

Jun 24th, 12:05 PM - 12:30 PM

Session D7: Entrance Arrangement of Fishways – Interaction of Entrance Location, Turbine Flow and Attraction Flow

Wolfgang Kampke

Federal Waterways Engineering and Research Institute

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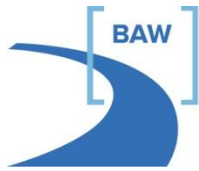


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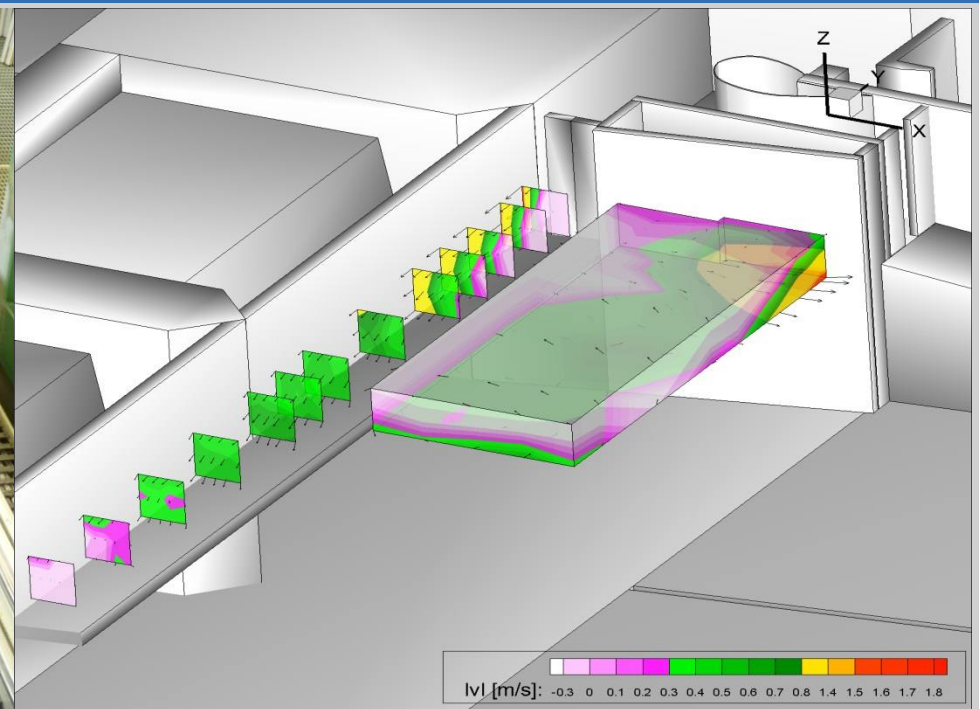
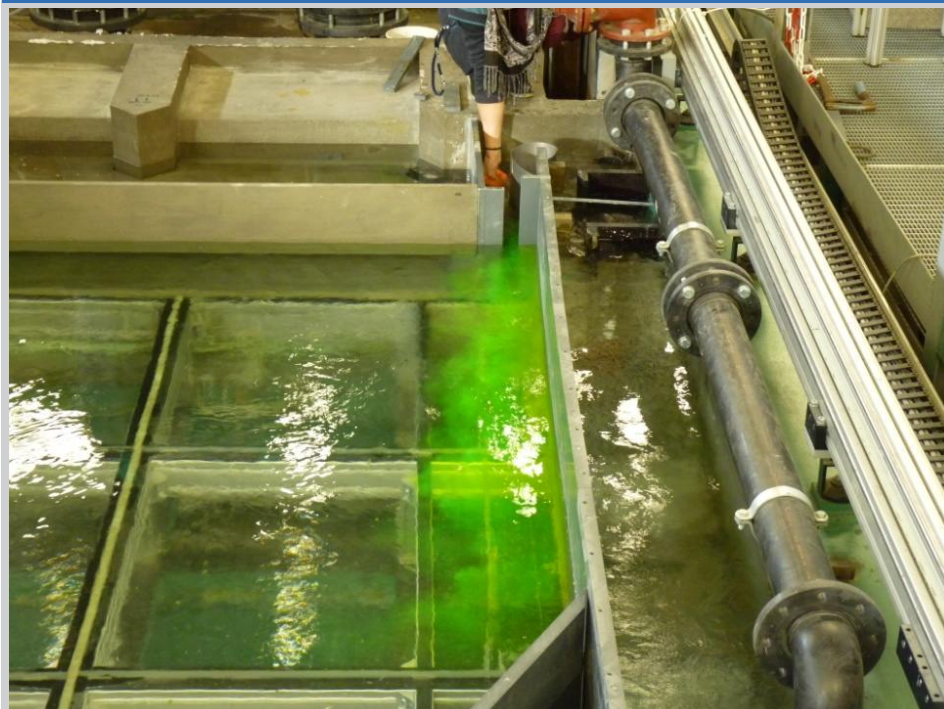
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Entrance arrangement of fishways – Interaction of entrance location, turbine flow and attraction flow

Dipl.-Ing. Wolfgang Kampke

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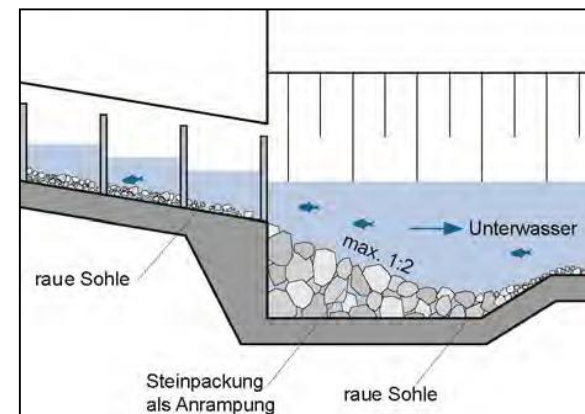
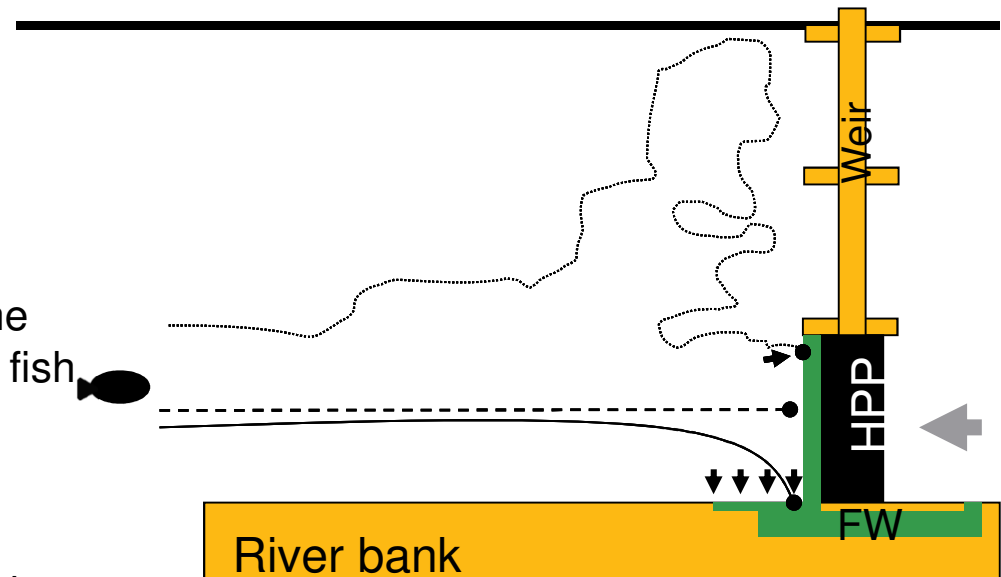


General design recommendations

How do fish find the fishway and enter it?

Relevant Aspects

- Location
- Design according to the requirements of the relevant species – long distance migratory fish and resident fish
- Entrance geometry
- Bed oriented species: Hydraulic migration corridor with substrate connection essential



Source : DWA 2014



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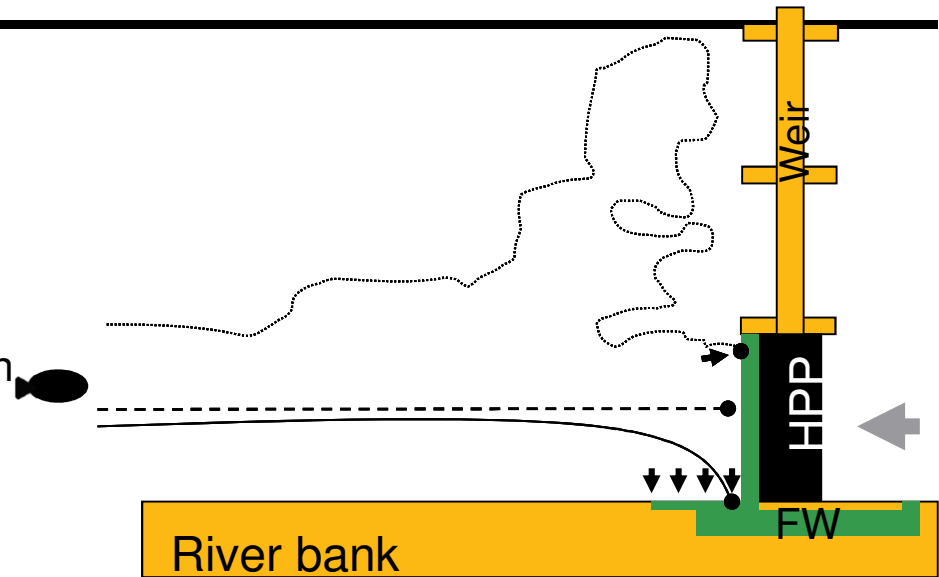
General design recommendations

How do fish find the fishway and enter it?

Relevant Aspects

- Location
- Design according to the requirements of the relevant species – long distance migratory fish and resident fish
- Entrance geometry
- Bed oriented species: Hydraulic migration corridor with substrate connection essential
- Guiding flow / formation of migration corridor
 - Angle of fishway flow
 - Flow conditions in the tailwater
 - Velocities
 - Discharge

Clear, definite design recommendations often do not exist.



France:

Larinier et al ,1992:

Larinier et al ,1992:

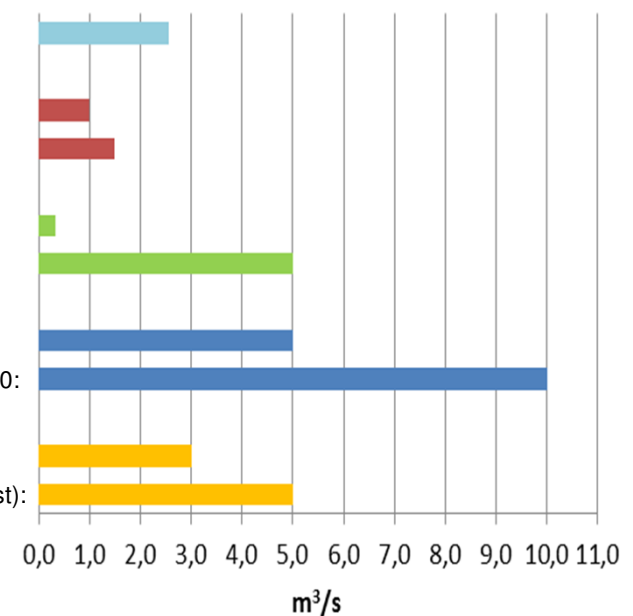
Larinier et al, 2002:

UK:

Environment Agency 2010:

US:

NMFS/USFWS (USA East):



Schütz et al. 2015



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Example designs



Source : Amt für Neckarausbau Heidelberg



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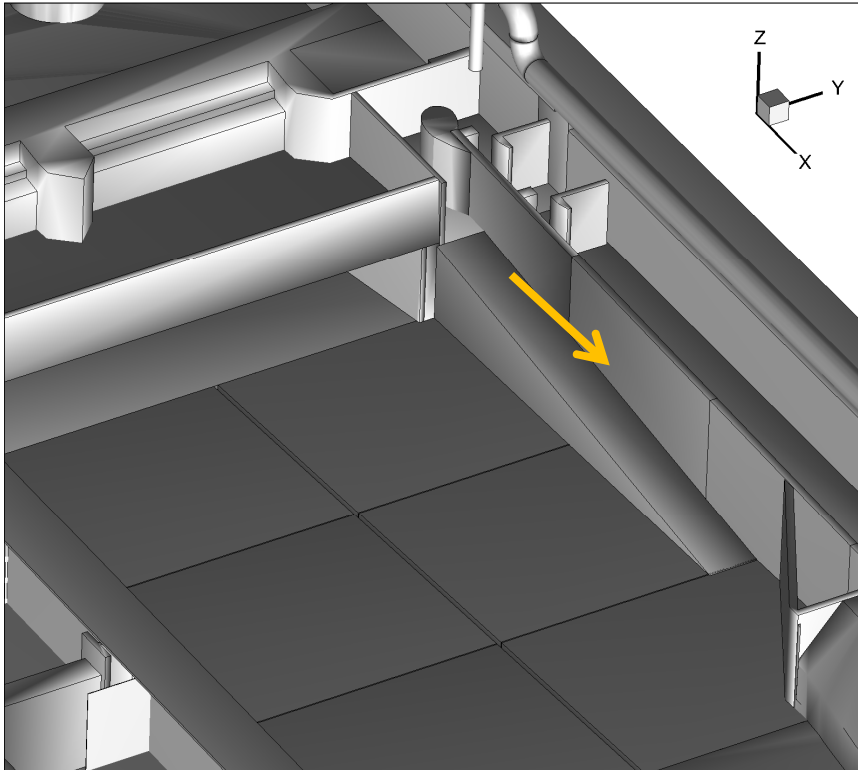
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Example designs

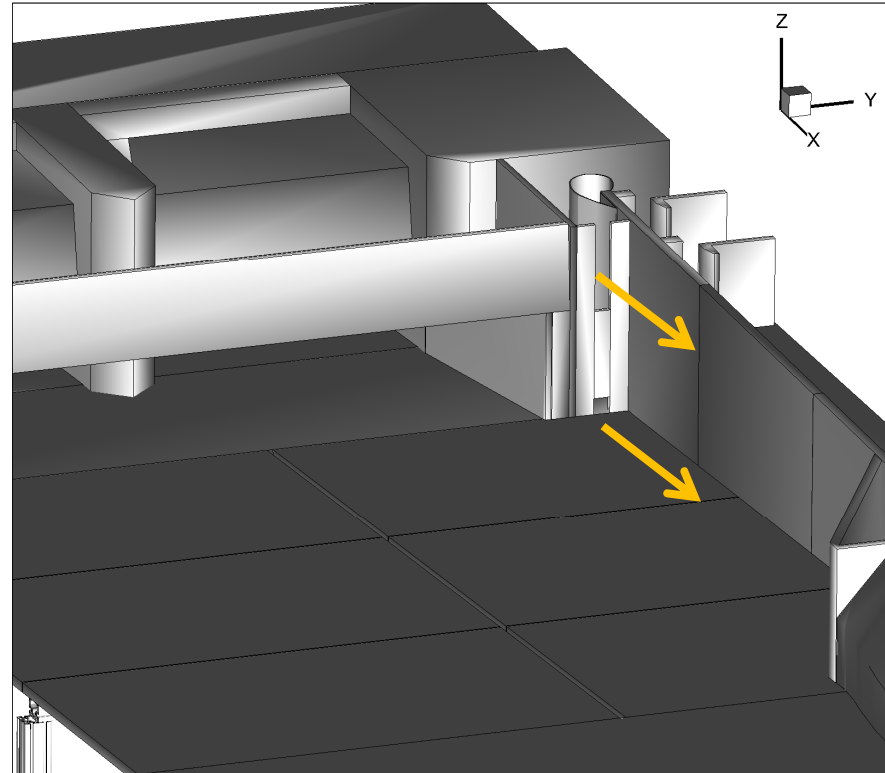


Entrance design

Typ A

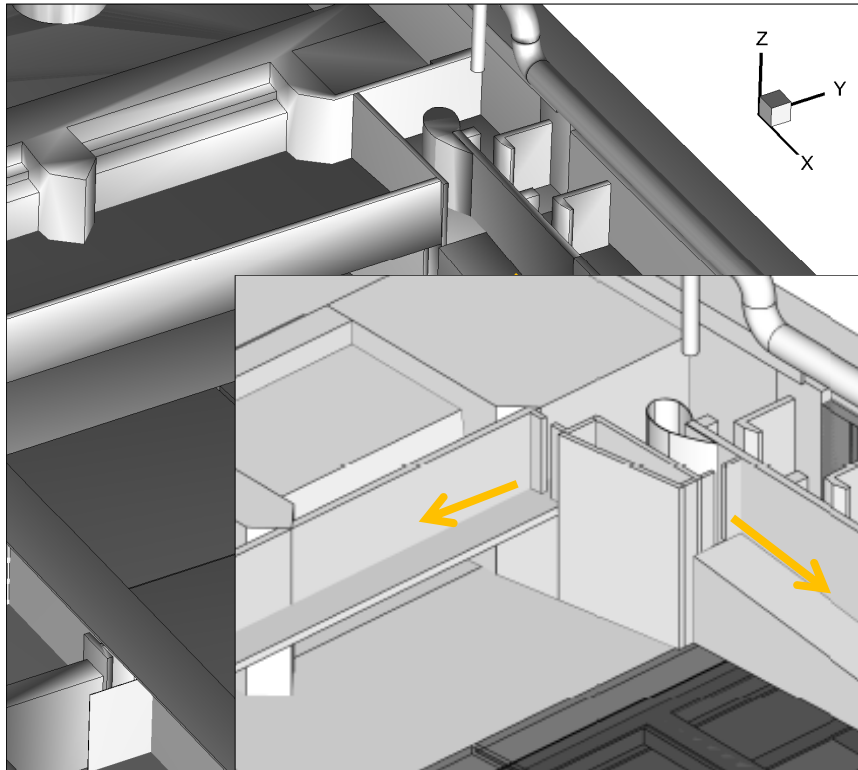


Typ B1&2

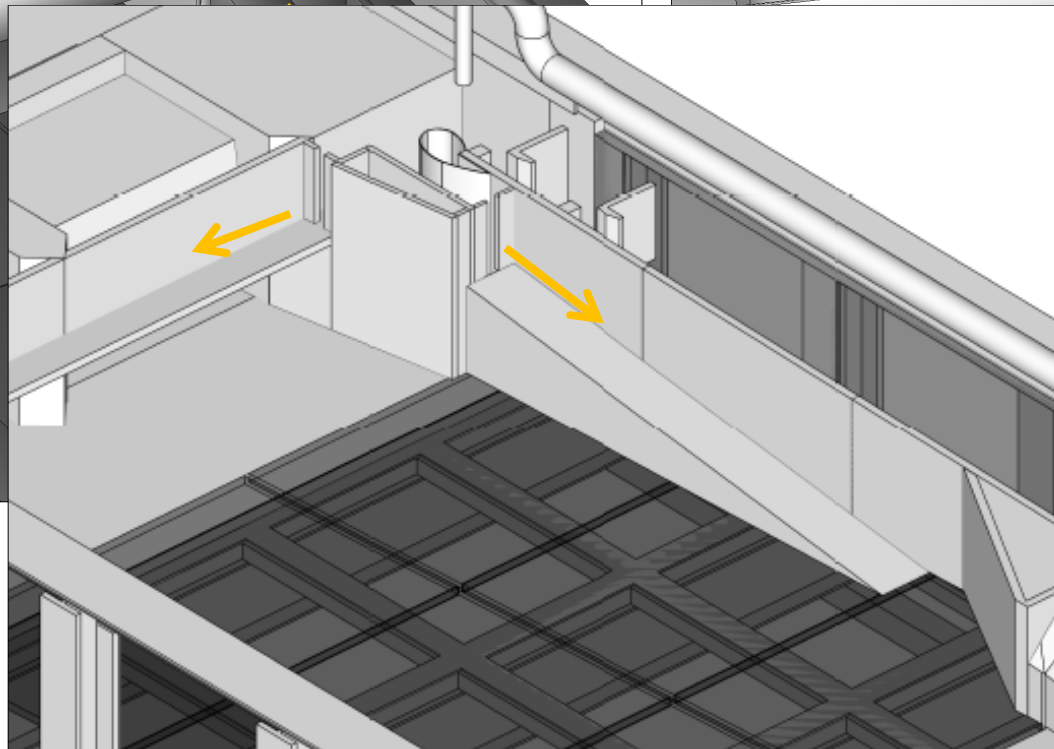
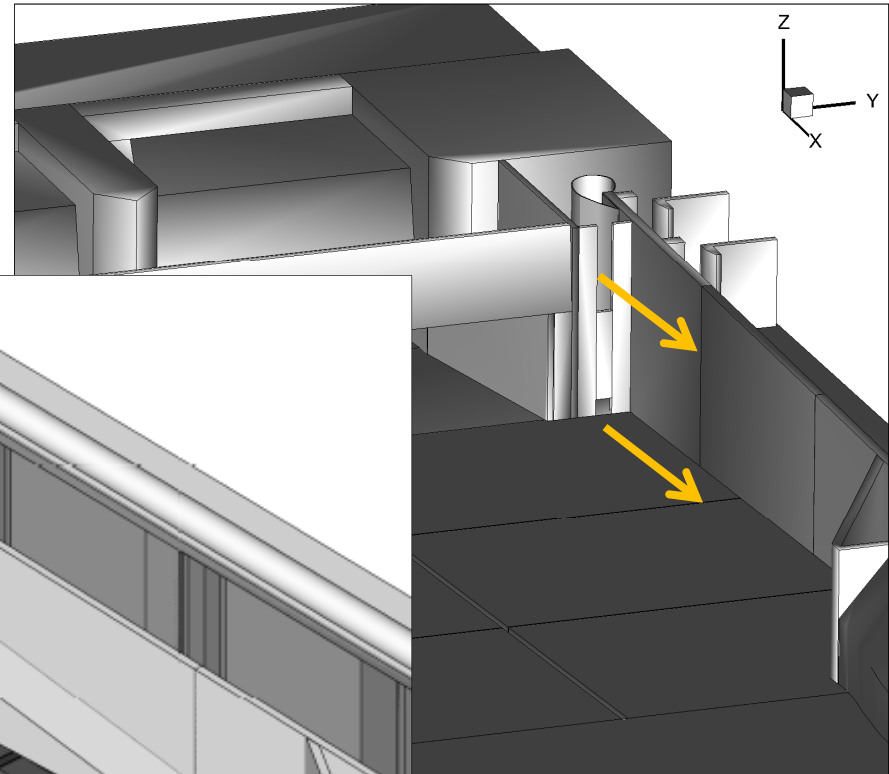


Entrance design

Typ A



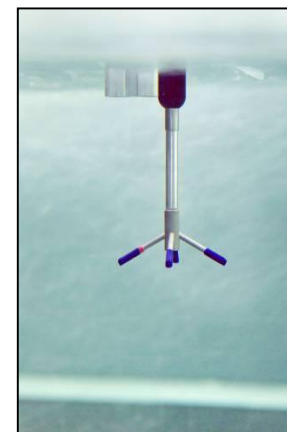
Typ B1&2



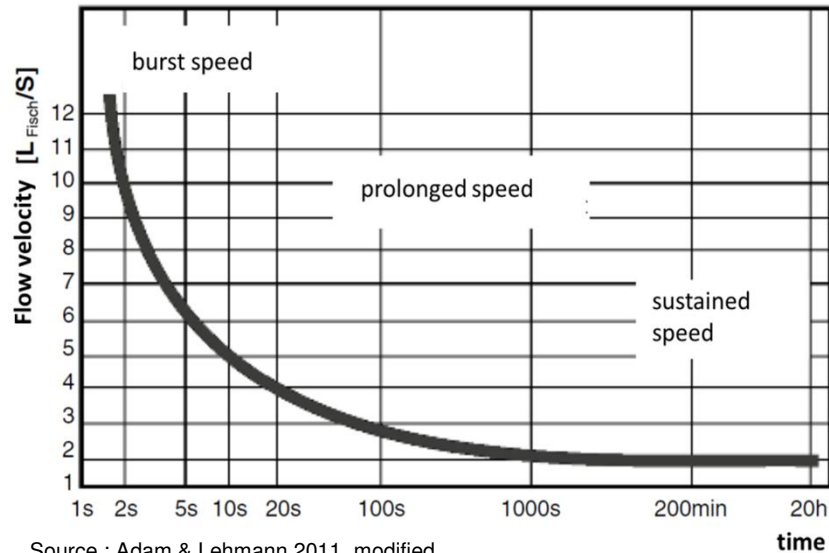
Typ C



Physical Model (M=1:10)



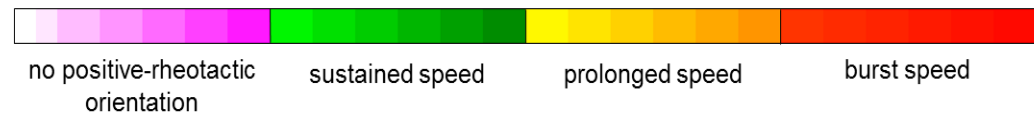
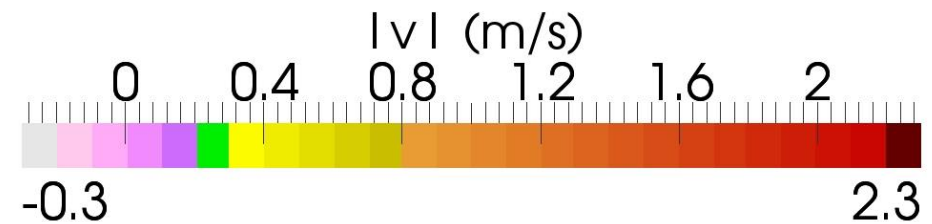
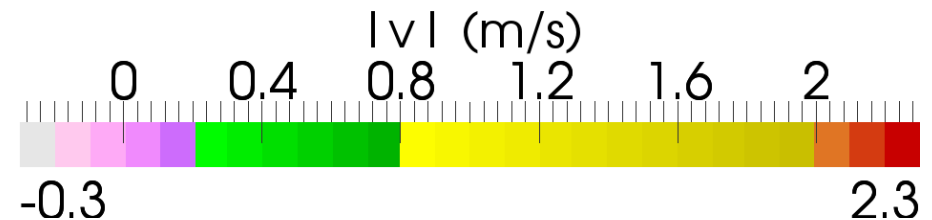
Evaluating hydraulic conditions



TL = 0,40 m
(barbel,
roach)

TL = 0,15 m
(bleak)

Swimming mode	Endurance	Velocity threshold
Max. sprint speed	≤ 20 sec	10 * TL/s 15 – 20 TL/s (for small fish)
Prolonged speed	> 20 sec; < 200 min	5* TL/S
Max. sustained speed	> 200 min	2* TL/s



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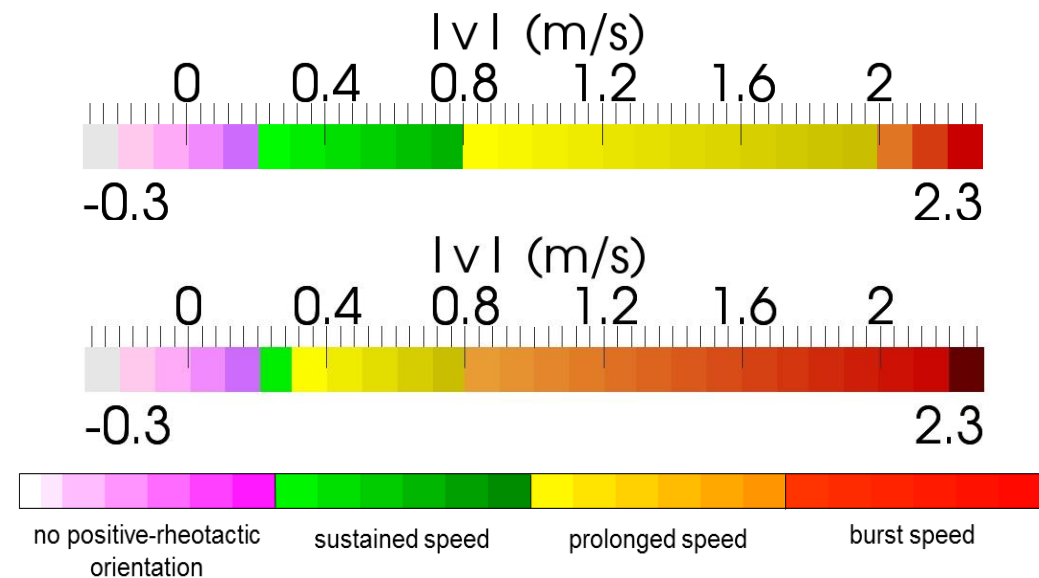
Evaluating hydraulic conditions

Criteria / Requirements:

- Continuous migration corridor
- Connecting different migration corridors
- Flow velocities in the migration corridor at sustained speed
- Avoid areas with prolonged or burst speed
- Avoid backflow areas

TL = 0,40 m
(barbel,
roach)

TL = 0,15 m
(bleak)

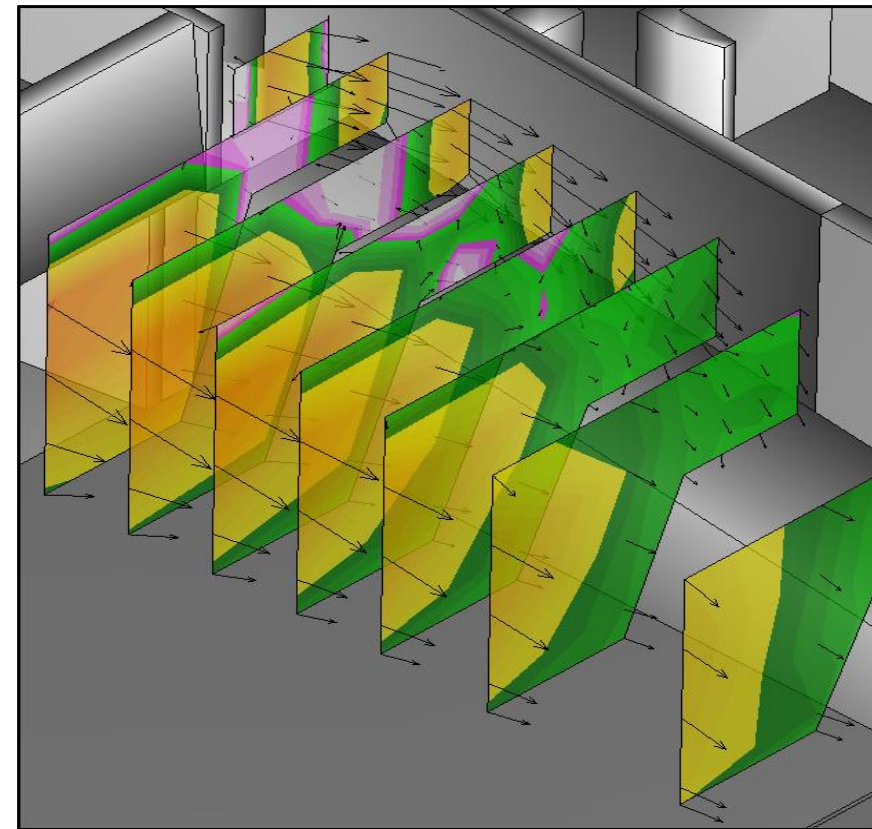
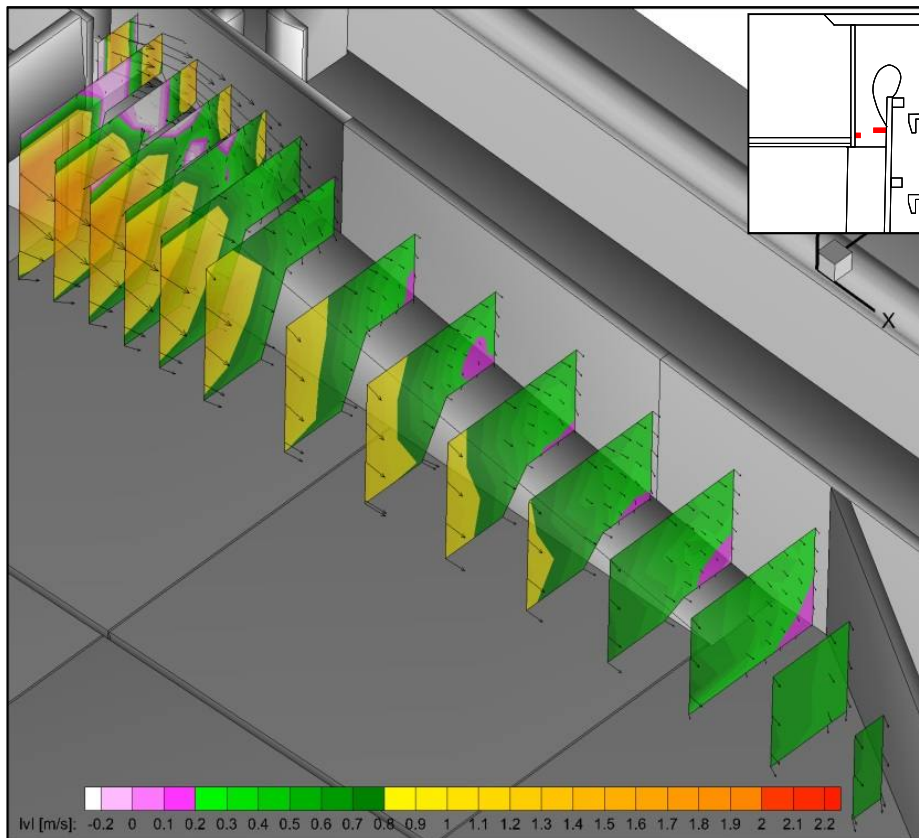
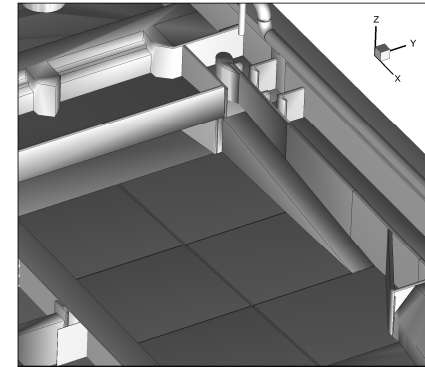


Typ A

High design flow

$$Q_{\text{Turb}} = 80 \text{ m}^3/\text{s}$$

$$Q_{\text{FW,total}} = 2,1 \text{ m}^3/\text{s}$$

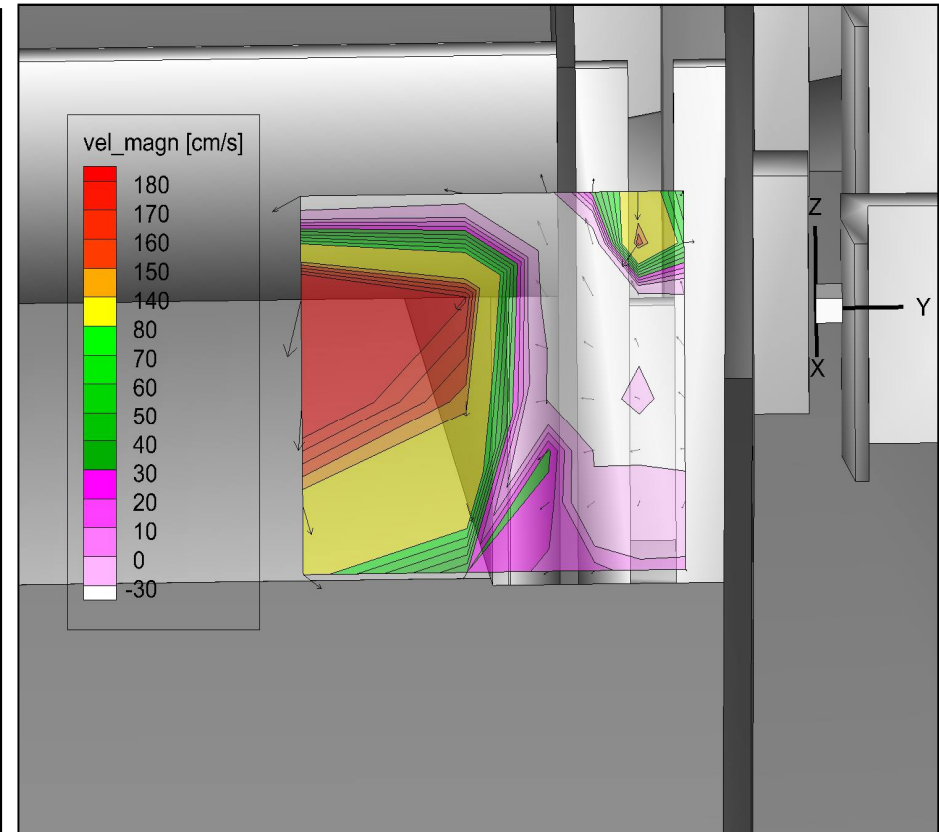
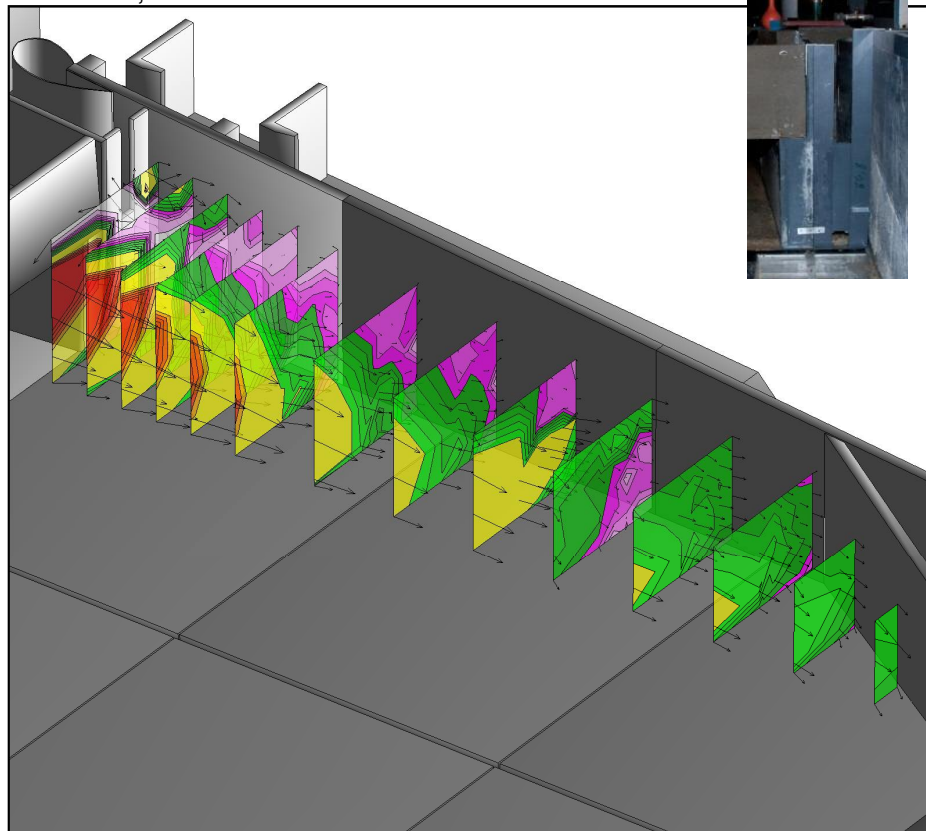
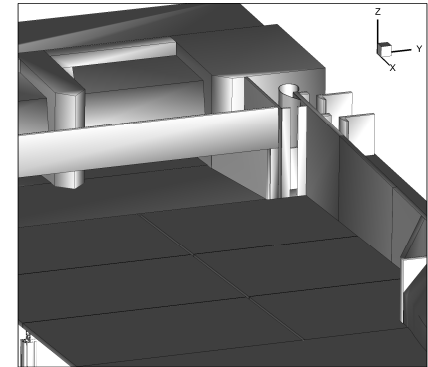


Typ B1

High design flow

$$Q_{\text{Turb}} = 80 \text{ m}^3/\text{s}$$

$$Q_{\text{FW,total}} = 1,9 \text{ m}^3/\text{s}$$



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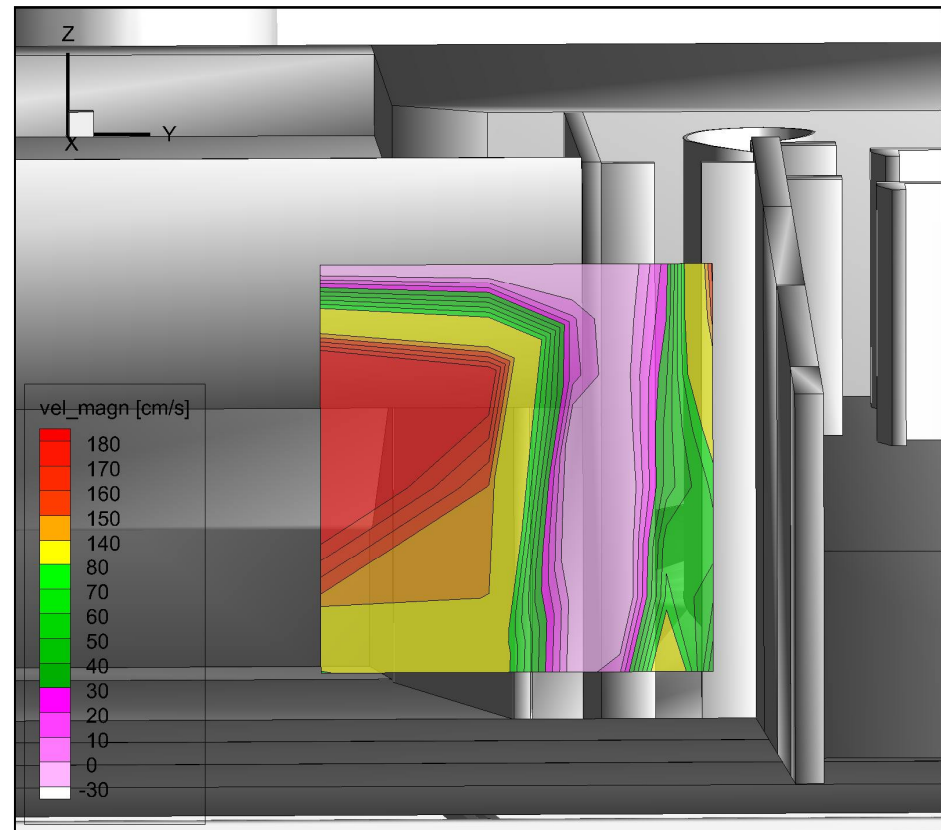
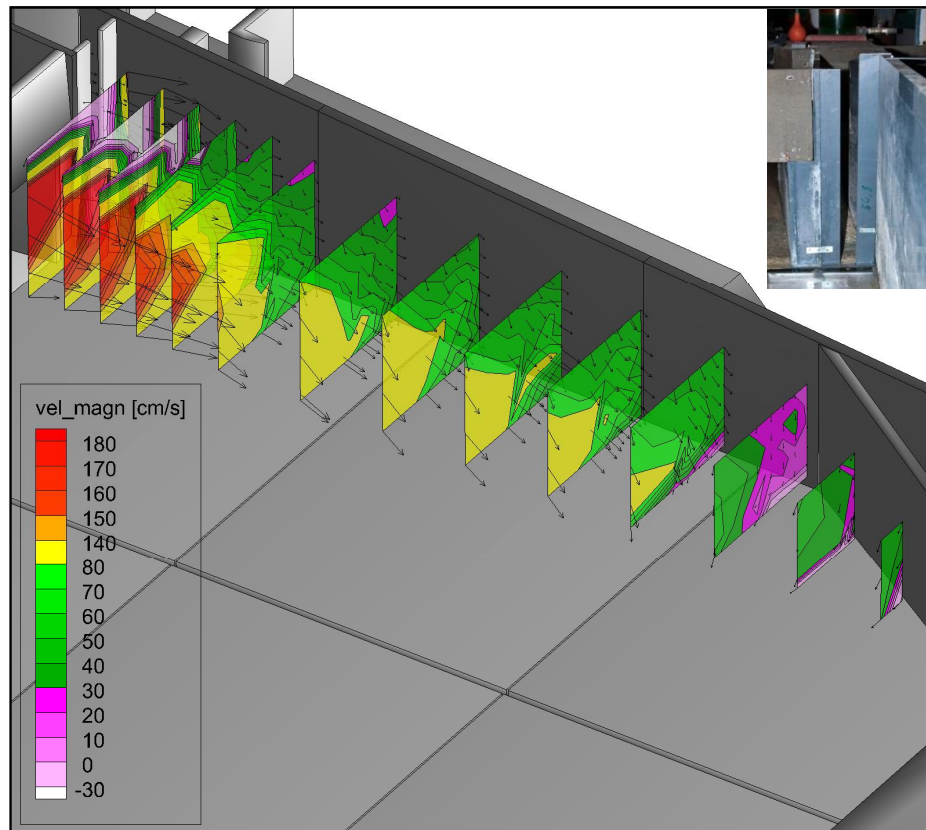
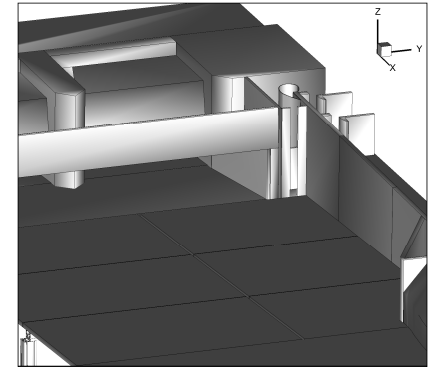
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Typ B2

High design flow

$$Q_{\text{Turb}} = 80 \text{ m}^3/\text{s}$$

$$Q_{\text{FW,total}} = 3,9 \text{ m}^3/\text{s}$$



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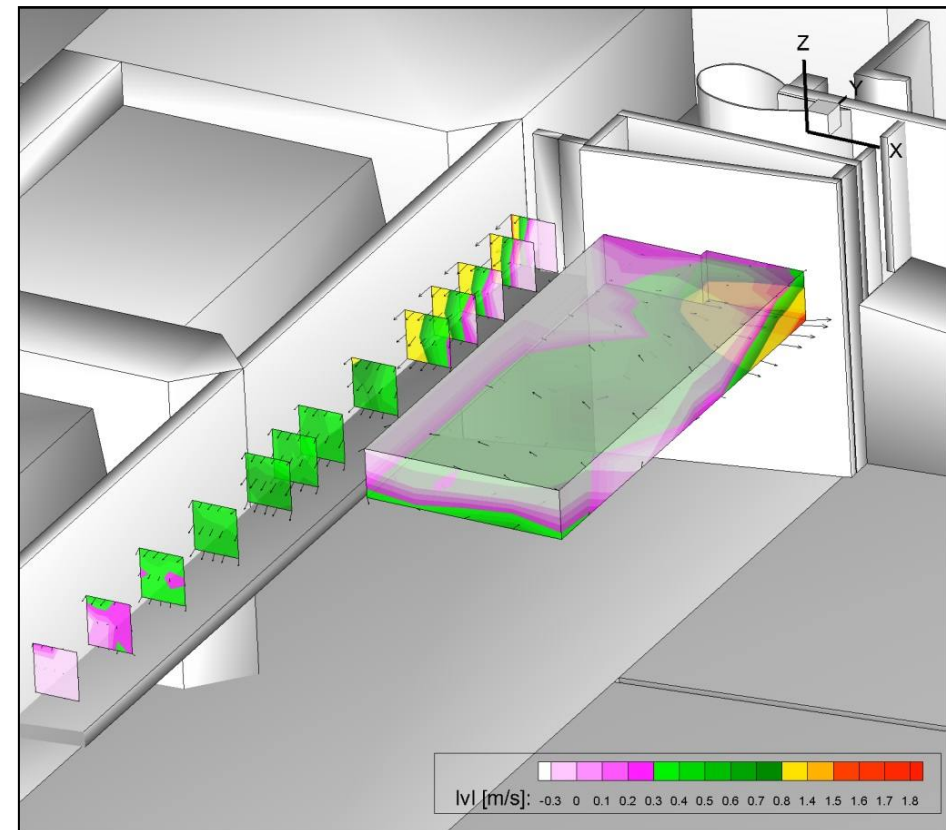
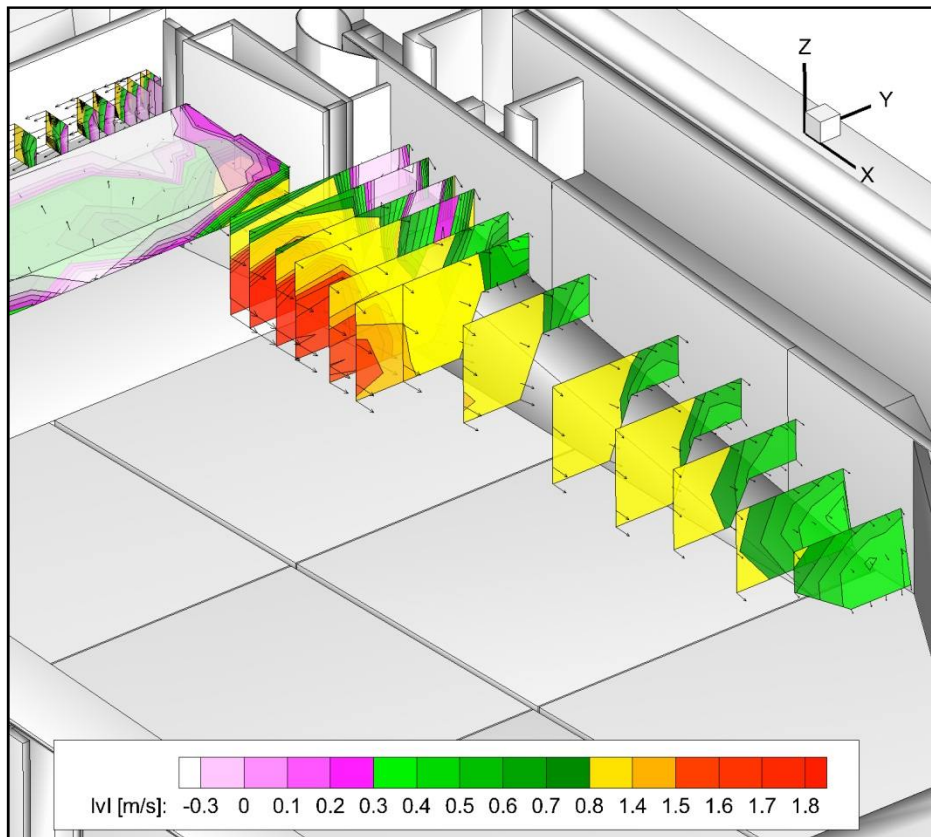
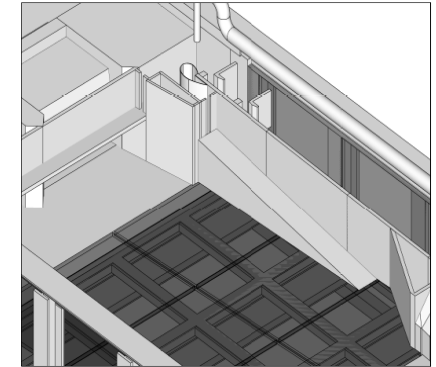
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Typ C

High design flow

$$Q_{\text{Turb}} = 80 \text{ m}^3/\text{s}$$

$$Q_{\text{FW,total}} = 3,9 \text{ m}^3/\text{s}$$



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Conclusions

Typ A:

- hydraulic migration corridor is existing for all studied conditions
- extends until the end of the ramp
- velocities are high at the entrance but still at a feasible level

Typ B1:

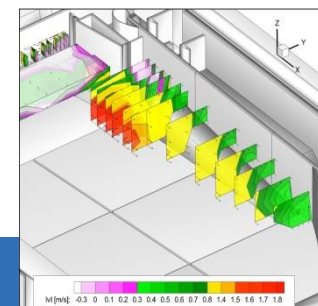
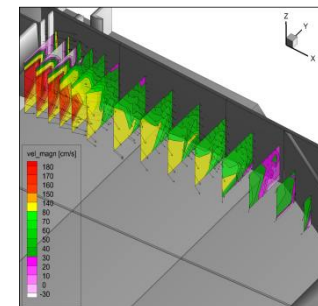
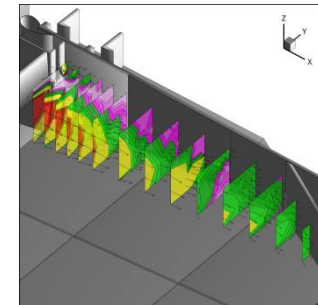
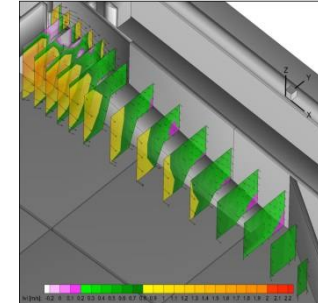
- hydraulic migration corridor is short at the surface
- hydraulic corridor at the bottom is disconnected
- surface velocities are high at the entrance and low at the bottom
- backflow area

Typ B2:

- hydraulic migration corridor is existing for all studied conditions
- velocities are in a suitable range
- necessary discharge is comparatively high

Typ C:

- hydraulic migration corridor is existing for all studied conditions
- velocities are in a suitable range
- limited connection between lateral and vertical corridor
- necessary discharge is comparatively high

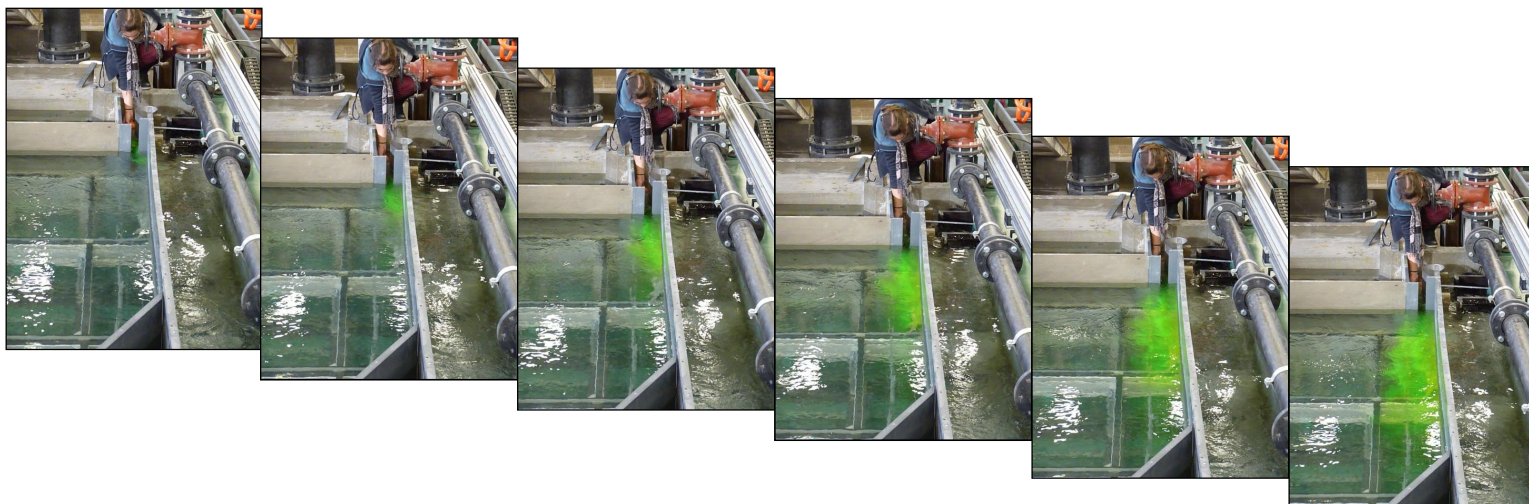


Summary/Outlook

- Different entrance designs comply with the regulations
- Comparison/evaluation of the hydraulic conditions
- Optimize the tested entrance designs
- Further design suggestions being used have to be tested
- We have to ask the fish! Biological Monitoring is essential:
Large role in our R&D Program for the next years at different pilot facilities (PIT-
Tags, Telemetry, DIDSON, etc.)



Thank you for your attention!



This presentation was made possible by the
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