

GOALS

- Interrogation at the nano-scale with resolution that is orders better than existing schemes
- Interrogation at the nano-scale that has bandwidth that is orders better than existing schemes
- Robust operation so that the need for sophisticated experimental setup is alleviated

IMPACT

- This will open new regimes of investigation at the nano-scale. Phenomena not observable yet due to high SNR will become accessible to researchers in basic as well as applied sciences
- Very high temporal resolutions will make it possible to study phenomena that evolve rapidly thus opening another front for basic science at the nanoscale.

APPROACH

- Micro-cantilever based devices form the main tool of investigation
- Use thermal noise constructively to counteract other uncertainties in stabilizing operating conditions. Yield considerably enhanced periods of operation. This results in enhanced resolution
- Use Model based imaging schemes that provide significant advantages in Bandwidth.

ACCOMPLISHMENTS

- Invented two new methods of imaging:
 - **Transient signal based imaging** (increased bandwidth by 2-3 orders)
 - **Static Non-contact Atomic Force Microscopy** (unparalleled resolution under ambient operating conditions)
- Developed robust control paradigm with Prof. Srinivasa Salapaka for nanopositioning

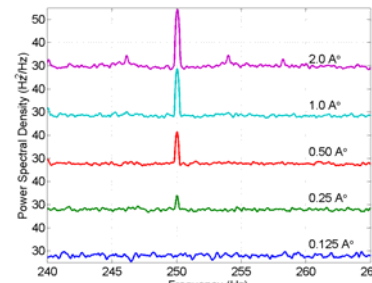


Figure 1

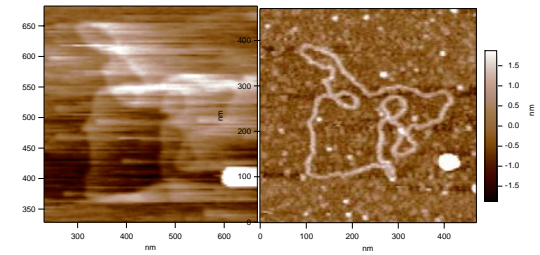


Figure 2

Figure 1: Static Non contact AFM developed by Prof. Salapaka can detect 0.25 Å changes in the sample position *in ambient conditions*.

Figure 2: The image (left) is the image of DNA using traditional methods. The image (right) is the image detected by the new model based technique (Transient Signal Imaging).

Bottlenecks and Open Research Questions

- The quest is for atomic resolution that can be achieved robustly and repeatedly
- The atomic resolution needs to be obtained at relatively high bandwidth
- The main bottleneck is caused by uncertainties and instabilities
- Both are issues where systems and control people can contribute
- Bio-specific imaging schemes is another vital issue
 - Model based imaging can provide these spectroscopy methods.
- Need to disseminate the methods to the application area concerned.