## A.3: Control system for beam based alignment in Indus-2

Indus-2 synchrotron radiation source (SRS) is a national facility which operates round the clock, providing maximum stored beam current of 200 mA at energy of 2.5 GeV. In a storage ring, it is desirable to have the electron beam trajectory as close as possible to the center of the quadrupole magnets (QPs). This reduces the requirement of correcting magnetic field strength and variation in the machine tune, which in turn results in reduced closed orbit distortion and improved beam-life time.

The difference between electrical axis of beam position indicators (BPI) and magnetic axis of adjacent QP is the offset which needs to be accounted to define the beam orbit. Correlating the magnetic axis of a QP with a nearby BPI via the beam, the true centre of the BPI can be established with high precision. This mechanism is known as beam based alignment (BBA).

BBA works on the principle of steering the beam to pass through the center of the QP, leading to a condition of no change in beam position at the adjacent BPI with change in QP strength. This requires independent setting of all the QP magnets of Indus-2 ring. Since many QP magnets are fed by a single power supply, individual active shunt power supplies (ASPS), connected across each QP, now enable the control of current in the individual magnets. This system will also serve for performing linear optics by closed orbit experiments in Indus-2.

*Control system hardware for ASPS:* There are 80 active-shunt bipolar power supplies corresponding to these quadrupoles. Supervisory control (SC) system is developed and installed in the Indus-2 MPS Hall to control the operation of these power supplies from remote location. VME bus based supervisory control system having three layer architecture is developed in accordance with the existing Indus-2 control system for seamless integration. At the equipment control layer (L-3), there are dedicated control modules that generate a stable bipolar reference of ±10 V, with 16-bit resolution for each magnet power supply to precisely vary the magnet current in the range of ±6 A, corresponding to ±3% change in the magnetic field. Readback of the actual current flowing through the magnet is also measured with 16-bit resolution. ProfiBus fieldbus protocol is used for information exchange between L-2 and L-3. Profi-slave controller situated at each equipment control station at L-3, communicates with the Profi-master at Layer-2 (L-2) over RS-485 bus. Each equipment controller (EC) (Figure A.3.1) is interfaced to four ASPS and total twenty such ECs are developed, interfaced and tested for the monitoring and control of 80 ASPS.

*Control system software for ASPS*: The software for monitoring and control of the ASPS has been implemented following the three-layer architecture followed in Indus-2 control system. However, the L-2 SC station is implemented using VxWorks based PowerPC CPU board. The data of 80 ASPS are now updated in the SCADA. The VxWorks based SC provides additional diagnostics features to query the parameter values of ASPS and log diagnostics information in the remote PC which is of immense help for quick diagnosis of any issue. The GUI panel (Figure A.3.2) provides all the required functionality for monitoring and control. It has features, like configurable increment in set values, replacement of faulty power supply without affecting GUI operation, additional diagnostics information panel for monitoring digital reference setting and analog reference read-back. The control scripts for history data logging were deployed for per-second recording of the history data. All user actions are recorded in API manager log with milliseconds time stamp.

Web applications have been developed for querying, retrieving, displaying and downloading the history data over RRCAT intranet.

*Fig. A.3.1: Equipment controllers in a control cabinet.*

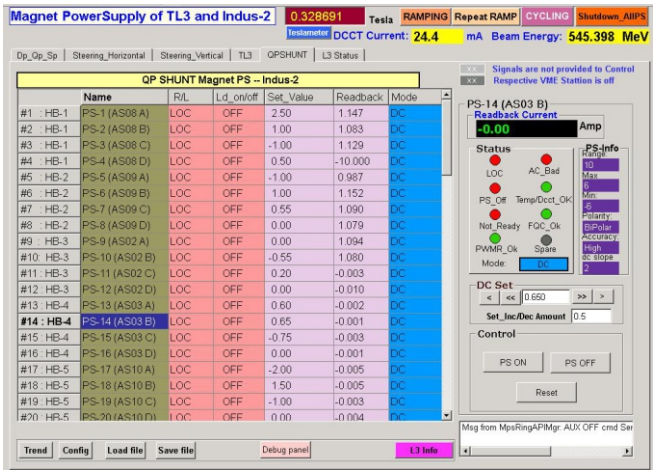


*Fig. A.3.2: GUI panel for monitoring and control of ASPS.*

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