Noise-dependence of Frequency Domain Holography reconstruction algorithms

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Plasma wakefield acceleration relies on imaging techniques such as Frequency Domain Holography (FDH) to gain information about the wakefield structure through image reconstruction. Simulation methods provide information regarding the basic process and some limitations, however it does not fully represent real-world experimental conditions [1]. For this reason, deviations to the structure as a result of the less than ideal experimental conditions introduces uncertainty in the reconstructed image. When reconstructing the information contained in a FDH, noise is introduced from a number of sources such as, residual background light [2], artifacts due to optical components [3], dark current (CCD noise) [3], high frequency amplification in image analysis [4, 5] *etc.* Developing an understanding of how noise affects the ideal situation informs the strengths and limitations of the reconstruction algorithm used.
This work uses a synthetically constructed wakefield pattern to create an 'ideal' scenario. Artificial noise is then introduced as a way to test the limitations of the reconstruction algorithm used. This algorithm has been tested on data procured from simulations run using PIC EPOCH code as a means to improve the resolution of FDH image analysis for wakefield structures and presented in this paper. It is expected that, in future, the FDH instrument will be incorporated into the plasma discharge device being developed by colleagues at Imperial College London for delivery to the AWAKE II experiment at the CERN laboratory.

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