

A.3: Development, installation and commissioning of horizontal pinger magnet system in Indus-2

A horizontal pinger magnet (an advanced diagnostic tool) has been integrated into the Indus-2 synchrotron radiation source (SRS) in Dec. 2021. Pinger magnet system is used for probing the linear and nonlinear dynamics of the beam by generating oscillations, which are captured by beam position indicators (BPIs) of the ring. This data is processed and used to study beam dynamics. The constituent units of pinger magnet system are: (i) Pinger magnet, (ii) Power supply to energise the magnet, and (iii) Control system to control & synchronize the power supply remotely. Typical specifications of horizontal pinger magnet and power supply are given in Table A.3.1.

Table A.3.1: Specifications of the horizontal pinger magnet and pulse power supply.

Beam energy/Deflection angle	2.5 GeV, 1.5 mrad
Max. peak magnetic field	593 G @ 2.7 kA
Magnet pole gap / width	56 mm / 106 mm
Magnet core length	200 mm
Effective magnetic length	219 mm
Inductance	565 nH
Magnetic field uniformity	$\pm 2 \times 10^{-3}$ (± 20 mm)
Magnetic field pulse width	948.8 ns @ 2.7 kA
Delay in peak magnetic field	66 ns (w.r.t. current)
Pulse shape	Half sine
Average Ti coating thickness	587.4 nm

The magnet and power supply were developed as per specifications. Power supply was realized with all its challenges of low inductance housing, high peak current and precision triggering. Design of pulse power circuit was guided by the motive to keep stray inductance minimum. In the pulse circuit, a pre-charged energy storage capacitor is discharged into the load magnet by triggering a thyatron switch. Challenges in the magnet design included realization of uniform magnetic field, low inductance coil with high voltage insulation and uniform Ti coated ceramic chamber. The coil was characterized with alumina vacuum chamber coated with Ti on inner surface. Due to Ti coating, the magnetic field is delayed with respect to current by 66 ns, which is shown in Figure A.3.1. The pulsed magnetic field uniformity achieved along pole width and pole gap is better than 2×10^{-3} as shown in Figure A.3.2.

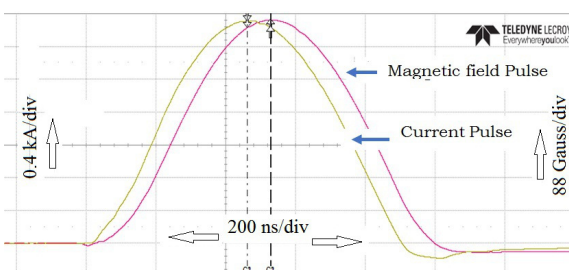


Fig. A.3.1: Current and delayed magnetic field pulse.

After the precision field measurements in lab, pinger magnet system was installed in Indus-2 ring. Power supply was integrated with Indus-2 timing control system (TCS) for triggering, monitoring and providing peak current reference. TCS was enhanced & augmented to include pinger magnet control part for display & control of I/O signals, delay settings for trigger pulses to pulse power supplies & BPIs, selective trigger facility to operate required pinger magnets, data logging & web display of parameters, etc. For the precision timing, trigger with very low time jitter (145 ps) was achieved (Figure A.3.3). Figure A.3.4 shows the installed pulse forming network next to the pinger magnet in the ring (right side) and Figure A.3.5 shows the installed power supply and system testing in ring. For further details, please refer to Theme Article T.1.

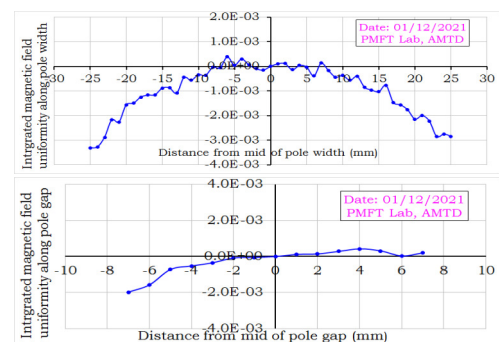


Fig. A.3.2: Magnetic field uniformity along pole width / gap.

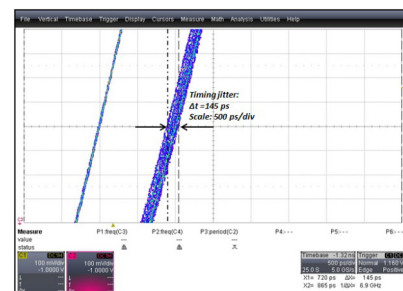


Fig. A.3.3: Channel to channel timing jitter of trigger 145 ps.

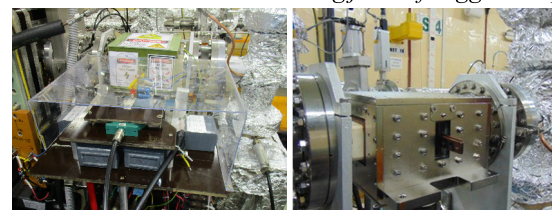


Figure A.3.4: Photograph of installed pulse forming network and horizontal pinger magnet.

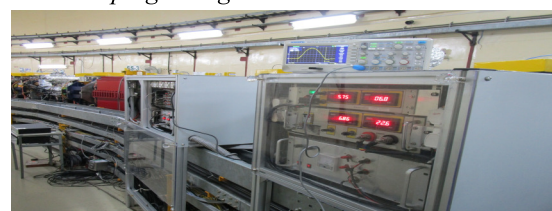


Fig. A.3.5: Commissioned power supply in Indus-2.

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