

On-The-Fly Calculation of Holographic Masks to Generate Arbitrary Spatiotemporal Beams

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The time reversal device enables the generation of arbitrary spatiotemporal beams, which could have applications including optical trapping and microscopy [1]. This device requires a hologram to be displayed on a spatial light modulator (SLM) located in the Fourier plane of a grism [1]. The SLM gives independent spatial and temporal control by controlling 45 Hermite Gaussian (HG) modes along the vertical axis and controlling 320 time steps along the horizontal axis, respectively. In this paper, defocus incurred for different time delays will be compensated for, leading to improved beam quality.

This delay is introduced by applying a spectral phase ramp hologram on the SLM to steer light through the different grism path lengths. To calculate this hologram, a modified, GPU accelerated, 2D FFT, Gerchberg-Saxton (GS) algorithm extended from [1] is used. The input source plane is defined in the SLM plane and the output plane is given by the goal pattern defined by HG modes for each time step. Figure 1a) shows the theoretical best letter "A" pattern with 45 HG modes and Figure 1b) shows the defocus of "A" at -21.9ps , which only has 83% overlap with the theoretical best. However, by compensating for this defocus seen in Figure 1c), a 98% overlap is obtained with the theoretical best. Compensating for defocus allows the time reversal device to generate advanced spatio-temporal beams at large delays.

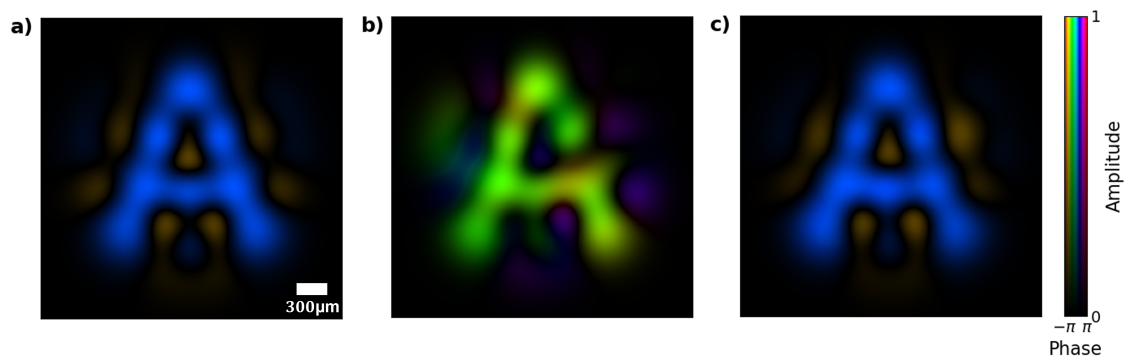


Figure 1: Effect of defocus on letter "A" pattern. a) Theoretical best pattern using 45 HG modes. b) Defocus of "A" at -21.9ps . c) Simulated "A" pattern compensating for defocus of b)

[1] M. Mounaix et al., "Time reversed optical waves by arbitrary vector spatiotemporal field generation," *Nat. Commun.*, vol. 11, no. 5813, Nov. 2020, doi: 10.1038/s41467-020-19601-3.