



Seeing beyond

Dalla Polvere alle Prestazioni

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ZEISS Industrial Quality Solutions

ZEISS Additive Manufacturing Solutions

RM Forum 2024
Museo Storico Alfa Romeo, Arese (MI)

ZEISS Group

Milestones & Financial Performance (30st Sept. 2023)

175
years



Revenue in € billion

10.1

EBIT in € billion

1.7

Revenue increase Vs. previous year

+15%

Patents Worldwide

11,300

R&D investments in € billion

1.5

Investment by % of revenue

15%



Carl Zeiss
Founder



Ernst Abbe
Partner

Founders Aspiration:

- Cutting-edge research
- Extreme precision and maximum quality
- Social responsibility
- Creating the Foundation

43,000 Employees

More than 100 Sites Worldwide

50 Countries

36

Nobel laureates
used ZEISS systems to advance
scientific progress

80%

of microchips worldwide
made on ASML lithography systems
with ZEISS optics

50

ZEISS Camera Lenses
were sent into space
during the NASA Apollo Mission

ZEISS Segments

Shaping the future (30st Sept. 2023)



Semiconductor
Manufacturing
Technology



3,555 € billion in revenue

Industrial
Quality & Research



2,295 € billion in revenue

Medical
Technology



2,504 € billion in revenue

Consumer
Markets

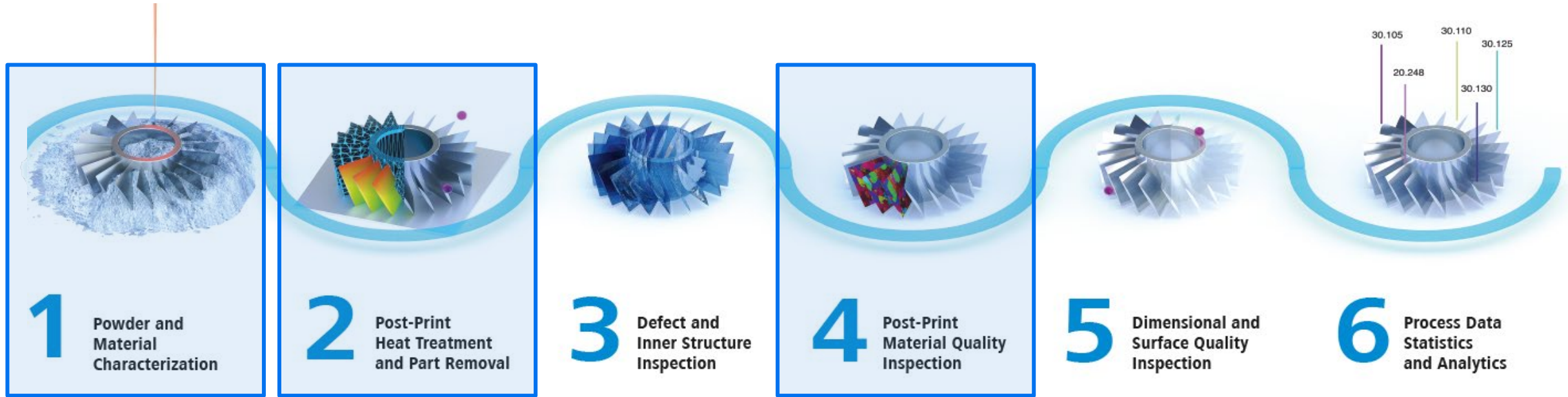


1,624 € billion in revenue

ZEISS Additive Manufacturing Solutions



La Blueline ZEISS segue il QC in tutte le fasi produttive dell'AM



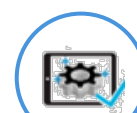
Light Microscopy (LM)



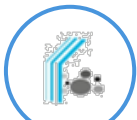
3D scanners



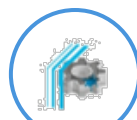
High precision measurement with CMM



Metrology & Data analysis softwares



Scanning electron microscopy (SEM)



Computer tomography & X-Ray microscopy

La Blueline ZEISS per l'Additive Manufacturing

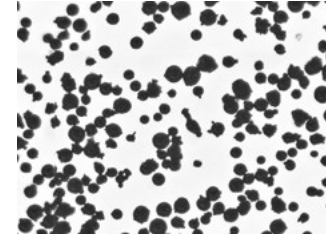
Caratterizzazione di Polveri e Materiali



Light Microscopy (LM)



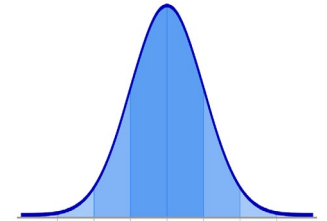
Quick powder sampling and reliable analysis of particle size distribution



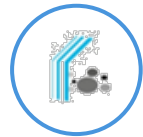
Metal powder in LM



Automated Segmentation



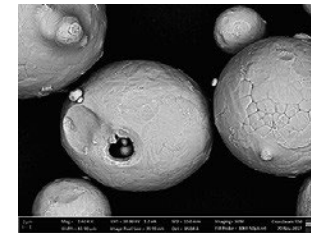
Particle size distribution



Scanning electron microscopy (SEM)



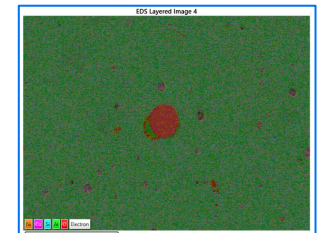
SEMs offer nanometer resolution and the ability to examine the atomic properties of powders



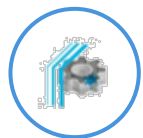
New powder



Recycled powder



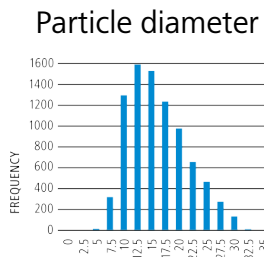
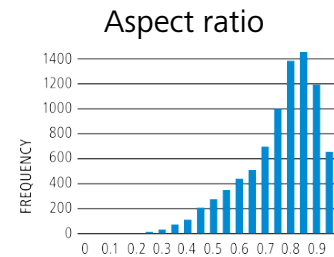
Element composition (EDS)



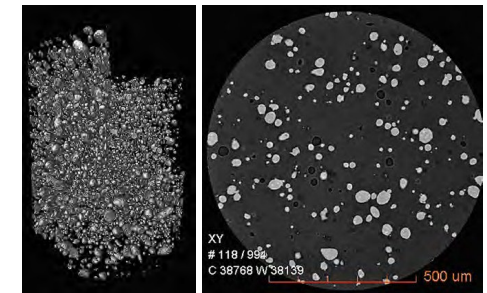
X-Ray microscopy (XRM)



X-rays allow detailed analysis of particle shape, size and volume distribution



8500+ particles analyzed for aspect ratio and diameter



La Blueline ZEISS per l'Additive Manufacturing

Trattamento Termico Post-Stampa e Rimozione delle Parti

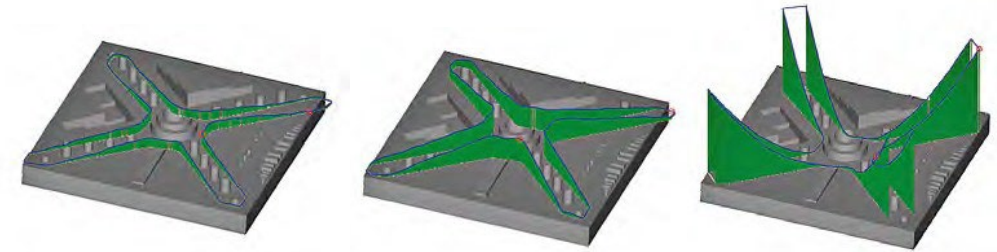


The form, size, and position of holes and features can be drastically affected by thermal stresses. The part could be within tolerance in as-built state, however, following heat treatment and part removal, significant distortions can be introduced.

As built		
	Nominal size	Deviation
TP 4mm ID +X.X	60.000	-0.019
TP 4mm ID +X.Y	0.000	0.000

After heat treatment		
	Nominal size	Deviation
TP 4mm ID +X.X	60.000	0.074
TP 4mm ID +X.Y	0.000	0.000

Removed from build plate		
	Nominal size	Deviation
TP 4mm ID +X.X	60.000	-0.187
TP 4mm ID +X.Y	0.000	0.000



As built

After heat treatment

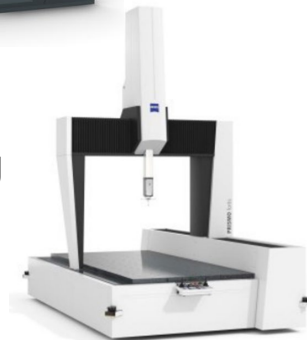
Removed from build plate and cleaned



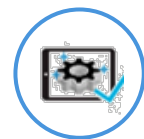
X-Ray CT



Coordinate Measuring Machines (CMMs)



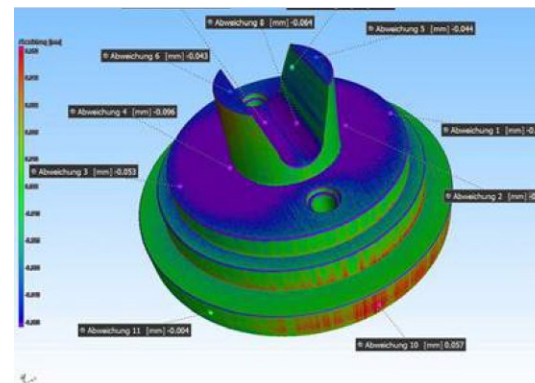
3D scanners



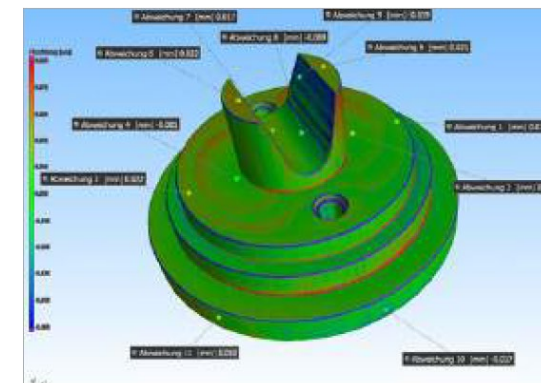
ZEISS Reverse Engineering

Correction of Print Input Data using ZRE

After the alignment of the nominal and actual data, the areas which must be corrected are automatically determined. After this correction loop, a watertight CAD / STL model can be provided to the 3D printer.



False color comparison (nominal/actual data) after first print



False color comparison (nominal/actual data) after first correction loop using ZRE

La Blueline ZEISS per l'Additive Manufacturing

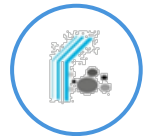
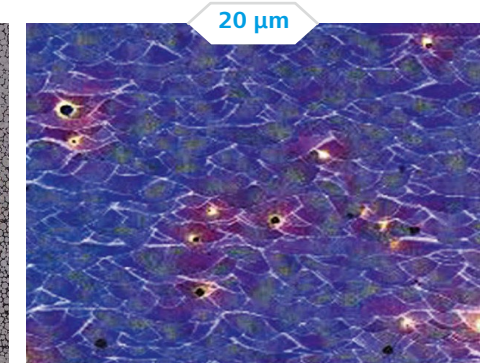
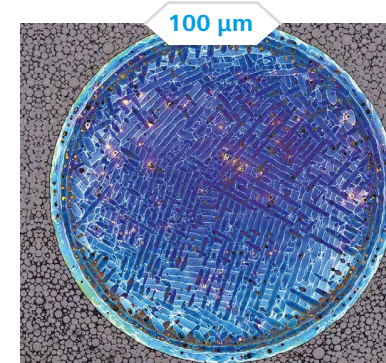
Controllo Qualità Post-Stampa



Light Microscopy (LM)



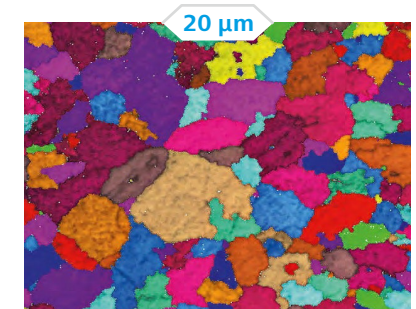
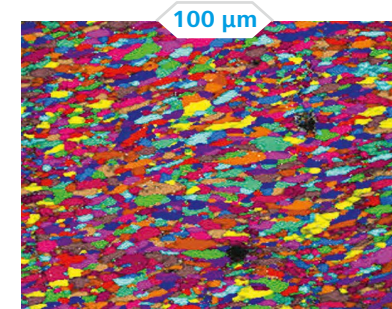
Scanning strategies and weld pools are among characteristic patterns which can be analyzed with optical microscopes and have a direct impact on mechanical properties



Scanning electron microscopy (SEM)



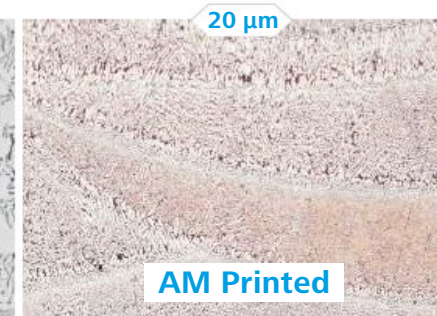
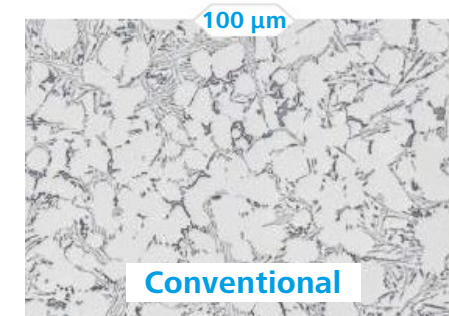
SEM with Electron Backscatter Diffraction (EBSD) allows for microstructural crystallographic characterization and study of crystalline or polycrystalline materials



Analysis of Grain Structure (via LM)

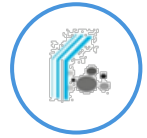


The grain structure produced by conventional means is very different from that of 3D printed parts of the same material. This difference will drastically influence the mechanical properties of the finished part



La Blueline ZEISS per la Manifattura Additiva

Siamo sicuri di sapere già tutto della metallografia applicata all'AM?

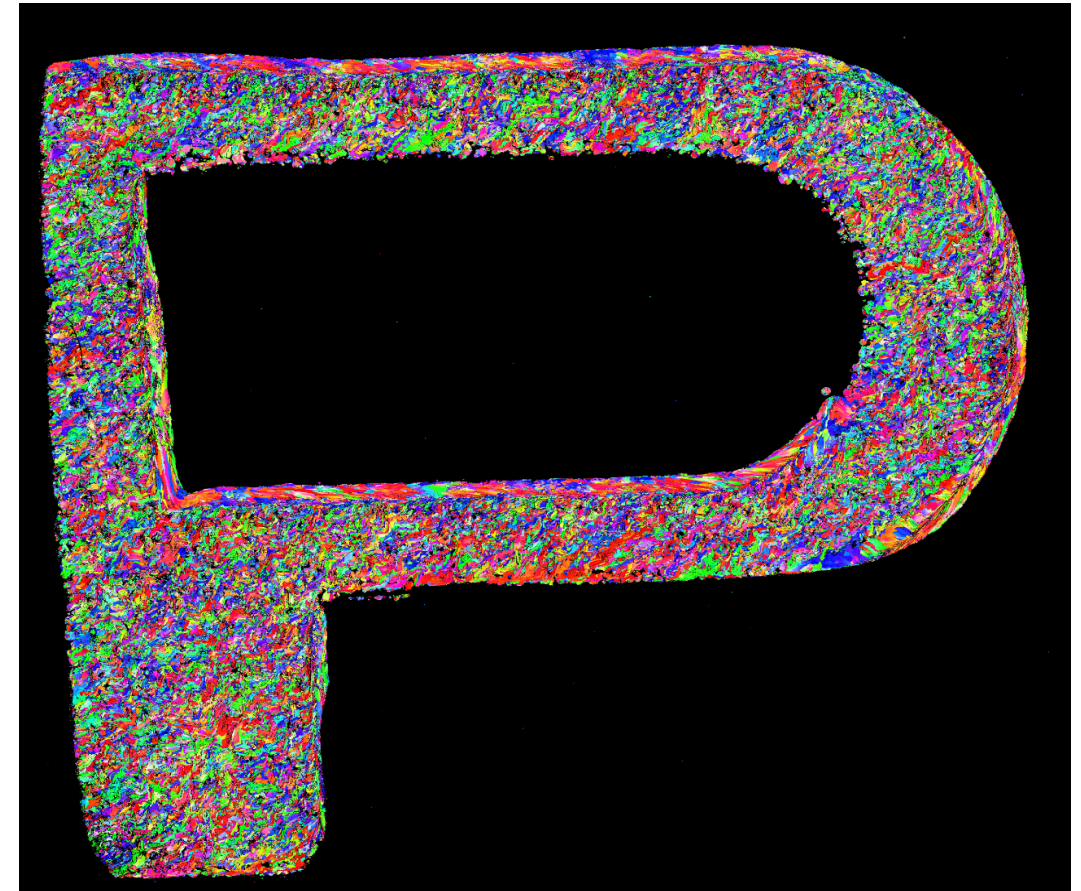
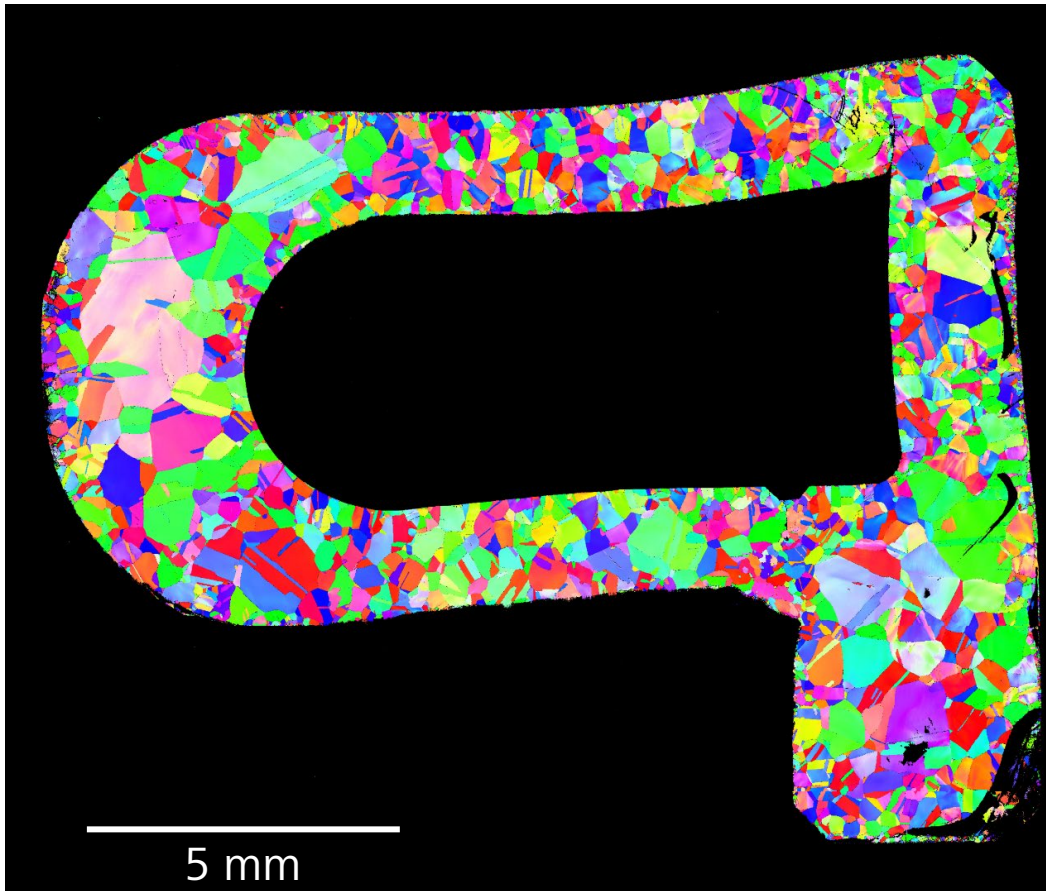


Scanning electron microscopy
(SEM-EBSD)

Copper coil

Conventional

AM Printed



L'Approccio ZEISS al Controllo Qualità

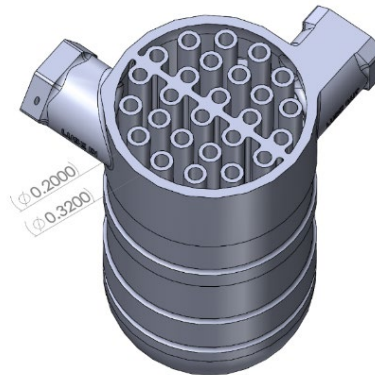
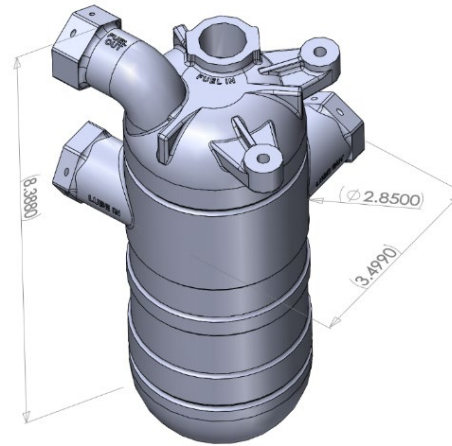


Caso di studio: Scambiatore di calore in AM per l'Aerospace

Scambiatori di calore impiegati per il raffreddamento dell'olio della turbina ed il contestuale preriscaldamento del carburante.

Questi radiatori hanno un **problema di approvvigionamento, elevato costo** dei pezzi di ricambio, **lunghi tempi di consegna** e conseguente **aumento della domanda**.

Nell'ambito del programma *America Makes*, UDRI e il Team AM stanno promuovendo lo studio per la **sostituzione degli scambiatori con modelli stampati in AM**.



L'Approccio ZEISS al Controllo Qualità

Caso di studio: Scambiatore di calore in AM per l'Aerospace



Misurazione e Analisi Multi-modale Correlativa del componente

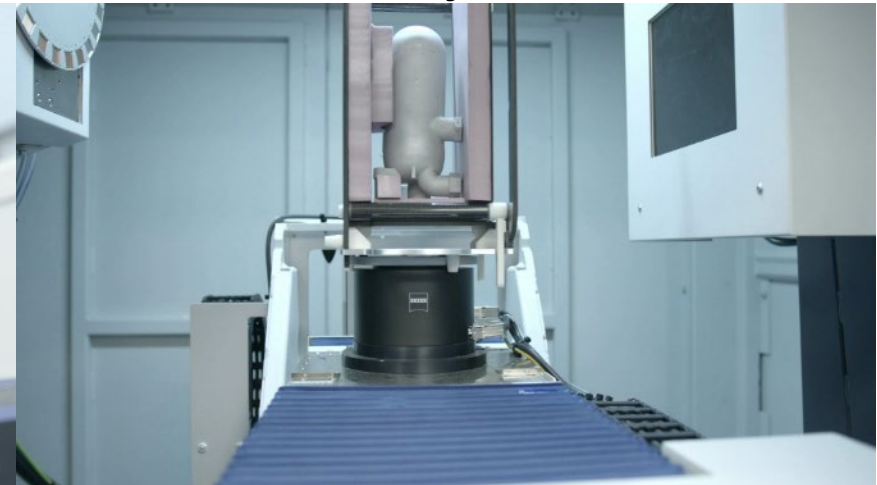
CMM



3D Scanner



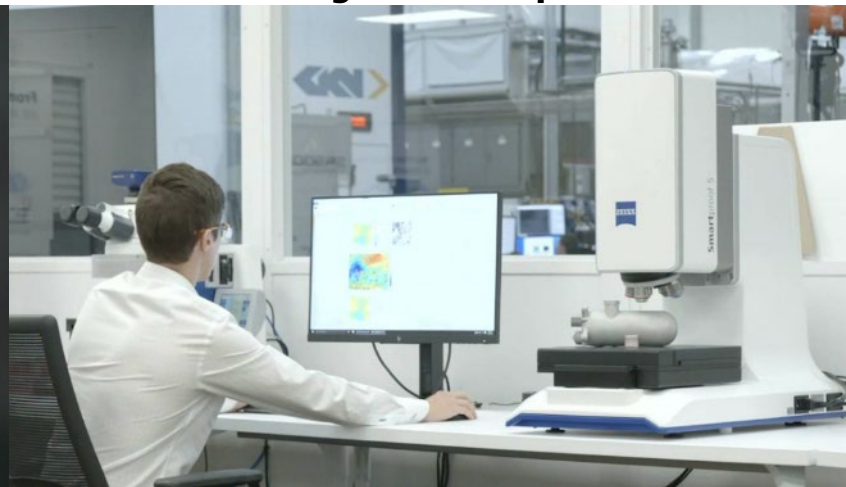
X-ray CT



Micro-CT



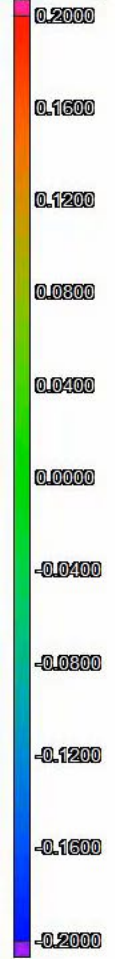
Light Microscope



SEM

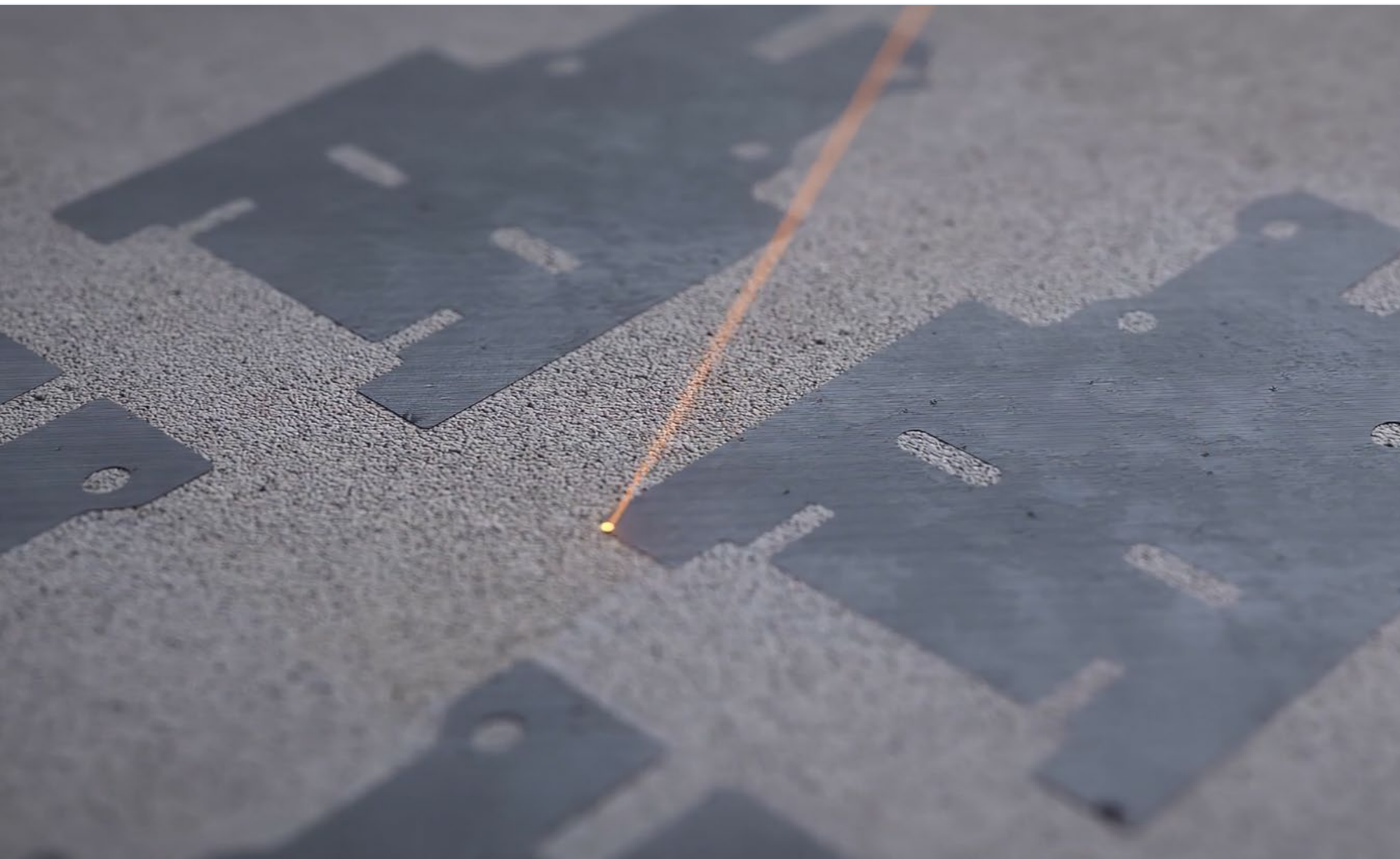


Deviation [mm]




ZEISS AM VERCES (AM parameter)

Qualifica rapida dei processi di stampa 3D



**Solution for rapid
print qualification**
ZEISS AM VERCES

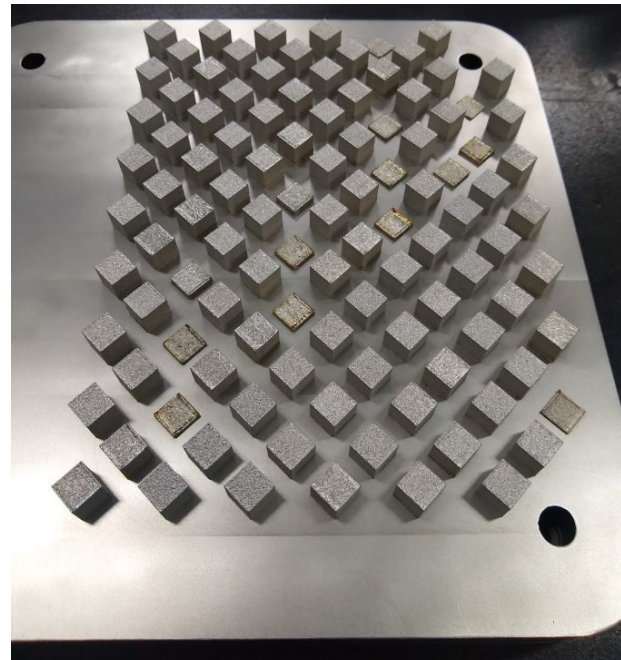
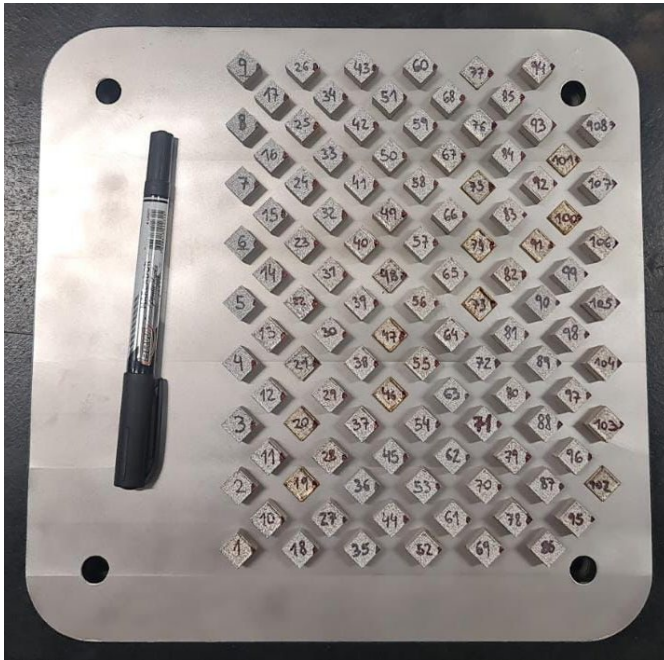


Seeing beyond

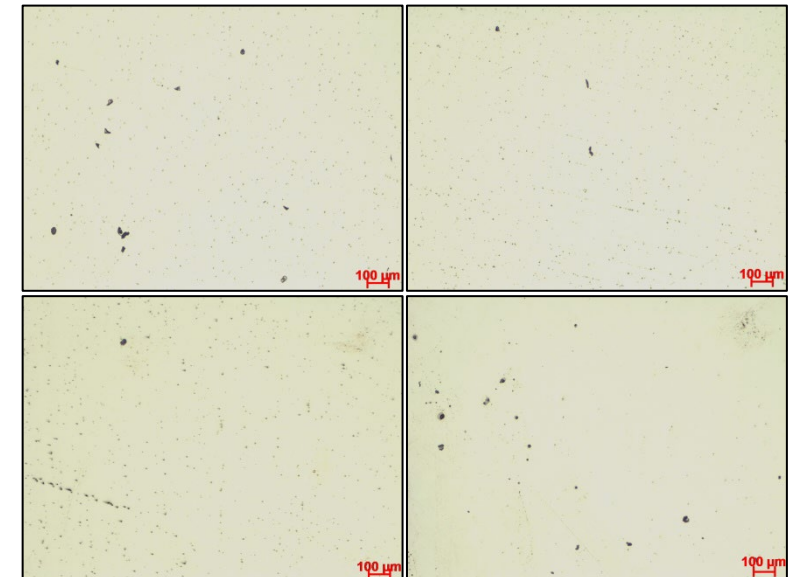
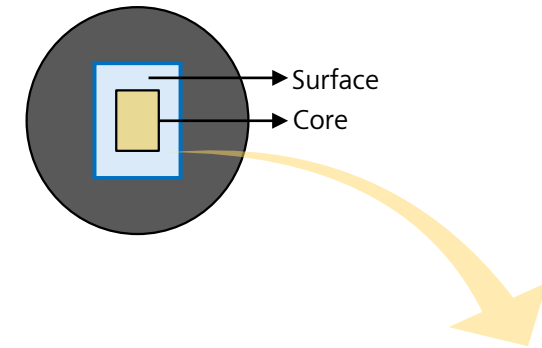
La messa a punto dei parametri per AM

Procedura standard

Cubic samples for new alloy development



Samples are cut, mounted in resin, ground and polished



Long and tedious process involving multiple manual steps

ZEISS AM VERCES

La soluzione ZEISS per la messa a punto ed il controllo dei processi di stampa



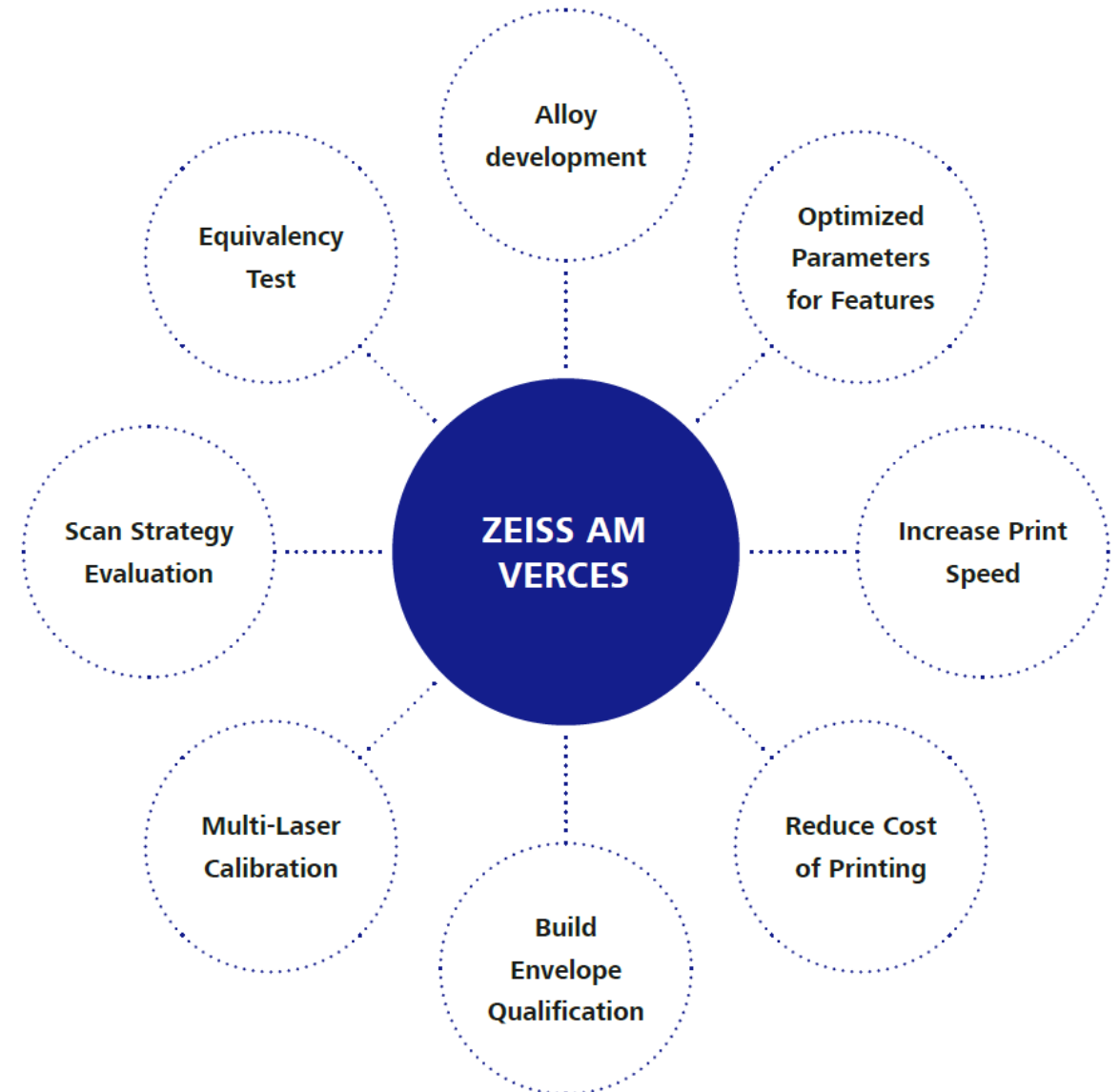
ZEISS AM VERCES is a fast, easy to use solution for process parameter qualification: new developments, optimization and standardization recipes

Reducing time to good parameters from weeks down to a day

Fast and reproducible evaluation of

- Porosity
- Pore morphology
- Geometric deformation in 3D

using a proprietary automated CT-based workflow.

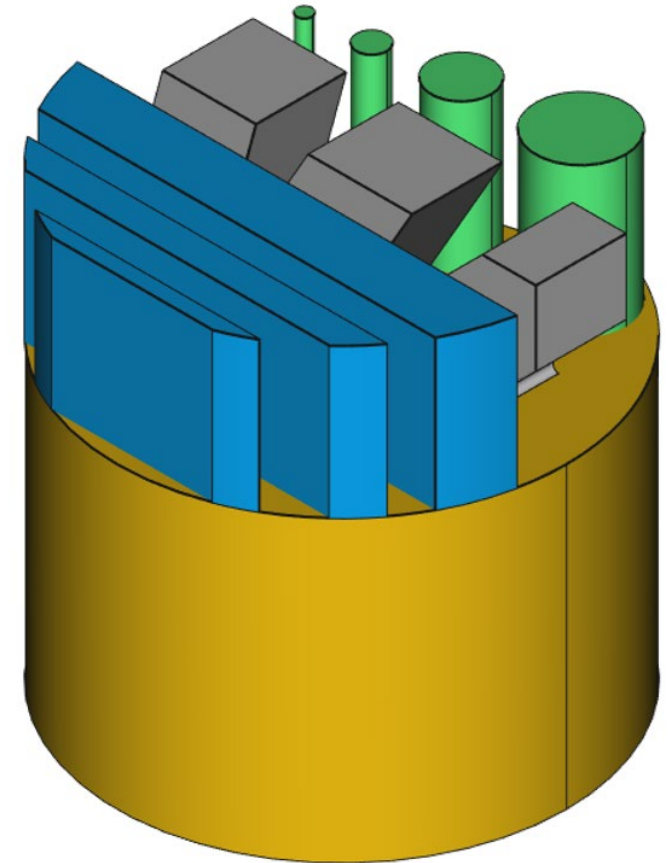


ZEISS AM VERCES

Standard di stampa: ZEISS Test Object (ZTO)



Section	Description
All Defects	Entire Sample
Outer Defects	500µm thick shell from surface representing contour
Inner Defects	Sample with 500µm outer shell excluded
Body	15mm Diameter x 10mm Tall Cylinder forming the base
Rod1	0.5mm Diameter x 5mm Tall Cylinder
Rod2	1.0mm Diameter x 5mm Tall Cylinder
Rod3	2.0mm Diameter x 5mm Tall Cylinder
Rod4	3.0mm Diameter x 5mm Tall Cylinder
Fin1	0.5mm Thick * 5mm Tall Fin / Wall
Fin2	1.0mm Thick * 5mm Tall Fin / Wall
Fin3	2.0mm Thick * 5mm Tall Fin / Wall
Fin4_15	3.0mm x 3.0mm cross section prism inclined at 15°
Fin4_30	3.0mm x 3.0mm cross section prism inclined at 30°
Fin4_45	3.0mm x 3.0mm cross section prism inclined at 45°

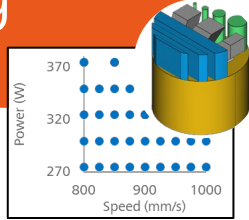


ZEISS AM VERCES

Flusso di lavoro automatizzato



Design of experiment and printing



Next Iteration

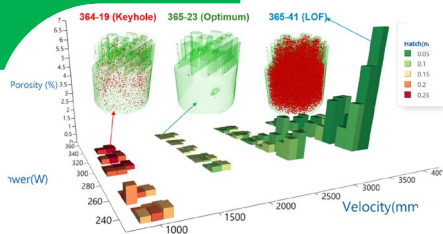
ZTO artifacts removed and shipped to ZEISS



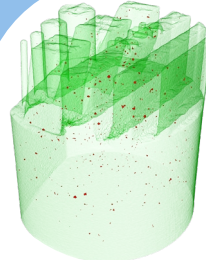
X-ray CT scan in dedicated holder



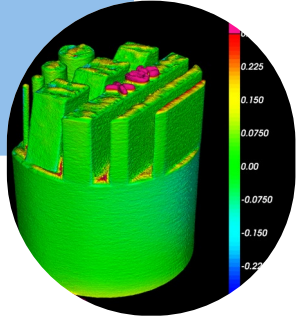
Interactive report to help determine the next iteration



Segmentation of pores and cracks



Automatic sample recognition (OCR) & CAD comparison for dimensional accuracy

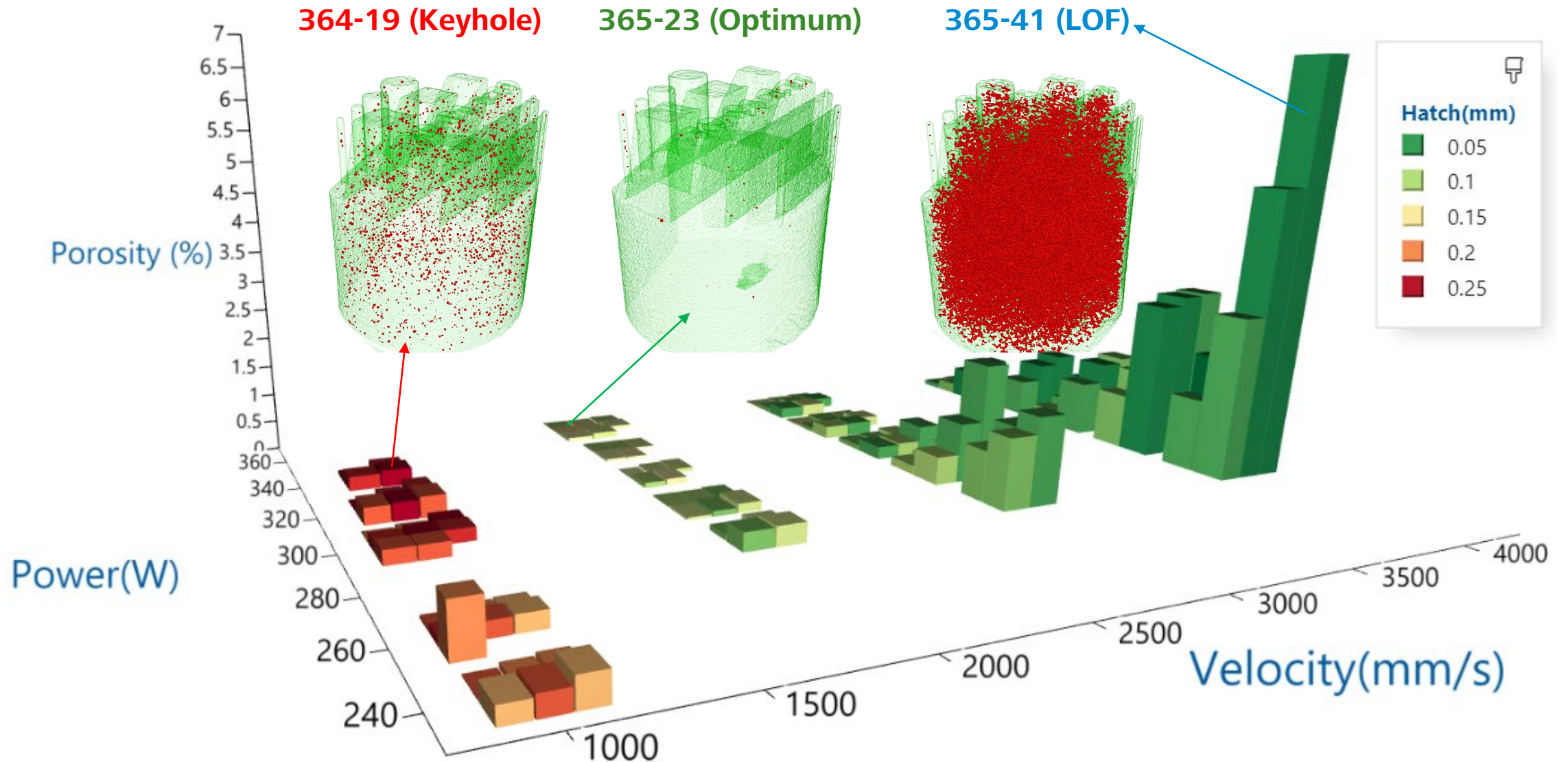


User Controlled Scanning
Image Processing
Report Results

ZEISS AM VERCES per la minimizzazione della Porosità

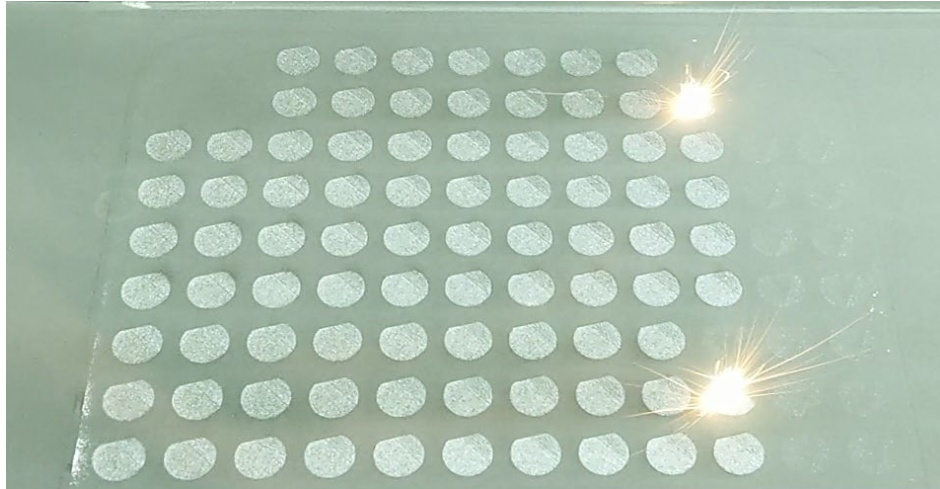


Comparazione della Porosità complessiva vs. Laser Power



ZEISS AM VERCES per la Laser Performance

Caratterizzazione rapida di sistemi single o multi-laser

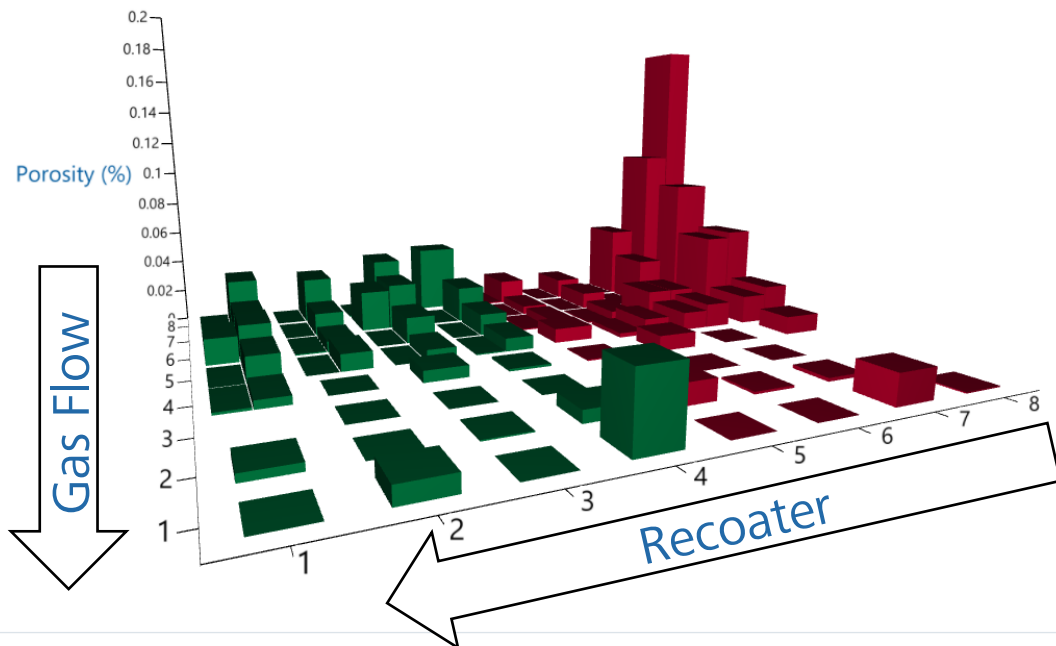


Multi-laser systems can rapidly produce large parts, however, part failure can be expensive

Quickly evaluate build performance of each laser with ZEISS AM VERCES

- Overlap regions evaluation
- Build envelope evaluation / laser
- Laser performance

Using ZEISS VERCES prior to a large build can help reducing build failure



ZEISS AM VERCES per l'uso di nuove polveri



Riduzione dei costi di processo con impiego di polveri riciclate

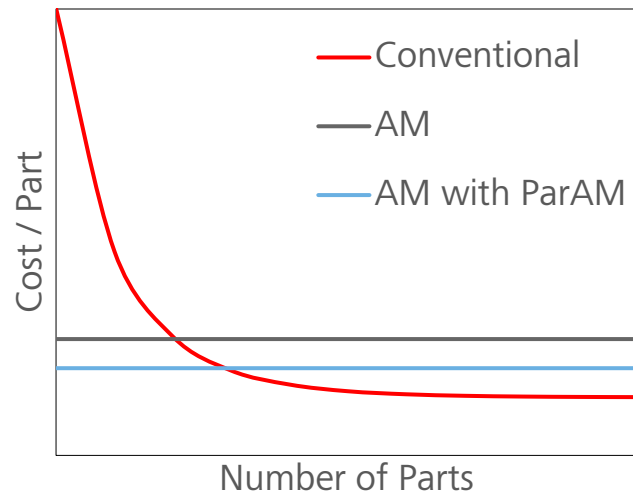


Produce defect free parts with low-cost powders
ZEISS AM VERCES can enable printing with

- Recycled powders
- Non-spherical powders
- Polydisperse in size powders

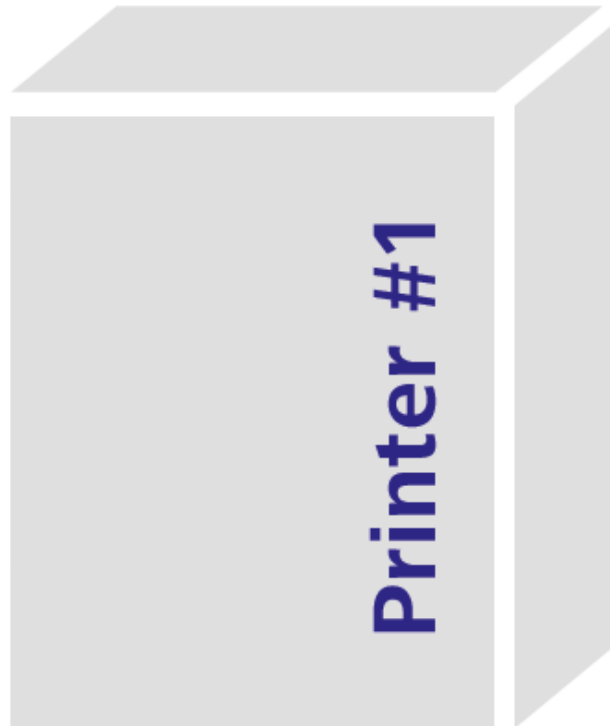
ZEISS AM VERCES allows to build your own optimal print parameter library for every situation

ZEISS AM VERCES could further reduce cost/part by printing with low-cost raw materials at optimized print parameters

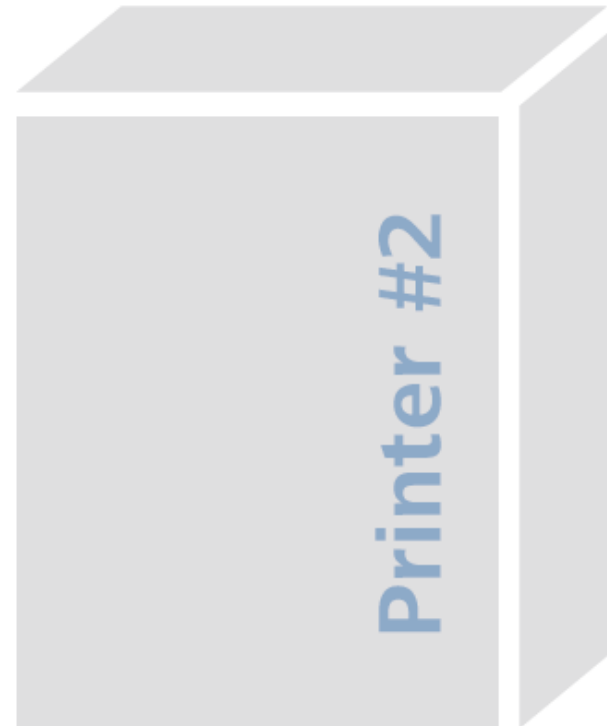


ZEISS AM VERCES per l'Equivalenza di Stampa

Valutare il funzionamento di macchine in siti diversi e nel tempo



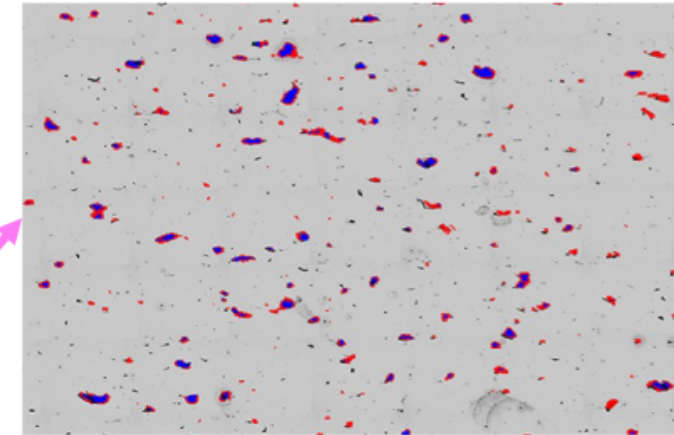
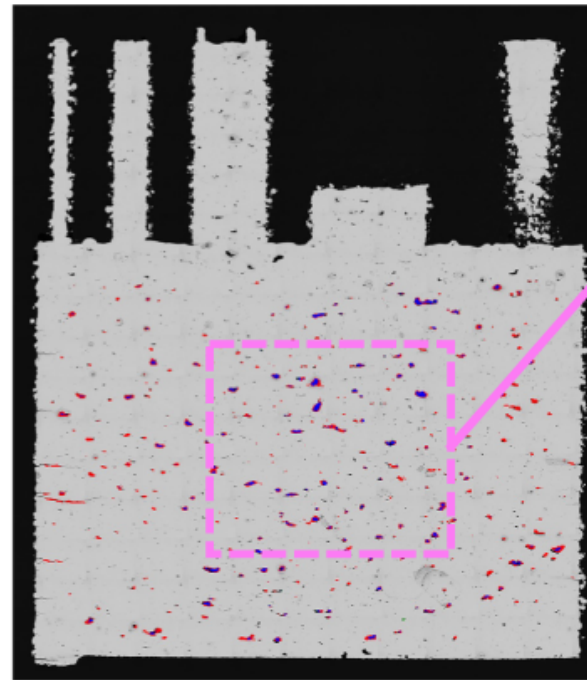
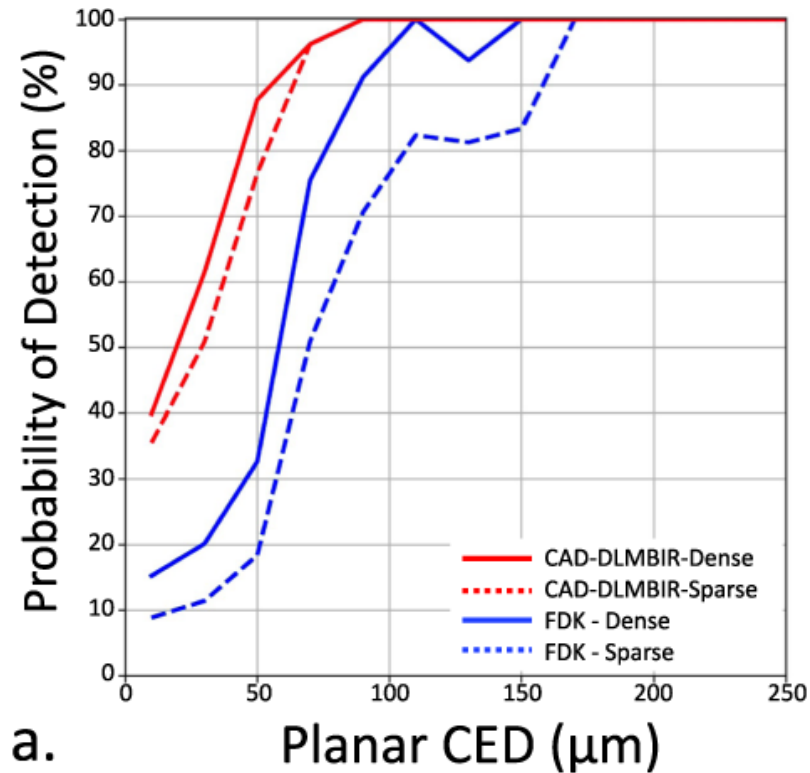
- Laser Parameters
- Powder Parameters
- Build plate parameters
- Gas Flow Parameters
- Recoater Parameters
- ...



- Laser Parameters
- Powder Parameters
- Build plate parameters
- Gas Flow Parameters
- Recoater Parameters
- ...

ZEISS AM VERCES: Quanto è affidabile?

Comparazione con lo stato dell'arte



- FDK-Dense and CAD-DLMBIR-Sparse
- Only CAD-DLMBIR-Sparse
- Only FDK-Dense (1 pixel!)

b. XCT Defects overlaid on Optical Microscopy



Seeing beyond

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