# Analyzing, Testing, Measuring

with Volume Graphics Software for Industrial CT

Why CT?

The Most Advanced Technology for 3D Inspection

Whatever it is you're making, industrial computed tomography (CT) scanning—when combined with data analysis and visualization capabilities of Volume Graphics software—provides the final word on quality assurance and supply of competitive products to your customers. By accurately representing both outer surfaces and inner structures, CT offers the unique possibility of getting a full understanding of your products' quality, whether they be engine blocks or solder joints on printed circuit boards.

Because CT reconstruction produces a complete representation of a component in 3D based on a large number of 2D X-ray images, CT allows you to answer even the most complex questions on the external and internal structures of a component and its material properties. The process of CT scanning is fast, sensitive, reliable, non-contact, and non-destructive. You can apply it at any stage of production, from prototyping to even testing inline on the shop floor. The variety of potential applications for industrial CT data analysis is broad and growing.
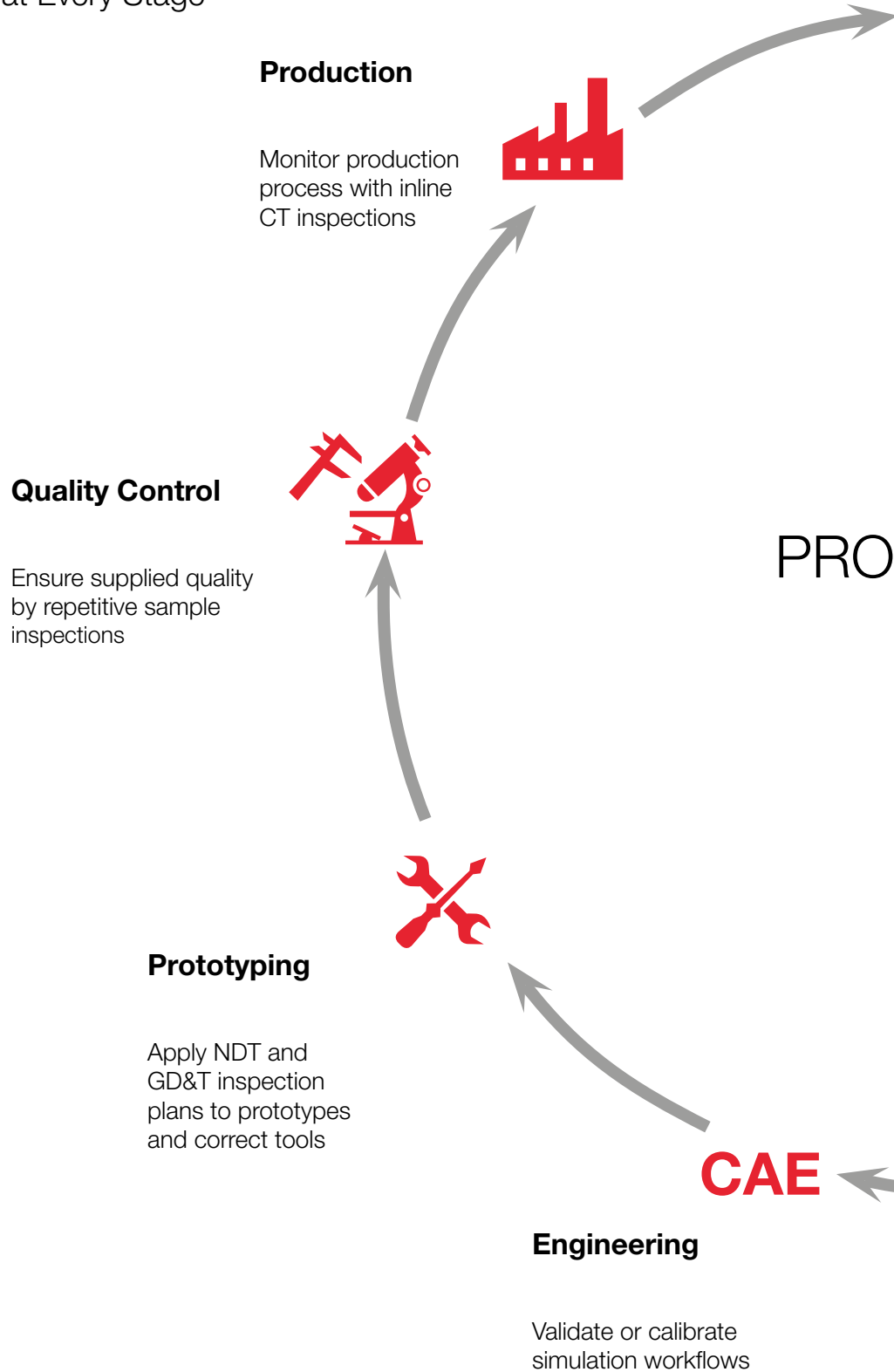
Pixel (2D)

Voxel (3D)
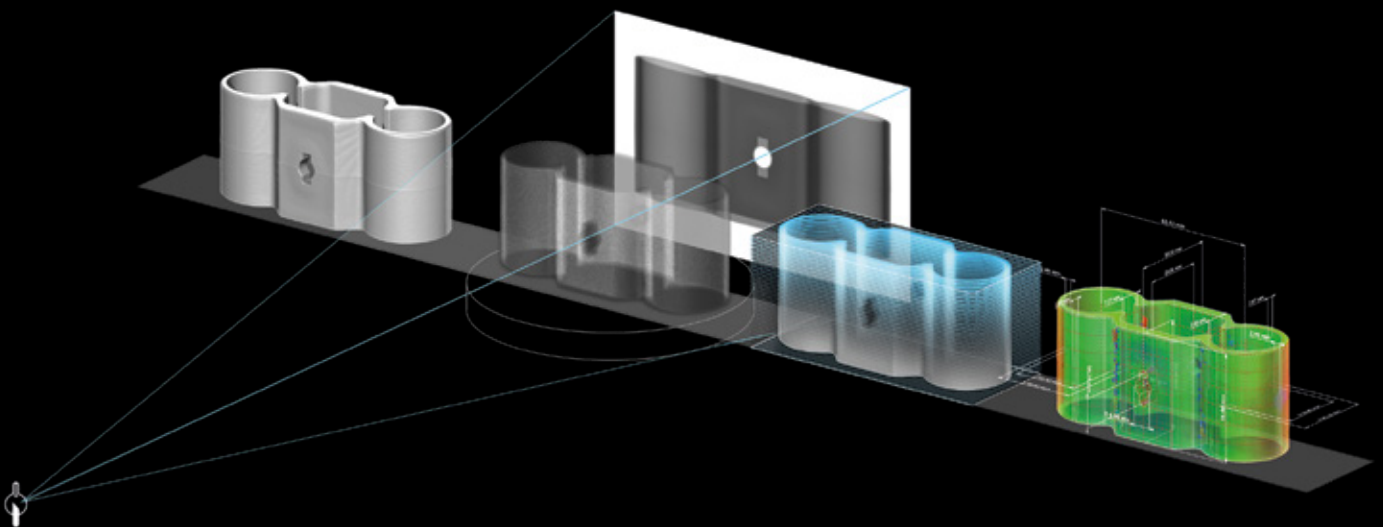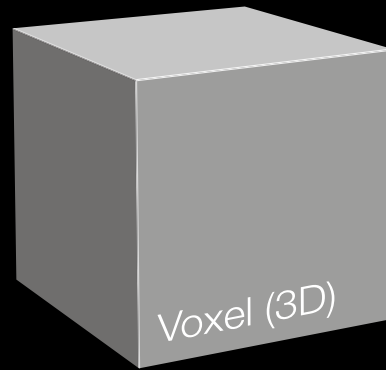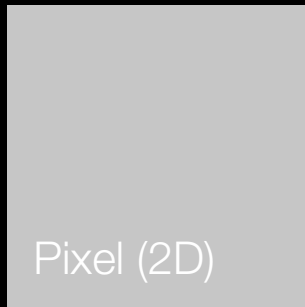
The voxel is key to the CT scan. When an X-ray beam's high-energy photons pass through their target, some are absorbed while others scatter, but the remaining strike the detector screen opposite the X-ray source. They then energize the (two-dimensional) pixels there in proportion to the density of the material being scanned as well as its thickness and attenuation values, generating a series of grayscale images. The software then reconstructs those millions of pixels into three-dimensional voxels, which make up a full three-dimensional visualization of the scanned object.

Yet to get measurements, find defects, create meshes, or perform simulations, advanced analysis and visualization software provided by Volume Graphics is needed.

With its fully integrated CT reconstruction function, Volume Graphics offers a seamless connection to the comprehensive analysis and measurement functions of its software. Moreover, the software works equally well with different CT systems from different manufacturers. Most major CT system providers sell Volume Graphics software together with their hardware. In addition, we rely on a worldwide network of distributors to serve our customers around the globe.

CT at All Stages of
a Product Life Cycle

For Comprehensive Insights at Every Stage

Production

Monitor production
process with inline
CT inspections

Quality Control

Ensure supplied quality
by repetitive sample
inspections

PRO

Prototyping

Apply NDT and
GD&T inspection
plans to prototypes
and correct tools

CAE

Engineering

Validate or calibrate
simulation workflows

Delivery

Ensure customer quality by checking pre-defined interface dimensions

Warranty & Reclaim

Analyze claims to determine root causes

Data Storage

Pack data for "lessons learned" in upcoming projects

DUCT LIFE CYCLE

Materials R&D

Characterize material microstructures

CAD

Design

Reverse engineer existing part geometries

A More Efficient Look Inside

Analyze Faster and Cost-Effectively with Volume Graphics Software

Like many of our customers, you too can save time and money by using industrial CT. This highly precise, non-destructive technology looks inside your products and finds defects that would otherwise remain hidden when using other inspection methods. However, industrial CT can only reveal its full potential when combined with the right software. Volume Graphics software is your key to unlocking this potential. Customers use our software on objects small and large, simple and complex. It works on parts made of metal, plastic, and composite materials—or all of them together.

Performing analysis tasks directly on voxel data not only opens up possibilities that go way beyond conventional destructive or other non-destructive methods—it also has efficiency benefits.*
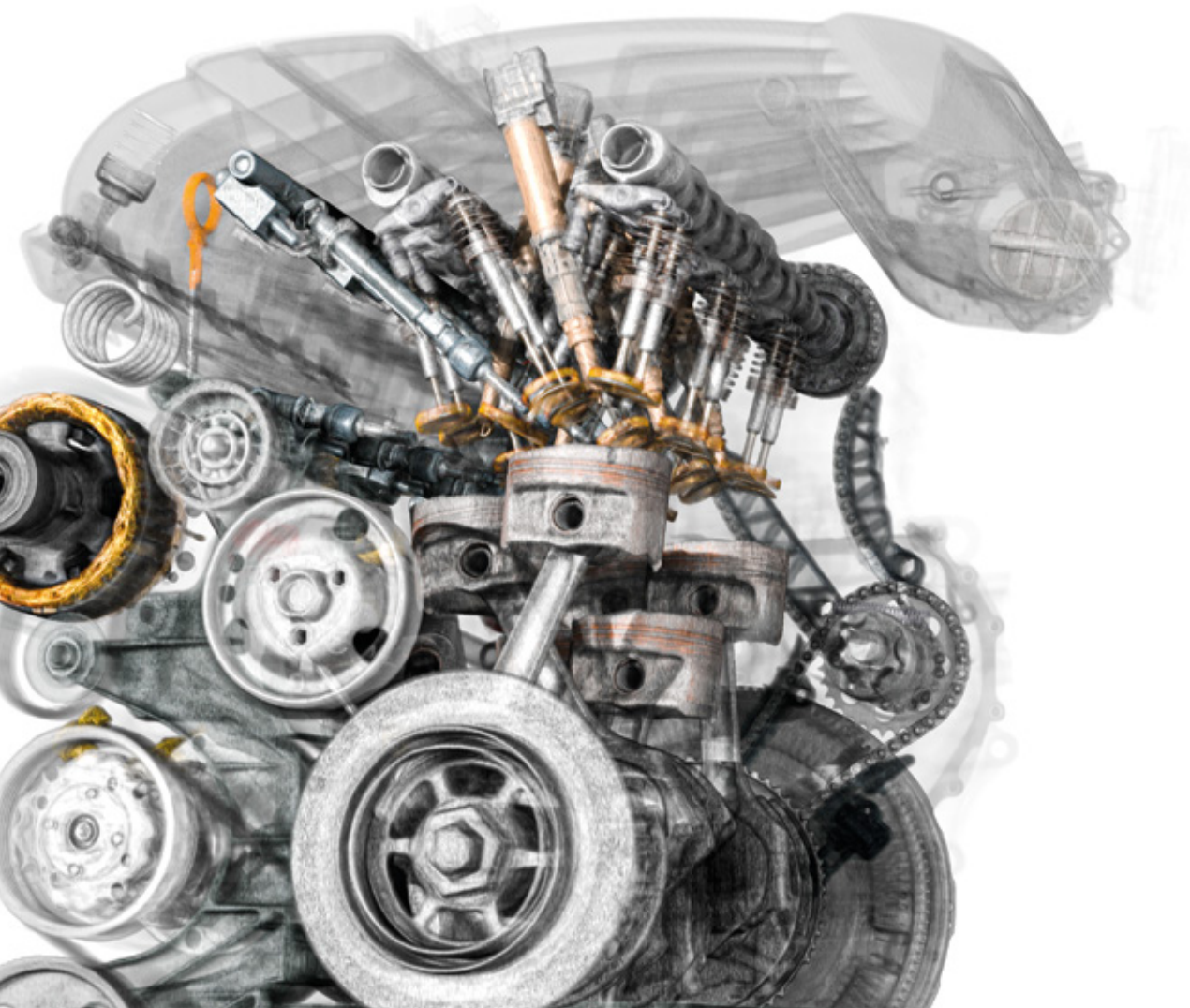
*The examples in this brochure are not meant to be representative. Actual efficiency gains are highly individual and vary from case to case.

Inspection Costs Reduced by 50 %

An automotive supplier uses industrial CT in combination with VGSTUDIO MAX to measure its connectors and their 1,200 measurement features

An Austrian automotive supplier reduced costs by around 50 % after introducing industrial computed tomography (CT) as a measurement tool. Measurements using conventional optical and tactile inspection methods took 450 man-hours for the initial acceptance alone and destroyed the part in the process. Industrial CT provides insight into virtually all features of the part without destroying it—and at lower costs. With the help of CT data and the macro and batch functionality of VGSTUDIO MAX, the same process only took 100 man-hours with only 80 more man-hours needed for final acceptance.
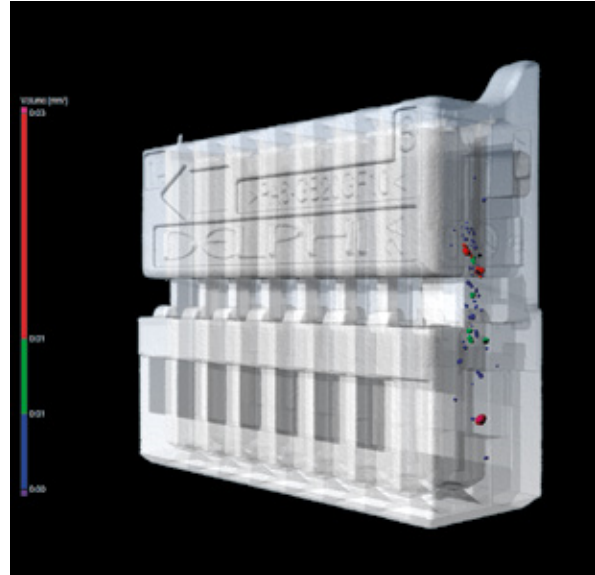
Inspection Time Decreased by 84 %

An automotive supplier uses industrial CT and Volume Graphics software to inspect several hundred individual features on the connector

The automotive supplier went from slice sectioning to using industrial CT-based metrology to inspect its plastic connectors—and thereby reduced the time needed for first article inspection from 75 to 12 man-hours while simultaneously improving measuring accuracy. This increase in speed was achieved in part by using the highly efficient measuring template functions of Volume Graphics software to inspect several hundred individual features of each connector.
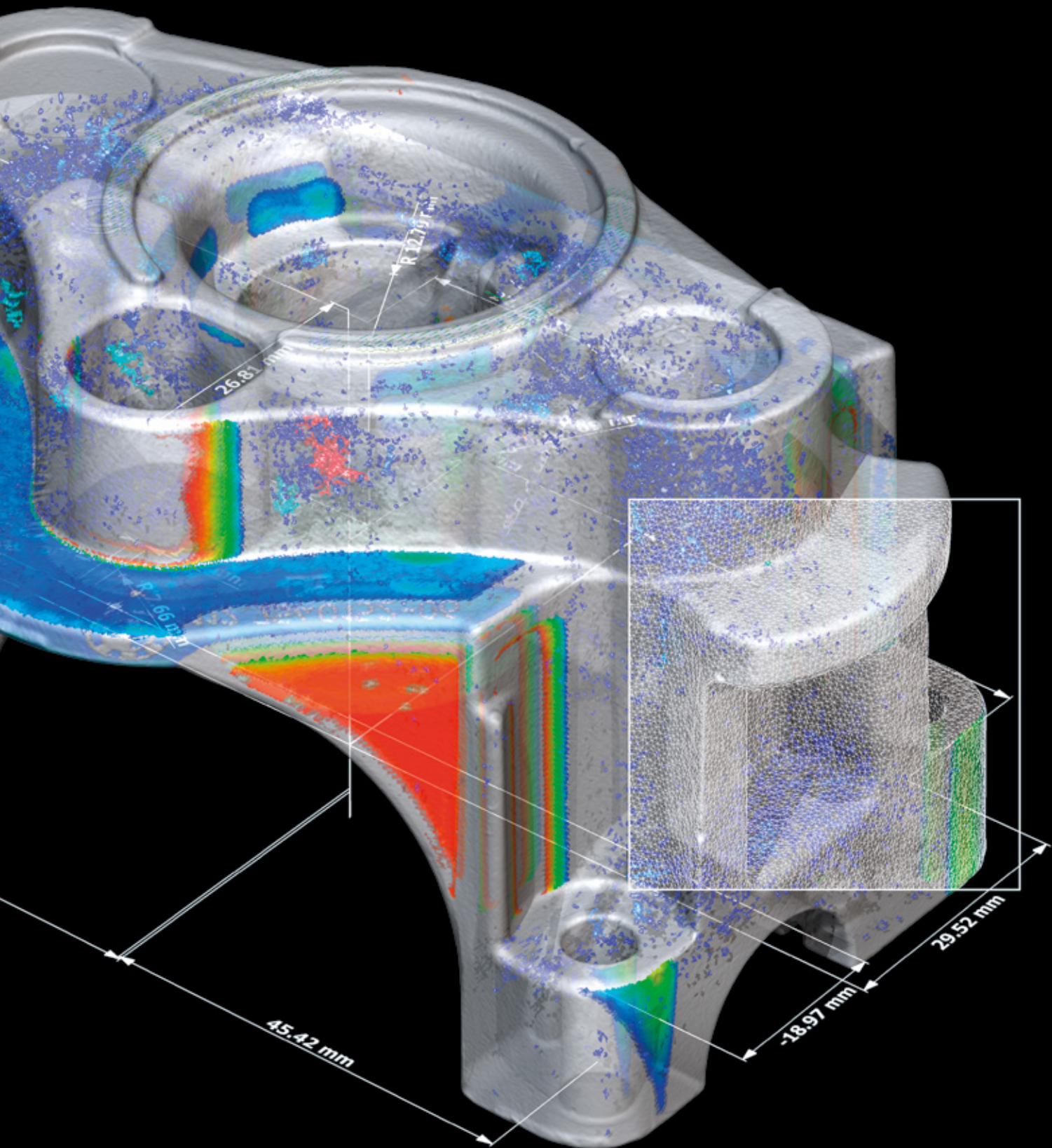
Volume Graphics

Software for Industrial CT

Overview

From design to serial production, Volume Graphics software 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.

With the Volume Graphics product family, composed of VGSTUDIO MAX, VGSTUDIO, VGMETROLOGY, VGinLINE, and myVGL, you can perform all kinds of analyses and visualizations directly on data using industrial CT.

Volume Graphics customers 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. It's time you join them.

Volume Graphics

A Leader in Comprehensive Quality Assurance since 1997

By choosing Volume Graphics software, you can rely on more than 20 years of experience in software development for non-destructive testing based on industrial CT. Today, a broad range of global customers across a wide range of industries (e.g., automotive, aerospace, and electronics) 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," "it's 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.*

FROST & SULLIVAN

2018

BEST PRACTICES AWARD

GLOBAL INDUSTRIAL COMPUTED TOMOGRAPHY SOFTWARE MARKET LEADERSHIP AWARD

Since 2020, Volume Graphics has been part of Hexagon. Hexagon is a global leader in sensors, software and autonomous solutions. Learn more about Hexagon (Nasdaq Stockholm: HEXA B) at hexagon.com and follow us @HexagonAB.

Benefits of Volume Graphics Software

A Future-Proof Investment That Provides Efficient Workflows to Tackle Your Challenges

Your products' quality faces numerous and challenging demands. Volume Graphics software provides 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, Volume Graphics software covers all your requirements related to metrology, defect detection and assessment, material properties, and simulations in a single software.

All its analysis, simulation, and visualization tools fit perfectly into your digital workflow.

Future-Proof

> **Leading developer** of CT analysis and visualization software

> **Comprehensive scope** of functionalities for all current and future tasks of CT data analysis

> **Stepwise functional extensions** based on a modular product concept

> **CT hardware-independent**, working equally well with different CT systems from different manufacturers

> **Strong hardware partner and distributor ecosystem** for worldwide availability of Volume Graphics software

Efficient

> **Wide range** of analyses for all sorts of tasks

> **Easy automation** of repetitive tasks incl. easy replication of analyses across periodic object structures

> **Fast handling** of huge data sets & analyses

> **Seamless digital workflow** from design and correction to inspection and production:
>   – Use one software for all analyses, including manufacturing geometry correction
>   – Transfer inspection plans from the lab to production lines
>   – Share data and results without format conversions

Solutions

> **Instructive and insightful results** based on analyses that contain all the inforequired to make decisions

> **Validated accuracy** of the results (surface determination, material analyses, etc.)

> **Competent support** pre- and after-sales with short response times

> **Worldwide training courses** at VG Academy to get you up to speed on using Volume Graphics software
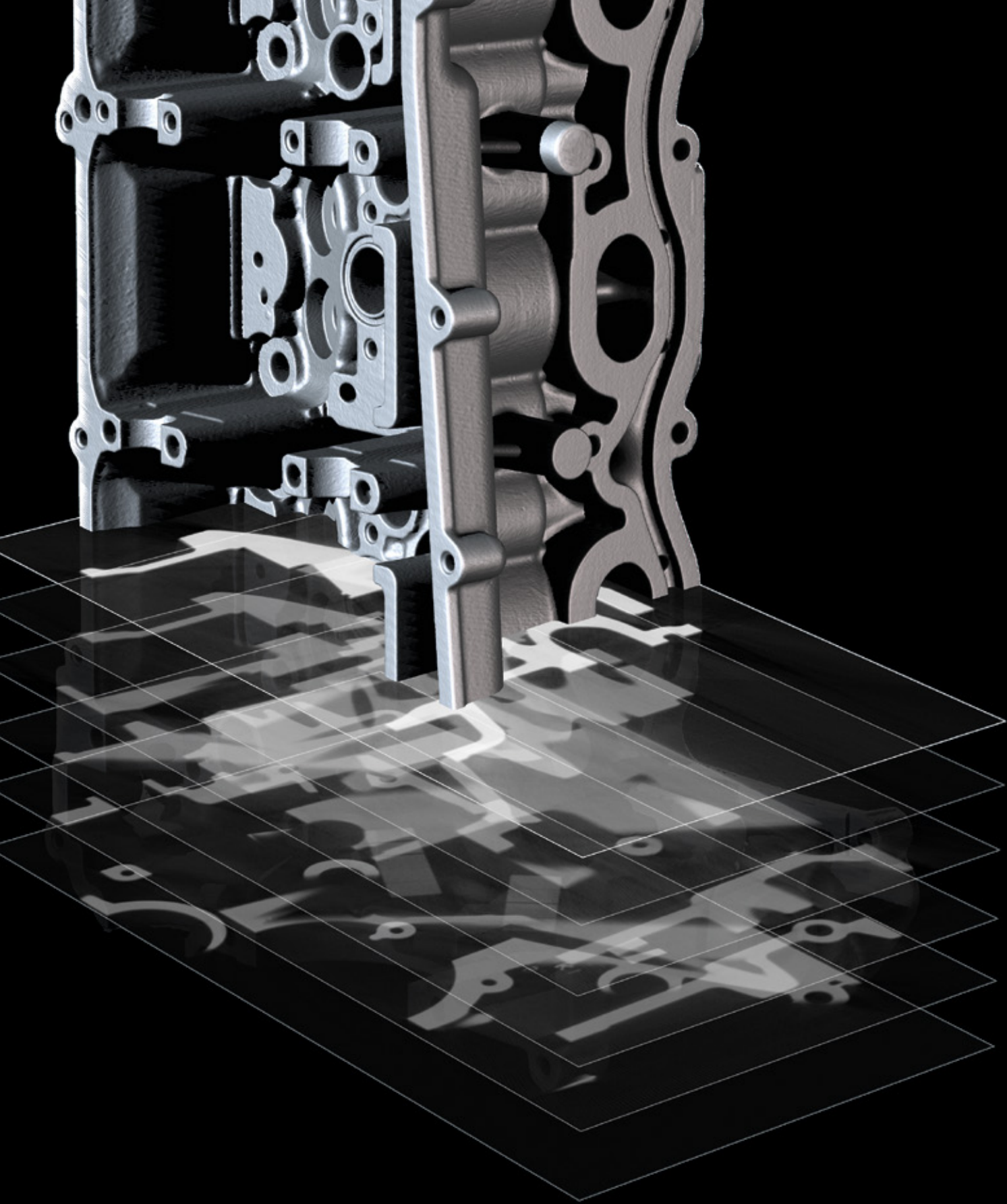
CT Reconstruction & Data Quality Analysis
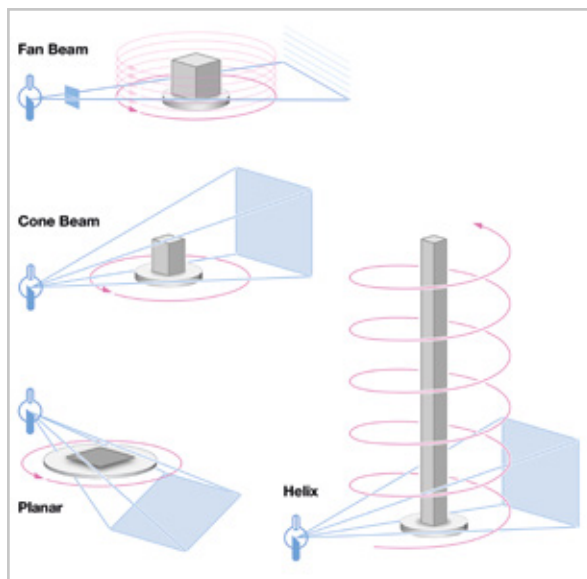
with Volume Graphics Software

Overview

The right algorithms for your scanner so you get the most out of your scans.

State-of-the-art CT-reconstruction algorithms and artifact reduction techniques to get the most out of your X-ray data.

Monitor the health of your measuring device through standard-conforming data quality analyses.

# CT Reconstruction & Data Quality Analysis Features

01 / Support of Various CT System Geometries

Calculate 3D volume data sets quickly and precisely from the images taken by a CT scanner. Volume Graphics software offers reconstruction algorithms for cone beam, fan beam, parallel beam, planar (tilt cone beam CT, tilt and warp cone beam CT, advanced CT), and helical (spiral) CT scan geometries.
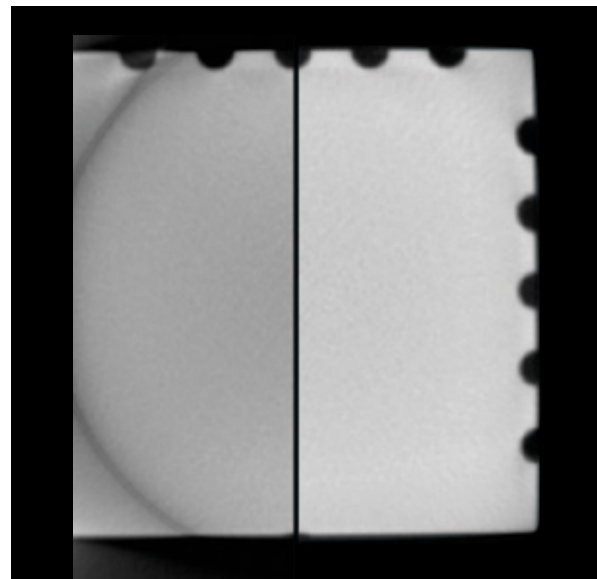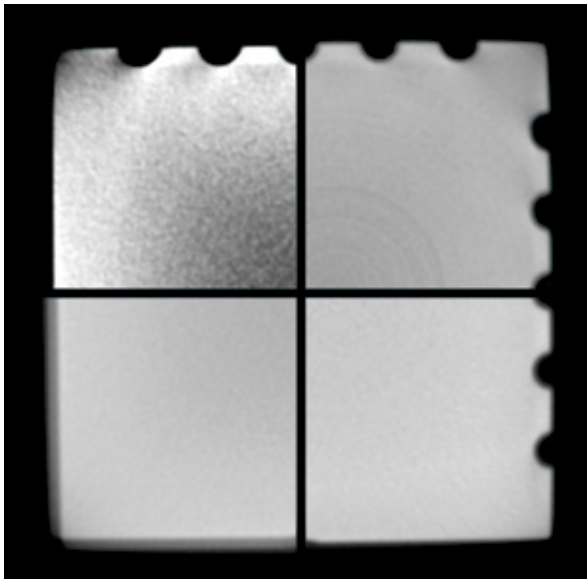
02 / Field-of-Measurement Extension/ Measuring Circuit Extension

Think even bigger. With the measuring circuit extensions, which allow you to shift either the detector or the object, you can also reconstruct large parts.
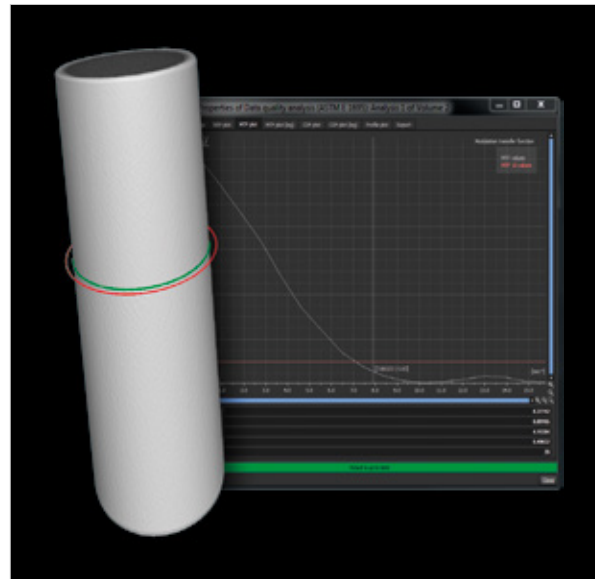
03

04

03 / Artifact Corrections

Improves image quality using sophisticated correc-
tions for beam hardening, noise and speckle, ring
artifacts, misalignment, and angular drift.

04 / Data Quality Analysis

Monitor the data quality of your CT scans over time
by keeping track of the spatial resolution and gray
value contrast resolution. This ensures a consistently
high-quality basis for your analysis and measure-
ment results. Volume Graphics software supports
data quality analysis according to ASTM E 1441 and
ASTM E 1695.

Benefits

> Independent of and compatible with all your CT hardware. Versatile 3D visualization of very large, multiple voxel,
  point cloud, mesh, and CAD data sets in one scene.

> Existing CT hardware can be upgraded with software-based artifact corrections and field-of-view extension

> Monitoring of CT scan quality to ensure accurate inspection results
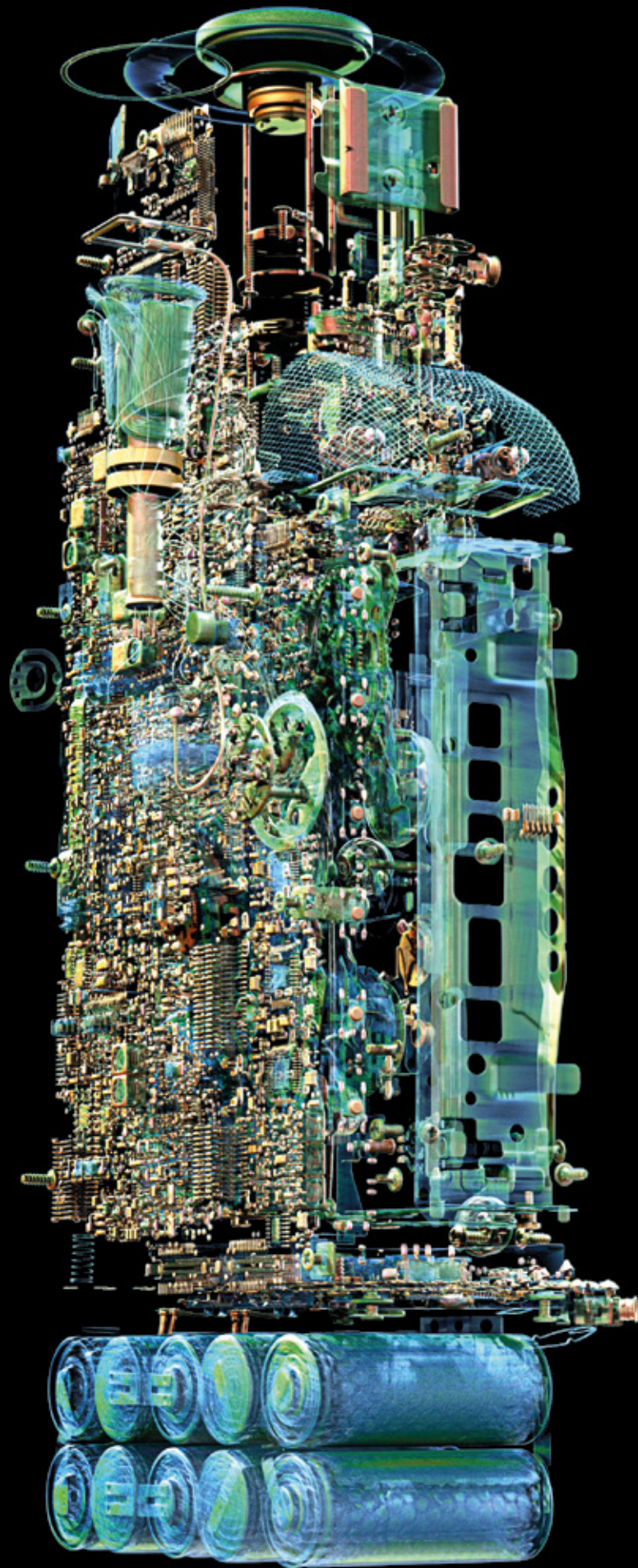
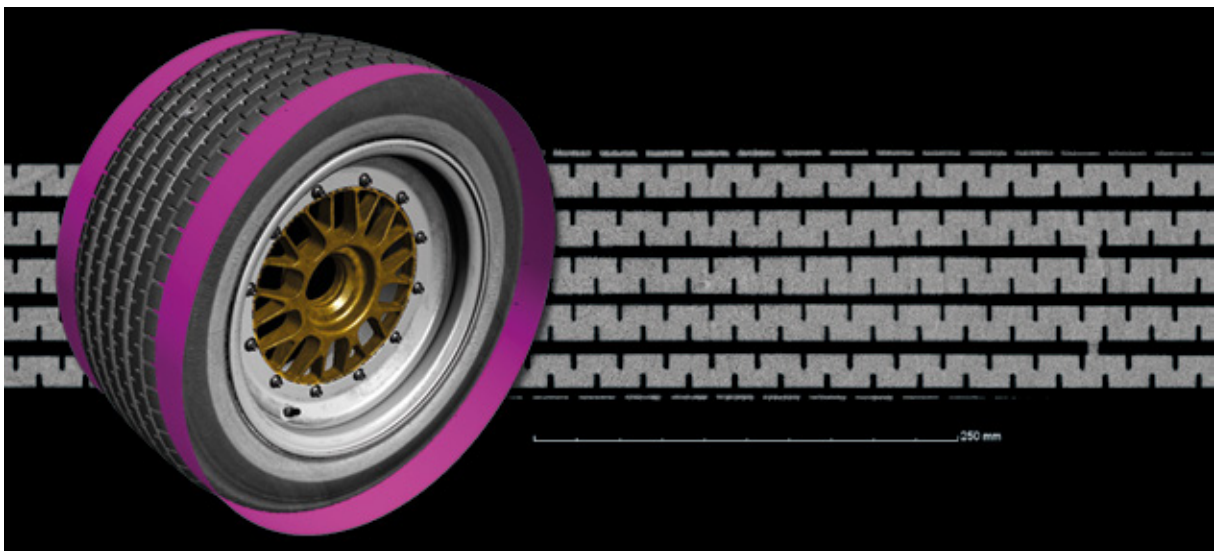# Visualization & Animation
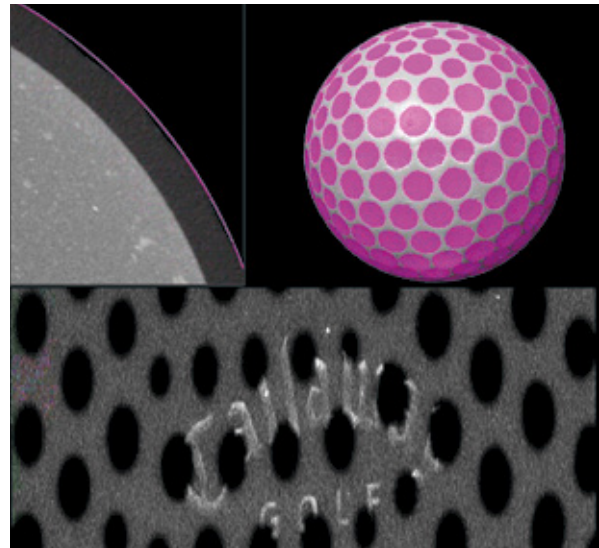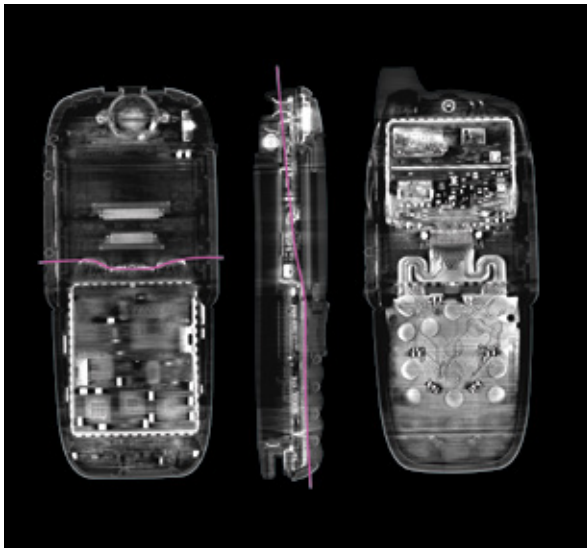
with Volume Graphics Software

Overview

Transform your data sets into stunning visualizations and animations—only your RAM is your limit.

Volume Graphics software lets you shine when presenting your findings to peers, decision makers, and the public. Impress in 3D and 2D, with exploded views and animations.

Visualization & Animation Features

01

01 / 2D Visualization

Display aspects of your CT scan in informative 2D visualizations. Volume Graphics software allows you to view 2D slices in arbitrary orientations and to rotate them around a customizable axis. Create 2D views of combined consecutive slices, unrolled objects, or leveled freeform surfaces.
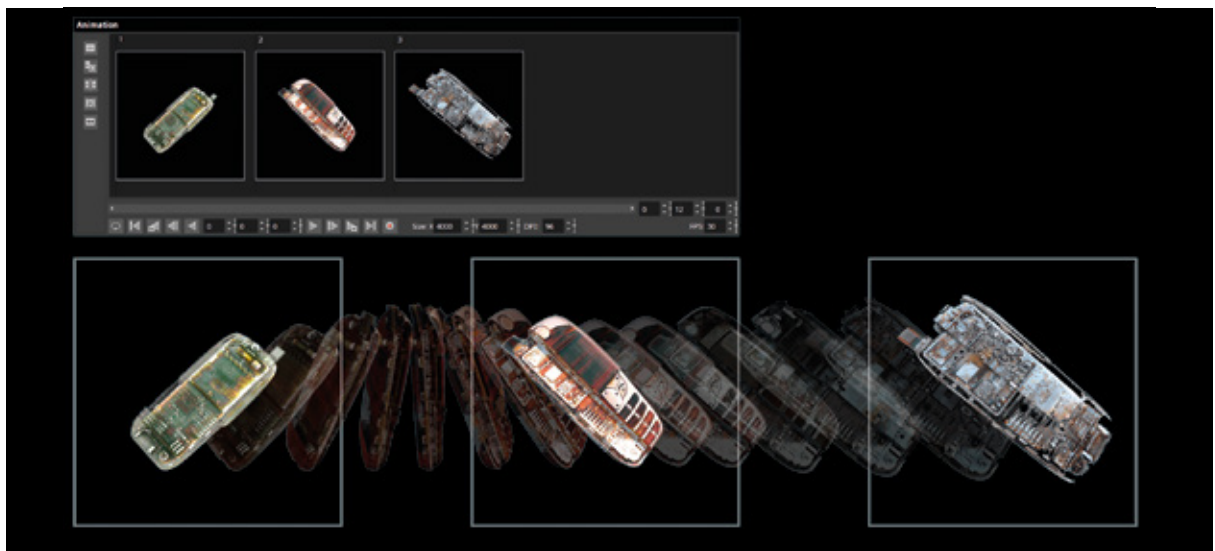
Visualization & Animation Features

02

03

02 / 3D Visualization

Render any number of data sets from different sources such as CT, optical scanners, or CAD models in one scene. Only your workstation's memory is the limit. Volume Graphics software supports voxel, point cloud, mesh (including textured meshes), and CAD data.

Photo-realistic illumination is applied to all objects, both volume and mesh data. Flexibly choose material appearance, light sources, and transparency as well as a range of clipping features for a glimpse into the object.

Show connected components in an exploded view. With the Object Exploder, this kind of industry-standard presentation is just a few clicks away.

03 / Animations

Create impressive animations of your volume data quickly and easily with Simple Keyframer, just by defining a few keyframes and letting the software do the rest—like camera movement and parameter blending in between. Or use Classic Keyframer to have full control over camera trajectories and timing.

To help viewers find orientation in your animation, indicate the exact position of the respective 2D slice in the 3D view—side-by-side or picture-in-picture.

Benefits

> Versatile 3D visualization of multiple even very large voxel, point cloud, mesh, and CAD data sets in one scene

> Insightful views into visualized objects through exploded views, unrolled objects, transparency settings, and a range of clipping features

> Stunning photo-realistic renderings enabled by real-time ray tracing, material appearance settings, and support of textured meshes

Dimensional Metrology & Reverse Engineering

with Volume Graphics Software

Overview

Volume Graphics software turns your computed tomography (CT) scanner into a coordinate measuring machine. It delivers ISO 5459 and ISO 1101 conforming metrology results on voxel, mesh, point cloud, and CAD data. The algorithms used to fit geometry elements to the extracted surfaces have been verified by the German National Metrology Institute PTB and the National Institute of Standards and Technology (NIST) of the United States Department of Commerce.
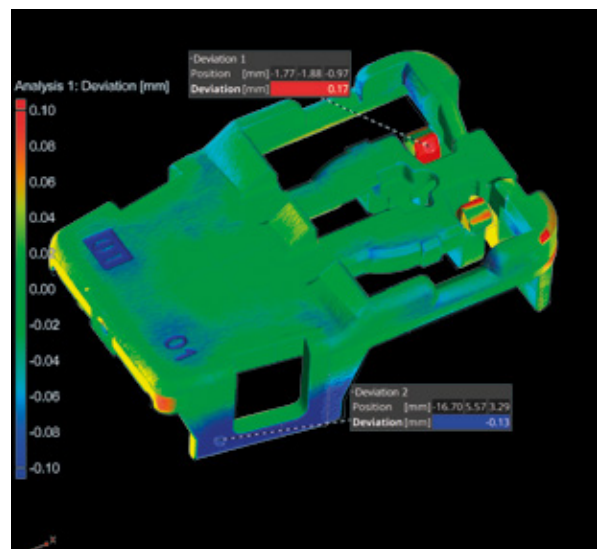
Dimensional Metrology Features

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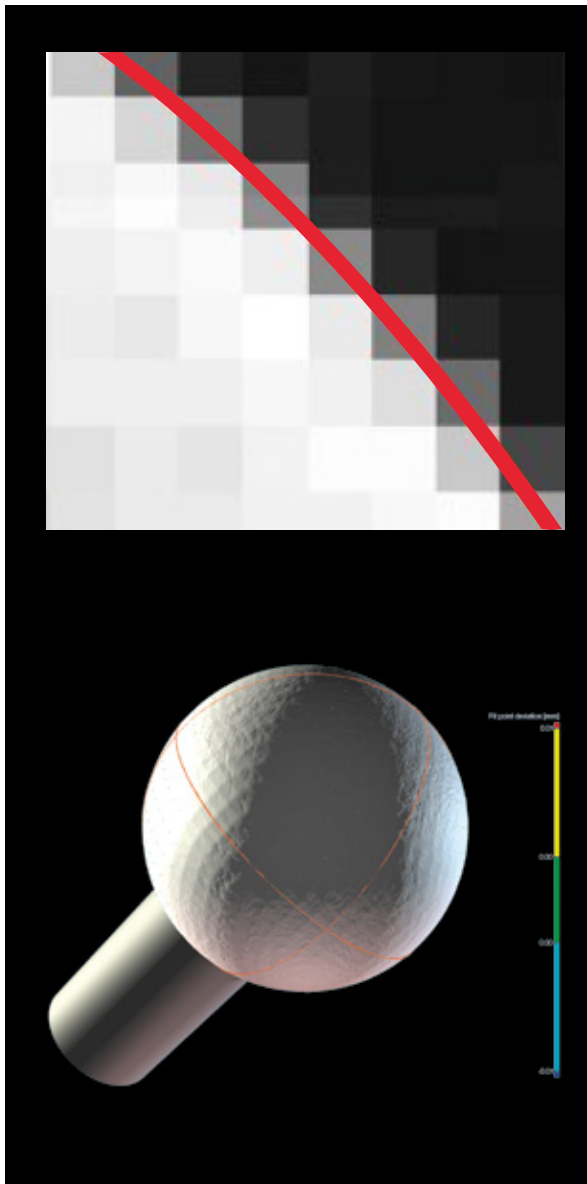
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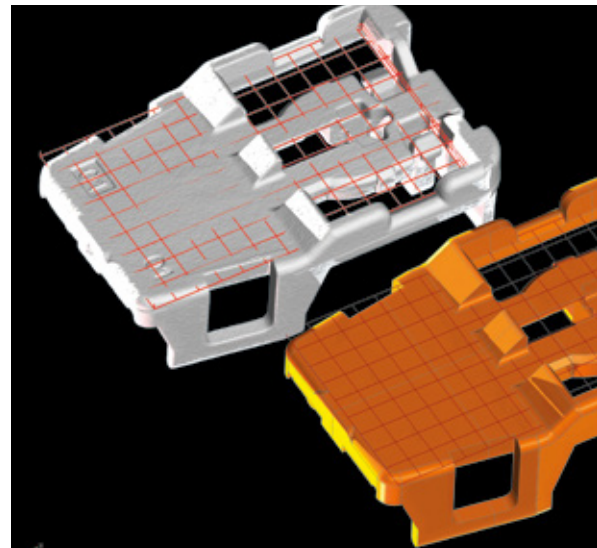
03

01 / Surface Determination

The Volume Graphics subvoxel-accurate, locally adaptive surface determination ensures minimum measurement uncertainty. Contrary to a generic iso 50 surface determination based on a global gray value threshold, it considers the local gray value profiles around the surface, which makes it robust against common artifacts in the gray values. The locally adaptive surface determination works for both single-material and multi-material CT scans.

02 / Alignments

Volume Graphics software supports various alignment techniques such as 3-2-1, RPS, and best fit, which allow you to solve even the most complex alignment tasks based on geometry elements, points, and regions—also in combination.
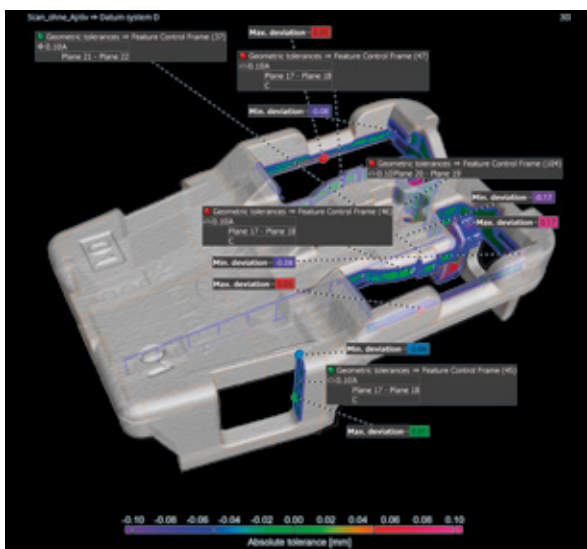
03 / Nominal/Actual Comparison

Compare your scanned object with its corresponding CAD data set. The nominal/actual comparison gives you color-coded results of deviations and local annotations.
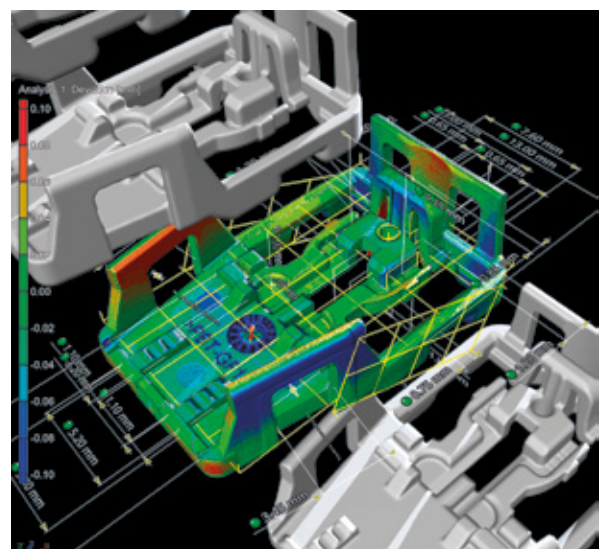
Dimensional Metrology Features

04
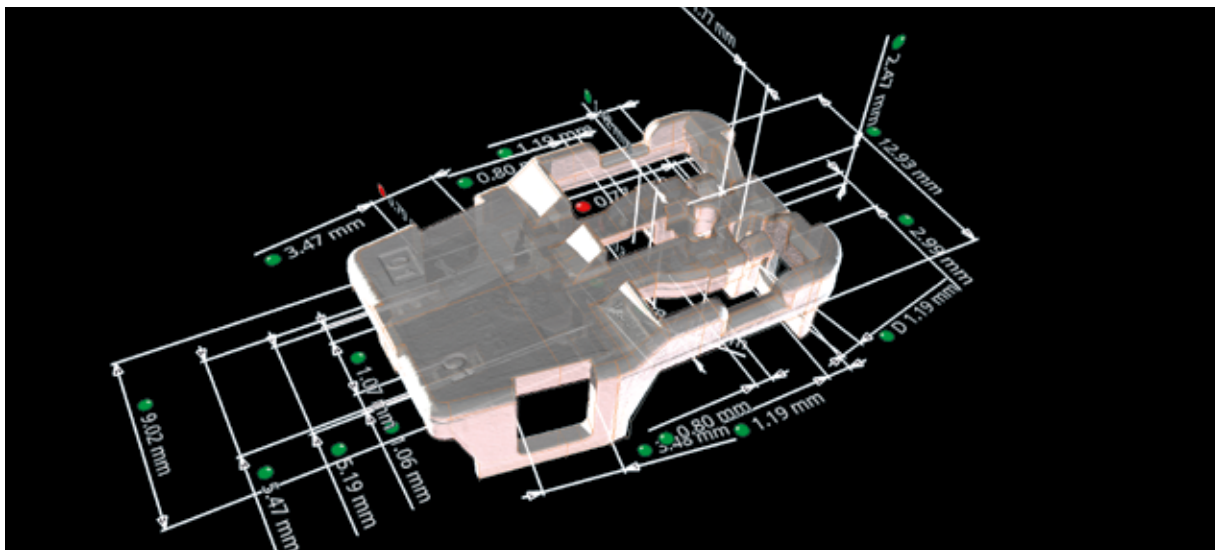
05

06

04 / Dimensional Measurements

In Volume Graphics software, you can measure 2D and 3D dimensions either with standardized tolerance tables to automatically set tolerances or individual tolerance tables to set name, dimension, and tolerance automatically by balloon number.

05 / GD&T

Volume Graphics supports all 17 GD&T callouts, such as line and surface profile as well as position with maximum material requirement (MMR). Local coordinate and datum systems enable you to perform sophisticated geometry analyses and simultaneous visualizations of multiple GD&T callouts.

06 / PMI Import and Automation

Volume Graphics software is compatible with all neutral CAD data types and most vendor-specific formats, including Product and Manufacturing Information (PMI), that provides additional part information, e.g., dimensioning, GD&T, layers, annotations, and captions. Processes can be automated using macros, batch processing, and templates.

Dimensional Metrology Features

07
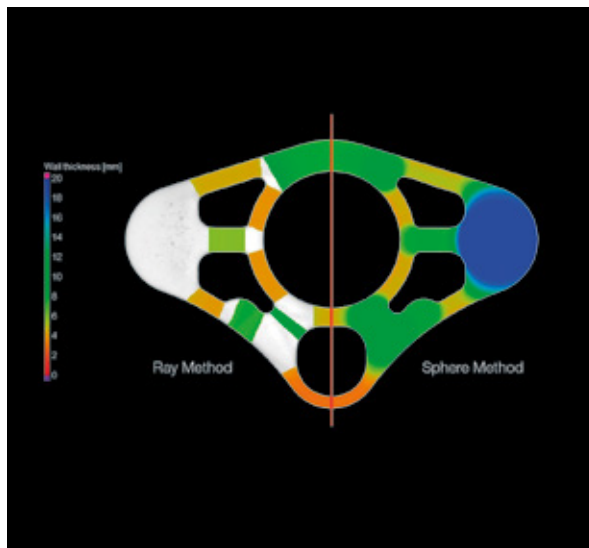
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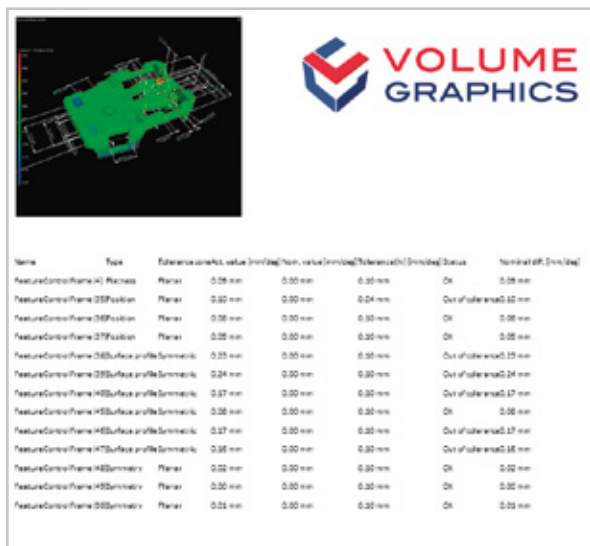
07 / Wall Thickness

Perform volumetric analyses of a part's thickness quickly and automatically—either using the ray method for parts with simple shapes or the sphere method for more organic shapes, including complex 3D-printed parts. Color-coded results help you localize areas with an insufficient or excessive wall thickness or a gap width within the voxel, point cloud, mesh, or CAD data set.

08 / Reporting

Get fully customizable reports including histograms, data tables, and insightful graphics. Reporting via Excel, PDF, and Q-DAS enable integration in downstream processes. Free viewer applications allow you to share information.

Benefits

Accurate

> Unique locally adaptive and subvoxel-accurate surface determination

> Surface representation directly on the CT data—no loss of accuracy and trace-ability from converting to a surface mesh

Efficient

> Import PMI measurement plans directly from CAD models

> Automate the replication of measurement plans across periodic structures

> Automate the implementation of measurement plans and reporting both in the lab and in production

> Use a compact file format for worldwide data sharing

Universal

> Hardware independent—can be combined with almost any CT or optical scanner

> Leading software for all industrial CT analyses, including metrology, defect analyses, and material structure analyses

Reverse Engineering Features

01
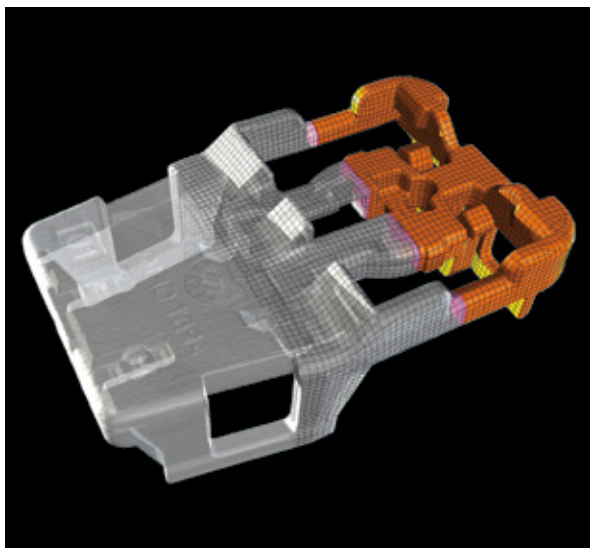
02

03

01 / Reverse Engineering

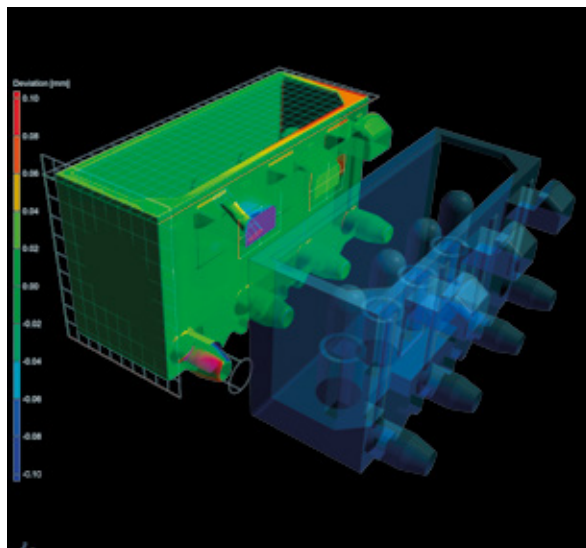Convert CT scans into CAD models you can use in your CAD systems with the reverse engineering functions in Volume Graphics software. The software generates an autosurface on a scan, i.e., a pattern of 4-sided patches that follow the edges and main features of the model, which can be exported as a STEP file to any CAD system.

02 / Manufacturing Geometry Correction

Optimize your tools or 3D printing geometries with the functions for manufacturing geometry correction. The software uses scans of your sample part to calculate suggestions for necessary changes to tools and molds to minimize iterations.

03 / 3D Printing Mesh Compensation

Create a surface mesh that compensates the difference between the actual object and the reference object—directly from the CT scan using mesh compensation. The software compensates the mesh sent to a 3D printer to eliminate deviations in the actual geometry caused by distortions, such as warpage. Choose arbitrary, defined, or gridded anchor points for the compensation. Use ROIs to define areas of interest and scale the deformation to your needs.

Benefits

> Accurate representation of scans and compensated tool geometries

> No need to learn a CAD system

> Works on point clouds, meshes, and CT scans
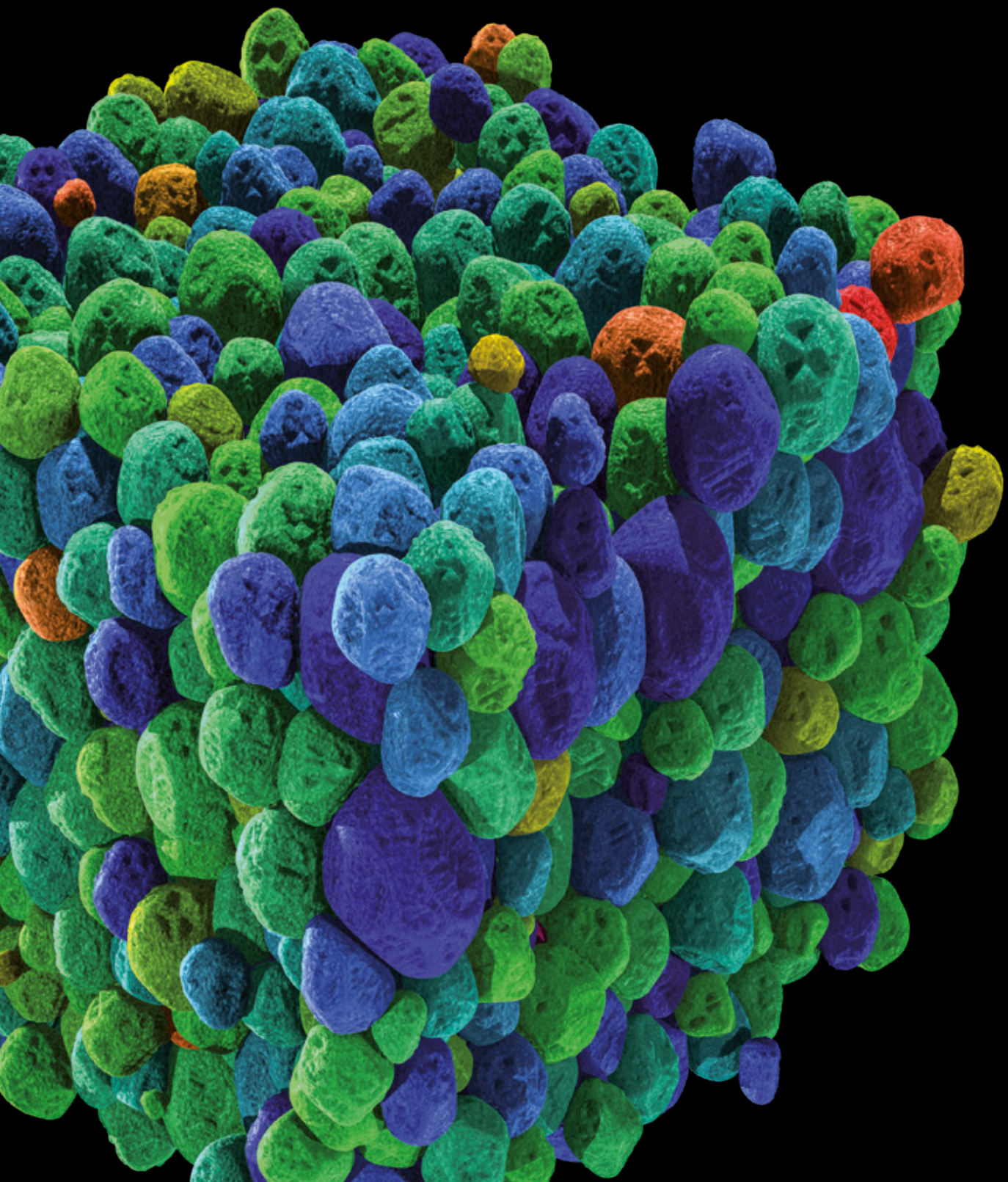
Material Analysis

with Volume Graphics Software

Overview

Reveal what's below the surface of your scanned parts. With Volume Graphics software, you can comprehensively investigate and quantify the material properties of your parts using non-destructive testing (NDT).
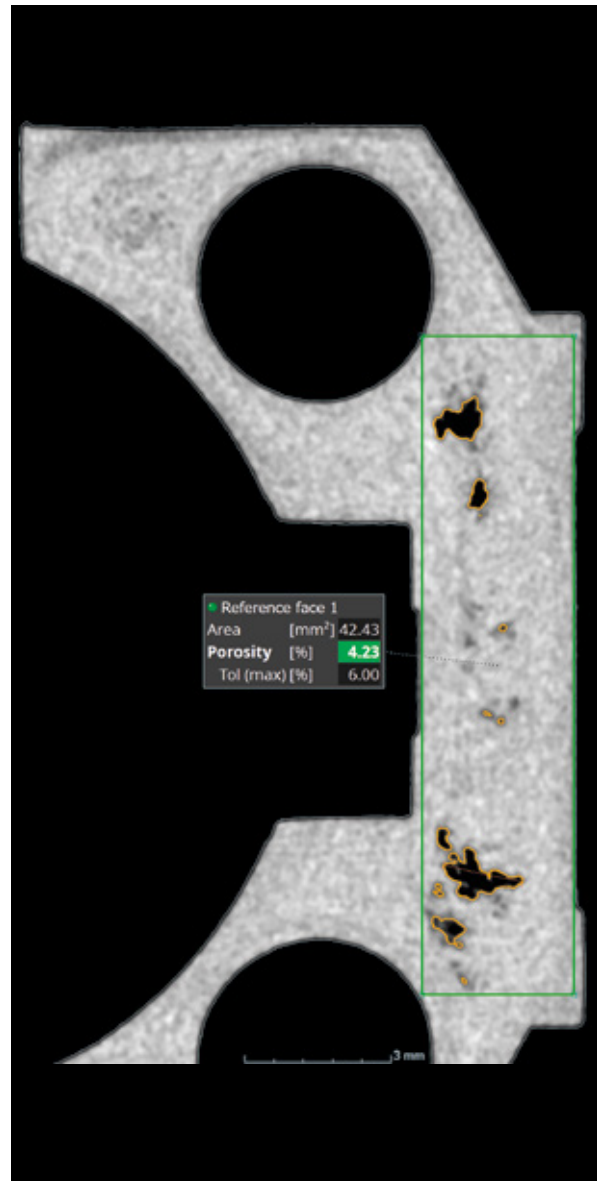
Analyze designed material properties as well as discontinuities and visualize them—from research and development to the production stages.
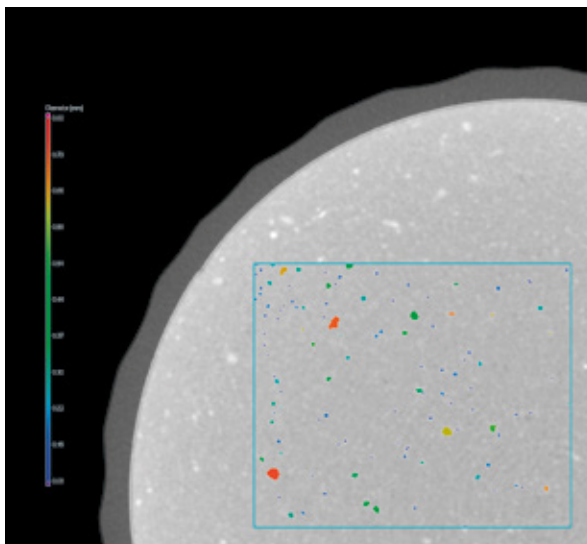
Material Analysis Features

01
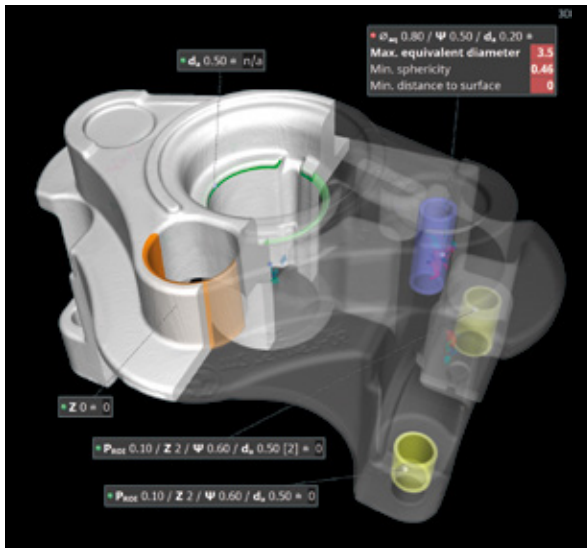
02

03

01 / 3D Porosity Analysis

Recognize and characterize porosity in three dimensions. Detailed parameters on size, shape, and number of discontinuities allow you to differentiate between gas pores and shrinkage deficits. The results can be combined and analyzed with the existing component wall thickness or a virtual machining of the component.

Inspect cast parts for porosity according to the Reference Sheet P 203 of the Federation of German Foundry Industry (BDG). Intuitive input functions make it easy to define porosity specifications based on the porosity key according to BDG P 203. By integrating important BDG P 203 specifications for porosity analysis as well as for the definition of three-dimensional characteristics of internal volume deficits, the software offers a fast, reliable, and comprehensible porosity analysis and evaluation of CT volume data.

03 / Inclusion Analysis

Detect particles within your part. With Volume Graphics software, you can detect unwanted contamination, for example, caused by machine wear, and explore the intended accumulation of added functional particles, such as metal flakes inside an insulator.

02 / 2D Porosity Analysis

Perform porosity analyses in accordance with supplier specifications or BDG guidelines, such as BDG P 202. In accordance with BDG guideline P 202 used in the automotive industry, Volume Graphics software can be used to determine the pore loss areas automatically and non-destructively in 2D CT cross-sectional images. The results can be combined with 3D CT analyses to investigate more complex technical issues.

Material Analysis Features

04

05
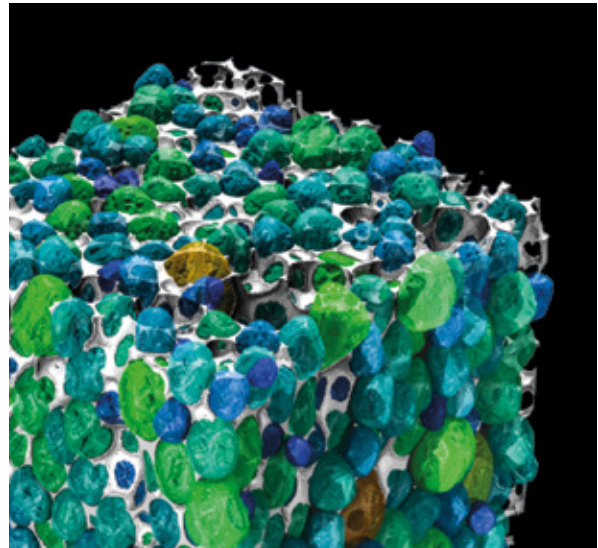
06

04 / Fiber Composite Analysis

Calculate and visualize local and global fiber orientations and fiber volume fractions in composite materials. Volume Graphics software enables you to calculate local and global fiber statistics in the form of fiber orientation tensors or histograms as well as porosity in the matrix material. Principal orientations of woven fabrics or lay-up materials can be determined. Fiber and matrix properties can be mapped to volume meshes and exported for use in your simulation software.
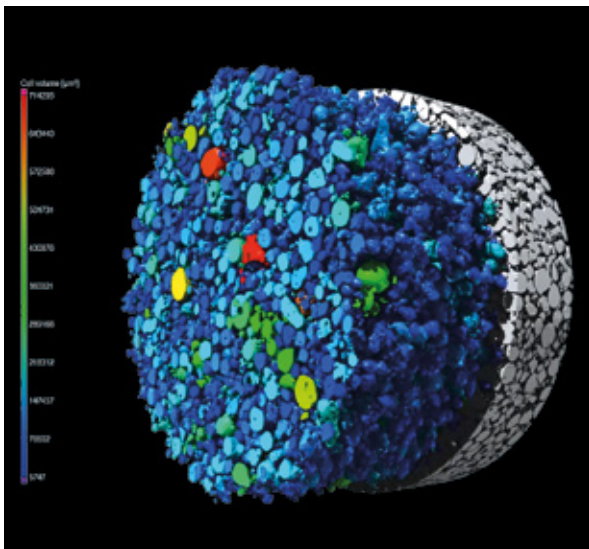
05 / Foam Analysis

Determine cell structures in porous foams. With Volume Graphics software, you can subdivide connected cells to individually quantify cell sizes and shapes. Strut thicknesses can be visualized locally and aggregated to global statistics, like through histograms.

06 / Powder Analysis

Determine grain structures in powders that are used for additive manufacturing, among others. You can use Volume Graphics software to separate particles to quantify features like volume, surface, and compactness for each particle individually, generate global statistics, and reveal directional dependencies that may result from the deposition of larger particles.

Material Analysis Features

07
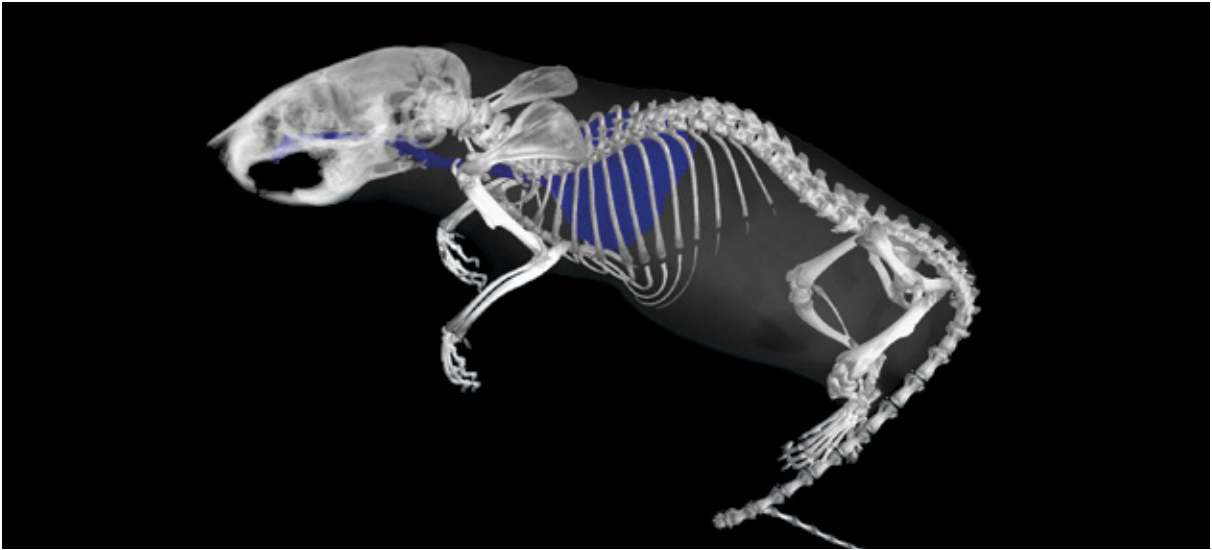
08

07 / Gray Value-Based Segmentation

Create regions of interest for segmenting different materials, which can be used in a wide range of applications—for example, you can create visualizations or perform further analyses based on a global selection of a gray value range of interest, manually selected regions constrained to specific gray value intervals, or the dynamic flooding o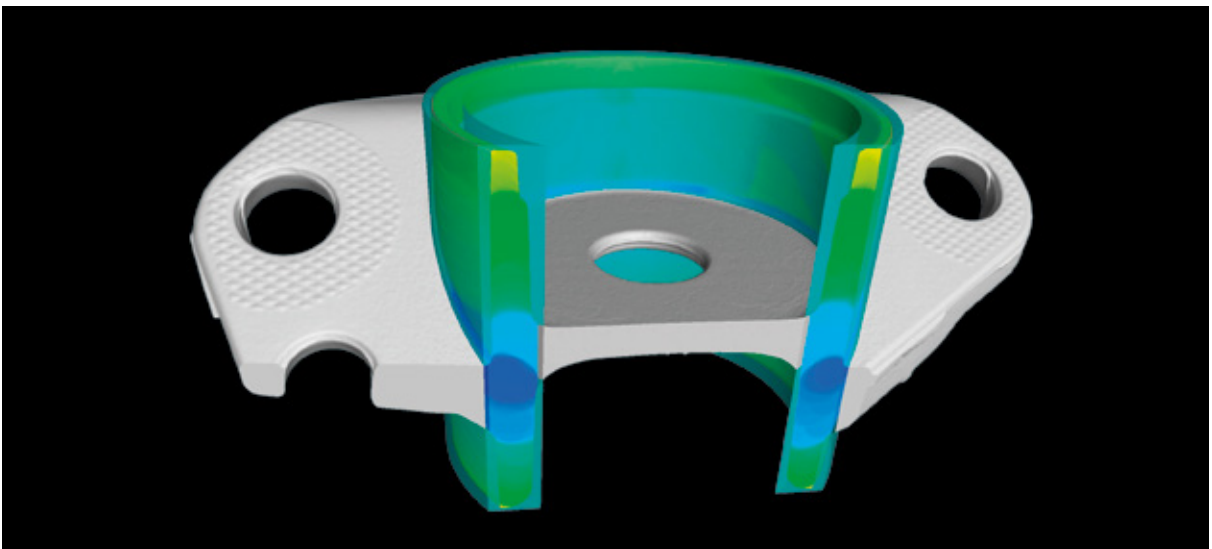f manually placed seed points until specified gray value limits are reached. Typical use cases include organic shapes in biological or geological samples, or organic shapes within engineered components like fluid channels.

08 / Shape-Based Segmentation

Create regions of interest with clearly defined shapes for visualization, segmentation, or further analyses from manually defined region outlines, automatically determined surfaces, or geometry elements fitted to surfaces combined with subsequent Boolean operations such as addition, subtraction, or intersection. Typical use cases include parts of engineered components or assemblies.

Material Analysis Features

09
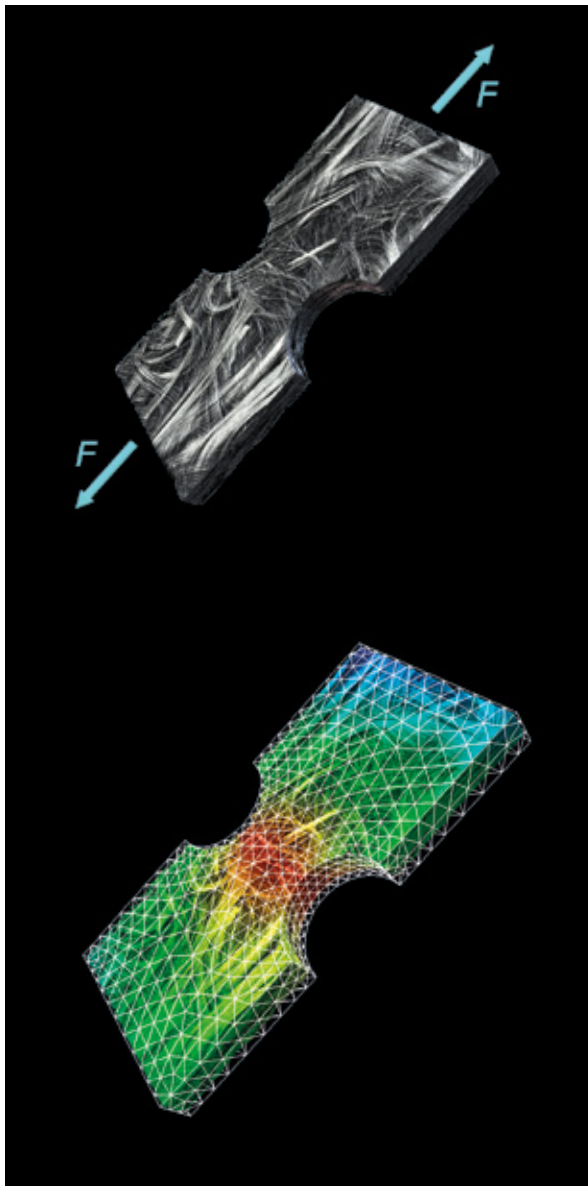
10

09 / Digital Volume Correlation

Quantify displacements between an initial and a deformed volume in a simple and intuitive way. With Volume Graphics software, you can calculate the movement of each voxel from one volum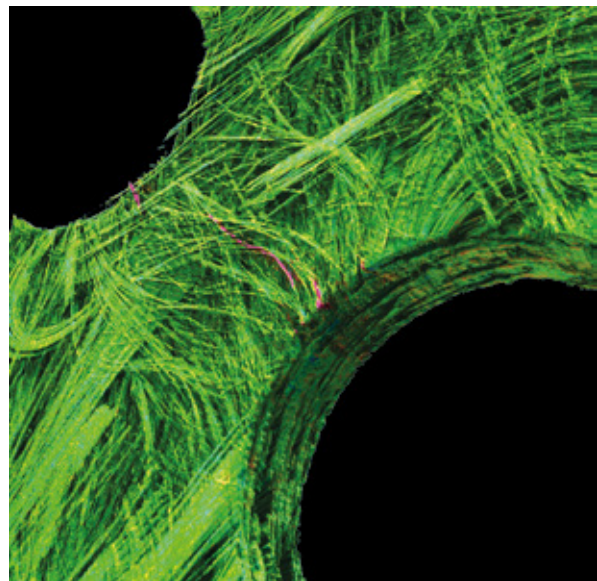e to another for the analysis of in-situ tests or part deformation based on real world component load. The software measures local displacement and strain tensors, visualizes deformations and movements via displacement arrows or lines, and maps results onto FE meshes to validate your simulations.

10 / Crack Detection

Identify cracks in your parts. With semi-automatic crack segmentation, you can quantify cracks in single scans. By using multiple scans, you can compare these data sets and detect defects that can't be seen with the naked eye. Defects can be characterized, for example, by their surface. The measurement of the remaining wall thickness provides valuable input for your material characterization.

Benefits

Proven

> Easy-to-perform analyses that don't require programming

> Detection of defects proven in industrial practice

> Reliable determination of material properties like fiber orientations, even on lower quality data

> Validated accuracy of results

Instructive

> Instructive results for the non-destructive testing of components

> Comprehensive characterization of complex materials such as fiber compounds, foams, and lattice structures

> Mapping of material parameters onto finite element meshes for simulation

Efficient

> Fast processing on large data sets

> Easy automation of repetitive tasks

> Fully automated workflows from data analysis to reporting and data export

Reporting

with Volume Graphics Software

Overview

Volume Graphics software gives you results you can use right away, including insightful graphics and comprehensive reports: from the export of images, histograms, and data tables in common file formats to the creation of comprehensive and completely customizable test reports and even interfaces to third-party quality management or statistical process control software.

Reporting Features
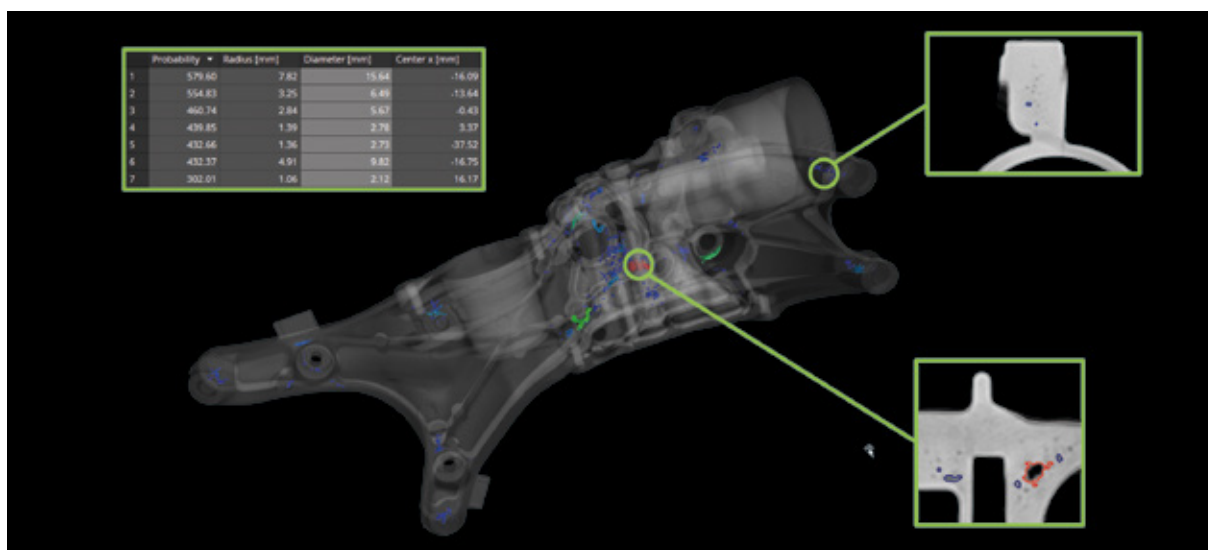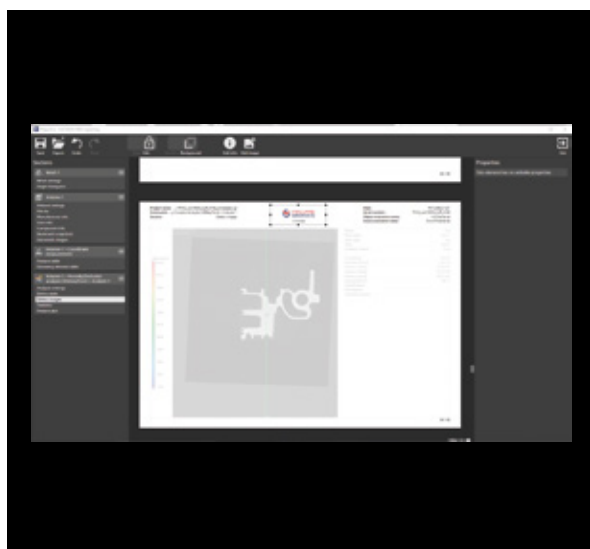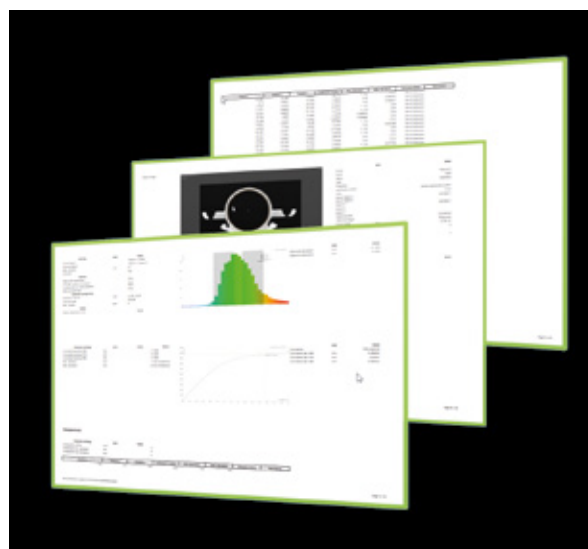
01 / Defining Reportable Content

Create reports based on the wealth of gray value and surface-based analyses and coordinate measurement features of Volume Graphics software. You can generate additional content by defining rules that automatically create images or interactive markers according to certain result features, like tolerance states or defect sizes, and add arbitrary views to your reports using the advanced visualization capabilities of the software.

02 / Integrated Reporting

Generate audience-appropriate reports that focus on numerical results, images, or combinations of the two. Volume Graphics software allows you to configure your report pages to include results and related content, part and project information, and even your company's logo. You can store reports as self-contained PDF or HTML documents that can be easily archived or shared or use viewer applications for an interactive view of the report and the full inspection project.

03 / Reporting via Excel

Create fully customizable reports directly with Volume Graphics software. With the Volume Graphics add-in for Microsoft Excel, you can adjust layout templates to display results according to your specific needs, or even derive and display additional data from the reported content using powerful Excel formulas. Share adapted templates with colleagues or use multiple ones to generate personalized reports for individual customers.

Reporting Features

04
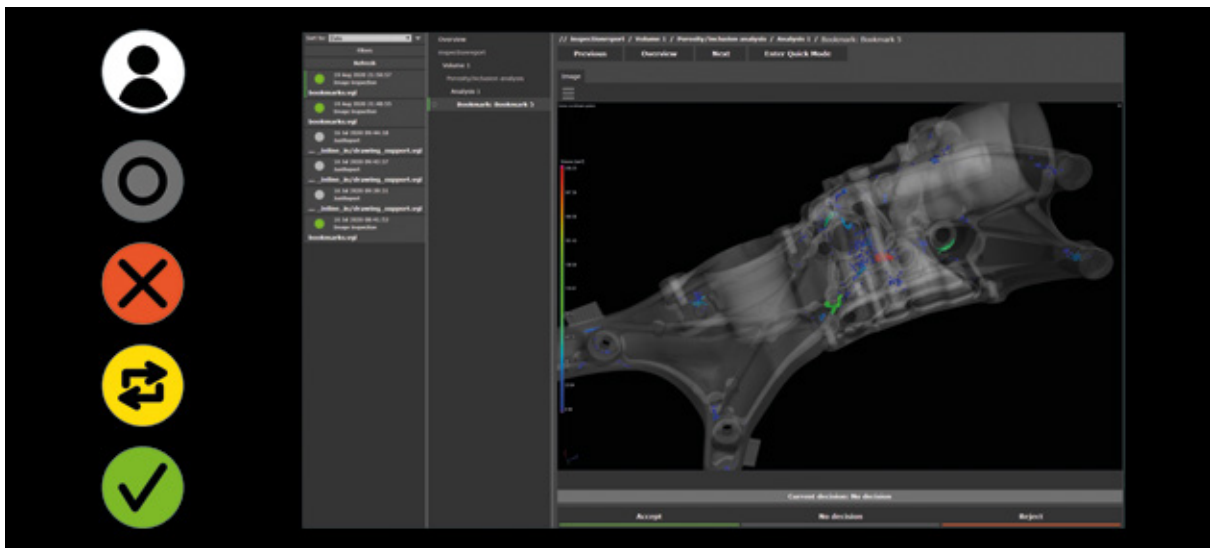
05
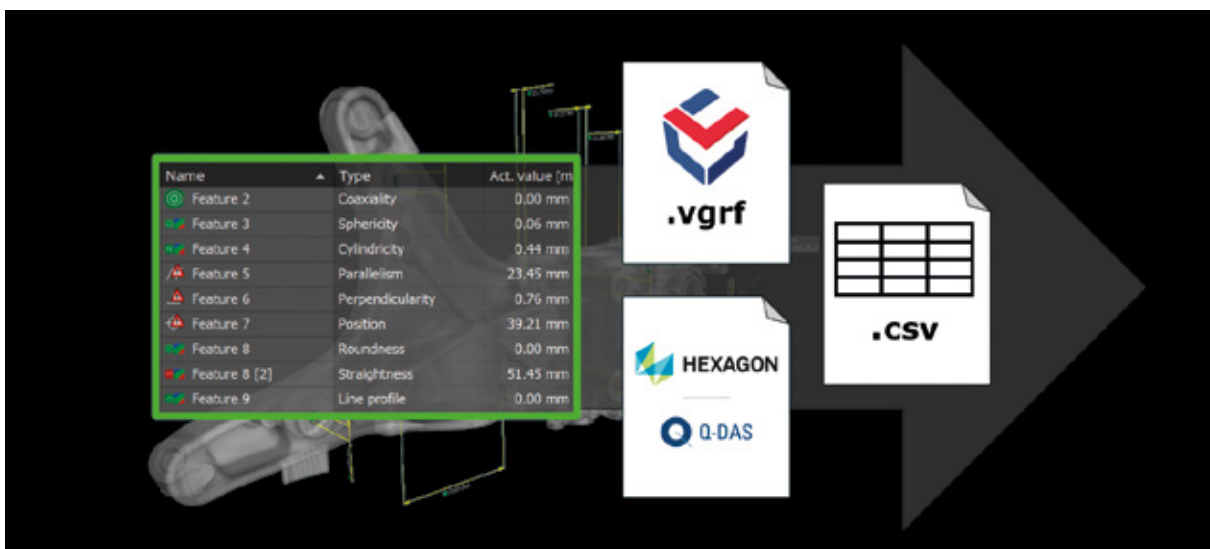
04 / Review in VGinLINE APPROVER

VGinLINE APPROVER is a web application that can display numerical or image results of stored inspections, show result positions on interactive 3D models of your part, and plot comparable results across different inspections. Enter comments or pass/fail decisions that can be exported in an interface format for use in other applications and are traced to individual password-protected user accounts.

05 / Q-DAS and Raw Data Export

Export complete coordinate measurement results or analysis data in the industry standard Q-DAS ASCII data transfer format or as CSV files. By supporting the Q-DAS format for data interchange, Volume Graphics software allows you to include CT result data in your existing processes for statistical process control and production monitoring. With the open CSV-based Volume Graphics Report Format, you can export results, meta data, and manual reviews to third-party software.

Benefits

> Informative combination of traceability data, numerical results, and 2D images

> Customizable content and level of detail for either management or technical experts

> Connectivity to third-party systems for all reported data
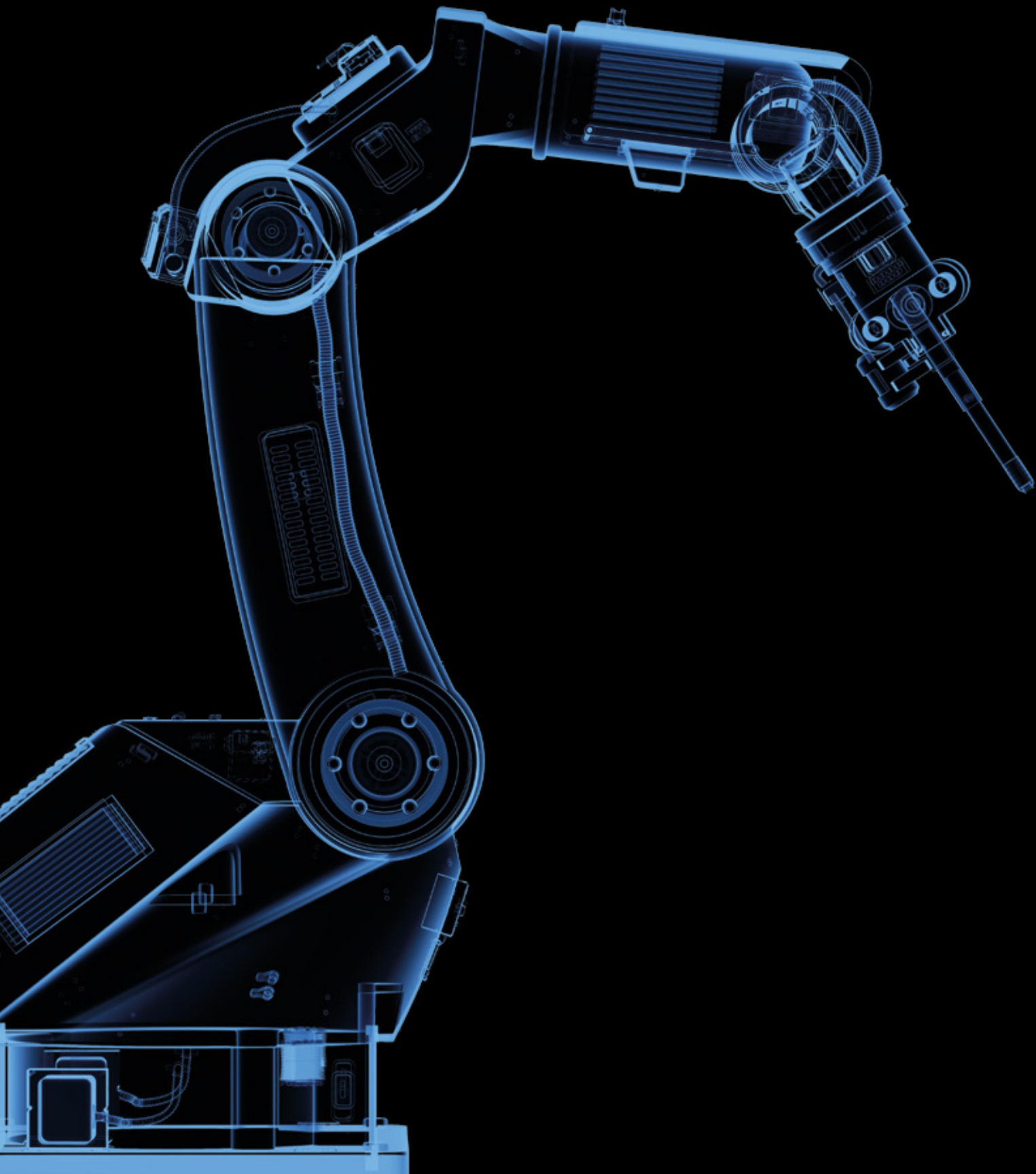
Automation

with Volume Graphics Software

Overview

Inspects your parts automatically and non-destructively with industrial computed tomography (CT) using Volume Graphics software. It's simple to set up and works with almost every CT system on the market.

Volume Graphics provides you with a ready-to-use solution that is both fast and flexible: Whenever parts need to be analyzed repeatedly, powerful automation functions will be at your side to help you speed up your work—from the semi-automated sample tests in quality labs and small batch series inspection to fully automated 100 % inspection on the shop floor.

Automation Features
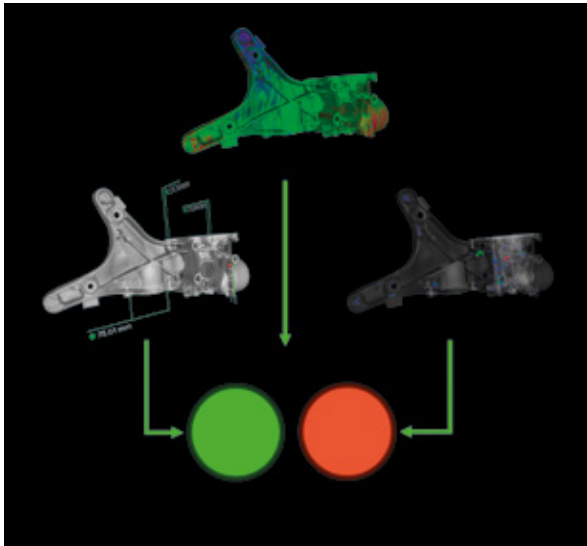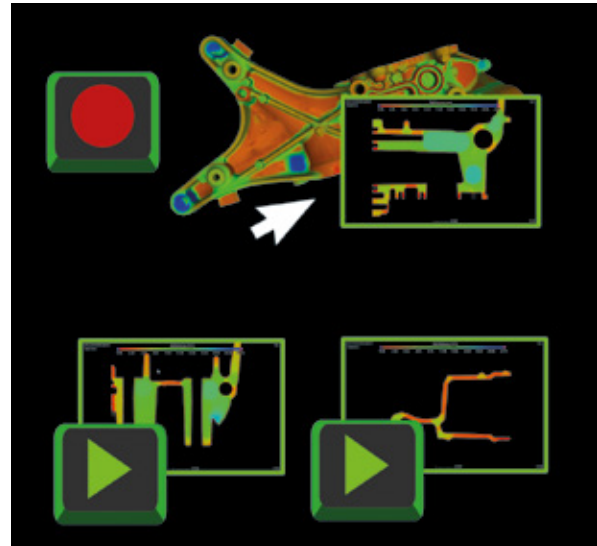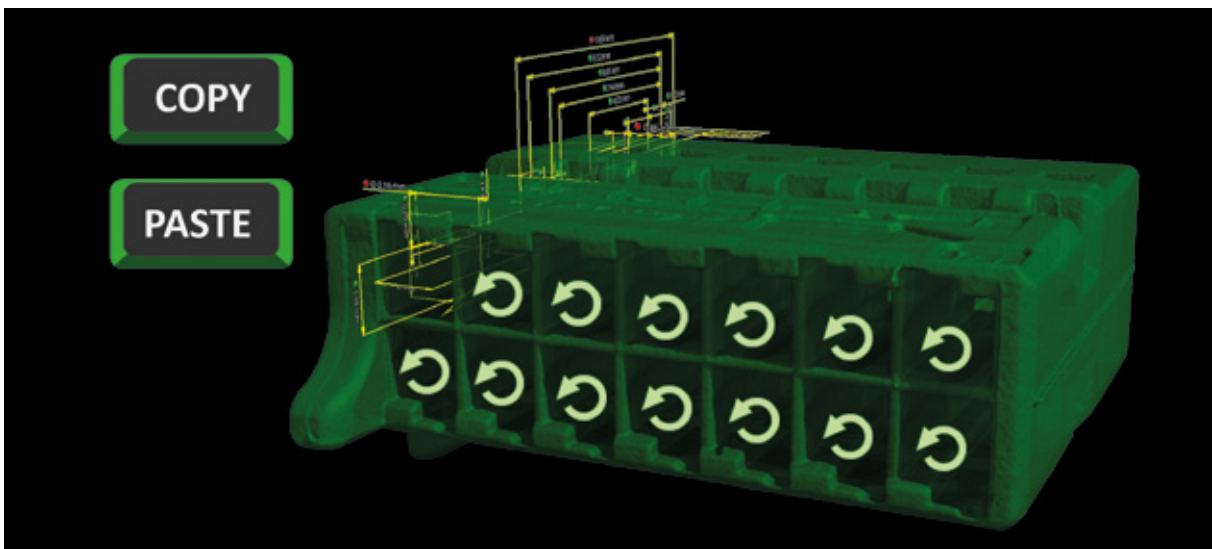
01 / Templates

Combine geometry elements, features, and dimensions into reusable measurement templates. Reusable analysis templates combine parameters, tolerances, and other settings of gray value or surface analyses. You can define different views on your data, switch between them, and store them in reusable bookmark templates.

02 / Macros

Record individual interactions with the software for storage and later use across different projects and application restarts. You can combine, shorten, or append macros and edit their input dependencies as well as file outputs for later adjustments. Play back previously recorded macros at any time to optimize your workflow and share them with colleagues for standardization.

03 / Automated Workflows

Copy complete measurement or analysis templates to similar areas within a single part to inspect repeating features. With automated workflows, you can apply macros that contain more complex operations to multiple scans of similar objects in a single project. Simplify manual inspections by combining recurring operations into macros that can be triggered via shortcuts and remain despite application restarts.

Automation Features

04

05

04 / Inspection Plans

Join macros, templates, and other dependencies like reference meshes to create completely self-contained inspection plans. Inspection plans enable you to easily inspect a series of parts by applying plans to a batch of projects, generating unique output such as reports or result projects for each plan. Create advanced plans that perform operations dependent on intermediate results to optimize performance or generate more in-depth results.

05 / VGinLINE Automation

Transfer inspection plans to the fully automatable VGinLINE system and automatically process any incoming input using one or more workstations. You can define different revisions of inspection plans to account for part variations and switch between them. VGinLINE enables you to automatically export results to auxiliary systems like the web-based VGinLINE APPROVER for manual review or to software for statistical process control using the Q-DAS ASCII data transfer format.

Benefits

> Save time and reduce potential errors in recurring inspections of the same parts

> Save time for repeated operations within single parts, multiple parts in a single project, or across whole batches of projects

> Easily transition from manual to semi-automated and fully automated inspection scenarios
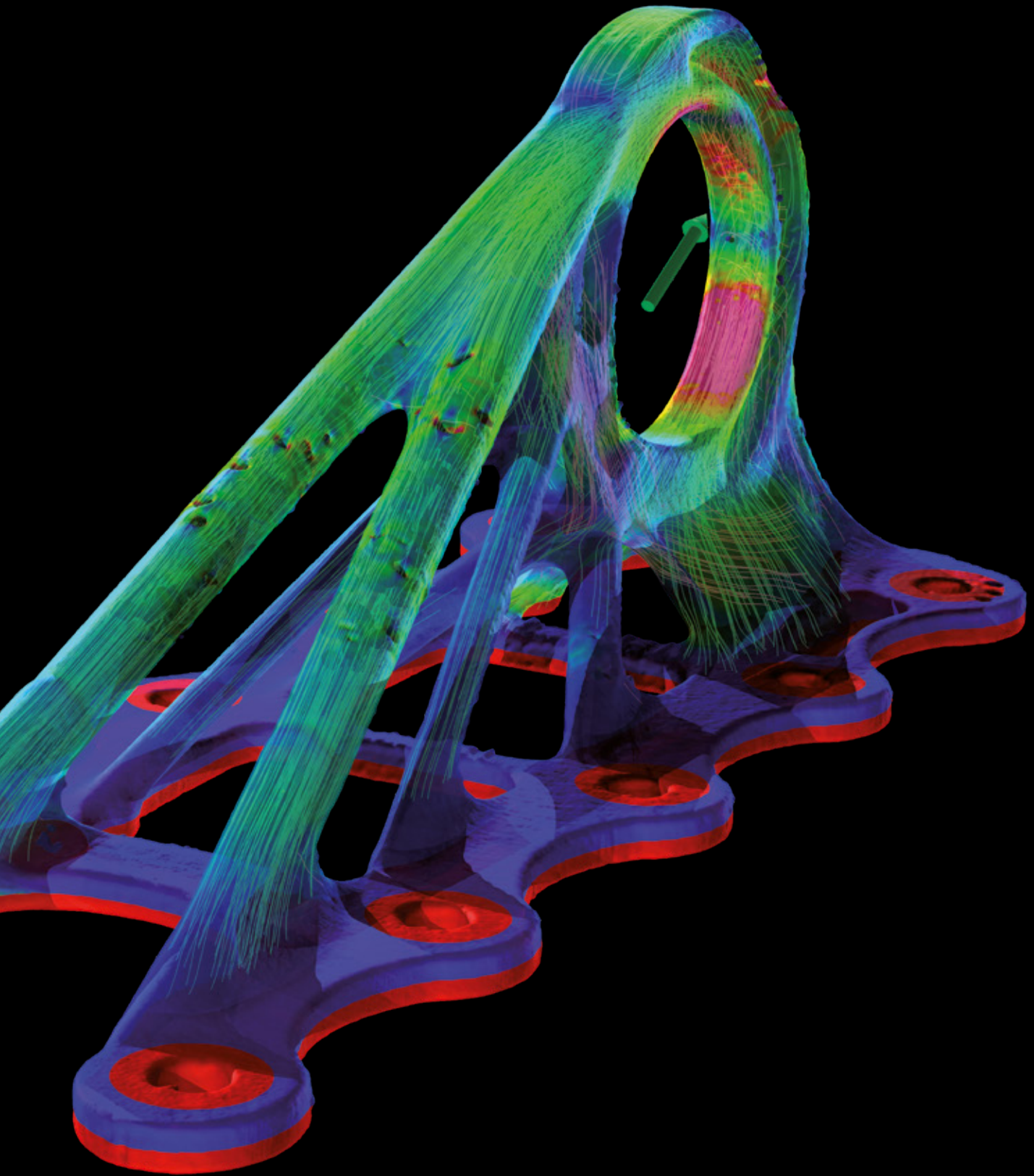
Simulation

with Volume Graphics Software

Overview

Simulate directly on CT data or prepare your CT data for export for simulation purposes.

Volume Graphics software gives you the tools to check your simulation workflows. Perform virtual stress tests or microstructure-level virtual flow and diffusion experiments directly on CT scans. Or create high-quality tetrahedral volume meshes for FEM simulations in third-party software.

Simulation Features

01
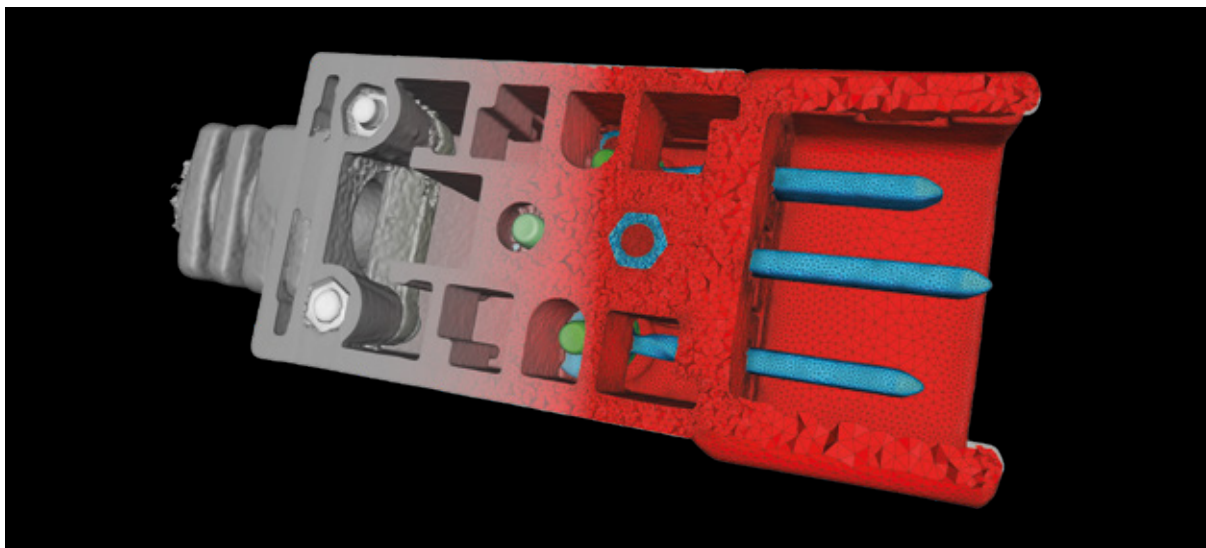
02
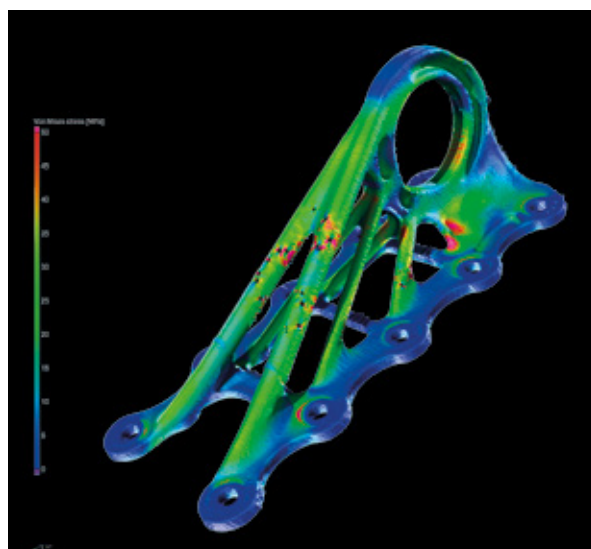
03
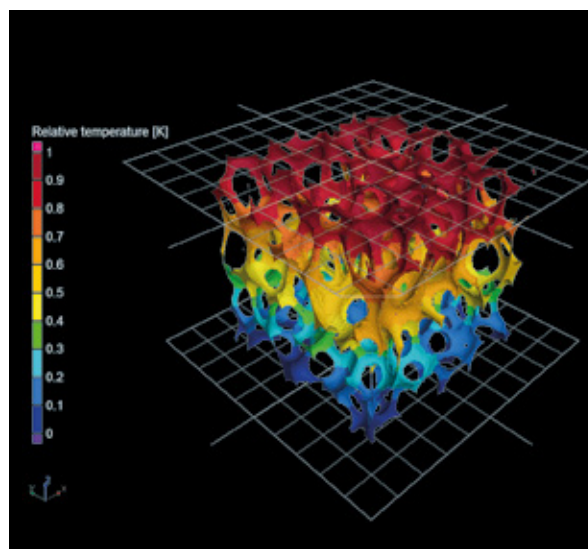
01 / Volume Meshing

Create accurate and high-quality tetrahedral volume meshes directly from CT scans of single-material and multi-material components or material samples. Volume meshes can be used for mechanical, fluid, thermal, electrical, and other simulations in third-party FEM simulation software. Works directly on the volume data of the CT scan without the need to create an intermediate surface mesh—thus avoiding a loss of geometry information and accuracy.

02 / Structural Mechanics Simulation

Perform FE stress simulations directly on CT scans. The structural mechanics simulation provides an easy-to-use simulation model that is particularly suitable for highly complex structures such as foams, lattice structures, or components with microporosity, since no geometry-conforming mesh is needed. With one click, you can include the results of a porosity analysis to simulate stress concentrations around defects. Results have been validated against experimental tests and classical FEM simulations.

03 / Thermal Conductivity Simulation

Simulate the stationary temperature and thermal flux fields in a porous or two-component material directly on a CT scan. With thermal conductivity simulation, you can perform virtual experiments on the CT data of a structure that simulate the transport of heat through the structure. The software enables you to calculate homogenized thermal conductivity on material samples and the local and global effective tensor-valued thermal conductivity.

Simulation Features

04
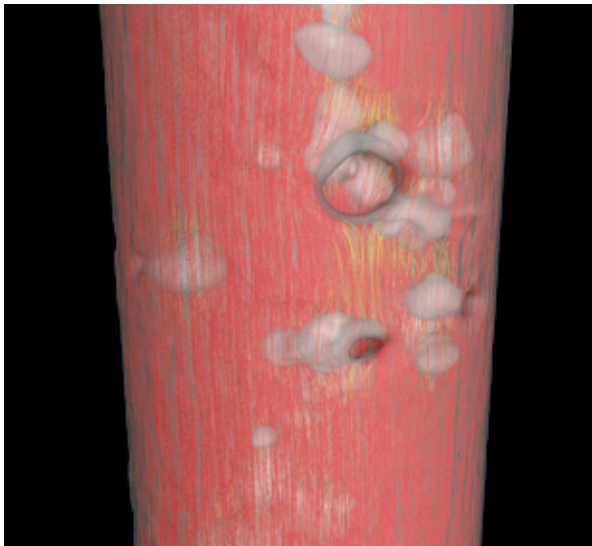
05
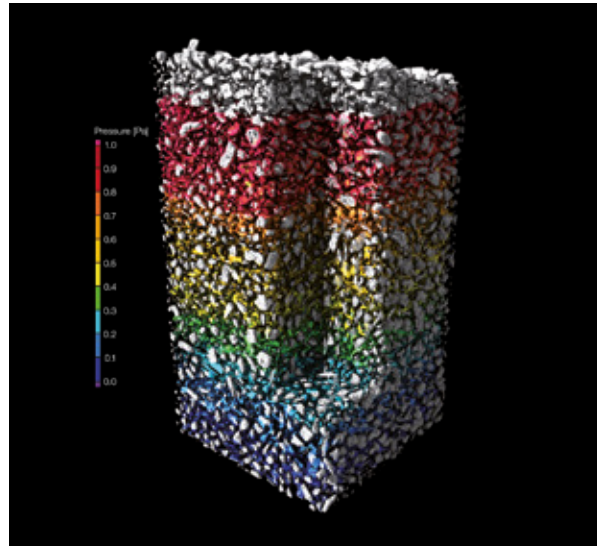
04 / Electrical Conductivity Simulation

Simulate the stationary electric potential and current fields in a porous or two-component material directly on the CT scan. With electrical conductivity simulation, you can perform virtual experiments on the CT data of a structure that simulate the transport of electrical charge through the structure. The software enables you to calculate homogenized electrical conductivity on material samples and the local and global effective tensor-valued electrical conductivity.

05 / More Transport Phenomena Simulations

Simulate various other transport phenomena, such as fluid flow or molecular diffusion through complex structures. With Volume Graphics software, you can simulate the stationary laminar flow of an incompressible single phase fluid through the voids of a porous material, calculate the capillary pressure drainage curve for a scanned porous material sample, and compute the diffusion of molecules through a porous material sample from a region of higher concentration to one of lower concentration.

Benefits

> Accurate and detailed representation of complex structures based on subvoxel-accurate material segmentation

> Easy to use, also for non-simulation experts

> Seamless and efficient workflow in one software—from material segmentation to simulation

Product Selection

Find Your Volume Graphics Software

VGSTUDIO MAX

Modular software suite offering the complete spectrum of Volume Graphics functionality
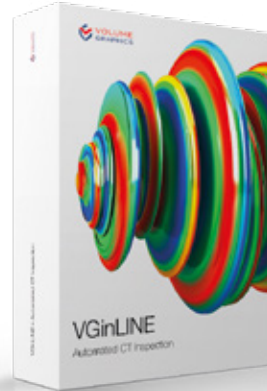
VGinLINE

For fully automated inspection of CT data on the shop floor
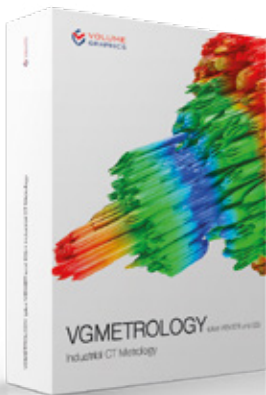
VGMETROLOGY

For GD&T in dimensional metrology departments
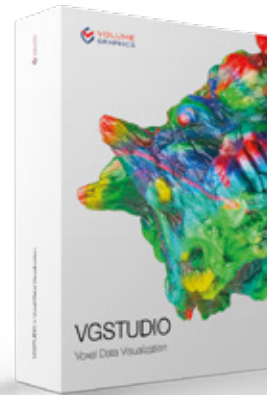
VGSTUDIO

For reconstruction and visualization of CT data

Products for Partners
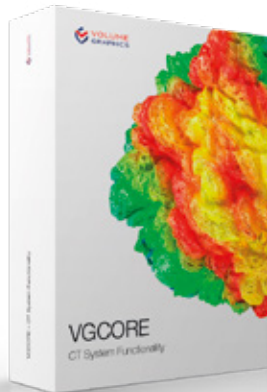
VGCORE

For integrating core functionality such as reconstruction or geometry calibration into CT systems

VGPROJECT SDK

For seamlessly connecting CT scanners to Volume Graphics software products

Free Viewer Applications
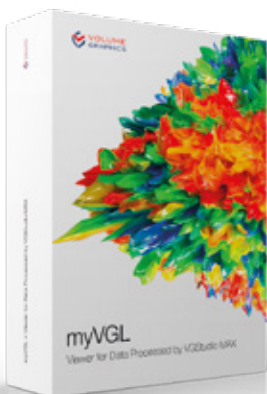
myVGL

For all inspection results
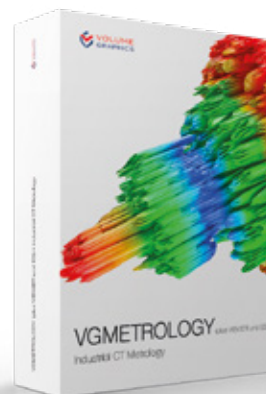
VGMETROLOGY VIEWER

For dimensional inspection results

Volume Graphics Products

Combinations for Typical Workflows

AT THE SCANNER

QUALITY OFFICE

VGSTUDIO (MAX)
for reconstruction and
data quality analysis

VGSTUDIO MAX
> for reconstruction and data quality
  analysis
> for all inspections and report generation
> for surface determination and material
  analyses
> for editing and testing inspection jobs

MANAGEMENT OFFICE

myVGL for review of reports
and detailed inspection reports

METROLOGY DEPARTMENT

VGMETROLOGY ESSENTIAL (ES) for
geometric dimensioning and tolerancing (GD&T)

ON THE SHOP FLOOR

VGinLINE for fully automated
inspection of incoming CT scans

Volume Graphics Products & Their Functions

A Comparison of VGSTUDIO MAX, VGSTUDIO, VGMETROLOGY, and myVGL

		myVGL	**VGSTUDIO**	**VGSTUDIO MAX**
		To view CT data, inspection results, and to generate reports (free of charge)	To reconstruct, visualize and animate CT data	All VG functionalities (GD&T, material analyses, simulation), scalable via add-on modules
CT Data Import	Open .vgl files with reconstructed CT data Import volumes or image stacks with reconstructed CT data	○ (.vgl only)	●	●
Visualization of CT Data, GD&T, and Analysis Results	3D and 2D rendering of CT data Views View analysis results	●	●	●
Reporting	Create integrated reports View integrated reports Create Excel reports Export tolerancing results in Q-DAS ASCII transfer format	●	●	●
Reconstruction & Data Quality Analysis	CT reconstruction Data quality analysis (ASTM E 1441/ASTM E 1695)		● (1)	● (1)
Animation	Video generation with Simple Keyframer Video generation with Classic Keyframer Object Exploder		○ (Simple Keyframer only)	●
Segmentation	ROI creation based on geometries ROI creation based on gray values			●
Surface Determination	Iso 50 surface determination Advanced surface determination (locally adaptive) Multi-material surface determination (locally adaptive) Use CAD, mesh, or ROI objects as starting contour Convert CT volumes to surface meshes			● (1)
CAD Import	CAD import (STEP, IGES) CAD import (native formats) CAD import (native formats) with PMI			● (1)

VGinLINE Cast & Mold Extended (incl. VGinLINE APPROVER)	VGinLINE Complete (incl. VGinLINE APPROVER)	VGMETROLOGY VIEWER	VGMETROLOGY ES	VGMETROLOGY
For fully automated GD&T and defect inspection of CT scans as they are generated	For fully automated GD&T and material structure inspection of CT scans as they are generated	To view GD&T inspection results and to generate reports (free of charge)	Satellite for GD&T on CT data with already determined surfaces from VGSTUDIO MAX	GD&T solution with surface determination for standard cases
●		O (.vgl with advanced surface determination only)		●
		O (no gray values, no material analyses)		
● (incl. database storage and manual re-evaluation)			●	
●				
O (w/o painting tool, crack tracking)				O (geometry based only)
●				O (advanced surface determination w/o starting contours only, no .stl export)
●		O (STEP, IGES only, no permanent saving)		● (1)

● Yes
O Partial
(1) Some or all functions require add-on module(s)

Volume Graphics Products & Their Functions

A Comparison of VGSTUDIO MAX,
VGSTUDIO, VGMETROLOGY,
and myVGL

		myVGL	VGSTUDIO	VGSTUDIO MAX
		To view CT data, inspection results, and to generate reports (free of charge)	To reconstruct, visualize and animate CT data	All VG functionalities (GD&T, material analyses, simulation), scalable via add-on modules
GD&T	Alignments Nominal/actual comparison Geometric Dimensioning & Tolerancing (GD&T) Copy & paste of GD&T measurement plans Wall thickness analysis			● (1)
Reverse Engineering	Manufacturing geometry correction Reverse engineering			● (1)
Material Analyses	Porosity analysis (3D acc. to BDG P 203) Porosity analysis (2D acc. to BDG P 202) Inclusion analysis Fiber composite material analysis Foam analysis and powder analysis Digital volume correlation			● (1)
Automation	Create macros Replay macros Create and execute reusable measurement templates Create and execute reusable analysis templates Create and execute self-contained inspection plans ("jobs") Batch processing			●
Inline Automation	Fully automatic analysis of scans as they come in Distribute inspections across multiple workstations			
Volume Meshing and Simulation	Volume meshing Structural mechanics simulation Transport phenomena simulation			● (1)

VGinLINE Cast & Mold Extended (incl. VGinLINE APPROVER)	VGinLINE Complete (incl. VGinLINE APPROVER)	VGMETROLOGY VIEWER	VGMETROLOGY ES	VGMETROLOGY
For fully automated GD&T and defect inspection of CT scans as they are generated	For fully automated GD&T and material structure inspection of CT scans as they are generated	To view GD&T inspection results and to generate reports (free of charge)	Satellite for GD&T on CT data with already determined surfaces from VGSTUDIO MAX	GD&T solution with surface determination for standard cases
●		O (no permanent saving, no copy&paste of measurement plans, no creation of nominal/actual comparisons and wall thickness analyses)		●
			● (1)	
O (porosity and inclusions only)	O (w/o Digital Volume Correlation)			
O (w/o creation of macros, measurement and analysis templates)			● (analysis templates for nominal/actual comparisons and wall thickness analysis)	
●				

● Yes
O Partial
(1) Some or all functions require add-on module(s)

Your Questions,
Your VGSTUDIO MAX

No matter which insights you need from 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, 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 too 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.

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.

*Depending on the platform, there are differences in the range of functions for different operating systems. See our continuously updated Product Information page for details: www.volumegraphics.com/en/support/product-information.html.

ADD-ON MODULES FOR MATERIAL ANALYSES

Extended Porosity/Inclusion Analysis Module for defect analysis according to BDG guideline P 202 for 2D porosity inspection and BDG guideline P 203 for 3D porosity inspection.

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

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

Digital Volume Correlation Module for the quantification of displacements between an initial and a deformed volume.

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

Structural Mechanics Simulation Module for the simulation of mechanical stress directly on CT data.
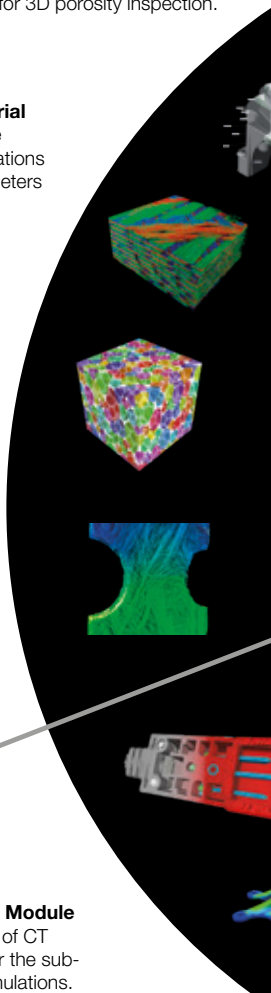
ADD-ON MODULES FOR SIMULA

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

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

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

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

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

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

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

Reverse Engineering Module for the conversion of CT scans into CAD models that can be used in CAD systems.

Transport Phenomena Simulation Module for the simulation of fluid, electrical or thermal flow and diffusion on different materials (e.g., porous or composite).

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

BASIC EDITION

ADD-ON MODULES FOR GEOMETRY ANALYSES

CT RECONSTRUCTION

Packages

VGSTUDIO MAX Tailored to Your Area of Application

Packages and Bundles

> Preconfigured for the most common tasks within various industries

> Considerable savings compared to buying individual 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

Packages/Bundles Includes	Geometry For metrology and quality control in a variety of industries	Material For lightweight construction and materials research	Cast & Mold For casting and injection molding, esp. 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			
Reverse Engineering Module			
Digital Volume Correlation 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 up on 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 in their daily work
●	●	●	●
●	●	●	●
●	●	●	●
●	●	●	●
●			●
	●		●
		●	●
			●
			●
			●
			●
			●
			●

*Depending on the platform, there are differences in the range of functions for different operating systems.
 See our continuously updated Product Information page for details: www.volumegraphics.com/en/support/product-information.html.
**Does not include the add-on modules CT Reconstruction, CAD Import, CAD Import with PMI, Structural Mechanics Cluster Extension.

License Models

The Right Licensing Model for Every Requirement

Floating

Use software flexibly across the world, a continent, or one city

Depending on the model you choose, our floating license models allow you to use a single license worldwide, continent-wide, or within one city. This increases your license utilization and reduces license management effort.

All floating license models allow for offline borrowing of a license from your floating license pool for up to 7 days, such as for a business trip or a conference. One user can run multiple instances of the software on the same computer without each one counting as a separate license. Each license includes different functions.

Global Floating

If you are a global company and want to use a single license worldwide at different locations in different time zones, Global Floating is the perfect license model for you. Compared to other license models, Global Floating requires fewer licenses, since you can use one license throughout the world.

Continental Floating

If you are a company with multiple sites across one continent, you can now share licenses across one continent. Continental floating licenses are available for usage in the Americas, EMEA (Europe, the Middle East, and Africa), or the Asia-Pacific region.

Local Floating

If you are a company with multiple users in one city who do not use the software full-time, you can share licenses across one city. Compared to a dongle license, the local floating license requires no effort to transport the dongle and avoids the risk of losing it.

Please note: The license server for the floating licenses is available free of charge and can also be installed on a virtual server. If you already have a Flexera server, you can also use it for Volume Graphics software.

Available for: VGSTUDIO MAX packages and packages with further add-on modules, VGMETROLOGY, and VGMETROLOGY ES (both with or without add-on modules).

Node-locked

Use software exclusively on a specific computer

If you know exactly what you need and where you'll need it, we recommend a node-locked license. The software is installed on the computer on which it is currently used. The node-locked license binds the software to this computer.

A node-locked license allows one user to run multiple instances of the software on one computer.

Please note: Once installed, the computer and platform are fixed.

Available for: VGSTUDIO MAX, VGSTUDIO, VGMETROLOGY, and VGMETROLOGY ES.

Dongle

Use software alternately on several computers without a network

Choose the dongle license if you want to use the software flexibly on different computers that are not connected to a network.

The dongle license consists of a hardware dongle and a license issued for this dongle. The software can be installed on any number of computers but can only be used when the dongle is connected to the computer.

A dongle license allows one user to run multiple instances of the software on one computer.

Please note: Only one dongle is issued per license. A loss of the dongle will result in a loss of the license.

Available for: VGSTUDIO MAX, VGSTUDIO, VGMETROLOGY, VGMETROLOGY ES, and VGinLINE.

Dongle License Protection

To minimize costs should your dongle become lost or stolen, we offer Dongle License Protection with a term of 12 months. In the event of loss, we will provide you with a new dongle and a new license for the remaining term for a fee of 2 % of the original list price of the software plus the applicable VAT per month or part thereof and a fixed handling fee.

Dongle License Protection is available for an annual fee or free of charge on request if you purchase an update/service agreement.

Update/Service Agreement

The update/service agreement keeps your software up to date at a reasonable price. Keep up with all current developments in the analysis and visualization of industrial CT data and save money compared to the regular upgrade price.

During the one-year term of the update/service agreement, you will receive all upgrades and bug fixes free of charge. In addition, you will enjoy priority support.

Available for: VGSTUDIO MAX, VGSTUDIO, VGMETROLOGY, VGMETROLOGY ES, and VGinLINE.

	Global Floating	Continental Floating	Local Floating	Node-Locked	Dongle
Summary	For global companies	For companies with multiple sites across one continent	For companies with multiple users in one city	For use on a specific computer	The easiest way to use software alternately on multiple computers without a network connection
Available for	VGSTUDIO MAX (only packages, optionally with further add-on modules), VGMETROLOGY, VGMETROLOGY ES	VGSTUDIO MAX (only packages, optionally with further add-on modules), VGMETROLOGY, VGMETROLOGY ES	VGSTUDIO MAX (only packages, optionally with further add-on modules), VGMETROLOGY, VGMETROLOGY ES	VGSTUDIO MAX, VGSTUDIO, VGMETROLOGY, VGMETROLOGY ES	VGSTUDIO MAX, VGSTUDIO, VGMETROLOGY, VGMETROLOGY ES, VGinLINE
Use on multiple computers	●	●	●		●
Floating within a network that extends across...	...the world	...one continental time zone range (Americas, EMEA, or Asia-Pacific)	...one city		
Multiple instances on one computer for one user	●	●	●	●	●
Usable without network connection	○ (temporarily)	○ (temporarily)	○ (temporarily)	●	●
Supports virtual license servers	●	●	●		
Hardware-independent	●	●	●	(computer-bound)	(dongle-bound)
Platform-independent	●	●	●		●

Technical Consulting

Insightful Expertise You Can Rely On

Our 20+ years of experience working in 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 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 have a CT system yet, we will 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, like on the extension of existing systems or new purchases, we will prepare a feasibility study and check how realistic your idea is and how it can best be implemented using our software.

Services for Analysis and Visualization

Our consulting team analyses 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 technical 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—all while guiding you throughout the process of purchasing your VGinLINE system.
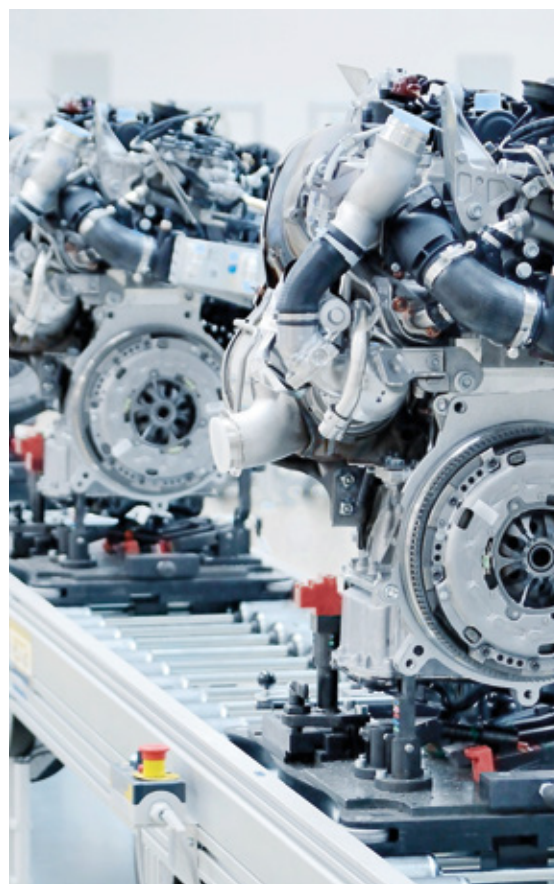
Learn to Inspect Better

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 work more confidently and efficiently with your VG software. Simply sign up for one of our various training courses!

All courses are available in German and English. Please contact us if you require training in other languages.

Training Locations

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

Training Options

> Basic Training courses for VGSTUDIO MAX
> 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@volumegraphics.com or by phone +49 6221 73920-810.

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