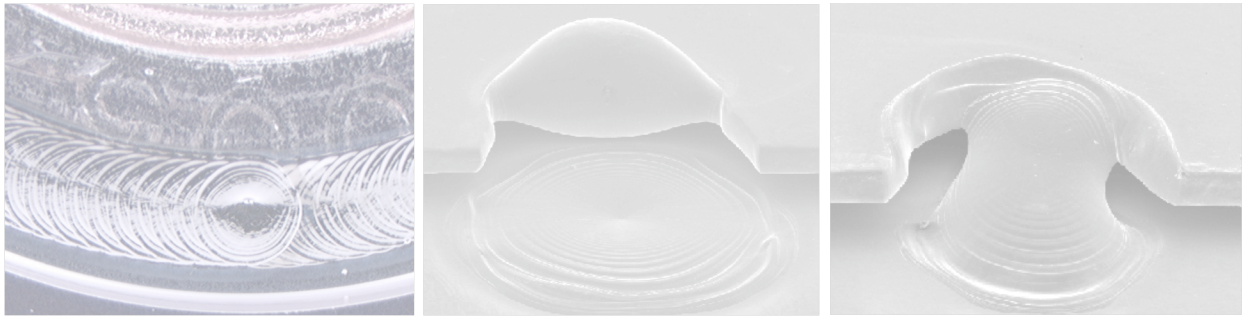
SAND2006-7273C



Toward a Predictive Capability of the Effects of Manufacturing Processes on Component Performance and Characteristics

Pat Notz, Allen Roach, Kristin Dion, Rick Givler, Polly Hopkins, Mario Martinez, Jerome Norris and Charles Robino

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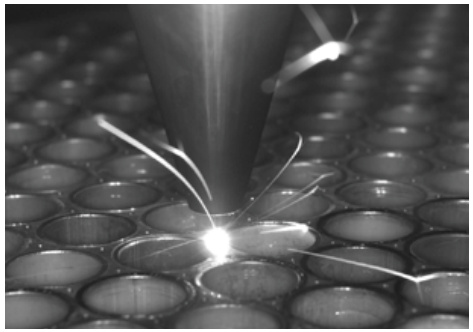

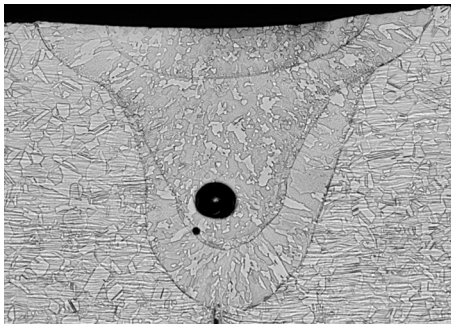

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Model-Based Enterprise

As-delivered state critical to performance

Stresses and distortions start at manufacture

M&S can connect performance to process parameters

M&S becoming standard operating procedure

Sophisticated and expansive software requirements

Laser Welding

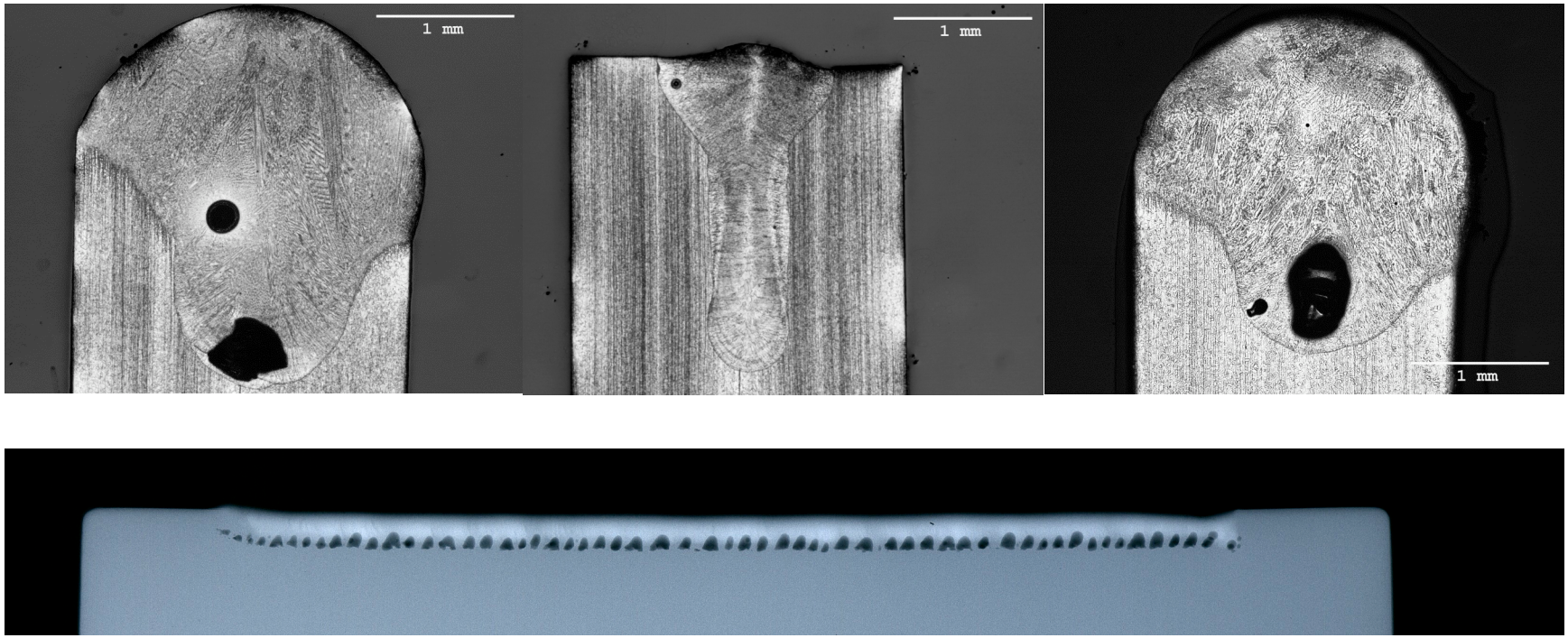
Highly used joining process

Low thermal loads

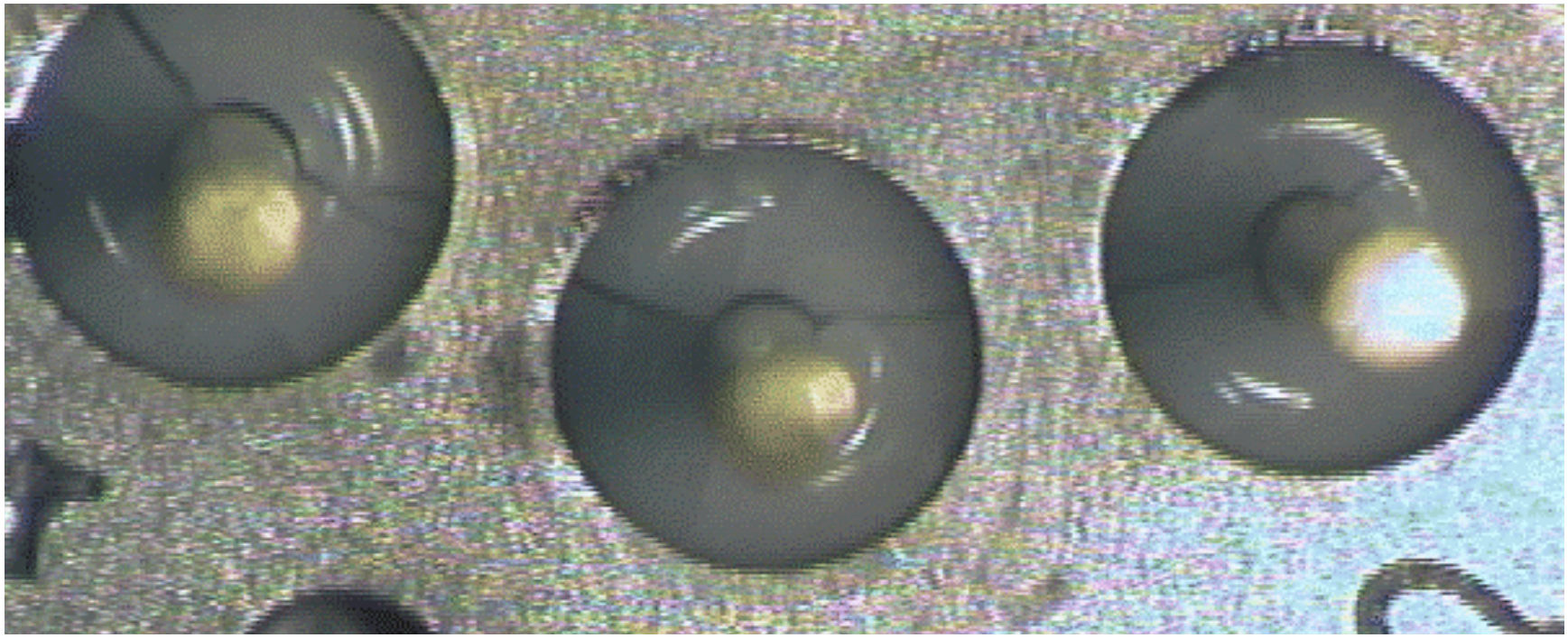
High precision, small scale welds

Several process parameters: power, speed, path, …

Local Effects of Laser Welding



Global Effects of Laser Welding



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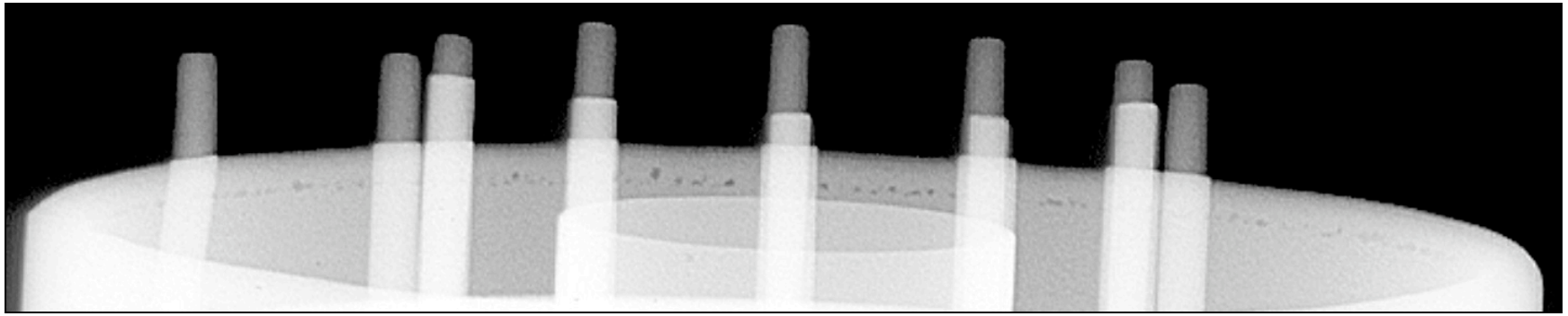
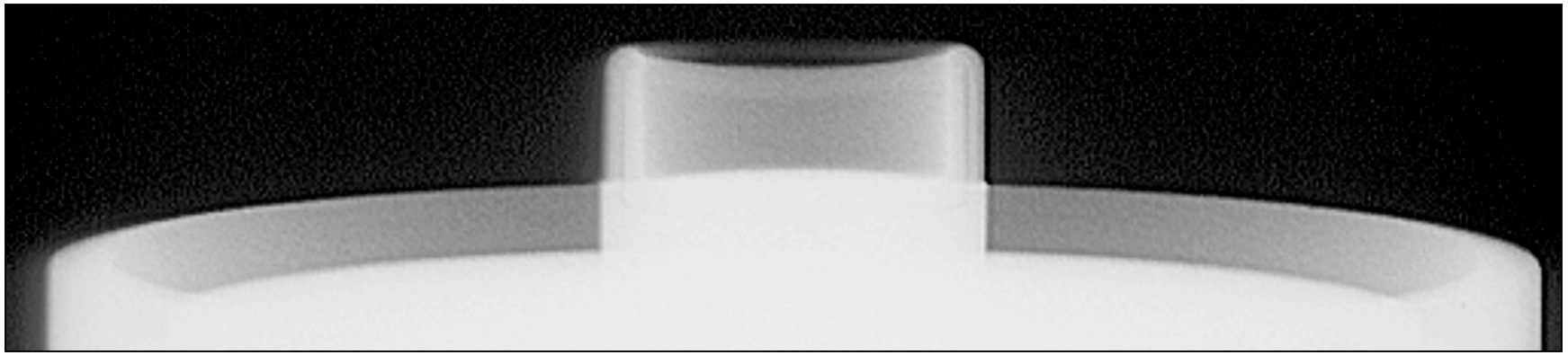
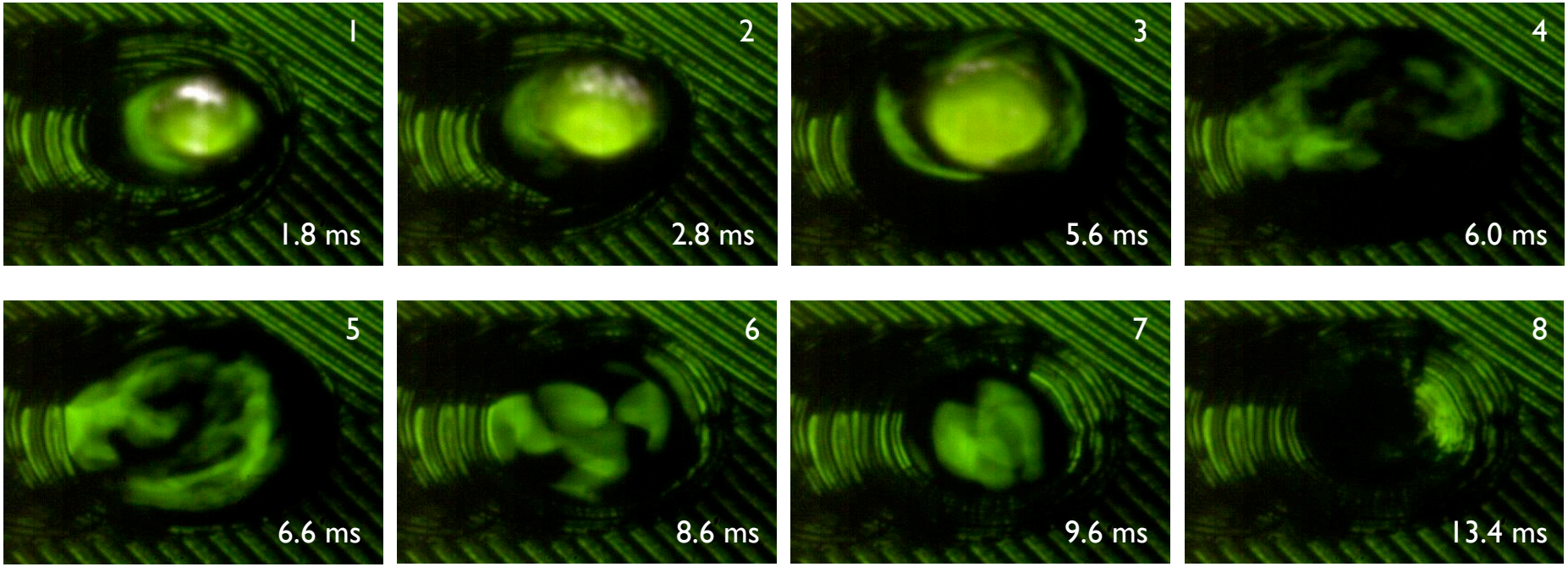
Process Improvement





Weld Pool Dynamics



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In Silico Lifecycle Analysis

Manufacture ⟶ Storage ⟶ Deployment

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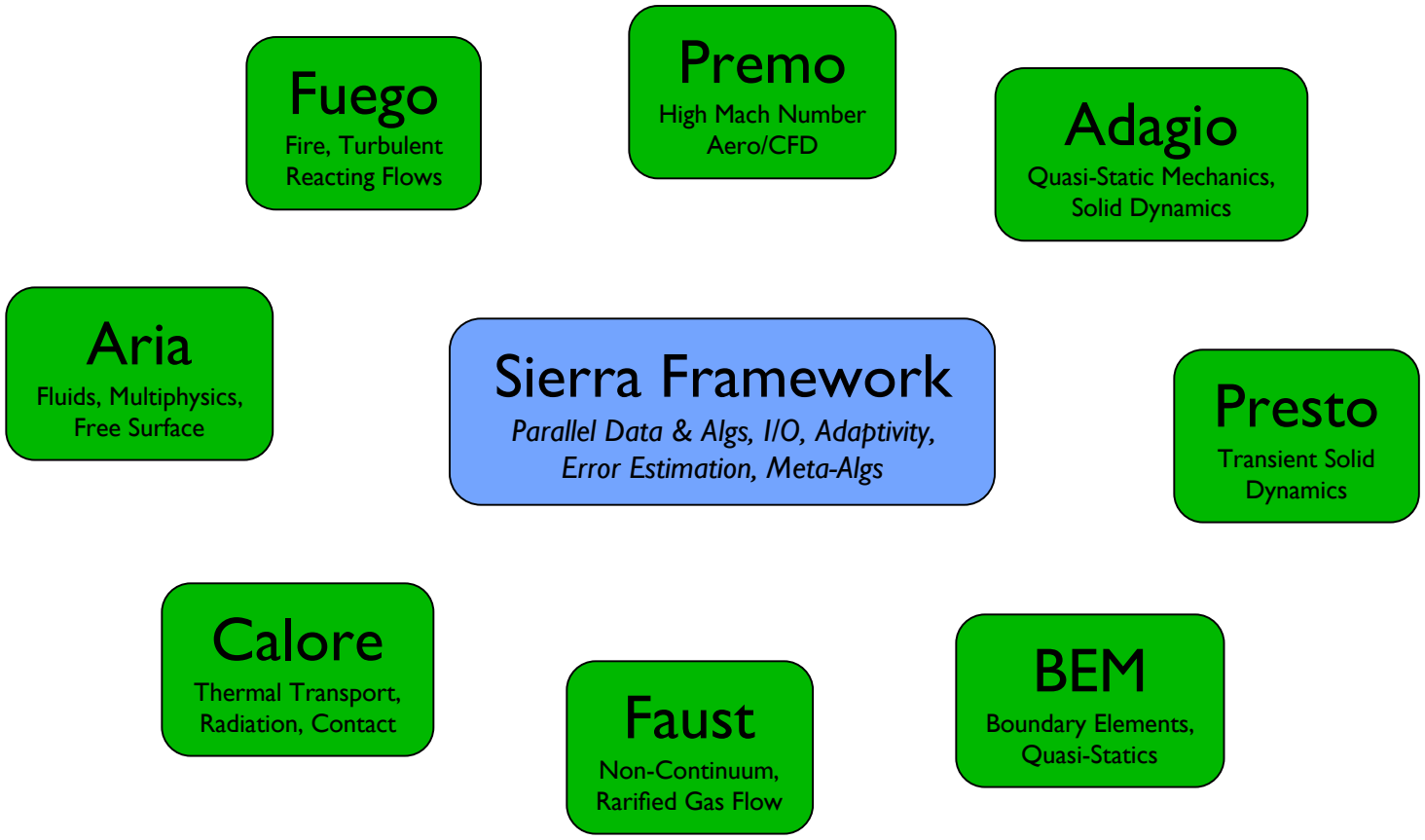
The Sierra Mechanics Suite



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The Sierra Mechanics Suite

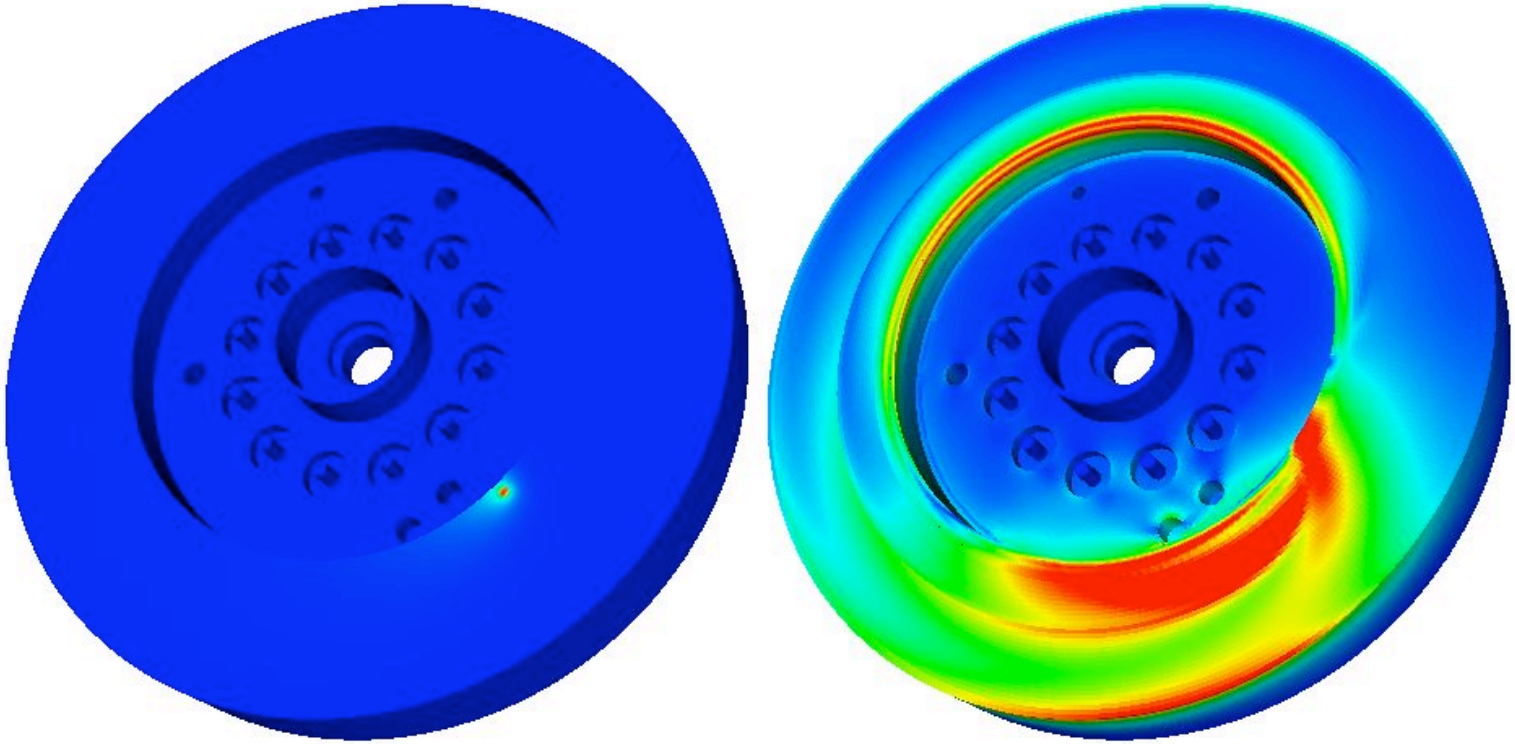
Shared data model, capabilities

Easy code coupling

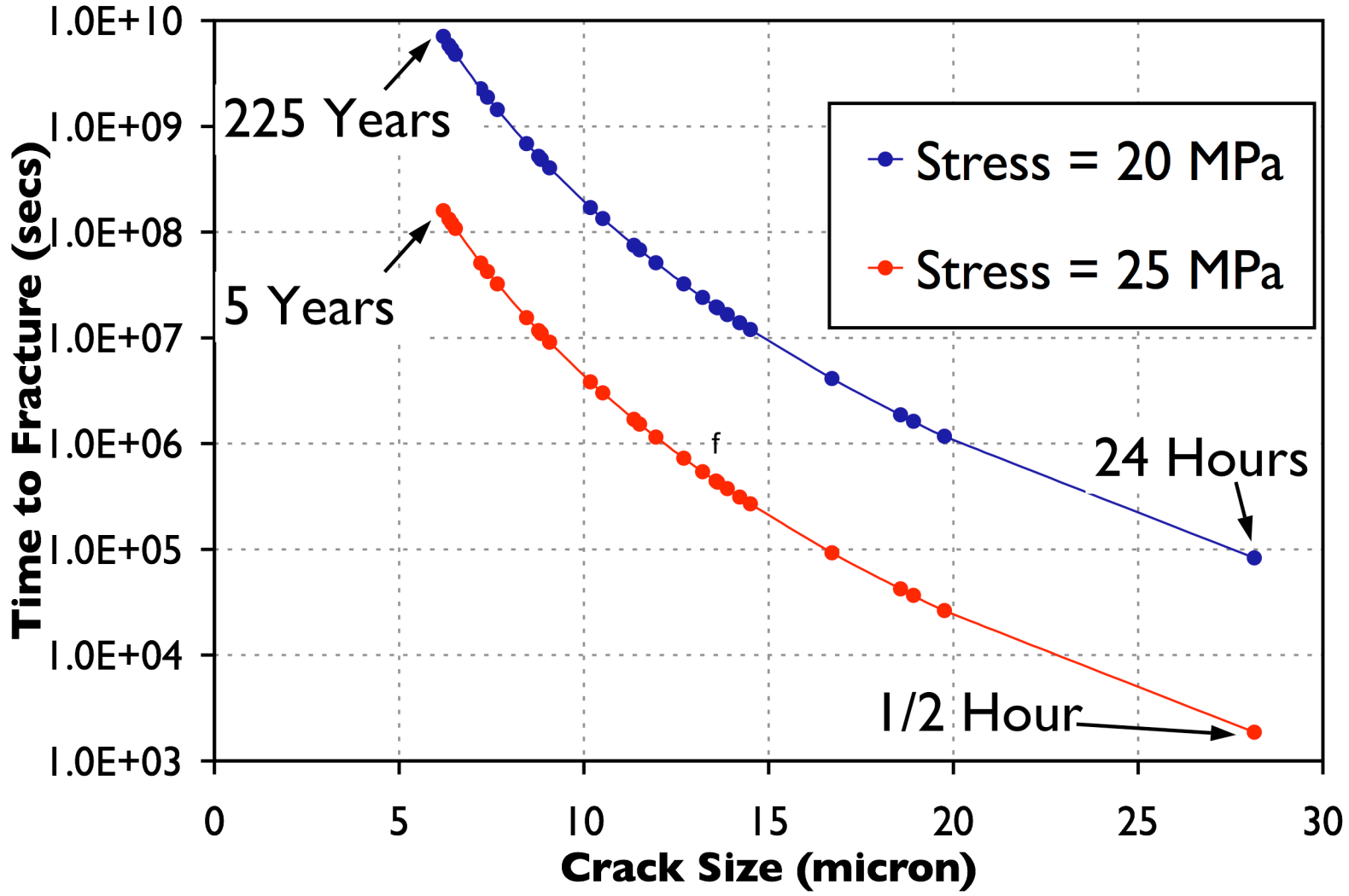
User orchestrated analysis

Single input file

Thermal-Structural Analysis



Predicting Probability of Failure



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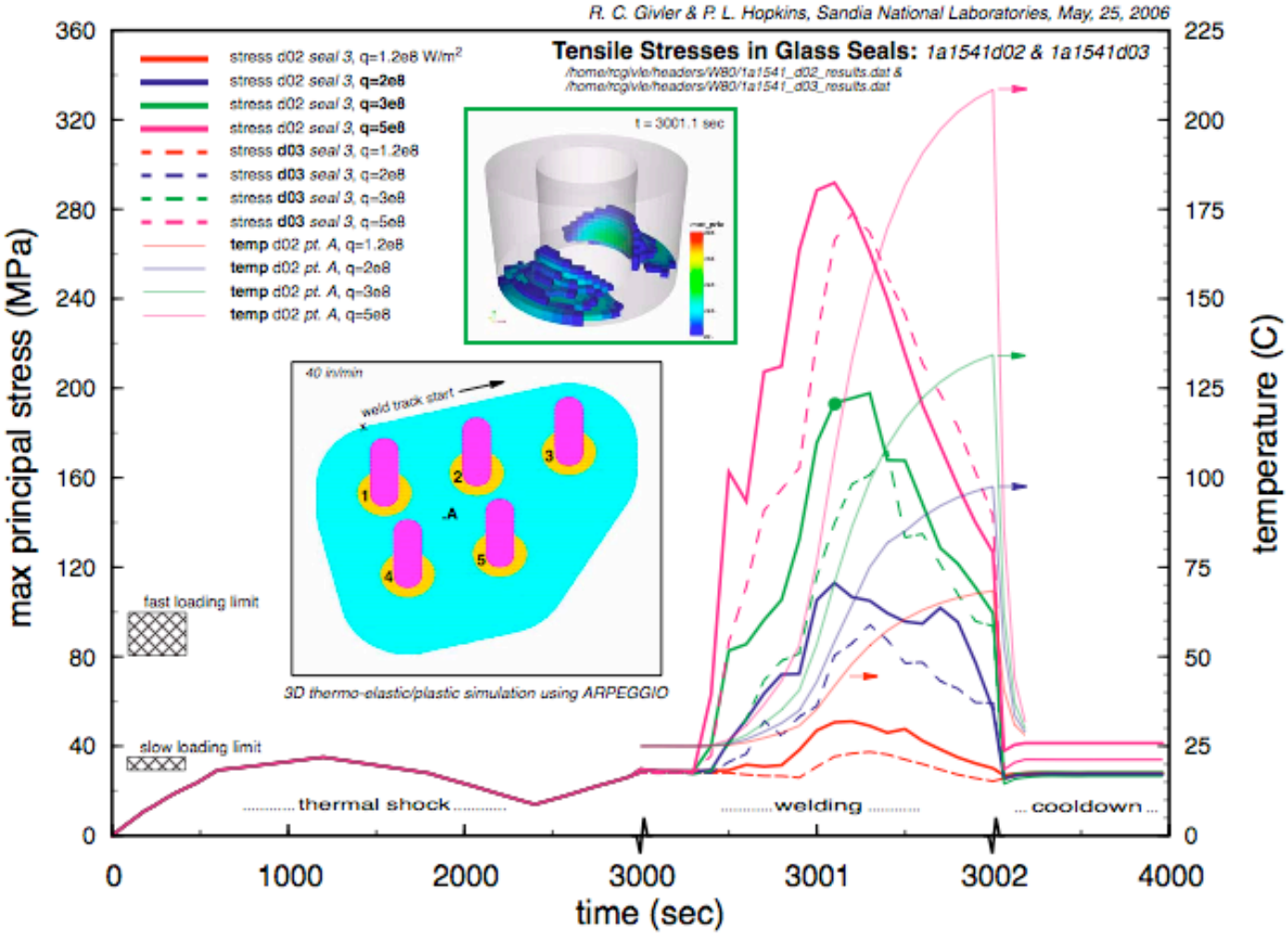
Predicting Probability of Failure



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User Defined Physics Coupling

```
Begin System Main
  Begin Transient Time_Block_1
    Advance Thermal_Glassing_Region
    Transfer Thermal_to_Structural_Glassing
    Advance Structural_Glassing_Region
  End

  Transfer Thermal_Glassing_to_Thermal

  Begin Transient Time_Block_2
    Advance Thermal_Region
    Transfer Thermal_to_Structural
    Advance Structural_Region
  End

  Transfer Thermal_to_Thermal_Cooldown

  Begin Transient Time_Block_3
    Advance Thermal_Cooldown_Region
    Transfer Thermal_to_Structural_Cooldown
    Advance Structural_Cooldown_Region
  End
End
```

Thermal →

Structural →

Transfer (loose coupling) →

Glassing

Weld

Cooldown

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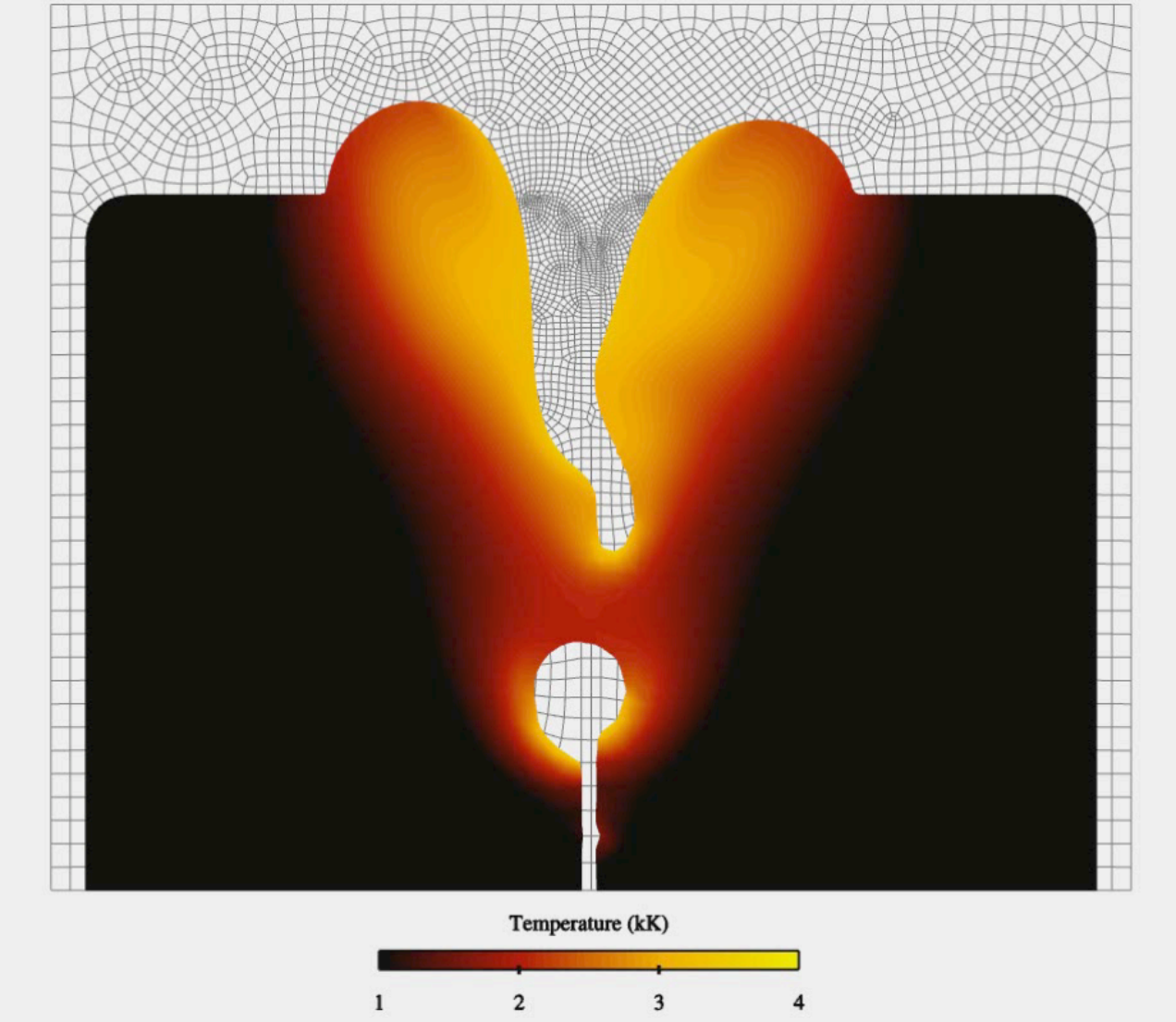
Thermal-Fluid Analysis



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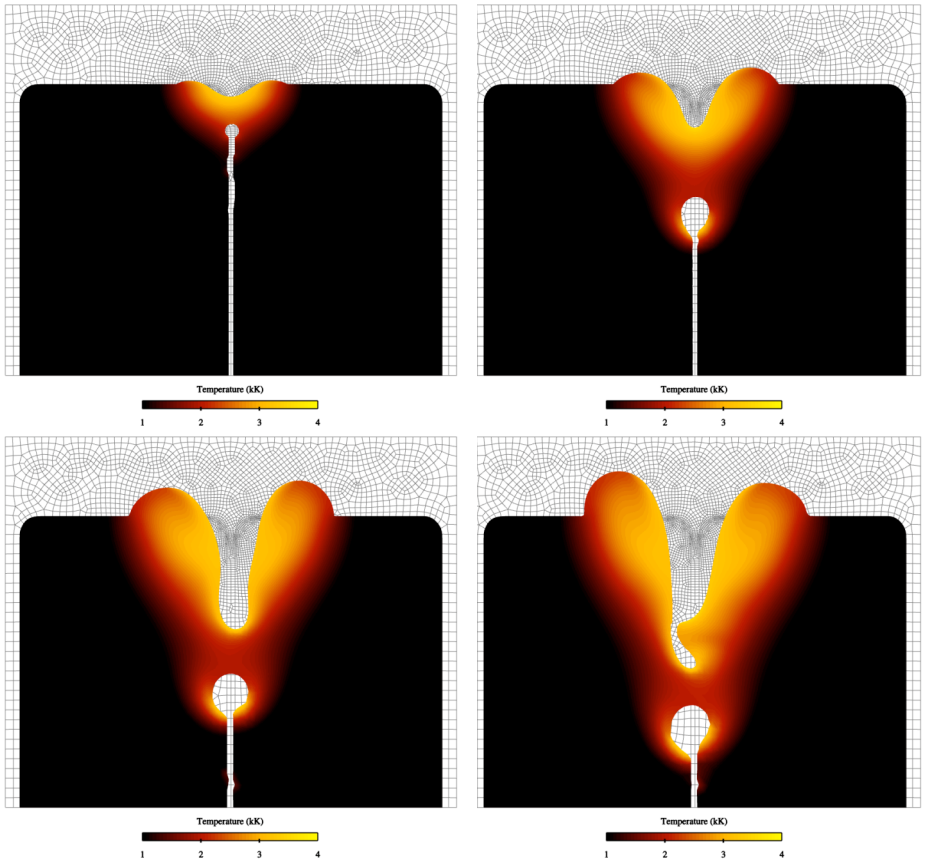
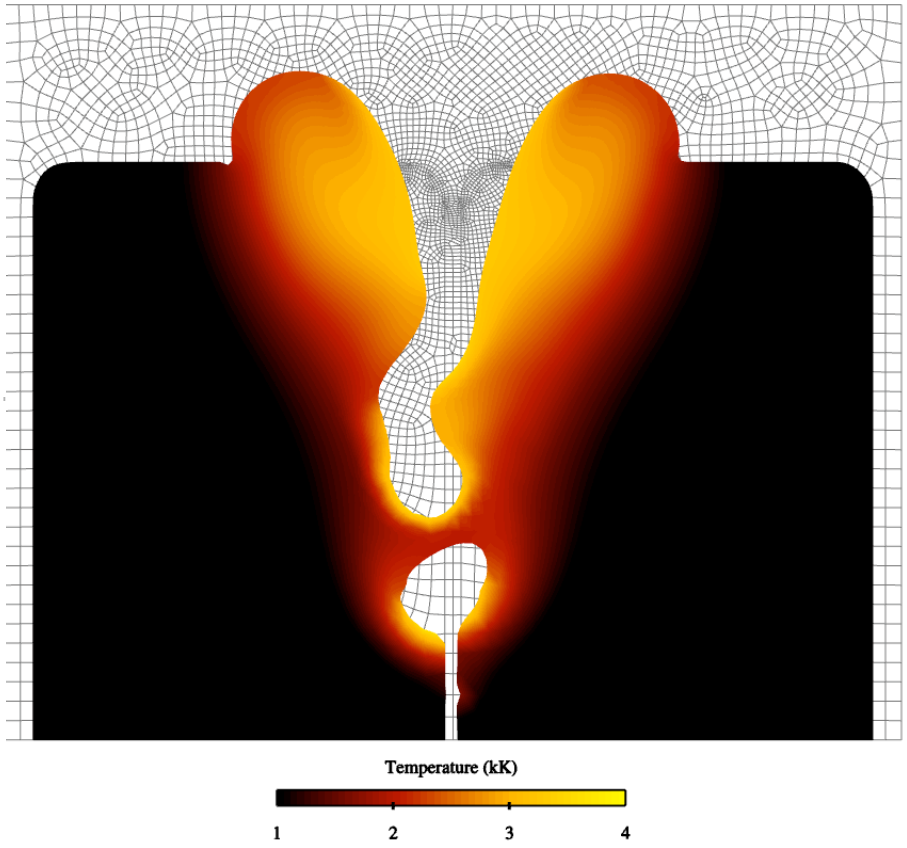
Thermal-Fluid Analysis





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Parallel & On-Going Efforts

Experimental verification

Thermal-fluid-structural capability

Experimental verification

Material characterization

Other physics and processes

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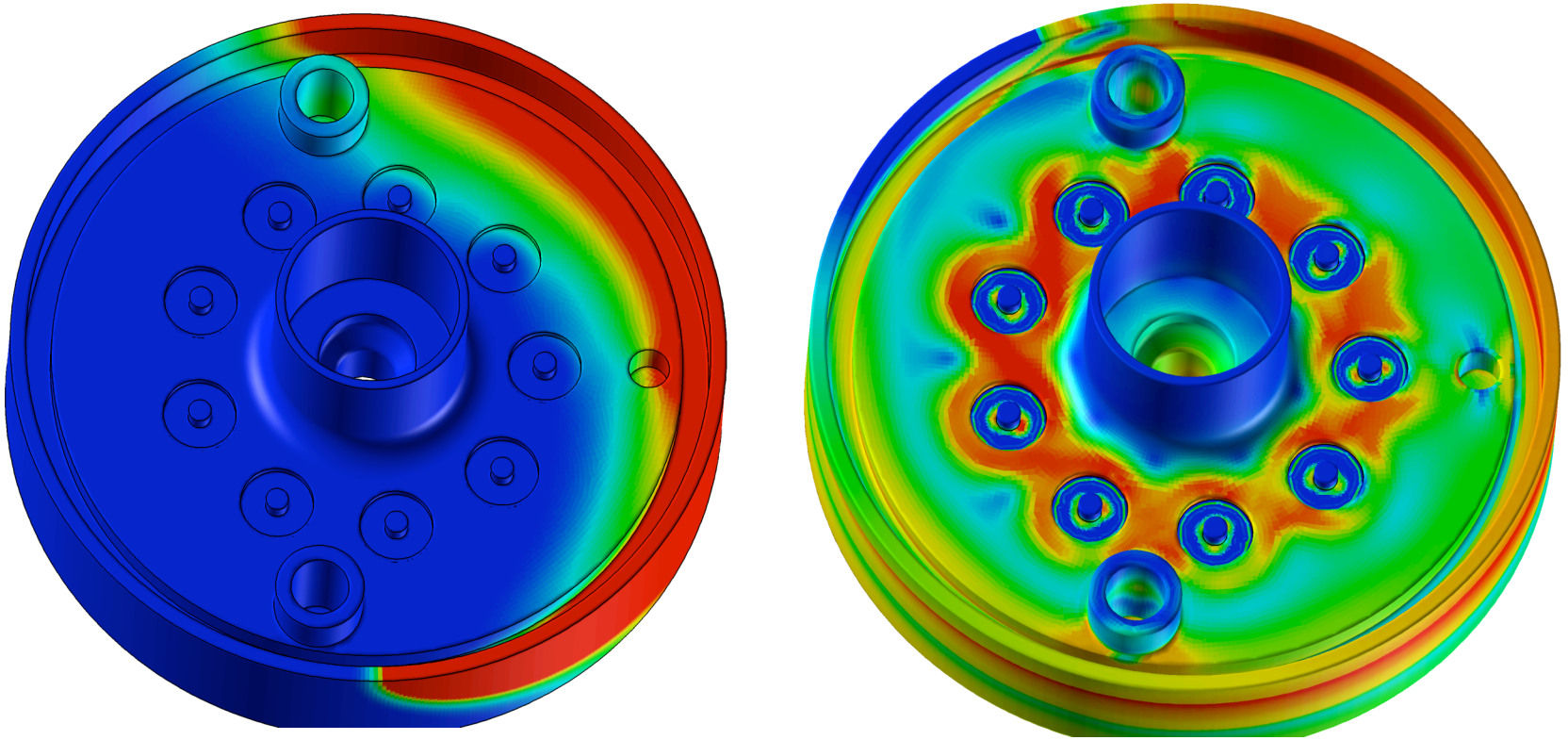
backup slides

Thermal-Structural Analysis



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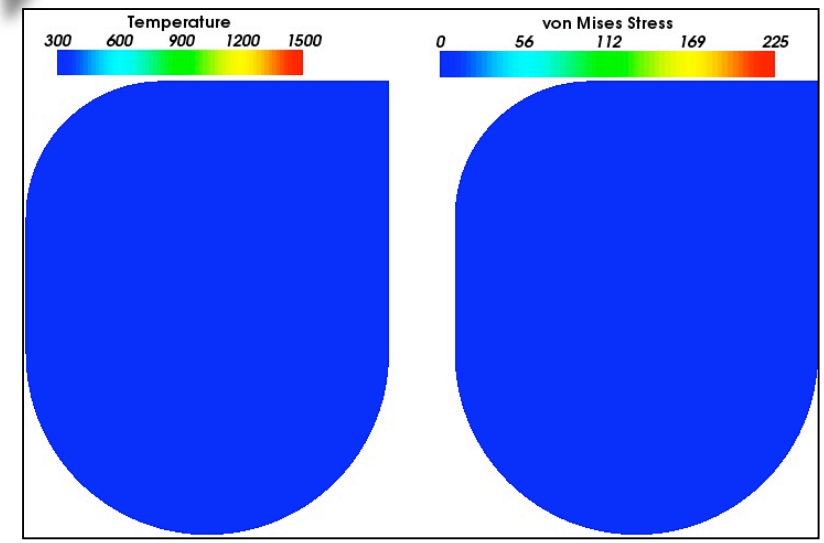
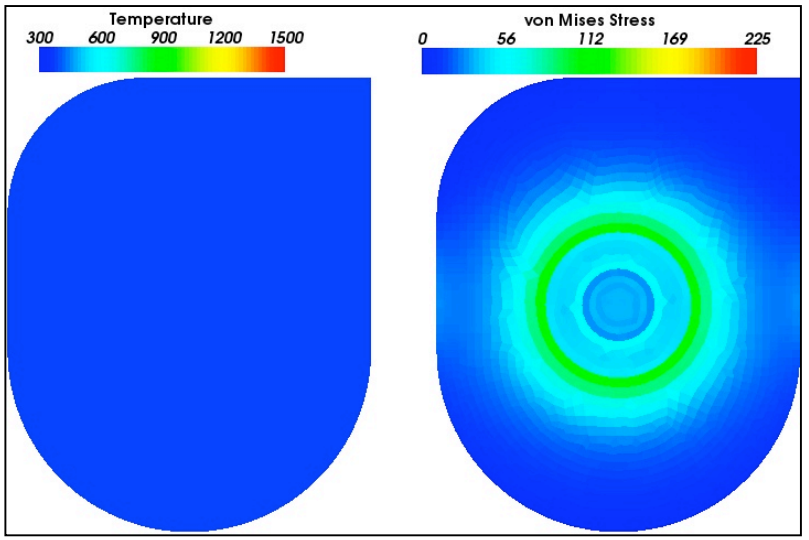
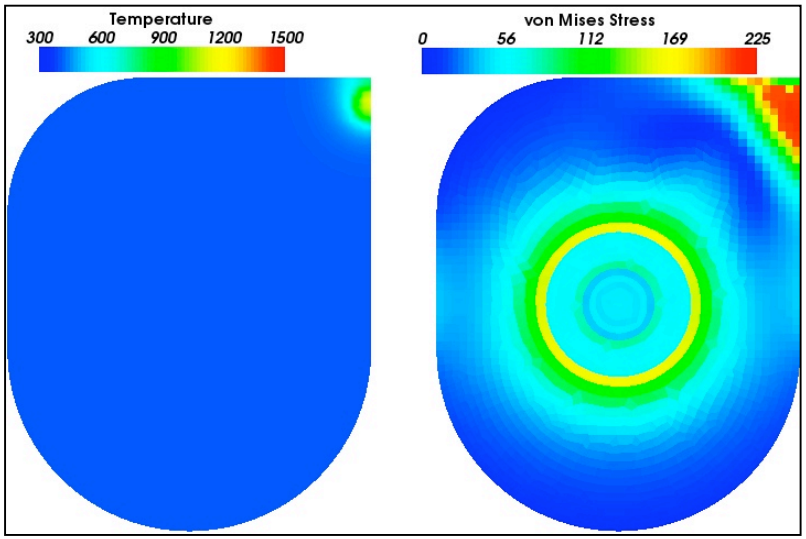
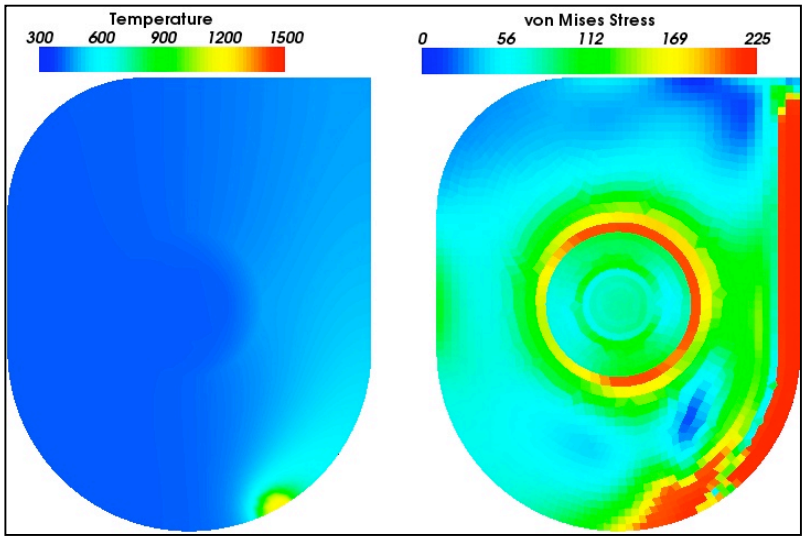
Laser Welding Induced Stress









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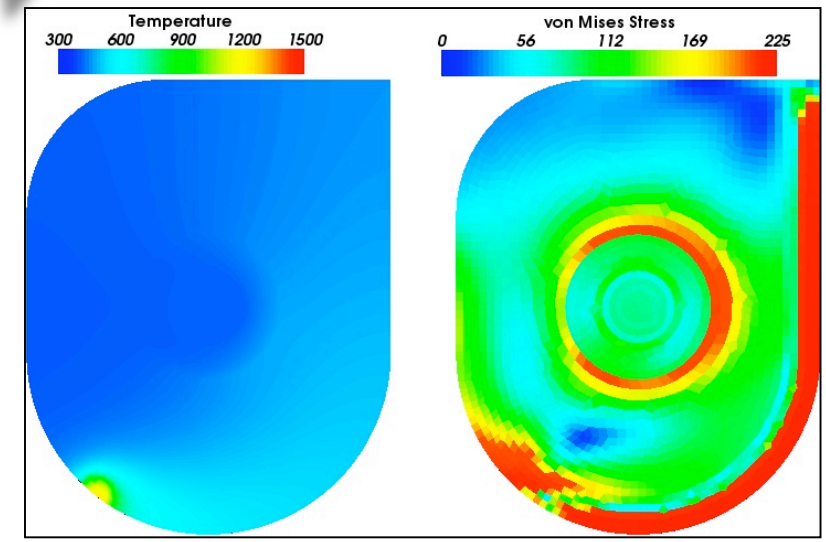
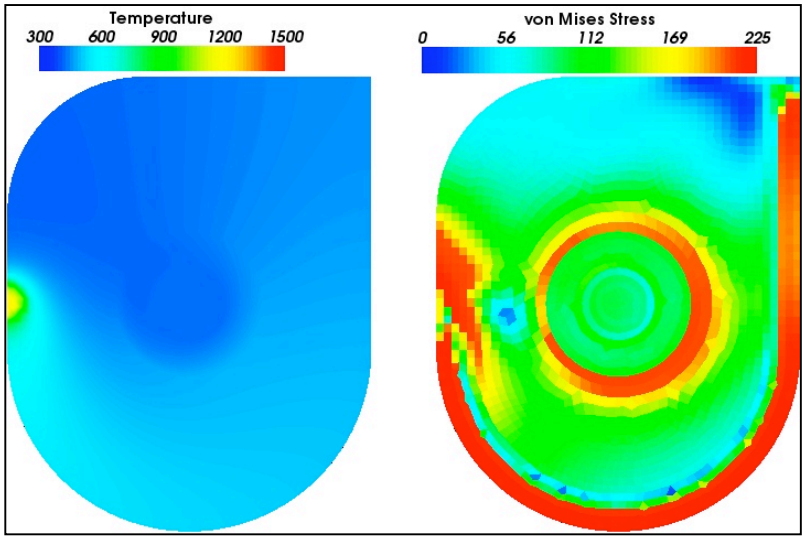
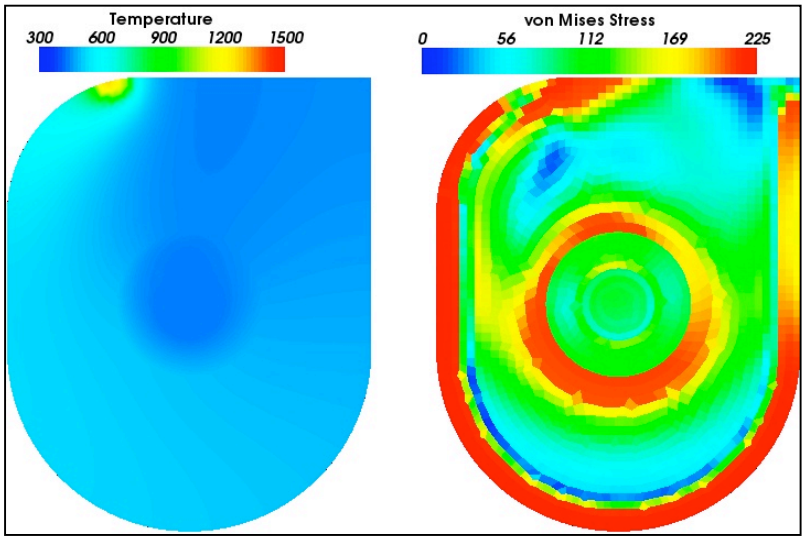
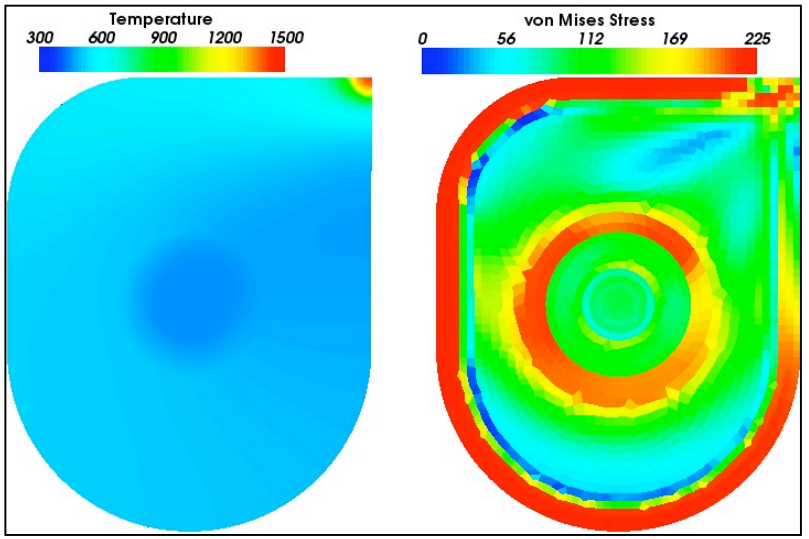
Laser Welding Induced Stress









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