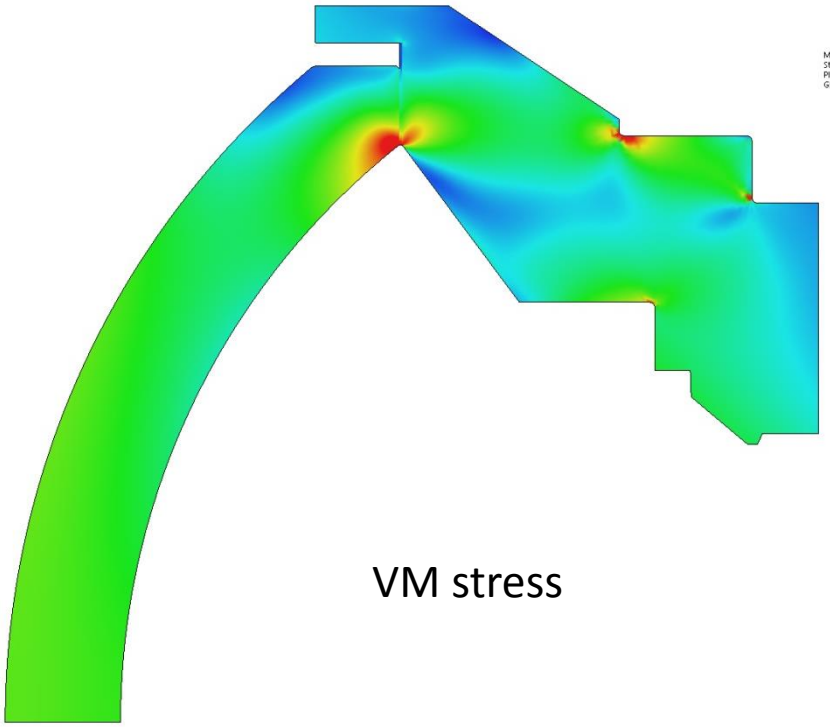
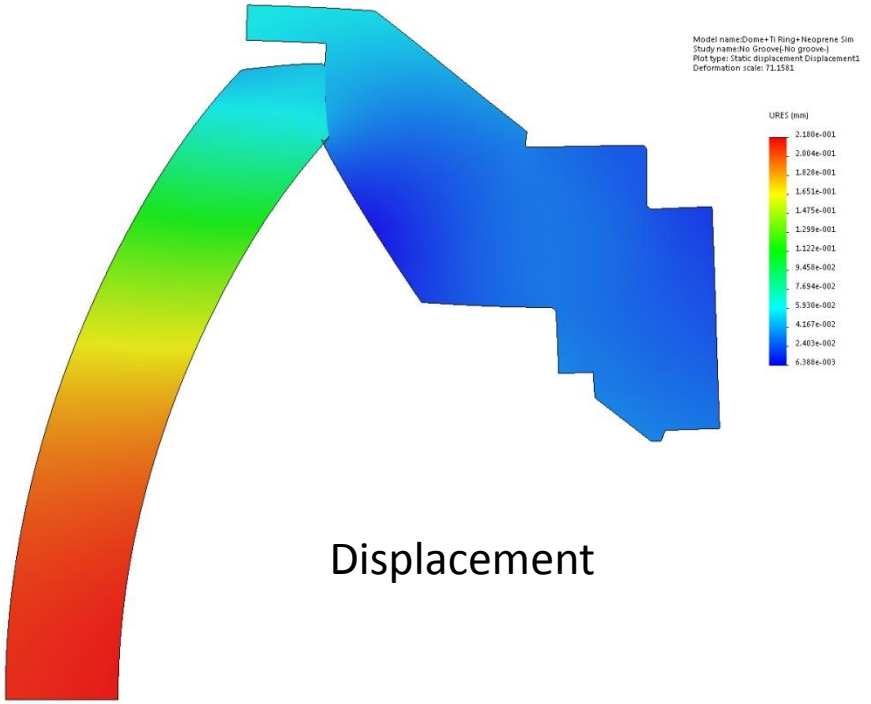
I2map dome port design

3/1/2016

First design



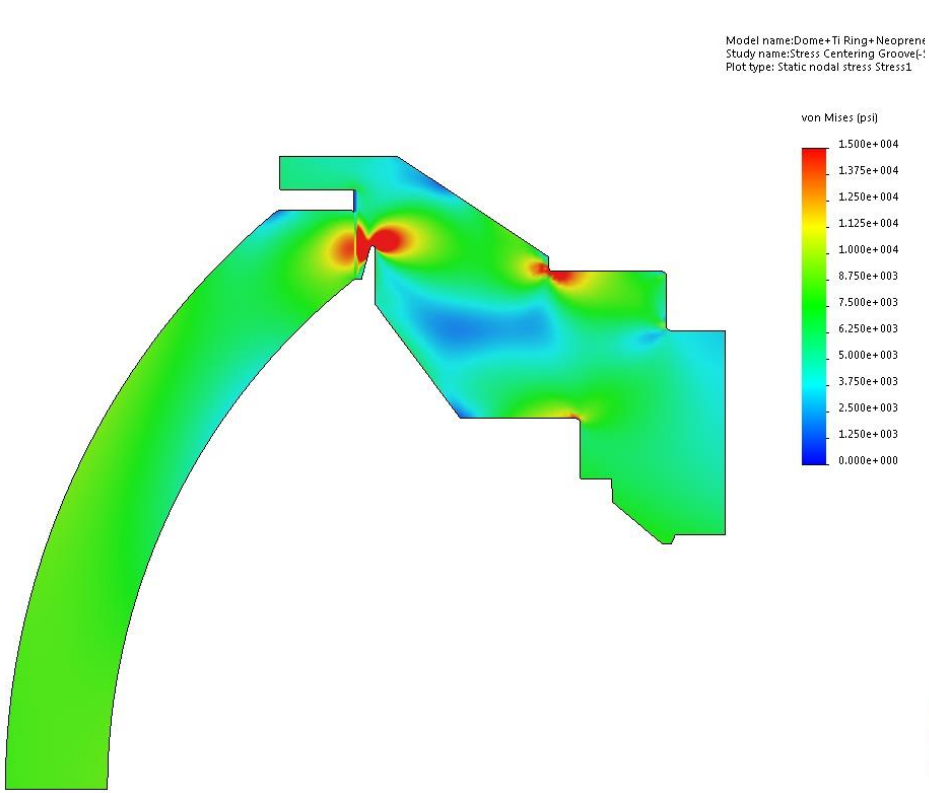
VM stress

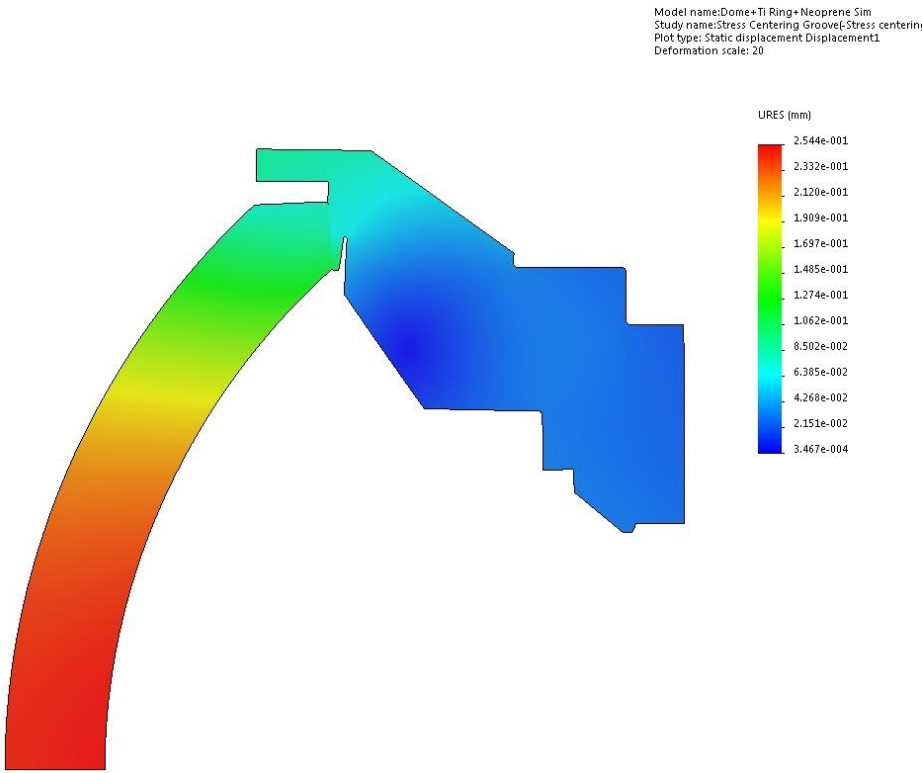


Displacement

- I assumed no sliding between glass and support ring (COF unknown)
- I was most concerned with compressive stress and thought tensile stress was low
- During first test, there was no sliding and tensile stress was low (glass exhibits low stress failure)

Second Design

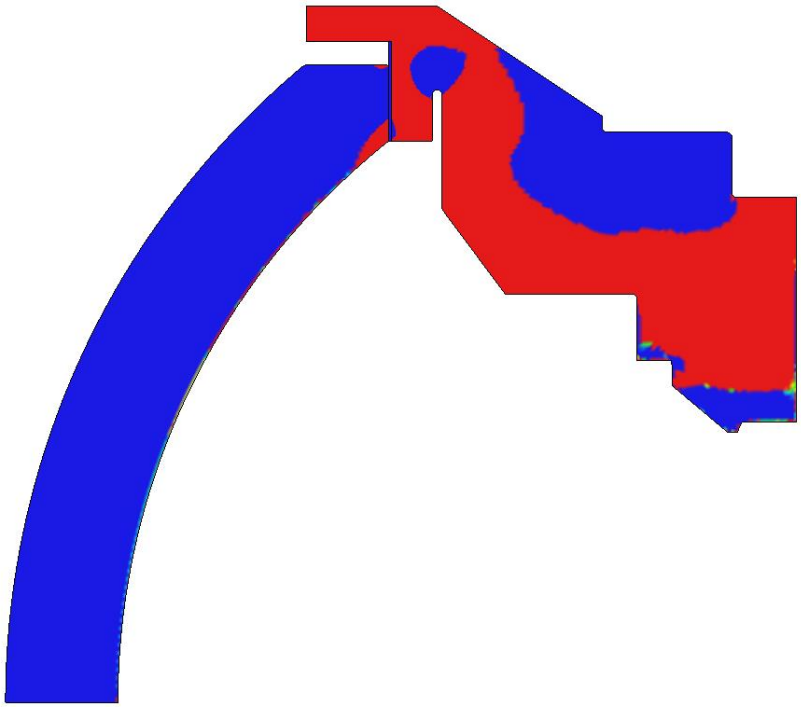


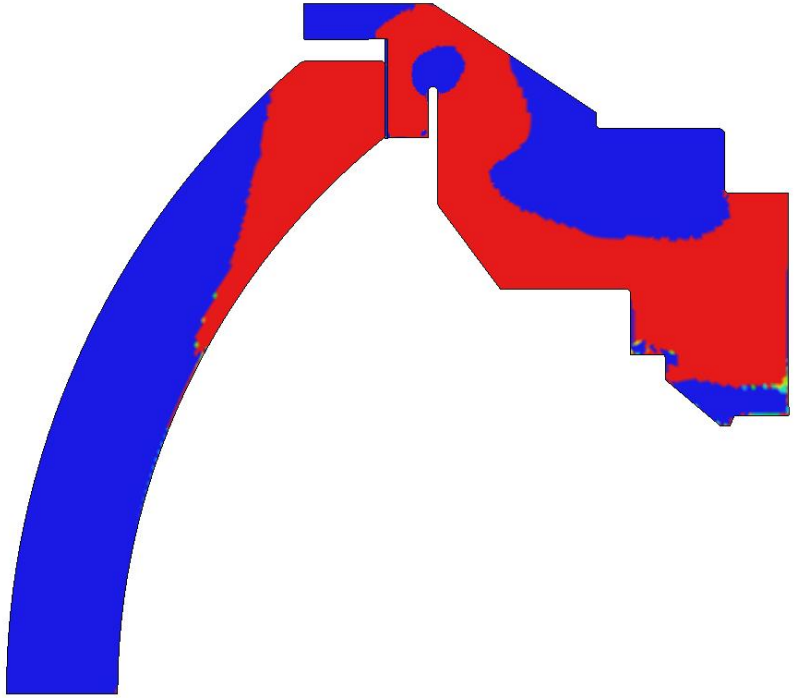


- we added a groove to decrease compressive stress and center it.
- Polished the glass, increased kapton thickness, even stress across seat decreased friction and resulted in sliding
- Glass failed in tension due to hoop stresses on the periphery

Comparison of sliding/no sliding cases

Blue: compressive stress
Red: tensile stress



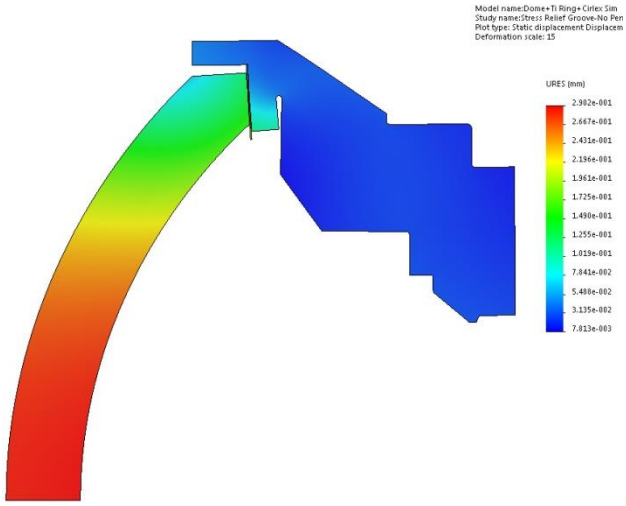


No sliding
Almost no tensile stress
Mean 1st principal stress (at 1577 psi):
on periphery: -188PSI
on seat: -355PSI

Sliding allowed
High tensile stress on periphery
MFPS on periphery: 6513PSI
on seat: 8982PSI

Comparison of sliding/no sliding, groove/no groove cases

Stress analysis for 1577 PSI (failure pressure)				
Distances are in inches				
Stresses are in PSI				
FPS: first principal stress (pure normal stress, positive is tension, negative is compression)				
	Groove in titanium ring		No groove	
	No Friction	Friction	No Friction	Friction
Maximum displacement on dome axis	0.0114	0.007	0.008	0.006
Maximum radial displacement	0.0046	0.001	0.003	0.0006
FPS on outside surface	6513	-188	4723	705
FPS on Seat	8982	-355	6471	-758



Measurement of axial displacement during test shows that FEA matches case where sliding is allowed.
Sliding causes large hoop stress (tension in the glass).
Groove causes even larger tensile stress when sliding is allowed

Solution: constrain the glass on the perimeter

Solution 1: insert a PEEK ring in the existing o-ring groove. FEA shows it's not very effective. Tension develops on the seat (groove too deep). Hoop tension is lowered but remains high. Sealing is challenging.

Solution 2: Insert a steel ring in the existing o-ring groove. Somewhat effective. Tension develops on the seat. Fabrication and sealing are very challenging.

Solution: constrain the glass on the perimeter

- Solution 3: Make a new titanium ring, keep the same glass. Many options: fill in the groove, add pre-tensioned steel ring on OD, etc. No easy solution.

- Solution 4: Make a new titanium ring and new glass with angled seat. Best solution in term of stresses in the glass but very expensive, time consuming and difficult to implement.

Comparison of retaining methods

Stress analysis for 1577 PSI (failure pressure)				
Distances are in inches				
Stresses are in PSI				
FPS: first principal stress (pure normal stress, positive is tension, negative is compression)				
	Grove in titanium ring			
	No Friction	Friction	PEEK retainer	Steel retainer
Maximun displacement on dome axis	0.0114	0.007	0.009	0.008
Maximum radial displacement	0.0046	0.001	0.002	0.001
FPS on outside surface	6513	-188	421	-1291
FPS on Seat	8982	-355	2263	-828