BEAM DYNAMICS SIMULATIONS OF LOW ENERGY ION BEAM FACILITY AT IUAC DELHI

Sarvesh Kumar, G. Rodrigues, A. Mandal, D. Kanjilal
Inter University Accelerator Centre, New Delhi

Abstract

A new low energy ion beam facility (LEIBF) is being developed for providing the mass analyzed highly charged intense ion beams of energy ranging from a few tens of keV to a few MeV for atomic, molecular and materials sciences research. The new facility will consist of an all permanent magnet 10GHz Electron Cyclotron Resonance (ECR) ion source (Nanogan) installed on a high voltage platform (400kV) which provides large currents of multiply charged ion beams. Higher currents and emittance at low energy of ion beam put a tremendous challenge to the beam optical design of this facility. The beam line consists of mainly the electrostatic quadrupoles, an accelerating section, switching magnet and suitable beam diagnostics including vacuum components. The accelerated ion beam is analyzed as well as guided to three different lines along 75^o, 90^o and 105^o using a large acceptance switching magnet. It will be possible to perform both implantation and irradiation of target samples with multiply charged intense ion beams. The details of transverse beam optics to all the beam lines using realistic case of Argon ion beam including space charge effects with TRANSPORT, GICOSY and TRACK beam optics codes are described.

TRANSVERSE BEAM OPTICS

The ion beam parameters are given in Table-1. The ion beam extracted from ECR ion source [1] have all possible charge states distribution which collectively get accelerated using an electrostatic column up to 400kV and focussed to the object point of large acceptance switching magnet [2,3] using an electrostatic quadrupole triplet [4]. The different charges states are focussed in a short zone before the switching magnet as shown in fig. 3. The particular charge and mass are then selected and switched to any of three beam lines at 75^o, 90^o and 105^o. The beam optics [5,6,7] is extensively studied with space charge effects, different acceleration schemes and emittance etc. by TRANSPORT code [8]. It has been observed the double focusing distance of switching magnet increases with decreasing bending angle and is maximum for 75^o beam line due to less bending. So the beam is focussed to target chamber with the help of an electrostatic quadrupole triplet collectively for 75^o beam line. The beam optics of switching magnet along different lines is shown in Fig. 1 using the TRANSPORT code. The ion optics is also studied for different charge states of Ar [10] beam and is collectively simulated using code TRANSPORT as shown in Fig. 3 for a constant extraction and accelerating potential and current. The beam optics of whole facility is also simulated using the code GICOSY [9] and is shown in Fig. 2. The layout of LEIBF as per optics design is shown in Fig. 4.

Table 1: Beam Parameters

Emittance (ε_x and ε_y)	100 π mm-mrad
Initial Energy (E)	30 keV/q
Max. ME/q^2 along 75^o, 90^o and 105^o lines (MeV.amu)	44.44, 30.09, 22.96

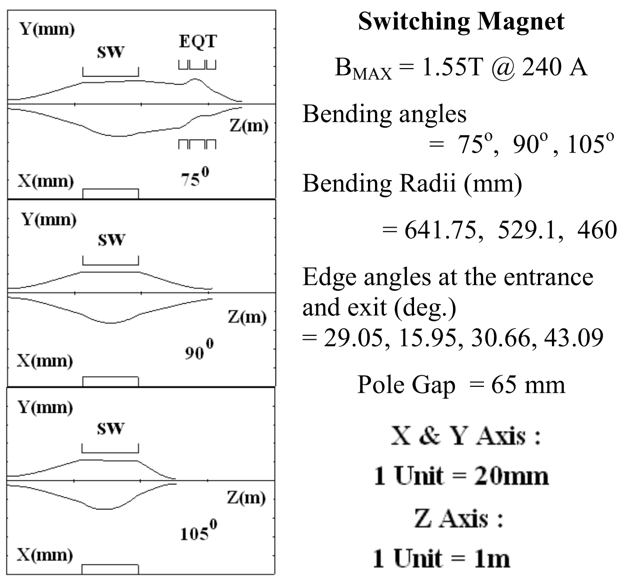


Figure 1: Beam optics of switching magnet using the TRANSPORT code

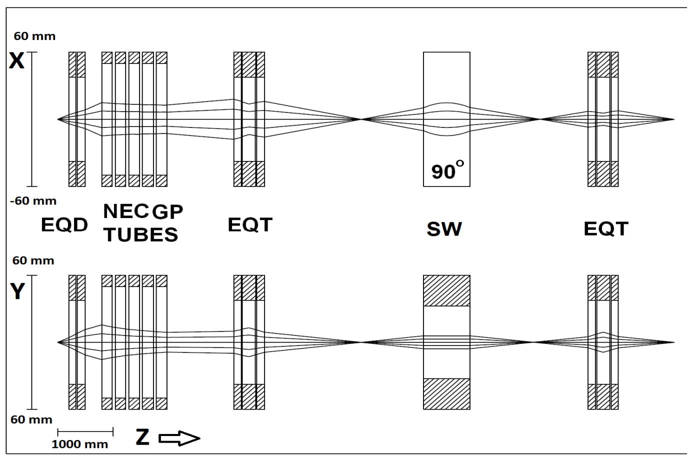


Figure 2: Beam optics of LEIBF using the GICOSY code

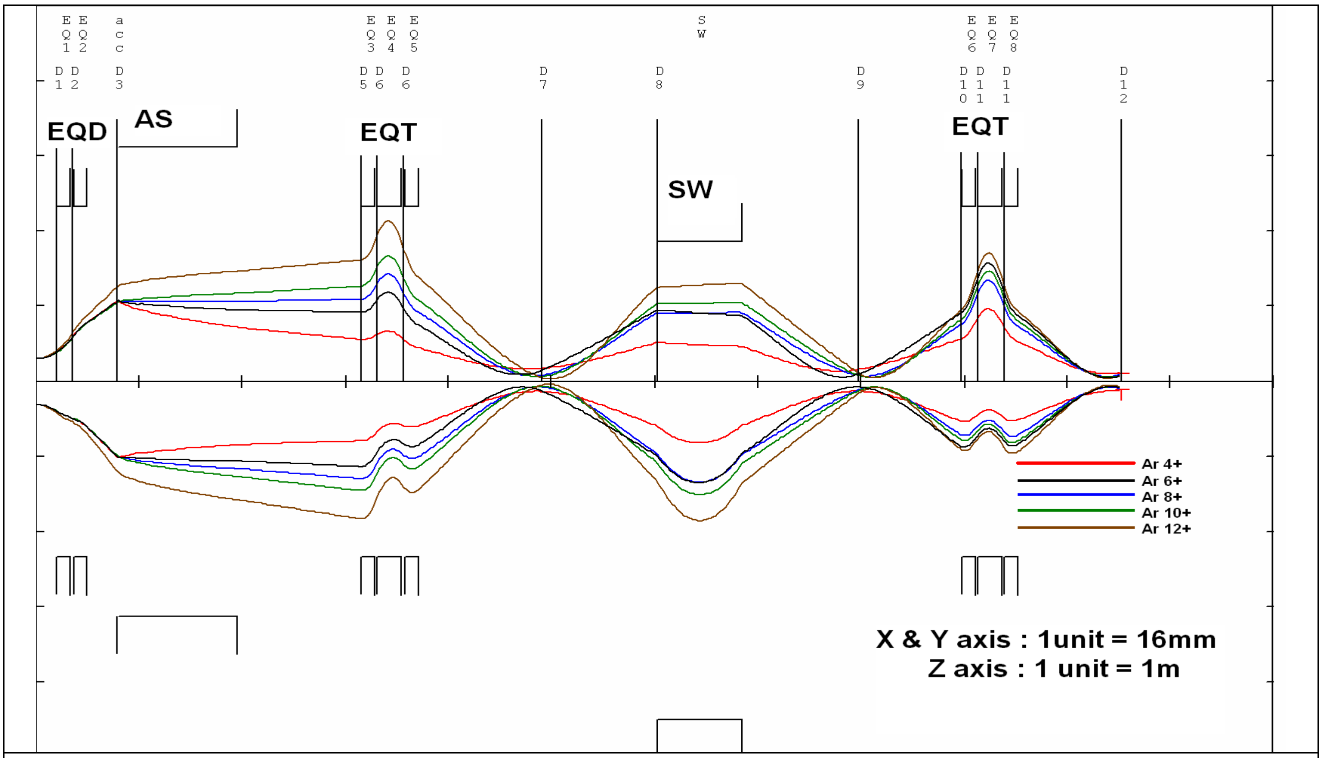
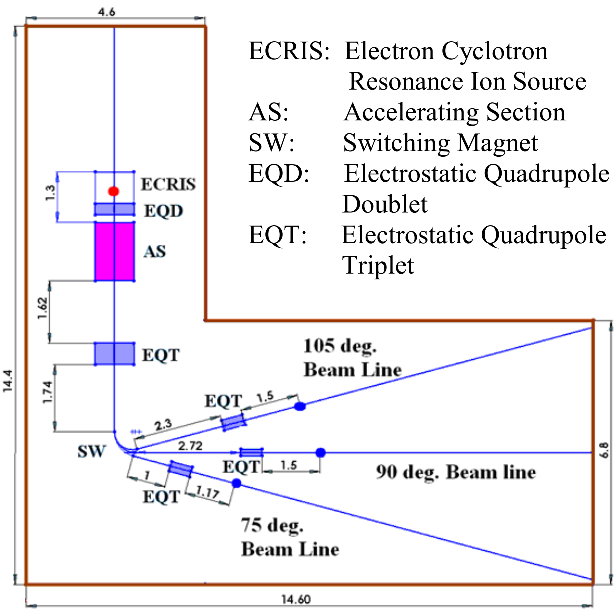


Figure 3: Transverse beam optics of Ar ion beam in different charge states with constant extraction and acceleration potential in full LEIBF using TRANSPORT code



ECRIS: Electron Cyclotron Resonance Ion Source
AS: Accelerating Section
SW: Switching Magnet
EQD: Electrostatic Quadrupole Doublet
EQT: Electrostatic Quadrupole Triplet

Figure 4: Layout of LEIBF (All dimensions are in meters)

CONCLUSION

The extensive ion optics calculation has helped for proper planning and commissioning of different beam lines of the LEIBF in terms of placement of beam optical components, diagnostic devices and vacuum pumps. All the components are installed accordingly with accurate

positioning and alignments for proper beam tuning in whole facility.

REFERENCES

[1] D.Kanjilal, T.Madhu, G. Rodrigues, U.K.Rao, C.P.Safvan, A.Roy, Ind. J. Pure Appl. Phys. 25 (2001)
[2] Sarvesh Kumar, G.Rodrigues, D.Kanjilal, A.Mandal, DAE Symp. on Nucl. Phys. V**52** (2007) 631
[3] Technical Report, IUAC/TR/SK/2008-09/20
[4] Technical Report, IUAC/TR/SK/2008-09/19
[5] Technical Report, IUAC/TR/SK/2008-09/18
[6] Sarvesh Kumar, P.Kumar, P.S.Lakshmy, C.P.Safvan, G.Rodrigues, D.Kanjilal, A.Mandal, DAE Symp. on Nucl. Phys. V**53** (2008) 763
[7] Sarvesh Kumar et al. Design of new Low Energy Ion Beam Facility at IUAC, Proceedings of InPAC-2009
[8] K.L. Brown, D.C. Carey, Ch. Iselin and F. Rothacker: Transport, a Computer Program for Designing Charged Particle Beam Transport Systems. See yellow reports CERN 73-16 (1973) & CERN 80-04 (1980).
[9] H.Weick, GICOSY homepage, <http://www-linux.gsi.de/~weick/gicosy/>.
[10] Technical Report, IUAC/TR/SK/2009-10/15