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technology for further and more efficient acceleration through LINAC 2 stage to 15 MeV.

Layout of major components

Purion XEmax consists of 7 modules: Injector, RF LINAC 1, Booster with charge selector magnets, RF LINAC 2 with 90° energy analyzer, High Energy Beam line (HEB) with beam scanner, S-bend angle corrector and Process module with the required implant control subsystems. All together, they form a large C shaped arrangement as shown in Fig. 1 in an enclosure of 8.65 × 8.8 m which fits nicely in the two traditional implanter tool bays. The injector, LINAC 1 and Process modules are inherited from Axcelis Purion XE [6]/VXE high energy implanters.

Purion XEmax has two modes of operation, Boost mode and non-Boost mode. In non-Boost mode, the booster module is a simple drift space with 90° bending magnets. In Boost mode, gas is introduced in the charge exchange canal to promote the charge exchange reactions. The 90° bending magnet system acts as a charge state selector to choose the desired charge state among the distribution created after the passage through the gas layer. The charge exchange canal is doubly di erentially pumped to keep the reactions within the Booster region. After the 2nd acceleration stage through LINAC 2, the beam goes through a 90° energy filter magnet system, a quadrupole doublet for focusing adjustment and is then electrostatically scanned horizontally into S-bend angle corrector magnet.

The S-bend corrector magnet system consists of two opposite polarity 35° dipole magnets and gives several process advantages over a single bend angle corrector magnet or an electrostatic angle corrector lens, so-called p-lens, as described later.

Energy and beam current

Table 1 shows the typical arsenic beam energy and available maximum beam current in pμA (particle μA = 6.25 ×

only in the horizontal direction and is stationary in the vertical direction. On all Axcelis Purion series high energy implanters, including XEmax, vertical angle control is done by adjusting wafer tilt after finding the mean vertical angle with a devise called VBA [9]. Despite its simplicity, the VBA is an efficient and precise tool for finding the mean vertical beam angle.

Beam angle control in the scanned or horizontal direction is much harder since the beam fanning out of the scanner is converted into a parallel shifting beam over a > 300 mm distance and the variation in angle is strongly affected by the architecture and quality of the angle corrector system.

The situation is very similar to the aberration in a large aperture low F optical lens. On an ion beam, however, the bundle of rays is not only finite in size, but also contains many ions of slightly different angles. Traditionally, only the “mean” angle within the ray was considered, but on Purion XEmax, we have paid great attention to minimizing the angle distribution within the ray.

On controlling the “mean” horizontal beam angle, the two coil currents on the S-bend angle corrector are adjusted to minimize the average over the measured mean angles at 7 locations within the 300 mm width. The balance between the two coil currents is adjusted to minimize the 1st order coefficient in the relationship between the 7 angles and the horizontal locations, normally called “beam parallelism”. The angle correction by the S-bend corrector achieves excellent parallelism of the scanned beam with mean beam angle measurements across the 300 mm scan width within a range of ± 0.03°.

In addition to minimizing the variation of the horizon-

Purion XEmax, Axcelis ultra