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Numerical experiments on plasma focus neon soft x-ray scaling

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Abstract

Numerical experiments are carried out systematically to determine the neon soft x-ray yield Y_{sxr} for optimized neon plasma focus with storage energy E_0 from 0.2 kJ to 1 MJ. The ratio $c = b/a$, of outer to inner electrode radii, and the operating voltage V_0 are kept constant. E_0 is varied by changing the capacitance C_0. Parametric variation at each E_0 follows the order operating pressure P_0, anode length z_0 and anode radius a until all realistic combinations of P_0, z_0 and a are investigated. At each E_0, the optimum combination of P_0, z_0 and a is found that produces the biggest Y_{sxr}. At low energies the soft x-ray yield scales as $Y_{sxr} \sim E_0^{1.6}$ whilst towards 1 MJ it becomes $Y_{sxr} \sim E_0^{0.8}$. The Y_{sxr} scaling laws are found to be $Y_{sxr} \sim I_{peak}^{3.2}$ (0.1–2.4 MA) and $Y_{sxr} \sim I_{pinch}^{3.6}$ (0.07–1.3 MA) throughout the range investigated. When numerical experimental points with other c values and mixed parameters are included, there is evidence that the Y_{sxr} versus I_{pinch} scaling is more robust and universal, remaining unchanged whilst the Y_{sxr} versus I_{peak} scaling changes slightly, with more scatter becoming evident.

1. Introduction

Plasma focus machines operated in neon have been studied as intense sources of soft x-rays (SXRs) with potential applications [1–3]. Whilst many recent experiments have concentrated efforts on low energy devices [1–3] with a view of operating these as repetitively pulsed sources, other experiments have looked at x-ray pulses from larger plasma focus devices [4, 5] extending to the megajoule regime. However, numerical experiments simulating x-ray pulses from plasma focus devices are gaining more interest in the public domain. For example, the Institute of Plasma Focus Studies [6] conducted a recent International Internet Workshop on Plasma Focus Numerical Experiments [7], at which it was demonstrated that the Lee model code [8] not only computes realistic focus pinch parameters, but also absolute values of SXR yield Y_{sxr} which are consistent with those measured experimentally. A comparison was made

