A.2: Installation and commissioning of upgraded Transport Line-1

Transport Line-1 (TL-1) in Indus-1 area, which was installed in 1995, was proposed to be replaced with an upgraded version to augment the diagnostic capabilities for better tuning of the parameters of TL-1 for increasing injection efficiency into the booster synchrotron. It has upgraded vacuum beam pipes with all knife edge sealing flange joints. Old sputter ion (SI) pumps have been replaced and two new SI pumps have been added to take care of additional gas load due to more number of diagnostic devices. A branch line is also installed after fabrication and vacuum qualification. This has a facility for measurement of energy spread of the 20 MeV microtron beam. Indigenously developed UHV compatible beam diagnostics devices namely, four upgraded beam profile monitors (BPM), two secondary emission wire monitors (SEWM), five beam slit monitors (BSM), and new UHV compatible ceramic chambers for fast current transformers (FCT) are also installed (Fig. A.2.1). Furthermore, one BSM and one Faraday cup are installed in the branch line.

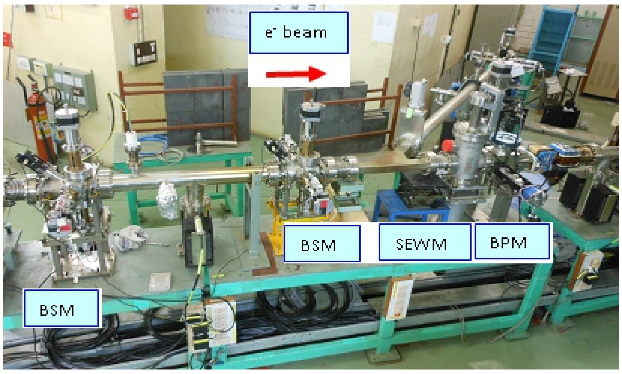

Fig. A.2.1: Upgraded beam diagnostic devices

In BPM, a stepper motor driven 1 mm thick fluorescent ceramic screen (AF995R) is used to measure transverse beam profile. In SEWM, a grid of 15 nos. x 15 nos. of insulated wires (Ø 100 µm gold plated tungsten), spaced by 2 mm is used. A 32-channel microcontroller based signal readout system has been developed for SEWM for measurement of transverse profile and position of the electron beam. Typical results are shown in Fig. A.2.2. The new BSMs have been

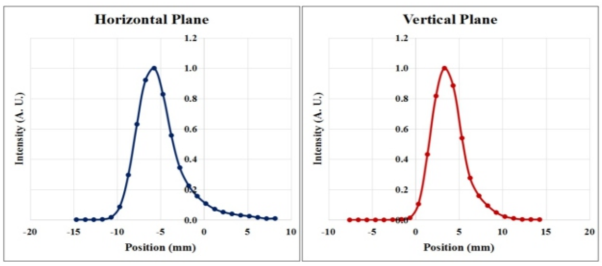

Fig. A.2.2: Measured beam profiles using BSM 3

added in the electron beam path to monitor the profile, and scrape and shape the beam extracted from microtron before injecting into the booster ring. A BSM control system hardware is developed using VME bus based modular system and software is developed using LabVIEW. Control algorithm is developed for positioning the blade as per user requirement. Software provides different modes of operation viz. inching mode, pre-configured modes for positioning all the four blades in a single click and single blade positioning mode. A switched integrator based signal processing electronics has been developed for the BSM. New TL-1 is divided in three sections with the help of gate valves for easy operation and maintenance. Each section has a vacuum gauge for pressure monitoring. Prior to installation, complete line was assembled and vacuum qualified in Lab. Reference axis for TL-1 comes from its quadrupole magnets (QP). Before installation, of new transport line the old transport line was dismantled after initial positional measurements. First section of the new line was assembled and leak tested with HMSLD to have a leak tightness of better than $1 x 10^{-9}$ mbar. All three sections were assembled and tested with similar procedure. Complete line was vacuum qualified and a base vacuum of $2 x 10^{-8}$ mbar was achieved without baking. Installing new TL-1 involved: 1) Transferring the references from QP of the TL-1 to rigid walls. 2) Online measurements to guide the installation of TL-1 components which forms the vacuum envelope. 3) Re-establishing old TL-1 reference from the control points on walls after putting back of the upper halves of the QPs. 4) Final alignment of the beam diagnostic devices like BSMs, SEWMs and BPMs, 15 degree magnet etc. in the same coordinate system as before the opening. Safety interlocks are implemented in hardware as well as in software. Interlocks protect slit blades from collision and over run. During positioning, software monitors minimum gap between the blades, whenever the gap approaches the gap violation limit, it stops the blade movement. TL-1 is functioning satisfactorily after commissioning since April 2017 (Fig. A.2.3).

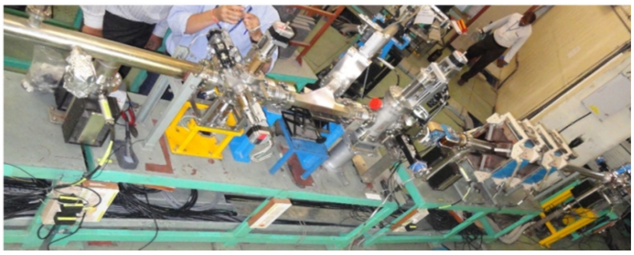

Fig. A.2.3: New TL-1 during installation

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Reported by:
R. Sridhar (srisri@rrcat.gov.in) on behalf of Indus Team