Supporting Information for:

High-speed lens-free holographic sensing of protein molecules using quantitative agglutination assays

Zhen Xiong, Colin J. Potter, and Euan McLeod*

College of Optical Sciences, 1630 E. University Boulevard, Tucson, Arizona 85719, USA

*Corresponding author

Euan McLeod

Email: euanmc@optics.arizona.edu

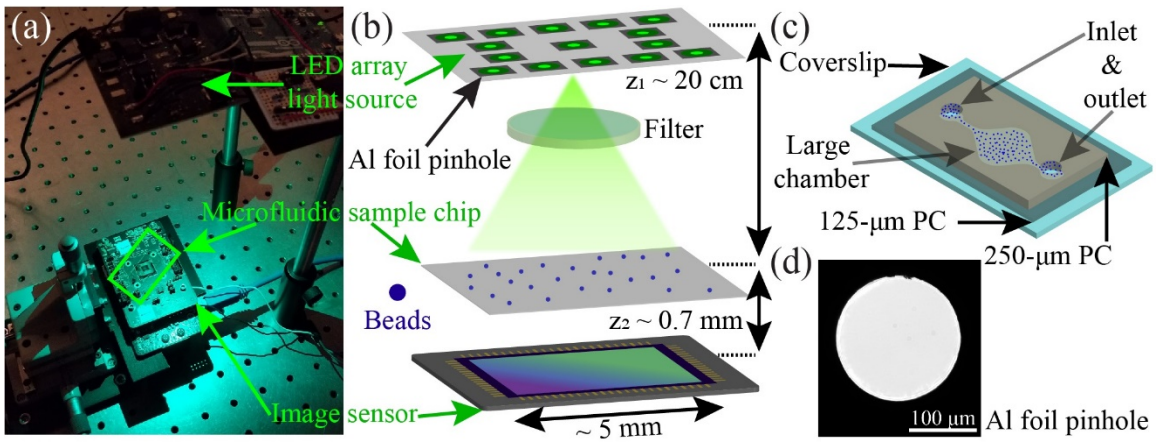

Figure S1: High-speed lens-free holographic microscope. (a) Photograph of our experimental platform. (b) Illustration of the hardware, including a custom LED array, a 3 nm bandwidth bandpass filter, custom aluminum foil pinholes, and a CMOS sensor. (c) Illustration of a MC consisting of two layers of laser-cut polycarbonate films and a glass coverslip. (d) Image of a hand-punched anodized aluminum foil pinhole under a 20X objective.

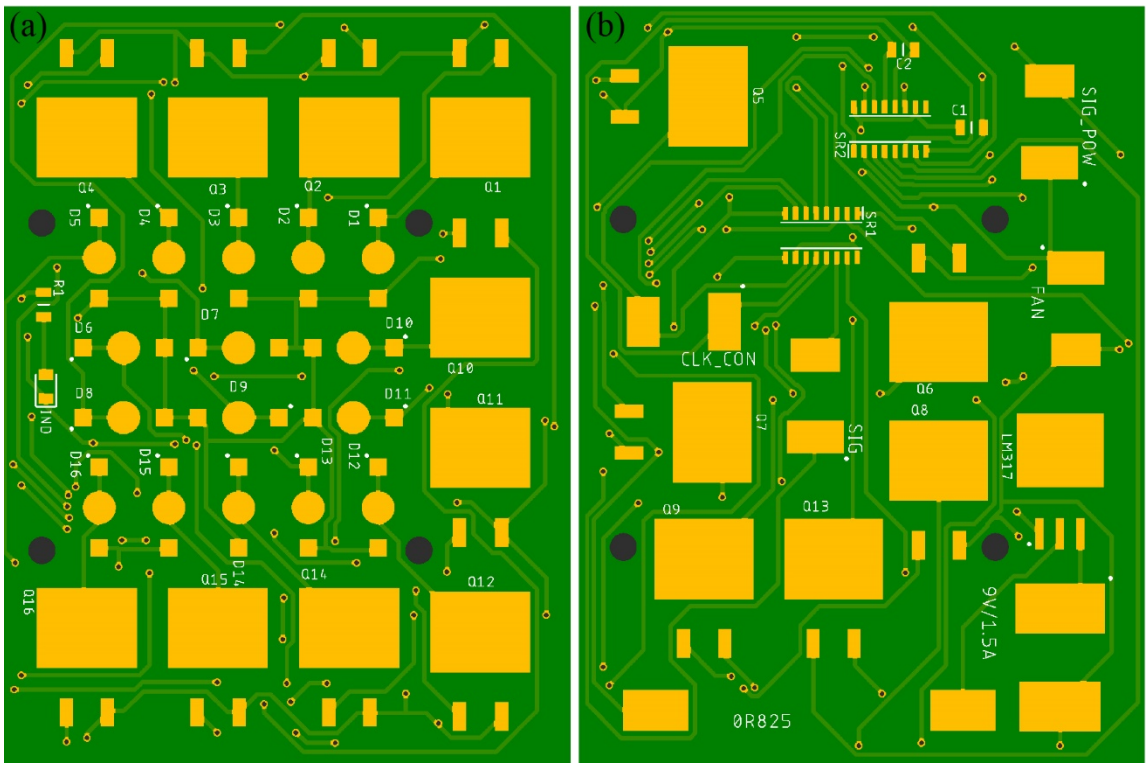

Figure S2: Aluminum-core printed circuit board previews. (a) Front side where high-power LEDs are soldered. (b) Back side where shift registers and other components are soldered. The board dimensions are 67 mm x 89 mm.

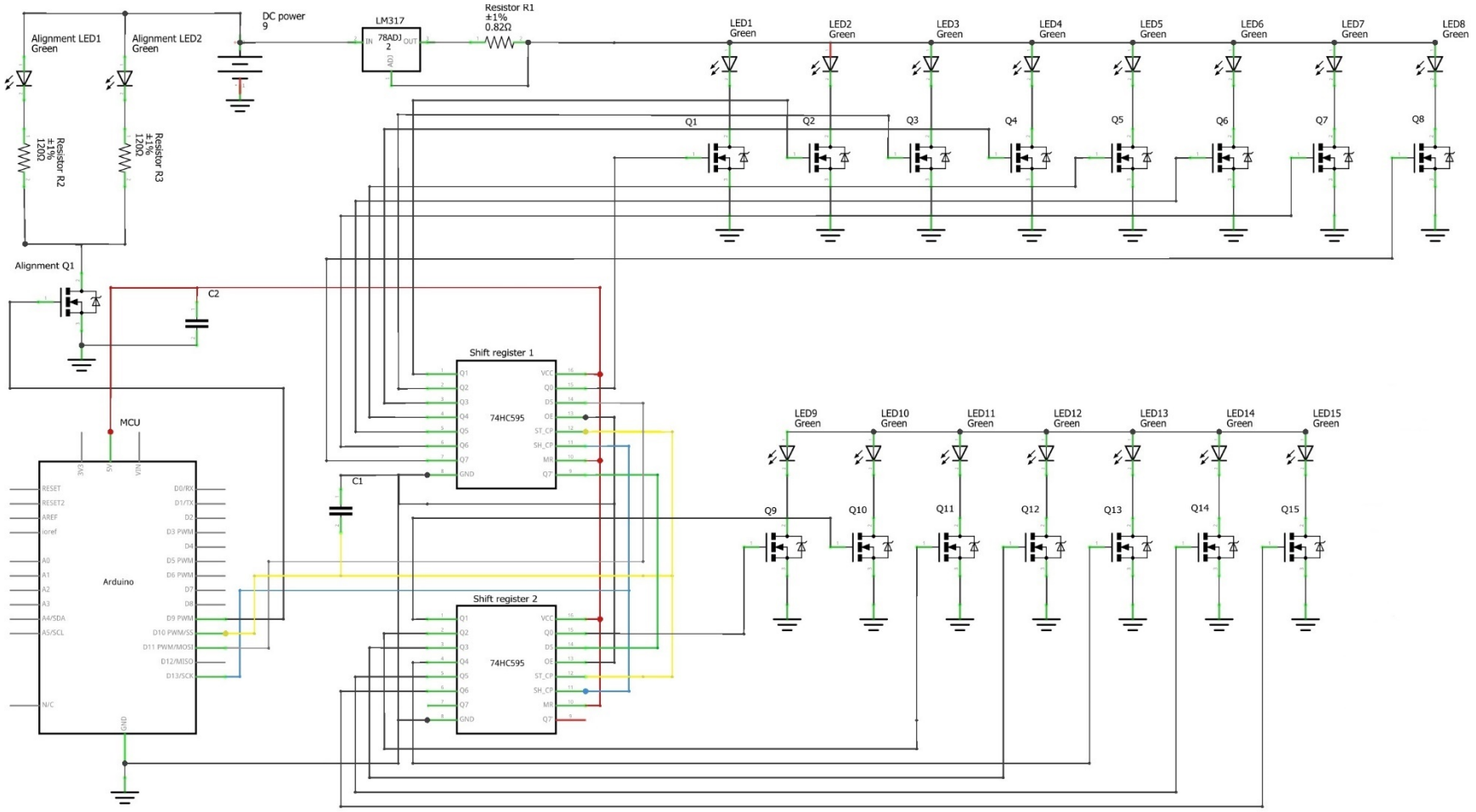

Figure S3: The schematic for our custom high-speed high-power LED array. An LM317 voltage regulator is used with a power resistor R1 to serve as a precision current-limiter circuit, which serves as a 1.5 A current source. An Arduino Leonardo microcontroller is used to communicate with two cascaded 8-bit shift registers (74HC595) via serial peripheral interface. Since 15 LEDs are switched on and off sequentially, the current source is shared among all LEDs. Two cascaded 8-bit shift registers are used to digitally switch 15 LEDs with 15 MOSFETs (STMicroelectronics STP40NF03L). For example, sending 0x02 from Arduino would turn on only LED2.

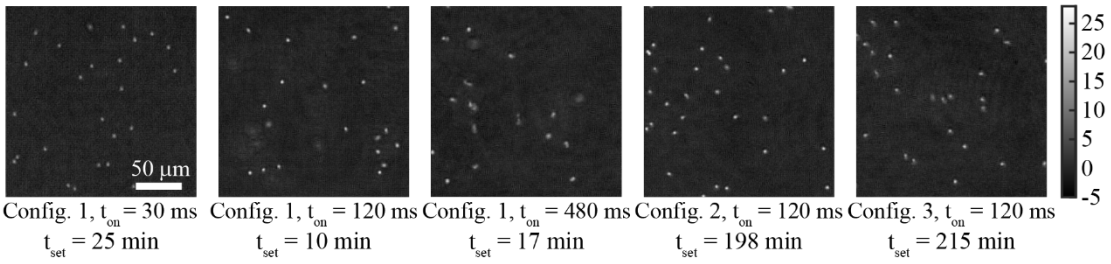

Figure S4: Amplitude reconstructions of 2-µm beads under various conditions. The colorbar is in terms of unitless SNR.

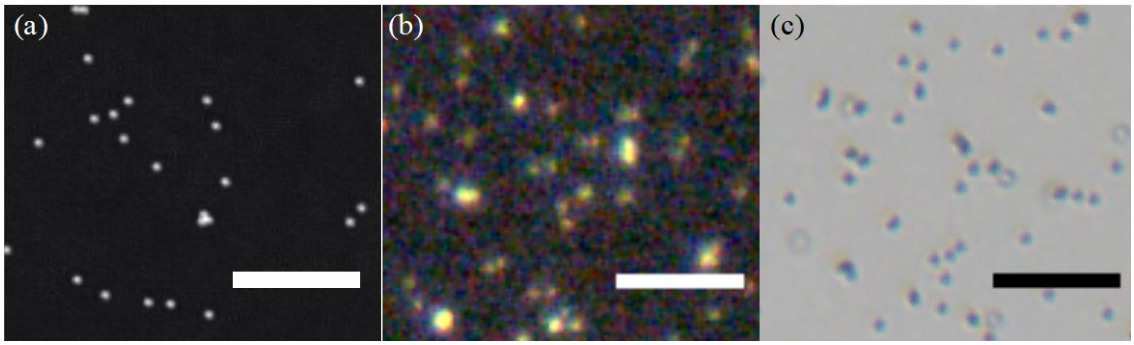

Figure S5: Representative images of 0.01% 2-μm B-beads with 60 ng/mL of NA in PBST using different imaging modalities. (a) LFHM image captured using the QLAB sensor. (b) Darkfield image and (c) brightfield image captured using a high-end Olympus BX-53 microscope with a 4× objective. Images captured with LFHM are visibly more resolved and have a significantly higher SNR than those captured by the Olympus microscope. Scale bars are all 50 μm long.

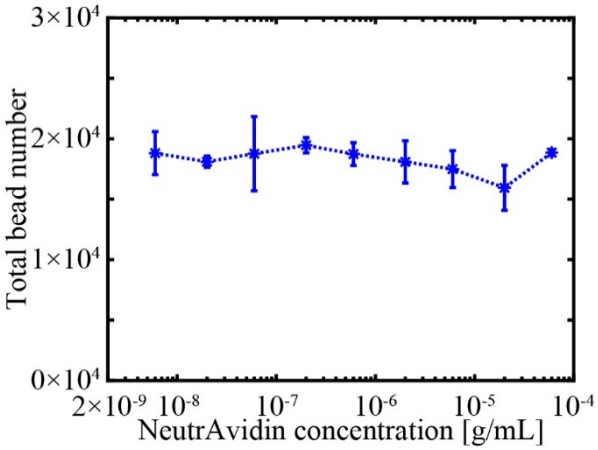

Figure S6: Total counted bead numbers for all NA concentrations in NA batch-to-batch repeatability experiments. The consistency in bead count indicates the repeatability of the process. The coefficient of variation in bead number over all experiments plotted is 9.1%.

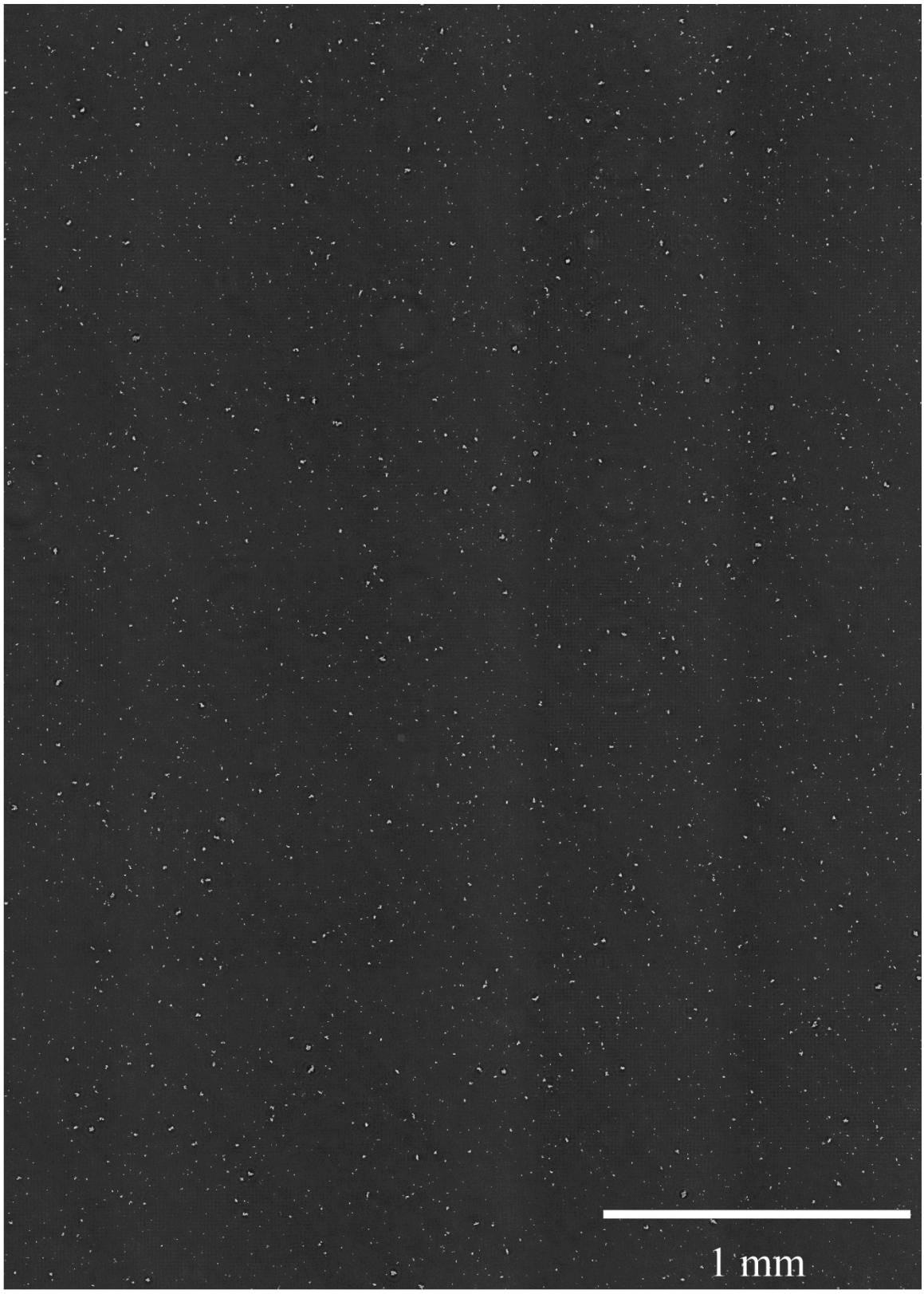

Figure S7: Full FOV reconstruction for a sample containing 2 μg/mL of NA and 0.01% 2-μm B-beads in PBST. This sample has 18268 2-μm B-beads exhibiting a bound ratio of 80.39%.

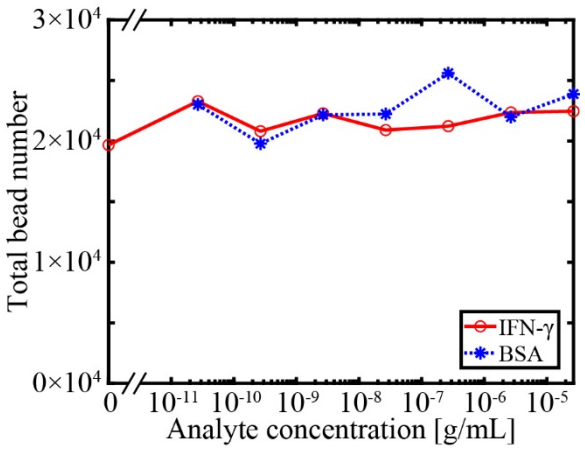

Figure S8: Total bead counts for IFN-γ sensing with BSA as a negative control. The consistency across experiments indicates the repeatability of the process. The combined coefficient of variation in bead number for both IFN-γ and BSA experiments is 6.9%.