MOL SWITCH: A molecular magnetic switch that links the biological and silicon worlds

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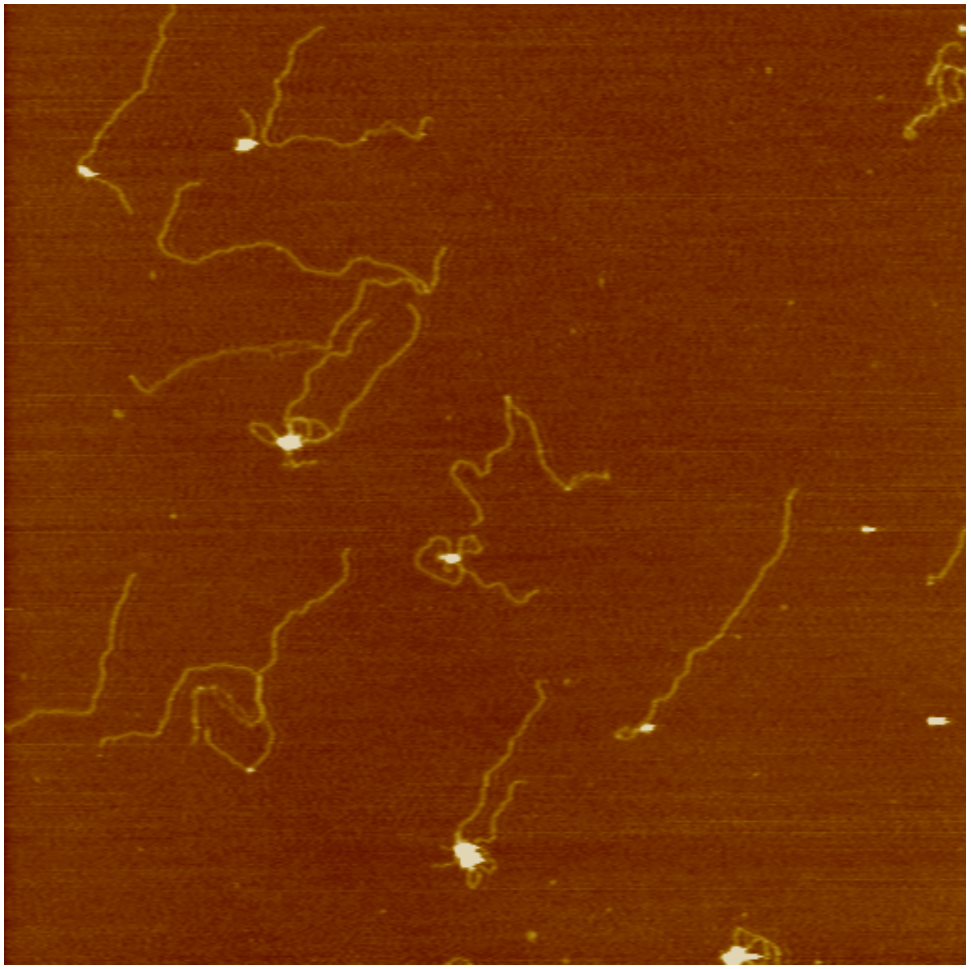
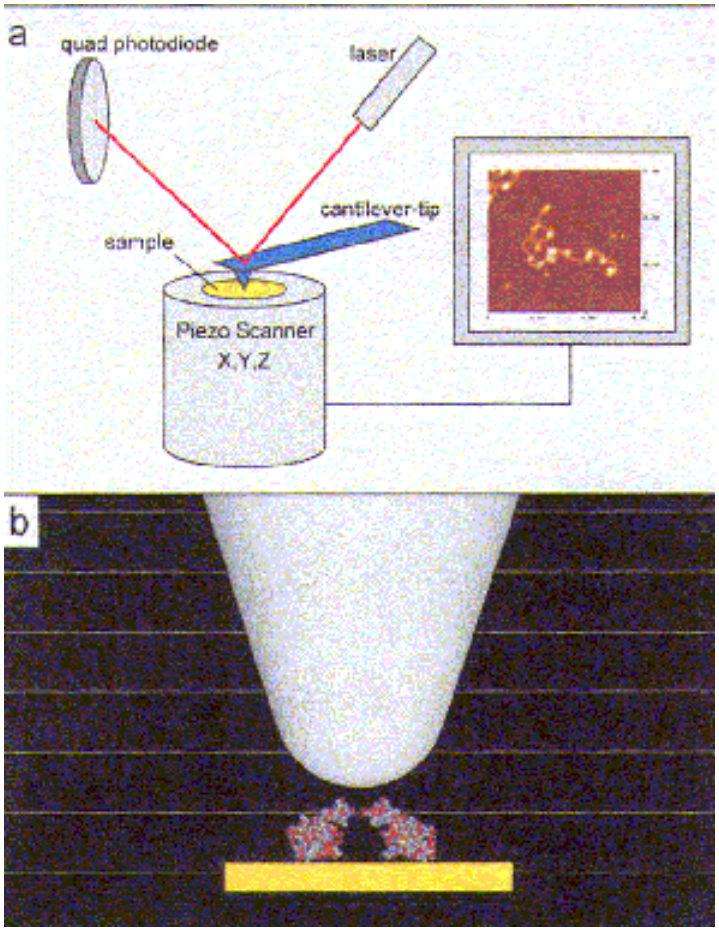
Mol Switch Primary Objectives

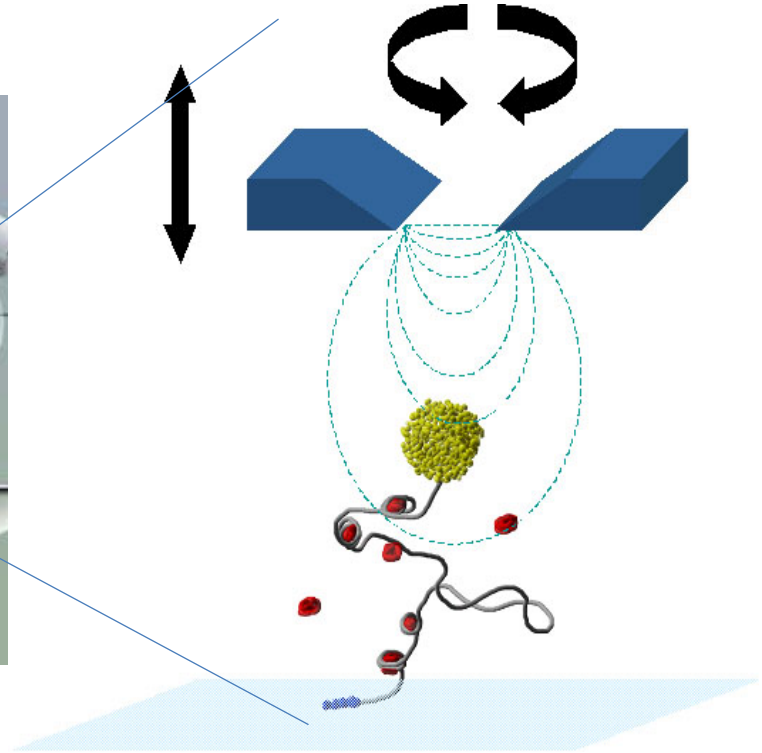
- To demonstrate that a biological molecular motor could pull micron-sized magnetic beads across micron-level distances.
- To show single-molecule activity of the motor and to enable technology transfer of these capabilities between partners.
- To detect this motion and fully characterise the motors to be studied.
- To determine the best method for detecting the moving magnetic particle and propose a prototype device as a single-molecule sensing system.
- To investigate fluorescence detection of movement as a possible route to single-molecule DNA sequencing.
- To investigate novel magnetic particles and show surface passivation, DNA attachment and their usefulness for the proposed device.

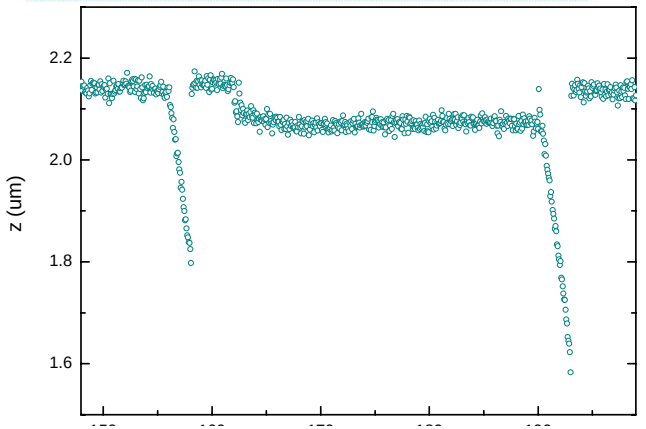
The Scanning Probe Microscope





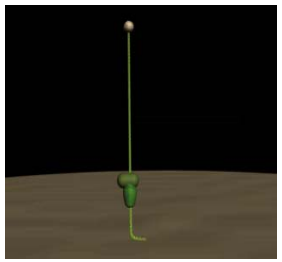
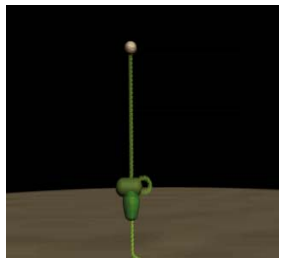
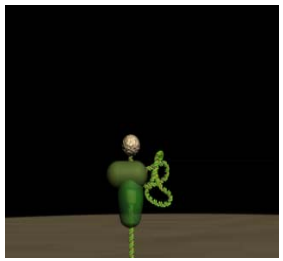
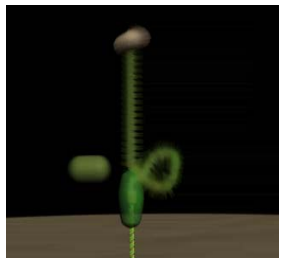
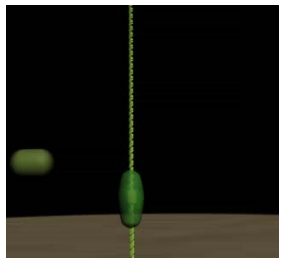
The Magnetic Tweezer Setup





Biological Molecular Motors

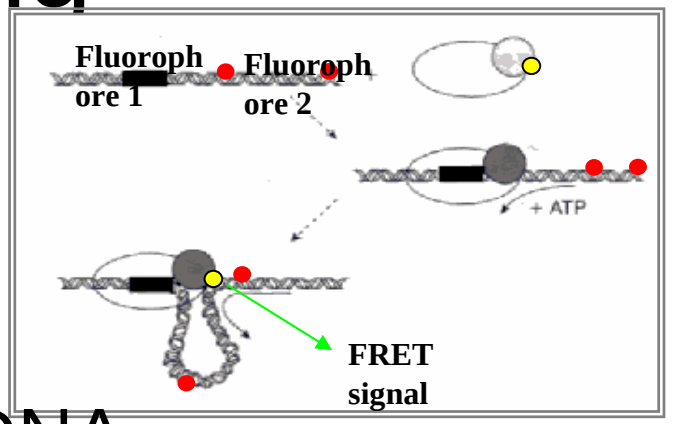
- The best known molecular motor is myosin, which is the single molecule involved in muscle movement.
- Another biological motor that is interesting for nanotechnology is ATP Synthase – this is a rotary motor, which can spin objects.
- The motors we are using are DNA translocases – they ‘pull’ DNA toward themselves following binding at a known site.
- Therefore, they will also pull a DNA-attached magnetic bead producing a nanoactuator/switch.

a  b  c  d  e 

The Mol Switch Device

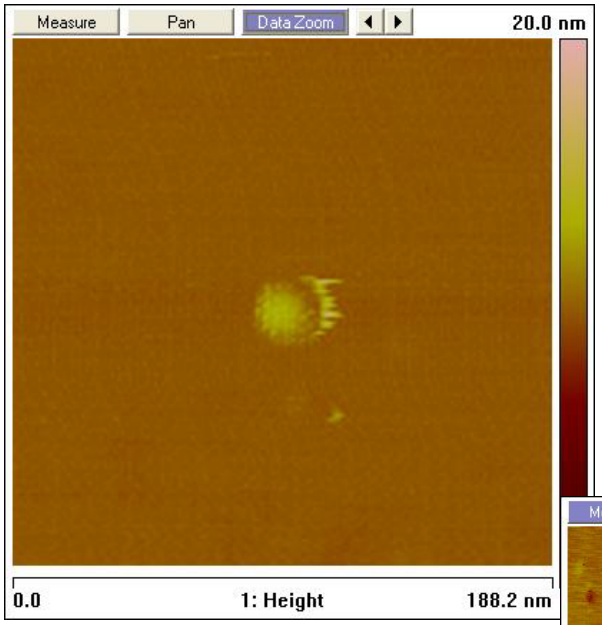
- A biological molecular motor has been shown to ‘pull’ DNA with a magnetic bead attached.
- We have shown that a Hall Effect Sensor can detect the moving magnetic particle.
- Therefore, we can link the biological and silicon worlds using this nanoactuator.
- We will use NEST funding to build this device as a modular biosensor.

Single Molecule DNA Sequencing



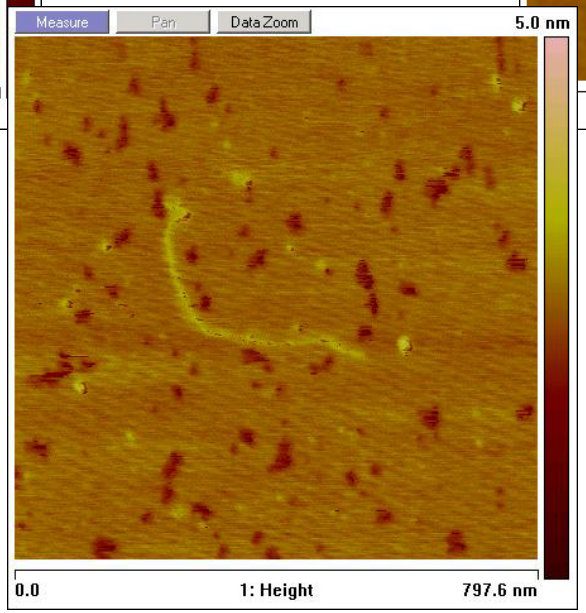
- We have demonstrated that a fluorophore can be attached to the motor and will produce a FRET signal with an adjacent fluor on the DNA.
- We have constructed long DNA molecules with a fluor at the distal end and shown time-resolved FRET.
- Therefore, it should be possible produce a prototype sequencing device to resolve SNPs.

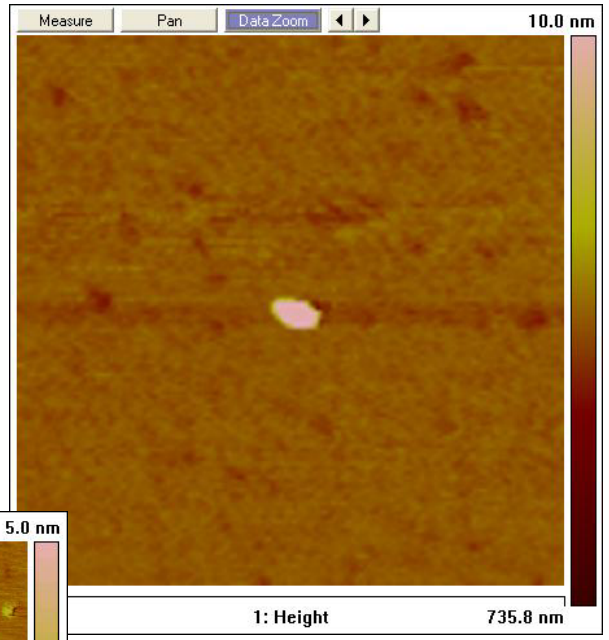
Novel Magnetic Beads



AFM image of the barium hexaferrite paramagnetic beads

DNA attachment to an avidin coated barium hexaferrite magnetic bead





AFM of the barium hexaferrite paramagnetic beads coated in avidin