



WIR DURCHSCHAUEN TECHNIK!

User Group Meeting Volume Graphics 12.9.2018

Efficient Optimization of Injection Moulds using Computed Tomography and VGSTUDIO MAX

Dipl. - Ing. Steffen Hachtel



Who is Hachtel?



50 employees in Aalen /
Germany

Customers in all business
areas:

Automotive

White appliances

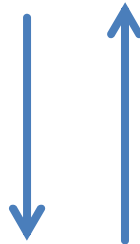
Aircraft

Electronics

Medicine

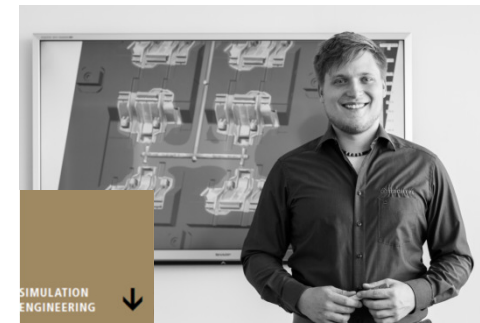
Etc.

Computed Tomography



Injection Moulding

Virtual Injection Moulding



Mould Making



BorgWarner

AUTOMOTIVE SYNERGIES



BRITA



AIRBUS
HELICOPTERS



AIRBUS
GROUP

fischer
AUTOMOTIVE SYSTEMS

MAHLE

preh



ebm**papst**

B/S/H/
BSH BOSCH UND SIEMENS HAUSGERÄTE GMBH

MHC
FAHRZEUGTECHNIK

MAHLE
BEHR



Deutsches Zentrum
für Luft- und Raumfahrt

CeramTec
THE CERAMIC EXPERTS



TRW

APWORKS
by Airbus Group

FÖHL

Continental

BOSCH



IMS:GEAR

Nestlé

GKN AEROSPACE

L'orange
YOUR POWERFUL INJECTION



ZOLLERN



Berlin Heart®

elringklinger

PÖPPELMANN



hangrohe

OECHSLER

uvex

GARDENA

bürkert

GWP

Amphenol



Webasto

WITZENMANN



ITT



Ticona

OSRAM

STAEDTLER



TAKATA

Industrial computed tomography

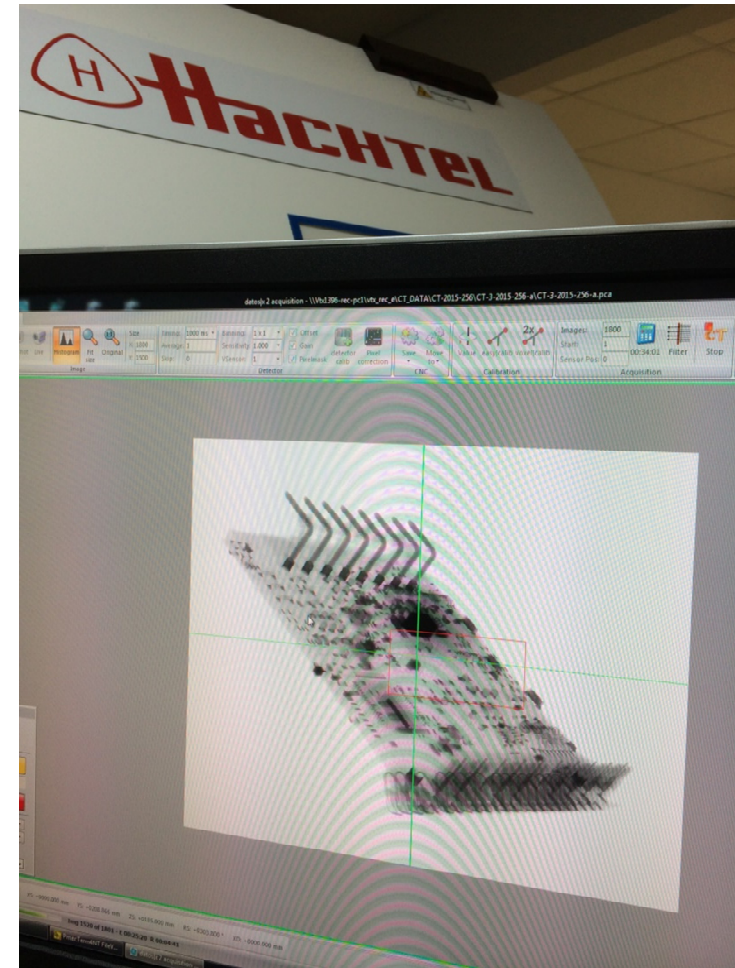


Established in 2008

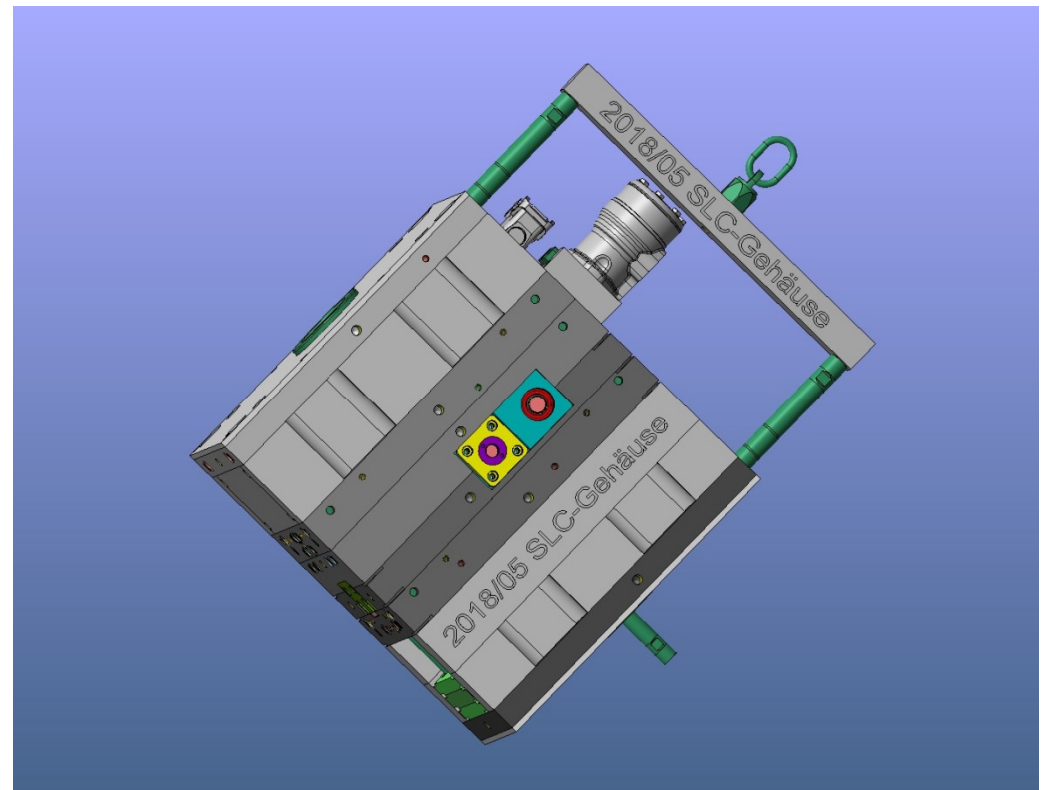
Pioneer user of the technology in the moulding business

5 CT facilities, 7 employees

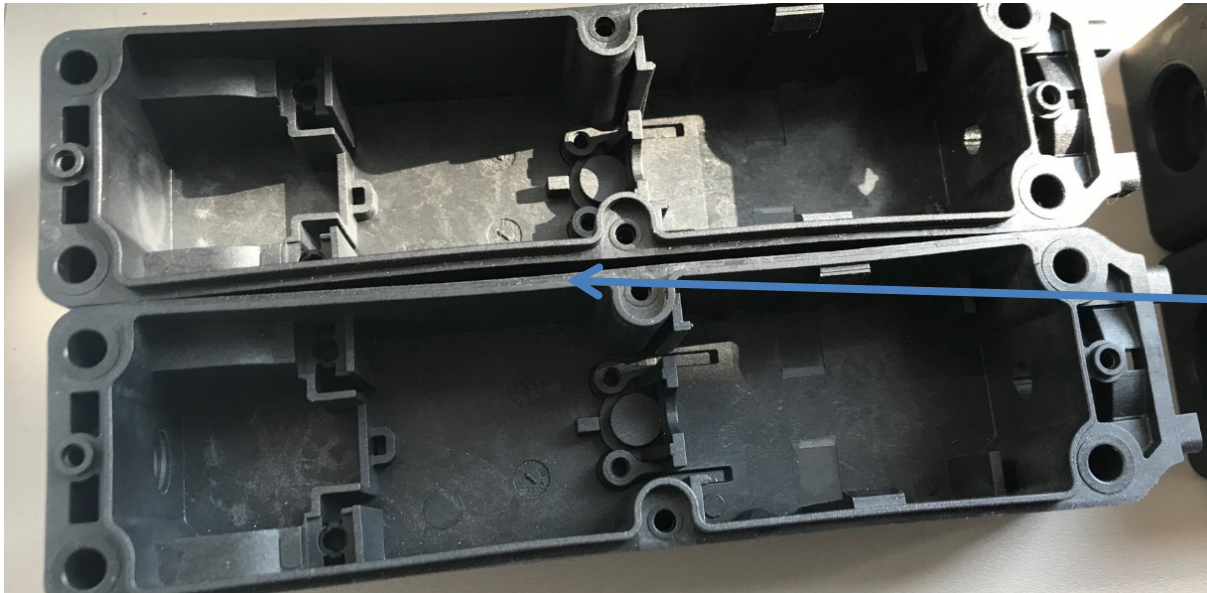
Workshops und coaching



The customer usually orders an injection mould...



... but in reality, he is not interested in the mould but in the parts only...



And the parts do not look alright!!

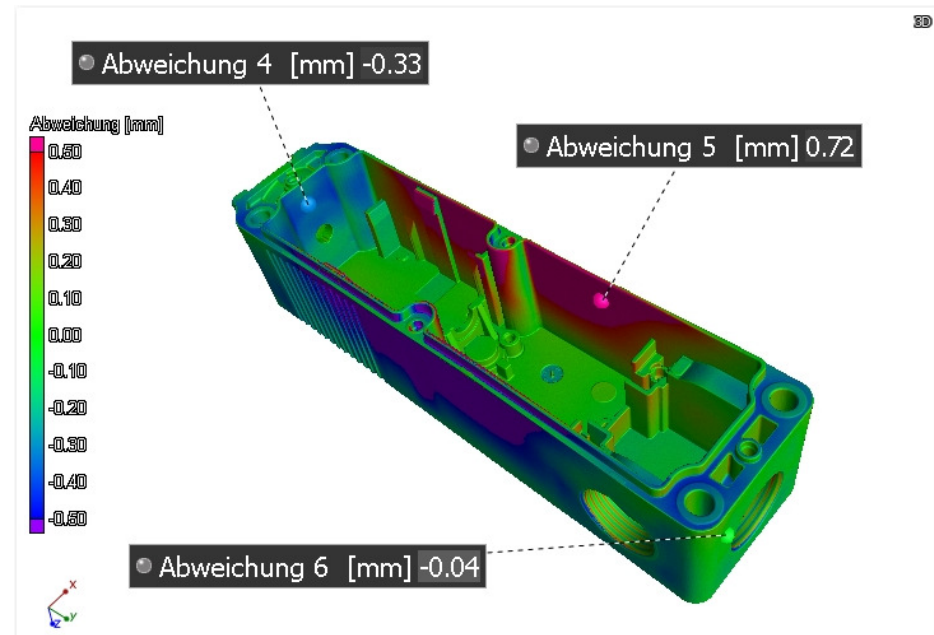
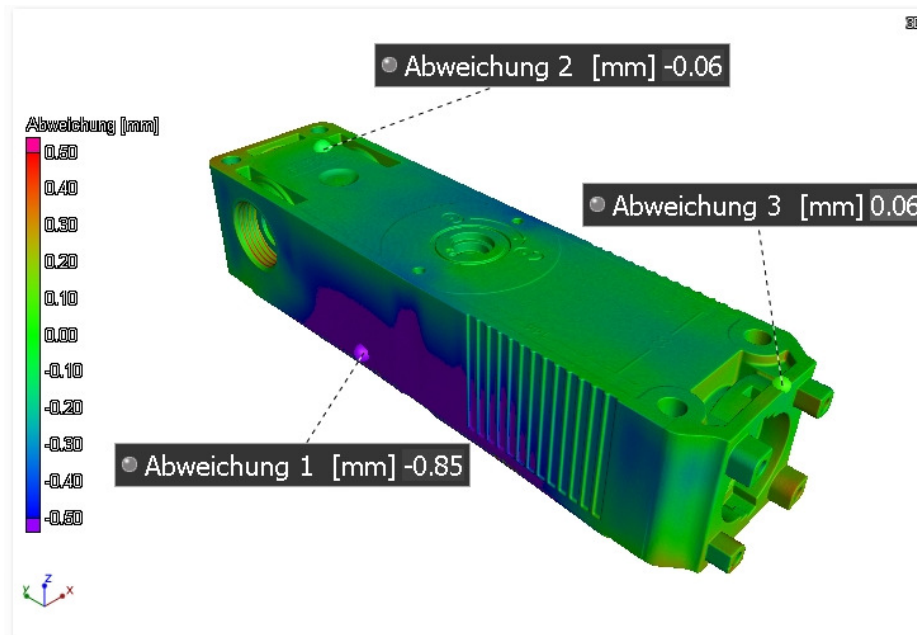
“A friendly dialog between mould maker, moulder and customer begins”

Mould makers are used to being scapegoats in the process chain and held responsible for all physical warpage effects.

Nominal/actual comparisons with VG and CT Data

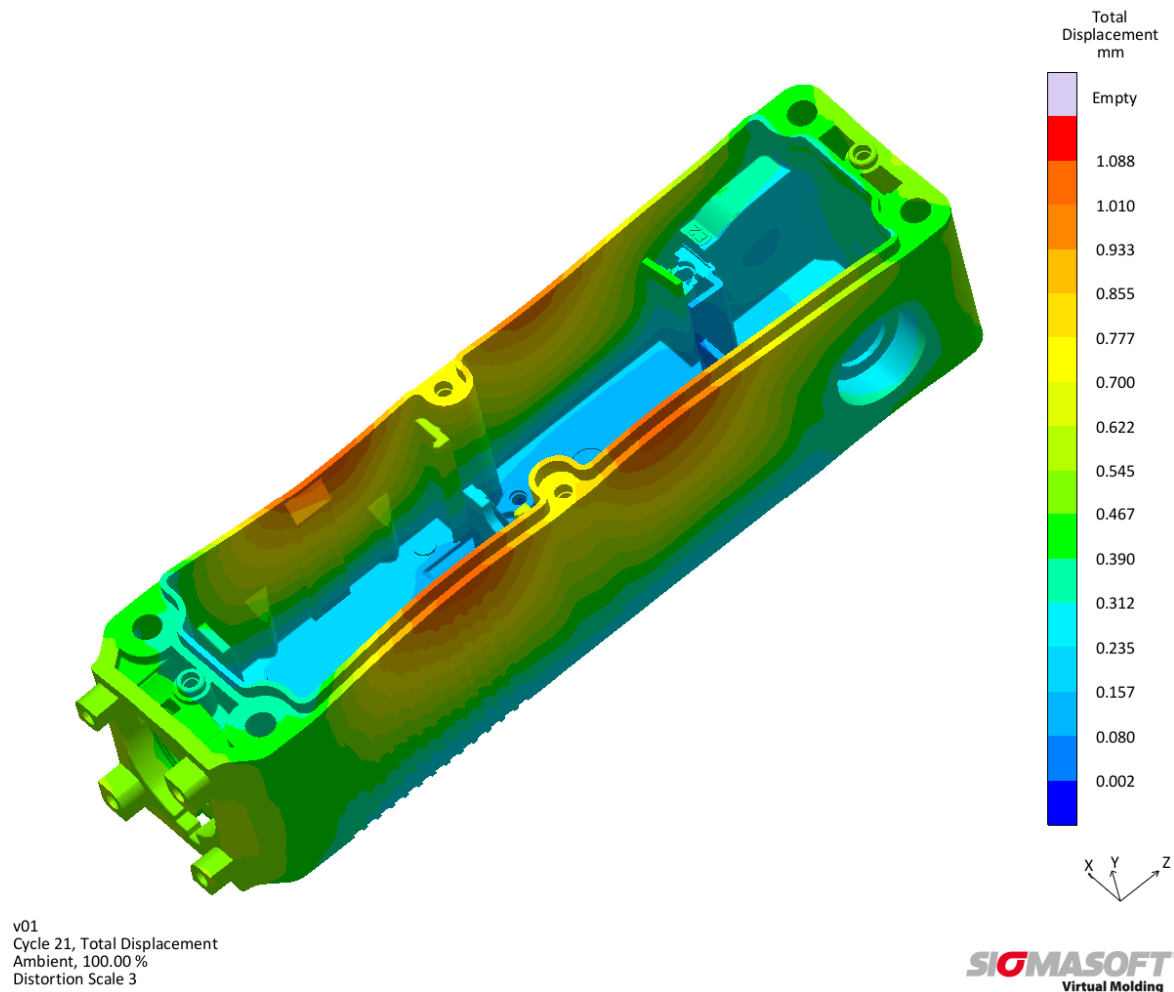
More than 0,7 to 0,8 mm deviation, assembling cannot be carried out

Baseline of the story: A perfect mould, but unusable parts.



However:

Simulation shows that warpage effects are a result of the geometry and material selection and not the mould design

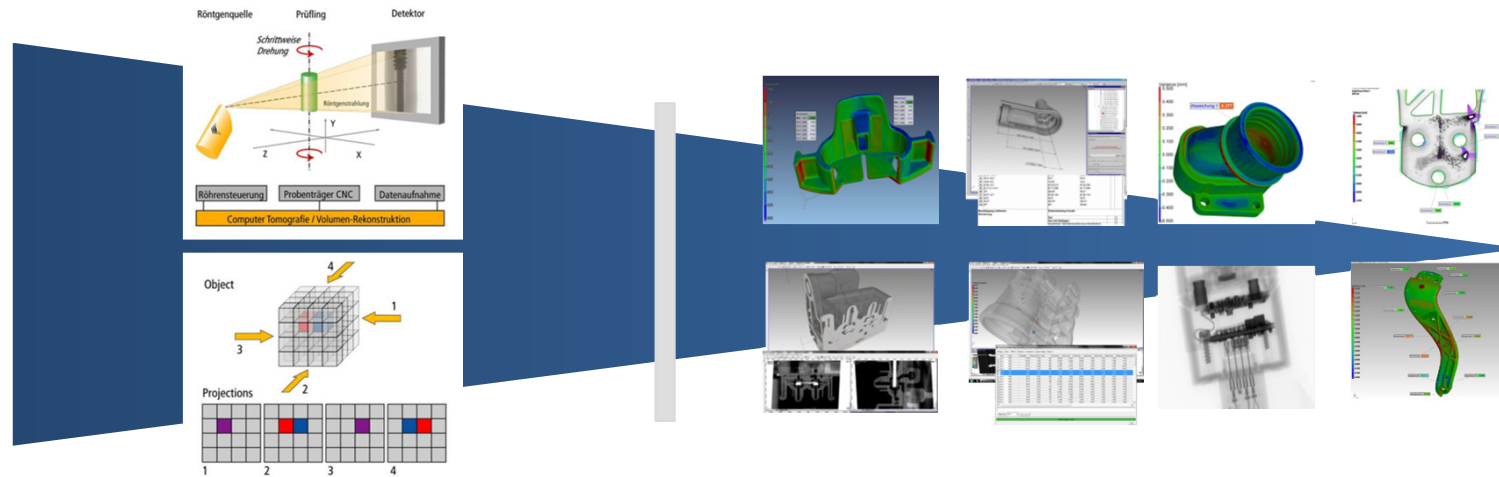


How it all began:
Industrial computed tomography used for mould optimization

Worm gear and corresponding spindle did not work together

All competitive tactile and optical measurements did not uncover the reason





Scanning:

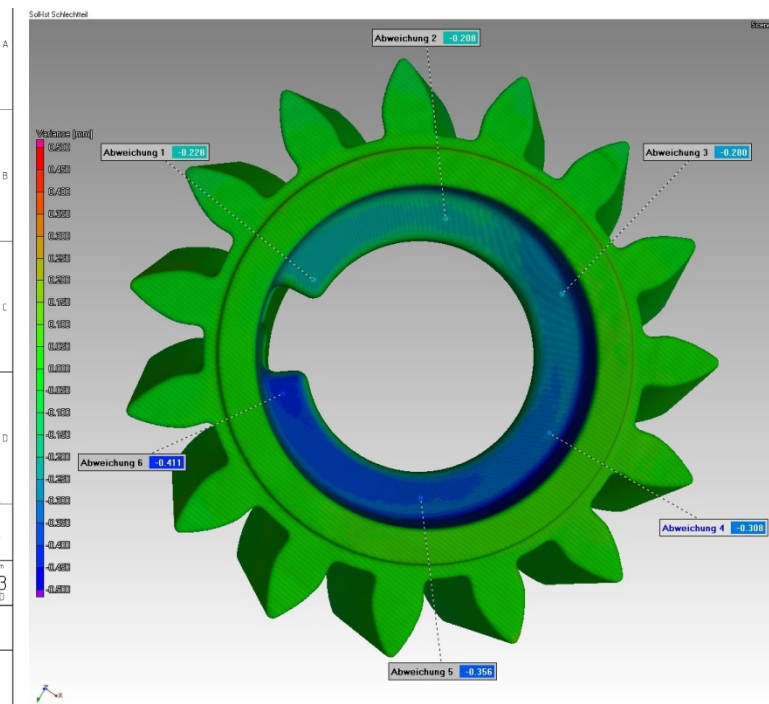
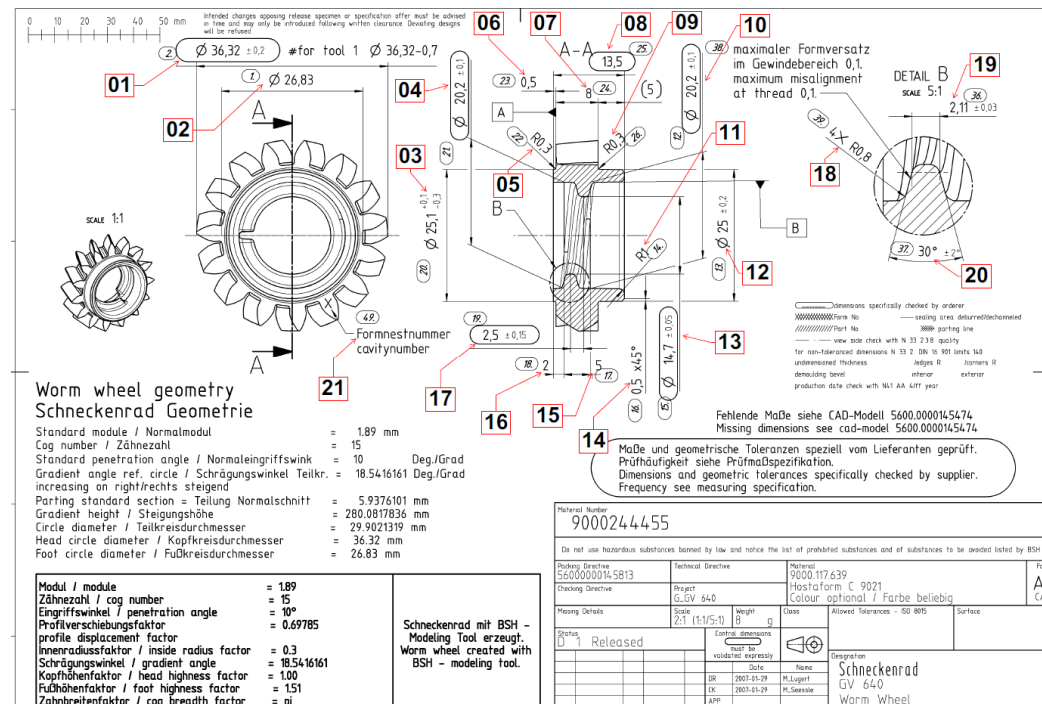
- Setting of scan parameters
- Calibration
- Scanning
- Reconstruction

□ Voxel model □

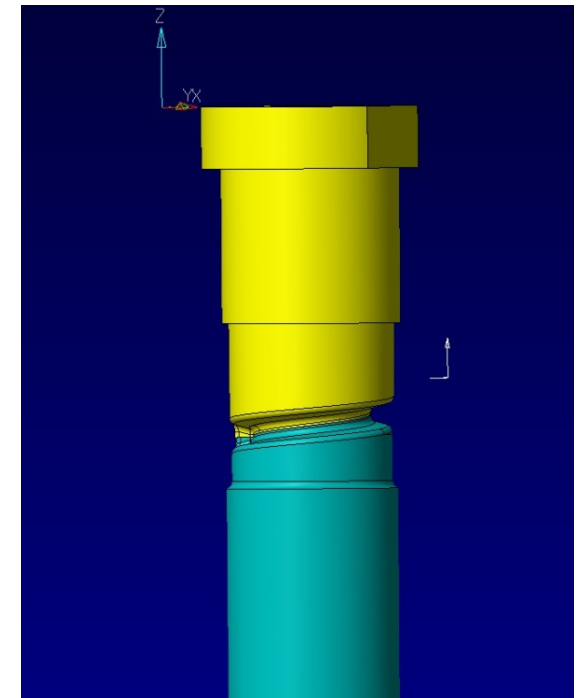
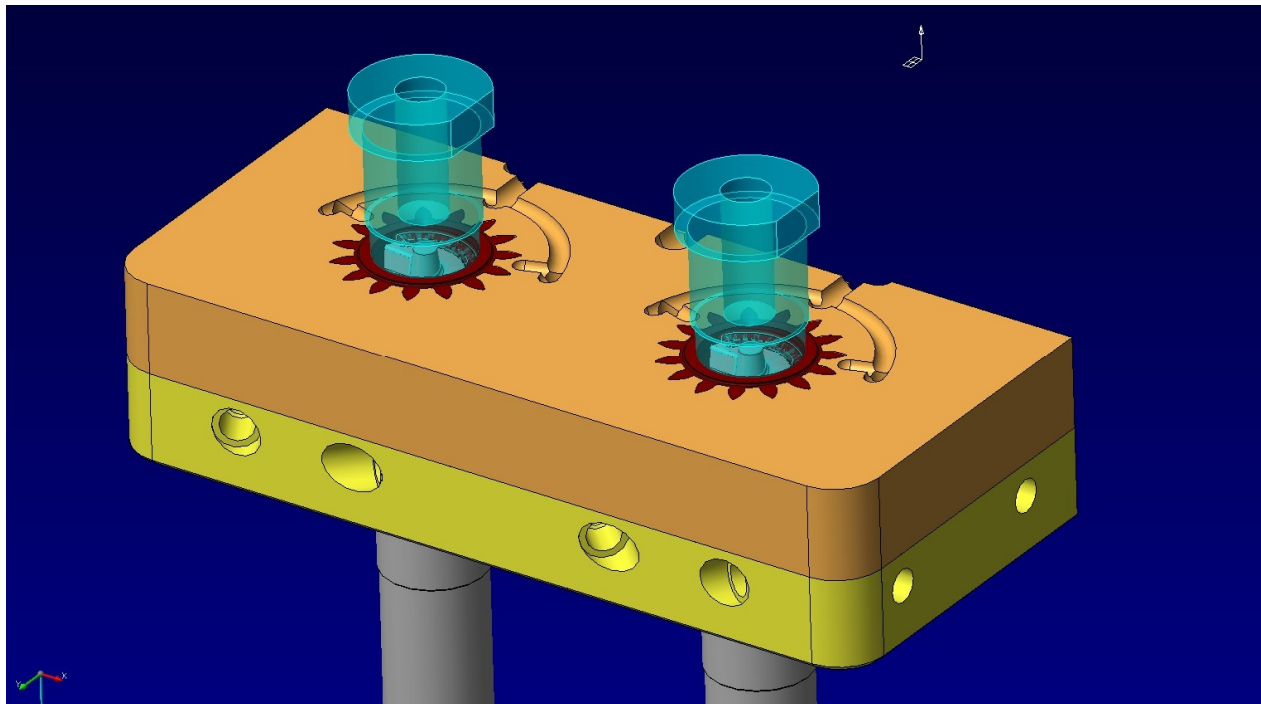
Data analyses (VG):

- Nominal/actual comparison
- STL-data generation
- Metrology
- Assembled group analyses
- Nondestructive defect analyses

Flank shape of the inner thread of the worm gear did not fit
Angle varies over the length of the part due to warpage

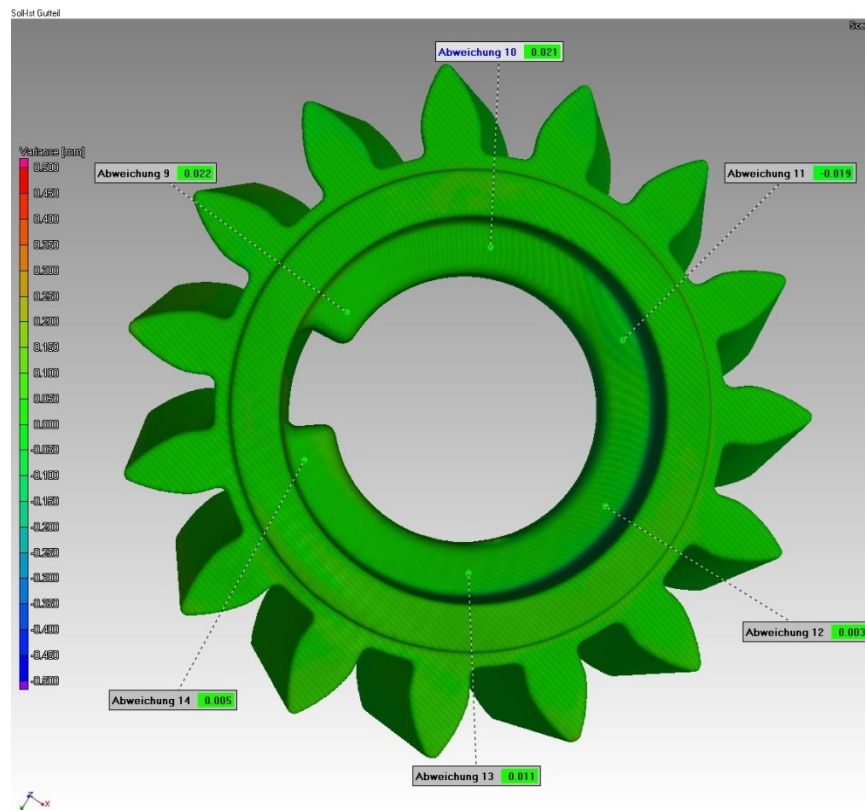
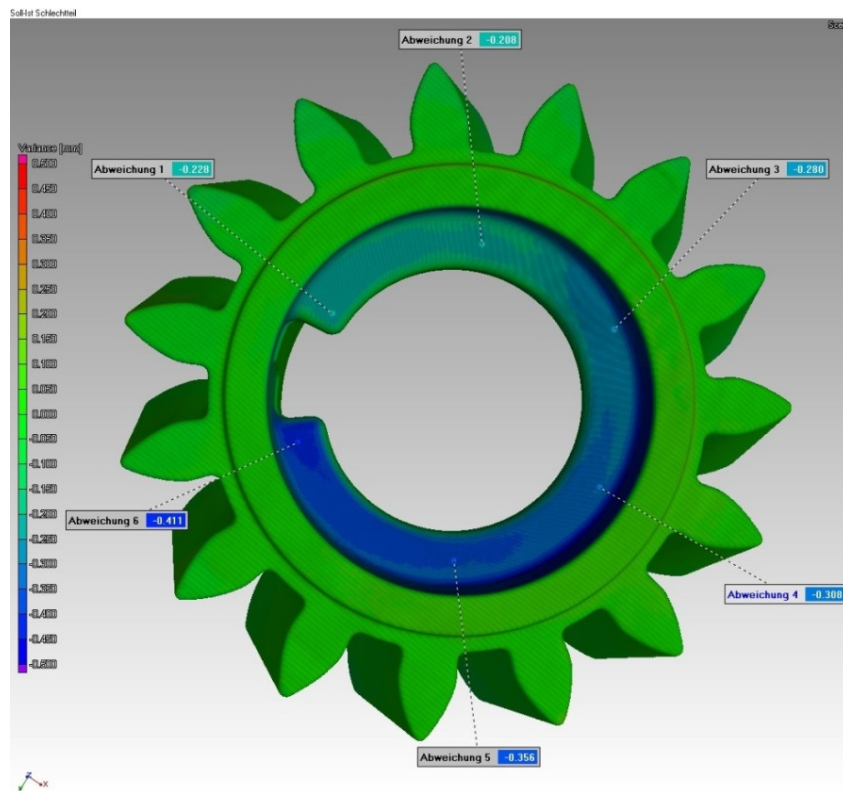


Correction of the injection mould could be done easily



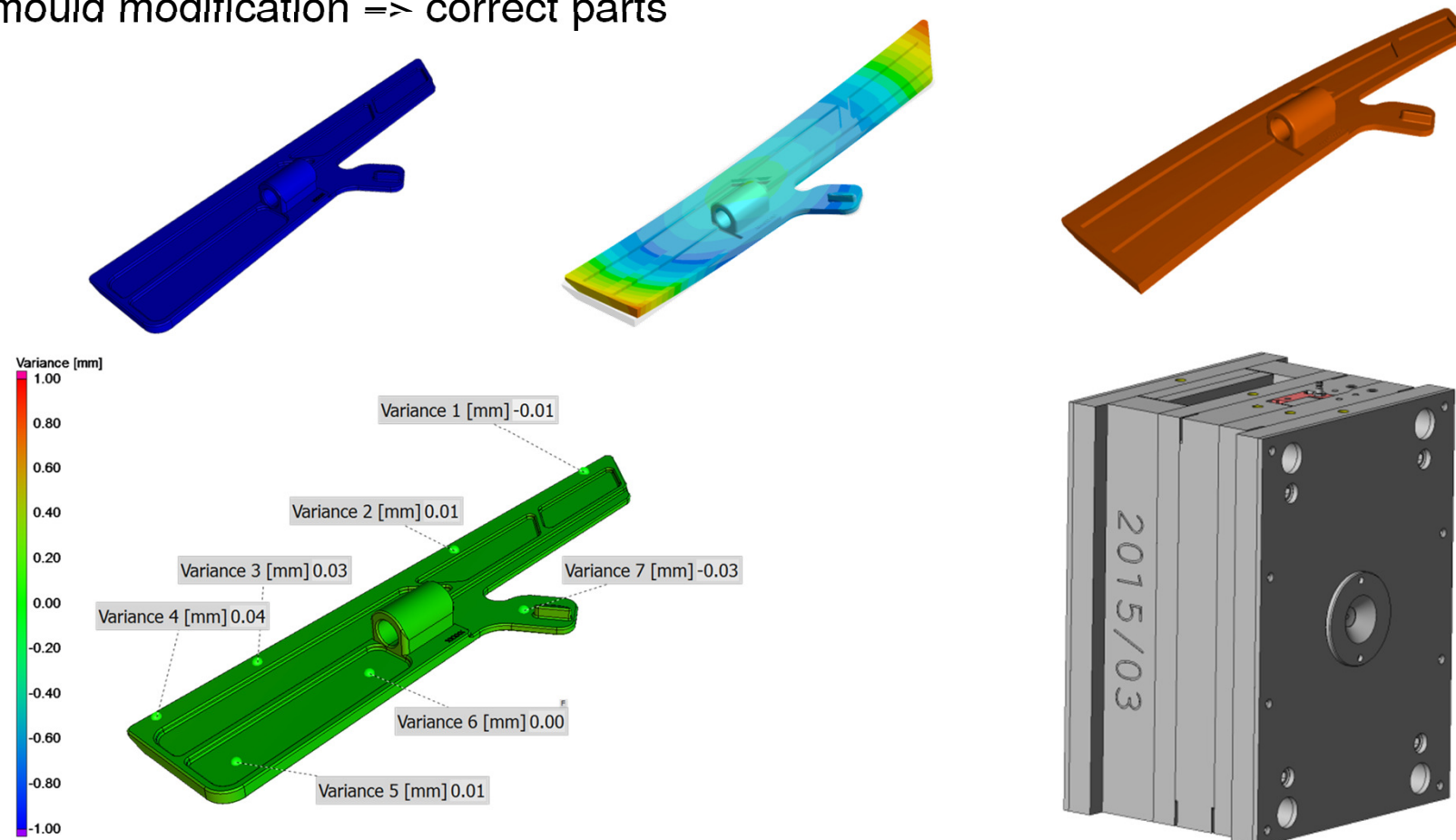
CT analysis reveals the problem very quickly and accurately.

Alternative measurement procedures such as tactile coordinate measurement machines or laser scanning technology did not offer qualified results.

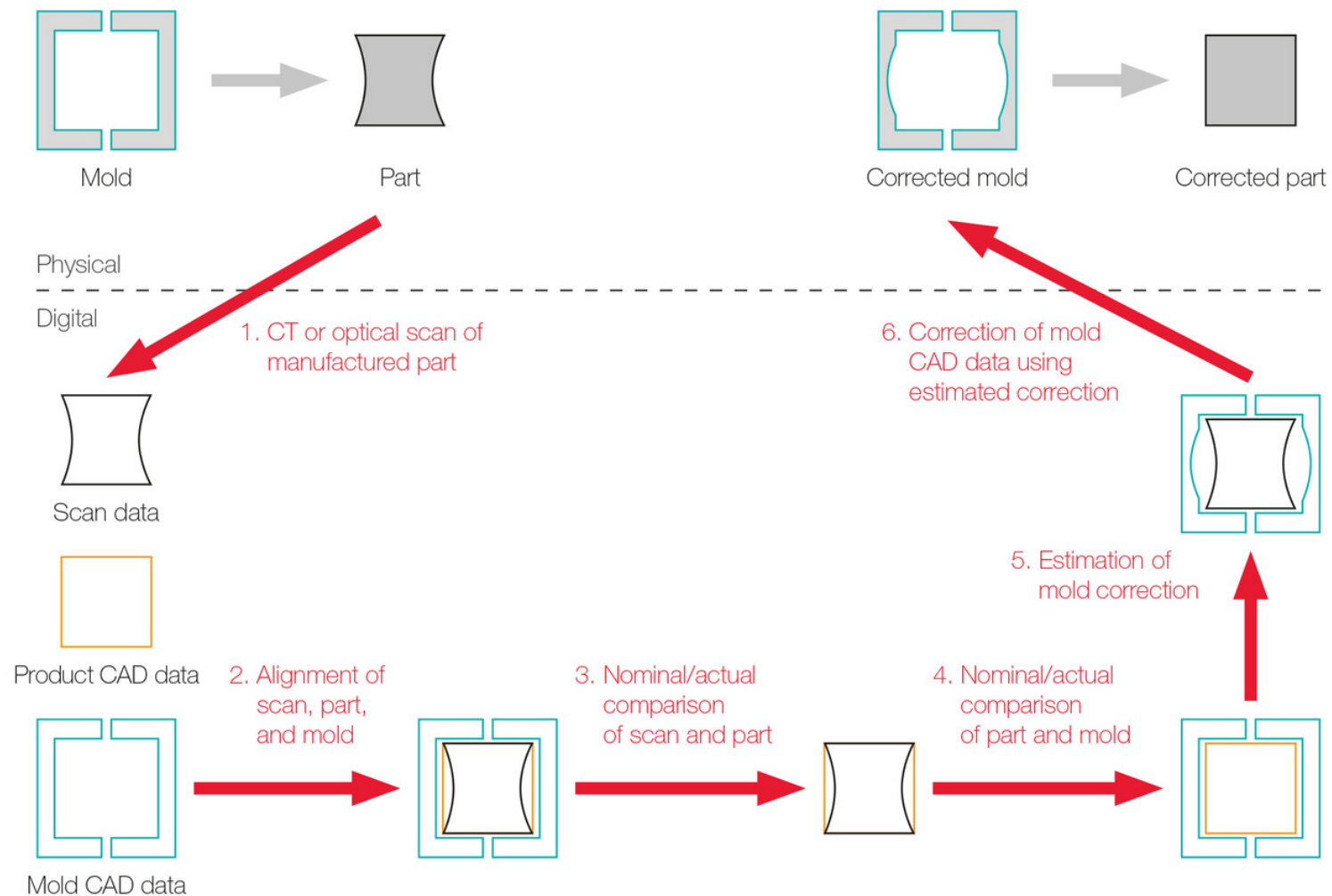


Our approach in 2007, geometry optimization with CT data

CAD => CT Scan => nominal/actual comparison => new inverse geometry => mould modification => correct parts



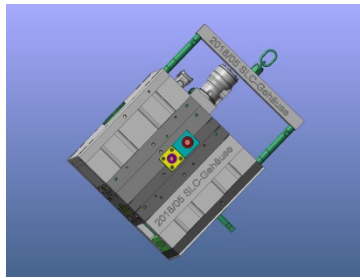
Work flow of mould optimization with the help of VGSTUDIO MAX 3.1.2



Quelle: Volume Graphics

Example No. 1: Housing for testing the work flow with VGSTUDIO MAX 3.2.1

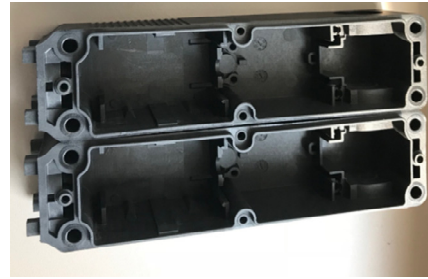




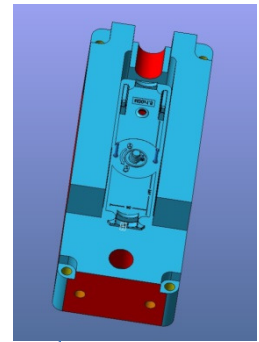
Mould



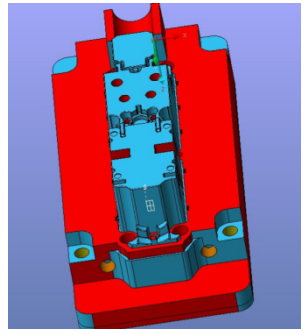
Parts



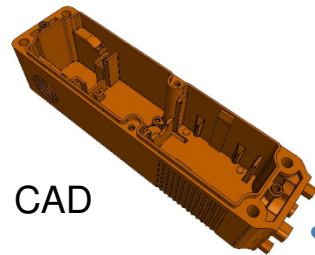
New parts



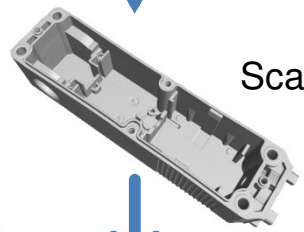
Corrected nozzle side



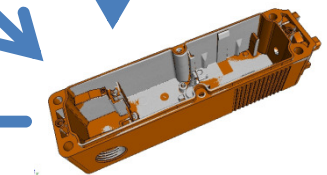
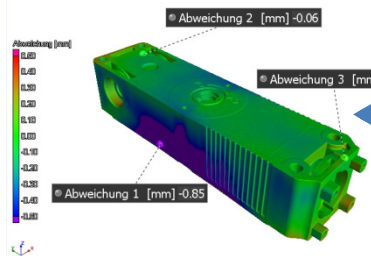
New ejector side



CAD

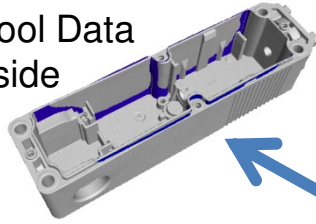


Scan

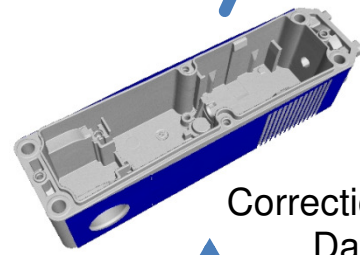


Nominal/actual comparison

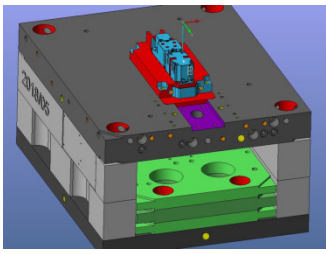
Correction Tool Data ejector side



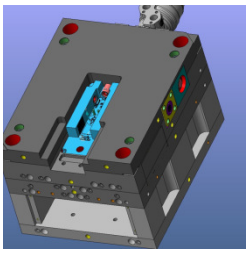
Correction Tool Data nozzle side



Mould CAD data



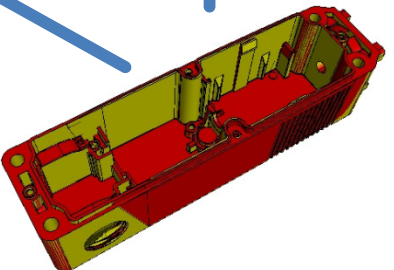
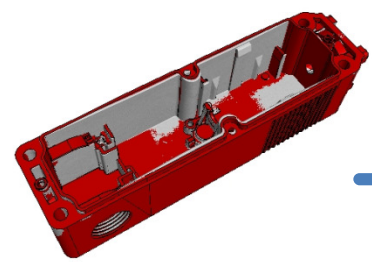
Ejector side



Nozzle side

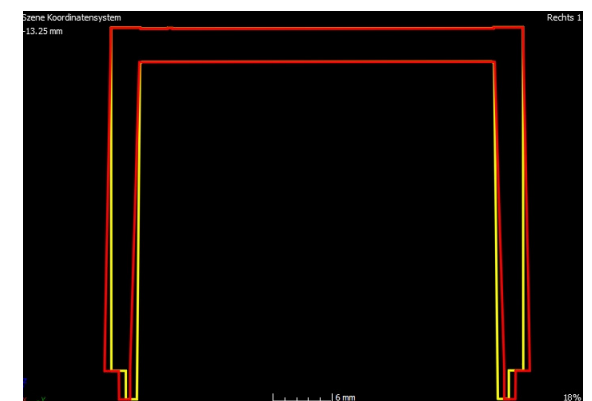
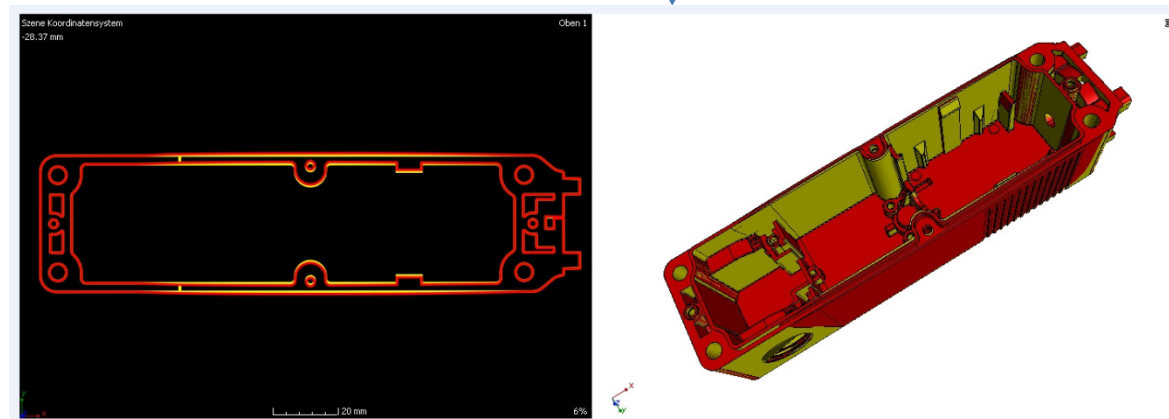
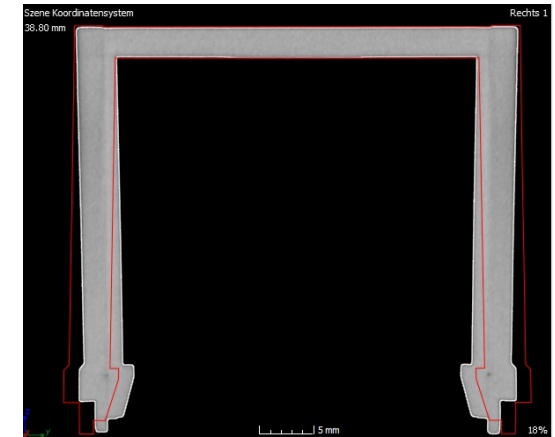
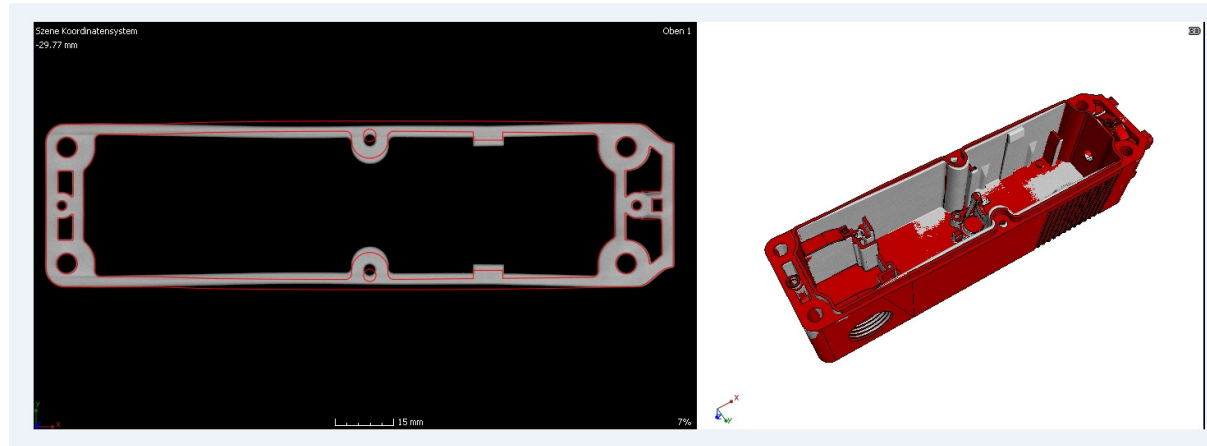


Inverse data against scan



Inverse new CAD File

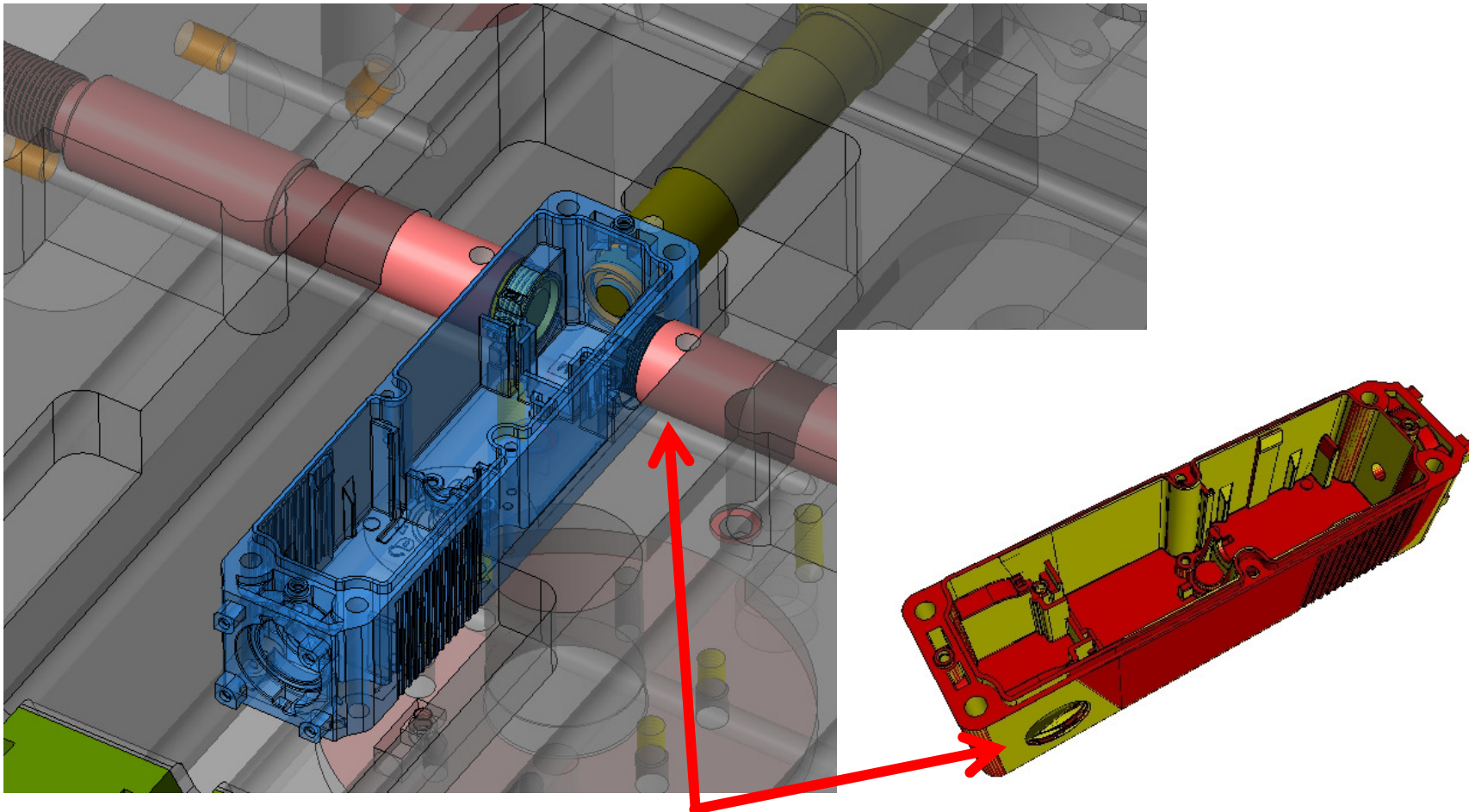
Correction file created from inverse data from scan vs. CAD original



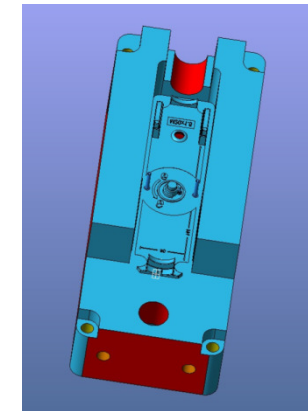
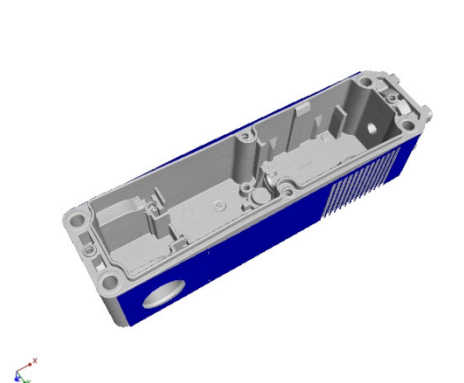
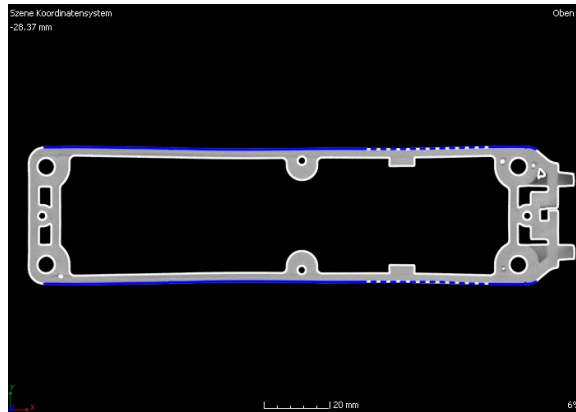
New CAD file created from found inverse correction file

Modification of the CAD file versus inverse file of the optimized data

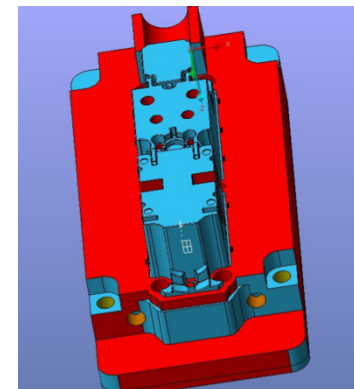
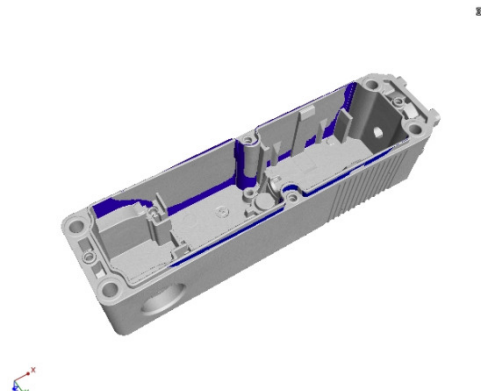
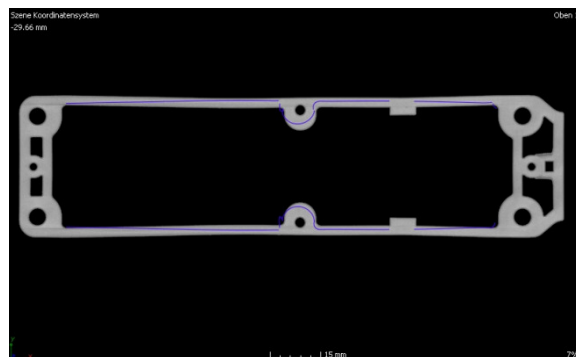
Limitation due to the thread cores



Correction of the mould data nozzle side
New electrodes and milling were necessary



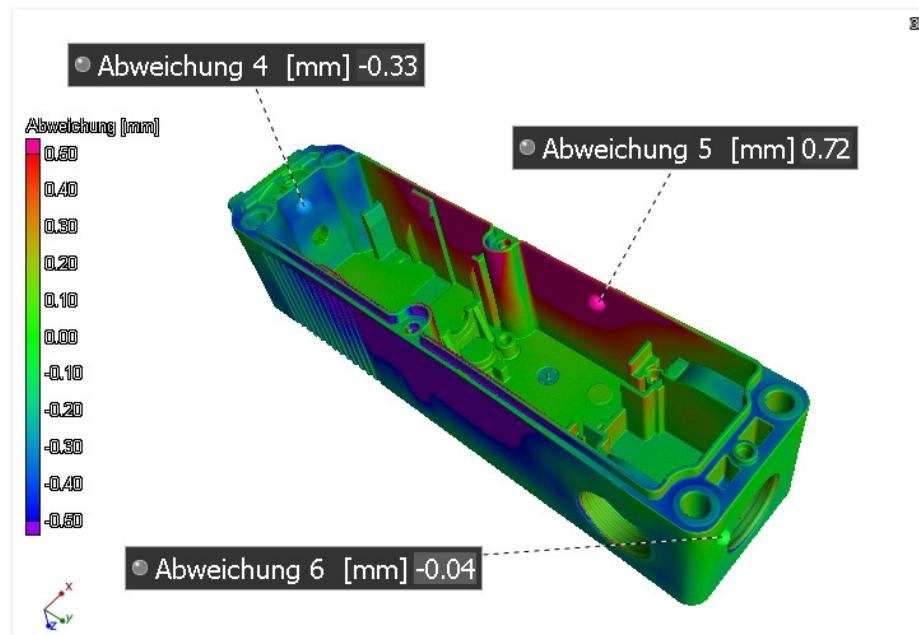
Correction of the mould data ejector side
Complete new core was necessary



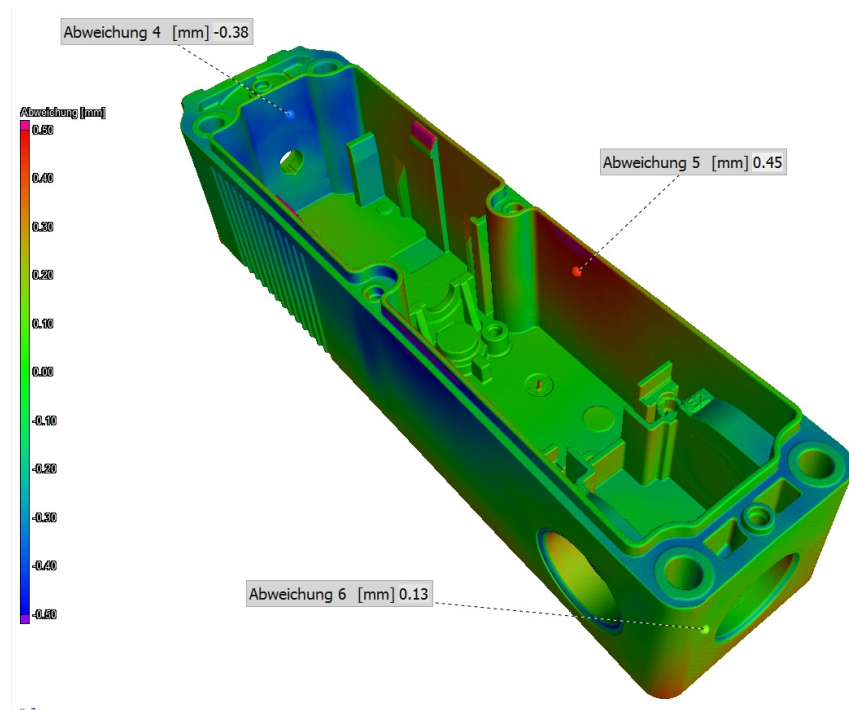
Deviation reduced to 0,3mm on each side

However, despite the inverse correction mode: No 100% success

Old part



Optimized part

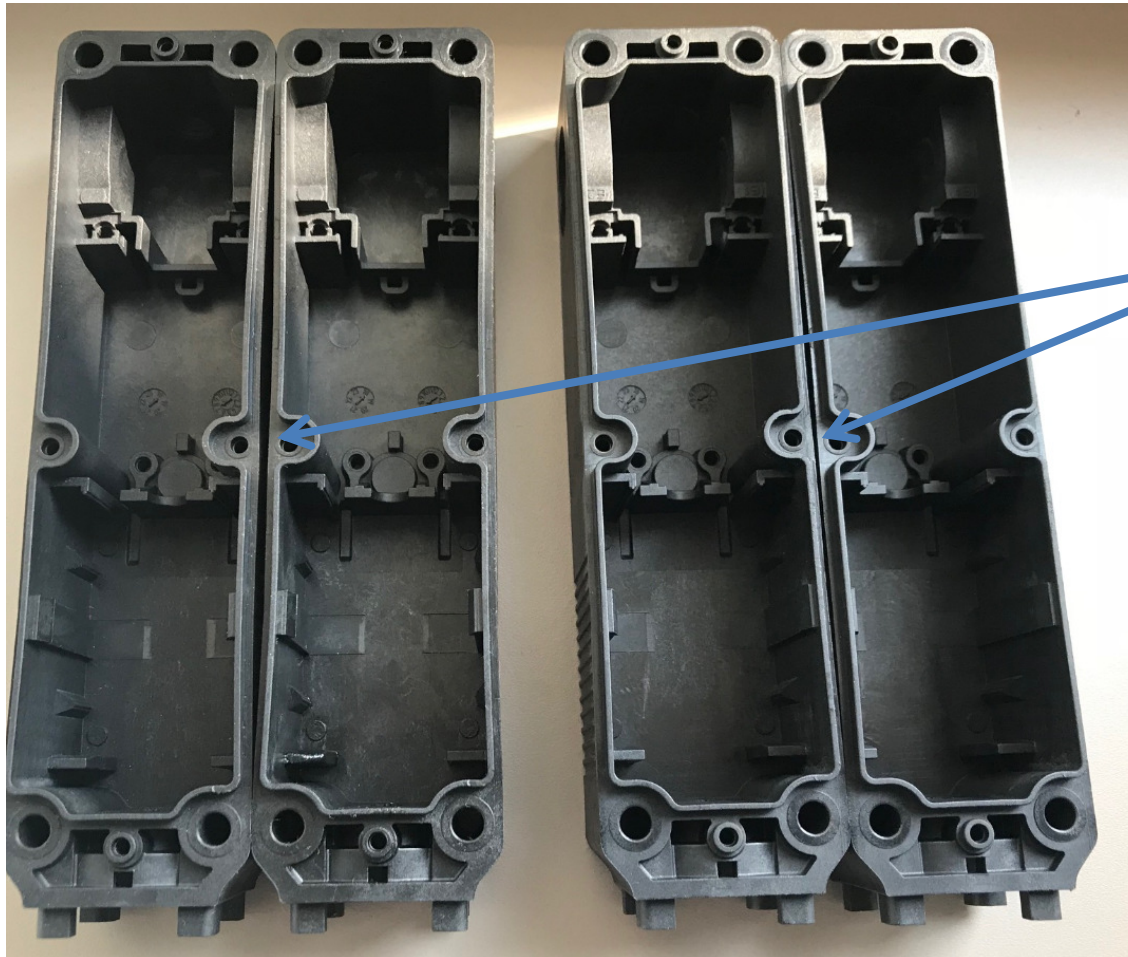


Mould optimization done with CT and VG



Old parts

Optimized parts



Gaps reduced
from 1,6mm to
0,5mm

Parts can be
used

Overall costs: 15.000.- €, 20% of the tool costs

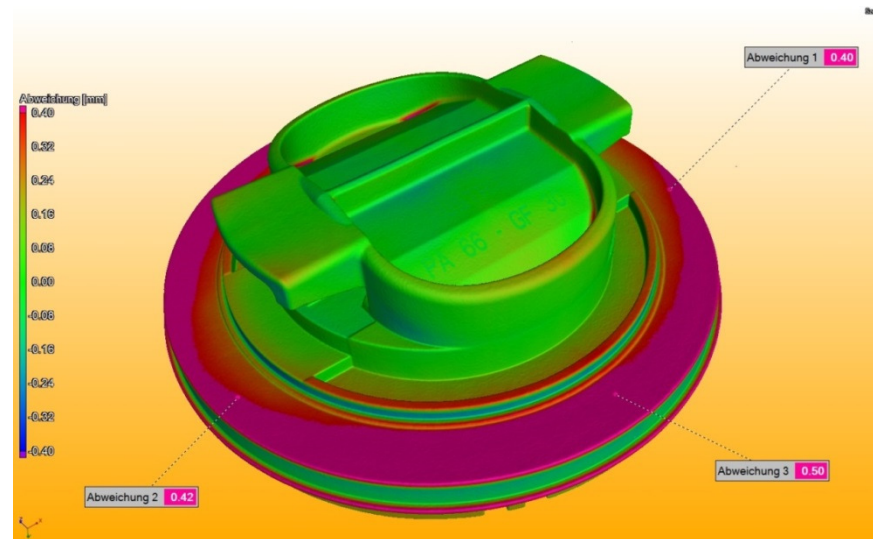
Example No. 2: Optimization philosophy of “Lid Rod”

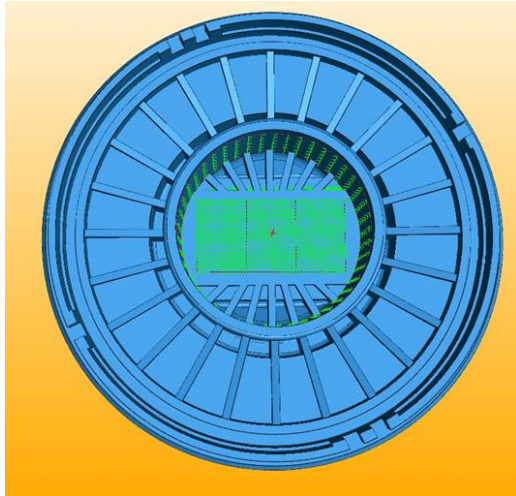


Nominal/actual comparison shows poor result.

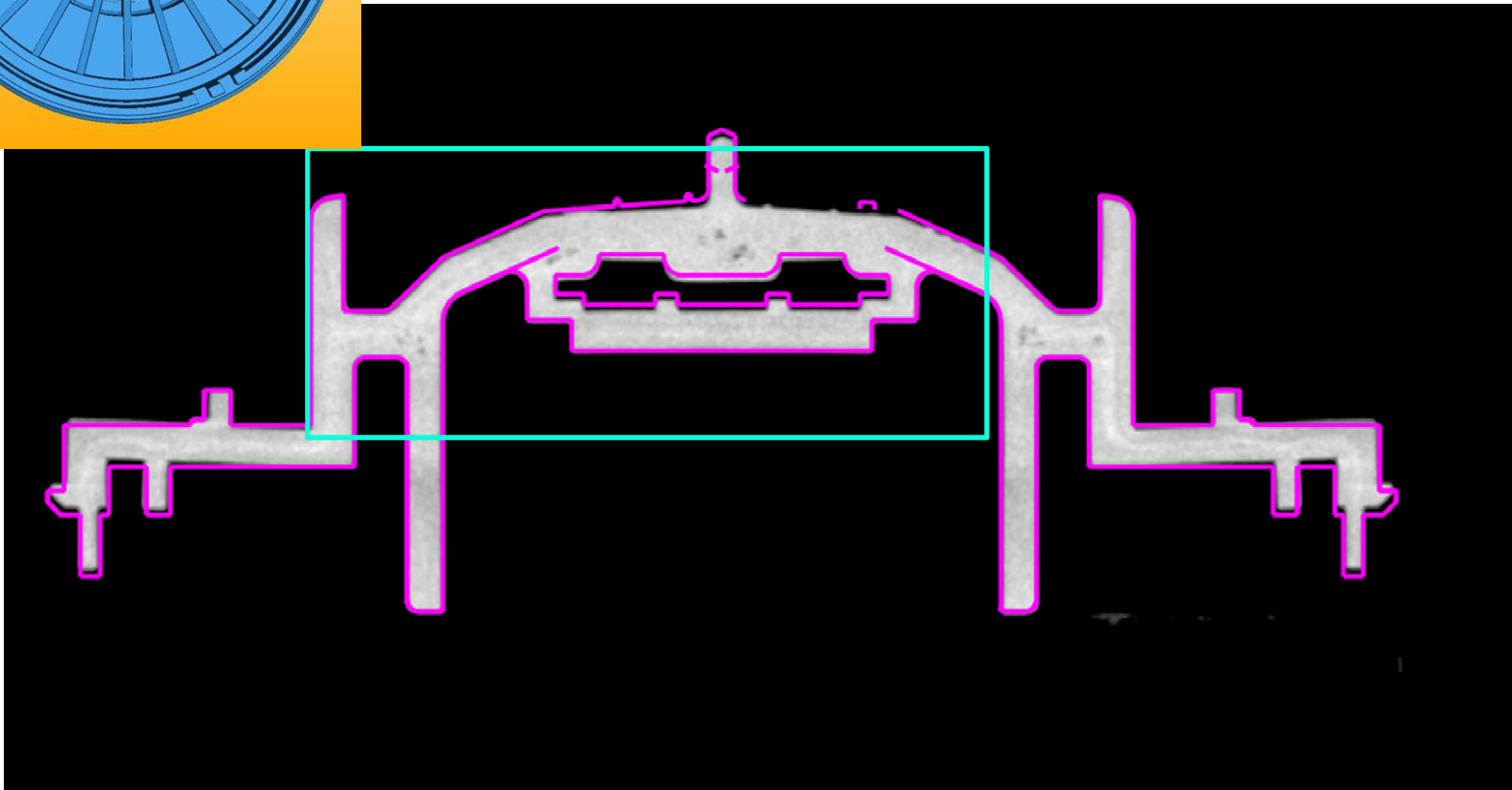
Question:

How to correct, how to compensate?





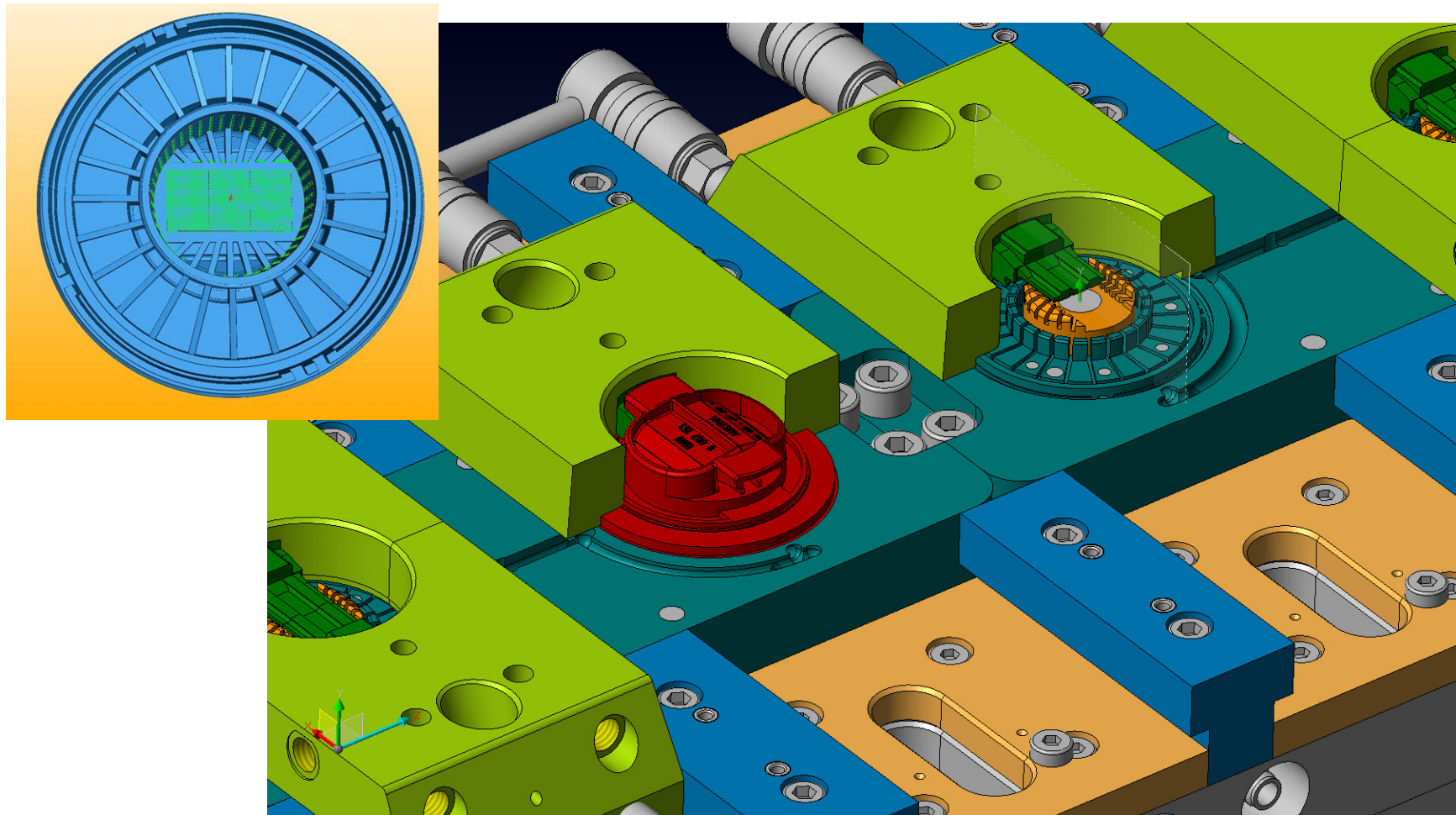
Alignment method 1:
Following the philosophy according to 3D tactile
measurement and the drawing
using regular geometrical elements



Alignment method 1:

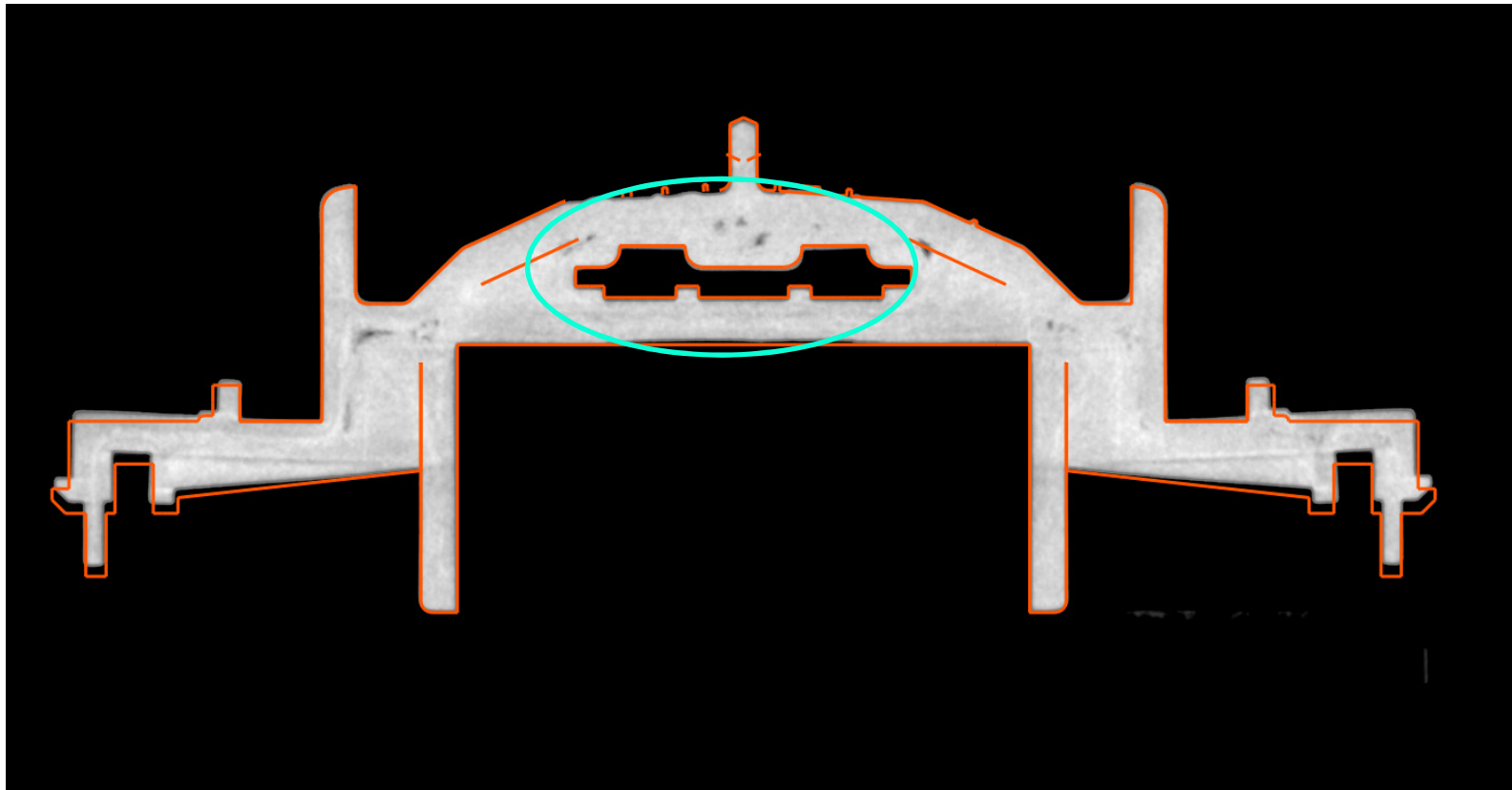
Tool optimization turns out to be very complicated and expensive.

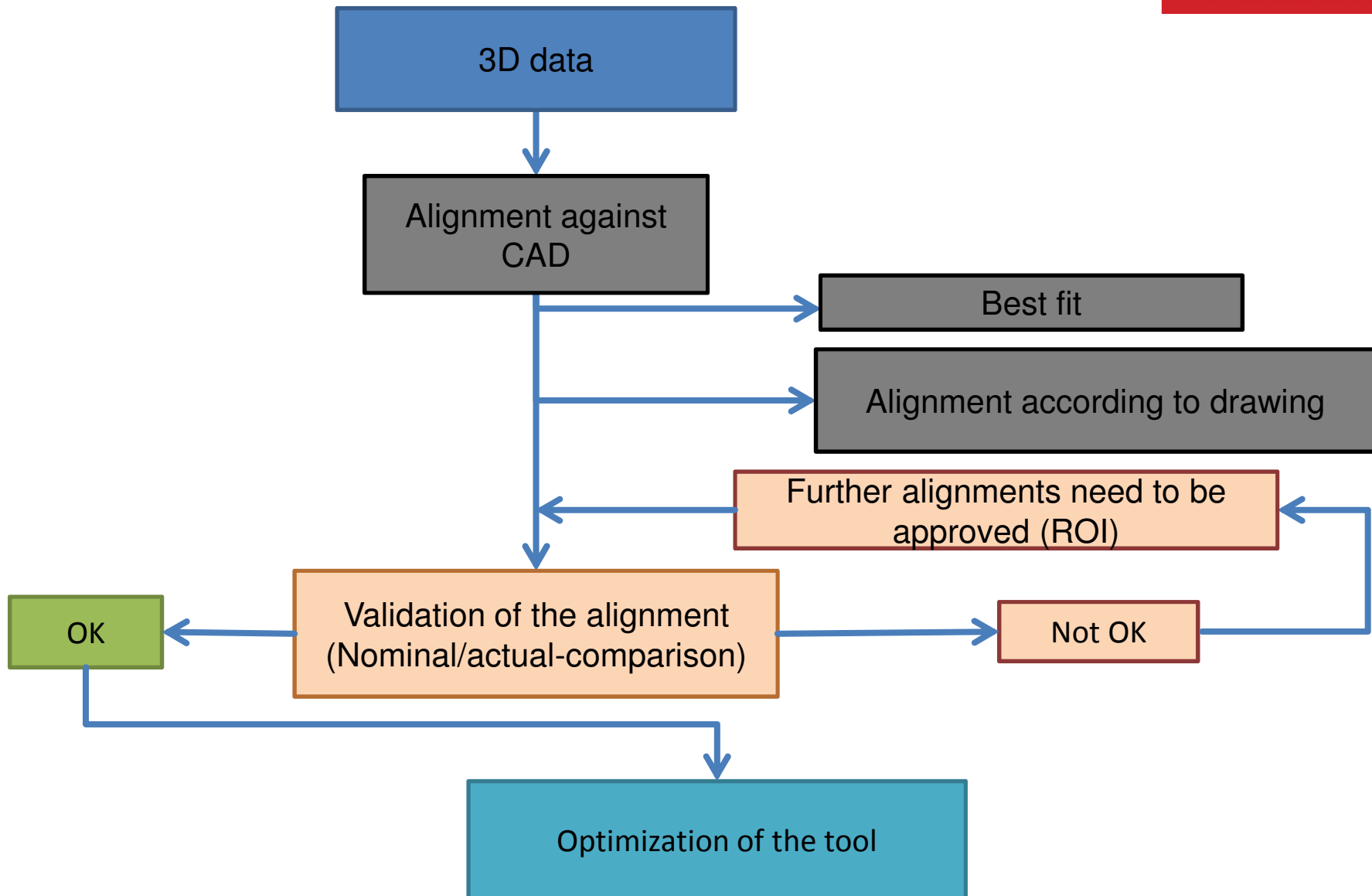
New sliders would be necessary.



Better alignment method following ROI in the slider area

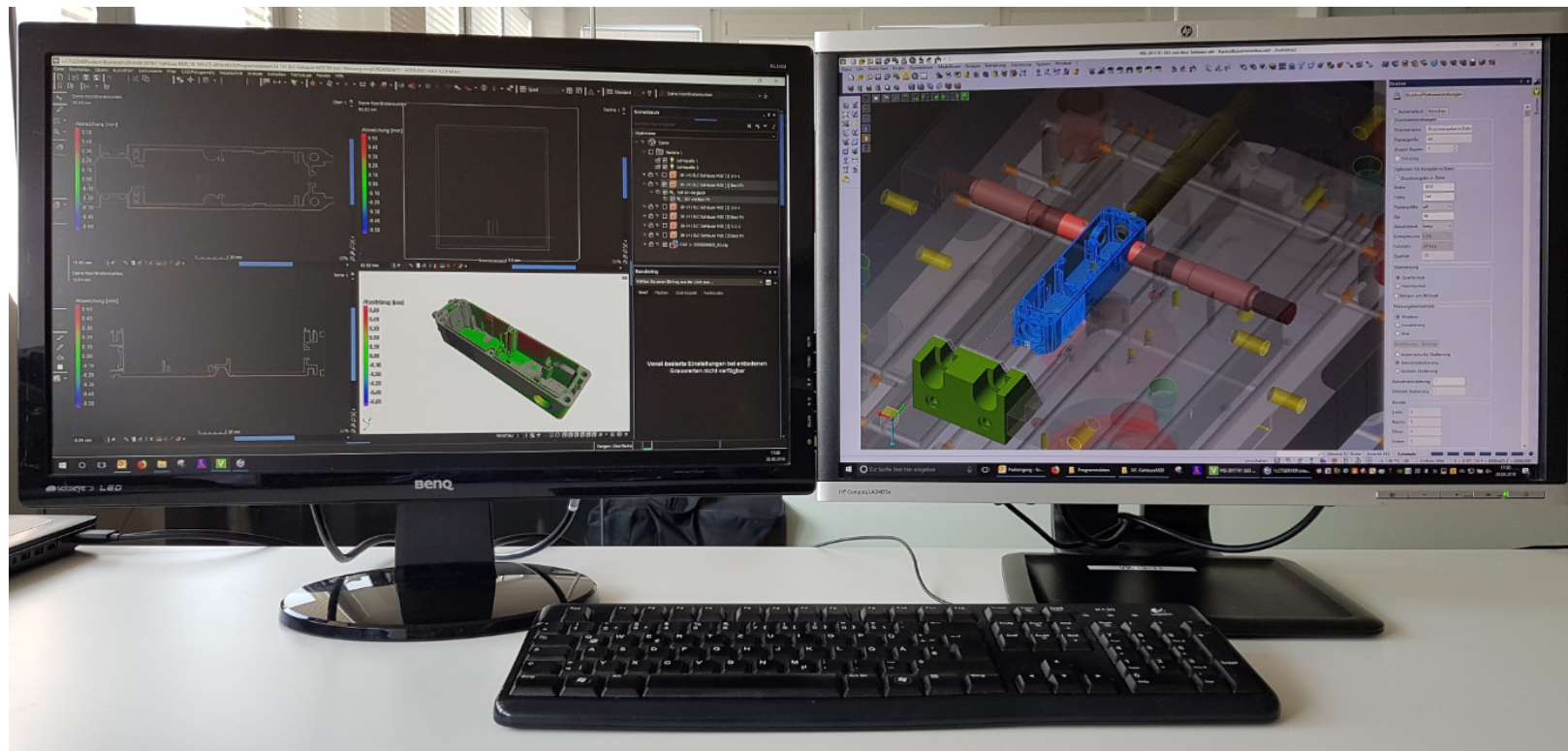
Sliders can still be used, lower costs and effort for mould optimization





Essential for an efficient mould optimization

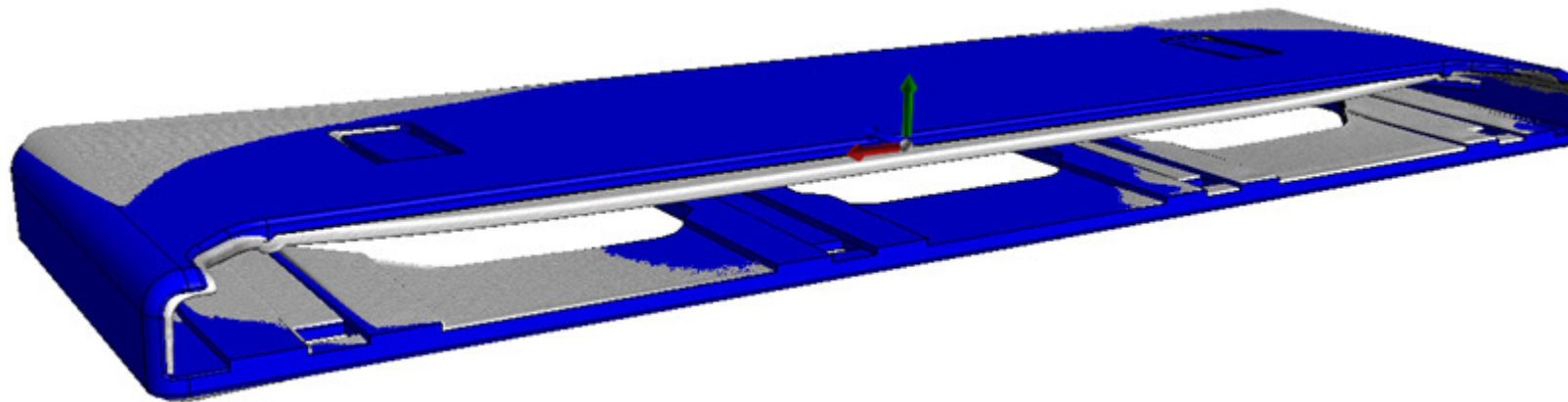
Parallel analysis of scans and design of the new CAD data



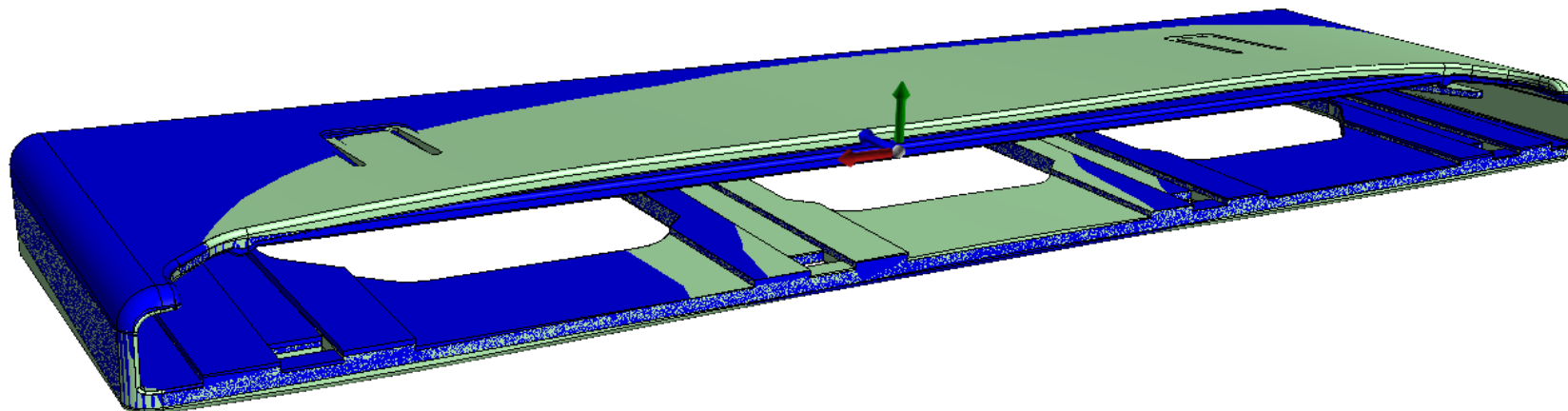
Example No. 3: Mould optimization of “Basket handle”



Comparison: CAD Data (blue) against scan of the part (grey)

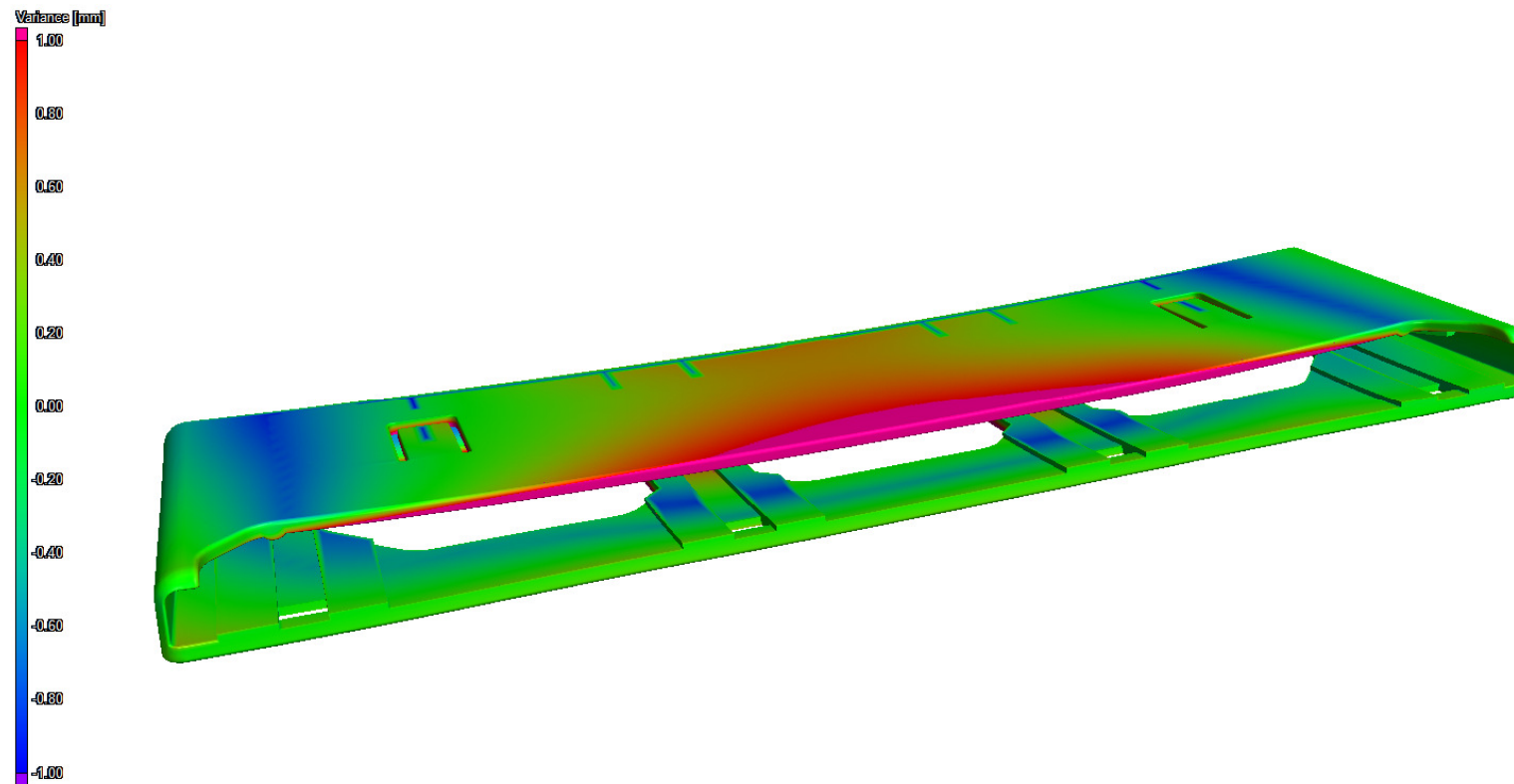


Inverse data to to correct the mould (similar to example 1)

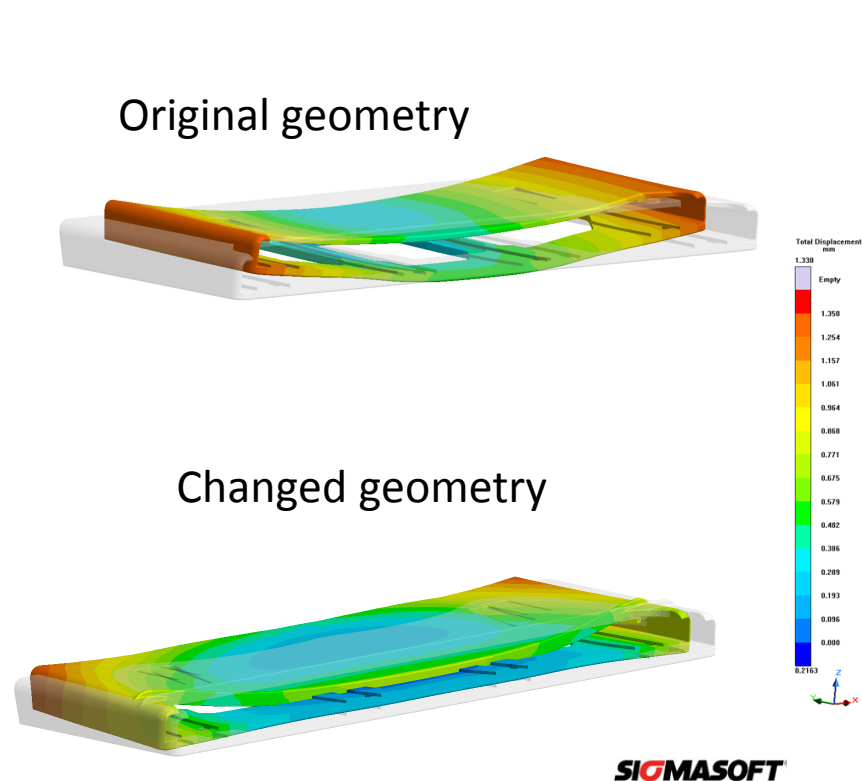


Results after “correction” were pretty poor.

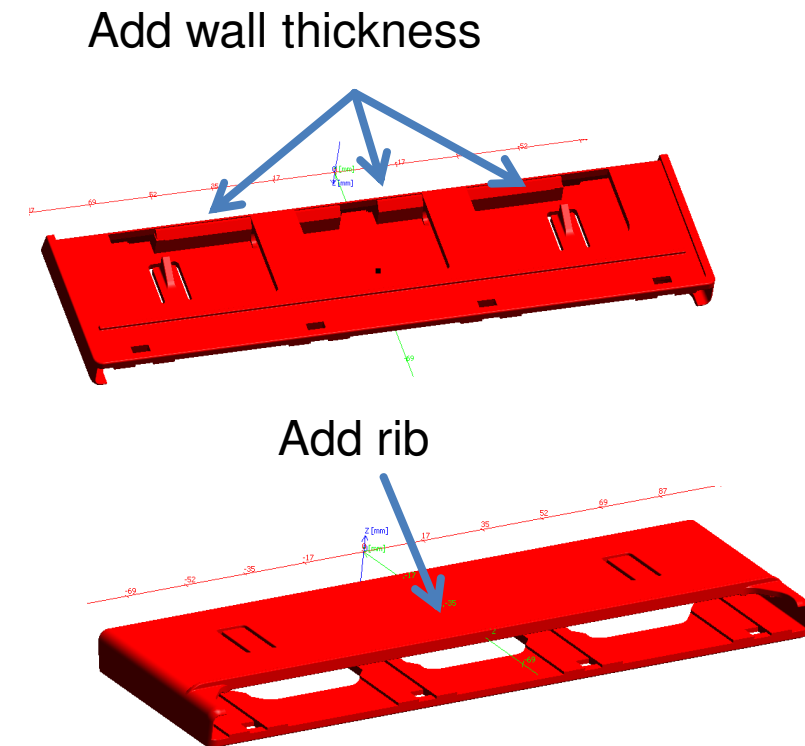
Material behaved differently, simple inverse corrections were not successful.



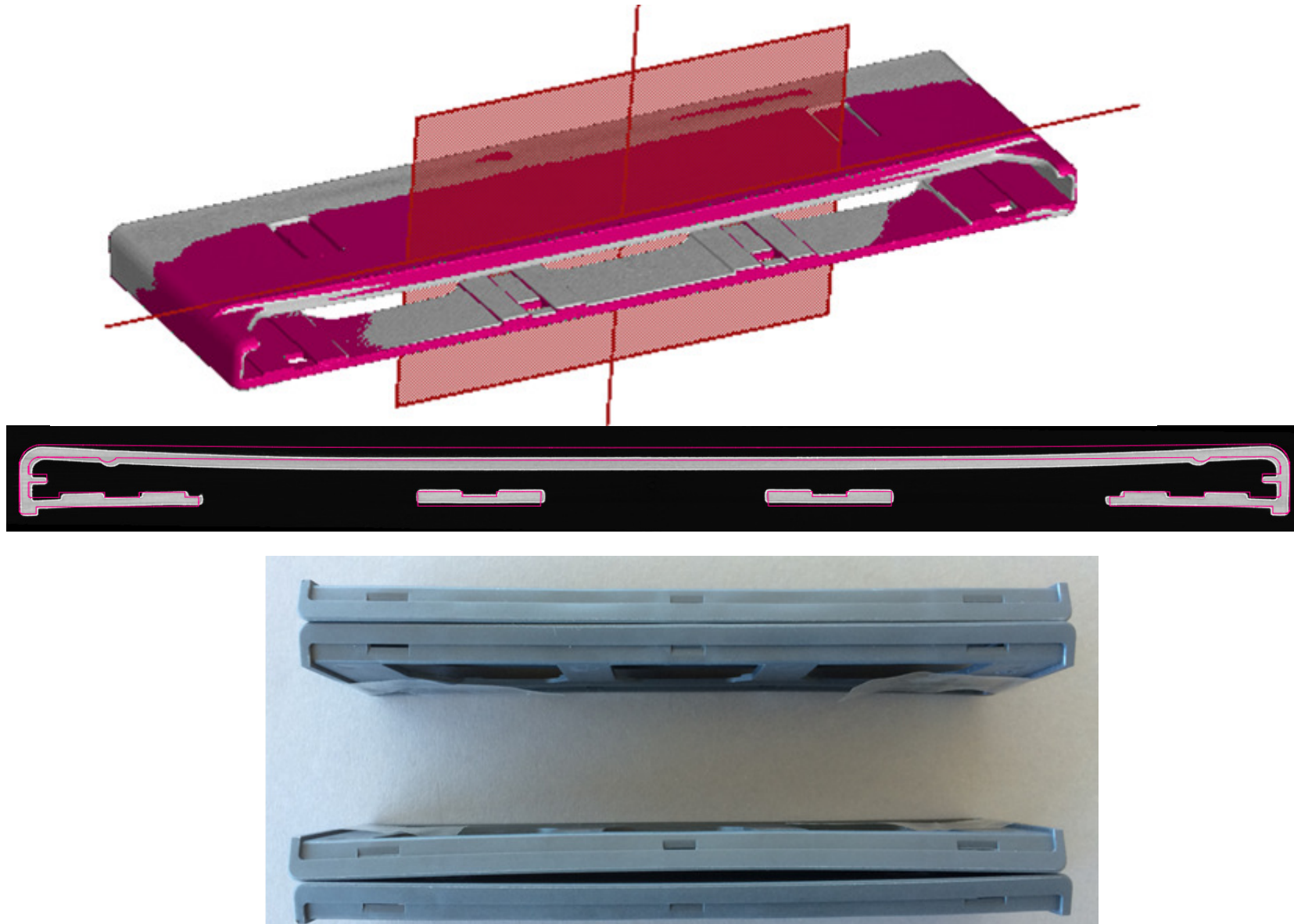
Variation of the part geometry **vs.** simple inverse correction mode



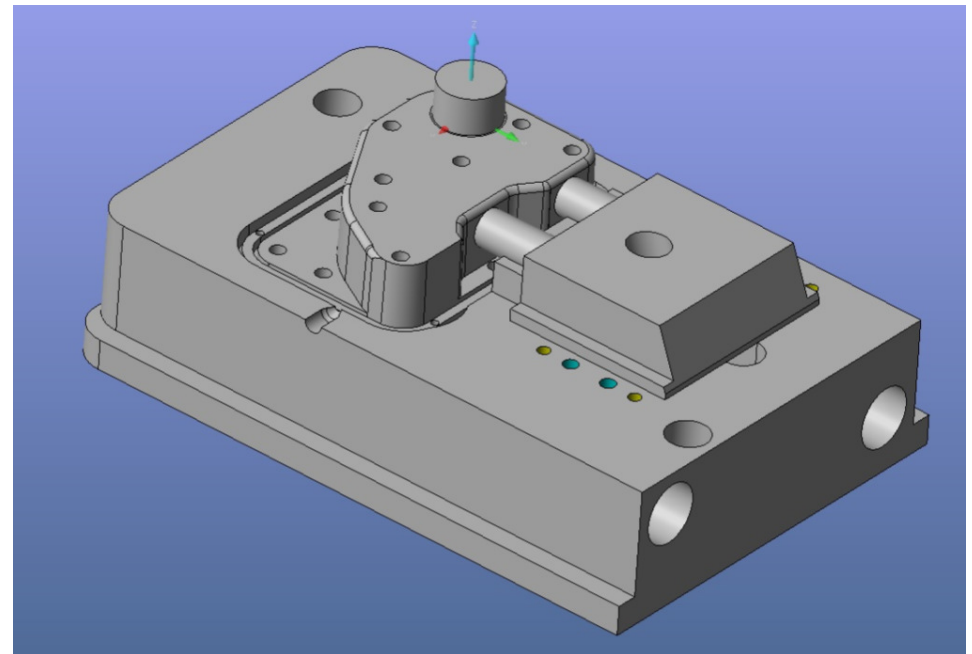
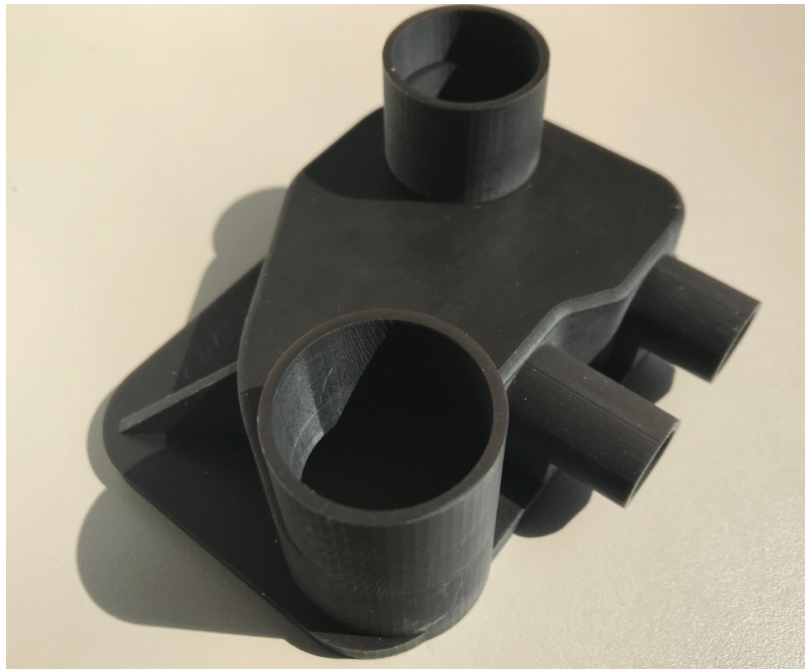
Scale Factor: 10

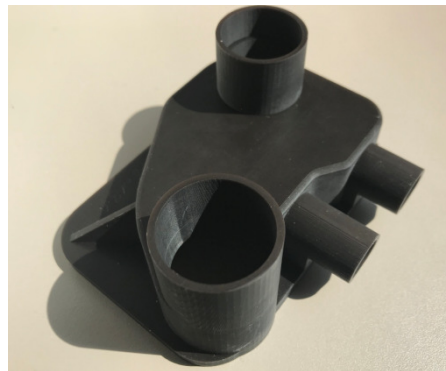


Nominal/actual comparison: CT scan of changed part (pink) against original part (grey)



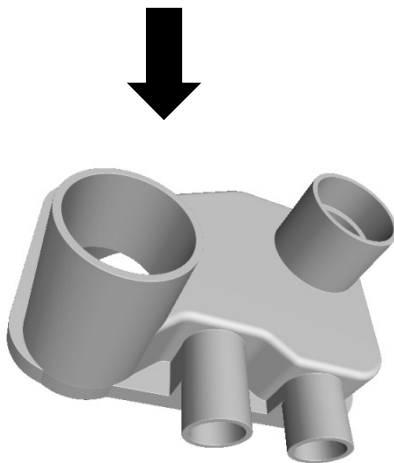
Example No. 4: Mould optimization of a “Housing part”



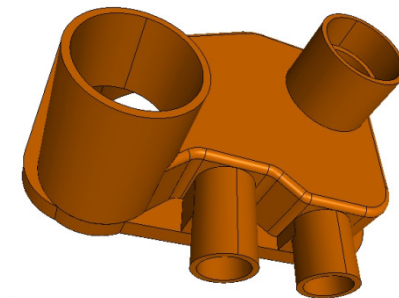
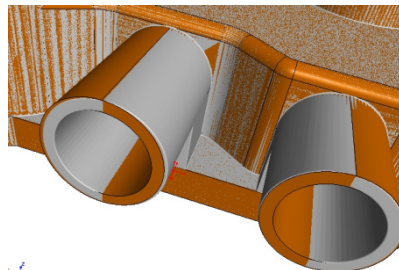


Part

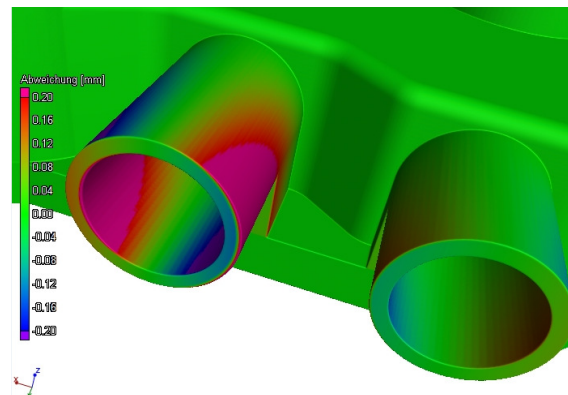
Nominal/actual
comparison



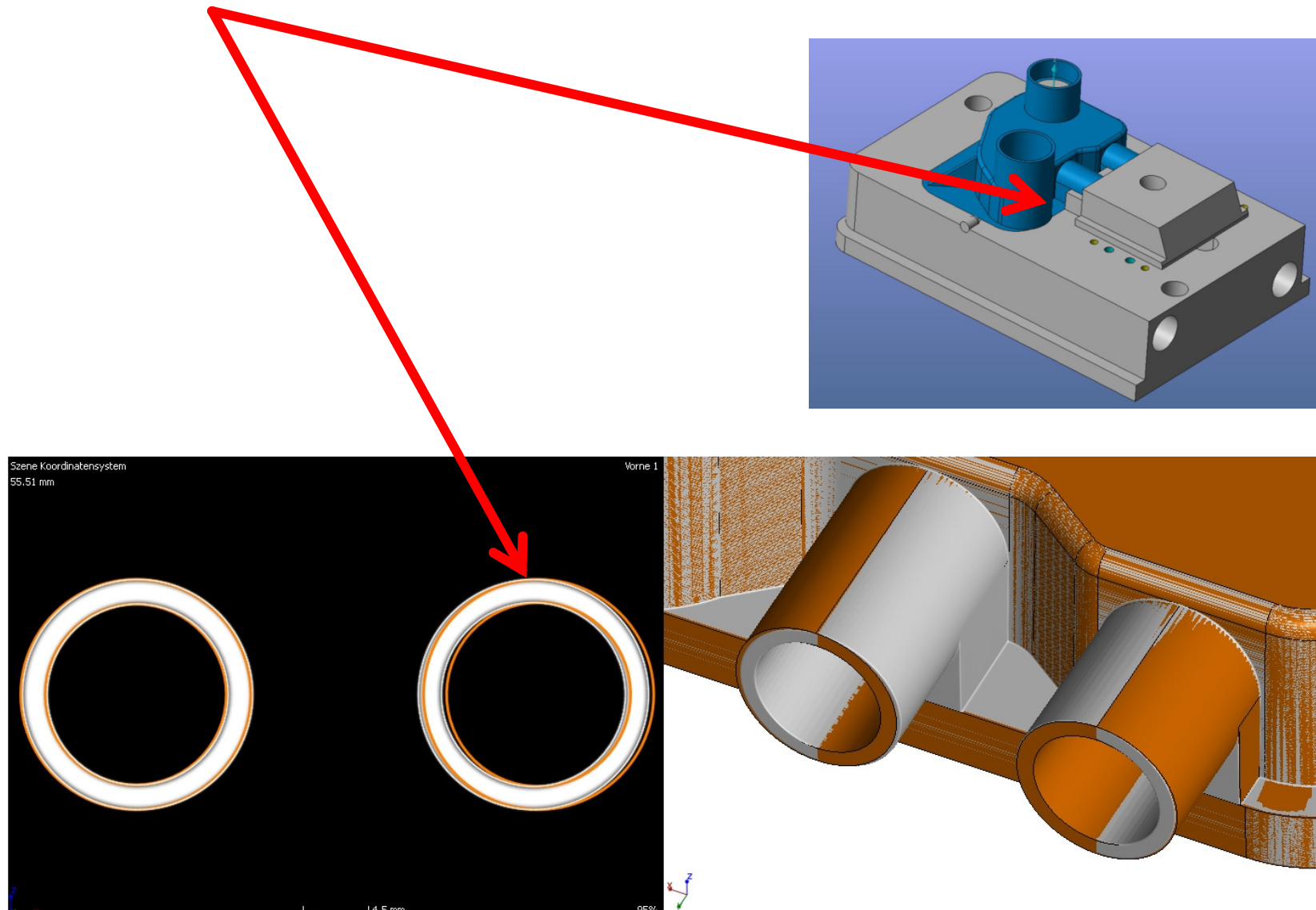
Scan



CAD



Mould optimization impossible due to ejecting situation!



Summary: Injection mould optimization with VGSTUDIO MAX 3.2.1

- ⇒ Mould optimization with VGSTUDIO MAX 3.2.1 is possible and a very useful tool.
- ⇒ However, inverse correction method can, but must not necessarily lead to satisfying results.
- ⇒ The alignment criteria are most essential for an effective mould optimization. VGSTUDIO MAX 3.2.1 offers a good tool for defining alignment criteria.
- ⇒ Some geometries cannot be optimized due to deformation limits.
- ⇒ It is far more effective to understand warpage in advance than to “correct” moulds afterwards.
- ⇒ The toolmaker is not the scapegoat for every warped part, therefore the expression “tool correction” is misleading.

CT scans visualized by VGSTUDIO MAX are an ideal tool to highlight warpage and metrology problems of polymer parts.



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Thank you for your attention!

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