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International Conference on Engineering and Ecohydrology for Fish Passage 2017

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Numerical Investigation of the Influence of a Guide Wall in a Fish-Friendly Weir

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Research project *Wachstumskern Flussstrom Plus*

- Six projects focused on energy conversion using free-stream water power plants with low ecological impact
- Projects: small-scale hydro power plants, fish monitoring, valuation and certification, development of technical components...

Source: (16.09.2016)
right:
left: http://www.unternehmen-region.de/_img/article/WK_Flussstrom-logo_rdax_336x238_85.jpg

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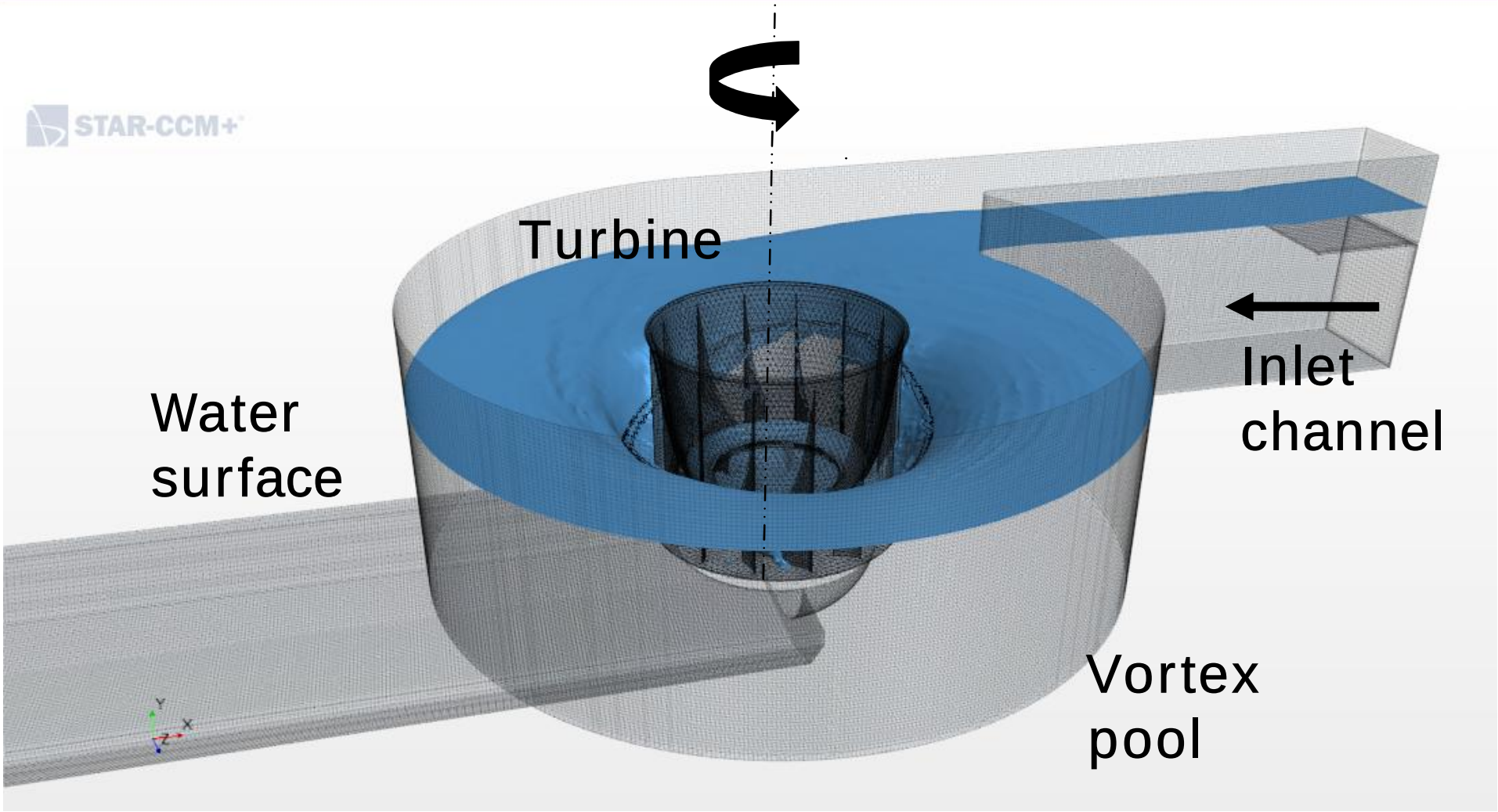
UNIVERSITÄT
MAGDEBURG

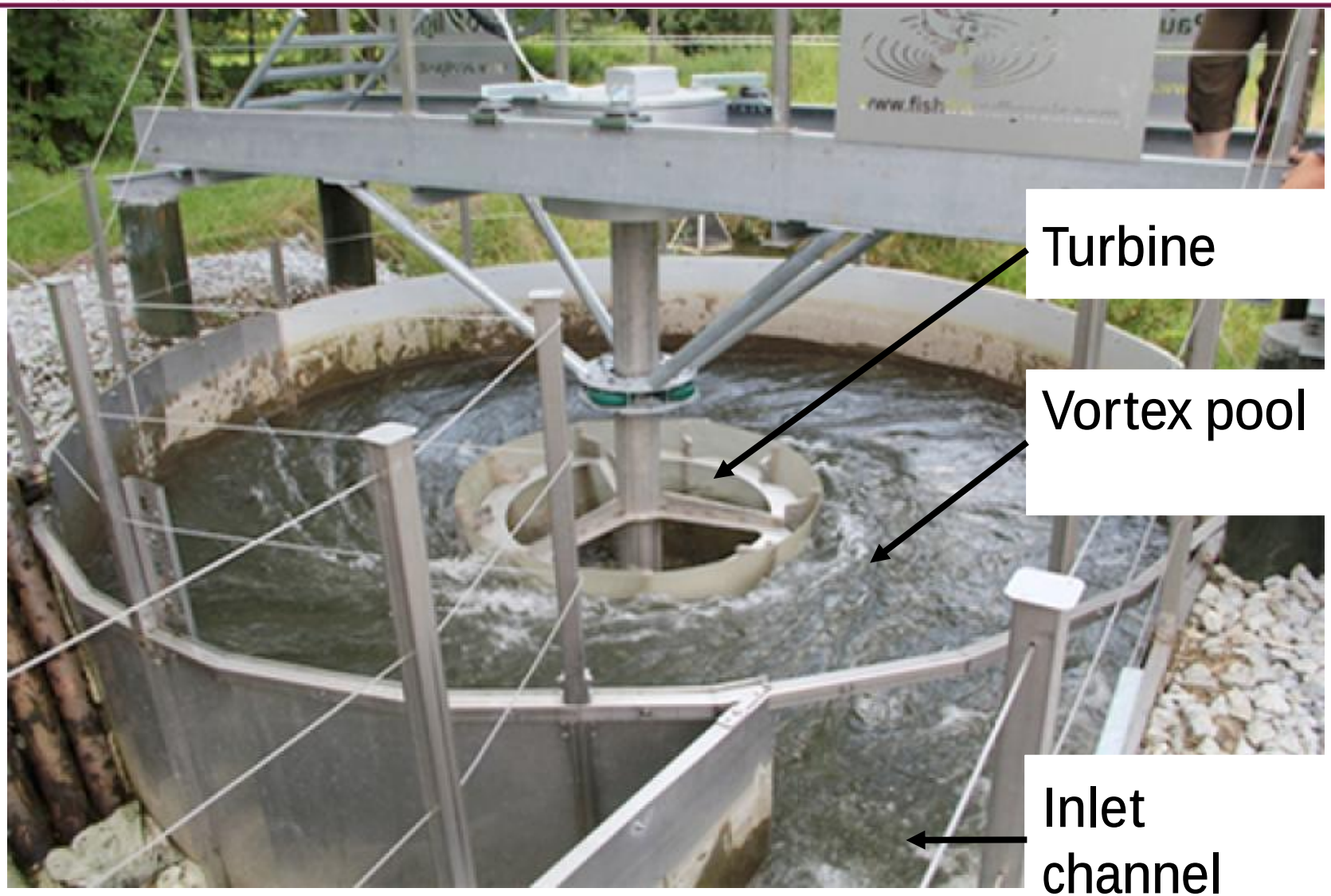
Numerical Investigation of the Influence of a Guide Wall in a Fish-Friendly Weir

Stephanie Müller
Olivier Cleynen
Dominique Thévenin

Project: Fish-Friendly Weir

- Numerical investigation of various geometrical parameters
  - Without & with turbine
  - Guide wall
  - Turbine clearance, number of blades ...
- Volume of fluid (VOF) method – 2 phase multiphase simulations (water & air)
- Unsteady, Reynolds-Averaged Navier-Stokes (RANS)


STAR-CCM+
Turbine
Inlet channel
Water surface
Vortex pool
Outlet channel



Source: (14.09.2016)
http://www.efre-thueringen.de/mam/efre/projekte/fittosize__800_0_17eef5a697bf84f34be94f2cd383410f_1311_abbildung_04.jpg

Outlet and outlet channel

Source: https://www.google.de/search?q=fisch+freundliches+wehr&client=firefox-b-ab&source=lnms&tbm=isch&sa=X&ved=0ahUKEwj1hO6a4brUAhWLK1AKHdzdBiQQ_AUICigB&biw=1252&bih=574&dpr=1.09#imgrc=RY7PYF0AhZ9TcM: (13.06.2017)

Simulation Settings

- Simulation software: Star-CCM+ V11
- Multiphase simulations (water & air)
- Settings:
  - 850 l/s, max. velocity at the inlet: 1.08 m/s
  - k-omega-SST turbulence model
  - Mass-flow inlet boundary condition

without turbine:

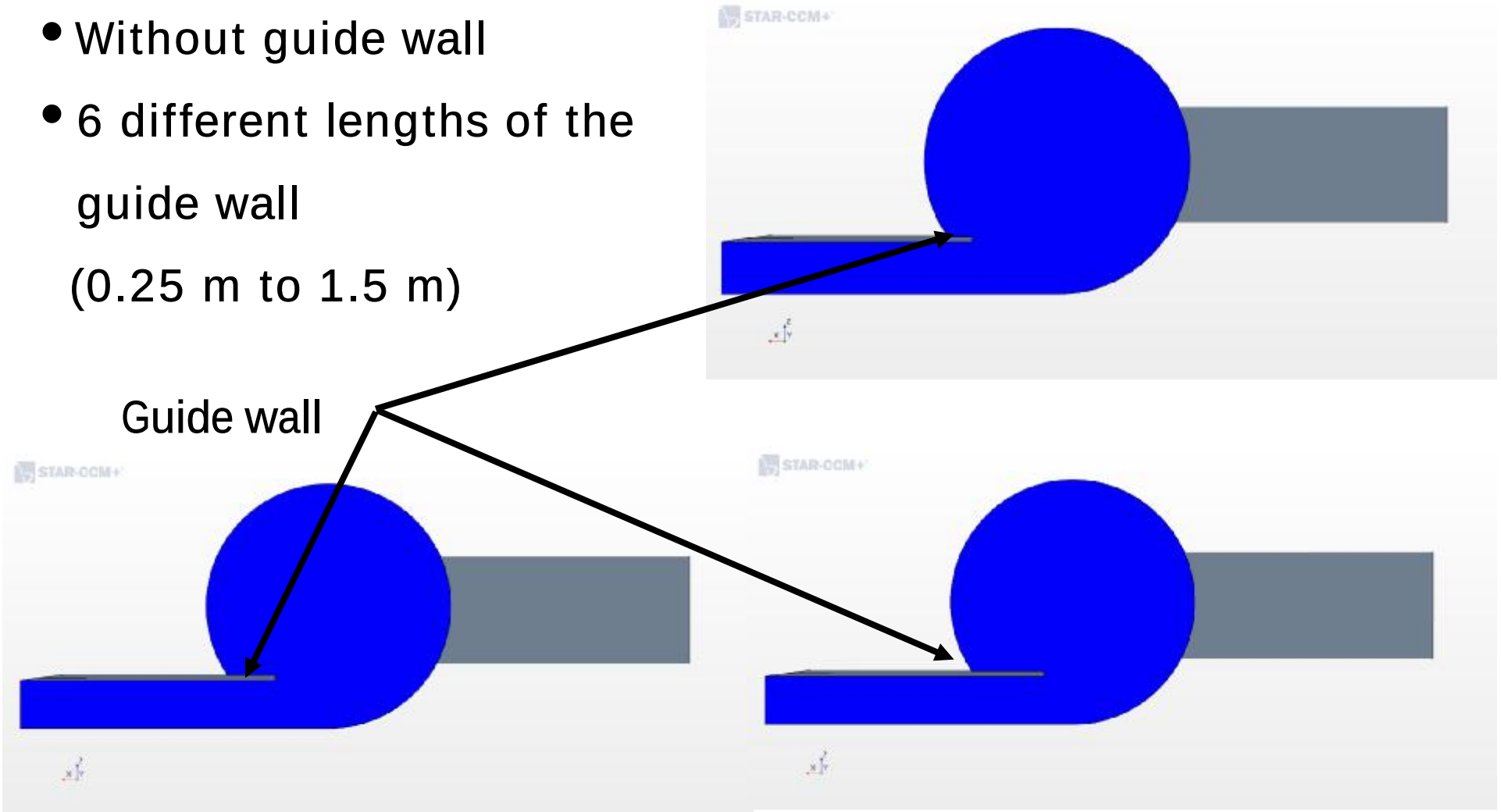
- ~1 mio. Cells
- HPC-Cluster: 48 cores
- Adaptive timestep & mesh

with turbine:

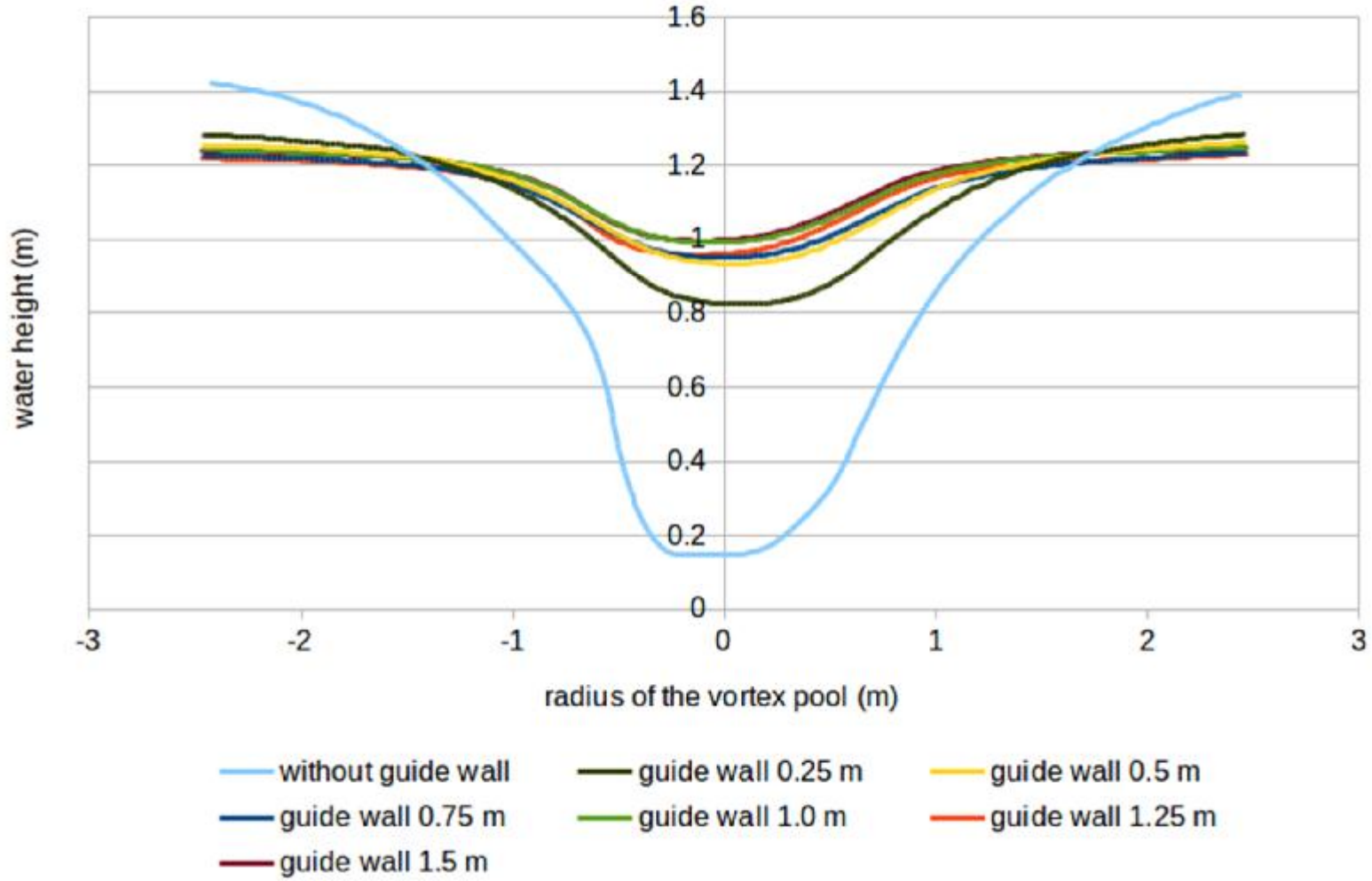
- ~4 mio. Cells
- HPC-Cluster: 128 cores

Guide wall

- Without guide wall
- 6 different lengths of the guide wall (0.25 m to 1.5 m)

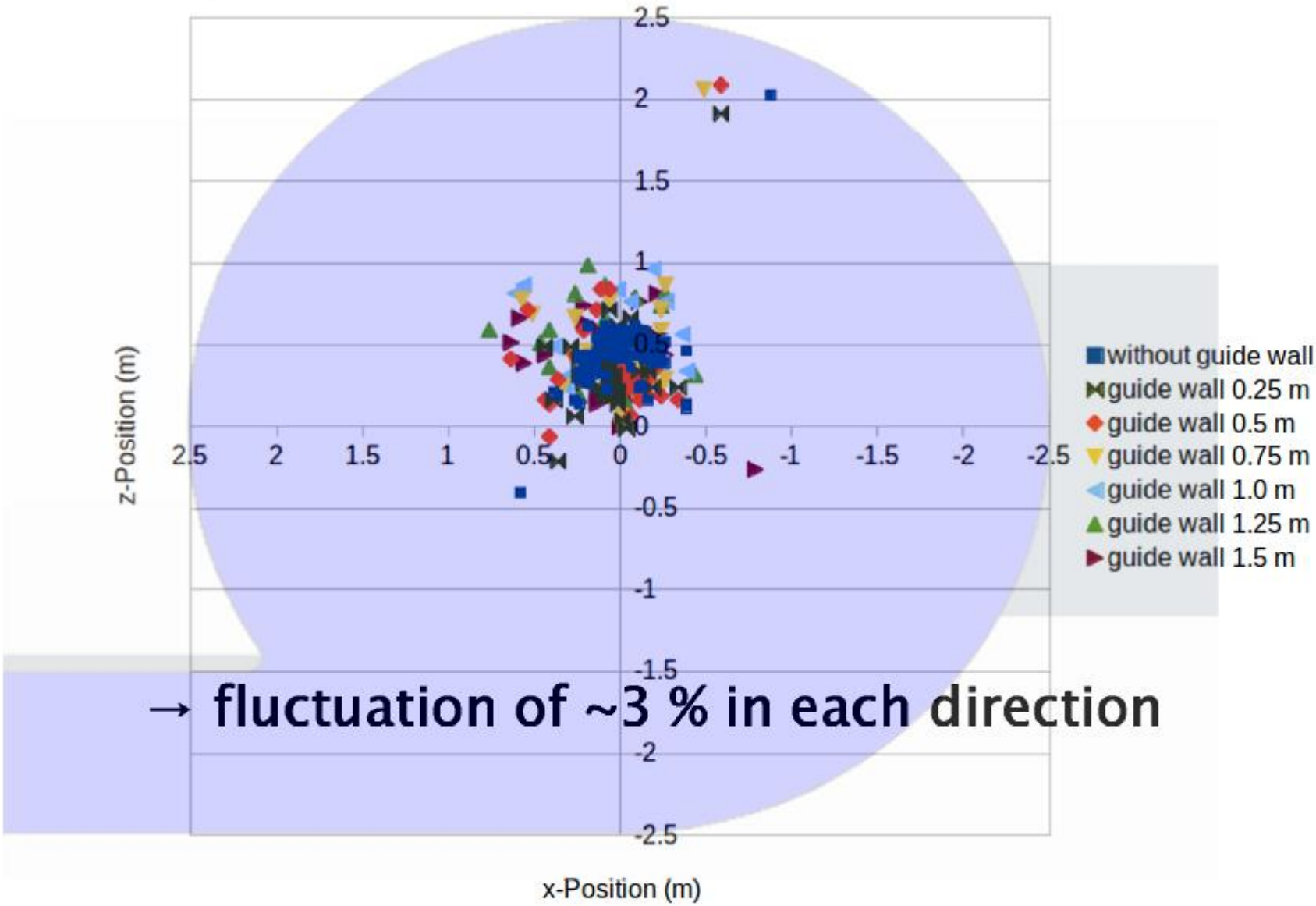


Vortex depth



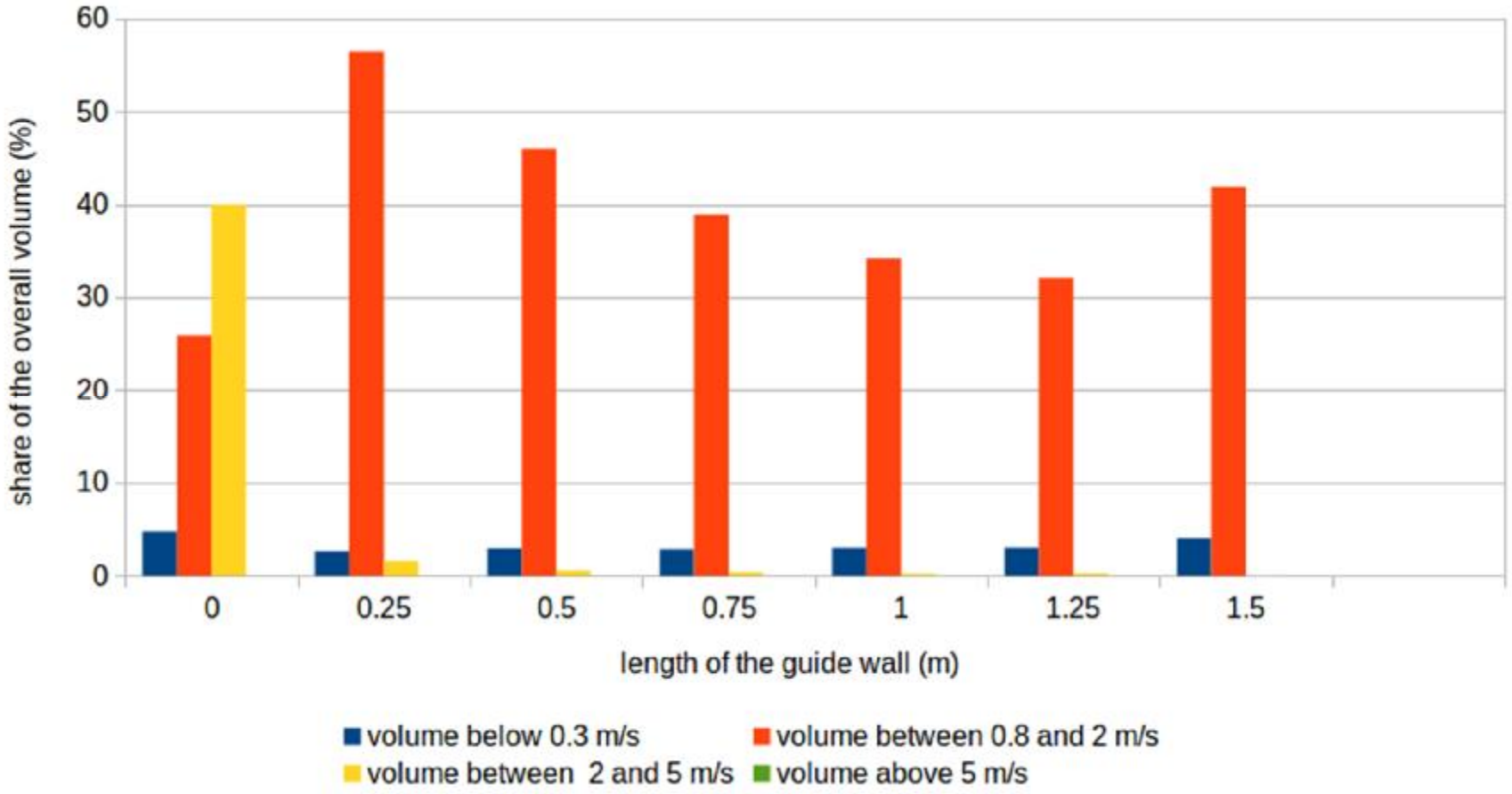
→ shallower and flatter vortices

Vortex position



→ fluctuation of ~3 % in each direction

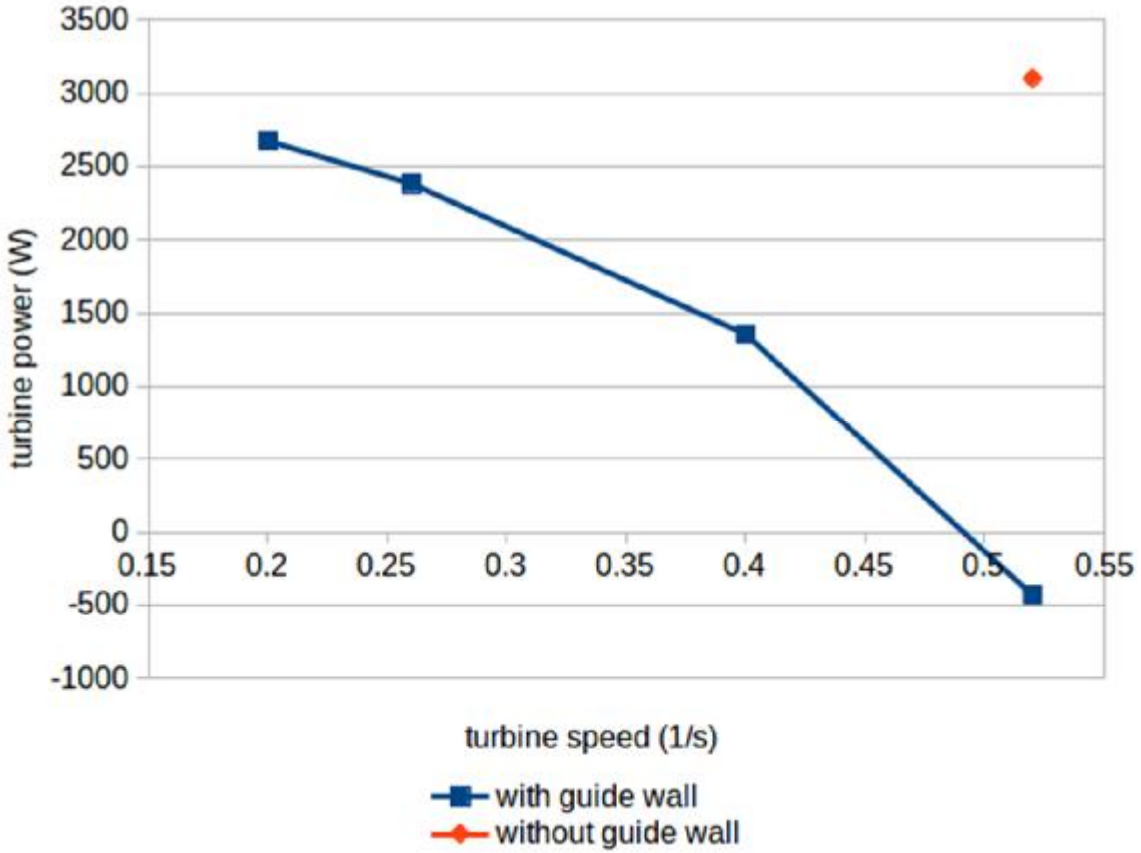
Influence of the guide wall on the velocities



→ shifting of the velocity distribution

Adaptation of the turbine speed

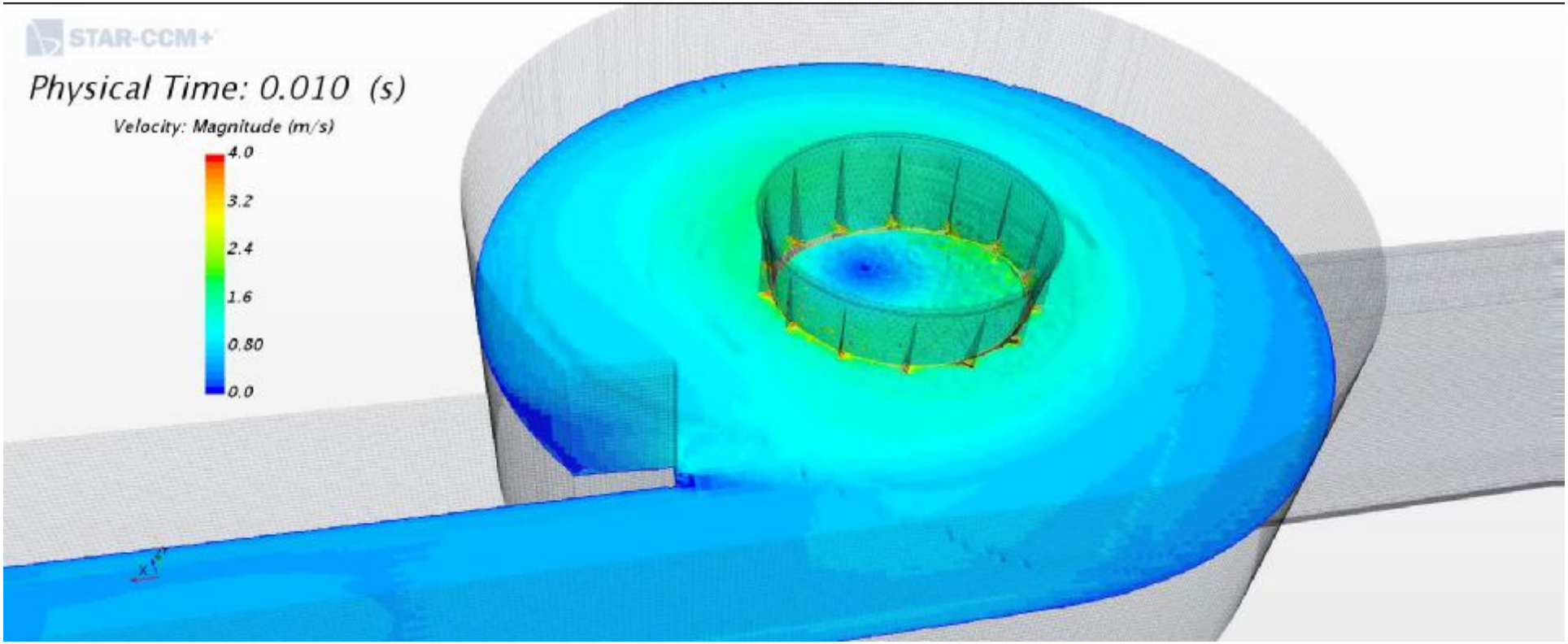
- Guide wall length: 0.5 m, volume flow rate: 850 l/s



→ acceptable difference in power

Conclusion – usage of a guide wall

- Benefits regarding the requirements of fish passage
- Turbine velocity must be adapted to maintain power



Conclusion – usage of CFD

- Complementary to experiments
- Allows:
  - Insight into the flow
  - Analysis of influence of geometrical parameters
  - Estimation of the compliance of fish passage requirements
  - Identification of potential for improvement
- Opportunity to guide and optimize fish experiments (?)
- But: long computational times, high computational resources

Thank you for your attention!

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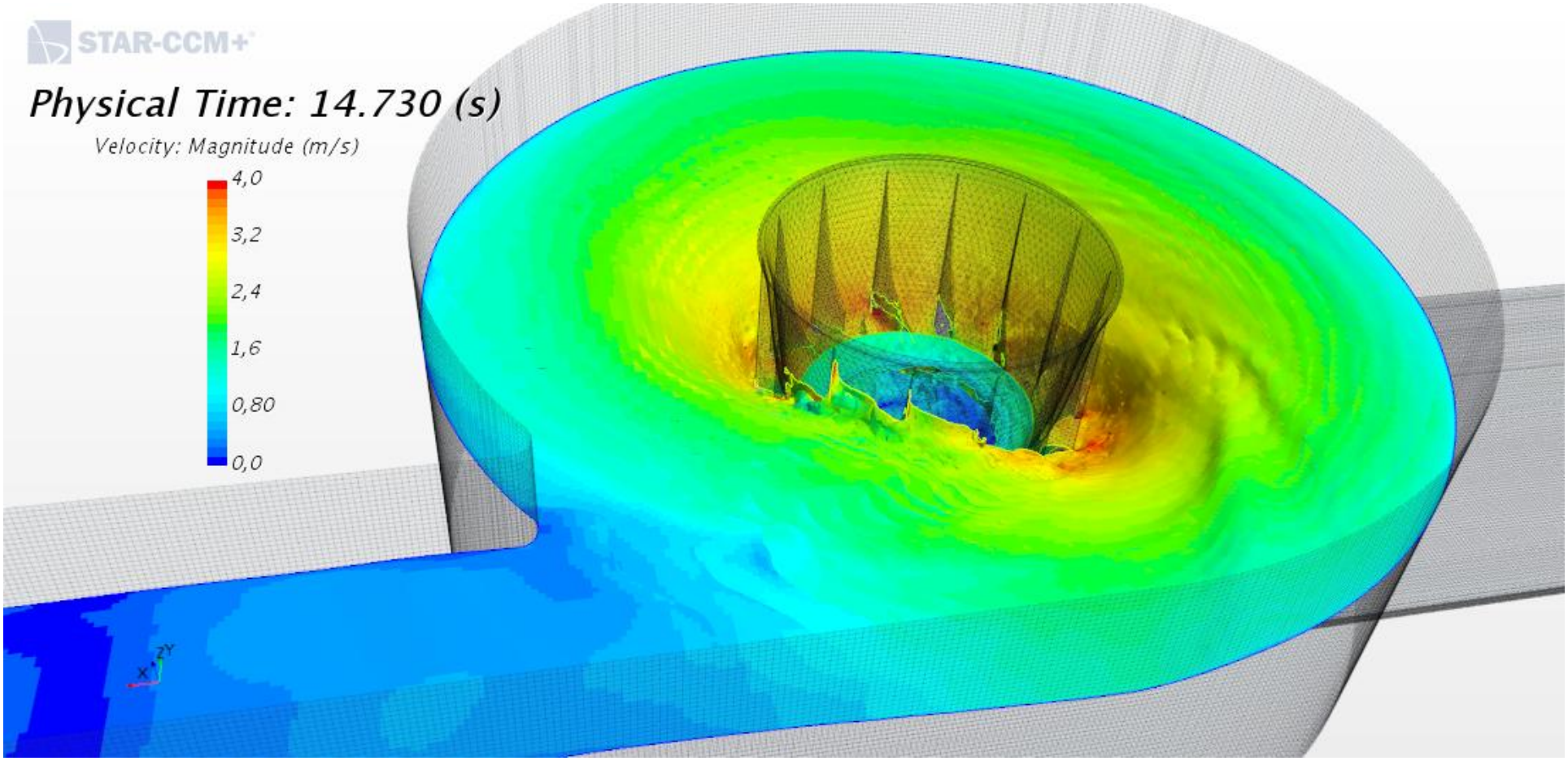
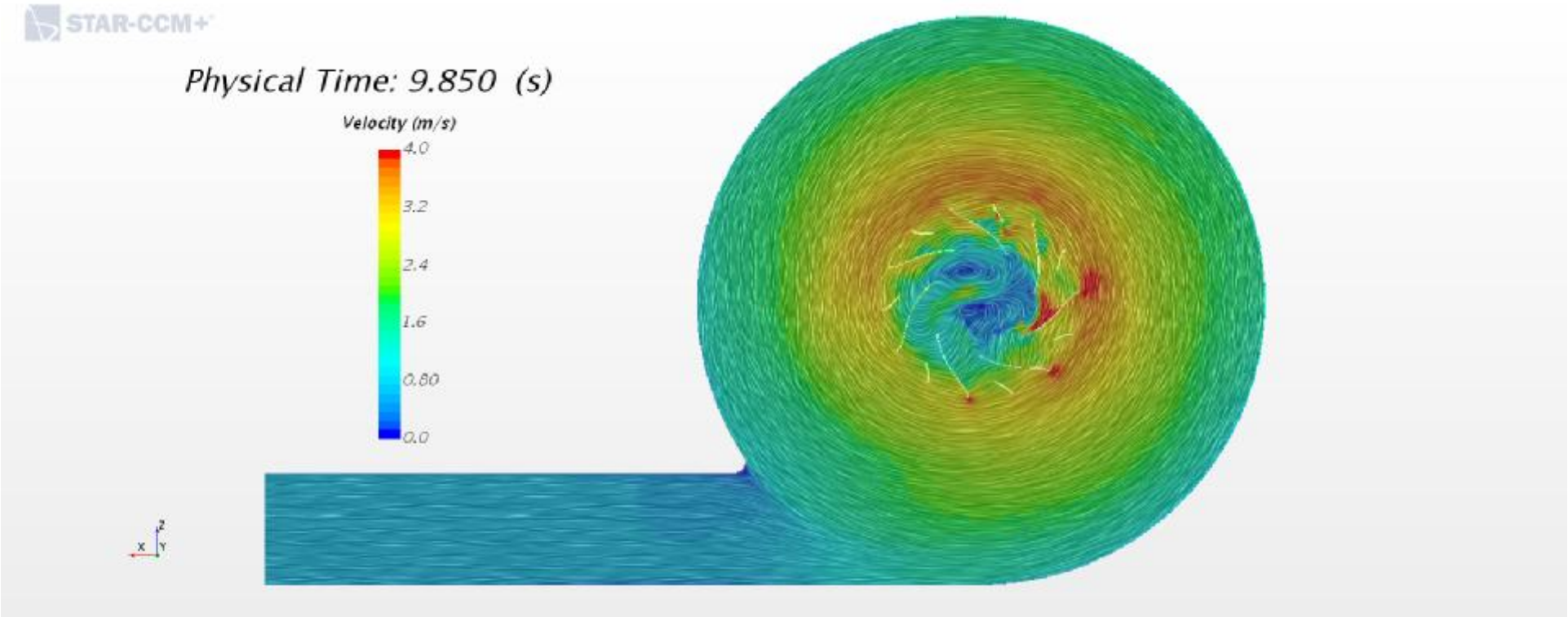
Bundesministerium für Bildung und Forschung

WACHSTUMSKERNE
UNTERNEHMEN REGION
Die BMBF-Innovationsinitiative Neue Länder


STAR-CCM+
Physical Time: 14.730 (s)
Velocity: Magnitude (m/s)
4,0
3,2
2,4
1,6
0,80
0,0


STAR-CCM+
Physical Time: 9.850 (s)
Velocity (m/s)
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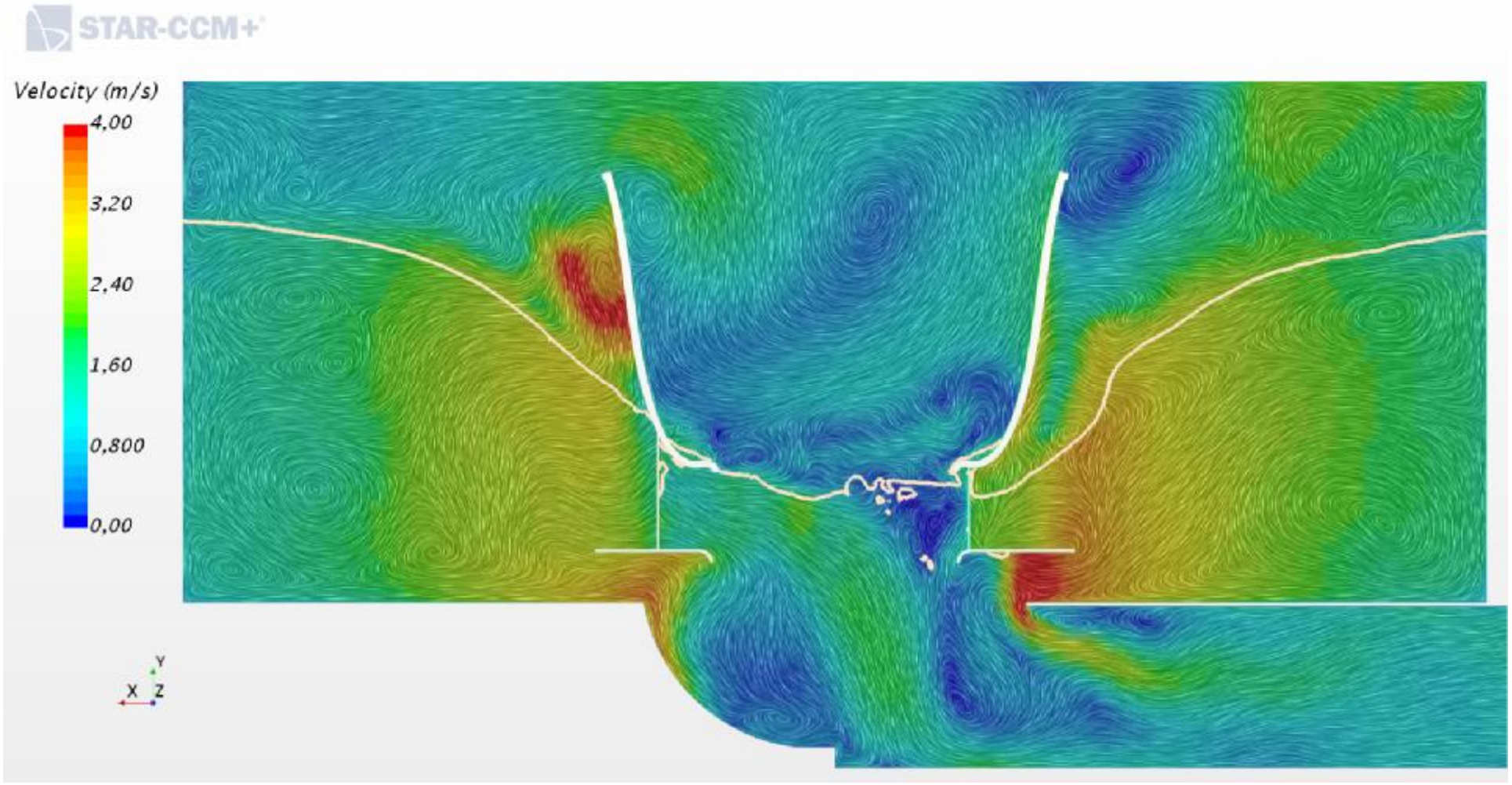
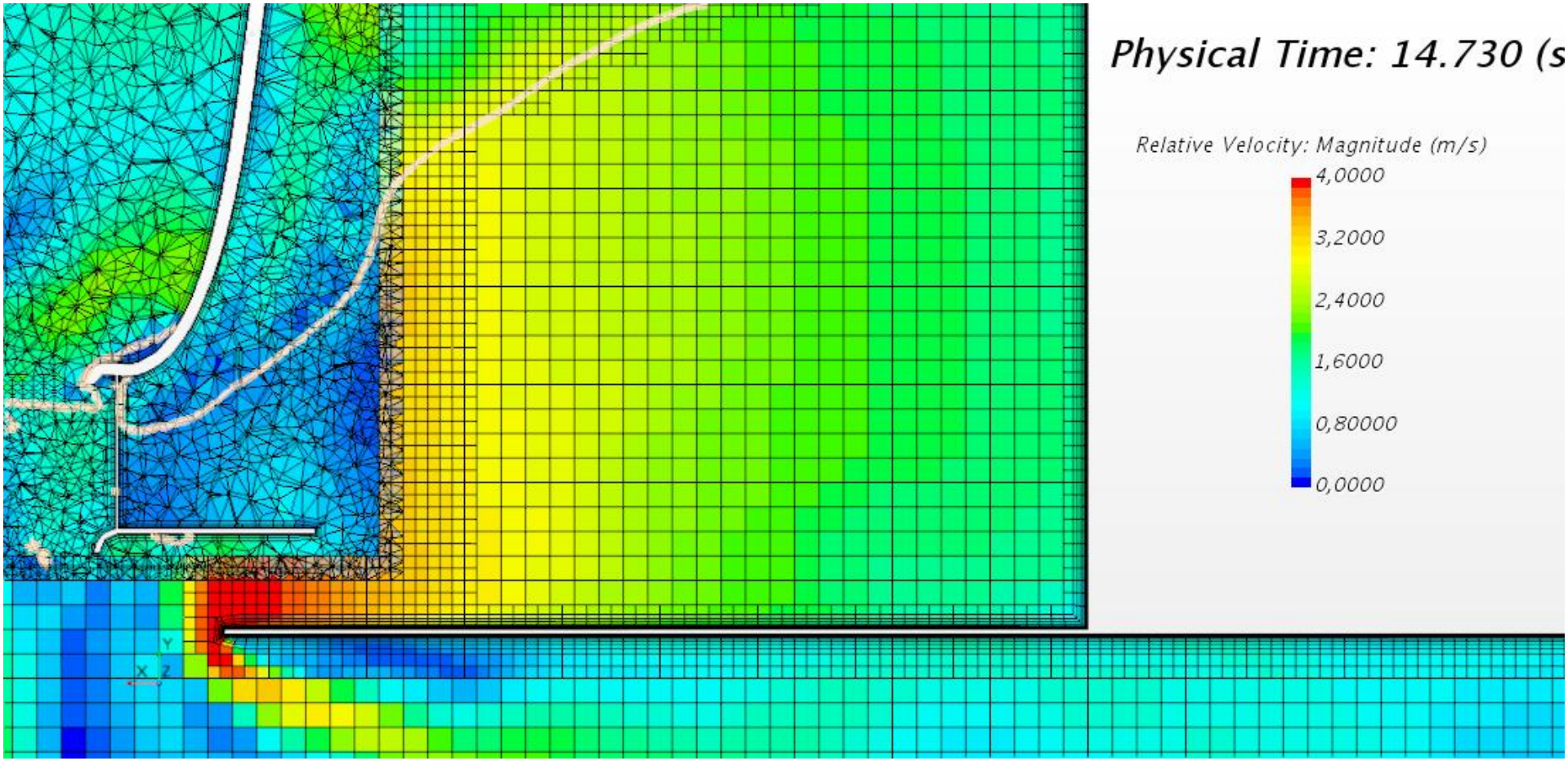
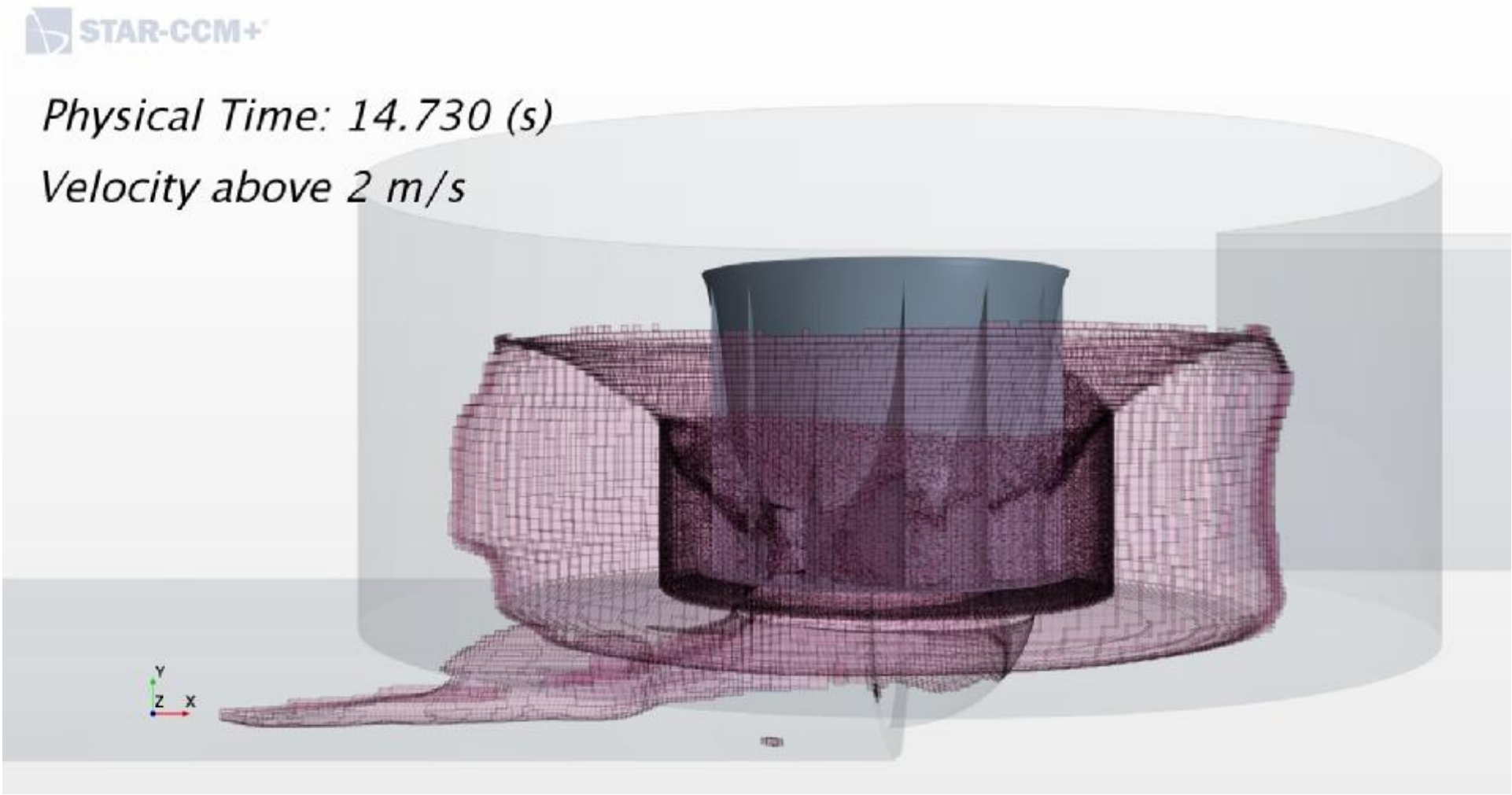
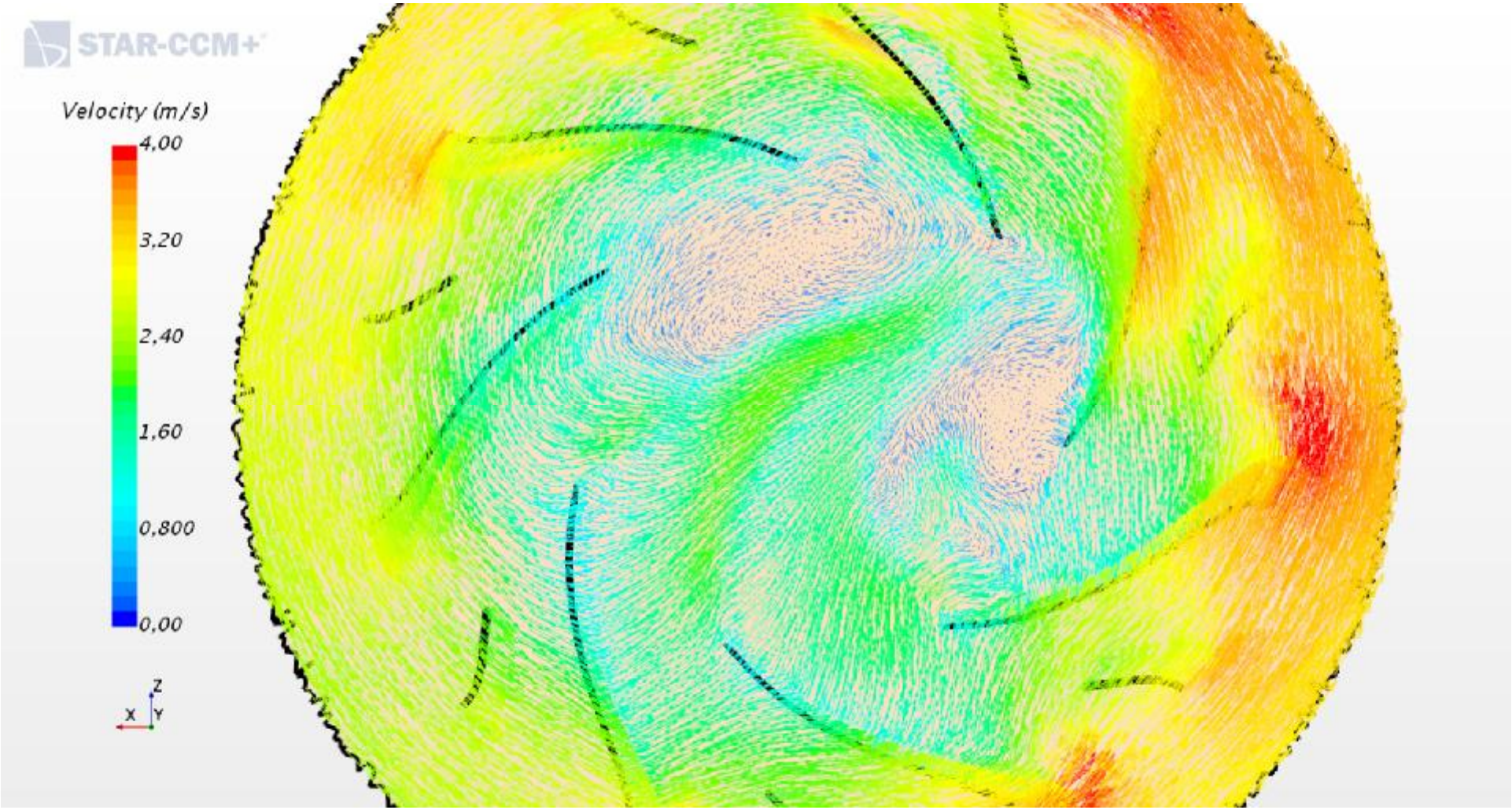
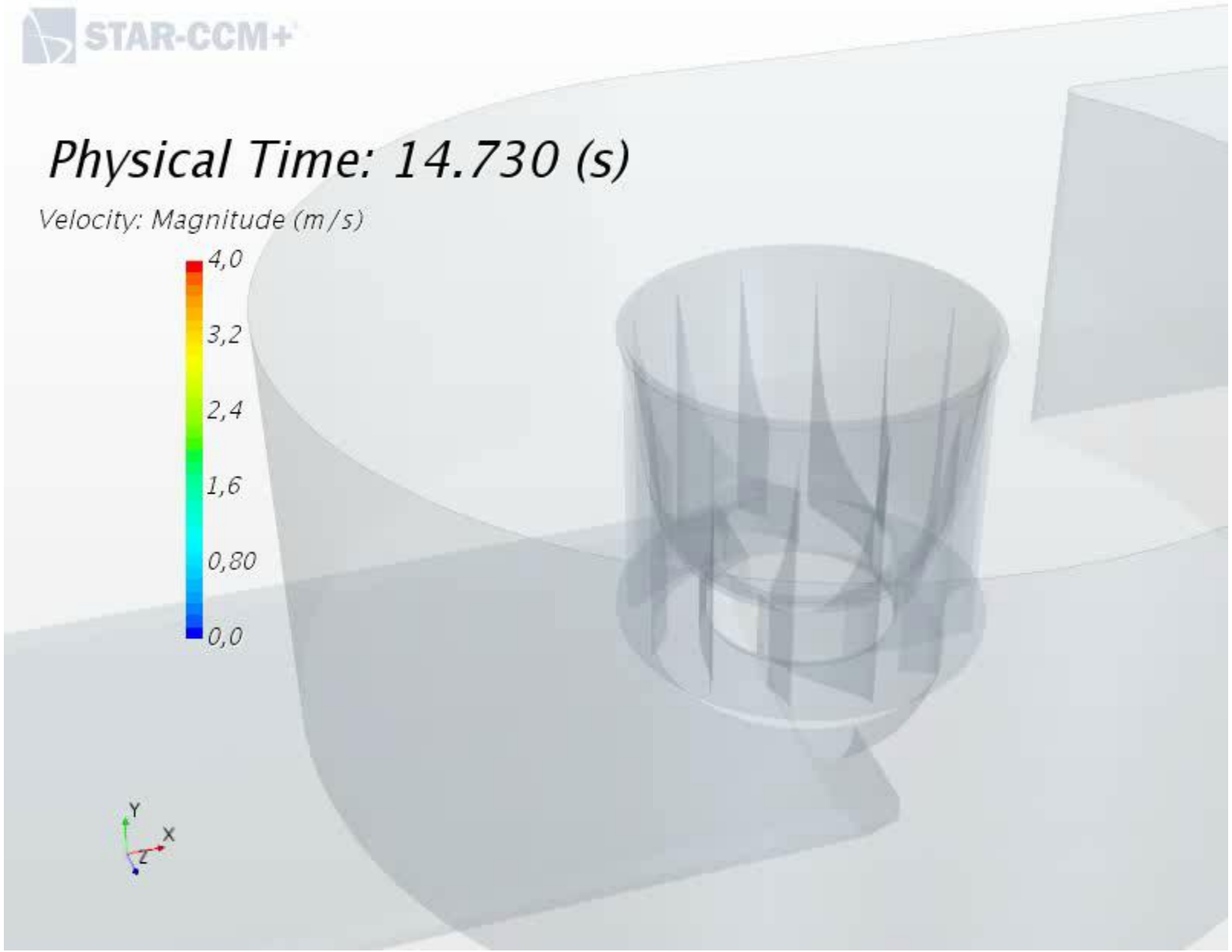
3.2
2.4
1.6
0.80
0.0


STAR-CCM+
Velocity (m/s)
4,00
3,20
2,40
1,60
0,800
0,00
Y
X Z


Physical Time: 14.730 (s
Relative Velocity: Magnitude (m/s)
4,0000
3,2000
2,4000
1,6000
0,80000
0,0000
Y
X
Z


STAR-CCM+
Physical Time: 14.730 (s)
Velocity above 2 m/s
Y
Z X


STAR-CCM+
Velocity (m/s)
4,00
3,20
2,40
1,60
0,800
0,00
Z
X
Y


STAR-CCM+
Physical Time: 14.730 (s)
Velocity: Magnitude (m/s)
4,0
3,2
2,4
1,6
0,80
0,0
Y
X
Z