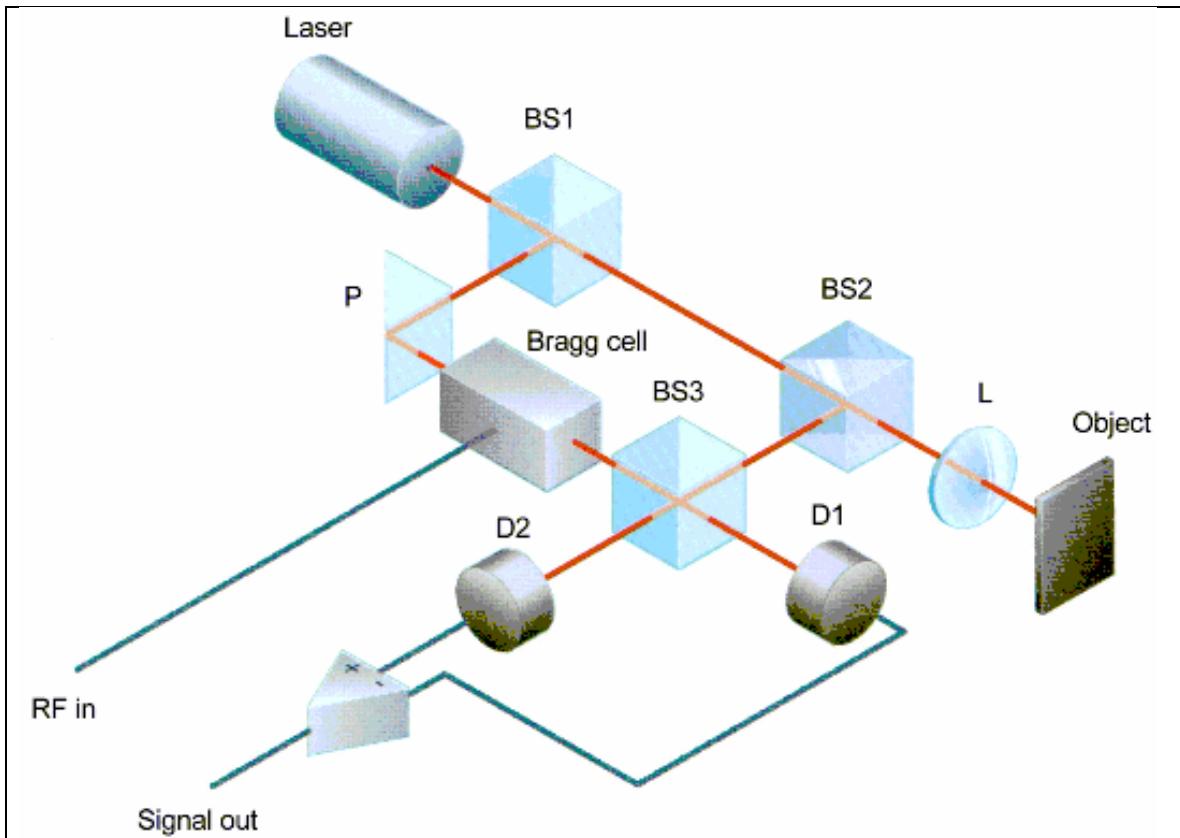


## AFM Simulation with Laser Doppler Vibrometry

A review of the paper “AFM verses THoT” will quickly show that the THoT sector length is longer than the normal AFM measurement width. And, as can be easily seen in that paper, the track spacing is also greater than the AFM “track”.

However, in vertical resolution, the LDV easily exceeds the measurement capability, accuracy and repeatability of the AFM. To understand how this is possible it is necessary to understand the inner workings of the LDV.

In basic terms and as can be seen in the laser diagram, the HeNe laser light beam, 632.8nm wavelength is divided into two paths. The path through Bragg cell to detector one (D1) is totally contained within the instrument and is used as a frequency reference source. The beam that is pointed at the test sample (Object) is subject to the variations on the surface of the test sample and is modulated by those variations. For a demonstration of how this works, see “Doppler Vibrometer Principles Video” in the Frequently Asked Questions section on the web site.



The two detector outputs are sent to a signal comparator and the electronics is capable of determining a shift as small as one part in one million or 0.0006328nm (0.006328 Angstroms).

Then, if we take the Nano-Scan function into account with the capability to capture defects that are well below the optical limit and the morphology function with the ability to measure the Rq of the sector scan, we have the basics for a tool to capture Ra, Rp and Rq.

To determine the Ra of the surface, it is necessary to capture an area that would, as close as possible, simulate the AFM type of measurement. To do this, we cannot use a single track, the results would be more analogous to that of a profilometer. We must use multiple tracks and sectors and report the information for the area in the same format as the AFM.

To make this measurement we gather the peak data, Rp, and the Rq for each sector and track. We then calculate the Ra information for the area. This is based on a ten track width of 20 microns total by four sectors. This means that for every 10 track width there will be 256 Ra, Rp and Rq calculations.

Unlike an AFM, the THoT tool measures the full circumference rather than a few spot measurements that could potentially miss critical information. It is also possible to quickly measure ID, MD and OD circumferences to obtain a very fast process control reading. Or, in less time than it takes to make several AFM measurements, the full surface can be examined.

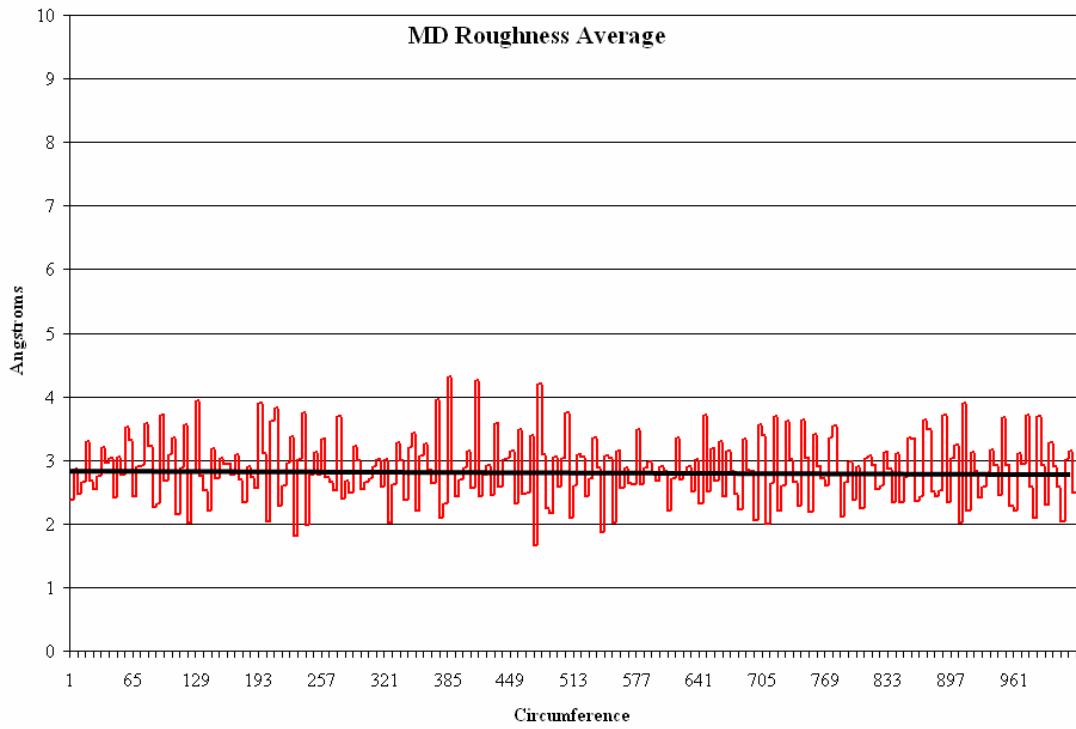
There is a disadvantage of the THoT roughness measurements as compared to the AFM. If you desire a high resolution image of a defect, use an AFM or SEM. This is covered in the paper "AFM verses THoT".

If you want very fast and repeatable measurements of large areas up to the full disk surface, this tool will provide that capability. And, to simulate current AFM process control, the display views can be set up to provide an unlimited number of measurement points.

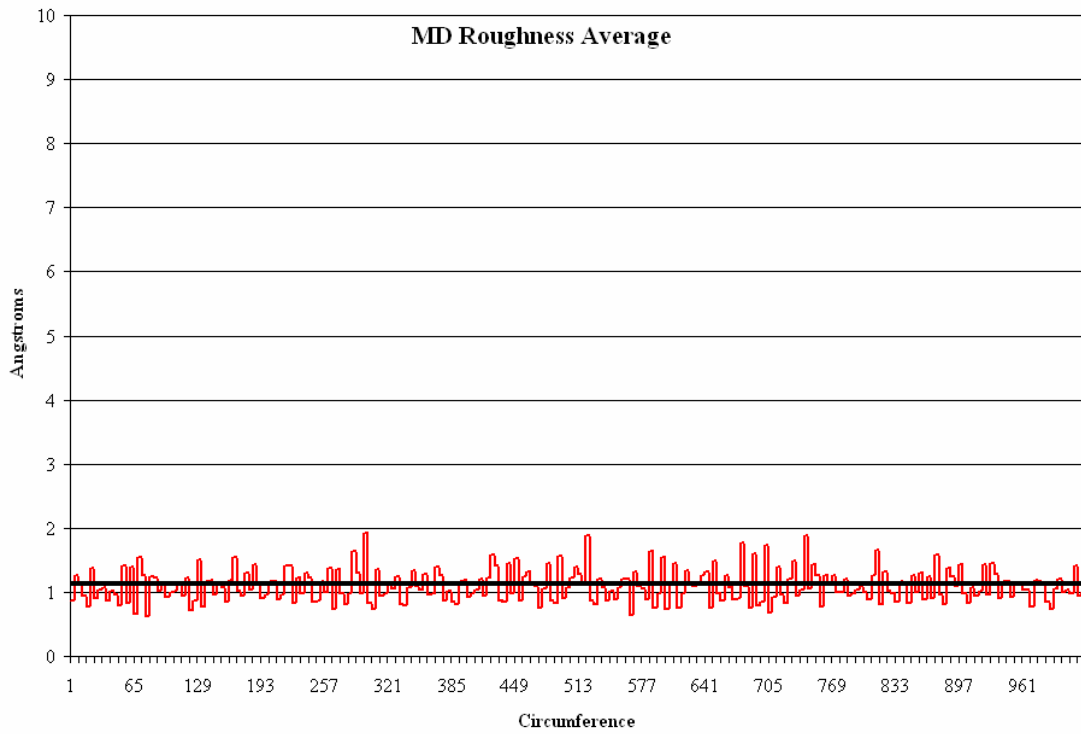
Following are three examples of two applications. The first two examples show a complete middle diameter linear trace with 256 measurements each. The first sample shows a relatively rough disk with an average MD roughness of 2.8 Angstroms. The second example has an average MD roughness of 1.2 Angstroms.

With an AFM it is normal, when an area of roughness is measured, to move the measurement to another area. If we apply that same technique to these two examples and use the lowest measurements we would have readings of 1.7 to 2.0 Angstroms on the rough disk and 0.7 to 0.8 Angstroms on the smooth disk.

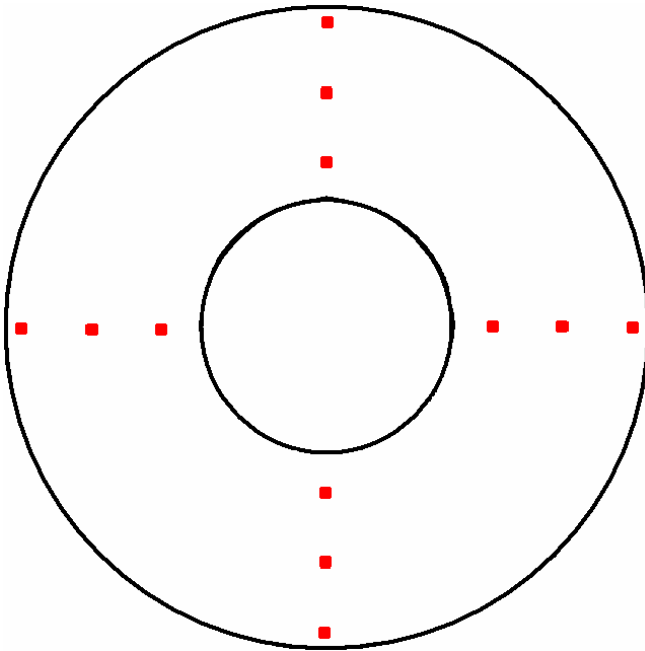
The third example takes a total of twelve measurements, much like the current application of the AFM with four measurements each at the ID, MD and OD of the disk. The difference is that these measurements are all completed within two minutes and can be expanded to the full disk or up to over 300,000 measurement samples on a 95mm disk.



Example 1 – Rough disk surface at the disk MD



Example 2 – Smooth disk surface at the disk MD



### Example 3

Four measurements at the ID  
Four measurements at the MD  
and  
Four measurements at the OD

For each selected view site, the Ra, Rp and Rq data are all captured and displayed. Mean, peak and average measurements are all provided and are saved to a text file that can be easily be parsed by automated systems for process control applications.

For each selected site the radius and angle of the measurement is recorded along with the nine measurements. Selected sites can be up to the full surface or up to 332,800 individual measurements on a single 95mm disk surface.