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137 AND 165 GHZ RADIOMETER MEASUREMENTS OF HOT ELECTRONS IN LDX*

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The levitated dipole experiment (LDX)¹ is investigating a levitated dipole magnetic configuration as an alternative confinement concept for fusion plasmas. A 1.1 MA, 68 cm mean diameter, 560 kg superconducting coil (F-coil) is floated for up to 3 hours between cryogenic recoolings by a 280 kA levitating coil during which time plasmas are pulsed by electron cyclotron breakdown and heating (ECH). Up to a total of 15 kW ECH power from three sources at 2.45 (2.5 kW), 6.4 (2.5 kW), and 10.5 GHz (10 kW) are pulsed to sustain plasmas for up to 14 s with a slowly decaying afterglow detectable for over 20 s. Electron densities in the range of 10^{11} cm^{-3} with highly peaked profiles ($\sim 1/r^4$) are diagnosed with a 4-channel 60 GHz interferometer.

Significant hot electron synchrotron emission has been observed with two heterodyne radiometers, at 137 and 165 GHz, 3 GHz double sideband (DBS) each and noise temp. of 3000 and 2000 K DBS, respectively. The receivers' field of view (FOV) were combined by a 4-port corrugated Al waveguide beamsplitter (quartz) block and transmitted in HE_{11} mode by a 35 mm dia., 1.1 m long ceramic waveguide to a quartz vacuum window ($>95\%$ trans. at 137 & 165 GHz) located below the F-coil. About 9 dB attenuation was necessary in the waveguide to avoid receiver saturation. The radiometer views were directed vertically upward 28 cm from the dipole axis in x-mode orientation. A 2.3 m distance from window to plasma peak resulted in $1/e^2$ plasma FOV diameters of 29 and 24 cm at 137/165 GHz, respectively.

Equivalent blackbody temperatures at 137/165 GHz as high as 620/410 eV were observed at the vacuum window during sustained plasma operation, dropping to about 110/60 eV within 1 s at the start of the afterglow and then decreasing exponentially to 0.2/0.1 eV about 24 s later. These are lower limits for the actual peak plasma emission because the receiver FOVs aren't uniformly filled by the plasma and are partially obstructed by the F-coil catcher. Interpretation in terms of the hot electron parameters requires integration over many ECE harmonics. The magnetic field varies over 0.4 - 3.1 Tesla along the peak density flux contour crossing the FOVs putting all the ECE harmonics from the 2nd to 14th in view. An initial evaluation of the ECE emissivity coefficient for observed 137/165 GHz ratios and signal levels results in a sustained hot electron temperature of about 100 keV with a lower limit on density of $2 \times 10^9 \text{ cm}^{-3}$ and afterglow confinement, $\tau > 6 \text{ s}$. ¹<http://psfcwww2.psfc.mit.edu/ldx/#>

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