PROCEDURE FOR ANALYZING GEOMETREICAL CHARACTERISTICS OF AN EDM CALIBRATION BENCH

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Overview

- Calibration Bench
- Research topic & Error Sources
- Methodology
- Results
- Future Research
- Conclusion

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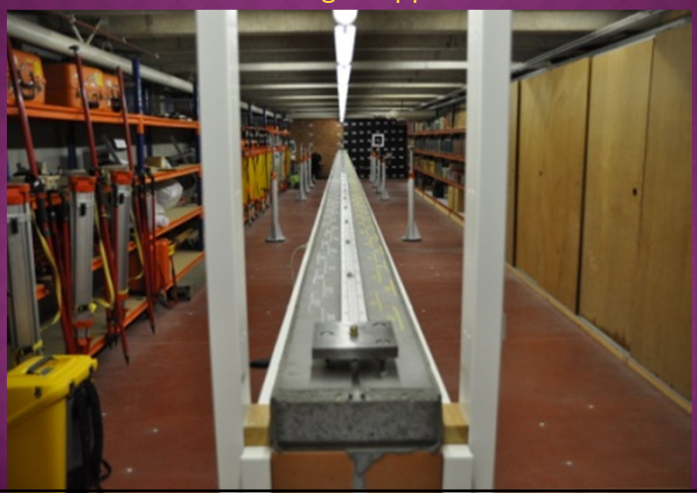
Calibration Bench (UGent)

- ca. 20 m length, 1 m high, 3 dm large
- Reinforced concrete beam on wall brick filled with sand. Total weight: approx. 105 kN.



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Calibration Bench (UGent)

- Lasertex LSP-30 interferometer (HeNe 633 nm)
- Range: 30 m
- Resolution: 0.001 or 0.01 mm (software setting)
- Accuracy: 0.001 mm + 1,5 ppm (<> typical 2 mm + 2 ppm for a total station, e.g. Trimble S6)

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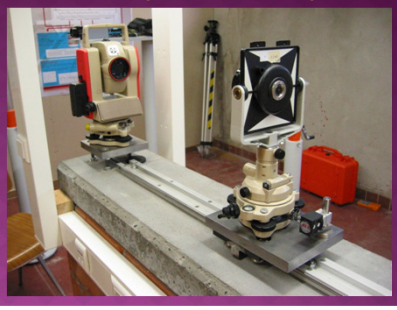
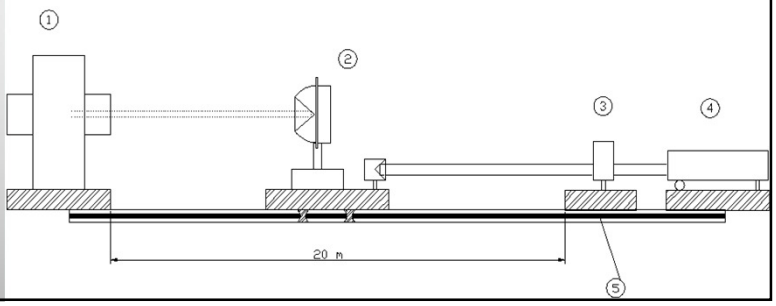
Calibration Bench (UGent)

- Carrier with double prism
- On aluminium rail
- Allows simultaneous distance measurements to both interferometer and total station





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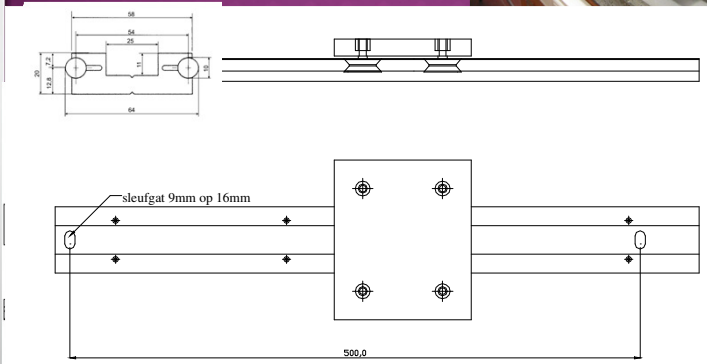
Calibration Bench (UGent)

- Manual movement
- Four lateral gliding wheels making contact with tubular steel tubes (10 mm diameter, 6 m length per section)



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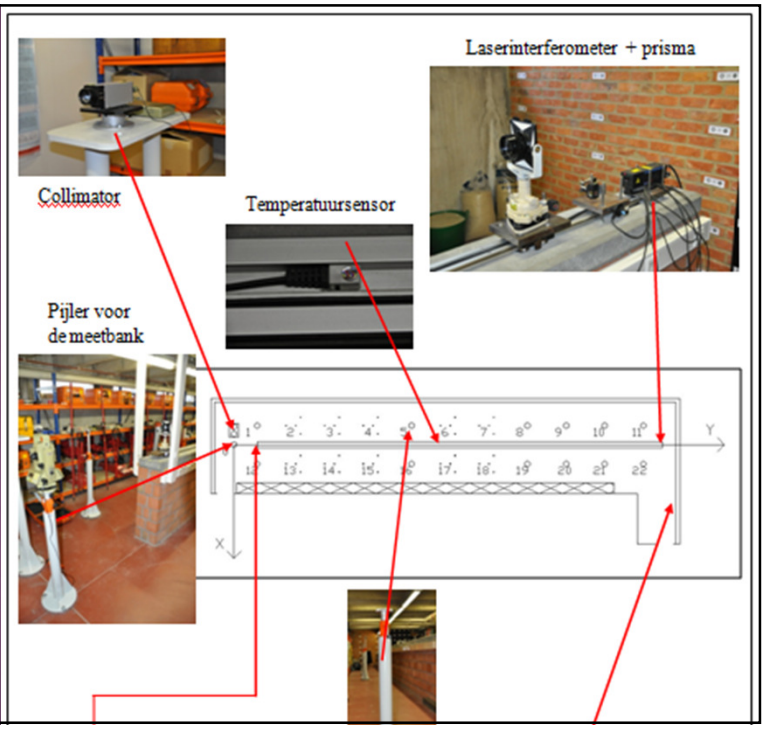

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Research topic

- Quantify the alignment errors of the moving carrier on the rail
  - Vertical and lateral offsets
  - Rotations (pitch, roll, yaw)
- Gather information to allow a well founded decision: either to physically adjust the rail or to compute and apply an error correction model.

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Additional error sources

- Influence of atmospheric conditions: temperature, air pressure and humidity
  - High accuracy atmospheric measurements with sensors attached to the rail
  - Lower accuracy atmospheric measurements in the lab with Weather station *Nexus Pro 2009*
- Dead path error
- Cosine error
- Abbe error
- Instability of the laserbeam
- …

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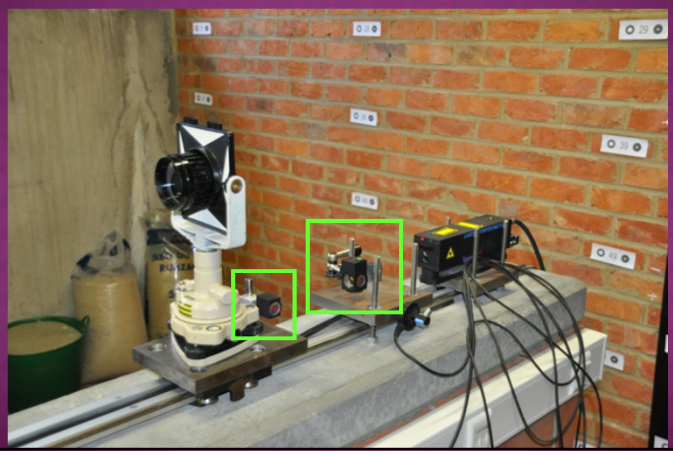
Laser Beam Alignment

- Minimum 80 % reflection strength of the laser beam signal needed in every point of the bench
- Fixed and moving interferometer prisms should be aligned with the laser beam



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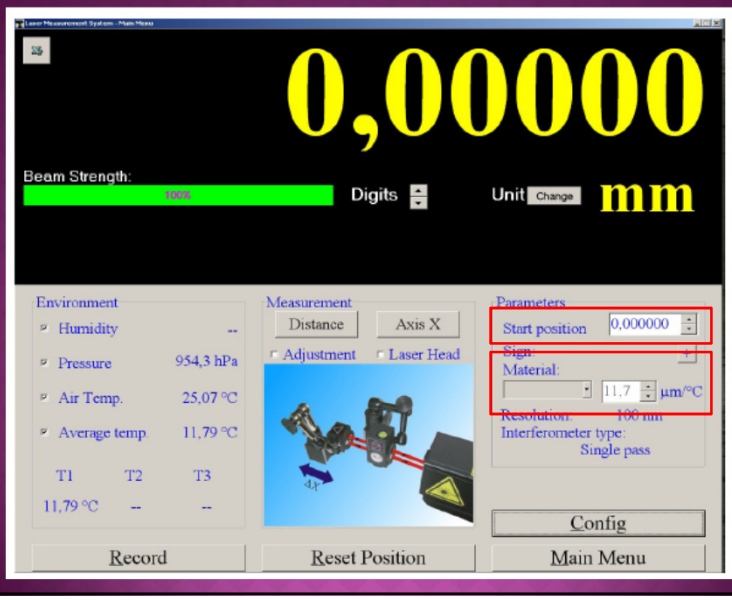
Software Settings



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Principles of Measurement

- Carrier has two targets at the left and right bottom sides of the carrier
- Zenithal (= vertical) and horizontal angle measurements are performed to both targets and also to the total station prism in the middle
- EDM to the prism is also performed

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Principles of Measurement

- Carrier is placed at the "end" (= near to the interferometer)
- The height of the totalstation (Trimble S6) is adapted so that the zenithal angle = 100 grades (horizontal line-of –sight)
- The Horizontal angle is set to zero

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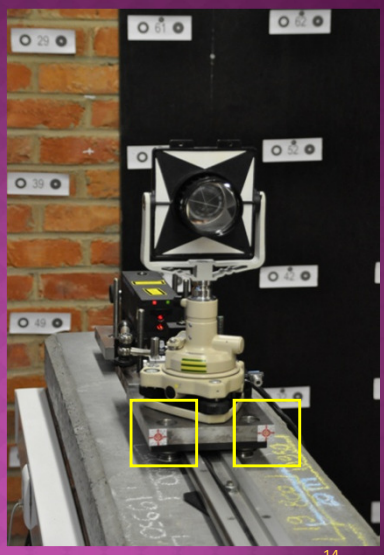
Principles of Measurement

- Measure every 15 cm
- Record the laserinterferometer distance
- Measure the vertical and horizontal angle to both targets and the prism and also measure the distance to the prism



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Principles of Measurement

1. Distance error (= difference between interferometer and total station)

2. Vertical offset

3. Lateral offset

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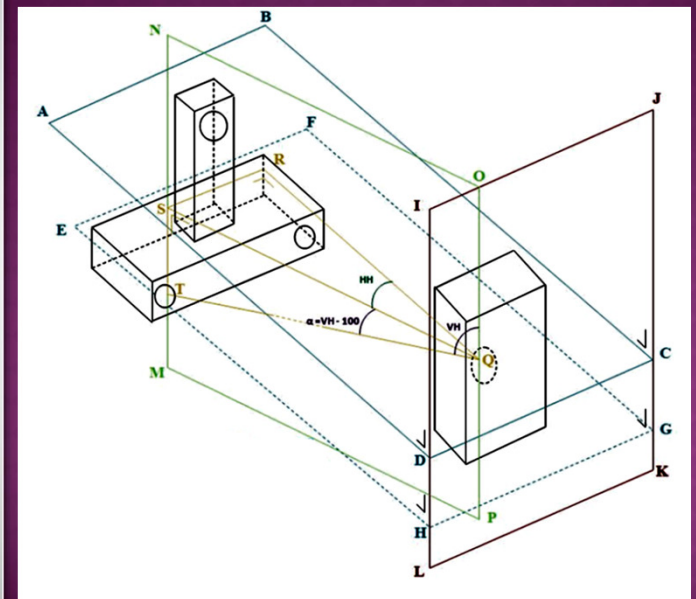
Computations



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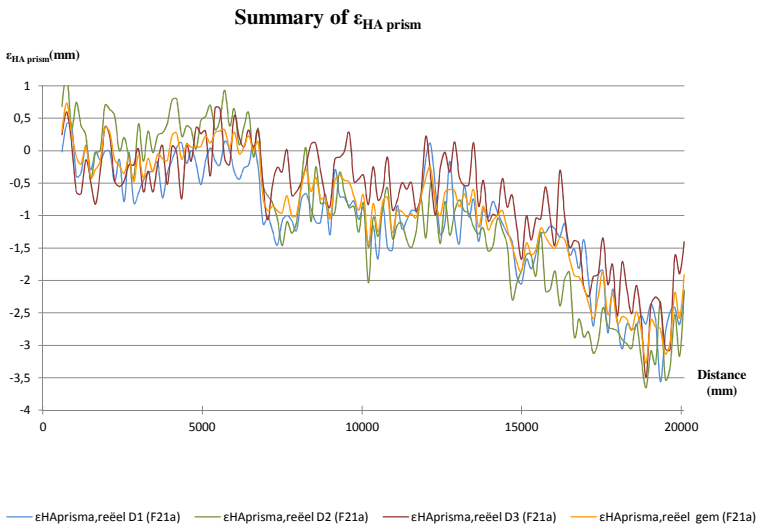
Distance Error



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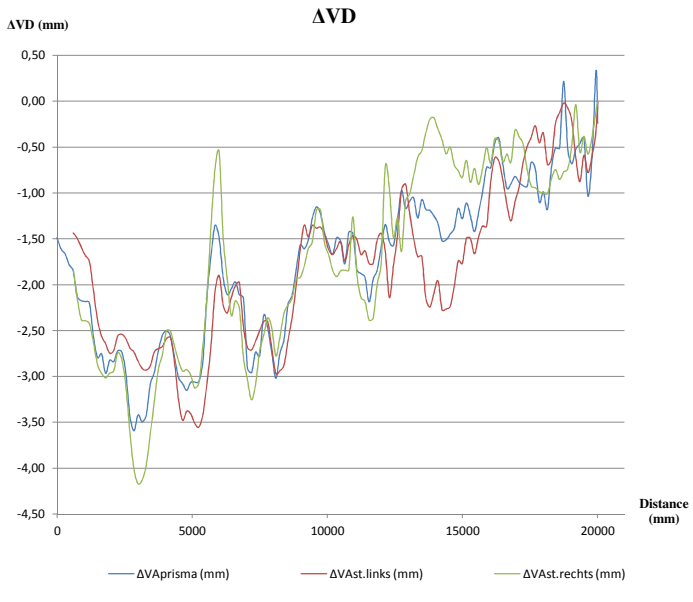
Vertical offset



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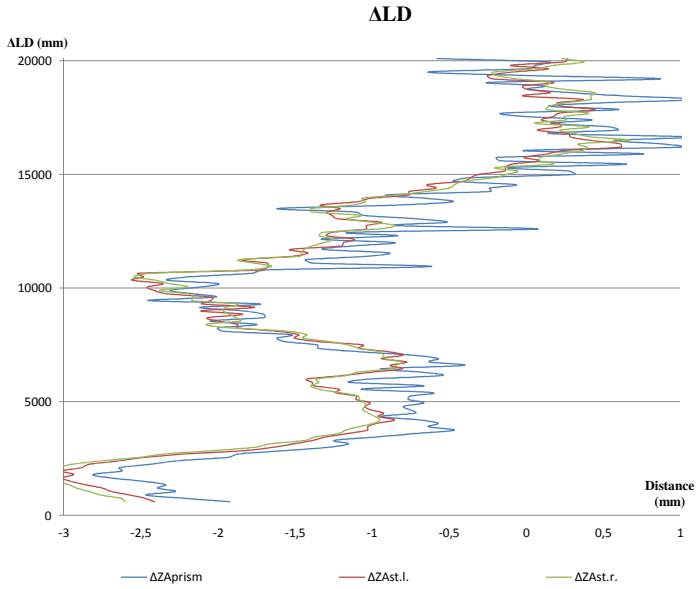
Lateral offset



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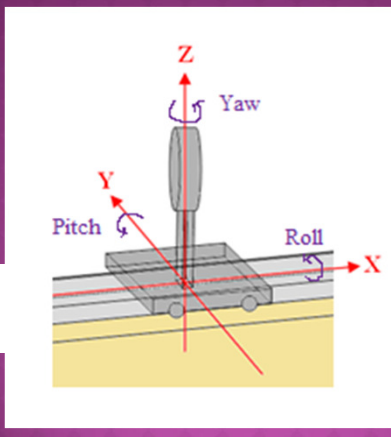
Rotations

- *Roll-, pitch-* en *yaw-rotations*



Towards totaalstation

Towards laserinterferometer

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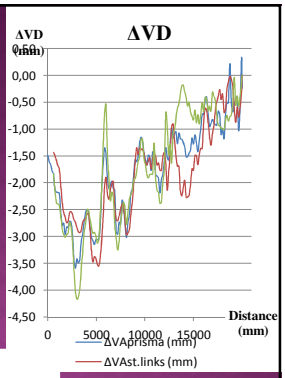
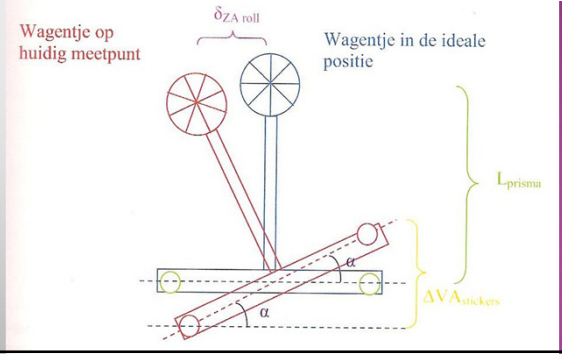
Roll

Computed out of left/right difference of vertical offsets





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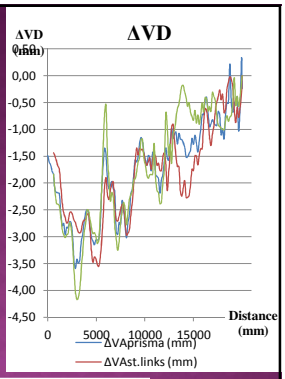
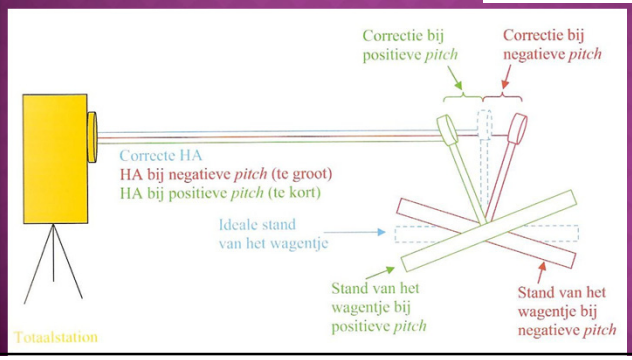
Pitch

Computed out of differences of vertical offsets in subsequent points





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Future

- Fixed reference point, independent from bench construction, for zero-settings
- Interferometric measurement of roll and pitch
- Decision about adjusting the rail or modelling the offsets is still to take

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Conclusion

- A methodology was suggested for the computation of horizontal and vertical offsets of an EDM calibration bench.
- The repeatability (approximation of the random error) of this methodology is in the order of 0.2-0.3 mm.
- With interferometry we hope to be able to measure with accuracies better than 0.1 mm.

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Thank you for your attention !

Questions?

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