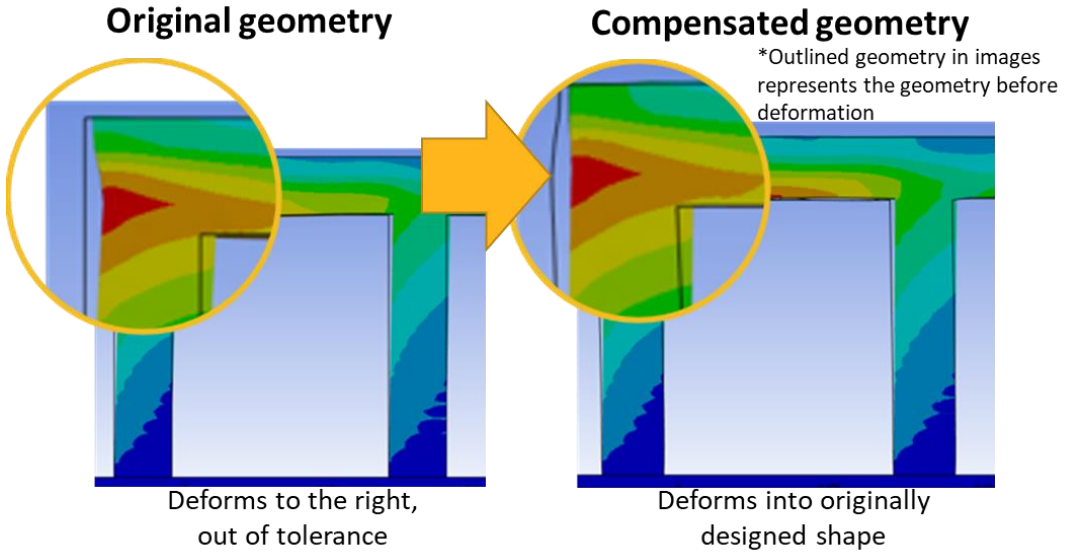
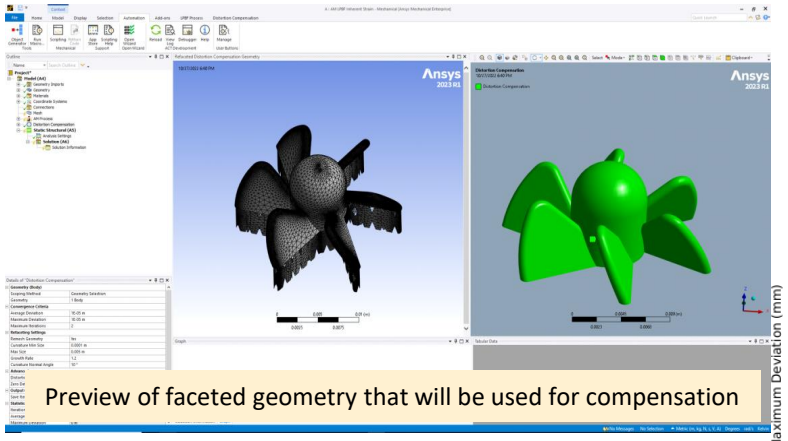
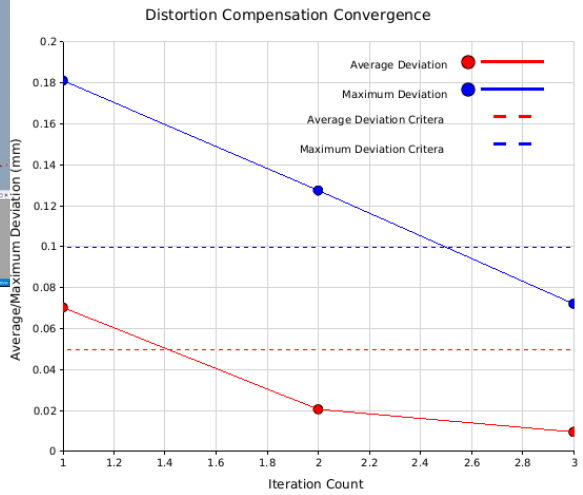
Release 2023 R1 Highlights
Ansys Additive Solutions

Automatic Distortion Compensation

- ‘Set it and forget it’ optimization wizard for distortion compensation
  - User sets deformation tolerance and max iterations
  - Control faceting level
  - Visualize faceting
  - **Extension automatically iterates** through solutions until the deformed part falls within tolerances
  - See convergence data
  - Option to output STL file from any/all iterations
  - Modify deformation of part near baseplate
  - Includes cutoff and springback calculations







2023 R1 Improvements to Automatic Distortion Compensation

More user controls w.r.t to output geometry

- Improvements in re-faceting the input stl mesh needed for compensation
- User controls for re-faceting operation
- Option to output stl at any/all iteration points
- "Zero Deformation at Base and Z Gap" are new options added to help with convergence. When enabled, the scaling of the deformations at nodes below the Z Gap will vary linearly from 0 at the baseplate to the 1 at the Z Gap

Preview of faceted geometry

- This new version allows the user to preview the faceted geometry that will be used for distortion compensation

Preview of the compensation convergence

- The convergence plot visualizes the iteration data like average and maximum deviations against the respective criteria and the iteration number. This will give the user a real time visualization of the performance of distortion compensation with selected parameters

Improved Usability

- Compensation enabled in conjunction with spring-back and cut-off simulations

Details of "Distortion Compensation"

Geometry (Body)	
Scoping Method	Geometry Selection
Geometry	1 Body
Convergence Criteria	
Average Deviation	1E-05 m
Maximum Deviation	1E-05 m
Maximum Iterations	2
Refaceting Settings	
Remesh Geometry	Yes
Curvature Min Size	0.0005 m
Max Size	0.002 m
Growth Rate	1.2
Curvature Normal Angle	10 °
Advanced	
Distortion Compensation Factor	0.75
Zero Deformations at Base	No
Output Controls	
Save Iteration Results	No
Statistics	
Iterations Completed	0
Average Deviation	0 m
Maximum Deviation	0 m

Fig.1 New re-faceting settings

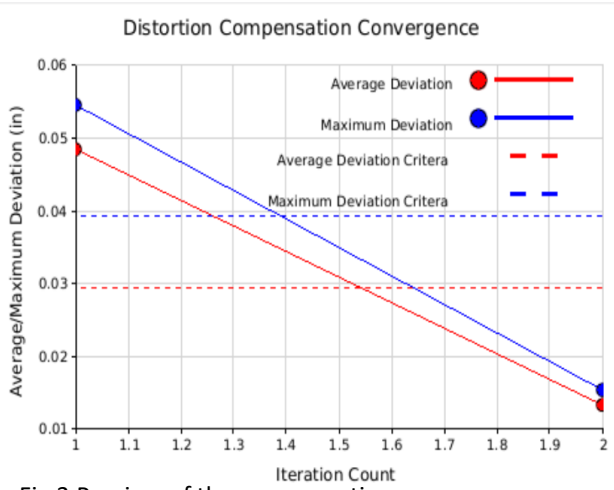


Fig.3 Preview of the compensation convergence

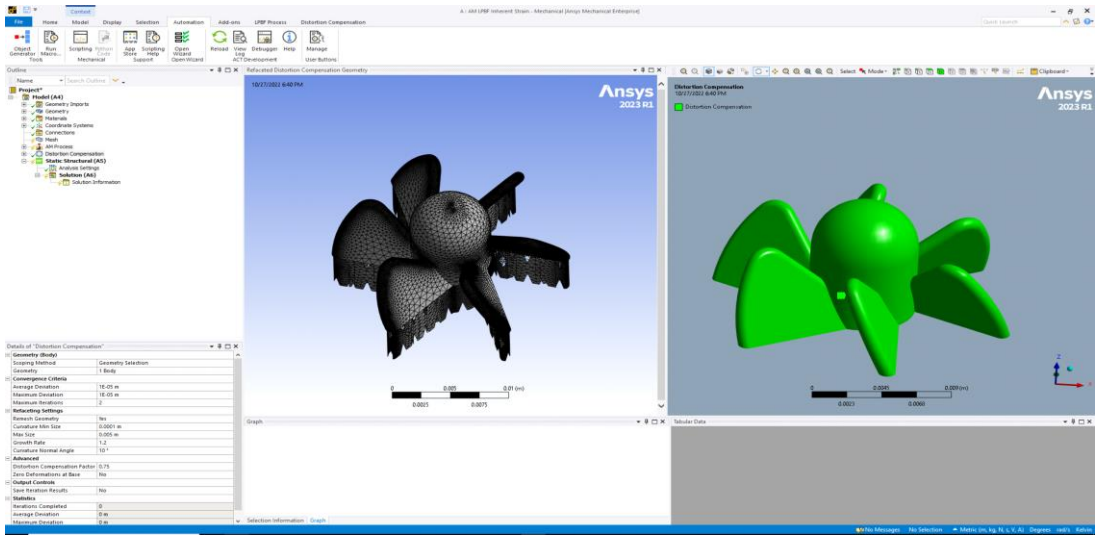


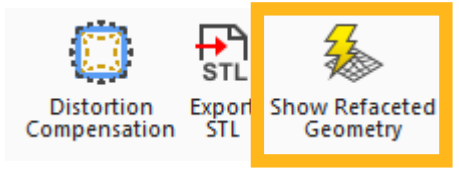
Fig.2 Preview of faceted geometry that will be used for compensation

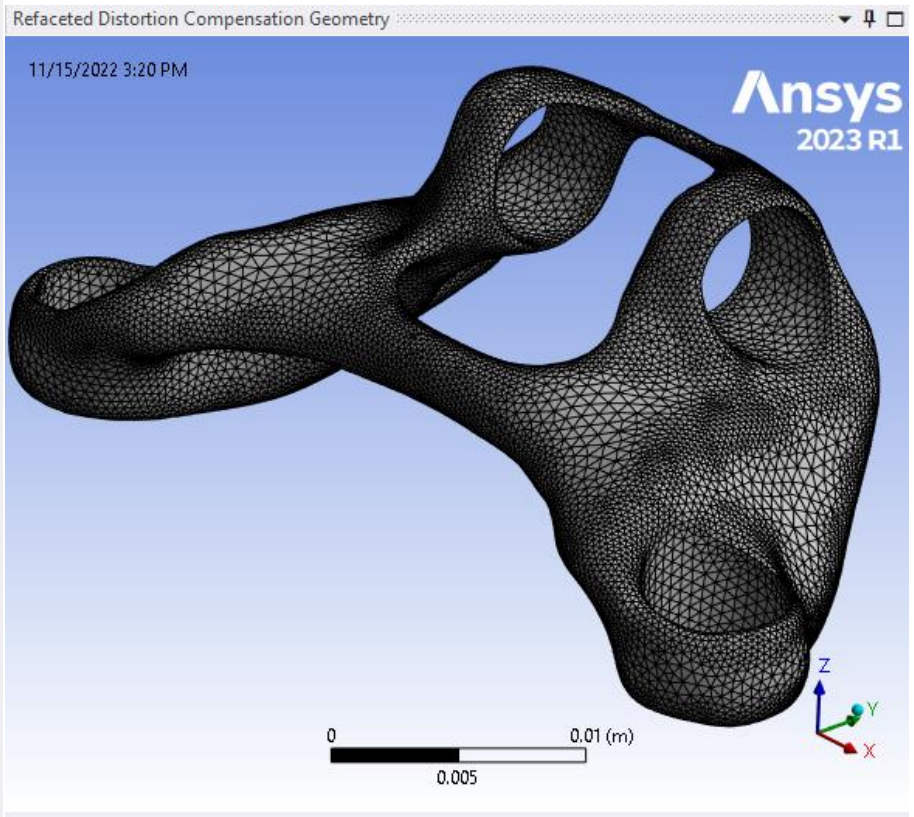
Distortion compensation: Refaceting Improvements

- Users now have greater control over the refaceted geometry
  - New inputs: Curvature Min Size, Max Size, Growth Rate, Curvature Normal Angle
- Users can preview the refaceted geometry with “Show Refaceted Geometry ”

Details of "Distortion Compensation"

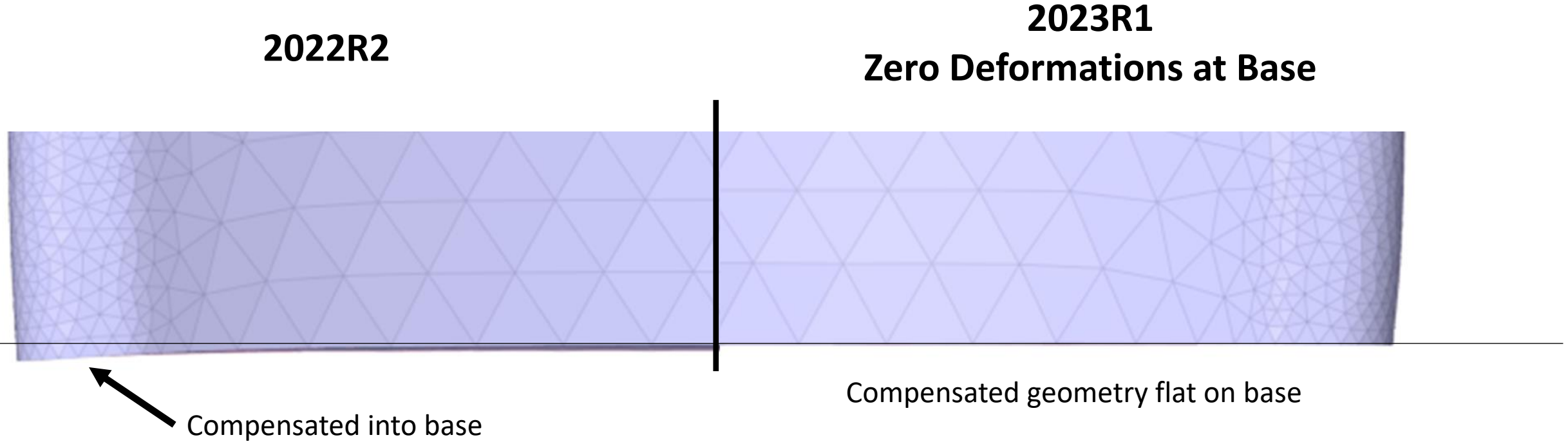
Geometry (Body)	
Scoping Method	Geometry Selection
Geometry	1 Body
Convergence Criteria	
Average Deviation	0.25 mm
Maximum Deviation	0.5 mm
Maximum Iterations	5
Refaceting Settings	
Remesh Geometry	Yes
Curvature Min Size	0.3 mm
Max Size	1 mm
Growth Rate	1.5
Curvature Normal Angle	10 °
Advanced	
Distortion Compensation Factor	0.75
Zero Deformations at Base	No
Output Controls	
Save Iteration Results	No
Statistics	
Iterations Completed	0
Average Deviation	0 mm
Maximum Deviation	0 mm



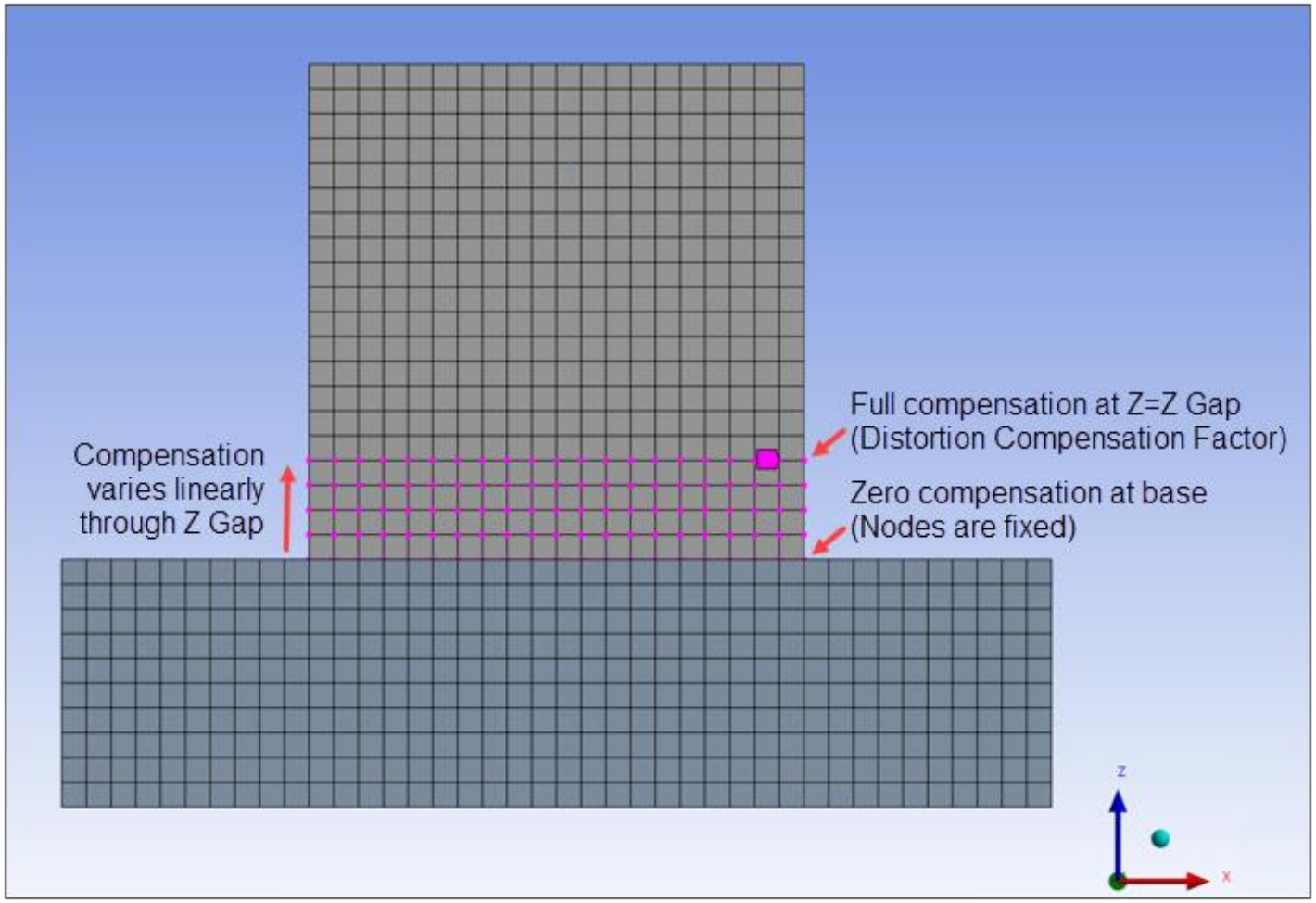


Distortion Compensation: AM Cutoff Improvements

- Ensure good connection to the base with “Zero Deformations at Base”
  - Particularly helpful with cutoff simulations to ensure the compensated geometry does not penetrate the base and has good contact for simulation



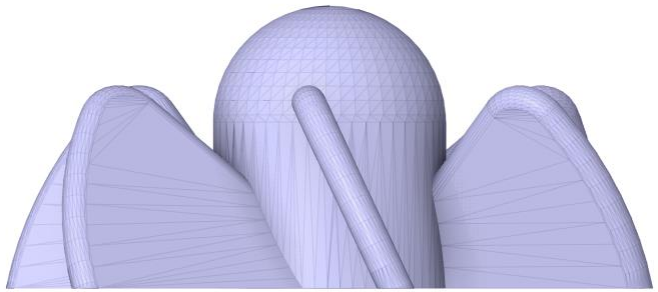
Distortion Compensation: Deformation Control Near Baseplate



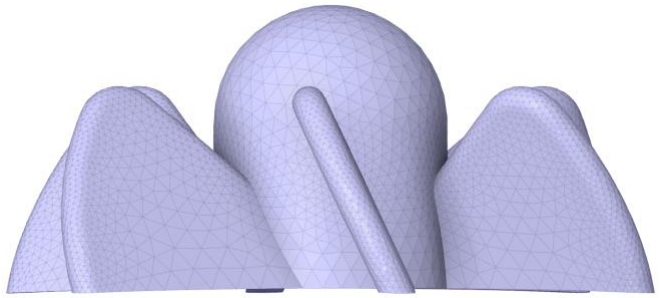
Distortion Compensation: Save Compensation History

- “Save Iteration Results” will save the compensated geometry from each iteration to provide more information to the user

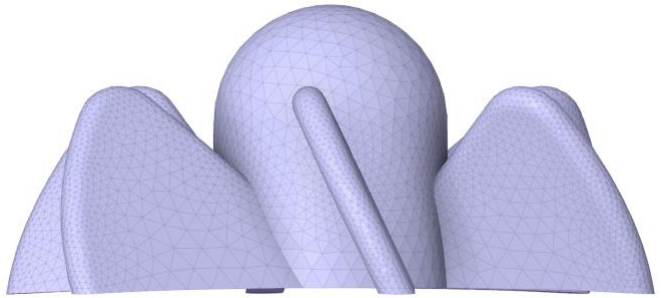
Iteration 1

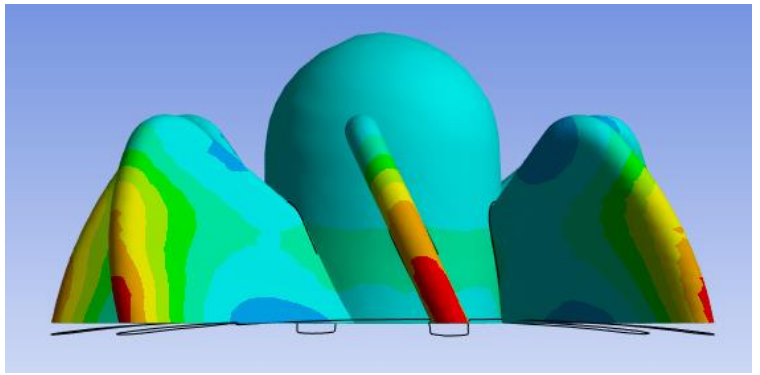


Iteration 2



Iteration 3





Other Improved Capabilities into Mechanical Additive

Other new capabilities

- Read build files from various manufactures for Scan Pattern and ML Thermal Strain simulations in WB Mechanical
- Spring-back/Cut-off simulations are improved with directional, progressive base removal
- Post-processing results include new High Strain result item
- Improved LPBF Setup Wizard now includes:
  - Scan Pattern and Thermal Strain options for Inherent Strain simulations
  - Option to import build file from supported machine manufacturers to define scan pattern
  - Option to enable Directional Cutoff removal step
- Adaptive mesh coarsening using AM Octree
  - For inherent strain simulations, mesh is coarsened adaptively away from laser source to reduce element count, reducing solver time
  - Element count reduced in bulk areas of the geometries

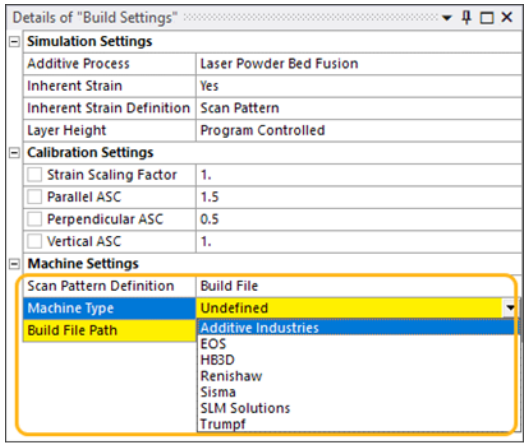


Fig.1 Build file reader

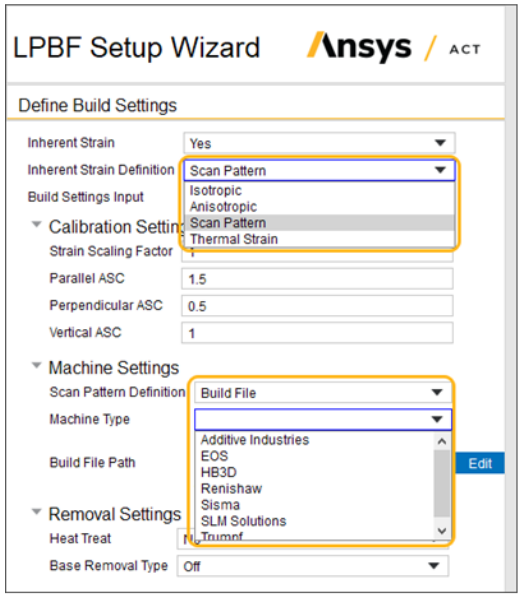
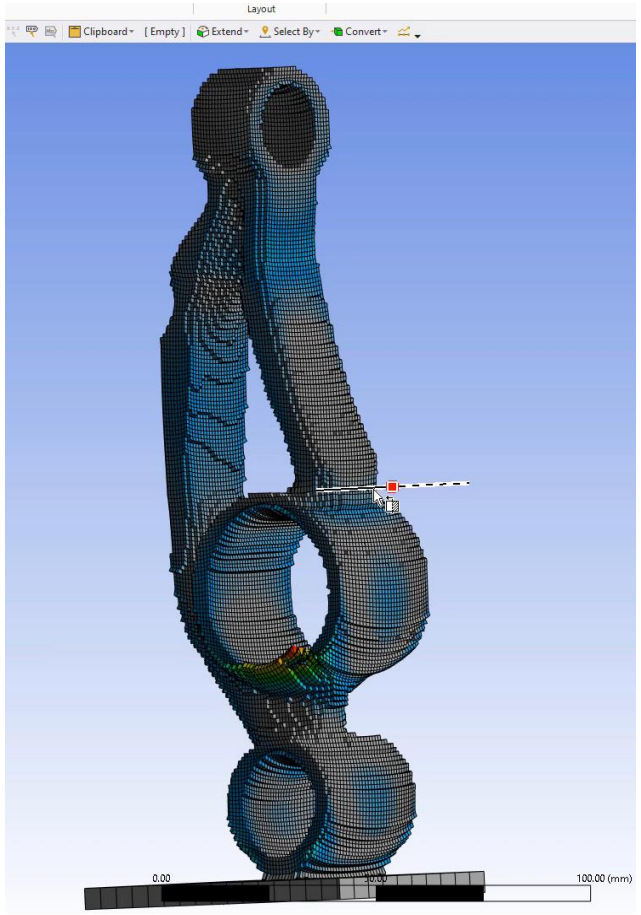


Fig.2 Improved LPBF Setup wizard

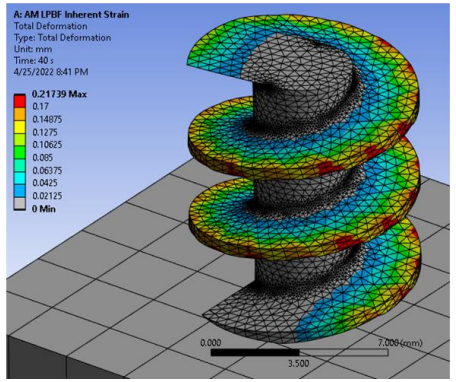


Video.1 Adaptive mesh coarsening using Octree

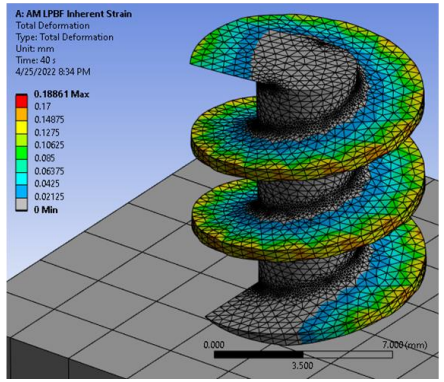
Workflow: Read Build Files in Mechanical

- Build files from various machine manufacturers can be read and used in Scan Pattern and Thermal Strain simulations
- Users are able to run simulation using the real scan pattern for their part
- Support machine types:
  - Additive Industries
  - EOS
  - HB3D
  - Renishaw
  - Sisma
  - SLM
  - Trumpf

Typical 67 deg rotating scan pattern
Max Deformation = 0.217



170 deg rotating scan pattern
Max Deformation = 0.189 (~15% decrease)

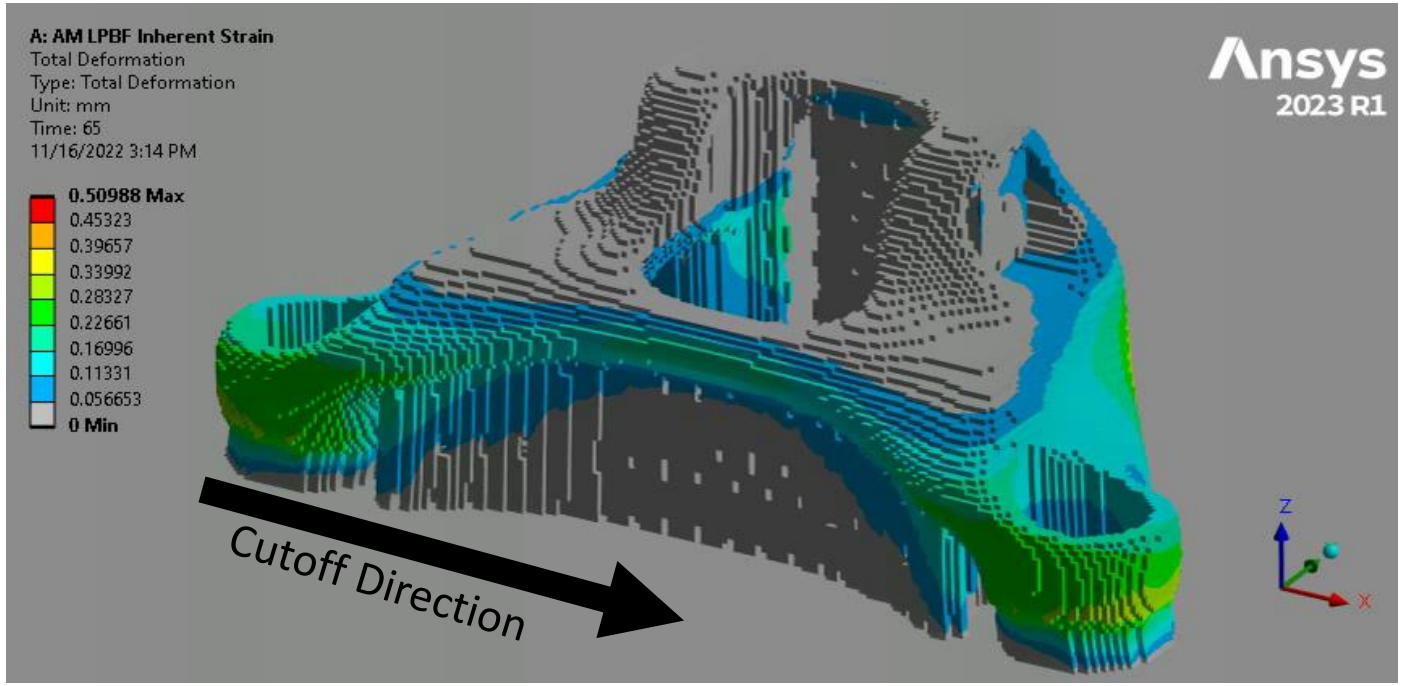


Details of "Build Settings"

Simulation Settings	
Additive Process	Laser Powder Bed Fusion
Inherent Strain	Yes
Inherent Strain Definition	Thermal Strain
Thermal Strain Method	Machine Learning Prediction
Machine Learning Model	316L Stainless Steel
Layer Height	Program Controlled
Calibration Settings	
Strain Scaling Factor	1.
Parallel ASC	1.5
Perpendicular ASC	0.5
Vertical ASC	1.
Machine Settings	
Scan Pattern Definition	Build File
Machine Type	EOS
Build File Path	E:\Projects_E\AI-bridge-default-stripe.zip
Hatch Spacing	0.125 mm
Scan Speed	1000. mm/s
Beam Power	300. W
Beam Diameter	0.1 mm
Build Conditions	
Preheat Temperature	100. °C

Workflow: Wizard Improvements

- Scan Pattern and Thermal Strain along with earlier Assumed Strain
- Directional cutoff controls allow the user to more accurately simulate the removal from the base plate



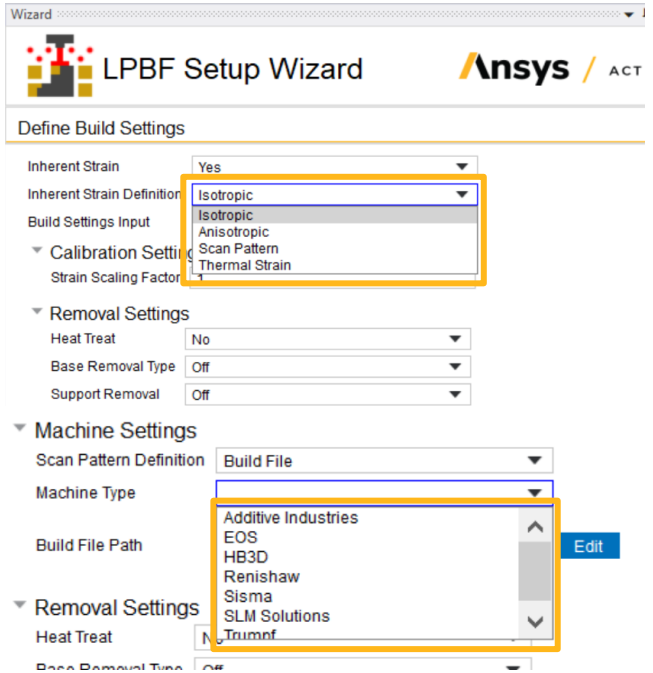
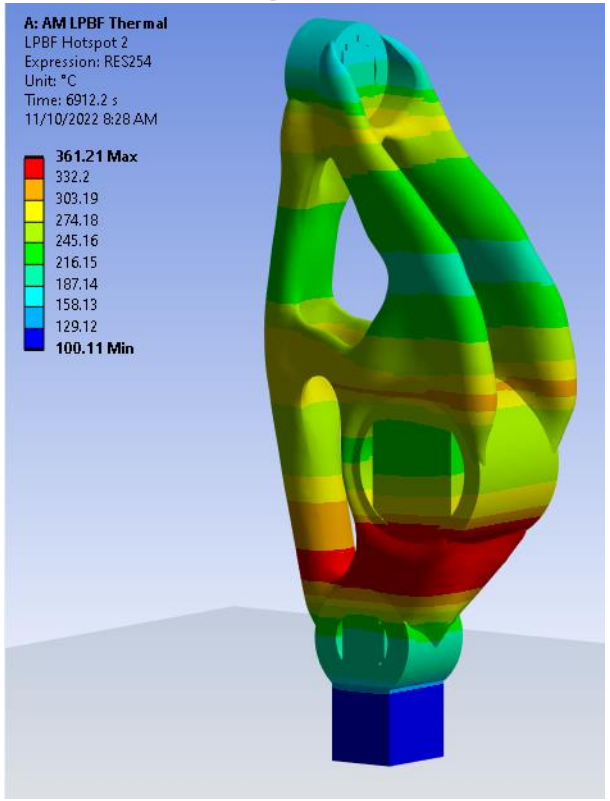


Fig.2 Improved AM setup wizard

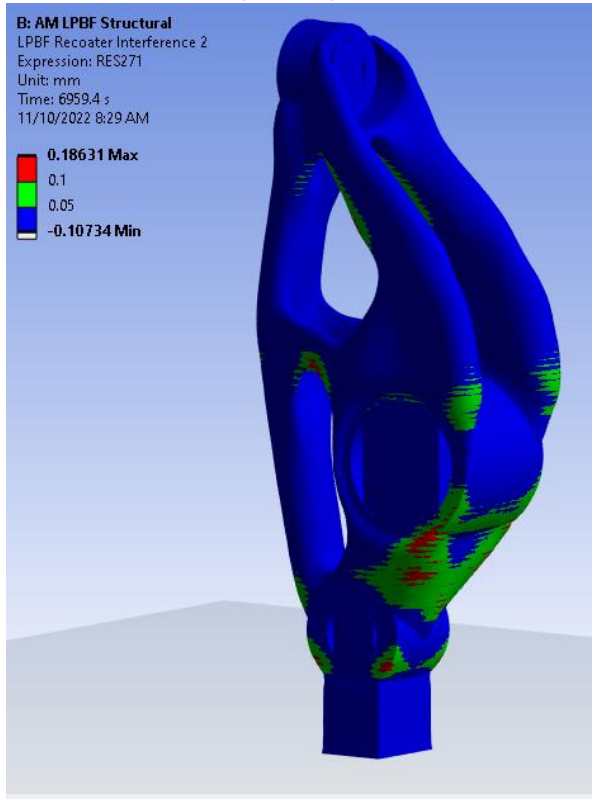
Workflow: AM Results

More Accessible AM Results

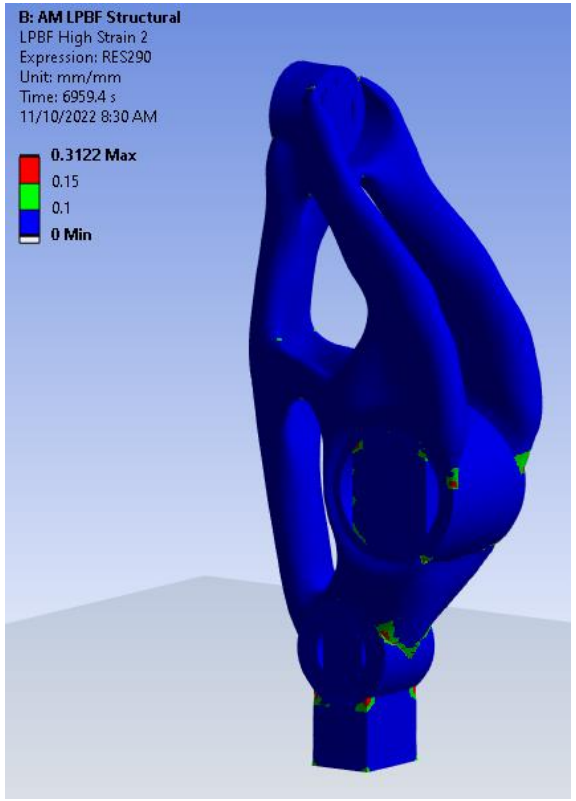
LPBF Hotspot: Identify regions of potential overheating



LPBF Recoater Interference: Identify regions where the recoater may impact the build



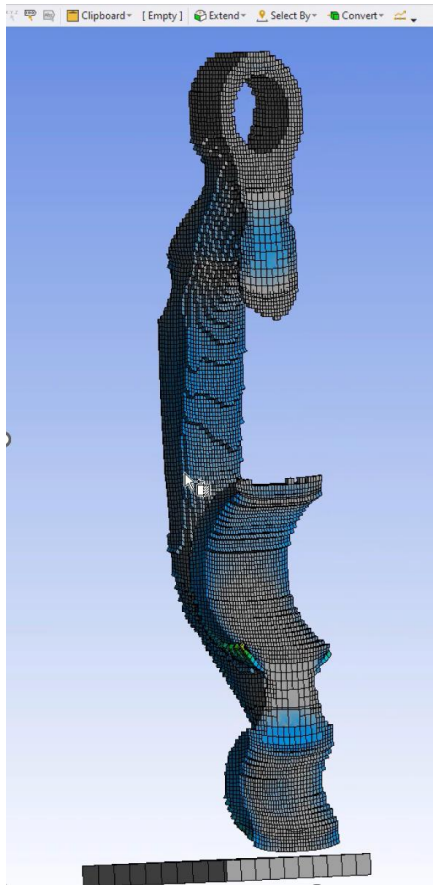
LPBF High Strain: Identify potential crack locations

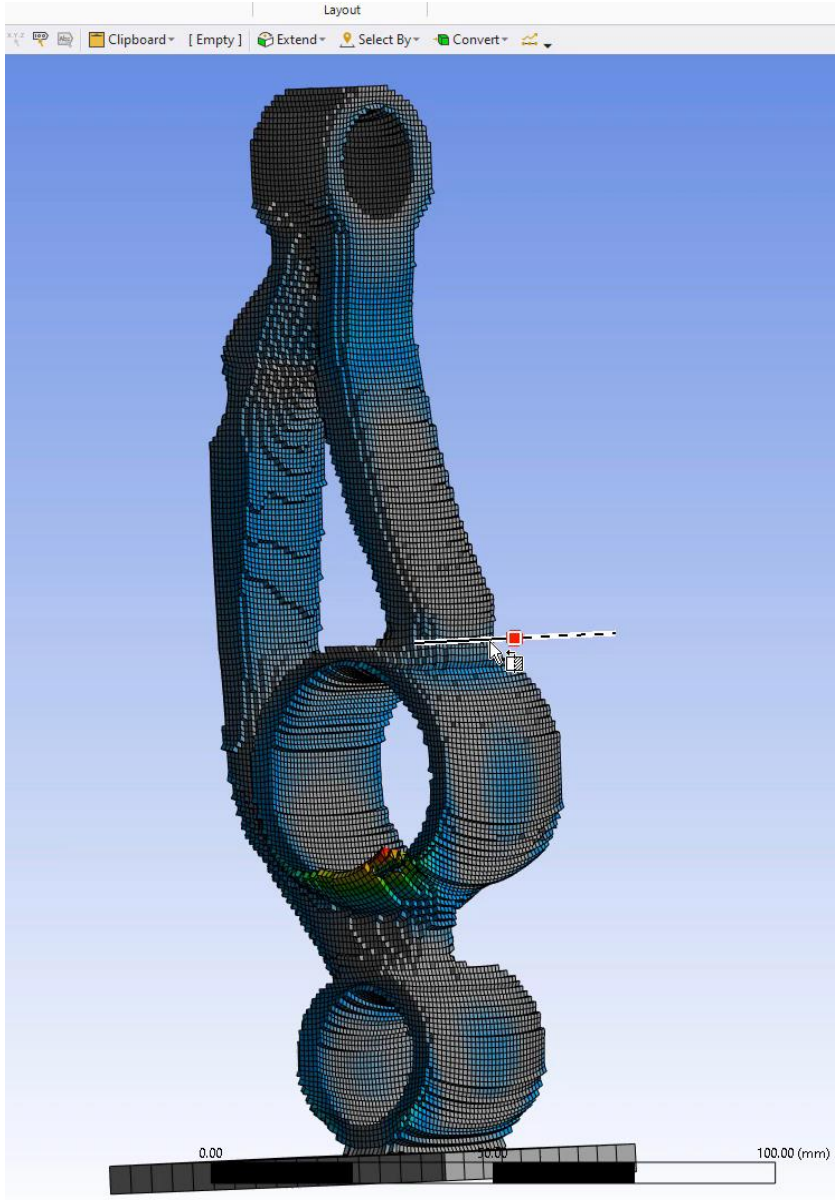


Adaptive Meshing with AM Octree

Octree Adaptive Meshing

- AM Octree option added for MAPDL and Mechanical
- Cubic voxels coarsened
  - Reduce element count
  - Speed up solve time
- Automatically avoids coarsening near laser source
- Significant impact on bulky geometries
- User input:
  - Remesh frequency
  - Start Layer
  - End Layer





Workflow: Automatic Deformation Calibration Process

Theme category

- Ease of use/Usability

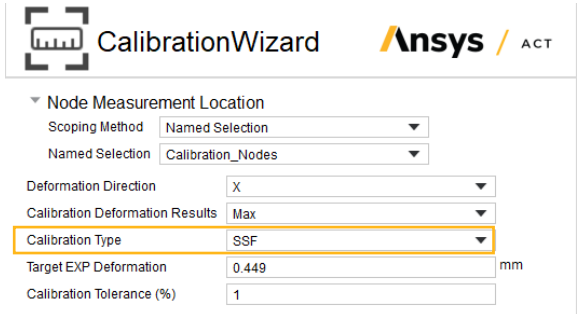
User pain points

- LPBF distortion simulation calibration workflow
  - Users manually run distortion simulations by applying iteratively calculated Strain Scaling Factors (SSF) and Anisotropic Strain Coefficients (ASC) to match simulation results with experimental target values within a given tolerance. Such manual processes are repeated by utilizing spreadsheet calculation table

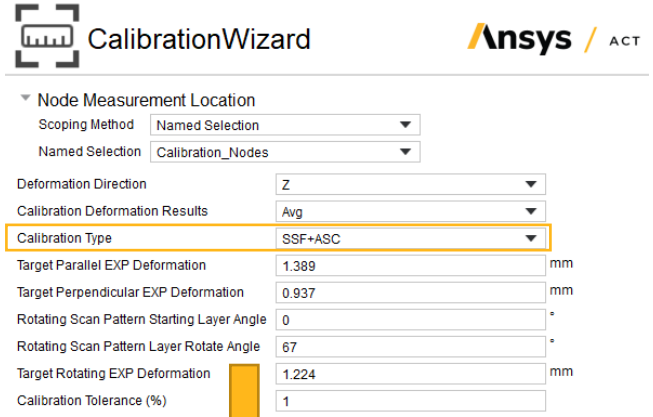
Benefits

- Streamline and automate the manual distortion calibration workflow for all LPBF distortion simulation modes via the new automatic distortion calibration wizard
- More calibration part types are added to calibration geometry library

SSF only calibration



SSF + ASC calibration



DX module automatically optimizes calibration factor(s)

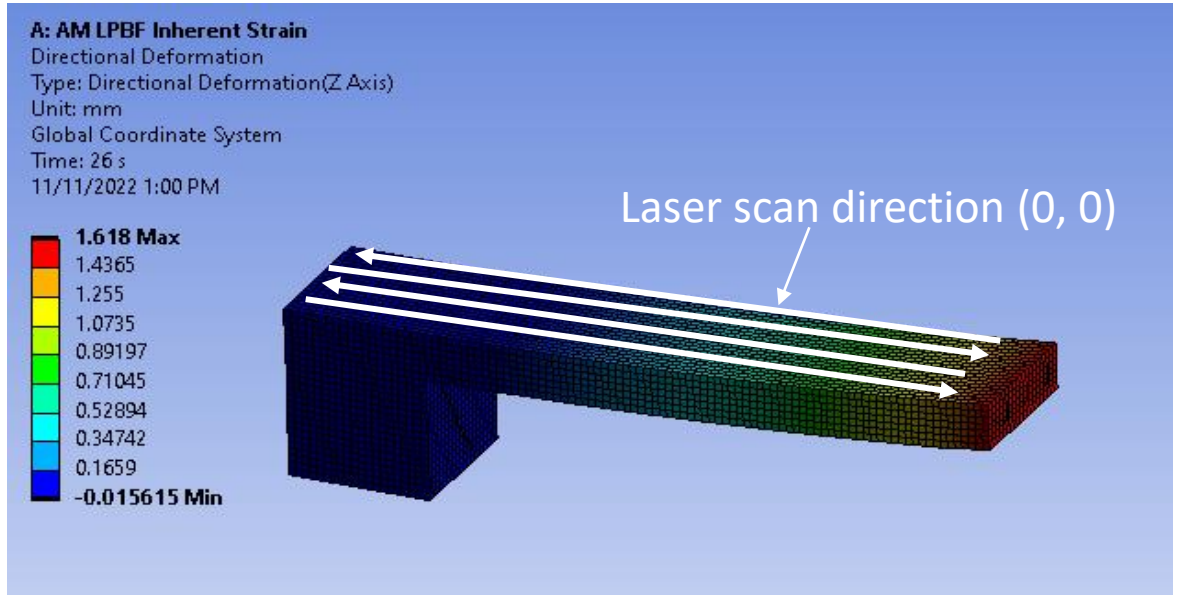
	Name	P1 - Build Settings Thermal Strain Scaling Factor	P2 - Calibration Deformation Maximum (mm)
2	1 DP 0	1	0.65576
3	2 DP 1	0.002	0.0018668
4	3 DP 2	0.684	0.47439
5	4 DP 3	0.647	0.45507
6	5 DP 4	0.638	0.45054

	Name	P1 - Build Settings Strain Scaling Factor	P2 - Build Settings Parallel ASC	P3 - Build Settings Perpendicular ASC	P4 - Build Settings Start Layer Angle (degree)	P5 - Build Settings Layer Rotation Angle (degree)	P6 - Calibration Deformation Average (mm)
2	1 DP 0	1	1.5	0.5	0	0	1.534
3	2 DP 1	1	1.5	0.5	90	0	0.75164
4	3 DP 2	1.018	1.363	0.637	0	0	1.5204
5	4 DP 3	1.018	1.363	0.637	90	0	0.92262
6	5 DP 4	1.005	1.305	0.695	0	0	1.5133
7	6 DP 5	1.005	1.305	0.695	90	0	0.97746
8	7 DP 6	1.05	1.267	0.733	0	0	1.5001
9	8 DP 7	1.05	1.267	0.733	90	0	1.0604
10	9 DP 8	0.002	1.363	0.637	0	0	0.0034021
11	10 DP 9	0.002	1.363	0.637	90	0	0.0018064
12	11 DP 10	1.018	1.015	0.985	0	0	1.3372
13	12 DP 11	1.018	1.015	0.985	90	0	1.3065
14	13 DP 12	0.954	1.286	0.714	0	0	1.5054
15	14 DP 13	0.954	1.286	0.714	90	0	0.95099
16	15 DP 14	0.903	1.275	0.725	0	0	1.4601
17	16 DP 15	0.903	1.275	0.725	90	0	0.91338
18	17 DP 16	0.885	1.357	0.643	0	0	1.5038
19	18 DP 17	0.885	1.357	0.643	90	0	0.8129
20	19 DP 18	0.889	1.237	0.763	0	0	1.406
21	20 DP 19	0.889	1.237	0.763	90	0	0.93801
22	21 DP 20	0.882	1.231	0.769	0	0	1.3908
23	22 DP 21	0.882	1.231	0.769	90	0	0.93684
24	23 DP 22	1	1.231	0.769	0	67	1.3063
25	24 DP 23	0.882	1.231	0.769	0	67	1.1678
27	26 DP 25	0.937	1.231	0.769	0	67	1.2346

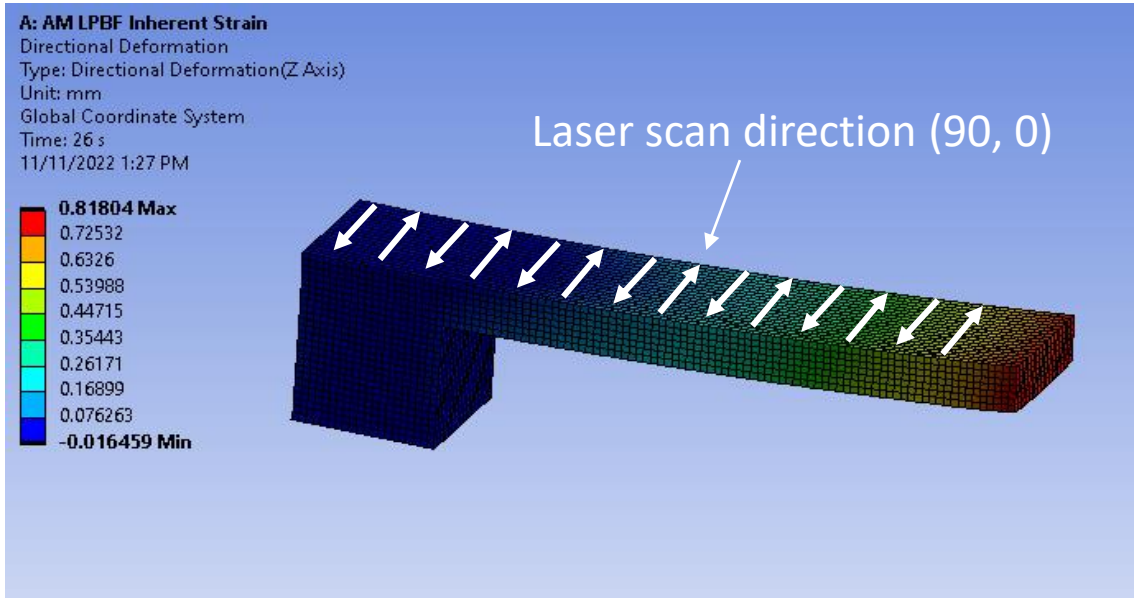
Workflow: Anisotropic Scaling Calibration Wizard

- Laser scan direction impacts strain
- Increase simulation fidelity through laser scan driven anisotropic strain
- Simple to use calibration wizard accommodates anisotropic values

316L SS cantilever with all vectors aligned parallel



316L SS cantilever with all vectors aligned



Improved DED Simulation

Introduce *Cluster Settings* object

- A table that allows import, export, and modifications of machine parameters for each cluster during a DED simulation. Great for optimizing process settings and improving printing quality (e.g., reduce distortion and localized overheating, etc.)

Improved G-Code reader performance

- G-Code cluster generation has been optimized to give up to 40x speed-up by optimizing the clustering algorithm

Simulation w/ non-planar base plate

- Enable DED simulation to consider parts building on non-planar base plates with improved contact generation workflow in wizard. It also provides a way to simulate DED repairing applications

Improved distortion prediction algorithm

- Newly deposited element clusters now follow the deformed shape beneath them resulting in deformation patterns and/or magnitudes that are now more closely aligned with the true shape

Cluster NS	Deposition Rate[mm³/s]	Cluster Preheat Temperature[°C]	Dwell Time[s]
el_loop_01	20	23	0
el_loop_02	20	23	0
el_loop_03	20	23	0
el_loop_04	20	23	0
el_loop_05	20	23	0
el_loop_06	20	23	0
el_loop_07	20	23	0
el_loop_08	20	23	0
el_loop_09	20	23	0
el_loop_10	20	23	0
el_loop_11	20	23	0
el_loop_12	20	23	0
el_loop_13	20	23	0
el_loop_14	20	23	0
el_loop_15	20	23	0
el_loop_16	20	23	0
el_loop_17	20	23	0
el_loop_18	20	23	0
el_loop_19	20	23	0
el_loop_20	20	23	0

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Fig.1 Clustering Settings table

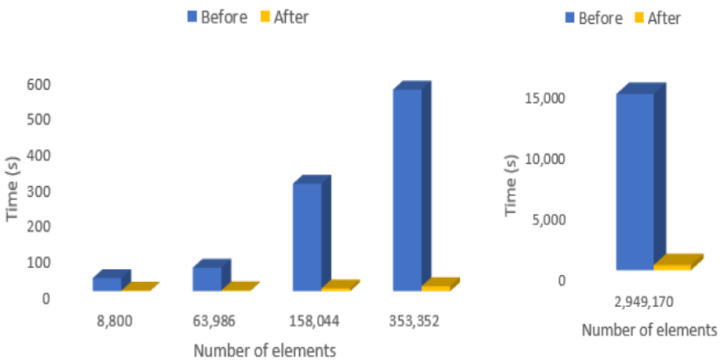


Fig.2 G-Code clustering cost before and after improvements

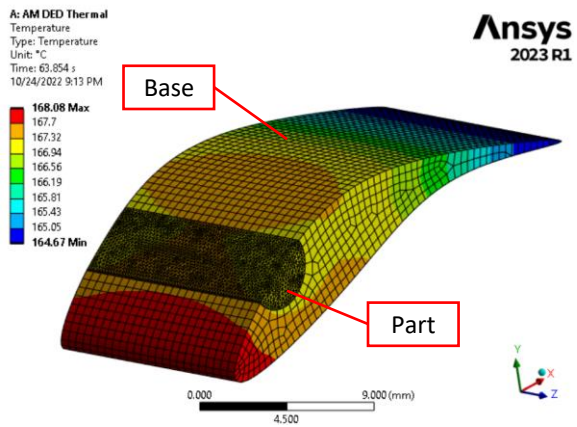


Fig.3 DED simulation w/ non-planar base plate

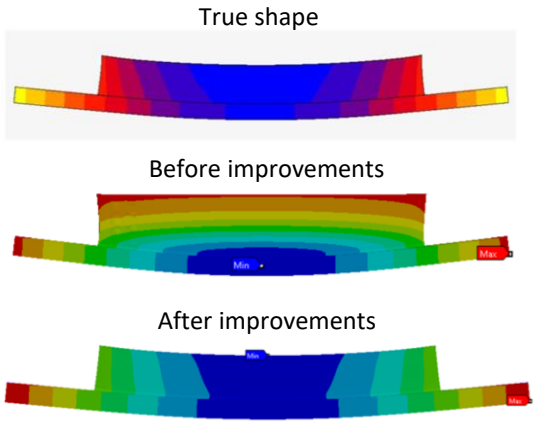
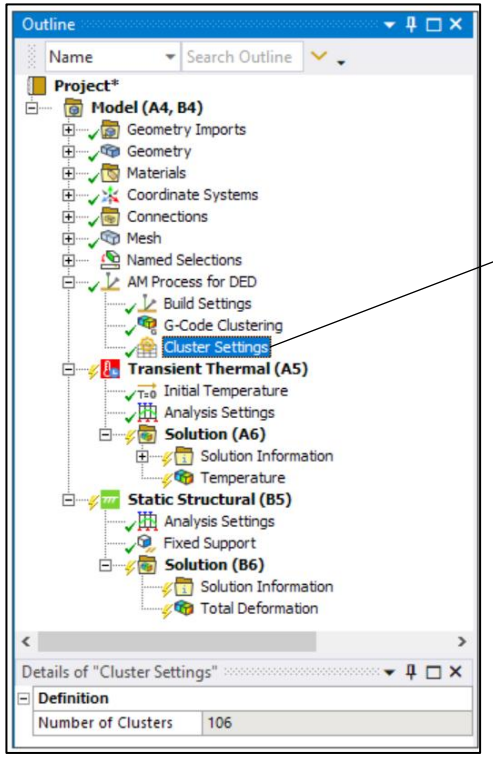


Fig.4 Distortion prediction algorithm improvements

DED: Cluster Settings Table

Clustering Settings object

- Optimize process settings to improve print quality (reduce overheating and distortion)
- Table to adjust process parameters for each cluster
  - Deposition Rate
  - Preheat Temperature
  - Dwell Time
- Cluster Settings object automatically inserted
- Import
- Export
- Edit



Cluster NS	Deposition Rate[mm³/s]	Cluster Preheat Temperature[°C]	Dwell Time[s]
el_loop_01	20	23	0
el_loop_02	20	23	0
el_loop_03	20	23	0
el_loop_04	20	23	0
el_loop_05	20	23	0
el_loop_06	20	23	0
el_loop_07	20	23	0
el_loop_08	20	23	0
el_loop_09	20	23	0
el_loop_10	20	23	0
el_loop_11	20	23	0
el_loop_12	20	23	0
el_loop_13	20	23	0
el_loop_14	20	23	0
el_loop_15	20	23	0
el_loop_16	20	23	0
el_loop_17	20	23	0
el_loop_18	20	23	0
el_loop_19	20	23	0
el_loop_20	20	23	0

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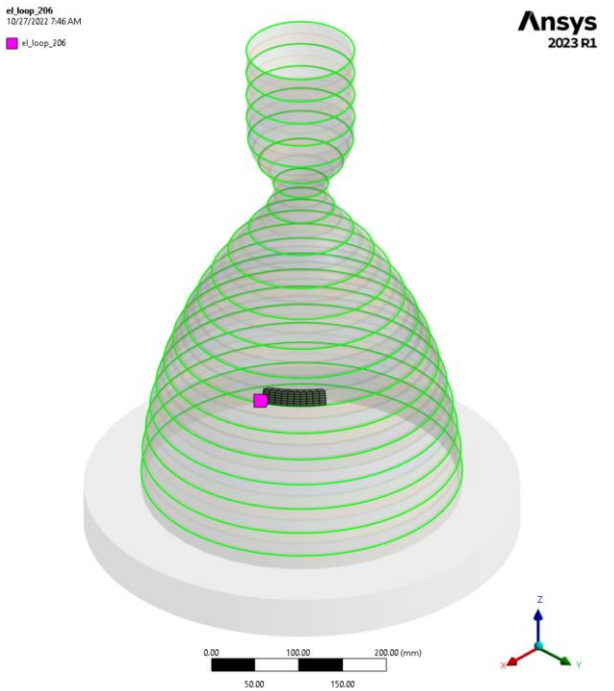


DED: Non-planar Baseplate

Simulation w/ non-planar base plate

- Simulate deposition on curved surfaces such as shafts, hubs, spheres, etc.
  - Understand how adding features impacts deposition and geometry
- Simulate deposition for repair of holes, indentations or removed areas
  - Avoid destruction of repairable geometry
- Improved contact generation workflow in wizard
  - Face geometry selection
  - Named selections

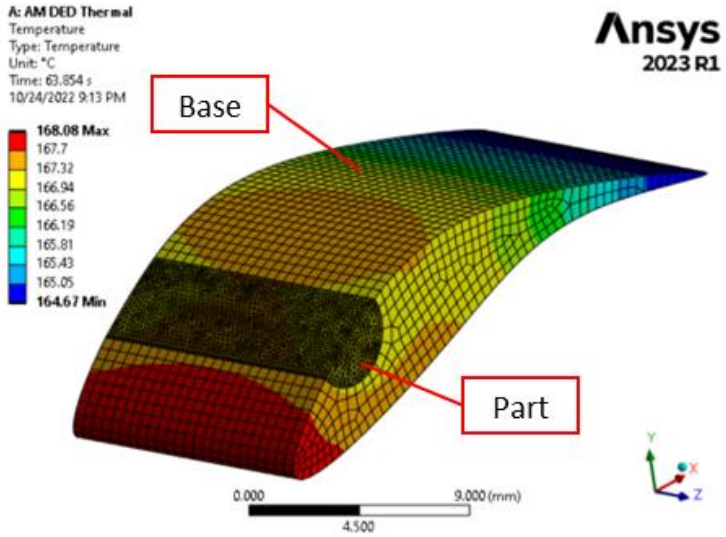
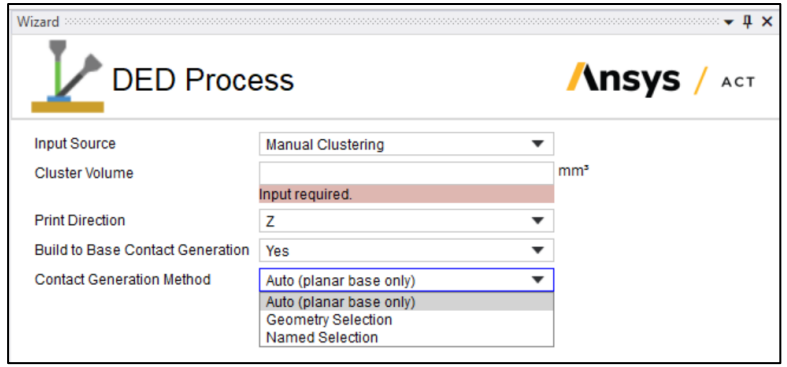


Fig.1 DED simulation w/ non-planar base plate



DED: Speed and Accuracy

Improved Gcode reader performance

- Gcode cluster generation has been optimized to give up to 40x speedup
- Reduces hours into minutes or seconds for clustering
- Dependent upon size and geometry

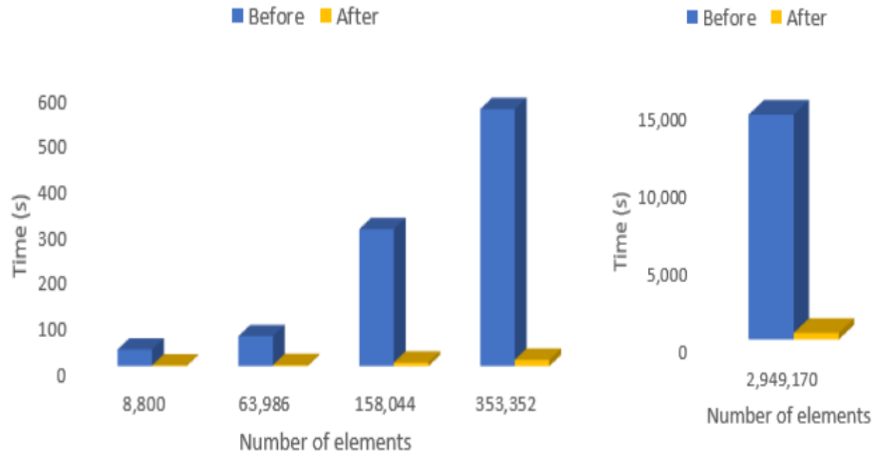


Fig.1 Gcode clustering cost before and after improvements

Large Deformation improvements

- The simulation takes into account of geometry true shape after large deformation to offer a better match to the reality
- Upper layer elements now follow the already deformed part beneath to improve accuracy.

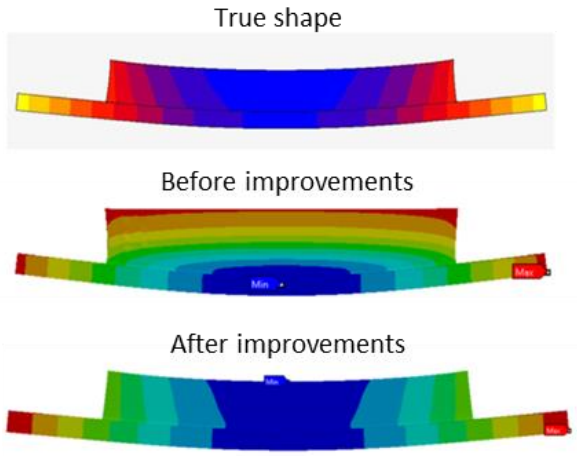


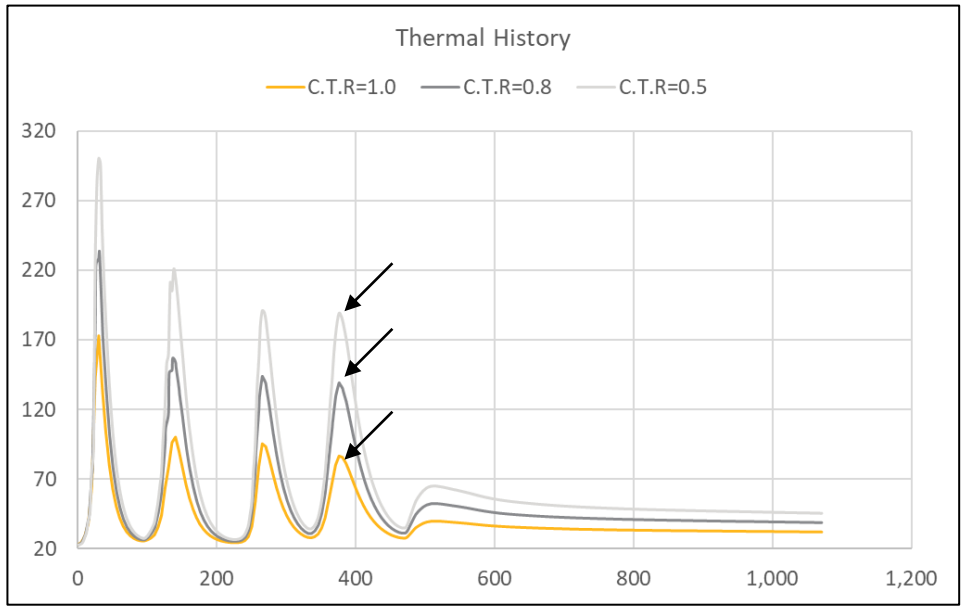
Fig.2 Distortion prediction algorithm improvements

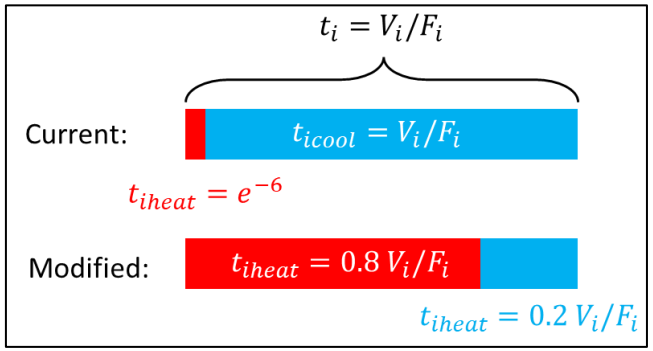
DED: Cluster Cooling Time Ratio Calibration Factor

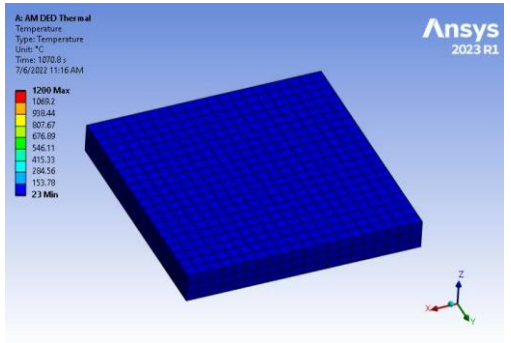
- Refine results by adjusting for variations in machines and materials
- 0 to 1 (default) control to adjust the heating and cooling distribution for cluster deposition.
- Lower value reduces cooling time and increases heating time
- Lower ratio results in higher temp spikes in DED thermal history

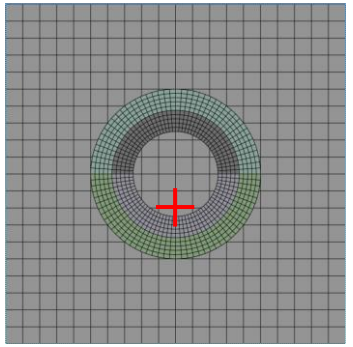
Details of "Build Settings"

Machine Settings	
Material Deposition Rate	100 [mm^3 sec^-1]
Build Conditions	
Preheat Temperature	23 °C
Scoping Method	Geometry Selection
Geometry	1 Face
Preheat During Printing	Off
Process Temperature	1200 °C
Room Temperature	23 °C
Gas Convection Coeff Build	1E-05 W/mm²·°C
Gas Convection Coeff Base Plate	1E-05 W/mm²·°C
Radiation	Off
Thermal Calibration	On
Cluster Cooling Time Ratio	0.2
Cooldown Conditions	
Room Temperature	23 °C
Gas Convection Coeff Build	1E-05 W/mm²·°C
Gas Convection Coeff Base Plate	1E-05 W/mm²·°C
Radiation	Off
Time	60 s







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