A Nano Coordinate Machine for Optical Dimensional Metrology

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Project Objectives

- Develop a non-contact, high precision sensor based upon a DVD auto-focusing probe.

- Integrate said probe with high precision stage with software interfact to create a functional nano-cmm system.
- Validate both the probe and the system through testing.

Auto-Focusing Probe Theory

- Laser is directed towards surface through objective lens
- Reflected signal passes through beam splitter and on to Photodiode Array
- Object surface must be near perpendicular to beam

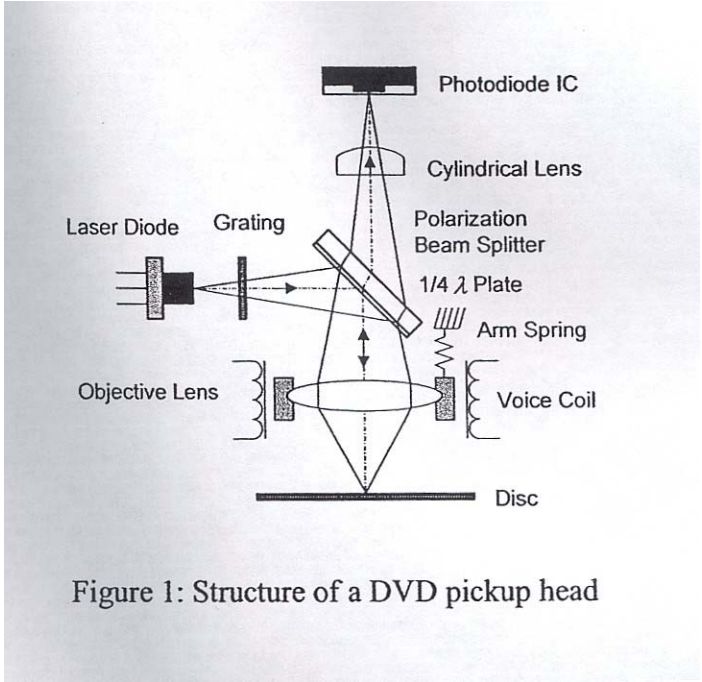

Figure 1: Structure of a DVD pickup head

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Auto-Focusing Probe Theory

- Reflected spot shape is detected by photodiode array and error signal is generated
- Error signal is used to reposition objective lens to maintain focus

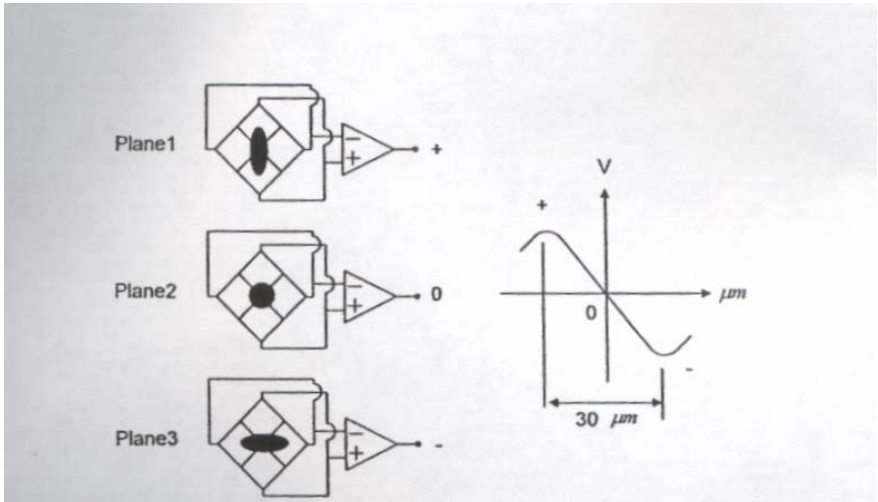

Figure 3: The variation of spot shapes with S-Curve

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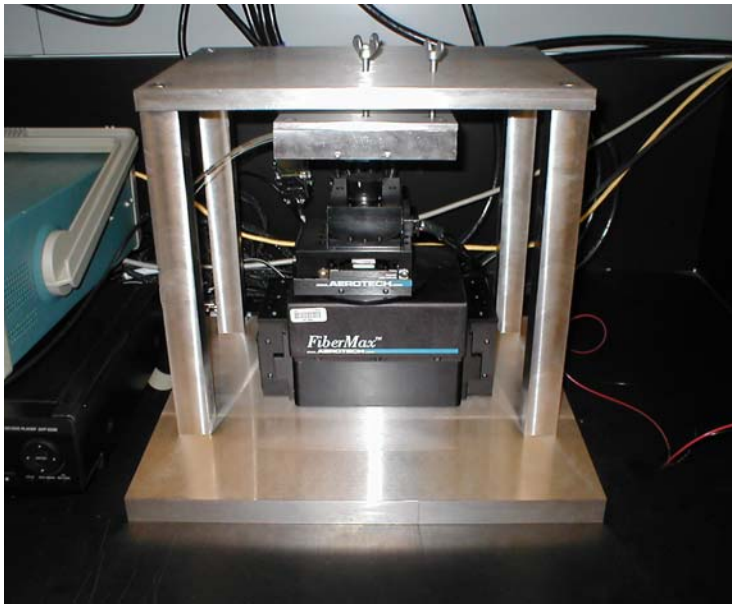
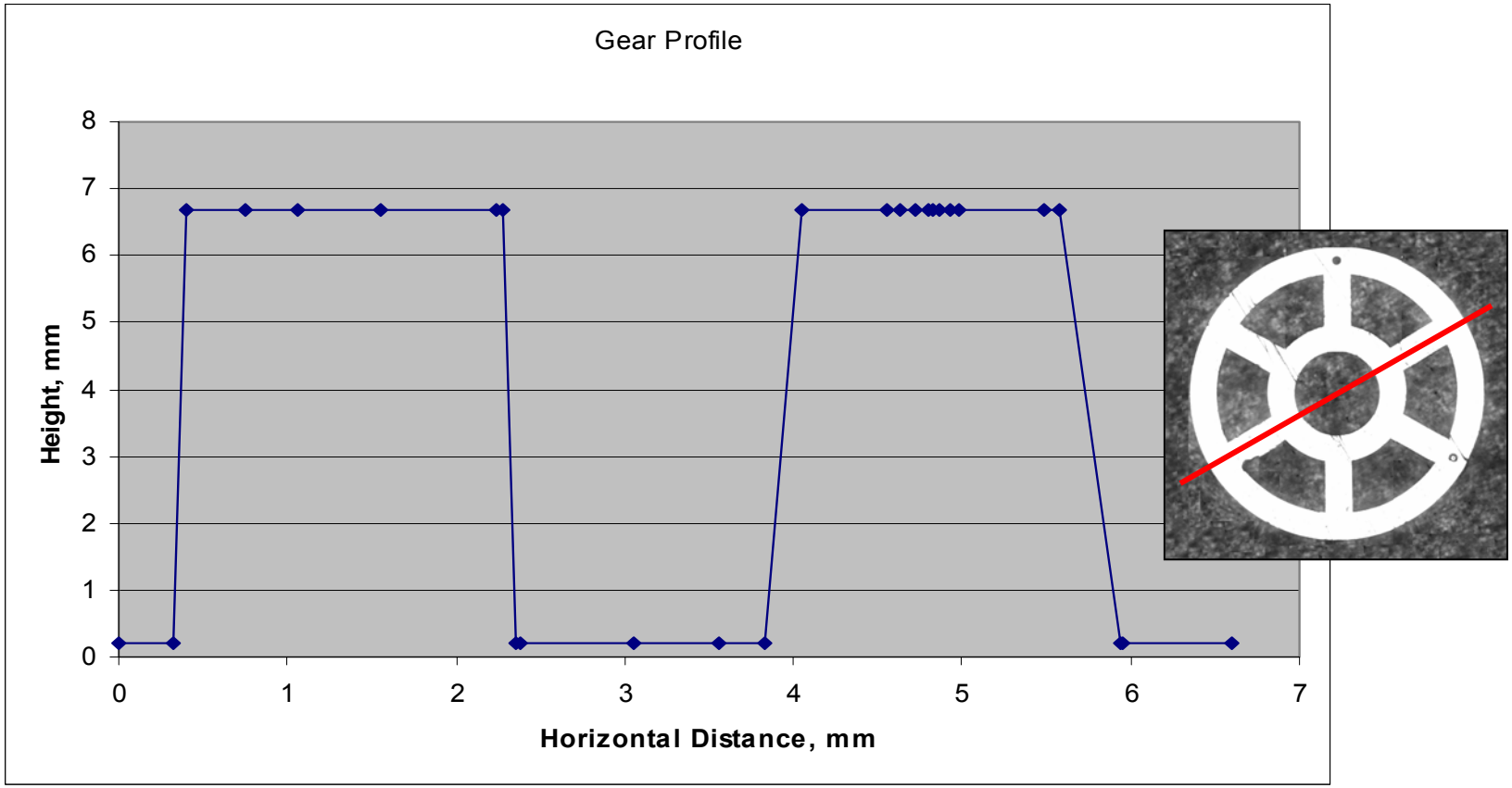
Nano-CMM System

- Fibermax 6-axis stage with 10 nanometer resolution in x-y directions, 2 nm in z direction
- Invar frame for minimum flex and expansion
- Sony KHS-220 optical pickup
- NI 12-bit analog DAQ card
- VB User Interface



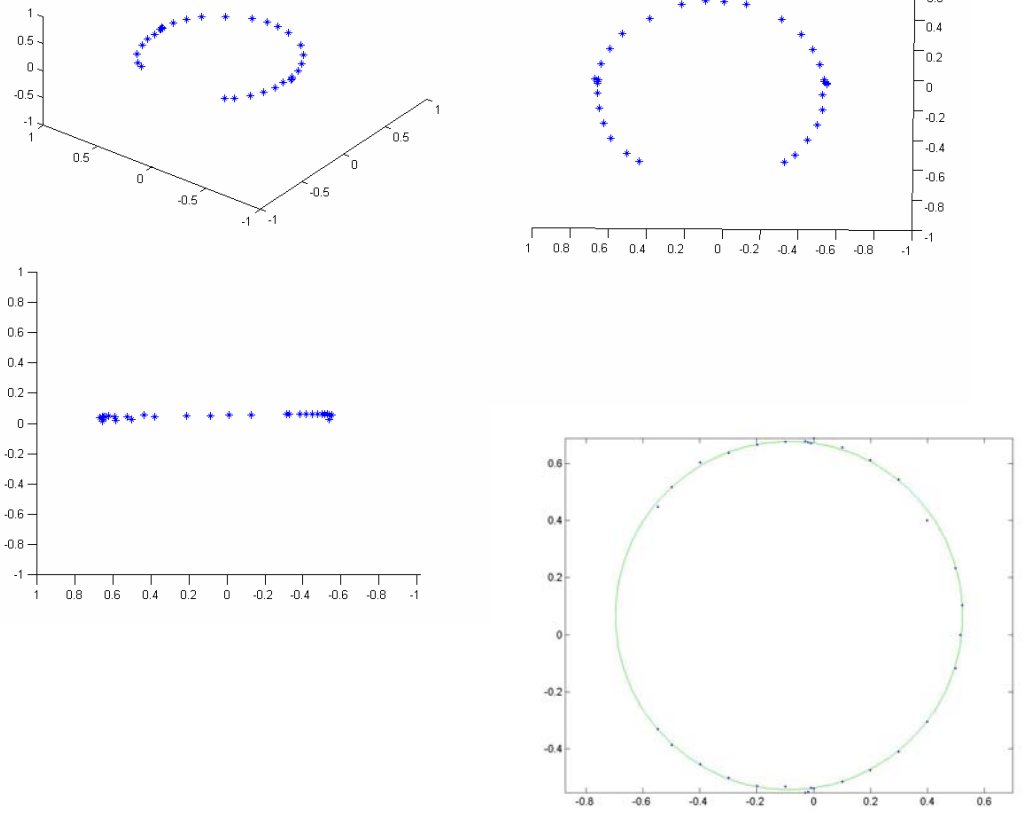
Gear Cross Section



Gear Cross Section Profile Measurement

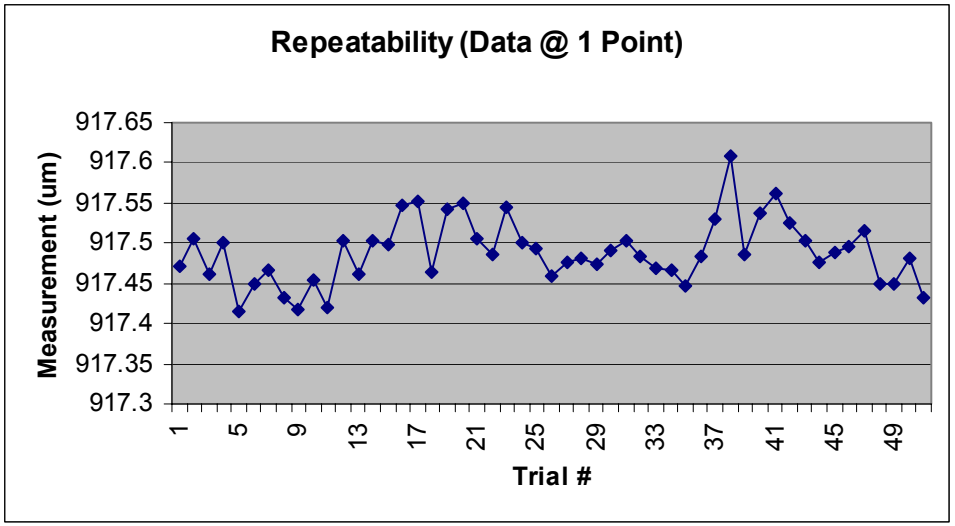
Edge Detection

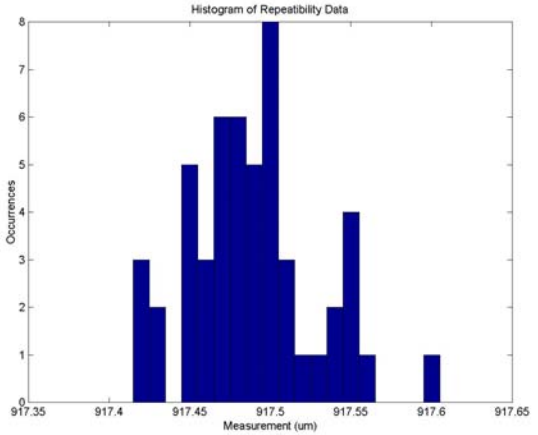
- Cross-section of 1.22 mm diameter microball
- Circle fit to acquired data



Dimensions in mm

Repeatability

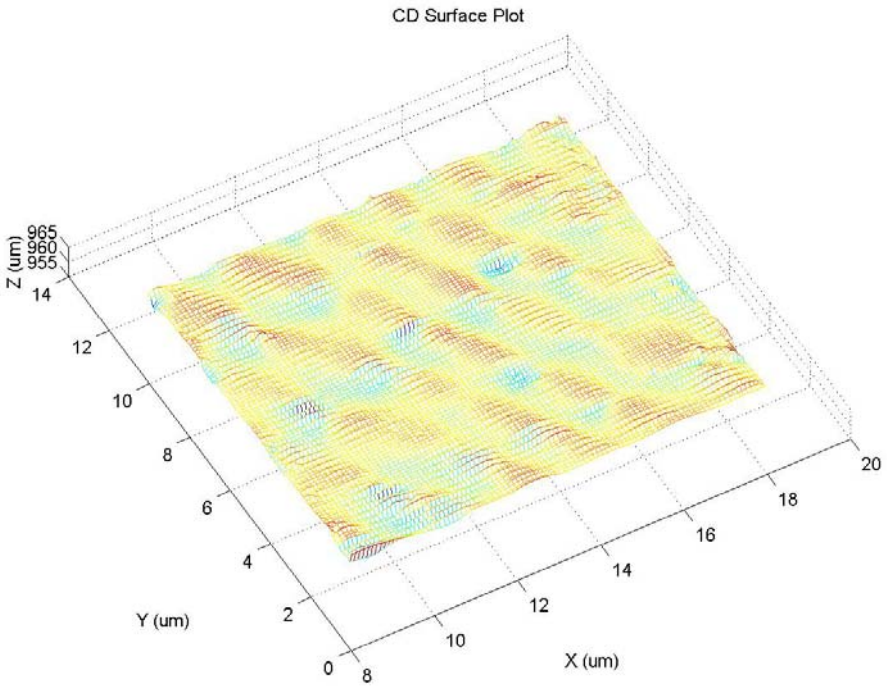




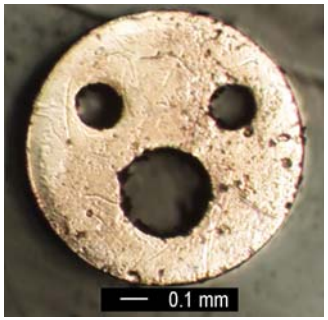
- 50 Data points at one location
- All points within 200 nm range

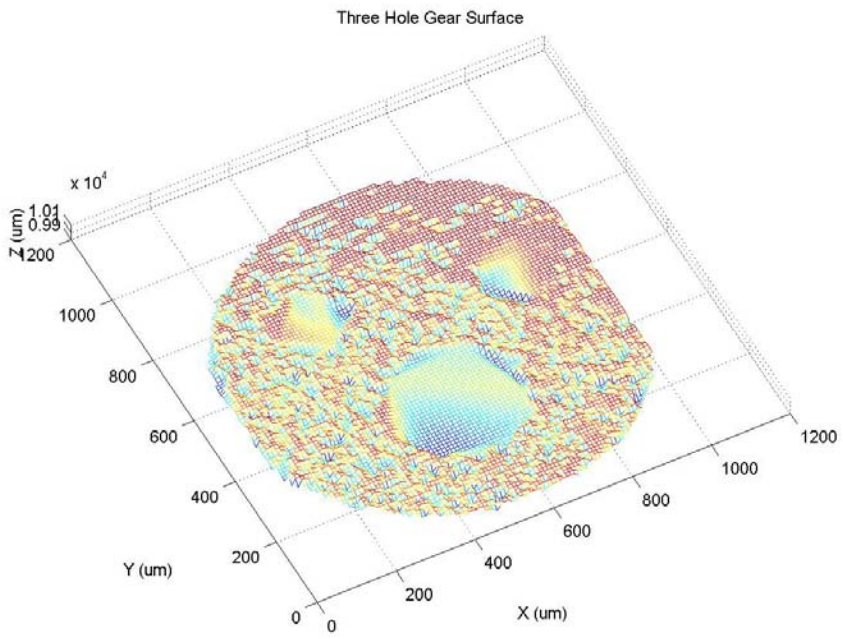
CD Surface Measurement

- CD tracks can be seen as raised red lines
- Nominal track pitch is 1.6 um
- Nominal track width is 0.6 um



Three Hole Gear Surface





Photograph, Raw Data, and Processed Data from Three Hole Gear