

Digital Surf
Surface Intelligence

Surface Imaging & Metrology Software

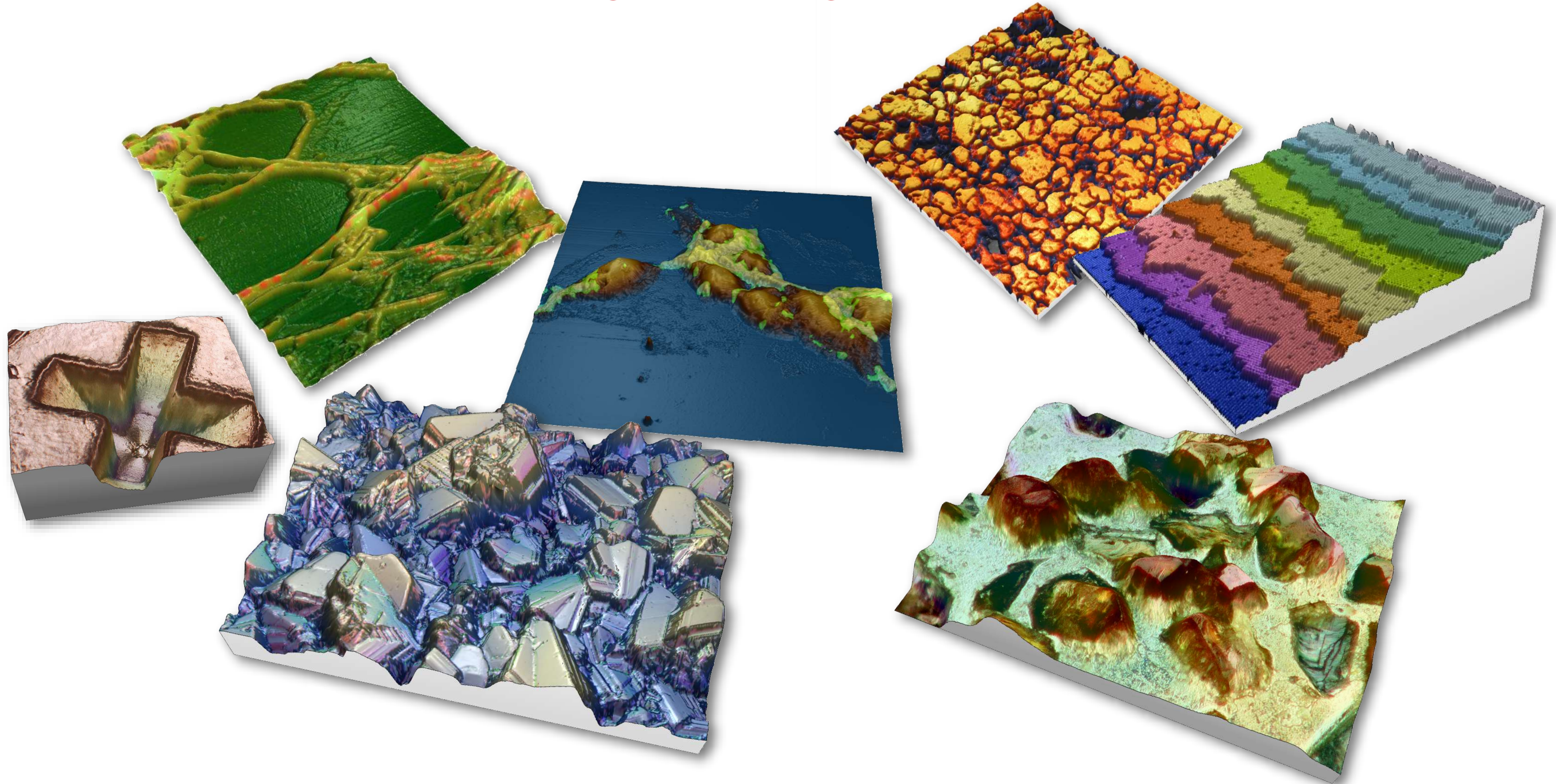
DIGITAL SURF / Arnaud VIOT / ANF, Paris June 2017

Analysis software

Key points

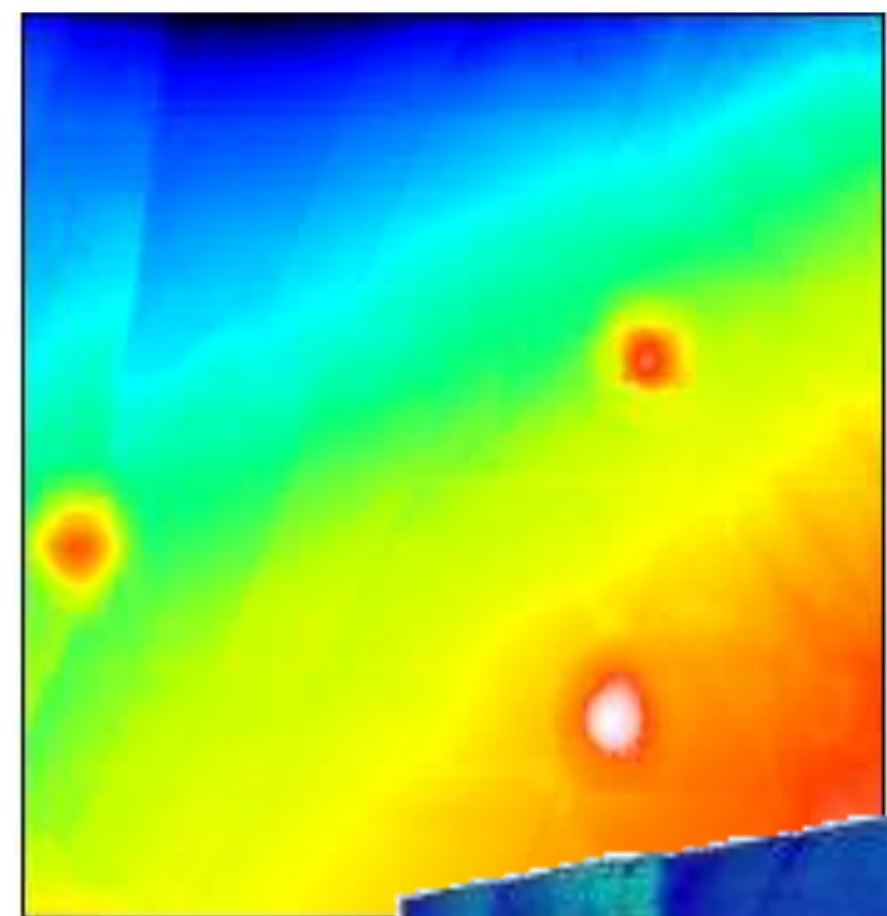
Cutting-edge 3D imaging

Seeing is believing!

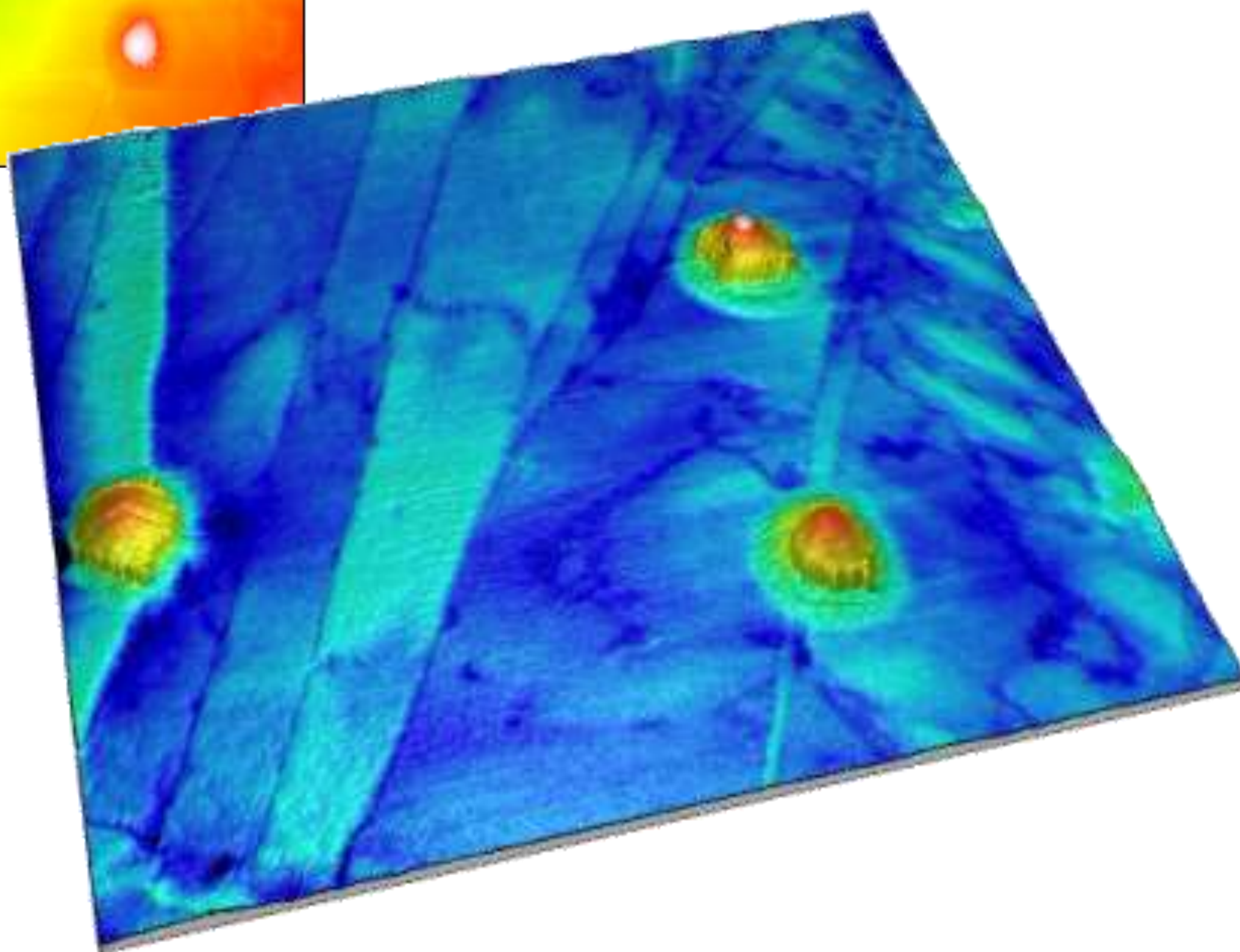


Powerful filters for dataset enhancement

Getting your data ready for analysis



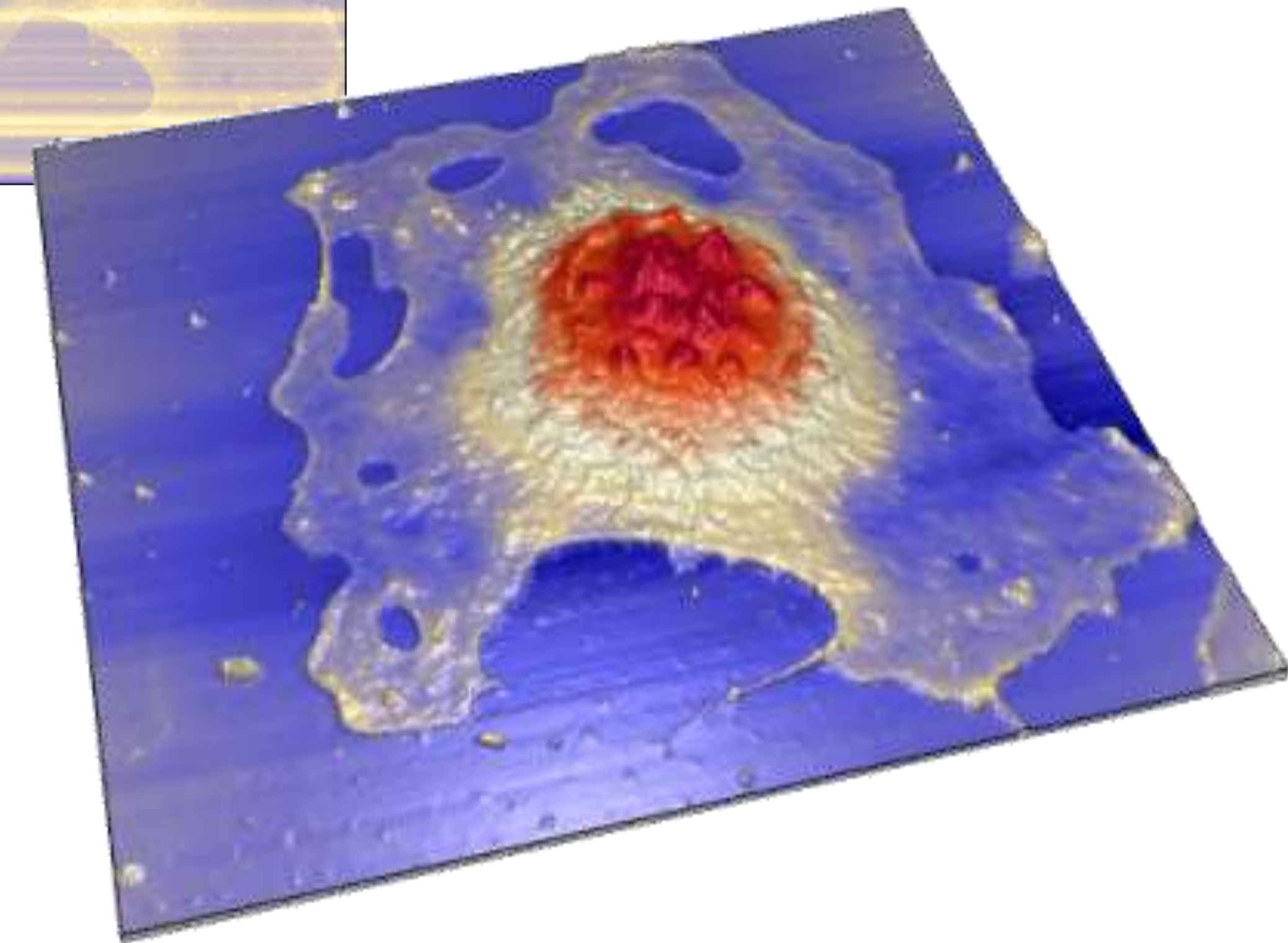
RAW Data



Plane correction & flattening



RAW Data



Line correction and isolated artefacts removal

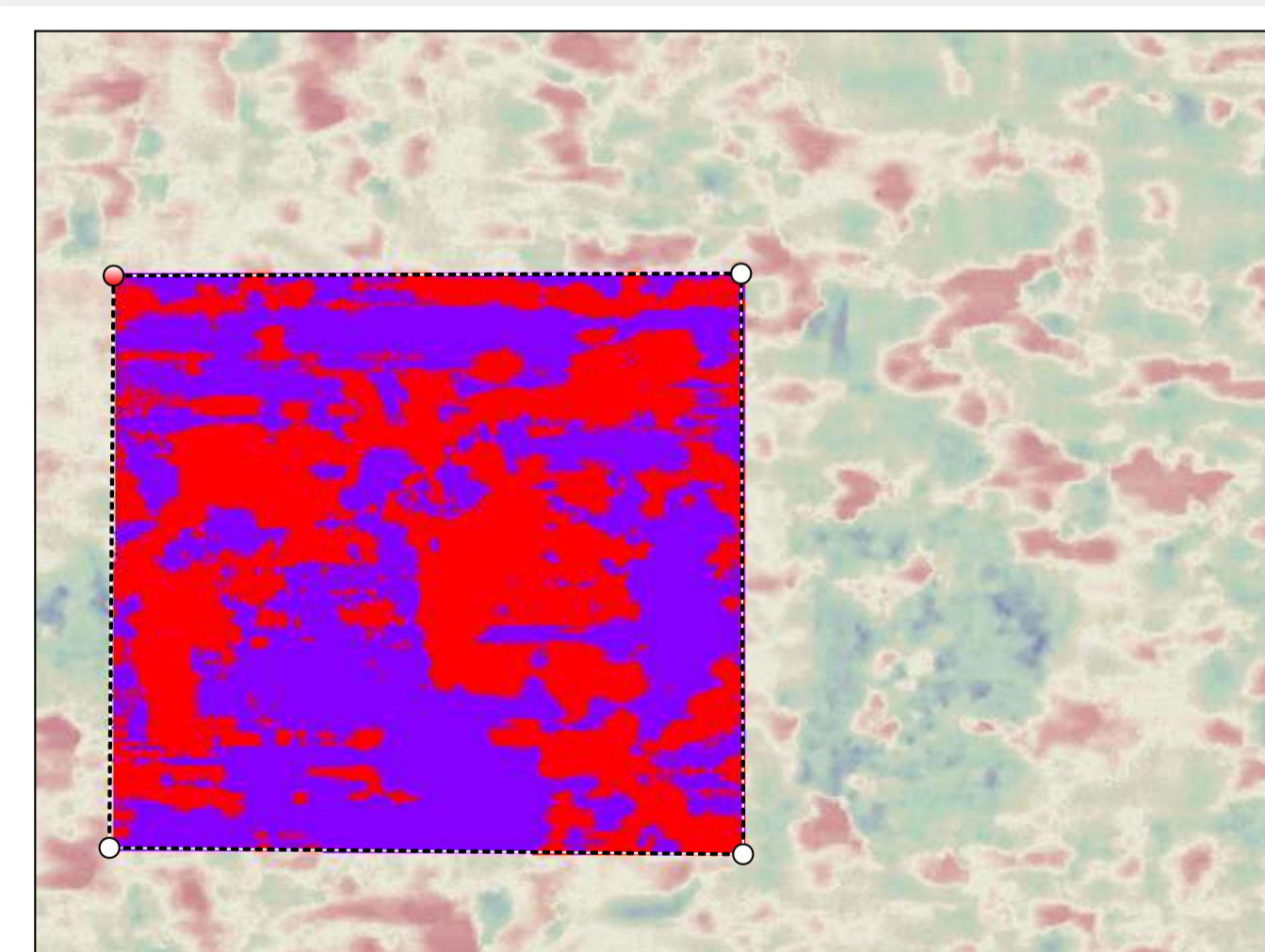
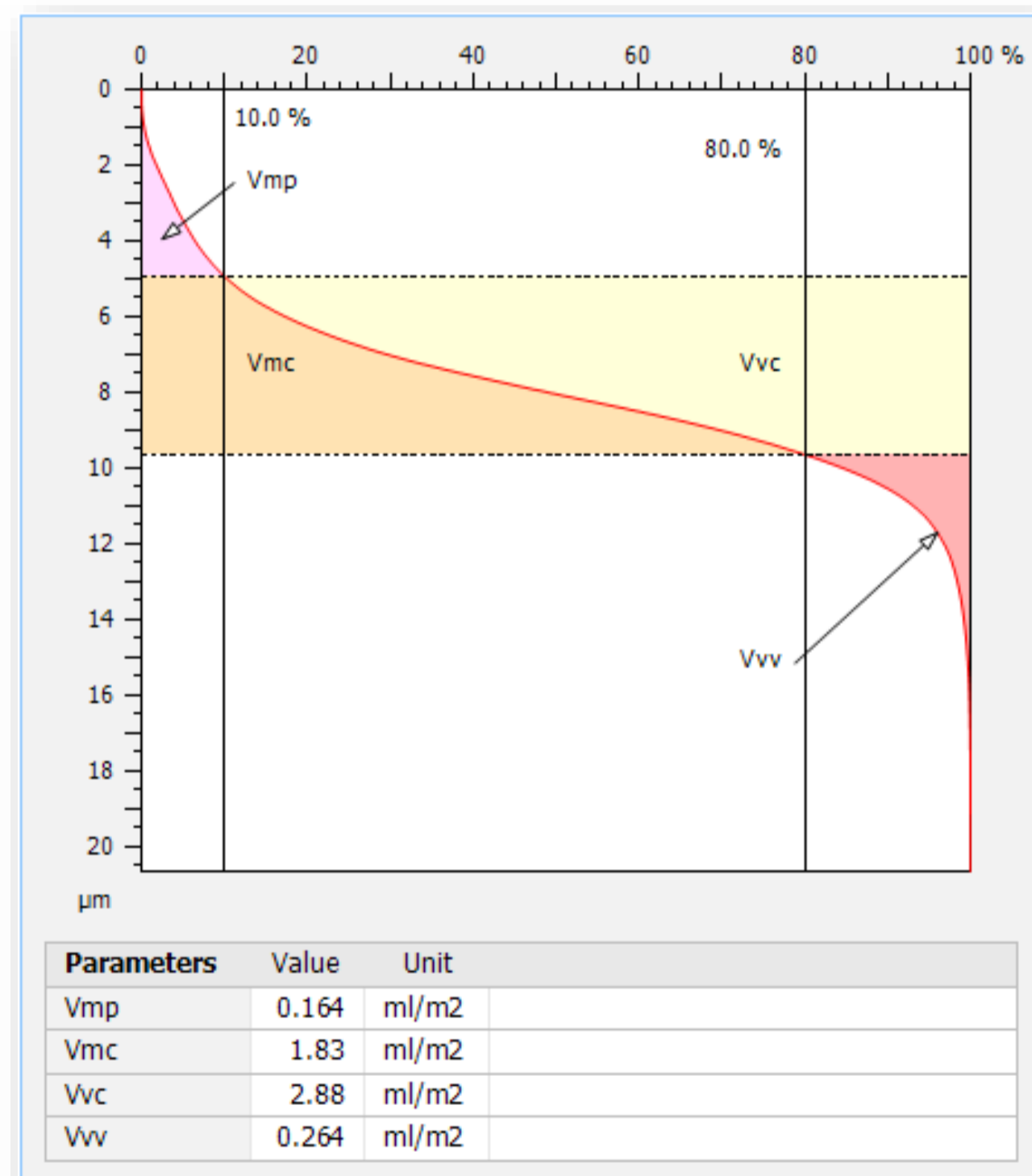
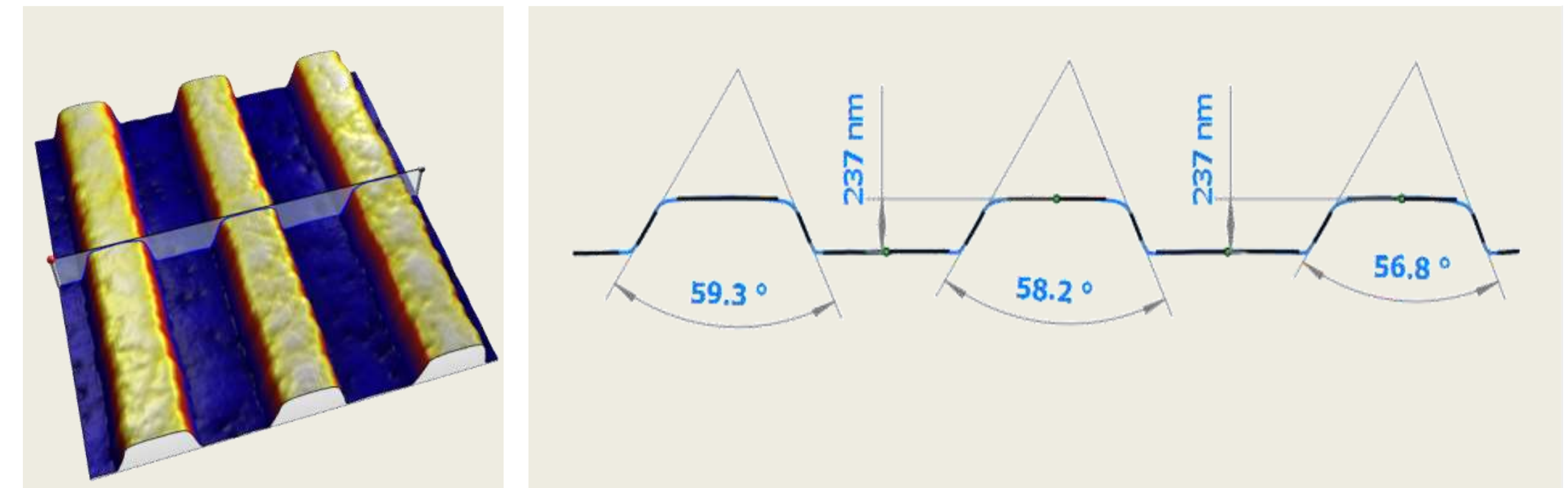
Surface imaging and analysis

Full set of areal surface texture parameters, volume, height, dimensional analysis etc.

| ISO 25178 | | | |
|------------------------------|---------|----|--|
| Height Parameters | | | |
| Sa | 1.75 | µm | Arithmetic mean height |
| Sq | 2.34 | µm | Root-mean-square height |
| Ssk | 0.246 | | Skewness |
| Sku | 4.03 | | Kurtosis |
| Sp | 7.91 | µm | Maximum peak height |
| Sv | 12.7 | µm | Maximum pit height |
| Sz | 20.7 | µm | Maximum height |
| Functional Parameters | | | |
| Smr | 0.00223 | % | $c = 0.1 \mu\text{m}$ under the highest peak Areal material ratio |
| Smc | 2.98 | µm | $p = 10\%$ Inverse areal material ratio |
| Sxp | 4.29 | µm | $p = 50\%, q = 97.5\%$ Extreme peak height |

Calculate areal surface texture parameters

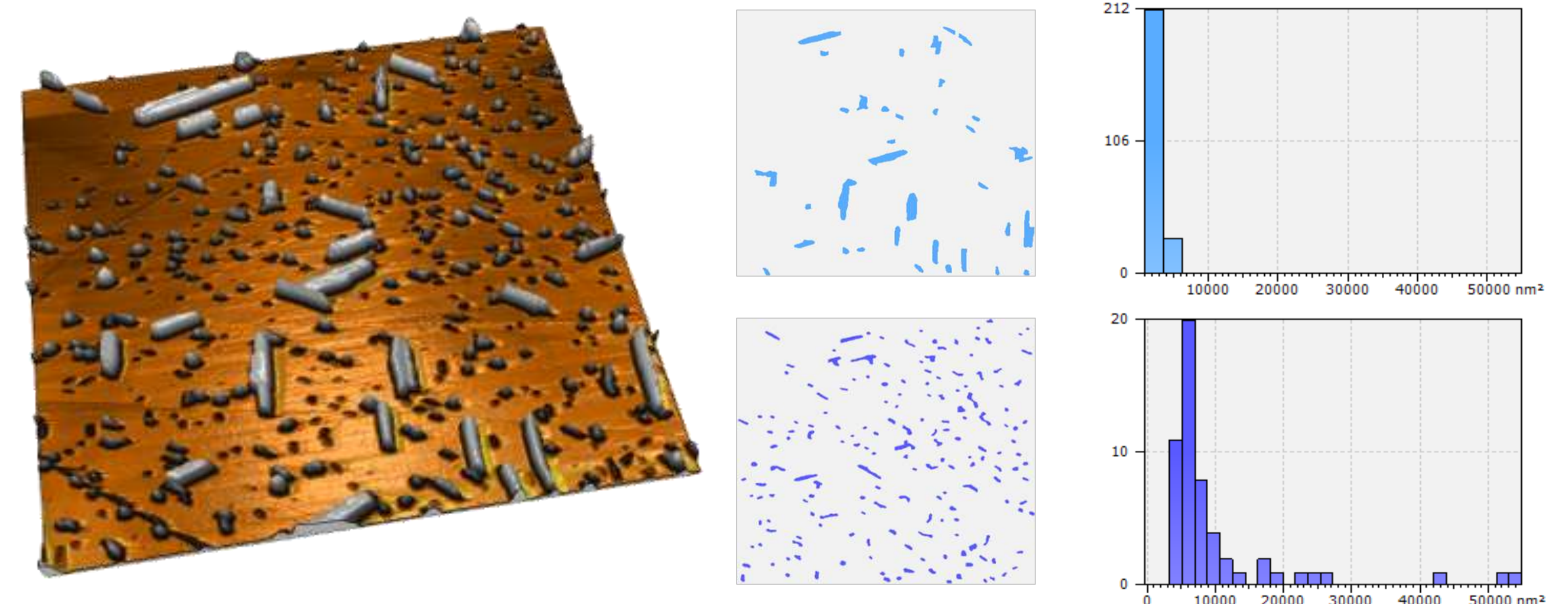
Extract vertical (x,z) or horizontal (x,y) nano-contours from a surface



| Parameters | Unit | Hole | Peak |
|-------------------|-----------------|---------|---------|
| Surface | mm ² | 0.896 | 0.783 |
| Volume | µm ³ | 1551800 | 1415776 |
| Max. depth/height | µm | 13.6 | 8.25 |
| Mean depth/height | µm | 1.73 | 1.81 |

Studies: height, bearing, volume etc.

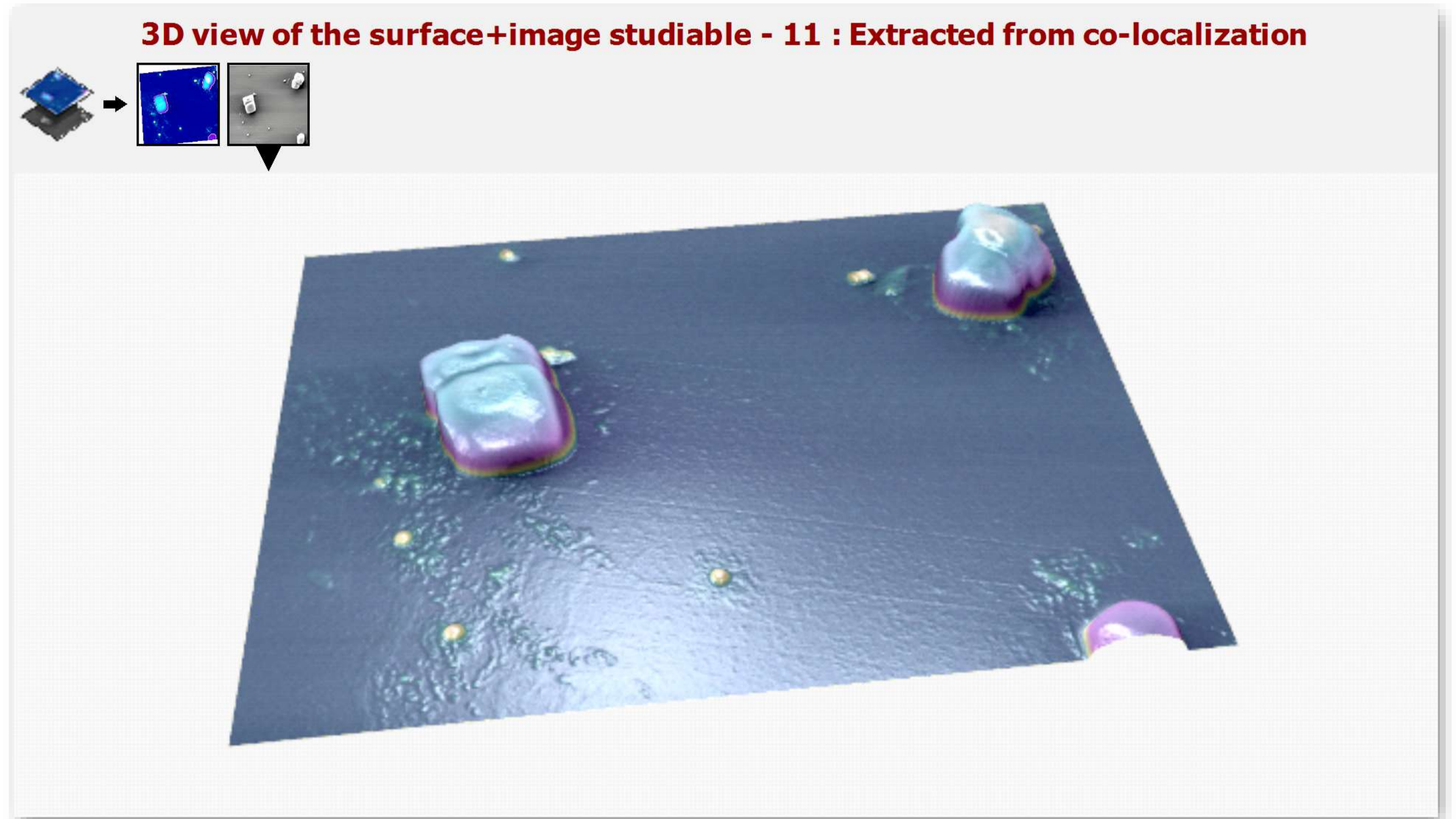
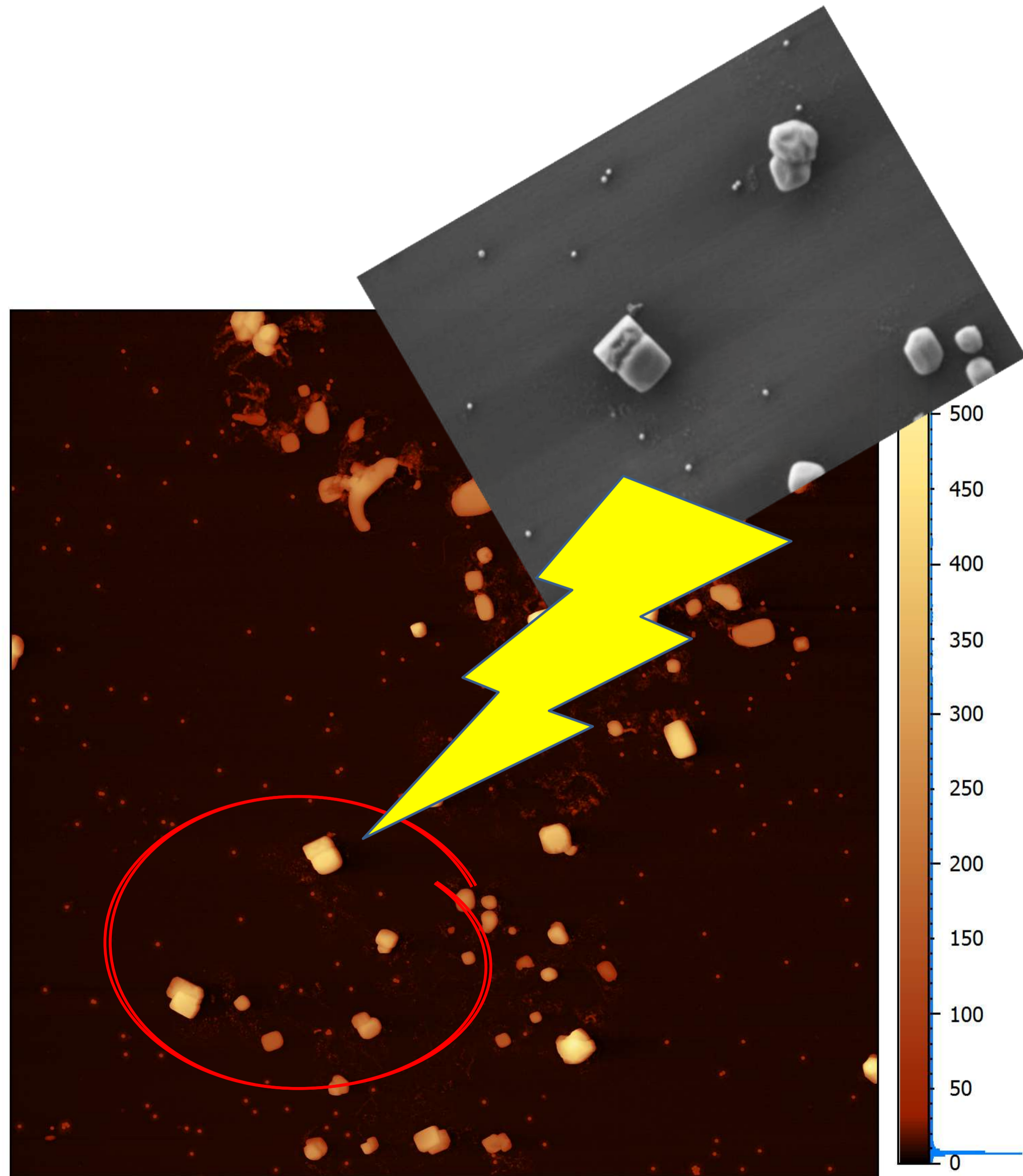
Study surface features, automatically detect particles by height or shape



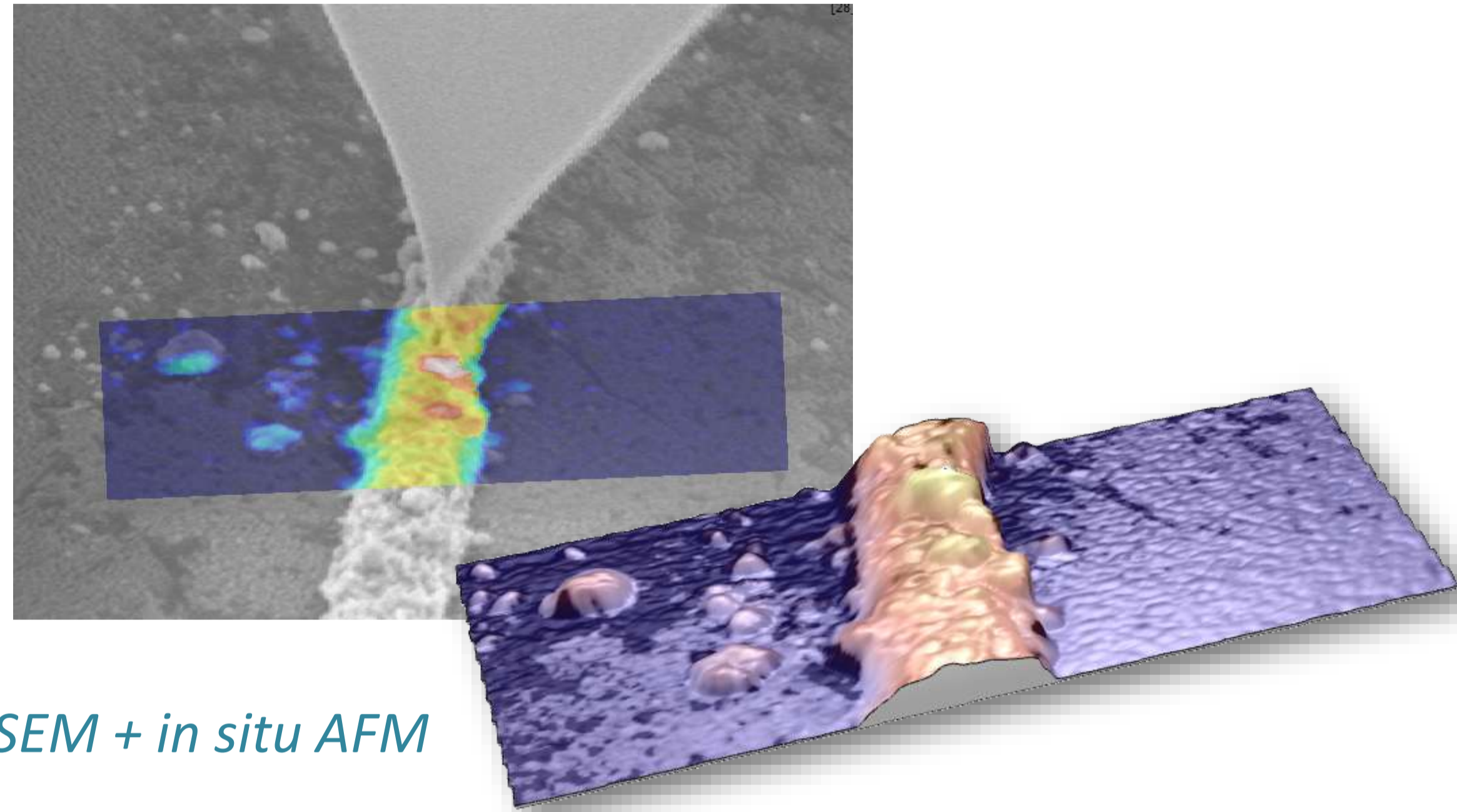
Calculate morphological parameters on particles and generate statistics

Combine data from different instrument types

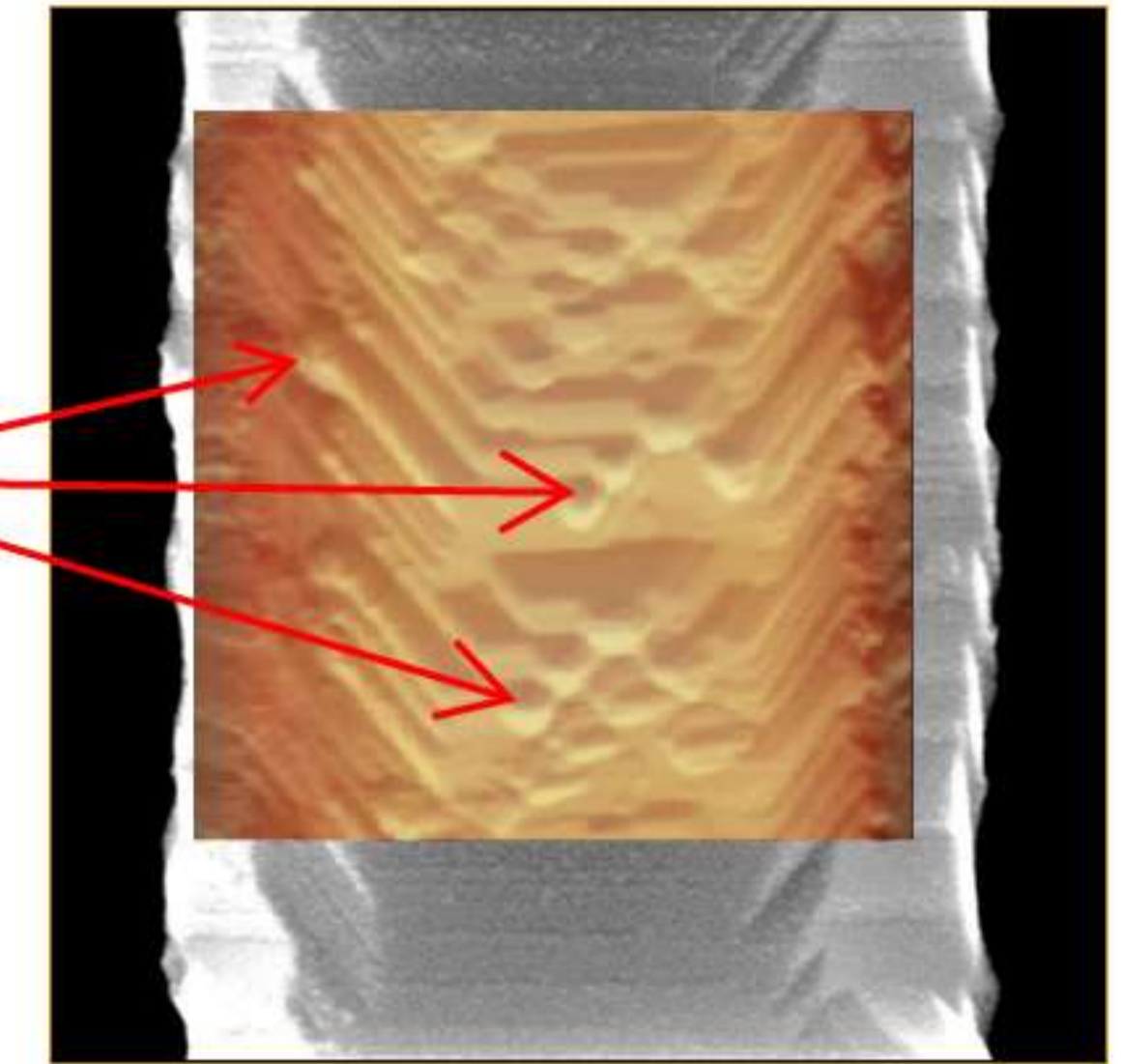
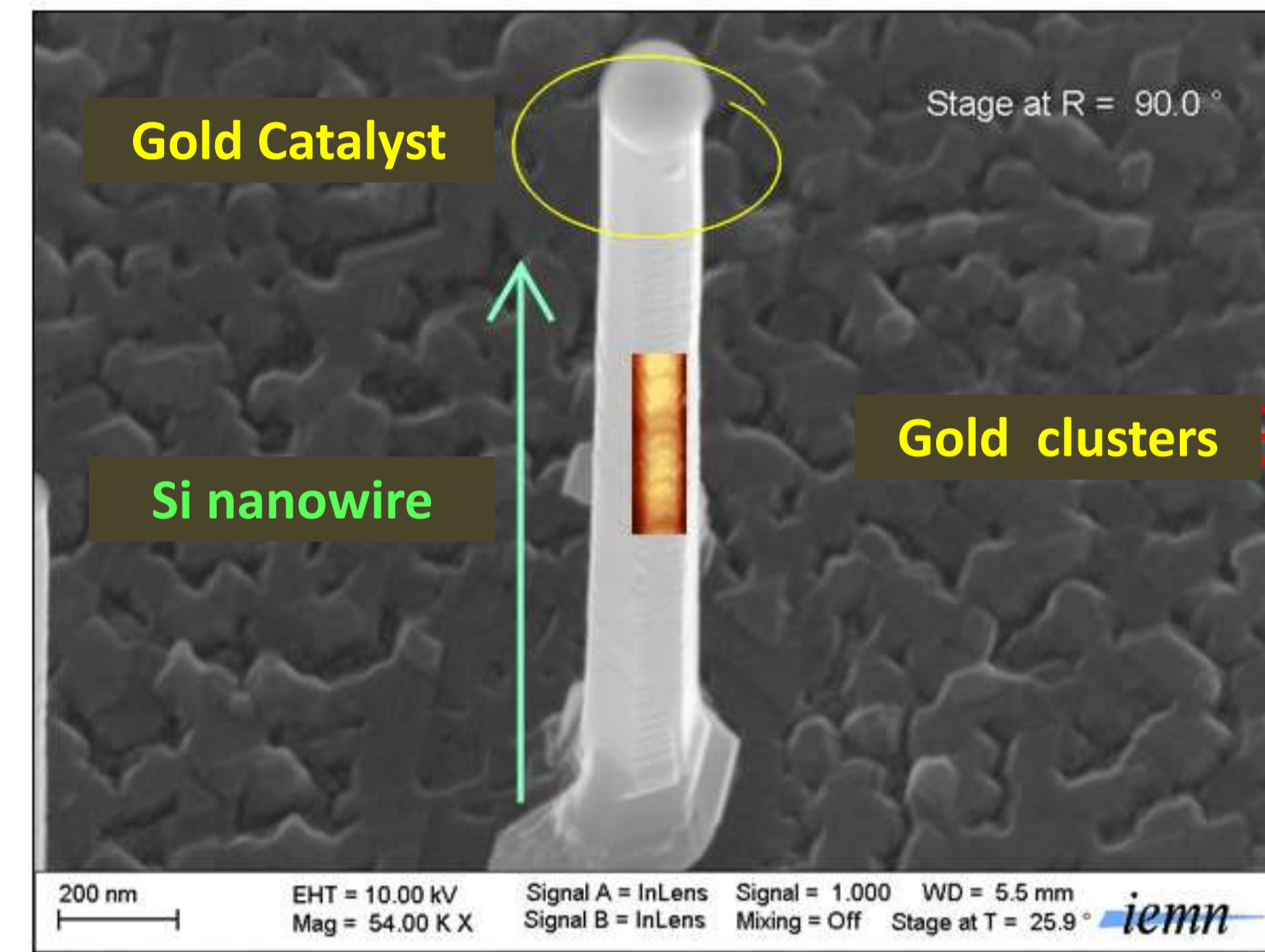
Colocalization: SEM image + 3D AFM topography



Combine data from different instrument types: examples

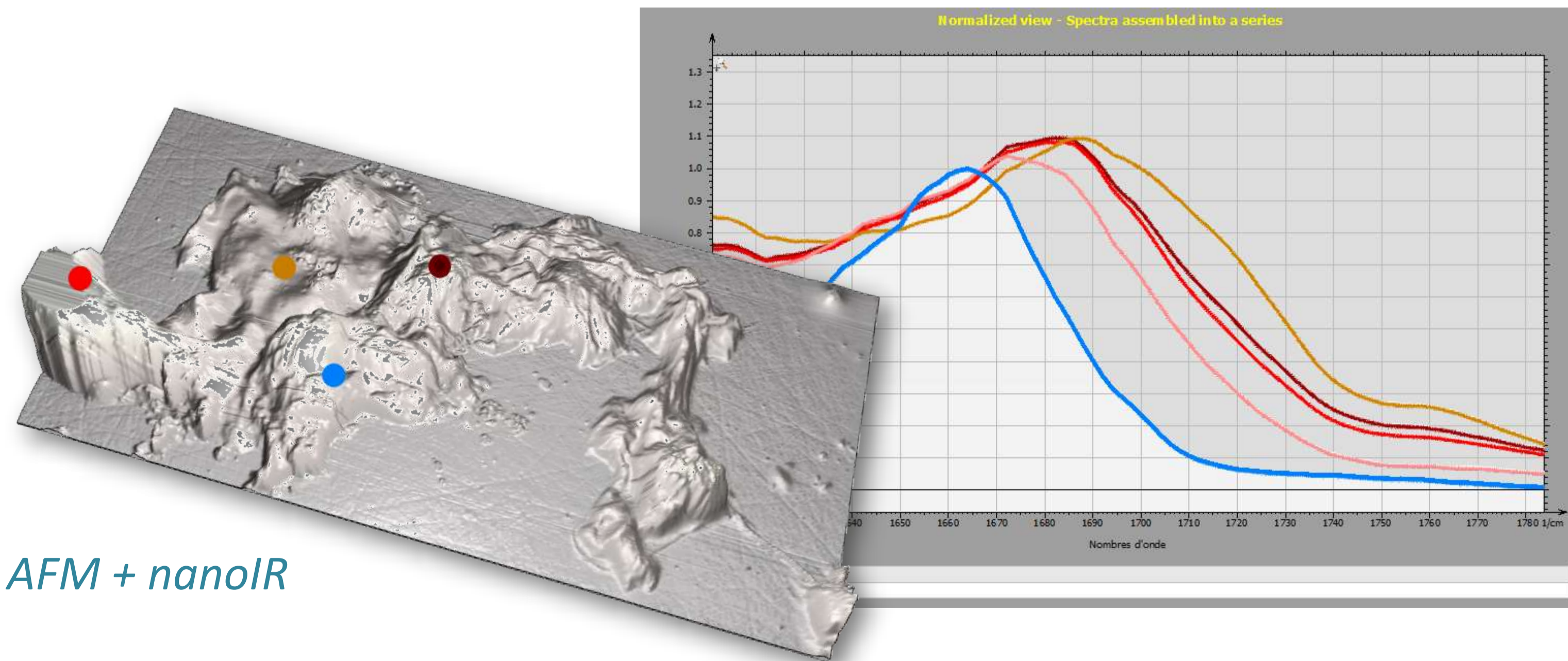


SEM + in situ AFM

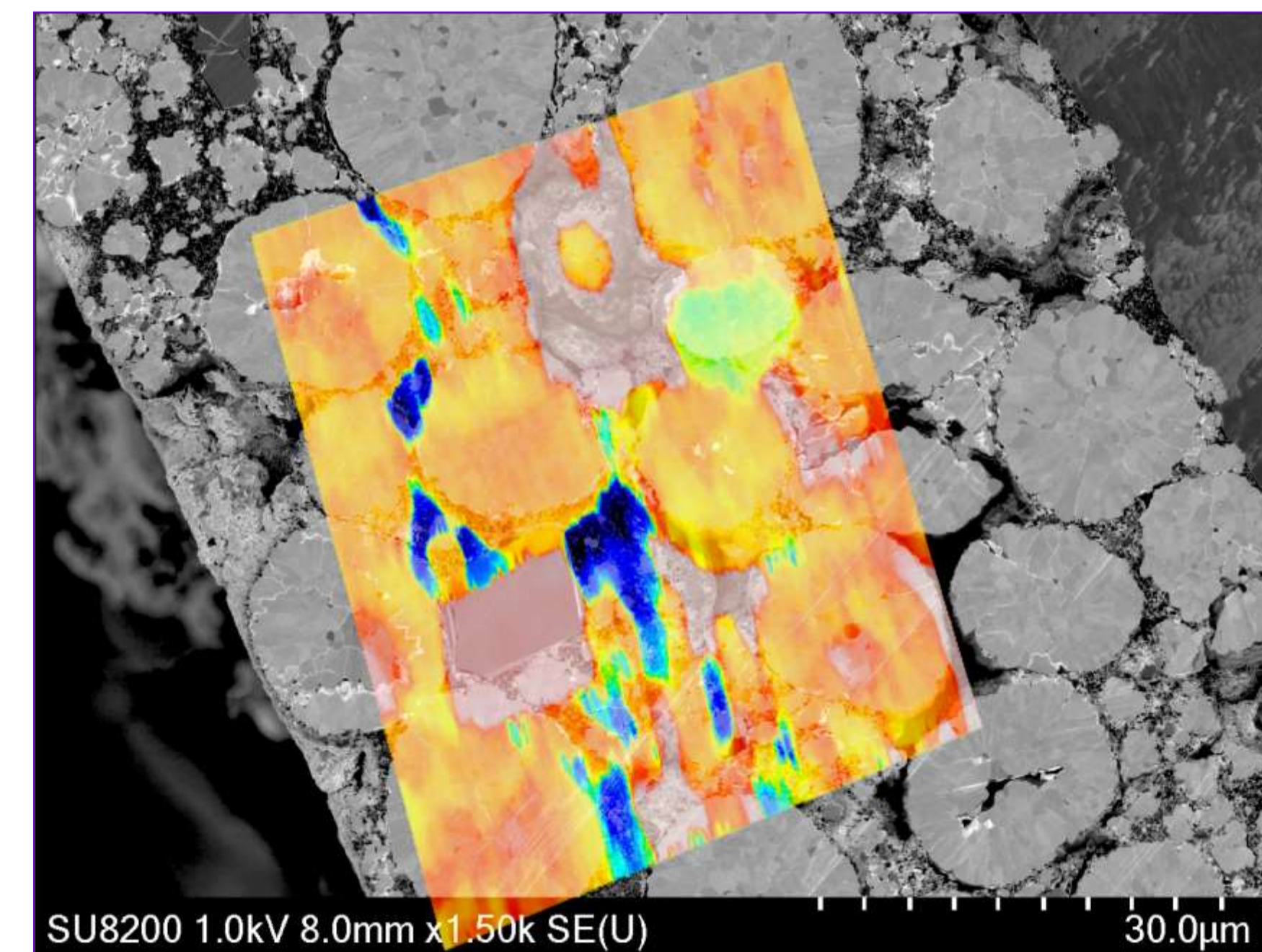


Colocalisation STM + SEM

SEM + STM



AFM + nanoIR



SEM + RFM

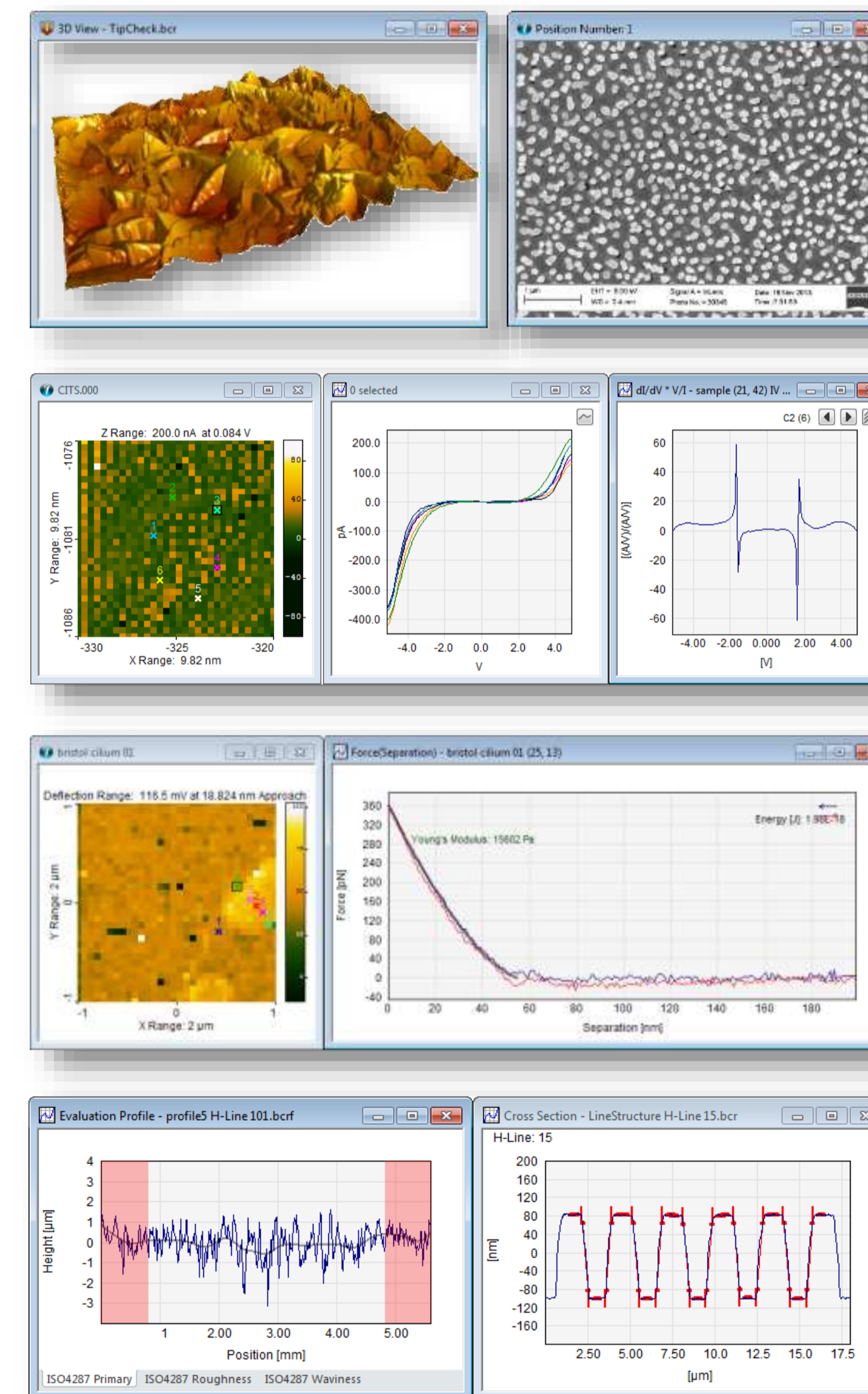
A wide range of applications



Renowned analysis software designed exclusively for SPM users

More than 100 data formats from:

- scanning probe microscopes (AFM, STM...)
- other digital imaging devices



Images

Topographic images, multichannel images, grayscale images

Force curves

Force volume images, single force curves, collections of force curves

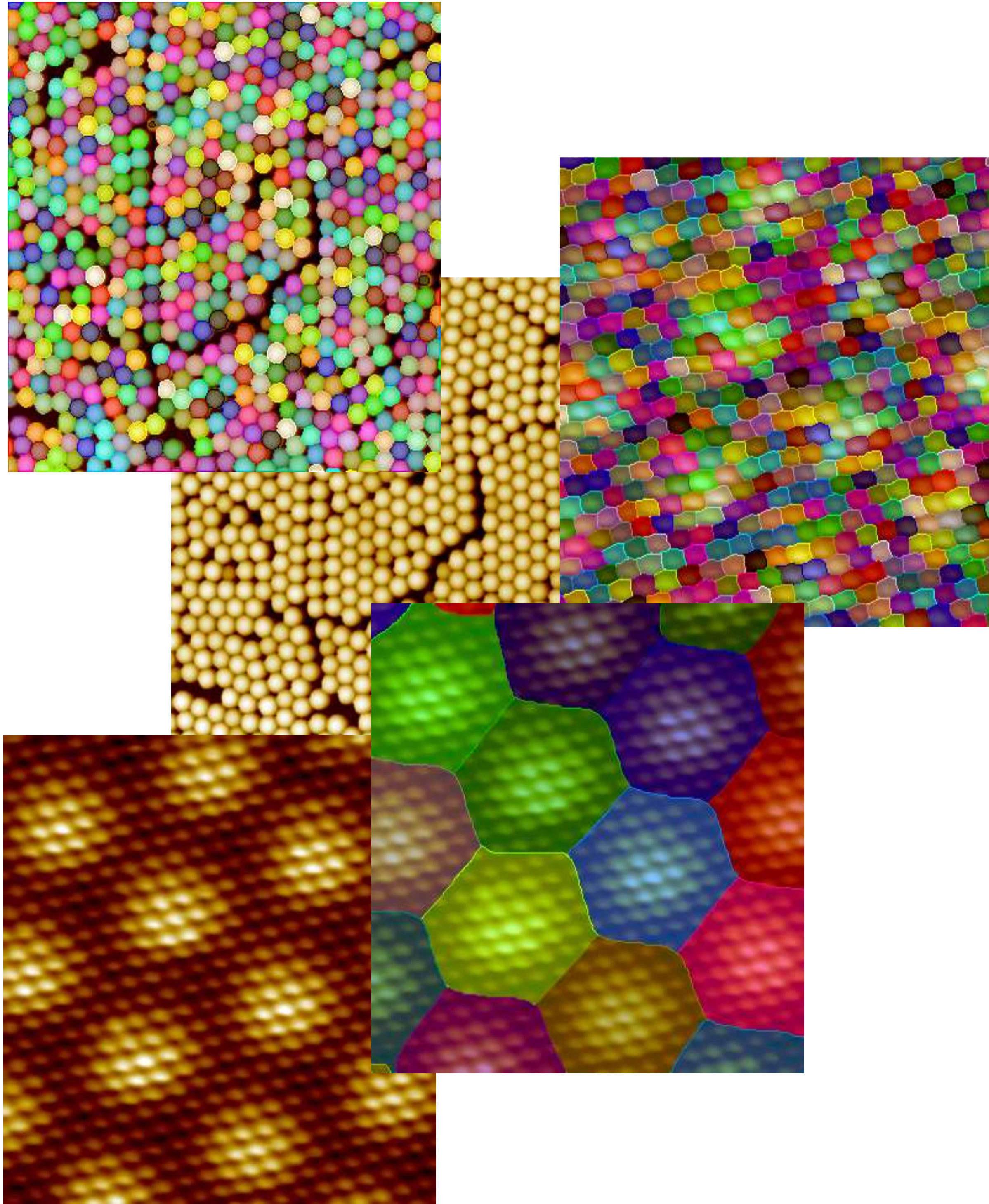
IV curve analysis

Collections of IV curves, STS images, CITS images

Profiles and other curve data

Single profiles or curves, collections of profiles

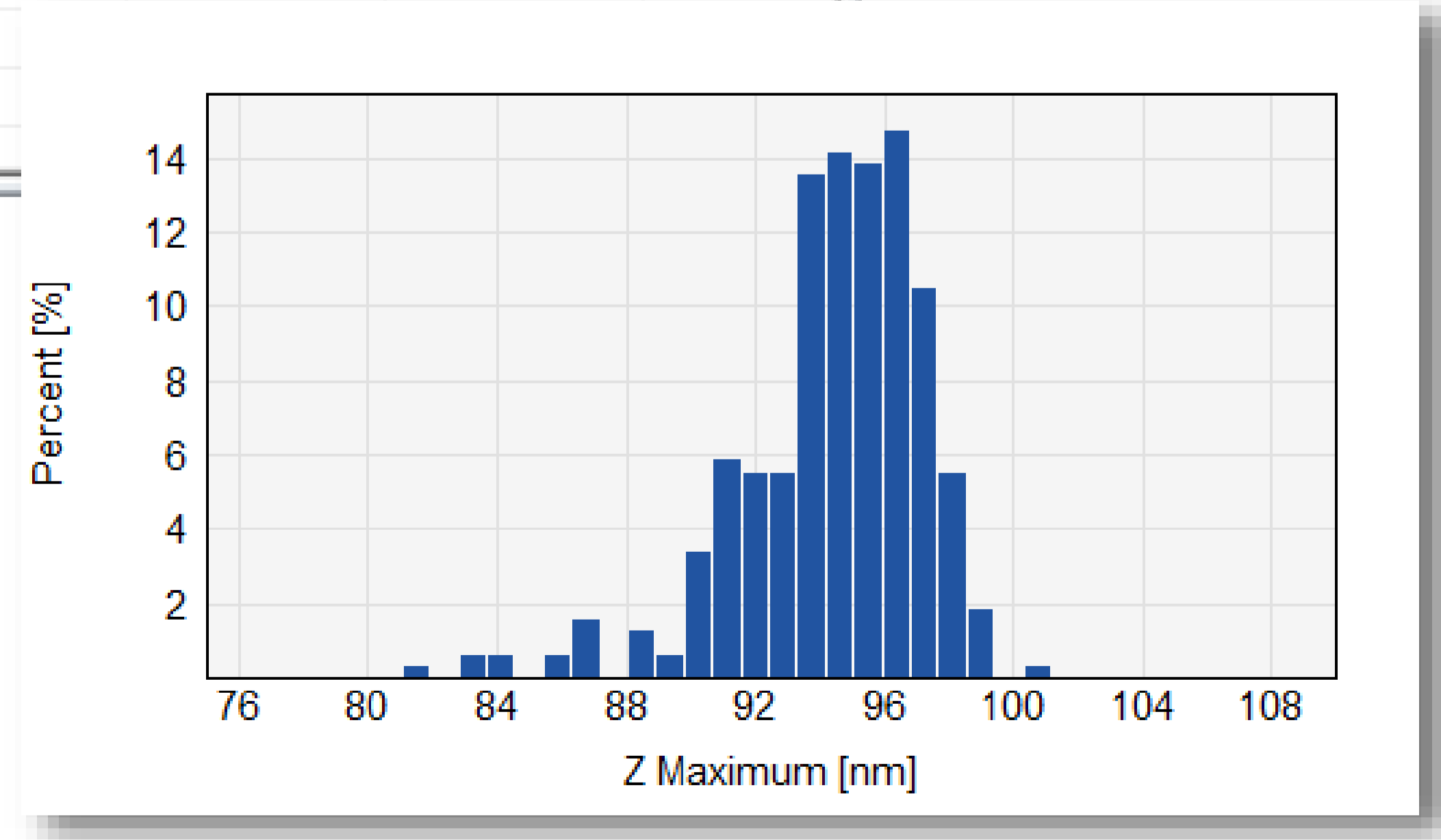
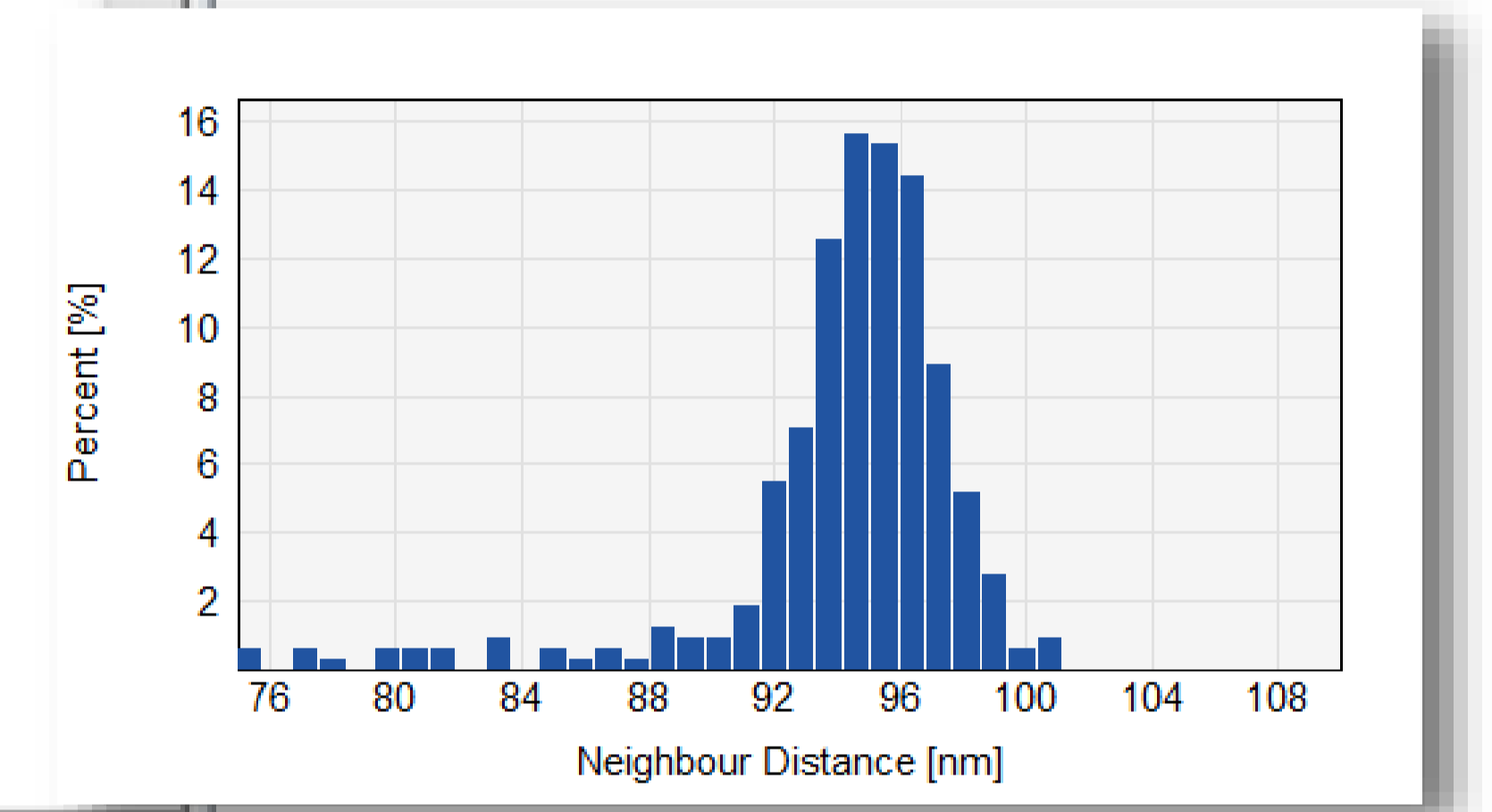
Particle & pore analysis



Shape Measurements: PS particles.bcrf

Image Collection Automatic

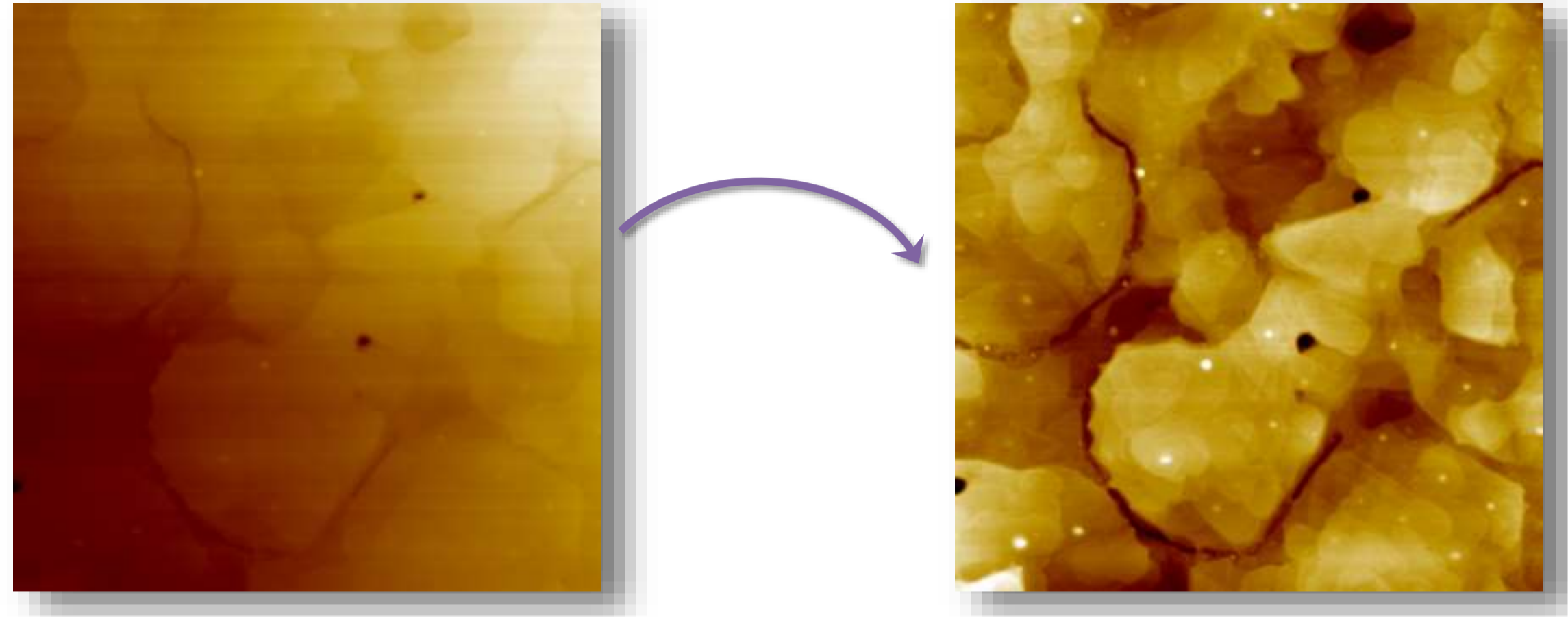
| ID | Area [nm ²] | Z Minimum [nm] | Z Maximum [nm] | Neighbour Distance [nm] |
|-----------|-------------------------|----------------|----------------|-------------------------|
| 240 | 4308.3 | 81.19 | 94.80 | 96.2 |
| 241 | 3805.7 | 81.20 | 92.80 | 91.8 |
| 242 | 5170.0 | 81.28 | 98.06 | 96.7 |
| 243 | 4811.0 | 81.18 | 95.67 | 93.6 |
| 244 | 4858.9 | 81.17 | 96.14 | 96.2 |
| 245 | 1244.6 | 81.18 | 84.54 | 89.2 |
| 246 | 4475.9 | 81.19 | 95.24 | 93.2 |
| 247 | 167.5 | 81.16 | 81.77 | 86.9 |
| 248 | 3733.9 | 81.21 | 93.02 | 93.0 |
| 249 | 4882.8 | 81.18 | 96.09 | 94.8 |
| 250 | 4475.9 | 81.30 | 94.16 | 96.4 |
| Minimum | 167.5 | 81.11 | 81.77 | 75.7 |
| Maximum | 6295.0 | 81.60 | 100.88 | 100.6 |
| Mean | 4245.9 | 81.21 | 94.46 | 94.3 |
| Std. Dev. | 1012.7 | | | |
| Count | 326 | | | |



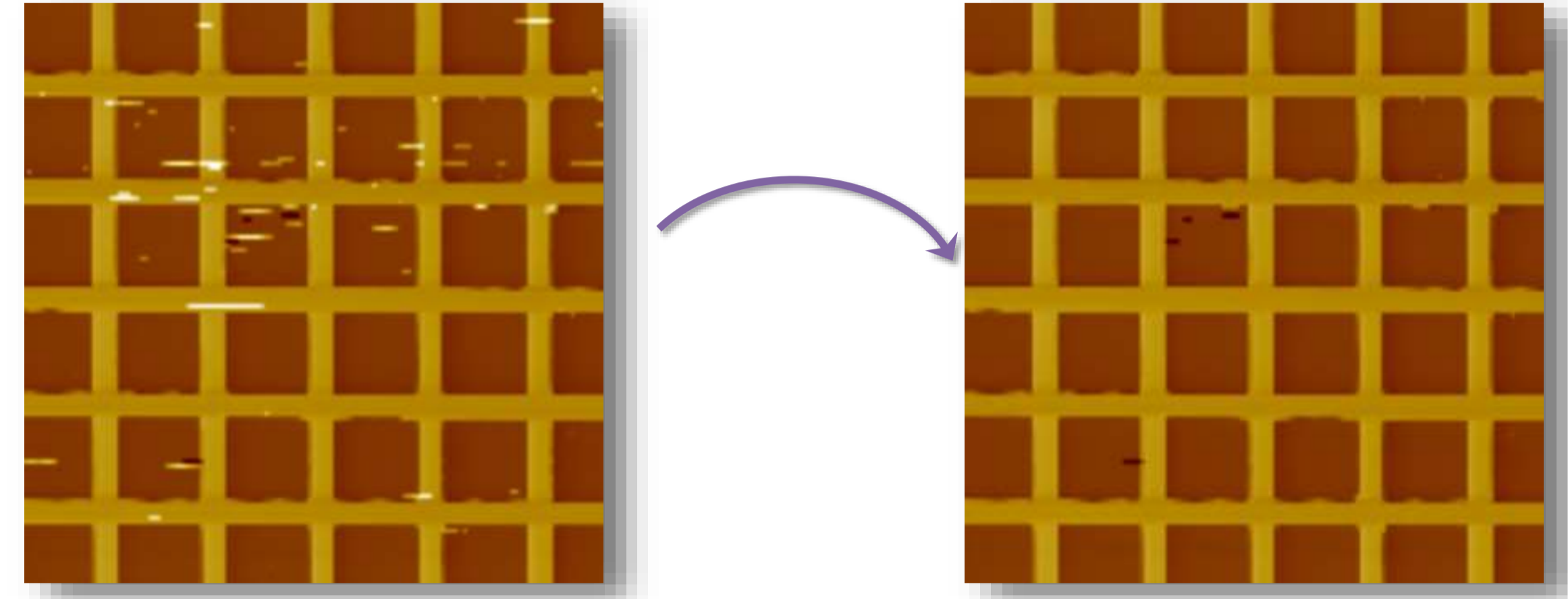
Correction and noise reduction



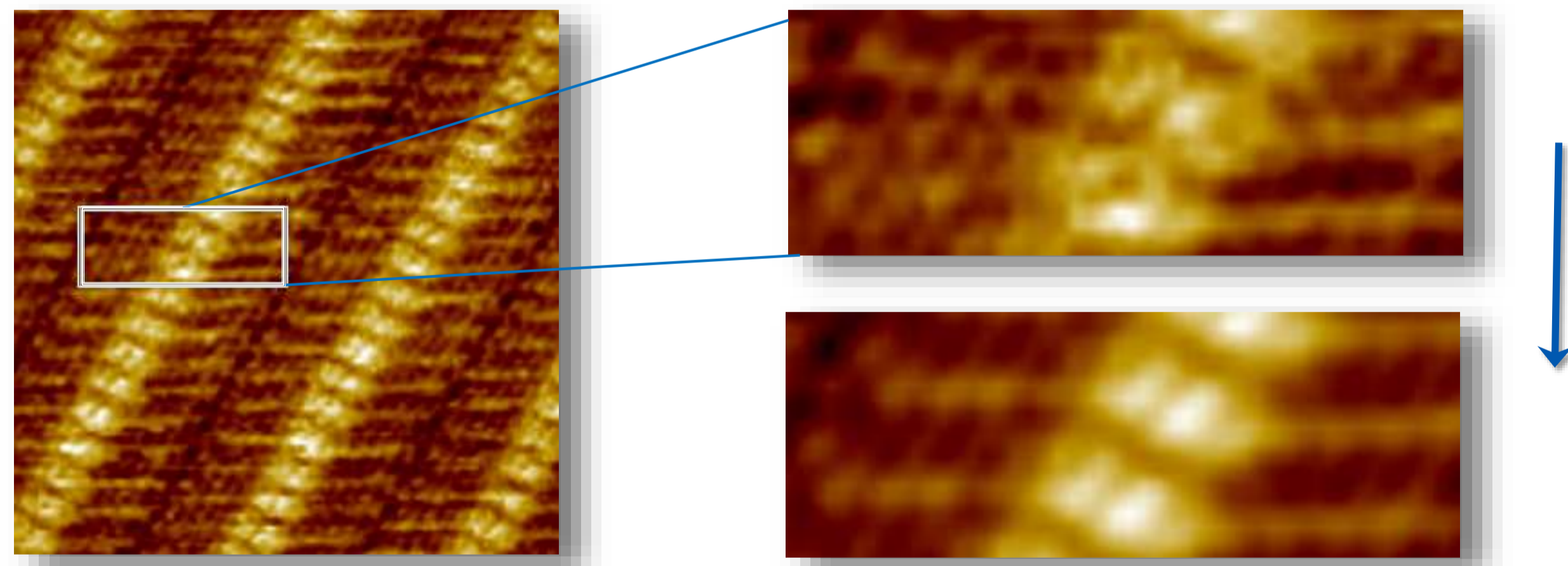
Plane correction



Filtering



Correlation averaging



Calibration

Unit Cell and Calibration Results

| Unit cell results | | | |
|-------------------|--------------|-------------|-------------------------|
| Coordinates [nm] | Length [nm] | Angle [deg] | |
| a vector | -9305 3892 | 10086.6 | 157.3 |
| b vector | 3872 9348 | 10118.1 | 67.50 |
| Angle a,b: | 89.80 degree | Area: | 1.02E+8 nm ² |

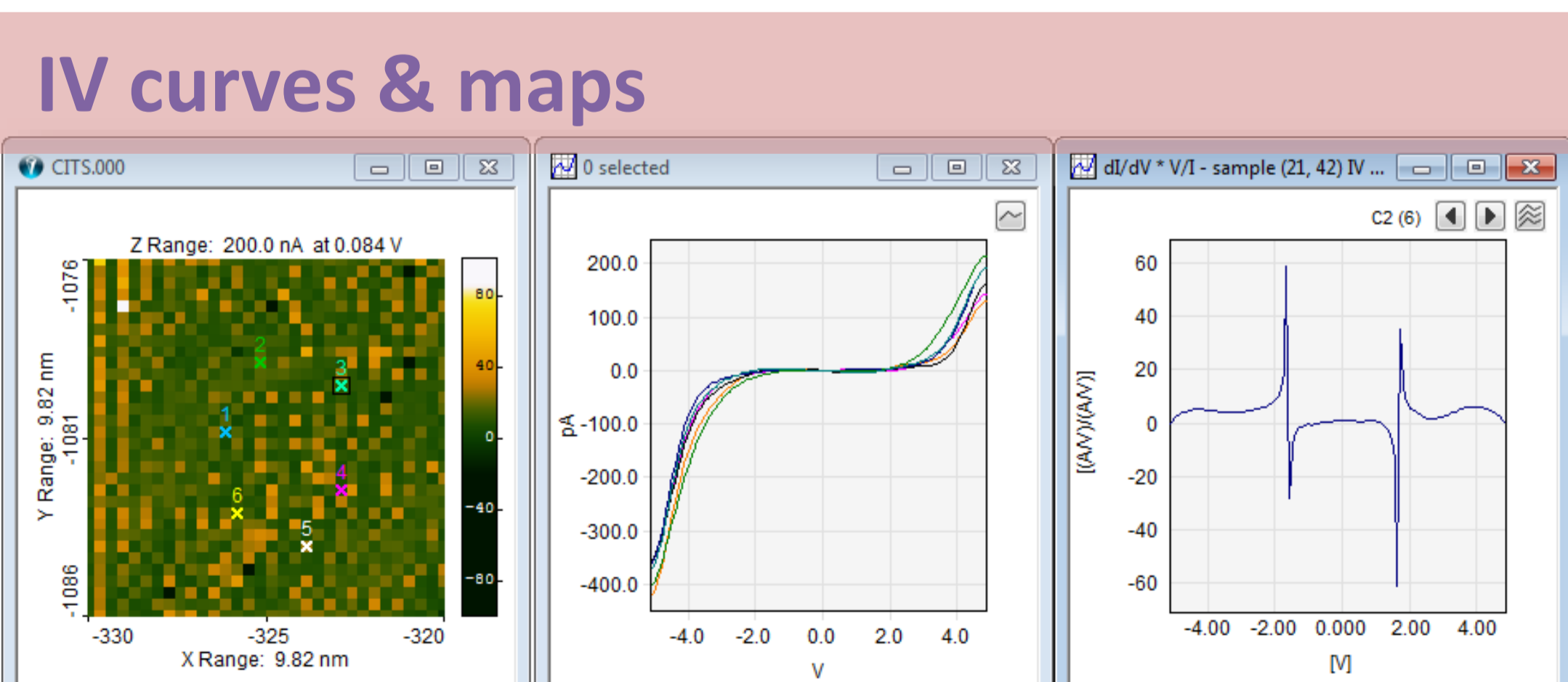
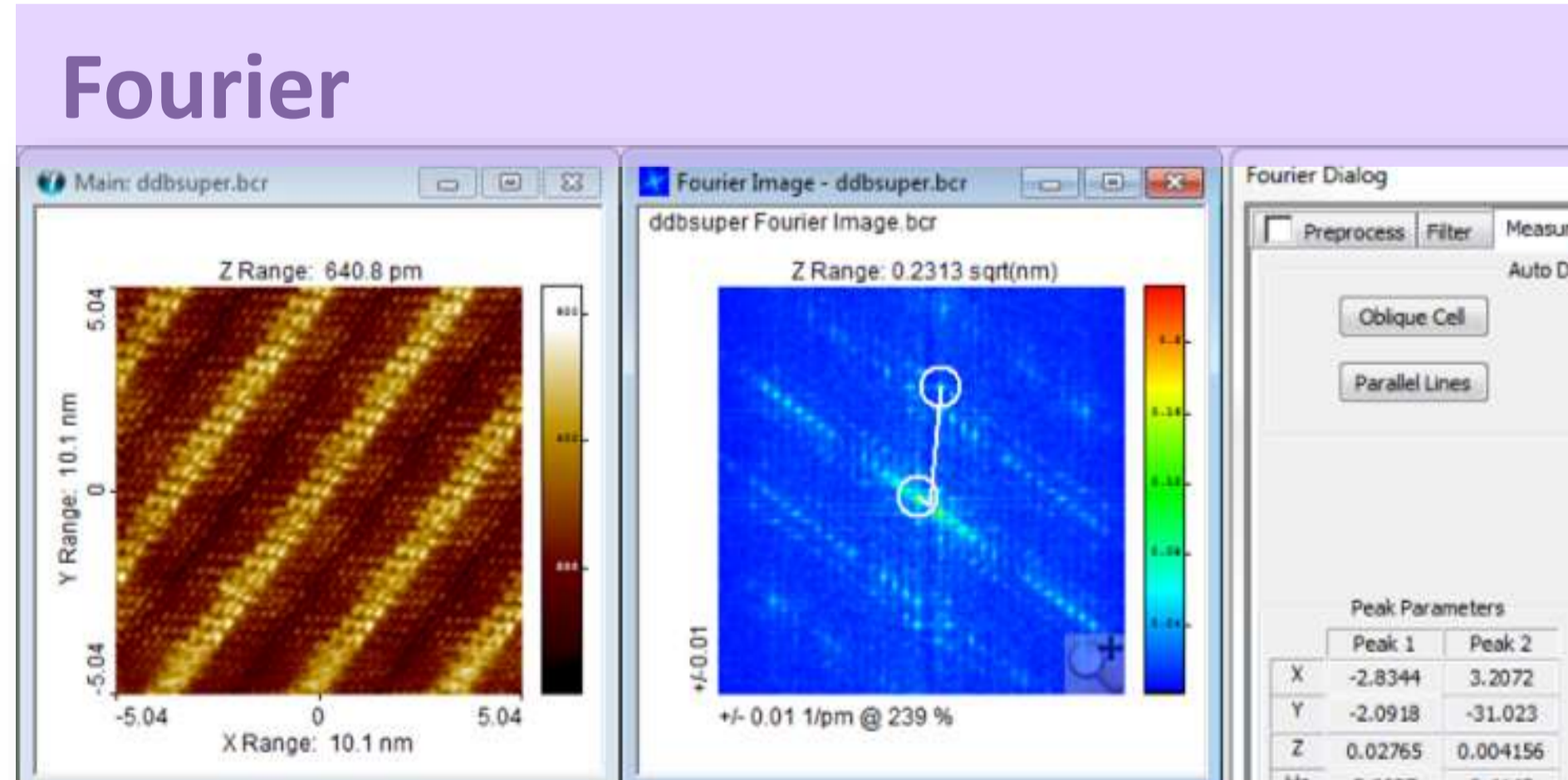
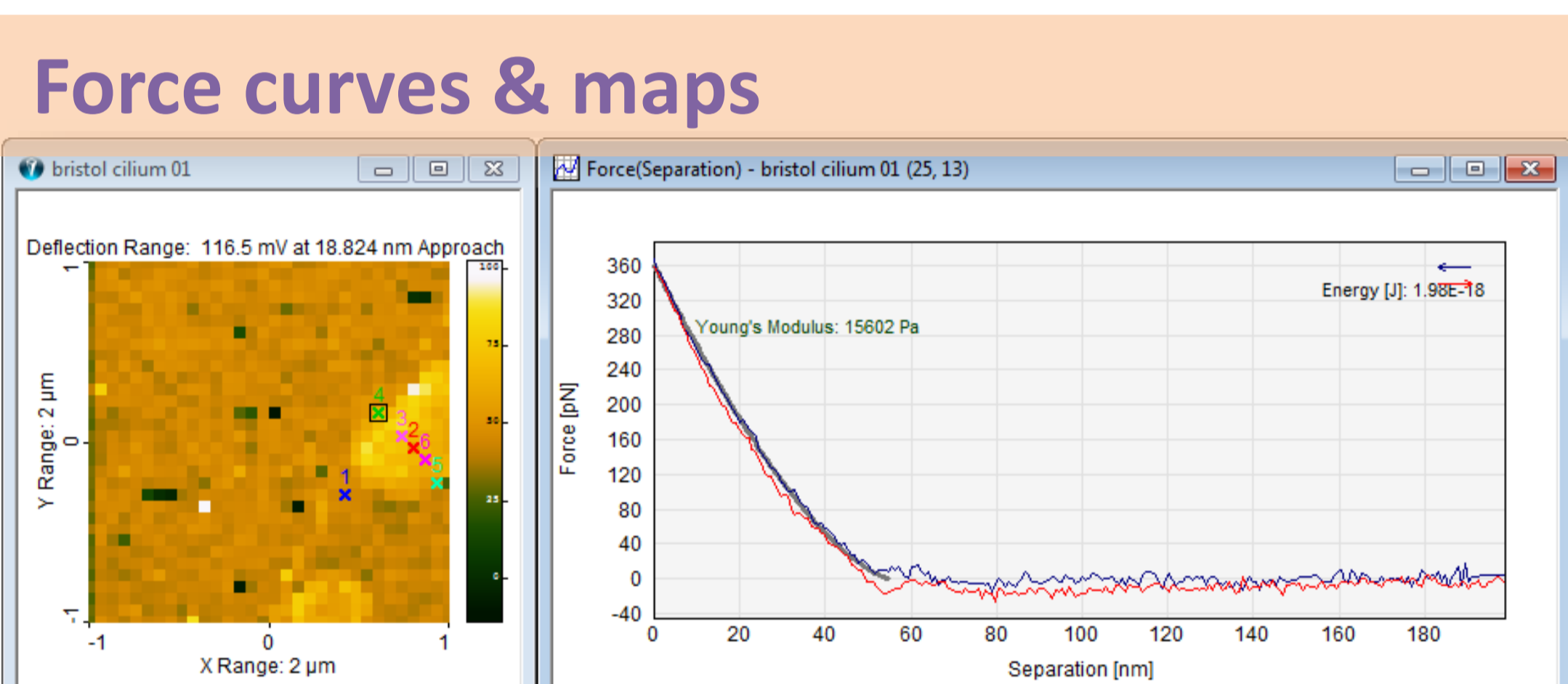
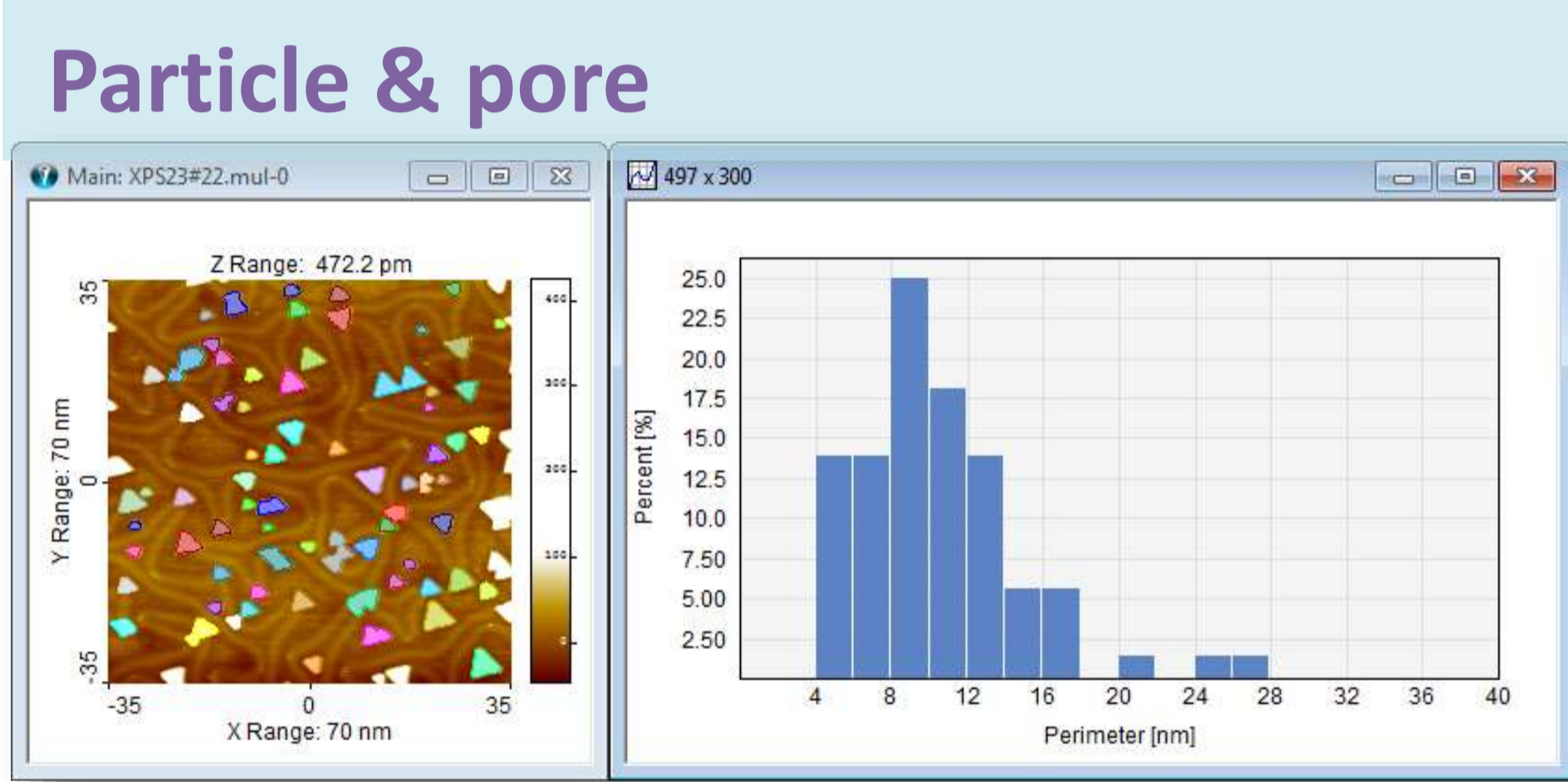
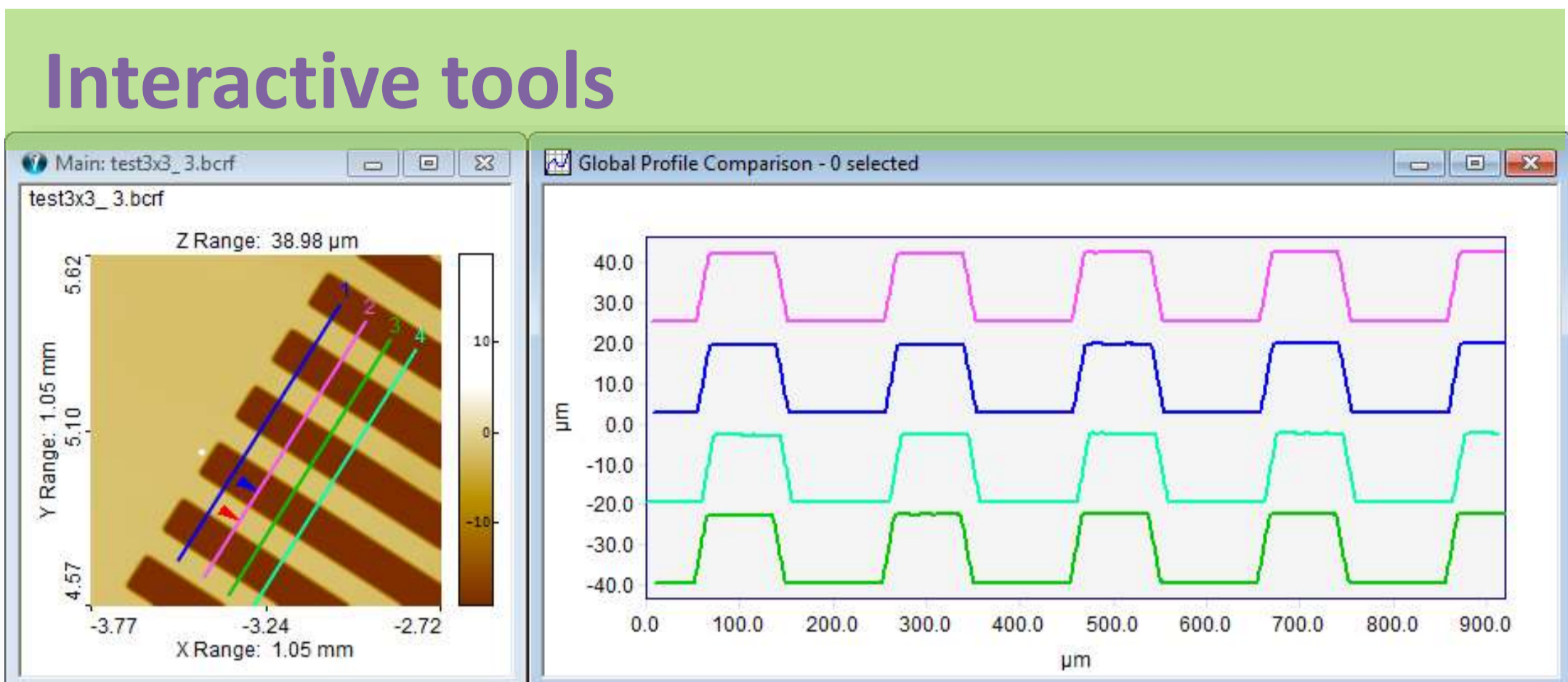
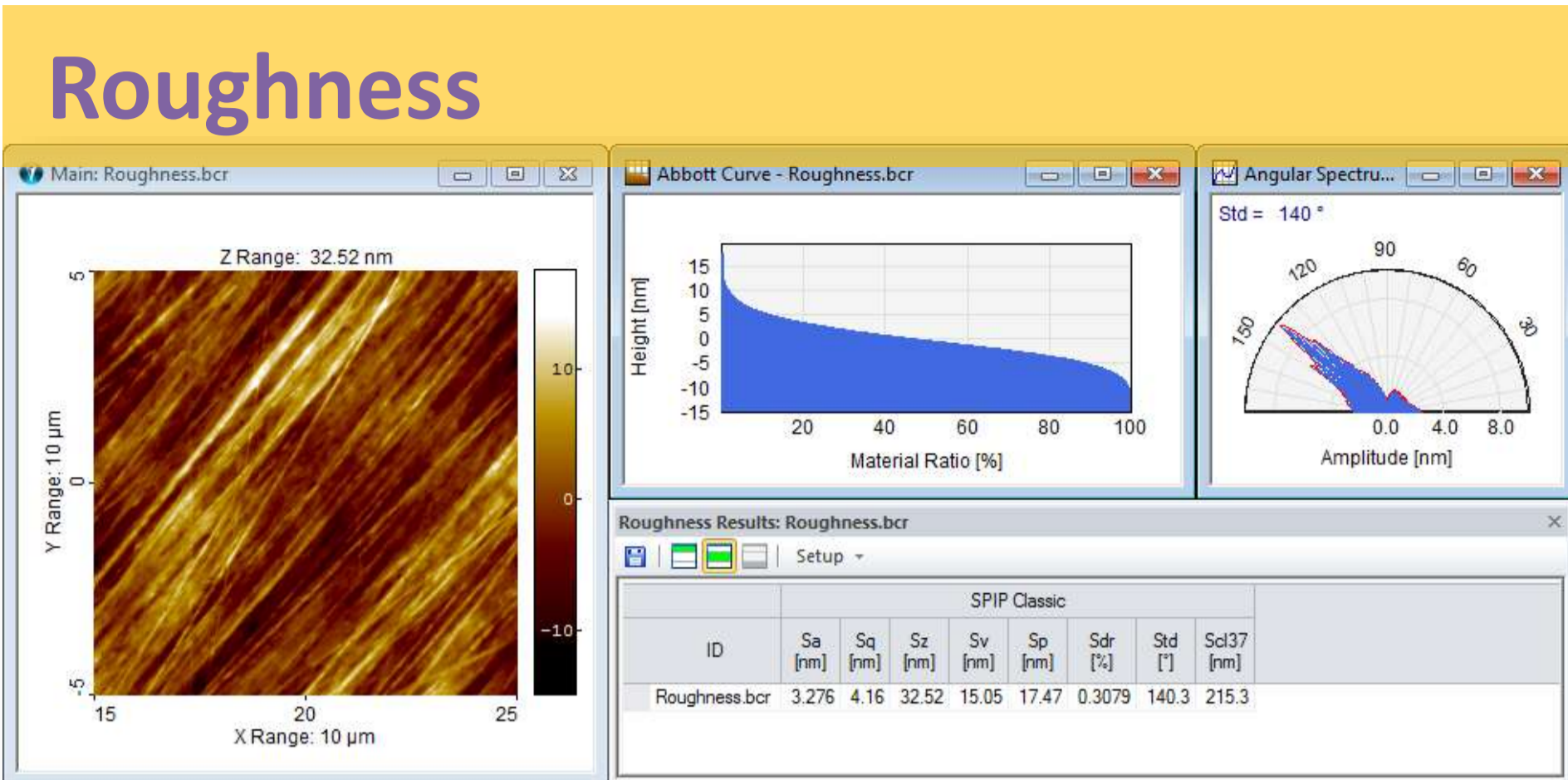
Correction Parameters

| Cx: | Cy: | dx/dy: | Gamma Error: | Drift: |
|-----------|-----------|-----------|--------------|-----------|
| 0.9921855 | 0.9875637 | 0.0002488 | 0.1443813 | 0618e-005 |

Unit cell

| x | y | size | Quality | Pixels |
|----------|--------------------|-------------|-------------------------|--------|
| a vector | -9305.314 3892.497 | 10086.64 nm | Mean Position Err. 0.64 | |
| b vector | 3872.020 9347.883 | 10118.08 nm | Standard Deviation 0.71 | |

Analysis & Inspection



Applications & markets



Instrument-oriented solutions

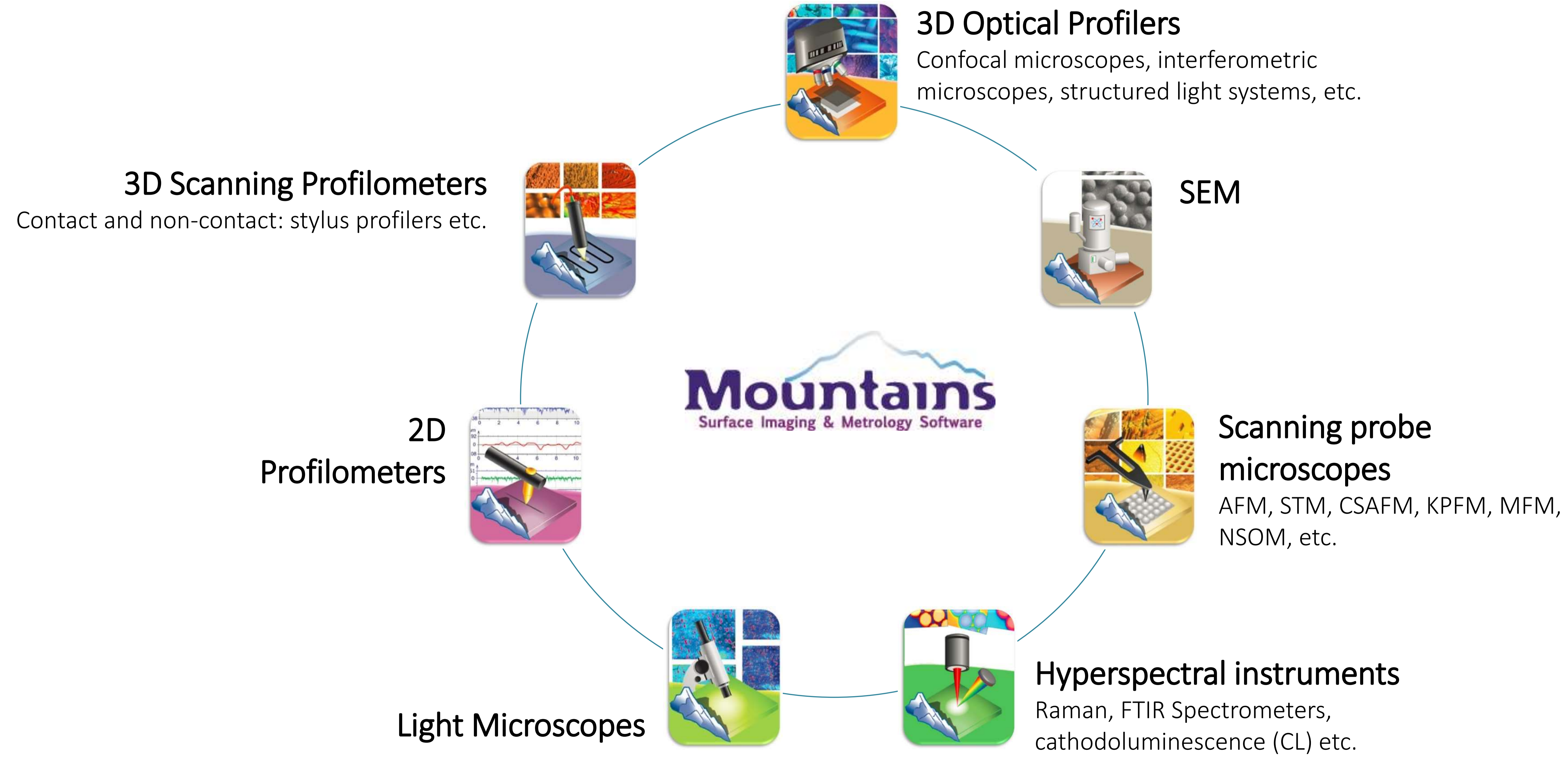
The image displays six vertical panels, each representing a different instrument-oriented solution. Each panel has a colored header with an icon, a central text label, and a screenshot of the software interface at the bottom.

- 2D surface profilometry:** Purple header with a stylized 2D surface profile icon. The software screenshot shows a 2D line graph and a data table.
- 3D surface profilometry:** Dark red header with a stylized 3D surface profile icon. The software screenshot shows a 3D surface map and a data table.
- WLI & Confocal microscopy:** Blue header with a stylized WLI/Confocal microscope icon. The software screenshot shows a 3D surface map and a data table.
- Scanning probe microscopy:** Orange header with a stylized SPM probe icon. The software screenshot shows a 3D surface map and a data table.
- Electron microscopy:** Teal header with a stylized electron microscope icon. The software screenshot shows a 3D surface map and a data table.
- Spectrometry:** Green header with a stylized spectrometer icon. The software screenshot shows a 3D surface map and a data table.

Surface imaging & metrology software – powered by Mountains technology®

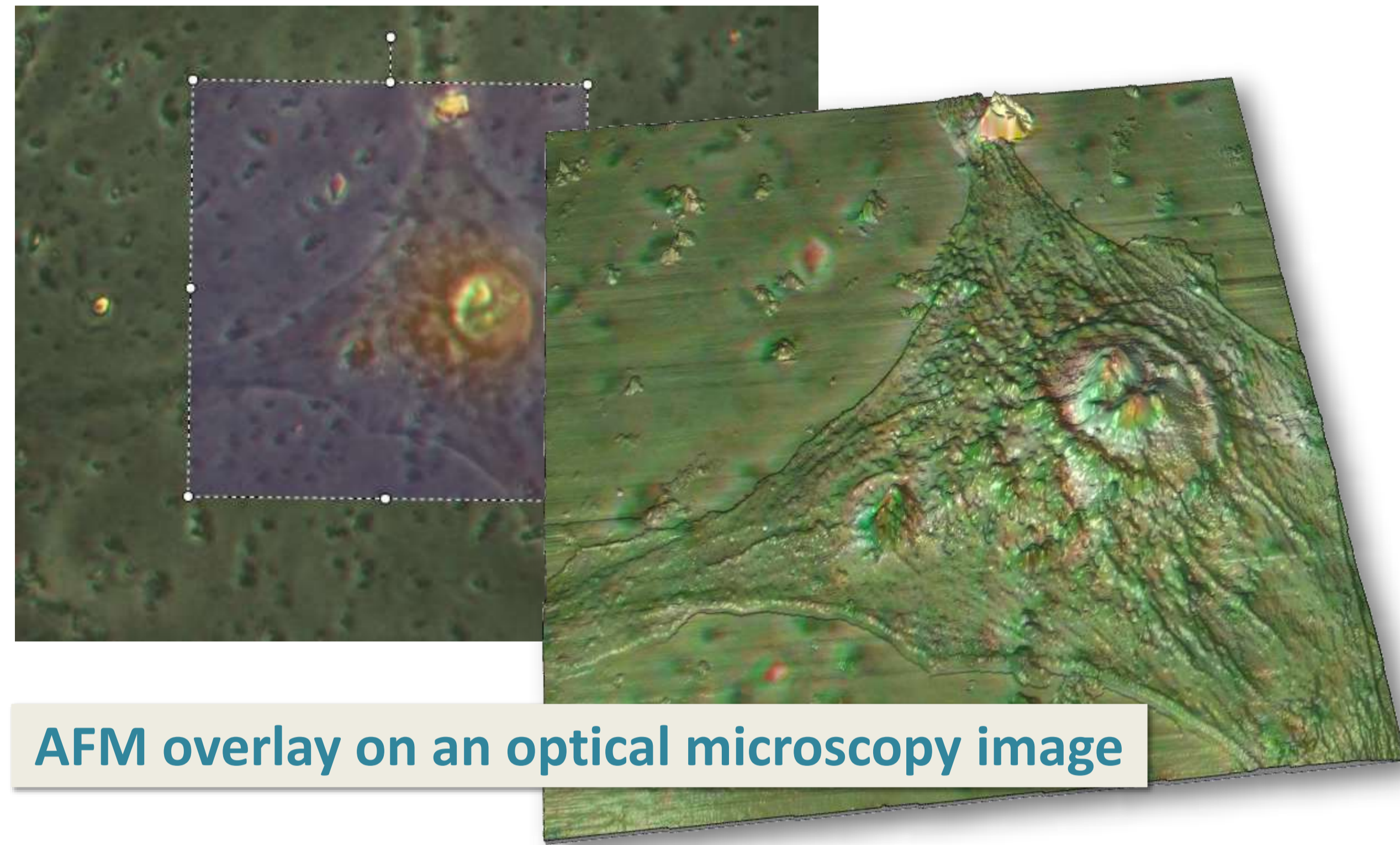


Mountains[®] software ONE technology for any instrument

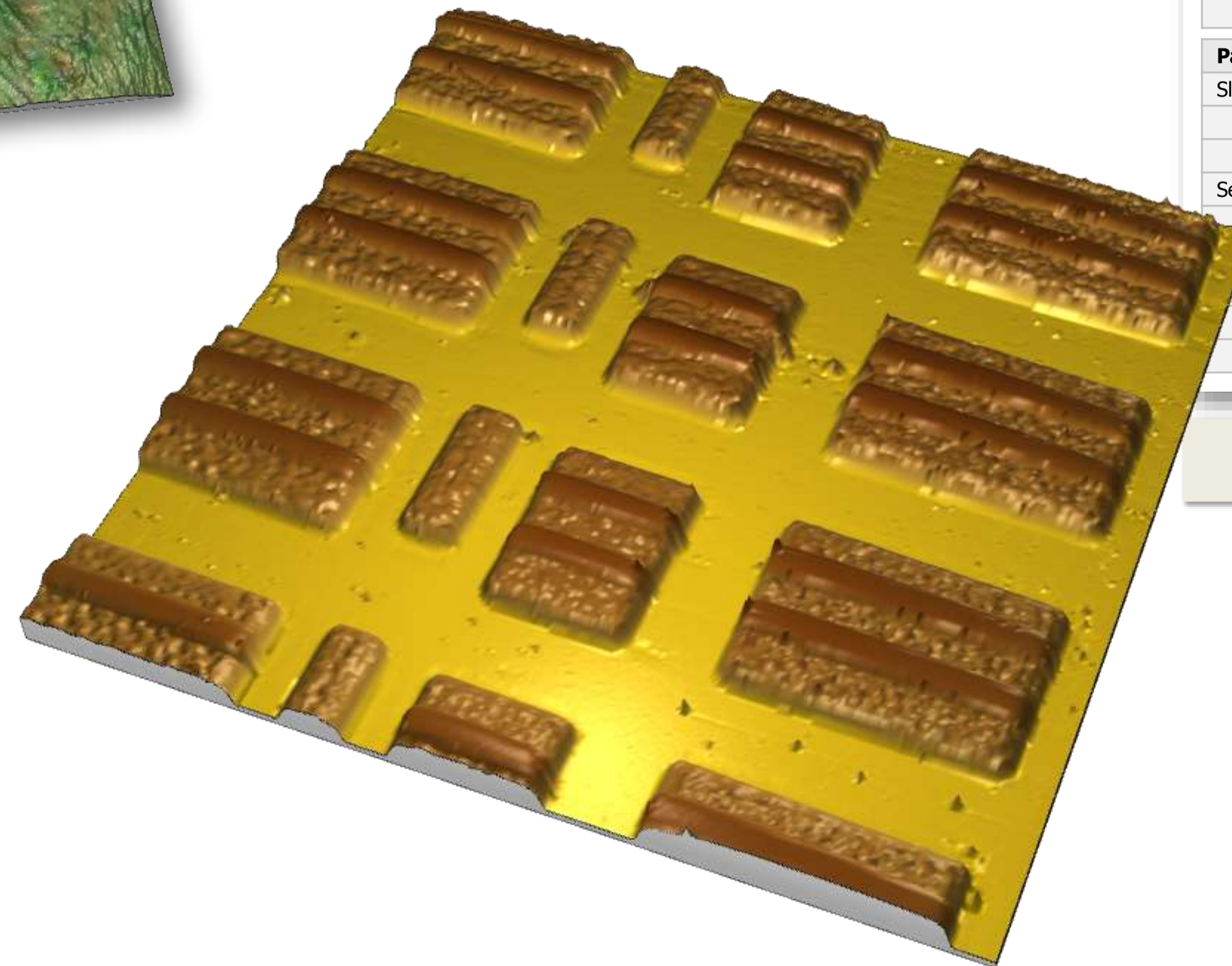


Premium software
Superset for all types of surface imaging and measuring instruments

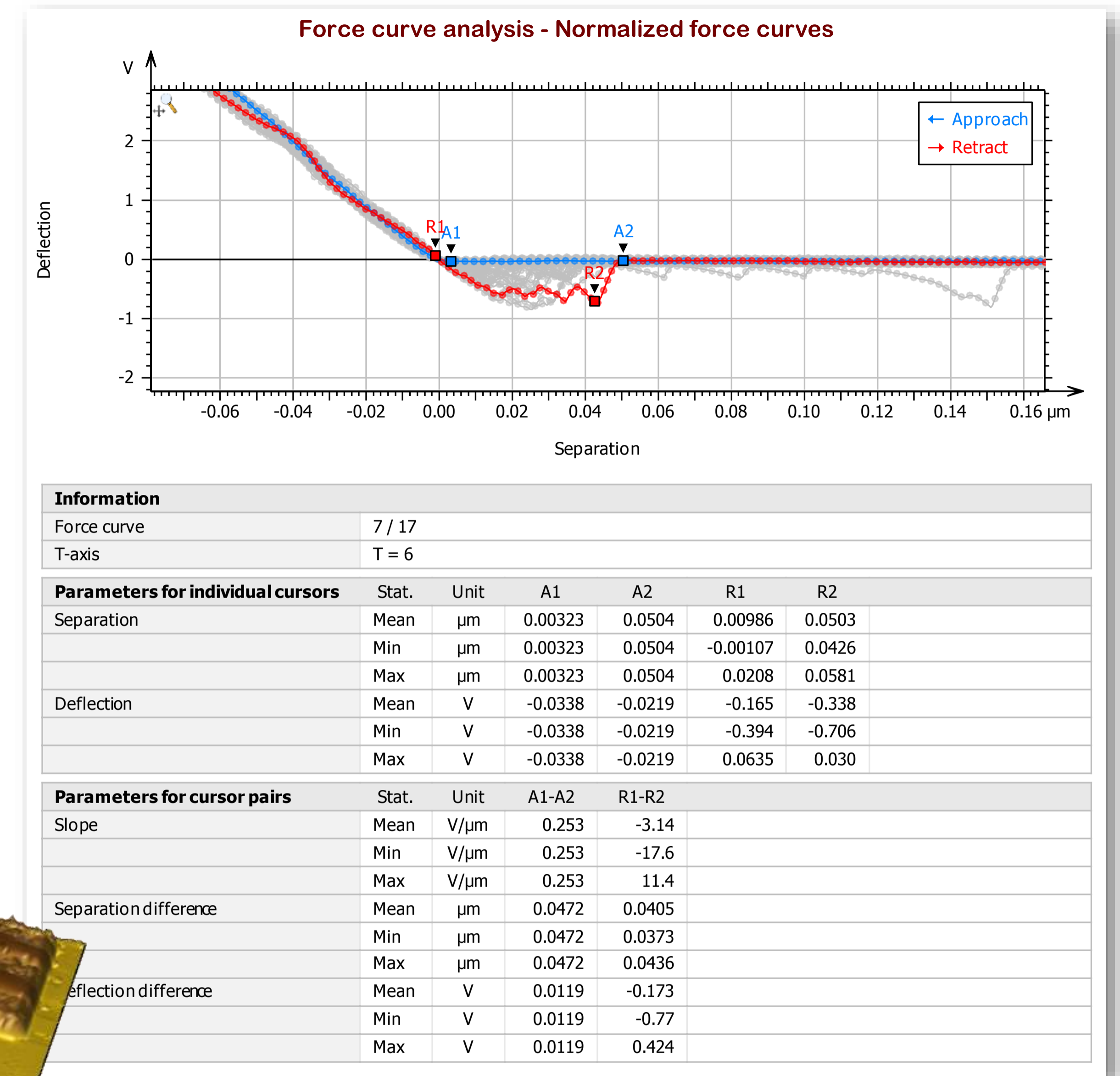
Mountains® software applications: further examples



AFM overlay on an optical microscopy image

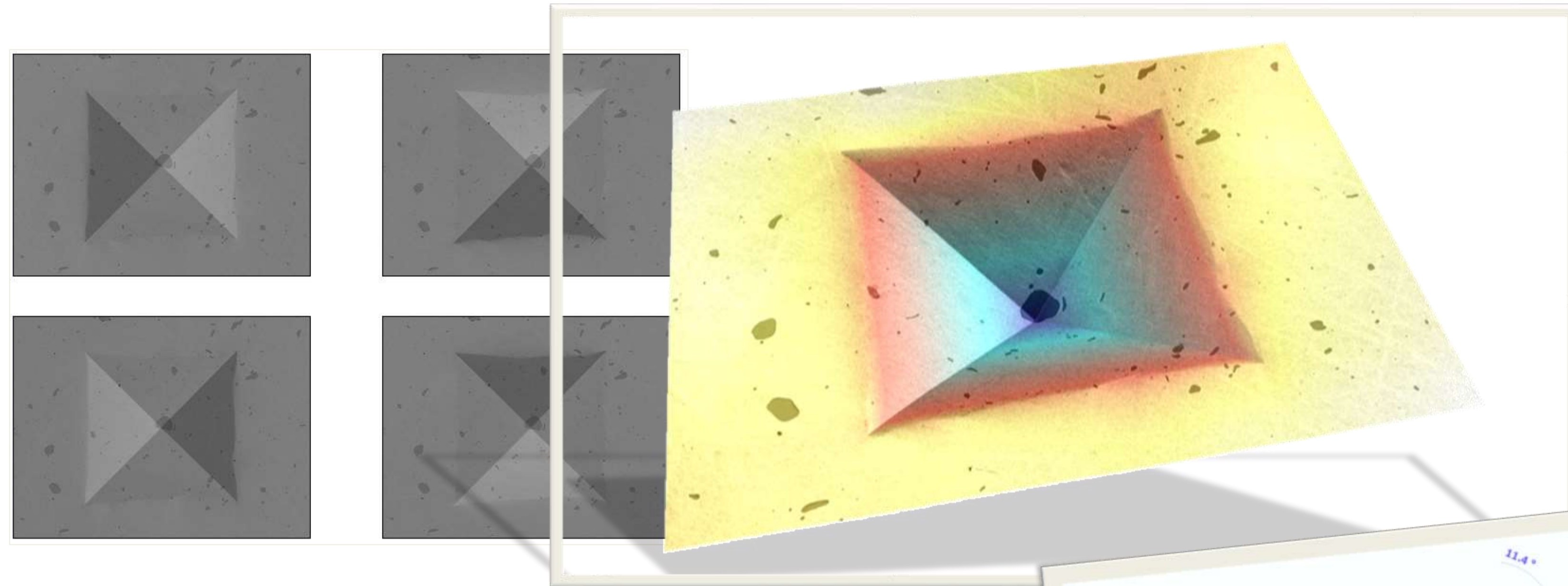


Advanced flattening operation on SDRAM

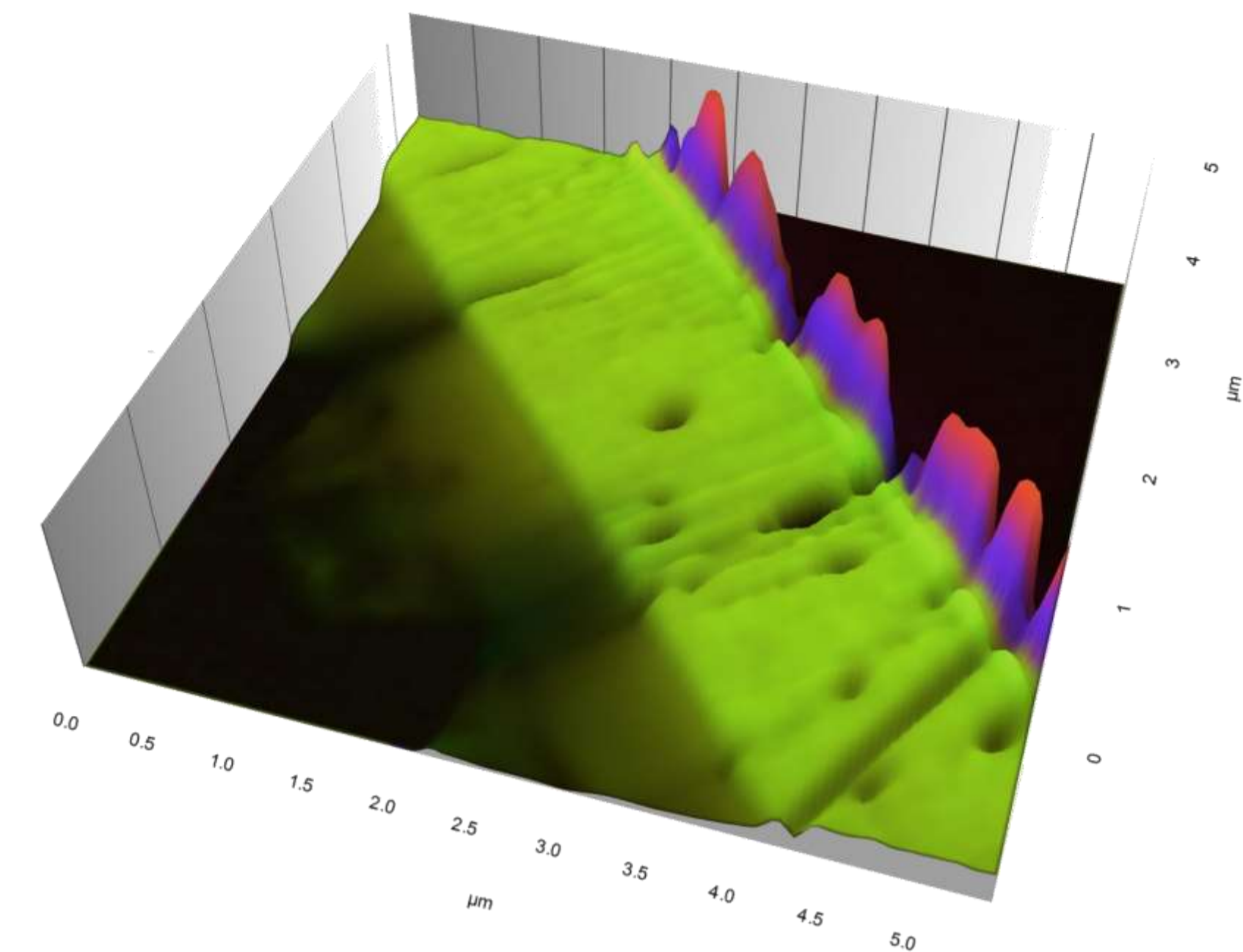
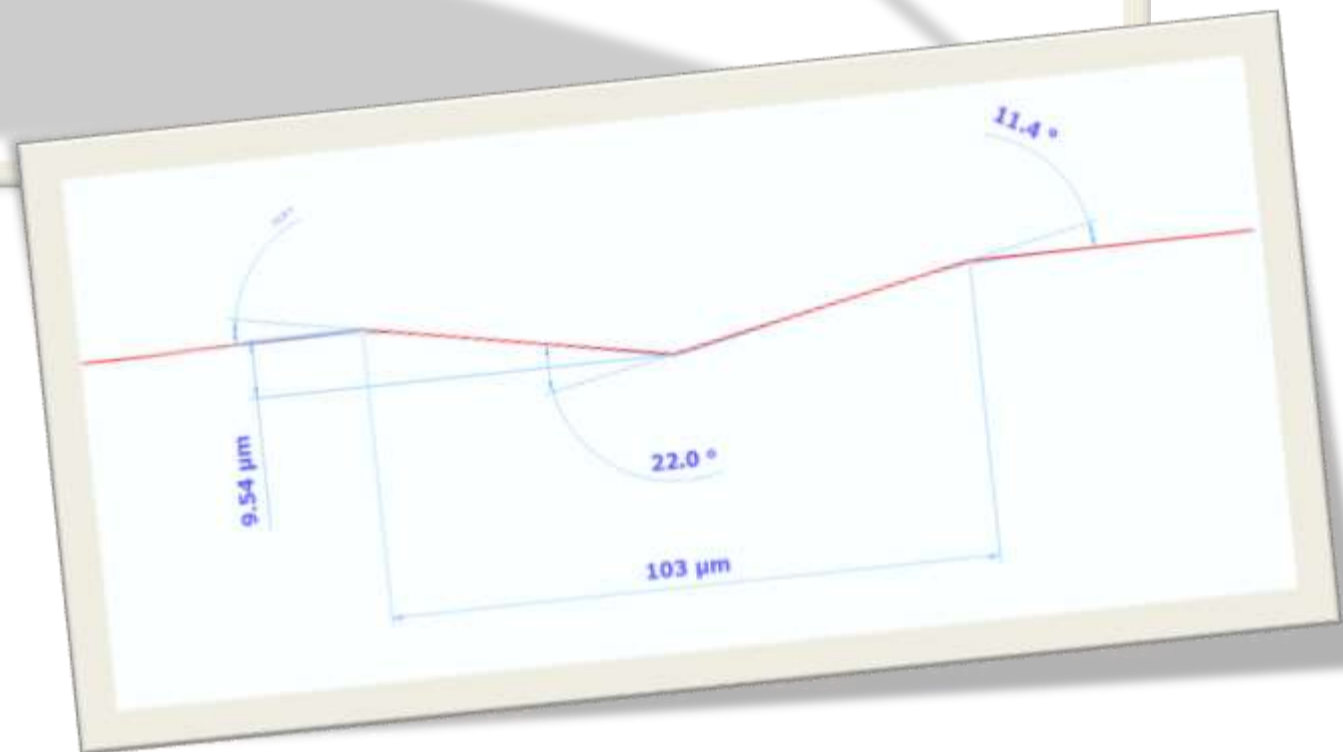


Series of force curves for WLC analysis

Mountains® software applications: further examples

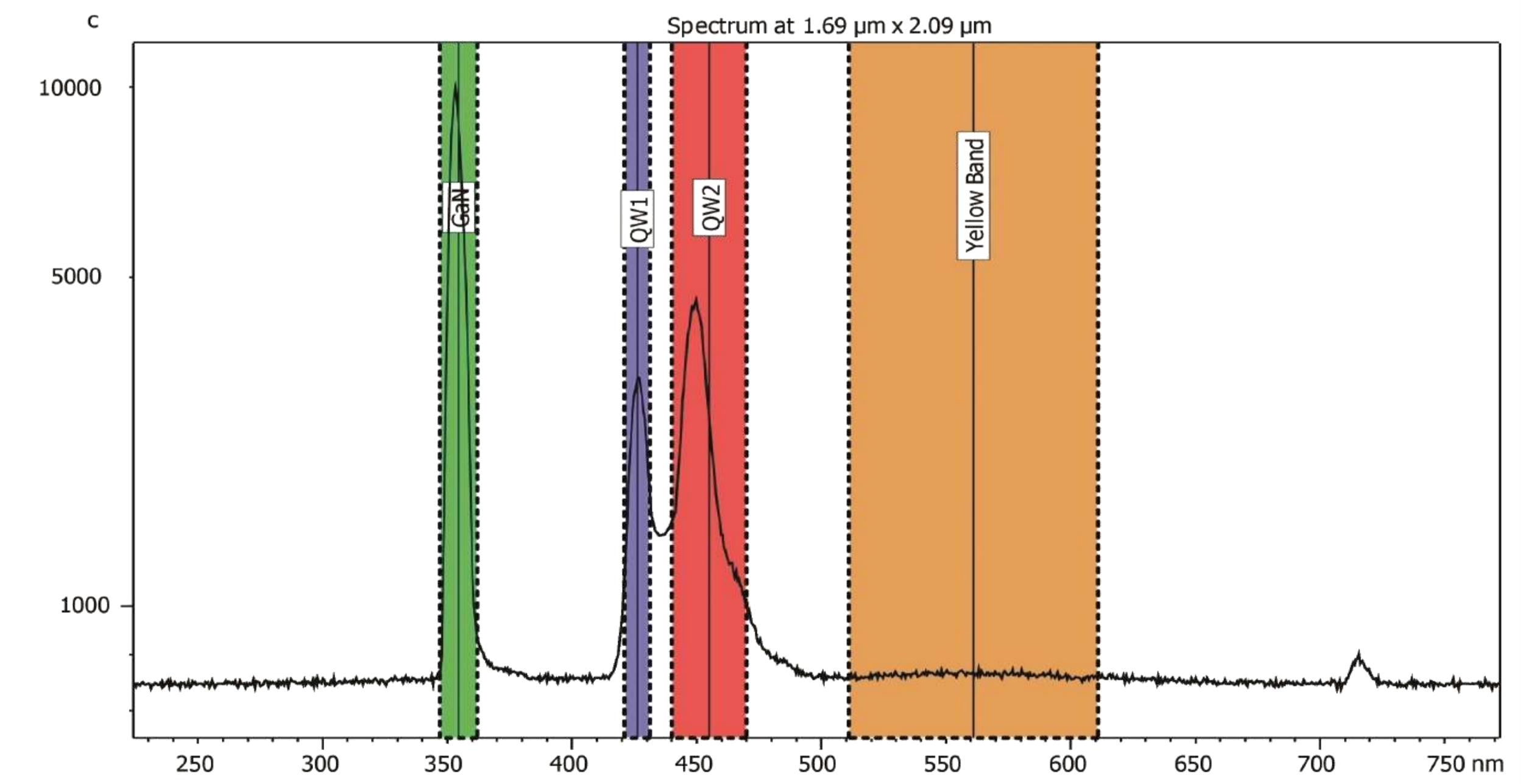


SEM images : 3D topography reconstruction based on images from four quadrant BSE detector

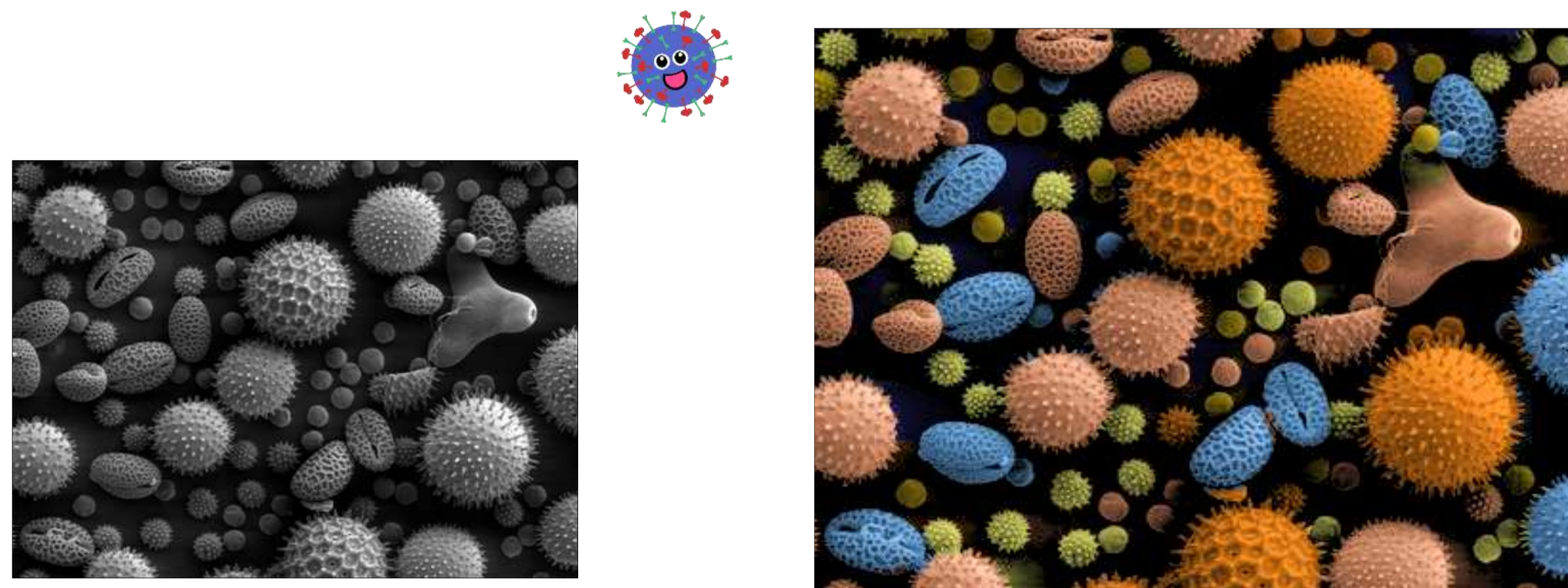


Cathodoluminescence : Gallium Nitride LED

Courtesy of Attolight



| Parameters | Unit | Yellow Band | GaN | QW1 | QW2 |
|------------|------|-------------|-----|-----|-----|
| Start | nm | 511 | 347 | 421 | 440 |
| End | nm | 611 | 362 | 431 | 470 |
| Width | nm | 100 | 15 | 10 | 30 |



SEM image enhancement : colorization, contrast, W balance

Free online Surface Metrology guide: www.digitalsurf.com/guide



Created by François Blateyron, Digital Surf COO

- › Expert on ISO/TC 213, responsible for defining standards in surface texture metrology (since 2003)
- › President of CEN (European Committee for Standardization)/TC90
- › Author of numerous articles on surface metrology

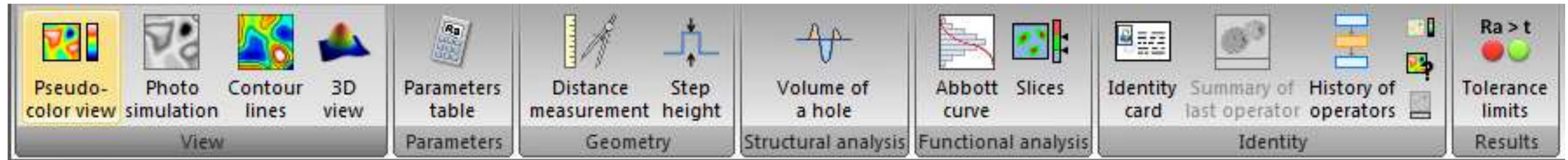
A screenshot of the Digital Surf website's 'Surface Metrology Guide' page. The page features the Digital Surf logo at the top left, with the tagline 'Surface Intelligence'. To the right of the logo are navigation links for 'Mountains® Software', 'Download', 'Information Center', 'Company', and 'Contact'. Further right are social media icons for Facebook and LinkedIn. Below these are additional navigation links: 'Media library', 'Specs', 'Printed Manual', and 'Metrology Guide'. The main heading is 'Surface Metrology Guide' in red. The introductory text states: 'Digital Surf has been strongly involved in surface texture analysis for more than twenty years. François Blateyron has been an active member of standardization committees in France and at ISO/TC 213. This activity has made it possible to develop advanced features in MountainsMap® based upon early work in standards and offer ready-to-use tools as soon as the standard is published.' It then says: 'This guide is divided in several sections, each dealing with an important aspect of surface metrology.' Below this is a list of sections in two columns:

- Introduction to Areal Surface Texture**: This section introduces the main concepts of surface texture and describes the recent standardization work.
- Areal Field Parameters**: This section describes Amplitude, Spatial and Hybrid parameters defined in ISO 25178.
- Areal (Field) Functional Parameters**: This section describes Bearing ratio, Sk and Volume parameters defined in ISO 25178, and Functional indices described in the SurfStand report.
- Areal Feature Parameters**: This section describes the feature parameters defined in ISO 25178 and their use for the characterization of surface motifs.
- Profile Parameters**: This section describes the profile parameters described in several ISO and national standards.
- Filtration Techniques**: This section describes the filters defined in ISO 16610.
- International Standards for Surface Texture**: This section provides a list of important ISO and national standards in the field of surface texture.
- Selected Bibliography**: This section provides a comprehensive bibliography of scientific papers and metrology books.
- Scientific publications using Mountains**: This section provides a list of papers citing MountainsMap or one of the custom products based on the Mountains Technology.

Key features of Mountains[®] software

Smart user environment

Top-down
object-oriented
ribbons



Expandable
tooltips

Contour lines

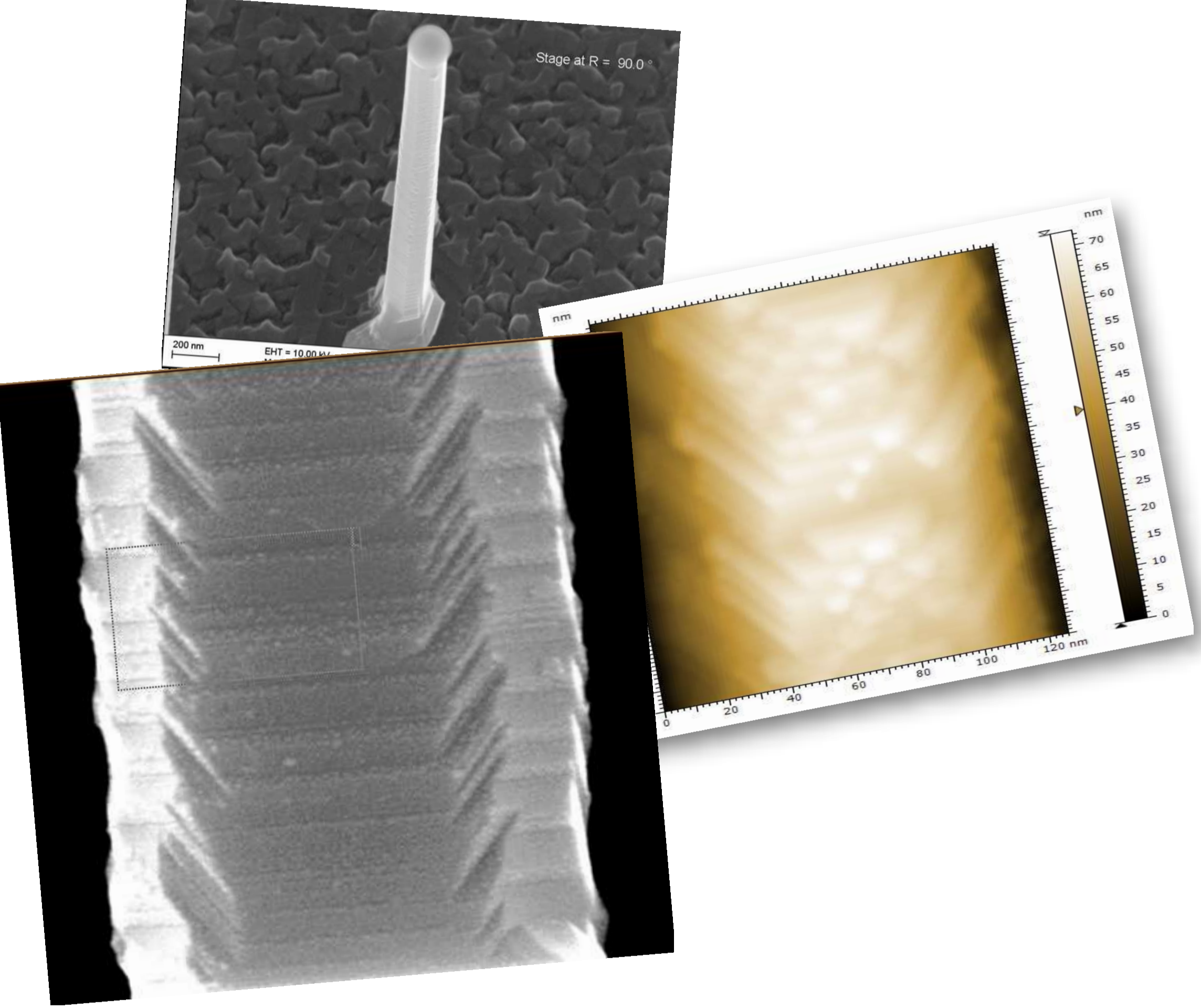
2D graph showing contour lines of surface points lying at the same height level, dividing the surface into regularly spaced out horizontal 'slices'.



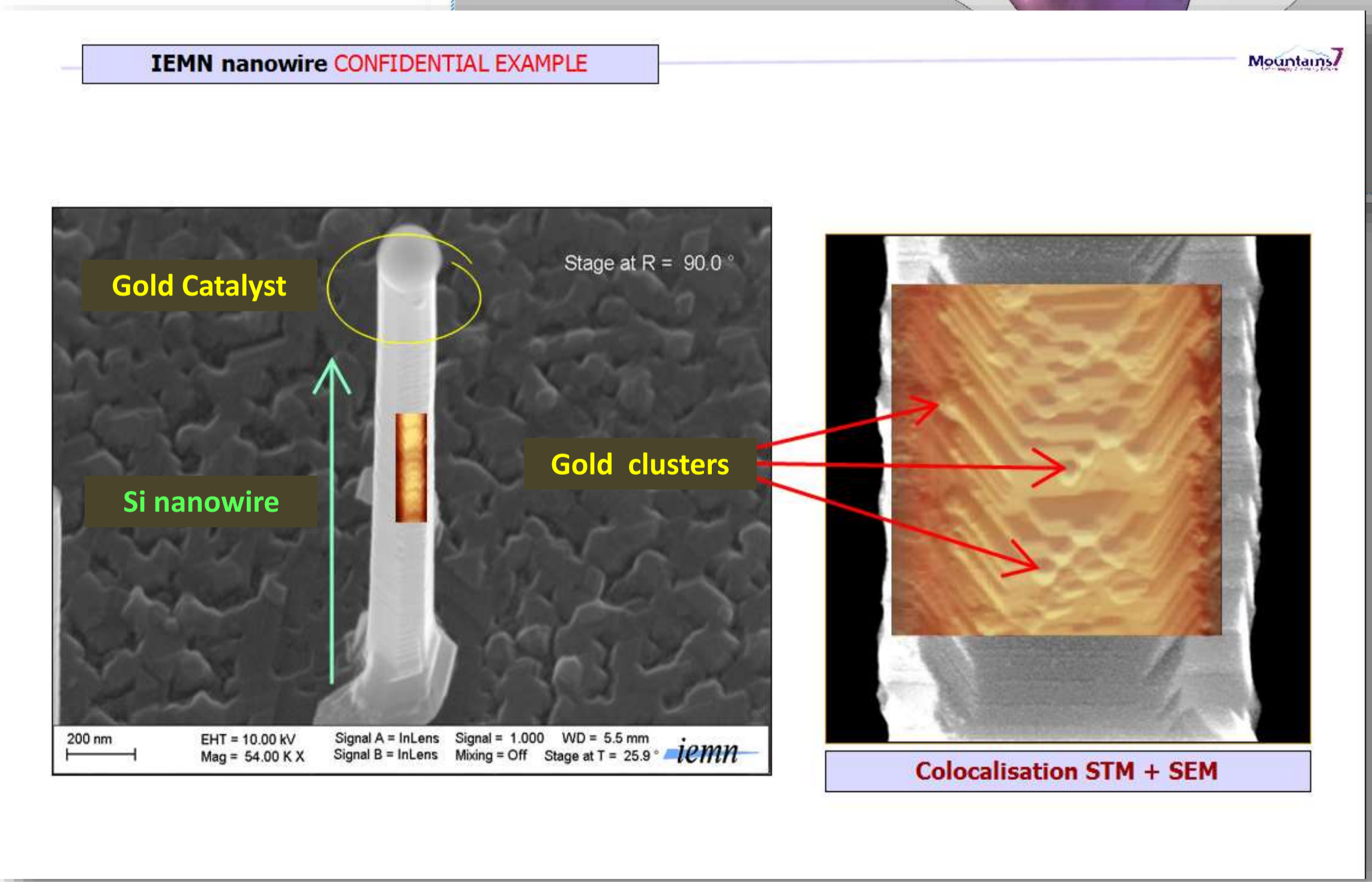
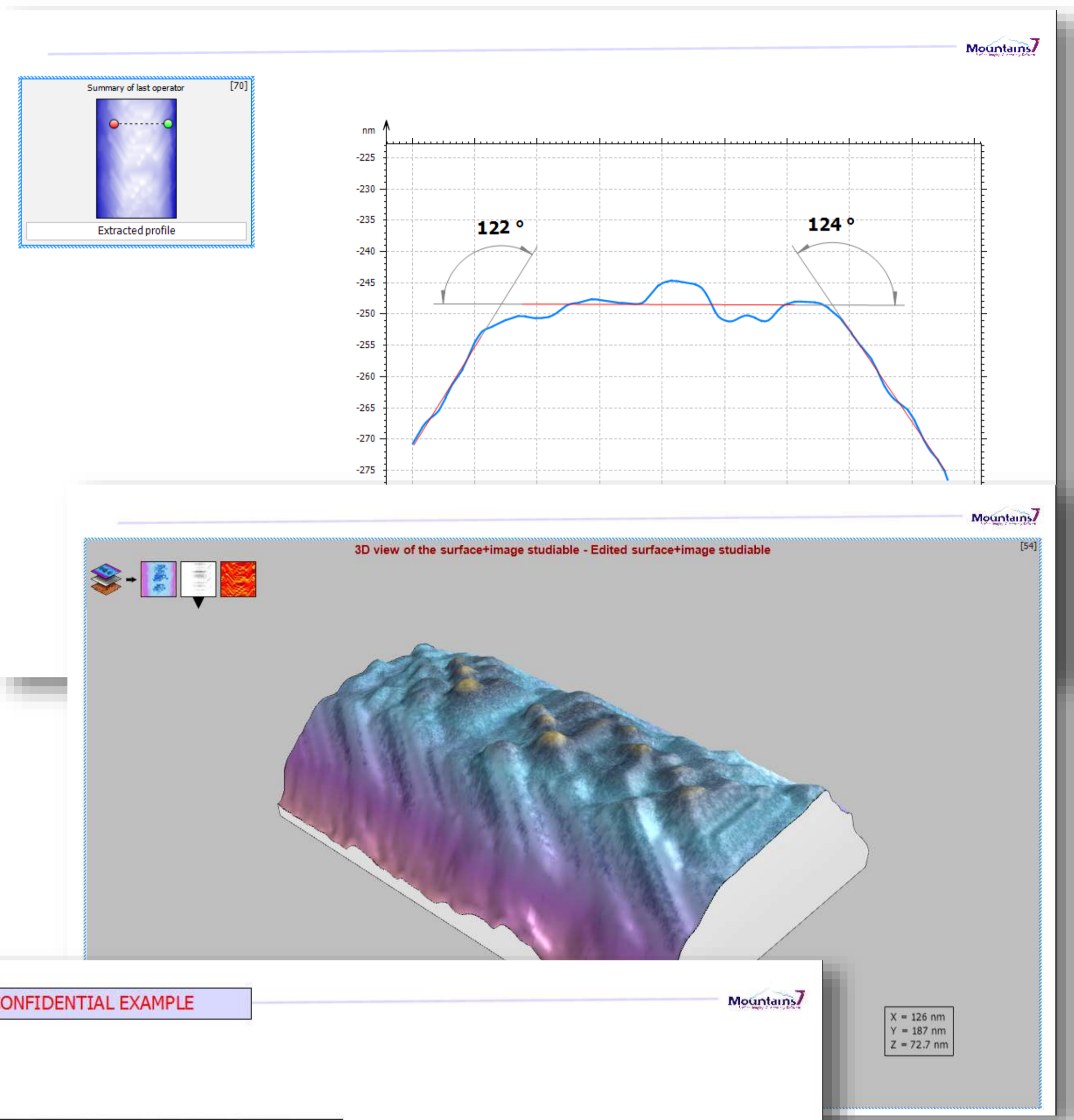
In 11 languages!



Organize datasets as visual analysis documents



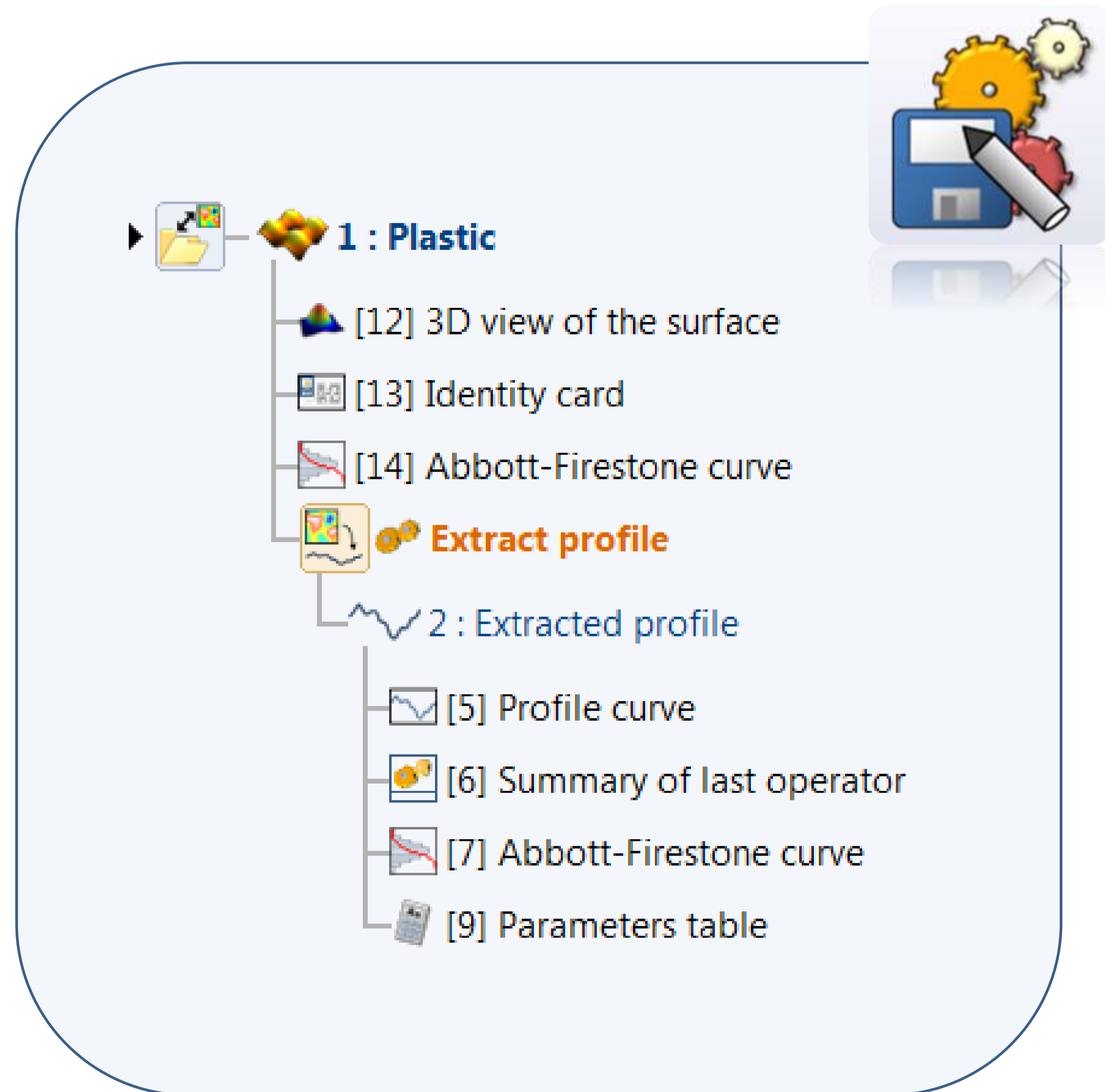
Visualize, analyze, report!





IMPORTANT

Stay in control thanks to the analysis workflow



All Mountains[®] documents integrate *an* analysis workflow

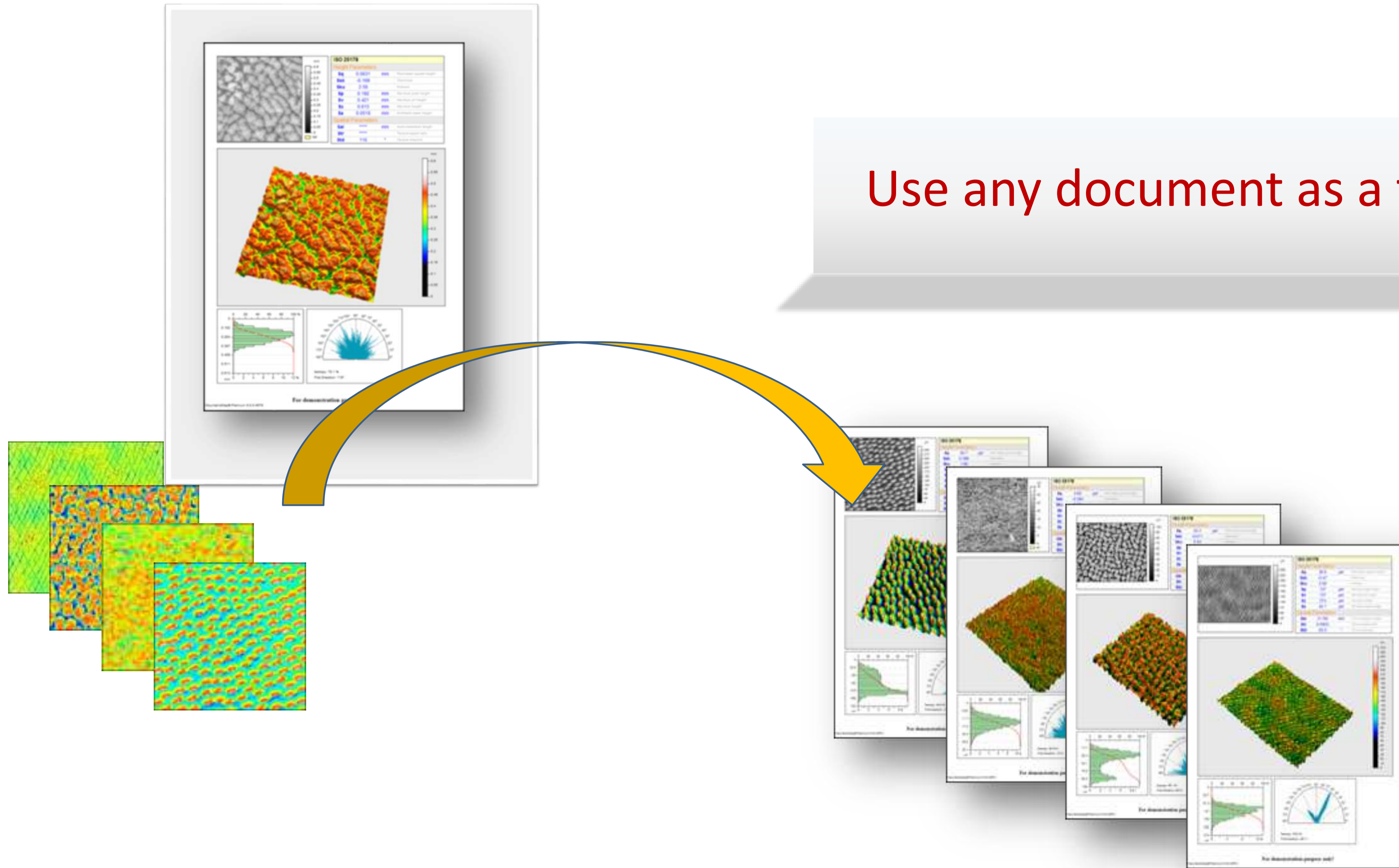
- Step by step overview
- Full metrological traceability
- Update any step at any time...
... dependent steps are recalculated automatically

Traceability, flexibility & automation GUARANTEED!



Speed up analysis with Templates and Minidocs[®]

Use any document as a template for automation



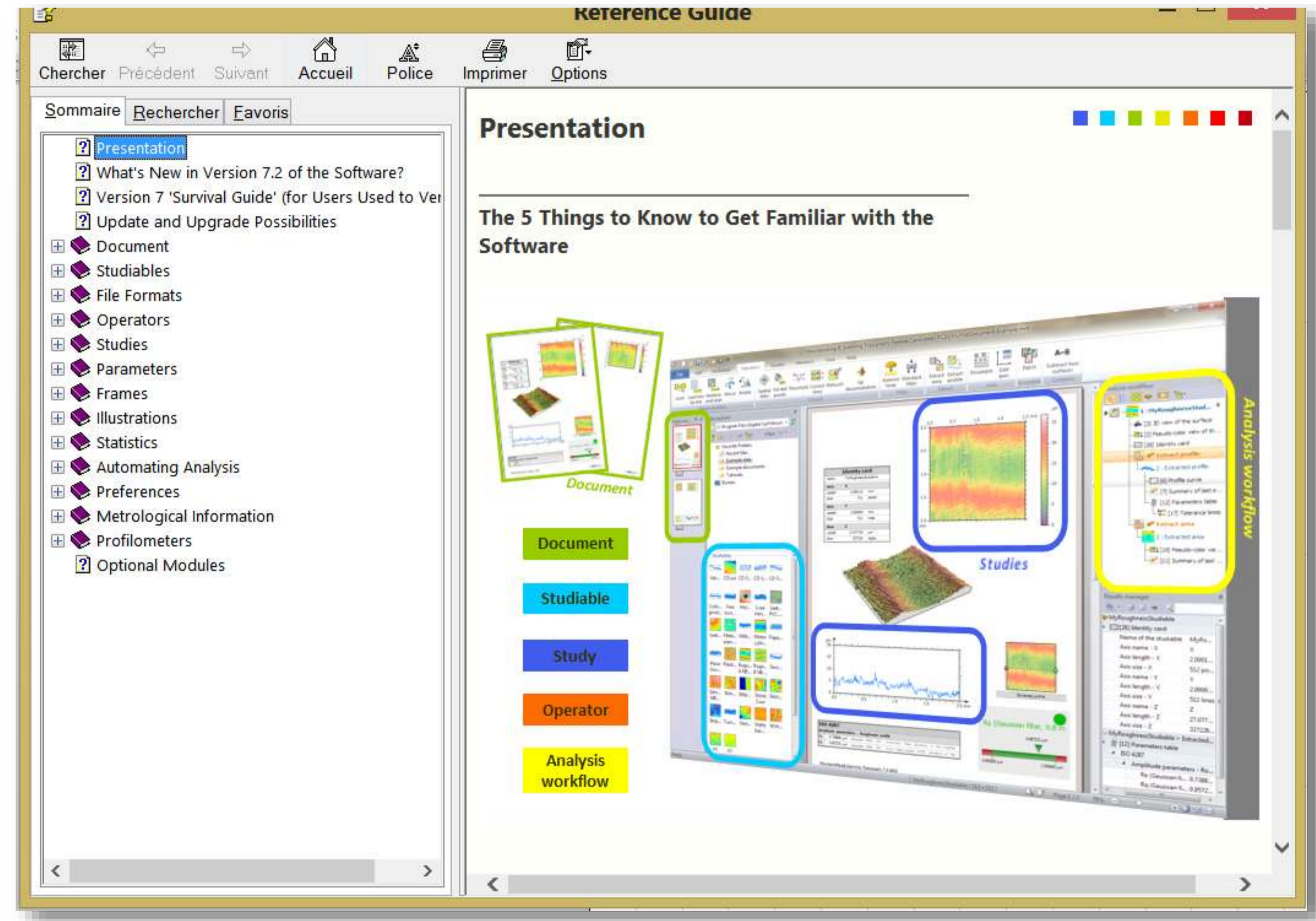


Please **help** me!

Press



.... and get comprehensive multi-lingual on-line help



Try Mountains® & SPIP™ for free and get more information

MountainsMap® free trial software



Try the full version of MountainsMap® for free.

- Surface imaging and metrology software designed for a wide variety of instrument types
- Analyze multiple types of surface data
- Turn your surface data into accurate, visual surface analysis reports

Please fill in the form below to obtain a 24 hour free trial. An activation code will be sent to the email address provided within 72 hours, allowing you to extend your free trial period to 30 days.

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Thank you for your attention

We hope you enjoy using Mountains[®] software and SPIP[™]!

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