universität innsbruck

Arbeitsbereich für Wasserbau

Pre-alpine river – 421a

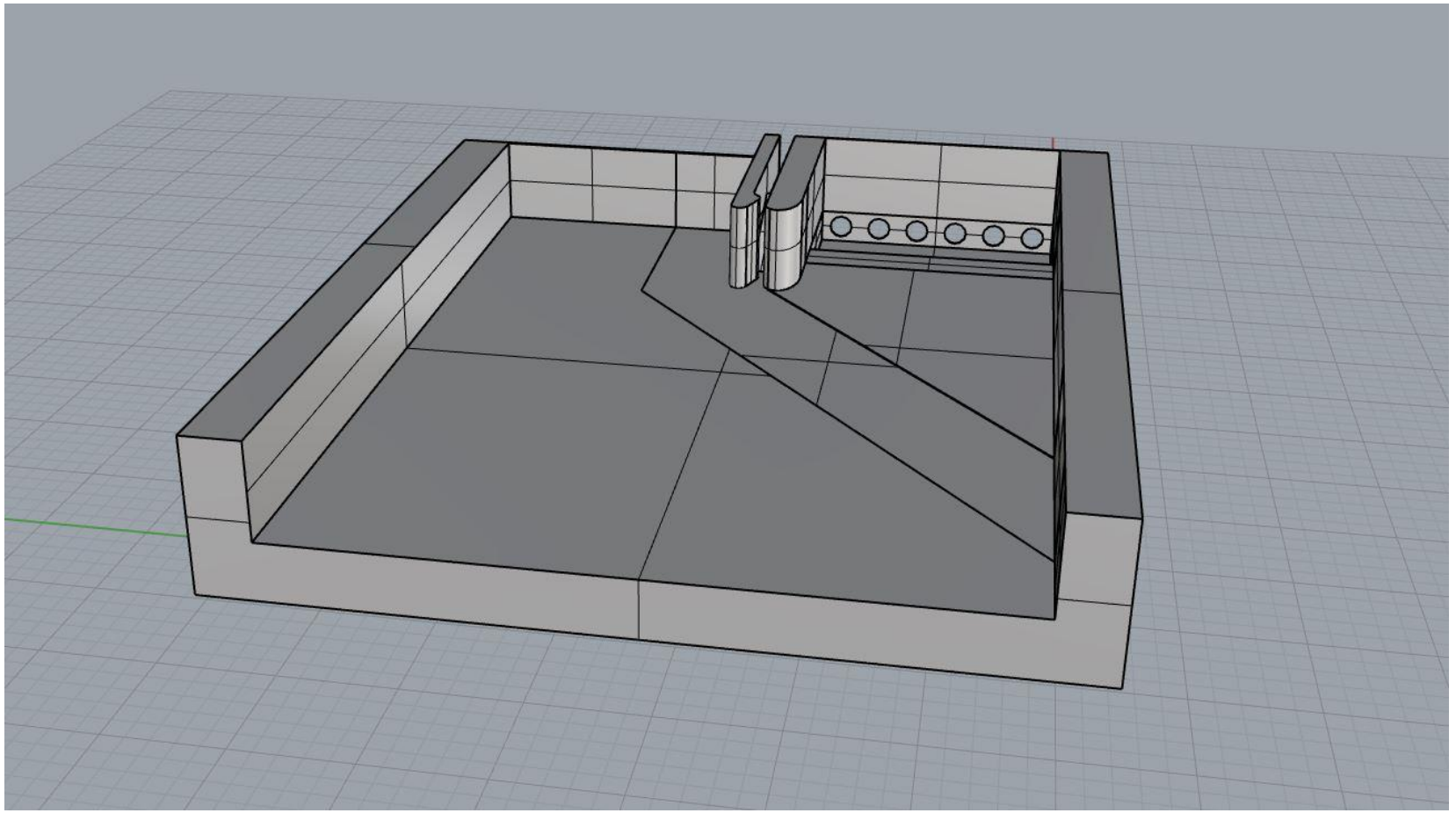
Initial design

28.11.2022

421a - General

River:

- Pre-alpine river
- Discharge: 50 m³/s
- Mean flow velocity: 0.36 m/s
- River width: 35 m
- Weir width: 16 m
- Flow depth: 4 m
- No slope



Turbines:

- 6 turbines with 1.4 m diameter
- Design discharge: 48 m³/s
- Head: 3 m
- Headrace channel width: 15 m

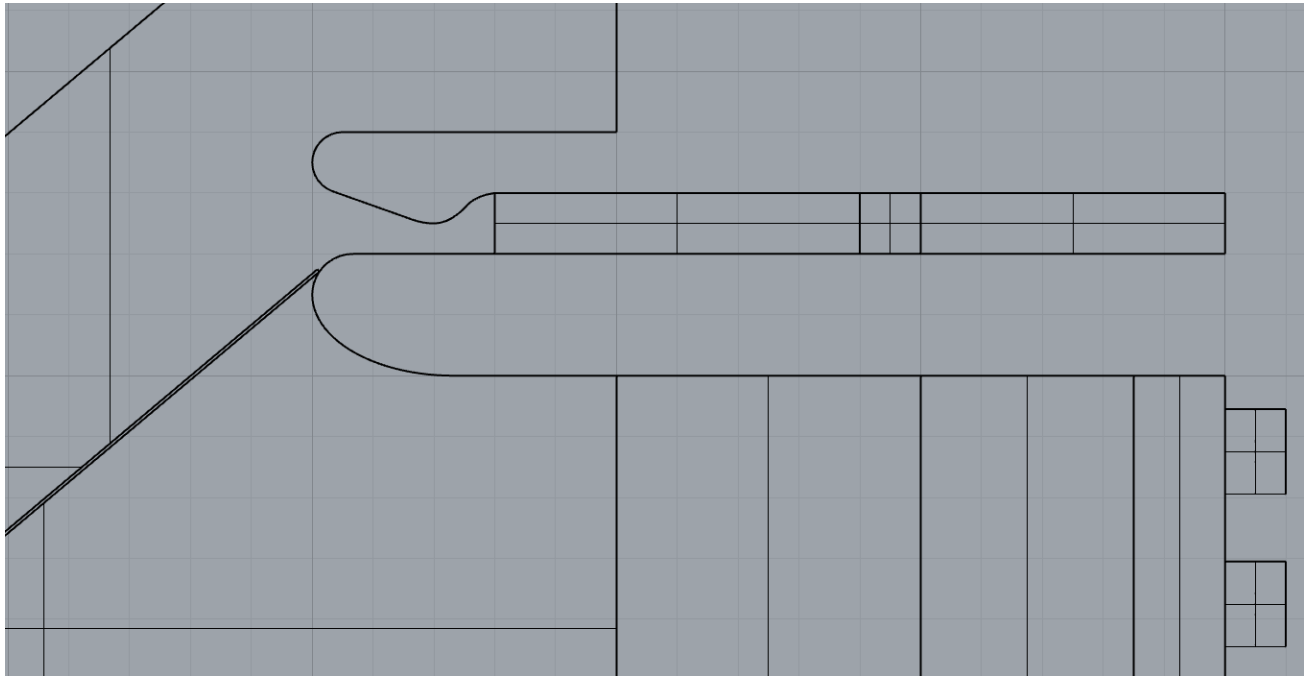
421a - General

<u>Bypass:</u>

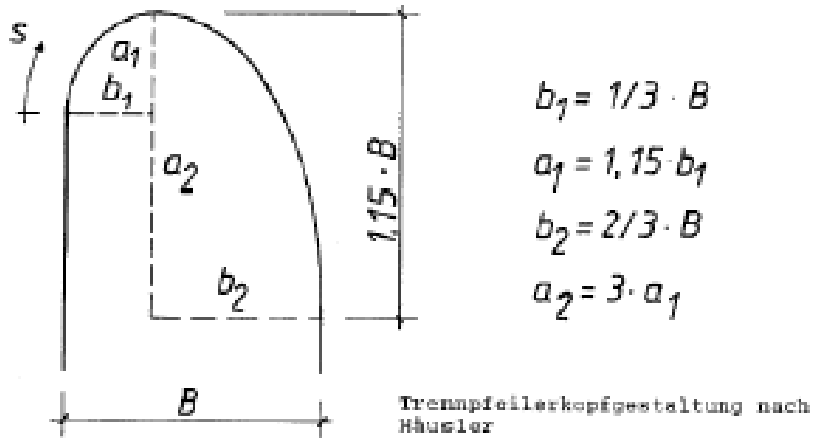
- Based on the angled bar rack bypass system by Ebel, Gluch & Kehl
- Bypass width: 1 m
- Ramp inclination: 26.6°
- Q (Bypass): 2 m³/s (4.0% of Q_{River})

<u>Dividing pier – turbine-side part:</u>

- Based on Häusler
- Width B: 2 m
- Length: 15 m
- $a_1 = b_1 = 0.77$ m
- $b_2 = 1.23$ m
- $a_2 = 2.31$ m



Layout of the bypass and dividing pier



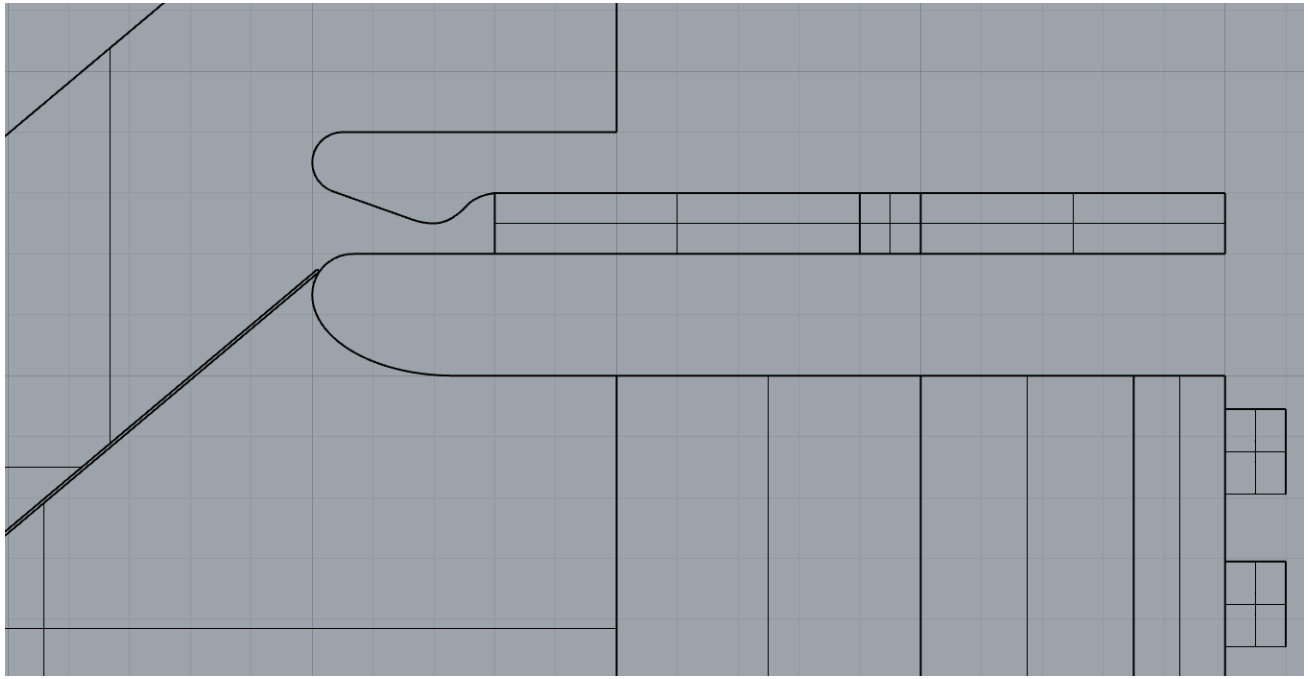
421a - General

Dividing pier – weir-side part:

- Width: 1 m
- Shape: Circular rounded
- Inlet gate: „Streamlined“ with 0.5 m width over the whole water column

Fish guidance structure (FGS):

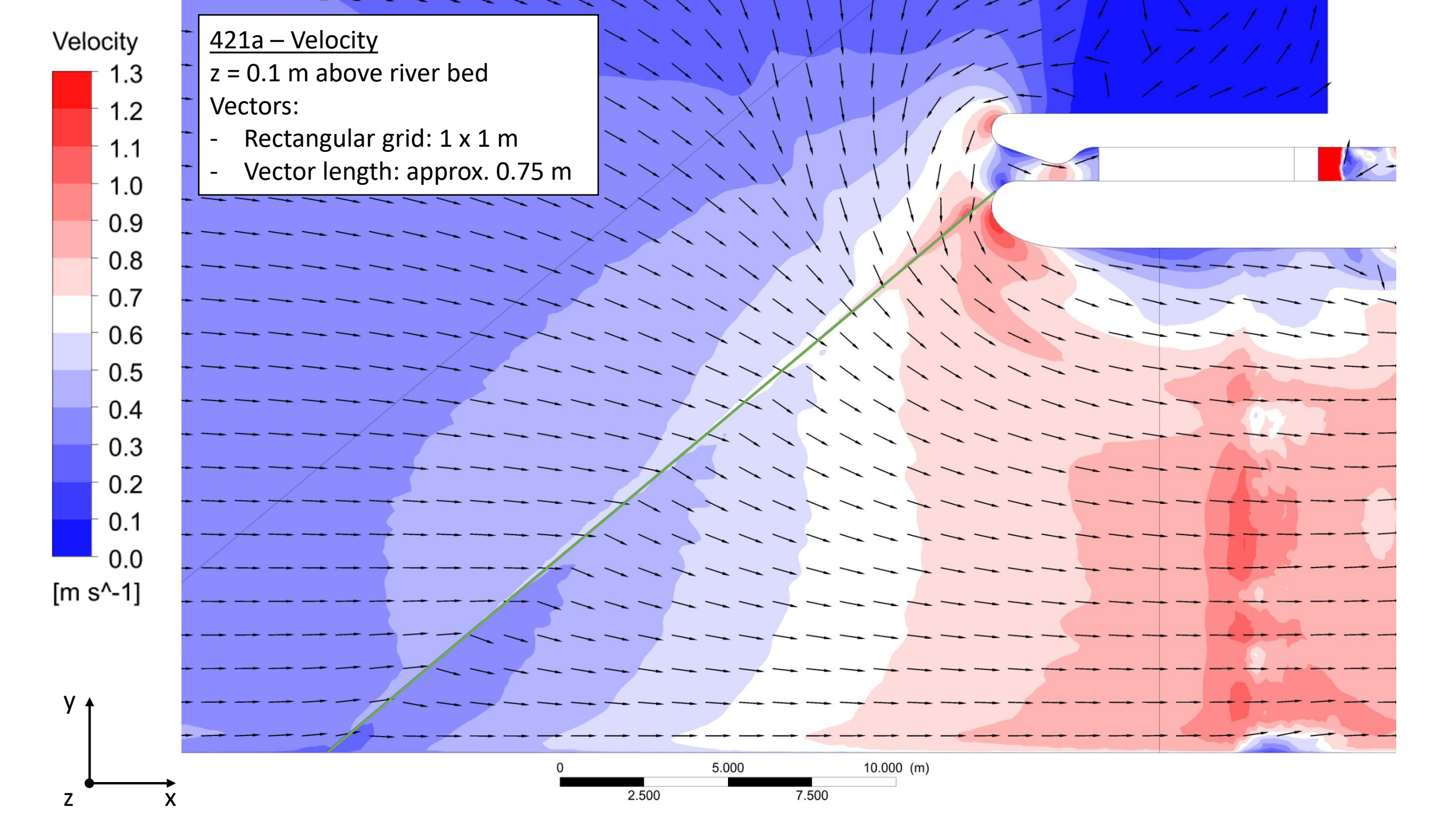
- Rack length: 25.94 m
- Mean velocity at rack:
  v = Q/A = 0.46 m/s
- Circular bar trash rack with 40° angle to the unaffected flow direction
- Head loss values depending on the horizontal inflow angle and the rack configuration

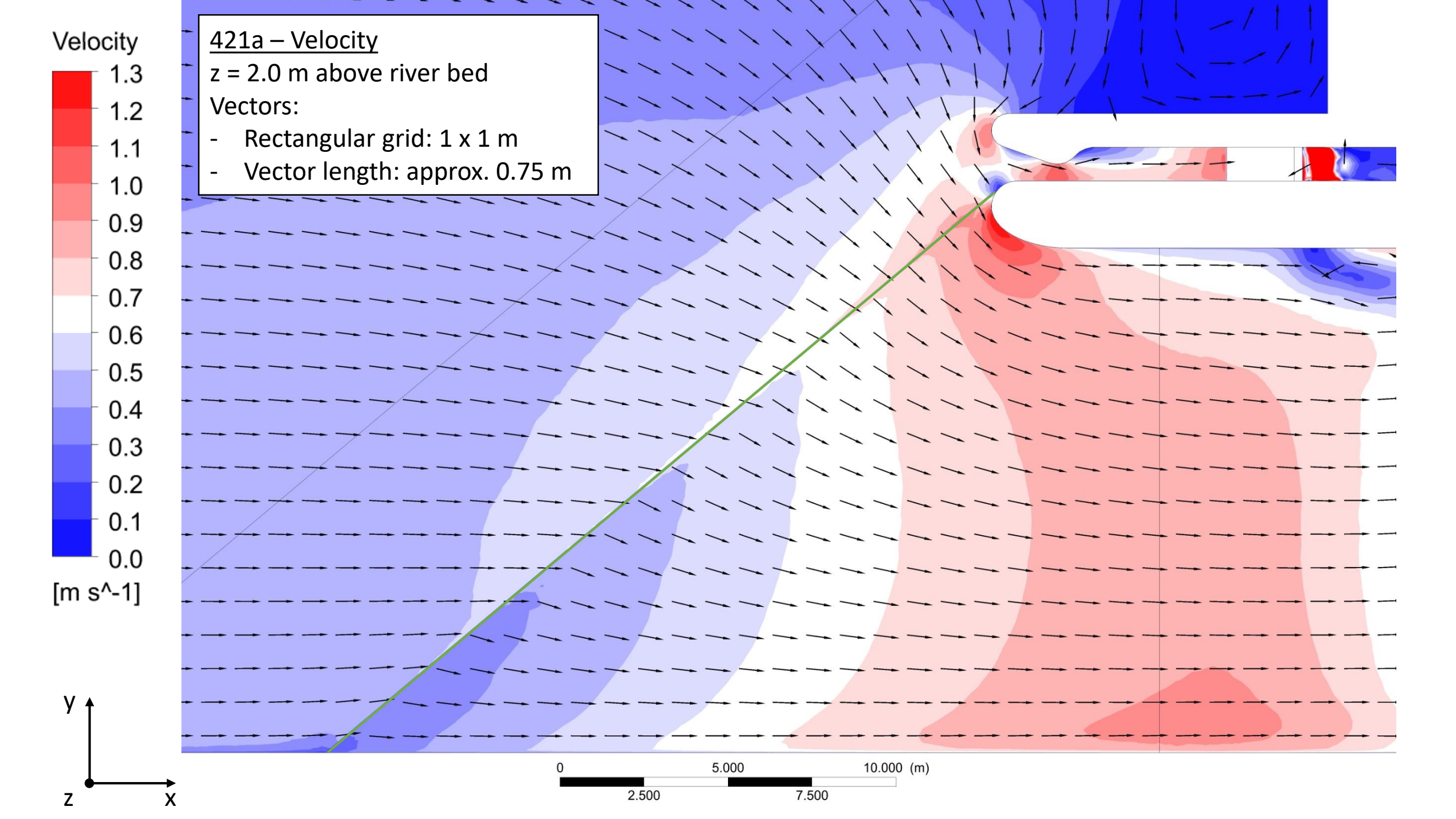


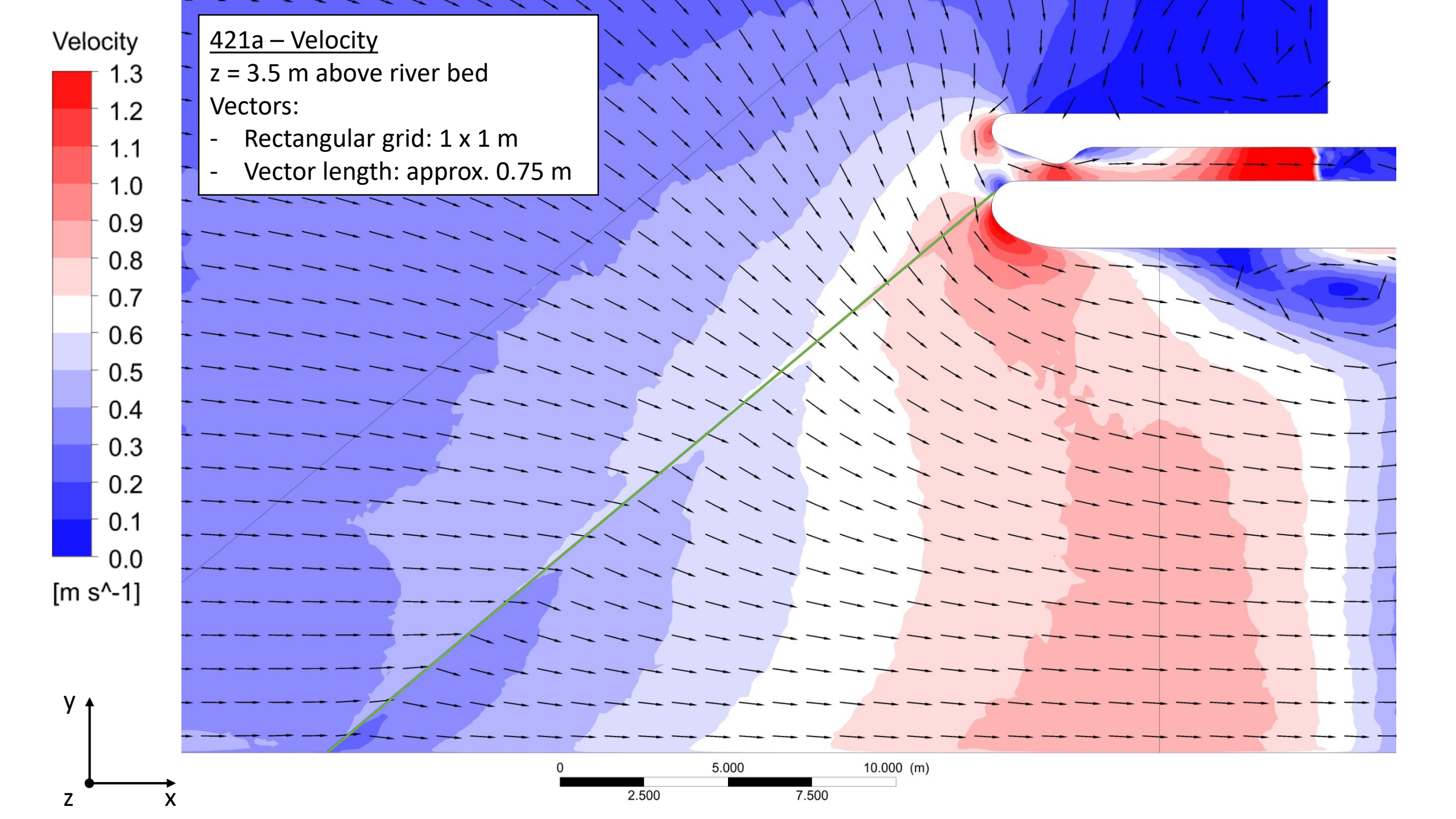
Layout of the bypass and dividing pier

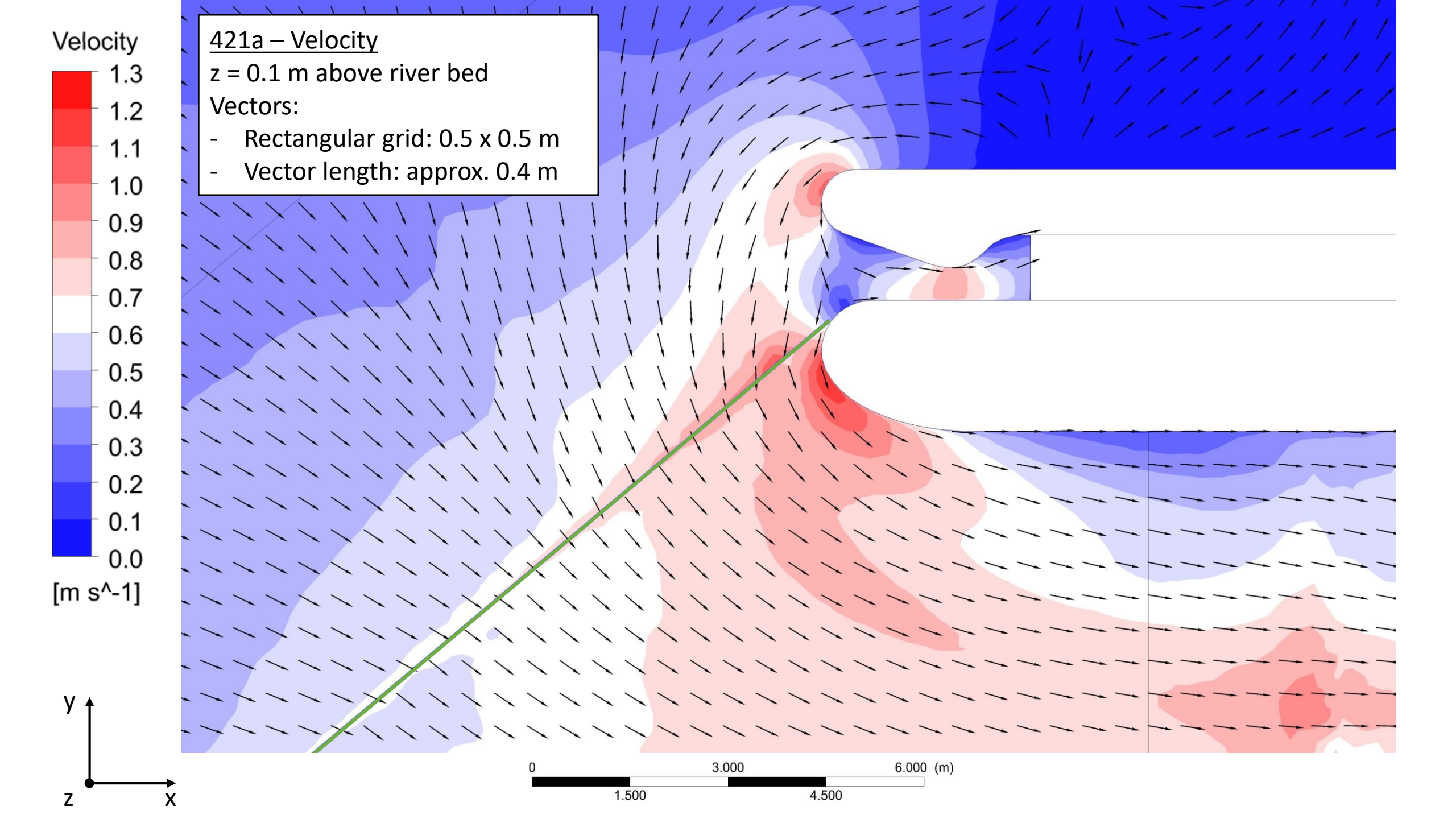
CBTR, 50% blocking ratio
(Formula: mod. Meusburger)

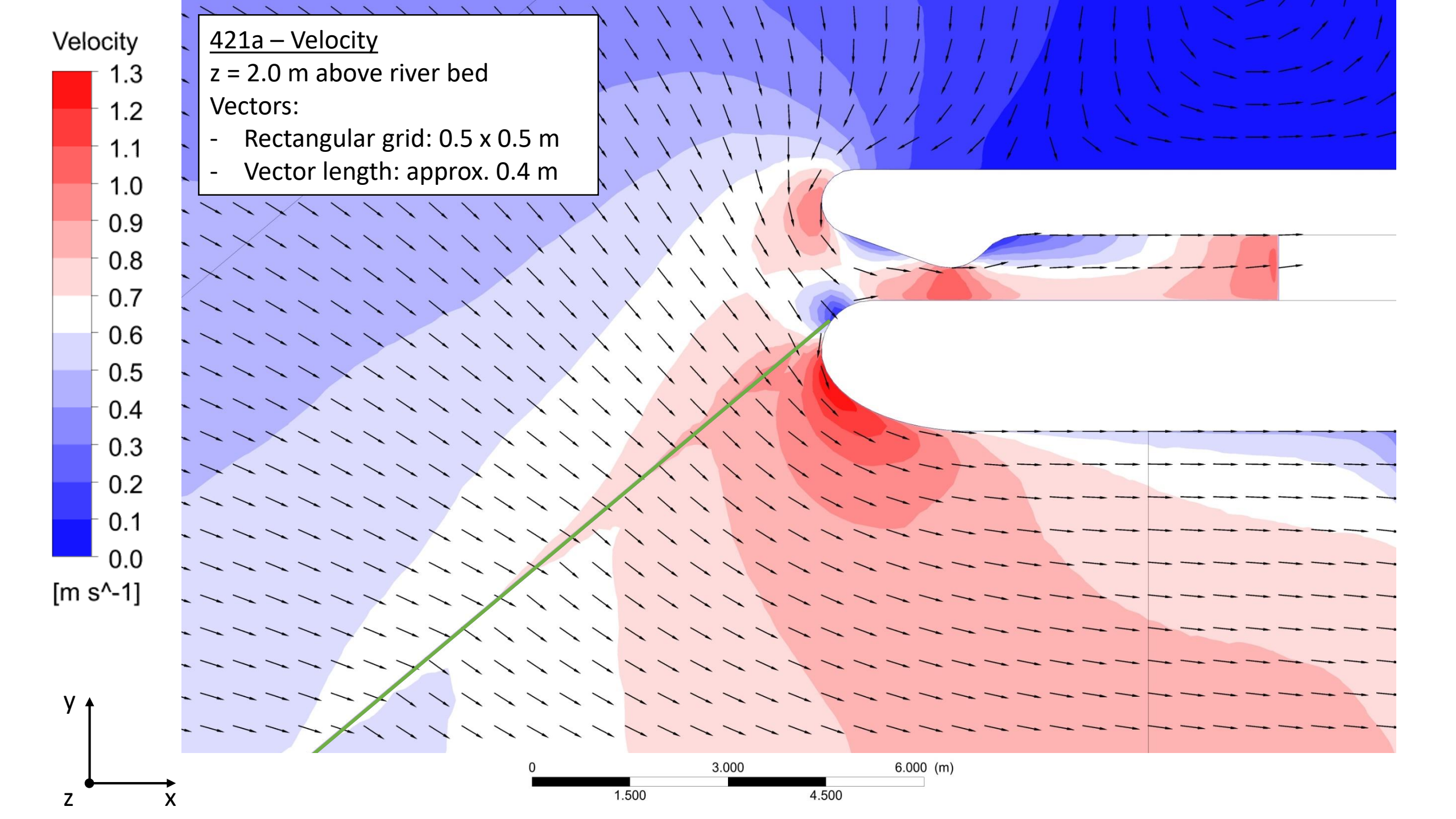
Degree	Head loss value
10	0.31
20	0.61
30	0.90
40	1.15
50	1.37
60	1.55
70	1.68
80	1.76
90	1.79

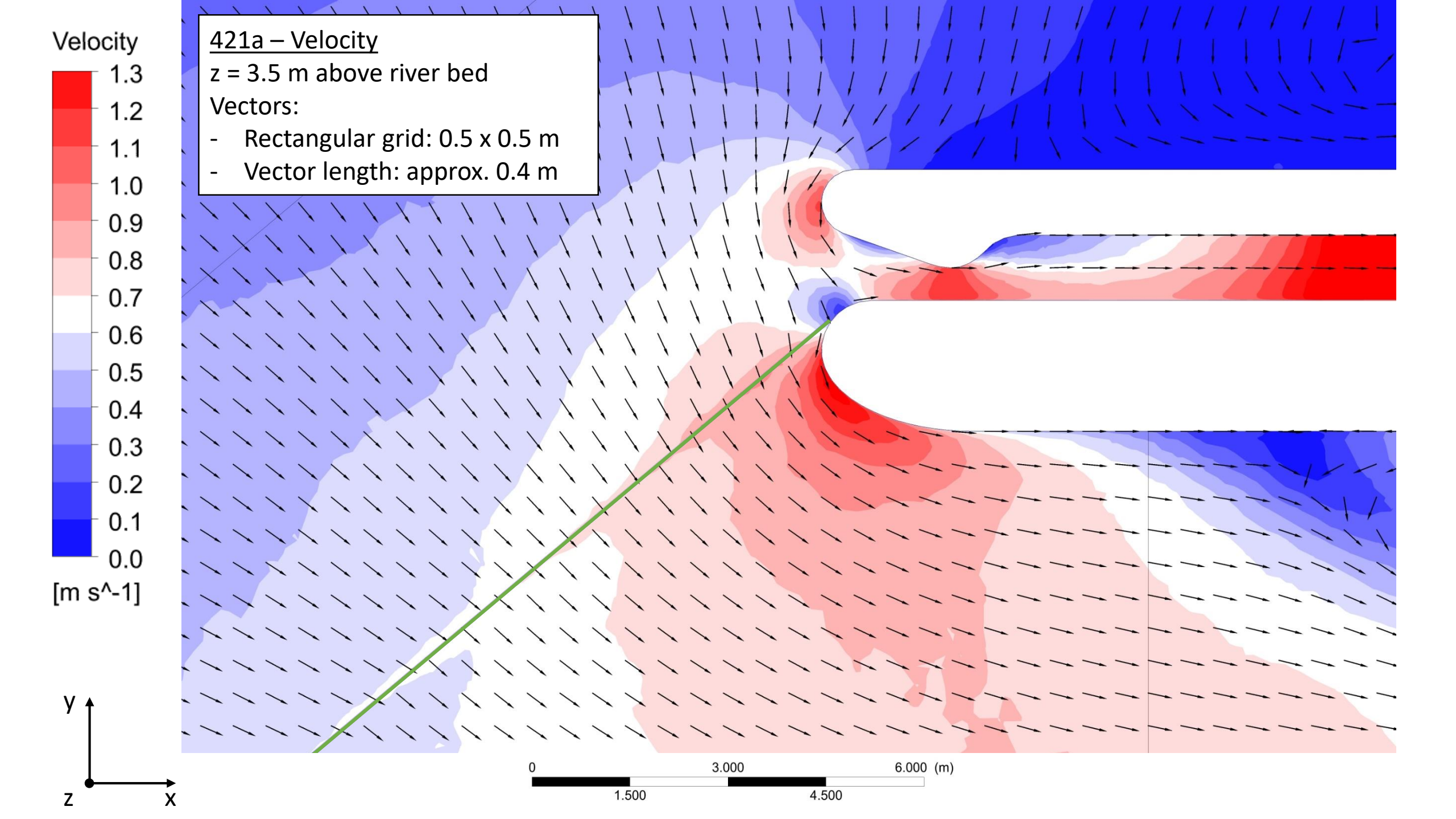

421a – Velocity
z = 0.1 m above river bed
Vectors:
- Rectangular grid: 1 x 1 m
- Vector length: approx. 0.75 m
Velocity
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
[m s^-1]
y
z
x
0
5.000
10.000 (m)
2.500
7.500

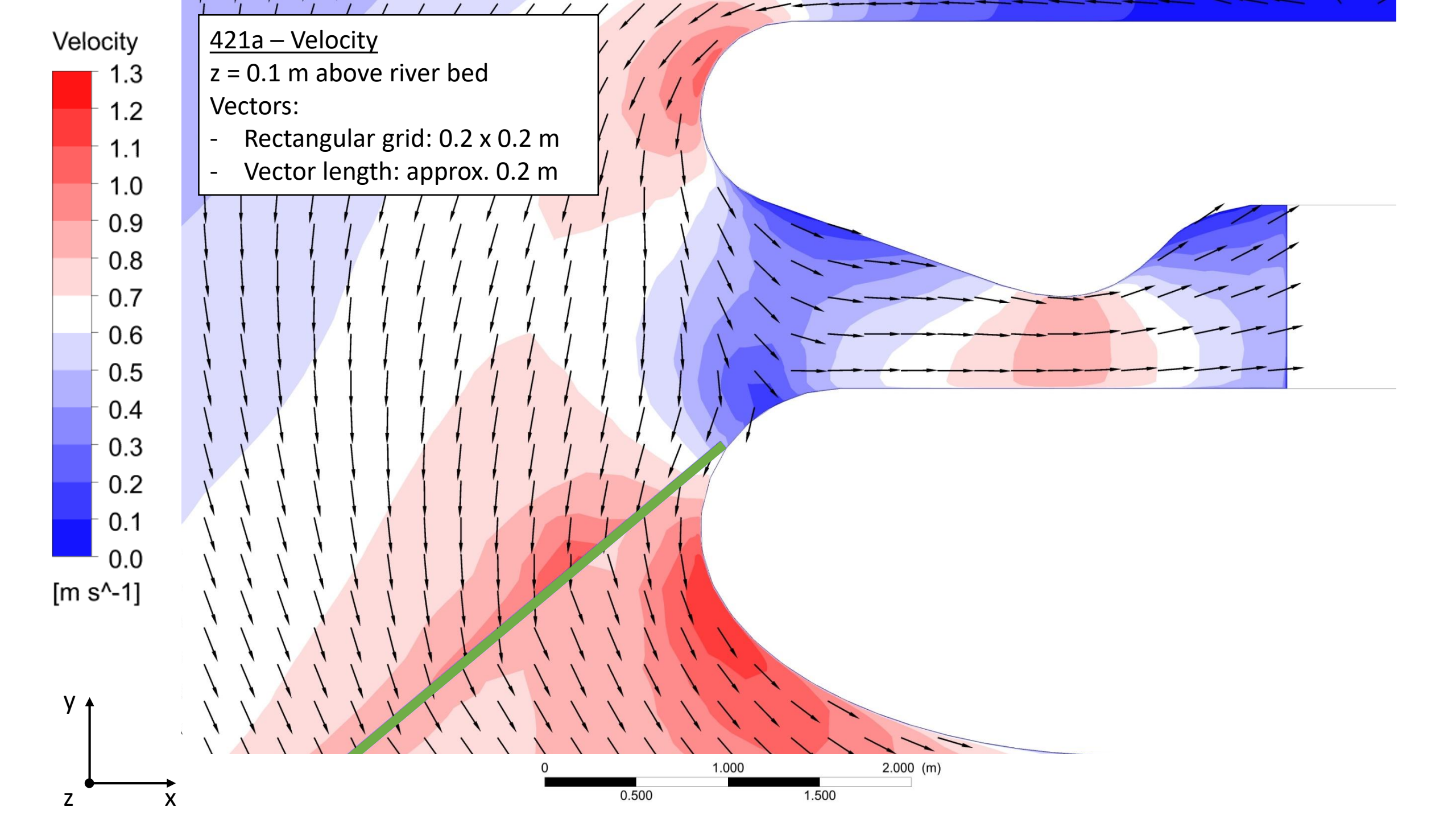

421a – Velocity
z = 2.0 m above river bed
Vectors:
- Rectangular grid: 1 x 1 m
- Vector length: approx. 0.75 m
Velocity
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
[m s^-1]
y
z
x
0
5.000
10.000 (m)
2.500
7.500

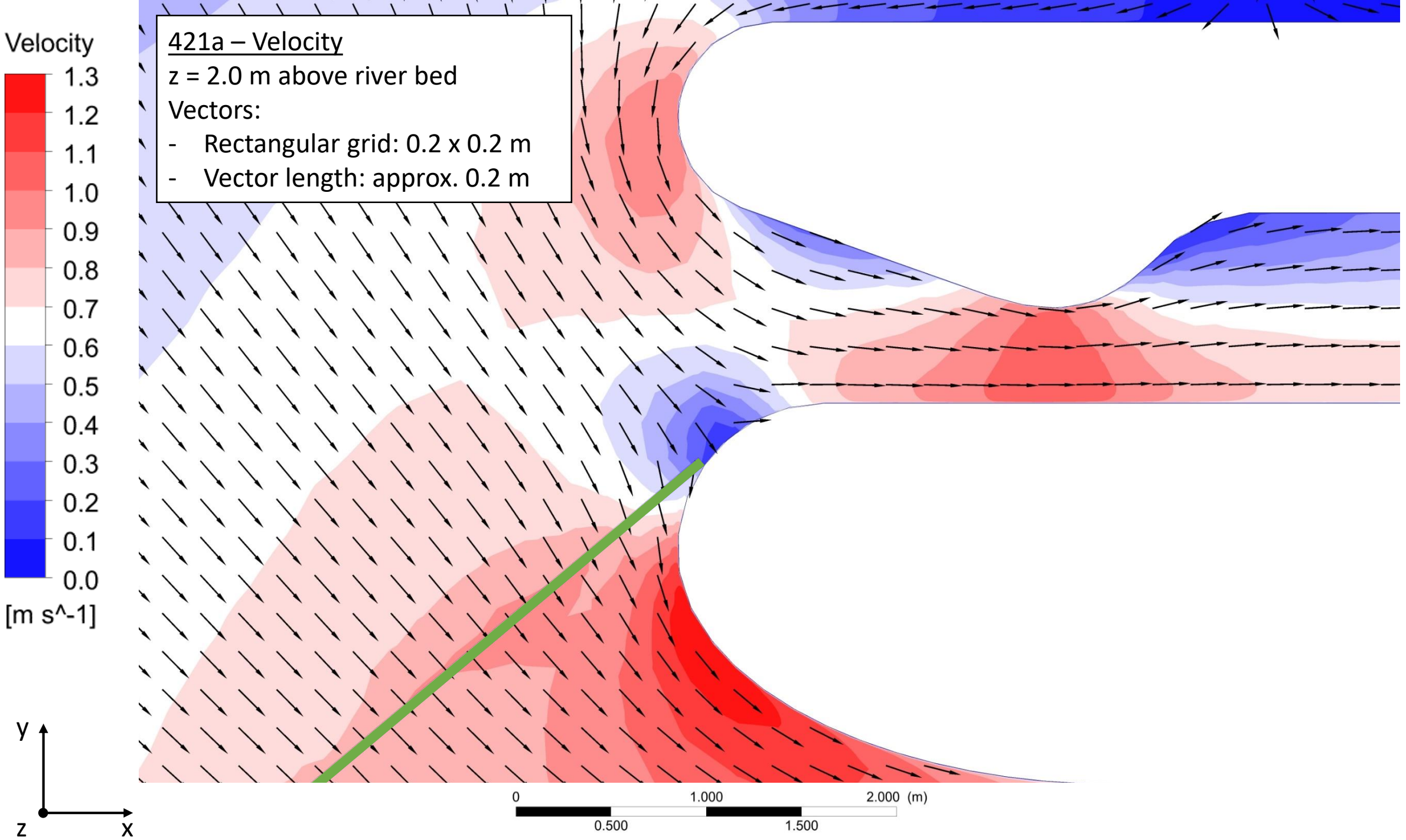

421a – Velocity
z = 3.5 m above river bed
Vectors:
- Rectangular grid: 1 x 1 m
- Vector length: approx. 0.75 m
Velocity
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
[m s^-1]
y
z
x
0
5.000
10.000 (m)
2.500
7.500

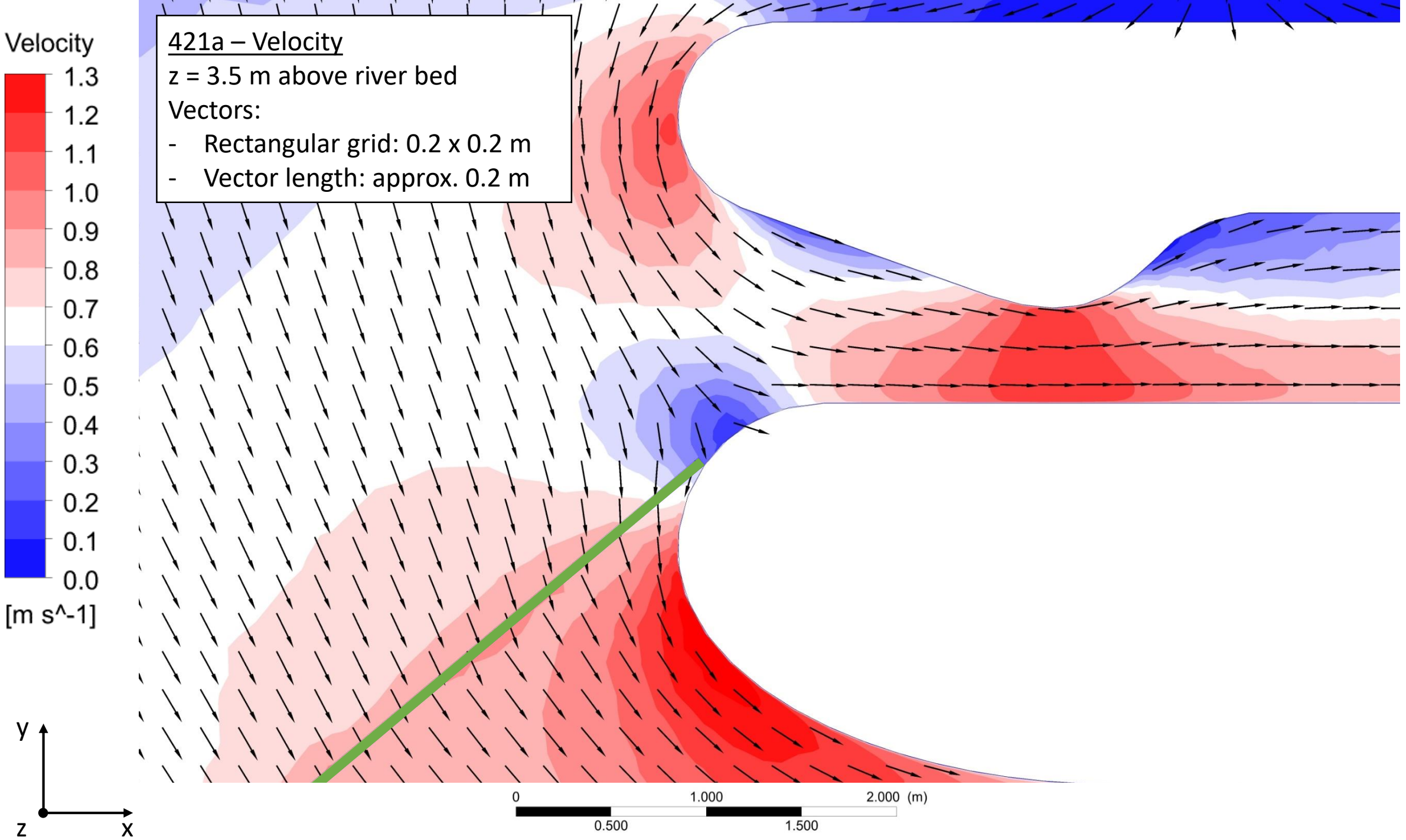

421a – Velocity
z = 0.1 m above river bed
Vectors:
- Rectangular grid: 0.5 x 0.5 m
- Vector length: approx. 0.4 m
Velocity
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
[m s^-1]
y
z
x
0
3.000
6.000 (m)
1.500
4.500

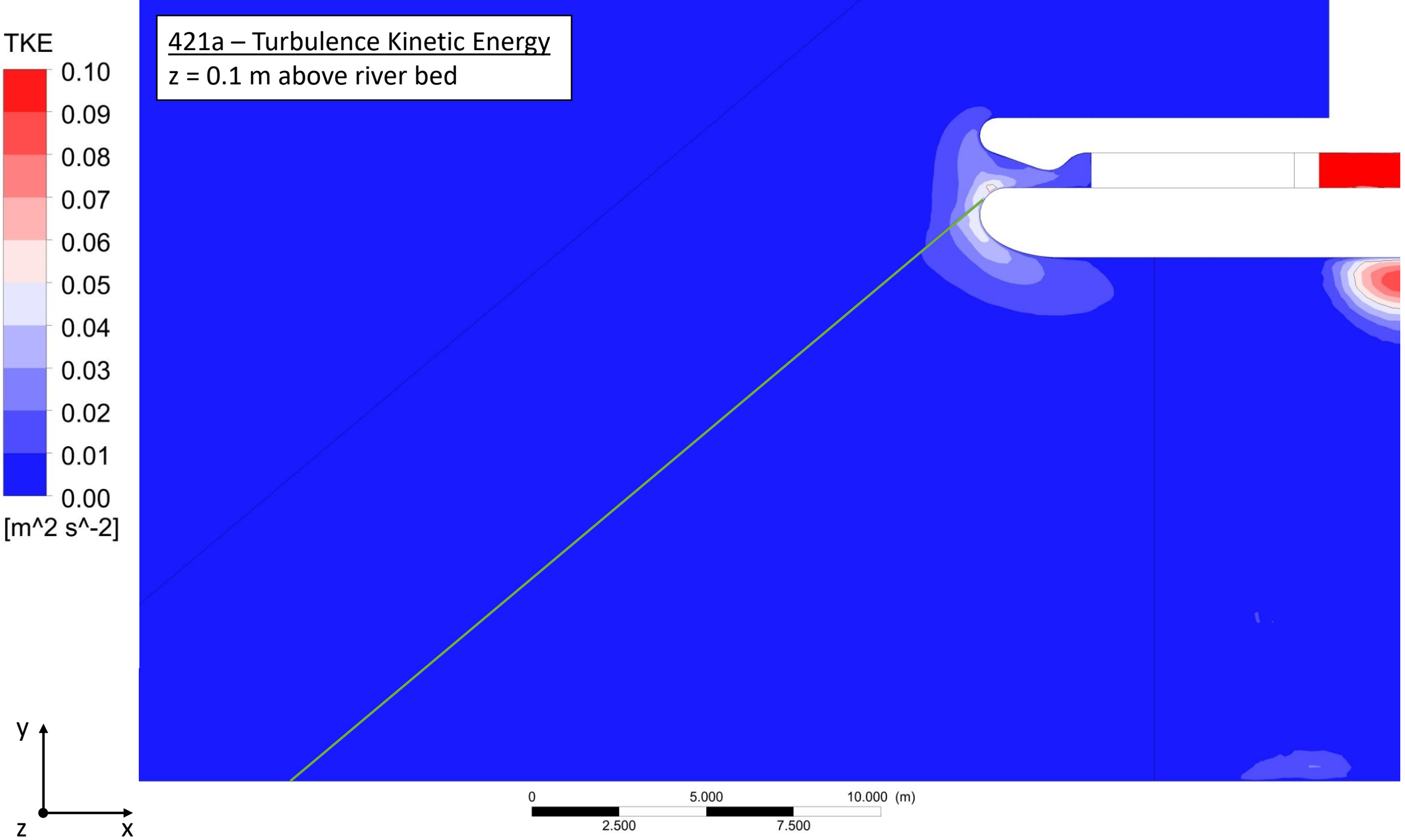

421a – Velocity
z = 2.0 m above river bed
Vectors:
- Rectangular grid: 0.5 x 0.5 m
- Vector length: approx. 0.4 m
Velocity
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
[m s^-1]
y
z
x
0
3.000
6.000 (m)
1.500
4.500

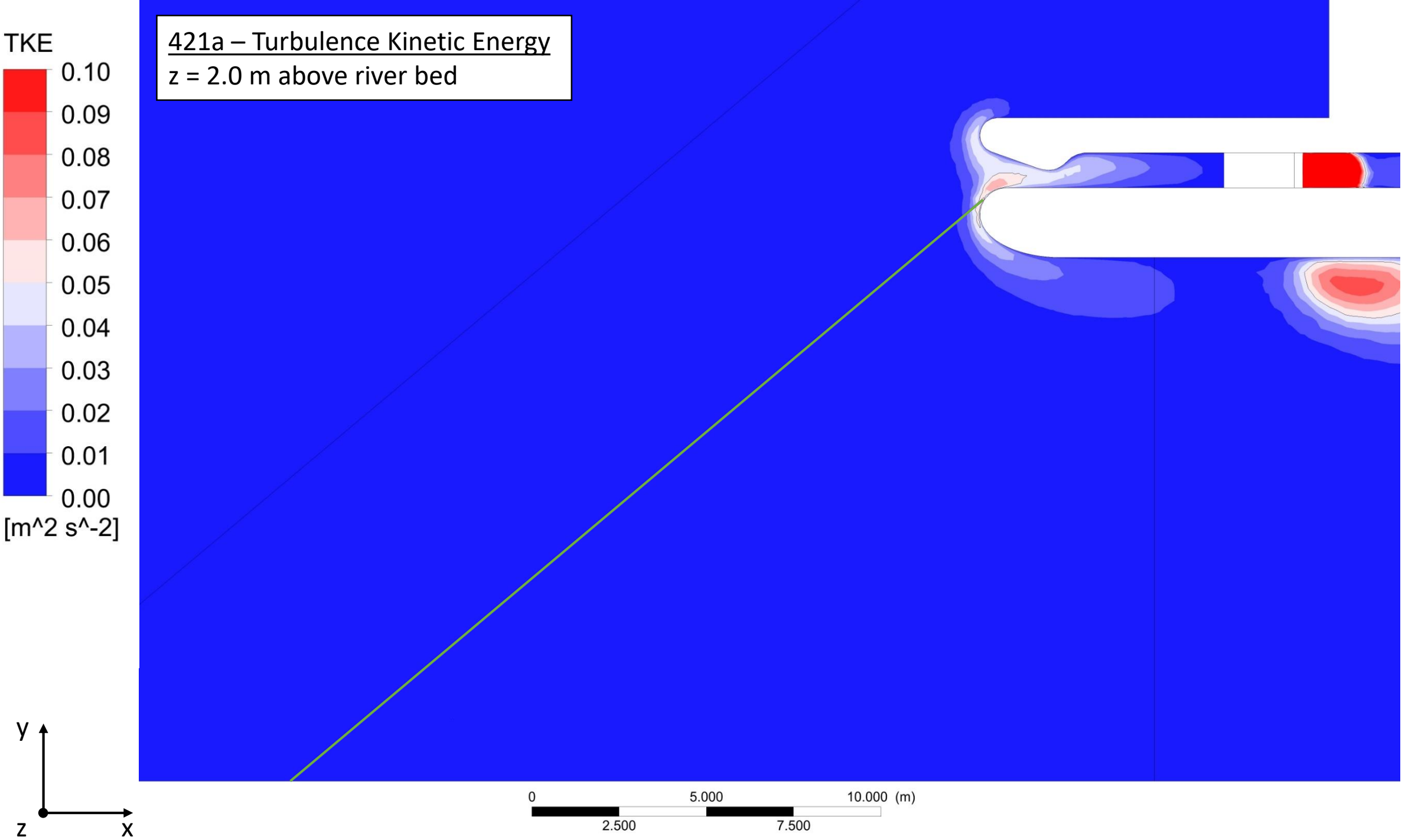

Velocity
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
[m s^-1]
421a – Velocity
z = 3.5 m above river bed
Vectors:
- Rectangular grid: 0.5 x 0.5 m
- Vector length: approx. 0.4 m
y
z
x
0
3.000
6.000 (m)
1.500
4.500

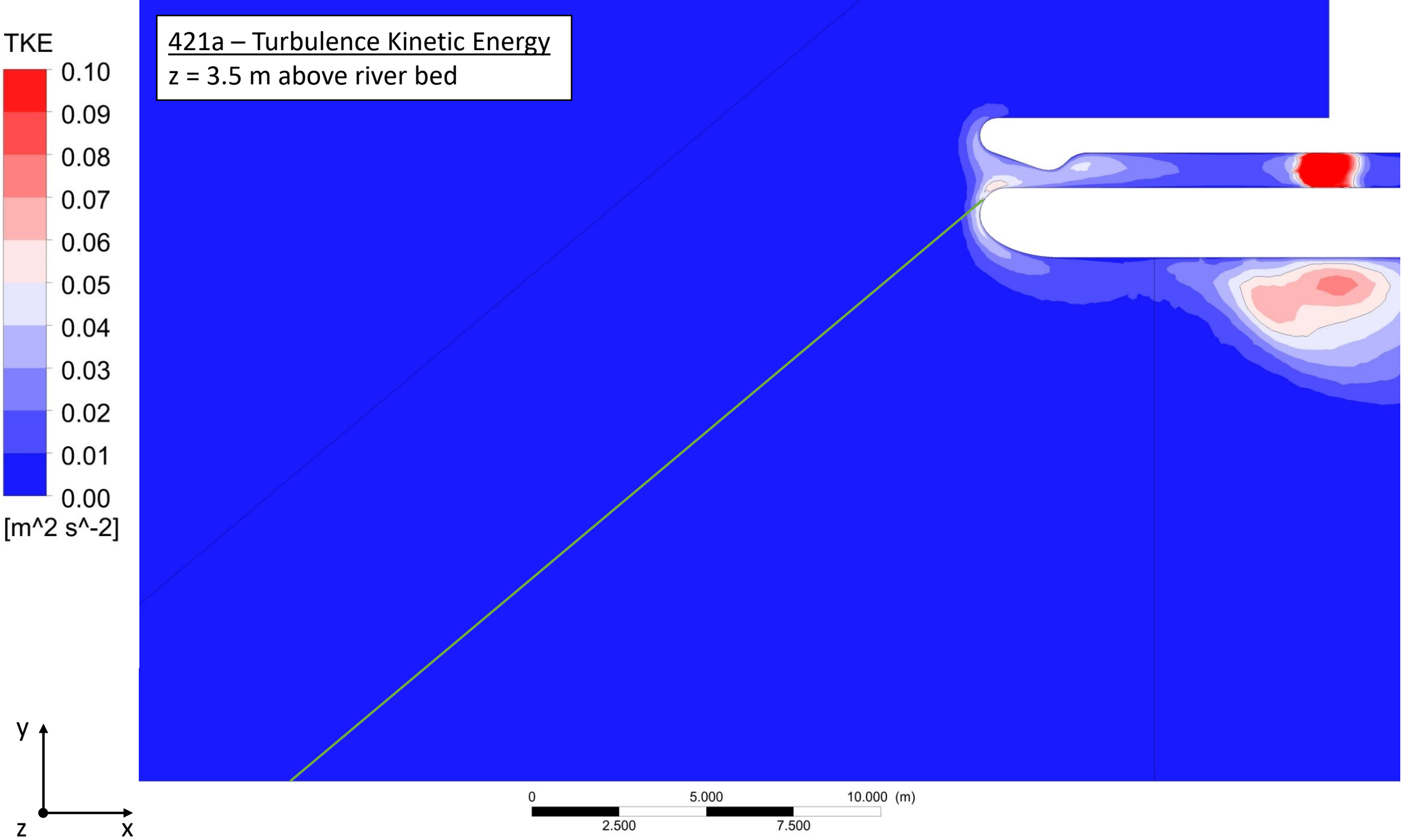

421a – Velocity
z = 0.1 m above river bed
Vectors:
- Rectangular grid: 0.2 x 0.2 m
- Vector length: approx. 0.2 m
Velocity
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
[m s^-1]
y
z
x
0
1.000
2.000 (m)
0.500
1.500

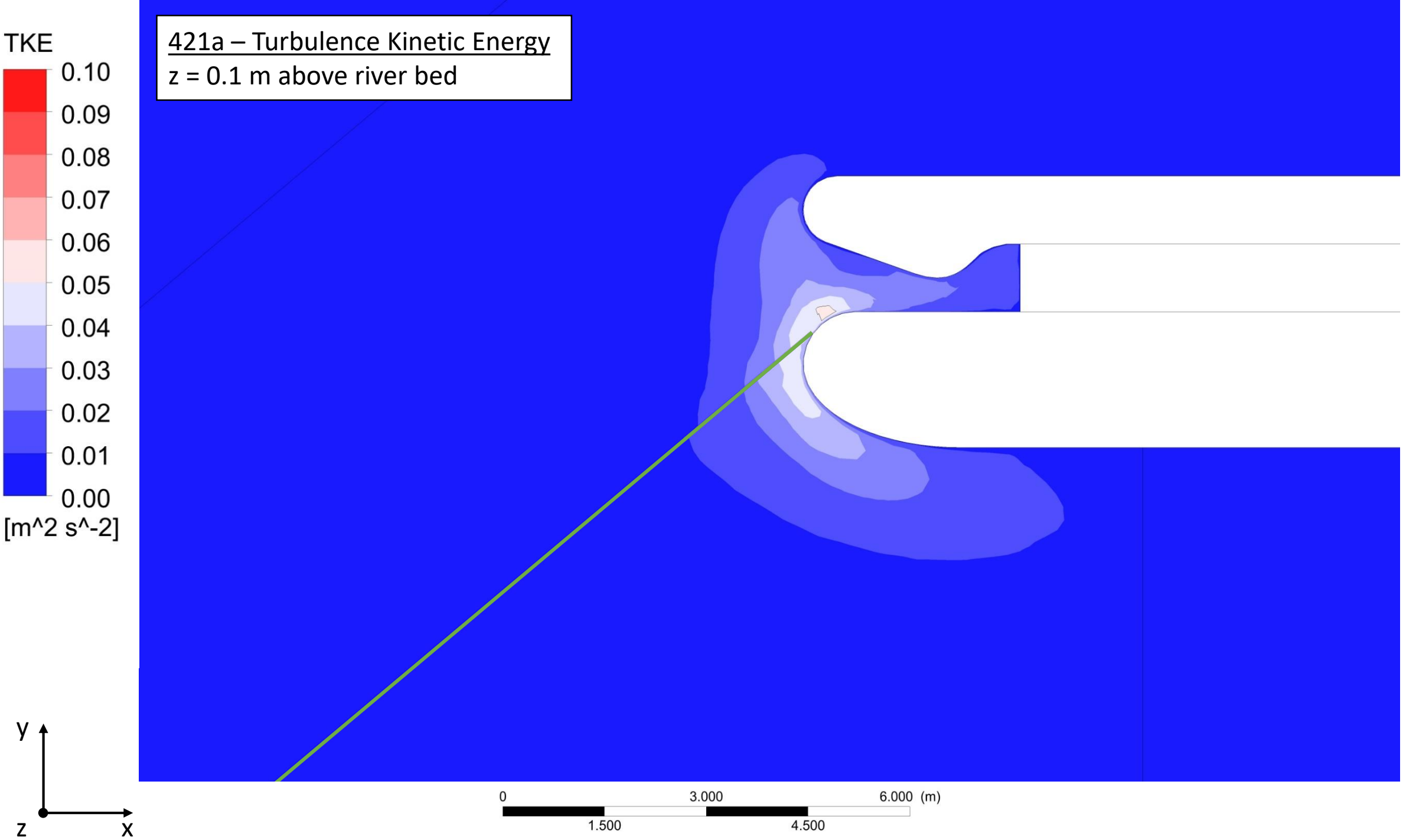

421a – Velocity
z = 2.0 m above river bed
Vectors:
- Rectangular grid: 0.2 x 0.2 m
- Vector length: approx. 0.2 m
Velocity
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
[m s^-1]
y
z
x
0
1.000
2.000 (m)
0.500
1.500

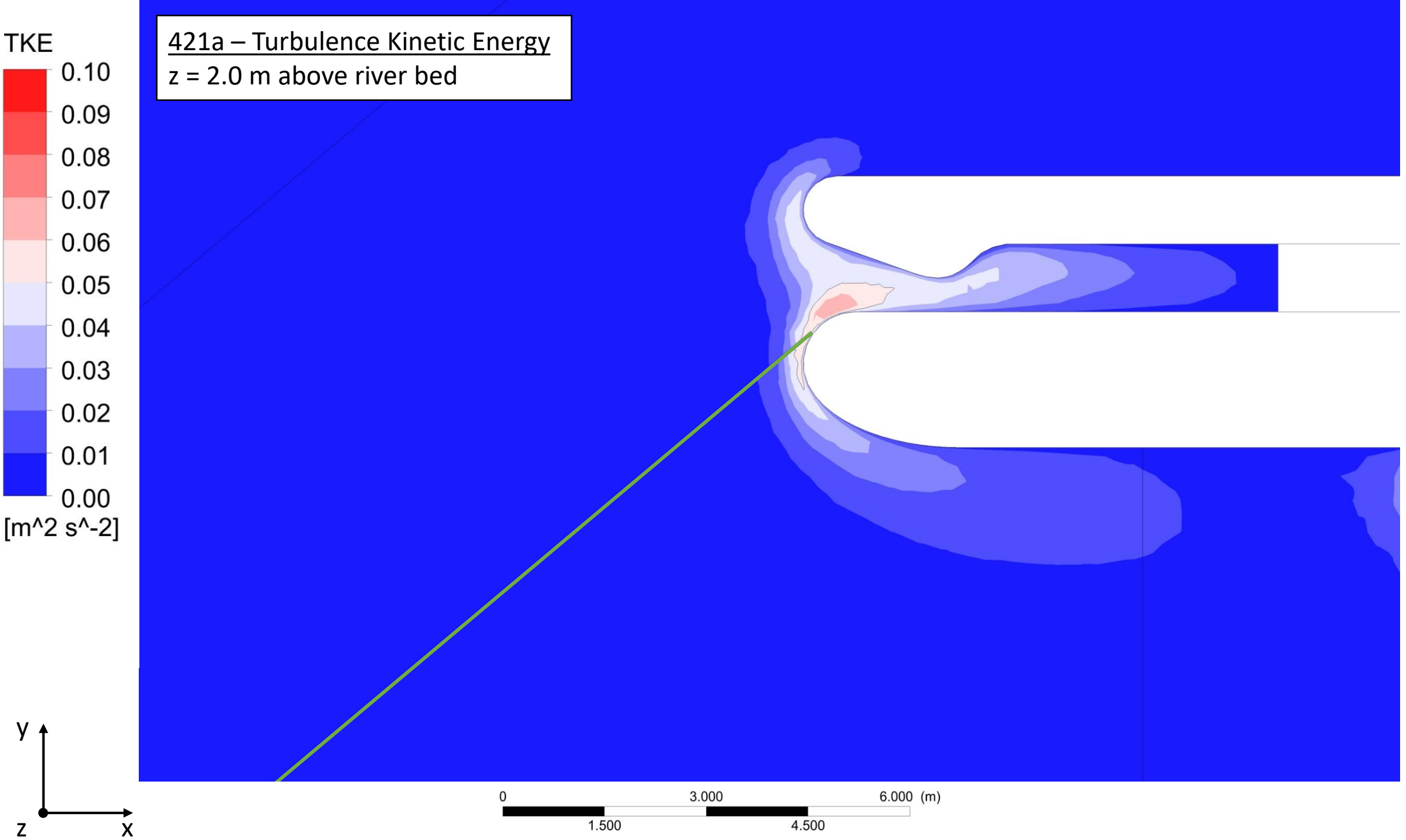

421a – Velocity
z = 3.5 m above river bed
Vectors:
- Rectangular grid: 0.2 x 0.2 m
- Vector length: approx. 0.2 m
Velocity
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
[m s^-1]
y
z
x
0
1.000
2.000 (m)
0.500
1.500

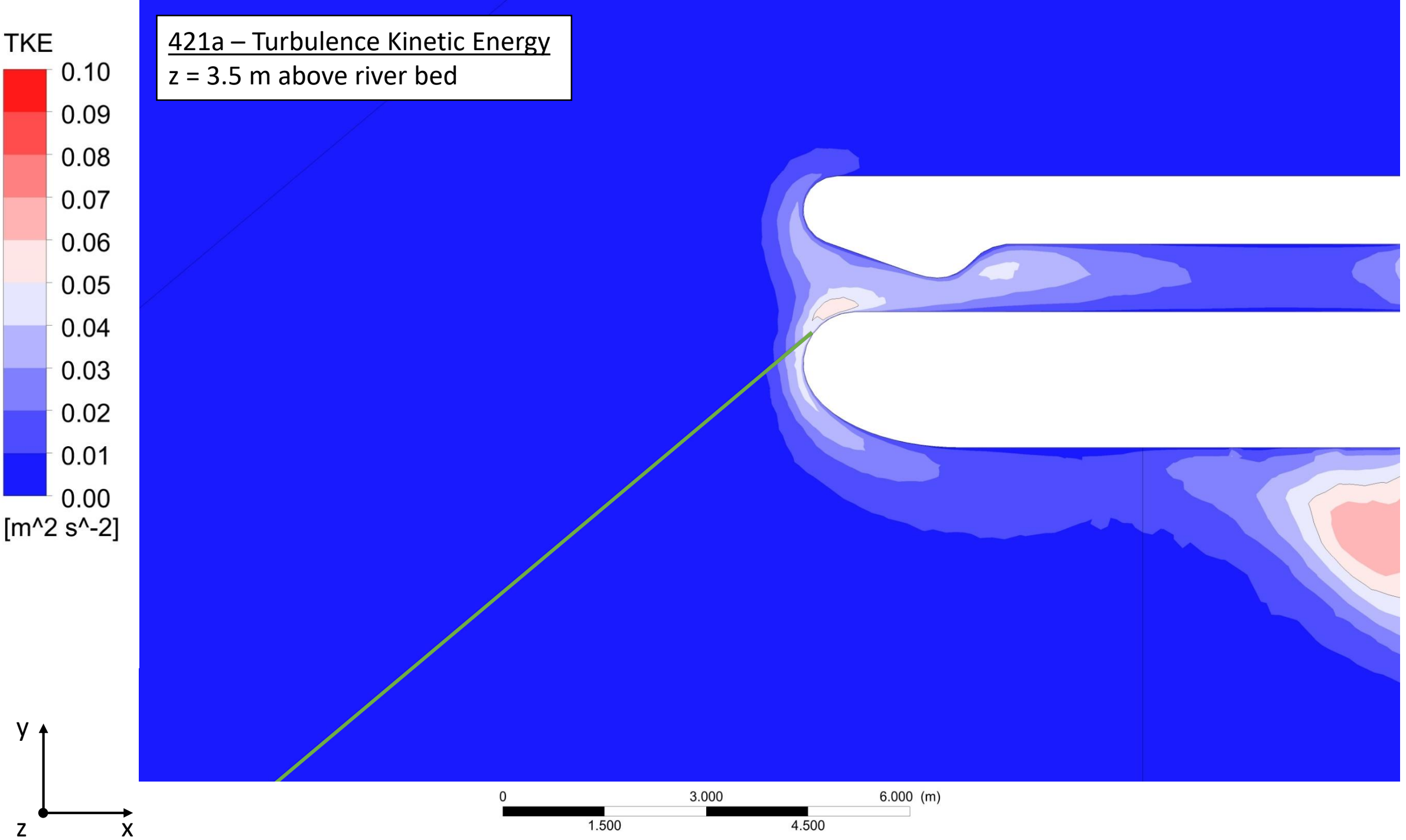

421a – Turbulence Kinetic Energy
z = 0.1 m above river bed
TKE
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
[m^2 s^-2]
y
z
x
0
5.000
10.000 (m)
2.500
7.500

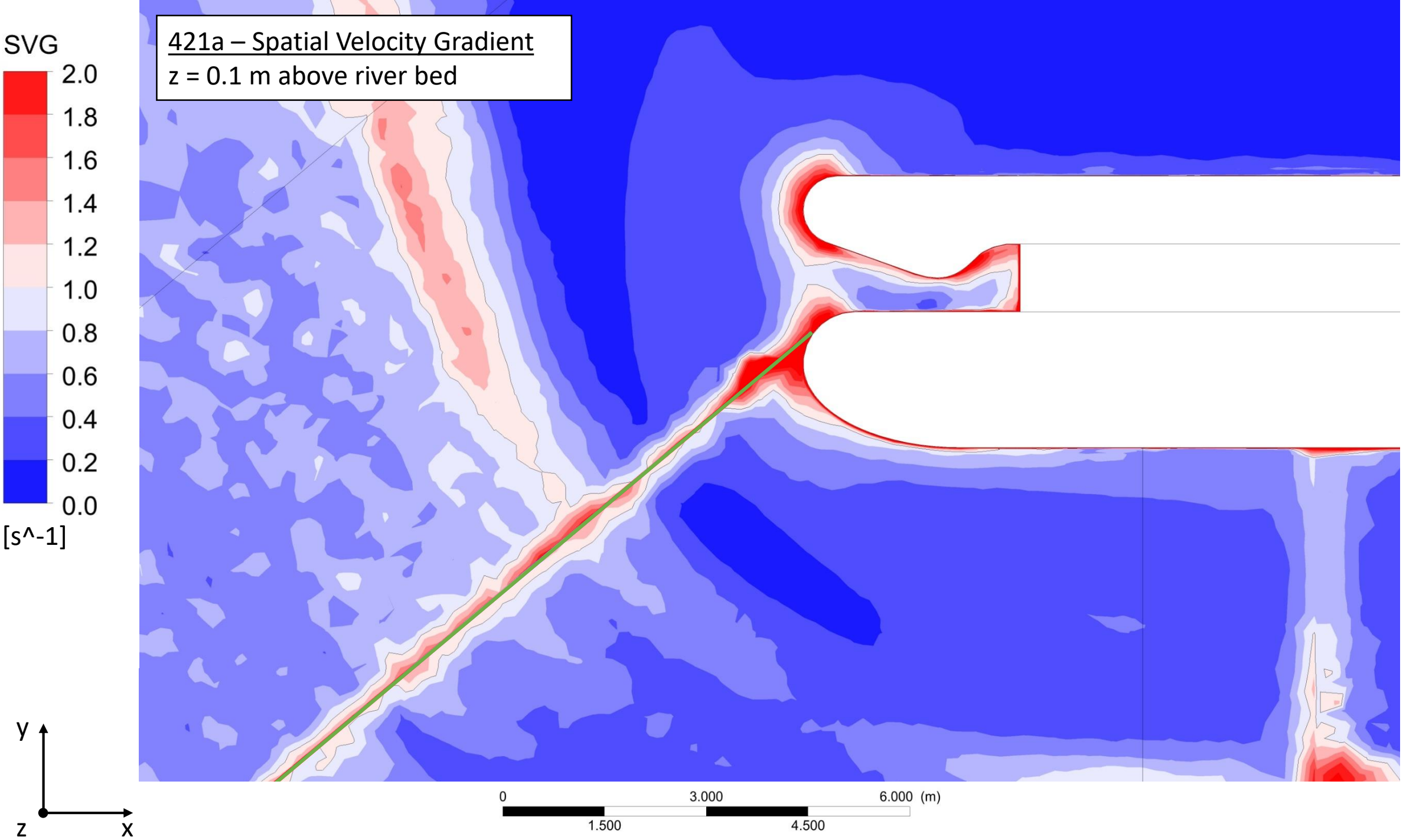

421a – Turbulence Kinetic Energy
z = 2.0 m above river bed
TKE
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
[m^2 s^-2]
y
z
x
0
5.000
10.000 (m)
2.500
7.500

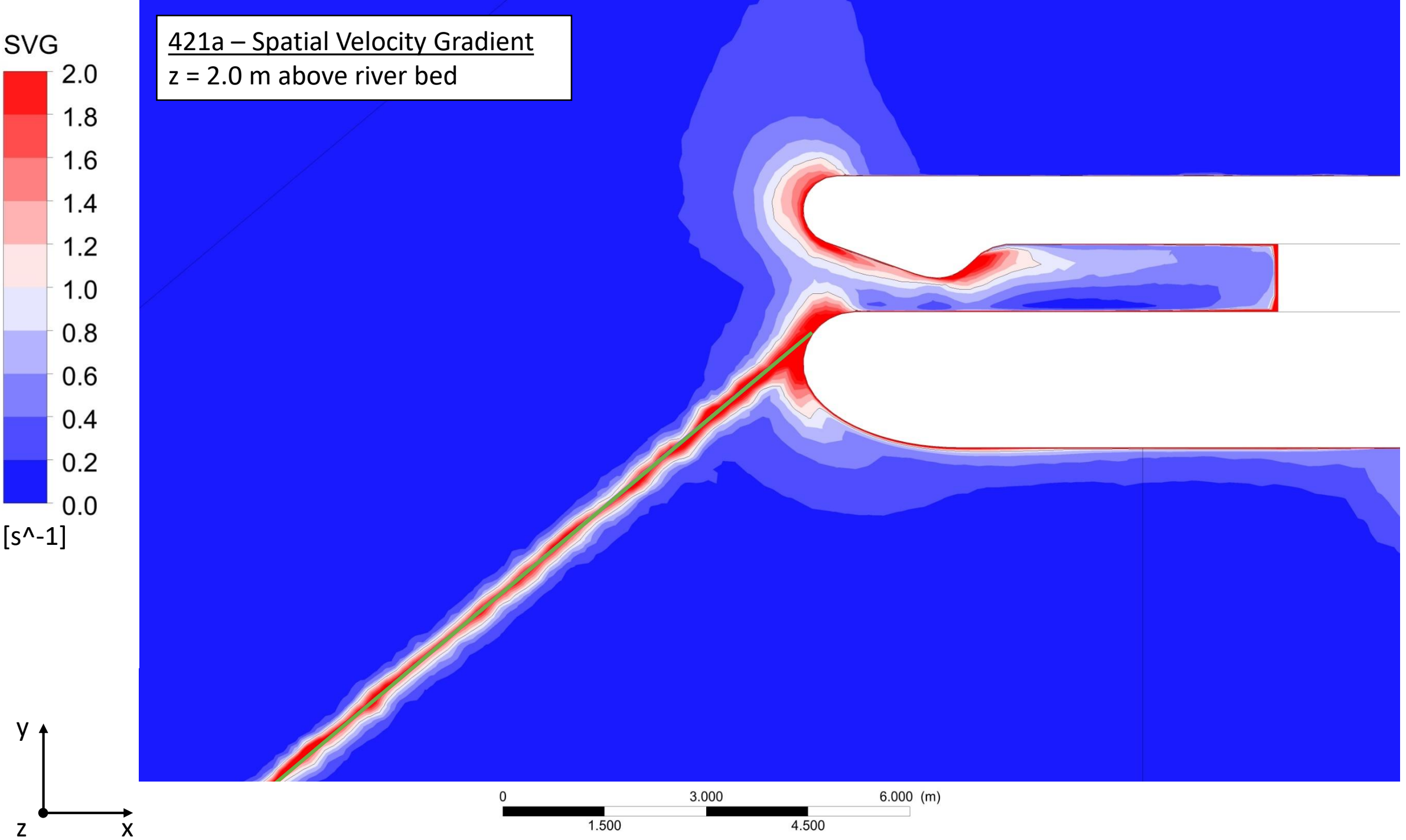

TKE
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
[m^2 s^-2]
421a – Turbulence Kinetic Energy
z = 3.5 m above river bed
y
z
x
0
5.000
10.000 (m)
2.500
7.500

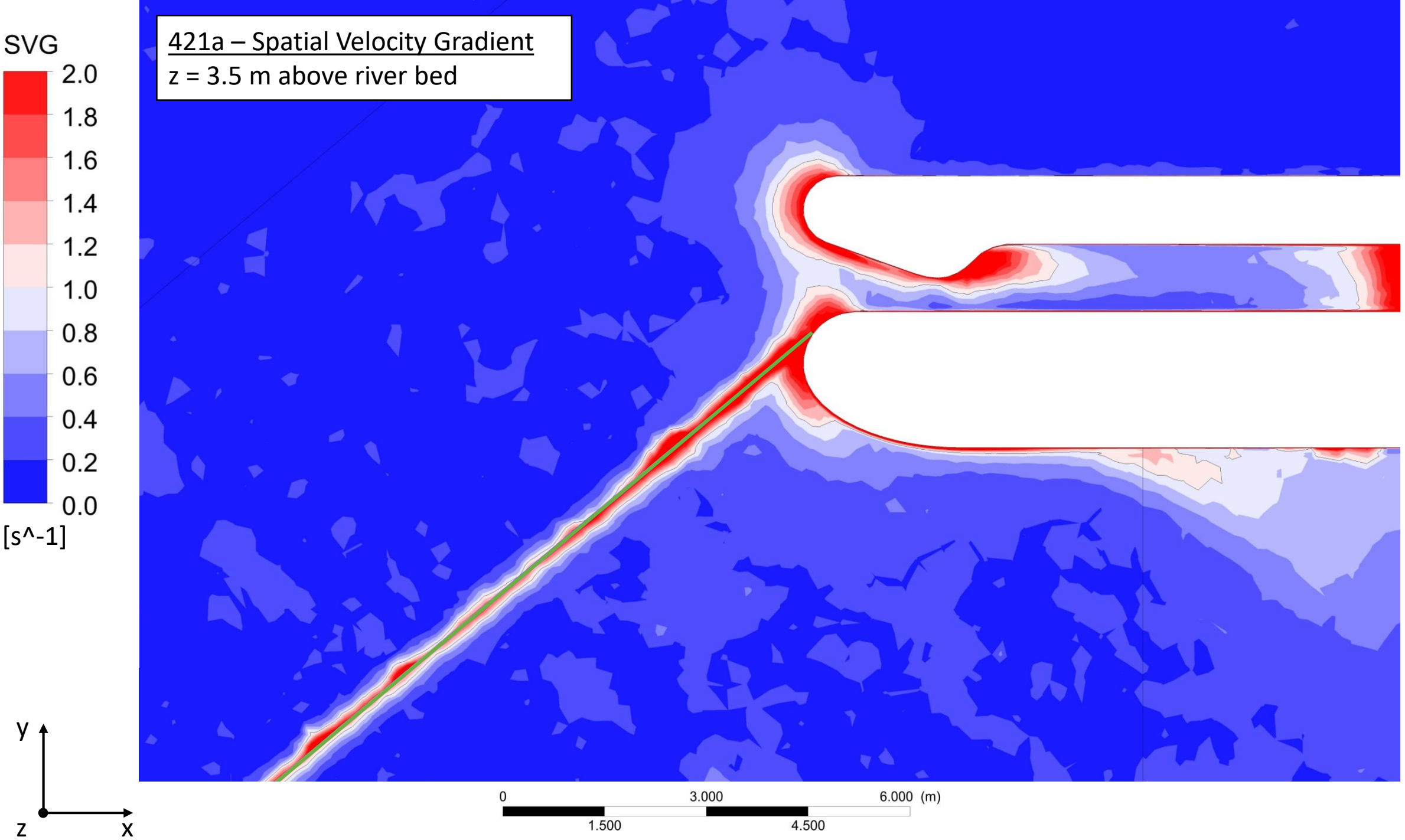

TKE
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
[m^2 s^-2]
421a – Turbulence Kinetic Energy
z = 0.1 m above river bed
y
z
x
0
3.000
6.000 (m)
1.500
4.500

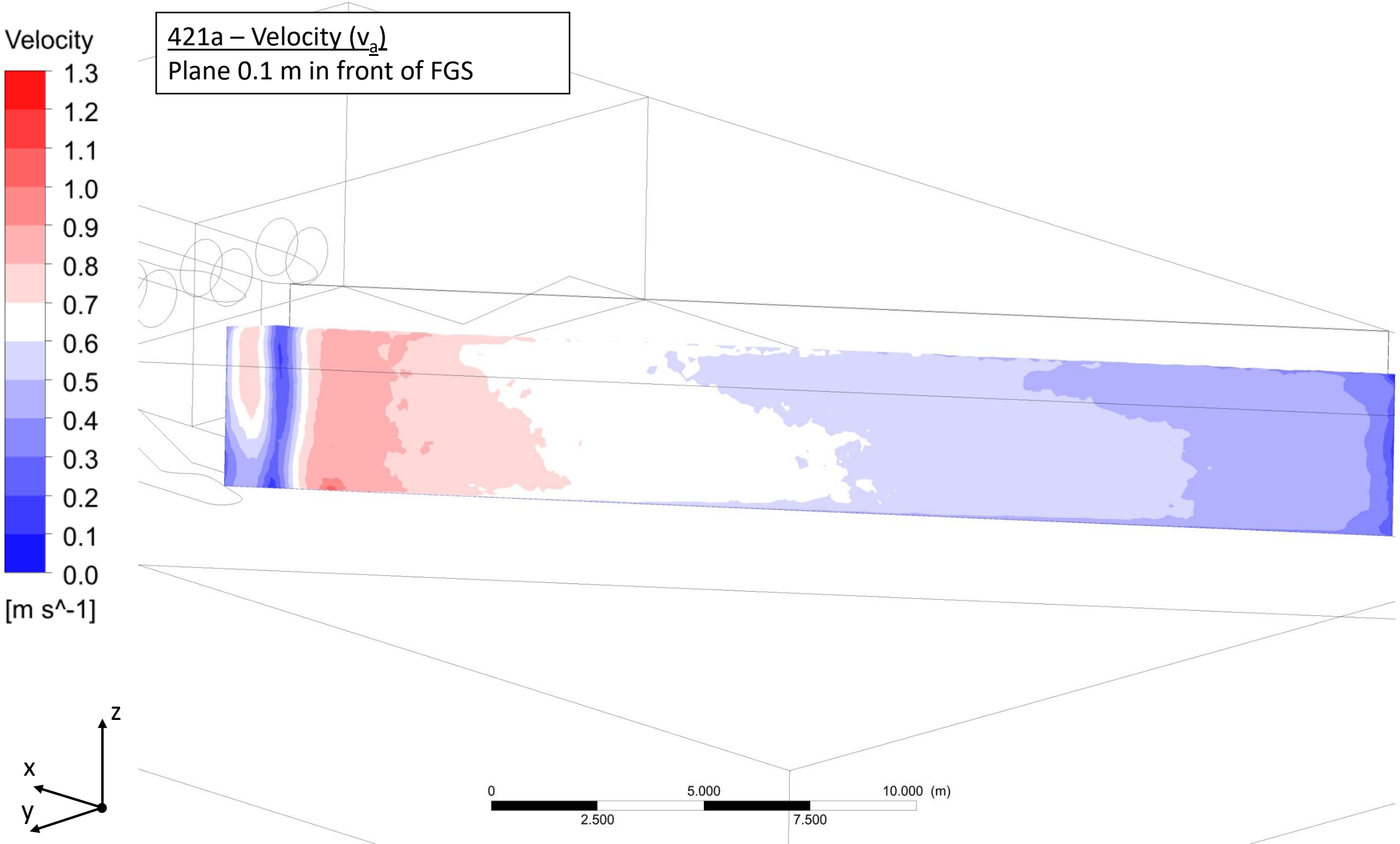

TKE
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
[m^2 s^-2]
421a – Turbulence Kinetic Energy
z = 2.0 m above river bed
y
z
x
0
3.000
6.000 (m)
1.500
4.500

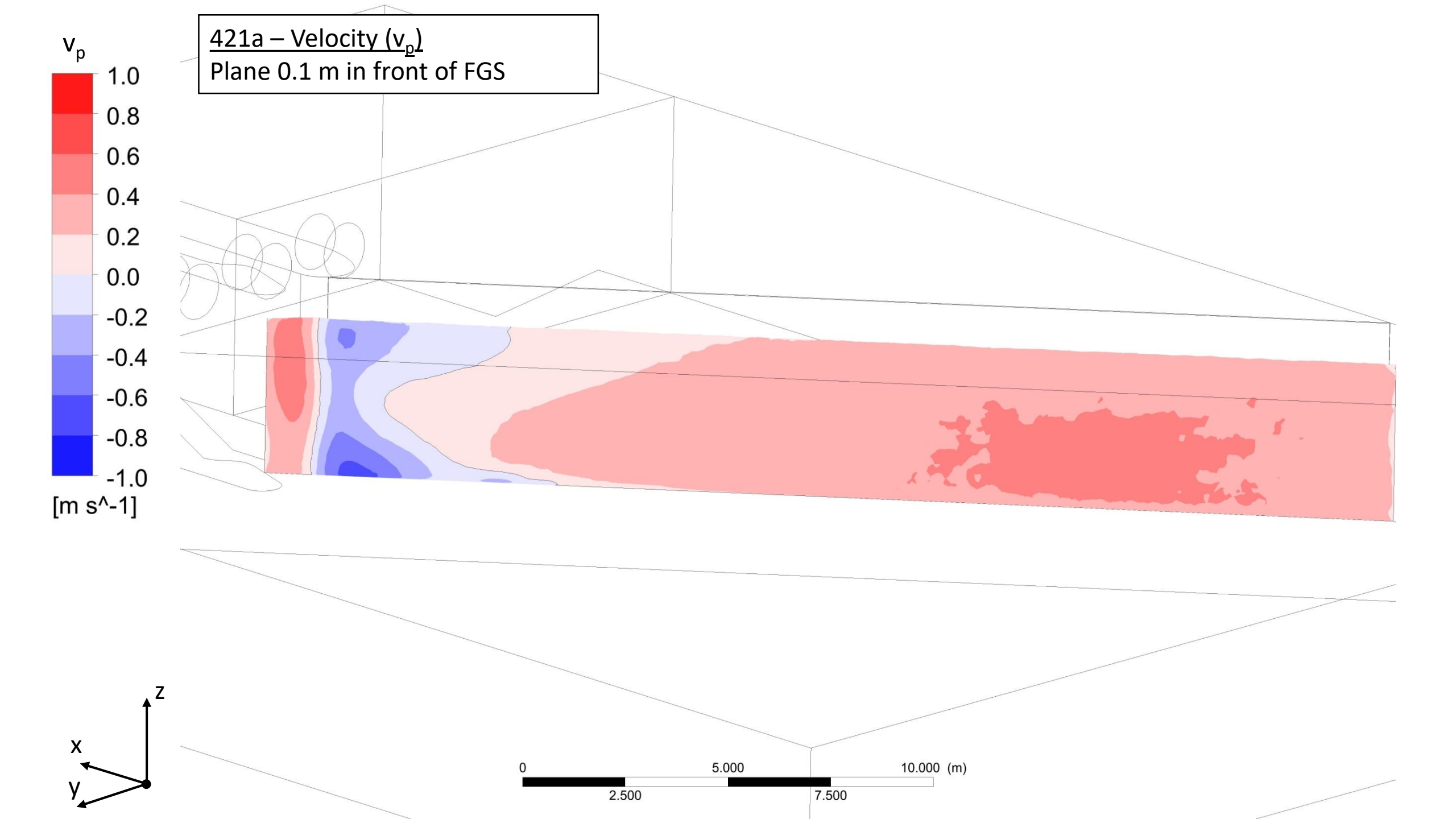

TKE
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
[m^2 s^-2]
421a – Turbulence Kinetic Energy
z = 3.5 m above river bed
y
z
x
0
3.000
6.000 (m)
1.500
4.500

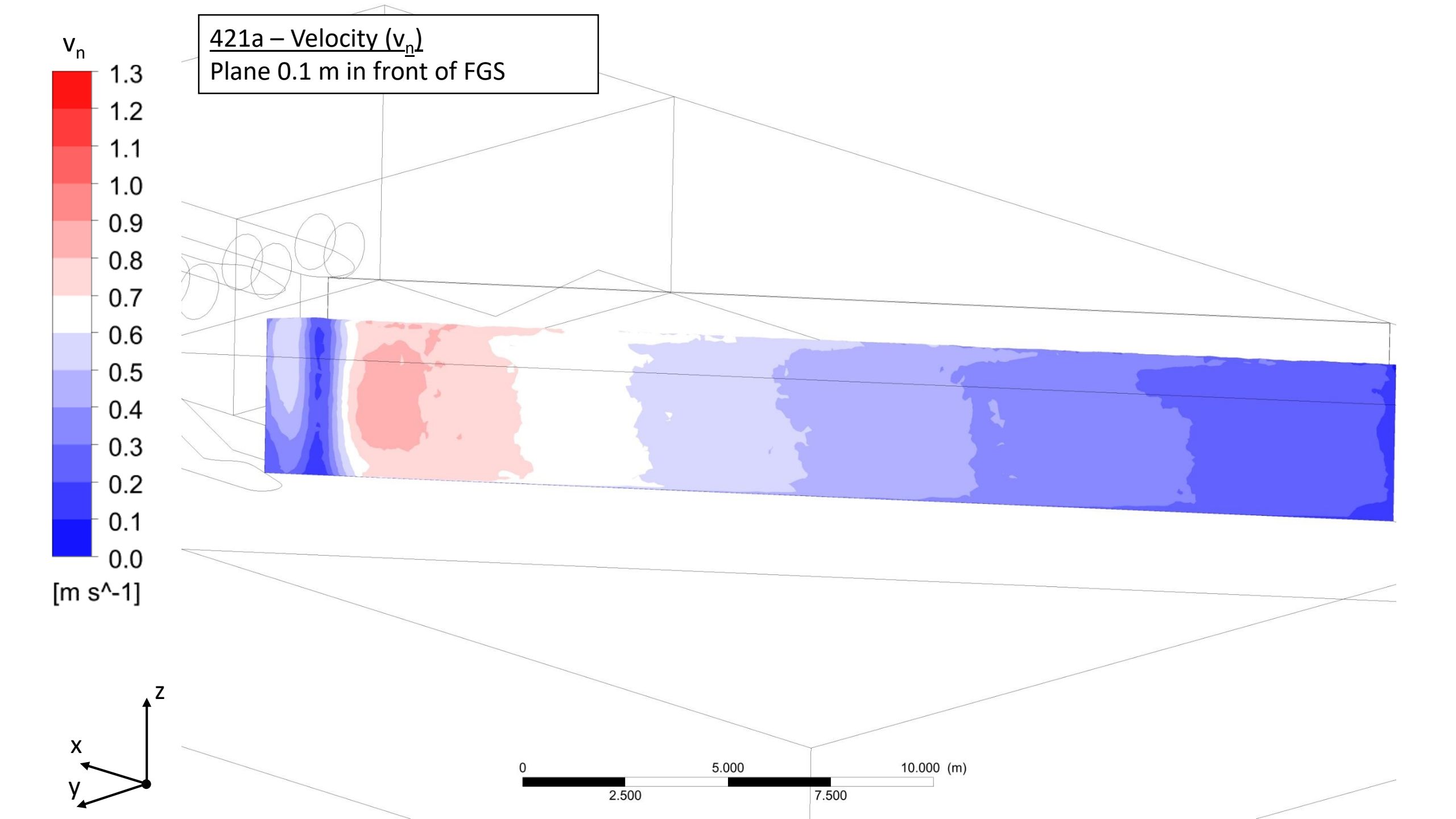

421a – Spatial Velocity Gradient
z = 0.1 m above river bed
SVG
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
[s^-1]
y
z
x
0
3.000
6.000 (m)
1.500
4.500

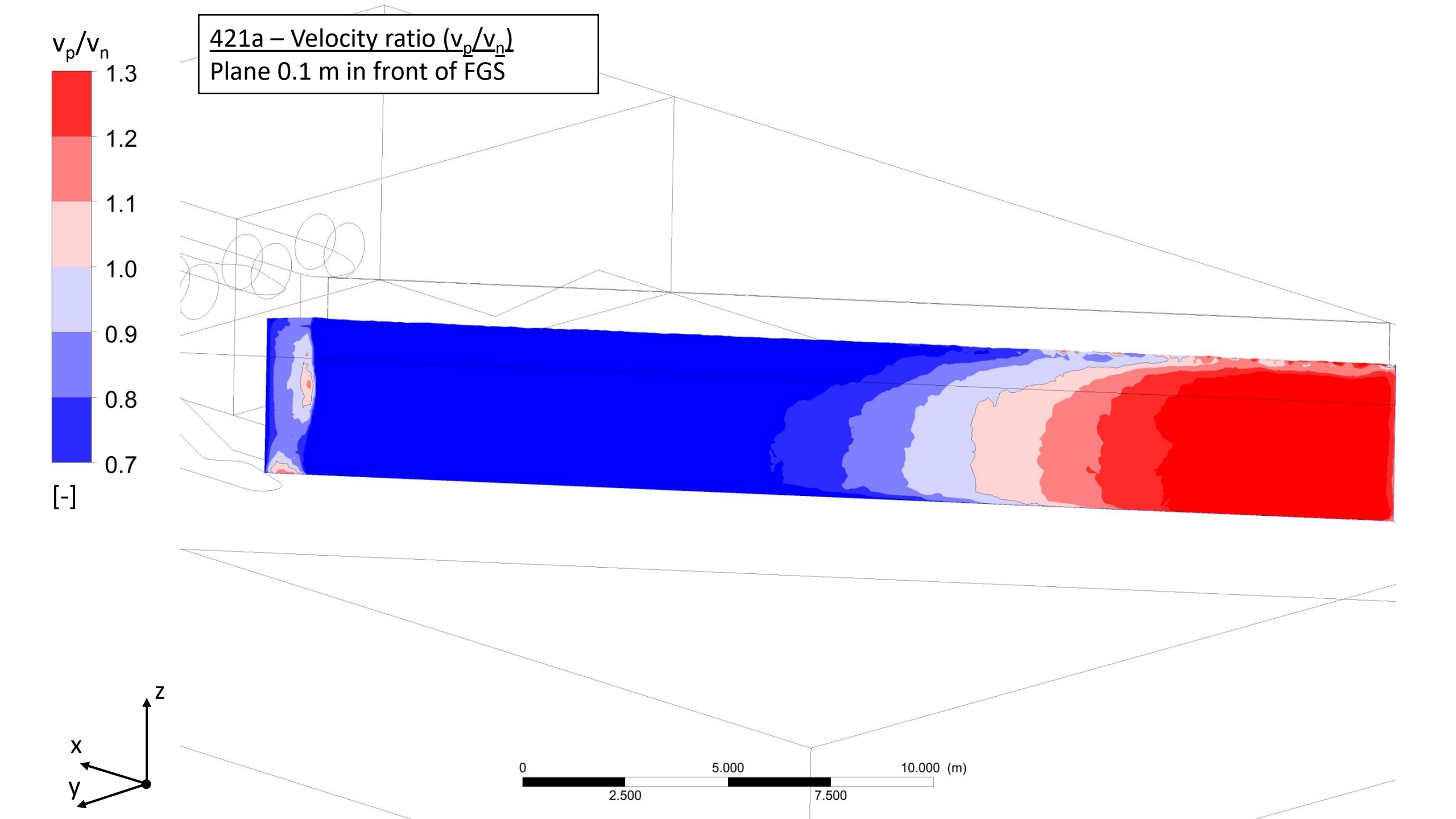

421a – Spatial Velocity Gradient
z = 2.0 m above river bed
SVG
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
[s^-1]
y
z
x
0
3.000
6.000 (m)
1.500
4.500

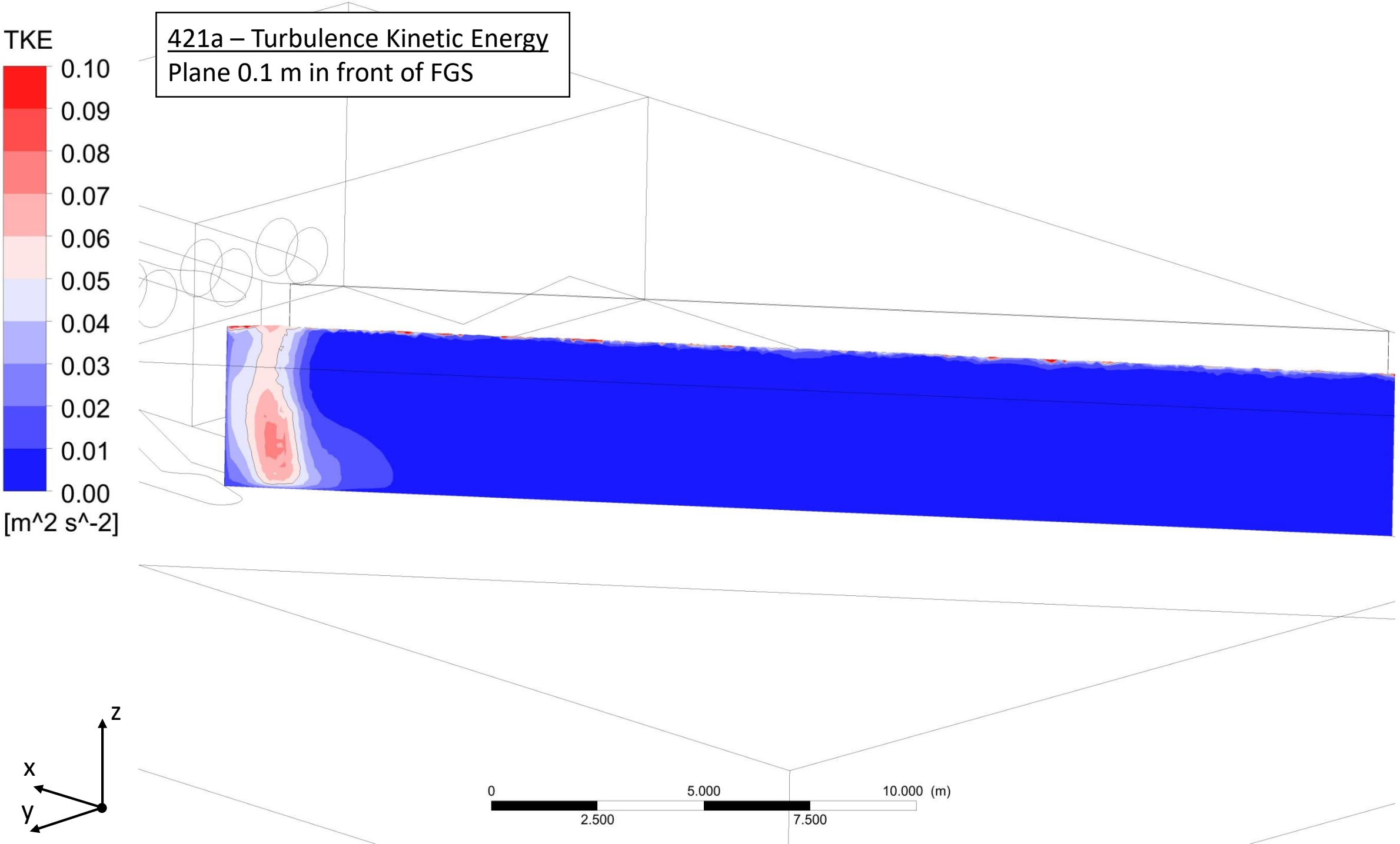

421a – Spatial Velocity Gradient
z = 3.5 m above river bed
SVG
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
[s^-1]
y
z
x
0
3.000
6.000 (m)
1.500
4.500

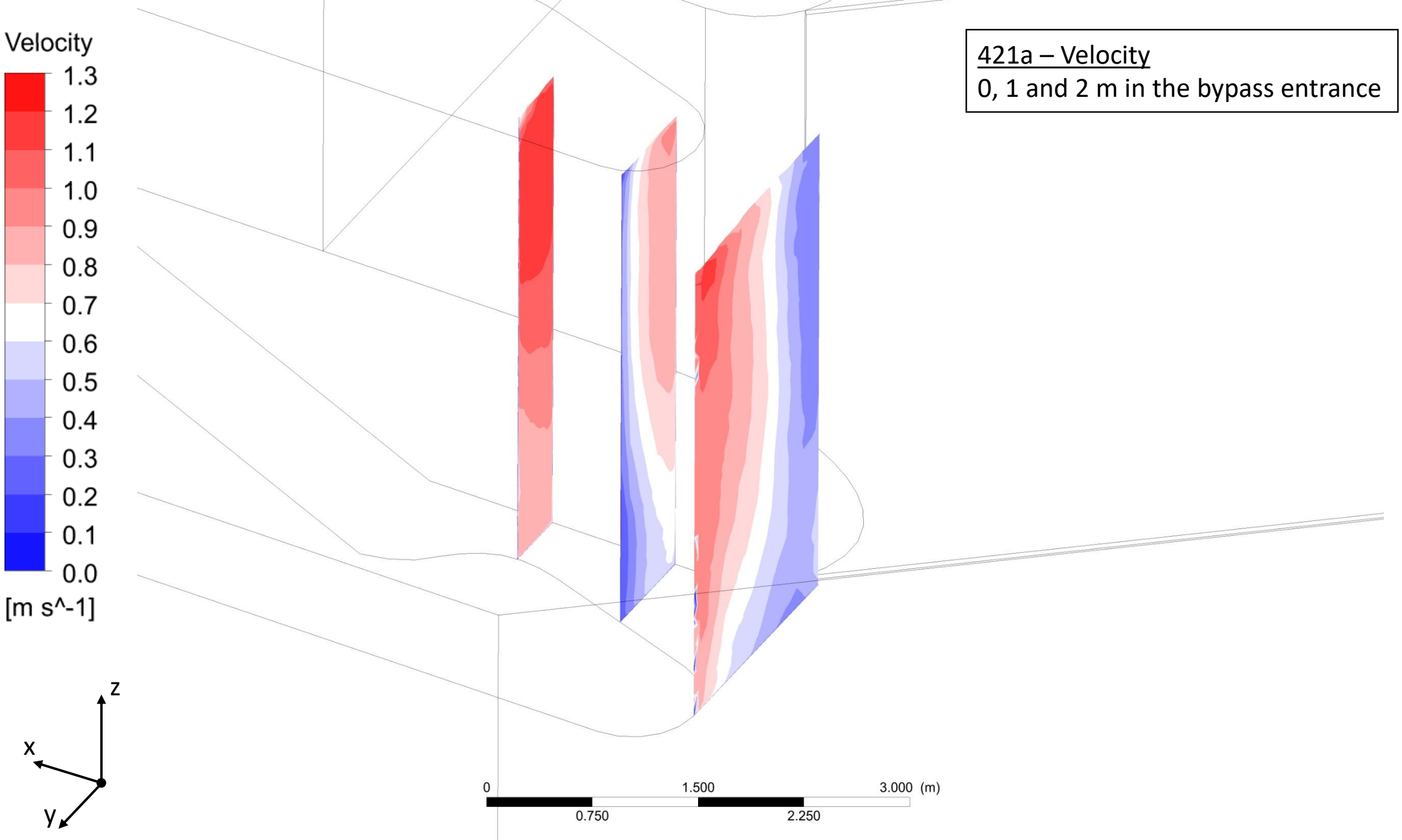

Velocity
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
[m s^-1]
421a – Velocity (v_a)
Plane 0.1 m in front of FGS
z
x
y
0
5.000
10.000 (m)
2.500
7.500


421a – Velocity (v_p)
Plane 0.1 m in front of FGS
v_p
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
[m s^-1]
z
x
y
0
5.000
10.000 (m)
2.500
7.500


421a – Velocity (v_n)
Plane 0.1 m in front of FGS
v_n
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
[m s^-1]
z
x
y
0
5.000
10.000 (m)
2.500
7.500

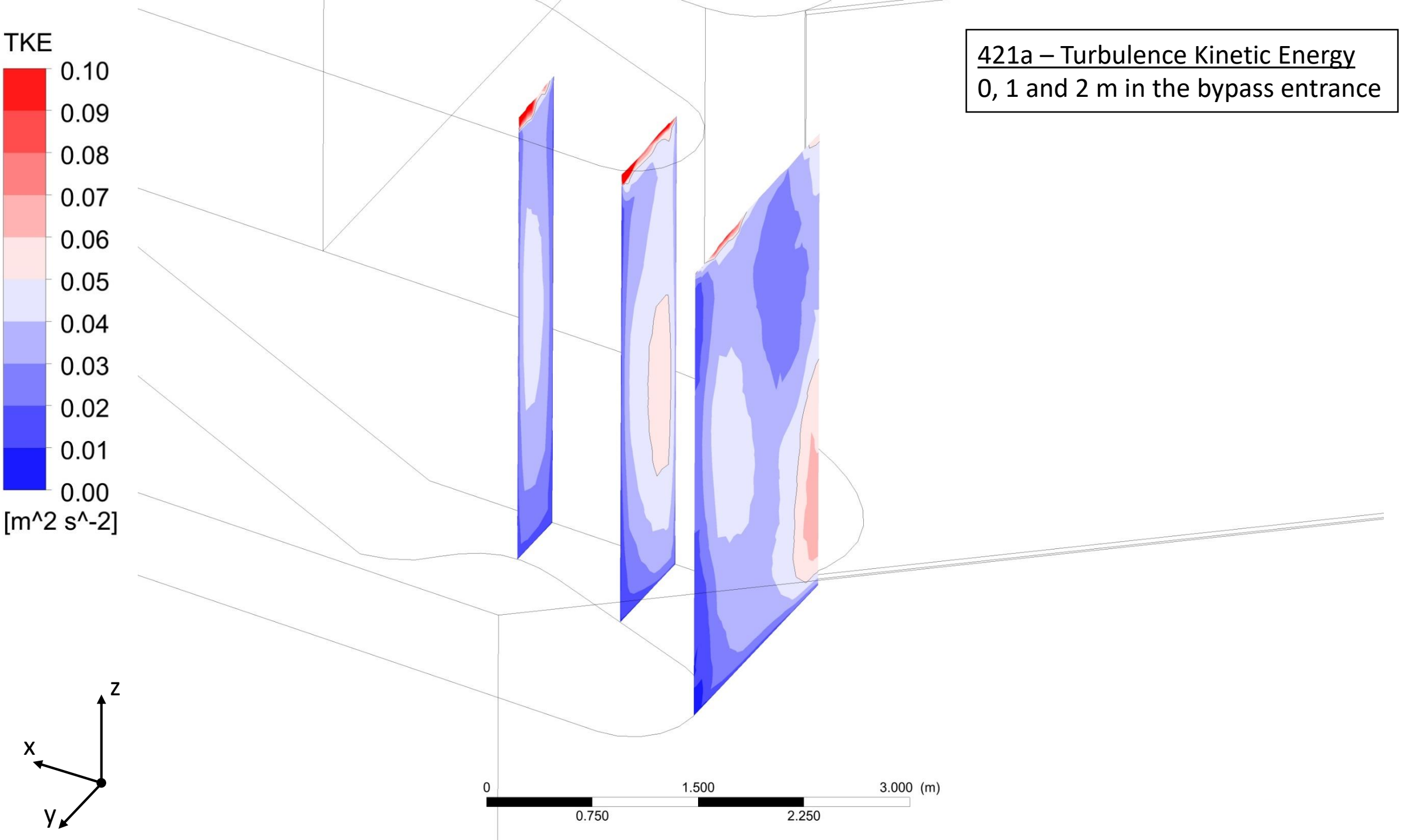

421a – Velocity ratio (v_p/v_n)
Plane 0.1 m in front of FGS
v_p/v_n
1.3
1.2
1.1
1.0
0.9
0.8
0.7
[-]
z
x
y
0
5.000
10.000 (m)
2.500
7.500


TKE
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
[m^2 s^-2]
421a – Turbulence Kinetic Energy
Plane 0.1 m in front of FGS
z
x
y
0
5.000
10.000 (m)
2.500
7.500



421a – Velocity

0, 1 and 2 m in the bypass entrance



421a – Turbulence Kinetic Energy

0, 1 and 2 m in the bypass entrance