Universität Rostock

Traditio et Innovatio

Hydrodynamic Loads on Two-Dimensional Sheets of Netting within the Range of Small Angels of Attack

by

Mathias Paschen & Karsten Breddermann

10th International Workshop

“Methods for the Development and Evaluation of maritime Technologies – DEMaT’11”

Split, October 26th – 29th, 2011

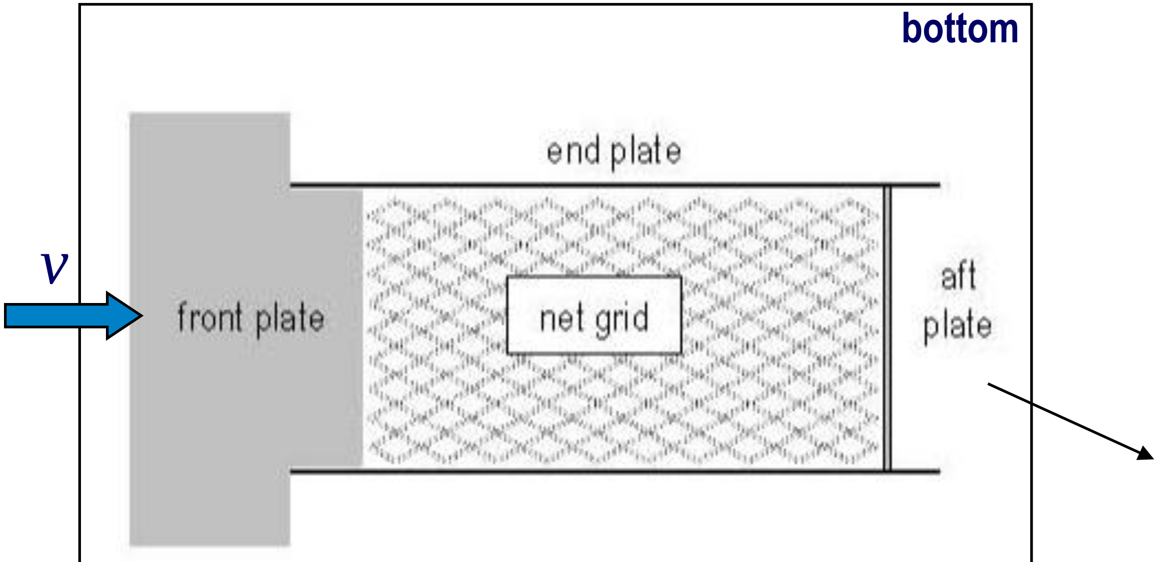
Intention:

- Improving the understanding of fluid-structure interactions in net-like structures especially in the cod-end of trawls ➔ indication for selectivity (?)

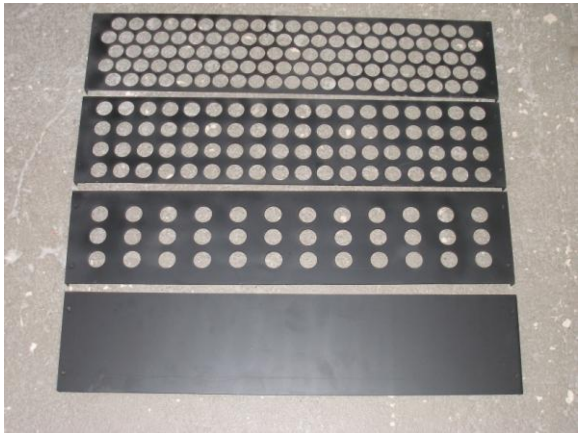
Methods used:

- Experimental methods:
  - wind tunnel tests with a stiff net grid [measurement of loads and current distribution by PIV and heated wires, several devices for current-manipulation]
- Theoretical methods:
  - Reynolds averaged Navier-Stokes (RANS) method and
  - Potential theory (Conformal mapping)

Experimental set-up



Top view of the experimental set-up



Perforated plates used for experimental simulation of porosity (*clogging due to caught fish*) of the aft part

Parameters of the grid:

l = 1450 mm   b = 750 mm

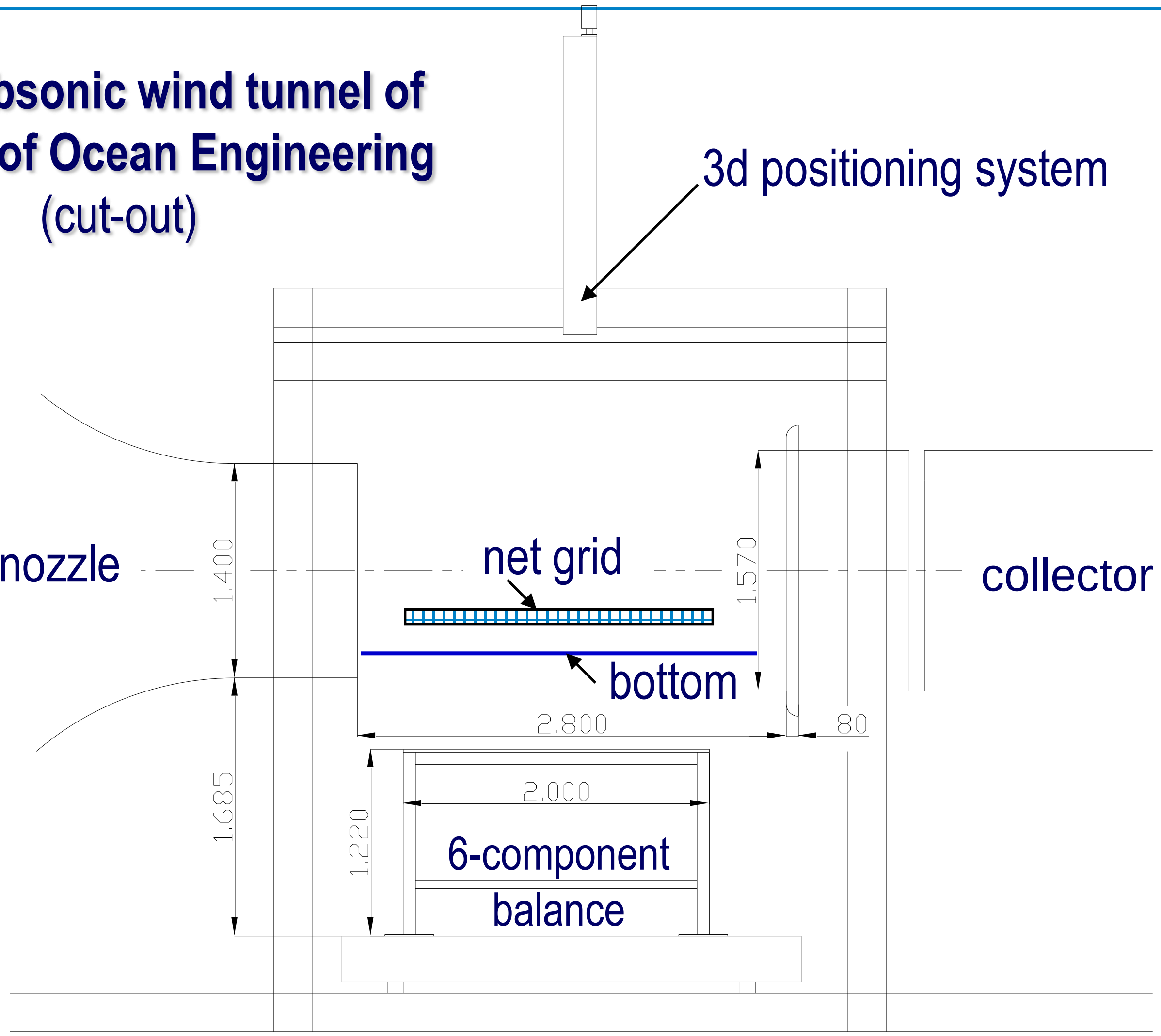
d = 10 mm   a = 83 mm

u_1 = 0.5   d/a = 0.12

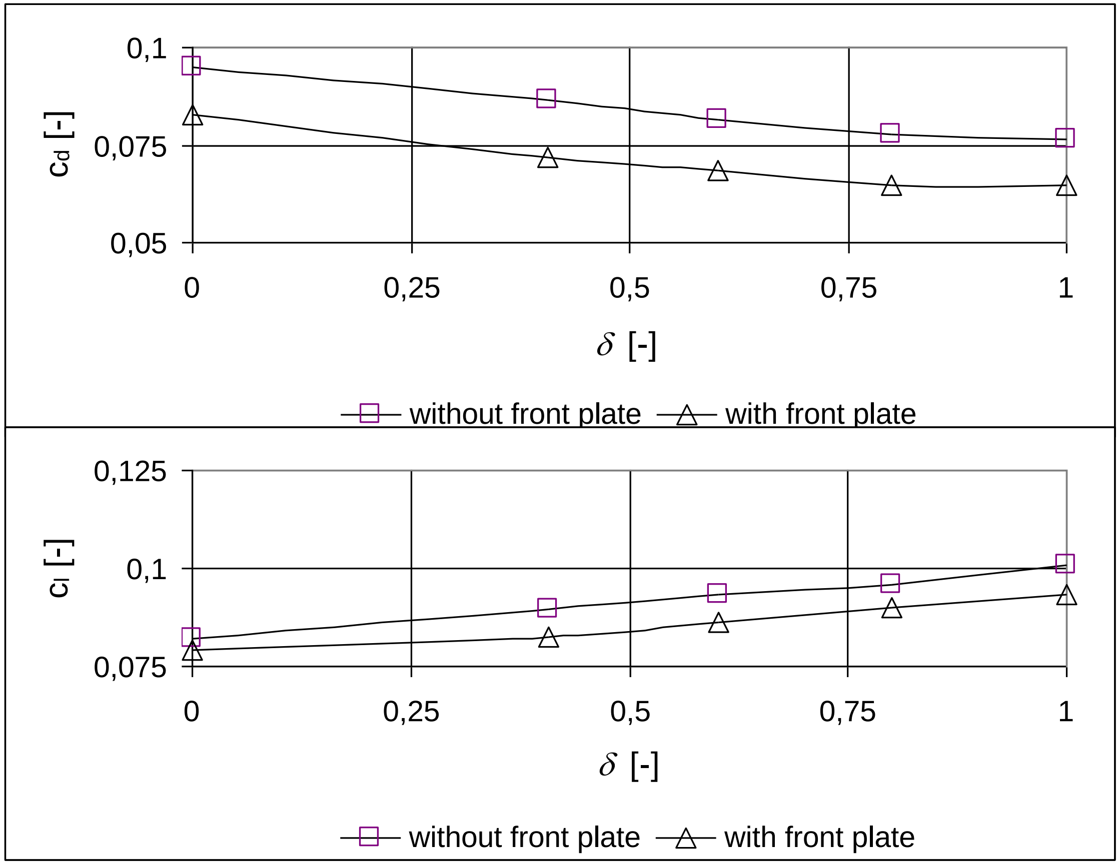
distance to the bottom: 167 mm

Experimental set-up

Large subsonic wind tunnel of the Chair of Ocean Engineering (cut-out)

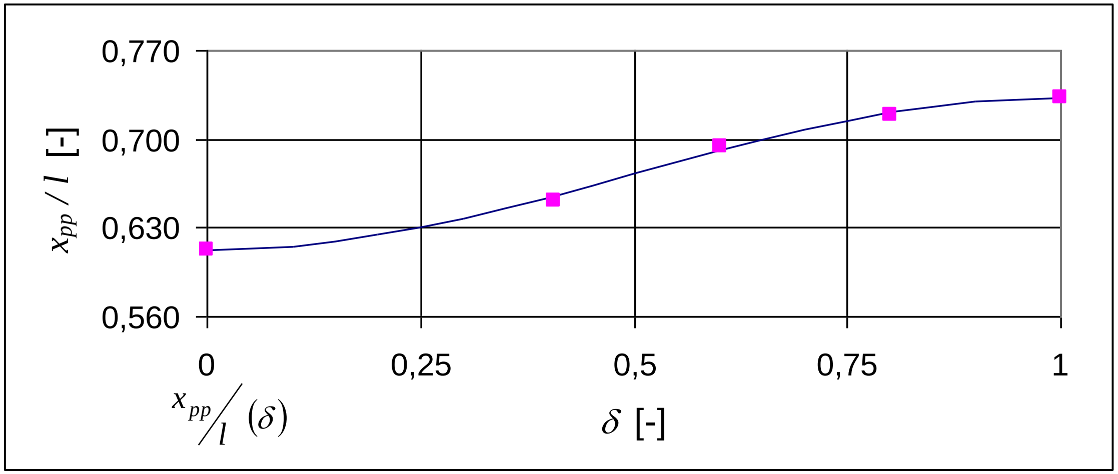


Results of experimental investigations



Influence of clogging δ on the dimensionless drag (c_d) and lift (c_l) coefficients

Results of experimental investigations



Position of the centre of pressure of the net grid against clogging δ (front plate)

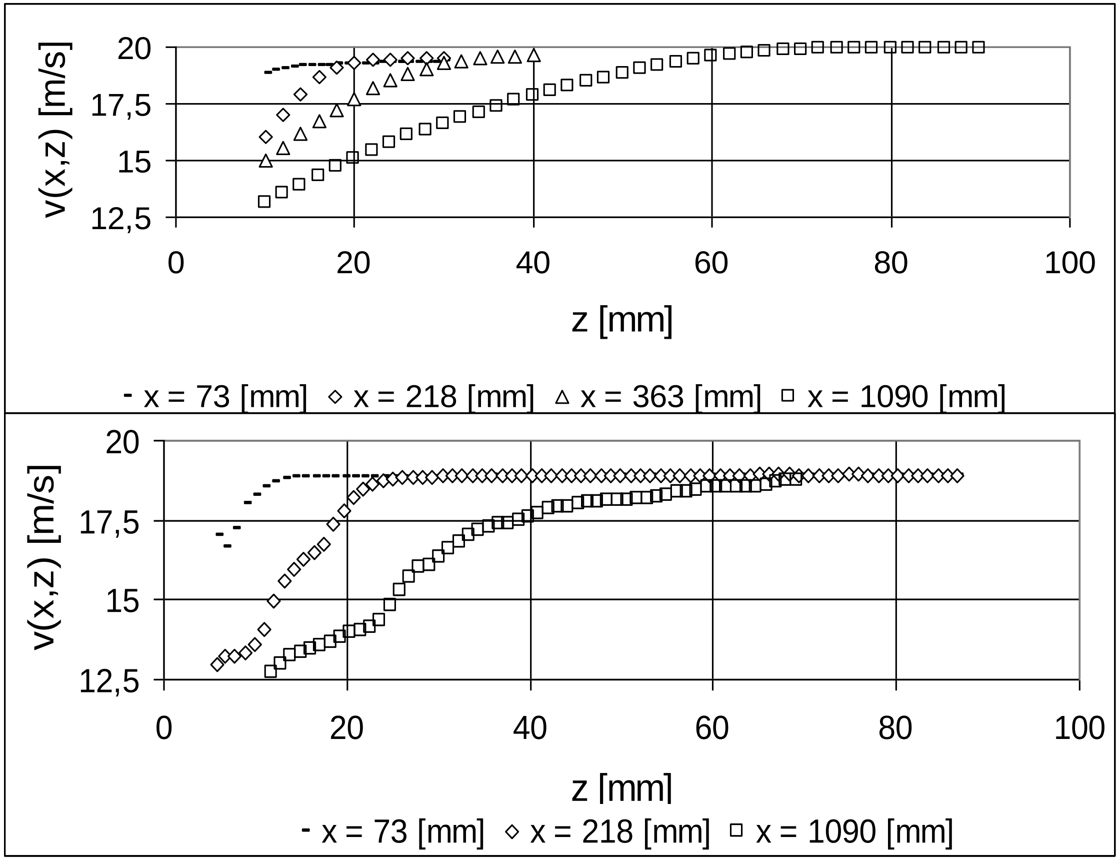
$$\frac{x_{pp}}{l}(\delta) = \left[\frac{x_{pp}}{l}(\delta = 1) - \frac{x_{pp}}{l}(\delta = 0)\right] \cdot \sin^2 \delta \cdot \frac{\pi}{2} + \frac{x_{pp}}{l}(\delta = 0)$$

with

$$\frac{x_{pp}}{l}(\delta = 0) = 0.613 \quad \text{and} \quad \frac{x_{pp}}{l}(\delta = 1) = 0.733.$$

Chair of Ocean Engineering
M. Paschen & K. Breddermann

Results of experimental investigations



measured by heated wire

v_0 = 19. 35 [m/s]

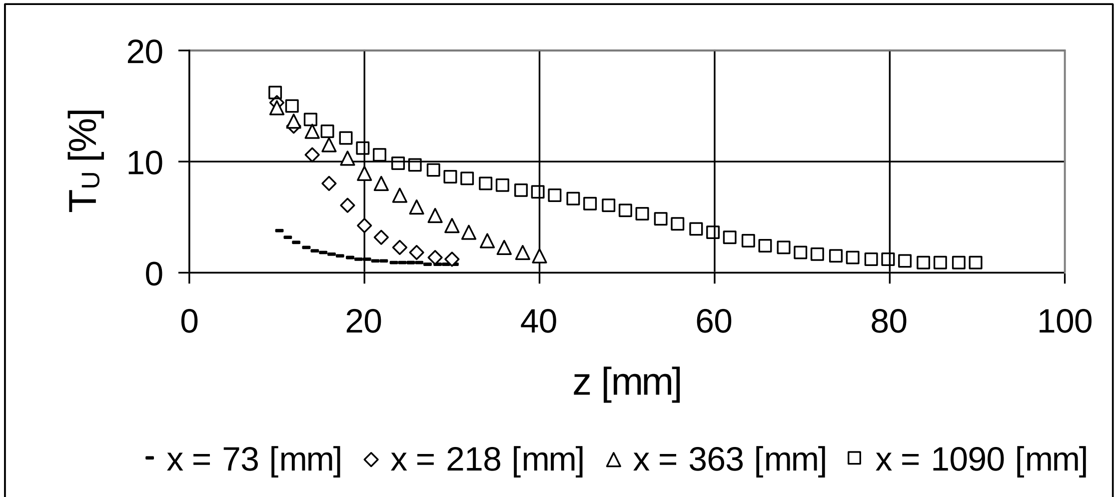
measured by PIV

$v_0 \approx$ 18.9 [m/s]

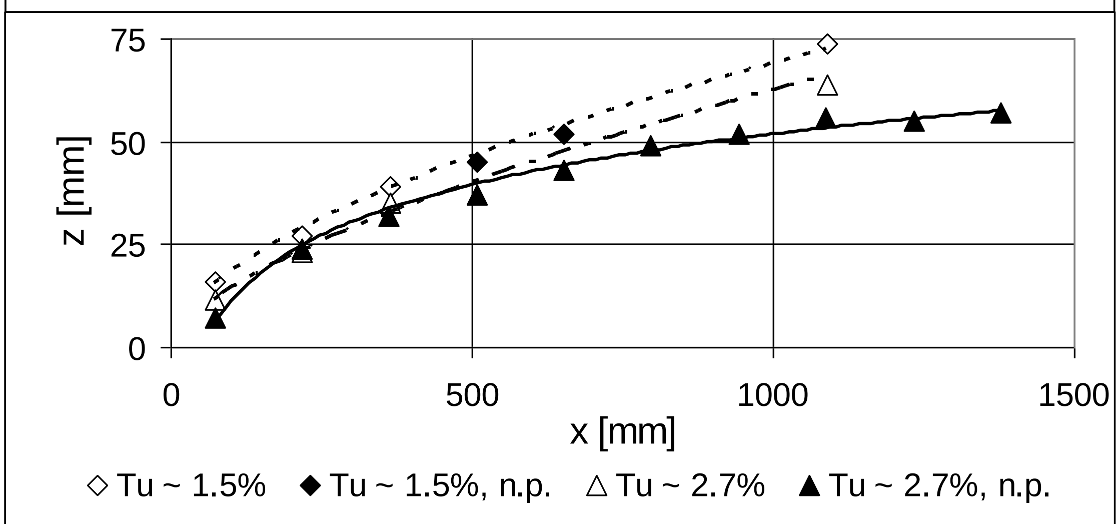
v(x,z) above net grid

v(x,z): resulting velocity in x-z-plane

Results of experimental investigations



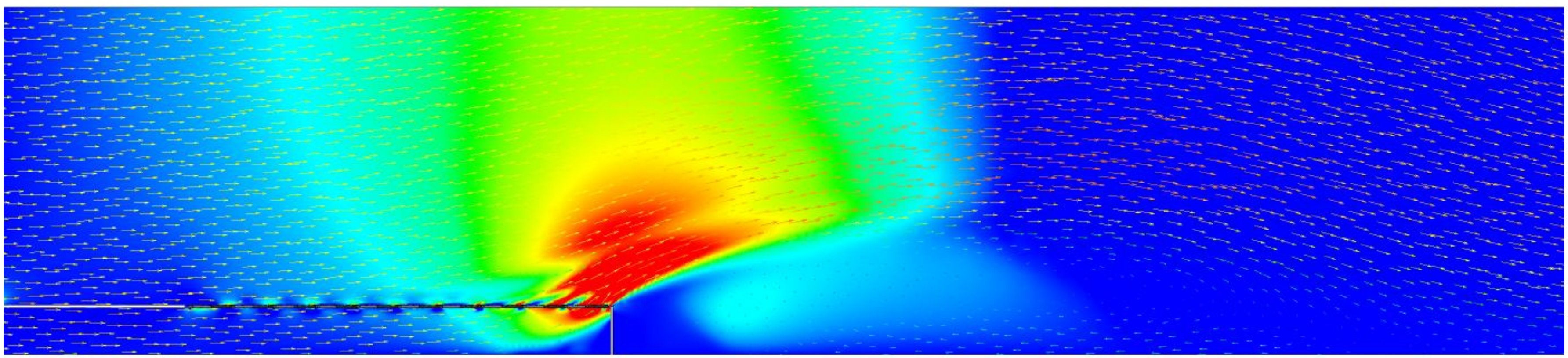
Intensity of turbulence of the current T_U above net grid measured by heated wire, $\delta = 1$, $v_0 = 19.35$ [m/s]



Curve of constant intensity of turbulence T_U above net grid measured by heated wire, $v_0 = 19.35$ [m/s]

(n.p.: free current without any front plate and aft plate)

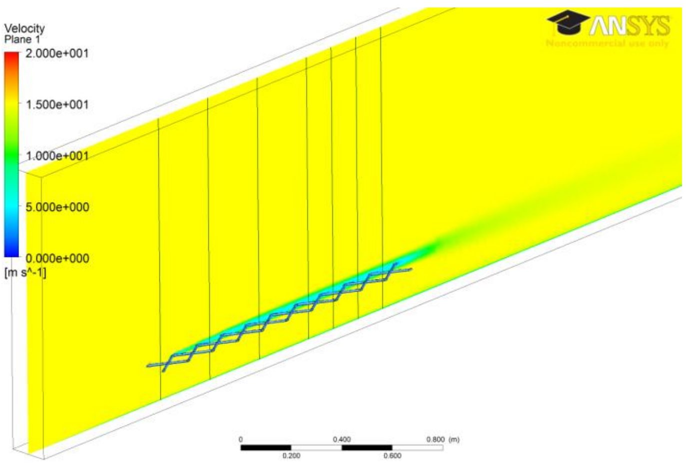
Prediction of the flow patterns around and through a net grid with Reynolds averaged Navier-Stokes (RANS) method

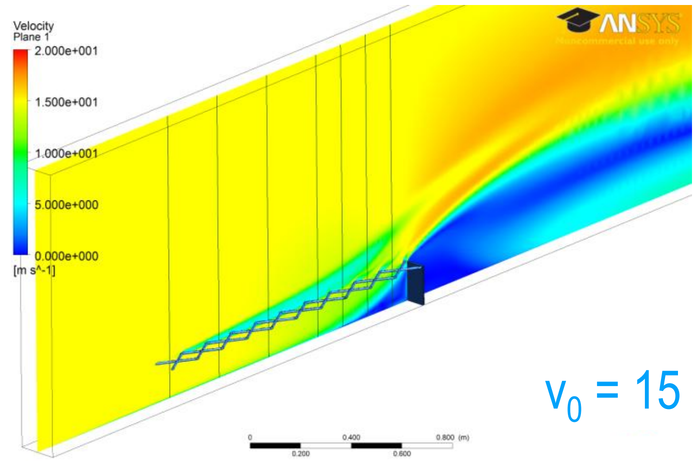


here: vector plot of calculated distribution of current close to the net grid

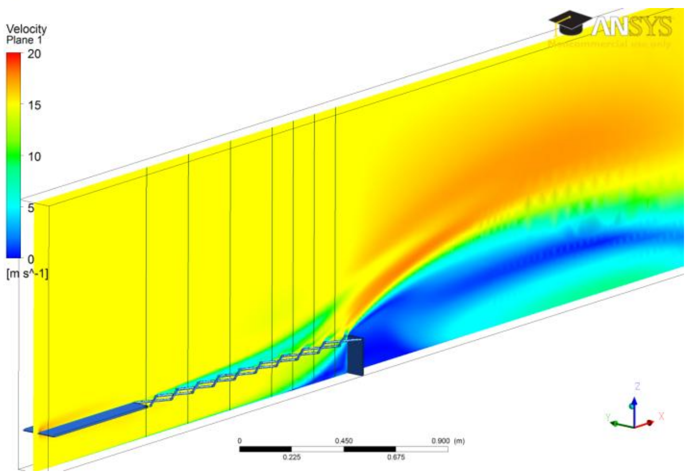
$v_0 = 15\ [ms^{-1}]$

Results of numerical simulations





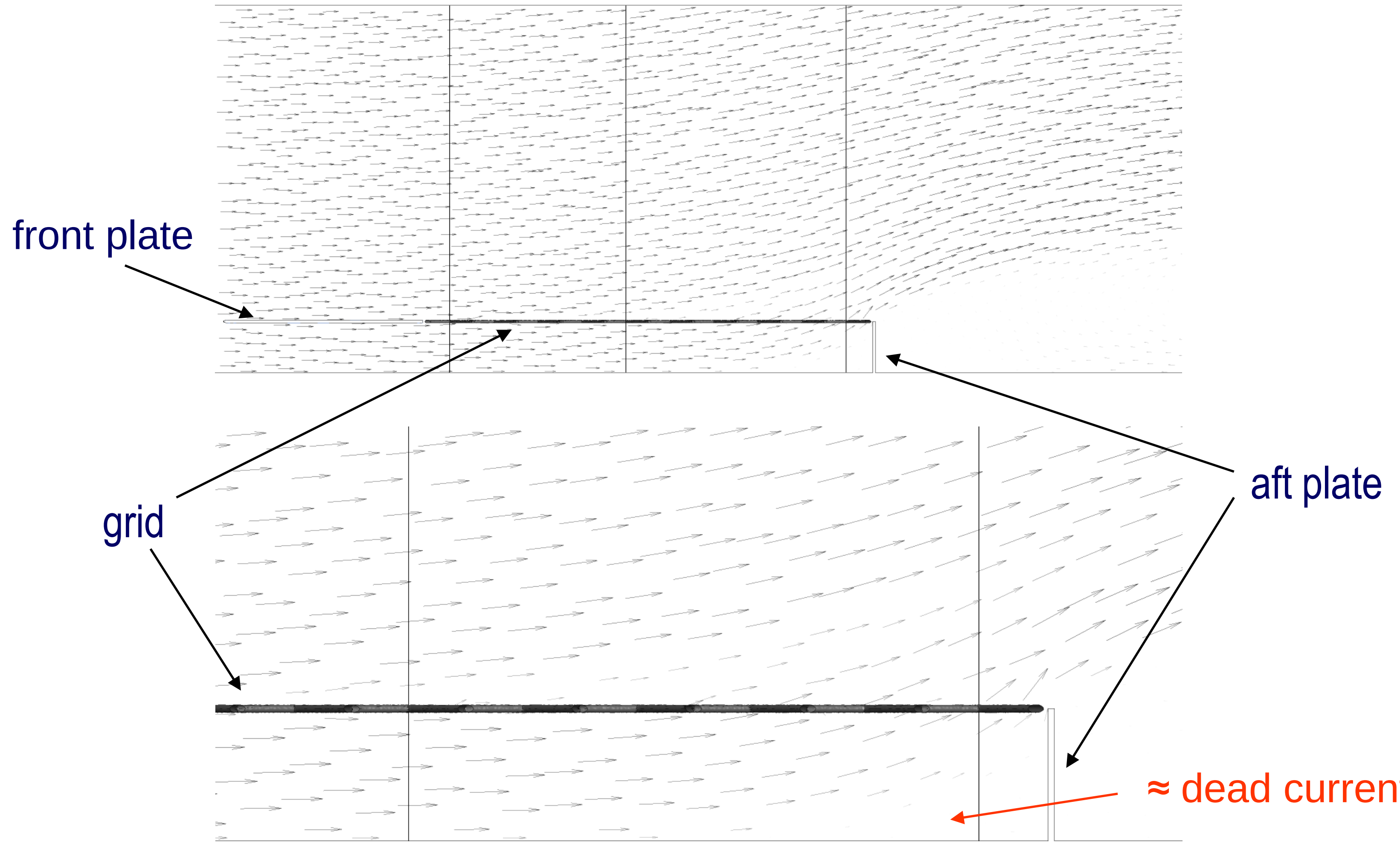
$v_0 = 15$ [ms-[1]]



To limit the numerical effort for the simulations the net grid was reduced to 2 meshes in the breadth. The length of the net grid and the parameters of the meshes were the same which were used during the model tests.

Number of cells and knots varied between 5.85 to 6.02 million and 1.29 to 1.39 million, respectively.

Results of numerical simulations

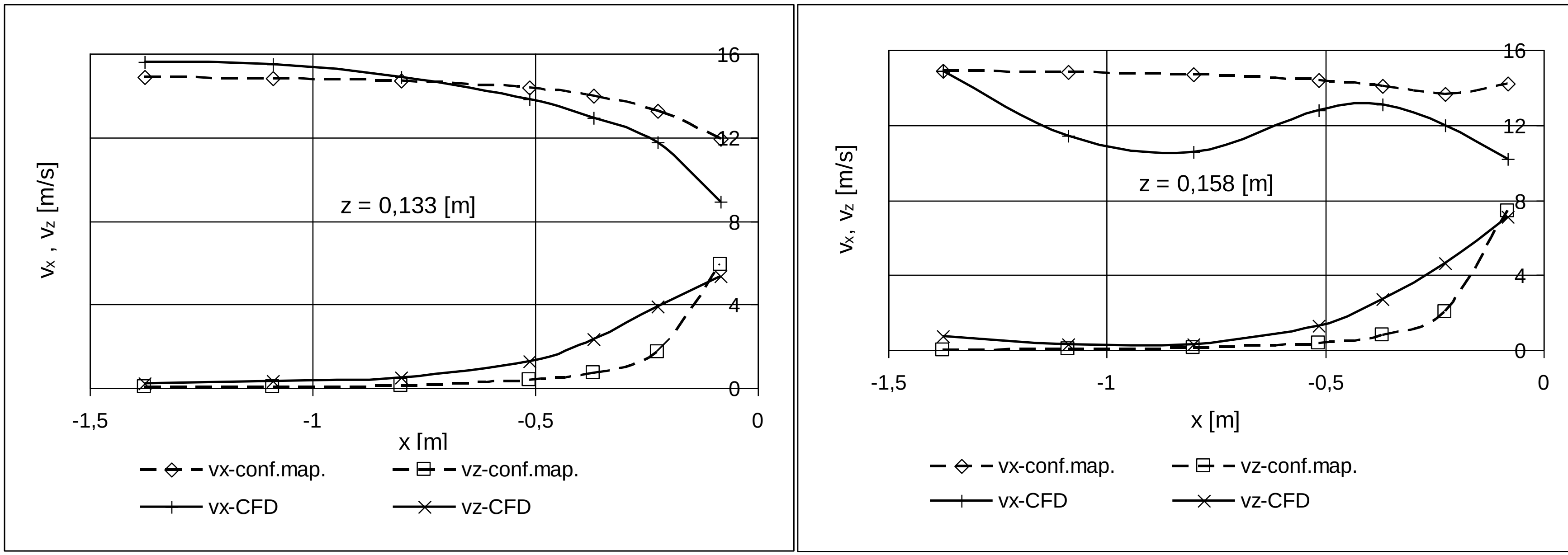


Vector plot of calculated distribution of current

$v_0 = 15$ [ms^{-1}]

Chair of Ocean Engineering
M. Paschen & K. Breddermann

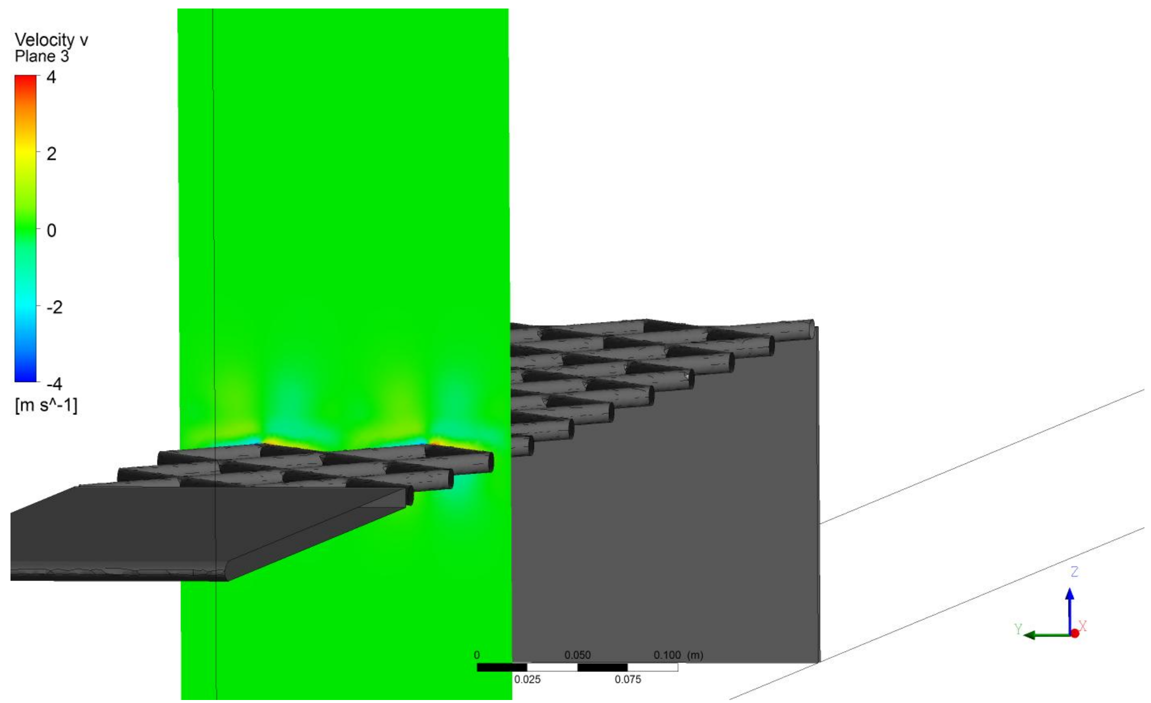
Results of numerical simulations



Results of compare-able numerical simulations regarding distribution of current between bottom and net grid

here: conformal mapping and CFD

Results of numerical simulations

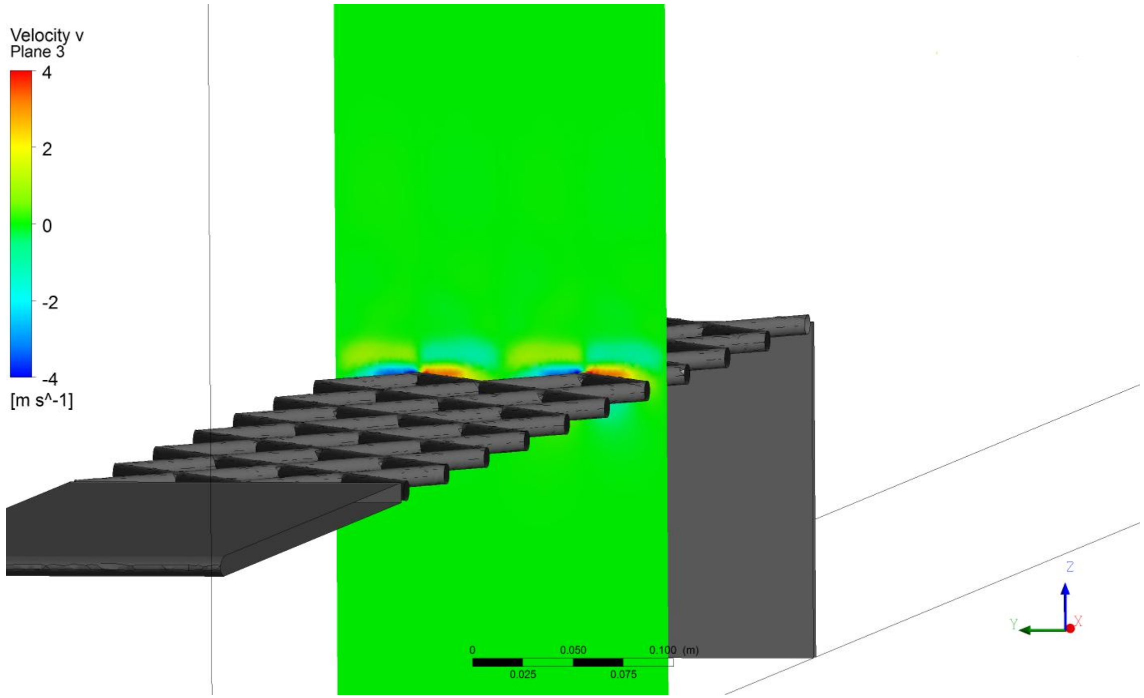


Results of in y-z- plane,

Mesh no. 2.5

$v_0 = 15$ [ms-^{1}]

Results of numerical simulations

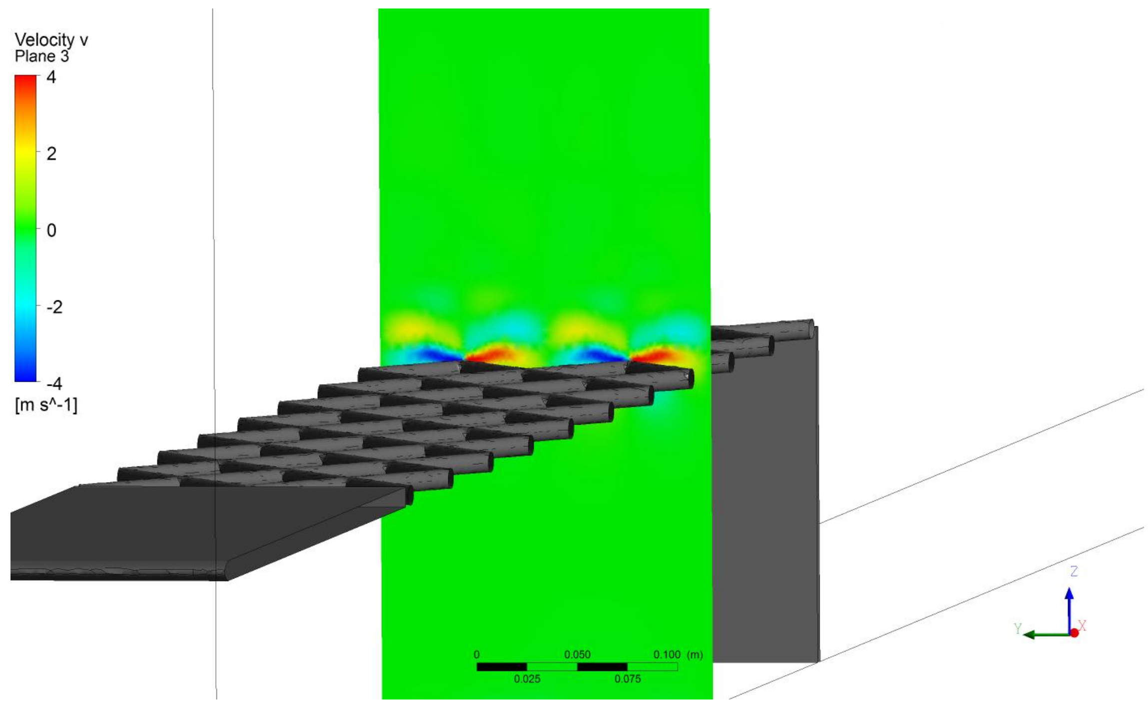


Results of in y-z- plane,

Mesh no. 6.5

v_0 = 15 [ms-1]

Results of numerical simulations

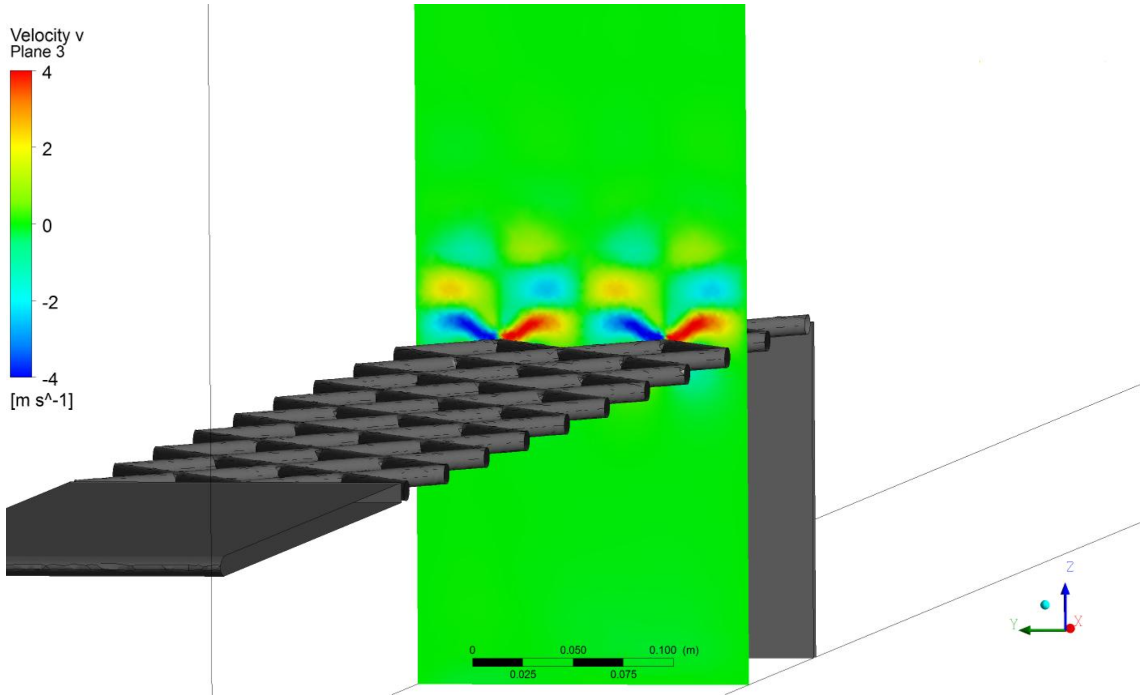


Results of in y-z- plane,

Mesh no. 7.5

v_0 = 15 [ms-1]

Results of numerical simulations



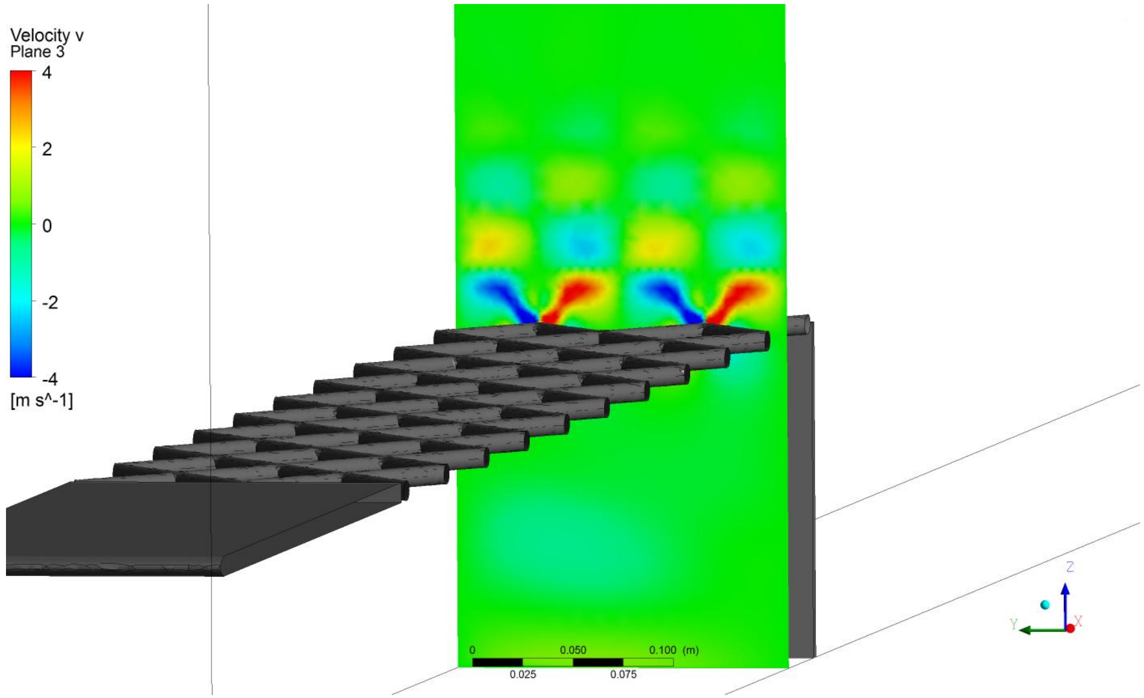
Results of in y-z- plane,

Mesh no. 8.5

v_0 = 15 [ms-^{1}]

Universität Rostock — Traditio et Innovatio

Results of numerical simulations



Results of in y-z- plane,

Mesh no. 9.5

$v_0 = 15$ [ms-^{1}]

Summary

- The results show that the experimental set-up has an enormous influence on net panels drag and lift coefficients. Marginal modifications may lead to significant changes.
- The results demonstrate an extensive dependency of both the installed front plate and the porosity of the aft plate on the fluid flow close to the net grid which is significant for the fluid loads.
- Fishing gears are often complicated and flexible systems which generally influence the fluid flow close to the netting. The influence may be significantly high.
- Software tools for computer aided net designs should consider these effects.
- Therefore, further studies on the basics of net mechanics should be focused on investigations for a trustworthy prediction of the flow through and around netting structures.

Thank you for your kind attention!

mathias.paschen@uni-rostock.de

karsten.breddermann@uni-rostock.de