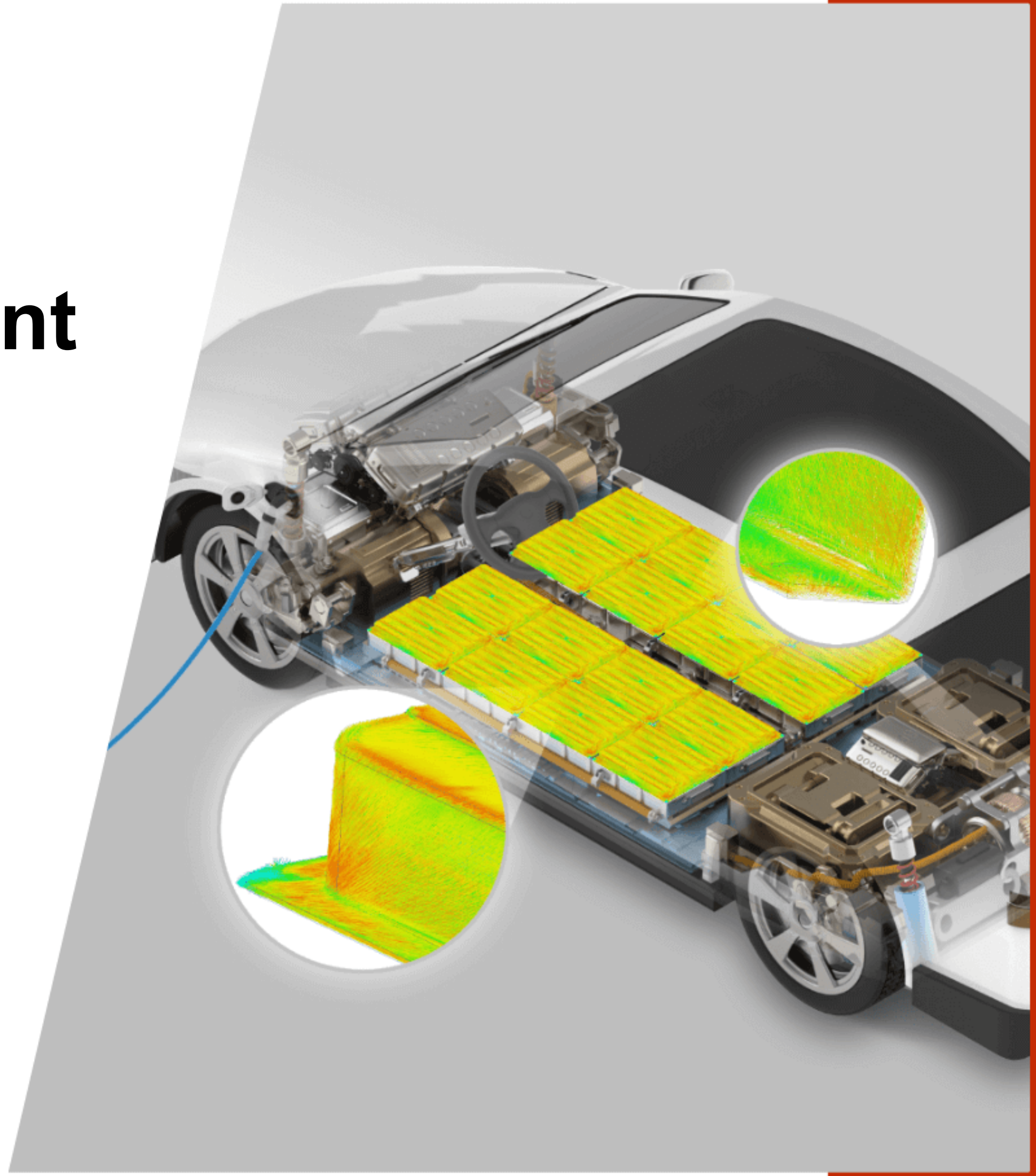
Smart Simulation of Low Constant Pressure Molding Using Virtual Sensors



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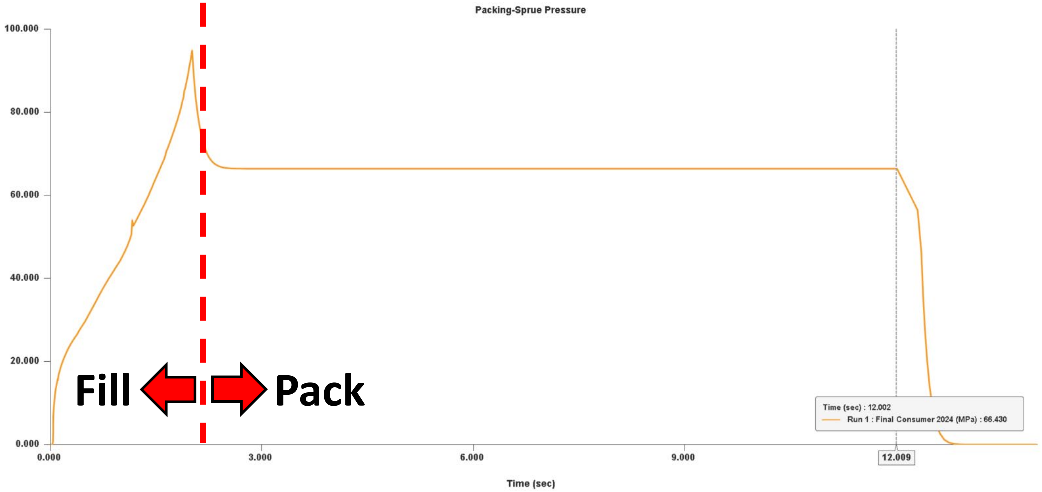
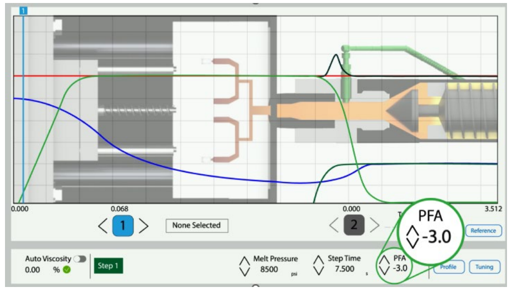
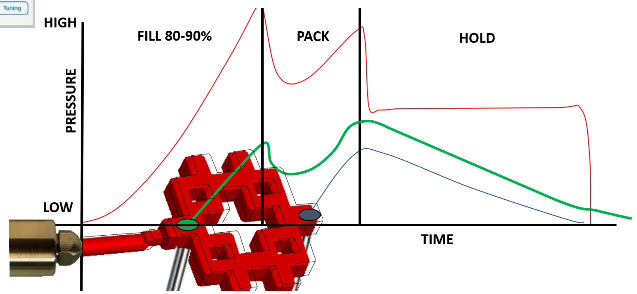
Low Pressure Molding Strategies

- Traditional Injection Molding has several challenges
  - High pressure / clamp tonnage
  - Abrupt & sensitive transition between Fill & Pack
  - Too many independent variables to adjust
    - REQUIRES MANUAL TWEAKING OF THE PROCESS ON THE FLOOR
- Sensor feedback strategies
  - iMFLUX
    - Uses a low constant pressure filling with a sensor feedback to pack the material as it flows
  - De-coupled III
    - Modulates the flow rate late in the filling based on cavity sensor information to allow packing to apply earlier in the process

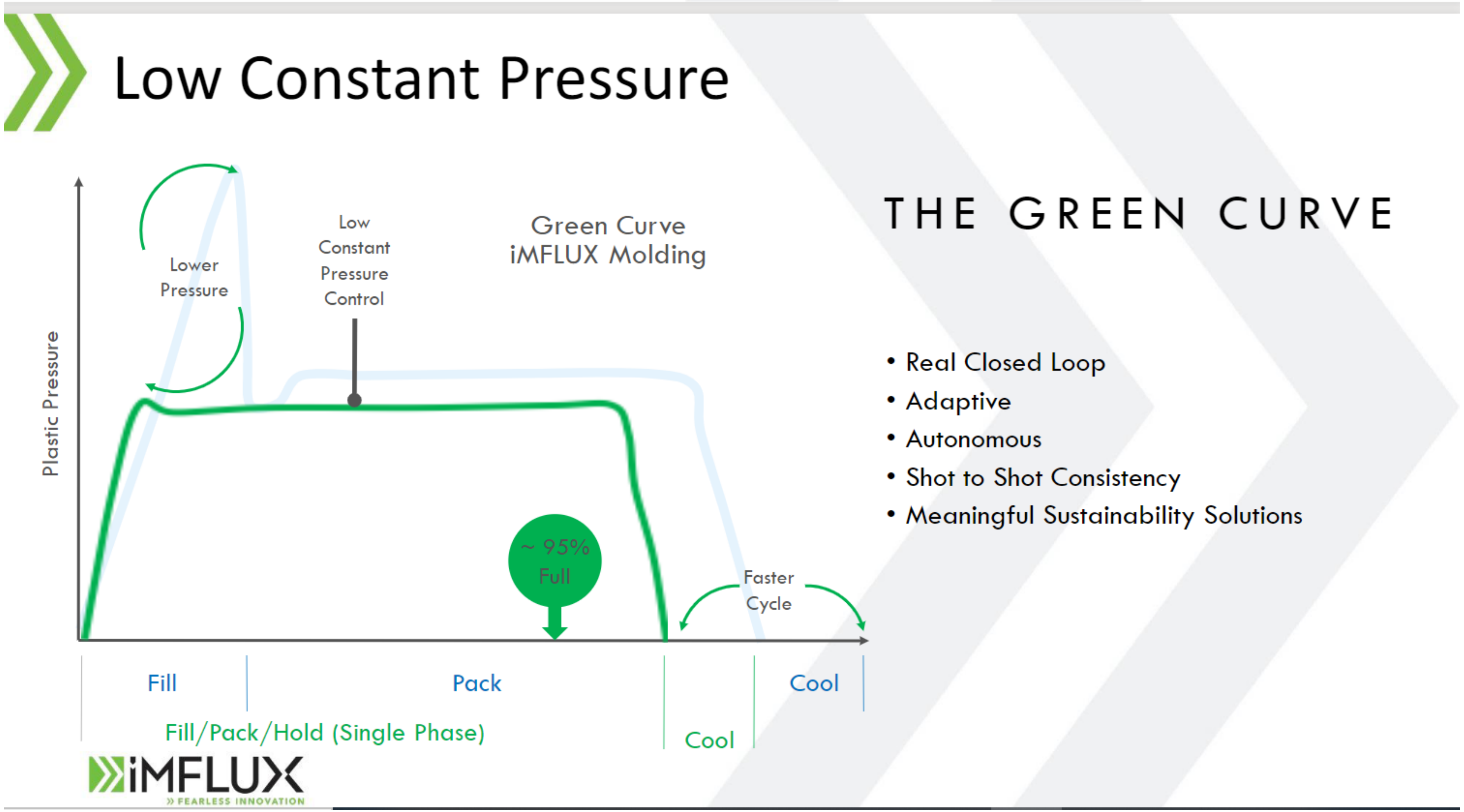






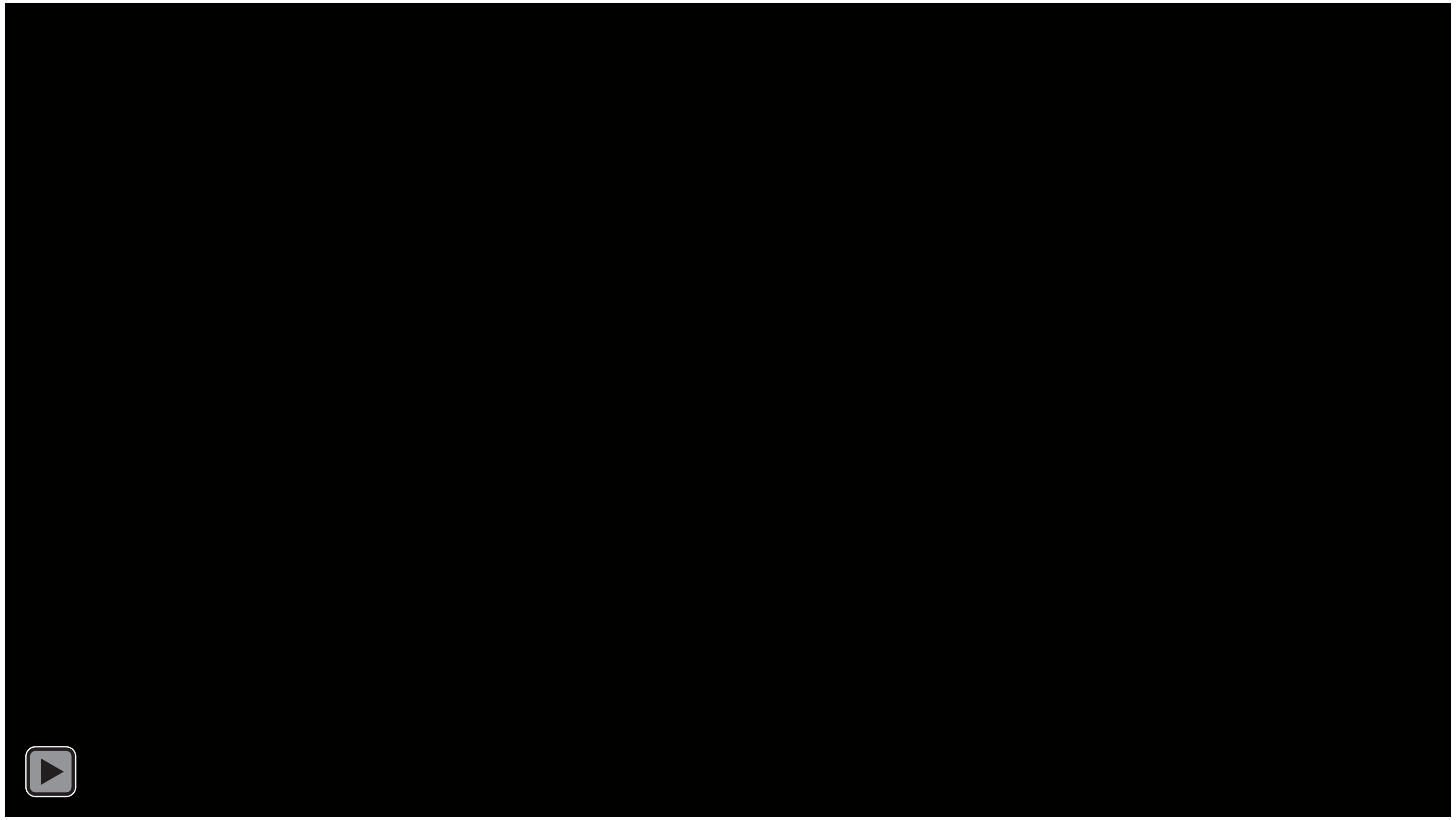
iMFLUX

What is iMFLUX?



How does iMFLUX Process work?

- **PFA is a pressure change factor that can be used to increase or decrease the melt pressure in response to cavity pressure values.**
- **PFA is a multiplier of cavity pressure that creates a melt pressure change**



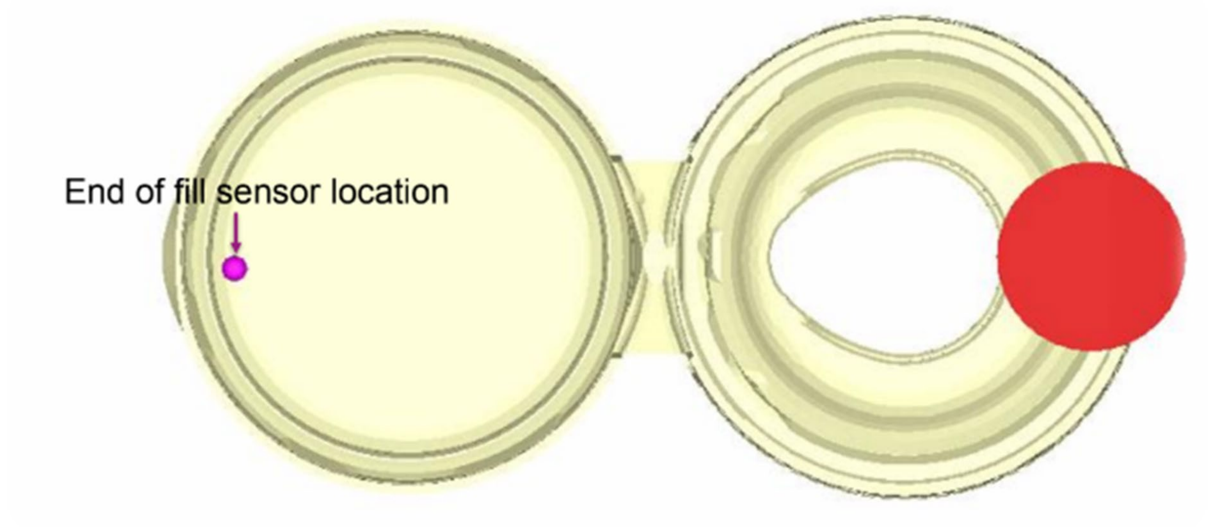
Hydraulic Pressure
Flow Rate
Cavity Sensor Pressure

Key parameters for iMFLUX simulation setup

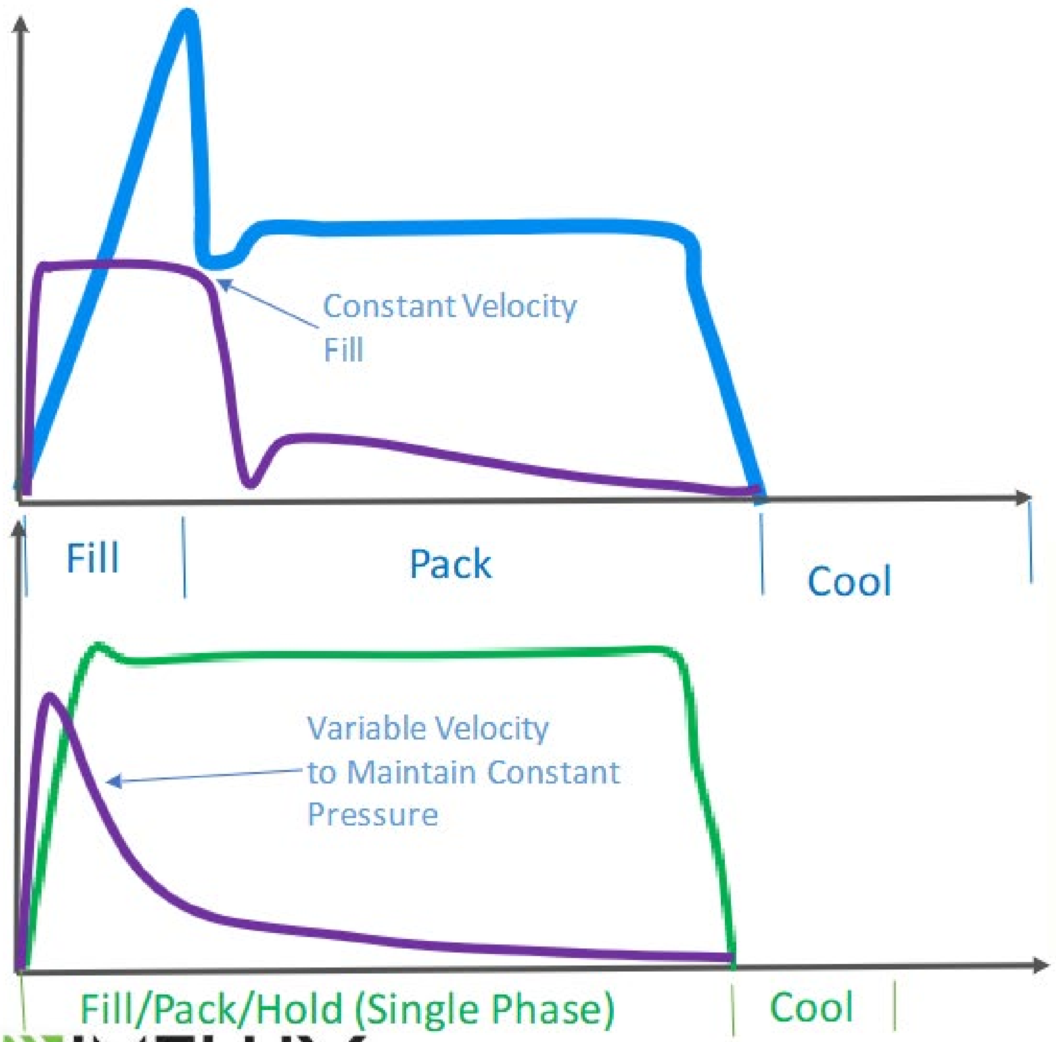
- **Need to know the lowest pressure required to get a full shot**

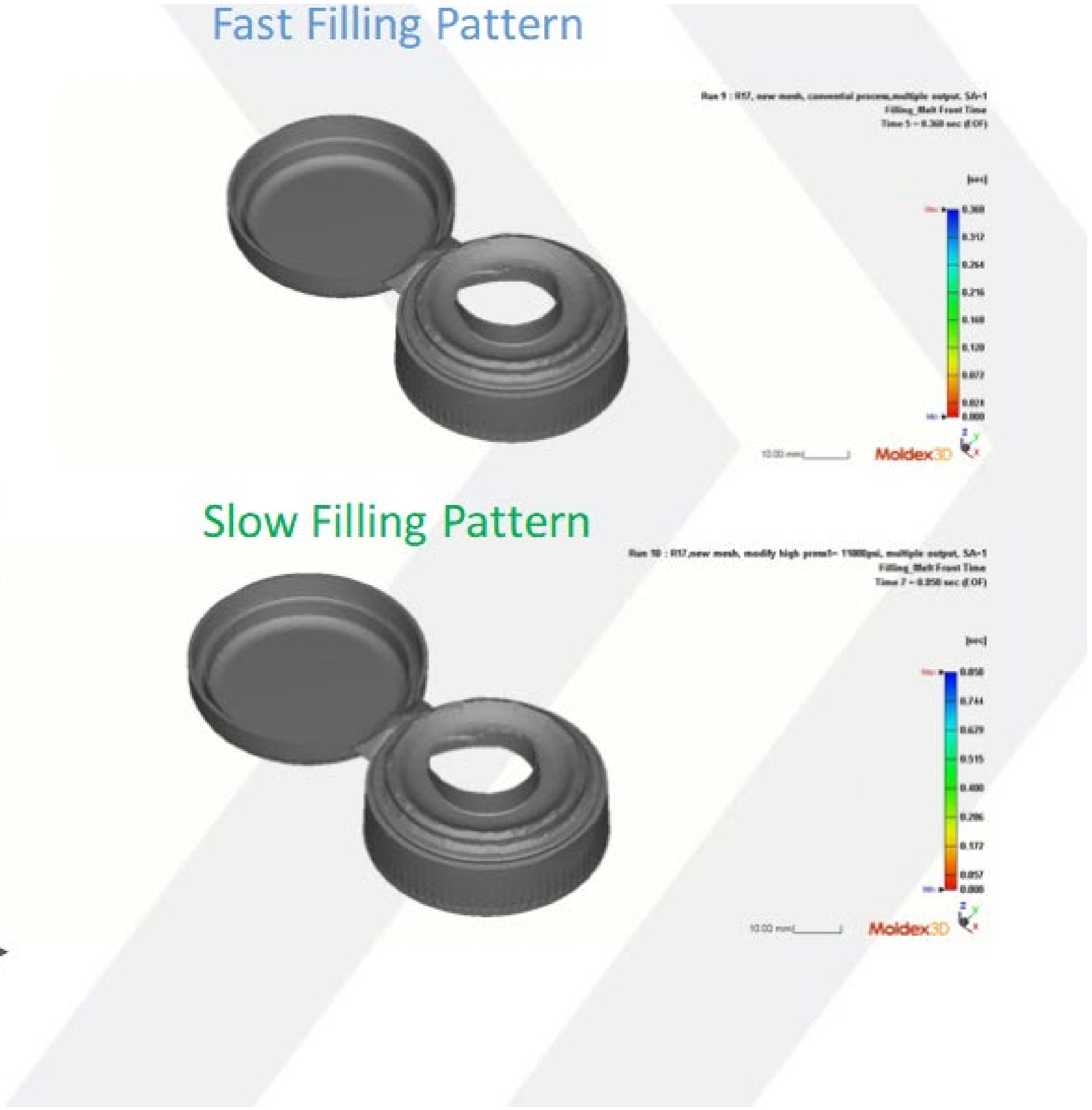
- **iMFLUX variables:**
  - **Minimum filling pressure (target pressure)**
  - **Virtual sensor location**
  - **PFA value**
  - **Initial flow rate**
  - **Approximate machine time constant**

Case Study - iMFLUX

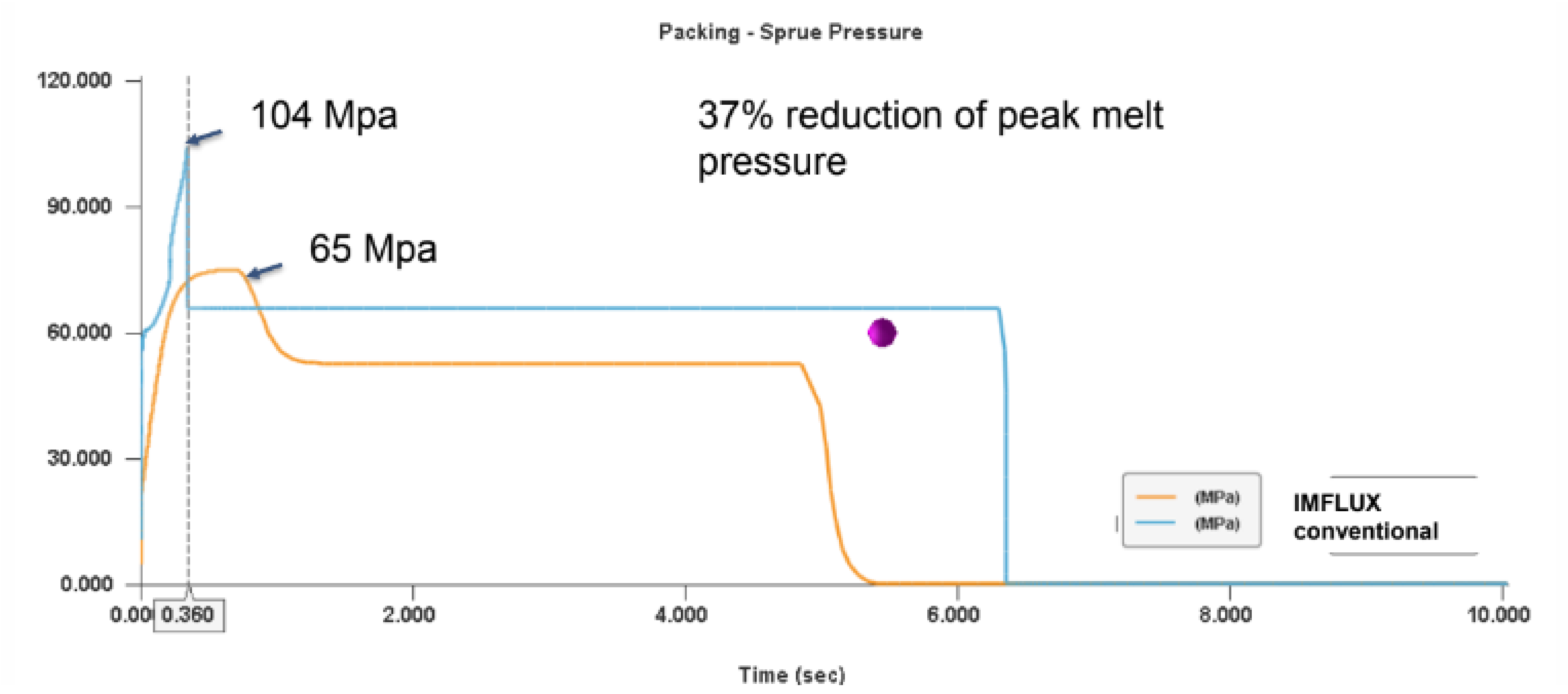


iMFLUX vs Conventional Velocity



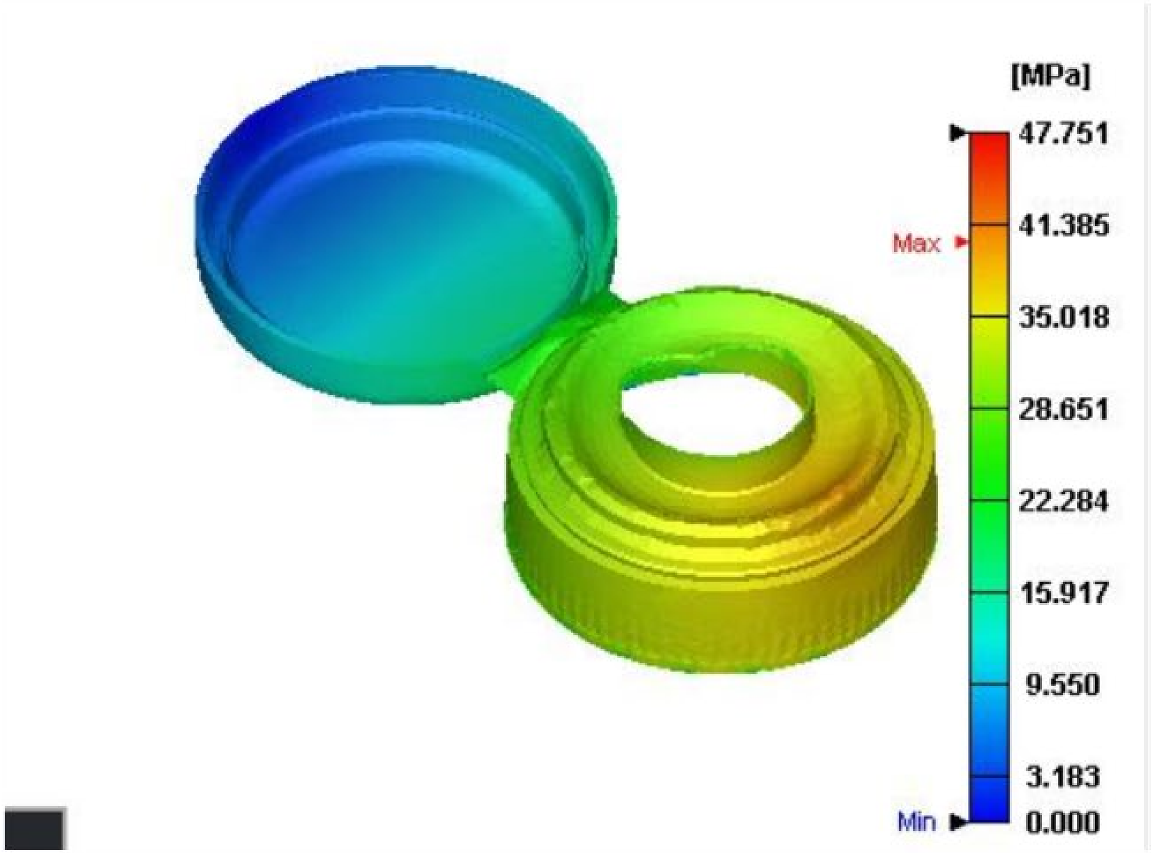


Case Study - iMFLUX

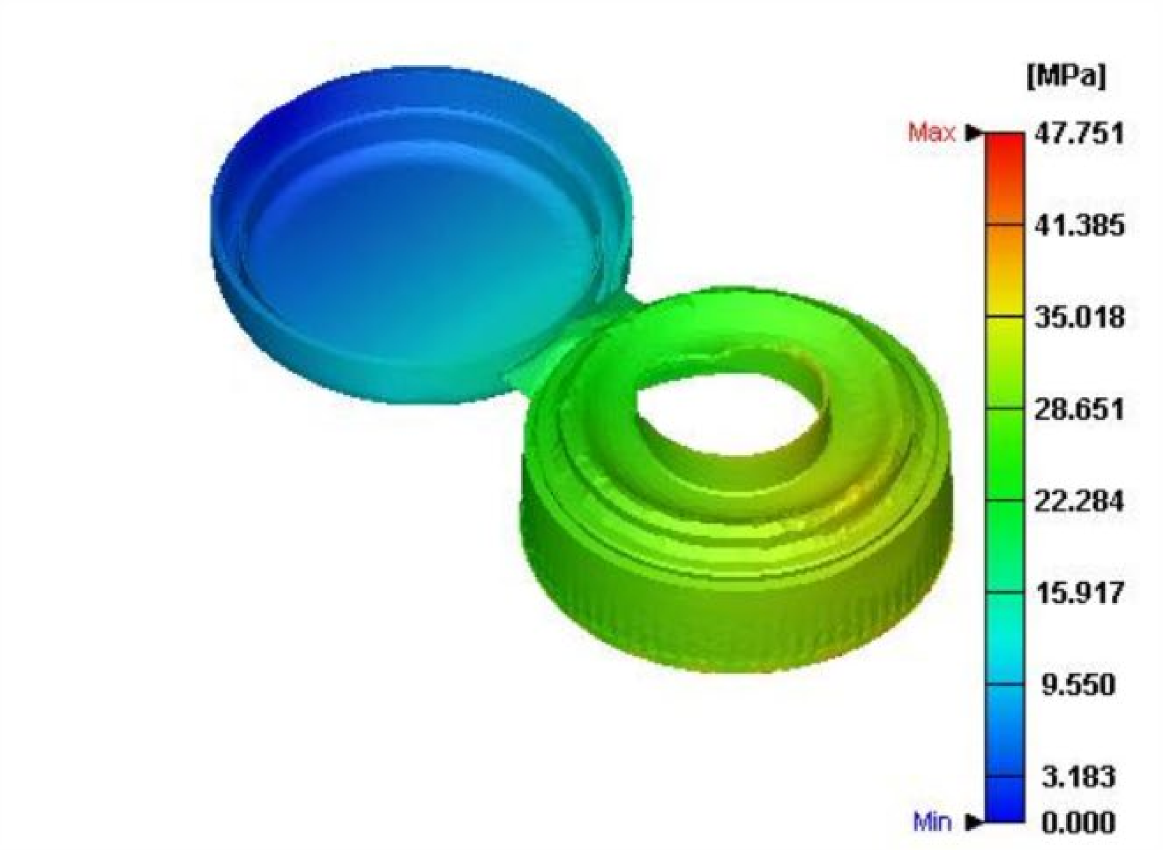


Case Study - iMFLUX

IMFLUX process



Conventional process

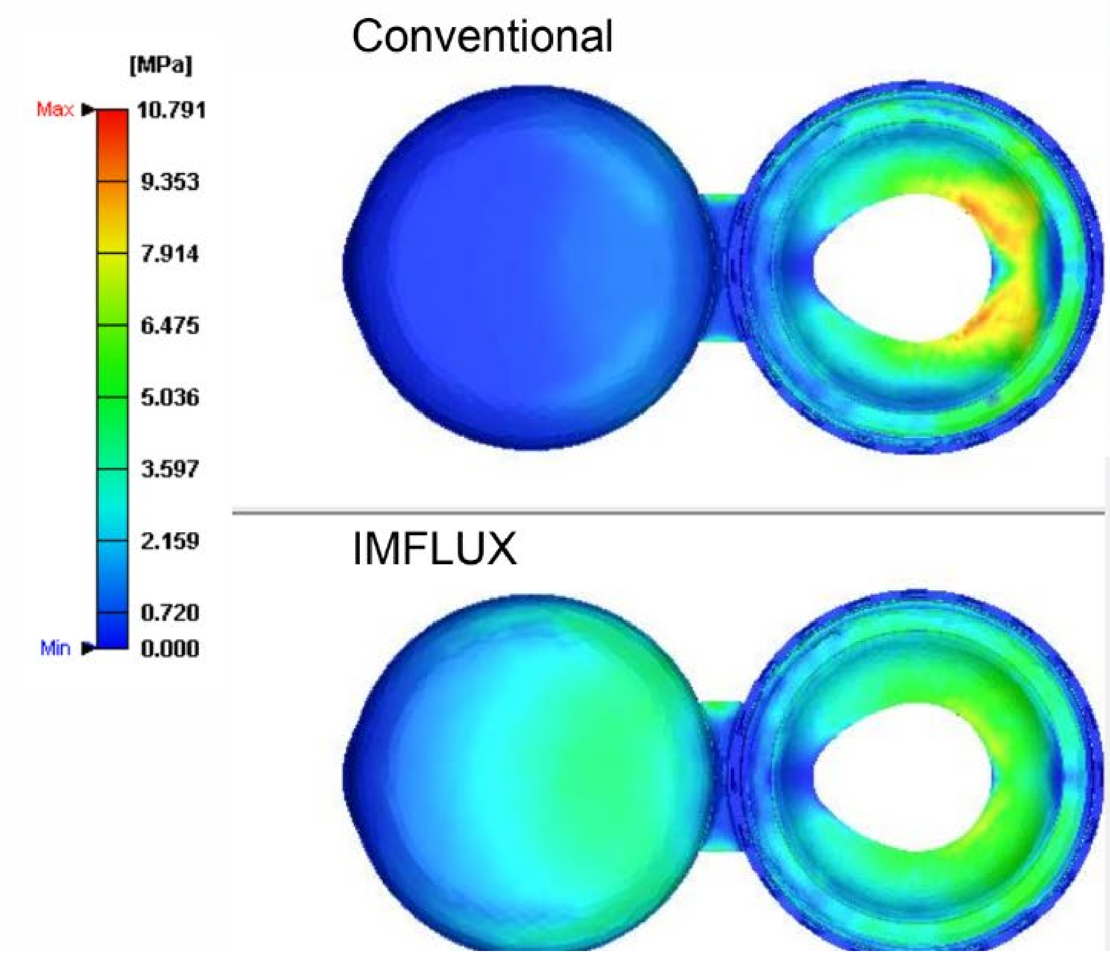


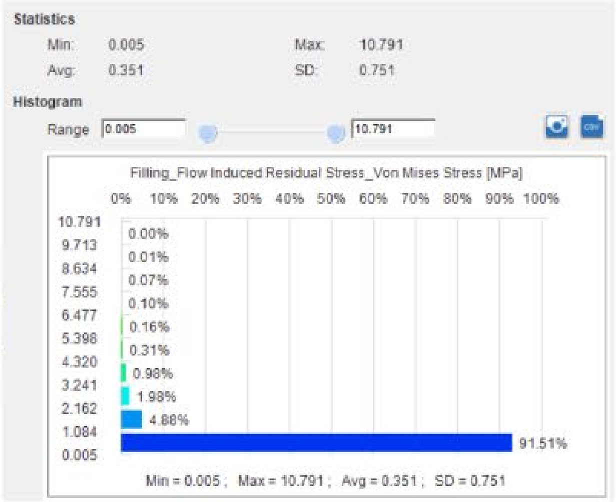
16% Reduction in Cavity pressure

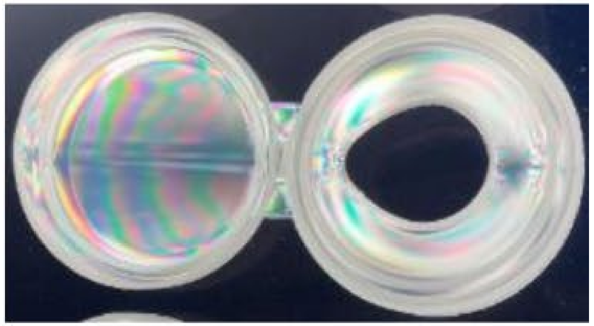
Case Study - iMFLUX

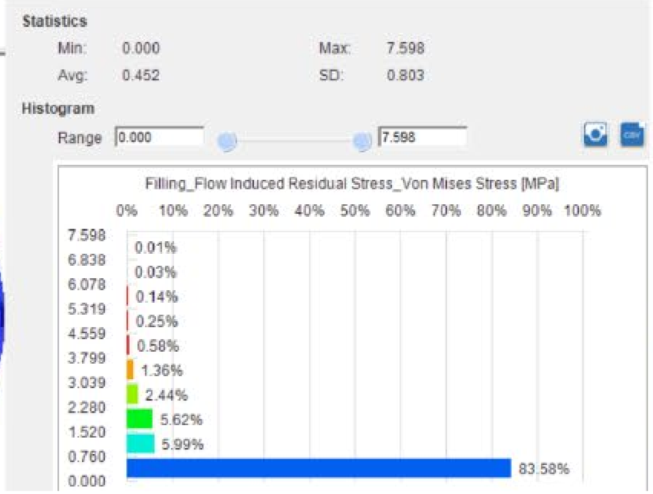
Case Study - iMFLUX

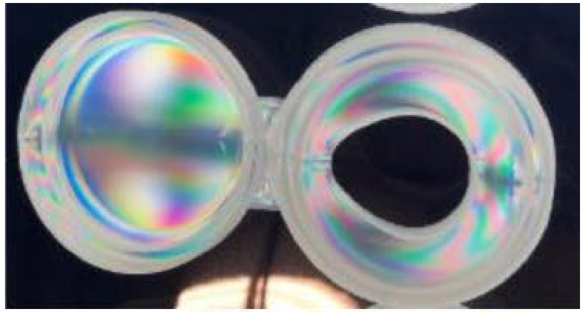
Flow-Induced Residual Stress











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Case Study - iMFLUX

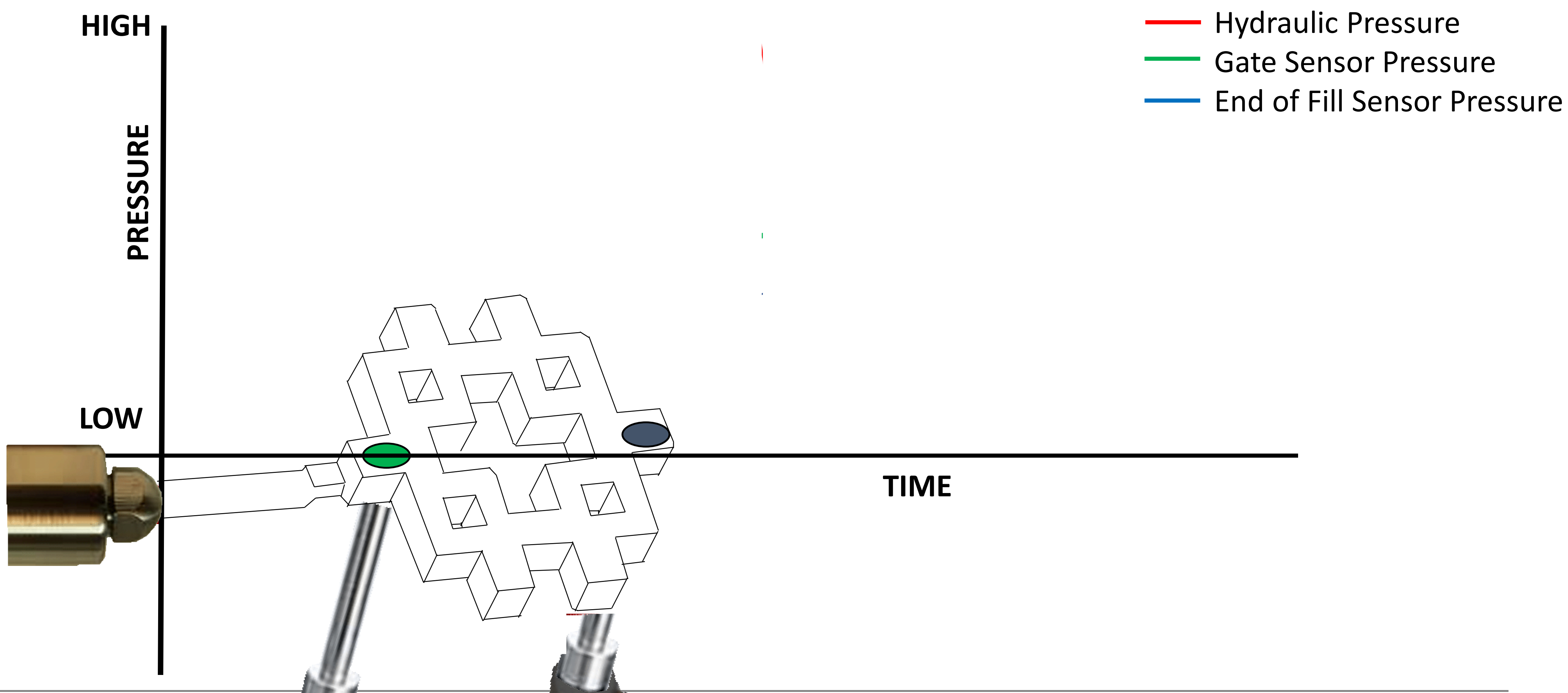
iMFLUX Benefits (Actual)

- 41% Reduction in Melt Pressure
- 46% Reduction in Cavity Pressure
- 3% Weight Reduction
- 8.75% Cycle Time Reduction
- 50% Increase in Cavitation (32 to 48 - *Tonnage @ 750)*
- 35% Tonnage Reduction (750 to 500 - *Cavitation @ 32)*

De-coupled III

What is Decoupled III (RJG)

- Fill to 80-90% of the parts
- Pack to a set cavity pressure
- Use hold time to maintain needed pressure in mold until gate seal (*if needed*)



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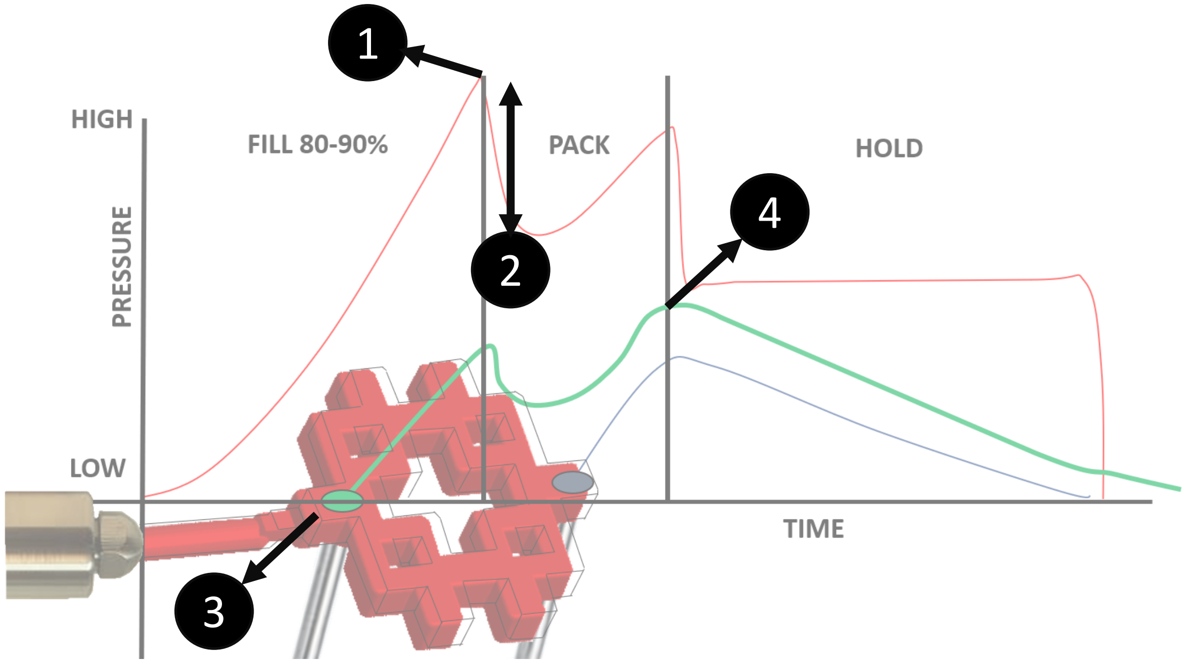
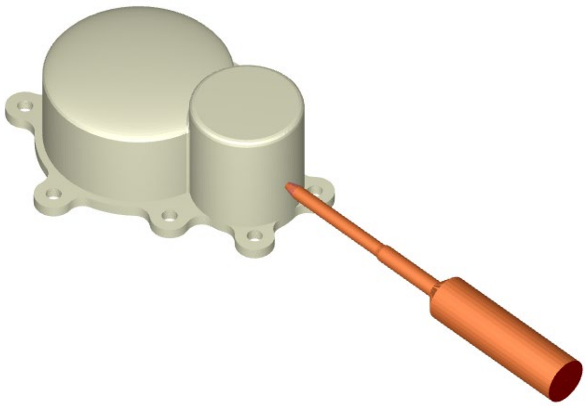
Important Parameters to be Determined for Decoupled III

1) When should the flow rate be dropped?
2) How much should the flow rate be dropped by?
3) Where is the sensor located in the geometry to specify switch to constant pressure stage?
4) What pressure should be used to determine when the switchover occurs?

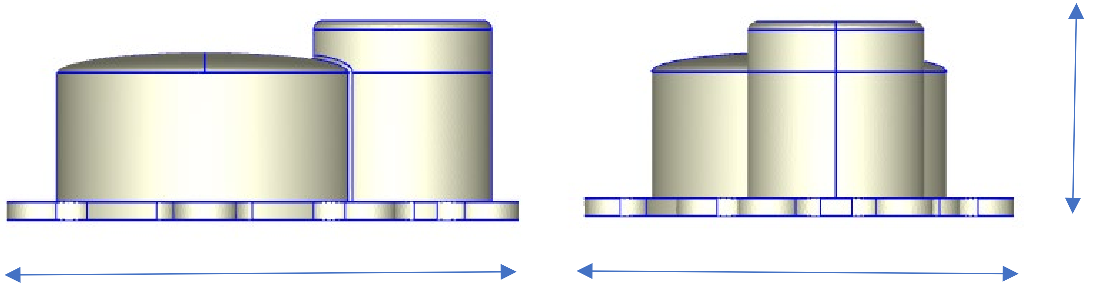


Case Study - Decoupled III

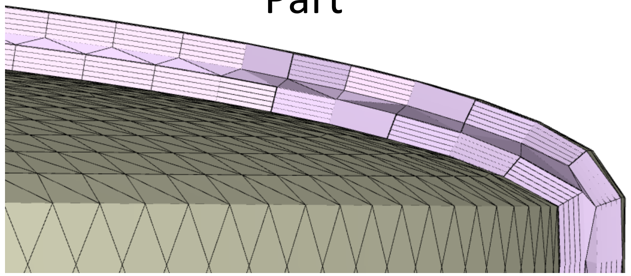
› Geometry



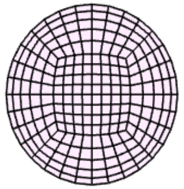
Model Details	
Mesh Type	Solid
Solid Mesh Element Co...	**2,194,968**
Part	406,654
Hot Runner	23,296
Moldbase	1,504,538
Cooling Channel	260,480
Surface Mesh Element...	**60,836**
Part	60,836
Dimension	**mm**
Part	276.80x233.33x108.00
Mold	1068.10x1068.10x1068.10
Projection Area	**cm²**
In Parting Direction (X)	166.125
Volume	**cc**
Part	257.36
Hot Runner	205.78



Part



Hot Runner



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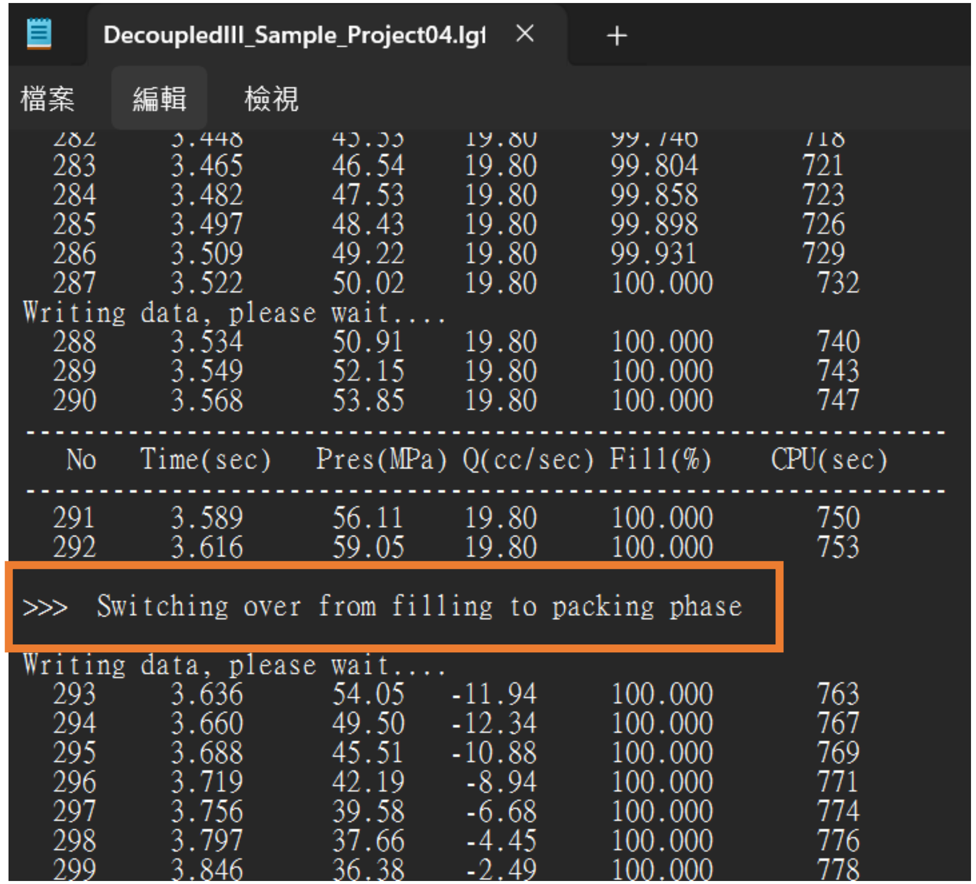
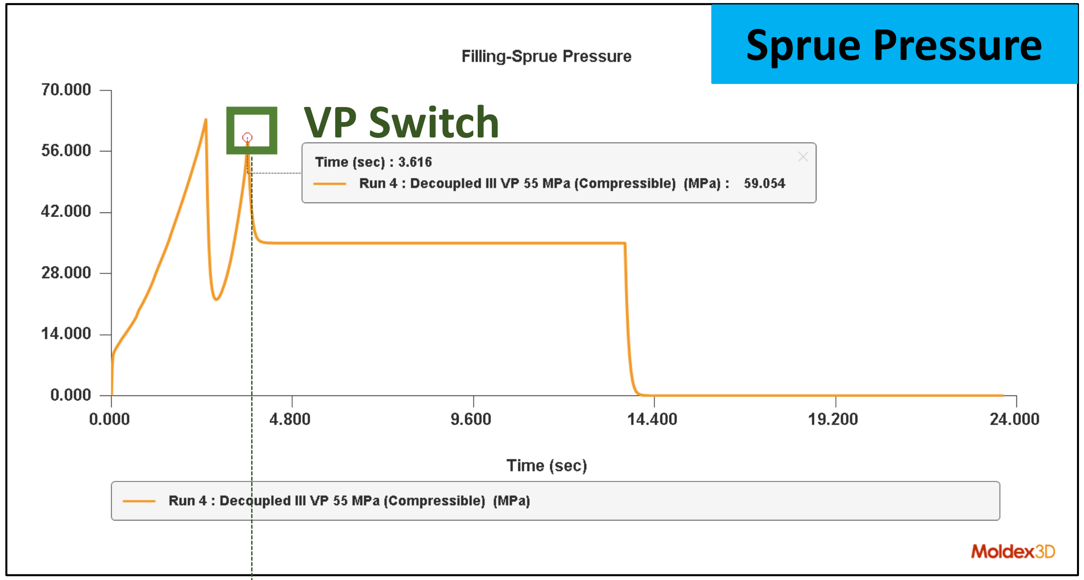
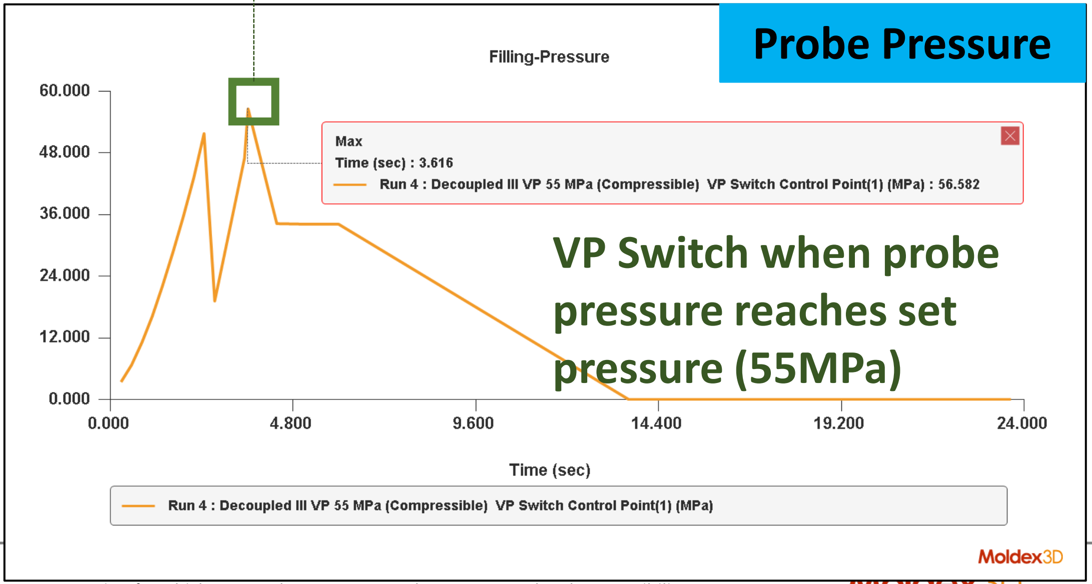
Case Study - Decoupled III

- Result
  - Check log file, VP is after 100% filled



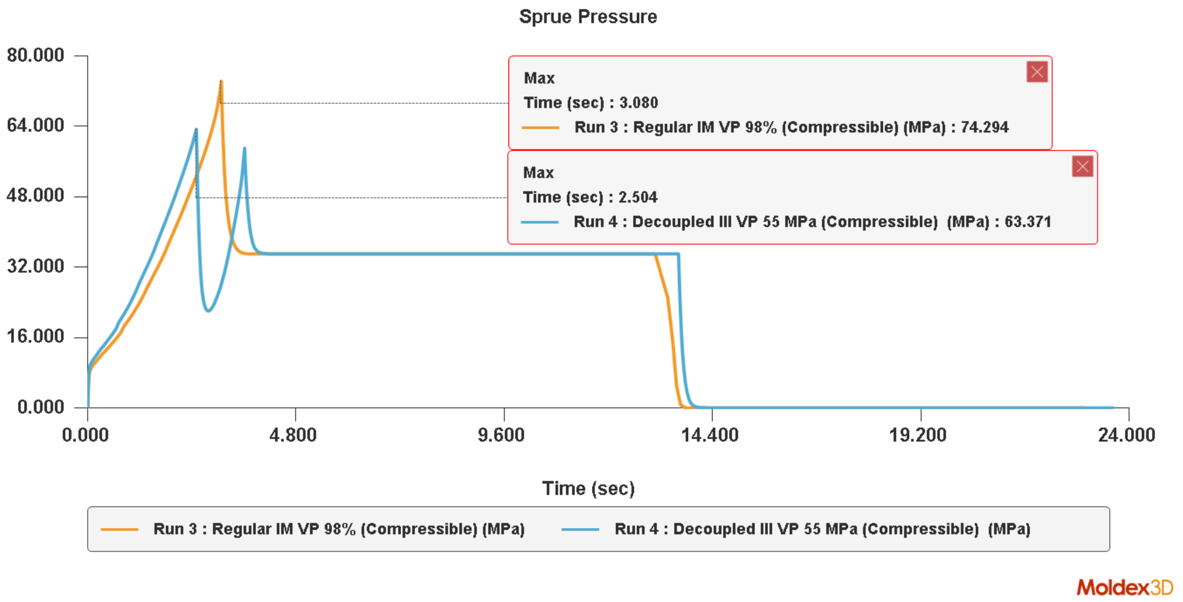
```
DecoupledIII_Sample_Project04.lgf
檔案   編輯   檢視
 282     3.448     45.55     19.80     99.746      718
 283     3.465     46.54     19.80     99.804      721
 284     3.482     47.53     19.80     99.858      723
 285     3.497     48.43     19.80     99.898      726
 286     3.509     49.22     19.80     99.931      729
 287     3.522     50.02     19.80    100.000      732
Writing data, please wait....
 288     3.534     50.91     19.80    100.000      740
 289     3.549     52.15     19.80    100.000      743
 290     3.568     53.85     19.80    100.000      747
------------------------------------------------------------
  No   Time(sec)   Pres(MPa) Q(cc/sec) Fill(%)    CPU(sec)
------------------------------------------------------------
 291     3.589     56.11     19.80    100.000      750
 292     3.616     59.05     19.80    100.000      753

>>>  Switching over from filling to packing phase

Writing data, please wait....
 293     3.636     54.05    -11.94    100.000      763
 294     3.660     49.50    -12.34    100.000      767
 295     3.688     45.51    -10.88    100.000      769
 296     3.719     42.19     -8.94    100.000      771
 297     3.756     39.58     -6.68    100.000      774
 298     3.797     37.66     -4.45    100.000      776
 299     3.846     36.38     -2.49    100.000      778
```



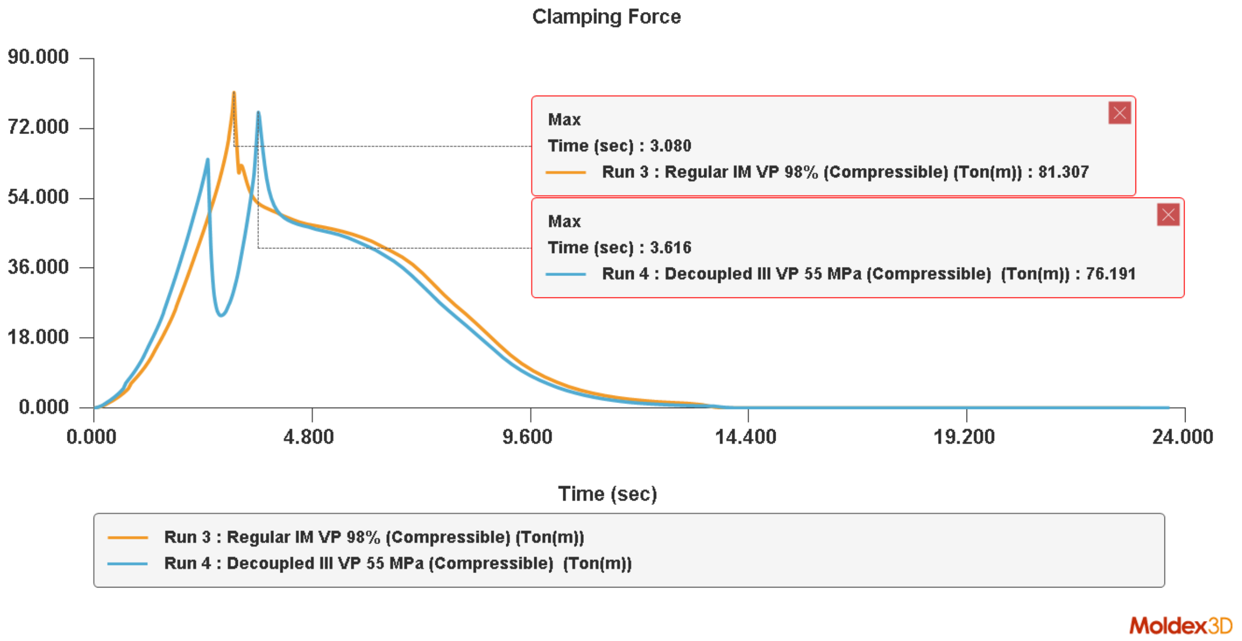


Case Study - Decoupled III

› Sprue Pressure comparison with regular IM



› Clamp Tonnage comparison with regular IM

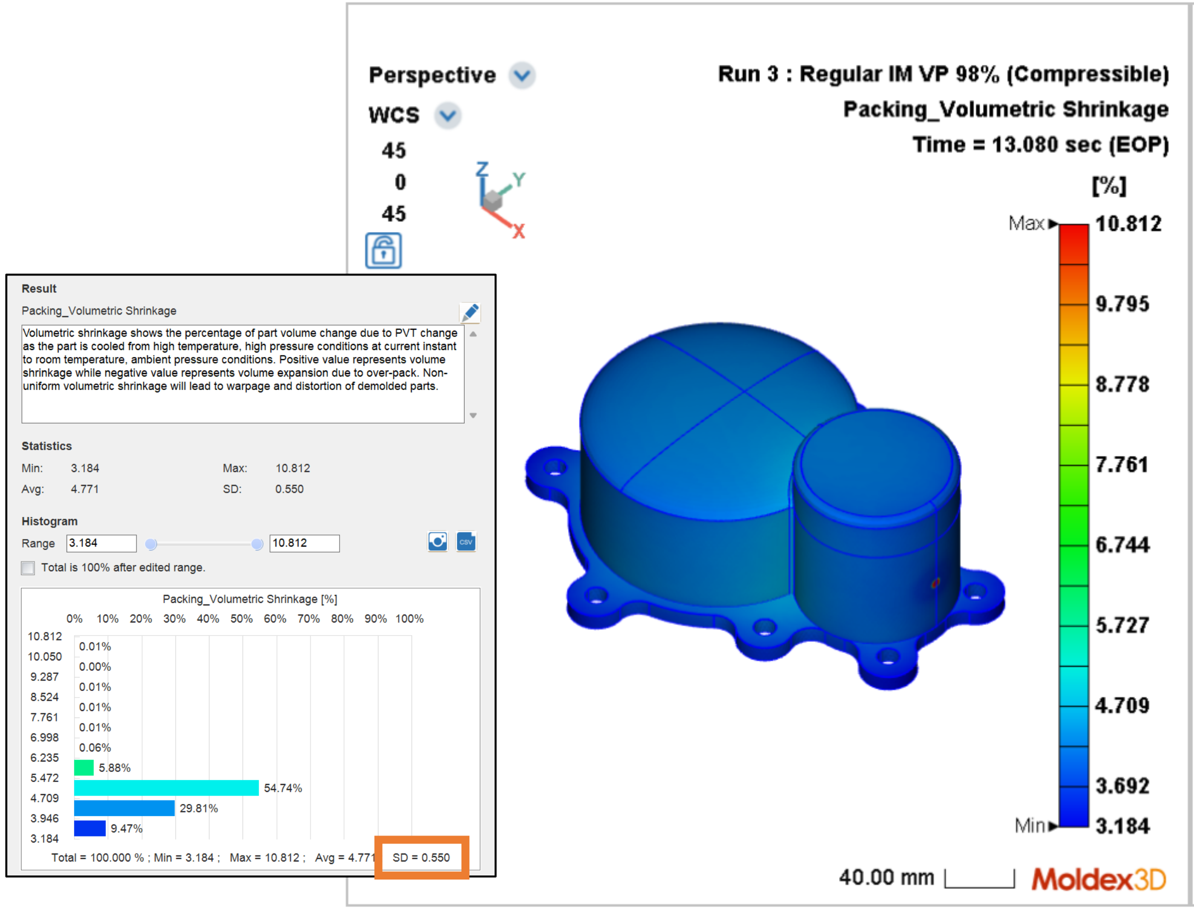


Case Study - Decoupled III

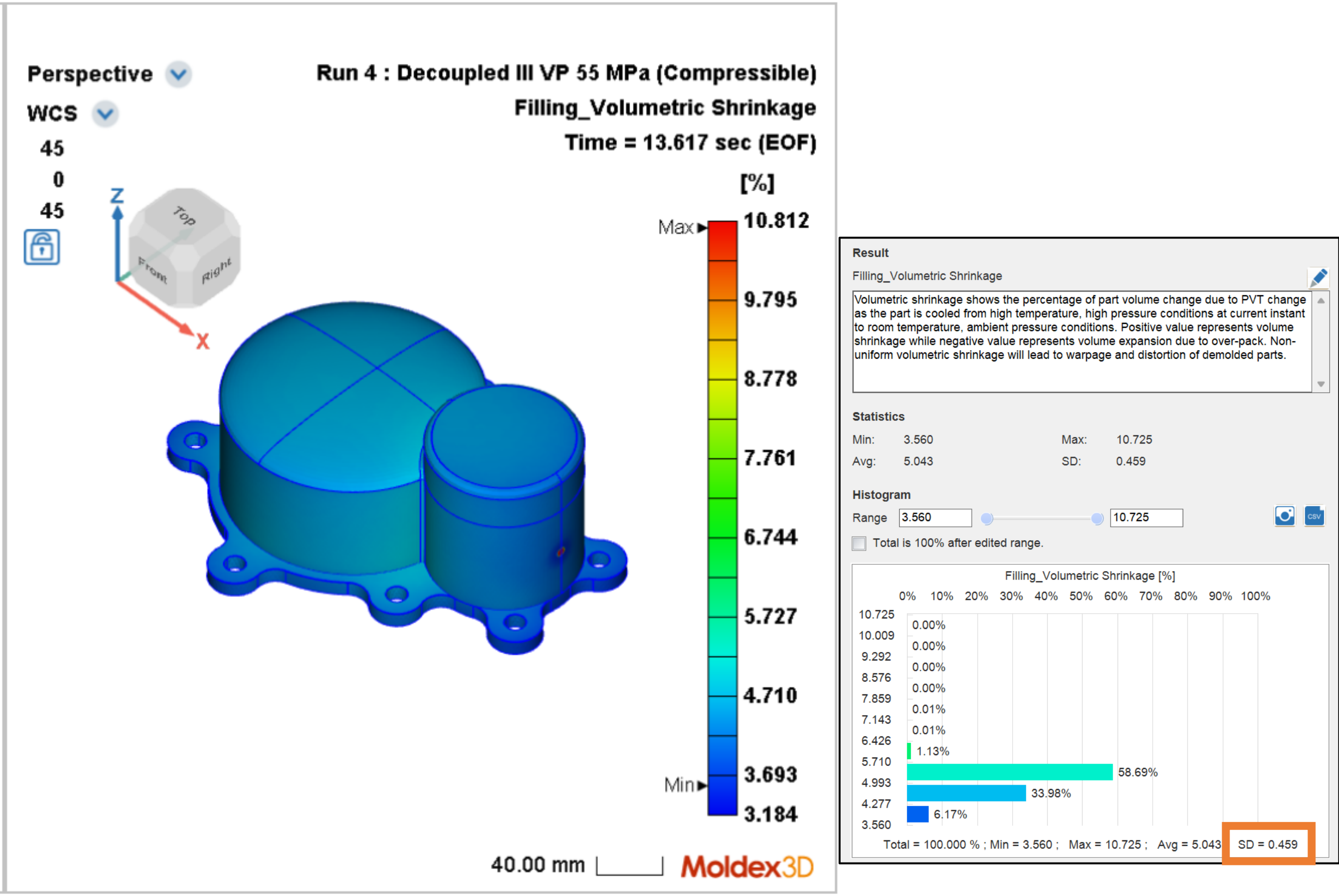
› Volumetric Shrinkage

– **Decoupled III gives a higher but more "even" shrinkage**

Regular IM



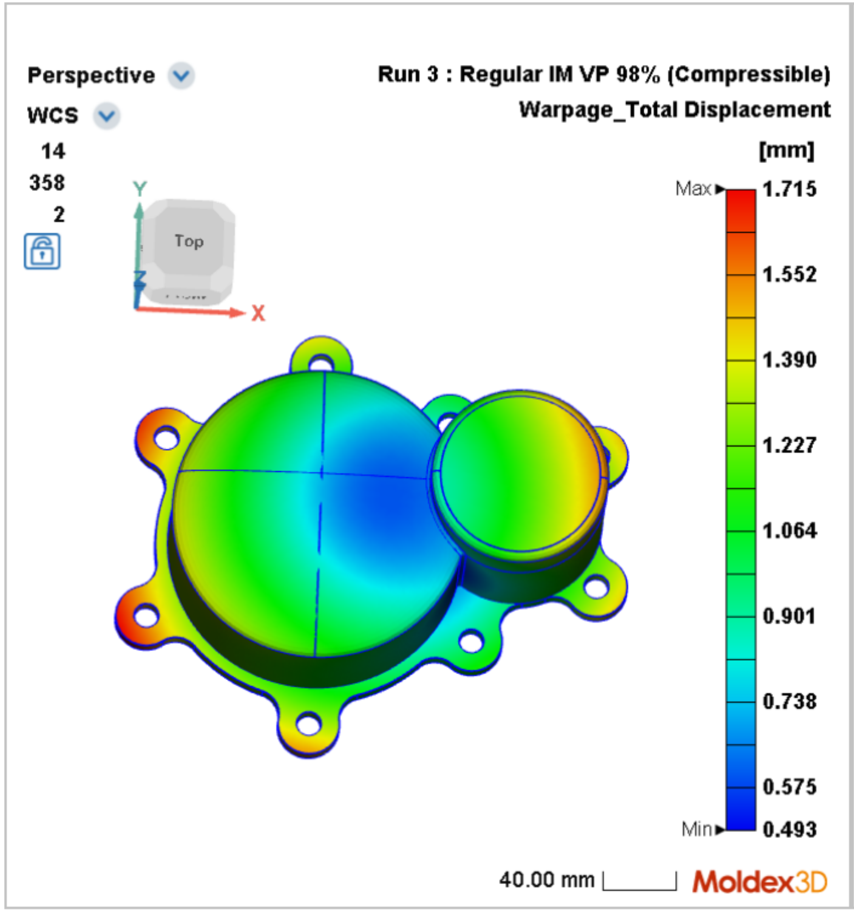
Decoupled III

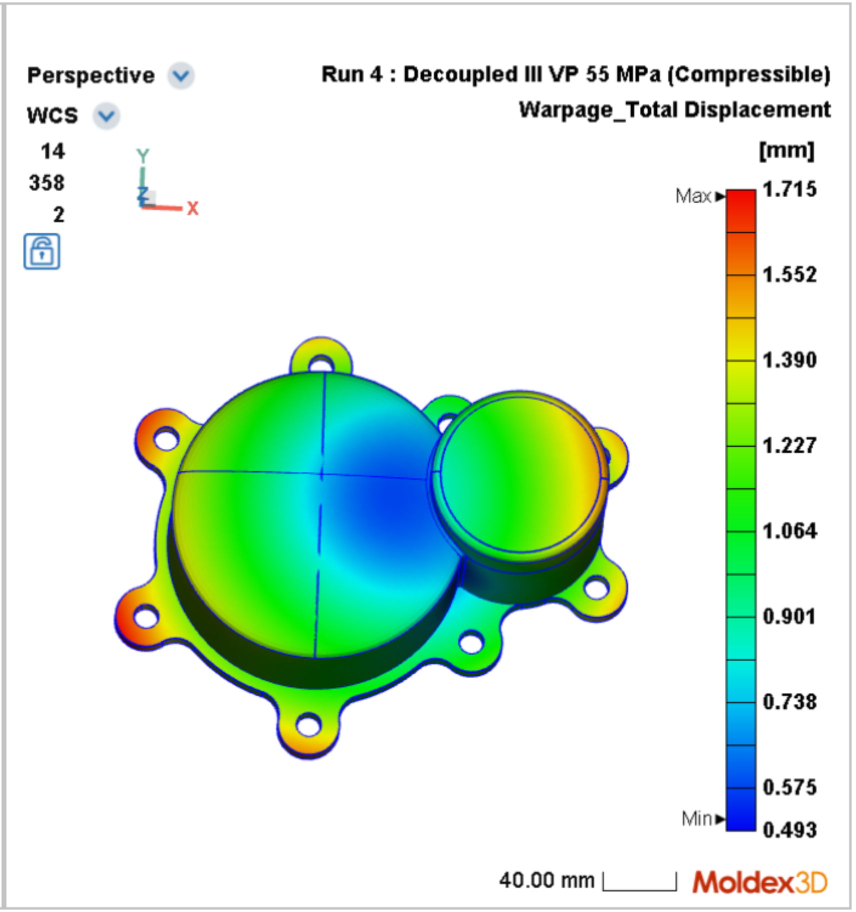


Case Study - Decoupled III

› Warpage

Regular IM	Decoupled III
Max: 1.715mm	Max: 1.702mm
Min: 0.493 mm	Min: 0.515 mm



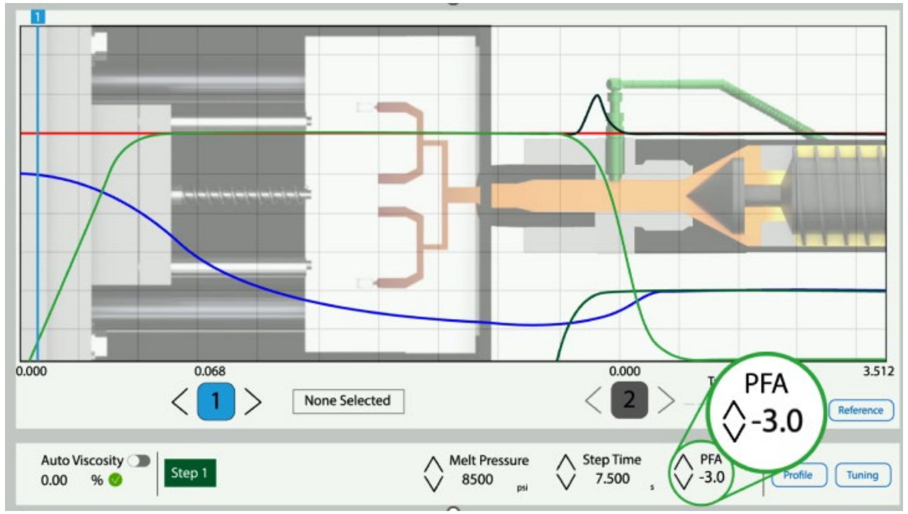


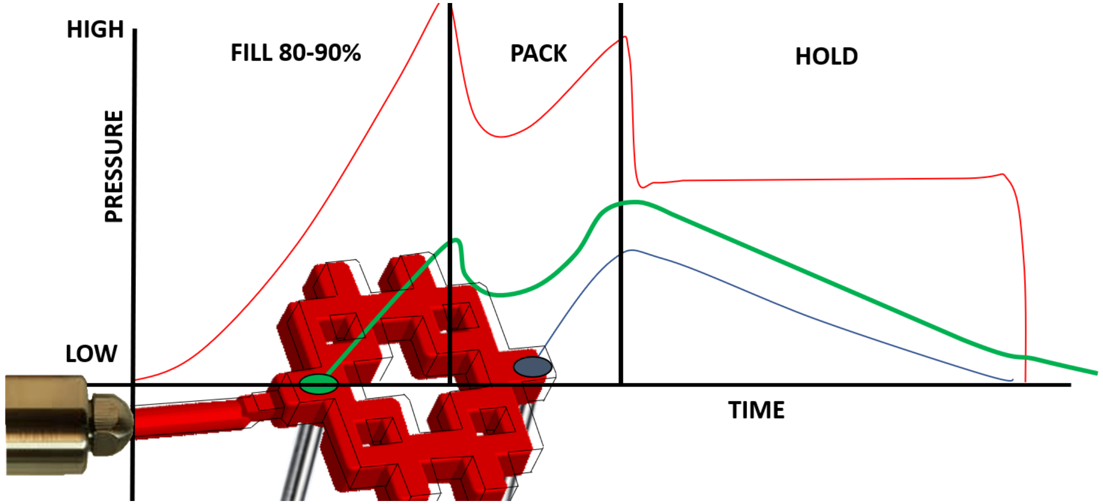
Conclusion

- **iMFLUX is a coupled approach that utilizes constant pressure and cavity sensor feedback to allow smoother filling**

- **De-coupled III used a flow rate modulation approach based on cavity sensor feedback to allow a smoother filling**

- **Both approaches can help to:**
  - **Even out cavity pressure**
  - **Smoothen the transition from fill to pack**
  - **Increase dimensional stability**





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