

A.1: Status report on operation of Indus accelerators

The Indus synchrotron radiation (SR) sources, constituting a national facility, provided SR beam to the users (Figures A.1.1 and A.1.2) regularly on round-the-clock basis. Both the machines maintained very good operational performance during the period from July 2019 till the machines were shutdown on 22nd March 2020. Machines remained in shutdown condition till 26th May 2020 in compliance to Government of India directives to contain spread of COVID-19. Subsequent to opening of the office from May 27, 2020 after lockdown, various checks at subsystem and overall integrated system level were planned and executed to restore the operation safely in phased manner with reduced manpower and following the COVID-19 related guidelines.

There was no major breakdown or unplanned shutdown in the machine during this period. Planned shutdowns of four to five days each were taken in the alternate months for preventive maintenance and a longer shutdown of three weeks for upgradation and maintenance activities. On fourteen operation days, which were reserved for machine studies and distributed over the year, experiments were carried out for analysis and performance improvement of the machines and its sub-systems. Taking this into account, the machine was operated in round-the-clock mode for 231 days during the period July 2019 to March 2020. The beam availability for users was 5120 hrs (~22 hrs/day) in Indus-1 and 3724 hrs (~16 hrs/day) in Indus-2. This performance is in line with the performance of the previous year.

Users from various universities, research institutes and national laboratories used the SR beam at beamlines in Indus-1 and Indus-2 for carrying out experiments. The total number of user experiments carried out at Indus beamlines was 518.

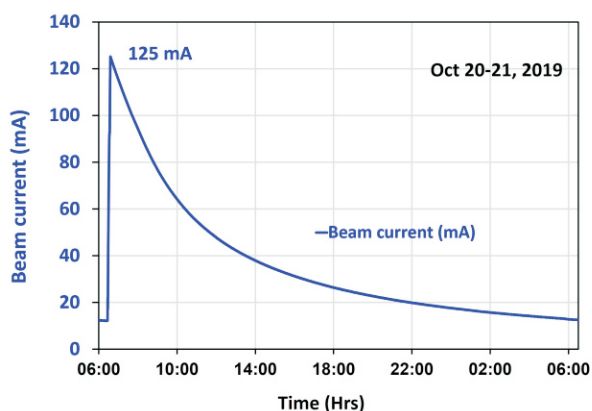


Fig. A.1.1: Typical user mode operation of Indus-1.

The beam lifetime in Indus-2 which improved significantly during first half of 2019, maintained its performance and gradually increased further. On 23rd October, 2019, lifetime of 84 h 48 m was recorded at 100 mA of stored current. This is the highest lifetime achieved so far in Indus-2.

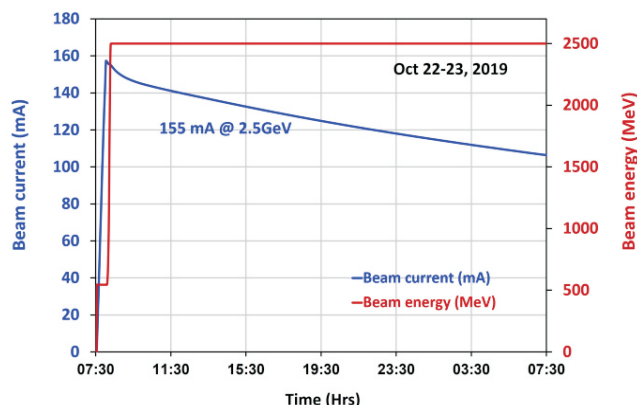


Fig. A.1.2: Typical user mode operation of Indus-2.

The fourth batch of operation staff comprising 29 personnel, who successfully completed the Training, Qualification and Licensing Programme (TQLP) during first half of the year, were inducted into round-the-clock shift operation with effect from August 2019 along with a few from the existing staff.

Installation of vertical pinger magnet in Indus-2 and other upgradation/maintenance activities: A major shutdown of three weeks was taken in Indus machines with effect from 16th December 2019 with all the necessary preparations in advance. A vertical pinger magnet, which is basically a pulsed magnet, along with its ceramic UHV chamber, pulsed power supply and timing control system was successfully installed in straight section SS-7 of Indus-2 (Figure A.1.3). Pinger magnet acts as a diagnostics tool for carrying out advanced beam dynamics studies. In addition, new quadrupole vacuum chamber compatible with adjoining pinger magnet in VS-7 vacuum segment and one new quadrupole vacuum chamber of VS-5 vacuum segment, replacing the existing one with leaky stainless steel to aluminium joint, were also installed. All these activities required venting of VS-5 and VS-7 vacuum segments comprising one fourth of Indus-2 ring.

Alongside, eight existing beam position indicators (BPIs) of these two vented segments were also replaced with their upgraded versions. After integration of vacuum chambers and BPIs in the ring, UHV condition in these segments was restored after bakeout and vacuum conditioning.

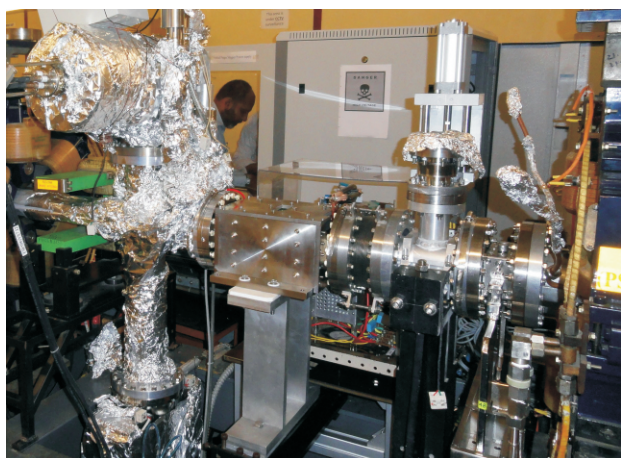


Fig. A.1.3: Vertical pinger magnet installed in Indus-2.

In parallel, 12 sputter ion pumps (SIPs) of the booster synchrotron which had been in use for more than 25 years, were replaced. A new inductive output tube (IOT) based RF power amplifier was installed to power one out of six RF cavities in Indus-2.

Resumption of Indus facility after lockdown: During the lockdown period, proper measures were taken to ensure the safety of Indus sub systems and Indus complex. The SIPs of UHV system, and safety and emergency systems like fire alarm system, emergency power and CCTV system etc. were kept on and monitored with the help of essential service staff after imparting necessary training.

Subsequent to opening of office after lockdown, a detailed plan for startup of Indus facility was prepared for execution with reduced manpower. Standard operating procedure (SOP)

for management of control room (Figure A.1.4) and other facilities related to shift operation was made to comply with COVID-19 work environment related precautions and guidelines.

After completion of system restoration activities, the operation of Indus facility was started in two shifts (06:15 to 20:30 hours) from 11th June 2020. During night, the sub-systems were kept in standby mode and monitored. Operation of Indus-1 was resumed on 17th June with 50 mA stored current which was gradually increased to 110 mA by the end of June 2020. In Indus-2, preparation for restart at low current for system conditioning was in advanced stage.



Fig. A.1.4: A view of Indus control room depicting work environment complying with COVID-19 related guidelines.

*Reported by:
T. A. Puntambekar (tushar@rrcat.gov.in)*