



# **SECA Core Technology Program SOFC Seal Meeting**

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## **Computational Modeling of Joining Processes**

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Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company,  
for the United States Department of Energy's National Nuclear Security Administration  
under contract DE-AC04-94AL85000.





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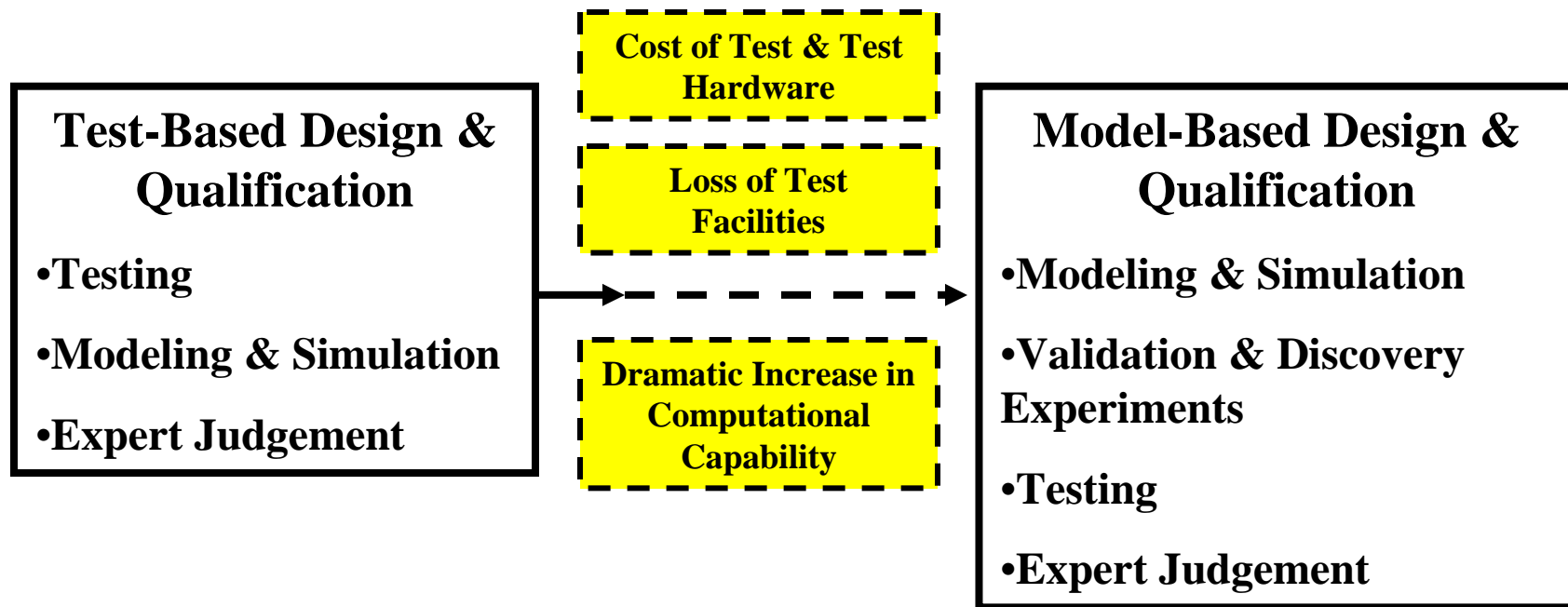
## Sandia's Broad Mission Translates Into A Broad Range of Applications

- SNL responsible for weapon system design & integration
- SNL is responsible for the design, development, manufacture, and stockpile health of non-nuclear components in nuclear weapons.
  - Neutron generators
  - Radars
  - Thermal Batteries
  - Actuators / explosive components
  - Others
- Modeling and simulation must support
  - System design
  - Component design
  - Manufacturing
  - Reliability
  - Forensic evaluation
  - Qualification



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## Increased Reliance on Modeling & Simulation





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## SNL ASCI Code Architecture Migration

VIPAR

Parachute performance code, vortex method coupled with transient dynamics

PRONTO

Transient dynamics  
Lagrangian solid mechanics

JAS

Quasi-static solid mechanics

COYOTE

Thermal mechanics with chemistry

GOMA

Incompressible fluid mechanics with free surfaces

PEGASUS

Neutron Tube Physics

FUEGO

Fire simulation

SALINAS

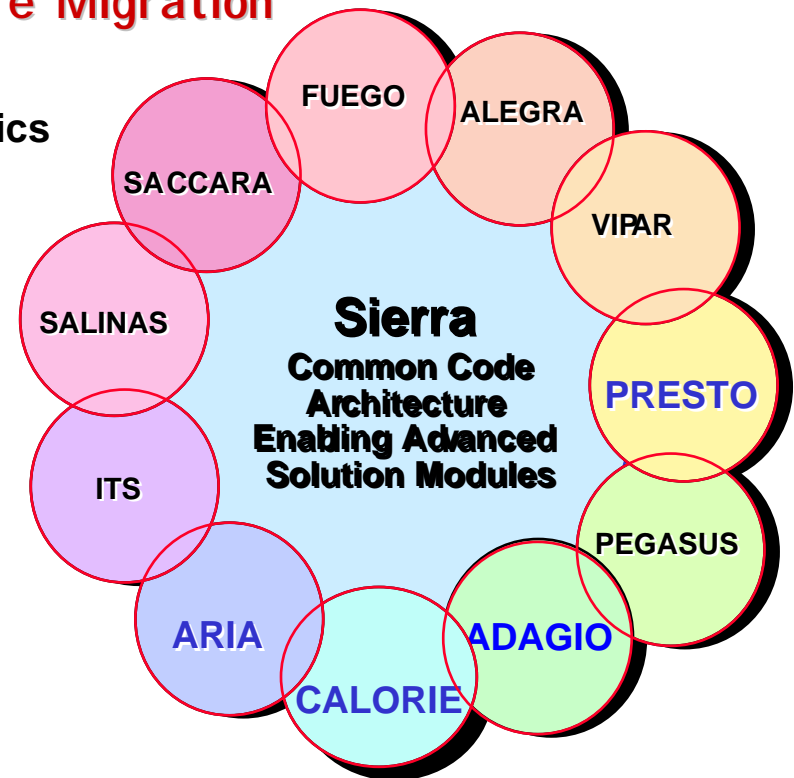
Linear structural dynamics

SACCARA

Compressible fluid mechanics

ITS

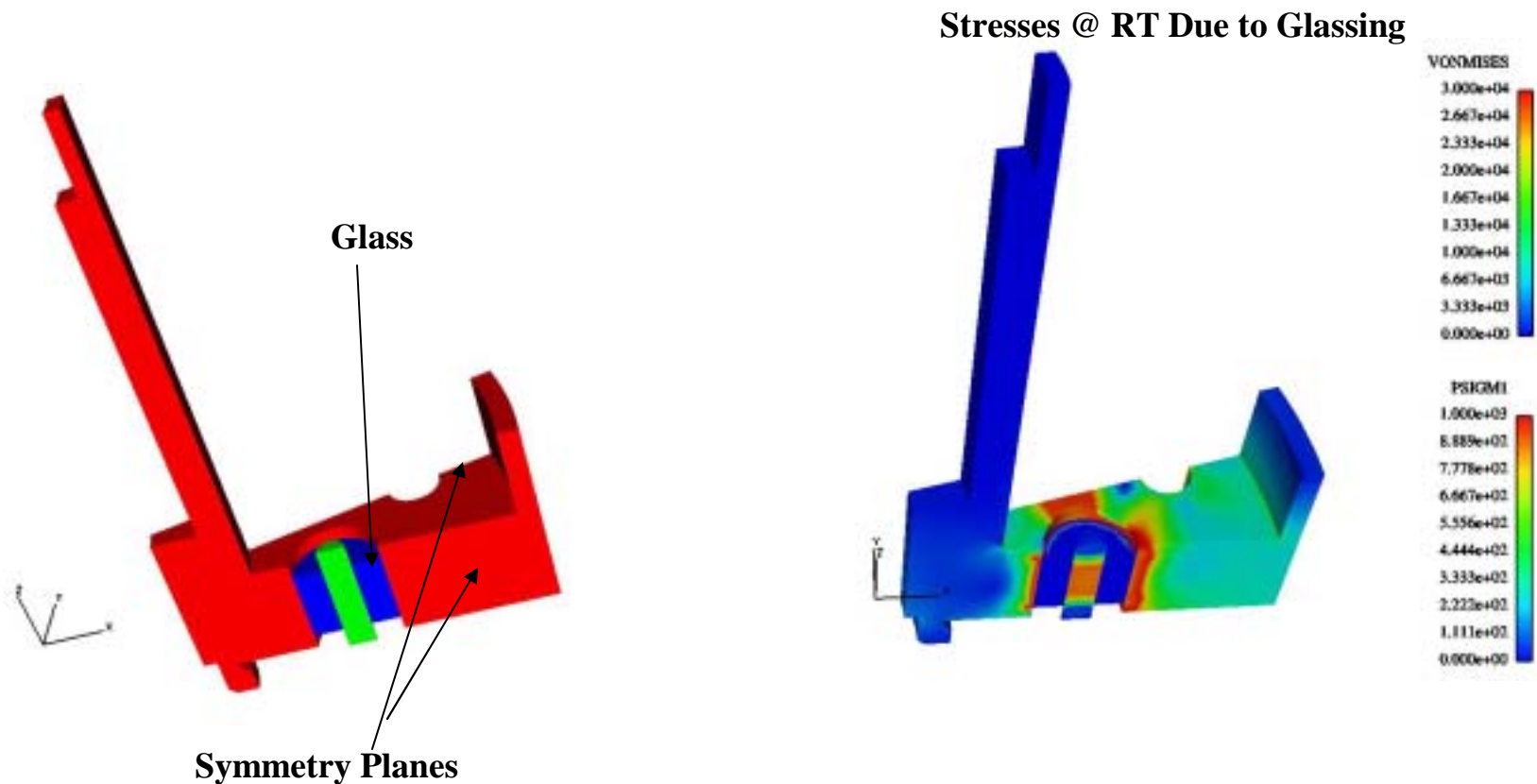
Radiation transport





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## Glass-to-Metal Seals

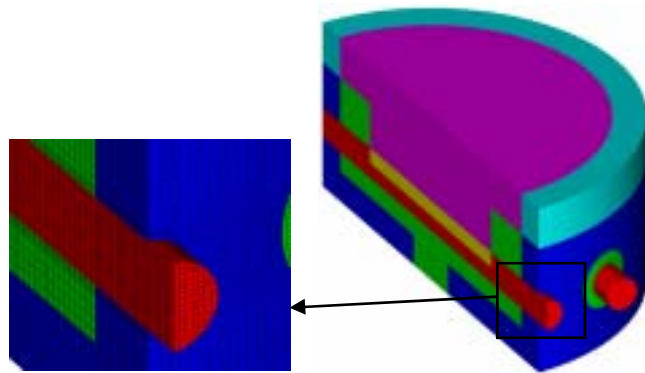




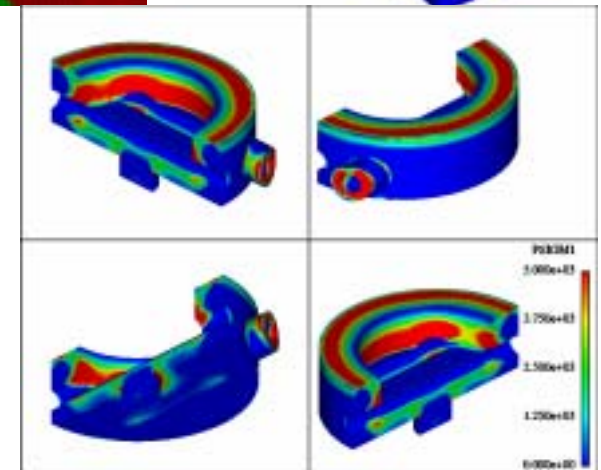
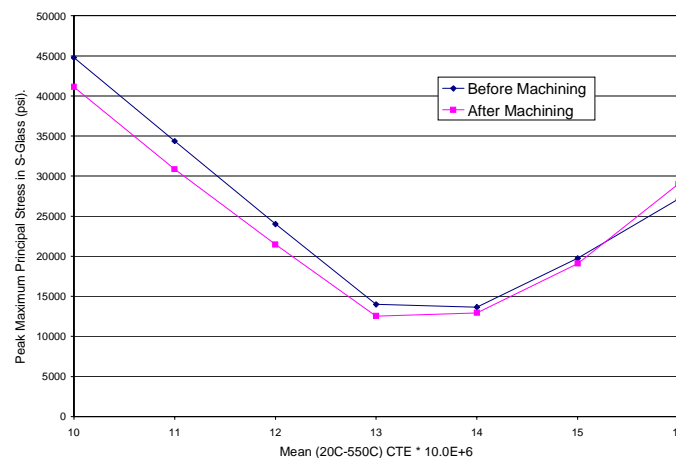
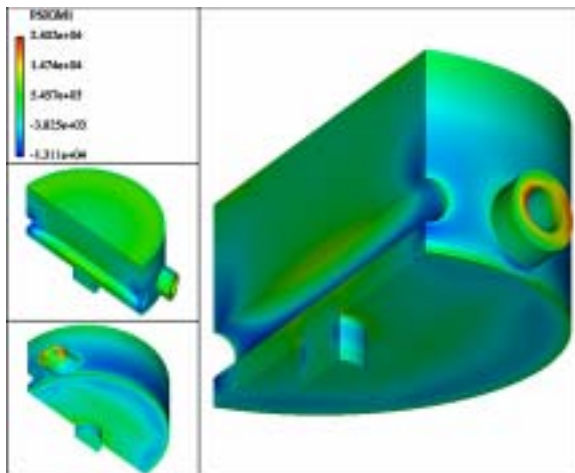
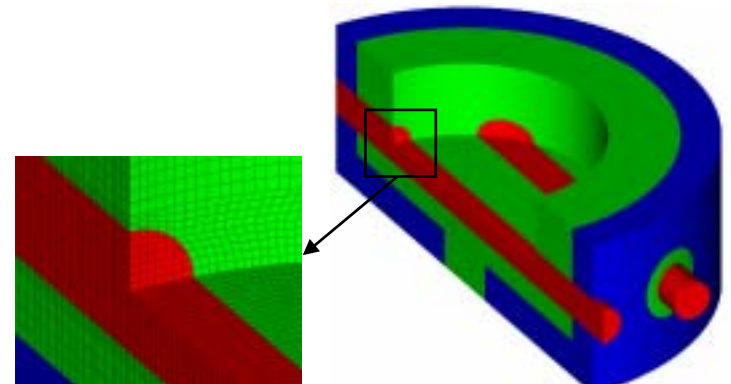
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## Glass Ceramic-to-Metal Seals

Before Machining



After Machining



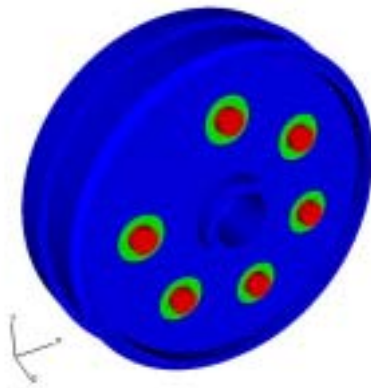




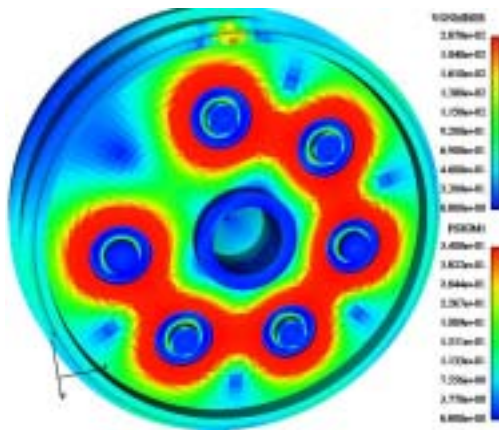
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## GTM + Laser Weld

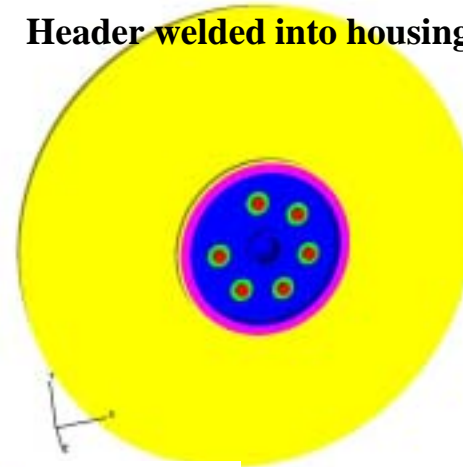
GTM Header



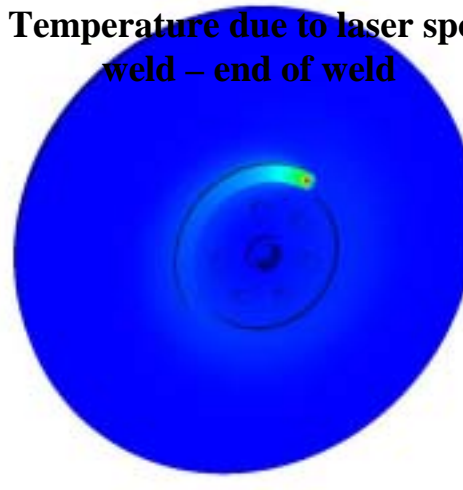
Stresses @ RT after glassing



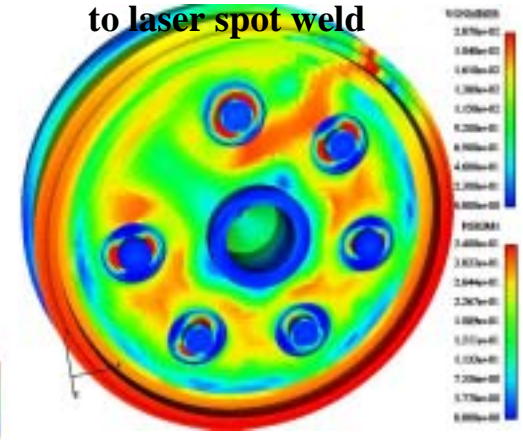
Header welded into housing



Temperature due to laser spot  
weld – end of weld



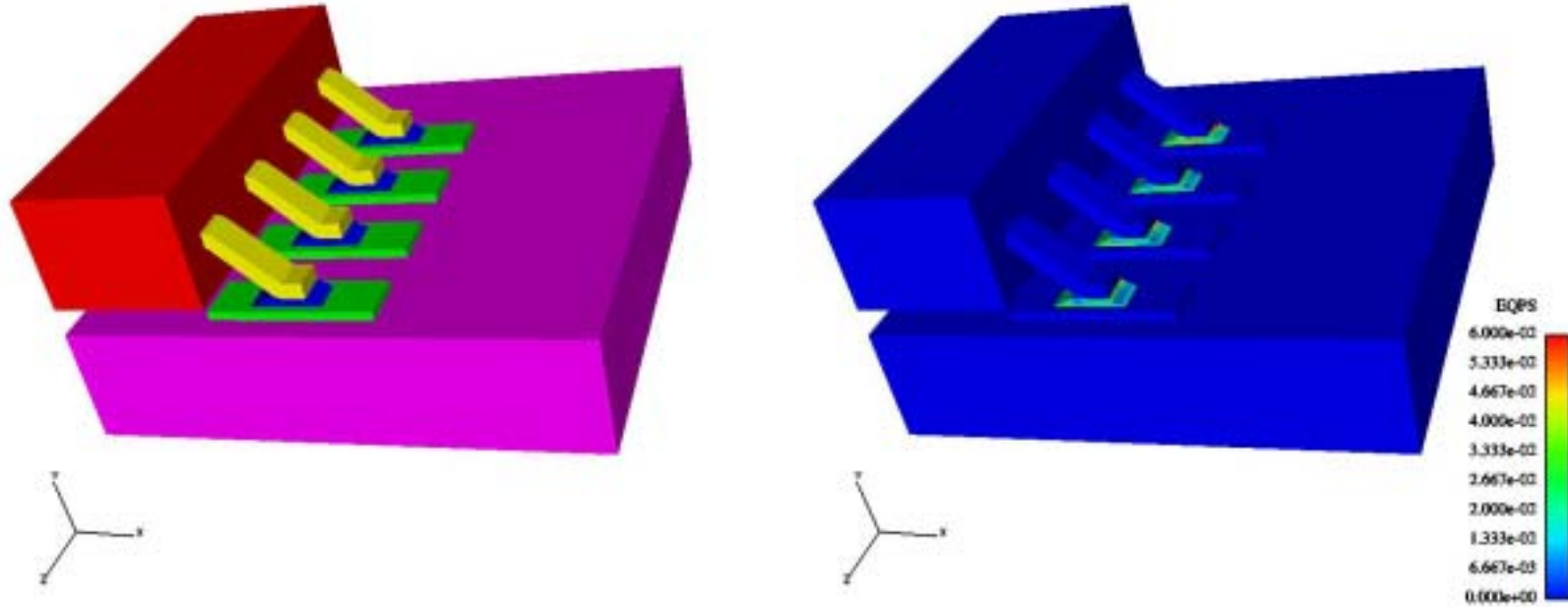
Stresses in header due  
to laser spot weld





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## Soldering

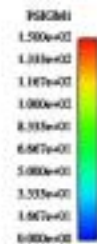
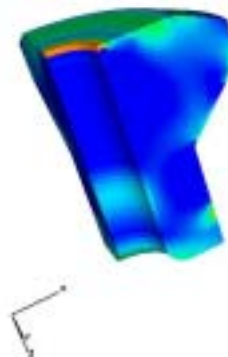
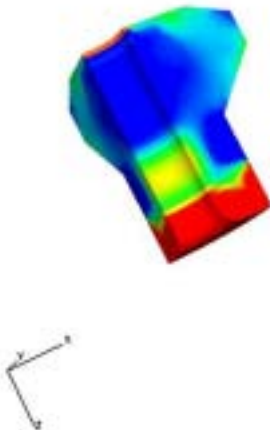
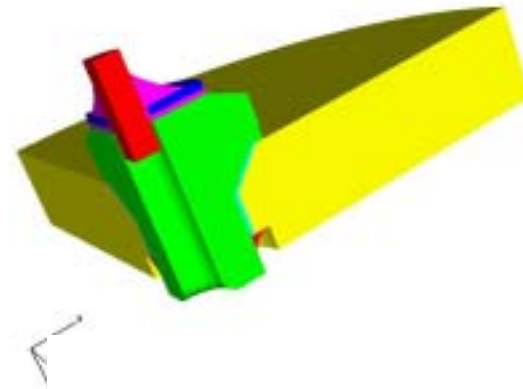
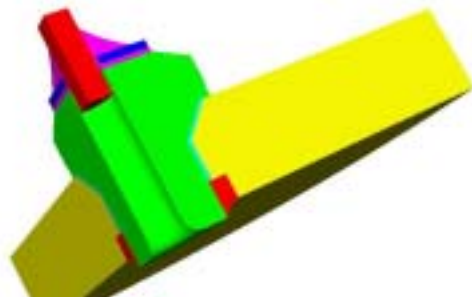






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## Ceramic-to-Metal Brazing

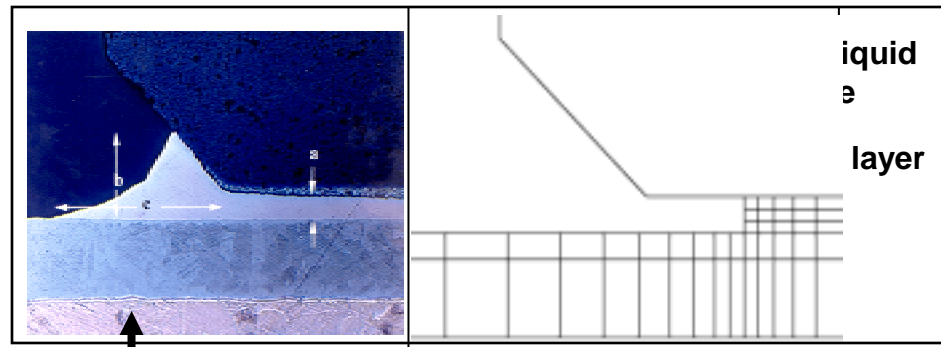
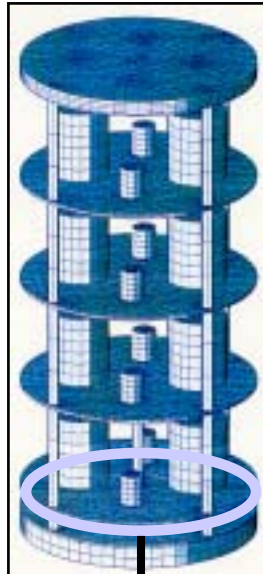




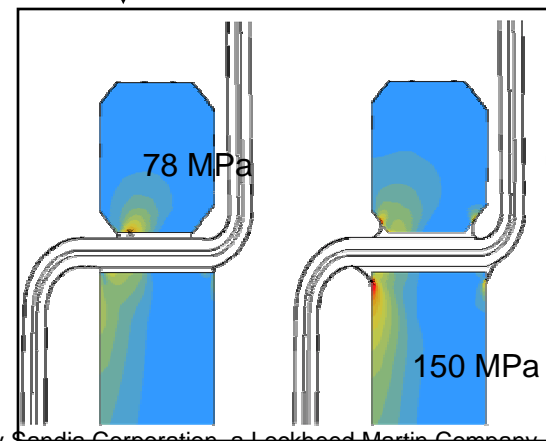
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## Model the Integrated Process

**2.) FLOW MODELING: Model Solidification Process with Temp vs. Time: Provides fillet shape for stress model**



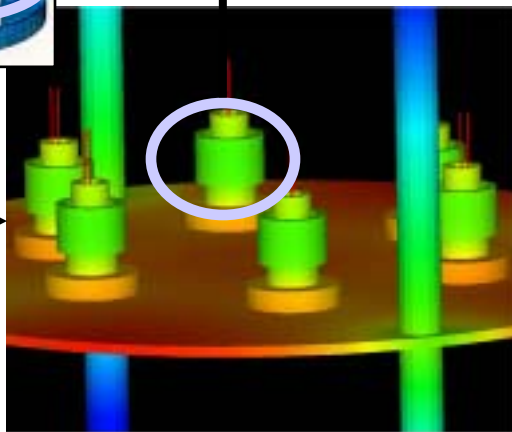
**3.) Stresses computed based on temp. history and fillet shape**



**4.) Compute failure probability of joint**

**1.) Thermal Modeling of Braze Furnace**

**Temp vs. time response**



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