Preliminary Disruption Analyses

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Overall Approach

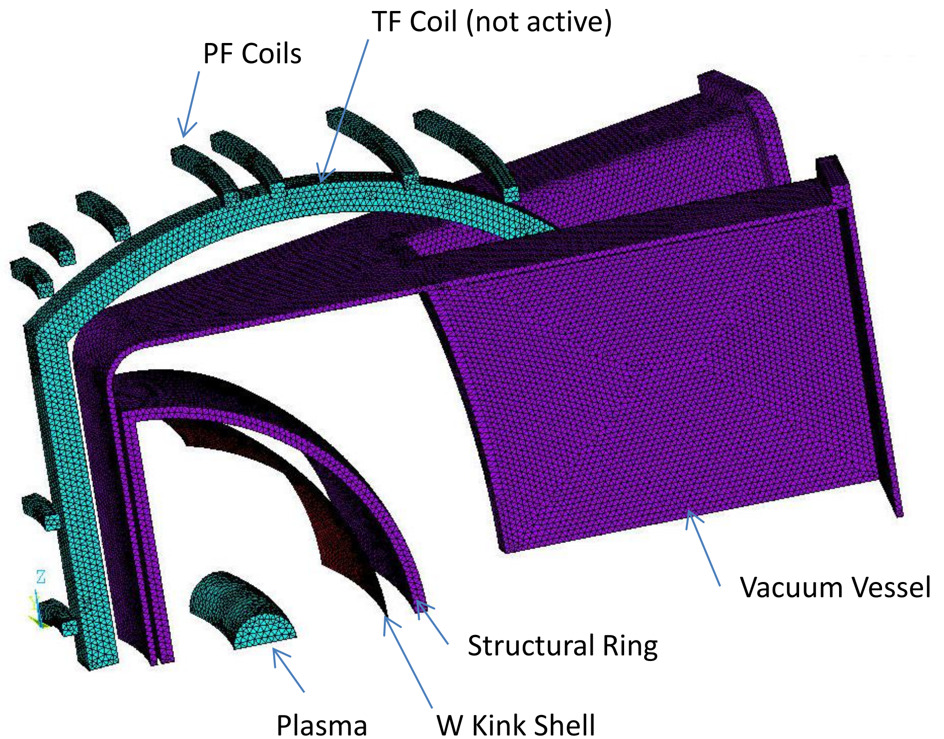
- At this point, we:
  - Consider only current quench (no plasma motion)
  - Assume plasma current drops linearly in 30 ms
  - Don’t model blanket or shield
  - Have not incorporated magnetic properties of ferritic steel structures
  - Have not included toroidal fields in force calculations
  - Have only a crude model of current distribution in plasma

Finite Element Model of the Continuous Core Structure

- Symmetry conditions for the sector model do not allow the poloidal and toroidal coils to modeled simultaneously. Only PF and plasma fields currently modeled.

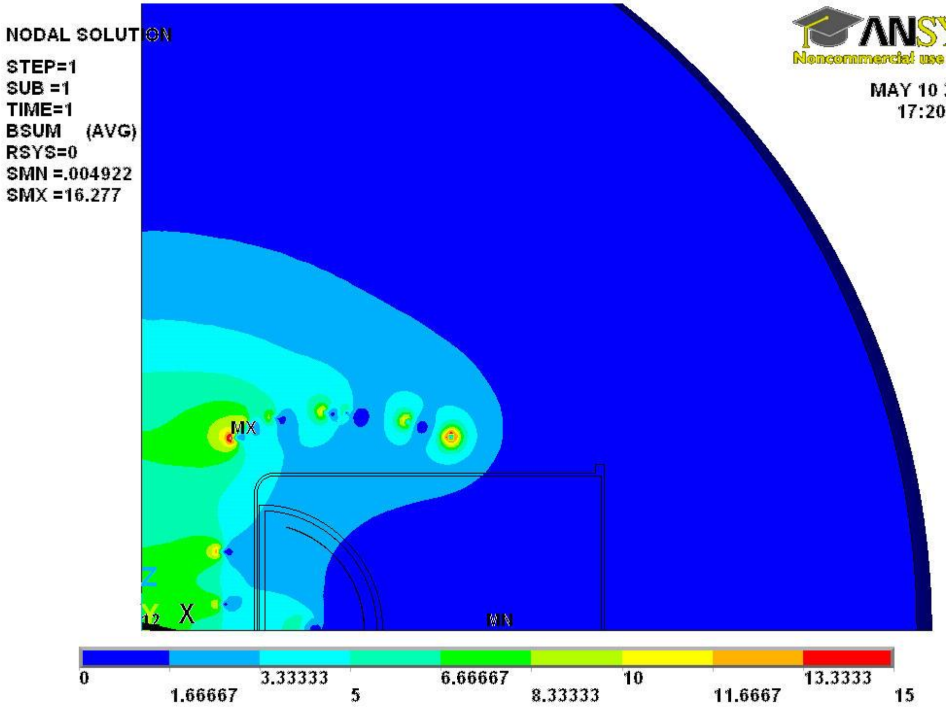
- Vacuum Vessel modeled as solid shell. Kink shell and structural ring use simplified, approximate geometry.

- Space elements not shown.

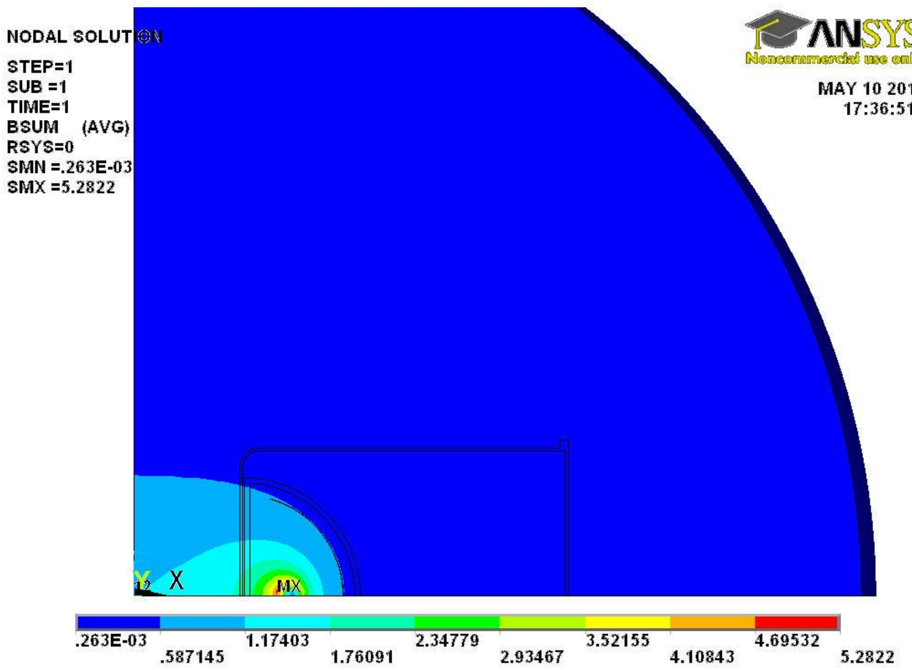


Total Magnetic Flux Density (BSUM) With Plasma Current

Plasma and PF Coils



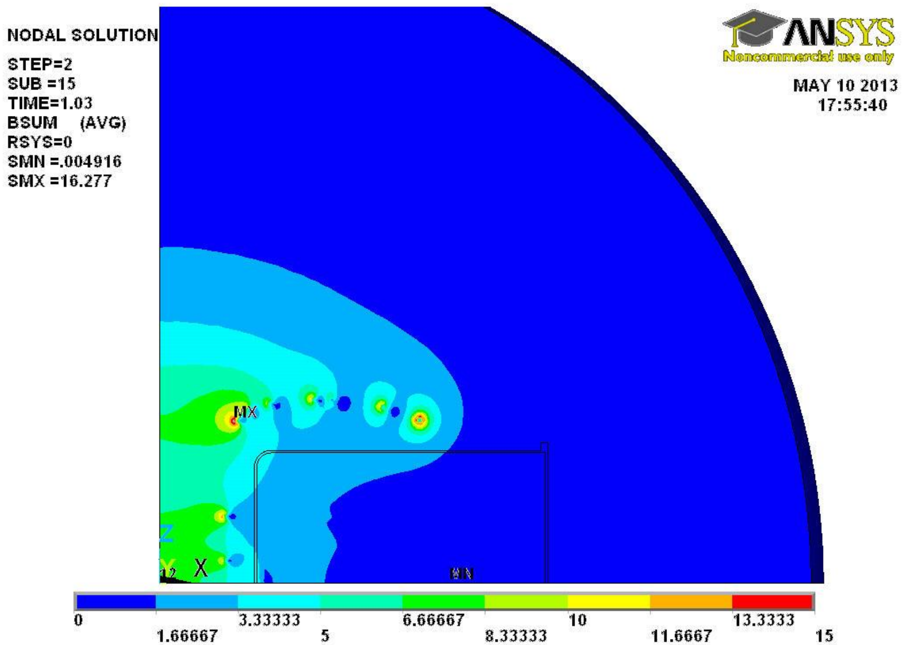
Plasma Only



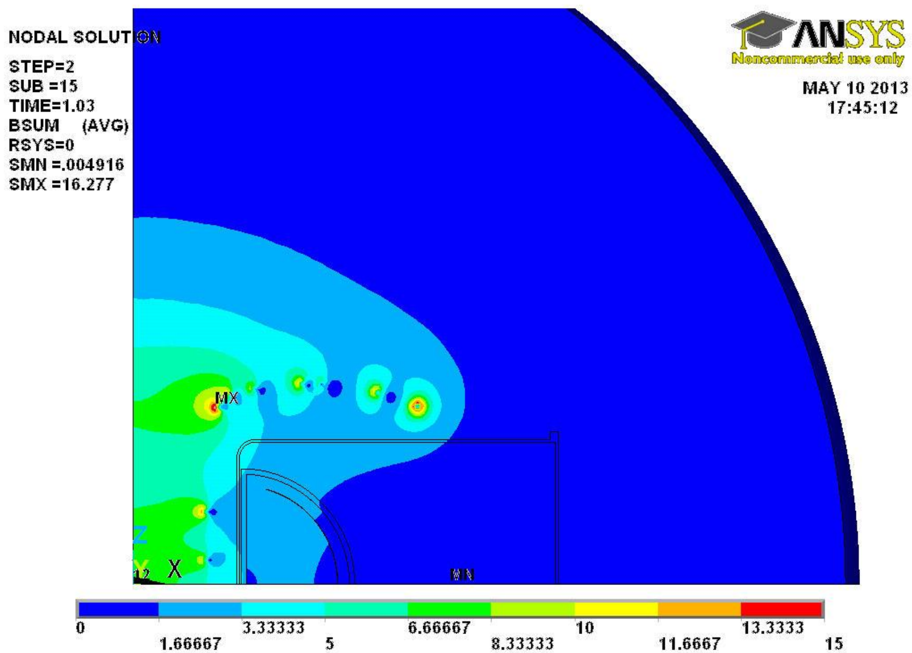
Total Magnetic Flux (BSUM) at 0.03 sec (End of Plasma Ramp-down)

- Plasma ramps down linearly over 0.03 sec
- The effect of conductive materials on the transient field can be seen

VV only Model



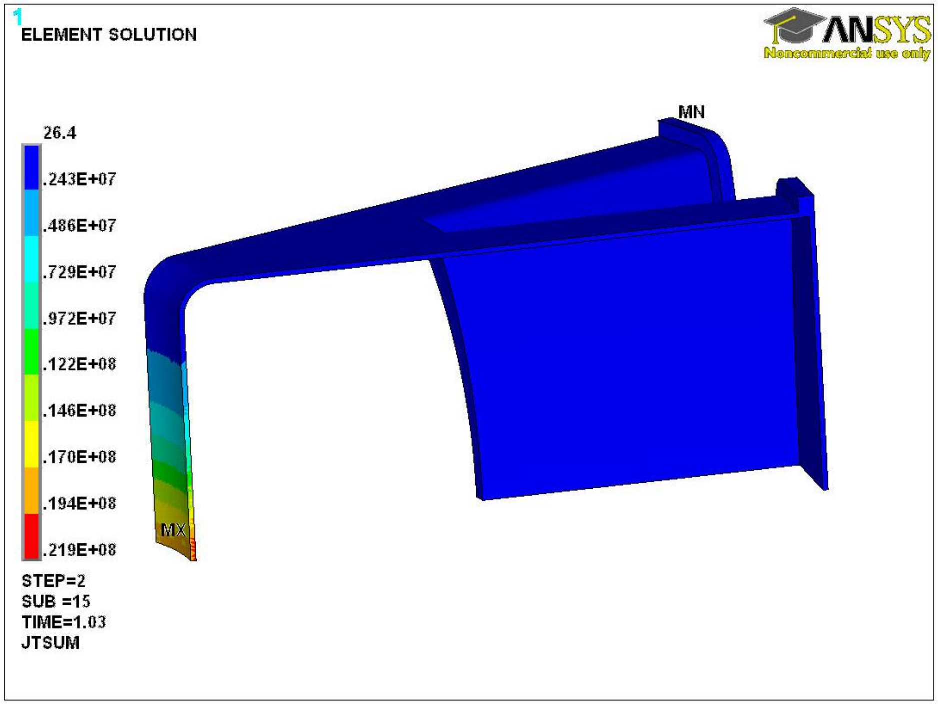
VV + Steel Ring + W Shell



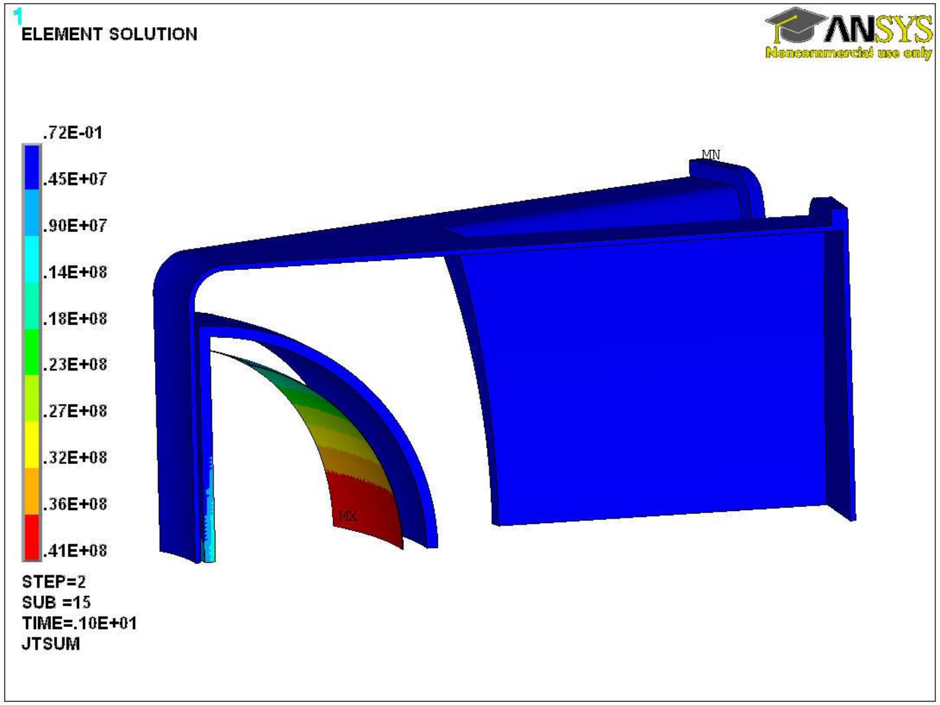
Current Densities at End of Plasma Ramp-down

Presence of Steel Ring and Kink Shell greatly alters induced currents in Vacuum Vessel

VV only Model

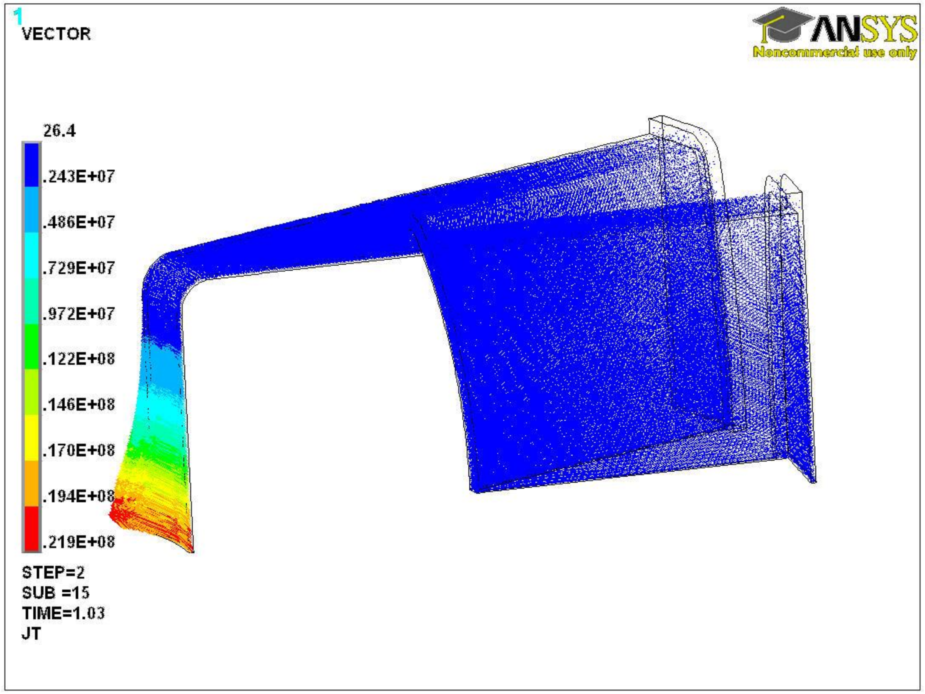


VV + Steel Ring + W Shell

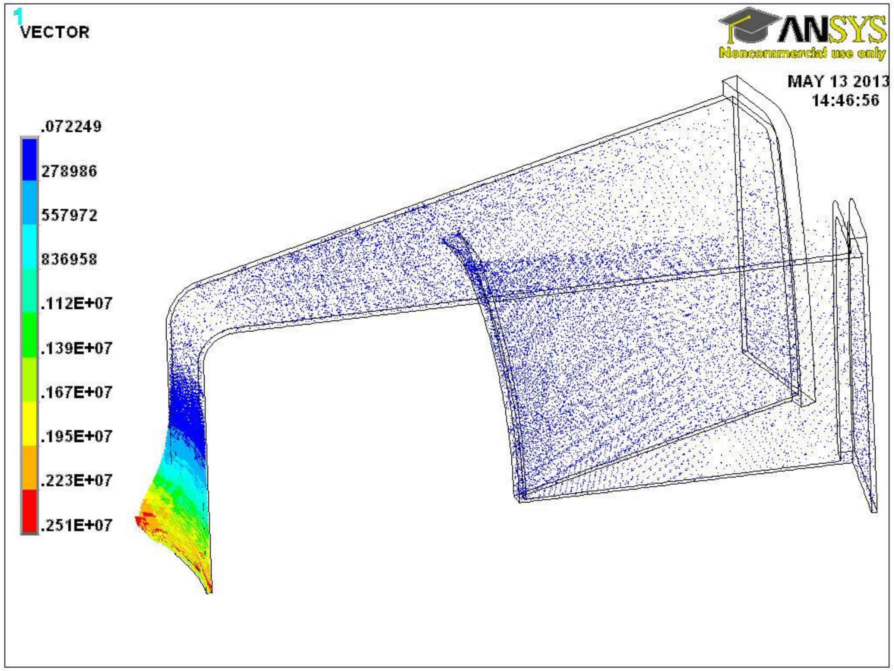


VV Current Densities at End of Plasma Ramp-down

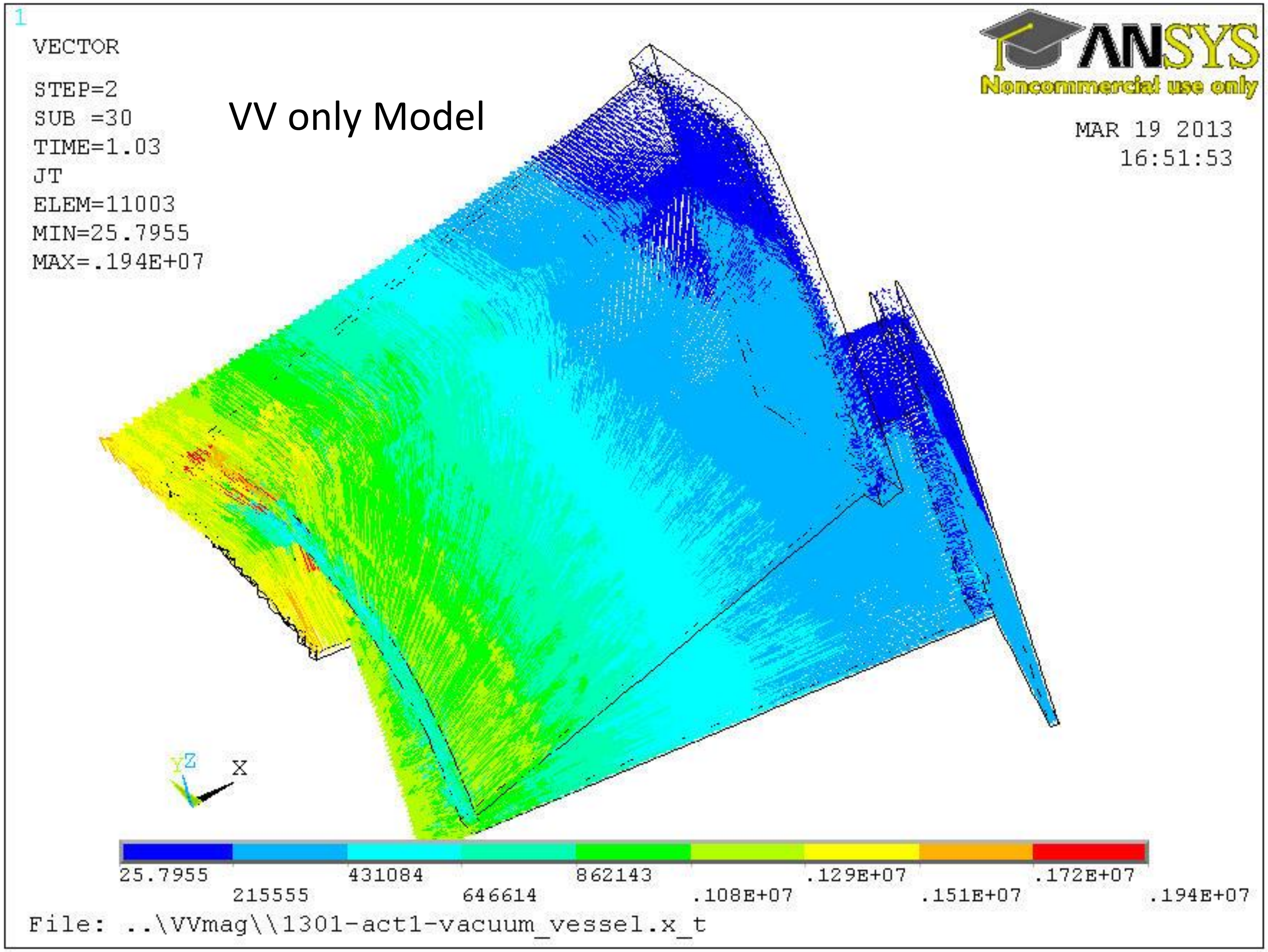
VV only Model



VV + Steel Ring + W Shell

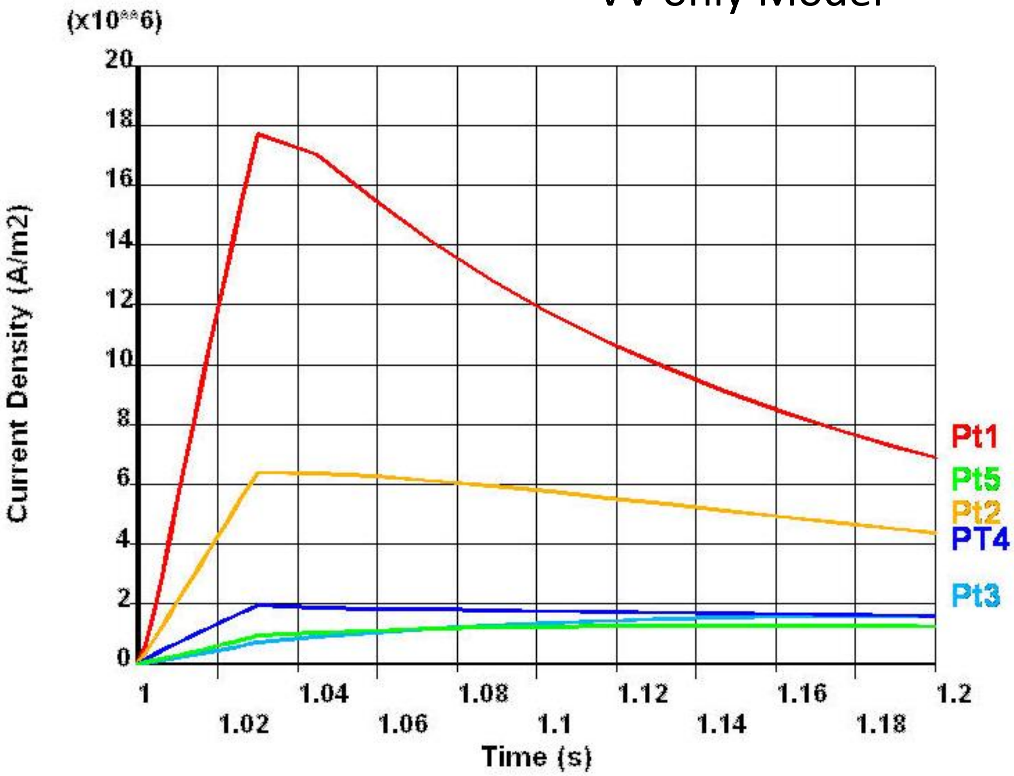


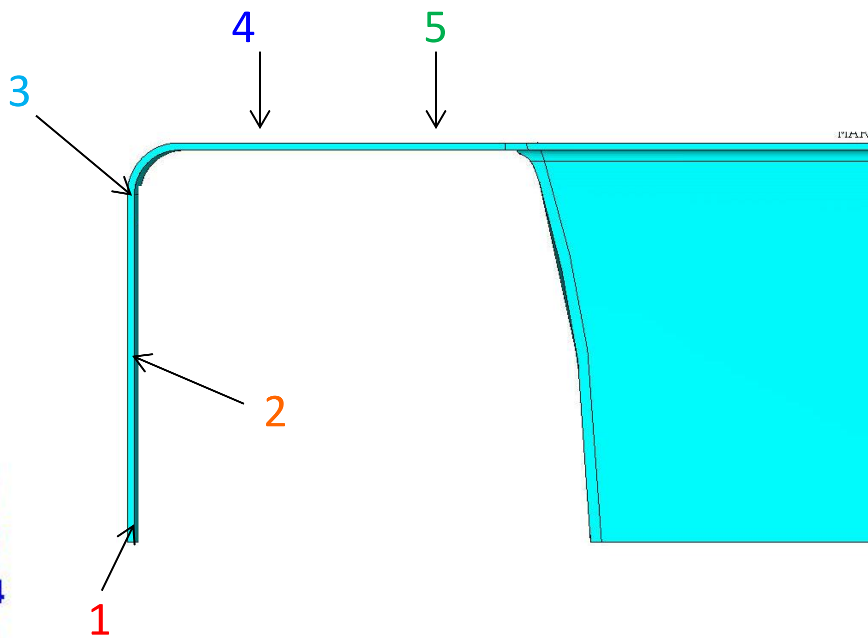
Current Densities in Outboard VV at End of Plasma Ramp-down



Current Densities vs Time in Vacuum Vessel During and After Shutdown

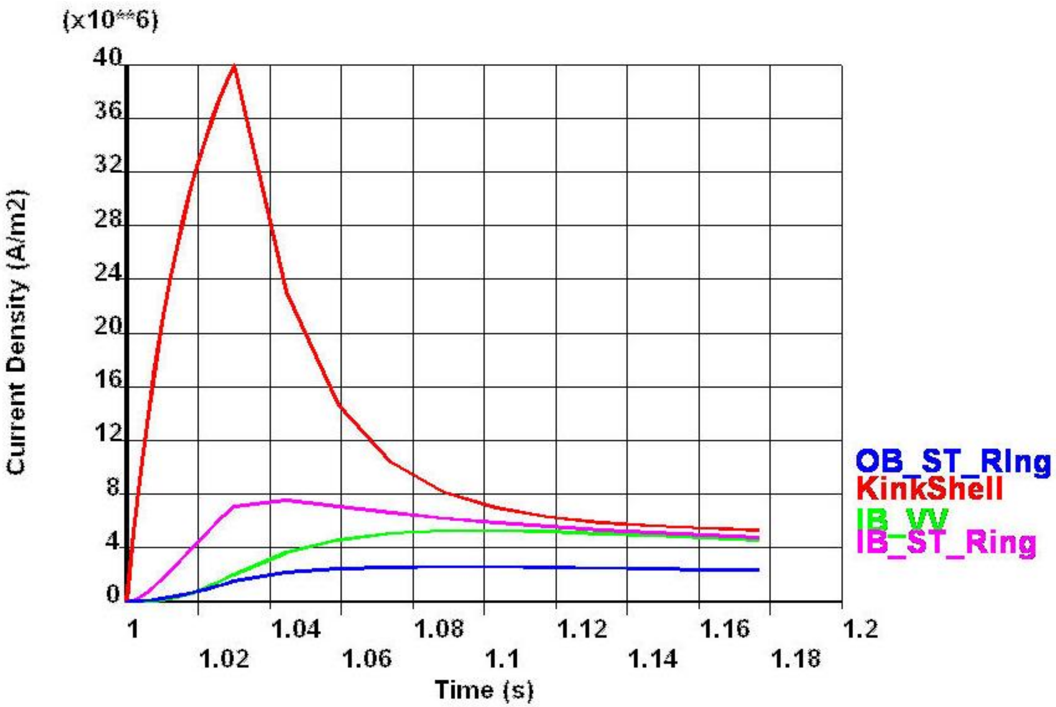
VV only Model

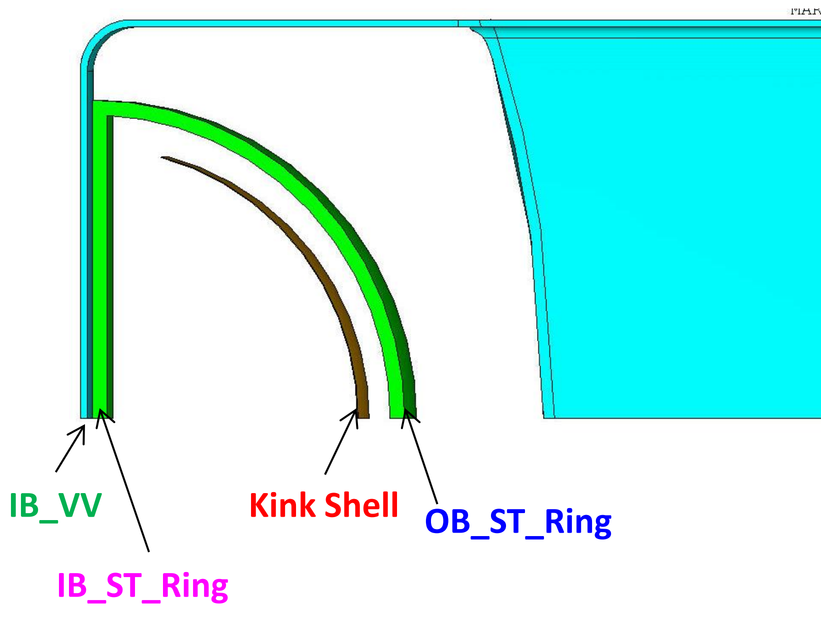




Current Density vs Time

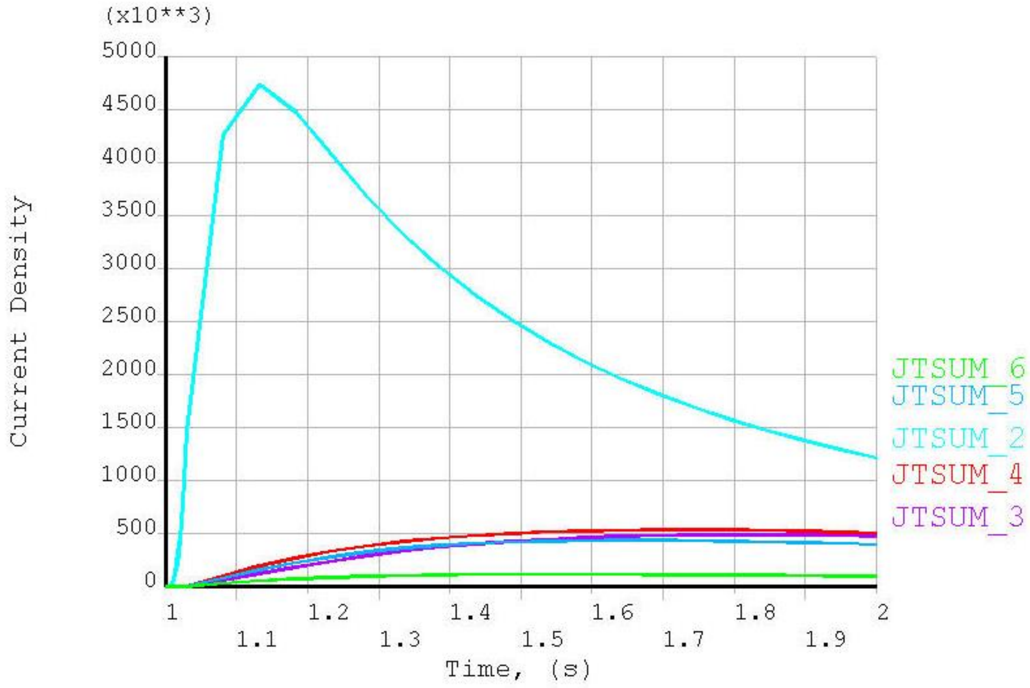
VV + Steel Ring + W Shell

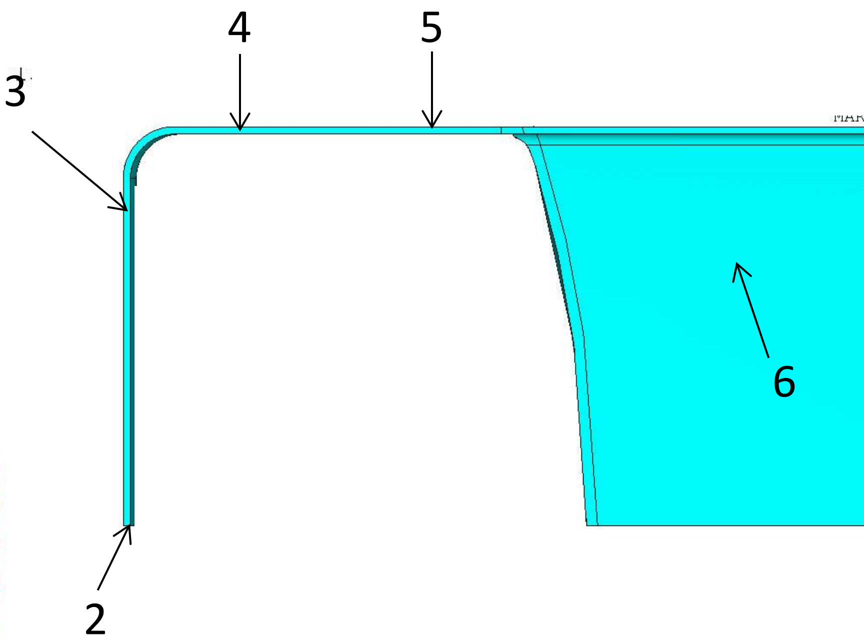




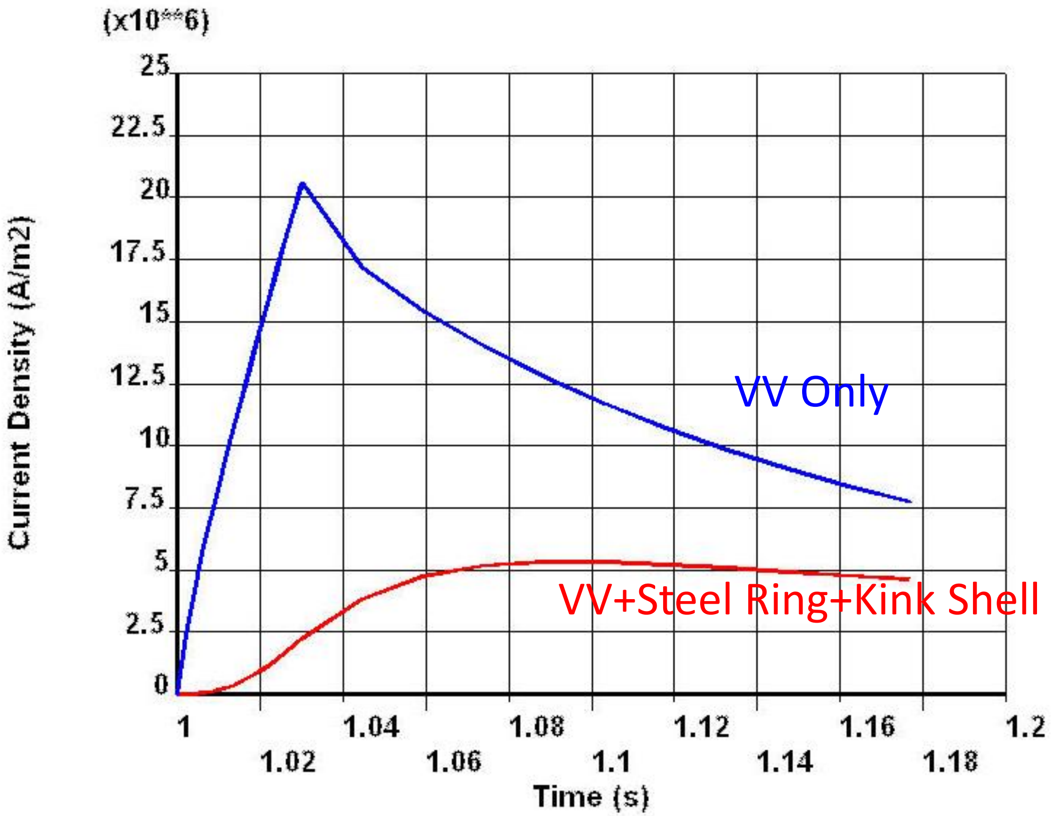
Current Densities vs Time in Vacuum Vessel During and After Shutdown

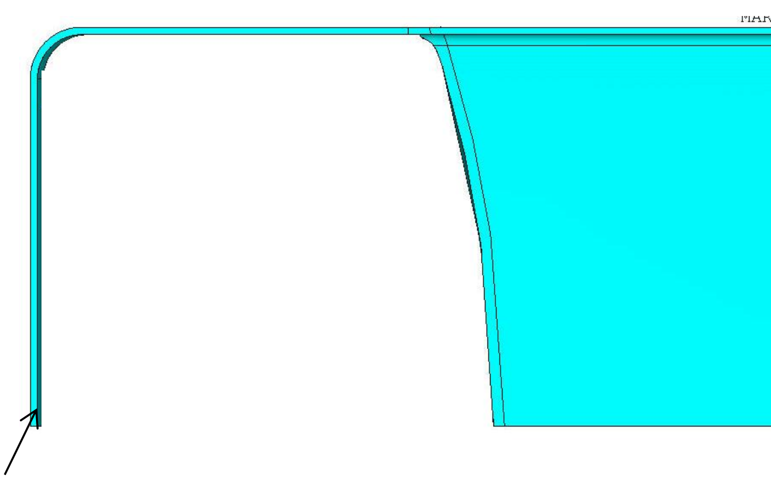
VV + Steel Ring + W Shell





Comparison of the Induced Currents for the VV only and More Complete Model

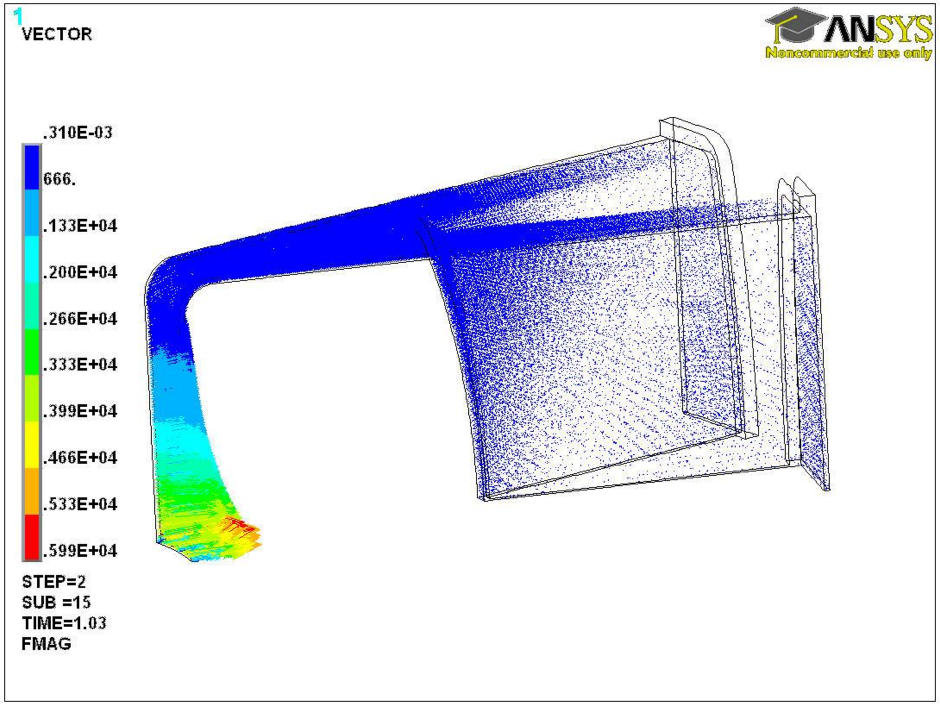




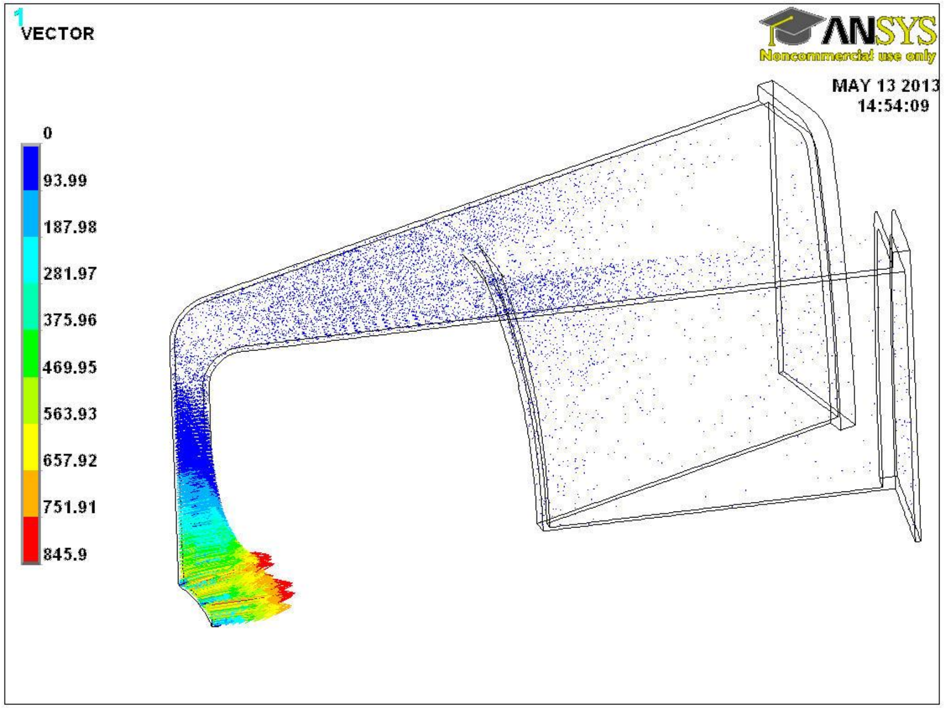
Forces on Vacuum Vessel at the End of Plasma Ramp-down from the Induced Currents in the Poloidal Field

Nodal Forces in Newtons (N)

VV only Model

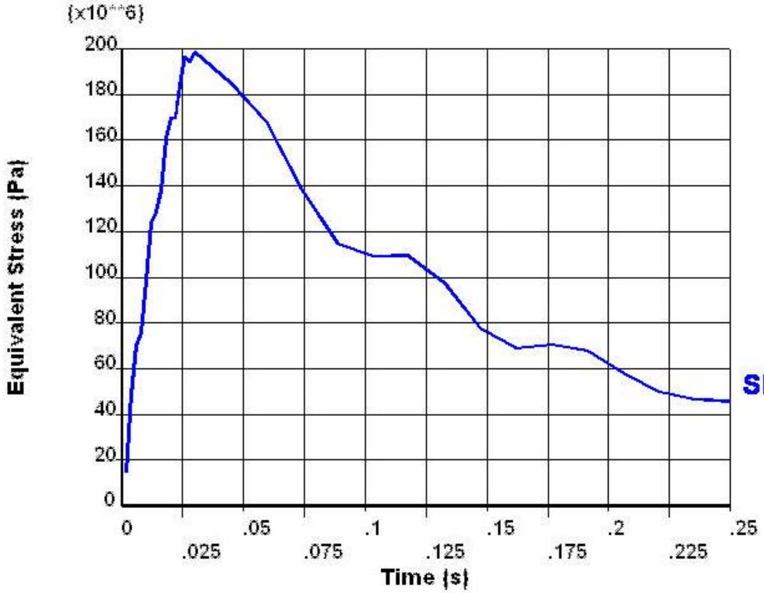


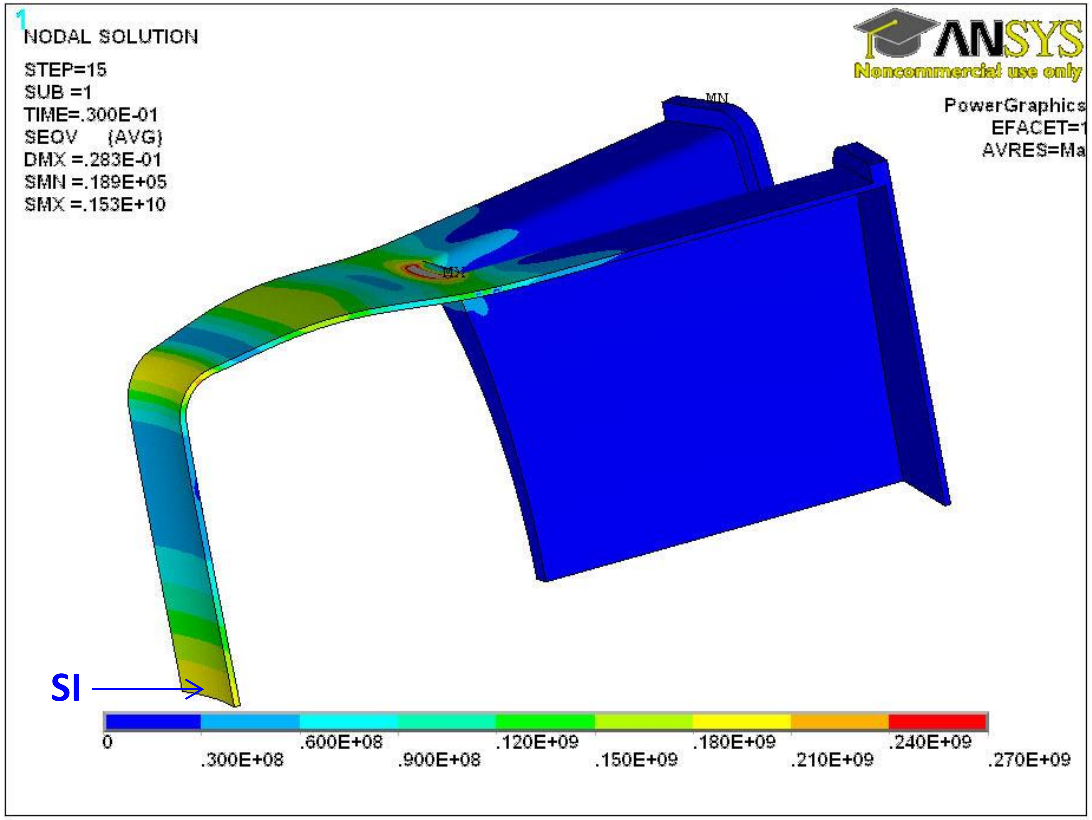
VV + Steel Ring + W Shell



Stresses From Magnetic Forces

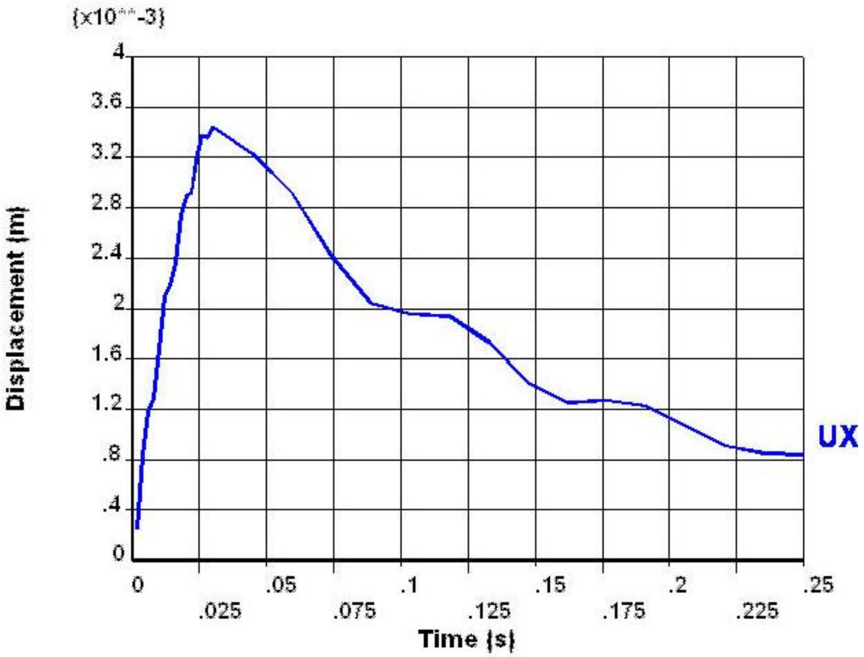
VV only Model

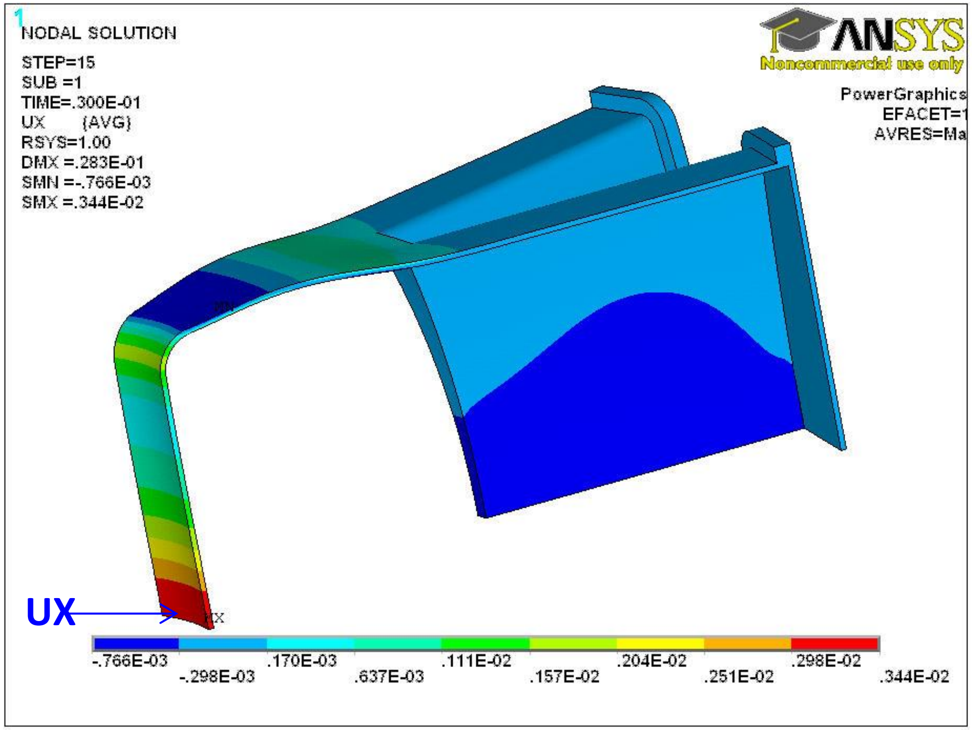




Displacements From Magnetic Forces

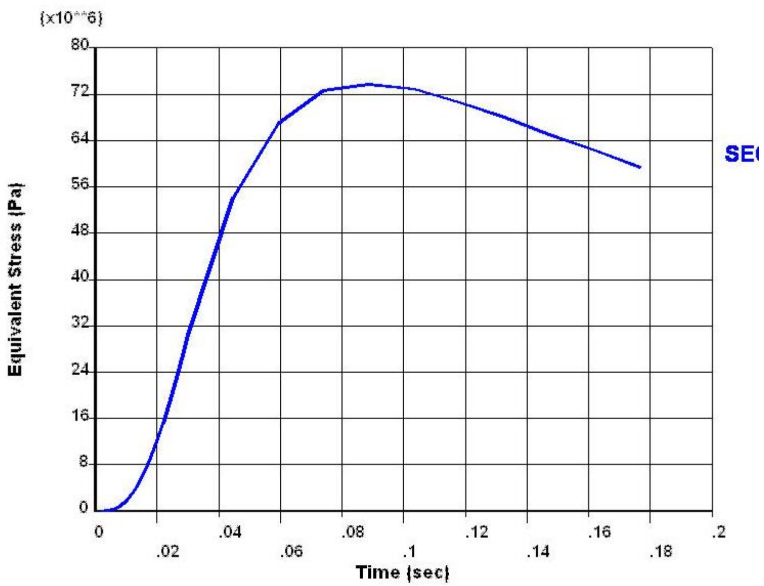
VV only Model

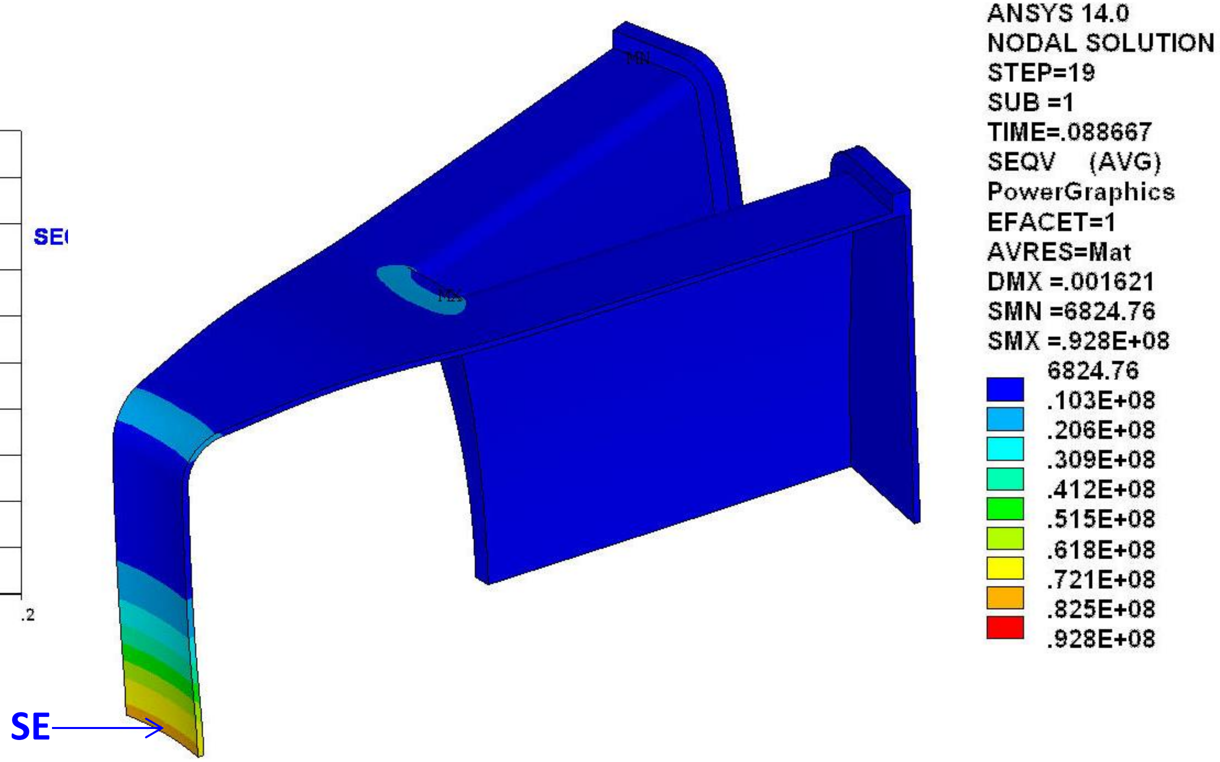




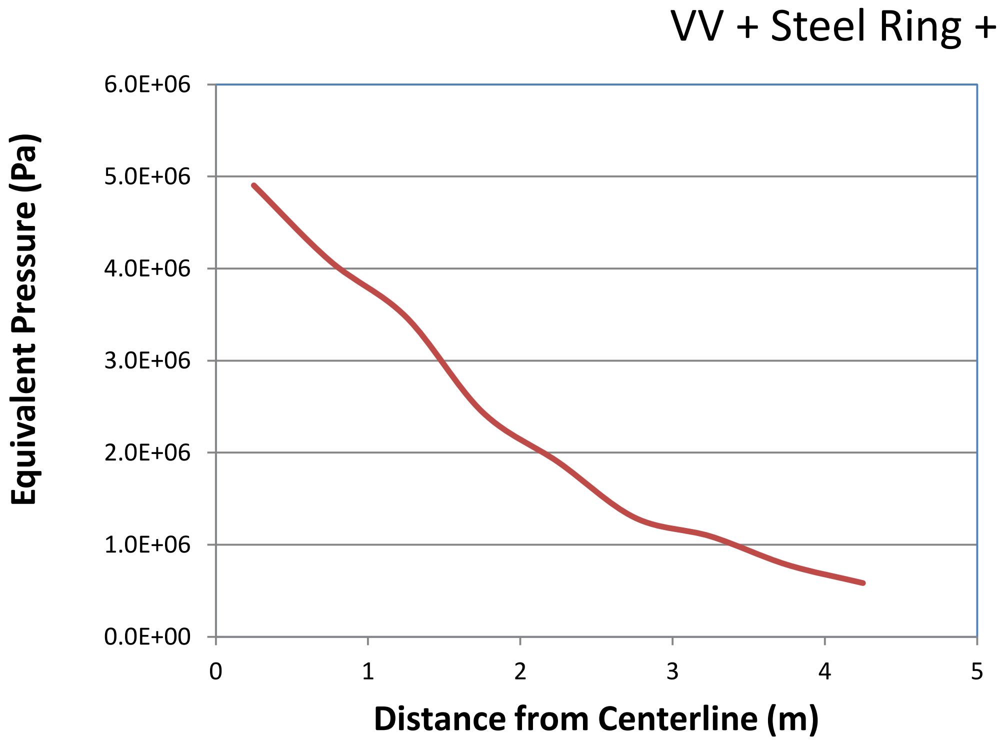
Stresses From Magnetic Forces

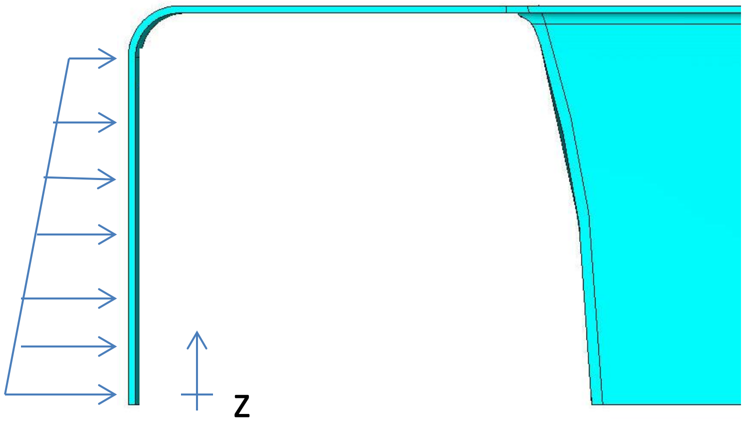
VV + Steel Ring + W Shell





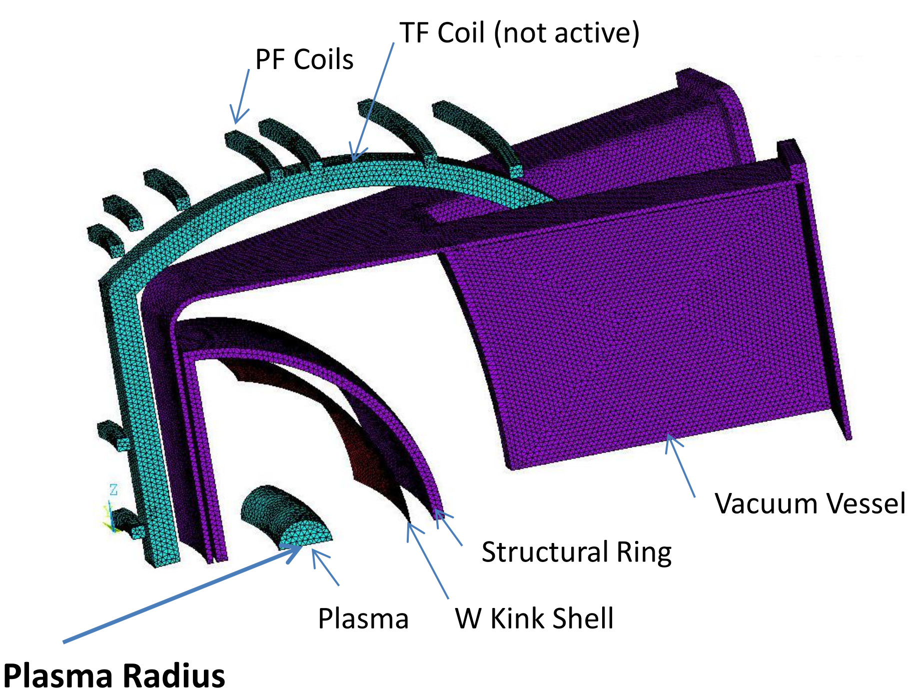
Magnetic Forces Approximated as Equivalent Pressure on Inner Wall of the Vacuum Vessel

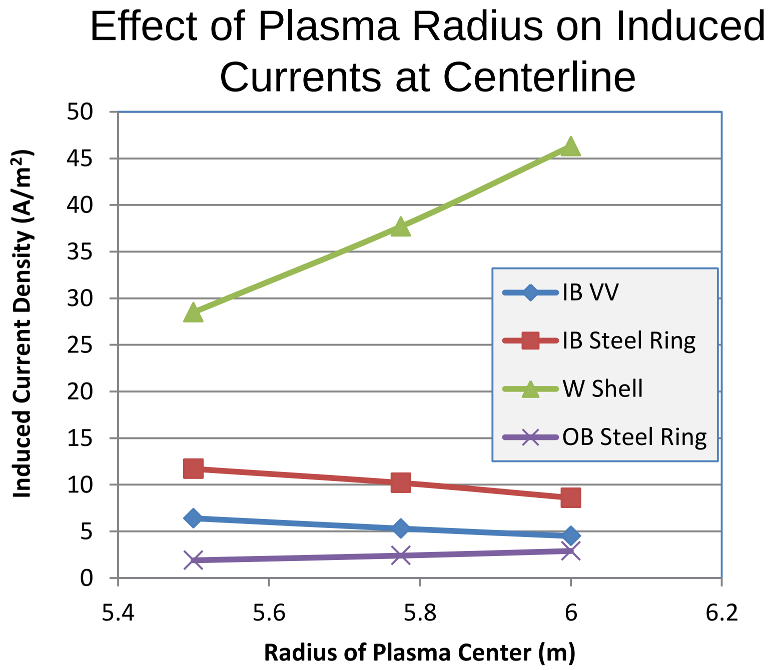




Location of Plasma Affects Induced Currents

- Plasma in current analyses is at a radius of 5.775 m. Is that reasonable for this divertor geometry?
- Do we need a better model of plasma shape?





Future Work

- Include magnetic fields from toroidal coils.
- Add magnetic properties of ferritic structures.
- Add blankets?
- Model plasma current distribution more accurately.