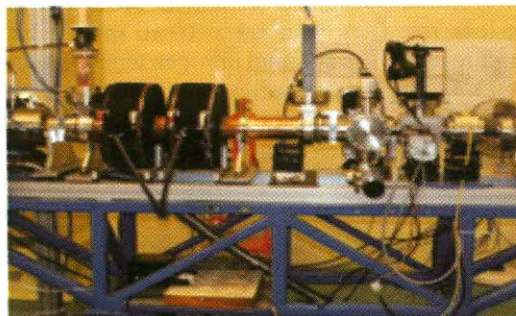


### A.14: Development of solenoids for Agriculture Radiation Processing Facility Project

The mission mode electron linear accelerator (linac) is being developed for Agriculture Radiation Processing Facility (ARPF) at RRCAT. Solenoid magnets are required for the focusing of electron beam accelerated in linac up to 5 MeV energy and 300 mA. Solenoids with magnetic field strength of 500 Gauss have been designed and developed for focusing of 5-10 MeV electron beam in the linac at RRCAT. This article provides a brief overview of the design, development & installation of solenoids in the electron linac.

Solenoidal fields are used in focusing of electron beam which are relatively high divergence and low energy electron beam (5-10 MeV). Solenoids provide simultaneous focusing in the x and y directions. As a result, they are useful for high-current beam transport. The positioning of solenoid towards the buncher side is resulting a better focusing of beam. Single solenoid is ideal but the requirement has been modified to two small solenoids with a gap for a LCW water connection between linac structures. The magnetic elements used in this structure are shown in Fig. A.14.1.

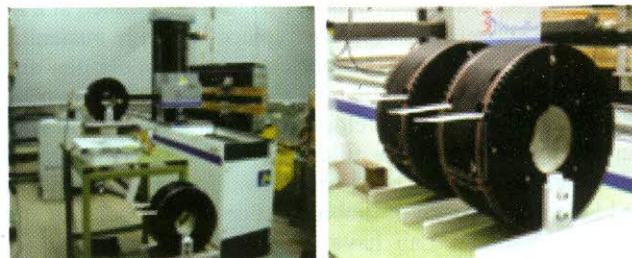


*Fig. A.14.1: Pair of Solenoids placed in the linac*

Magnet design simulation has been carried out in cylindrical symmetry using 2D POISSON code. The solenoids are kept ~76 mm away from the entry of the linac structure after the coupler assembly and consequently magnetic field at the entry of linac structure is less than the required field of 300 Gauss. The iron jacket near to solenoid magnet is provided and optimized in such a manner to increase the field at the entry of linac structure and also more fringing field is contributed at the entry. Hence inner diameter of one circular iron disk of jacket is increased than nominal value. Collimator magnet is positioned before the linac structure. The magnetic influence of this collimator magnet with the solenoid magnet is also simulated at different excitation and results are found satisfactory. The solenoid magnet have the inner bore diameter of 132 mm and outer diameter of 316 mm and length of solenoid is around 175 mm. The solenoid coils are air cooled and covered with iron jacket to increase central field and reduce fringing field. The coils are air cooled and provided with newly developed, vertical

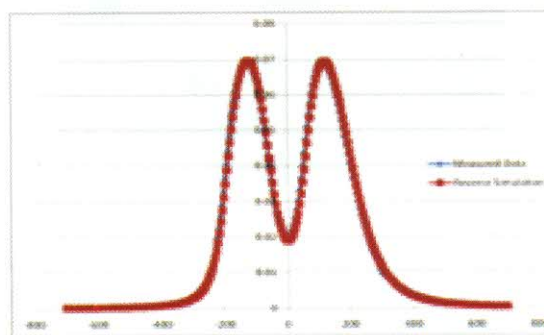
and radial aluminium heat sinks for heat dissipation. The magnetic field of about 500 Gauss is generated in the centre of solenoid at 9500 ampere-turn.

Magnetic field measurements have been carried out using PC based 3D coordinate measuring machine with a Hall probe is shown in Fig. A.14.2. Group 3 make DTM 151 Hall probe was used with the accuracy of  $\pm 0.01\%$  of reading and  $\pm 0.006\%$  of full scale maximum at 25 °C, verified against NMR probe.



*Fig. A.14.2: Solenoids in the measurement bench*

The field mapping has been done for the integrated field uniformity along the axial direction over aperture of  $\pm 50$  mm. The field measurement of each solenoids have been done independently as well as keeping solenoids together with distance of 75 mm away edge to edge of the magnet. The field interference in the vicinity of other nearby magnets has also been measured. It has been observed magnetic field homogeneity of each sub magnetic component is very less affecting each other and found within acceptable range. The combined magnetic field homogeneity of both the solenoids has also been measured. Measured and simulated magnetic field profile is shown in Fig. A.14.3.



*Fig. A.14.3: Measured & simulated field results*

The measured magnetic field homogeneity is well agreement with simulated result. The solenoid magnets have been installed in the linac and found satisfactorily during prototype operation of the linac.

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