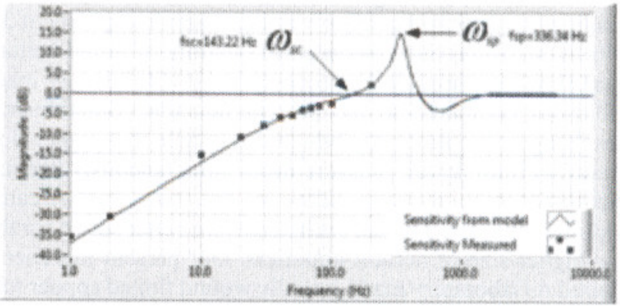


Fig.A.7.2 Measured systems noise sensitivity in horizontal plane

The noise characteristics of the system in both the planes are captured and using this data set, the Auto Regressive (AR) model of noise is derived. The TF of corrector power supplies, the delays offered by controller and power supply controller are experimentally derived. Using These TFs of controller, power supply and accelerator system, the simulation program is developed in LabVIEW for the overall system. This has helped in deciding the modifications and enhancements needed for implementing the global FOFB with 16 BPIs in the next stage.

With this system, correction bandwidth upto 70Hz is successfully achieved and it brings down the naturally occurring beam position variation from ±30μm pk-pk (H plane) and ±10μm pk-pk (V plane) to ±3μm pk-pk in both the planes.

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