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## Session D1: Experimental Study on Flow Patterns in Vertical Slot Fishways

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# Experimental study on flow patterns in vertical slot fishways

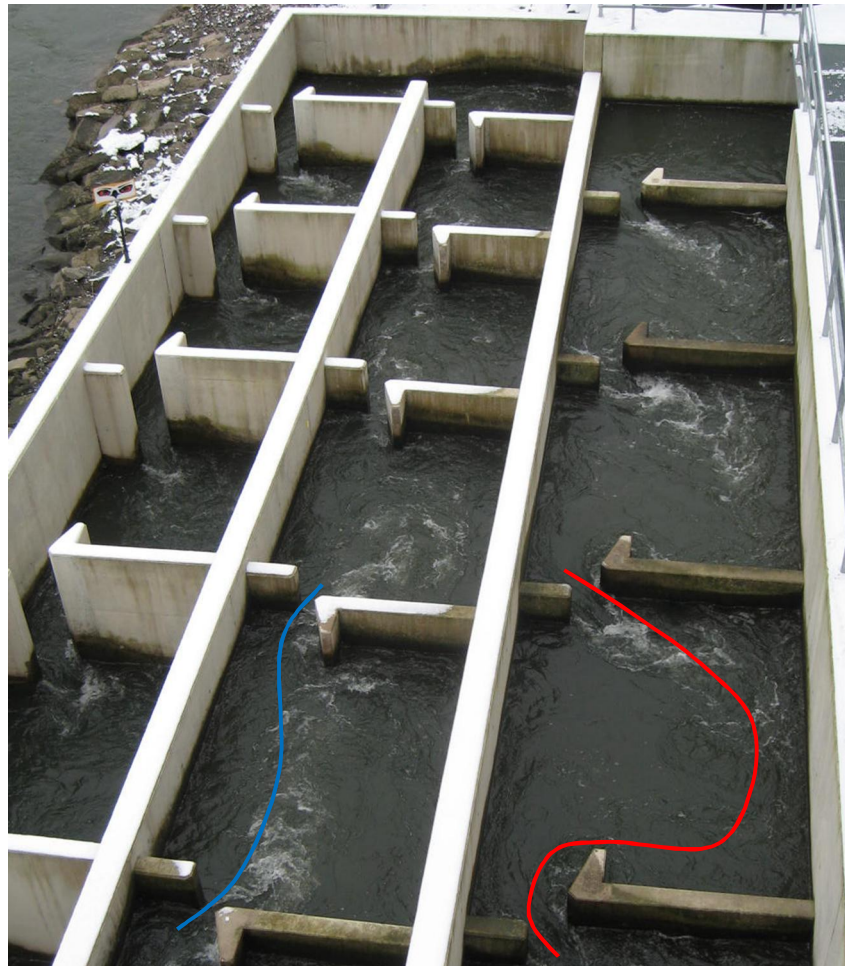
INSTITUTE FOR WATER AND RIVER BASIN MANAGEMENT – Prof. Dr.-Ing. Nestmann

Dipl.-Ing. Verena Höger

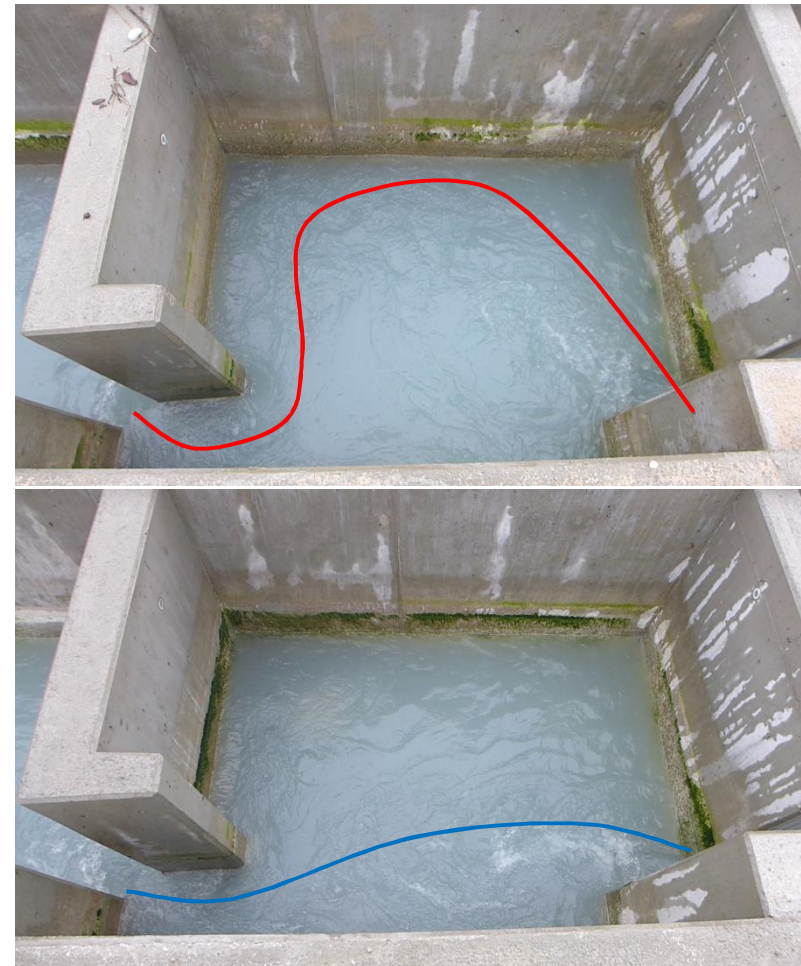


A cooperation between the Institute for Water and River Basin Management of KIT and the Federal Waterways Engineering and Research Institute

# Introduction



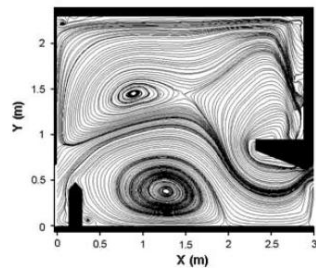
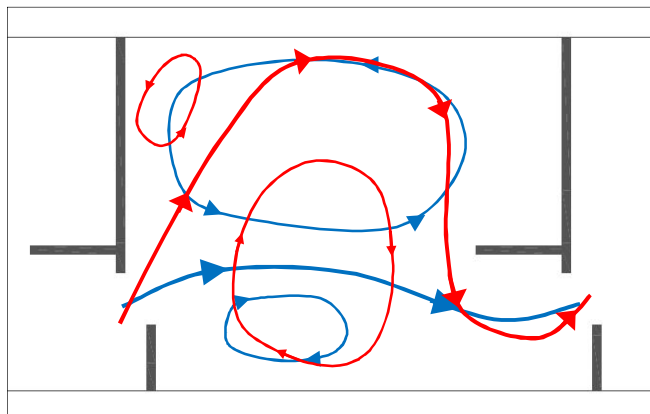
FAA Koblenz, Mosel (BAW)



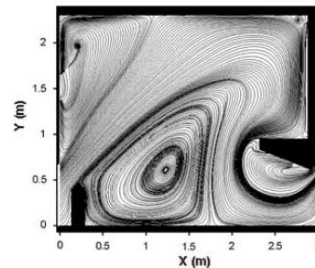
FAA Krün, Obere Isar (Musall)

# Introduction

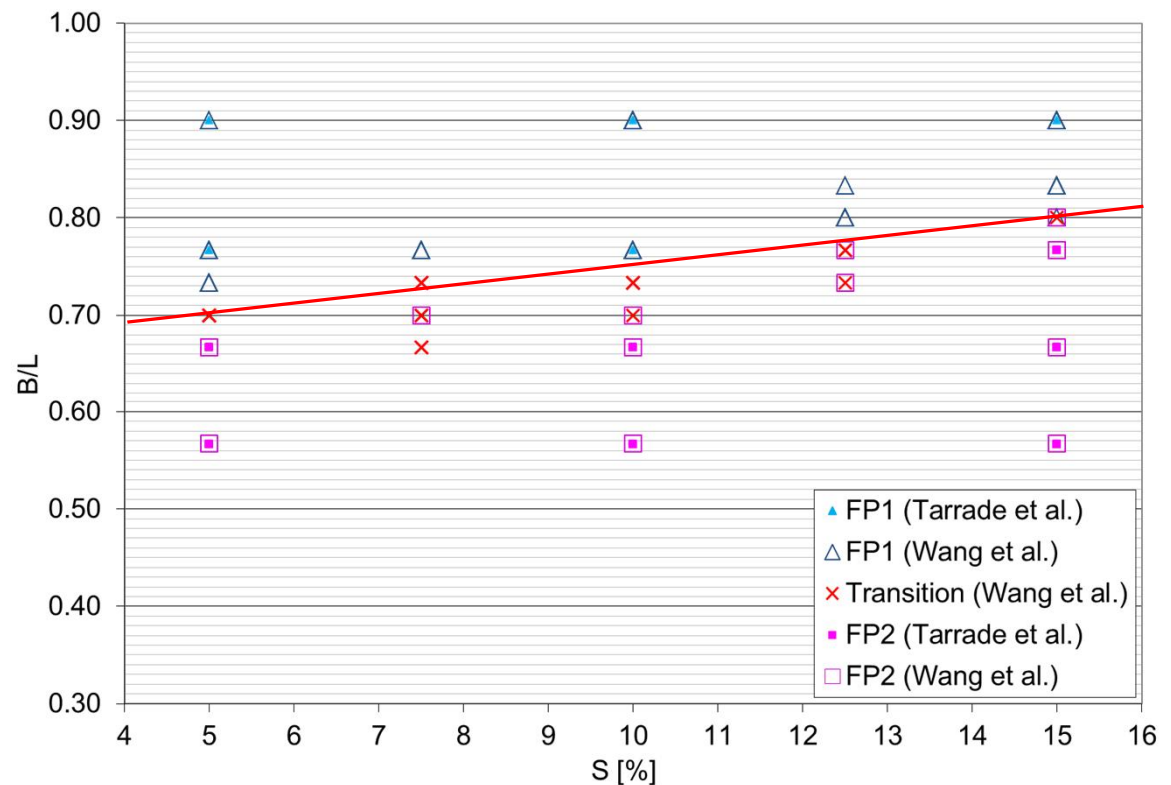
- flow pattern 1 (FP1) und flow pattern 2 (FP2)



(Tarrade 2008)

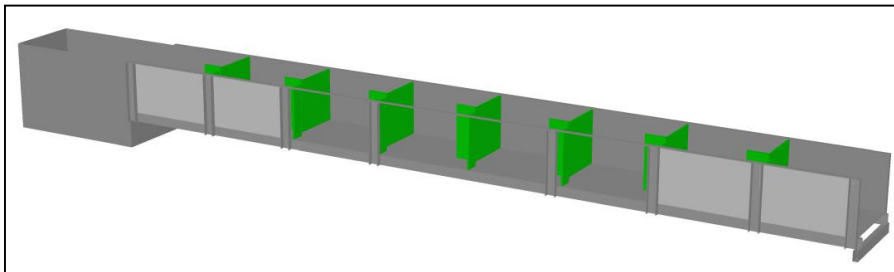


(Tarrade 2008)



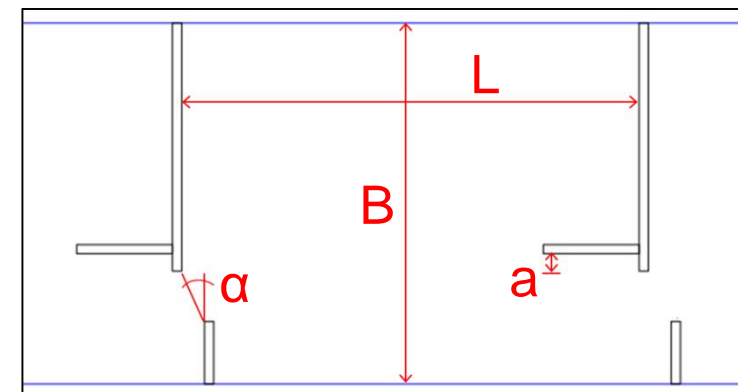
# Material and methods - Experimental setup

- Physical model at Theodor-Rehbock-Laboratory of the IWG (KIT)
- 9.5 m x 0.79 m flume
- Variable slope
- 6 pools (variable geometry)



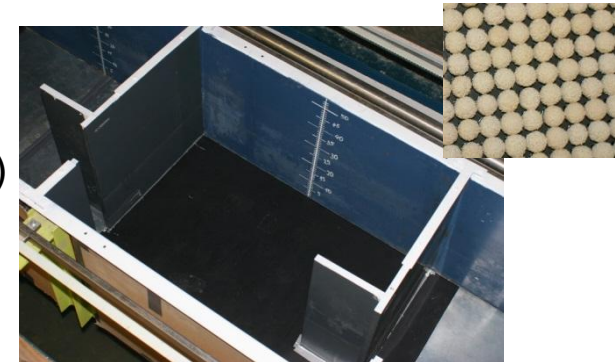
Investigated geometric parameters:

- **B/L**-ratio (0.6 to 0.8)
- angle of slot  $\alpha$  ( $24^\circ$  to  $56^\circ$ )
- distance from the guide wall to the slot **a** (3.8 and 7.1 cm)
- slope of the fishway **S** (2.8% to 5%)

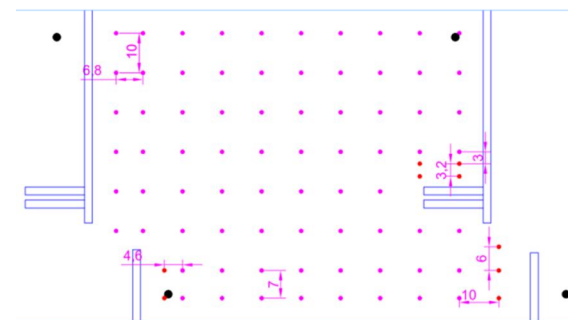


# Material and methods - Methodology

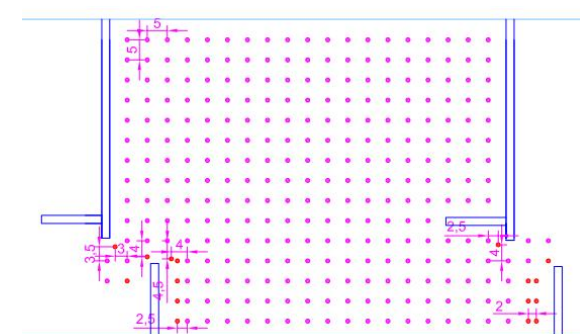
- long time exposure of water surface
- exposure time: 4.9 s
- Tracer particles: white rubber sponge ball (15 mm diameter)
- pool: black bottom, white edging



- water depths
- ultrasonic distance sensor
- mesh: ~10 x 10 cm



- Acoustic Doppler Velocimeter (ADV)
- 300 s measuring time per measuring point
- mesh: ~ 5 x 5 x 5 cm



# Results - Long time exposure

$B/L = 0.75$   
 $\alpha = 24^\circ$   
 $a_{LW} = 0.38 \text{ cm}$

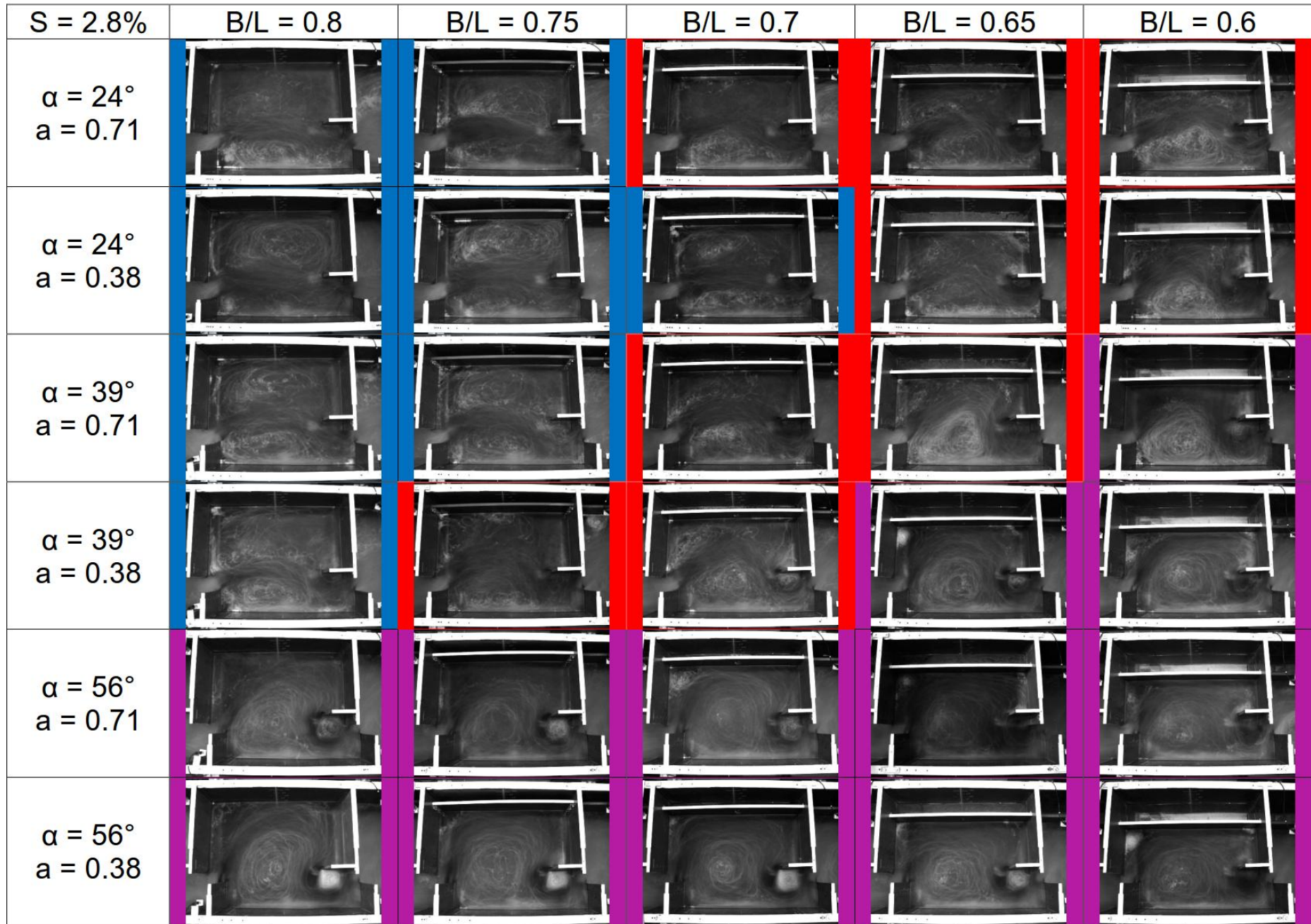


$B/L = 0.75$   
 $\alpha = 39^\circ$   
 $a_{LW} = 0.38 \text{ cm}$



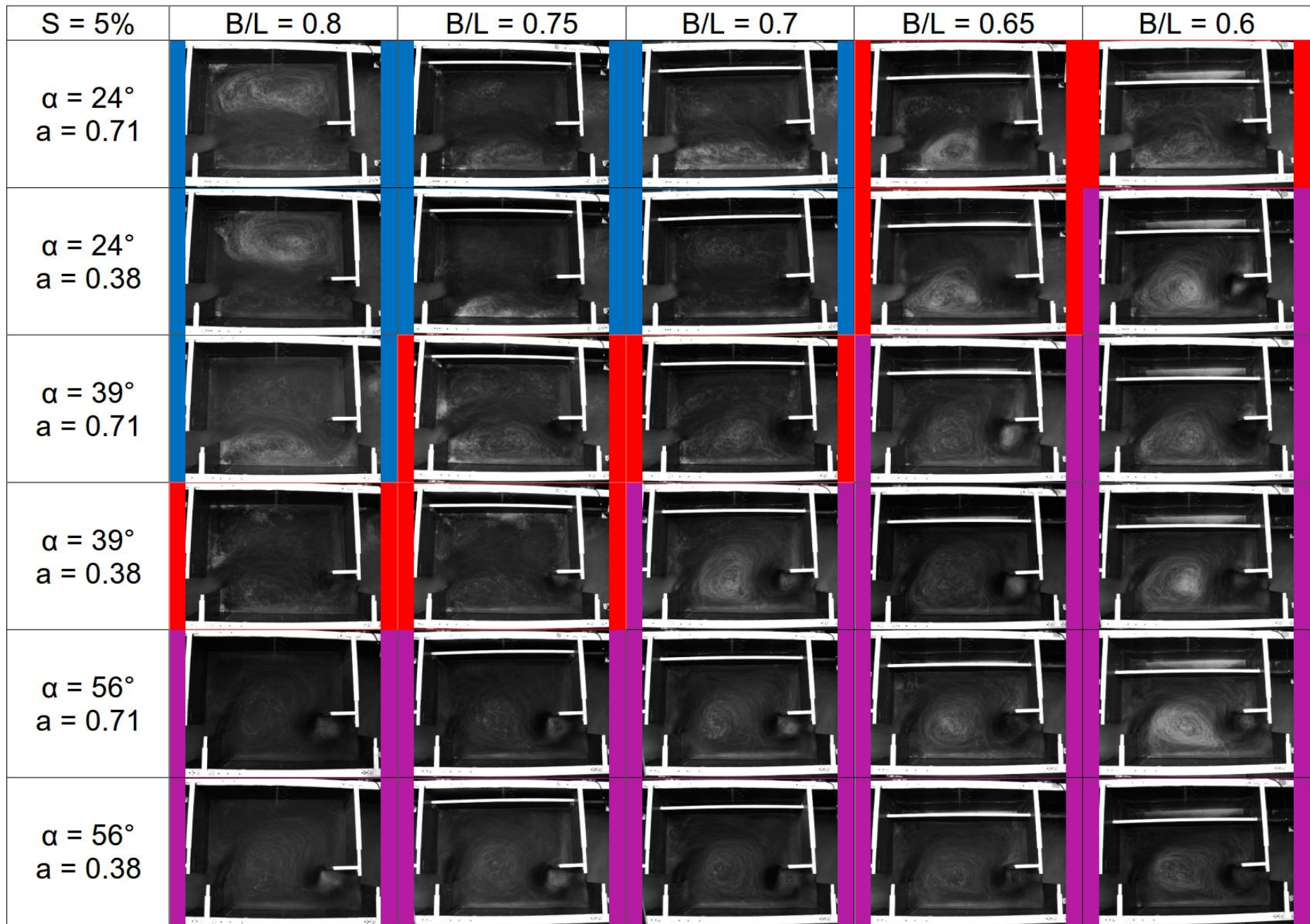
**FP1**  
**FP2**  
**Transition**

$B/L = 0.75$   
 $\alpha = 56^\circ$   
 $a_{LW} = 0.38 \text{ cm}$



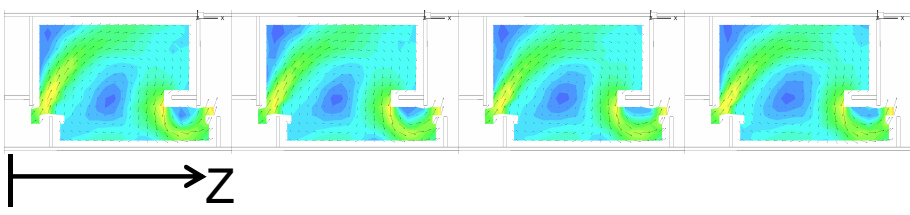
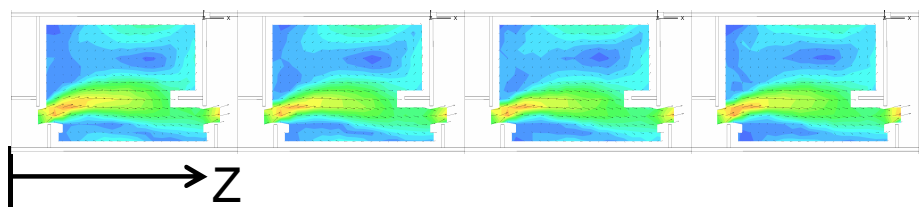
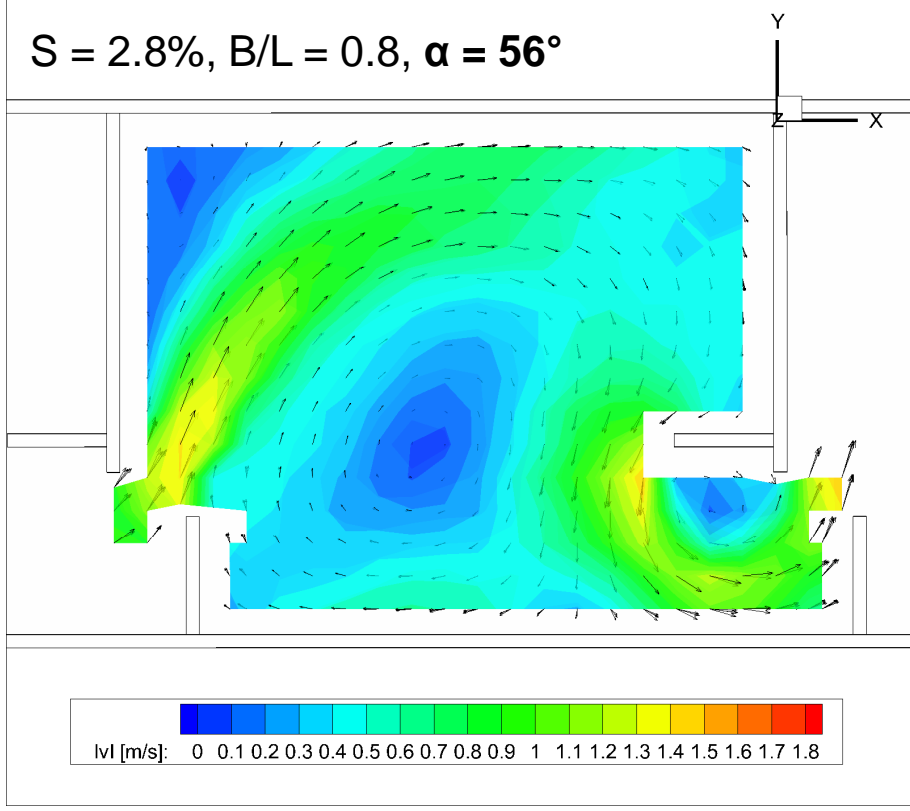
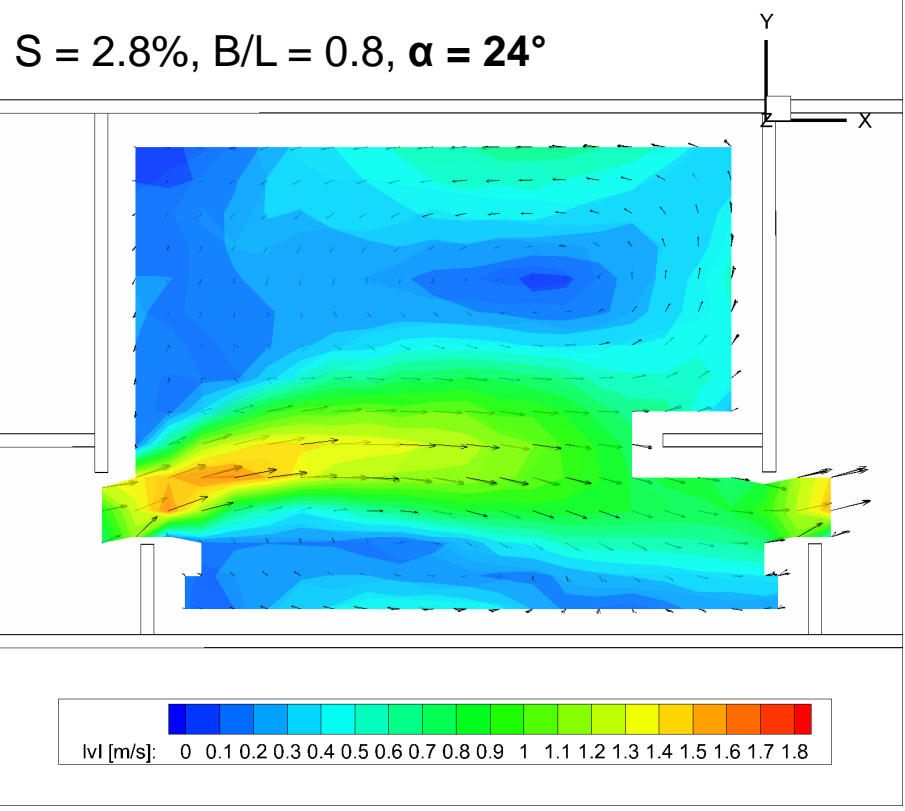
FP1; Transition; FP2



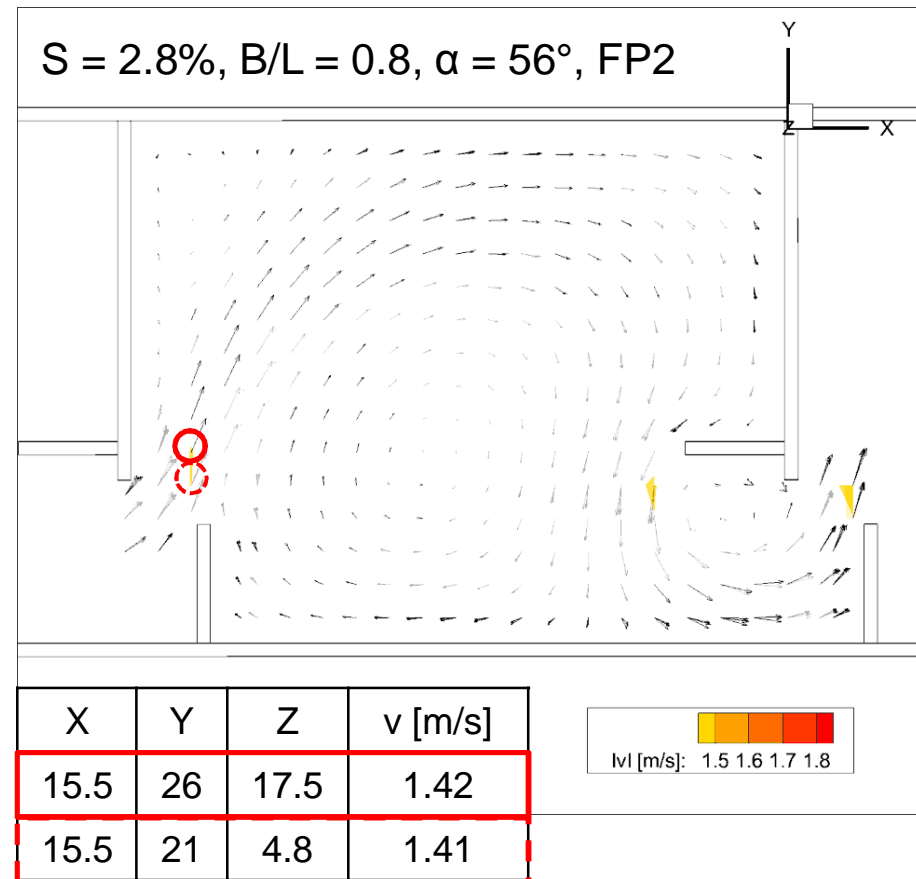
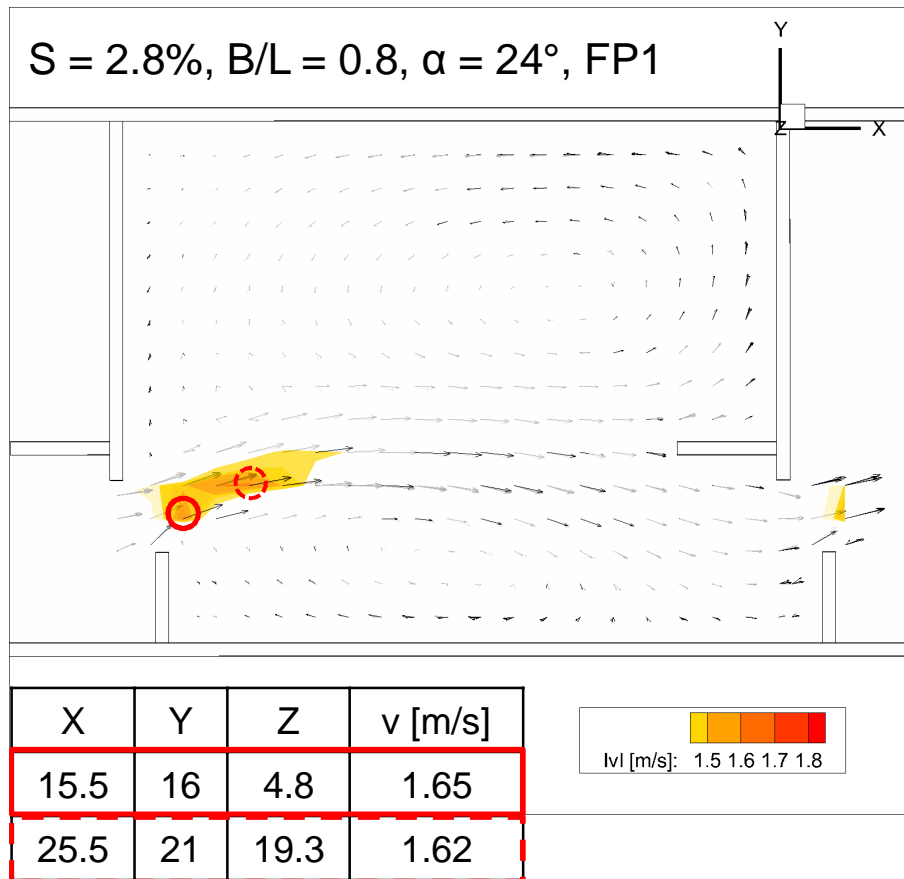


FP1; Transition; FP2

# Results - Velocities



# Results - Maximum velocities

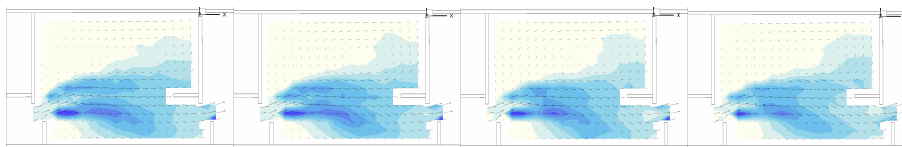
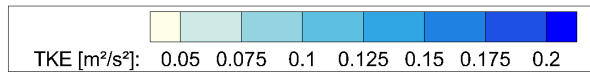
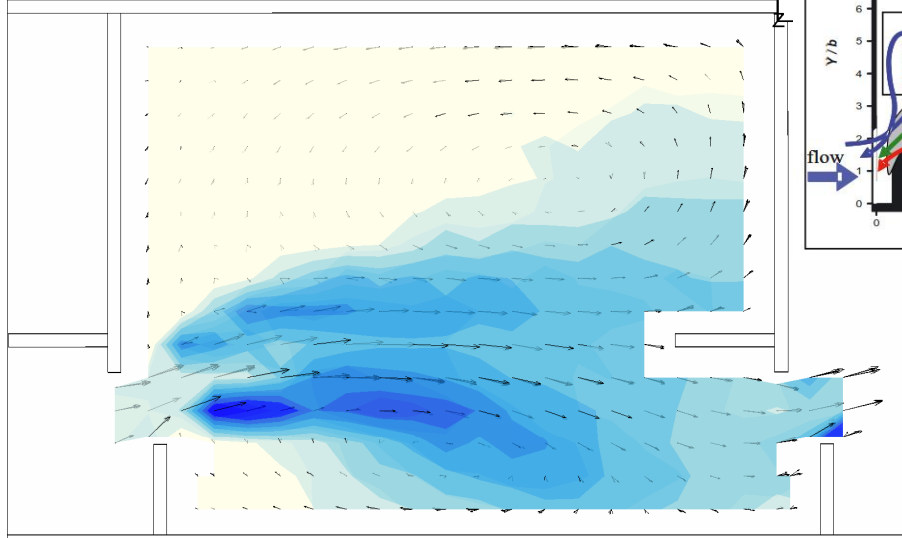


■  $\Delta h = 0.105 \text{ cm}$

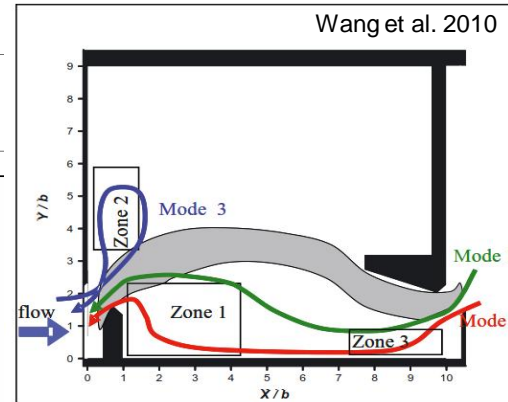
■  $v_{\max} = \sqrt{2g\Delta h} = 1.44 \text{ m/s}$

# Results - TKE

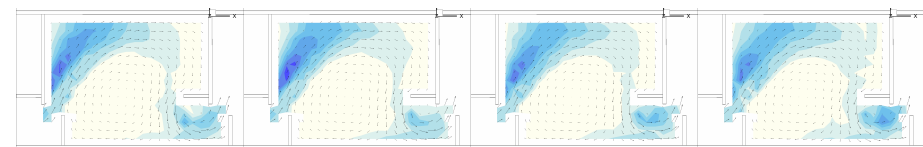
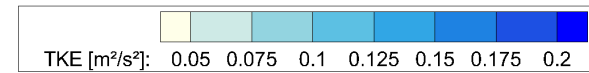
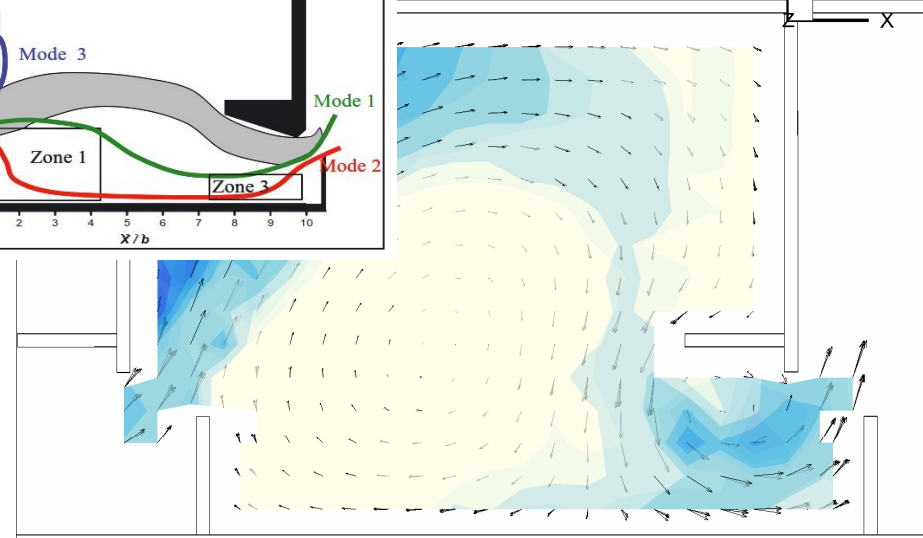
$S = 2.8\%$ ,  $B/L = 0.8$ ,  $\alpha = 24^\circ$ , FP1



→ Z



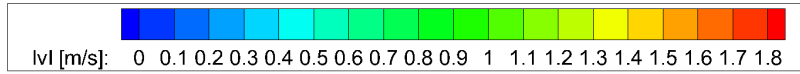
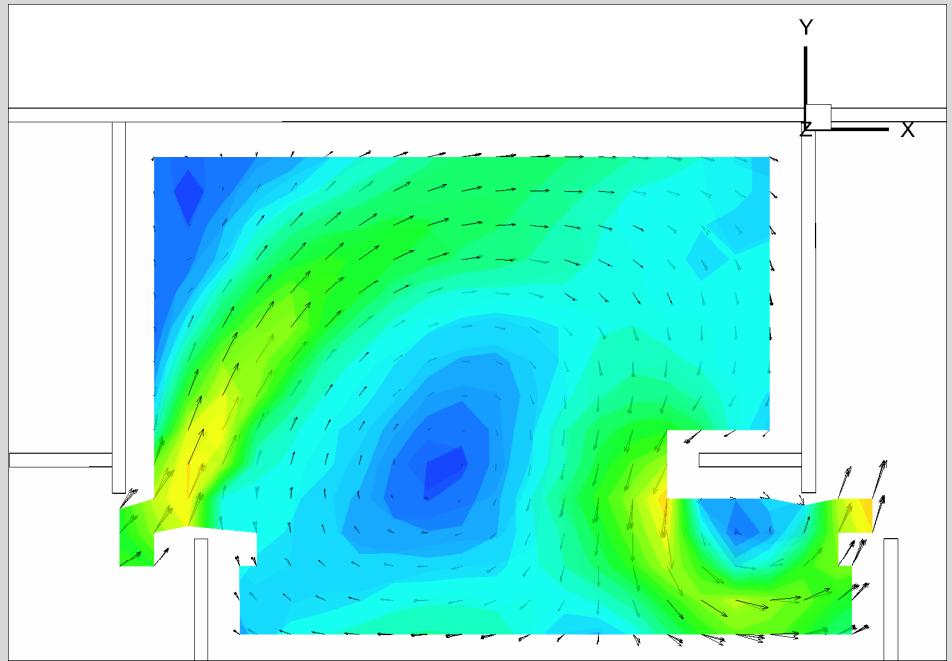
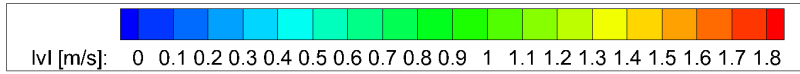
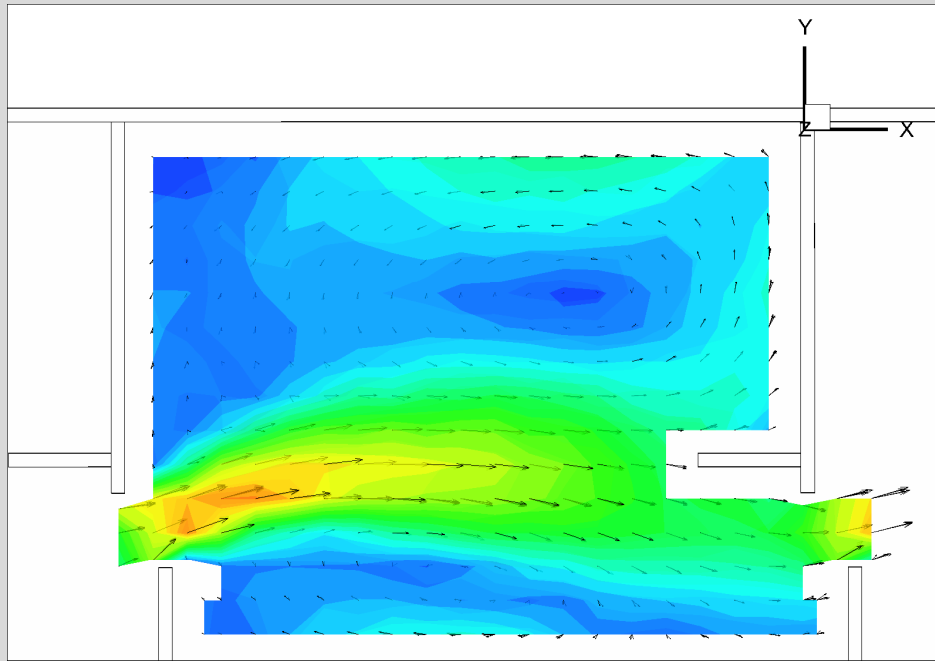
$S = 3\%$ ,  $\alpha = 56^\circ$ , FP2



→ Z

## Conclusions and Outlook

- flow patterns can vary for identical slope and B/L
- more geometrical parameters influence the flow patterns
- angle of slot  $\alpha$  is an important parameter
- $v_{\max}$  at FP1 is  $\sim 15\%$  larger than at FP2
- maximum velocities are allocated about whole depth
- at FP2:  $v_{\max}$  is  $\sim \sqrt{2g\Delta h}$
- more, selected variants will be studied by ADV measurements



**Thank you for your attention.**