



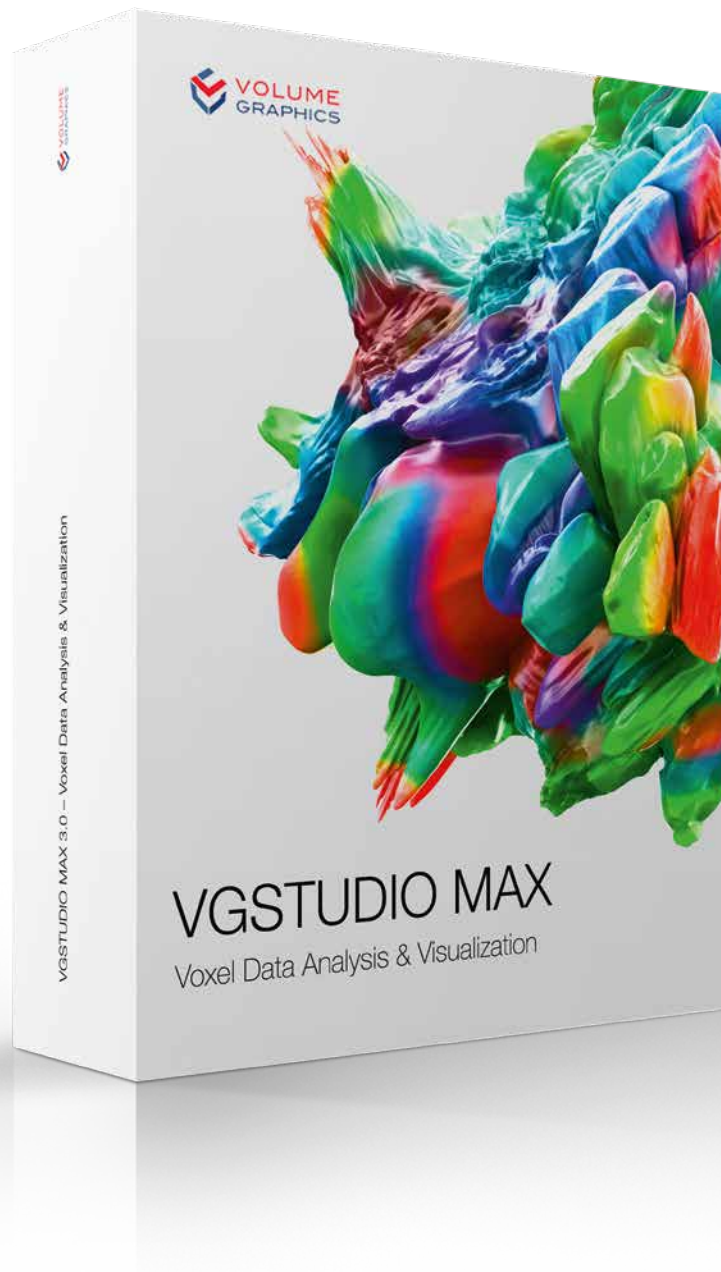
**VOLUME
GRAPHICS**

Enabling better products



VGSTUDIO MAX

High-End Industrial CT Software



VGSTUDIO MAX

High-End Software for the Analysis and Visualization of CT Data

From design to serial production, VGSTUDIO MAX enables you to keep the quality high by getting full insight into your products. At every step of the production process. All over the world.

Volume Graphics

Enabling better products

By choosing Volume Graphics software, you can rely on more than 20 years of experience in the development of software for non-destructive testing. Today, a broad range of global customers, e.g., from the automotive, aerospace, and electronics industries, use Volume Graphics software for quality assurance in product development and production. For an ever-growing community of users around the world, Volume Graphics is the software of choice.

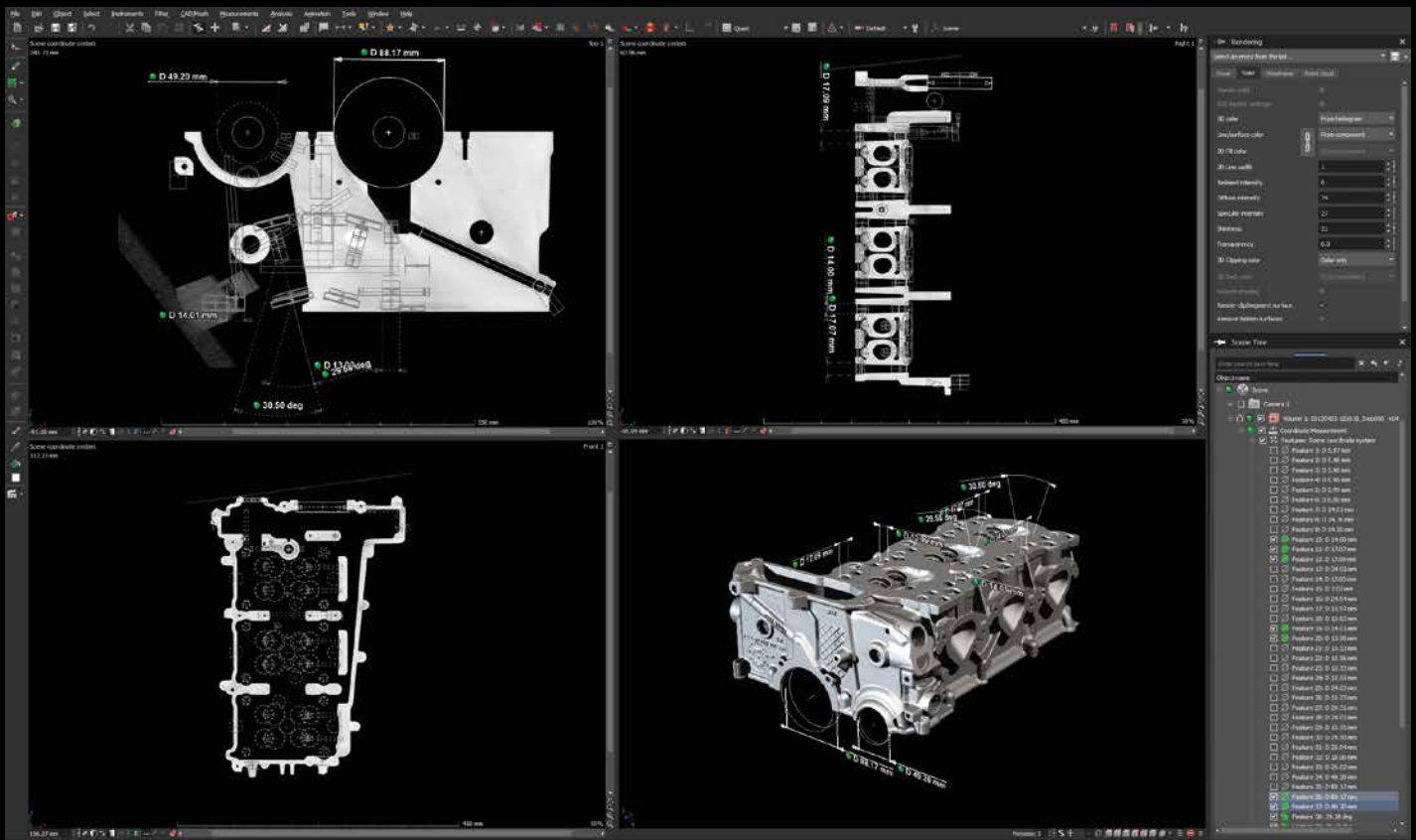
Frost & Sullivan, a leading market research and consulting firm, recognized Volume Graphics in an independent benchmark analysis as market leader in the CT software sector with a market share of about 80 percent in 2017. For its “strong overall performance”, “its singular contributions toward consistently advancing the CT systems market”, and a “thorough understanding of end users’ needs”, Volume Graphics has earned Frost & Sullivan’s 2018 Market Leadership award.*

Volume Graphics customers all over the world in both industry and science know that Volume Graphics software gives them a decisive advantage: The ability to gain reliable insights and make better products.

Join them.



* Source: Frost & Sullivan Award Write Up
www.volumegraphics.com/en/frost



VGSTUDIO MAX covers all your requirements in a single software.

It's not about VGSTUDIO MAX.

It's about the results it delivers.

The demands on the quality of your products are numerous and challenging. The tools in VGSTUDIO MAX provide you with the reliable results you need to make the right decisions to meet these demands. Whether you are using the all-encompassing technology of CT or other 3D data formats such as point cloud, mesh, and CAD; VGSTUDIO MAX covers all your requirements related to metrology, defect detection and assessment, material properties, or simulations in a single software. All of its analysis, simulation, and visualization tools fit perfectly into your digital workflow.

Obtain results quickly, easily—and with incredible accuracy. The metrology algorithms are tested by the national institutes PTB and NIST.* Furthermore, VGSTUDIO MAX can determine the surfaces of your scanned objects, including the smallest details, with subvoxel accuracy.

* PTB and NIST verified: This software contains the Volume Graphics Metrology Kernel VGMK 3.2.0 140356 which passed the PTB test for "Evaluation software based on minimum-zone method for coordinate measuring machines" and the PTB test for "Evaluation software based on least-squares method for coordinate measuring machines" and which was verified by the NIST "Algorithm Testing and Evaluation Program for Coordinate Measuring Systems". The test results were obtained under Windows (64 bit).

Built for Efficiency

VGSTUDIO MAX gives you results you can use right away, including insightful graphics and comprehensive reports. It is built from the ground up to handle even large data sets. When dealing with repetitive tasks, powerful automation functions are at your side to help you speed up your work. Analyzing periodic structures of an object becomes a breeze with the easy replication of analyses.

Share your results without time-consuming format conversion: With the free myVGL viewer, everyone can open files in the .vgl format, the widely used standard for the exchange of 3D data from industrial CT.

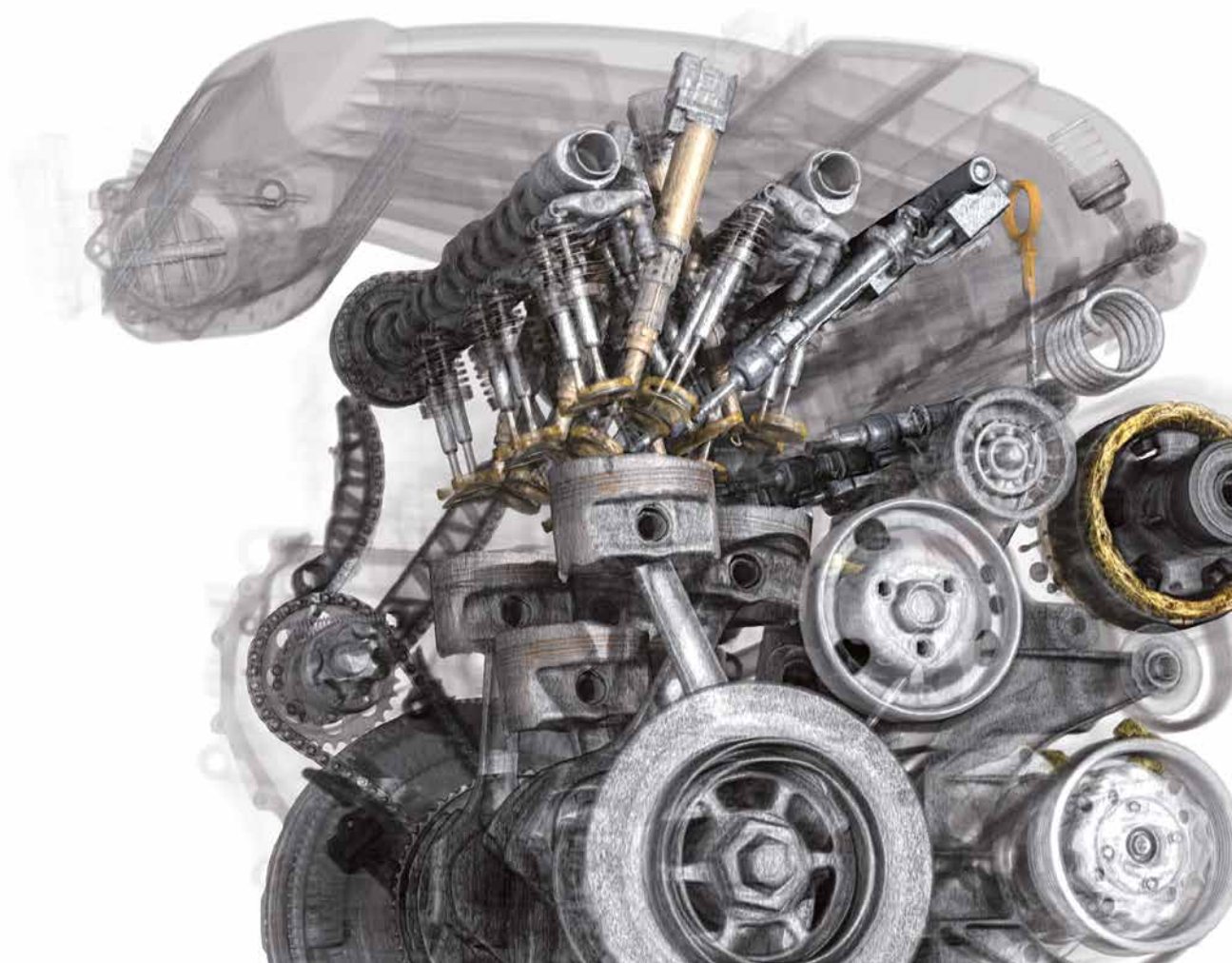
Ready for Tomorrow

VGSTUDIO MAX is designed for seamless operation, whether in the laboratory, in production, or during the transition from laboratory to production. Its comprehensive set of features is based on a deep understanding of your current and future needs in the field of CT data analysis.

Thanks to its modular concept, VGSTUDIO MAX evolves with you. Step by step. And independently of your CT hardware.

Peace of Mind Included

When you choose VGSTUDIO MAX, you get the peace of mind that comes with knowing that you have a team of experts with a deep understanding of your tasks at your side. This begins even before the purchase when our sales experts help you configure your VGSTUDIO MAX and our consultants evaluate your specific challenges and continues long after the purchase: an optional update/service agreement keeps your software up to date, a competent team of specialists with short response times is there to support you, and training courses at VG Academy get you up to speed in using VGSTUDIO MAX.



Your Questions, Your VGSTUDIO MAX

No matter which insights you need to gain about your products, the configuration options in VGSTUDIO MAX will get you there your way.

Basic Edition

Your starting point is the basic edition. It offers innovative measuring instruments, visualization capabilities for visual inspections as well as reporting and presentation functions.

Add-on Modules

Choose from a wide selection of modules for material analysis, geometry analysis, simulation, and CT reconstruction. And if your needs grow, so does VGSTUDIO MAX.

Packages and Bundles

To make it easier for you, VGSTUDIO MAX is available in pre-configured packages tailored to the most common application areas. A package includes a VGSTUDIO MAX license, a selection of add-on modules, and a one-year update/service agreement. If you already own a VGSTUDIO MAX license, you can add a pre-configured bundle to your VGSTUDIO MAX. A bundle consists of a selection of add-on modules and a one-year update/service agreement. See pages 28 and 29 for a complete overview.

Ever-Evolving

VGSTUDIO MAX is always getting better, with new features rolling out regularly. With our optional update/service agreement, you can keep up with current developments in the analysis and visualization of industrial CT data while still saving money compared to the regular upgrade price.

Add-on Modules for Material Analyses

Extended Porosity/Inclusion Analysis Module for defect analysis according to specifications P 202 and P 201.
More on page 21

Fiber Composite Material Analysis Module for the calculation of fiber orientations and other relevant parameters in composite materials.
More on page 22

Foam/Powder Analysis Module for the determination of cell structures in porous foams and filter materials.
More on page 23

Volume Meshing Module for the conversion of CT data to meshes for the subsequent use in simulations.
More on page 25

Structural Mechanics Simulation Module for the simulation of mechanical stress directly on CT data.
More on page 26

Add-on Modules for Simulation

Basic Edition

Porosity/Inclusion Analysis Module for the non-destructive defect discovery in castings, including prediction of pore cuts.
More on page 20

Coordinate Measurement Module for measurements on even the most difficult-to-access surfaces of a component.
More on page 14

CAD Import Module for the import of native CAD files such as CATIA V5 and Creo/Pro/ENGINEER.
More on page 16

CAD Import with PMI Module for the additional import of Product and Manufacturing Information (PMI).
More on page 16

Nominal/Actual Comparison Module for the comparison of manufactured parts with CAD, mesh, or other voxel data.
More on page 17

Wall Thickness Analysis Module for the localization of insufficient or excessive wall thickness or gap width.
More on page 17

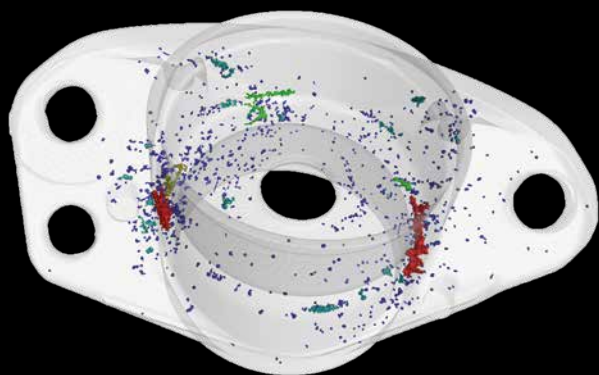
Manufacturing Geometry Correction Module for the correction of tools for injection molding or casting and 3D printing geometries.
More on page 18

CT Reconstruction Module for the reconstruction of 3D volume data sets using images taken by a CT scanner.
More on page 12

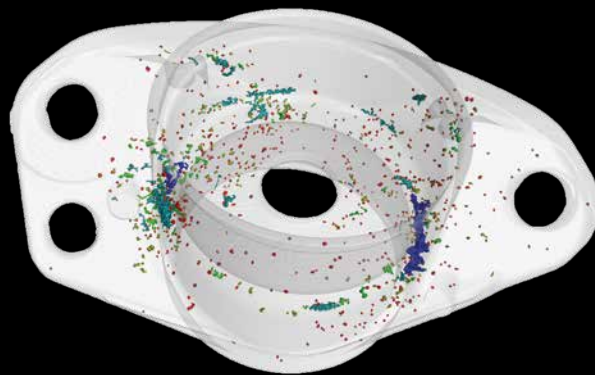
Transport Phenomena Simulation Module for the simulation of fluid, electrical or thermal flow and diffusion, e.g., on porous or composite materials.
More on page 27

Add-on Modules for Geometry Analyses

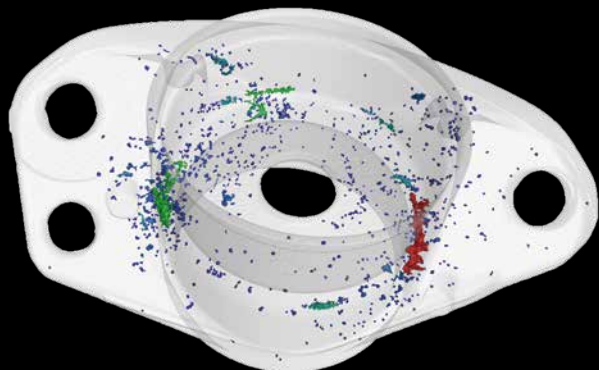
CT Reconstruction



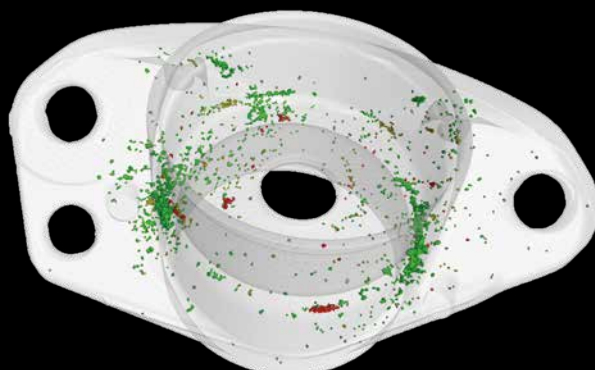
Volume



Sphericity



Diameter



Distance to Surface

Use active columns to quickly switch between parameters for color-coding your analysis results.

Basic Edition

Your starting point into the world of Volume Graphics.

User Interface

- > **Dark theme** for working with gray value images
- > **Bright theme** for measurement tasks
- > **3D rotation options** for better usability

Data Integrity and Safety Features

- > **Protection of raw data** against unwanted exchanges and manipulations
- > **Detection of simultaneous access** to a project file
- > **Merging of all files, folders, and source data** into a single file

Active Columns

- > **Quickly and easily switch between parameters for color-coding analysis results.***
- > For example, switch between visualizing a defect by its volume and its diameter with a click of the mouse.

Instruments

- > **For the simple measuring of distances, gray values, and angles**
- > Support macros and templates
- > Support tolerances

* May require add-on module(s).



The cylindrical surface of a bottleneck has been unrolled to be viewed in a 'flattened' slice image.

Work with Bent Structures

- > **Unroll objects** and then scroll into the object slice by slice.
- > **Level a bent surface**, segment the leveled surface, and then transfer the segmentation back onto the bent surface.
- > **Combine consecutive slices** into a single 2D view to have all information in these slices visible at a glance.

Bookmarks

- > **Save bookmarks, including 3D and 2D views, clippings, selected coordinate systems, and rendering settings.**
- > Export and import bookmarks, even within macros.
- > Apply bookmarks to different data sets.
- > Include views from bookmarks in reports.

Supported 3D Formats

- > **Work natively with voxel, point cloud, mesh, and CAD data.**
- > Benefit from less measurement uncertainty, since the fitting of geometry elements is optimized for each supported data type (voxel, CAD, mesh, and point cloud data).*
- > Repair and optimize corrupt CAD and mesh data during import.
- > Convert CAD or mesh data to voxel, voxel to mesh, or point cloud to mesh.
- > Create Regions of Interest (ROI) on CAD or mesh data and then use them for nominal/actual comparisons and wall thickness analyses.*
- > Create ROI templates on the CAD model—before the actual CT scan—and perform fast, automated geometry inspection tasks in combination with evaluation templates.*
- > Import textured meshes and colored point clouds for a more meaningful documentation and visual analysis of objects.

* May require add-on module(s).

Mathematical Calculations on Voxel Data

- > **Add, subtract, and average voxel data sets.**
- > Combine data sets that, e.g., have been scanned using different techniques into one meaningful data set.
- > Create a “golden” surface from the mean value of several scans.

Animation Options

- > **Create high-quality renderings.**
- > The object exploder animates exploded views of segmented objects.
- > In movies, see the exact position of the respective slice within the 3D model picture in picture.

Segmentation Tools

- > **Separate data sets into individual parts (Regions of Interest or ROIs) that may consist of different components, materials, etc. using manual selection and drawing tools as well as semi-automated tools.**
- > Use subvoxel-accurate segmentation to further increase accuracy.
- > Use CAD models as a starting contour for a (locally) adaptive surface determination and easily generate accurate surfaces, especially in multi-material scenarios.*
- > Create ROIs from clipping objects.
- > Restrict analyses and visualizations to individual ROIs.
- > Use the drawing tool with upper and lower threshold values to easily separate even data sets with fluctuating gray values.
- > Specifically analyze near-surface properties with the enveloping ROI.

Analyses

- > Data quality analysis according to the ASTM E 1695 standard to monitor the CT scan quality over time
- > Text recognition to read out object identifiers such as cavity markers from CT scans

* Requires the Coordinate Measurement Module.

** May require add-on module(s).

Combined Analyses

- > **Combine the results of successive analyses.****
- > Combine, e.g., a wall thickness analysis with a porosity/inclusion analysis to classify a defect according to its size in relation to the local wall thickness.

Evaluations

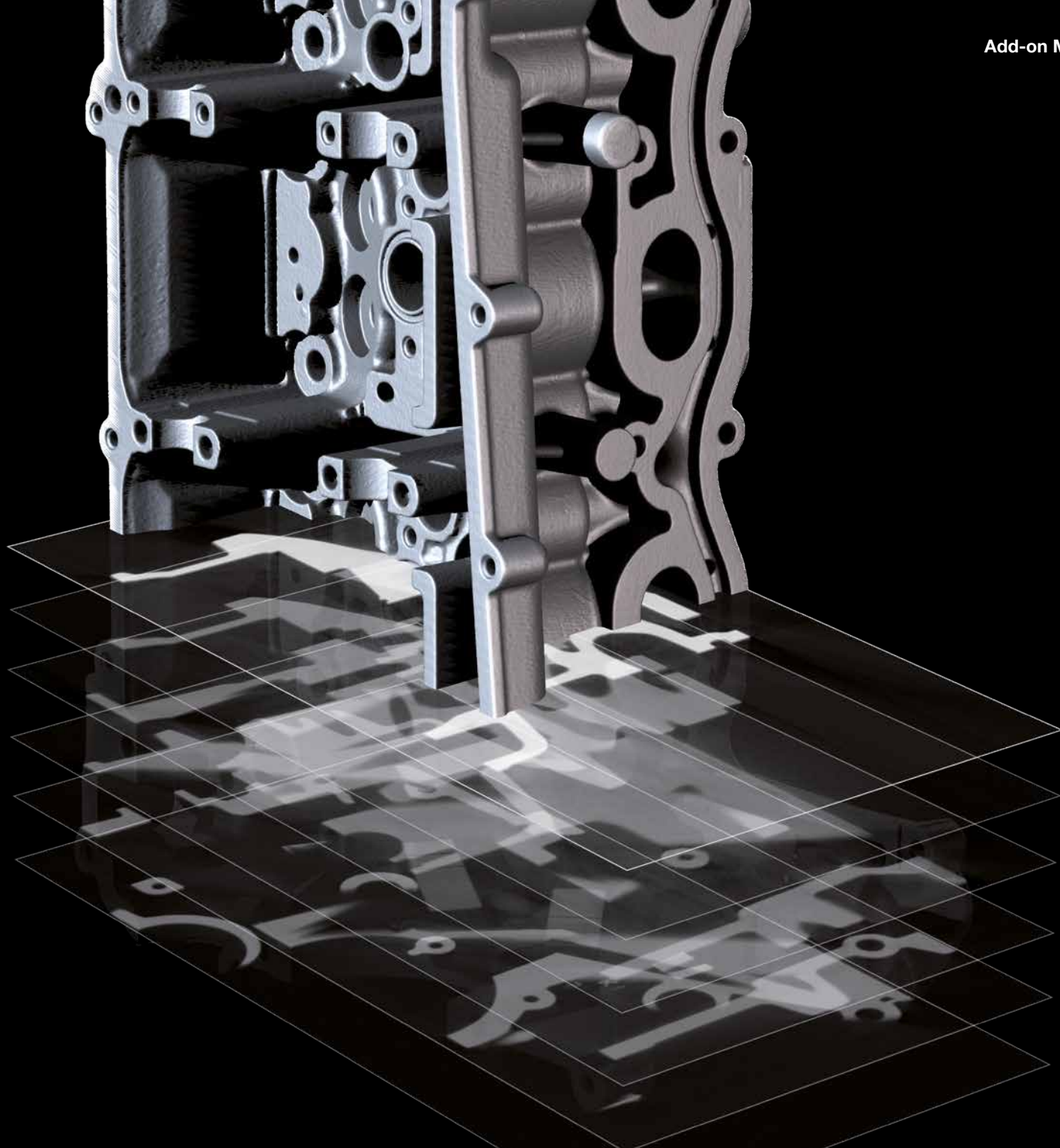
- > **Save comprehensive inspection plans as evaluations to inspect parts semi- or fully automatically.**
- > Connect the results of diverse analyses in order to achieve conclusive pass/fail decisions.
- > Use evaluations generated with VGSTUDIO MAX for serial inspection in VGINLINE.

Document and Export

- > **Export images (color-coded in 3D and 2D), histograms, and data tables in common file formats to work with them in other applications.**
- > Export all results in a standardized folder and file structure.
- > Create comprehensive and completely customizable test reports hand in hand with Microsoft Excel (requires Microsoft Excel).
- > See the exact position of the respective slice within the 3D model picture in picture when saving slice images.
- > Generate reports on all analyses linked to an object.
- > Define rules with which VGSTUDIO MAX generates images or annotations, e.g., to generate pictures of all defects exceeding a certain size.*
- > Export results of measurements and analyses to third-party Quality Management or Statistical Process Control software via the widely used Q-DAS data exchange format.

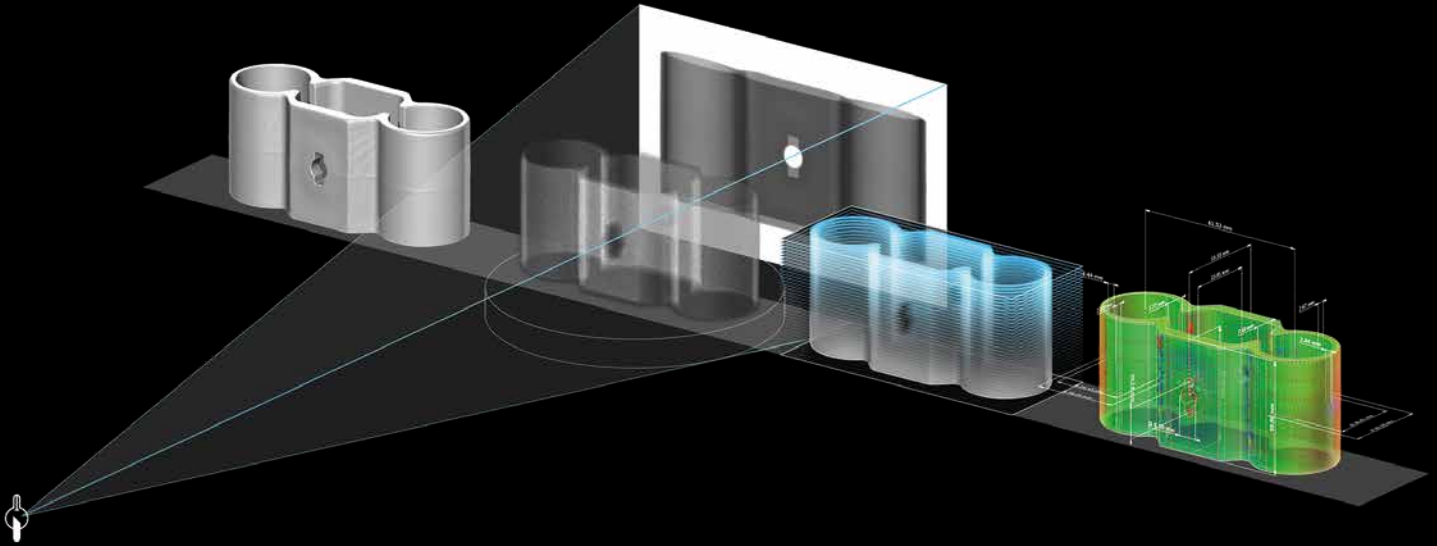
Macros and Templates

- > **Automate the analysis of single data sets or a group of data sets with macros and templates.****
- > Combine macros like building blocks in various contexts and constellations.
- > Use macros, templates, and inspection plans created in VGSTUDIO MAX for automation with VGINLINE.



Add-on Modules for CT Reconstruction

The right algorithms for your scanner so you get the most out of your scans: the add-on modules for CT reconstruction offered by Volume Graphics.



The CT Reconstruction Module seamlessly fits into your daily workflow.



CT Reconstruction Module

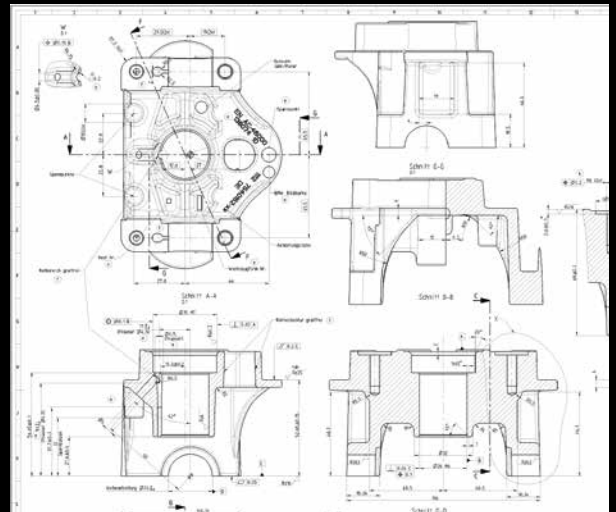
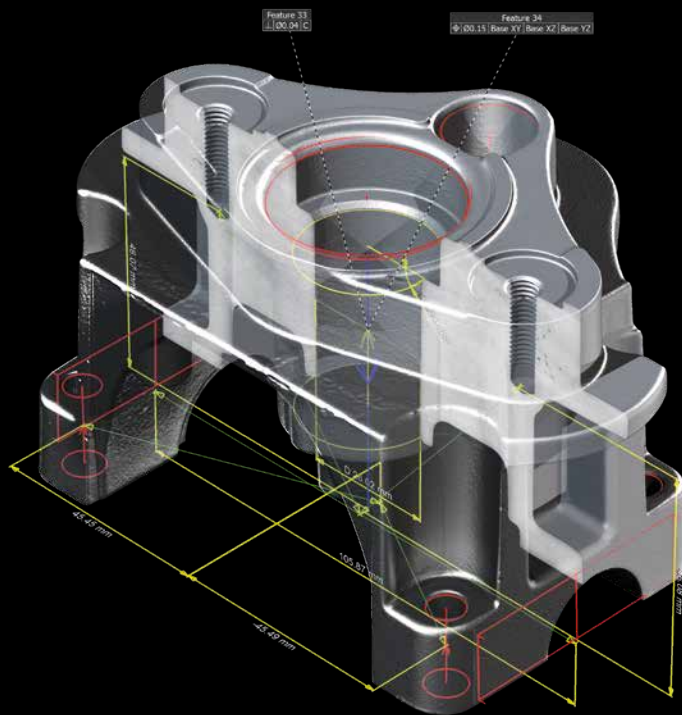
> Quickly and precisely calculates 3D volume data sets from the images taken by a CT scanner, which can then be analyzed and visualized in VGSTUDIO MAX.

- > Supports cone beam, fan beam, parallel beam, planar, and helical (spiral) CT.
- > Reconstructs large parts by using field of view extensions.
- > Features robust, automatic scan geometry corrections (e.g., detector shift and rotation axis tilt).
- > Supports Feldkamp, Davis, and Kress (FDK) and Algebraic Reconstruction Technique (ART) for image reconstruction.
- > Improves the image quality using the standard Volume Graphics beam hardening correction or the optional Iterative Artifact Reduction (IAR)*.
- > Reduces metal and ring artifacts.
- > Provides slice and volume previews for faster evaluation of CT measurements.
- > Uses one or multiple GPUs to speed up calculations by incorporating OpenCL.
- > Supports automatic parameter import of many CT systems.
- > Reconstruction can be limited to multiple Regions of Interest with arbitrary shapes.

* Technology licensed by Fraunhofer EZRT

Add-on Modules for Geometry Analyses

Geometry analyses to qualify even the most complex outer and inner geometries: the add-on modules for geometry analyses offered by Volume Graphics.



Easily apply a conventional measurement plan to your voxel data.

Coordinate Measurement Module

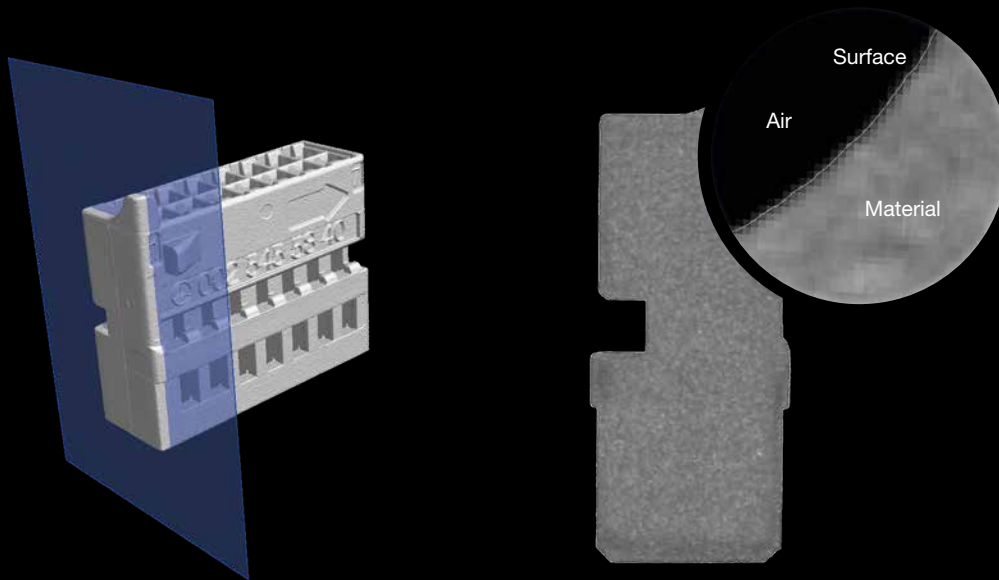
> Measures even the most difficult-to-access surfaces of a component

- > Measurements on voxel, point cloud, mesh, and CAD data
- > GD&T functionality (based on DIN EN ISO 1101)
- > Geometry element fitting optimized for voxel, CAD, and mesh data
- > Registration with boundary conditions, e.g., rotation of an object around one axis only while locking the others
- > Alignment techniques, e.g., 3-2-1 registration that allows for offsets and subsequent rotations for solving highly complex alignment tasks
- > Feature-based registration mode that aligns a scan which only covers a section of a sample to, e.g., the CAD model of the entire part

- > Tolerancing of registration results to determine their quality
- > Automatic selection of the type of geometry element to be fitted
- > Automated generation of datum systems
- > Creation of common datums
- > Line and surface profile tolerances
- > Construction with geometry elements
- > Extraction of min./max. fit points
- > Reduction of measurement uncertainty due to thousands of automatically generated fit points
- > Preparation of inspection plans on CAD data, CT scan or mesh data
- > Saving of compact .mvgl files for VGMETROLOGY ES

The Volume Graphics Metrology Kernel in VGSTUDIO MAX has been tested by the national institutes PTB (Physikalisch-Technische Bundesanstalt) and NIST (National Institute of Standards and Technology).*

* PTB and NIST verified: This software contains the Volume Graphics Metrology Kernel VGMK 3.2.0 140356 which passed the PTB test for "Evaluation software based on minimum-zone method for coordinate measuring machines" and the PTB test for "Evaluation software based on least-squares method for coordinate measuring machines" and which was verified by the NIST "Algorithm Testing and Evaluation Program for Coordinate Measuring Systems". The test results were obtained under Windows (64 bit).



The surface is between material and air. Often, the surface is defined by a single gray value. When using Advanced Surface Determination, however, the gray values are processed depending on the gray values of the surrounding voxels. The result is a much more accurate surface.

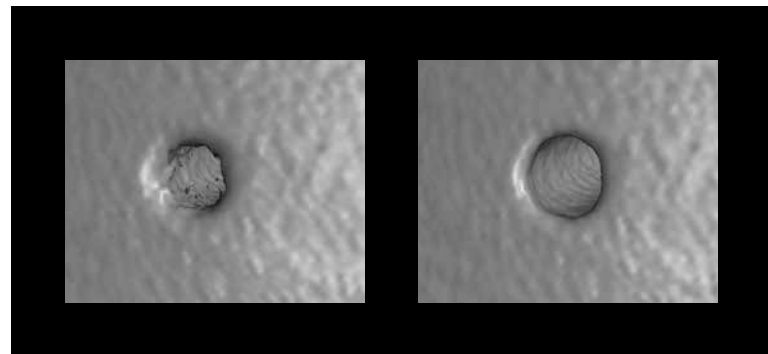


Advanced Surface Determination

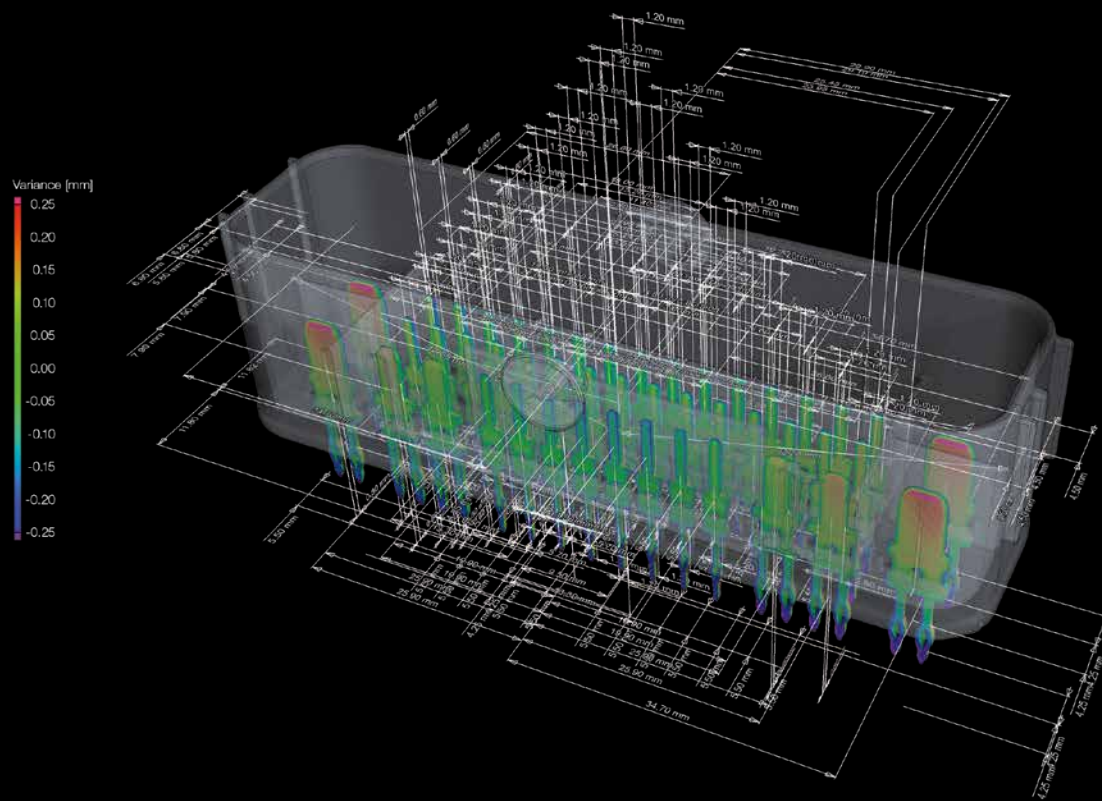
Part of the Coordinate Measurement Module

> **Subvoxel-accurate surface determination makes even those details visible that are smaller than a voxel—automatically, manually, and interval-based.**

- > Gray values of individual voxels are processed depending on the gray values of the surrounding voxels, which makes the surface determination markedly more accurate.
- > The interval-based mode allows for a high-accuracy, locally adaptive surface determination, even within an automated environment and with changing gray value conditions.
- > Multi-material mode for simultaneous determination of the surfaces of multiple material within a volume, resulting in one component per material



Not just smoother but also more accurate: Using the subvoxel-accurate surface determination (right) reduces your measurement uncertainty by giving you details the voxel-based surface determination (left) is not able to show.



With the corresponding add-on module, VGSTUDIO MAX understands additional information stored in PMI data.



CAD Import Module*

- > **Uses native CAD files such as CATIA V5 and Creo/Pro/ENGINEER for nominal/actual comparisons, segmentation, and other tasks (in addition to the STEP and IGES formats in the basic edition of VGSTUDIO MAX).****
- > Offers enhanced auto-completion modes.
- > Replaces CAD geometries with matching geometry elements.
- > Automatically translates CAD views into bookmarks.

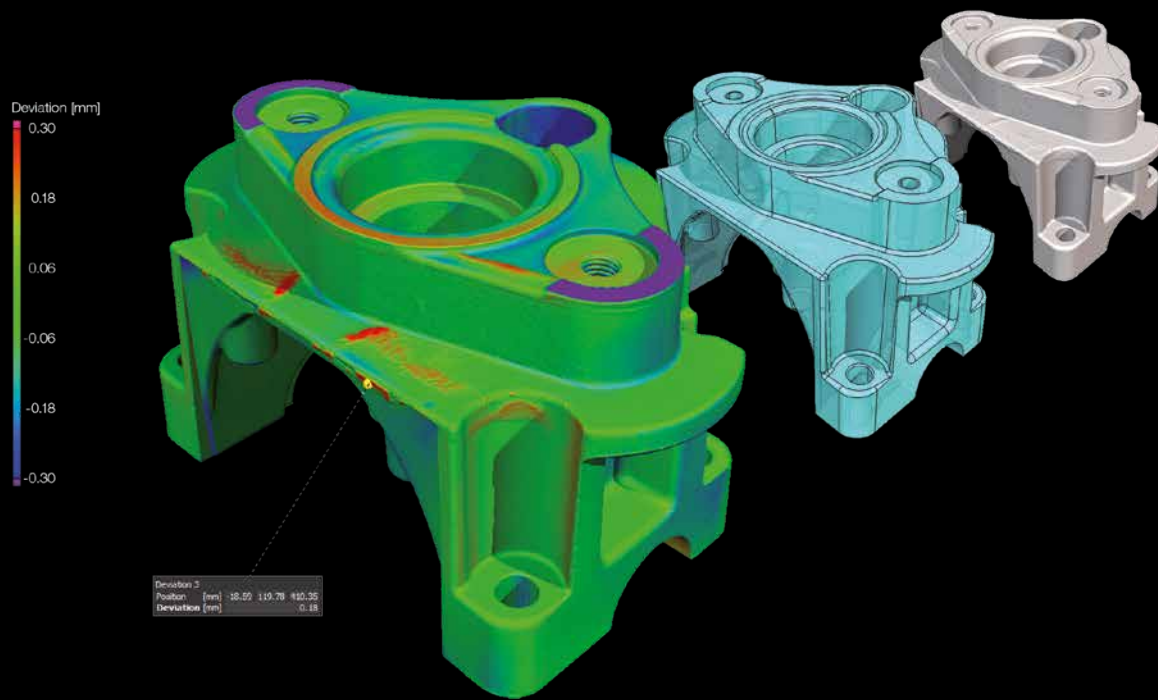
CAD Import with PMI*

- > **Understands so-called Product and Manufacturing Information (PMI) that is generated in many current CAD systems and provides additional part information, e.g., dimensioning, GD&T, layers, annotations, or captions.*****
- > Saves a considerable amount of time when preparing measurement plans and thus increases the efficiency of your quality control by intelligently evaluating PMI data.
- > Comes with all features of the CAD Import Module.

* CAD translation technology supplied by Tech Soft 3D

** Supported CAD formats: CATIA V5 (up to V5-6 R2018), Creo (up to 5.0 Beta); in beta status: CATIA V4 (up to 4.2.5), JT (up to 10.0), Pro/ENGINEER (up to 19.0), Unigraphics/NX (V11.0 to NX 12.0), Solid Edge (V19 – 20, ST – ST10), SolidWorks (from 97 up to 2018)

*** PMI import supported for CATIA V5 and Creo; in beta status: Pro/ENGINEER and Unigraphics/NX



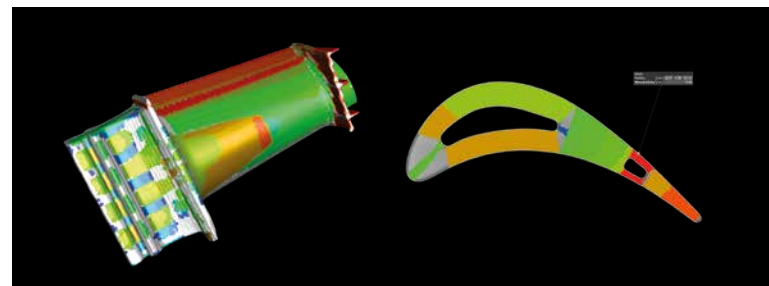
Compare your scanned object with its respective CAD data set. Get color-coded results of deviations and local annotations.

Nominal/Actual Comparison Module*

- > **Allows for a geometric comparison of voxel, mesh, and CAD data.**
- > Application of tolerances to the nominal/actual comparison with various parameters, e.g., deviation (minimum, maximum, cumulated).

Wall Thickness Analysis Module

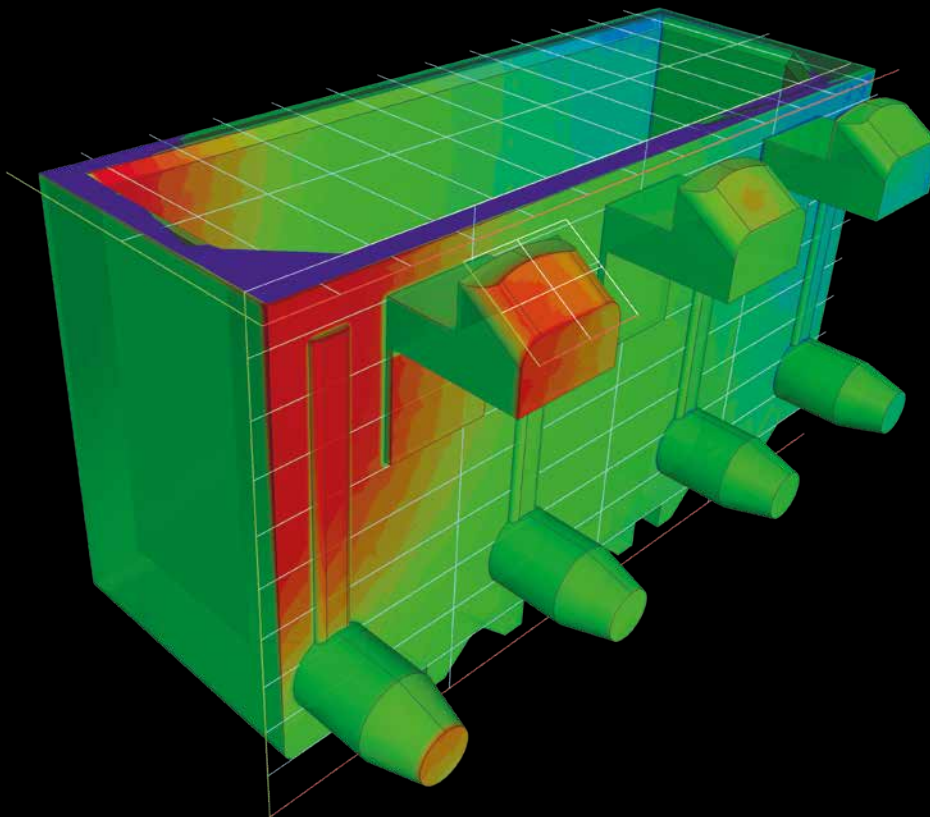
- > **Automatically and quickly analyzes wall thicknesses.****
- > Works for near parallel surfaces (ray method) as well as for curved or branching surfaces (sphere method), including complex 3D printed shapes.
- > Localizes areas with an insufficient or excessive wall thickness or gap width automatically and directly within the voxel, point cloud, mesh, or CAD data set.
- > Allows the application of tolerances with various parameters, e.g., thickness (minimum, maximum, mean, deviation).
- > Reduces the number of false detections with a noise filter, which is especially helpful for automated inspections.



Color-coded results of a wall thickness analysis

* Requires the Coordinate Measurement Module

** Use in combination with Coordinate Measurement Module recommended



Get a color-coded visualization that shows you at a glance any deviations of the manufactured part from the target model.

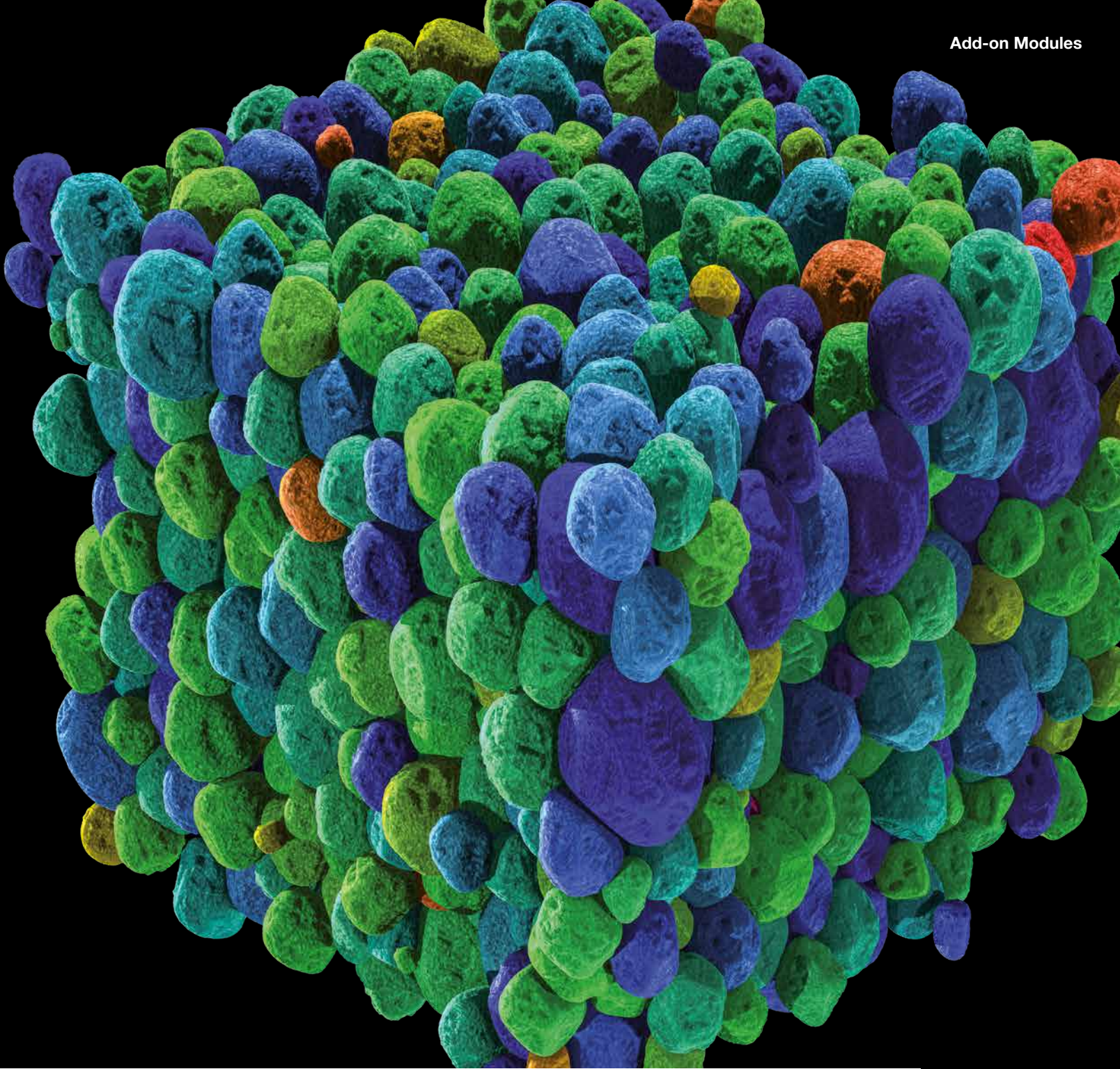


Manufacturing Geometry Correction Module

> **Corrects tools for injection molding or casting and 3D printing geometries in a seamless digital workflow with a lower number of iterations—keeping the quality up and the time to market short.***

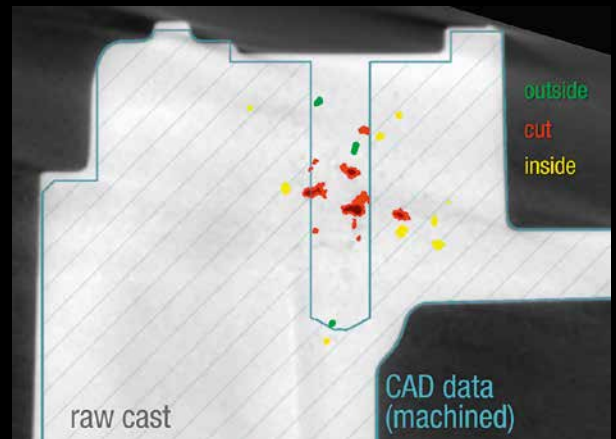
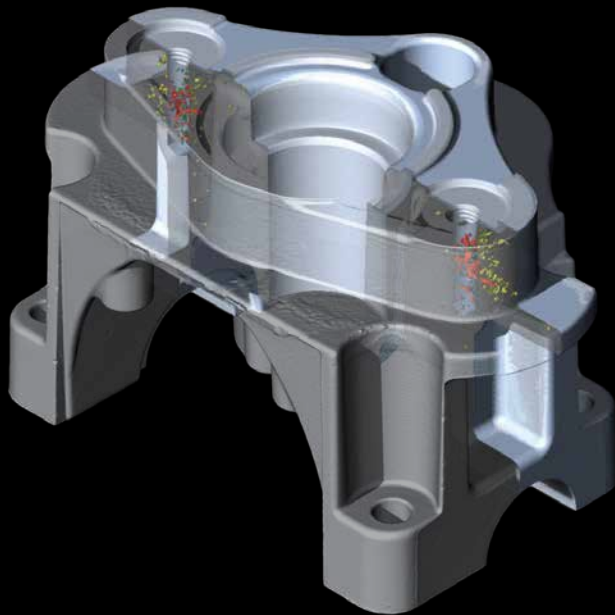
- > Processes voxel, .stl, and CAD data together in one software.
- > Calculates changes to injection molds, punching tools, or geometries of 3D printed parts based on scans of your sample part.
- > Provides a color-coded visualization that shows you at a glance any deviations of the manufactured part from the target model, including curvatures and undercuts.
- > Uses scan data of the part to quickly and easily generate correction areas in CAD format to adapt the part and the tool shape.
- > Exports information about the newly calculated surfaces directly as CAD faces.

* Requires the Coordinate Measurement Module and the Nominal/Actual Comparison Module



Add-on Modules for Material Analyses

Material analyses to reveal what's below the surface of your scanned parts: the add-on modules for material analyses offered by Volume Graphics.

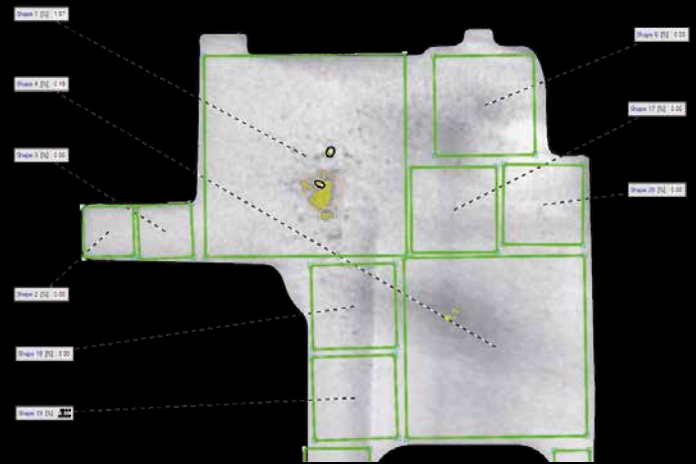
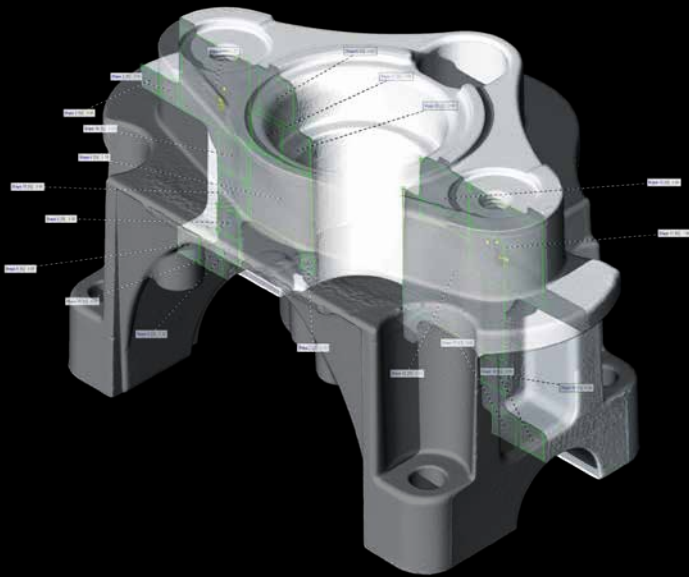


Defect	Volume [mm³]	Type	Coordinate	Size	Distance to Surface [mm]	Distance to Nearest Defect [mm]	Distance to Farthest Defect [mm]	Distance to Center of Mass [mm]	Distance to Edge [mm]	Distance to Corner [mm]
1.1	0.01	Pore	10, 10, 10	0.1	10.0	10.0	10.0	10.0	10.0	10.0
1.2	0.02	Pore	20, 20, 20	0.2	20.0	20.0	20.0	20.0	20.0	20.0
1.3	0.03	Pore	30, 30, 30	0.3	30.0	30.0	30.0	30.0	30.0	30.0
1.4	0.04	Pore	40, 40, 40	0.4	40.0	40.0	40.0	40.0	40.0	40.0
1.5	0.05	Pore	50, 50, 50	0.5	50.0	50.0	50.0	50.0	50.0	50.0
1.6	0.06	Pore	60, 60, 60	0.6	60.0	60.0	60.0	60.0	60.0	60.0
1.7	0.07	Pore	70, 70, 70	0.7	70.0	70.0	70.0	70.0	70.0	70.0
1.8	0.08	Pore	80, 80, 80	0.8	80.0	80.0	80.0	80.0	80.0	80.0
1.9	0.09	Pore	90, 90, 90	0.9	90.0	90.0	90.0	90.0	90.0	90.0
2.0	0.10	Pore	100, 100, 100	1.0	100.0	100.0	100.0	100.0	100.0	100.0
2.1	0.11	Pore	110, 110, 110	1.1	110.0	110.0	110.0	110.0	110.0	110.0
2.2	0.12	Pore	120, 120, 120	1.2	120.0	120.0	120.0	120.0	120.0	120.0
2.3	0.13	Pore	130, 130, 130	1.3	130.0	130.0	130.0	130.0	130.0	130.0
2.4	0.14	Pore	140, 140, 140	1.4	140.0	140.0	140.0	140.0	140.0	140.0
2.5	0.15	Pore	150, 150, 150	1.5	150.0	150.0	150.0	150.0	150.0	150.0
2.6	0.16	Pore	160, 160, 160	1.6	160.0	160.0	160.0	160.0	160.0	160.0
2.7	0.17	Pore	170, 170, 170	1.7	170.0	170.0	170.0	170.0	170.0	170.0
2.8	0.18	Pore	180, 180, 180	1.8	180.0	180.0	180.0	180.0	180.0	180.0
2.9	0.19	Pore	190, 190, 190	1.9	190.0	190.0	190.0	190.0	190.0	190.0
3.0	0.20	Pore	200, 200, 200	2.0	200.0	200.0	200.0	200.0	200.0	200.0
3.1	0.21	Pore	210, 210, 210	2.1	210.0	210.0	210.0	210.0	210.0	210.0
3.2	0.22	Pore	220, 220, 220	2.2	220.0	220.0	220.0	220.0	220.0	220.0
3.3	0.23	Pore	230, 230, 230	2.3	230.0	230.0	230.0	230.0	230.0	230.0
3.4	0.24	Pore	240, 240, 240	2.4	240.0	240.0	240.0	240.0	240.0	240.0
3.5	0.25	Pore	250, 250, 250	2.5	250.0	250.0	250.0	250.0	250.0	250.0
3.6	0.26	Pore	260, 260, 260	2.6	260.0	260.0	260.0	260.0	260.0	260.0
3.7	0.27	Pore	270, 270, 270	2.7	270.0	270.0	270.0	270.0	270.0	270.0
3.8	0.28	Pore	280, 280, 280	2.8	280.0	280.0	280.0	280.0	280.0	280.0
3.9	0.29	Pore	290, 290, 290	2.9	290.0	290.0	290.0	290.0	290.0	290.0
4.0	0.30	Pore	300, 300, 300	3.0	300.0	300.0	300.0	300.0	300.0	300.0
4.1	0.31	Pore	310, 310, 310	3.1	310.0	310.0	310.0	310.0	310.0	310.0
4.2	0.32	Pore	320, 320, 320	3.2	320.0	320.0	320.0	320.0	320.0	320.0
4.3	0.33	Pore	330, 330, 330	3.3	330.0	330.0	330.0	330.0	330.0	330.0
4.4	0.34	Pore	340, 340, 340	3.4	340.0	340.0	340.0	340.0	340.0	340.0
4.5	0.35	Pore	350, 350, 350	3.5	350.0	350.0	350.0	350.0	350.0	350.0
4.6	0.36	Pore	360, 360, 360	3.6	360.0	360.0	360.0	360.0	360.0	360.0
4.7	0.37	Pore	370, 370, 370	3.7	370.0	370.0	370.0	370.0	370.0	370.0
4.8	0.38	Pore	380, 380, 380	3.8	380.0	380.0	380.0	380.0	380.0	380.0
4.9	0.39	Pore	390, 390, 390	3.9	390.0	390.0	390.0	390.0	390.0	390.0
5.0	0.40	Pore	400, 400, 400	4.0	400.0	400.0	400.0	400.0	400.0	400.0
5.1	0.41	Pore	410, 410, 410	4.1	410.0	410.0	410.0	410.0	410.0	410.0
5.2	0.42	Pore	420, 420, 420	4.2	420.0	420.0	420.0	420.0	420.0	420.0
5.3	0.43	Pore	430, 430, 430	4.3	430.0	430.0	430.0	430.0	430.0	430.0
5.4	0.44	Pore	440, 440, 440	4.4	440.0	440.0	440.0	440.0	440.0	440.0
5.5	0.45	Pore	450, 450, 450	4.5	450.0	450.0	450.0	450.0	450.0	450.0
5.6	0.46	Pore	460, 460, 460	4.6	460.0	460.0	460.0	460.0	460.0	460.0
5.7	0.47	Pore	470, 470, 470	4.7	470.0	470.0	470.0	470.0	470.0	470.0
5.8	0.48	Pore	480, 480, 480	4.8	480.0	480.0	480.0	480.0	480.0	480.0
5.9	0.49	Pore	490, 490, 490	4.9	490.0	490.0	490.0	490.0	490.0	490.0
6.0	0.50	Pore	500, 500, 500	5.0	500.0	500.0	500.0	500.0	500.0	500.0
6.1	0.51	Pore	510, 510, 510	5.1	510.0	510.0	510.0	510.0	510.0	510.0
6.2	0.52	Pore	520, 520, 520	5.2	520.0	520.0	520.0	520.0	520.0	520.0
6.3	0.53	Pore	530, 530, 530	5.3	530.0	530.0	530.0	530.0	530.0	530.0
6.4	0.54	Pore	540, 540, 540	5.4	540.0	540.0	540.0	540.0	540.0	540.0
6.5	0.55	Pore	550, 550, 550	5.5	550.0	550.0	550.0	550.0	550.0	550.0
6.6	0.56	Pore	560, 560, 560	5.6	560.0	560.0	560.0	560.0	560.0	560.0
6.7	0.57	Pore	570, 570, 570	5.7	570.0	570.0	570.0	570.0	570.0	570.0
6.8	0.58	Pore	580, 580, 580	5.8	580.0	580.0	580.0	580.0	580.0	580.0
6.9	0.59	Pore	590, 590, 590	5.9	590.0	590.0	590.0	590.0	590.0	590.0
7.0	0.60	Pore	600, 600, 600	6.0	600.0	600.0	600.0	600.0	600.0	600.0
7.1	0.61	Pore	610, 610, 610	6.1	610.0	610.0	610.0	610.0	610.0	610.0
7.2	0.62	Pore	620, 620, 620	6.2	620.0	620.0	620.0	620.0	620.0	620.0
7.3	0.63	Pore	630, 630, 630	6.3	630.0	630.0	630.0	630.0	630.0	630.0
7.4	0.64	Pore	640, 640, 640	6.4	640.0	640.0	640.0	640.0	640.0	640.0
7.5	0.65	Pore	650, 650, 650	6.5	650.0	650.0	650.0	650.0	650.0	650.0
7.6	0.66	Pore	660, 660, 660	6.6	660.0	660.0	660.0	660.0	660.0	660.0
7.7	0.67	Pore	670, 670, 670	6.7	670.0	670.0	670.0	670.0	670.0	670.0
7.8	0.68	Pore	680, 680, 680	6.8	680.0	680.0	680.0	680.0	680.0	680.0
7.9	0.69	Pore	690, 690, 690	6.9	690.0	690.0	690.0	690.0	690.0	690.0
8.0	0.70	Pore	700, 700, 700	7.0	700.0	700.0	700.0	700.0	700.0	700.0
8.1	0.71	Pore	710, 710, 710	7.1	710.0	710.0	710.0	710.0	710.0	710.0
8.2	0.72	Pore	720, 720, 720	7.2	720.0	720.0	720.0	720.0	720.0	720.0
8.3	0.73	Pore	730, 730, 730	7.3	730.0	730.0	730.0	730.0	730.0	730.0
8.4	0.74	Pore	740, 740, 740	7.4	740.0	740.0	740.0	740.0	740.0	740.0
8.5	0.75	Pore	750, 750, 750	7.5	750.0	750.0	750.0	750.0	750.0	750.0
8.6	0.76	Pore	760, 760, 760	7.6	760.0	760.0	760.0	760.0	760.0	760.0
8.7	0.77	Pore	770, 770, 770	7.7	770.0	770.0	770.0	770.0	770.0	770.0
8.8	0.78	Pore	780, 780, 780	7.8	780.0	780.0	780.0	780.0	780.0	780.0
8.9	0.79	Pore	790, 790, 790	7.9	790.0	790.0	790.0	790.0	790.0	790.0
9.0	0.80	Pore	800, 800, 800	8.0	800.0	800.0	800.0	800.0	800.0	800.0
9.1	0.81	Pore	810, 810, 810	8.1	810.0	810.0	810.0	810.0	810.0	810.0
9.2	0.82	Pore	820, 820, 820	8.2	820.0	820.0	820.0	820.0	820.0	820.0
9.3	0.83	Pore	830, 830, 830	8.3	830.0	830.0	830.0	830.0	830.0	830.0
9.4	0.84	Pore	840, 840, 840	8.4	840.0	840.0	840.0	840.0	840.0	840.0
9.5	0.85	Pore	850, 850, 850	8.5	850.0	850.0	850.0	850.0	850.0	850.0
9.6	0.86	Pore	860, 860, 860	8.6	860.0	860.0	860.0	860.0	860.0	860.0
9.7	0.87	Pore	870, 870, 870	8.7	870.0	870.0	870.0	870.0	870.0	870.0
9.8	0.88	Pore	880, 880, 880	8.8	880.0	880.0	880.0	880.0	880.0	880.0
9.9	0.89	Pore	890, 890, 890	8.9	890.0	890.0	890.0	890.0	890.0	890.0
10.0	0.90	Pore	900, 900, 900	9.0	900.0	900.0	900.0	900.0	900.0	900.0
10.1	0.91	Pore	910, 910, 910	9.1	910.0	910.0	910.0	910.0	910.0	910.0
10.2	0.92	Pore	920, 920, 920	9.2	920.0	920.0	920.0	920.0	920.0	920.0
10.3	0.93	Pore	930, 930, 930	9.3	930.0	930.0	930.0	930.0	930.0	930.0
10.4	0.94	Pore	940, 940, 940	9.4	940.0	940.0	940.0	940.0	940.0	940.0
10.5	0.95	Pore	950, 950, 950	9.5	950.0	950.0	950.0	950.0	950.0	950.0
10.6	0.96	Pore	960, 960, 960	9.6	960.0	960.0	960.0	960.0	960.0	960.0
10.7	0.97	Pore	970, 970, 970	9.7	970.0	970.0	970.0	970.0	970.0	970.0
10.8	0.98	Pore	980, 980, 980	9.8	980.0	980.0	980.0	980.0	980.0	980.0
10.9	0.99	Pore	990, 990, 990	9.9	990.0	990.0	990.0	990.0	990.0	990.0
11.0	1.00	Pore	1000, 1000, 1000	10.0	1000.0	1000.0	1000.0	1000.0	1000.0	1000.0

Color-coded visualization of detected inclusions in a 3D view, a 2D view with simulated machining, and as a table

Porosity/Inclusion Analysis Module

- > **Locates pores, holes, and inclusions within parts and provides detailed information about these defects.**
- > Calculates various parameters for each defect (defect position, defect compactness, defect size and geometry, gap to closest defect, distance of each defect to a reference surface).
- > Shows if and how pores would be cut during machining—before actually machining the part (CAD file of the part required).
- > Calculates the overall percentage of porosity and visualizes it in a defect volume histogram.
- > Finds defects of different shapes using the filter function.
- > Identifies areas with high porosity as porosity hot spots
- > Visualizes both individual defects and locally averaged porosity color-coded, as a table, or as a scatterplot.
- > Exports analysis results to MAGMASOFT® as .emv file or loads them onto an existing PATRAN® or NASTRAN® mesh for FEM simulation or comparison with casting simulations.
- > Uses the VGEasyPore algorithm for an easy-to-use and fast defect detection, based on relative or absolute definition of the minimum local contrast of pores.
- > Uses the VGDefX defect detection algorithm for an optimized calculation of defects based on different criteria.

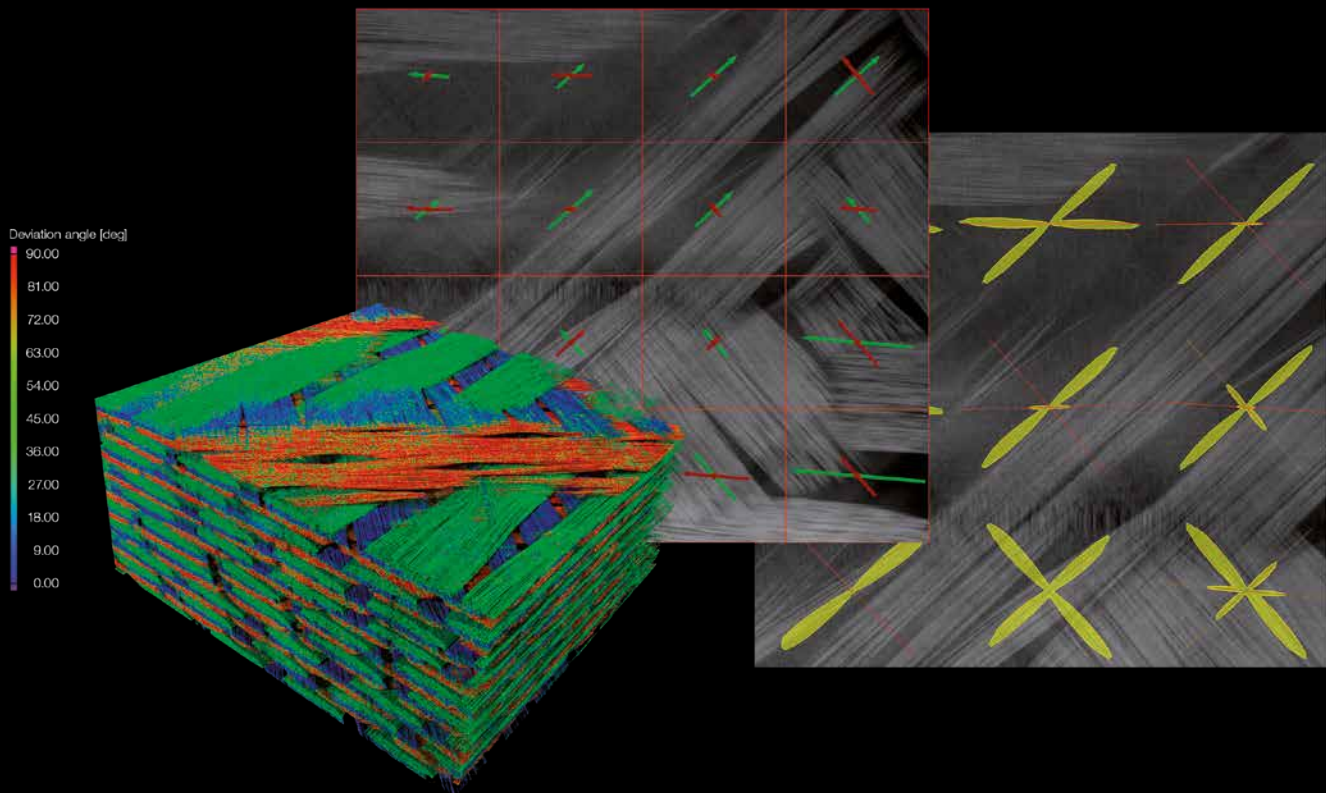


2D analysis according to P 202/P 201 directly in the CT data



Extended Porosity/Inclusion Analysis Module

- > **Supports defect analyses in accordance with the VDG rules P 202 (VW 50093) and P 201 (VW 50097).**
- > Eliminates the need for the time-consuming production of micrograph sections and the preparation of samples in many cases.
- > Quantifies the surface size of defects in CT slice images automatically.
- > Supports templates to rapidly and repeatedly analyze all parts without manual intervention.
- > Includes local adaptive mode for improved pore detection.

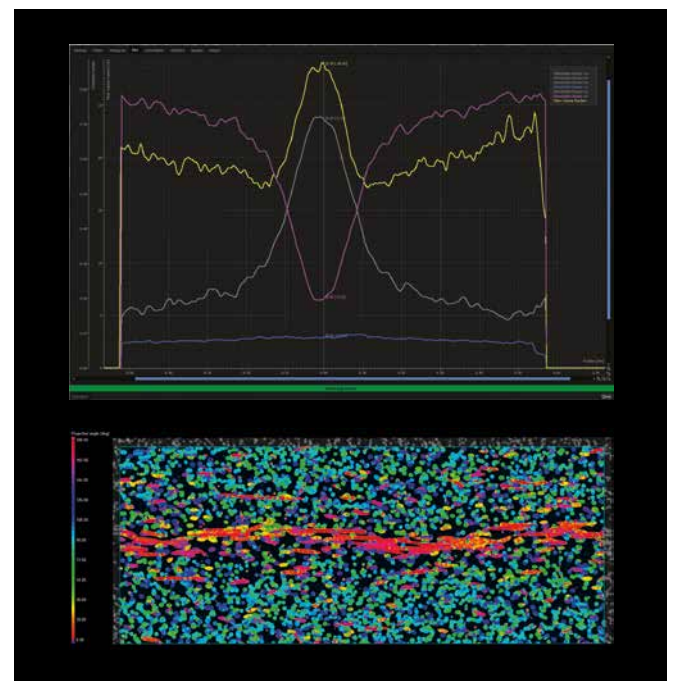


Analyze fiber composites, color code different fiber orientations, see main directions, and display orientation distributions.

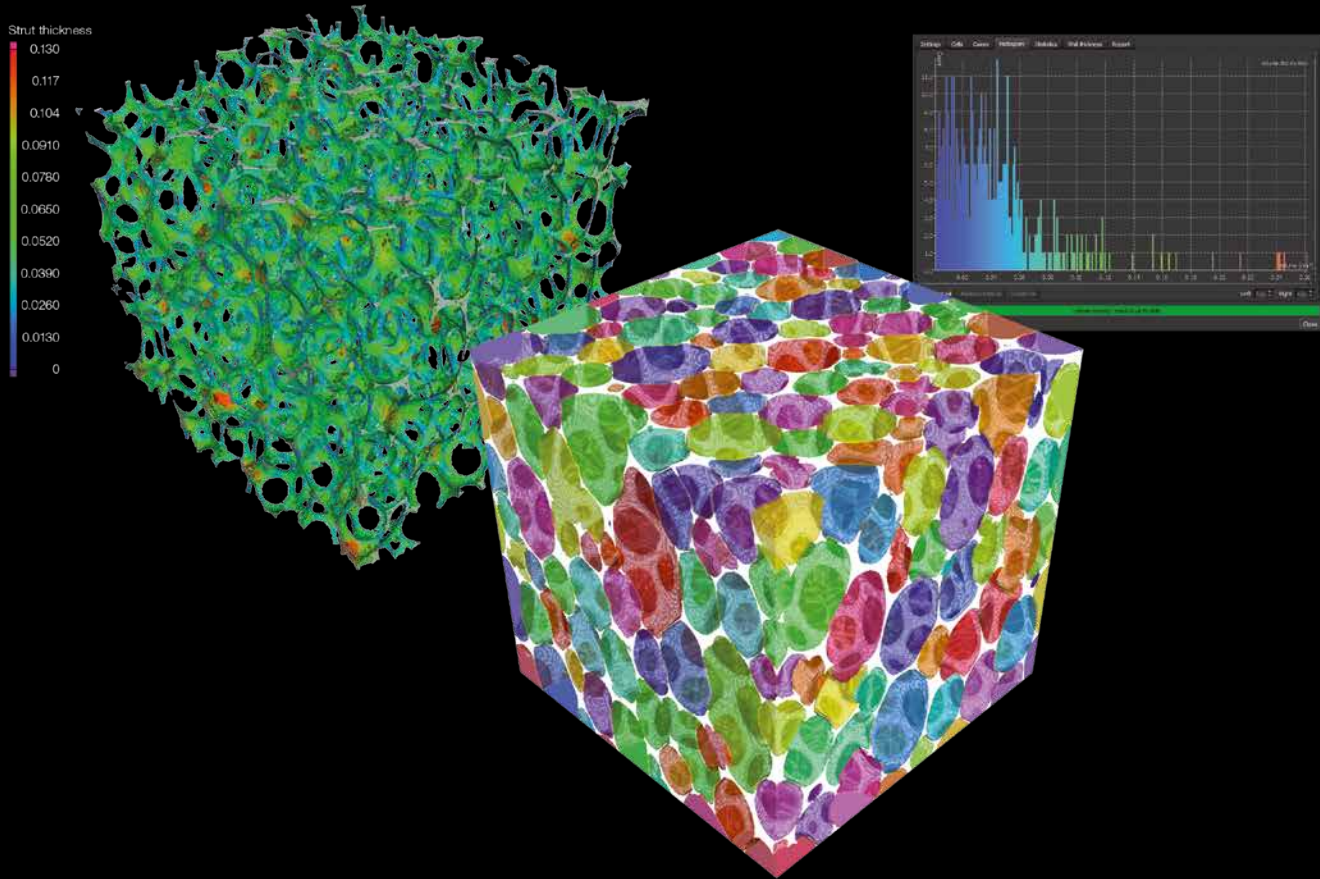
Fiber Composite Material Analysis Module

> Provides insights into fiber composite materials such as carbon-fiber-reinforced plastic (CFRP) or glass-reinforced plastic (GRP).

- > Calculates, e.g., local fiber orientations, local fiber volume fractions, global fiber orientation distributions, and global volume fractions.
- > Displays local fiber orientation in color code or as vectors or tensors.
- > Shows the detailed angular distribution of any number of directions in a 2D histogram.
- > Determines the main orientations for fabrics or rovings
- > Displays global orientation distribution, e.g., as a histogram.
- > Produces line plots of the individual components of the orientation tensor in order to easily compare nominal and actual values.
- > Imports meshes thanks to the support of PATRAN® and NASTRAN® files.
- > Exports analyzed material properties for use in your simulation software.



Top: Orientation tensor for the three main directions.
The horizontal axis indicates the horizontal position (in the plate).
Bottom: Corresponding slice selection.



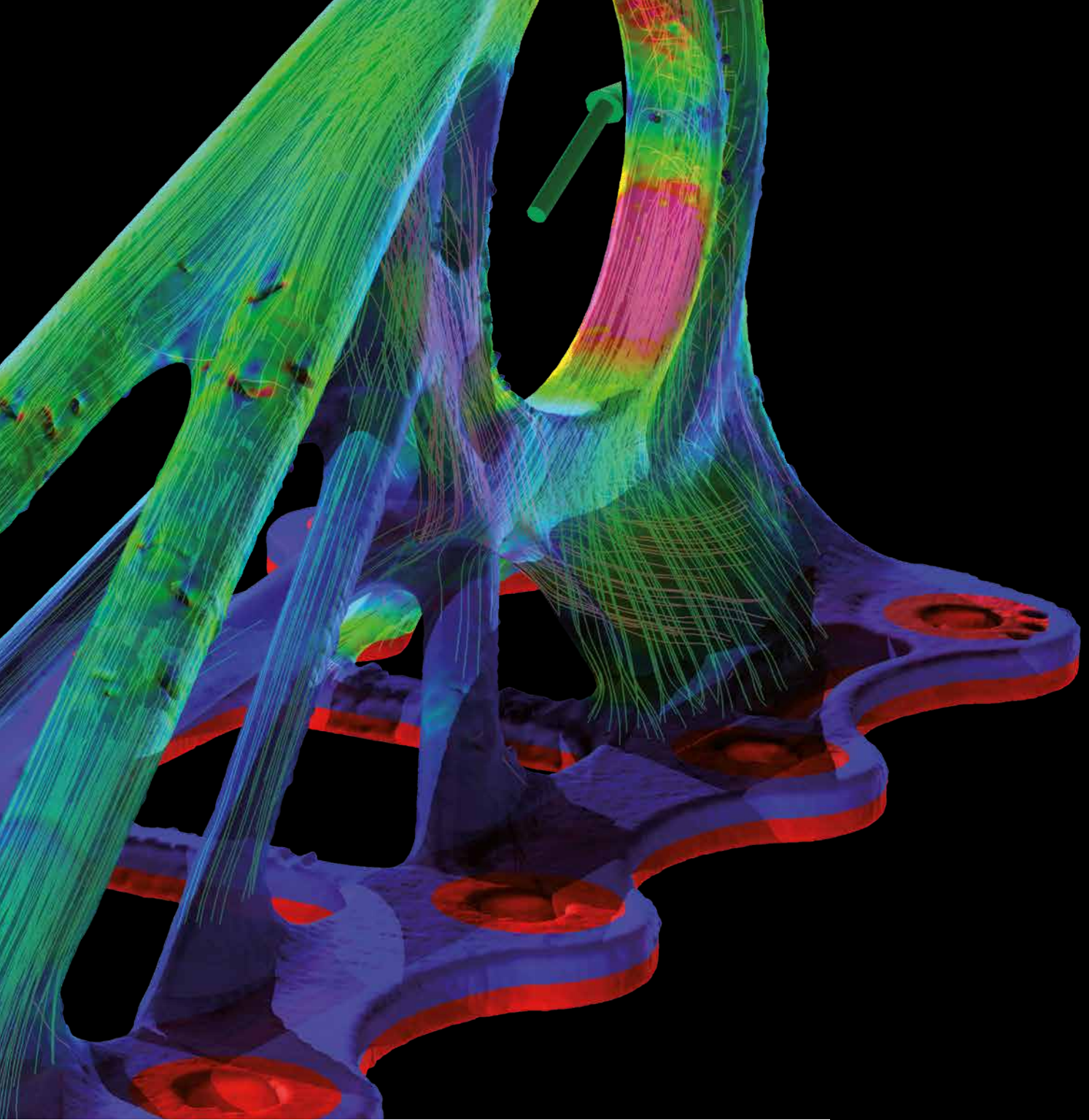
Visualize foam or foam-like structures and calculate properties.



Foam/Powder Analysis Module

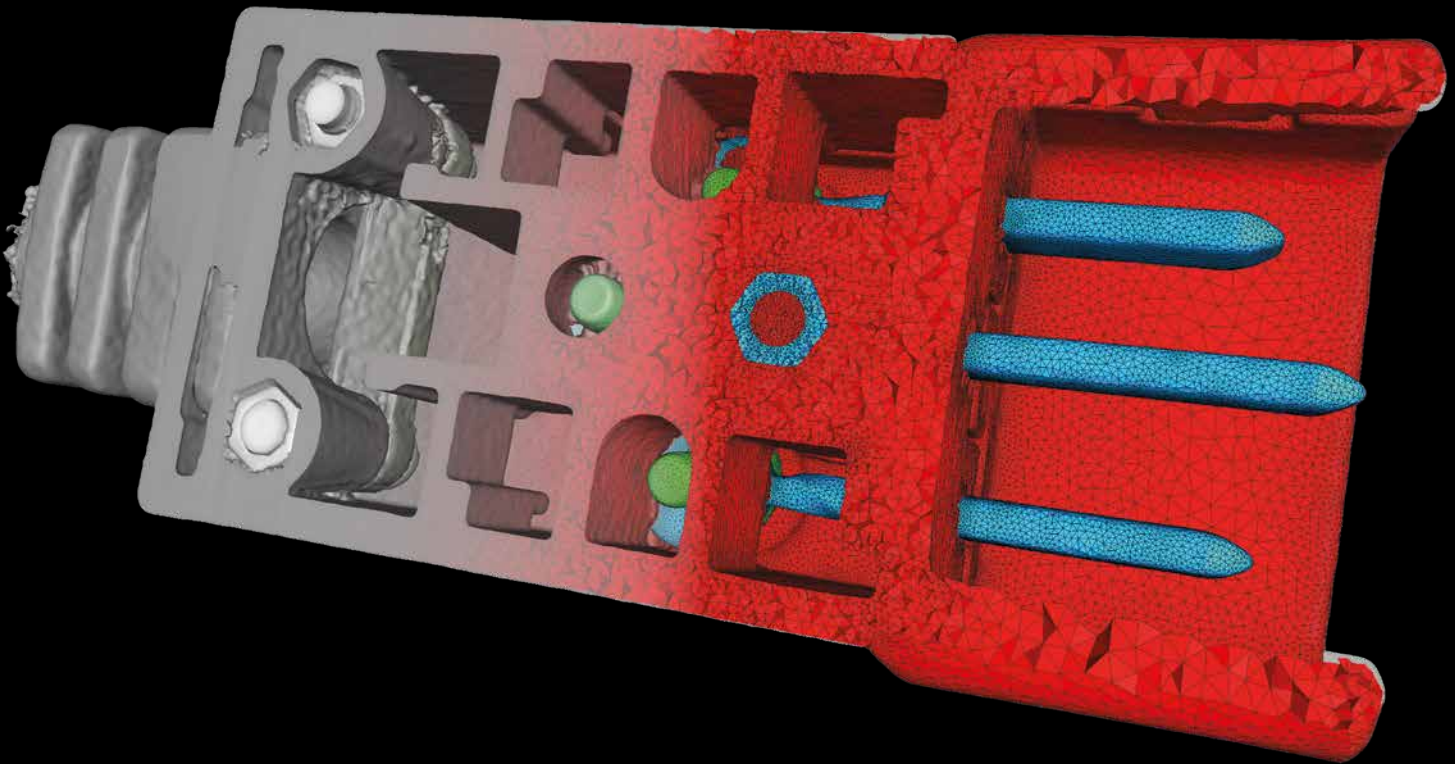
> Analyzes the structure of cells in porous media and of grains in powders.

- > For example:
 - Cell/grain volumes, surfaces and sphericities
 - Contact surfaces
 - Strut thicknesses/gap widths
 - Euler number
 - Average and total curvature
- > Shows your results color-coded, as a histogram, or as a table.
- > Allows you to use active columns to switch easily between different parameters.
- > Enables you to exclude border area to limit unwanted side effects.



Add-on Modules for Simulation

Simulate directly on CT data or prepare your CT data for export for simulation purposes: the add-on modules for simulation offered by Volume Graphics.



The Volume Meshing Module generates high-quality, solver-ready meshes



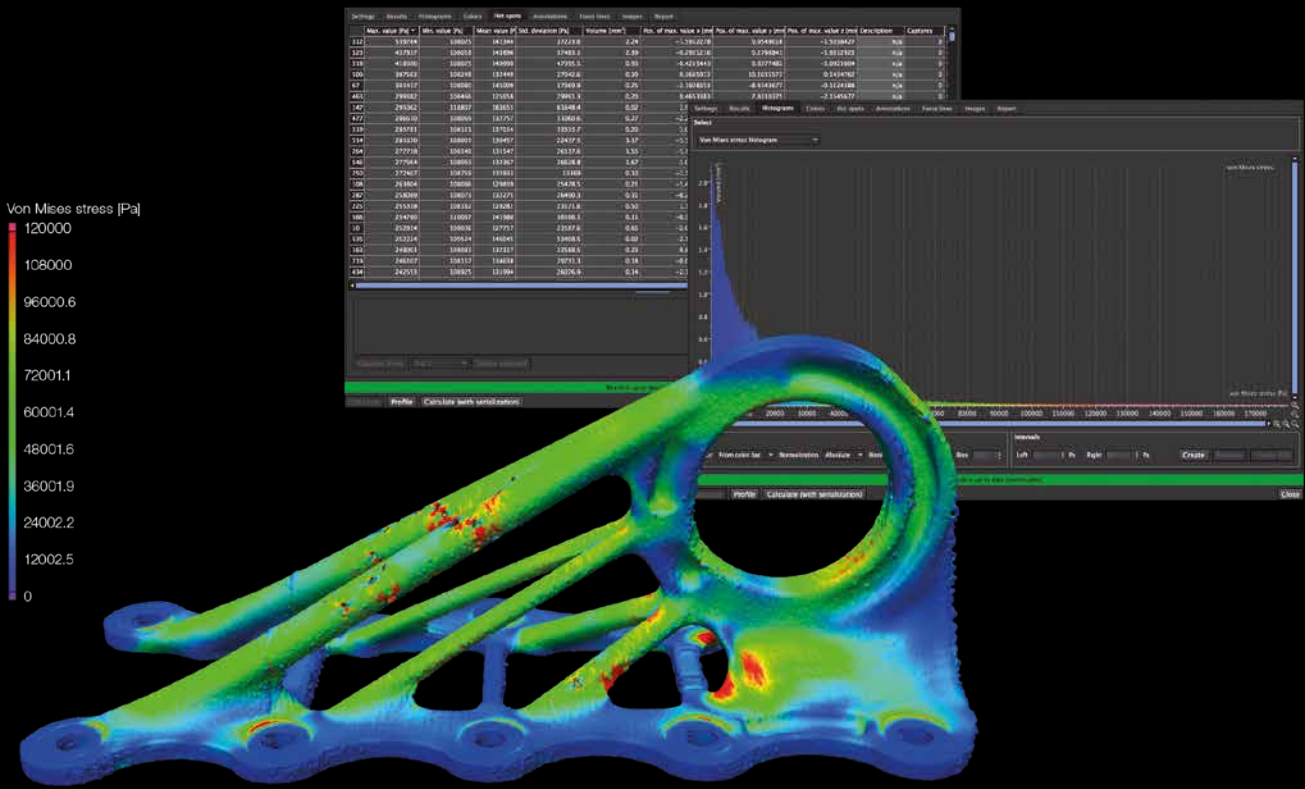
Volume Meshing Module

> **Creates accurate and high-quality tetrahedral volume meshes from your CT scans which can be used for mechanical, fluid, thermal, electrical, and other FEM simulations in third-party software**

- > Based directly on the subvoxel-accurate surface determination for single or multiple materials in your scanned components or material probes*
- > Creates a tetrahedral mesh for each selected material component, with congruent tetrahedron faces and shared nodes at material interfaces
- > No intermediate surface mesh—thus avoiding loss of geometry information
- > Flexible adaptation of the geometric accuracy of the volume meshes for each material
- > Option to create a finer mesh for a particular Region of Interest
- > Generates high-quality, solver-ready meshes
- > The mesh quality can be assured using statistics for tetrahedron count, shape parameters (aspect ratios, radius ratios, dihedral angles), and sizes
- > Export of the generated volume meshes in .pat (PATRAN®) or .inp (Abaqus) format
- > Each cell of the generated volume mesh can be loaded with additional information which may be required for simulation, such as fiber orientations, fiber volume fractions, porosity volume fractions**, or gray values
- > Complete workflow from CT scan to volume mesh in one software

* Requires the Coordinate Measurement Module

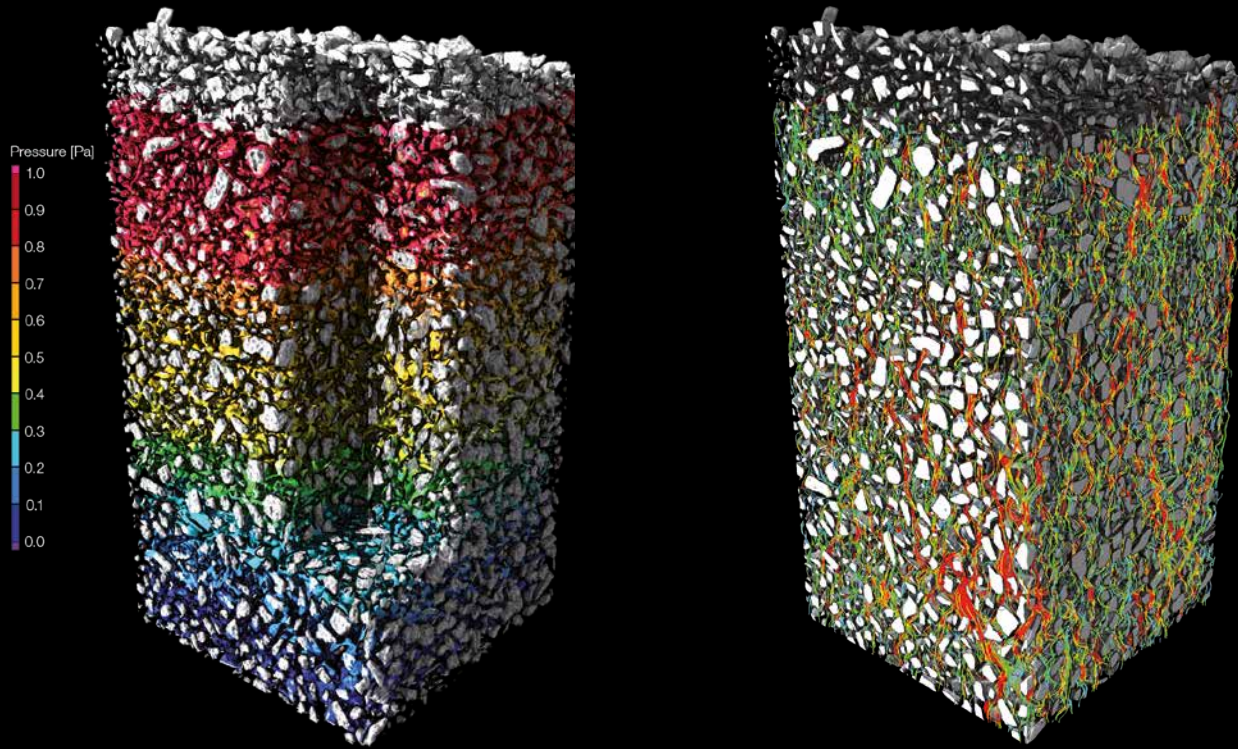
** Requires the respective modules



Color-coded display of the locations of the weak points directly on the scan of an additively manufactured cabin bracket

Structural Mechanics Simulation Module

- > **Performs virtual stress tests on your scanned part and helps you assess the impact of discontinuities on the part's stability.**
- > Identifies the most likely locations of failure with the automatic hot spot analysis.
- > Works directly on voxel data and eliminates meshing as a source of error.
- > Supports three types of static loads: directed force, torque, and pressure.
- > Calculates and visualizes force lines, local displacements, and failure-related variables such as von Mises stress or the maximum principal stress.
- > Simulates both the actual part with all its discontinuities and shape deviations as well as the CAD model, allowing comparisons between the two.
- > Is easy to use.
- > Works even on highly complex structures such as foams or other porous media.
- > Suitable for components or probes made from one or multiple linear-elastic materials.
- > Fast distributable computing on up to 16 network computers (requires Structural Mechanics Cluster Extension.)



Color-coded visualization of transport phenomena, left: pressure, right: streamline view



Transport Phenomena Simulation Module

- > **Performs microstructure level virtual flow and diffusion experiments directly on CT scans of porous and multi-component materials—no meshing required.**
- > Calculates homogenized material properties such as absolute permeability, tortuosity, formation factor, molecular diffusivity, electrical resistivity, thermal conductivity, or porosity.
- > Calculates tensor-valued material properties for anisotropic samples.
- > Allows you to stop and re-start the calculation to inspect intermediate results.
- > Enables you to use microstructure level simulation results in large-scale simulations by enriching imported mesh cells in various formats (e.g., NASTRAN®, PATRAN®) with homogenized material properties determined with VGSTUDIO MAX and to use these enriched mesh cells in third-party simulation software.
- > Uses one or more GPUs to speed up calculations thanks to OpenCL.

Capillary Pressure Module

Part of the Transport Phenomena Simulation Module

- > **Provides quantities that are used, e.g., in geosciences to characterize soil and rock samples.**
- > Computes the pore size distribution and the capillary pressure drainage curve for a scanned porous material.
- > Performs virtual MICP (mercury injection capillary pressure) experiments.

Licenses and Packages

Licensing Options

- > Five license models: node-locked, local floating, continental floating, global floating, or dongle license
- > Six languages: English, German, French, Japanese, Chinese, and Korean
- > Free evaluation license with full functionality: www.volumegraphics.com/evaluation
- > Optional update/service agreement for access to regular product updates and priority support
- > Individually combinable add-on modules for tailoring VGSTUDIO MAX to your needs

Packages and Bundles

- > Preconfigured for the most common tasks within various industries
- > Considerable savings in comparison to buying modules separately
- > Package: Includes a VGSTUDIO MAX license, a selection of add-on modules, and a one-year update/service agreement
- > Bundle: Consists of a selection of add-on modules and a one-year update/service agreement

Includes	Packages/Bundles	Geometry	Material	Cast & Mold
		For metrology and quality control in a variety of industries	For lightweight construction and materials research	For casting and injection molding, e.g., in the automotive and aerospace industry
Coordinate Measurement Module		✓	✓	✓
Nominal/Actual Comparison Module		✓		✓
Wall Thickness Analysis Module		✓		✓
Porosity/Inclusion Analysis Module			✓	✓
Extended Porosity/Inclusion Analysis Module				
Fiber Composite Material Analysis Module			✓	
Foam/Powder Analysis Module			✓	
Manufacturing Geometry Correction Module				
Volume Meshing Module				
Structural Mechanics Simulation Module				
Transport Phenomena Simulation Module				

System Requirements

VGSTUDIO MAX runs on modern, off-the-shelf PCs and is available for Windows, macOS, and Ubuntu Linux. Please visit our website to read about the latest system requirements: www.volumegraphics.com/requirements



Cast & Mold Extended	Composites & Plastic	Additive Manufacturing	Complete*
For aluminum casting, mainly for the automotive industry	For industries working with plastic injection molding and fiber composite materials	For the inspection of additively manufactured parts, including powders	For advanced users in quality assurance labs who face different analysis and measurement tasks as part of their daily work
✓	✓	✓	✓
✓	✓	✓	✓
✓	✓	✓	✓
✓	✓	✓	✓
✓			✓
	✓		✓
		✓	✓
			✓
			✓
			✓
			✓

* Does not include the add-on modules CT Reconstruction, CAD Import, CAD Import with PMI, Structural Mechanics Cluster Extension

Technical Consulting

Insightful Expertise You Can Rely On

Our more than 20 years of experience working in the area of industrial computed tomography and 3D imaging technologies have given our consultants insightful expertise you can rely on. Volume Graphics Technical Consulting can help you use CT hardware and Volume Graphics software to answer your specific questions in a way that's ideally tailored to your particular needs.

We evaluate the specific requirements for your applications, create the optimal Volume Graphics software configuration and general CT hardware specification, and even offer complete evaluations as a contract service.

Consulting for System Purchases

If you don't yet have a CT system, we work with you to evaluate whether your task can be solved with CT and, if so, how. We translate your needs into reliable technical specifications, taking feasibility, budget, material to be inspected, required resolution, location (close to production or laboratory), and other relevant requirements into account.

Consulting for Complex Tasks

For more complex questions, e.g., for the extension of existing systems or new purchases, we prepare a feasibility study and check how realistic the customer's idea is and how it can best be implemented using our software.

Services for Analysis and Visualization

Our consulting team analyzes your CT data according to your requirements. If it's necessary, we can refer you to a scanning service provider.

Services for VGinLINE

Especially in the automation of inspection procedures, we support you by providing the necessary technological know-how. Together, we provide the basis you need to best solve your inspection tasks with maximum efficiency.

If you're working with us on a larger automation project using VGinLINE, we can create the inspection plan according to your requirements. In cooperation with VG Academy, we can also train you in the everyday use of VGinLINE. And all of this in addition to guiding you throughout the process of purchasing your VGinLINE system.





VG Academy

Training Information

VG Academy has one goal: to enable you to better solve your inspection tasks with our products. As your partner for training courses and workshops for all Volume Graphics software products, we help you to work more confidently and efficiently with your VG software. Simply sign up for one of our various training courses!

Training Locations

- > VG Academy at Volume Graphics Headquarters in Heidelberg, Germany
- > VG Academy in Charlotte, NC, USA; Nagoya, Japan; and Beijing, China
- > On-site at your office

Training Options

- > Basic and Focus training courses for VGSTUDIO MAX
- > Introductory VGMETROLOGY training
- > VGMETROLOGY VIEWER training
- > Boot Camps and individual workshops
- > Train-the-Trainer (for VG partners)
- > ... and much more

How to Sign Up

If you wish to participate in a training course or if you have any further questions, please contact us via e-mail at academy-us@volumegraphics.com or by phone +1 704 248 7736 Ext. 110. The interactive training consultant on our website is also an excellent resource for finding a course that's right for you: www.volumegraphics.com/en/training-consultant



Volume Graphics GmbH has subsidiaries in the US, Japan, China, and Singapore. To broaden our global footprint even more, we can rely on a worldwide network of distributors.

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