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Beam Steering Due to Displaced Slots

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FUSION ENERGY DIVISION

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ABSTRACT

Using a two-dimensional algorithm, steering of triode slots was investigated for the first time with a reasonable accounting of the ion extraction sheath.

Steering of beamlets from displaced apertures¹ is an important method of providing focused ion beams. A preliminary study of triode slot displacement shows (a) no sheath influenced steering for a uniform plasma, (b) impingement mitigated steering, (c) perveance independent steering so long as there is no impingement (consistent with experimental data¹), and (d) steering in excess of paraxial analysis.^{2,3} These conclusions are inferred from the evidence presented in the figures. Figure 1 illustrates trajectories and equipotential contours as a function of plasma density for slots displaced by a fixed amount. Figure 2 illustrates trajectories and equipotential contours for various slot displacements at a fixed plasma density. Steering angle as a function of plasma density is shown in Fig. 3 for the slot displacement shown in Fig. 2(c). In combination with Fig. 1, Fig. 3 shows that over the range of perveance where there is no slot interception, the steering angle is independent of source plasma density. When interception occurs, the steering angle is reduced. Figure 4 shows steering angle as a function of slot displacement as deduced from Fig. 2. Also shown is the result of the linear paraxial analysis.^{2,3} Figure 5 shows rms divergence angle as a function of plasma density, as deduced from Fig. 1 for the slot displacement shown in Fig. 2(c).

Fig. 1. Trajectories and equipotentials for six different plasma densities with a displaced slot. (a) $n_e = 0.31$, (b) $n_e = 0.41$, (c) $n_e = 0.61$, (d) $n_e = 0.91$, (e) $n_e = 1.35$, (f) $n_e = 2.06$ (arbitrary units).

Fig. 2. Trajectories and equipotentials for various slot displacements at fixed plasma density.

Fig. 3. Steering angle as a function of plasma density. The points labeled A-F correspond to the six cases in Fig. 1.

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Fig. 4. Steering angle as a function of slot displacement, Δ , divided by the gap distance, Z . The points are the computational results; the line results from a paraxial analysis.

Fig. 5. Beam rms divergence angle as a function of plasma density for slot displacement shown in Fig. 2(c).

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