EFFECTS OF AN AXIAL TARGET ON THE RADIATION OF IMPLODING WIRE ARRAYS

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Thin wires have been added on the axis of cylindrical and conical wire arrays to investigate the effect of sheared plasma flows on the z-pinch stability[1]. This addition significantly affected the x-ray emission of the conical wire arrays, while having little effect on that of the cylindrical ones. In addition, the material of the axial target had a strong influence on the radiation output. The experiments were performed on the 1 MA Zebra Z-pinch generator at the Nevada Terawatt Facility using conical and cylindrical wire arrays with and without a center wire. The arrays consisted of 8 aluminum wires 15 μm in diameter. Aluminum or copper wires of various thicknesses were used on axis.

Broad spectral range radiation measured with bolometers indicated that the presence of an additional aluminum wire on the axis of the conical wire arrays causes an enhancement in the total energy emitted. No significant enhancement was observed in the case of adding aluminum wires on the axis of cylindrical arrays. The x-ray pinhole images of conical wire array pinches showed reduced emissivity of the plasma on axis with the presence of a center wire. One possible explanation is that the central wire remains cold throughout most of the pinch phase, preventing compression into a hot pinch. However, the hollow emissivity profile was not noticeable for the case of cylindrical wire arrays, even for the case of a 50 μm aluminum axial wire. To clarify this issue, the emission of conical wire arrays with 50 μm copper central wire was compared with that of identical arrays with 50 μm aluminum central wire. The x-ray energy yield was significantly higher when using a copper wire. The emissivity of the axial plasma region was higher as well. Moreover, the energy of the photons emitted from the axial region surpassed 3 keV, indicating a high temperature source. At the plasma temperature required for the observed photon energies, aluminum would be fully ionized, so its emissivity would be reduced. In addition, the pinch diameter measured from x-ray pinhole images, was much smaller when using a copper center wire than in the case of an aluminum center wire. The reduced diameter of the copper pinch compared to that of the aluminum pinch and the dependence on the atomic number of the central wire material indicate that radiative cooling plays a significant role in the conical wire array pinch dynamics.

1. D. Martinez et al., “Analysis of conical wire array z-pinch stability with a center wire”, 7th International Conference on Dense Z-Pinches, 2009, pp. 121-124.

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