Electron Beam Properties Emitted From Deuterium Plasma Focus: Scaling Laws

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Abstract:
The Lee model is extended to study and characterize the electron beams emitted from plasma-focus devices. It is then first applied to characterize the electron beams emitted from low and high-energy plasma focus operated with deuterium gas. The numerical experiments on NX2 device at 15 torr of deuterium give the following results: electron fluence = 5.7 x 10^{22} m^{-2}, electron flux = 16 x 10^{29} m^{-2} s^{-1}, the relativistic kinetic mean energy of the electron = 56 keV, electron number = 2 x 10^{16}, electron current = 91 kA, and damage factor = 2.7 x 10^{12} $W \cdot m^{-2}$s0.5. Then, the effect of pressure on the beam characteristics is studied. The energy of the beam at pinch exit changes from around 57 J (1.9% of the stored energy E_0) to 176 J (6% E_0) with

characteristics is studied. The energy of the beam at pinch exit changes from around 57 J (1.9% of the stored energy E_0) to 176 J (6%E_0) with maximum value of 180 J (6.1%E_0 at 15 torr, and these results are compared with the measured values 3.2%E_0 on NX2. Scaling trends are suggested for electron beam characteristics. The energy fluence and the power flow density (energy flux) have a variation 4.3- 265 x 10^7 J· m^{-2} and 2.2 - 19 x 10^{15} W· m^{-2}, respectively. The electron beam current ranges from 12 to 700 kA being 9%-35% of Ipeak. The energy beam YEB scales on average as YEB =6.55x $E_0$1.45 at energies in the 1 to 500 kJ regions (YEB in J and E_0 in kJ), and YEB =1x 10^{-6}Ipinch3.53 and YEB =2x 10^{-6}Ipeak3.14 (Ipeak and Ipinch in kA and YEB in J). These results provide much needed benchmark reference values and scaling trends for electron beams of a plasma focus operated in deuterium gas.

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