A.1: Off-line magnetic field integral measurement of APPLE-2 Undulator

An Advanced Planar Polarized Light Emitter (APPLE-2) type undulator has been installed in LS-5 of Indus-2 to facilitate magnetic circular dichroism (MCD) and magnetic linear dichroism (MLD) experiments for the users. The photon energy range of interest is 300eV to 1500eV including higher harmonics. First and second integrals of undulator magnetic field decide change in beam angle and position respectively. Measurement of these integrals is essential for characterizing the field quality. Before installation in Indus-2 ring, the magnetic field integrals of APPLE-2 undulator were measured using the indigenously developed stretched wire set up.

This article presents technical challenges in indigenous development of a stretched wire (Litz wire of 100 strands, 0.1 mm diameter), and precision measurement system with capability of measuring first and second field integrals with repeatability within 0.05 G-m and 0.05 G-m^2.

The on axis magnetic field integrals-first and second field integrals of undulator determine its effect on the electron beam by changing its angle and position respectively. To minimize the change in angle and position of the electron beam, a very low limit is set for the first (second) field integral of an undulator typically in the range of 0.2-2 G-m (G-m^2). The inaccuracies associated with point by point measurement method using Hall probe such as small DC offset, errors in carriage movement produce field integrals exceeding the specified limits. To estimate the field integrals of an undulator with high accuracy, stretched wire measurement set up is developed in-house as shown in Fig. A.1.1. This involves movement of a long stretched wire loop in DC magnetic field to induce voltage. The induce voltage when integrated over time gives the value of the field integral.

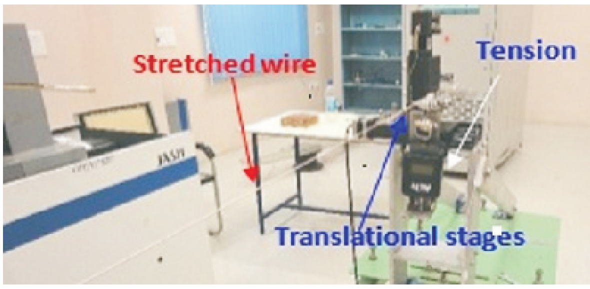

Fig.A.1.1: Stretched wire measurement setup

A long multi strands Litz wire is used for the field integral measurement of undulator. The measuring bench consists of two mobile supports on which X-Y motorized translation stages are mounted. The total length of the Litz wire is 9 m. Wire length of ~ 3.6 m is stretched with tension at one end and is placed inside the pole gap of the undulator and rest of the wire segment is kept outside the undulator as shown in Fig. A.1.2.

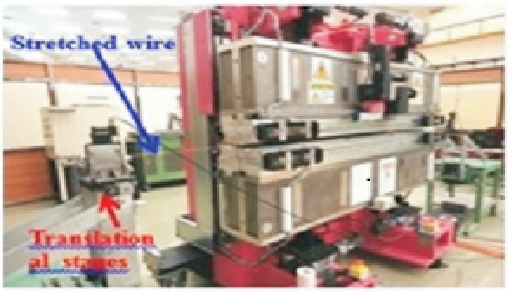

Fig.A.1.2: APPLE-2 undulator in the measurement bench using stretched wire setup

Figures A.1.3 and A.1.4 show the on-axis horizontal first (Ix) & second (IIx) magnetic field integrals and vertical first (Iy) & second (IIy) magnetic field integrals at different pole gaps for three different phases respectively. Placement accuracy of the wire around the axis is within ~ ± 1 mm.

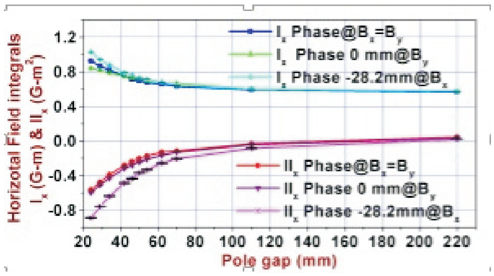

Fig. A.1.3: On-axis first (Ix) & second (IIx) horizontal magnetic field integrals at different pole gaps

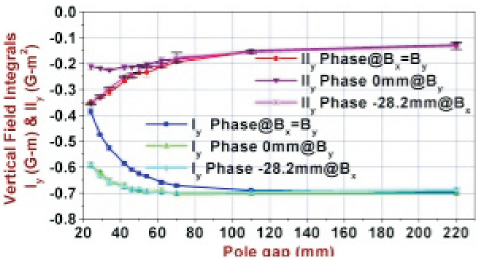

Fig. A.1.4: On-axis first (Iy) & second (IIy) vertical magnetic field integrals at different pole gaps

The values of the field integrals for both the components change at lower pole gaps as compared to the higher pole gaps. At pole gap of 24 mm, the change in values of the field integrals I_x (I_y) and II_x (II_y) w.r.t the background (integrals at 220 mm) are found within 0.45 G-m (0.31 G-m) and -0.91 G-m^2 (-0.22 G-m^2) respectively. The measurement repeatability (standard deviation) of first and second field integrals values are found ≤ 0.05G-m and ≤ 0.05 G-m^2 respectively.

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