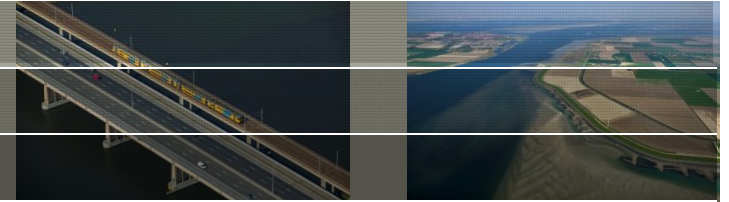




CFD modellering van bellenscherm in stromend water

17 maart 2017

Inhoud



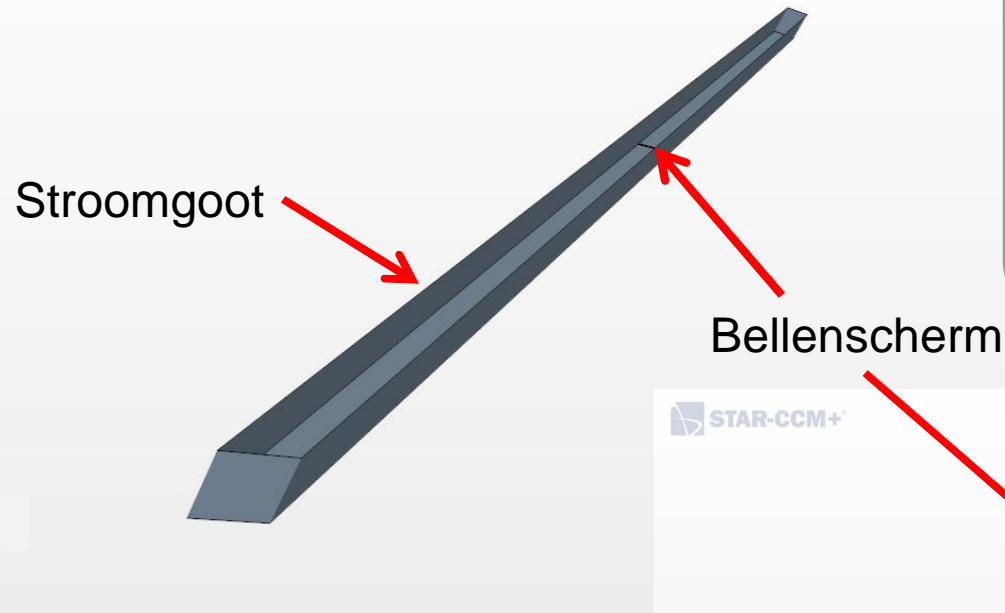
1. Beschrijving CFD resultaten
2. Literatuuroverzicht
3. Discussie:
 1. Onzekerheid in CFD resultaten
 2. Vergelijking met literatuur
 3. Betekenis CFD resultaten
 4. Volgende stappen



1
Bellenschermer in stilstaand water

Bellenscherm in stilstaand water: domein

STAR-CCM+



Model instellingen:

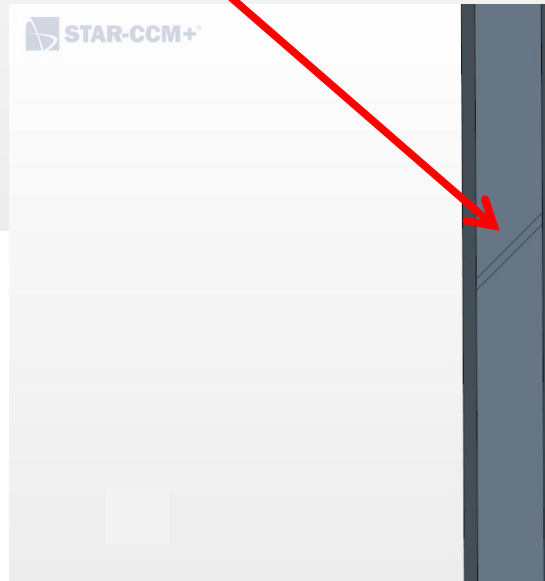
$$U_{in} = 0 \text{ m/s}$$

$$Q_{lucht} = 4,2 \cdot 10^{-3} \text{ m}^3 \text{ s}^{-1} \text{ m}^{-1}$$

$$\alpha_{scherm} = 45^\circ$$

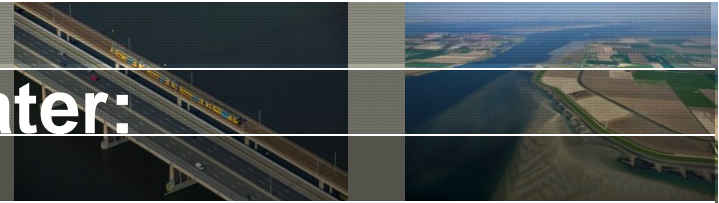
Solver: Lagrangian Multiphase

STAR-CCM+

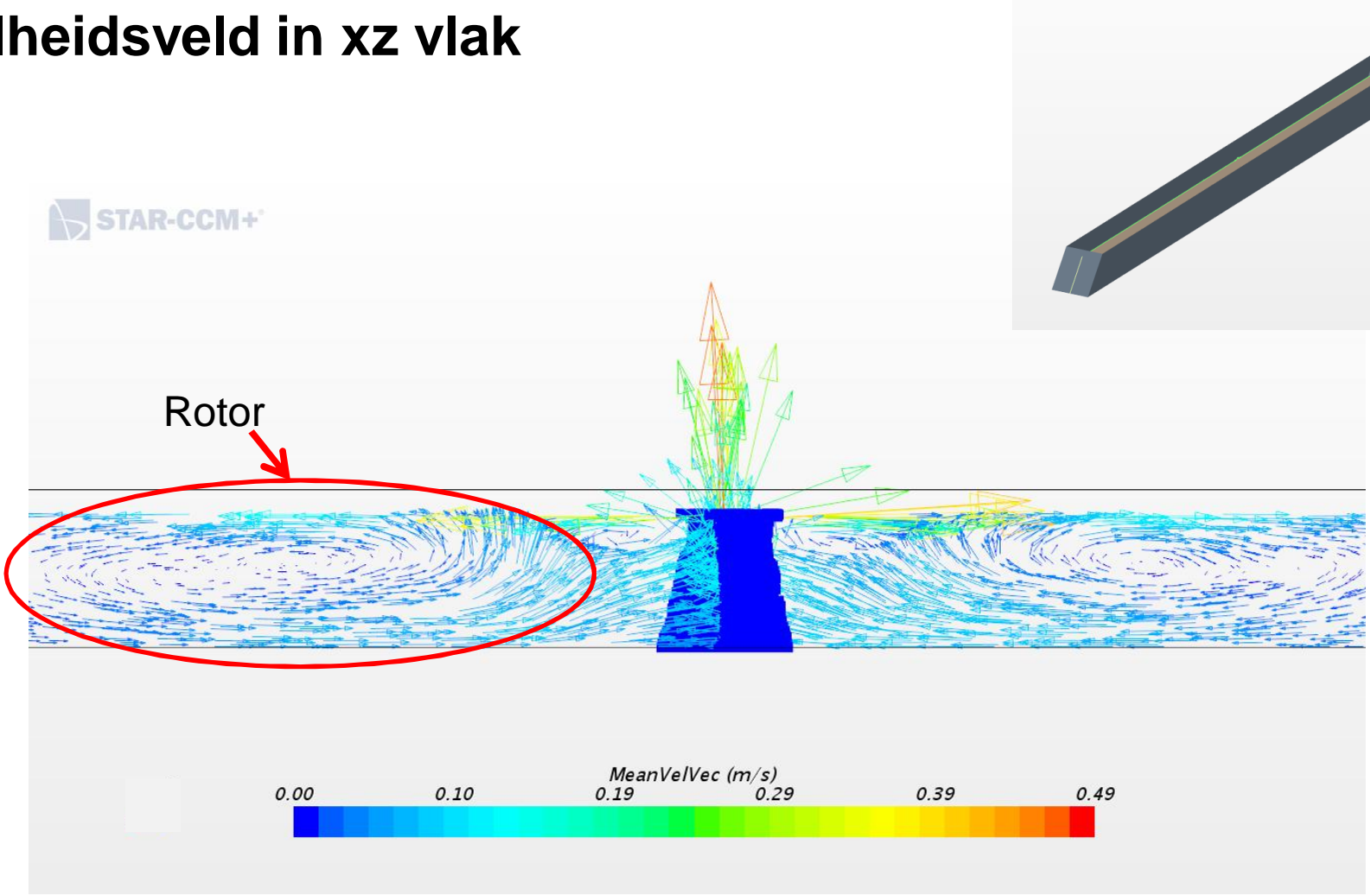


Deltares

Bellenscherm in stilstaand water:



Snelheidsveld in xz vlak

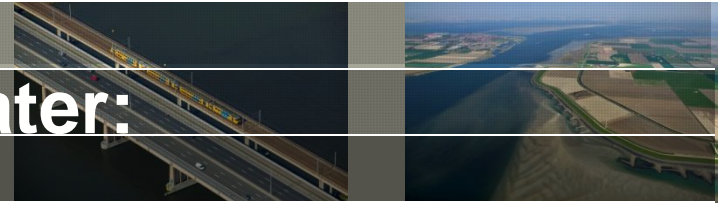


Bellenscherm_NoCurrent.sim

17 maart 2017

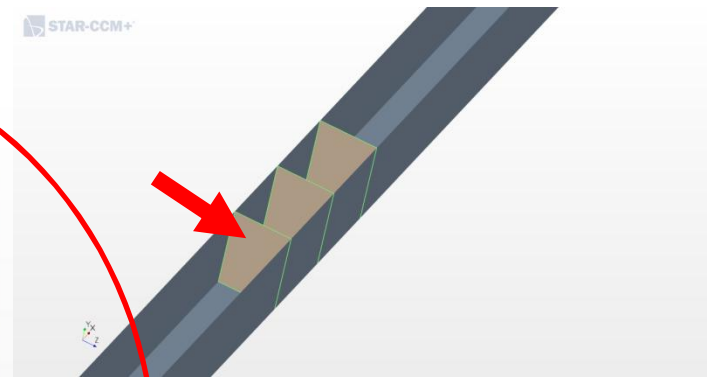
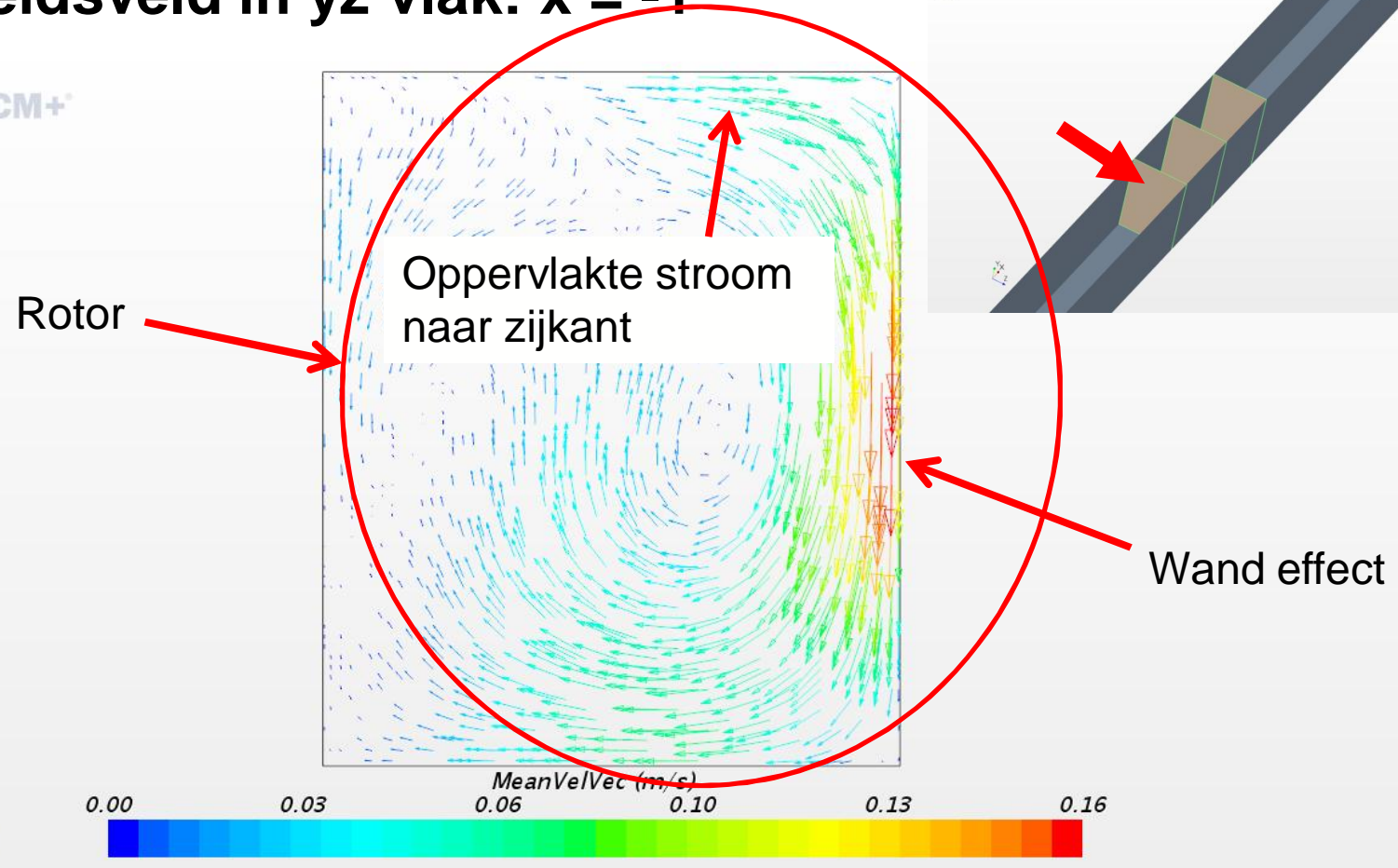
Deltares

Bellenscherm in stilstaand water:

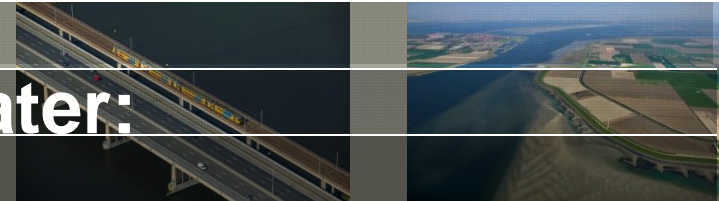


Snelheidsveld in yz vlak: $x = -1$

STAR-CCM+

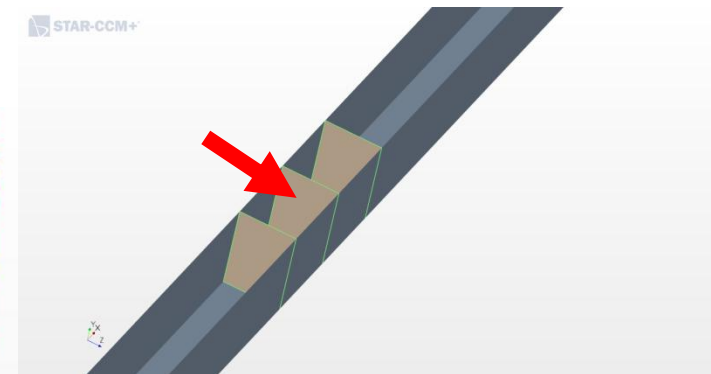
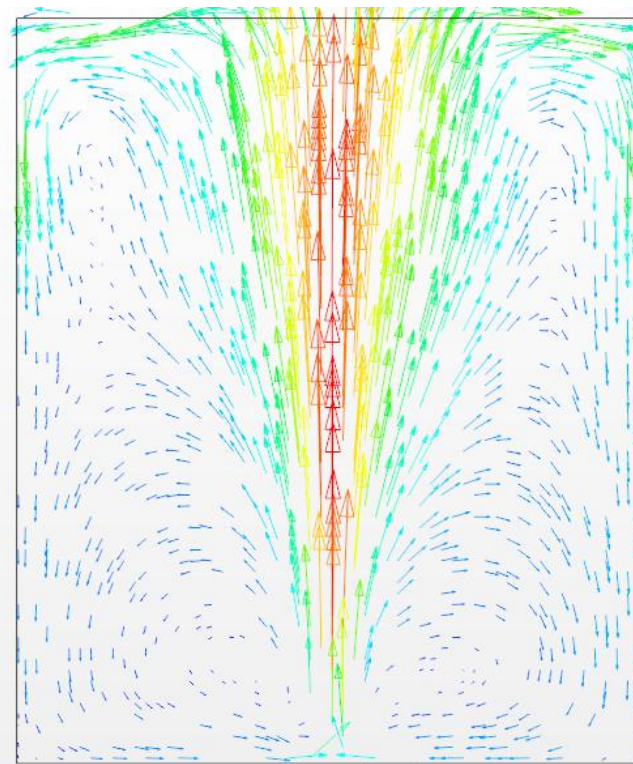


Bellenscherm in stilstaand water:

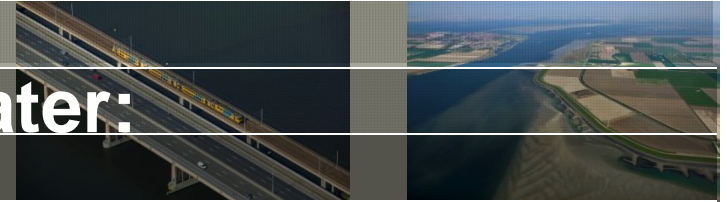


Snelheidsveld in yz vlak: $x = 0$

STAR-CCM+

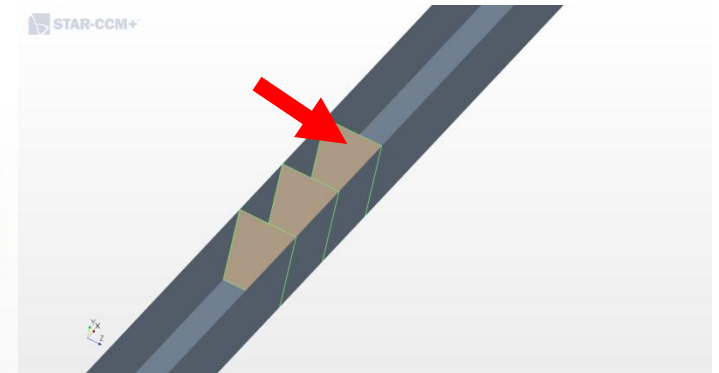
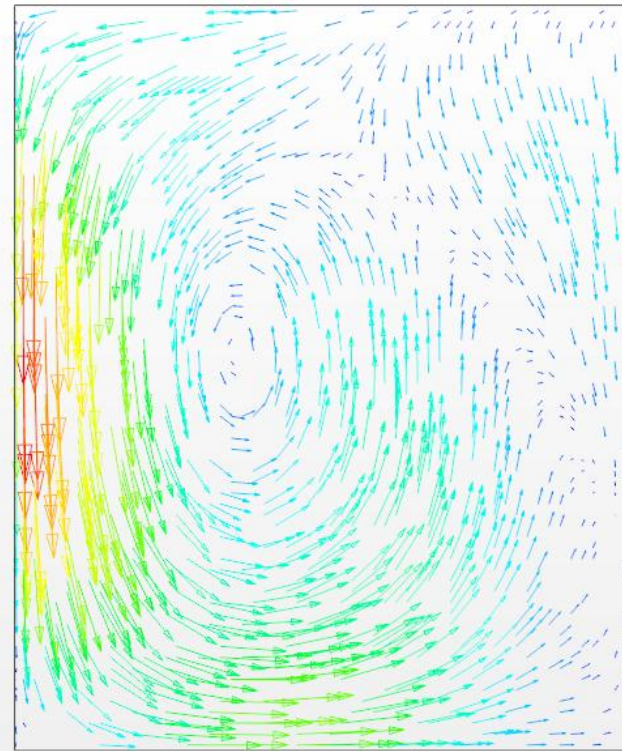


Bellenscherm in stilstaand water:

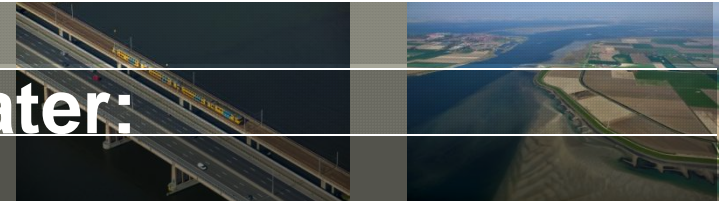


Snelheidsveld in yz vlak: $x = 1$

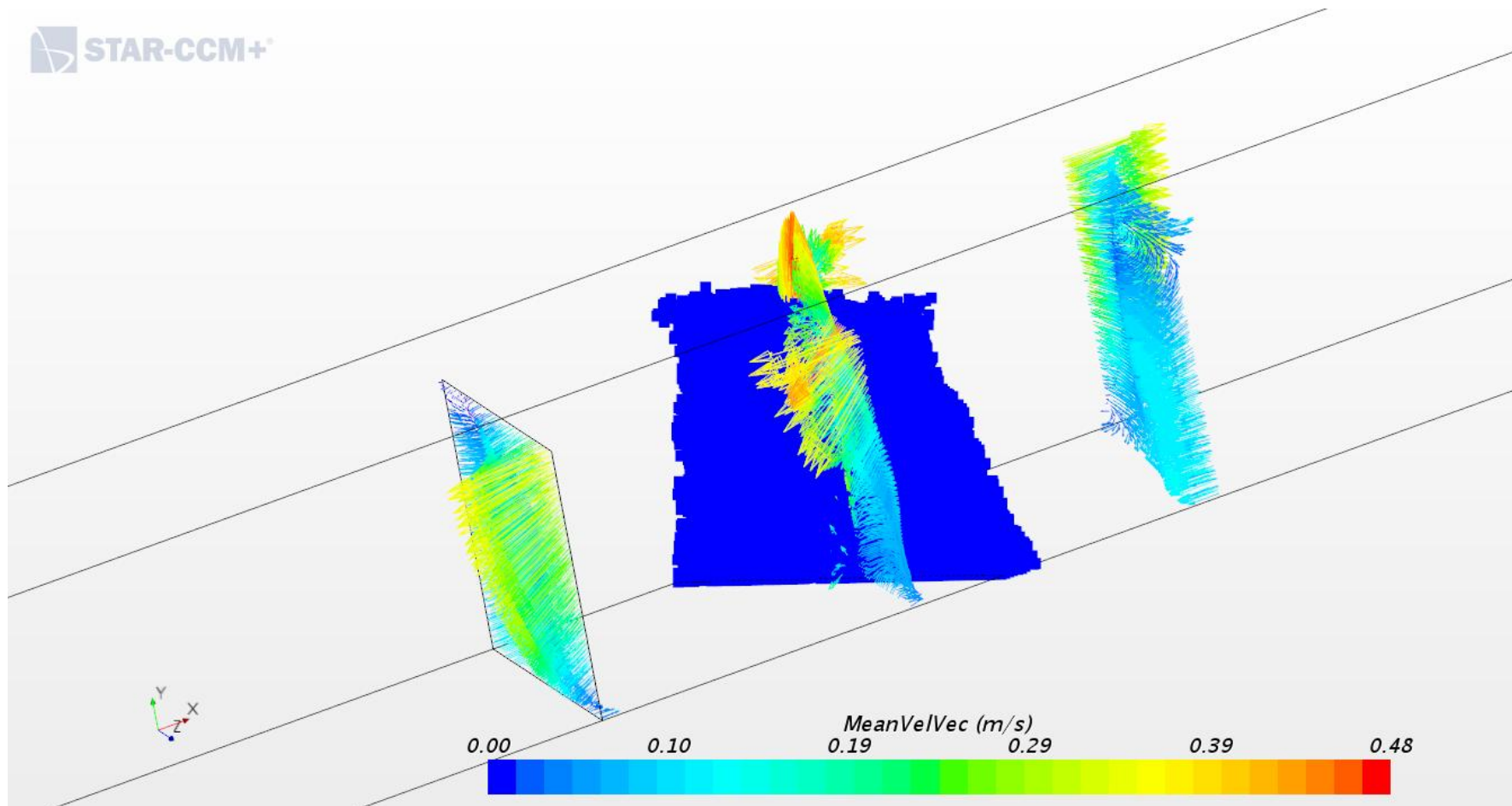
STAR-CCM+



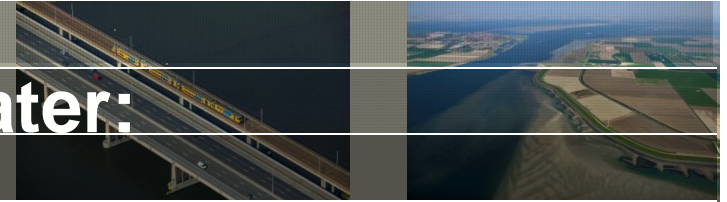
Bellenscherm in stilstaand water:



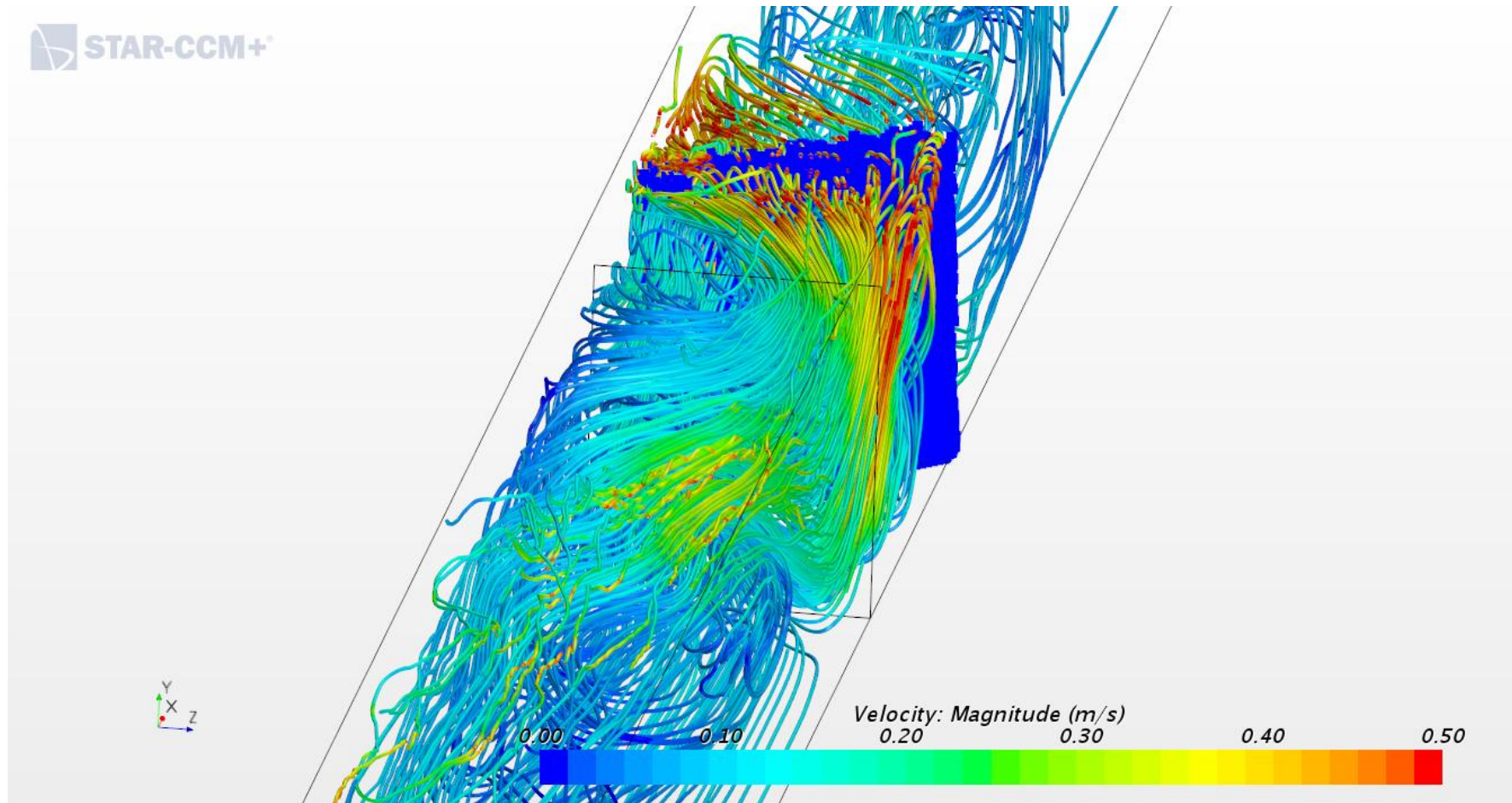
3D Snelheidsveld en bubbelscherm



Bellenscherm in stilstaand water:



3D stroomlijnen uit yz-vlak: $x = -1$





2

Bellenscherm in stromend water

Deltares

Bellenscherm in stromend water (1):

Snelheidsveld in xz vlak

Model instellingen:

$$U_{in} = 1,2 \text{ m/s}$$

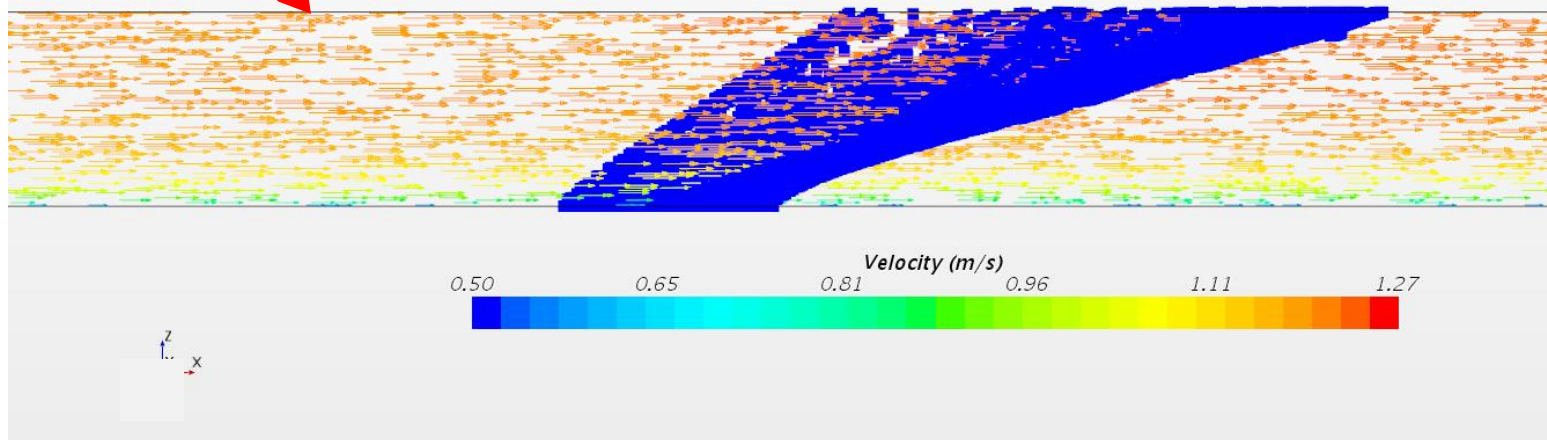
$$Q_{lucht} = 2,5 \cdot 10^{-3} \text{ m}^3 \text{ s}^{-1} \text{ m}^{-1}$$

$$\alpha_{scherm} = 45^\circ$$

Solver: Lagrangian Multiphase

STAR-CCM+

Geen rotor vorming



bellenscherm_12_45deg_lagrigidlid.sim

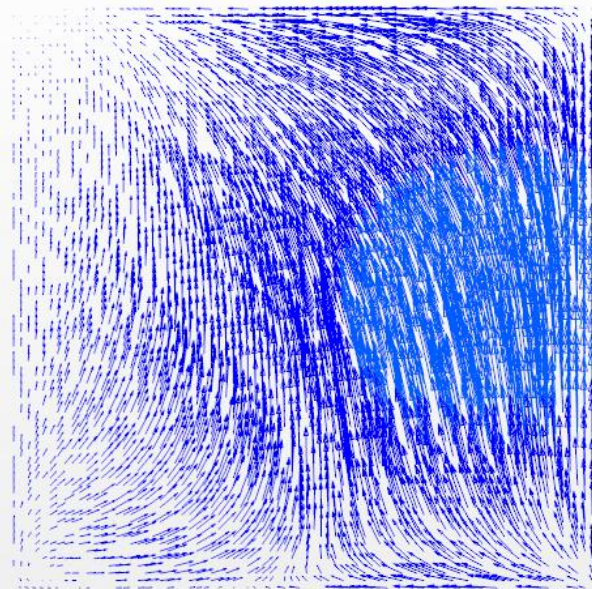
17 maart 2017

Deltares

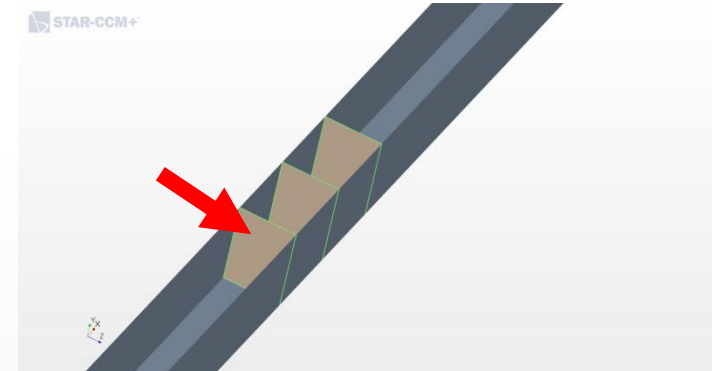
Bellenscherm in stromend water (1):

Snelheidsveld in yz vlak: $x = -1$

STAR-CCM+



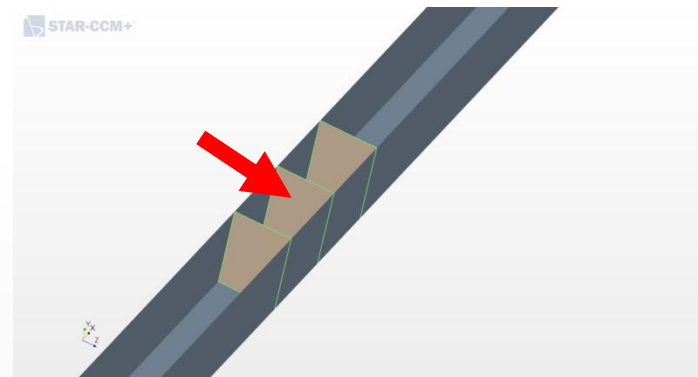
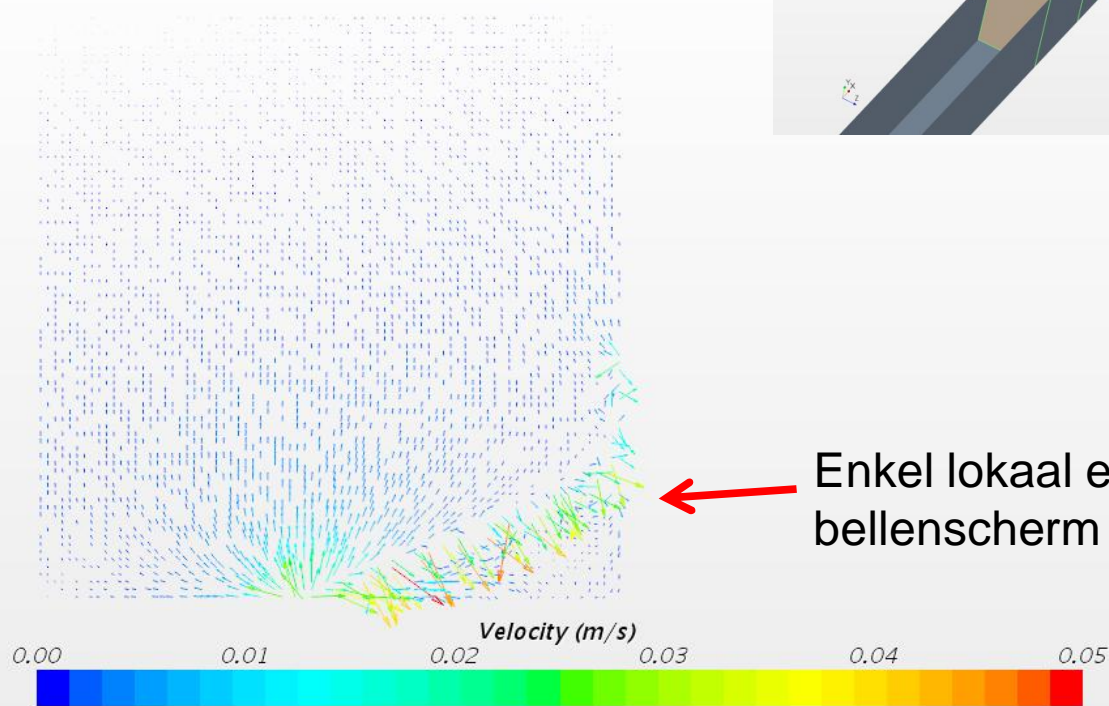
Let op schaal:
snelheid nagenoeg 0!



Bellenscherm in stromend water (1):

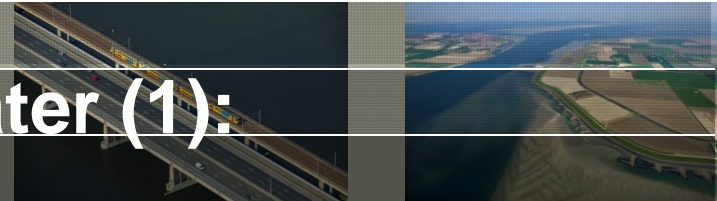
Snelheidsveld in yz vlak: $x = 0$

STAR-CCM+



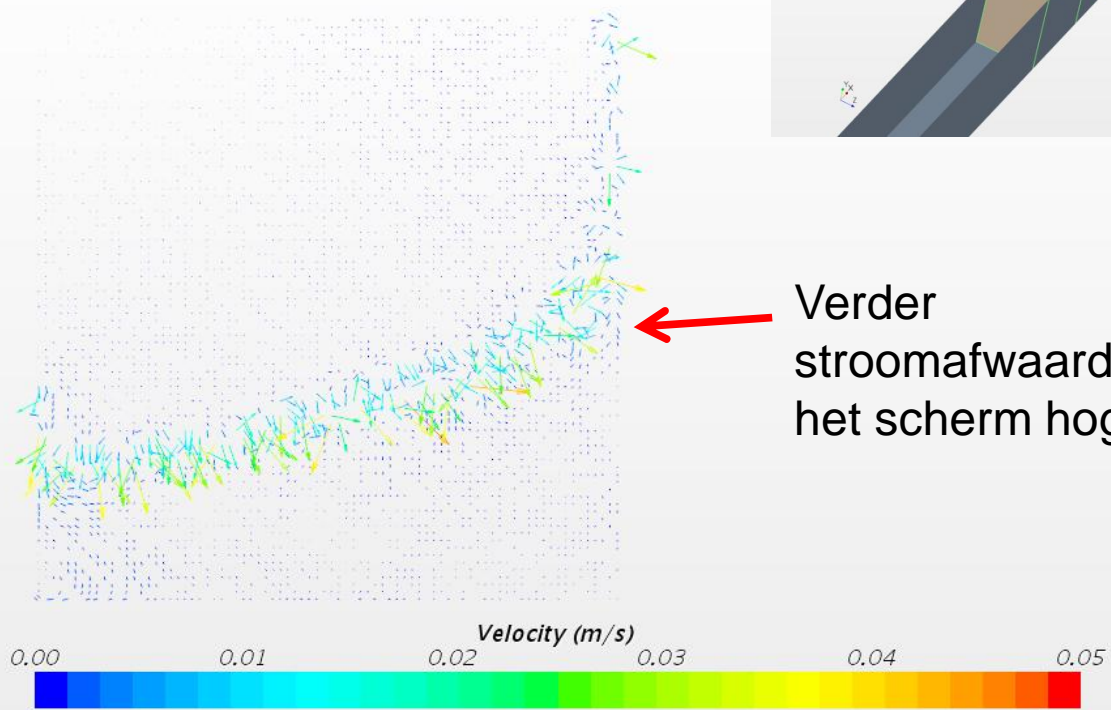
Enkel lokaal effect bellenscherm

Bellenscherm in stromend water (1):

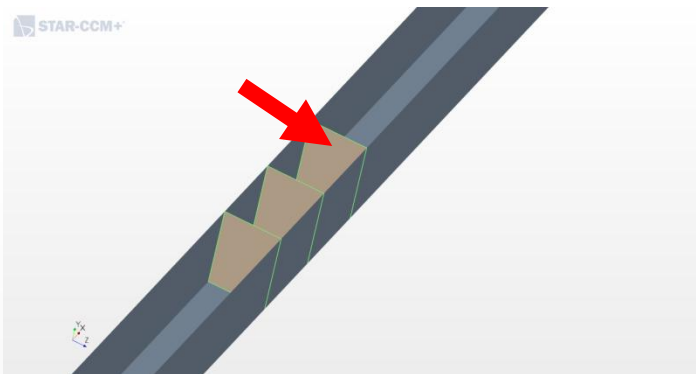


Snelheidsveld in yz vlak: $x = 1$

STAR-CCM+

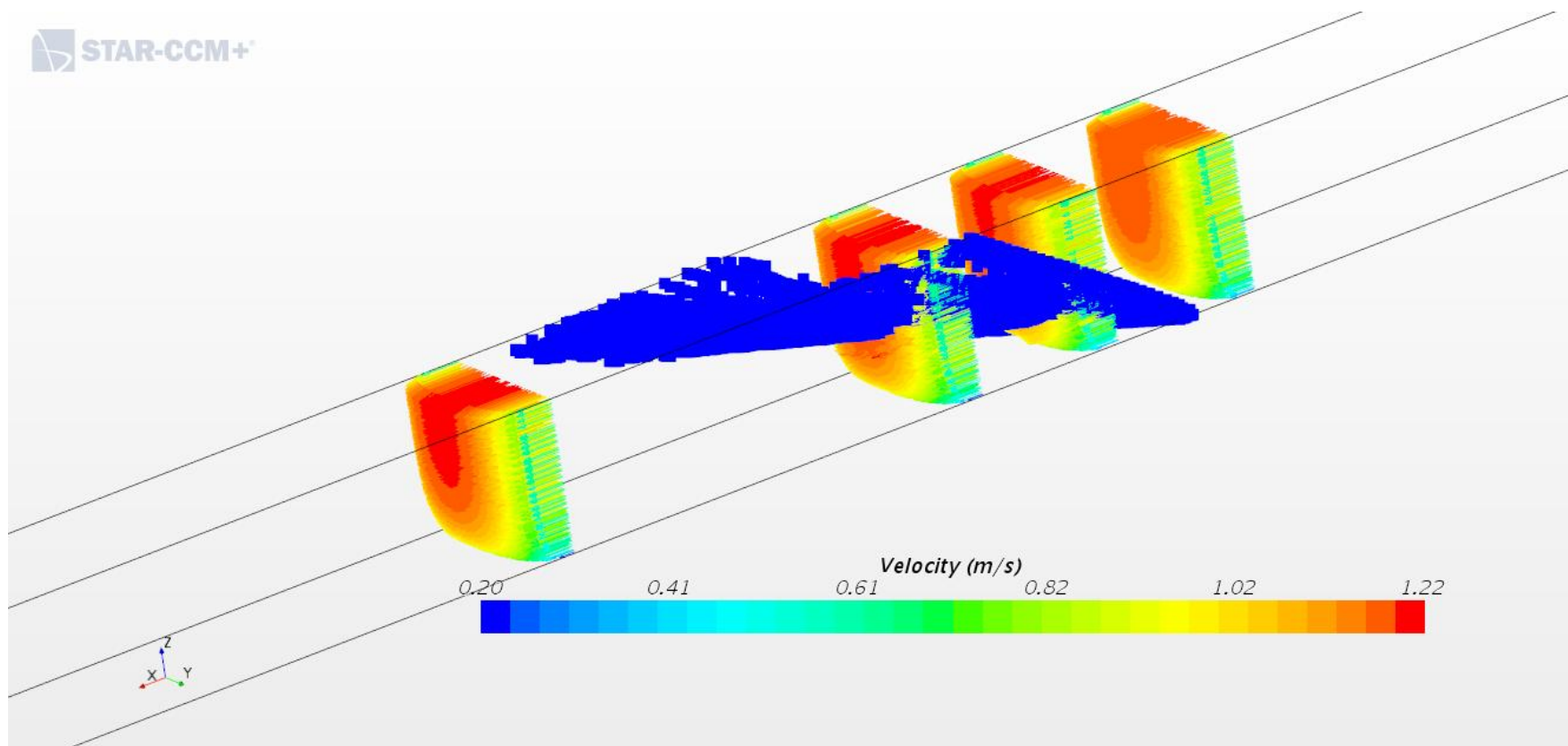


Verder stroomafwaards is het scherm hoger



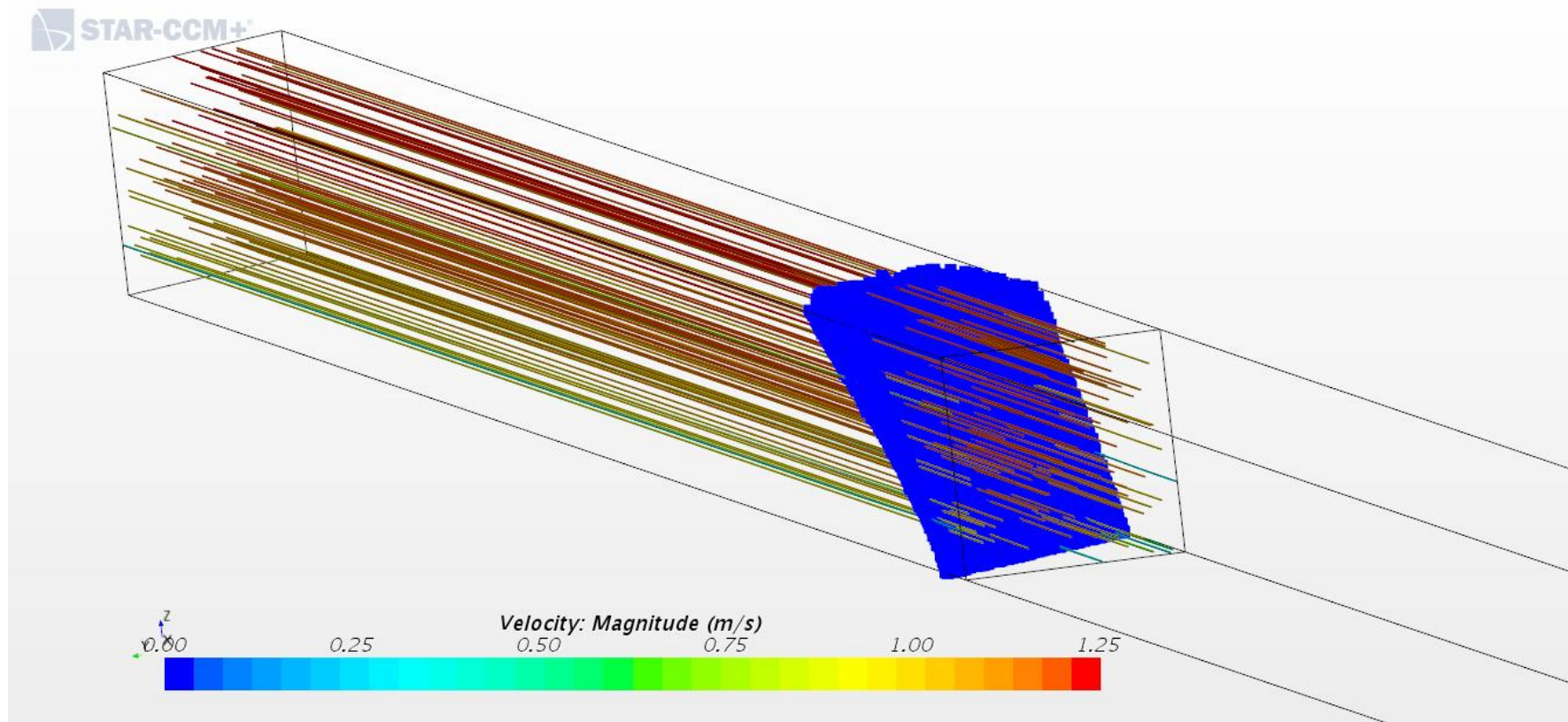
Bellenscherm in stromend water (1):

3D Snelheidsveld en bellenscherm

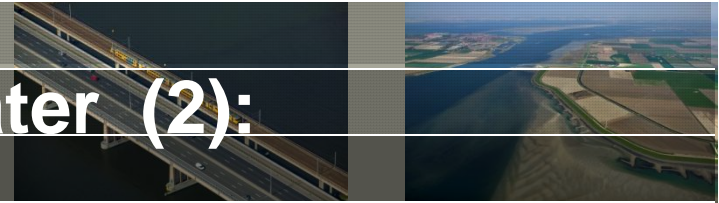


Bellenscherm in stromend water (1):

3D stroomlijnen uit yz-vlak: $x = -1$



Bellenscherm in stromend water (2):



Snelheidsveld in xz vlak

Stroomsnelheid in goot & luchtdebiet
aangepast

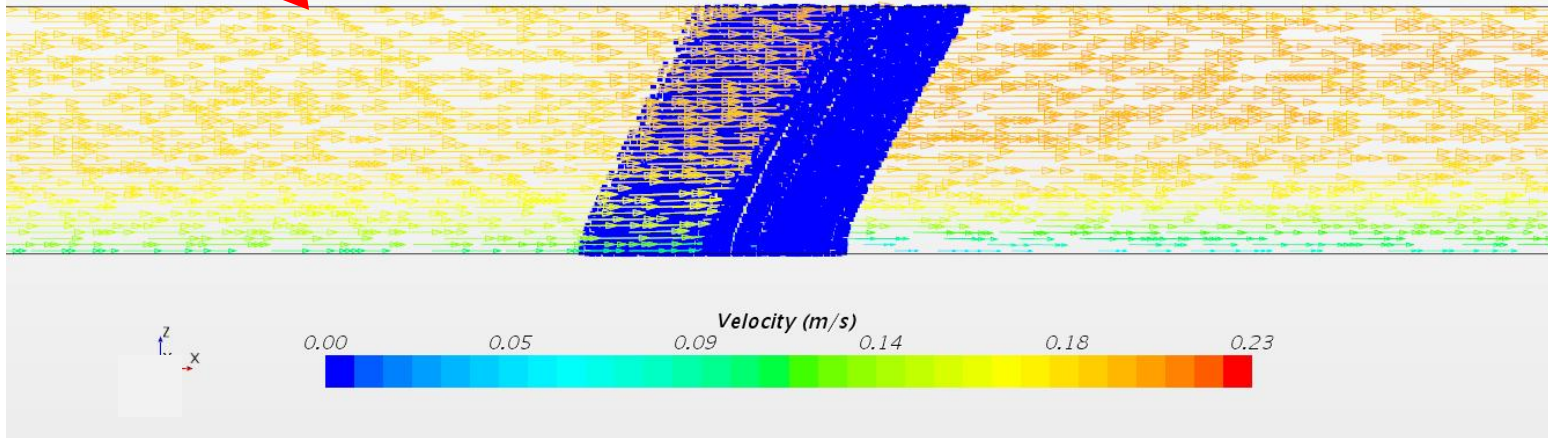


Model instellingen:

$U_{in} = 0,2 \text{ m/s}$
 $Q_{lucht} = 5,7 \cdot 10^{-3} \text{ m}^3\text{s}^{-1}\text{m}^{-1}$
 $\alpha_{scherm} = 45^\circ$

Solver: Lagrangian Multiphase

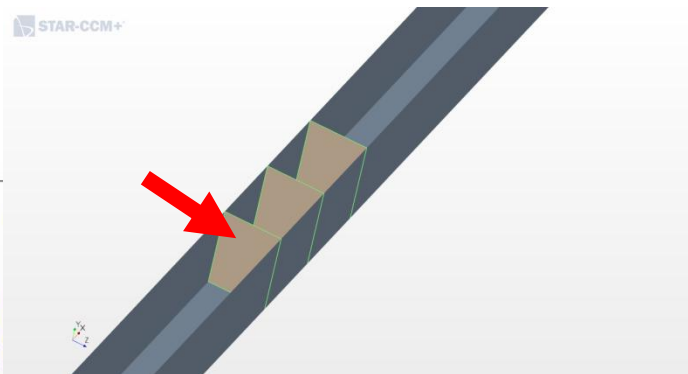
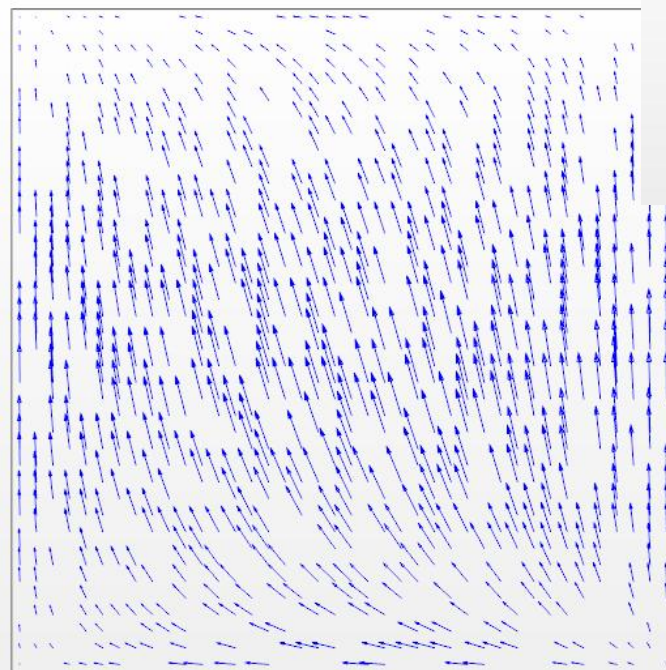
Geen rotor vorming



Bellenscherm in stromend water (2):

Snelheidsveld in yz vlak: $x = -1$

STAR-CCM+



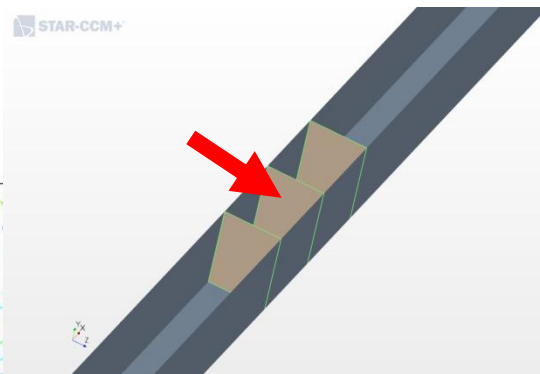
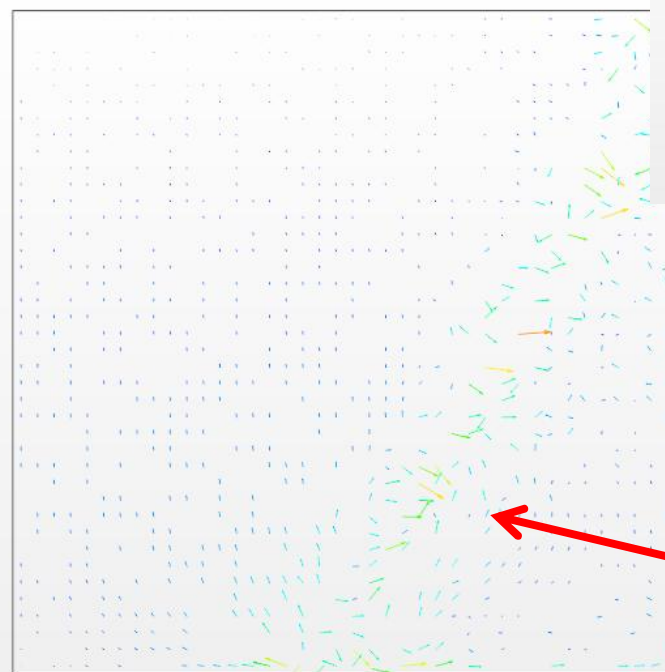
Let op schaal:
snelheid nagenoeg 0!



Bellenscherm in stromend water (2):

Snelheidsveld in yz vlak: $x = 0$

STAR-CCM+



Enkel lokaal effect
bellenscherm

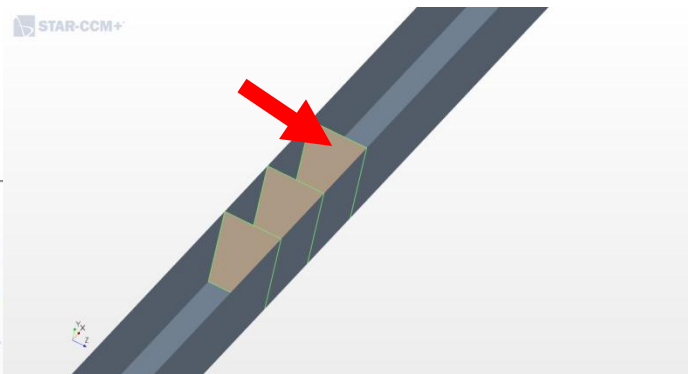


Bellenscherm in stromend water (2):

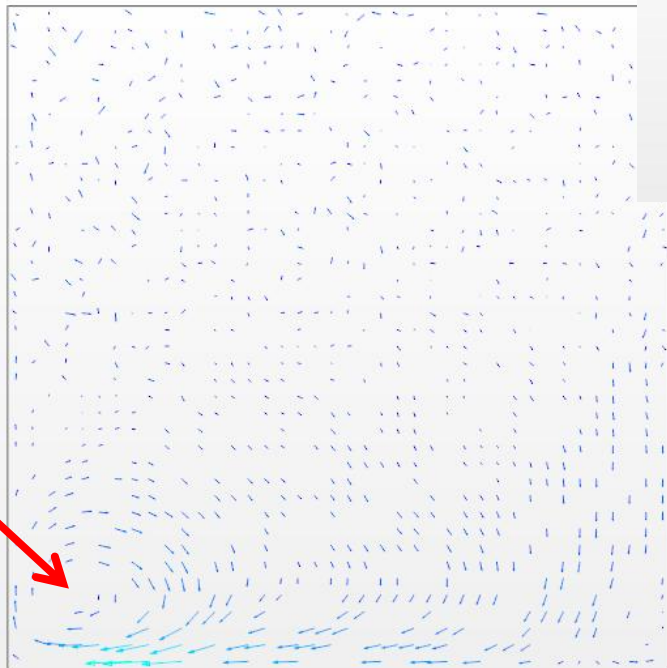
Snelheidsveld in yz vlak: $x = 1$

STAR-CCM+

STAR-CCM+



Heel zwakke
circulatiecel
zichtbaar, maar
tegengesteld aan
verwachte richting

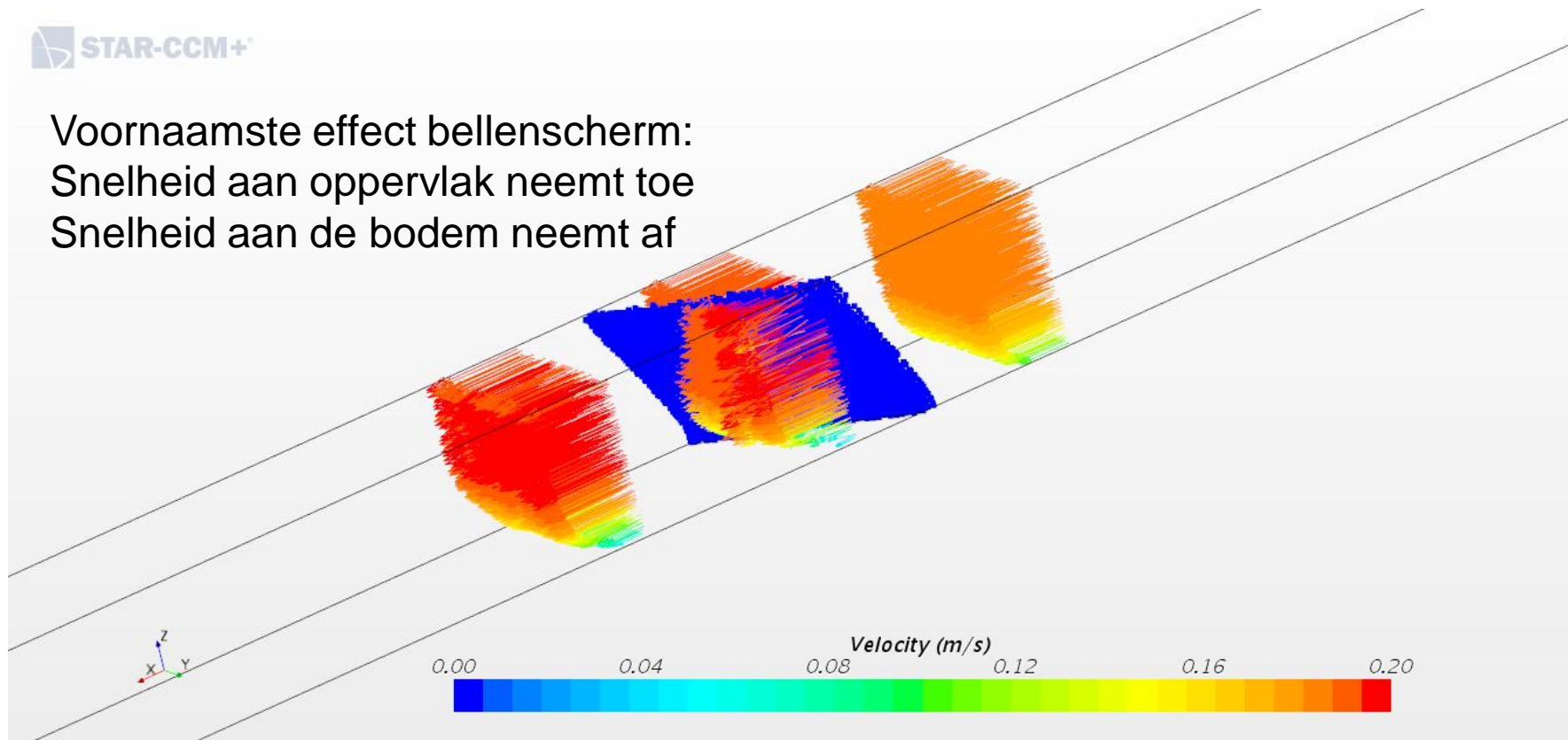


Bellenscherm in stromend water (2):

3D Snelheidsveld en bellenscherm

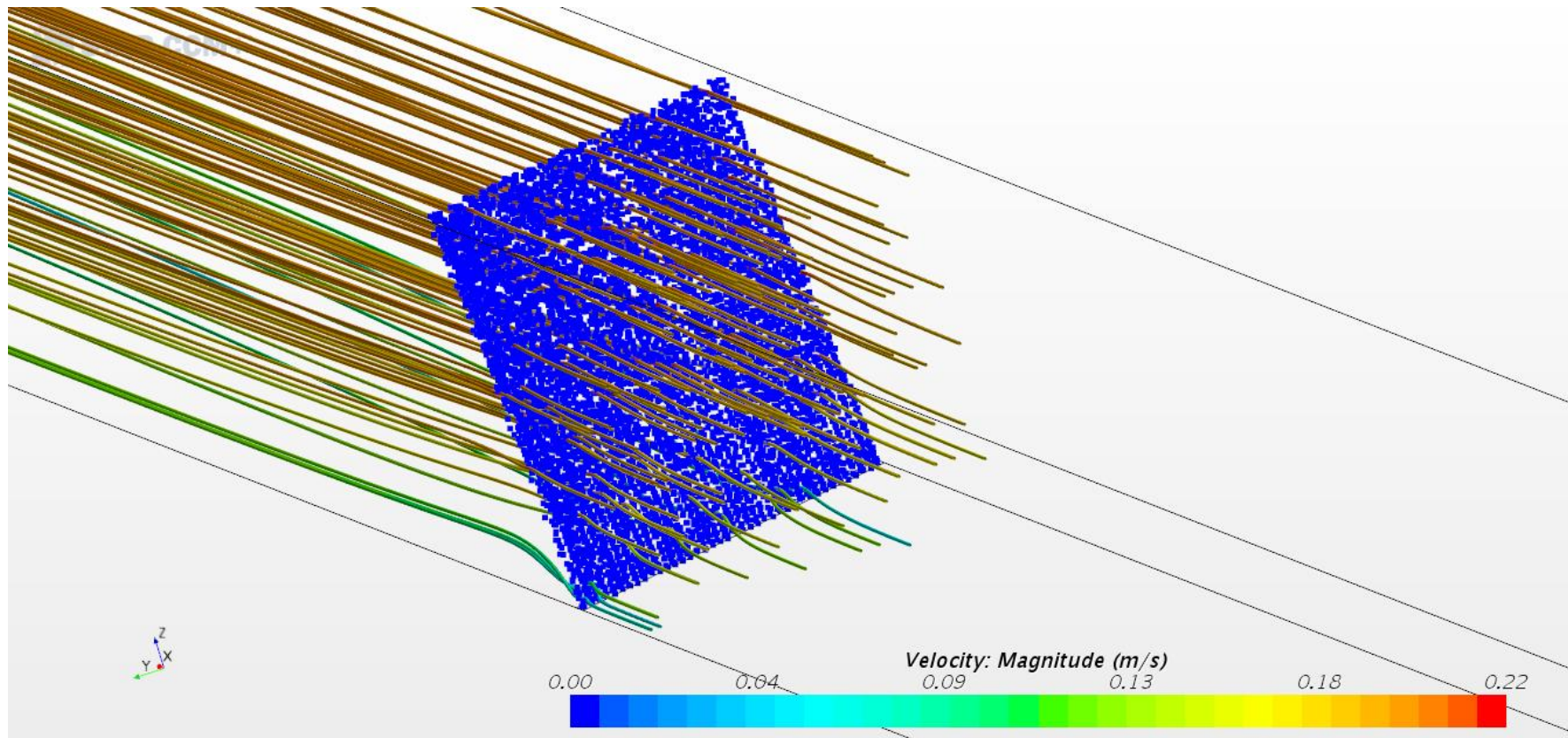


Voornaamste effect bellenscherm:
Snelheid aan oppervlak neemt toe
Snelheid aan de bodem neemt af



Bellenscherm in stromend water (1):

3D stroomlijnen uit yz-vlak: $x = -1$

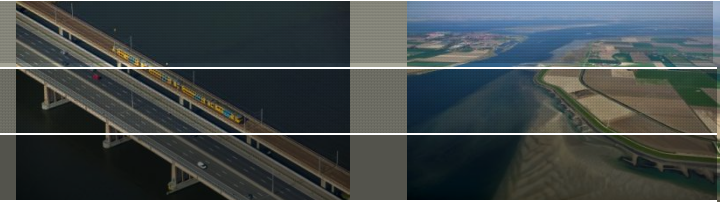


An aerial photograph showing a coastal region. A large body of water is on the left, with a dike or barrier extending from the land into the water. The land is divided into various agricultural plots, some green and some brown. A small town or village is visible in the background on the left. The sky is clear and blue.

3

Literatuur bellenschermen in stromend water

Literatuur:



Lo 1996: The effect of air-bubble barriers in containing oil-slick movement

1. Laboratorium experimenten om de prestaties van een bubbel scherm in stroming te testen
2. Experimenten in een stroomgoot: 50 m lang, 0,6 m breed en met een water diepte van 0,9 m
3. Een lineair verband werd gevonden tussen de stroomsnelheid en het minimaal benodigde luchtdebiet om olie tegen te houden.
4. Bij een stroomsnelheid van 0.2 m/s was een luchtdebiet van $\sim 1,6 \cdot 10^{-3} \text{ m}^3\text{s}^{-1}\text{m}^{-1}$ benodigd.
5. Bellenscherm stond loodrecht op de stroming

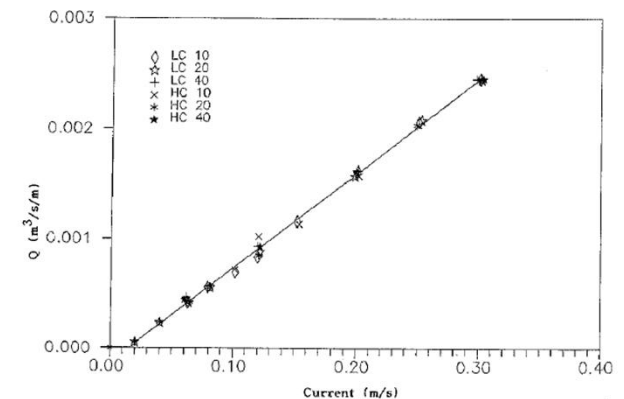


Fig. 2. The relationship between the current velocity and the minimum airflow rate (Q) required to avoid oil flow through the barrier from the surface.

Literatuur:

Leifer et al. 2016: Fluid motions associated with engineered area bubble plumes

1. Laboratorium experimenten om de prestaties van een bubbel scherm in stroming te testen
2. Experimenten in een stroomgoot: 30 m lang, 8 m breed en met een water diepte van 2,7 m
3. Het bubbelscherm werd niet op de bodem geplaatst en er werd een verticale achterwand gemonteerd
4. Oppervlakte stroomsnelheden van 0,4 m/s konden worden tegengehouden met een luchtdebiet van $2,1 \cdot 10^{-2} \text{ m}^3 \text{ s}^{-1} \text{ m}^{-1}$
5. Bij te grote stroomsnelheden werd de 'rotor' boven het scherm geduwd

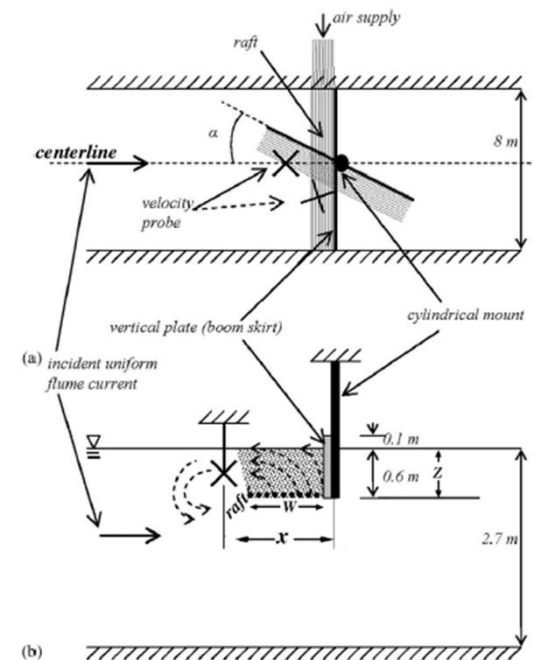
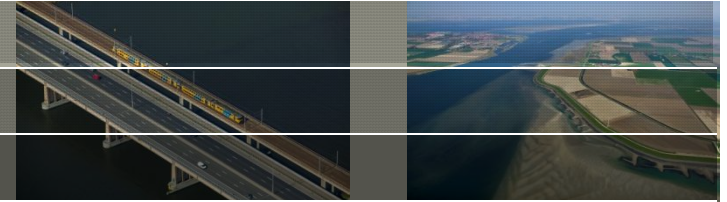


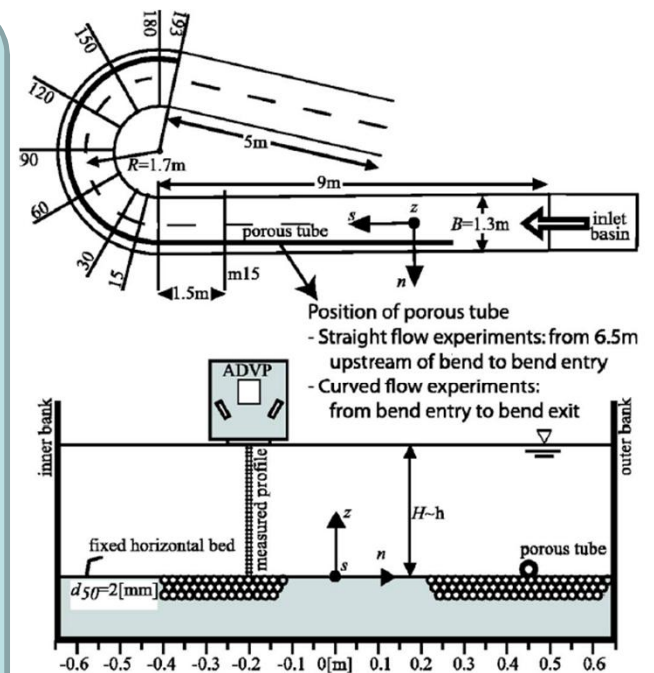
Fig. 2. (a) Plan view and (b) side view schematics of laboratory setup of the bubble raft experiments for perpendicular ($a = 90^\circ$) and angled ($a = 23^\circ$) orientations to the current; the velocity probe was located at x , the distance from the skirt, W = raft width, Z = raft depth; a cylindrical mount supports the raft

Literatuur:



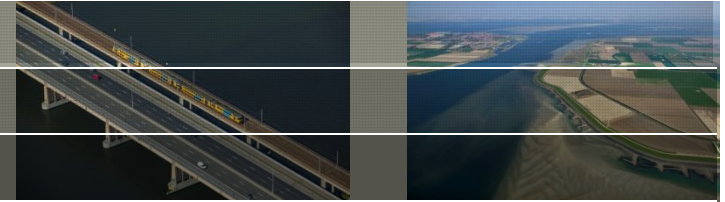
Blankaert et al. 2008: Redistribution of Velocity and Bed-Shear Stress in Straight and Curved Open Channels by Means of a Bubble Screen: Laboratory Experiments

1. Laboratorium experimenten om te onderzoeken of een bubbelscherm een circulatiecel kan vormen die dwars op de stroomrichting staat
2. Experimenten bij zeer lage waterdiepte: 0,16 m. Breedte: 1,3 m.
3. Een circulatie cel werd gevormd bij een stroomsnelheid van 0,2 m/s en luchtdebiet van $1,6 \cdot 10^{-4} \text{ m}^3 \text{ s}^{-1} \text{ m}^{-1}$



Q [l/s]	H [m]	U [m/s]	$(g/C_p)^{1/2}$ [m ^{1/2} s ⁻¹]	Re [10 ³]	Fr [l]	R/B [l]	H/R [l]	B/H [l]
89	0.159	0.43	34	69	0.35	1.31	0.094	8.2

Literatuur:



Blankaert et al. 2008: Redistribution of Velocity and Bed-Shear Stress in Straight and Curved Open Channels by Means of a Bubble Screen: Laboratory Experiments

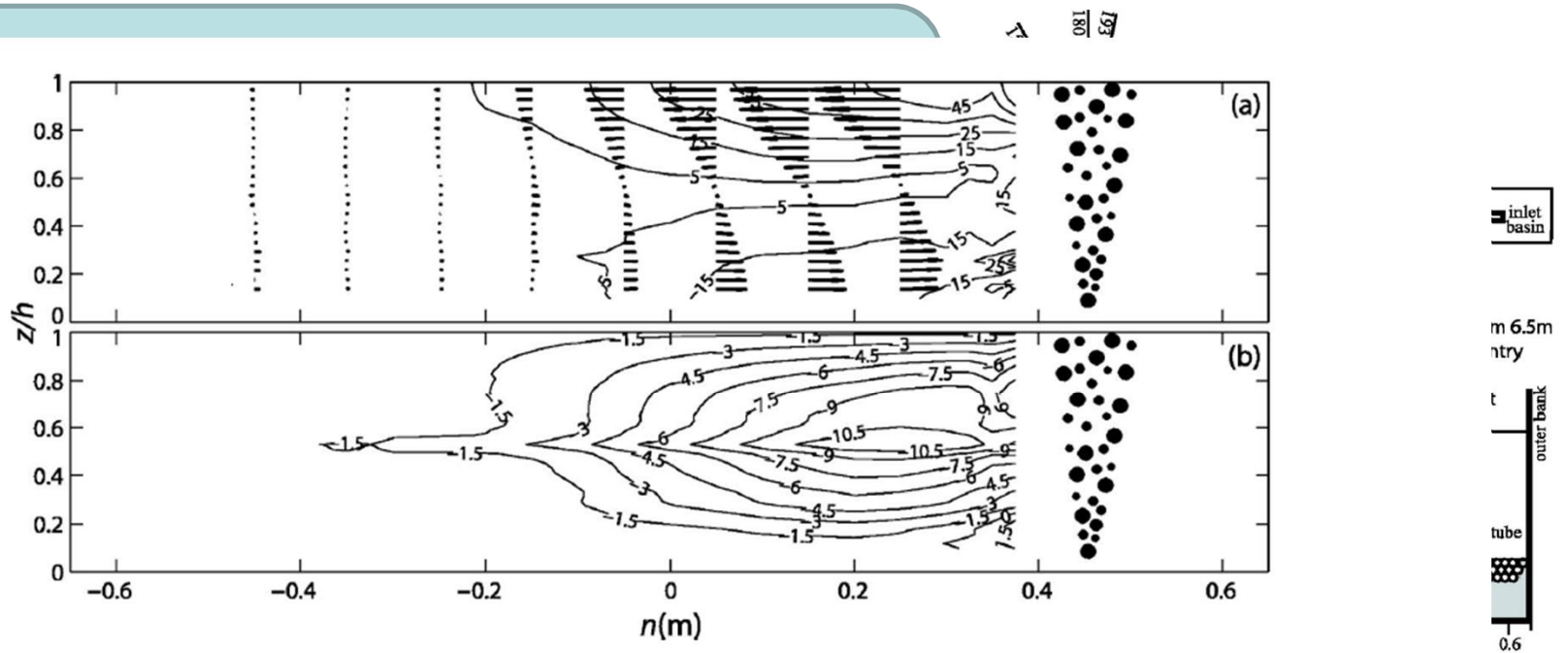


Fig. 4. Bubble-screen induced cross-stream flow and cross-stream circulation in the straight reach: (a) normalized vector representation $(v_n, v_z)/U$. The isolines show the magnitude of the vector in [%]; (b) normalized pseudostreamfunction, $100\psi/(UH)$.

89	0.159	0.43	34	69	0.35	1.31	0.094	8.2
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4

**Bellenscherm in stromend water
– loodrecht op stroming**

Deltares

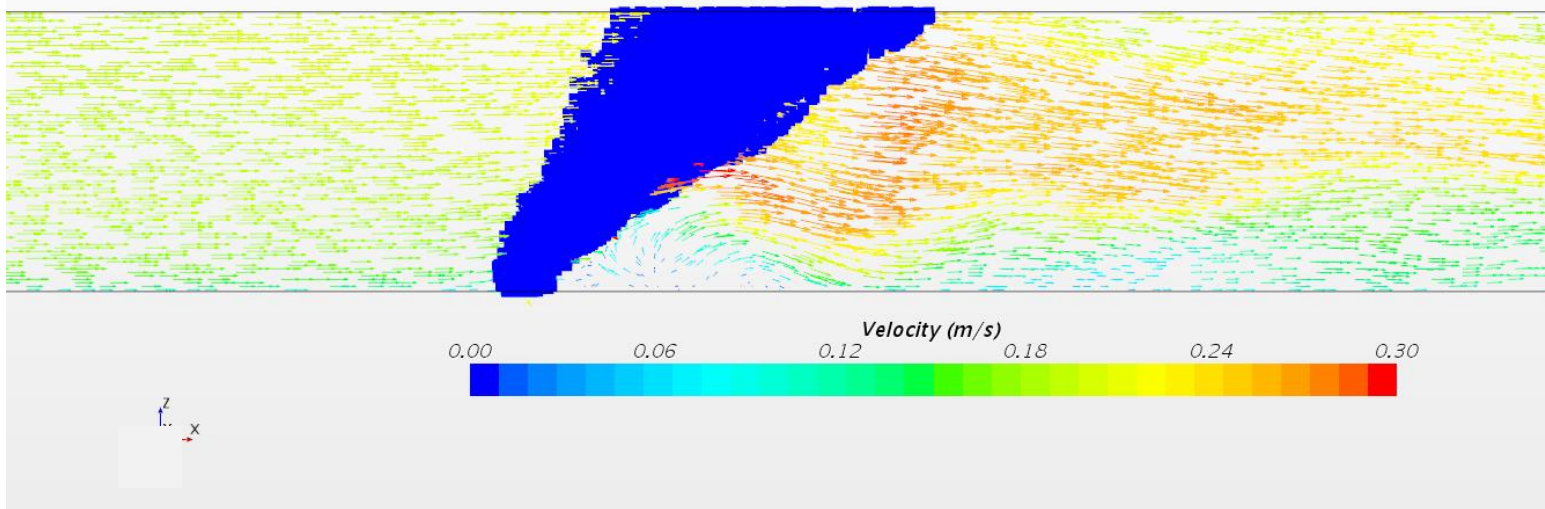
Bellenscherm in stromend water - loodrecht

Snelheidsveld in xz vlak

Hoog luchtdebiet en scherm
loodrecht op stroming



Bellenscherm heeft nu duidelijk
effect op stroming



Model instellingen:

$$U_{in} = 0,2 \text{ m/s}$$

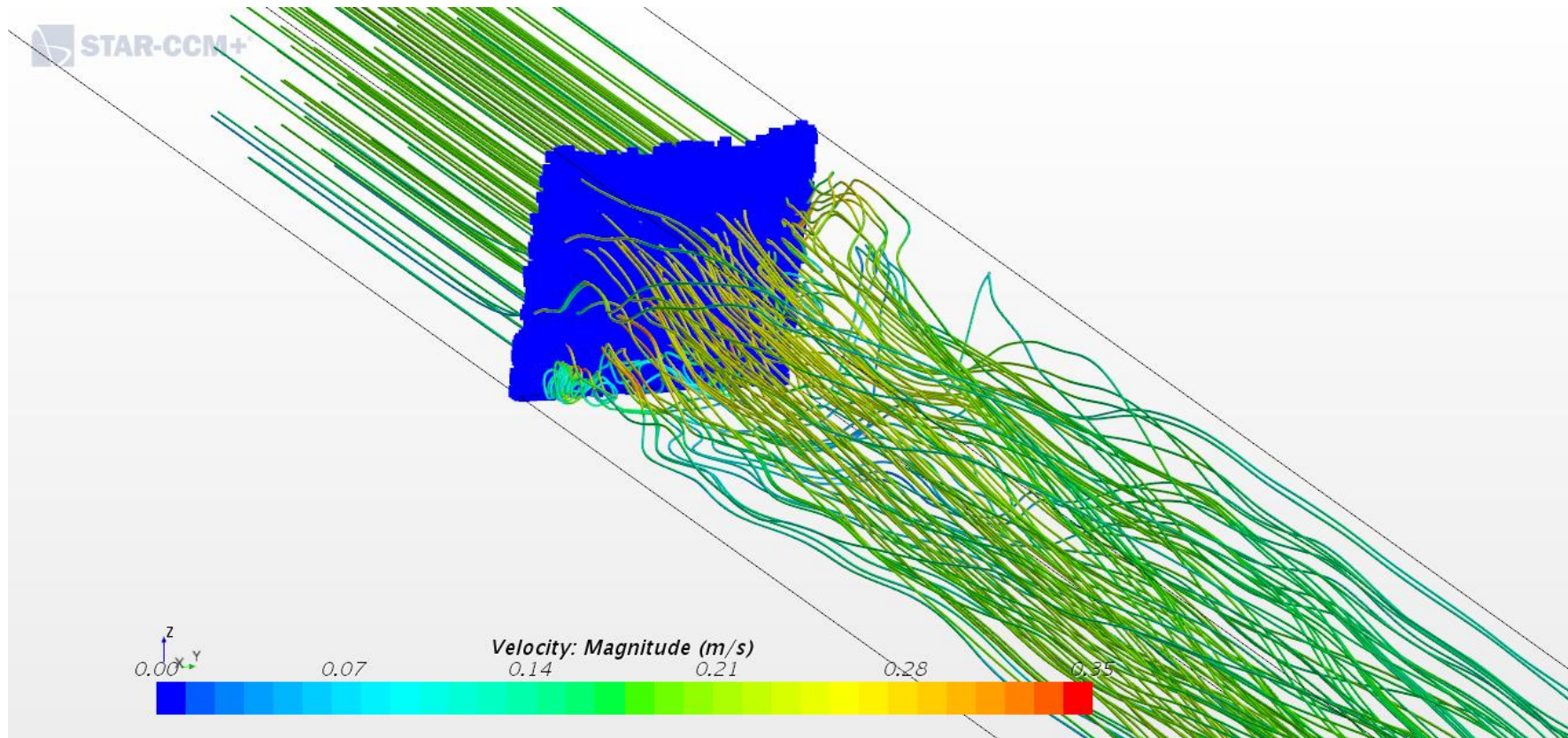
$$Q_{lucht} = 2,5 \cdot 10^{-2} \text{ m}^3 \text{ s}^{-1} \text{ m}^{-1}$$

$$\alpha_{scherm} = 90^\circ$$

Solver: Lagrangian Multiphase

Bellenscherm in stromend water - loodrecht

3D stroomlijnen uit yz-vlak: $x = -4$

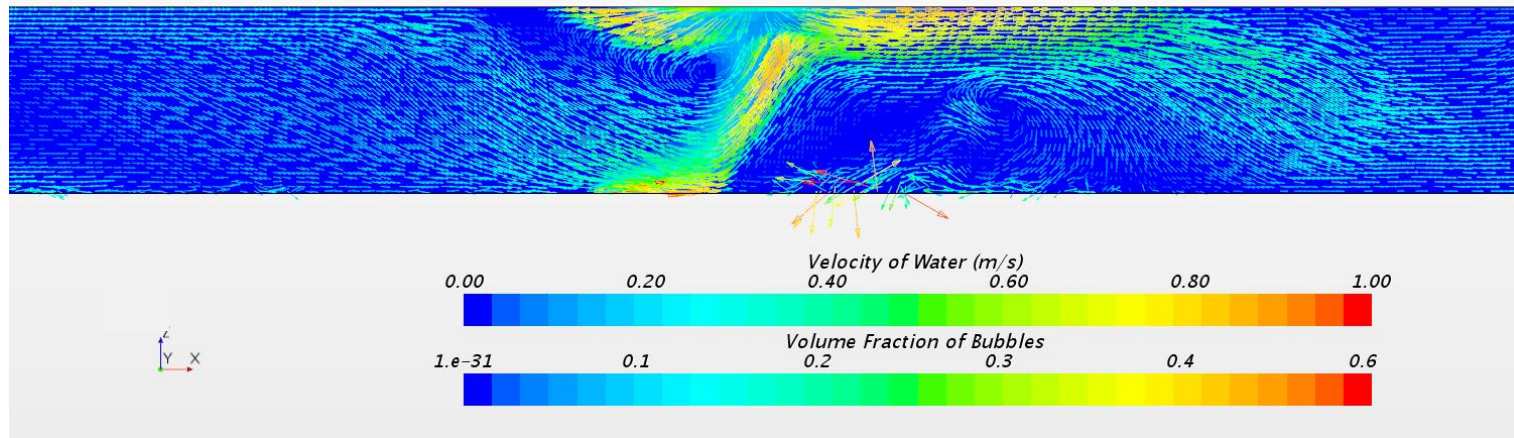


Bellenscherm in stromend water - loodrecht

Snelheidsveld in xz vlak

Totaal andere stroming bij andere benadering van de bellen. Echter, deze simulatie is 'ontploft' en daarmee niet betrouwbaarder

STAR-CCM+



Model instellingen:

$$U_{in} = 0,2 \text{ m/s}$$
$$Q_{lucht} = 2,5 \cdot 10^{-2} \text{ m}^3 \text{ s}^{-1} \text{ m}^{-1}$$
$$\alpha_{scherm} = 90^\circ$$

Solver: Eulerian Multiphase

Bellenscherm in stromend water - loodrecht

3D stroomlijnen uit yz-vlak: $x = -1$

