Surface imaging, analysis & metrology software

for confocal microscopes - optical interferometric microscopes – other 3D optical microscopes and profilers

- Cutting edge real time 3D imaging of surface topography
- Color & intensity image overlays on topography for fast feature location
- Remove measurement artifacts
- Increase field of view virtually in software
- State of the art analysis of surface geometry and texture
- Add optional modules for advanced applications
- Automate analysis and publish results easily
See everything that you measure
Real time visualization of 3D surface topography

- Zoom in on a 3D surface, rotate it and amplify heights in real time.
- Apply image enhancement tools.
- Choose the best lighting conditions & renderings.
- Define your own color palette for the vertical scale.
- Define a flight plan, fly over features of interest on a surface and save your flight as a video for presentations.
- Display contour diagrams and photo simulations.
- Extract 2D profiles from a 3D surface for visualization and analysis.
- Convert RGB images into pseudo 3D images with the z axis in intensity units.

Overlays on 3D surface topography

- Manipulate multi-channel topography, color and intensity layers simultaneously.
- Overlay color and intensity images on 3D surface topography and locate surface features faster.

Miniature icons for selecting multi-channel layers.
Use natural color or intensity for 3D rendering

- Define the transparency level of the color image or intensity image overlay to obtain the best 3D surface rendering.

![Images of courtesy of Carl Zeiss](Images of courtesy of Carl Zeiss)

Fine tuning the transparency of an image overlay on 3D surface topography between natural color (0% transparency) and pseudo color (100%).

Normalize spatial position

- Level the surface by assigning the horizontal reference to any custom area or the whole surface.
- Flip and rotate the surface.
- Extract regions of interest for independent analysis.

Eliminate data acquisition defects

- Remove outliers.
- Resample & smooth to enhance the visual resolution.
- Remove local defects, automatically or manually.

Increase field of view virtually

Sometimes the field of view of an instrument is too limited to measure the whole surface under study in a single pass. Sometimes the vertical range is the problem. In both of these cases MountainsMap® Imaging Topography can overcome instrument limitations:

- Automatically stitch together multiple measurements that overlap on the horizontal plane - to increase the field of view.
- Interactively patch two or more surface measurements at different heights into a single surface ready for analysis - to increase the vertical range.
Analyze surface geometry
From distance, area, step height and volume calculation to full dimensional analysis

Geometric analysis
MountainsMap® Imaging Topography assures the fast and accurate analysis of surface geometry with tools for measuring:

- Distances.
- Angles.
- Areas of peaks & valleys.
- Volumes of bumps and holes.
- Step heights on surfaces and profiles

Sub-surface analysis
Extract a region of interest and analyze it just like a complete surface

Sub-surface extraction methods
There are several methods for extracting sub-surfaces:

- Extract a rectangular or non-rectangular zone.
- Remove a slice from a surface by thresholding.
- Automatically partition a surface into motifs (texture cells), then use the Partition and Level operator to extract a sub-surface and level it.

Calculate parameters for a sub-surface only
Once a sub-surface or region of interest has been extracted it can be analyzed in exactly the same way as a full surface - parameters are calculated on the sub-surface only. This makes it possible, for example, to study the roughness, flatness and coplanarity of planes on MEMS and mechanical and electronic components.

Surface texture characterization in accordance with international standards
Advanced ISO 16610 filtering techniques and ISO 25178 3D parameters

From Gaussian to advanced ISO 16610 filtering techniques
The roughness and waviness components of surfaces are separated using the latest ISO 16610 advanced filtering techniques, including robust Gaussian and spline filters. Older filtering techniques are also supported.

From Ra to ISO 25178 3D parameters
MountainsMap® Imaging Topography includes a basic set of ISO parameters:

- 3D parameters defined in ISO 25178 including height (Sa, Sq, Ssk, Sku, Sz, etc.) and functional (Smr, Smc, Sxp) parameters.
- ISO 4287 primary and roughness parameters (Ra, Rq, Rsk, Rmr, Rdc, Rdg, RFC, etc.).

The right standards, wherever you are
In addition to ISO parameters MountainsMap® Imaging Topography calculates ASME B46.1 2D and 3D parameters (USA), displays GB/T (China), DIN (Germany), JIS (Japan), NF (France), BSI (UK), UNE (Spain) and UNI (Italy) equivalents of ISO parameters when they are available, and calculates older EUR 15178 3D parameters.

Functional analysis
Functional studies include:

- Abbott-Firestone bearing ratio curve & depth distribution histogram.
- Subtraction of one surface from another (wear)
- Calculation of the material/void volume ratio and thickness of surface slices.
Highly intuitive desktop publishing environment
Full metrological traceability, automation, fine tuning on the fly

Visual analysis reports
In MountainsMap® Imaging Topography you build a visual analysis report frame by frame, page by page, working in a comfortable desktop publishing environment. Frames contain 3D and other views of surface data, the results of applying filters, analytical studies, ISO and national parameters, measurement identity cards, comments and illustrations. You can navigate to any frame in a report by selecting it in the page viewer.

Smart user environment
The smart user environment - with logical top-down organization of all functions and contextual object-oriented ribbons - means that you can go from idea to action with minimum effort. A full screen mode provides maximum comfort when you are carrying out a specific analytical study. Furthermore you can work in your own language thanks to the fact that the user interface - including expanded graphical tooltips that provide a first level of help - is available in ten languages (EN, FR, DE, ES, IT, PL, BR, JP, CN, KR). In addition, a complete reference manual (EN, FR, DE, JP) with illustrations and examples can be accessed simply by pressing the F1 key.

Full metrological traceability
Every analysis step is recorded in a hierarchical analysis workflow to assure full metrological traceability. Analysis steps in the workflow can be fine tuned at any time. All dependent steps are recalculated automatically.

Powerful automation features
Once an analysis report has been completed it can be applied as a template to automate the analysis of multiple measurement data files. In addition common sequences of analysis steps can be saved in a library for insertion into future analysis reports to gain time.

Pass/fail with tolerancing
Pass/fail criteria with tolerances can be defined for any parameter. Green/red pass fail traffic lights are displayed automatically and the parameter value and tolerance limits are shown graphically.

Data export
Frames and pages can be exported as bitmaps up to 1200 dpi for poster sessions. Finished reports can be exported in PDF and RTF formats for easy circulation. All numerical results, including pass/fail status, are accessible in the Results Manager panel and can be exported in Excel-compatible text files for interfacing with 3rd party software, including quality management software.

Page format
Pages in analysis reports have standard or user-defined portrait, landscape or onscreen formats. A master page can be set up with elements that will be repeated on all pages (company information, logo, page number, etc.).
MountainsMap® Imaging Topography Optional Modules
For advanced and specialized applications

3D advanced surface texture module

Advanced 3D studies, parameters and filters

- Calculate advanced 3D surface texture and form parameters - ISO 25178 functional volume (Vmp, Vmc, Vvc, Vvv), spatial (Sal, Str, Std) and hybrid (Sdq, Sdr) parameters - ISO 12178 flatness (FLTt, FLTp, FLTv, FLTq) parameters.
- Study functional volume parameters graphically - visualize friction, core and lubrication zones on tribological surfaces.
- Study surface isotropy, directionality and periodicity - view dominant surface directions on a compass rose and calculate parameters.
- Apply morphological filters to surfaces - erosion, dilation, opening, closing, and sequential filters.
- Analyze furrows - visualize furrows and calculate furrow parameters.
- Analyze fractal dimensions of surfaces using the enclosing boxes and morphological envelopes methods.
- Study circular profiles - with the abscissa in degree units.
- MATLAB™ compatibility - use MATLAB™ scripts to define custom filters for 3D surfaces - execute the scripts in MountainsMap®. (Note: MATLAB™ and MountainsMap® must be installed on the same PC.)

Grains and particles analysis module

Study isolated surface features

- Automatically detect and count grains, particles, islands, bumps, holes and motifs (texture cells) using multiple methods:
  
  2D grains and particles with respect to selected horizontal plane - separate grains from the background by binarization on a selected horizontal plane - sort grains into subsets with respect to any parameter.
  
  3D grains (islands) with respect to a selected height.
  
  Motifs in accordance with a configurable ISO 25178 segmentation by watersheds algorithm and Wolf pruning.
- Calculate morphological parameters for individual grains, etc.
- Generate statistics for all grains, etc. and subsets.
- Calculate ISO 25178 features parameters (Spd, Spc, S5p, S5v, S10z, Sha, Sda, Shv, Sdv).
- Special features for microlens arrays - display spherical caps, calculate spherical parameters.
3D Fourier & wavelets analysis module

Analyze process-surface interactions

- **Frequency analysis** - interactive frequency spectrum, interactive power spectrum density, autocorrelation and intercorrelation.
- **Calculate isotropy, directionality and periodicity** - view dominant surface directions on a compass rose and calculate parameters.
- **Denoise surfaces** using the FFT plot editor.
- **Discrete wavelet filtering** (3D surfaces and 2D profiles) - visualize a surface or profile at multiple scale levels - select roughness and waviness scale levels.
- **Continuous wavelet decomposition** - study scale levels and spatial locations where phenomena occur.

Contour analysis module

Straightforward component dimensioning

- **Extract a vertical (x,z) or horizontal (x,y) contour (profile)** from a surface.
- **Define nominal form** using straightforward interactive tools to associate geometric elements with contours.
- **Calculate dimensions** (including distances, radii, diameters and angles) using autodimensioning and interactive tools.

Advanced contour analysis module

Comprehensive form deviation analysis

- All of the features in the Contour Analysis module.
- Compare measured contours with CAD data (DXF) or user-defined nominal form.
- **Specify tolerances** including large positional tolerances if required.
- **Visualize form deviations** easily with magnified graphics.
- **Automatically generate a table of results** including pass/fail status.
- **Gothic arch analysis** of bearings.
Colocalization module

Combine data from different instrument types for correlative studies

- Colocalize surface data obtained by different instruments - 3D surface topography data obtained by instruments with limited field of view can be colocalized with images obtained by microscopes with wider field of view* - images from different instruments can also be colocalized to highlight surface features (see example).
- Overlay images on 3D topography (z axis in height units) or on pseudo 3D images (z axis in intensity units) - set overlay transparency level.

* Note: instrument compatibility depends on the file formats supported by the installed MountainsMap® software.

Statistics module

Multiple static/dynamic surface data populations

- Prepare data automatically using templates - include all parameters for statistical analysis in a predefined analysis workflow - use it as a template for automatically generating analysis reports on one or more populations.
- Generate statistical reports - select the static or dynamic population(s) to be analyzed and create a report with parameter tables, control charts, histograms, box plots and scatter plots as required - statistics for dynamic populations are updated automatically.
- Monitor key metrological and process parameters - control charts include standard deviation limits (1 to 3 sigma), control limits and vertical bars separating different populations, together with yield, capability (Cpk) and other parameters.

Control chart for a parameter
### 2D advanced surface texture module

**Advanced 2D analytical studies & filters for profiles**

- Apply advanced 2D filtering techniques – remove form and apply roughness/waviness filters from Gaussian to ISO 16610 – apply morphological filters – denoise profiles using the FFT plot editor – profile subtraction
- Correct measurement anomalies – use data correction tools (thresholding, retouching, resampling) to eliminate anomalies and improve resolution prior to analysis.
- Analyze fractal dimensions of profiles using the enclosing boxes and morphological envelopes methods.
- Overcome measurement limits virtually – join overlapping profiles.
- Generate statistics on series of profiles – the profiles in the series can be extracted from a series of surfaces or from the same surface.
- MATLAB™ compatibility – use MATLAB™ scripts to define custom filters for 2D profiles - execute the scripts in MountainsMap®. (Note: MATLAB™ and MountainsMap® must be installed on the same PC.)

![ISO 16610 filtering techniques for 2D profiles with end effect management](image)

**Graphical study of Rk parameters**

### 2D Automotive module

**2D functional parameters and studies**

- Study Rk parameters associated with wear and lubrication graphically – visualize friction, core and lubrication zones on tribological profiles.

### Lead (twist) analysis

**2nd generation lead analysis (automotive industry)**

- Automatically generate a lead analysis report (for manufacturing efficient radial seals that reduce oil consumption) in accordance with the Mercedes-Benz 2009 engineering standard - including lead parameters and visualization of dewobbled measured surface structure and lead surface topography.

Left. 2nd generation lead (twist) analysis report in accordance with the Mercedes-Benz engineering standard.
### SPM extension module

**Work with SPM data**

- **Load SPM file formats** – almost all formats generated by SPM’s (scanning probe microscopes) and SPM software packages are supported.
- **Correct SPM image acquisition errors** – tools include line correction and tip deconvolution.
- **Manipulate multiple SPM layers simultaneously** – topography, deflection, phase, current, etc.
- **Overlay non-topography layers on 3D topography** – study correlations between phase, current or another layer and 3D topography.

![Image of SPM data files using the SPM Extension module](Images_of_courtesy_of_ICMAB-CSIC)

### 4D series module

**Visualize, filter and analyze series of surfaces and images**

- **Combine a series of surfaces** (z axis height) or converted images (z axis intensity) for 4D analysis with respect to time, temperature, magnetic field or another dimension.
- **Visualize surface, profile and point evolution**, even fly over a surface as it changes and record a movie for presentations.
- **Generate statistics** on surface texture parameter evolution.
- **Filter out noise and highlight areas with different kinetic behavior** using the Karhunen-Loève transform (principal component analysis).

![Image of MountainsMap® Imaging Topography](MountainsMap®_Imaging_Topography)
## Selected standard and optional features

### MountainsMap® Imaging Topography

#### Compatibility
- Confocal microscopes - interferometric microscopes – digital holographic microscopes – focus variation microscopes – structured light systems – standard RGB image file formats – plus with optional extension scanning probe microscopes (AFM, MFM, CSAFM, STM, SNOM, etc.) and with optional upgrade single point 3D or 2D scanning profilometers, scanning electron microscopes and other instruments

#### Smart desktop publishing user environment

#### Surface visualization
- Real time imaging of 3D surface topography (z axis in height units) – visualization and manipulation of multi-channel topography-color-intensity files with overlays of non-topographical layers on 3D surface topography - selectable rendering, lighting and height amplification – color coded Z-axis palettes with data point distribution histogram – surface flyovers with video export - contour diagrams - photo-simulations - 2D profile extraction – conversion of RGB images into 3D images with z axis in intensity units

#### Data normalization & correction
- Leveling - XY or Z inversion - rotation - zone extraction - thresholding - filling in missing points - retouching - resampling – stitching of overlapping measurements on the horizontal plane into a single surface – patching of measurements at different heights into a single surface

#### Filters
- Form removal (surfaces) - roughness/waviness filters (Gaussian to ISO 16610) - spatial filters (including smoothing) - automatic outlier removal and filling - surface subtraction

#### Analysis
- Distance, angle, area, volume, step heights measurement – bearing ratio curve and depth histogram - material/void volume and thickness of vertical slices - sub-surface (region of interest) extraction and analysis

#### Parameters

### MountainsMap® Imaging Topography Optional Modules

#### 3D Advanced Surface Texture

#### Grains & Particles Analysis
- Automatic detection of grains, particles, islands, bumps, holes and motifs (texture cells) using multiple morphological parameters – statistics – ISO 25178 features parameters – spherical parameters (microlens arrays)

#### 3D Fourier & Wavelets Analysis
- Frequency spectrum – power spectrum density – surface autocorrelation and intercorrelation – FFT plot editor – discrete wavelet filtering (surfaces and profiles) - continuous wavelet decomposition (profiles)

#### Contour Analysis
- Extraction of vertical (x,z) and horizontal (x,y) contours (profile) from surfaces - nominal form definition by association of geometric elements with contour – geometric dimensioning

#### Advanced Contour Analysis
- Comparison of measured contours with DXF CAD data or user-defined nominal form – tolerance specification – magnified form deviation graphics – table of pass/fail results – Gothic arch bearings analysis

#### 2D Advanced Surface Texture
- Form removal - ISO 16610 2D roughness/waviness filters – morphological filters - 2D Fourier analysis including frequency spectrum and power density - FFT plot editor – profile data correction tools – profile subtraction – profile joining – 2D fractal analysis - series of profiles creation and analysis with statistics - MATLAB® compatibility (custom filters)

#### 2D Automotive

#### 4D Series
- 4D visualization, filtering and analysis of series of 3D surface images – surface, profile and point evolution – surface flyover movie export – statistics on surface texture parameters – Karhunen-Loève transform (principal component analysis) for noise filtering and highlighting of areas with different kinetic behavior

#### Statistics
- Automated data preparation using templates – statistical reports on multiple static and/or dynamic surface data populations - control charts for monitoring metrological and process parameters

#### Lead Analysis
- Automatic 2nd generation lead (twist) analysis report according to 2009 Mercedes-Benz engineering standard

#### SPM Extension
- Load SPM file formats – correct SPM image acquisition errors (tools include line correction and tip deconvolution) – manipulate multiple SPM layers simultaneously – overlay non-topography layers (phase, current, etc.) on 3D surface topography – study correlations between phase, current or another layer and 3D topography

#### Colocalization
- Colocalization of surface data images (and/or topography) obtained by different instrument types or detectors – overlay images on 3D surface topography for correlative studies

### MountainsMap® Imaging Topography Upgrade to MountainsMap® Universal and Premium

#### Universal Upgrade
- Upgrade to MountainsMap® Universal for compatibility with scanning probe microscopes, contact and non-contact 3D/2D surface profilometers and form measuring systems - wider range of optional modules including modules providing compatibility with scanning electron microscopes and spectrometers (Raman, FT-IR)

#### Premium Upgrade
- Upgrade to MountainsMap® Premium - top of the line package compatible with the same instrument types as MountainsMaps® Universal and containing all MountainsMap® Imaging Topography modules except for Advanced Contour Analysis and Lead Analysis.
## Requirements

### PC requirements

<table>
<thead>
<tr>
<th>Minimum requirements</th>
<th>Operating system</th>
<th>Windows 8 (64-bit or 32-bit) or Windows 7 (64-bit or 32-bit) or Windows Vista (64-bit or 32-bit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAM</td>
<td>4 GB</td>
<td></td>
</tr>
<tr>
<td>Graphics board</td>
<td>Hardware accelerated OpenGL or Direct3D</td>
<td></td>
</tr>
<tr>
<td>Resolution</td>
<td>1280 x 768 in thousands of colors</td>
<td></td>
</tr>
<tr>
<td>HDD free space</td>
<td>800 MB</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>1 free USB port</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Recommended</th>
<th>Operating system</th>
<th>Windows 8 (64-bit) or Windows 7 (64-bit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processor</td>
<td>Quadcore</td>
<td></td>
</tr>
<tr>
<td>Resolution</td>
<td>1600 x 1024 in thousands of colors</td>
<td></td>
</tr>
</tbody>
</table>