Precision Machined Part Inspection With 3D Profilometry

Prepared by
Craig Leising
6 Morgan, Ste156, Irvine CA 92618 · P: 949.461.9292 · F: 949.461.9232 · nanovea.com

INTRO:

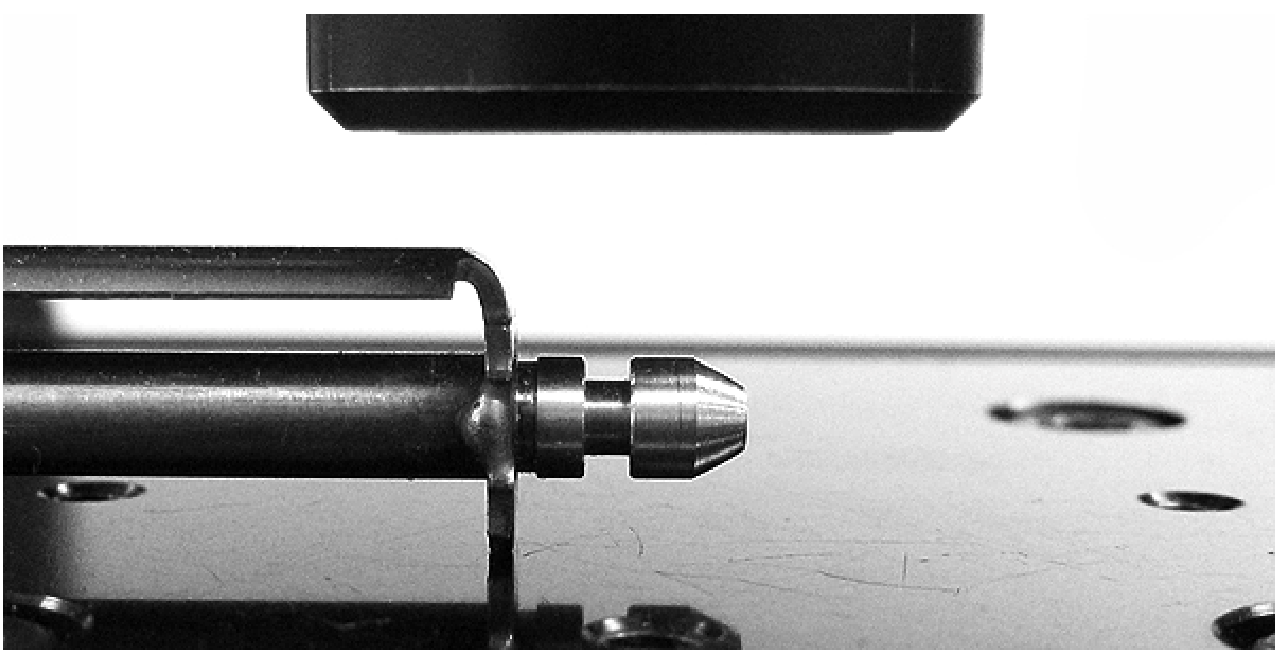
Precision machining needs to be precise, hence the name, which makes quality control absolutely critical to any process. There is always a chance of error and it is less expensive and more efficient to ensure quality before mass production. As parts become smaller and precision expectations increase, the need for advanced and reliable measurement inspection capability becomes a requirement.

IMPORTANCE OF 3D NON CONTACT PROFILOMETER FOR MACHINED PARTS

Utilizing white light chromatic confocal technology, the Nanovea Profilometer has superior capability to measure nearly any material by providing true raw data of measurement points without software manipulation. That includes measurement of unique and steep angles, reflective and absorbing surfaces found within the broad range of machined parts. The Nanovea Profilometer provides a full 3D image to give a more complete understanding of surface features. Without this capability, identification of machined surfaces would rely either on slower 2D contact information or high cost imaging techniques, including Interferometry, where the software manipulates lost measurement data points making results questionable. Understanding the full range of the surface characteristics (dimension, shape and roughness among many others) will be critical to successful precision machining; as will the technique chosen to achieve precision control.

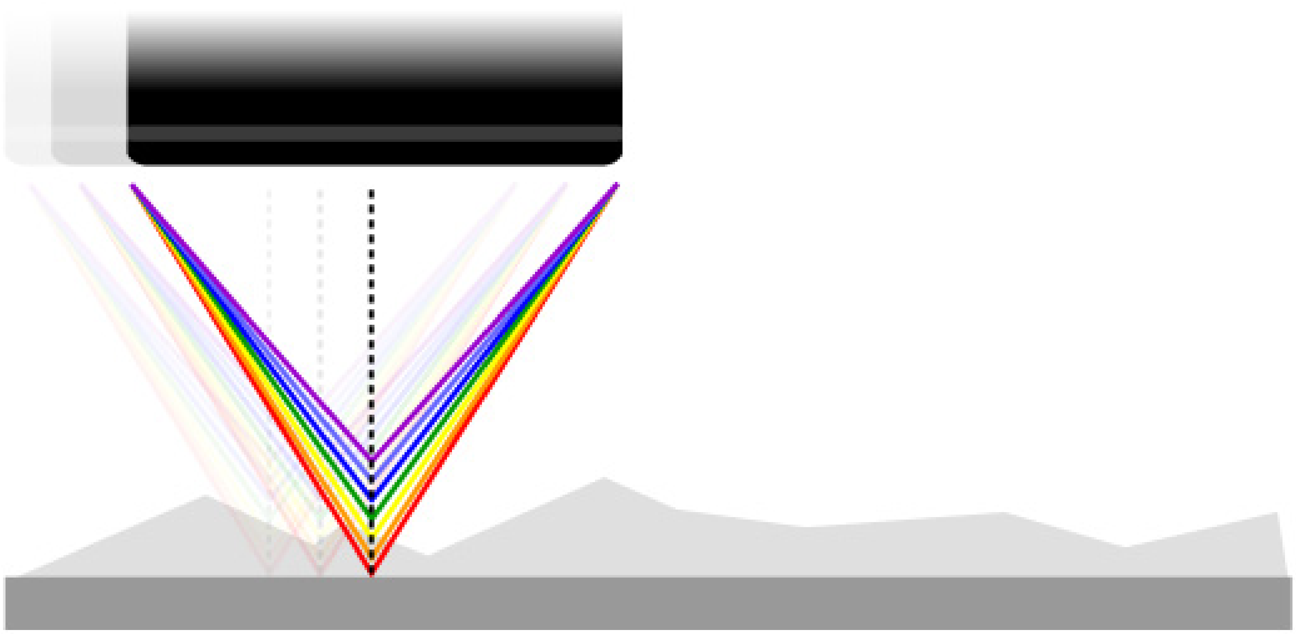
MEASUREMENT OBJECTIVE

In this application, the Nanovea ST400 is used to measure the surface of precision machined part with varying dimensions. There is an endless list of surface parameters that can be automatically calculated after the 3D surface profile. Here we will review the 3D surface and select areas of interest to further analyze, including dimension, radius, roughness and others.



MEASUREMENT PRINCIPLE:

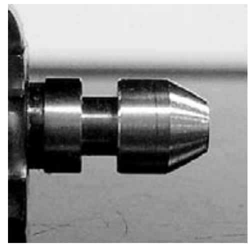
The axial chromatism technique uses a white light source, where light passes through an objective lens with a high degree of chromatic aberration. The refractive index of the objective lens will vary in relation to the wavelength of the light. In effect, each separate wavelength of the incident white light will re-focus at a different distance from the lens (different height). When the measured sample is within the range of possible heights, a single monochromatic point will be focalized to form the image. Due to the confocal configuration of the system, only the focused wavelength will pass through the spatial filter with high efficiency, thus causing all other wavelengths to be out of focus. The spectral analysis is done using a diffraction grating. This technique deviates each wavelength at a different position, intercepting a line of CCD, which in turn indicates the position of the maximum intensity and allows direct correspondence to the Z height position.



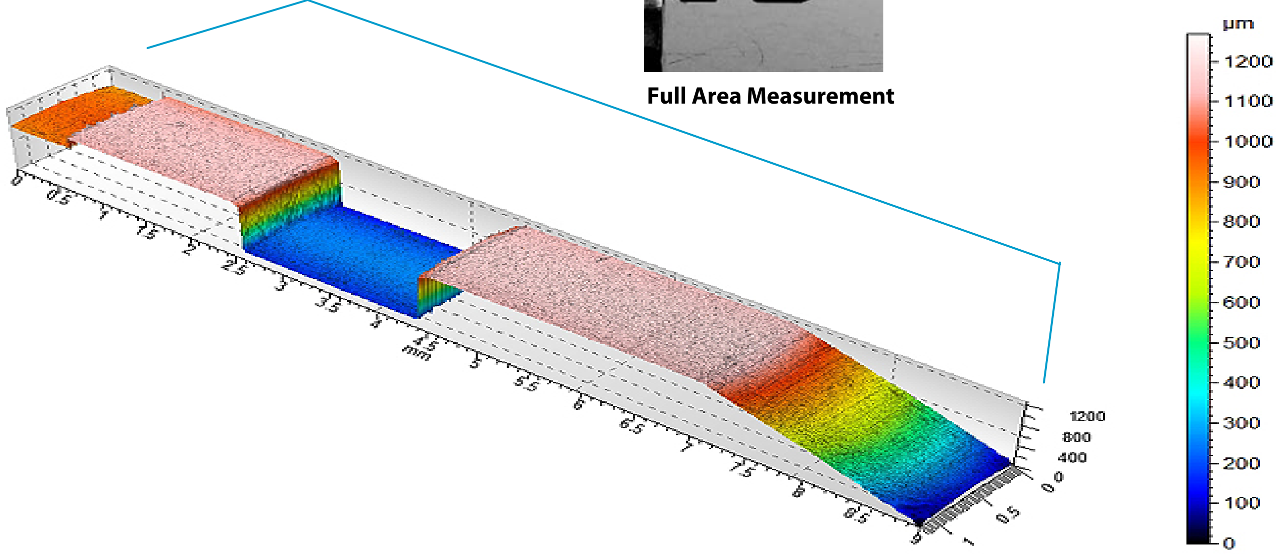
Nanovea optical pens have zero influence from sample reflectivity. Variations require no sample preparation and have advanced ability to measure high surface angles. Capable of large Z measurement ranges. Measure any material: transparent/opaque, specular/diffusive, polished/rough. Measurement includes: Profile Dimension, Roughness Finish Texture, Shape Form Topography, Flatness Warpage Planarity, Volume Area, Step-Height Depth Thickness and many others.

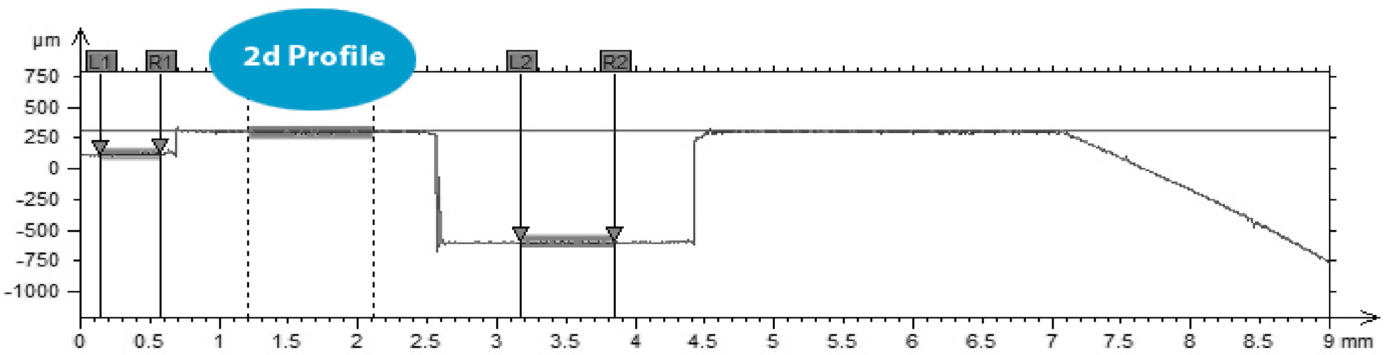
RESULTS:

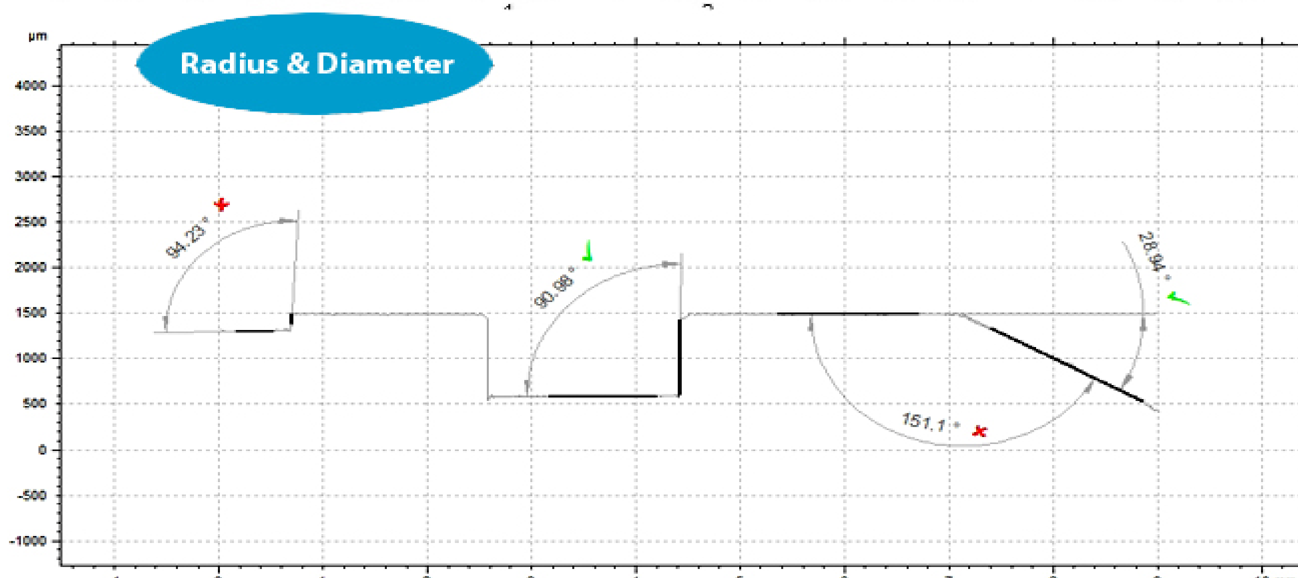
Full Area Measurement:



Full Area Measurement

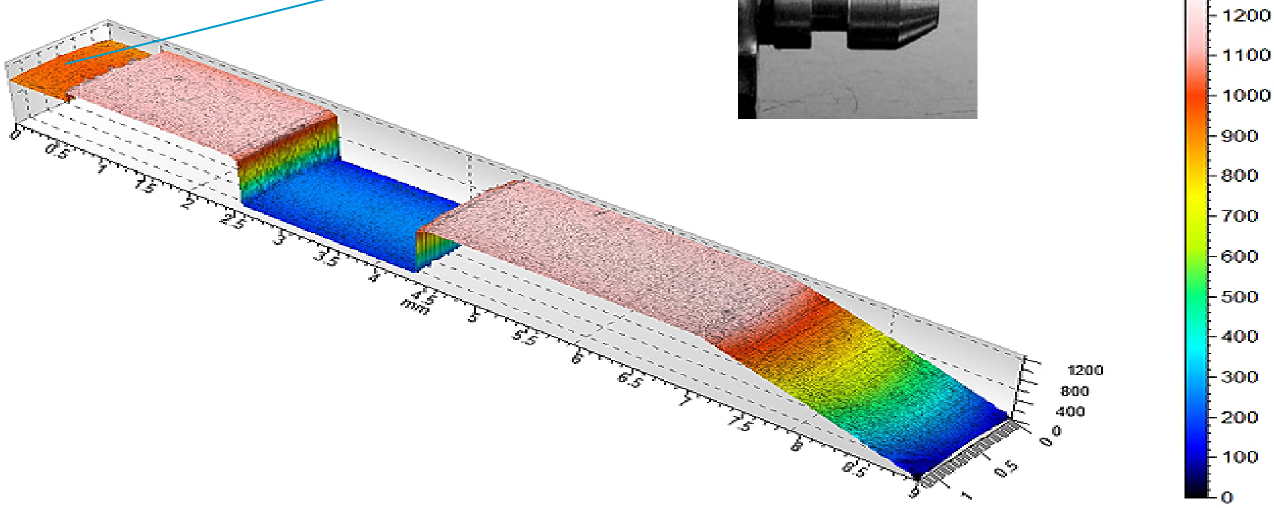


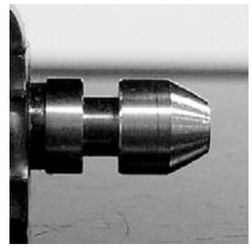


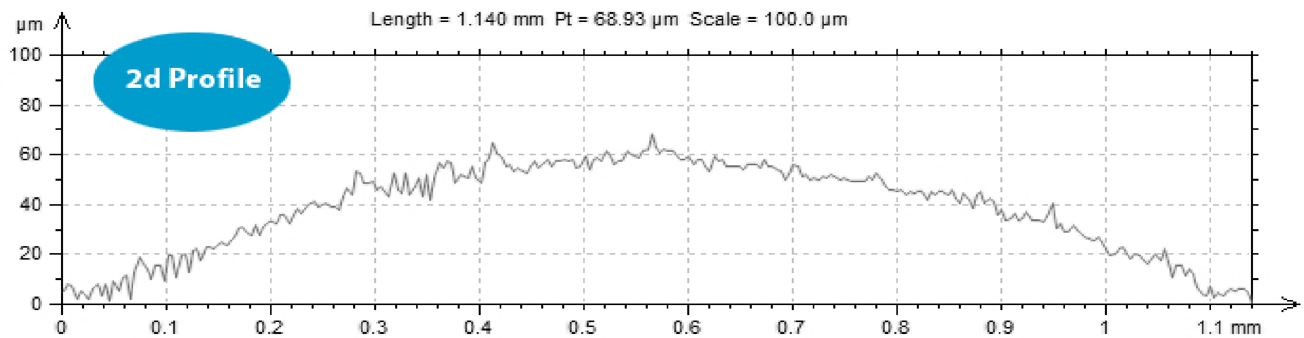


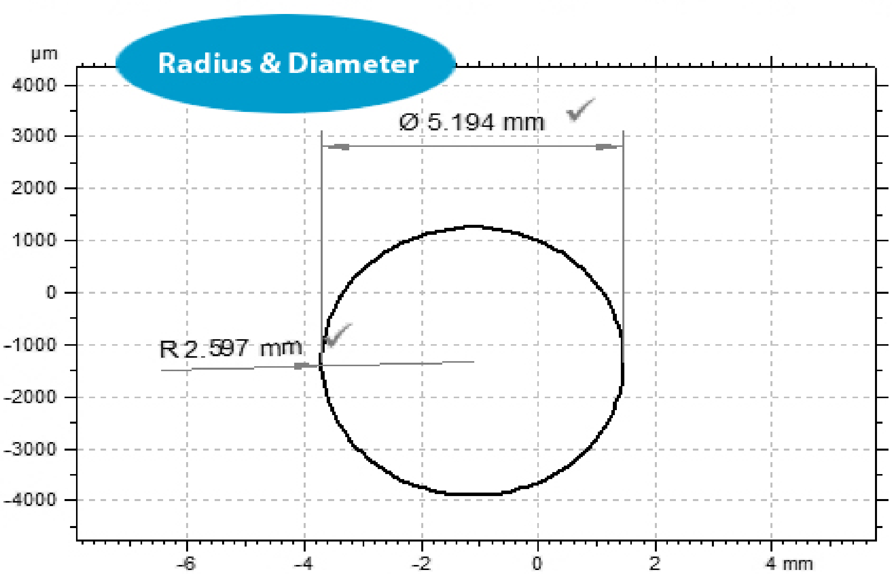
RESULTS:

Area #1:







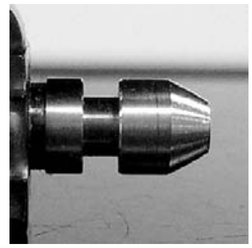


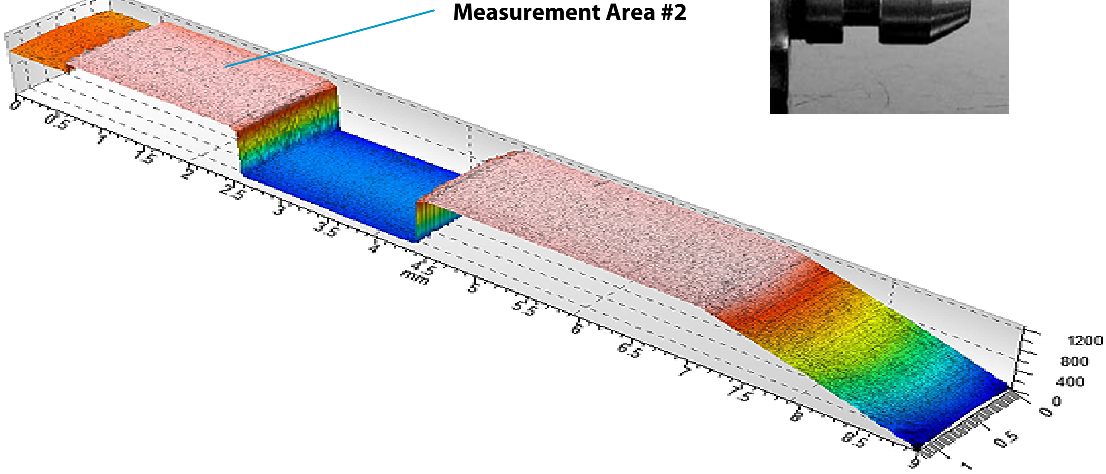
Roughness

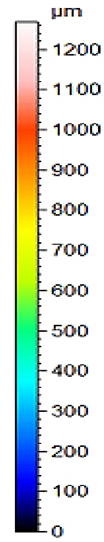
ISO 4287		
Amplitude parameters - Roug		
Rp	6.008	µm
Rv	3.973	µm
Rz	9.980	µm
Rc	4.472	µm
Rt	14.66	µm
Ra	1.454	µm
Rq	1.982	µm
Rsk	0.5845	
Rku	4.029	
Material Ratio parameters - F		
Rmr	0.4464	%
Rdc	2.684	µm

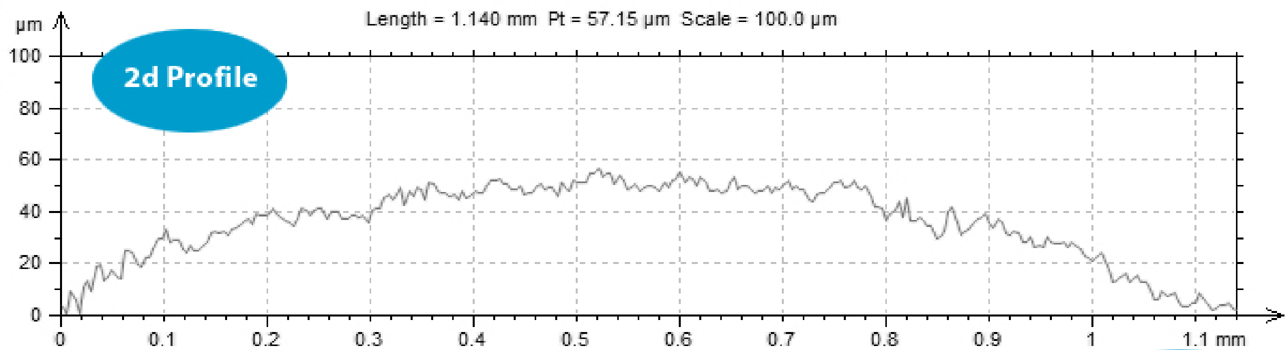
RESULTS:

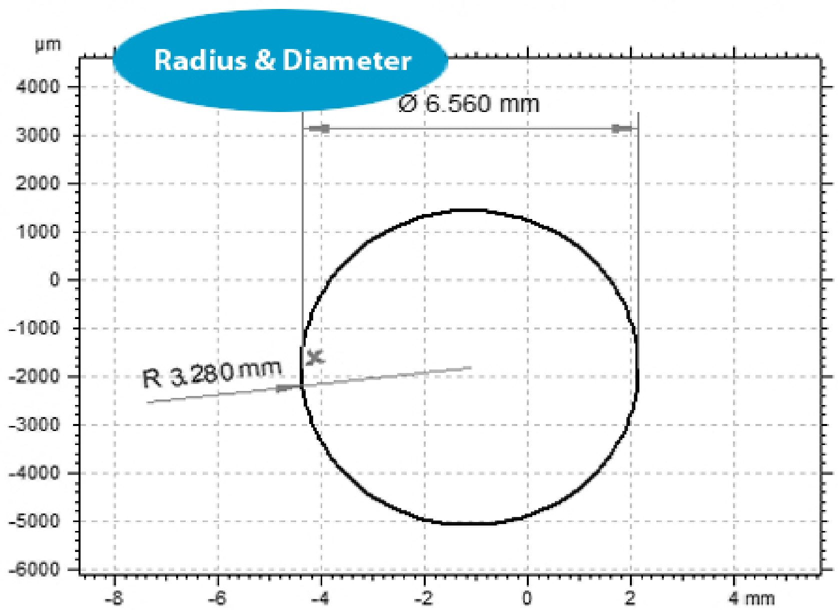
Area #2:









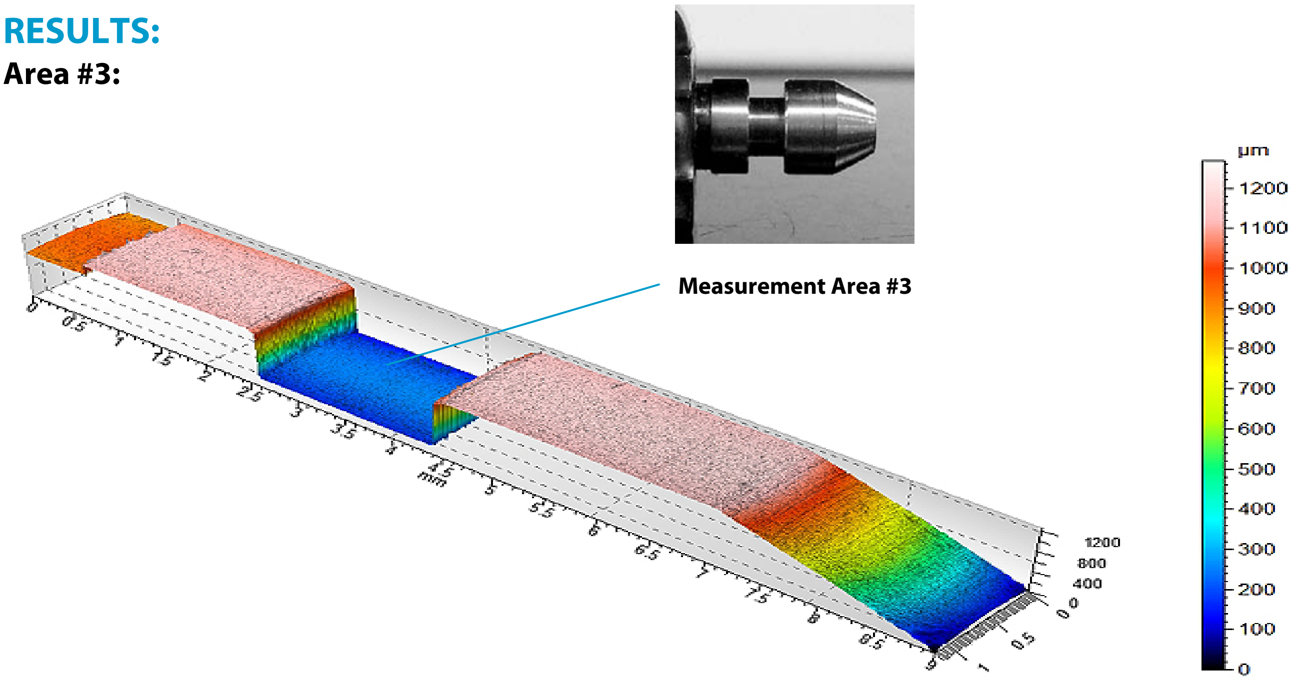


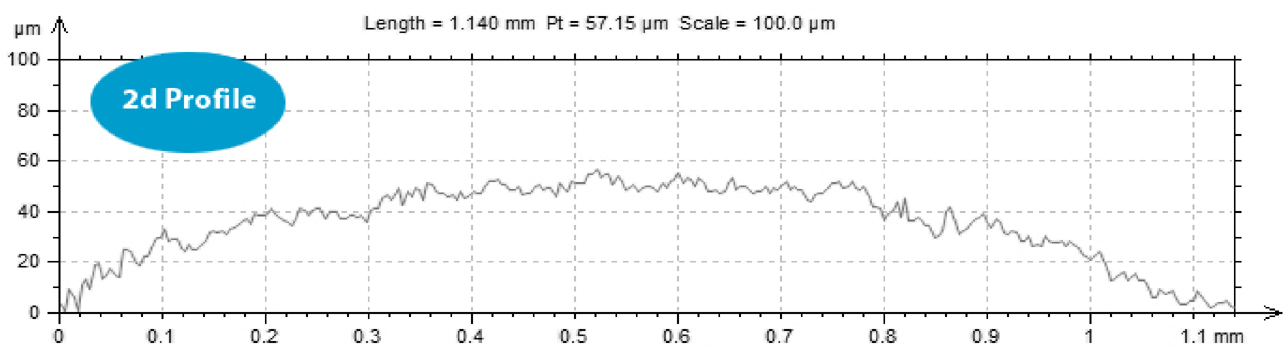
Roughness

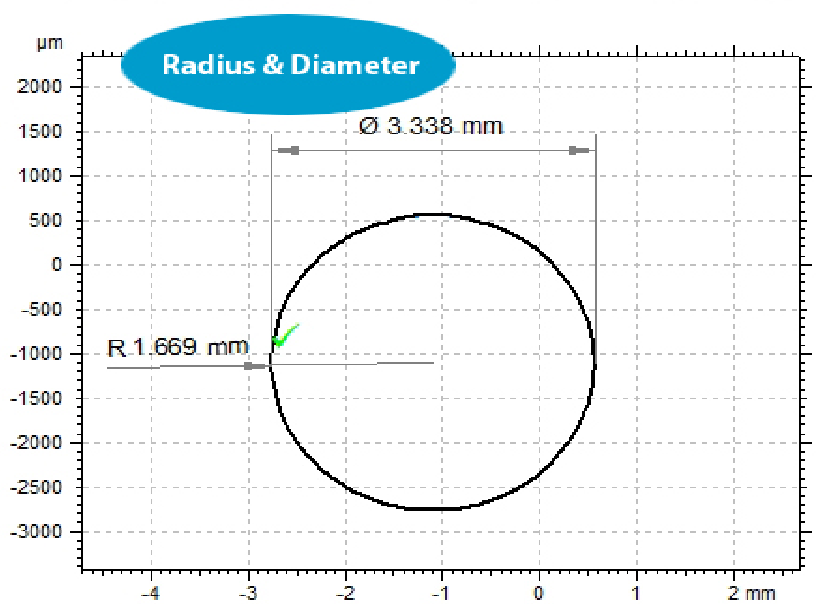
ISO 4287		
Amplitude parameters - Rou		
Rp	4.155	µm
Rv	4.804	µm
Rz	8.959	µm
Rc	5.933	µm
Rt	11.69	µm
Ra	1.881	µm
Rq	2.280	µm
Rsk	-0.127	
Rku	2.299	
Material Ratio parameters - I		
Rmr	1.786	%
Rdc	4.107	µm

RESULTS:

Area #3:







Roughness

ISO 4287		
Amplitude parameters - Roug		
Rp	5.263	µm
Rv	4.293	µm
Rz	9.556	µm
Rc	4.720	µm
Rt	13.44	µm
Ra	1.623	µm
Rq	2.030	µm
Rsk	0.1270	
Rku	3.066	
Material Ratio parameters - F		
Rmr	0.8929	%
Rdc	3.580	µm

CONCLUSION:

In this application, we have shown how the Nanovea ST400 3D Non Contact Profilometer can precisely characterize both the full dimensional profile and the nanometer roughness of the precision machined part. Here we have shown the broad measurement capability to control the important parameters of the part. From these 3D surface measurements, areas of interest can quickly be identified and then analyzed with a list of endless measurements (Dimension, Roughness Finish Texture, Shape Form Topography, Flatness Warpage Planarity, Volume Area, Step-Height and others). A 2D cross section can quickly be chosen to analyze further details. With this information precision machined parts can be broadly investigated with a complete set of surface measurement resources. It is important to note that all measurement seen here can be controlled for pass-fail inspection. The St400 can be equipped with machine vision to quickly select areas for inspection with either visual 2D or 3D measurements. Nanovea 3D Profilometer speeds range from 20mm/s to 1m/s for laboratory or research to the needs of hi-speed inspection, can be built with custom size, speeds, scanning capabilities, Class 1 Clean Room compliance, with Indexing Conveyor and for Inline or online Integration. To learn more about the Nanovea Profilometer.