



Physical modelling of sediment transport in mountain torrents upstream of open check dams



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Check dam in the region of Trent (Italy)

Paper Code: EGU2015-6166
14/04/2015 Programme Session GM7.1



OVERVIEW

- ▶ RESEARCH BACKGROUND
- ▶ CASE STUDIES
- ▶ MODEL DESIGN
- ▶ MEASURING SYSTEM
- ▶ EVALUATION TARGET



Research background

- **Sediment and habitat dynamics (Wasserbau & Ökologie)**
 - » funding: Swiss Federal Office for the Environment (FOEN)

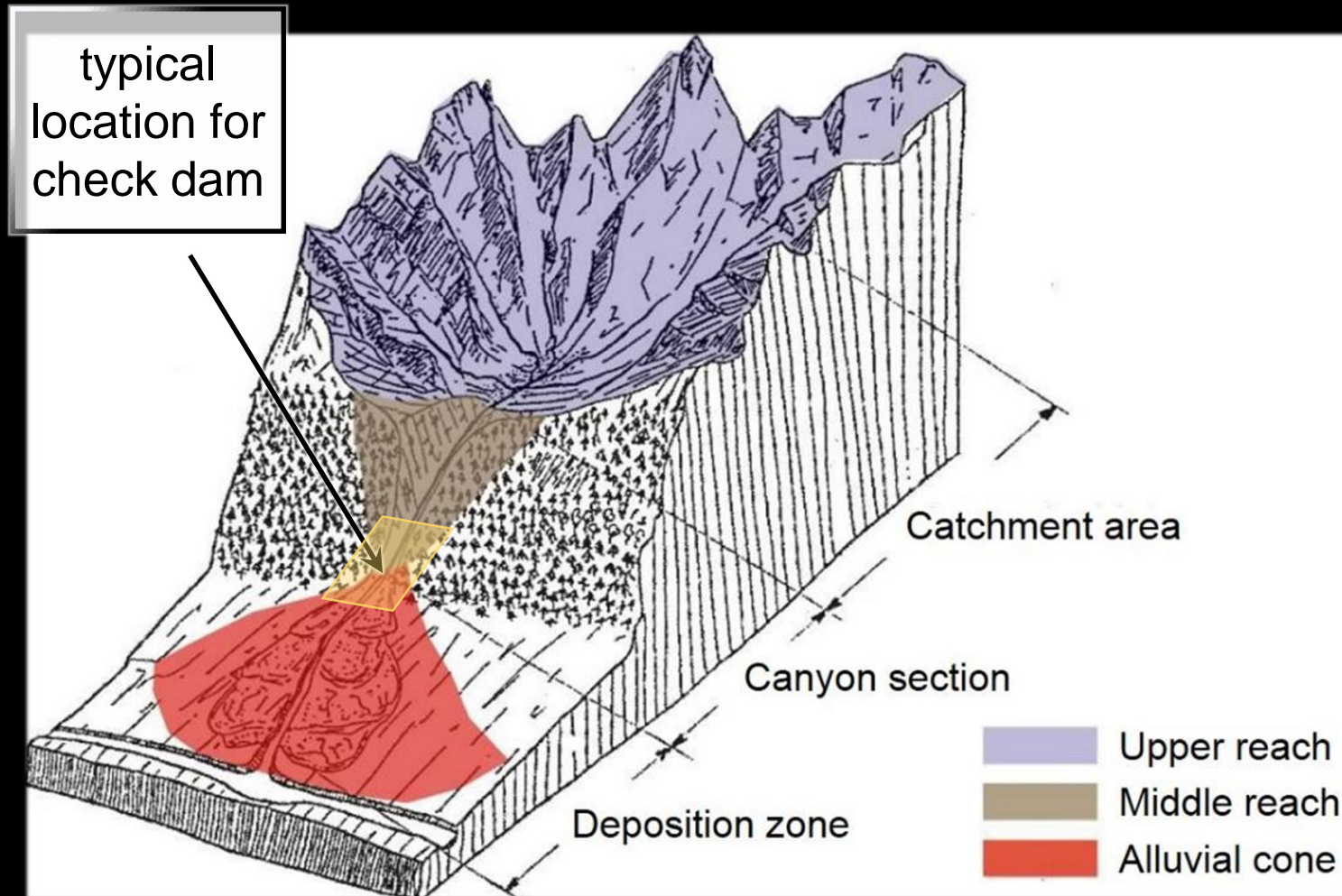


Promotion of sediment continuity

- » conditioned sediment retention in upstream reaches
- » avoid sediment scarcity in draining channels

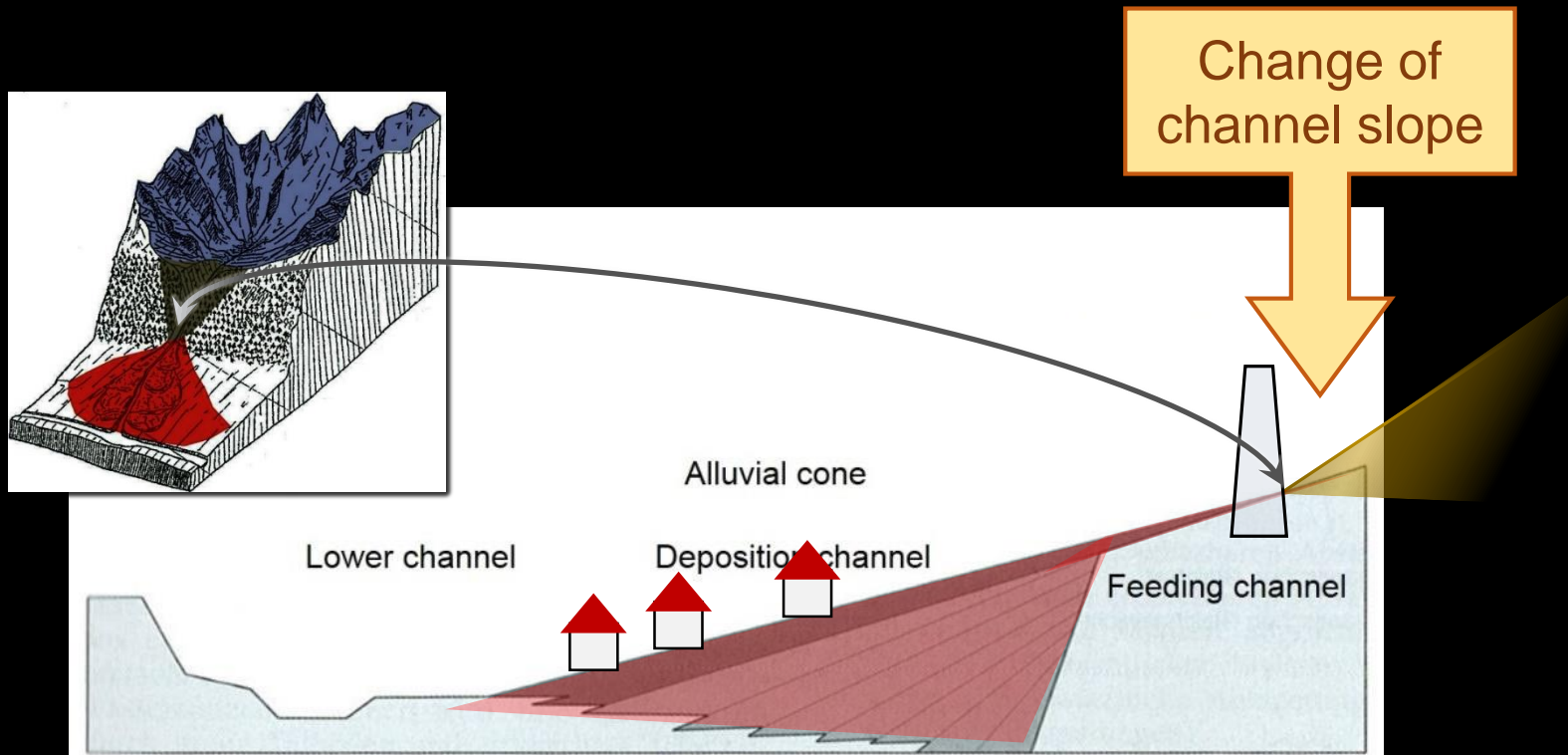


Situation in the terrain (1)



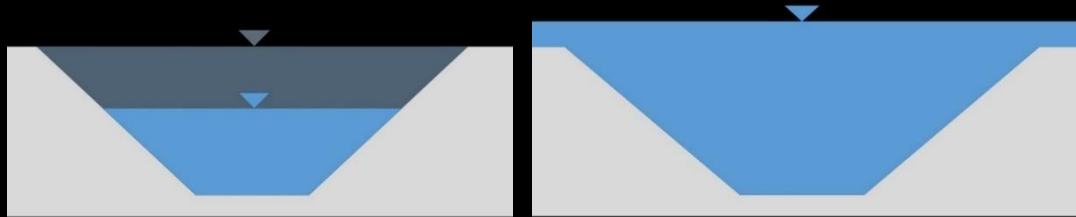
Situation in the terrain (2)

- At channel slope change: varying sediment transport capacity



Hydraulic aspects

- ▶ Floods and sediments are crucial for river ecology
- ▶ Large floods threaten infrastructures



- ▶ Challenge: Design flood protection which
 - » provides sufficient safety for dwellers
 - » allows dynamic river development



- ➡ optimization of open check dams in terms of sediment transport continuity is required
- or
- ➡ what impact on sediment transport have flow obstacles in steep gravel bed rivers?



Research approach

- ▶ Physical model most suitable
- ▶ Model design based on case studies of torrents and open check dams in the Alps

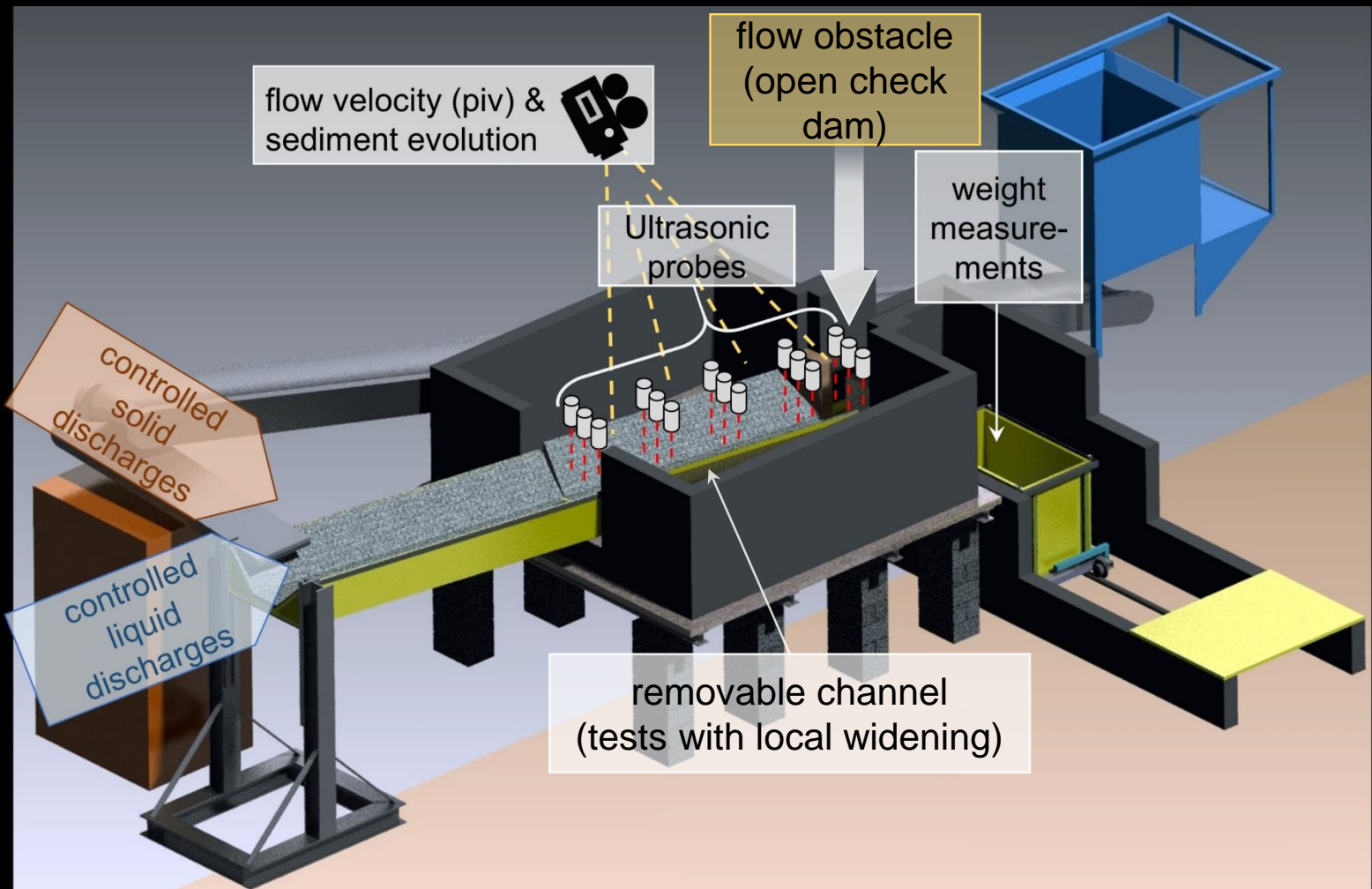


- ▶ No specific scale, but assures practical relevance
 - » length ratios
 - » similarity of sediment transport





MODEL DESIGN



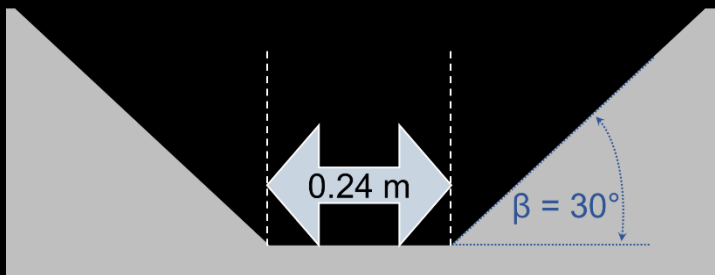
Design aspects – Channel

► Roughness

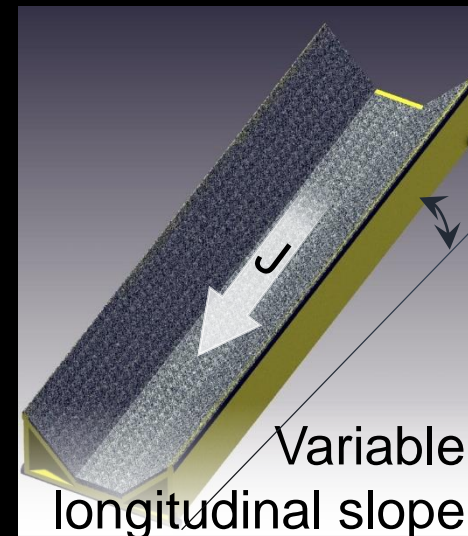
- » channel bed composed of grains $> D_{84}$ of mobile sediment



► Geometry

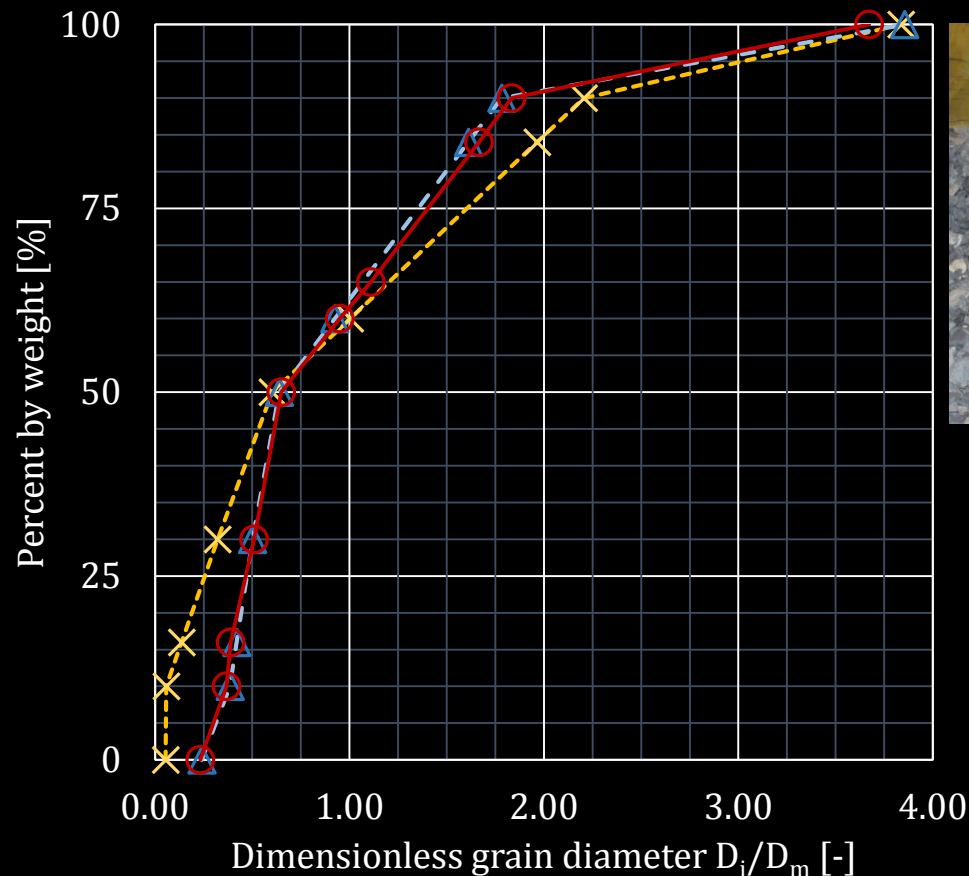


- » $J = 2 / 4 / 6 \%$



Design aspects – Sediment feeding

- Used sediment mixture based on dimensionless curve for Alpine rivers established by Hersberger (2003)

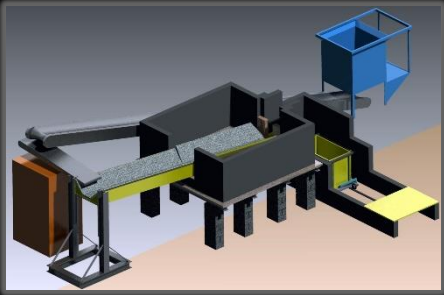


- x-- Alps (own study)
- △-- Alps (Hersberger, 2003)
- Used mixture



Design aspects – Sediment feeding

- Supply system: Release container + conveyor belts



Sediment output

- Measurement system: filter basket + scale
suspended with a mobile crane



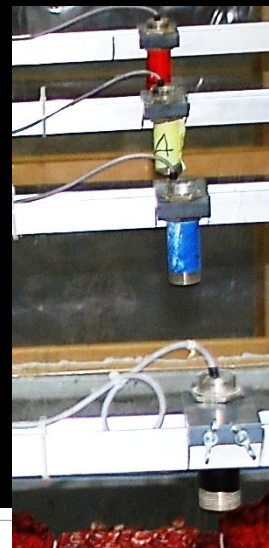
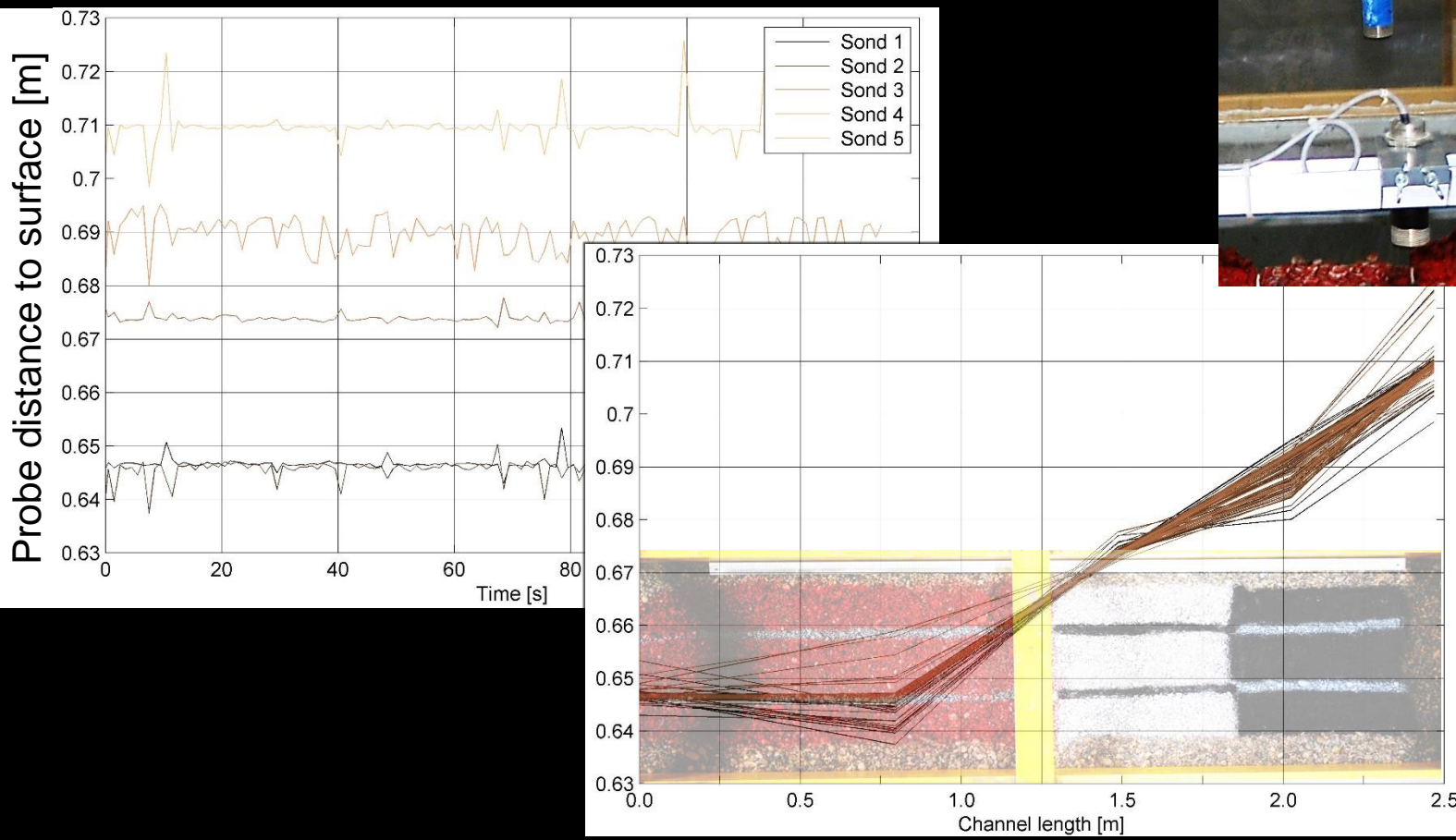
wireless data
transfer [1/s]





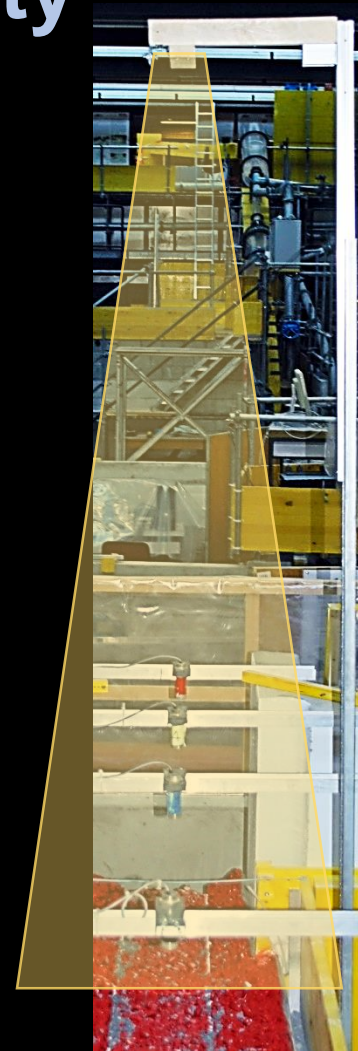
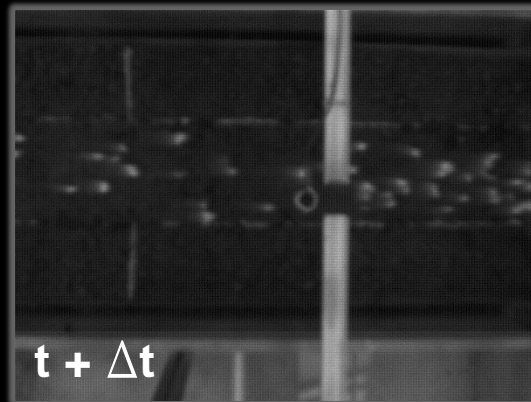
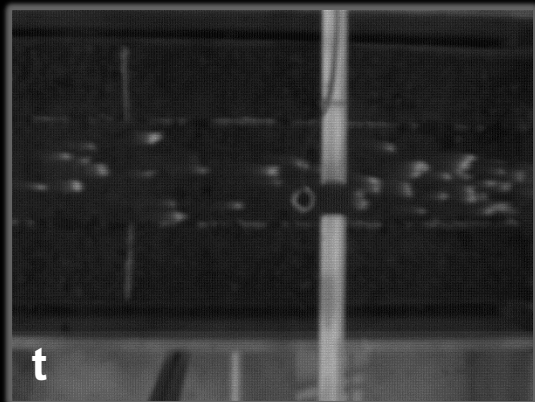
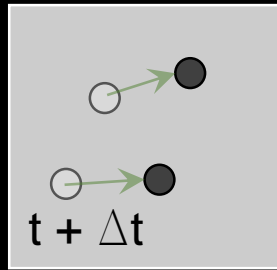
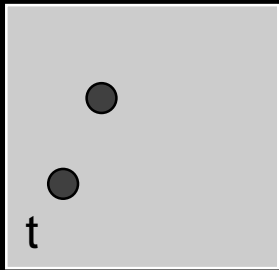
Water level recording

► Ultrasonic probes



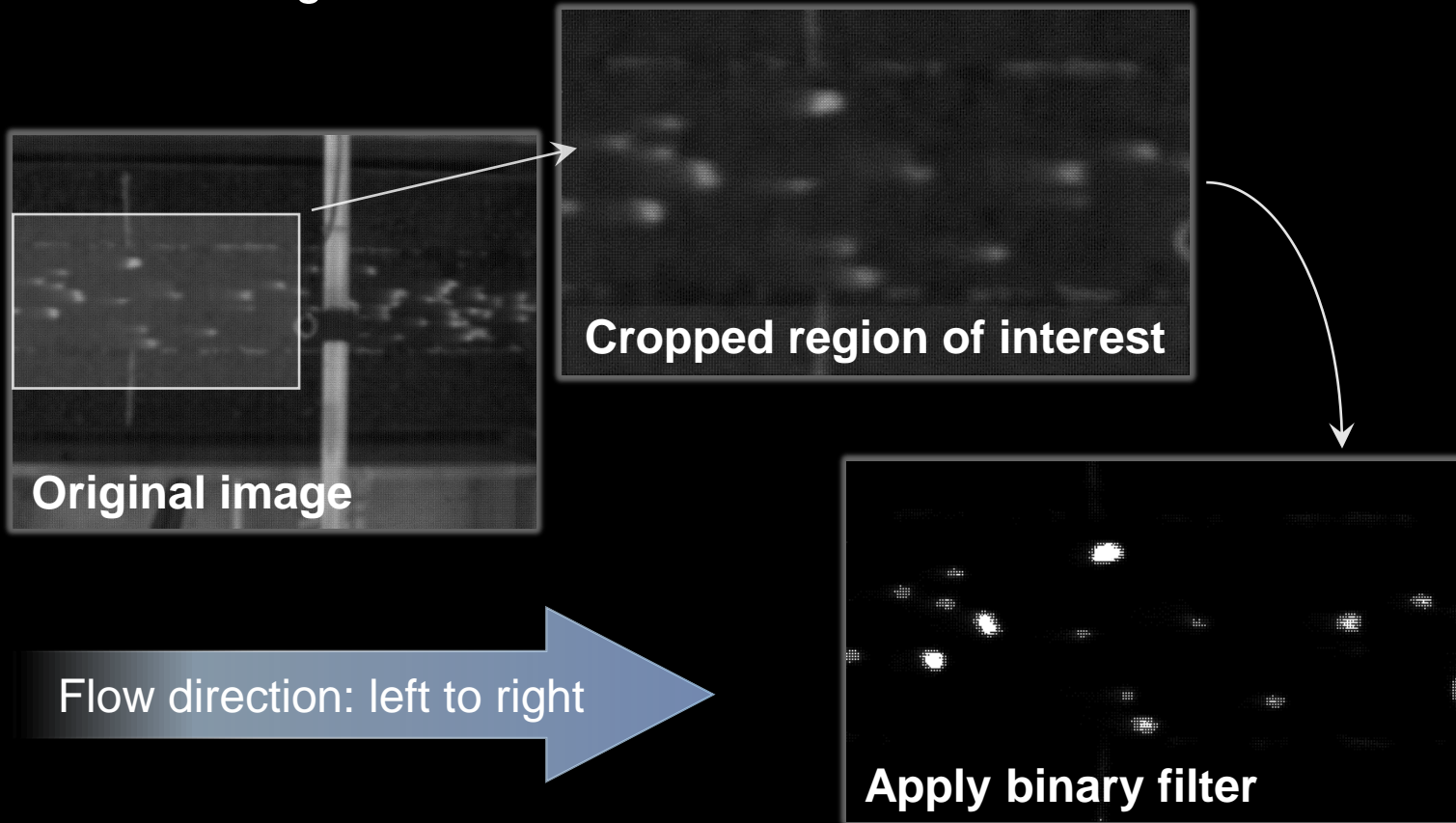
Surface flow velocity

- Particle image velocimetry
 - » industrial CMOS camera (SMX-160C)
 - » wide lens opening (1.4-1.8)



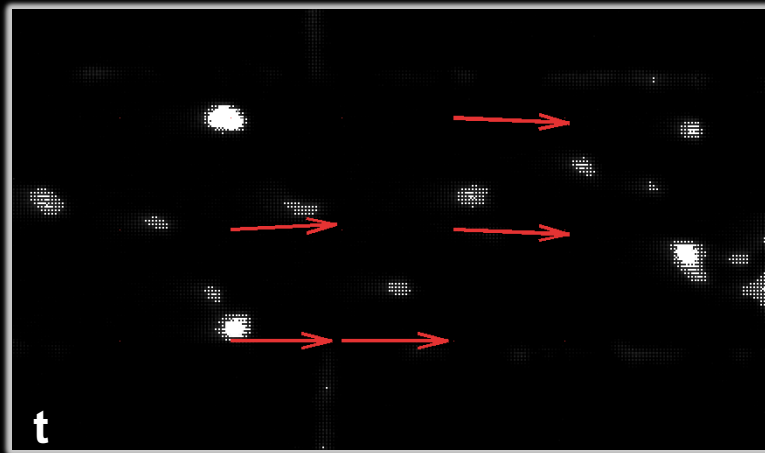
Surface flow velocity

- ▶ Particle image velocimetry
 - » image abstraction

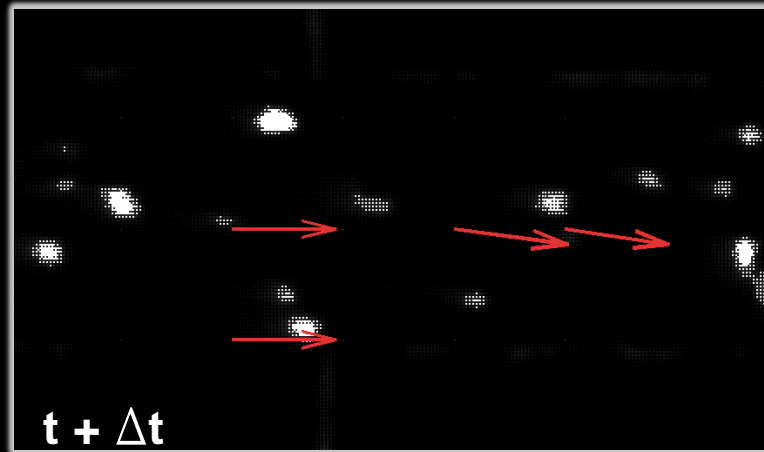


Surface flow velocity

- ▶ Particle image velocimetry
 - » identification of particle movement

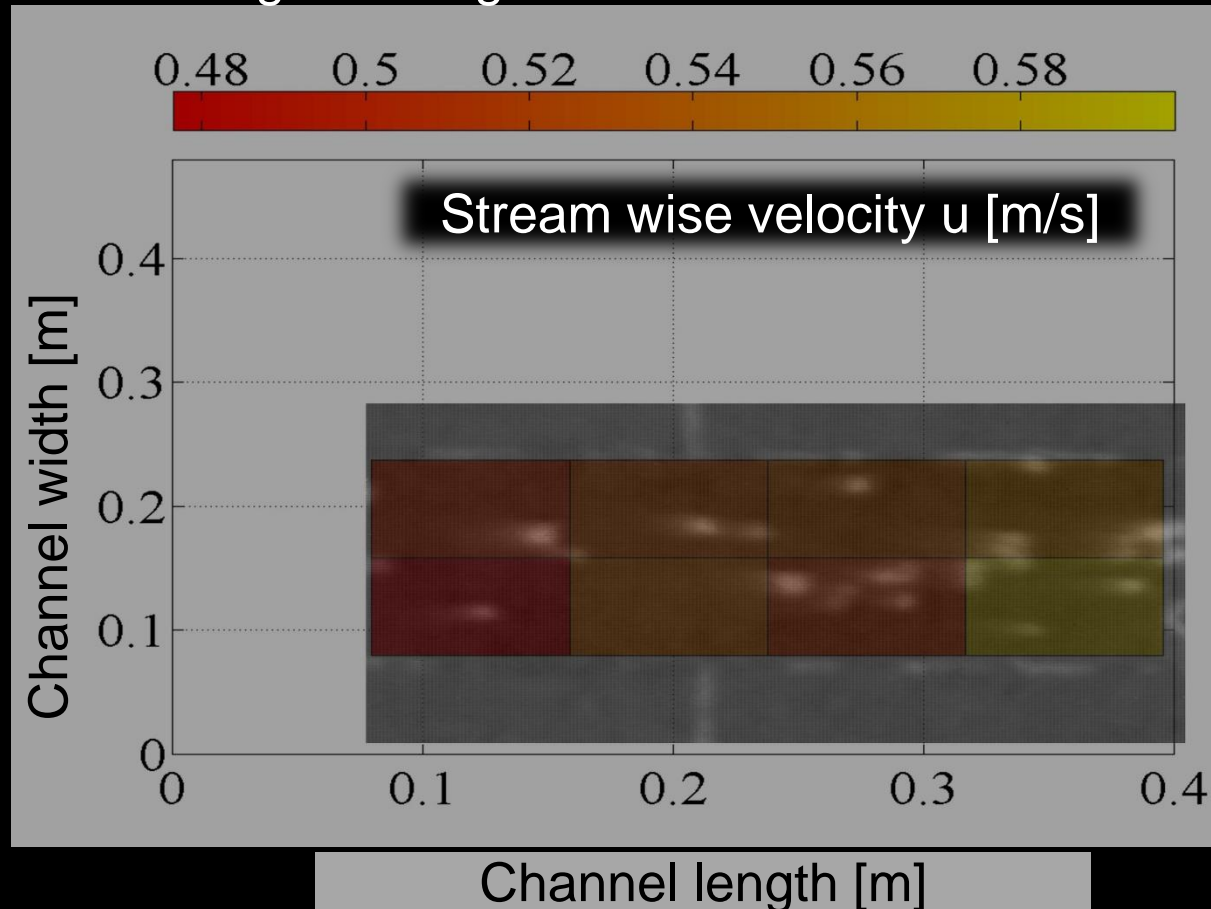


Flow direction: left to right



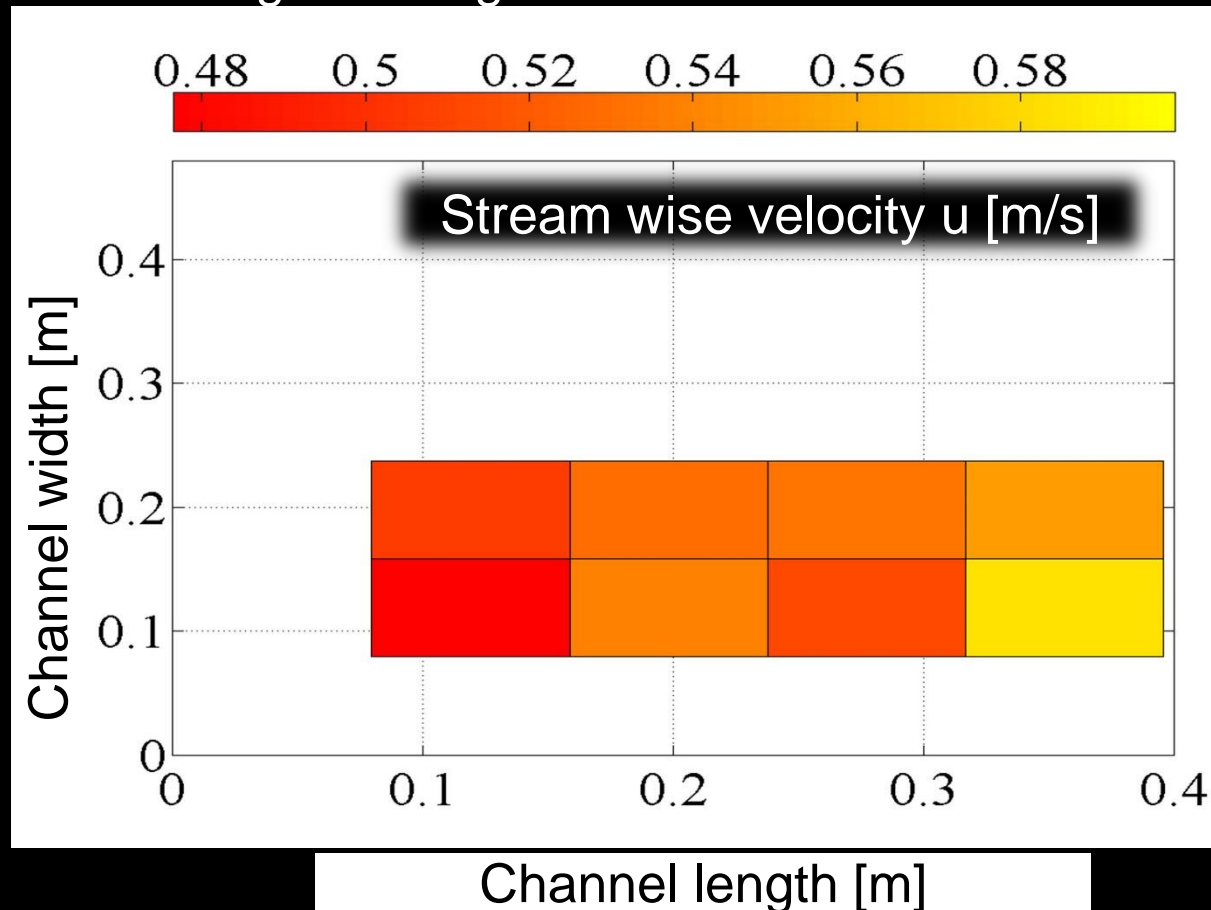
Surface flow velocity

- Particle image velocimetry
 - » time average of image series



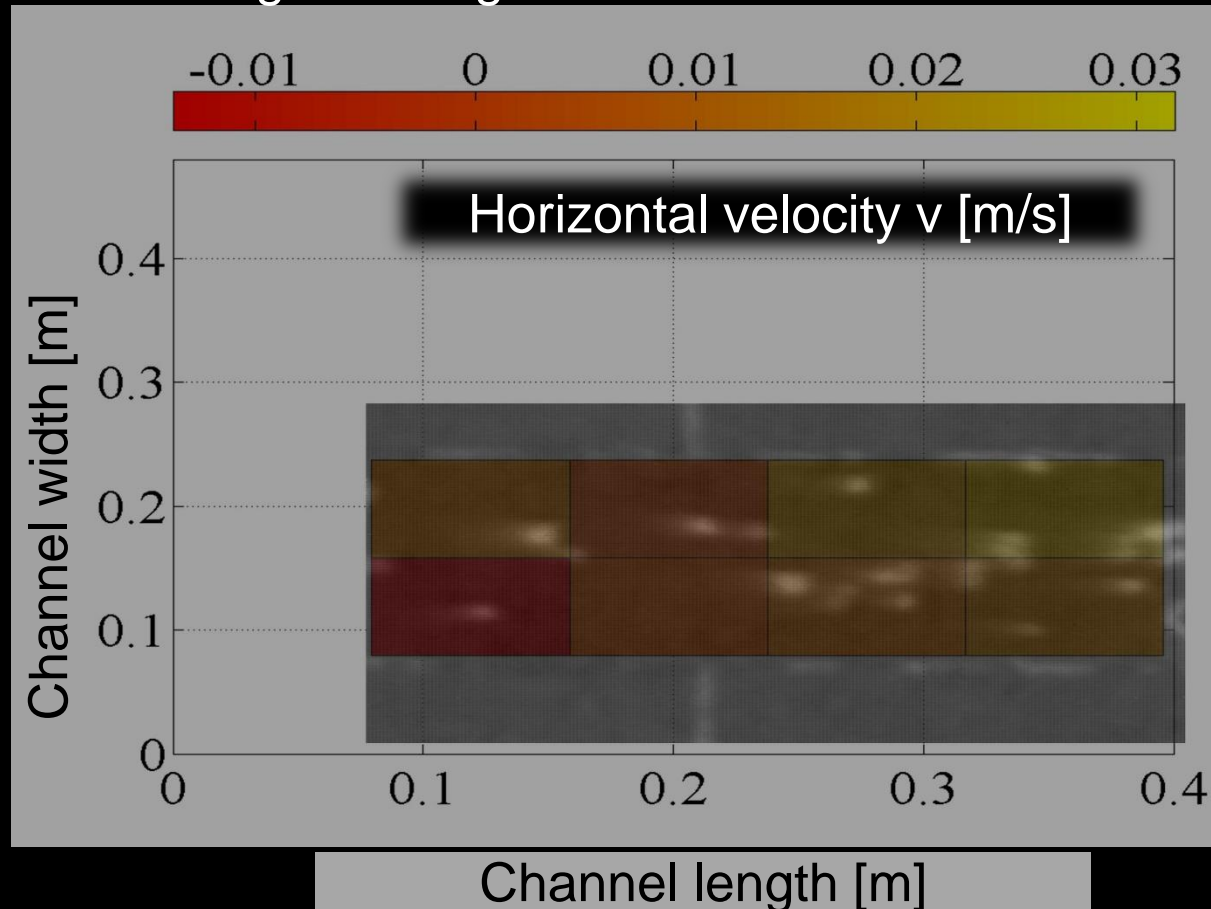
Surface flow velocity

- ▶ Particle image velocimetry
 - » time average of image series



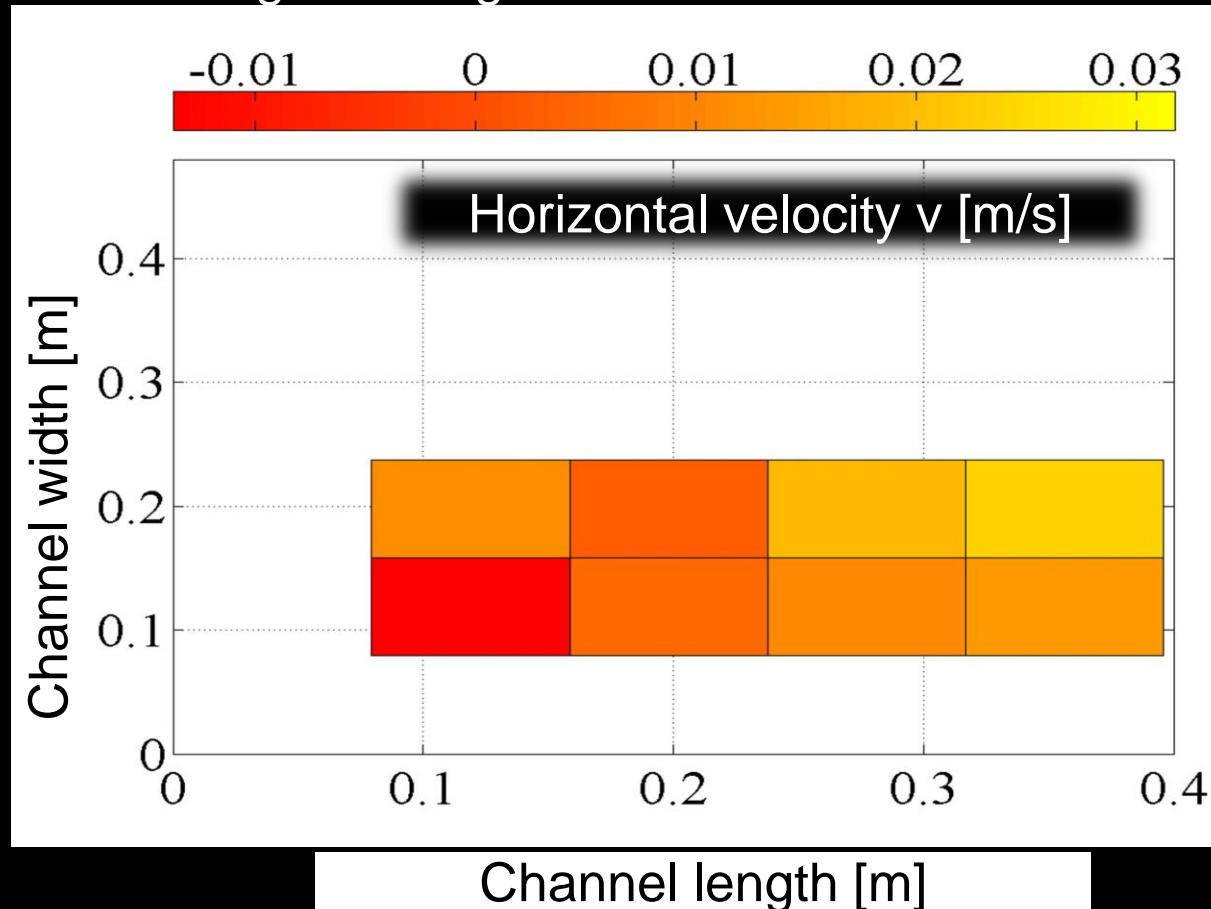
Surface flow velocity

- Particle image velocimetry
 - » time average of image series



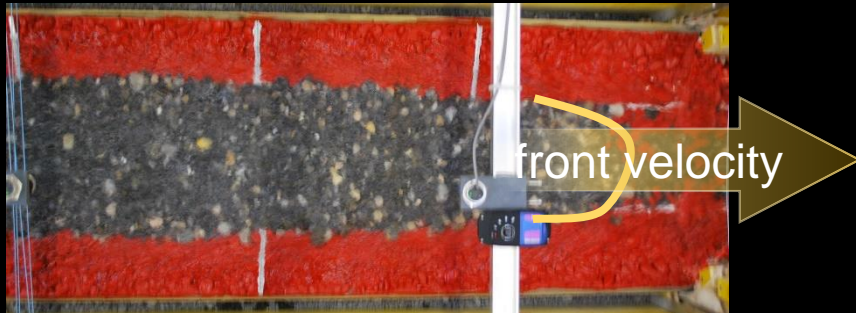
Surface flow velocity

- ▶ Particle image velocimetry
 - » time average of image series



Sediment depositions

- Zenithal photography
 - » same principal as for flow velocity
 - » different time resolution (4 frames per minute)

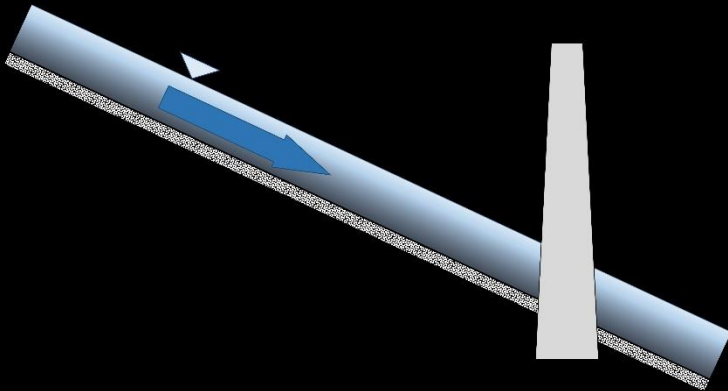


Evaluation target

- ▶ Derivation of flow energy balance + energy losses ...
- ▶ Derivation of transport capacity ...

... along the whole channel ...

... across obstacles (i.e. open check dam) ...






Acknowledgements...

... to the Swiss Federal Office for
the Environment (project funding)

 Schweizerische Eidgenossenschaft Confédération suisse Confederazione Svizzera Confederaziun svizra	Federal Office for the Environment FOEN
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Partners:



Swiss federal institute
for forest, snow and
landscape research


Swiss federal institute of
aquatic science and technology


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Thank you for your attention.

Questions?

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