Supplemental Document

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Spatio-temporal performance in an incoherent holography lattice light-sheet microscope (IHLLS): supplement

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Spatio-temporal performance in an incoherent holography lattice light-sheet microscope (IHLLS)

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Visualization 1

Video supporting Fig. 1d-g, showing a demo of the scanning idea in both systems, LLS and IHLLS.
Visualization_LLS_IHLLS.avi, http://prism.osapublishing.org/Staff/Details/425069

Supplementary Info 1

Interference efficiency calculation. Referring to equation 16 from [1], $\tan(\varphi) \cong \frac{2R_0}{z_h} \leq \frac{\lambda}{2\delta_c}$, we get $0.03234 \leq 0.04$, where $R_0 = \max(R_{01}, R_{02}) = \max(11.393\, mm, 9.781\, mm) = 11.393\, mm$, R_{01}, R_{02} are the radii of the two beams at the exit of lens TL_4 , $z_h = 664\, mm$, is the distance from TL_4 to camera, $\lambda = 520\, nm$ the emission wavelength, and $\delta_c = 6.5\, \mu m$ is the camera pixel size.

Supplementary Info 2

Optical simulations of IHLLS were performed in two steps. First, the correct distances between each sequential optical component and the focal length of f_{SLM} of a diffractive lens superimposed on the SLM, were calculated to match the transversal pixel magnification of 62.5 in both configurations, conventional LLS, and IHLLS 1L, using OpticsStudio (Zemax, LLC) optical design, Fig. S1 a. It was determined that for an emission wavelength of 520 nm, and with an overall transversal magnification set to 62.5, the distances should be about , $d_1 = 75\ mm$, $d_2 = 95.074\ mm$, $d_3 = 288.914\ mm$, $d_4 = 103.660\ mm$, $d_5 = 103.660\ mm$, $d_6 = 288.914\ mm$, and the distance between the lens TL_4 to the detector should be about 664 mm (i.e., $d_7 = 664\, mm$) , and the focal length of the single diffractive lens superimposed on the SLM was determined to be $f_{SLM} = 400\, mm$. For this step, the transversal magnification of 62.5 was checked by imaging the USAF 1951 resolution target, group 7, element 6, with both instruments using a white light source. Second, an optimization of a multi-configuration optical system, Fig. S1 b, c, were performed to calculate the focal lengths of the two diffractive lenses superimposed on the SLM to provide maximum overlap of the two beams at the plane of the detector but keeping fixed all the distances $d_1 \div d_7$.found in the previous step. After performing the optimization, the values of the two focal lengths were found to be $f_{d1} = 220\, mm$ and $f_{d2} = 2356\, mm$., which were used for the design of the two diffractive lenses. These two lenses focus at a distance $d_{7\_1} = 555.185\, mm$ in the front of the camera, Fig. S1 b, and at $d_{7\_1} = 826.793\, mm$ behind the camera, Fig. S1 c, respectively. In implementation, the distance $d_{7\_1} + d_8$ may need to be tuned by ±0.3 depending on tolerances and imperfections of optical parameters of other elements of the system (e.g., tolerances of lenses, tolerances of phase resolution of the SLM, etc.). (i.e., $d_{7\_1} + d_8 = 664.298\ mm$, when calculating f_{d1} , and $d_{7\_1} + d_8 = 663.793\ mm$, when calculating f_{d2}.

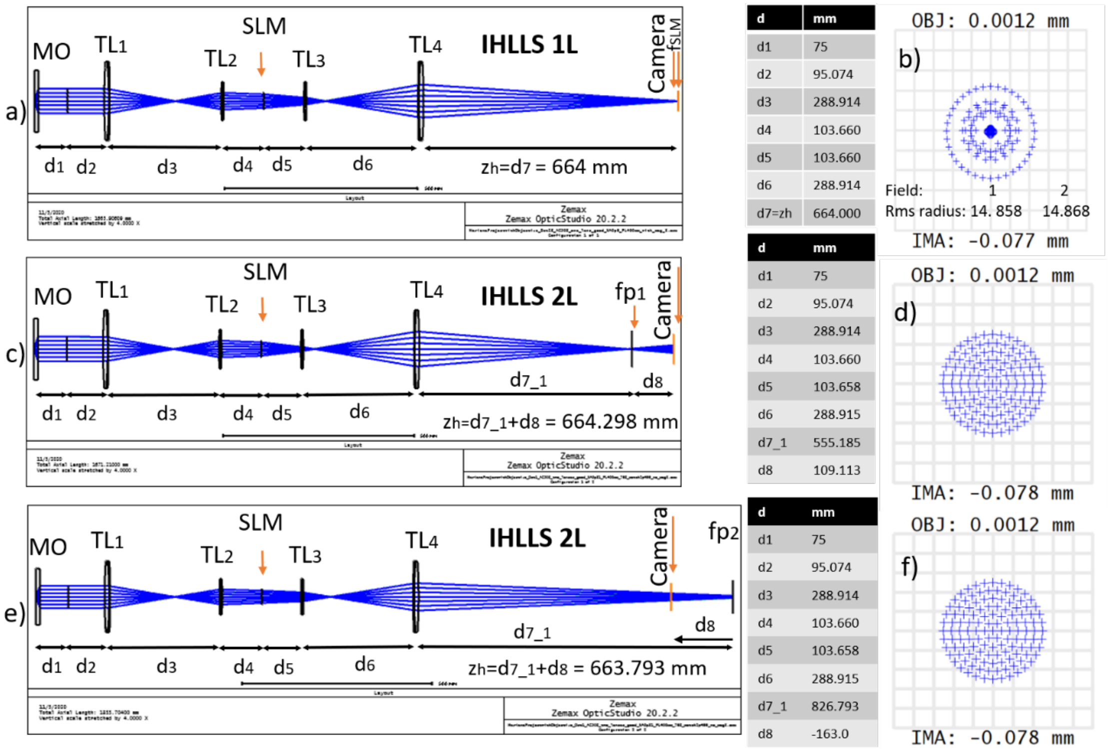

Fig. S1 Optical design of the IHLLS; a) Ray tracing using only one diffractive lens; b) The spot diagram from a); c) Ray tracing using two diffractive lenses, f_{p1} the first focus position; d) The spot diagram from c); e) Ray tracing using two diffractive lenses, f_{p2} the second focus position; f) The spot diagram from e). The distance d_1 is the distance between the MO and a dummy surface with infinite radius needed to check the beam collimation after the MO. The distance d_2 is the distance between the dummy surface and lens TL_1.

References

1. B. Katz, J. Rosen, R. Kelner, and G. Brooker, "Enhanced resolution and throughput of Fresnel incoherent correlation holography (FINCH) using dual diffractive lenses on a spatial light modulator (SLM)," Opt Express **20**, 9109-9121 (2012).