ADVANCES AND PROCESSING APPROACHES IN 3D TEXTURE MEASUREMENTS

Reinhard Wehr

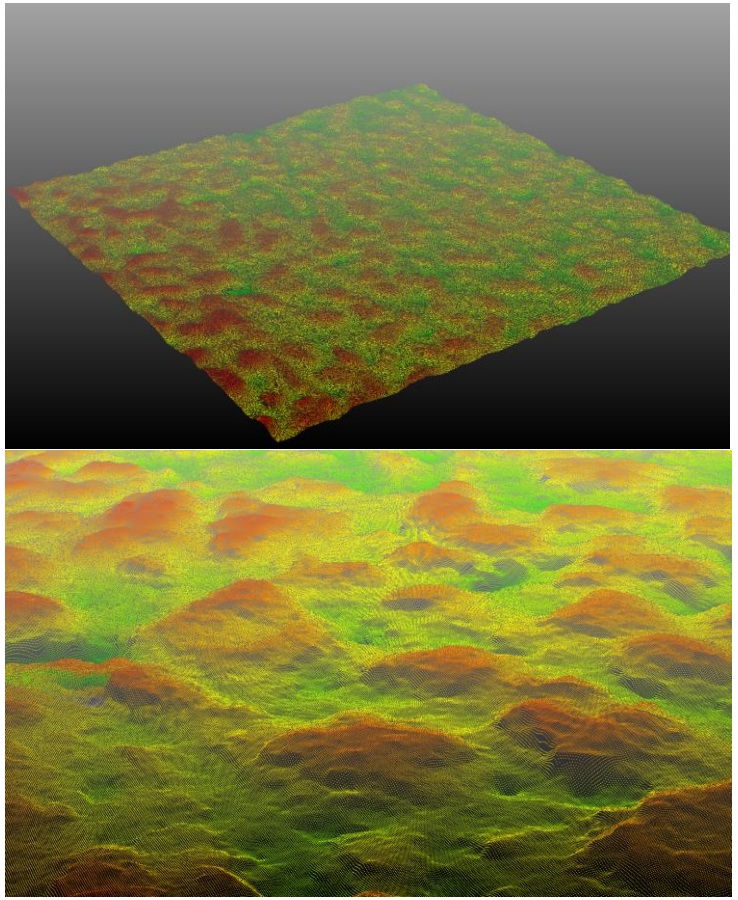
ERPUG 2021

Vienna

contact: reinhard.wehr@ait.ac.at

NEW SENSOR TECHNOLOGIES

- Emergence of new sensor technologies for recording of 3D road surface texture
- New anisotropic road surfaces – e.g. diamond grinding
- Sensors can be distinguished according to:
  - Stationary – moving – high-speed measurements
  - Local (single area) or continuous measurements
  - Resolution, recording width and length
- Common result: 3D point cloud of various shape and resolution
- Need for comparable, traceable post processing
- Motivation AIT – new sensor system with:
  - Continuous measurements @ 100 km/h
  - Resolution: 60 µm – currently focused on macrotexture
  - Recording width ~ 10 cm



DATA PROCESSING

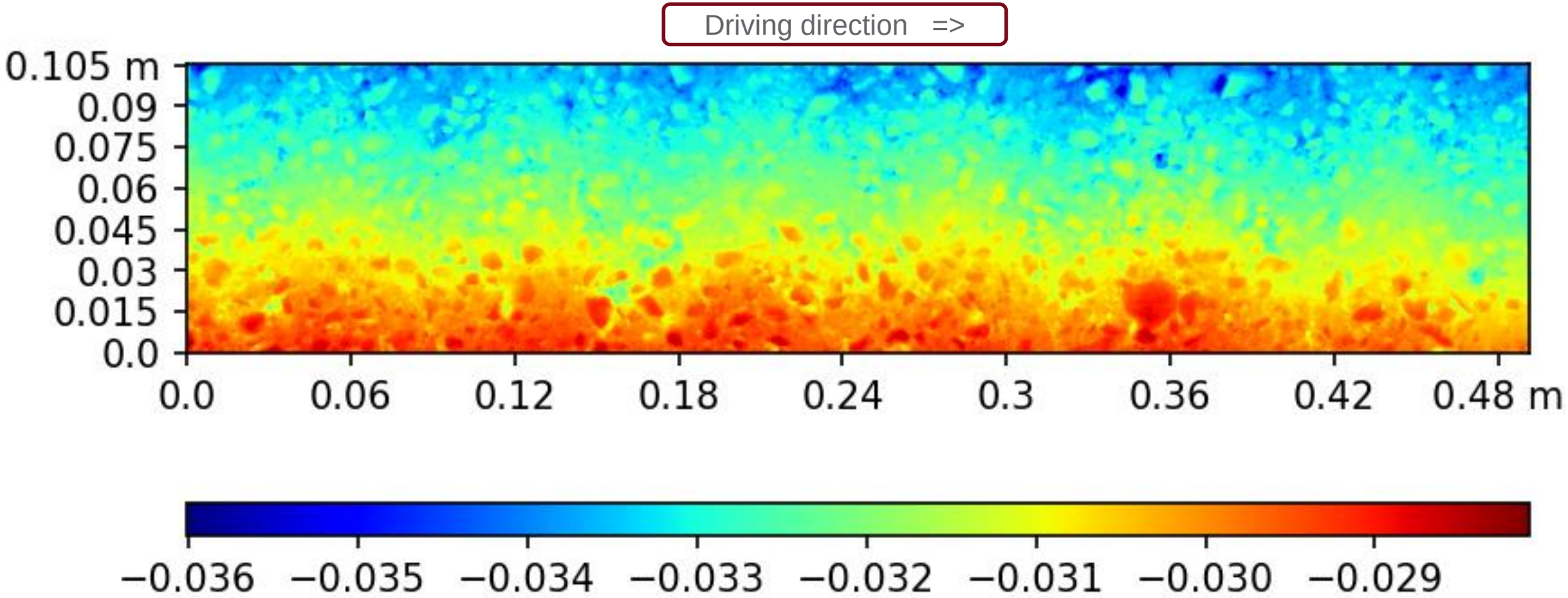
- 3D point cloud

Raw data

- Data processing on (continuous) texture – outlier and dropout treatment
- Possible need for regularisation of point cloud – dependent on resolution and aim
- Levelling of texture patches
- Windowing for treatment of spectral leakage
- Calculation of texture parameters on single patch
- Side notes: data handling and performance

PRE-PROCESSING

Raw texture data

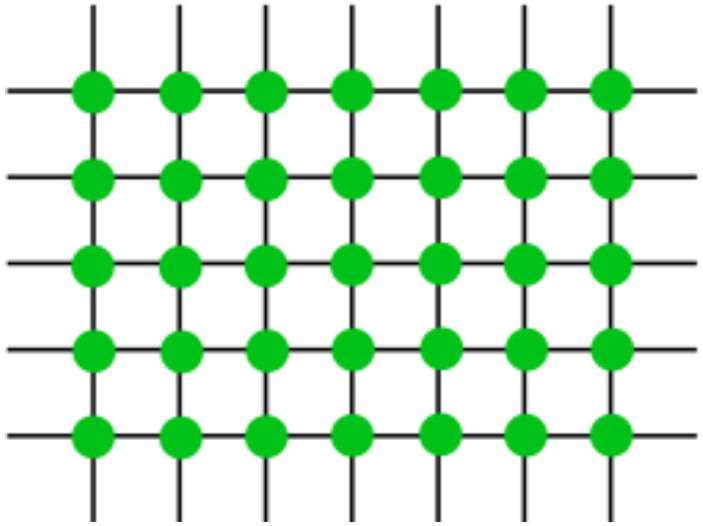


PRE-PROCESSING

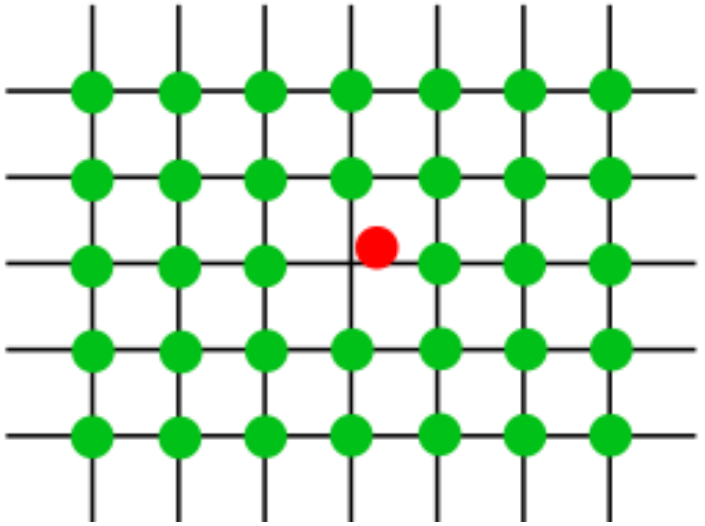
Grid regularisation and dropout removal:

- e.g. linear / (cubic) spline / nearest interpolation in 2 dimensions
- can be computationally expensive

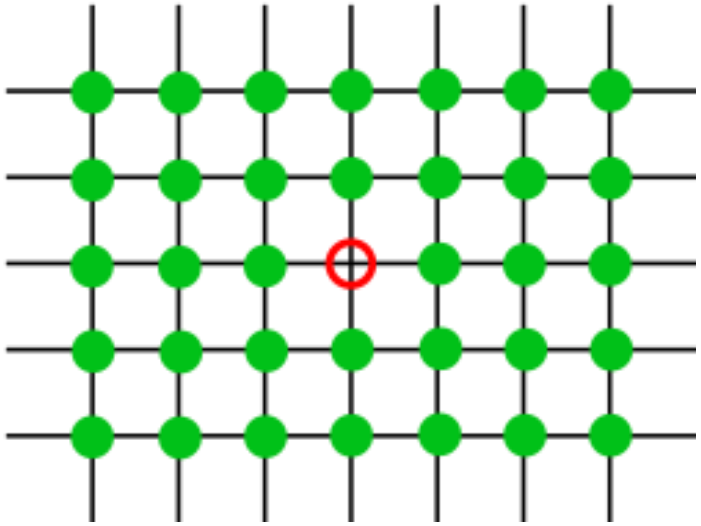
regular grid



non-regular grid



dropouts



DATA PROCESSING

- 3D point cloud

Raw data

- Data processing on (continuous) texture – outlier and dropout treatment
- Possible need for regularisation of point cloud – dependent on resolution and aim

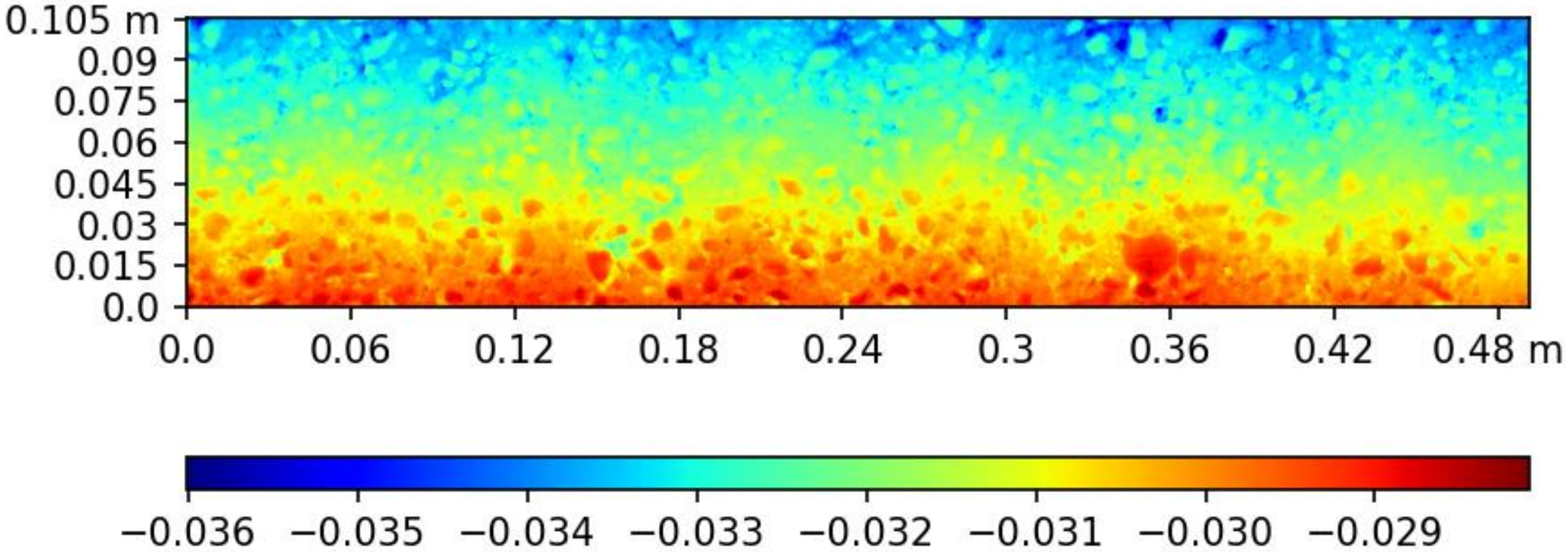
- Levelling of texture patches
- Windowing for treatment of spectral leakage

Pre-Processing

- Calculation of texture parameters on single patch
- Side notes: data handling and performance

FILTERING

Raw texture data



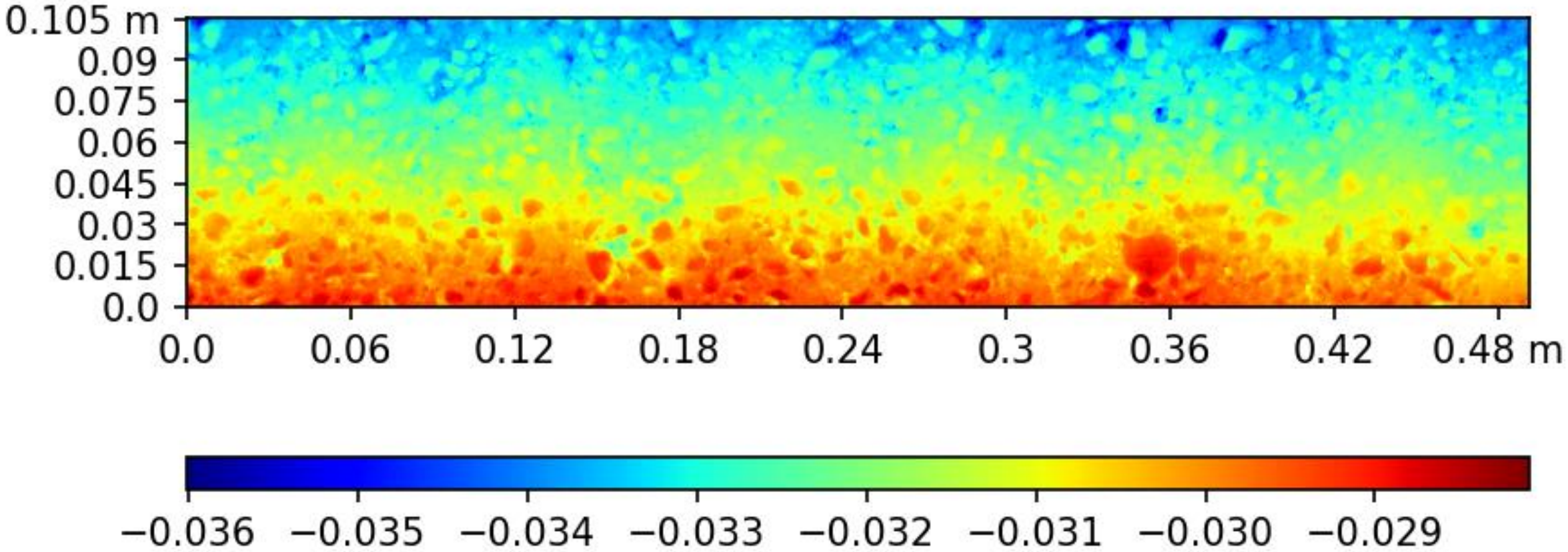
FILTERING

Exemplary methods for levelling of 3D texture:

- Calculation of average (linear) plane and subtracting result from original picture
  - Will reduce left/right tilt of measured data
  - Will not reduce within-texture waviness
  - Will be dependent on raw texture shape
- Calculation of Gaussian blur image of 3D texture data (convolution of texture data with gaussian function) and subtracting result from original picture
  - Will reduce left/right tilt of measured data
  - Will reduce (local) waviness of texture
  - Will be dependent on Gaussian kernel

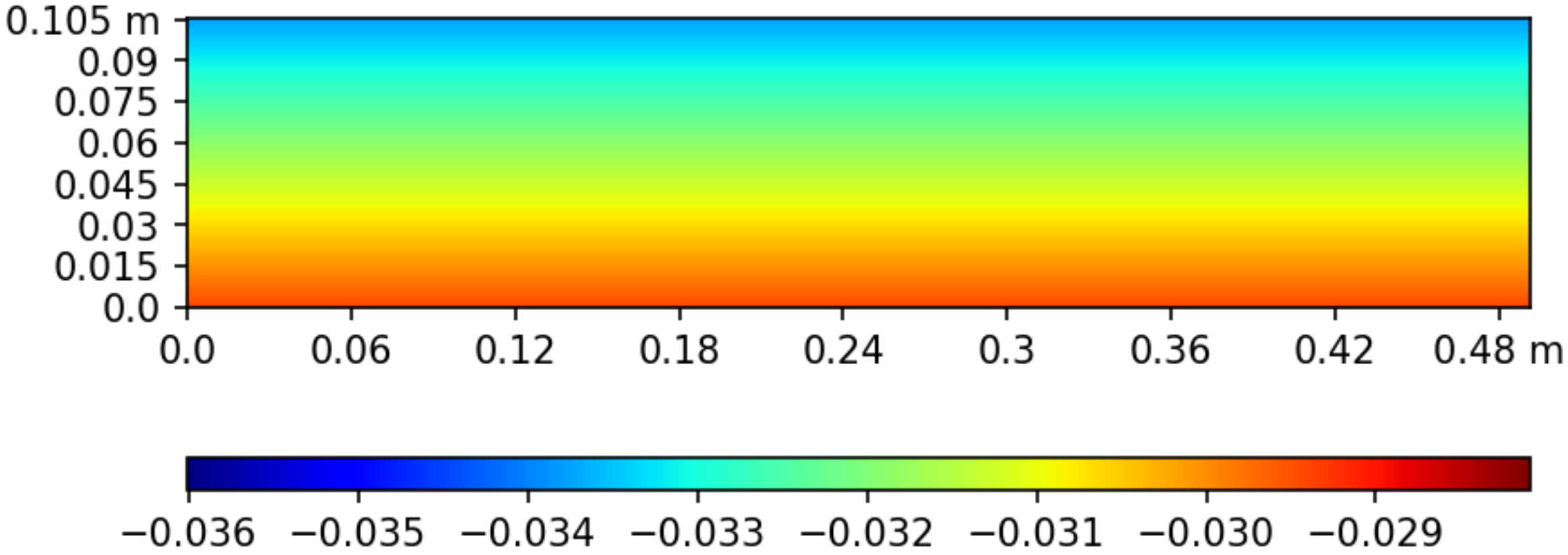
FILTERING

Raw texture data



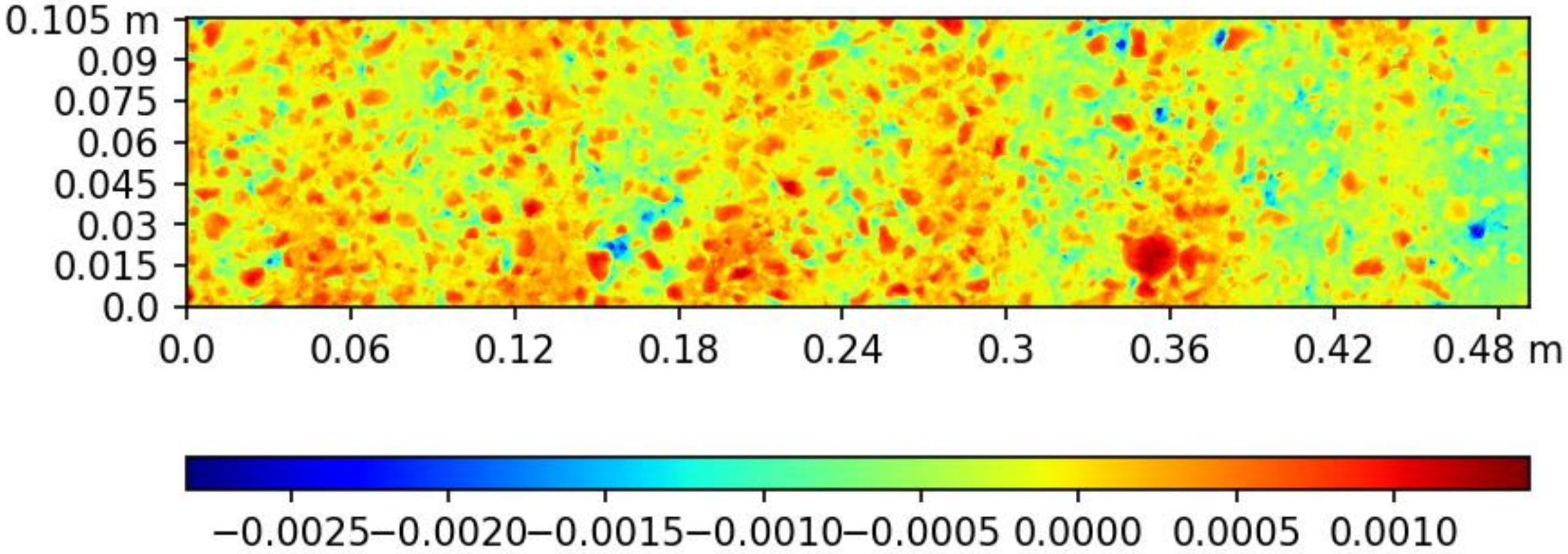
FILTERING

Raw texture data – calculation of linear filter



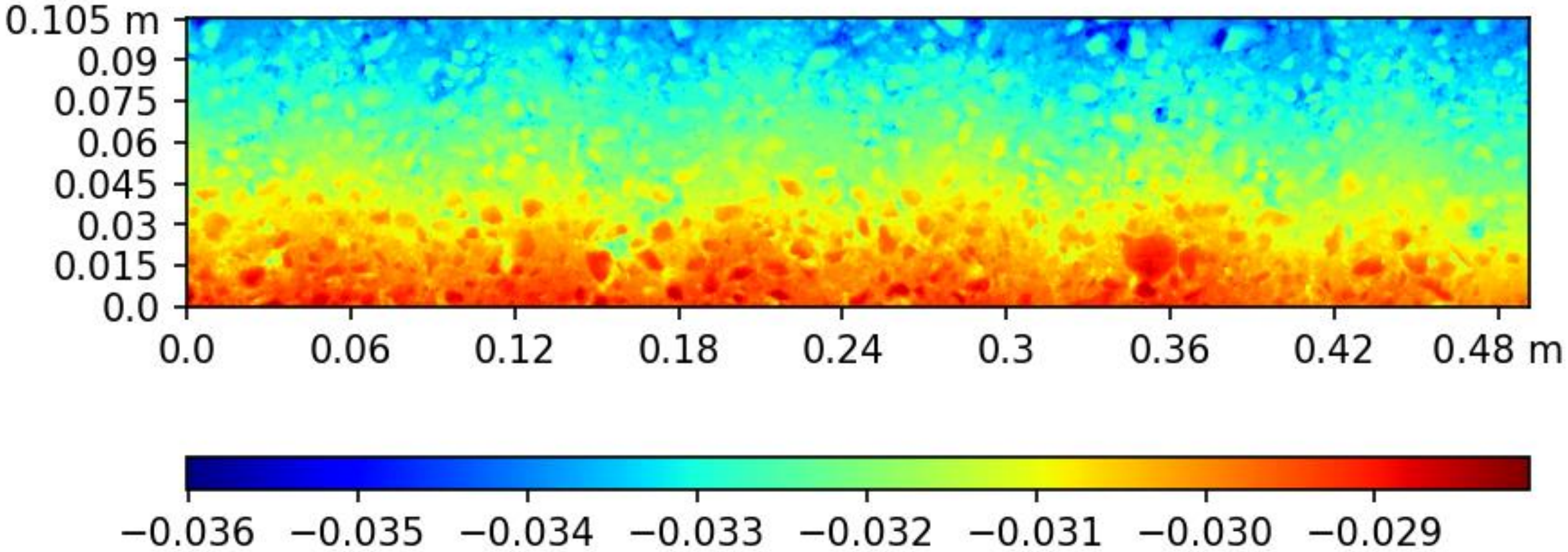
FILTERING

Raw texture data – calculation of linear filter



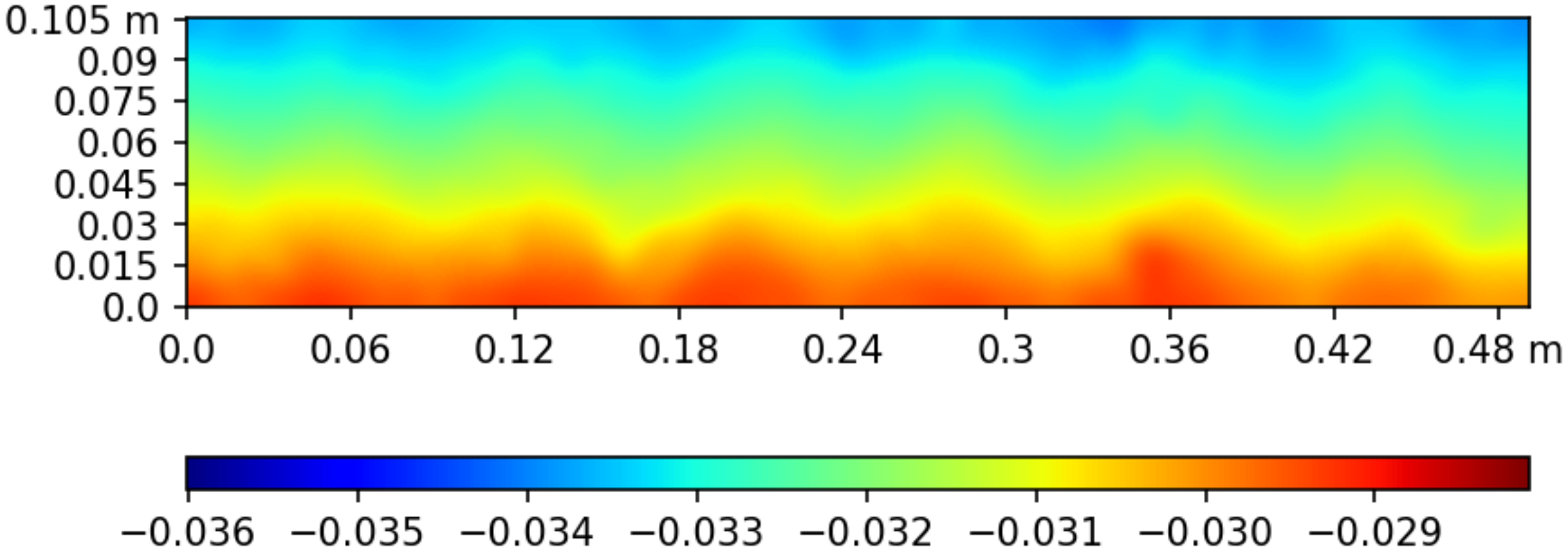
FILTERING

Raw texture data



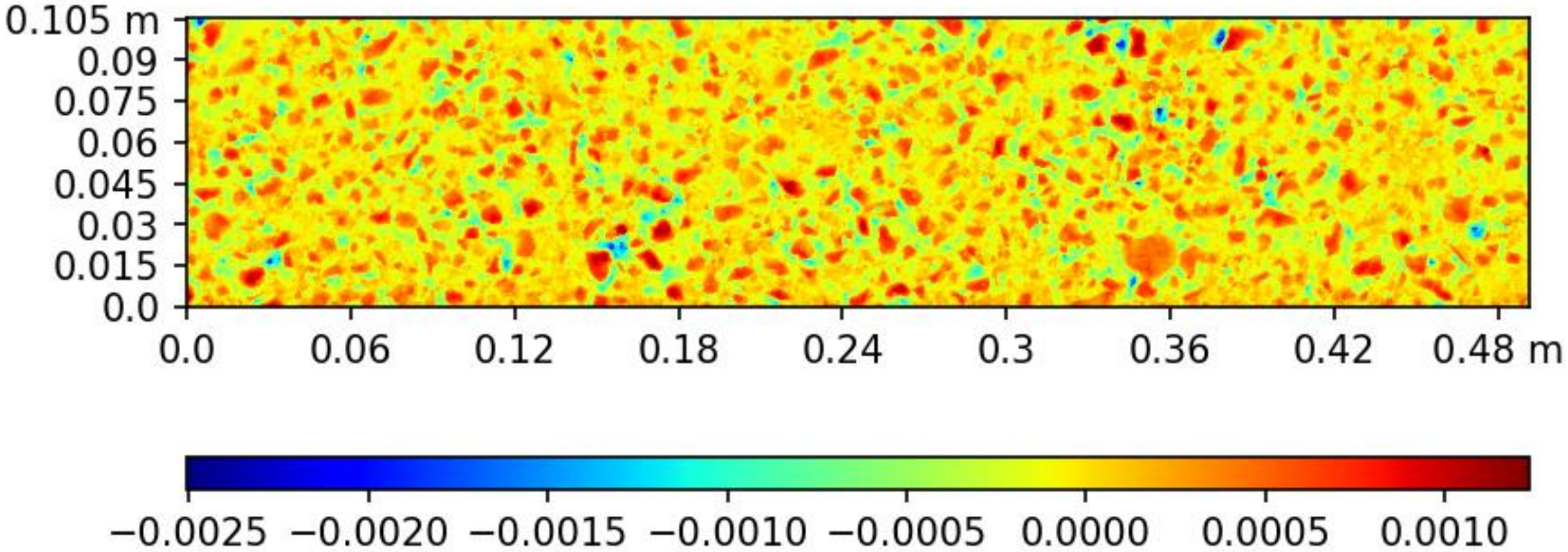
FILTERING

Raw texture data – calculation of gaussian blur filter (low-pass filter)



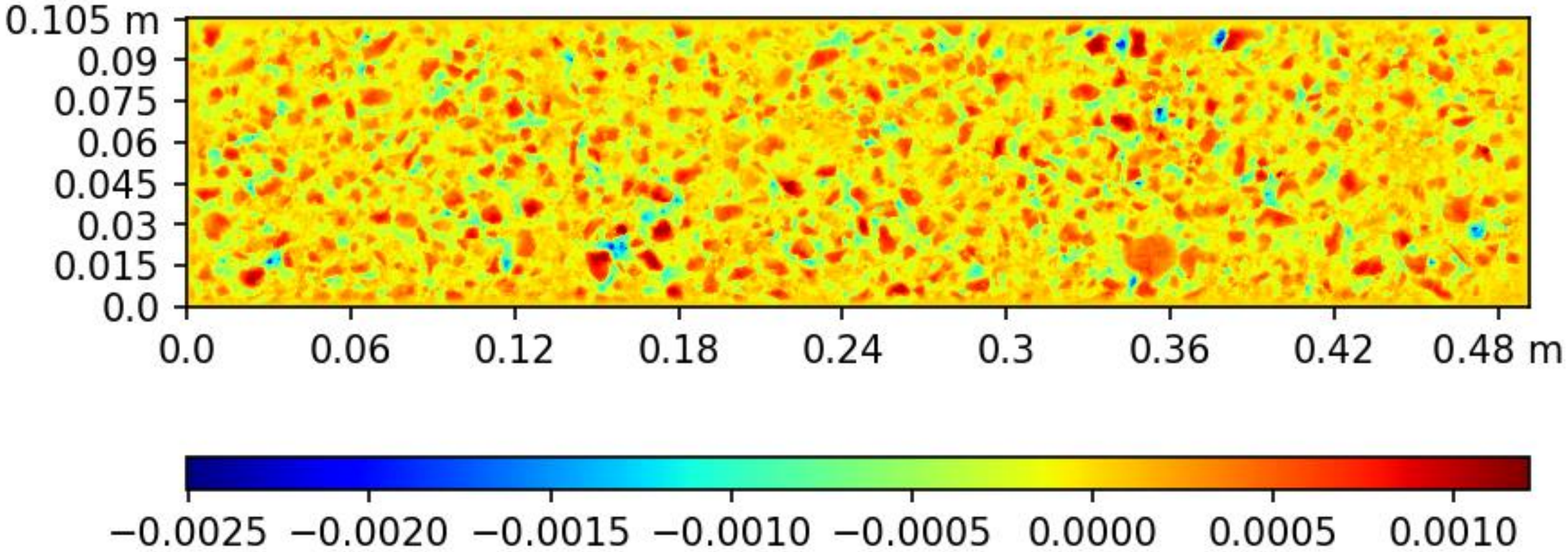
FILTERING

Levelling of texture patch – subtraction of gaussian blur filter



FILTERING

Windowing to reduce edge effects / leakage



DATA PROCESSING

- 3D point cloud

Raw data

- Data processing on (continuous) texture – outlier and dropout treatment
- Possible need for regularisation of point cloud – dependent on resolution and aim

- Levelling of texture patches
- Windowing for treatment of spectral leakage

Pre-Processing

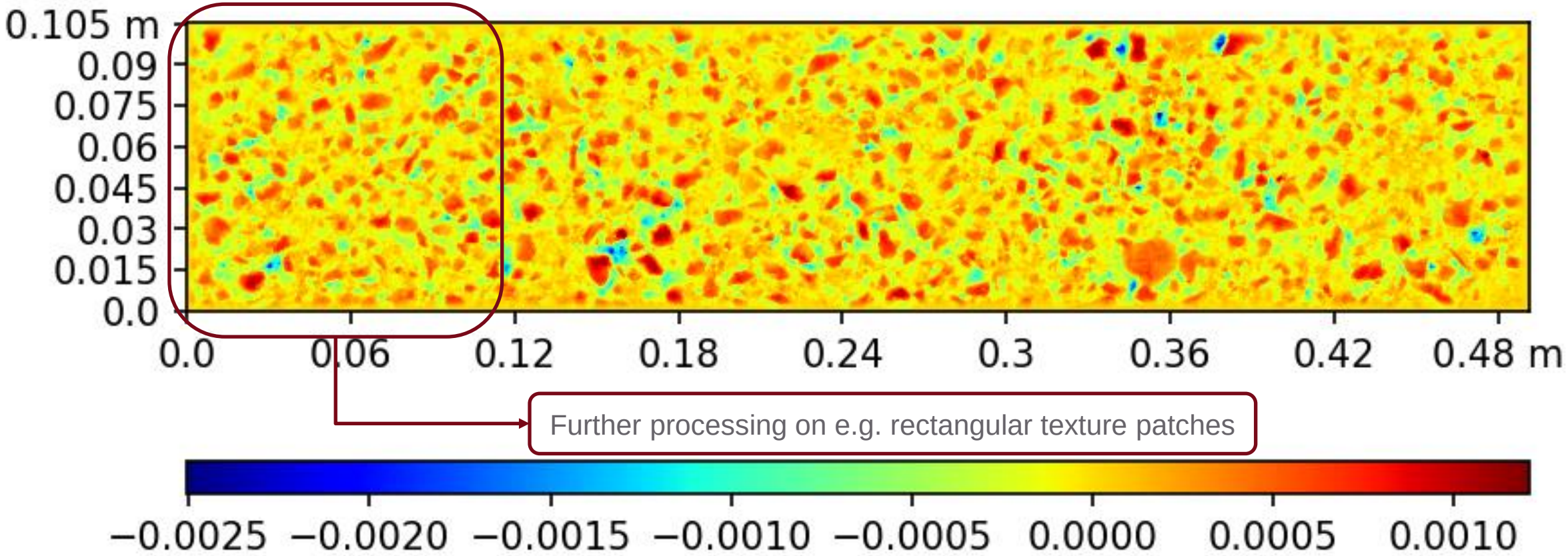
- Calculation of texture parameters on single patch

Description of road surface

- Side notes: data handling and performance

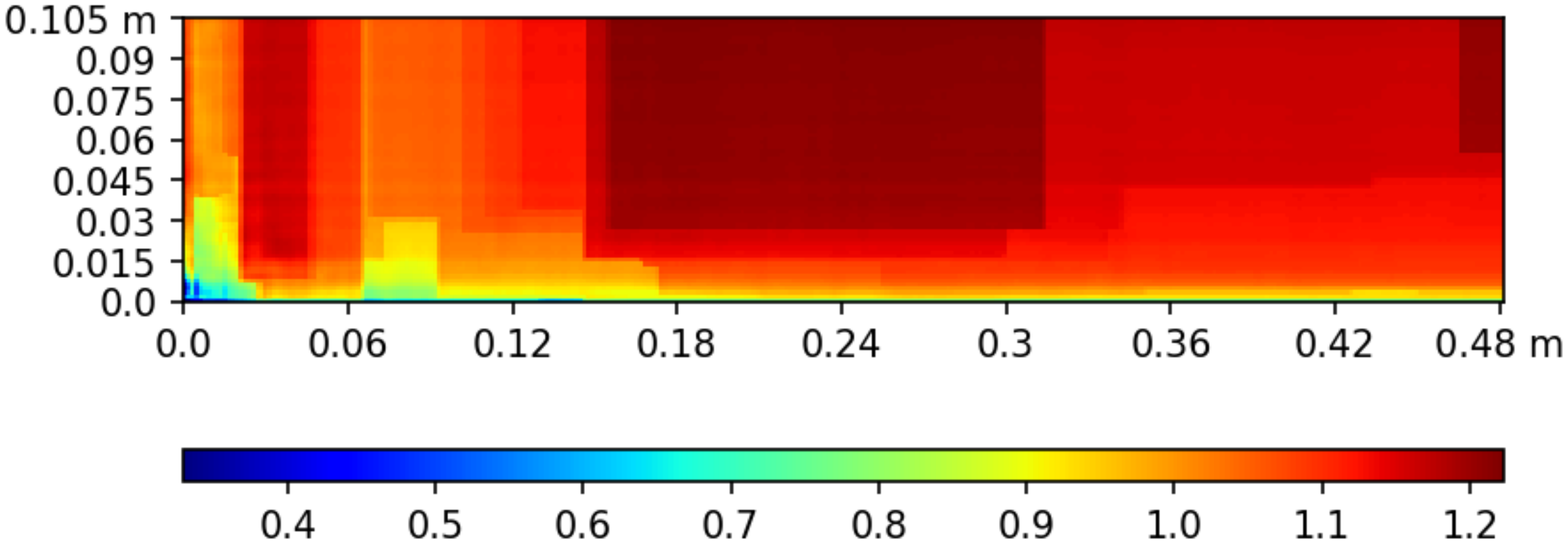
CALCULATION OF TEXTURE PARAMETERS

Cut windowed textures to patches



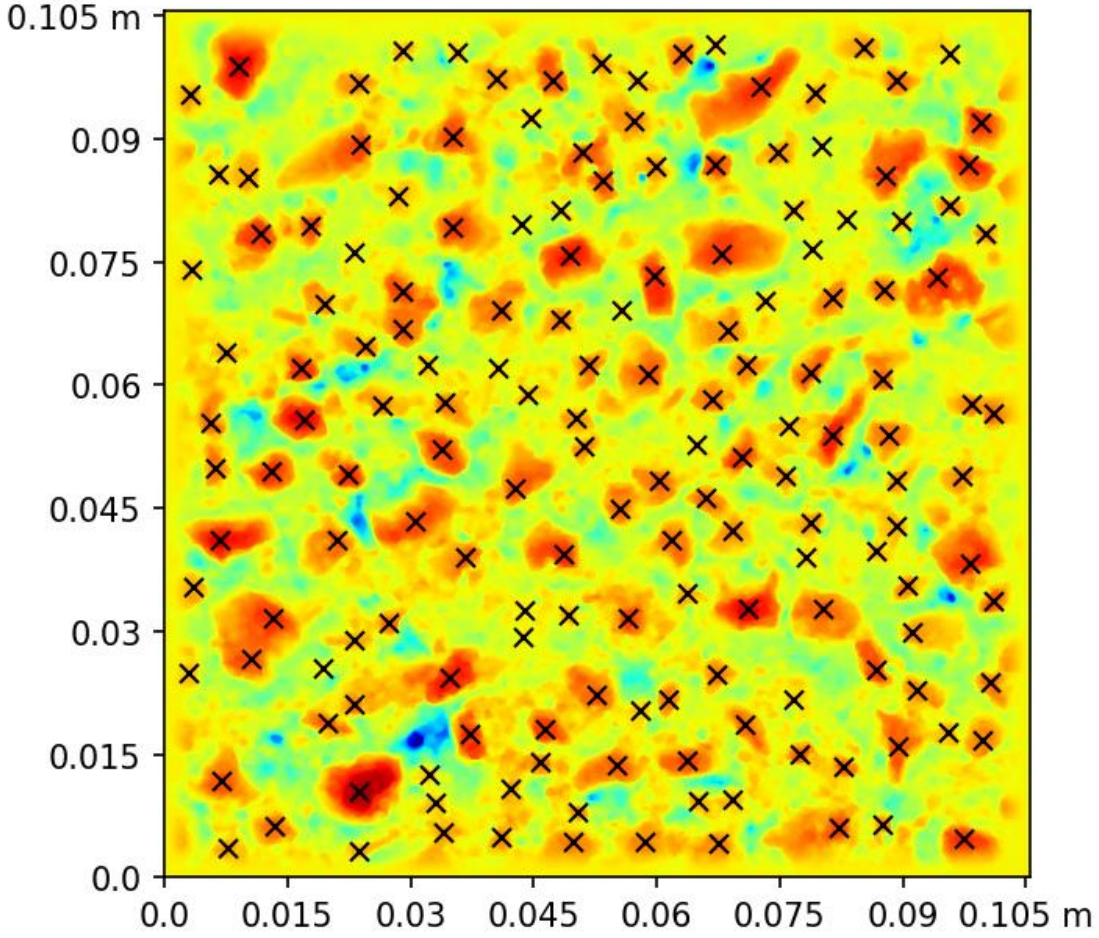
CALCULATION OF TEXTURE PARAMETERS

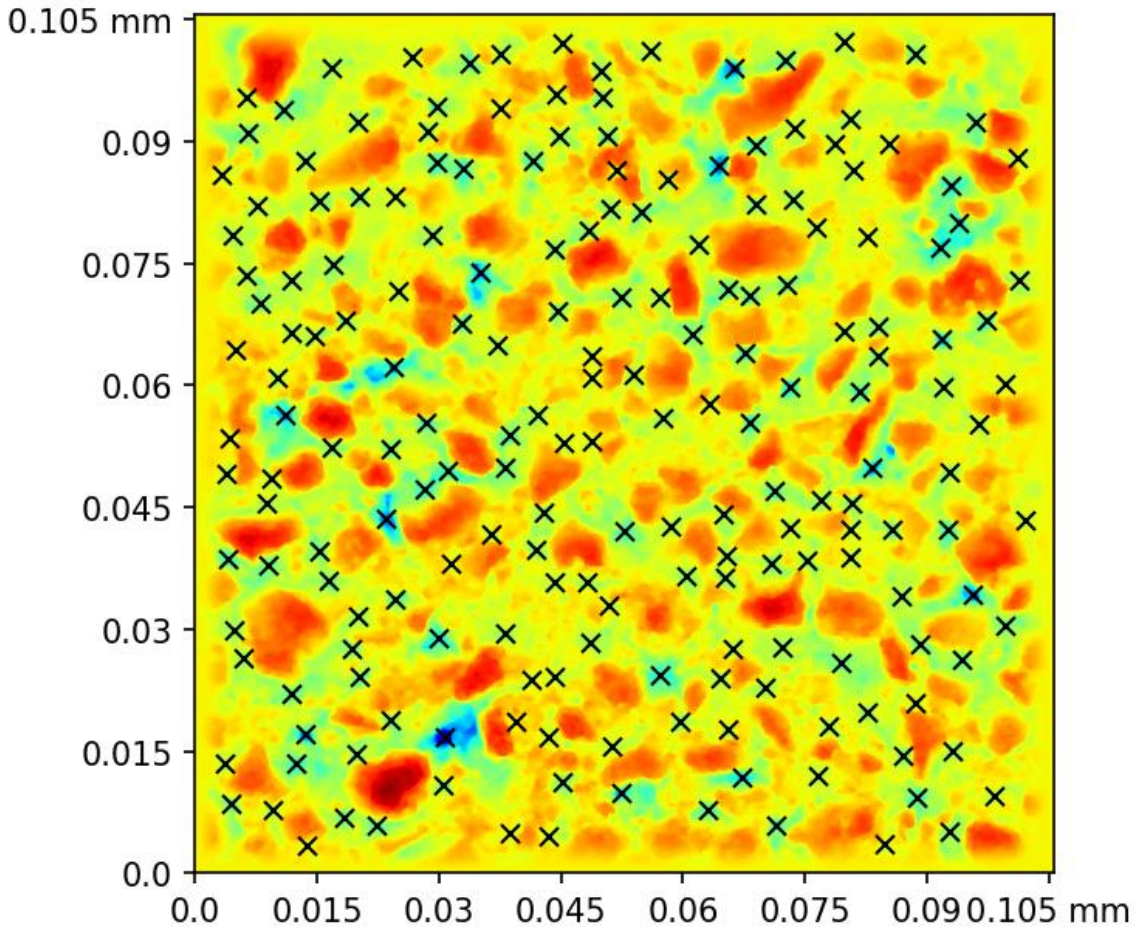
Example: calculation of MPD(-like) parameter on different texture shapes



CALCULATION OF TEXTURE PARAMETERS

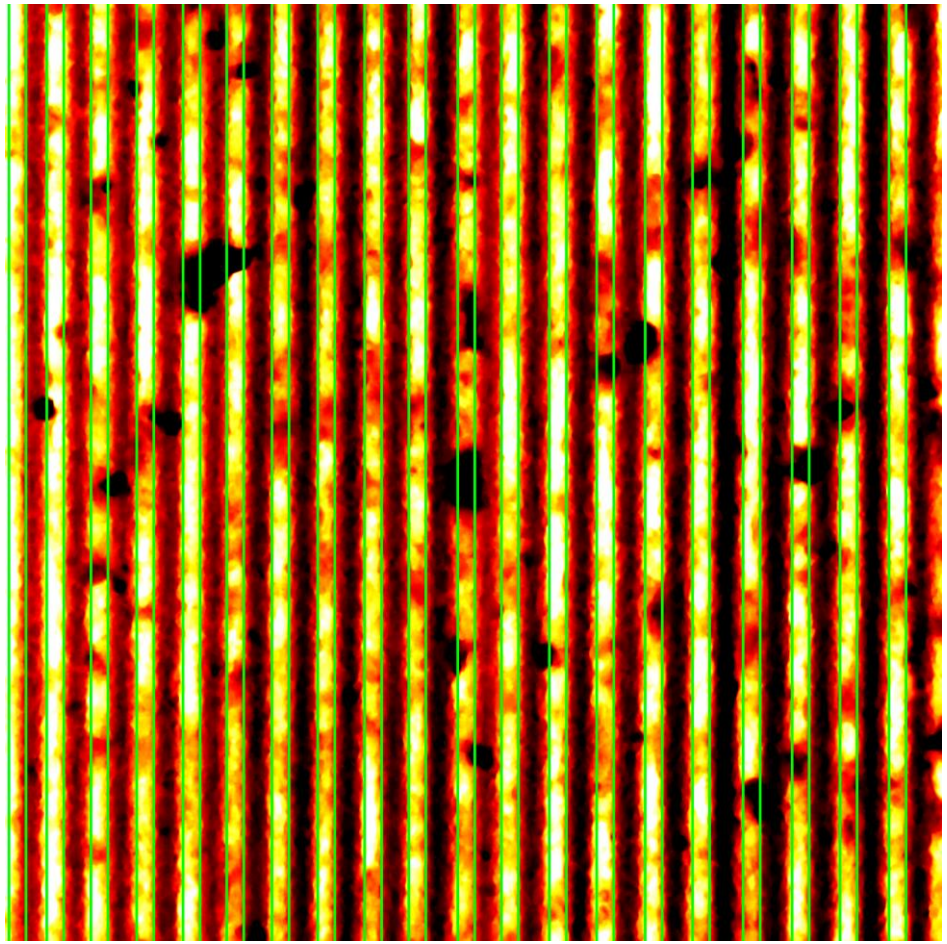
Texture parameters: local maxima and minima

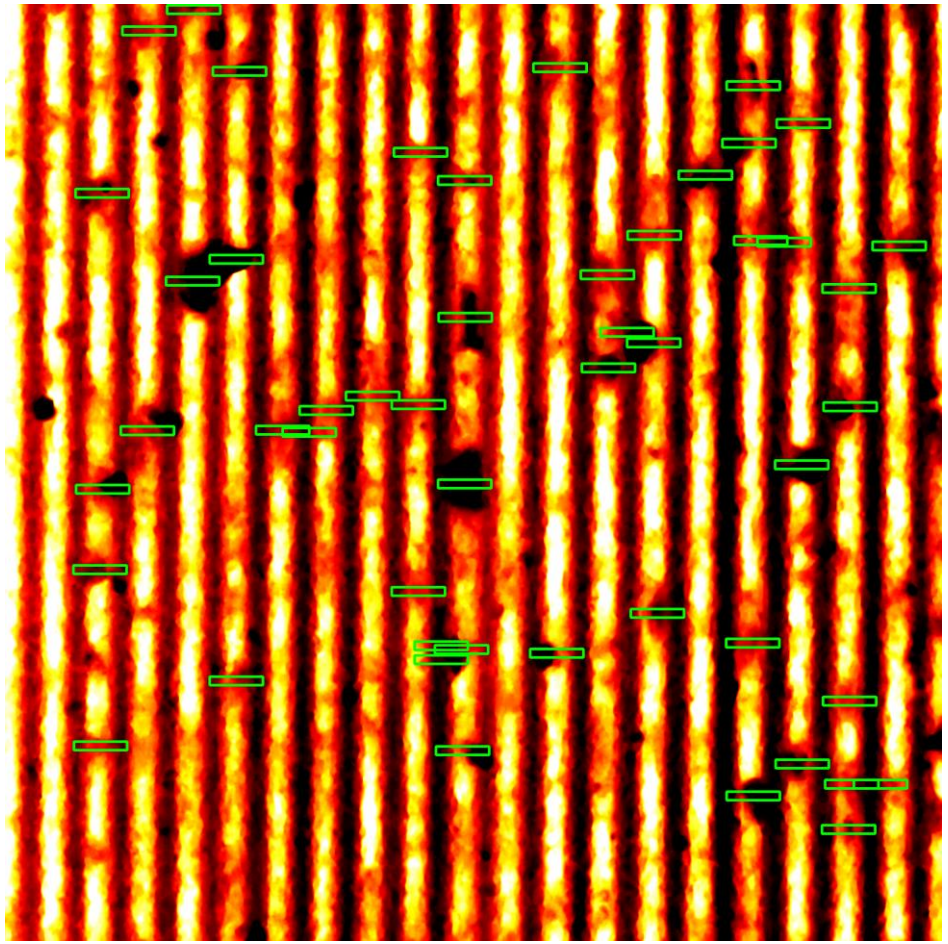




CALCULATION OF TEXTURE PARAMETERS

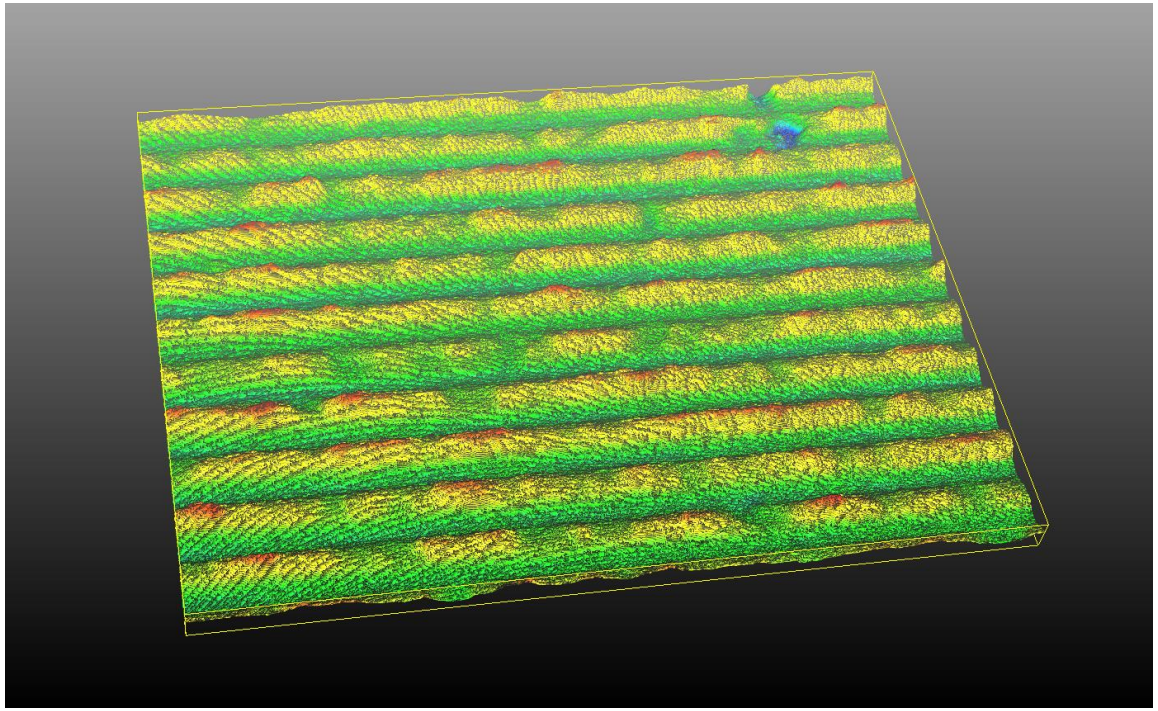
Specialised feature detection: detection of diamond grinding bars and fractures

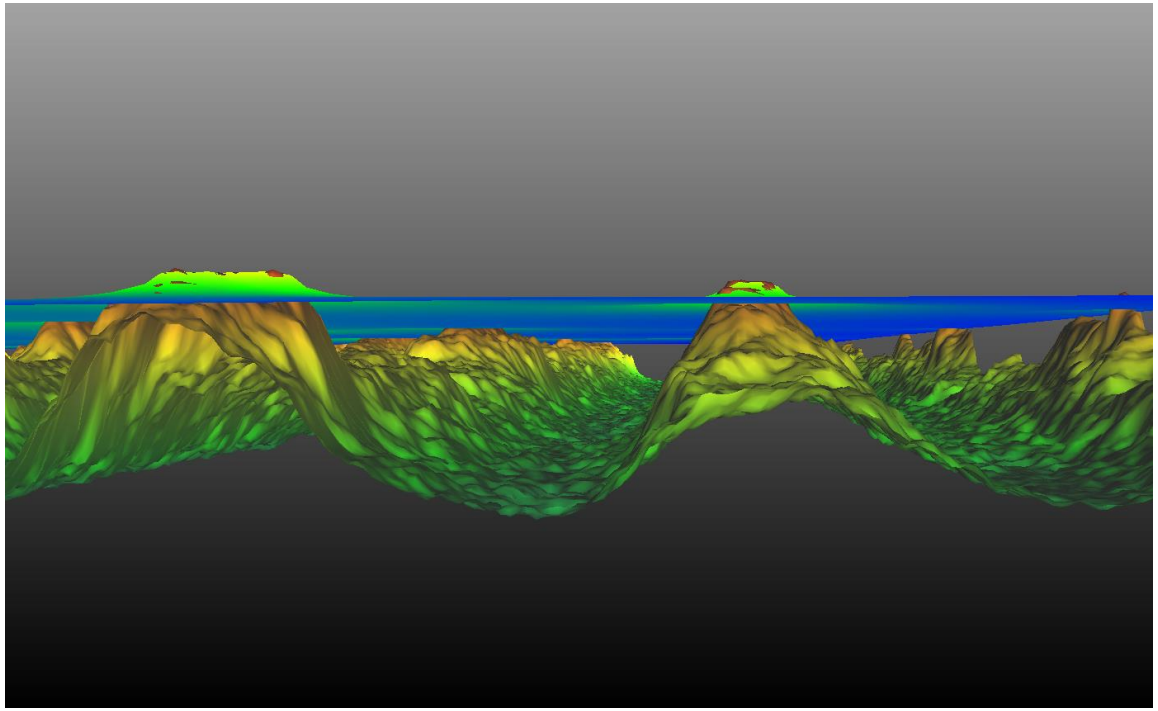




CALCULATION OF TEXTURE PARAMETERS

Calculation of tyre deformation in contact patch and cavity between tyre and road surface





DATA PROCESSING

Spatial data and image processing – open-source libraries

DATA PROCESSING

- 3D point cloud

Raw data

- Data processing on (continuous) texture – outlier and dropout treatment
- Possible need for regularisation of point cloud – dependent on resolution and aim

- Levelling of texture patches
- Windowing for treatment of spectral leakage

Pre-Processing

- Calculation of texture parameters on single patch

Description of road surface

- Side notes: data handling and performance

Usability

THANK YOU!

R. Wehr
reinhard.wehr@ait.ac.at