# Volume Graphics

Porosity Inspection for Castings
acc. BDG Reference Sheet P 203

# New Porosity Inspection Functionality
## acc. to BDG Reference Sheet P 203

—

VGSTUDIO MAX

Industrial Computed Tomography Inspection Software
for Light Metal Castings

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# BDG Reference Sheet P 203

BDG - Bundesverband der Deutschen Gießerei-Industrie e.V.



**Fig. 01: BDG Reference Sheet P 203**
Source: www.guss.de

# Short History Lesson

> VDG Reference Sheet P 201 was one of the first approaches to **standardize the evaluate** of **surface porosity**



Porosität kleines Quadrat: 1 %
Porosität großes Quadrat: 12 %
Porosität gestricheltes Quadrat: ca. 30 %
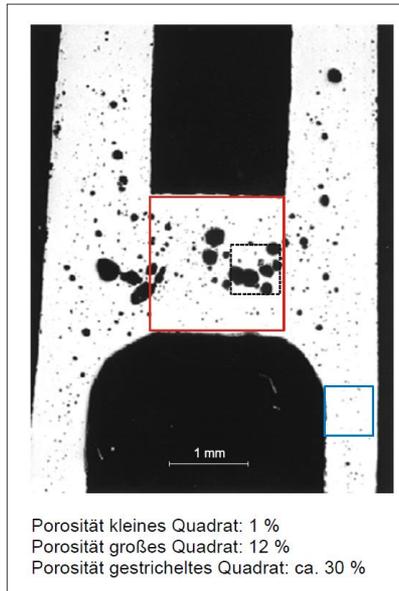
**Fig. 02: Reference surfaces for determining the porosity**
Source: www.guss.de



**VDG - MERKBLATT**

| Volumendefizite von Gußstücken aus Nichteisenmetallen | P 201 Mai 2002 |

**BDG Reference Sheet** — P202
Version: September 2010
BDG-Layout August 2015

Volume Deficits of Castings Made from Aluminium, Magnesium, and Zinc Casting Alloys

**BDG – Richtlinie** — P 203
Stand: 12. Dezember 2019

Porositätsanalyse und -beurteilung mittels industrieller Röntgen-Computertomographie (CT)

# Short History Lesson

> BDG - P 202 was the successor of VDG - P 201

> Both were designed to measure porosity characteristics **inside a cutting plane**

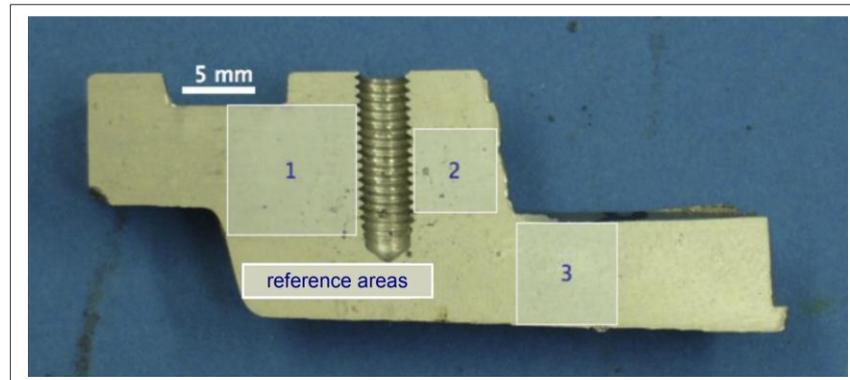> Before VGSTUDIO MAX, this was done by simply **cutting open** the cast part



**Fig. 03: Section plane of a casting with reference areas**
Source: www.guss.de



**VDG - MERKBLATT**

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# Short History Lesson

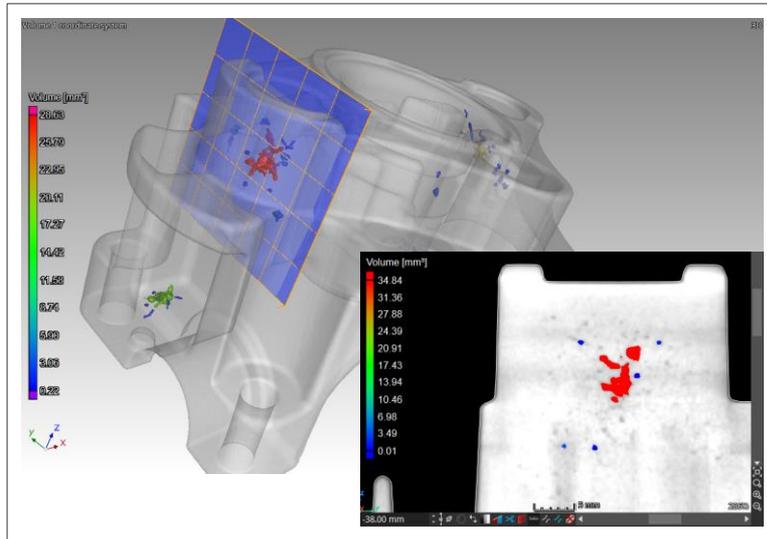> With VGSTUDIO MAX, the user can first inspect in 3D CT in order to select the **layer with the highest porosity**



**Fig. 04: 2D Section plane in 3D CT volume data**
Source: Volume Graphics GmbH



**VDG - MERKBLATT**

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# Short History Lesson

> The user had to define regular shapes (**squares**, **circles**, **triangles**) in which the P 202 porosity key was applied



BDG P202-%5/⌀2.5

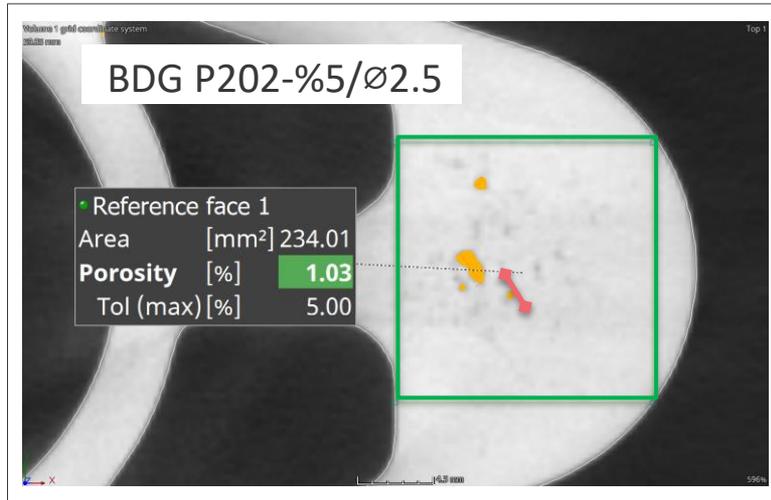| Reference face 1 | | |
|---|---|---|
| Area | [mm²] | 234.01 |
| **Porosity** | [%] | **1.03** |
| Tol (max) | [%] | 5.00 |

**Fig. 05: 2D Section with reference area in 3D CT volume data**
Source: Volume Graphics GmbH



## VDG - MERKBLATT

| Volumendefizite von Gußstücken aus Nichteisenmetallen | P 201 Mai 2002 |
|---|---|

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# Short History Lesson

> If the user altered the position of the inspection layer slightly, the **OK/NOK** decision might change as well
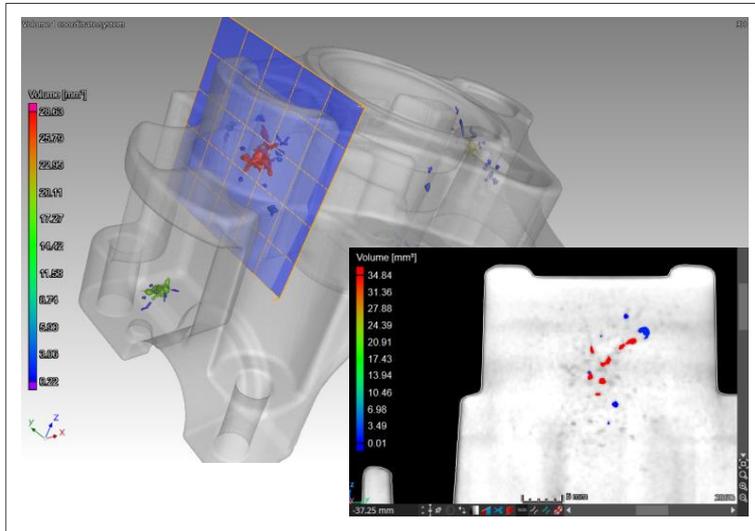


**Fig. 06: Altered position of 2D section plane in 3D CT volume data**
Source: Volume Graphics GmbH

# BDG Reference Sheet P 203

> The BDG Reference Sheet P 203 describes now cast part inspection for porosity in **3D**
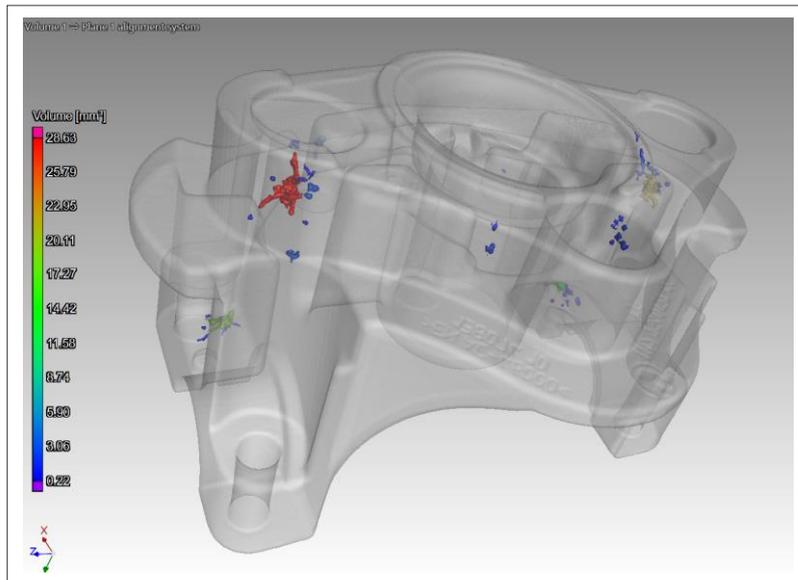


**Fig. 07: 3D CT volume data with detected porosity**
Source: Volume Graphics GmbH



**VDG - MERKBLATT**

| Volumendefizite von Gußstücken aus Nichteisenmetallen | P 201 Mai 2002 |

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Stand: 12. Dezember 2019

Porositätsanalyse und -beurteilung mittels industrieller Röntgen-Computertomographie (CT)

# BDG Reference Sheet P 203

**Example for P 203 porosity inspection**

> Define the cast part areas in 2D/3D CAD for later porosity inspection

> Hollow cylinder for functional area with Ø 26 H6 and 3.0 mm inspection thickness

> This example is namend "ROI 2" (Region-of-Interest #2)

> Define **porosity key** acc. BDG P 203 for this example:

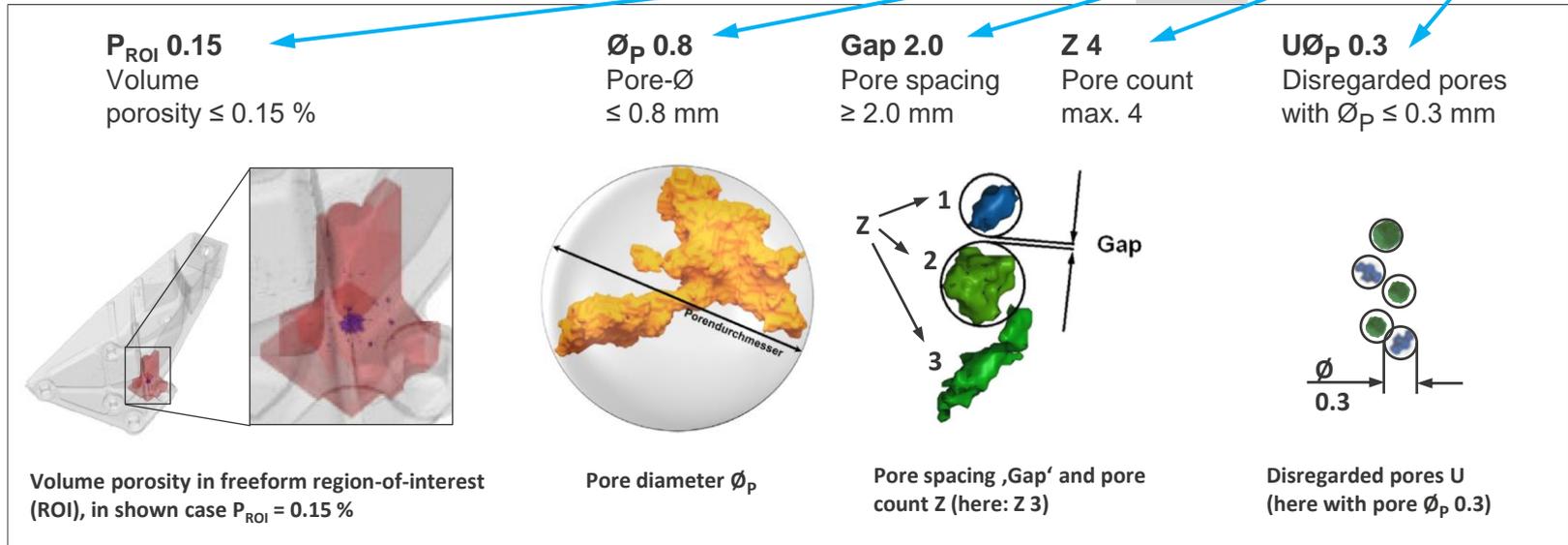$P_{ROI}$ 0.15 / $Ø_p$ 0.8 / Gap 2.0 / Z 4 / $UØ_p$ 0.3
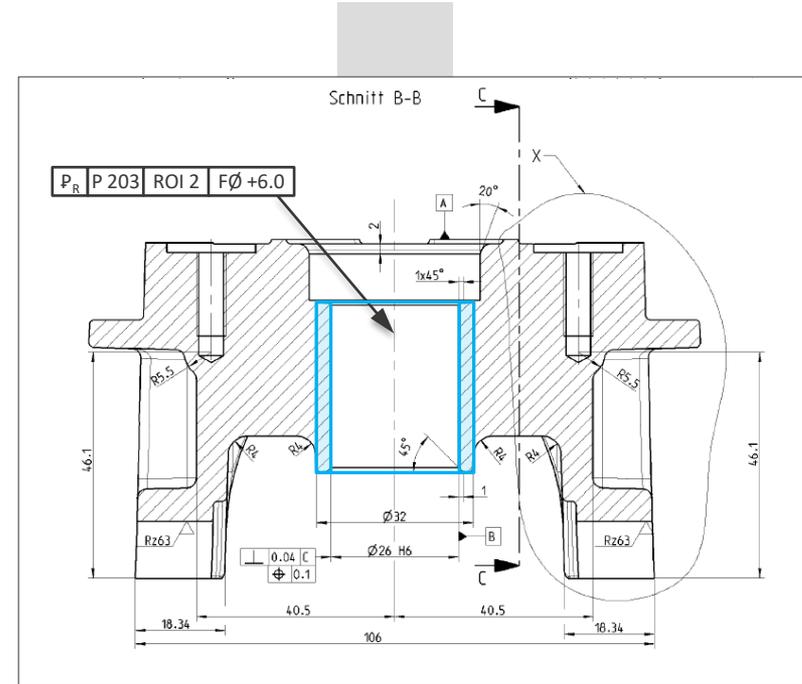


**Fig. 08: Drawing section with porosity inspection sample**
Source: Volume Graphics GmbH

# BDG Reference Sheet P 203

**Explanation for P 203 Porosity Key example:** Ø 26 H6 (ROI 2)

$P_{ROI}$ 0.15 / $Ø_p$ 0.8 / Gap 2.0 / Z 4 / $UØ_p$ 0.3



**$P_{ROI}$ 0.15**
Volume
porosity ≤ 0.15 %

**$Ø_P$ 0.8**
Pore-Ø
≤ 0.8 mm

**Gap 2.0**
Pore spacing
≥ 2.0 mm

**Z 4**
Pore count
max. 4

**$UØ_P$ 0.3**
Disregarded pores
with $Ø_P$ ≤ 0.3 mm

**Volume porosity in freeform region-of-interest (ROI), in shown case $P_{ROI}$ = 0.15 %**

**Pore diameter $Ø_P$**

**Pore spacing ‚Gap' and pore count Z (here: Z 3)**

**Disregarded pores U (here with pore $Ø_P$ 0.3)**

**Fig. 09: P 203 Porosity key sample explanation**
Source: BDG Reference Sheet P 203 & Volume Graphics

# Porosity Analysis with VGSTUDIO MAX
## acc. BDG Reference Sheet P 203

**Porosity Inspection Workflow**

> Start CT equipment & VGSTUDIO MAX

> Scan the cast part

> Load 3D CT voxel data (VGL file)

> Perform Surface Determination and "EasyPore" Porosity Detection
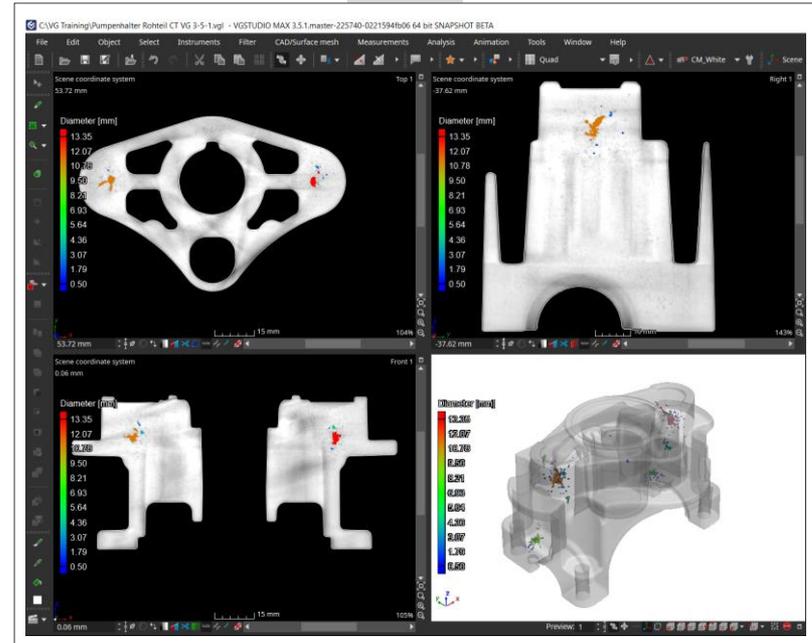
> Start Porosity Analysis "P 203"



**Fig. 10: Porosity analysis result**
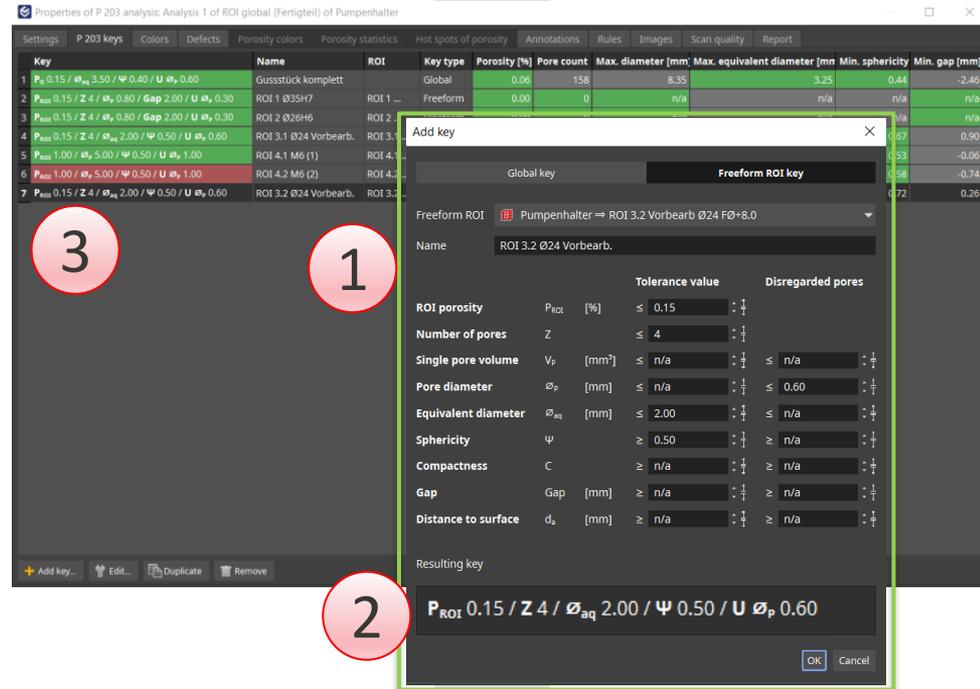Source: Volume Graphics GmbH

# Porosity Analysis with VGSTUDIO MAX
## acc. BDG Reference Sheet P 203

**(1) Apply the BDG - P 203 porosity key**

- intuitive via the input mask "P 203 key"
- porosity parameters acc. to a porosity inspection plan or technical drawing
- for $P_G$ global (complete cast)
- for $P_{ROI}$ (free defined sub-volumes)

**(2)** Direct display of the BDG - P 203 porosity key, resulting from the value inputs

**(3)** Tabular display of the porosity inspection results incl. the BDG - P 203 porosity key in 1$^{st}$ column



**Fig. 11: Porosity key input mask**
Source: Volume Graphics GmbH

# Porosity Analysis with VGSTUDIO MAX
## acc. BDG Reference Sheet P 203

**Results from the porosity analysis**

> are clearly displayed in the 3D window for each examined area in the scanned cast

> including the "P 203" porosity key used

> and including the green/red colored OK/NOK evaluations

**Finally create Inspection Report**

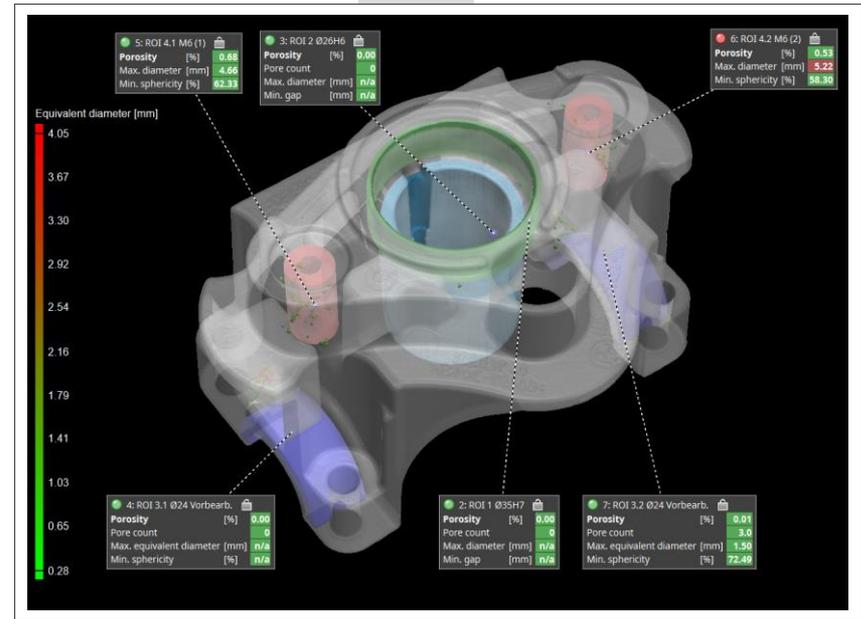> including listing of all porosity keys according to BDG - P 203



**Fig. 12: 3D view of Porosity analysis results**
Source: Volume Graphics GmbH

# Porosity Analysis with VGSTUDIO MAX
## acc. BDG Reference Sheet P 203

**Your added value with 3D iCT and Porosity Analysis P 203**

> Elimination of time-consuming manually performed porosity inspections

**Hand-crafted porosity inspection** without CT porosity analysis ➜ **approx. 120 to 150 minutes**

| cut casting segments | prepare casting segments (machine/grind & polish) | microscopic examination & pore count | create pictures | prepare pictures and create report |

**Semi-automatic CT inspection** ➜ **approx. 5 to 15 minutes**

| 3D CT scan incl. 3D porosity analysis & report |

➜ **Ø Time savings: up to 95 %** !
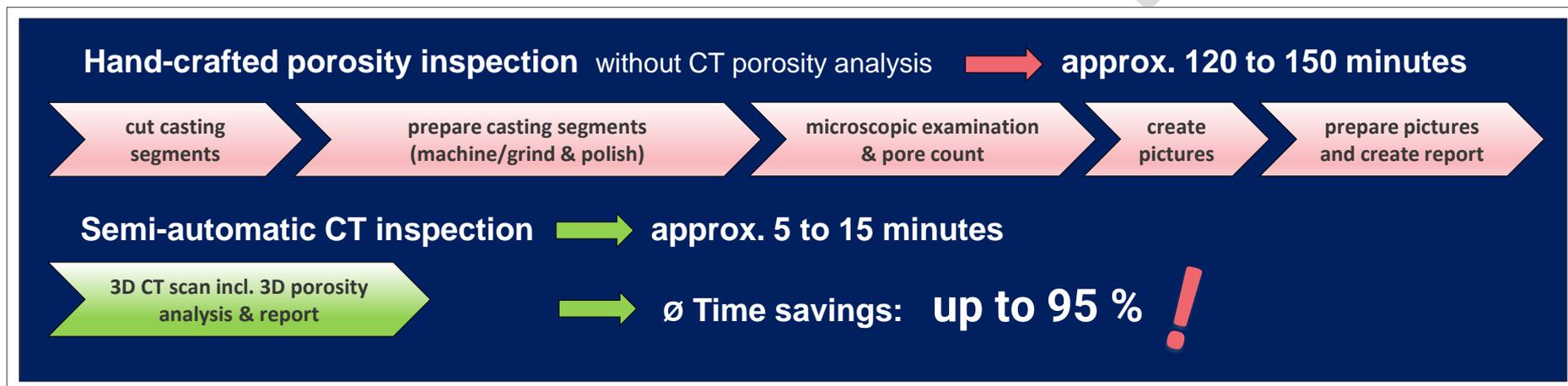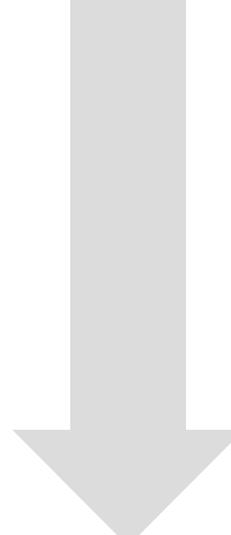
**Fig. 13: Time savings with CT porosity inspection**
Source:  Volume Graphics GmbH

# Porosity Analysis with VGSTUDIO MAX
## acc. BDG Reference Sheet P 203

> **BDG Reference Sheet P 203**
> - describes test method for the 3D determination and assessment of volume deficits
> - opens new approaches for quality monitoring using industrial CT in the foundry

> **The Porosity Key acc. to BDG Reference Sheet P 203**
> - simplifies a porosity specification
> - can be integrated in 2D and 3D CAD
> - enable transparent test regulations for suppliers and customers

▶ **Ready for BDG Reference Sheet P 203 compliant inspection of cast parts**

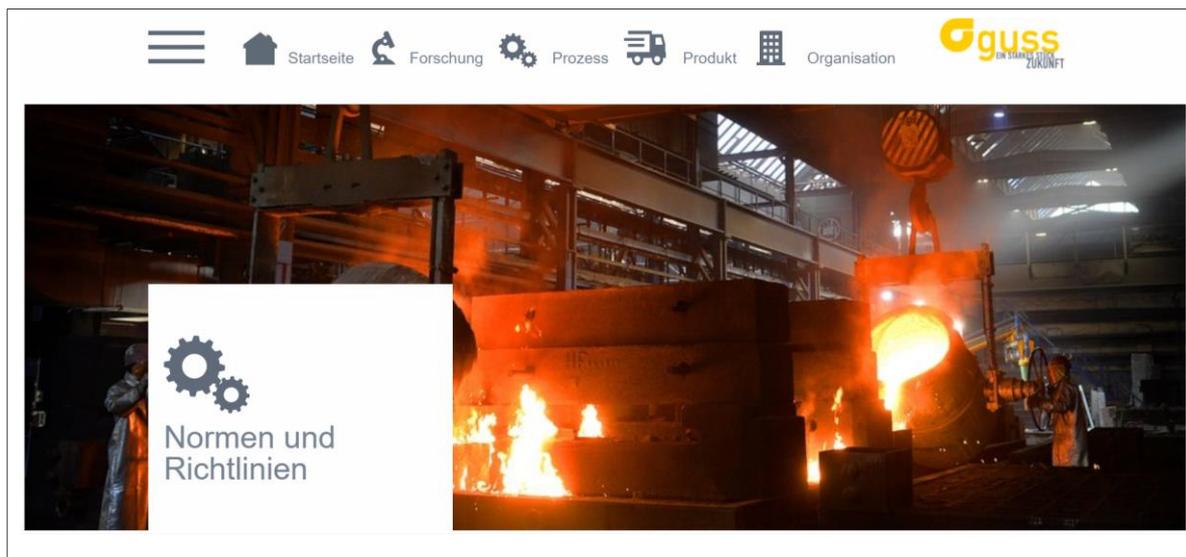# Porosity Analysis with VGSTUDIO MAX
## acc. BDG Reference Sheet P 203

> **The results of the porosity analysis acc. to BDG Reference Sheet P 203**

- lead to dedicated OK and NOK decisions
- can be exported and used for
    - statistical evaluations (SPC)
    - process capability analyzes ($C_p/C_{pK}$)
    - trend analysis
    - casting process optimization
    - traceability
    - strength calculations and simulations

▶ **Ready for BDG Reference Sheet P 203 compliant inspection of cast parts**

# Porosity Analysis with VGSTUDIO MAX
## acc. BDG Reference Sheet P 203

BDG Reference Sheet P 203

Download link:
https://www.guss.de/prozess/normen-und-richtlinien



Fig. 14: BDGuss Website
Source: www.guss.de

▶ **Ready for BDG Reference Sheet P 203 compliant inspection of cast parts**

# Porosity Analysis with VGSTUDIO MAX
## acc. BDG Reference Sheet P 203

> **Fully 3D analysis on CT data**

> **Non-destructive** inspection

> **High flexibility** for porosity inspection

> Clearly defined **inspection workflow**

> Standardized tolerance description with BDG - P 203 Porosity Keys

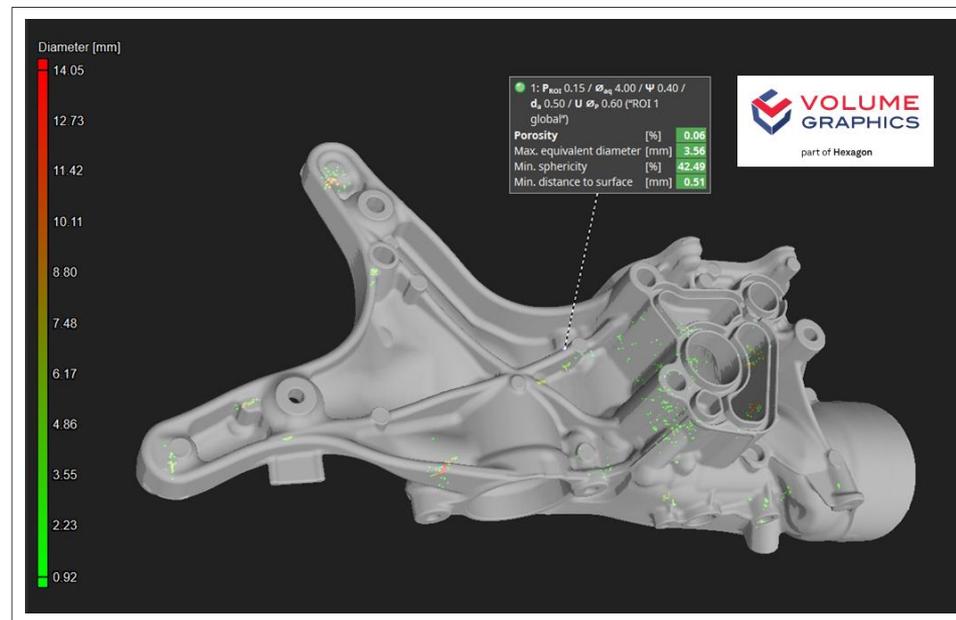> CT-scan quality: Automatic monitoring and documentation of Q-factor acc. BDG - P 203



**Fig. 15: Example with 3D view of „global" porosity analysis results**
Source: Volume Graphics GmbH

▶ **Ready for BDG Reference Sheet P 203 compliant inspection of cast parts**

# Porosity Analysis with VGSTUDIO MAX
## acc. BDG Reference Sheet P 203

> **Approved** Volume Graphics algorithms for reliable porosity detection

> Different porosity keys can be defined on **regions of special interest** (ROIs)

> ROIs can already be defined as volumes on **3D CAD** and imported to VGSTUDIO MAX

> **Porosity keys** are easy to generate

> Allows quality assessment **from product design to final production**
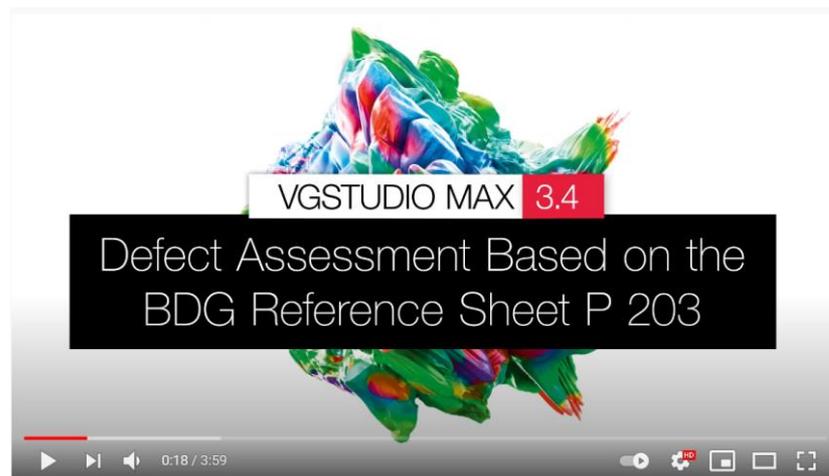


Link 1: Volumegraphics.com/en/products/vgstudio-max
Link 2: Video English
Link 3: Video Deutsch

> **Ready for BDG Reference Sheet P 203 compliant inspection of cast parts**

# Glück auf!

Do you have questions?

Give us a call:  +49 6221 73920 60

Or send us an e-mail to:  sales@volumegraphics.com

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