

Leica's Pinpoint EDM Technology with Modified Signal Processing and Novel Optomechanical Features

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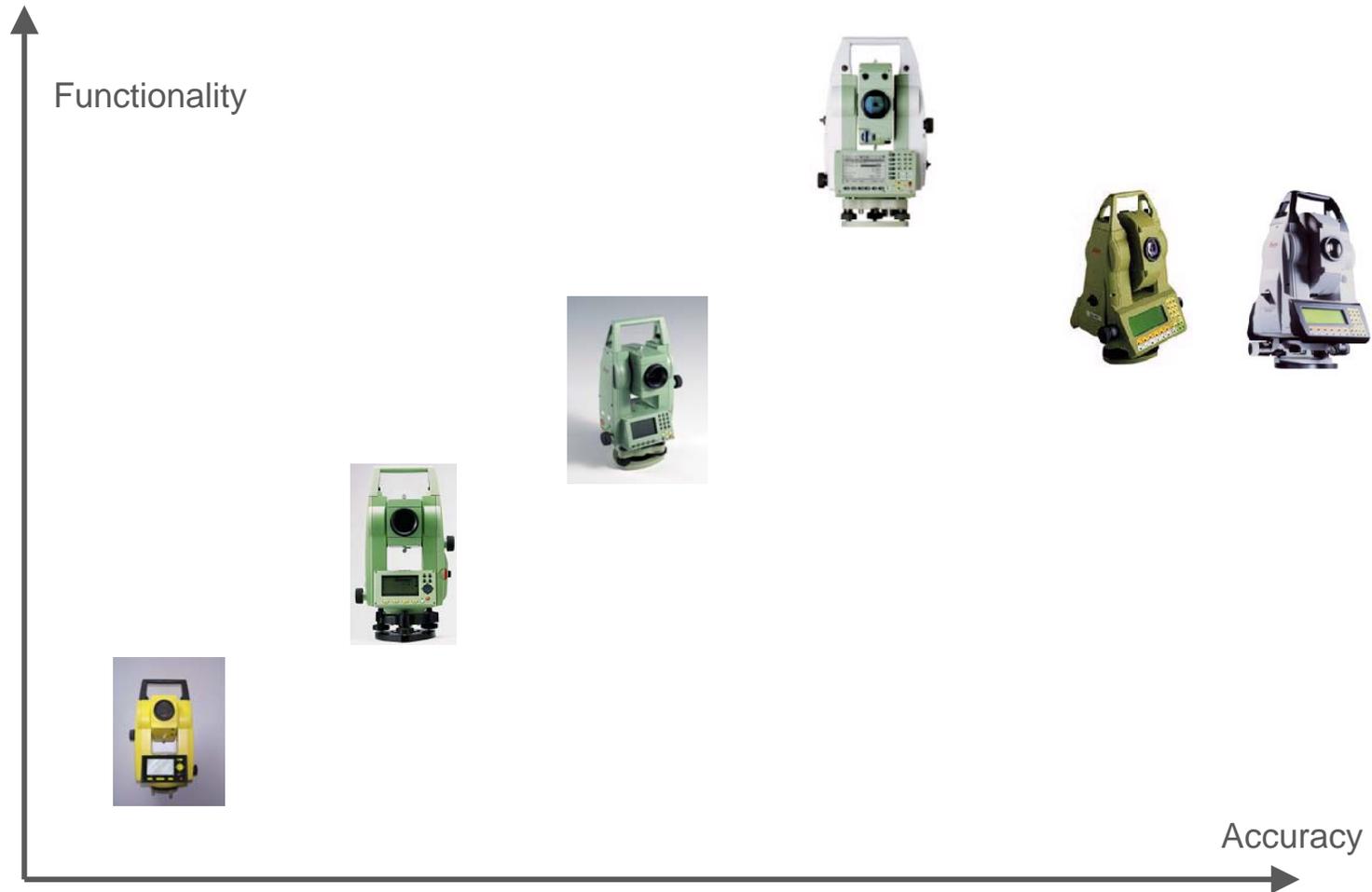
▪ New Optomechanical features

▪ Conclusions

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Leica's Total Station



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Leica's Telescope

- High quality optics
- Accurate reflector, reflector-less and long range EDM
- Automated prism finding
 - Automatic Target Recognition (ATR)
 - Power Search (PS)
- Small and coherent laser spot
- Emitted Guiding lights (EGL)

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ATR

- Emits infra-red light while video-imaging is on
- Locates reflected light
- Steers the cross-hair to the lightened spot until the angular offset is less than 50 cc (16 arcsec)
- Measures angle and distance

In case there are more than one reflecting spot, the emitter goes on and off to find the activated prism



Emitter on

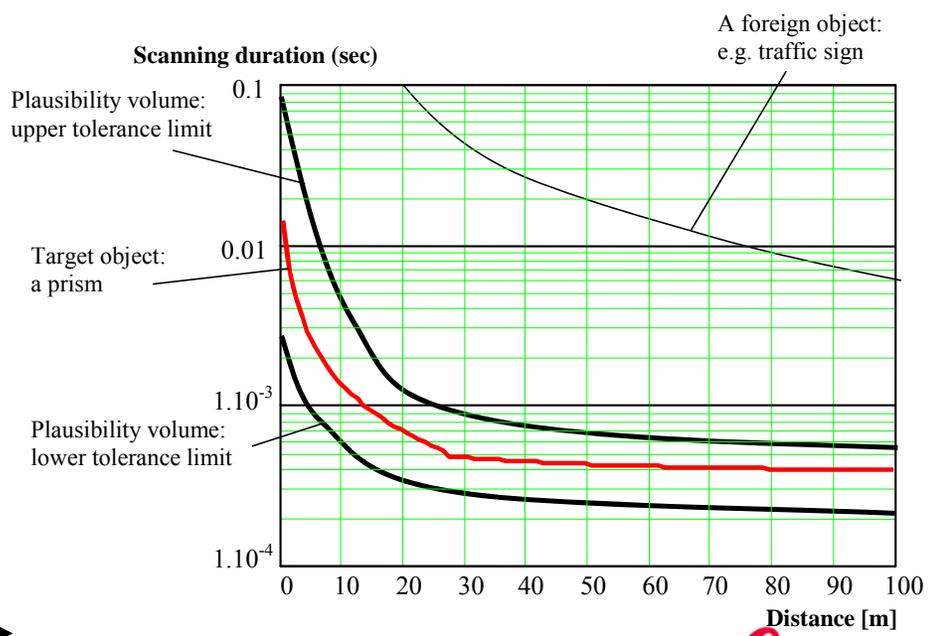
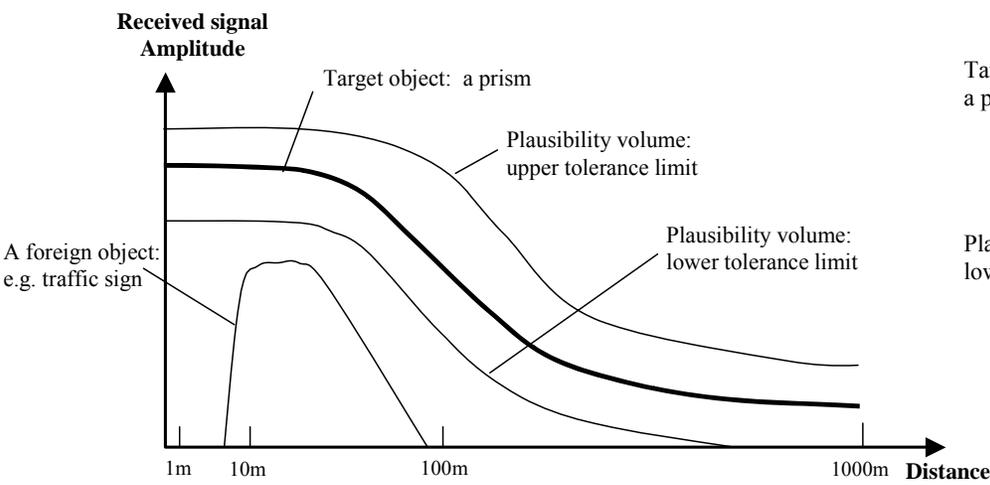
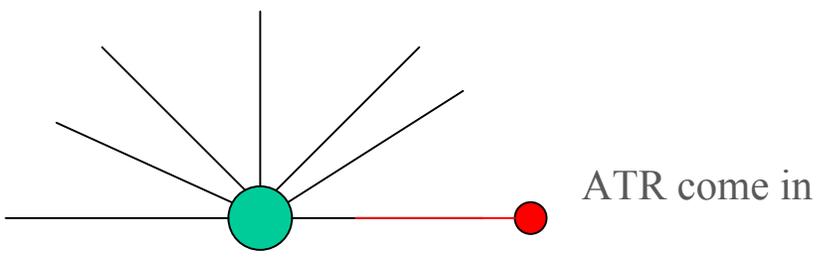


Emitter off

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Power Search (PS)



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EDM Current Technologies

Time of Flight (TOF) & Phase Shift

Time of Flight	Phase Shift
OK > 500 m but less accurate	Difficult > 400 m
multi-target realisation, but needs excellent laser coherence (expensive)	multi-target realisation not possible (inseparable signals)
Highly affected by environmental conditions	

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Leica's EDM Technology - System Analyser

- Permit accurate (in the mm range) RL measurements to objects over large distances (> 500 m) within few seconds (< 12 sec).
- Permit identification (and correct surveying) of multiple targets.
- Permit distance measurements independently of general atmospheric influences, such as, dust, smoke, mist, rain or snowfall, etc.
- Make on-board distance calibration available which runs simultaneously with the distance measurement to avoid thermal drifts and interrupts of measurement flow.

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System Analyser

- Large number of high frequencies (100MHz) are emitted to collect distance information with exclusively high resolution
 - Every frequency contributes to the final result giving high accuracy ($\lambda \sim 1.5\text{m}$)
 - Sub-mm distance resolution is achievable
 - No time is wasted for ambiguity resolution.
 - Selective w r t hard targets and blind w r t soft targets that have low-pass behaviour: 1 to 5 MHz
 - Large number of frequencies causes redundancy: any interruption in the signal path can be detected and neglected
- Ultra short laser pulses in sub-nsec range within pulse-trains of $\geq 100\text{MHz}$
 - Energy's emitted at higher harmonics (1GHz) supporting high distance resolution
 - Noise is minimised due to the steepness of the wave

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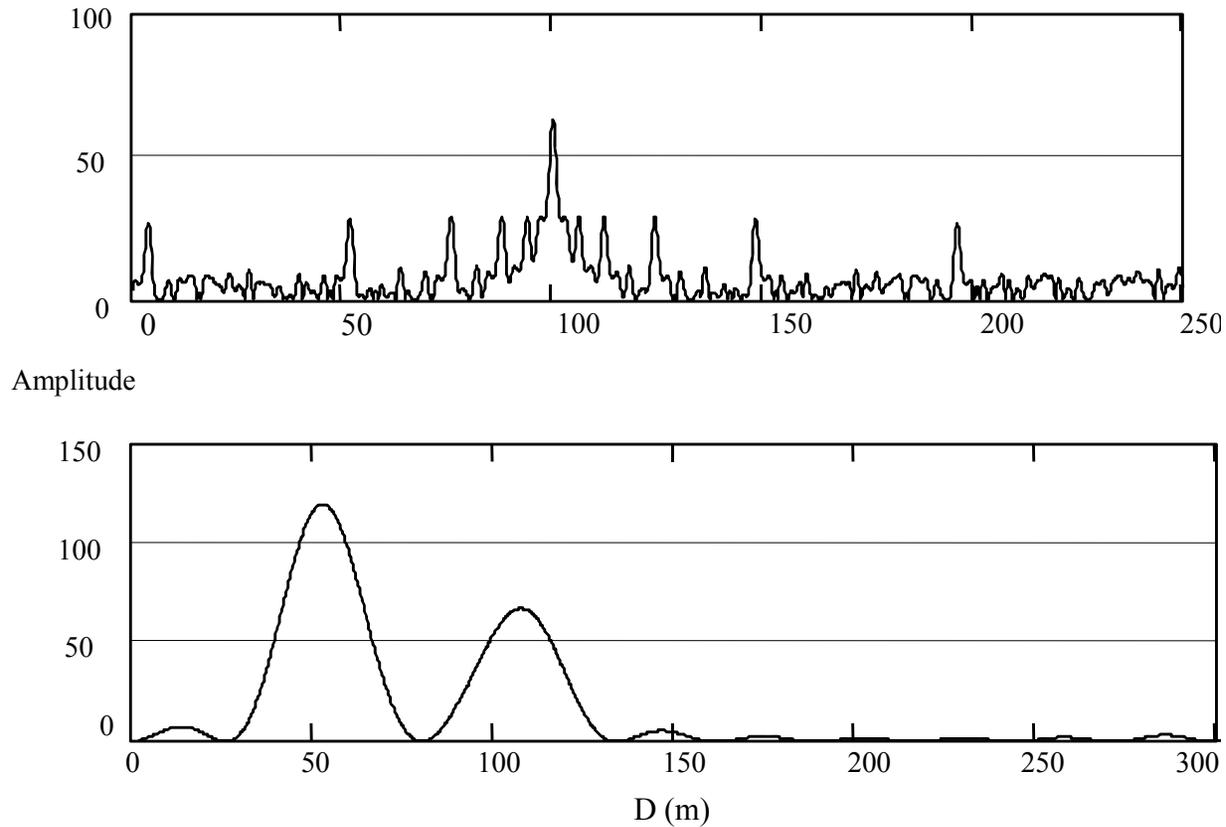
System Analyser

- After sampling the received signals, a merit-function (which is comparative to a time-of-flight signal) is constructed based on using all the incoming signal information
 - Thus, all the information between the EDM and Target is included in a quasi-continuous system
 - Advanced algorithms perform a **System Analysis** to get the function whose **maximum is the sought distance**
- Number of used modulation frequencies depends on the received signal strength
 - At high signal levels 4 frequencies are sufficient
 - At low signal levels up to 10 frequencies are emitted and analysed

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System Analyser

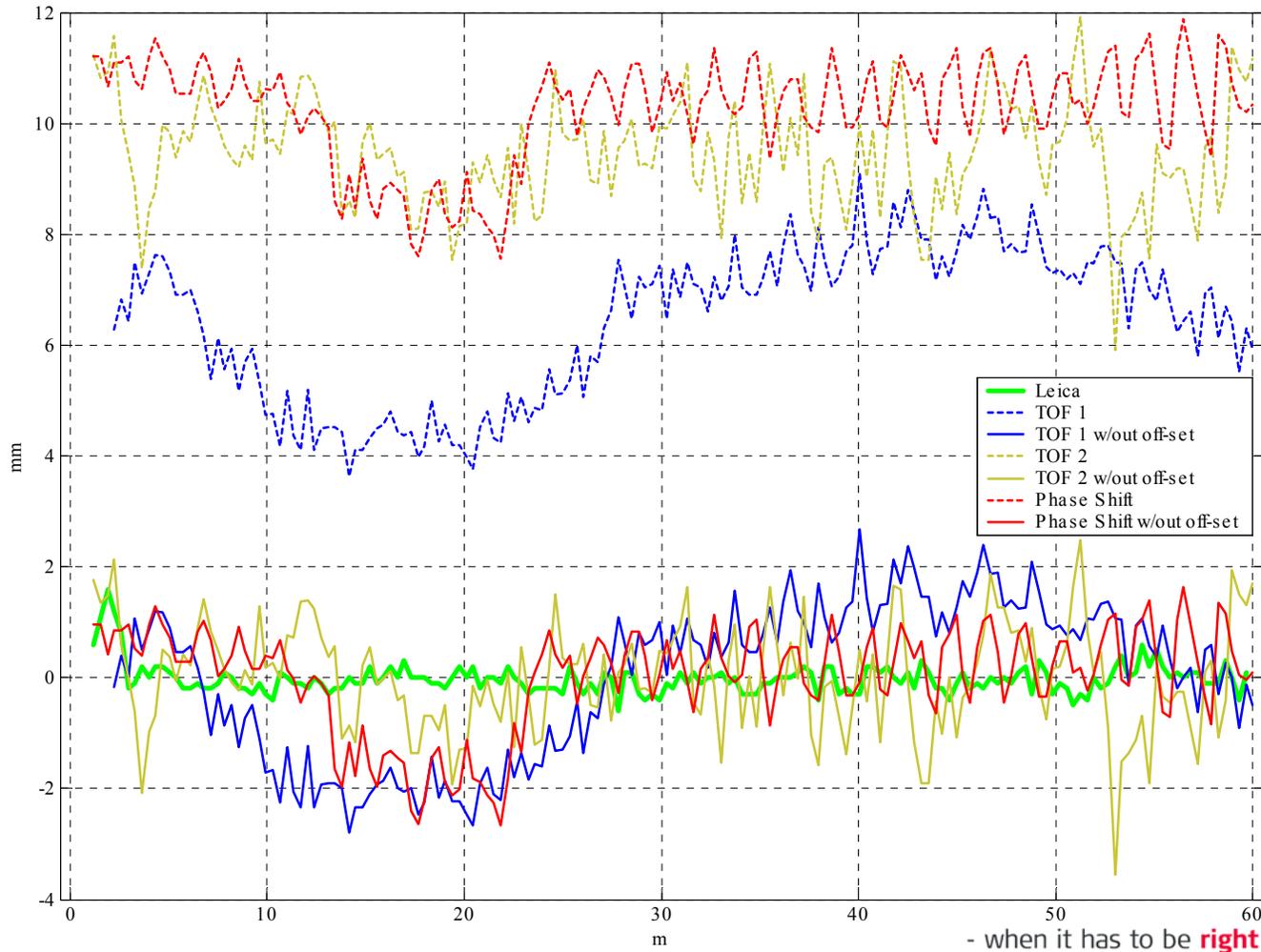


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Leica's EDM Accuracy (1)

Comparison with an Interferometer: up to 60 meter with a 30 cm step

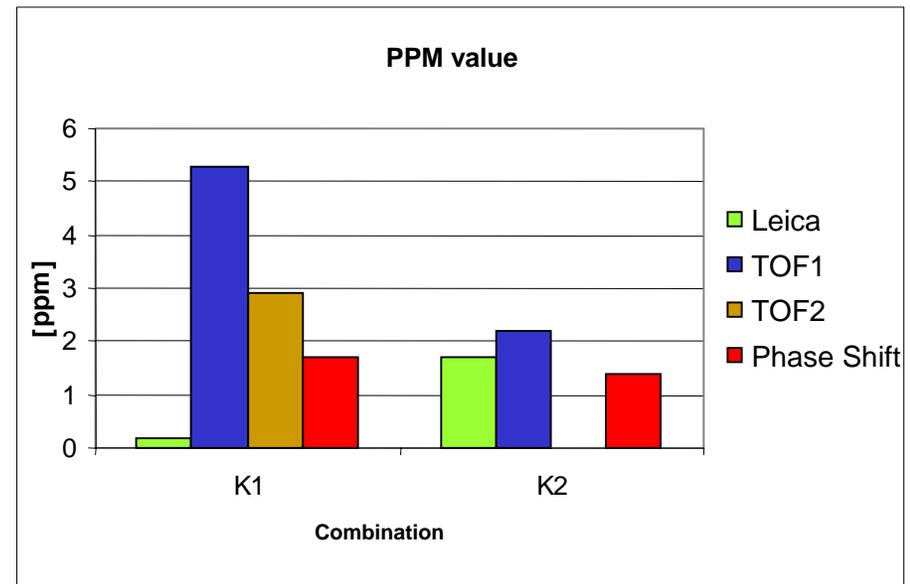
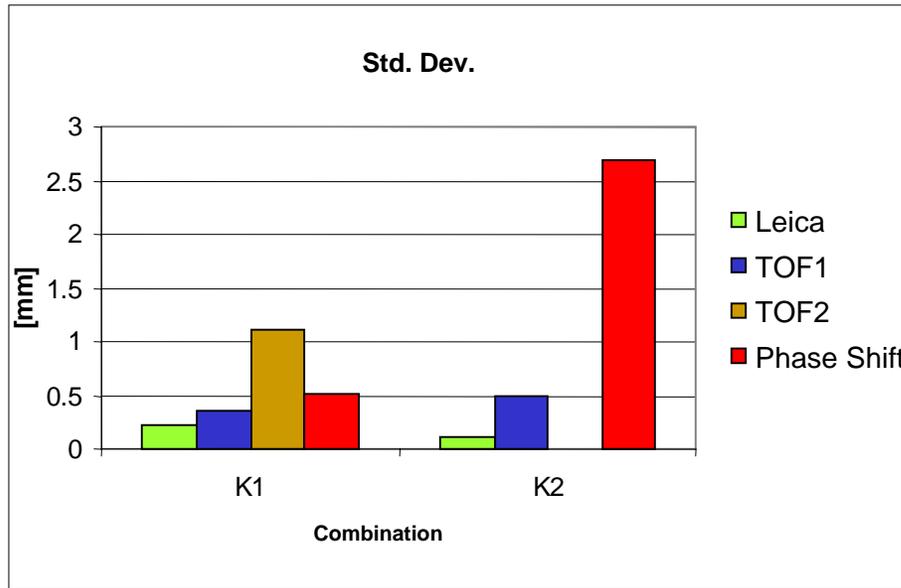


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Leica's EDM Accuracy (2)

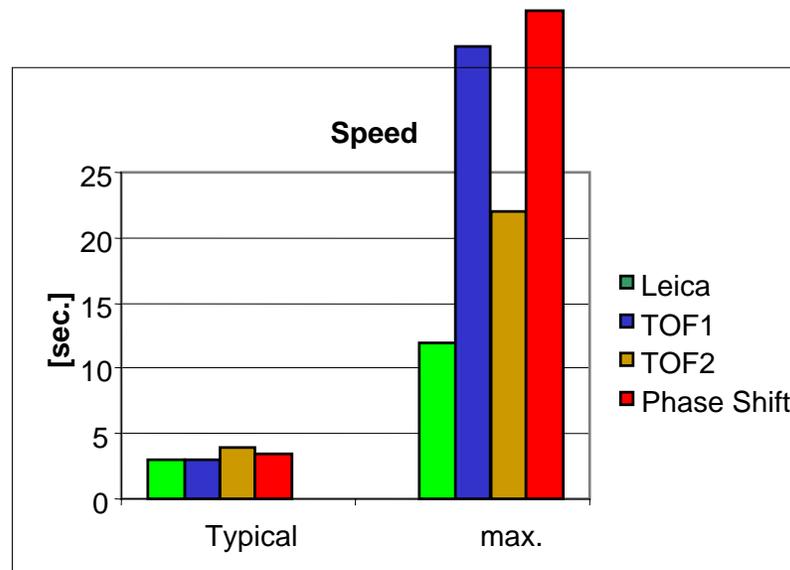
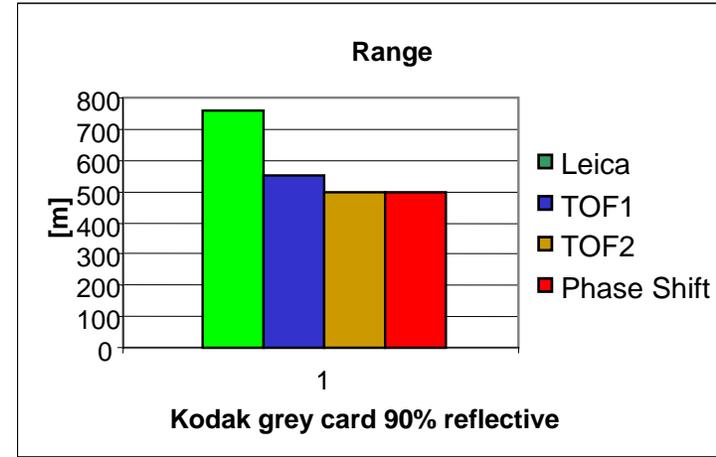
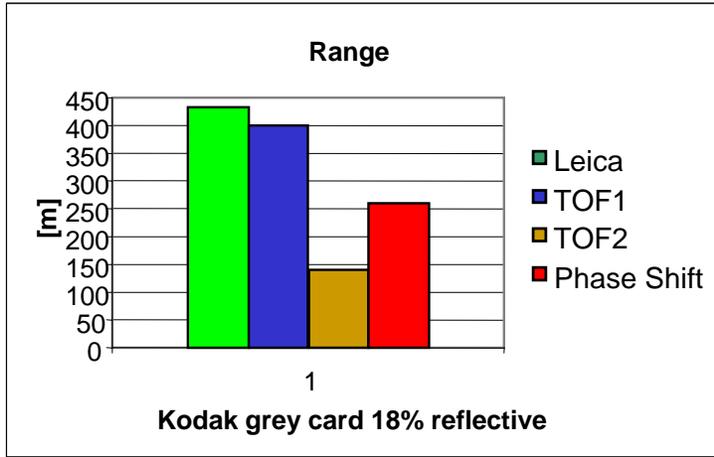
ISO range measurements; max.dist.: K1 = 500m , K2 = 1000



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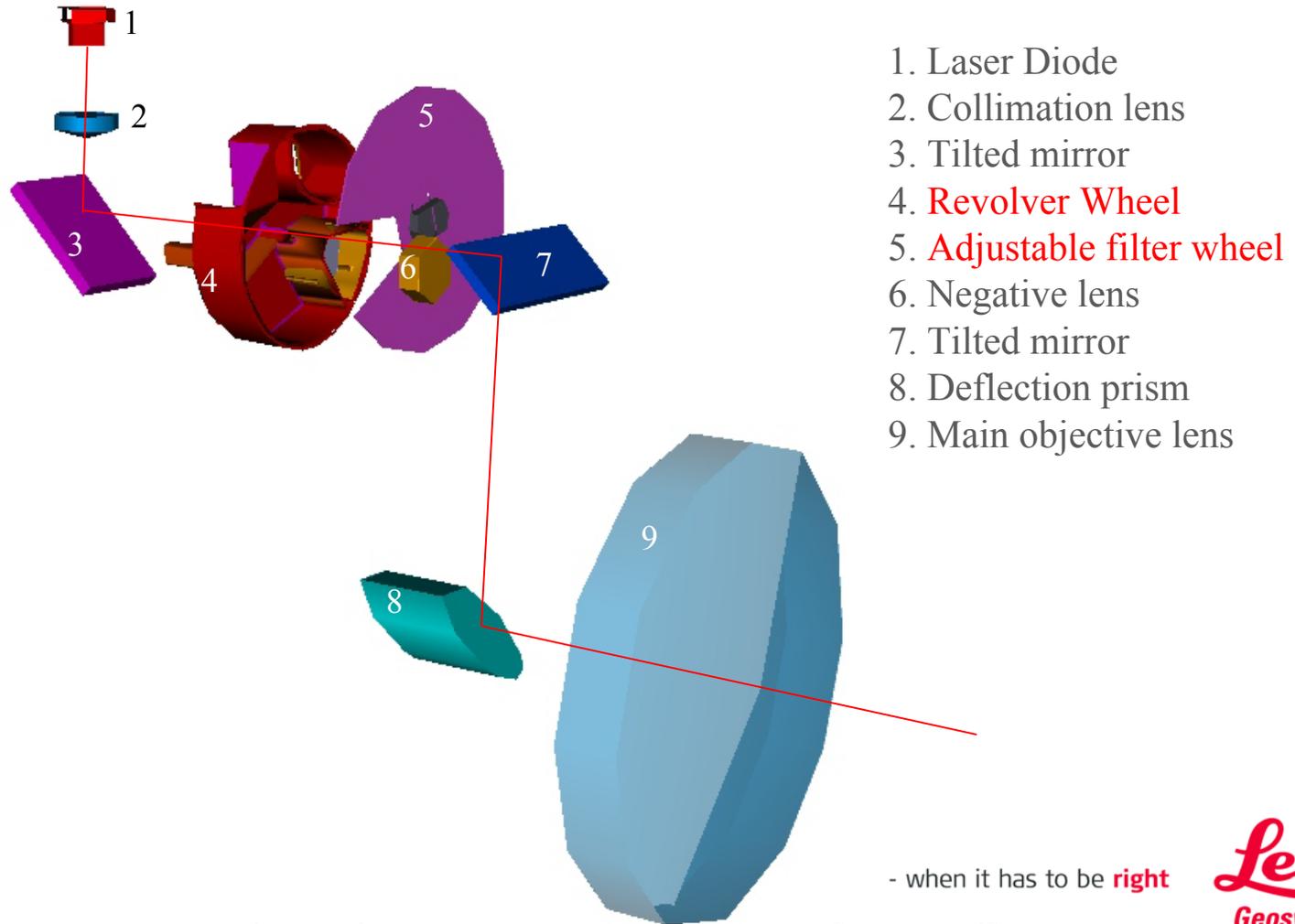
Range and Speed



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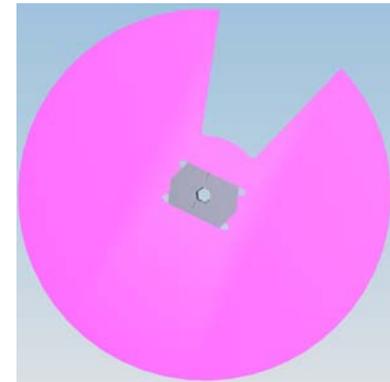
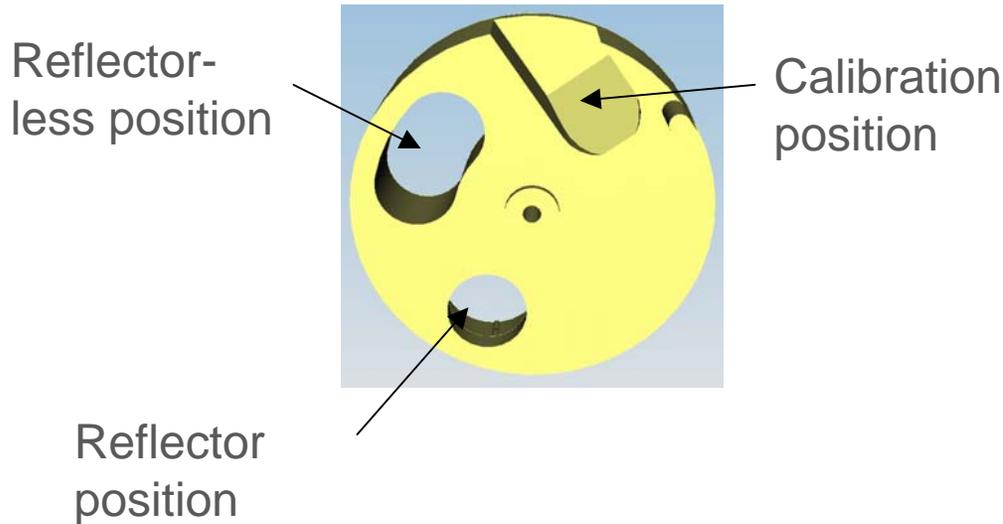


New Optomechanical Design



New Optomechanical Design

Movable parts



It intelligently takes a position that depends on the strength of the reflected laser

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Design Improvements

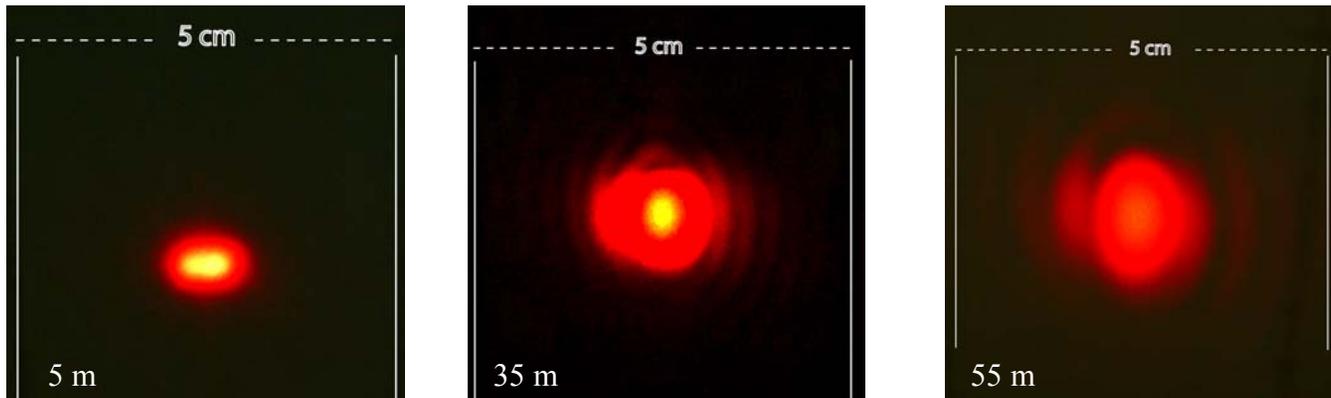
Thus:

- Improving optical beam path
 - Due to the reduced number of parts in the optical path
- Improving beam stability
 - Due to the lack of moving mirrors/lenses and improvements of the geometric coupling
- Improving the MTF (Modulation Transfer Function)
 - Sharper optical picture/impression for optical sighting through telescope
- Eliminating the need for user adjustment of the laser beam
- Allowing no misalignments or deviations between the reflector and reflectorless beam

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Laser Spot

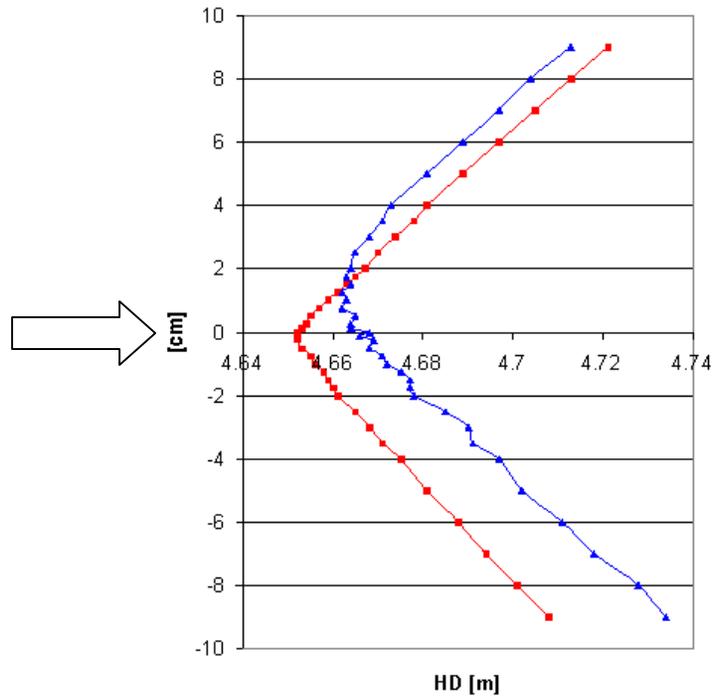


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Effectiveness of Laser Spot

— Leica' EDM — TOF EDM



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Conclusions

- Leica's EDM "System Analyser" is superior to existing technology
 - Able to measure accurate distances with 4 to 6 times lower signals than with a conventional phase-method. Measures routinely to distance > 650 m with maximum time of 12 sec
 - Further investigations are carried out to improve the maximum likelihood approach model in order to measure ranges to more than 1000m on bright diffusive targets.
- A new optomechanical design that overcomes potential disadvantages found in the old design, especially in terms of beam stability, image quality, laser beam spot geometry, etc.

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Thank you!

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