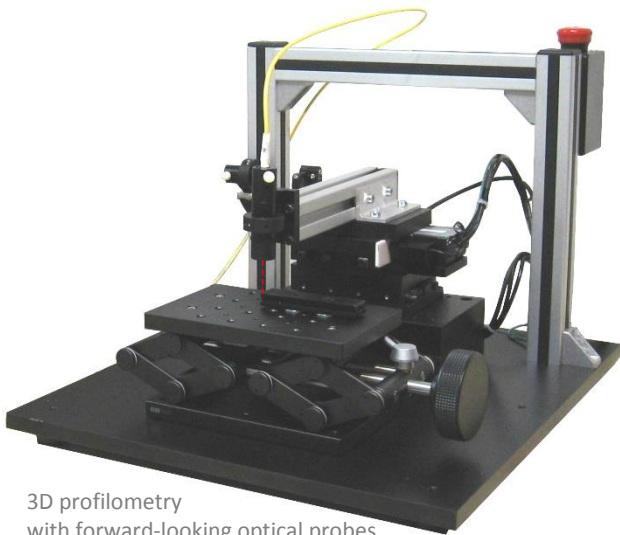
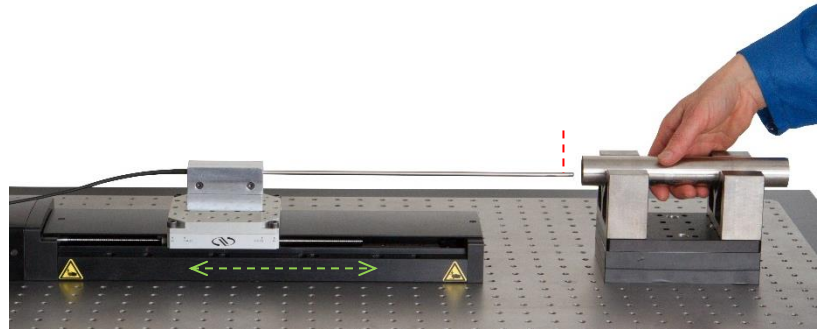


# OPTICAL 3D PROFILOMETER™ system

For non-contact 3D surface and thickness measurements



3D profilometry with forward-looking optical probes



3D profilometry in hard-to-reach spaces (e.g., bore ID) with side-looking optical probes

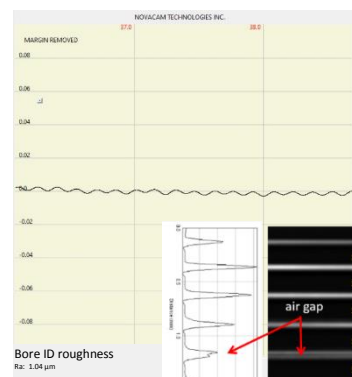
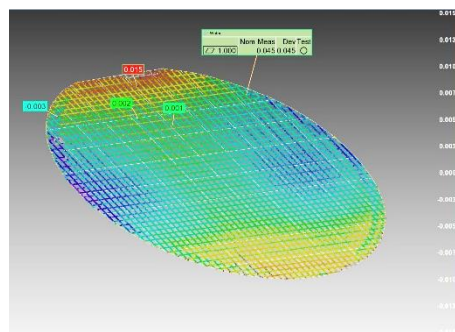
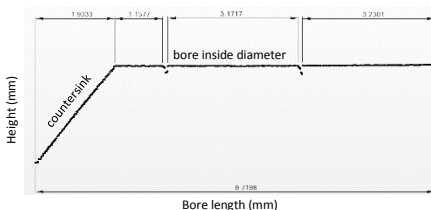
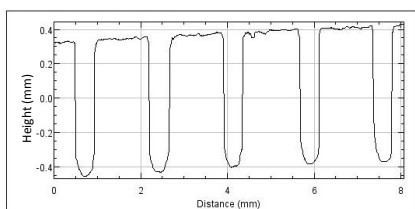
Probes may be integrated with precision stages, third-party CMMs, CNC machines or robots to support high-volume continuous flow manufacturing.

✓ Wide range of micron-precision 3D measurements on inside or outside surfaces

- 3-dimensional geometry - GD&T parameters
- Roughness measurement
- Defect detection - cracks, scratches
- Thickness measurement of semi-transparent material coatings

✓ Fully configurable automated inspection

✓ Fiber-based probes easily integrated in fully automated & robotized inspection setups



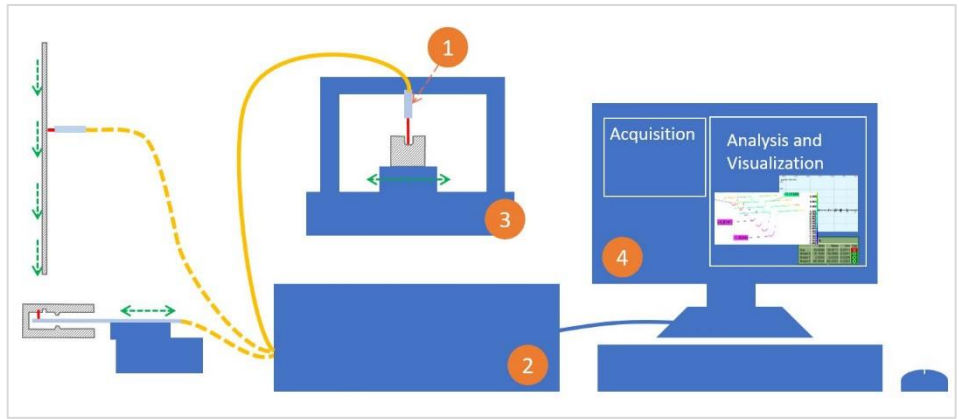
# System Benefits

- ✓ **3D measurements of dimensional profiles, roughness, defects, and thickness – all with the same probe**
- ✓ **Measures high-aspect-ratio features such as undercuts, cross-holes, chamfers, rifling, threads, O-ring grooves, and edges**
- ✓ **Reduced inspection cycle time:** up to 100,000 measurements per second, each representing a 3D topographic point
- ✓ **Flexible options for evaluating inspected parts with third party software:** measured features can be compared to CAD or to user-defined set of locations, nominals, and tolerances
- ✓ **Simple scan definition and execution:** The scanning sequence defined by programming the system with a joystick
- ✓ **Time-saving automated reporting:** Following a scan, go-no-go reports can be produced automatically, and results logged in a manner compatible with industry-standard mechanisms
- ✓ **Adaptable to hostile environments:** radioactive, very hot, cryogenic, vacuum, etc.
- ✓ **No need for expensive consumables:** Optical probes do not wear out like contact probes.

# System components

NOVACAM™ OPTICAL 3D PROFILOMETER™ system is a modular fiber-optics based system comprising:

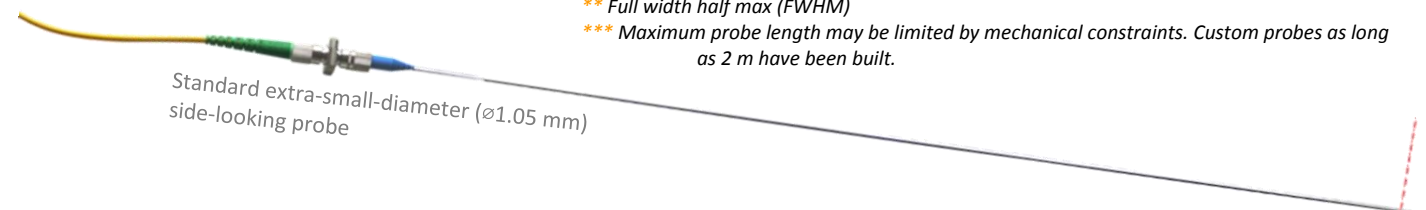
- (1) Optical forward-looking or side-looking probe
- (2) MICROCAM™ interferometer
- (3) Inspection station
- (4) PC
- (5) Motion controller(s) (not shown) and, optionally,
- (6) multiplexing hardware (not shown)



## 1 Optical probes

The forward- and side-looking probes may be mounted on various motion stages or installed next to a moving surface to acquire long profiles.

### Examples of NOVACAM probes



### Standard probe characteristics\*

Type of probe	Probe diameter (mm)	Maximum standoff (mm)	Typical spot size** (µm)	Probe length (mm)
Forward-looking probes	17.8	68	2.2 to 23	50-300***
Side-looking probes	0.55	0.5	4 to 25	
	1.05	1		
	2.4	1.3		
	3.05	4.8		
	4.6	15		
	17.8	54		

\* Custom probes with non-standard diameters (such as ø8.8 or ø30.5 mm), lengths, spot sizes, and light beam angles (different from the standard 90°) or for extreme temperatures, high pressures, or other hostile environments are built upon request.

\*\* Full width half max (FWHM)

\*\*\* Maximum probe length may be limited by mechanical constraints. Custom probes as long as 2 m have been built.

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## MICROCAM™ interferometer

The interferometer provides the light source to the optical probe and processes the optical signal received from the probe. The probe and the interferometer are connected with an optical fiber.



### MICROCAM interferometer models

	MICROCAM-3D		MICROCAM-4D
<b>General characteristics</b>			
Technology	low-coherence interferometry		
Light wavelength	1310 nm, infrared		
Size of interferometer enclosure box (depth x width x height)	4U rackable enclosure 445 x 445 x 178 mm		
<b>Non-contact measurements</b>			
Scanning depth range options*	3.5 mm	7 mm	5 mm
Acquisition (A-scan) rate	2.10 kHz	1.05 kHz	100 kHz
Axial (Z-axis) resolution	< 0.5 $\mu\text{m}$		
Light spot size (Lateral [XY-axis] resolution)	2.2 - 146 $\mu\text{m}$ , typically 2.2 to 25 $\mu\text{m}$		
Standoff distance	0.5 - 100 mm for standard probes, up to 1 m for non-standard probes		
Repeatability**	< 1 $\mu\text{m}$		
<b>Thickness measurements</b>			
Thickness measurement range (optical in air)	10 $\mu\text{m}$ - 3.5 mm	10 $\mu\text{m}$ - 7 mm	20 $\mu\text{m}$ - 5 mm
Typical materials for thickness measurements	glass, polymers, multi-layer films, coatings, plastics, silicone, liquids, specular or non-specular		
Sample reflectivity	0.1 - 100%		

\* To further increase maximum scanning depth, a mechanical displacement axis is available.

\*\* The stated repeatability pertains to a system where the optical sensor is not moving with respect to the measured surface. The repeatability of the motion mechanism is usually bigger; this can be effectively addressed by the use of a glass reference plate.

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## Inspection station

Inspection station configurations are application-dependent and can be supplied by Novacam. Fixturing for the part is not included.

**For lab and shop floor inspection**, profilometer inspection stations typically include probe displacement in 1, 2, or 3 axes. Granite tables are optionally available and recommended for some applications.

**For automated inline industrial inspection**, the probes may be integrated with precision stages, third-party CMMs (coordinate-measuring machines), CNC (computer numerical control) machines, or robots to support high-volume continuous flow manufacturing.

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## PC, monitor and joystick

The OPTICAL 3D PROFILOMETER system comes with a PC, monitor, mouse, and joystick.

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## Motion controller(s)

Motion controllers are included. Depending on the number of additional motion axis required, the motion controller(s) are housed in a 2U, 3U, or 4U rackable enclosure.

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## Hardware for multiplexing support (optional)

Optical switches are available for multiplexing up to 8 probes to a single MICROCAM interferometer. Multiplexed probes may be used one at a time. This option brings additional return on investment (ROI) to many installations.

# System software

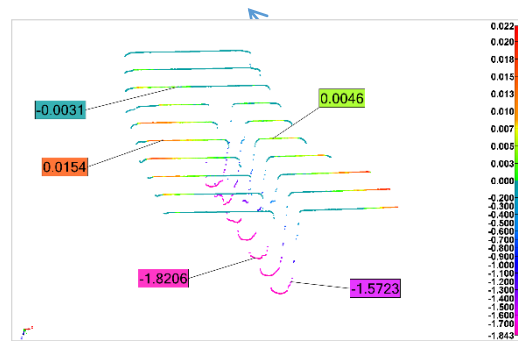
The 3D OPTICAL PROFILOMETER system comes with NOVACAM high-performance data acquisition software, which is PC, Windows®-based, and user-friendly for scan programming. The system simultaneously generates 3 data sets from the same scan: 3D point cloud, light intensity image, and height image. The height and light intensity images facilitate defect detection. STL file format is also available.

An application programming interface (API) is available for system integrators and OEMs to accommodate a wide variety of online and offline applications. Exported results may be integrated with data loggers and SPC software.

A turnkey solution for full GD&T analysis of measured parts is available with InnovMetric PolyWorks® Inspector metrology software that may be purchased with the system. Go-no-go reporting is easily programmed and automated. Operators benefit from capabilities such as a quick visual comparison (deviation map) of the acquired part measurements to pre-specified tolerances or to the CAD of the part.

Visualizing the scan data may be accomplished by importing the data into third party visualization and numerical analysis software such as PolyWorks Inspector, Geomagic, ImageJ, SolidWorks, Octave, MatLab, Mathematica, IDL, or IGOR Pro.

Deriving application-specific measurements from the 3D point cloud is available through a selection of in-house and third-party software. Novacam supports the following options:



Multiple profiles of an EDM machined seal slot on an aerospace stator blade. Slot is ~ 30 mm (1.2”) long, 0.4 mm (0.0157”) wide and 1.8 mm (0.07”) deep. The 3D point cloud was viewed with PolyWorks® Inspector GD&T software.

## Data processing options

	Novacam in-house software	3 <sup>rd</sup> party software, such as
Dimensional measurements (GD&T parameters)		PolyWorks Inspector (turnkey solution), Geomagic
Roughness and surface analysis	✓	TrueSurf, MountainsMap
Thickness	✓	
Volume loss	✓	
Defects	Custom-developed*	

\* Novacam offers the option of custom data processing, reporting, and defect detection programs that can be written based on client requirements.

## Standard system configuration

- MICROCAM-3D interferometer
- Choice of
  - 1 standard ø17.8 mm forward-looking probe
  - OR
  - 1 standard ø4.6 mm side-looking probe (for ID up to 300 mm (12”) deep)
- 2-axis inspection station and 2-axis motion controller
- Manual adjustment of probe height
- PC with NOVACAM acquisition software
- 1-year warranty

## Instrument safety

NOVACAM OPTICAL 3D PROFILOMETER systems feature an in-probe red laser pointer (650 nm wavelength) for alignment purposes. The systems are Class 1M Laser products, with < 20 mW of infrared and < 5 mW of in-probe laser pointer.

**Novacam Technologies Inc.**  
 1755 Blvd. St Regis, Suite #130  
 Dollard-Des-Ormeaux, QC, H9B 2M9, Canada

For more information, email [info@novacam.com](mailto:info@novacam.com) / call 514-694-4002 / toll-free 1-866-694-4002 or visit [www.novacam.com](http://www.novacam.com)