



High accuracy laser meter for system calibration

Modern Geodetic Systems have internal ranging accuracy better than 1 mm

Calibration/Excentricity has to be done with 100 μm accuracy

- distance to calibration target
- excentricity vector to geodetic markers
- monitoring of collocation vectors

1. Principle of Operation
2. Ranging Results
3. Perspectives/Modifications





High accuracy laser meter for system calibration

Intention of Project: High Accuracy Laser Meter for Industrial / **Geodetic** Application

Short Range: 5 m (**100 m**)

eyesafe, visible Diode, non **cooperative** target

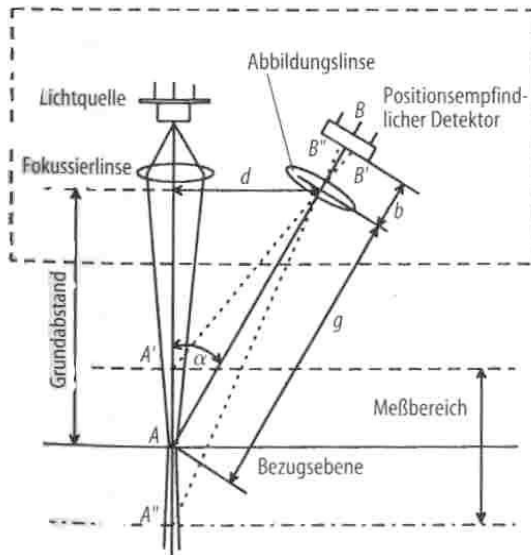
- Accuracy and Reproducibility: 0.1 mm
new operational principle
- High Aquisition Rate: **1 Hz** - 1 kHz
simple measurement
- **Long Term Stability** / Low Cost
absolute calibration



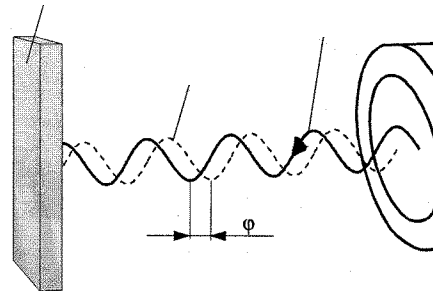
High accuracy laser meter for system calibration

Possible Operational Principles

Triangulation

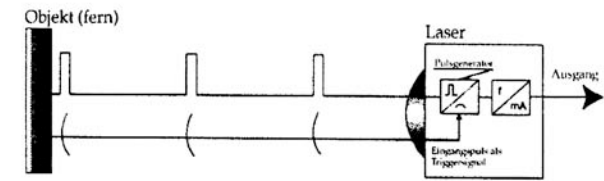


Phase Difference



Ambiguity if
wavelength < distance

TOF

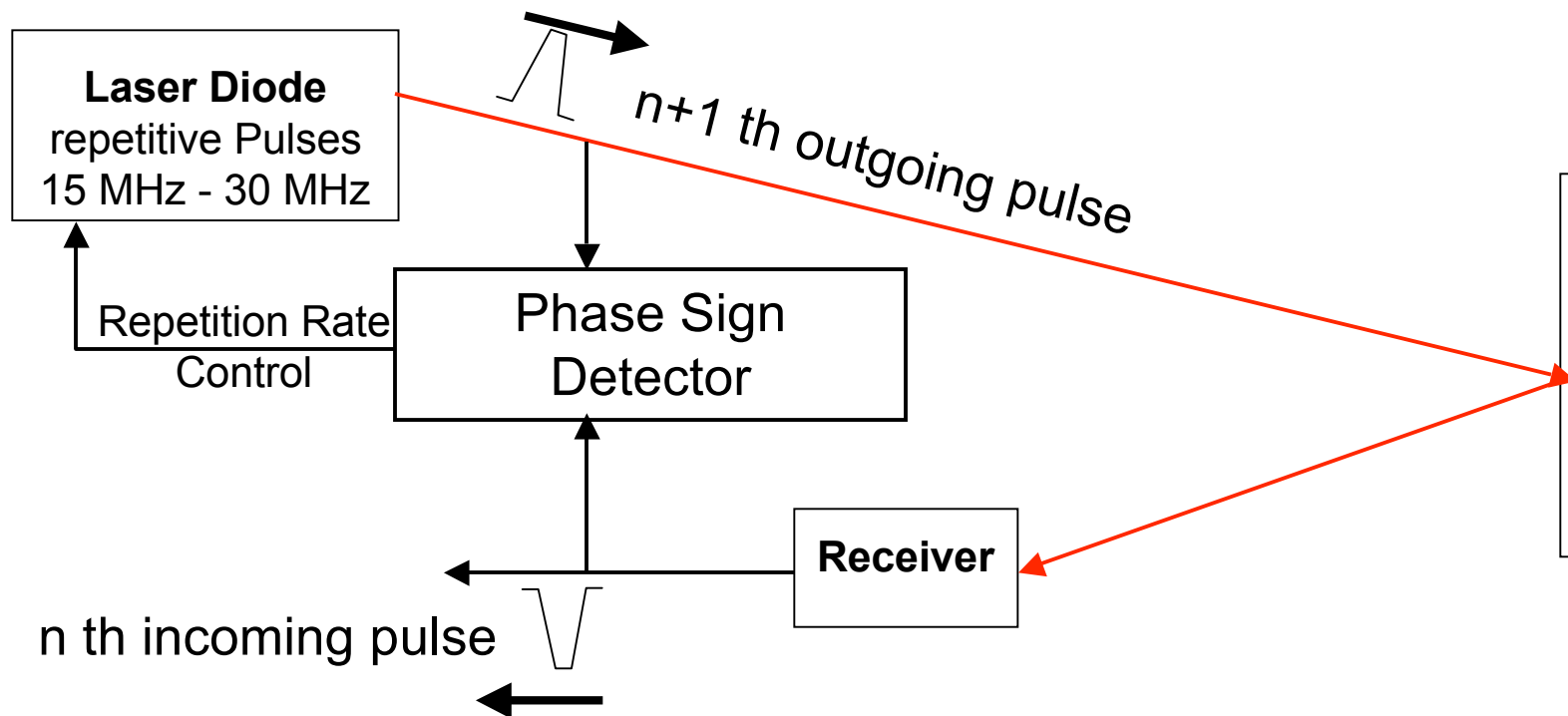


Long distance capability
Limited accuracy

Long distance capability
High accuracy



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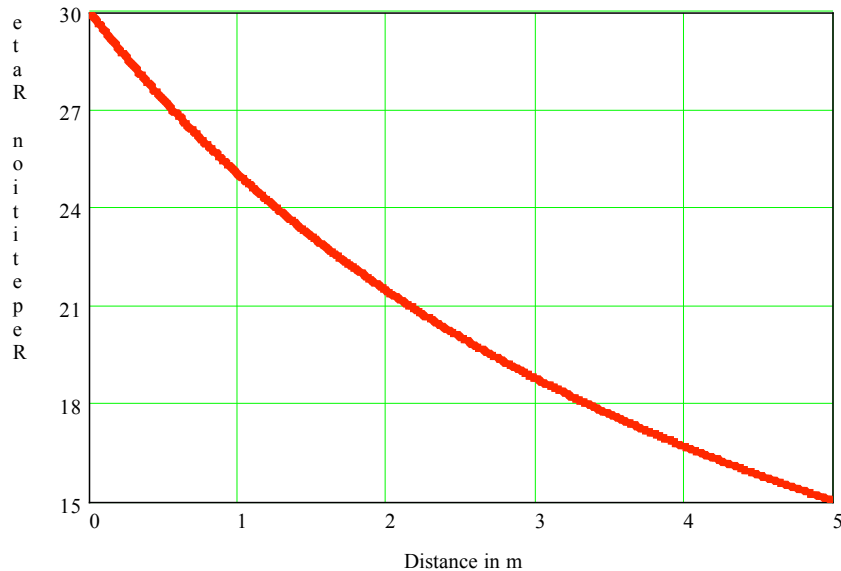


- Fast signal rise time: High sensitivity of phase sign detection
- Measurement cycle: few 10 ns: Many averages per measurement cycle
- Frequent fibre calibration / Calibration to known target
- Simple range measurement by frequency count

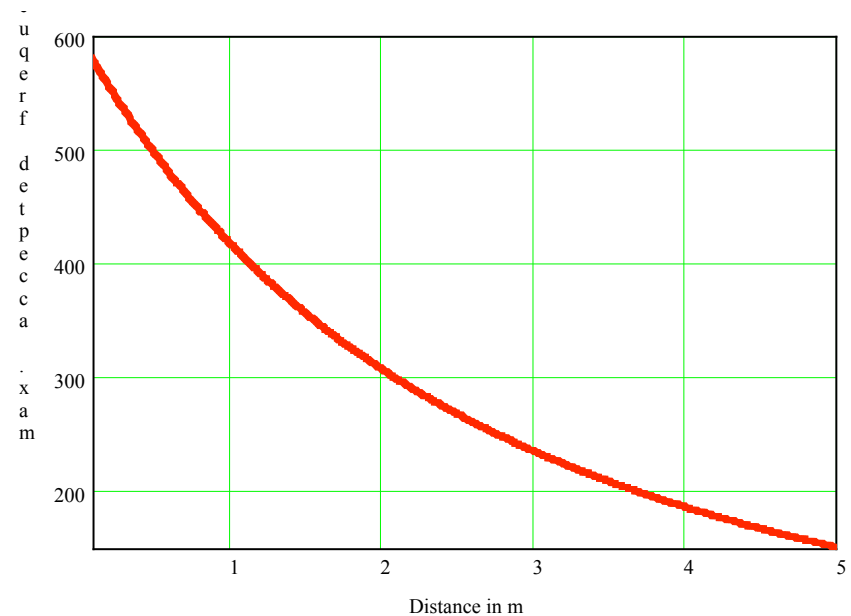


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Laser Diode Repetition Rate versus Distance to Target



Max. acceptable frequency error for 0.1 mm ranging accuracy versus Distance to Target

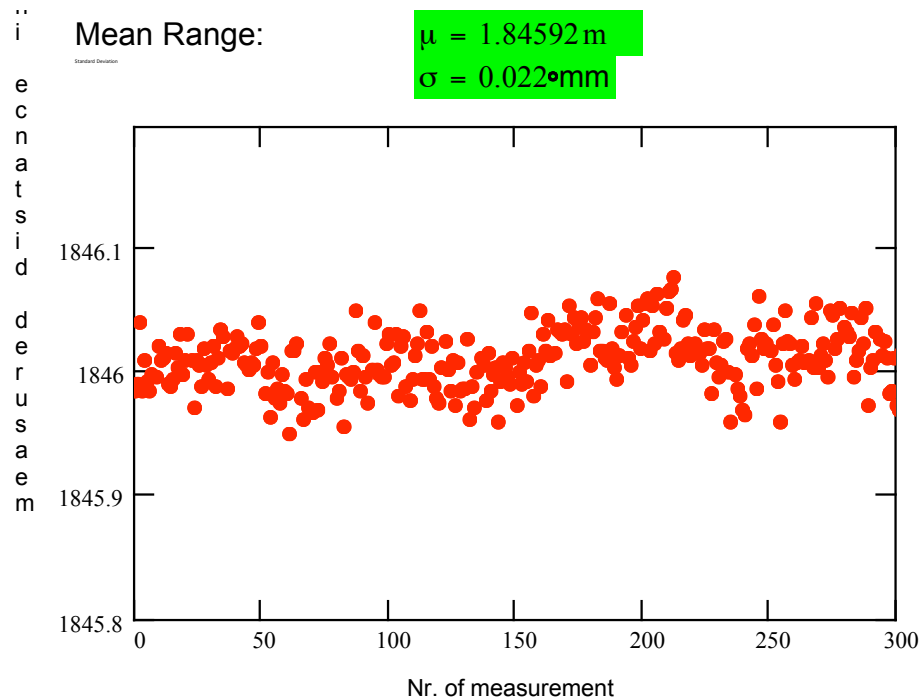




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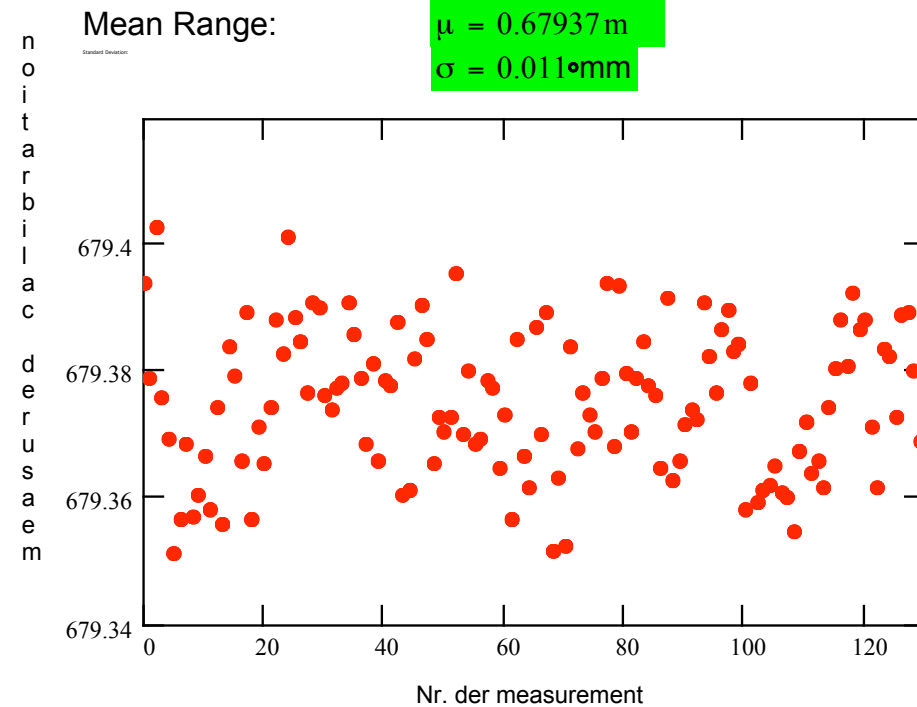
Ranging Results

Non cooperative target
10 ms measurement time



Calibration Results

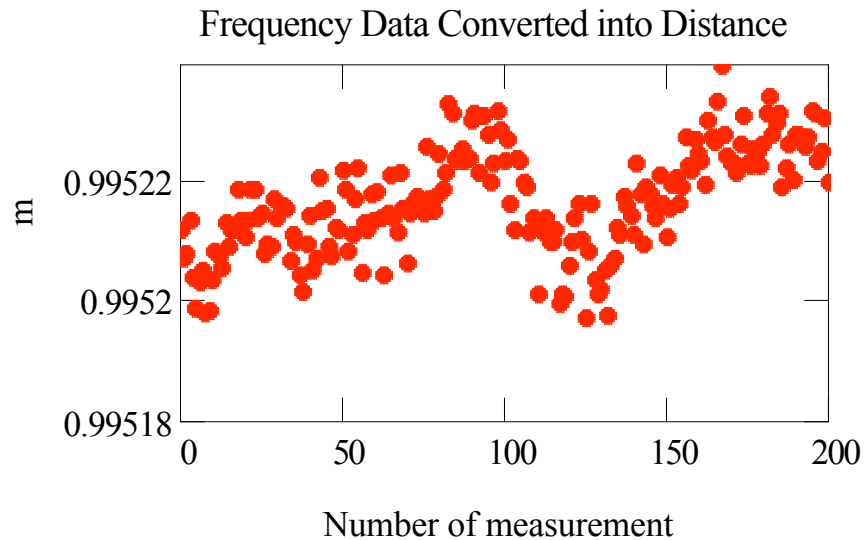
Stable return level
10 ms measurement time





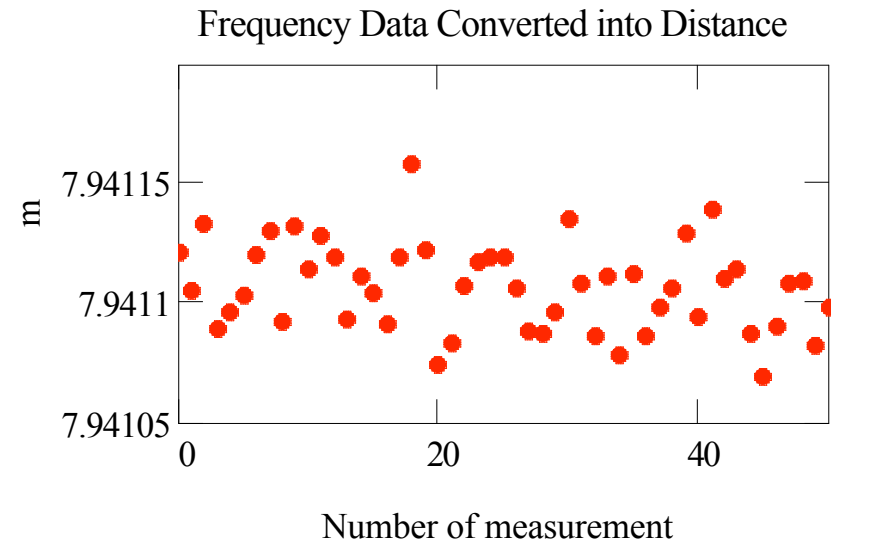
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Ranging Results
1s measurement time
5 m max. range
1 m target distance



Mean_value = 0.99522 m Standarddeviation = 8.8 μm

Ranging Results
1s measurement time
20 m max. range
8 m target distance

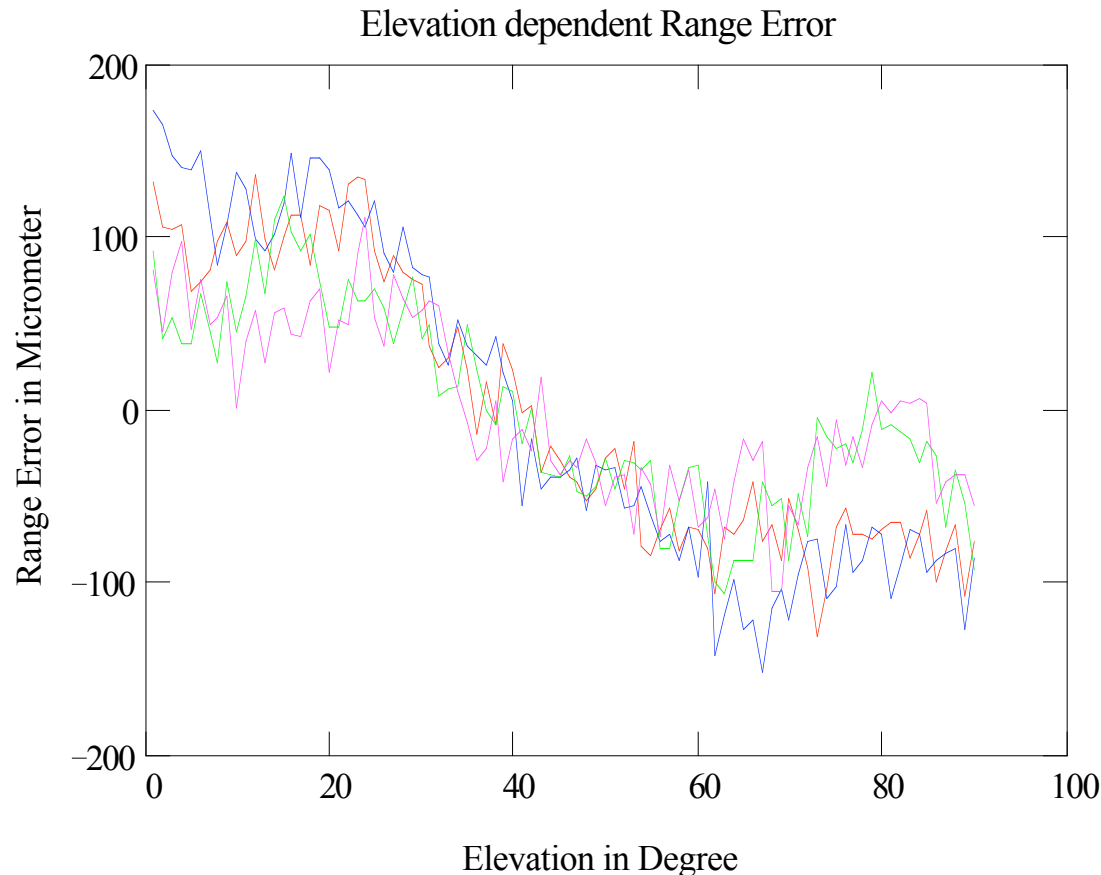


Mean_value = 7.94111 m Standarddeviation = 18.3 μm



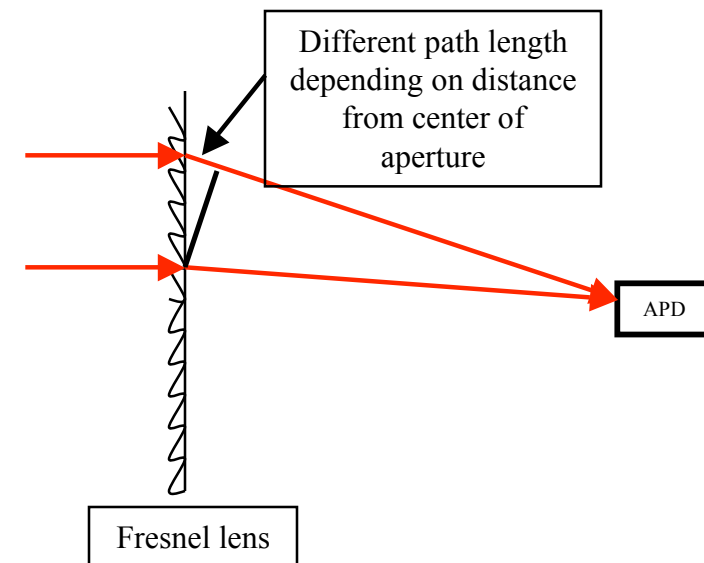
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Ranging through Graz SLR Telescope with moving Elevation Axis



Four consecutive measurements

Drift just due to moving return spot on fresnel lens → changing path length



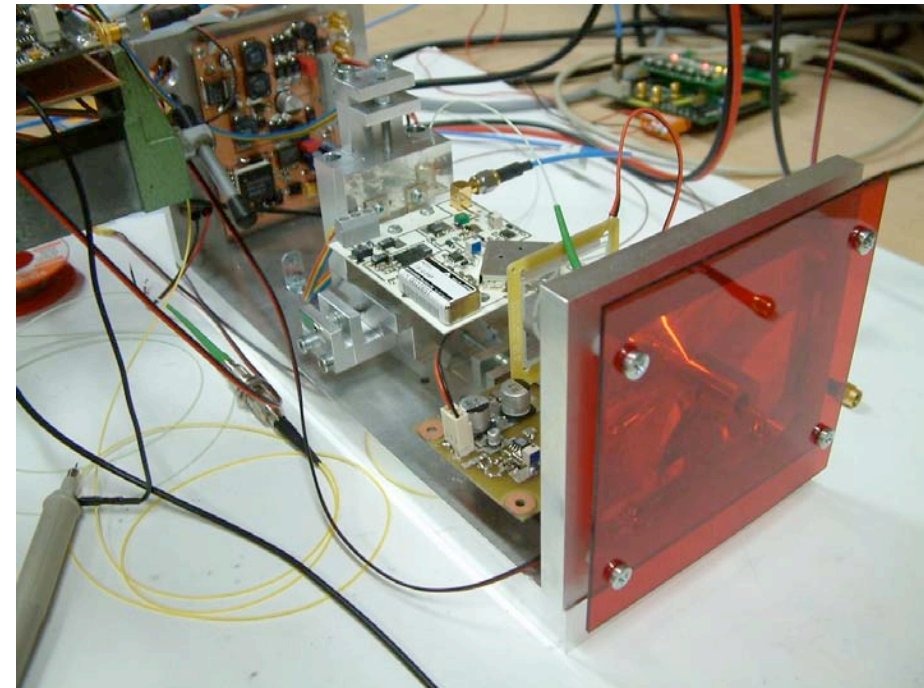


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Status	Geodetic Application
Large diameter Fresnel Lens for noncooperative target → variable pathlength through different areas of lens no problem for diffuse reflection	Reflector → Directional reflection Small glass lens for ranging to reflector → fixed path length through aperture
Integrated fibre switch for calibration → additional noise compromises accuracy	Calibration to external target
Designed for fast (1 ms) steps in distance and return level → high speed, high bandwidth control circuit compromises accuracy	Limiting bandwidth of control circuit will increase accuracy and stability
Fast (1 ms, 10 ms) measurement gate limits accuracy	1 Hz measurement rate gives best accuracy
Frequency measurement through internal counter	External atomic frequency stabilized counter is used to measure frequency



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Advantage for collocated instruments

Routine fully automatic site survey up to 100 m distance

- Small, lightweight package for continuous installation
- Remote control, fast acquisition time
- Sub mm ranging accuracy to noncooperative targets (5 m) and reflectors (100 m)

frequent realtime test of excentricity vector
with 0.1 mm accuracy