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Usage of optical fiber in metrology – Applications in Hexagon products

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AGENDA

01 Hexagon Overview

02 Optical fibers in Hexagon products

03 Presentation of the newly released HP-O Solution

04 Automatic optical connection

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Hexagon in brief

- Scandinavian conglomerate with no core business
- Ola Rollén joins as President and CEO and identifies measurement technologies as a focus area

- when it has to be right

Leica Geosystems

- Strategic acquisition of Leica Geosystems expands Hexagon's measurement technologies to include both Metrology and Geosystems offerings

INTERGRAPH®

- Acquisition of Intergraph fulfils software gap, further strengthening measurement technology offerings
- Enables Hexagon to develop and provide integrated solutions

- 2000	2000 - 2004	2004 - 2006	2007 – 2009	2010 -2014	Vision

brown & sharpe

- Multiple measurement technology acquisitions, including Brown & Sharpe, begin to align business to strategy

NovAtel

- Acquisition of NovAtel adds core competences in GPS and inertial technologies
- Pursuit to streamline business portfolio complete
- Now a leading global measurement technology firm

Hexagon aspires to play a leading role in the effort to solve the challenges the world is facing through its **design, measurement and visualisation** technologies

Nearly **14 000 employees** in over **40 countries**
More than 3 000 employees engaged in R&D
More than **2 700 active patents** in patent portfolio

11% of net sales invested in R&D

2.4bn EUR turnover

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Overview of some Hexagon product ranges

Hexagon Geosystems

Industrial Theodolites & Laser Stations

Airborne sensors

Hexagon Metrology

CMMs

Sensors

Multisensor & Optical Systems

Portable Measuring Arms

Laser Tracker Systems

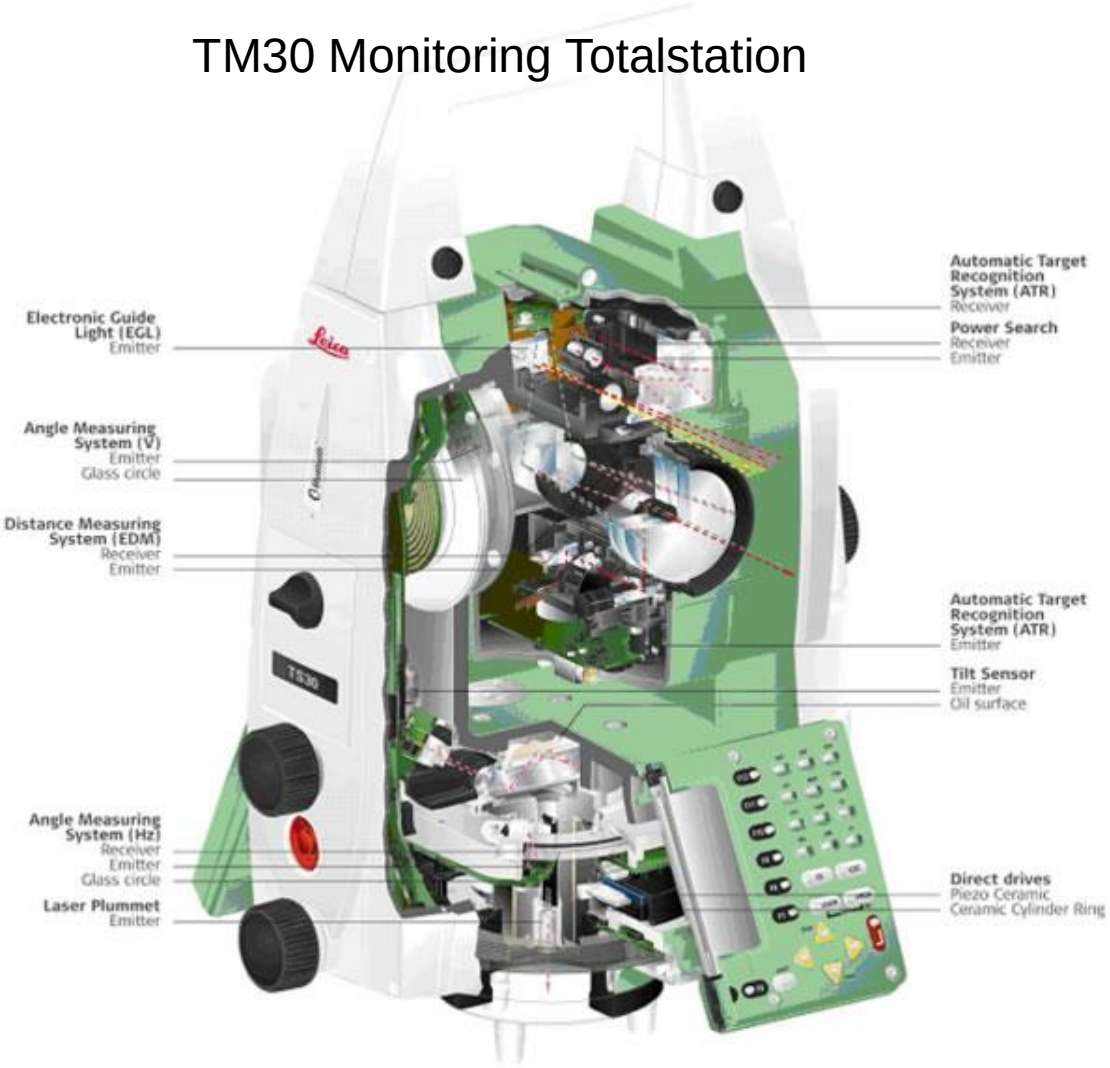
Confidential

Automated Solutions

02. Optical fibers in Hexagon Products

Well established free beam know-how in Hexagon

TM30 Monitoring Totalstation



Decades of experience in precision monitoring

So far, optics in Hexagon product were largely relying on free beam optics rather than fiber optics

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Which hexagon products use optical fibers ?

Hexagon Geosystems

Industrial Theodolites & Total stations

Fibered laser scanners

HDS 8810
(mine scanning)

ALS70
(airborne LIDAR)

Hexagon Metrology

Coordinate measurement machines (CMM) & sensors

Laser Tracker Systems

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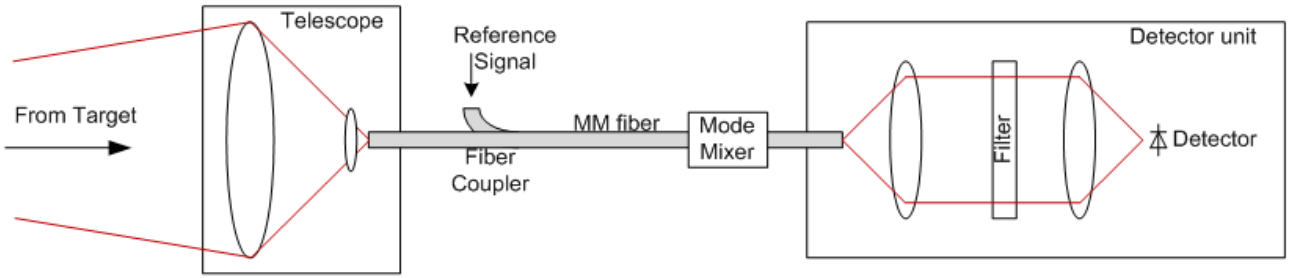
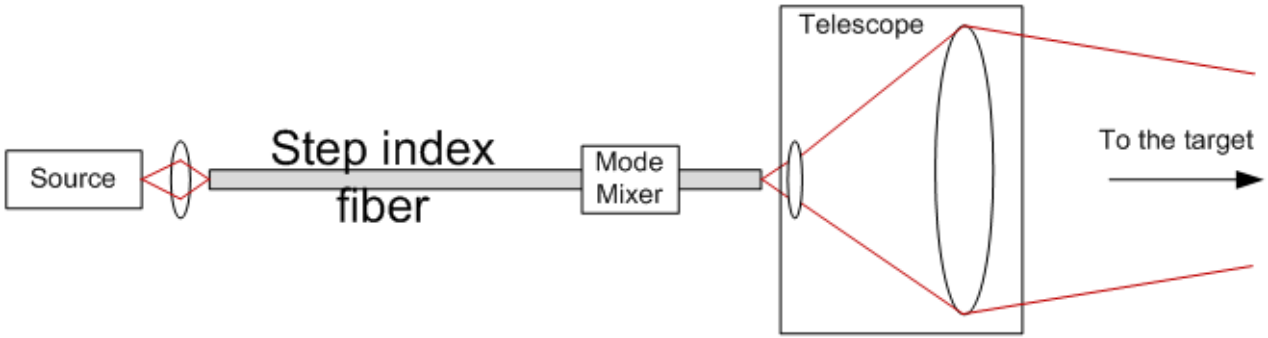
Optical fibers in Hexagon products: examples

1. Light collection for distance measurement



2. Generation of uniform illumination



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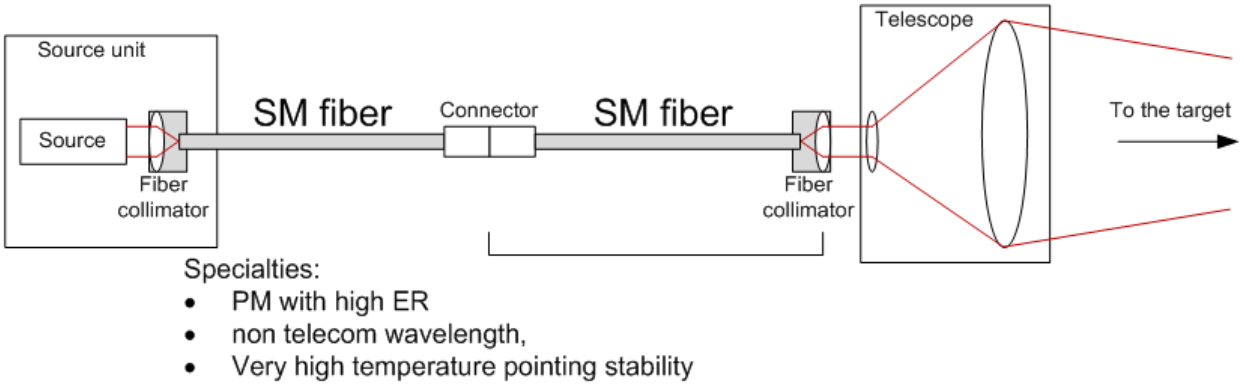
Optical fibers in Hexagon products: examples

3. DFB seed optical fiber amplifiers as pulsed laser source

4. Shifting light emission from one location to an other



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Optical fibers in Hexagon product : New technology

5. Fiber interferometers: newly released HP-O (Hexagon Probe – optical)

“New HP-O Solution from Hexagon Metrology 25 April 2014”
(Control Fair”, Stuttgart, Mai 2014)

“Optical measurement reaches new dimension. Speed, accuracy and accessibility change the rules for scanning.
Hexagon Metrology has launched the HP-O technology solution, a new scanning technology on stationary CMMs based on frequency-modulated interferometric optical distance measurement.”

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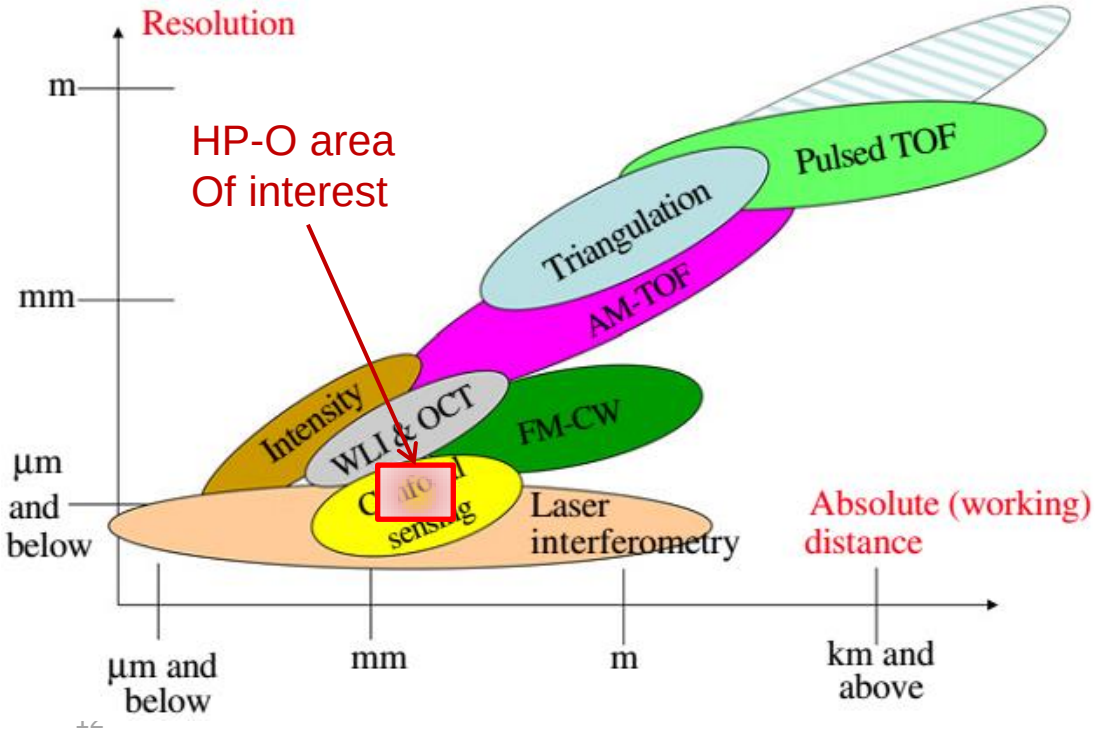
03. Presentation of the newly released HP-O Solution

Optical technologies competing in HP-O's "resolution vs distance" range of interest

- Chromatic confocal sensors
- Frequency modulated interferometry
- Laser interferometry (HeNe)
- Two wavelengths interferometry
- White light interferometry



Source: Advances in Optics and Photonics 4, 441–471 (2012), Garry Berkovic

Acronyms:

WLI = White light interferometry
TOF = Time of flight
FM-CW = Frequency modulated continuous wave
OCT = Optical coherence tomography

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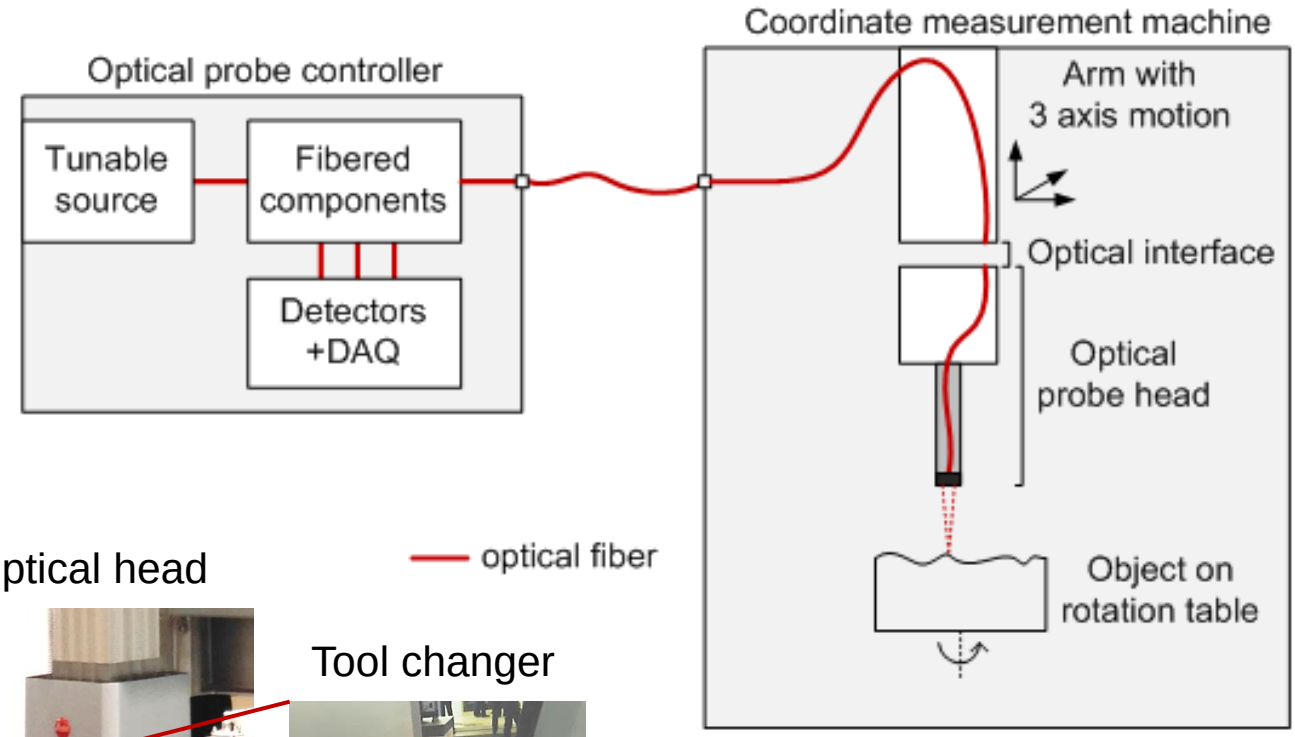
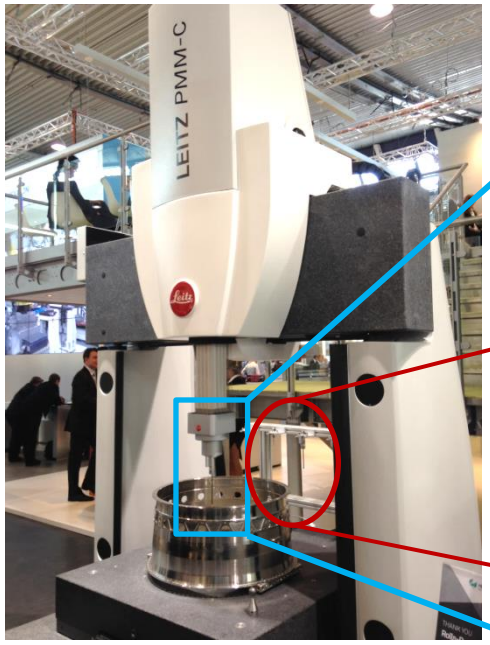
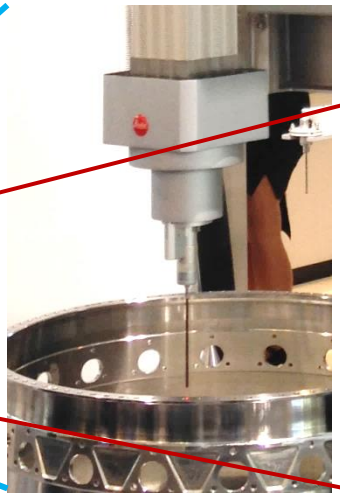
HP-O way of operation



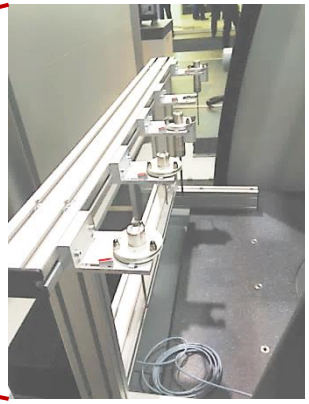
CMM



Optical head



Tool changer



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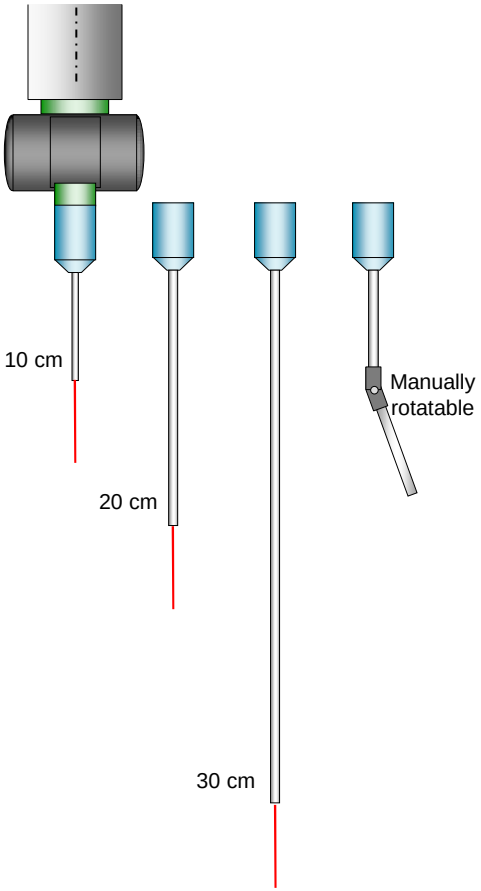
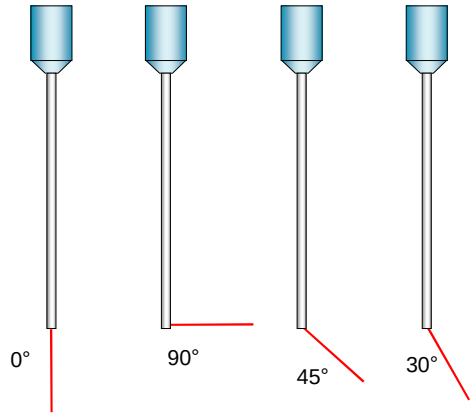
Optical probe head configurations proposed

Different stylus configurations

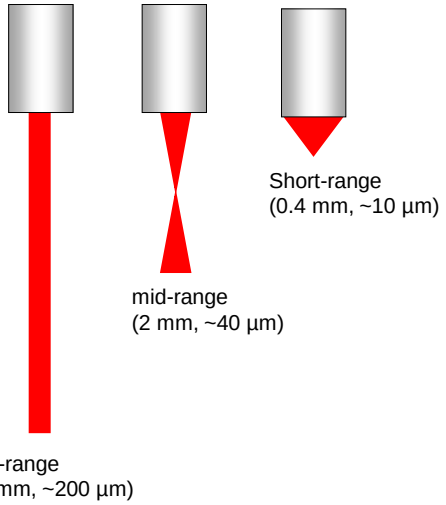


Different pointing directions



Different beam shapes

(measurement range, spot size)



All combinations are possible

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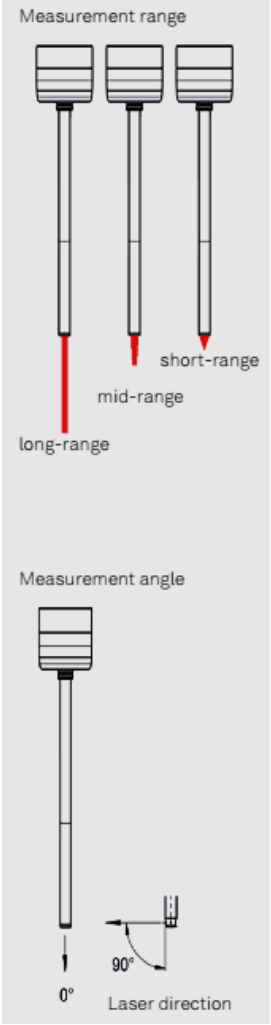
HP-O preliminary specifications (technical announcement)

HP-O Technical Specifications

Probe Type	frequency modulated interferometric optical distance measurement
Laser Wavelength	1550 nm
Laser Class	2
Probe Measurement Directions	0°, 90°
Probe Shaft Dimensions	~100 mm ø 3 / 5 mm
Probe Types	Fixed / Adjustable (3-joint)
Probe Weight	~190 g
Measurement range	± 10 mm long-range ± 1 mm mid-range ± 0.2 mm short-range
Working Distance	16/15 mm (0/90°) long-range 10.5/9.3 mm (0/90°) mid-range 6.5/4.3 mm (0/90°) short-range
Spot Size (in focus)	180 µm long-range 40 µm mid-range 11 µm short-range
Acceptance Angle (rough metal surface)	± 10° long-range ± 30° mid-range ± 30° short-range
Acceptance Angle (mirror surface)	± 0.3° long-range ± 1° mid-range ± 4° short-range
Resolution	0.9 nm
Repeatability on an optical surface	0.2 µm (3 σ)
Crash Protection	x,y,z via spring force of stylus module
Output signal	digital 24-bit via USB
Styli lengths	100mm



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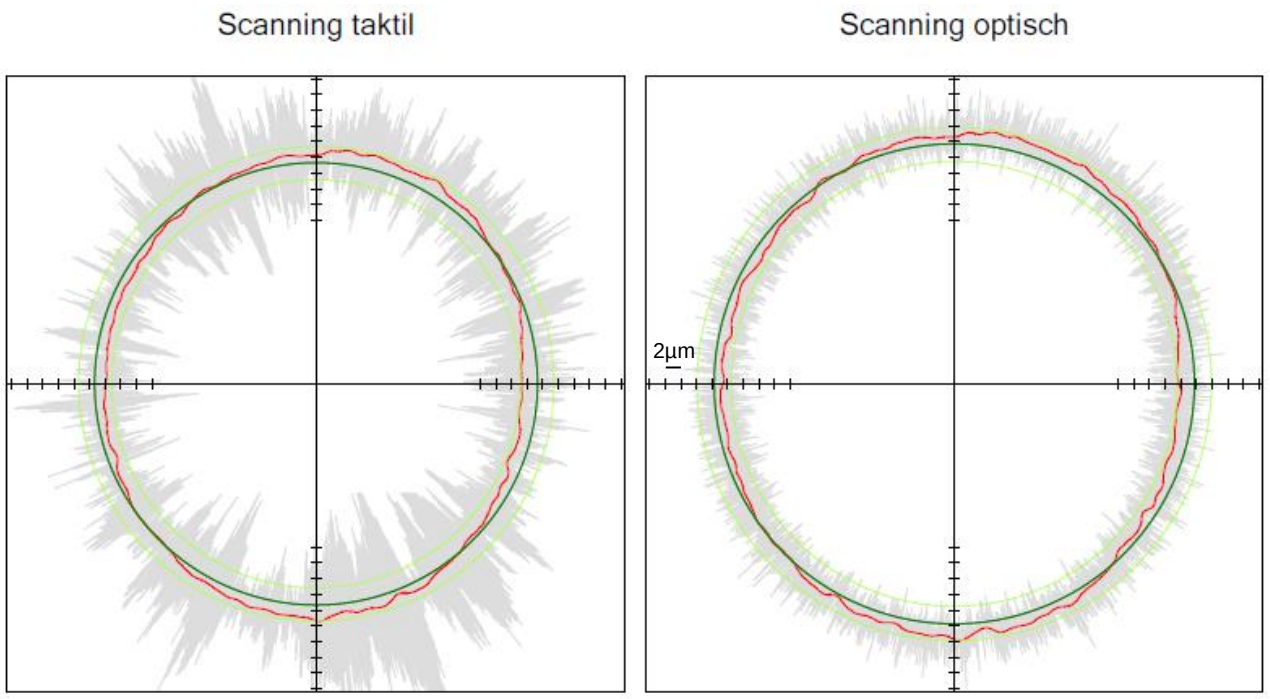
HP-O measurement example: Tactile vs optical measurement

Object measured: turbine housing, Ø25.8cm scanned at 20mm/s.

Filter: moving average on 50 datapoints.



Raw Data

Filtered measurement

Ideal form (circle)

HP-O measures the same “form error” of 4µm than a tactile machine

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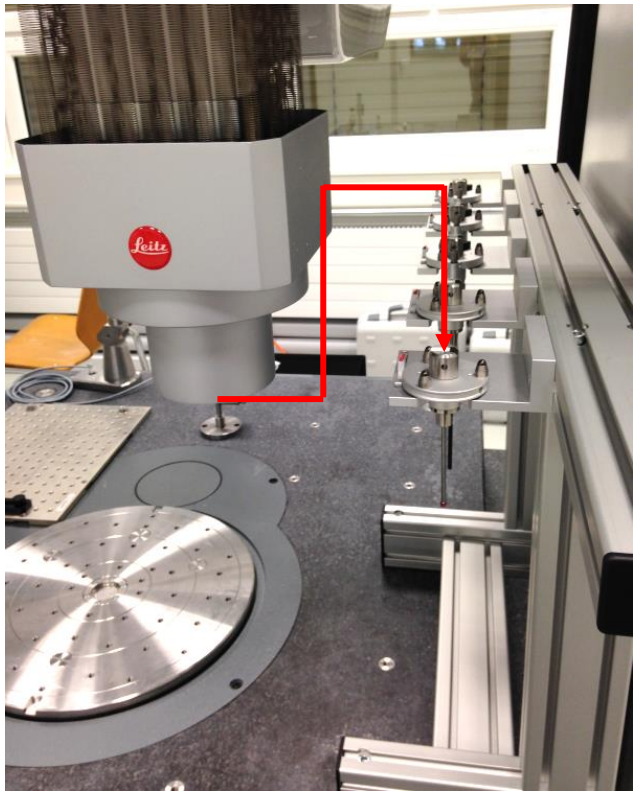
04. Automatic Optical Connection

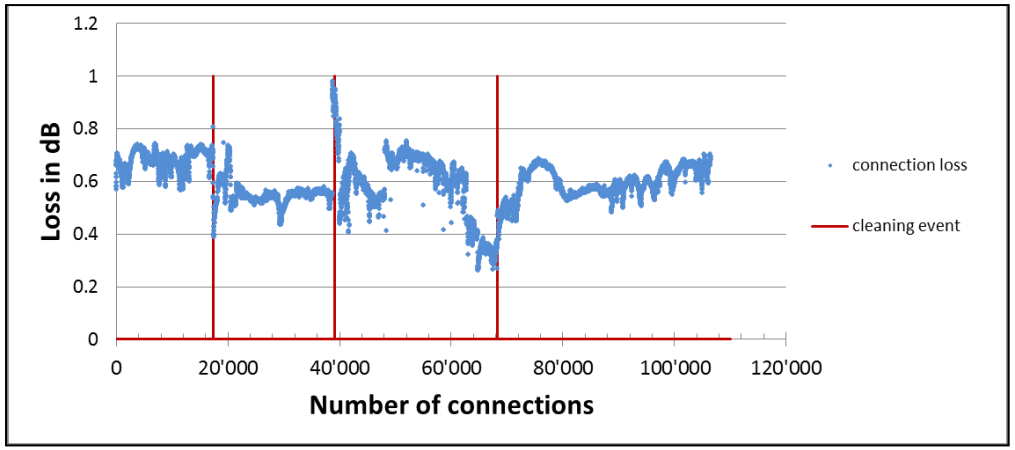
Optical connection test with an automatic arm

The automatic connection of the optical head requires to be specified for 100’000 connection cycles, where standard connectors are typically specified for 1’000 manual connections only



Connection challenges:

- Transmission still high after 100’000 connection (loss <~1dB)
- Connector cleaning methodology: when and how to clean both interface sides ?



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Summary

- Examples review of fiber assemblies used in Hexagon
- Presentation of the new HP-O solution for CMMs (coordinate measurement machines)
- Automatic pickup of optical probes, allowing 100’000+ connections