Investigation and Optimization of Neon Soft X-ray of the INTI Plasma Focus at 12 kV

by

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ABSTRACT

This thesis describes the theoretical and experimental investigations of the x-ray (specifically neon soft x-ray) properties and the plasma dynamics of the INTI Plasma Focus. The purpose of the research is two-fold, firstly to optimize the neon SXR yield of the INTI Plasma Focus (3 kJ, Mather type) machine; and secondly to investigate the correlation of the characteristic neon SXR signal pulse with the plasma focus dynamics.

The optimization of the SXR yield involved three steps. Firstly the optimization was carried out numerically using the 6 phase Lee Model Code (version RADPFV6.1b). The numerical experiments were accomplished at 12 kV to determine the optimum configuration for the electrodes using the INTI PF machine. The model parameters were determined and retained as $f_m = 0.05$, $f_c = 0.7$, $f_{mr} = 0.2$ and $f_{cr} = 0.8$. The pressure (P), anode length (z), and anode radius (a) were parametrically varied while the value of cathode radius (b) was fixed at 3.2 cm. Secondly, the optimization experiments carried out at Centre for Plasma Research, INTI International University were guided by the numerical experiments with an optimized anode ('a' =1.2 cm and z =7.3 cm) designed as a screw-on type that retained the original radius until it just emerged out of the insulator sleeve. Thirdly, enhancement of yield was attempted by doping neon with krypton (Ne 97.5% + Kr 2.5%, Ne 95% + Kr 5%, Ne 90% + Kr 10% and Ne 80% + Kr 20%). Series of experiments using the original anode ('a' =0.95 cm and z =16 cm) were performed in the laboratory at 12 kV and operating neon gas pressure of 2.0 Torr. These experimental results were verified using the Lee Model code by adjusting the pressure for each admixture. The adjustments considered volumetric proportions of neon taking into account the difference in atomic weights (Ne-20 and Kr-84).

Finally, the correlation of characteristic neon SXR pulse with the plasma focus dynamics was investigated using a) the original anode of 16 cm length and 0.95 cm radius in neon, b) the optimized anode of 7.3 cm length and 1.2 cm radius in neon and c) the different Ne-Kr admixtures. Using the Lee Model code, an excel template was developed to plot the SXR pulse with the fitted measured and computed current traces. The template also shows different time markers such as the radial phase, the

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