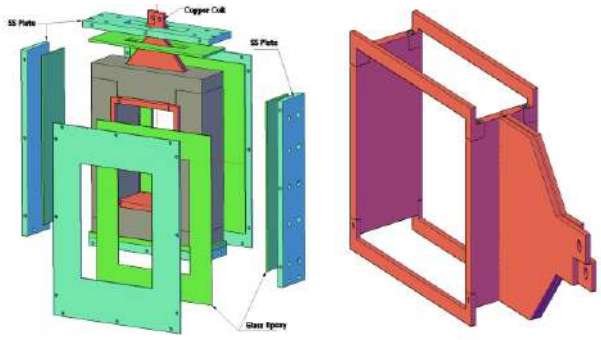
E.7: Development of fast dipole magnet for IRFEL

A pulsed magnetic field is required to study the energy spread of electron beam within a macropulse in IRFEL. For this, a linearly rising magnetic field having an integrated magnetic field of 2000 G-cm to 3000 G-cm in the pole aperture is required. A field uniformity of 1×10^{-2} in good field region (GFR) ±10 mm must be achieved. To fulfill this requirement, a fast dipole (vertical kicker) magnet has been designed, developed, characterised and deployed in IRFEL.

The physical length of the magnet should be less than 42 mm due to limitation of available physical space along beam direction for the magnet. A window frame magnet geometry was chosen in order to be able to achieve the required integrated field and field uniformity. The magnet consists of Ni-Zn ferrite core and a single turn copper coil. The magnet design was carried out using opera 3D Elektra solver. Several 3D simulations have been performed and magnet parameters were optimized.

Figure E.7.1 shows the exploded 3D view of the magnet and its excitation coil. The magnet core is fabricated from Ni-Zn ferrite blocks. The excitation coil is single turn and it has been developed using ETP copper. It has provision to open and install it around the ceramic vacuum chamber without disturbing the chamber. The Cu coil conductors were insulated using Kapton tape. The magnet outer casing is developed from stainless steel. The ferrite core, copper coil and glass epoxy sheets have been assembled precisely into stainless steel casing. The achieved pole gap accuracy is ± 0.01 mm.



(a) (b)

Fig. E.7.1: a) Assembly view of the magnet, b) Single turn excitation coil of the magnet.

The magnet was excited by a linearly rising current pulse (8 - 8.5 us) of 2.8 kA peak and corresponding magnetic field was measured. The magnetic field measurements was carried out using search coil method. The search coil signal is measured using PC based 14-bit digitizer system and DSO. The search coil was precisely placed and moved in the pole aperture using 3-axis bench. Figure E.7.2 shows the measured current and magnetic field waveforms.

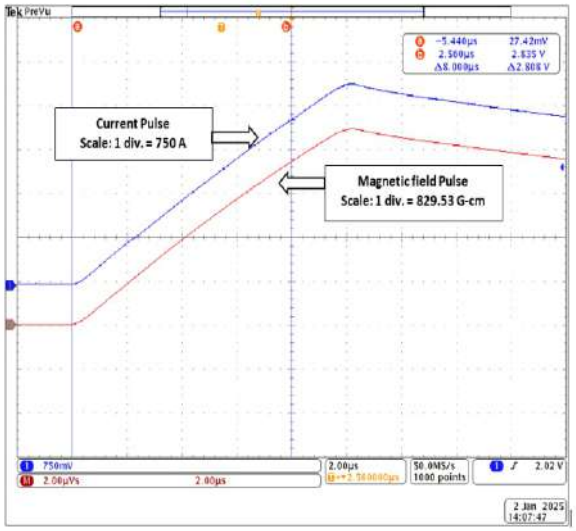
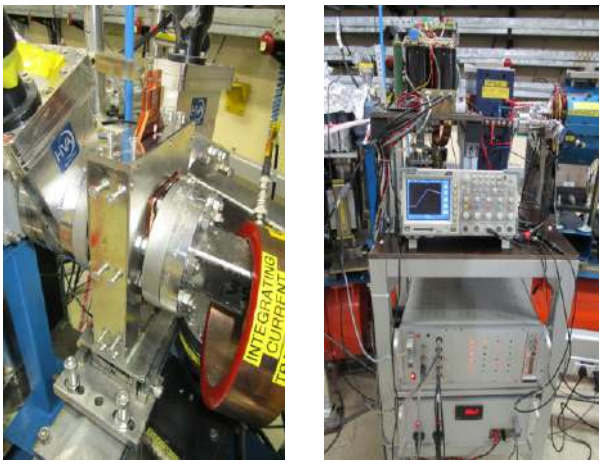


Fig. E.7.2: Measured current and magnetic field waveforms.

The fast dipole magnet installed in the IRFEL beam line and its power supply are shown in Fig. E.7.3.



(a) (b)

Fig. E.7.3: The fast dipole magnet installed in IRFEL: a) Magnet, b) Magnet being energised.

The measured field uniformity is better than $\pm1.11\times10^{-2}$ over good field region (± 10 mm) which fulfills the requirement. The magnet installed in the IRFEL beam line.

Reported by:
Shesh Nath Singh (snsingh@rrcat.gov.in)