A.1: Optical fibre based analog signal isolation for Indus-2 Controls

Indus-2 timing system has been experiencing random problems due to high noise levels generated by pulsed power supplies. The noise is primarily conducted into the system even though all analog and digital signals are isolated. Recently an analog isolation layer was introduced for providing additional isolation to the setting reference of pulsed power supplies. The voltage references for setting pulsed power supplies are generated from a VME bus based isolated DAC card but this isolation was not sufficient to cope with the noise due to high EMI. For enhancing the system immunity to conducted EMI, optical fibre (OFBR) based signal interface was developed in Accelerator Control Section (ACS). Voltage (V) to Frequency (F) & F-to-V principle of signal transmission was adopted.

The analog signal is converted to frequency and transferred to the receiving end by OFBR/optical transmitter (OP-TX)/optical receiver (OP-RECV) assembly. At the receiving end the frequency signal is converted back to voltage signal. Further, depending on the system requirement, the voltage signal is converted into a 4-20mA current loop signal.

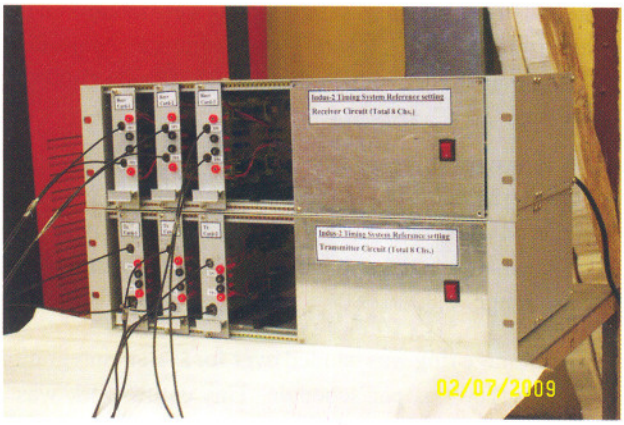

Fig. A.1.1: Optical fibre based isolator units

Transmitter and receiver parts are developed in two different cards with required protection, indication and test-points for each channel. Single ended 0-10V input is converted to 4-20 mA current loop output. Burr Brown make chip VFC32 is configured as V-F/F-V converter whereas HFBR 1521/2521 are used as optical transmitter/receiver. Plastic fibre is used for interfacing transmitter and receiver channels. XTR110 is used to generate current loop signal. The cards developed were tested /calibrated in the lab. A linearity of 0.019% and stability of 0.02% (10 hrs) could be achieved.

Two separate units (Fig. A.1.1), comprising transmitter and receiver cards, are developed. Voltage input of transmitter unit is given from the DAC card, whereas the current output from receiver unit is connected to the pulsed power supply reference input. Total six power supplies are interfaced by the assembly. All the units were tested with the actual load and found working satisfactorily. The system has been deployed for regular use.

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A.2: Activities during recent shutdown of Indus-2

In an electron storage ring, Photon Induced Desorption (PID) yield varies from 10^{-2} for a good chemically cleaned surface to 10^{-6} for the surface subjected to hundreds of ampere hours of beam cleaning. Installation of beam line front ends (BLFE) requires venting of the vacuum segments of storage ring, which almost nullifies the effect of beam cleaning and the beam life time is adversely affected. Therefore, it was decided to avoid venting of storage ring for installation of BLFEs in future and to install UHV gate valves (GV0) on all the twelve unused dipole radiation beam line ports of Indus-2. However, the high synchrotron radiation power density in Indus-2 necessitates that these gate valves were kept open during the machine operation and the radiation was made to fall on the water cooled end flanges, installed down stream. It was also decided that pending jobs on vacuum envelope are also taken up so that the storage ring is not vented for a few years to come. Accordingly, a shutdown of Indus-2 was planned, from June 1, 2009 to July 14, 2009. The following major activities were carried out :-

- Beam Line Front End (BLF) components were assembled in following 12 beam lines: BL - 1, 2, 3, 4, 6, 18, 19, 21, 22, 23, 24 and 26. Each beam line was provided with a Bellow chamber, Gate Valve (GV-0), Adopter chamber and Water Cooled Flange and their support structures. Thermocouples were installed to monitor temperature of end flanges using 160 channel Temperature Monitoring System. Pneumatic pressure lines were also provided to operate these valves. All

GV0s were hard wired with controllers on the instrumentation gallery. The control and status signals from these controllers will be used for interlocks.

- To facilitate higher beam current operation, RF Cavity Sector was vented and the couplers were dismantled to change the β values to 1. These were reassembled and cavity sector was evacuated. All the four cavities were baked for 48 hours to achieve base vacuum $<10^{-9}$ mbar.
- Leaky Straight Section Chamber SSS3-L1 was replaced with new all aluminum chamber along with a new Sputter Ion Pump and a Titanium Sublimation Pump (TSP).
- Five nos. of Titanium Sublimation Pumps (TSPs) were fabricated, chemically cleaned, vacuum degassed and assembled with DS seal flanges in LSS-L2 chambers of LSS # 2, 3, 4, 5 and 6. Eight TSP cartridges along with Ø152 CF zero length adopters were fabricated and assembled in all the SSS-L2 chambers. Worn out TSP filaments were replaced in VS-2 -TSP #6, VS-3-TSP #10, VS-4-TSP #6 and VS-8-TSP #1.
- Eleven nos. of water cooled flanges were replaced in 0° Ports of Dipole magnet (DP) chambers #1, 4, 5, 6, 8, 9, 11, 12, 13, 15 and 16.
- To minimize effect of fringing field of magnets, orientation of BA Gauges was changed at DP # 1, 2, 3, 4, 7, 8, 10, 11, 14 and 15. The worn out filament assembly of BA Gauges were replaced in Vacuum Segment, VS-3-BAG #5 and VS-5-BAG #2.
- One 270 l/s Sputter Ion Pump was replaced with new SIP in DP-12-SIP #3.
- RGA Heads were replaced in DP-7 & 8 chambers.
- RF Contact Sector valves #5 & #6 were replaced.
- Upper half of Sextupole magnet in SSS-3 was opened and then reassembled after installation of new vacuum chamber.
- The aged flexible polyurethane tubing of LCW connections in all dipoles and seven cells were replaced. Leaky connections were brazed.
- The old and internally corroded mild steel pipelines of secondary chilled water side of all the precision chiller units were dismantled and replaced with new stainless steel pipelines along with thermal insulation. The completed lines were recommissioned.
- The coolant water temperature transmitters of Indus-2 ring area and RF klystron power supply area were calibrated and reinstalled with improved reading accuracy of <0.75%.
- To accommodate the new pressure sensor and also to make easy approach of the LCW devices, the LCW sub-header at Long Straight Section, LSS–1 was modified and relocated near TL-3 injection in the ring. As a result of installation of new BLFE components, LCW sub headers were modified in the Short Straight Section, SSS-1 (BL-1&2) and LSS-2 (BL 3&4), LSS-5 (BL-18&19), SSS-5 (BL-20, 21 & 22). This will also make the system easily approachable during maintenance and the devices can be easily monitored.
- Functionality of Indus-2 Flow Switches was checked and flow balancing was carried out for proper distribution of coolant water in the ring.
- Alignment and survey data were recorded for Indus-2 ring.
- After assembly, system was subjected to rigorous leak detection to better than 2×10^{-10} mbar.l.s^{-1} leak tightness. Each of the eight vacuum segments and r.f cavity secters were baked sector wise for more than 48 hours (~ 120 °C for Al and 250 °C for SS components). Baking was carried out by using Pressurized hot water generators, heater strips and tapes. Temperatures were monitored and controlled by 32 channel temperature controllers. Vacuum in the 10^{-10} mbar range was achieved in >90% of the ring.
- In Transport Line-3, edge welded bellows of Beam Position Monitors #7 & 8 and the 35l/s SIP #23 & 24 were replaced with new ones. This part of TL-3 was leak checked, evacuated and baked to achive vacuum in 10^{-9} mbar range.

The Storage ring was handed over for system integration on 13th July 2009 as per schedule. This entire work was a successful team from UHV Section, ISUD, Magnet Fabrication Section, Alignment lab, Beam Diagnostics Section, Coolant Systems Lab, Accelerator Control Section. R.F Division and IOAPDD

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