

What is an AFM?

An AFM is a surface scanning instrument used in the field of nanotechnology to image samples. An AFM works by measuring the atomic force interaction between the sample and a superfine tip attached to a vibrating cantilever. As the tip comes into contact with the surface of the sample, a change in vibration amplitude occurs due to electron cloud interaction of sample and tip. Ensuring a constant amplitude of vibration allows a sample to be imaged.

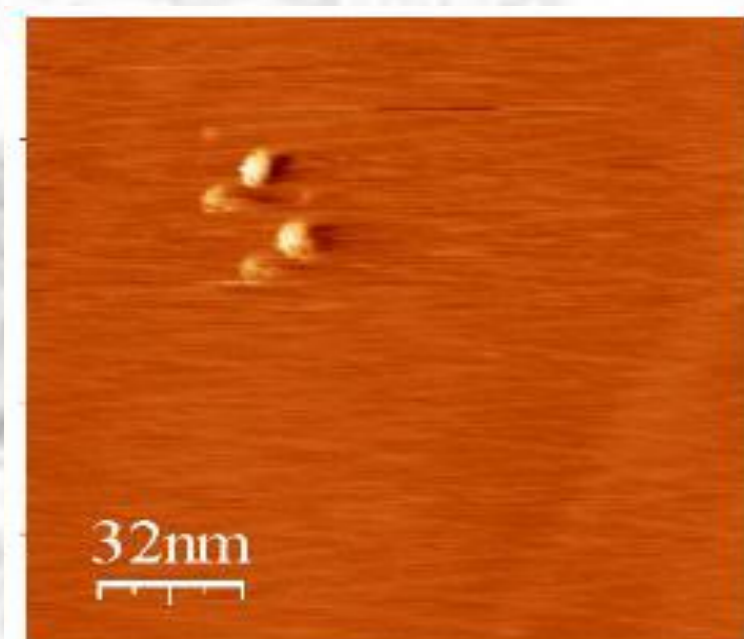


Figure 1: 10 nm Pt particles on HOPG [1]

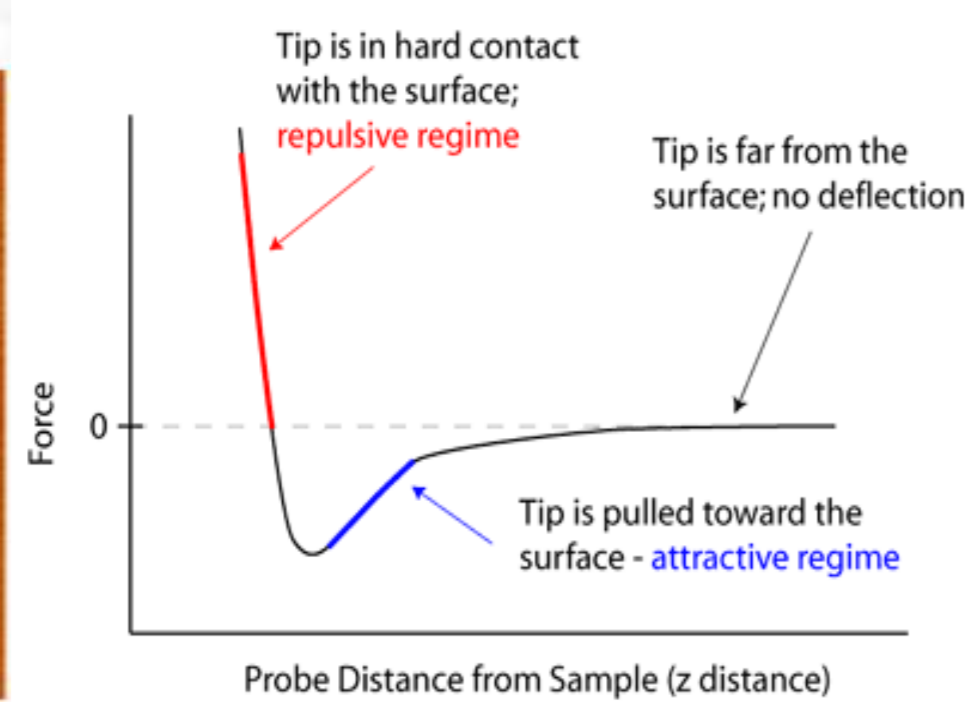


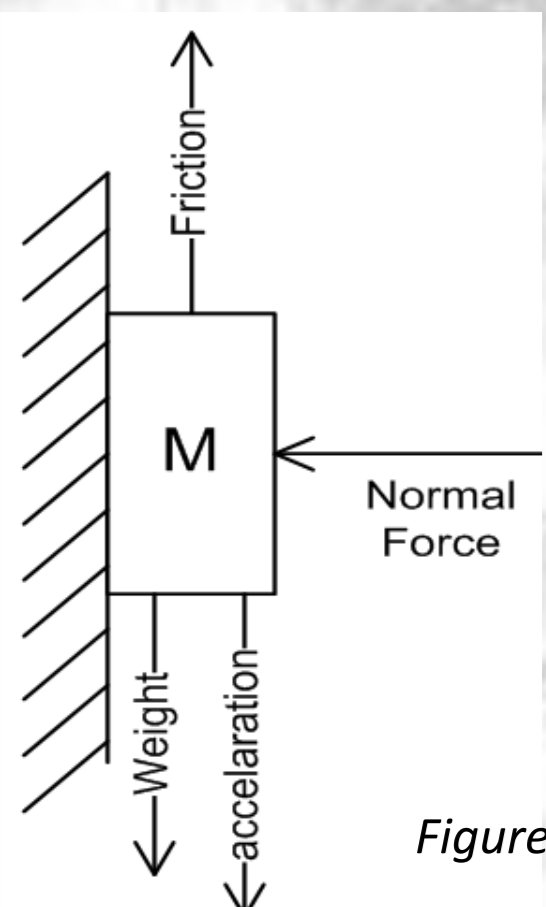
Figure 2: Force distribution between tip and sample [2]

Design Objectives

To innovatively design a high resolution 3-dimensional scanner to be minimally affected by external vibration, thermal drift and electrical noise. The design process included several electrical circuit boards for signal routing and processing between the computer and AFM.

Key Principle

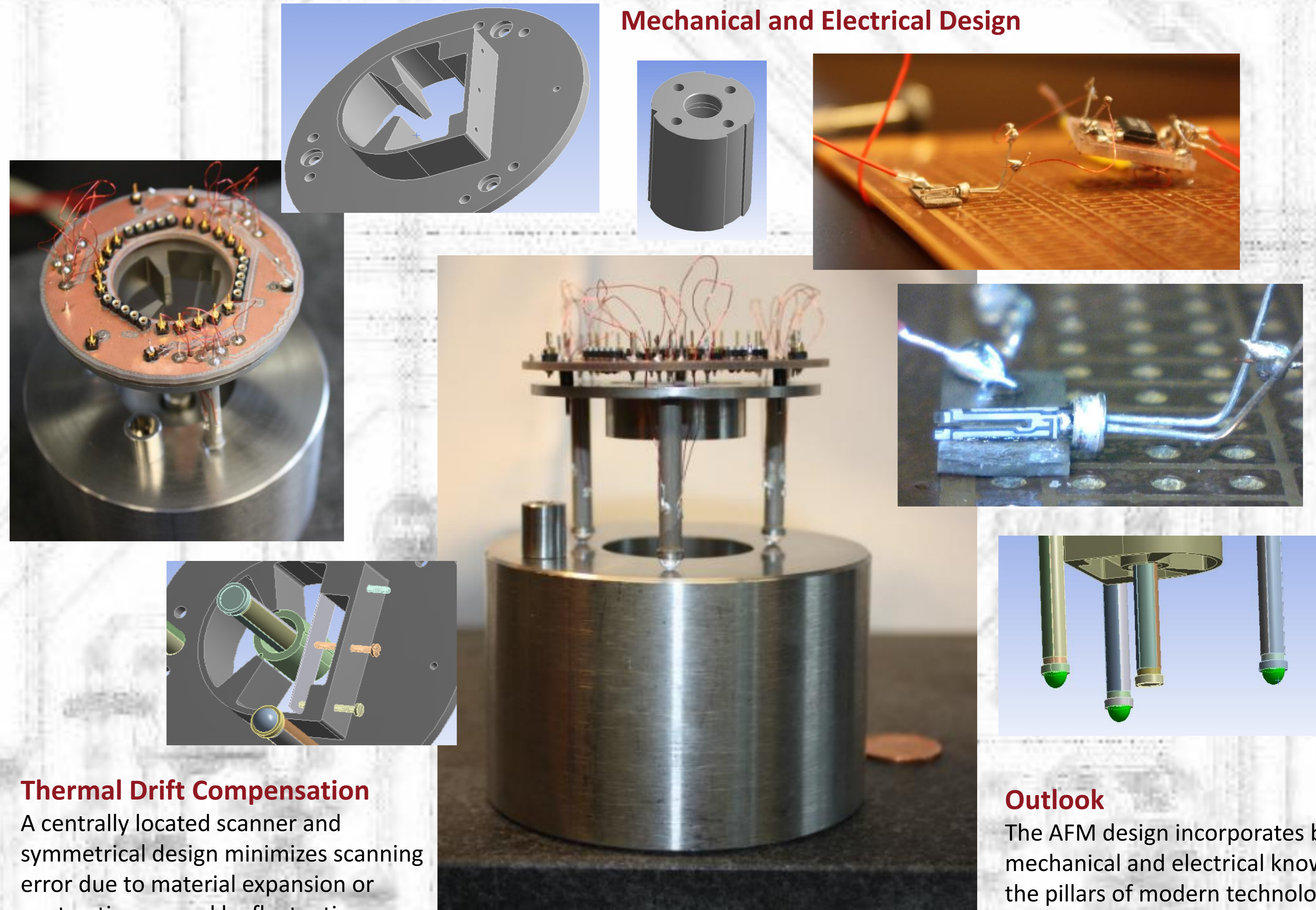
The 'slip stick' principle was implemented in the design for 3-dimensional coarse sample approach. Figure 3 is a simplified representation of slip stick motion along the vertical axis, working with gravity while moving down, and against gravity on the way back up to initial position.



$$\frac{Mg}{\mu_s} < N < \frac{M(a \pm g)}{\mu_s}$$

Figure 3: Slip stick motion

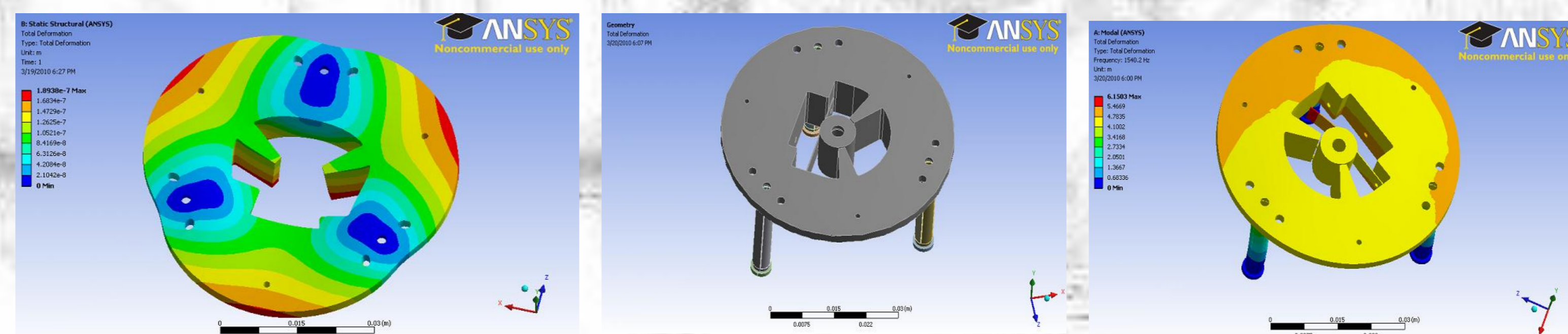
Mechanical and Electrical Design



Thermal Drift Compensation

A centrally located scanner and symmetrical design minimizes scanning error due to material expansion or contraction caused by fluctuating ambient temperatures.

Design Analysis



Outlook

The AFM design incorporates both mechanical and electrical knowledge, the pillars of modern technology, making it an ideal engineering design project.

References

- [1] Lal, Ashwin. Thesis: *Synthesis of metal nanoparticles by electrolytical STM and electrochemical discharges*. Lausanne, EPFL, 2007.
- [2] Chen, C. Julia. *Introduction to Scanning Tunneling Microscopy*. Oxford University Press, USA. 1993. Chapter 1.