ECPD 2021
European Conference on Plasma Diagnostics

The application of coded apertures to high-resolution imaging of high energy x-rays and fusion neutrons

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Laser-plasma x-ray sources have garnered interest from various communities due to their ability to generate high photon-energies from a small source size. The passive imaging of high-energy x-rays and neutrons is also a useful diagnostic in laser-driven fusion as well as laboratory astrophysics experiments which aim to study small samples of transient electron-positron plasmas.

Here we demonstrate a coded aperture with scatter and partial attenuation included, which we have dubbed a 'CASPA'. We compare CASPAs to the more common method of pinhole imaging, confirming the well-known throughput increase of coded apertures, and showing that the decoding algorithm relaxes the need for a thick substrate. We simulate a 511 keV x-ray source through ray-tracing and Geant4 simulations to show how partial attenuation of the source by the CASPA allows for a superior signal to noise ratio with respect to a standard pinhole system. In addition, we demonstrate successful imaging of high-energy emission at higher resolution than previously attainable. Finally, we demonstrate the potential applications in fusion neutron imaging, through simulations of a NIF like implosion geometry, and outline how this technique could be applied to measurements of implosion asymmetry.

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