MULTIPLE SOURCE 2.45 TO 28 GHz ELECTRON CYCLOTRON HEATING ON THE LEVITATED DIPOLE EXPERIMENT*

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The levitated dipole experiment (LDX)[1] is investigating a magnetic dipole field configuration similar to planetary magnetospheres as an alterative confinement concept for fusion plasmas. Recent experiments have confirmed that stationary, highly peaked plasma density profiles (> 50 core to edge) are formed by the conservation of the product of plasma density and differential flux tube volume ($V = \oint dl/B$). These natural peaked profiles are maintained by ambient plasma turbulence[2], contrary to experience with plasmas inside a set of coils where turbulence acts to flatten profiles. LDX uses a 1.1 MA, 34 cm mean radius, 560 kg superconducting coil (F-coil) that is freely floated by a 280 kA levitating coil for over 2 hours between cryogenic recoolings. Plasmas are started and sustained by electron cyclotron heating (ECH) on closed flux surfaces encircling the F-coil that cross the outer midplane radius between 67 and 177 cm. The magnetic field strength varies from 0.007 to 3.2 Tesla around the F-coil on these flux surfaces corresponding to EC resonance between 0.2 to 90 GHz. Consequently, ECH in a magnetic dipole is possible with a multiplicity of sources at many frequencies.

LDX has five ECH sources installed with a combined power of 26.9 kW: two 2.45 GHz magnetrons at 2.5 and 1.9 kW, a 6.4 GHz, 2.5 kW klystron, a 10.5 GHz, 10 kW klystron, and a 28 GHz, 10 kW gyrotron. Power is launched by bounce angle cut fundamental rectangular waveguides except for the gyrotron beam which uses a 32 mm dia. circular TE_{01} Vlasov cut launcher. Plasma power deposition depends on multiple reflections inside the 5 m diameter vacuum chamber because the diverging antenna patterns exceed the plasma size and encompass a wide range of $\boldsymbol{k} \times \boldsymbol{B}$ angles allowing only a small fraction of the linearly polarized launched power to couple to plasma modes on the first pass. Experiments with the magnetron and klystron sources have shown the peak plasma density increases linearly with power to the mid 10^{11} cm^{-3} range. 2.45 GHz cutoff on the midplane does not appear to perturb plasma absorption. The addition of the gyrotron source is expected to continue increasing density. Absorption modeling and recent plasma observations will be presented.

1. http://psfcwww2.psfc.mit.edu/ldx/#
2. A.C. Boxer *etal*, "Turbulent inward pinch of plasma confined by a levitated dipole magnet", Nature Physics, to be published, 2010.

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