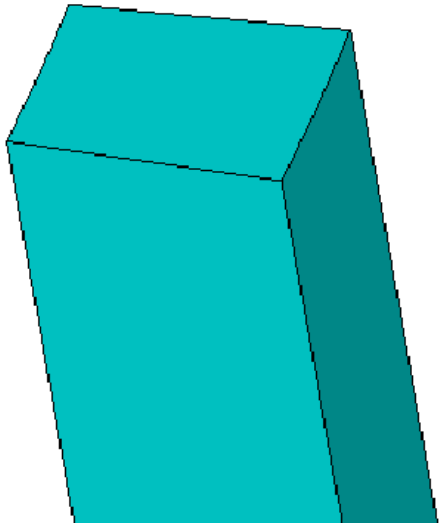
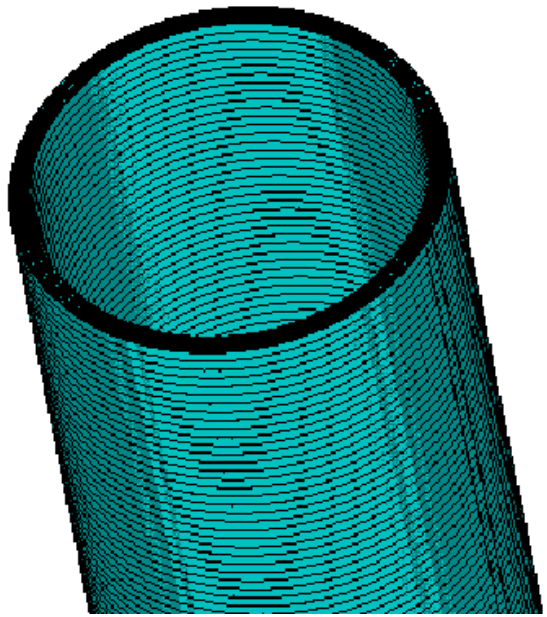
Magneto-solid dynamic analysis of single horn

Test – cylinder model

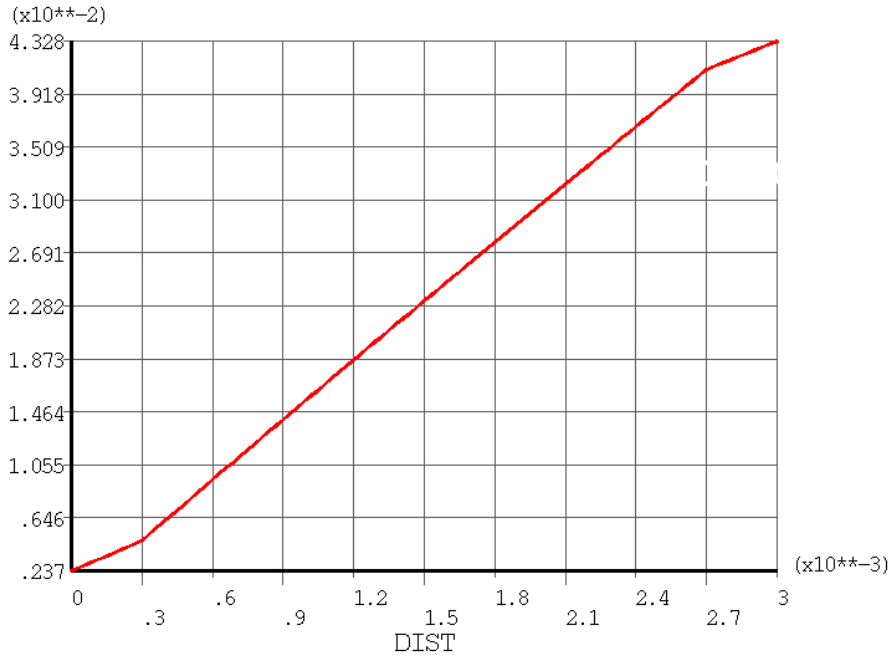




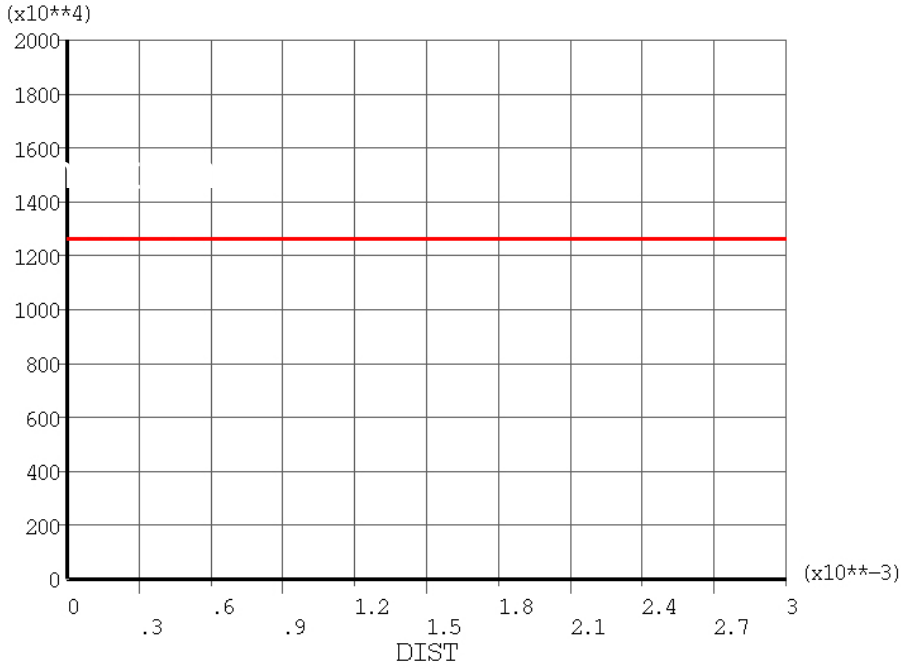
Cylinder magnetic results

Direct current (I_{rms}=7500[A])

Magnetic Flux Density [T]



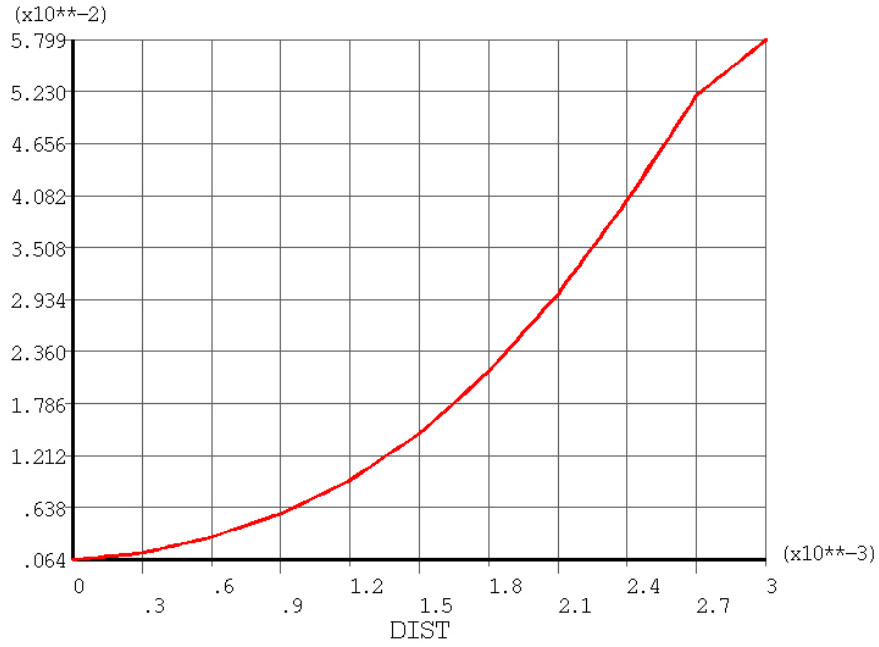
Current Density [A/m²]



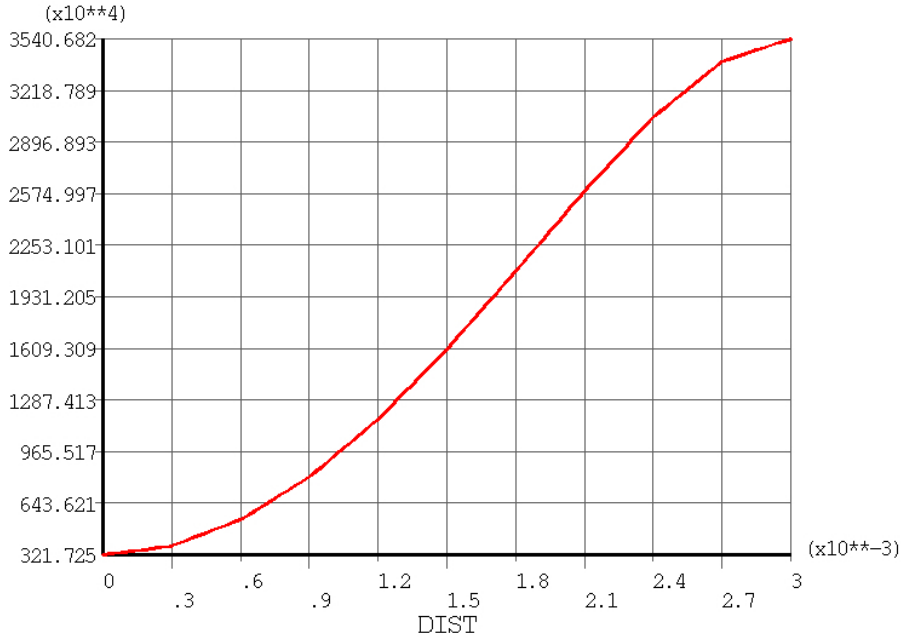
Cylinder magnetic results

Sinusoidal current (I_{rms}=7500[A], f=5000[Hz])

Magnetic Flux Density [T]



Current Density [A/m^2]



Cylinder magnetic results (analytical solution)

Sinusoidal current (I_{rms}=7500[A], f=5000[Hz])

Skin depth $\Longrightarrow$ $\delta = \sqrt{\dfrac{\rho}{\pi f \mu}}$ $\quad \mu = \mu_r \mu_0$

$\mu = 4\pi \cdot 10^{-7}[\mathrm{H/m}]$
$\rho = 4 \cdot 10^{-8}[\Omega\mathrm{m}]$
$f = 5000[\mathrm{Hz}]$

$\Longrightarrow$ $\delta = 0.0014[\mathrm{m}]$

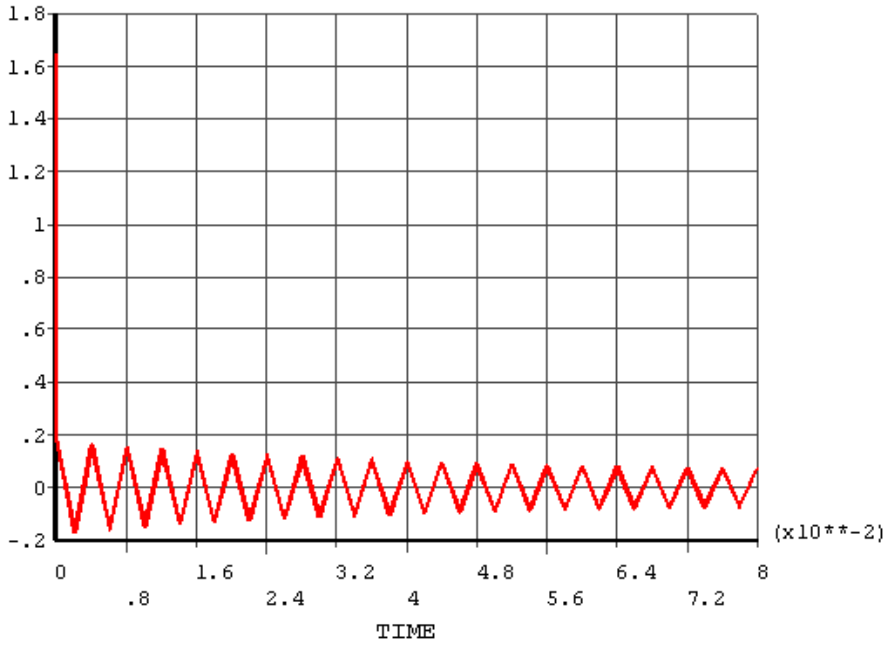
$$B(d,t) = \mu_0 \frac{I}{2\pi r} e^{-\frac{d}{\delta}} \cos\left(\frac{d}{\delta} - 2\pi f t\right)$$

$$J_r(d,t) = \frac{I\sqrt{2}}{2\pi r \delta} e^{-\frac{d}{\delta}} \cos\left(\frac{d}{\delta} - 2\pi f t - \frac{\pi}{4}\right)$$

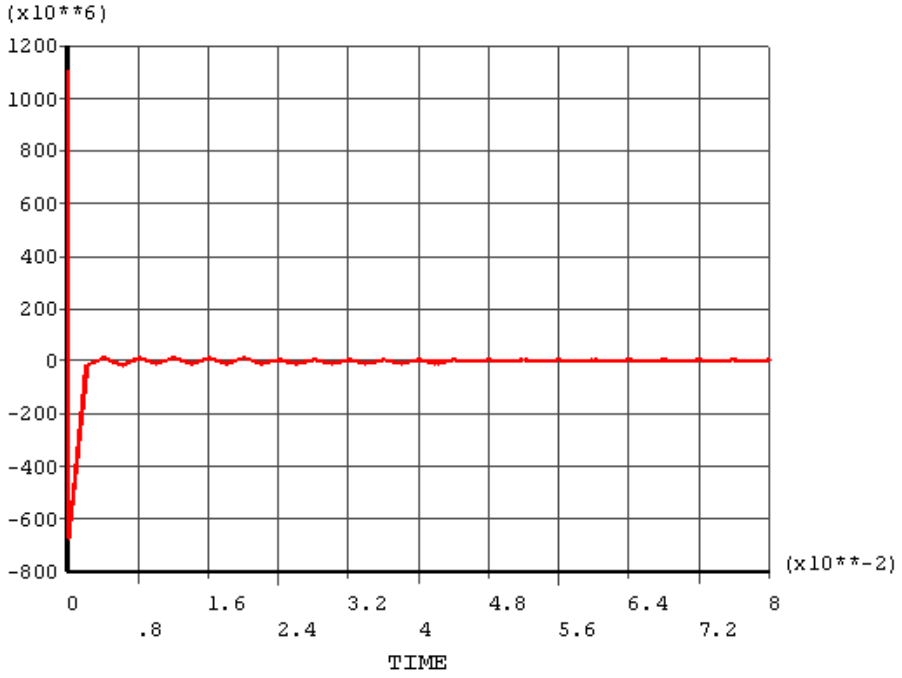
Cylinder magnetic results

Impulse current (I_{max}=300[kA])

Magnetic Flux Density [T]



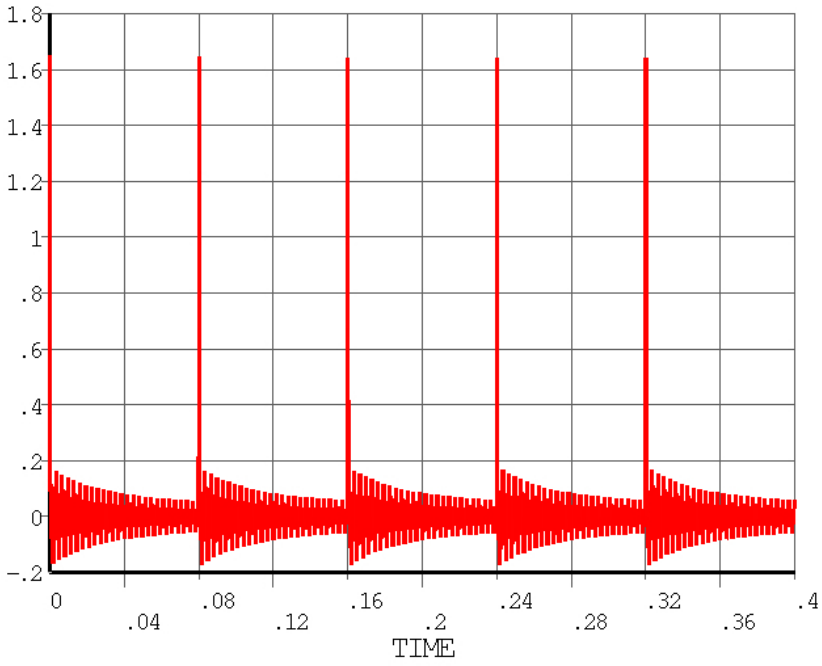
Current Density [A/m^2]



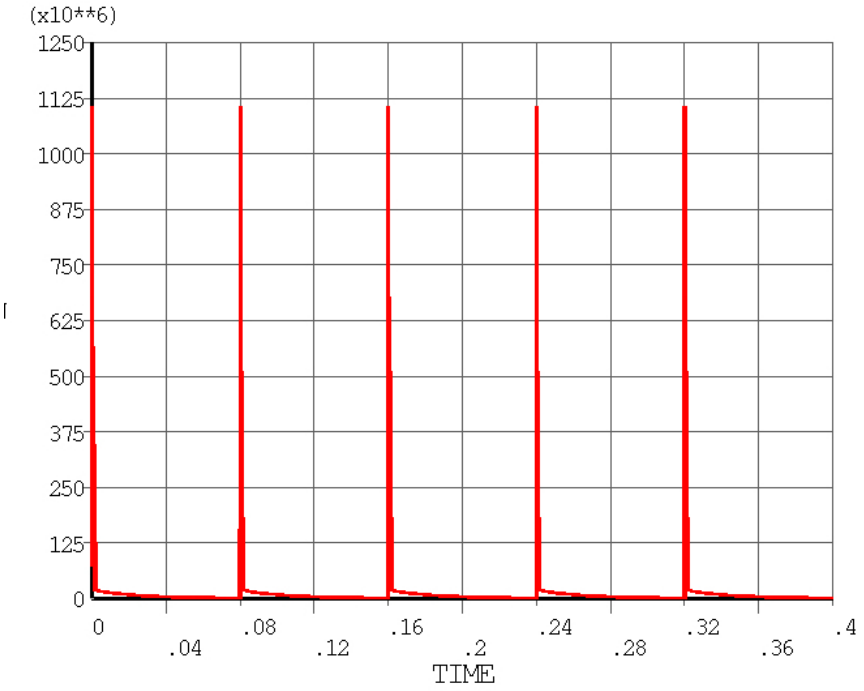
Cylinder magnetic results

Multiple impulse currents (I_{max}=300[kA], f=12.5[Hz])

Magnetic Flux Density [T]



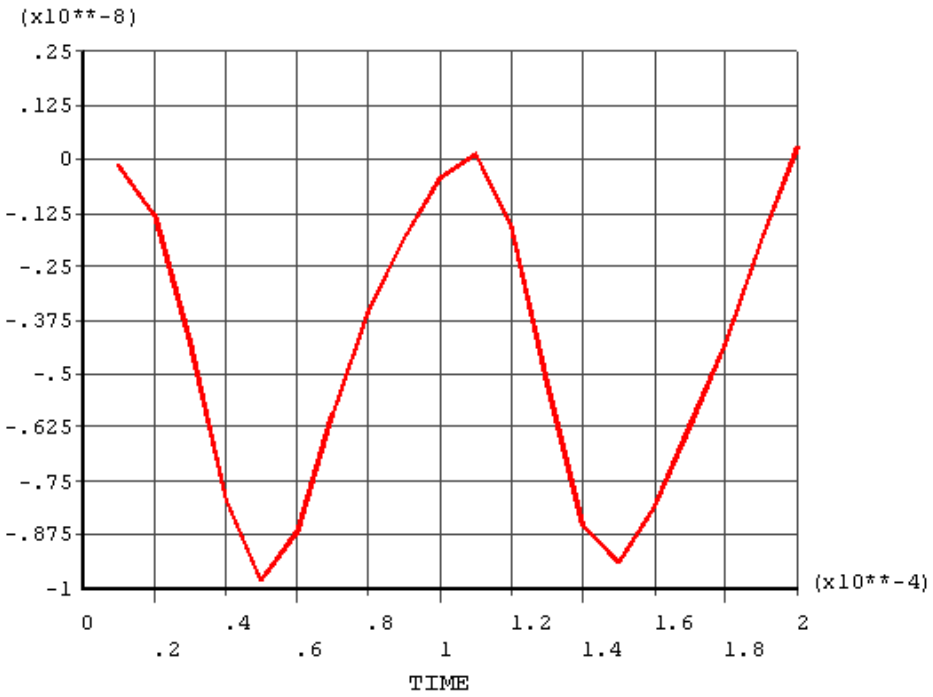
Current Density [A/m^2]



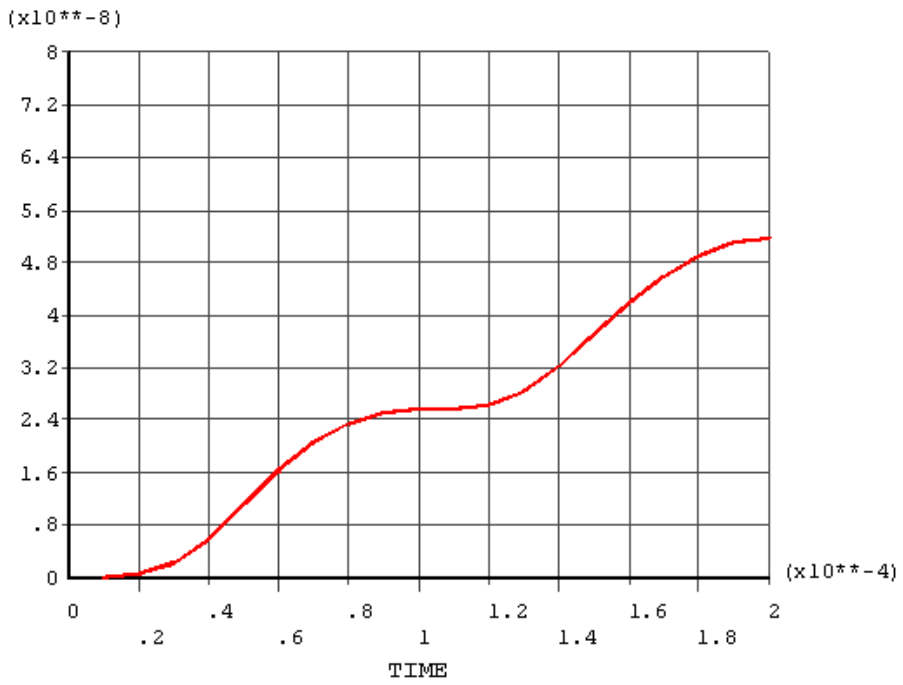
Cylinder structural results

Sinusoidal current (I_{rms}=7500[A], f=50[Hz])

Radial Displacement [m]



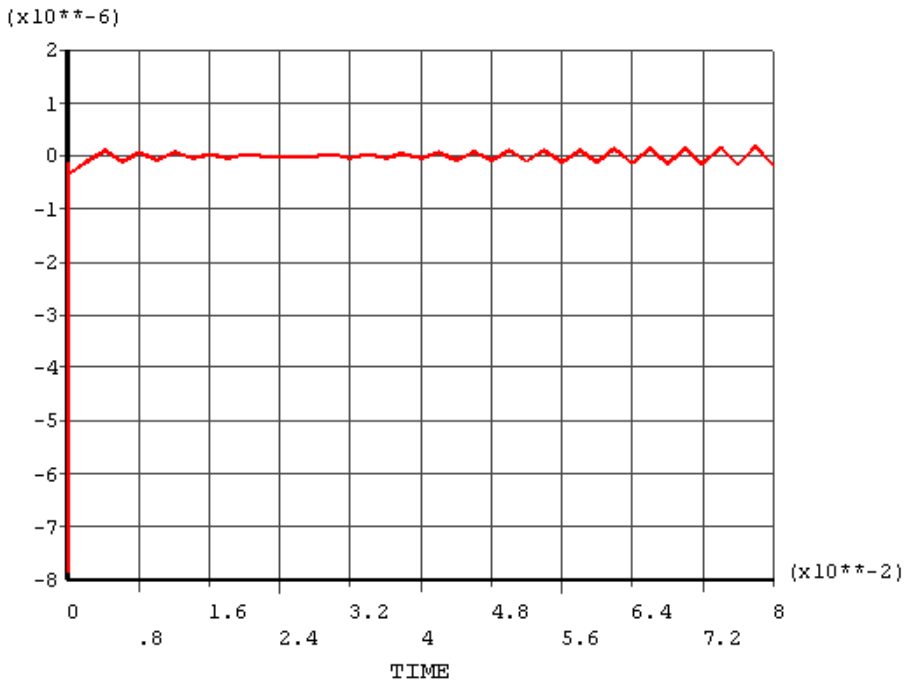
Longitudinal Displacement [m]



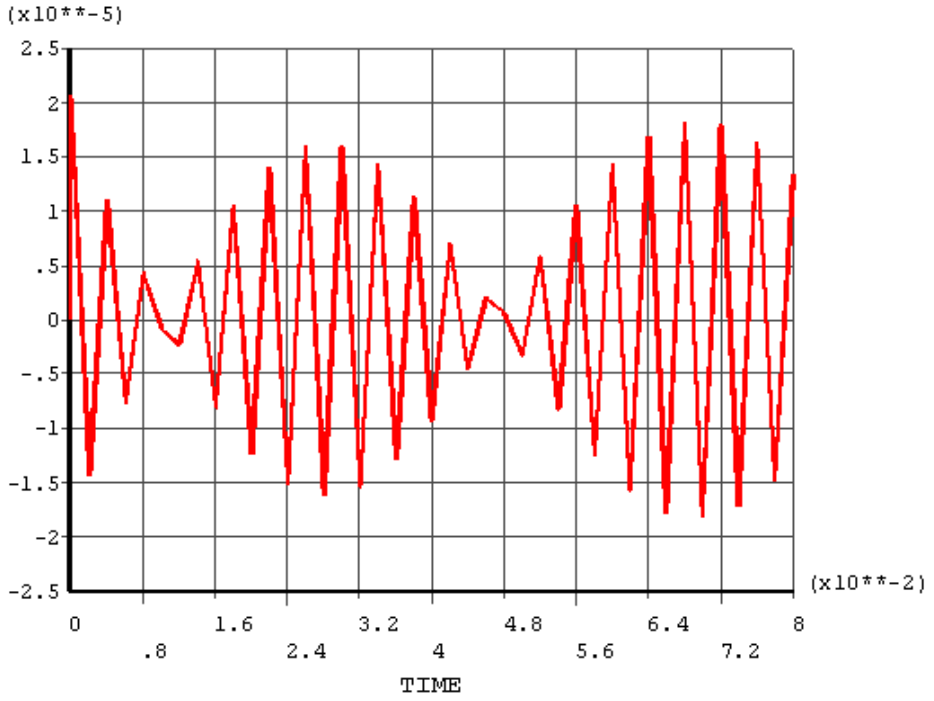
Cylinder structural results

Impulse current (I_{max}=300[kA])

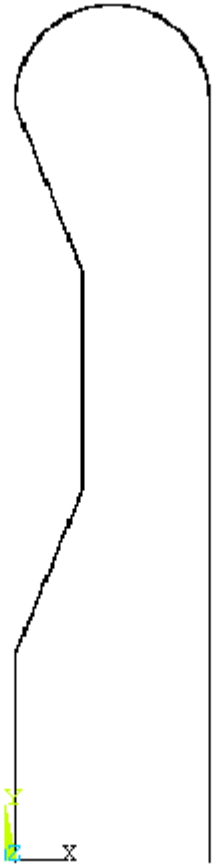
Radial Displacement [m]



Longitudinal Displacement [m]

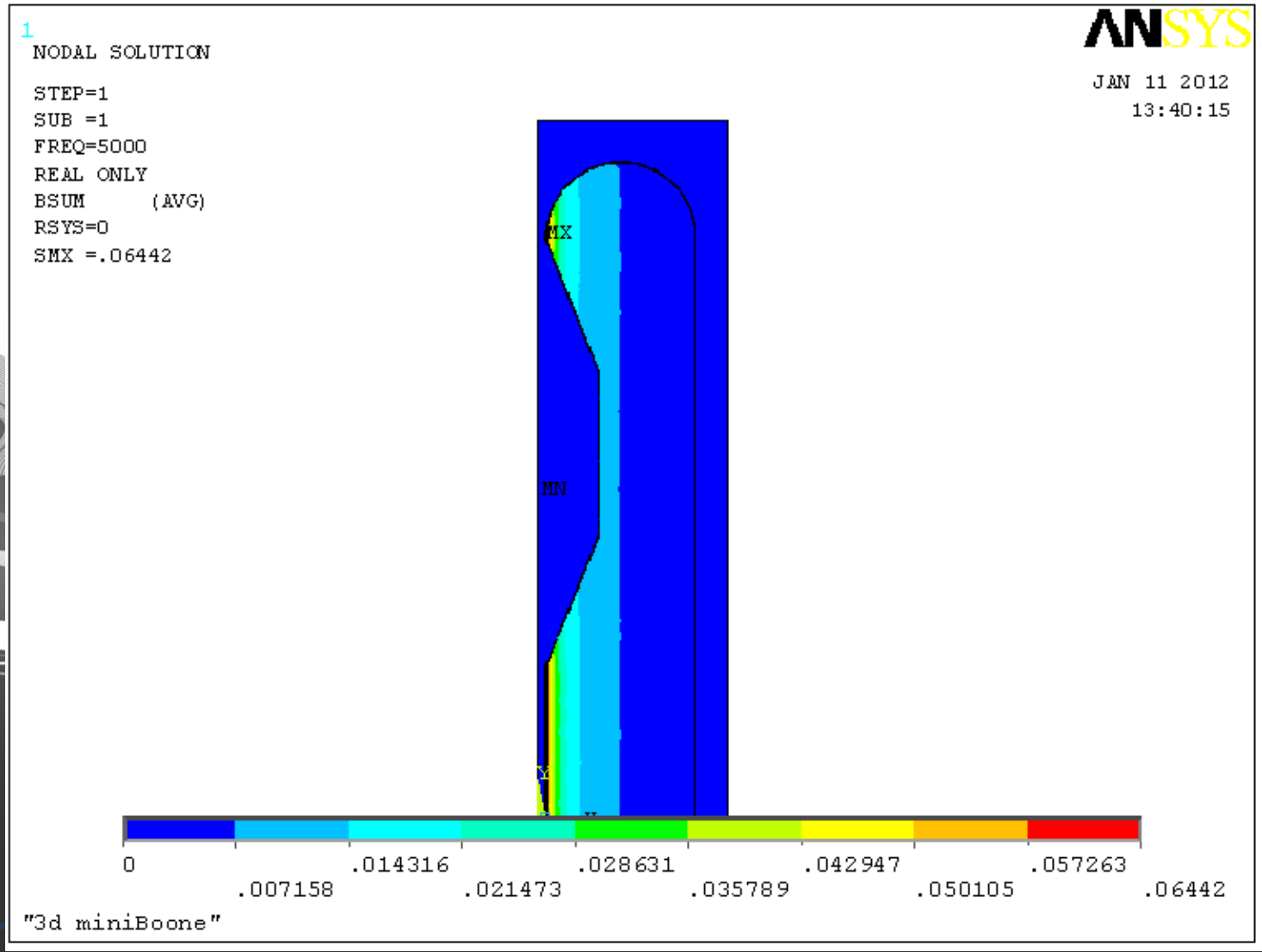


Horn partial model



Horn magnetic flux density [T]

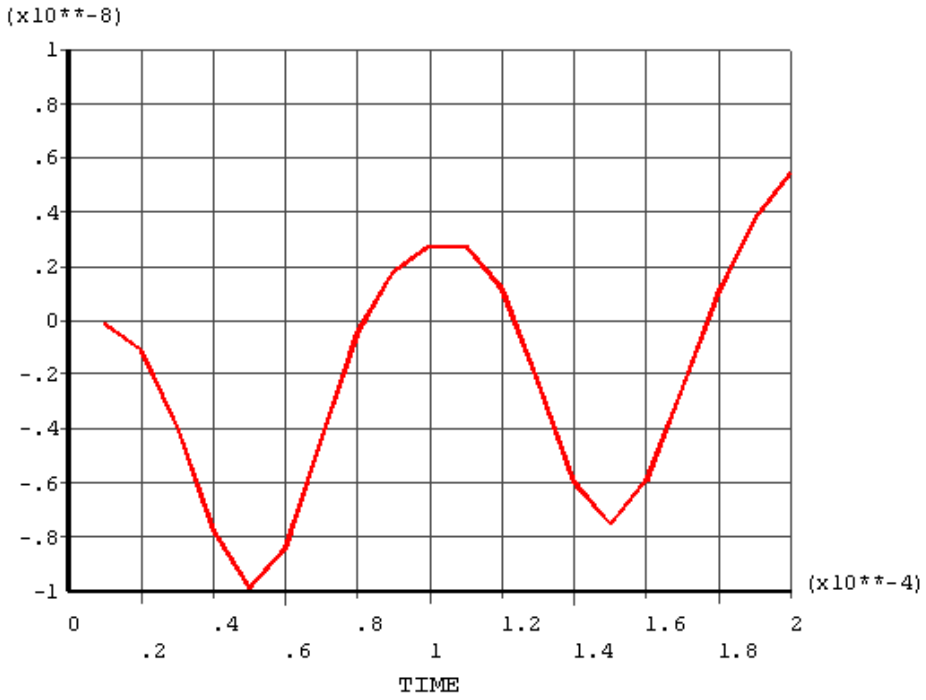
Sinusoidal current (I_{rms}=7500[A], f=50[Hz])



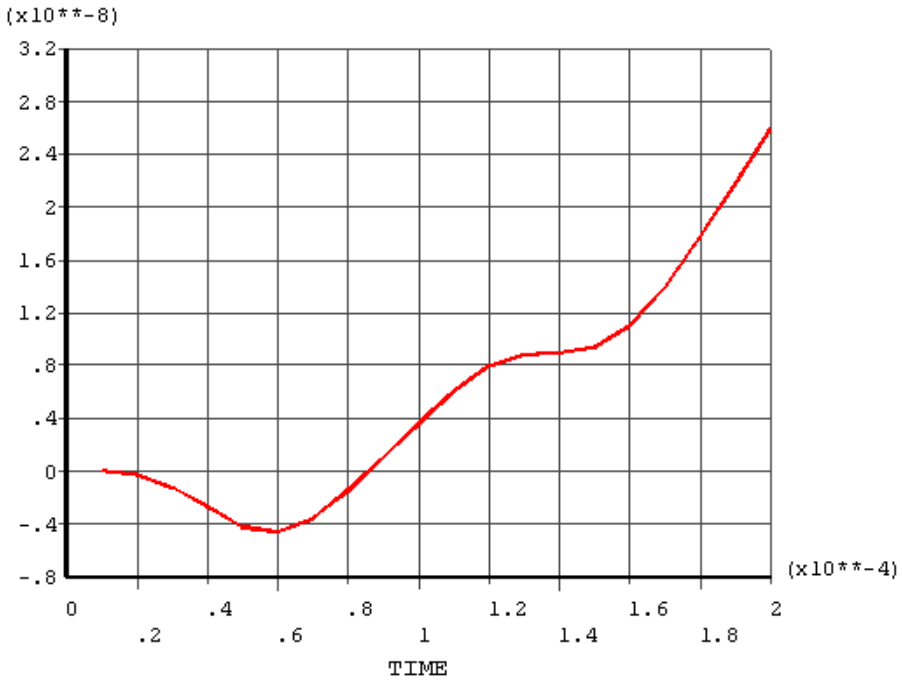
Horn structural results

Sinusoidal current (I_{rms}=7500[A], f=50[Hz])

Radial Displacement [m]

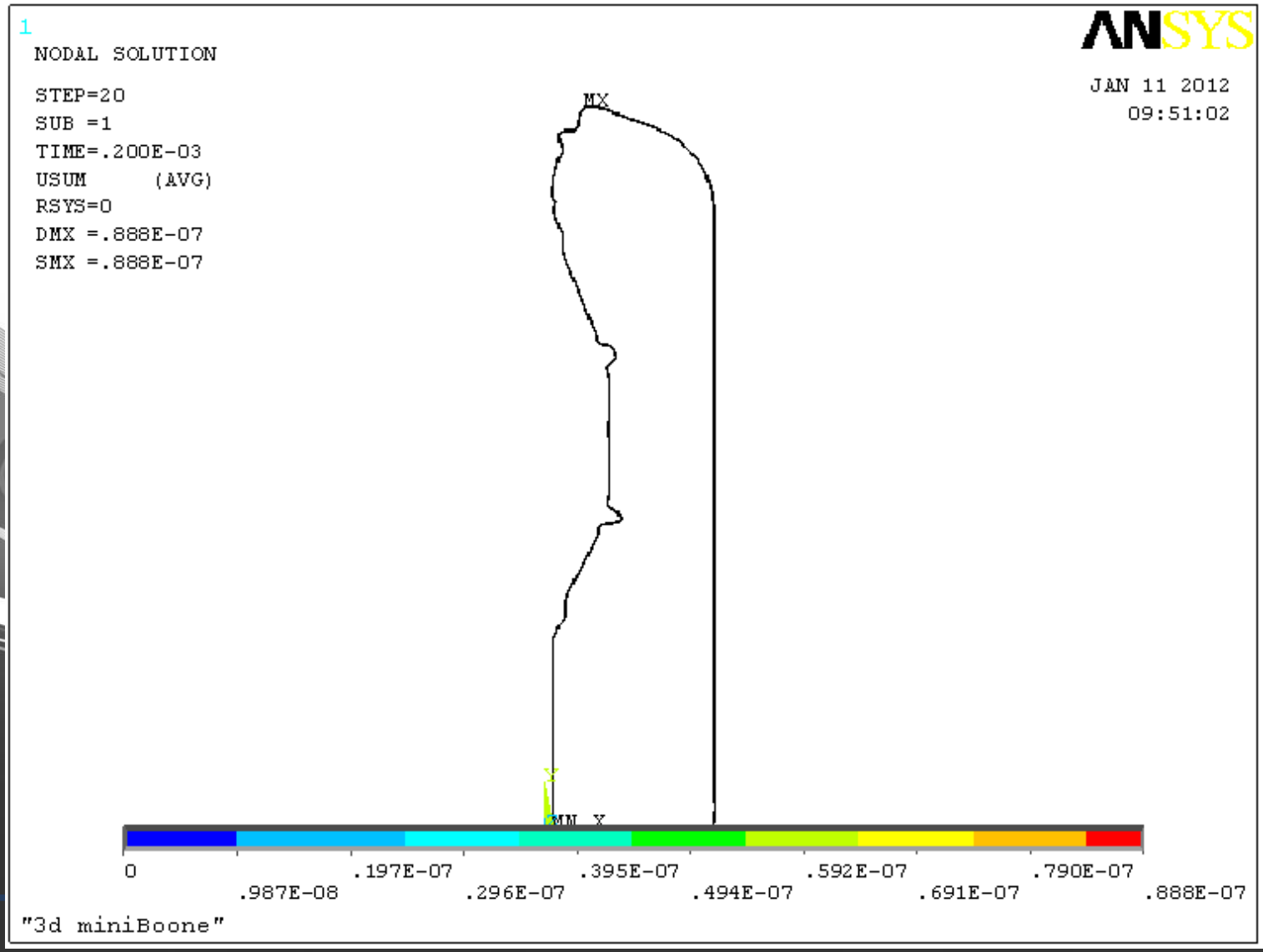


Longitudinal Displacement [m]



Horn displacements [m]

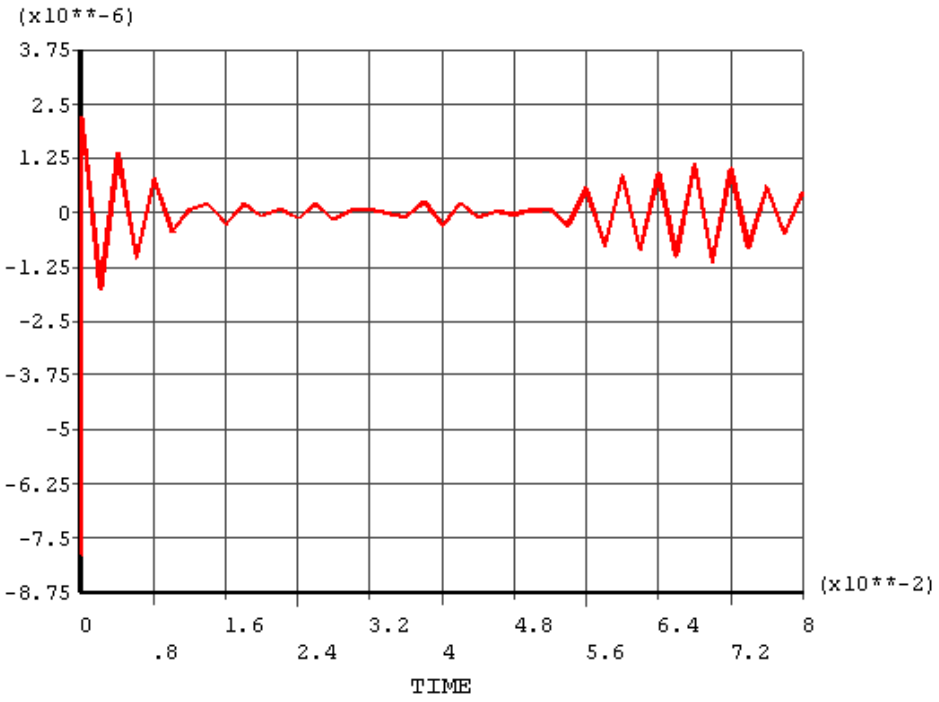
Sinusoidal current (I_{rms}=7500[A], f=50[Hz])



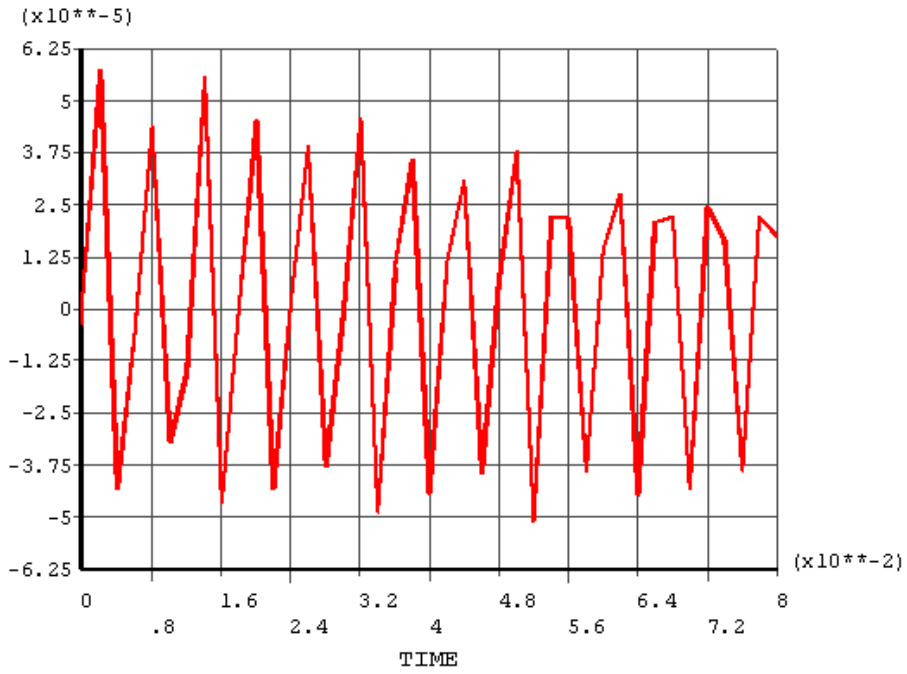
Horn structural results

Impulse current (I_{max}=300[kA])

Radial Displacement [m]

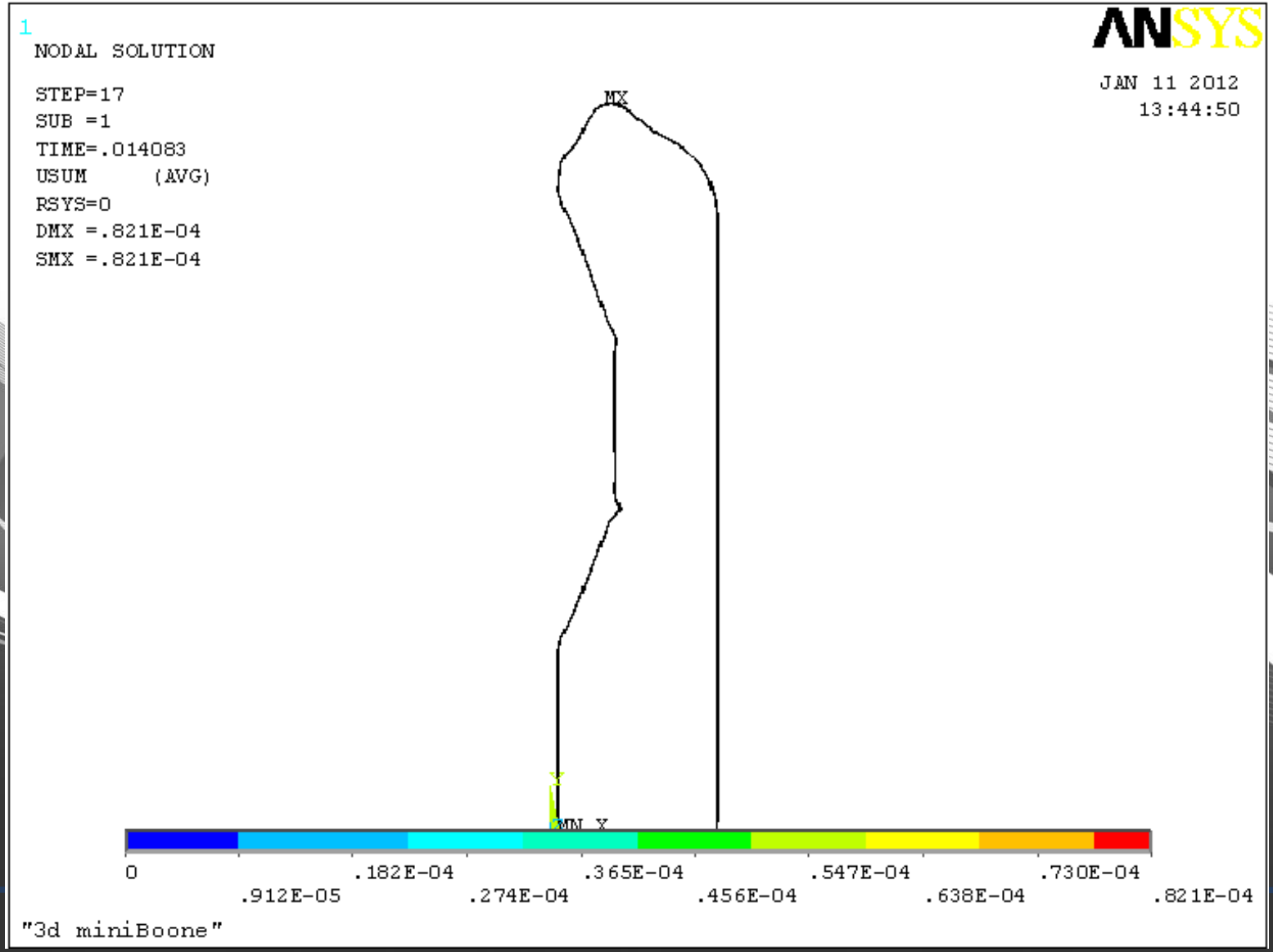


Longitudinal Displacement [m]



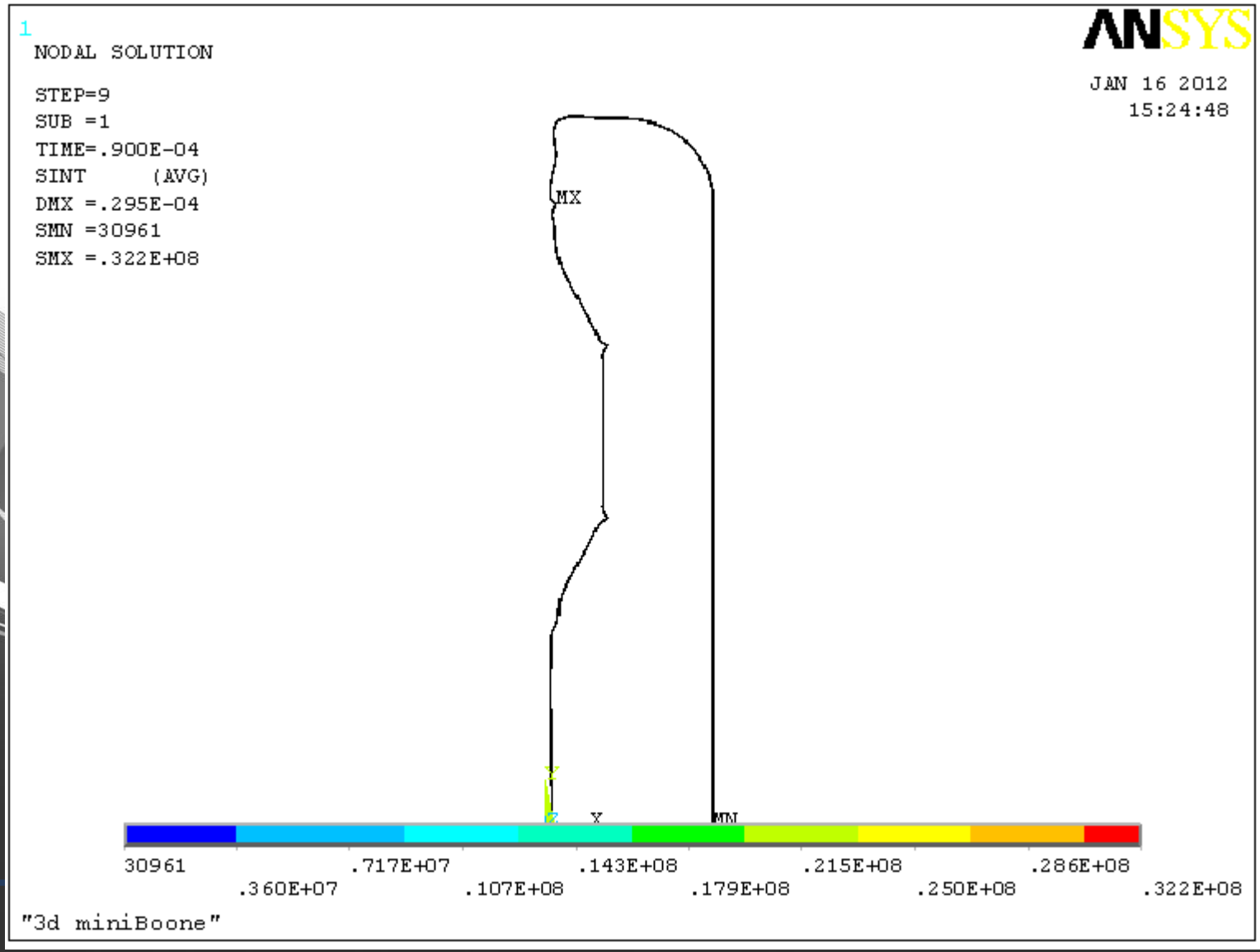
Horn displacements [m]

Impulse current (I_{max}=300[kA])



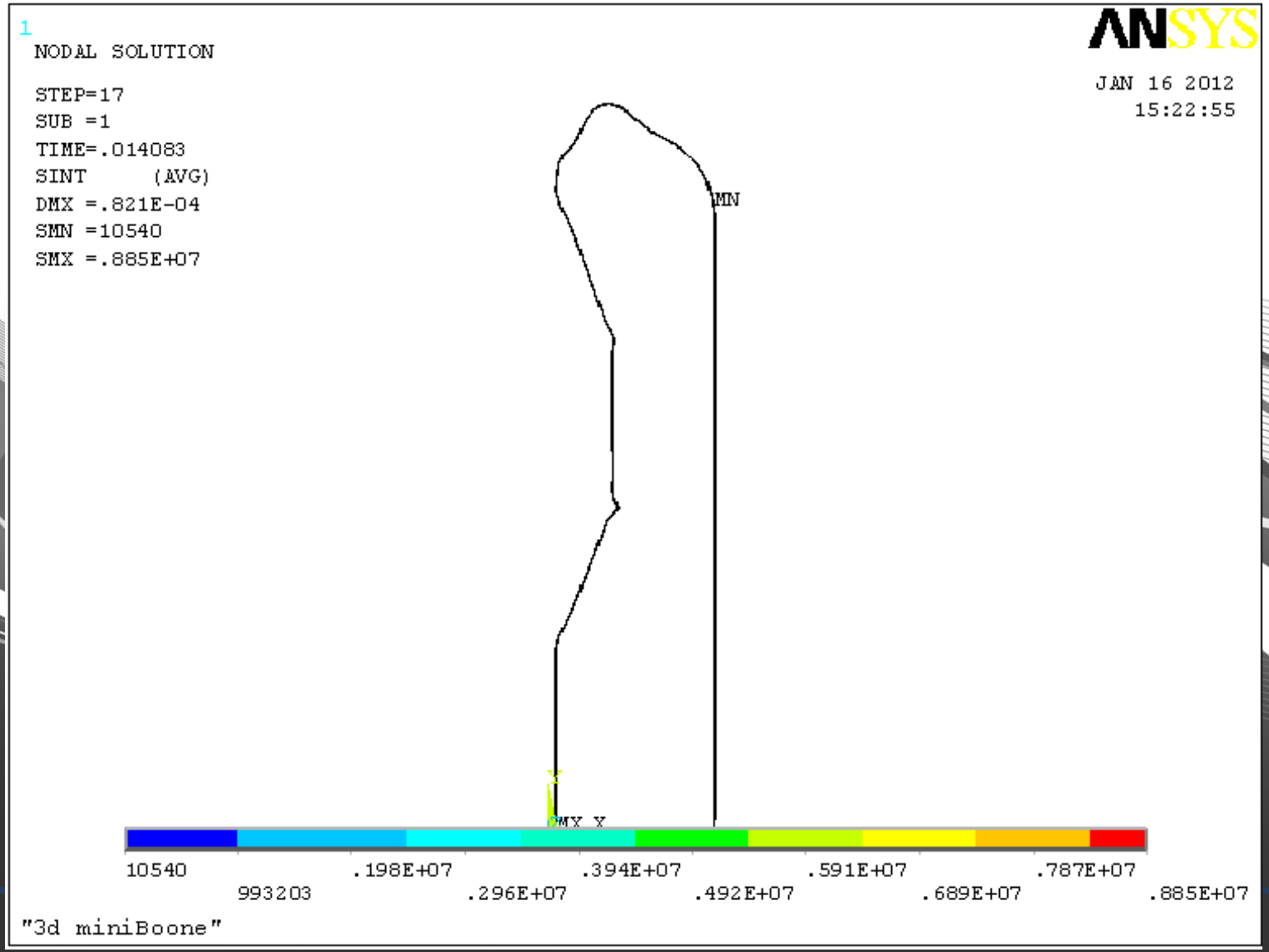
Horn stress intensity [MPa]

Impulse current (I_{max}=300[kA])



Horn stress intensity [MPa]

Impulse current (I_{max}=300[kA])



Conclusion

A complete magneto-solid dynamic analysis of a single horn was performed, that includes the calculation of the distribution of the current density across the cylinder, which takes into account the skin effect, the calculation of the magnetic field and the mechanical response due to mechanical forces.

This analysis extends the previous study, in which the kinetic forces were defined as pressures.

An axisymmetric case was studied by modelling a wedge, with the symmetry boundary conditions on its size. The analysis of full structure requires much more computation time.

The general stress levels are in good agreement with previous studies done by Piotr Cupial.