Supplementary Material

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Focusing on moving targets through scattering samples: supplementary material

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Published 1 October 2014

This document provides supplementary information to "Focusing on moving targets through scattering samples," http://dx.doi.org/10.1364/optica.1.000227. It includes a whole schematic diagram for the self-built optical system for TRACK experiment, figures of TRACK focusing through 0.5 mm thick chicken breast tissue, a measured scattering angle distribution of the diffusing sample, a comparison between traditional reflective bead guide-stars to TRACK, a direct measurement of the TRACK focus size in X and Y direction, optical spectra for fluorescent beads and dichroic mirror transmission and a timing chart for dynamic focusing on moving target and optical flow cytometry, respectively.

http://dx.doi.org/10.1364/optica.1.000227.s001

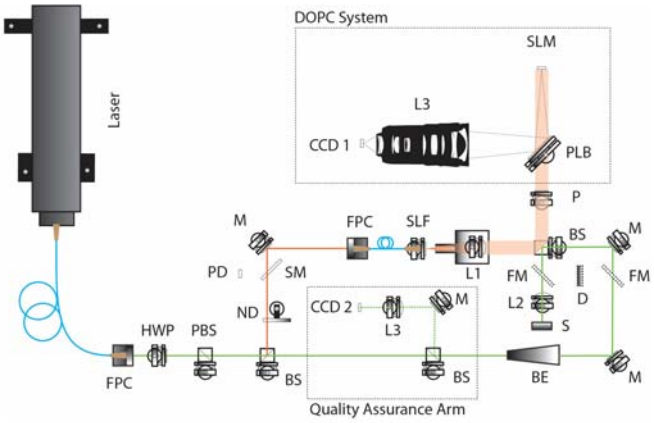

Fig. S1. Setup diagram: Abbreviation: ND-Neutral Density filter wheel, BE-Beam Expander, BS1,2,3-Beam Splitter 1,2,3, BSH-Beam shutter, D-Diffuser, FM-Flip Mirror, FPC-Fiber Port Collimator, HWP-Half-wave Plate,L1,2,3-Lens 1,2,3, M-Mirror, P-Polarization Plate, PBS-Polarizing Beam Splitter, PD-Photo Detector, PLB-Plate beam splitter, S-Sample, SM-Sample Mirror, SLF-Spatial Light Filter, SLM-Spatial Light ModulatorSetup diagram: Abbreviation: ND-Neutral Density filter wheel, BE-Beam Expander, BS1,2,3-Beam Splitter 1,2,3, BSH-Beam shutter, D-Diffuser, FM-Flip Mirror, FPC-Fiber Port Collimator, HWP-Half-wave Plate,L1,2,3-Lens 1,2,3, M-Mirror, P-Polarization Plate, PBS-Polarizing Beam Splitter, PD-Photo Detector, PLB-Plate beam splitter, S-Sample, SM-Sample Mirror, SLF-Spatial Light Filter, SLM-Spatial Light Modulator.

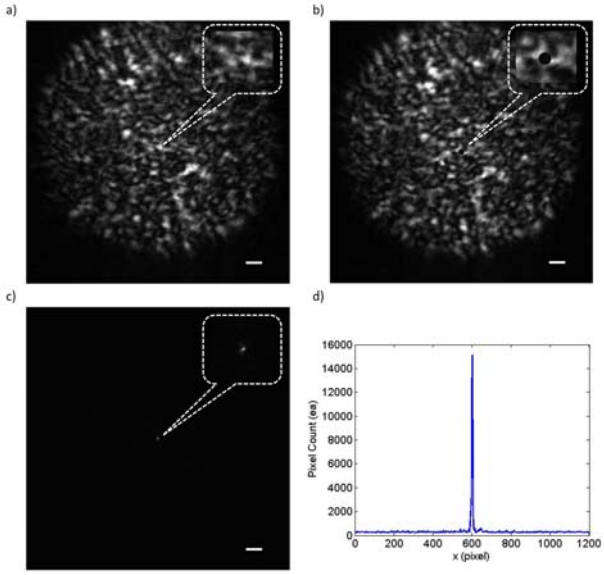

Fig. S2. TRACK focusing with an experimental setup analogous to the one in Fig 2, except that the diffuser was replaced with 0.5 mm thick chicken breast tissue (μ_s: 30 mm^{-1}), a) Laser speckle captured when the target is outside the speckle formed behind a 0.5 mm thick section of chicken breast , b) laser speckle when the target moves in, c) phase-conjugate focus, d) cross section of the focus. Scale bars: 100 μm.

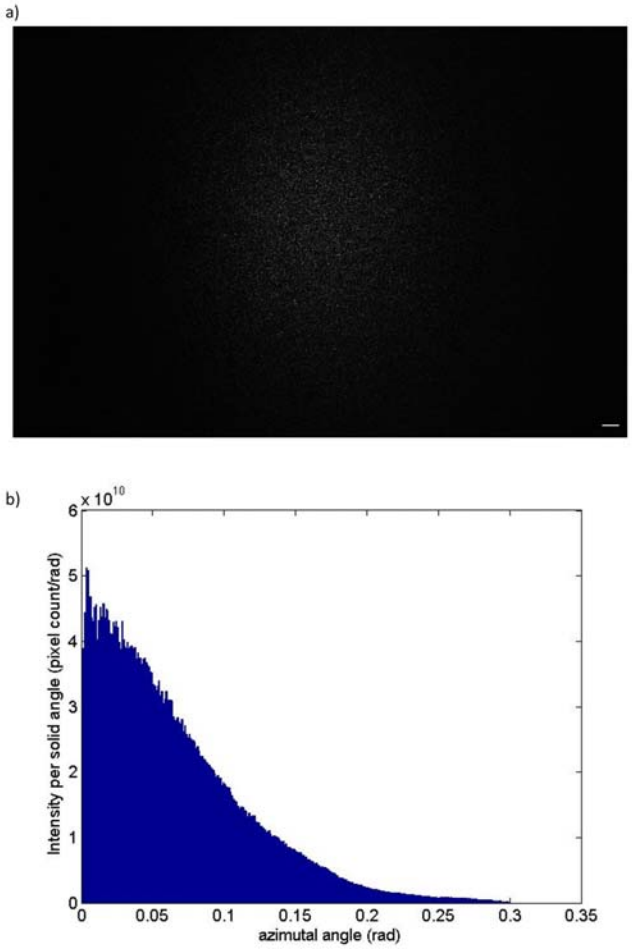

Fig. S3. Angle distribution of the diffusing sample a) Speckle pattern captured 7.25cm behind the diffusor attached to a pinhole shined laser through, b)Distribution of intensity scattering angle.. Scale bar: 1 mm.

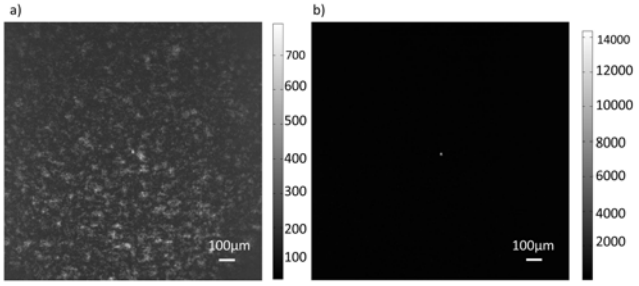

Fig. S4. To compare TRACK to traditional reflective bead guide-stars, we performed an experiment analogous to the one described in Figure 2, but started by time-reversing just one wavefront M_1 (recorded when a reflective bead was present behind the scattering medium – see Eq 2).a) Image recorded by the observing camera when such a wavefront was time-reversed. The focus is barely visible on top of the background b) TRACK focusing with the difference wavefront (M_1-M_2) where M_2 was the wavefront recorded after the target was moved outside the field of view.

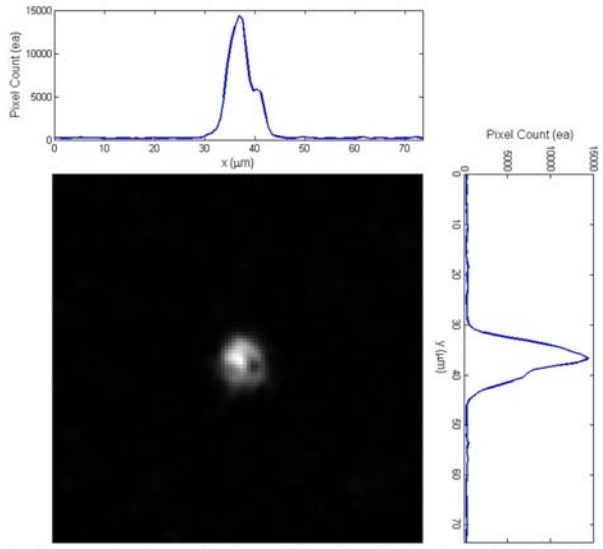

Fig. S5. PSF characterization, the focal spot has a FWHM of 10 μm, by 11 μm . In this experiment, the size of the retro-reflective bead was 42 μm and the speckle size at the target was 2.6 μm. The fact that the focus was smaller than the bead illustrates that the focus shape approximates the reflectivity function ($R(x_b)$, which is highest near the center of the retro-reflective spherical bead).

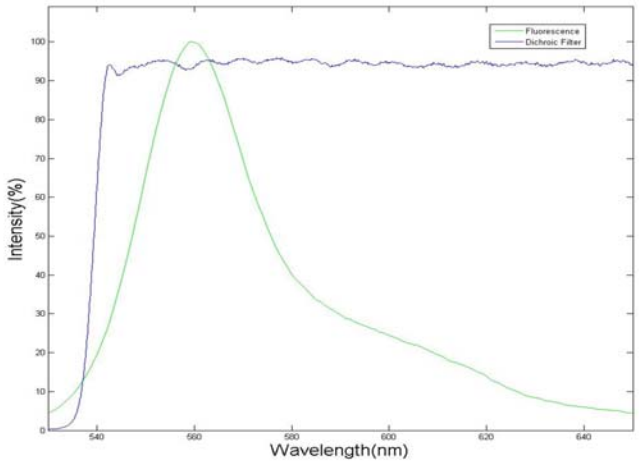

Fig. S6. Fluorescence spectrum of cytometry bead and dichroic mirror transmission spectrum.

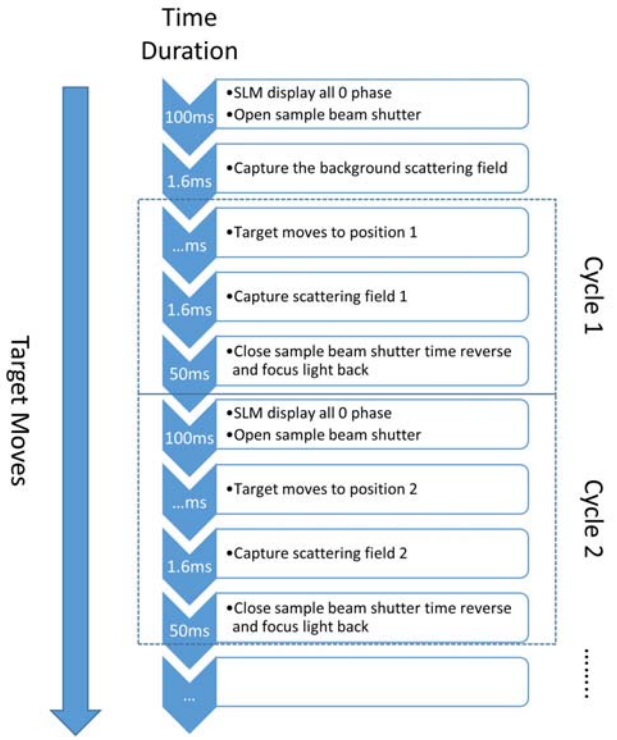

Fig. S7. Experimental timing for the experiment in Figure 3.

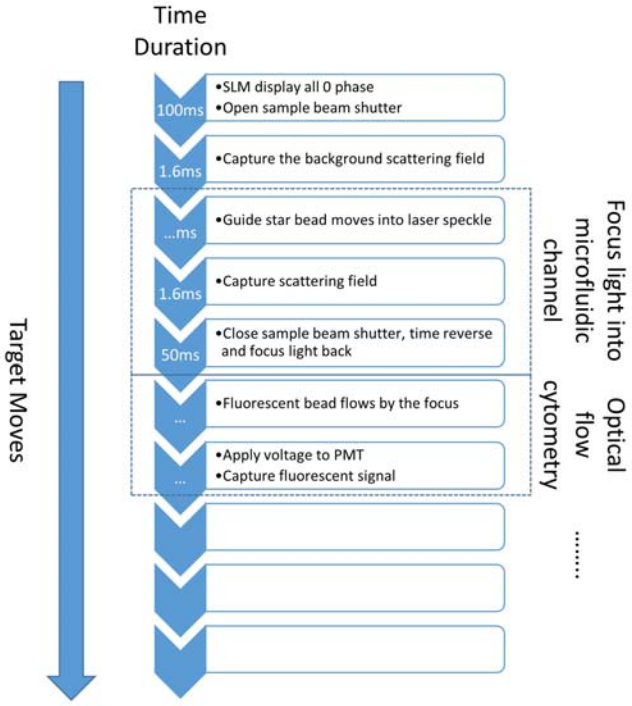

Fig. S8. Experimental timing for the experiment in Figure 4.