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Innovations I: The Fish-Lifting Trough: A Combined Trash-Rack Cleaner and Fish Passage Device

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The Fish-lifting Trough– a Combined Trash-rack Cleaner and Fish Passage Device

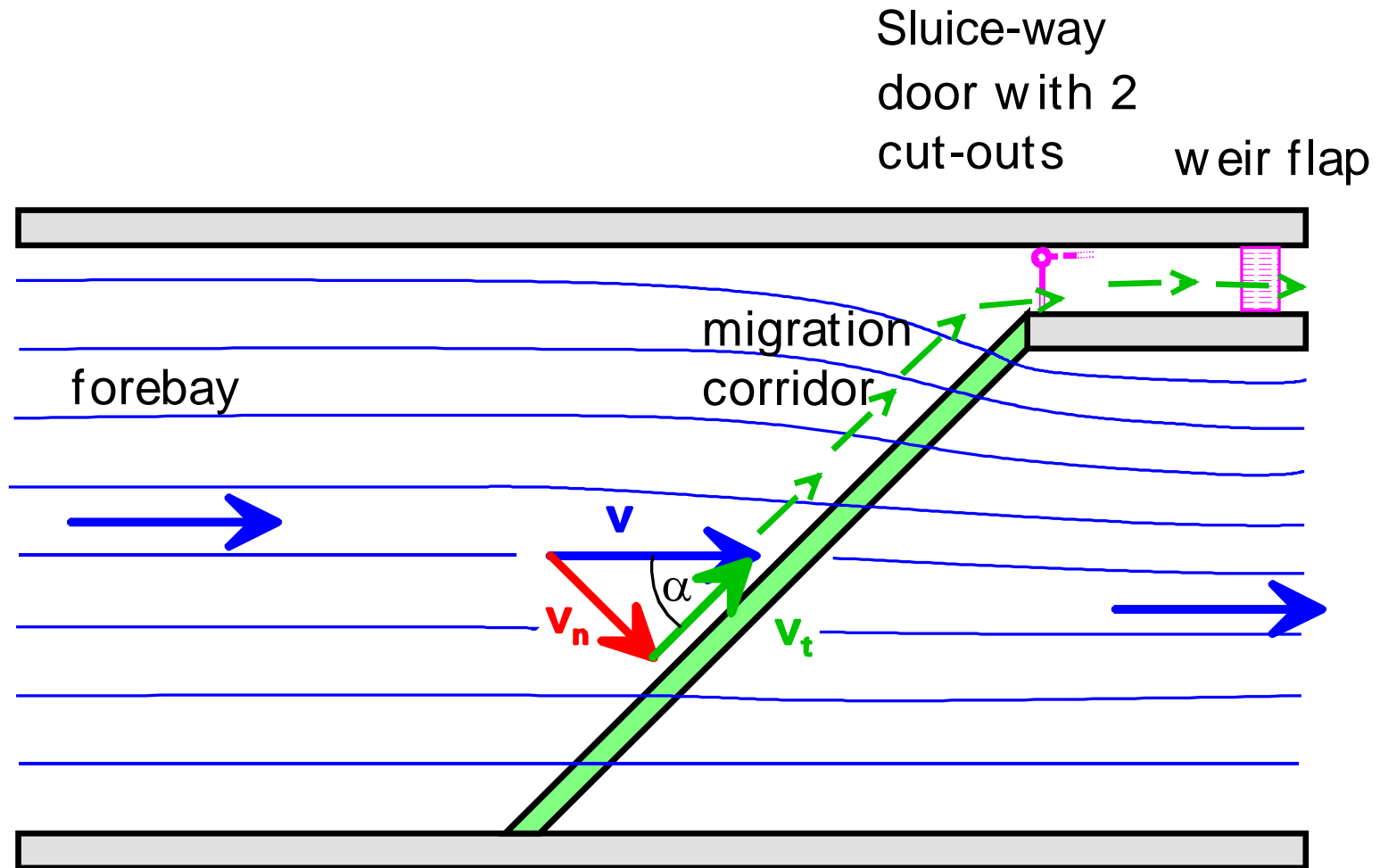
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Testing Facilities
University of Kassel, Germany

- Remarks for downstream guidance of fish in Germany
- Concept and function of fish-lifting trough
- Lab tests
- Pilote site Interlaken



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The Angled Screen



Design Criteria for Angled Screen

Design criteria (after Courret and Larinier (1)):

- Perpendicular component of approach velocity v_n not greater than 0,50 m/s.
- Tangential component equal or greater than perpendicular component => angle of intersection α between streamlines and surface not greater than 45 degrees

Criterion for unforced and promptly migration into the bypass: limited acceleration and velocity (according to different authors):

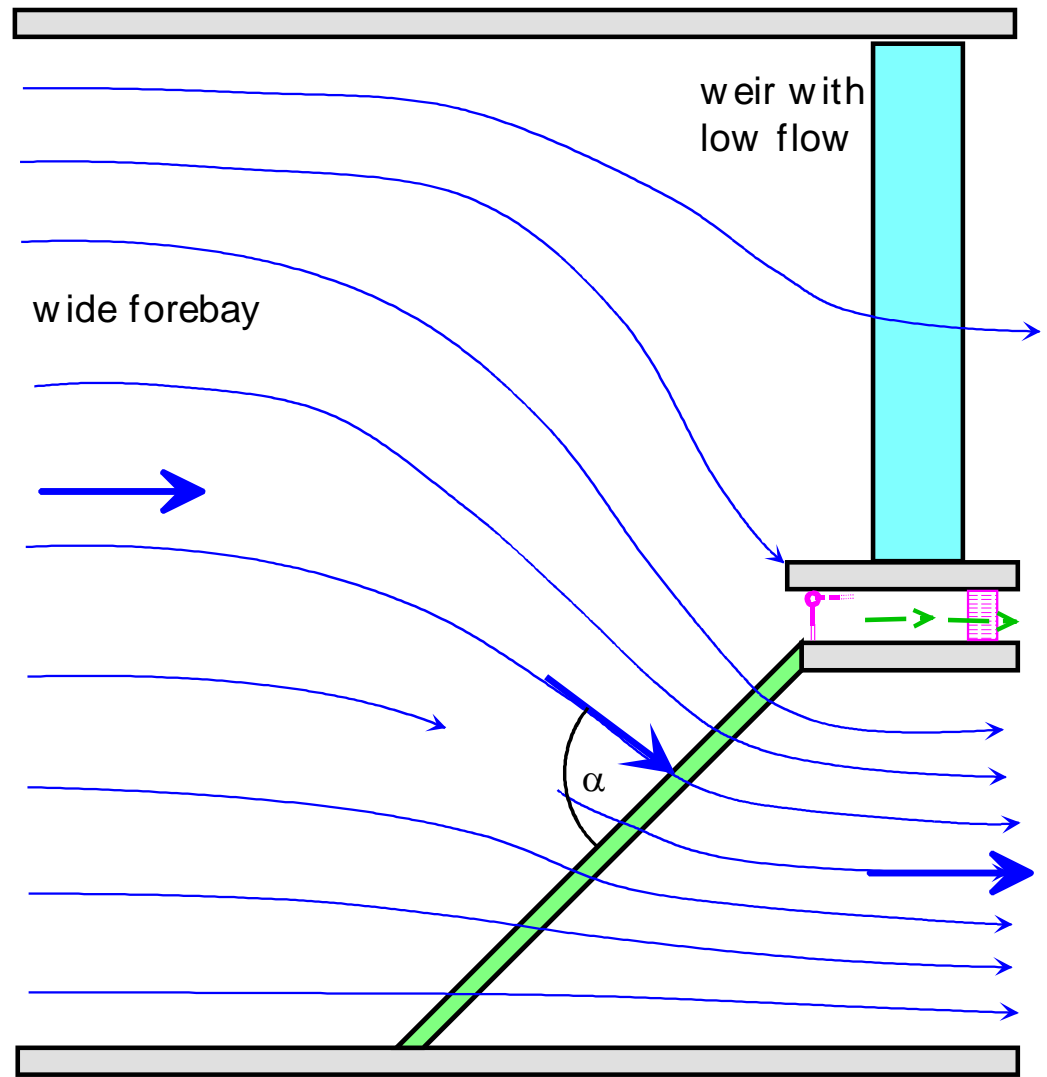
- $v < 0,60$ m/s => complex hydraulic control, difficult to comply

1: Courret, D.; Larinier, M.: Guide pour la conception de Prises d'eau « ichthyocompatibles » pour les petites centrales hydroelectriques. RAPPORT GHAAPE RA.08.04; Nov. 2008

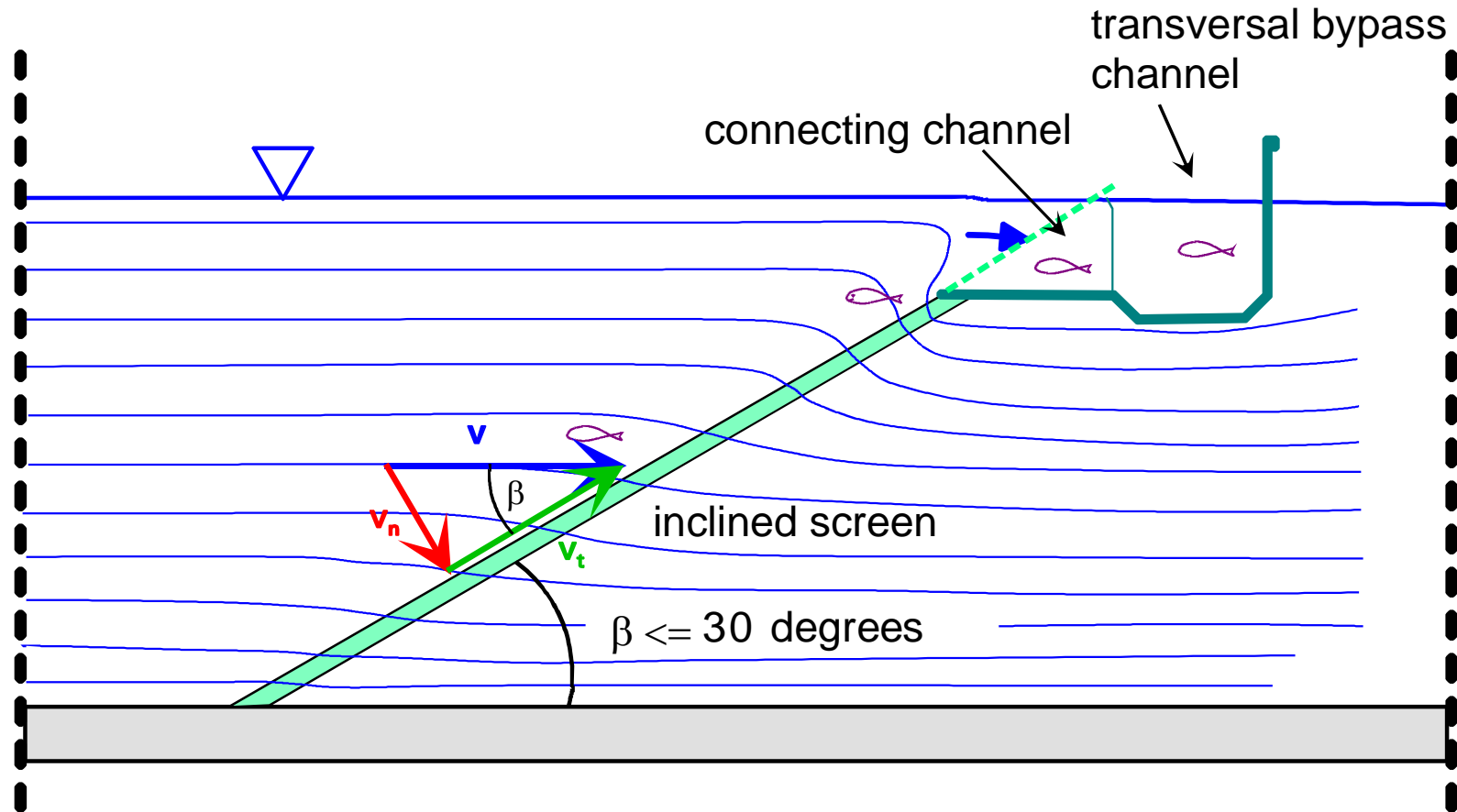
Restricted Application of Angled Screens

If the forebay is wider than the aspect width of the screen, streamlines intersect the screen with much larger angles => **guidance vanishes** in the middle of the screen => no guidance to the bypass entrance sections

Fish is subject to **delay** and **predation**



Inclined Screen



Design Criteria for Inclined Screen

Design criteria (after Courret and Larinier (1)):

- Perpendicular component of approach velocity v_n not greater than 0,50 m/s.
- Tangential component equal or greater two times the perpendicular component ($v_t \geq 2 \times v_n$) \Rightarrow angle of intersection α between streamlines and surface about 26 degrees (often 30 degrees used)

Criterion for unforced and promptly migration into the bypass: limited acceleration and velocity (according to different authors):

- $v \leq 0,60$ m/s \Rightarrow complex hydraulic control, difficult to comply

1: Courret, D.; Larinier, M.: Guide pour la conception de Prises d'eau « ichthyocompatibles » pour les petites centrales hydroelectriques. RAPPORT GHAAPE RA.08.04; Nov. 2008

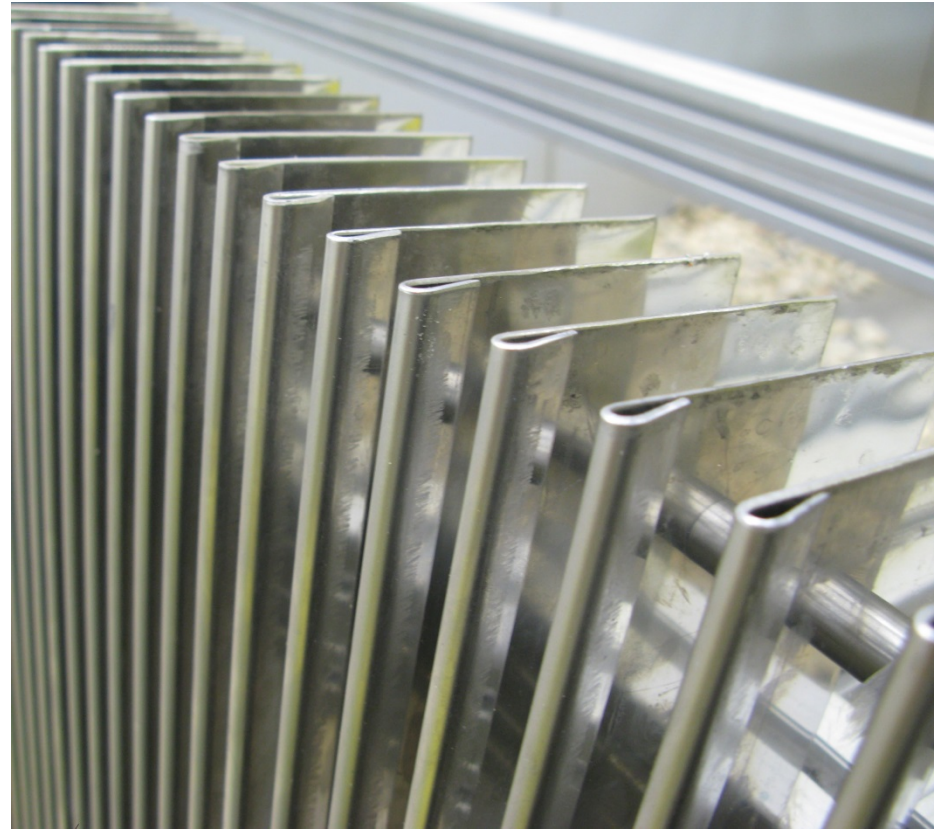
Disadvantages of Both Fish Guiding Systems

- Large screen area
- Large building pit
- Long-time interruption of turbine operation
- Long outreach or long track for the trash-rack cleaner
- Hydraulic conditions in bypass difficult to control

Expensive and hard to realize at existing sites!

(Not) New Concept of Catch and Carry: Take the fish with the Trash-rack Cleaner

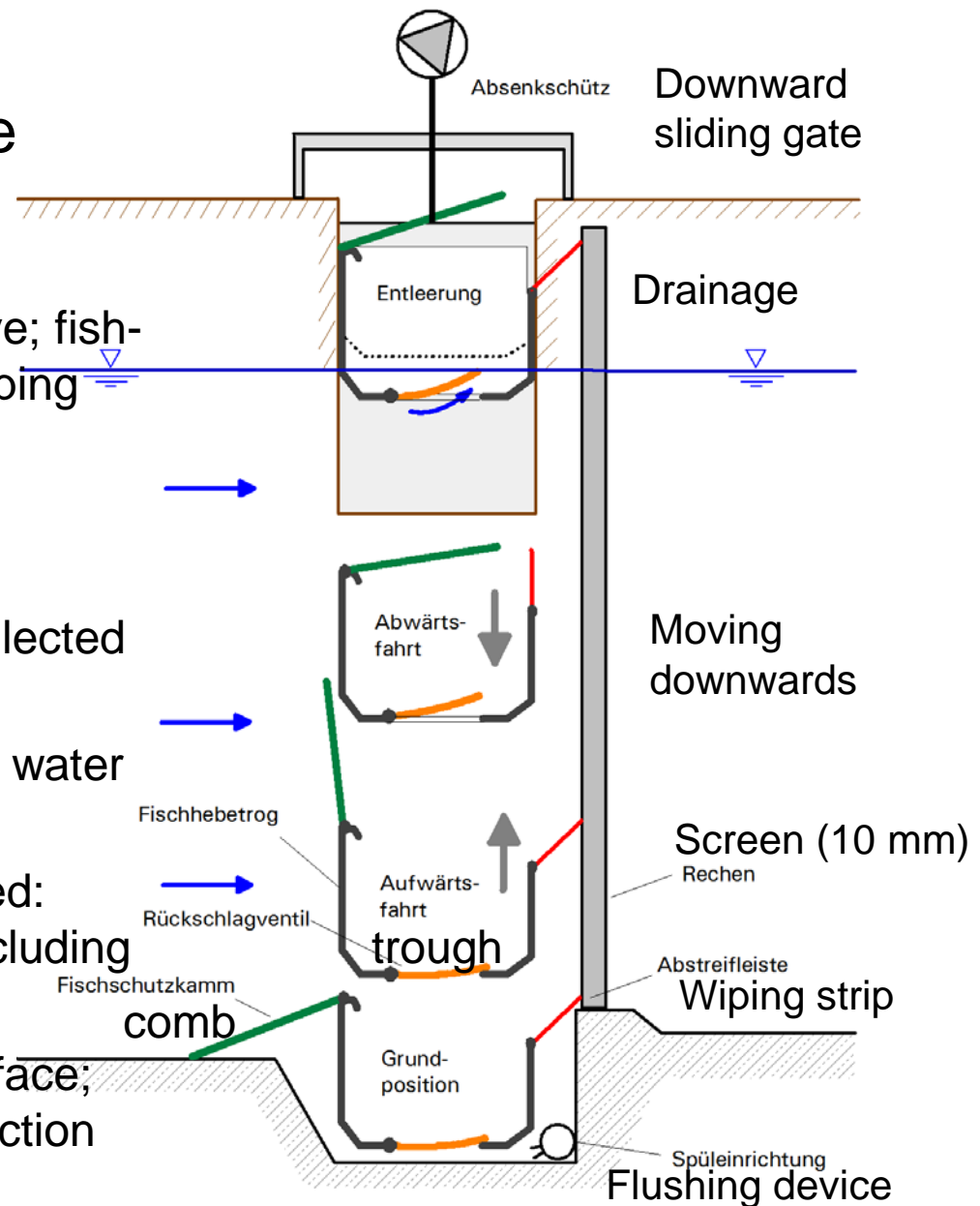
- Combination with „Fish-friendly Trash Screen“
- Screen vertical (not angled, not inclined)
- Cleaner wipes debris off the screen and catches fish in a trough
- Trough is drained close to the water surface
- Fish and debris are washed to the tailrace



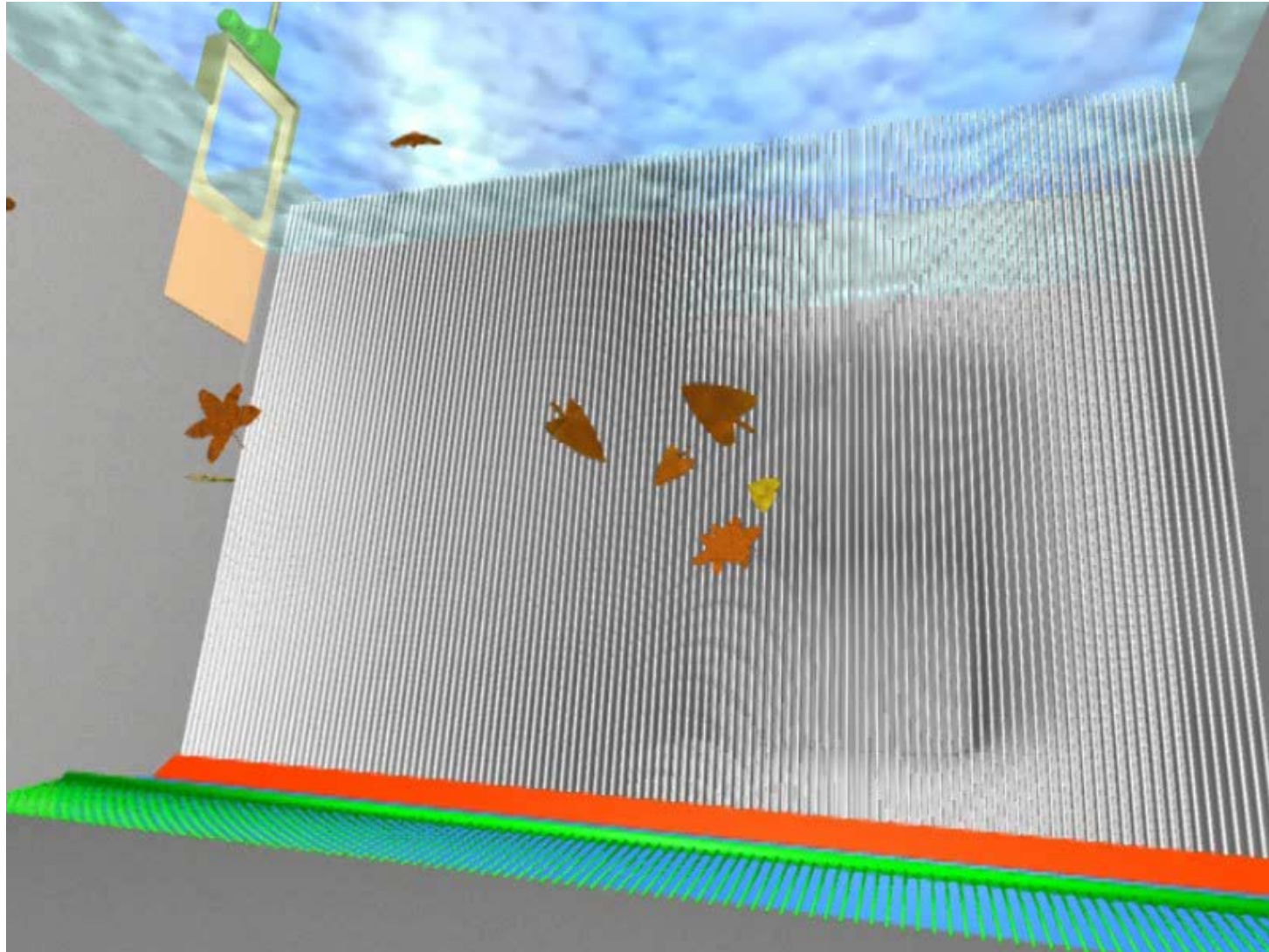
The „Fish-friendly Screen“ – a product of Klawa GmbH, Germany (www.klawa-gmbh.de)

Functional Principle of the Fish-lifting Trough

- Home position in bottom groove; fish-protection comb on bottom; wiping strip on screen surface
- Fish protection comb is turned upwards; trough moves up
- Debris is wiped off; fish are collected in wake of comb
- Tips of comb teeth head out of water surface: fish are trapped
- Sliding gate is lowered = opened: content of trough is drained including fish and debris
- Wiping strip is lifted off the surface; trough moves down; fish-protection comb is layed down



Animation of Fish-lifting trough



Research and Development Project



gefördert durch



Deutsche
Bundesstiftung Umwelt

www.dbu.de

Entwicklung und Untersuchung einer neuartigen Kombination von Fischabstiegsvorrichtung und Rechenreiniger. Report dbu project no. 27863 – 24/0
Development and test of a new combination of fish-bypass and trash-screen cleaner

Longitudinal Section of the Test Setup

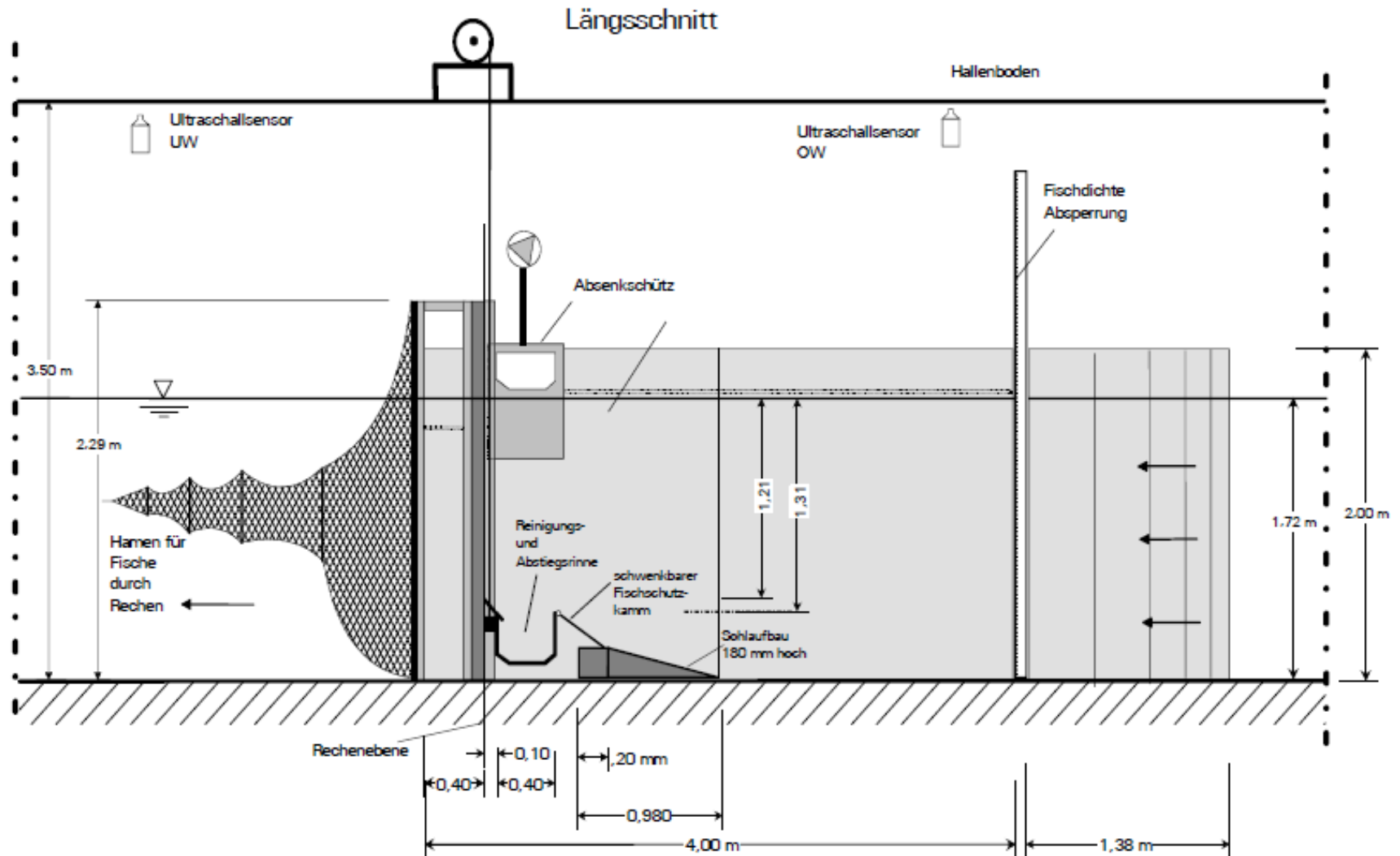
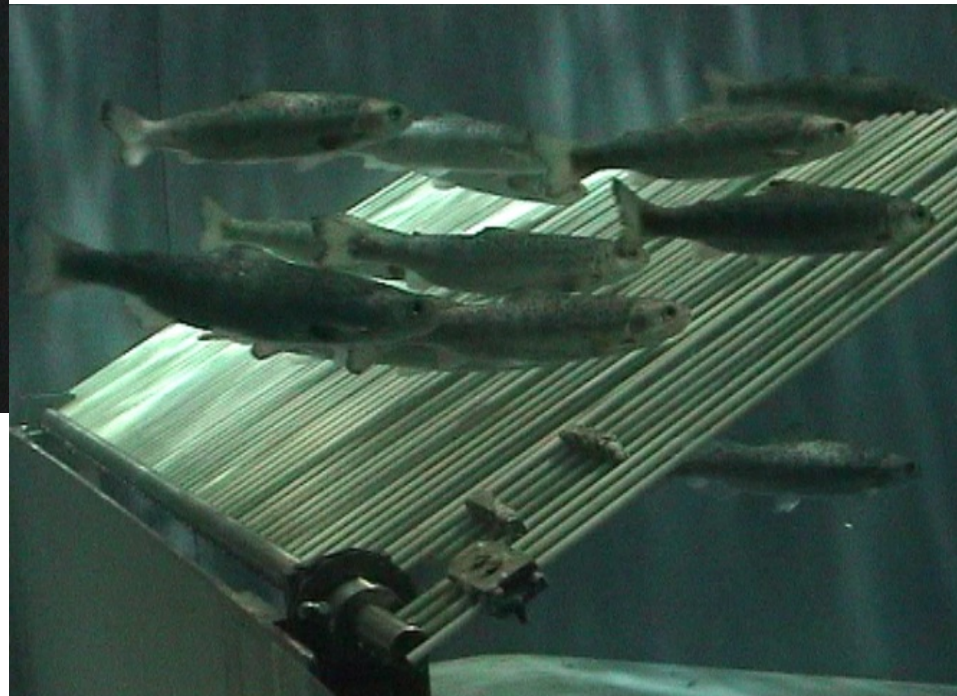


Bild 3: Längsschnitt des Versuchsstandes

Laboratory Tests with Live Fish

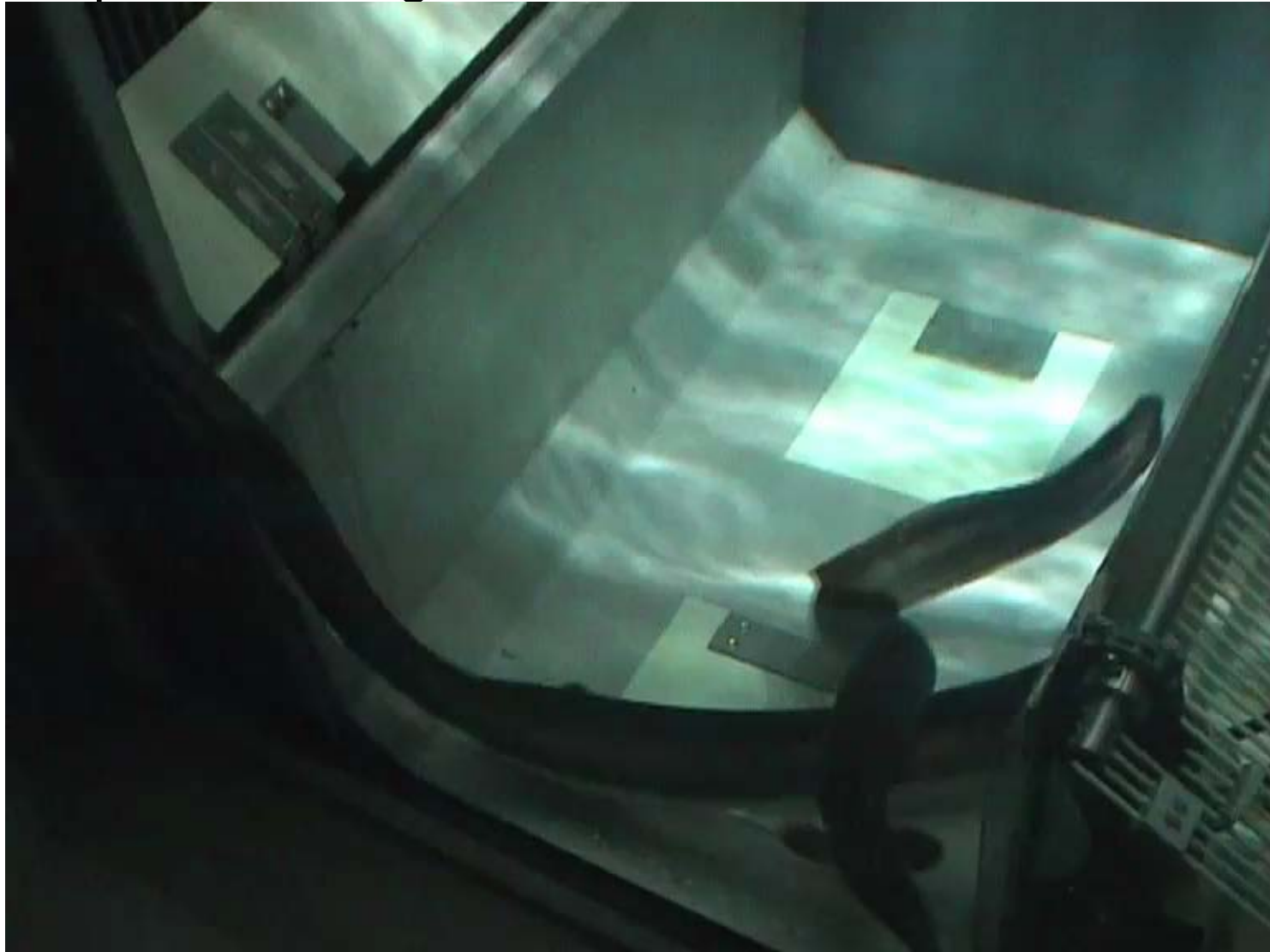


Fish-lifting trough with eels (*Anguilla anguilla*)



Fish-lifting trough with salmon smolts (*Salmo salar*)

Eel Capture and Migration

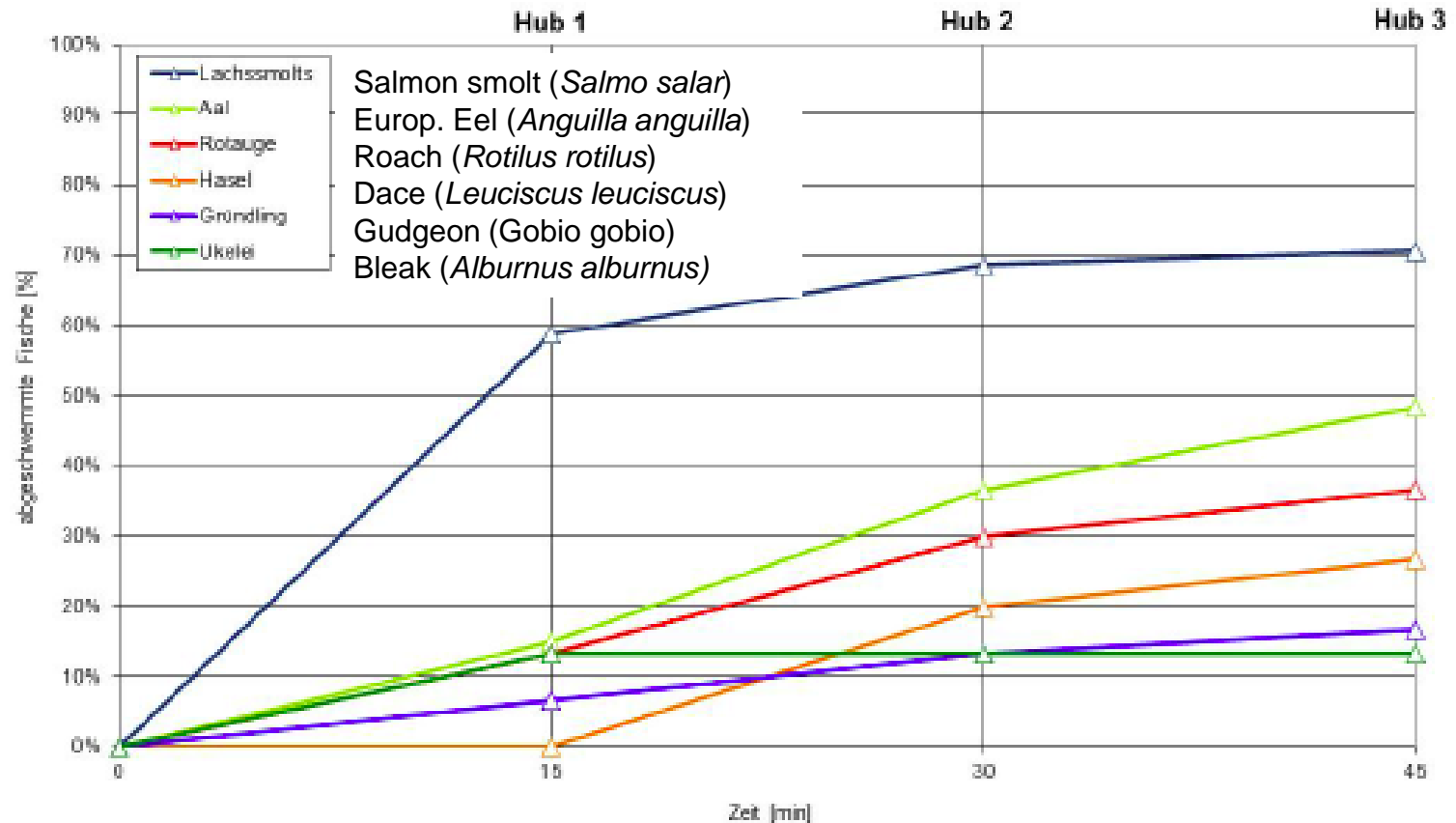


Salmon Capture and Transport



Rate of Transported Fish

Auswertung der Fischrinnenversuche
Anströmgeschwindigkeit: 0,5 m/s



Pilote Site in Interlaken/Switzerland



Technical Data of Pilote Site Hydropower Plant Interlaken (operated by: IBI Industrielle Betriebe Interlaken, Switzerland)

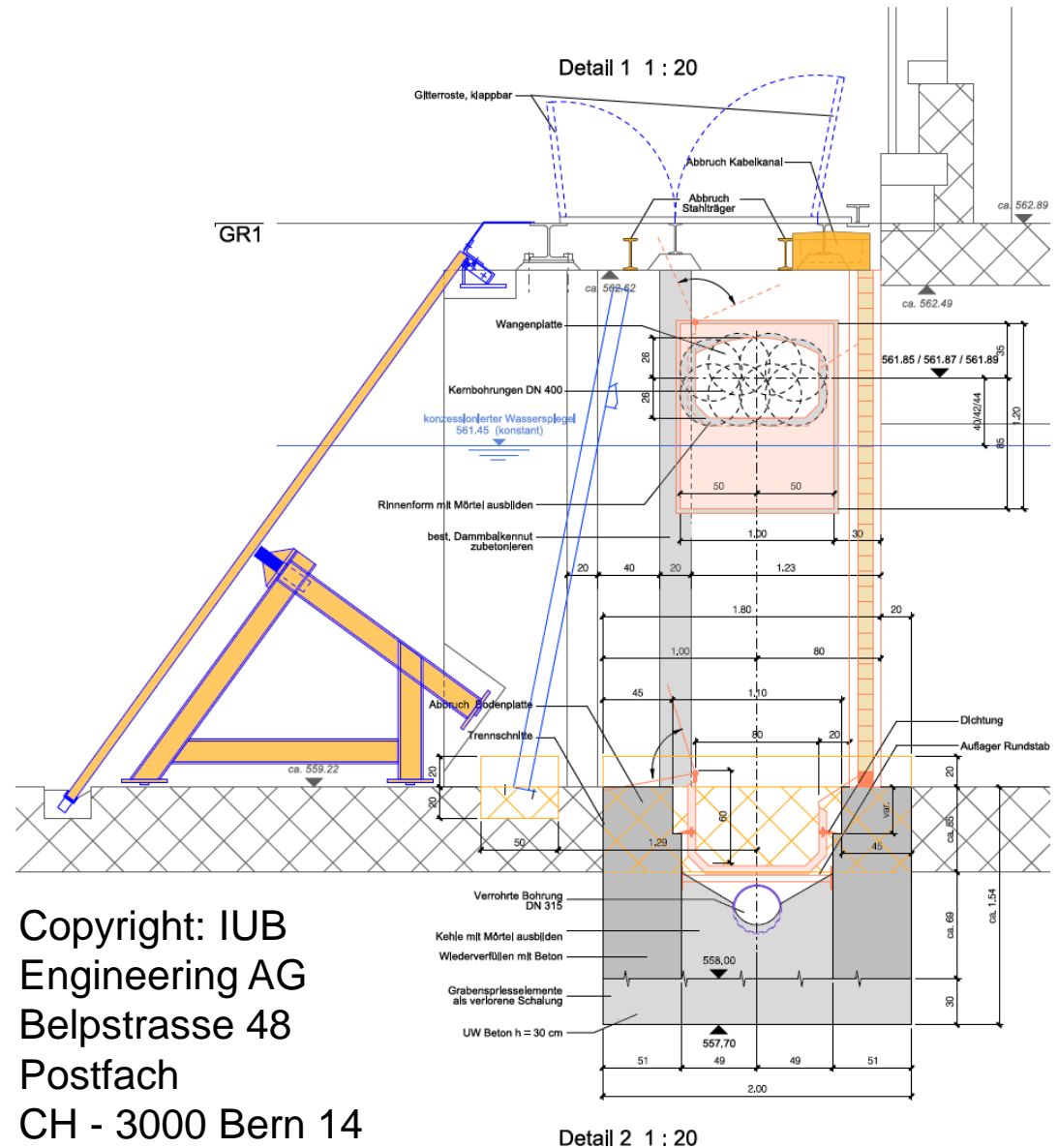
- Max. discharge: 30 m³/s
- Head: 3,50 m
- 3 turbines with separate approach channels
- Width of each channel: 4,50 m
- Water depth upstream screen: 2,11 m
- Approach velocity: 1,05 m/s

New Fish-related Components at Hydropower Plant Interlaken

1. Fish-friendly trash screen; clear spacing 10 mm
2. 3 Fish-lifting troughs in a row: 3 x 4,50 m; synchronized operation
3. New fish lock with a brush-furnished slope inside; the brushes dissipate hydraulic energy while filling the lock
4. Attraction current jet-pumps enhance the attraction flow at the lock's entrance

Longitudinal Section through Pilote Site Interlaken

- The construction works are just going on.
- Operation starts in September 2016.
- A 2 years intense monitoring on efficiency of the trough and the new fish lock will be conducted.



Advantages of the Fish-lifting Trough

- Very low water demand
- Hydraulic paraconditions are simple to control
- Short construction length (in flow direction) -> easy to install in existing hydroelectric plants
- Mean waiting time for the fish 10 min => no delays
- low predation risk in the forebay
- low selectivity; high efficiency
- Less cost and effort (compared to guiding screens)
- Fish-related functions are combined with essential functions for hydropower purposes

Summary

- The Fish-lifting trough is a combined trash screen cleaner and fish transporter.
- It takes fishes of all species which are upstream of the screen (closer than 0,80 - 1,20 m) with a high rate to the tailrace.
- Fish and debris are washed downstream.
- The fish-lifting trough is optimal with a vertical fish-friendly screen (with 10 mm clear spacing: head loss = 7 mm for 0,50 m/s approach velocity)).

Thank you!

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www: www.uni-kassel.de/fb14/vpuw



References: Hassinger, R.; Huebner, D.: Entwicklung und Untersuchung einer neuartigen Kombination von Fischabstiegsvorrichtung und Rechenreiniger. Report dbu project no. 27863 – 24/0, Feb. 2013 (available as *.PDF from author)