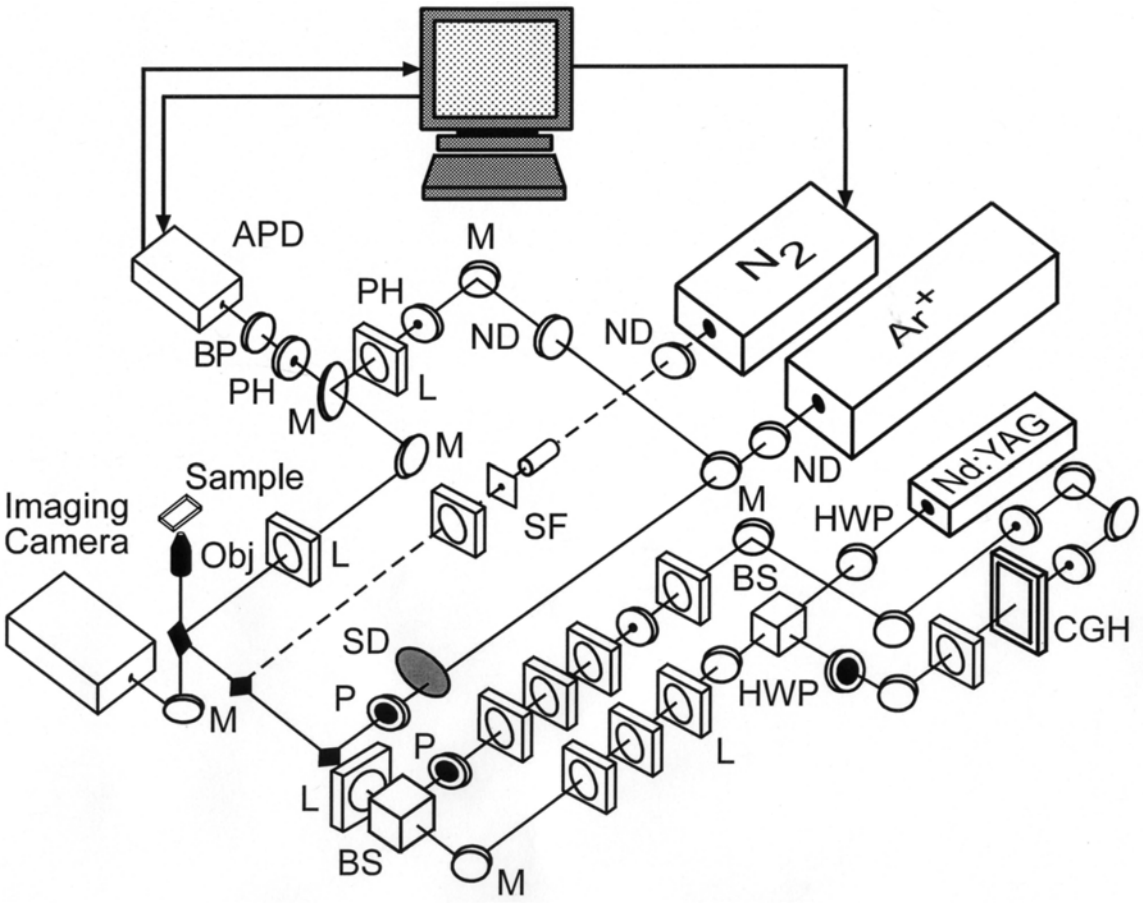

Figure S1: Schematic of optical setup. Avalanche photodiode (APD), band pass filter (BP), beam splitter (BS), computer generated hologram (CGH), half-wave plate (HWP), lens (L), mirror (M), neutral density filter (ND), objective (Obj), polarizer (P), pin hole (PH), spatial filter (SF), spinning diffuser (SD)

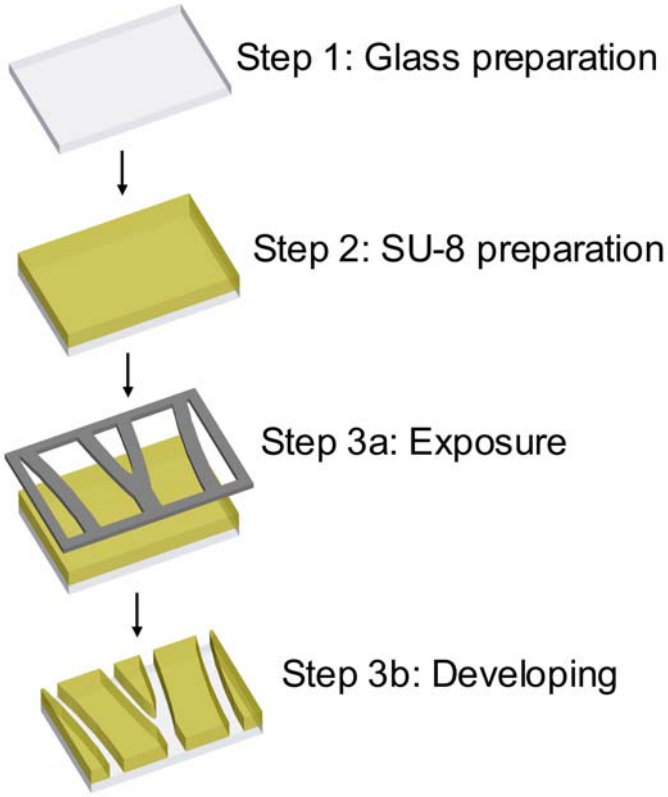

Figure S2: Illustration of the steps for the fabrication of the computer generated hologram (CGH).

Step 1: To prepare contamination-free substrates prior to photoresist deposition, glass coverslips (Gold Seal, No.1 thickness, 48×55mm) were placed in a Teflon rack and submerged in a cleaning solution consisting of DI water, NH_4OH (28-30% as NH_3), and 30% H_2O_2 at a volumetric ratio of 3:2:1. The solution was then brought to boil and maintained at boiling for 1 hr. Upon cooling, the glass substrates were rinsed with isopropyl alcohol (IPA) and dried with N_2, then maintained at 65ºC on a hotplate in a class 100 clean-room environment. **Step 2**: SU-8 2025 (Microchem Corp, Newton, MA), which is a negative photoresist, was spun onto the cleaned glass substrate at 800 rpm for 15seconds then 1500 rpm for 45 seconds, resulting in a film of ~60μm thickness. The substrate was then soft-baked on a hotplate at 65ºC for 5 minutes, followed by 105ºC for 10 minutes, then allowed to cool to room temperature.

Step 3: The photoresist-coated glass substrate was exposed to UV light for 2½ minutes in a Kasper 2001

mask aligner. After exposure, the substrate was baked at an incline of ~30º (to promote blazing) at 65ºC for 20 minutes, then at 105ºC for 25 minutes. Upon cooling, the photoresist was developed by gently rinsing in the following solvents sequentially: IPA, 50% Propylene glycol monomethyl ether acetate (PGMEA) in IPA, and 100% PGMEA. The resulting hologram was rinsed again in IPA, dried with N_2, baked flat at 65ºC for 5 minutes, then at 105ºC for 5 minutes to remove any residual solvents.

Glass is clear, SU-8 is brown, and the photo mask is dark gray.

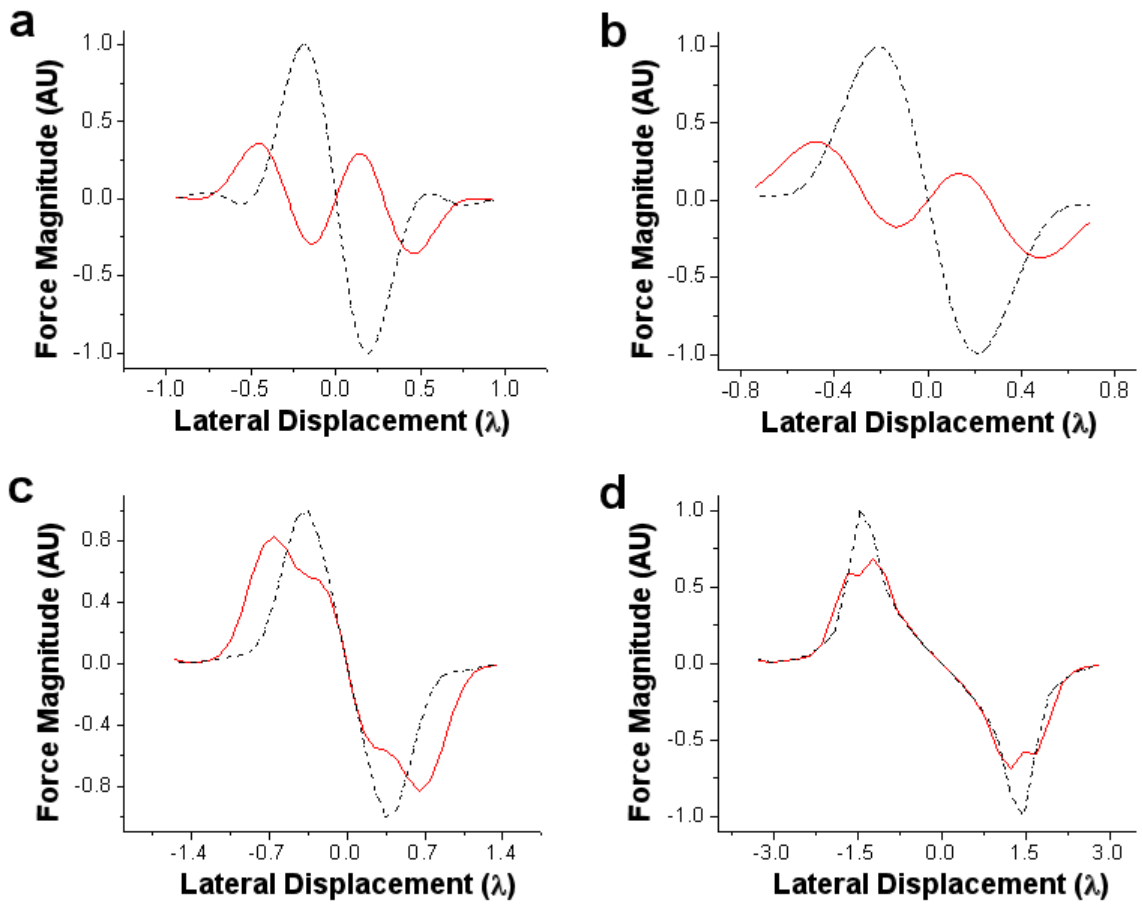

Figure S3. Simulations showing the lateral gradient force as a function of displacement from the center of the trap. The solid red line corresponds to the vortex trap and the dashed black line to the Gaussian trap. Calculations were performed for 100nm (a), 500nm (b), 1μm (c), and 3μm (d) trapped particles, respectively.