Infrastructure Commission (INFCOM)
Standing Committee on Measurements, Instrumentation and Traceability (SC-MINT)
Expert Team on Quality, Traceability and Calibration (ET-QTC)

Calibration of Wind Instruments

Part-4: Requirements for the Laboratory Setup (2)

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Content

Part 1:

- Introduction to this topic and historical information
- Concepts and definitions

Part 2:

- Methods of measurement

Part 3:

- Requirements for the laboratory setup #1

Part 4:

- **Requirements for the laboratory setup #2**

Part 5:

- General procedure
- Calibration example #1
- Calibration example #2
- Calibration example #3
- References and links

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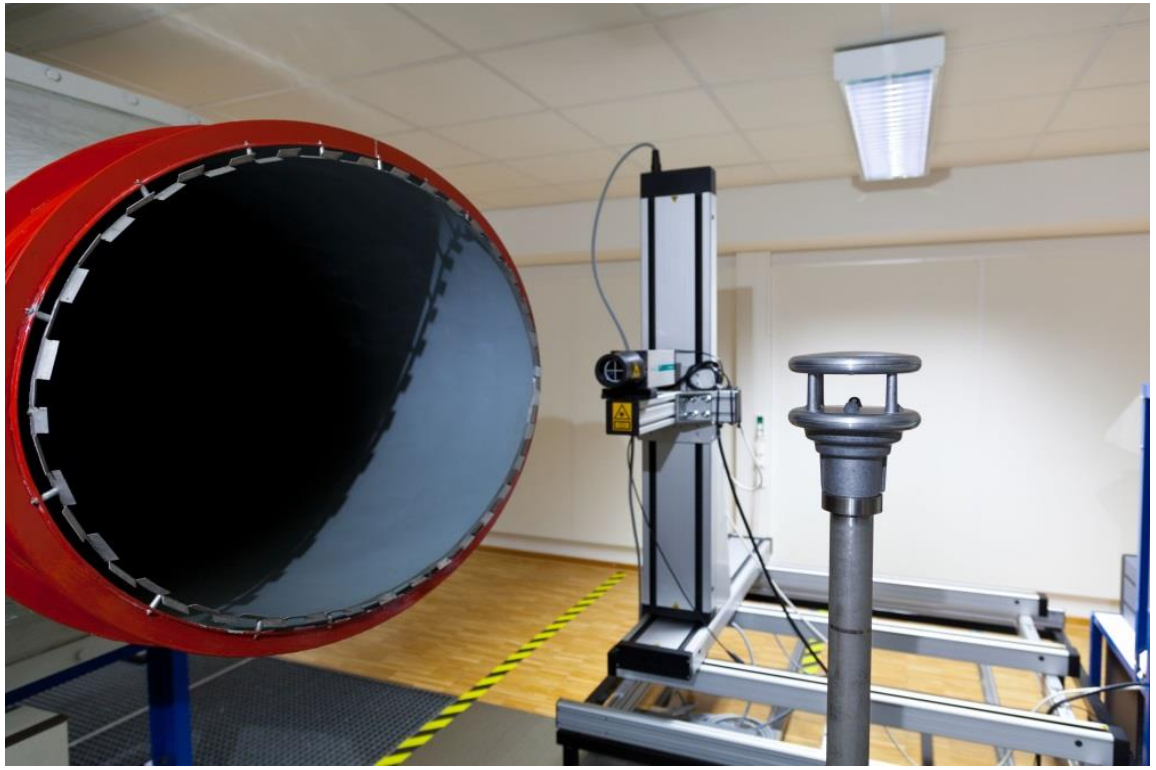
Requirements for the laboratory setup

- the calibration of anemometers is particularly difficult because there are many influencing factors
  - the flow profile
  - blocking effects of the device under test and the reference, as these influence the wind field (e.g. static pitot tubes)
  - immersion depth
  - placement of reference and DUT
  - longitudinal increasing of the flow speed between nozzle and collector
  - wall effects if a wind tunnel with a closed measuring section is used
  - effects of mounting poles …

Requirements for the laboratory setup

investigation of the flow characteristics using the laser doppler anemometer and 3D traverse system



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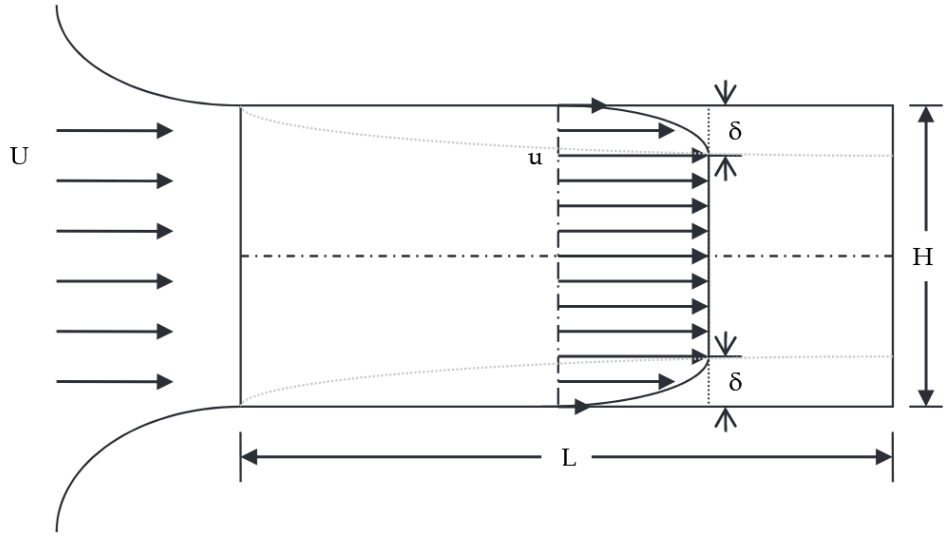
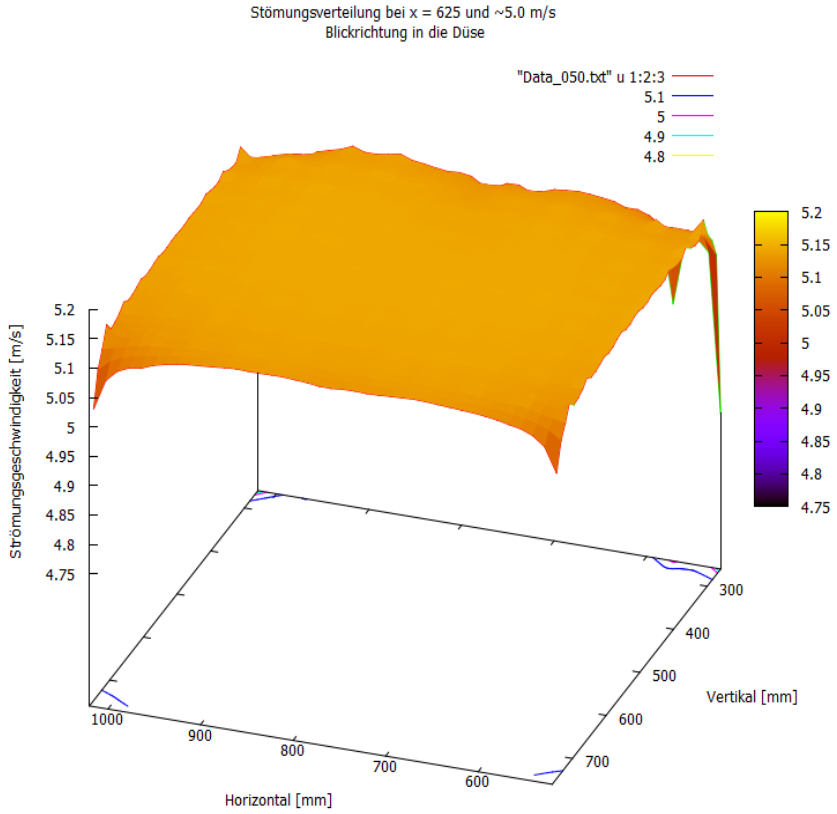
Requirements for the laboratory setup



Graphical Representation of Boundary Layer Theory in Wind Tunnel Test Section

(C) http://cdn.intechweb.org/pdfs/16674.pdf



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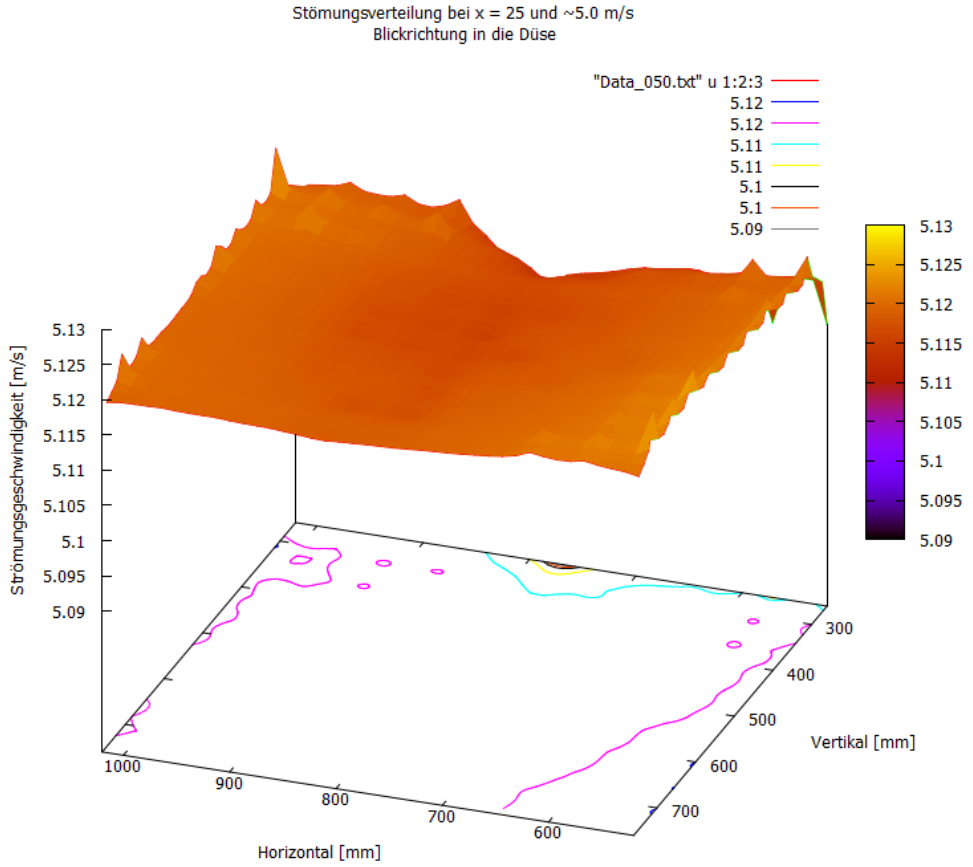
Requirements for the laboratory setup

wind field at the nozzle at wind speed of ~5 m/s



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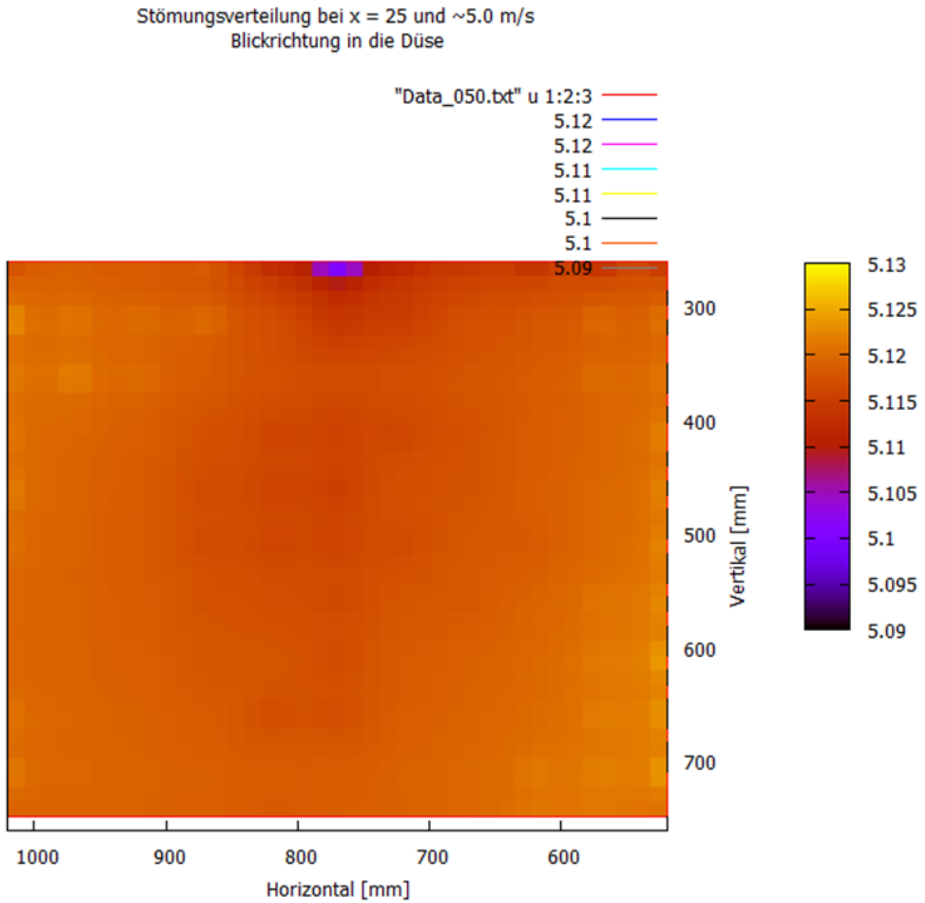
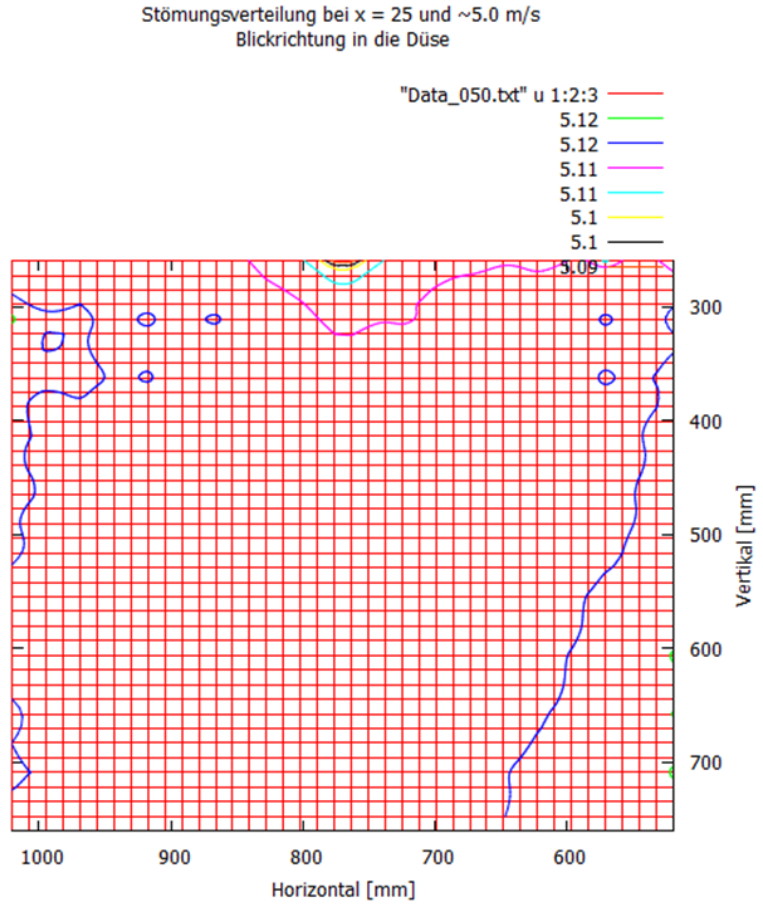
Requirements for the laboratory setup

wind field at the nozzle at wind speed of ~5 m/s





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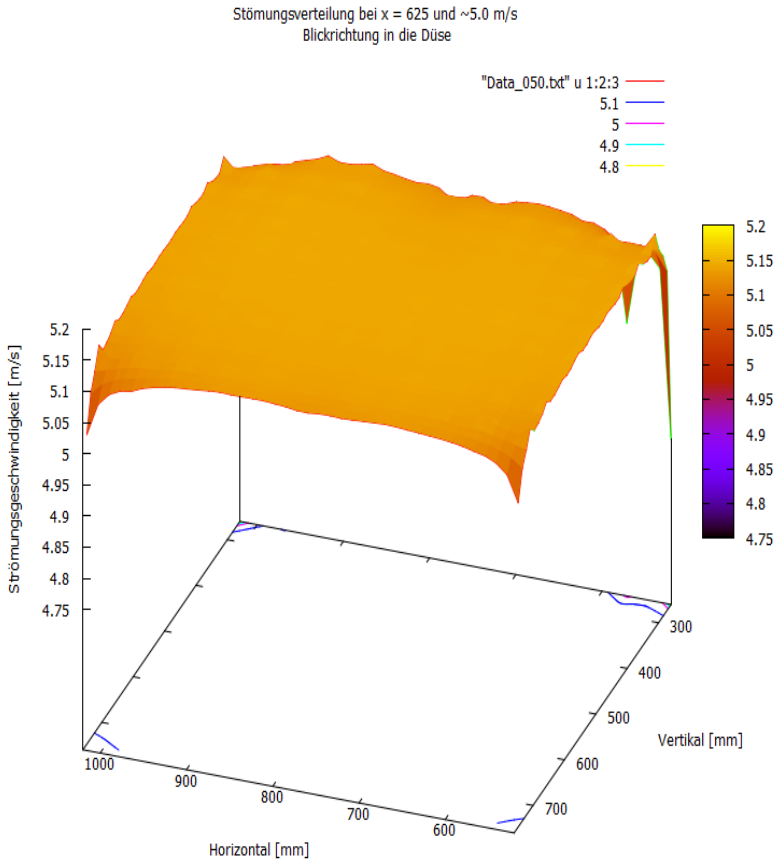
Requirements for the laboratory setup

wind field at position of DUT at wind speed of ~5 m/s



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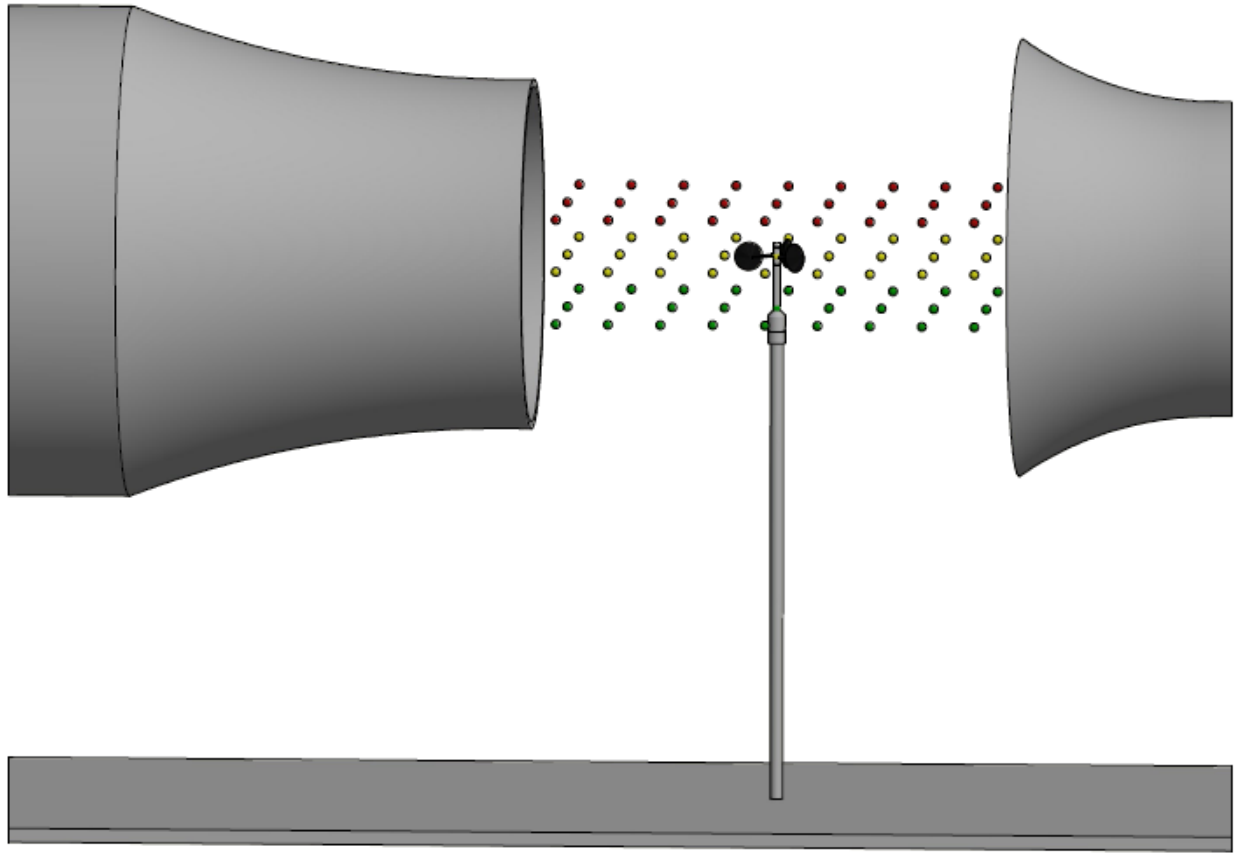
Requirements for the laboratory setup

homogeneity test with a large number of mesh-shaped measuring positions



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Requirements for the laboratory setup

the immersion depth

- the anemometer normally positioned in the centre of the free jet
- if an anemometer is set up in a wind tunnel, the resistance of the test rig increases and the volume flow decreases
- however, the lower the anemometer is positioned in the air flow, the higher the value displayed
- the air flows through the cups and around the pole, not only radial around the pole but also axial
- In case of cup anemometer the axial air flow leads to the head of the anemometer and accelerates the cups

Requirements for the laboratory setup

the effect of immersion depth depends on:

- the geometry of the anemometer
- the body structure of the pole
- the nozzle cross section

Requirements for the laboratory setup

the blockage effect

- this effect is influenced by the immersion depth and the size of the anemometer
- basically: the bigger the head and the pole of an anemometer is the higher is the blockage effect in the flow field
- the pressure accumulates against the flow direction
- an influence on the result of the reference is possible

Requirements for the laboratory setup

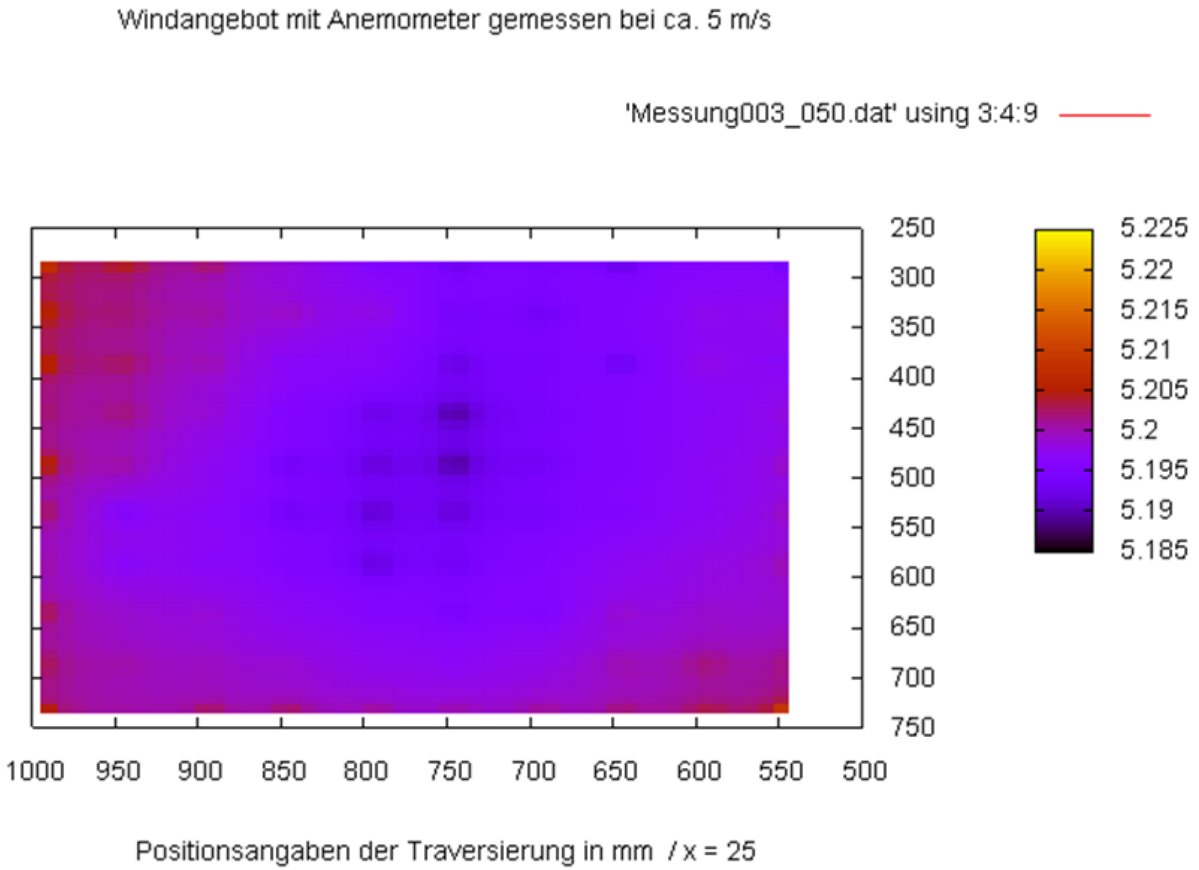
the blockage effect

- the test bed resistance in the wind tunnel raises up and the volume flow decreases
- in a closed measuring section the air velocity raises around the probe ⇒ the value at the DUT increases
- in an open measuring section the air flow enlarges around the probe ⇒ the value at the DUT decreases

Requirements for the laboratory setup

the blockage effect

- wind field at the nozzle with mounted cup anemometer at wind speed of ~5 m/s



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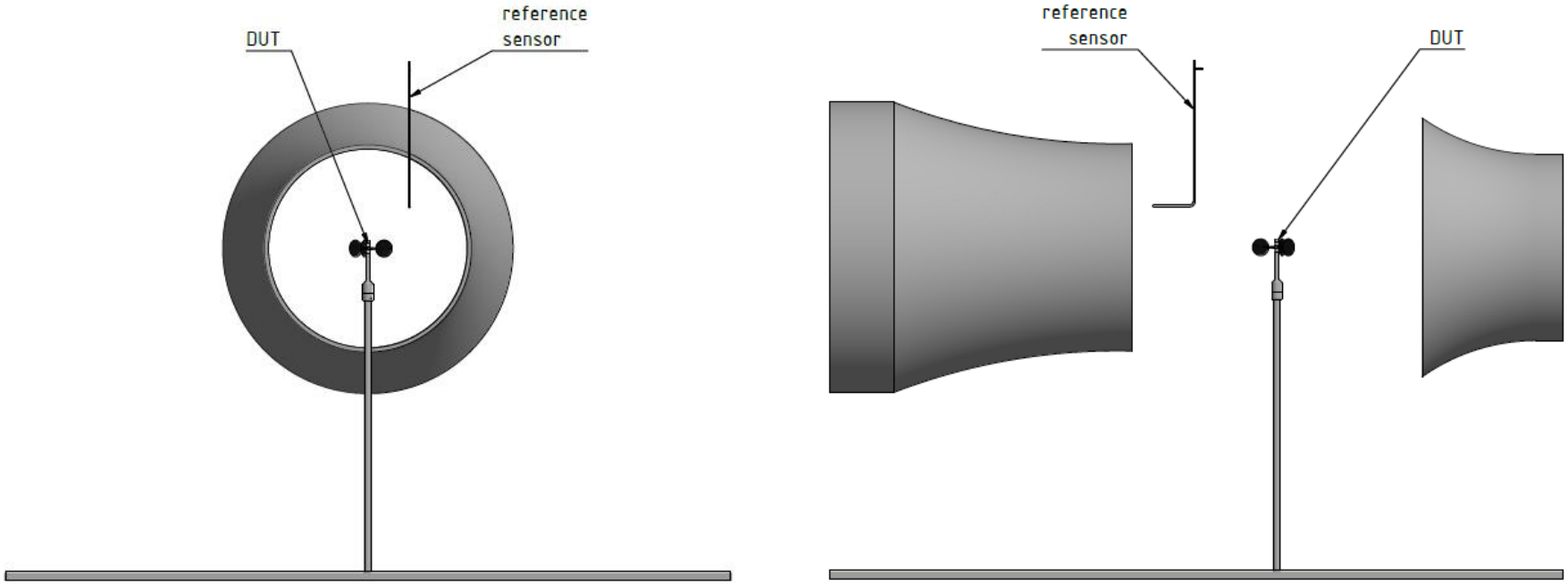
Requirements for the laboratory setup

placement of reference and device under test

- the reference and DUT should not be aligned
- tip of the pitot tube should be far from the outlet of wind tunnel



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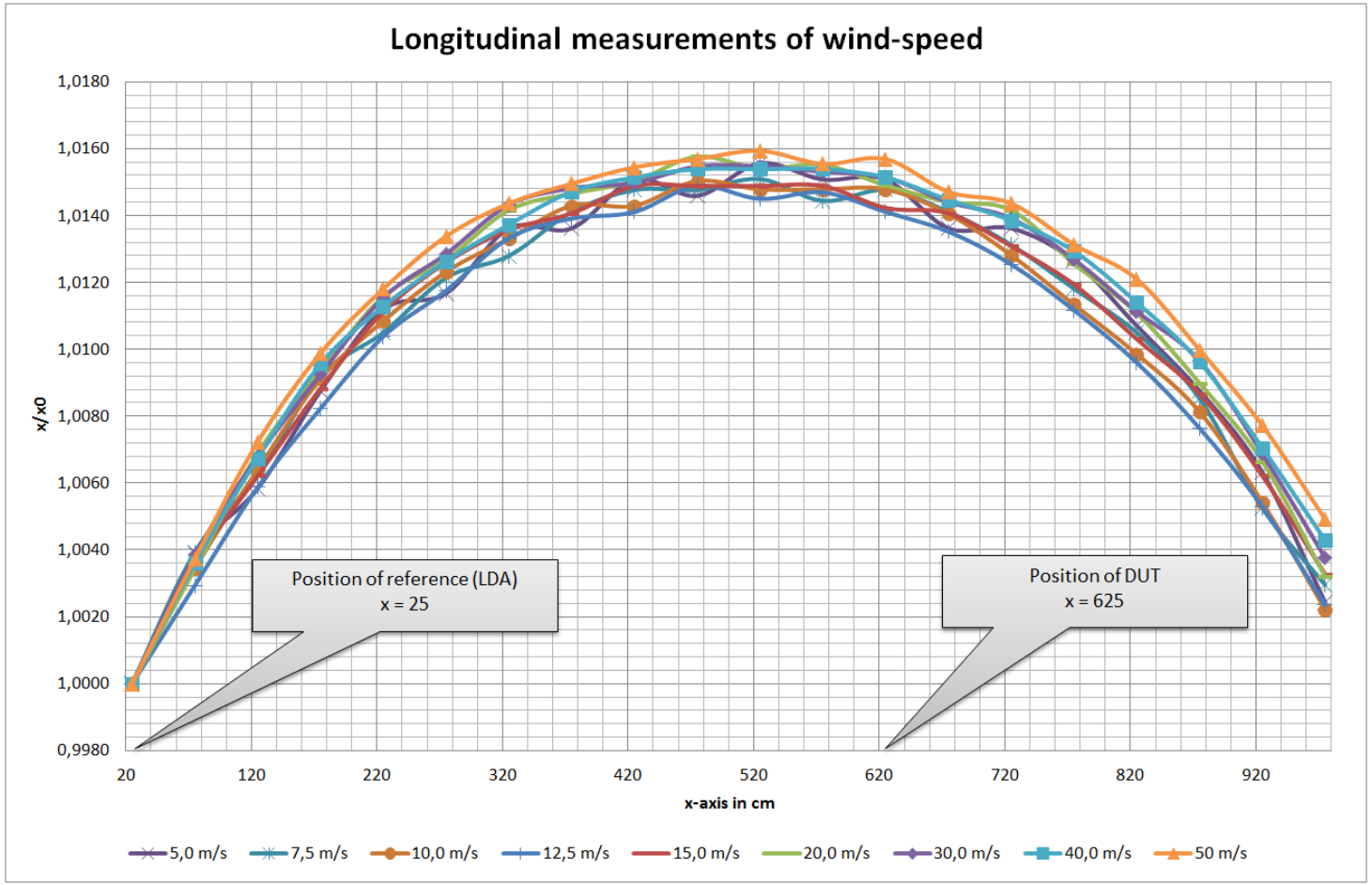
Requirements for the laboratory setup

- reference
  - upstream
  - the presence of the reference shall not substantially affect the flow field in the wind tunnel

- device under test
  - the presence of the anemometer shall not substantially affect the reference measurements

Requirements for the laboratory setup

longitudinal increase of flow speed



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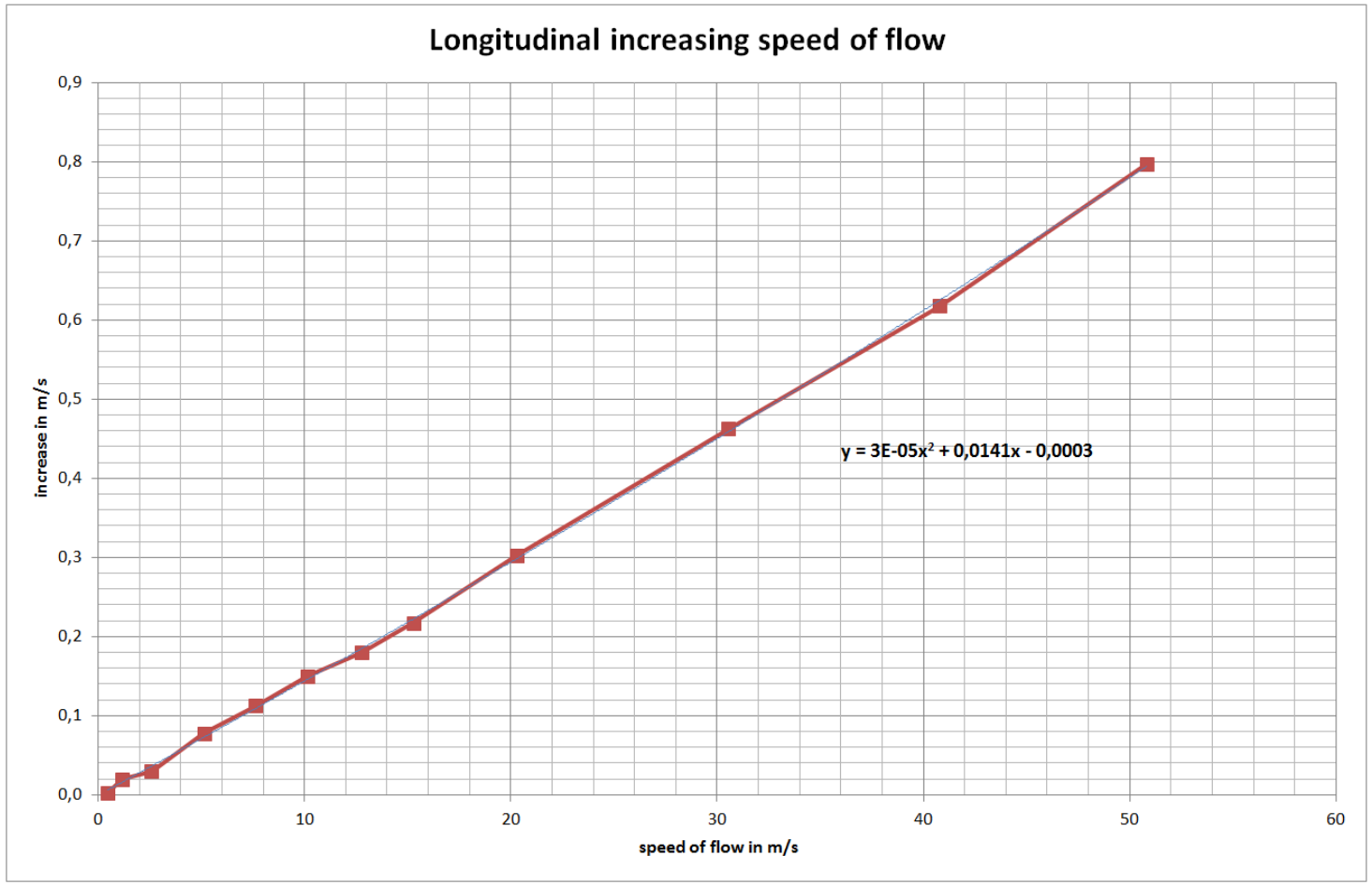
Requirements for the laboratory setup

longitudinal increase of flow speed



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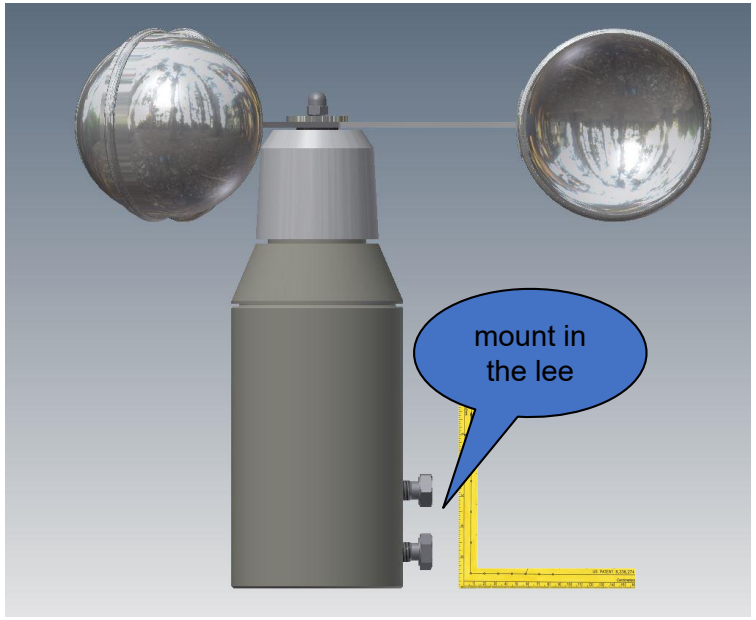
Requirements for the laboratory setup

the influence of the calibration object

- as already mentioned, it is not possible to measure with the reference at the location of the DUT
- each type of DUT in turn influences the flow
- the position of screws alone can lead to changed values



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Requirements for the laboratory setup

the influence of the calibration object

Thies Ultrasonic Compact 2D

Lambrecht u[sonic]

- both are extremely similar
- they differ in only a few details

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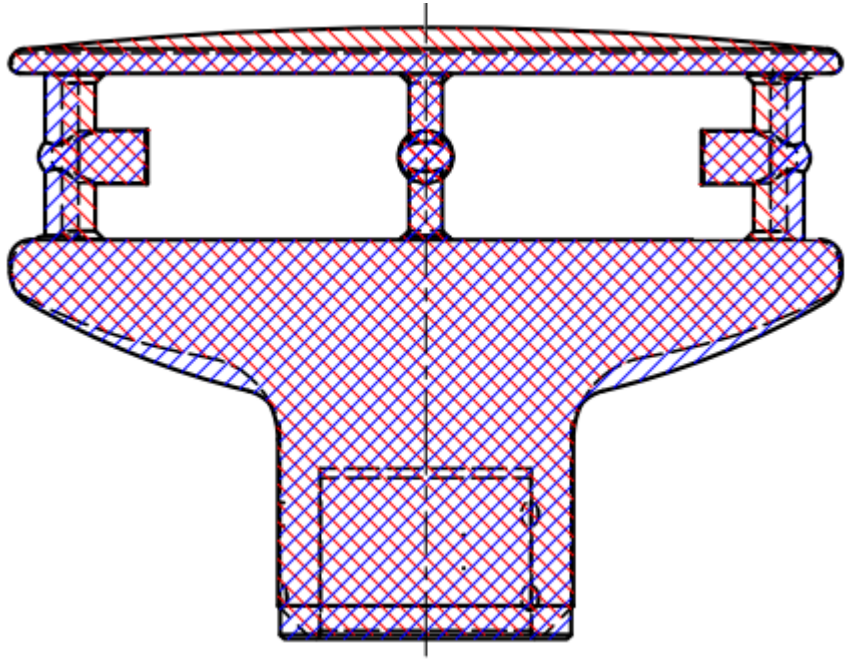
Requirements for the laboratory setup

the influence of the calibration object

- if you overlay both, you can see the differences in detail
- the u[sonic] has a curved lid
- the sonotrodes are mounted slightly differently
- the lower part of the housing differs slightly

- do the differences have an effect???
  - the answer is yes and results in a different correction of the reference measurement values



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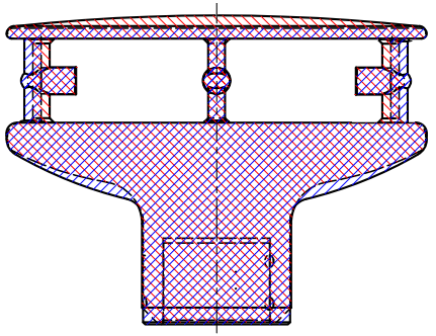
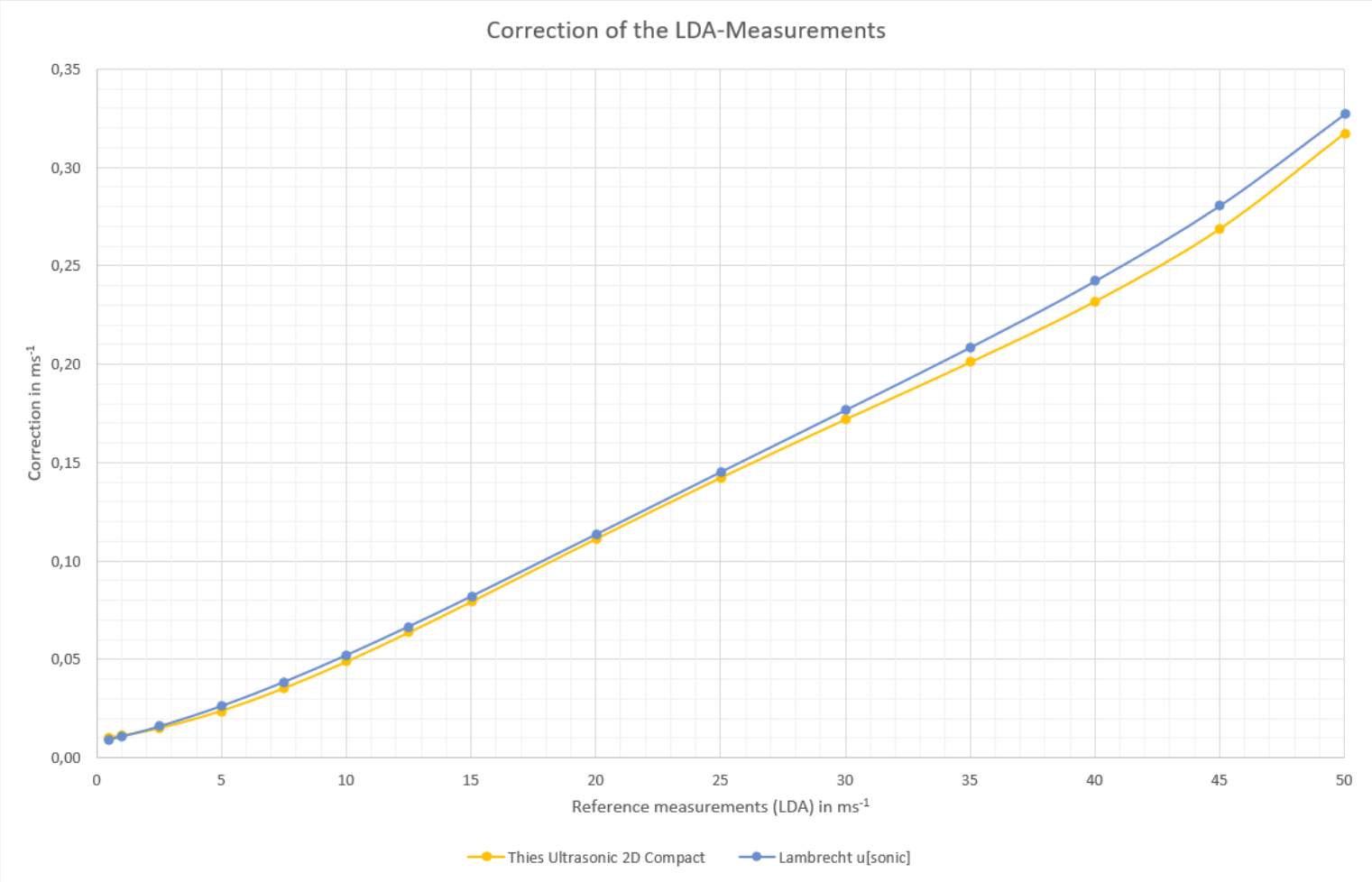
Requirements for the laboratory setup



the influence of the calibration object



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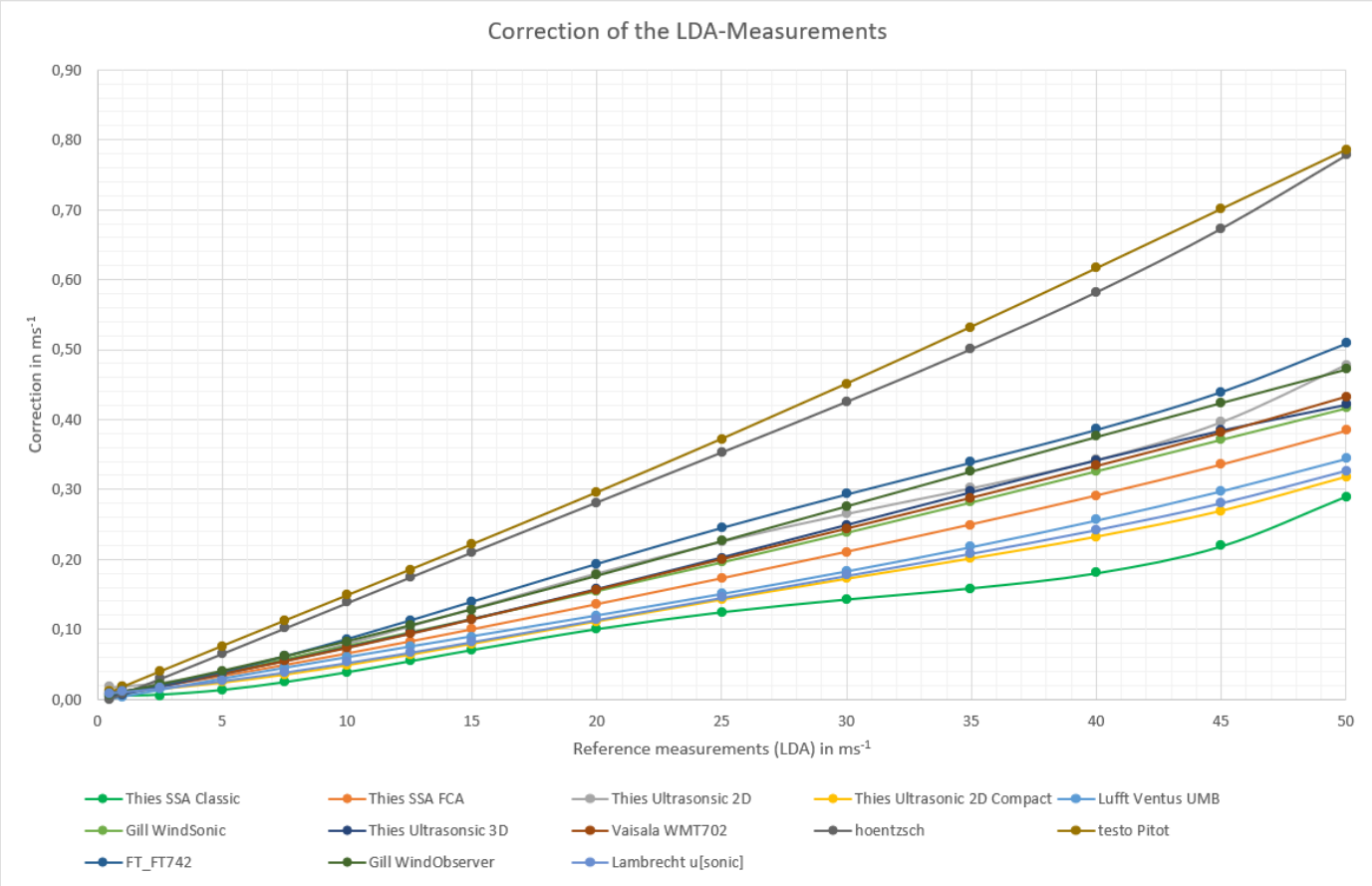
Requirements for the laboratory setup

the influence of the calibration object

- it is necessary to determine a correction curve for each model



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Requirements for the laboratory setup

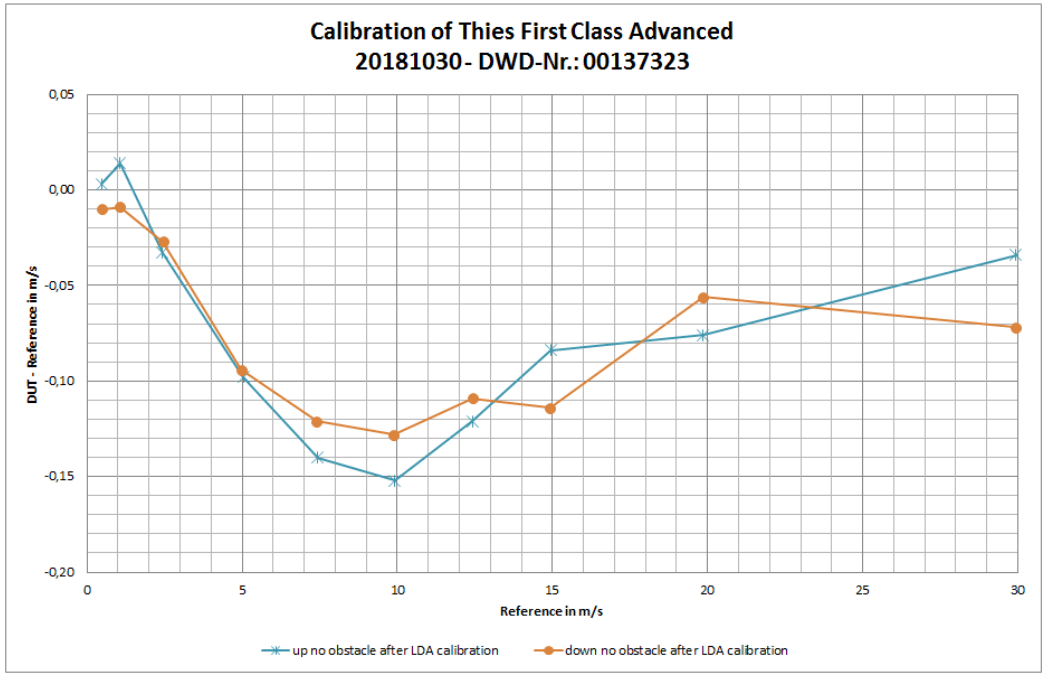
hysteresis

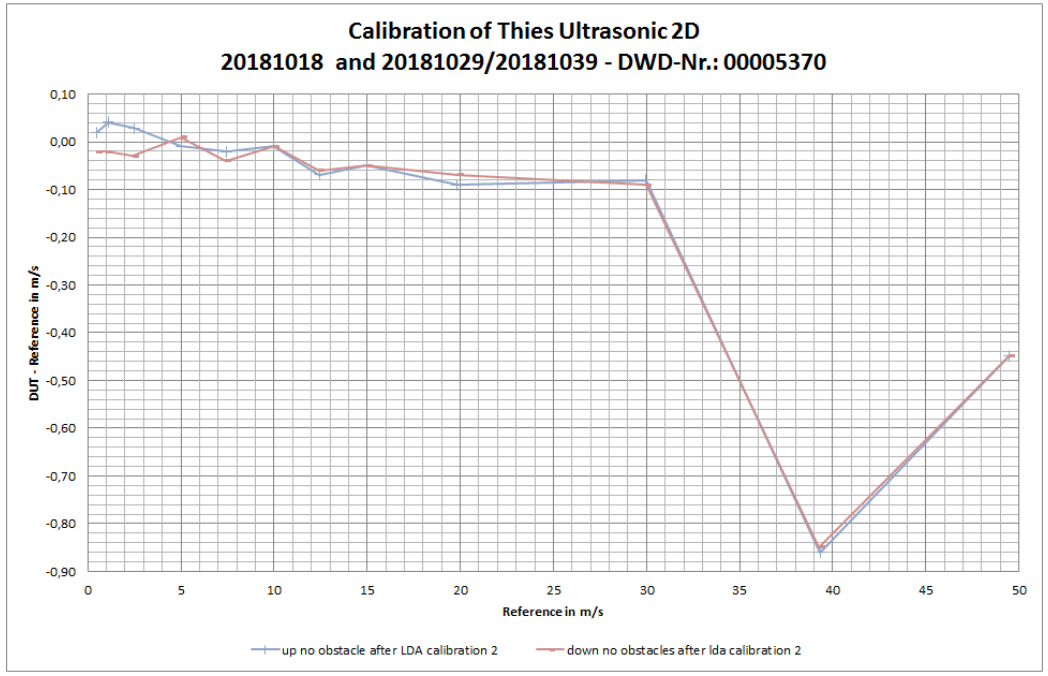
- by taking readings both for increasing steps and for decreasing steps, it is possible to identify hysteresis effects are present in the measuring equipment
  - in case of using LDA there is no hysteresis effect
  - effects may occur using pitot static tubes and using equipment to determine the density of air

Requirements for the laboratory setup

hysteresis

- no hysteresis effect recognizable





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Calibration of Wind Instruments
End of Part 4

Thank you.

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