



Application Note for Defence Industry

Measuring Barrel Straightness with NOVACAM™ Non-Contact 3D Metrology Systems

Introduction

Gun barrel straightness is a key contributor to weapon accuracy and therefore also a key requirement in the manufacture of all calibers, including barrels with rifling. NOVACAM™ non-contact 3D metrology systems provide fast and highly repeatable straightness¹ measurements on all sizes of barrels, whether they are smoothbores or rifled bores.

Straightness Measurement – Precise, Efficient, Automated

NOVACAM TUBEINSPECT 3D metrology system measures barrel straightness **with sub-micron precision and accuracy** using a small-diameter optical scanning probe. The probe easily enters the bore to acquire 3 or more circular measurement profiles at selected depths inside the barrel. From the obtained 3D point cloud, GD&T software calculates the axial straightness of the barrel (Figure 1).

The measurement, analysis and reporting process is **fully automated**, with the operator simply pressing a start button. **The process takes seconds or minutes**, depending on the barrel length and the number of circular profiles.

Straightness Measurement Precision Better than 0.5 µm (0.02 thou)

Notably, the precision of straightness measurements with the TUBEINSPECT system is < 0.5 µm (0.00002"). Precision (measurement repeatability) is expressed here as standard deviation of test results.

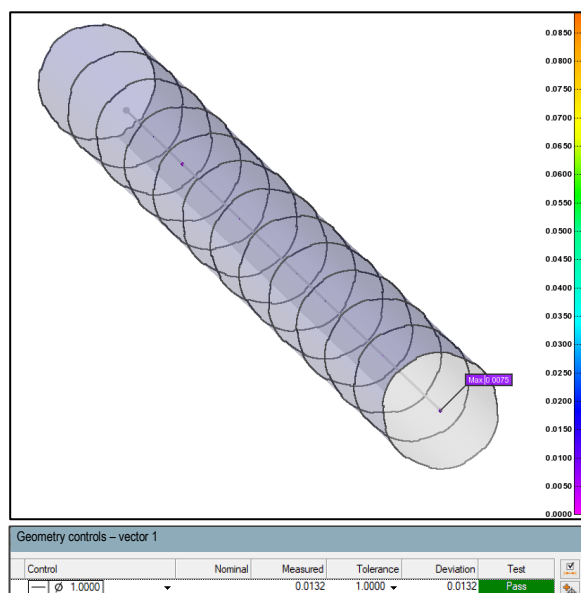


Figure 1: Once the TUBEINSPECT system acquires the 3D point cloud data, PolyWorks® Inspector is used to calculate and report the centerline axis straightness.

Example: GD&T straightness was measured on a 220 mm long section of a 22 caliber (5.6 mm diameter) barrel. An ID circumferential profile was acquired every 20 mm. The measurement was repeated 10 times. The following results were obtained:

Pass #	Bore 1 straightness	
	(µm)	(inches)
1	16.5932	0.000653276
2	16.6601	0.000655910
3	16.4591	0.000647996
4	16.6170	0.000654213
5	16.3722	0.000644575
6	16.5454	0.000651394
7	16.7292	0.000658630
8	17.1656	0.000675811
9	16.4850	0.000649016
10	16.5103	0.000650012
Standard deviation	0.21976	0.00000865209

¹ In this document, barrel straightness is defined as the straightness of the barrel centerline axis.

Centerline Axis Useful to Measure Chamber Coaxiality

For some TUBEINSPECT system users, the centerline axis obtained above as part of bore straightness measurement also serves as a datum for chamber measurements, particularly for measuring chamber coaxiality.

Technology Advantages

The TUBEINSPECT system is based on low-coherence interferometry, which offers:

- Fast, precise, and easily automated ID measurements
- Higher sensitivity, micron resolution, and excellent repeatability compared to triangulation or chromatic confocal
- Immunity to ambient lighting and higher sensitivity compared to laser interferometry.

Higher sensitivity enables measurement and imaging of even some angled surfaces.

System Features & Benefits

The TUBEINSPECT system comes preconfigured with a NOVACAM Barrel Analysis PolyWorks

package for automated barrel and rifling inspection reporting. The system is a standard off-the-shelf product that provides:

- Micron-precision measurements
- High speed of measurement - up to 100,000 3D point measurements per second
- Non-contact measurements of barrel ID dimensions: straightness, roundness, concentricity, runout, widths and IDs of rifling lands and grooves, flank angles, twist rate (standard and progressive), polygonal rifling, chamber features, and more.

Bonus measurements that can be obtained with the same system and probe include:

- Surface defects, roughness, chatter
- Outside diameter (OD) of barrels
- OD of reamers, mandrels and other barrel machining tools.

Conclusion

Novacam encourages technicians and engineers in charge of barrel manufacturing and quality control to contact us to discuss your barrel inspection applications and metrology challenges.

NOVACAM™ 3D metrology systems for ID straightness measurement

System name	Type of optical sensor	Straightness measurement of	Range of calibers	Barrel Length*
TUBEINSPECT™ system	Side-looking probe	ID and/or OD	0.172" (4 mm) to 3.5" (90 mm)	Up to 40" (1,000 mm)
BOREINSPECT™ system	Side-looking rotational probe	ID	0.172" (4 mm) to 3.5" (90 mm)	Up to 12" (300 mm)

* The listed barrel lengths are measured with standard probe models. Probes with non-standard lengths are custom-built upon request. Custom probes as long as 2 m have been built.

Notes:

- Each NOVACAM system includes a MICROCAM™-3D/4D interferometer (19" rack-mountable instrument) and a mini desktop-size PC or laptop that hosts NOVACAM data acquisition software and, typically, PolyWorks® Inspector GD&T software for 3D data analysis
- Watch a short video on bore ID measurement measurements with the TUBEINSPECT system:
<https://www.novacam.com/resources/novacam-metrology-videos/3d-tube-id-measurement-video/>

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