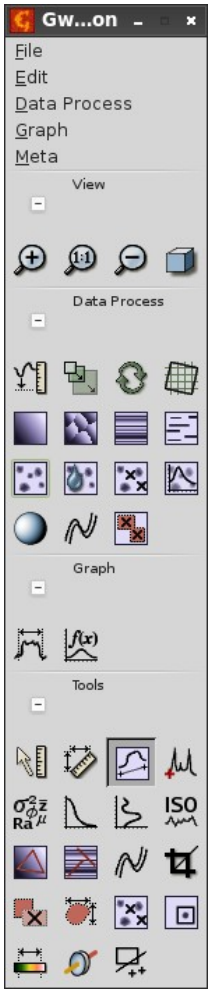
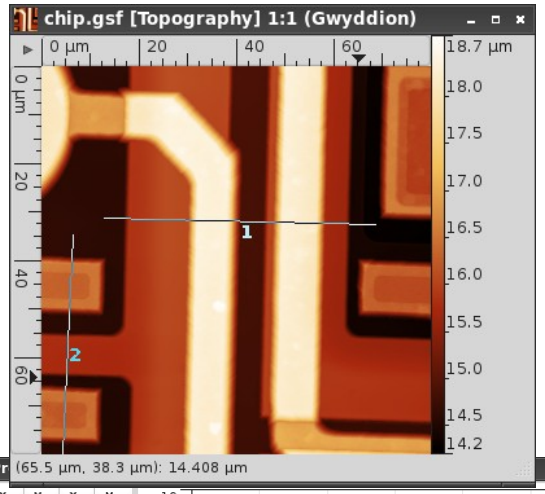
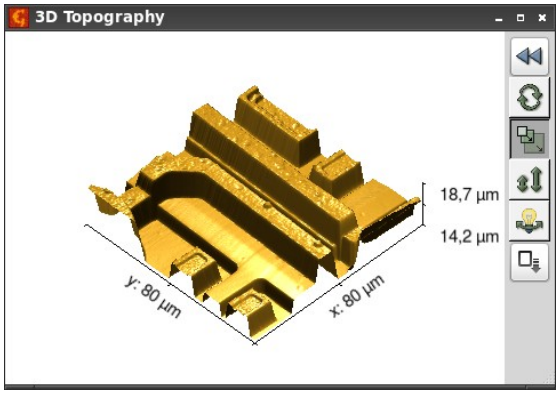
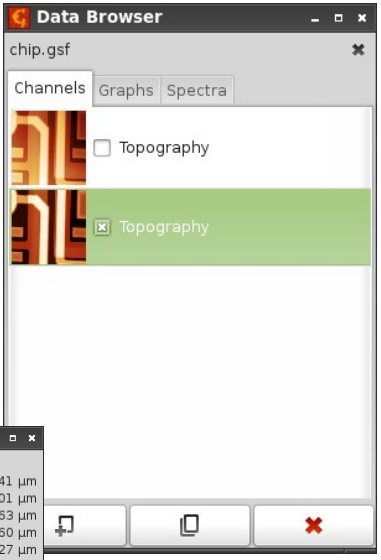
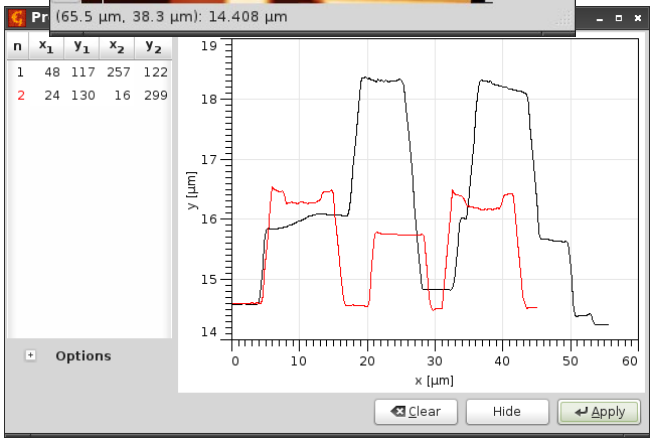
Gwyddion

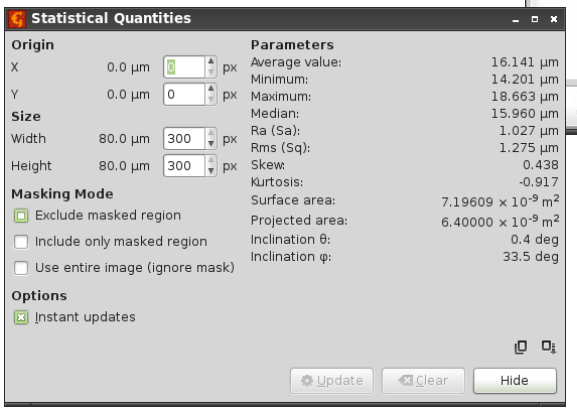












Analysis and processing of SPM data

Introduction

- Gwyddion is a free software developed by two researchers from the Czech Metrology Institute (http://www.cmi.cz), dedicated to the analysis and the processing of SPM data
- Website : http://gwyddion.net
- Main developers:
  - David Nečas (Yeti)
  - Petr Klapetek
- Current stable version (April 2012) : 2.27
- Available languages: Czech, English, French, German, Italian, Russian, Spanish

Introduction

- Gwyddion is available for the following operating systems:
  - Linux
  - Windows
  - Mac OS X
  - FreeBSD
- The latest beta binaries are updated daily for Windows and for Ubuntu-based distributions *via* a PPA: ppa:gwyddion-spm/gwyddion-svn
- Sources are also updated daily

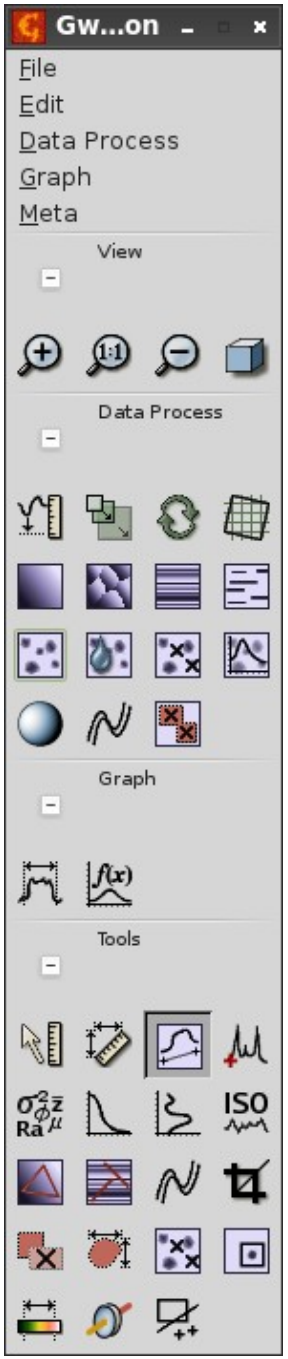
Development

- Developers are always ready and open to add new features :
  - New processing module
  - Import of unsupported formats (if you provide enough documentation and example files)
  - You should suscribe to the user list for that:
    - https://lists.sourceforge.net/lists/listinfo/gwyddion-users
- Of course, you can also participate by creating new processing or import modules

File formats

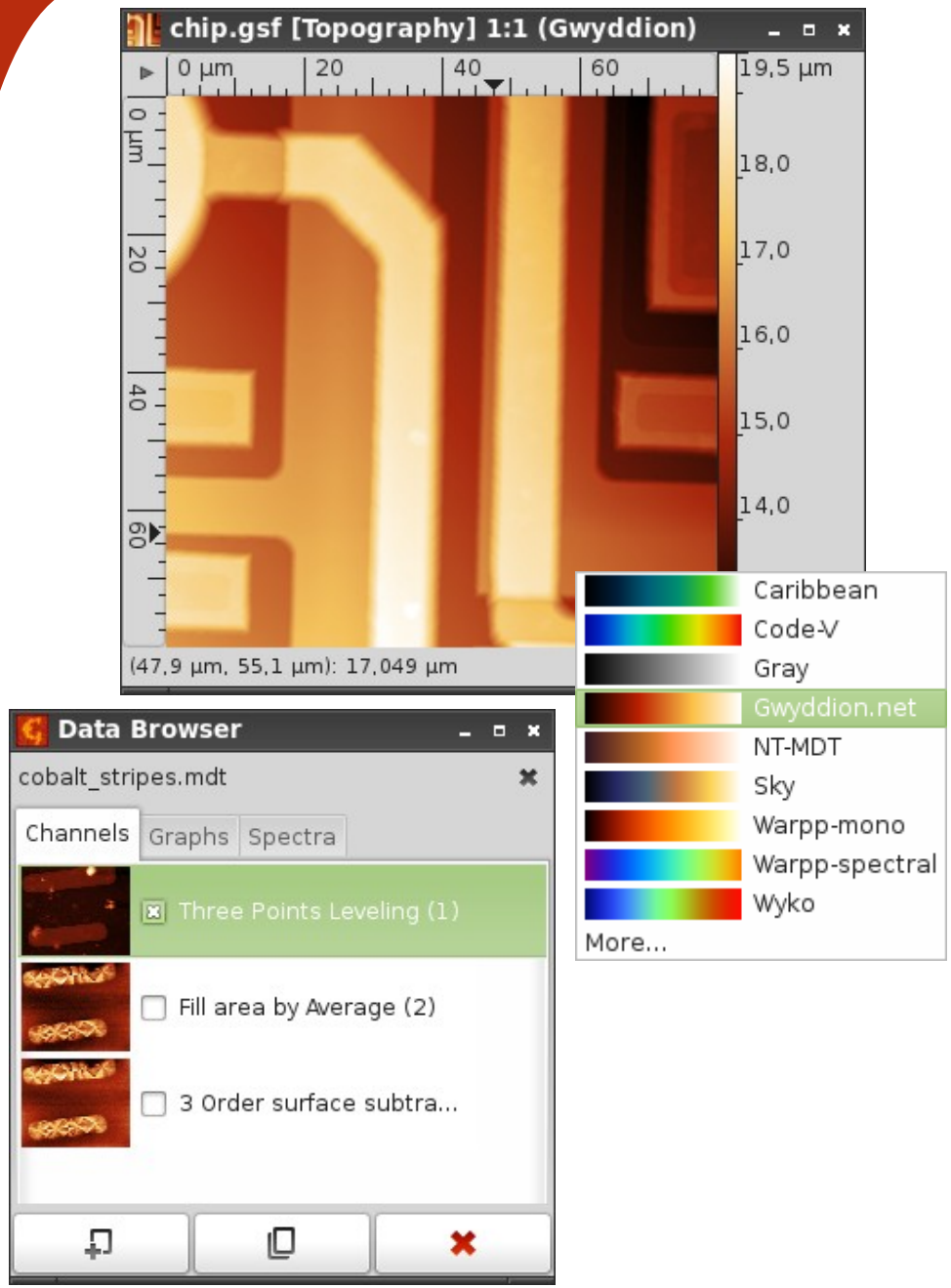
- One of the main goals of Gwyddion is to allow the import of as much formats as possible
  - More than 90 file formats are currently supported
  - Unsupported text and binary files can be manually imported
- Several exported formats are available
  - Gwyddion native: saves all channels, curves, spectra
  - Gwyddion simple field : single-channel format
  - ISO 28600:2011
  - Some SPM formats
  - Usual image formats : BMP, PNG, JPEG...
  - ASCII text file

Interface



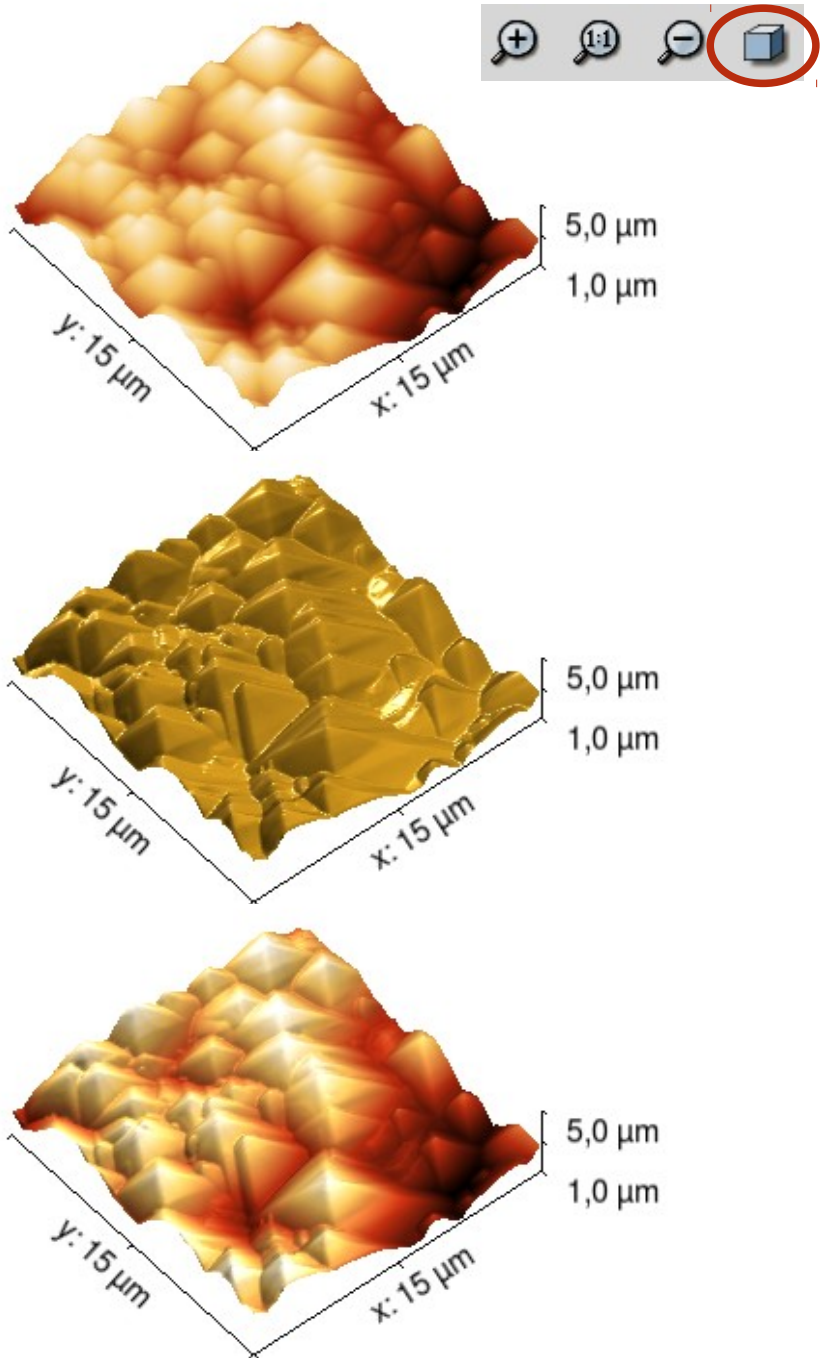
- Gwyddion is very intuitive and simple to use
- The main window comprises:
  - Menus to access all functions
  - Display buttons (zoom, 3D view)
  - Basic processing functions (levelling, artifact correction...)
  - Graph fitting functions
  - Data analysis tools

Data display



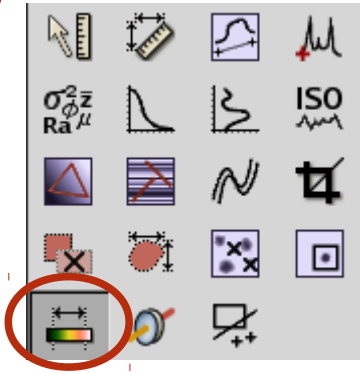
- Gwyddion can display data using various color gradients
  - Right click on the scale will display the gradients list
- The available channels in a given file can be managed with the data browser

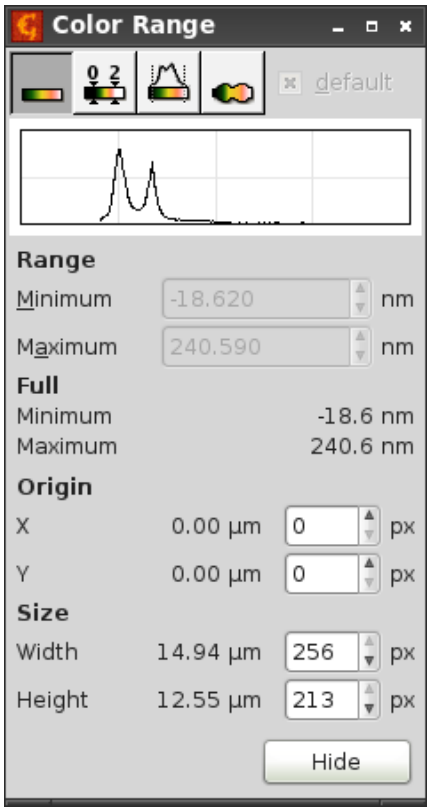
3D display

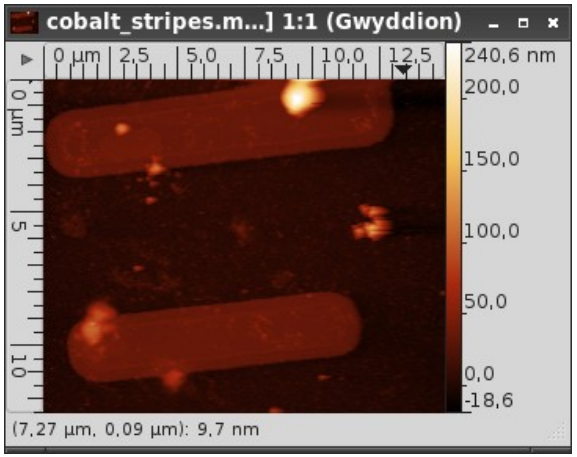


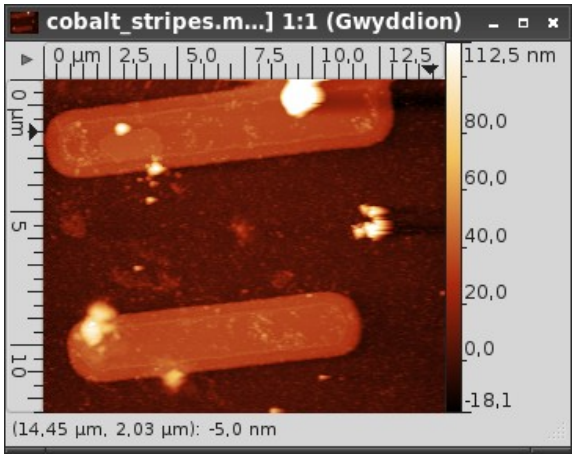
- 3 display modes are avaible:
  - Gradient: uses the same gradients as in the 2D view
  - Lighting: uses a more or less diffusing texture
  - Overlay: uses a gradient or an image over a texture

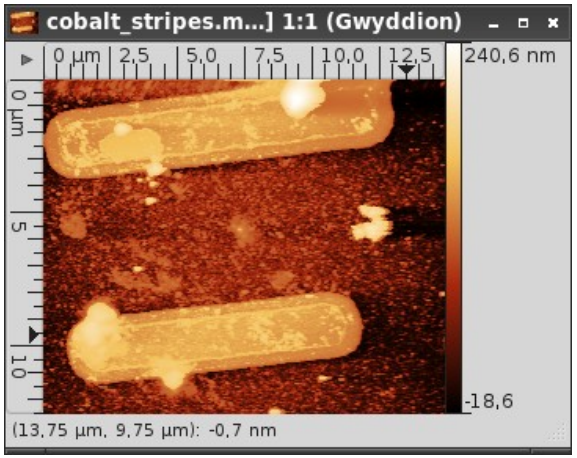
Color scale





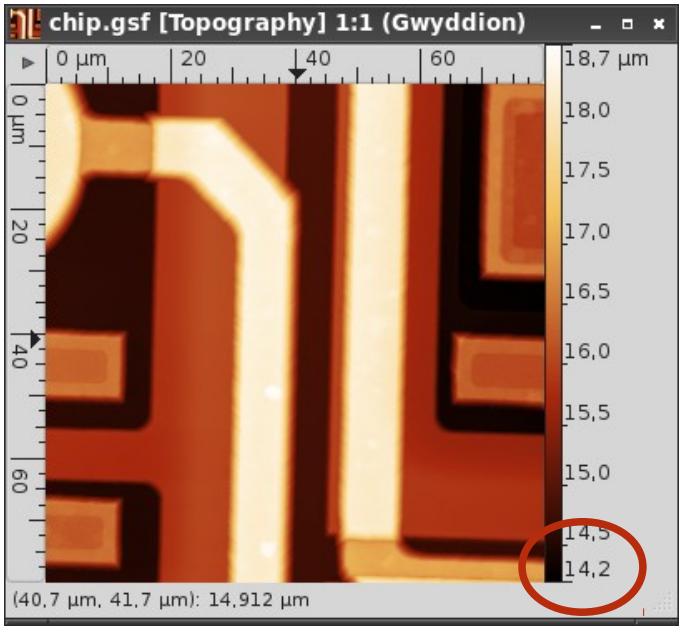


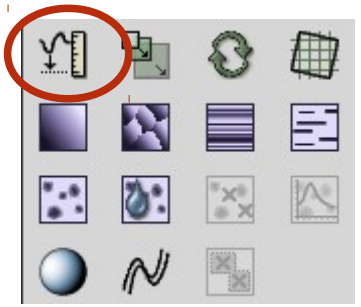


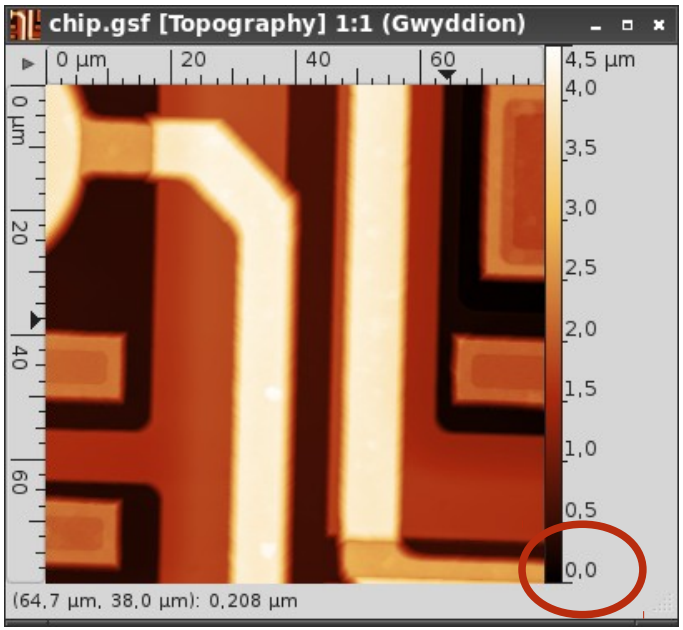


- Several color ranges are available:
  - Full range
  - Partial range, manually defined
  - Automatic range with outliers exclusion
  - Non-linear range

Basic operations: set minimum to zero

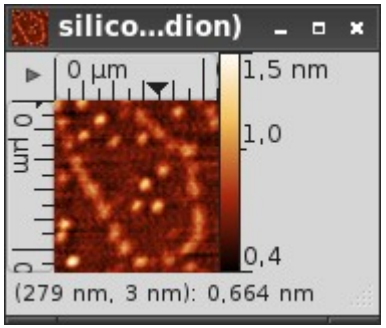


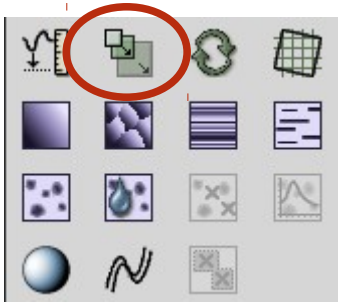




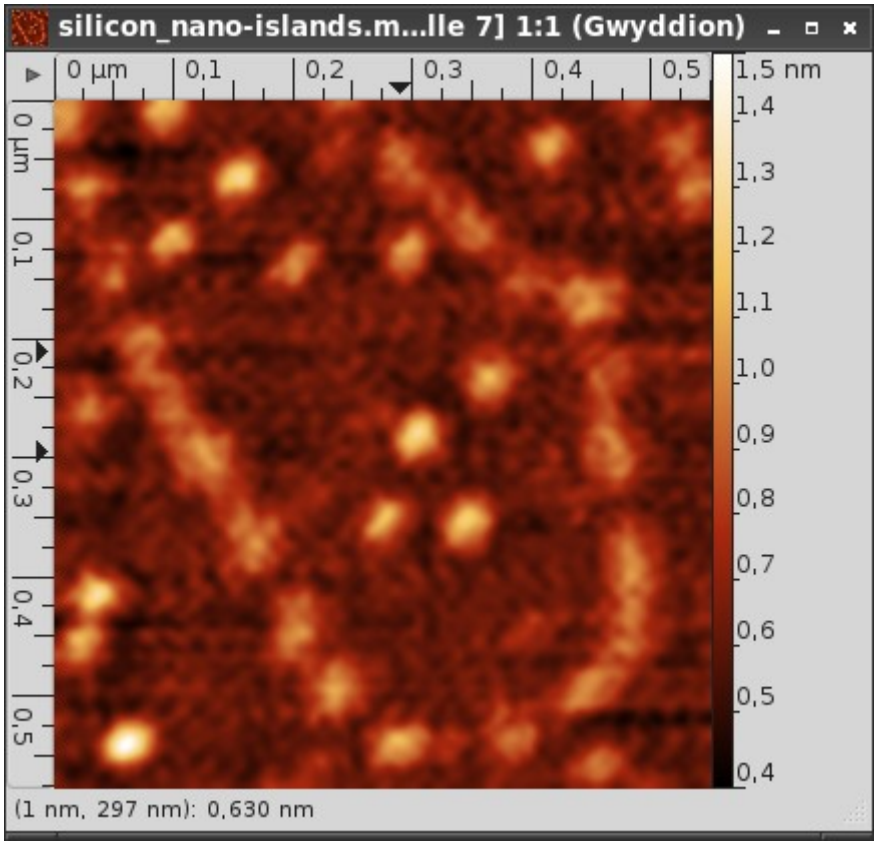
- Modifies the height range so that the minimum value equals zero

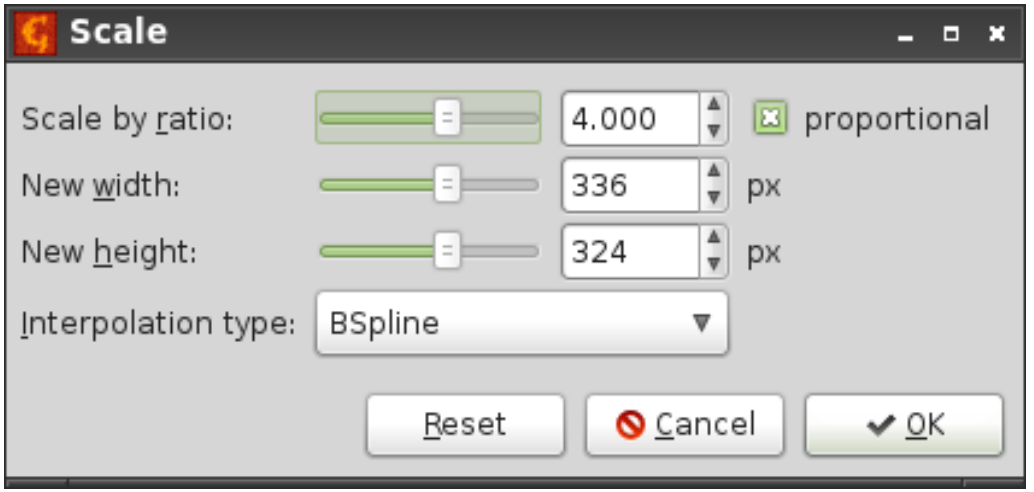
Basic operations: scale change



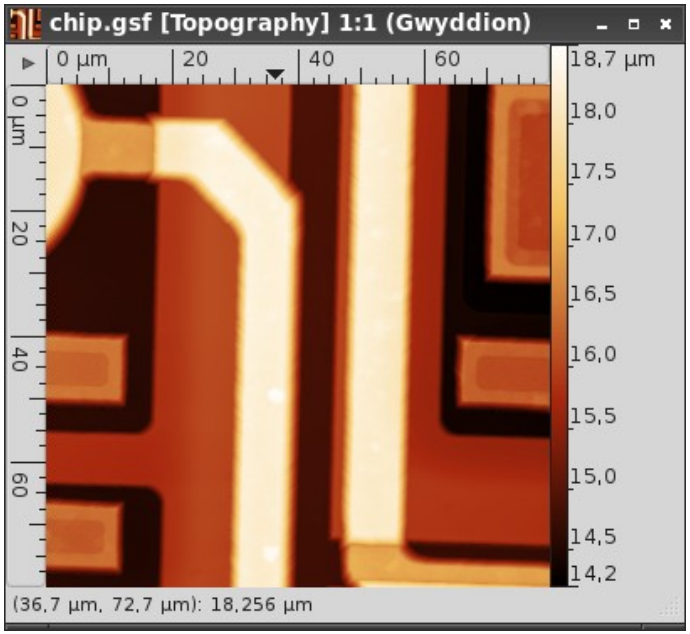


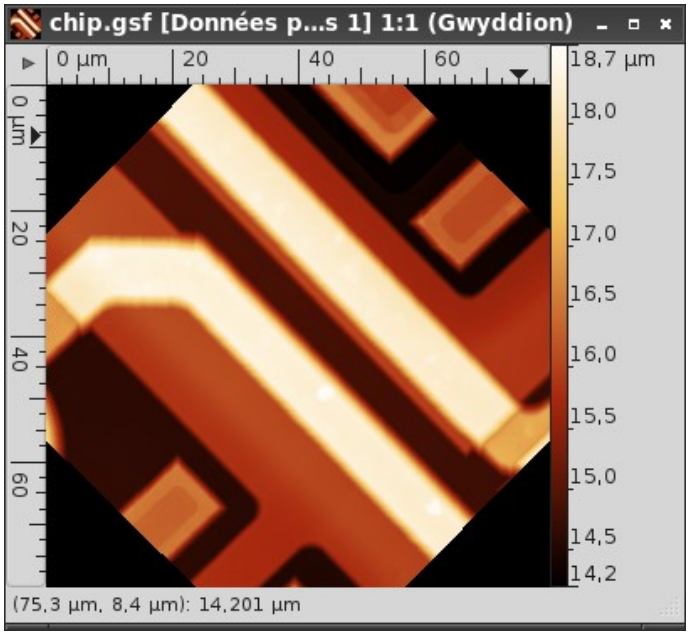
- Allows to resize an image, using various interpolation types

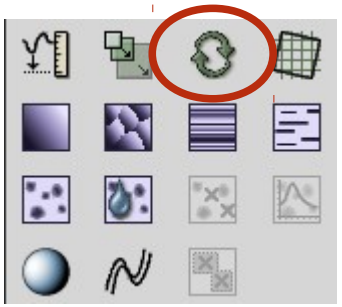




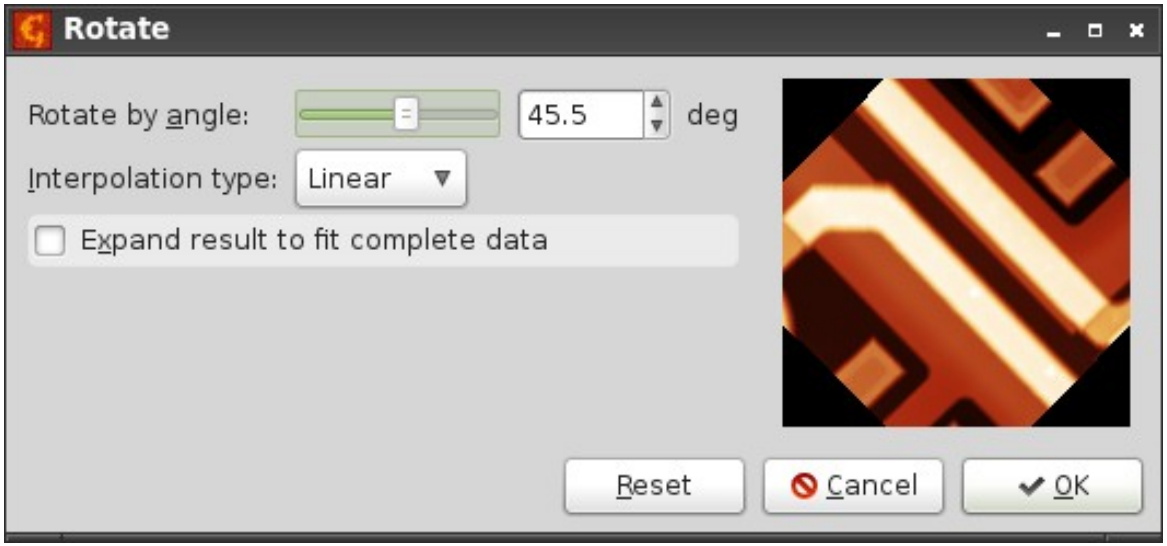
Basic operations: rotation



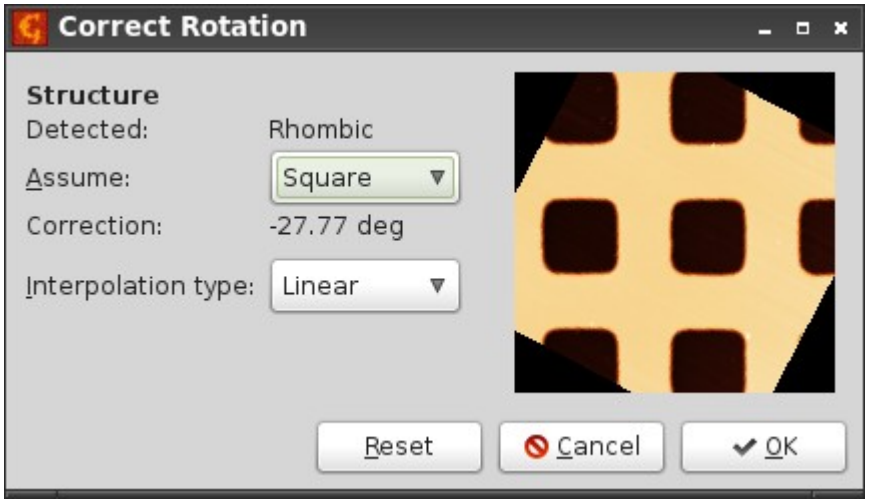


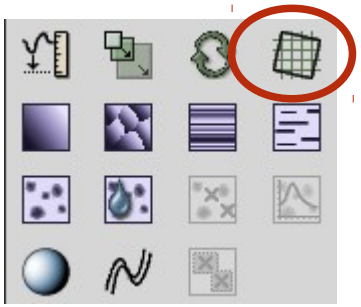


- The image can be rotated using an arbitrary angle

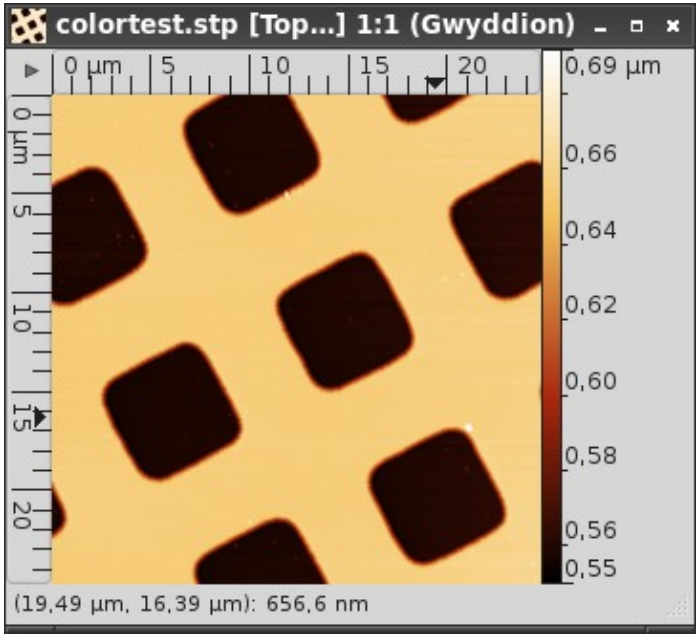


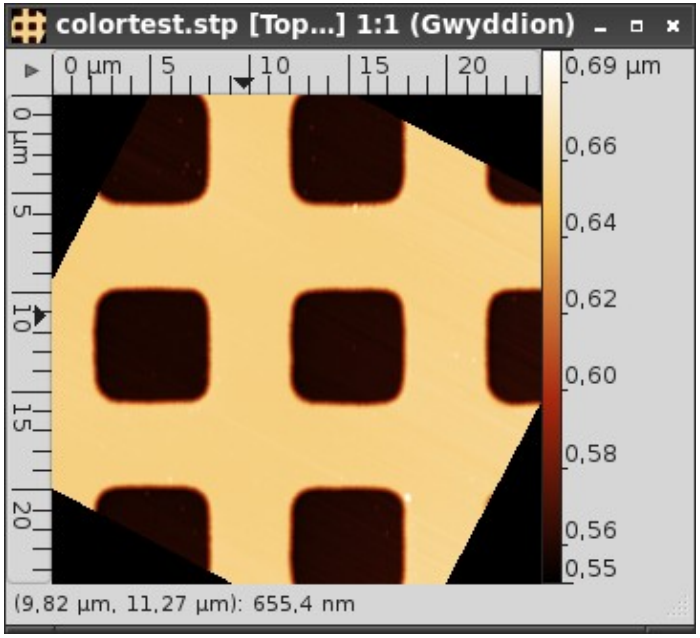
Basic operations: unrotate



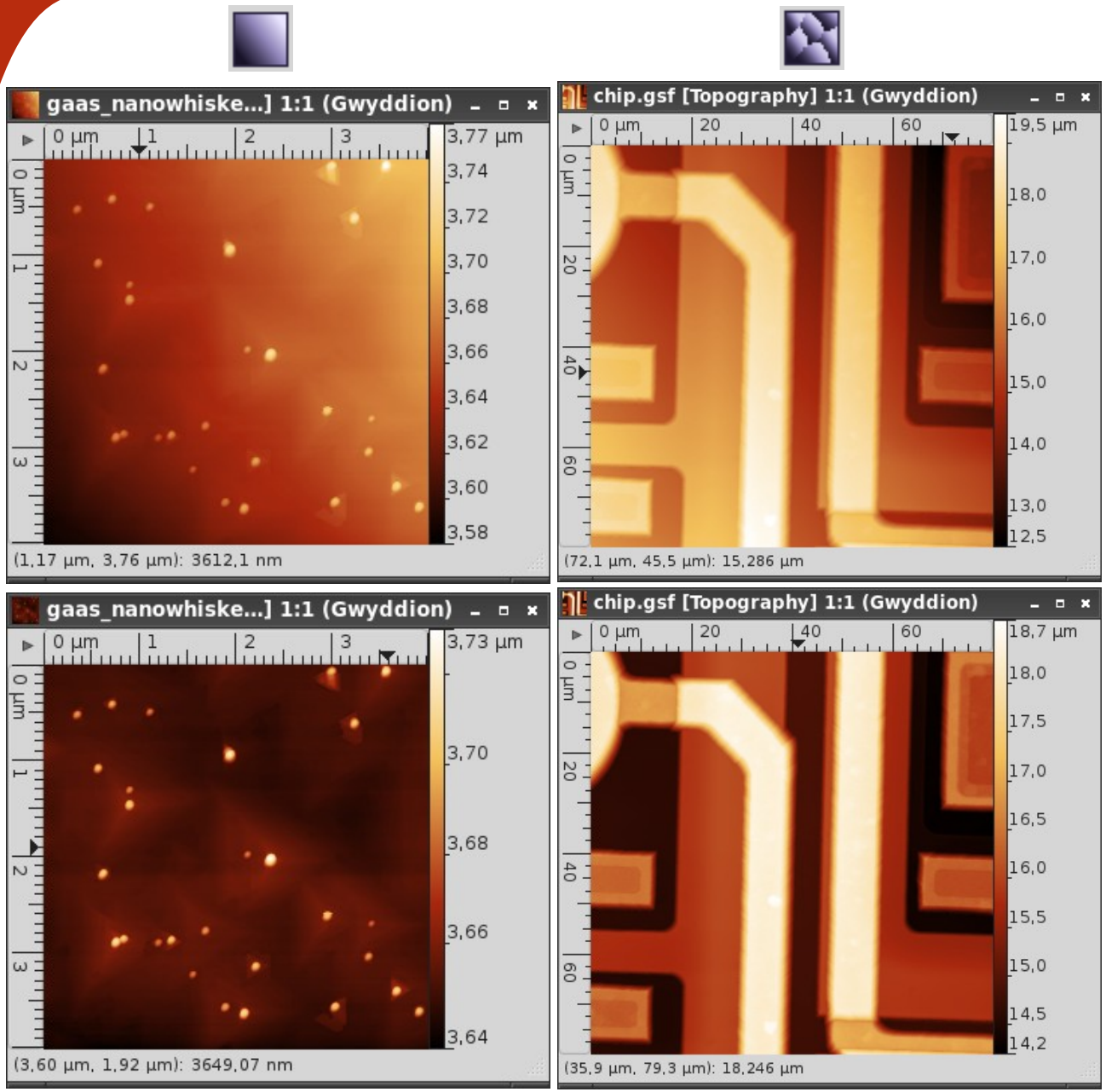


- The image orientation can be corrected taking into account the symmetries present in the data

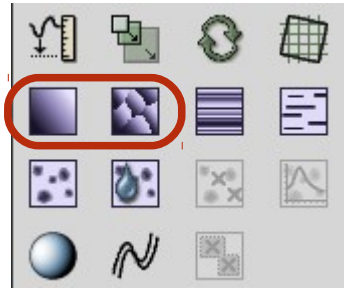




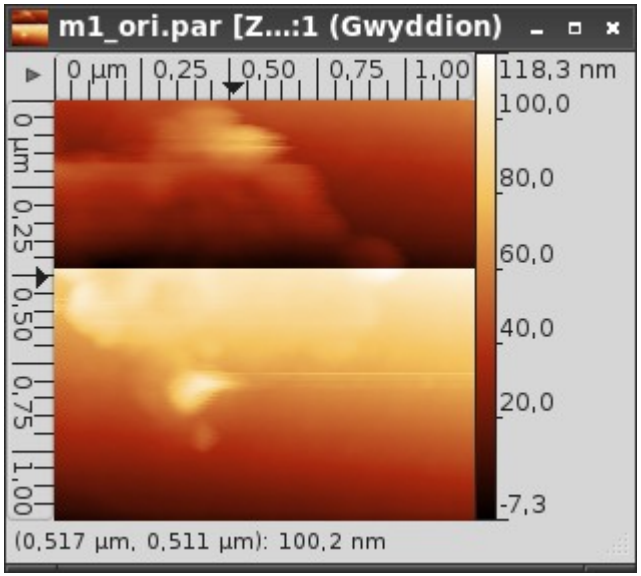
Basic operations: tilt removal

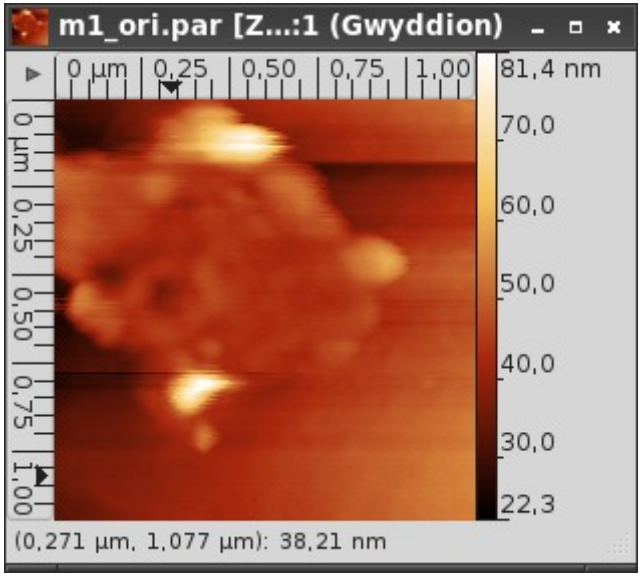


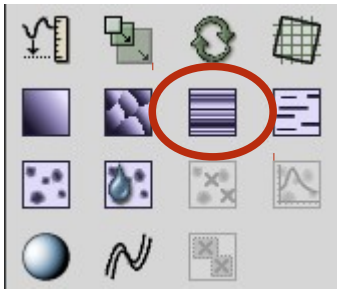
- Tilt can be removed in two ways:
  - Subtracting the average plane
  - Using facet (plane zone) analysis

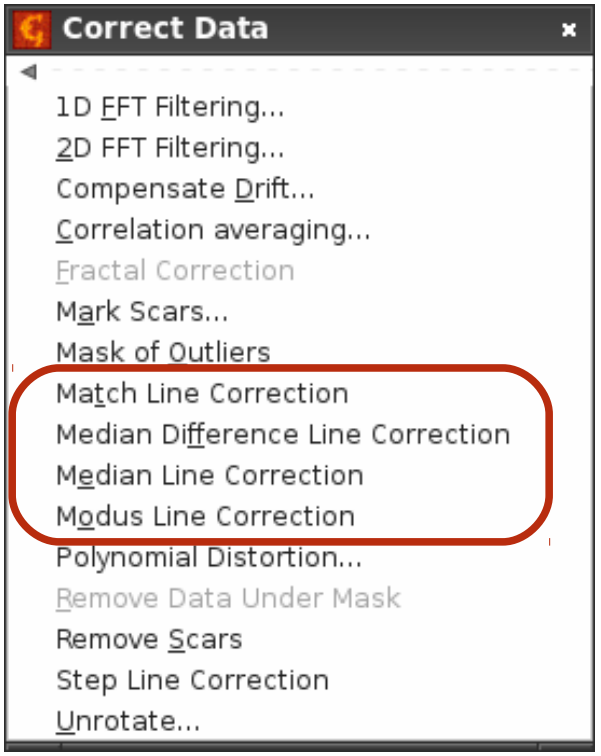


Basic operations: step correction



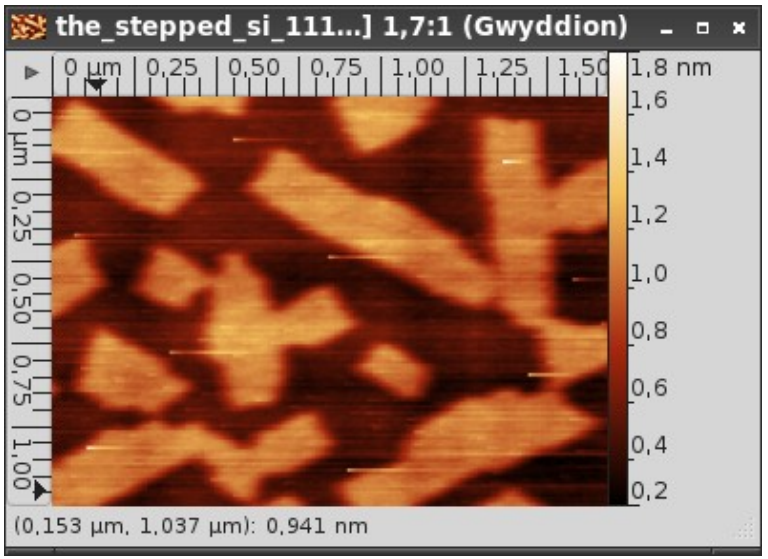




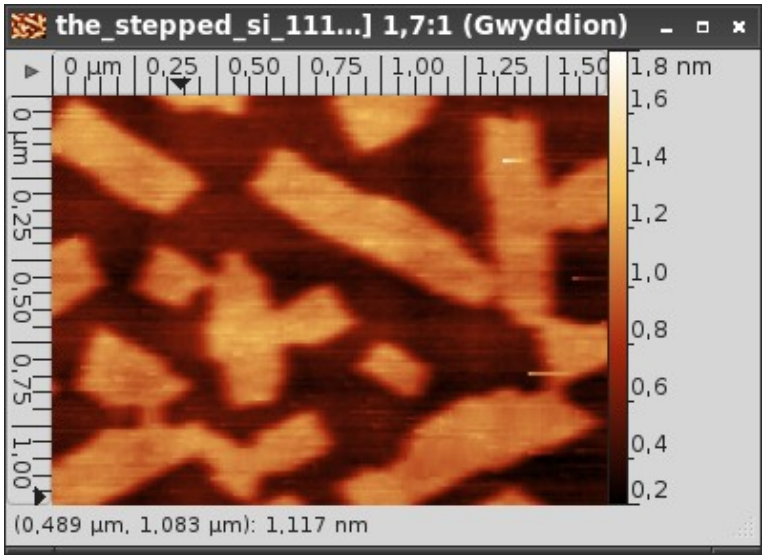


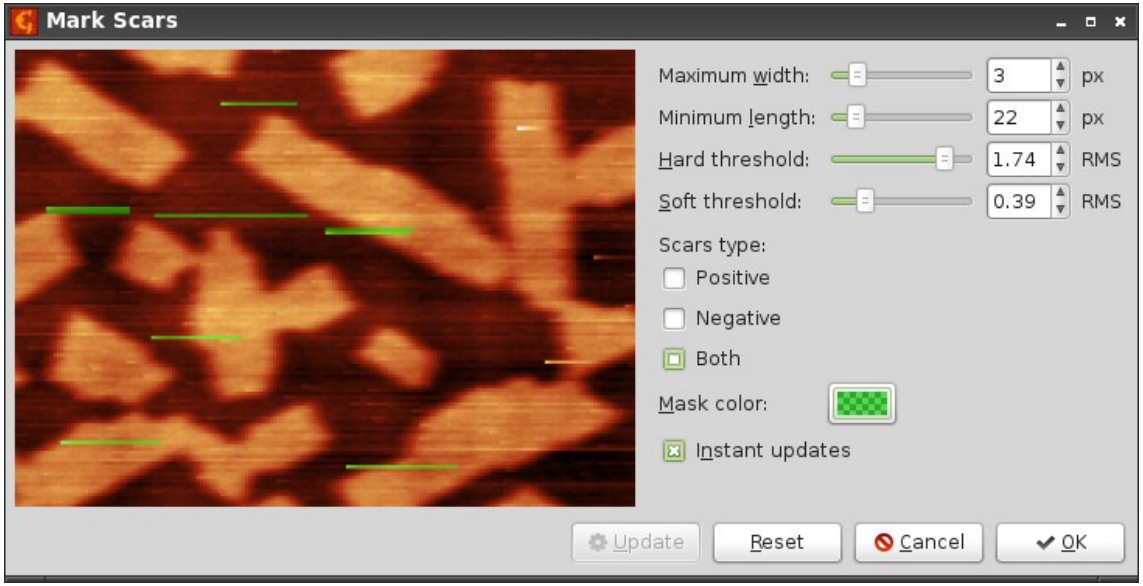
- Median line correction is directly avaible
- Other methods are available in the Data Process → Correct Data menu

Basic operations: artifact correction

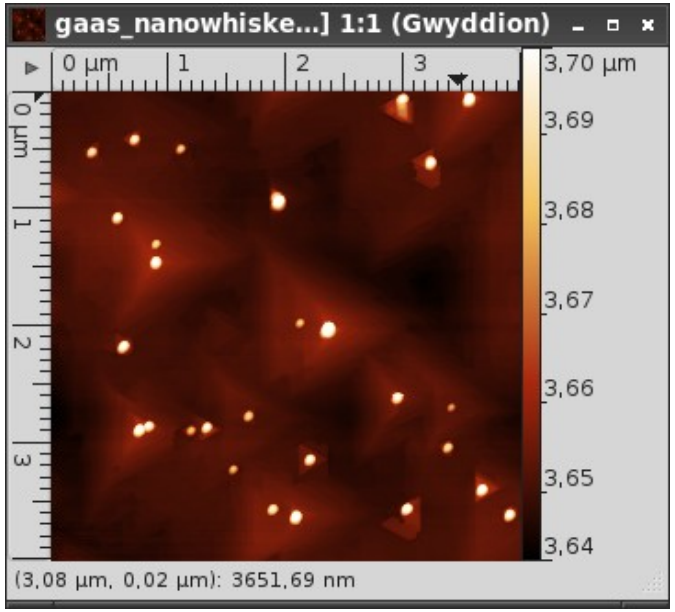


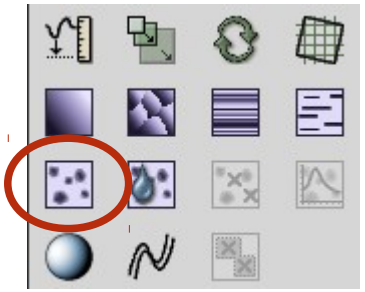
- Linear artifacts can be easily removed
- One can also mark them using Correct Data → Mark scars





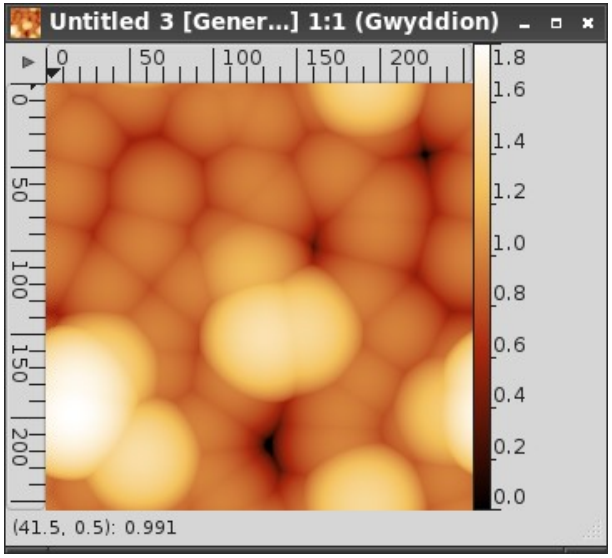
Basic operations: grain marking

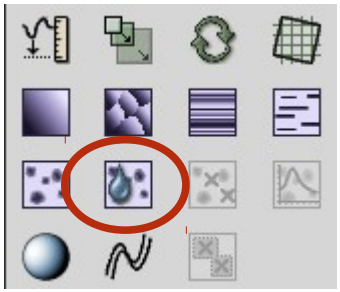




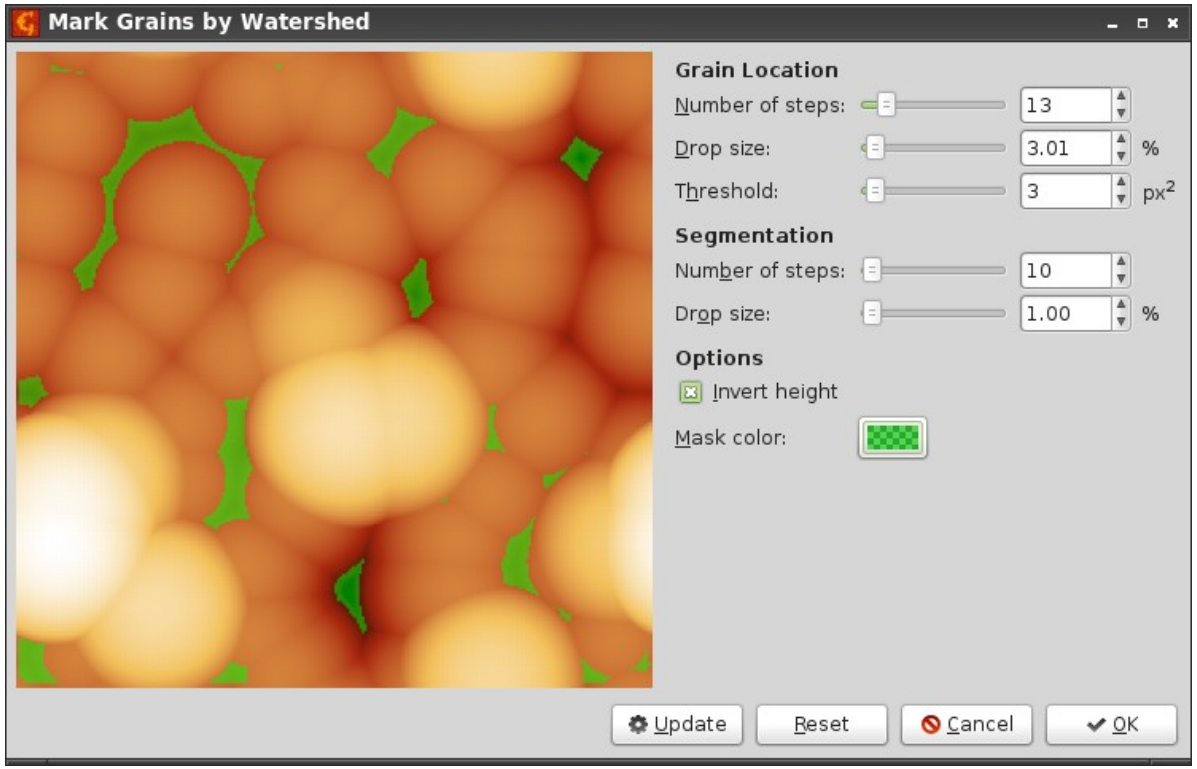
- Local defects (grains) can be marked based on:
  - Relative height
  - Curvature
  - Slope

Basic operations: watershed marking

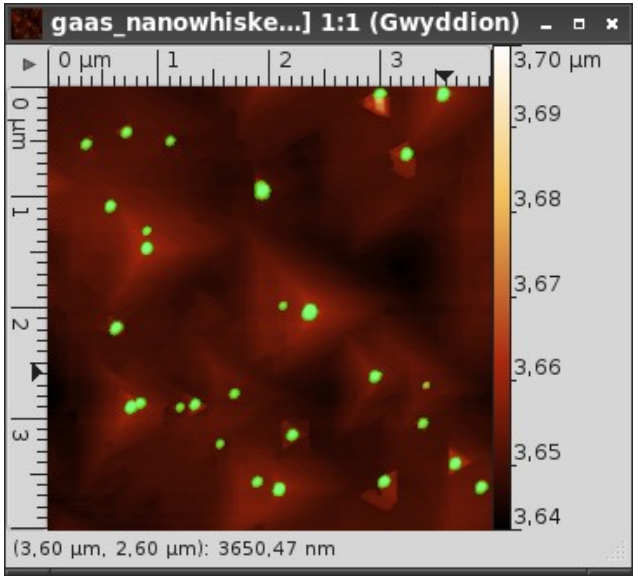


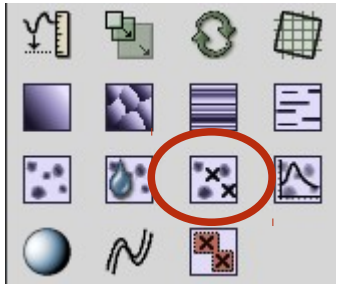


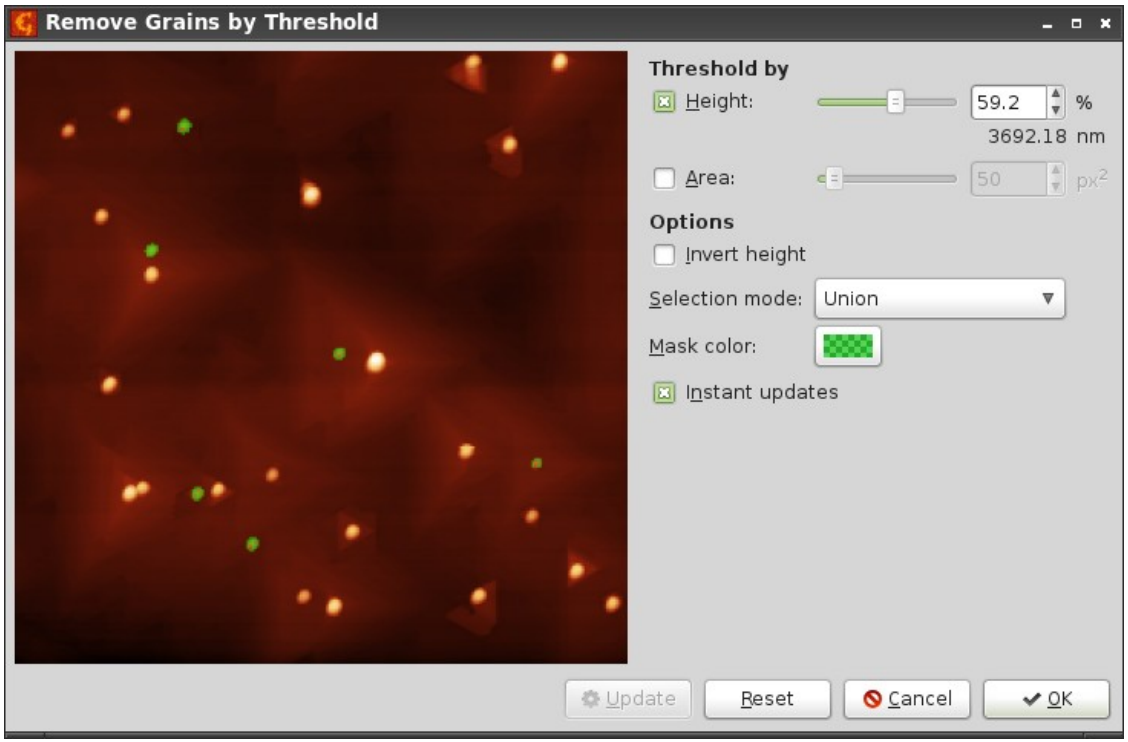
- Watershed allows marking of grains or other areas on more complex surfaces



Basic operations: grain removal

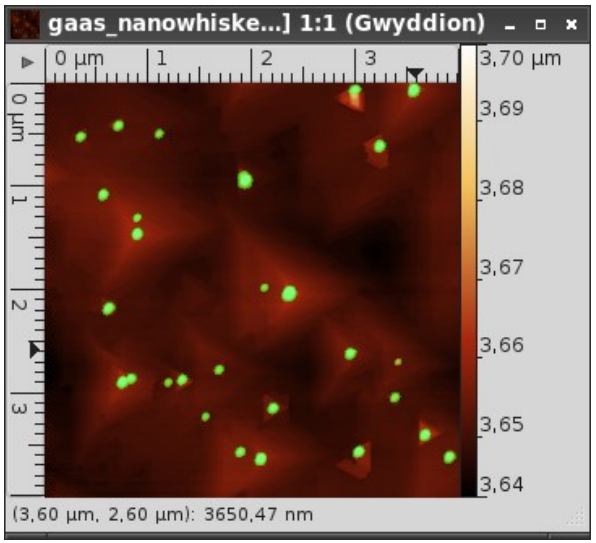


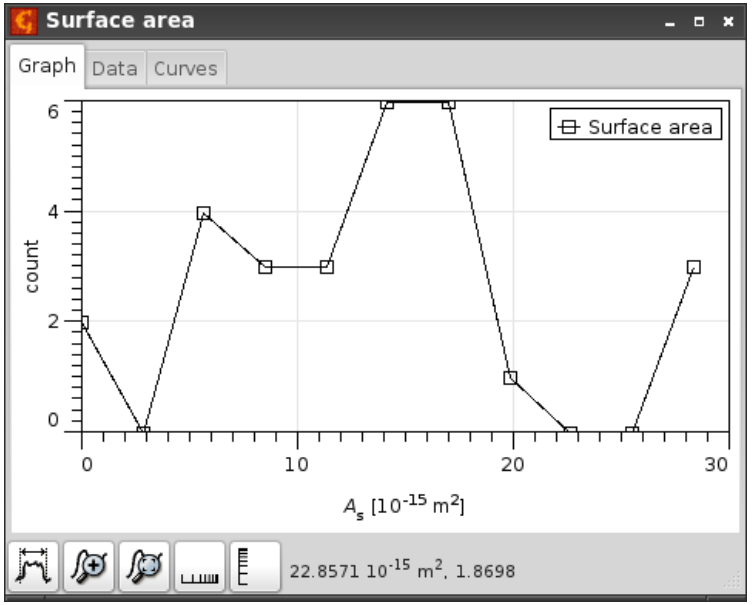


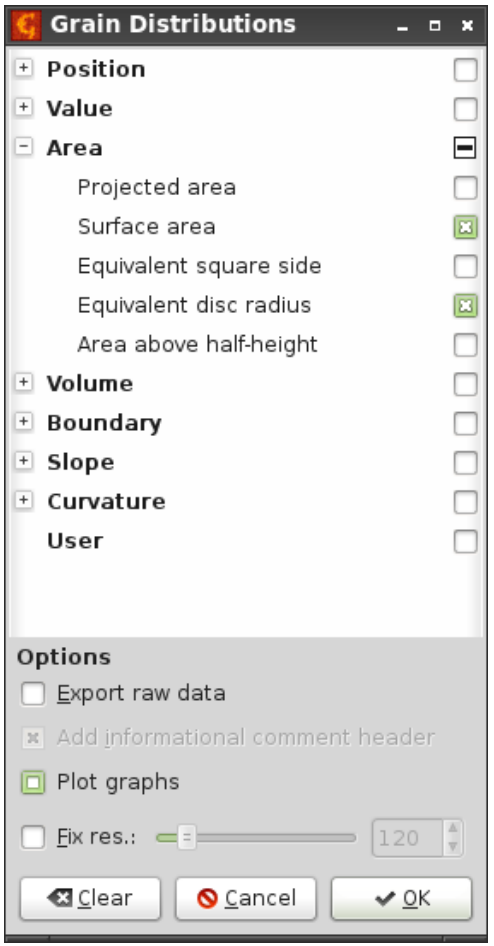


- Inverse function of grain marking
- One can remove marked areas based on relative height or area

Basic operations: grain distributions

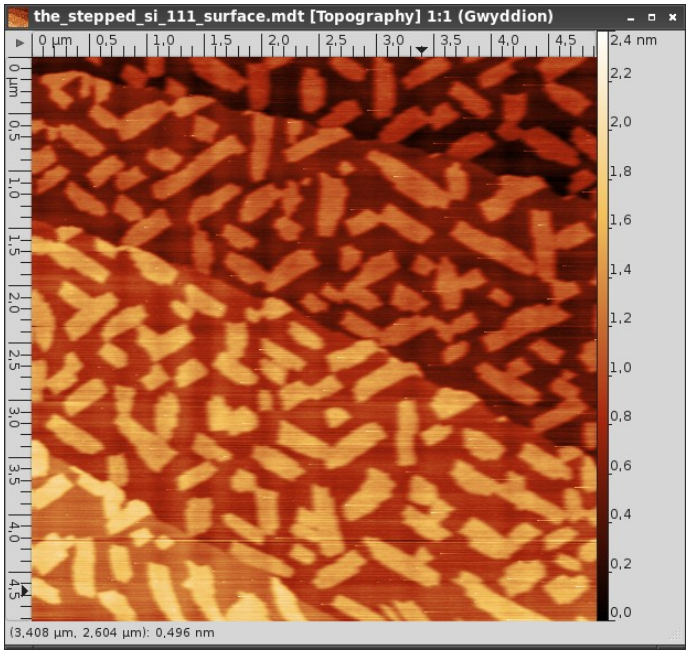


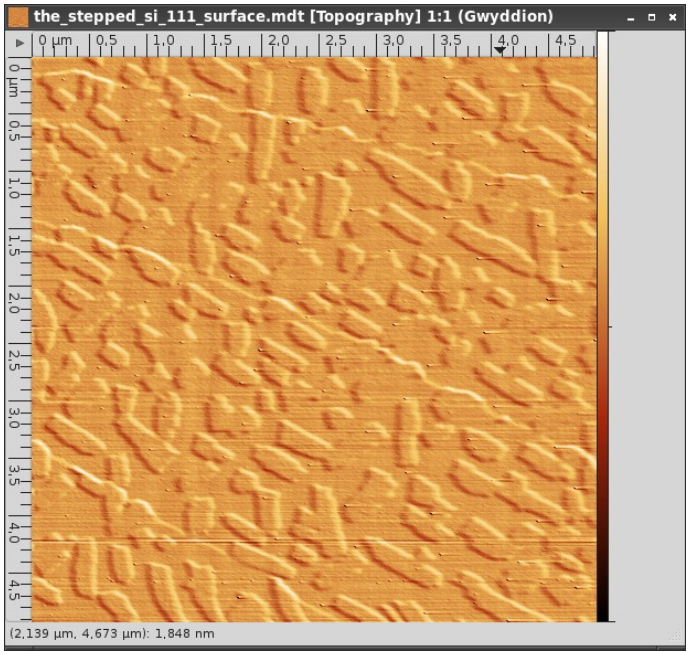


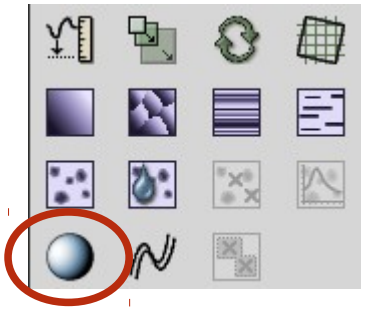


- Provides statistical data of the marked areas:
  - Height
  - Surface
  - Volume
  - ...

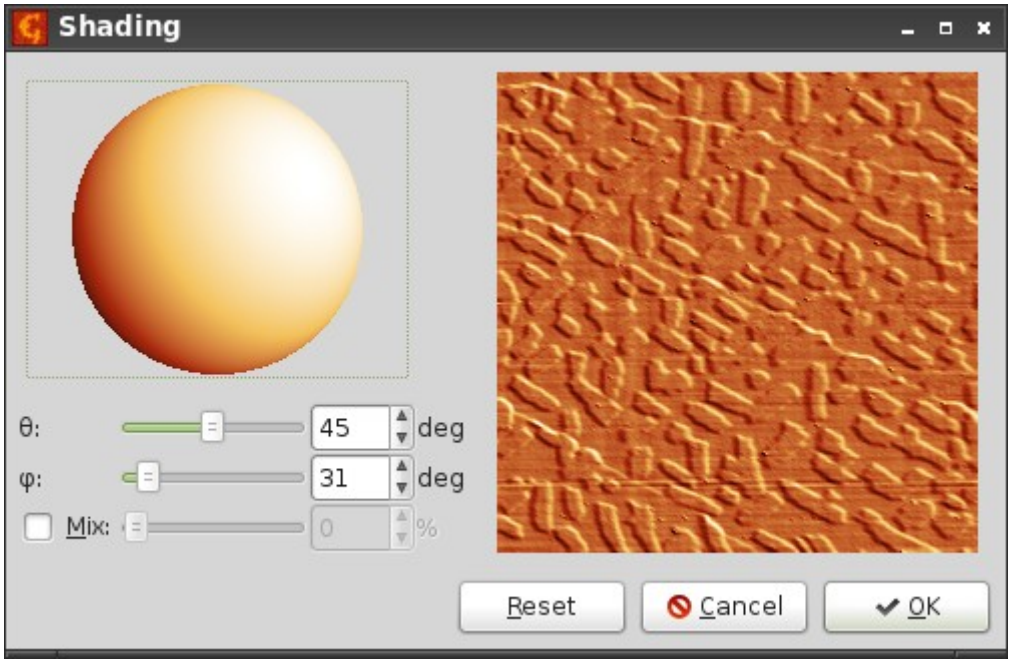
Basic operations: shadow



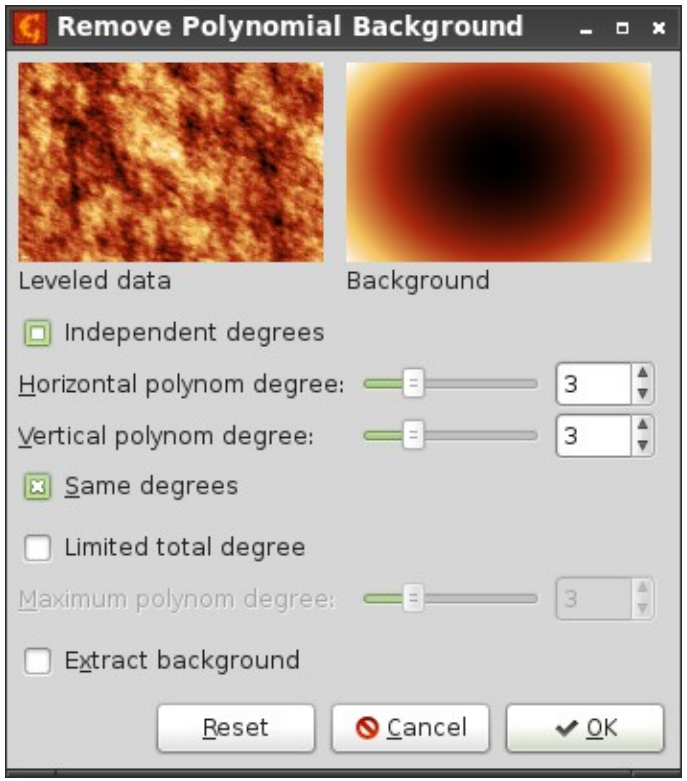


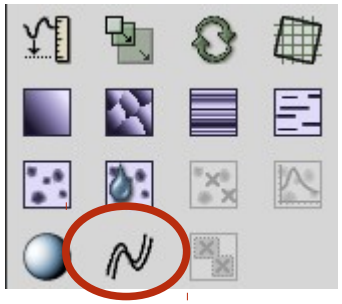


- Creates a shadow effect on the data

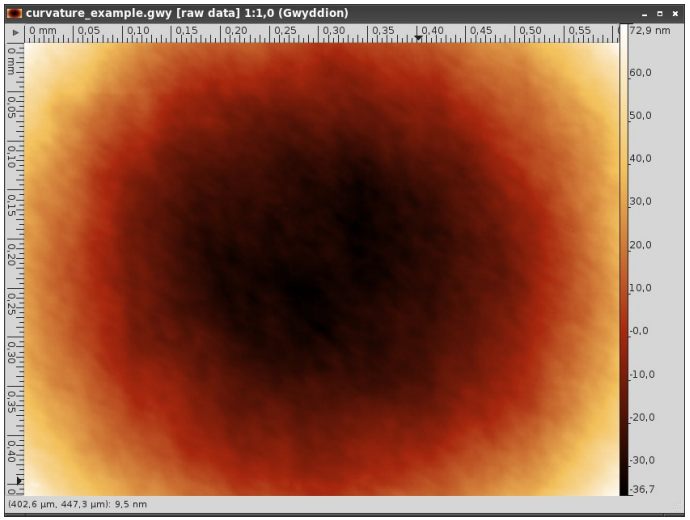


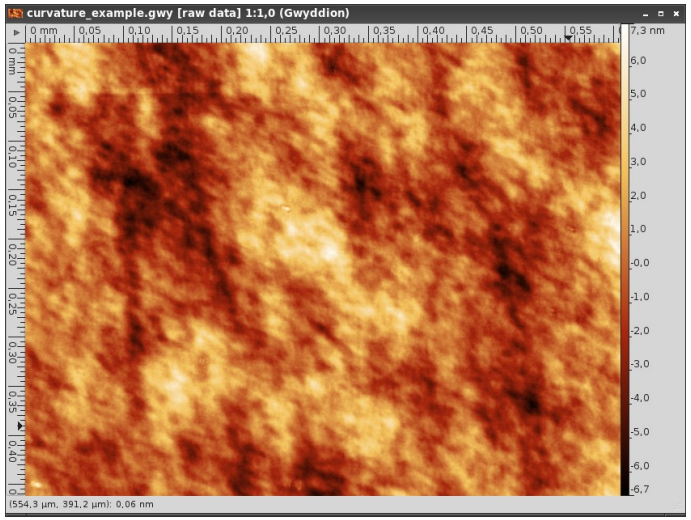
Basic operations: background removal



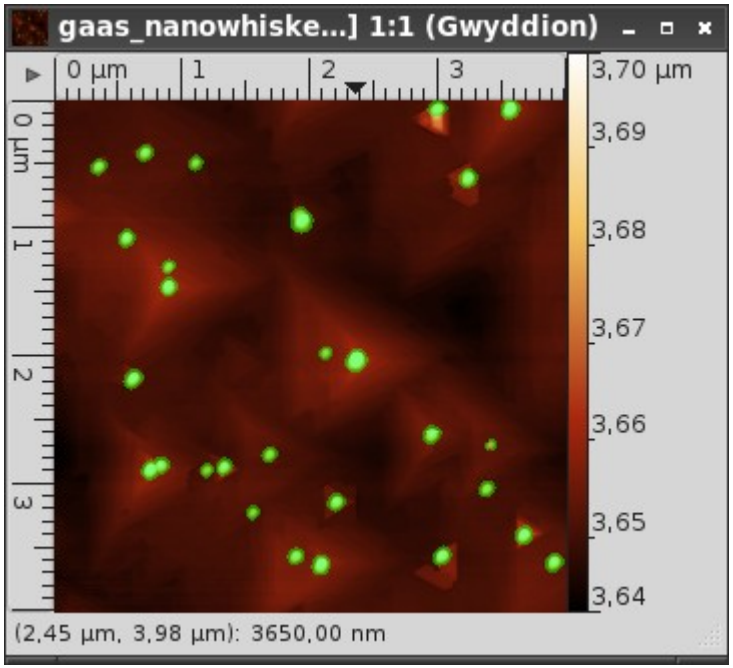


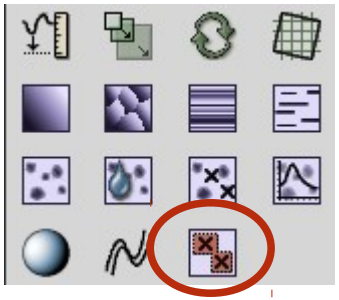
- Background can be removed based on a polynomial
- This feature allows an easy removal of tilt and curvature of the data

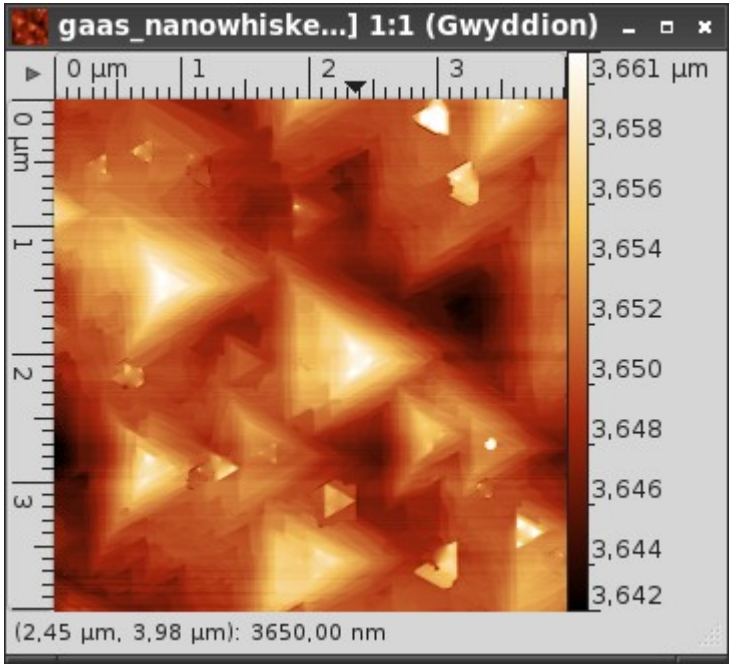




Basic operations: data removal

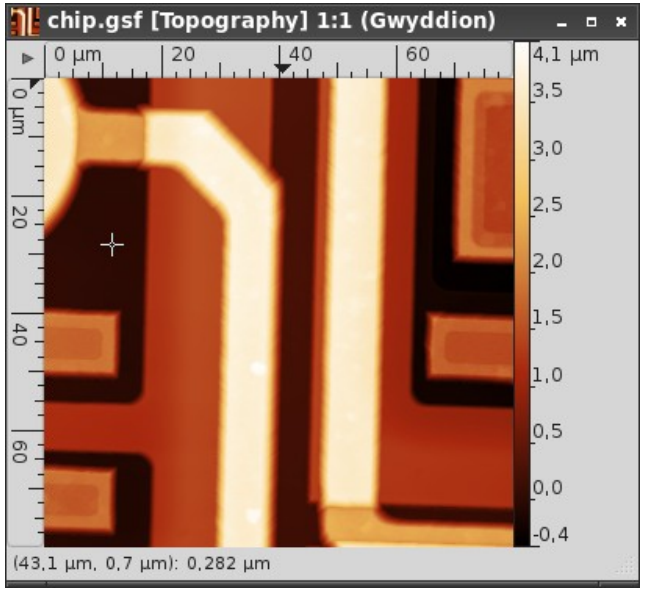


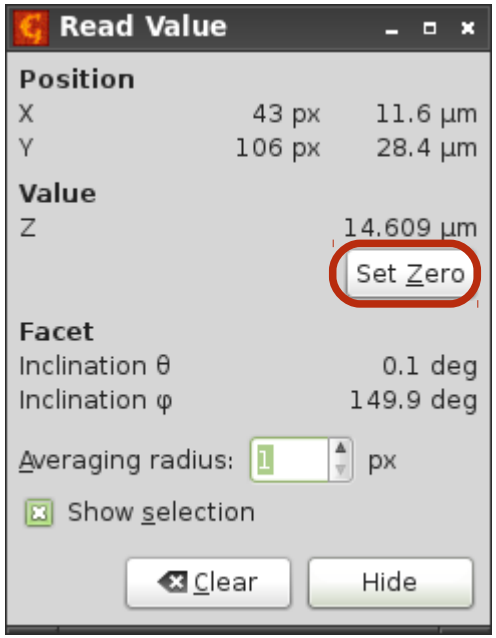




- Interpolates data under the mask
- Useful to remove hot spots or artifacts present on an image

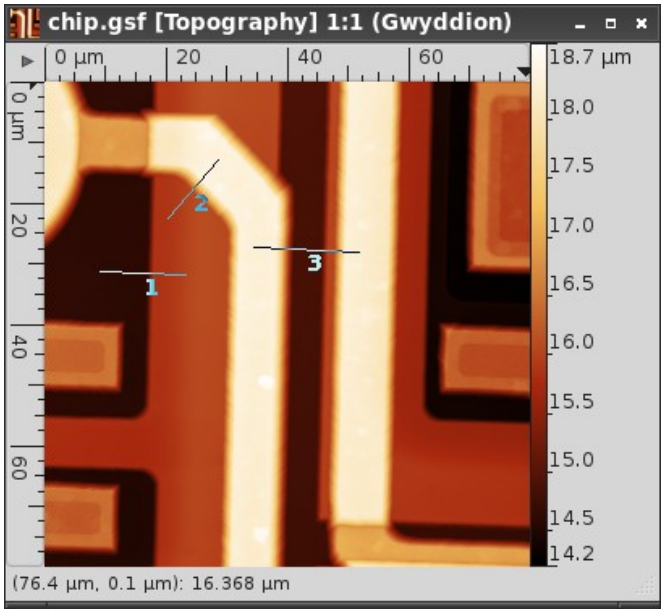
Tools: height and zero setting



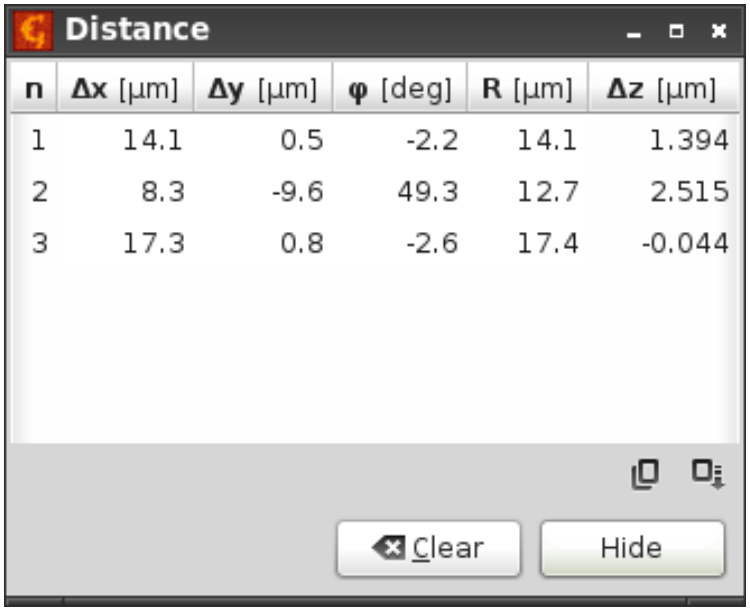


- Simple tool that displays the height at a given point on the image
- The « Set Zero » button allows to define the zero level of the image

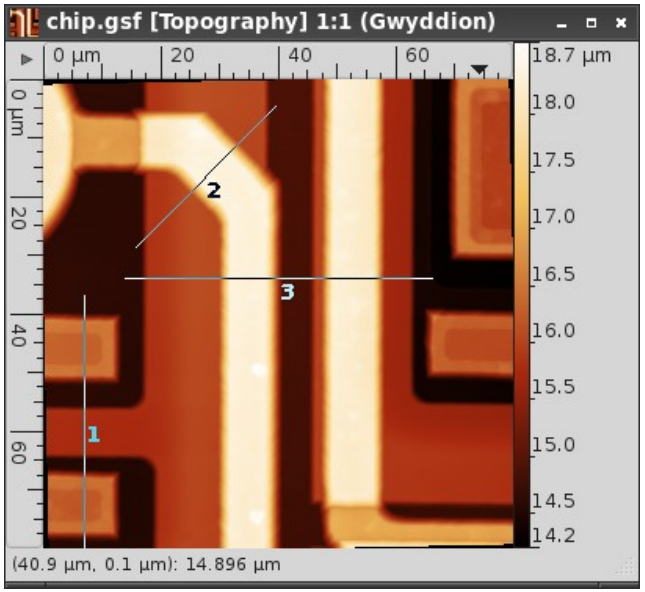
Tools: distances

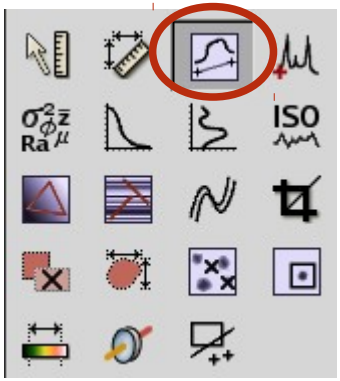


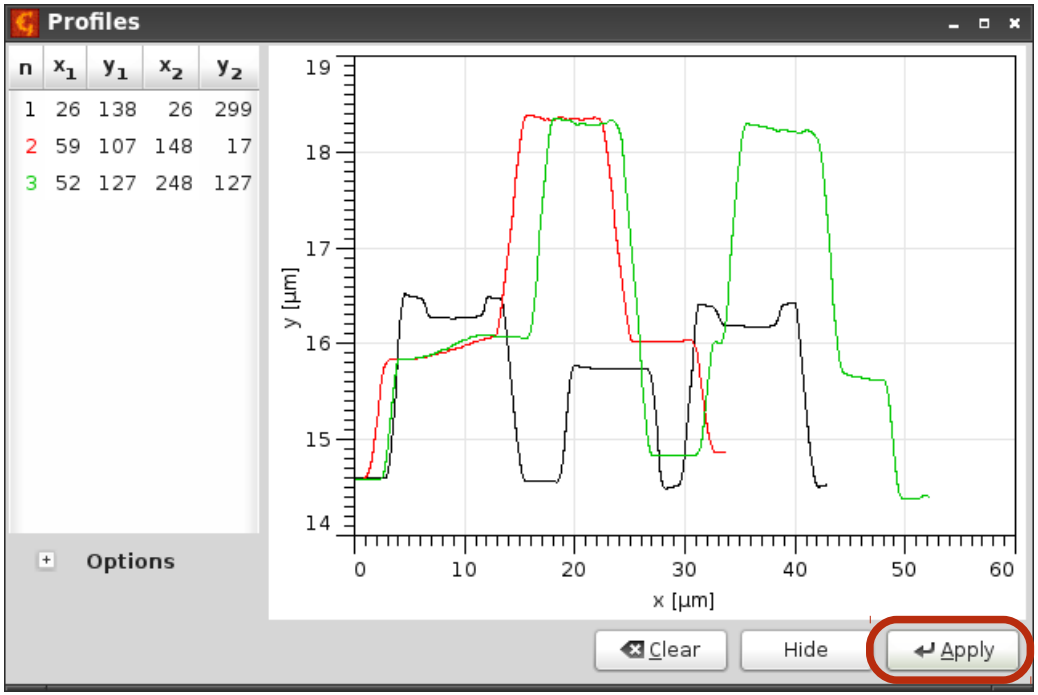
- Displays the distance and height difference between two points



Tools: profiles

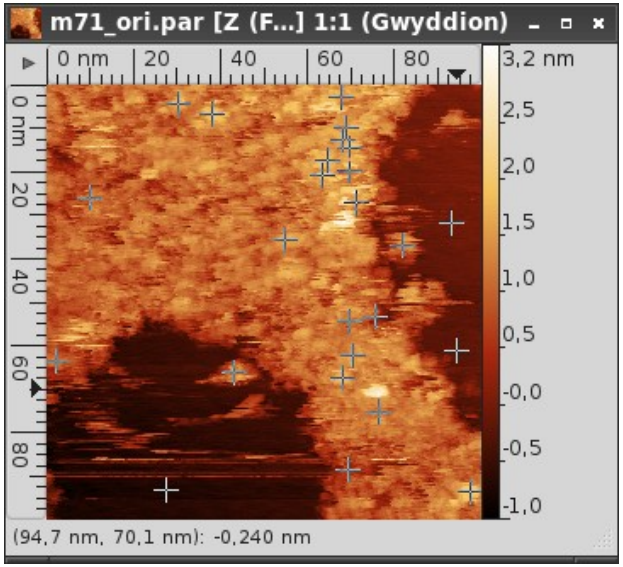


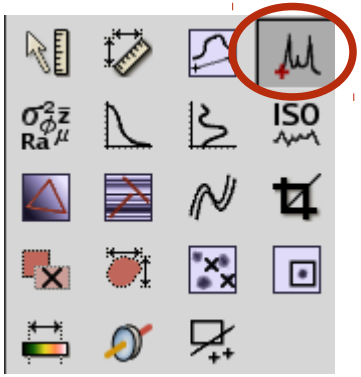


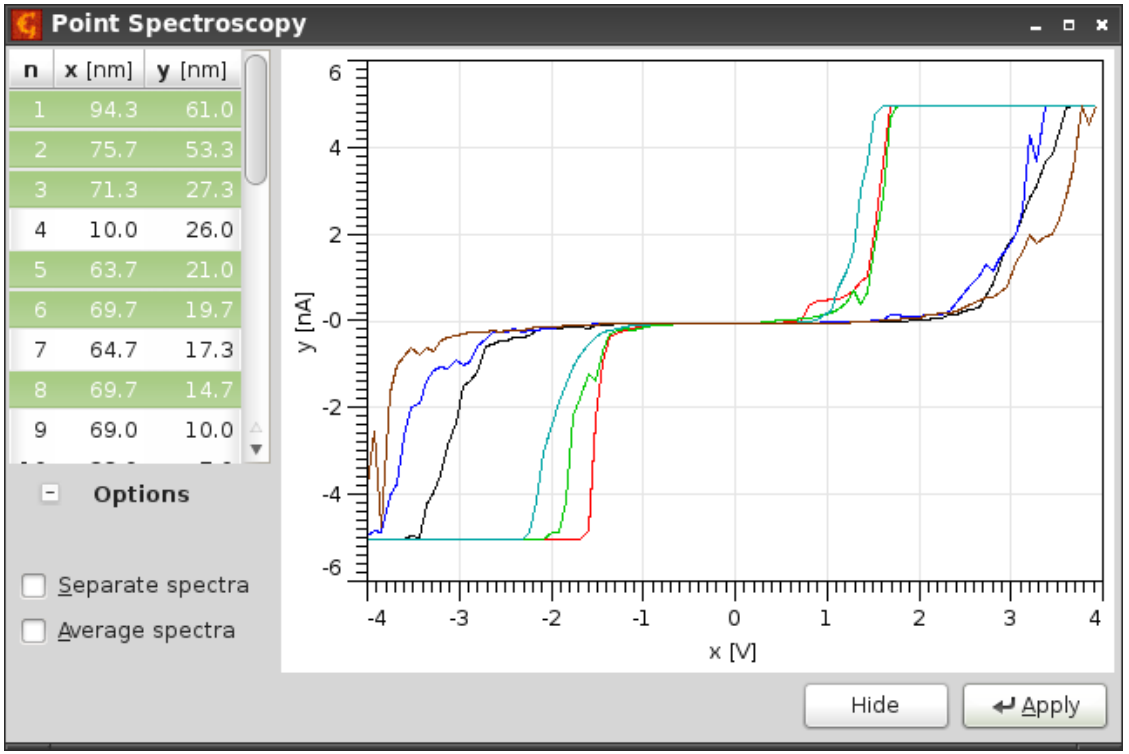


- One can display as much profiles as desired
- Shift key allows to orient the lines every 15°
- The « Apply » button exports the profiles to a new window

Tools: point spectroscopy

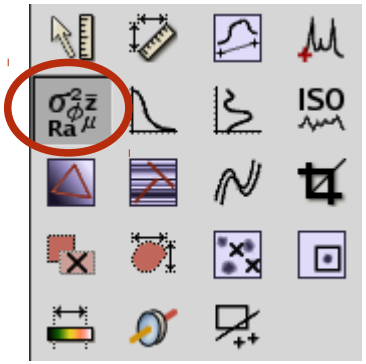


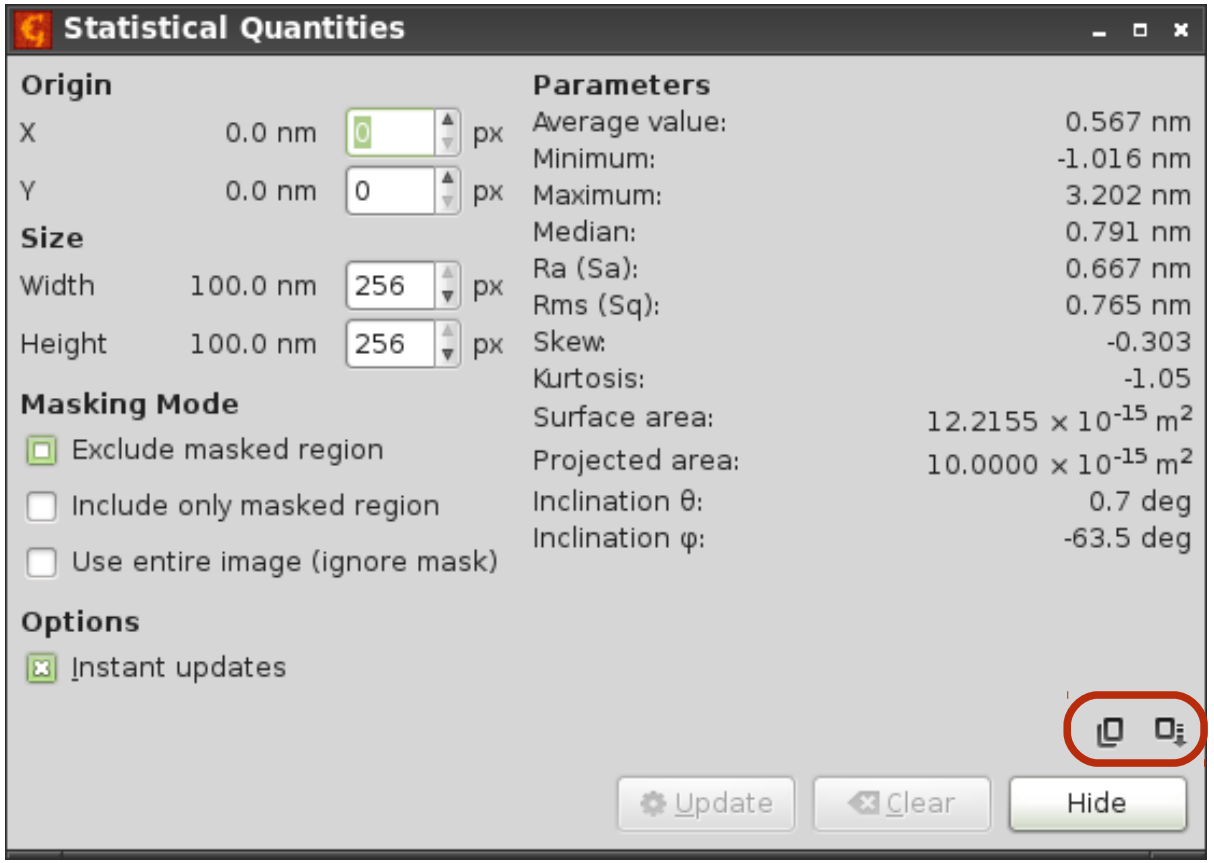




- This tools displays the spectra present in the data
- The position of each spectrum is given on the data window

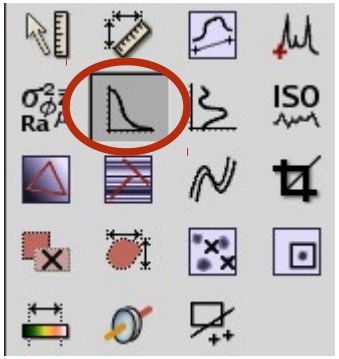
Tools: statistics

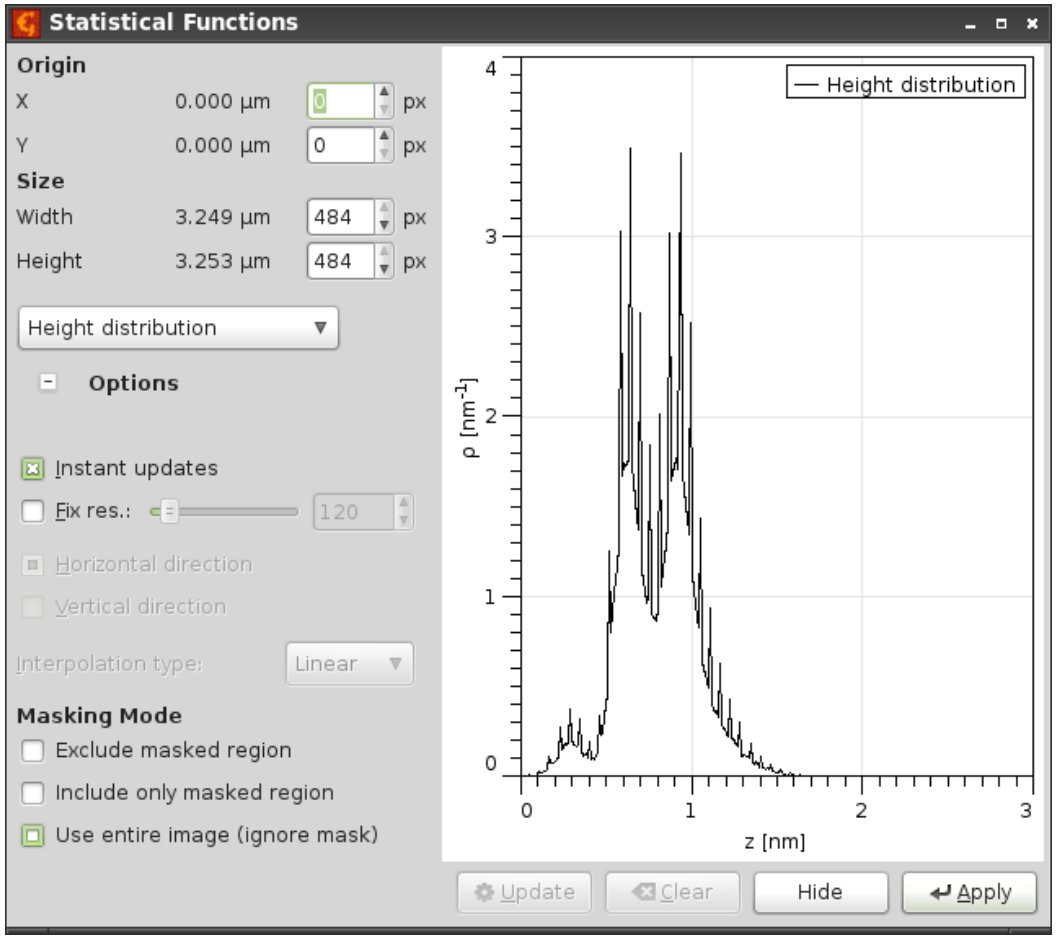




- Statistical data can be computed on all or a part of the data
- Two buttons allow to copy and save the data

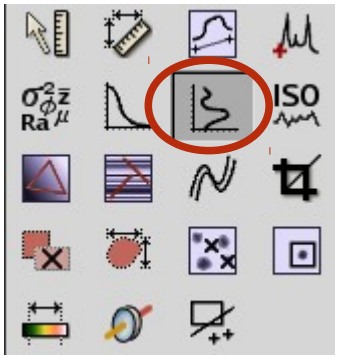
Tools: distributions

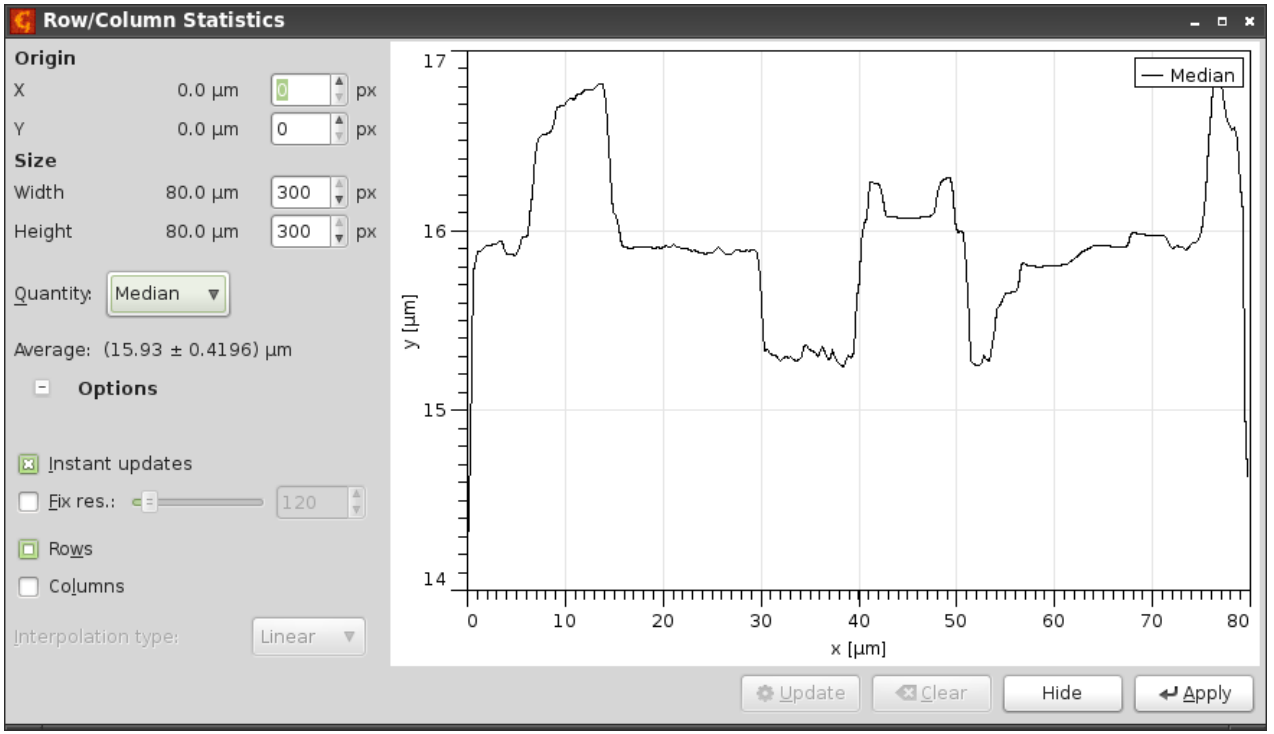




- Various types of distributions can be computed:
  - Height distribution
  - Auto-correlation
  - PSD
  - ...

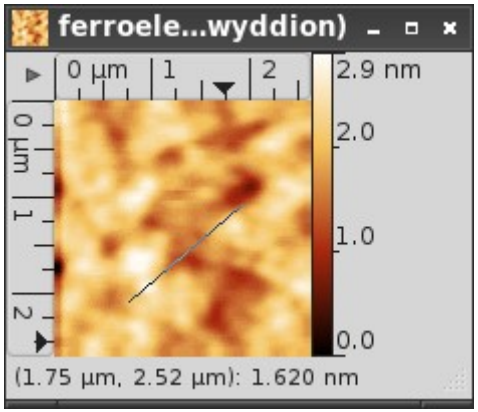
Tools: row/column statistics

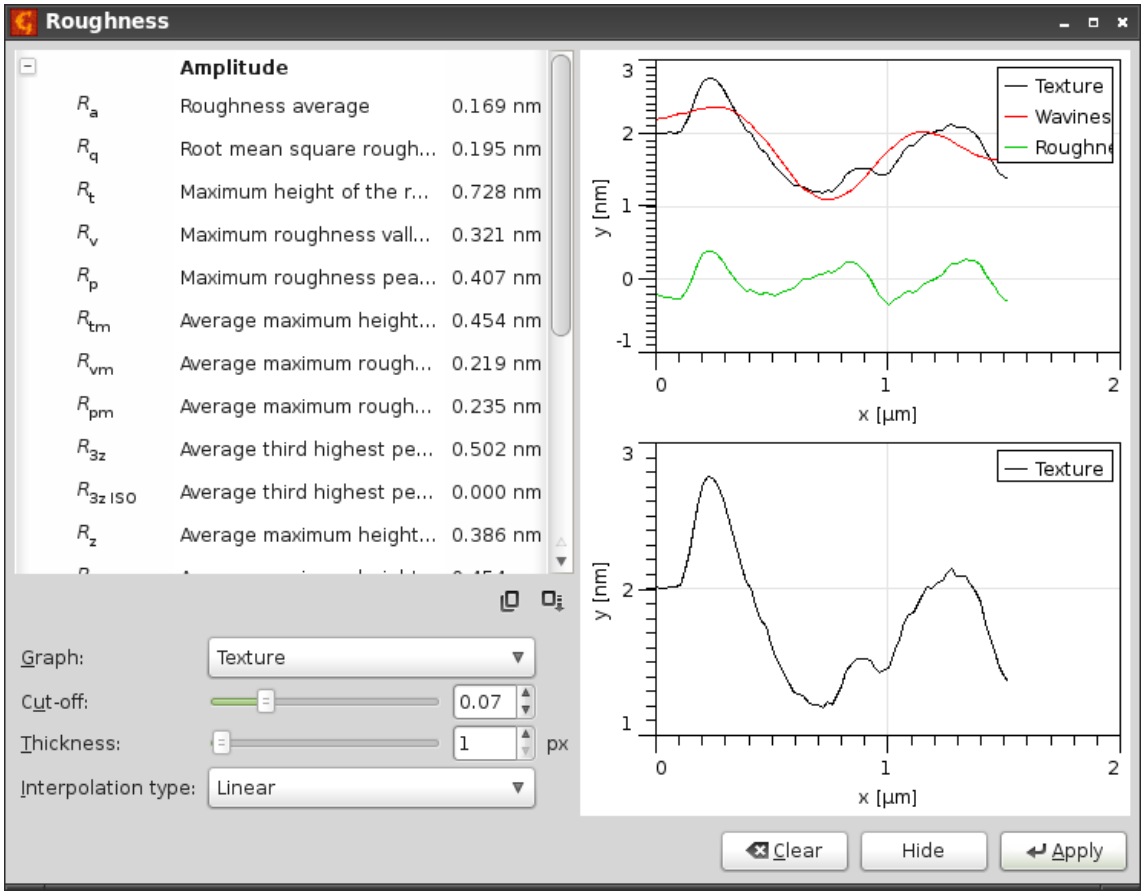




- Computes basic data for each line or column:
  - Minimum
  - Maximum
  - Mean
  - RMS
  - ...

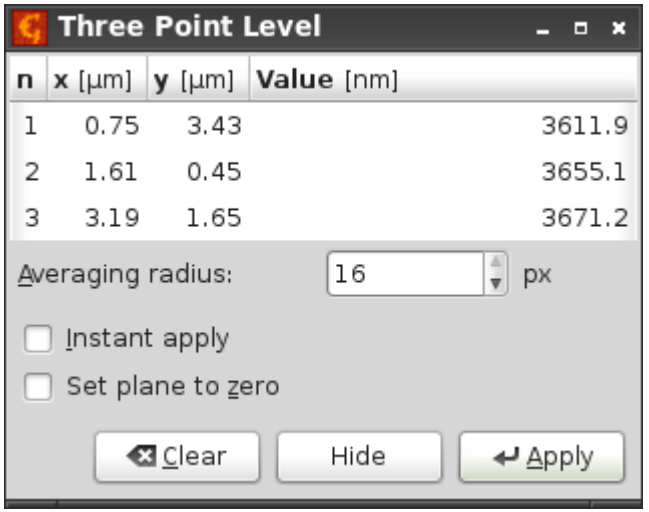
Tools: roughness

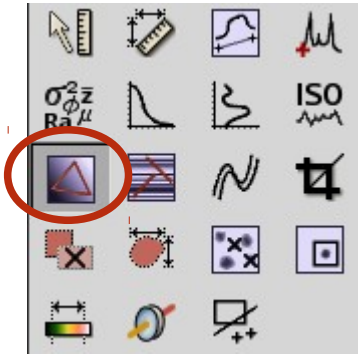




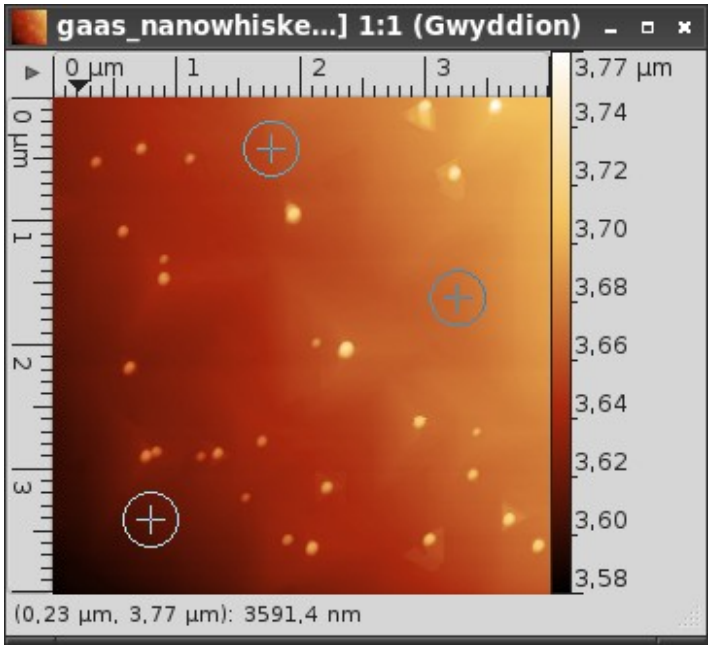
- Provides roughness data according ISO 4287 standard
- The analysis is done along a linear selection
- The cut-off parameter adjusts the separation between waviness and roughness

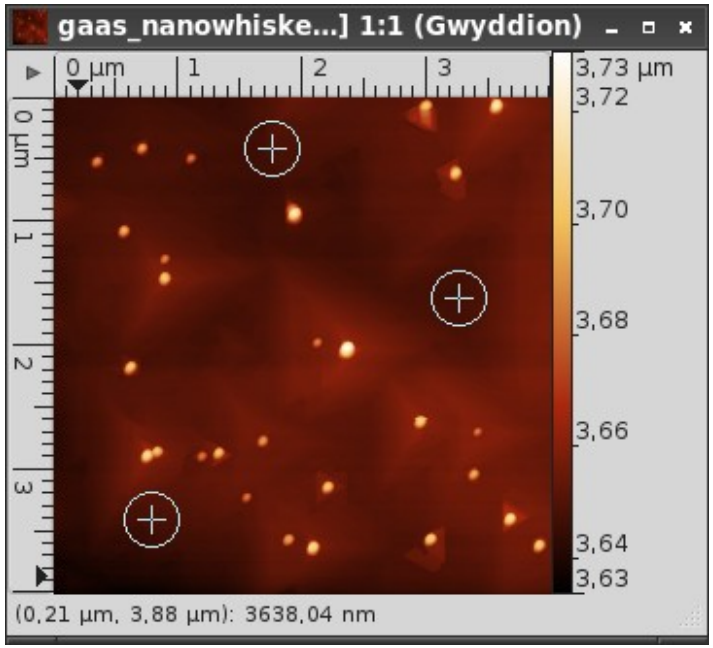
Tools: 3-point levelling



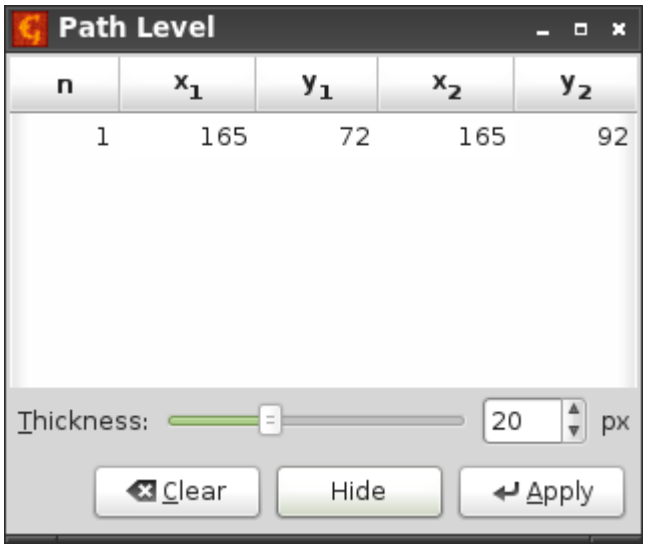


- This tool allows to define the points to put at the same level
- An area can be defined to get rid of the noise

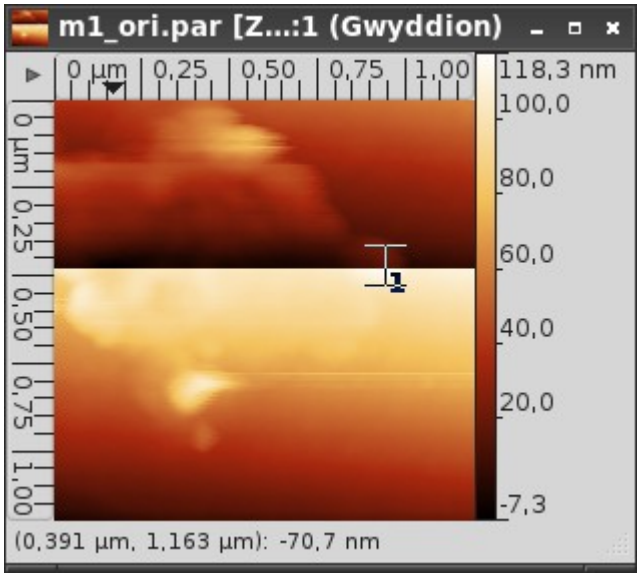


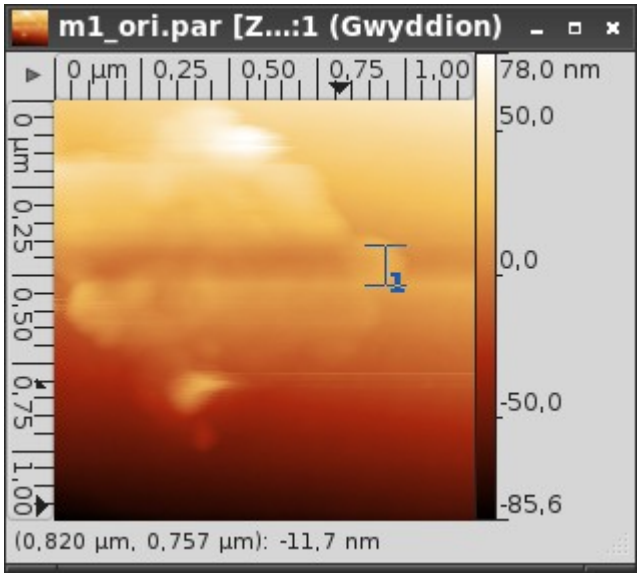


Tools: path levelling

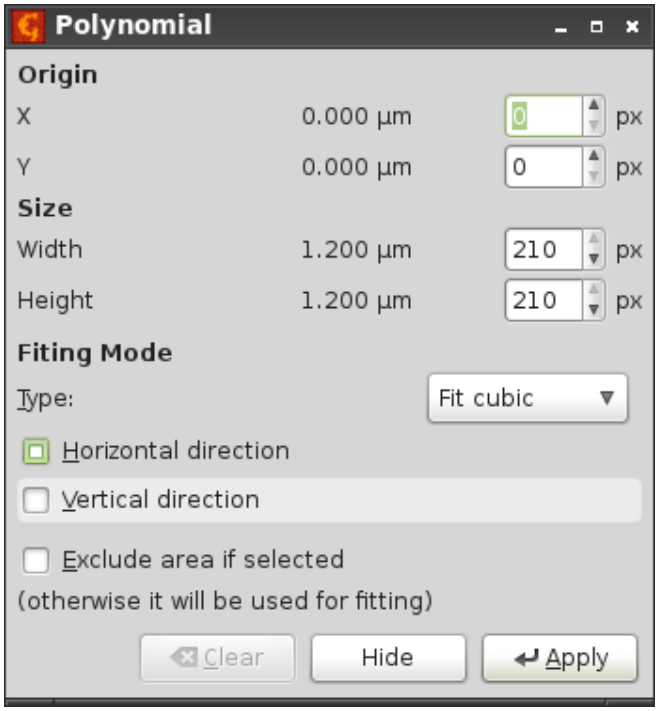


- This tool is similar to the line correction, but here one can define the zones to correct using linear selections

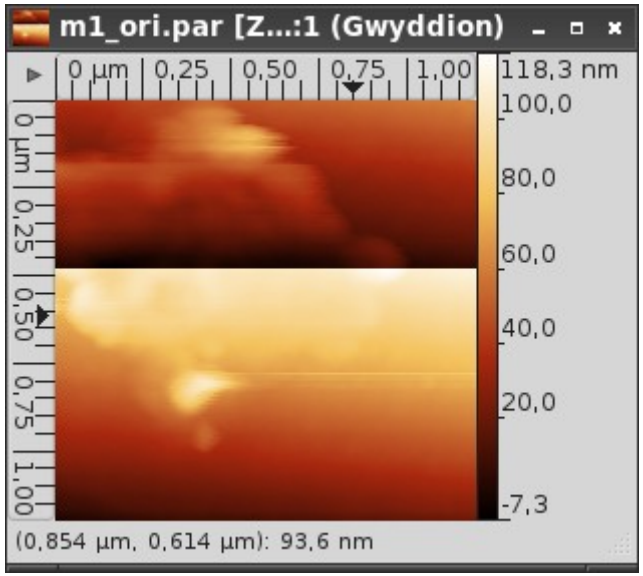


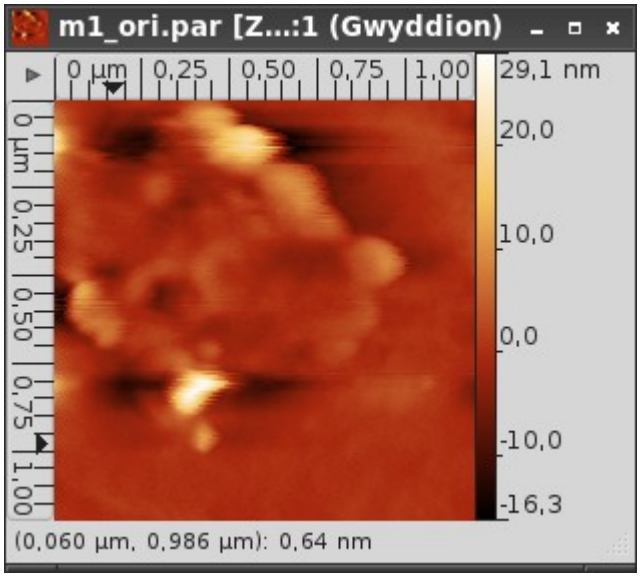


Tools: polynomial levelling

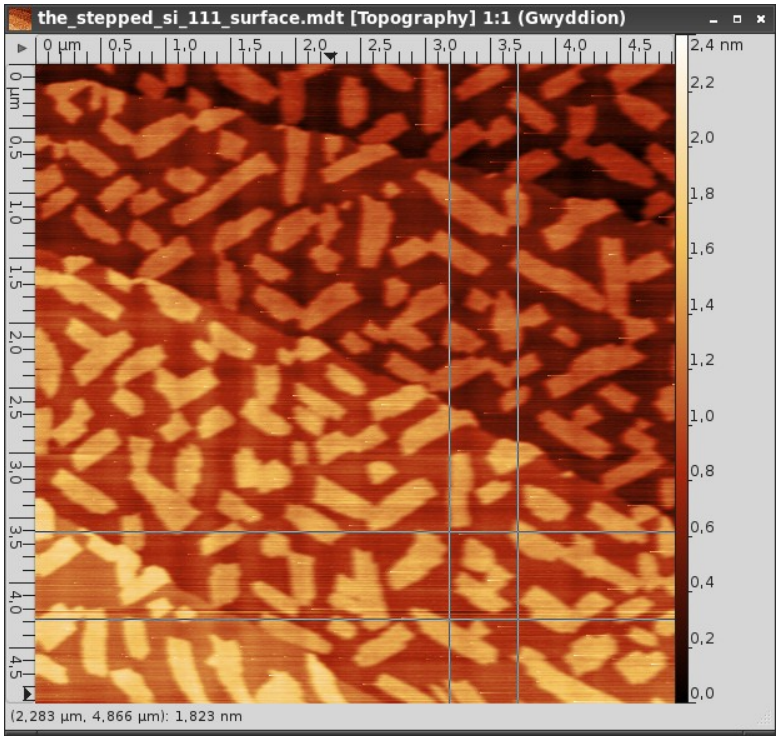


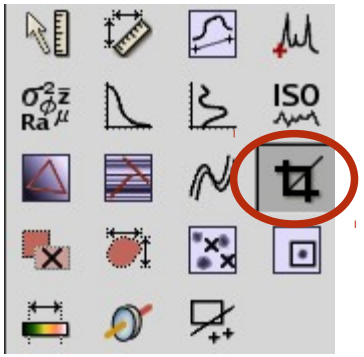
- Another method to correct the steps between lines, using a polynomial with an adjustable order



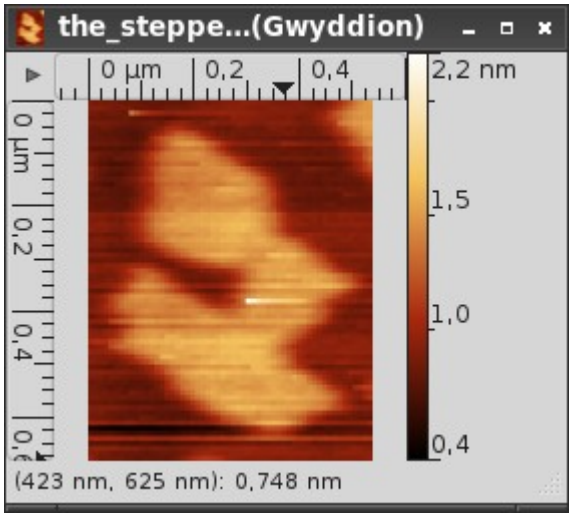


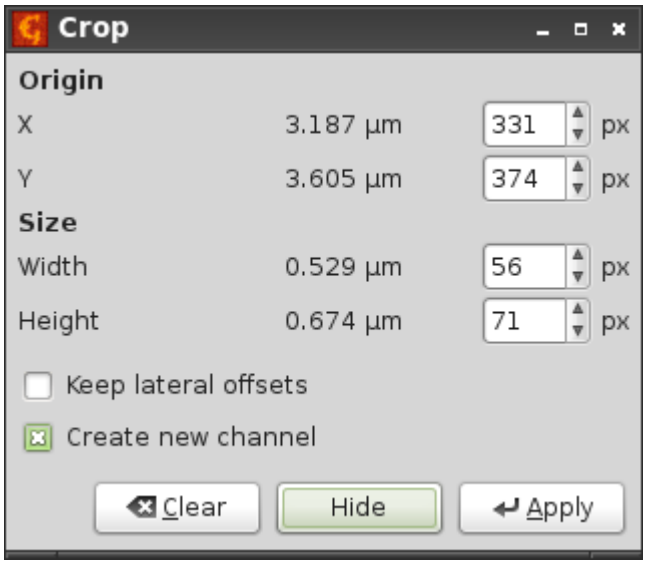
Tools: crop



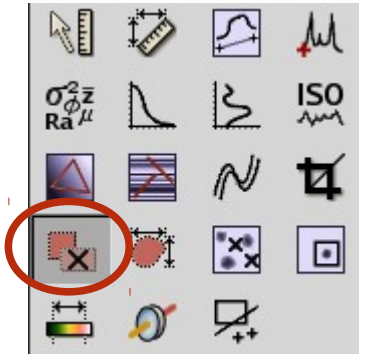


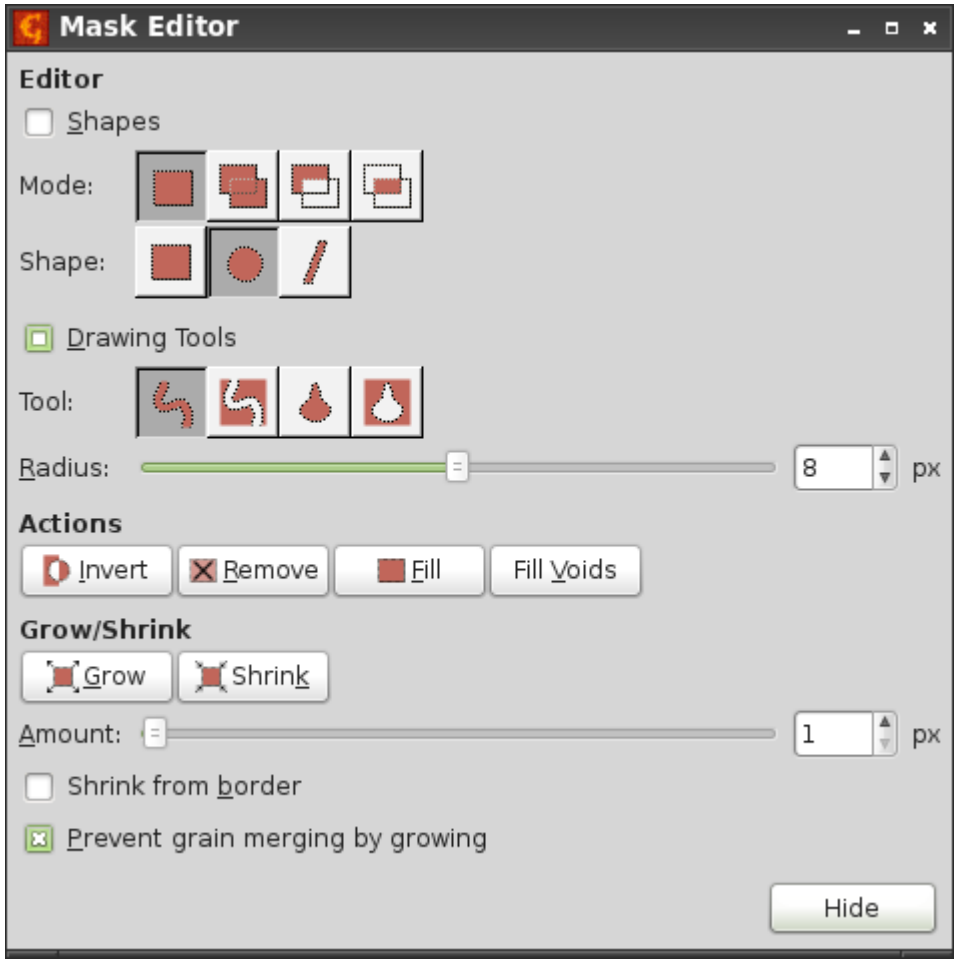
- Extracts a part of an image





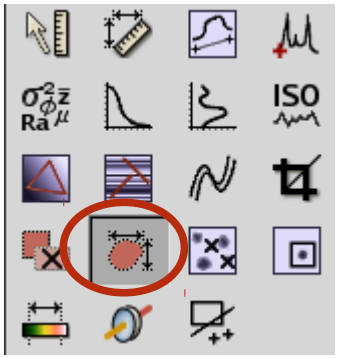
Tools: mask editor



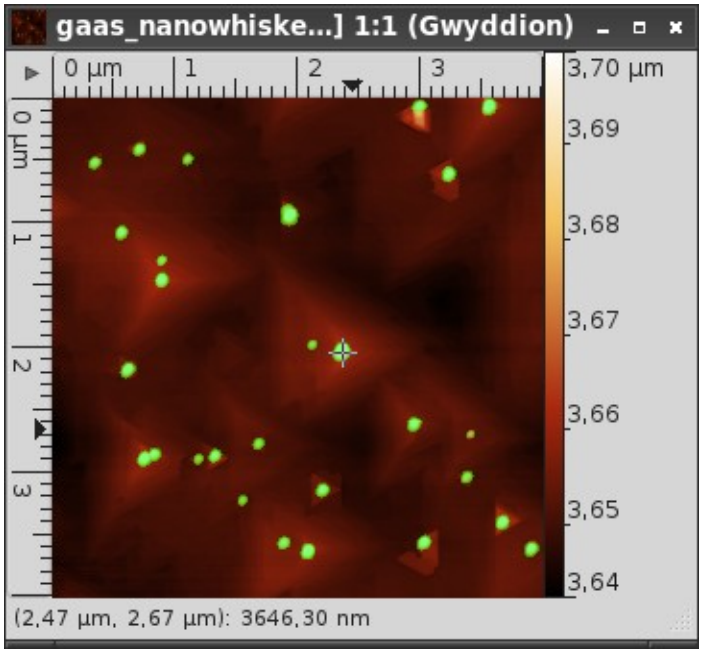


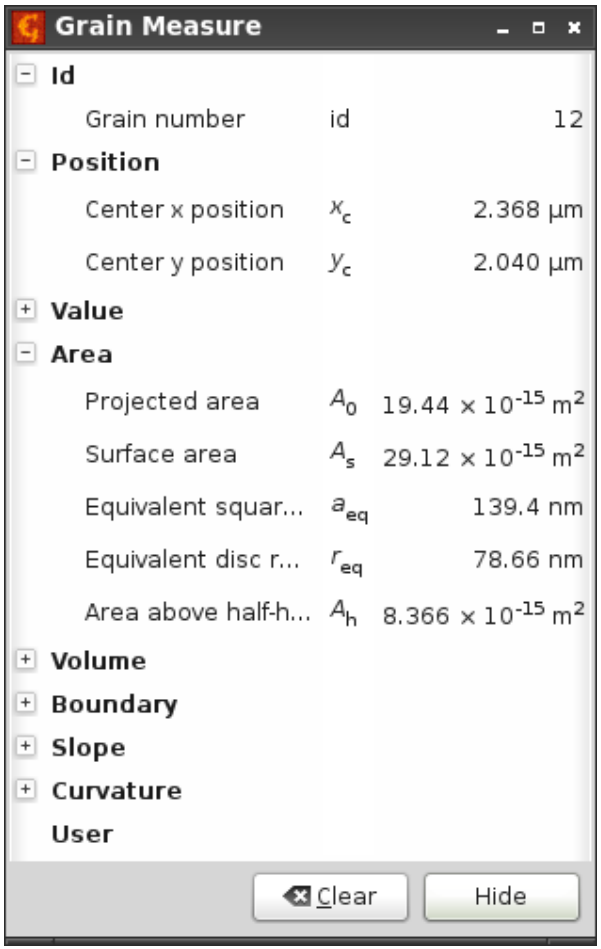
- The mask can have different goals:
  - Mark specific details (grains, facets)
  - Mark defects (scan artifacts, hot pixels)
  - Mark the « no data » points used by some file formats

Tools: grain measuring

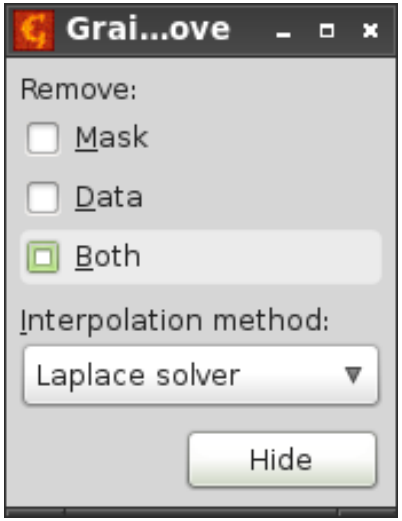


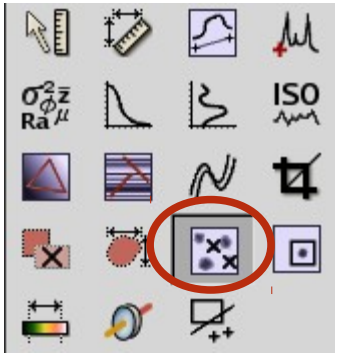
- Displays grain characteristics
- Just select the desired marked area to get its position, surface, volume...



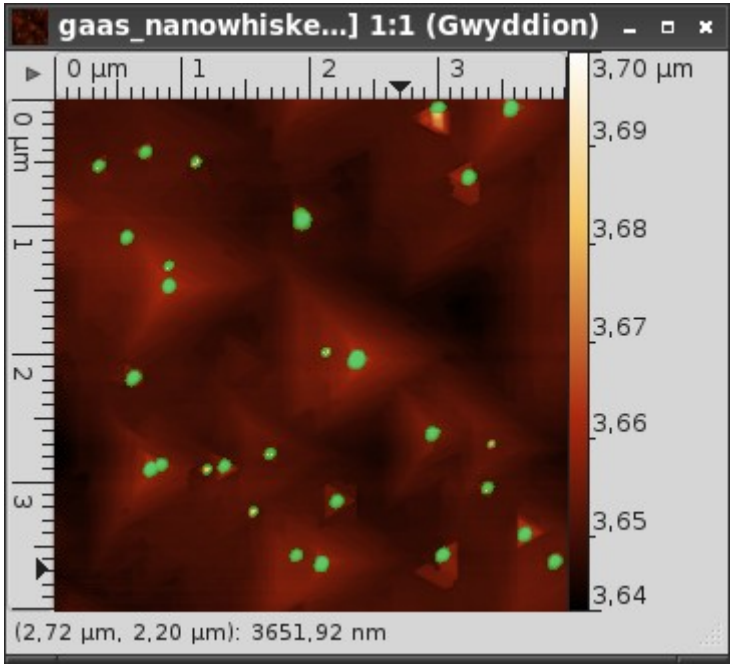


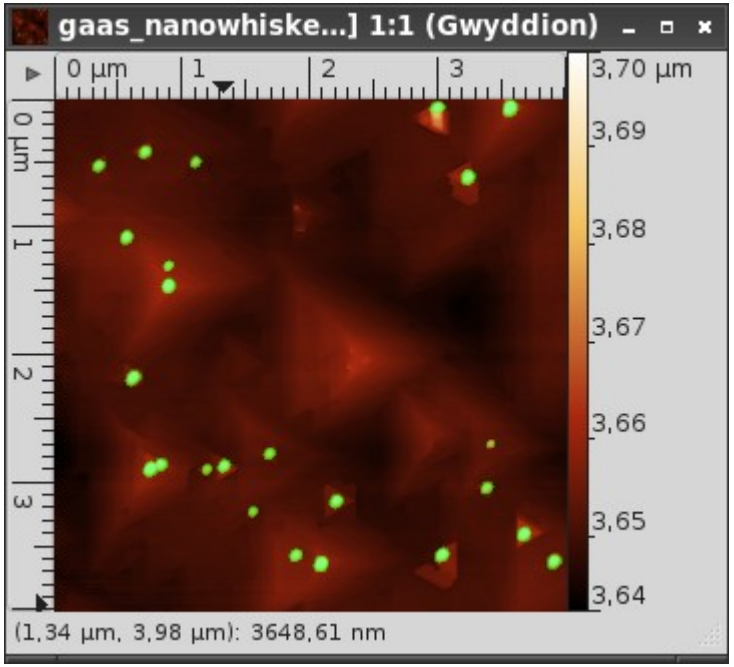
Tools: grain removal



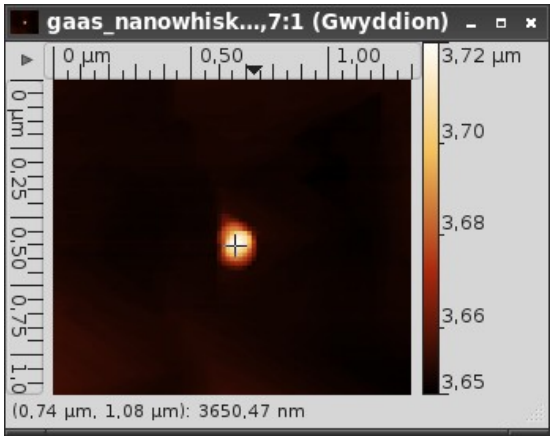


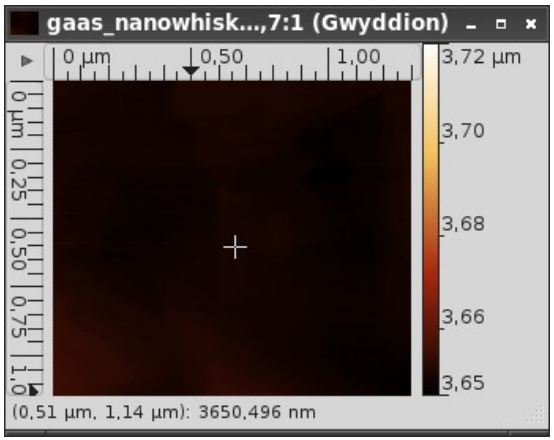
- This tool removes the mask and/or the underlying data

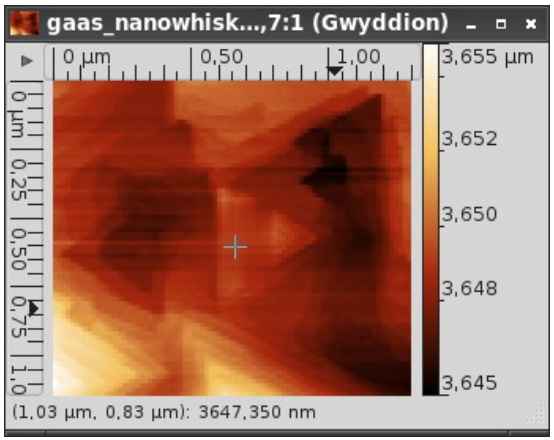




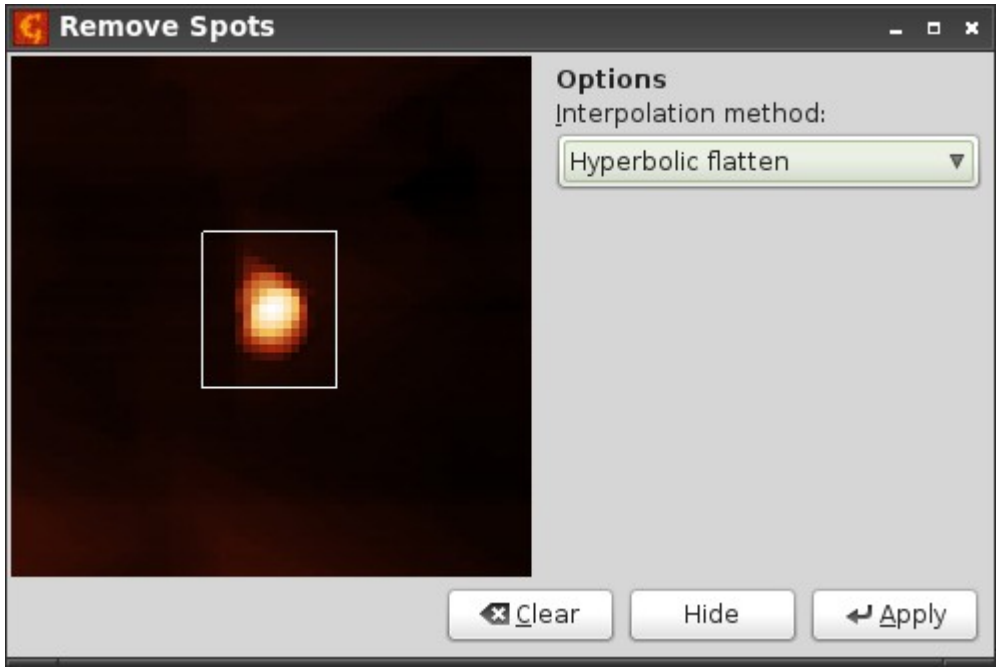
Tools: defect removal



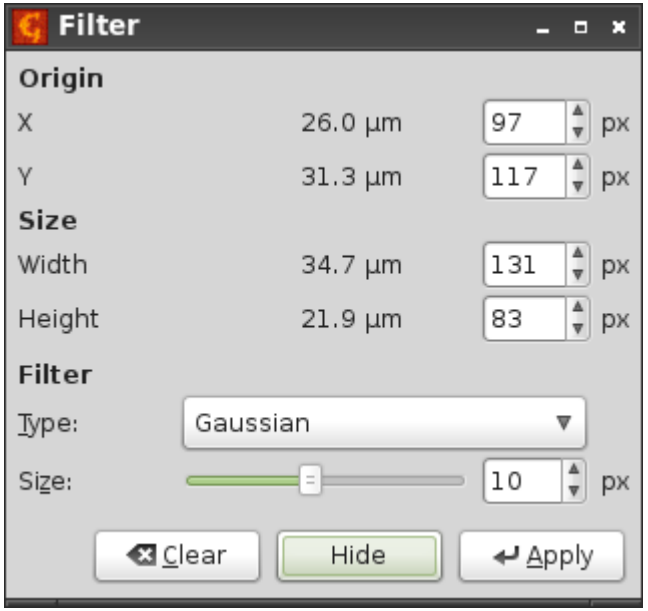


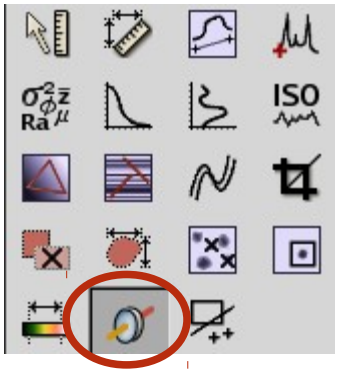


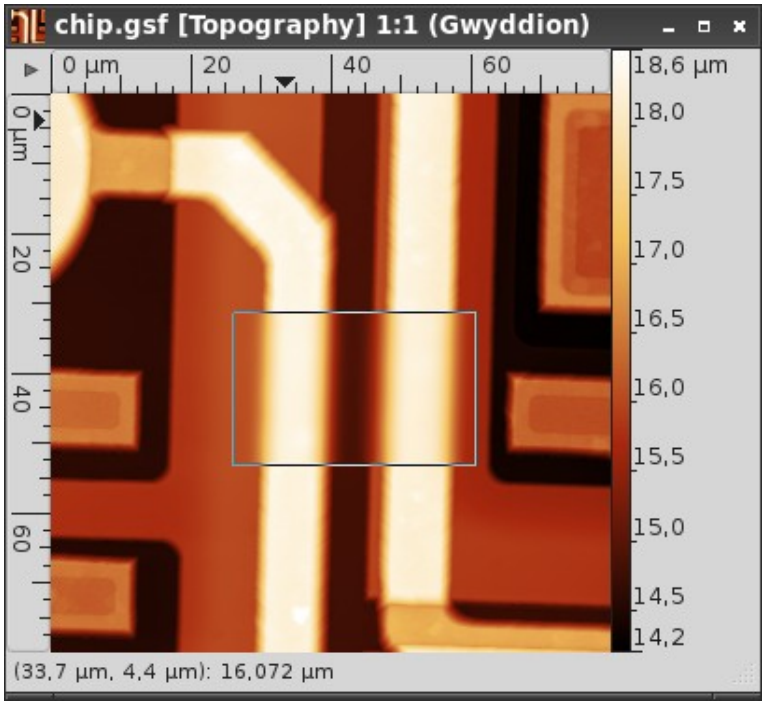
- Local correction of the data using various interpolation algorithms



Tools: filtering

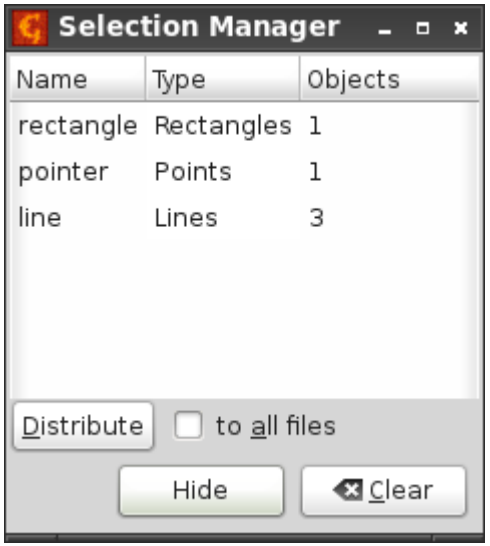


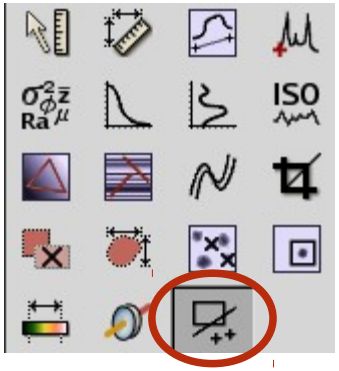


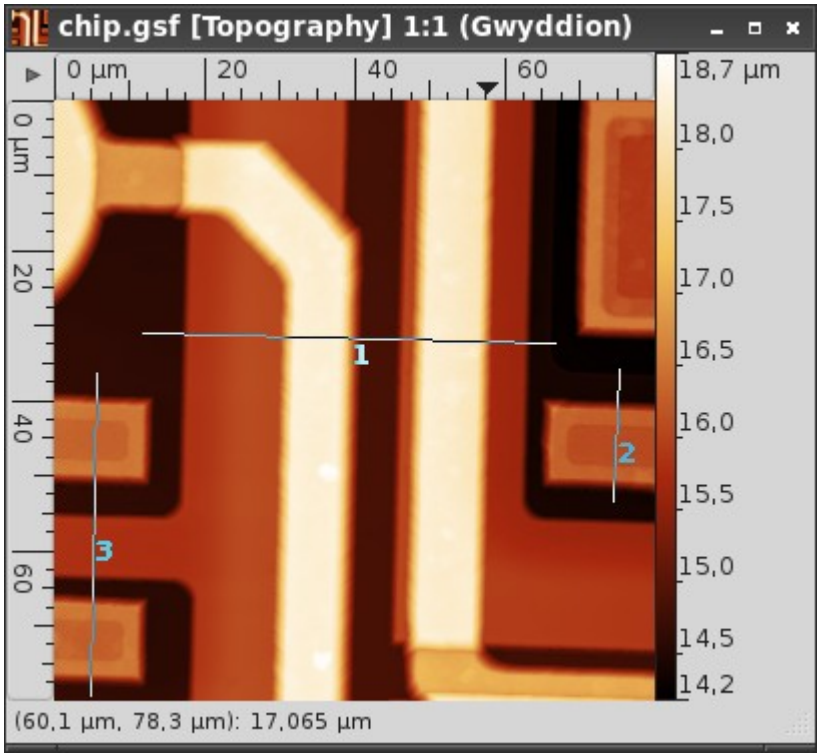


- This tool provides some classical filters:
  - Gaussian
  - Median
  - …
- The filter can be applied on a selected area

Tools: selections

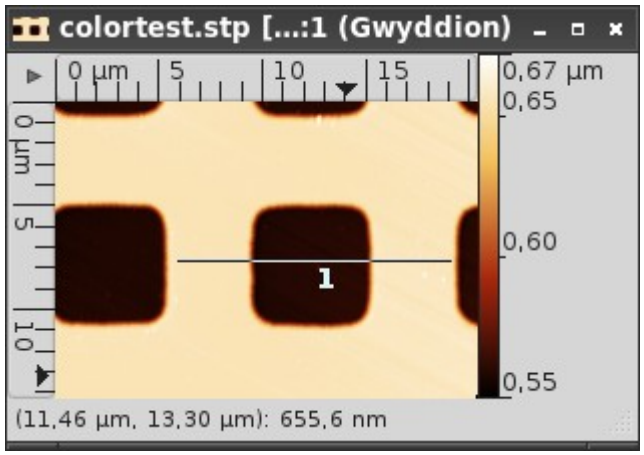


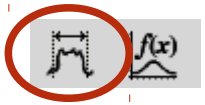


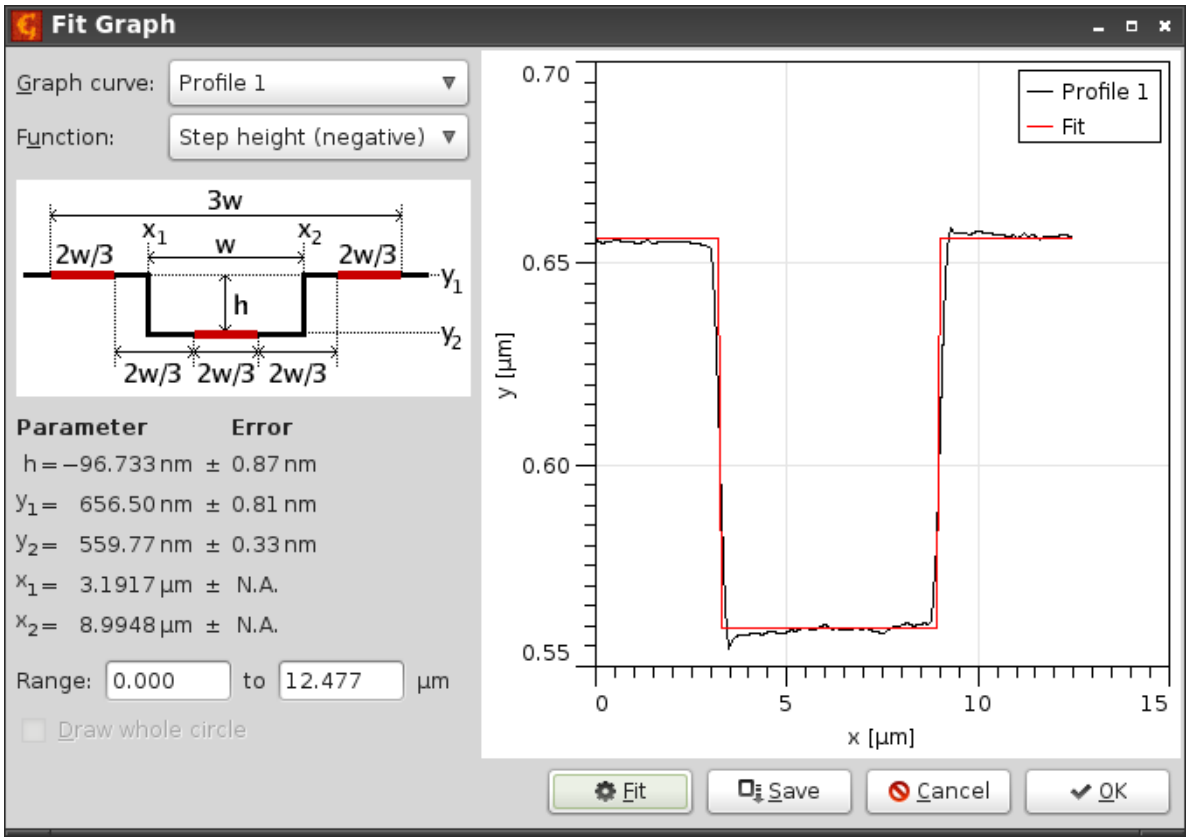


- This tool displays the selections (points, lines, rectangular areas) used by the other tools
- The « Distribute » button applies the selections to the other channels or files

Curve fitting: step and edge

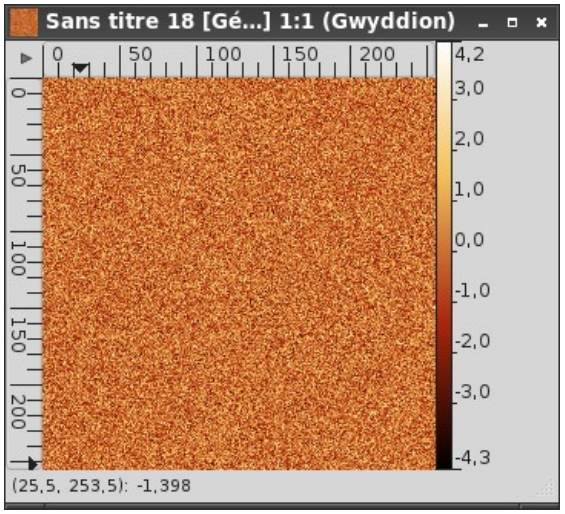


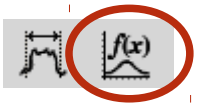


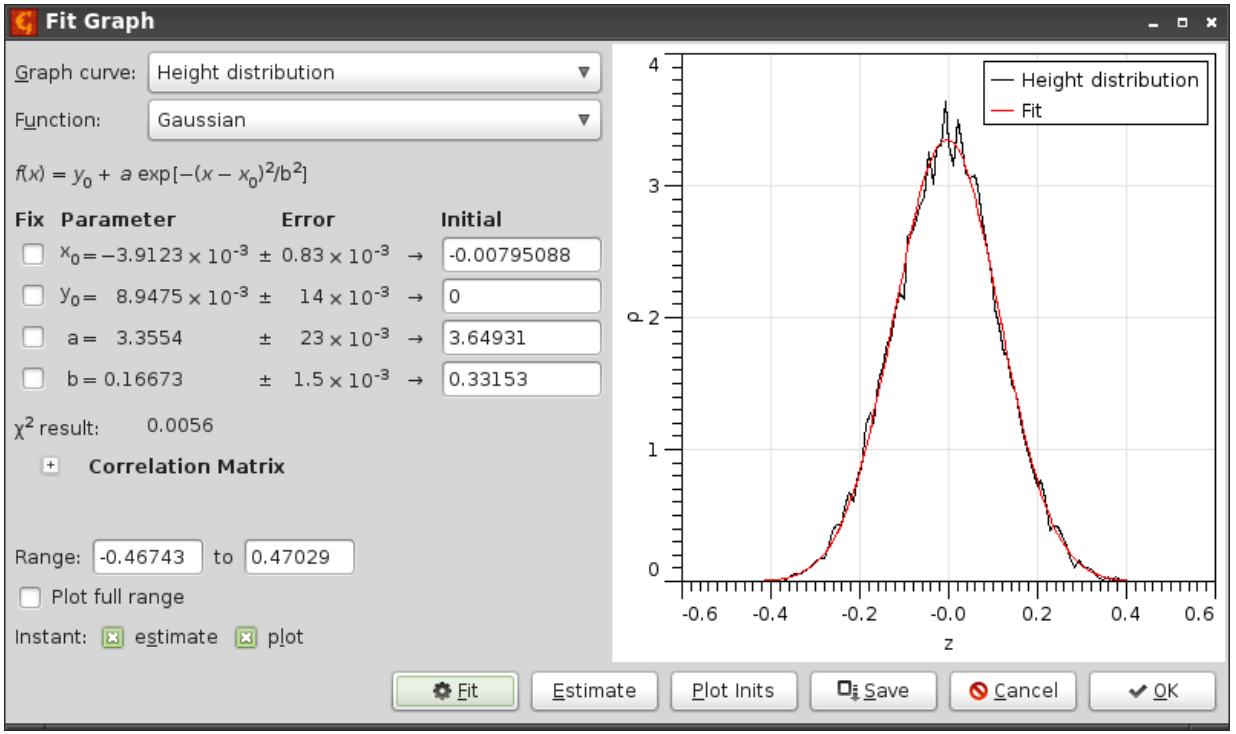


- The critical dimension tool can compute the width and/or the height of a step or an edge profile

Curve fitting: functions

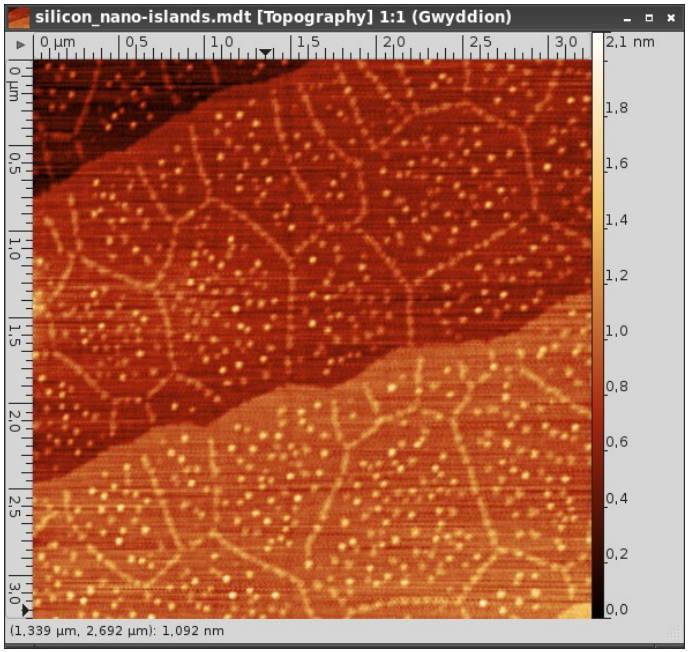


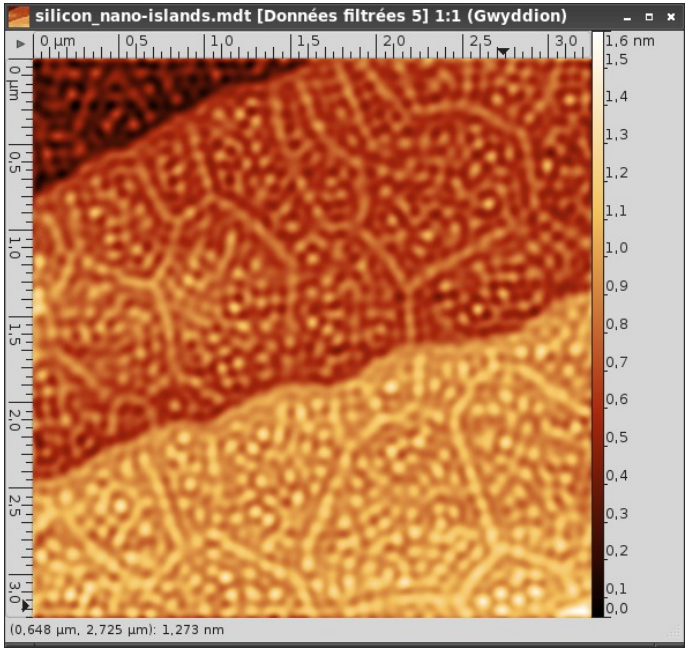




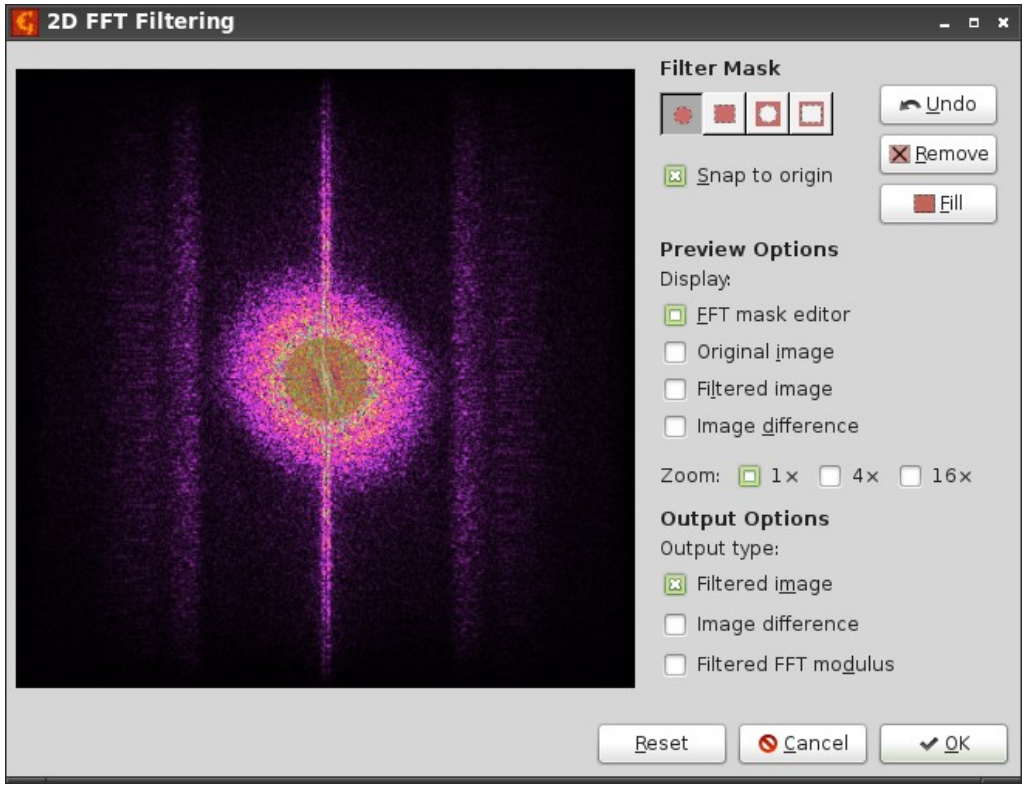
- Profiles can be fitted using various functions:
  - Gaussian
  - Lorentzian
  - Exponential
  - Polynomial
  - ...

Other features: FFT filtering

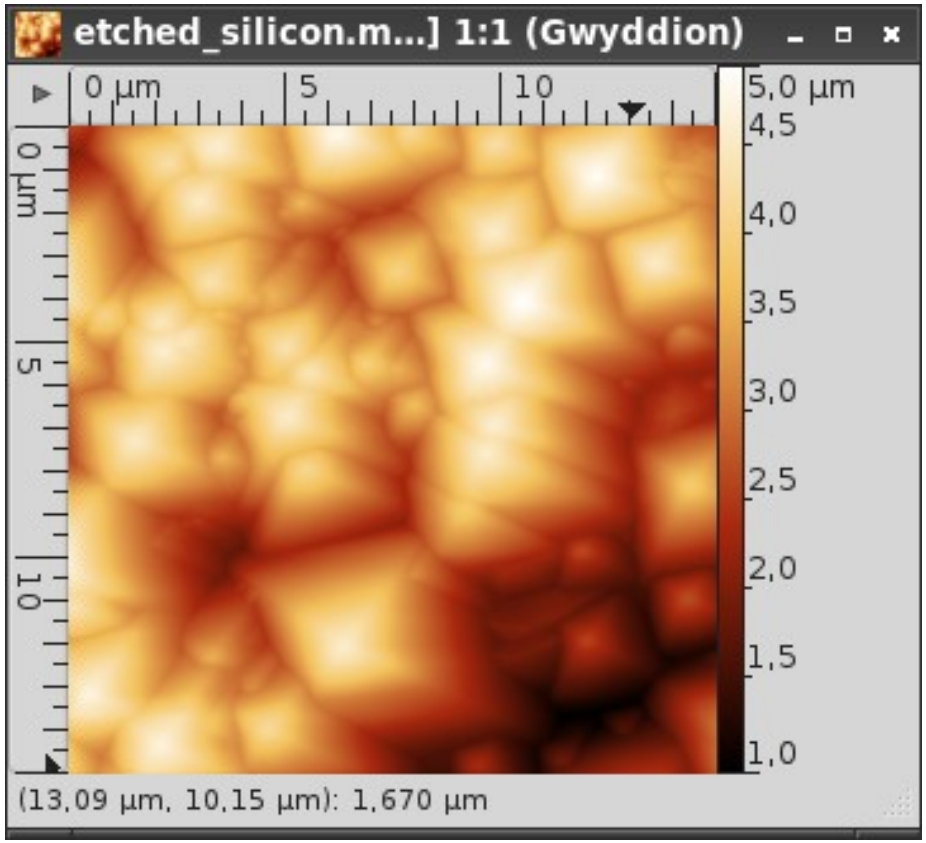




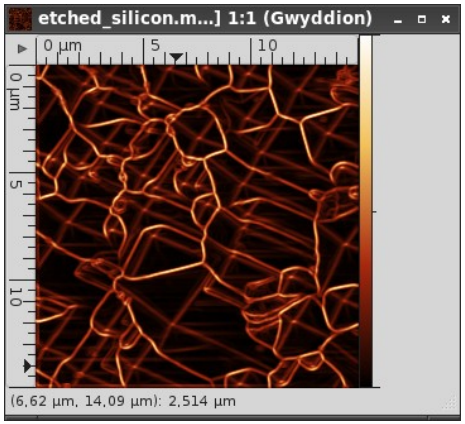
- Correct Data → 2D FFT Filtering
- This tool displays the FT and the result of the filtering

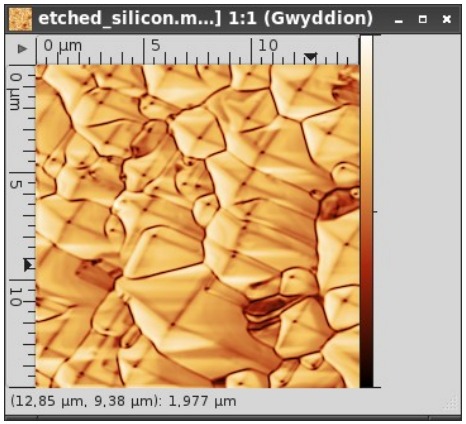


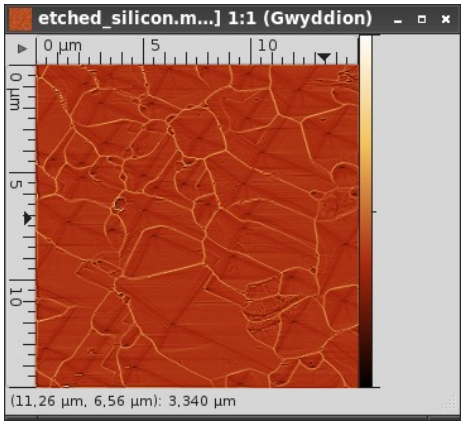
Other features: presentations

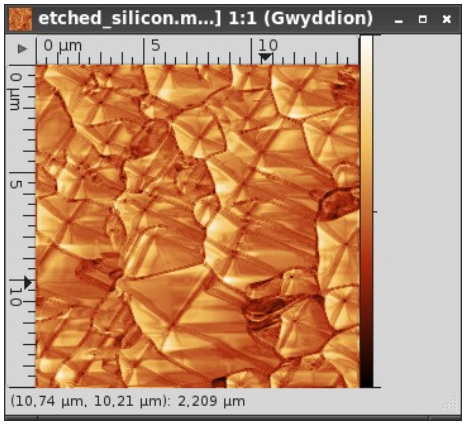


- A presentation is a layer applied over the data, giving a better rendering of some details in the image:
  - Edge detection
  - Logarithmic scale
  - ...





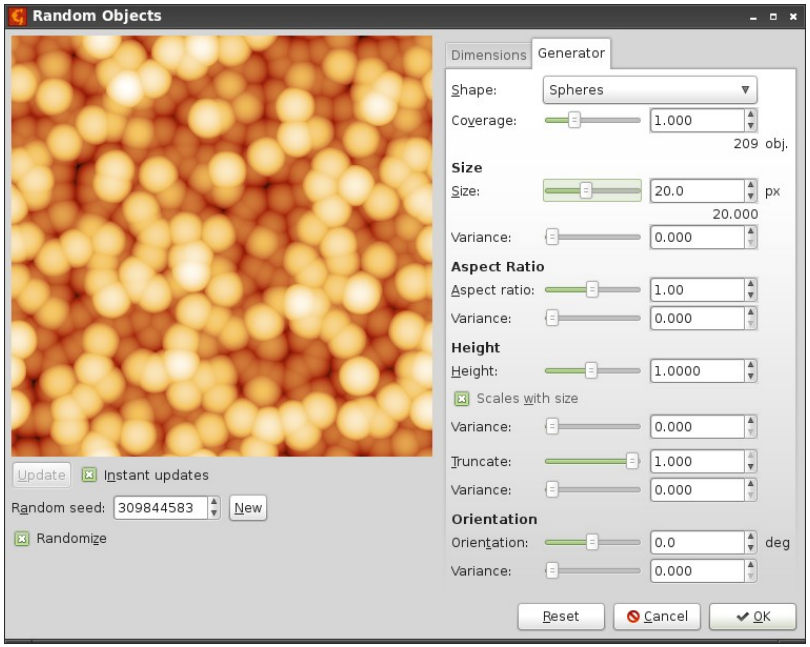


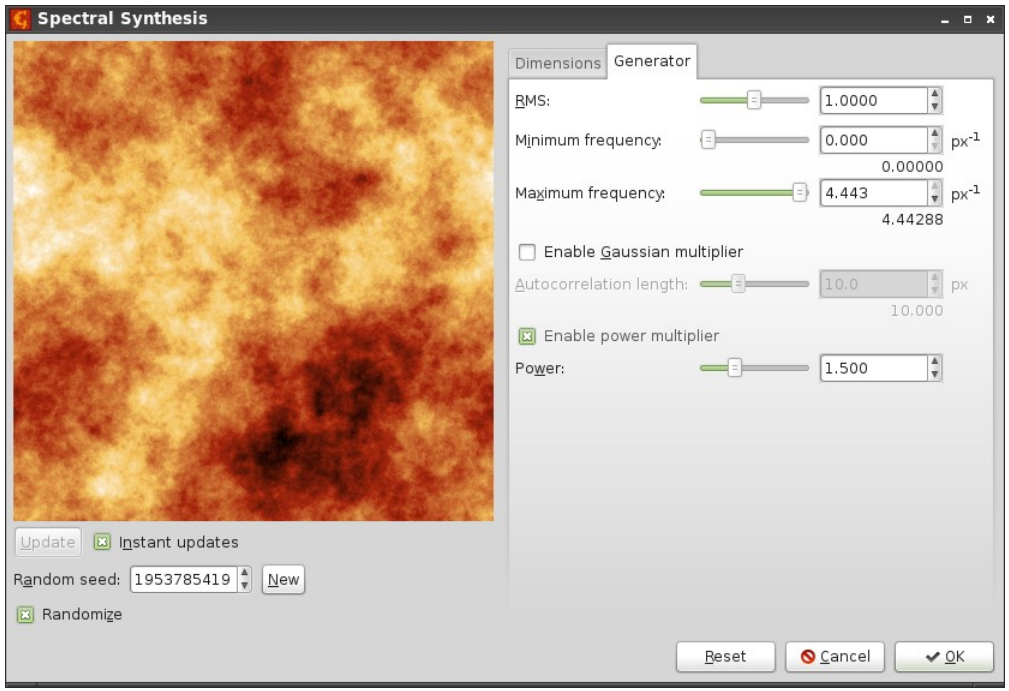


Other features: surface synthesis

- Warning: this set of features can be fatal to your productivity...
- Different synthesis types are available:
  - Noise
  - Linear noise
  - Pattern: ridges, steps, holes
  - Objects: spheres, pyramids, gaussians...
  - Particles
  - Spectral: PSD-based random surface
- Various options are available for each type

Other features: surface synthesis





- Objects
  - One can modify the aspect ratio and the orientation of the objects
- Spectral
  - The power multiplier generates a fractal surface

And much more...

- Gwyddion has a lot of features, just try them !