



August 2026

Target Segment Thermostructural Analysis

Joseph B. Tipton, Jr.

Engineering Analyst, Second Target Station



U.S. DEPARTMENT
of **ENERGY**

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Outline

- Front Matter
- Introduction & Requirements
- CAD Geometry
- Mesh Discretization
- Material Models
- Manufacturing Simulation Residual Stresses
- Static Load Cases
- Fatigue Load Cases
- Ratcheting Analysis
- Sensitivity Analysis & Results

Three charge questions are addressed in this presentation

#2

Has the design been shown to meet the requirements?

#3

Do DACs and other supporting documentation adequately support the final design?

#5

Is the design sufficiently mature to proceed with finalizing the procurement package?

This presentation summarizes 3 DACs (all reviewed, signed, published) as part of the Target Assembly scope

S03020000-DAC10000

**Target Systems Analysis:
Material Model Definitions**



Joseph B. Tipton, Jr.
Justin Mach

May 5, 2026

IN718(SA) constitutive
models by Justin Mach


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S03020400-DAC10000

**Target Segment Thermostructural
Analysis**



Joseph B. Tipton, Jr.

April 21, 2026

Analysis inspired and
guided by Justin Mach


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S03020400-DAC10001-R01

**Second Target Station Project:
Analysis of Target Inconel-to-
Tantalum Debonding**



T. McManamy
J. Tipton

July, 2026

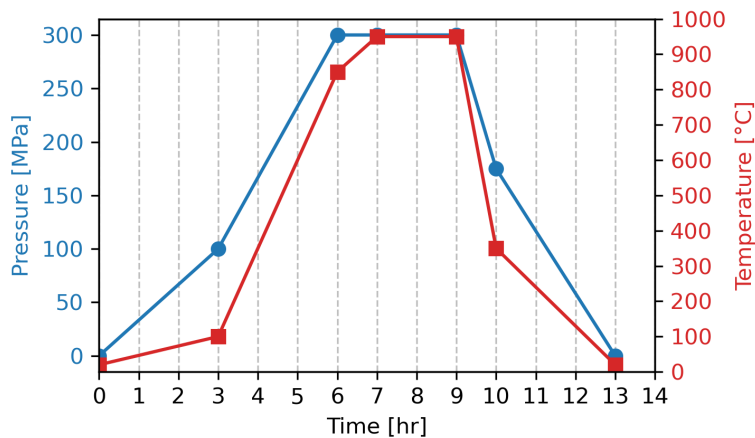
Analysis created by Tom
McManamy


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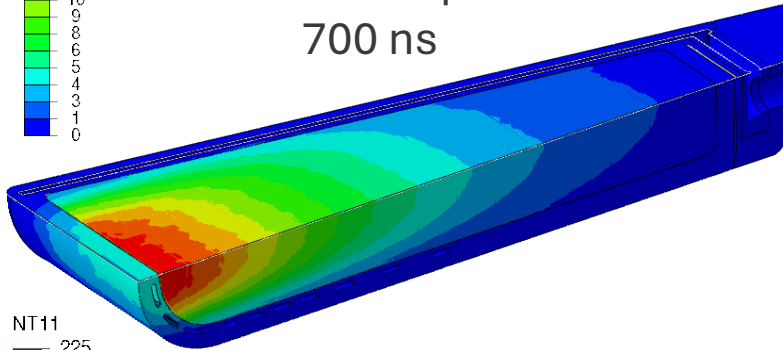
Key parameters driving target segment structural performance

Case		Beam Loads						Body Loads			Water		
ID	Case	Power kW	Focus ^a 10 ¹¹	Profile Name	Offset v/h, mm	Pulses 10 ⁸	Trips 10 ⁵	Grav	Rot	Accel	Temp °C	Flow gpm	Press psi
A	Nominal	700	6.24	60cm ²	0/0	1.35	1.25	Y	Y	N	32.2	7.5	36

Manufacturing HIP Profile

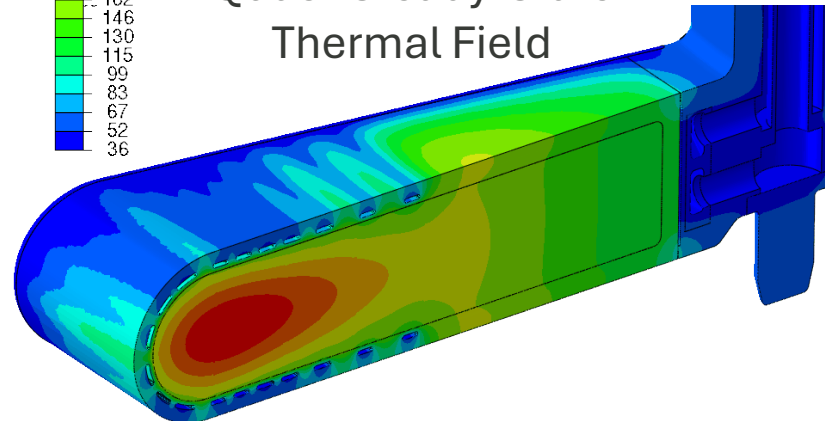


Pulse ΔT ramp over 700 ns

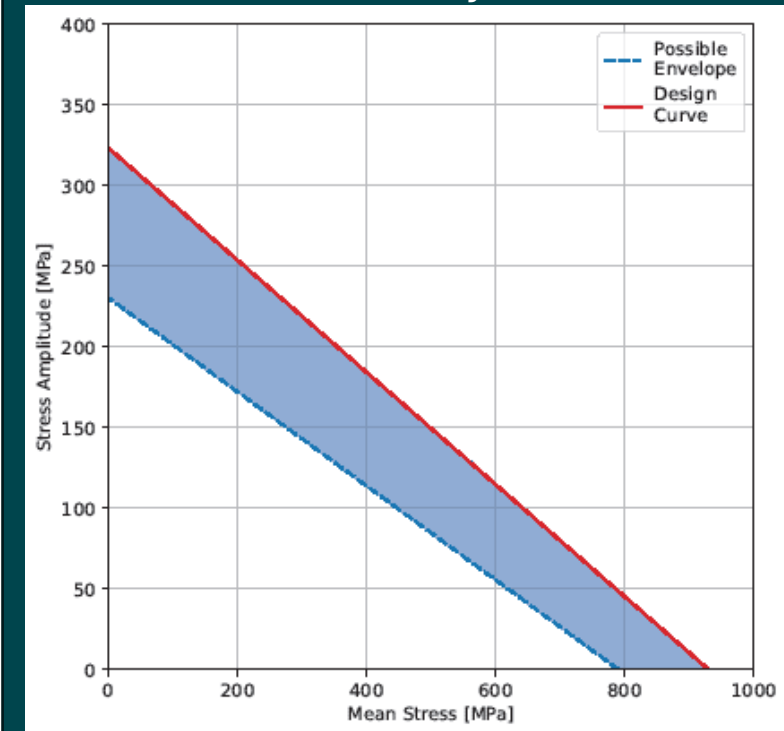


Quasi-Steady-State Thermal Field

NT11



IN718(SA) Goodman Diagram @ 1.35M Cycles



Introduction & Requirements

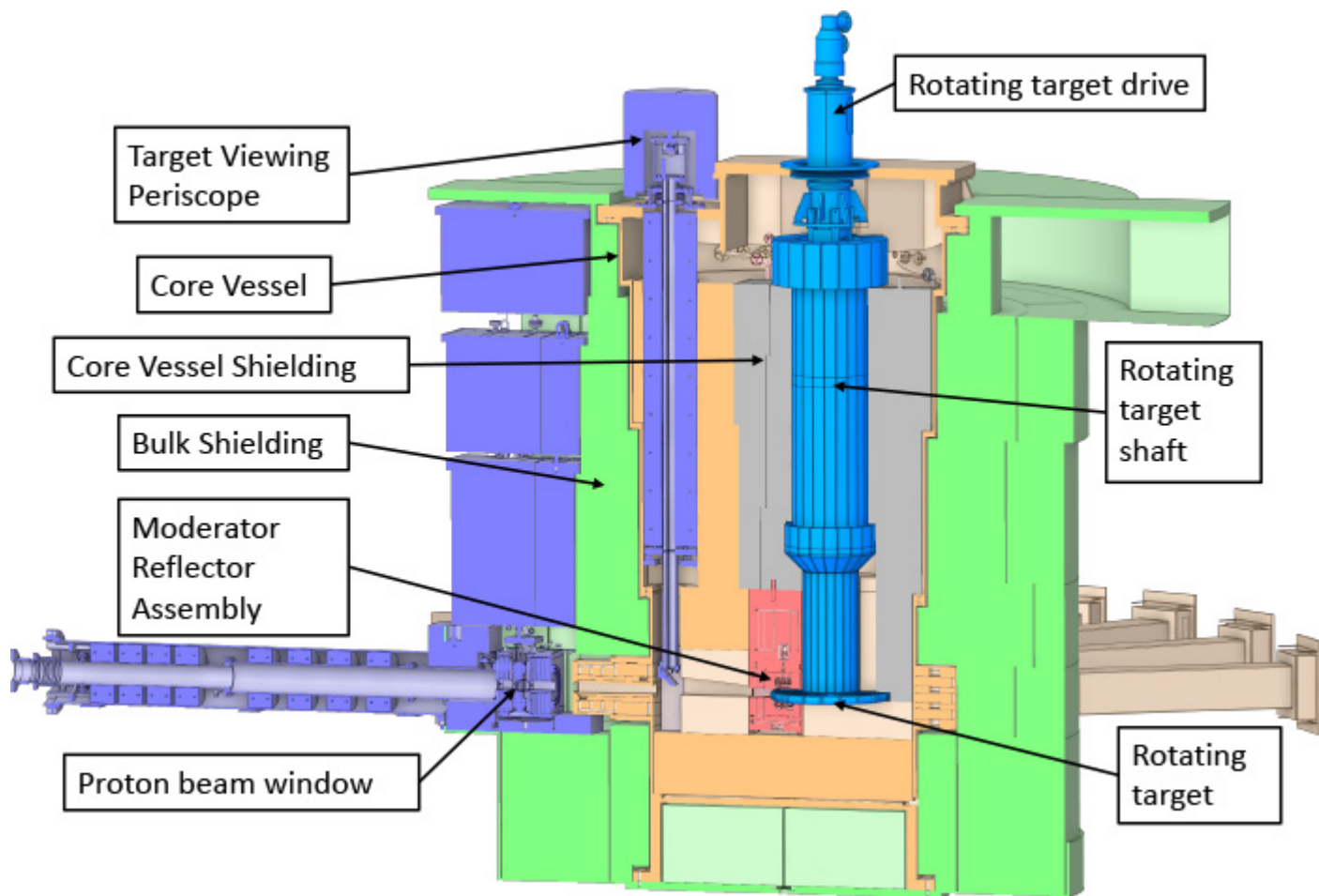
What part of the target segment is analyzed?

What information is used to construct analyses?

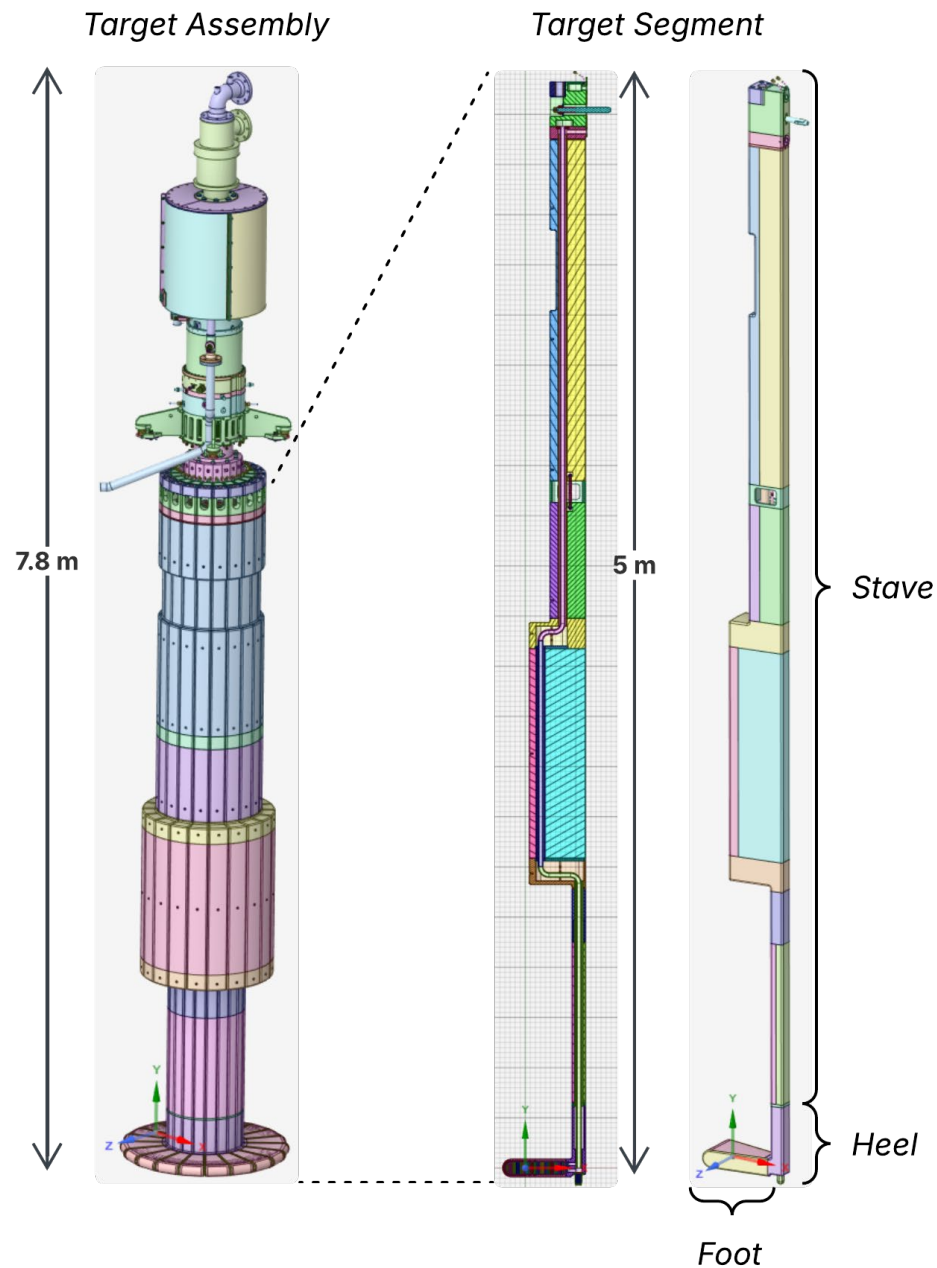
What requirements are addressed?

How are the requirements translated into analyses?

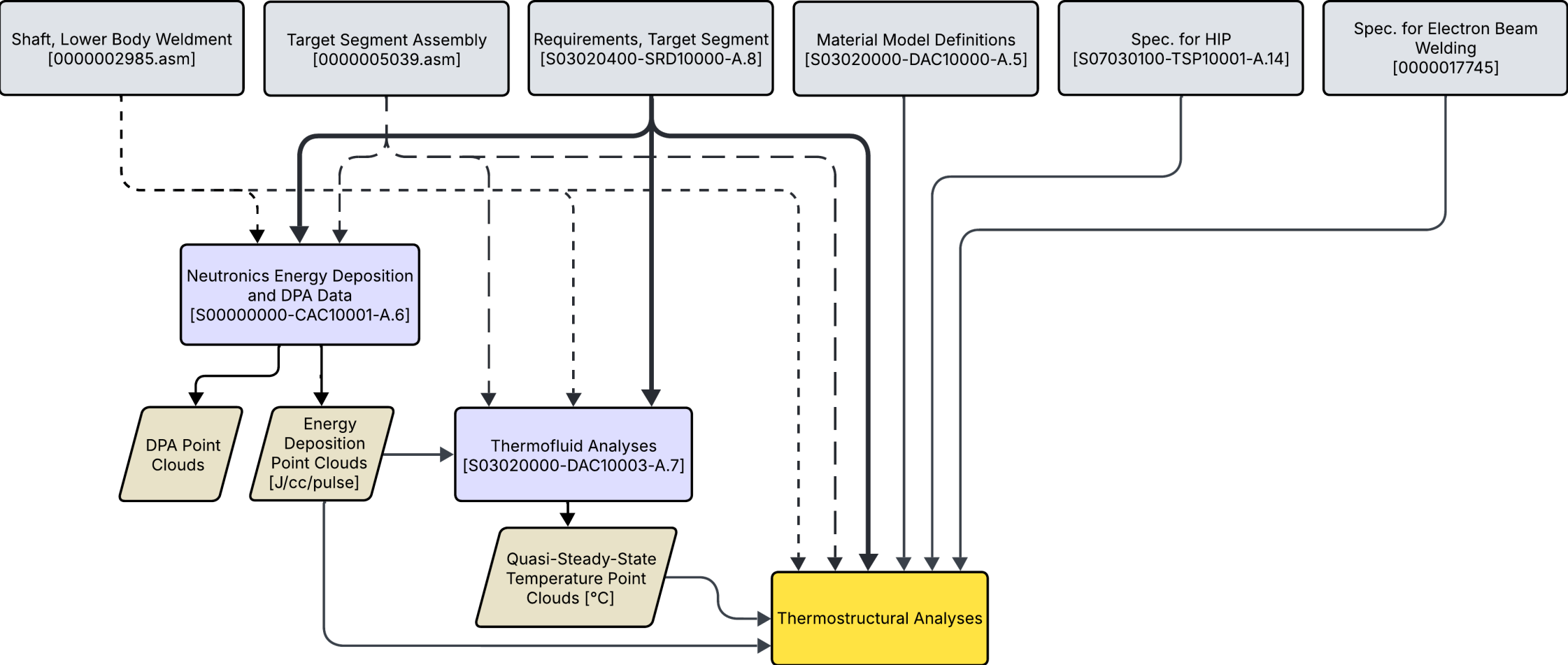
The scope of this analysis is the target segment foot & heel



<https://neutrons.ornl.gov/sts/sts-target-systems>



Analyses derive from CAD, DACs, Reqmnts, Mat'ls, and Specs



REQMT: 1600 - Design Loads and Acceptance Criteria

The target segment shall be designed so that limit states (structural integrity) are maintained under all load combinations (including seismic). Loads and limit states are defined by:

Table 1. Failure Mode Acceptance Criterion

Failure Mode ^a	ASME ^a	ASCE 7	AISC 360	NASA	Judgment	Datasheet
Seismic Interactions		X				
General Stress	X	X				
Weld Stresses	X					
Residual Stress	X					
Buckling	X					
Resonance					X	
Cyclic Loading	X ^b					
Bolt Pullout				X		
Bolt Failure	X					
Slip Critical Joints			X			
COTS components						X ^c

^a Limit states and methods of evaluation only. Target Assembly is not a pressure vessel and does not require fabrication methods, stamping, material sourcing, and allowable materials.

^b Ref (*Sec VIII, D2, ASME Boiler and Pressure Vessel Code, Rules for Construction of Pressure Vessels*) limit states are followed for the segment leg, shaft, and drive where possible but the nature and materials of the Target Segment foot do not adhere to the Boiler and Pressure Vessel Code (BPVC). The code provides conservative lifetimes to prevent failures, whereas the project acknowledges failure will occur and is interested in an accurate lifetime assessment.

^c Manufacturer Data Sheets may not include complete data on all load scenarios. The engineer must use good judgment or a conservative approach to failure modes or loadings beyond the manufacturer's published data.

Note: This specifically includes the segment attachment pin during a seismic event

REQMT: 1574 - Segment Lifetime

Segment Fatigue margin shall be equal to or greater than 1 for a 10-year operational life for all materials with the following load combinations:

Case		Beam Loads						Body Loads			Water			State	Criteria
ID	Case	Power kW	Focus ^a 10 ¹¹	Profile Name	Offset v/h, mm	Pulses 10 ⁸	Trips 10 ⁵	Grav	Rot	Accel	Temp °C	Flow gpm	Press psi	State	Criteria
A	Nominal	700	6.24	60cm ²	0/0	1.35	1.25	Y	Y	N	32.2	7.5	36	WOL ^b	Req 1574 ^c
B	Nominal-corner	700	6.24	60cm ²	8.5/12	1.35	1.25	Y	Y	N	32.2	7.5	36	WOL ^b	Req 1574 ^d
C	Nominal-low flow	700	6.24	60cm ²	0/0	1.35	1.25	Y	Y	N	32.2	5.71	36	WOL ^b	Req 1574 ^d
D	Overfocused	714	6.6	57cm ²	0/0	1.35	1.25	Y	Y	N	32.2	7.5	36	WOL ^b	Req 1574 ^c
E	Diffuse	700	4.61	94.5cm ²	0/0	1.35	1.25	Y	Y	N	32.2	7.5	36	WOL ^b	Req 1574 ^d

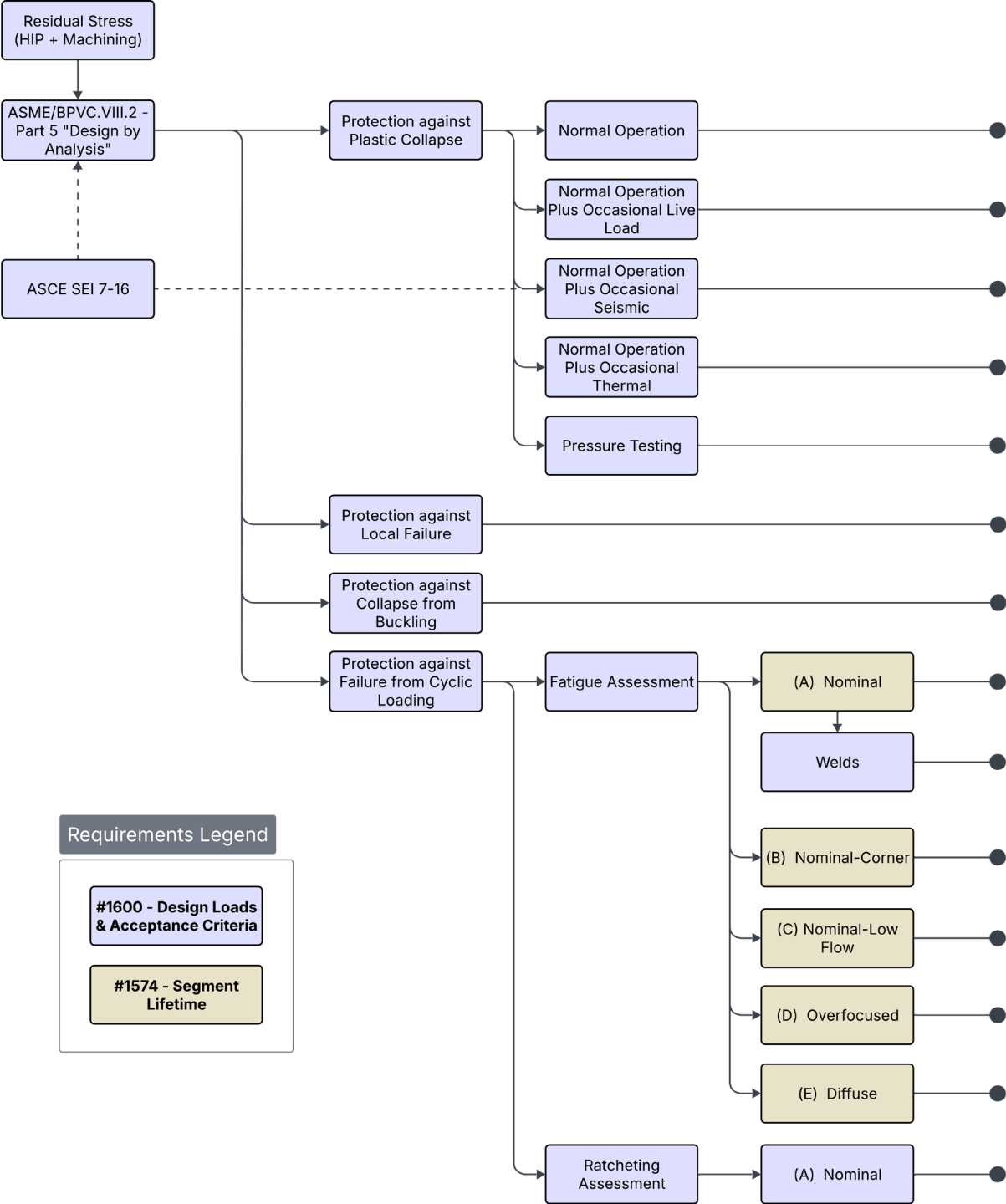
^a protons/mm²/sec

^b Worst of Life material conditions (irradiated elastic modulus and thermal conductivity, but not strength)

^c Fatigue methodology (weld reduction factors, etc.) determined in accordance with ASME BPVC Sec. VIII.2, Part 5; allowable stresses are determined from best-in class irradiated material limits and not ASME fatigue curves.

^d Fatigue lifetime criteria to be evaluated; minor deviations in life are acceptable for edge, corner, and worst case conditions

Analyses derived from requirements . . .



CAD Geometry

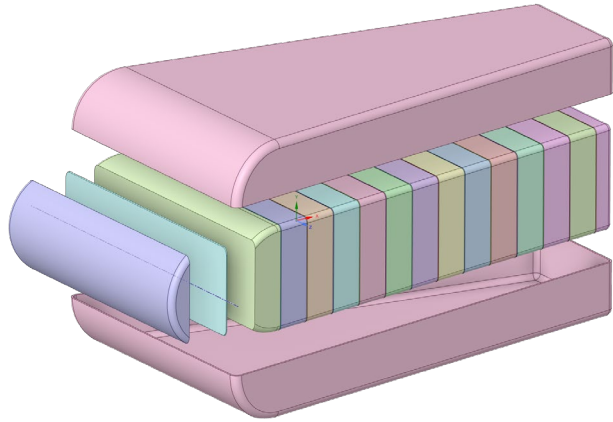
What CAD models are used?

How are the CAD models simplified for analysis?

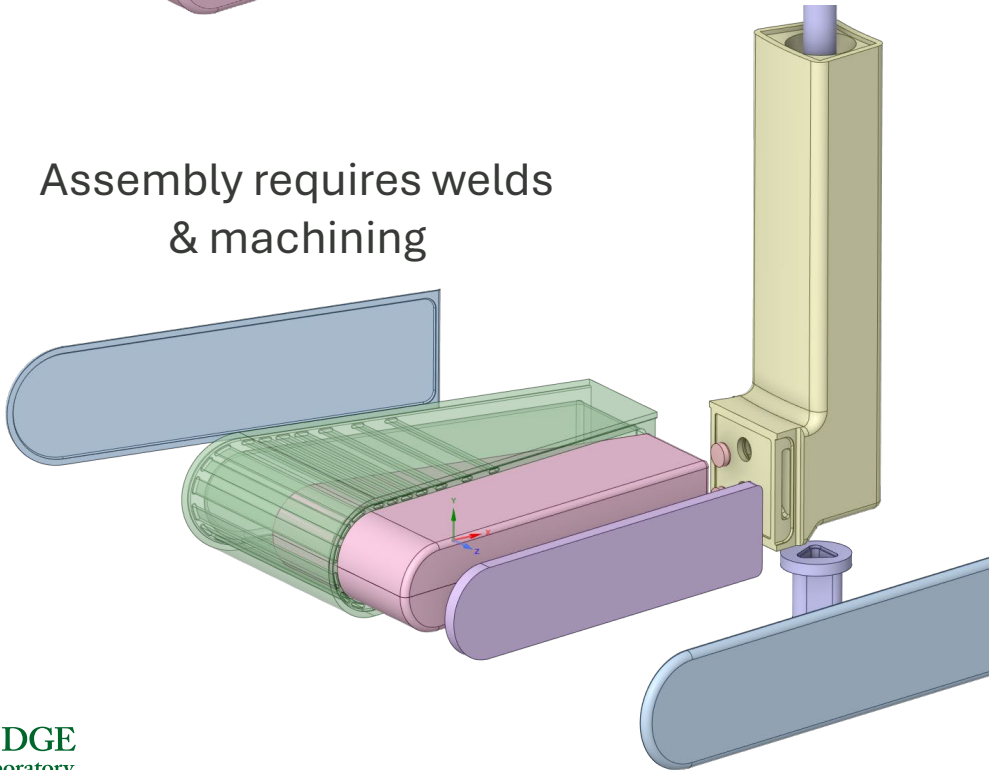
How do the CAD models capture the manufacturing reality?

Model focuses on heel/foot and captures key welds

W/Ta laminate

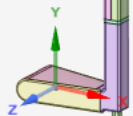
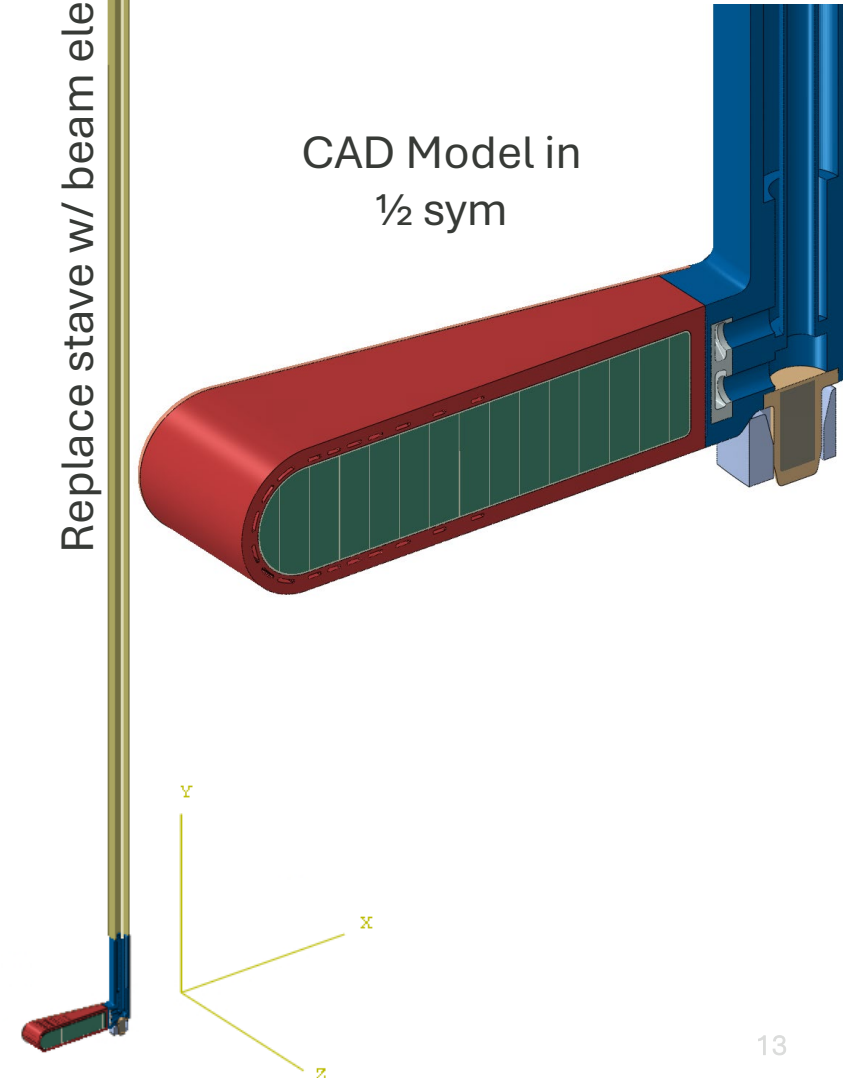


Assembly requires welds
& machining



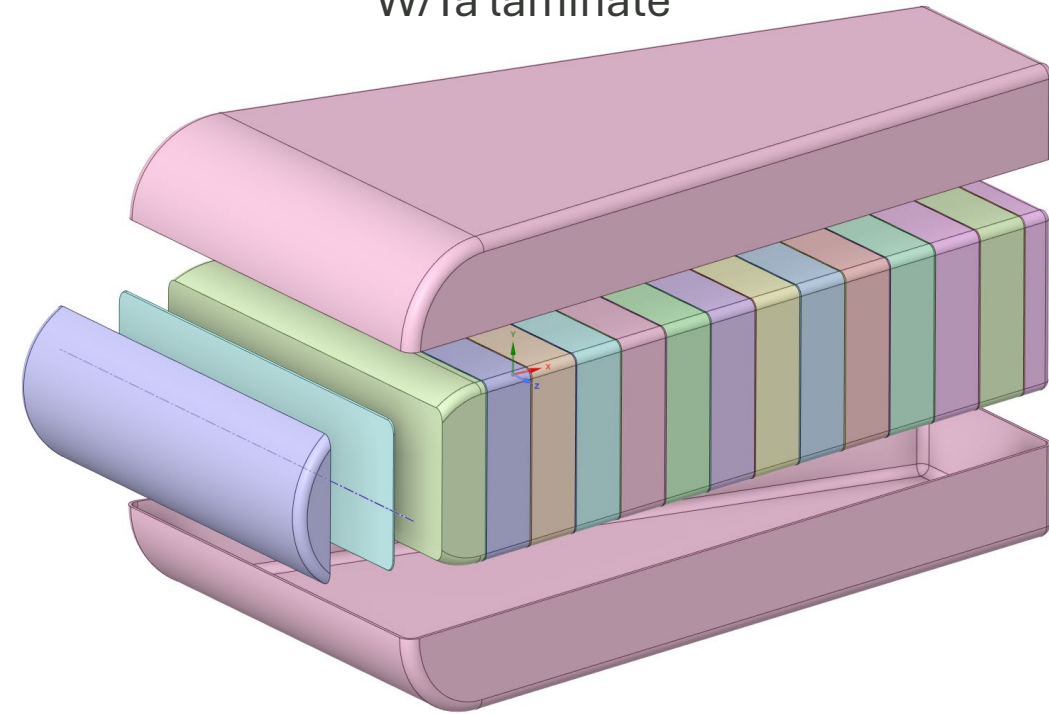
Replace stave w/ beam element

CAD Model in
 $\frac{1}{2}$ sym

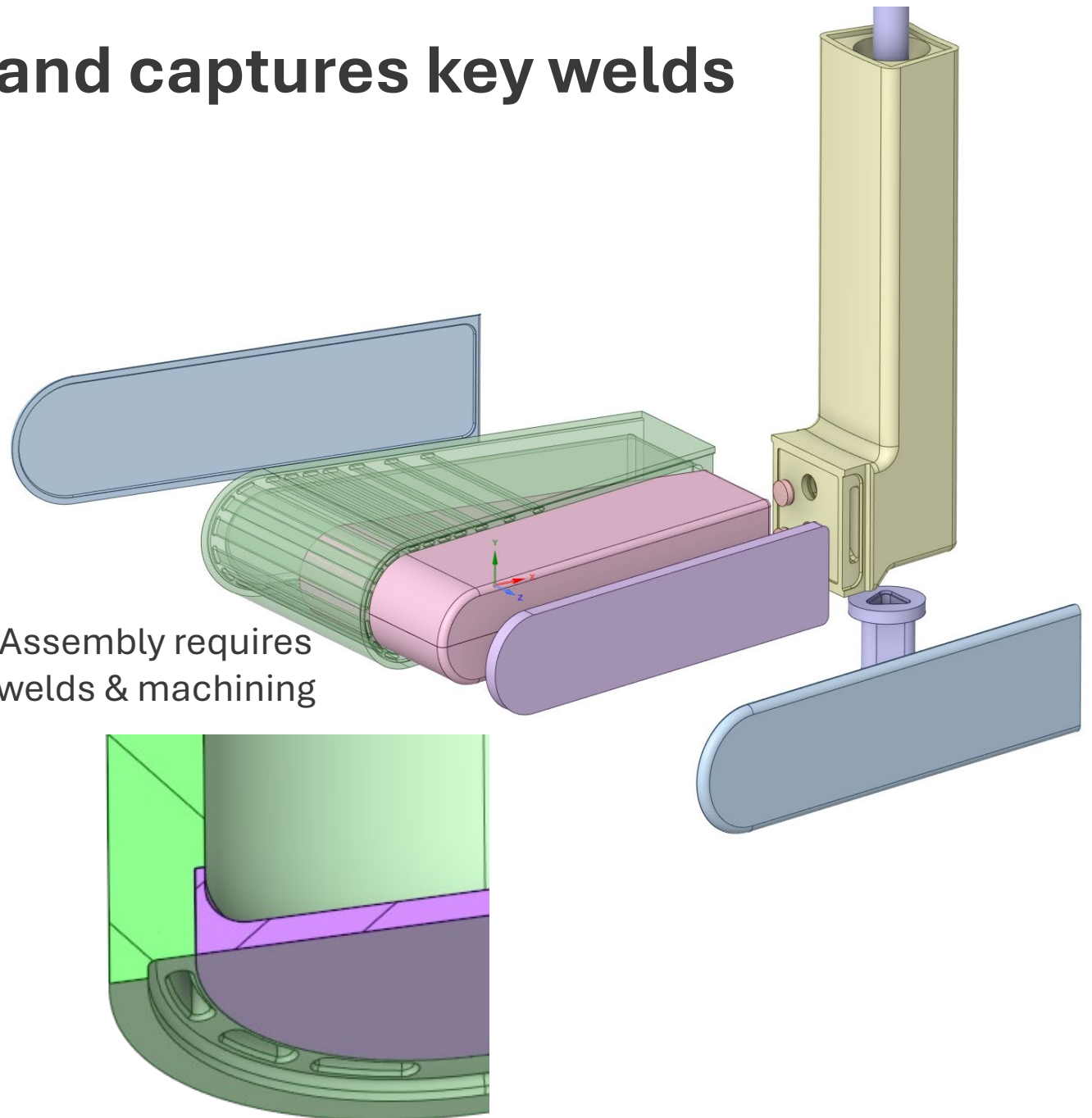


Model focuses on heel/foot and captures key welds

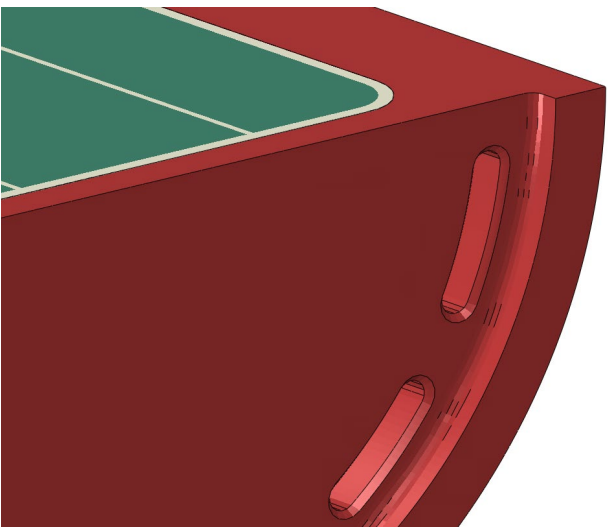
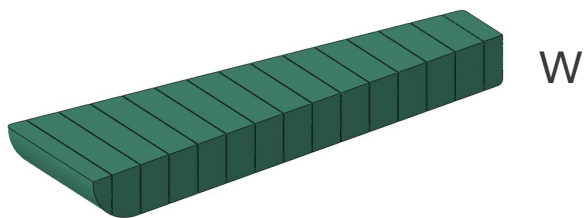
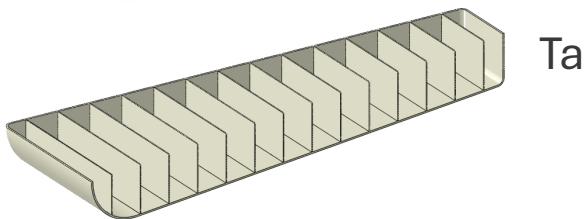
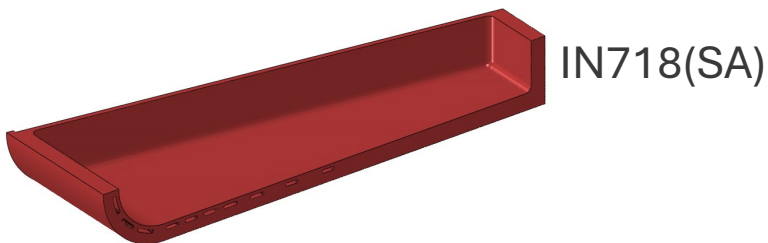
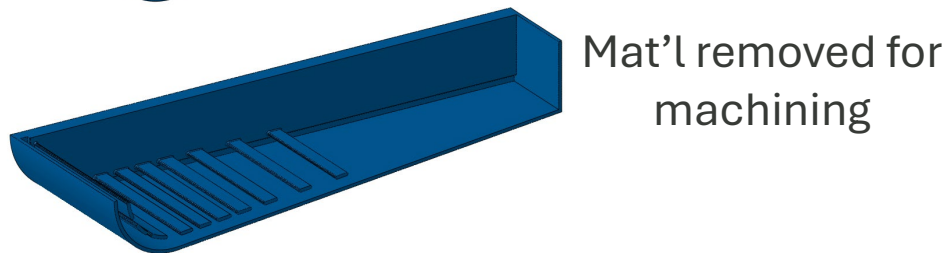
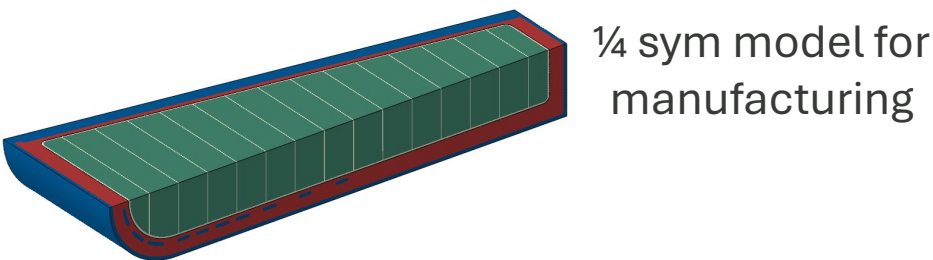
W/Ta laminate



Assembly requires
welds & machining

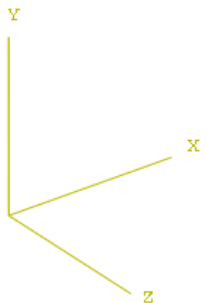
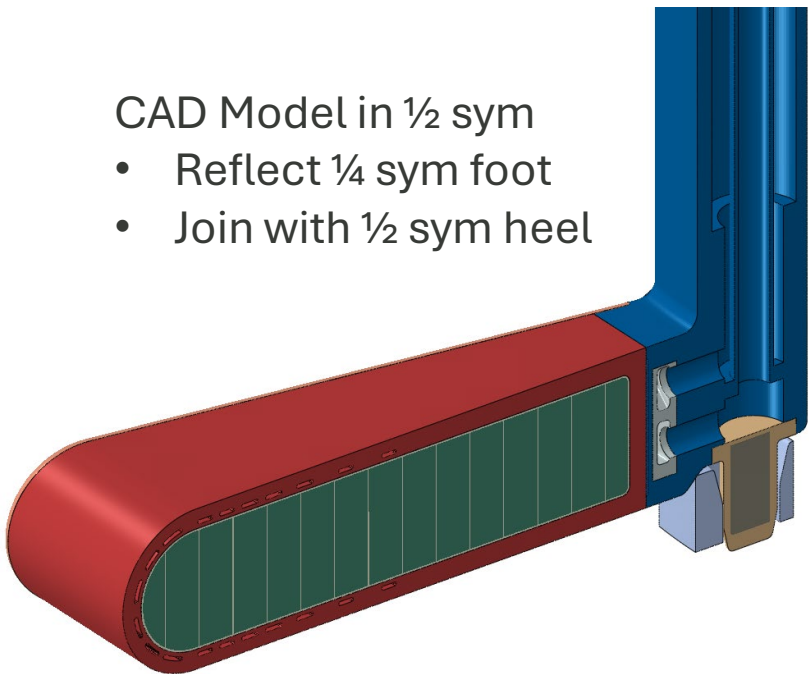


Analysis model invokes symmetry and uses beam for stave

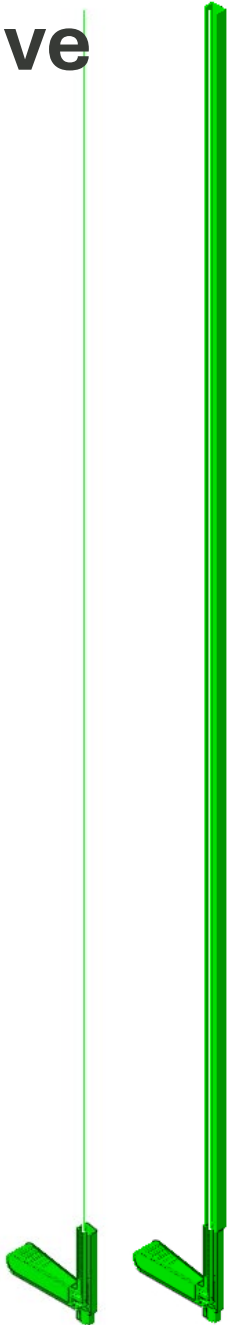
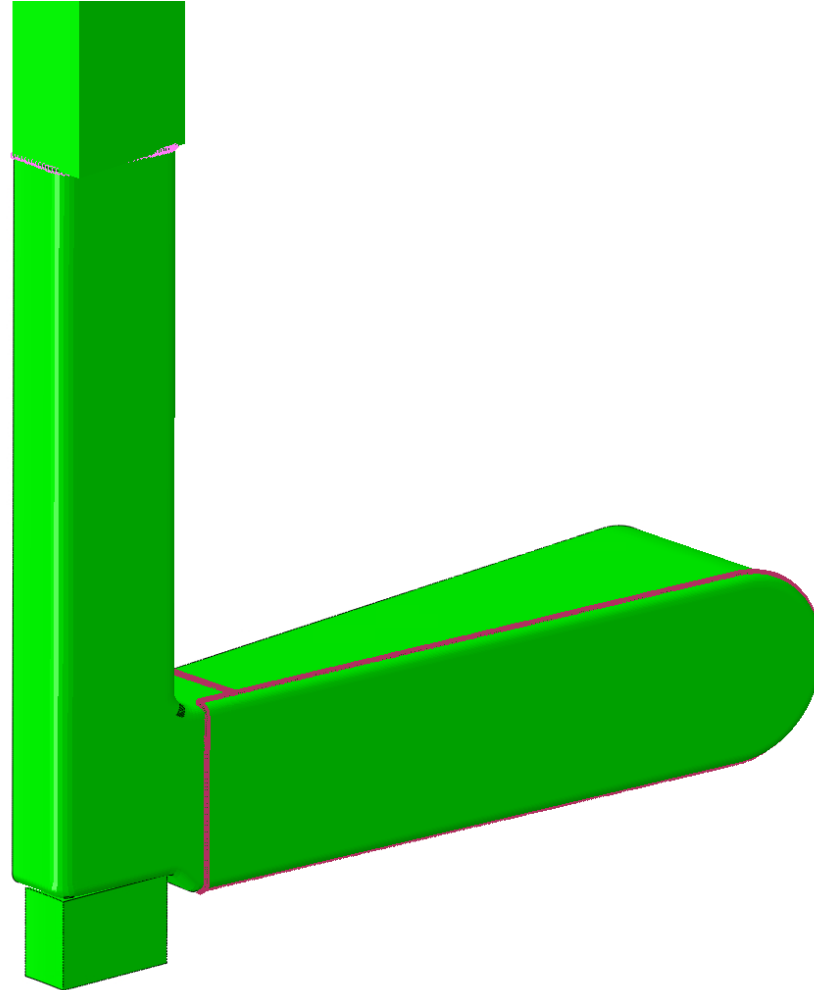
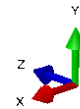
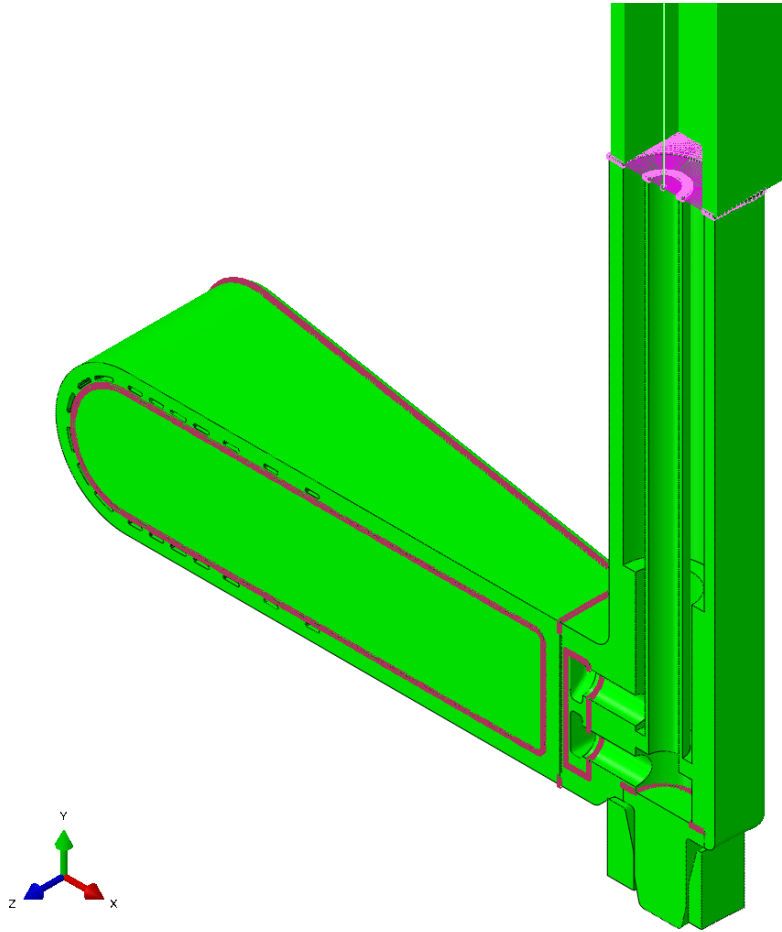


Replace stave w/ beam element

- CAD Model in 1/2 sym
- Reflect 1/4 sym foot
 - Join with 1/2 sym heel



Analysis model invokes symmetry and uses beam for stave



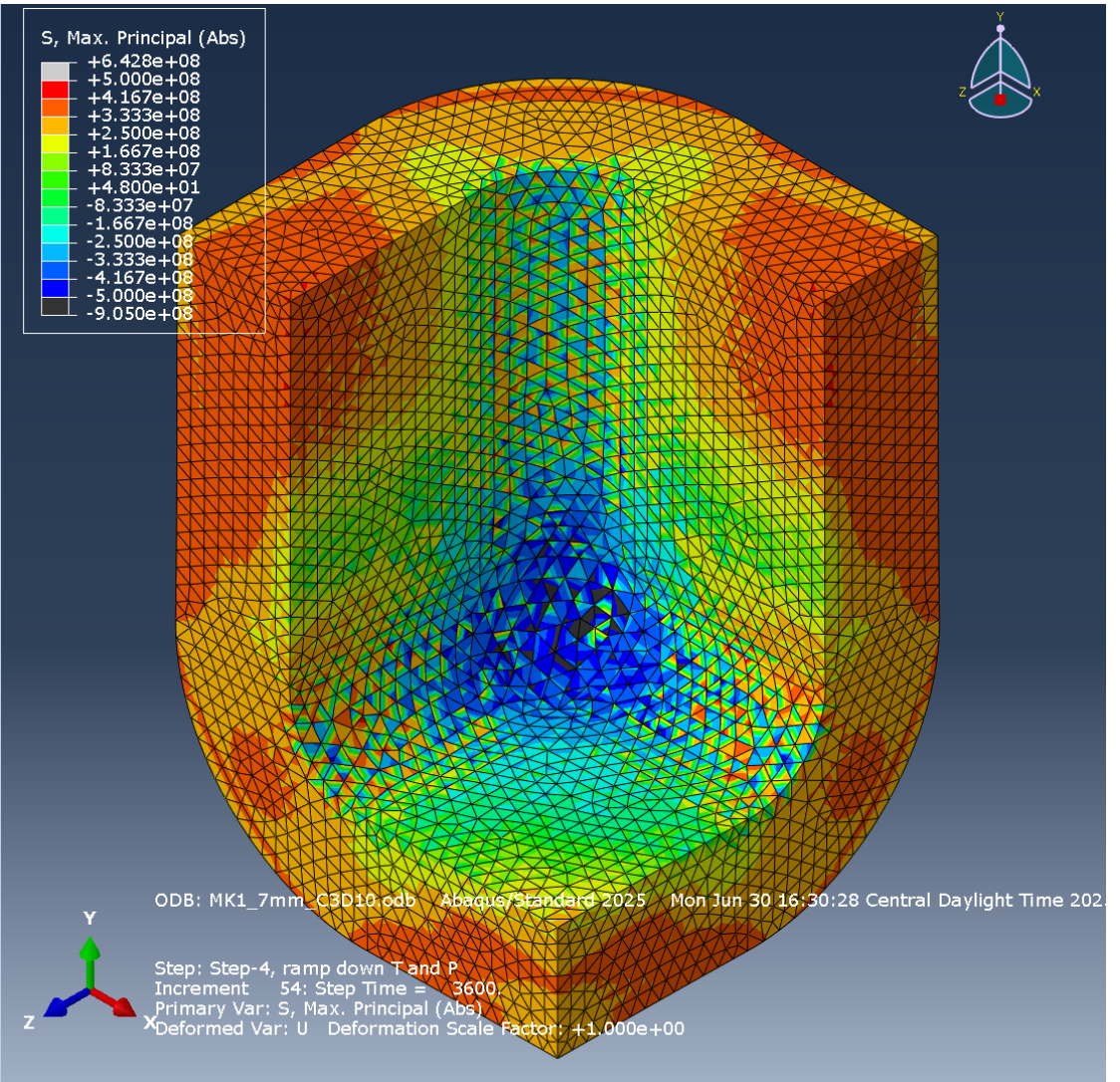
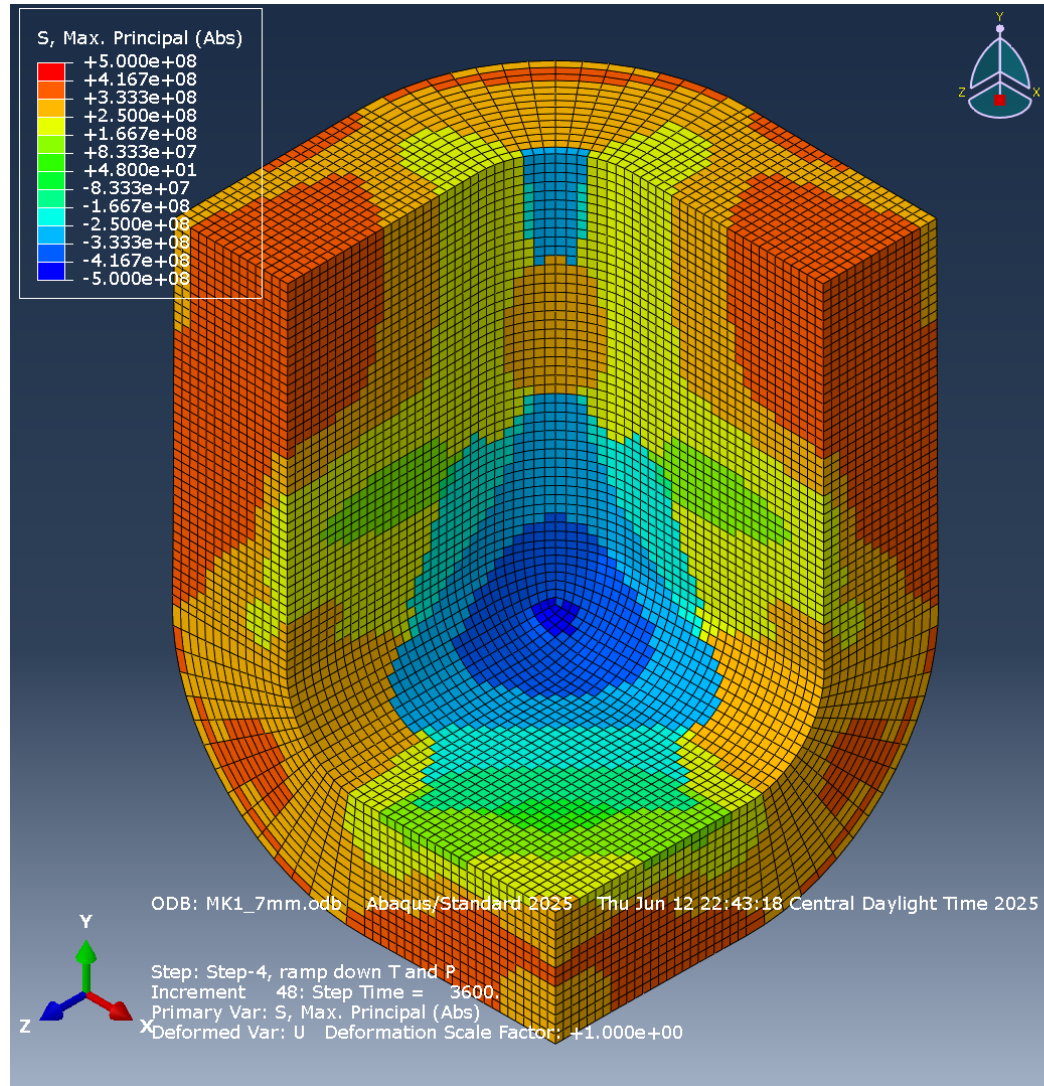
Discretization

Why HEX elements are required.

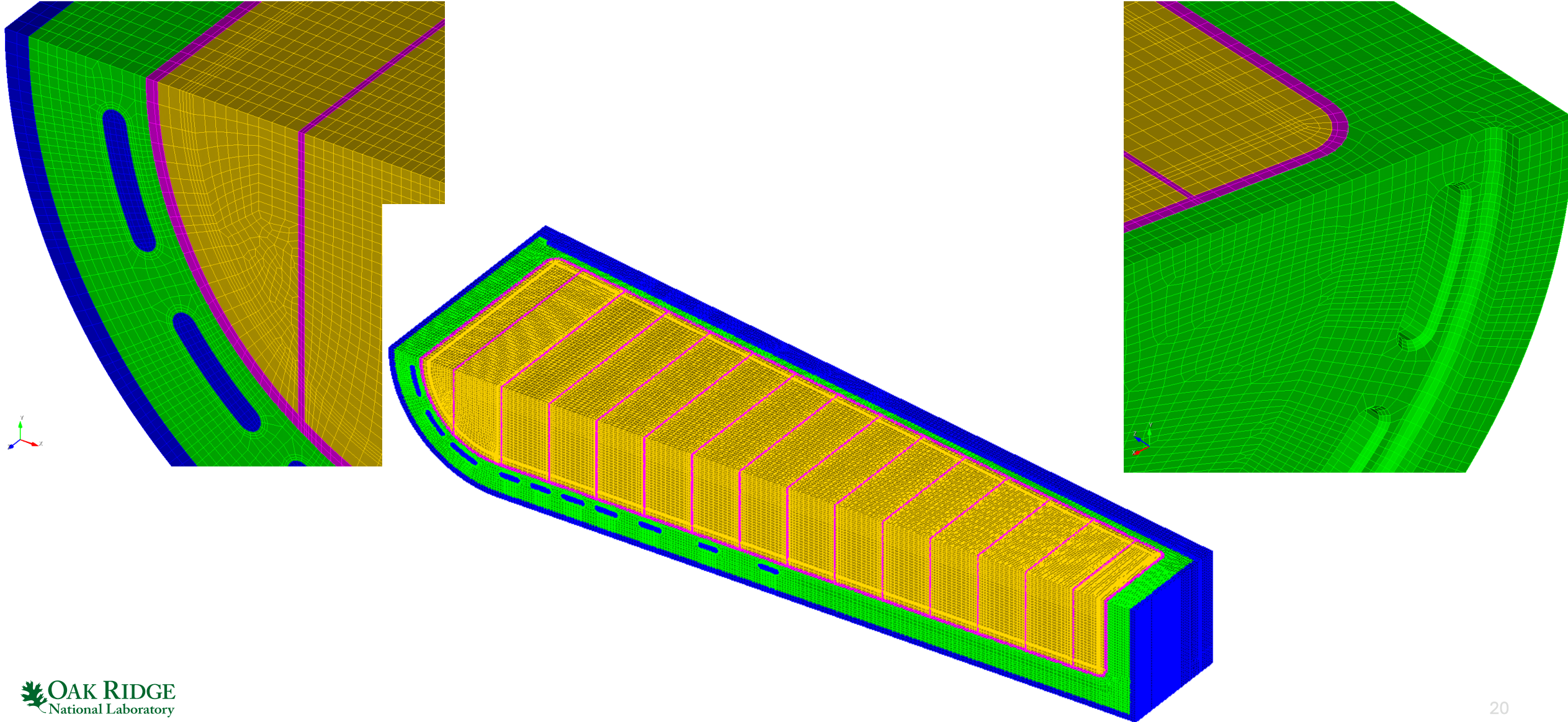
Discretization of major components.

Contacts in model require Hex (C3D8R) instead of Tet (C3D10M) elements

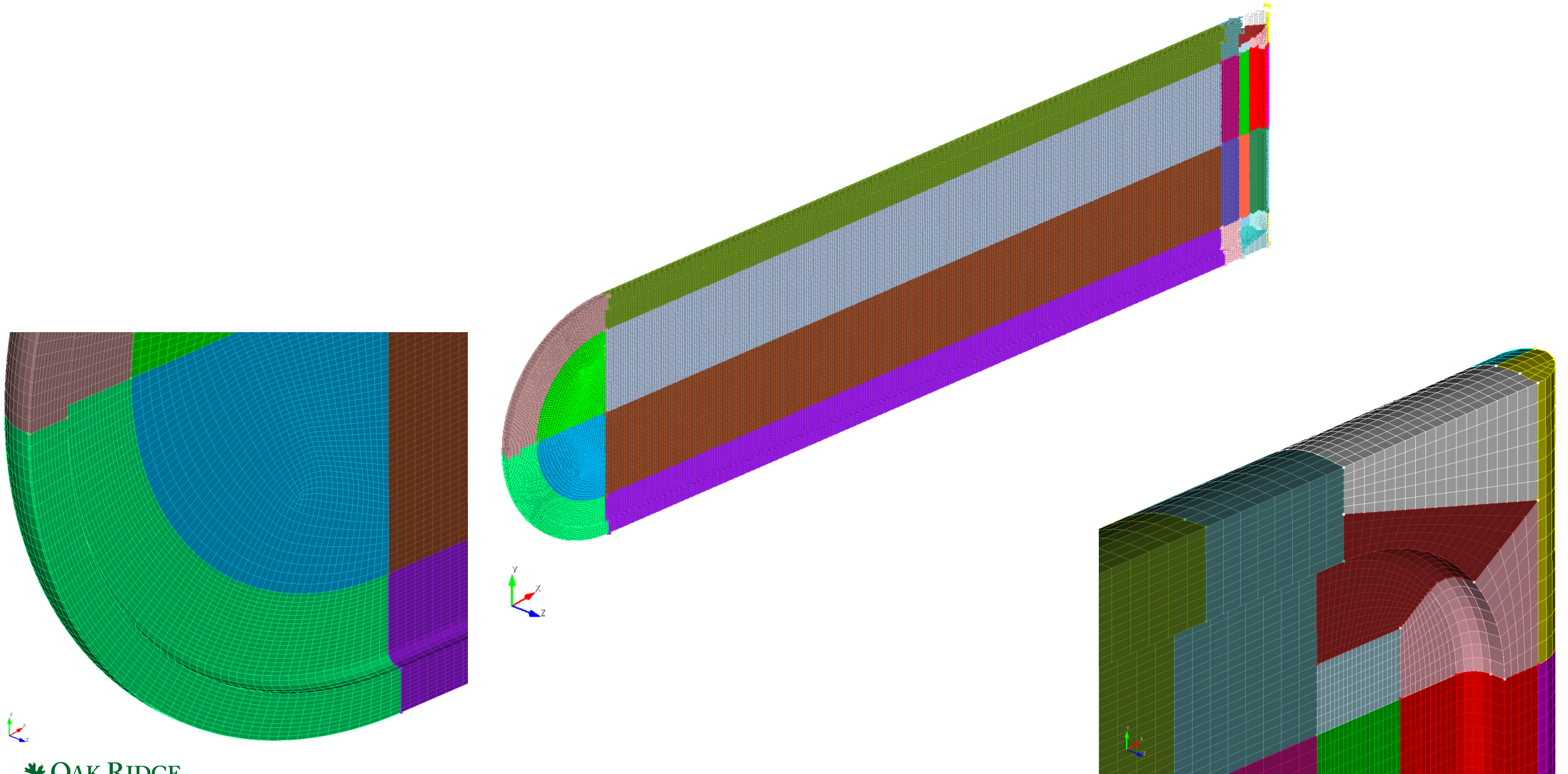
MK1 R&D model by Justin Mach



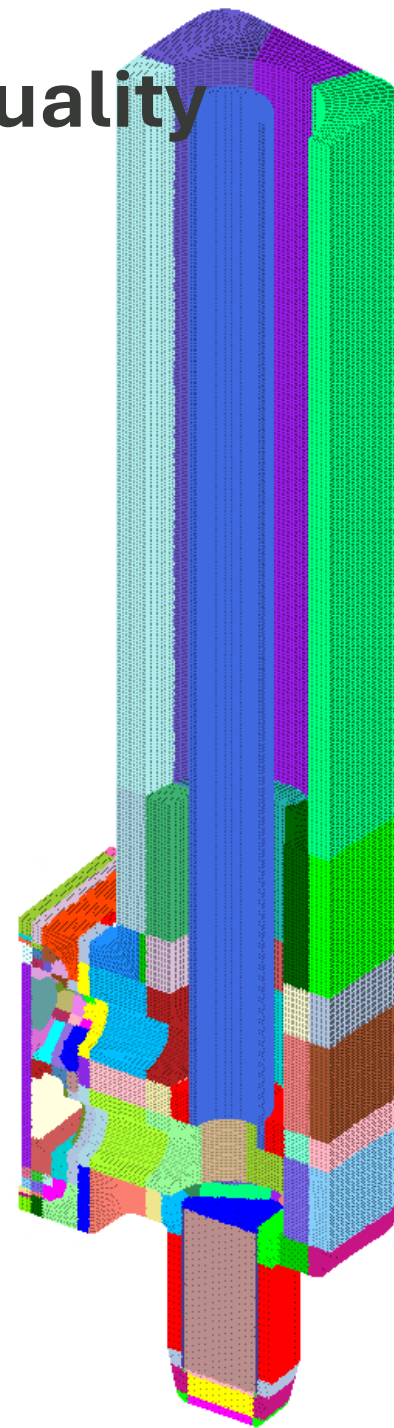
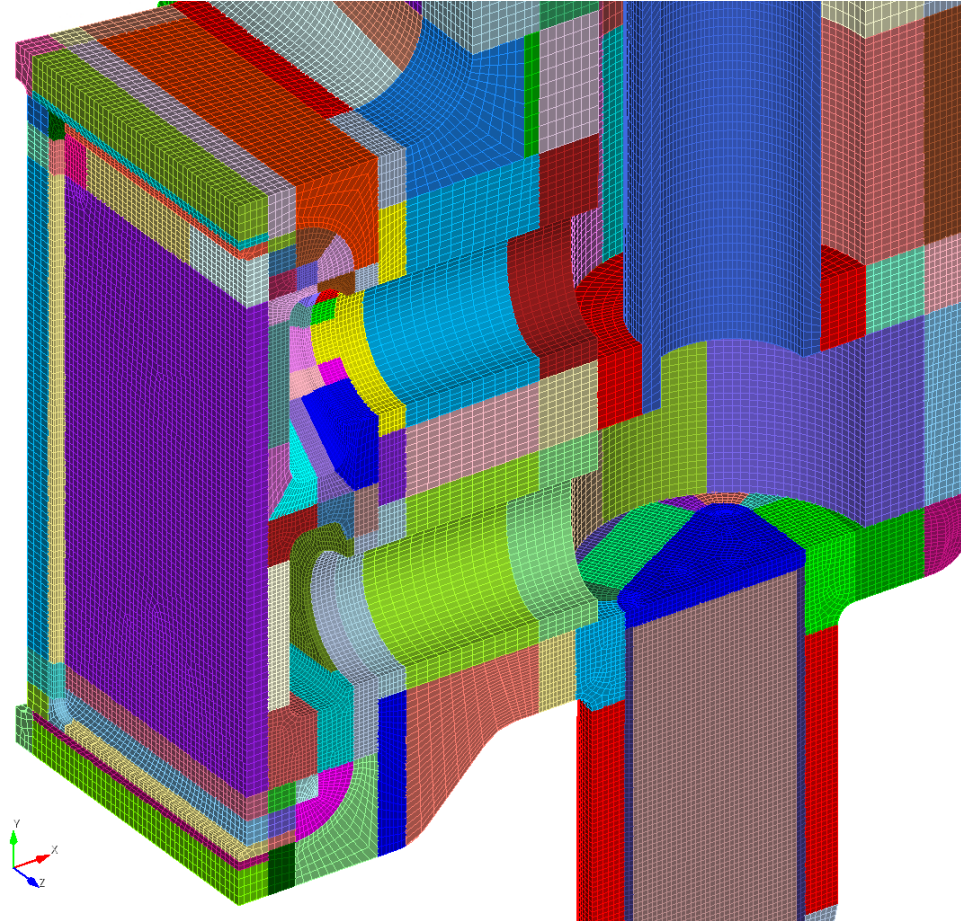
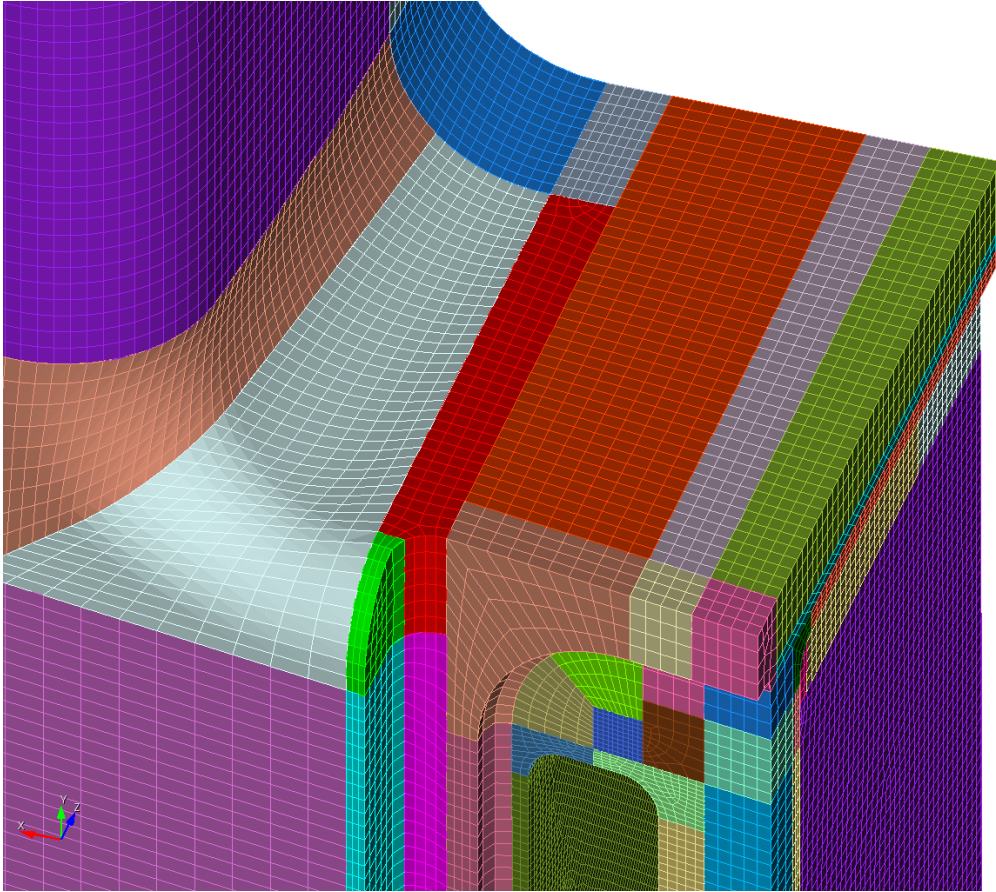
Quarter Sym Target: 1.2M elements with 1,138 low quality



Flow Cover: 285k elements with 554 low quality



Half Sym Target Heel: 755k elements with 1,150 low quality



Material Models

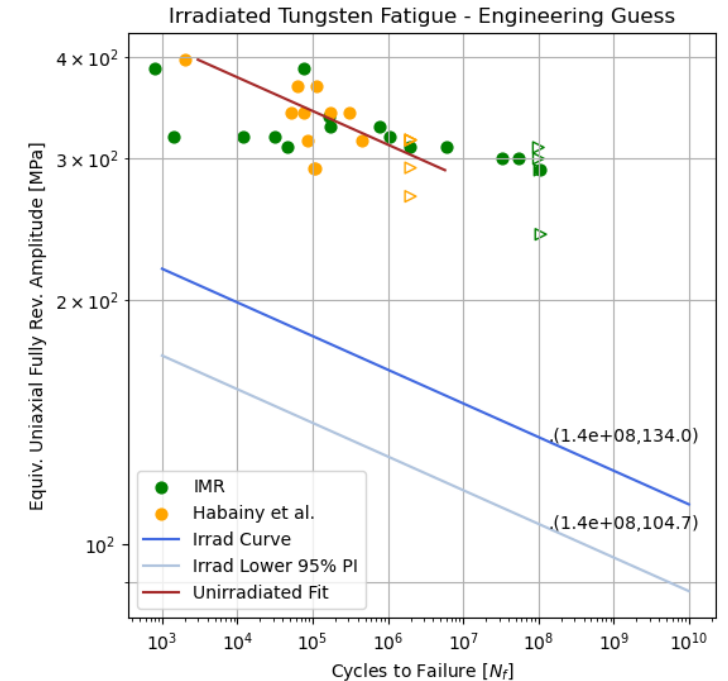
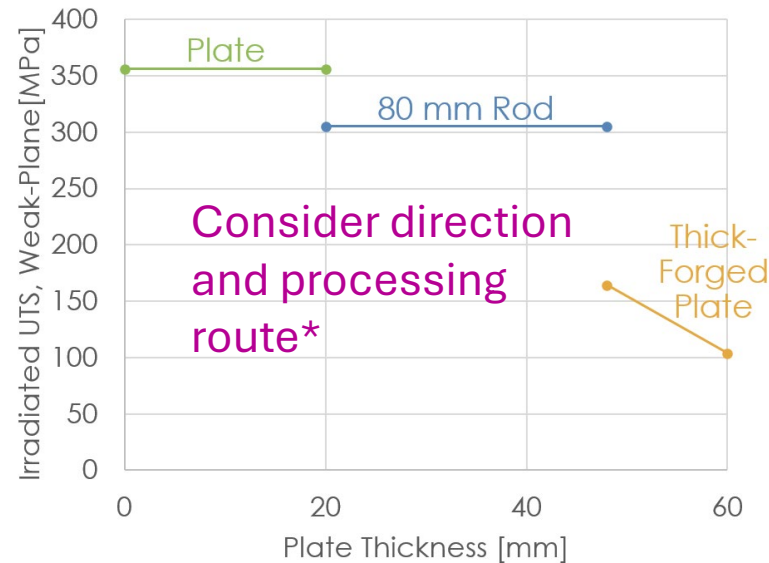
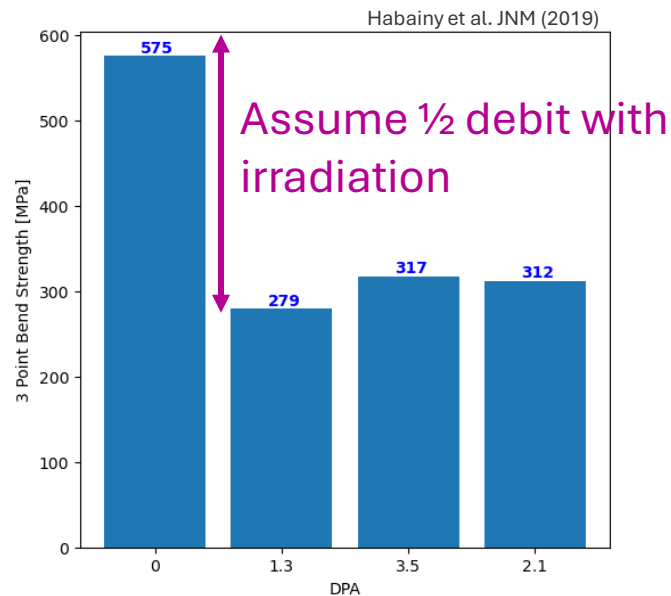
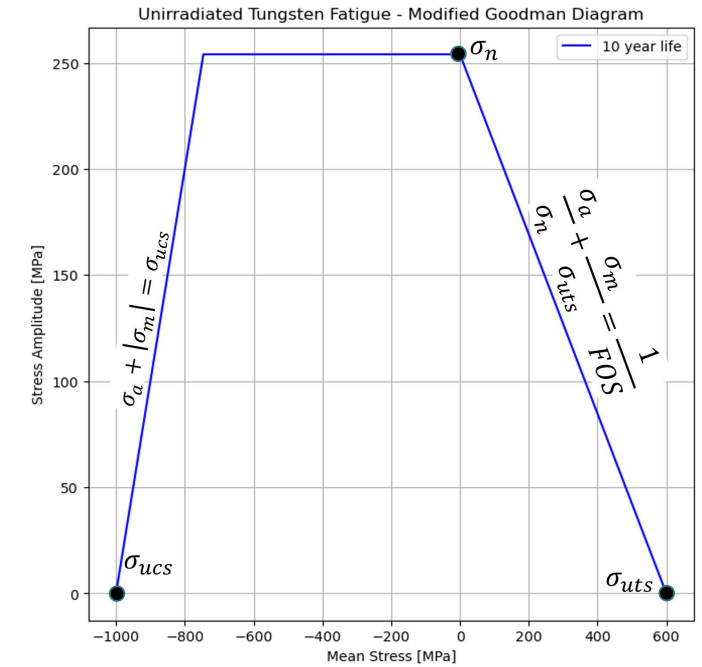
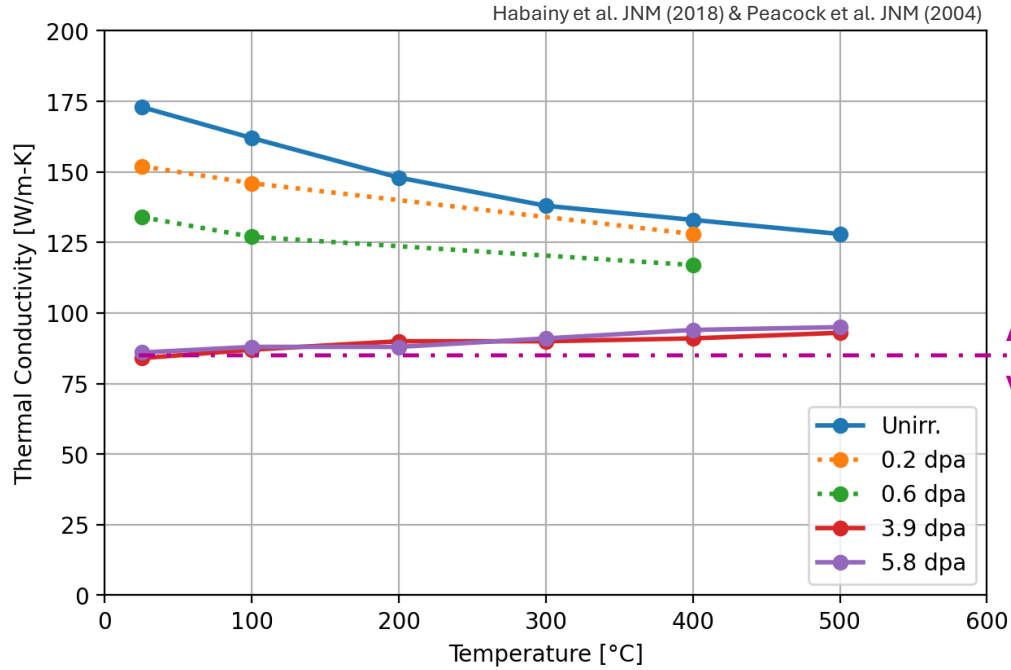
Tungsten

Tantalum

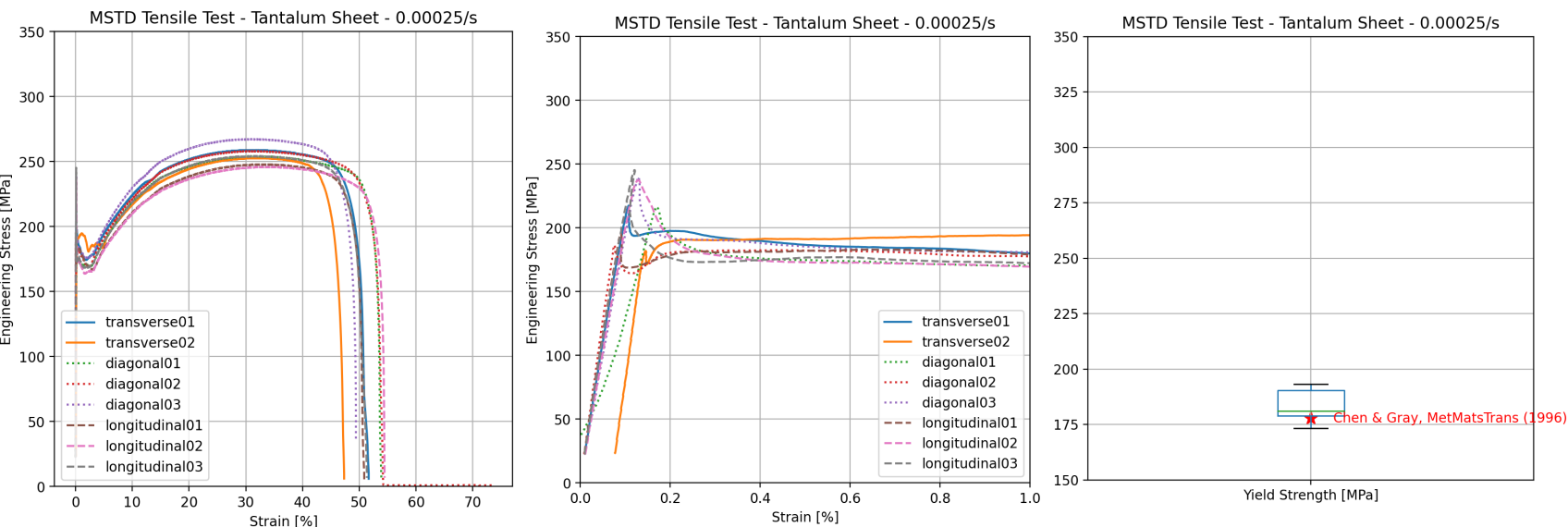
Stainless Steel

Inconel 718 (Solution Annealed)

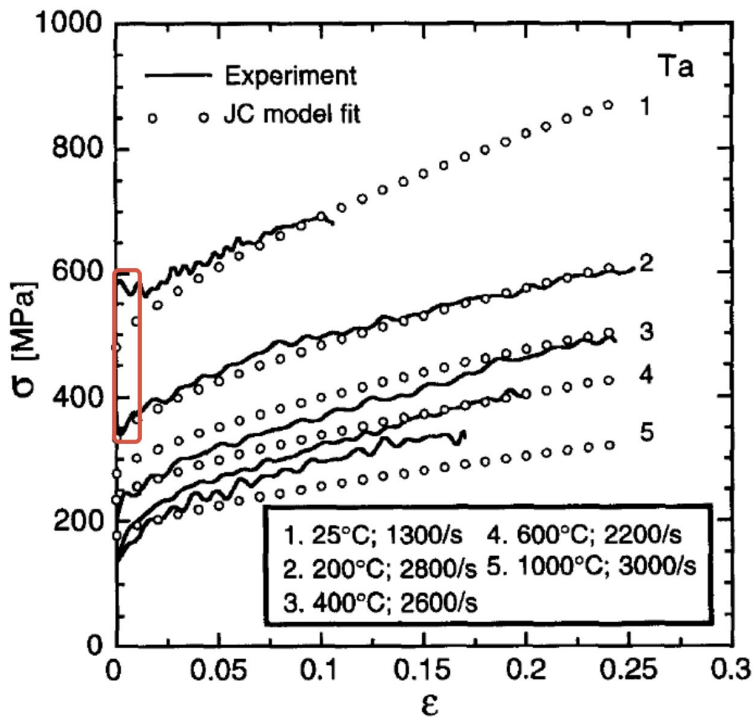
Key tungsten material models



Key tantalum material models



Thermoelastic-plastic material model captures plastic hardening and temperature softening. Strain rate effects not considered.



A. JC Model^[15]

$$\sigma = (A + B \cdot \epsilon_p^n)(1 + C \cdot \ln \dot{\epsilon}^*)(1 - T^{*m}) \quad [3]$$

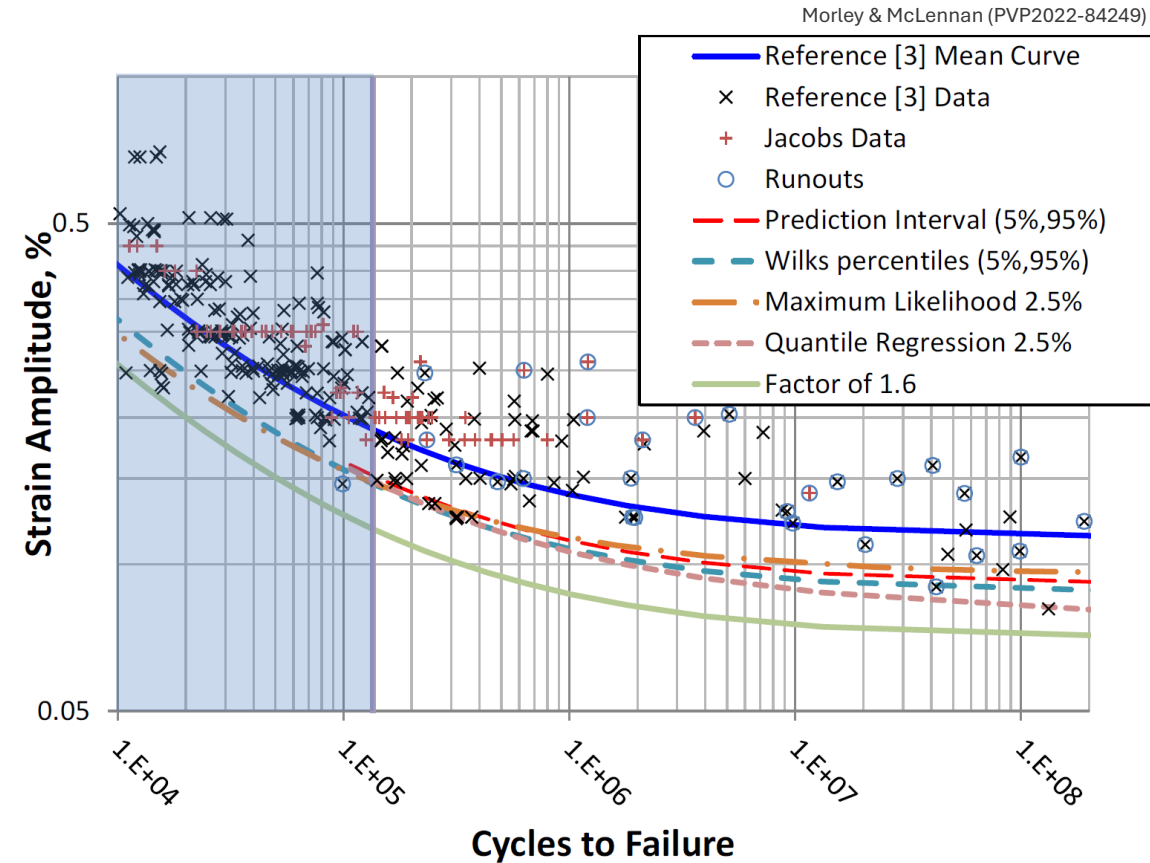
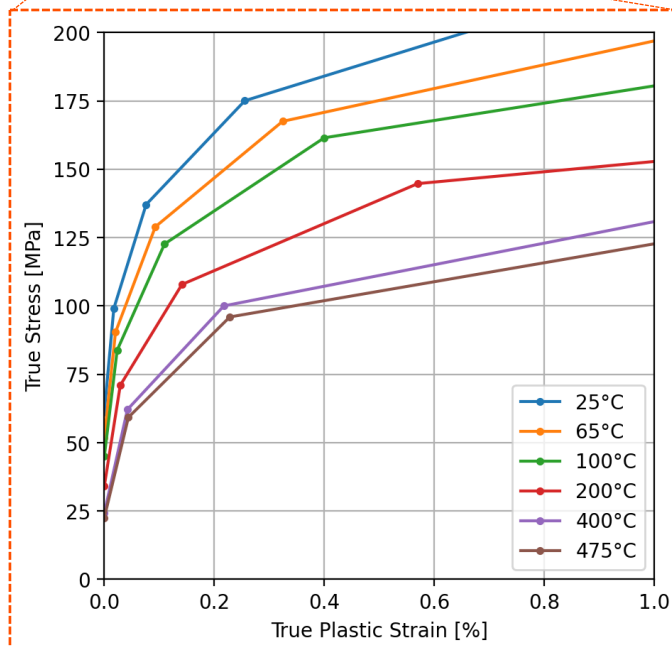
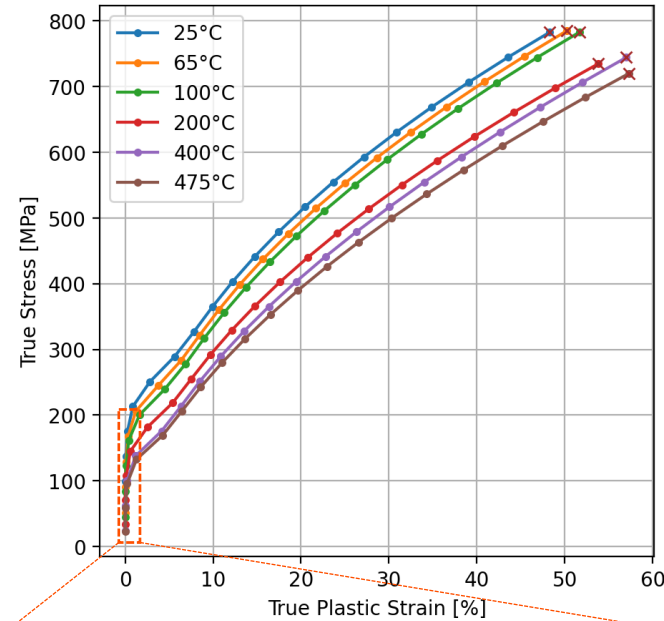
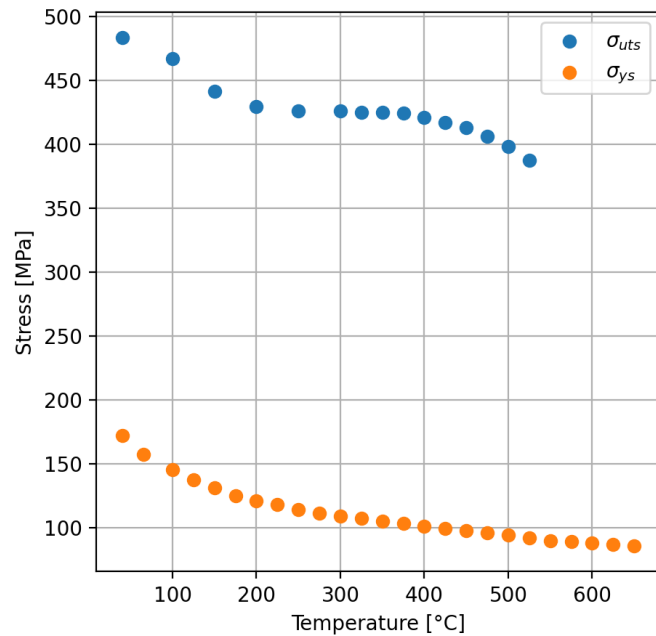
where $\dot{\epsilon}^*$ is a nondimensional strain-rate value, ϵ_p is the plastic strain, and T^* is $(T - T_{\text{room}})/(T_{\text{melt}} - T_{\text{room}})$. The value of T is in degrees kelvin, and A , B , n , C , and m are constants for this model.

Table III. Fitting Parameters for JC Model

	A (MPa)	B (MPa)	n	C	m	T_m (K)
Ta	340	750	0.7	0.0575	0.400	3250

Key stainless steel material models

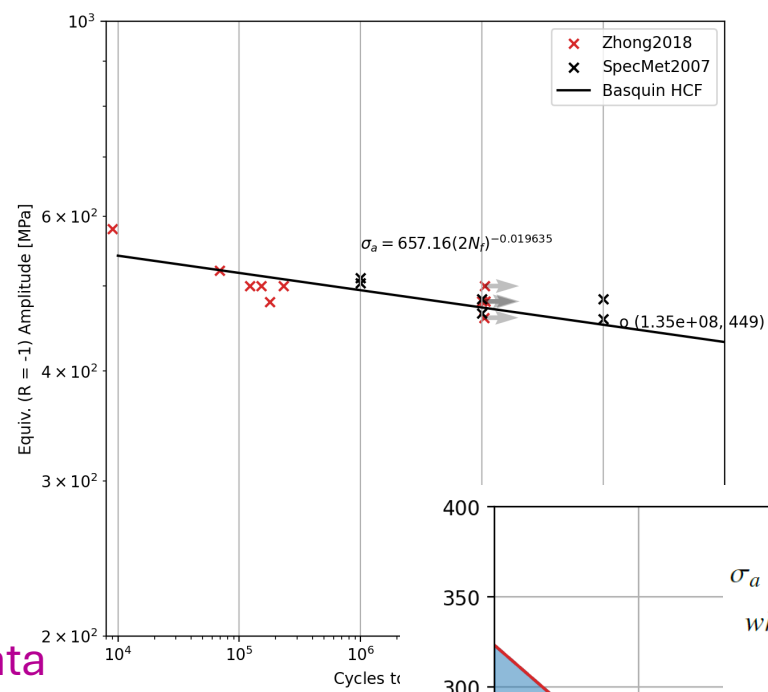
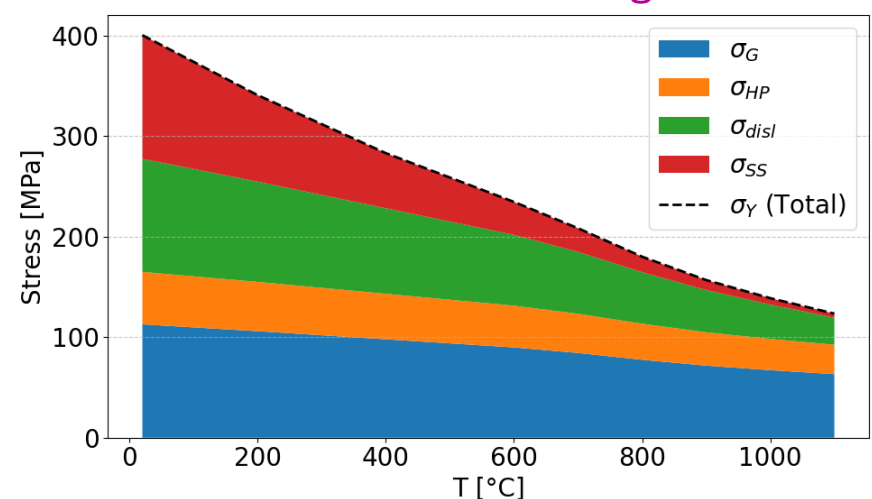
ASME/BPVC provides thermoelastic-plastic models



Mean fatigue life curve comes from NUREG data that was used to update ASME/BPVC

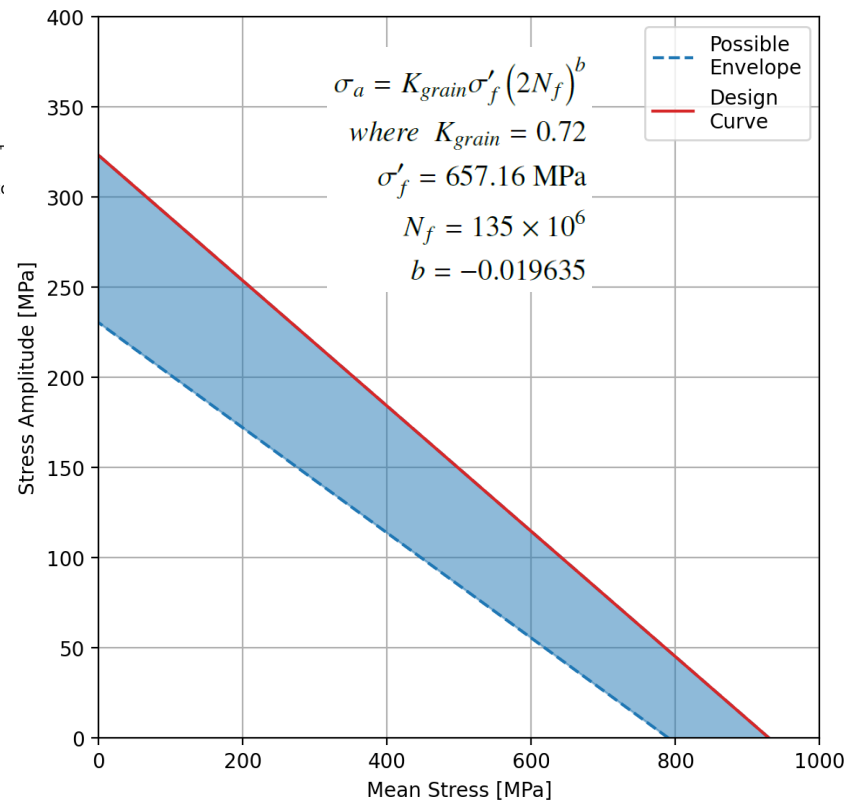
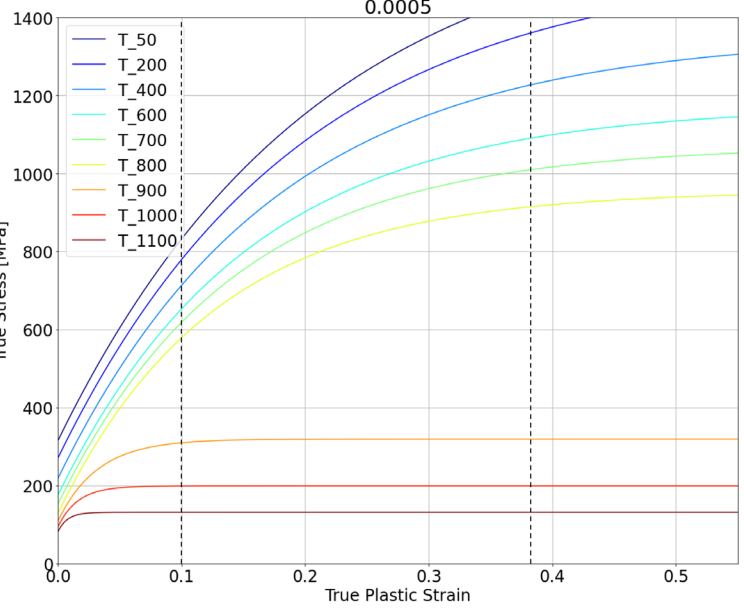
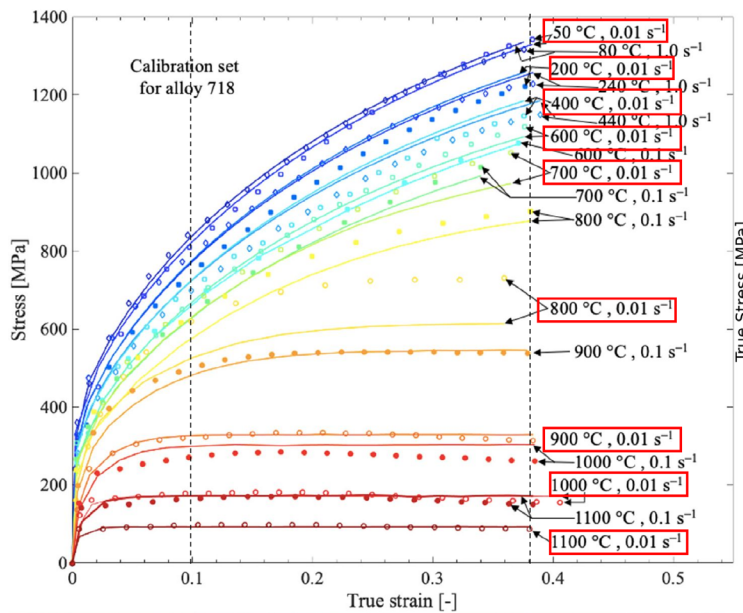
Key IN718 material models for solution annealed condition

Mechanistic modeling of YS



Fatigue curve informed from published data in SA condition

Thermoelastic-plastic model calibrated to published data



Manufacturing Simulation Residual Stresses

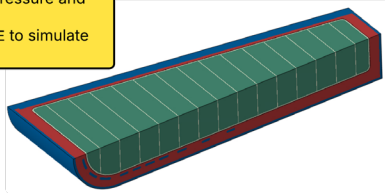
HIP simulation + Creep = High Residual Stresses

Machining simulation redistributes stresses

Manufacturing simulation captures the significant residual stresses

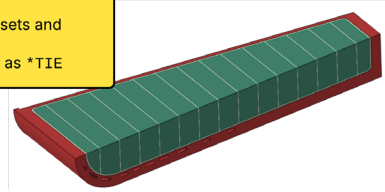
abq_quarter_mfg.inp

- manufacturing simulation of the target foot
- Abaqus|Implicit using *VISCO to capture creep
- Ta/IN718 contact modeled as *FRICTION $\mu=0.4$ and then *FRICTION, ROUGH
- 4 steps of HIP using *DSLOAD for pressure and *TEMPERATURE
- 1 step of *MODEL CHANGE, REMOVE to simulate machining of water passages



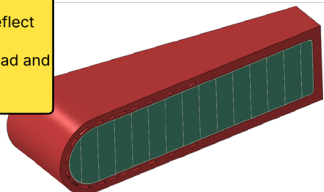
abq_quarter_mod.inp

- dummy simulation of target foot
- Abaqus|Implicit
- use *IMPORT to load previous result, sans machined volume
- use *INCLUDE to redefine element sets and materials, sans machined volume
- redefine Ta/IN718 contact surfaces as *TIE

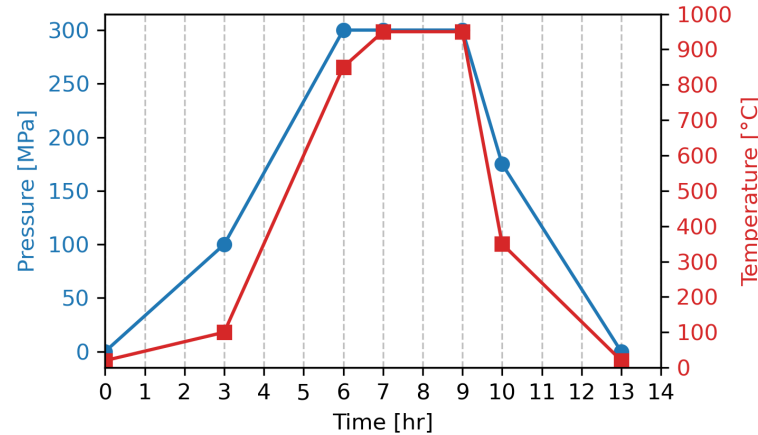


abq_half_mfg.inp

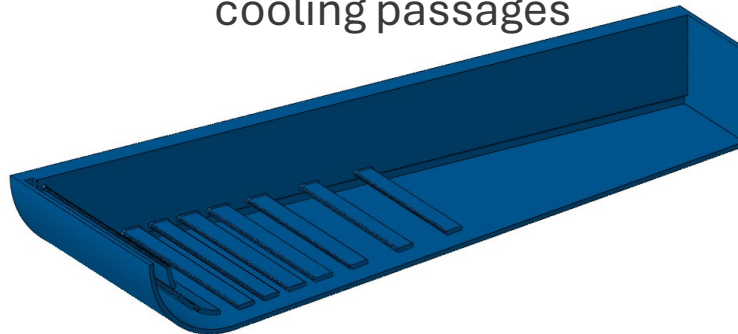
- dummy simulation of target foot
- Abaqus|Implicit
- use *SYMMETRIC MODEL GENERATION to reflect quarter sym into half sym
- use *SYMMETRIC RESULTS TRANSFER to load and apply previous result



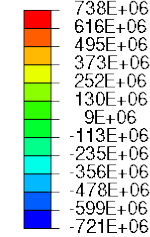
HIP Profile w/ Creep



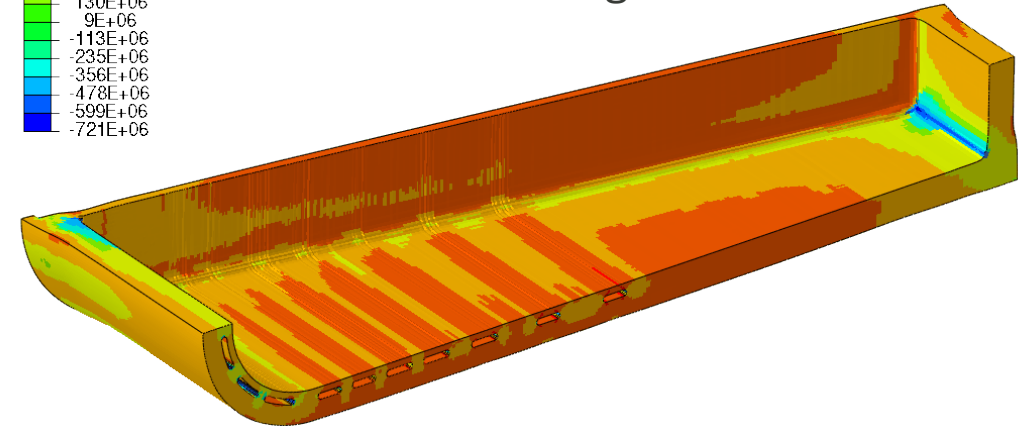
Machining
cooling passages



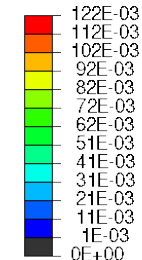
S, Max. Principal (Abs)



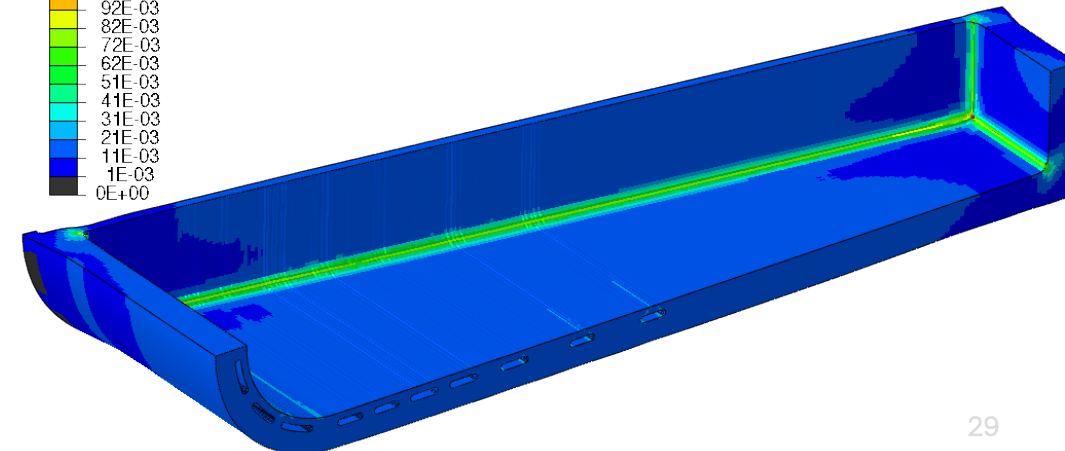
Significant Plastic
Hardening



PEEQ

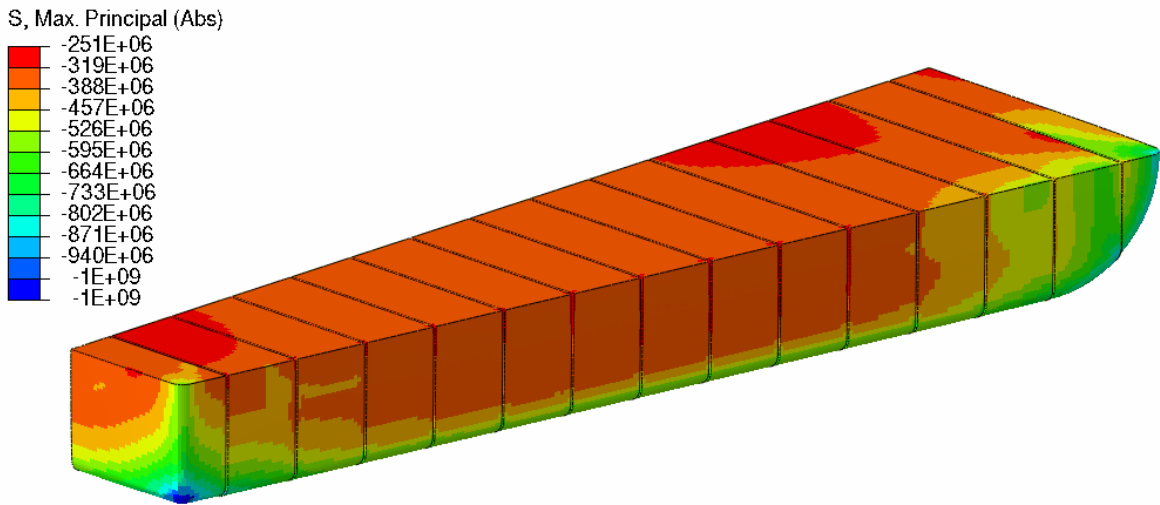


High Plastic Strains

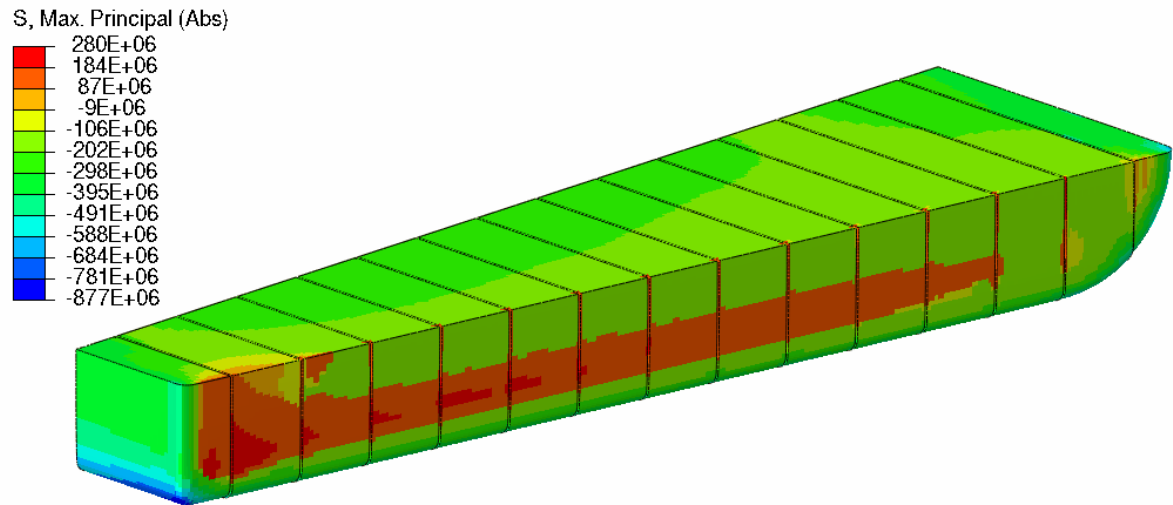


Tungsten stress state is complicated by machining operation

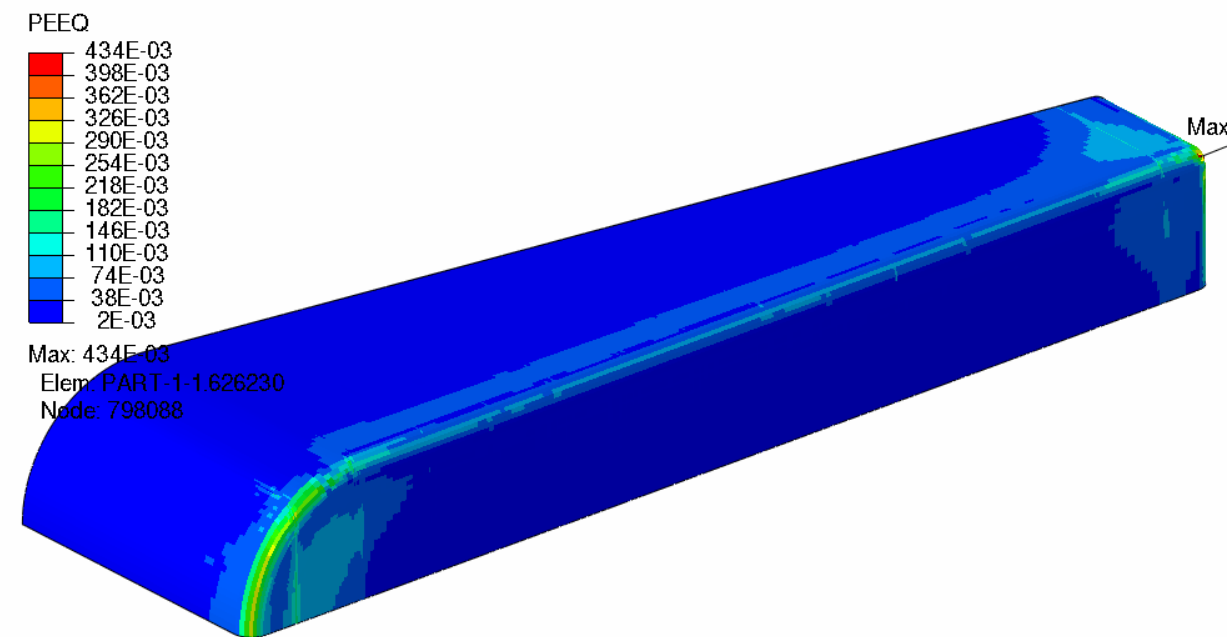
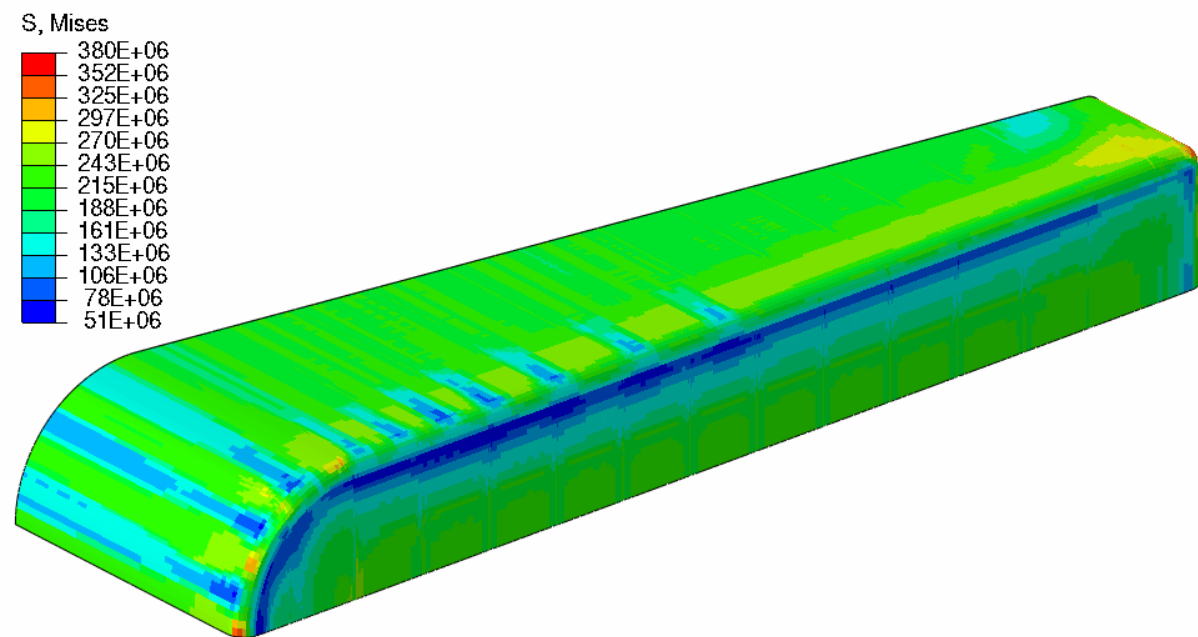
Before machining simulation



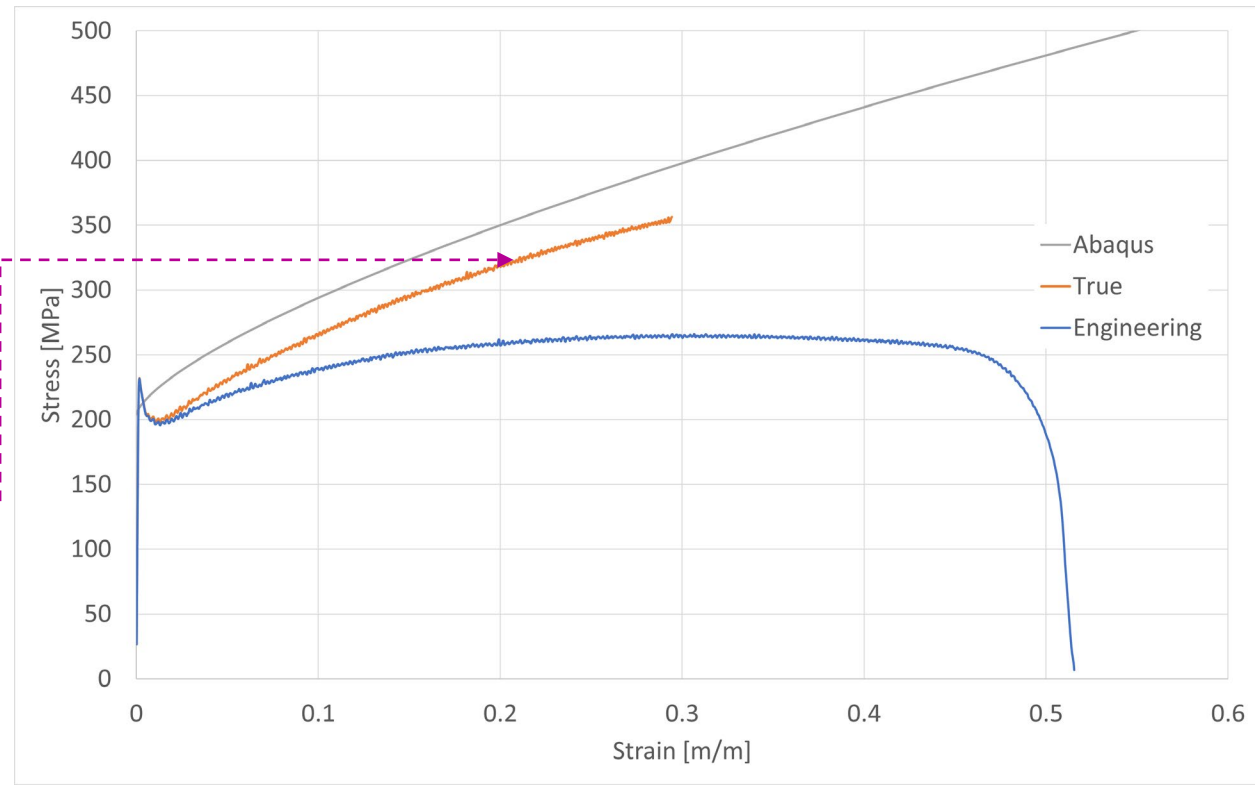
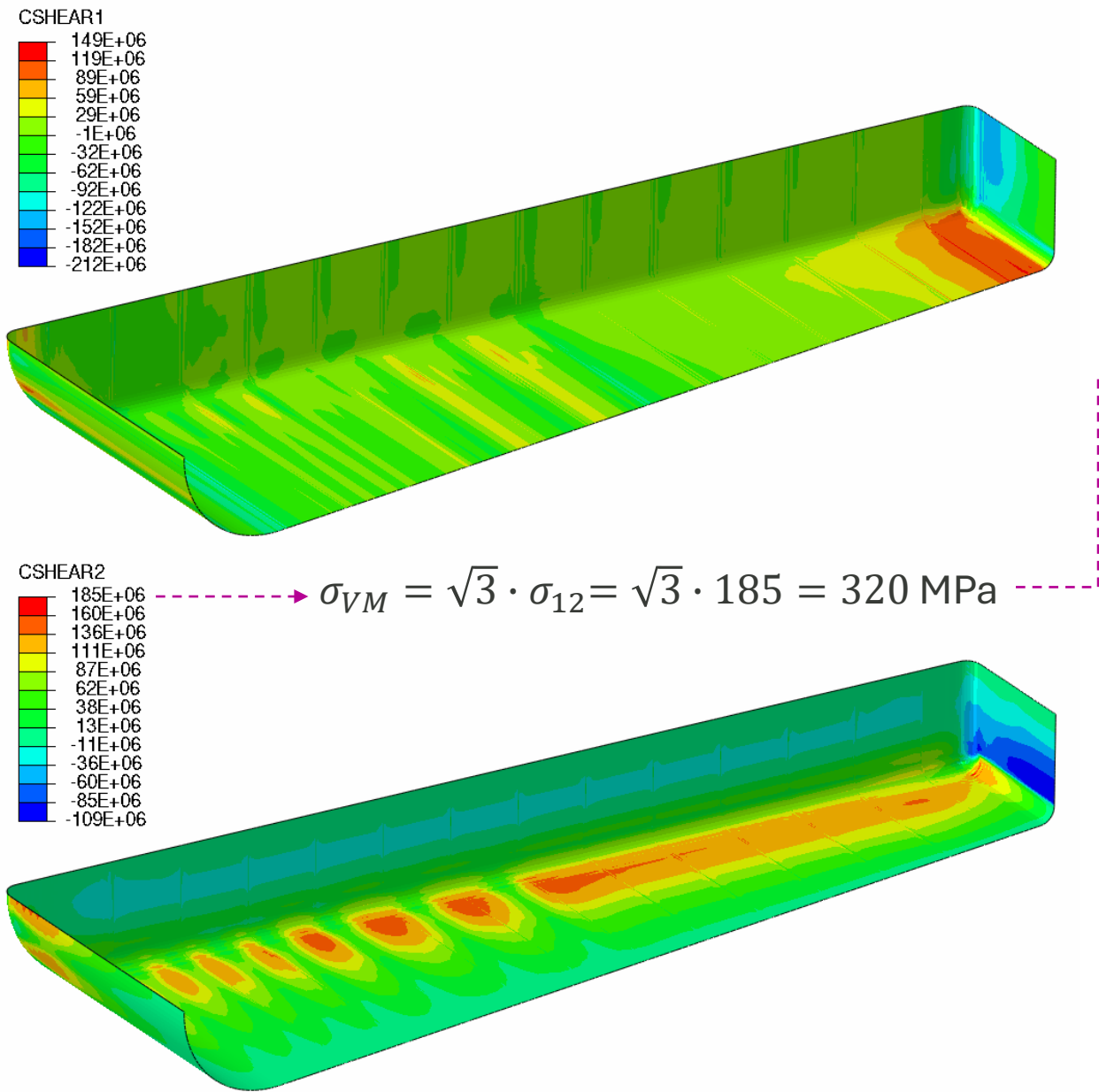
After machining operation



Tantalum provides compliant inner layer

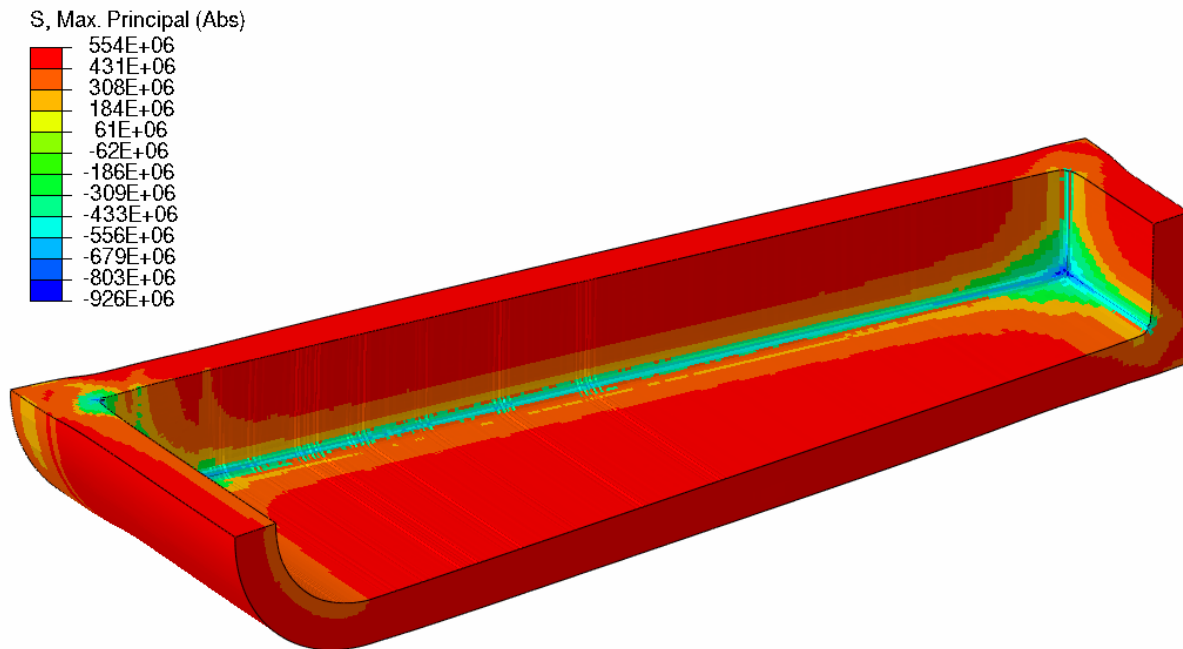


Tantalum has sufficient strength to support Ta/IN718 bond

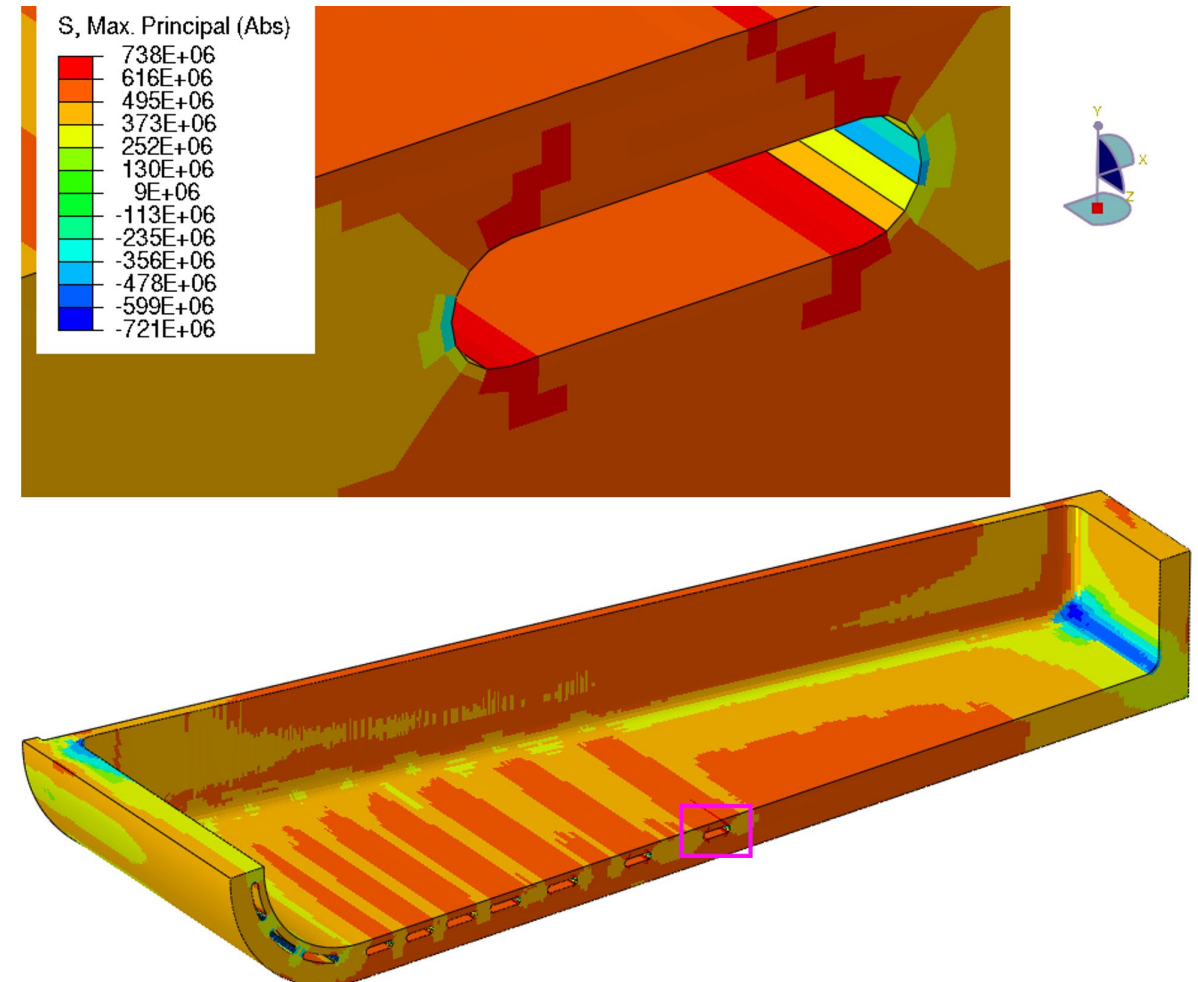


Machining places peak stresses at Inconel cooling passages

Before machining simulation

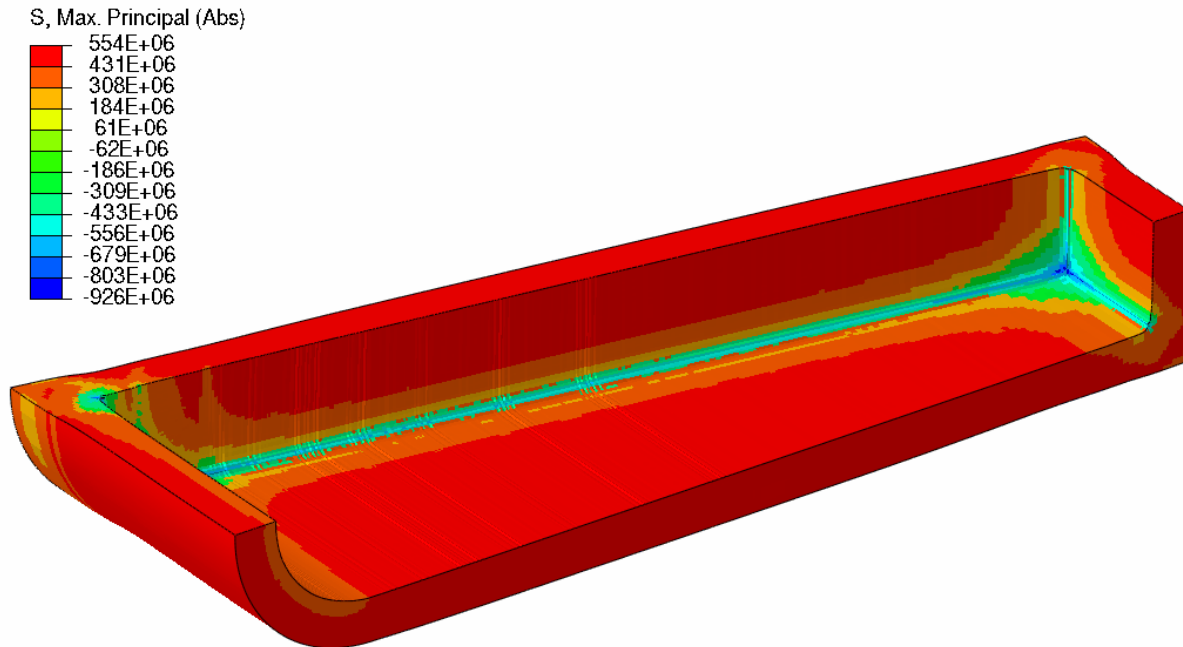


After machining simulation

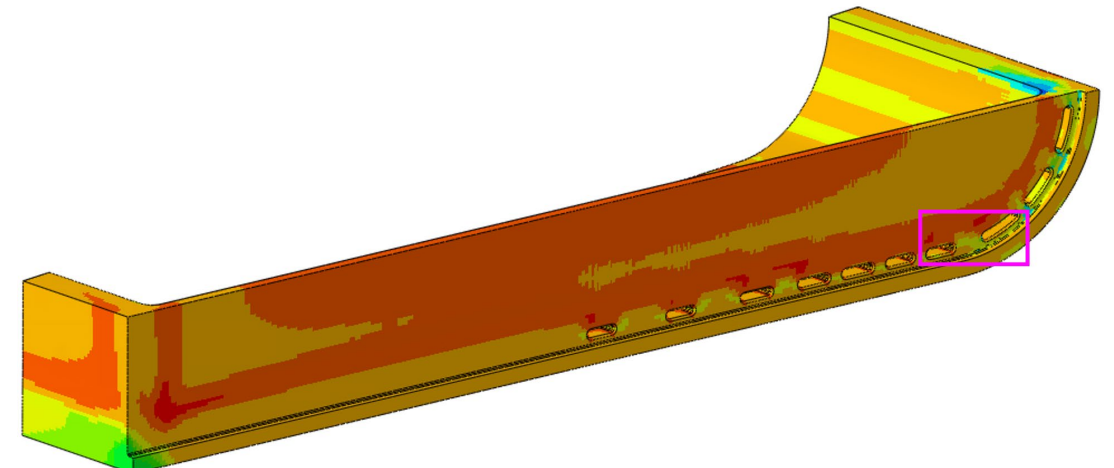
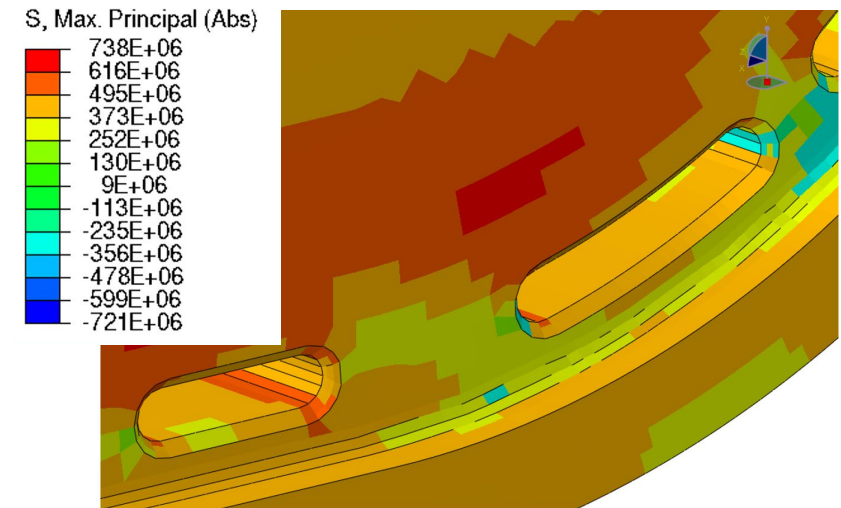


Machining places peak stresses at Inconel cooling passages

Before machining simulation



After machining simulation



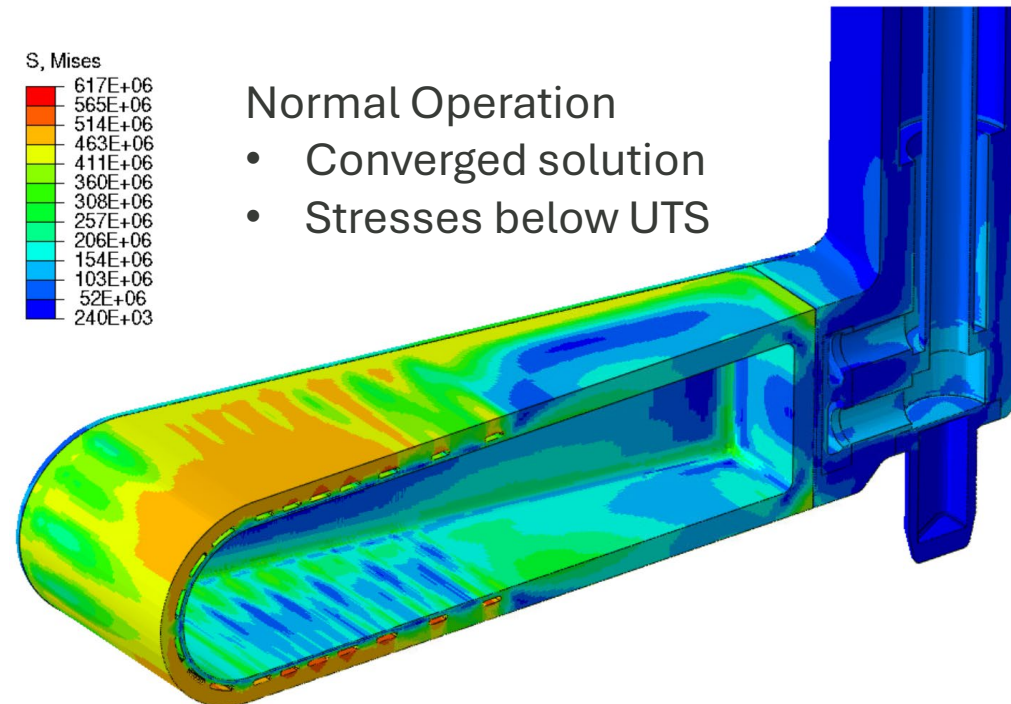
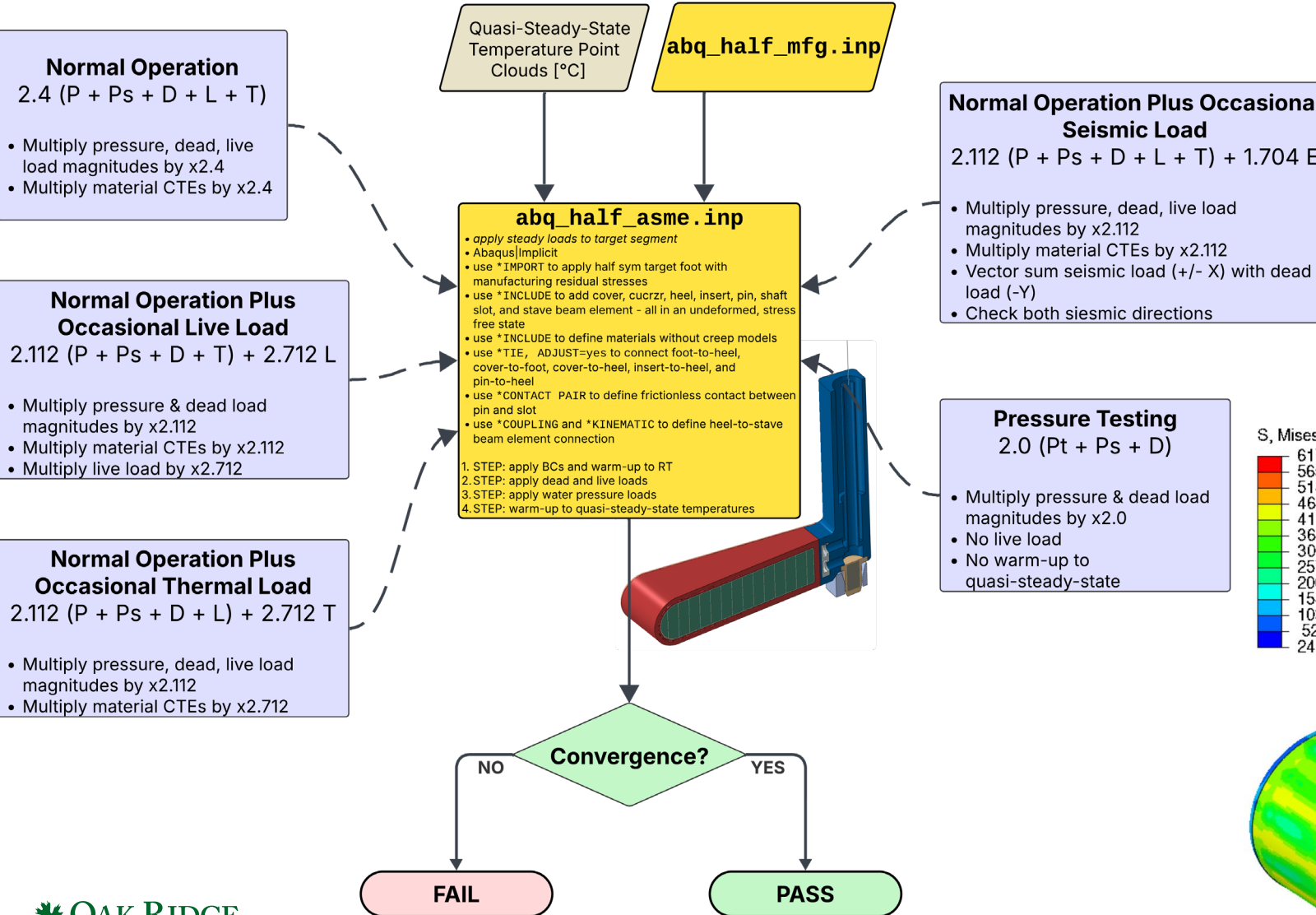
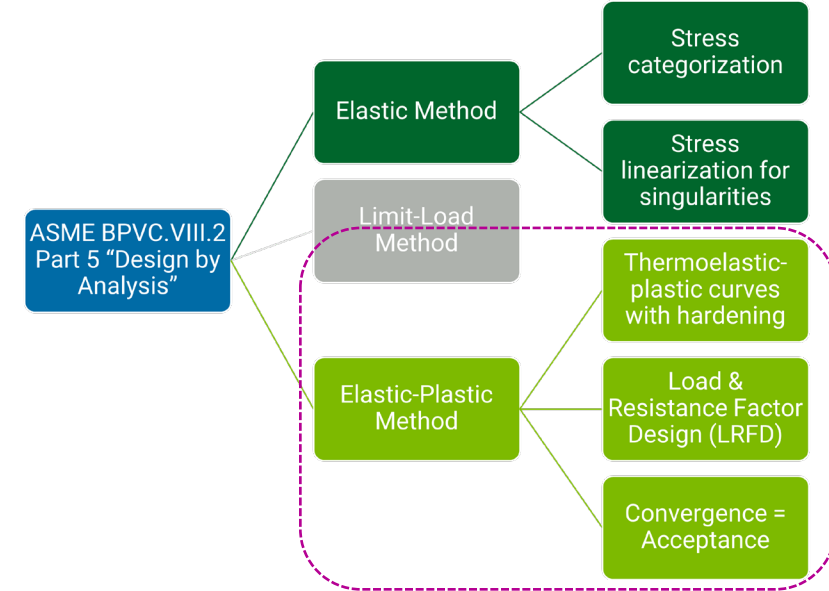
Static Load Cases

Use ASME/BPVC elastic-plastic methodology to incorporate manufacturing residual stresses.

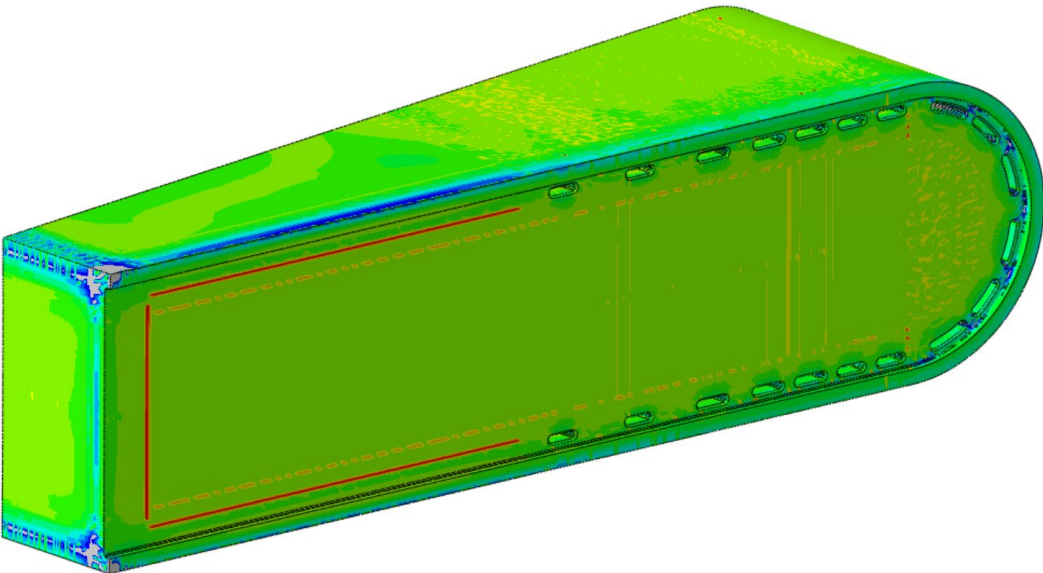
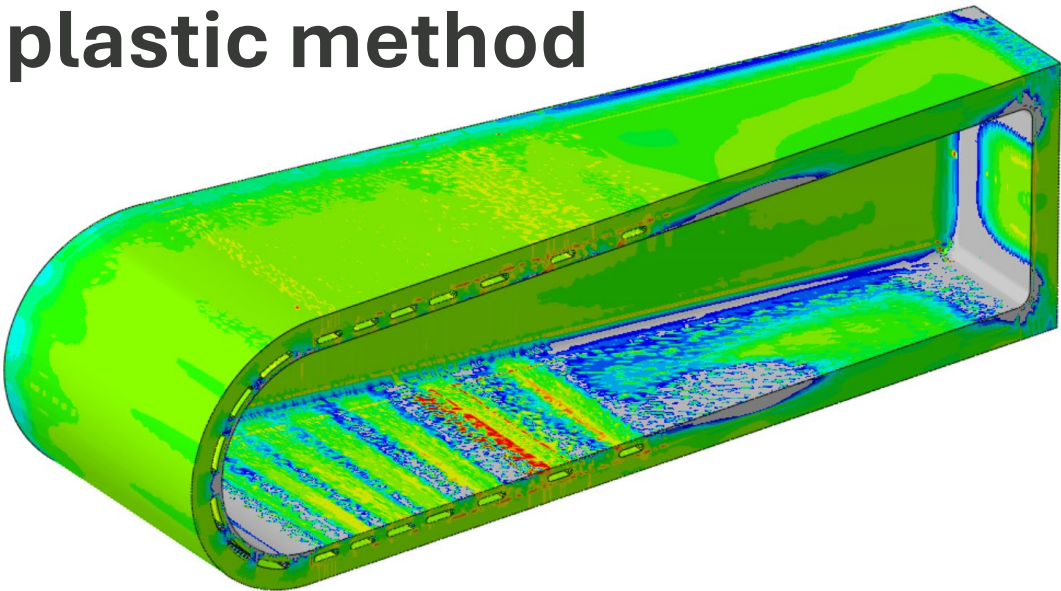
Consider plastic collapse and local failure modes.

Buckling failure considered negligible.

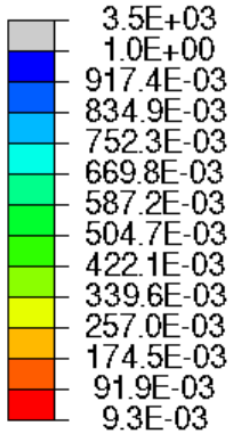
All load cases pass for protection against plastic collapse



Adequate strain margin against local failure using elastic-plastic method

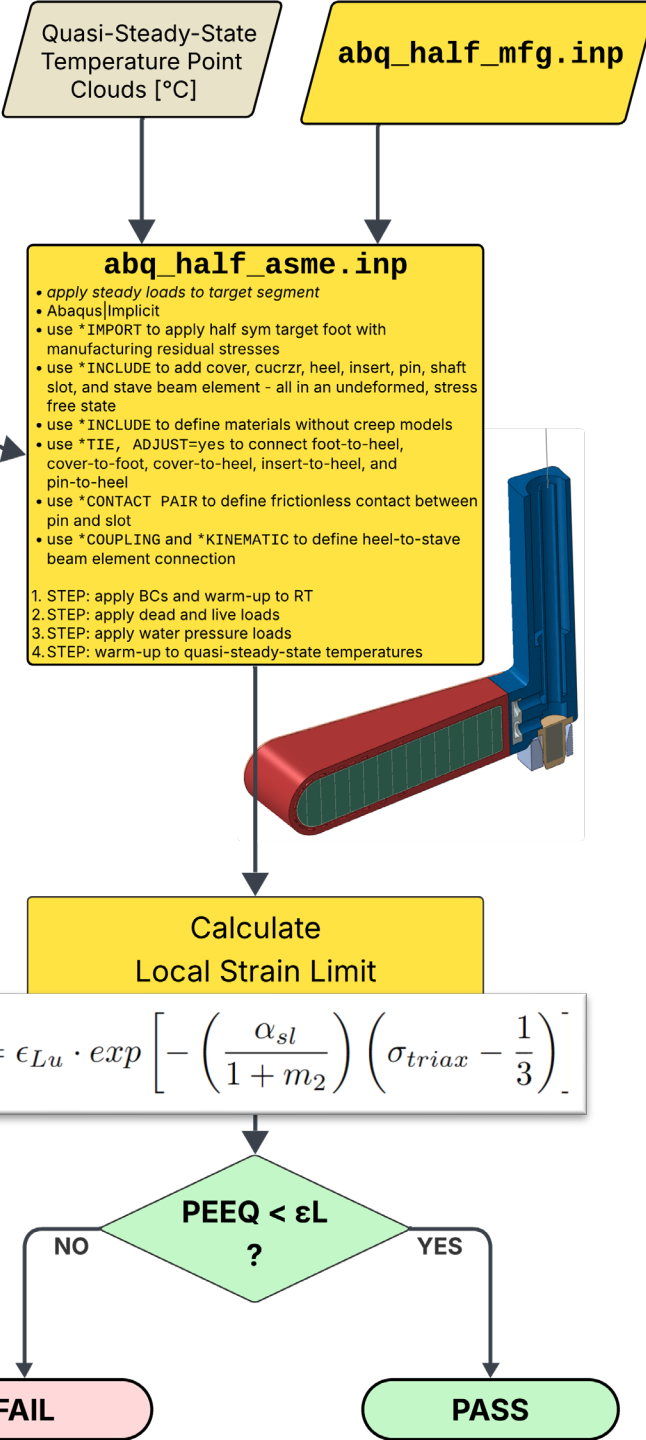


$$E_{margin} = \epsilon_L - PEEQ$$



Normal Operation
1.7 (P + Ps + D + L + T)

- Multiply pressure, dead, live load magnitudes by x1.7
- Multiply material CTEs by x1.7



Fatigue Load Cases

Quasi-static simulation of response to beam trip

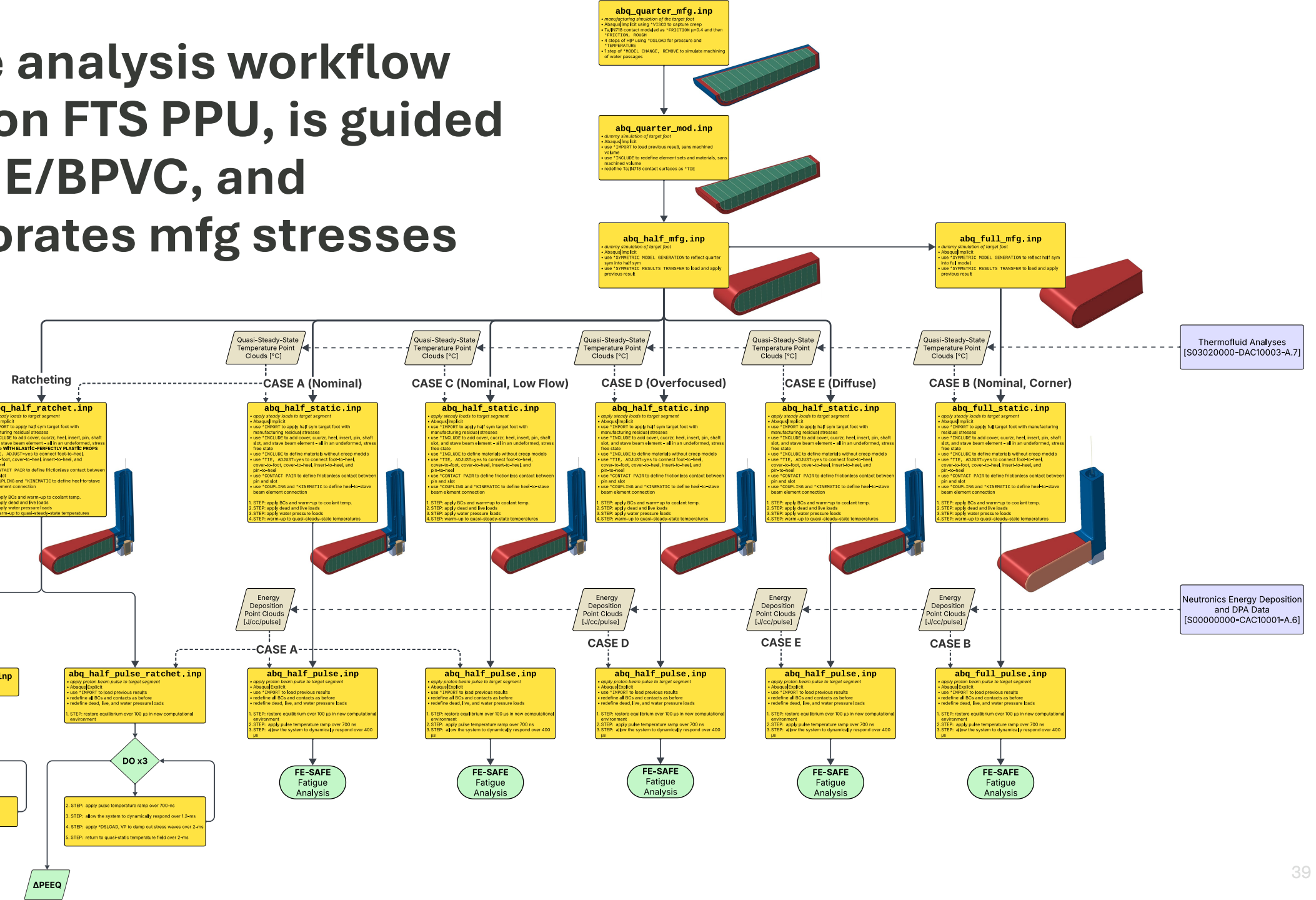
Explicit dynamic simulation of response to proton beam pulse

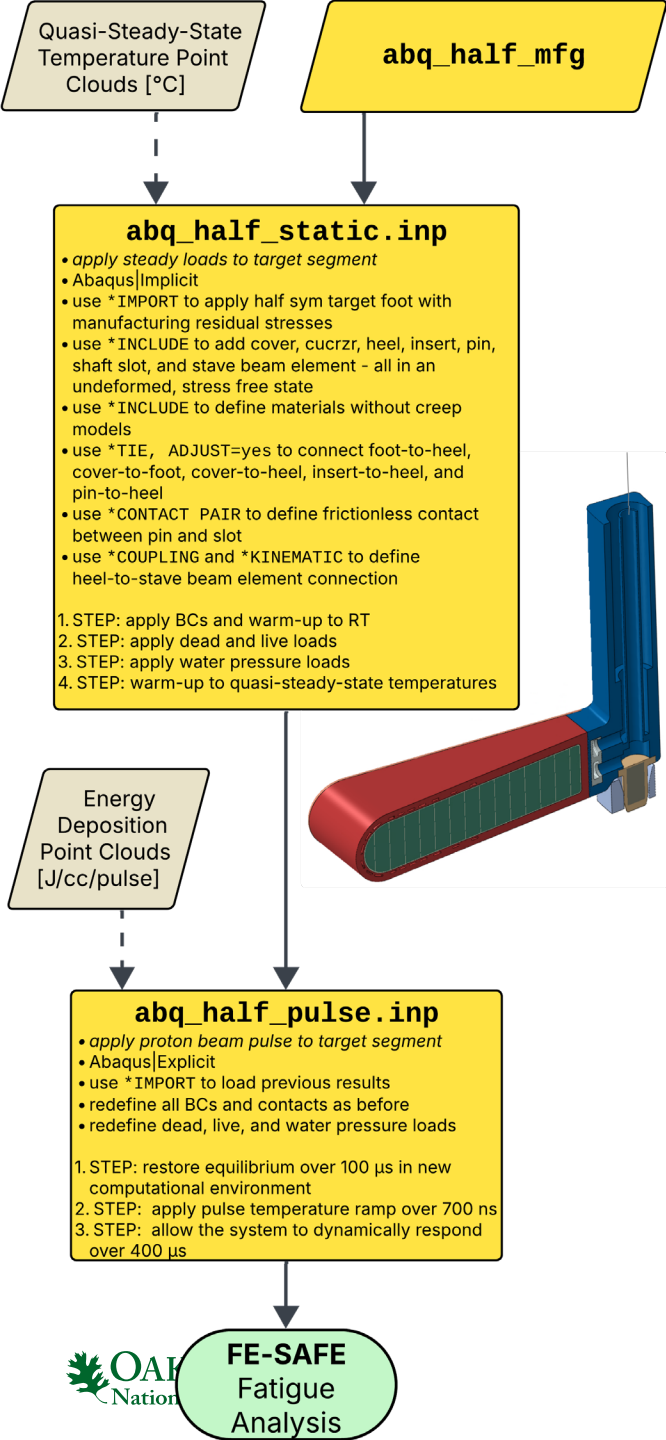
Critical plane fatigue analysis using FE-SAFE

Consideration of beam cases

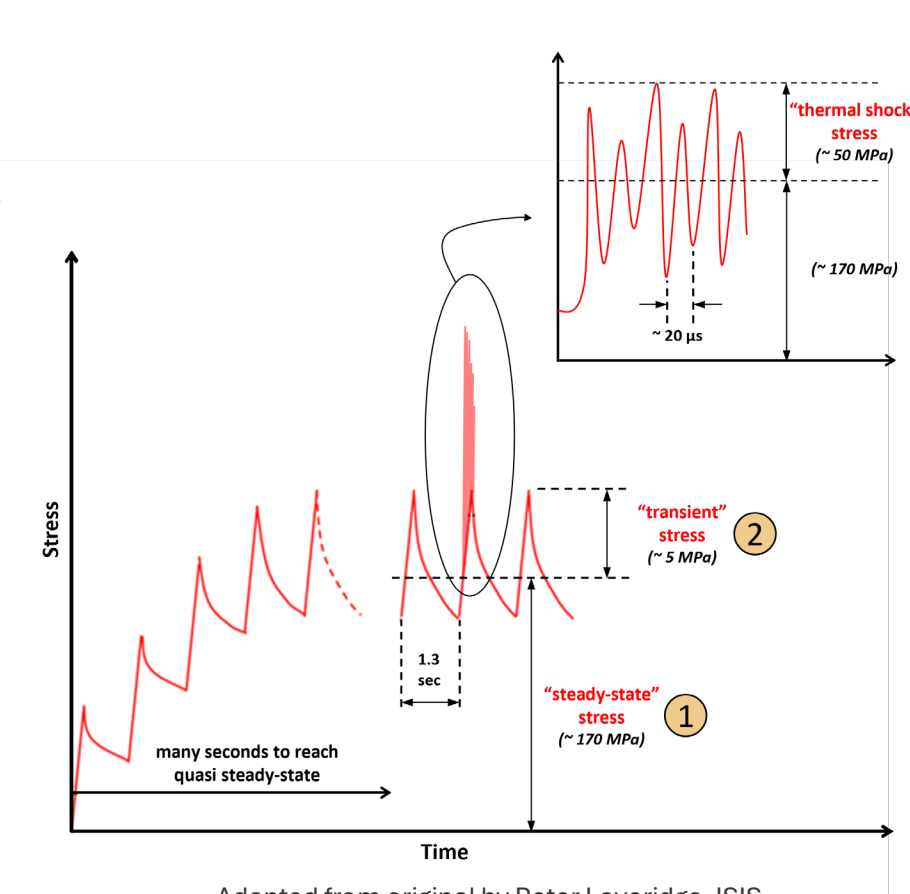
Weld analysis

Fatigue analysis workflow builds on FTS PPU, is guided by ASME/BPVC, and incorporates mfg stresses

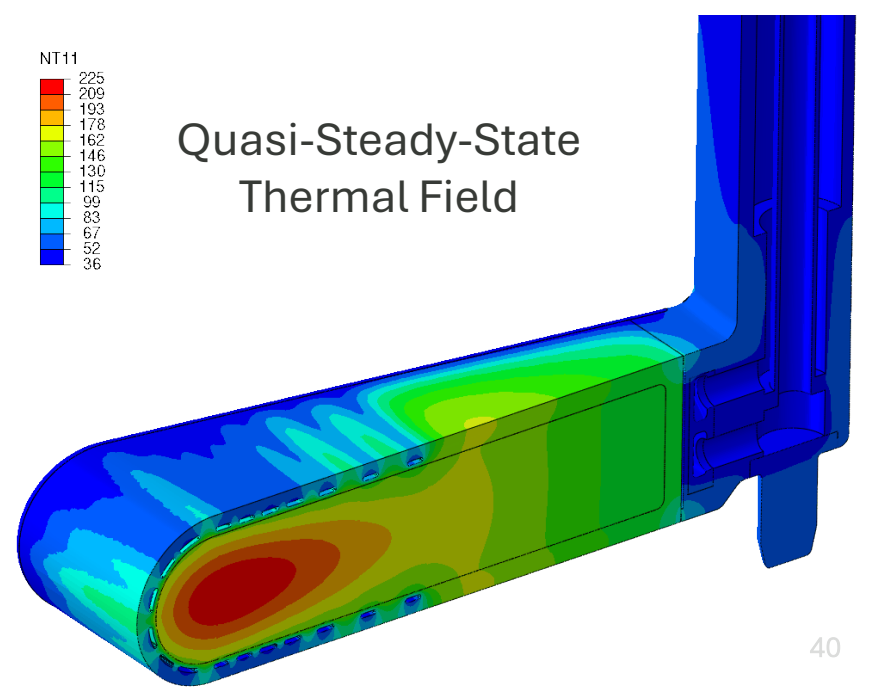
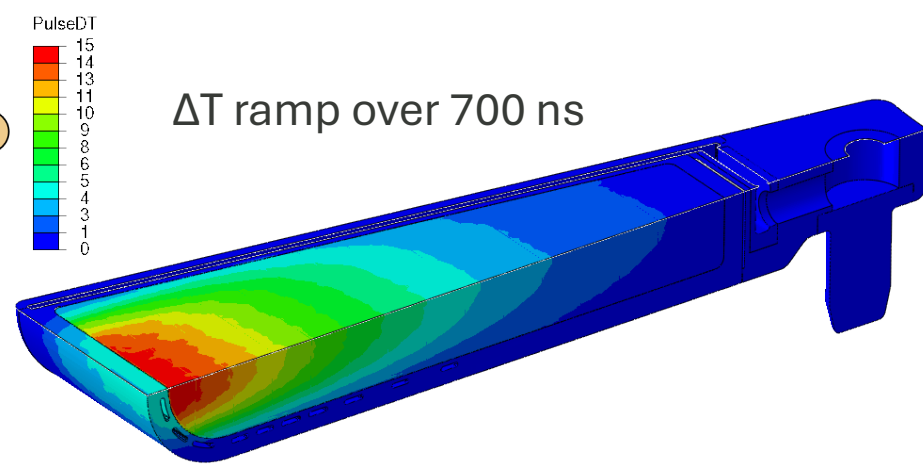




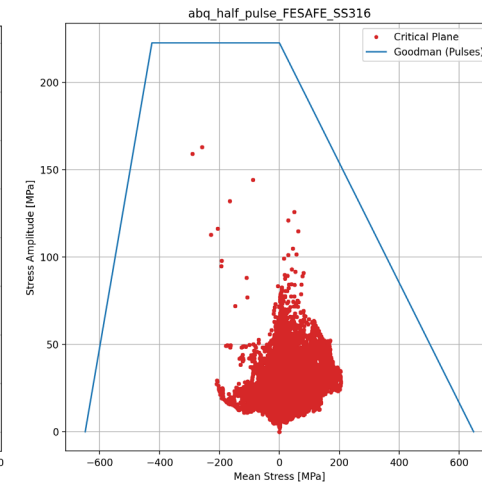
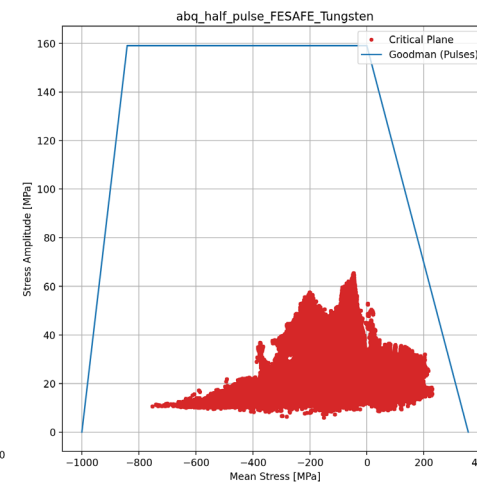
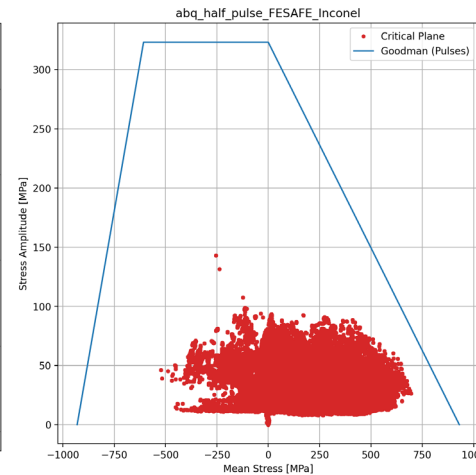
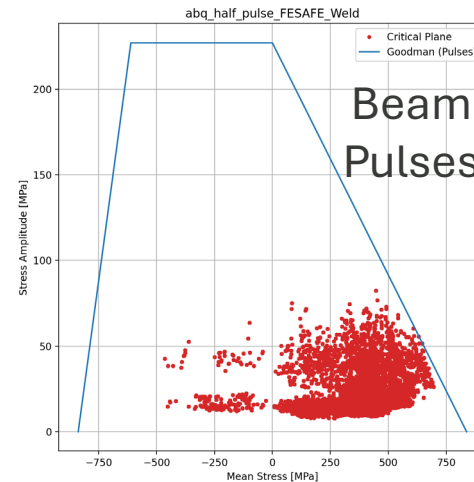
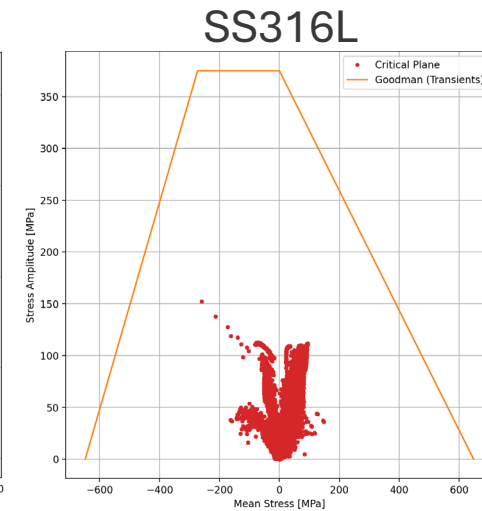
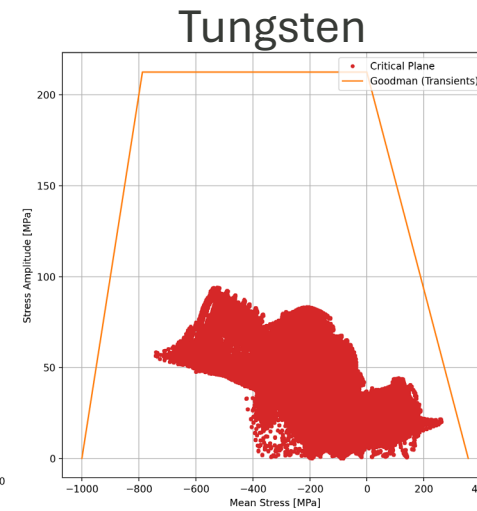
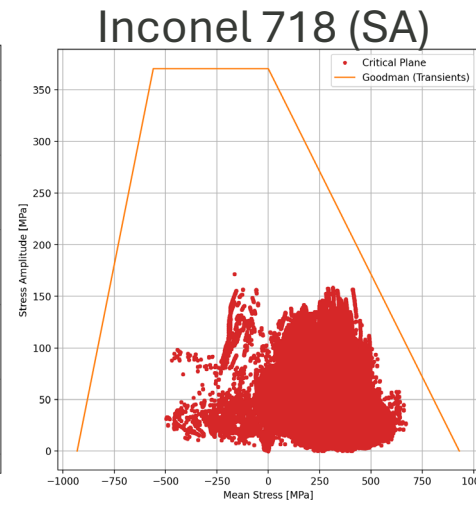
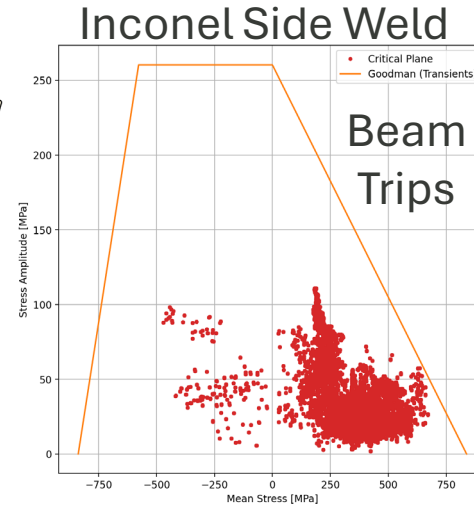
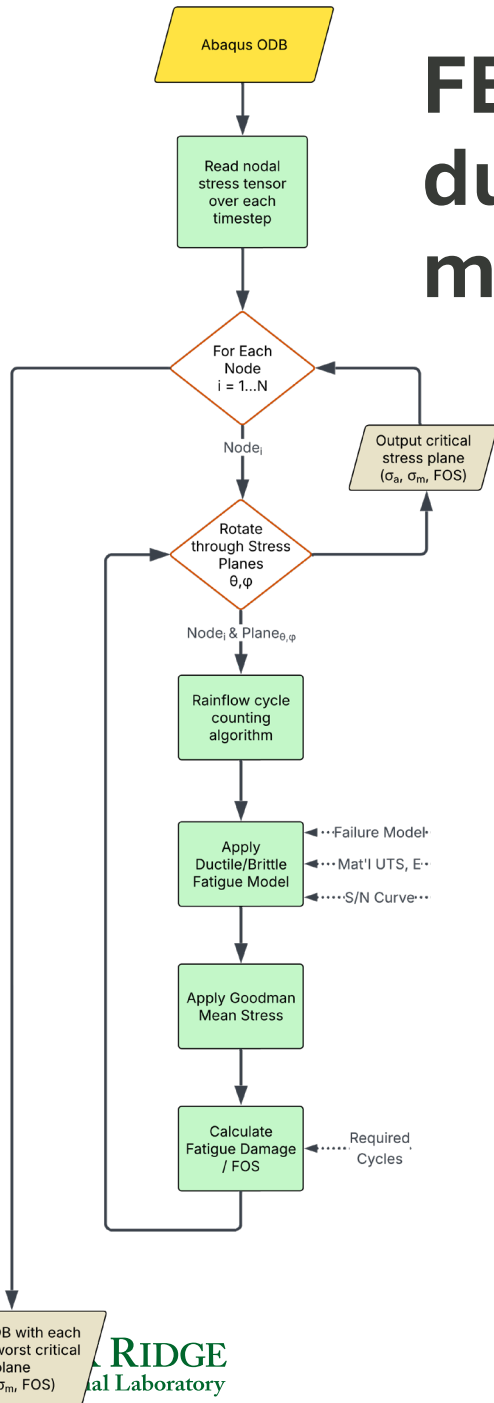
Cyclic analyses capture manufacturing, steady-state and pulse thermal shock stresses



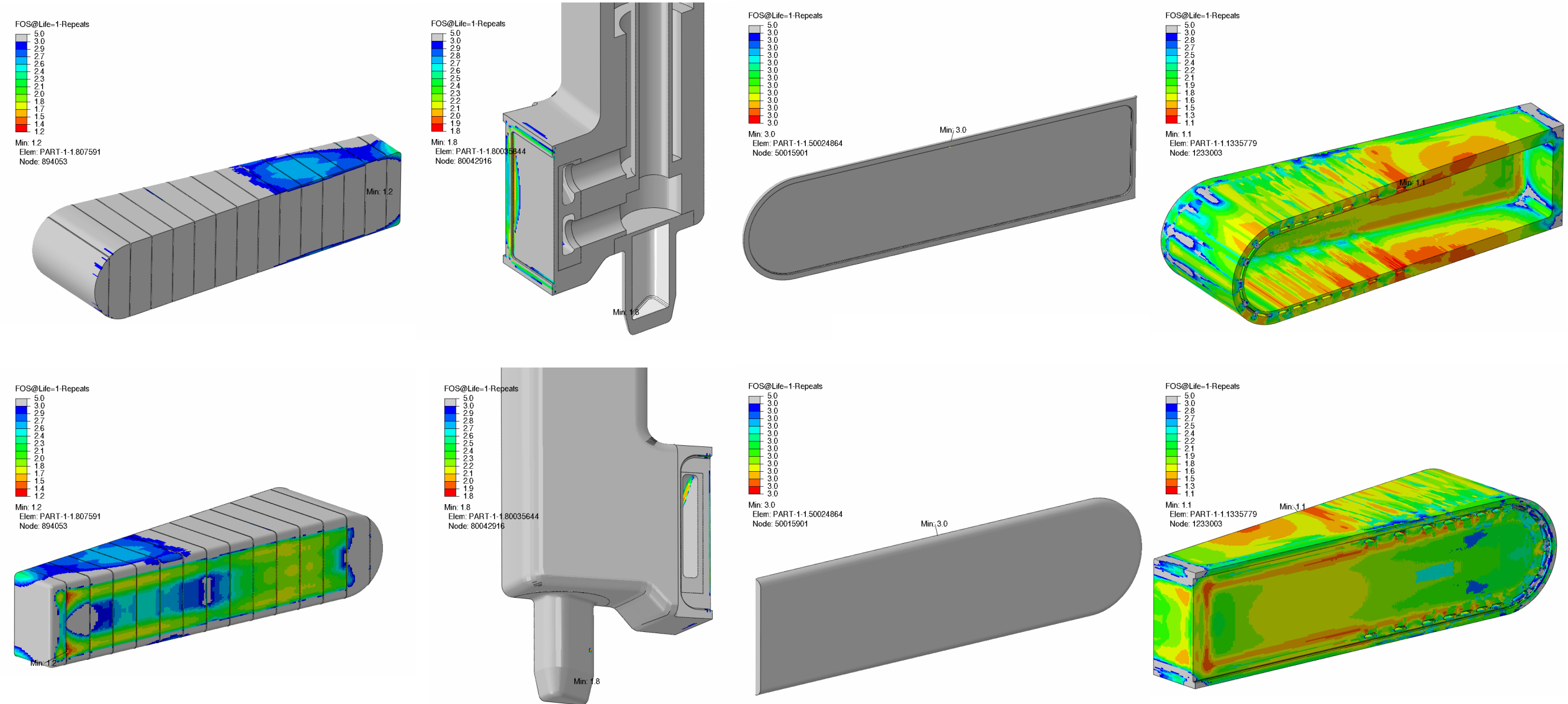
Adapted from original by Peter Loveridge, ISIS



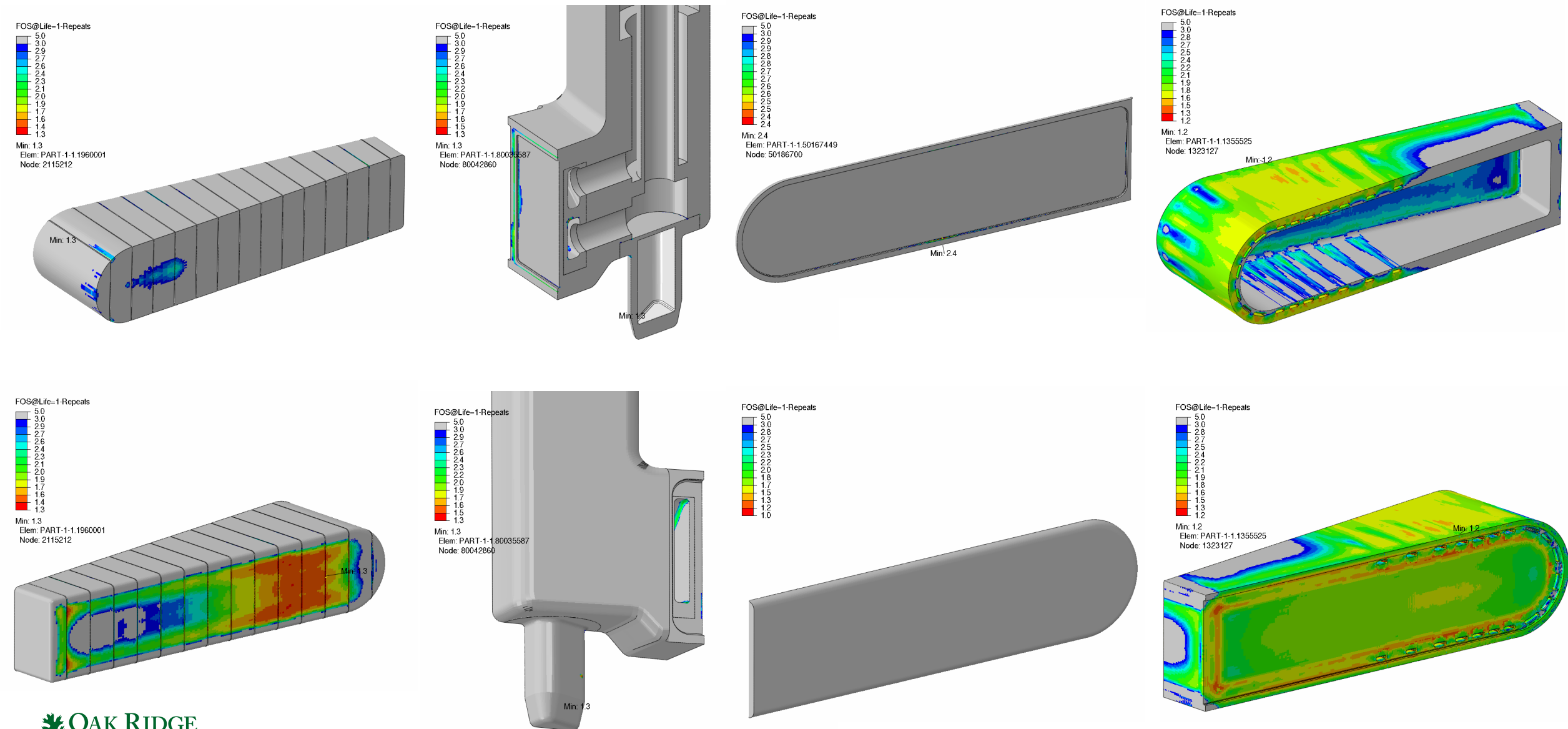
FE-SAFE fatigue software analyzes brittle tungsten, ductile SS316L, ductile Inconel, & welds for 10 yr. mean life of beam trips and beam pulses. All pass*



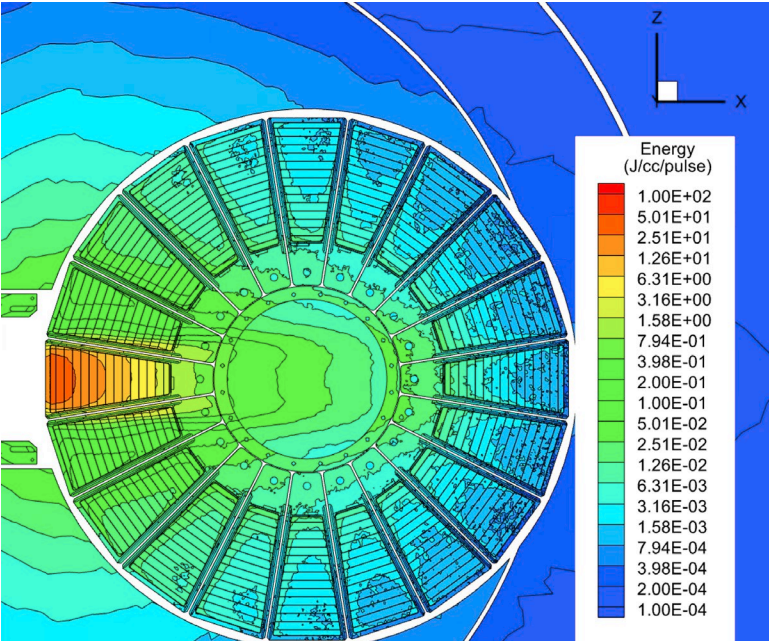
Nominal beam trip fatigue contour plots of FOS



Nominal beam pulse fatigue contour plots of FOS



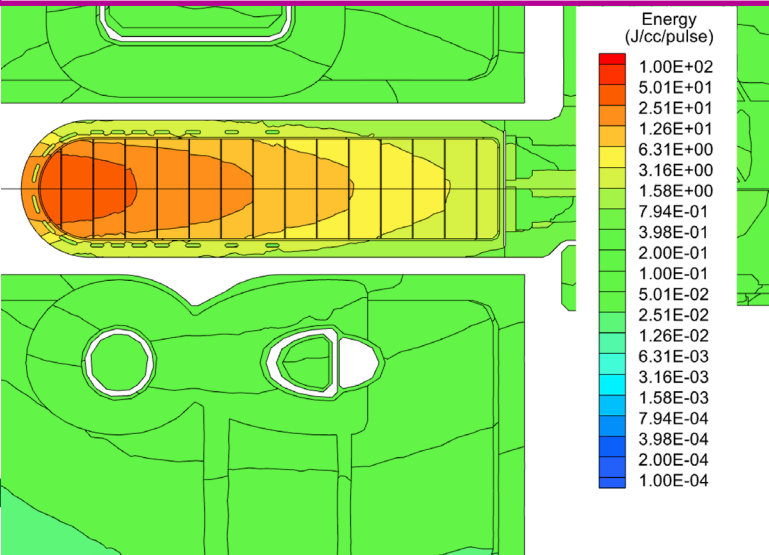
Nominal Beam



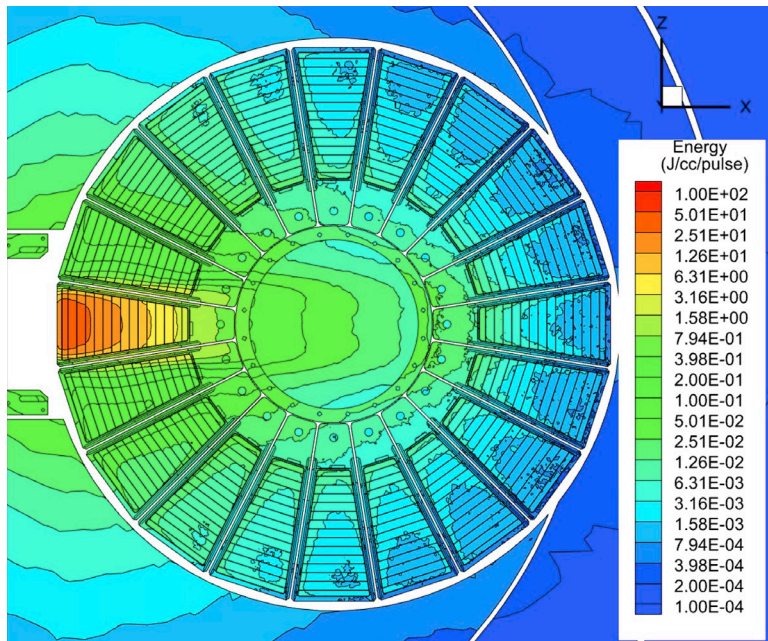
Total heating (kW) for the 20 segments is:

	Tungsten	CuCrZr	Inconel	Steel	Water	Tantalum
kW	292.796577	0.3027881	34.4737958	29.1214263	4.0672098	17.5808941

with Steel and Water in the legs extending up to Y=100cm. Max. energy deposition in Tungsten is 38.1 J/cc/pulse.



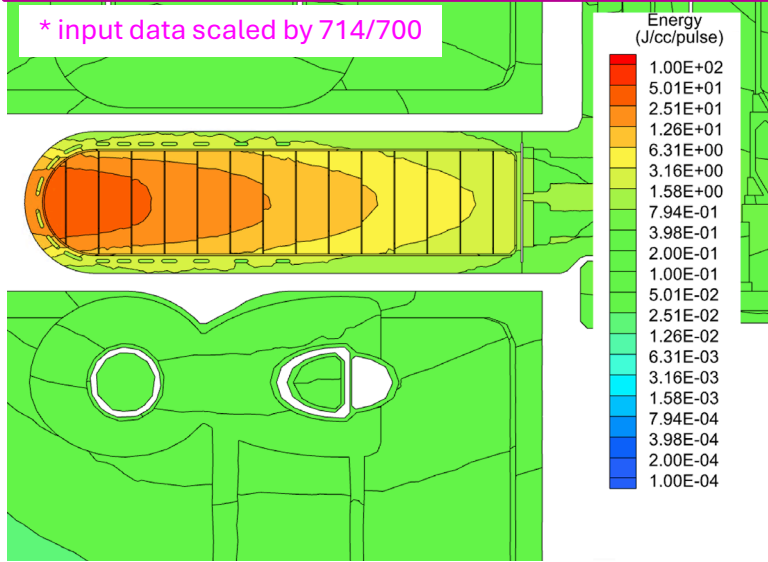
Focused Beam



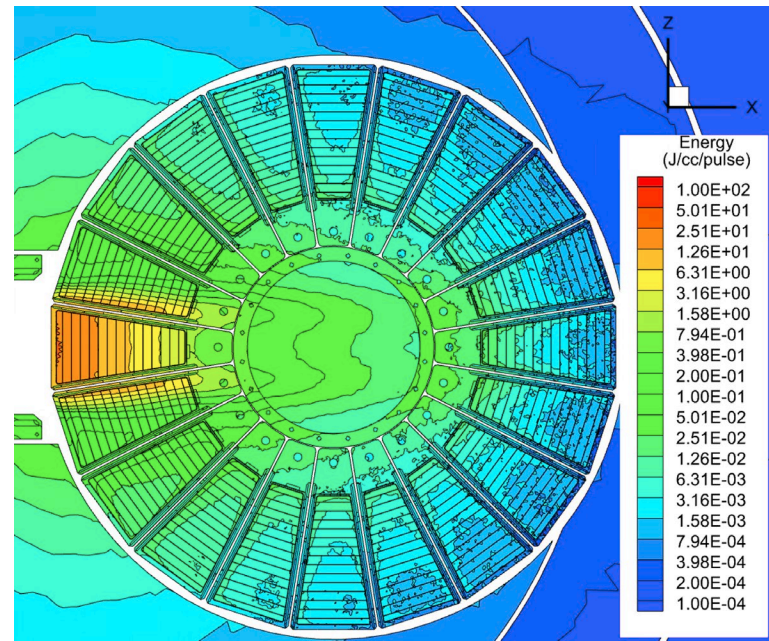
Assuming the 700 kW power, MCNP's total heating is:

	Tungsten	CuCrZr	Inconel	Steel	Water	Tantalum	TOTAL kW
	296.25055	0.29444108	33.591191	27.7405765	3.93066951	17.3506376	379.158066

and I am getting about 5% higher peak energy deposition in tungsten compared to the nominal beam.



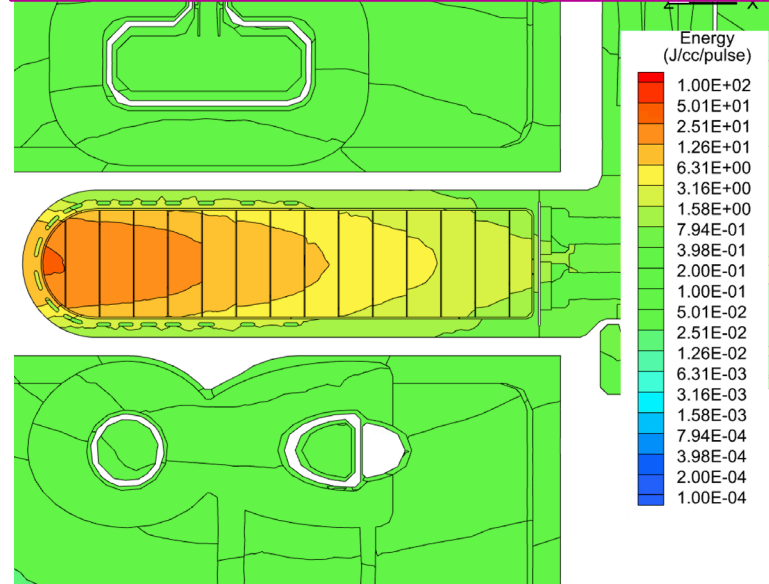
Diffuse Beam



MCNP's total heating for this case is:

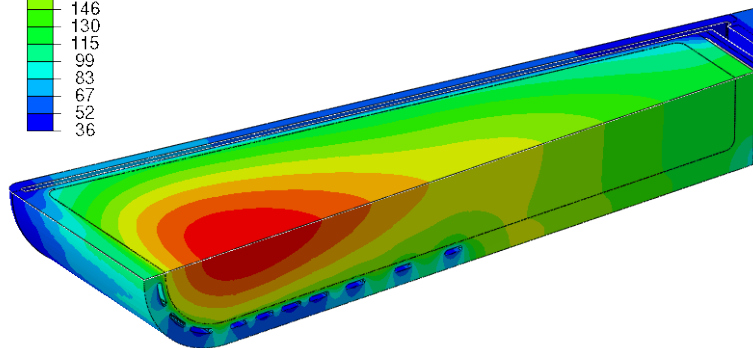
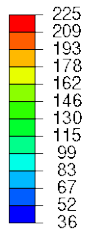
	Tungsten	CuCrZr	Inconel	Steel	Water	Tantalum	TOTAL kW
	267.420028	0.36135986	38.9614045	42.2033843	5.35037149	19.2055631	373.50211

Peak energy deposition in tungsten is 72.5% of the nominal beam case.

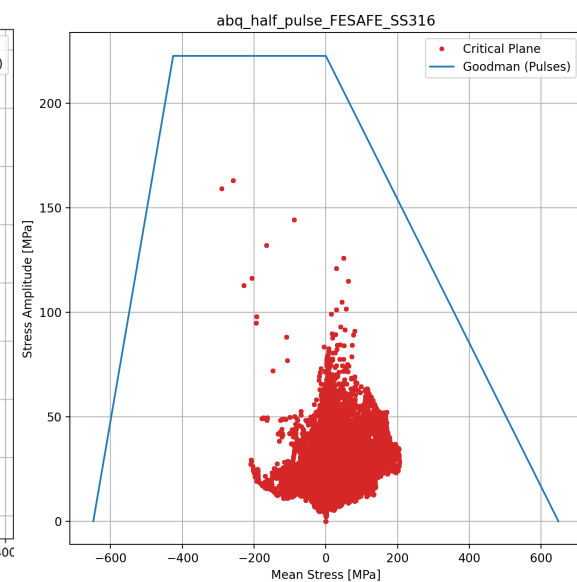
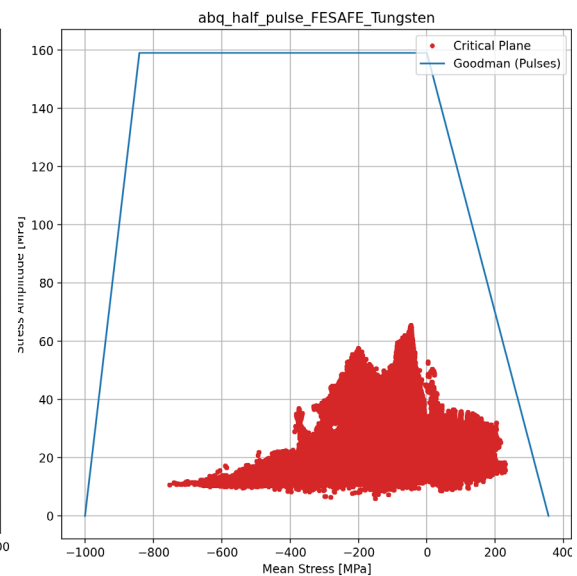
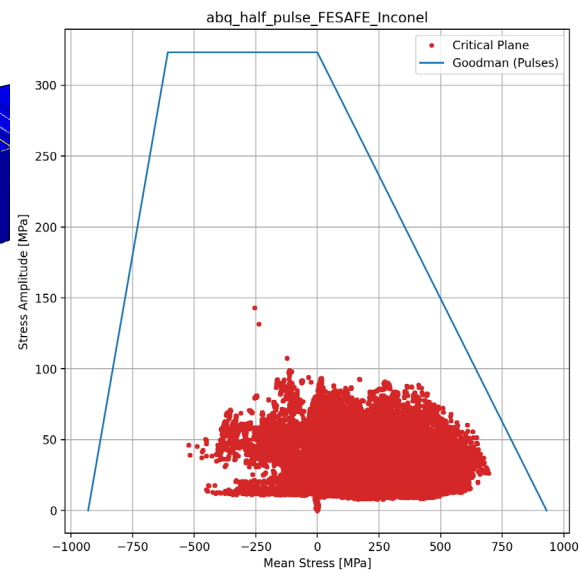
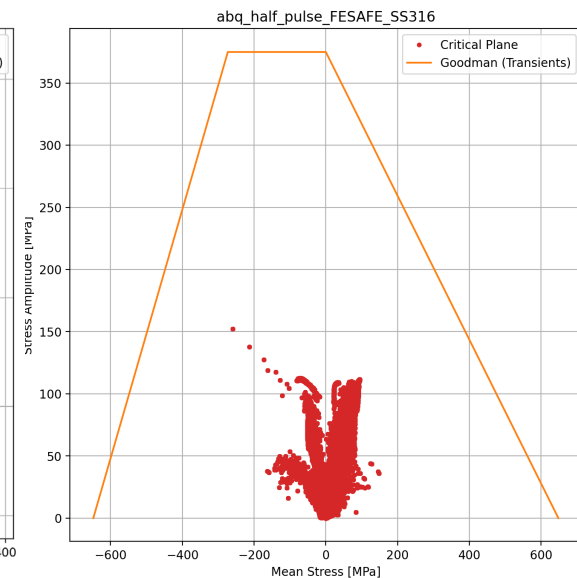
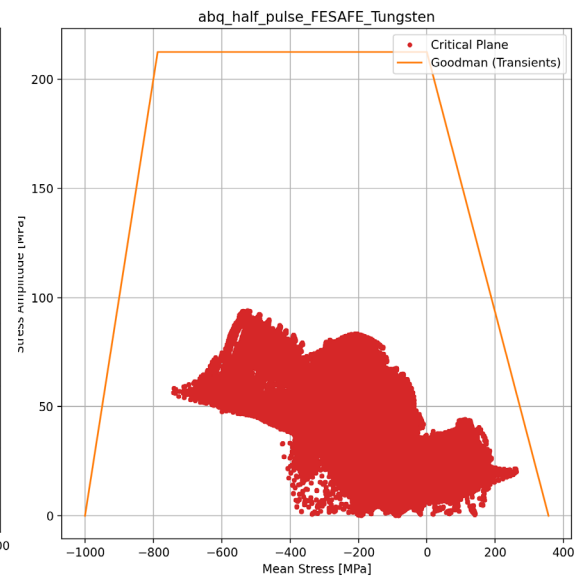
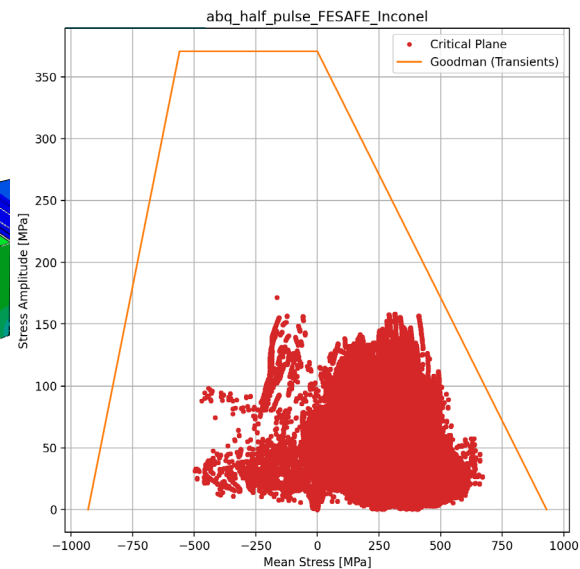
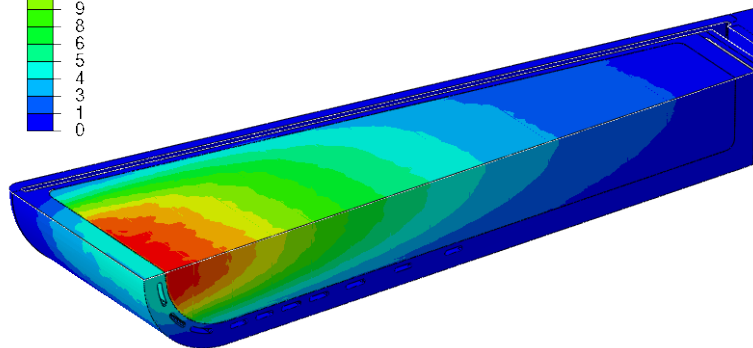
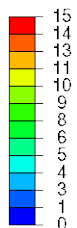


Nominal Beam

NT11

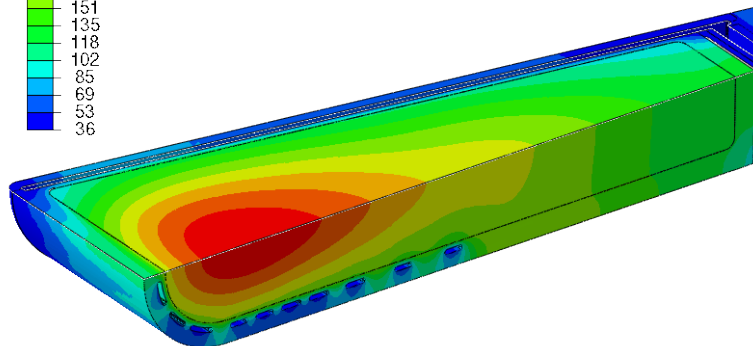
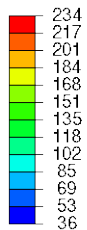


PulseDT

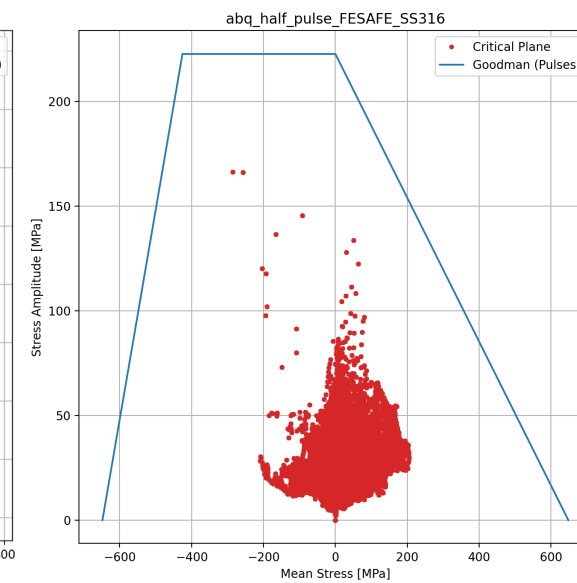
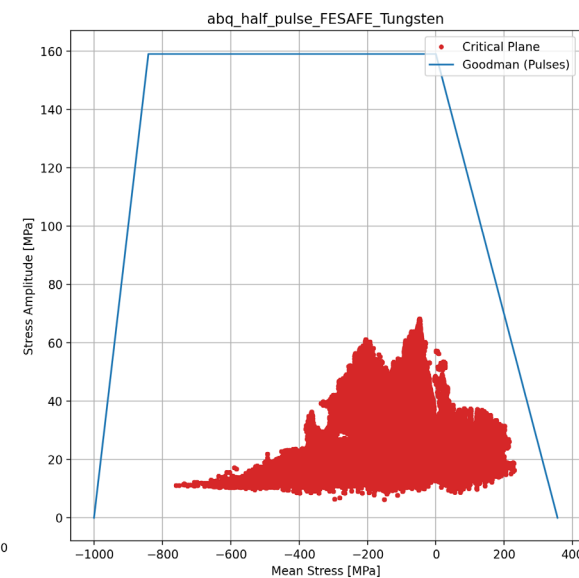
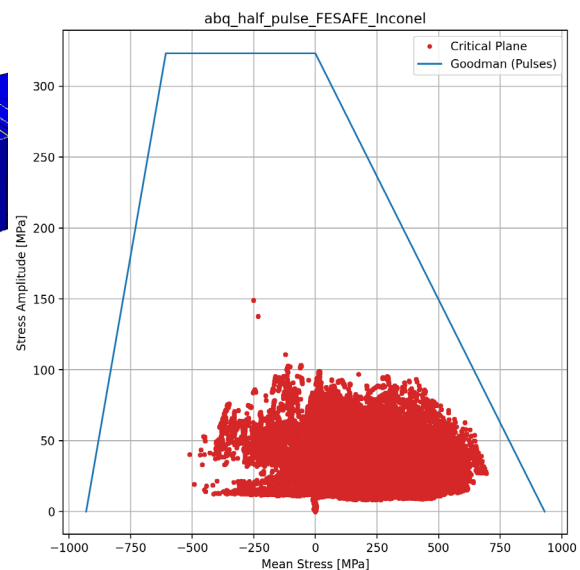
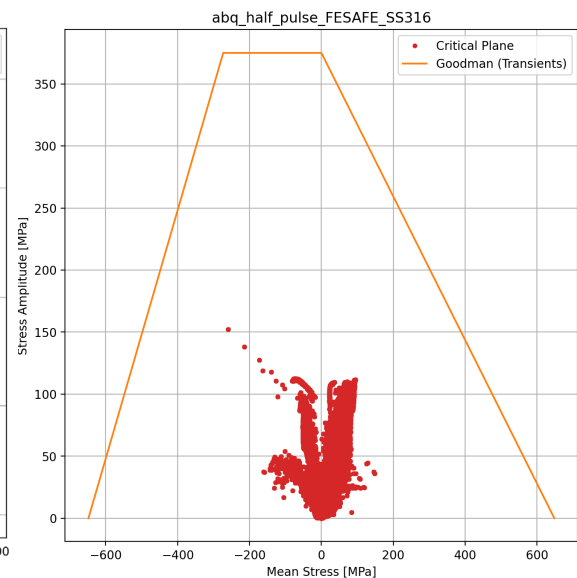
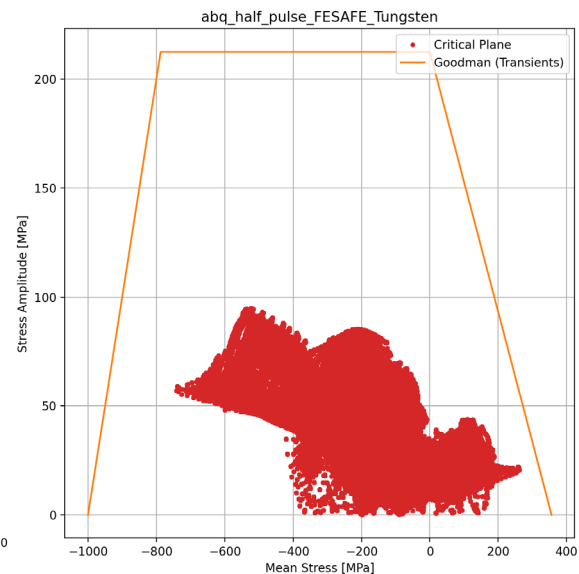
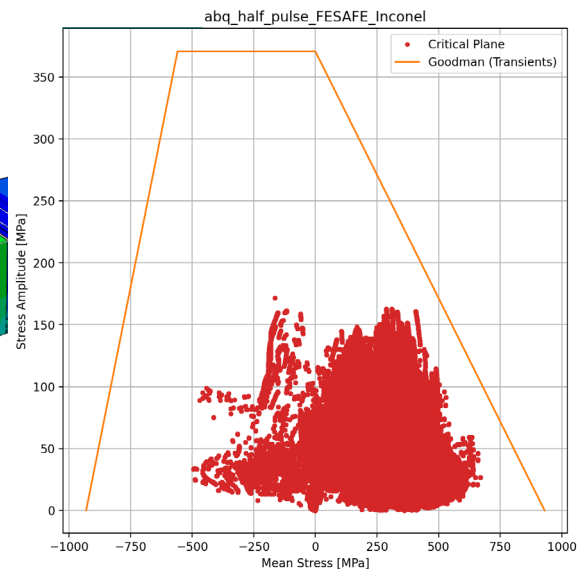
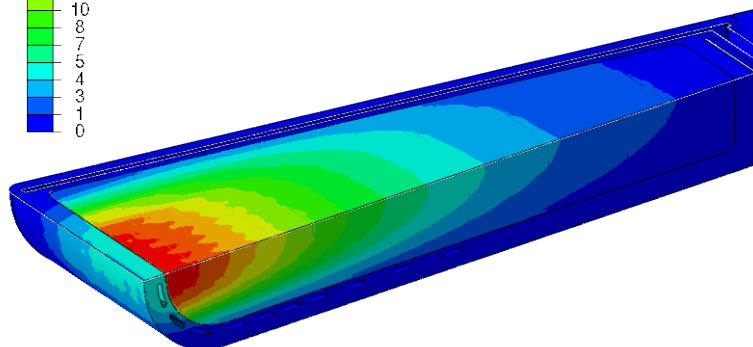
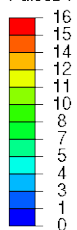


Focused Beam

NT11

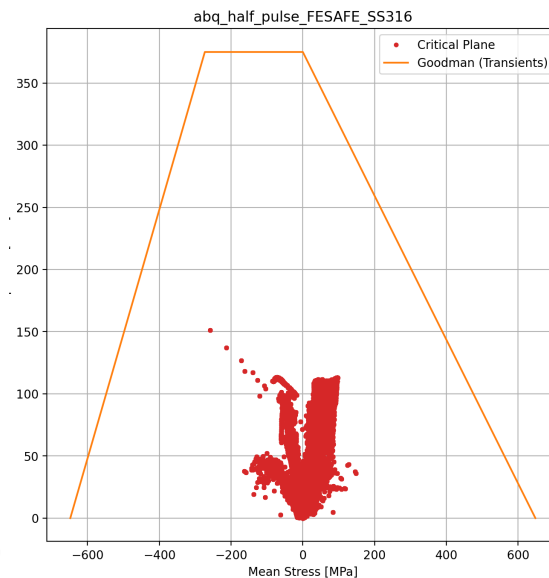
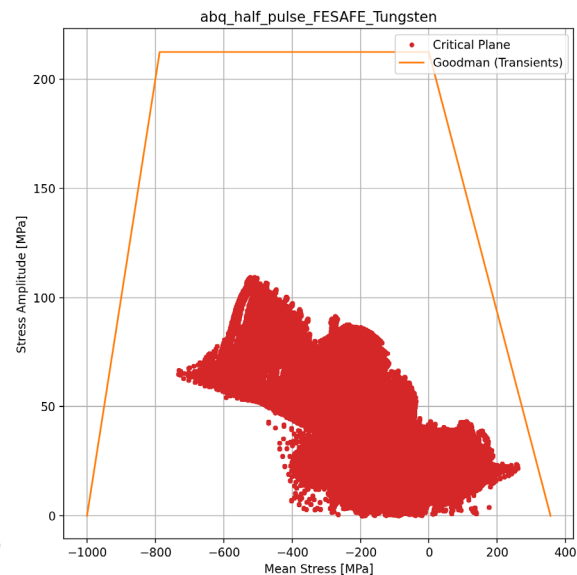
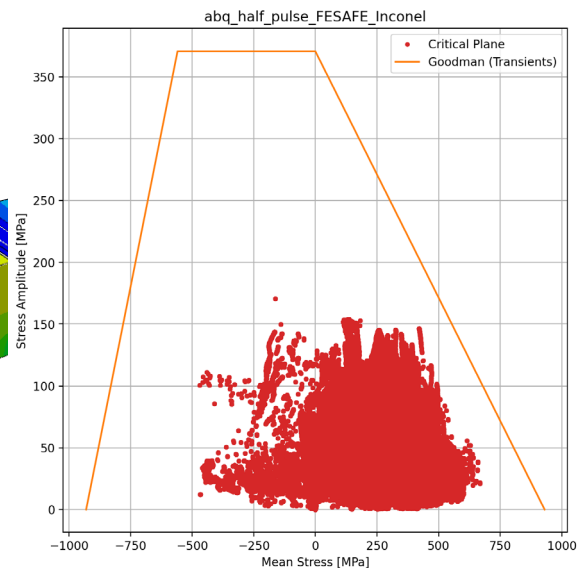
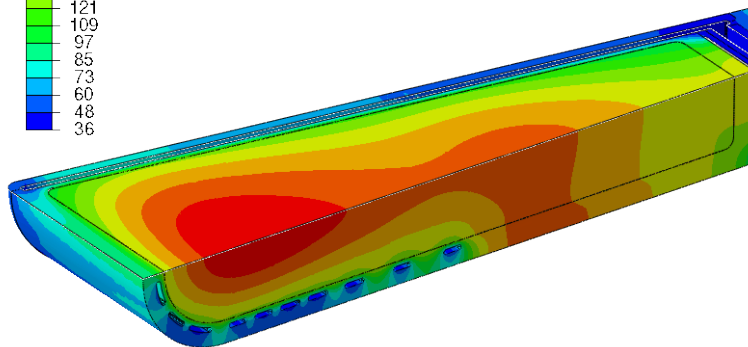
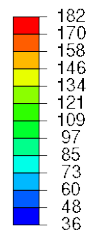


PulseDT

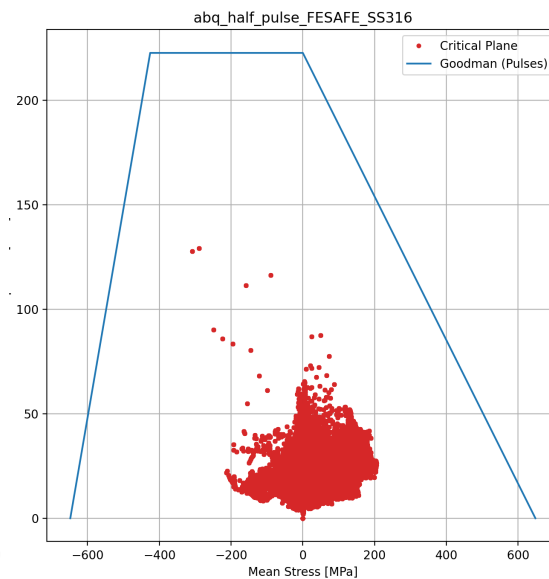
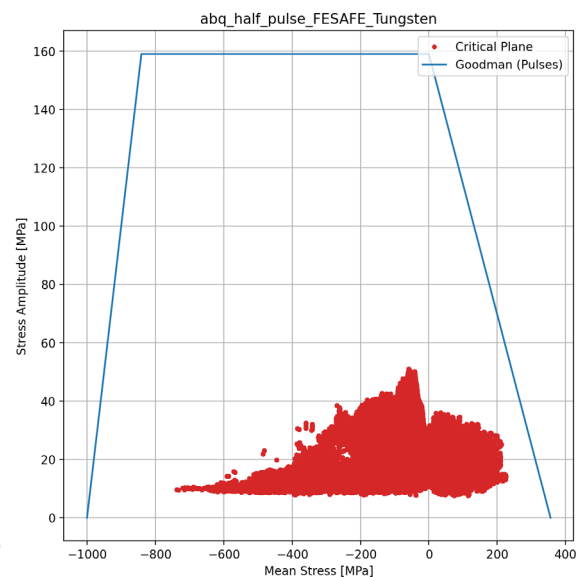
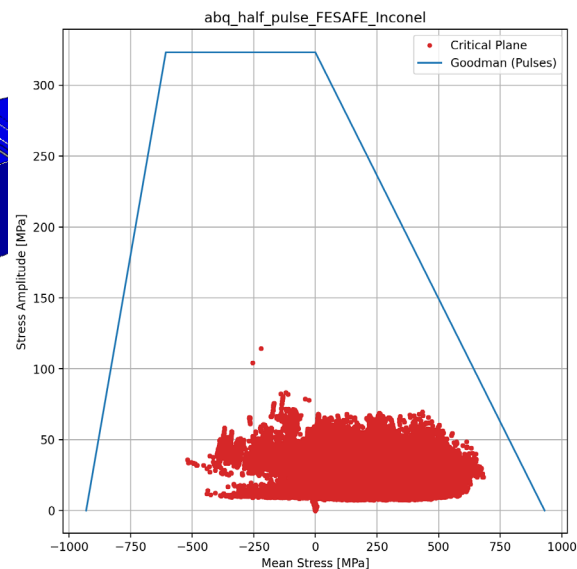
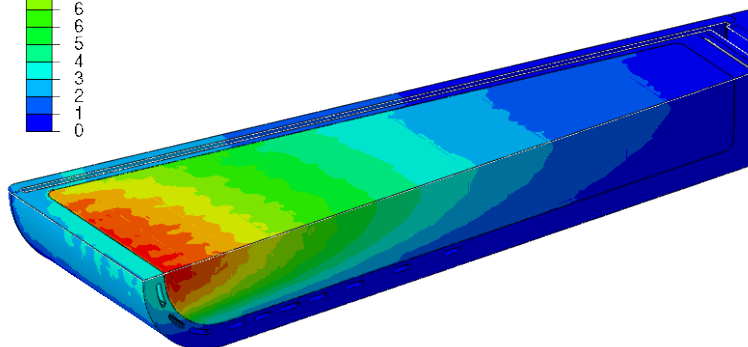
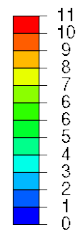


Diffuse Beam

NT11

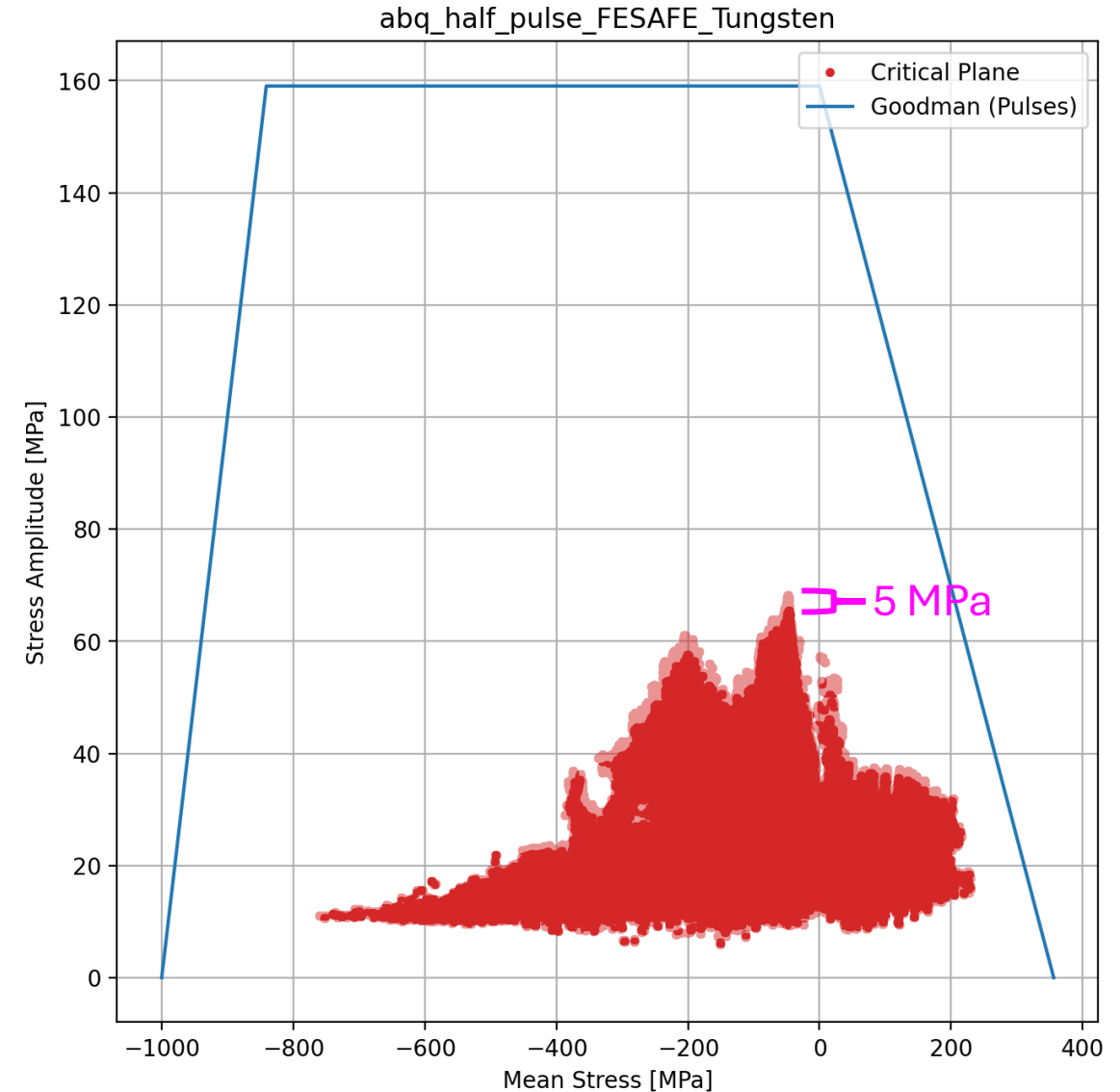


PulseDT

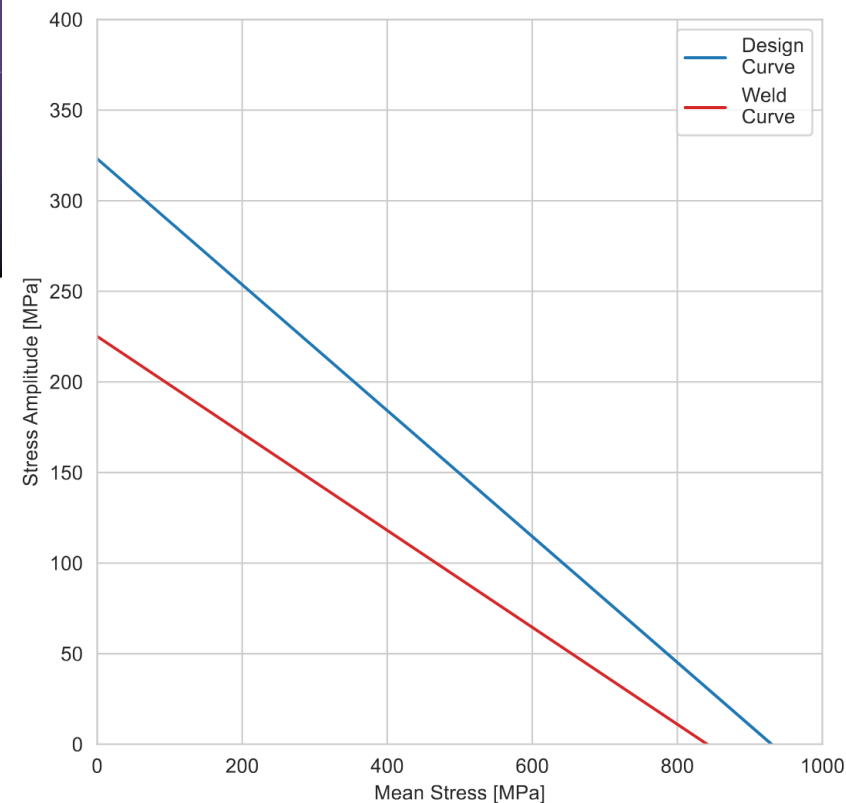
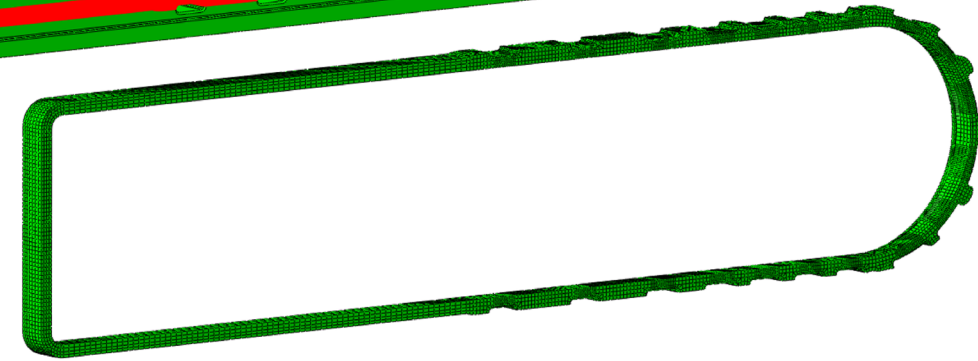
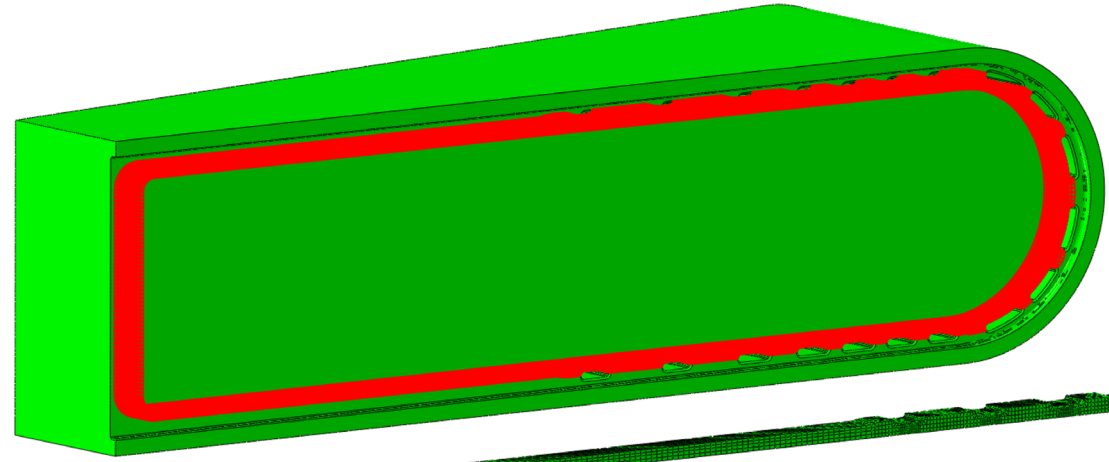
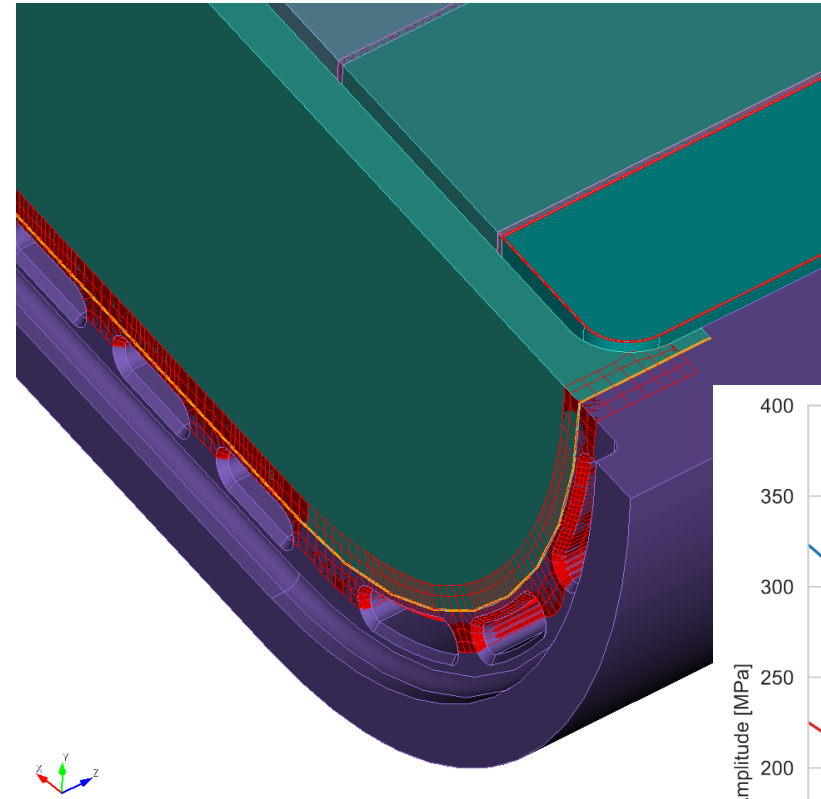


Nominal – Focused Comparison

- Per load case, peak energy deposition for focused beam is:
 - $6.6/6.24 = 1.058$ or a 5.8% increase
- The peak pulse ΔT in my fitted temps goes from 15 to 16°C
 - $1/15 = 6.7\%$ increase
- Peak σ_{amp} in W for nominal beam is ~65 MPa
 - $65 \text{ MPa} * 1.06 = 69 \text{ MPa}$
 - Indeed, the overlaid plot shows peak increases to around 70 MPa

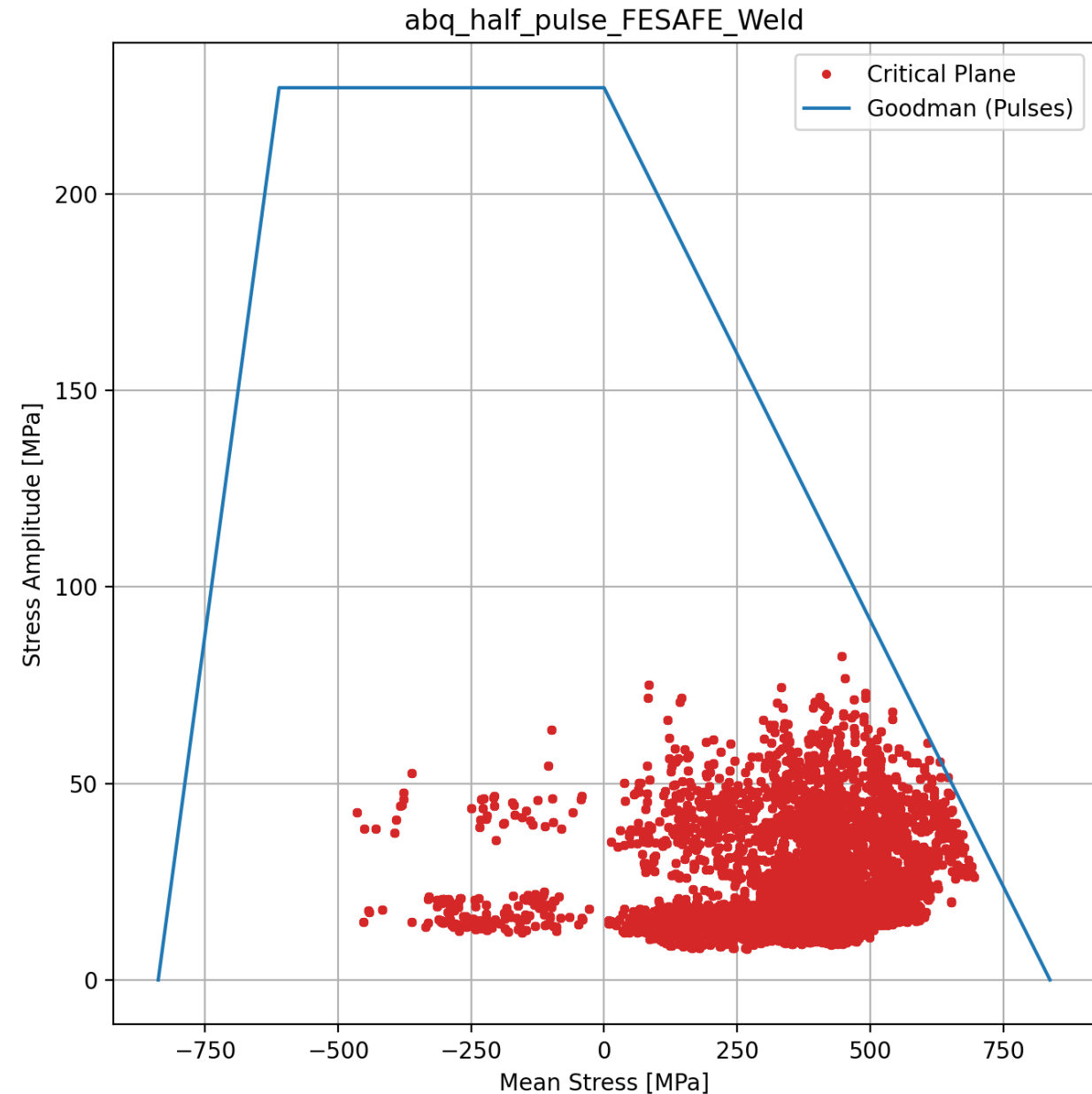
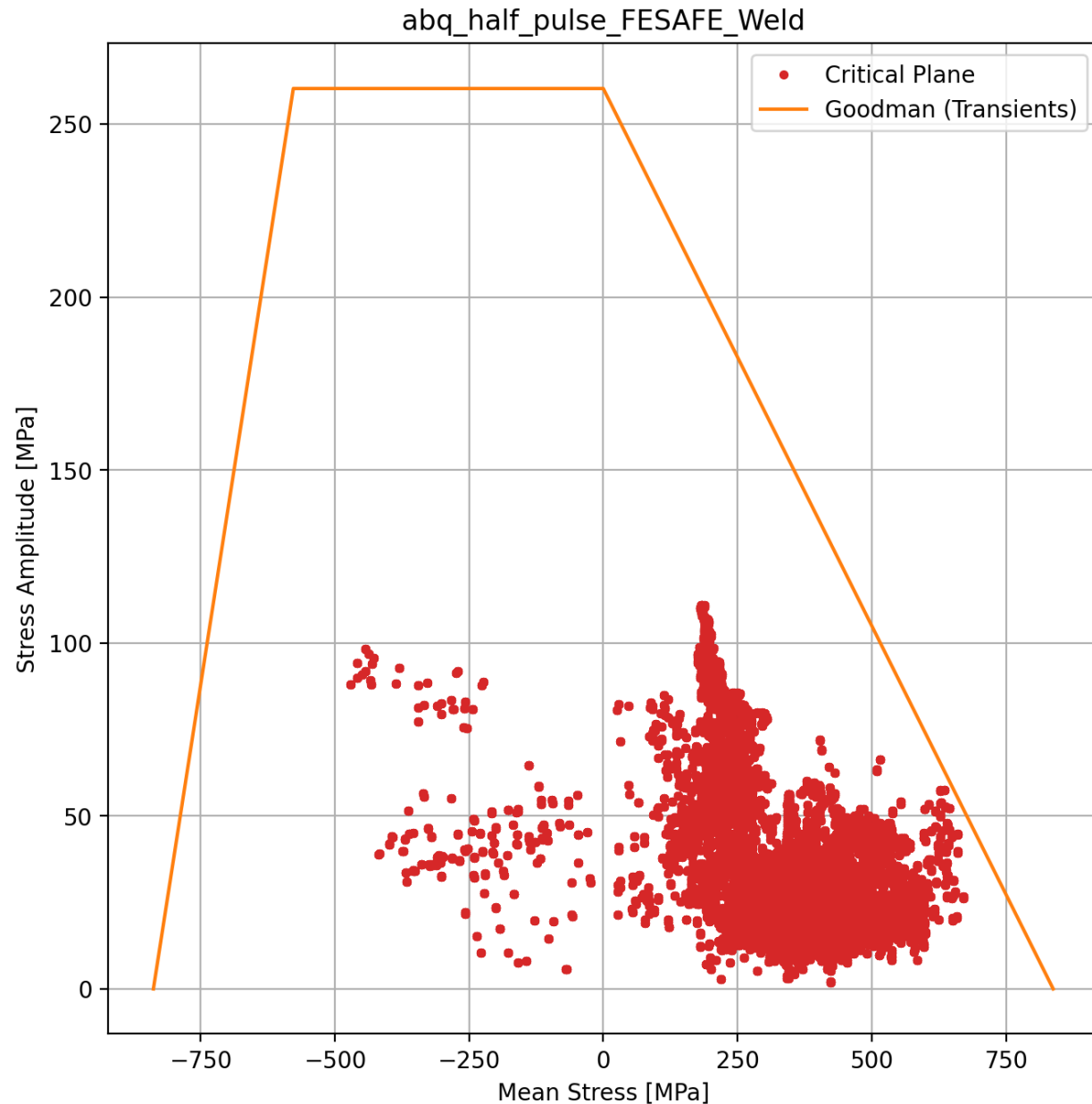


Weld effects on fatigue strength are incorporated into the model



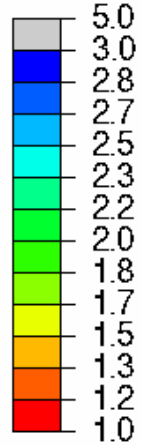
- ← Weld fatigue Goodman diagram for 1.35M cycles
- UTS debited by published testing of filler vs. bar stock
 - Fatigue strength debited by inferred behavior of IN718(PH)

Marginal performance found at edge of HAZ



We accept the marginal performance found at edge of HAZ

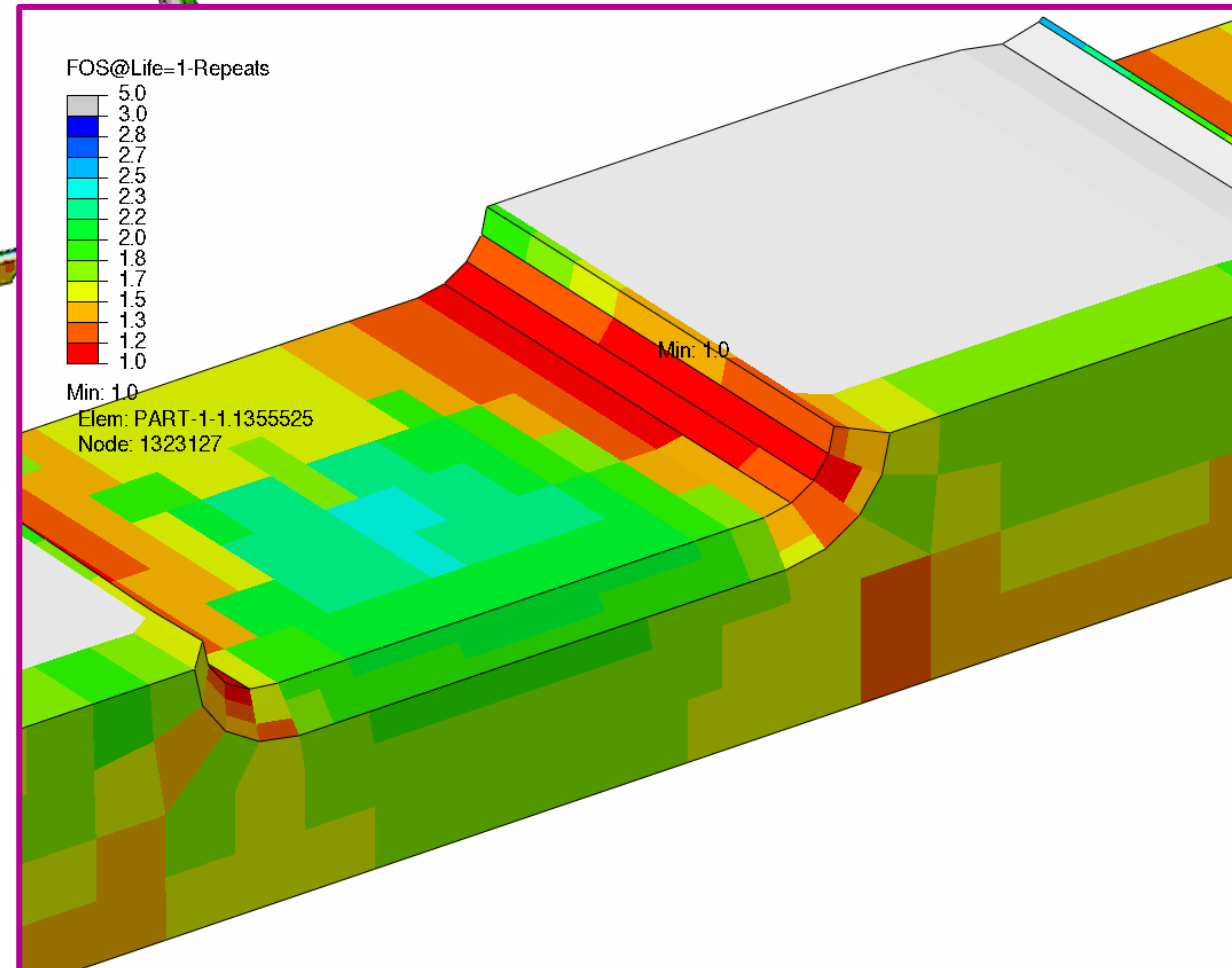
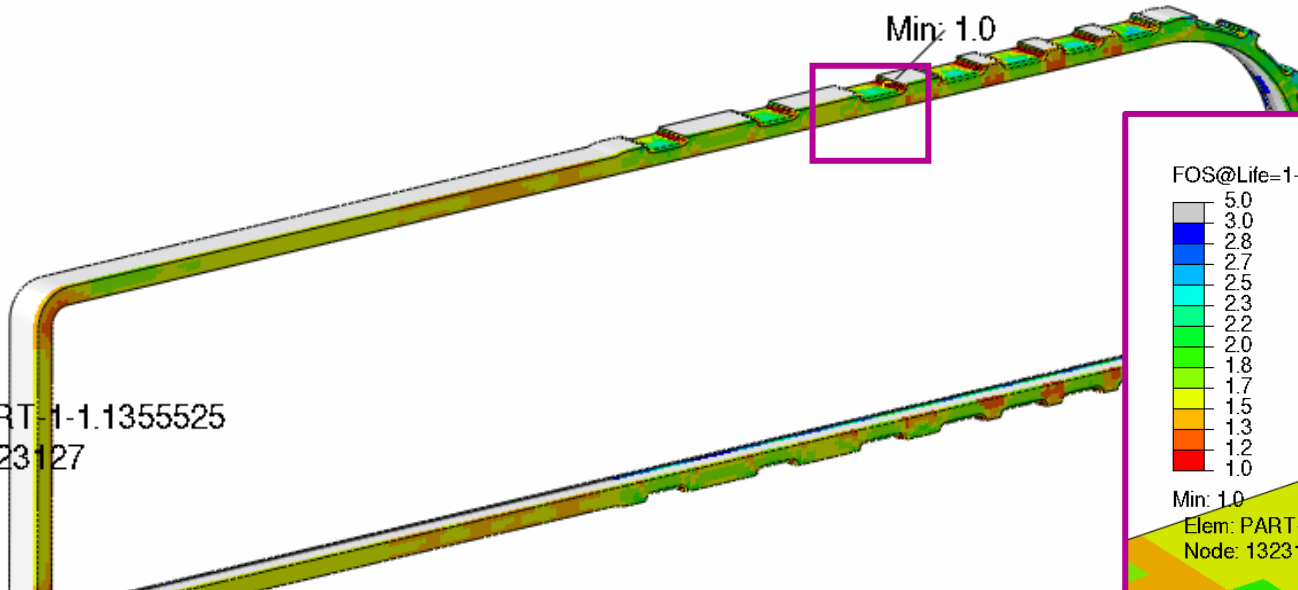
FOS@Life=1-Repeats



Min: 1.0

Elem: PART-1-1.1355525

Node: 1323127



Why do we accept this?

- One element fails at 0.92 FOS
- Mesh convergence not demonstrated
- Weld goes through HIP as a kind of post-weld heat treat
- On the edge of an estimated HAZ
- Assumes 10 years of fatigue with full residual stresses
- Does not take credit for residual stresses from machining
- Does not take credit for any surface treatments

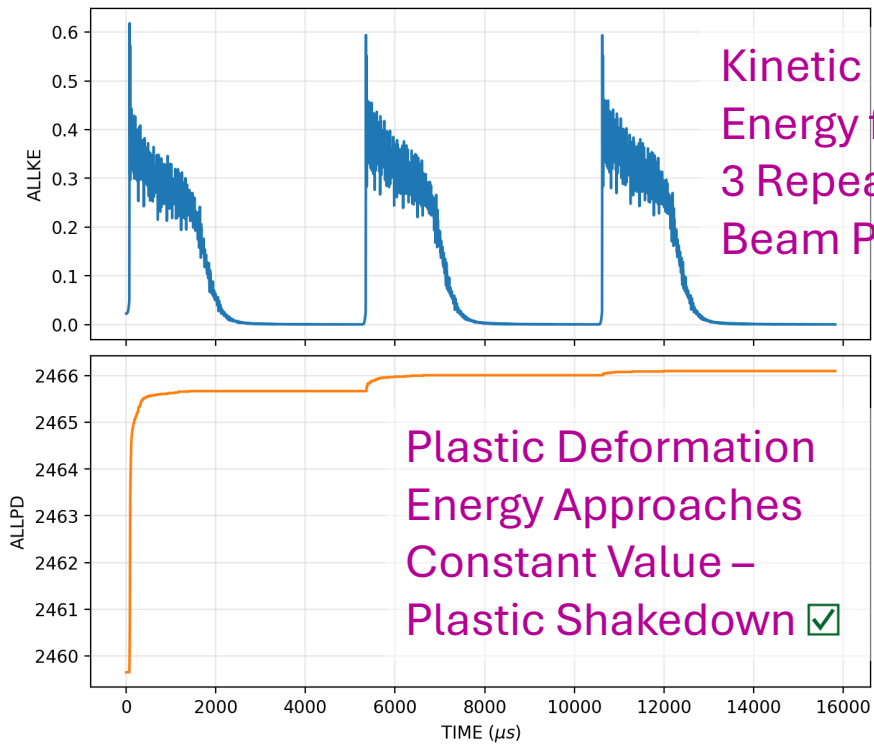
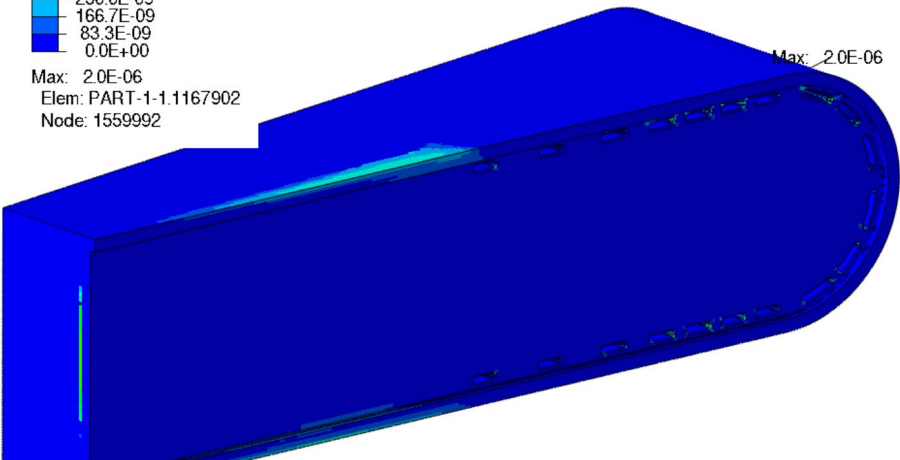
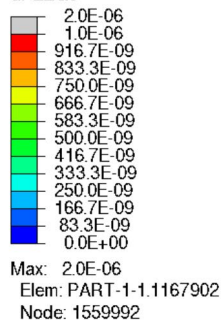
Ratcheting Analysis

Apply multiple beam trip and beam pulse loadings

Test for plastic shakedown

Plastic ratcheting analyzed for both beam trips and pulses

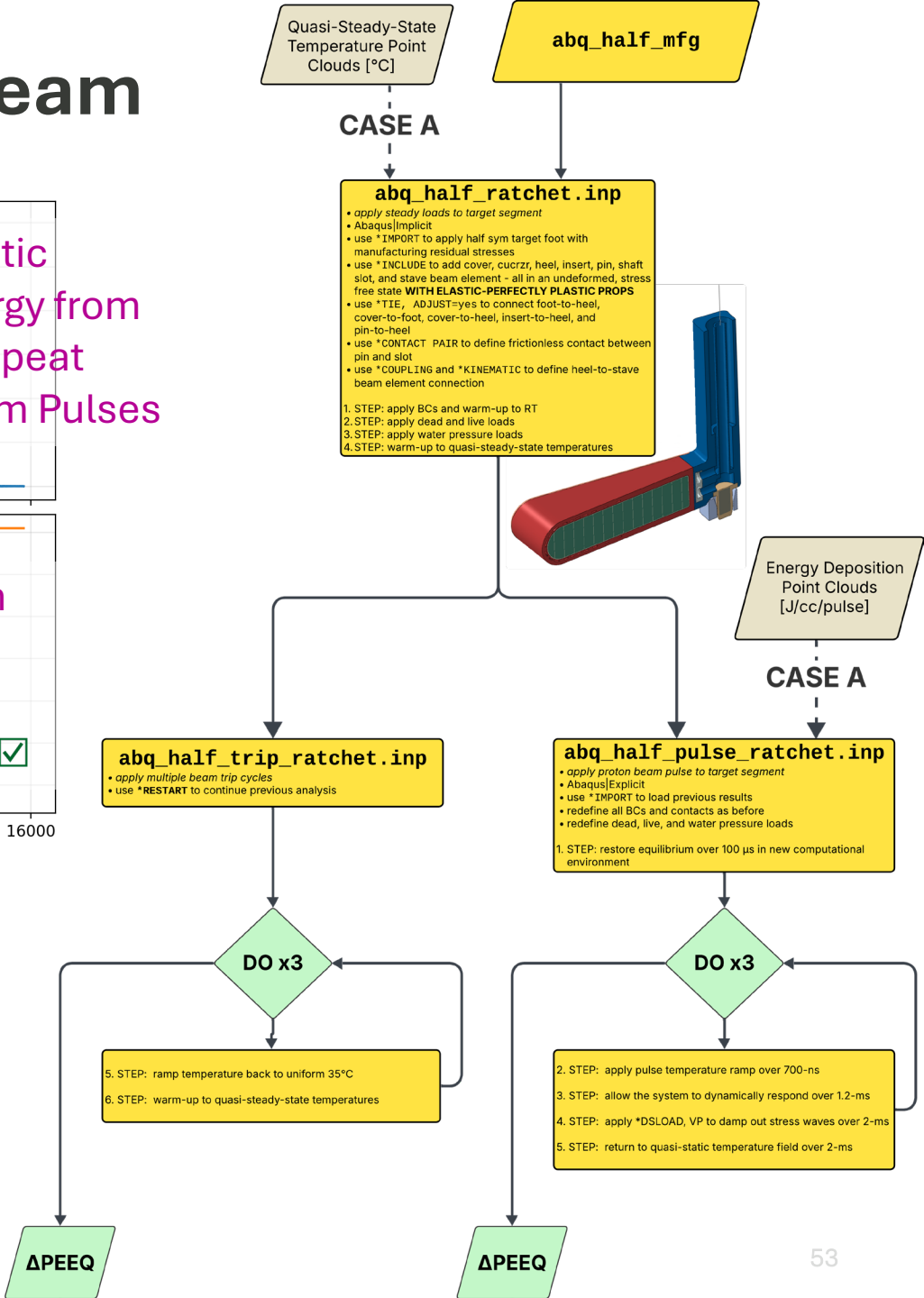
$\Delta PEEQ$ after 3rd trip



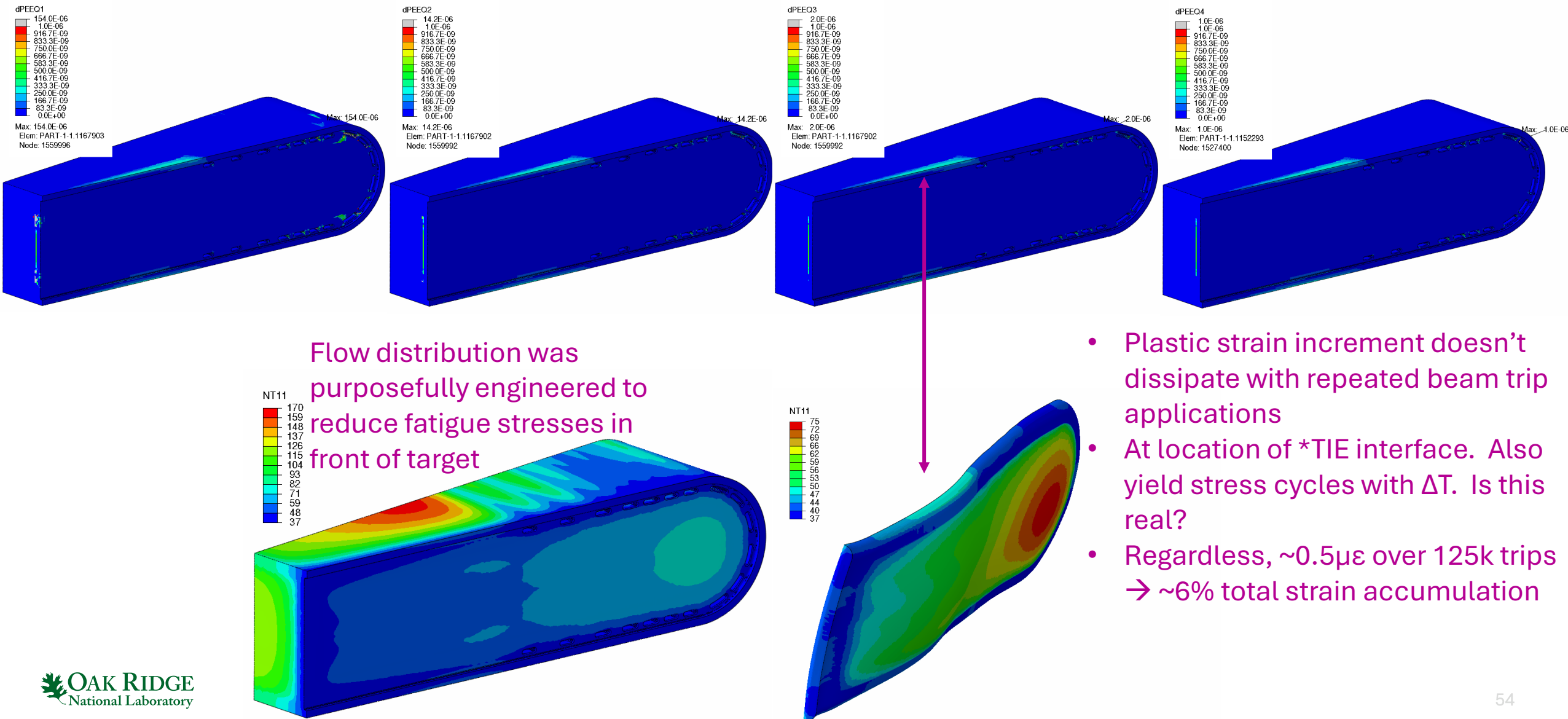
Kinetic Energy from 3 Repeat Beam Pulses

Plastic Deformation Energy Approaches Constant Value – Plastic Shakedown ☒

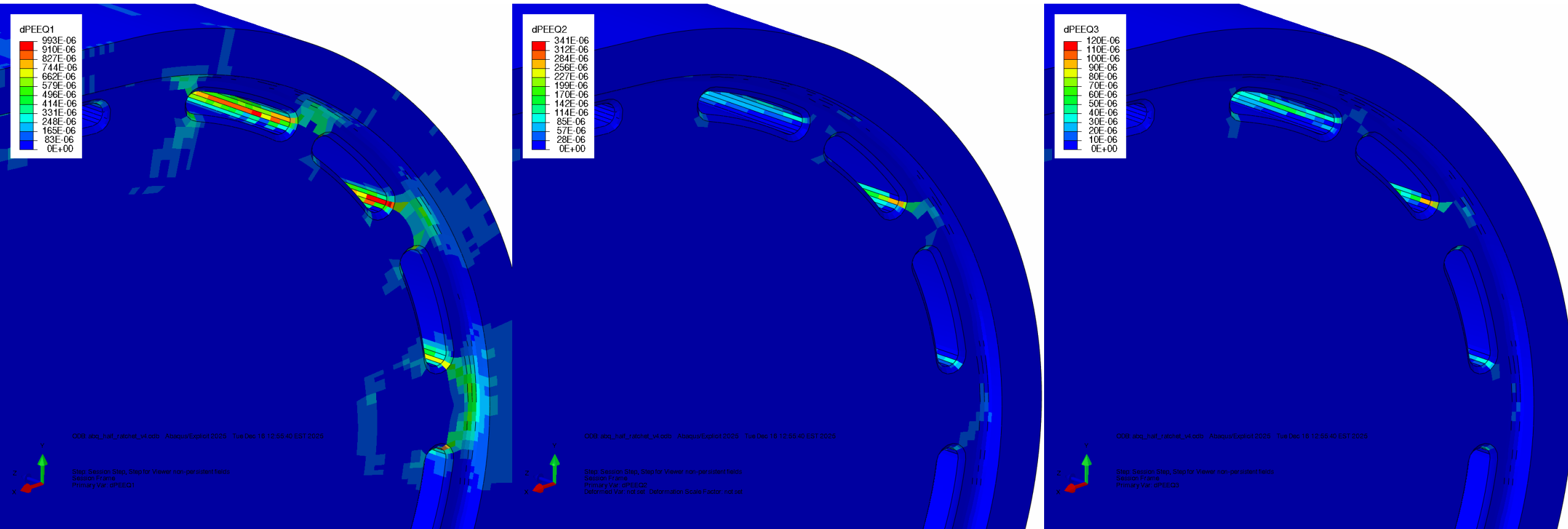
Beam Trips More Challenging for Ratcheting. Areas of Concern, but Surrounded by Plastic Shakedown



Beam trip ratcheting analysis shows hot spot corresponding to area of higher heating causing flow cover bend stress



Beam pulse ratcheting analysis shows progressive shakedown and an elastic core



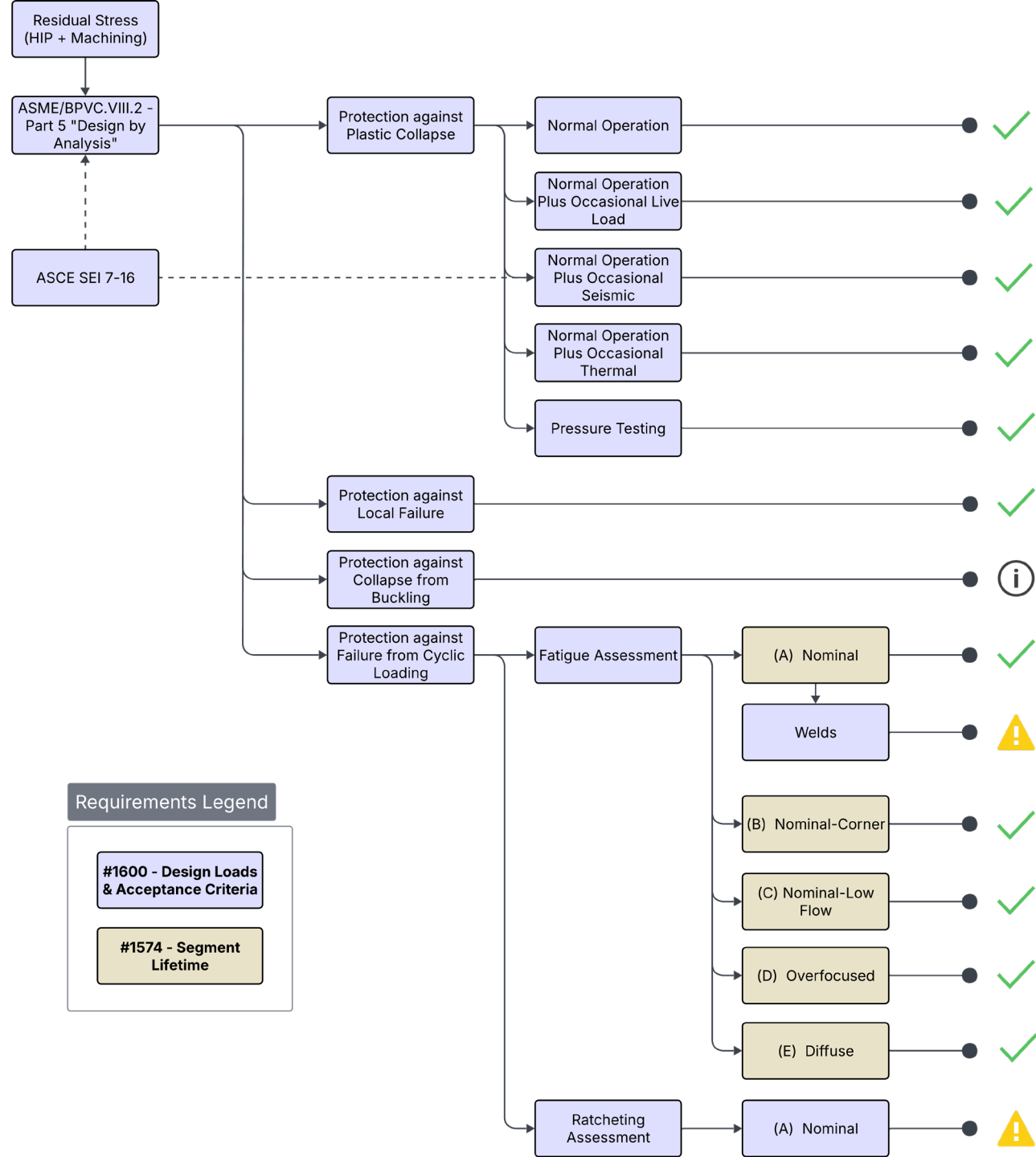
Results & Sensitivity Analyses

Requirements summary

Sensitivity analyses to gain confidence in results

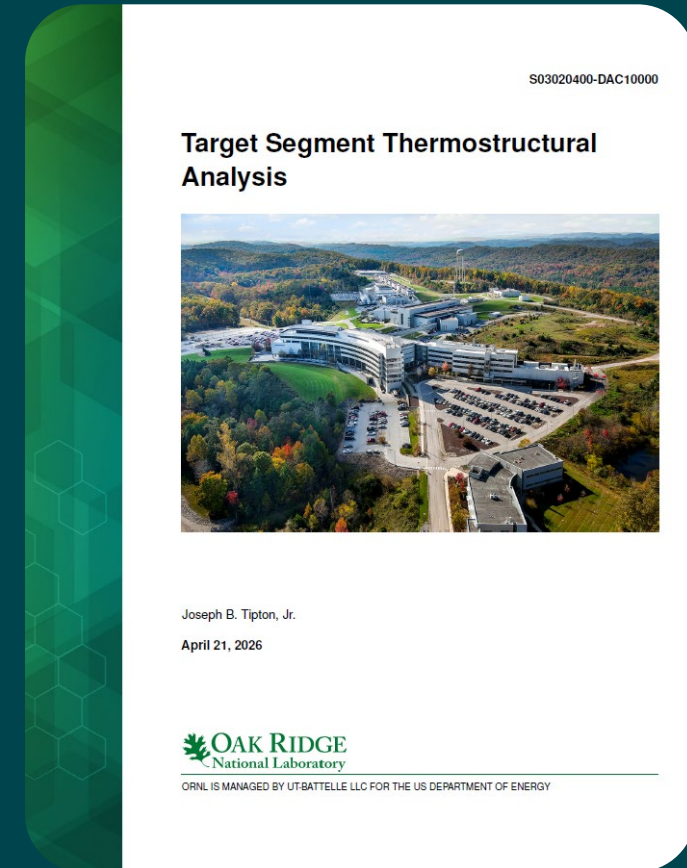
Full debonding analysis to quantify effect on fatigue

Analyses show requirements are met with 2 caveats . . .



Multiple sensitivity analyses performed to gain confidence in results

- Effect of Water Pulses
- Sensitivity to Tungsten Modulus
- Sensitivity to Duration of Simulation
- Sensitivity to Pulse Duration
- Sensitivity to Data Output Frequency
- Sensitivity to Fatigue Model
- Sensitivity to Fatigue UTS
- Sensitivity to Fatigue Strength
- Sensitivity to Combined Fatigue Damage
- Mesh Refinement (Inconclusive)



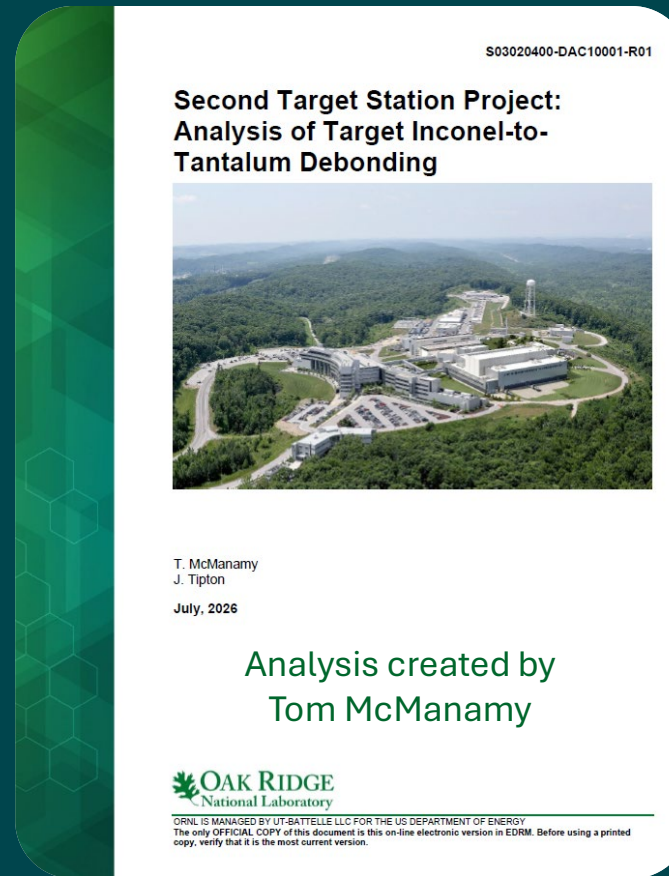
Sensitivity to debonding was published as an additional DAC

IN718/Ta/W bonds successfully demonstrated by R&D

Bond strength characterization not available

Ta assumed to provide continuous ductility and brittle W assumed to be crack-free

How sensitive is target segment to complete debonding of spallation package from shroud?



Can we still satisfy requirements?

REQMT #1574

- Segment Fatigue margin shall be equal to or greater than 1 for a 10-year operational life for all materials . . .

REQMT #3466

- The steady-state temperature in any portion of the tungsten shall not exceed 800°C without cooling . . .
- Derived from Credited Controls to avoid vaporization of tungsten

The screenshot displays the ANSYS Workbench environment. On the left, the 'Edit Interaction' dialog box is open, showing the configuration for a 'Surface-to-surface contact (Standard)' interaction named 'In_Ta'. The 'Main surface' is 'inconel_ta' and the 'Secondary surface' is 'tantalum-1.Ta_inconel'. The 'Sliding formulation' is set to 'Finite sliding', and the 'Discretization method' is 'Surface to surface'. The 'Degree of smoothing for main surface' is set to 0.2. The 'Contact tracking' is set to 'Two configurations (path)'. The 'Secondary Adjustment' tab is selected, showing 'Surface Smoothing', 'Clearance', and 'Bonding' options. The 'Contact interaction property' is 'In_ta', and the 'Options' are 'Interference Fit...'. The 'Contact controls' are set to '(Default)'. The 'Active in this step' checkbox is checked. The 'OK' and 'Cancel' buttons are at the bottom.

In the background, a 3D model of a mechanical assembly is visible. The assembly consists of a base plate with a central slot and a top plate with a curved end. The top plate is highlighted in red, indicating it is the selected surface for the contact interaction.

On the right side of the image, there is a vertical toolbar with the following options: 'Edit Contact Property', 'Name: In_ta', 'Contact Property Options', 'Tangential Behavior', 'Normal Behavior' (highlighted in blue), and 'Thermal Conductance'.

Edit Contact Property

Name: In_ta

Contact Property Options

- Tangential Behavior
- Normal Behavior
- Thermal Conductance**

Mechanical Thermal Electrical

Thermal Conductance

Definition: Tabular

☐ Use only clearance-dependency data
☒ Use only pressure-dependency data
☐ Use both clearance- and pressure-dependency data

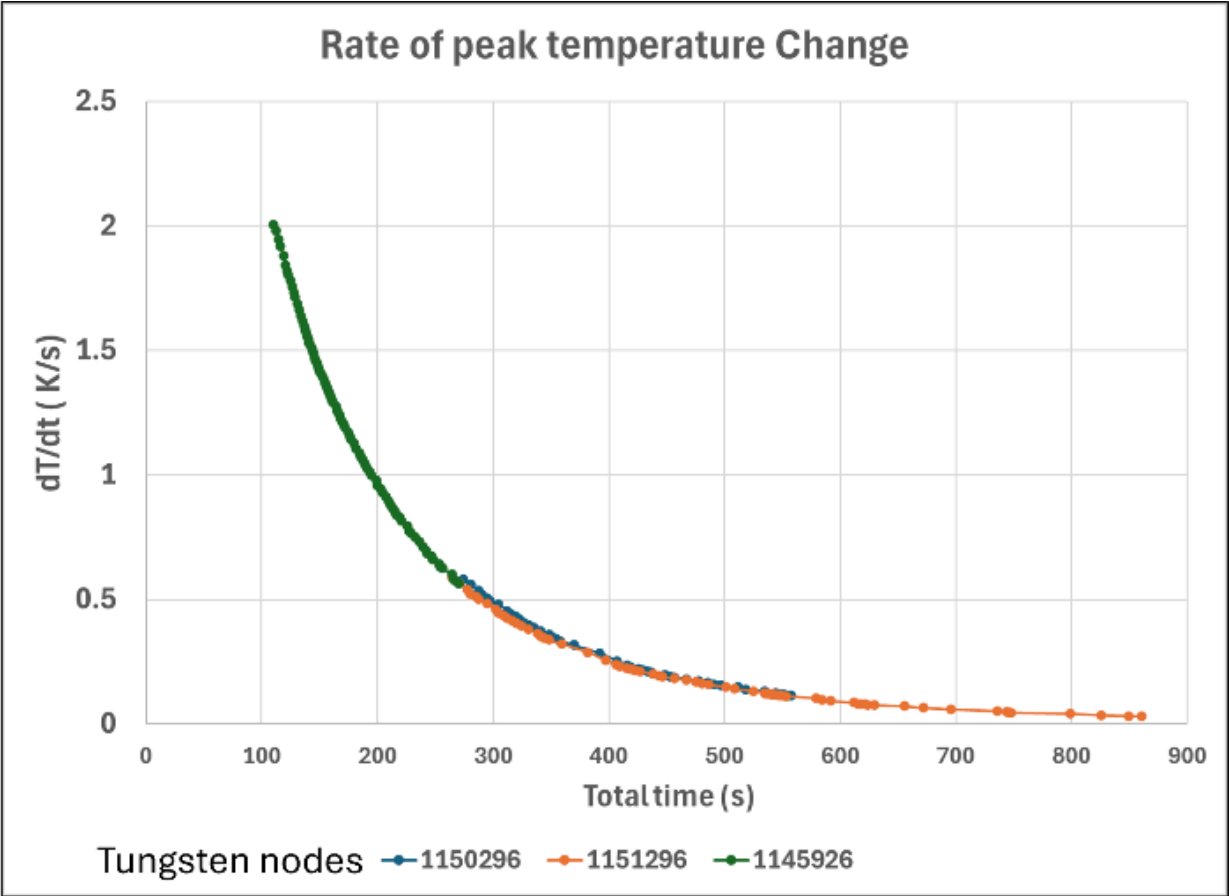
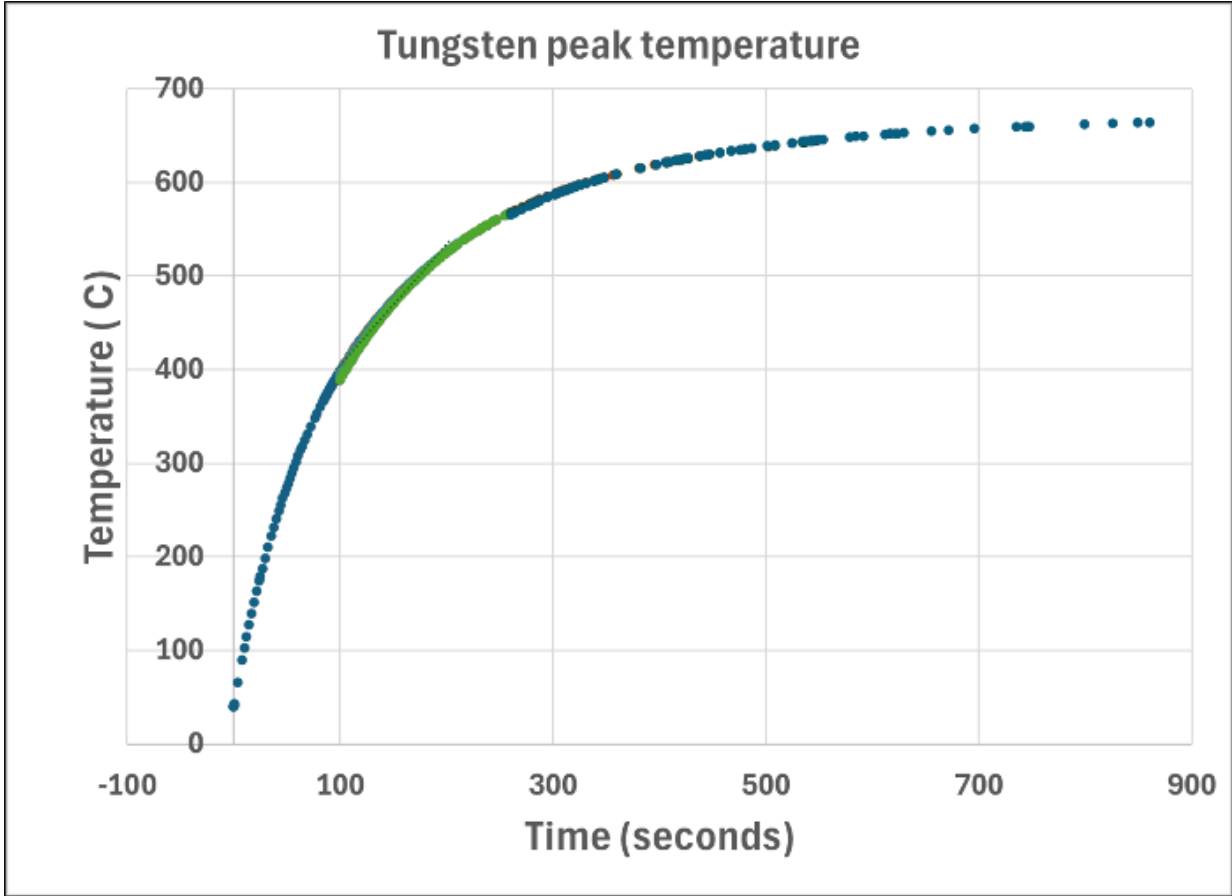
Clearance Dependency Pressure Dependency

☐ Use temperature-dependent data
☐ Use mass flow rate-dependent data (Standard only)

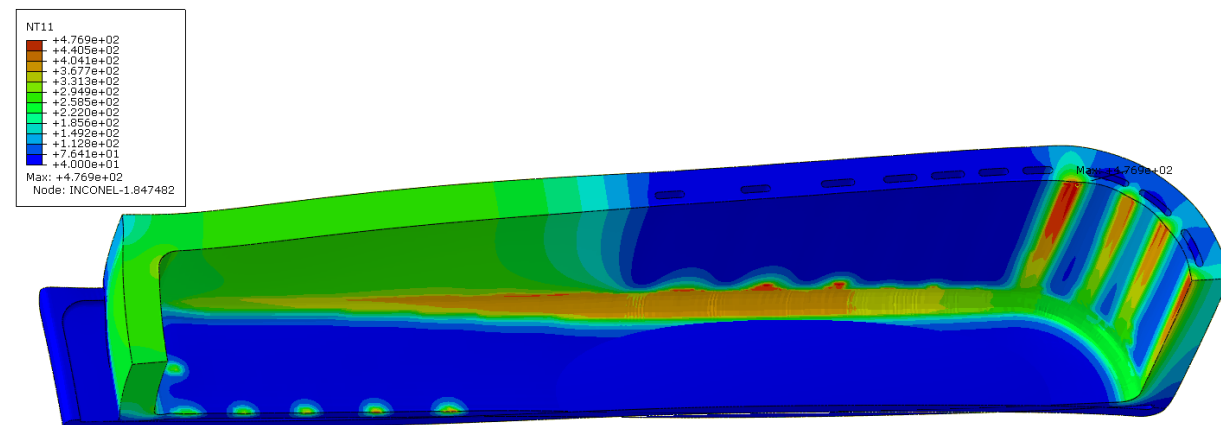
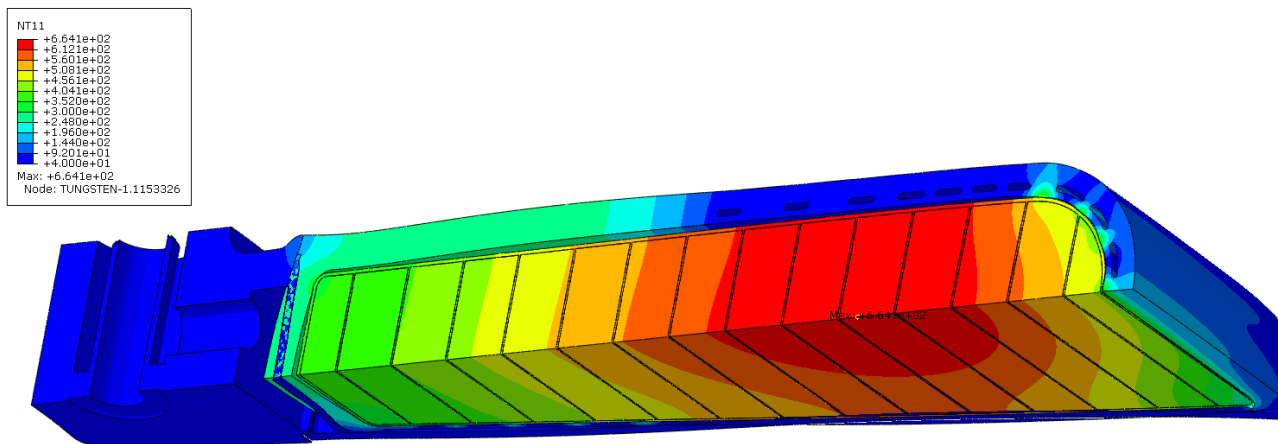
Number of field variables: 0

Conductance	Pressure
0	0
1.33	1
2.54	2
3.72	3
4.88	4
6.02	5
7.14	6
8.26	7
9.36	8
10.5	9
11.5	10
12.6	11

Fully-coupled, transient simulation shows W peak temperature remains below limit



CTE mismatch creates strong contact (& heat transfer) at edges and front cooling channels



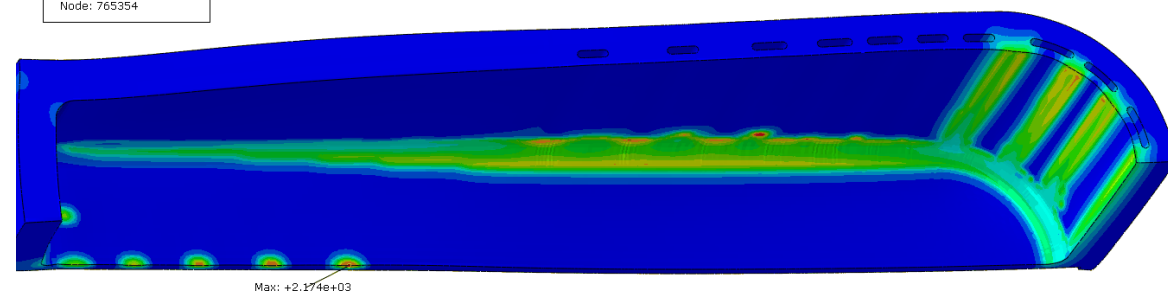
In_Ta debonded restart 22
ODB: debond_hex6_restart22.odb Abaqus/Standard 2025 Mon Feb 23 09:25:31 Eastern Standard Time 2026

Step: Step-5, second restart
Increment: 1424; Step Time = 600.0
Primary Var: NT11
Deformed Var: U Deformation Scale Factor: +3.000e+01

HFL Magnitude
(Avg: 75%)

+2.174e+03
+1.993e+03
+1.812e+03
+1.631e+03
+1.449e+03
+1.268e+03
+1.087e+03
+9.059e+02
+7.247e+02
+5.435e+02
+3.624e+02
+1.812e+02
+4.016e-02

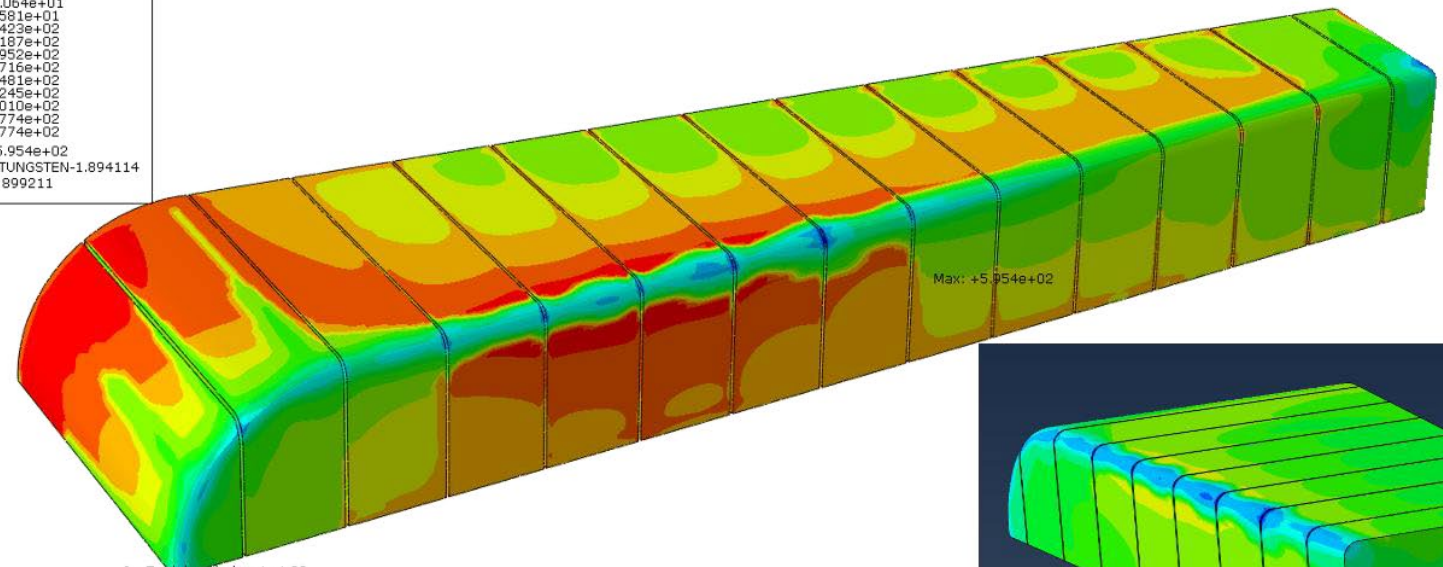
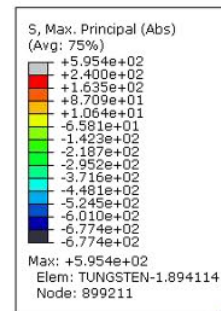
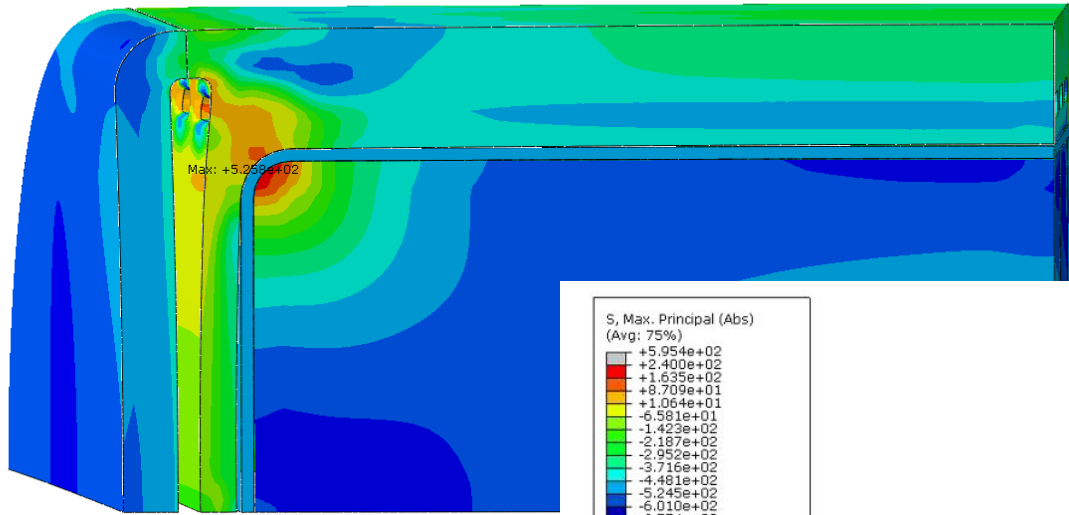
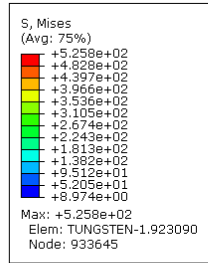
Max: +2.174e+03
Elem: INCONEL-1.759870
Node: 765354



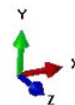
In_Ta debonded restart 22
ODB: debond_hex6_restart22.odb Abaqus/Standard 2025 Mon Feb 23 09:25:31 Eastern Standard Time 2026

Step: Step-5, second restart
Increment: 1424; Step Time = 600.0
Primary Var: HFL Magnitude
Deformed Var: U Deformation Scale Factor: +3.000e+01

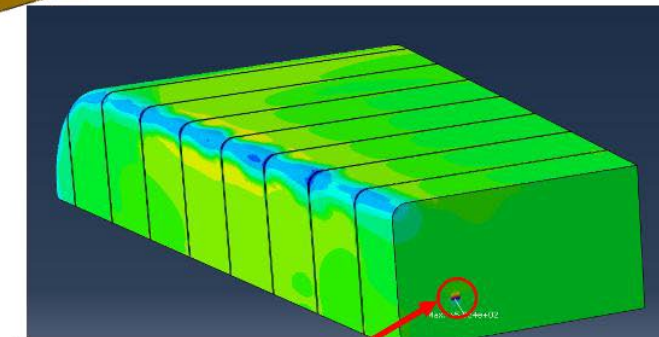
CTE mismatch creates strong contact (& heat transfer) at edges and front cooling channels



In_Ta debonded restart 22
ODB: debond_hex6_restart22.odb Abaqus/Standard 2025 Mon Feb 23 09:25:31 Eastern Standard Time 2026

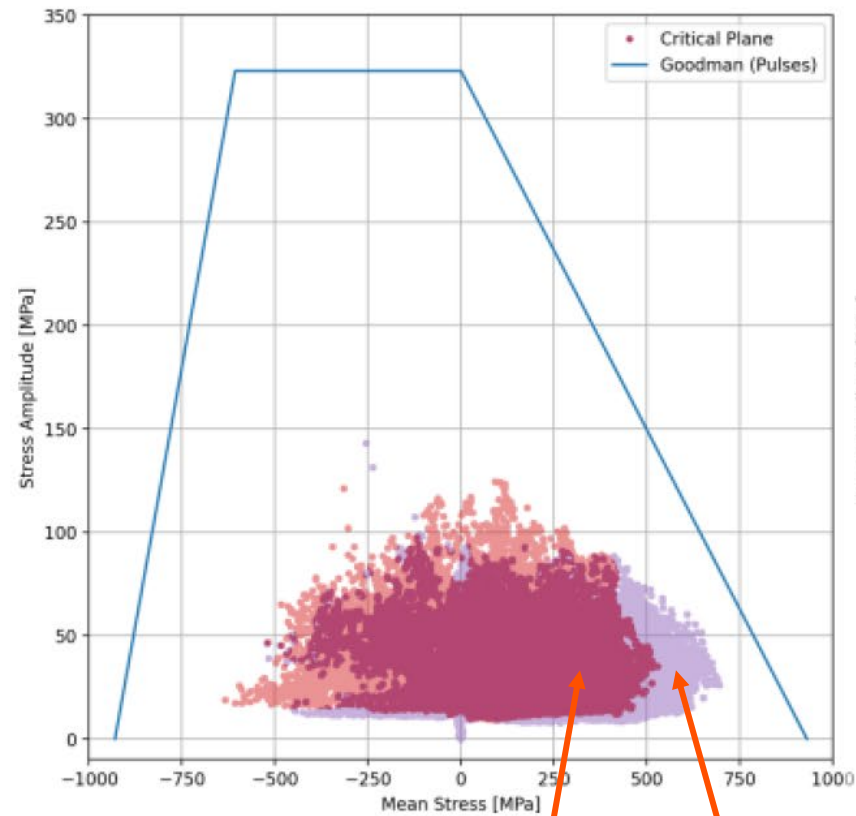


Step: Step-5, second restart
Increment: 1424; Step Time = 600.0
Primary Var: S, Max. Principal (Abs)
Deformed Var: U Deformation Scale Factor: +1.000e+00



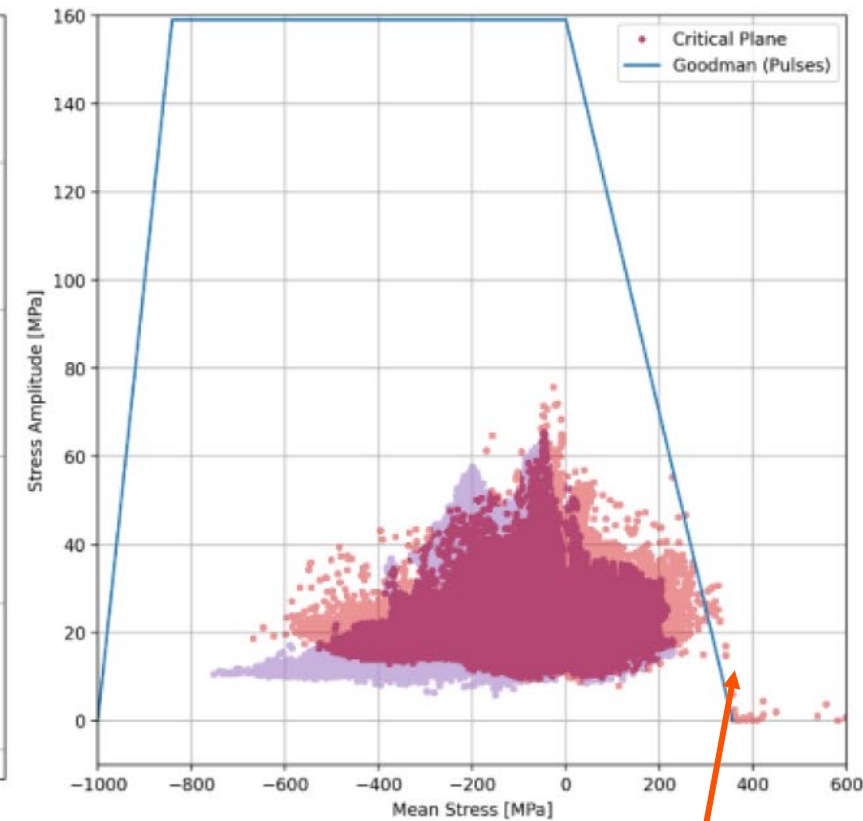
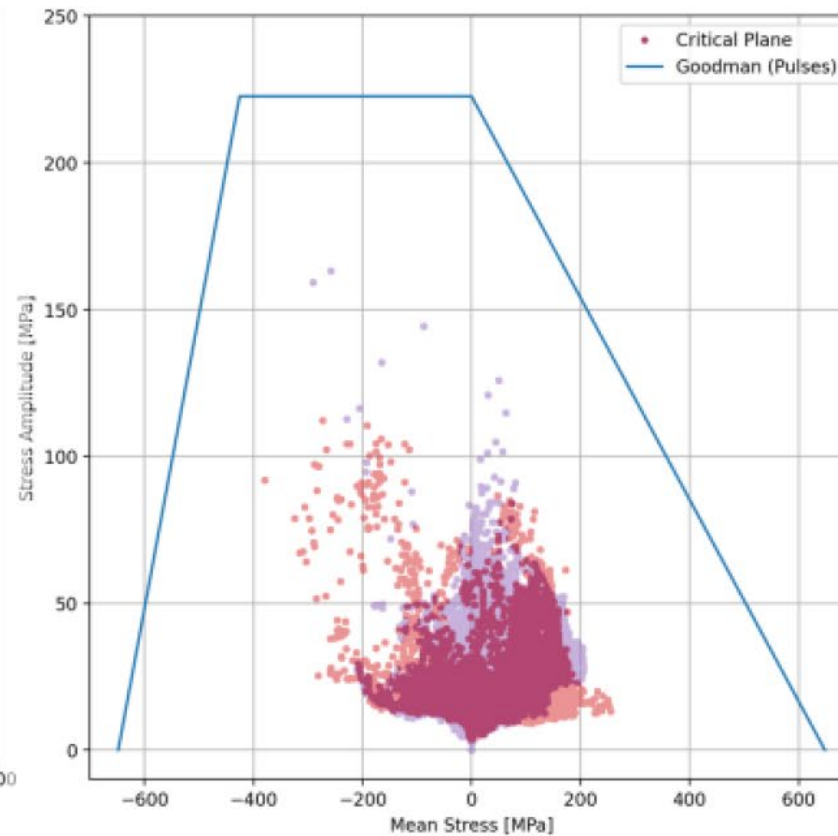
Possible singularity at peak

Pulse fatigue analysis compares 10-year performance against bonded baseline



Debonded
fatigue

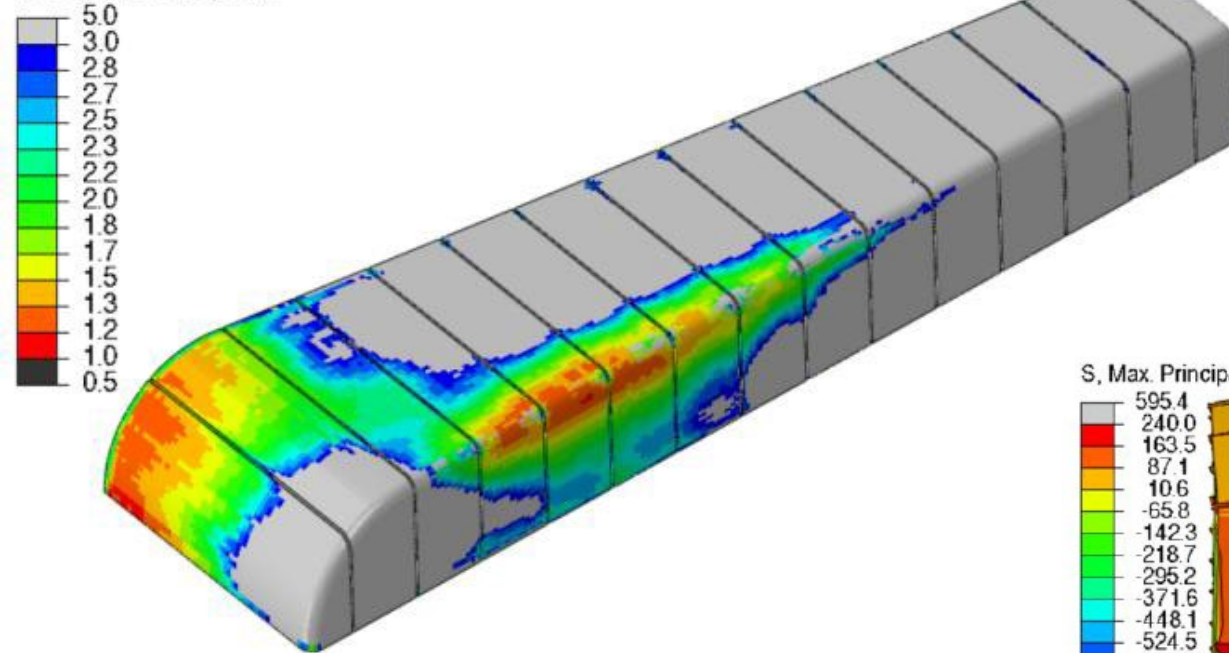
Bonded
baseline



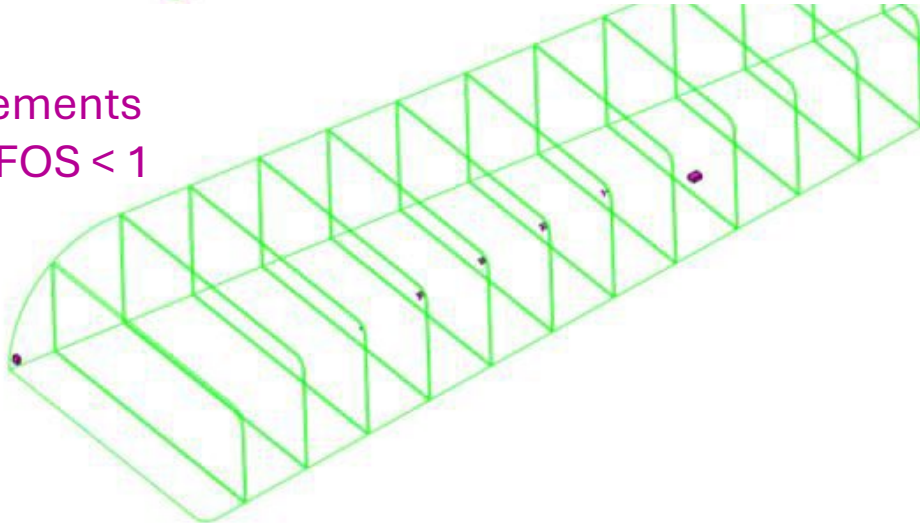
Some tungsten
elements fail

Some tungsten elements fail – Acceptable as Inconel shroud continues to provide structure

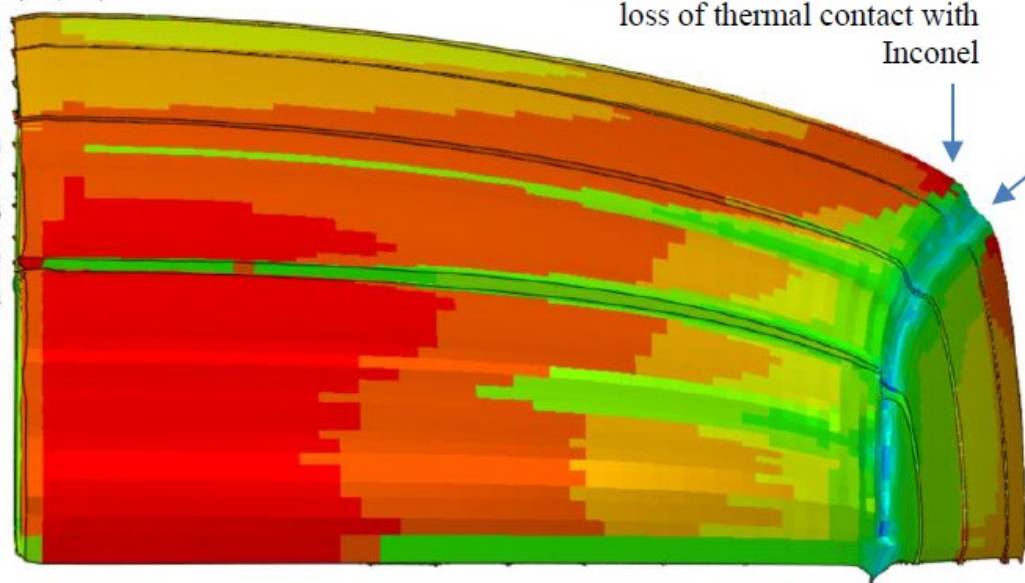
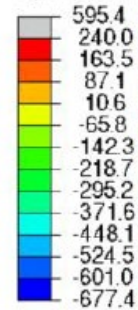
FOS@Life=1-Repeats



W elements
with FOS < 1



S, Max. Principal (Abs)



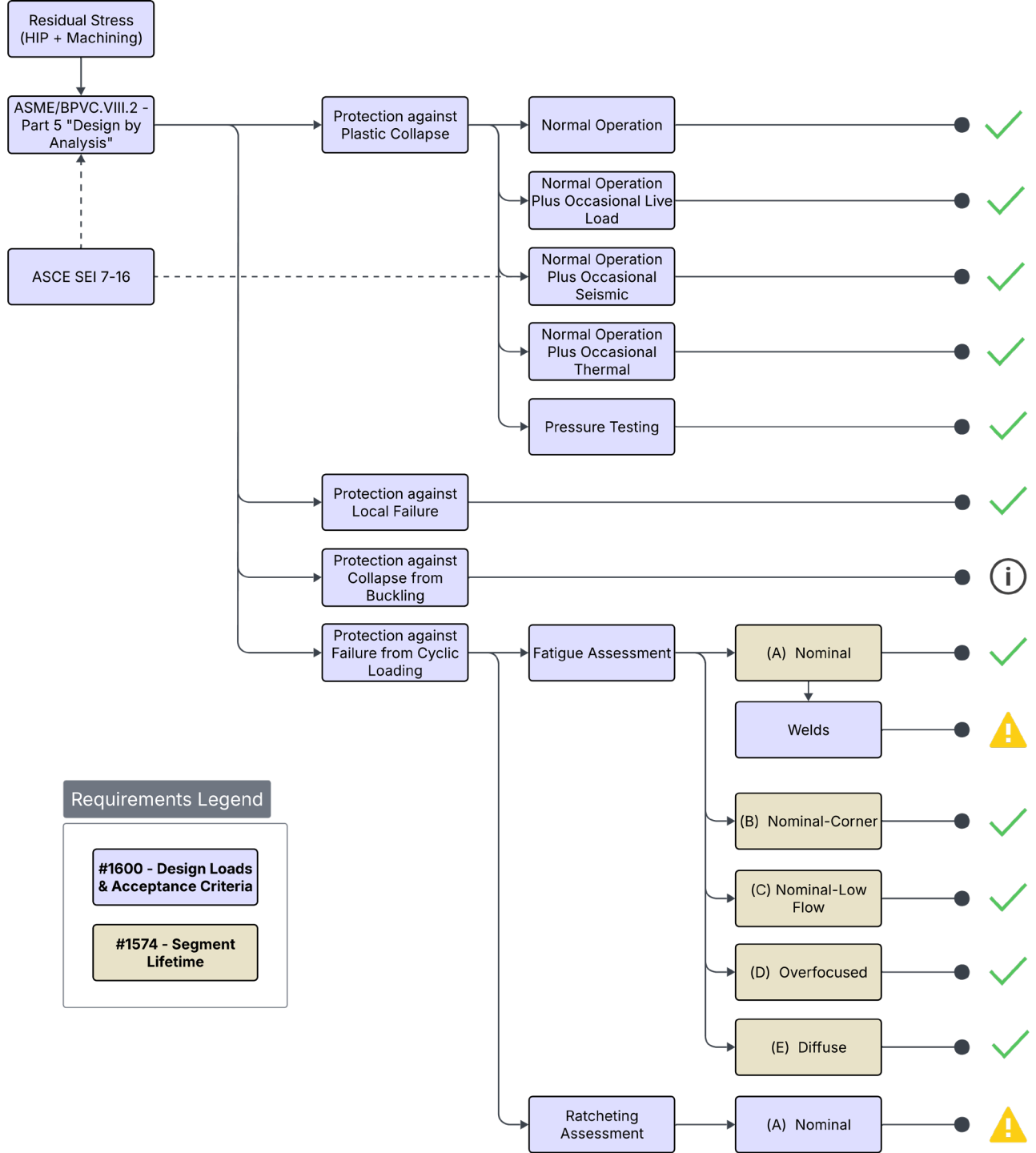
Tensile “bulging” effect due to
loss of thermal contact with
Inconel

Compressive stresses
from contact with
Inconel shroud

Analyses show requirements are met with 2 caveats →

In addition:

- Multiple sensitivity analyses performed to gain confidence in results
- Full debond analysis shows target can still meet key requirements



Target segment thermostructural analyses support important charge questions

#2

Has the design been shown to meet the requirements?



#3

Do DACs and other supporting documentation adequately support the final design?



#5

Is the design sufficiently mature to proceed with finalizing the procurement package?



Thank you!

Questions?

