How to Accomplish Low Stress While Molding Polyester BMC

Goal of Presentation

Our goal is:

- To present correct gate placement that gives us the lowest stress

I will accomplish this by:

- Focusing on stress of the polyester using von mises
- Analyzing results to help locate the best gate location with minimal stress

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Agenda

1. Results by Type of Analysis – Sigmasoft Thermoset Part (From GrabCAD)
   - -Von Mises – What is it?
   - -Analyzing stress
   - -Analyzing fibers
   - -Simulation set up
   - -Results and discussion

Von Mises

Let's start out explaining what Von Mises is. Von Mises stress is a measure of the total amount of stress acting on a material at a given point.

Von Mises stress is a theoretical stress that represents a measure of the total amount of stress acting on a material at a given point. However, von Mises stress does not take into account any material failure criteria, such as ultimate tensile strength, or fracture toughness. These failure criterias are the limiting factors that determine the material's ability to withstand stress before failure occurs. Therefore, while von Mises stress can provide insight into the state of stress in a material, it cannot predict the exact point at which failure will occur.

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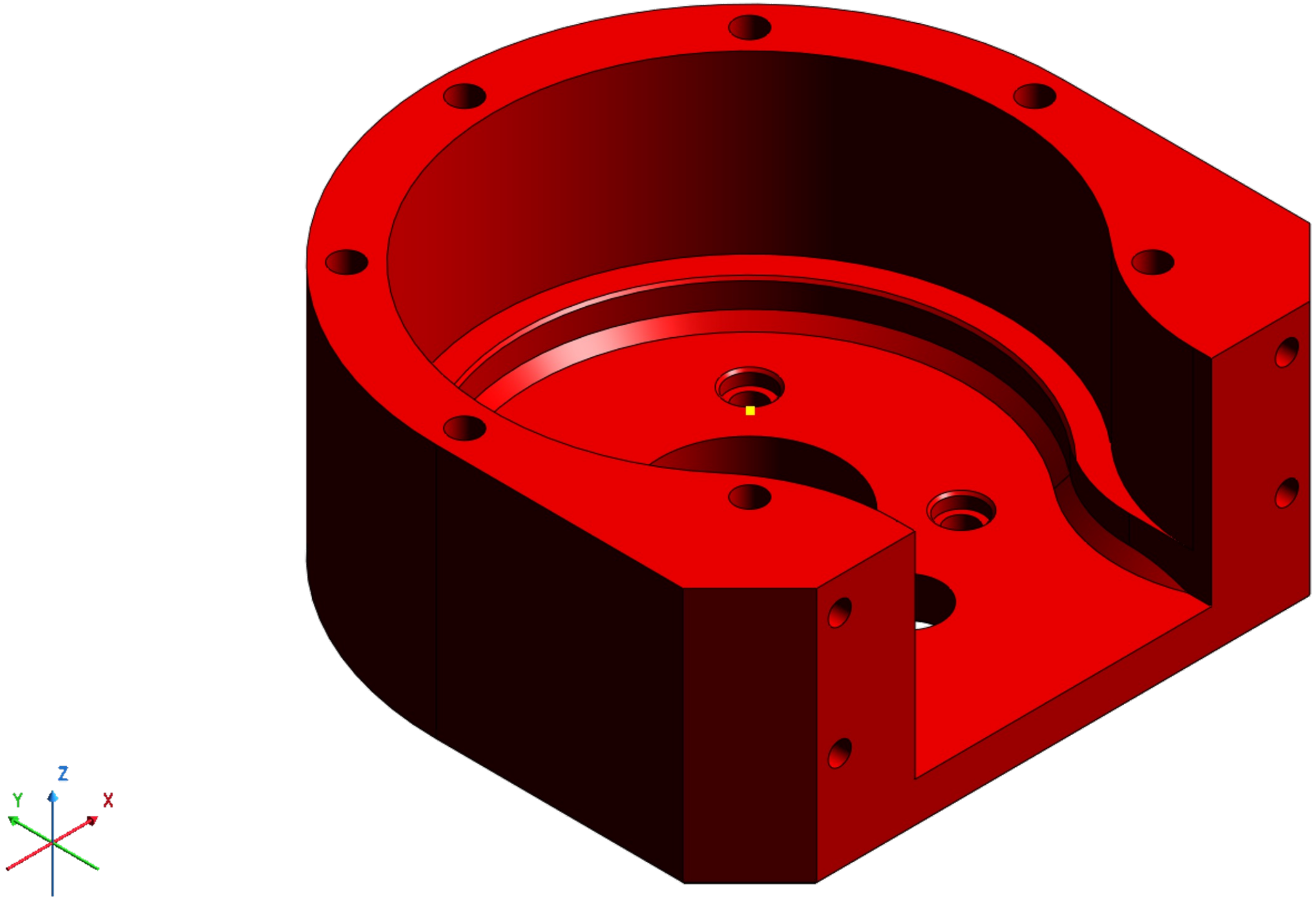
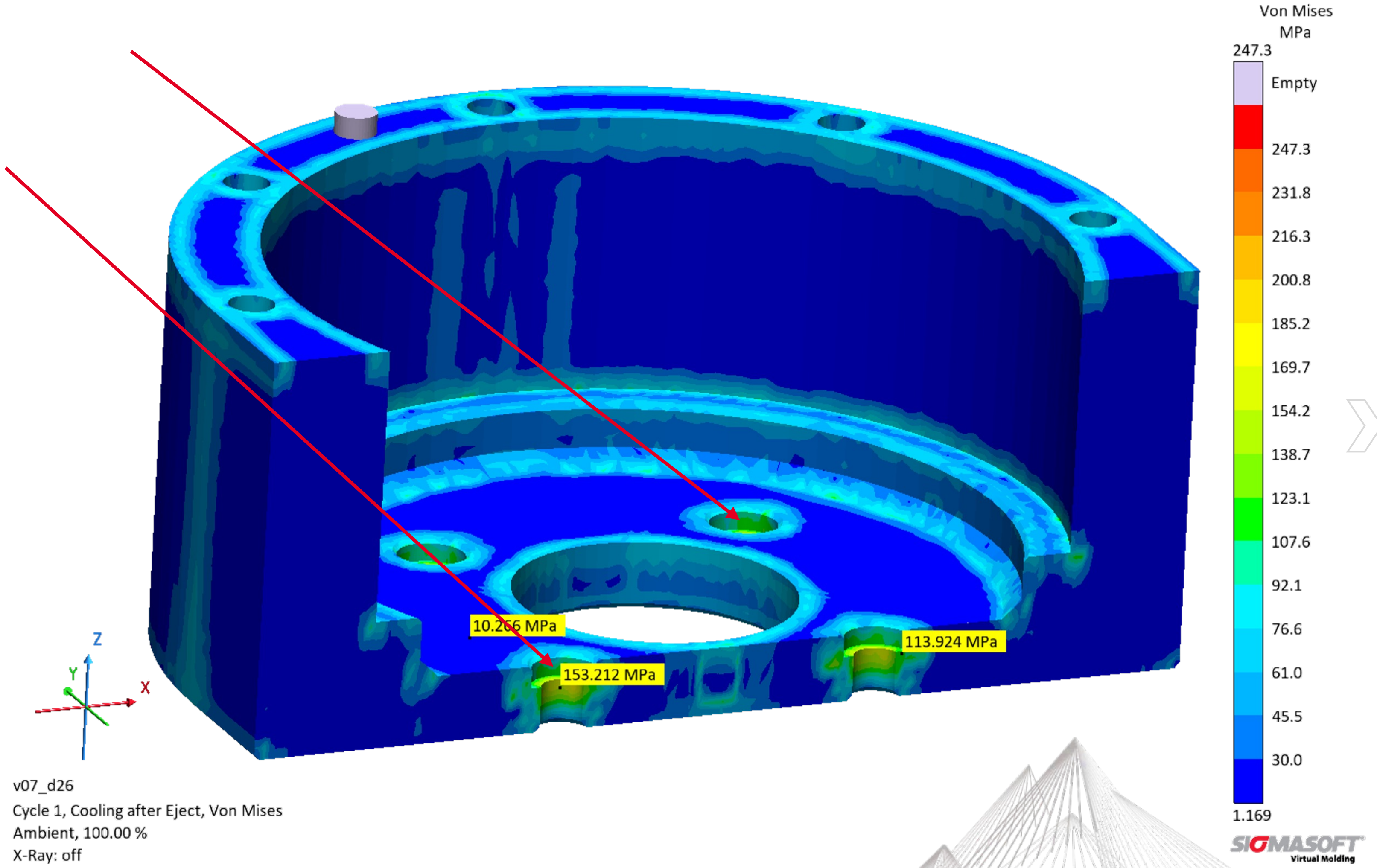
Analyzing Pump Cover



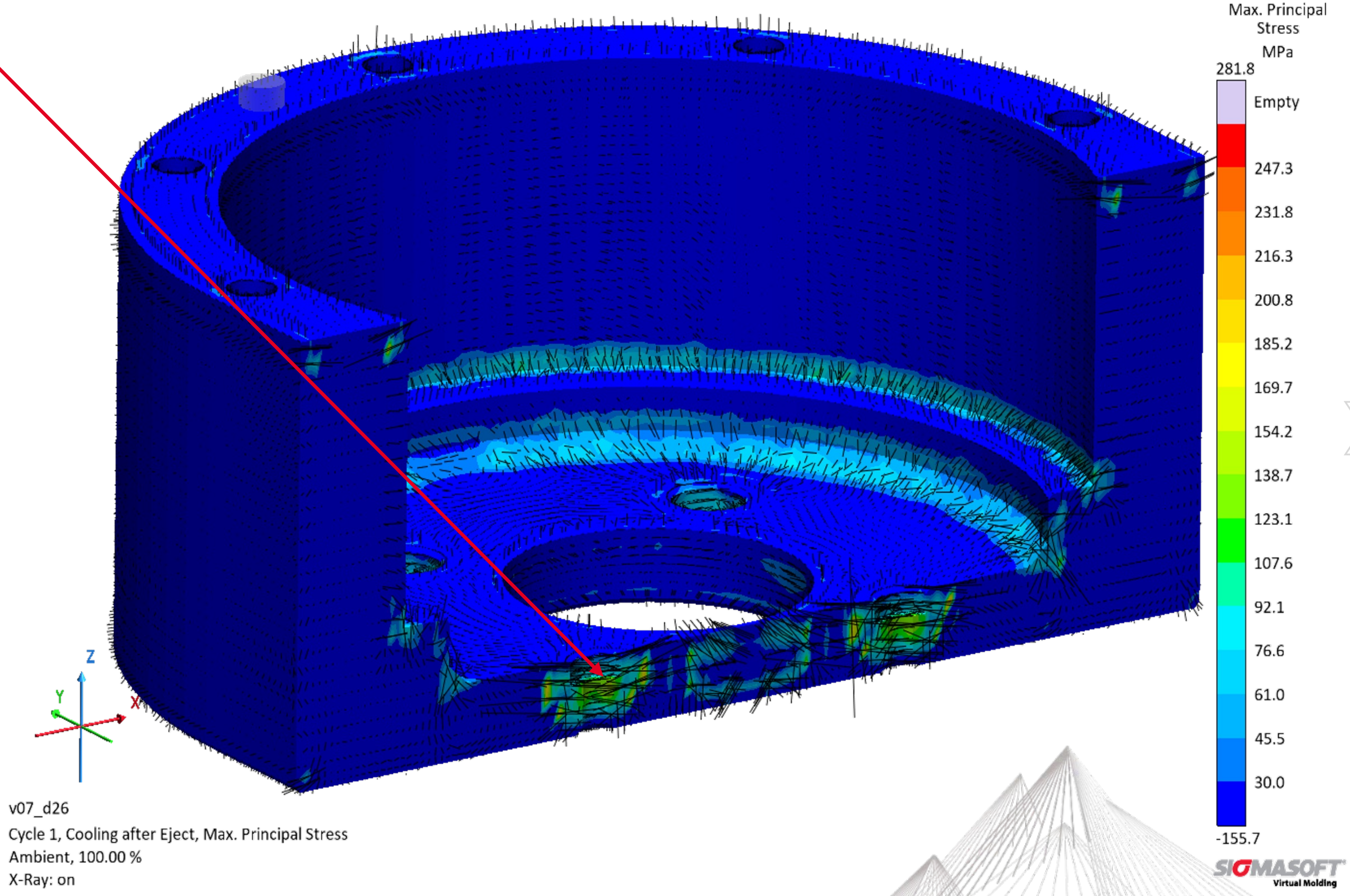
Analyzing Stress – Von Mises

- Arrows represent Von Mises stress in the part. This specific area might be of interest if you screwing a bolt in.



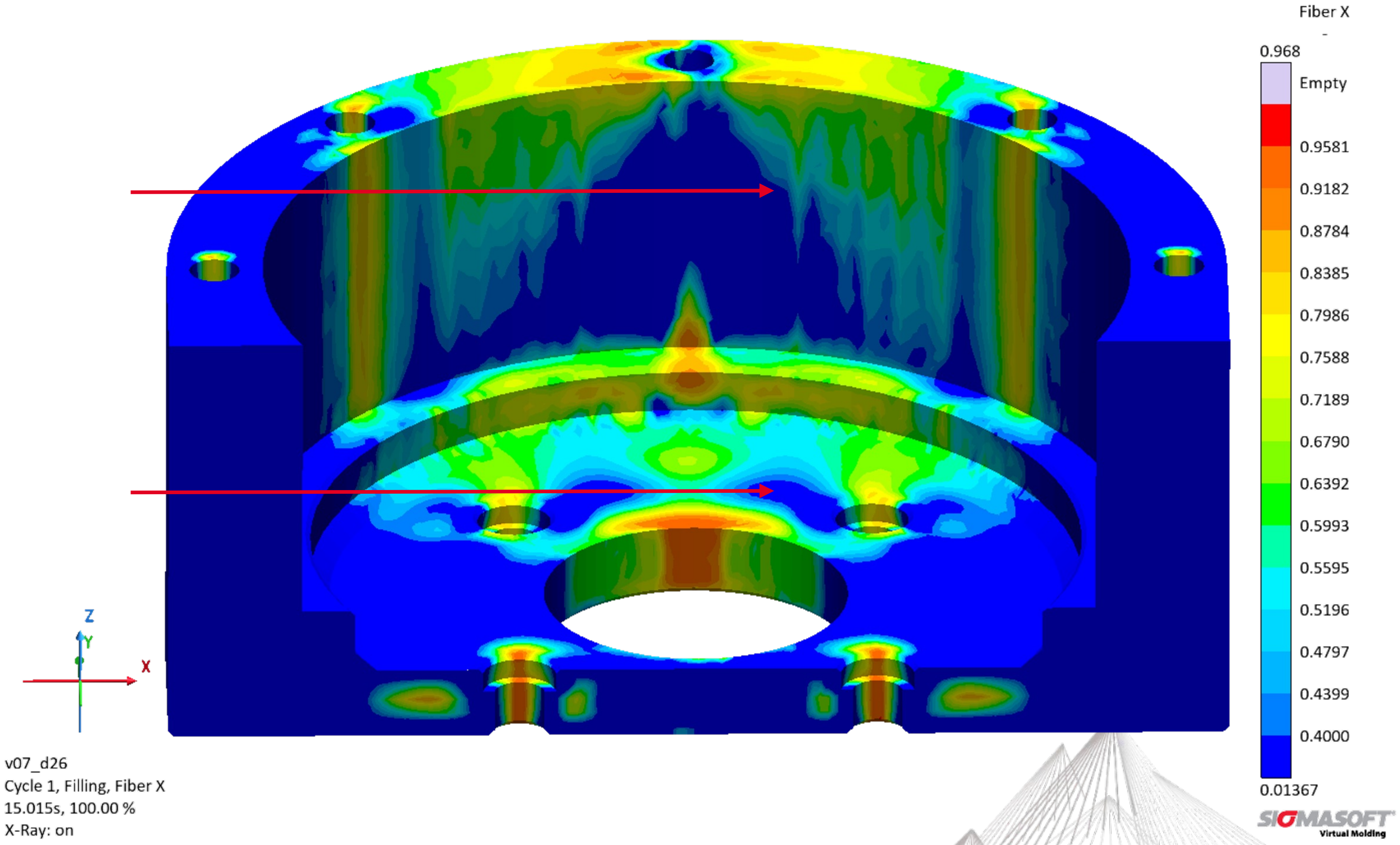
Analyzing Stress – Max Principle Stress

- Arrow represent high stress areas in the part. This represents high stress areas in the part especially on the bottom of the part.



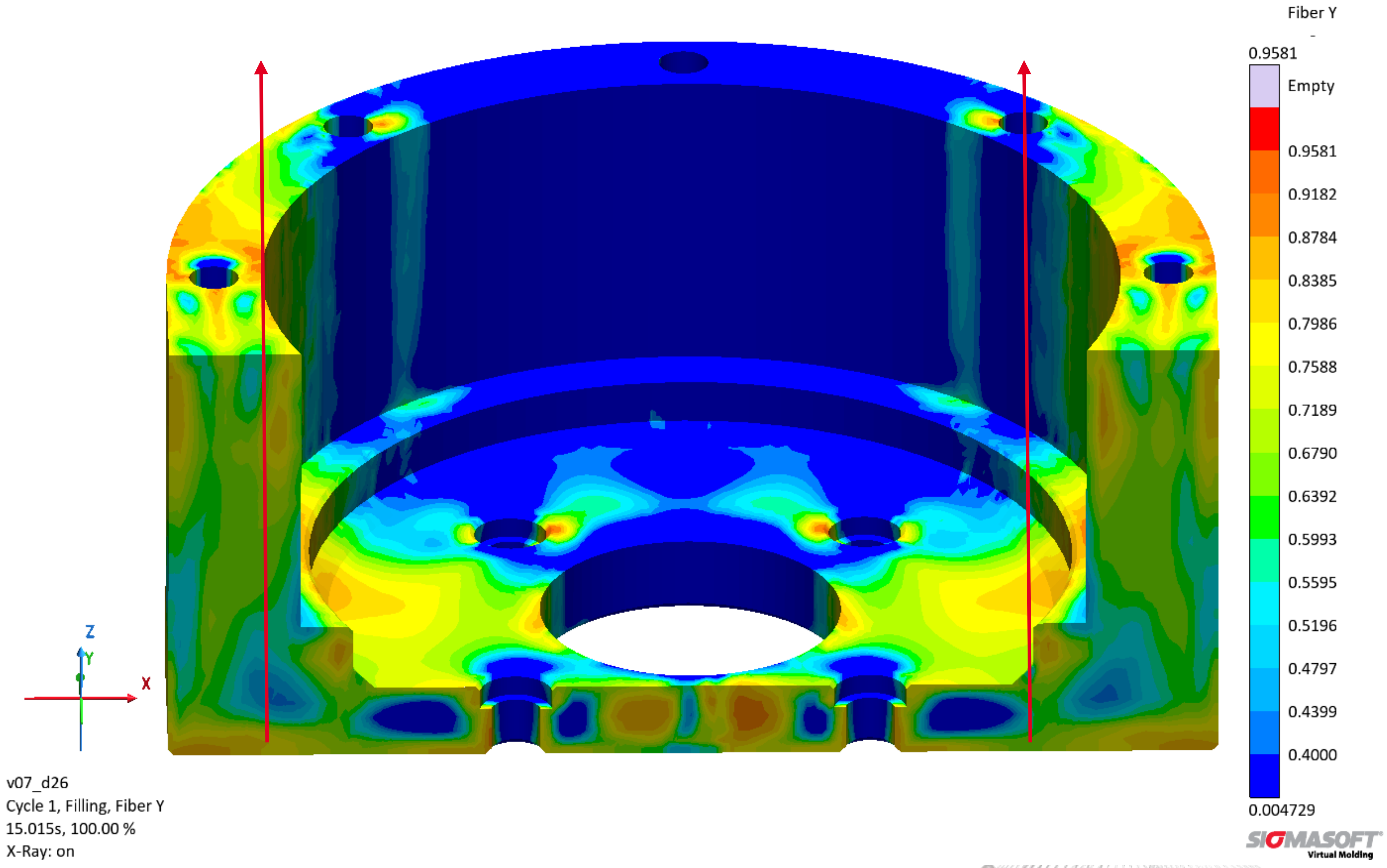
Analyzing Fiber X Direction

- Arrows represent fiber flow in X direction. Blue areas represent low % of orientated fibers where red areas represent high % of orientated fibers. Scale is set from 40-95%.



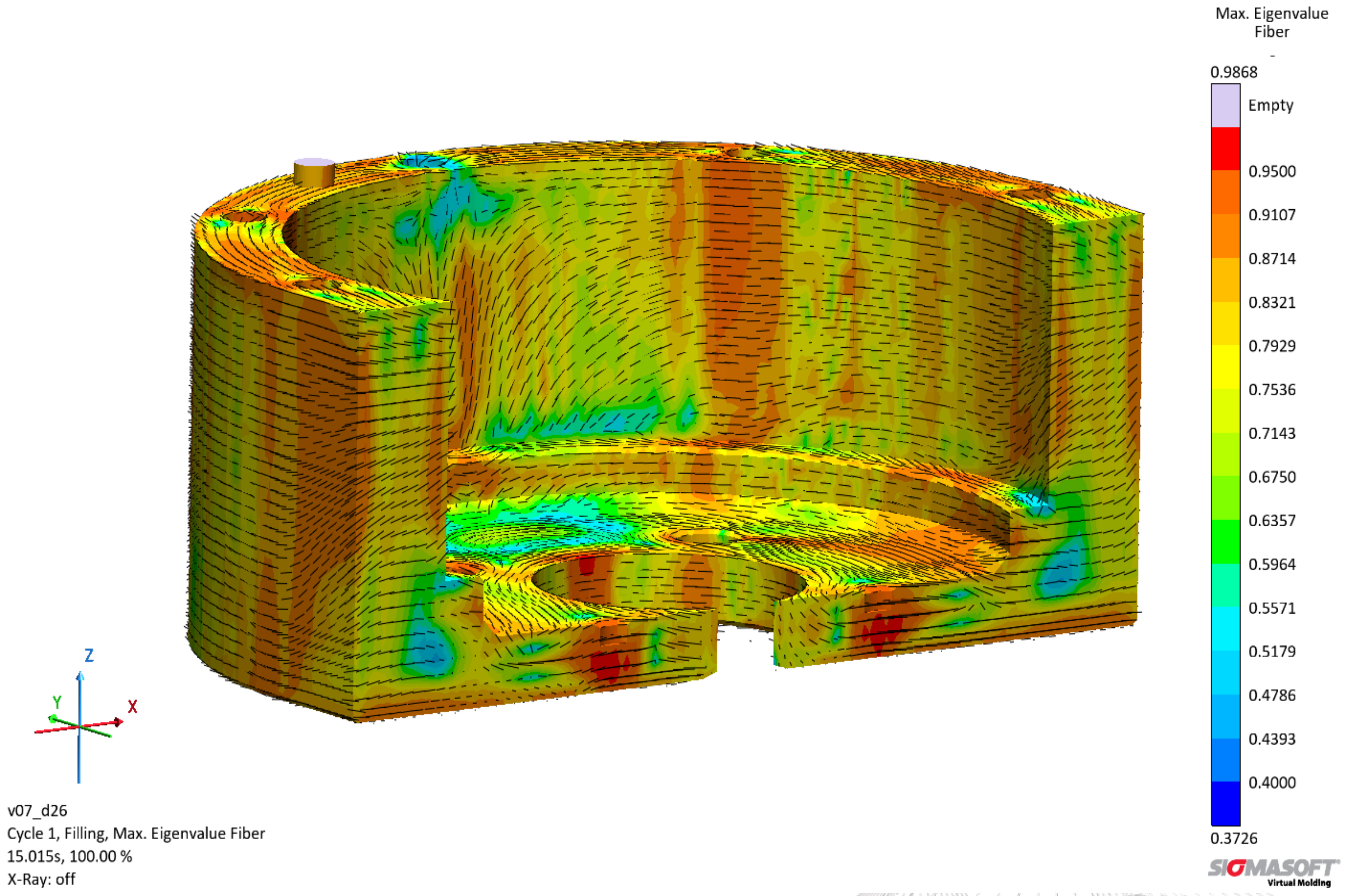
Analyzing Fiber Y Direction

- Arrows represent fiber flow in Y direction. Blue areas represent low % of orientated fibers where red areas represent high % of orientated fibers. Scale is set from 40-95%.



Analyzing Fibers Using Max. Eigenvalue

Max. Eigenvalue – Measurement orientation of fibers in the flow direction. Scale represents percentage on how many fibers are orientated in a specific area.



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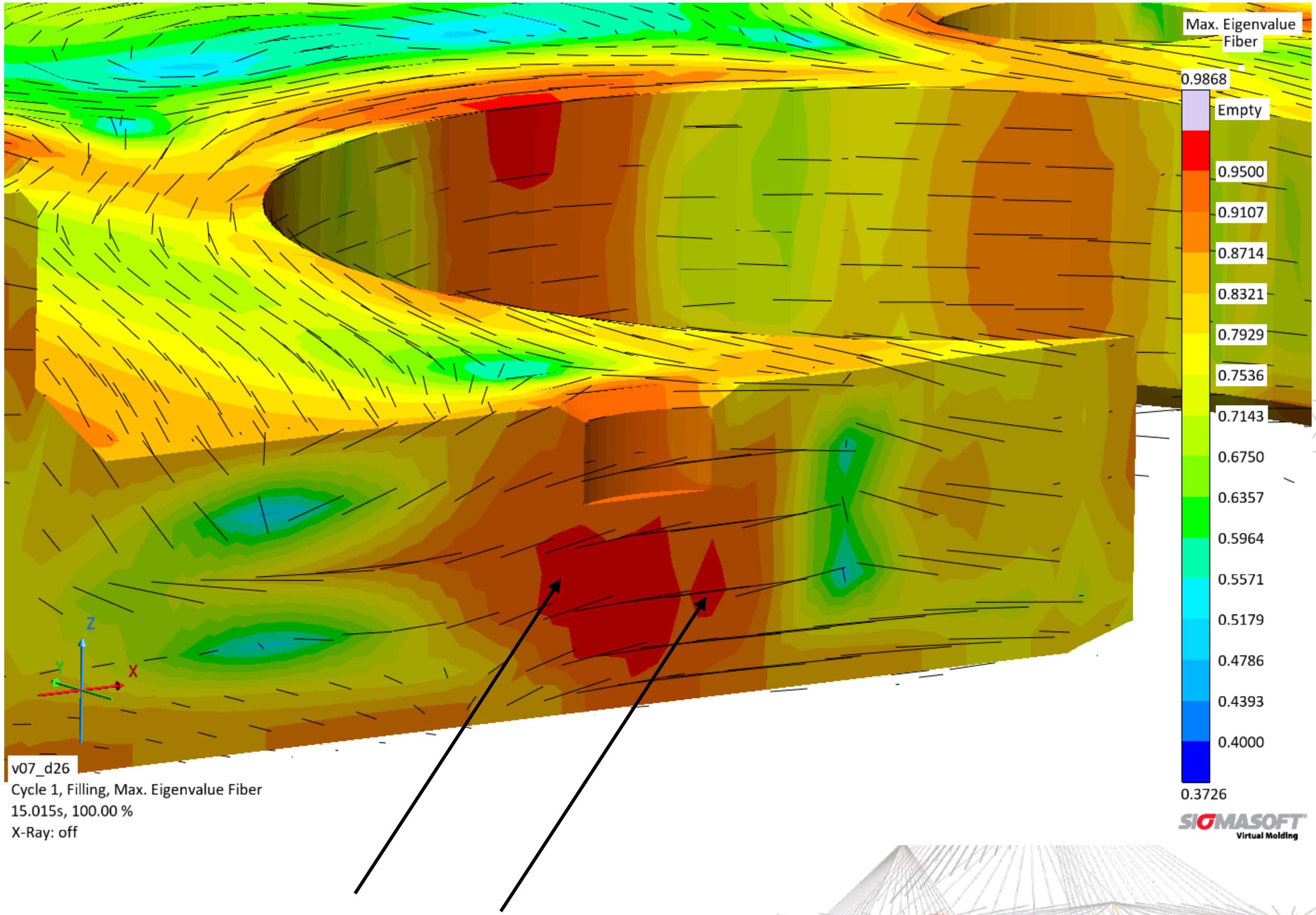


Analyzing Fibers in Sigmasoft

Edit Material of database User (5.3.1.2)

Data Edit Memo Change History Help

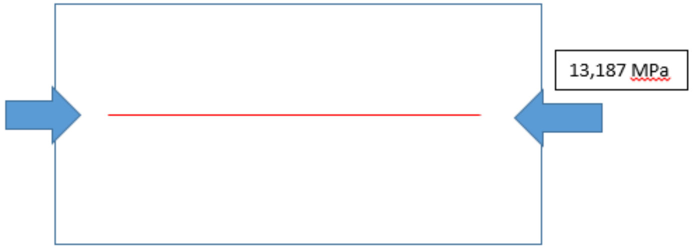
Mechanical Property Table

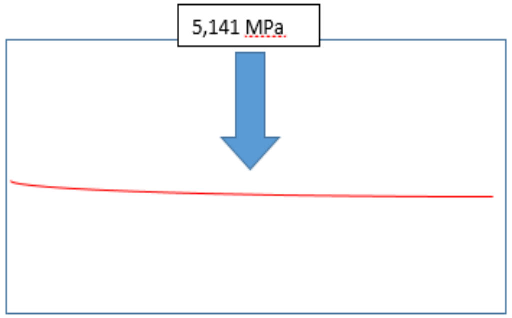
Flow

X-Flow

% Shrinkage & Warpage

main orientation	33	50	60	70	80	90	100	[%]
E_flow	6768	7352	7985	8679	9587	10977	13187	[MPa]
E_trans	6768	7352	6717	6086	5531	5172	5141	[MPa]
Alpha_flow	2.61e-05	1.10e-05	6.97e-06	3.51e-06	8.71e-07	-3.71e-07	4.50e-07	[1/°C]
Alpha_trans	2.61e-05	1.10e-05	1.59e-05	2.16e-05	2.81e-05	3.45e-05	3.89e-05	[1/°C]
Total								
S_flow total (300)	0.53	0.22	0.14	6.88e-02	1.49e-02	-1.04e-02	6.32e-03	[%]
S_trans total (300)	0.53	0.22	0.32	0.44	0.57	0.70	0.79	[%]
S_flow total (800)	0.48	0.20	0.12	5.80e-02	8.64e-03	-1.46e-02	7.74e-04	[%]
S_trans total (800)	0.48	0.20	0.29	0.40	0.52	0.64	0.72	[%]
Thermal								
S_flow thermal (300)	0.58	0.24	0.15	7.76e-02	1.93e-02	-8.20e-03	9.95e-03	[%]
S_trans thermal (300)	0.58	0.24	0.35	0.48	0.62	0.76	0.86	[%]
S_flow thermal (800)	0.61	0.26	0.16	8.16e-02	2.02e-02	-8.61e-03	1.05e-02	[%]
S_trans thermal (800)	0.61	0.26	0.37	0.50	0.65	0.80	0.90	[%]
Pressure								
S_flow pressure (300)	-4.73e-02	-2.17e-02	-1.47e-02	-8.84e-03	-4.35e-03	-2.23e-03	-3.63e-03	[%]
S_trans pressure (300)	-4.73e-02	-2.17e-02	-2.99e-02	-3.96e-02	-5.07e-02	-6.16e-02	-6.91e-02	[%]
S_flow pressure (800)	-0.13	-5.78e-02	-3.92e-02	-2.36e-02	-1.16e-02	-5.95e-03	-9.68e-03	[%]
S_trans pressure (800)	-0.13	-5.78e-02	-7.96e-02	-0.11	-0.14	-0.16	-0.18	[%]





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Tool Setup in Sigmasoft

While simulating polyester material I used heatmed for my mold material at a temperature 140°C. Heatmed gives consistent heating throughout the simulation. It's telling the program to hold 140°C throughout the simulation instead of varying the temperature.

Material Used

- 20% glass fiber reinforced polyester BMC
- 40% glass fiber reinforced polyester BMC

Gate Location and Design Variables Setup

I placed gate locations at thick and thin areas on the part. That way we can lean how this effects stress in our part.

Design Variables

	Design Variable	Dataset List	Dependency
☑	Part Material Class - Material Data	User/BMC_Particle User/BMC_REG	<None>

	Design Variable	Selection	Dependency
☑	Geometry geometry_exchange_001 - Activated item	1 | Gate 1 2 | Gate 2 3 | Gate 3 4 | Gate 4 5 | Gate 5 6 | Gate 6	<None>

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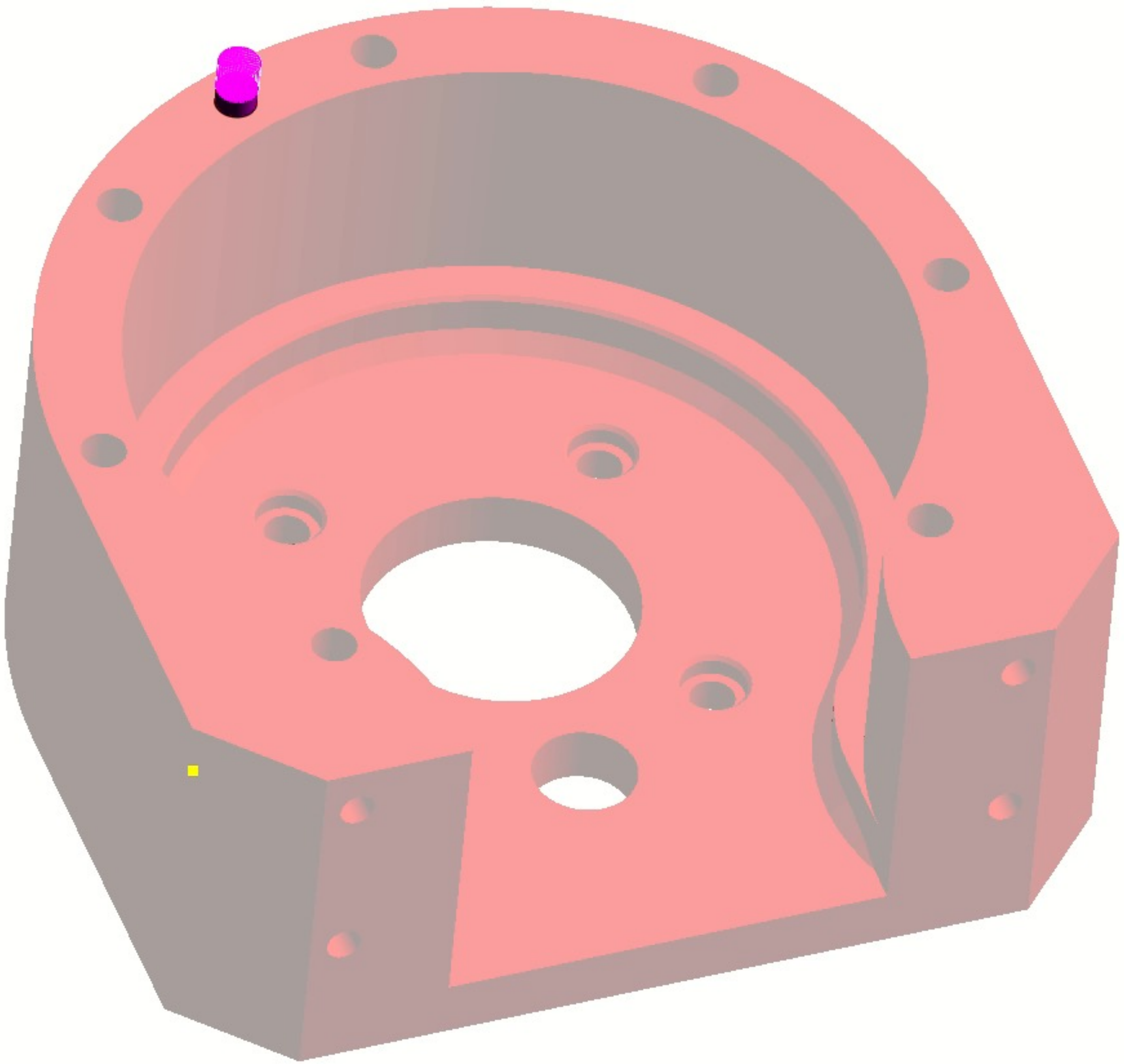
Gate Locations



Gate Location and Design Variables Setup

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Gate Location and Design Variables Setup

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	Design Variable	Selection	Dependency
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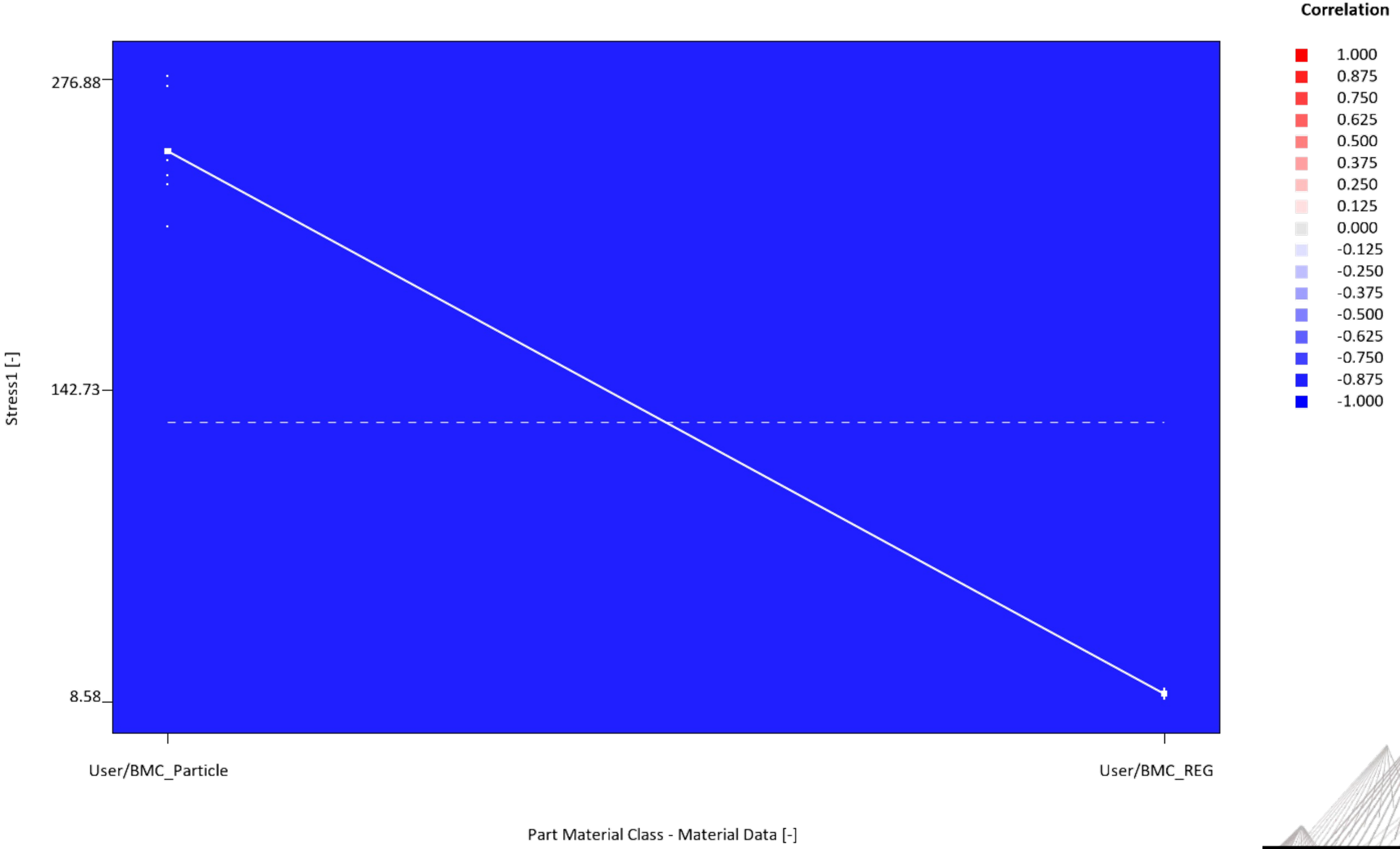
Objectives
- Air Entrapment
- Stress1
- Voids

Gate Location - Results and Discussion

Stress is higher on particle 40 glass filled polyester vs. low filled



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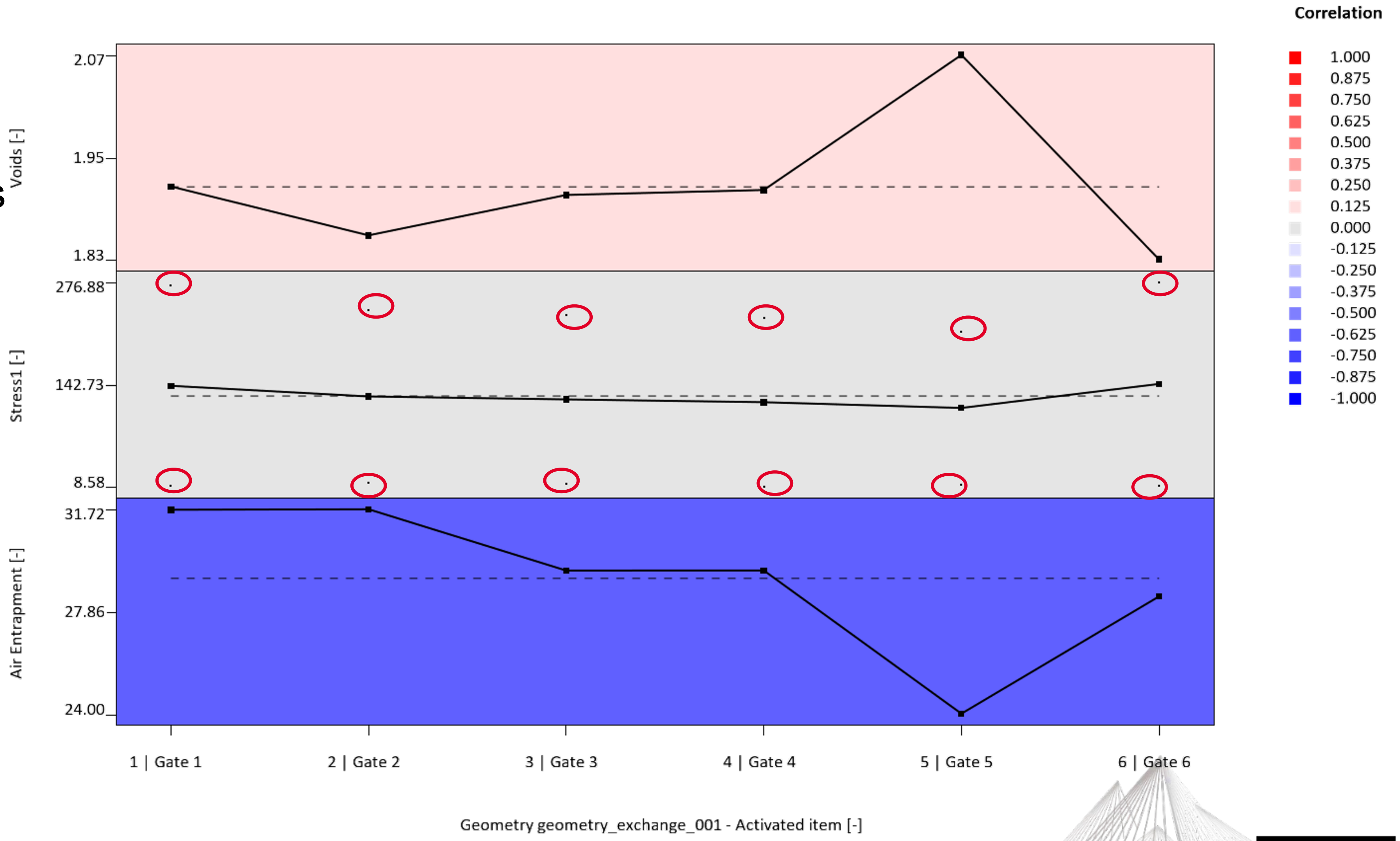
Gate Location - Results and Discussion

- Gate 1 (Design 1) has the worse overall air entrapment and stress
- Gate 6 (Design 12) is the best choice because of the low voids, stress



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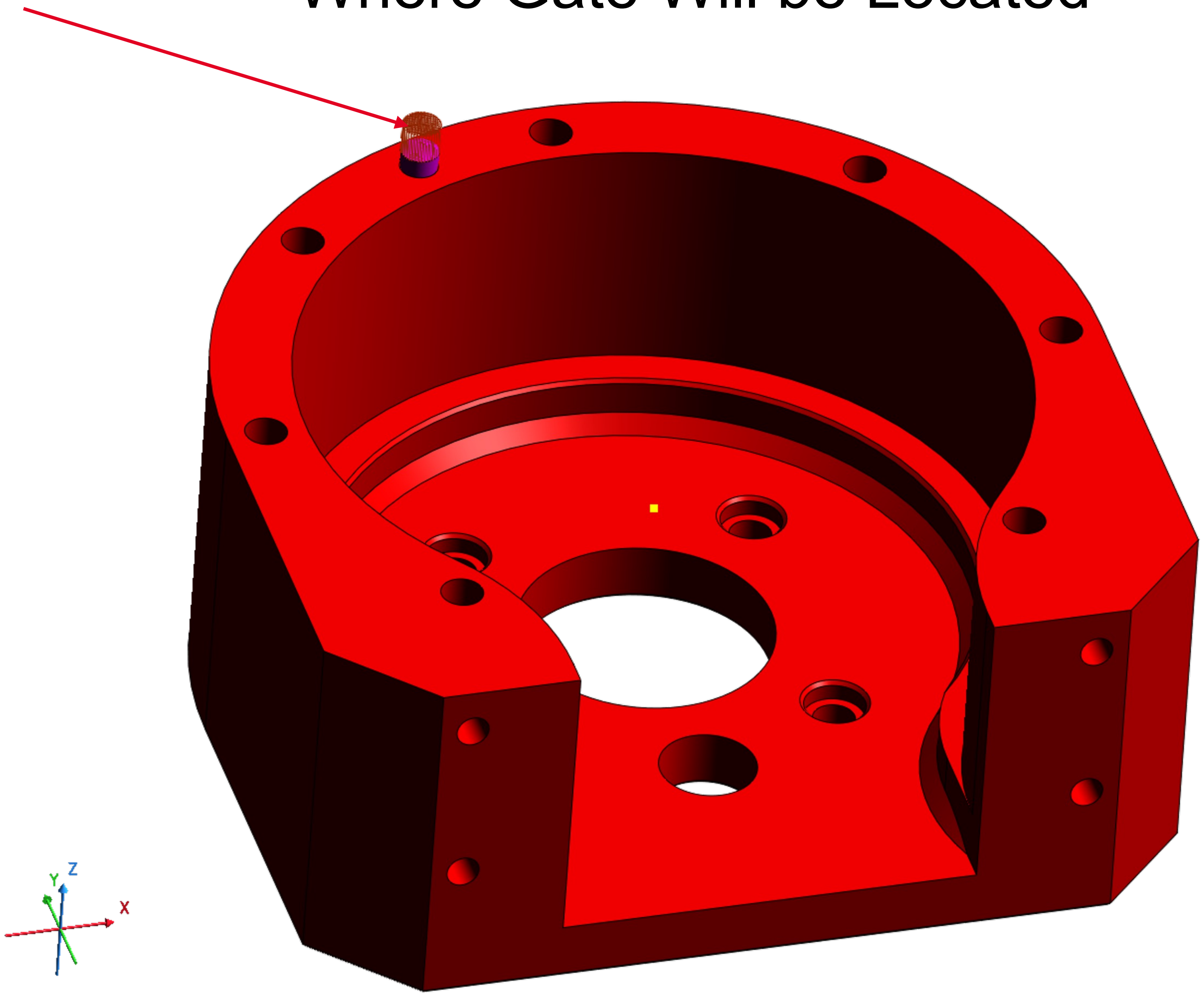
Gate Location - Results and Discussion

Best gate

	Rank	Design	Part Material Class - Material Data (-)	Geometry geometry_exchange_001...	Air Entrapment (-)	Stress1 (-)	Voids (-)
	Rank 1	Design 12	User/BMC_REG	6 | Gate 6	28.43	9.55	1.83
	Rank 2	Design 10	User/BMC_REG	5 | Gate 5	24.0	11.39	2.07
	Rank 3	Design 6	User/BMC_REG	3 | Gate 3	29.41	11.84	1.91
	Rank 4	Design 8	User/BMC_REG	4 | Gate 4	29.41	8.58	1.91
	Rank 5	Design 4	User/BMC_REG	2 | Gate 2	31.72	12.99	1.86
	Rank 6	Design 2	User/BMC_REG	1 | Gate 1	31.7	9.14	1.92
	Rank 7	Design 11	User/BMC_Particle	6 | Gate 6	28.43	276.88	1.83
	Rank 8	Design 9	User/BMC_Particle	5 | Gate 5	24.0	212.02	2.07
	Rank 9	Design 5	User/BMC_Particle	3 | Gate 3	29.41	233.99	1.91
	Rank 10	Design 7	User/BMC_Particle	4 | Gate 4	29.41	229.91	1.91
	Rank 11	Design 3	User/BMC_Particle	2 | Gate 2	31.72	240.58	1.86
	Rank 12	Design 1	User/BMC_Particle	1 | Gate 1	31.7	272.41	1.92

Worse gate

Scenario 1 – Customer Dictates Where Gate Will be Located



Optimizing Worse Gate Location

Goal - Minimum Stress, Voids and Air Trap

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Design Variables

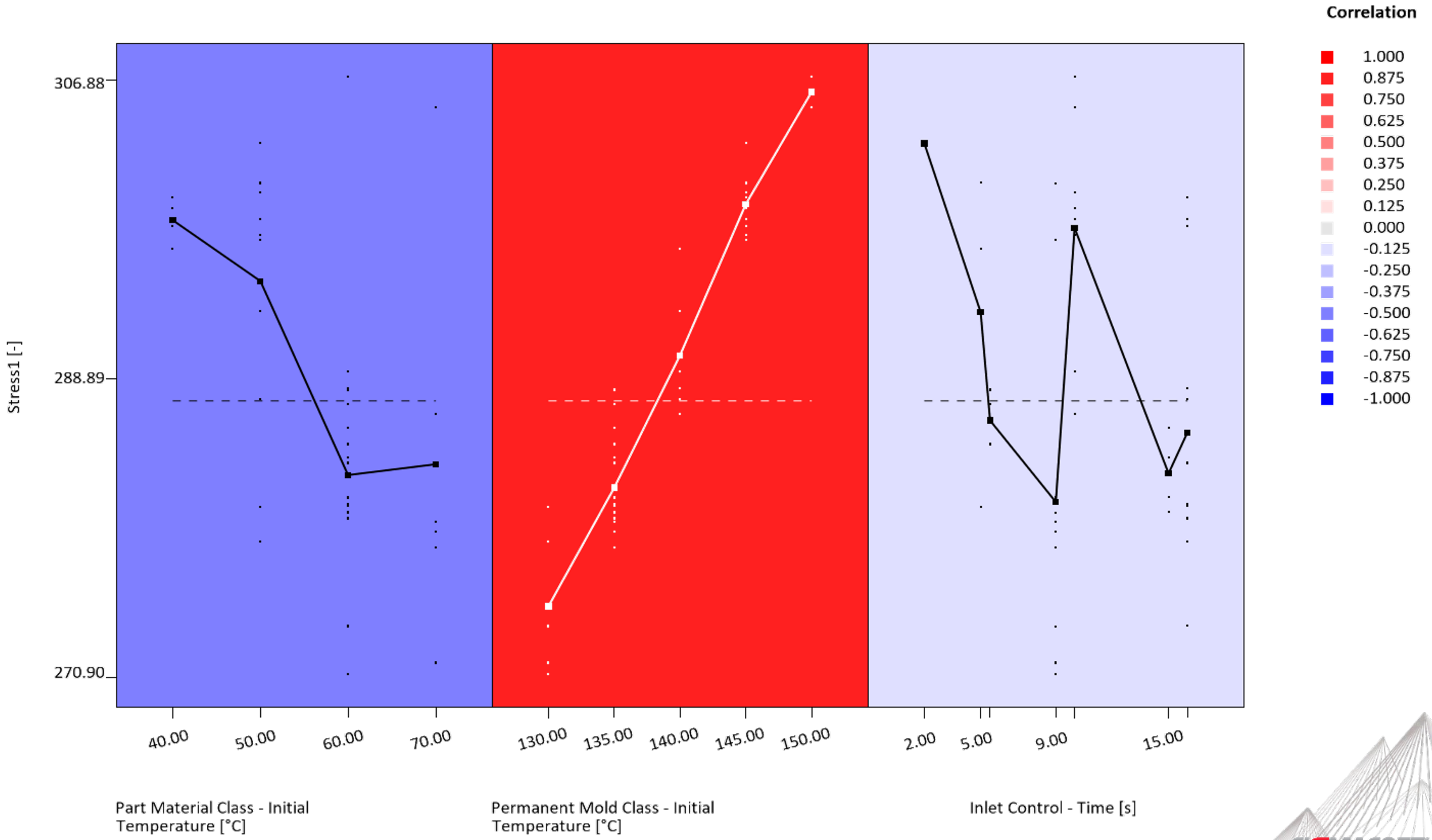
Design Variables

	Design Variable	Lower Limit (s)	Upper Limit (s)	Step (s)	Dependency
☑	Filling - Filling Time	5.0	20.0	5.0	<None>

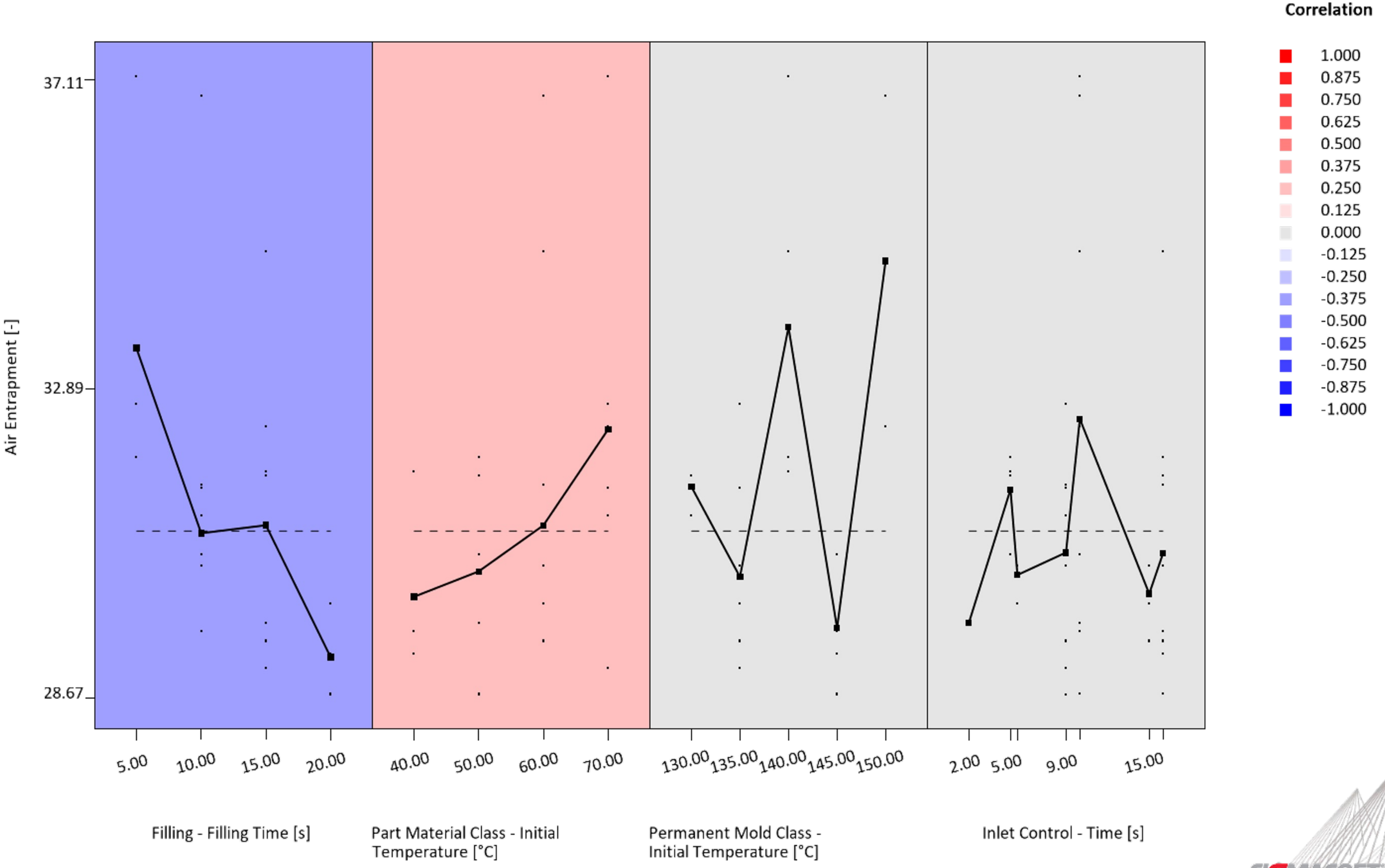
	Design Variable	Lower Limit (°C)	Upper Limit (°C)	Step (°C)	Dependency
☑	Permanent Mold Class - Initial Temperature	130.0	150.0	5.0	<None>
☑	Part Material Class - Initial Temperature	40.0	70.0	10.0	<None>

	Design Variable	Lower Limit (s)	Upper Limit (s)	Step (s)	Dependency
☑	Inlet Control - Time	2.0	16.0	3.5	<None>
☑	Mold Open Step - Permanent Mold ID 1 - Time	140.0	170.0	10.0	<None>

Stress vs. Material Temperature, Mold Temperature and Pack Time



Air Entrapment vs. Fill Time, Material Temp., Mold Temp and Pack Time



So, which design gives us the lowest stress?

- Design 60 – Lowest stress with below design settings
- 10 second filling time
- 60°C Material Temperature (When injected)
- 130°C Mold Temperature
- 170 Seconds Mold Open
- 9 Second Pack Time

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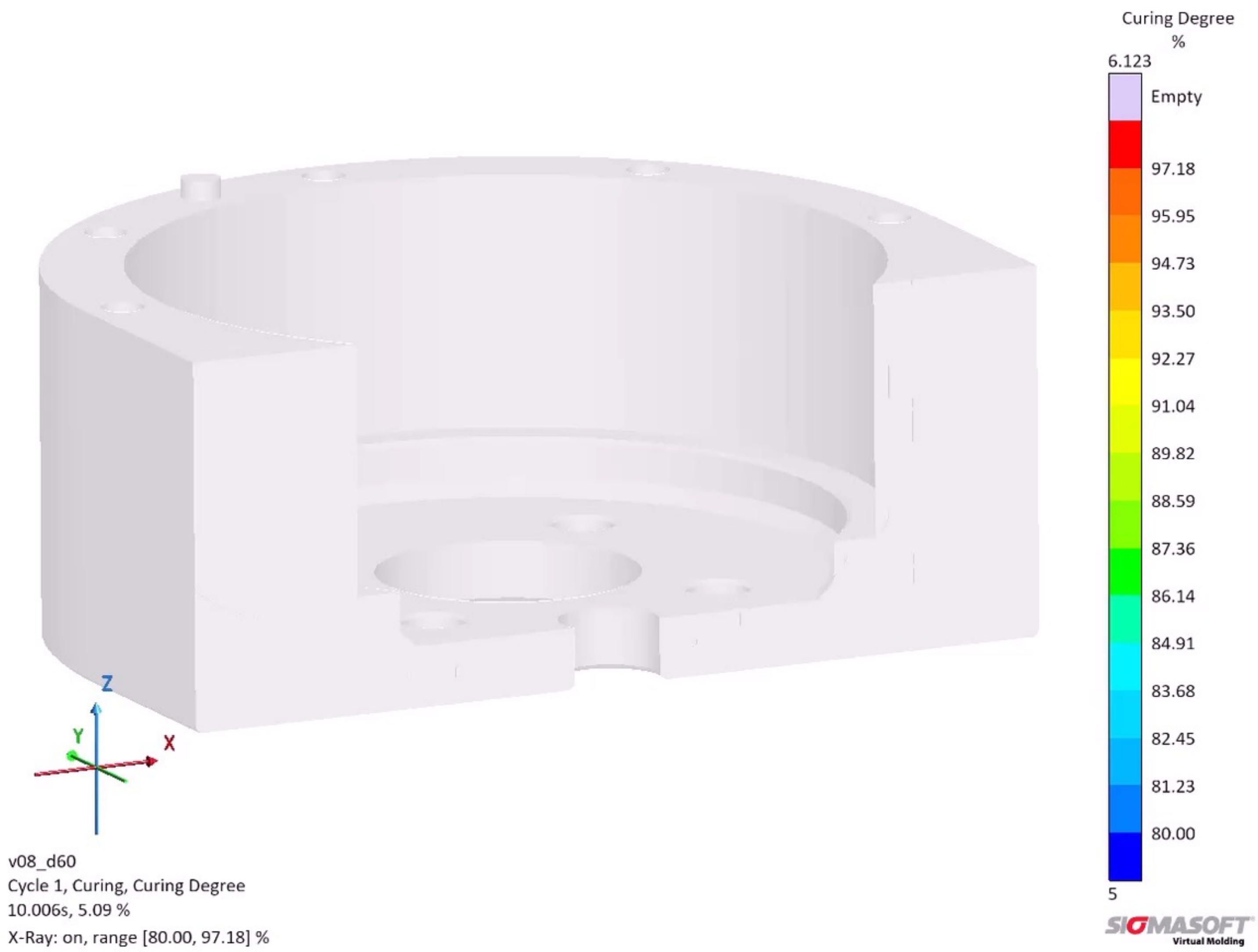
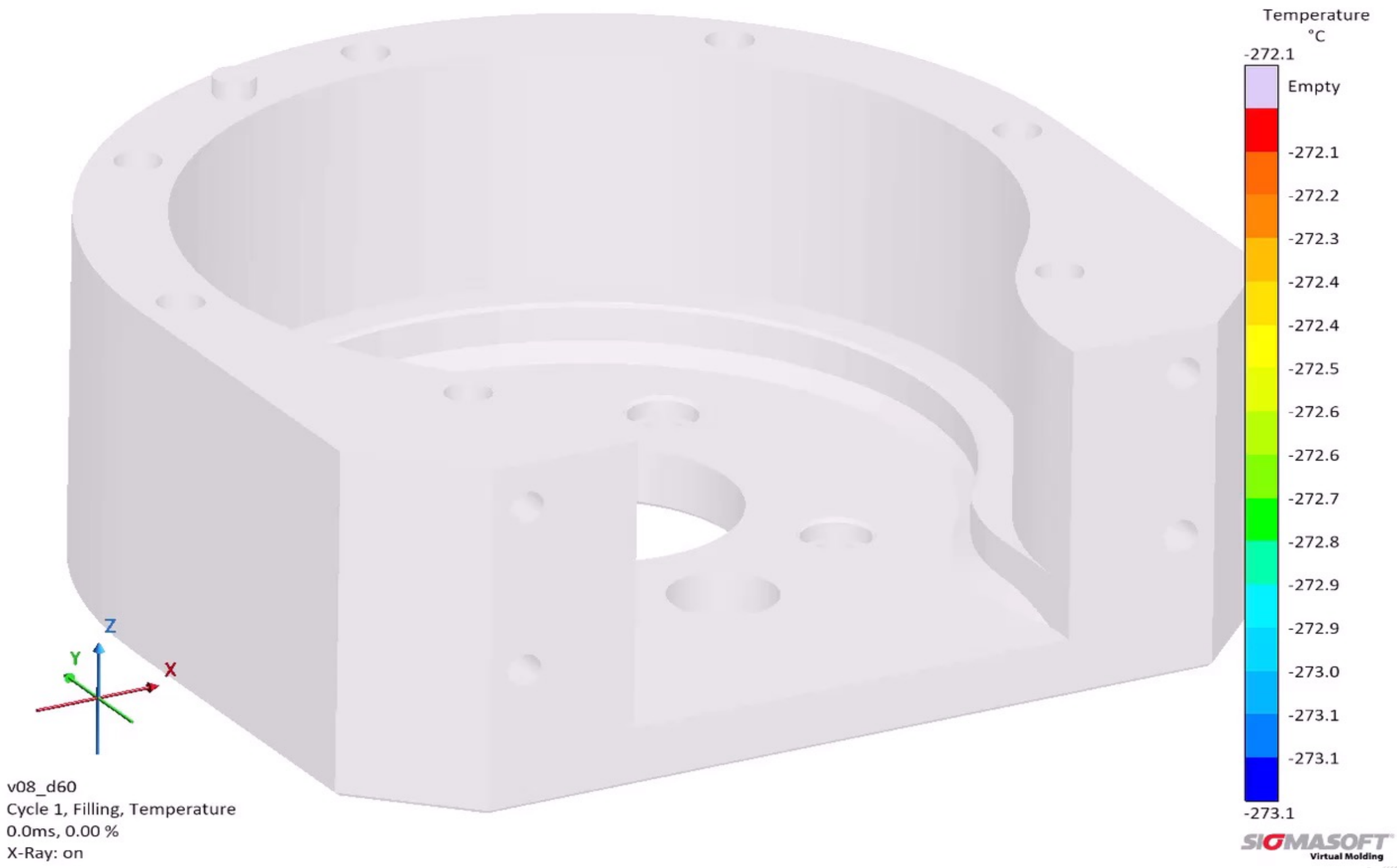
Curing Degree of Design 60

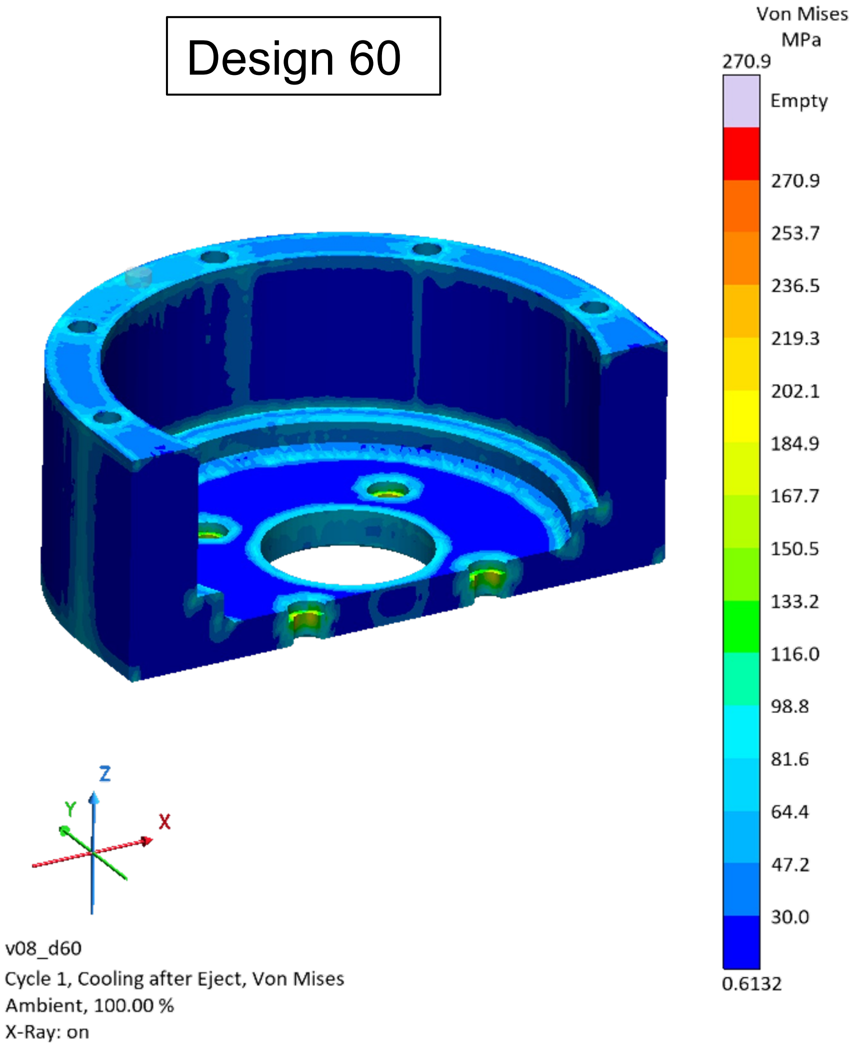


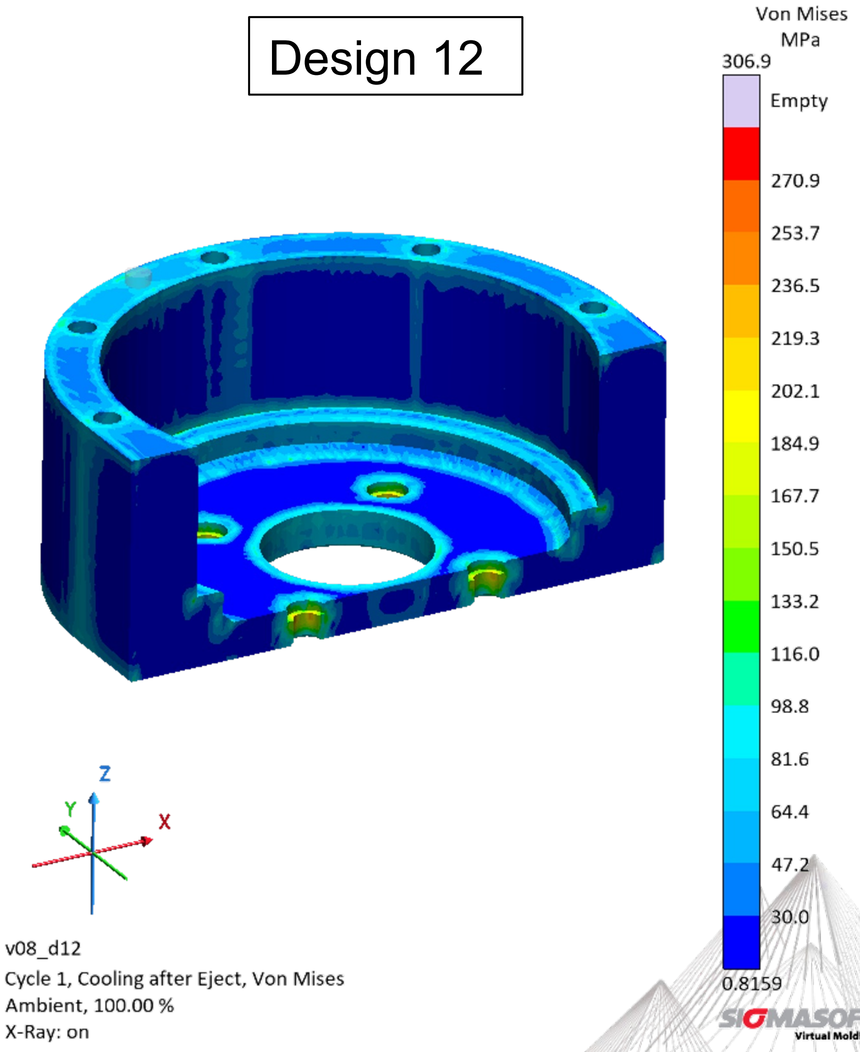
Filling Temperature of Design 60



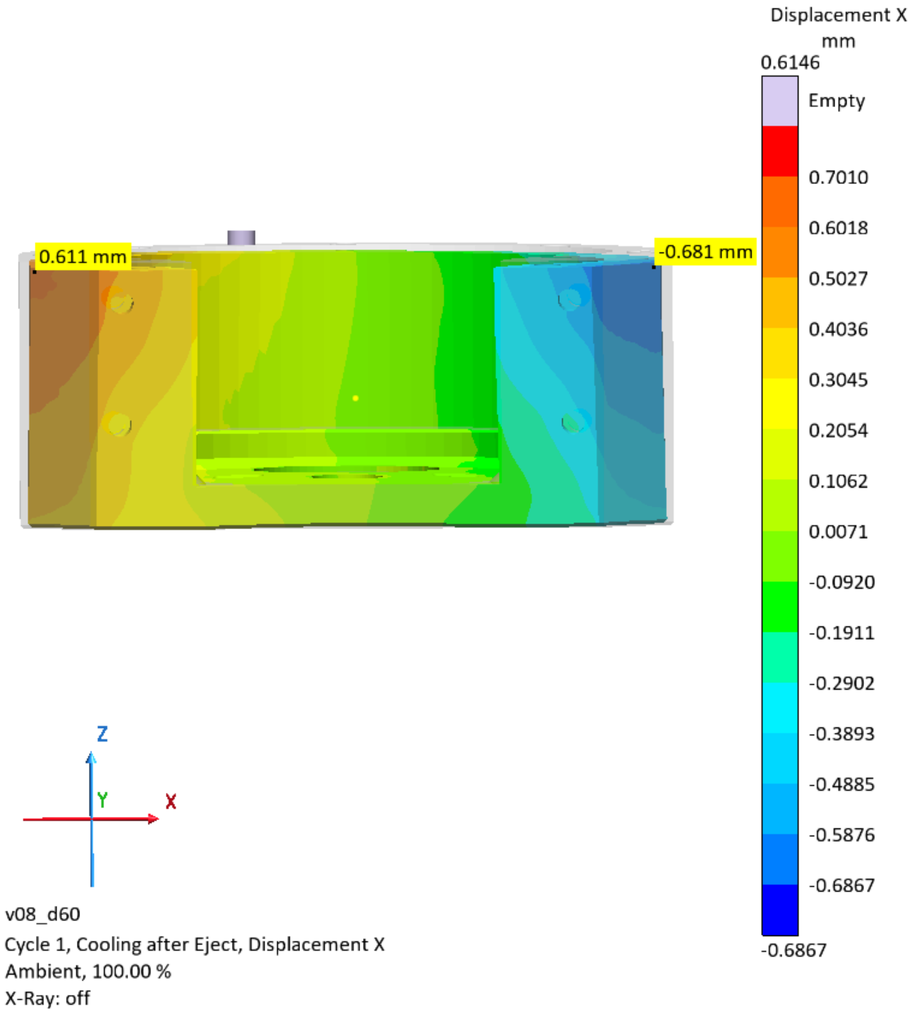
Von Misses Design 60 (Lowest Stress) vs. Design 12 (highest Stress)

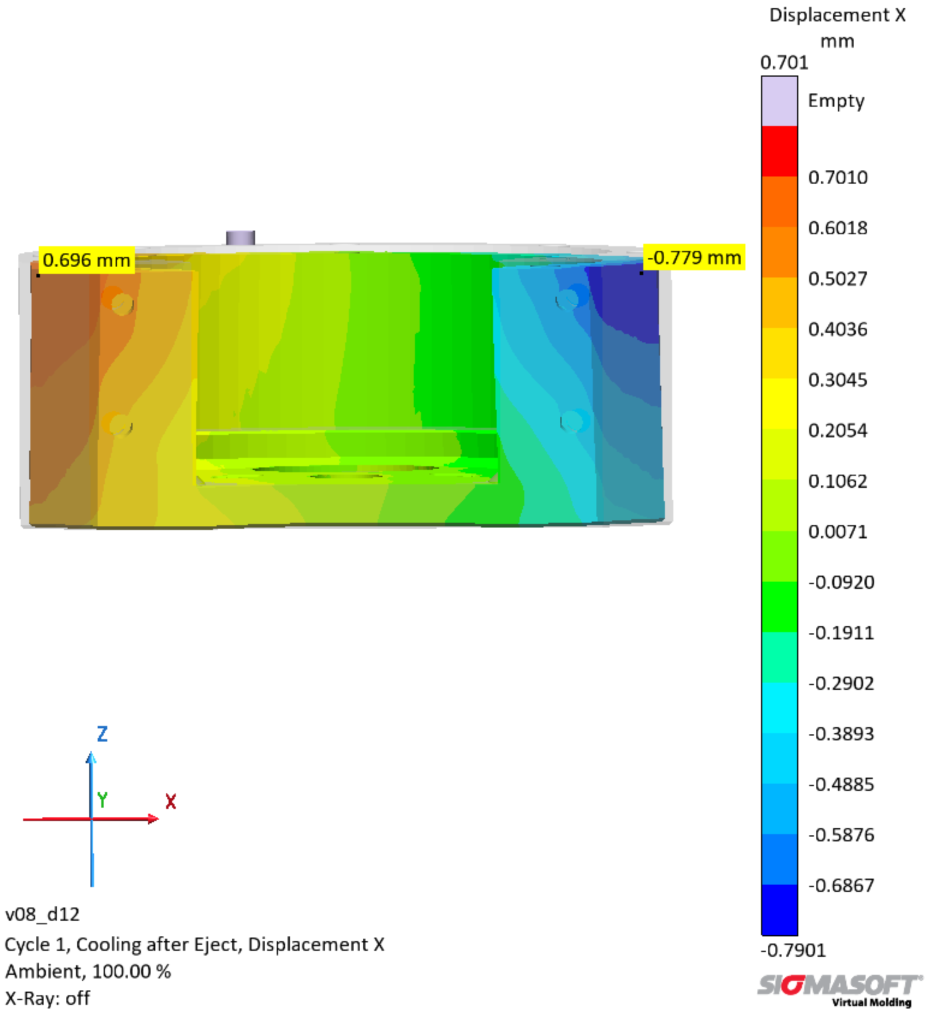
- Design 12 – Highest stress with below design settings
- 10 second filling time
- 60°C Material Temperature (When injected)
- 150°C Mold Temperature
- 160 Seconds Mold Open
- 10 Second Pack Time





Shrinkage & Warpage Design 60 vs. Design 12





Optimizing Best Gate Location

Goal - Minimum Stress, Voids and Air Trap

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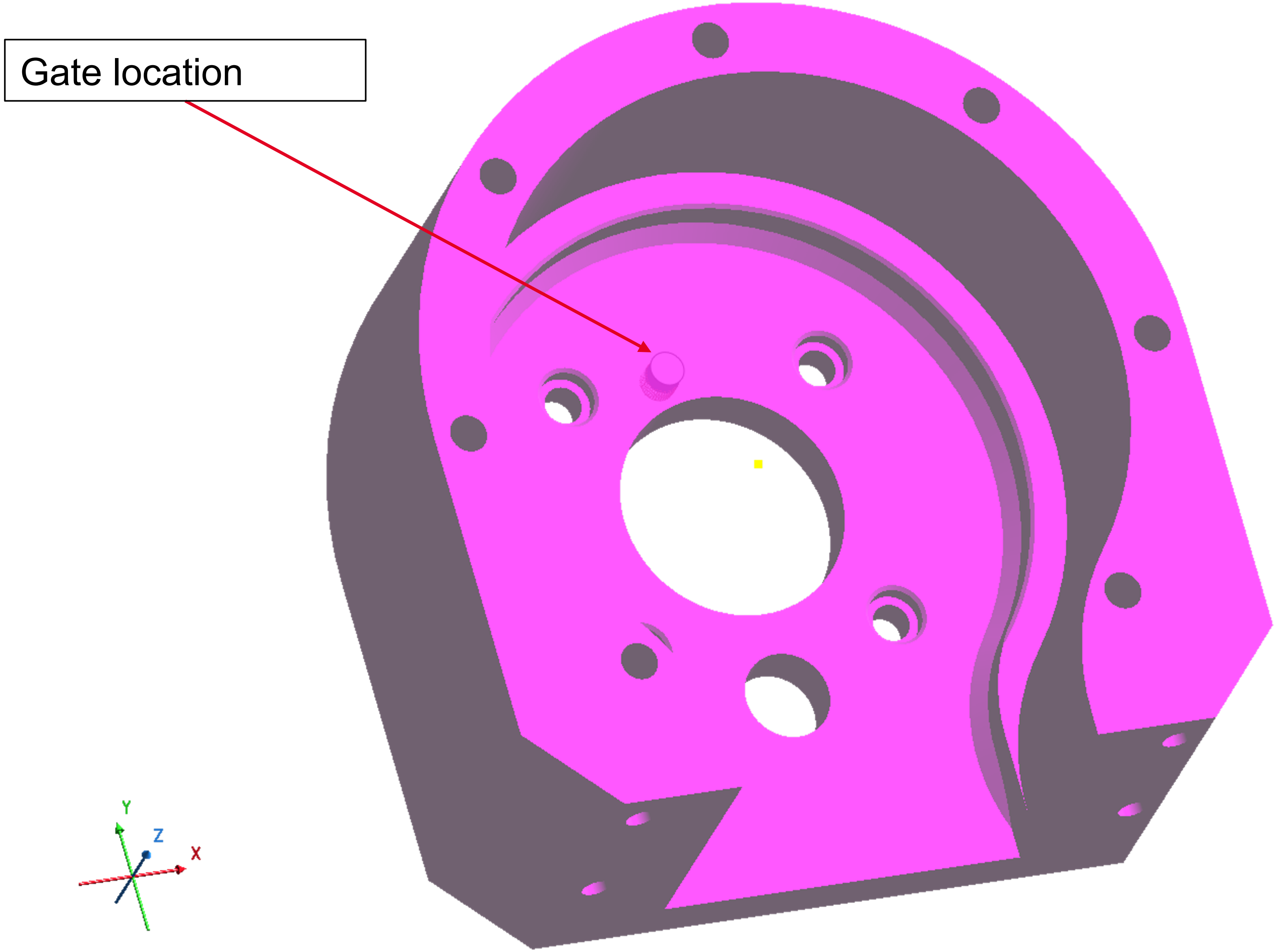
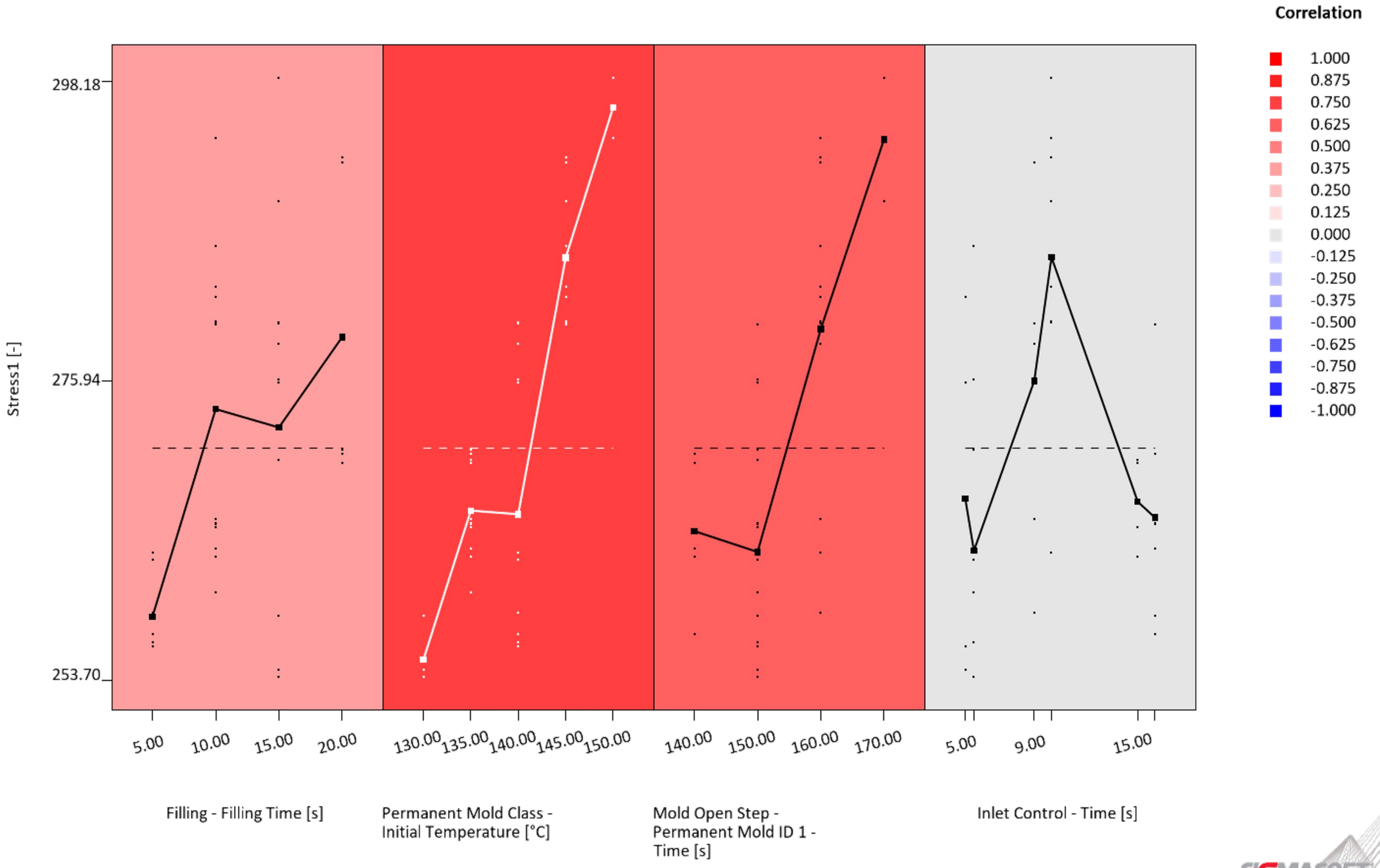
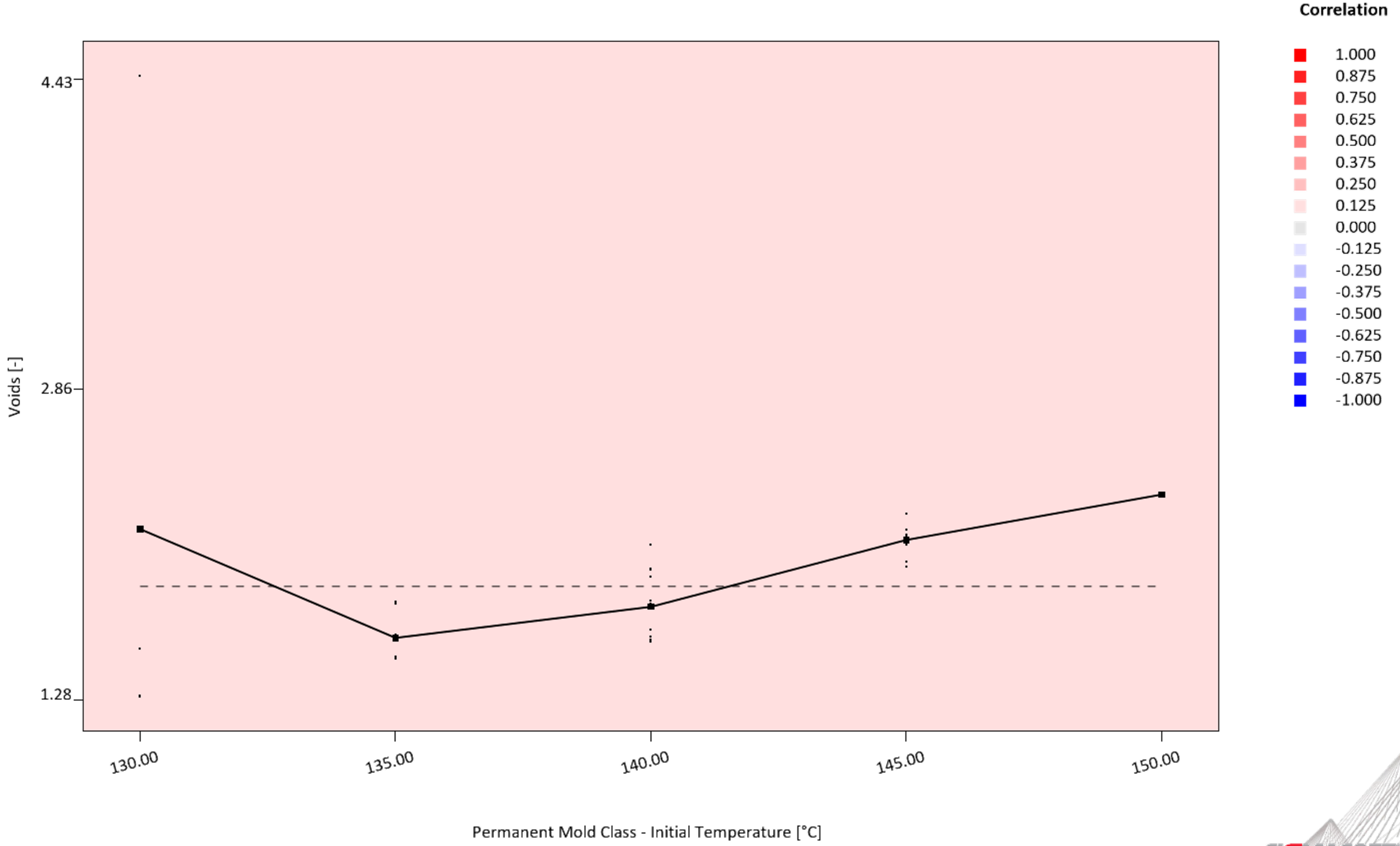

Gate location
Y
Z
X

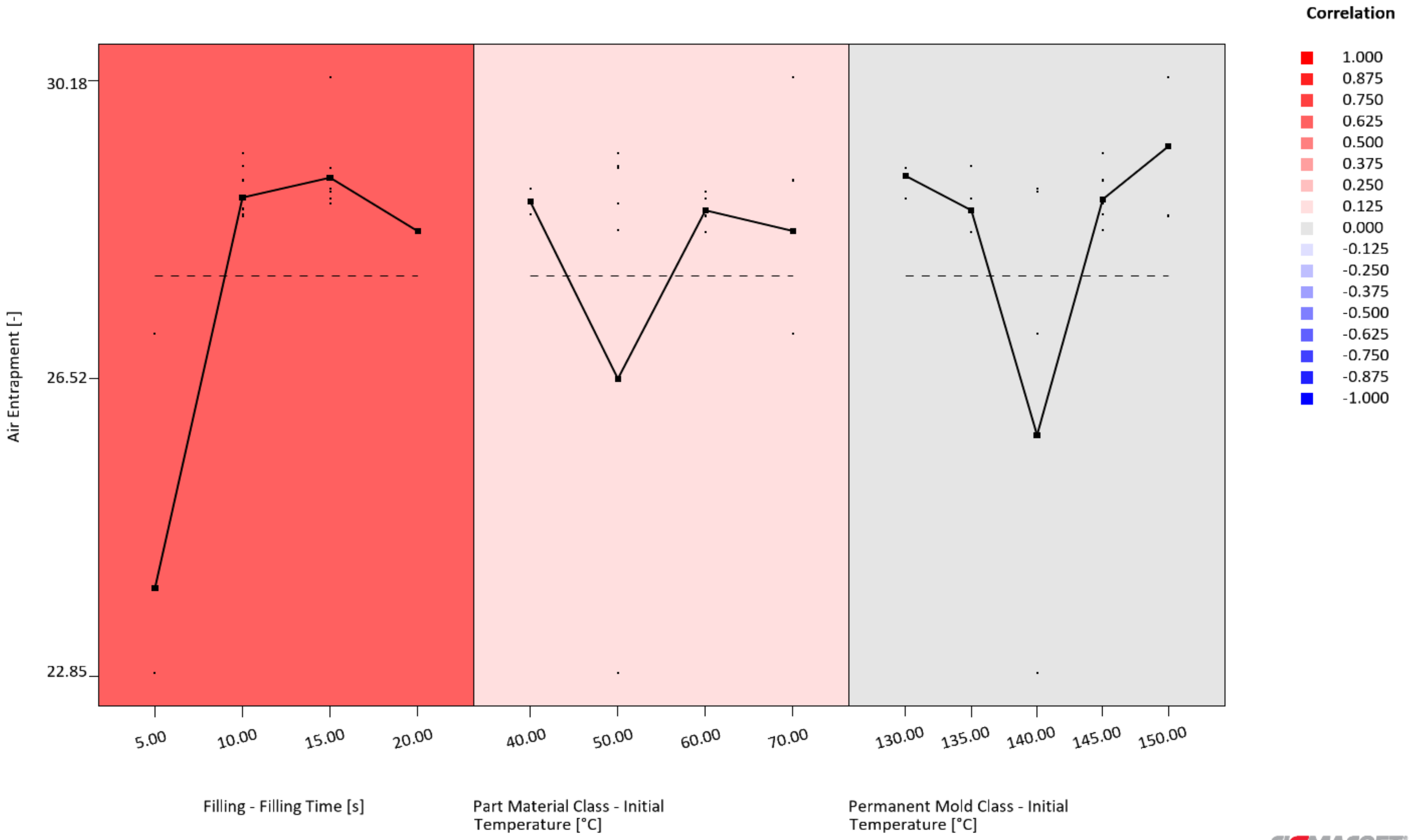
Stress vs. Filling time, Mold Temperature, Mold Open Time and Pack Time



Voids vs. Mold Temperature °C



Air Entrapment vs. Filling Time, Material Temperature and Mold Temperature °C



- Design 34 – Lowest stress with below design settings
- 15 second filling time
- 50°C Material Temperature (When injected)
- 130°C Mold Temperature
- 150 Seconds Mold Open
- 5.5 Second Pack Time

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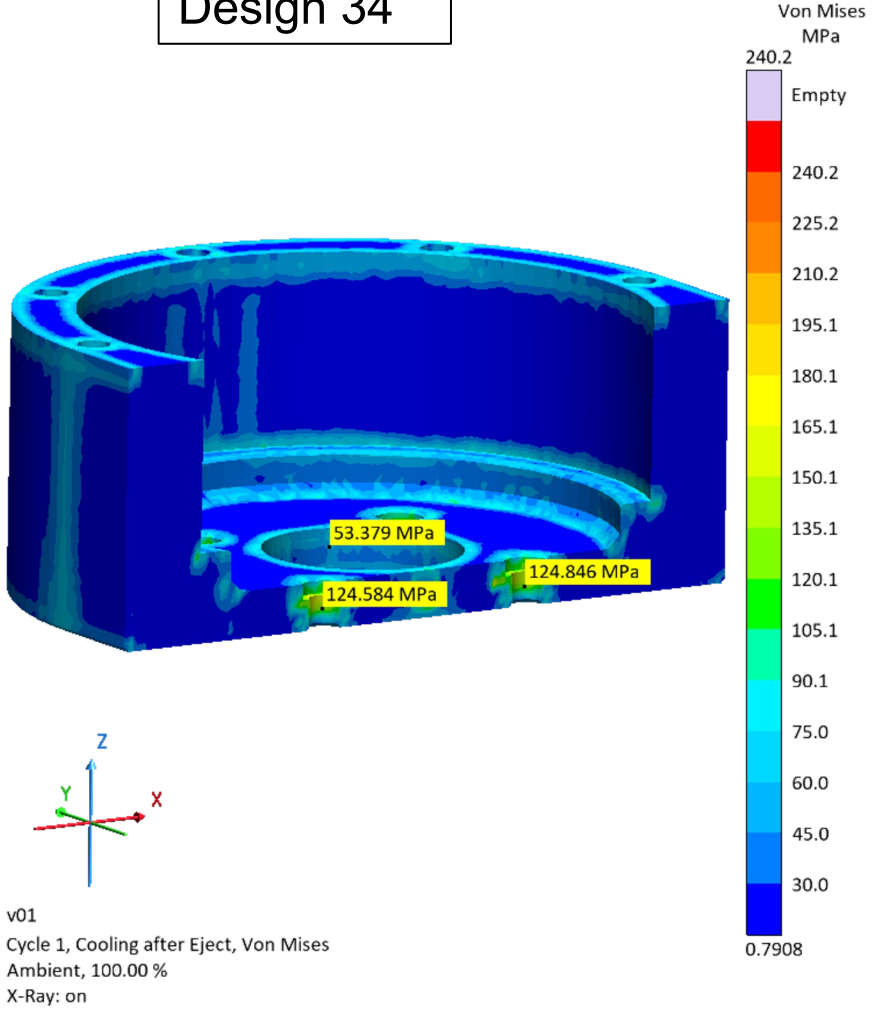
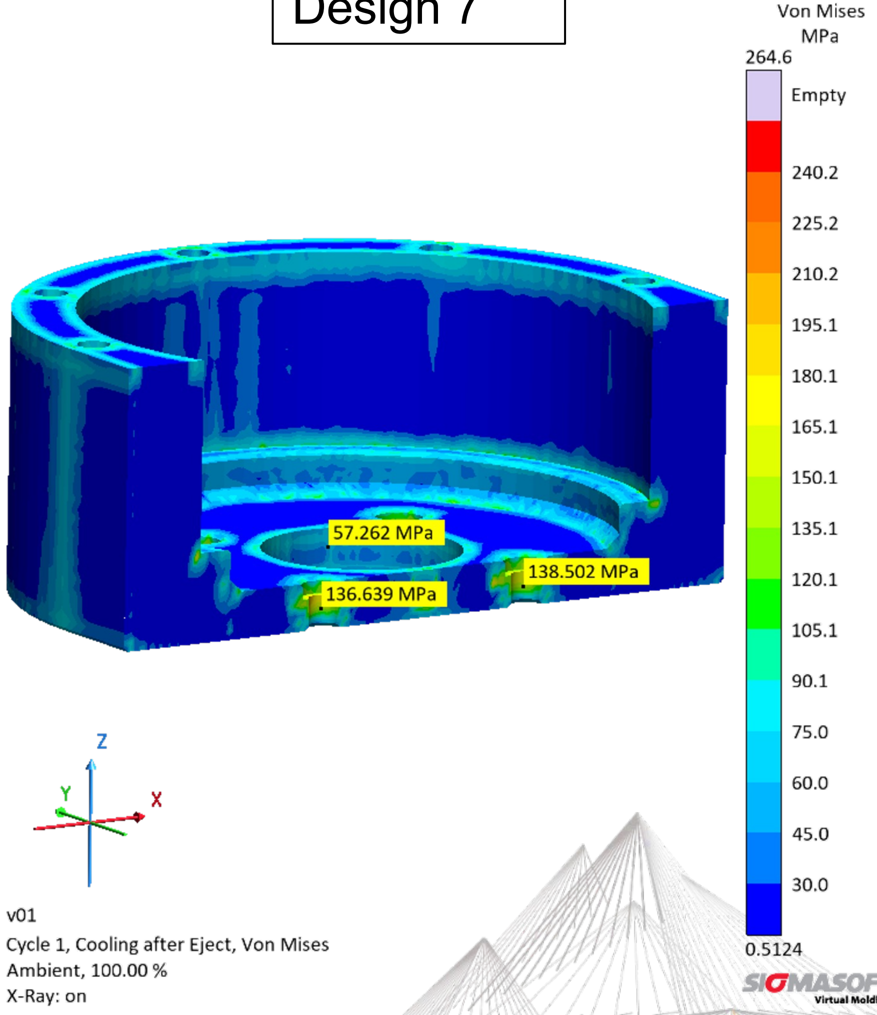
Von Misses Design 34 (Lowest Stress) vs. Design 7 (highest Stress)

- Design 7 – Highest stress with below design settings
- 10 second filling time
- 70°C Material Temperature (When injected)
- 150°C Mold Temperature
- 170 Seconds Mold Open
- 10 Second Pack Time

Design 34

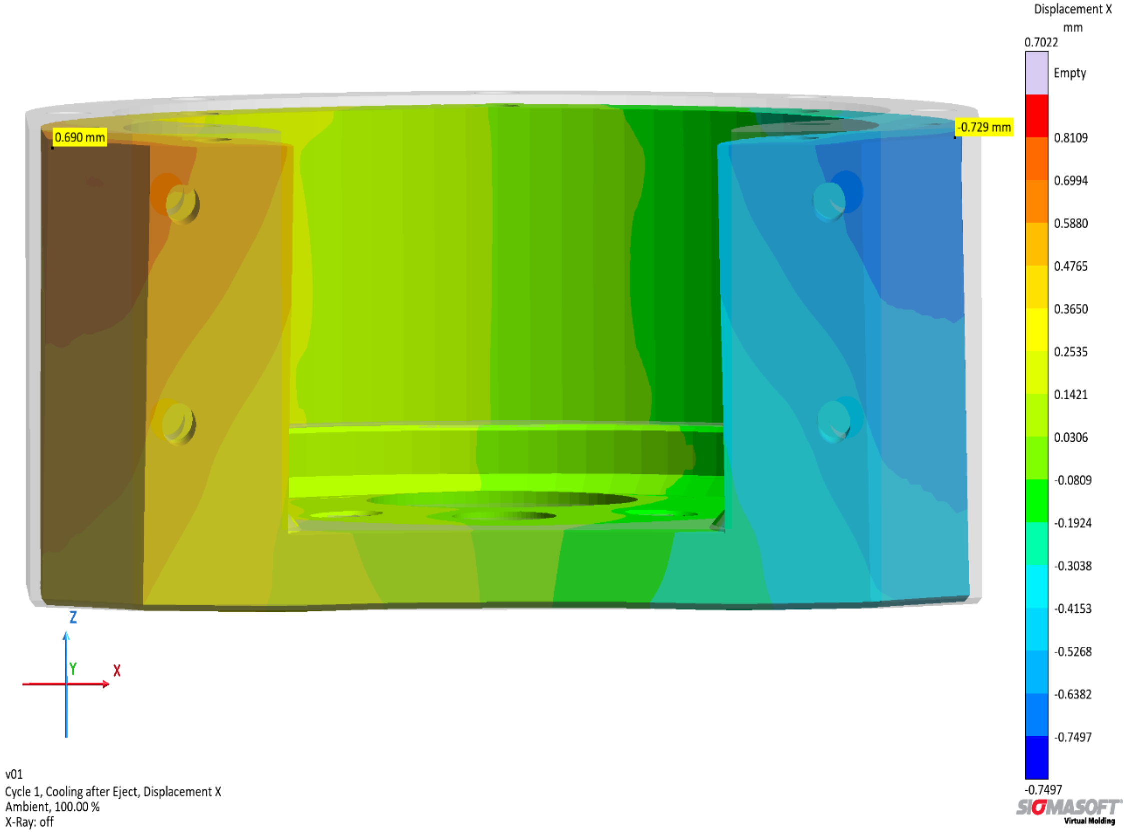


Design 7

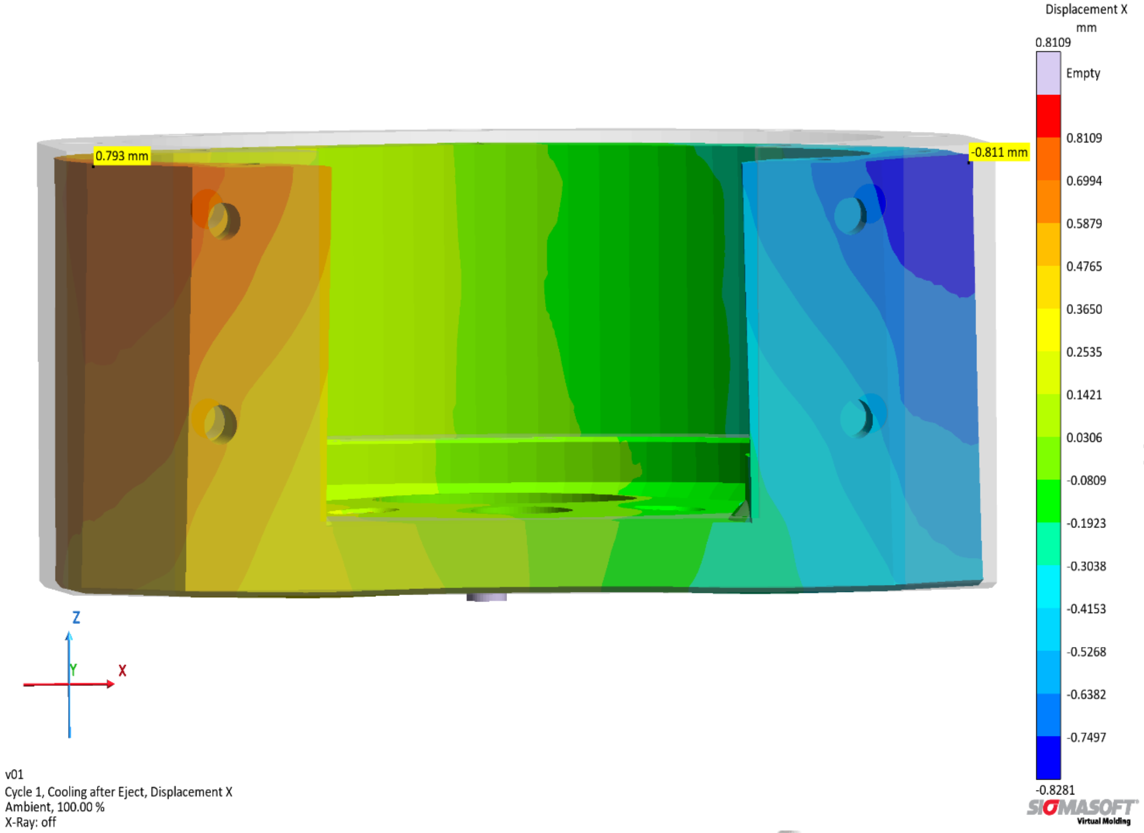


Shrinkage & Warpage Design 34 vs. Design 7

Design 34



Design 7



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Remarks

- Data suggests that analyzing von mises and specific process parameters can lead to low stress while molding thermoset polyester. Fill time, mold temperature, pack time and material temperature effect stress with thermoset polyester.

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Questions