

Technical University of Denmark



Characterization of a New Open Jet Wind Tunnel to Optimize and Test Vertical Axis Wind Turbines Using Flow Visualization and Measurement

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Objectives

Characterize a new open jet wind tunnel and define the uniform test section where performance studies of small VAWTs will be carried out.

Methods

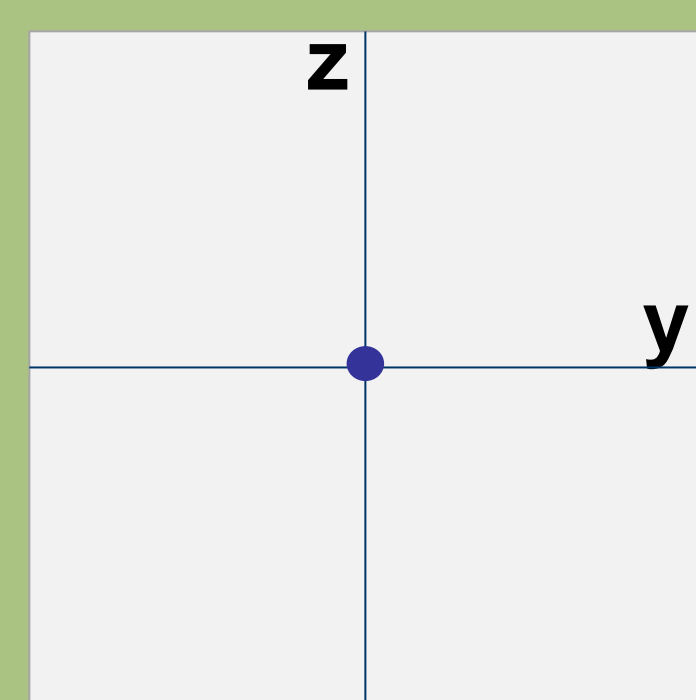


BACK VIEW

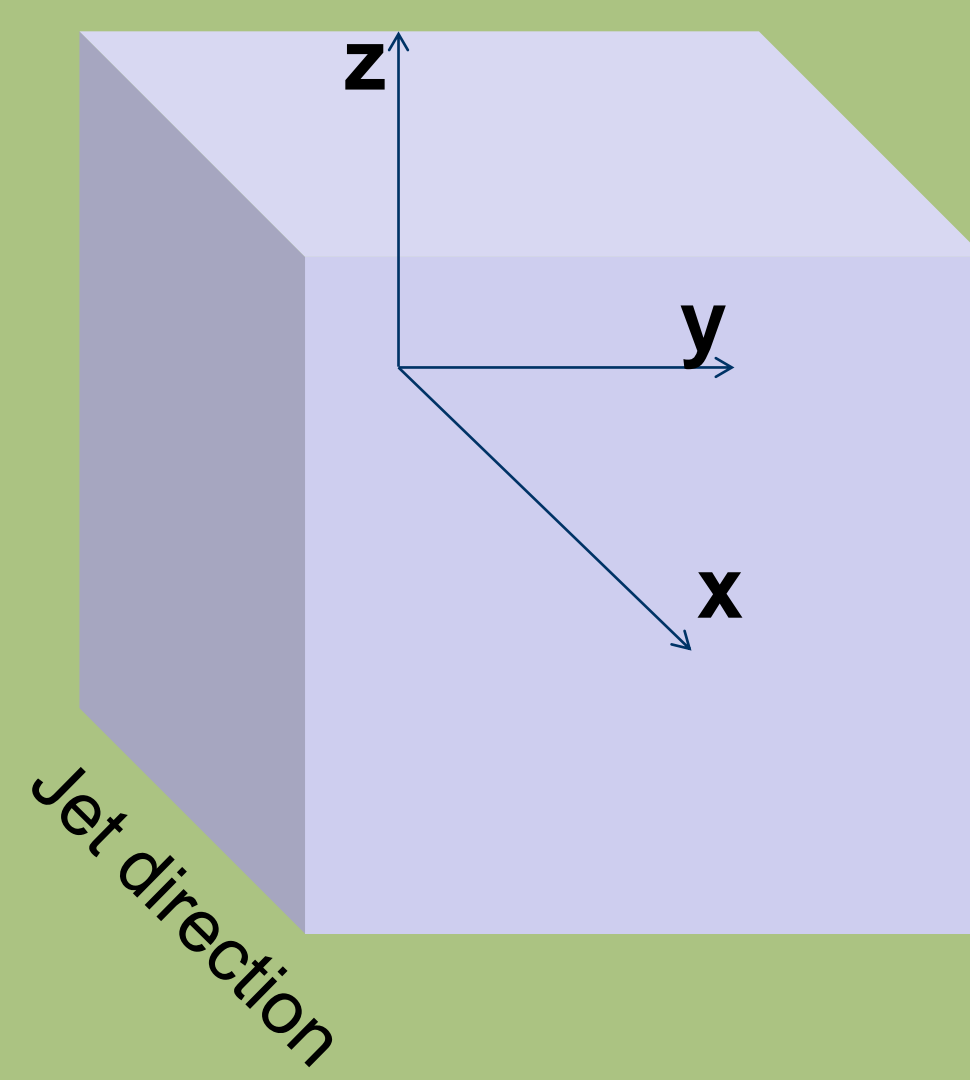
SIDE VIEW

FRONT VIEW

The origin of the coordinate system is in the centre of the nozzle exit



• Coordinate origin

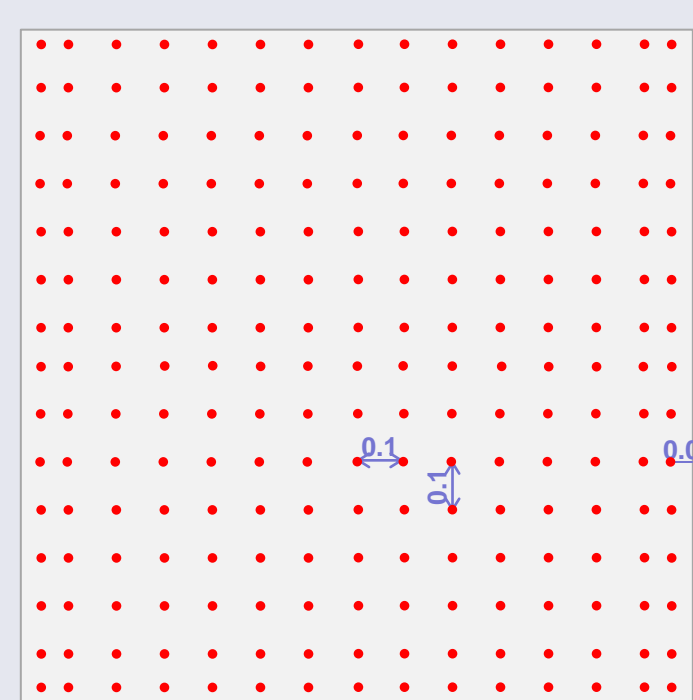


Jet direction

The flow characteristics were analysed by measurements with:

A) Single hotwire probe

The measurements were taken in several planes parallel to the nozzle exit and along the jet axis. The mean velocity as well as the turbulence intensity was estimated at every position of the defined working grid (red points).

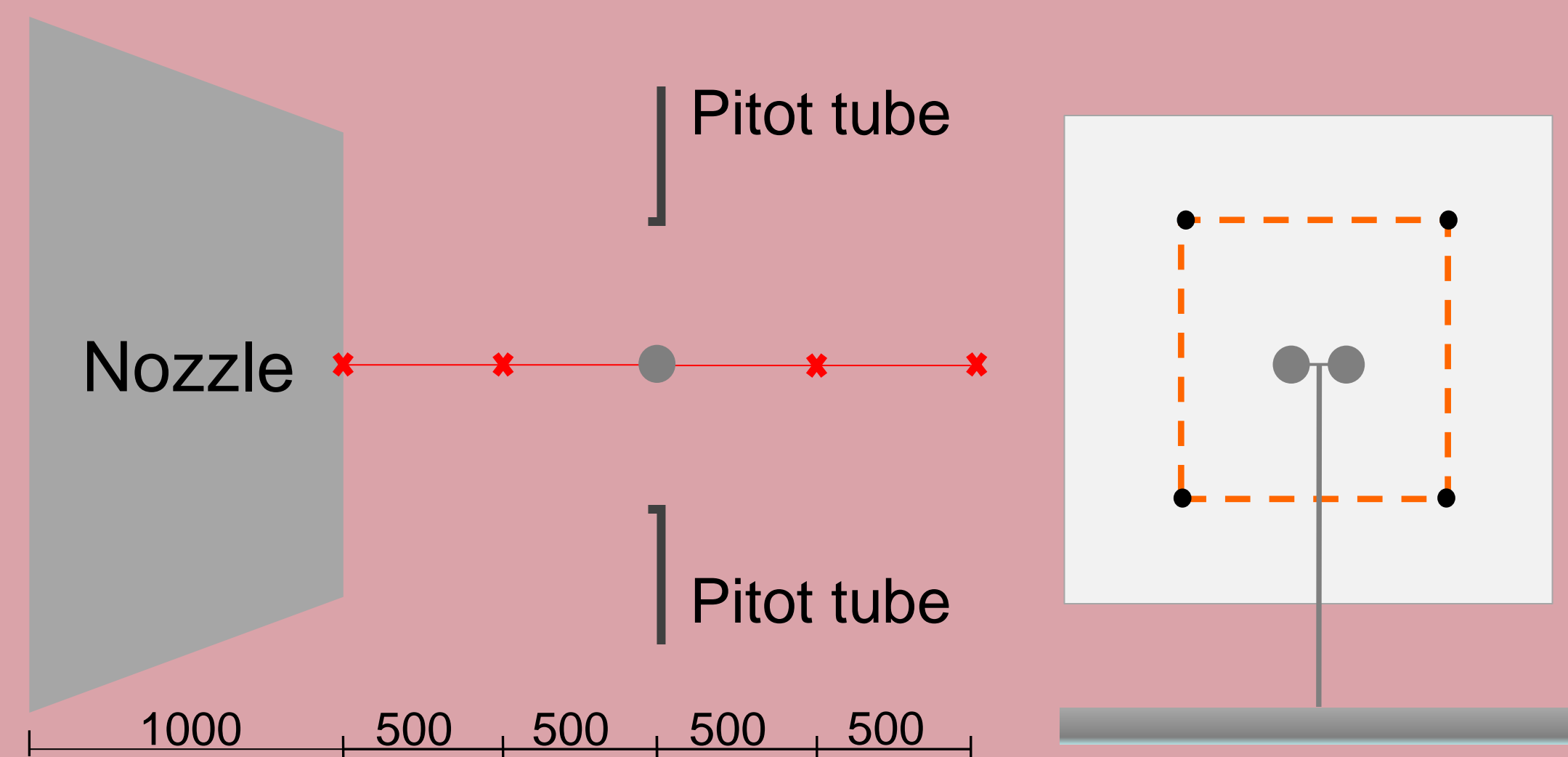


Working grid of the test section.

B) Cup anemometer



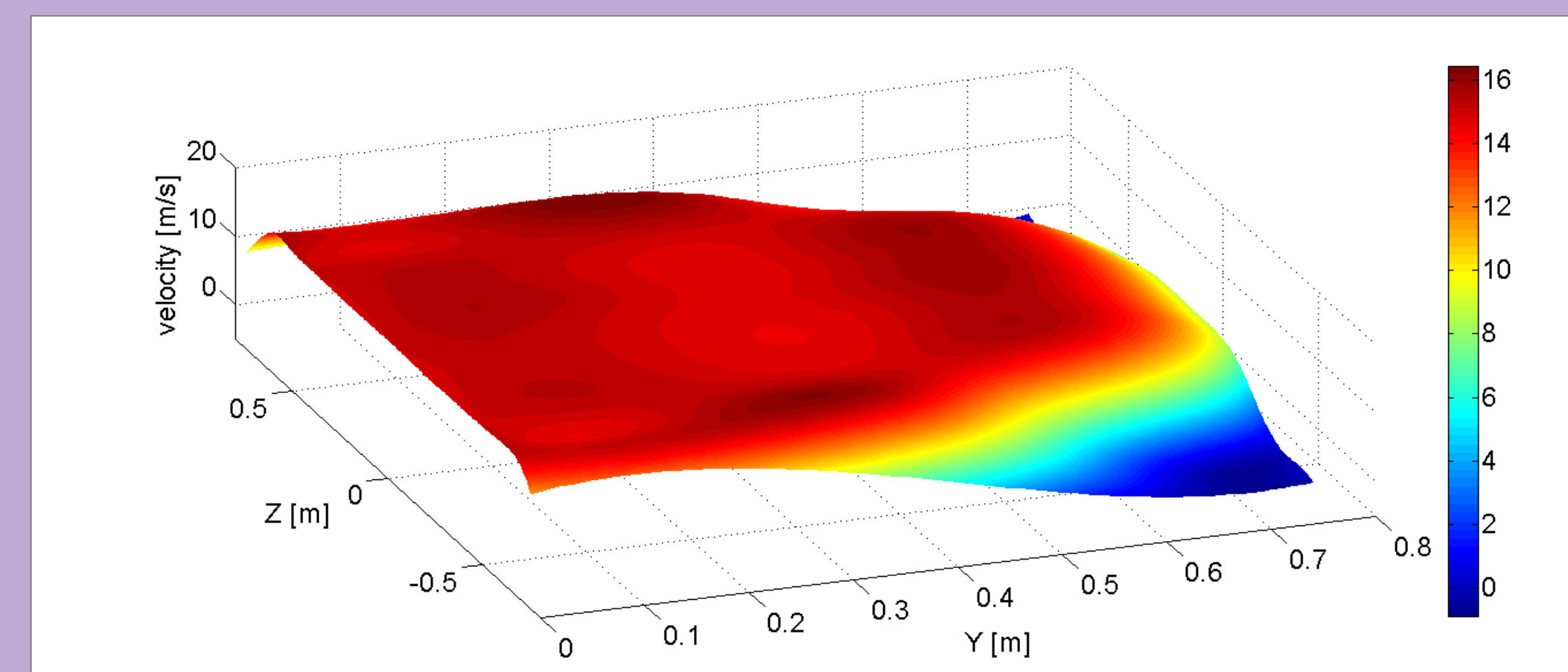
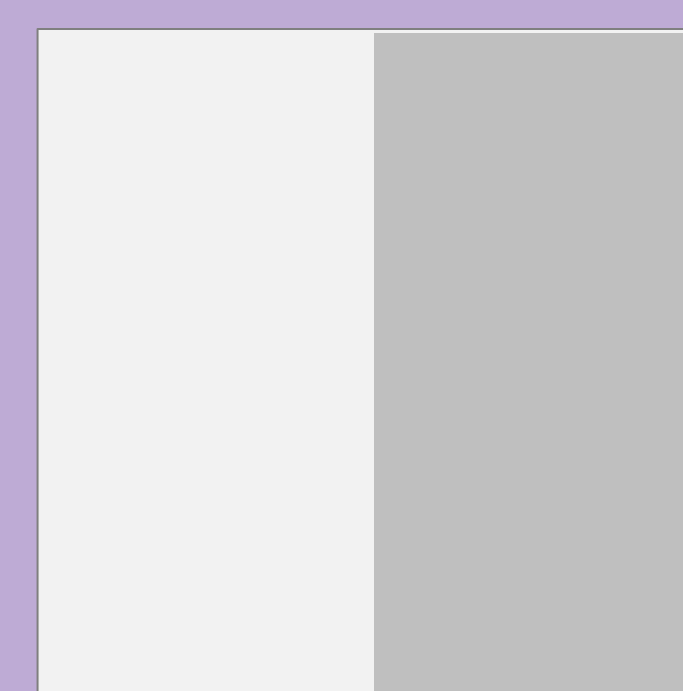
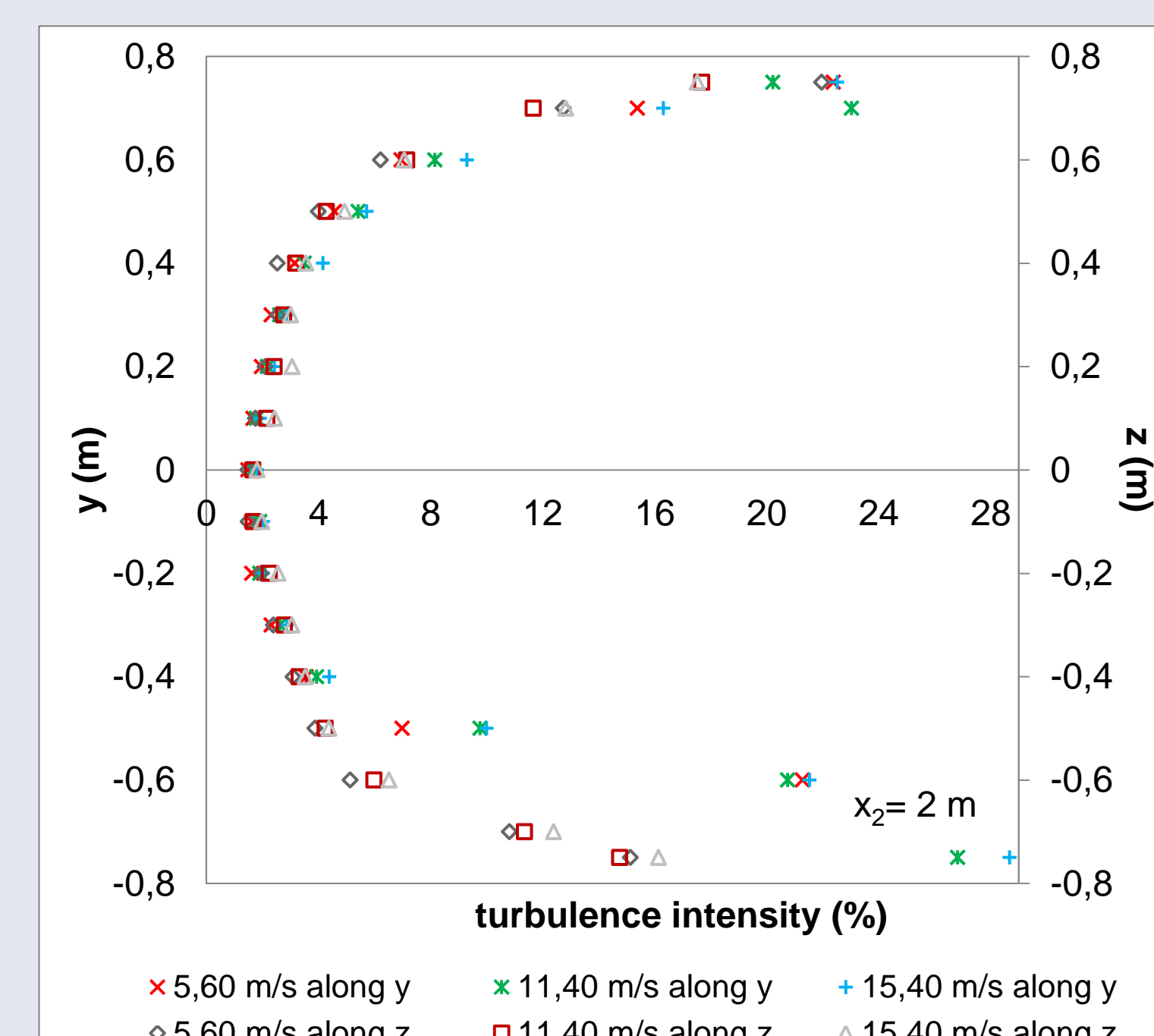
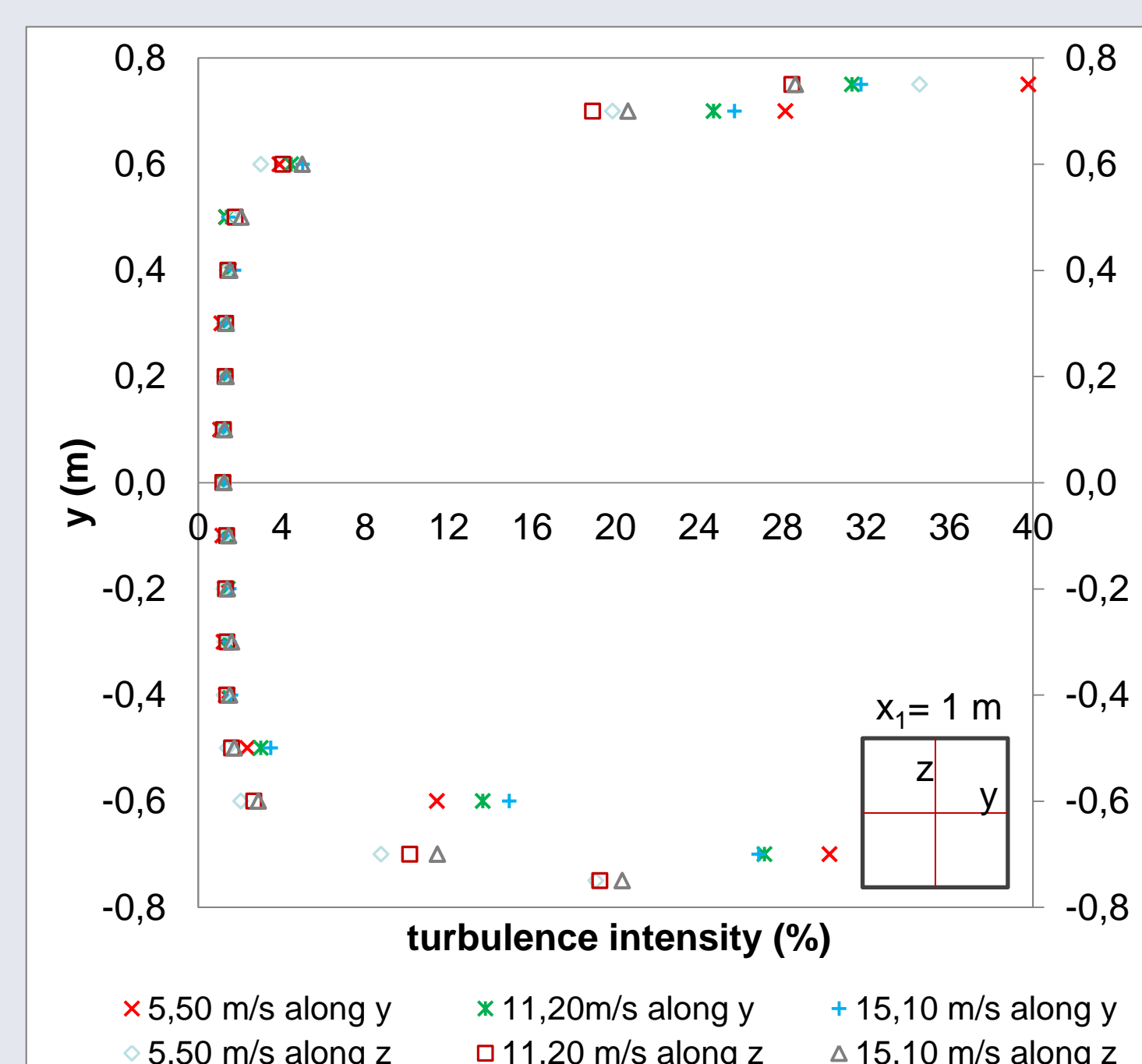
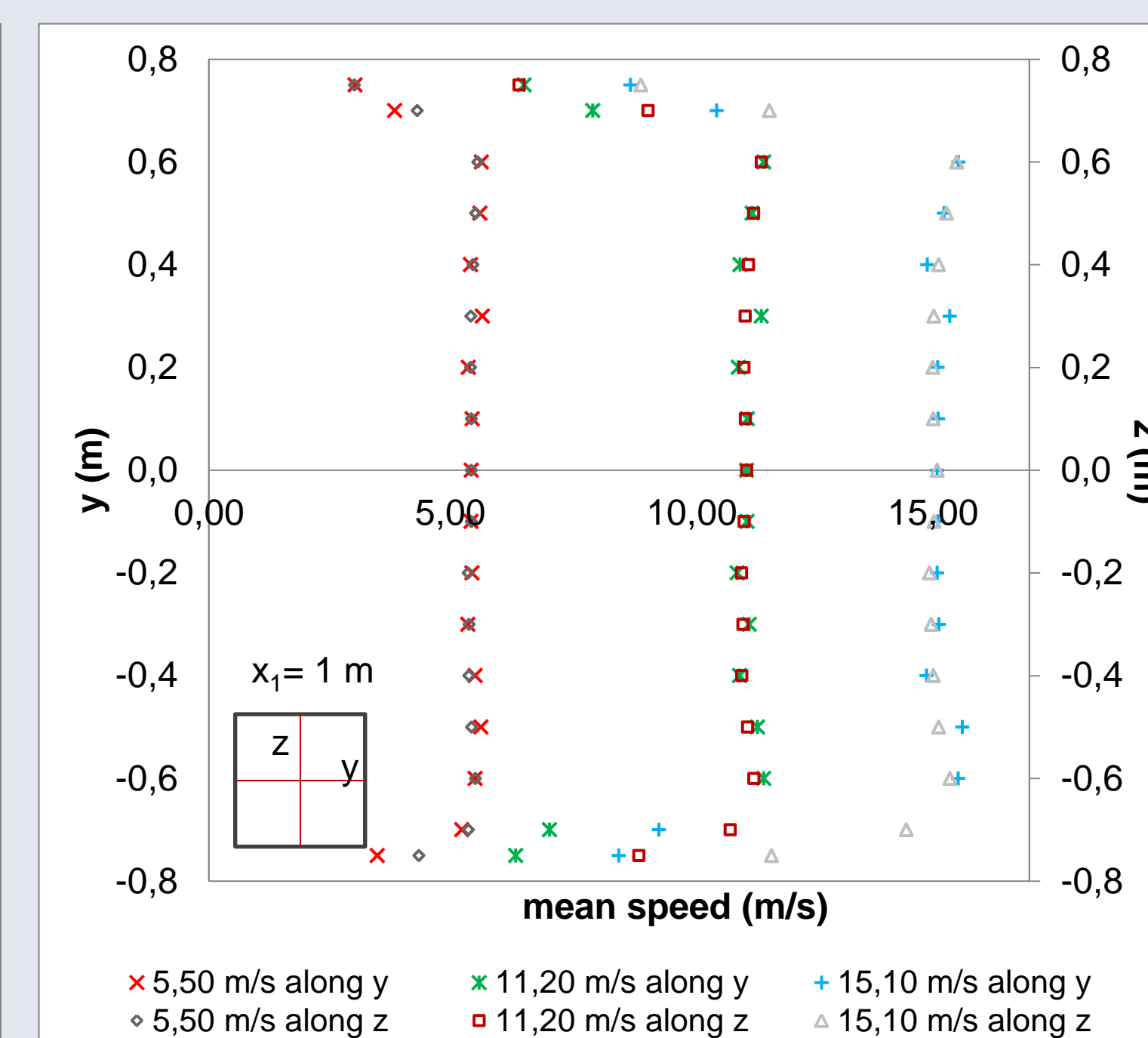
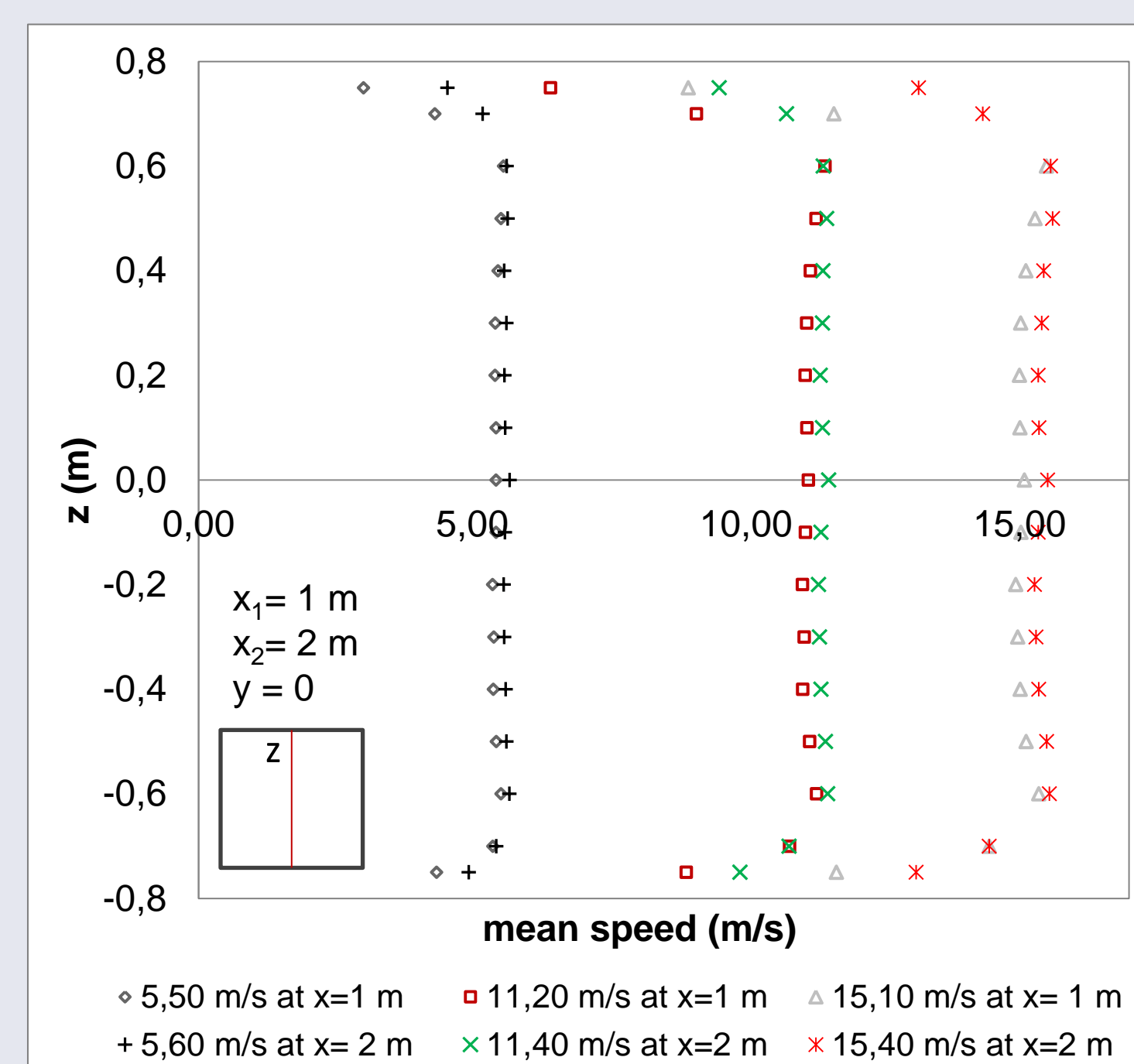
WindSensor
Type P 2546A
Risø DTU



- Test section (1500 x 1500 mm²)
- Uniform test section (800 x 800 mm²)
- × Measured positions
- Pitot tubes positions
- Cup anemometer calibrated

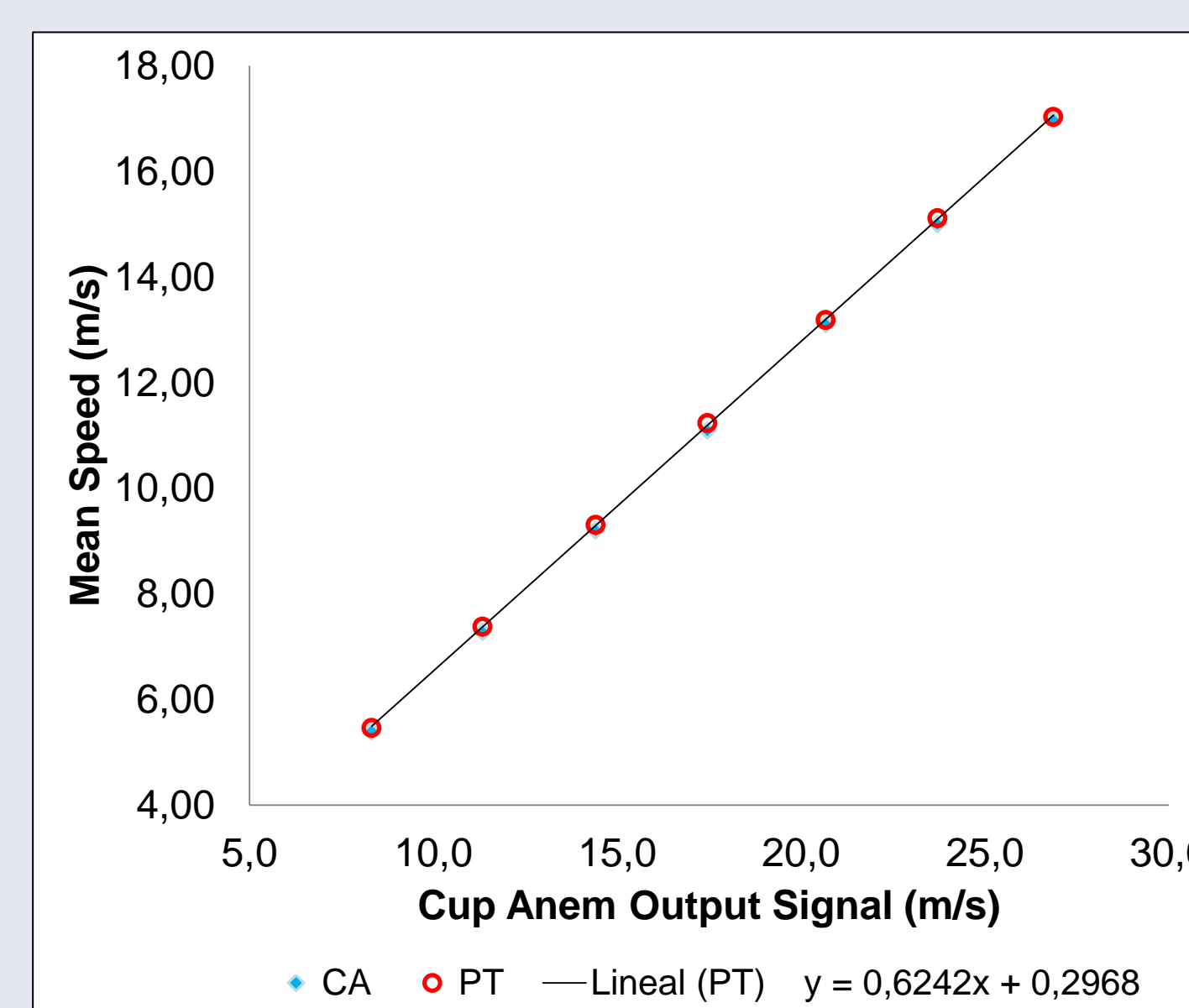
Results

Exit Flow Uniformity and Turbulence Characteristics



The 3D graph presents mean velocity along positive z and y axis

Cup anemometer calibration



Mean speeds by cup anemometer (CA). Average speeds by pitot tubes (PT). Linear fit obtained in 4-Winds OJWT $y=0.6242 \cdot x(m/s)/(1/s)+0.297m/s$.

Conclusions

The final design of the open jet tunnel is original and allows for fair performance at comparably low cost.

Present fair characteristics in the central section.

Can be operated at constants mean velocities and relatively low turbulence intensities.

Results of a cup anemometer calibrated an accredited laboratory show that the test section and conditions can provide new insight of cup anemometers.