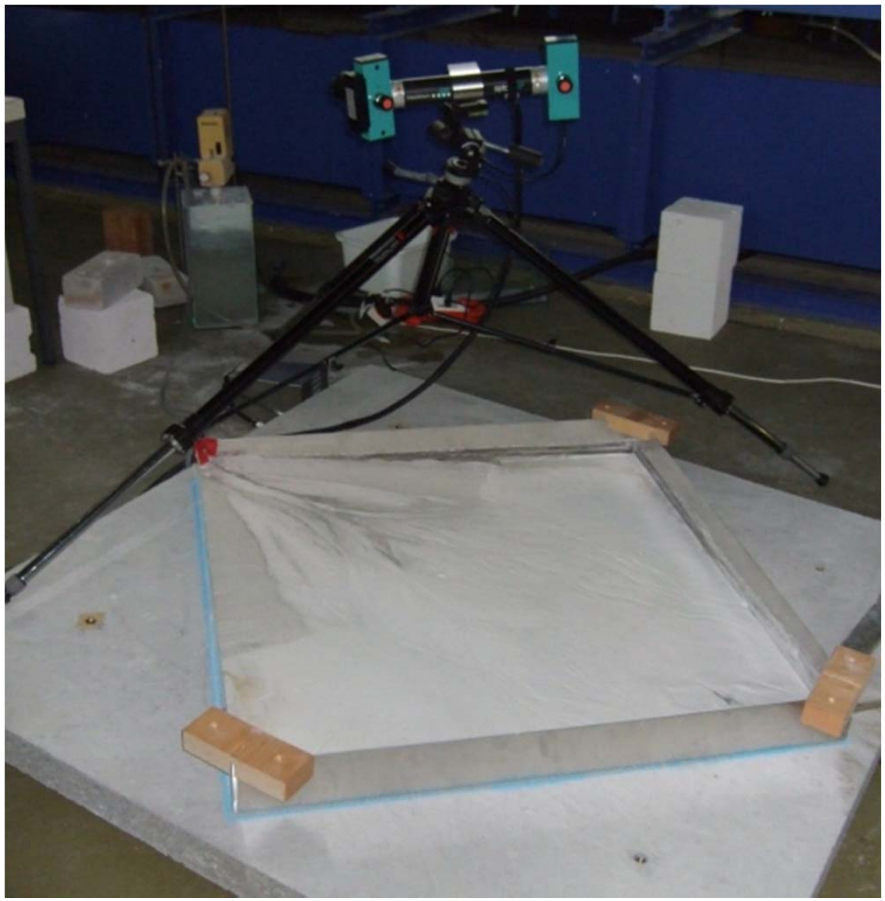

# Laboratory Flume Experiment with a Coded Structured Light System

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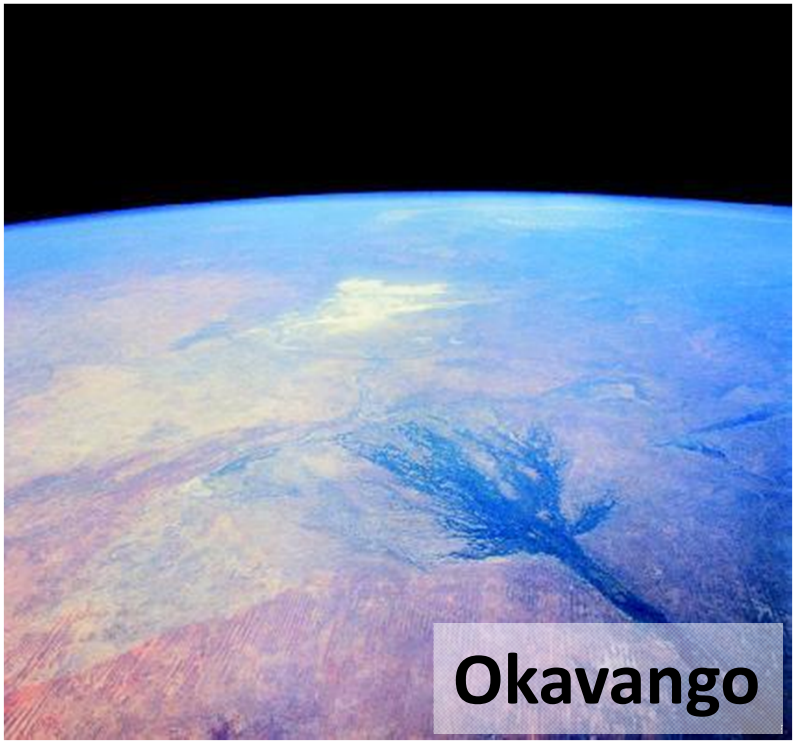
# Introduction

- Inland deltas in several places around the world, e.g. **Okavango** (Botswana), The Sudd (the Sudan), Danube (Slovakia).

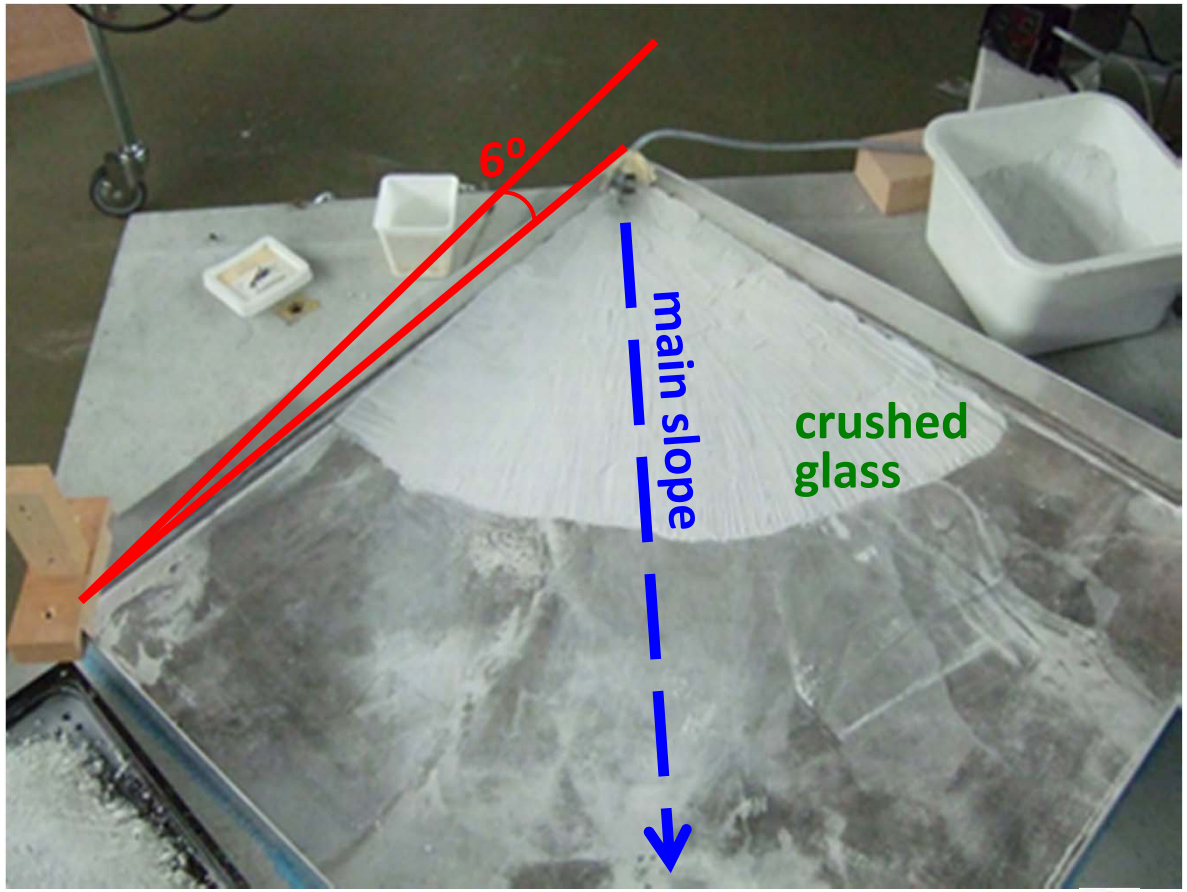



# Introduction

- New mathematical models have to developed for describing;
  1) long-term dynamics of the sediment transport, and
  2) evolution of the delta on geological scale.
- Seybold et al. (Geophysical Research Letters, 37(8), 2010) developed such a model, so called **reduced complexity model** to study the **formation** of inland deltas.
- A micro scale artificial inland delta was generated in lab conditions for the **validation** of **this model** .
- **The presented work here** explains this lab-scale flume experiment.

# Laboratory setup

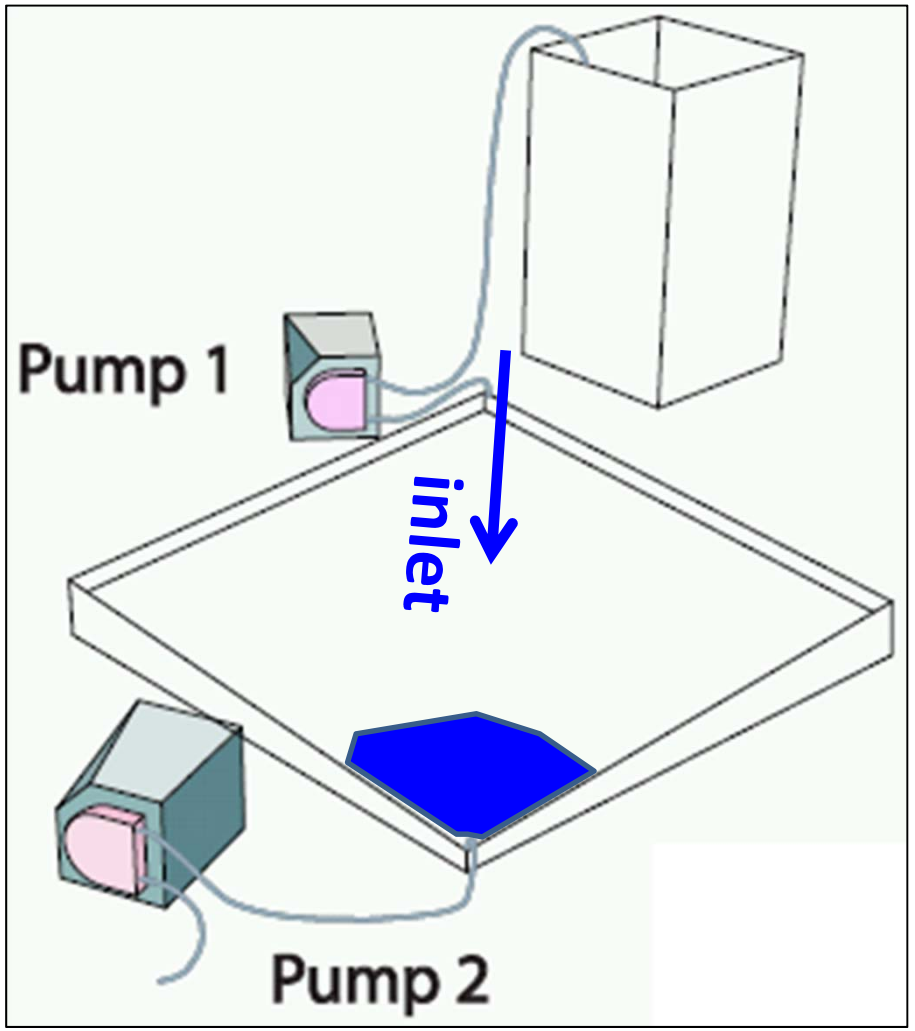
- 1 x 1 m aluminum basin
- Fixed at an inclination of about 6 degree
- Main slope runs along diagonal
- Initial surface
- Crushed glass
  2R = 50-120 micron



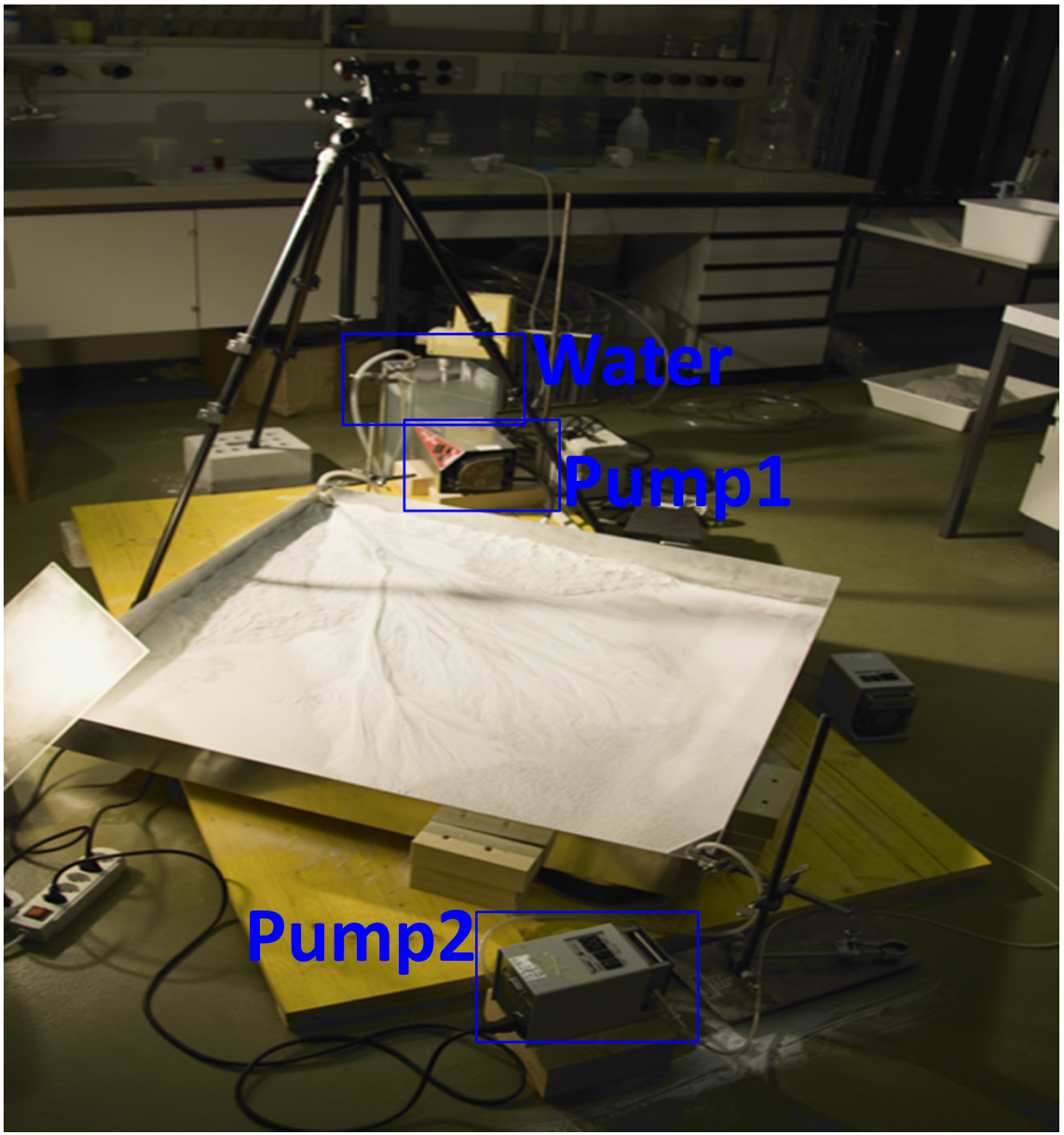
# Laboratory setup

- Sediment is continuously mixed with water and injected at a steady rate by **Pump1.**

- Infiltrated water which accumulates at the bottom edge is continuously pumped out by **Pump2**.

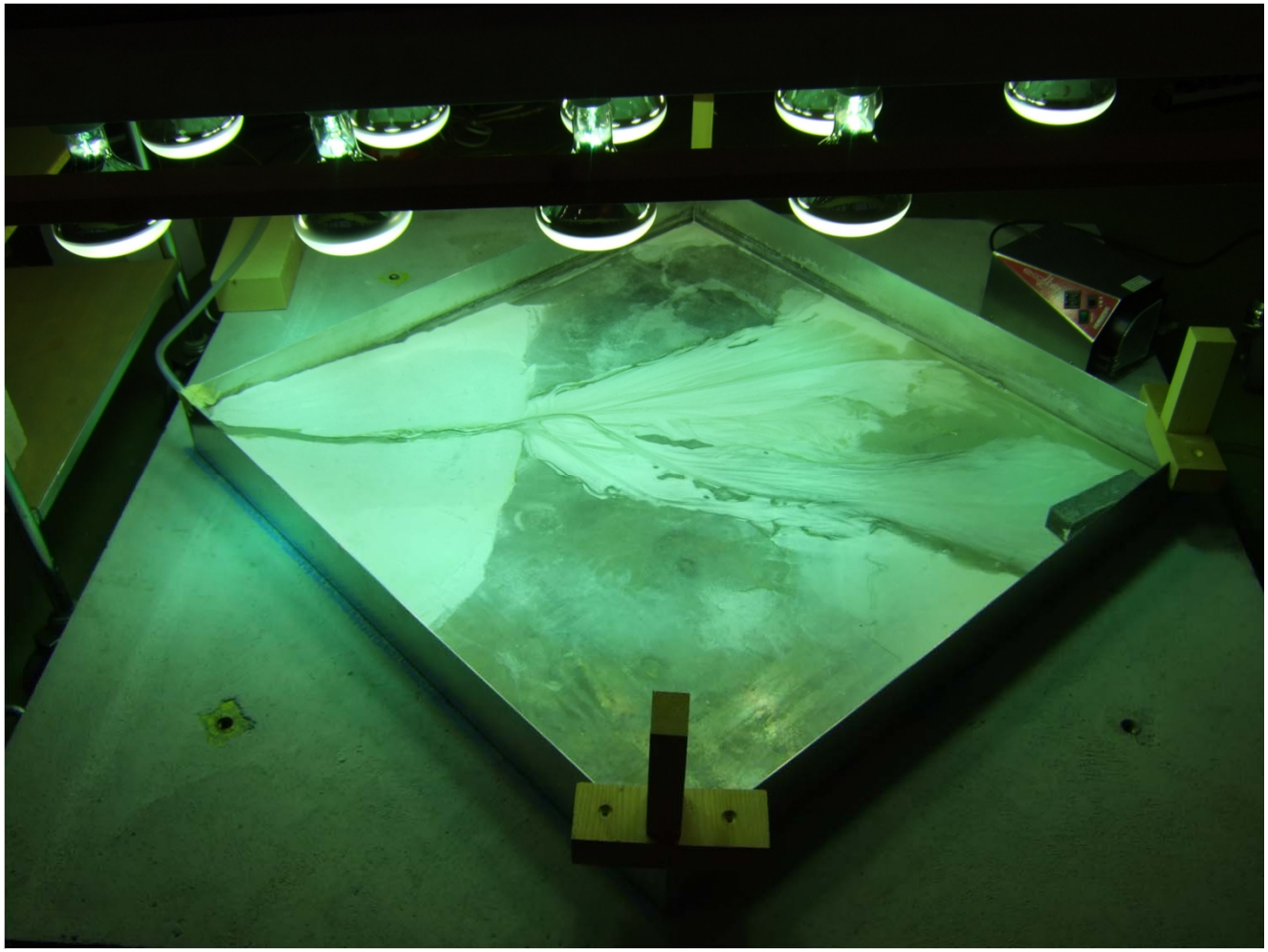


# Laboratory setup

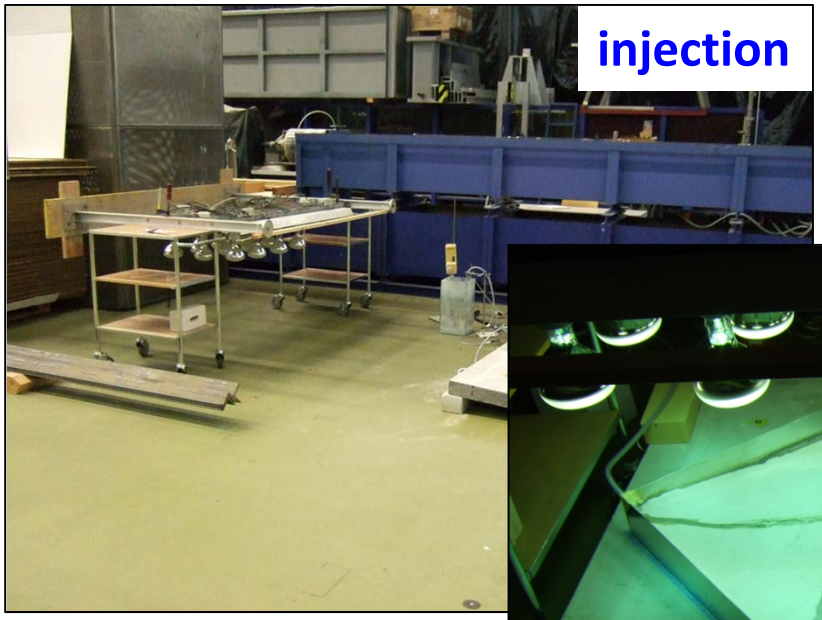


# Laboratory setup

- In addition, water is evaporated by an array of fifteen 300W **heat lambs**, fixed about 15 cm above surface.

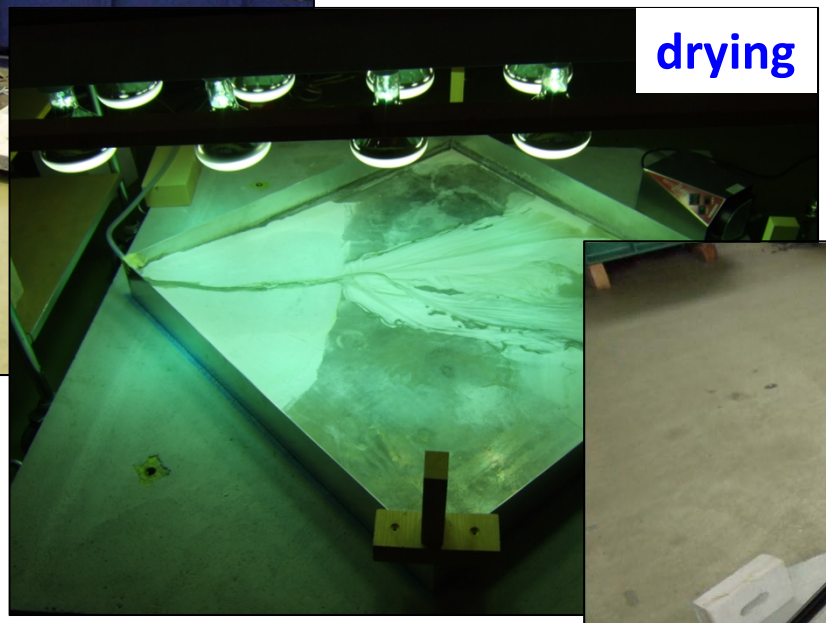


# The experiment is run as follows

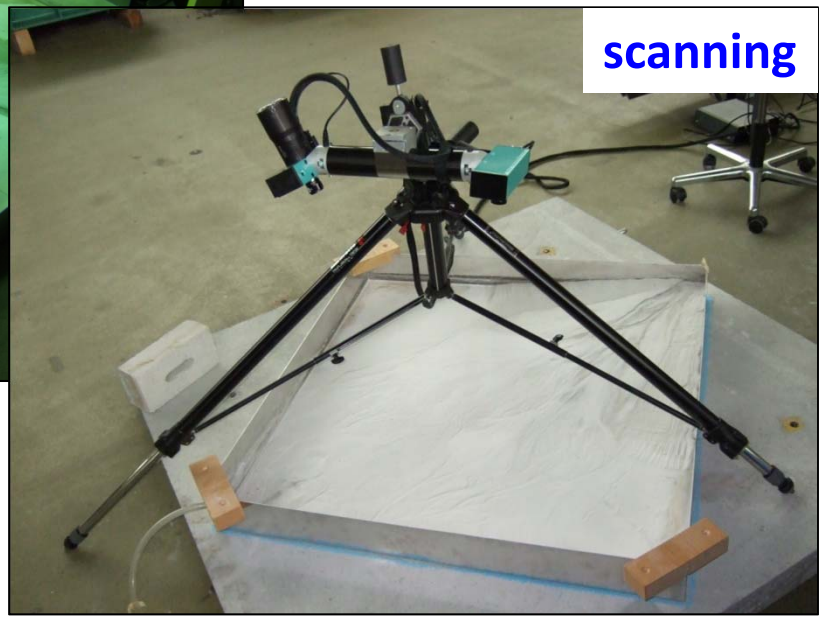



45 min

2 h




1.5 h

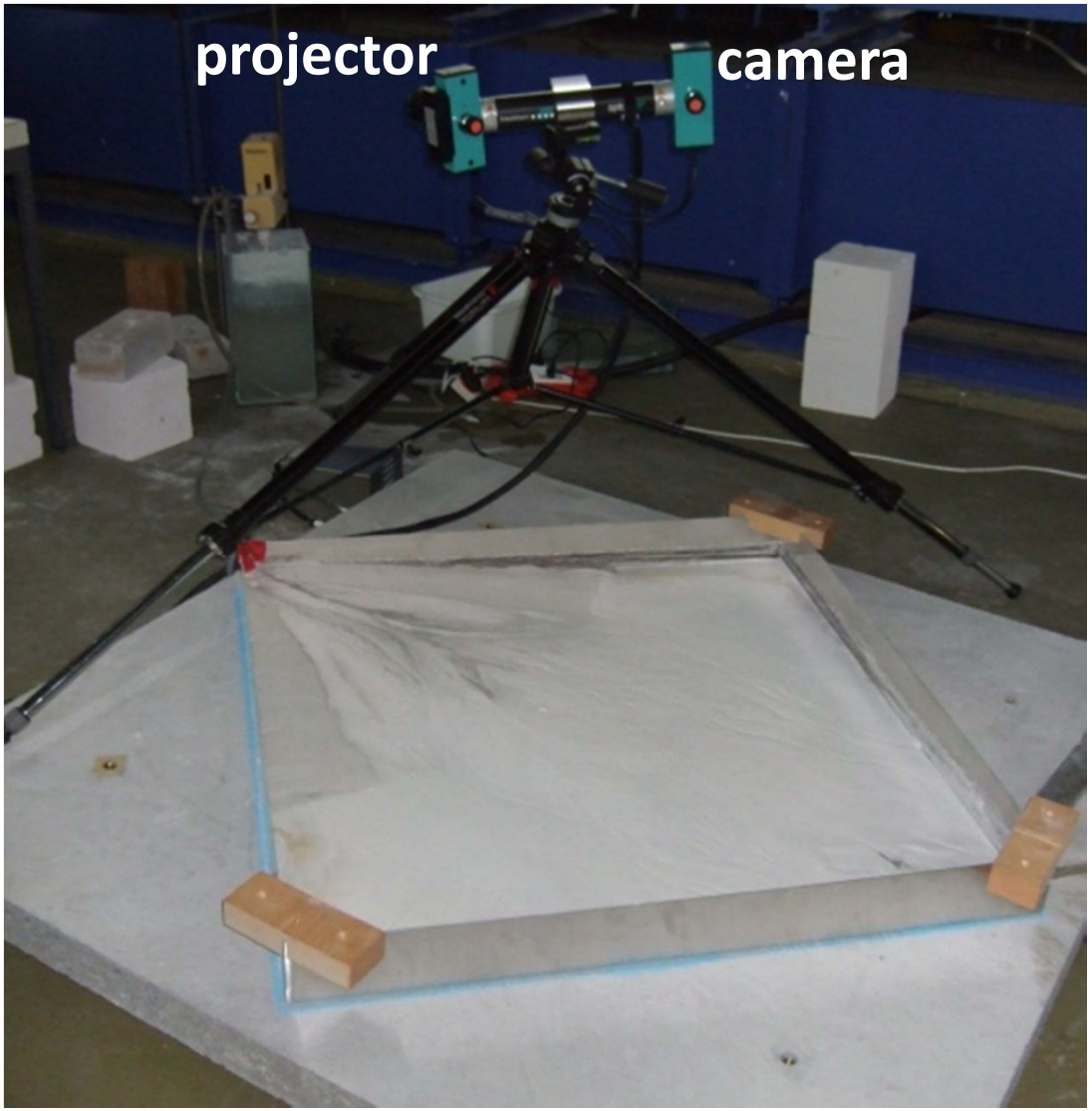



- Injection **+** drying **+** scanning **= an epoch**
- Epoch **0** intial condition.
- Totally **5 epochs** of data sets: epoch 0, 1, 2, 3, and 4.

# Breuckmann OptoTOP-SE scanner

- Structured light system with **fringe projection**

- FOV: 400 x 315 mm
- Acq. time < 1 sec.
- Weight: 2-3 kg
- 1280 x 1024 (1.3M) points per scan
- X-Y-Z & intensity
- Feature accuracy 50 – 100 micron

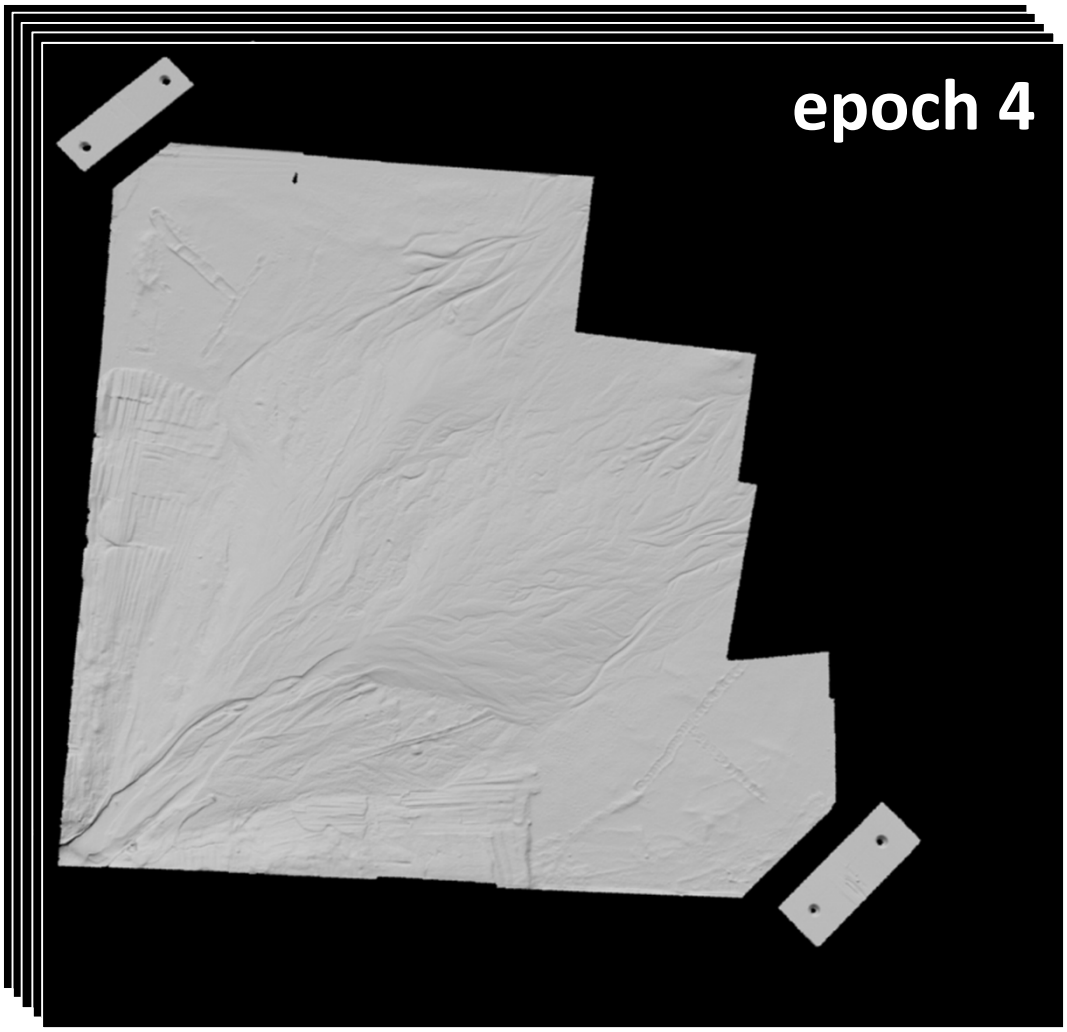


# Scanning & co-registration

- The project lasted in 2 days.
- Due to limited FOV of the scanner, several scans (13–15) have to be performed.
- These scans are combined into a co-registered mosaic to cover the entire surface **of the related epoch**, using the **LS3D method** (Gruen and Akca, ISPRS Journal of Photogrammetry and Remote Sensing, 59(3), 2005).
- The LS3D is a rigorous algorithm for matching of overlapping 3D point clouds, without using the explicit tie points.

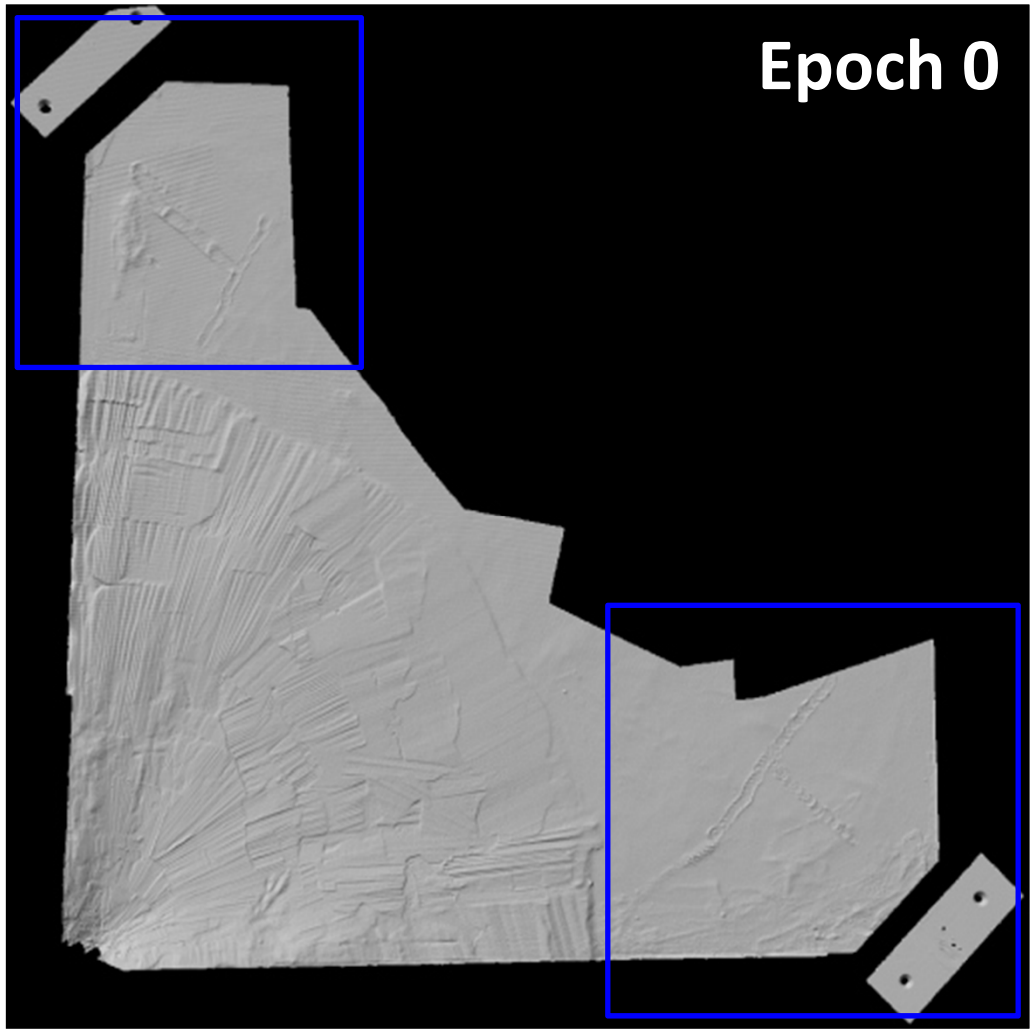
# Scan co-registration

- Each epoch has 13-15 scan data to be co-registered.
- Average std. dev. of co-registration 50 microns.
- Once co-registered, each epoch is re-sampled into a DEM using SCOP++ (point spacing 300 microns).
- **But**, inter-epochs **not** aligned **yet**!



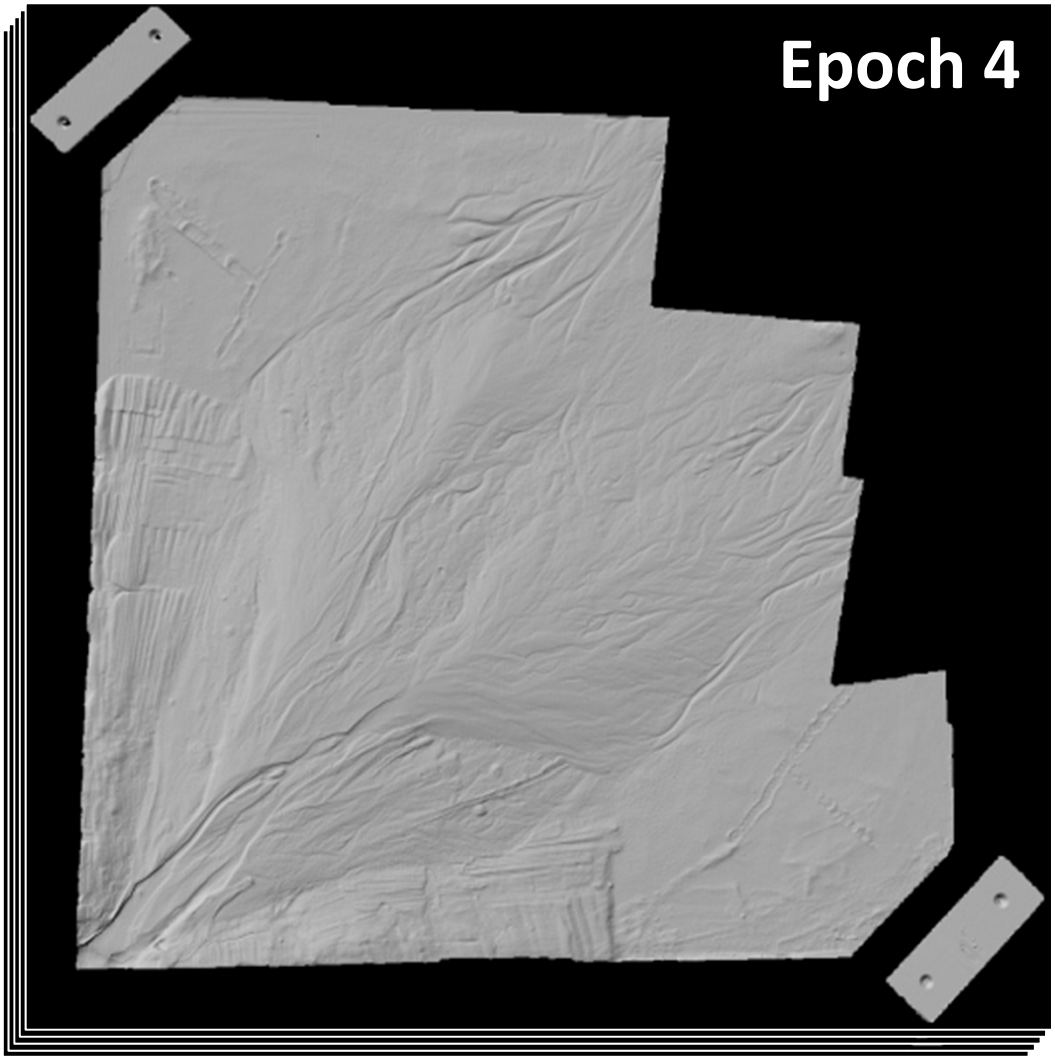
# Epoch co-registration

- In order to perform the **spatio-temporal analysis**, all DEMs have to be transformed into a common system.
- We choose **epoch0** as the **datum**, remaining epochs are co-registered.
- Multi – patch matching.



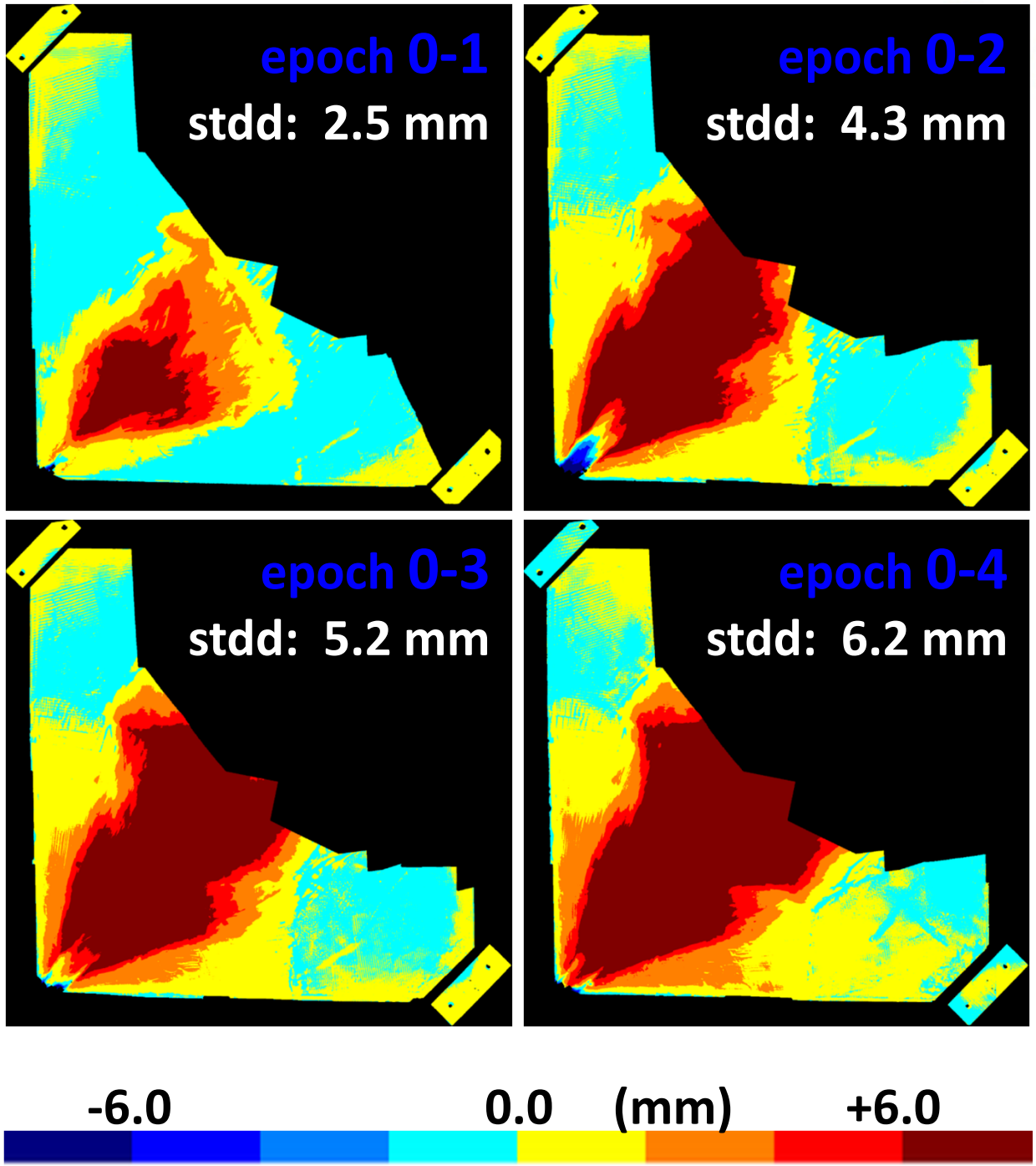
# Epoch co-registration

- Then, all epochs are co-registered to **epoch0.**



# 3D comparison

- **3D comparison** techniques in order to **quantitatively** analyze the **change** in surface.
- All epochs are compared to **epoch0**.

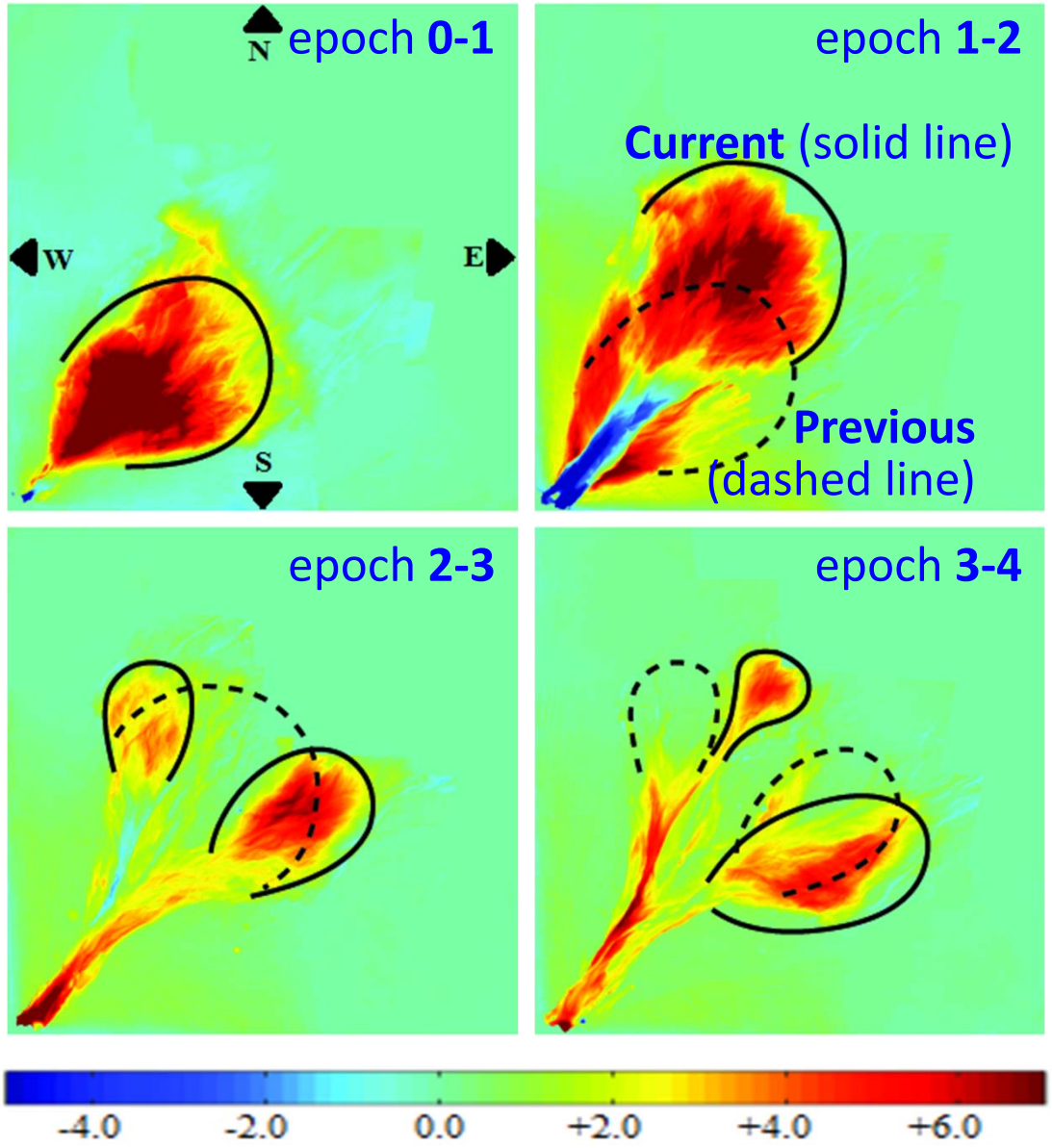


# Topography dynamics

- The total **deposited volume** of each epoch can be obtained by subtracting **sucessive** DEMs:
  - **V1** = 573 cm3
  - **V2** = 904 cm3
  - **V3** = 614 cm3
  - **V4** = 740 cm3

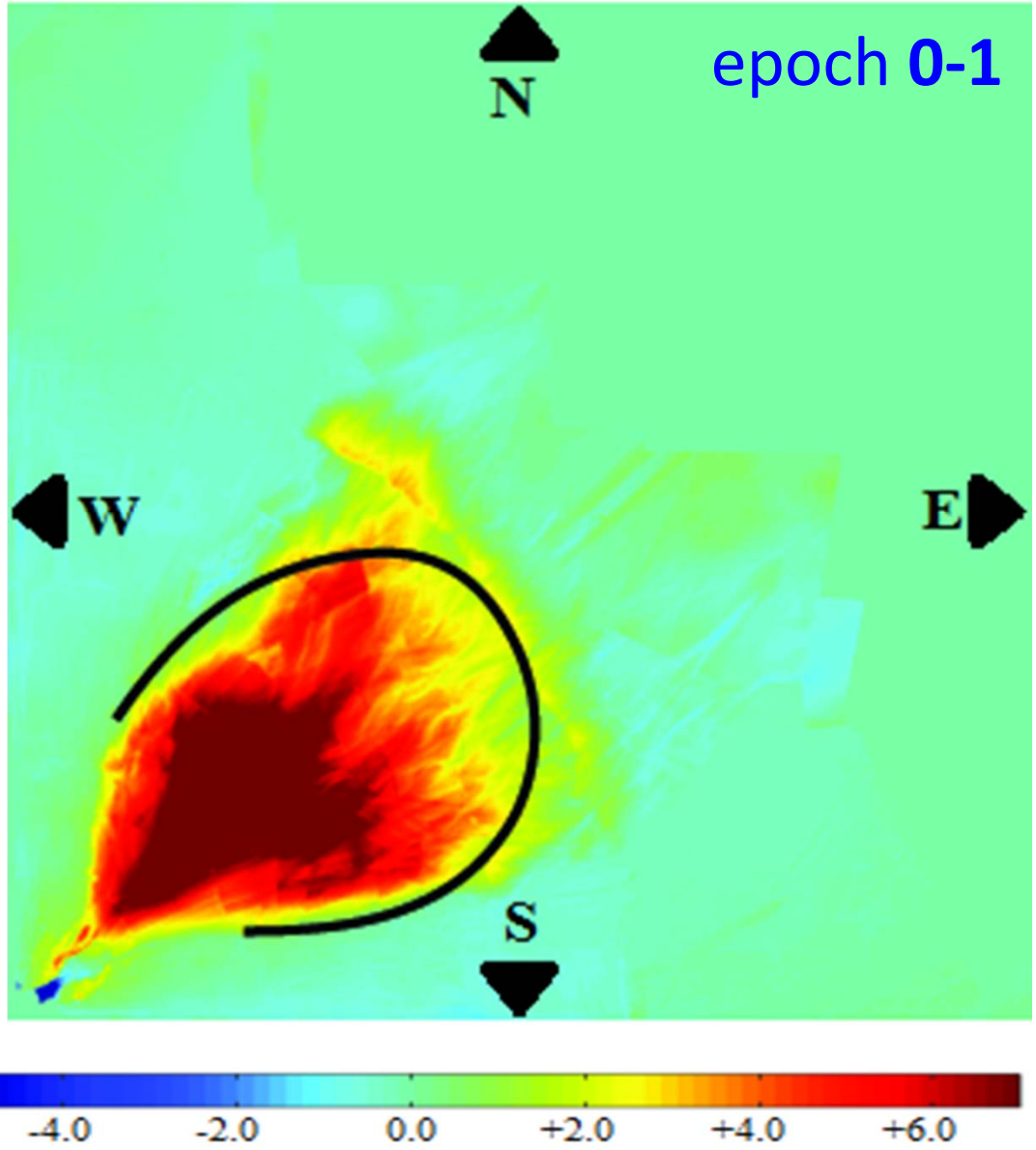
# Topography dynamics

- **Change** in surface between the **successive** epoches.
- Different **deposition** lobes for each epoch.



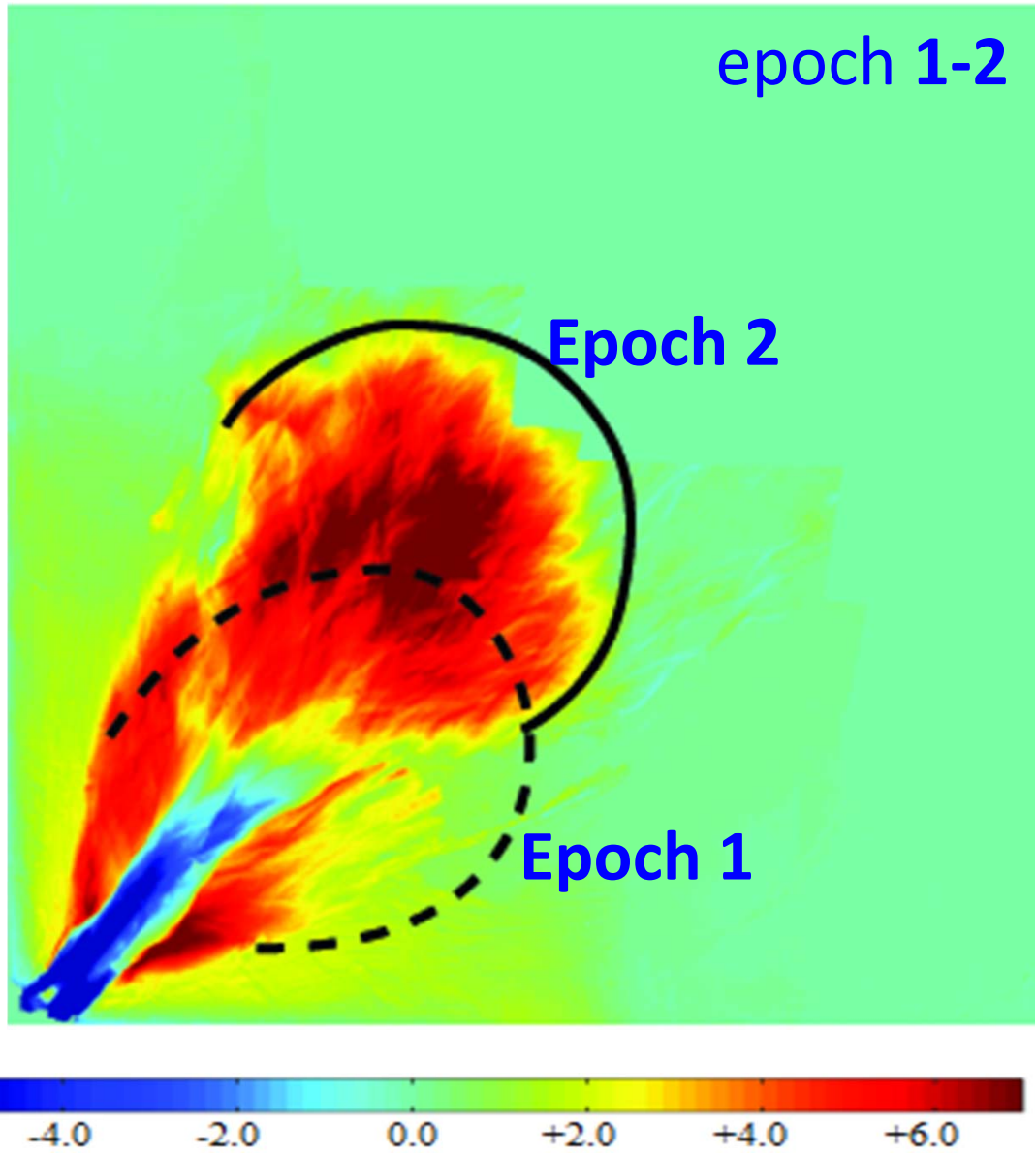
# Topography dynamics

- During the **first epoch** the stream mainly deposits its sediment just after a short inlet zone, and filling up the domain.



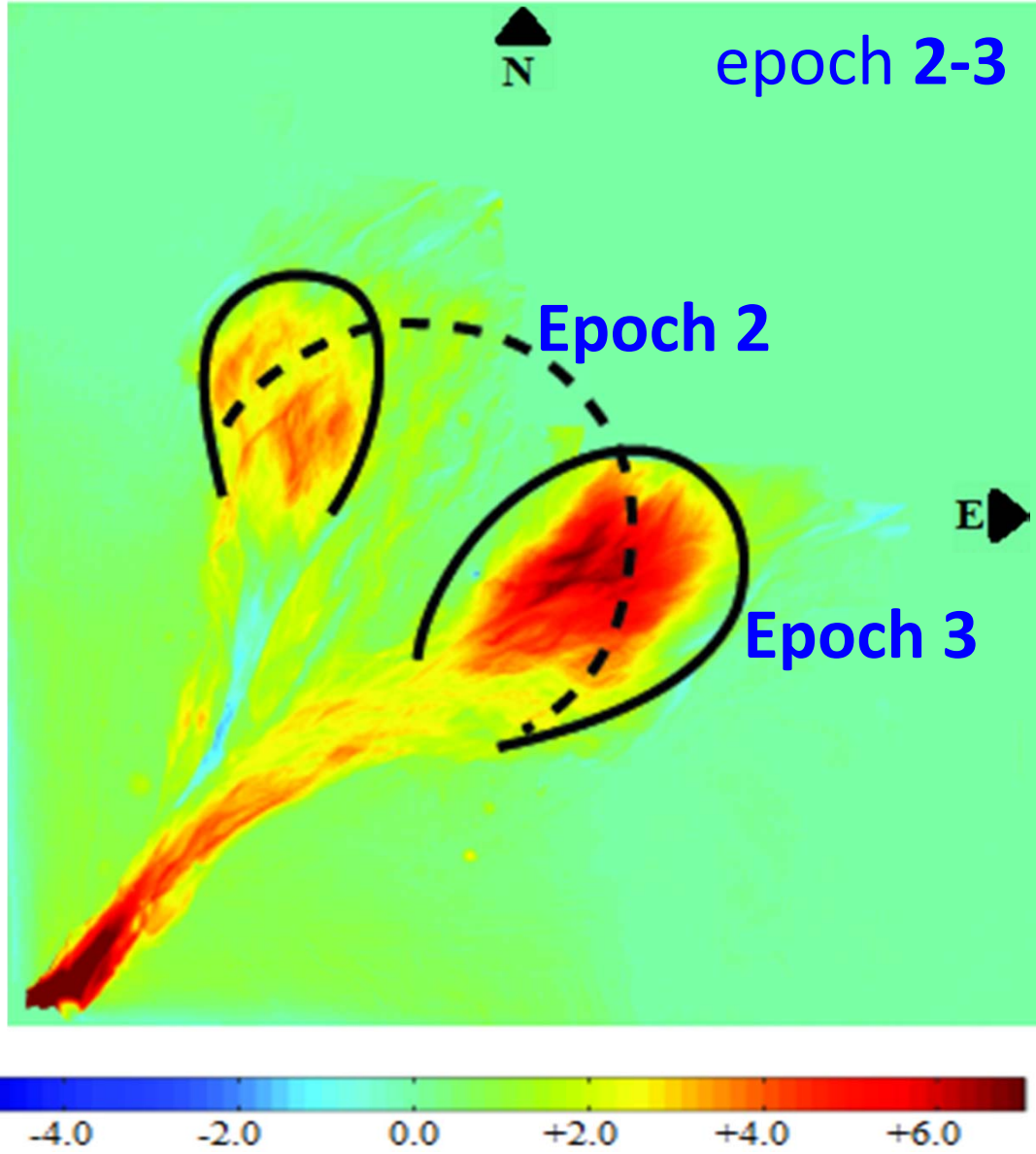
# Topography dynamics

- In the **second injection** the main flow direction is blocked by the first deposition lobe.
- Thus, the stream first starts to **incise a channel** before it spreads out into a new fan zone.



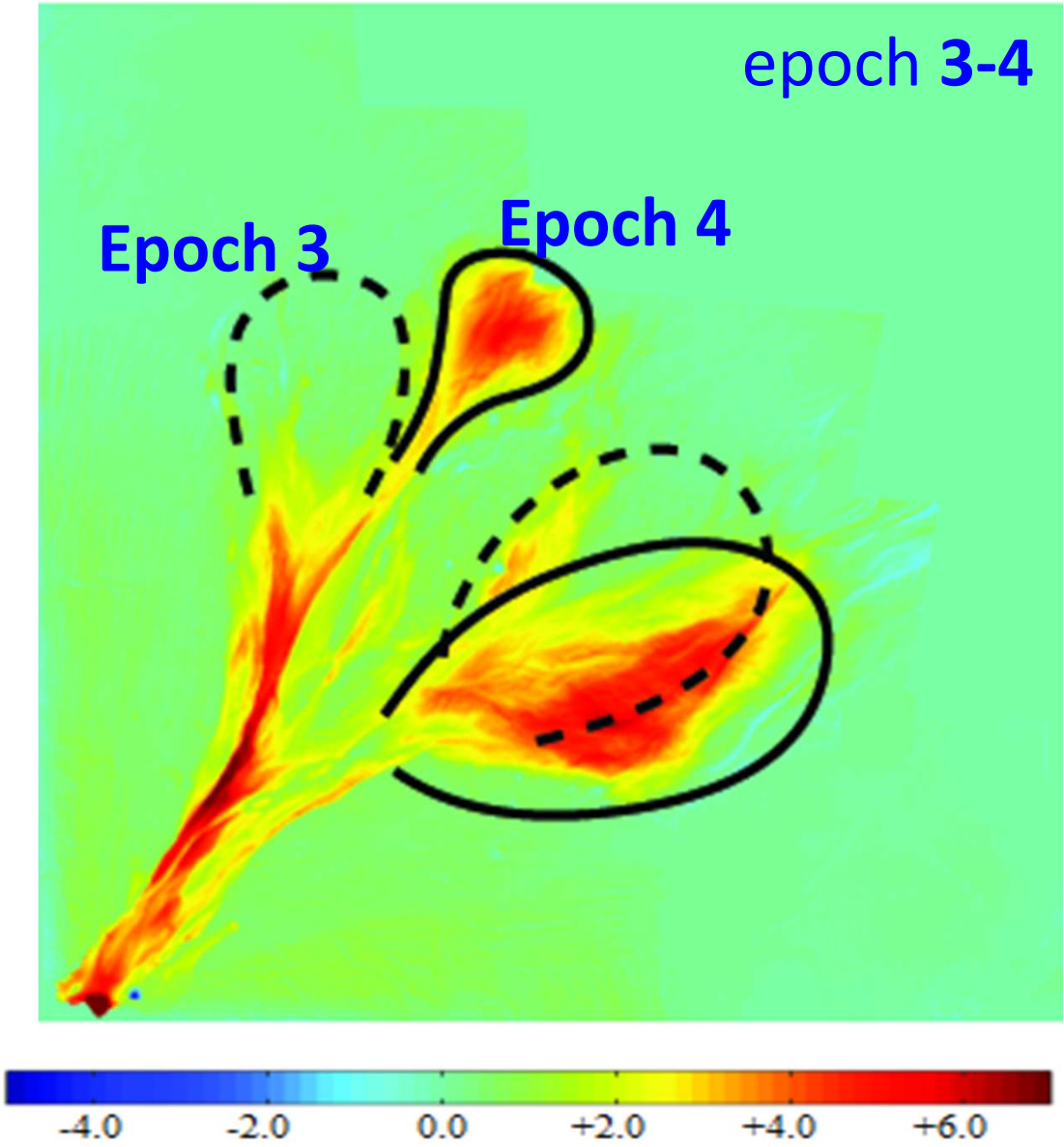
# Topography dynamics

- During the **third epoch**, the deposition inside the channel bed starts forming a new sediment layer.
- The main deposition lobe switches to **east**, while a new channel branch erodes through the side walls of the previous lobe forming a new lobe towards the **north**.



# Topography dynamics

- In the **fourth epoch**, one can clearly see distribution of the deposits in a larger domain and thus forming a **deltaic** fan.



# Conclusions

- The formation of inland deltas has been **simulated** using a laboratory-scale flume experiment.

- The surface topography has been scanned using a **Breuckmann 3D scanner**, resulting DEMs have been co-registered, and **spatio-temporal dynamics** have been analyzed.

- The pattern formation mechanisms and the resulting morphology are **similar** to those observed **in nature**, but on a different scale in **space** and **time**.

# Thank you for your attention !