



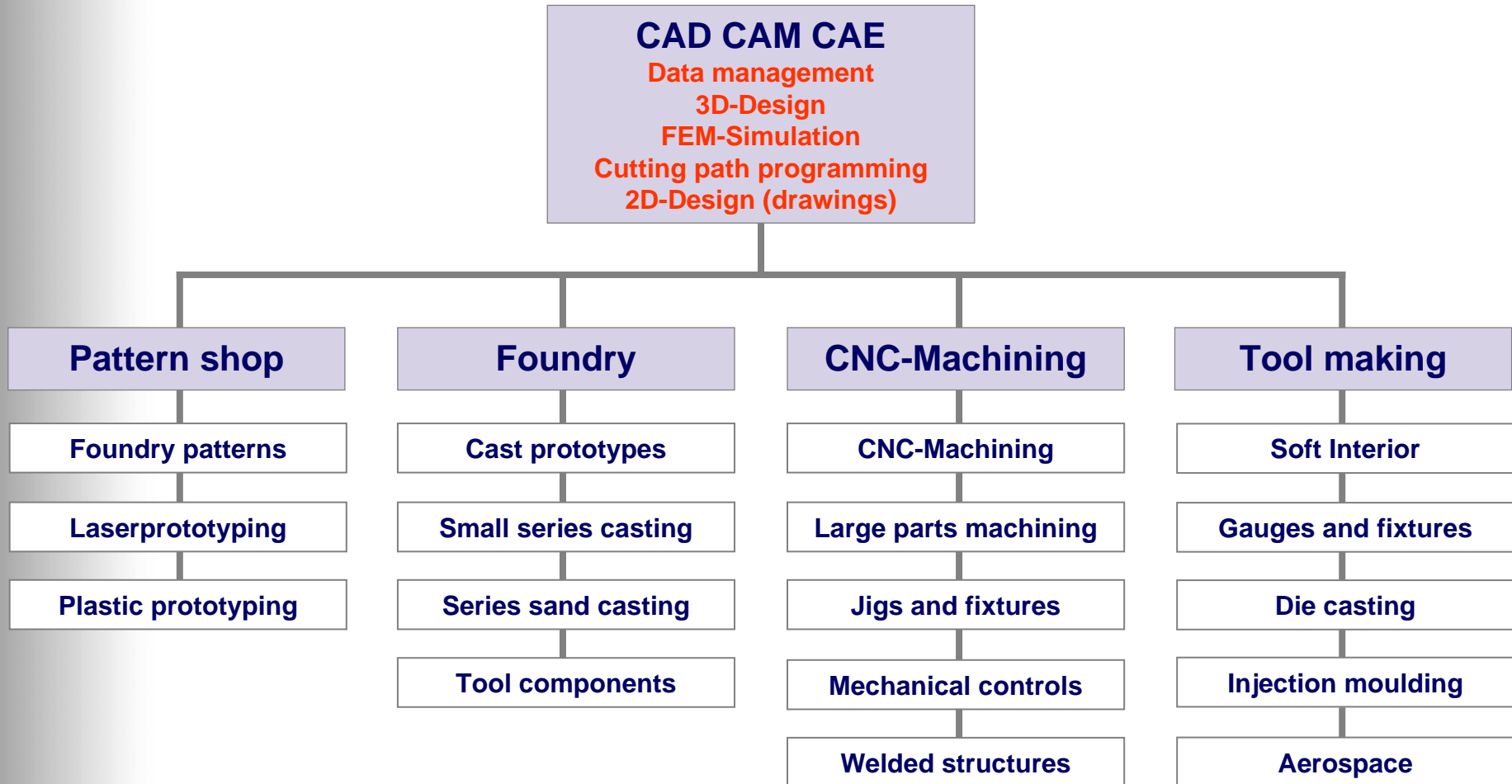
*Rapid casting development  
by means of Qualified Master Casting (QMC)  
and numerical simulation modeling*

***Grunewald***  
***Group***

***Dr. Joachim Gundlach***

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- 1. Grunewald**
- 2. Rapid Prototyping techniques**
- 3. casting development and  
Qualified Master Casting „QMC“**
- 4. small series production**
- 5. castings**



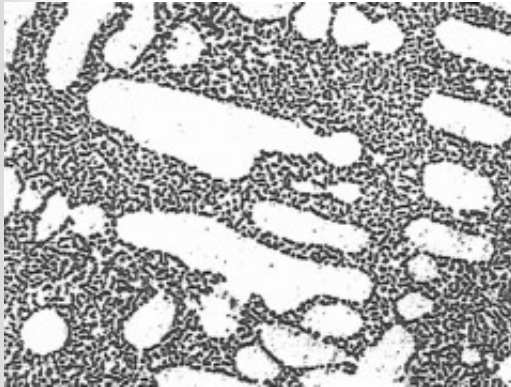
- 1. Grunewald**
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- Selective Laser Sintering Polystyrol  
*- casting models  
for functional prototypes*
- Selective Laser Sintering Polyamid  
*- direct functional prototypes  
- master patterns  
for small series casting production*
- Stereolithography  
*- master patterns  
for small series casting production*
- plastic component production  
*- vacuum castings*



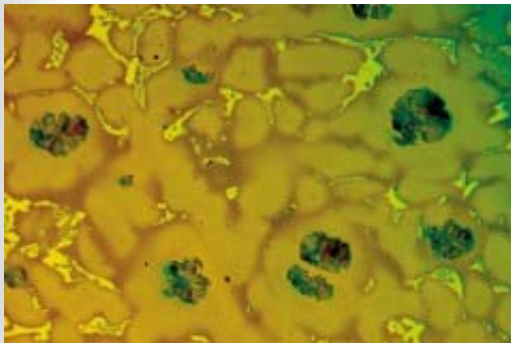
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aluminum

RR350, VW023, 226, a356, a357,  
239, 233, 231 and  
special alloys,

incl. T5, T6, T7 heat treatment  
and various surface treatments



iron

GJS-350..., GJS-400..., GJS-450..., GJS-500..., GJS-600...,  
GJS-700..., GJS-800..., GJS-800...,  
GJL-100..., GJL-150..., GJL-200..., GJL-250..., GJL-300...,  
GJL-350...und  
special alloys,  
incl. heat treatment

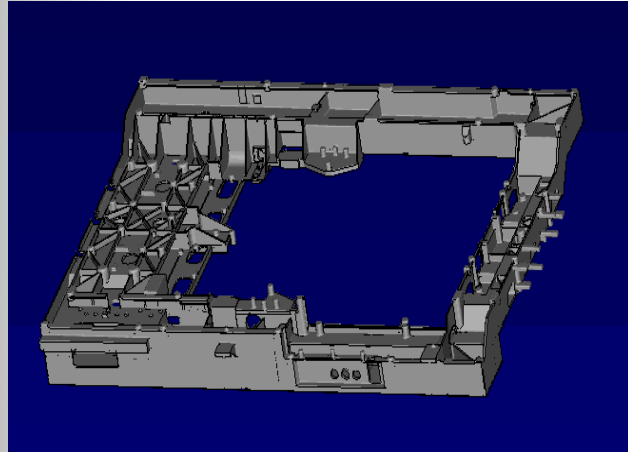
## **Qualified Master Casting (QMC)**

basic features are:

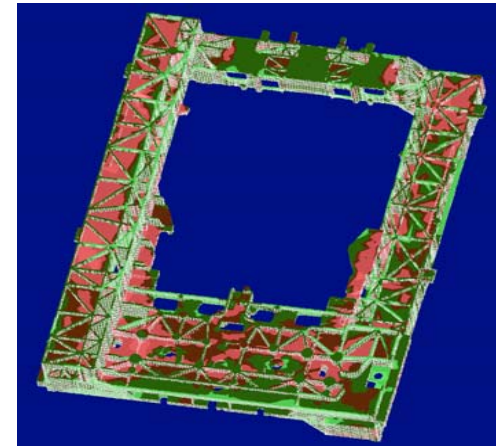
1. laser sintered polystyrene models
2. plaster investment moulds
3. low pressure or gravity casting
4. specialised NC-machining
5. required quality inspections and documentation



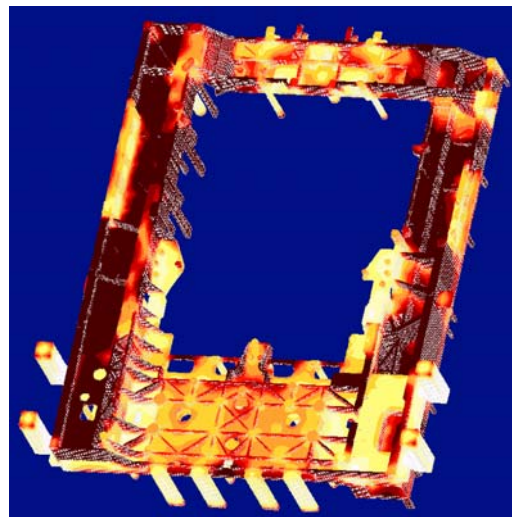
rapid casting development  
with simulation and QMC



mechanical properties

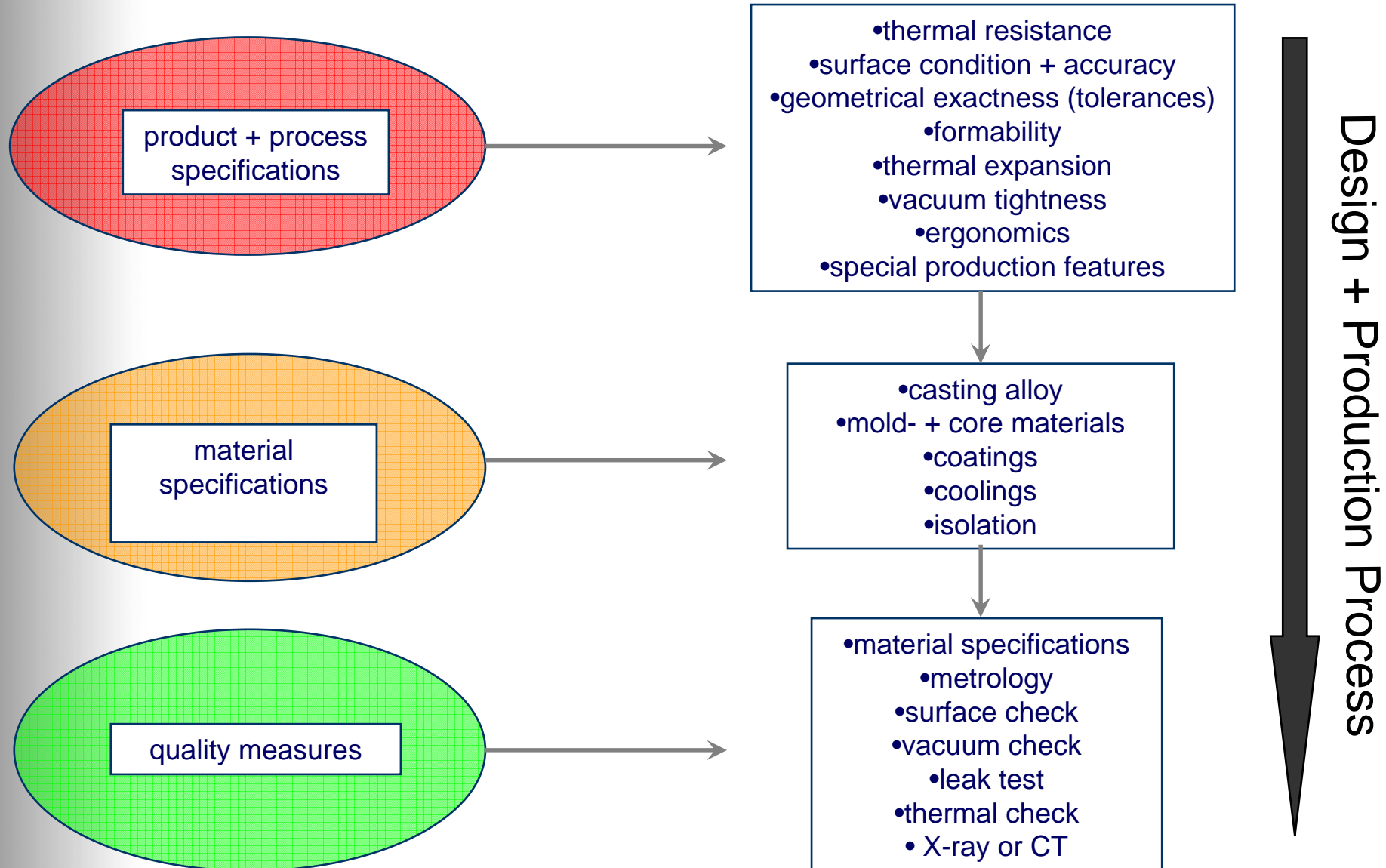


process parameter

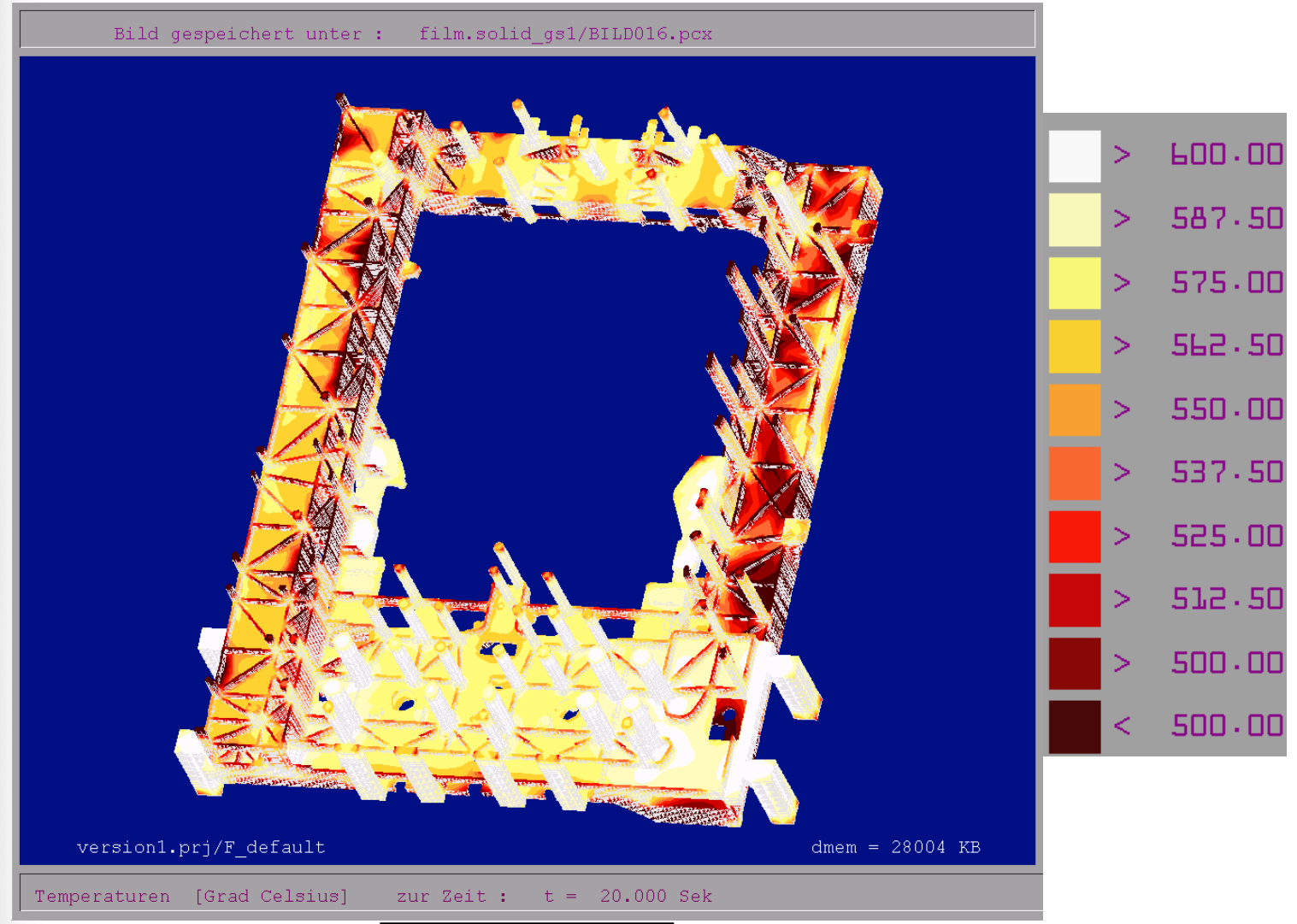


thermal properties

# rapid casting development with simulation and QMC

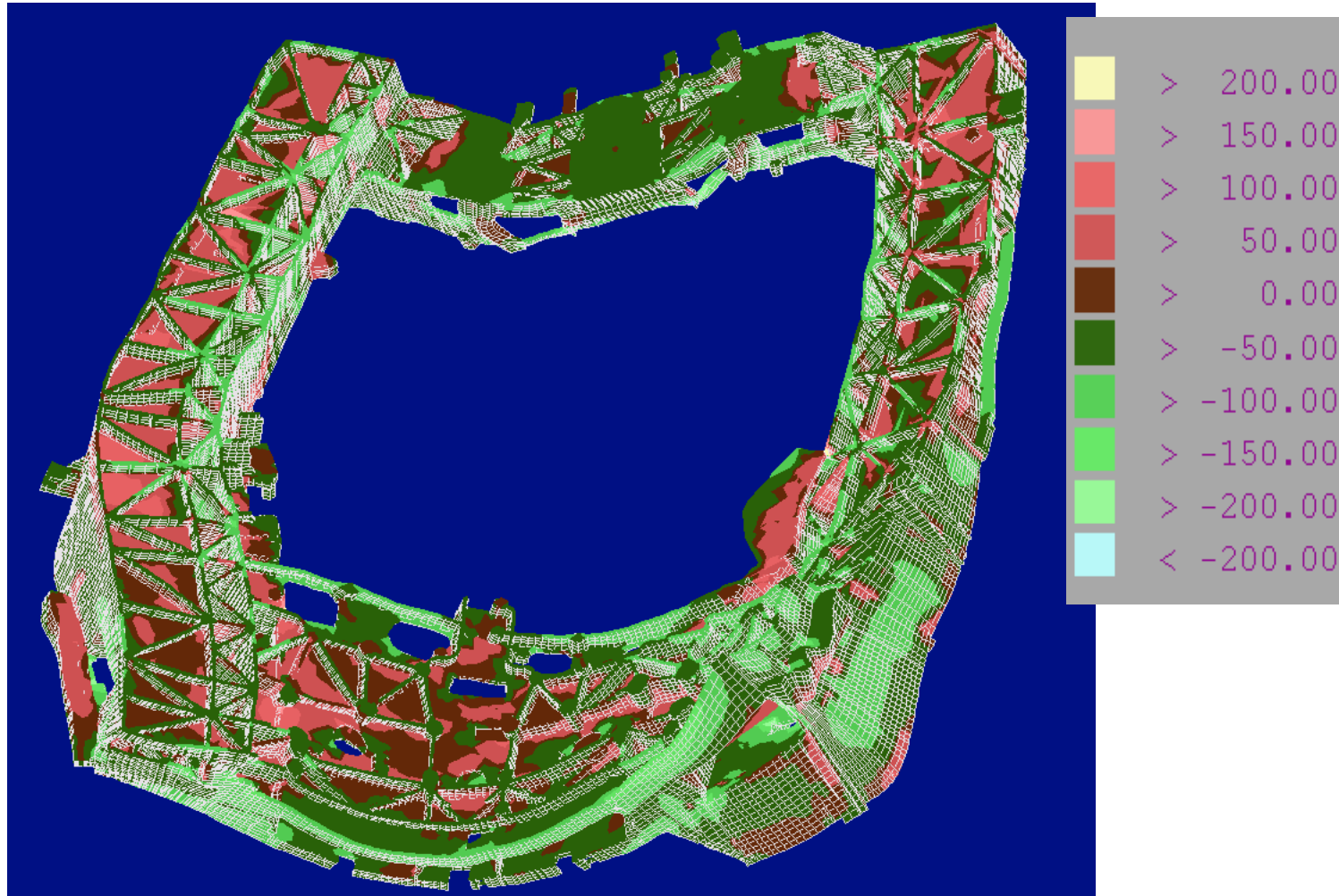


# rapid casting development with simulation and QMC



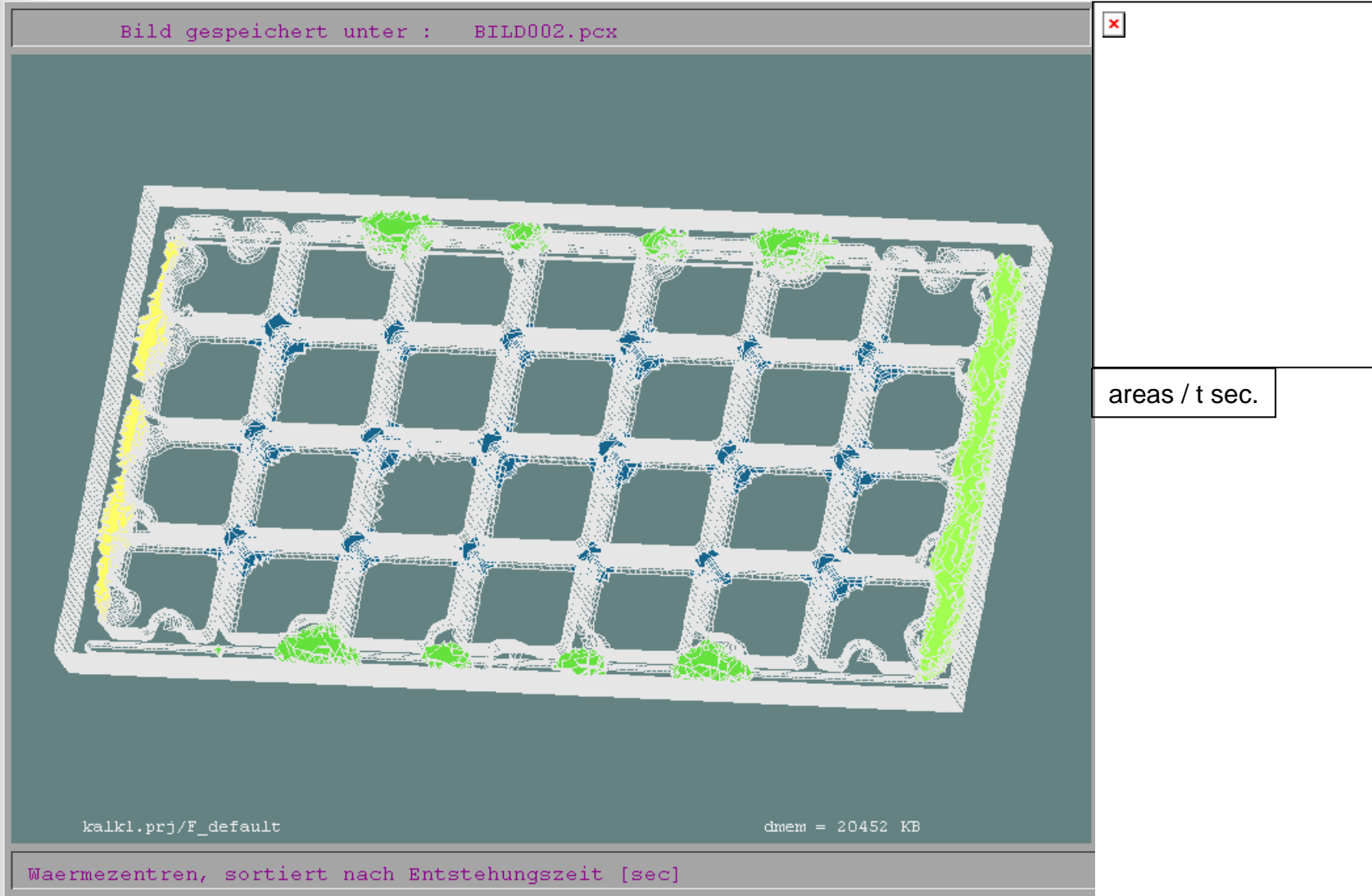
temperature fields °C

rapid casting development  
with simulation and QMC



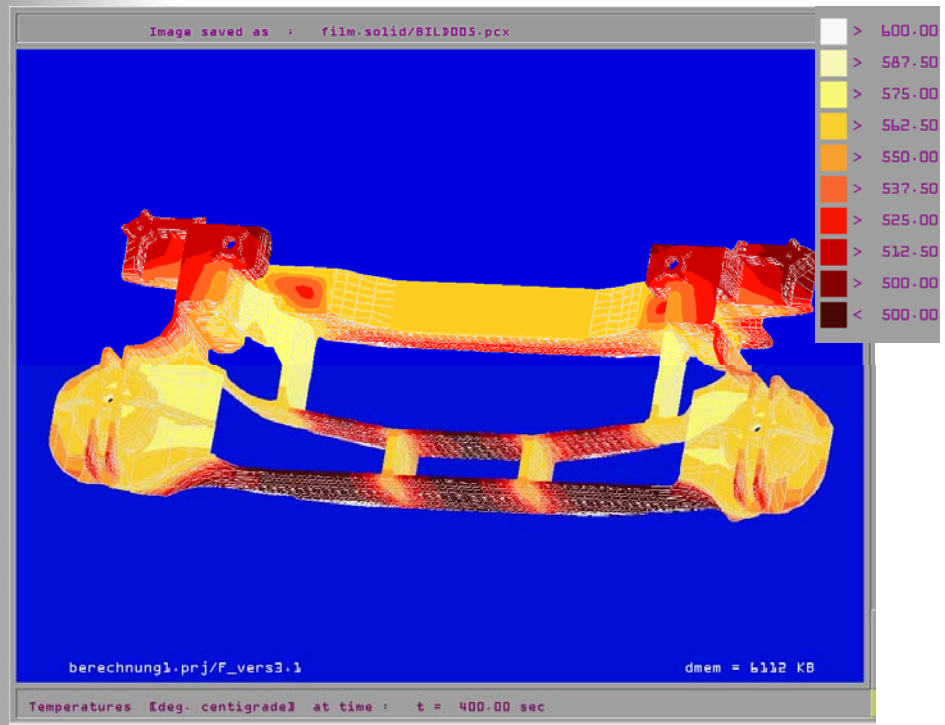
residual stresses, shrinkage + distortion

# rapid casting development with simulation and QMC

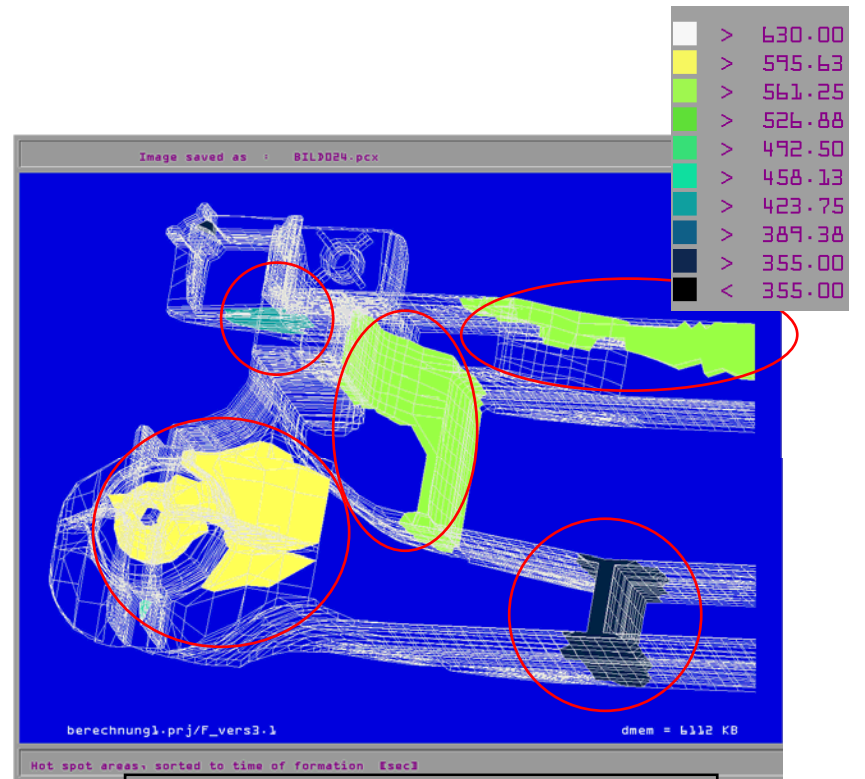


# rapid casting development with simulation and QMC

## localisation of hot spots + areas of isolated rest fluid



temperature fields °C

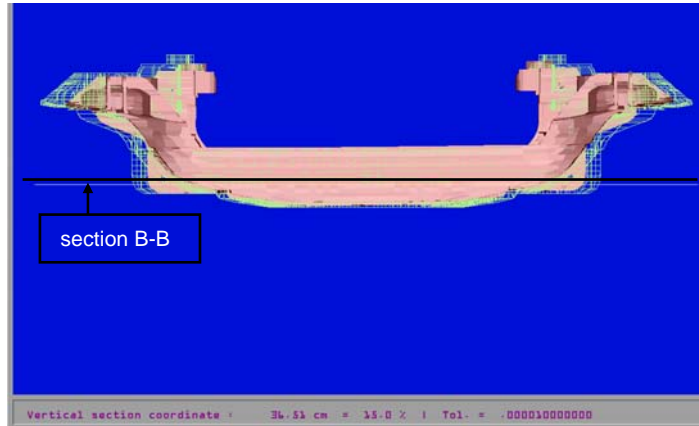


areas of isolated rest fluid, porosities

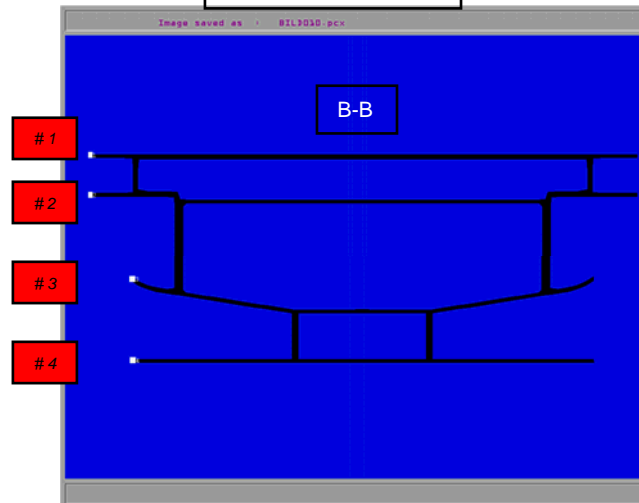
# rapid casting development with simulation and QMC



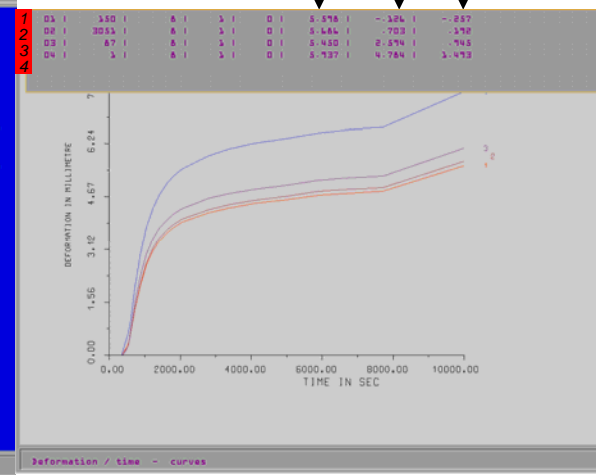
## shrinkage + distortion values in x-,y- and z-direction



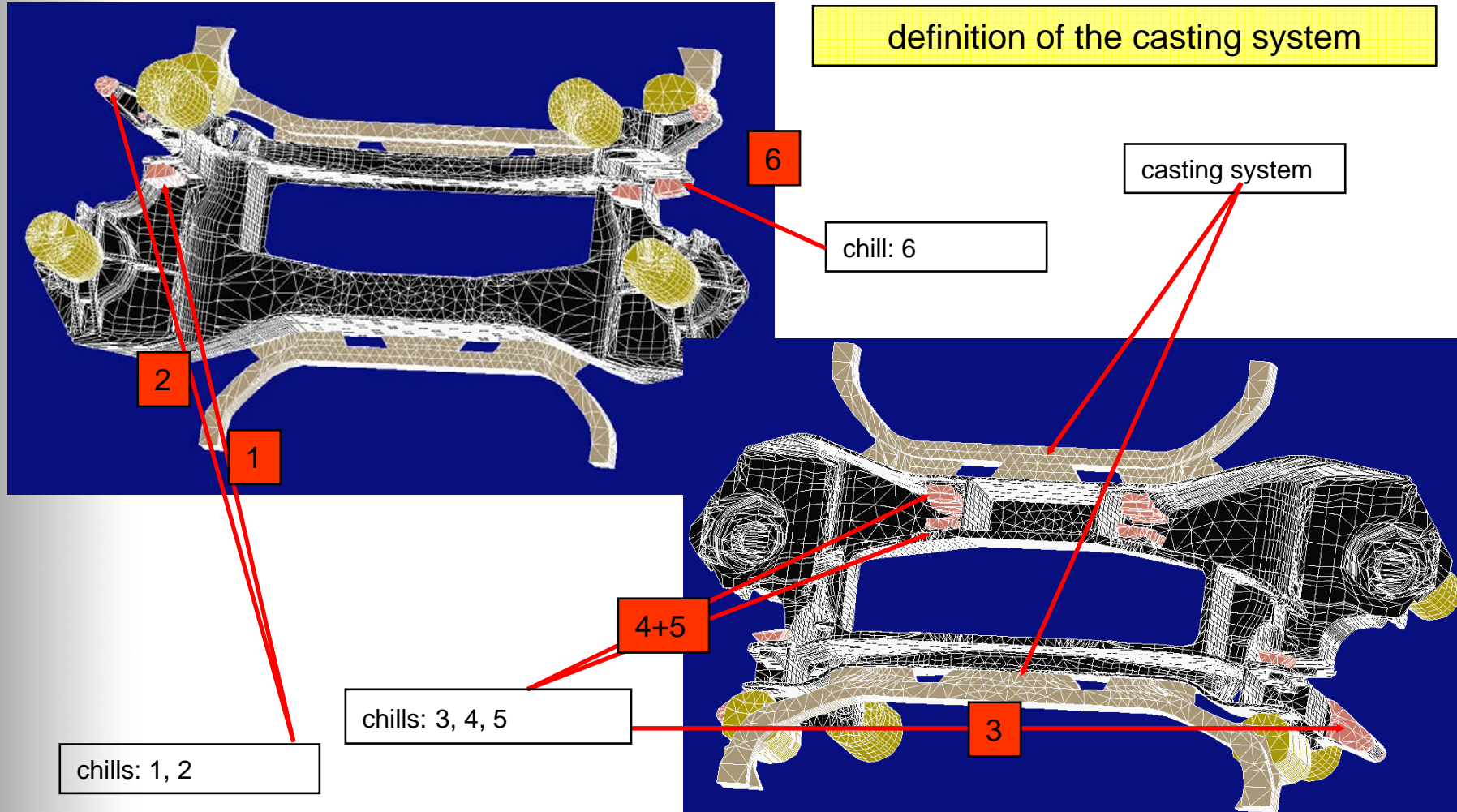
choice of points



shrinkage + distortion  
X Y Z

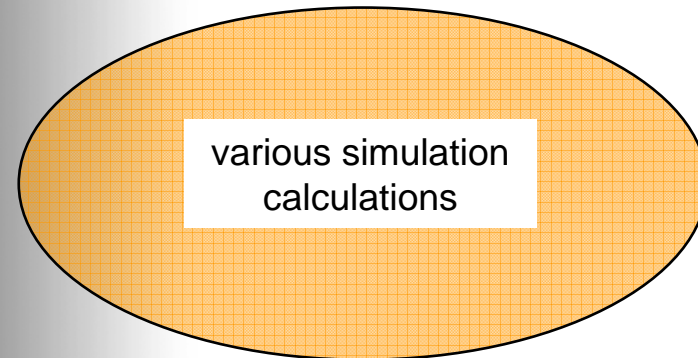
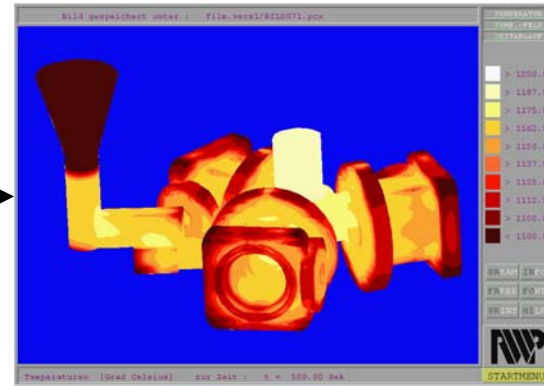
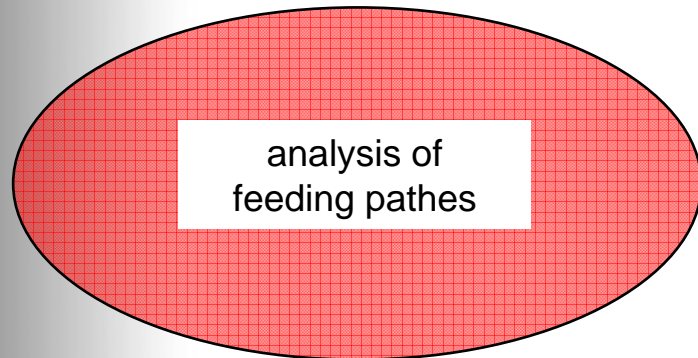


rapid casting development  
with simulation and QMC

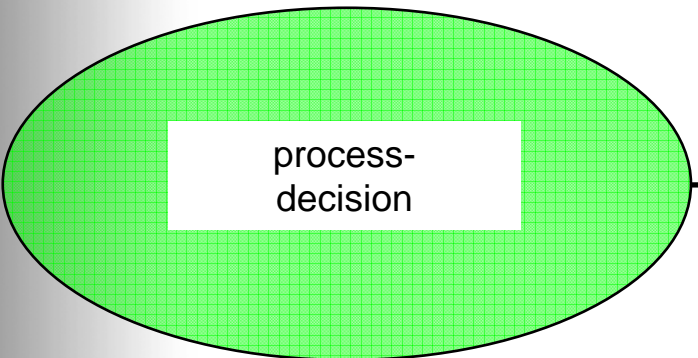
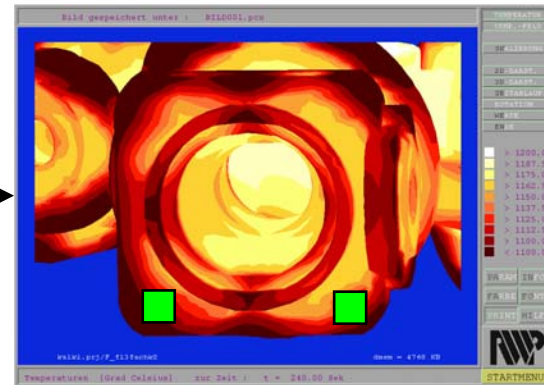




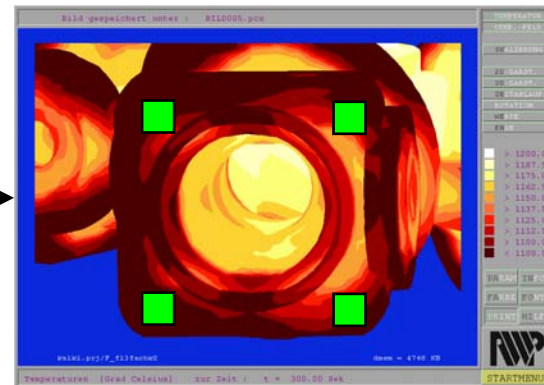
# rapid casting development with simulation and QMC



chills in LP

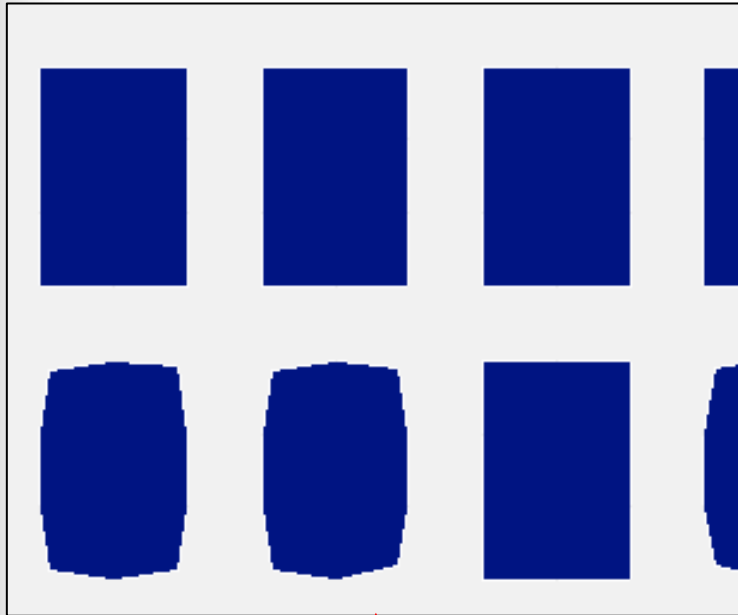


chills in LP + UP

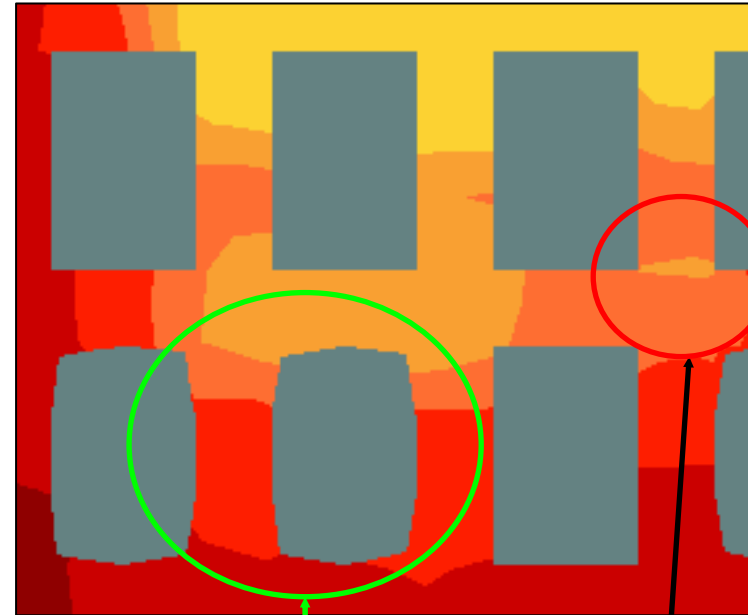


development





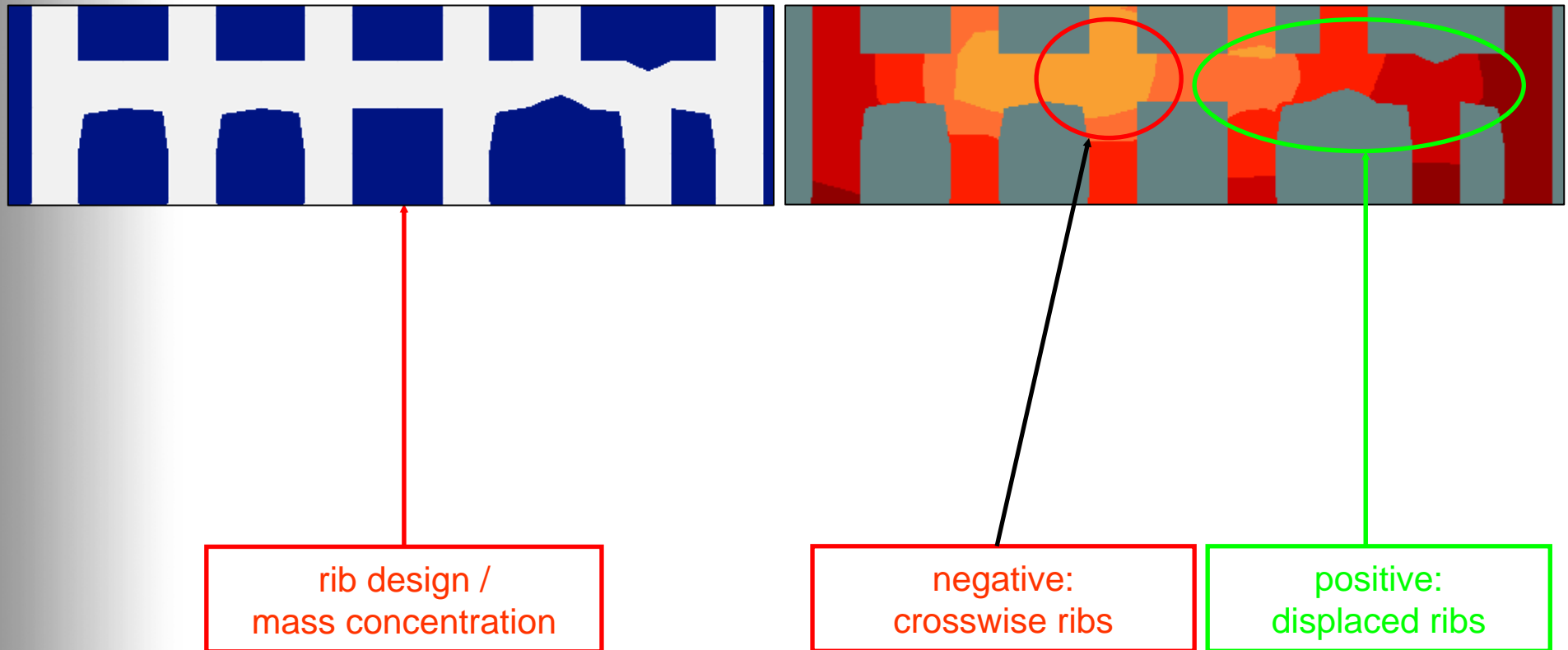
rounded and not  
rounded angles



positive:  
rounded angles

negative:  
heating up of not  
rounded angles

rapid casting development  
with simulation and QMC



rapid casting development  
with simulation and QMC

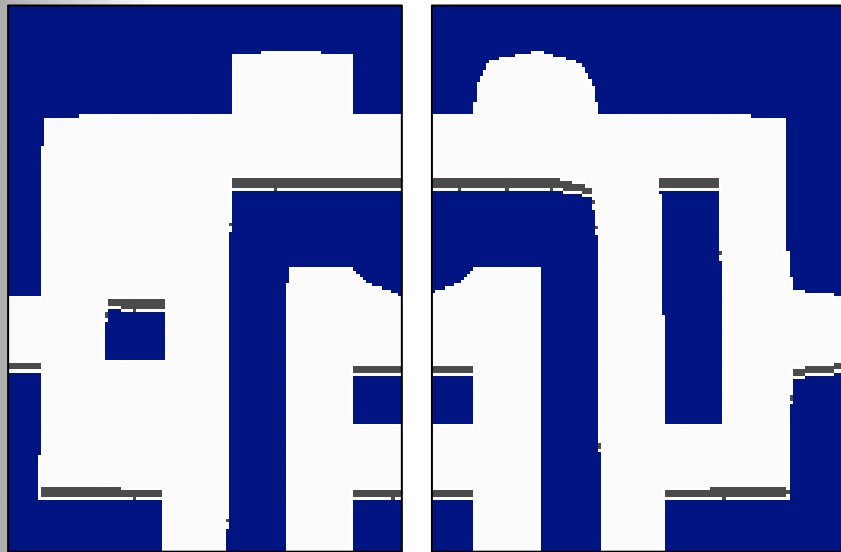


mass concentration



negative:  
no clearance

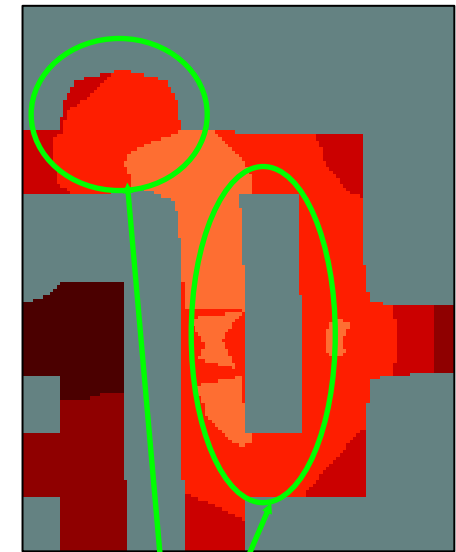
positive:  
clearance



wall geometry  
and button

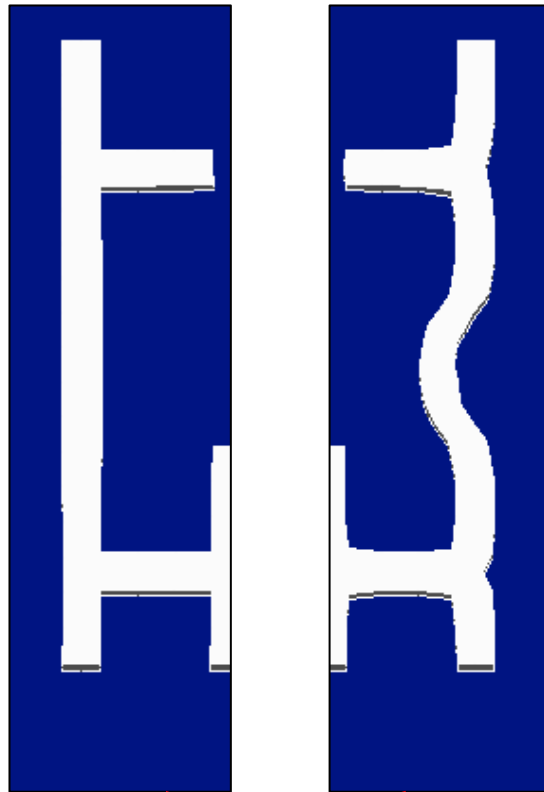


negative:  
small window,  
angular button



positive:  
bigger window,  
equal wall thickness,  
rounded button

rapid casting development  
with simulation and QMC



wall geometry

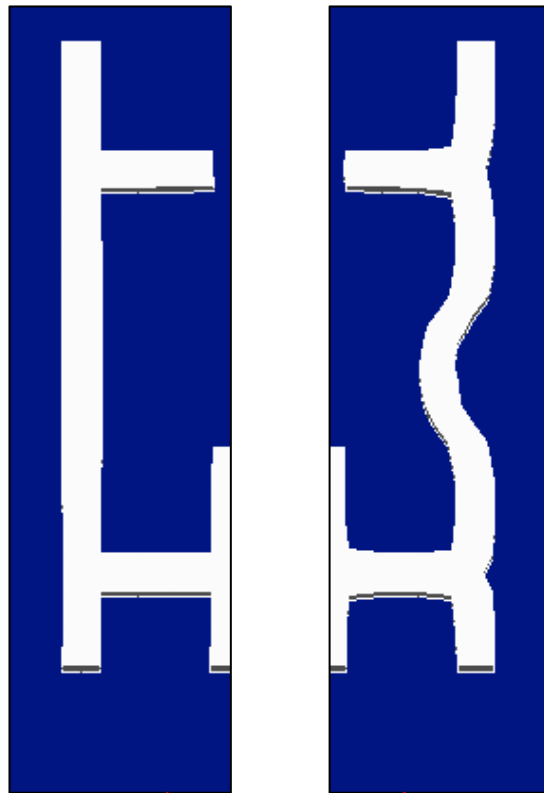


negative:  
straight wall

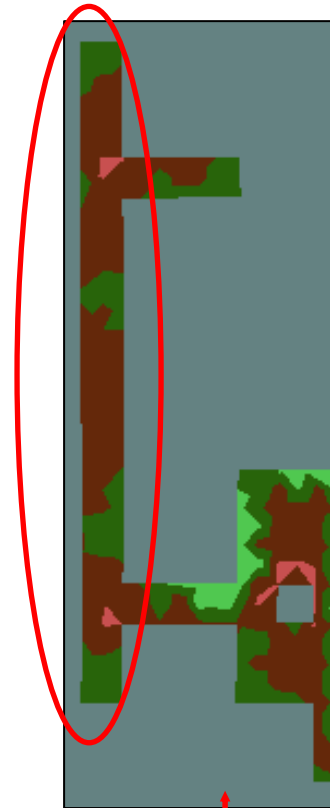


positive:  
geometry change,  
rounded

rapid casting development  
with simulation and QMC



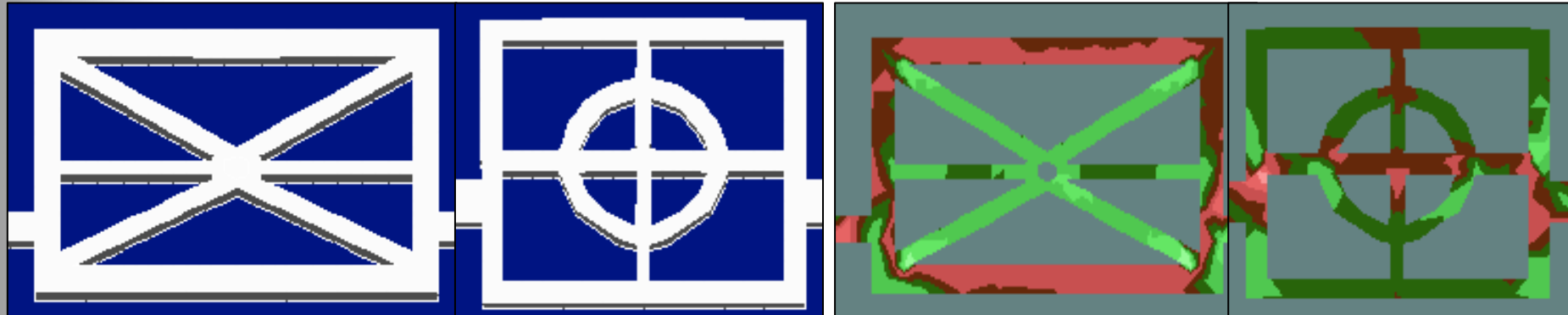
wall geometry



negative:  
straight wall



positive:  
geometry change,  
change of compression  
stress to tensile stress



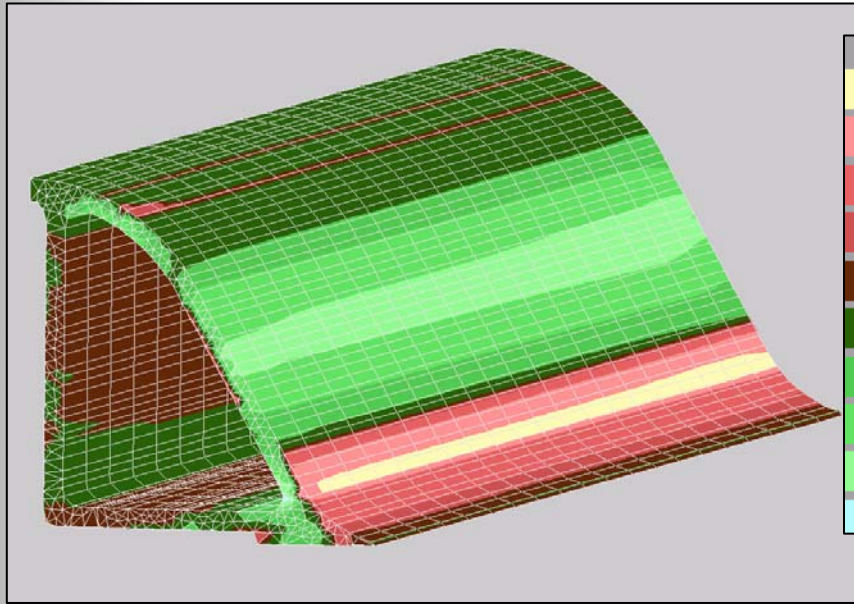
different rib  
geometries

negative:  
diagonal wise

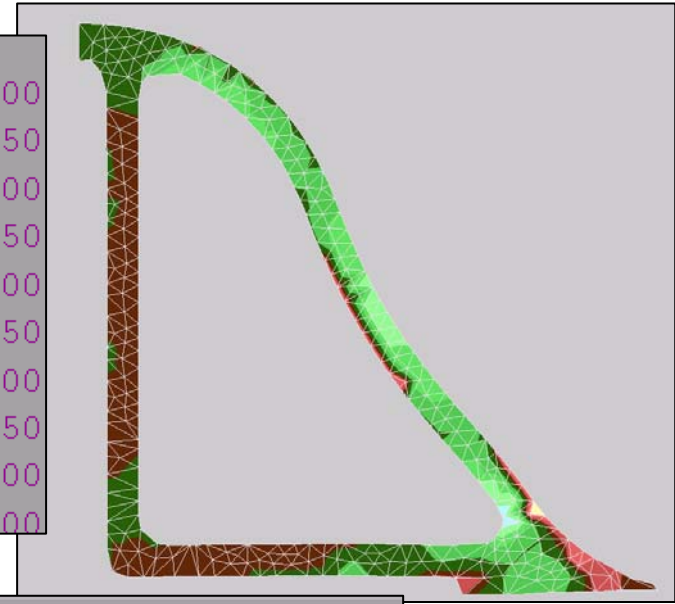
positive:  
circular



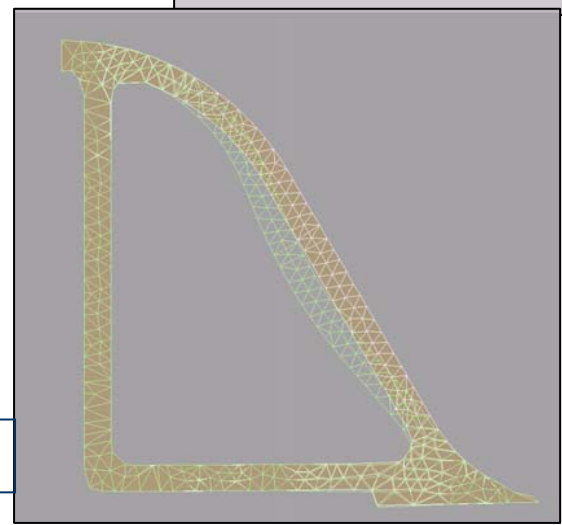
# rapid casting development with simulation and QMC



Yellow	>	38.00
Light Green	>	28.50
Green	>	19.00
Dark Green	>	9.50
Brown	>	0.00
Dark Brown	>	-19.50
Red	>	-39.00
Orange	>	-58.50
Light Blue	>	-78.00
Dark Blue	<	-78.00

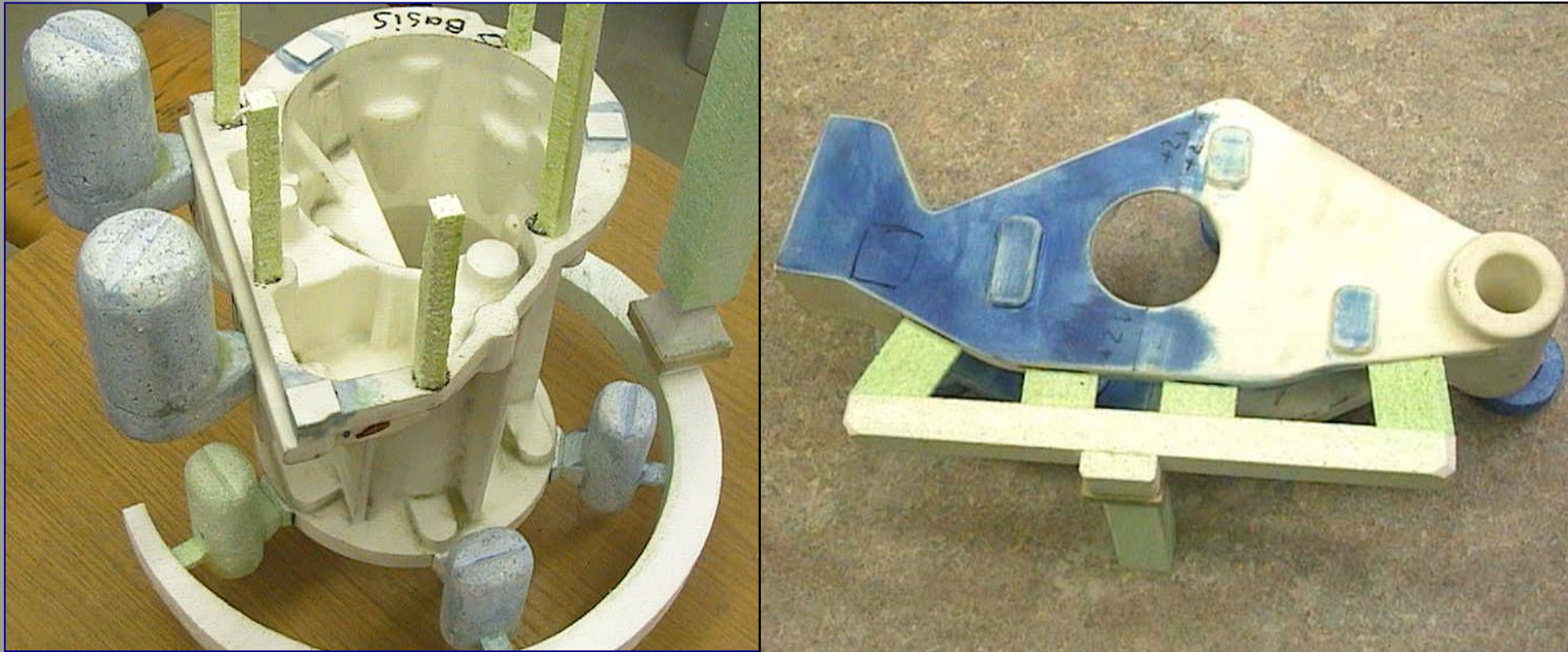


compression and tensile stresses



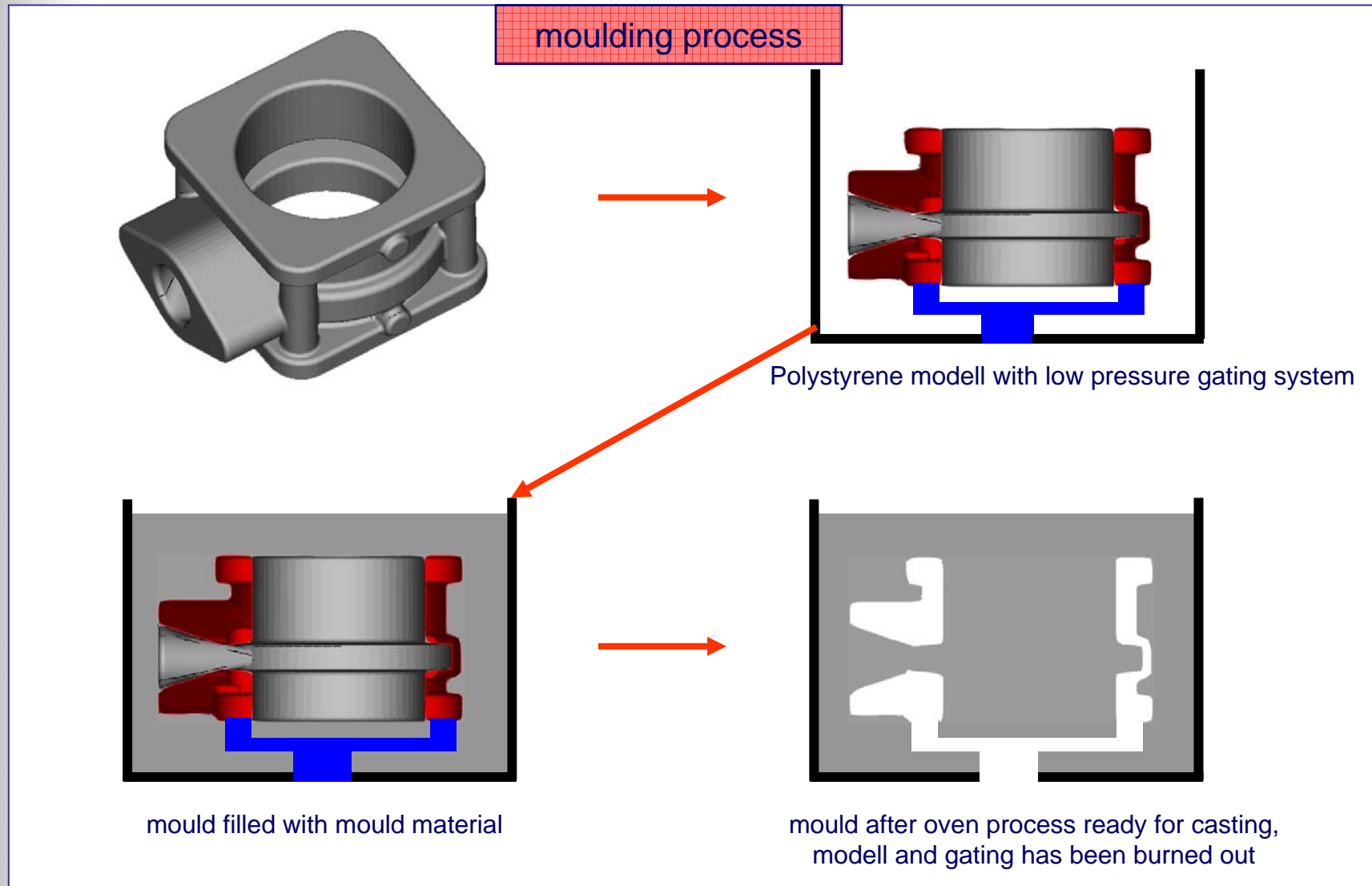
distortion

rapid casting development  
with simulation and QMC



The casting system, including gating, feeding and cooling  
will be fitted to the master model.

Special cooling techniques cause defined mechanical properties  
in the castings.

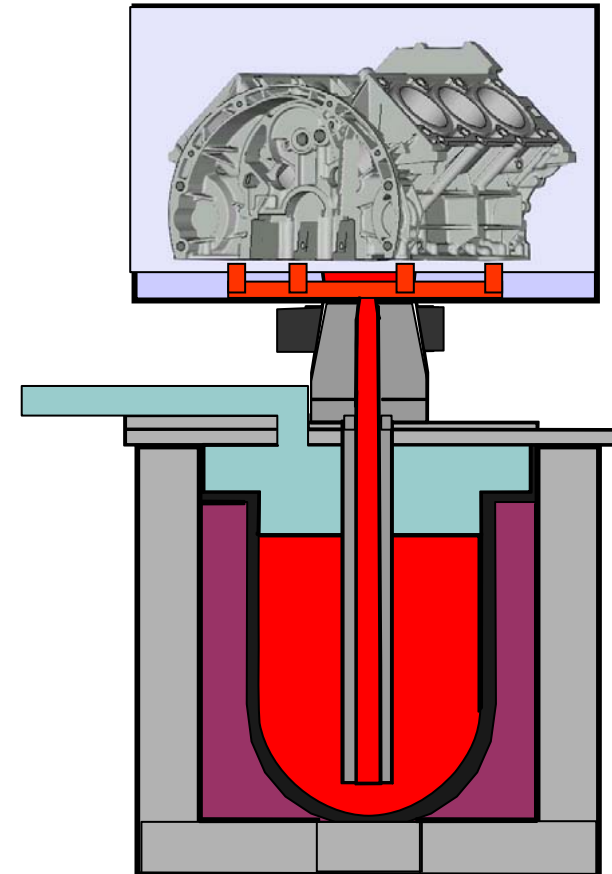


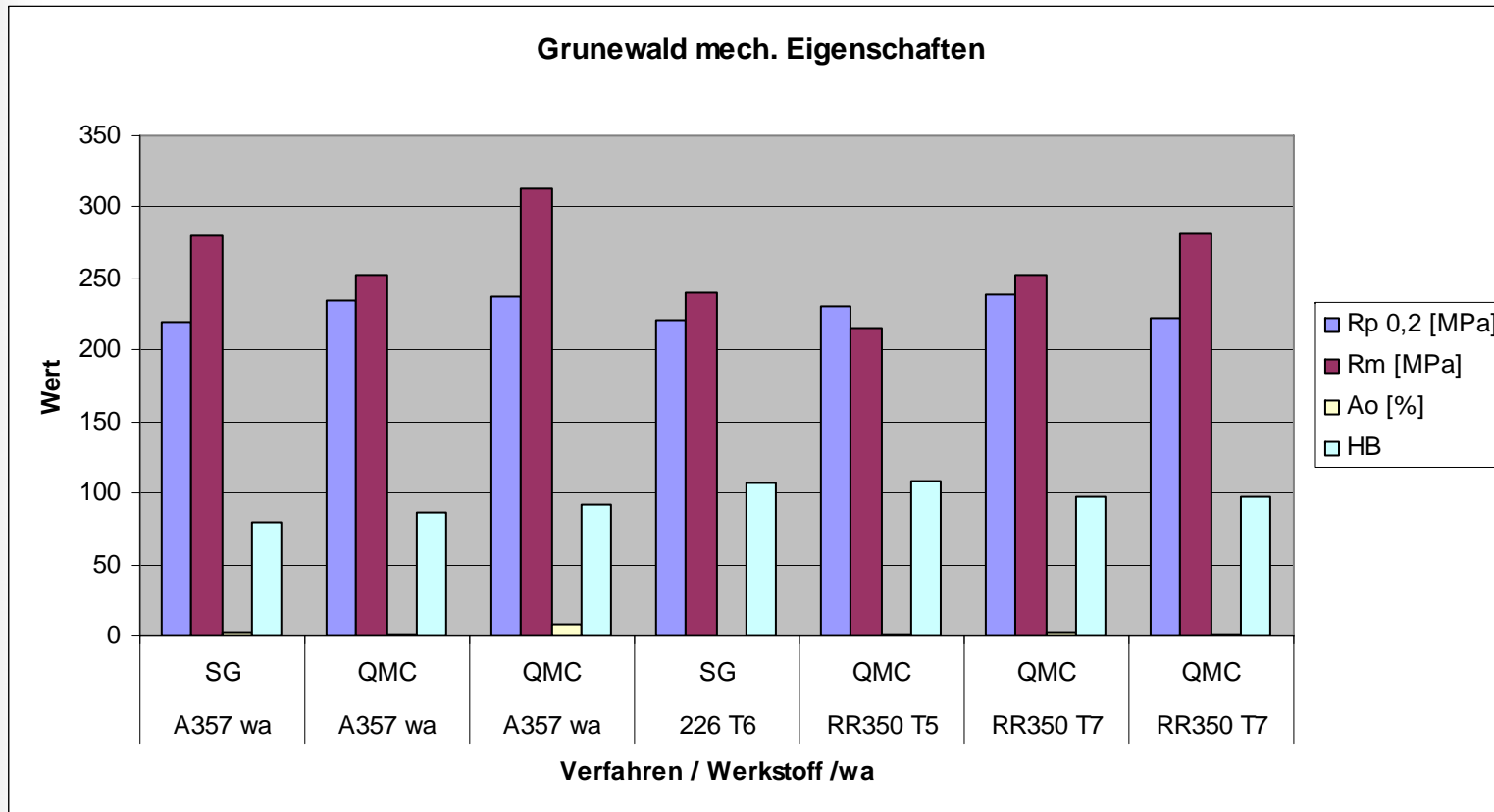
rapid casting development  
with simulation and QMC



### low pressure casting machine

- year of construction: 2004
- contents of crucible 300 kg Al, (exchangable crucible)
- dynamic pressure control
- small series production





mechanical properties

rapid casting development  
with simulation and QMC



NC-processing

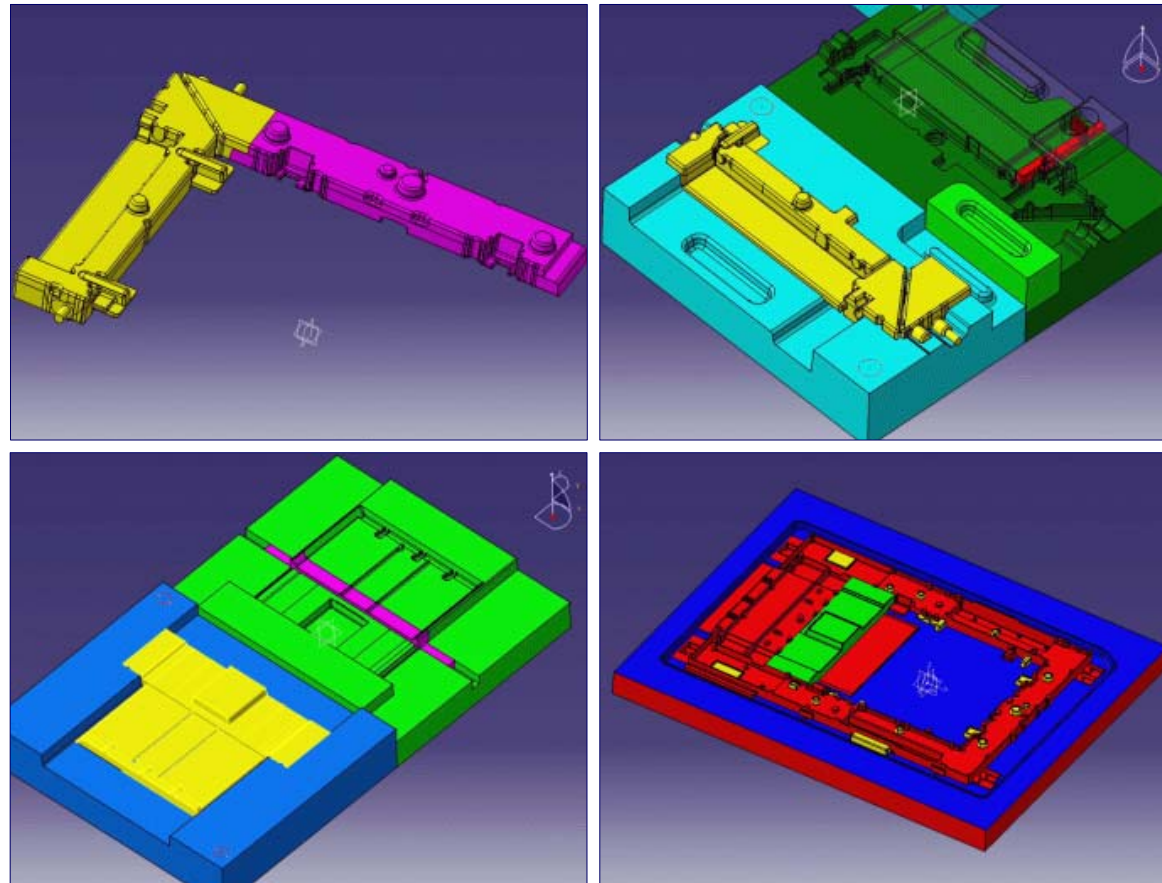
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## **Rapid Tooling + sand- and die casting**

- CAD design of the tool or laser sintered masters on basis of 3D-product data
- machined tools (HSC)
- modular tool architecture
- shaping of undercuts with single inserts
- sand moulds or permanent moulds (iron or steel)
- low pressure casting technique
- process adapted NC-machining
- process matched quality measures and documentation

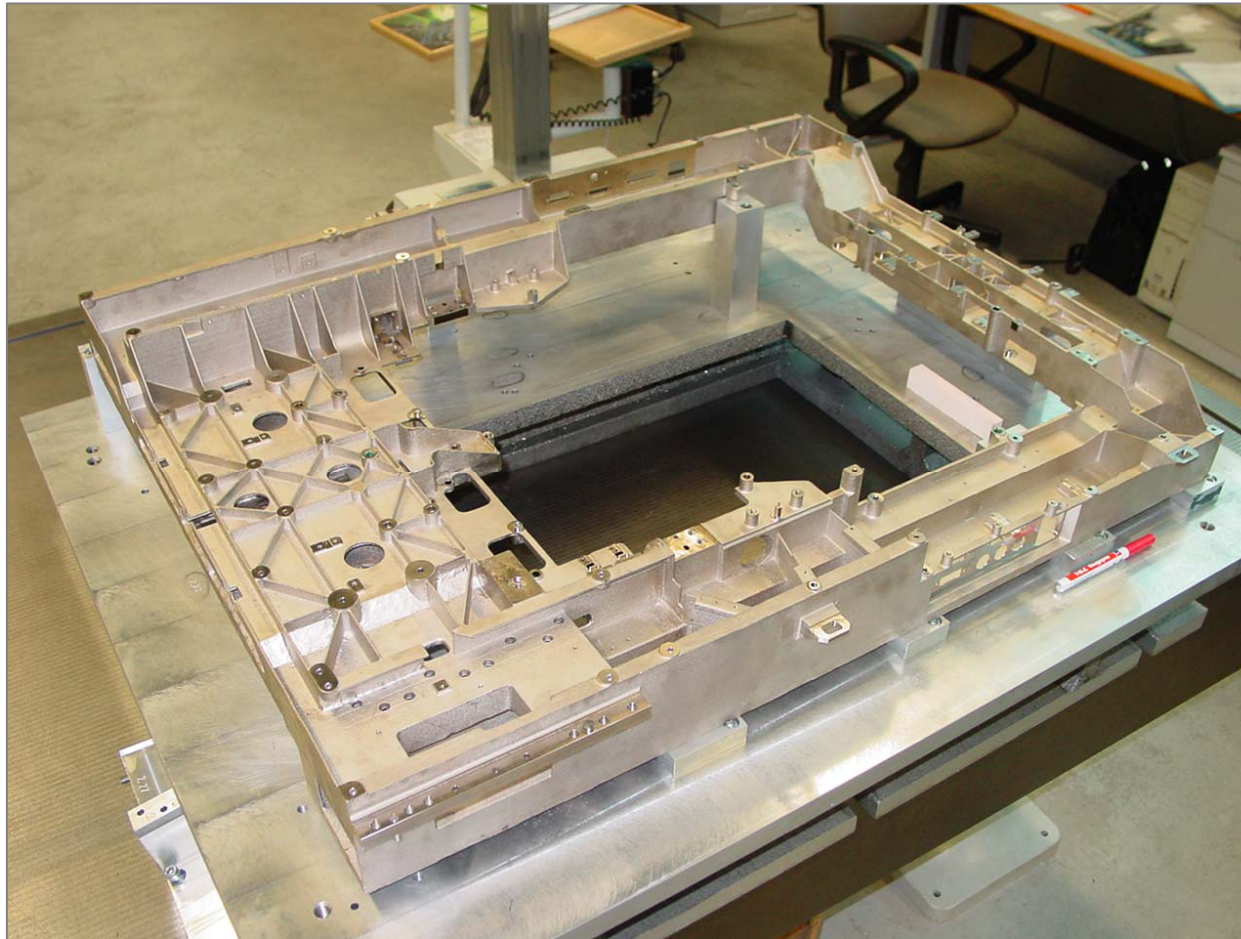


rapid casting development  
with simulation and QMC



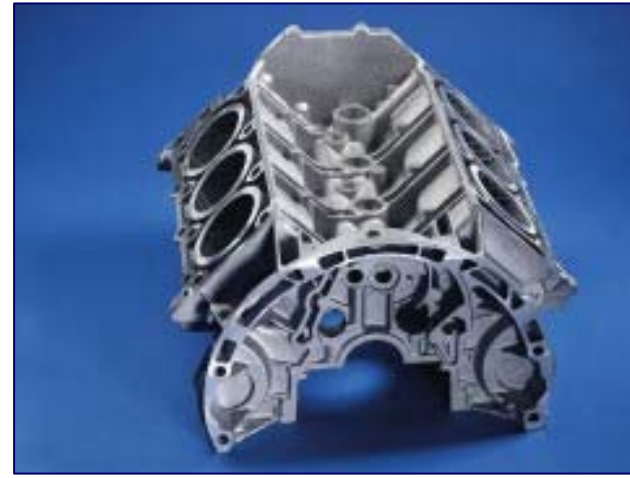
**CAD-Design of a Sand Casting Pattern in CATIA V5**

rapid casting development  
with simulation and QMC



**high performance frame – a356**

rapid casting development  
with simulation and QMC



sand castings

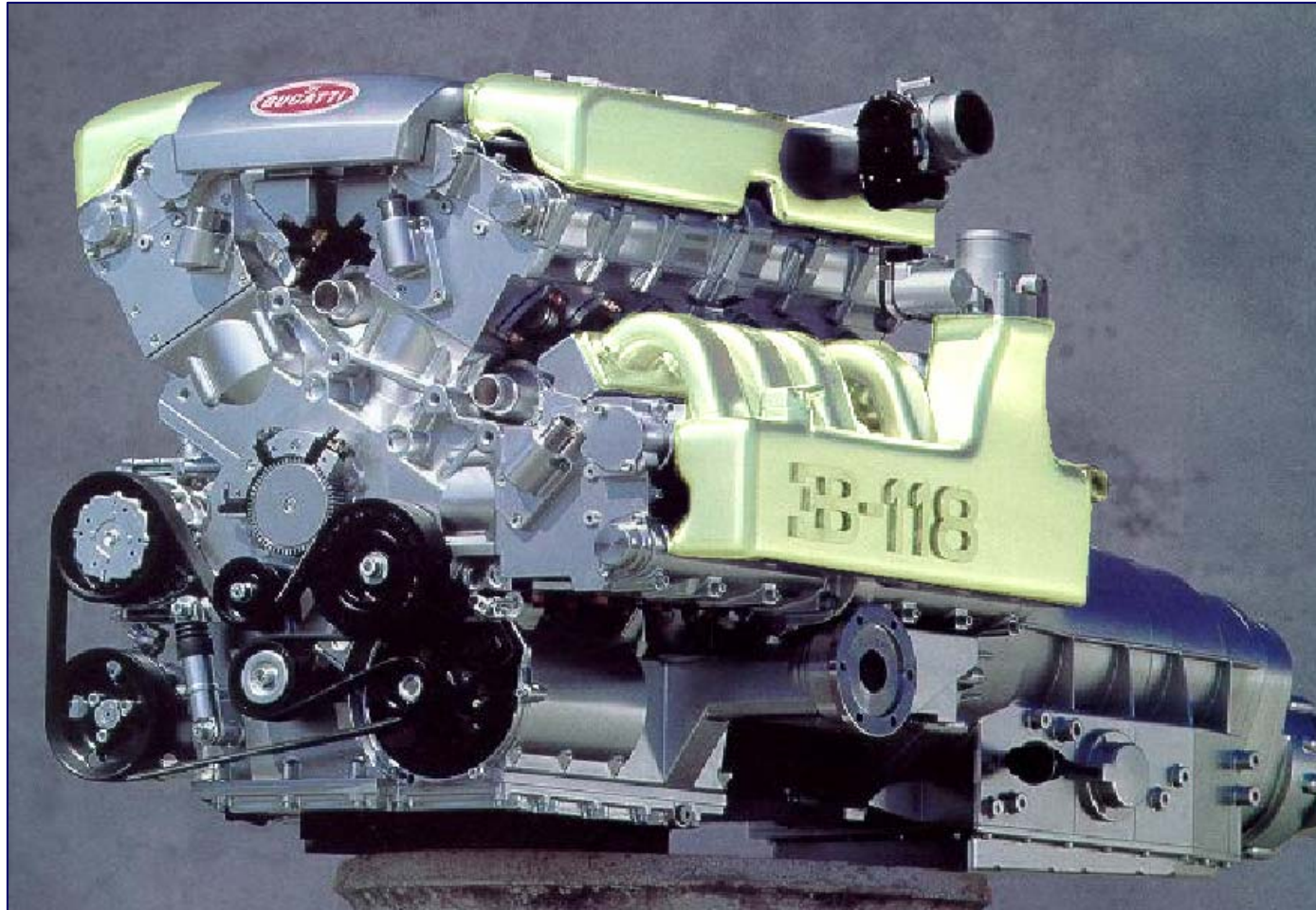
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rapid casting development  
with simulation and QMC



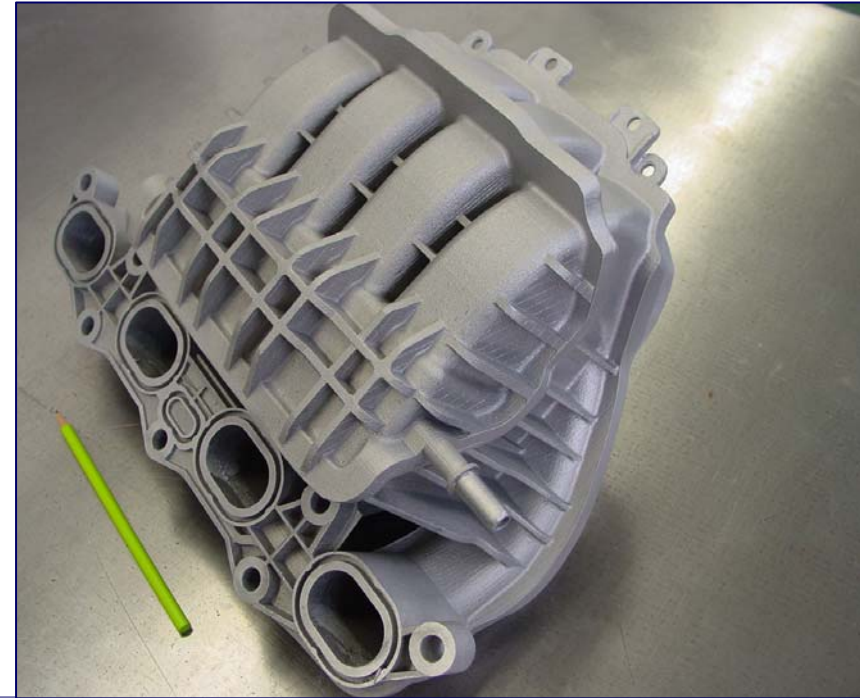
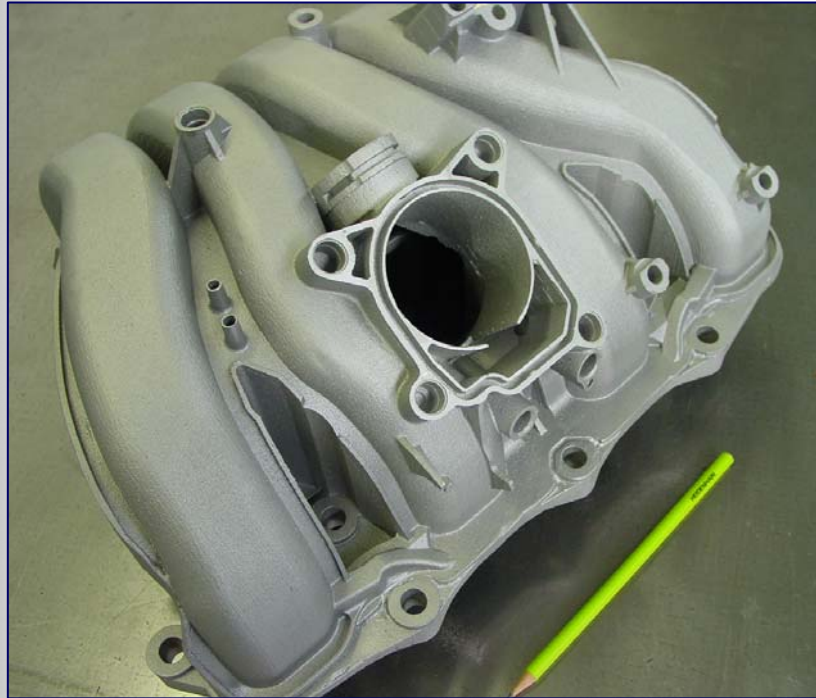
**exhaust manifold - Ni-resist**

rapid casting development  
with simulation and QMC



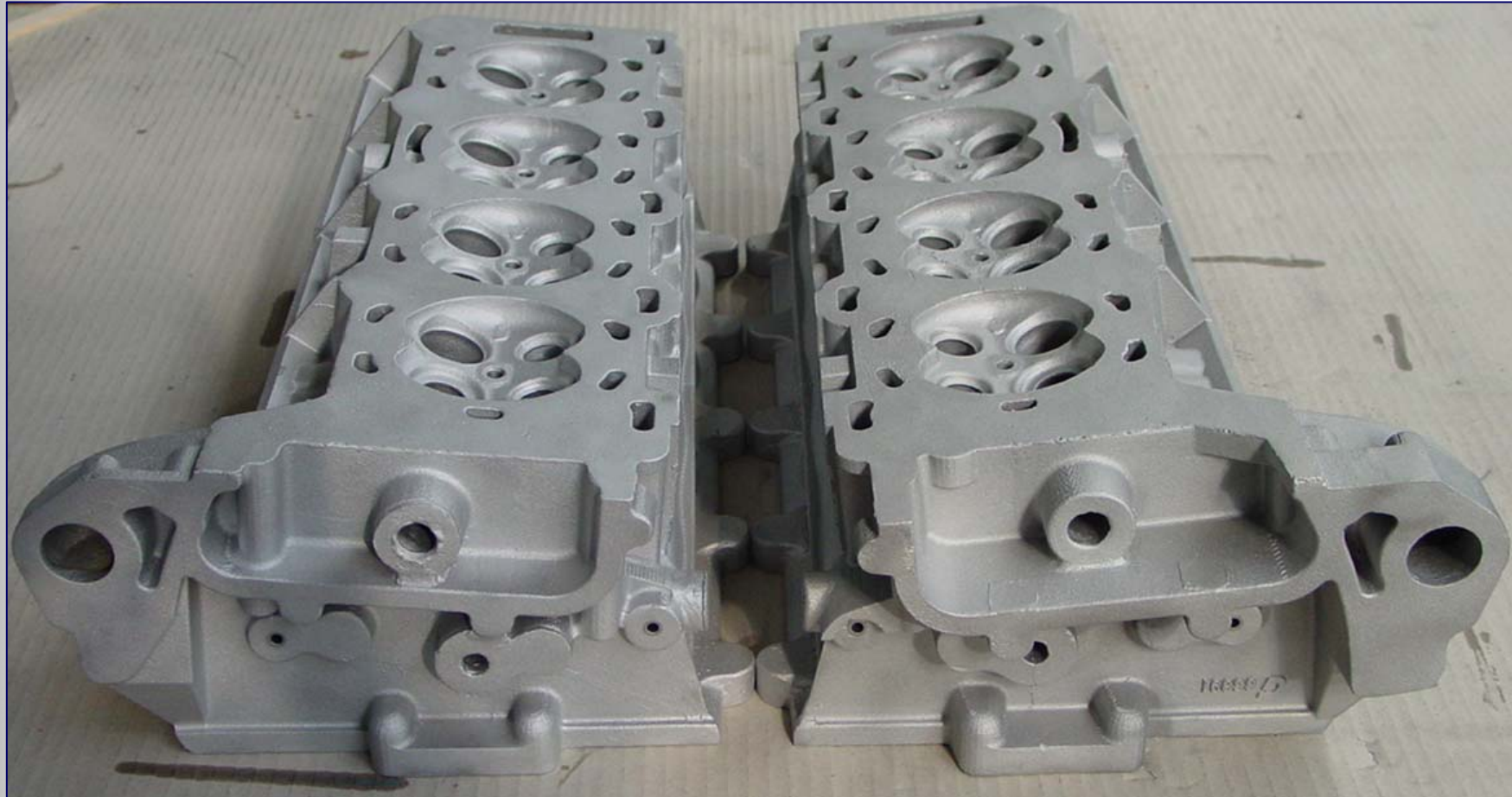
**aluminum components for the 18-cylinder engine  
(VW/Bugatti)**

rapid casting development  
with simulation and QMC



**suction pipe**  
**Qualified Netshape Casting „QNS“**

rapid casting development  
with simulation and QMC



**V8-RH/LH cylinder heads (Jaguar) - a357**