Application of a videometric measurement system to investigate spatial dike breach

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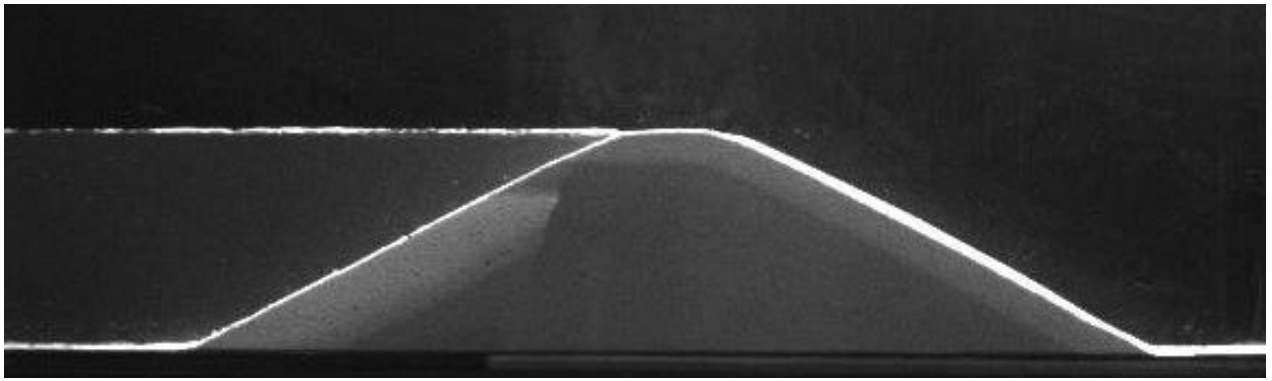
Contents

1. Problem and goal

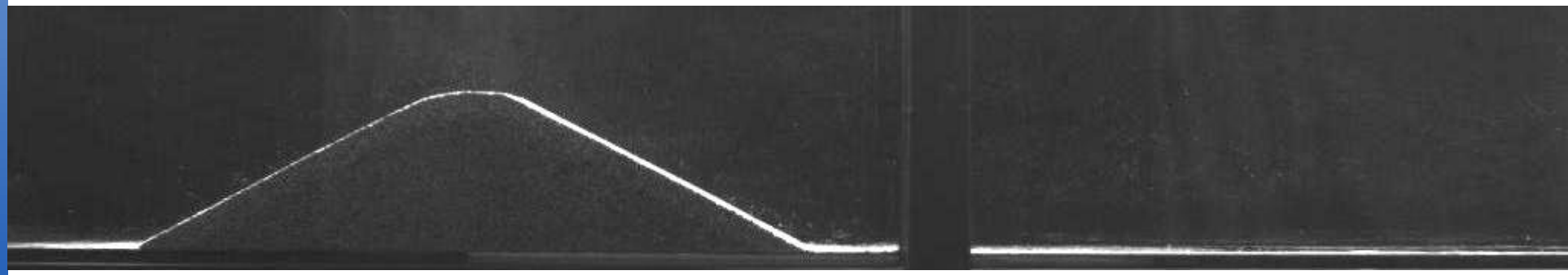
2D breach test

- Simple trapezoidal model dike
- Homogenous, non-cohesive sand or gravel
- Neither surface layer, nor core
- Steady discharge, falling reservoir level
- Plane erosion



1. Problem and goal

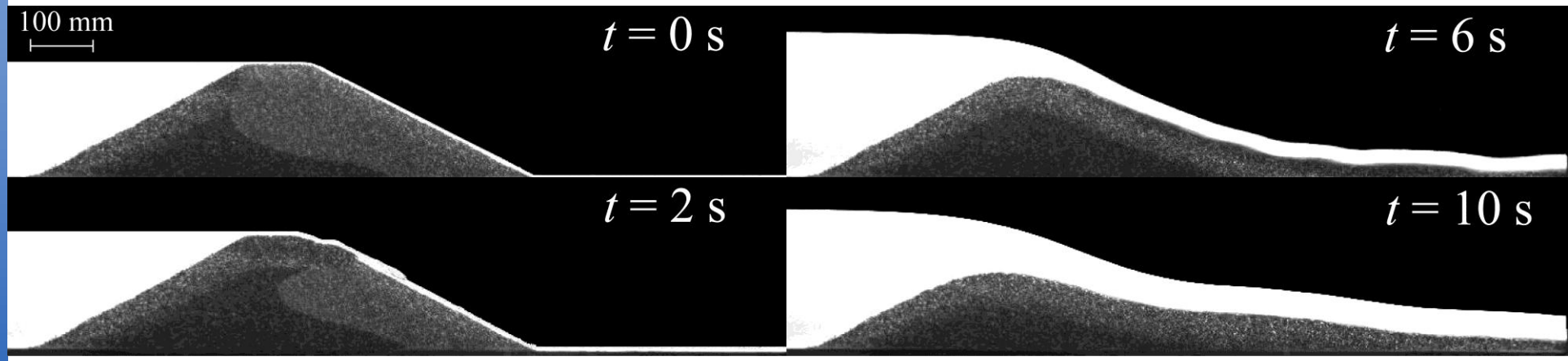
2D breach test



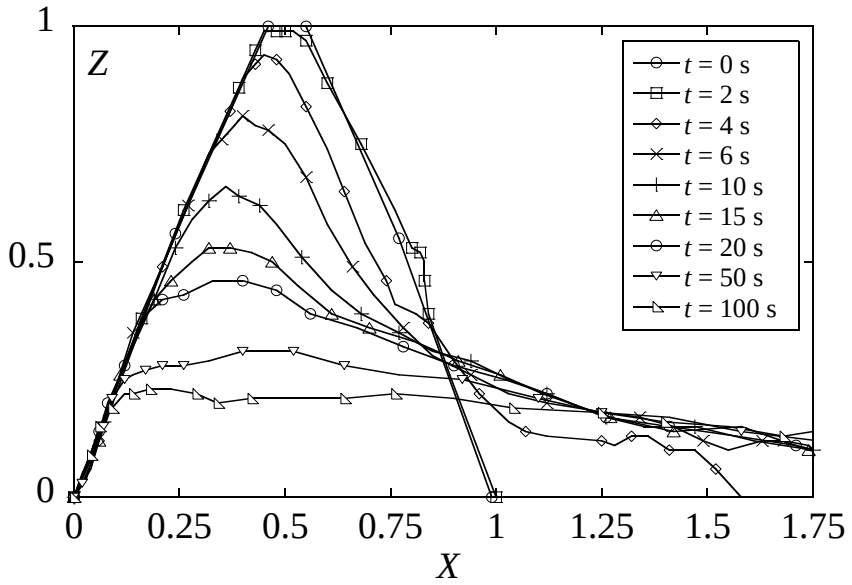
Q_o = 6 l/s, w = 0.20 m, b = 0.20 m, d = 2 mm, S_o = 1:2

1. Problem and goal

2D breach test

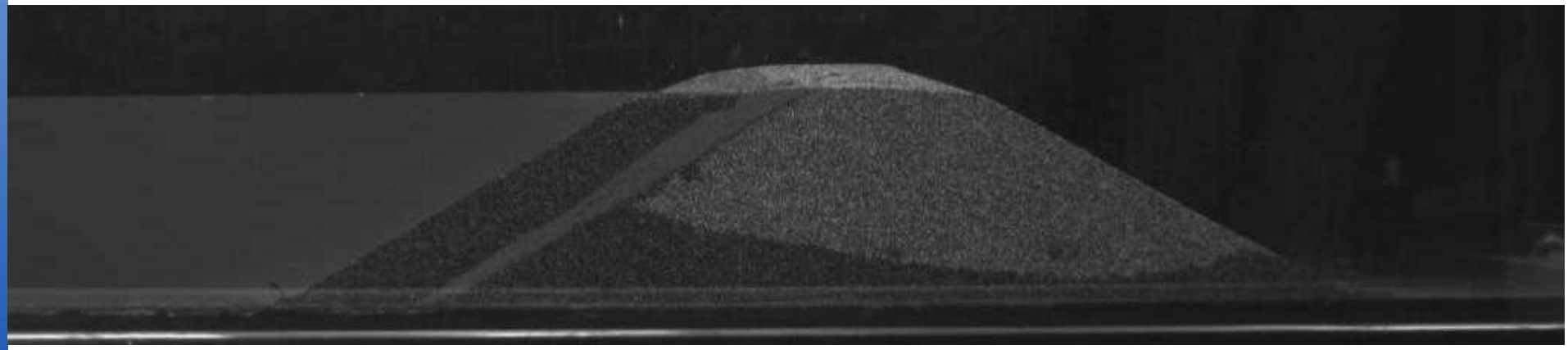


Breach profiles



1. Problem and goal

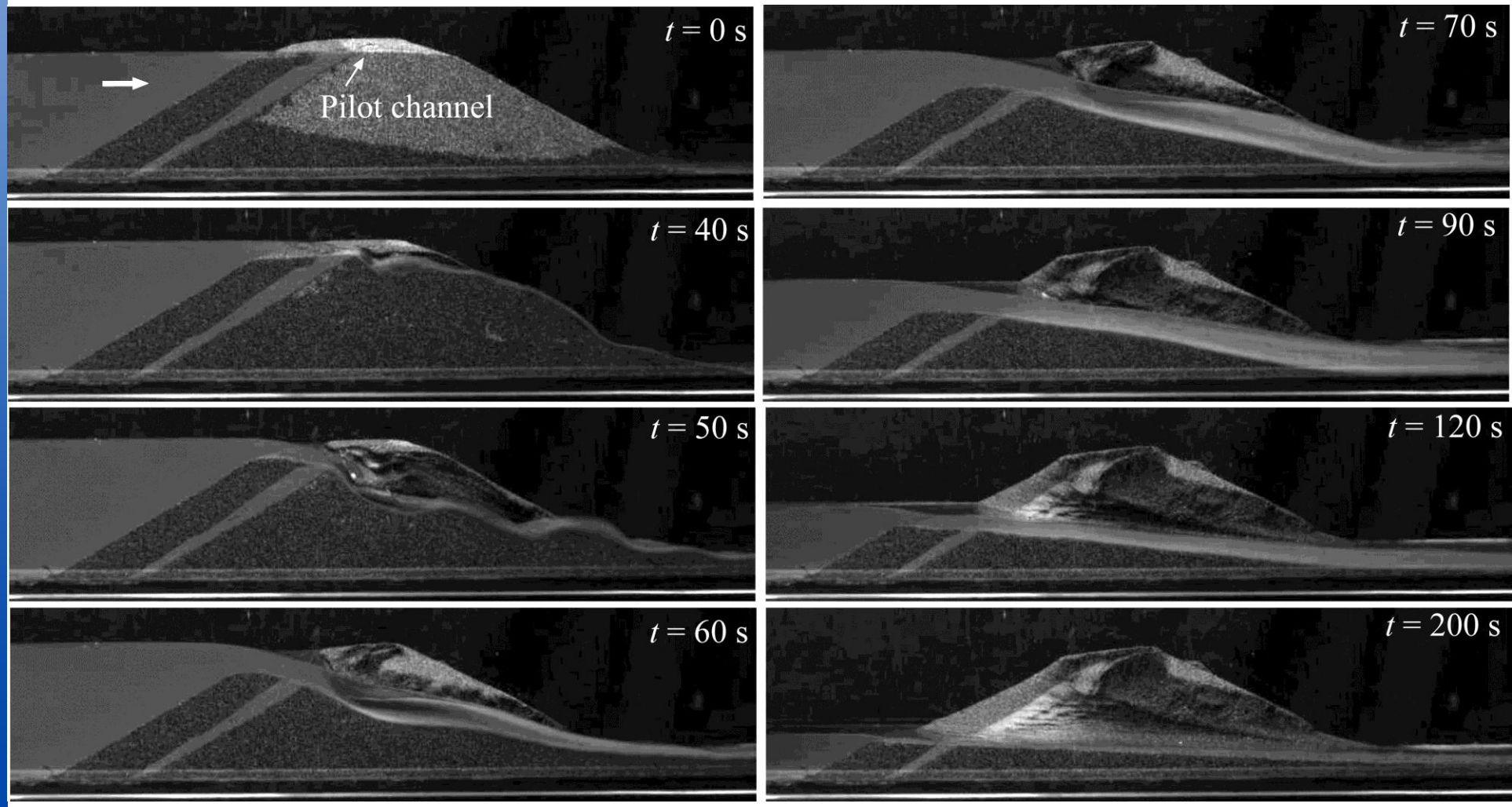
3D breach test



w = 0.20 m, b = 0.40 m, d = 2 mm, S_o = 1:2

1. Problem and goal

3D breach test



1. Problem and goal

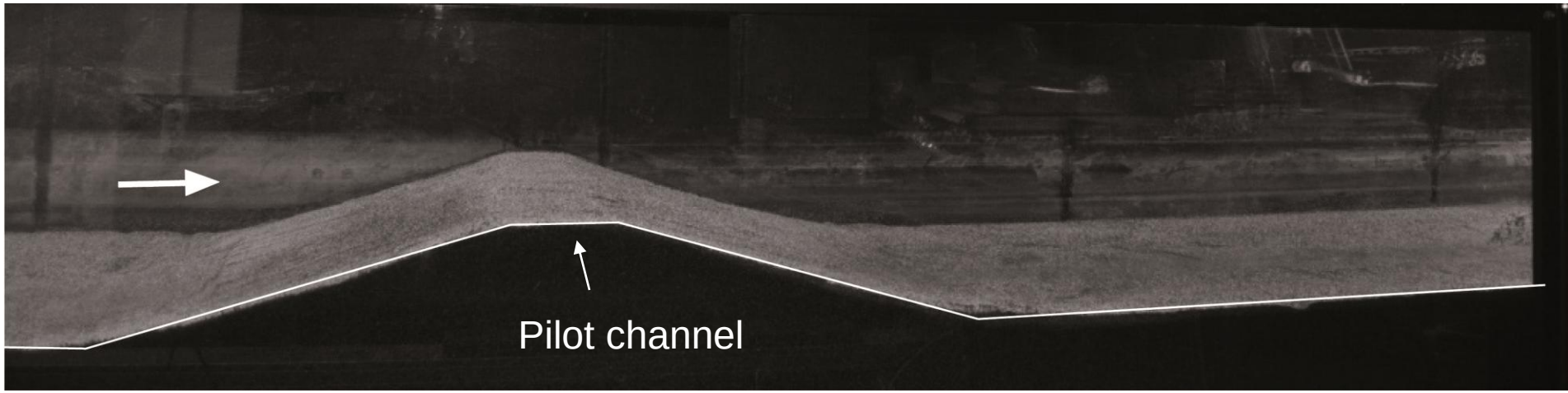
3D breach test

- Determination through channel side wall not possible
- Intrusive measurements influence the breach process

- Coleman et al. (2002): Reservoir draining at several stages
- Pickert et al. (2004): Fringe projection
- Roszov (2003): Washout indicators

→ **Nonintrusive videometric measurement system (AICON)**

2. Hydraulic model



Dike width = 1.0 m

Dike height = 0.20 m

Movable bed

Sediment diameter = 1.13 mm

Slopes = 1:3

3. Videometric measurement system

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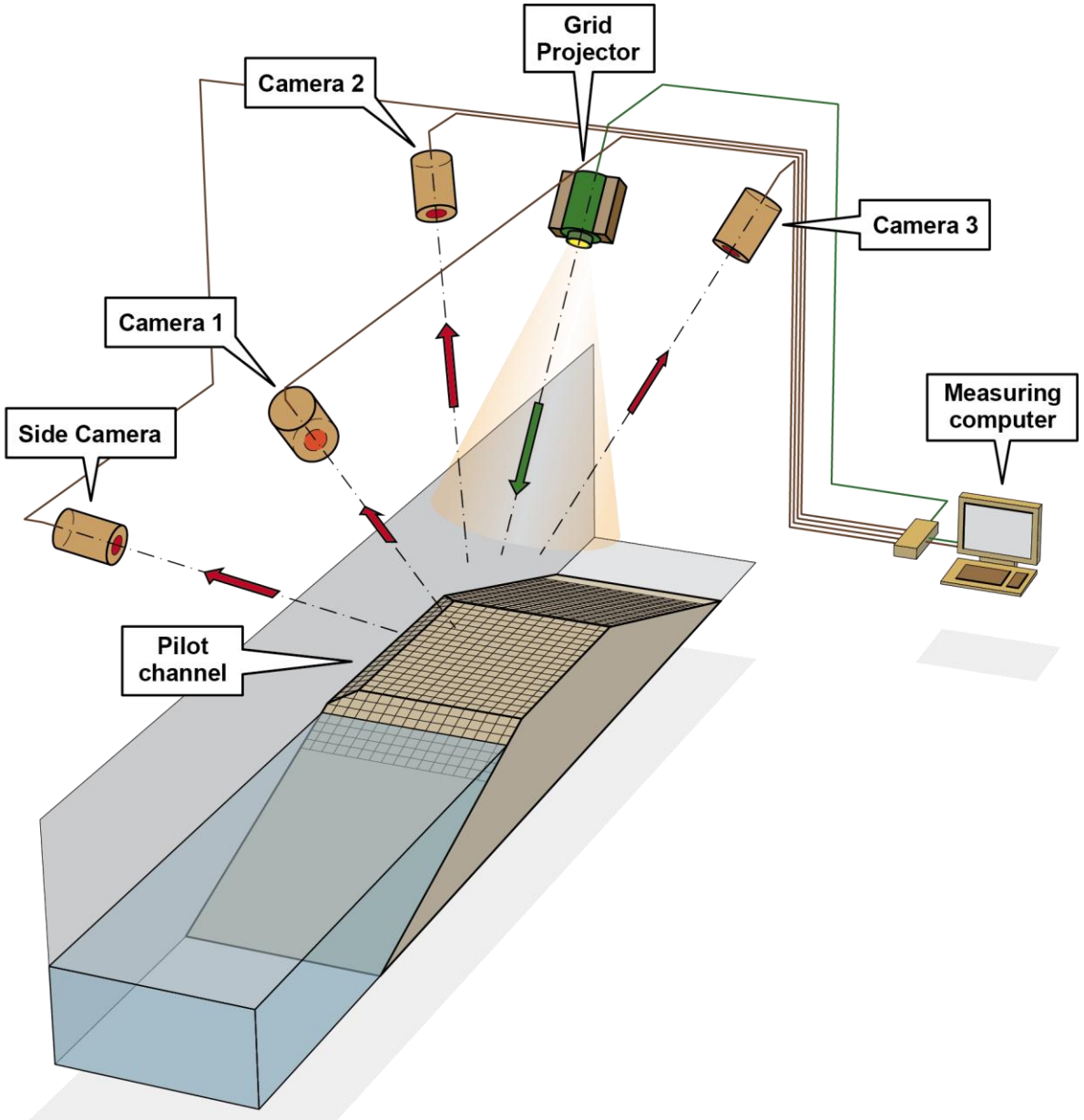
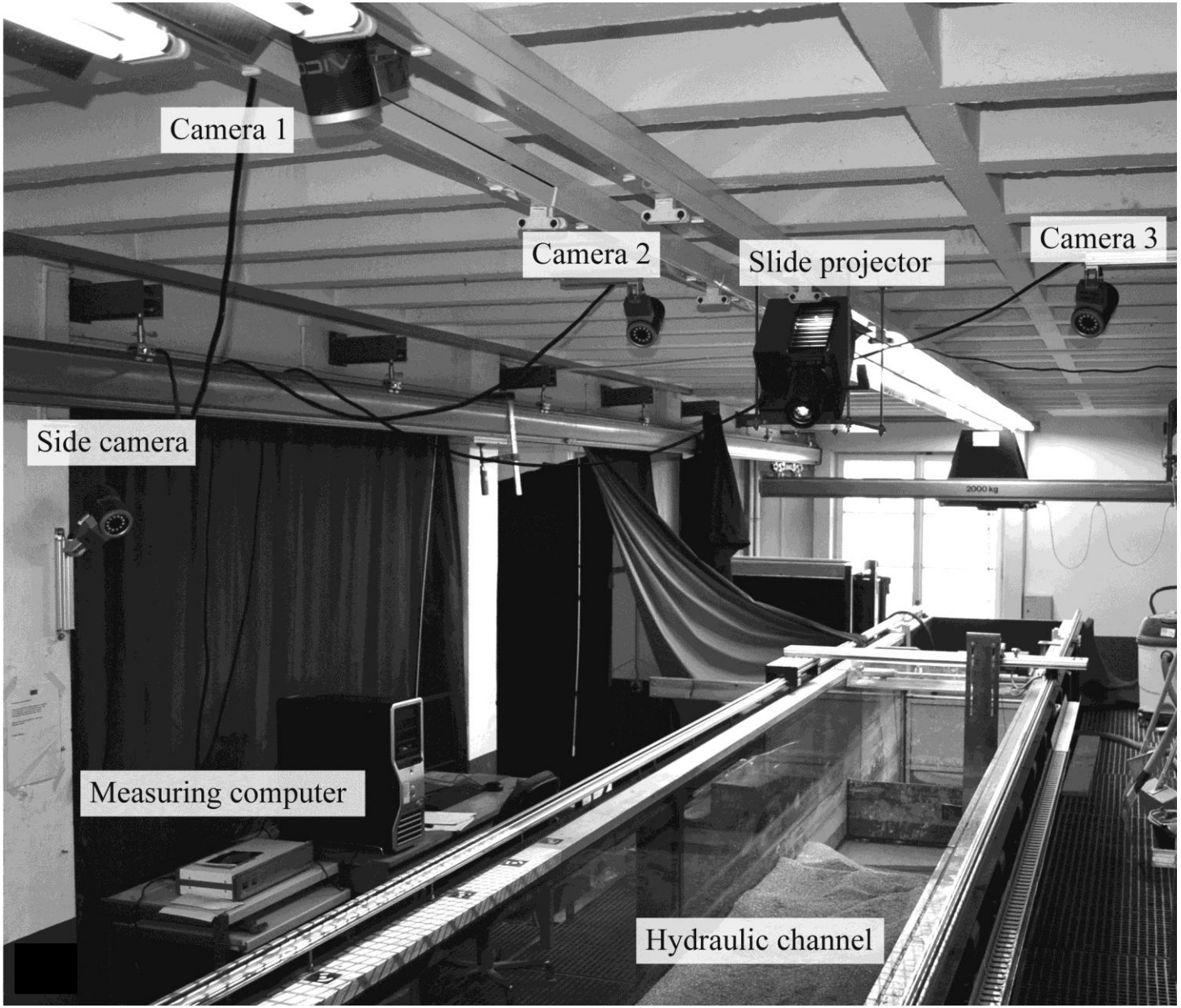
- Stereoscopic-videometric measurement system
- Developed for BAW, Karlsruhe
- Continuously measure bed structures through the water surface:
  - Constant flow depths
  - Small velocities
  - Slow changes in bed structure

→ **Apply to the spatial dike breach problem**

3. Videometric measurement system

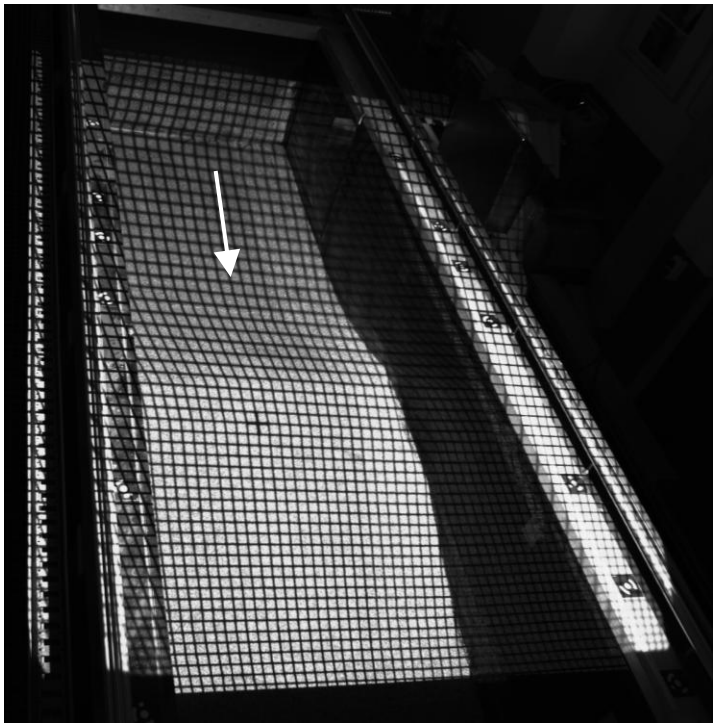


3. Videometric measurement system

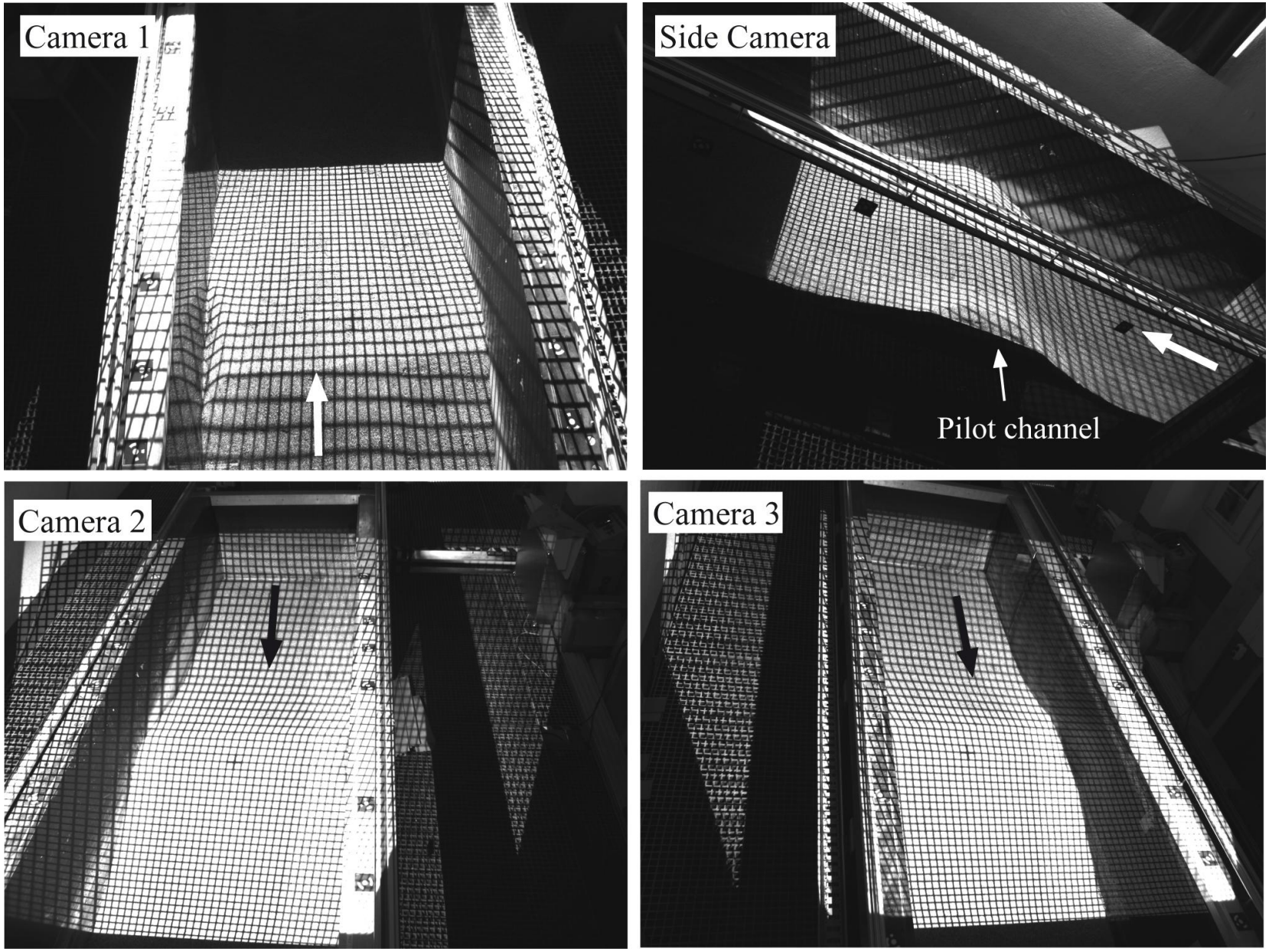


3. Videometric measurement system

- Projector projects a rectangular grid on the sediment surface
- Sediment surface reflects a distorted grid
- 3 synchronized CCD cameras record the grid, 1.3 Mio. Pixel, 15Hz
- 1 camera records the flow depth through the channel side wall



3. Videometric measurement system



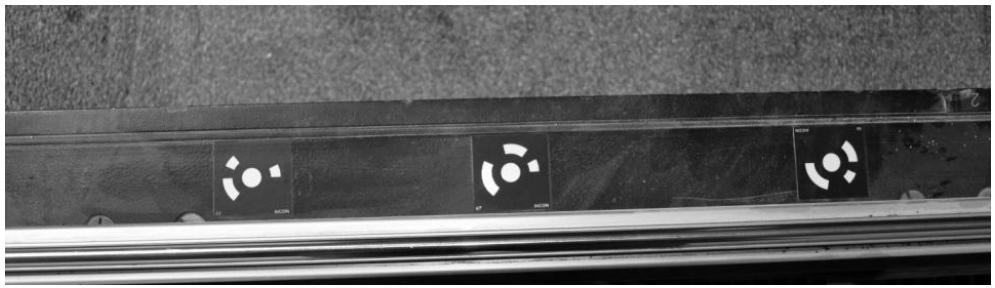
3. Videometric measurement system

Evaluation of images

- Determine flow depth from side camera to account for distortion
- Locate starting grid point in two images
- Grid points are automatically identified by AICON software
- Each grid point is assigned to 3D coordinates (Triangulation)

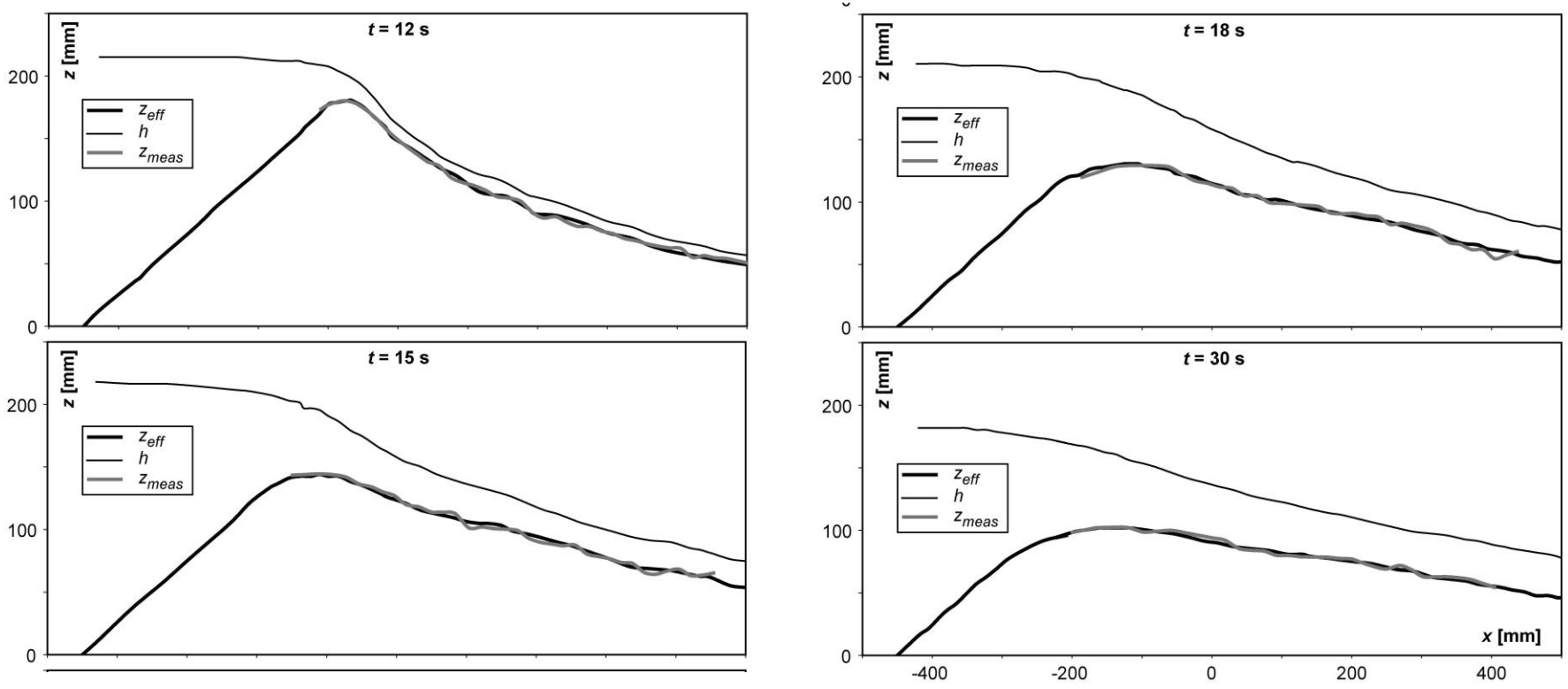
Orientation

- Camera orientation with calibration panel
- Channel orientation with coded marks



3. Videometric measurement system

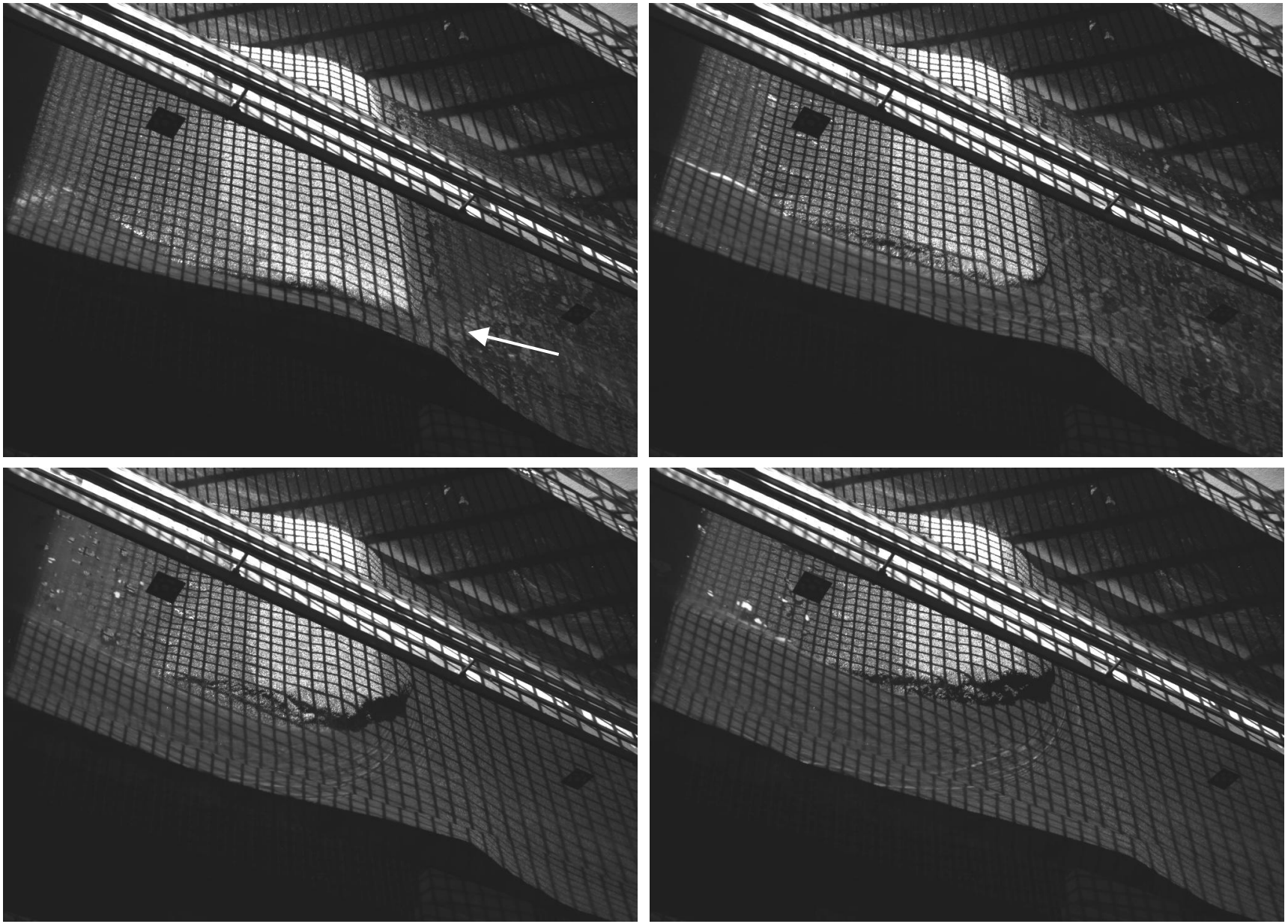
Measuring accuracy – 2D breach test



Z_{eff} = Side Camera

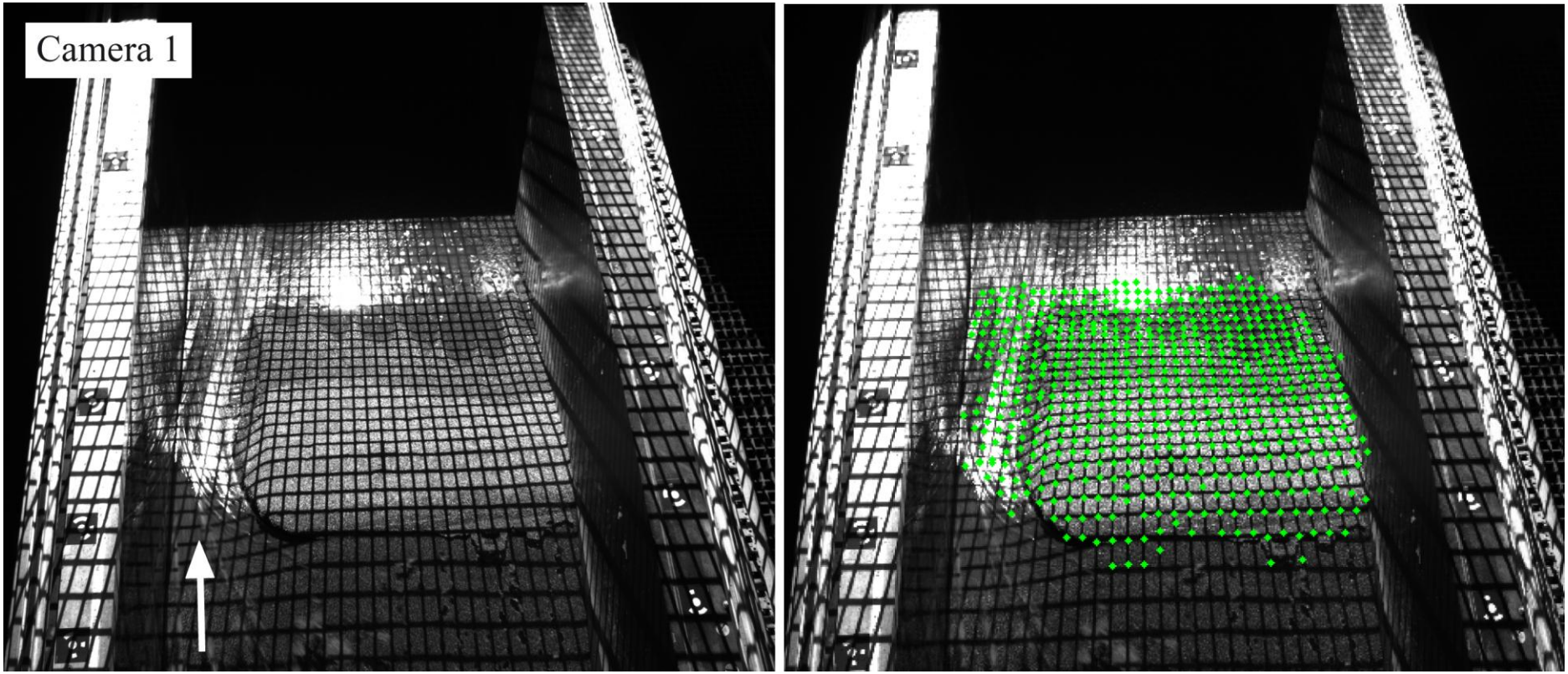
Z_{meas} = AICON

4. Results



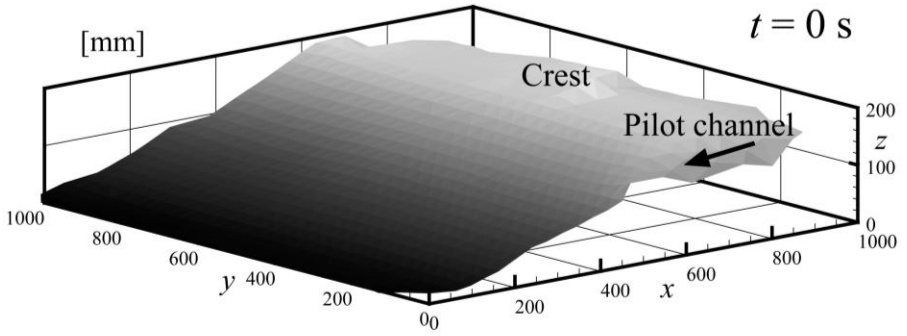
4. Results

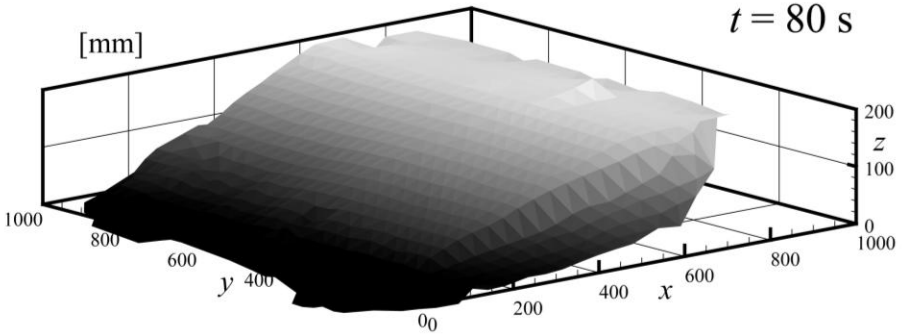
Evaluation of 3D coordinates

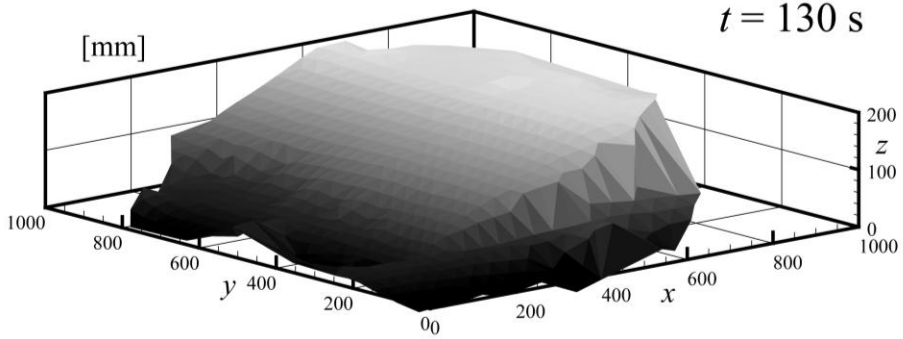


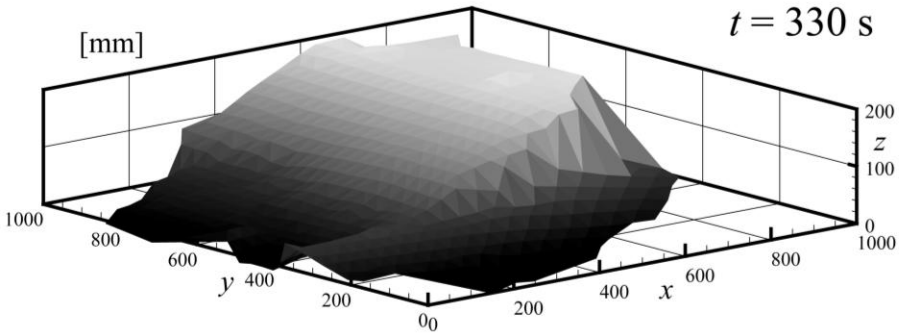
4. Results

3D breach profiles









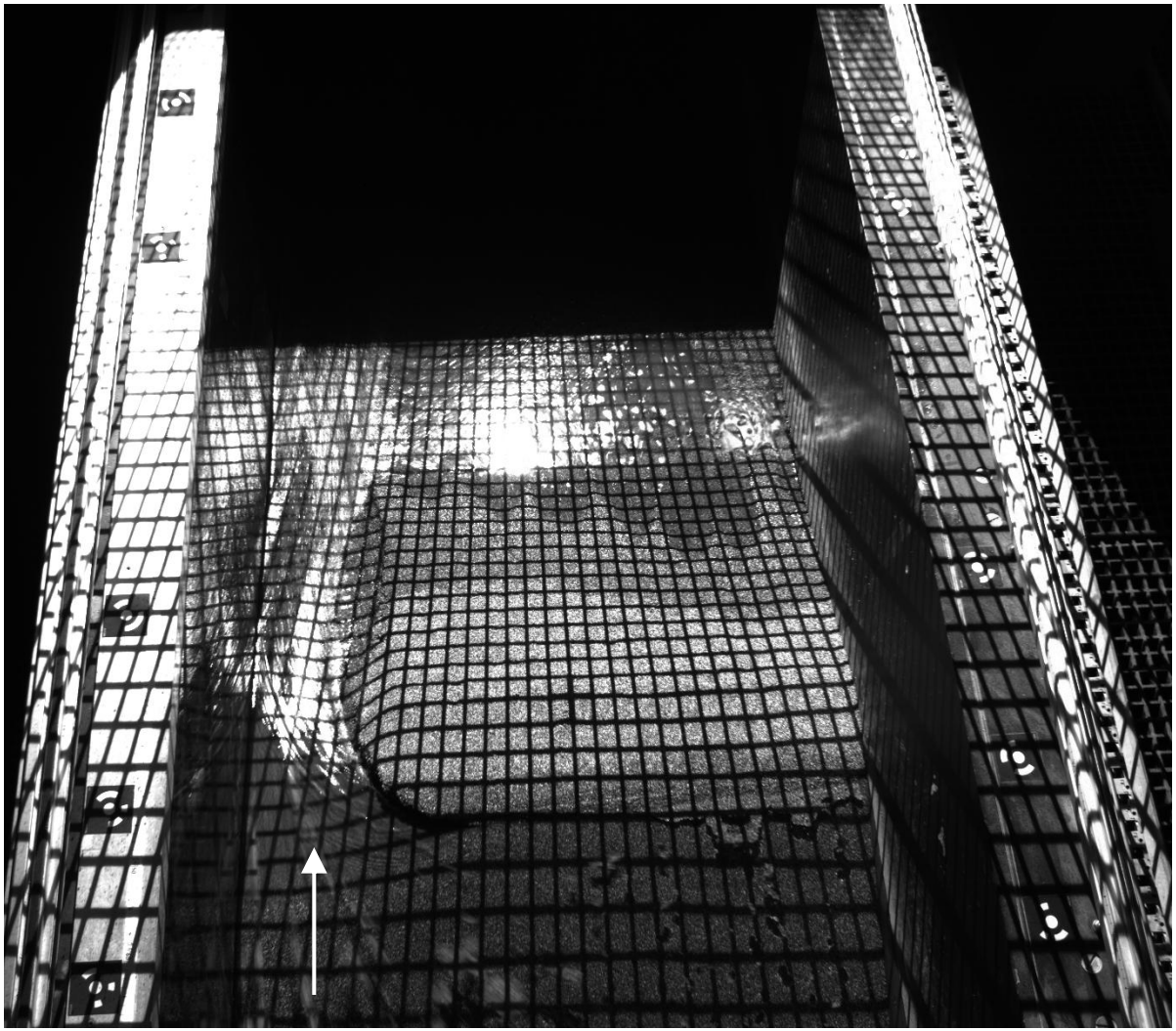
4. Results

Challenges

- Contrast between the sediment and the grid varies during the test as sediment colour changes as it gets wet
- Projected grid is partly distorted due to inclined dike surfaces and the projector position
- Light of projector is reflected on water surface, especially at large times under high outflow discharge. These reflections disturb the visibility of the sediment surface.
- Surface waves and suspended sediment may complicate the grid point detection due to reduced visibility
- Breach side slope may be steep and grid detection therefore fails as the vertical displacement of the grid points is too large.

4. Results

Challenges



5. Conclusions

- 3D dike breach tests due to overtopping
- Application of new videometric measurement system
- Non-intrusive method
- Determination of 3D breach profiles
- First tests provide motivating results

6. Outlook

- Improve test setup
- Systematic 3D dike breach tests
- Breach cross sections
- Erosion rates
- Numerical modeling

Thank you !

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