Experiments Performed:

I) Single bead:

a) Single 1 um bead was modulated with sine signal near one wall (Sample chamber had two walls though). We verified the theoretical phase difference ~ frequency relation considering Faxen correction.

b) Single bead was modulated with sine signal far away from the wall. We have data to verify the theoretical phase difference ~ frequency relation.

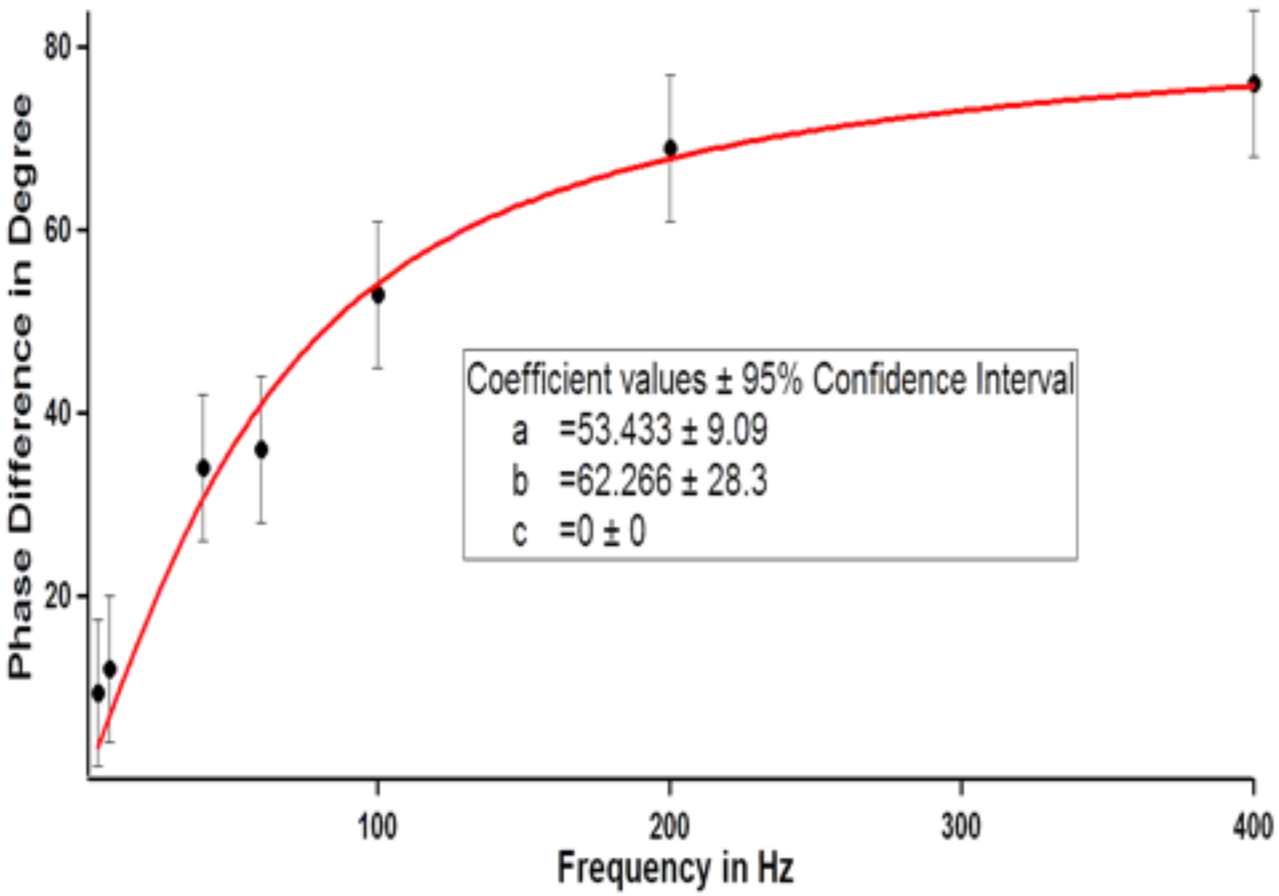
c) We verified the Faxen correction experimentally after building a 3D trap. Changed bead-wall distance to verify this. Found a distance where wall effects seemed to be minimal for 3 um beads.

II) Two beads:

a) Studied motion of 3 um probe bead in response to control bead driven by square wave at different bead separations and control bead frequencies. The response is exponential with the presence of 3 distinct time constants. Wall effect should be minimal.

b) Studied phase difference of probe with drive at different frequencies and bead-bead separations.

Single 3 um bead modulated with sine signal near one wall

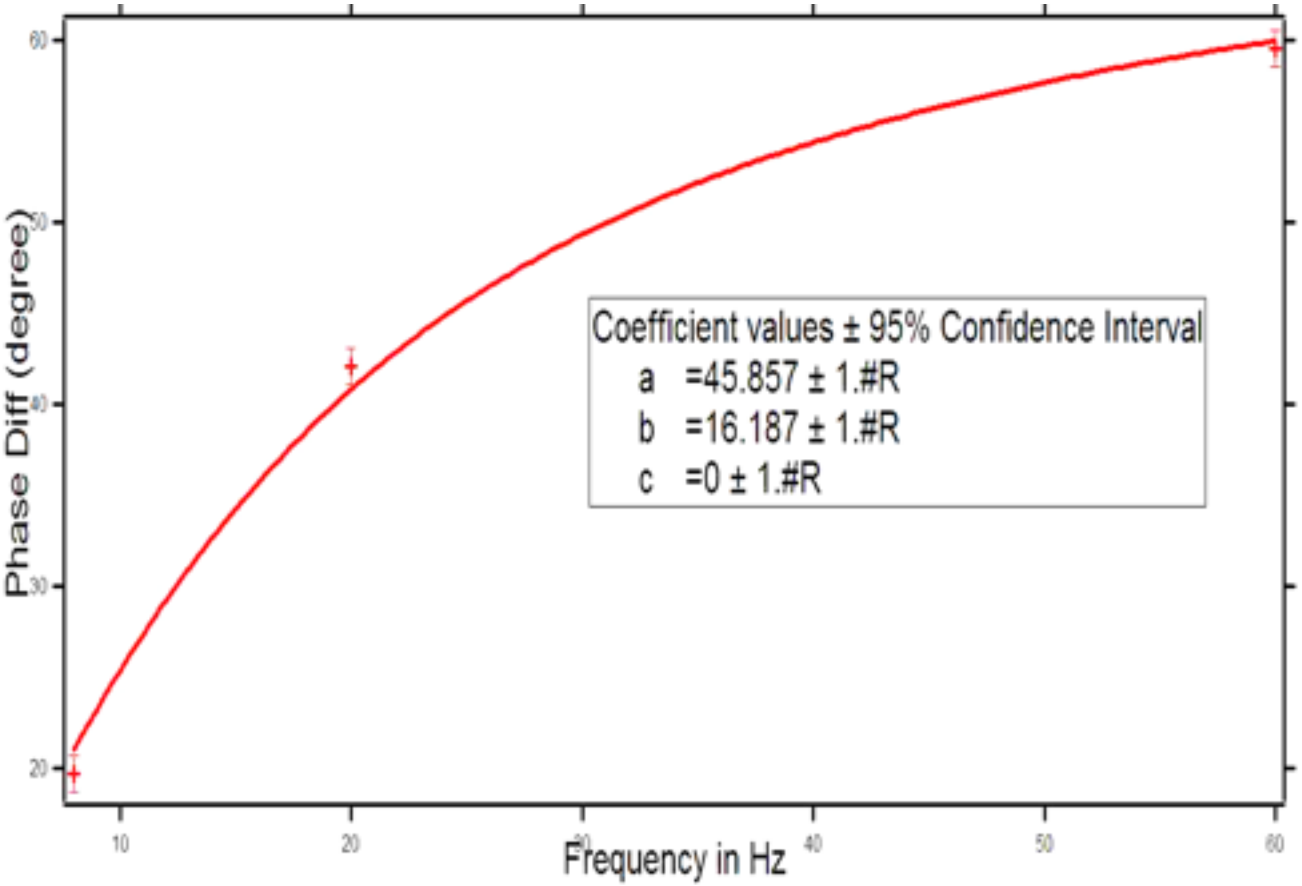


Theoretical $\Delta\emptyset = \tan^{-1}\frac{frequency}{corner\ frequency}$

Corner frequency =

$(41.565 \pm 2.415)Hz.$

Single 3 um bead was modulated with sine signal far away from the wall.



Theoretical $\Delta\text{Ø} = \tan^{-1}\dfrac{frequency}{corner\ frequency}$

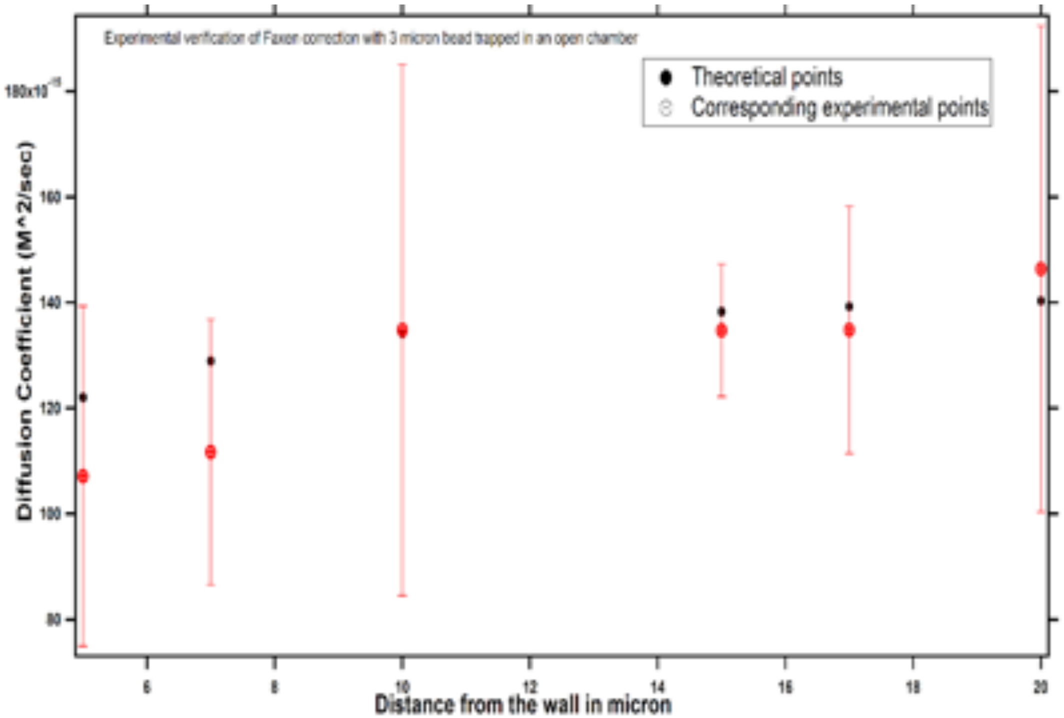
Corner frequency = $(9.5 \pm 1.5)Hz$.

Verification of the Faxen correction experimentally for 3 um bead

Faxen Correction : $$\gamma_0 = \frac{6\pi\eta a}{\left[1 - \frac{9}{16}\left(\frac{a}{h}\right) + \frac{1}{8}\left(\frac{a}{h}\right)^3 - \frac{45}{256}\left(\frac{a}{h}\right)^4 - \frac{1}{16}\left(\frac{a}{h}\right)^5\right]}$$

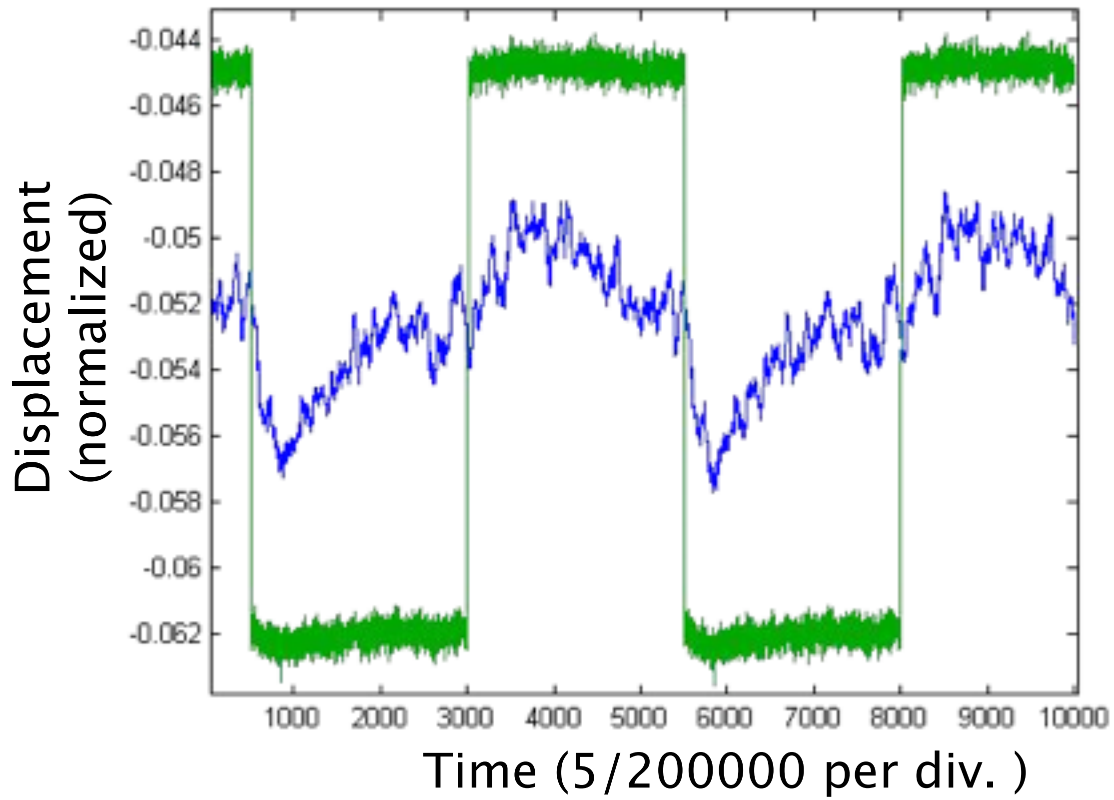
a is the radius of the particle, h is the distance from the nearest wall

Theoretical diffusion coefficient $D = \frac{k_B T}{\gamma_0}$



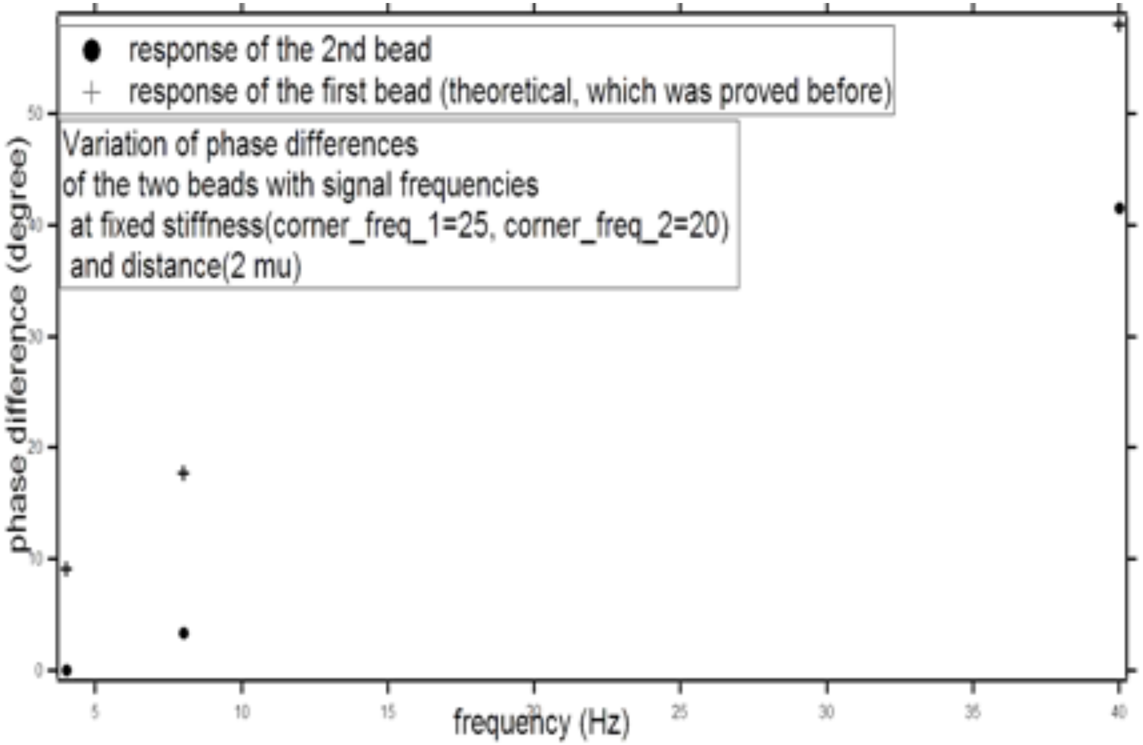
Variation of diffusion coefficient of water with height from the nearest wall at 300K (Black spots are the theoretical points and the red crosses are the corresponding experimental results .)

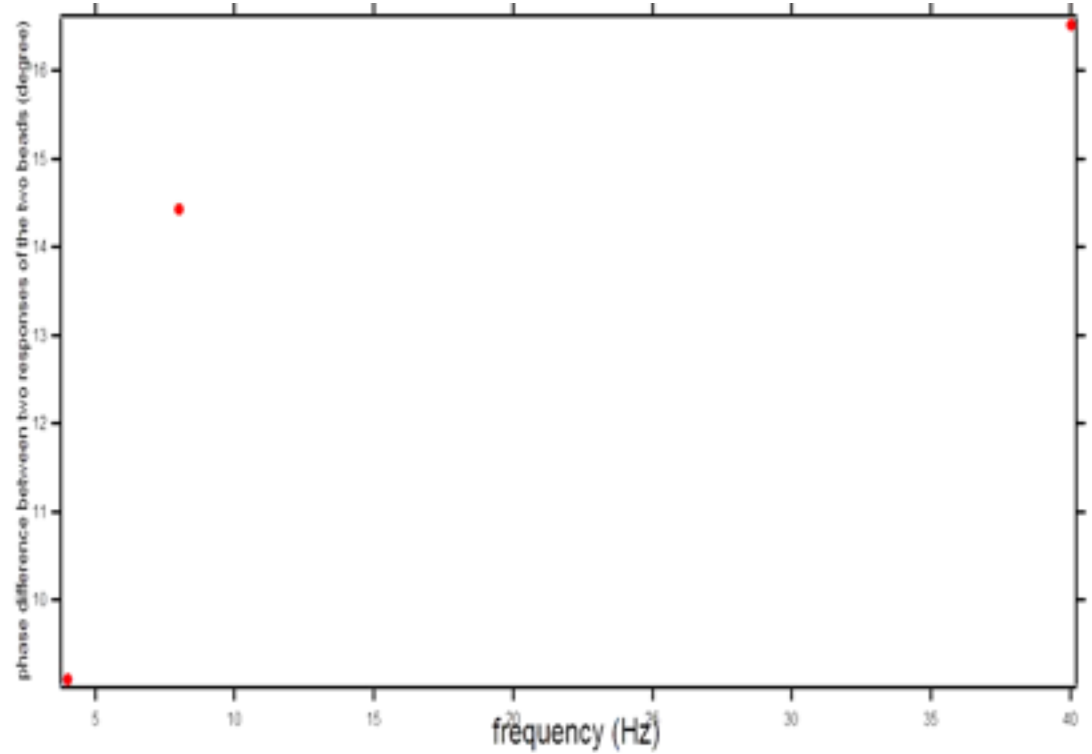
Two bead problem: response of probe bead



There are three exponentials we obtain in response to the square driving pulse – the third exponential that appears in response to the flat portion of the square wave is due the stiffness of the probe trap. This was predicted in theory as well.

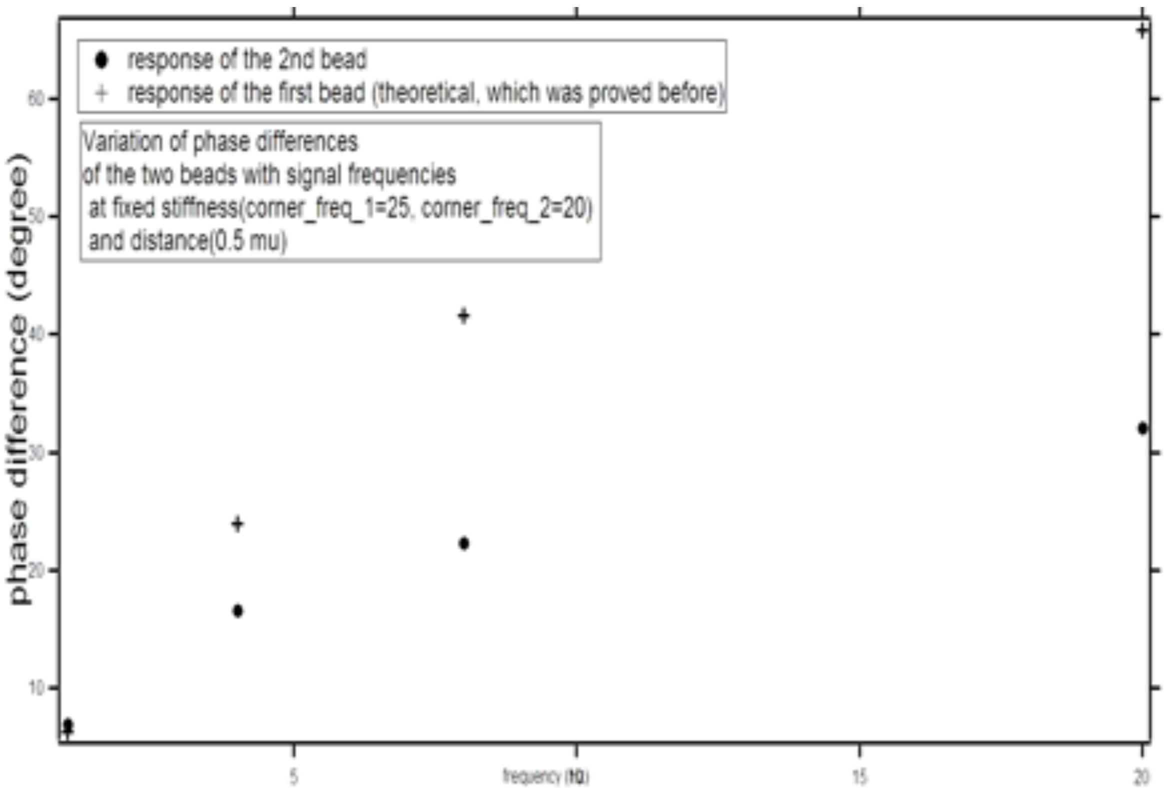
Two bead problem: phase difference of 3 um dia probe bead response w.r.t drive

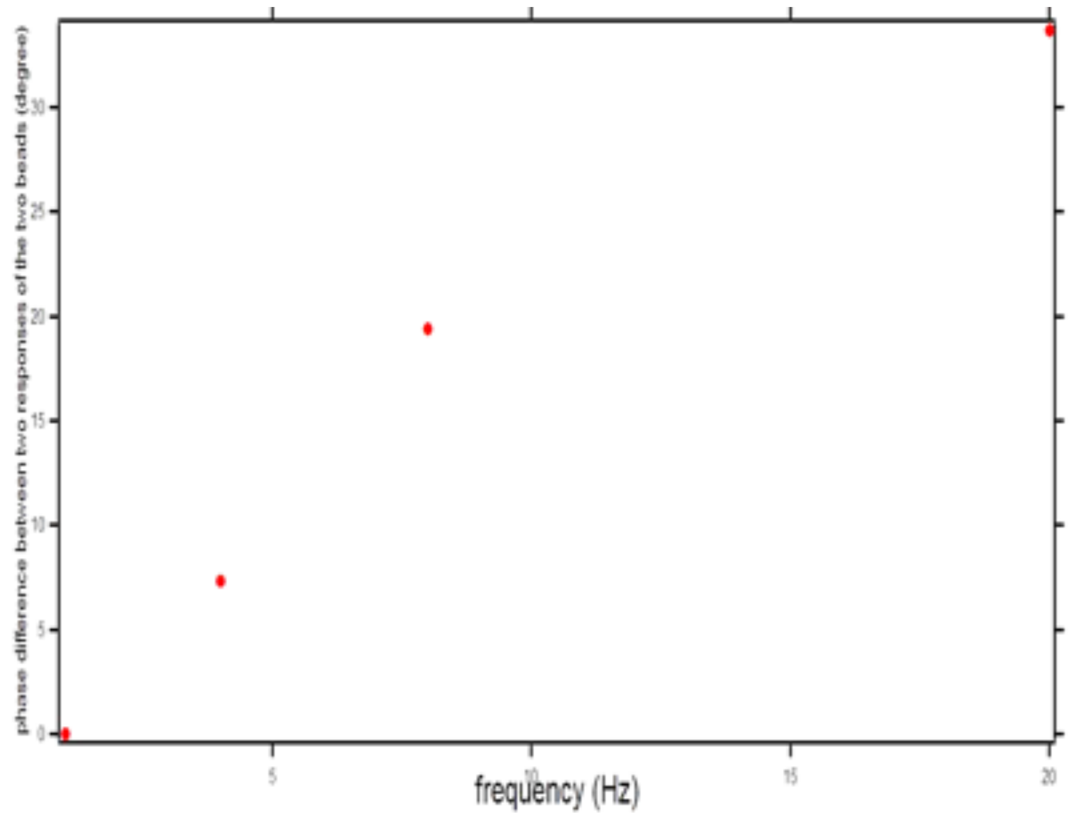




Observed the variation of phase difference between driving square pulse and probe bead response with driving frequency. Distance between two beads: 2 micron surface to surface distance (Signal amplitude 0.34 micron)

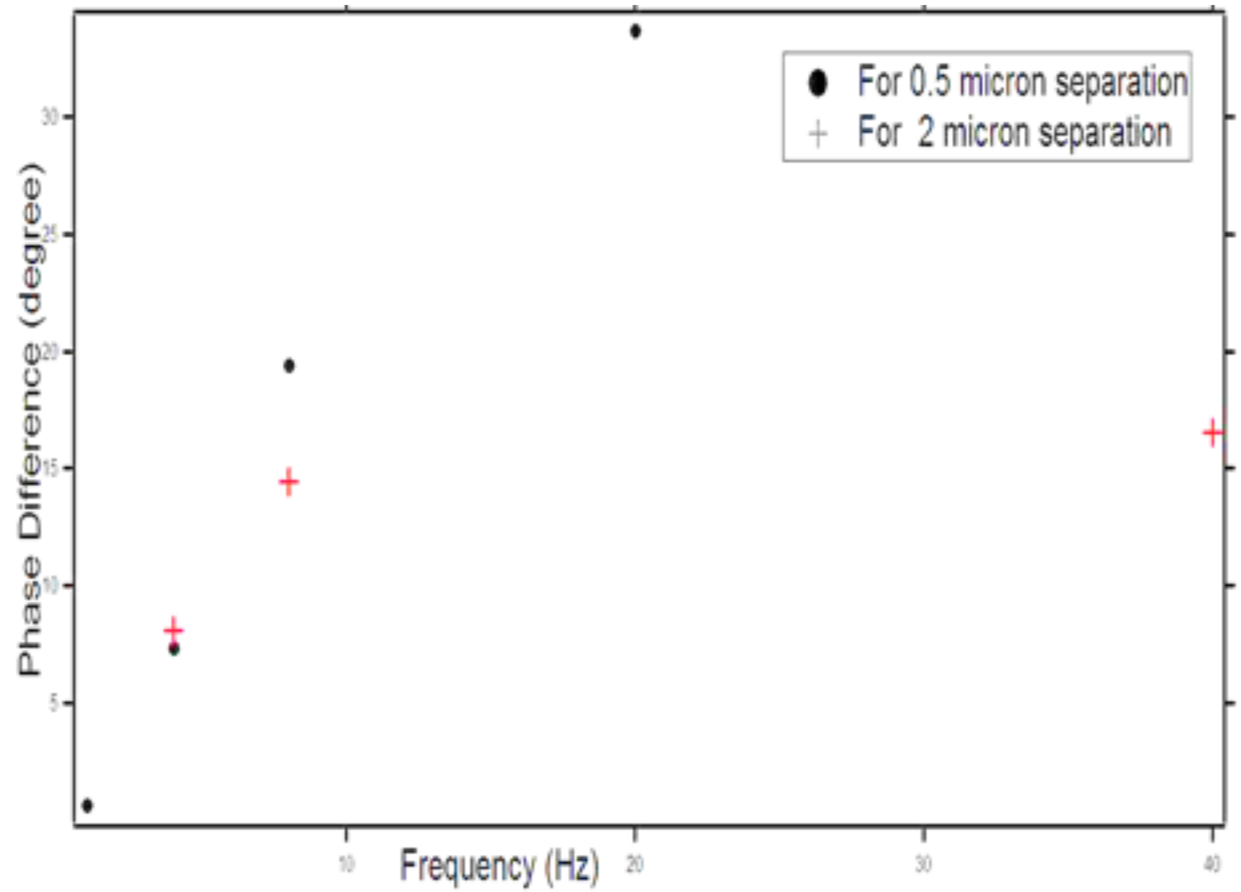
Two bead problem: phase difference of probe bead response with drive





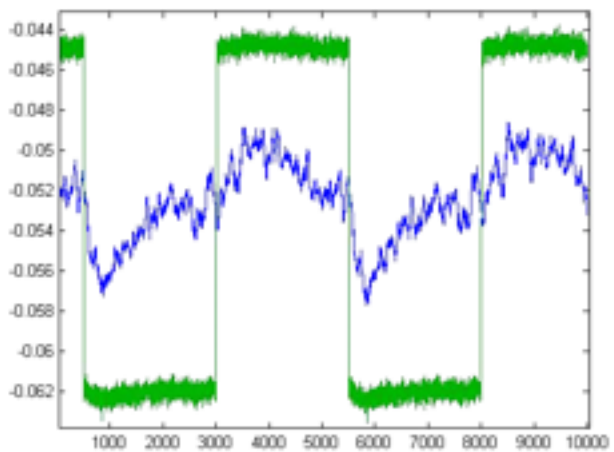
Distance between two beads: 0.5 micron surface to surface distance
(Signal amplitude 0.34 micron)

Conclusion: The phase difference versus frequency for different separations are different

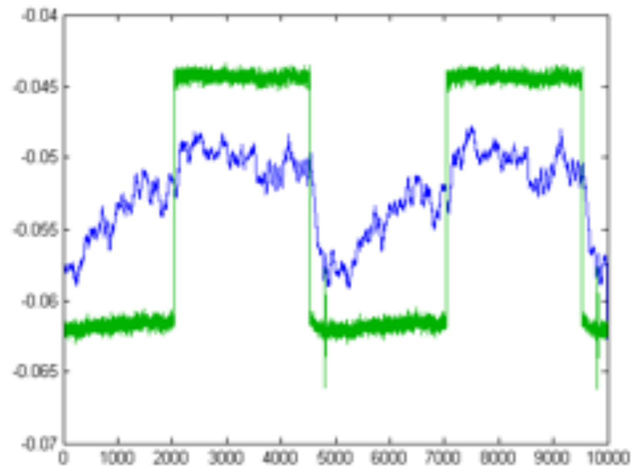


Plot of the shift from single bead phase~frequency relation with frequency for two distances. Single bead character comes as we separate them infinitely.

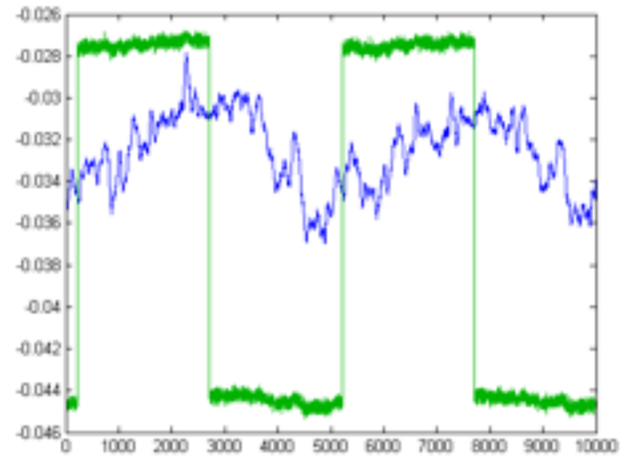
Two bead problem: variation of phase vs separation



Amplitude 0.34 micron (8 hz)



Amplitude 0.5 micron (8 hz)



Amplitude 0.084 micron (8 hz)

We also studied the variation of phase for different control amplitudes (that basically changes the bead separation) for 2 micron surface-surface distance.