Expanding Hydrogen plasma in diverging Magnetic fields in an ECR based Large Volume Plasma System

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Expansion of Hydrogen plasma from a compact μ-wave electron cyclotron resonance (ECR) based plasma source into a large volume expansion chamber was studied experimentally at different gas pressures and input powers. The compact ECR plasma source (CEPS) [1-2] is a portable cylindrical chamber (dia: 9.0 cm, length: 11.5 cm) which is enveloped by an axially-poled assembly of permanent ring magnets (NdFeB). It is mounted on the top of the large expansion chamber (dia ~ 100 cm & height ~ 100 cm) [3]. The magnet assembly generates a unique magnetic field profile inside the CEPS and a diverging field into the expansion chamber. A movable cylindrical Langmuir probe was scanned axially from the source to far downstream of the expansion chamber to study the effect of expansion on the plasma parameters, especially at the junction. Initial experiments were conducted with minimum μ-wave power ≈ 400W and at pressure of 1-5 mTorr. Uniform and moderate hydrogen plasma densities, n_e in the range of ~ 5 – 10 × 10^{10}/cm^3 with electron temperature T_e ~ 0.5 - 3 eV, for the aforementioned pressure range, were observed, while a sharp fall in plasma potential V_p (~ 200 V in gap of 5 cm) were noticed at the junction of CEPS and expansion chamber. This steep fall is expected to accelerate ions to very high energy and overall lead to formation of a plasma beam. This feature became more visually evident when the power was increased beyond 600W. Separate plasma columns were seen to form inside the expansion chamber, rather than a diffuse flaring plasma along the diverging magnetic field, as observed at lower powers. A retarding field energy analyser (RFEA) measurement is currently underway to find the existence of these high energy ions.

References:

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