## Supplementary Materials

# Active microrheology using pulsed optical tweezers to probe viscoelasticity of Lamin A

**C. Mukherjee[1,¶], A. Kundu[2¶], R. Dey[2], A. Banerjee[2*] & K. Sengupta[1,*]**

1. **Biophysics & Structural Genomics Division, Saha Institute of Nuclear Physics, 1/AF Bidhannagar, Kolkata- 700064, West Bengal, India; Homi Bhabha National Institute, Anushaktinagar, Mumbai-400076, Maharashtra, India**
2. **Department of Physical Sciences, Indian Institute of Science Education and Research Kolkata, Mohanpur, West Bengal, India**

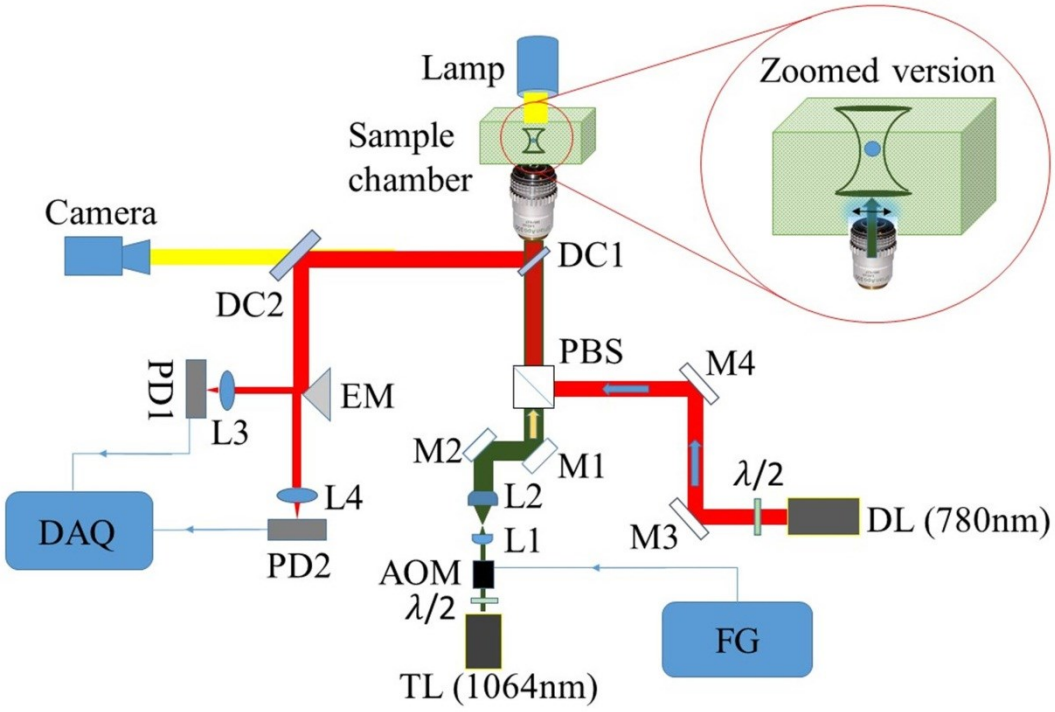
**¶ Authors contributed equally**

***To whom correspondence should be addressed: kaushik.sengupta@saha.ac.in, ayan@iiserkol.ac.in**

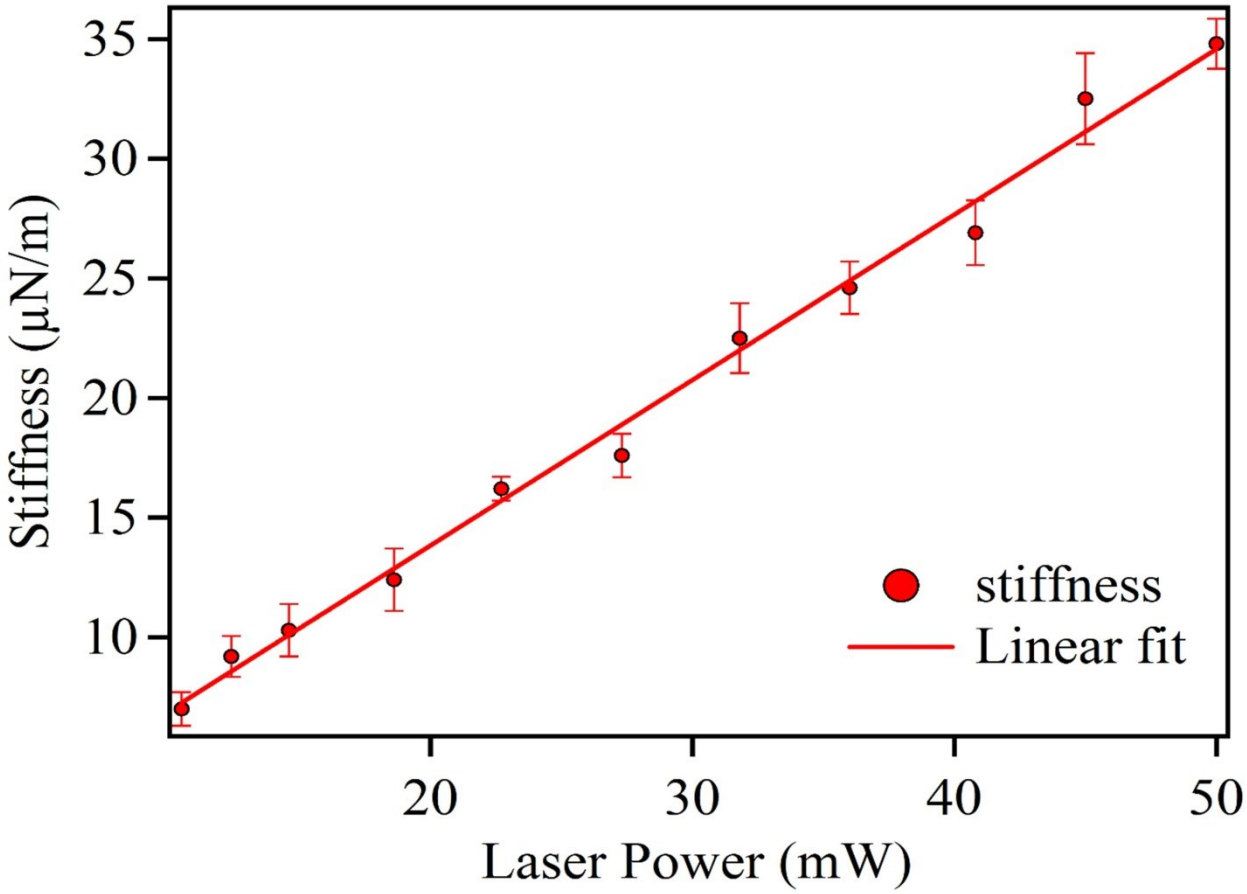
### Measurement with Optical Tweezers

Before using the Optical Tweezers setup, the light sensitive photodetectors have to be calibrated from voltage to the unit of length. We mainly performed this using equipartition of energy, and also from the power spectrum. We initially calibrated our system in water. This conversion factor depends mainly on the refractive index of the sample, so can in principle change with the change in the concentration. But absolute position fluctuation is not needed in our technique as we rely in the phase response to perform our measurements. Only the trap stiffness is necessary which remains unchanged with the change in the sample, as the trap stiffness is mainly a function of the laser power. In Supplementary Figure 2, we plotted the trap stiffness as measured by the equipartition of energy technique, by varying the power of the trapping laser. We found that, the stiffness increased linearly with increasing power of the laser, as expected. In addition, we

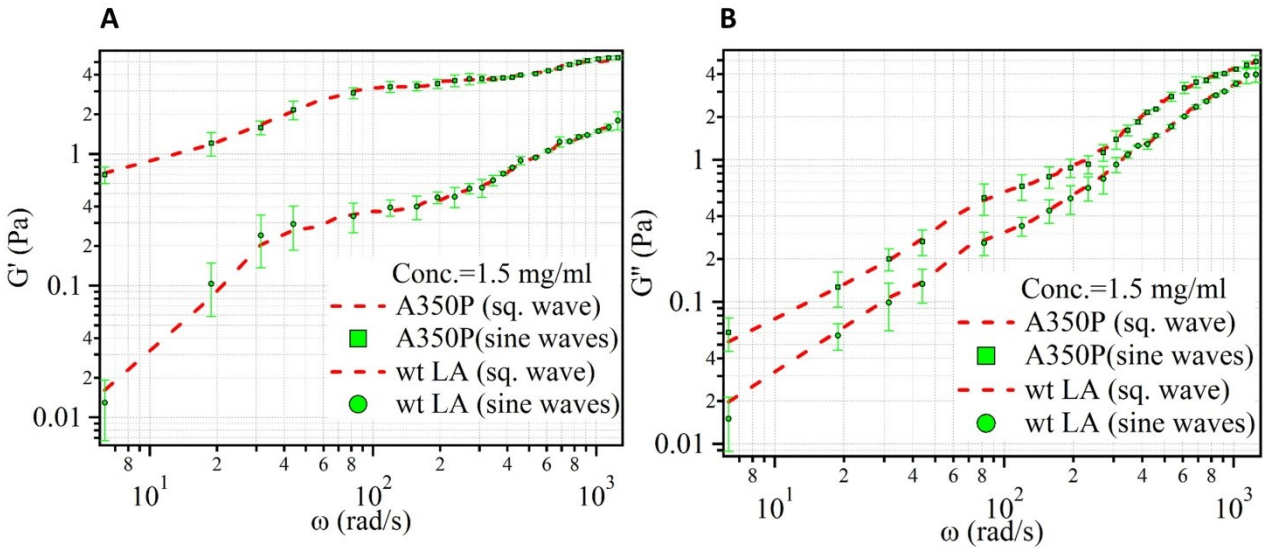
carried out a test of our technique with the conventional microrheology technique of modulating the trap center using a single sinusoidal wave. While we had already shown that the measured values of the microrheological parameters obtained from our pulse scanned optical tweezers matched with that obtained from single sine wave rheology [23] – we performed this exercise more as a consistency check. The results of this exercise are displayed in Supplementary Figure 3. Clearly, the measured values of G' and G" using square pulse excitations matched the results obtained with single sine waves over broad range of frequency, as we have shown in Supplementary Figure 3 (A) and (B) for a particular concentration of 1.5 mg/ml. However, the errors were higher in the single sine wave excitation scheme for the following reasons: (a) while using sine wave excitations to measure the frequency response of the sample, we needed to perform the experiment with individual sine waves of different frequencies -- therefore, to obtain a wideband statistics, it took considerably greater measurement time compared to pulse-scanned optical tweezers and (b) more time in the experiment could lead to added noise and disturbances in the measured system from the presence of other particles, which could be mitigated to a considerable extent using our single shot technique.




**Supplementary Figure 1. Experimental setup of pulsed optical tweezers**: Here TL: Traping laser ( λ = 1064 nm), DL: Detection laser ( λ = 780 nm),  : Half waveplate, AOM: Acousto-optic-modulator, L: Lens, M: Mirror, EM: Edge mirror, DC: Dichroic, PBS: Polarizing beam splitter, PD: Photodiode, FG: Function generator, DAQ: Data acquisition card.




**Supplementary Figure 2. Stiffness of the optical trap measured with varying laser power.**




**Supplementary Figure 3. Comparison of the (A) storage moduli (*G'*) and (B) loss moduli (*G''*) of wt LA and A350P as measured with pulsed Optical tweezers and conventional single-sine wave active microrheology.**