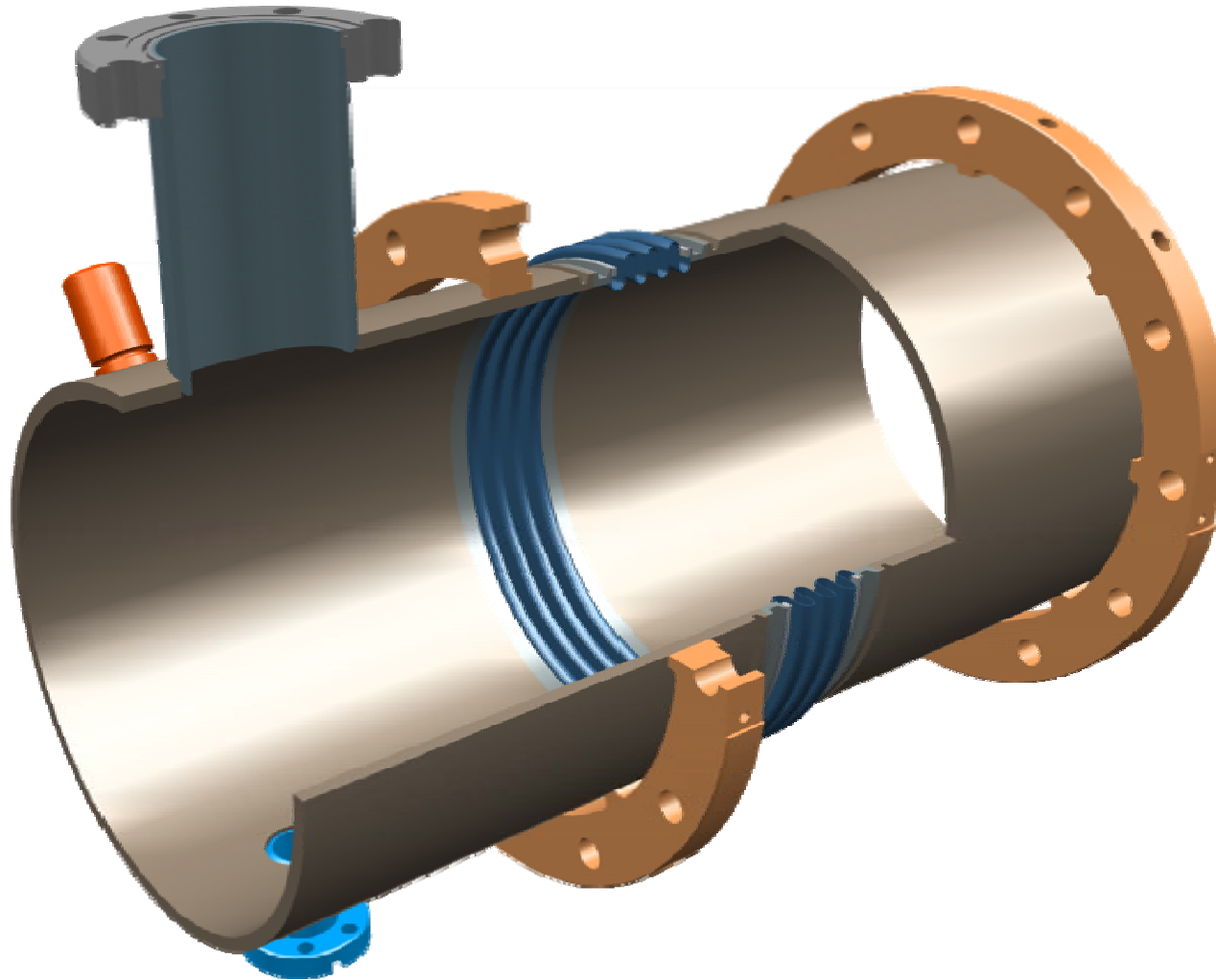
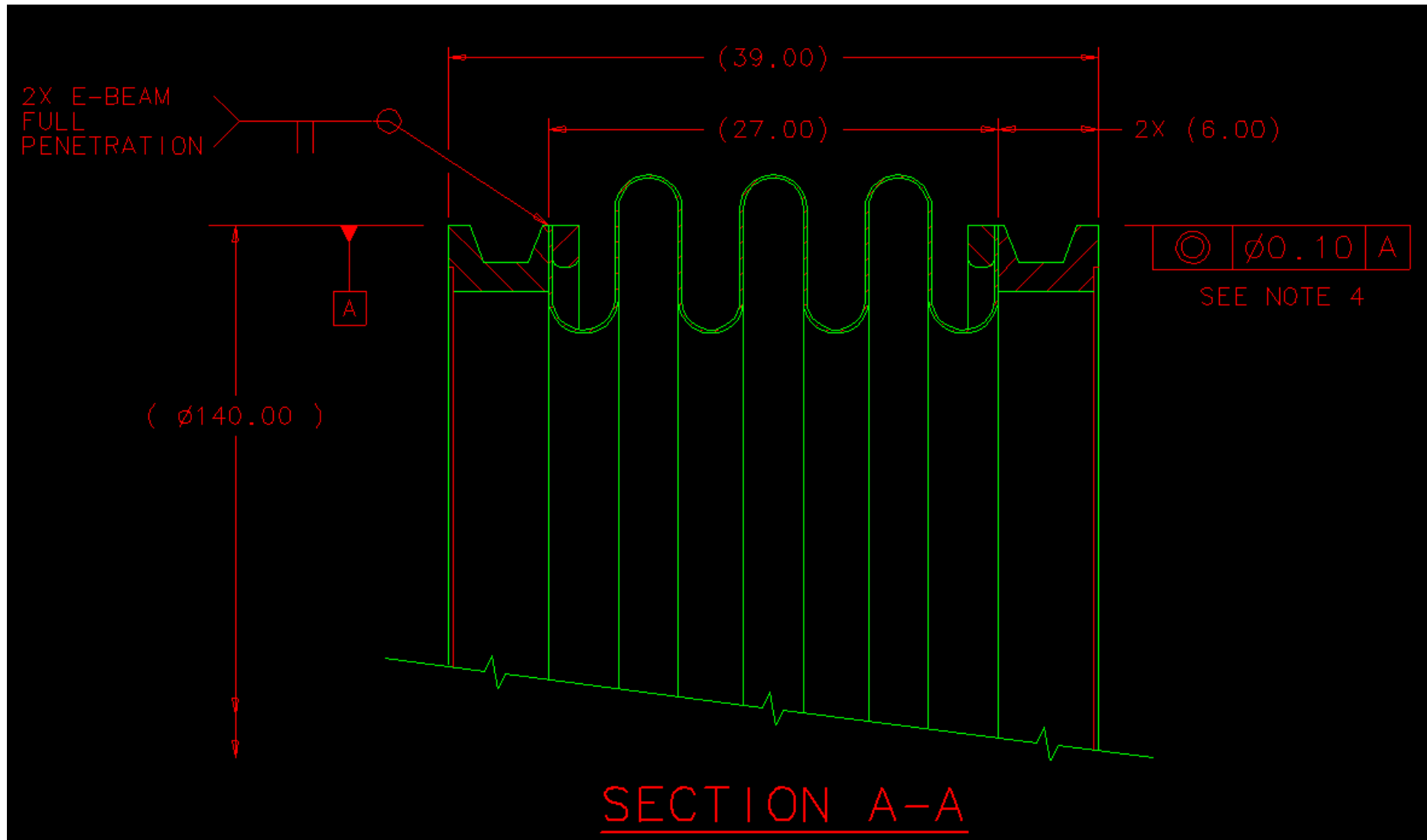


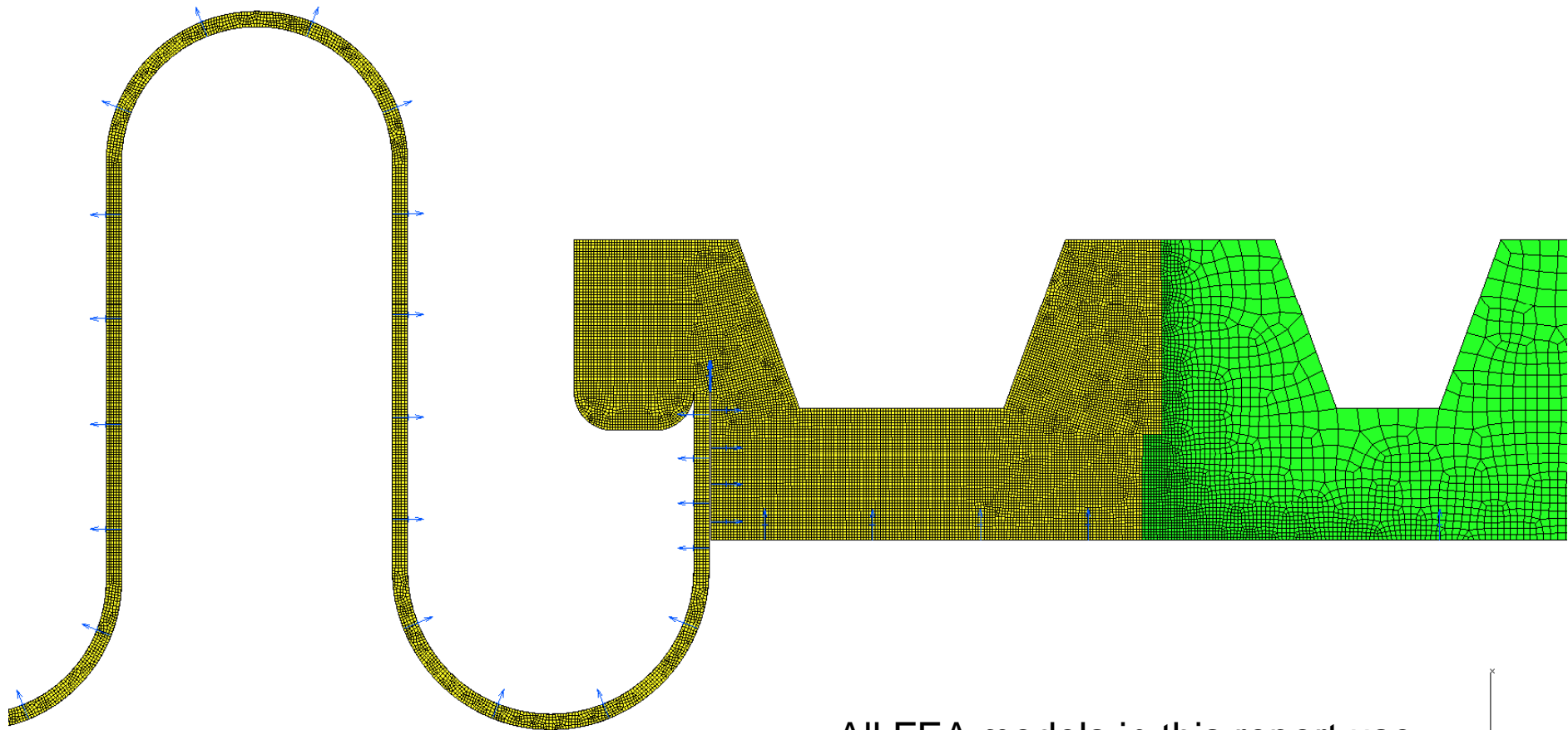
Titanium Bellows Comparison for the 3.9 GHz Helium Vessel



Current 3.9 GHz Bellows Design

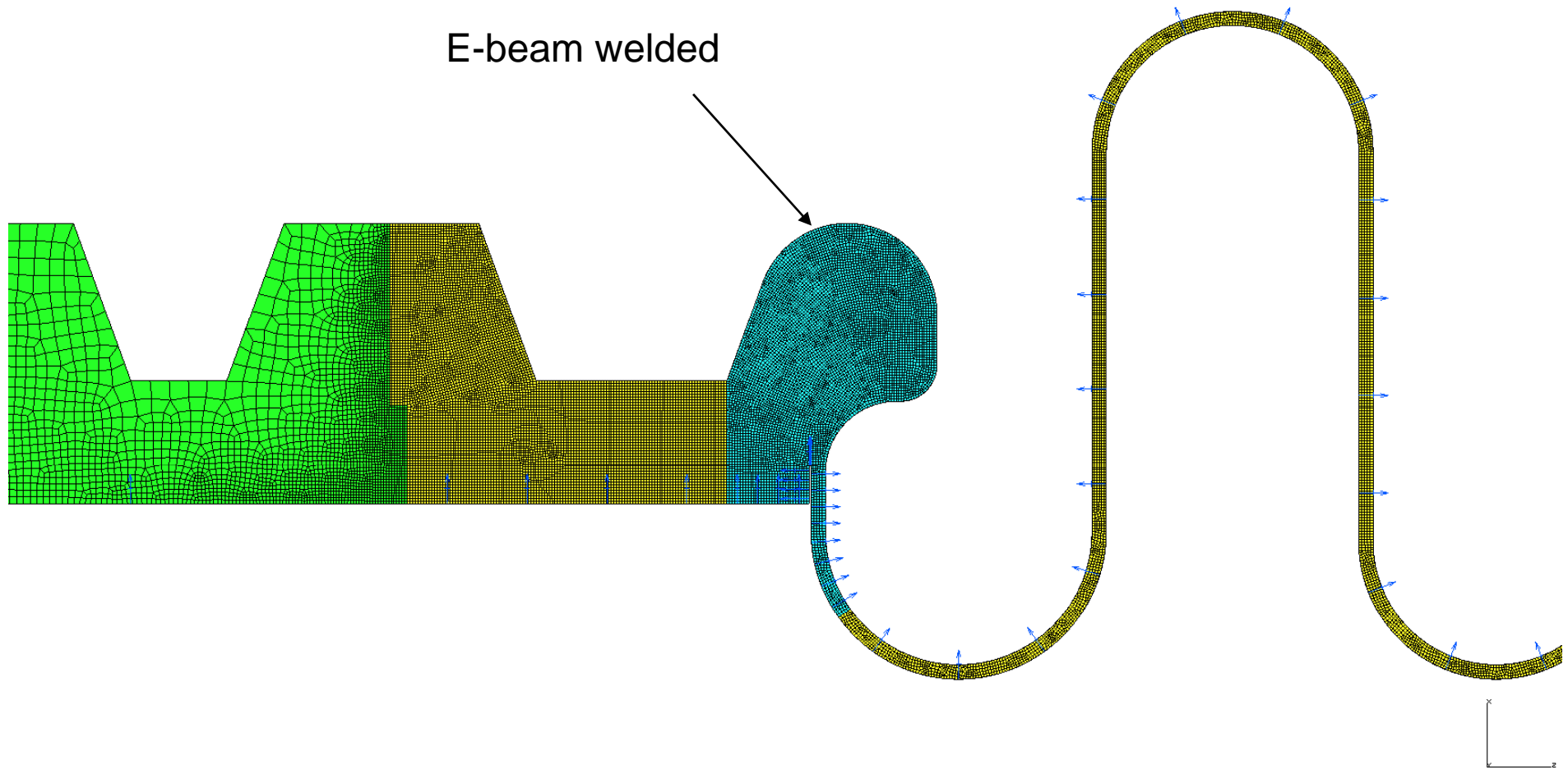


FEA Model of the 3.9 GHz Bellows

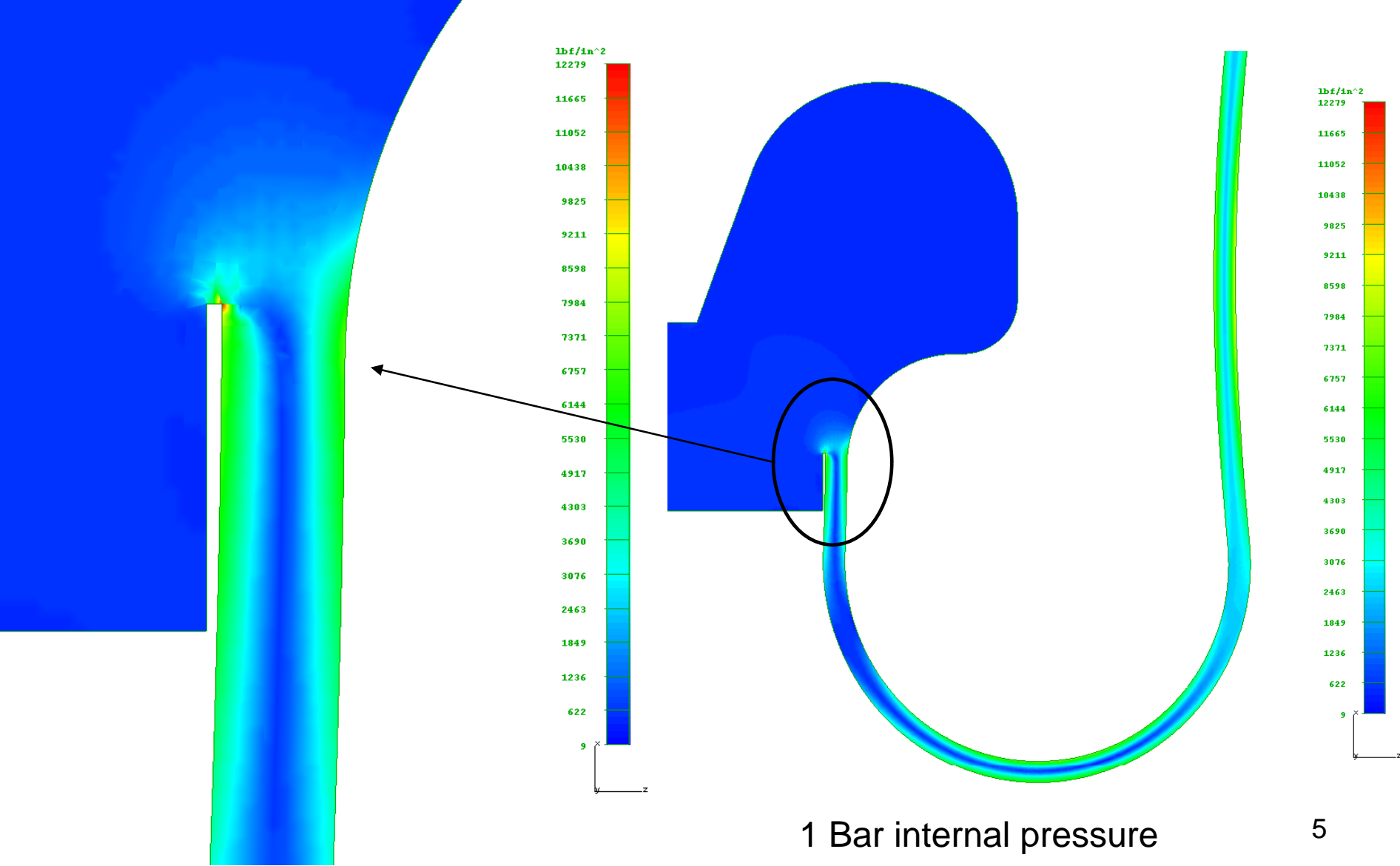


All FEA models in this report use
the axisymmetric element type

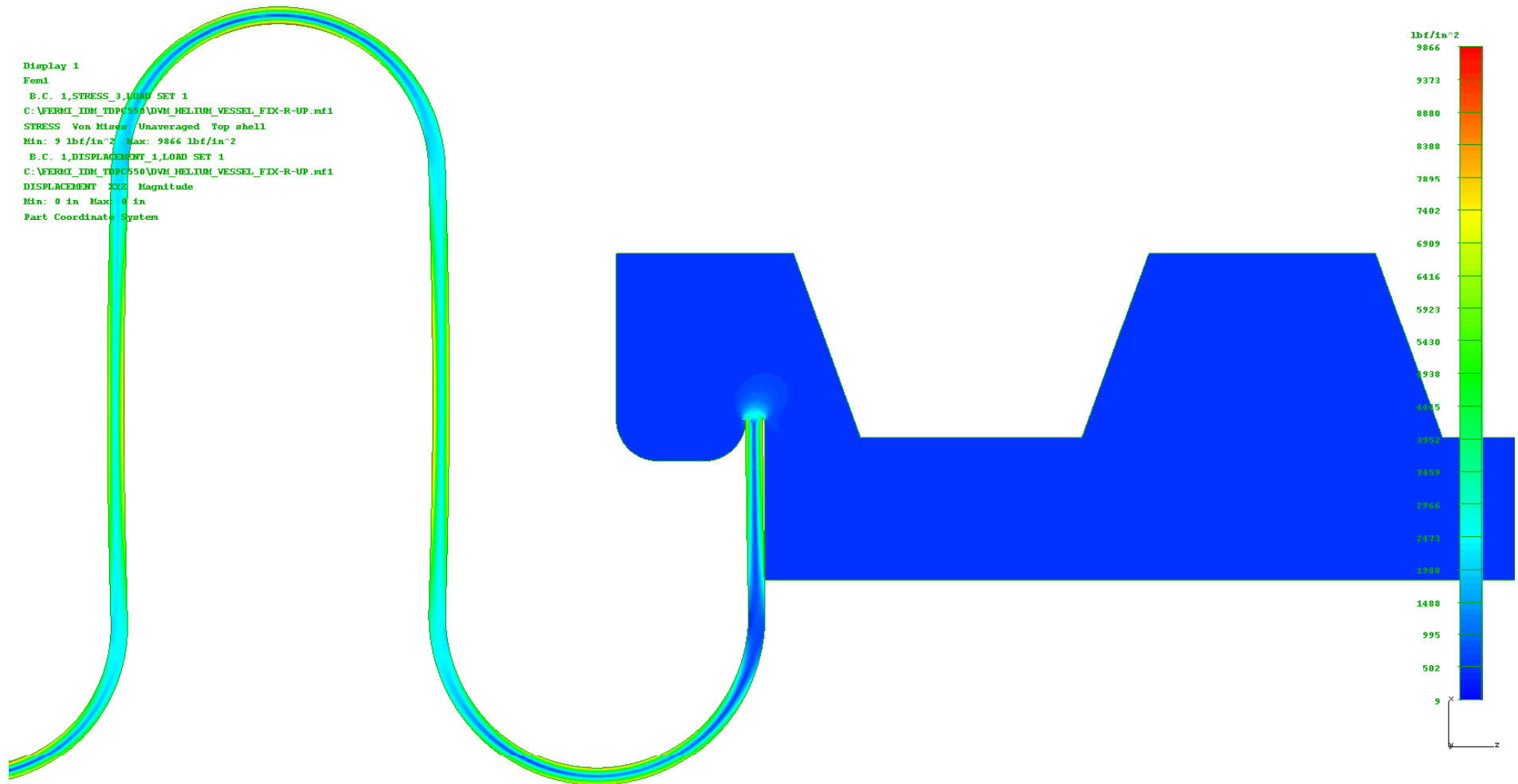
FEA Model of the 3.9 GHz Bellows



FEA Results of the 3.9 GHz Bellows

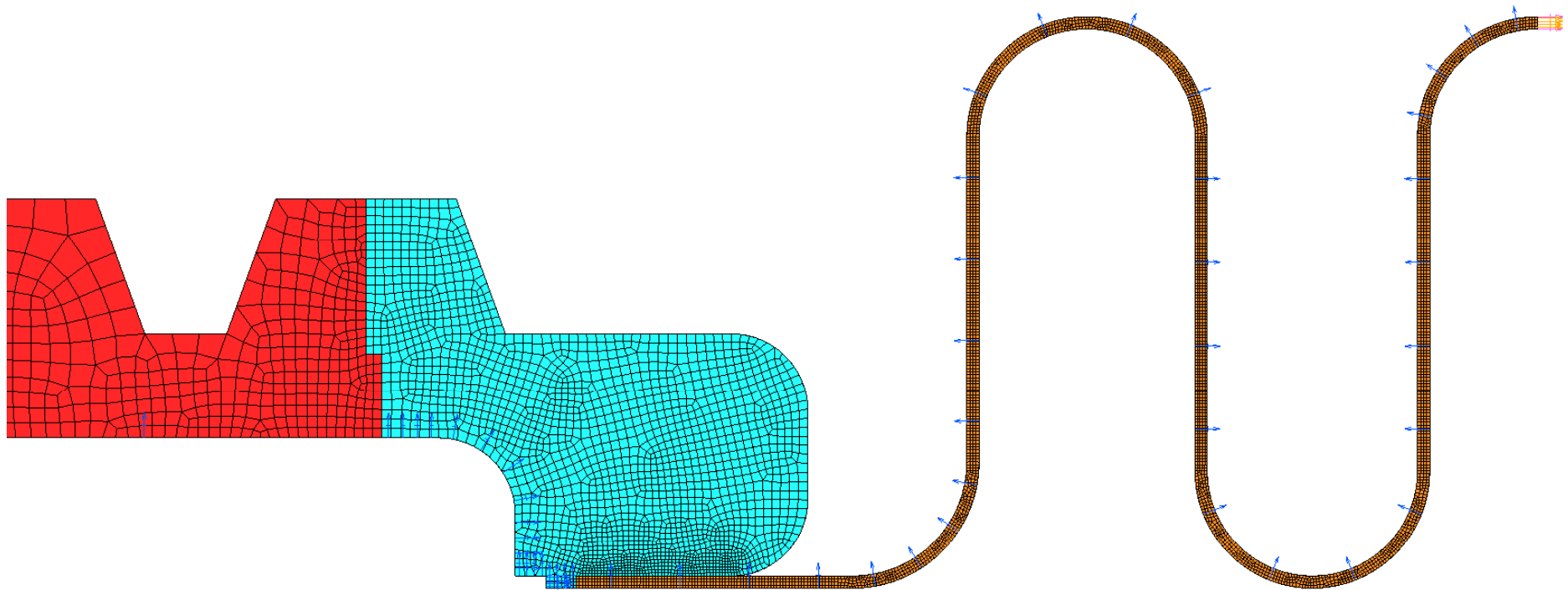


FEA Results of the 3.9 GHz Bellows



1 Bar internal pressure

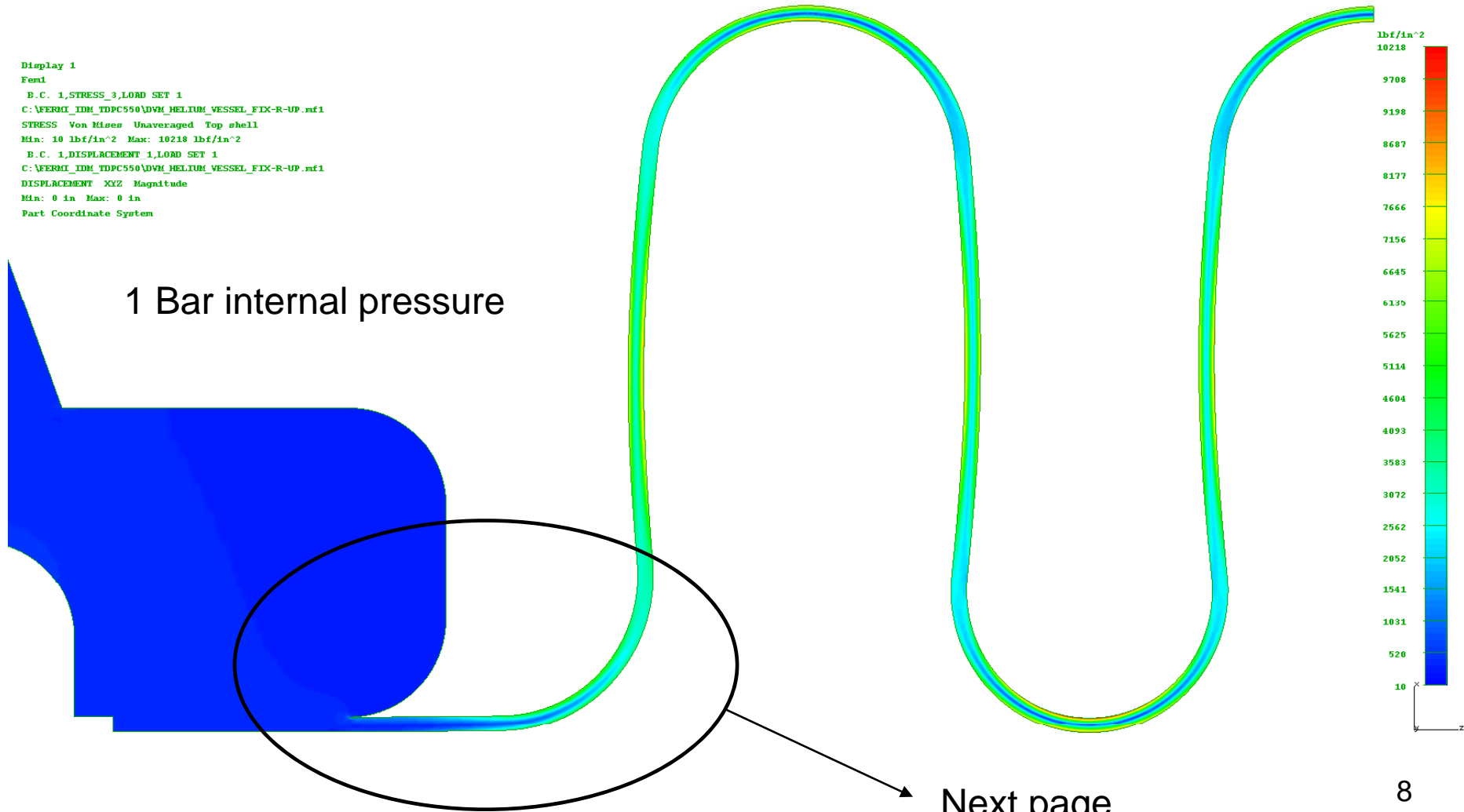
FEA Model of the 3.9 GHz Proposed Bellows



FEA Results of the 3.9 GHz Proposed Bellows

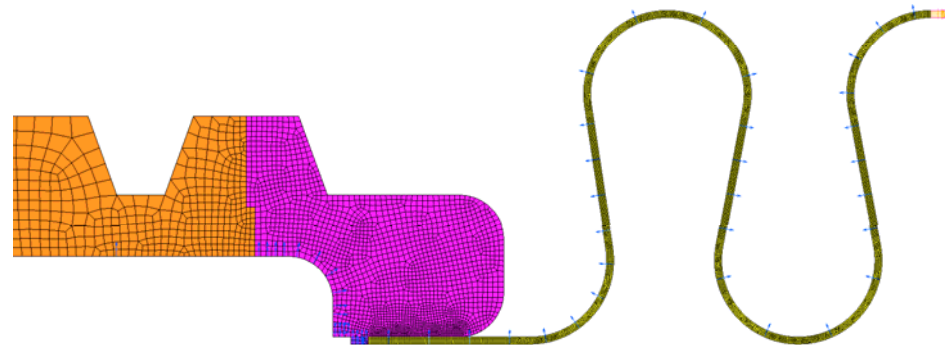
```
Display 1  
Fem1  
B.C. 1,STRESS_3,LOAD SET 1  
C:\FERMI_IDM_TDPC550\DVH_HELIUM_VESSEL_FIX-R-UP.mf1  
STRESS Von Mises Unaveraged Top shell  
Min: 10 lbf/in^2 Max: 10218 lbf/in^2  
B.C. 1,DISPLACEMENT 1,LOAD SET 1  
C:\FERMI_IDM_TDPC550\DVH_HELIUM_VESSEL_FIX-R-UP.mf1  
DISPLACEMENT XYZ Magnitude  
Min: 0 in Max: 0 in  
Part Coordinate System
```

1 Bar internal pressure



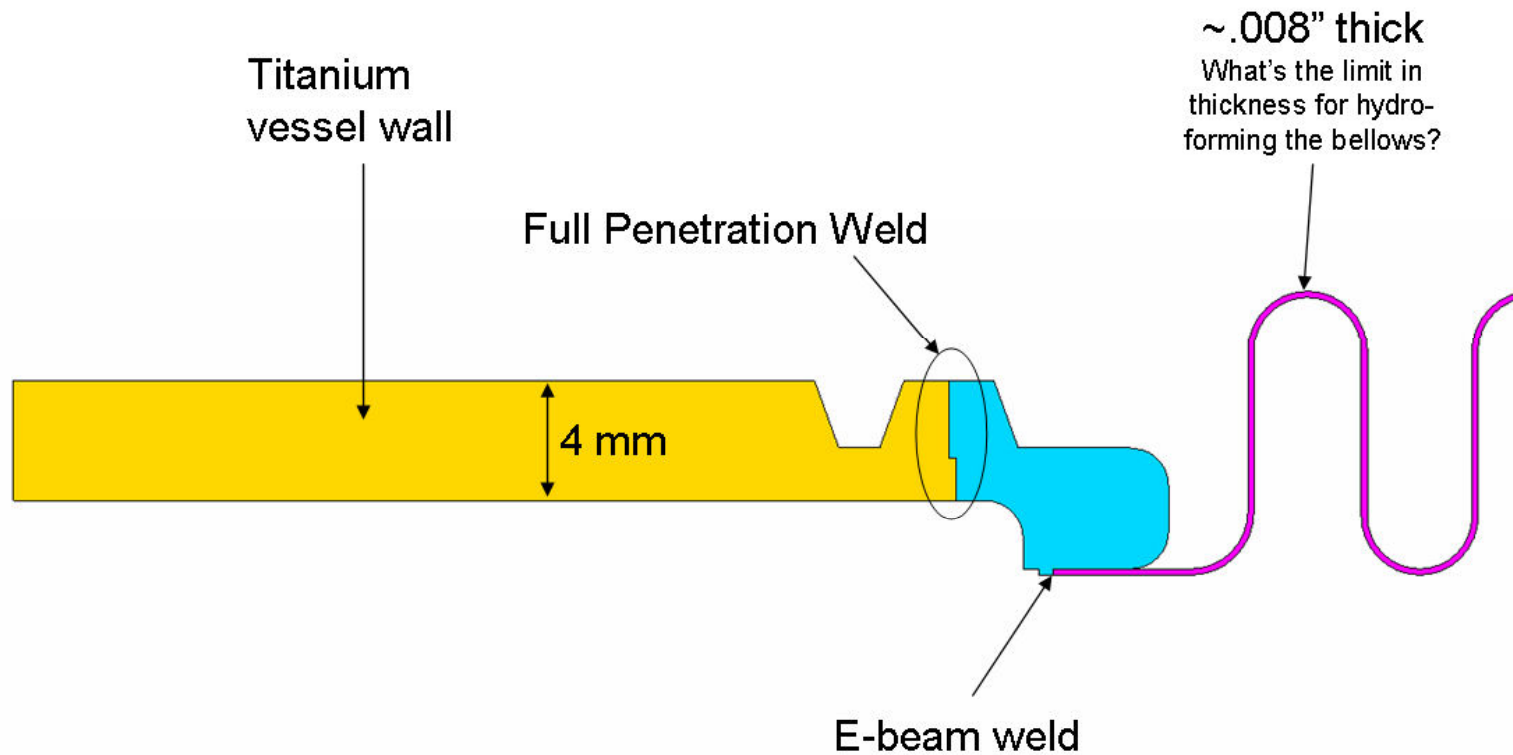
Proposed Bellows Changes

- Thicker Bellows (perhaps .012" thick)
- Weld Rings that look more like a bellows cuff to reduce:
 - Flexing
 - Stress concentrations
 - Fabrication complexity and cost
 - Difficult welding



Sent to Vendor for Comments

Titanium Helium Vessel and Titanium Bellows

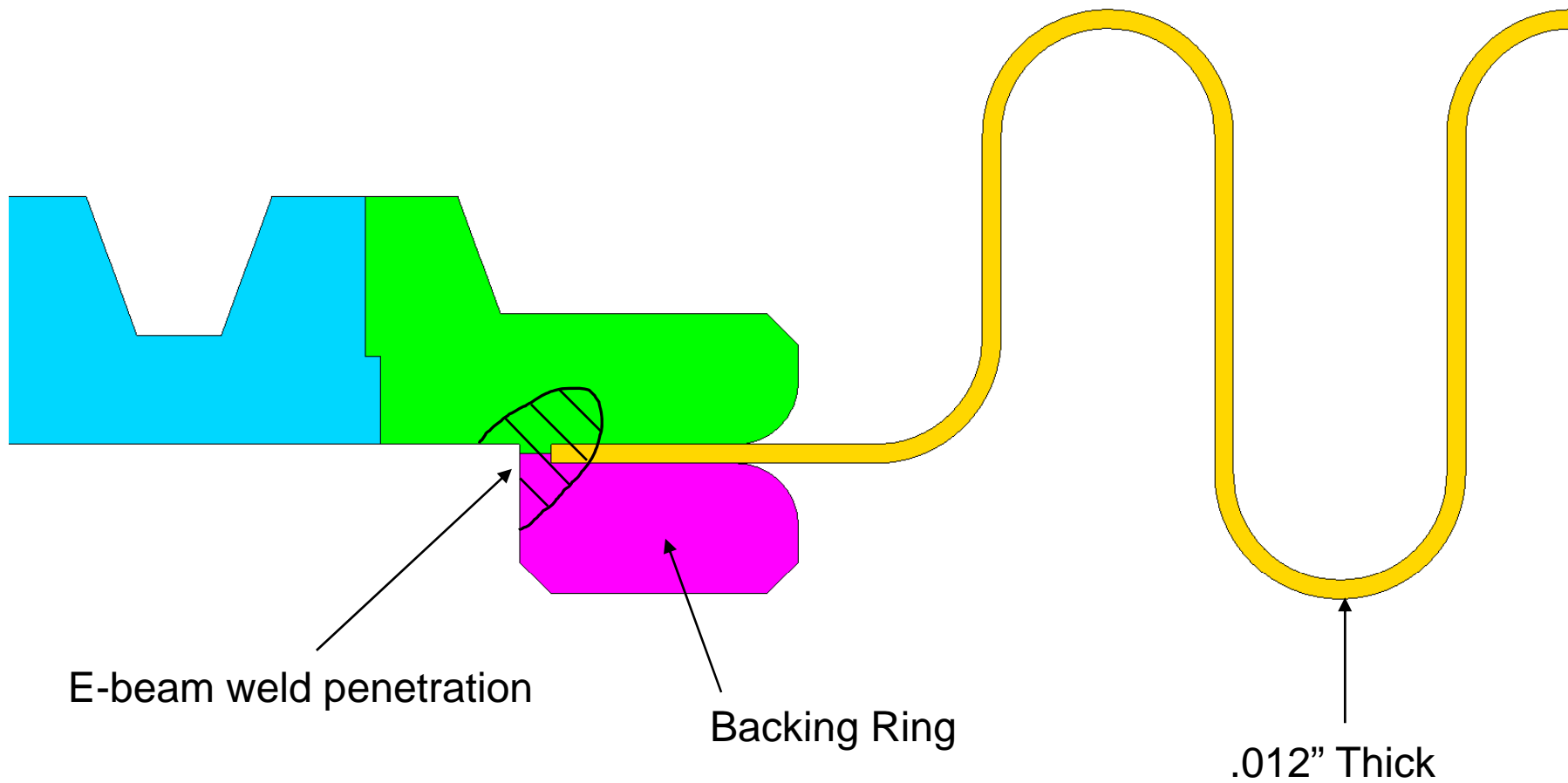


Proposed Design Change (WIP)
(internal pressure of 4 bar, warm)

6/19/07

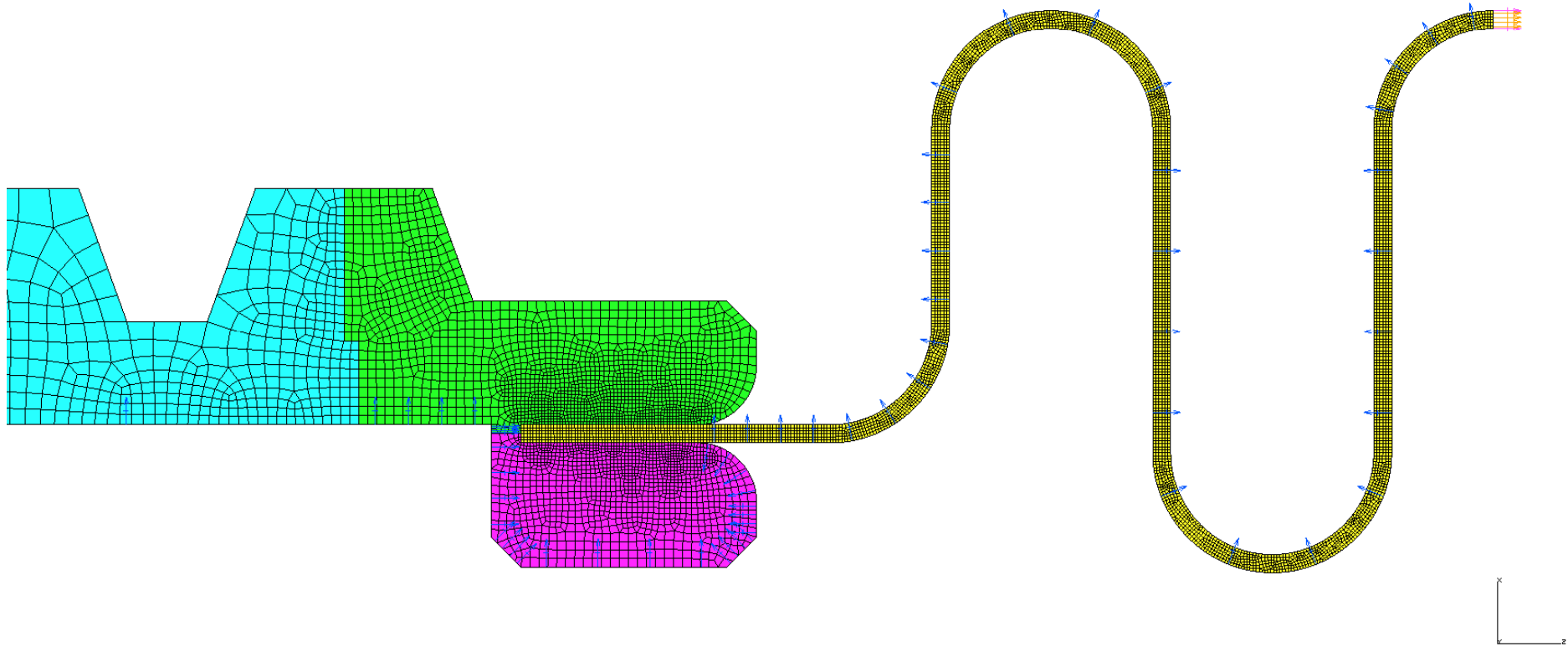
11

Design Proposal after 1st Meeting



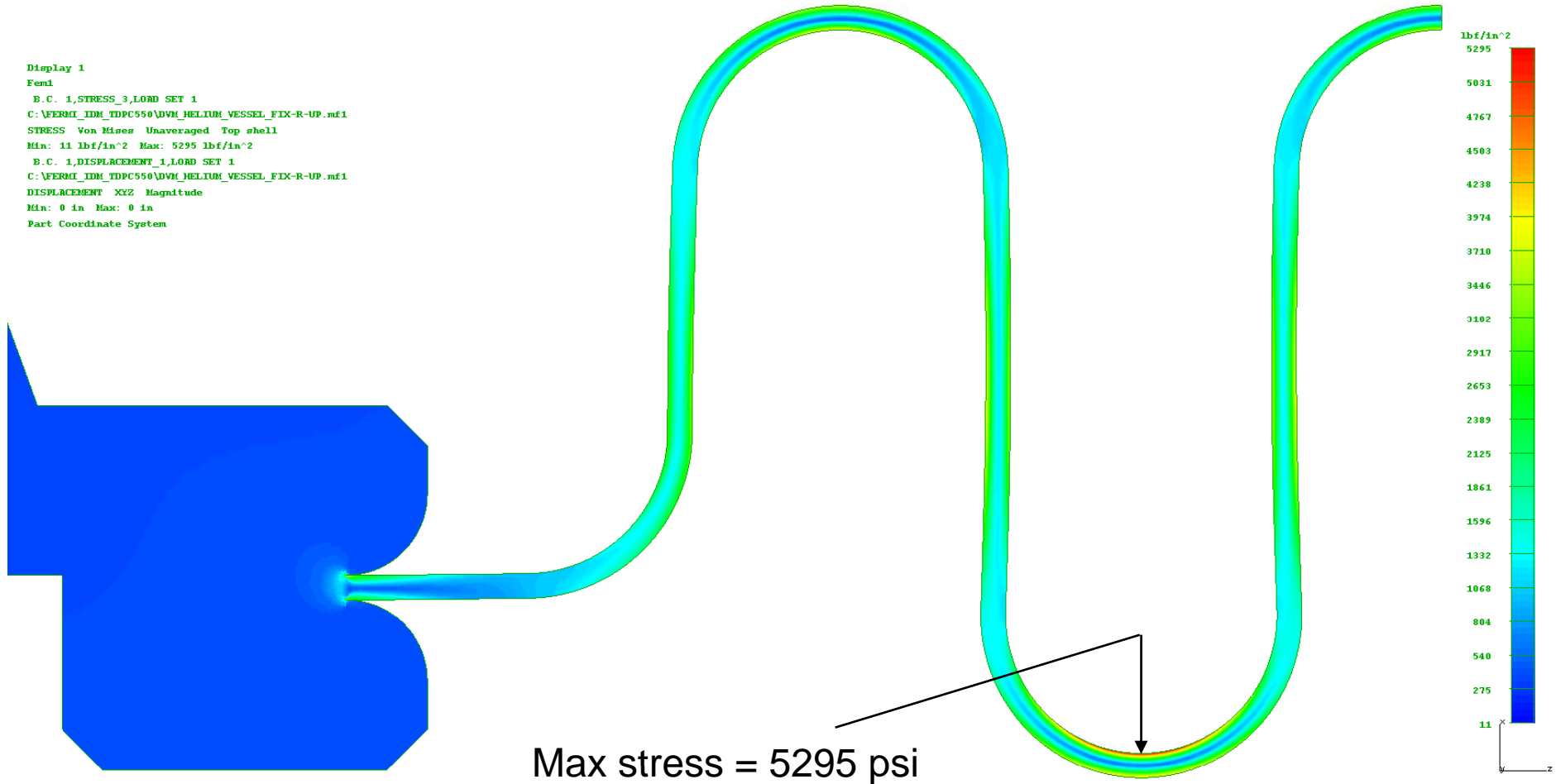
Design Proposal FEA Model 1

1 Bar internal pressure only



Design Proposal FEA Results 1

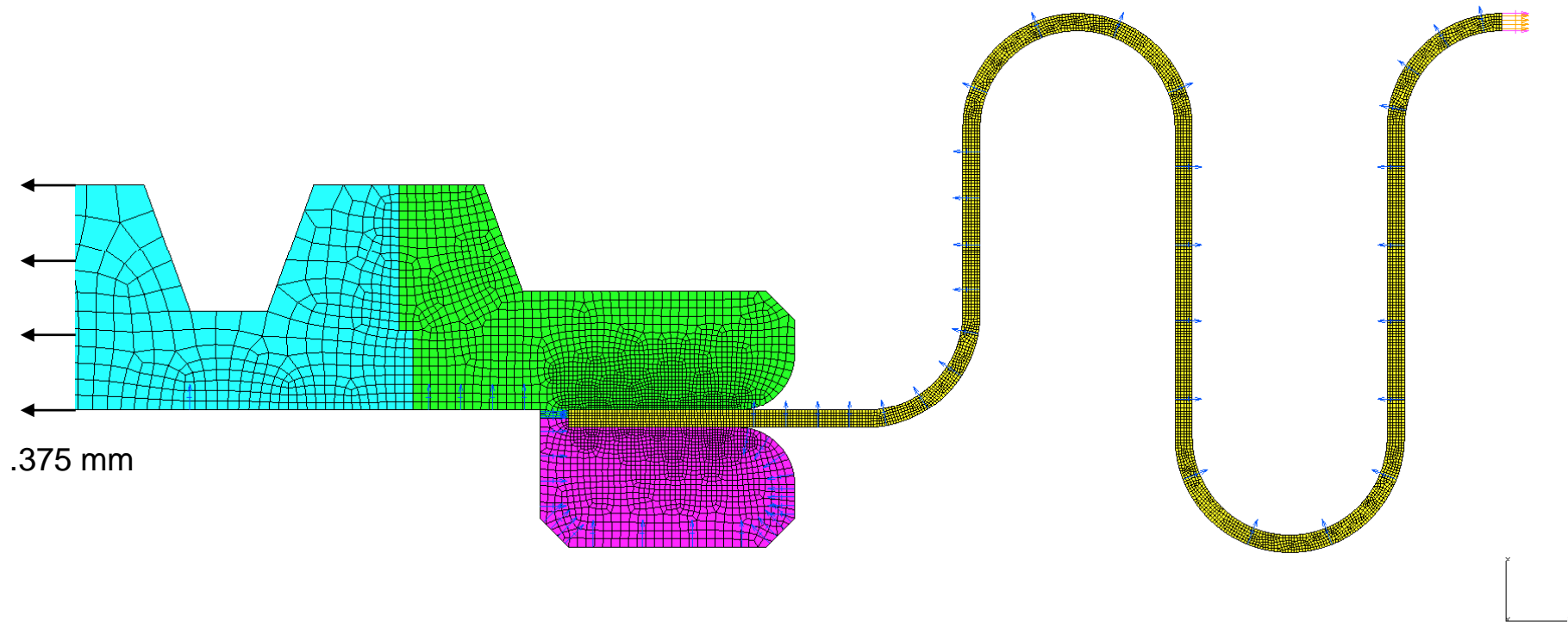
```
Display 1  
Fem1  
E.C. 1,STRESS_3,LOAD SET 1  
C:\FERMI_IDM_TDP0550\DVH_HELIUM_VESSEL_FIX-R-UP.mf1  
STRESS Von Mises Unaveraged Top shell  
Min: 11 lbf/in^2 Max: 5295 lbf/in^2  
E.C. 1,DISPLACEMENT_1,LOAD SET 1  
C:\FERMI_IDM_TDP0550\DVH_HELIUM_VESSEL_FIX-R-UP.mf1  
DISPLACEMENT XYZ Magnitude  
Min: 0 in Max: 0 in  
Part Coordinate System
```



14

Design Proposal FEA Model 2

4 Bar internal pressure w/ .375 mm bellows stretch

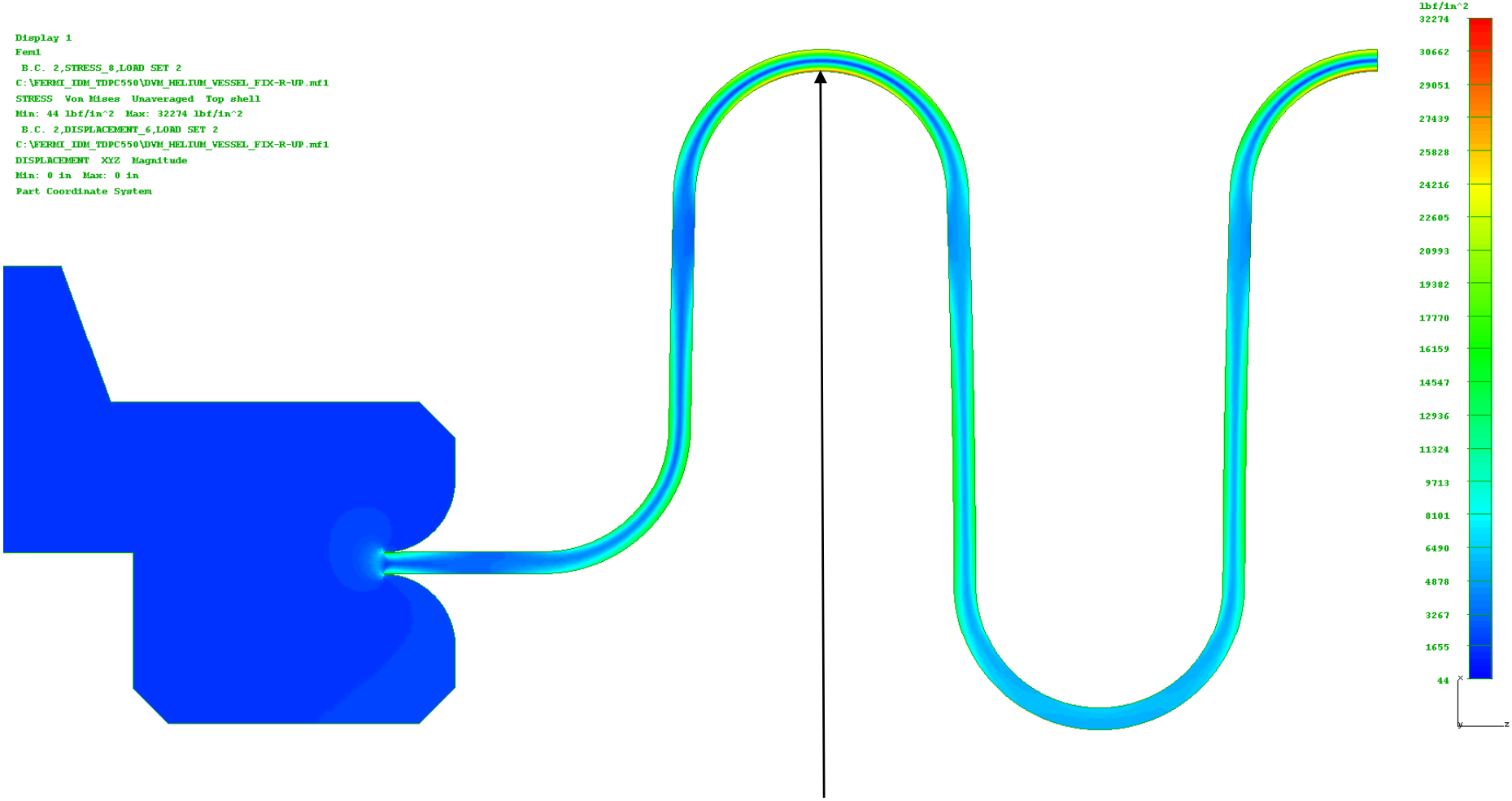


*Symmetric loading condition:
actual stretch = .75mm*

Design Proposal FEA Results 2

4 Bar internal pressure w/ .375 mm bellows stretch

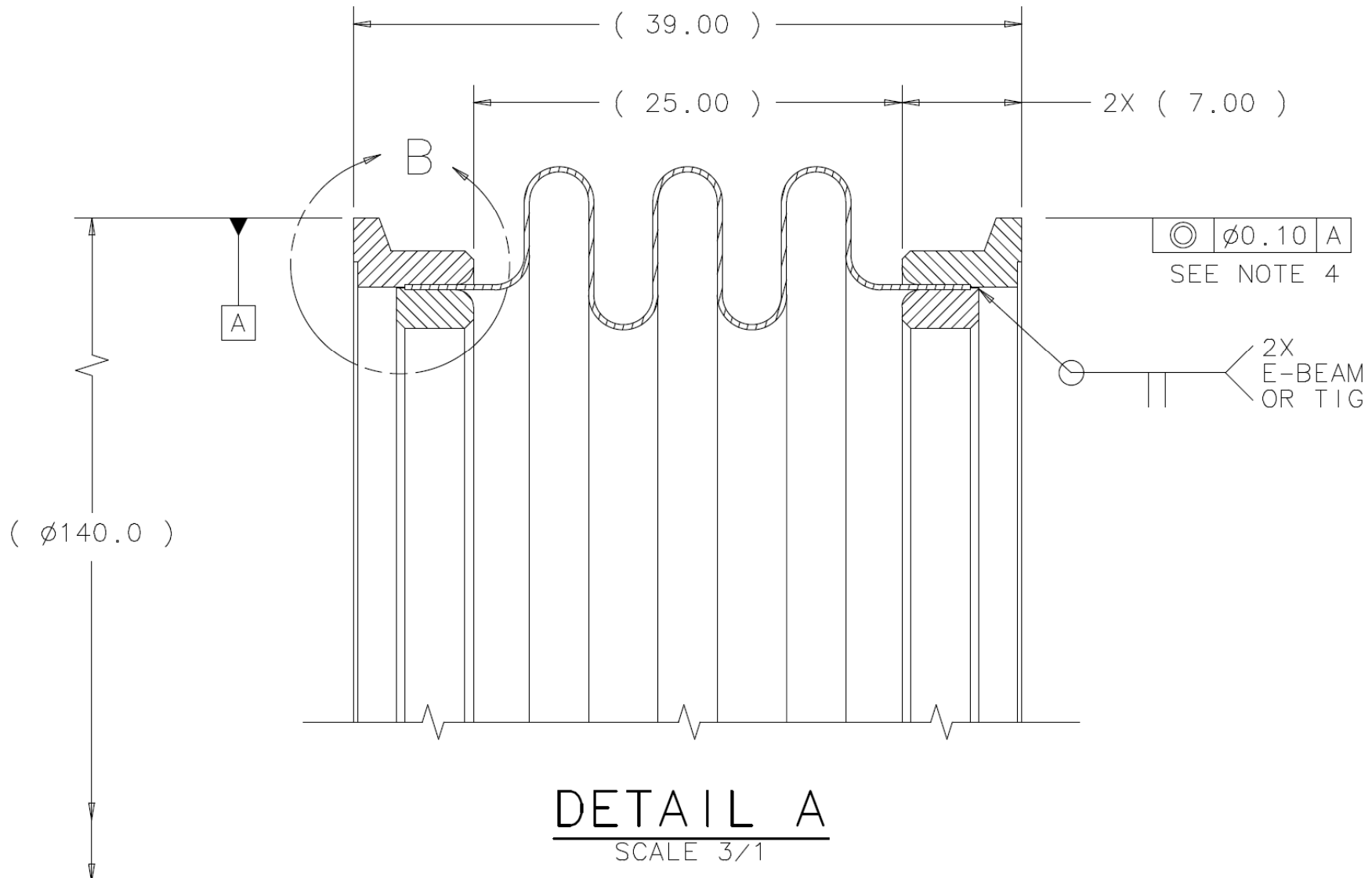
```
Display 1  
Fem1  
B.C. 2,STRESS_8,LOAD SET 2  
C:\FERMI_IDM_TDP0550\DVH_HELIUM_VESSEL_FIX-R-UP.mf1  
STRESS Von Mises Unaveraged Top shell  
Min: 44 lbf/in^2 Max: 32274 lbf/in^2  
B.C. 2,DISPLACEMENT_6,LOAD SET 2  
C:\FERMI_IDM_TDP0550\DVH_HELIUM_VESSEL_FIX-R-UP.mf1  
DISPLACEMENT XYZ Magnitude  
Min: 0 in Max: 0 in  
Part Coordinate System
```



Max stress = 32274 psi

Design Sent to Vendor

(3rd Harmonic)



Conclusions

- Bellows redesign looks adequate for 4 Bar, warm.
- Backing ring helps with e-beam welding and reduces stresses in the weld when leak testing the vessel.
- Thicker bellows (.012") greatly reduces stress and allows the bellows to meet the 4 Bar criteria.
- Waiting for vendor feed-back on fabrication variations.
- 3-D model and drawings completed.