A novel powerful beam steerer cum scanner for ECR ion beam at VECC

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Introduction

In the early nineties a 6.4 GHz Electron Cyclotron Resonance (ECR) ion source was developed indigenously at VECC to inject multiply charged heavy ion beams into the cyclotron at VECC Kolkata [1,2] for subsequent acceleration to high energies, This facility is being utilized since 1997 to successfully deliver high energy heavy ion beams for experiments in nuclear physics and other related fields of research.

The ion source was designed to meet the injection parameters of the cyclotron and operates with the maximum extraction potential of 10 kilo-Volt. To meet the energy requirements of some projectile ions, a one stage dc acceleration facility has been incorporated in the beam line enabling us to deliver beams up to 1 MeV for certain charge states and species.

In order to place the beam perfectly on the target, people often utilize beam steerers [3,4] which make small correction to the beam direction. Generally magnetic steerers are used which are low field bending magnets working in both the vertical and horizontal planes. Another requirement is to scan the required target area with a small size beam so that the area is uniformly irradiated.

A dual purpose novel powerful steering magnet has been designed and developed for the ECR beam line and also for scanning the beam for other experimental purposes. The magnet assembly can be used either for beam steering only, or in the dual mode for both beam positioning and scanning purposes. The assembly can steer and scan the beam both on X-X and Y-Y directions, and can control the beam over a 15mm×15mm area over a plane perpendicular to the axis of beam propagation. It can also control the beam at its maximum energy level. It has four 100mm×64mm soft iron poles sitting over a beam pipe diameter of 104mm. By using a specially contoured return yoke, the assembly can produce a maximum of 500 Gauss field in both the directions and the magnets can be ramped up to almost 500 gauss at two different frequencies. The horizontal line frequency is 10 hertz and the vertical frame repeats at every second.

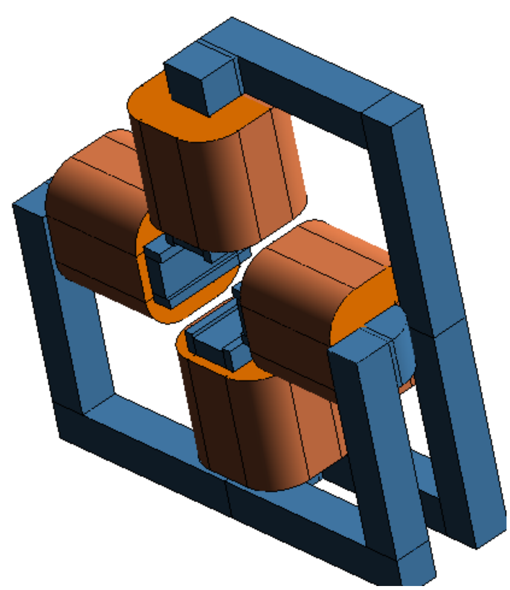

Fig. 1. The steerer-scanner with the coils inserted

A computer designed magnet frame with coils and the actually fabricated magnet yoke assembly are shown in Fig. 1 and Fig. 2.

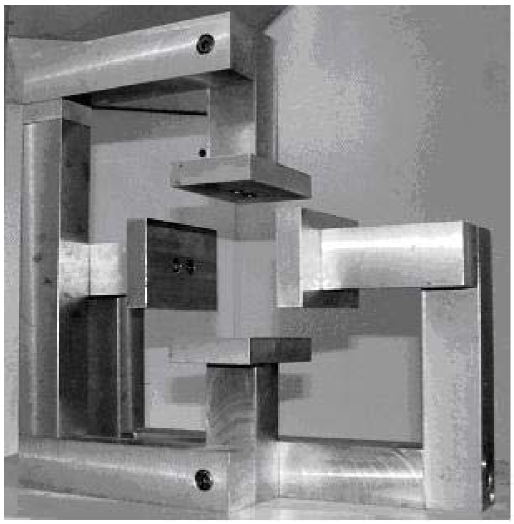

Fig. 2. The fabricated iron structure with the twisted and contoured yokes.

Design features

In conventional beam steerers no yoke is used. It is because the field requirement is generally small, a bending by only a fraction of a degree is needed and so the field level is low. In our case a strong magnetic field of about 500 gauss is required because the steerer had to be placed quite near the target because of the absence of suitable location at a far away distance in the beam line. The short steering distance necessitated the use of strong field and hence the iron yoke.

However, it is difficult to use yokes in steering magnets. Since the steerting in the two transverse planes are different the fields need to be independently varied. Therefore the two yokes need to be separated physically. At first it appears to be topologically absurd to be able to connect two sets of opposite poles, placed 180^0 apart, without a mix-up of the two connecting yokes. We have achieved it by using yokes which are smaller in cross-section than the poles, and then twisting the yokes in a way shown in Fig.1. It is obvious that the use of iron yokes in the steerer should reduce the number of turns in the coil and thus the power requirement.

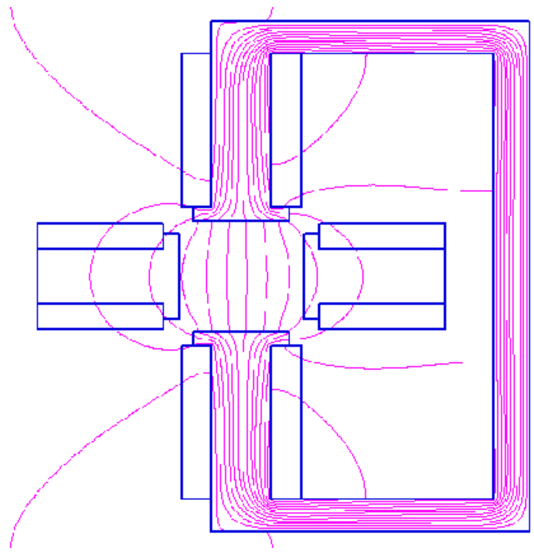

Fig.3. Flux lines for beam steerer in a single direction with two connected poles. The other two poles are shown to be disconnected

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